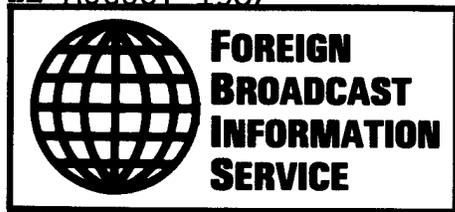


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# ***JPRS Report***

# **Science & Technology**

***Europe & Latin America***

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SCIENCE & TECHNOLOGY  
EUROPE & LATIN AMERICA

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ITALIAN SPACE DIRECTOR: SOVIET LAUNCH OF ITALSAT POSSIBLE

Rome PTT & TLC in Italian Jan 87 pp 51-55

[Interview with Professor Luciano Guerriero, National Space Plan director, by Antonio Bruno: "An Ariane for ITALSAT"]

[Text] In 1987, we will spend 800 billion for space activities. ITALSAT-2 will be a reality soon. Italian modules for the U.S.A. Space Station.

Another year has ended in the field of space activities, offering us moving moments such as, for example, the Voyager undertaking which, as it approached Uranus, sent us "live" the suggestive images of the planet and its moons. Or the close-in meeting of the European Giotto probe with the comet Halley. But 1986 was also the year of the Challenger tragedy and its heroic crew.

1986 undoubtedly was a year full of events in the field of space activities which revived the interest of public opinion in space projects that called for ever heavier investments in human, technological, and financial terms. As we know, Italy is also actively participating in this great technological, scientific, and industrial undertaking which we call the exploration and conquest of the "fourth environment."

Professor Luciano Guerriero, director of the PSN (National Space Plan) talked to us about Italian space activities; in the course of this interview, which was given specifically for the readers of POSTE E TELECOMUNICAZIONI, he offers us an overview of progress being made in the various programs included in the PSN as well as the future prospects opening up for Italy in the space field at the European and international levels in terms of Italy's possible direct participation in the American Space Station program.

[Question] Professor Guerriero, 1986 was a year full of events in the area of space activities: The Voyager undertaking, the meeting of the Giotto probe with Halley, but it was also the year of the Challenger disaster. This tragedy not only stopped all space activities of NASA but also those of various nations that were planning to use the Shuttle for launching their satellites. We would like you to tell us what effect the Shuttle disaster had on the Italian space programs.

[Answer] I would like to say first of all that, following the Challenger tragedy, we regretfully had to acknowledge the poor management of NASA which was unmistakably brought to light by the well-known Rogers report. Above all as regards shortcomings and responsibilities connected with the challenger disaster which could have been avoided.

When I thought about this great tragedy for the first time, I ruled out the possibility that NASA could have been responsible for what happened since I am quite familiar with the safety criteria adopted by NASA. But, as I said, in the light of the Rogers report, I had to take another look at the situation because the document shows that the structural weaknesses of the space ship were well known at the various responsibility levels of NASA.

To answer your question, the challenger tragedy obviously postponed Shuttle launches to 1988 thus forcing NASA to reschedule all the missions which had already been planned earlier.

As a result of the rescheduling of the Shuttle missions, many programs were thus postponed or simply dropped; I am talking here primarily about those missions which called for the transportation and orbiting of commercial satellites, such as, for example, those intended for space telecommunications.

As regards more specifically the Italian space programs, these are not heavily penalized by this new rescheduling of the Shuttle launches. For example, the Tethered, whose launch was planned for 1988, has been rescheduled by NASA for the second half of 1990.

As regards ITALSAT, the national satellite intended for domestic telecommunications will be launched with the European Ariane booster in connection with which negotiations are now in progress concerning the definition and drafting of the contract with Arianespace.

To that end, we had conducted lengthy negotiations with NASA--prior to the challenger tragedy--to develop a launch assumption of ITALSAT with the Shuttle since the Italian satellites are bicompatible with the two space transportation systems.

However, looking at the current state of affairs, the NASA offer for the launching of ITALSAT is no longer operative in view of the events connected with the Challenger tragedy.

[Question] How much will it cost to launch ITALSAT with Ariane?

[Answer] First of all, we have to distinguish the launch as such from the launch program. In particular, the estimated cost of launching ITALSAT with Ariane--which was recently brought to the attention of the CIPE [Interministerial Committee for Economic Planning]--is 107 billion lire. This amount includes the cost of the launcher, of the insurance, and the entire launch procedure. Viceversa, the NASA offer implied a saving of about 20 billion as against the 107 billion for the launch of ITALSAT with the European vehicle; but, quite apart from purely economic consideration, there is a compensation factor here of a political and industrial nature which led to the choice of having ITALSAT launched with Ariane.

This choice, as I said, in addition to being made for considerations of a political-industrial nature, also springs from technical assessments since a launch made with Ariane saves fuel, during the phase of placing the satellite in a stationary earth orbit, thus increasing its operational lifetime by 2 years.

ITALSAT was originally designed as a pre-operational satellite but is now moving toward becoming an operational satellite for the so-called fast digital telecommunications network; we recently had a request for building an ITALSAT-2 so as to be able to put together an operational segment covering our entire national territory.

[Question] Professor, do you anticipate that the ITALSAT-1 engineering cabin will be used for ITALSAT-2?

[Answer] Yes, I think so, since we certainly want to promote the construction of another ITALSAT with maximum urgency so as to offer the country--by the start of the decade of the 1990's two telecommunications satellites which will be integrated into the future digital communication network.

[Question] During the recent work of the IAF, the Soviets expressed their specific interest in launching ITALSAT with their Proton vehicle. Is their any truth, Professor Guerriero, in these statements that were released by officials of Glavkosmos?

[Answer] I must tell you that right now there is no contact with the Soviets as regards a possible launch of ITALSAT with Proton but it is clear that we must keep in mind the evolution of the real situation at this time in the field of space transportation systems. For example, the Chinese are offering their "Long March" launcher at very convenient prices. However, we cannot talk in terms of commercial negotiations either with the Soviets or with the Chinese through the PSN; but, as I said, we have been negotiating with Arianespace and we agreed on costs and standards that will obviously govern the choice of Arianespace in the light of certain advantages deriving from the fact that Italy is one of the member countries of the ESA.

[Question] When do you anticipate that ITALSAT will be launched with Ariane?

[Answer] The agreement with Arianespace calls for the satellite to be launched starting in the second half of 1989; indeed, the delivery of the satellite is scheduled for 1988, except for unforeseen developments.

[Question] What could happen if Arianespace cannot meet the costs or the launch times of ITALSAT?

[Answer] It is obvious that in this unfortunate case we would have to see what we can do with other suppliers of automatic space transportation systems. I am thinking here of the private American carriers that are selling their disposable vehicles, such as the Delta and the Titan missiles.

## ITALSAT Not the Only but One of Several CNR Space Programs

[Question] Professor Guerriero, so far we have been talking about ITALSAT, in other words, the most demanding program of the PSN from the financial and also from the technological aspects; but the space plan also calls for other important and interesting programs, such as Tethered, Lageos, Iris and SAX. What is the state of the art as far as these programs are concerned?

[Answer] The year 1986 represents an advance for the National Space Plan into activities because, as I said earlier, the programs are in the midst of their practical implementation phase in spite of the difficulties encountered in managing such a vast space program with inadequate facilities and with rules of the game which, as regards the contract and decision-making aspects, are inadequate for space activities that are supposed to be dynamic.

We did manage to get important programs into the space plan which did call and will continue to call for investments by the hundreds of billions. But all of this necessarily involved a major organizational effort on the part of the CNR; parallel to this, it also required a great act of faith on the part of the nation's industry in this sector.

In substance, we asked industry to invest in men, means, and structures without being able to give industry a guarantee that the programs provided for under the PSN would be completed.

In spite of these difficulties--which are also due to the rigid rules governing the parastate sector--we have been making progress and we have achieved excellent results. The year 1986 therefore closes with an extremely positive balance for the PSN. We can say that the industrial commitment of ITALSAT, as I said before, calls for the delivery of the satellite by the end of 1988. In the meantime, we have introduced the requirement of building an ITALSAT-2 for the next updating of the plan which will have to be approved by CIPE.

The delivery of the launch vehicle by 1988 has also been planned for the IRIS program and the same has been said for the scientific satellites, the Tethered and the SAX.

[Question] As we know, Professor Guerriero, in addition to the programs being carried out within the PSN, Italy is also actively involved in space programs that are being carried out in the framework of the ESA, including the Columbus program which is of the utmost importance here. What, in your opinion, might be a possible commitment of the PSN in the context of this prestigious European space program?

[Answer] To be able to answer your question, I must first of all say something about Italy's basic decisions in the field of space activities at the European and international levels; the PSN always insisted on the importance of a significant and decisive Italian commitment both as regards the Ariane program and Columbus. In the meantime, as regards the contribution of the PSN to the Columbus program, I must say that we do not have freedom of initiative at this time because, as everybody knows, we have been called upon to carry out a space plan according to the program outlines drawn up by the CIPE.

However, in the updating of the space plan we introduced all of the variants to be able to support the Columbus program.

Right now, on the basis of a specific assignment from Minister Granelli, our team of engineers and experts is working in Germany with DFVLR [German Aviation and Space Experimental Institute] to develop a technical analysis so as to evaluate the operability utilization of the Columbus system in which Italy intends to participate with its own, high-level contribution.

This already is a highly important fact because PSN for the first time is acting as the technical arm of the Scientific Research Ministry which goes beyond the original motivations that gave rise to the PSN.

In particular, as we look at the PSN, in addition to the Italian commitment at the ESA level, concerning the Columbus program, there is also a significant bilateral relationship between Italy and the United States as regards a capable Italian presence in the Space Station program of NASA.

The fact is that the bilateral relationship with NASA generates new technological capacities for the Italian space industry which enable it to work side by side with American industry, thus playing a partnership role as it happening, for example, with the Tethered and Hageos II programs.

This is a significant result and we therefore intend to expand this possible cooperation between Italy and the United States through other bilateral programs. This is why we submitted, under the PSN, an assumption to NASA as to our direct and bilateral contribution to the Space Station program.

#### Italian Contribution to European and NATO Space Programs

[Question] How did NASA officials receive the Italian proposal for joining the space station program?

[Answer] With extreme interest, I would say, since NASA suggested to us that we work in a sector in which the Italian contribution could certainly be developed successfully.

In substance, the possible Italian participation can take the shape of supplying NASA with logistic modules or the logistic system, that is to say, the entire operational part covering the shuttle movement between the earth and the Space Station.

All of this is certainly a significant segment as regards the operational life of the Space Station. Italy could thus participate in this great space undertaking by supplying pressurized modules which would have to have highly advanced characteristics as compared to Spacelab and the Columbus module.

Naturally, we should have come out with this idea a year ago but we thought, by common agreement with Minister Granelli, and also with NASA, that we should not anticipate the time frame with respect to the conclusion of the ESA-NASA accord regarding European participation in the space station program.

We did as a matter of fact a short time ago inform ESA that we were interested in developing a bilateral relationship with NASA for Italian participation in the Space Station program.

In this connection, in the context of the fund allocations anticipated for the next 5-year term for the space plan, we also included some final figures in order to put this bilateral relationship together with NASA so that Italy may play its own role in the Space Station program.

[Question] Professor Guerriero, would you please tell us just exactly where the government proposal for the establishment of the Italian Space Agency now stands?

[Answer] As you know, the administration proposal, which is paralleled by a similar communist proposal, is now in the final phase in the Center. And was to have been passed by that constitutional body last November.

[Question] Professor, do you think that the ASI [Italian Space Agency] will in the end solve all of the problems of a legal-administrative nature, problems of strategic planning for Italian space activities, as well as all of the problems concerning personnel currently working for the PSN?

[Answer] I do not deny that we have some serious elements of confusion here in this respect, such as the way we would fit ASI personnel into our civil service establishment where pay scales certainly are not very competitive as compared to those in private industry; now, this confronts us with quite a few difficulties when it comes to getting and holding on to highly skilled personnel for the ASI.

Besides, it is a fact that high professional skills are an indispensable requirement for managing and coordinating a space program of vast dimensions.

Let us not forget that the updating of the PSN for the next 5-year term, which was submitted to the CIPE for approval, calls for spending 400 billion in 1987 and the same amount will be needed for Italy's commitment within ESA.

I therefore think that a space agency, which must handle 800 billion lire per year, must necessarily have highly skilled personnel also in order to be able to play the role of intelligent "client" in dealing with the nation's industry.

[Question] Professor Guerriero, before finishing our chat on Italian space activities, I believe that we ought to talk a moment about the possibilities that Italy might also get its own team of specialist astronauts. What do you think about that?

[Answer] The presence of man in space is certainly fundamental but it will come where his presence is strictly necessary.

It was not by chance that, following the Challenger disaster, there has been a substantial change in the atmosphere of great optimism where, according to some people, going into space was like taking an air taxi.

I therefore think that only specialists who are competent in the particular scientific or technological topic areas should go into space and those are the people who are going to be in demand for the future Shuttle or space station missions.

Now, as regards the possibility of establishing a group of Italian astronauts, it would be necessary to demonstrate their usefulness.

For example, the Tethered program calls for employing an Italian astronaut specialist who would work side by side with the Americans on board the Shuttle but this is certainly not a pleasure trip, nor is it a big show because man is working in space at the very boundary of the technological frontier which we have today and the Challenger tragedy reminded us of that in a sad fashion.

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CSO: 3698/558

## EUREKA MULTIMEDIA OPEN SYSTEM STANDARD DESCRIBED

Paris ENJEUX in French No 79 Apr 87 pp 65-67

[Article by Francois Michel, general manager, and Bernard Bastie, executive director of GIE Bull-Copernique "Archimede:" "EUREKA's MOSES Project (Multimedia Open System European Standard)"]

[Text] The MOSES (Multimedia Open System European Standard) project was developed by Bull, Copernique and ICL, and approved at a EUREKA interministerial meeting held in June 1986. Bull and Copernique have created a GIE [Economic Interest Group] named ARCHIMEDE (European multi-MEDIA ARCHItecture) to act as ICL's partner in the project.

#### Project Objectives

Up until now, computer-based systems have specialized in handling the most repetitive and routine business tasks such as keeping accounts, payroll, process controls, scientific computation, etc..

The techniques currently being used were designed to process numeric and alphanumeric data and, more recently, words. This kind of data processing is termed "structured data processing."

At the present time, we have to come to grips with the innovations offered by the integration of unstructured data using new media such as images and voice. We will use the term "multimedia system" to indicate all the equipment necessary to manipulate and process both the new unstructured data and conventional alphanumeric data.

The major feature of these systems is the full integration of the structured and unstructured data manipulation at each stage of the data processing operation (from the workstation to the database and the host computer). This integration involves mixing data such as photographs, technical drawings, signature facsimiles, patterns, and so on with alphanumeric databases.

Integration will have an effect on all the equipment used because of the need to have a highly interactive structure, that is, a multimedia message processor between the workstation, the database and the host computer. This message processor will make it possible to create, retrieve, and process various kinds of alphanumeric and unstructured data, starting from the

workstation.

The three companies involved in the project have decided to develop and produce multimedia open systems that will involve the development of a new generation of multimedia database servers with integrated multimedia in all the equipment (hosts, workstations, specialized peripheral equipment such as scanners and optical disks) and the associated message processors.

The project will also include a preliminary study on further integration of artificial intelligence processors, intended to pave the way for new forms of data processing between now and 1990.

#### Market and Competition

Large multimedia systems form part of the market for systems that include databases and workstations. This market is experiencing tremendous growth and is surging ahead in spite of the current crisis in the American computer market. Today, no one is able to propose a multimedia system truly comparable to the one we intend to develop.

The types of applications possible with multimedia systems are the following:

- Decisionmaking aids (data center applications);
- Computer-aided manufacturing;
- Applications in the health and teaching sectors;
- Correspondence management;
- Electronic mail.

The competitive advantages of the multimedia system are:

- Highly efficient access to relational databases using the SQL interface standard. The specialized architecture of the multimedia system will offer advantages in terms of performance over conventional system architectures;
- Simultaneous support for relational and navigational access into the database. This option is not currently offered by manufacturers, although it is necessary for applications such as production management and terminology management;
- Support for structured and unstructured multimedia data in applications involving text, vectored or scanned images, voice, etc..

There is a growing demand for multimedia data support in applications for office automation, manufacturing, etc.. Manufacturers currently do not offer all these functions. Multimedia data support, combining both navigational and relational access, as well as free-text data retrieval, represents a considerable competitive advantage in that it offers the following possibilities:

- A user-friendly integrated system that includes support for both the user interface and for general-purpose applications such as office automation, using personal computers and workstations connected to

the multimedia operating system;

--Modular growth to meet user needs concerning expansion of the system, for example, to increase the size of the database, the number of end users in the system, etc.;

--Flexibility, offering a choice in the association of servers to workstations to meet the needs of the various types of users.

## Technical Features

### Architecture

The multimedia system will comprise multimedia servers and workstations connected to a local network. The multimedia data and object server will exchange information with the host computer (large central processing units, and minicomputers).

### Multimedia Server

The multimedia server comprises the following logic components:

--A secondary database;

--A primary database.

Multimedia primary objects include images, drawings, and voice. The size of these objects varies greatly and may be considerable. These objects are stored on a physical support such as a magnetic or optical disk.

Secondary databases are used to identify and retrieve primary objects. Structured user data are stored in the secondary database.

The system uses European industrial standards such as OSI, ODA, and X-Open.

The documents (images, production files, drawings, and maps selected by specific commands may be displayed sequentially or by proximity in a given sector.

### Multimedia Printing System

The multimedia printing system will print documents originating in the servers or workstations. In general, it will be a high-speed printer capable of printing all types of documents.

### Multimedia Workstations

#### Types of Workstations

Workstations at the lower end of the scale will be based on the MSDOS standard. Workstations at the higher end will be based on UNIX or X-Open

standards. Low-level workstations can be connected to the local network through a cluster controller, while high-level workstations are connected directly to the local network.

### Man-Machine Interface

The interface will be designed to make the system user-friendly for non-expert computer users. The quality of this interface is considered a key factor for the success of MOSES.

The interface will be based on a graphic toolbox comprising devices such as icons, menus, and windows. Icons will be used to represent objects (for instance, a document mode) and the menu commands (for instance, a hand to indicate leafing through a document). The menus are non-exhaustive command lists and each menu comprises a limited number of commands. If a command is complex, it can generate another menu. The menus are of the pop-up kind, which means that they appear only when in use and disappear when files have been seen. The data are contained in windows, and several windows may be visualized simultaneously on the screen. The window offers a physical view of the space for data. It can be moved in all directions (using scrolling commands) to visualize additional information. Windows may overlap to optimize the screen's physical space. Certain windows are reserved for the system itself. User assistance and information messages, for instance, are posted in special windows. The feature window is another device provided to allow the user to visualize the attributes of the posted object (in the case of a paragraph, for example, all justification values, the types of character being used, and other information will be available). This capability is extremely useful because it makes the user aware of all the features available with the window showing their type and coding.

Two language interpreters are provided, one for reference, and the other for creation. The first one interprets the different requests for selection or updating and transforms them into internal queries which are accepted by the database management system. The second one allows the user to use basic objects either scanned or typed on a keyboard to create more complex objects corresponding to a particular conceptual model (for example, books or cards).

Access to a multimedia system comprising a large variety of subjects (maps, handbooks, books, encyclopedias, and public information) and containing a vast quantity of data, requires an extremely well designed man-machine interface. This user-friendly interface must offer both high performance and efficiency. The primary objective of the MOSES project is to make the multimedia electronic documentation system much more powerful than its paper counterpart. To achieve this objective, we must create a data model containing a large amount of semantic information and a man-machine interface which, with its user-friendly features, shows all the links between the objects constituting the documents as well as the structured representation of the entire database.

Considerable research is necessary at the present time to construct such an interface. The present trend is to produce interface extensions of the QBE (Query By Example) type, and to include more semantics in the data model; queries are expressed in the form of tables to be filled out.

Another trend is to process natural languages (NLP). SDMS (Spatial Data Management Systems) have been proposed to access large databases with screen display of icons and conceptual models.

"Basic" filters and "access plans" will be provided. Filters will be presented as forms to be filled out by the user with values or value intervals. Access plans will allow the user to chart his way inside the base, beginning with a graphic representation of the document components and their interconnection.

#### Description of a Workstation

A workstation may comprise the following elements:

- Black-and-white or color screen with a bit map and window operation ("raster op");
- Mouse;
- Small document scanner;
- Document printer;
- Voice recognition and synthesis device.

#### Document Scanner

The document scanner is a shared resource used to scan large books.

#### Slide Scanner

This device scans slides loaded on a carousel. It ensures compression of the scanned image and the creation of pages consisting of text and images.

#### Connection to a Host Computer

A host computer can communicate with the multimedia server through high-speed connections. It performs the following functions:

- File transfers;
- Access to services offered by the server;
- Support for specific multimedia applications based on services offered by the server and described in the paragraph entitled Market and Competition.

#### Conclusion

The MOSES project is an "open" project from the following two viewpoints:

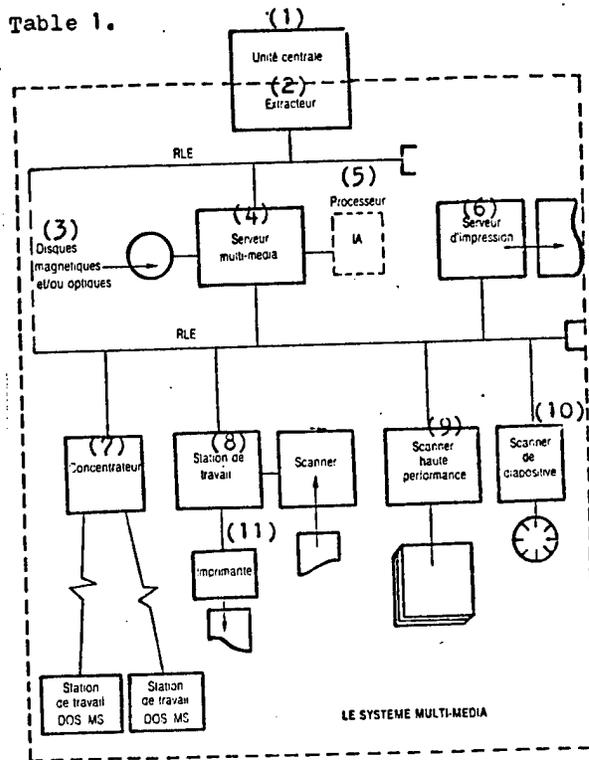
- The architecture used;

--The possibility offered to other companies to become "associate partners" in MOSES.

MOSES opens up extremely interesting possibilities for European industry at a time when technological innovation is leading to very important changes in the supply of computer-based systems and, consequently, to changes in the nature of the competition.

[Please see next page for table]

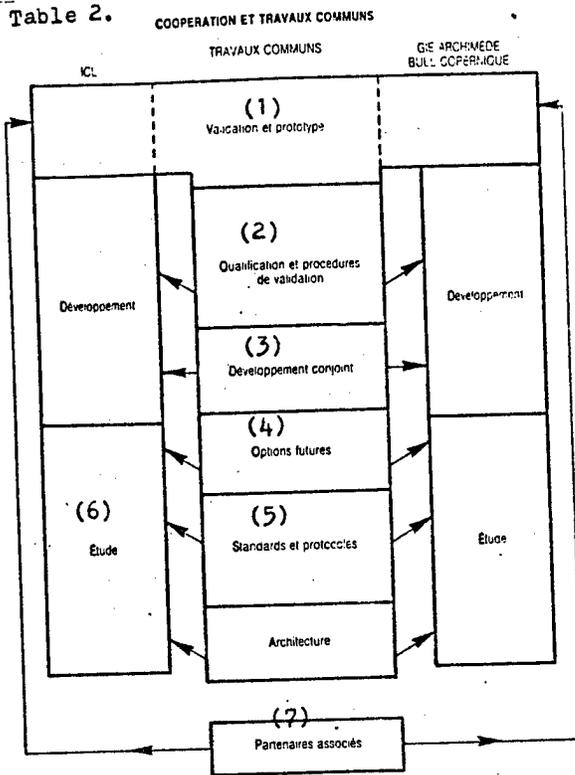
Table 1. The Multimedia System



Key:

1. Central processing unit
2. Retrieval system
3. Magnetic and/or optical disks
4. Multimedia server
5. Processor
6. Printing system
7. Concentrator
8. Workstation
9. High-efficiency scanner
10. Slide scanner
11. Printer

Table 2. Cooperation and Joint Tasks



Key:

1. Validation and production of the prototype
2. Feature definition and validation procedures
3. Joint development
4. Future options
5. Standards and protocols
6. Study
7. Associate partners

8615

CSO: 3698/M286

## BRIEFS

OLIVETTI/EDS JOINT VENTURE--Olivetti and EDS (Electronic Data Systems) established ISM (Integrated Systems Management), a joint venture which will operate in the systems integration field. The new company's initial objective will be to operate first of all in Italy and then in Europe in connection with the data processing projects of big establishments. Elserino Piol, Olivetti general manager for strategies and development, said the following in commenting on this agreement: "Olivetti, with its broad hold on world markets and its vast range of products, and EDS, with its reputation and vast experience in managing big projects and communications networks, will provide a complete response to the emerging request for systems integration." EDS (45,000 employees in 23 countries) specializes in the integration of big systems and the management of computer centers and has its own global telecommunications network. [Text] [Milan ELETTRONICA OGGI in Italian Apr 87 p 22] 5058

CSO: 3698/558

## FRG ROBOT BASE EXPANDING

Paris L'USINE NOUVELLE in French 26 Mar 87 p 22

[Article by Gerard Larpent, special correspondent: "Germany Outstripping France: German Manufacturers Have Increased Their Lead Thanks To Federal Government Aid"]

[Text] In 1986 alone, German industry purchased 3,600 robots, or the equivalent of the entire French robot base. With a total of 12,400 robots, Germany represents a third of the European robotics market; its robot base is almost half that of the United States (26,000 robots).

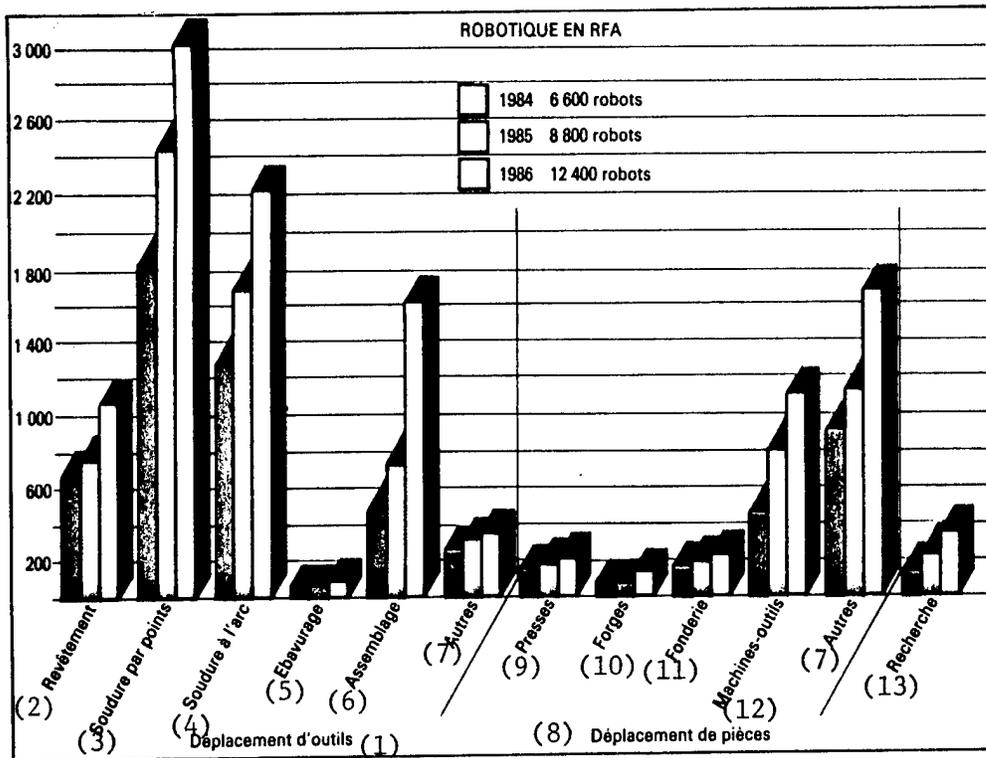
These figures, published by Stuttgart's IPA [Institute for Production and Automation] institute, show how much the gap between France and Germany widened last year: Despite notable efforts by PSA [Peugeot S.A.] and Renault, the leading robot consumers, German manufacturers have increased their lead. While welding remains the best-equipped sector [in Germany], others such as assembly or part handling for machining have made spectacular progress.

