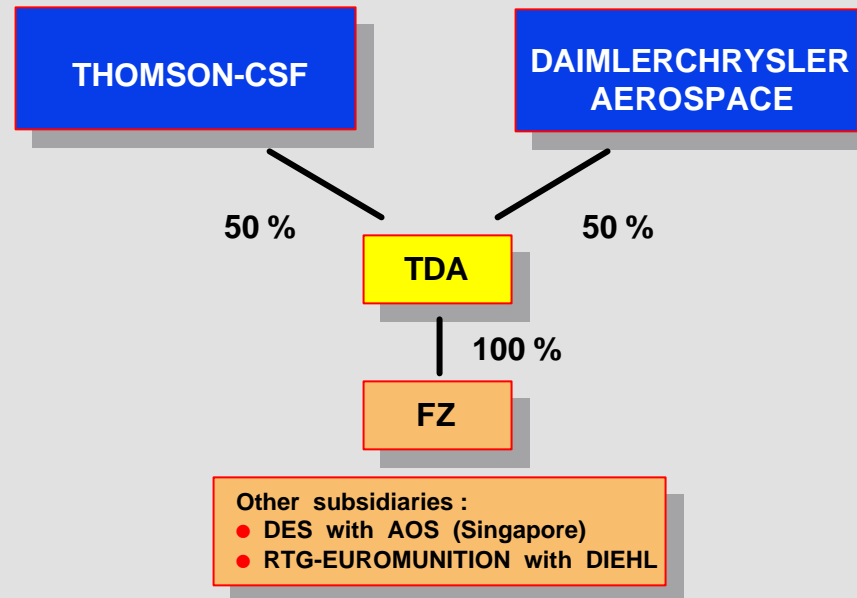

**ROCKET - ASSISTED AMMUNITION TECHNOLOGIES
for 120 mm MORTARS**



MUNITIONS TECHNOLOGY SYMPOSIUM
In Pleasanton on April 11 - 12, 2000

ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS



- **Historical European ordnance leader since WW 1**
 - **Fuzes**
 - **Mortars**
 - **Rockets**
 - **Warheads**
 - **Anti-tank systems**

ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

TDA AND ROCKET ASSISTED TECHNOLOGIES

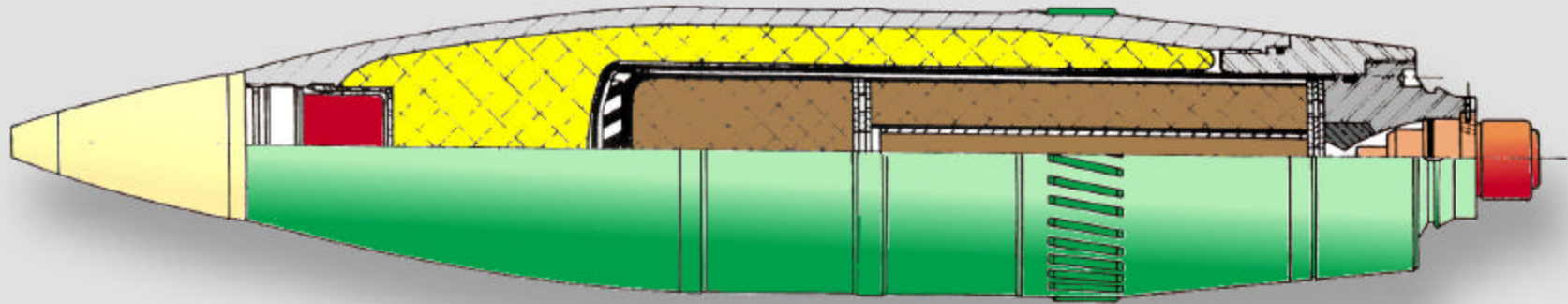
- TDA spent half century to investigate various RAP technologies
- TDA has explored :
 - Army applications (120 mm mortars, 155 and 203 mm SPH)
 - Naval applications (100 mm French Navy gun)
 - Missile applications (140 mm missile caliber)
- TDA has identified and demonstrated four RAP technology areas :
 - Impulse in flight technology : 120 mm mortar RAP (13 km)
 - Sustained rocket assisted technology : 120 mm mortar RAP-VLR (17 km)
 - “Isostatic” technology : 120 mm mortar and 155 mm gun projectiles
 - Ramjet technology : 155 mm gun projectile

ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

PROJECTILE	RAP	RAP- VLR	Isostatic RAP	Ramjet
CALIBER	120 mm	120 mm	120 & 155 mm	155 mm
RANGE	13 km	17 km	13 km (120 mm) 32 km (155 mm)	35 km
MORTAR & GUN TYPE	Rifled	Smooth & Rifled	Rifled	Rifled
"g" LEVEL	9 000 g	6 000 g	9 000 g (120 mm) 11 000 g (155 mm)	11 000 g
BURNING TIME	3.5 s	30 s	8 s (120 mm)	12 s
STATUS	Serial production	Feasibility	Feasibility	Feasibility

ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm RAP

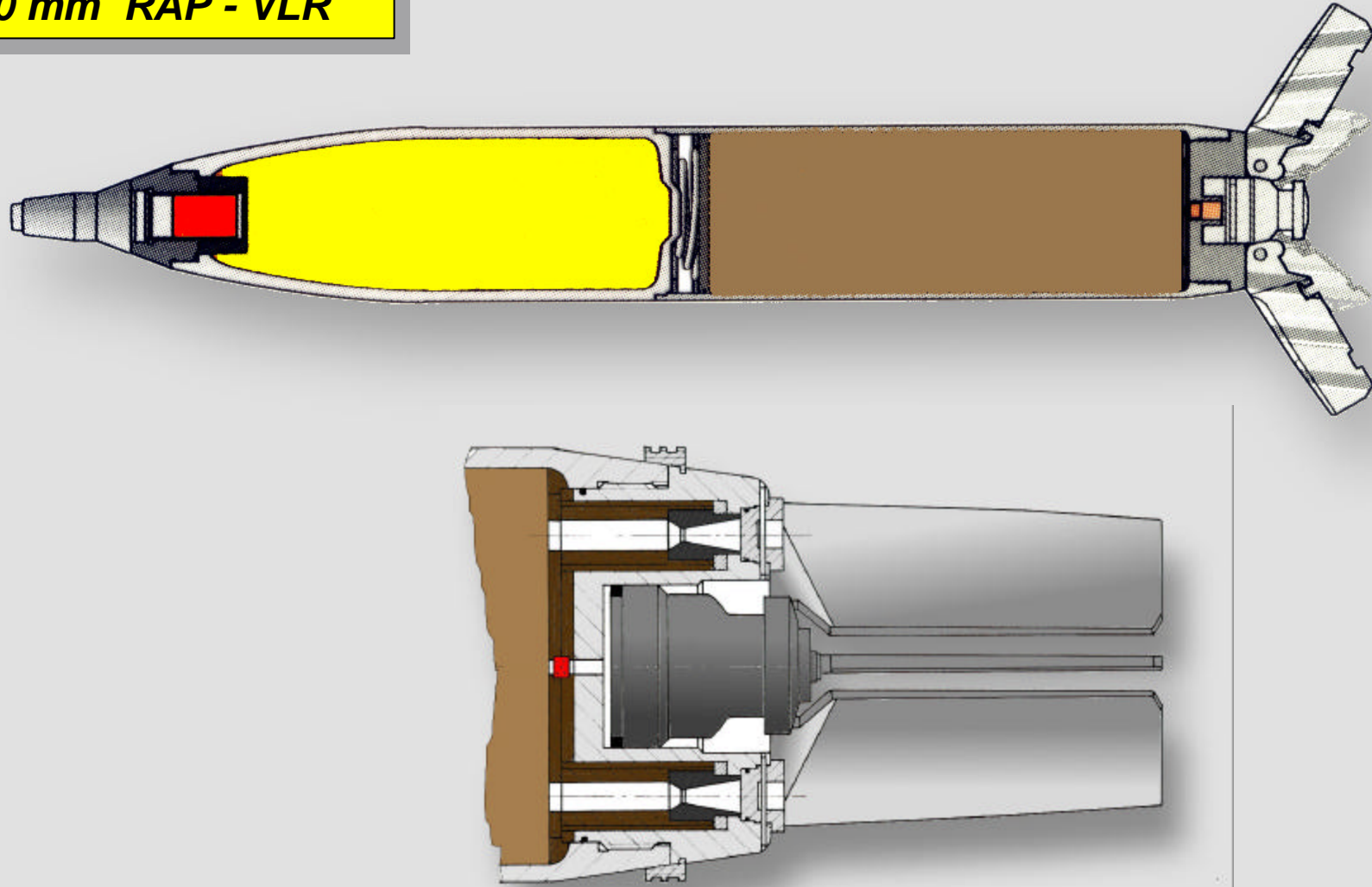


ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

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ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm RAP - VLR

