"New High Energetic Components for Future Ammunition Design"

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NEW HIGH PERFORMANCE PROPELLANTS

NITROCHEMIE

Video

If you want to hit future targets, you need the best and most reliable propulsion system design

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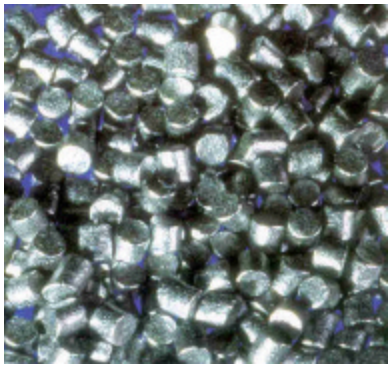
Contents of Presentation

- New Propellants for Medium Caliber Applications
- Improved Propulsion Systems for Mortars
- Future Propellants for Tank Ammunition (SCDB)
- Conclusions

NEW HIGH PERFORMANCE PROPELLANTS

Part 1: Medium Caliber Propellants



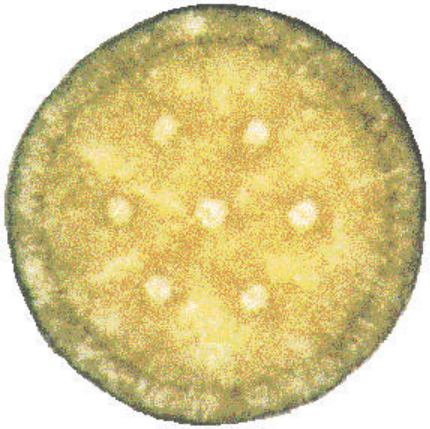
NEW HIGH PERFORMANCE PROPELLANTS

Medium Caliber Propellants - Overview

NITROCHEMIE

Single Base
performance-improved

- **Improved interior ballistic performance due to optimised surface coating / increased bulk density**
- **Best solution for full caliber ammunition !**



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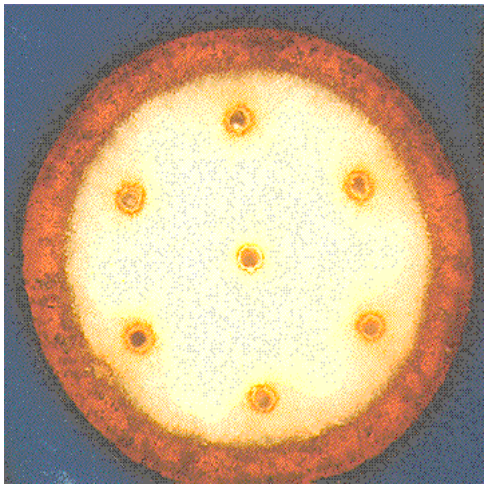
EI
Extruded-Impregnated

- **Significant performance gain due to two-layer surface coating / reduced temperature sensitivity**
- **Best solution for sub caliber kinetic energy ammunition ! ("State of the Art")**



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EI+
NGL-free

- NGL-free EI variant with similar performance
- Better stability + cook-off beh. / lower flame temp.
- For special applications (aircraft ammunition)

EI++
NGL-free/semi-nitramine

- Nitroglycerine-free / semi-nitramine EI variant
- In development for future design demands

NEW HIGH PERFORMANCE PROPELLANTS

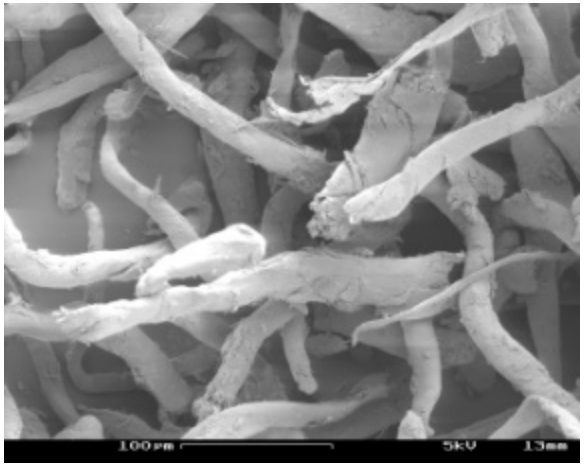
Manufacture of EI® / EI+ Propellant (schematized)

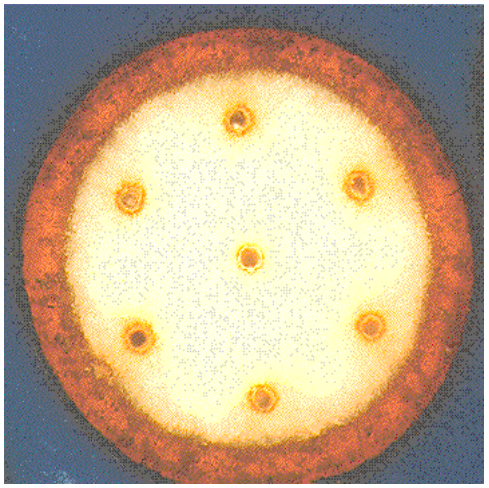
NITROCHEMIE

NC-Processing by Extrusion

Impregnation with Nitroglycerine and Non-Energetic Coating

Nitrocellulose Fibers → **EI-Green Propellant (single base)** → **EI®-Propellant**





NEW HIGH PERFORMANCE PROPELLANTS

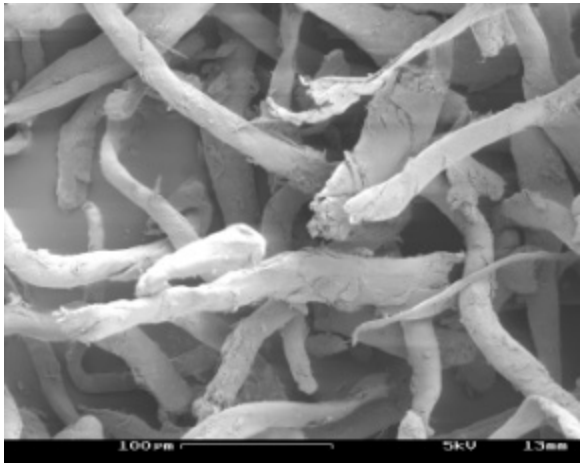
Manufacture of EI® / EI+ Propellant (schematized)

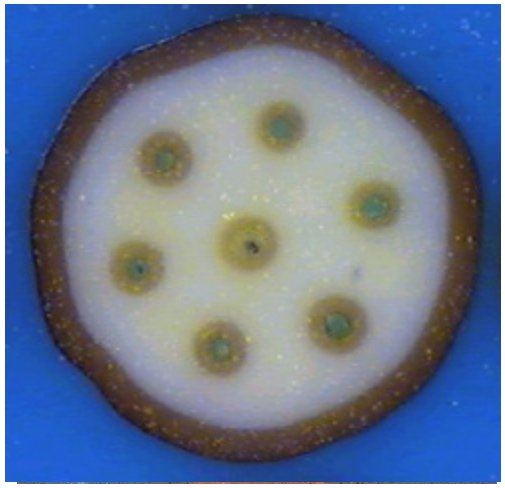
NITROCHEMIE

NC-Processing by Extrusion

Impregnation with new Energetic Plasticizers and Non-Energetic Coating

Nitrocellulose Fibers → **EI-Green Propellant (single base)** → **EI+-Propellant**





NEW HIGH PERFORMANCE PROPELLANTS

EI® Propellant for Medium Caliber Applications

An already well established Technology

NITROCHEMIE

Qualified Applications:

25 mm APFSDS	Mecar
25 mm APFSDS (M919)	Primex
27 mm APFSDS Midas	Mauser
27 mm FAPDS	Mauser
30 mm APFSDS	Royal Ordnance
30 mm APFSDS	NAMMO
30 mm APFSDS/FAPDS/TP	OCP/Mauser
35 mm APFSDS	Rheinmetall

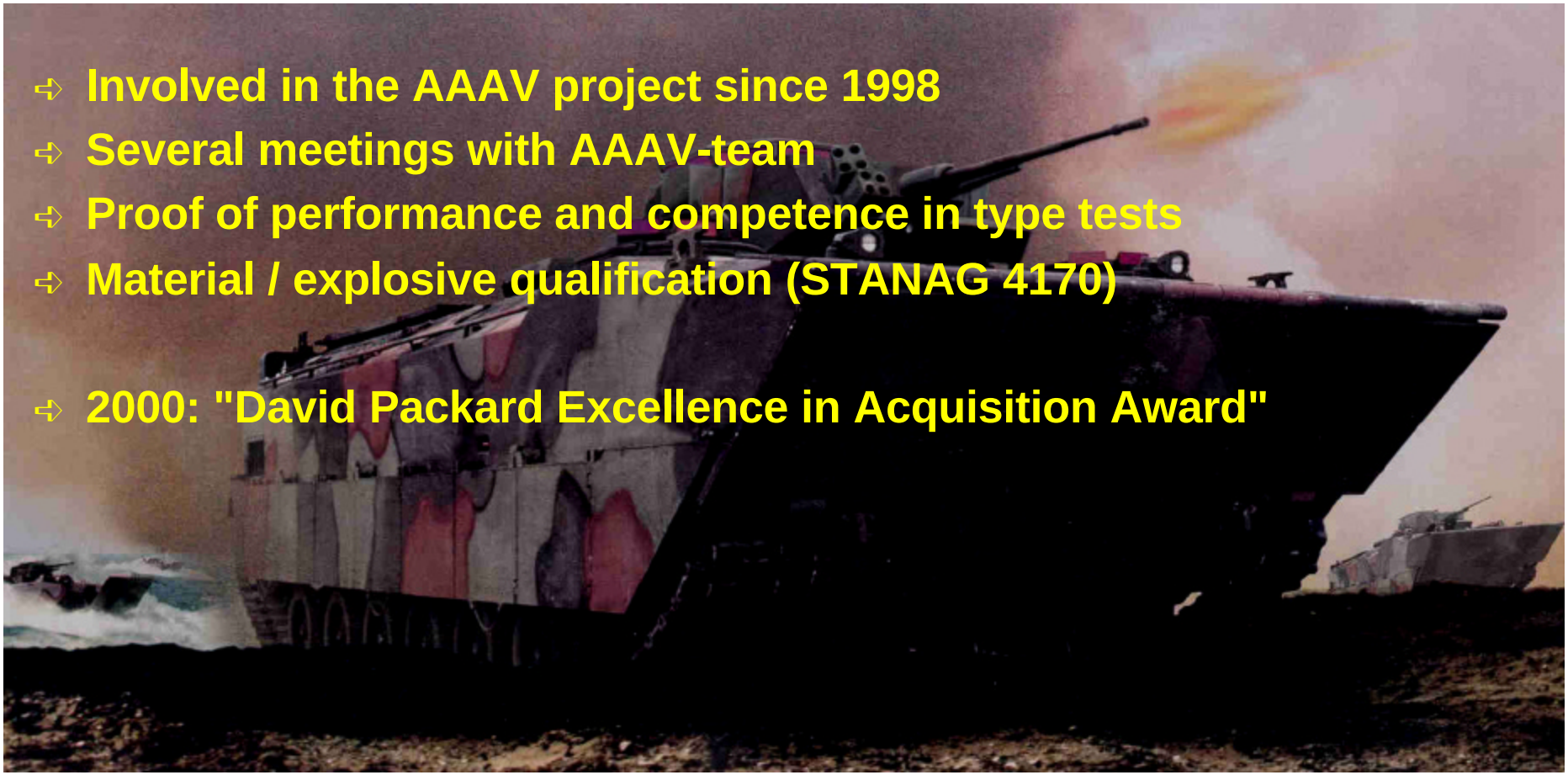
NEW HIGH PERFORMANCE PROPELLANTS

EI® Propellant for 25 mm APFSDS-T M 919

- Enables high performance with good barrel life (≥ 3000 rounds)
- EI propellant is US qualified / in series production since 1998
- This advanced propulsion system, combined with the product improvement program already in progress, allows the M 919 to remain attractive for at least an other decade

NEW HIGH PERFORMANCE PROPELLANTS

NITROCHEMIE's Contribution to 30/40 mm AAAV Programme



- Involved in the AAAV project since 1998
- Several meetings with AAAV-team
- Proof of performance and competence in type tests
- Material / explosive qualification (STANAG 4170)

- 2000: "David Packard Excellence in Acquisition Award"

David Packard
Excellence In Acquisition Award

US Marine Corps
DRPM AAA
Mark 46 30/40mm Weapons System

Kurt Ryf

The Mark 46 Weapons System is a world-class model of acquisition reform exemplifying the principles of CAIV, Interoperability, and IPPD to improve warfighter capability while reducing total ownership cost.

April 5, 2000

Jacques S. Gansler
Under Secretary of Defense
for Acquisition, Technology,
and Logistics

NEW HIGH PERFORMANCE PROPELLANTS

NITROCHEMIE's Contribution to 30/40 mm AAAV Programme

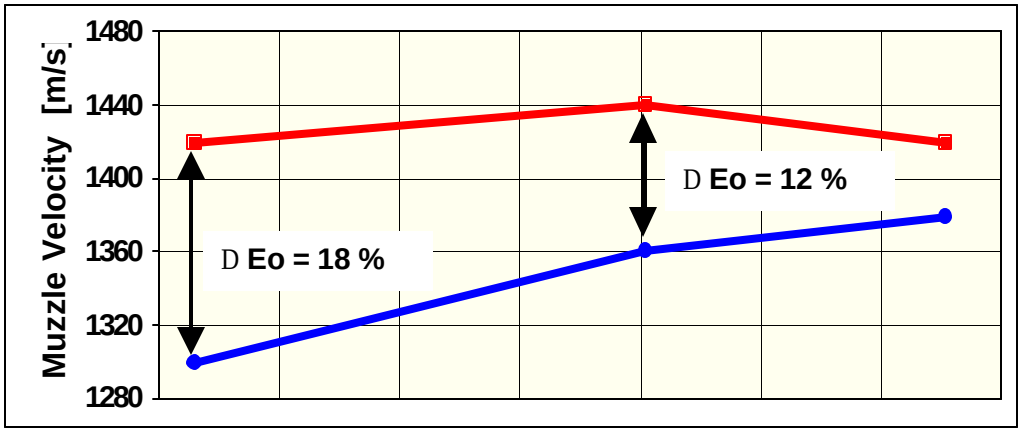
- **Development of highest performance EI-propellants for 30 mm APFSDS-T ammunition systems (NAMMO and Oerlikon Contraves Pyrotec AG OCP)**

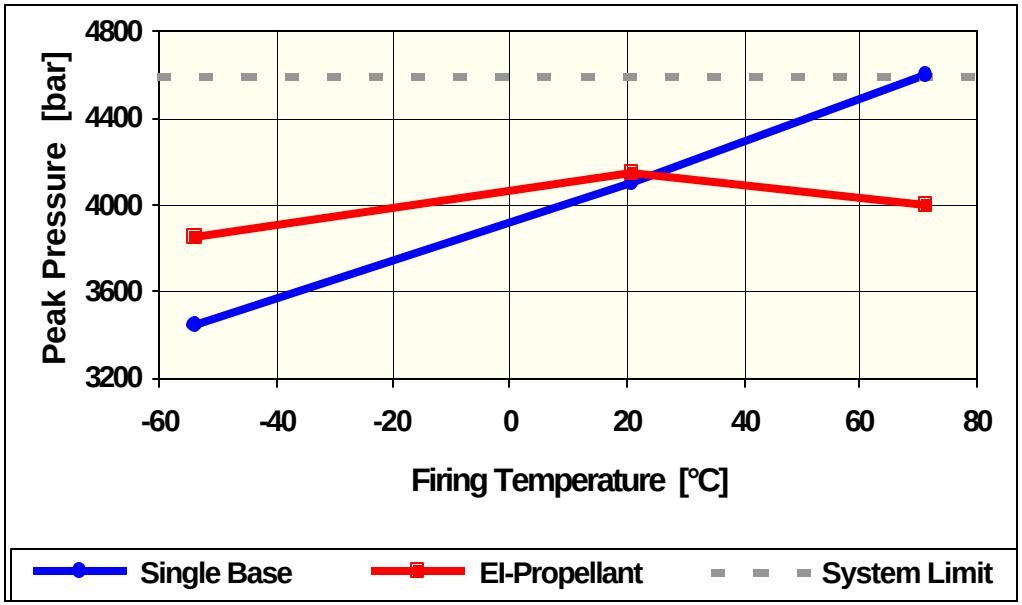
- **Type classified and qualified for AAAV-program:**
  - **APFSDS-T rounds of both suppliers**
  - **MP-T round of NAMMO**

NEW HIGH PERFORMANCE PROPELLANTS

EI® Propellant for 30 mm x 173 APFSDS-T

Firing Tests in 30 mm Bushmaster II





- Significant performance gain
- Excellent temperature behaviour

NEW HIGH PERFORMANCE PROPELLANTS

NITROCHEMIE's Contribution to 30/40 mm AAAV Programme

- **Contributions to the concept phase of the 40 mm Super Forty program**
- **EI^{+} and EI^{++} are candidates with the potential to fulfill ambitious demands for future upgunned combat systems**
  - **APFSDS-T**
  - **AIRBURST**

NEW HIGH PERFORMANCE PROPELLANTS

Propellants for Future Aircraft Fighter Systems

Eurofighter

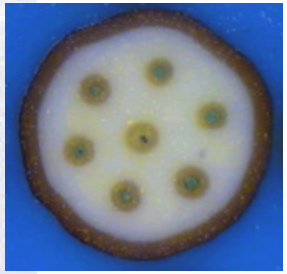
Rafale

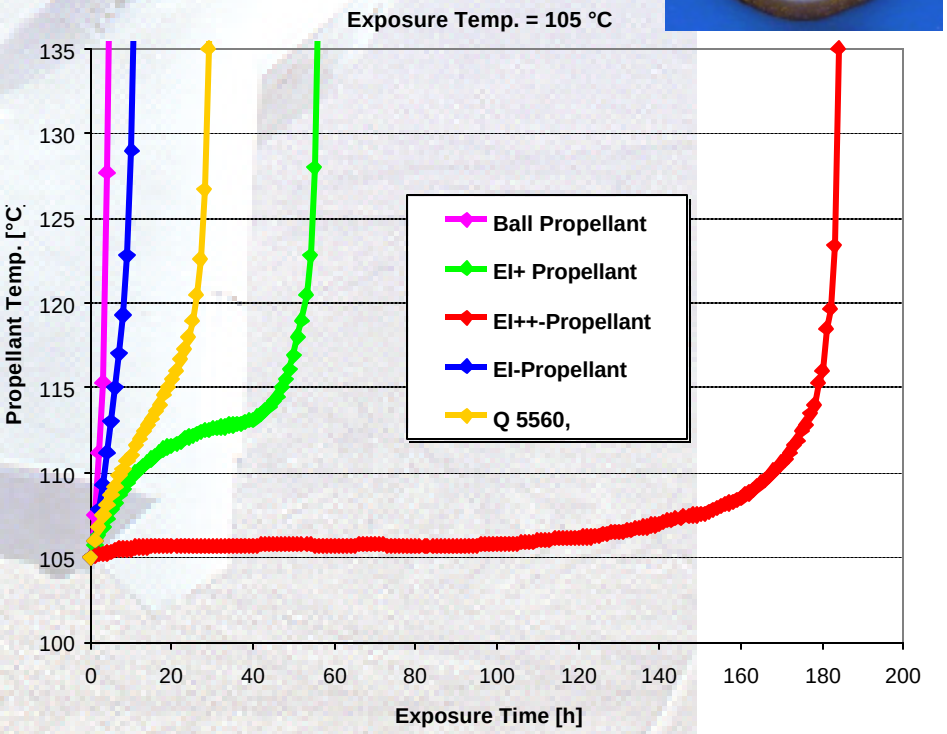
Joint Strike Fighter

NEW HIGH PERFORMANCE PROPELLANTS

Improved Propulsion Design for Future Aircraft (Fighter) Ammunition

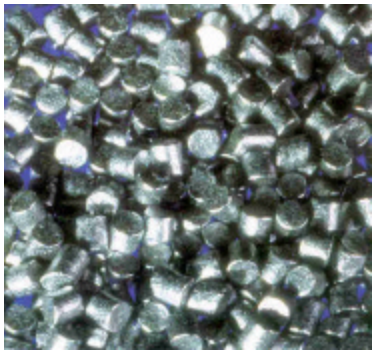
- The new, nitroglycerine-free propellants EI^{+} and EI^{++} show significantly improved features if compared to the ball powders or double base propellants presently used in such applications, in particular:
  - Better cook-off behavior
  - Tremendously improved chemical stability
  - Excellent ballistic stability
  - Low temperature-sensitivity (equal to EI-type)
  - Excellent interior ballistic performance (equal or better than EI)

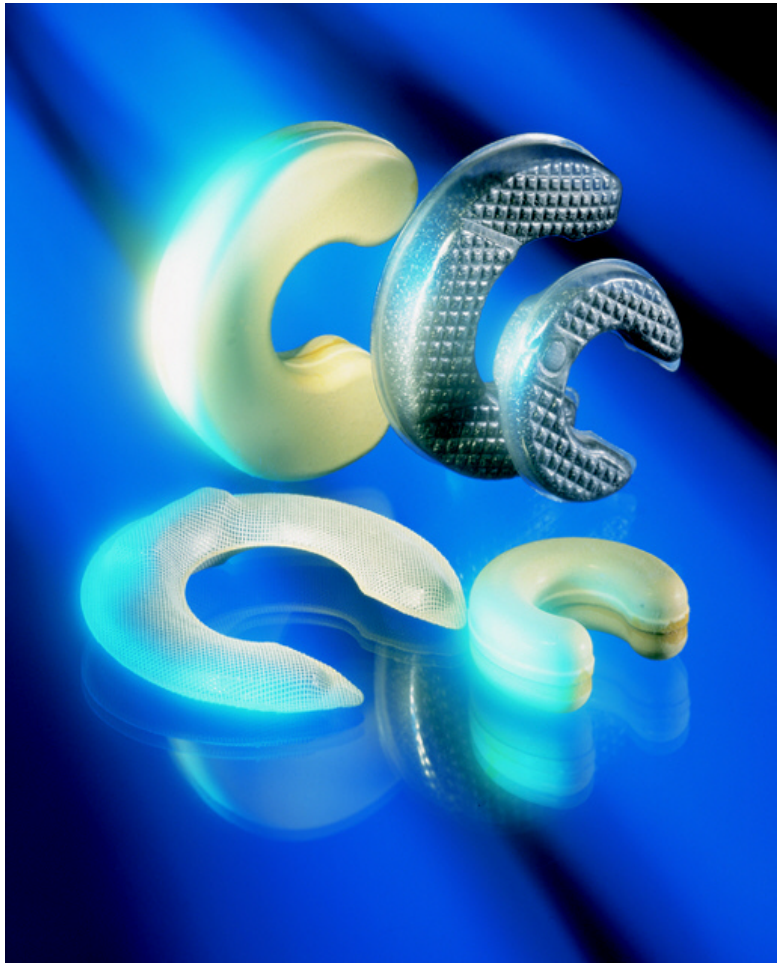




NEW HIGH PERFORMANCE PROPELLANTS

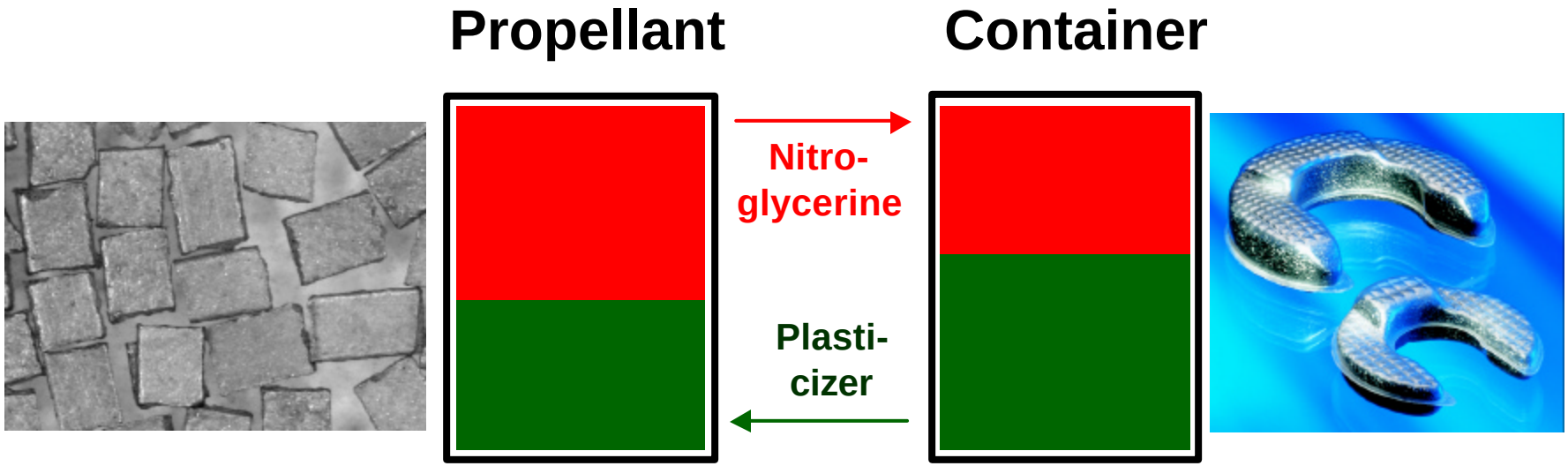
Part 2: Mortar Propellants





Aging Problems of Mortar Charges

- Modern mortar augmenting charges consist of combustible containers (made from celluloid or felted fiber), filled with granular double base propellant
- Such systems, however, suffer from **severe aging-related problems**



- Containers take up more than 30% of nitroglycerine within 1 - 3 years
- and loose more than 50% of their original plasticizer content

Aging Problems of Mortar Charges

- Such diffusion processes cause the following problems

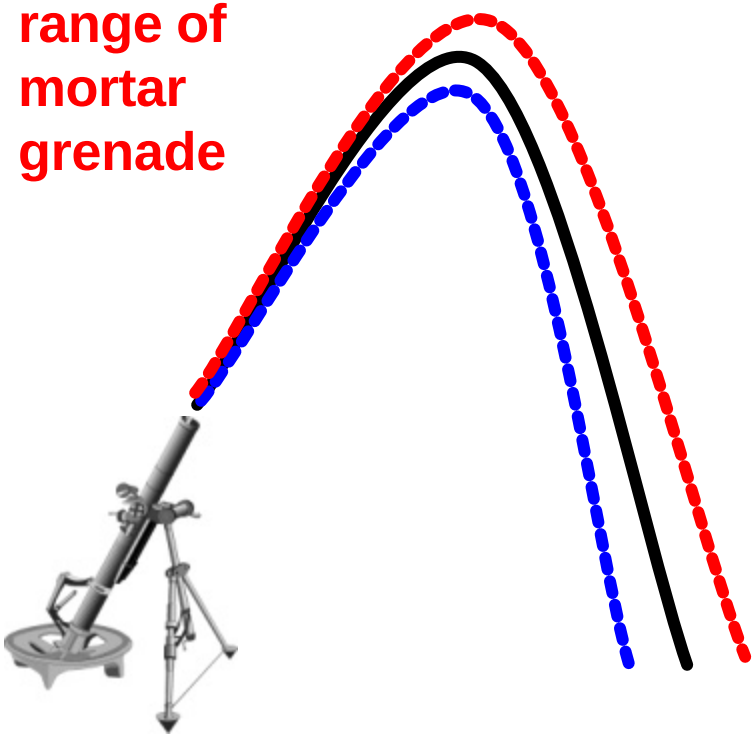
- Strong embrittlement of **celluloid containers** at low temperatures

- **Rupture of containers during handling**

- **Safety risk**

- **Strong changes in interior ballistic behaviour (v_0 / p_{max})**

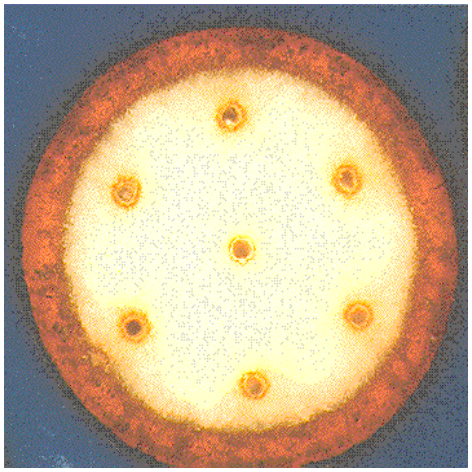
- **Change of range of mortar grenade**

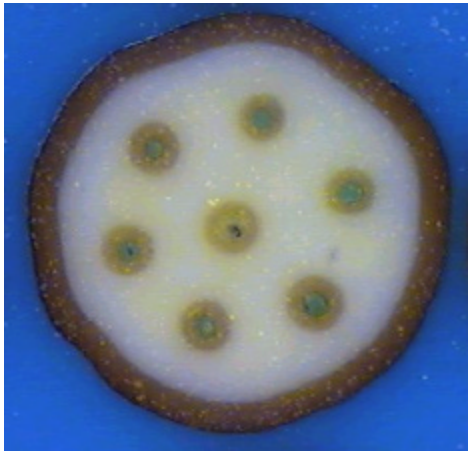


NEW HIGH PERFORMANCE PROPELLANTS

Improved Propulsion Systems for Mortars: EI® / EI+ / EI++ - Propellant Family

- The propellants of the EI®-family allow to tremendously improve the characteristics of mortar charge systems:
  - Significantly higher interior ballistic performance than single base propellants
  - Reduced dispersion of v_0 and p_{max}
  - Reduction of nitroglycerine and plasticizer diffusion by factor 3 - 10 (compared to double base propellants) and therefore
  - No aging related problems such as container embrittlement / loss of dimensional stability
  - Significantly improved ballistic stability / shelf life





NEW HIGH PERFORMANCE PROPELLANTS

EI® Propellant for 60 mm MAPAM

- RUAG's MAPAM (Mortar Anti-Personal Anti-Material Cartridge) shows greatly enhanced lethality
- Propulsion systems basing on celluloid and felted fibre containers are available, both with EI® propellant
- MAPAM System is qualified in Switzerland / in qualification in USA

NEW HIGH PERFORMANCE PROPELLANTS

Alternative Propellant for 120 mm Mortar

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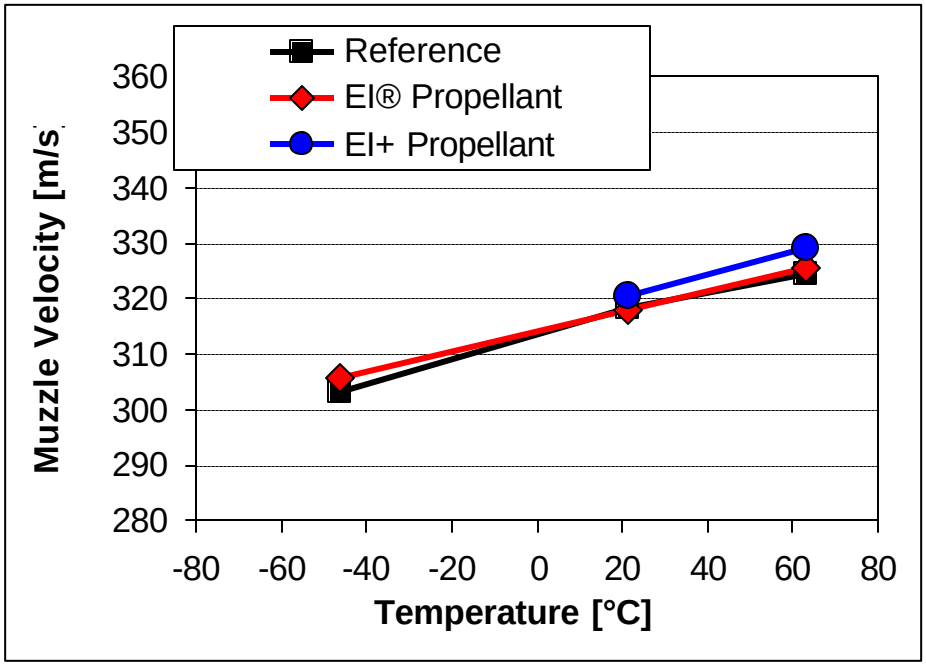
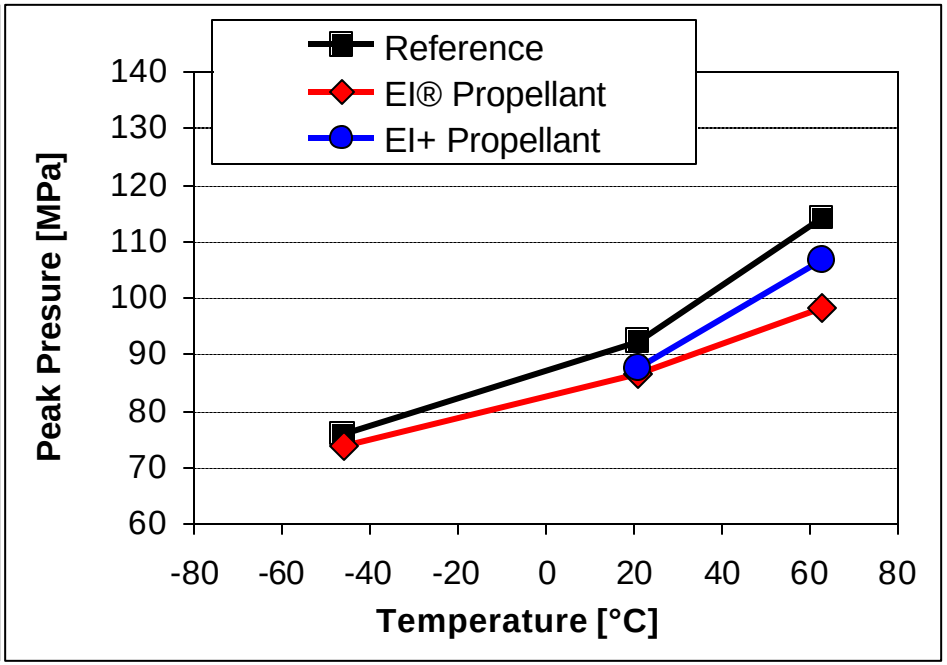
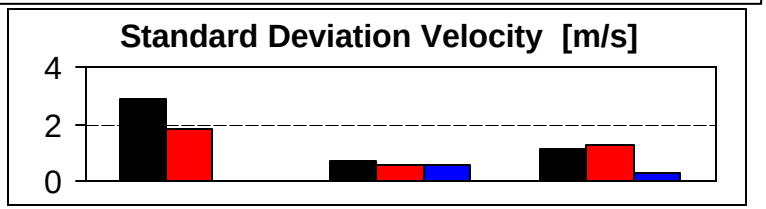
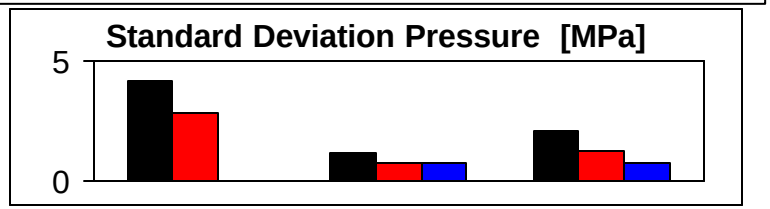
Feasibility study: Results from firing test