Federal government aid provided last year for a program to equip small- and medium-sized manufacturers with robots has spurred market growth and aided the development of manufacturers.

Thus, 120 firms now produce robots. Although Sweden's Asea ranks among the six producers supplying 80 percent of the market (including Kuka, Reis, and Volkswagen), imports account for only 33 percent of the robots installed in Germany.

"Our response to foreign competitors, particularly the Japanese, is to produce more sophisticated robots," explains Klaus Baumeister, head of IPA's automation department. Institutes such as the IPA, the IPK in Berlin, and the WZL in Aachen have thus contributed significantly to robot penetration in the German automobile and machine tool industries. "Over the next 5 years, we plan to study new technologies for clean rooms," Klaus Baumeister points out.

FRG Robot Base. The pace of equipment acquisition accelerated sharply in 1986.



Key:

- |                      |                        |
|----------------------|------------------------|
| 1. Handling of tools | 8. Handling of objects |
| 2. Coating           | 9. Presses             |
| 3. Spot welding      | 10. Forges             |
| 4. Arc welding       | 11. Foundry            |
| 5. Deburring         | 12. Machine tools      |
| 6. Assembly          | 13. Research           |
| 7. Other             |                        |

25046/9604  
CSO: 3698/A207

## ESPRIT AI PROGRAM FOR PRODUCTION MANAGEMENT EVALUATED

Paris ZERO UN INFORMATIQUE in French 6 Apr 87 p 16

[Article by Isabelle Grosse: "AI Integration in Manufacturing"]

[Text] ESPRIT 932 is part of a large-scale program which aims at improving plant flexibility and reducing execution times, inventory costs and production cost per unit. It involves the largest integration of expert systems in manufacturing processes.

ESPRIT 932 represents 139 man-years and 15 million ECU's over a period of 4 years. The project began a little over a year ago in January 1986. Official fact finders and experts, who met in mid-March to discuss its progress, expressed their satisfaction.

France, the UK, Italy, and the FRG are the four EEC countries participating in this project. Philips provides the main industrial thrust, together with SGN [General Company for New Technologies] (France), Pirelli (Italy), and BICC [British Insulated Callender's Cables Ltd] (UK). The goal of ESPRIT 932 is to develop software tools to reduce the gap between production planning and installation of industrial units.

Different methods have been selected to implement this production monitoring aid system.

They come together as follows:

- SADT [structured analysis and design technique], which allows standardized modeling, structuring, and ordering of information;
- GRAI, which produces a system model for decisionmaking;
- NBS, which adapts to the specific functions of firm.

With the GRAI method, the concepts of targets and planning period are included in the description of each activity (see box).

Using this methodological template, expert systems are to be integrated at different levels. Each expert system is dedicated to performing a task in detail. Planning, diagnostic, and interpretational functions can thus be handled.

## A User Interface for Organizing Knowledge

To this end, a knowledge acquisition module is currently being studied by AI specialists from Italian universities. It involves creating a user interface which allows the user to organize and model knowledge.

Why have AI technologies been preferred over conventional programming modes? An initial answer is that AI methods allow the processing of very different types of information, as is the case in production management. Further, the types of processing operations to be executed are reflected by numerous problems resolved using expert systems (diagnostics, interpretation, training).

There are thus two approaches to the problem: One which is downward and handles production planning as a whole, without going into the details of functions, the other which, inversely, performs these tasks. Three factories have so far been the object of field studies: the Philips car radio facility in Wetzlar, the Pirelli tire factory in Turin, and the BICC cable factory in London. Using these industrial environments, analyses have been made of the decisionmaking networks for planning and controlling production.

The results of these analyses have been used to develop simulation systems which have proven useful in optimizing the rate and reliability of production.

[Box]

## GRAI: A Method for Production Management Assistance

The GRAI method is applicable to production management systems. It is one of the series of approaches based on systems analysis, the best known of which is the Merise method. This method is based on the idea that any production system can be broken down into three subsystems: hardware, data, and decisionmaking. The last, together with components of the other two subsystems, constitutes the method's field of application.

The decisionmaking system is divided according to two criteria: a temporal one, based on an activity's planning period and implementation target, and a second one bearing on the functional aspects of decisionmaking. The planning period is defined as the cycle of reviewing the goals of an activity while the implementation target represents the time interval during which results of an activity can be achieved. The tools of the GRAI method, grid and network, stem directly from this division. The grid is nothing more than a table in which decisions are plotted by function in a single column and by level in a single line. A level consists of the data of planning period and implementation target. The GRAI network provides a graphic representation of the relations and links between activities. On this diagram, decisionmaking and execution activities are identified.

The advantage of such a model is that it produces a representation mode combined with upward analysis. This gives a synthesized view including all the elements of the control system. The stage following analysis consists in highlighting dysfunctions based on the decisionmaking grids.

The applications of the GRAI method range from analyzing existing industrial systems to designing new ones: production diagnostics for industrial companies, improvement of control systems, development of master plans and establishing specifications for automating control procedures.

25060/12951

CSO: 3698/A212

## BRIEFS

ITALY'S CNR TO RESEARCH ROBOTICS--The new ""Robotica" project of the CNR [National Research Council], which has now been finalized, calls for an investment of about 70 billion over the next 5 years to which will be added at least another 17 allocated by the various industries. The research lines include the following: Mechanical components; programing systems; artificial intelligence techniques with expert support systems for users and with the employment of advanced VLSI technologies; development of vision sensors and tactile sensors; integration of robots into production systems. Plans also call for the award of 140 study scholarships for advanced personnel training. Last year, the more than 50 Italian producers--in 1984, there were 42 of them --had a billing volume of about 110 billion lire and the domestic market keeps growing along with the world market at rates of 20 percent per year. In the auto industry, the average annual utilization growth rate is even higher and comes to around 30 percent. Several thousand mechanical arms and more than 2,600 robots of various types are presently installed in Italy. Among the most important participants in the CNR we have Comau, Jobs, Olivetti, IBM Italia, Bisiach, and Carru, ASEA, Mandelli, Teater, Selenia, Elsag, Prima Progetti, Fiar, Sapri, and Camel. [Text] [Milan INDUSTRIA OGGI in Italian Feb 87 p 37] 5058

CSO: 3698/558

## BELGIUM'S IMEC MICROELECTRONICS RESEARCH LABORATORY

Brussels DE STANDAARD in Dutch 8 May 87 p 25

[Article by Pieter van Dooren: "Flanders Technology International: Flemish Chips on a World Level"]

[Text] Louvain--When I visited the most modern chip laboratory last year in the United States, in Technology Triangle Park in North Carolina, the director told me that there was only one lab in the world that they were willing to compare themselves to. It was in Flanders, and was called IMEC. Sometimes you hear it from other people...

IMEC is housed in a brand-new building, in which no small amount of marble was used, at the edge of the science campus of the Catholic University of Louvain in Heverlee. It is an inter-university lab, in which the strengths of the universities and industrial colleges are brought together, and which moreover works closely with researchers from industry. It was established at the end of 1983, and in mid-1984 it began to actively recruit personnel. It moved into its present building in May of last year. At present, there are 285 employees, of which 65 percent are researchers, a very high percentage.

These scientists are working on four different tasks. The first department, INVOMEK, is working on education. Through a computer network, it maintains contact with terminals at 13 industrial colleges and computers at three universities, through which new chip designers are trained. These designers thus have all the facilities of a superlab. Their chips are also actually made. One piece of silicon will hold the chips of 16 different designers, which are then produced all at once. This is much cheaper than letting each person make his own chip. Last year, Flanders turned out 250 electronics engineers who are entirely up-to-date in their field, thanks to INVOMEK.

"However," Director Prof Van Overstraeten adds, "we also train industrial designers, with training according to need. In this way, people from the European Cern laboratory developed with our help five chips, two of which are now in production." Quite a recommendation, because Cern, a world leader in research into elementary particles, is known as a lab that settles only for the very best.

## Specific

A second department consisting of 35 people is developing new design methods. The age in which it was possible to design a chip by hand is long past. This would take too many thousands of hours. The current design methods make it possible to create extremely powerful chips that easily execute the most difficult programs. But even these chips are becoming increasingly outdated. The new trend is ASICs (application specific integrated circuits), in which the task to be executed is directly built into the chip.

Such chips can perform only one task, but they can consequently do so much faster than a "common" chip. They contain several tens of thousands to hundreds of thousands of transistors. What happened to the days when manufacturers of hi-fi products proudly boasted "contains 35 transistors and 17 diodes"?

ASICs are developing very rapidly. "We don't believe in programs any more," Van Overstraeten says. "If it can only be made fast enough, a specific chip is much more interesting." Chips (so-called silicon compilers) are even being made for converting a user language into the machine language understood by the computer, which is no easy task. IMEC itself has already developed two silicon compilers. Work is being done on a compact disk on one chip.

Van Overstraeten sees a good opportunity here for Europe: Such chips can be incorporated into many traditional products, and Europe is rich in traditional sectors.

## Making

After "designing," of course, comes "making." The group working on this requires the largest share of lab space. Not simply space, however, but dust-free space. On the scale of a chip, a hair resembles a fully grown tree trunk, so that a high degree of air purity is indispensable. The lab is kept at "class 100" (a maximum of 100 dust particles larger than 0.2 thousandths of a millimeter per cubic foot). The important equipment (30 percent of the surface area) is even at class 10. "We just did a measurement, and in various places it appears that we have achieved class zero. At first we thought that our meters were broken," says engineer Fluit, head of the logistics department, with a certain amount of pride in his eyes.

He puts us into astronaut suits and leads us into the "clean room" via a lock chamber. The floor is made of special tiles with tiny holes. Air is continually pumped through the ceiling, and it disappears through the floor towards the gigantic filter and pump installations (2.5 million cubic meters an hour), which occupies almost the entire bottom floor, in addition to five more towers along the lab. The space is slightly overpressured so that no outside air can get in if there is a leak. The air is replaced 600 times an hour. The temperature is kept constant within a range of 0.2 degrees Celsius, and air humidity within a range of two percent. The floor of the lab is vibration-free, built on its own posts free of the rest of the building. Each floor plate measures six by six meters and weighs 42 tons. The entire building, with air purification, fire and gas detection systems, and transport

and treatment systems for poisonous gases, was built by Belgian contractors. It was an experience that has brought them other contracts since then.

Inside, Martian-like figures are working with all types of equipment in solemn silence: computer-driven quartz ovens, ion implantation devices, machines for making thin films grow on chips, micro-manipulators, electron microscopes, conduits with strange gases, etchers, lithography systems with and without electron rays, lasers, growth equipment with molecular beams, mass spectrometers. In industry, the dimensions of the components on chips have shrunk to 1.25 to 2 thousandths of a millimeter. Work is already being done here on the next generation, the "sub-micron" chips, with components of 0.2-0.3 thousandths of a millimeter, spaced only 0.7 thousandths of a millimeter apart.

Together with UCB, this department has also developed a new light-sensitive lacquer for photographic etching. Using this, it is possible to work in the sub-micron realm; moreover, what used to be a process involving several steps can now be done in one layer. The project was incorporated into Eureka.

#### Gallium Arsenide

The technology is becoming increasingly complex, but even smaller dimensions are possible if one is able and willing to pay a price for them. The problem is the travel time of the signals. We will have to move to superconductivity, which since a couple of months ago now appears to be feasible, or to optical connections. There are also a number of possibilities there: Gallium arsenide and its relatives, the so-called III-V structures, which are able to produce light but also convert into electric signals, have recently been successfully grown on a silicon sub-layer, so that signal processing and signal transfer can be integrated on one chip.

Gallium arsenide is in a different department, which was assigned one-sixth of the 11,000 square meters of lab space. It is separate in order to avoid mutual contamination.

Gallium arsenide circuits work faster and with less release of heat than silicon. Even more interesting are the supergrids, where extremely thin layers of various III-V materials are grown on top of one another. Using this method, for example, a HEMT--high electron mobility transistor--can be built for super-rapid logic circuits. In this way, sensitivity can also be adjusted to certain wavelengths, so that better solar cells as well as interesting detectors will result. During our talk, Prof Van Overstraeten plays with an X-ray detector the size of a matchbox, which can be used for quality control of welding seams, but also in order to get an X-ray image directly on a television screen in a form that is suitable for all electronic techniques of pattern recognition, image improvement and the like.

#### Packaging

The fourth scientific department is studying materials and packaging. After all, you cannot just build a chip by itself; you also have to package it in a form that makes it usable for installation in all sorts of equipment. In the

lab, we see a researcher working with micro-tweezers under a microscope trying to pull the connecting wires loose from a chip. A PC neatly notes the level of force at which each wire comes loose. This is quality testing of a new technique whereby the connections are no longer done in gold wire, but rather in aluminum.

More general questions, such as why faults develop in integrated circuits, are also being tackled. A great deal of it has to do with the material from which the chips are made. The lab studies amorphous and polycrystalline materials, thin films on an insulator and the like. The group is also working on solar cells and on sensors, for gases, for pressure and for mini photocopiers

IMEC is an inter-university facility, intended to bring together strengths and avoid duplication, but microelectronics is such a broad field that the lab cannot do everything. There are other groups working at the universities in specific areas. About 20 people at the universities are on the IMEC payroll, and 10 or so projects are under way in conjunction with university groups. More fundamental research in chemistry, physics, mathematics and computer science is also being done in cooperation with the universities.

But IMEC's range of contact is broader than that. Cooperation is under way with more than 70 companies throughout Europe and with around five companies in the United States. "We did not go out seeking them, they came to us themselves." Only small and medium-sized companies are actively approached, because it is not as easy for them to come forward. According to Van Overstraeten, secrecy is rarely a problem. IMEC requests the right to publication, and "whoever wants to work secretly isolates himself." Industrial contracts account for 40 percent of the billion francs in the annual operating budget, which says something about the lab's quality image. There is plenty of work; at present, around 60 doctorates are being worked on, with 40 to 50 licentiate projects each year.

PHOTO CAPTIONS [Photos not reproduced]

1. Your reporter in standard lab dress, at a machine for doping amorphous silicon.
2. With this little device, a researcher tears connecting wires loose, like a child pulling the legs off a fly, but with a more serious goal. The lab is studying whether it is possible to replace expensive gold connections with copper or aluminum.
3. Engineer Fluit demonstrates the pick of the litter in equipment for applying films on chips: with molecular bundles, in high vacuum.

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CSO: 3698/570

## RESULTS OF ESPRIT LIQUID CRYSTAL DISPLAY PROJECT

Coburg OPTO ELEKTRONIK MAGAZIN in German No 2 Vol 3, 1987 pp 108-111

[Article by Dr Norbert Marschall, head of the Department of Solid-State Physics at the Frankfurt/Main Research Institute, Theodor-Stern-Kai 1, 6000 Frankfurt 70, FRG: "Silicon Thin-Film Transistors for Liquid Crystal Display Control: Example of European Cooperation in the ESPRIT Program"]

[Excerpts] Liquid crystal large-size displays with high display quality for various customer-specific applications have been produced for several years at the AEG plants in Ulm. In these displays, all screen elements have separate feed lines, which are combined into groups at the edge of the display and are activated by several individual integrated driver circuits. The integrated driver circuits are mounted directly on the display substrate using a special "chip on glass" technology. This single-segment control permits a display quality with high contrast as well as a large angle of view.

The trend in new international developments is currently moving towards displays with high information density. By dividing the display surface into a multitude of image points in an XY matrix pattern, a sufficiently high number of lines and columns permits the easily programmable display of text and graphics, including alternating display capable of gray tones and colors. The problem is to develop a control for the large number of liquid crystal image points in which the presently high quality of the display remains constant in terms of contrast and angle of view. Text, graphics and, where applicable, pictures should be displayed free of the flicker effect with sufficiently rapid image alternation.

The Europeans do not want to permanently give way to the Japanese in this important area. This why several large European companies and research institutes have come together in a joint project within the framework of the ESPRIT program, aiming to make up for Japan's edge. Besides AEG, the other participants are GEC, Thomson-CSF, CNET [French National Telecommunications Studies Center] and Modulex. The question of whether AEG should report on this project at this stage, even though the partners are in the lead in Europe but not on the international level, was discussed at length. It was decided to proceed with the report because it was believed that it is a good example of the stimulating effect of the ESPRIT program, combining the available resources of different EC countries in one project. In this way, the development of

high-resolution liquid crystal displays can be pursued on a broader level, even using different technological solutions.

#### Results of Use of Thin-Film Transistors for Image Point Control

Crucial to the success of thin-film transistors is the development of a high-grade and fault-free insulator layer in conjunction with reliably mastering etching techniques. The division of labor within the ESPRIT program with respect to this central task was arranged such that each of the major partners pursues the full course of one transistor technology. The results are later made available to all partners for further optimization and evaluation.

In this context, AEG is working with a special insulator technology based on  $\text{SiO}_2$ , while other partners are working on  $\text{Si}_3\text{N}_4$  and other silicon semiconductor thin-film material.

The control requirements with the switching currents and switching speeds indicated above [not included] can be fulfilled by thin-film transistors made of amorphous silicon layers, a semiconductor material with relatively low carrier mobility compared to monocrystal silicon. Figure 3 shows the design of this type of thin-film transistors from separate elements; the layout is with a gate electrode at the bottom. In order to produce the thin-film transistor as a MOSFET, the combined deposition of semiconductor and insulator layer is of primary importance. Plasma-supported CVD (chemical vapor deposition) from gaseous hydrosilicon with diluent and dopant gases as well as added reactive gases was chosen as a large-scale and inexpensive deposition method on glass substrates. Figure 4 [not included] shows the lab model for this type of deposition unit at AEG's Frankfurt Research Institute. Figure 5a depicts a section from a thin-film transistor matrix produced in it, and Figure 5b [not included] shows a greatly magnified image point cell with a single thin-film transistor. This is a test sample of a control matrix for a relatively coarse structure with a image point size of approximately 1 mm. Figure 6a shows the operational electric switching properties for a characteristic current pulse of 30  $\mu\text{s}$  duration. Stable current values with switching times under 1  $\mu\text{s}$  were achieved. Figure 6b depicts performance characteristics of this type of thin-line transistor in the pulsed state of operation corresponding to the control requirements of a display with a high number of lines. In the developments presented here, a coarser structure--channel length of the thin-film transistor of 20  $\mu\text{m}$ --was chosen than is internationally customary, the goal being to achieve a simpler photolithographic structure. The characteristics shown in Figure 6b also meet the requirements for image point control, even with the longer channel length.

In Figure 7, a test sample of a thin-film transistor matrix by the Frankfurt Research Institute is depicted. In cooperation with the Ulm AEG plant, matrix displays were produced for experimental purposes using the production technology available there for field-effect liquid crystal displays. It was possible to show that the thin-film transistors with relatively coarse channel structures achieve high switching contrast and have sufficiently rapid closing times, so that they are also appropriate for matrix displays with high numbers of lines.

## Silicon Thin-Film Transistors for Driver Electronics

The properties of amorphous silicon layers are inadequate for the development of silicon thin-film transistors with higher switching speeds, as needed in the shift registers for external control of lines and columns. Polycrystal silicon layers that are deposited on glass in compact-grained form using low temperature processes appear to be suitable as semiconductor layers with higher carrier mobility. Figure 8 [not included] shows a lab deposition unit for polycrystal silicon layers using electron-beam evaporation at the Frankfurt Research Institute. This is presently one of the attractive production processes. The production of layers like these using low-temperature processes is still in a developmental stage on the worldwide level. The goal of the work under way at the AEG Research Institute is to achieve processes with very low deposition temperatures so that inexpensive alkaline glass can be used as a substrate. However, shift register controls on this type of inexpensive, large-surface display substrate will clearly not be realized until far into the future. There are distant prospects for fully-integrated control electronics using thin-film technology, whereby in this regard polycrystal silicon thin-film transistors as well will be considered increasingly for image point control.

### Summary

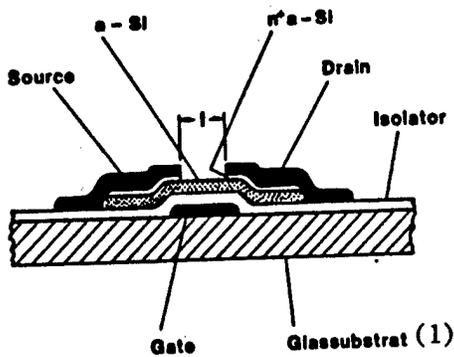
We have presented an area of research and development in which AEG, in cooperation with European partner companies and institutes, is working within the framework of the ESPRIT program. Based on the high-quality liquid crystal displays with single-segment control currently under production at AEG, high-resolution dot screen displays are to be developed. With silicon thin-film transistors in an XY matrix pattern for controlling the image points, the current high quality of display should be achieved even with high-resolution dot screen displays. The goal at the AEG Research Institute in Frankfurt, in conjunction with the company's production facilities in Ulm, is the conform development of an optimally simple thin-film transistor technology in the direction of liquid crystal cell technologies, both those tested and those that have yet to be developed. The target of procedural developments in the deposition processes for amorphous silicon and for the insulator layers is to make it possible to use inexpensive glass as substrates. This step is necessary for the market feasibility of larger text and graphic displays. One major technical problem has to do with avoiding short-circuit errors at line crossing points as well as within the thin-film transistors. The development of high-quality insulator layers will play a major role in solving this problem.

Compared to cathode-ray tubes with the central control electronics for the electron beam, control of a flat display screen using active matrix control demands a relatively costly array of control elements. As a flat display, it requires--in addition to the arrangement of the image points in the display surface--a similarly flat control electronic layout for "distributing information" to the individual image points. The main advantages over the cathode-ray tube are the flat construction, less weight and a much lower power requirement at lower operating voltage. These characteristics are particularly advantageous for portable units as well as for limited assembly sizes, e.g.,

car dashboard units, comfort telephones with display, text and graphic displays for all types of visual display equipment, including color screens in televisions.

The initial phase of the work on which this report is based was supported in part by funding from the Federal Ministry for Research and Technology, and later by the European Commission within the framework of the ESPRIT program.

Figure 3. Layout of a field-effect thin-film transistor with amorphous silicon



Key:

(1) Glass substrate

Figure 5a. Test sample

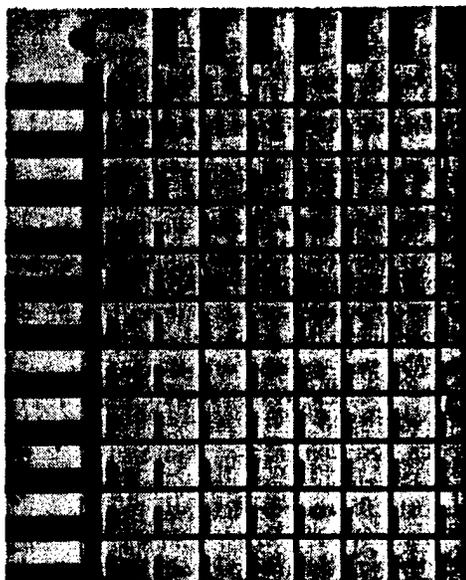


Figure 6a. Drain current pulse for an a-Si thin-film transistor

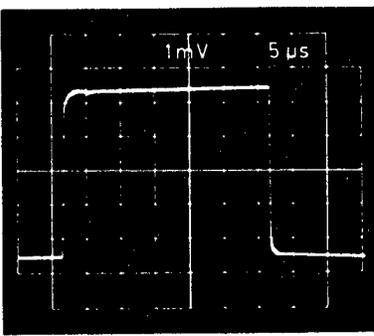
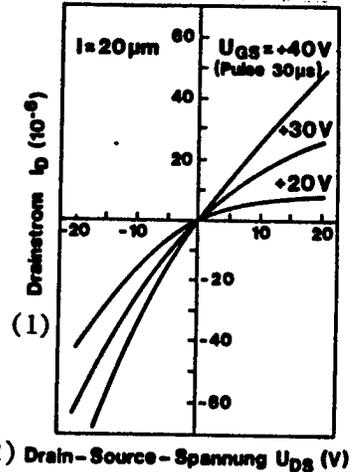
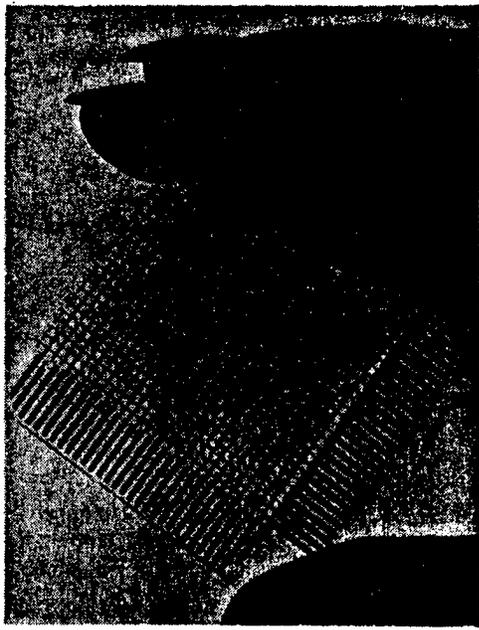


Figure 6b. Performance characteristics of an a-Si thin-film transistor (20 μm channel length)



Key:  
 (1) Drain current  
 (2) Drain-source voltage

Figure 7. Transistor matrix



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 CSO: 3698/562

## FRG FUNDS R&amp;D FOR RAPID IMAGE PROCESSING COMPUTER

Coburg OPTO ELEKTRONIK MAGAZIN in German No 2 Vol 3, 1987 pp 149-150

[Article by Dr D. Paul of the Fraunhofer Institute for Information and Data Processing (IITB): "Family of Rapid Image Processing Computers Joint Project"]

[Excerpts] Automatic image evaluation is increasingly making its way into a large number of fields. These include earth remote sensing, meteorology, materials, medicine, high-energy physics, criminology and industry. Especially in industry, automatic image evaluation is considered a key technology for the future development of production and quality control processes.

In view of the significance of the field and of activities in the United States in particular, the Federal Ministry for Research and Technology initiated the "Family of Rapid Image Processing Computers" joint project. Since 1985, seven companies and seven institutes have worked together within the framework of this project. The companies involved are Heimann (Wiesbaden), IBP Pietzsch (Ettlingen), Krupp Atlas Elektronik (Bremen), Ernst Leitz (Wetzlar), Siemens (Karlsruhe), VTE (Braunschweig) and Carl Zeiss (Oberkochen). The participating research institutes are the Technical University of Braunschweig, the University of Bremen, the FZI in Karlsruhe, the ZGDV Darmstadt and the Fraunhofer-Gesellschaft. The companies are responsible for 50 percent of the costs of the project, the other 50 percent being borne by the Federal Ministry for Research and Technology.

The goal of the project is to develop a computer family for image evaluation, whereby the partners will build the various members of this computer family using a common architecture and in part common components (such as bus systems, image memory or special processors for certain processes). The individual members of the family will maintain their own look through special fittings, through which the partners in the project will be able to develop them in keeping with their company-specific market interests.

Regardless of what fittings a concrete member of the planned family of computers may have, its architecture will reflect the step-by-step process in the automatic evaluation of images. A rough distinction is made between three stages: The first stage after image input is the "pre-processing" stage. The result of this is another image. During this stage, the image is rectified,

for example, or perturbations are suppressed and interesting features (such as edges) are highlighted. In the next stage, "feature extraction," certain characteristics of the pre-processed image are calculated, such as half-tone distribution or characteristics of subjects, such as the position and surface area of dark spots in an image. The result of feature extraction is no longer images, but rather feature vectors or lists of primitives. On the basis of this compressed data, the third stage--the "symbol-oriented processing" stage--provides information on the image, such as on the quality of a work piece or about its position and orientation in space.

For the architecture of rapid image processing computers, this step-by-step process means that separate processors for pre-processing, feature extraction and symbol-oriented processing are provided for, thus making assembly line work possible. In the pre-processing and feature extraction stages, it could be worthwhile to develop processors for specific standard procedures. In this way, a drastic increase in potential output is achieved, especially if several specialized processors work parallel to one another, extracting different types of features from the image at the same time. Specialized processors during the symbol-oriented processing stage have thus far proven to be pointless, since the currently used processes for this stage must be strictly adapted to its respective task.