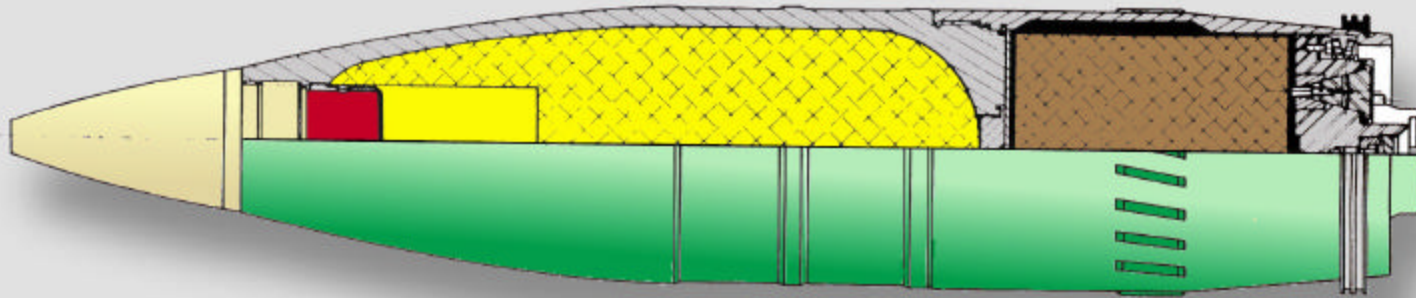


ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

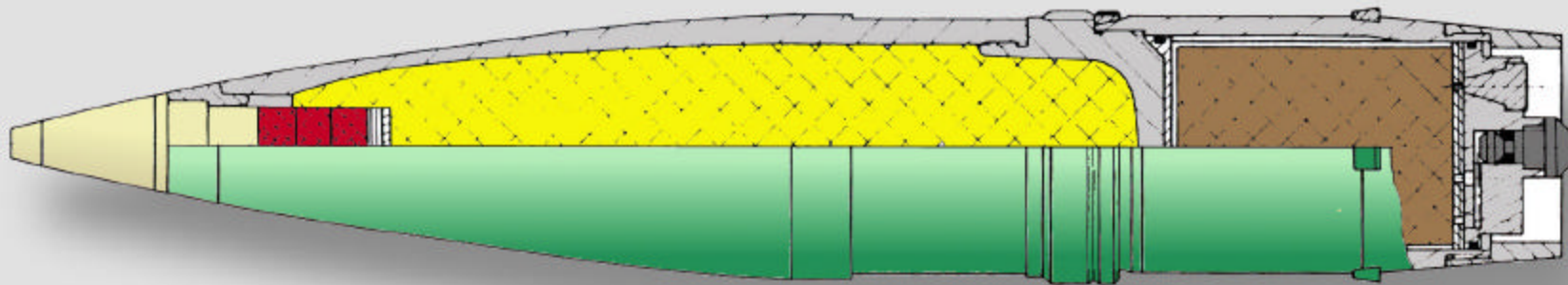
PROJECTILE	RAP	RAP- VLR	Isostatic RAP	Ramjet
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ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm isostatic RAP



155 mm isostatic RAP

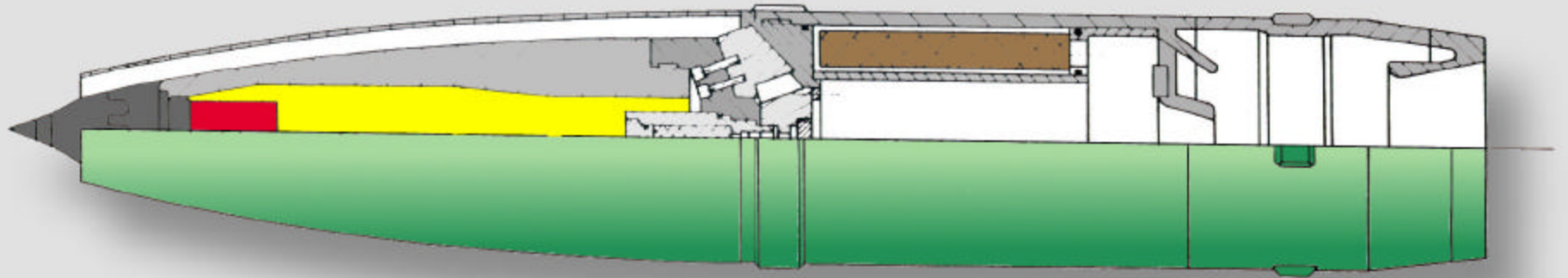


ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

PROJECTILE	RAP	RAP- VLR	Isostatic RAP	Ramjet
CALIBER	120 mm	120 mm	120 & 155 mm	155 mm
RANGE	13 km	17 km	13 km (120 mm) 32 km (155 mm)	35 km
MORTAR & GUN TYPE	Rifled	Smooth & Rifled	Rifled	Rifled
"g" LEVEL	9 000 g	6 000 g	9 000 g (120 mm) 11 000 g (155 mm)	11 000 g
BURNING TIME	3.5 s	30 s	8 s (120 mm)	12 s
STATUS	Serial production	Feasibility	Feasibility	Feasibility

ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

155 mm ramjet projectile



ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm RAP

- **Purpose :**

- Increase range by 60% (from 8 km to 13 km)