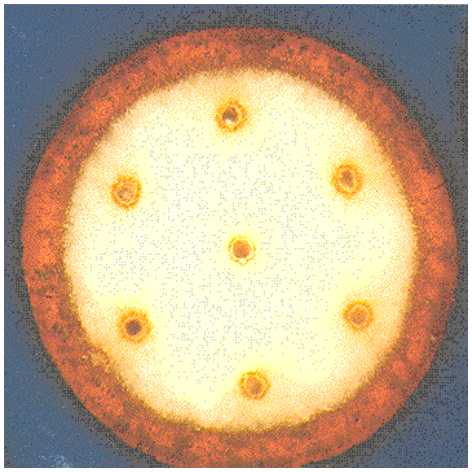


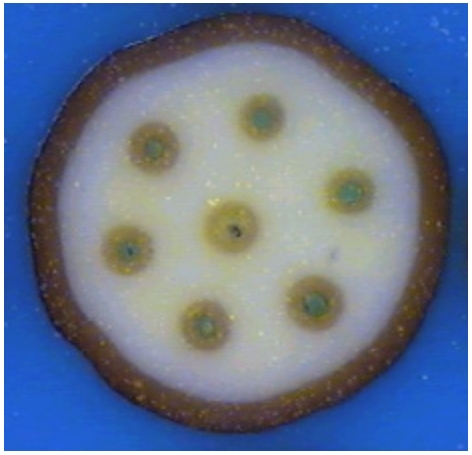
➪ Equal performance at reduced pressure level / dispersion of v_0 and p_{max}

NEW HIGH PERFORMANCE PROPELLANTS

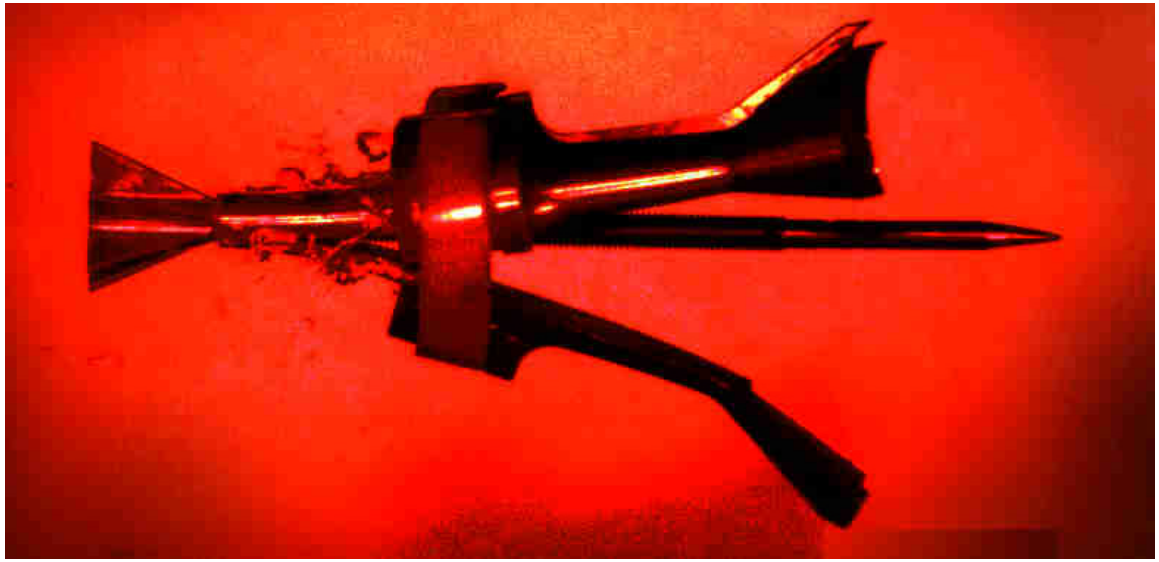
Improved Propulsion Systems for Mortars: EI® / EI+ / EI++ - Propellant Family

- Almost everywhere in the world, mortar charges cause problems:
  - Lots are locked because of safety objections
  - Containers have to be replaced every 5 - 7 years
- In several systems, double base propellants are therefore replaced by EI propellants
  - 60 mm mortar bomb (Switzerland)
  - 60 and 81mm long range grenade (SA)
  - 120 mm MAT-120 (Spain)
- For many other systems, introduction of EI® / EI+ propellants is in progress or at least considered
  - 60 mm MAPAM (Switzerland/USA)
  - 81 mm MO 81 LLR (France)





Part 3: Propellants for Tank Ammunition



NEW HIGH PERFORMANCE PROPELLANTS

SCDB® Technology for Tank Ammunition

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New Trends in armement of rapid deployment troops

- **light and air transportable fighting systems**
- **Sufficient fire power**
- **Compact gun systems**
- **Availability in near future**

NEW HIGH PERFORMANCE PROPELLANTS

Army Transformation

Available gun systems
- **L7 A1**
- **M 68 A1**

Future gun systems
- **Smooth bore gun**
- **Laser/plasma-ignition**
- **ETC-Technology**

- **KE-round**
- **Multi purpose round**

Need of Enhanced or new propulsion design

NEW HIGH PERFORMANCE PROPELLANTS

SCDB® Technology for a “miraculous” performance

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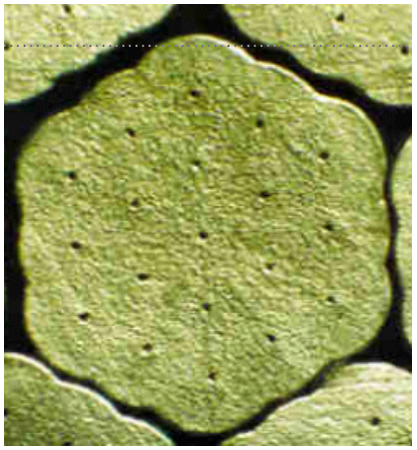
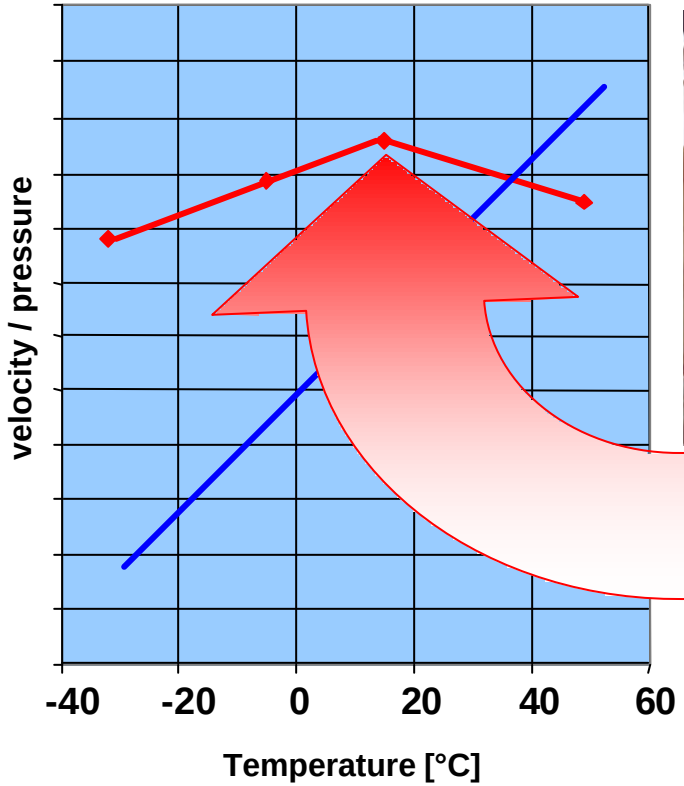
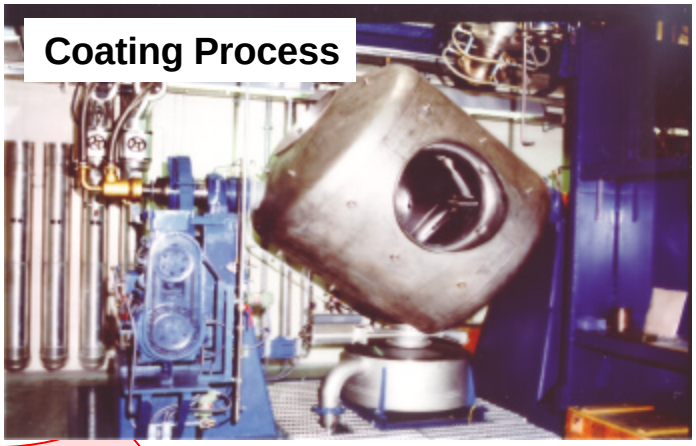
Characteristic of „Miracle propellant“