The joint project is to take place in two phases. The first phase began in mid-1985 and will end in mid-1987. By then, the specifications for the planned computer family are to have been drawn up. Accordingly, work on the project at present is concentrating on questions of computer architecture in defining interfaces, establishing bus systems and with respect to communication in the system. Because the architecture of the overall computer and the architecture of the special processors to be deployed in the computer are very interdependent, special processors with varying functional principles have been designed by several partners, some of which have even been spot tested. Other focal points of research are in the area of developing processes for image evaluation, interfaces for the input and output of images and the inclusion of artificial images. With respect to the programming of the computer, basic research is under way on operating systems, the user interface and programming languages.

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CSO: 3698/562

## EEC'S NUCLEAR FUSION PROGRAMS EXPLAINED

Brussels EEC EUROPEAN FILE in English Feb 87 pp 3-4, 6-11

[Excerpts] The magnitude of the energy problem for Europe and the world can be demonstrated by a few statistics. Each year, the gross internal energy consumption of the European Community is nearly 1,000 million tonnes of oil equivalent (toe). In 1985, the cost of the Community imports of energy products exceeded 120,000 million ECU. (Footnote) (1 ECU (European currency unit) = about 0.73 pounds, 0.76 Irish pounds or US \$1.07 (at exchange rates current on 8 January 1987)) At world level, it is generally believed that, before the middle of the century, the combined effects of the expected growth of population and the average per capita consumption of energy will lead to a doubling, even a tripling, of world consumption from its current bill of between 6,000 to 7,000 million toe per year.

Between now and the middle of the next century, 80% of world oil reserves are expected to have been exhausted. In these circumstances, an orderly transition to a "post-oil" society can be ensured only if strategic plans to encourage the use of alternative sources of energy are quickly developed. The exploitation of alternative sources capable of meeting long-term energy needs is all the more urgent because of ecological problems--in particular, acid rain and increased carbon dioxide in the atmosphere--resulting from the use of oil and coal reserves (which remain very substantial). These problems lead us to conclude that after the first decades of the twenty-first century, the use of combustible fossil fuels may gradually have to be abandoned.

Anyone who might be tempted by current petrol prices at the pump to ignore the energy problems of the next century, should be reminded that daily price fluctuations do not alter the underlying trend: unless it can be replaced, a consumable product will become more expensive as it becomes scarcer. We run the risk of learning this lesson fairly quickly when the North Sea oil reserves have been exhausted. In any case, with the cost of oil remaining high for the European economy, the best use that could be made of the current breathing space in the oil market would be to encourage the development of long-term alternative sources such as solar energy, fast breeder reactors, and controlled thermonuclear fusion.

It is not the intention here to analyse the long-term advantages and disadvantages of these various resources, currently being developed in

parallel European programmes. Compared to fast breeder reactors, nuclear fusion is only at the preliminary stage of development. Nonetheless, as this document will show, it may be a trump card in the long term.

#### The Development of the Community Fusion Programme

The year 1958 saw the creation of Euratom, the European Atomic Energy Agency, and also a conference, organized in Geneva by the United Nations, which liberated fusion research from the constraints of military secrecy. It became clear at this time that fusion by magnetic confinement would not be as easy to achieve as had initially been thought. In view therefore of fusion's potential advantages for Europe and the enormous practical difficulties of implementation, Community member countries decided to integrate their individual national efforts into a single European programme which would support and coordinate the activities of all the specialized laboratories located in Member States. Since then, these laboratories have been bound to the Community by contracts of association which provide for Euratom participation in personnel and financing. The European Commission has full executive responsibility for the programme and is assisted by a consultative committee on the fusion programme, composed of national experts. In addition, a joint undertaking has been established for the JET project; it is administered by the JET Council and a project director. The collective nature of this project and its remarkable team spirit are testified to by several decisions of the Community's Council of Ministers. These describe the Community fusion programme as "a part of a long-term cooperative project embracing all the work undertaken in the field of controlled thermonuclear fusion in the Member States. It is designed to lead in due course to the joint construction of prototypes with a view to industrial-scale production and marketing". Such an undertaking is without precedent in the history of international scientific cooperation.

The evolution of the European programme, from one decade to the next, may be schematized as follows:

- In the 1960s, priority was accorded to the problems of magnetic confinement and, to a lesser degree, the heating of plasma. The European Commission paid particular attention to avoiding unnecessary duplication and encouraging information exchanges. However, the dimension of the problem changed after the first successes of a Soviet tokamak; Europe had to catch up on, and do better than, the USSR. To encourage the work of national laboratories, the Community raised its financial support from the usual level of 25% to nearly 45% for capital investment for the construction of major experimental plants of joint interest.

- The 1970s were characterized by the construction of several machines of the tokamak type. The design and start of construction of JET (Joint European Torus) was the climax of this period. JET was the first project proposed in the world for a major experimental machine in the fusion field. Its realization was the result of joint efforts by national laboratories and the Community, which covered 80% of the costs.

- The 1980s have so far been marked by scientific and technical developments which place the European programme in the first rank of world fusion research.

The Community fusion programme has demonstrated its effectiveness. Starting from national laboratories, large and small, a veritable scientific and technical community has been built up in the common interest. Its "mobility" budget has given a vigorous impetus to scientific exchanges between the various European laboratories. In addition, the participation of Sweden and Switzerland, two non-member countries, is another sign of success of a programme which is open to new partners and to the integration of their activities in the pursuit of a common aim. Fusion is the only scientific area in which there is full integration at the European level; its programme structure and content make it a model for other European activities in the science and technology field.

#### Objectives and Content of the European Programme

The developmental path towards a fusion reactor able to produce energy can be divided, albeit arbitrarily, into three sections: demonstration of the scientific feasibility of a fusion reactor, of its technological feasibility and--eventually--of its economic feasibility. With the JET, medium-sized tokamaks and their foreign equivalents, we are still at the stage of scientific feasibility. However, it is now considered that the successor to JET, the NET (Next European Torus), which is at the preliminary project stage, should fully confirm the scientific feasibility and should also tackle the problems of technological feasibility.

The current objectives of the fusion programme are:

- To establish the physical and technological base necessary for the detailed design of NET. To do so, full use must be made of JET and other specialized medium-sized tokamaks. A strengthening of the technological side of the programme is also needed.
- To undertake, probably in 1989-90, the detailed design of NET.
- To explore the potential of certain alternative tokamak configurations (stellarators and reversed field pinches).

Impressive results have already been achieved with European machines. Two examples are given below:

- Located at Culham in the United Kingdom, JET represents the most advanced fusion experiment in the world. Following the installation of powerful supplementary heating systems, plasma temperature was recently raised to more than 100 million degrees. To improve even further on this performance, it seems that it will be necessary to reinforce the machine.
- A new way of confining plasma, obtained in the Asdex tokamak located at Garching in Germany, has confirmed that it is possible to suppress, or at least limit, certain effects of heating plasma that shorten the duration of confinement.

Several other machines have been equipped with powerful plasma heating systems, while others are under construction. Four of these machines, located at Cadarache (France), Garching (Germany), Frascati (Italy) and Culham (United Kingdom), are of the tokamak type. In addition, a new stellarator is being constructed at Garching as well as a reversed field pinch at Padua (Italy).

Parallel with experiments in plasma physics, a major programme to develop the technologies required for NET and, in the longer term, for a fusion reactor, has been started in the following fields:

- Superconducting magnets for the creation of "continuous" magnetic fields.
- Components for a tritium recovery system.
- Blanket technology (two types of lithium compounds for the production of tritium are being examined).
- Materials for the reactor structure, its primary inner wall, thermal insulation, etc.
- Safety and the environment: prevention of the possible escape of tritium in gaseous form and treatment of the used reactor components contaminated by tritium.

The Community's Joint Research Centre actively participates in work related to tritium technology, materials and security.

In addition, the contribution made by European industry was a determining factor in the successful construction of JET and other experimental machines.

A new Community fusion programme is being prepared; it will run for a five-year period (1987-91). The proposal for a second framework programme for Community technological research and development, submitted by the European Commission to the Council of Ministers, foresees an allocation of 1,100 million ECU for fusion over five years.

#### Future Prospects

The ultimate goal of the Community fusion programme is the construction of a demonstration reactor, DEMO, able to produce electricity in a satisfactory manner. DEMO should also serve as a model for the use of tritium in optimal conditions of safety and reliability. Between JET, which is concerned solely with scientific demonstration, and DEMO, there is clearly much ground to be covered. Nevertheless, it is hoped, and generally considered feasible, to cover this distance in one step through NET, which is the new medium-term objective of the European programme. NET should be an intermediate machine provided with all the components derived from the first generation of fusion reactor. While NET will certainly be a tokamak, choice of basic design for DEMO remains open. However, it is considered that the required technological developments are more or less common to all toroidal confinement configurations.

As happened with JET some 12 years ago, a study group has been established to define NET specifications. The group is based at Garching. The experience and results gained from the operation of JET and medium-sized machines already installed or under construction, together with anticipated technological progress, make it probable that the NET project can start in a few years from now. Other anticipated scientific and technological progress should enable construction to begin during the first half of the coming decade. However, it is all the more difficult to forecast at this stage because it is not certain whether NET will remain a purely European undertaking. There are certain indications today that, due in particular to the high cost of this intermediary stage, the machine may be constructed as part of a broader, perhaps world-wide, cooperative effort.

### Progress in International Cooperation

The availability of fusion energy could be of considerable advantage to all mankind, exceeding by far the benefits and prestige which any one country might gain from perfecting a single fusion reactor. In any event, a rapid dissemination of the new technology can be expected, making it available to all. If every country with the necessary scientific and technical resources has to participate in fusion research, such research would clearly gain from being undertaken in a spirit of cooperation rather than of competition. Coordination of efforts would enable the goal to be attained more easily, more rapidly and more economically.

At the moment, there are four fusion programmes which are more or less equivalent: in the Community, the USSR, the United States and Japan. The scale of these programmes, their achievements and their goals are comparable. The Community fusion programme is, however, the first supranational attempt which has made a major contribution to scientific and technical progress. As it stands today, the programme structure and content make Europe an attractive partner in international cooperation.

Several agreements have already been signed under the aegis of the International Energy Agency of the OECD, the organization which groups industrialized countries with free market economies. Agreements have been concluded by the Community, and more specifically by Euratom, on behalf of all countries participating in the European programme. These agreements join together:

- The Community, the United States, Canada, Switzerland and Turkey to study the interaction between plasma and the tokamak chamber (this work is being carried out at the Textor tokamak at Juelich in Germany).
- The Community, the United States, Japan and Switzerland to develop superconducting magnetic coils.
- The Community and the United States in research on torus physics and plasma technology, applicable to certain types of tokamak and also to the development of certain alternative configurations: stellarators and reversed field pinches.

- The Community, the United States and Japan for cooperation among their three principal tokamaks, including the JET.

The Community will soon be linked to most of its major partners by general bilateral agreements. Such agreements have already been signed with Canada and the United States, while an agreement with Japan is under preparation. Furthermore, the Community participates in Intor, the working group of the International Atomic Energy Agency, as do the three other major fusion powers, including the USSR. By virtue of measures agreed at the Summit of Western powers, held at Versailles in 1982, the European Commission plays a key role, with the American Government, in strengthening international cooperation in the fusion field.

Following the 1985 American-Soviet Summit in Geneva, one cannot rule out cooperation at world level measuring up to the high cost of NET and the complexity of the equipment needed. The overtures made in this direction by Mr Reagan and Mr Gorbachev were received with interest by world fusion specialists and Western authorities are actively studying in detail the feasibility of such an undertaking.

Physicists assume and hope that nature allows plasma to be confined for the necessary length of time while it is maintained at temperatures exceeding 100 million degrees, but they still have to find simple means of establishing such conditions. In addition, engineers still have the task of developing advanced technologies which would allow wide-scale exploitation of these conditions in a reliable and efficient manner.

The hope is that physical problems will be resolved by studying the current generation of machines, and in particular, the JET, so that the next step, the construction of an experimental fusion reactor, may begin, if necessary in a framework of major international cooperation.

As regards the ecological aspects of fusion, the future appears equally favourable, as indicated in a report prepared for the European Parliament. The principal advantages to be underlined are the minimal consequences of a serious accident and the lack of any important long-term risk.

CSO: 3698/A231

## MADELIN ON FRANCE'S NEW DATA PROCESSING POLICY

Paris ZERO UN INFORMATIQUE in French 13 Apr 87 p 3

[Article by Evelyne de Lestrac: "Alain Madelin at the SICOB fair: Simplifying Government Structures"; first paragraph is ZERO UN INFORMATIQUE introduction]

[Text] Industry Minister Alain Madelin, inaugurating the 38th SICOB fair at the Paris-Nord-Villepinte Exhibition Park last week, reconfirmed his ministry's major "deregulating" decisions in the area of data processing.

In data processing, according to the minister, speaking with a burst of optimism, the slump could be labeled "another word for change... of rhythm, of era, of system." We should also remember that in the United States the recovery began last year with a market growth of some 8 percent. France is registering a "respectable" growth rate (up 5 percent) with first prize going to the software, micro, and minicomputer sectors, whose market grew by 20 percent in 1986.

In this context, "the government has redefined its role and redirected its actions." Alain Madelin thus recalled the pro-competition principle (removal of price controls, liberalization of exchange restrictions, privatization of nationalized companies) introduced by the government in anticipation of the single European market of 1992. Regarding international competition, he added, "We must guard against any protectionist tendencies as well as any signs of naivete," mentioning the semiconductor "trade war" between Japan and the United States, before confirming the imminent promulgation of a decree on rules governing leased lines in the telecommunications field.

#### The Recommendations of the Brule Report Are Already Being Implemented

Referring to the reduction in governmental structures "through the elimination of organizations which have become useless," Alain Madelin did not fail to mention that steps announced last autumn, following the Brule report, were being implemented. The minister considers that "the government no longer needs to artificially support the drive for computerization," thus confirming the elimination of the World Data Processing Center, effective 1 July. The Data Processing Agency [ADI], which ceased operations on 28 February and which will be legally abolished on 31 December, has had some of its activities transferred. This will allow the ministry to directly monitor "the most

promising" research and technology transfer projects, particularly in the area of software engineering. Other projects will be assigned to research centers or to companies, such as the SEDOS networks standardization project, transferred to the INRIA [National Institute for Research on Data Processing and Automation] and to Bull. At the same time ANVAR's [National Agency for the Implementation of Research]role has been strengthened, "funds have been reallocated to support innovative software packages developed by companies." ANVAR thus committed close to Fr 31 million to this sector during last quarter of 1986.

With an eye to the competitive market, the CESIA (Study Center of Information Systems in Public Administrations) is to eventually acquire the status of a public corporation early in the second half of the year. This requires that its activities be financed "entirely by income from its contracts." The Center, which had 1986 sales of Fr 45 million, today has some 100 employees.

As regards changes to government activities in the data processing industry, Alain Madelin also provided specific information regarding the ministry's 1987 budget for the data processing and electronics sectors: Fr 2.547 billion (excluding endowments) compared to Fr 2.380 billion last year, or an increase of close to 10 percent. This change, which affects the major areas of development (support to small- and medium-sized companies, incentives for cooperation between public research and companies...) as well as methods for implementation, will depend on an advisory board led by Bernard Esambert, president of Compagnie Financiere.

Finally, as regards standardization activities, the minister mentioned the role of AFNOR French Association for Standardization, which, with increased funding, has taken over all the activities of the BNI (Bureau of Data Processing Standardization). Emphasizing the importance of the area known as "standards and certification," Alain Madelin stressed the need "to rapidly acquire test structures and laboratories in the information and telecommunications fields," before announcing the upcoming creation of a "National Steering Committee Board for Certification Activities."

[Box, p 3]

#### Developments in Certification

In this regard, Alain Madelin mentions the guidelines his ministry has defined: Thus, the soon-to-be-established National Steering Committee for Certification Activities will consist of representatives from all the various economic partners. With a double mission, it is to become, first, the contact for European authorities; and second, a center for dialogue on a national scale, for leaders in the information and telecommunications sectors (including value-added activities).

At the same time, professional initiatives, such as the creation of the ACERLI (French Association of Test Centers for Industrial Local Area Networks), will be encouraged. AFNOR is extending its certification activities to information technologies. In addition, the role of the CNET National Institute for Telecommunications Studies has been strengthened by the recent creation of a validation service available to companies for testing communications protocols.

A team of experts will soon begin working with the National Testing Network to assist in the creation (on a voluntary basis) of a coordinated network of test and validation laboratories whose work will be recognized on an international level. Lastly, highly sophisticated laboratories will be encouraged to develop testing methods.

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## HUNGARY: CONTRIBUTIONS TO HALLEY'S COMET RESEARCH

Budapest MERES ES AUTOMATIKA in Hungarian No 3, 1987 pp 73-84

[Article by I. Apathy, Mrs P. Bereczki, G. Endroczy, J. Ero Jr, T. Gombosi, A. Gschwindt, L. Lohonyai, Gy. Kozma, I. Naday, I. Renyi, A. Somogyi, F. Szabo, L. Szabo, S. Szalai, K. Szego, A. Varga and P. Zalan: "Hungarian Achievements in Halley's Comet Research." The first two paragraphs are the Hungarian summary.]

[Text] The article describes the scientific instrumentation of the VEGA space probes, summarizes the chief technical data for the equipment prepared with Hungarian participation and touches on some characteristic technical solutions. In addition, it illustrates with an example how important circumspect planning and careful work are in space research.

The article briefly summarizes the conduct of the experiment and the most important scientific results.

In the years just past there were preparations for and execution of a grand space experiment carried out with international cooperation--observation by space probes of Halley's Comet as it approached the Earth, or rather the Sun, in 1985-86. A number of space probes performed near or quasi-near observations and, naturally, from the first observation of the returning comet on 26 October 1983 hundreds of telescopes located on Earth took thousands of photographs of the comet in various portions of its trajectory.

The European Space Agency (ESA) combining 12 nations launched the Giotto probe, the Interkozmos organization of the Soviet Union and the socialist countries, with the participation of experts from Austria, France, the FRG and the USA, launched the two identically constructed VEGA-1 and VEGA-2 probes, and the Japanese Aeronautics and Space Research Institute (ISAS) launched the SAKIGAKE (Pioneer) (formerly MS-T5) and SUISEI (Comet) (formerly PLANET-A) probes to study the comet. NASA, the space research organization of the USA, using complex orbit modification maneuvers, converted the ISEE-3 (International Sun-Earth Explorer) probe, launched in 1978, to comet research (Giacobini-Zinner and Halley) under the name ICE (International Cometary Explorer). Observations from Earth were coordinated by the International Halley WATCH (IHW). Table 1 illustrates the chief data for the several probes and Figure 1 illustrates their passage relative to the comet.

Table 1. Probes Studying Halley's Comet

	VEGA-1 VEGA-2 -----	GIOTTO -----	SAKIGAKE SUISEI -----	ICE (ISEE-3) -----
Launch	15 Dec 84 21 Dec 84	2 Jul 85	8 Jan 85 18 Aug 85	12 Aug 87 (22 Dec 83)*
Carrying rocket	Proton	Ariane-1	M-3S II.II. M-3S II.II.	
Type of probe	VENYERA 3 tang. stab.	GEOS spin/despin	spin/despin	spin/despin
Encounter, 86	6 Mar 7:20:06 9 Mar 7:20:00	14 Mar 0:03:02	11 Mar 4:17:51 8 Mar 13:05:49	28 Mar
Distance from nucleus	8,890 km 8,030 km	605 km	6.99*10 <sup>6</sup> km 151,000 m	31.4*10 <sup>6</sup> km
Relative speed at encounter	79.2 km/s 76.8 km/s	68.44 km/s	73 km/s	
Weight of scientific equipment	152 kg	54.4	15 kg 10 kg	
Telemetry speed	65,536 bit/s	38,948 bit/s	1,024 bit/s	512 bit/s
Dust protection	yes	yes	no	no

#### Measurement Tasks and Instruments for Comet Research

Comets are special planets of our solar system, sometimes the most spectacular objects in the sky, their unexpected appearance often caused fear in people. According to our present thinking there is a cloud, the so-called Oort Cloud, at the border of our solar system--50,000 times the distance from the Sun to the Earth--which consists of comet nuclei. These comet nuclei are remnants of the original material of our solar system, faithfully preserving the composition and form of it as of about 4-5 billion years ago.

From time to time, as a result of the gravitational fields of various heavenly bodies, smaller or larger pieces from the clouds made up of comet nuclei come near the Sun, and we observe them as comets. Near the Sun, as a result of solar radiation, gases and small solid matter parts ("dust particles") are released from the comet nucleus. Staying for a time in the vicinity of the nucleus the matter given off forms a coma and then, departing from the nucleus, it creates the tail of the comet. We know a lot about comets from terrestrial observations, but previously we had to rely on theories and guesswork regarding regions deep within the coma or near the comet nucleus.

Study of comets and a knowledge of their material composition and properties expands to a significant degree our knowledge of the composition and formation of our solar system.

So the basic goals of comet research with the space probes were the following:

- determining the physical characteristics of the comet nucleus (size, form, surface, temperature),
- studying the structure and dynamics of the coma regions around the nucleus,
- determining the composition of the gas around the nucleus (the "parent" molecules),
- determining the composition and mass distribution of the dust particles,
- studying the interaction between the solar wind and the atmosphere and ionosphere of the comet.

The goals of the study and the technical possibilities together determined the instrumentation of the several probes (Table 2).

Table 2. Comet Research Instrumentation of the Space Probes

		VEGA-1/2	GIOTTO	SUISEI (Planet A)	SAKIGAKE (MS-T5)	ICE
		-----	-----	-----	-----	---
Remote sensing:	TV system:					
	narrow angle	x	x			
	wide angle	x				
	UV camera					
	IR spectrometer	x		x		
	Photopolarimeter		x			
	3 chan. spectrometer	x				
Gas/dust measure.:	Neutral gas anal.	x	x			
	Ion mass spectr.	x	x			
	Dust mass spectr.	x	x			
	Dust detector	x	x			
Plasma measure.:	Solar wind ion	x	x	x	x	
	Solar wind electron	x	x	x		x
	Plasma wave	x			x	x
	Medium energy charged particle anal.	x	x		x	
	Magnetometer	x	x		x	x
	Plasma composition					x
	Other:	Radio wave				

Hungarian researchers--physicists and engineers--had an opportunity for participation primarily in the comet research program of the VEGA space

experiment, but to a certain extent they also contributed to the success of the Giotto program. (They participated in testing the software of the television system of Giotto; the test results on the television system for the VEGA probes made it possible for Giotto to so closely approach the nucleus of Halley's comet.)

Table 3 describes the instrumentation of the VEGA space probes, the consumption and weight of the several instruments and the amount of information provided by them.

Table 3. Instrumentation of the VEGA Space Probes

Instrument	Partici- pants	Task	Mass (kg)	Consum. (W)	Telemetry	
					Slow Tr1/Tr2	Fast (bits/s)
-----						
Optical experiments:						
TVS	Television sys.	CNES IK-Hun IK-Sov	Photographing nucleus and environment (angles: 0.43x0.57 and 3.5x5.3 deg.)	32	50	---/-- 32,768
TKS	3 channel spectrometer	CNES IK-Bul IK-Sov	Spectrograms of coma radiation in 0.12<math>\lambda</math> <math><1.9</math> micron band	14	30	---/-- 12,288
IKS	Infrared spectrometer	CNES IK-Sov	Detecting coma IR radiation and heat radiation of nucleus in 2.5<math>\lambda</math> <math><12</math> micron band	18	18	3.6/3.6 2,048
ASP-G	Turning platform	IK-Cze IK-Hun IK-Sov	Directing IKS, TKS, TVS equip. toward nucleus	82	30	---/1.8 512
In situ dust experiments:						
PUMA	Dust mass spect.	CNES IK-Sov MPS	Studying composition of dust particles	19	31	---/-- 10,240
SP1	Dust particle counter	IK-Sov	Studying flux and mass distribution of dust ( $m > 10^{-16}g$ )	2	0.6	---/1.8 150
SP2	"	"	"	4	4.5	" 1,024
DUSMA	"	IK-Hun MPS-USA IK-Sov IK-Hun	Studying flux and mass distribution of dust ( $m > 1.5 \times 10^{-13}g$ )	3	2	0.3/09. 1,024/ 2
FOTON	Dust particle detector	IK-Sov	Detecting large particles (under shield)	2	4	analog channel

Table 3. (Continued)

Instrument	Partici- pants	Task	Mass (kg)	Consum. (W)	Telemetry	
					Slow Tr1/Tr2	Fast (bits/s)
-----						
In situ neutral gas, plasma and field meters:						
ING	Neutral gas analyzer	MPS-USA IK-Hun IK-Sov	Determining composition of neutral gas (1-80 AMU)	7.5	8.5	0.3/0.9 1,024/2
PLAZMAG	Comet plasma spectrometer	MPS IK-Hun IK-Sov	Determining composition and energy distribution of ion and electron flux	9	8	1.3/12.6 2,048
TUNDE-M	High energy particle spectrometer	MPS IK-Hun IK-Sov	Determining energy and flux distribution of accelerated comet ions (50 keV-13.5 Mev/nuc)	5	6	0.45/5.4 512
MISCHA	Magnetometer	AAS IK-Sov	Measuring magnetic field	4	6	0.45/1.8 512
APV-N	Wave and plasma analyzer	IK-Cze IK-Sov IK-Pol	Determining plasma wave (0.01-1000 Hz) and plasma ion flux	5	7	--/23.4 2,048
APV-V	"	CNES IK-Sov	Measuring plasma wave (0-300 kHz), plasma density and temperature	3	3	--/12.6 512
Service type equipment:						
BLISZI	Central data collector	IK-Hun IK-Sov	Collecting and ordering measurement results from scientific instruments	9	13	--/-- --
BUNA	Central command receiver	IK-Sov	Decoding commands received from Earth, controlling instruments	13	8	--/-- --

Hungarian experts designed and made the following of the VEGA space probe equipment:

- the central data collector (BLISZI),
- the plasma analyzer (PLAZMAG),
- the charged particle detector (TUNDE),
- the on-board electronics and earth control system for the television system (TVS),
- earth control equipment for the neutral gas analyzer (ING) and dust spectrometer (DUSMA), and

--control of the turning platform (ASZP-G) with the aid of special software and a microcomputer built into the television system.

Four of the instruments included in the probe equipment study interplanetary space (with relatively little information content) as well as doing comet research and in the vicinity of the comet there was a need for high speed (and very high consumption) telemetry to forward the large volume of information provided by all the instruments, so the VEGA probes were provided with a dual telemetry system:

--the TM 3,072 bit/s speed slow and  
--the RL 65,536 bit/s speed fast telemetry.

The slow telemetry system also has several operating modes:

--Trassa-1 (from launch until 2 days before meeting with the comet) with data storage on a 5 Mbit capacity tape recorder and readout about every 20 days,

--Trassa-2 (during the 2 days before and following the meeting with the exception of 2 hours each) with data storage on a 5 Mbit capacity tape recorder and readout every day), and

--direct data transmission (for 2 hours on days minus 2, minus 1, plus 1 and plus 2 relative to the meeting and from hour minus 2 to hour plus 1 relative to the meeting).

The fast telemetry operates only in the direct data transmission mode in periods coinciding with the direct data transmission mode of the slow telemetry.

Design, construction and testing were done with broad international and domestic cooperation. A collective of the Central Physics Research Institute of the MTA [Hungarian Academy of Sciences] and of the Microwave Communications Engineering Faculty of the BME [Budapest Technical University] solved a significant part of the tasks in Hungary, but other faculties of the BME and ELTE [Lorand Eotvos Science University], the Astronomical Research Institute of the MTA and people from the TIT [Society for the Propagation of Scientific Knowledge] Planetarium cooperated in the work and workers from the REMIX enterprise helped with design and manufacture of special parts.

When designing, assembling, calibrating and testing the equipment one had to ensure very reliable operation under extreme conditions (vacuum heat effects, vibration and acceleration effects, radiation load, etc.). This presented our technical experts with the great task of mastering and applying peak technologies in a very short time. Development of the television system presented especially great difficulties, partly because of the new CCD (charge-coupled device) image sensor, still under development, chosen as the image sensor and partly because of the technical tasks to be solved by the system.

As a result of the stabilization of the probe in three axes the orientation of the optical instruments toward the comet could be solved only by mounting

their gear on a turnable platform fixed to the probe. Naturally this platform had to be controlled and in the interest of increasing reliability a number of control solutions were developed. These are, in order of control priority:

- CCD sensor microcomputer processing,
- programmed course data,
- four and eight segment analog signal processing (star transmitter),
- CCD sensor hardware signal processing,
- earth commands (through TV system), and
- earth commands (directly to the platform).