- **Requirement :**

- Keep common logistics with 120 mm mortar projectile family
(Same shape, same weight, same propellant charge, same ballistic)

- **Main challenges :**

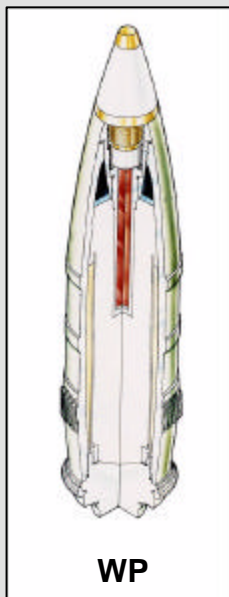
- Resist at very cold temperature for the DB propellant grain :
 - To axial (9 000 g) and radial (250 000 rd/s²) accelerations
 - To rotation speed (12 000 rev/mn)
- Keep warhead at acceptable temperature during the DB propellant combustion
- Maintain combustion characteristics under high rotation speed

ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

A LARGE AMMUNITION FAMILY



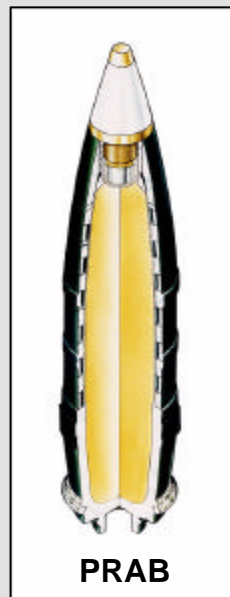
HE



WP



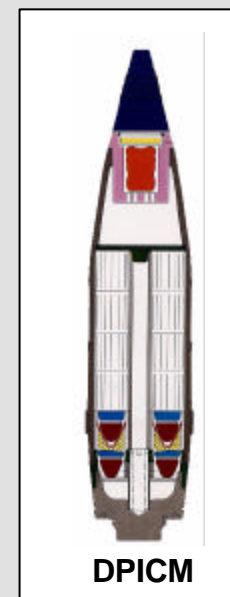
PRAC



PRAB



ILLUM



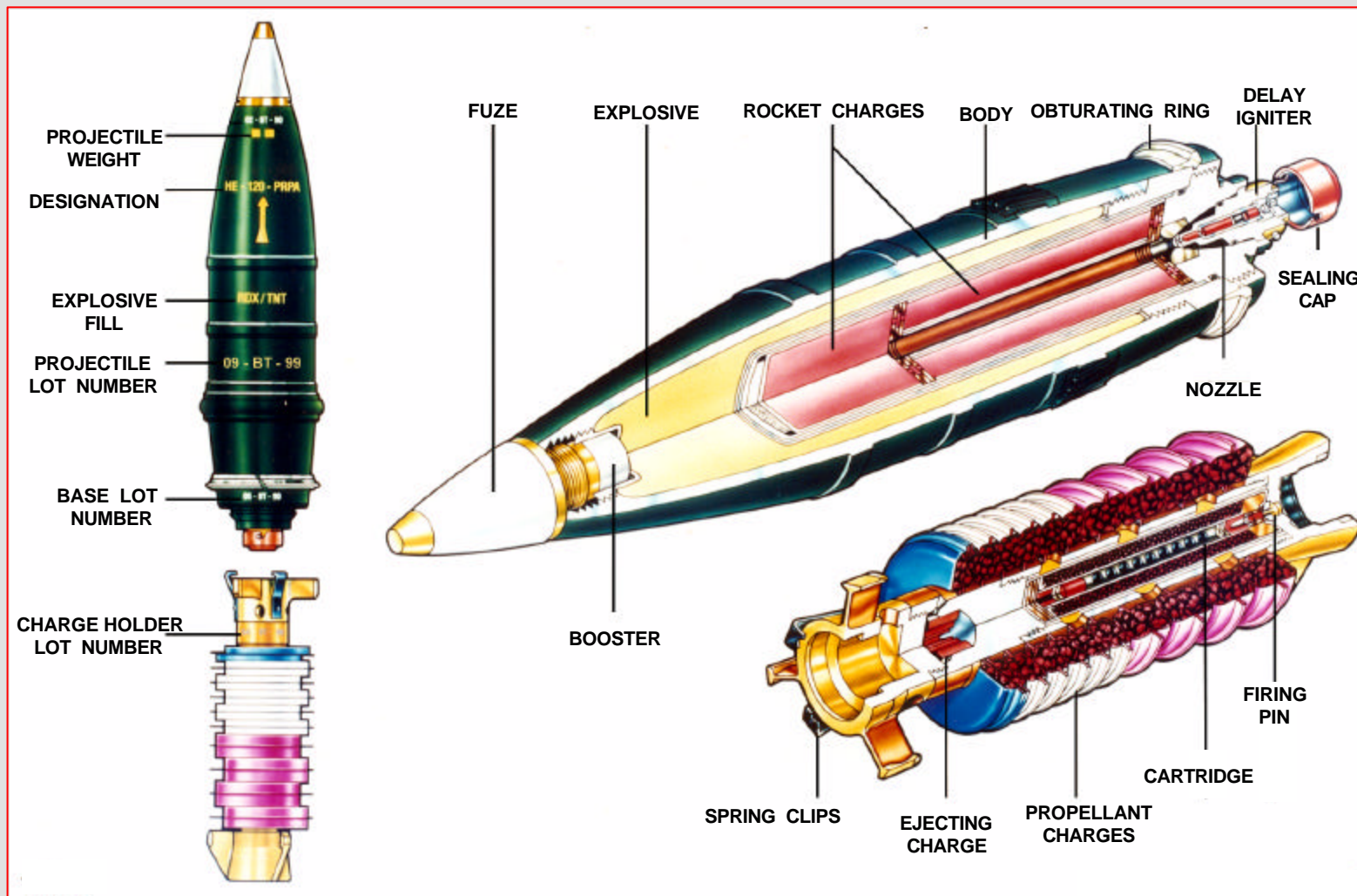
DPICM

ROCKET ASSISTANCE

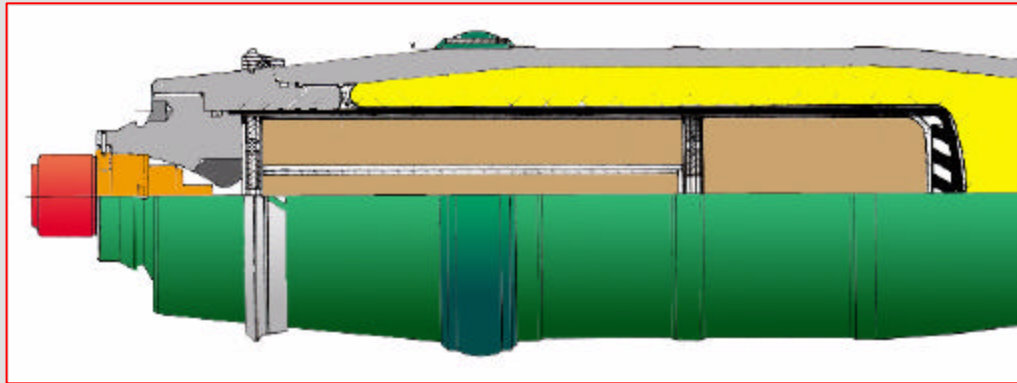
RANGE 13 km

ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

HIGH EXPLOSIVE (WITH ROCKET ASSISTANCE) AMMUNITION : HE-120 mm - RAP

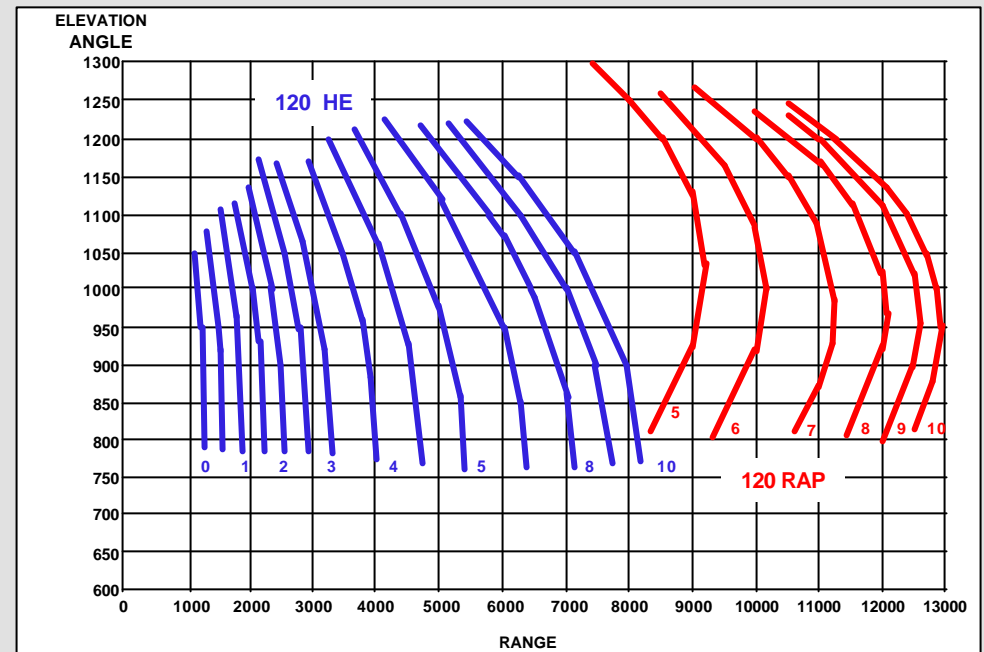
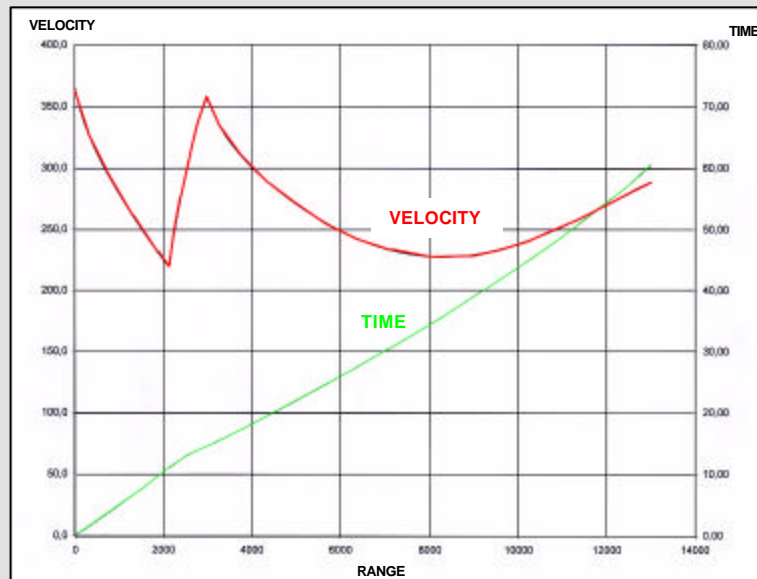


ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS



ROCKET ASSISTED PROJECTILE

- 1.3 kg of D.B propellant
- Burning time : 3.5 s
- Impetus : 2 500 N.s
- Ignition delay : 11 s
- « g » level : 11 000



ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm RAP

- Purpose :
 - Increase range by 60% (from 8 km to 13 km)

- Requirement :
 - Keep common logistics with 120 mm mortar projectile family
(Same shape, same weight, same propellant charge, same ballistic)

- Main challenges :
 - Resist at very cold temperature for the DB propellant grain :
 - To axial (9 000 g) and radial (250 000 rd/s²) accelerations
 - To rotation speed (12 000 rev/mn)
 - Keep warhead at acceptable temperature during the DB propellant combustion
 - Maintain combustion characteristics under high rotation speed

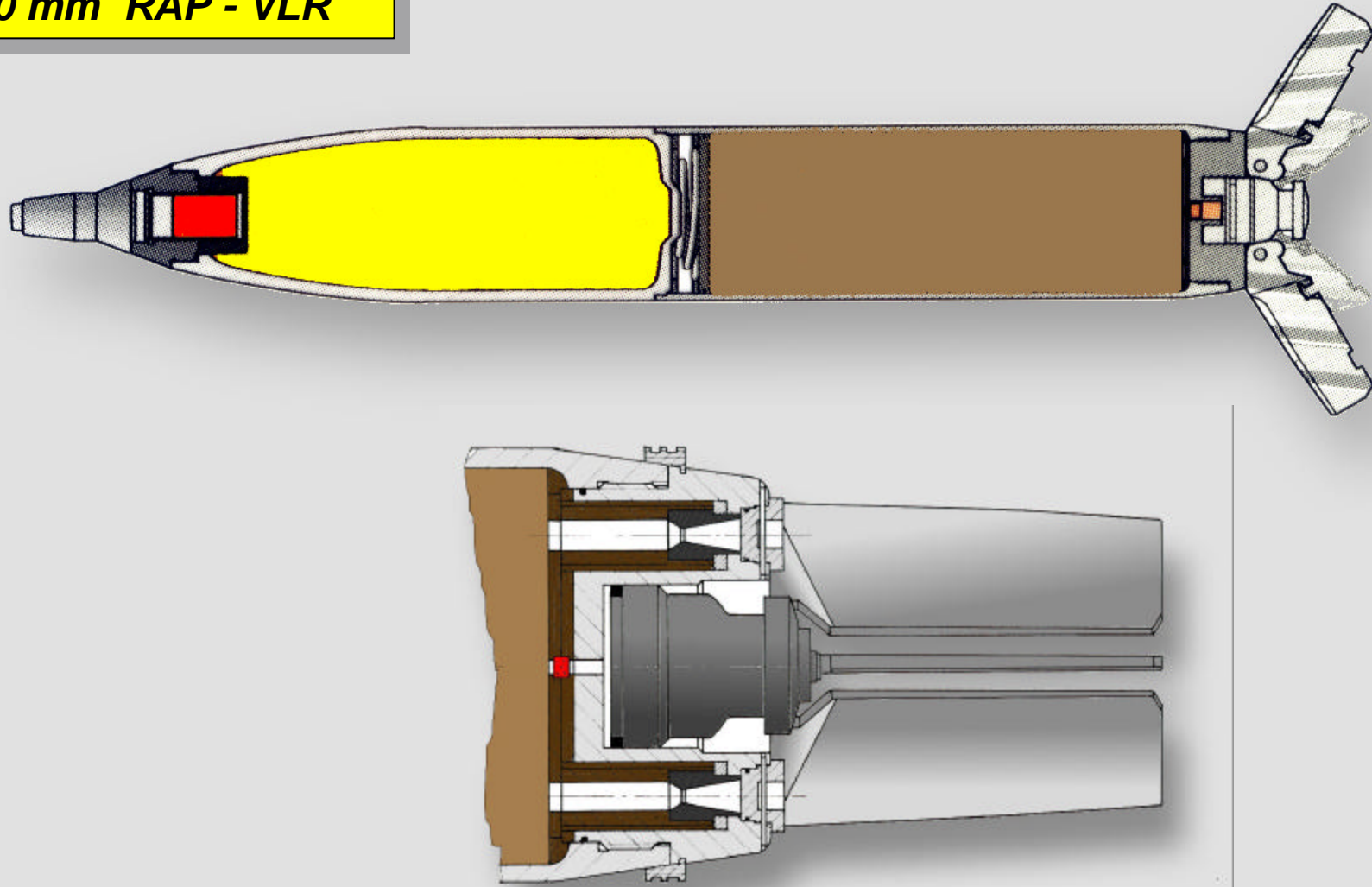
ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm RAP - VLR

- **Purpose :**
 - Match 105 mm light gun range
- **Requirements :**
 - Compatible with TDA 120 mm universal mortar tube
 - Compatible with 120 mm smooth mortar tube
- **Results data :**
 - Flight tests in January 1986
 - 17 km range demonstrated in GAVRES French MOD Center
 - French Army contract completed in 1991
- **Main challenges :**
 - Resist axial acceleration (9 000 g) at very cold temperature for the propellant grain
 - Fins resistance during the acceleration phase
 - Fins correct opening
 - Temperature control at aft end during the combustion phase (30 s)

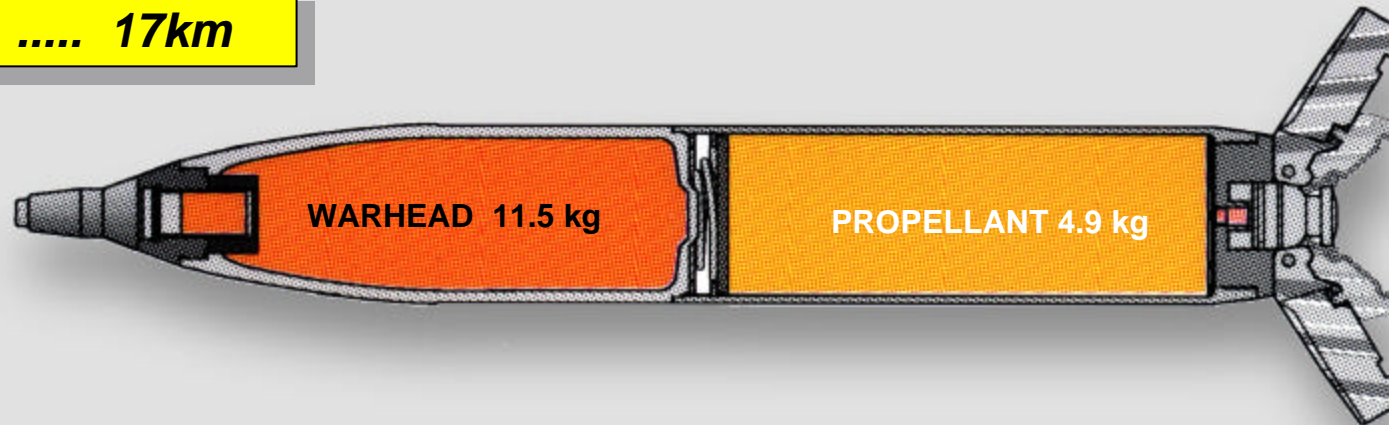
ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm RAP - VLR



ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

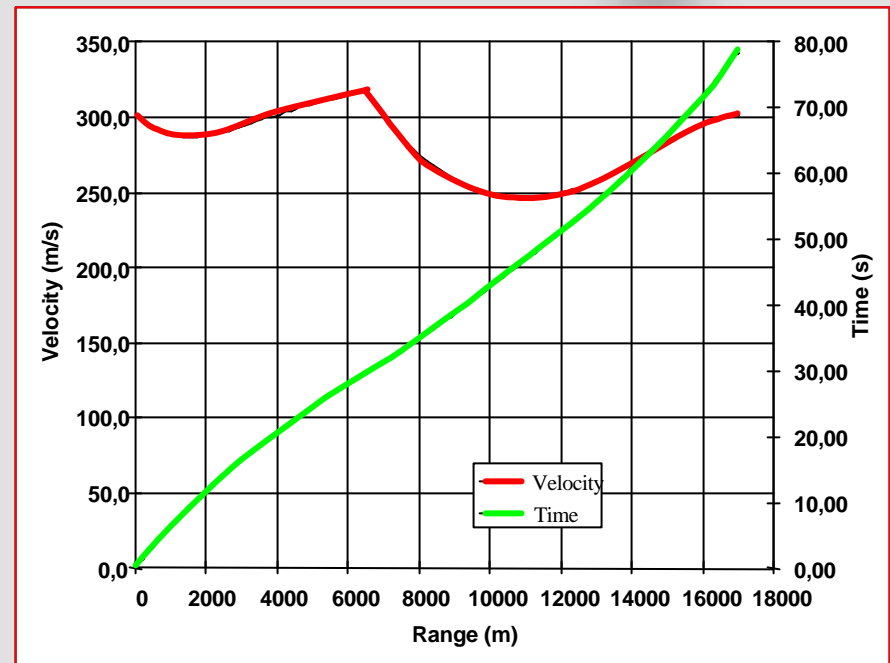
RANGE 17km



DATA

- **WEIGHT :** 24 kg
- **LENGTH :** 954 mm
- **RANGE :** 17 000 m
- **FINS STABILIZED**
- **PROPELLANT :**
 - **WEIGHT :** 4.9 kg
 - **BURNING TIME :** 30 s
 - **DELAY :** 0 s
- **MUZZLE VELOCITY :** 302 m/s
- **MAX PRESSURE :** 120 MPa

IN DEVELOPMENT



ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm RAP - VLR

- Purpose :
 - Match 105 mm light gun range
- Requirements :
 - Compatible with TDA 120 mm universal mortar tube
 - Compatible with 120 mm smooth mortar tube
- Results data :
 - Flight tests in January 1986
 - 17 km range demonstrated in GAVRES French MOD Center
 - French Army contract completed in 1991
- Main challenges :
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 - Fins resistance during the acceleration phase
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ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

FLIGHT TESTS



ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

120 mm RAP - VLR

- Purpose :
 - Match 105 mm light gun range
- Requirements :
 - Compatible with TDA 120 mm universal mortar tube
 - Compatible with 120 mm smooth mortar tube
- Results data :
 - Flight tests in January 1986
 - 17 km range demonstrated in GAVRES French MOD Center
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ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

GROWTH POTENTIAL

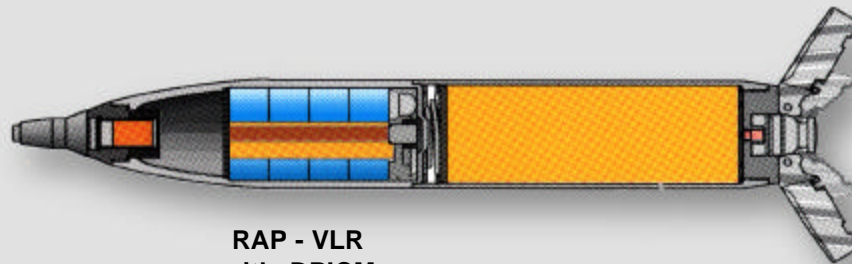
- Carry lethal or non lethal payloads
- Flexible design trading range versus payload
- Increase kill probability by using smart fuzes (SAMPRASS fuze)



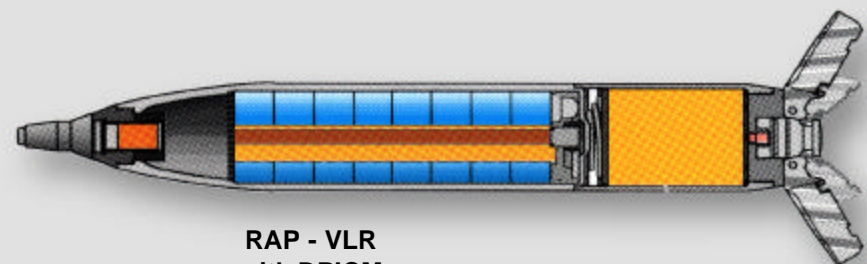
RAP - VLR
with HE warhead



RAP - VLR
with non lethal payload



RAP - VLR
with DPICM



RAP - VLR
with DPICM

ROCKET- ASSISTED AMMUNITION TECHNOLOGIES FOR 120 mm MORTARS

CONCLUSION

- TDA will present other RAP technologies in next future
- TDA is looking for cooperation with U.S experts