7th ESA Round-Table on MNT for Space Applications

Finding the Place for MEMS in Space

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Outline

MEMS/MNT for Space –where does it fit?
- » Development strategy

- Micropropulsion – where MNT makes a difference
  - » Where we are today
  - » Directions for the future

- Spin-off products

Concluding remarks
- » MEMS for space and the innovation process

The right place for MNT in Space

- Unique functionality or performance
- Low mass, volume and power (miniaturisation)
- Secondary effects:
  - » Increased redundancy without mass penalty
  - » Quality control from batch manufacturing
  - » Modularity: Multiple components/functions in single housing

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Development philosophy

- Start simple and aim for the “end to end” tests
- Increase functionality and performance iteratively
- “Spin out” components if possible
- Accept a certain level of risks and set backs

  –its part of the development process

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From proposal to launch in 5 years

2005 — 2006 — 2007 — 2008 — 2009 — 2010

NanoSpace starts operation

phase B contract

First test of MEMS thruster

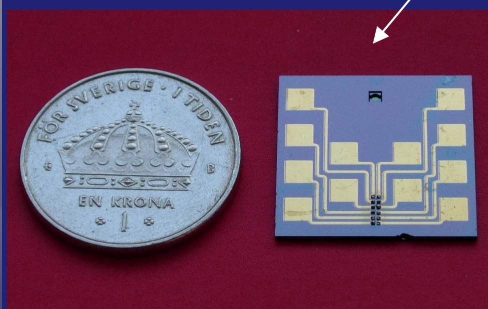
1st complete thruster module

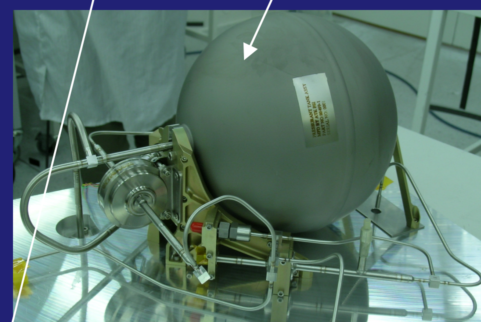
1 st delivery of flight H/W

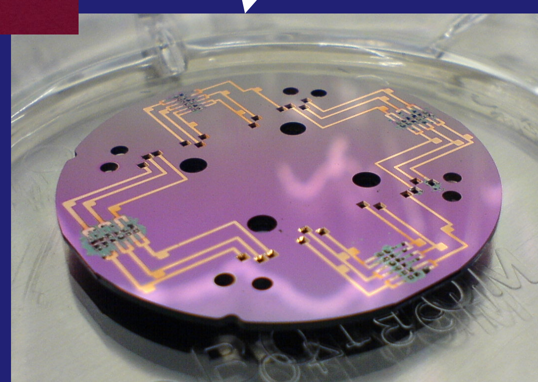
Final delivery to Prisma

End-to-end testing on S/C

Launch!

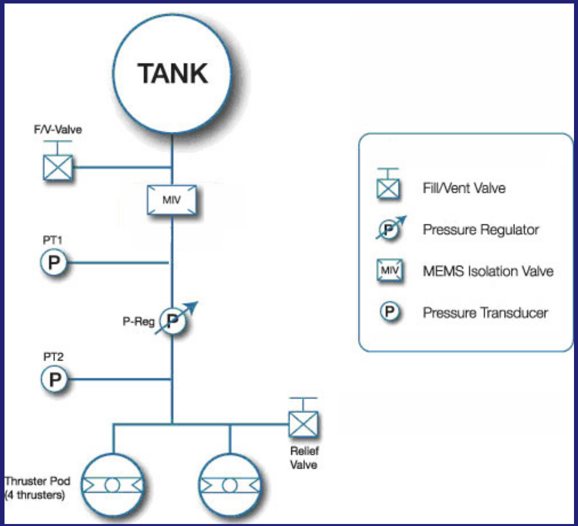


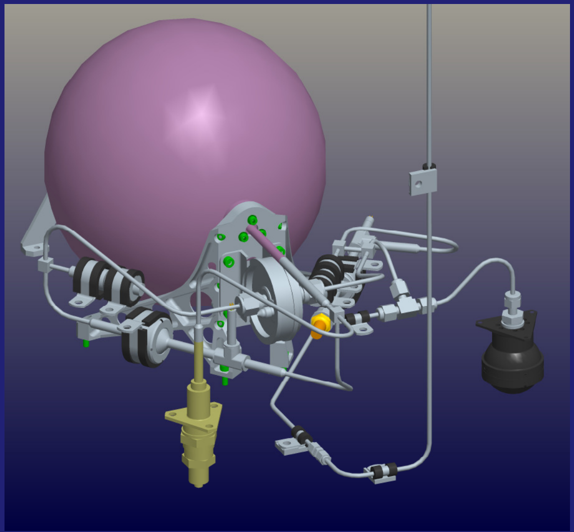


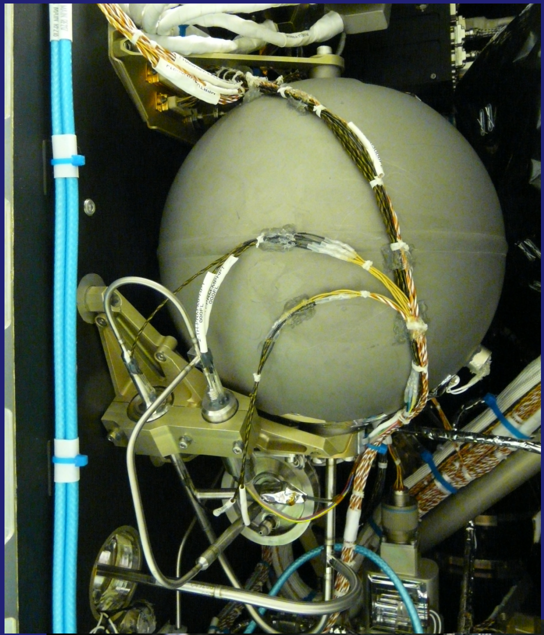


MEMS onboard PRISMA

Micropropulsion system



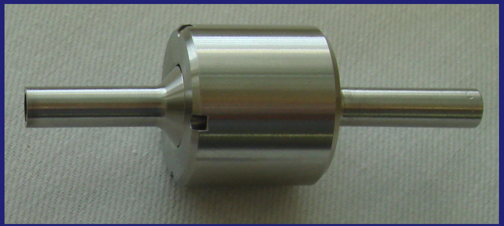




MEMS Thruster module

MEMS-based pressure sensor (delivered by Presens, (N))

MEMS Isolation valve & filter
MEMS Pressure relief valve



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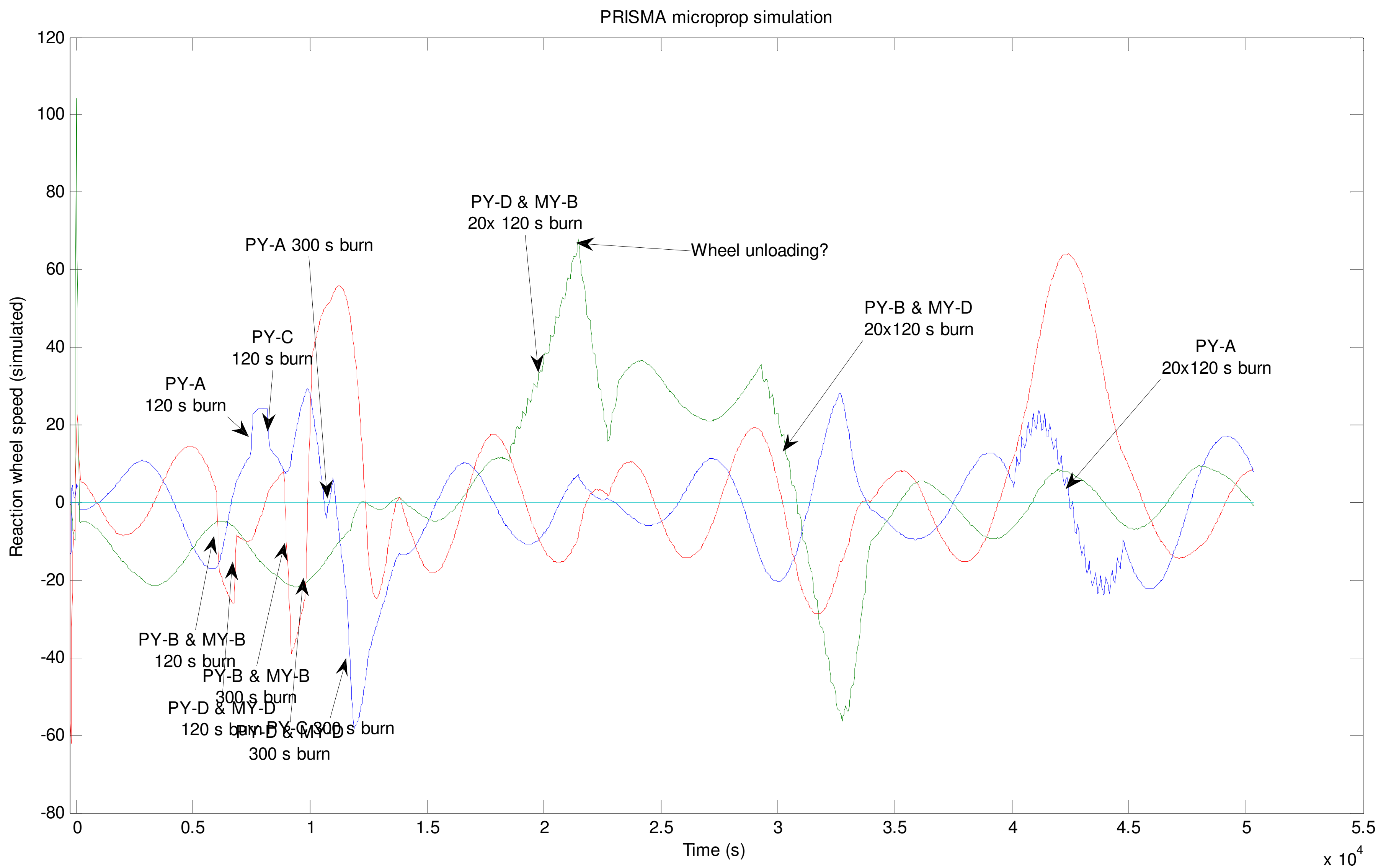
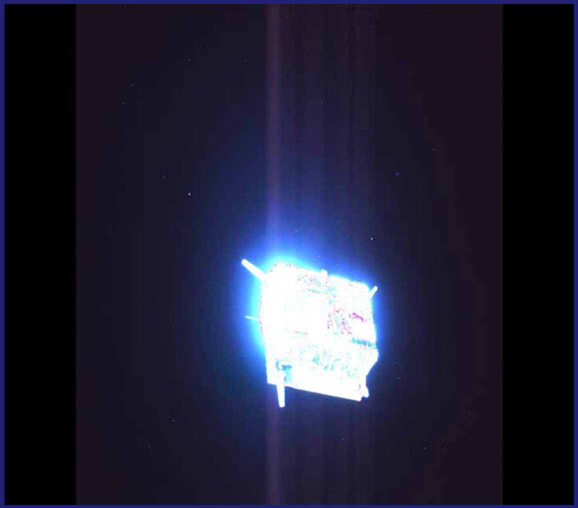
Microthrusters make a difference