A significant part of the control solutions (with the exception of points 3 and 6) were realized within the television system. The control problem was made especially difficult by the retrograde revolution of Halley's Comet (in a direction opposed to the orbital movement of Earth) as a result of which the relative speed of the comet and the space probe was very great, about 80 km/s, which is 3,600 times the customary speed of an auto, or 288,000 kilometers per hour. Near to the comet (e.g., passing at a distance of 10,000 kilometers) this speed required that the optical axis turn with an angular speed of about 0.5 degrees per second, which made customary position control impossible. To solve the problem near to the comet we developed a predicted speed control method based on computing the relative paths.

Accordingly there were two methods of controlling the platform:

- position control with a precision of  $\phi = \text{plus or minus } 5 \text{ minutes of arc}$ , and
- speed control with a precision of  $\phi/t = \text{plus or minus } 1 \text{ minute/s}$ .

Taking into consideration the control requirements discussed above, the orientation system had to perform the following tasks:

- recognition of the comet and its nucleus,
- selection of the proper "exposure times",
- tracking the recognized comet path or predicting its path,
- providing the proper control signal to the platform,
- passing technological and coordinate data to Earth,
- receiving, interpreting and executing commands arriving from Earth.

The great relative speed of the encounter also made it very difficult to develop an orientation system. The probe would be in the vicinity of the comet for only about plus or minus 10 minutes, and the message exchange time required about 20 minutes due to the large distance from Earth. This greatly limited the possibility of intervention from Earth.

#### Hungarian Instruments for the VEGA Program

We summarize below the properties of the equipment made with Hungarian participation and the results achieved.

## BLISZI

The BLISZI collects the measurement data of the several items of scientific equipment according to the given seance program (Trassa-1, Trassa-2 and direct data transmission), puts it into the proper format, provides it with an identifying code and passes it to the telemetry units at a transmission speed of 3,072 bit/s or 65,536 bit/s. In the interest of meeting the increased reliability requirements the equipment had a triple cold reserve for both slow and fast telemetry channels and was built with 54LS..J series SSI and MSI circuits. This meant additional reserves for the equipment using both telemetries--with certain constraints it is true. The cold reserve solution chosen contained certain compromises, since in event of failure the switching over requires intervention from Earth and so the time loss deriving from the great distance could have meant loss of information. Majority logic reserves had to be rejected because of the large number of input and output points (extra weight, volume, consumption and less reliability). It proves the correctness of our choice that during the nearly 2 year flight of the VEGA probes there were no failures in the course of periodic testing and measurements in a total of  $2 \times 3 \times 2 = 12$  channels.

## PLAZMAG

The PLAZMAG measurement system consists of six sensors and their associated electronics. Its task was to determine the energy spectrum of the ions and electrons in the coma and solar wind and the neutral gas cloud around the comet.

The neutral gas molecules or dust particles striking, with great energy due to the high speed of the probe, a detector consisting of a gilded metal sheet placed perpendicular to the speed vector produces secondary electrons. A very sensitive current meter with logarithmic characteristics measures the current of these.

Two uniform cylinder shaped multi-electrode level analyzers measure the total ion flux of the solar wind and around the comet, thus one looks in the direction of the Sun and the other in the direction of the relative speed vector (in the direction of the comet).

Two electrostatic analyzers of similar construction and operation measure the spectral distribution of the ion components of the comet plasma and solar wind. The voltage connected to the bent sheet pairs deflects the charged particles arriving between the sheets at great speed, forcing them onto a curved path. In the case of a deflecting voltage thus given only ions with a definite energy reach unobstructed the recording devices placed at the end of the sheet pair--a special electron multiplier or canalatron. Counting for a given time the particles which get through at each voltage value gives the value of ion flux at each energy interval. Thus the spectral distribution of the ion flux can be easily determined by changing the deflecting voltage.

The ions enter the detector looking toward the comet practically at the relative speed of the probe (about 80 km/s), thus the energy distribution measured here can be interpreted as a mass distribution ( $E = m \cdot v^2 / 2$ ).

In essentially the same way, but with an analyzing voltage of opposite polarity, the energy spectrum of the electrons is taken with the sixth detector.

A number of high precision, fast operating controllable voltage sources with broad voltage ranges (from a few volts to a few kilovolts) had to be developed to serve the level analyzers, charged particle spectrometers, calibrating spectrometers and canalatrons.

Organizing the measurement is the task of the microprocessor central unit--controlling the sensors and the voltage generators serving them, collecting, preprocessing and temporarily storing the measurement data and passing them to the telemetry system of the probe and selecting the appropriate operational mode on the basis of an interpretation of the on-board command codes. Programmable timing circuits, input circuits, an A/D converter and an analog multiplexer are connected to the microprocessor and its memory unit. Control of the measurement takes place through the output circuits and the D/A converters.

In the central unit we used a CDP 1802 microprocessor made by RCA and space tested by NASA and as memory we used CMOS-PROM's and CMOS-RAM's. The program memory capacity is 3 K bytes and the data memory capacity is 4 K bytes. The clock generator is 2 MHz and contains a specially suspended, vibration and acceleration resistant quartz crystal.

The central unit, with its memories, input circuits, A/D converter and multiplexers, has a hot reserve; switching to the reserve is automatic in the event of a faulty program run. Automatic operation can be counterchecked by earth command. The telemetry interfaces have cold reserves and can be switched over by earth command independent of the central unit or one another. The circuits receiving an individual command are duplicated; three circuits receive the coded command signal and then switch to the appropriate parts of the device through majority logic.

The chief data for the PLAZMAG equipment are:

total mass--7.5 kg  
power consumption--8 W (1.5 W in reserve operation)  
measurement ranges:  
solar wind ion--50 eV to 25 keV  
comet ion--15 eV to 3.5 keV  
electron--3 eV to 5 keV.

In this case also the circumspect design, the manufacturing technology developed and the careful testing had a significant role in the good results achieved. Disregarding the failure of one detector the equipment "survived" intact the 440 day space voyage to the encounter with the comet. One of the microprocessor systems on the VEGA-2 probe failed shortly before the encounter--presumably due to colliding with a dust particle (other instruments failed at the same time). The measurements could be continued successfully with the other microprocessor--which remained intact.

## TUNDE-M

The task of the TUNDE-M equipment was sensing ions from the comet and determining their energy distribution and--during the year and a half flight--recording electrons and cosmic radiation particles from the Sun.

A specially designed telescope was developed to carry out the task. The telescope consists of surface barrier layer Si semiconductor detectors, one 100 microns thick and one 1,000 microns thick, and a scintillation detector surrounding them. A microchannel plate senses the signals of the scintillation detector, which plays the role of anticoincidence detector.

Use of the semiconductor detectors and the microchannel plate make possible creation of a small telescope with reliable operation resisting the mechanical demands.

The low energy ions lose all their energy in the first 100 micron thick detector, so its signal will be proportional to the energy of the ions.

The higher energy particles pass through the first detector and are slowed down in the second detector. Such a so-called delta E/E detector system makes it possible to classify the particles according to energy and type (electron, proton, alpha particle, etc.).

Operation of a delta E/E type telescope is based on the fact that of the particles with the same energy but of different types passing through the thin detector those with larger mass will pass through with a greater energy loss. If we measure the magnitude of the signals produced by a particle in the thin and thick detectors we can conclude the total energy of the particle from the sum of the two signals and we can conclude the type of the particle from their ratio.

In the interest of increasing the reliability of the device it contains two telescopes, each of which consists of two semiconductor detectors and one anticoincidence scintillation counter. The signal processing electronics of both telescopes, including the multichannel analyzer and power unit, operate in an autonomous mode. For this instrument also an RCA CDP 1802 microprocessor controls the digital part operating from either of the power units. Its tasks are organization of the measurement, data collection, compacting, storing and passing on the measurement results, receiving and interpreting earth commands and periodic checking of the operation of the device. The operating program is contained in 2 K ROM memory; 2 K RAM is available for data processing. The memory system contains triple redundancy and majority logic guarantees correction of faulty data.

The instrument--including the telescopes--makes up one unit mechanically. Its chief technical data are:

mass--4 kg

consumption--5 W

energy range of ion channels--40 keV to 650 keV

energy range for energetic particles:

electron--175 keV to 730 keV

proton--3.2 MeV to 13 MeV

alpha particle--12.6 MeV to 51 MeV

other charged particles--13 MeV/nucleon.

In the case of the TUNDE equipment the advantage of using redundant solutions was shown. Presumably as a result of the initial pitching and tossing of the space probe the detector system closest to the direction of the sun failed due to overload (scorched by the sun?). Measurements bringing significant, new results were done with the other--reserve--detector system.

### Television System

Taking into consideration the control requirements and the basic comet research goals the television system had to carry out the following tasks:

- seeking the comet and its nucleus,
- recognizing the comet and its nucleus,
- selecting the proper exposure time,
- tracking the recognized comet path or predicting its path,
- providing the proper control signal to the platform,
- preparing scientific pictures with various color filters and sending them to Earth,
- receiving, interpreting and executing commands coming from Earth.

The television system contains:

- one f=1200 mm focal distance small angle mirror camera,
- one f=150 mm focal distance large angle camera, and
- a data processing unit.

In both cameras, after a prism, there were two Soviet made charge coupled light sensing matrixes (CCD) containing 512 x 576 pixels each 18 x 24 microns in size. In front of the CCD's there was one each mechanical shutter--with the exception of the straight branch of the large angle camera; so these CCD's receive light only during the exposure time. In the straight branch of the large angle camera there is a half covered CCD which operates in the television mode with an exposure time determined by electronics. An eight position color filter disk is placed in the straight branch of the small angle camera, making it possible to prepare photographs in different spectral ranges. Figure 2 illustrates the characteristics of the several color filters. In the filter disk placed in the straight branch of the large angle camera were red filters with different pass abilities to regulate the amount of light reaching the CCD. Fixed red filters were placed in front of the side CCD's.

In the interest of increasing reliability there are separate control electronics for each CCD; these contain read-control circuits for the CCD's, a video amplifier, an analog-digital converter and shutter and filter control circuits.

Table With Figure 2: Filters

Designation	Wave length (nm)	Band width (nm) (plus or minus)	Permeability (percent)
1. glass	450-1050	--	90
2. far infrared	930	70	80
3. near infrared	810	50	80
4. orange	510	90	80
5. red (1)	695	65	80
6. red (2)	695	65	8
7. red (3)	695	68	0.8
8. narrow band blue	444	2.3	40

The processing unit of the television system contains two microcomputers. The task of one computer is to recognize the comet on the basis of the visual information received and to ensure tracking by controlling the platform--taking into consideration the path of the probe relative to the comet. The task of the other computer is preparation of the scientific pictures and transmission to Earth of the visual and service information obtained.

The orientation computer has no direct link with Earth so it is the task of the picture processing computer to pass the information pertaining to the orientation system. The orientation computer was based on an NSC 800 CMOS microprocessor. The program memory (24 K bytes) and the operational memory (8 K bytes) are error protected using Hamming code. The orientation hardware reduces the digitized image coming from the sensors to a 256 x 256 size.

There are two possibilities for this:

--compacted format. In this case 2 x 2 pixels of the CCD correspond to one point of the virtual image.

--clipping (or window) format. In this case the processor programs which 256 x 256 window of the entire CCD surface will be processed.

It is also possible to correct by digital means individual error points--or faulty columns--of the CCD matrix. This is based on the fact that an unilluminated CCD gives a homogeneous dark image, so faulty pixels appear lit. We store the address of these lit points and after the actual exposure we replace the light values of these points with the light values of the pixel preceding them.

The corrected visual image is evaluated by the following special purpose hardware:

- pre-orientation matrix,
- orientation image memory,
- amplitude analyzer,
- brightest points circuit.

The pre-orientation matrix consists of 16 x 16 matrix elements. One element of the matrix is equal to 16 x 16 virtual pixels. The circuit determines the indexes of the brightest matrix element.

The orientation image memory is capable of storing 4 K bytes of 64 x 64 virtual pixels.

The virtual image can be loaded into memory in three ways:

--in a 4 x 4 compacted format. In this case each pixel of the orientation image corresponds to 4 x 4 pixels of the virtual image.

--in a 2 x 2 compacted format. In this case each pixel of the orientation image corresponds to 2 x 2 pixels of the virtual image, so only a quarter of it is processed. The location of the window on the entire surface of the virtual image can be moved by a program.

--in 1 x 1 clipped format. In this mode a 64 x 64 window of the virtual image is written to memory. Its location can be programmed as desired.

The primary purpose of the orientation image memory is to further refine the comet position roughly determined by the pre-orientation matrix.

The amplitude analyzer produces the light strength distribution of the virtual image on 64 channels. One can read from the individual channels how many pixel brightness values fell between the given value limits. This circuit facilitates determination of the optimal exposure time.

The brightest points circuit stores the address and data for points brighter than the given threshold. The maximum memory capacity is 1,024 K words, where one word contains a 16 bit address and 8 bits of data. If the correct exposure time is established the memory does not overflow and the CPU can determine from the data whether these points form an interdependent area.

The orientation microcomputer converts the comet position determined from the data of the orientation circuit into a platform coordinate system and with the cooperation of the platform interface circuits it forwards this to the platform.

Although in the event of failure it is possible to use an image prepared from any closed CCD for orientation purposes the chief strategy of seeking, recognizing and tracking the comet used:

- compacted images prepared from the side CCD of the large angle camera,
- clipped images prepared from the side CCD of the large angle camera,
- compacted images prepared from the side CCD of the small angle camera, and
- clipped images prepared from the side CCD of the small angle camera.

These were used in order (in the event of error individual steps could be skipped as a result of the adaptive property of the system). Depending on the results of the constant self-testing the system itself decided which of the

above listed special purpose hardware elements to use to determine the position of the comet.

The image processing computer was also based on an NSC 800 CMOS microprocessor. Its program memory (12 K bytes) and operational memory (4 K bytes) were error protected with Hamming coding. A 16 K byte capacity image memory is placed in the direct address domain of the microprocessor; after photographing this is loaded by special purpose hardware with a 128 x 128 pixel (clipped) 7 bit image. In the automatic mode the computer determines the exposure time needed to prepare the next picture on the basis of this picture.

The image processing system had a number of ways to prepare the scientific pictures. So the following images could be prepared with any channel CCD which had a shutter:

- a 128 x 128 clipped image around a center determined by orientation,
- minimosaics of four 128 x 128 clipped images around the center of the CCD,
- sixteen 128 x 128 images located sequentially on the entire CCD surface,
- the entire software controlled image (in this case the CCD itself is the picture memory),
- in the event of failure the entire image passed on by the hardware circuits.

The sequence one after another of the several scientific pictures (the image sequence) could be determined in various ways:

--an image sequence stored in ROM memory--decided on before launch (naturally depending on the seances, that is on the distance from the comet),

--a picture or image series defined by earth commands,

--a command series sent up at the end of individual seances to define a new image sequence, which is preserved in the reserve mode between seances and which can be activated by a single command in the next seance.

During the mission, in the interest of achieveing scientific results, we did make use of these varied possibilities!

The television system of VEGA-2 also gave a good example of the necessity of functional reserves. Thirtytwo minutes before the encounter with the comet the orientation microcomputer stopped functioning--presumably as a result of a discharge following collision with a dust cloud (in the course of later testing it proved operational again). The next priority level orientation system, the 8 segment star transmitter, automatically took over control.

The Guarantor of Success is Circumspect Planning, Good Technology and Careful Control

The success of a space experiment depends on good manufacturing technology and careful checking on Earth in addition to a design which strives for optimal redundancy, taking into consideration the priority importance of the given task and the weight and consumption possibilities, that is, strives for circuit and functional reserves.

We developed the technology we used on the basis of our own earlier experiences and on standards established by the Soviet Union, NASA and the ESA:

- we used MIL Standard parts,
- we tested the parts individually, artificially aged them according to the defined themes, and then again checked their technical parameters,
- we cleaned the parts separately and then prepared them for use,
- we mounted the parts on printed circuit boards according to special prescriptions,
- careful cleaning followed completion of assembly,
- another cleaning and application of a protective lacquer followed card calibration,
- after putting the cards together we did a complete calibration and then used special tests to test all the equipment.

In addition to the testing described above we also subjected one unit of every type of on-board instrument, a unit corresponding to the flying unit, to type classification tests. The type classification test decided whether the instrument, as a type, was suitable for use on a space probe, whether it met the prescriptions pertaining to such a device. This test could not be done on the units to be launched because the test was of the "torture" type, using the instrument to the limit of the possibilities.

The several groups of type studies were:

- a combined heat-vacuum test with cyclic loads;
- mechanical load tests:
  - vibration tests,
  - acoustic tests,
  - a linear acceleration test,
  - a collision test;
- electrical tests:
  - a functional test,
  - an electromagnetic interaction (interference) test.

In the course of preparing, delivering and integrating the scientific measuring instruments to be put on board with the on-board service system they had to be checked functionally a number of times. In such cases a special earth checking system proved the perfect operation of the on-board instrument.

The last step of earth checking is the so-called integrated or complex test. This was done on the models of the probe and on the final probe. At this time all the on-board instruments are mounted on the probe and the on-board service system is also operating (Figure 3).

In the course of autonomous and complex testing the earth checking system has to imitate to different degrees the missing quantities to be measured and the environment of the probe (the telemetry command system, etc.) and evaluate the response of the system. It is a property demanded of the earth checking system that it be able to evaluate the response of the on-board equipment, that is

the output data of it. If it is properly made the earth checking equipment is also suitable for fast quasi-realtime evaluation of measurement results obtained during the space mission and thus for scientific guidance of the space experiment. In the case of the VEGA experiment we used a network made up primarily of the earth checking equipment, in addition to a large computer evaluating system, for scientific guidance of the experiment.

After appropriate decoding the earth checking equipment for the central data collector (BLISZI) received the signals arriving to Earth and distributed them among the equipment checking the individual scientific experiments. Two such control centers were established--one on the Crimean Peninsula, near the 70 meter diameter orientable antenna set up at Yevpatoriya (the technical guidance center for the space experiment was also at Yevpatoriya), and the other at the Space Research Institute (IKI) of the Soviet Academy of Sciences in Moscow. The latter received signals from Yevpatoriya and from the 64 meter receiving antenna at Medvezhie Ozera near Moscow. A special telephone link was available between the guidance centers. Measurement results were forwarded to Budapest by space telecommunications (with the aid of a geostationary satellite) and by leased telephone line and by courier.

The VEGA space probes, with the scientific equipment on board, were launched on 15 and 21 December 1984 from the Baikonur launch station of the Soviet Union. After the successful launch the probes were put in orbit around the Earth. After almost three quarters of a revolution they turned on the third stage rockets and the probes started toward Venus. After the rockets separated the antennas and solar elements were opened one after another and they turned on the equipment which also studied interplanetary space. The instruments using only the fast telemetry were checked about every two months. After a successful experiment conducted near Venus in June 1985 the probes continued their trip toward Halley's Comet. On 12 and 15 February 1986, after course corrections, the protective shields of the platform complexes were removed and the platforms were put into the initial operational position. On 14 February 1986 the platform of the VEGA-1 was turned, by earth command, toward Jupiter and at 1010 Moscow time there appeared on the screen of the earth checking system the picture of Jupiter taken and forwarded by the television system of the VEGA-1 probe. This began the last testing, with the aid of Jupiter and Saturn, of the VEGA probes before the meeting with Halley's Comet.

The VEGA-1 probe transmitted the first picture of the comet, from a distance of 14 million kilometers, on 4 March 1986 and in it one can already see a part of the tail of the comet. The best picture of the nucleus of the comet was transmitted by the VEGA-2 probe on 9 March 1986 at 0720 world time. On 11 March 1986 the VEGA-2 probe was already more than 14 million kilometers from the comet and thus ended the great adventure of the VEGA probes, observation of Halley's Comet. Disregarding minor damage caused by comet dust the probes themselves continued their journeys around the Sun in an operational state and continued research on interplanetary space. At the same time astronomers and ballistic experts are studying whether it might be possible, with course modification, to make a near study of some asteroid.

## Scientific Results

According to the most interesting scientific results of the space experiment the comet has a solid nucleus (potato shaped) the longer diameter of which is 14 plus or minus 1 kilometers and the shorter 7.5 plus or minus 1 kilometers. The period of rotation of the nucleus is 53 plus or minus 2 hours. The albedo of the nucleus (coefficient of light reflection) is extraordinarily small-- 0.04 plus 0.02 or minus .001. The above data pertaining to the nucleus were provided, naturally, by the television system.

With the aid of the infrared spectrometer they succeeded in determining the surface temperature, about 375 K.

With other instruments they determined the quantity of gases released by the comet and found that the loss is  $1.3 \cdot 10^{30}$  water molecules per second. It is probable that in addition to  $H_2O$  molecules  $CO_2$  molecules occur in the largest quantities. The in situ dust measurements were done in the  $m > 10^{-6}$  gramm range. On the basis of the VEGA-1 measurements the dust release is  $10^7$  grams per second; VEGA-2 measured a value of  $5 \cdot 10^6$  grams per second. The television pictures show a strong asymmetry of dust release.

The PUMA mass spectrometer determined the chemical composition of the dust particles. They indicated the following elements: H, O, Mg, Ca, Fe and C.

The TUNDE energetic particle detector on board VEGA-1 noted intensively energetic (greater than or equal to 40 keV) ions in the vicinity of Halley's Comet (at a distance of  $10^7$  kilometers). They succeeded in identifying three ranges in which the ions show different properties. In the outer range, at a distance of several times  $10^6$  kilometers, one can find so-called "pick-up" ions accelerated by the solar wind. The most intensive particle fluxes appear in the second range, within the "bow shock" at a few times  $10^5$  kilometers distance from the nucleus. The innermost range,  $10^4$  kilometers in size, is characterized by the lowest ion intensity and by sharp intensity peaks in the vicinity of closest approach (8,900 kilometers from the nucleus).

With the aid of the PLAZMAG instrument they succeeded in determining changes in plasma parameters and particle distribution as a function of distance from the comet, the structure of the "bow-shock" of the comet, changes in the chemical composition of the plasma, greatly enriched by heavy ions, as the comet is approached and the distribution of neutral gas along the path of the probe.

Both VEGA missions were successful, the on-board equipment passed the test well, especially outstanding was the good operation of the first intelligent space robot--it successfully solved recognition of the comet and following its path.

We also can be proud of this achievement, for Hungarian experts made all the electronics and the control software for one of the elements of the system, the television equipment.

But our scientists and technical experts are already preparing for a new adventure. The target is Mars and its satellite Phobos. Start is in 1988.

Manuscript received 6 January 1987.

#### FIGURE CAPTIONS

1. p 73. Space probes sent to study Halley's Comet and data on their courses in the vicinity of the comet nucleus, from a report of the ESA Western European space research organization.
2. p 78. Characteristics of the color filters used on the VEGA space probes sent to study Halley's Comet.
3. p 80. The complex testing of the instruments of the VEGA space probe (photograph).

#### Biographic Sketches

Istvan Apathy is an electrical engineer and a scientific worker. After obtaining his degree he worked for one year at the TKI [Telecommunications Research Institute]. Since 1970 he has been a member of the KFKI [Central Physics Research Institute] Space Electronics Group, more recently the leader of it. He is a member of the leadership of the Central Astronautics Special Department of the MTESZ [Federation of Technical and Scientific Associations] and chairman of the Space Technology work committee. He received the Erno Nagy Medal in recognition of his space research activity. The Space Electronics Group deals with development and preparation of instruments to do physical measurements in space. He participates in this work directly as a developmental engineer in addition to coordinating the work, primarily in the development of switching power units and digital systems. He likes to deal with reliability problems. He received the State Prize in 1986 for his work in the VEGA program and the Soviet government awarded him the decoration Sign of Appreciation.

Ilona Kereny (Mrs Peter Bereczki) earned her degree at the Electrical Engineering School of the BME [Budapest Technical University] in 1967. At present she works for the Nuclear Energy Research Institute of the KFKI, in an independent designing sphere. Previously she worked at the Medicor Works and the Instrument Industry Research Institute, where her chief activity was design and construction of medical instruments and industrial control activity. She participated actively in design and development of the CAMAC system. At the KFKI she participated first in the development of experimental physics equipment and then joined the work of the VEGA program. Within this framework she dealt primarily with the testing and radiation resistance studies on parts. In 1986 she received the silver degree of the Labor Medal for her work in the VEGA program.

Gabor Endroczi, mechanical engineer and scientific worker, earned his degree in precision engineering and optics at the Mechanical Engineering School of the BME in 1977. Since graduating from the university he has worked at his present place of work, the technical administration of the KFKI, in the

Vibration Diagnostics Laboratory. He joined the space research program for the first time in 1978. He participated in development and earth checking of the domestic equipment used in the mission of the first Hungarian astronaut. He did mechanical designing for the electronic units of three Hungarian devices in the Venus-Halley program, the PLAZMAG, the On-Board Central Data Collector and the TV system. In addition he did the mechanical checking (vibration, acoustics, thermal, etc.) and type studies on the domestic equipment in the program. In 1986 he received the gold degree of the Labor Medal for his work in the VEGA program.

Janos Ero Jr graduated in measurement and control technology at the Electrical Engineering School of the BME in 1978. He deals with design and programming of microprocessor devices at the KFKI. His chief works are an intelligent cassette data recorder, the basic modules of the KITTY earth checking system, the program operating ING-KITTY and a large capacity magnetic tape earth data recording system with an EMU-11 computer. He received the gold degree of the Labor Medal in 1986 for his work in the VEGA program.

Dr Tamas Gombosi is a doctor of physical sciences. He earned his physics degree in 1970 at the Natural Sciences School of the Lorand Eotvos Science University. He participated in the Hungarian-Bulgarian measurement which was the first to show the intragalactic anisotropy of cosmic radiation. Among other things he participated in processing and interpreting the data from the Soviet Prognoz and Venera experiments and the American Pioneer Venus Orbiter. He studied the interplanetary and coronal diffusion of flier particles of solar origin. He achieved new results in research on the ionosphere of Venus and developed a model to interpret the night ionosphere of the planet. In recent years he has had significant achievements in modeling comets. He is a chief scientific worker in the Cosmic Physics Department of the KFKI. He has offices in a number of domestic and international organizations. He is associate chairman of the Fourth Department, dealing with solar wind and interplanetary magnetic fields, of the International Geophysics and Aeronomics Association (IAGA). He is a member of the International Scientific and Technical Committee for the Venus-Halley program and the scientific coordinator of the program in Hungary.

Gyula Kozma defended his electrical engineering diploma at the BME in 1966. From 1955 to 1959 he worked in a Budapest service department for entertainment electronics. At the KFKI he dealt from the beginning with nuclear electronics. In the past 25 years he has participated in the development, design and installation of numerous instruments and measurement systems. In his present assignment as chief of a scientific department he deals with development of measurement systems serving space research goals being prepared with international cooperation. In 1986 he received the bronze degree of the Labor Medal for his work in the VEGA program.

Laszlo Lohonyai earned his electrical engineering degree at the Leningrad Technical University in 1966 and has worked at the KFKI since. For four and a half years, beginning in 1977, he was a colleague of the High Energy Laboratory of the United Atomic Research Institute in Dubna. He summarized the work he had done there in a candidate's thesis which he defended successfully in 1981. His chief areas of activity are development of nuclear instruments

and measurement systems and design of signal processing electronics for multi-filament proportional and drift chambers. He has served as technical deputy chief of the VEGA program since 1981. In 1986 he received the silver degree of the Labor Medal for his work in the VEGA program.

Dr Andras Gschwindt graduated from the Electrical Engineering School of the BME in 1965. Since 1965 he has been working in the microwave communications engineering faculty of the BME. His present assignment is university assistant professor and chief of the space research group of the faculty. His teaching activity is related to radio systems. He began his space research work in 1983 receiving meteorological satellites as a member of a student science club. Under his leadership his group developed subassemblies for various telemetry, satellite data collection and other physical measuring devices in the Interkozmos programs. In 1986 he received the State Prize for his work in the VEGA program.