Advanced Process Technology



Propellant of any shape (geometry) and formulation (impetus)



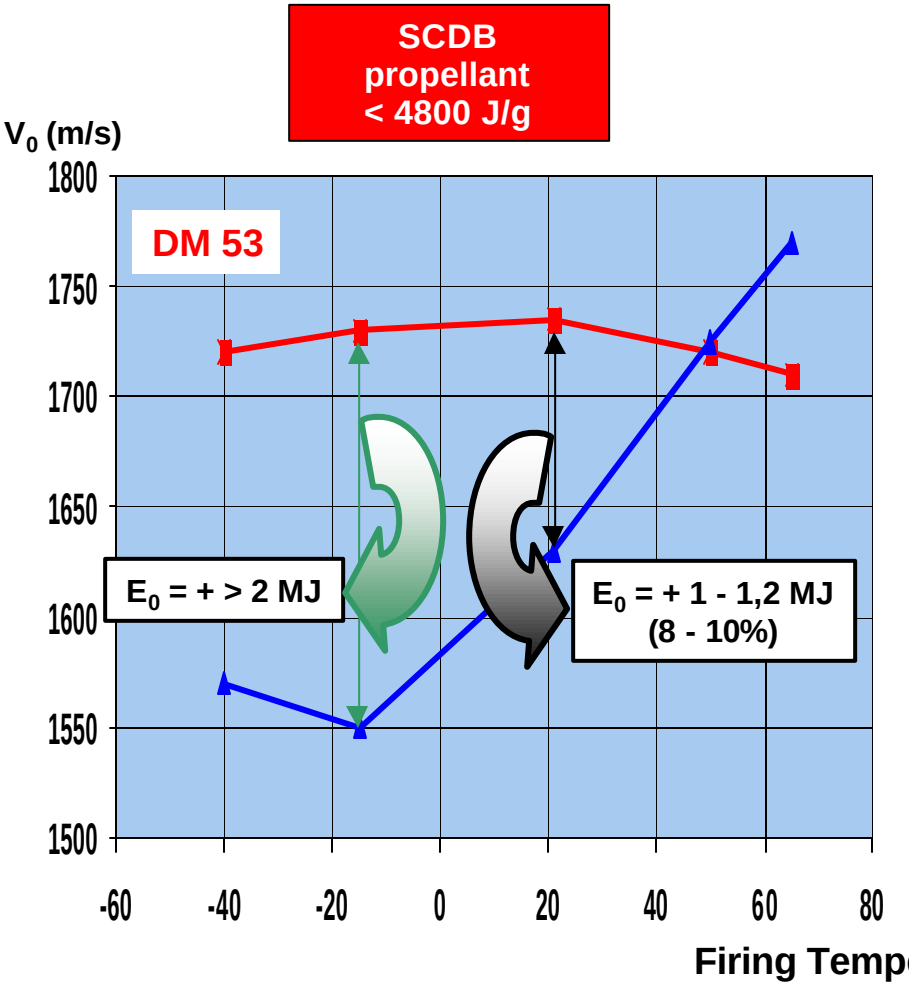


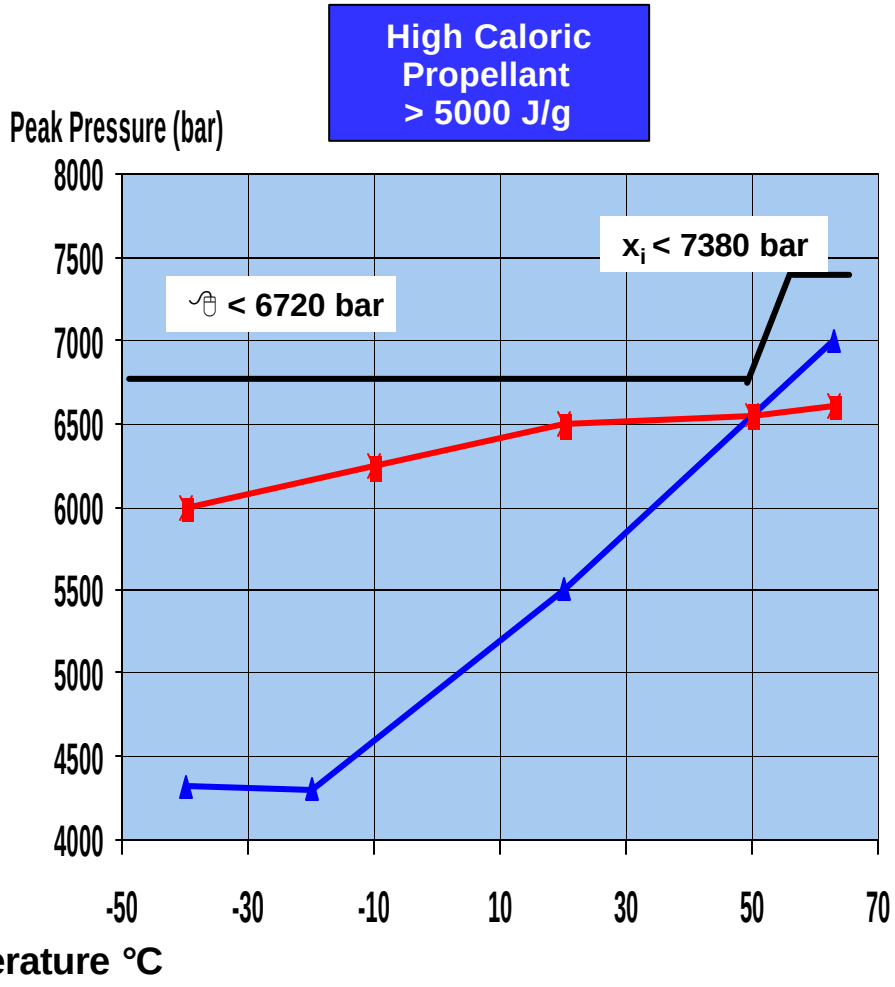
Modifying
- **form function**
- **burn rate**

