BEYOND THE CHALLENGE

Development of a 140 Am^2 Magnetorquer designed for Improved Demisability

www.lusospace.com

13-10-2022

Agenda Presentation

What we do, is who we are.

- About Lusospace
- Magnetorquers
- Demisability
- MRQ140
- Conclusions

About LusoSpace

Skills

Main activity areas

Lusospace engineering teams support companies and organizations in the activities of research and development of advanced technology.
With specialists in Photonics, Electronics, Mechanics and Software development, our multidisciplinary team covers a wide range of knowledge areas.

AOCS

Magnetometers, Magnetorquers

Photonics

OGSE, Laser Communications, Lidars, Telescopes, …

Electronics

EGSE, Precision amplification, Front Ends, Ancillary Electronics

Mechanical

Large Systems, Composites

Software

Embedded (FPGA), Augmented Reality

Lusospace numbers

In 16+ years of space engineering

Years

20+

Years in activity

Lusospace has more than 20 years of experience in Space Engineering projects

Months

250+

HW Fly Time

Our hardware accumulates more than 250 months of Space fly time.

Missions

20+

Space Missions

The effective participation in more than 30 missions gave us relevant experience and know-how.

Space HW

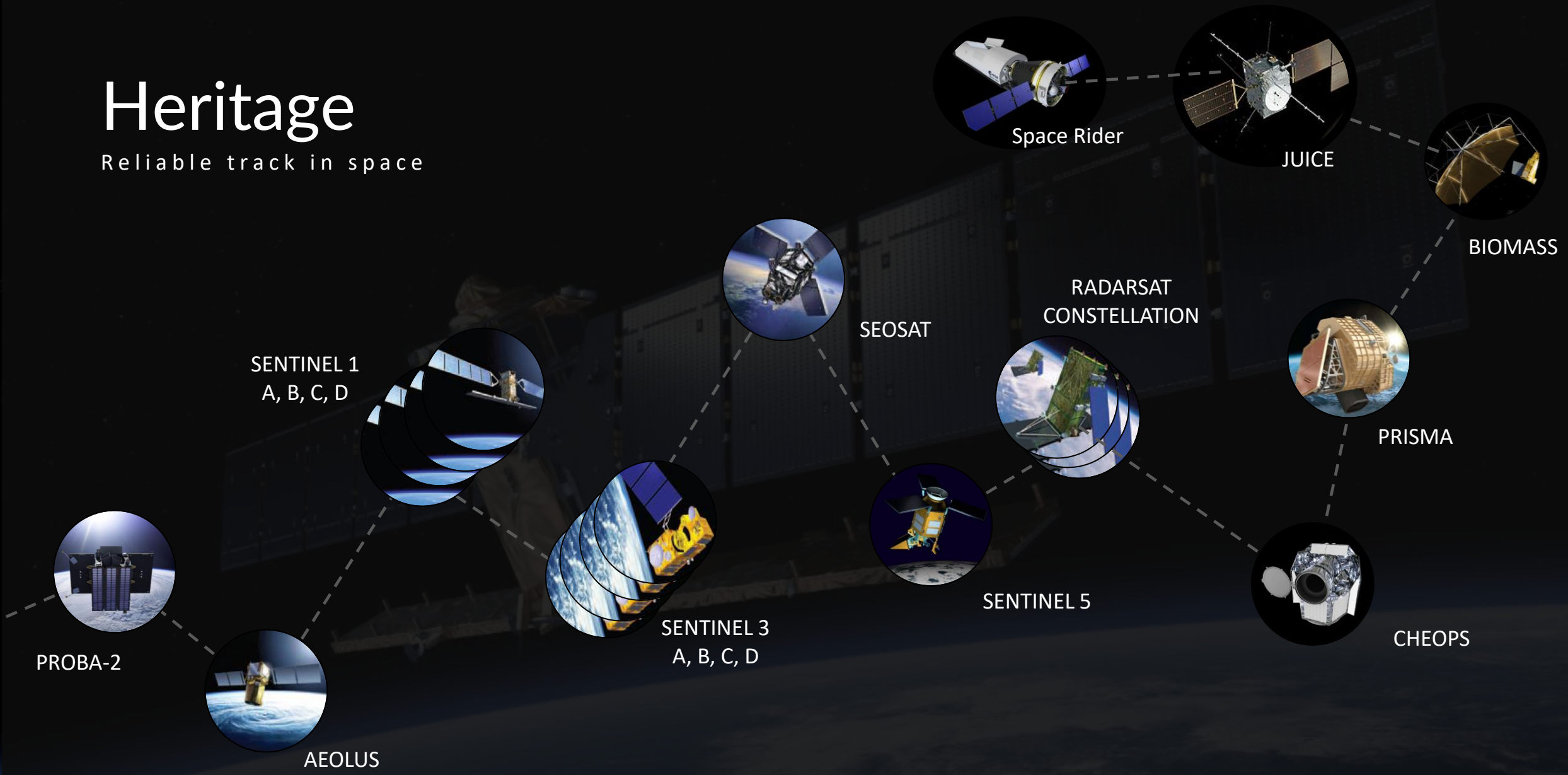
35+

Space HW Delivered

From the 35+ space hardware unit sets delivered, 12 were already launched.

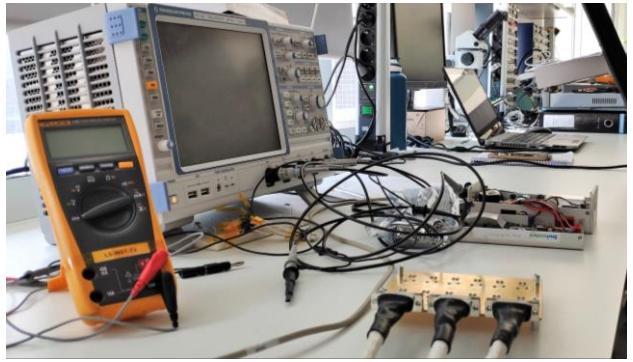
Heritage

Reliable track in space



Facilities

+500m2 office space, +300m2 lab space



300 m2 of lab space

Split between 2 locations, Lusospace offices occupy more than 500m2, including 300m2 of labs.

Labs

- 15m2 ISO 5 Clean Room (class 100)
- 100m2 ISO 7 Clean Room (class 10,000)
- 15m2 Electronics Lab
- 20m2 Optics Lab
- 20m2 Testing Room
- 130m2 Potential expansion

Main equipment

- Thermal-vacuum chamber
- Thermal cycling chamber,
- Helmholtz Calibration system
- Laser Interferometer
- Fiber Splicing Machine
- Others

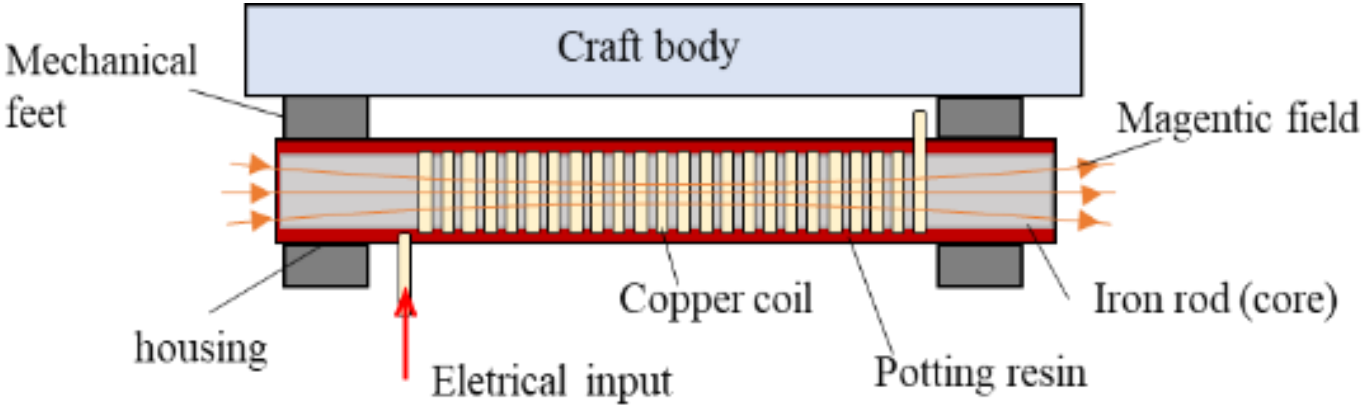
Partners

Building strong and long relationships

Best service our company

Since 2002, Lusospace has established long and prosperous relationships with our partners.