Istvan Naday earned his electrical engineering degree at the BME in 1972. Since then he has worked at the KFKI. Since 1980 he has been deputy chief of a scientific main department, the Technical Main Department of the RMKI [Particle and Nuclear Physics Research Institute]. At first he dealt primarily with design of nuclear measurement instruments and measurement systems. In 1981-82 he worked at the Julich Nuclear Research Institute (FRG) as a guest researcher. In the VEGA space research program his task was guidance of manufacturing organization and technological planning. In 1986 he received the gold degree of the Labor Medal for his work in the VEGA program.

Istvan Renyi earned his degree in communications engineering at the Electrical Engineering School of the BME in 1968. Since then he has worked at the Measurement and Computer Technology Research Institute of the KFKI. In the beginning he designed peripheral systems and graphics devices for small computers. Then, with a scholarship from McMaster University in Canada, he worked on development of special purpose processors. At present he deals with digital image processing, and obtained a candidate's degree in technical sciences on this subject in 1981. In 1986 he received the gold degree of the Labor Medal for his work in the VEGA program.

Dr Antal Somogyi is a doctor of physical sciences. He earned his degree in 1943 at the Lorand Eotvos Science University. With his study of extended air showers he refined the energy spectrum of primary cosmic radiation in the range around  $10^{15}$  eV. He was leader of the Hungarian-Bulgarian experiment which first showed in a credible way that the intragalactic directional distribution of cosmic radiation is not isotropic. He participated in a number of international artificial satellite experiments, studying primarily the structure of interplanetary plasma and magnetic fields and the propagation of particles of solar origin. He is a scientific consultant for the KFKI. He is an official in numerous international and domestic scientific organizations. He is a member of the top leadership (BUREAU) of COSPAR. He is a member of the International Scientific and Technical Committee of the Venus-Halley (VEGA) program and scientific chief of the TUNDE experiment of the VEGA probe.

Ferenc Szabo earned his electrical engineering degree at the BME in 1951. He was director of the Atomic Energy Research Institute from 1957 to 1978 and has

been director-in-chief of the KFKI since 1978. He has been a corresponding member of the Hungarian Academy of Sciences since 1982. He is a member of the National Atomic Energy Committee and vice chairman of the International Scientific and Technical Committee of the Venus-Halley Program. He is a member of the Interkozmos Council of the Hungarian Academy of Sciences and chairman of the Cosmic Physics Committee of the Interkozmos Council. He is a vice president of the MTESZ. He received the Academy Prize in 1974 and the State Prize in 1978. In 1986 he received the State Prize for his direction of the VEGA program and the Soviet government decorated him with the order Friendship of the Peoples.

Laszlo Szabo earned his degree at the Electrical Engineering School of the BME in 1956. He has worked at the KFKI since 1956. Since 1972 he has been chief of the Technical Main Department of the Particle and Nuclear Physics Research Institute of the KFKI. In the beginning he dealt with development of nuclear instruments. He shared in the Institute Prize in 1970 for development of the Modular Nuclear Instrument family. In 1980 he was awarded the State Prize for development and spread of CAMAC systems. Between 1956 and 1972 he taught first at the Atomic Physics Faculty of the BME and then at the Instrument and Measurement Technology Faculty. At present he is also a member of the State Testing Committee. He has dealt with space research since 1980. He is the Hungarian technical leader of the VEGA experiment aimed at observing Halley's Comet and a member of the International Scientific and Technical Committee which guides the program. At present he is Hungarian technical leader of the Phobos space experiment. In 1986 he received the State Prize for his work in the VEGA program; the Soviet government gave him with the decoration Sign of Appreciation.

Sandor Szalai graduated from the Electrical Engineering School of the BME in 1962. In 1970 he earned a special engineering degree in process control. He worked at the United Atomic Research Institute in Dubna for 6 years. He participated in designing a number of computerized measurement systems. He defended his candidate's thesis in 1977. At the KFKI he worked on designing CAMAC modules and systems and after 1981 he was leader of the television system for the VEGA program. In 1986 he received the State Prize for his work in the VEGA program.

Karoly Szego is a candidate in physical sciences. He earned his physics degree in 1966 at the Natural Sciences School of the Lorand Eotvos Science University and has worked at the KFKI since. In the beginning he dealt with the theory of interactions of elementary particles and then with models describing the structure of hadrons. He has also dealt with space research since 1975. His research areas are creating models describing the structure of comets, a more precise description of dust and gas interactions in comet atmospheres and a study of the shock wave formed at the limit of a comet's atmosphere. He won his candidate's degree in 1973. He worked at the CERN for a year in 1976 as a guest researcher. Since 1974 he has been scientific director of the Particle and Nuclear Physics Research Institute of the KFKI. In the beginning he was a member of the Cosmic Physics Committee of the Interkozmos Council; at present he is vice president of the Council. Representing director-in-chief Ferenc Szabo he guided the work on the VEGA program in Hungary. In 1986 he received

the State Prize for his work in the VEGA program; the Soviet government awarded him the decoration Sign of Appreciation.

Andras Vargha earned his physics degree in 1964 at the Lomonosov University in Moscow. He began his cosmic radiation research with a study of extended air showers. He participated in the Hungarian-Bulgarian measurement, performed on Musala Peak in Bulgaria, which showed in a credible way for the first time in the world that the intragalactic direction distribution of cosmic radiation is not even. He has participated in processing and interpreting data from a number of international space research experiments. He is a scientific department chief in the Cosmic Physics Department of the KFKI. He is secretary of the Cosmic Radiation Work Group in the planetary and geophysical organization of the socialist countries (KAPG). He is the commissioned secretary of the physics committee of the Interkozmos Council of the Hungarian Academy of Sciences.

Peter Zalan completed his mechanical engineering studies at the BME. He worked in industry for 12 years. Since 1979 he has dealt with development of multi-filament proportional detectors at the KFKI. He participated in the VEGA program in designing optical control equipment and in organizing instrument manufacture. In 1986 he received the bronze degree of the Labor Medal for his work in the VEGA program.

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## BULGARIAN BIOTECH INDUSTRY ENCOURAGING JOINT VENTURES

Paris CPE BULLETIN in French Feb-Mar 87 pp 14-15

[Article signed R.B.: "Biotechnology in Bulgaria"]

[Text] Bulgaria is becoming CEMA's most advanced member in biotechnology. Determined to establish a competitive biotechnology industry as soon as possible, Bulgaria decreed in 1985 that its development was one of the country's main priorities. Cooperation between the Ministry of Equipment, the Institutes for Industrial Chemistry, the Committee for the Advancement of Science and Technology and the Industrial Association has resulted in the creation of the Biotechnika Corporation.

The seven major projects on the agenda, which are being carried out in close collaboration with West European companies, could bring Bulgarian high technology to the international level. The only industrial uses of microorganisms involved two Soviet units, started in 1964, which--based on agricultural, forest, chemical, and food wastes--produced a small quantity of proteins using *Candida* and *Trichosporon* cultures. In 1985 the Soviet Government decided to increase production to more than 200, metric tons.

The city of Sofia remains unquestionably the main Bulgarian research center. The strong points of this research are:

- A patent for the production of glucose isomerase using a *Streptomyces* culture;
- Immunoglobulins and betaglobulin;
- Cultures of *Thiobacillus ferrooxidans* allowing good lixiviation (solutions containing copper sulfide in concentrations ranging from 16.52 percent to 35.05 percent);
- A method for the production of giant liposomes (the size of a cell) to be used later in biotechnological processes;
- Two-dimensional electrophoresis, cell adhesion and fusion in an electric field with radial symmetry (generated by a platinum wire placed in the center of a metal cylinder).

This country is currently an important producer of antibiotics, notably Bacitracine, Flavopharm, and Tylosine. Embryo deep freezing and transplanting technology is being widely used to increase cattle herds (20 embryo transfer centers are already in operation). Cloning techniques are soon to be introduced, and it is important to note that a gene bank has been opened with financial and

technical assistance of the United Nations FAO [Food and Agricultural Organization] in Sadovo.

In vitro cell culture is being used to obtain virus-free plants (potatoes and fruit trees). New hybrids are being sought especially among cereals.

Since March 1980, legislation has allowed the formation of joint ventures; it provides favorable credit terms and quite substantial tax discounts (over 20 percent). Moreover, it allows foreign partners to hold a majority of the shares. This policy reorientation led to the formation of seven "joint ventures" in 1985, and thus far it has been the British who have primarily contributed to this rapid development.

APV International PLC (Crawley) opened the way to these bilateral projects by forming with Bioinvest (genetic engineering and fermentation, Sofia) a pharmaceutical and agro-food company called APV-Bioinvest in which it holds 51 percent of the capital. Bioinvest has also conducted extensive negotiations with Celltech to market diagnostic tests based on monoclonal antibodies in CEMA under English license.

John Brown Engineers and Constructors Ltd. (London) and FTO Technika (Sofia) started a joint enzyme factory in Katuniza. Production is mainly intended for the pharmaceutical industry (an investment of 20 to 50 million pounds sterling). Other partners in joint ventures with Bulgarian companies are FANUC, Mitsukoshi (Japan) and Honeywell (United States).

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## SAMPLINGS FROM BUDAPEST INTERNATIONAL FAIR

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87  
pp 1, 2

## [Excerpts] Fair of Promises

Just as 1987 is a promising year so this year's spring Budapest International Fair appears promising also. We are thinking, for example, of the PPC [professional personal computer] competition. In our brief preliminary report we succeeded in wringing promises from 16 firms or institutions which will, hopefully, be realized in smaller or larger series.

## Features of OMF [National Technical Development Committee] Stand

Traditionally the National Technical Development Committee appears with an independent exhibit. The themes at Pavilion 23 show the results of technological and design developments aimed at economical material use. The use of computer technology--in accordance with the concept--figures in a large part of the total of 34 small exhibits.

For example, they show for the first time the entire photo composing system of ITEX, from the text input based on the Proper computer family through editing and composing to projection. The latter is solved with a machine representing peak technology (we wrote about it in detail in our issue No 2, 1986). We await with interest a graphic work station making possible press make-up.

The Lenin Metallurgical Works has solved manufacture of steels with extra small carbon content using computerized control. Beside this we can see one of the first domestic applications of the LAOCON system; posters show a system built for subsequent automation of plastic injection molding machines. Rekar is represented by a special purpose robot to serve a new generation of machine tools, in addition to the arc welding robots. The Gardenia Lace Curtain Factory solved with computerized control the preparation of punch cards for Jacquard warp looms, which promises a productivity increase of about six times.

The Central Mining Development Institute has developed a miniature personal code transmitter built into a miner's lamp. The device, part of a system developed for personnel safety control, also offers a possibility for

additional information processing. At Ganz-Danubius they modernized the preparation of cutting plans with a computer, with the cooperation of the SZKI [Computer Technology Research Institute and Innovation Center] and Innofinance. Finally, an outstanding item will be introduced by Ganz-MAVAG; it proves the efficiency of the finite elements method for such things as a motortrain made for the Soviet Union and a cassette reloader for nuclear power plants.

#### 16 Bit Robotron

Discussions have begun for delivery in Hungary of the first 16 bit Robotron made professional personal computers. A number of domestic vendors are interested in the A7100 computer, which is amply supplied with basic and applications software. They are now developing the MS-DOS system for the machine. We must still wait for a machine with complete IBM PC compatibility.

Also at the joint GDR exhibit we will see the 1:10 ratio model of the ESZ 1057 computer introduced at the Leipzig spring fair. For the time being all we know of the machine, which belongs to the ESZR [Uniform Computer Technology System] third series, is that it was also made for CAD/CAM applications. The A6471 image processing system contains a K1630 computer corresponding to the SZM 4; it is suitable for evaluation of industrial, medical and thermal photographs with the aid of a color monitor and image store and has a video camera, microscope connection possibility. The A5222 data collection terminal and the A5240 time recording and stepping system were designed for harsh operational conditions.

#### Videoton Plans

For the leading computer manufacturers 1986 counted as the year of "plus." It appears that this year will be so for us. Janos Gantner, director of the Videoton Computer Technology Factory, talked to our journal last year about the following strategy of Videoton; well, the little word "plus" appearing in the designations for the smallest and largest Videoton computers is a good example of this. They had to add operational memory and background stores to the earlier ESZ 1011, thanks to which the "plus" covers a substantial performance increase; and the TVC, in the school and home computer category, merits the "plus" designation not only because of the two 1 megabyte floppy disk units but also because of the MS-DOS compatible operating system they added, so that the machine can enter the professional PC category.

Some got a zero instead of a plus, the VT-110, VT-160 means the 16 bit category and VT-320 means the 32 bit category. They will show CAD/CAM applications on a machine with a central unit corresponding to the Motorola 68010 microprocessor, including a system suitable for designing power plant pipe networks and a system which edits printing press documentation. The VT-320's and the ESZ 1011 Plus have been connected into an Ethernet local network, which can also be seen at the Videoton stand in Pavilion K. On the XT and AT category PPC's they are showing, in cooperation with Saldo, office, financial and accounting application possibilities.

Another little plus can also be seen at the Videoton stand, things which will be commodities in years to come but which today are only developmental achievements. One can regard as such, for example, their optical disk document retrieval system.

#### Questions About 386 Computer

The small cooperatives are planning their 386 machines as a sort of surprise so it is very difficult to get them to say in advance if they will be at the BNV [Budapest International Fair] with 386, IBM compatible equipment. It is very probable that Instrument Technology will let this peak model out of the bag, for development there is taking place in two directions--they are designing an 80386 microprocessor as both a base card and an expansion card. The purpose of the latter would be to make it possible to easily change AT's sold earlier into 386 computers.

The two types of 386 card, of their own design, well supplement the card family which the Instrument Technology Small Cooperative has designed for XT and AT machines, local networks, process control and various special applications. It is important to emphasize the independent introduction of the cards, not depending on a computer, because one of the professional differences of opinion today is that according to the members of the PerComp Association the cards should be made here with 2-4 layer printed circuit technology and according to other PPC manufacturers it would pay better to import them.

The independent design of network coupling cards justifies Instrument Technology. After the success reaped in the West by their ArcNet type card it appears that they will be the East European representatives of Novell. And if they have the network and they have the East they will display their EastStar computer with intelligent LAN terminals. At their D/1 Pavilion, outside the hall, they will also show various CAD program packages and designing systems containing special peripherals. And while little is being said about the Intel microprocessor 32 bit peak model, there is no secrecy about the Motorola 32 bit peak model--a 68010 microprocessor has been put into the further developed TM16. (The BNV will make possible a comparison in the area of multi-user computers with architectures based on the VME bus at least in the world of IBM compatible PC's, for Videoton and Csepel Electronic among others, in addition to Instrument Technology, are promising something new.)

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## DISPLAYS AT MIPEL IN BUDAPEST

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87 p 3

[Article by Miklos Horvath: "MIPEL Something--But Is It Real?"]

[Text] MIPEL '87 could be visited this year between 7 and 10 April. The International Instrument and Industrial Electronics Exhibit, held every 2 years, was located, with four others, in Pavilion A of Hungexpo. For the first time here a professional exhibit had a ministerial level patron.

In his opening statement Laszlo Kapolyi, minister of industry, said, among other things, that the acceleration of technical progress is a stressed task in the difficult period standing before Hungarian industry. Our enterprises must link more vigorously than before into the international division of labor, must participate in building up contacts and cooperation making possible a flow of modern technologies.

For this reason greater attention must be turned to professional exhibits hereafter, because they can become suitable forums for building contacts.

#### The Landscape Before Local Area Networks...

At a preliminary press conference Hungexpo characterised MIPEL as a computer technology centered parade of nearly forty exhibitors--half foreign and half Hungarian--and promised CAD/CAM systems, robots and integrated network systems at the head of the parade. In contrast to this we could see no robots, and although a good number of the larger domestically developed CAD systems were represented we could discover a computer integrated manufacturing system ("plodding along", to retain the style [the Hungarian for "plodding along" is rendered "CAM-mogosan"--one of a number of puns in the article]) at most at one remove, among the universally applicable computer systems. On the other hand the offering of local network hardware and software products moved over a truly broad scale--in regard to individual LAN types, expandability and accessories, because there was much less difference in price.

The exhibitors were grouped around the two limits of the special area--the manufacturers of discrete and integrated circuit elements and parts and those delivering very modern automatic equipment to produce them (primarily from

capitalist countries) on the one hand and, on the other, those offering microcomputers, accessories, networks and software (most of them Hungarians).

It is thanks primarily to the West German export firm ITC (Intercircuit GmbH) that with the aid of their German, Italian and American partners special purpose equipment represented every phase of the production of printed wiring circuit sheets and integrated chips. In addition to systems for mechanical processing, cleansing during and after manufacture, push-through washing and mounting of parts, the exhibits outstanding for performance and versatility were the Italian Mania MPP 3828 system to test unassembled circuit boards and the American Nicolet Mikrox PC-2 system for automatic, real-time X ray radiography which discloses with great certainty the invisible faults in hybrid circuits made with multi-layer technology.

Turning to the Hungarian CAD systems, the absence of a customary demonstration computer struck the eye. The Macintosh disappeared from the stand of Graphisoft, an unmistakable sign that new winds are blowing there. The BIOGRAPH two-dimensional designing system is already made for IBM 615X 32 bit computers under a C language AIX operating system (compatible with UNIX System V). The common element assortment database can be used by work stations connected into a network with Ethernet or Token Ring couplers.

They are also planning to release a version of their three-dimensional pipe network designing system, RAPID, which will be compatible with the IBM AT. It is interesting, as the representative of the small cooperative noted, that Hungarian designing institutes do not need such complex isometry, RAPID can do too much for them, so the AT version will be adjusted to domestic expectations. (It would be fortunate if the associations formed for large series manufacture of Hungarian PPC's [professional personal computers] would include it in the program inventory for their machines.)

The MAT based designing system of Instrument Technology joins a variable hardware configuration to several program packages. The Cosy [Cooperative Systems Subsidiary of SZTAKI--the Computer Technology and Automation Research Institute] is offering a two-dimensional system called CADdy for Varyter XT/AT machines in an MS-DOS environment.

The emperor of local networks dominated the VARYLAND created by MTA SZTAKI Cosy. The name of the variable communications control (file-server) is VARYCOM and it can realize the integration of various types of LAN's of various levels from the LANPBOX heterogeneous network through the ArcNet, etc. types to the most developed, centrally controlled networks. Even a C-64 could access it!

A number of exhibitors, including Microsystem, Controll and Instrument Technology, offered networks quite amply.

Microsoft, 6...

Multiplan, Word, Rbase and many other Microsoft leader articles as well as program languages and compilers caused the greatest surprise in the offering of Szamalk [Computer Technology Applications Enterprise] OSAK [National

Software Archives and Tracking Service]. Especially so because in most cases the prices did not exceed, for example, half or two thirds of the prices of the Magiszter Bookstore. The orders collected will be followed by delivery in 2-3 months and even then the purchaser can get the article selected at the same price even if the manufacturer is then trading it with a higher version number.

An "exotic flower" in the world of IBM PC compatible domestic software is the SAGO applications program generator, of Polish origin, which enriches the OSAK assortment in the area of high level programming environments, above COBOL.

Finally we should devote a little attention to two summary statements heard in regard to the stands, more precisely to the extremes embodied in them: "A fascinating world..." and "We always offer our computers at the price at which we can deliver them." What is between these two may be Hungarian computer technology today, and MIPEL '87 was a reflection of this--not free of distortions.

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## HUNGARY: DATABASE SYSTEM FOR LAN'S

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87 p 5

[Text] In many cases in our country there is an attempt to organize business systems for 16 bit PC's which scrape (or even exceed) the limit of the abilities of a personal computer, which handle large data files and satisfy complicated user requirements. At the MTA SZTAKI [Computer Technology and Automation Research Institute of the Hungarian Academy of Sciences] they developed the LATOR database management program for the purpose of satisfying such needs. The software, which can be operated in a local network, was expressly developed for experienced system developers. With it one can effectively create programs to handle large volumes of data.

In concept and data organization LATOR, completely their own development, differs a bit from the relational database managers known on the market. They offer the product, with a data structure similar to CODASYL, primarily for online transaction handling systems where fast response time is essential and where reliability of data and easily handled, up-dated management of a database with a complex structure is an important factor. The database can be used through host language programs (the languages supported are Pascal and C) but it can also be accessed with the aid of the database management language of LATOR itself. In a LAN environment there is a possibility for record level blocking to user programs, transaction ending signals are used and a communications area assigned to the work station is available. In the case of relatively few database management systems in this category can one find the special service by virtue of which the LATOR database can be simply restored from some error by using a well developed auxiliary program assortment.

At present the database manager can be installed for the Orchid PCnet and the Olivetti LAN (10 net) and for networks compatible with them, but the developers promise that the system will soon be adaptable for other LAN's as well. The minimal resource requirements are 256 K RAM, one floppy disk drive and a DOS 3.0 or higher operating system. The capacity of the hard disks limits the size of the data structures and their number is limited only by the size of the internal memory.

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## HUNGARY: AGRICULTURAL SOFTWARE TO USSR

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87 p 5

[Text] The Agricultural Business Organization and Computer Technology Institute (MUSZI) has signed a business agreement exceeding all previous undertakings. In accordance with it, beginning in 1987, it will deliver to the Soviet Union software and the computer technology equipment needed to operate it to a value of about 50 million rubles.

Experts of Soviet agriculture dealing with computer technology are expecting Hungarian aid in operation of the complex information system of the poultry combine near Moscow and in collecting the data needed for more up-to-date data processing by the supervisory organ dealing with agricultural production in the Moscow region. A further goal is to use the tools purchased from the MUSZI to aid smoother supply of fruits and vegetables to the Soviet capital and achieve a qualitative improvement in this area, from purchase of produce through warehousing to shop network distribution. It is reported that the results of the cooperation will really be felt probably after 3 years.

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## HUNGARY: RECOGNITA, OPTICAL CHARACTER READER

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87 p 5

[Text] Recognita, the character reading program of the SZKI [Computer Technology Research Institute and Innovation Center], has developed much since its first showing a year ago. Nothing proves this better than the fact that it appeared at the Hannover Fair this spring and about 20 firms offered to sell it.

The software reads from an image digitizer (text scanner) information written with a carbon ribbon typewriter or printed in good quality (e.g., laser or daisy wheel peripheral) on pages with a maximum A/4 format and recognizes the text read in while preserving its format. Recognita can be run on any IBM compatible PC. It gets its input data from an image digitizing device with a resolution of 300 pixels per inch, well suited to a personal computer in speed and size.

An essential element is that it can be taught to recognize various character types and to "understand" special characters or faulty characters on the typewriter. The bit image of unrecognizable parts of text is displayed, enlarged, on the screen. Proportional characters are also recognized.

The developers offer Recognita, which has window and menu management, primarily for office automation purposes and tasks connected with text editing (handling letters, contract files, etc.). It can also be used advantageously for handling and processing telex messages.

Reading speed depends on the speed of the image digitizer (e.g., this is 20 seconds per page with the Microtek peripheral) and the recognition time (on a Proper this is 40 seconds per page for a 2,000 character page and on a 286AT it is 8 seconds per page).

A new age is beginning: The PC is learning to read from paper, the user is freed of the labor and time demanded by retyping and information can be recorded eight or ten times more quickly (or even more quickly than that) than the speed of keying and--what is very essential--free of typing errors.

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## HUNGARY: PHYSICS RESEARCH INSTITUTE COMPUTERS MEET CAD REQUIREMENTS

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87 p 5

[Text] Applications systems aiding primarily electronic and mechanical design and manufacture at industrial and research and development enterprises can be developed using the 32 bit TPA-11/540 and TPA-11/580 computers of the KFKI [Central Physics Research Institute]. These already satisfy the speed, memory and input-output capacity requirements of large CAD systems and solve computation intensive tasks within an acceptable time. And the MOS-VP operating system supports the writing and running of large programs.

The KFKI has now taken a step in the software line as well. They have developed several 32 bit program systems the use of which is now being prepared at the research institute. The CAD-S system aids design of printed circuits and multiple layer, highly complex circuit cards. The advantage of the program is that parallel with the input of the circuit diagram data it prepares a list of connections so they do not have to be typed in from the keyboard.

They are also preparing mechanical designing systems called CAD-A and CAD-E. CAD-A is a system supporting at a high level the preparation of drawing documentation and production of control data for three and five axis processing machines. CAD-E is a high performance, conversational program package for spatial modeling of objects. It is characteristic of it that with its aid the models can be stored in a database, can be retrieved therefrom and modified or built into other models. The software handles free-form curves and surfaces or objects defined by such surfaces in a manner similar to traditional geometric elements.

CAD-F can perform general purpose finite element analysis. It supports solution of tasks connected with dimensioning procedures which arise in the course of engineering design work (determining tension and movement fields, self-vibration and self-frequency; study of constant or transient temperature fields; fracture studies, etc.).

CAD-P is a conversational program for preparation of finite element analyses and processing of their results. Its command set makes possible fast determination of physical and material properties, limit conditions and load states in addition to creation of the geometric model.

In order to better exploit the possibilities of the four mechanical systems they have realized direct data flow among them. The two designing systems stand highest in the hierarchy. The geometric model of the workpiece can be built up with one of these. The link between A and E can be created with an IGES (Initial Graphic Exchange Standard) software interface. Data from the designing systems can be transferred to CAD-P, which has a direct, bidirectional link with CAD-F.

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## HUNGARY: SOFTWARE FOR PUBLIC HEALTH

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87 p 6

[Interview with Pal Simon and Jozsef Hozmann by Marton Vargha: "Is The ESZTIK on a New Path?"]

[Text] At the second national microcomputer meeting visitors could become acquainted at a joint exhibit with health affairs applications. The joint action was taken at the initiative of the ESZTIK [Organization, Planning and Information Center of the Ministry of Health]. We talked with Pal Simon, director of the ESZTIK, and with Jozsef Hozmann, chief of the information department.

[Question] What does this joint action mean from the viewpoint of Hungarian health affairs and what results do you expect from it?

[Answer by Pal Simon] We missed the proper moment to supply health affairs institutions with centrally planned and executed programs and a uniform computer inventory which would lead in computerization. The ministry expected ESZTIK to prepare, primarily, basic statistics and records, while planning, the cultivation of health affairs informatics and computerized aid to medical work were forced into the background.

There was in health affairs--as in every ministry--a Computer Technology Applications Committee (SZAB), but we never got as far as developing a uniform, workable concept. Because of this the available resources were spent on essentially isolated, ad hoc computerization and programs. Some of these succeeded well and are in operation today and there are--or were--abortive experiments. But even the successful developments did not get so far as to be real model systems which could be copied and propagated.

The drying up of central resources and the appearance of microcomputers created a new situation. Obtaining money from this or that source the health affairs institutions began independent developments and some of the developments have already appeared on the market as products. In order that it not be necessary to pursue the same deadends everywhere and so that the experience obtained everywhere should contribute to achieving the best price/performance ratio there is certainly a need for bringing the developments together. It is certain that this could not be done with the

traditional tools of branch guidance, so we think that the ESZTIK must find its place on the market. We are creating an expert group the members of which are capable of developing a long-range concept for health affairs informatics, who can say in which areas it is worthwhile and necessary to have computerization and what those hardware tools are on which we can build.

We intend to implement the achievements and recommendations of this expert group not by force but rather with market tools. We want to serve the health affairs institutions by seeking out proven, operable systems and recommending that the best be adopted--we may aid with concessions and price supports.

In order to carry out this new role, a consulting rather than directing role, the ESZTIK needs greater freedom of movement, and we are now working on attaining this. Instead of being a background institution of the ministry we would like to become an undertaking active in the forefront of health affairs, therapy and prevention, an undertaking which makes decisions not only in regard to how long it will take to provide a statistic but rather in regard to at what level it can serve the development of computer technology and informatics at hospitals and clinics.

[Question] What concrete steps can we expect in the near future?

[Answer by Jozsef Hozmann] There is a good chance that the ESZTIK will develop in health affairs a service similar to that of a software house or commercial house. This year we are holding for the third time the MEDISOFT exhibit, which indicates, together with the present joint health affairs exhibit, that there are foundations for this change. The next step will be to constantly take over finished programs for distribution; and we will undertake to install them, train people in their use and maintain them. If a healthy price/performance ratio develops and suitable reference systems are provided, then purely market tools can be used to aid the spread of uniform, practically standard hospital informatics systems with the aid of which it will later be possible to constantly track and monitor the state of health of the populace.

The effort aimed at creating a health affairs software market received support from an important source when a desire was formulated at the November NJSZT [Janos Neumann Computer Science Society] congress according to which the individual developments in computer technology must finally be converted into real products which can be sold in large numbers.

