Raytheon

Miniaturization of IR & Small Arms Fire Control

2002 International Infantry & JSSAP Section Symposium

Atlantic City

15 May 2002

Chuck Nourrcier

Raytheon Electronic Systems

cnourrcier@raytheon.com

972 344 4857

Raytheon Uncooled IR Products

...mature product base...market growth opportunities

Military


SMRTII


DVE


TWS


LRF/DCA


Crusader


OCSW


Pocket Sight


Helmet Mounted FLIR


LPUIR


Ultra Light Sight

1980s Over a decade of technology leadership!

Commercial


Police P200


300 Series


NightDriver (Cadillac)


NightDriver Display


PalmIR


PalmIR Pro


ProtectIR 4000B


2000 AS


ControlIR 2000B

Raytheon

Thermal Weapon Sights

Raytheon

TWS Weapon-Fire Robustness - Been There!

Raytheon
LIGHT FORCES

M2

M24

M240

M60

MK19

M249

M2

M16

M4

Not Pictured:
M203, AT4

AN/PAS-13 Thermal Weapon Sight

Raytheon
LIGHT FORCES

Key Benefits:

- Enables soldiers to see in limited visibility situations, regardless of light conditions, including absolute darkness, bright sunlight, and through most battlefield obscurants at max effective ranges of weapon systems.
- Combat proven by US and allied armed forces
- Eyecup-activated stand-by mode
- Electronically generated reticles allow compatibility with a broad range of weapons

Applications:

- Handheld or weapon mounted up to .50 Caliber or grenade launchers
- Replaces TVS-5 and PVS-4 image intensifiers

System Description

Complete line of advanced infrared weapon sight with advanced features and rugged, lightweight, modular construction that compatible with a range of weapons.

Program Summary

- Joint U.S. Army (lead) / USMC program
- Multi-year contract (3 yr base, 2 yr option)
- 1998-2003 period of performance
- Over 5000 TWSs delivered, >10,000 options remain

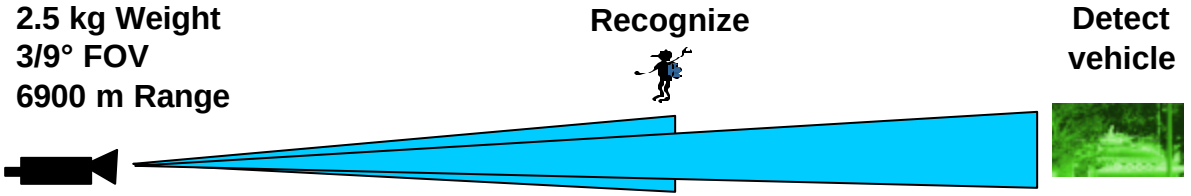
System Key Performance Parameters

Raytheon LIGHT FORCES

HTWS

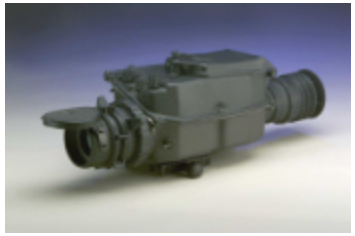
Used with M2, M4, MK19, M24, M82A2

10 hrs Operation
2.5 kg Weight
3/9° FOV
6900 m Range

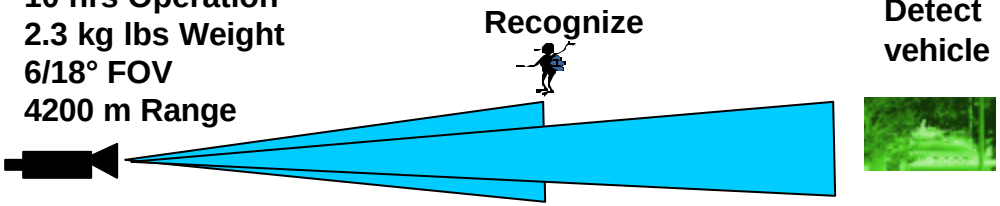


MTWS

Used with M4, M16, M60, M240, M249



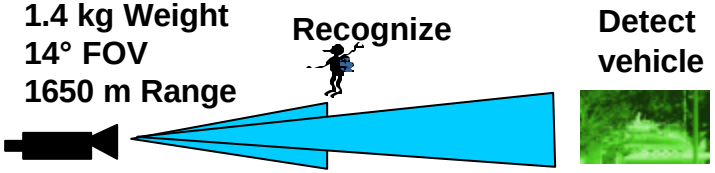
10 hrs Operation
2.3 kg lbs Weight
6/18° FOV
4200 m Range