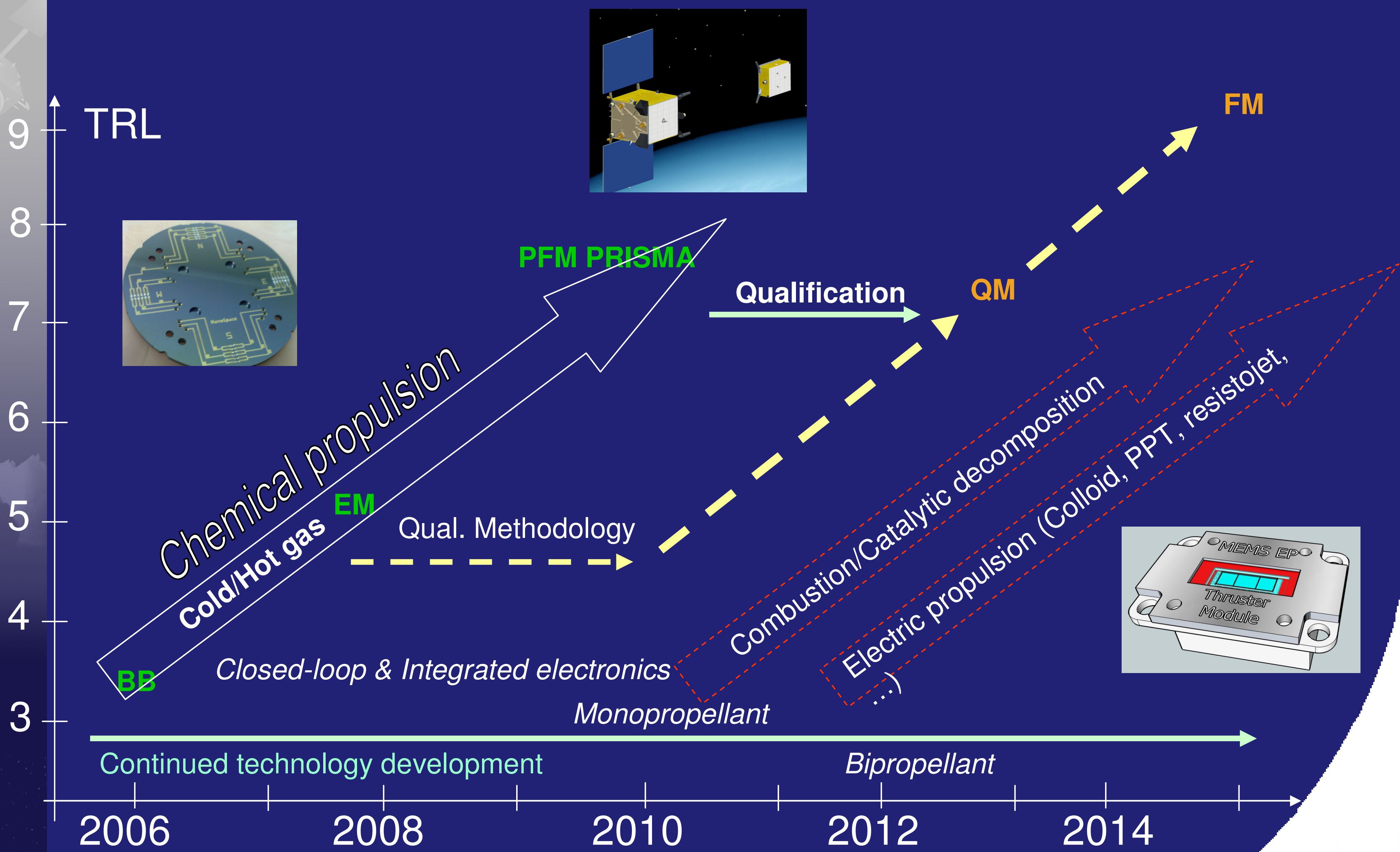


Where are we today?

… in space!



Roadmap: MEMS-based Micropropulsion



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Roadmap – In plain words

Development of high performance MEMS propulsion:

- Cold gas -> hot gas -> combustion -> bi-propellants in order to increase the specific impulse
- In parallel: Various types of electric propulsion

Miniaturization of propellant storage and feed system:

- Valves, pressure sensors, pressure regulator, filters can be made small and highly integrated using MEMS technology

Integration of sensors & closed loop control:

- Sensors and electronics can be small and integrated in the individual components

Spinn-off products:

- Valves, sensors, filters, regulators, etc..

Next generation micropropulsion thrusters

Current technology:

Thruster commands is based upon calibration tests on ground

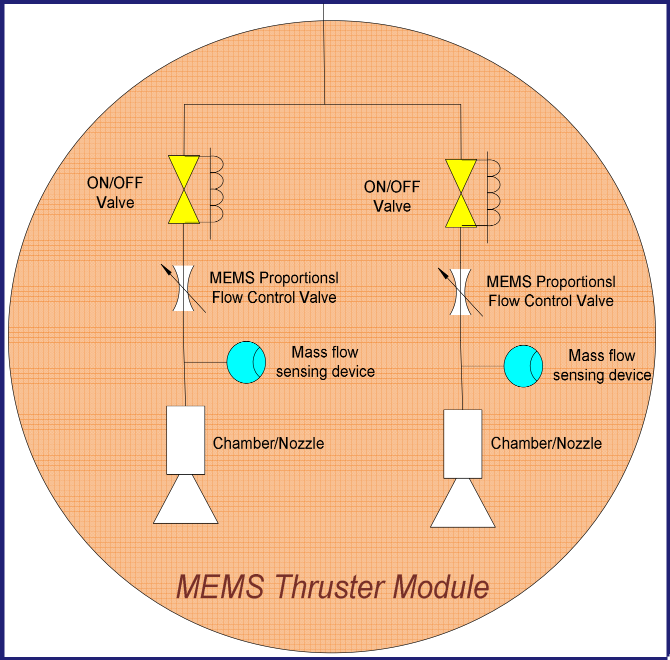
The challenge:

Missions requiring “drag free flight”

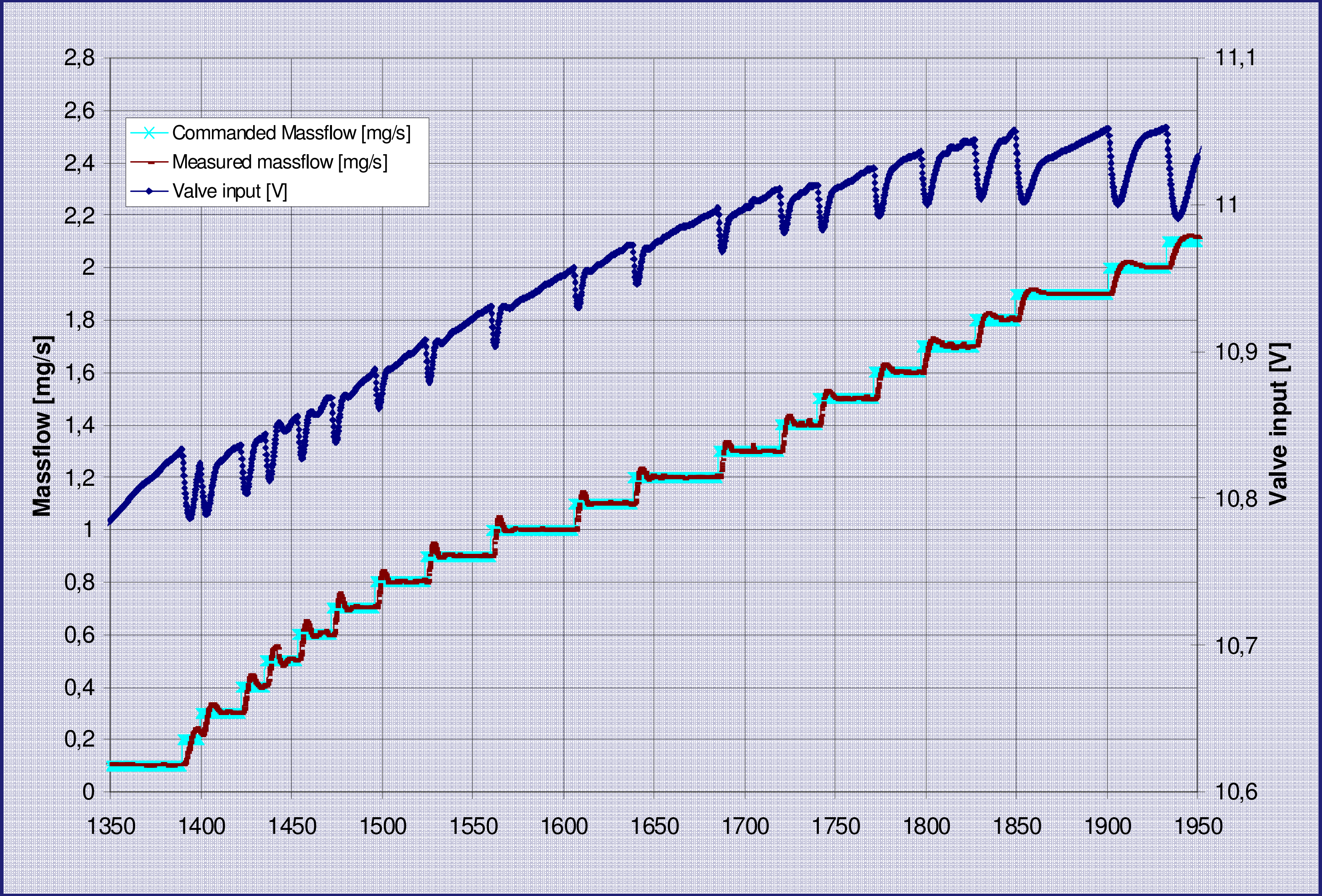
Solution:

Measure delivered thrust in real time and implement this in a control loop!

Requires integrated sensors



Early testing of 1 mN closed loop thrust control engine



The integrated MEMS sensor controls the valve input current to achieve the targeted massflow (and thus thrust)

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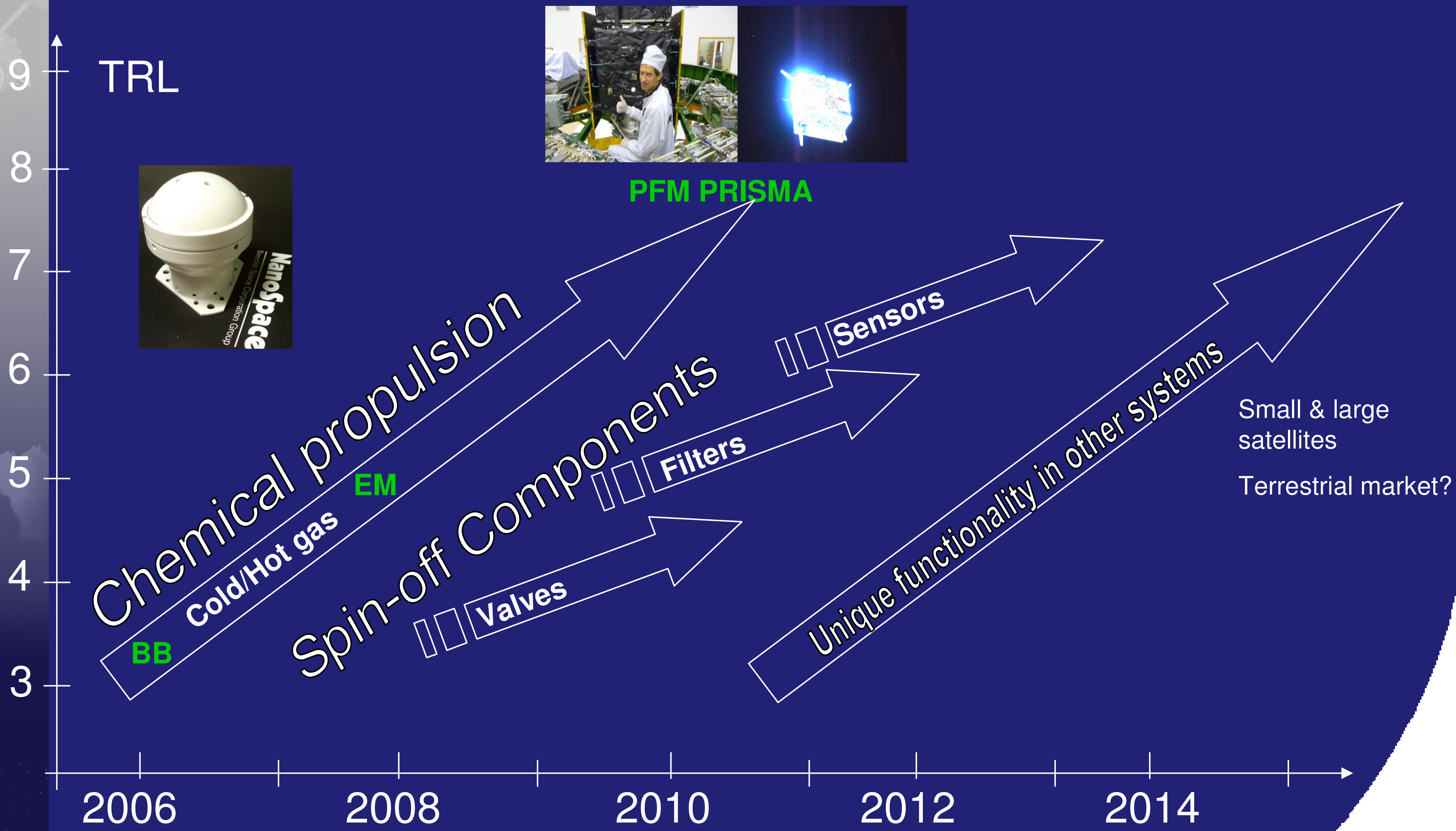
MEMS devices finding their place



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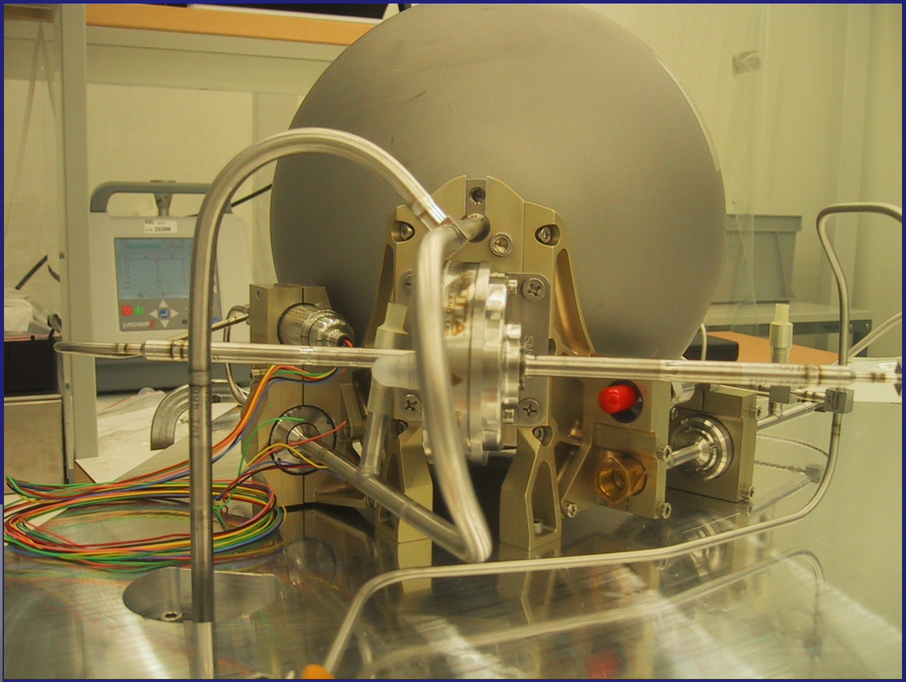
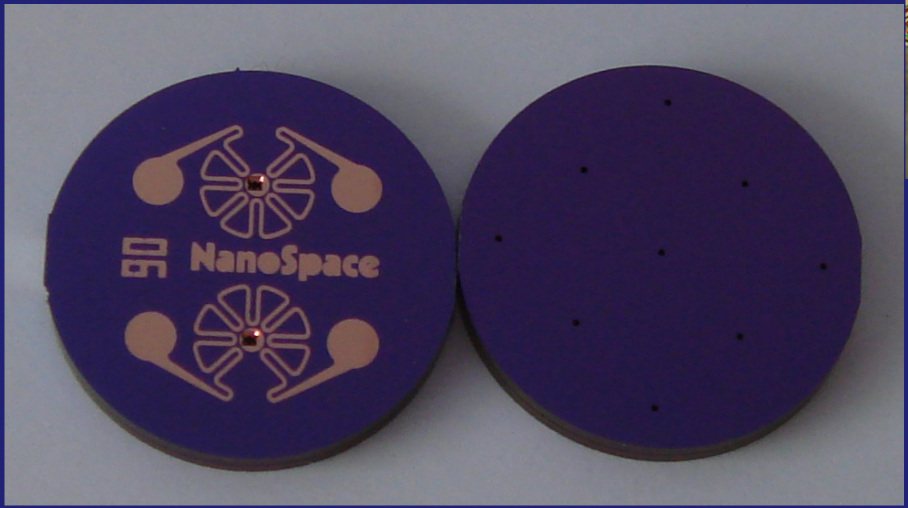
MEMS isolation valve