Magnetorquers (MTQ)



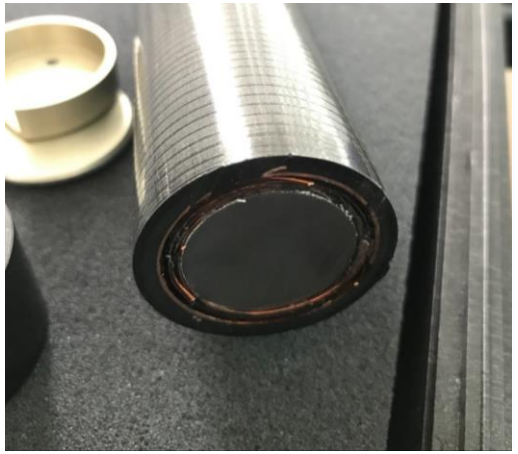
MTQs are S/C elements that use a ferrous core to amplify the magnetic field of a coil of wire.

MTQs generate a torque on the S/C by interacting with Earth's magnetic field.

MTQs are S/C elements that, during uncontrolled re-entries, have <u>high probability of surviving re-entry</u> and hitting the ground.

Demisability

Magnetorquer Demisability



Non demisable Magnetorquer (LusoSpace)
Source: ESA Cleanspace webpage

Non demisable Magnetorquer in wind-tunnel
Source: Belstead UK with Lusospace MTQ

Due to the size, layered structure, high melting temperatures, and often late separation from the S/C, the core of the MTQ will often survive re-entry.

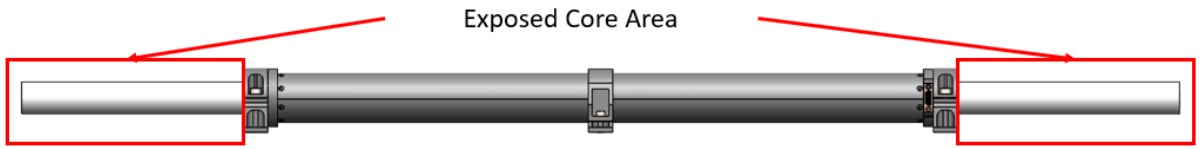
A baseline MTQ without design for demisability was tested in the plasma wind tunnel at DLR with the help of Belstead UK.

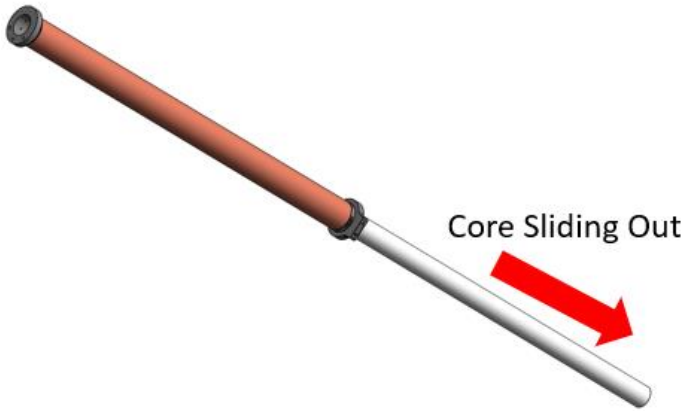
A design study was performed to analyse possible design changes to increase the demisability of the MTQ.

Demisable Magnetorquer

BB design: Design for demisability highlights

1. Core exposed, for earlier thermal exposure
2. Long and thin diameter
3. No potting material to allow winding separation
4. External housing made in aluminium
5. Internal housing allowing core slide (vs. coil wound around core)
6. S/C interface screws in PEEK to promote release from S/C