LTWS

Used with M16, M4, M203, M136, AT4

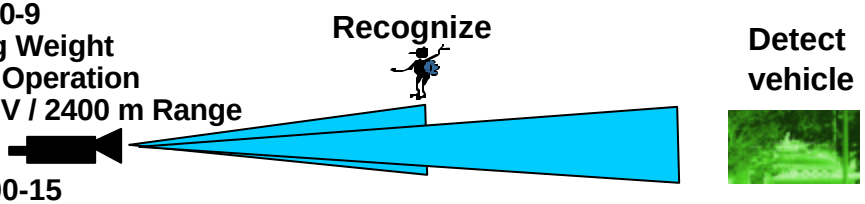
10 hrs Operation
1.4 kg Weight
14° FOV
1650 m Range



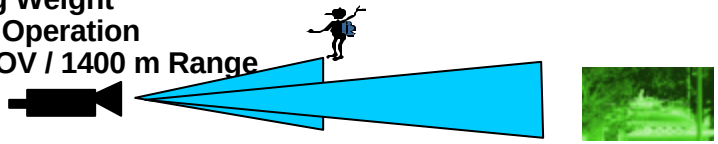
W1000

Various Weapons

W1000-9
1.7 kg Weight
8 hrs Operation
9° FOV / 2400 m Range

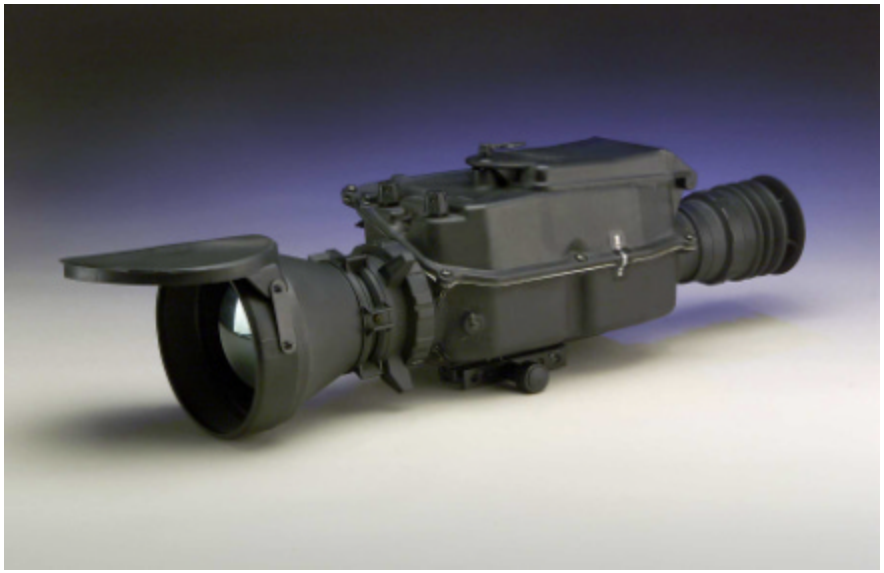


W1000-15
1.6 kg Weight
8 hrs Operation
15° FOV / 1400 m Range



Heavy & Medium Thermal Weapon Sights

Raytheon
LIGHTFORCES



HTWS

- Det/Rec of Man: 1650 NFOV
- WFOV: 9^{O} az x 3.6^{O} el
- NFOV: 3^{O} az x 1.8^{O} el
- Mag: W = 3.3X, N = 10X
- Weight: 5.38 lbs w/o Battery

MTWS

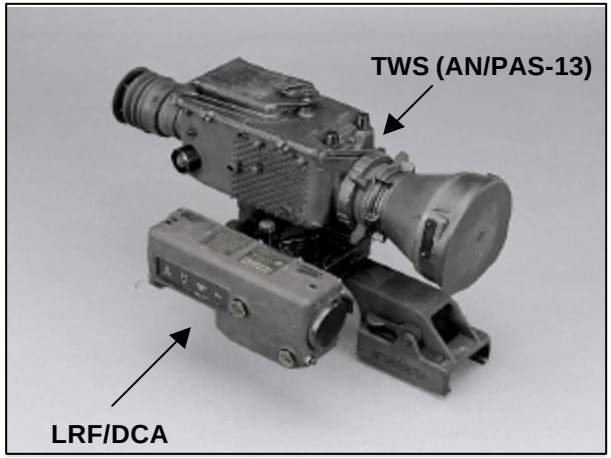
- Det/Rec of Man: 2200 NFOV
- WFOV: 18^{O} az x 10.8^{O} el
- NFOV: 6^{O} az x 5.4^{O} el
- Mag: W = 1.66X, N = 5X
- Weight: 4.38 lbs w/o Battery

