Gun Propellants For The 27 mm Cal. Gun Eurofighter Jet

Dr. Dietmar Mueller

Fraunhofer Institut Chemische Technologie (ICT), D-76327 Pfinztal, Germany

mue@ict.fhg.de

Walter Langlotz

Diehl BGT Defence GmbH & Co. KG

D - 90552 Roethenbach a. d. Pegnitz, Germany

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DIEHL BGT Defence

Content

- Introduction
- DNDA - Propellants
  - Thermodynamic Characteristics
  - Temperature Behaviour of LTC Propellant in Closed Vessel
  - Performance, Safety Test Results
  - Sensitivity Data DNDA - Propellants
  - Shaped Charge Tests
  - Erosivity
- Gun Firing
  - 75 mm cal. Propellant Charges (2 LTC Propellants)
  - 27 mm cal. Eurofighter (EF) Propellant Charges
- EF Propellant 27 mm cal. for PELE Ammunition
- PELE Ammunition Concept
- Results & Conclusion

Introduction

Since approx. 100 years are known the Nitrocellulose Propellants

Self - Ignition Temperature ~ 175 °C

Also the Multi Base Propellants like SCDB and EI, ECL Propellants are

giving the Self - Ignition at ~ 175 °C

Nitrocellulose Propellants based on DNDA and RDX the

LTC Propellants are showing

- First Generation

  Self - Ignition Temperature 200 - 210 °C

- Second Generation

  Self - Ignition Temperature > 220 °C (Eurofighter Propellant etc.)

DNDA Gun Propellants

- RDX
- Binder, Nitrocellulose
- DNDA Plasticizer

✳ Plasticizer mixed into the Propellant - Dough

NO SURFACE COATING

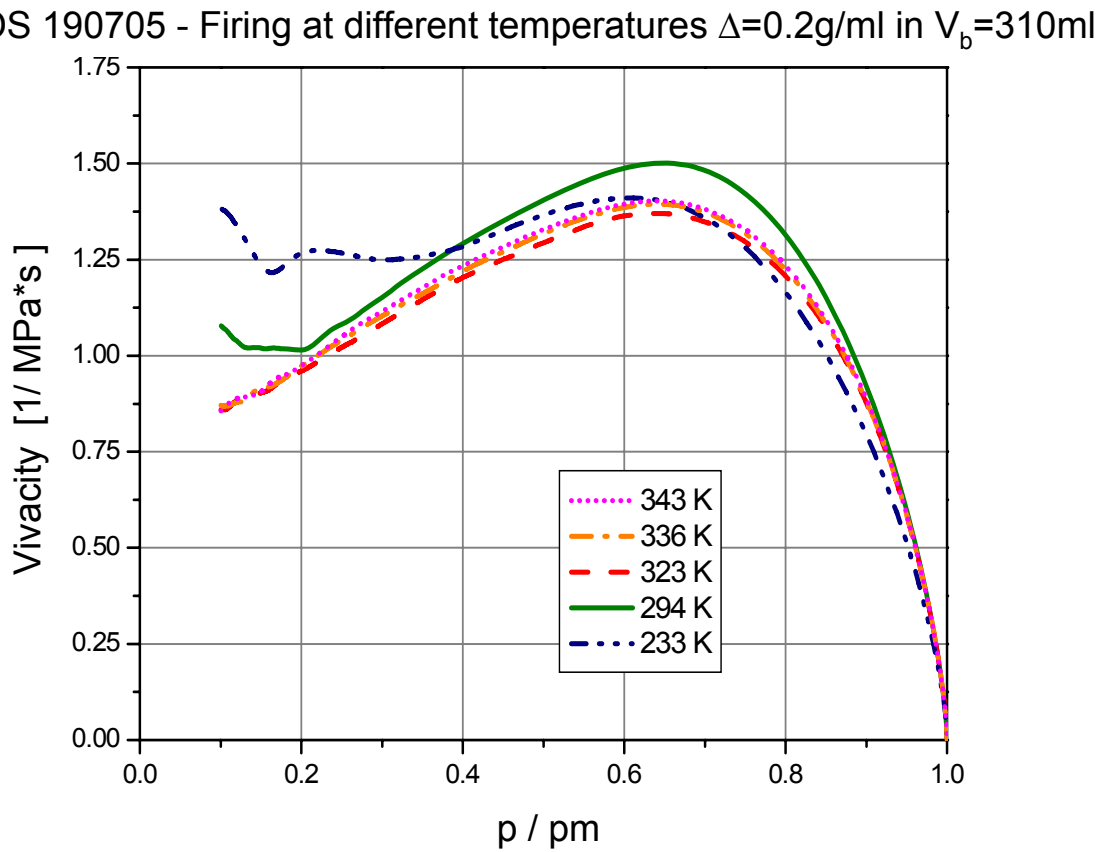
- energy density adaptable
- flame temperature approx. 500 K lower compared to NC Propellants

Formulation	*Impetus (J/g)*	*Flame Temp (K)*	*$\overline{M}w$ (g/mole)*
A	***1080***	***2540***	***19.4***
B	***1180***	***2910***	***20.8***
C	***1300***	***3390***	***21.6***

Closed Vessel Behaviour of LTC Propellants

Vivacity of Gun Propellant based on DNDA

Range -40 °C till +70 °C



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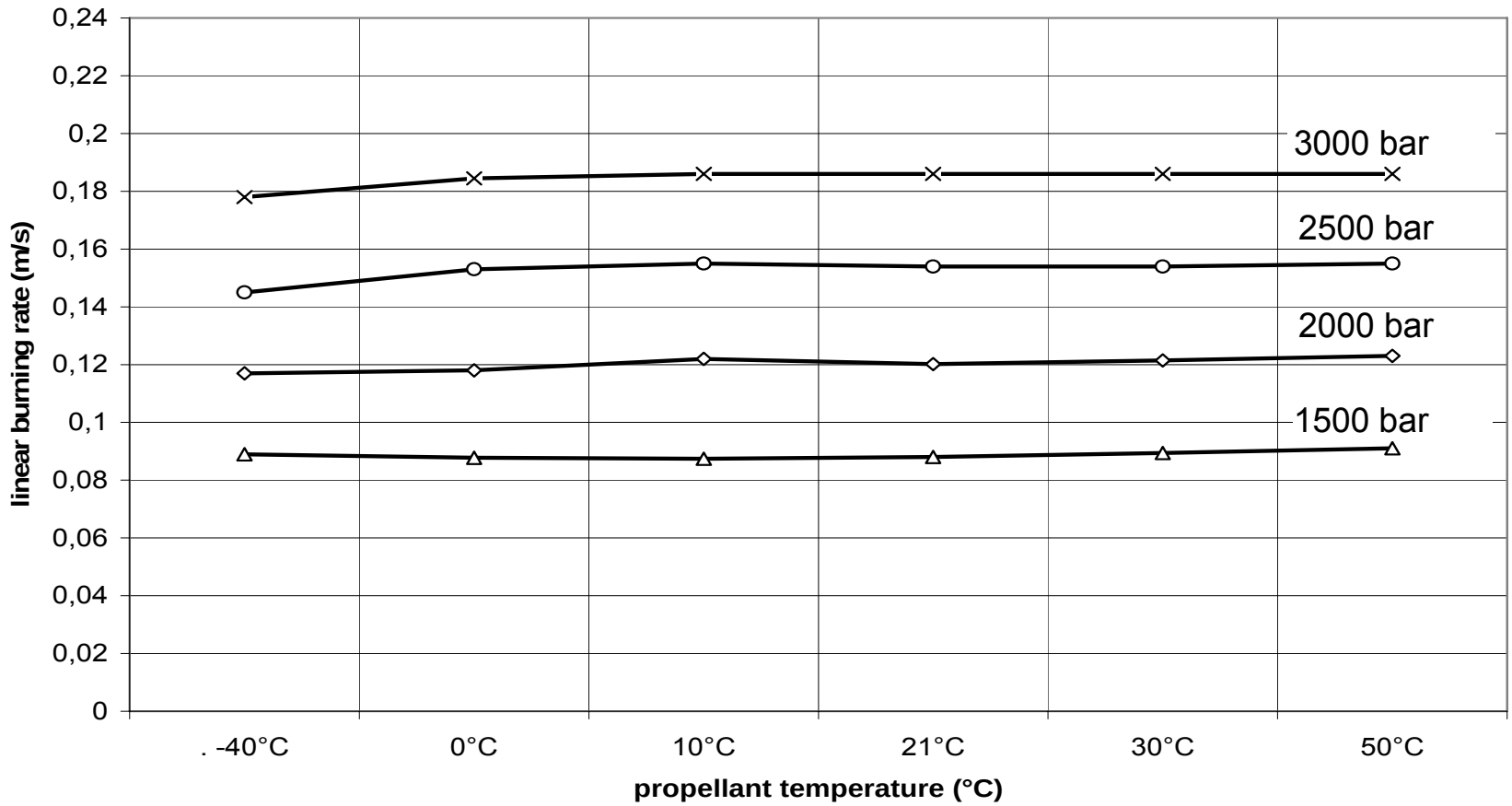
Linear burning rate of LTC Propellants at different pressures



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Perfomance, Safety Test Results

Performance data

Formulation	Impetus (J/g)	T_f (K)	$\overline{M}w$ (g/mole)
1	1080	2540	19.4
2	1180	2910	20.8
3	1300	3990	21.6

Safety data

Loss of weight after 18 days	< 1.10 %
Loss of weight after 30 days	< 1.65 %
Sensitivity to friction	160 N
Sensitivity to impact	4 J
Self - Ignition temperature	> 220 °C
Fast cook - off test	burning
Shaped charge impact test	Class A

Sensitivity Data of different DNDA - Propellants

	RDX - Prop. ICT 1	i-RDX - Prop. ICT 20	RDX - Prop. mod. DNDA ICT 3
Reaktion Class Shaped Charge Test cal. 35 mm	A	A	B
	Propellant not burning, still in cartridge		
Friction Sensitivity [N]	288	240	240
Impact Sensitivity [Nm]	6,0	6,0	5,0
Ignition Temperature [°C]	> 220	> 216	> 219
1“ Detonation - Tube	no Detonation		
MG cal.50 / 12.7 mm	IM Reaktion Type 5 (MIL - STD 2105 B) WIWEB Results		

Shaped Charge Tests,

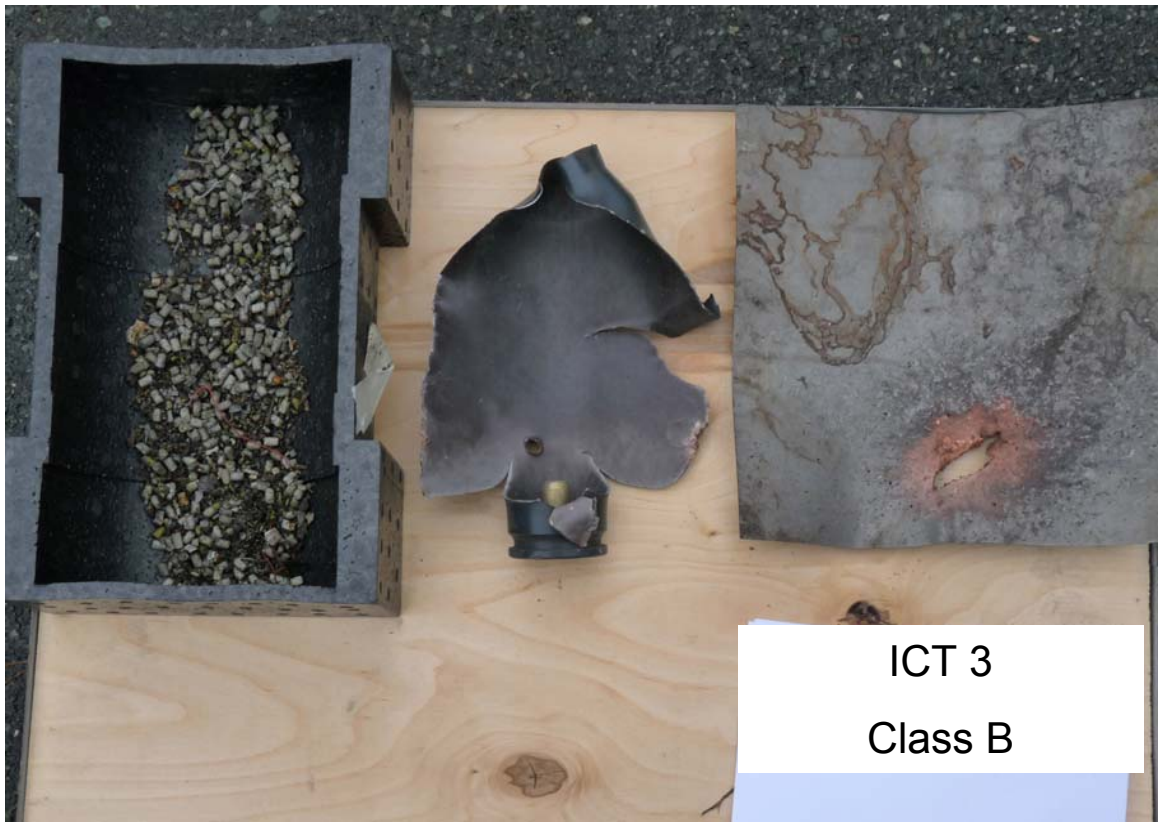
DNDA - Propellant ICT 1 (RDX), ICT 20 (i-RDX)