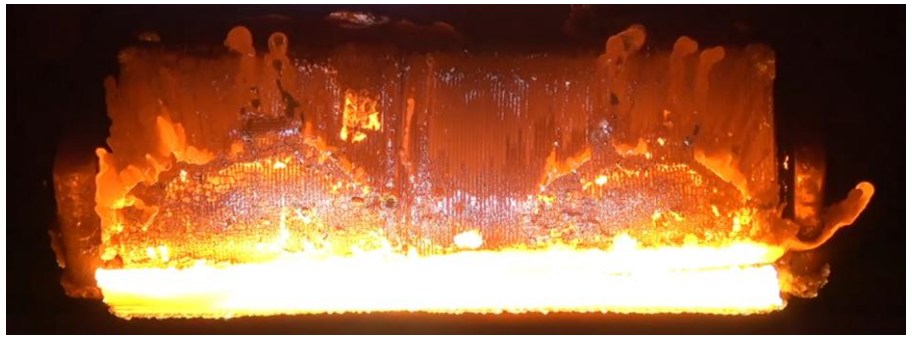




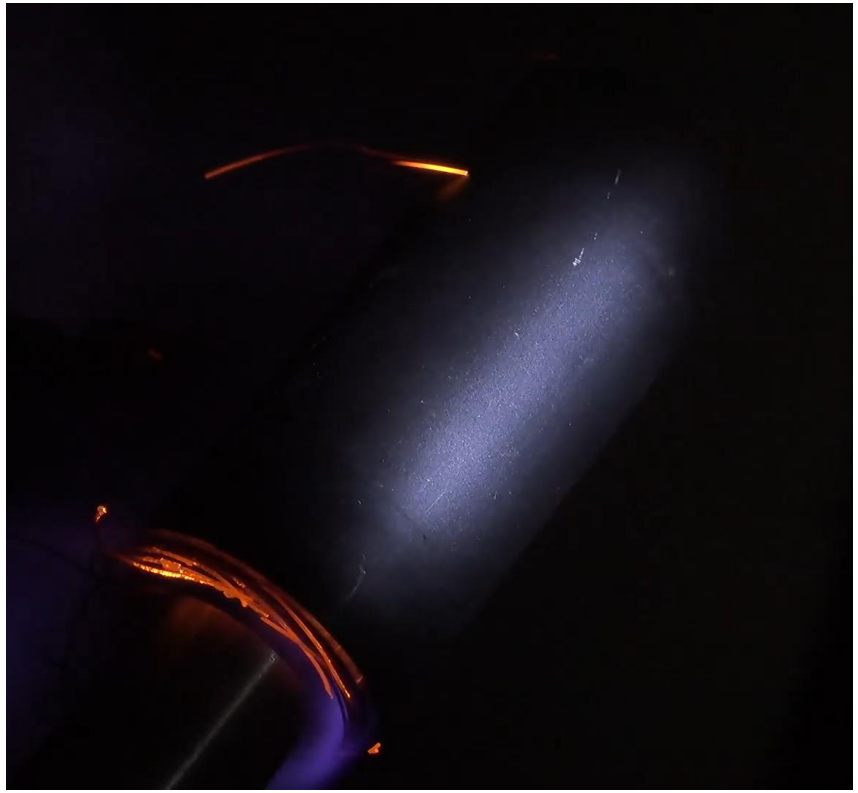
Demisable Magnetorquer

BB test: demisability test comparison to baseline

Baseline: Potted Coil after CFRP demise



Demisable:
Un-potted Coil with Aluminium housing



Demisable Magnetorquer

BB test: demisability test highlights

1. The exposure of the core showed that heating of the core would begin earlier and conduct to the inner core allowing earlier heating

2. Long and thin diameter generally gives more surface area and demises faster in simulations

3. The absence of potting material allowed winding separation

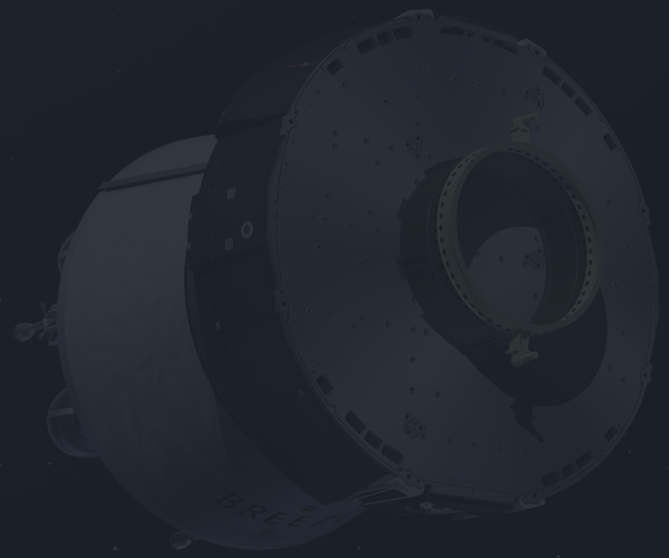
4. External housing made in aluminium demises faster than CFRP

5. Internal housing did not permit 'slide out' for this implementation, and this feature was dropped to reduce development time.

6. S/C interface was not tested, due to test setup limitations (plasma chamber size)

Demisability simulation comparison of DMTQ to Standard with Aluminium and CFRP housing.