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## HUNGARY: FUTURE METERING SYSTEMS

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87 p 24

[Article by Elemer Kozma, chief of the science department of the MIKI (Instrument Industry Research Institute) Metering Technology Development Enterprise: "Metering Systems for the Factories of the Future"]

[Excerpt] Under present production conditions a completely integrated system is realistic only in the most developed industrial countries, but the creation of less integrated systems is absolutely necessary to solve the production tasks of even less developed industrial countries.

We will describe below two systems made up of automatic devices developed by MIKI which are harbingers of truly highly integrated systems.

## Instrumentation of IC Manufacture

Some elements of this system are already in operation; full development will be realized by the end of 1987.

The operation of the system is briefly as follows:

## A. Experimental Manufacture

1. Circuit design of the IC to be manufactured takes place at a CAD station. Input data for the technological phases is created during the designing process.
2. The first test point in the course of manufacture is a test of the basic structure (the so-called test structure) determined by the technology. The Parametric Test System (PTS) developed by MIKI takes care of this task.

The characteristics of the test structure to be studied are loaded into the memory of the PTS through the MIKNET local network. Test results go to disk files and upon completion of the measurements they can be sent to the central data processing unit (KME).

3. After completion of the technological processes of wafer manufacture there is a functional check of the wafer which ends with designation of the bad

chips. The measurement results (parameter values, number of good/bad chips, etc.) can be sent in the offline mode to the KME. The automatic devices used are ICA-203, ICA-204 types. The database of the KME can be accessed directly from the designing system, so the experiences of experimental manufacture can be taken into consideration in the designing process.

4. The IC's classified as suitable in the wafer test are encapsulated. Following this the encapsulated IC's are checked again, as a result of which they can be put in classes.

High precision automatic devices are needed for the measurement tasks formulated in points 2, 3 and 4; measurement speed is not a primary characteristic for them.

The manufacturing parameters can be set on the basis of the data collected in the KME, taking into consideration the spread of the manufacturing line. As a result of the testing processes described in points 3 and 4 one gets an algorithm for the measurements to be done on a given type of IC. The program to be run on the local control units of the series testing test stations can be produced with computer aided procedures on the developmental station of special purpose automatic devices on the basis of these algorithms. The MIKI 2000 automatic device family was designed taking into consideration its use in an integrated system.

#### B. Large Series Manufacture

5. In the case of series testing a special purpose automatic device (MIKI 2400) is connected with an automatic measurement work station (e.g., EM-680 manipulator); the results of wafer measurements go to the KME in the online mode. Feedback to the technology becomes possible after running offline trend analysis programs on the data collected. In the case of a closed technology the wafer measurement work stations also provide the information needed to cut the wafers apart.

6. Measurement and classification of the encapsulated IC's is the next control task. Here there are various types of automated work stations--mechanical feeders (e.g., IMO-01) and feeders supplemented with a heat chamber to make climate tests possible.

The measurement results go to the KME in the online mode; in the event of any change in the yield the KME gives a warning signal to operations control.

The ratio of wafer measurement and encapsulated test stations is determined by the yield index of the semiconductor technology used.

By exchanging the measurement adapters of the MIKI 2400 system we can switch to measuring a new IC type; the measurement programs can be loaded centrally into the control unit of the special purpose automatic devices in accordance with the new configuration.

Through the KME unit the system described above becomes part of a higher hierarchy. The KME contains the appropriate coupler (Cheapernet) and software.

## Automation of Electronics Plant

Our following example describes the integrated development of a plant in an electronic equipment factory, using the automatic devices developed by MIKI.

The operation is as follows:

1. Electric and print designing of the circuits takes place on a MIKI 2500 designing station. Some of the information needed for designing is available on the spot, but the necessary standards and designs of finished subassemblies can also be called from the database of the plant. A simulation can be done before completion of the final circuit diagram. The printing plan for the circuits and the electrical documentation are prepared on the graphic work station of the designing station. On the basis of the connection plan provided for printing the equipment automatically produces the test program for the in-circuit test, the program needed to control the drilling machine, the program for the automatic parts mounter and the test program for parts to be checked before assembly.

The database needed to operate the repair station is also created at this station.

2. Checking of the more important active and passive parts before assembly takes place at the work stations checking incoming goods. The data for the tested parts go to the KME for later trend analysis.

3. The parts mounting automatic device places the necessary parts into the printed circuit with the aid of a program loaded from the MIKINET network.

4. The in-circuit test station checks the connections on the assembled, soldered printed circuit boards (shortcircuit test, break test); it checks the passive parts according to value and functionally tests the active analog and digital parts.

The final result of the test is printed in line code on the accompanying card affixed to the printed circuit (position number of faulty parts, the parameters of the error, etc.).

5. Cards found to be faulty in the in-circuit test go to the repair station (MIKI 2900). After reading in by reading the line code on the card accompanying the printed circuit the station identifies the printed circuit and an assembly diagram of the card is displayed on a color graphic terminal, highlighting the parts found faulty by diagnostics. Following replacement of the faulty parts the printed circuit again goes to the in-circuit station.

6. The next station performs the functional check of the printed circuit. In the event of faulty operation the printed circuit again goes to the repair station.

7. Following complete assembly of the equipment there can be a full test of the finished device. Depending on the character of the equipment these tests will require inclusion of additional automated test stations, developed from members of the MIKI 2000 family. Linked through the MIKINET the new stations will be able to cooperate organically with the integrated system.

## HUNGARY: TRANSLATION PROGRAM FOR ADA

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87  
pp 28, 29

[Article by Laszlo Zajki: "The Hungarian Ada"]

[Text] According to reports in the Ada Newsletter there were, in December 1986, 56 Ada compilers accepted on the basis of validity tests. Already in 1985 an international conference for users was organized with the title "Ada in Practice." A few institutions already prepare their products only in the Ada language. In Hungary the majority of programmers have hardly even heard of this language and actual use simply does not exist. It cannot, because there is no accessible translating program.

There were only preliminary documents (Preliminary Ada, Rationale) when, at the initiative of Ivan Bach from SZTAKI [Computer Technology and Automation Research Institute], a group of experts began to study the new language. Shortly after reading the materials a decision was made that a translating program must be prepared. In 1980 an organizational structure had been outlined, the already existing SZKFT, which coordinated the joint developments of the five largest computer technology research institutes (MTA SZTAKI, the SZKI [Computer Technology Research Institute and Innovation Center], Szamalk [Computer Technology Applications Enterprise], MTA KFKI [Central Physics Research Institute of the Hungarian Academy of Sciences] and Vifi [Videoton Developmental Institute]), which provided an opportunity to begin the work. The leader of the group was Balint Domolki (SZKI) and the representatives of the firms were Ivan Bach (SZTAKI), Zoltan Loborczi (Szamalk), Miklos Papp (KFKI) and Laszlo Szoke (Vifi).

Plans for a translating program were compiled by 1982 and programming began with full force then. Soon after beginning the work it became clear that the task involved was larger than any previous estimate and that the developmental machine requirements were many times greater than planned. The participating institutes (primarily SZTAKI) made their computer capacities available to the limits of their possibilities.

At the "peak time" the personnel of the project numbered 35, which was accompanied by serious organizational difficulties. Work was being done on a total of 11 computers in various developmental phases and keeping records on

the swiftly proliferating programs proved an insoluble task. It had to be admitted that the original goal (full realization of the Ada language) could not be met, the time limits were continually extended and more and more money was being used up. The only way out was to post an intermediate goal, and the work could be concluded after this was attained. If we leave out of Ada the prescriptions pertaining to representation and the generic units then the essence of the language does not change but the programming and testing time is reduced by one-fifth or even by one-third.

A somewhat limited version was prepared by 1984 under the IBM/CMS and OS and VAX/VMS operating systems. Simultaneous with the last corrections it was also transferred to TPA-11/RSX-11 (KFKI) and ESZ 1011 (Vifi) computers. Although the transfers required modification of a number of program parts, and this could also have an effect on the main version, these did not on the whole cause as much difficulty as might have been expected. The selection of the developmental tools and methods had a role in this; the CDL2 language laboratory proved to be an effective aid.

In the course of planning and programming it turned out that the description of the language which had appeared complete and precise on first reading left many questions unanswered, or gave interpretation possibilities which contradicted one another. Because of the size and complexity of the Ada language the members of the group could deal only with individual partial tasks; only in this way did basic analysis and planning become possible.

The two most difficult parts of the translating program, the semantic analyzer and code generator, required more than half of the work. (Gyorgy Kariko developed the semantic analyzer while the work group of Gusztav Groszmann and Erno Farkas developed the code generator.) The role of the library and running system were constantly upgraded, especially because of their effect on running speed.

Creation of a working system consists not only of writing the programs. The checking of translating programs requires especially many test programs. They prepared a plan for a systematically structured test system (test net), but unfortunately it was not realized. We now know that this was not by chance--the SofTech firm used nearly 100 programmers for 6 years to write the validity testing test package and the result is more than one million source lines. This work alone would have exceeded the possibilities of the group. They succeeded in producing here at home about 1,200 test programs totaling 20,000 source lines, and with their aid they were able to eliminate many errors.

So we cannot say that we have checked the compiler completely; it is probable that many hidden errors could be found in it in addition to the known errors.

Another problem proving insoluble was preparation and recording of documentation. Such a large scale project requires careful recording of precisely formulated documents. Unfortunately there was insufficient human and machine capacity even for programming so how could good documentation have been prepared? The vicious circle--good documents are needed for programming but preparation of them takes assets away from programming--led to compromises: The program is not good enough and the documentation is not

complete. Turnover is unavoidable with so many people and training the new members also takes much time and energy from worthwhile work.

The critical period for the project was 1984-85. During the 4 years of the development the participants had been worn out, many had left the group, because the conditions kept deteriorating. There were still many defects in the programs. The earlier loosely structured group broke up and there was not much chance for an honorable conclusion. It was some consolation--but not compensation--that this was the most successful Ada group in the socialist countries, and the partial achievement made it possible to become acquainted with Ada.

After long discussions the SZKI decided to continue the work, and formed a ten person nucleus to prepare an Ada system which could be used in practice.

Using experiences with the first version, and adding many new implementation ideas, an entirely new translating program is being prepared--in the Ada language. More than half of the programs already exist and a version which can be released will probably be prepared by the end of 1987. A few of the chief goals should be mentioned--realization of a complete Ada language, making the user environment convenient and a significant increase in translation speed.

The piquancy of the new situation is that not only must we make an Ada compiler system but we must also program in Ada, so the first user of the system will be the group dealing with development itself.

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## HUNGARY: SZAMALK BUYS AUTOMATIC SYSTEM FOR KINEMATIC ANALYSIS FROM FRG

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87  
pp 32, 33

[Article by Tamas Kolossa: "ASKA: For CAD-FEM-CAM Designers"]

[Excerpts] The Szamalk [Computer Technology Applications Enterprise] recently purchased the West German ASKA system (Automatic System for Kinematic Analysis) and hopefully domestic industrial and practical use will spread.

## Hungarosoftware

In our country, after one or two construction industry applications, FEM (Finite Element Method) research began in 1972, first at the Heavy Industry Technical University in Miskolc. The method was soon included in the study materials as well. The Mechanics Faculty prepared a number of industrial program systems, including one with Autokut to check bus frames, to compute flexible structures with axially symmetric geometry and deformation. In addition to the machine industry applications they also solved a number of mining tasks. Today, on a commission from Videoton, they are developing a general purpose system using minicomputers for two-dimensional structures and an ESZ 1035 and larger computers for three-dimensional structures. The developments have been held back by the lack of graphic peripherals. (Laszlo Cser noted this in 1985 and the situation has not improved since!)

Several institutes and faculties of the Budapest Technical University also use program packages they developed themselves. Workers at the Machine Structure Institute have developed a method to study two and three-dimensional rod and beam structures and sheet designs in which the size of the tasks which can be solved is not limited. The programs include data preparation and plotter modules (so-called pre and post-processors). A study of bodies of rotation and shells, including pressure containing vessels, and dimensioning of pipes makes up a significant proportion of the research. In addition to their own programs the Technical Mechanics Faculty is constantly working for the IKOSS firm, vendors of the ASKA. Developments done for Ikarus are significant at the the Transportation Engineering School. Sanitary engineers have achieved results in heat and fluid mechanics calculations.

There are great traditions for FEM applications at Ganz-MAVAG. First of all they use systems they developed themselves to dimension and check railroad vehicles, motors and water machinery. At present they are trying to rewrite the programs from an ESZ 1040 computer for IBM PC/XT and AT machines and seeking a way to connect to a CAD system. The Electric Power Industry Research Institute (Veiki) has achieved outstanding results in studies of the tension distribution of three-dimensional structural elements with optional geometries and loads. Their program called FEMGEN prepares considerable input data for finite element calculations. There are separate programs for plastic deformations, creeping, study of spatial cracking and calculation of fracture safety factors. Their program package for strength tests of nuclear power plant structural elements was developed and used during the previous 5-year OKKFT [National Medium-Range Research and Development Plan].

We must also mention the work of the Central Mining Development Institute, the Veszprem Chemical Industry University and the MTA SZTAKI [Computer Technology and Automation Research Institute of the Hungarian Academy of Sciences] and the efforts of the GKFT, the Machine Manufacturing Technology Research and Development Association, to turn domestic developments into a common basis.

We can glean the following information from the 1985 interim report:

An OMFB [National Technical Development Committee] study prepared in 1980 was debated by experts in 1982 under the leadership of the ministry of industry. They came to the conclusion that despite the numerous domestic initiatives we are behind with developments in comparison to the needs. Despite appearances use of the method is not primarily a computer technology problem. What is needed is the close cooperation of technicians versed in computer technology and of industrial experts. They recommended then the acquisition of the ASKA. In 1983, in the interest of the goal, the Veiki recommended creation of an association, and a number of institutions expressed a willingness to join it. But the initiative was not followed up.

According to experts developments continued to be isolated and scattered in 1985. "The present state of affairs is characterized by diffusion and lack of coordination and thus by parallel activity, superfluous rivalry, professional jealousy and a multiplicity of hardware environments." Domestic solutions are linked to concrete industrial commissions so they have an ad hoc character, which limits their spread. Generally applicable, large computer systems with a large element set and graphic pre and post-processors were very much lacking. It is characteristic of the backwardness that use of FEM is already routine in developed industrial countries while the emphasis in development falls increasingly on linking up with automated engineering design and optimization procedures.

For nearly 10 years our experts debated whether there was a need, in contrast to domestic developments, for acquisition of a large computer, general system. They debated this way, with an exclusionary view (either this or that), until it turned out that the country was not capable of creating a large system on its own. By way of comparison, development, testing and documentation of the ASKA required about 250 engineer years. Documentation takes up 13 volumes and the number of program lines is about 250,000.

This is why professional public opinion awaited the news--The ASKA has come!

#### Various Models

Of course, acquisition did not depend on domestic intentions alone. The ASKA is not the only large finite element program package known. But it is the only one among the best which can be purchased. The export permit was issued in September of last year; according to some it just slipped under the embargo limitations. Even so it was possible only to buy version 7.9, with the promise that in the near future they would probably authorize the 8.5 version, and then it would be delivered immediately.

Development of it began circa 1960 in the Flight and Space Statics and Dynamics Institute of Stuttgart University, with NATO financing. In order to use contemporary versions one needs background storage of at least 5 million words and central memory capacity of 64-128 kilobytes. The system, written in the FORTRAN language, was prepared for third generation machines. It has been installed on almost all known types. The first application was in 1965; since then it has proven its abilities in the areas of space flight and artificial satellite manufacture, among others. The largest use thus far has been design of an icebreaker, with one million elementary nodes.

From the beginning the IKOSS (IKO Software Service GmbH) has sold the ASKA. The West German firm already uses an 8.6 version, and is developing a 9.0 version. Szamalk bought the package with unlimited use rights on one machine, for foreign exchange equivalent to almost 10 million forints. The package contains parallel pre and post-processors called FEMGEN and FEMVIEW (just by chance the name of the former coincides with that of the Veiki program). The program, which arrived last November, is already working on the large IBM of Szamalk; conversational graphic systems were put into operation this March. The enterprise has organized an internal, house study course for its own workers, which outside experts have also joined. According to their plans they will not only provide users with machine time but will also undertake task solution. According to preliminary calculations a task requiring a few hours of machine time, with the cooperation of system programmers and one engineer, can be solved at a cost of 100,000 to 200,000 forints. Broader use naturally requires reference applications and in this spirit they are selling a few water affairs, construction and transportation industry tasks. So the first orders have arrived. Intelligent, graphic terminals based on the IBM PC/AT are being used as graphics stations and they are experimenting with the Tekemu terminal of the SZTAKI.

They also plan--with considerable material support from the OMF--to create a finite element CAD service network. The users would be able to link into the system over remote data processing lines or on microcomputers they could access the pre and post-processors or they could send in their data on floppy disks. All these plans fit in well with the intensive CAD/CAM development efforts started recently under the guidance of the Ministry of Industry and the OMF.

The IKOSS has an interest in the Hungarian software developed or to be developed for the system. High quality systems which solve specific technical problems enjoy great demand. One can also read this in the study: "A circle of extraordinarily well trained FEM users and developers is available to the people's economy. If this circle were not already occupied with writing programs to solve systems of equations but rather had available a modern, general program system, it could turn all its energy to solving technical problems and developing problem oriented programs."

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## HUNGARY: ADDITIONAL FAIR BRIEFS

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87 p 64

## [Text] Controll Prices

The Controll Small Cooperative intends to announce a drastic price reduction, about 25-30 percent, for its XT and AT compatible PC's. In addition it is offering its usual one year guarantee for Controll PC's and local networks purchased during the time of the BNV [Budapest International Fair] free of charge. They have announced a 50 percent reduction in the price of the Orchid compatible LAN coupler card.

## MOM Plans

The MOM [Hungarian Optical Works] will appear at this year's spring BNV with a family of half-height floppy disk drives. They are introducing the MF 58D (5.25 inch diameter, 80 band, two-sided) with a capacity of 1 megabyte (720 kilobytes formatted), the MF 54D (5.25 inch, 40 band, two-sided) with a capacity of 0.5 megabytes (360 kilobytes formatted) and a single-sided version of it, the MF 54S. According to their plans they will accept orders for the devices, for delivery this year, at the fair.

## Through Pronet

The SZKI [Computer Technology Research Institute and Innovation Center] is calling attention to itself with a few further developed and several new products. Among other things they will show version 3.0 of the Pronet local network system which is compatible with the IBM PC Network and Netbios. A new image processing program package will be shown on their own image processing processor. The center of interest will be a text scanning optical page reader technique using a scanner unit connected to a Proper and the RECOGNITA software which they developed themselves. Also appearing at the fair will be the PROGRESS editing system, a personal identification system using the CARDIO magnetic strip card, a Hungarian version of the Open Access integrated program package, MPROLOG artificial intelligence applications, a version of the Teledata system (Teledos) and cards for Proper computers assembled with the new surface mounting technology. They also plan an RJE network demonstration between the BNV and the SZKI headquarters, on a Pronet base.

## TPA Family

The Central Physics Research Institute will show an integrated machine industry designing and manufacturing system based on its 32 bit TPA-11/500 computer family. They will connect a CNC controlled milling machine to the TPA-11/540 configuration exhibited. A new item will be a transaction processing system working on a TPA-11/170 computer for warehouse, production control and banking and commercial purposes.

The plasma diagnostics simulator provides digital and analog signals to check a complex automation system for thermonuclear fusion experiment equipment and to finalize the programs which operate it. With its use the tasks can be performed without using fusion equipment.

## New SZM

Szamalk [Computer Technology Applications Enterprise] will exhibit, among other things, the SZM 1420+B computer, applications connected with automated engineering designing on a Siemens graphics terminal and IBM terminal emulation.

## Orion Terminal

Orion figures at this year's spring BNV with terminals. The new ADP-2100 device, compatible with the DEC VT-100, appears with a pleasing exterior. They have connected an ADP 3287 matrix printer (a modified version of the BHG PRT-80) to the ADP 3276 remote group terminal, with a maximum of eight ADP 3278 screen devices.

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## HUNGARY: USE OF DEEP LEVEL SPECTROMETER IN GRADING SEMICONDUCTORS

Budapest MERES ES AUTOMATIKA in Hungarian No 2, 1987 pp 56-59

[Article by Dr Gyorgy Ferenczi, of the Technical Physics Research Institute of the Hungarian Academy of Sciences: "A Modern Deep Level Spectrometer and Its Uses in Grading Semiconductor Materials and Structures"]

[Text] Simplifying somewhat we can indicate the developmental aspirations of the microelectronics industry along two easily separated lines.

The first area--still dominant according to the value of industrial production--is research and development on silicon based semiconductor devices. From many viewpoints silicon is optimal, it has properties which cannot be attained with other semiconducting materials and the maturity of the materials technology guarantees it a leading role in the microelectronics industry for decades to come. Development is aimed primarily at exploiting the advantages which can be won by increasing the density of integration through reduction in size. In the final analysis this means cheaper production of faster and more complex--multifunction--electronic devices. We usually indicate the degree of integration density by the thickness of the thinnest insulating layer. Line thickness in circuits now under development has gone below one micron. In the case of such small dimensions the local inhomogeneities which previously caused no problem have become fundamental failure sources. These inhomogeneities are primarily due to the presence of oxygen and carbon atoms unavoidably built into the crystal during manufacture of silicon monocrystals. Another source of crystal faults is the new technological procedures which have become necessary as a result of the decrease in size, the radiation damage caused by so-called dry chemical operations.

The other chief direction in microelectronics research and development is represented by new devices using the family of type III-V compound semiconductors. Devices based on GaAs and related compounds, exploiting the special physical properties of the primary material, are being used in optoelectronics, very high speed digital technology and microwave technology. The primary materials for these semiconductor materials are binary, ternary and quaternary compounds which can never be made entirely stoichiometrically. For this reason crystal faults and their complexes are always present in the

semiconductor crystals, significantly influencing the electric parameters of the material and even the life expectancy of the devices.

One can gather from what has been said thus far that in both areas of emphasis for the microelectronics industry the problems to be solved necessarily include the discovery and identification of crystal faults and the development of technological procedures to eliminate their harmful effects.

The most effective method even today for discovering crystal faults was developed by D. V. Lang of Bell Laboratories in 1974 (1). The author and his colleagues have significantly further developed the original method, deep level transient spectroscopy (DLTS in the English abbreviation), and have developed grading equipment based on these principles. At present the equipment developed by us is present on the world market with the greatest marketing share. In what follows we will describe the operating principles of this equipment and a few of its uses.

### Deep Level Spectroscopy

Electrically active crystal faults create bound states--deep levels--in the forbidden band of semiconductors. Among the methods suitable for studying them the space charge spectroscopic methods proved most suitable for detecting crystal faults in semiconductor devices. The charge state of the deep levels in the space charge range of the device can be changed by electrical or optical excitation. In the course of restoring thermal balance we can detect the charge carriers liberated from the bound state by change in the current flowing through the device or by change in the capacitance of the device. In the ideal case the capacitance of the sample after excitation returns to the balance state exponentially at constant temperatures. The absolute value of the capacitance change characterizes the concentration of the deep level, the sign of the change characterizes the type of level (majority or minority) and the time constant characterizes the activation energy of the level. The time necessary for saturation charging of the level is a measure of the capture cross section.

The DLTS measurement automated the capacitance transient measurement at constant temperature, recognizing that the exponential could be well characterized with average values taken at two different times and, further, that if the temperature change is slow compared to the detection speed of the transients then the measurement means the detection of quasi-balance states one after another. Figure 1 illustrates this measurement principle, where in contrast to Lang's original idea the detection of the transient signal takes place with a symmetrical square weight function, which results in a substantially better signal-noise relationship than the original box-car arrangement (2).

After introduction of the DLTS principle use of a symmetrical square weight function, that is of a lock-in amplifier, seemed obvious to many. They were not used in practice because of the slow recovery time of traditional lock-ins after an overload and because of the measurement error caused by the phase angle which could only be chosen as a constant independent of the duration of the capacitance transients. The principle of automatically maintaining the

phase angle independent of the repeat frequency, introduced by us, and the procedures used to avoid overload of the lock-in (3) made possible for the first time the performance of high sensitivity DLTS measurements. We further exploited the possibilities in the lock-in principle (Figure 2) by introducing the Differential DLTS procedure (4).

By introducing the double exposure which can be seen in the figure and by maintaining the repeat frequency of the lock-in unchanged the switching transients are integrated, the 0-point stability is significantly improved and, last but not least, it becomes possible to use two excitation pulses--shifted half a period from one another. The latter possibility is suitable for determining the distribution profile of the deep concentration of the deep levels very precisely--with a resolution limited only by the Debye length. Another possibility of theoretical importance derives from the phase position lock-in solution independent of the repeat frequency. Deviating from the basic idea of the DLTS principle by maintaining the temperature of the sample at a constant value but by continual scanning of the repeat frequency one can also prepare a deep level spectrum. Figure 3 illustrates this so-called isothermal frequency scan DLTS principle (5).

The frequency scan measurement is actually a return to the capacitance decay measurement at constant temperature--eliminating the disadvantages thereof.

A measurement done under conditions of thermal balance also guarantees greater precision and one can achieve a substantially better energy breakdown. Making it unnecessary to change temperature during the measurement also means a theoretical advantage. The traditional DLTS measurement is also a heat treatment, which is unavoidably accompanied by crystal fault reactions--the measurement can change the object to be measured. This cannot happen with frequency scan DLTS.

#### The Measurement System

A special measurement system had to be devised for optimal implementation of the measurement principles introduced by us. It had to provide a thousandth of a degree of phase angle stability for the lock-in amplifier and interference free switching on of very short excitation pulses. In order to exploit the advantages of the frequency scan principle a maximal repeat frequency range had to be chosen, which required the design of a capacitance meter with very short response time (5 microseconds). Finally, the measurement system had to be computer controlled. A significant part of the measurement system is made up of the evaluation software which contains the evaluation procedures developed by us (e.g., the electric field dependence of emission probability, determining the depth distribution of the deep levels, etc.). In addition the program contains a complete library of Arrhenius plots of known deep levels, so it also identifies the levels studied. The measurement system makes possible a determination of the activation energy with a precision of 1 meV. This sensitivity, substantially exceeding the precision of earlier procedures, made possible the level identification described in the next section, the separation of energetically close levels.

## Radiation Damage in Silicon

We would like to illustrate the use of deep level spectroscopy in connection with a concrete example from among the applications of research on crystal faults mentioned in the introduction.

In the course of manufacturing silicon monocrystals carbon and oxygen contamination gets built unavoidably into the crystal lattice. In the course of preparing the semiconductor device, as a result of heat treatment, the originally electrically inactive contaminating atoms are rearranged, producing precipitates and even electrically active complexes. So a precise knowledge of the concentration of these contaminants and a careful check of the amount being built in during manufacturing technology are very important. In practical cases the limit sensitivity of the traditional test method--based on infrared absorption measurement--is around  $10^{16}$  atoms/cm<sup>3</sup>. This sensitivity does not satisfy the requirements of VLSI technology.

It was long recognized that as a result of radiation damage (in the course of electron, proton or other implantation) there arose electrically active contaminations containing carbon and oxygen. Ferenczi and colleagues (6) have shown that in reality two independent complexes--lying very close to one another energetically--create an acceptor type level 0.35 eV from the valence band of silicon. These are the C-O-V and C<sub>S</sub>-Si<sub>I</sub>-C<sub>S</sub> complexes. The concentration of the latter complex correlates well with the concentration of all carbon which can be found in the sample; indeed, turning it around, the total carbon volume can be determined from the concentration of the C<sub>S</sub>-Si<sub>I</sub>-C<sub>S</sub> center.

The consequences of this recognition are:

- a. The lower limit for determining the carbon concentration became  $10^{10}$  atoms/cm<sup>3</sup> which means, in contrast to earlier procedures, a sensitivity increase of six orders of magnitude.
- b. It became possible to determine the carbon concentration with a lateral resolution of 1 micron, which makes possible a study of the carbon-oxygen precipitation mechanism with much greater precision compared to earlier methods.

The frequency scan DLTS measurement made it possible to achieve the above results.

### An Expression of Thanks

First of all I would like to thank those of my colleagues who were my comrades in various phases of the work in developing and using the Deep Level Spectrometer: Laszlo Benkovics, Janos Boda, Laszlo Dozsa, Gyurgy Fule, Peter Horvath, Detlef Huber, Jozsef Kiss, Tibor Pavelka, Dr Maria Somogyi and Ferenc Toth.