Class A

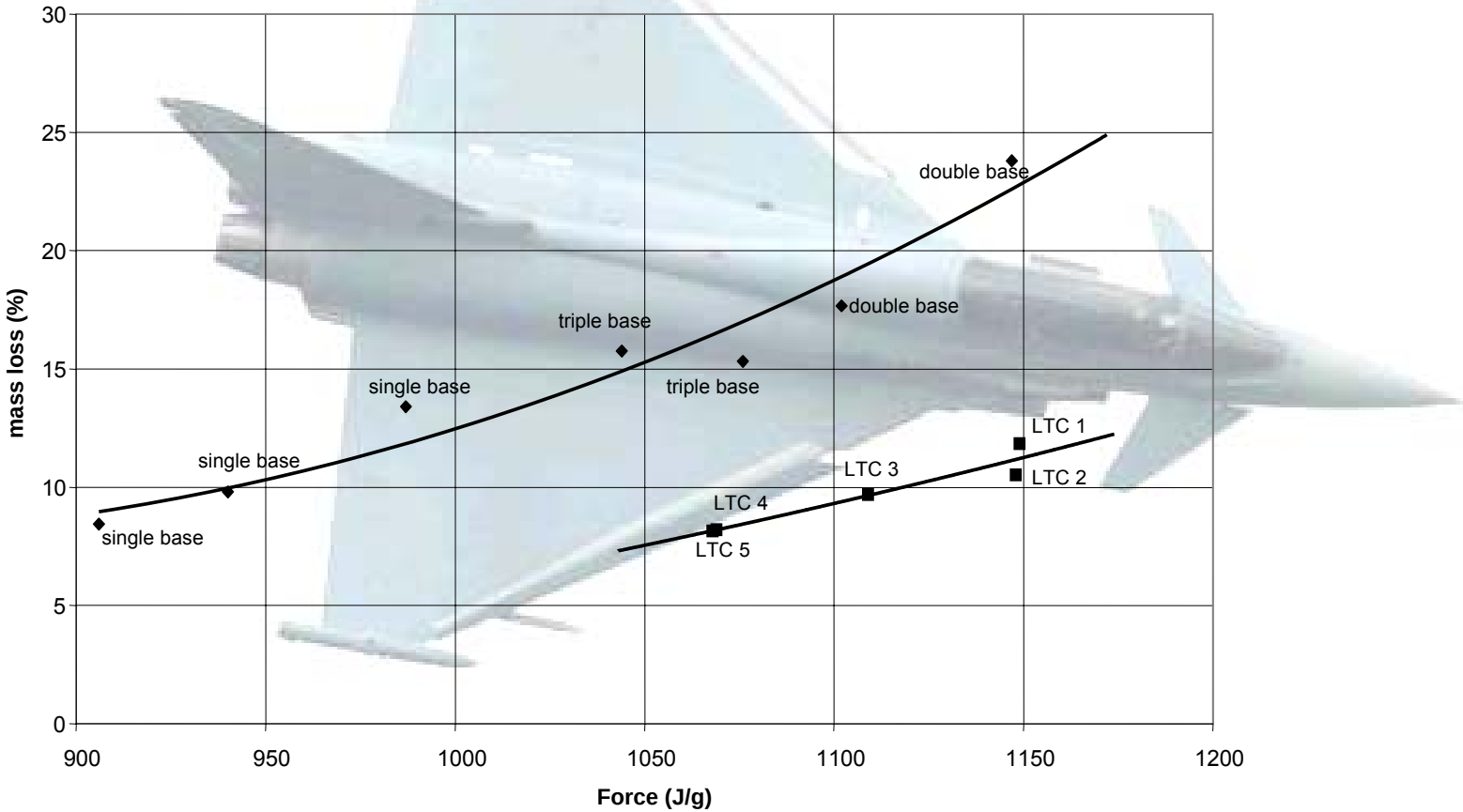
Class A

Shaped Charge Test,

DNDA - Propellant ICT 3, Class B Test Result



Erosivity of LTC Propellants and Conventional Propellants



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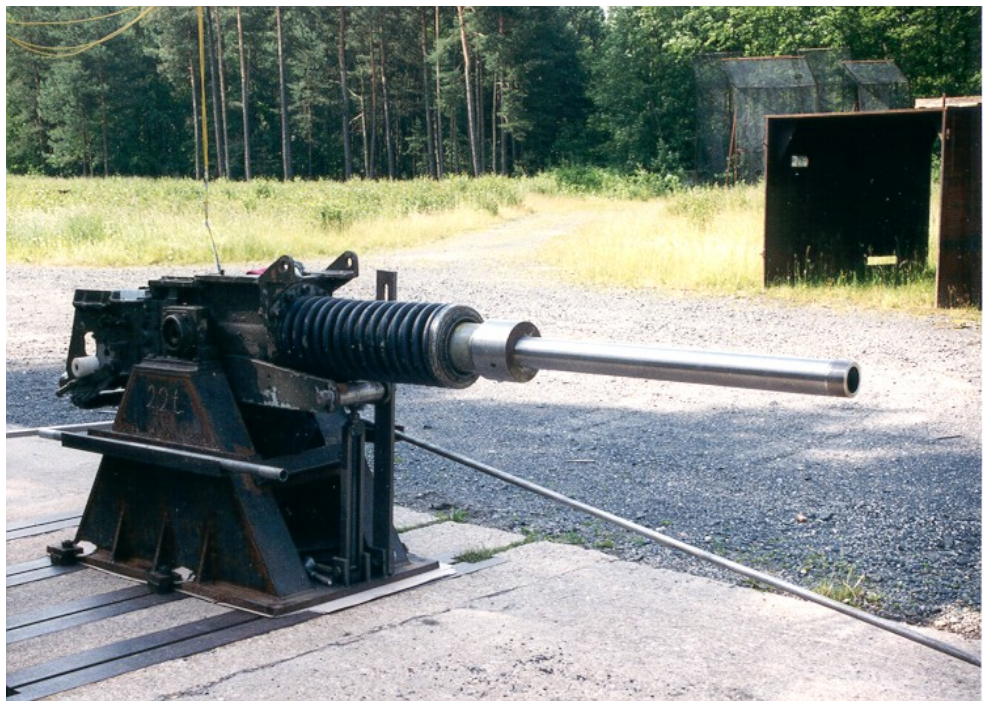
75 mm Scale model gun derived from 120 mm cal. tank gun (Diehl BGT)

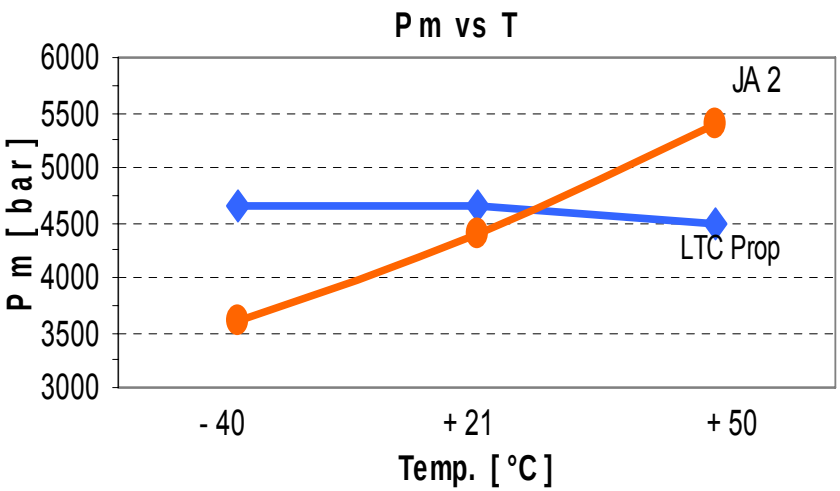
- based on interior ballistic similary laws
- less cost (combustible paper case, less propellant mass)



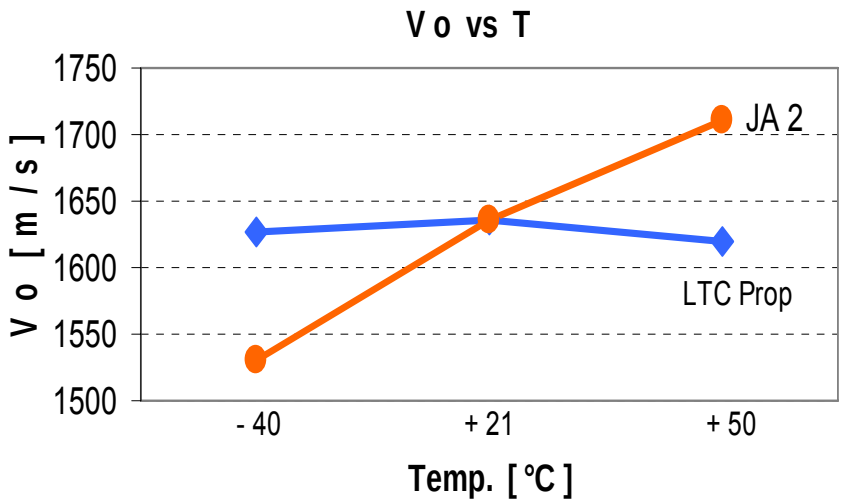
Test Firing in 75 mm cal. Model Gun (Diehl BGT)

Optimized propellant for firing at 21°C

gas pressure vs temp.



muzzle velocity vs temp.



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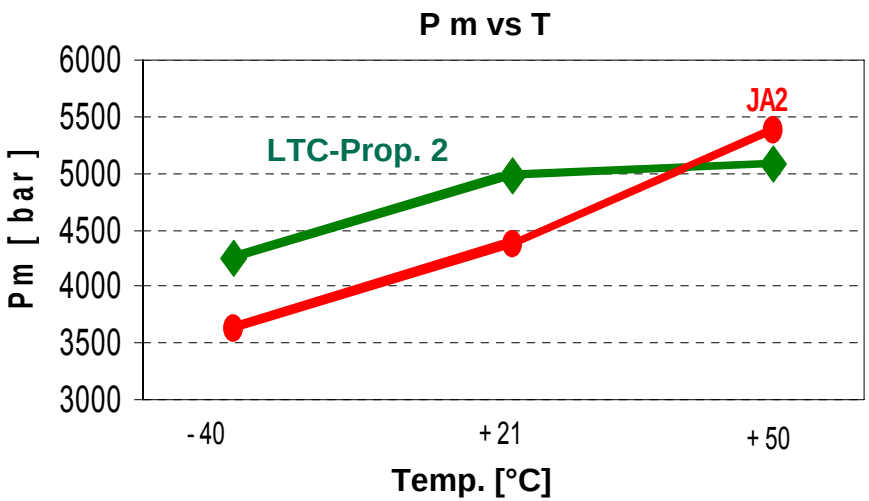
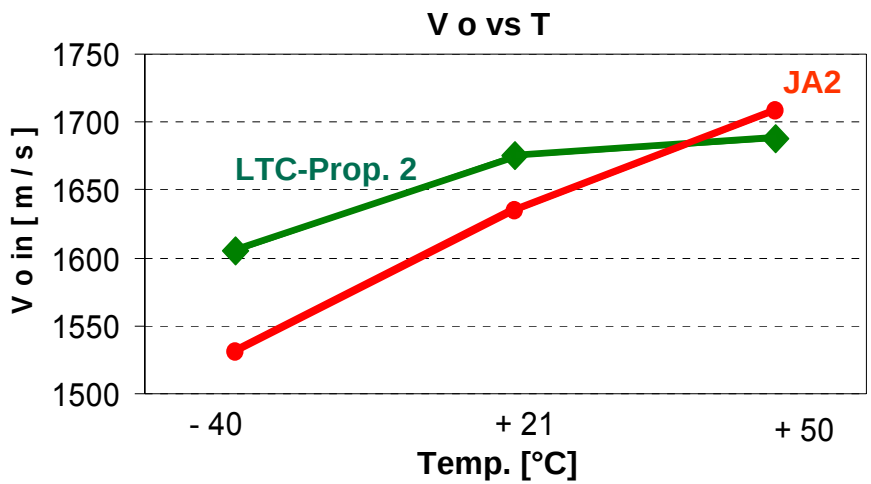
Test Firing in 75 mm cal. Model Gun (Diehl BGT)

Performance optimized propellant

gas pressure vs temp.



muzzle velocity vs temp.



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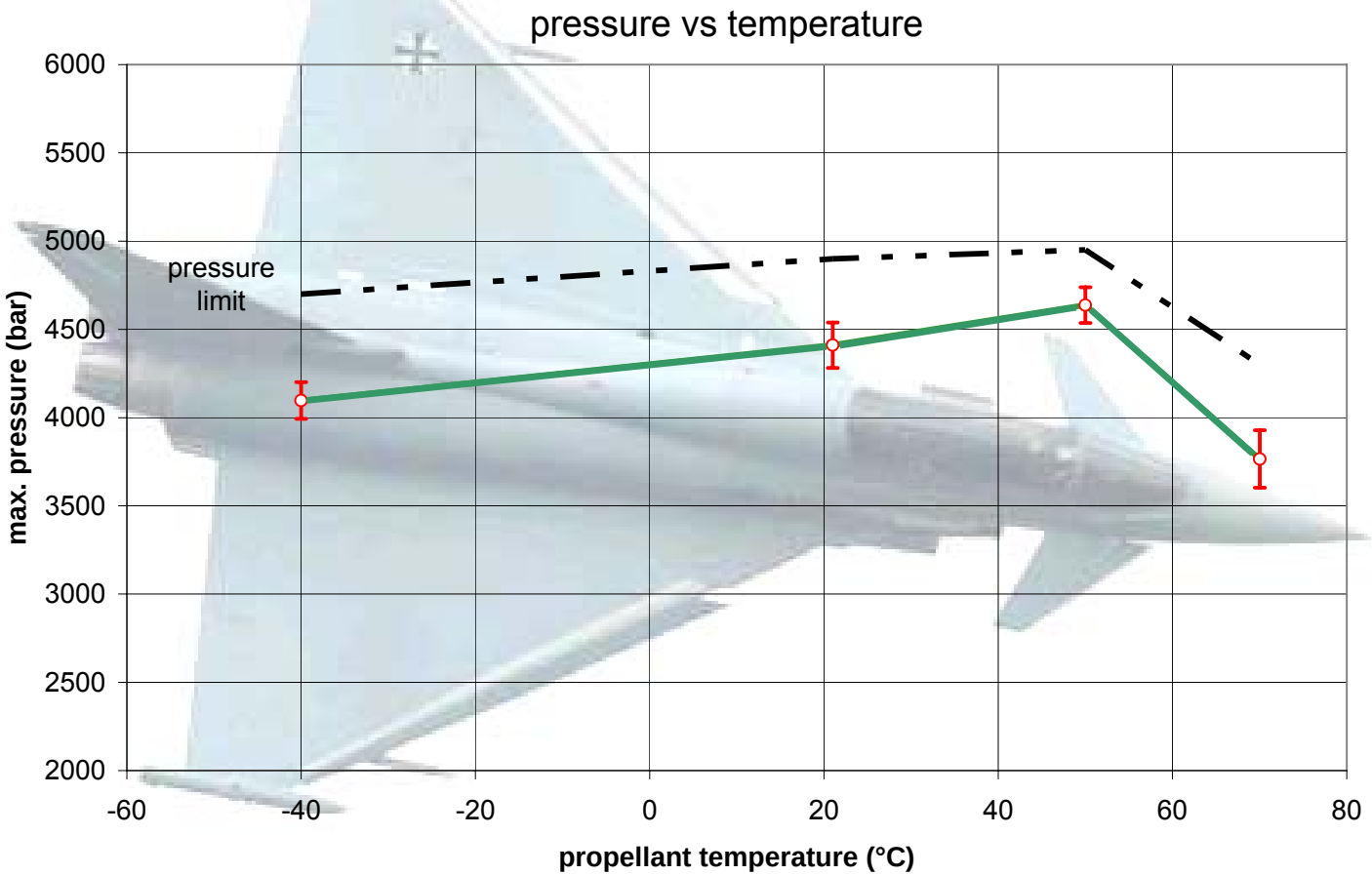
EF Propellant

Gun Firing 27 mm cal. Eurofighter



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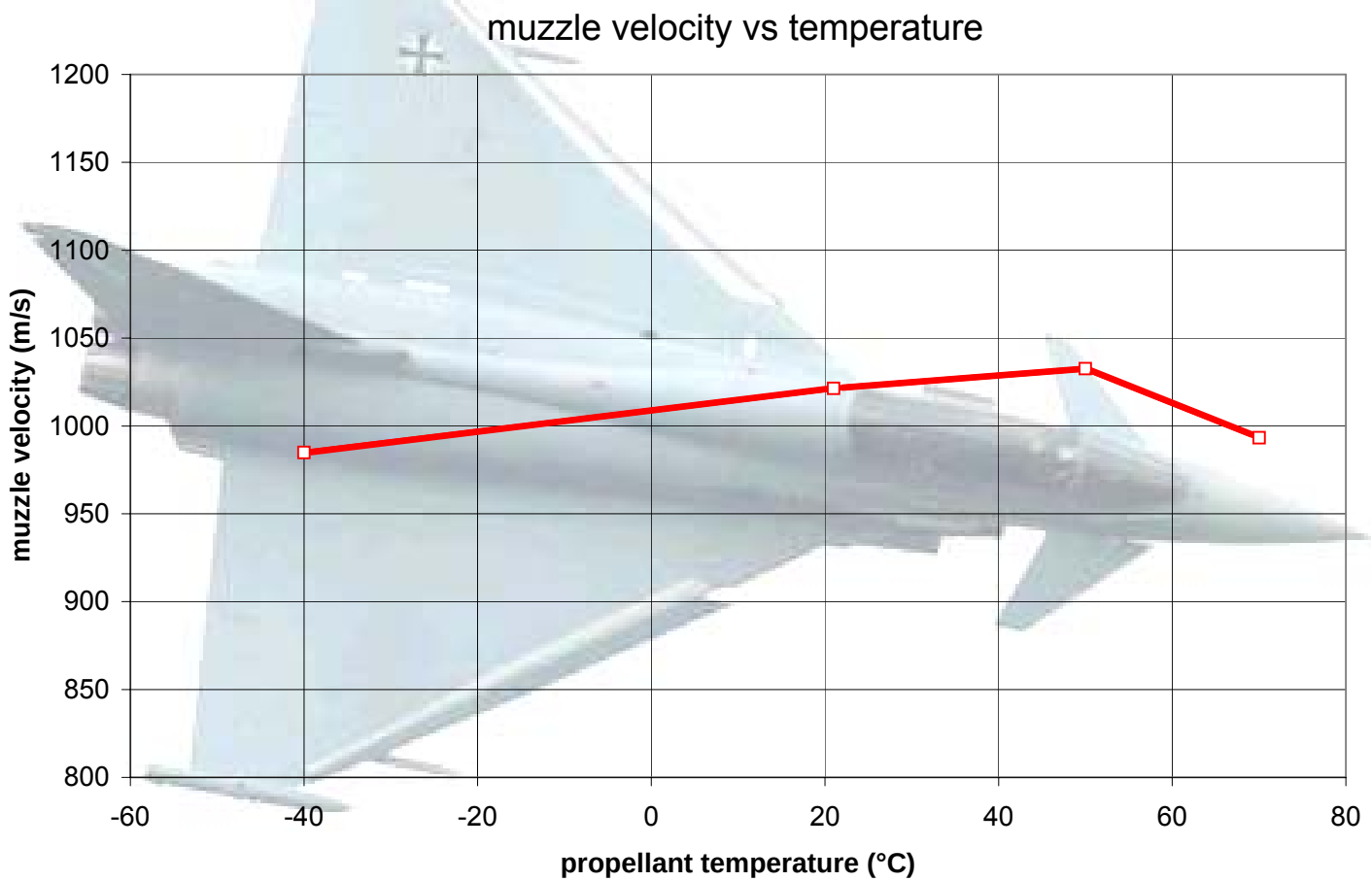
EF Propellant

Gun Firing 27 mm cal. Eurofighter



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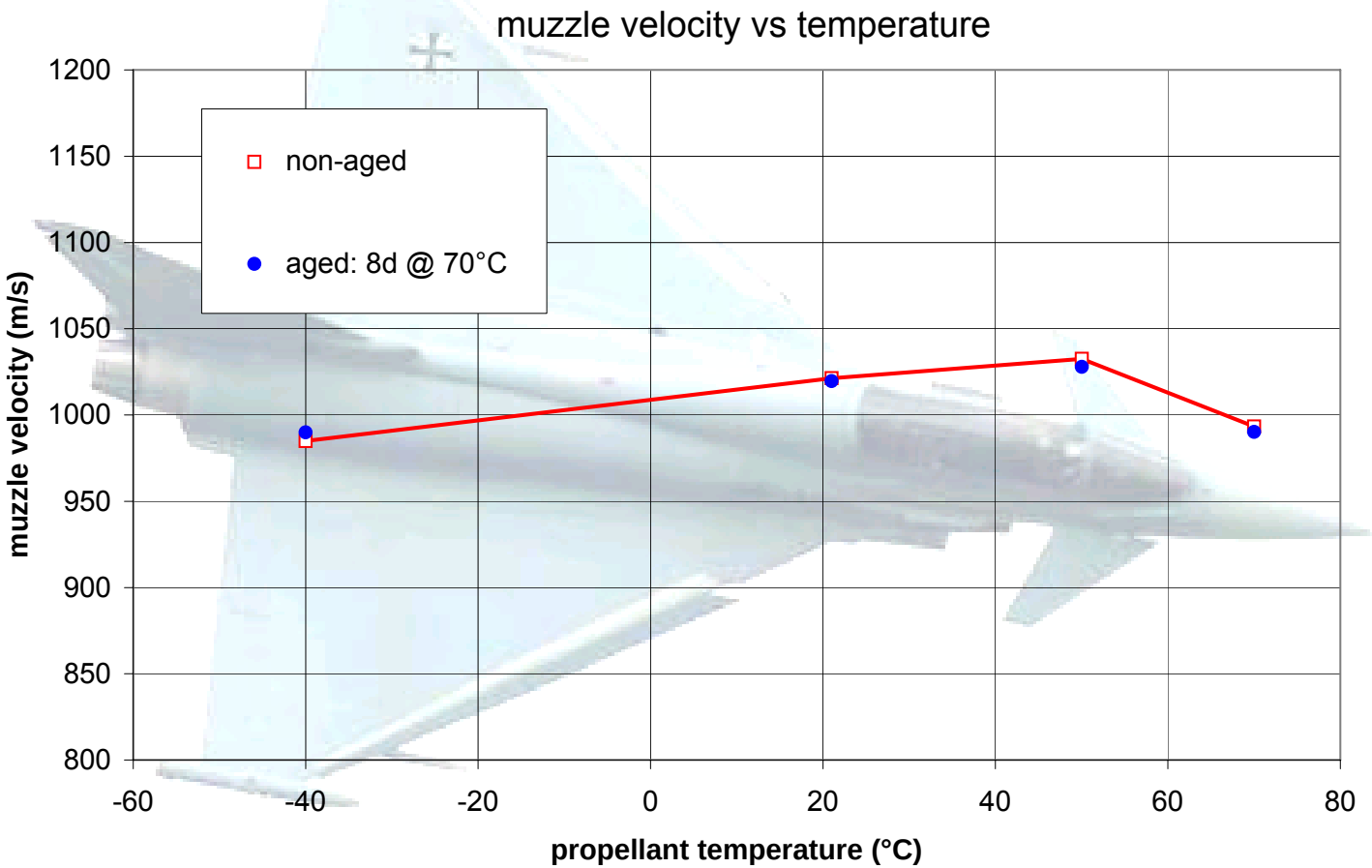
EF Propellant

Aged propellant compared with non aged propellant



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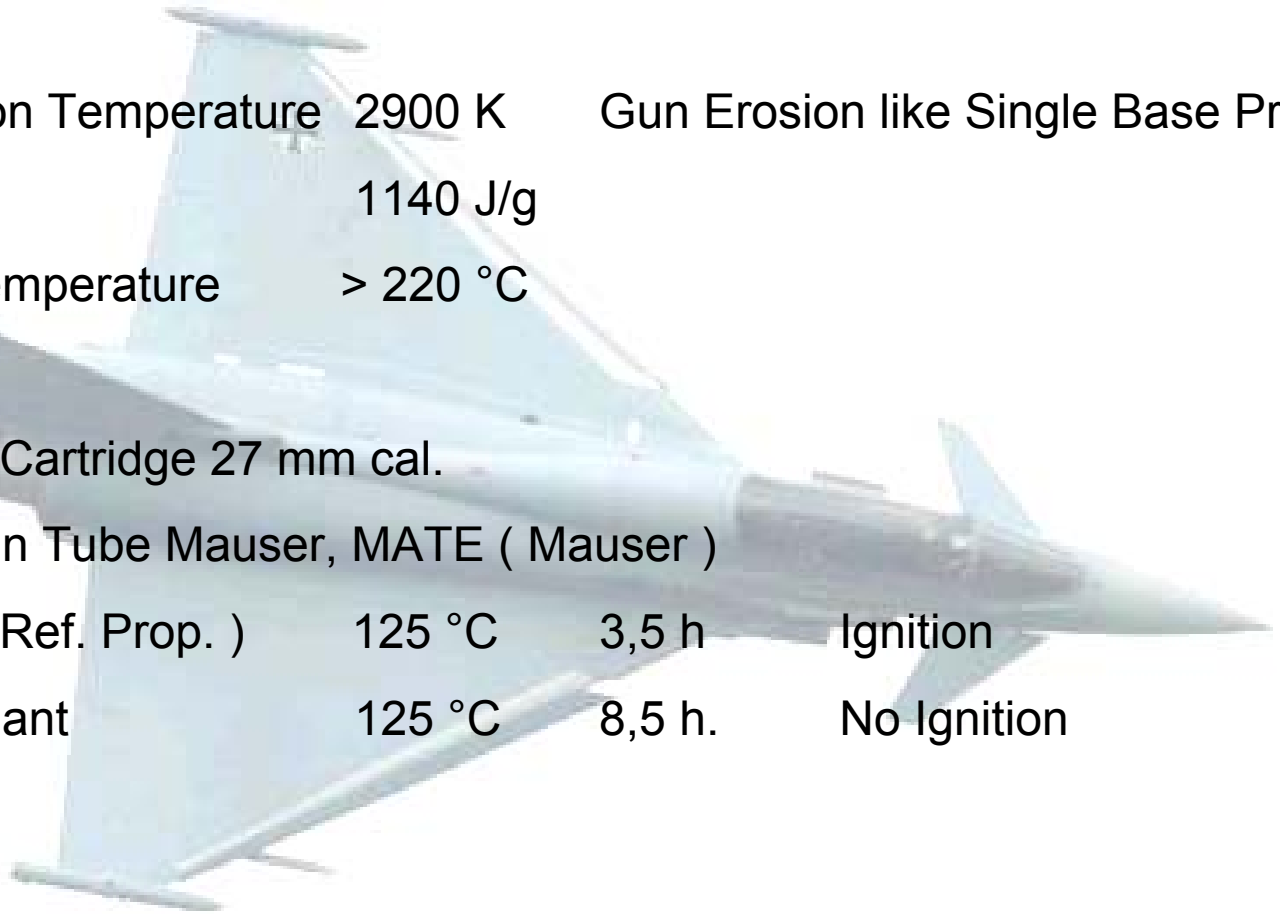
EF Propellant 27 mm cal. Eurofighter PELE Cartridge



