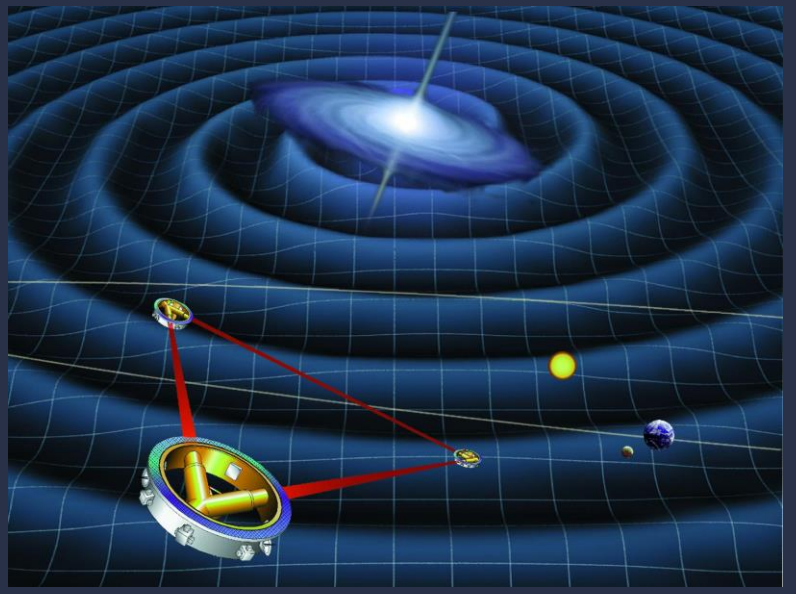
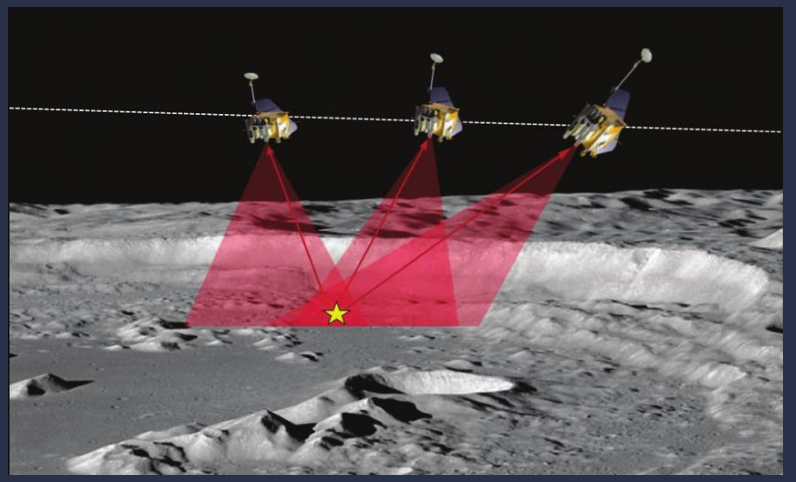
Space Metrology: Laser for the LISA Mission and 3D imaging LiDAR





Photonics 4 Space

Lauriane Karlen, Senior R&D Engineer, CSEM
lauriane.karlen@csem.ch

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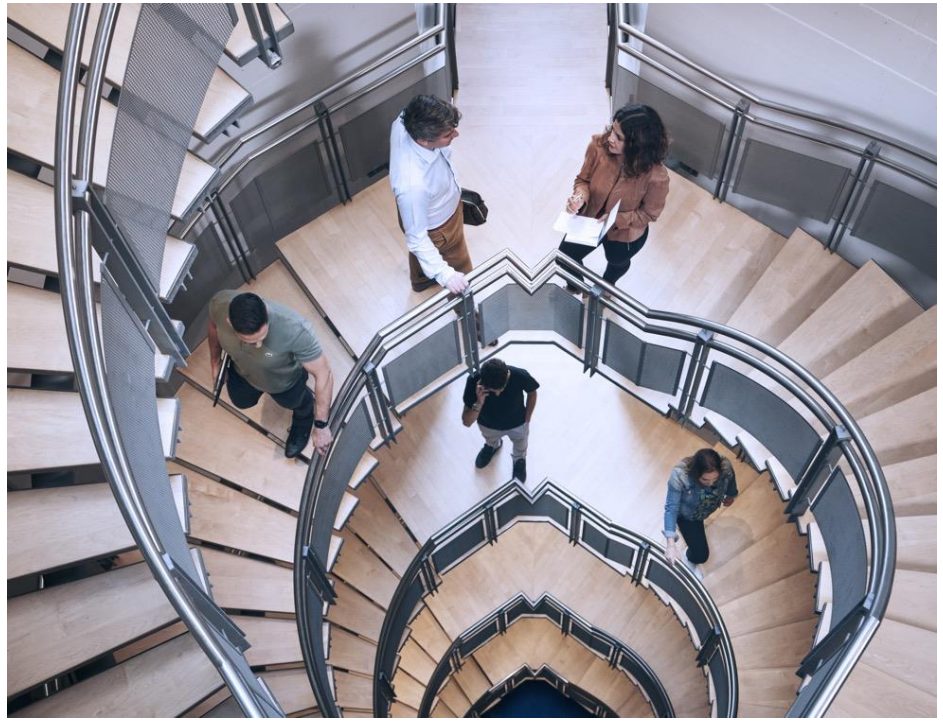
SWISS PHOTONICS

COMBINING EXPERTISE, PASSION, AND DIVERSITY FOR SUCCESS



We are a public-private, non-profit, