EURENCO
GROUPE SNPE

NEW PROCESS FOR PRODUCTION OF HIGH PURITY ADN - DEVELOPMENT AND SCALE-UP

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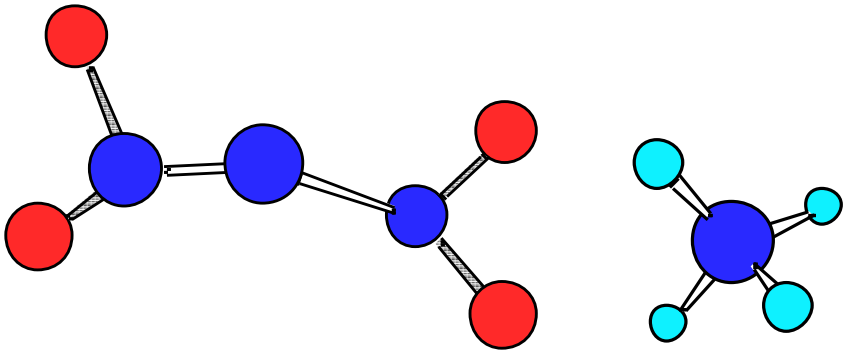
UNIQUE KNOW-HOW

MULTIFACETED RANGE

SSC ECAPS

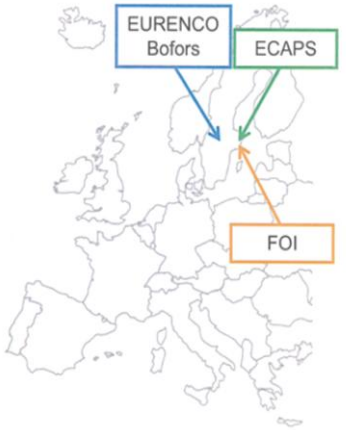
ADN

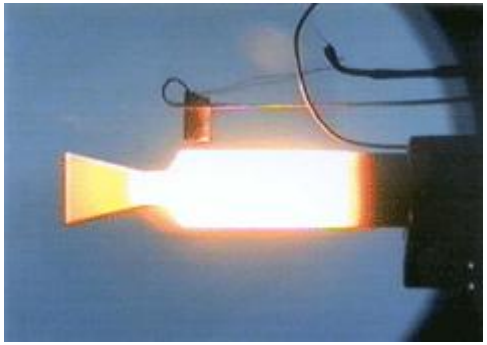
- Explosive and oxidizer with extraordinary properties
- Low signature / minimal smoke
- High burning rate
- High specific impulse
- Chlorine free
- No toxic residues
- Environmentally benign
- Environmentally friendly alternative to eg. AP
- Potentially inexpensive



Development of monopropellant

- ADN-based liquid monopropellant concept developed by FOI and ECAPS
- Thruster developed by ECAPS
- Propellant developed by Eurenco Bofors and ECAPS
- Propellant produced and tested by EURENCO Bofors, Karlskoga





ECAPS

Development of monopropellant

Demands on propulsion

- Performance
- Compatibility
- Stability
- Density
- Transport classification
- Handling safety
- Vapour pressure
- Viscosity
- Radiation tolerance
- Speed of sound
- Heat capacity
- Conductivity
- Thermal conductivity
- Purity

LMP 103S

• ADN	60-65 %
• Methanol	15-20 %
• Ammonia	3-6 %
• Water	

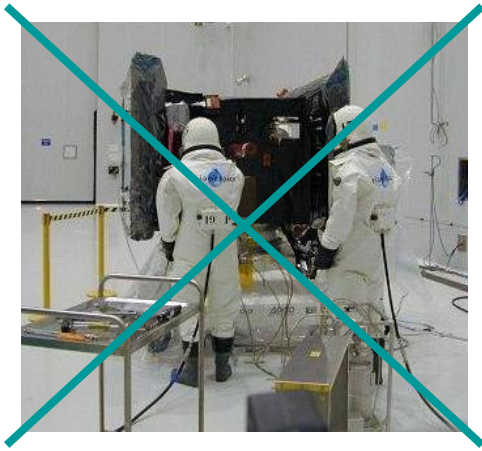
Compared to Hydrazine:

Higher specific impulse (6%)
Higher density (24%)
Higher payload / longer missions

ADN vs Hydrazine

Hydrazine:

- Carcinogenic
- Toxic
- Environmentally hazardous



ADN:

- Non-toxic
- Environmentally benign

ADN is more stable, less toxic and less harmful than Hydrazine and might be a good, greener replacement

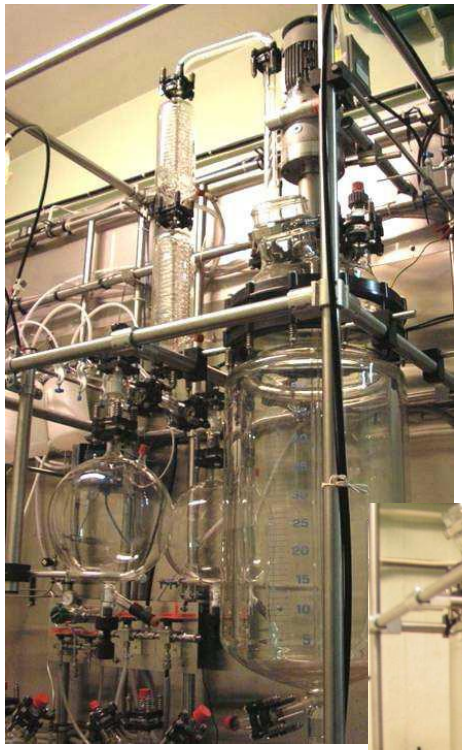
Purification process

2006 Process development starts

- Standard chemical operation steps
- Minimum time at elevated temperature
- pH control

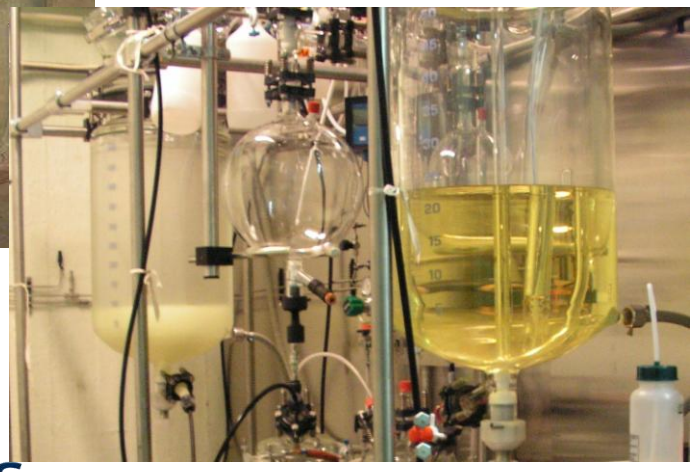
2007 Lab process ready

Purification process scale up



2008 Scale up to bench scale

- 25-60 liters
- Glass and Teflon
- New equipment
- Capacity 6kg/week, later increased to 10 kg/week



Purification process scale up

2010 Work with 200 N thruster requires larger quantities of flight grade ADN

2011 Scale up to pilot plant

- 500 liters
- Stainless steel
- Standard pilot plant equipment
- Capacity > 10 kg/day

ECAPS

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Quality standard product

Substance	Amount [ppm]	Substance	Amount [ppm]	Substance	Amount [ppm]	Substance	Amount [ppm]
Ag	0.001	Eu	***	Nb	***	Sm	***
Al	0.04	Fe	0.1	Nd	***	Sn	***
As	***	Ga	***	Ni	0.03	Sr	0.001
Au	***	Gd	***	Os	***	Ta	***
B	***	Ge	***	P	0.2	Tb	***
Ba	0.005	Hf	***	Pb	0.002	Te	
Be	***	Hg	***	Pd	***	Ti	***
Bi	***	Ho	***	Pr	***	Th	***
Br	0.2	I	***	Pt	***	Tl	***
Ca	0.001	Ir	***	Rb	1.2	Tm	***
Cd	***	K	1600	Re	***	U	***
Ce	***	La	***	Rh	***	V	***
Co	0.001	Li	***	Ru	***	W	0.04
Cs	***	Lu	***	S	11	Y	***
Cr	0.06	Mg	0.4	Sb	***	Yb	***
Cu	0.013	Mn	0.003	Sc	***	Zn	0.3
Dy	***	Mo	0.005	Se	***	Zr	0.004
Er	***	Na	7	Si	0.3		

*** Not detectable

SSC ECAPS

Comp. bench scale / pilot plant

Impurity	Req. in spec. [ppm]	Bench scale [ppm]	Pilot plant [ppm]
Metals	< 9	5	5
Sulphur	< 8	5	8
Calcium	< 0.8	0.1	0.1
Silicon	< 0.8	<0.5	<0.5