Combustion Temperature	2900 K	Gun Erosion like Single Base Propellant
Force	1140 J/g	
Ignition Temperature	> 220 °C	

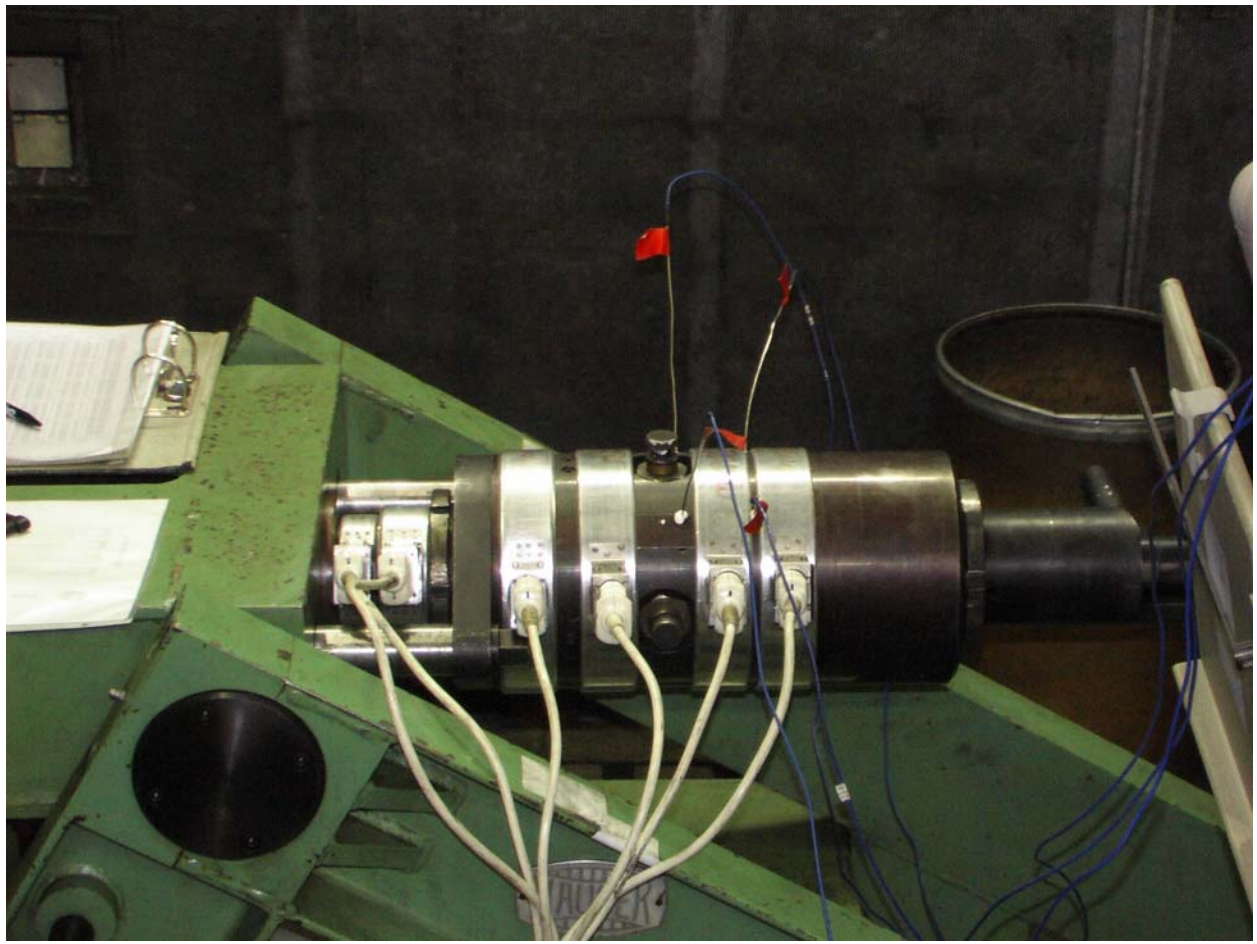
Cook - off Cartridge 27 mm cal.

27 mm Gun Tube Mauser, MATE (Mauser)

Q 5560 (Ref. Prop.)	125 °C	3,5 h	Ignition
EF Propellant	125 °C	8,5 h.	No Ignition

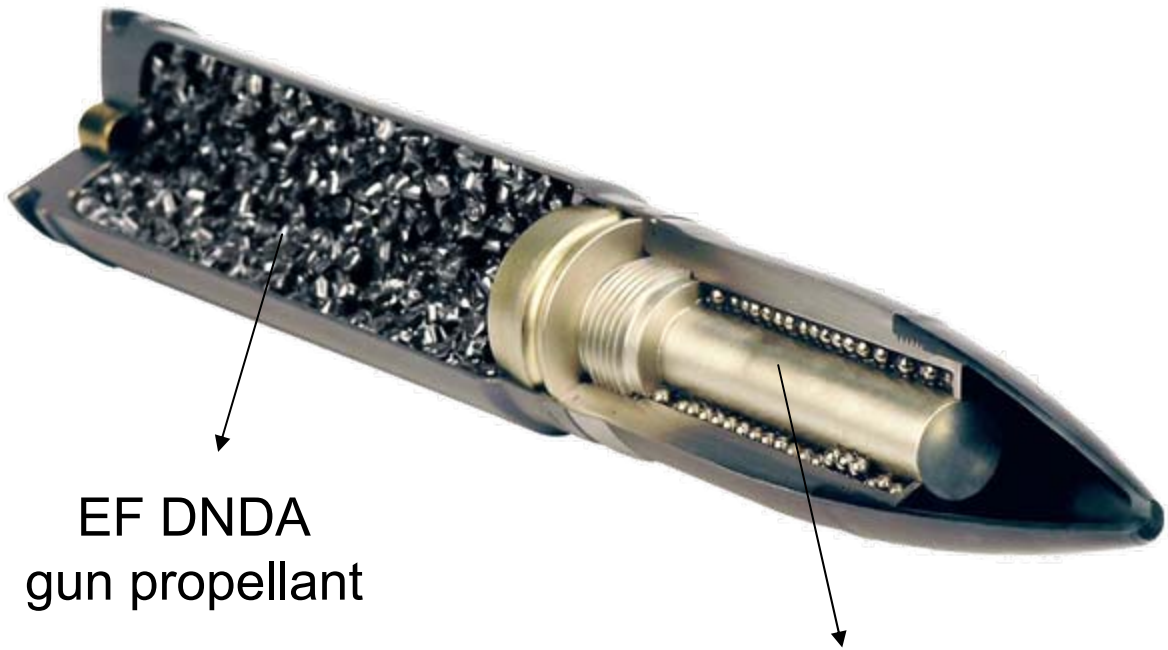
Cook - Off Test in Gun Tube 27 mm cal. (MATE)

Gun Test Tube



PELE Cartridge 27 mm cal.