- An isolation valve near the propellant tank to ensure “No leak” before the system is operated (similar to a pyro-valve)
- A particle filter included
- Redundant (2 inlets, 9 outlets)





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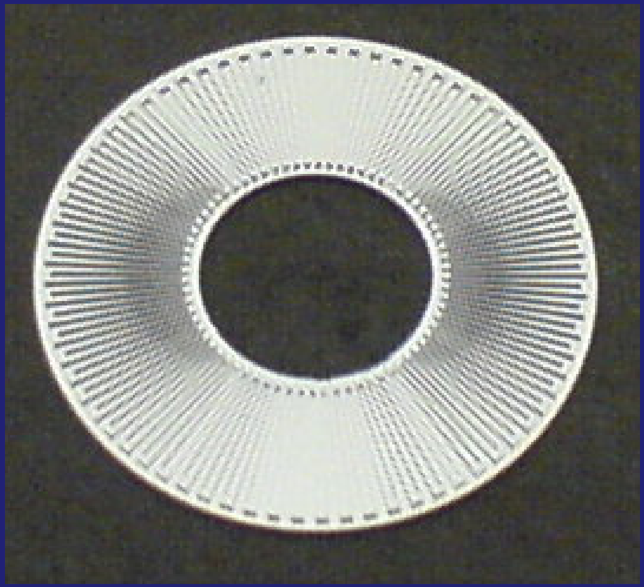
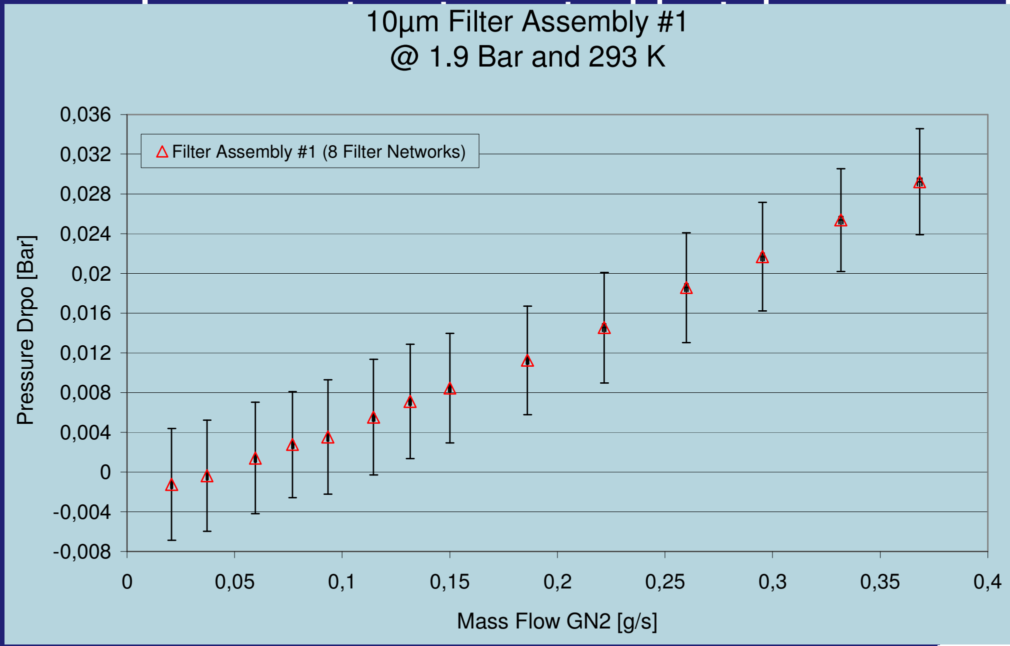
High capacity MEMS Filters