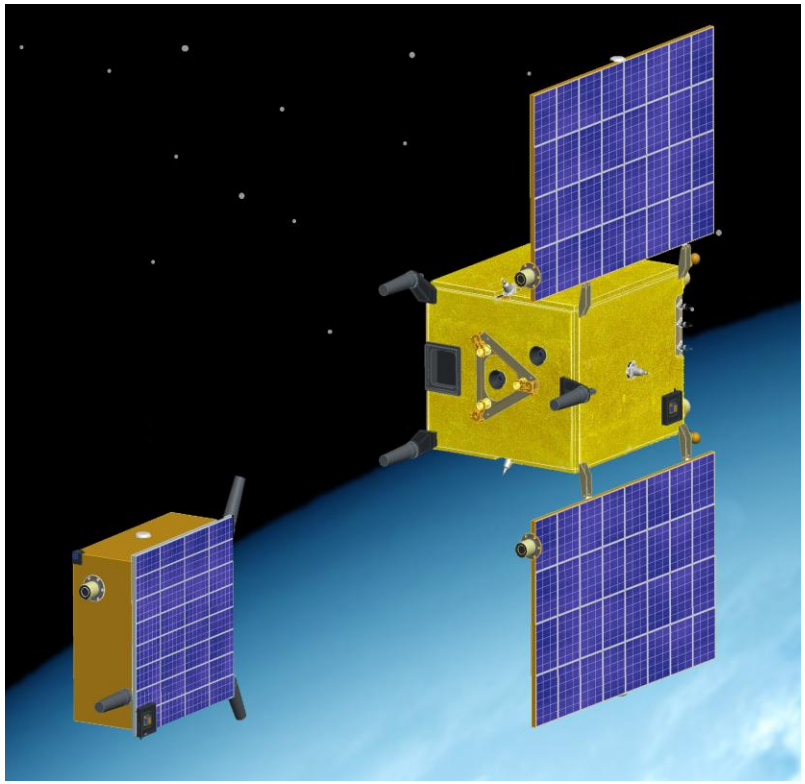
Comp. bench scale / pilot plant

Metal	Bench scale ADN [glass]	Pilot plant ADN [stainless steel]
Cu	0.01 ppm	0.14 ppm
Zn	< 0.05 ppm	0.17 ppm
Fe	< 0.04 ppm	0.04 ppm

Propellant characterization

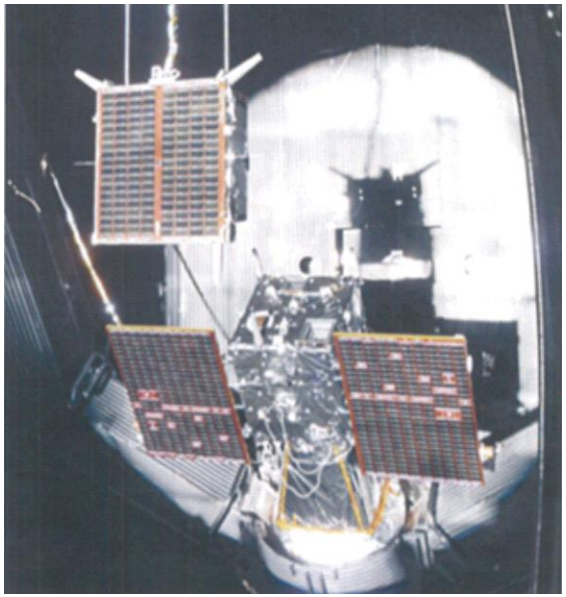
Physical and chemical characteristics
Safety tests
UN transport classification
Radiation tolerance
Material compatibility
Corrosion tests
Storage (cold and warm)
Storability ”end-to-end”

Prisma -HPGP system Space qualification



- Formation flying with two satellites; Mango and Tango.
- One conventional satellite, Tango
- One satellite with a HPGP-system and a conventional Hydrazine system Mango.
- The project included transportation, handling, fuelling etc.