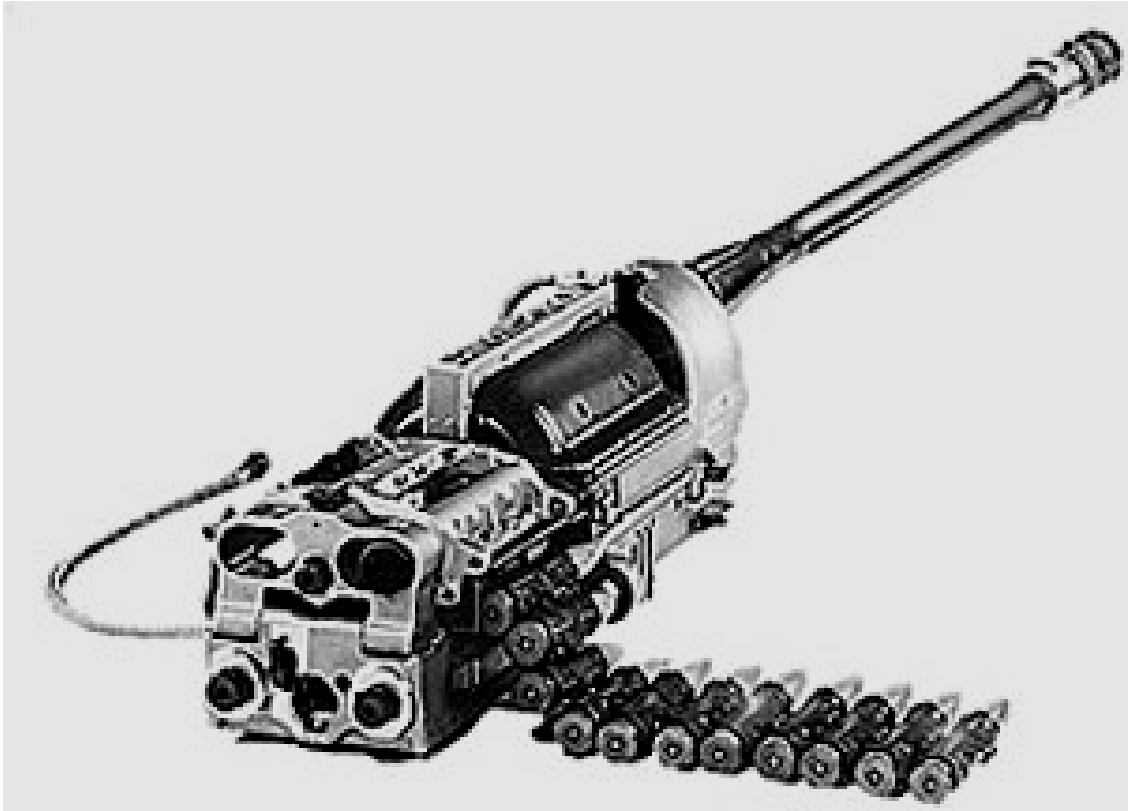
PELE = **P**enetrator with **E**nhanced **L**ateral **E**fficiency



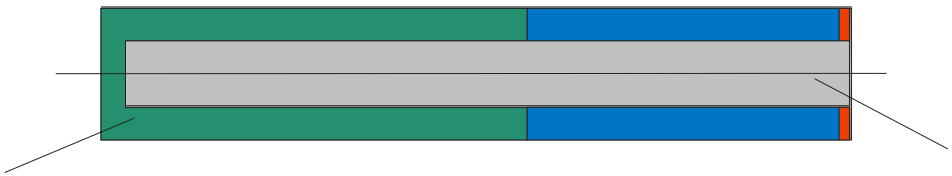
EF DNDA
gun propellant

PELE® projectile DM 83 and
DM 93 (with tracer)

Eurofighter BK 27
27 mm cal.



Diehl PELE Ammunition Concept



high density material for tube
I.e. tungsten, steel

low density material for inner core
I.e. plastic or aluminum

- PELE Projectiles

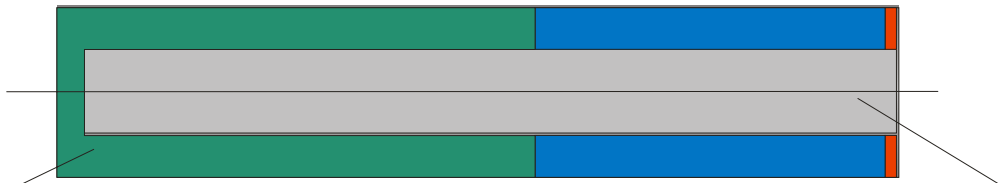
  → Highly effective against all targets

- New type of LTC propellant

  with low flame temperature (reduced erosion), high cook - off temperature

  - high shot precision within the temperature range > No v_o - correction necessary
  - high internal ballistic safety

PELE Function



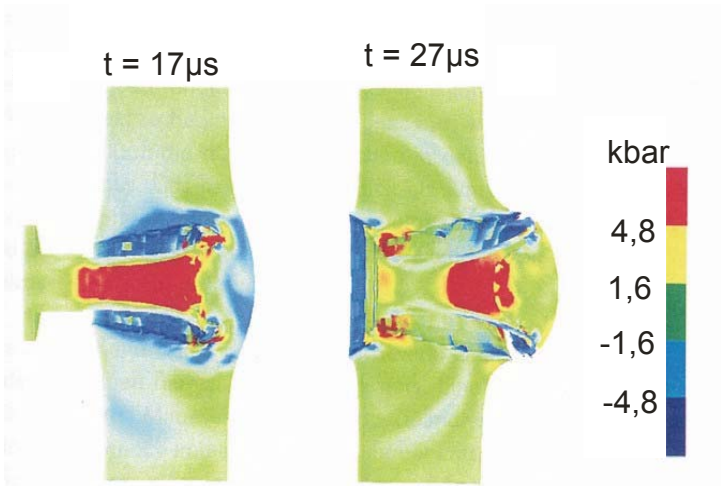
high density material for tube
I.e. tungsten, steel

low density material for inner core
I.e. plastic or aluminum

Part I: Erosion by penetration

Part II: Fragments by PELE effect
(Adjustable between 30% and 100%)

Part III: Penetration and/or PELE effect in next plates Adjustable between 0% and 70%)



Pressure distribution on penetrator

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Results & Conclusion

- LTC Propellants based on DNDA 5,7 and RDX for a wide Caliber - Range
- Excellent Shaped Charge Testresults (Reaktion Class A)
- High Self - Ignition Temperature > 220 °C
- Insensitive, Reaction Type 5 (MIL - STD 2105 B)
  IM Characteristic
  MG 12.7 mm cal. firing on Steeltube with propellant
- Excellent Long - Term Stability
- Low Combustion Temperature at High Force and Low Gun Tube Erosion
- Less Sensitive in Hot Gun Tube (MATE)
- Propellant Charge for Eurofighter Gun, 27 mm cal. PELE Cartridge