The AN/PAS TWS is subject to the United States Arms Export Control Act (AECA) and the International Traffic in Arms Regulations (ITAR). Export requires license approval from the US State Dept./Office of Defense Trade Controls. Cleared for Public Release August 2000 by SAPA/ and NV-RSTA.

TWS Modular Ballistic Solution (TWS MBS)

Raytheon

Specification	TWS	LRF/DCA
Length	40 cm (15.8 in)	21.6 cm (8.5 in)
Width	16 cm (6.3 in)	8.3 cm (3.25 in)
Height	16 cm (6.3 in)	10.16 cm (4.0 in)
Weight w/ battery	2.3 kg (5.0 lb)	0.8 kg (1.8 lb)
Operating Temperature	-37º C to +49º C	-32º C to +49º C
Storage Temperature	-46º C to +71º C	-46º C to +71º C
Time to operation	Less than 120 seconds	Instantaneous
Power Requirements	6 volt BA-5847 or BB-2847	3 volt BA-5123/U or DL123A or commercial equivalent (2 ea)
Mounting	MIL-STD-1913 Rail System	MIL-STD-1913 Rail System
Remote Operation/ Data Transfer	RS-170	RS-232
Mechanical Shock	Withstands primary weapon fire shock (Mk19, M2, and other crew served weapons). Remains aligned after weapons fire.	
Range Output	First or last target ranges are displayed on the TWS within 0.2 seconds after valid return. User selectable. Selected range used for the partial ballistic solution.	
Recognize Man	2.8km	N/A
Detect Vehicle	6.9 km	N/A
Image Polarity	White hot/Black hot	N/A
Detector	40 x 16 scanning FPA, 3-5µm	N/A
Cooling	6-stage thermoelectric cooler	N/A
Detection Range	N/A	99% P(d) at >2500m, 2.3m x 2.3m 10% reflectivity target, 7km visibility
Range Accuracy	N/A	+/- 5 m (3 sigma)
Laser Fire	N/A	<0.10 sec. w/in receipt of command
Substained Fire	N/A	60 pulses/minute continuous
Eyesafety	N/A	Class I per ANSI-Z136-1-1993
False Return Rate	N/A	<1%
Wavelength	N/A	1.533 micron
Beam Divergence	N/A	86% within 0.8mr
Pulse Width	N/A	15-20 ns Full Width Half Maximum



The Thermal Weapon Sight Modular Ballistic Solution (TWS MBS) system combines a fully qualified and fielded Thermal Weapon Sight (AN/PAS-13) cabled to the Manportable Laser Rangfinder/Digital Compass Assembly (LRF/DCA) to provide a disturbed reticle for accurate engagements to the outer effective ranges of the MK19 and M2 platforms (greater than 2km). Both the TWS and LRF/DCA have been tested extensively on the MK19, M2, and other crew served weapons. The TWS MBS can be remotely operated and viewed through a common RS-170 interface port. The interface bracket for both platforms use the standard issue Army brackets with an additional rail grabber for mounting the LRF.

Light Thermal Weapon Sight (LTWS)

Raytheon

Weight (lb)	1.4 kg (3.0 lb) w/ battery
Detection Range	
Human	550 m
Vehicle	1650 m
Field of View	15 deg az x 11.3° el
Operating Temperature	-37° C to +49° C
Maintenance	Cleaning only
Video Output	RS-170/NTSC
Power Requirements	Commercial AA Batteries or auxiliary power (via connector for DC sources)
Mission Operation Life	5 hrs on commercial AA alkaline or lithium batteries
Detector	320 x 240 staring (76,800 pixels) FPA
Spectral Band	8-12 µm (longwave infrared)
Cooling	Uncooled ferroelectric
Weapon Compatibility	M16, M4 - Up to fully automatic 5.56mm CAL
Mounting	Picatinny MIL-1913 or NATO/STANAG

The Light Thermal Weapon Sight (LTWS) is one of the lightest thermal sights available to today's warfighter. The LTWS is based on the combat-proven technology that drives Raytheon's highly fielded line of thermal imaging products. Features of the LTWS are a 2-to-1 electronic zoom, Liquid Crystal Display (LCD), and an eyecup activated stand-by mode for power conservation. The use of the LTWS cannot be detected since it emits no light or RF energy, and it can be used round the clock as ambient light is not required for its operation. Its light weight and compact design make it ideal for use as a hand-held imager and as a rifle mounted sight.