The manufacturer of the instrument prepared on the basis of our ideas is the Radelkis Industrial Cooperative. At present the equipment is used successfully

in microelectronics research and development in 20 countries. Figure 4 shows the most modern DLS-82E model.

Manuscript received 22 October 1986.

#### Biographic Note

Dr Gyorgy Ferenczi graduated in physics from the Natural Sciences School of the Lorand Eotvos Science University in 1970 and since then has worked for the Technical Physics Research Institute (MFKI) of the Hungarian Academy of Sciences. He began by dealing with development of physical grading methods for illuminating diodes, which later became a study of a more general problem, electrically active fault locations in semiconducting materials. He won his candidate's degree in this theme. As one practical result of device physics research the MFKI-KFKI [Central Physics Research Institute] research group led by him developed the first Deep Level Spectrometer to appear on the world market. He is the author of about 50 scientific papers and patents and has been awarded a number of scientific prizes. He is chairman of the Semiconductor Physics Group of the Lorand Eotvos Physics Society.

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#### FIGURE CAPTIONS

1. p 57. Principle of temperature dependent DLTS measurement done with lock-in averaging.
2. p 57. The differential DLTS principle.
3. p 58. The principle of isothermal frequency scan DLTS measurement.
4. p 58. The SemiTrap DLS-82E model.

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## HUNGARY: DEVELOPMENTS IN PHYSICS RESEARCH IN 1986 SUMMARIZED

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[Article by Dezso Kiss, Central Physics Research Institute: "Domestic Physics in 1986." Originally a speech given at the program "The Role of Hungarians in World Natural Science and Technical Progress" organized by the World Federation of Hungarians, August 1986.]

[Text] I think it requires no special explanation that a brief review of the present status of domestic physics research cannot at all strive to be complete. So I must ask the forgiveness of those colleagues whose research areas are not mentioned. This is in no way a value judgment; please ascribe it to the limited space. It may not be as acceptable and understandable to everyone that when reporting on some themes there will be a great deal of simplification and it is possible that in some cases one might raise the charge of naivete. I think, however, that those colleagues about whose themes I write and who, naturally, are expert cultivators of them from every viewpoint will not take it amiss if in a review of this nature I cannot strive for very precise descriptions and cannot go into detail. Please, never forget that if they were to read about an area of physics far from their own it is possible that they would put the article down in vexation because facts, concepts and phenomena unknown or less known to them were used presuming common knowledge.

One feature of this report is that it does not speak of theoretical research; at most the theoretical themes are listed, as an "inventory," and naturally here also one cannot say that every theme has been mentioned. The prejudice for experimental themes can be explained partly by the fact that these are closer to the experience and training of the author but partly it is to compensate a bit for the relative neglect of the experimental view in Hungary as opposed to theoretical knowledge which has--in an understandable way from many viewpoints--grown most vigorous. At the same time it would be wrong to deny that it is simpler to describe an experimental theme and experimental problems than theoretical ones, where most often every word in the designation of the given theme is a complex concept the understanding of which would require a separate explanation.

Most arbitrarily, but I think not entirely without foundation, I would like to speak below of the following areas:

- I. Solid body physics research;
- II. Reactor physics and technical research;
- III. Nuclear physics research;
- IV. Particle physics research; and
- V. Other physics research.

#### I. Solid Body Physics Research

In our country solid body physics is a relatively preferred area in experimental research. One reason for this is that solid body physics research--although requiring considerable laboratory equipment and significant sums--requires much less than other areas, such as particle physics. So domestic possibilities for solid body physics do not lag so far behind the international field as in, for example, particle physics. One could also say that solid body physics research can be cultivated efficiently and profitably in a small and relatively less industrially developed country such as Hungary. The other side of the coin is that in solid body physics research even the basic research is closer to being applied sooner or later than is the case with other research (e.g., particle physics). So in an atmosphere--I call it close to earth--where one expects from research developmental results and economic profit as soon as possible solid body physics research stands closer than others to the ideal.

As a result solid body research probably constitutes the most extensive branch of domestic research. It is cultivated in the following research institutes and institutions of higher learning, the total number of researchers being between 200 and 300:

- Technical Physics Research Institute,
- Central Physics Research Institute,
- Lorand Eotvos Science University,
- Natural Science Research Laboratory,
- Budapest Technical University,
- Attila Jozsef Science University,
- Lajos Kossuth Science University,
- Central Chemical Research Institute,
- Nuclear Research Institute,
- Heavy Industry Technical University,
- Isotope Institute.

The research is coordinated by the MTA [Hungarian Academy of Sciences] within the framework of the "national guide for solid body research."

We will discuss the research areas cultivated by theme and not by research site for most themes are cultivated in cooperation among institutes; indeed, international collaboration is very common.

The following more important themes can be picked out of research in the solid body physics area:

1. laser research and development;
2. metal physics research;
3. study of near unidimensional conductors;
4. liquid crystals;
5. study of amorphous semiconductors;
7. solid body theoretical research.

#### 1. Laser Research and Development

The first domestically made laser "flashed" not quite 3 years after the first such equipment in the world began to operate.

Professor Lajos Janossy, then director of the KFKI [Central Physics Research Institute], had a crucial role in this work; he needed the possibilities offered by lasers to continue his world famous photon experiments. Thus it is natural that the research group dealing with this did the pioneering work and even today the intellectual heirs of this activity represent the most important base for laser research in Hungary.

Naturally the sphere has expanded greatly in the past quarter century. Of the educational institutions research was started primarily by the Attila Jozsef Science University in Szeged and by the BME [Budapest Technical University] while Tungstram carries out manufacturing activity. There are already more than a thousand lasers being used in everyday practice in various areas of industry and science.

The size, location and technical and economic possibilities of Hungary very strongly influence the development of this area. Here also we should not forget the relatively modest traditions of the optics industry nor the international problems existing in connection with lasers and with "high technology" in general. On the basis of all this it can be said that it is not possible to cultivate the entire spectrum of laser physics here at home. In general the domestic researchers and manufacturers--with the exception of a few activities forced by unavoidable economic necessity--try to deal with internationally significant and interesting tasks in areas judged less important by the "big guys." For the above reasons it is understandable that this work absolutely demands international cooperation, wherever and to whatever extent this is possible.

The scope makes it impossible to conjure up the work done even by titles, so the following is intended only as selected illustrations.

Before the appearance of lasers the KFKI, in the classic "Physics-Optics Laboratory", proved the linear property of the photon-electron interaction in the case of very small light intensities. With lasers they found a new aspect of the process with large light intensities; for the first time in the world they succeeded in demonstrating one of the most important phenomena of modern optics and quantum electronics, the so-called nonlinear or multiphoton photo

effect. Since achieving the first results the work has continued in close cooperation with Soviet, French and Canadian research institutes.

The first demonstration of another nonlinear optical phenomenon was also a domestic achievement--the molecules of a liquid crystal can be reoriented by the electric field of laser light, similar to reorientation by a traditional electric or magnetic field. The new phenomenon makes possible further study of the properties of liquid crystals and could aid a better understanding of the interactions of biological systems and laser light and in the more distant future might be used in optoelectronic devices which could be used in practice. This result was achieved in cooperation between the KFKI and the Lebedyev Institute in Moscow.

Today, lasers are already indispensable tools for industry and medicine. The carbon dioxide laser processing equipment developed by Tungsram and the Machine Tool Industry Works is routinely used for cutting, engraving, heat treatment, etc. of metals and other hard materials. High powered Nd-YAG solid body lasers developed at the KFKI are used in the domestic electronics industry. Surgical equipment based on this same YAG laser--equipment developed and manufactured by the KFKI--is already used successfully in a number of domestic hospitals for gastroenterological, urological, pulmonological, etc. purposes.

The miniature Nd-phosphate glass pulse laser developed by the KFKI is unique in the world. Numerous applications from instruction through production to ophthalmological and spectroscopic uses require such a portable, easily set up and cheap device which also has outstanding radiating parameters (1 mrad divergence, 0.5 MW peak output). The MOM [Hungarian Optical Works] and an Austrian firm have already begun manufacture of it.

Low powered gas lasers are already indispensable tools for laboratory and industrial measurement technology. The MOM is engaged in series manufacture of the well known helium-neon lasers radiating red light. In recent years researchers at the KFKI have achieved internationally recognized results in research on a new type of gas laser, the so-called cavity cathode excited gas laser. The cavity cathode helium-krypton gas laser developed by them radiates in the blue range of the spectrum, which is a very great advantage in applications because this shorter wave length significantly increases the efficiency of numerous physical and biological processes, the sensitivity of detectors and the precision of measurements. Within a few years this new laser type could replace for some tasks the presently used, very expensive Argon-ion lasers.

Researchers at the Attila Jozsef Science University in Szeged, in cooperation with the Max Planck Institute in Gottingen, have developed a family of dye lasers with an optimal linkage of Hungarian intellectual achievements and German technical possibilities which has won international recognition both scientifically and economically.

## 2. Metal Physics Research

The so-called glass metals (amorphous metals) can be produced by several methods. In the first group of technologies the alloy (melt) in the liquid phase is somehow brought into contact with a cooling medium at a low temperature (room temperature or lower) and the liquid state is "frozen" in the event of a sufficiently fast cooling speed. The cooling speed theoretically attainable is  $10^{10}$  K/s; that which can be easily attained in practice is 106 K/s.

According to our present knowledge the greatest cooling speed can be attained with laser heat treatment. A large mass of initial material very quickly cools the thin surface layer greatly heated up by the laser. Deviating from the generally used fast cooling technologies (various versions of anvil-hammer or fast turning disk) the cooling medium for laser fast cooling is the same material as the alloy becoming the glass metal, so what is involved is surface enameling of the same material. One can attain a cooling speed of  $10^{10}$  K/s, approximately three orders of magnitude greater than in the case of customary technologies.

The physical properties of amorphous materials depend greatly on the atomic scale structure of these materials. Since there is no long-range crystallographic order in amorphous materials it is naturally the proximate (because generally we are talking about multi-component systems), chemical and topological order which influences the properties. In addition to binding distances (proximities) the local order must also involve the direction of them. Determining this order is not at all an easy task. The X ray, neutron and electron scatter methods determining structure provide a one-dimensional projection of the distribution of the atoms and since monocrystals cannot be used as an aid the seriousness of the problem can be seen. It may not be superfluous to mention as an analogy that the problem is approximately the same as if one had to determine the characteristics of crystal structures exclusively from scatter (X-ray) measurements done on polycrystal samples. Whence can one expect help?

In the first place from the use of local methods such as nuclear magnetic resonance (NMR) and Mossbauer spectroscopy; with these methods the resonant atomic nucleus directly informs its environment through hyperfine interactions, and this information is especially valuable if it pertains to local symmetry.

In the second place from modeling. Physical models, originally made up of balls and now designed by computers, aid in understanding the short and medium range order of the structure of amorphous materials.

A sphere of questions as exciting as structure and structural change within the amorphous state pertains to partial or complete recrystallization taking place when heating to a higher temperature; this requires substantial atom transport and--since we are talking about the solid phase--"empty places" making the movement of the atoms possible. Although the final result is a crystalline order the details of the crystallization provide information about

the amorphous phase, for the process takes place in that. Our researchers have achieved numerous results in these areas.

### 3. Study of Near Unidimensional Conductors

In recent years the study of near unidimensional conducting solid bodies has brought internationally recognized results. The electron structure of near unidimensional metal crystals is unstable; at low temperatures they most frequently go into an insulating state. The phase transformation is driven by the interaction of metal electrons and lattice vibrations. In the low temperature semiconducting state the lattice structure and the electron density periodically modulate. The electric and magnetic properties of the structure thus produced differ greatly from those of customary semiconductors.

At the KFKI they made a detailed study of the dependence of the electric conductivity of organic charge transfer salt complexes on the systematization of the structure. Deviation from the ideal structure of the crystal can be caused by the systematization of the orientation of the molecules, by chemical contaminations or by gamma, electron or neutron irradiation. Because of the near unidimensional structure the crystal faults have an increased effect in causing change in the course of the phase transformation and in the low temperature transport properties.

Similarly, some conducting polymers also have near unidimensional properties. The best known of the conducting polymers is polyacetylene; in addition to the KFKI the KKKI [Central Chemical Research Institute] and the Synthetics Industry Research Institute have joined in the study of it.

In materials where the crystal structure is built up of atomic or molecular chains separated from one another a strong anisotropy can lead to formation of a near unidimensional electron system. Then the electron orbits of the atoms making up the chain form a unidimensional conducting band; while there are extended wave function electron states along the chains the electron transfer between chains is negligible.

The unidimensional electron cloud is unstable. At low temperatures, in the course of interaction with the ions, there develops an electron density which varies periodically in space (and a deformation of the crystal lattice connected with this). The wave length of the oscillation of charge density is independent of the original lattice distances--the appearance of the new period can be demonstrated directly with classical diffraction methods. The low temperature, so-called Peiers distorted phase is not metallic; e.g., as in semiconductors the small field electric conductance is realized by charge carriers excited through a forbidden band.

What makes such materials interesting is that in addition to the elementary electron excitations the charge density waves (TSH) as a whole can be made to move. Such a collective electron state had been observed earlier only in superconductors. The collective TSH excitations are sharply reflected in the strongly nonlinear conductance properties, in the incredibly high dielectric constants ( $10^8$  to  $10^{10}$ ) and in anomalous complex conductivity showing the frequency dependence. One of the most intensively studied phenomena is narrow

band noise, the alternating current component at a well defined frequency observed in the voltage response of the charge density waves given to direct current excitation.

Domestic research on low dimension materials has made a significant contribution to understanding the TSH dynamics. Experiments done at the Central Physics Research Institute were the first to show the deformability of charge density waves, the memory effects deriving from metastable TSH states and the "weak", nonexponential, relaxation of TSH configurations deviating from the balance state. Of fundamental importance for developing a microscopic picture were observations pertaining to the details of sliding TSH conductance such as the observation of coherent oscillating charge density wave domains and the direct measurement of the drift speed of collective movement. The experimental work was inspired by and based on the theoretical background represented by the domestic school of solid body theoretical research which also extends to this area.

#### 4. Liquid Crystal Research

The nonlinear behavior of liquid crystal mixtures is studied with X-ray diffraction, thermal, dielectric and spectroscopic methods. It has been established that an important role is played in the formation of induced smectic phases (soapy material, the molecules are in layers and their long axes are in one direction) by dipole-dipole interactions and by the link between soft and rigid molecular segments.

They began a study of ferroelectric smectic phases. The work began with synthesis of kiral structure (a material the structure of which shows no mirror symmetry, a spiral structure) homolog sequences (a family of compounds the members of which differ in the length of the carbon chain) and then continued with the preparation of phase diagrams for the purpose of setting the appropriate temperature range. Ordering the helix structure phase is not a simple technical task. They developed a new method--they can order a sample of optional thickness using periodic clipping. In homogeneous samples they measured spontaneous polarization, the switching time and the Goldstone and soft dielectric modes appearing in the new phase (the Goldstone and soft dielectric modes are wave movements in the spiral structure of the material). They discovered a new cross-effect (electromechanical) and developed a theory to interpret it.

The ferroelectric liquid crystals not only posed a multiplicity of new basic research problems but also promised significant results in the area of applications. The switching time, shorter by three orders of magnitude, will probably bring a big change in the manufacture of displays.

A newly spreading trend in liquid crystal research is a study of the fast cooled state. At a cooling speed of several hundred degrees per minute certain liquid crystals solidify in such a way as to preserve the structure they had in the liquid state, and a solid nematic (the molecules are in one direction with their long axes but the centers of gravity are disordered) or smectic phase is formed. The study of this state is interesting because it constitutes a transition between amorphous and crystalline structures; indeed, they have

observed a number of phase transformations when heating up the solid nematic phase produced by fast cooling of a nematic material called MBBA; these create increasingly ordered structural states all the way up to a crystalline structure before melting.

## 5. Study of Semiconductors

The interest of the research group dealing with amorphous semiconductors at the KFKI is directed partly at a discovery of the structure and photoelectric properties of hydrogenated amorphous silicon. In material produced with this special technique (so-called glow-discharge) the hydrogen is built into the sites of torn (hanging) bonds existing in the amorphous silicon in such a way as to neutralize the states created in the charged band of the semiconductor by the original fault locations, as a result of which the state density in the forbidden band is drastically reduced and we get an easily dopable material with good electronic properties. Because of the cheapness of this material it could play a significant role in direct transformation of solar energy into electric power. They have already made experimental solar cells at the KFKI which have an efficiency better than 6 percent. The same material could be used in the area of xerography and for manufacture of thin layer devices (e.g., optoelectronic converters, flat liquid crystal color television driving circuits and memory devices).

The other chief direction of the above group is discovery of the properties of so-called chalcogenide semiconductors (chalcogenides are compounds of the chalcogenic elements--sulfur, selenium, tellurium). In some types of chalcogenide semiconductors the diffusion of metals accelerates significantly under the effect of light and the solubility in organic solvents of bands doped with metal in this way differs greatly from the solubility of undoped parts. With this photodoping effect, using monochromatic laser light or holographic imaging techniques, one can attain submicron (equal to or less than 0.1 millimicron [ $\mu\text{-m}$ , possibly a typo for  $\mu\text{-m}$ , micron]) line resolution. This technology can be used not only to prepare high resolution optical grids but also with its aid one can produce VLSI circuit masks and it can play a significant role in manufacture of thin layer optoelectronic devices as well.

At the Technical Physics Research Institute (MFKI) of the MTA research on luminescence and semiconductors has been conducted for more than 20 years, since the institute was formed, resting on a long and successful past in the area of luminescence. The present optoelectronic research developed after the gradual development of those two areas together with the swift development of optoelectronics and at present they are studying primarily the physics and chemistry of optoelectronic materials and devices, the development of physical methods connected with the above area and applications possibilities for the semiconductor devices developed.

The above activity covers a very broad scale, in accordance with the unique Hungarian structure, from basic research to production of industrially useful small series. Among the results of recent years special international recognition was given to the materials research at the MFKI in the course of which they succeeded in producing new semiconducting materials and structures.

The semiconducting alloys produced at the institute, the so-called pseudo-ternary antimonides (AlGaInSb and GaPAsSb), made possible the production of entirely new semiconducting laser structures and photodetectors which in the future may have a very important role in optical communications engineering. Of similar significance is the technological development achieved in the production of supergrids (multilayer structures of various materials with a 2-50 nm periodicity, comparable to the de Broglie wave length of free electrons). They used supergrids to produce laser diodes having the greatest power and life span known so far, the most sensitive photodetectors and the fastest transistor containing a thin layer (HEMT), from which revolutionary changes in electronics are expected. Previously the above structures could be produced only with peak technologies (e.g., molecule ray epitaxia). The method developed at the MFKI is substantially faster and cheaper than the methods used thus far.

Research on the monocrystals of semiconducting materials is also connected with materials research. This pertains primarily to the production, study and use of the increasingly important so-called binary semiconductors, monocrystals of GaAs, InAs and GaSb. Outstanding in this research was the first GaSb crystal growth in space, in the course of INTERKOZMOS research, which has been repeated since in West European space programs. The institute uses the above materials, especially the GaAs, to develop semiconductor lasers, already considered traditional.

In the course of the above laser research the chief efforts are being directed at increasing the life span of GaAs-GaAlAs based laser diodes developed at the institute and working in the 0.8-0.9 micron range. At present the chief applications areas for these lasers are telecommunications engineering and laser xerography, so questions of reliability are of fundamental importance. There has also been significant progress in the area of creating a technology for InP (GaInAsP) based laser diodes radiating in the 1.3-1.55 micron range, suiting the so-called second optical window of light conducting fibers. In this optical range one also needs detectors which are not Si based, suiting the laser diodes, so they have started development of AlGaInSb quaternary photo diodes using the new semiconductors mentioned above; these are suitable for detection in the 0.7-1.7 micron wave length range.

In addition to the technological development they have developed classification systems, very highly valued even internationally, to aid the development of these semiconductors and devices. The deep level spectroscopic equipment (DLTS) they developed is the best such equipment in the world today; it is indicative of how modern it is that they succeeded in selling it even in Japan. With a swift development of the equipment and of the possibilities of the method a fast, high precision measurement method is now available for semiconductor research and manufacturing bases in the case of both Si and compound conductors, from semiconducting primary materials to structured wafers and discrete devices.

## 6. Solid Body Theoretical Research

Theoretical studies are being conducted on the following themes:

- a. the physics of phase transformations; the phenomenon of relaxation in spin glasses and the spin-spin correlation;
- b. a study of systems showing chaotic behavior;
- c. in the area of metal physics a study of the interactions of electrons and two-state systems in amorphous metals;
- d. the "paraconducting" state of granular superconductors;
- e. the interaction of a contaminating atom and a charge density wave in unidimensional systems;
- f. the Bose condensed phase of spin polarized hydrogen;
- g. the interaction of electrons with strong electromagnetic fields.

In the near future theoretical research on these themes will continue in the area of solid body physics. The use of computerized simulation is expected in a few areas, although the domestic computer possibilities greatly limit this.

## II. Reactor Physics and Technical Research

Reactor physics research in Hungary began in the second half of the 1950's at the Central Physics Research Institute. The research reactor put into operation in 1959 gave a great boost to the development of this branch of science; then, one after another, there were experimental and computational observations acquired on the zero output critical assemblies. In addition to a number of theoretical achievements they developed systems of computer programs for a precise determination of the neutron physics processes taking place in reactors.

Most important among the experimental methods of reactor physics are the measurements done on so-called zero reactors which have a nuclear structure similar to large reactors but which work at a low output level. A number of such zero reactors have been built; the ZR-6 reactor now in operation was created to do measurements used in power plant reactors. Research on this equipment now takes place within broad international cooperation.

Another classic research area is a theoretical and experimental study of the heat transfer processes taking place in reactors, and the development of computer program systems. Special attention is being turned to a clarification of accident conditions in power plant reactors and methods to prevent accidents. The NVH equipment is suitable for execution of large scale measurements and experiments as well, including a study of 1,000 MW output reactors and simulation of accident conditions. Here the fuel elements of a reactor are simulated with electric heating to a 2.5 MW output level.

Another classical research area is reactor diagnostics. They draw conclusions primarily pertaining to reactor states from temporal variations in the parameters. The theoretical achievements of our reactor research are recognized throughout the world and the Paks Nuclear Power Plant is one of the few nuclear power plants in the world where a built-in diagnostics system operates. This is our own development and it has proven its utility a number of times.

Our own reactor instrumentation had to be developed for the domestic tasks as well. In a number of cases these instruments are also exported.

There is already more than 10 years experience in the area of developing computer technology systems helping to operate reactors and nuclear power plants. The computers and systems established for the research reactors work at home and abroad and the computer system monitoring blocks III and IV of the Paks Nuclear Power Plant were also developed domestically.

Hungary is a country poor in fuels. Most of the crude oil serving as a source for electric power production is imported and our coal reserves are sufficient to feed only a part of the power plants. So the use of nuclear energy is of ever increasing significance.

Within the framework of the Hungarian nuclear power program our first nuclear power plant, the Paks Nuclear Power Plant, is already partly in operation and partly under construction. The first 440 MW block of the power plant built with Soviet-Hungarian cooperation went into operation at the end of 1982 and has operated since with outstanding technical and economic indexes. The second block was put into operation a year and a half ago, the third block went into operation in the fall of 1986 and the fourth block will be finished by the end of 1987. Thus about 30 percent of Hungarian power plant capacity will have a nuclear base. Nuclear energy will necessarily play a large role in our future power plant construction plans.

Naturally the development of an industrial and scientific base is an important condition for implementation of such an ambitious nuclear energy program. In certain special areas Hungarian industry manufactures equipment used in nuclear power plants for our own use and for export. We have gained very much experience in building, installing and operating nuclear power plants and fortunately we began to build up the scientific base very early as well.

Our first research reactor went into operation in 1959 and it created very many opportunities for nuclear research. These opportunities were exploited well. Among these it is perhaps important to mention only one, the manufacture of a significant quantity of radioactive isotopes for medical and industrial use, partly for domestic use and partly for export. Great care was also turned to training experts. The domestically designed and manufactured training reactor of the Budapest Technical University has served the training of nuclear experts since 1971. The experts of domestic research institutes have dealt with problems of reactor physics, the heat physics of reactors, control of reactors, radiation protection and nuclear environmental monitoring since 1960.

Among the numerous achievements of research and development in radiation protection and nuclear environmental monitoring we should mention the complete nuclear environmental monitoring system of the KFKI and the Paks Nuclear Power Plant; there is significant international interest in this today.

Going beyond the original applications the thermoluminescent dosimeters (TLD) developed for radiation protection purposes also found applications in space research. The especially small and light PILLE dosimeters have already been used in Soviet and American spacecraft.

### III. Nuclear Physics Research

Experimental nuclear physics is now dealt with in five places in Hungary and theoretical nuclear physics is dealt with in four:

Experimental: 1. the Experimental Physics Faculty of the KLTE [Lajos Kossuth Science University]; 2. ATOMKI [Nuclear Research Institute]; 3. the KFKI; 4. the ELTE [Lorand Eotvos Science University] Atomic Physics Faculty; and 5. the Isotope Institute.

Theoretical: 1. the ELTE Theoretical Physics Faculty; 2. the ELTE Atomic Physics Faculty; 3. the KFKI RMKI [Particle and Nuclear Physics Research Institute] Theoretical Physics Department; and 4. ATOMKI.

#### 1. The Experimental Physics Faculty of the KLTE (Debrecen)

Its chief profile is experimental fast neutron physics. The more important concrete themes are:

##### a. A Study of the Cross Section of Fast Neutron Reactions

In the beginning local conditions limited these studies to a relatively narrow neutron energy range around 3 and 14 MeV. In the past decade the development of international contacts made possible measurement of excitation functions in the 6-11 MeV range. The cross section measurements were done primarily with an activation technique based on semiconductor and scintillation spectrometers.

On the basis of the measurements and data in the literature they discovered in the  $N-Z$  function of the  $(n,2n)$  cross sections around 14 MeV a systematic element for which they gave a simple empirical formula.

Through measurement of the beta activity of tritium they determined a cross section of  $(n,t)$  reactions around 14 MeV in which they demonstrated a strong even-odd dependency. They interpreted the results with the aid of the Hauser-Feschbach model. These studies are continuing now within the framework of international cooperation.

They developed a gamma spectroscopic method to measure the mass distribution of products arising in nuclear fission produced by fast neutrons and used the method successfully to determine the energy dependence of mass distribution in the case of uranium. They measured a number of  $(n,2n)$ ,  $(n,p)$ ,  $(n,\alpha)$  and  $(n,\gamma)$  reaction cross sections with the activation technique for neutron

energies around 14 MeV which pertain primarily to structural materials for fusion and fast reactors.

They measured with great precision, in the 6-11 MeV energy interval, the excitation function of the (n,2n) reaction taking place in splitting nuclei which are important from a few reactor physics viewpoints. A study is now under way of the fine structure which can be found near the threshold in the excitation function of the  $^{27}\text{Al}(n,\alpha)$  reaction.

They measured for a number of nuclei the cross sections averaged for the neutron spectrum of  $^{252}\text{Cf}$ .

Going beyond the activation technique they are in the process of adopting the time of flight method and with this method--as part of international cooperation--they are participating in a study of the inelastic scattering of 14 MeV neutrons.

They are planning similar neutron physics studies in the Cyclotron Laboratory of ATOMKI, exploiting the possibility offered by the cyclotron for varying the neutron energy.

#### b. A Study of Charged Particle Reactions

Using the activation and solid body tracer detector techniques they measured the cross section of the nuclear reaction produced by low energy protons and deuterons, which is significant from nuclear-astrophysics viewpoints.

They will soon complete studies based on (p,gamma) reactions pertaining to the energy verification of proton and deuteron beams.

#### c. Physical-Analytical Studies

Physical-analytical measurements are regularly done according to need on metal alloys, rock and biological samples. The faculty has adapted a number of physical-analytical methods (neutron activation analysis, X-ray fluorescence) for this purpose. Two patents were also obtained in connection with the physical-analytical studies.

They developed a quantitative method to determine the uranium and thorium content of the more important alloying materials for aluminum and of rock samples.

They determined for reactor structural materials the effective distance of repelled nuclei for a study of radiation damage caused by fast neutrons.

#### d. Development of Experimental Equipment and Methods

They developed a 200 kV neutron generator and a pulse operating (nanosecond) neutron generator and are now building a powerful ( $10^{12}$  n/s) neutron generator. The latter will be used to study radiation damage to reactor structural materials.