Etched disk technology:

- High flow rate/low pressure drop
- Scalable design
- High capacity of particles
- Can be made compatible to most fluids



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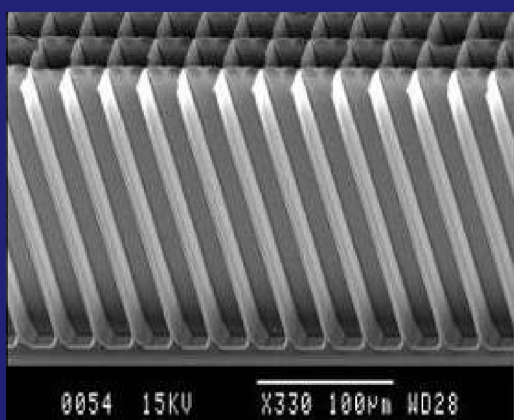
A novel Scintillator to improve quality of X-ray images

-Space know-how enables manufacturing of novel MEMS chip



Current state of the art digital X-ray

+ No chemicals involved
+ Fast image processing and distribution
+ Lower x-ray dose

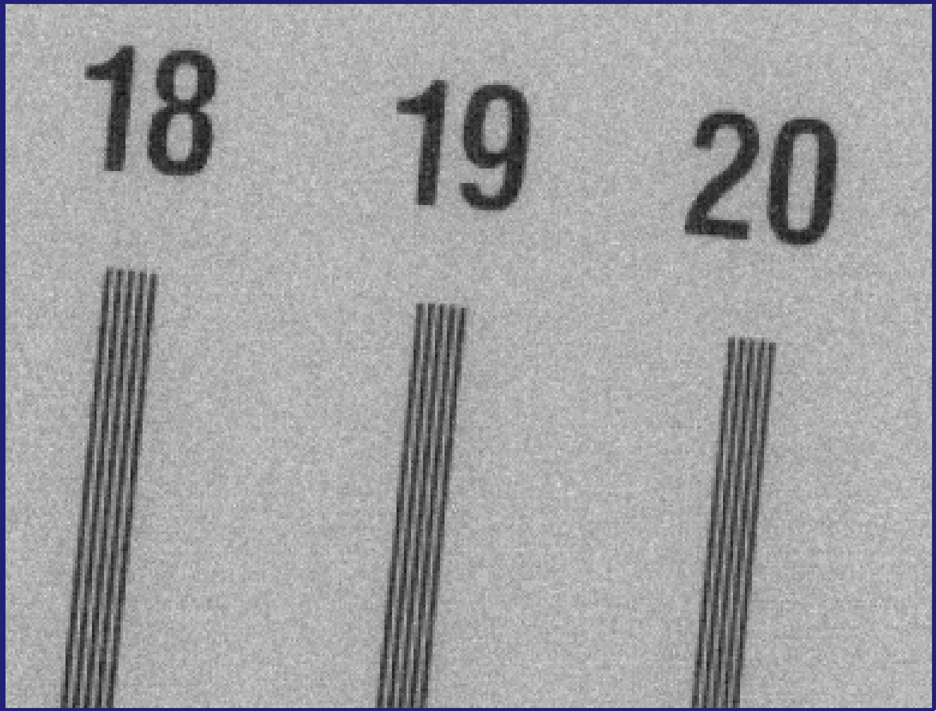
- Lower resolution and contrast

Solution:
The new MEMS based scintillator technology

Product development done by Scint-X (www.scint-x.com)

Results - Comparison with ”state of the art” technology

State of the art scintillator



Scint-X scintillator (20um pitch)

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MEMS for space and the innovation process

- Is the space Community less innovative?
- Short comings in the R&D process
  - Attention and funding levels
  - IPR strategy
- Inherent obstacles in space
  - Market volumes
  - Project cycles
  - The ”flight qualified” catch 22
  - Mind-set about risks and potential failures

> Boost innovations by more funding, frequent flight opportunities and accept a certain level of risk!