W1000 Uncooled Thermal Weapon Sight

Raytheon
LIGHT FORCES

Key Benefits:

- Detects targets in limited visibility situations, regardless of light conditions, including absolute darkness, bright sunlight, and through most battlefield obscurants
- Combat proven by US and allied armed forces
- Undetectable since IR light and illuminators are not required for use
- Electronically generated reticles allow compatibility with a broad range of weapons

Applications:

- Hand-held thermal imager
- Rifle-mounted sight adaptable to a broad range of weapons, up to 7.62mm (.308cal) guns.

System Description

Lightweight thermal weapon sight that employs Raytheon's proven uncooled focal plane array technology. Rugged, durable construction is combined with advanced features and extended battery life to fit any mission profile.

AN/VAS-5 Driver's Vision Enhancer (DVE)

Raytheon
LIGHT FORCES

Key Benefits:

- Improved **24 hour driving capability** to wheeled and tracked vehicles.
- Penetrate smoke, fog and other battlefield obscurants.
- Enhances mobility and maintains OPTEMP.

System Description:

Infrared sensor module & flat panel display with operator controls (B-Kit) and vehicle unique mounting (A-Kit).

Program Status

- US Army fielding began in 1998 w/ Bradley, M113
- USMC fielding began in 2Q01 w/ M1, LAV, AAV
- US Army plans to field DVE to all vehicles in IBCT
- USCG plans to field DVE for small & medium security/rescue boats beginning 3Q02
- Delivered 1400 systems
- Backlog, 3000 systems

Low Cost Microsensors
640x480 Dual-FOV Camera

The Next Generation of Thermal Weapon Sights

Raytheon

NVESD

Uncooled VOx Microbolometer Sensor Evolution

Measured Sensor NETD @ f/1 is Based on 320x240 Arrays

290 mK

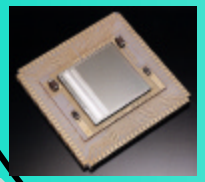
230 mK

TECHNOLOGY ADVANCEMENT

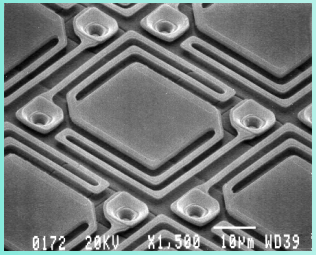
50 µm Detector

25 µm Detector

Array Format
320x240



New Readout Concepts



Array Formats
160x128
320x240
640x480

87 mK

68 mK

42 mK

34 mK

14 mK

100 mK

49 mK

35 mK

First Image

1996 | 1997 | 1998 | 1999 | 2000 | 2001

Electronics Size
Power

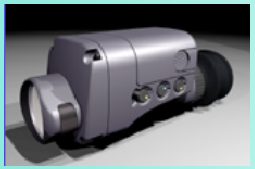
40 in²
<5 Watts

<10 in²
<2 Watts

<3 in²
<1W

Low Power Electronics

SENSOR DEVELOPMENT



Micro-sensors/Micro-sights/µUAVs
Missiles Seekers/Threat Warning

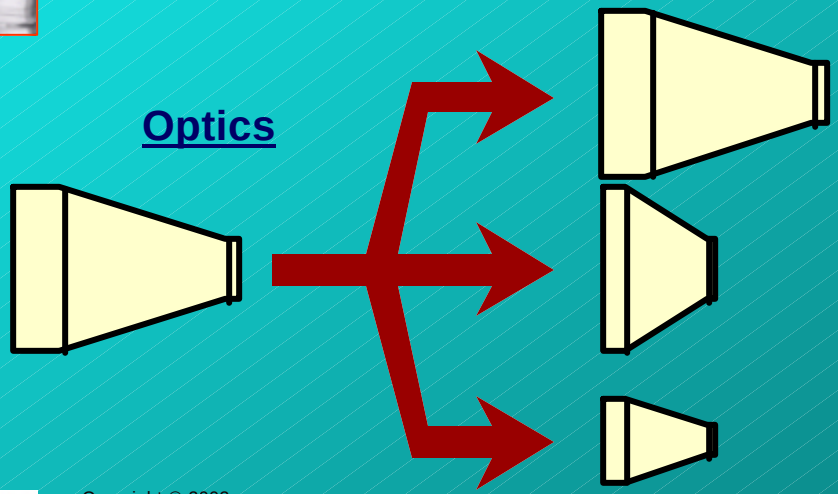
Raytheon

Small Pixel Detector Arrays Miniaturize Modern InfraRed Sensors

50 mm Sensors

25 mm Sensors

Optics



Expanded Trade Space

2× improvement in IFOV
@ constant f/#, aperture

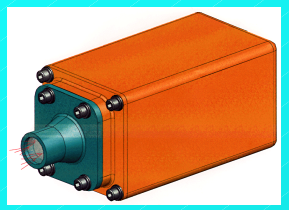
~2× improvement in NETD
@ constant aperture, IFOV