They developed, for a personal computer, a program package to control Ge(Li)-gamma spectroscopic measurements and evaluate the gamma spectra. A program package was also prepared to evaluate X-ray fluorescence analytical measurements.

They cooperate with a number of foreign institutes and organizations; the two most important of these may be the International Atomic Energy Agency in Vienna and the Physics-Energetics Institute in Obninsk.

2. The Atomic Research Institute (ATOMKI) [As published; ATOMKI is usually called the Nuclear (atommag) Research Institute rather than the Atomic (atom) Research Institute.]

In the past period ATOMKI has used proton and alpha beams with energies of 0.5-5 MeV for experimental nuclear physics research; these are provided by a 5 MV Van de Graaff accelerator they made themselves. In these experiments they made use of the great energy stability (700 eV) and of the fact that the energy of the beam can be varied continuously.

a. The measurement methods available are the following:

--charged particle spectroscopy: in a scatter chamber equipped with an eight surface solid body detector and with solid body tracer detectors (they raised the technology of these to the world level);

--high resolution gamma spectroscopy: with Ge(Li) detectors and with extreme purity Ge detectors;

--internal conversion electron spectroscopy: with a super conducting magnetic electron transport system (SMS), in the interest of increasing the detection efficiency of the electron in the case of a large background, and with a compact, mini-orange spectrometer.

b. They studied the following areas:

1. Charged particle spectroscopy:

--from the angular distribution of elastically scattered protons they determined the low energy behavior of the parameters of an optical model. The results showed that the optical parameters obtained from high energy scatter are not valid at low energies;

--they determined the parameters of nuclear resonances with the aid of elastic proton and alpha scatter.

2. Gamma spectroscopy:

--they studied, in the case of very low cross section processes, the nuclear structure in (alpha, gamma) nuclear reactions;

--they determined the life span of nuclear levels with the aid of the Doppler effect.

### 3. In-beam nuclear spectroscopy:

--with the aid of standard gamma and internal conversion electron spectroscopy they made a systematic study of heavy odd transition nuclei.

### 4. Interdisciplinary studies:

--the technique developed made possible the use of nuclear physics methods in other branches of science. For example, they developed a proton induced X-ray emission method (PIXE) and proton induced gamma method. They studied such questions as the effect of pregnancy or radiation therapy on the composition of human blood. They also did analytical work for industry.

### c. Cyclotron

A compact sector focusing cyclotron recently began operation; it accelerates protons to 20 MeV, deuterons to 10 MeV and alpha particles to 20 MeV. With the aid of the cyclotron they intend to do not only basic research but also applied and interdisciplinary research.

Great efforts are being made at the institute on research in the area of atom ion collisions, which is today a very promising area of physics.

The institute has very broad international contacts, in the socialist camp and with Western countries. They perform many of their experiments in international collaboration (e.g., a Debrecen group has been working at Dubna for years).

### 3. The Central Physics Research Institute (KFKI)

Experimental nuclear physics research is done in the Particle and Nuclear Physics Research Institute (RMKI) of the research center. The larger tools available are: a 5 MV Van de Graaff generator, a 500 kV heavy ion accelerator (implanter), a 1 meter tokamak and a research reactor now being rebuilt. In addition the researchers of the institute do work on a number of higher energy accelerators abroad.

In recent times the ratio of basic research, earlier covering a very broad spectrum, has significantly declined, but even now research is being done on a number of themes.

a. With the Van de Graaff generator they do nuclear structure studies with low energy nuclear reactions. They have studied primarily, with 2-4.5 MeV protons, the structure of  $1g_{9/2}$  and  $2d_{9/2}$  isobar analog resonances of moderately heavy nuclei ( $50\text{Cr}$ - $92\text{Mn}$ ). In the course of this they measured the differential cross section of  $(p,p_0)$ ,  $(p,p_1)$ ,  $(p,p_1\gamma)$  and  $(p,p_2\gamma)$  reactions and the gamma angular distribution. They showed that the lowest primary excitations of the target nucleus play a very significant role in the fragmentation of these resonances. In recent years measurements on this theme have continued in cooperation with the GDR and Canada.

b. They did a study of direct nuclear reactions at energies between 25 and 80 MeV in cooperation with the FRG, at the Hamburg University and in Julich. Here they measured the elastic and inelastic scatter of protons, deuterons and  $^3\text{He}$  particles and 1, 2 and 4 nucleon transfer reactions in rare earth metals and the s-d shell. The purpose of the measurements was clarification of the reaction mechanism and of nuclear structure problems. In the course of interpretation they performed a phenomenological and microscopic optical model analysis. They showed that the anomaly, compared to theoretical expectations, found in the measured transitions leading to members of the base state rotation band in alpha transfer reactions and the transitions leading to non-normal parity members of the excited bands, which are forbidden but which were found to be strong in the experiments, are consequences of the coupling of the inelastic scatter channels to the reaction channels.

c. The group studying medium energy nuclear reactions did measurements with the Swiss SIN accelerator and at the Leningrad Nuclear Physics Institute (Gatchina) using telescope detectors and multifilament proportional chambers developed here at home. At the SIN they measured the angular and energy distribution of pions, protons, deuterons and tritons arising from the bombardment of various nuclei (C, Cu, Bi) with 300-550 MeV neutrons. They found that in a broad range the inclusive hadron production shows scale properties. They also studied inclusive particle production using the 1 GeV proton beam of the Gatchina accelerator, in  $^{40}\text{Ca}$ ,  $^{44}\text{Ca}$ ,  $^{48}\text{Ca}$  isotopes. According to their results the reaction mechanism, in the case of the production of various particles, shows deviant behavior as a function of neutron number. In exclusive measurements here they determined the polarization of protons produced in  $\text{pd} > \text{ppn}$  reactions. Their results showed the dominance of the quasi-free scatter mechanism.

d. In the area of nuclear fission, in cooperation with the Obninsk (Soviet Union) Physics-Energetics Institute, they performed broad studies to determine the spontaneous fission neutron spectrum of  $^{252}\text{Cf}$ , recommended as a standard neutron source by the IAEA. They did the measurements with a gas scintillation chamber and a  $^6\text{Li}$  glass detector, using the time of flight technique. According to their results the spectrum can be well described with  $T=1.42$  MeV parameter Maxwell distribution. They also measured, for  $^{233}\text{U}$ ,  $^{235}\text{U}$  and  $^{239}\text{Pu}$  nuclei, the spectrum of fission neutrons created as a result of the thermal neutrons of the reactor and determined the parameters of the distribution. Last year, in cooperation with GDR researchers, they measured the angular distribution of the fission neutrons of  $^{252}\text{Cf}$  in the low energy range as well, which is significant from the viewpoint of the mechanism of neutron emission.

e. In recent times applied nuclear physics research has gotten an ever greater role in addition to basic research. Some of this--Mossbauer spectroscopy, positron annihilation--pertains expressly to materials science. They are studying problems connected with realization of nuclear fusion using the MT-1 tokamak, namely plasma stabilities and the plasma-wall interaction. They have shown that the qualitative interdependencies of disruptions arising at or near the density boundary or of phenomena immediately preceding disruptions are identical with the scale rules measured on "large" tokamaks. They have done measurements to study spatial transport processes between the plasma column

and the wall and in regard to energy flow and how contaminating ions get into the plasma.

Nuclear analytical research is done with the Van de Graaff accelerator. Here, using protons and alpha particles, they apply the RBS (Rutherford Back Scattering) and ERD (Elastic Recoil Detection) techniques--sometimes combined with one another or with other methods--to surface analytical studies. The goals are, among other things, a surface study of microelectronic devices, determination of the effect of ion implantation in oxidation and amorphization of surface layers, and a study of the formation of new phases. They have also done measurements in the area of plasma-wall interactions to show the contaminants coming from the wall and to simulate the effect of the plasma. They have done significant developmental work in the course of which they optimized the depth resolution of the RBS method and the sensitivity and resolution of the ERD method. In another group of analytical studies they are doing thin layer studies on the reaction of deuterons with light nuclei--(d,d), d, (alpha). In this theme they have done oxygen determinations and have measured the amount and lateral distribution of carbon in silicon and semiconductors and the sodium and aluminum on graphite foil. The latter are also connected to nuclear fusion research; in regard to the discharge this is basic research.

#### 4. The ELTE Atomic Physics Faculty

The Atomic Physics Faculty has a NG-200E and a NA-2 neutron generator. The two neutron generators are supplemented by a fast neutron spectrometer to measure time of flight and by a computer controlled neutron activation measurement method.

The nuclear physics studies are done with neutrons falling in an energy range around 14 MeV produced by a  $T(d,n)^4He$  nuclear reaction.

a. They have studied the elastic and inelastic scatter of fast neutrons, short lived isomer states excited by neutrons, the "competition" of neutrons and gamma photons emitted from excited atomic nuclei and the cross section of activation nuclear reactions which produce short half-life isotopes.

b. Using nuclear analytic methods they have done fast 14 MeV neutron activation studies to determine the composition of rock samples and to determine the nitrogen content in organic and biological samples.

Using the X-ray fluorescence analytic method they have studied environmental contamination (Pb, Cd, Zn, Cu) on samples from various places. They have studied the build-up of heavy metals in rat livers. They have dealt with a determination of the concentration of microelements in human blood and with a determination of rare earth metals in rocks.

c. Within the framework of international MTA-NSF (USA) cooperation two people from the faculty are studying light fragments produced in heavy ion nuclear reactions and the energy and angular distribution of neutrons using the superconducting cyclotron at Michigan State University.

One person is studying monopole and giant resonances at the Julich Nuclear Physics Research Institute, FRG.

Within the framework of cooperation with the Vienna NAU they are participating in the measurement of nuclear cross section data.

#### 5. The Isotope Institute

At the Isotope Institute they are studying the excitation of isomers of stable atomic nuclei with gamma, electron and positron irradiation. Good possibilities for this are provided by a  $^{60}\text{Co}$  irradiating station (currently 70 kCi) and by a 4.5 MeV 10 microA pulse operating linear accelerator. These also made possible practical applications such as measurement of large activations and dose intensities on the basis of isomer activation and gamma activation analysis to determine the noble metals in art treasures, antiquities, coins, industrial wastes and mines and to determine a few elements in foodstuffs and medicines. A new and promising area is determination of the burn-up of nuclear reactor fuel elements with the gamma activation technique on the basis of the hard gamma radiation of some of the fission products ( $^{140}\text{La}$ ,  $^{144}\text{Ce}$ ).

It was recently discovered that in addition to resonance absorption and Coulomb excitation one must also reckon with other mechanisms such as the filling of vacancies in internal electron shells or energy transfer directly to the nucleus without irradiation as a result of positron annihilation (NEET, positron excitation). They have also begun to develop a theoretical model for the latter phenomenon. Cooperation with the Tohoku University (Sendai, Japan) has begun on these themes.

Recently an astrophysics aspect to this theme has emerged. Gamma and positron annihilation activation, considered exotic in traditional nuclear physics, may play a significant role in the nucleosynthesis of heavy elements.

In addition the reaction (n,n' $\gamma$ ) produced by fast neutrons of a few MeV is especially suitable for non-selective excitation of low energy and spin states of atomic nuclei. A study of the intruder states arising near closed nucleon shells or subshells and the form isometry connected with them is very important from the viewpoint of clarifying the effect on one another of the particle and collective degrees of freedom and the fundamental interaction mechanisms creating deformation.

They have shown that by increasing the neutron number stable even-even molybdenum nuclei form a transitional chain between the spherical and strongly deformed heavy molybdenum nuclei. They also succeeded in explaining the phenomenon theoretically with a version of the interaction boson model which distinguishes protons and neutrons (IBM-II). In cooperation with the University of Kentucky in the USA they discovered intruder states in the very interesting twice semi-magic  $^{96}\text{Zr}$  nucleus.

Nucleus structure research is basic research but the spectrometer and data collection program system developed for the measurements can also be used in other areas. Marketing of it is now under way.

Among their long-range plans is an extension of this method on the rebuilt KFKI research reactor for  $(n,n'\gamma)$   $(n,n'e)$  measurements. Thus far it has not been used in the case of reactor neutrons.

Their photoacoustic research was motivated directly by the fact that the materials used as solid body dosimeters are usually powders or ceramics and so their optical properties cannot be studied with traditional methods. They prepared an open Helmholtz resonator photoacoustic chamber which makes possible the measurement of radiation-free transitions of very small absorption monocrystals. They built photoacoustic equipment to study the optical properties of LiF powders as a function of irradiation dose. Their other methodological developments are directed primarily at modern photoacoustic or related methods in which one can derive photo-"acoustic" information from the reflected warming light beam. The procedure can also be used in gases and in vacuum. Another goal is measurement of the electron pulses of accelerators in situ.

## 6. Theoretical Nuclear Physics

This is characterized not only by links among the theoretical research sites mentioned but also by cooperation with large European and overseas research sites (the N. Bohr Institute, the Darmstadt Heavy Ion Physics Center, Los Alamos National Lab, etc.). The themes studied include classical nuclear physics problems (properties of light and medium nuclei, low energy nuclear reactions) and charting the exciting world of special forms of matter realized in relativistic heavy ion collisions.

## IV. Particle Physics

Experimental particle physics research takes place at only one research site in Hungary, in the Central Physics Research Institute, in its Particle and Nuclear Physics Research Institute. Theoretical particle physics studies are conducted by the ELTE Theoretical Physics and Atomic Physics Faculty as well as the above KFKI institute. In an understandable way the research is done in broader than usual international collaboration. The two most important cooperating partners are the United Atomic Research Institute in Dubna and the CERN.

### 1. Experimental Activity Conducted in Collaboration with CERN

#### a. EMC (European Muon Collaboration)

This cooperation studies the quark structure of nucleons or nuclei by measuring the deep inelastic scatter of muons. It was formed at CERN in 1977 (with the participation of 14 laboratories from five countries); the experimental equipment and program (and personnel) have been expanded over time; the last data collection measurement was in the summer of 1985.

In the first phase of the experiment (NA2) the EMC equipment consisted of a large electronic spectrometer installed in the high energy (equal to or less than 280 GeV) muon beam at CERN. With the aid of the equipment the

collaboration studied the deeply inelastic muon scatter on H<sub>2</sub>, D<sub>2</sub> and heavy (Fe) targets. With a precise measurement of the incoming and scattered muon pulse they determined the kinematic variables; by comparing the experimental distributions and the distributions of a Monte Carlo program simulating the equipment they determined the cross section of the scatter process, or the so-called structure functions figuring in it which describe the structure of the nucleon (nucleus).

In addition to the scattered muons the spectrometer made it possible to measure the fast hadrons produced, advancing in a center-of-mass system, that is, made possible a study of hadron production in deeply inelastic muon scatter.

Later the equipment was expanded with a large streamer chamber surrounding the target and with an electronic vertex detector system (a detector mapping the immediate environment of the primary interaction) serving to measure the particles flying out under the large angle (this was the NA9 phase) thus making possible a measurement of the entire final state.

The chief results of the EMC are as follows (about 40 publications in the Phys. Lett., Nucl. Phys. and Zeitschrift f. Phys.):

--measurement of the F<sub>2</sub> structure function in a large range of kinematic variables and determination of the gamma QCD (quantum color dynamics) parameter characterizing scale violation;

--the "charting" of hadron production in deeply inelastic muon scatter and steps taken in the direction of understanding the producing mechanism;

--demonstration that the quark structure (structure function) of the nucleon depends on the environment of the nucleon, the structure in another nucleus as in an isolated nucleon (the "EMC effect");

--a study of J/psi and "charm" quark production in muon scatter.

A six member Hungarian group participated and participates (presently in computerized evaluation) in the EMC.

#### b. LEP, L3 Cooperation

This is one of four experiments accepted for the LEP. (The LEP, Large Electron Positron, is the new large accelerator of CERN now under construction in which electrons with energies of 50 GeV will collide with positrons with energies of 50 GeV.) Researchers from about 35 laboratories in all parts of the world (USA, China, Western Europe, the Soviet Union, Hungary, GDR, India) will take part in it. The leader is S. C. Ting, an American Nobel prize physicist of Chinese extraction.

The equipment consists of a central vertex detector (Time Expansion Chamber), an electromagnetic calorimeter surrounding it, a hadron calorimeter which includes the former and a muon detector system; all the equipment is in a

magnetic field (the field is about 0.5 T throughout the entire very large volume).

The chief "abilities" of the detector are:

--high precision pulse measurement of photons, electrons and muons ( $\Delta p/p$  equal to or less than 1 percent);

--precise measurement of the energy of hadrons (narrow hadron shower) produced in the collision;

--precise measurement of vertex.

The chief physical goals (the equipment was optimized for attainment of these) are:

--a precise check of the standard model and a search for scalar parts (e.g., Higgs) with  $e^+e^- \rightarrow l\bar{l}X$  type missing mass measurements (l-lepton);

--discovery of new phenomena (not predicted by theory) with a precise measurement of e, mu, gamma and hadron jets.

At present the equipment is being built and the parts tested and calibrated; at the same time they are now preparing the experiment processing computer network and the software which will process the data.

According to its possibilities the Hungarian group (5-6 people) is participating very actively in software development (Monte Carlo development, detector optimization with Monte Carlo, development of a form recognition program for the electromagnetic calorimeter, etc.).

The equipment will be completely ready by the time the LEP starts up (about the end of 1988). By then the whole system will be such that one can go quickly from the early measurements to physical results.

#### c. EHS (European Hybrid Spectrometer)

A joint working session of the NA22, NA23 and NA27 themes using the EHS accepted six members of the Budapest RMKI as members of the NA23 cooperation.

The experimental discovery of the fourth quark, "charm", 10 years ago necessitated a study of those very short life span states or resonances predicted by QCD where the charm quark is produced together with its antiparticle. The goal of the experiments which led to building the EHS was a precise determination of the life span of the charm-anticharm states.

The soul of the spectrometer is a fast operating, high resolution H<sub>2</sub> bubble chamber used as a vertex detector in which the hadron-nucleon (or hadron-nucleus) interactions take place and one can observe the charged decay products of neutral states. Measurements done on stereo photographs provide the physical characteristics (pulse, spatial angles, etc.) of the low energy secondary particles. The electronic detectors of the spectrometer (Cherenkov,

proportional and drift chambers) make it possible to identify from pulse and ionization data the high energy particles proceeding in a narrow spatial angle.

After performing the requested test measurements (about 200, an inelastic interaction measured earlier in Vienna) a large number of methodical checks showed that our measurement precision corresponds outstandingly to the results of participating laboratories obtained on automatic or semi-automatic equipment.

The present theme of the NA23 cooperation is a study of diffractively produced strange-antistrange, charm-anticharm states in 360 GeV/c pp collisions.

## 2. Cooperation with the United Atomic Research Institute at Dubna

### a. The RISZK Experiment

The Dubna institute built a 5 meter streamer chamber in which they intended to study hadron interactions. Later the chamber was supplemented with other detectors and thus a hybrid system was created. The events taking place were recorded on film. The films are being processed by the cooperating laboratories (including the KFKI). The actual experiments with RISZK have been completed, the measurement data collected is now being processed.

### b. Neutrino Calorimeter

The Dubna and Serpukhov institutes, in cooperation with Berlin (GDR) and Budapest laboratories, built a very large device to detect neutrinos which has outstanding parameters. The equipment is suitable for measuring all energy released in neutrino interactions (which is why it is called a calorimeter) and for determining the tracks of certain charged secondary particles. The former is done with the aid of liquid scintillator detectors and the latter with the aid of drift chambers. The entire detector is surrounded by a magnetic ring so if muons are produced they cannot leave the equipment but rather register in the magnetic spectrometer at the end of the neutrino detector. This is necessary so that we can separate two types of neutrino interaction, the so-called charged current and neutral current interactions. In the former case muons are always produced; in the latter they are not. The equipment was made and set up on the Serpukhov accelerator; the first technical measurements (e.g., to determine the background) have been made already. Actual physical measurements will begin in the near future. The first physics problem which the equipment is intended to study is a search for heavy neutrinos.

### c. The Baikal Experiment

Hungarian researchers are also participating in a very interesting neutrino experiment where the neutrinos are not produced with the aid of accelerators or reactors but rather they are studying the properties of neutrinos arriving with cosmic radiation. Cosmic neutrinos arriving in the waters of Lake Baikal can interact with nucleons in the water and because of their high energy many

high energy secondary particles (e.g., muons) will be produced. These move in the water at a speed greater than the speed of light (in water). In such cases, as is well known, Cherenkov radiation is produced; a weak blue light is produced by neutrino interactions. This can be detected by a multitude of photon-electron multipliers immersed in the water. Lake Baikal is especially suited for such experiments because setting up the electron multipliers through holes cut in the ice is simple and safe. (There are now 24 such electron multipliers but they intend to increase this to several thousand later.) After the ice melts the equipment is held by buoys and anchors. The signals of the photo-electron multipliers are carried by a cable on the lake bottom to the shore about 5 kilometers away. Preliminary processing of the signals is done in the water by the electron multiplier system itself and final processing is done on shore with the aid of computers. The depth of the water where the equipment is located is 1,300 meters. With the aid of this one can study the nuclear physics interactions of neutrinos, astrophysics problems and other questions only distantly or not at all related to neutrino physics. The first measurement, already completed, falls in the latter category; they tried to find the magnetic monopoles predicted by theory; they provided an upper limit for the intensity of possible monopoles.

### 3. Theoretical Particle Physics

The three theoretical research groups (ELTE Theoretical Physics Faculty, ELTE Atomic Physics Faculty and the KFKI, RMKI Theoretical Department) work in close cooperation in a number of areas but the extensive system of international contacts (CERN, N. Bohr Institute, etc.) is also an indispensable part of their work. Among the most important, most fruitful research themes we must mention the quantum color dynamics studies, research on the special dynamic properties (monopoles) of nonlinear space theories with local scale symmetry, and phenomenological calculations connected with the most modern experiments of our day (production of high energy signals, energy correlation, electroweak phenomenology).

### V. Other

The following themes are put in the "other" category not because they are less important but rather partly for lack of space and partly because separate, detailed talks have been given about them. Their significance is substantially greater than could be reflected in this brief summary.

#### 1. Space Physics

Among the results achieved in Hungary in space physics the most outstanding is our role in the VEGA mission. We joined the international space program set up to study Halley's Comet in situ and led by the Moscow Space Research Institute in 1981.

Within the framework of the program our task was production, calibration, certification and Earth testing of certain on-board instruments needed for the VEGA experiment. By the end of 1984 we had prepared the following equipment, two or three of each device:

- the Television System (TVSZ),
- the Central Data Collector (BLISZI),
- the TUNDE analyzer to detect medium energy charged particles;
- the PLAZMAG low energy plasma measurement equipment.

The space probes rendezvoused with Halley's comet on 6 and 9 March 1986. Both meetings were successful.

The most important and most interesting scientific results were: the comet has a solid nucleus (potato shaped) with a longer diameter of about 14 kilometers and a shorter diameter of 7.5 kilometers. The period of rotation of the nucleus is 53 times every 2 hours; the albedo of the nucleus is extraordinarily small, 0.04 (plus 0.02, minus 0.01).

## 2. Biophysics Research

The present revolution in biology and the prospects for biotechnology have prompted a number of physicists to change careers; the significance of biophysics has increased swiftly. It is very difficult to precisely define the exact subject of biophysics; research being done around the world in an extraordinary number of fields falls under the designation of biophysics. Naturally this applies to Hungary also, so I will try to list only the chief research directions without trying to rank order them or be complete.

--Hungarian biophysicists are doing active and successful research on the transformation of light into biological energy, through both photosynthesis and bacterial processes.

--Research on biological membranes is of exceptional importance. In this area they use the physics and biophysics approach to study, among other things, transport processes, the distribution of surface receptors and membrane fluidity.

--Muscle biophysics research has great traditions and is being done with considerable forces.

--In the area of radiation biology they are studying the DNA harming effect of various radiations and are doing medical physics and radiation protection research which can be summarized under the name "health physics."

--The initiatives of experimental and theoretical physicists in the areas of neurobiology, neurobotics and theoretical biology are very promising.

--Research in which special nuclear and atomic physics methods are used to solve biological and biochemical problems is relatively new.

## 3. Shell Physics Research

Domestic shell physics research has the following chief themes: chemical bonding, molecular structure, spectroscopy theory, molecular dynamics, molecular aggregates and surface states. Even this listing shows that it is difficult to separate shell physics research from other areas of physics

(e.g., solid body physics) or from other scientific areas (e.g., chemistry) and "pure" shell physics research is being done in only a few cases. In addition to basic research a large proportion of the studies are connected to direct applications (e.g., in the pharmaceutical and crop protection materials industry), even in regard to their theoretical character. The above is also reflected in the composition of the shell physics research sites. To a significant degree the research--including the theoretical--is being done at non-physics research sites.

The chief methods used are theoretical research, positron annihilation, optical spectroscopy (UV, IR, Raman), resonance methods (MMR, ESR), Mossbauer spectroscopy, ESCA and gas electron diffraction.

The theoretical research (ELTE, KLTE, BME, KKKI) is directed partly at development of theoretical methods (ab initio force constant computations, the X-alpha method, use of pseudopotentials) and partly is connected with research (BME, KKKI) on new types of problems (surfaces, clusters, molecular electronics). Other research is aimed at direct applications (e.g., Chinoi). In a number of cases this is directly interdependent with experimental work taking place at the research sites.

The most extensive experimental research takes place in the larger Academy institutes (KFKI, ATOMKI, KKKI). We should mention the research connected with the magnetic property of materials, the electron structure of frozen solutions, the electron structure of quasi-unidimensional materials, use of electron spectroscopy and resonance methods. The workshops at the universities also play a significant role.

Unfortunately the research needs for modern instruments and computers are so high that a significant part of the research can be done only in international cooperation--due to the more modest nature of domestic possibilities. The Hungarian researchers are trying to take advantage of the possibilities offered by international cooperation. There are about 70 domestic research sites maintaining working contact with 100 foreign research sites.

#### 4. Gravitational Research

The significance of general relativity theoretical research has increased recently. We can count the beginnings of domestic research from the world famous experiments of Lorand Eotvos.

For about two decades the theoretical group working at the Central Physics Research Institute has been dealing with the development of relativity studies. Their efforts were directed at a solution of the hard mathematical problem obtained with the gravitation equations but they also contributed to the international effort to unite gravitation and quantum theory. They are dealing productively with the physics of black holes, with gravitational collapse and with cosmology. A group made up of researchers from the ELTE Geophysics Faculty, the BME, MOM and KFKI is preparing to repeat the gravitation experiments of Eotvos with modern techniques.

In preparing the lecture and in writing the article I received very great help from the following colleagues: Gyula Csikai, Janos Gado, Sandor Gueth, Jozsef Kecskemeti, Ede Koltay, Gyorgy Mihaly, D. Lajos Nagy, Karoly Rozsa, Zoltan Szokefalvy-Nagy, Janos Valko, Andras Varga and Arpad Veres.

I would like to thank them on this occasion.

## HUNGARY: LIMITED PERMISSION TO RECEIVE SATELLITE TV

Budapest COMPUTERWORLD/SZAMITASTECHNIKA in Hungarian No 10-11, 18 May 87  
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[Excerpt from a column compiled by Huba Bruckner: "Satellite Communications;  
An Indispensable Heavenly Link"]

[Excerpt] Domestic Situation

In Hungary, first of all, the guests of certain Budapest hotels (eight in the beginning, according to plans) will be able--in a way similar to Yugoslavia--to see the satellite television broadcasts, as public viewers. The Hungarian Post Office--without whose permission one cannot install a satellite receiving antenna--has thus far not authorized public reception of the present transmissions by other cable television systems.

In addition to the Post Office a few enterprises and small undertakings, including the Telecommunications Research Institute (TKI), the Budapest Technical University, Orion, Videoton, the Communications Engineering Cooperative, the Computext Developmental Enterprise and the Parabola, Vitech and MiniMax small cooperatives, are dealing with problems of space telecommunications. A number of them are participating in the Interkozmos program. Thus, for example, the TKI developed and manufactures the Intercsat channel generating unit. The products of the small undertakings are only rarely installed domestically--lacking permits. For this reason they see a market for their products primarily abroad.

A radical change in the situation can be expected with the appearance of direct broadcasting satellites (in a favorable case as early as August of this year), for reception of these programs need not be authorized in accordance with the International Radio Regulations. In our country the complete cost of building a ten station public reception system capable of receiving 40 channels is expected to be 30,000 to 35,000 forints per inhabitant.

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