Enhanced Performance

NEW HIGH PERFORMANCE PROPELLANTS

Enhancement of 120 mm KE-round

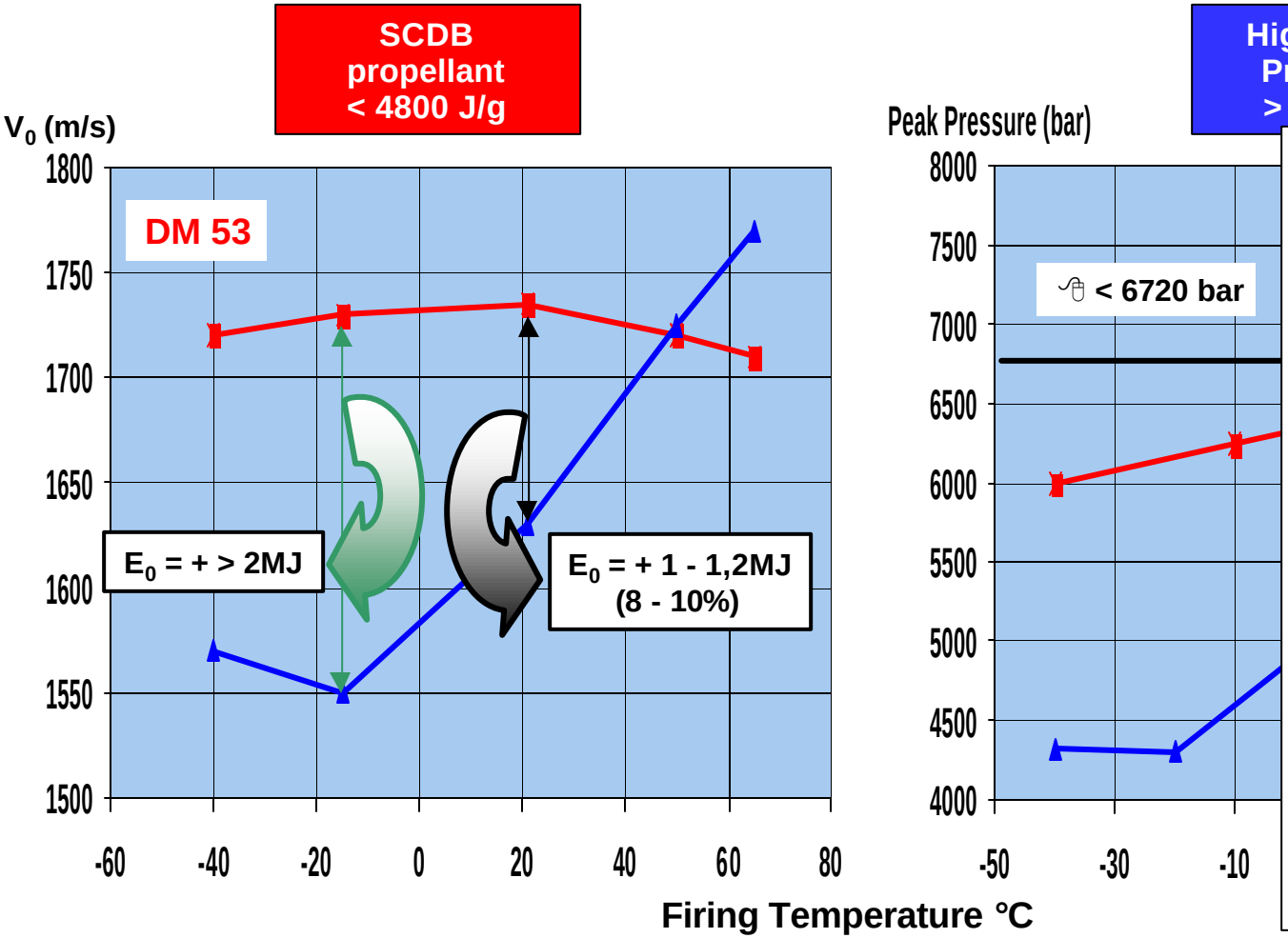




NEW HIGH PERFORMANCE PROPELLANTS

Enhancement of 120 mm KE-round

„Not a miracle but the truth“



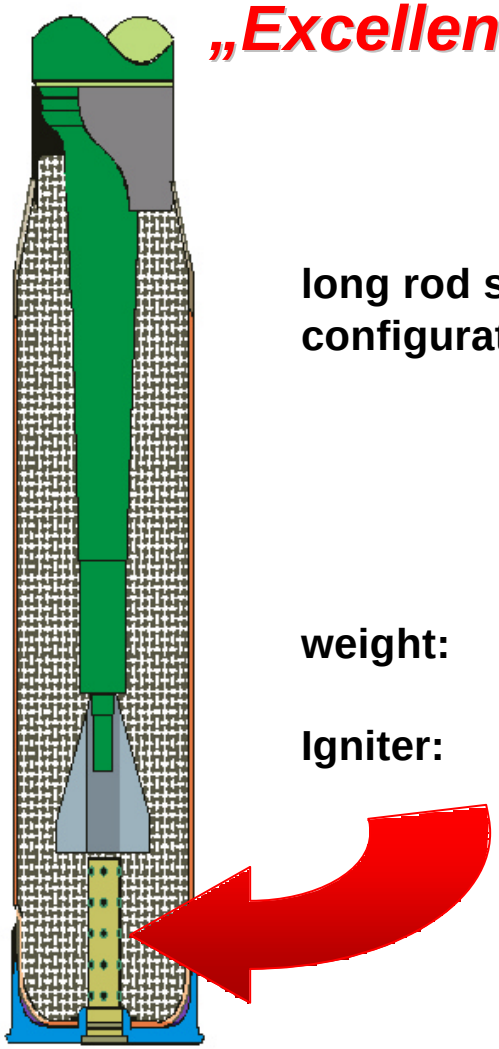
Benefits

- **higher penetration capability**
- **shorter time of flight**
- **longer range**
- **improved hit probability**
- **unchanged ballistics over entire tempe-rature range**