~8× reduction in volume
@ constant f/#, IFOV

Raytheon

Small Pixel Enables Wide Range of Applications

160 x 128 | 320 x 240 | 640 x 480 | Megapixel

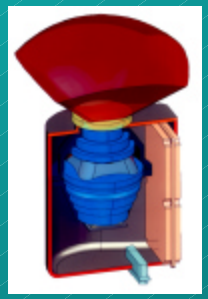


Microsensors

Man-Portable

µ-UAV

Long-Range Surveillance & Targeting



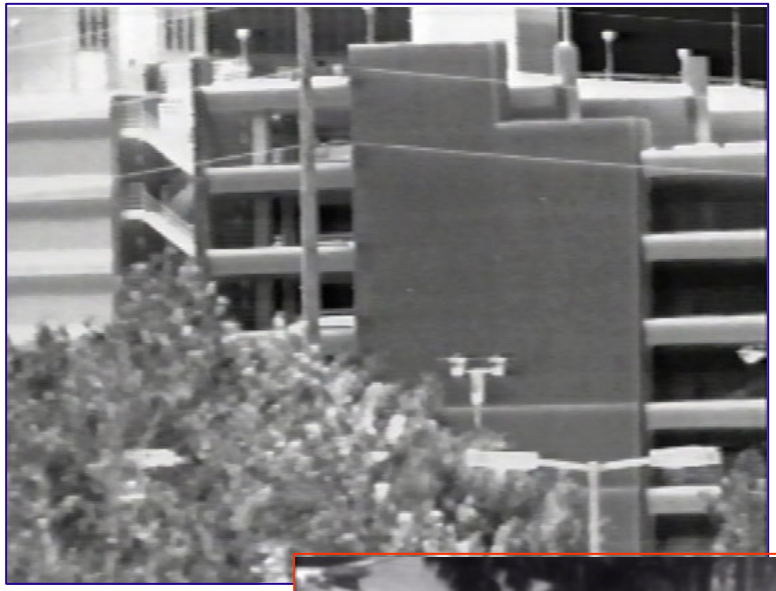
Ultra-WFOV Imaging

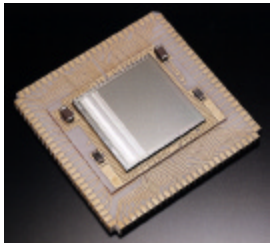
Missiles

Raytheo

Uncooled VOx 320 x 240
25 mm Pixel Compact Camera

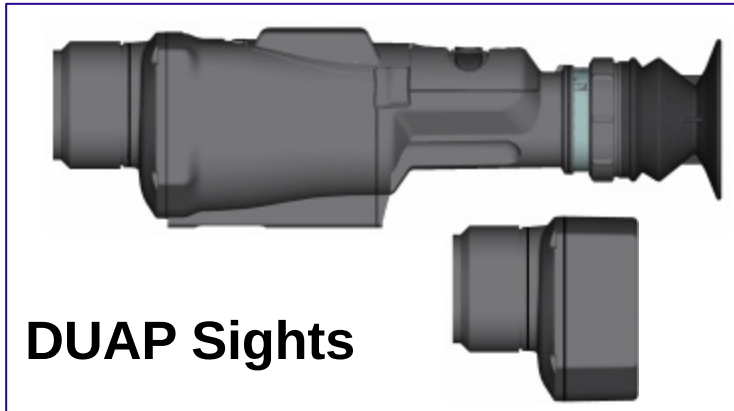
Raytheon
LIGHTFORCES





25 mm Pixel 320x240 Camera
60 mK NEDT

- 1.8 watt Sensor Power
- August 2000 Camera



DUAP Sights

SB-246 VOx Delivers State-of-Art 640x480 Uncooled Imagery

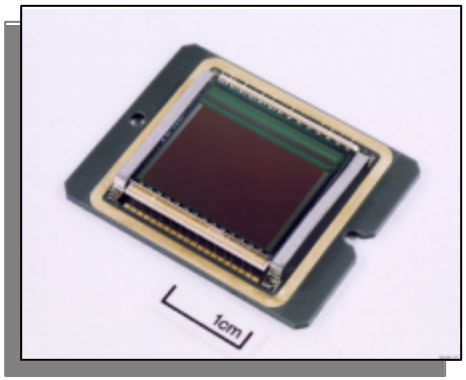
Raytheon
LIGHTFORCES

- ✓ TV equivalent resolution of 640 x 480
- ✓ No cryogenic cooler

- ✓ Smallest detector pitch in industry - 25 um
- ✓ Highest Sensitivity
- ✓ Lowest Power - 2.8 Watts
- ✓ Battery Operated

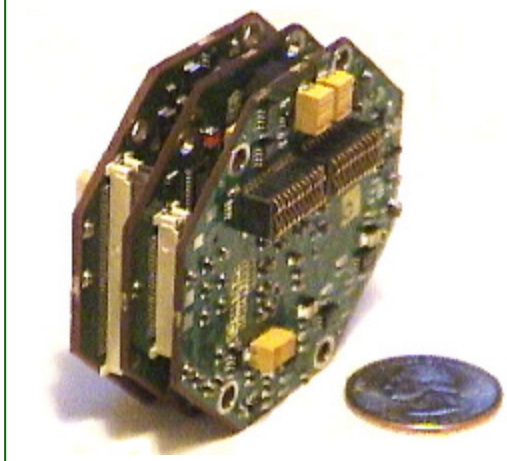
4.6^{o} x 6.1^{o} FOV Images

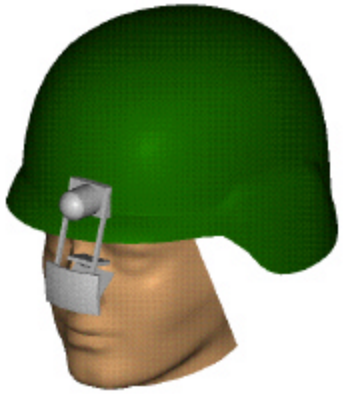
640x480 Sensor Engine Meets Aggressive Goals



640x480 25 μm Detector

- Detector fits into 320x240 packaging
- Sufficient room for indium ring for wafer level packaging.





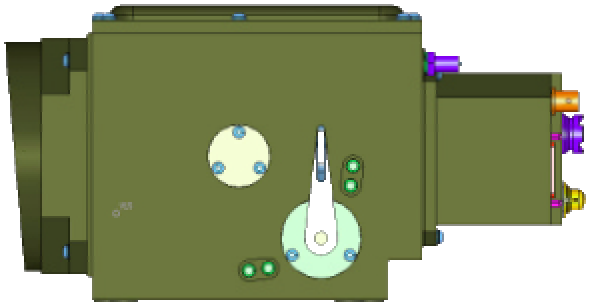
2.5”x2.5”x1” Compact Sensor Engine
< 145 Gram Sensor Engine Weight

2.8 Watt Typical Operational Power

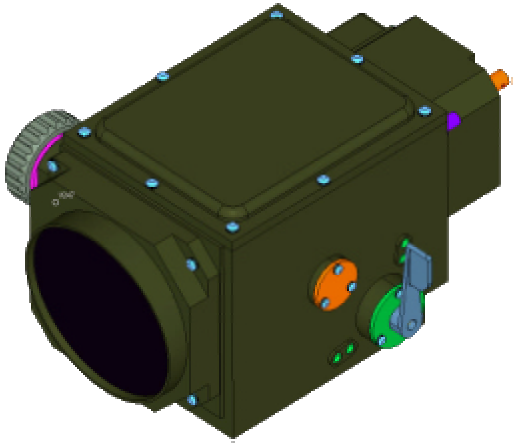
Dramatically reduced uncooled sensor cost, power, size & weight