Release Altitude (km)	Demise Probability (out of 1)		
	DMTQ	**Standard Aluminium**	**Standard CFRP**
78	**0.98**	0.59	0.56
75	**0.80**	0.35	0.29
70	0.26	0	0
65	0	0	0



MTQ-140

MTQ140

LS used the D4D guidelines it helped develop to design a MTQ140 Am^2

A contract is in place to supply the Space Rider mission (3 units, MTQ140 Am^2)

ESA is involved to support the material and process qualifications to mitigate risks

Material coating qualification tests passed.

TVAC cycles completed for winding process qualification.

MTQ140

Performance and specifications

Property Under Test	Criterion	Result
Length	620 ± 2 mm	622mm
Mass	< 3.8 Kg	3.14 kg
Impedance	54±5 Ω @22C	54.3 Ohm @20C
Inductance	6 H < I < 20 H	8.7 H
Time Constant	< 200 ms	163 ms
Power Consumption (140)	< 5 W	4.25 W @20C
V @ 140 Am^2 @ 20 ºC	< 28 V	15.2 V
Linearity Error (140 Am^2)	≤ 0.5%	0.25±0.04%
Residual MDM (140 Am^2)	≤ 0.3%	0.21±0.05%
Alignment of field to MIRF	< 1°	0.67°±0.3°

Conclusions

Conclusions

1. LS developed, with ESA and Belstead, design features for magnetorquers that increase their demisability, and can scale with MTQ size.

2. The improved demisability was confirmed in tests and simulation.

3. Using the D4D design features, LS designed and manufactured a 140Am^2 MTQ Qualification Model (QM).

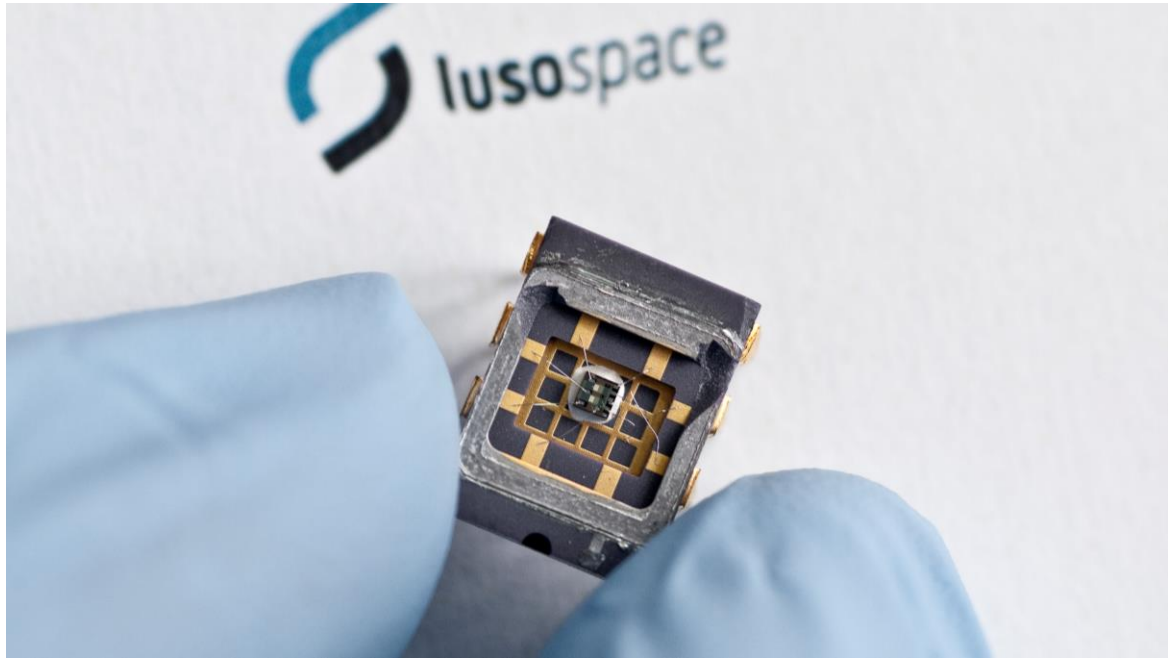
4. Qualification of materials and processes are ongoing but promising.

5. Performance of the QM meets general requirements of Industry for small MTQ.

6. Environmental tests of QM await final qualifications of materials and processes.

Get In Touch

We will be pleased to help you.



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