US Contract Feasibillity Study

NITROCHEMIE

„Excellent adaptability to any configuration“

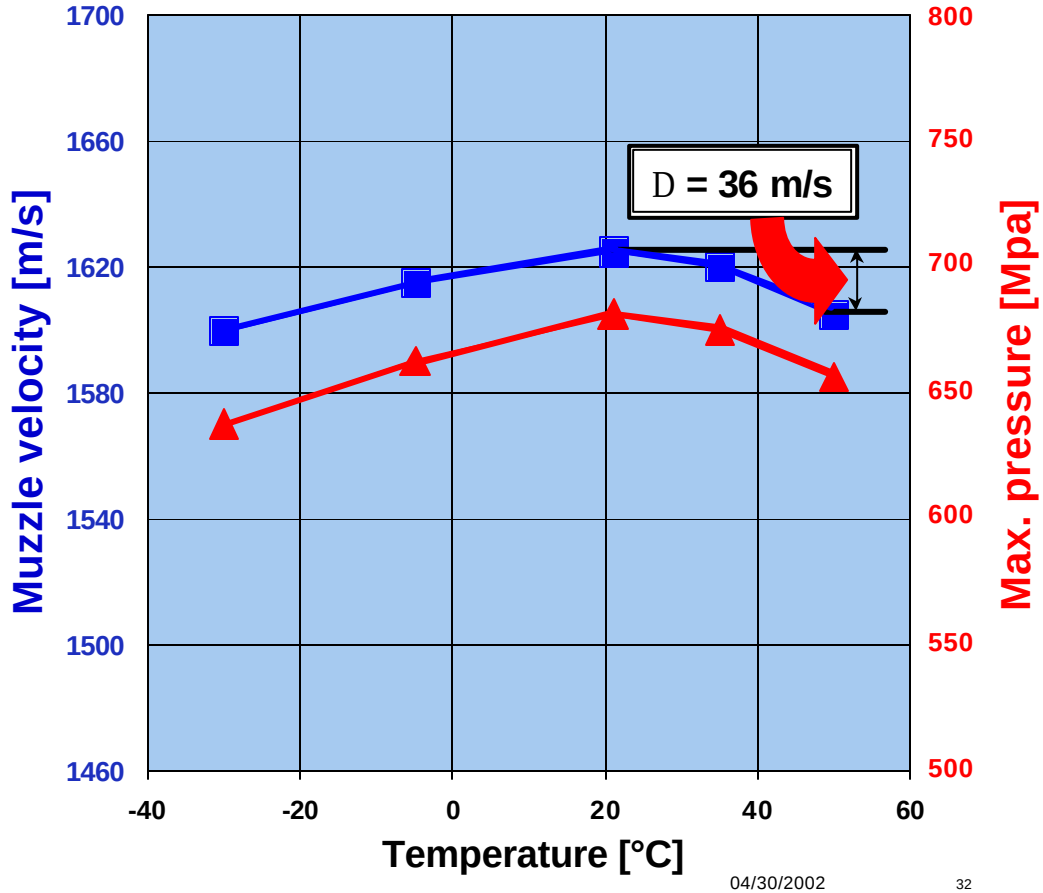


long rod slug configuration

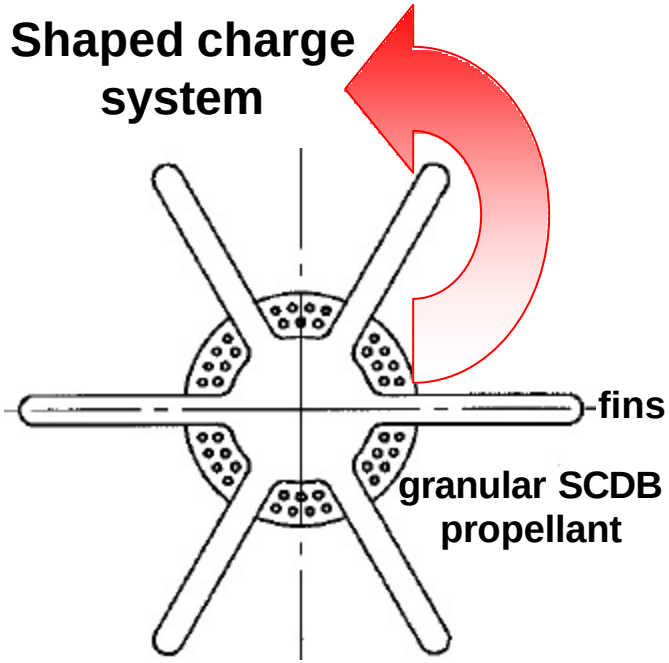
weight: 9.41 kg

Igniter: 86 mm

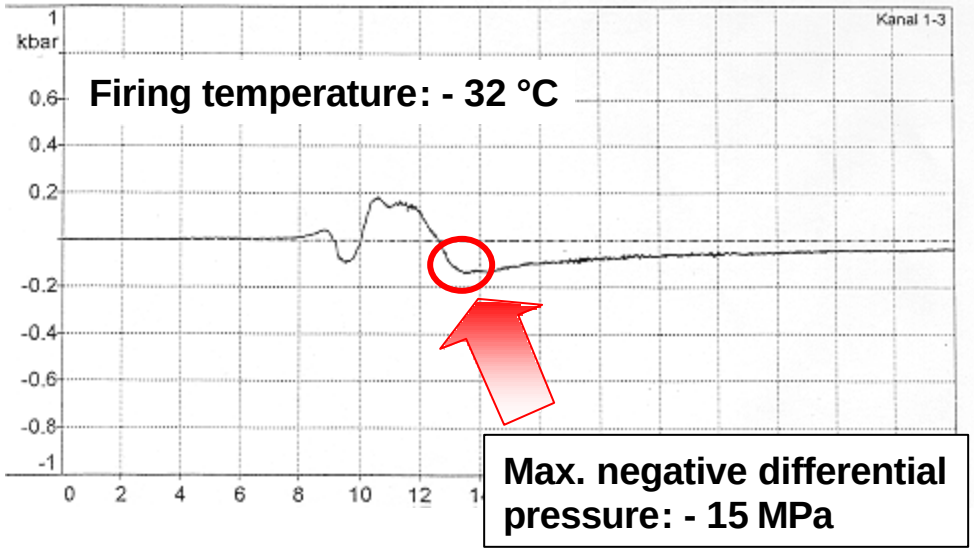
gun firing test from 120 mm / L 44 SB-barrel



Firing Safety with Short Igniter



$\triangle p = p1 - p3$



- good ignition transfer
  no signs of pressure waves
- maximization of performance
  high loading density

Performance Prospects for 120 mm KE

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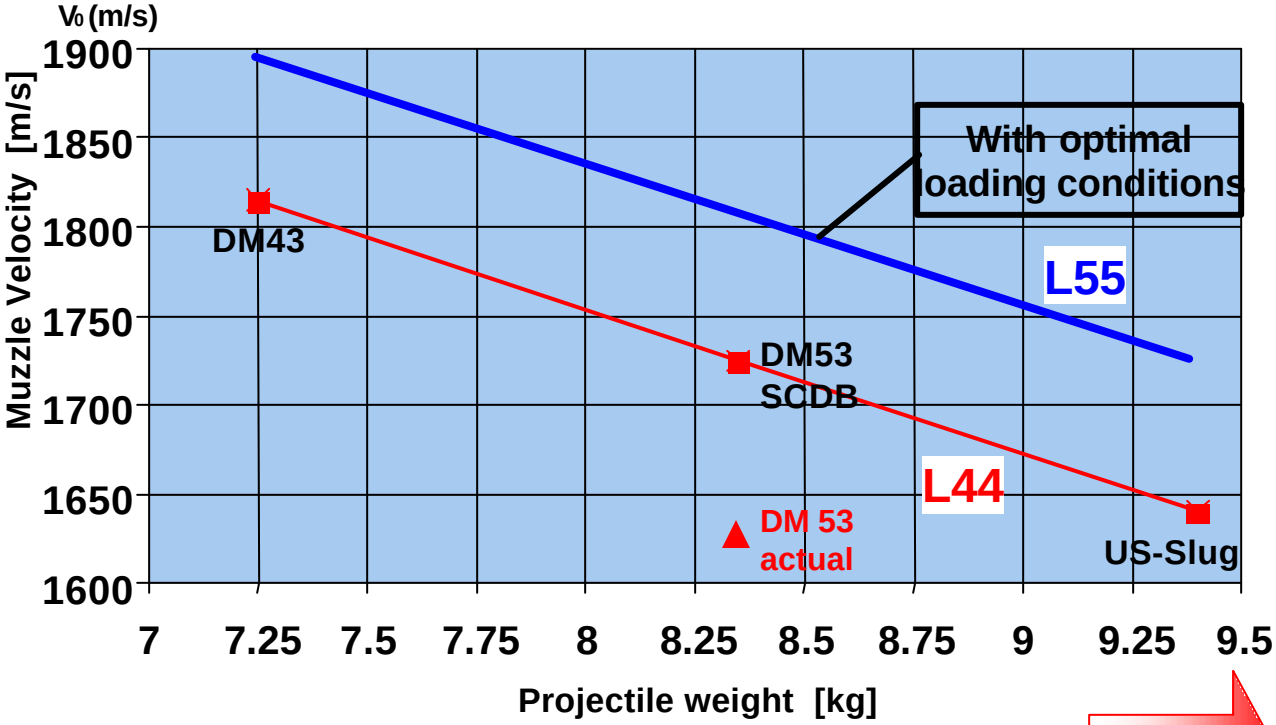
Calculated Muzzle Velocities for 21 °C



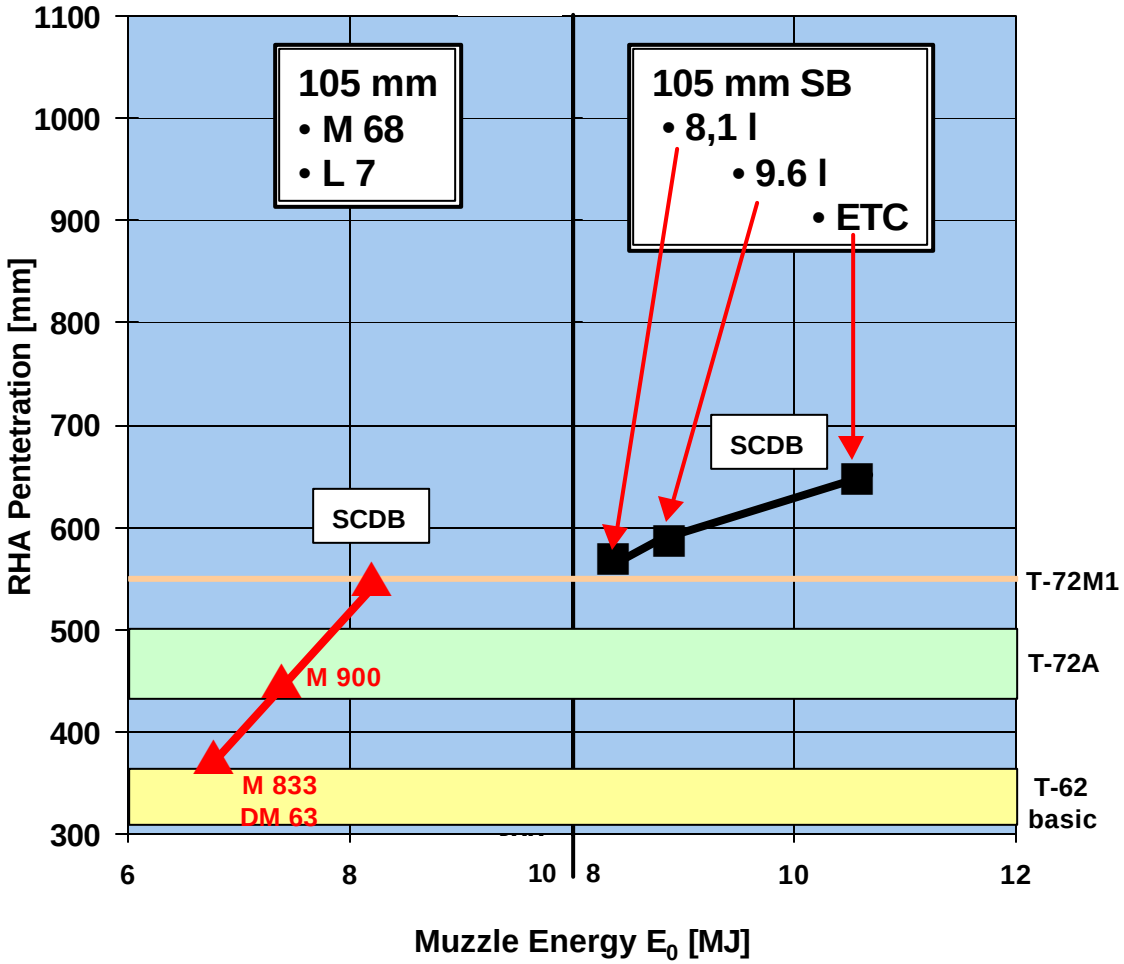
Performance gain by using SCDB-Technology in any of 120 mm KE-configuration

80 - 100 m/s at 21 °C
> 150 m/s at 0 °C

significant improvement of penetration capa-bility !

NEW HIGH PERFORMANCE PROPELLANTS

Potential for Penetration Improvements



Attractive Concepts

- **Conventional**

  Last generation KE-round improved with SDCB => defeat T-72

- **Future possibilites**

  Smooth Bore gun in combination with SCDB

„There is always a way to defeat new threats“

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Conclusions

- The Swiss can fly almost as good as Harry Potter .....

- ..... and they have a solution for most of your propulsion-related problems !!!!