Prisma mission



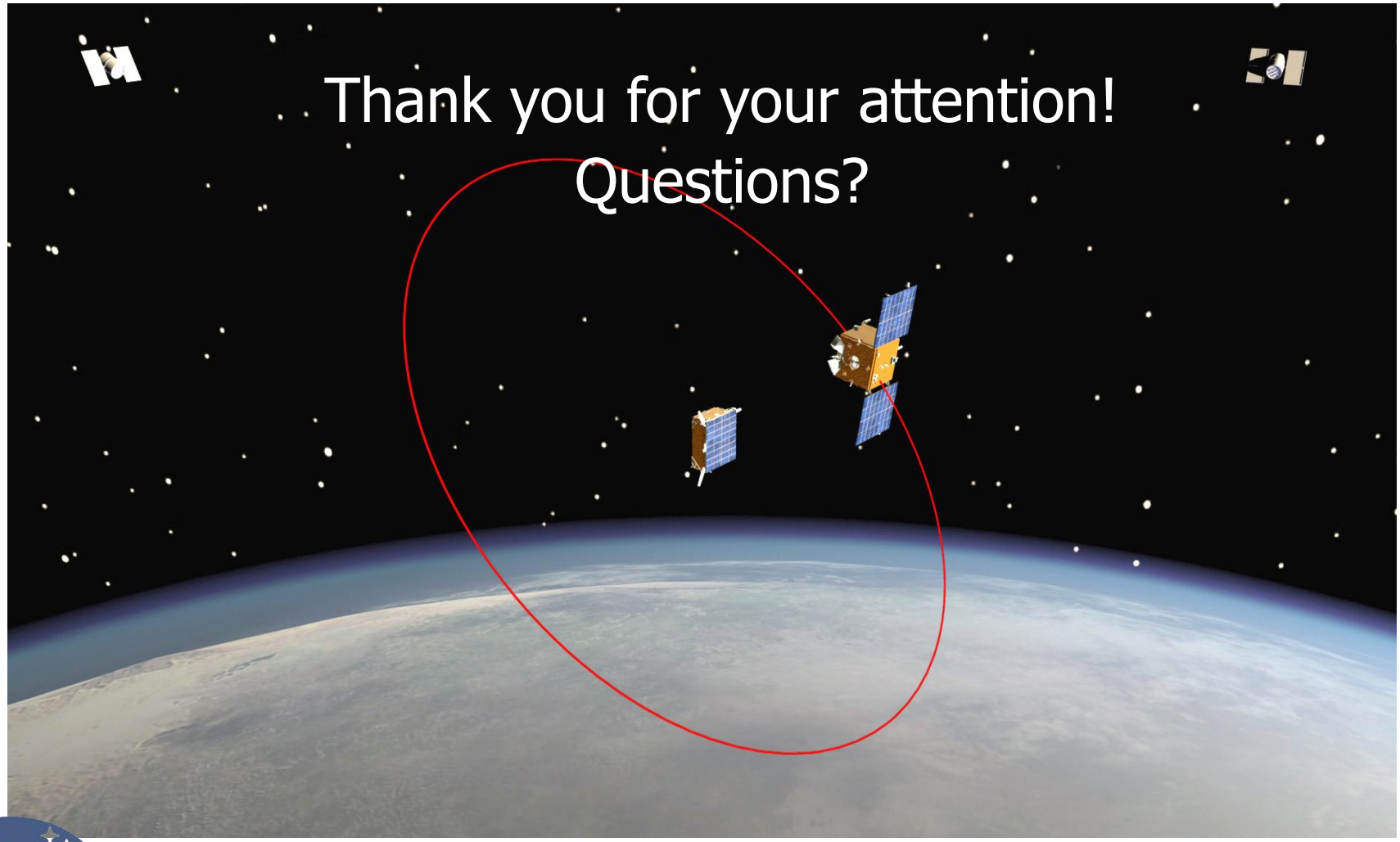
- More than two year in orbit
- More than 360 test sequences
- Over 50 000 pulses
- 3 hours accumulated burning time
- In average 8 % higher specific impulse than hydrazine (expected 6%)

Summary

- Eurenco Bofors AB and ECAPS have developed an advanced purification procedure that gives high purity space grade ADN (99.999% with respect to non-volatile compounds).
- This process has been scaled up from lab scale via bench scale into pilot plant and high purity flight grade ADN can now be produced with good capacity.
- More than 200 kg of flight grade ADN has been manufactured.
- The process has proved to work in standard stainless steel production equipment.

Summary

- High purity flight grade ADN from EuB has been used in ECAPS liquid monopropellant LMP-103S and is successfully space qualified on the Prisma satellites.
- The HPGP-technology gives better performance, reduced risk in handling and less environmental impact.
- The reduced risks makes handling significantly less costly.
- Both the propellant and the thruster are space qualified and will set a new standard for coming missions.
- The interest for the LMP-103S monopropellant is large and growing.


Thank you for your attention!
Questions?