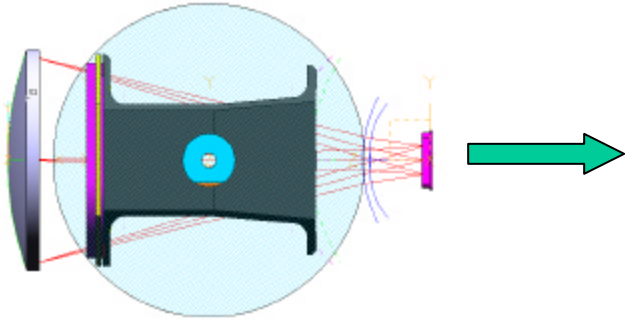
640x480 Uncooled Camera

Raytheon
LIGHTFORCES



Dual Field-of-View
3.6” Aperture Optics
640 x 480, 25 μm pixel



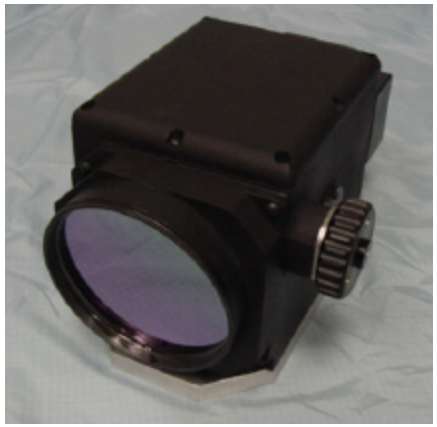


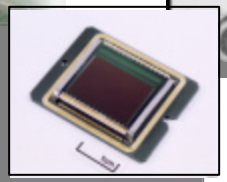
Compact Optical Form

OVERALL SIZE: 10.9 L x 7.7 W x 5.4 H
MAIN HOUSING: 10.2 L x 4.9 W x 5.4 H

Low Cost MicroSensors Program Summary

Raytheon
LIGHT FORCES

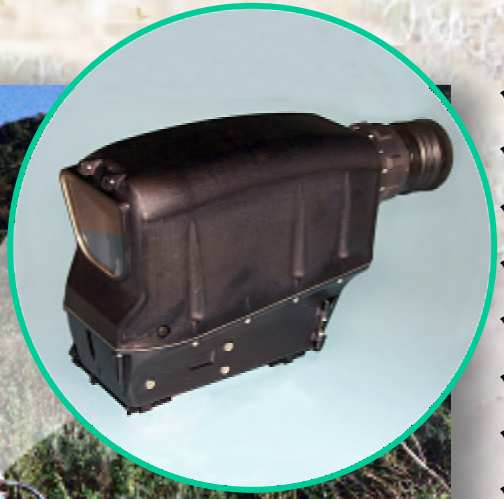




- Raytheon 25 um pixel uncooled technology providing light-weight, compact, low power, affordable solutions
- 640x480 imagery ushers in new uncooled era

OCSW ATD TA/FCS
- Status -

Raytheon



Full Solution Fire Control

- ✓ 2.2 km Range Performance
- ✓ < ±1 meter Laser Rangefinder
- ✓ Ballistic Processor
- ✓ Single Reticle
- ✓ Fuze Setter
- ✓ Digital Compass
- ✓ Cant & Elevation Sensors
- ✓ Embedded Training
- ✓ Tactical Engagement Simulation
- ✓ Combat ID
- ✓ Thermal Sensor Interface
- ✓ Direct View Optics 5x9.5° FOV
- ✓ Land Warrior I/O
- ✓ NIR & Visible Laser Pointers
- ✓ Laser Steering
- ✓ Motion Tracker
- ✓ Atmospheric Temp. & Pressure
- ✓ Moving Targets

Demonstrated on Weapon
> 2000 Live Rounds Failure Free

Raytheon

Miniaturization of IR & Small Arms Fire Control

2002 International Infantry & JSSAP Section Symposium

Atlantic City

15 May 2002

Chuck Nourrcier

Raytheon Electronic Systems

cnourrcier@raytheon.com

972 344 4857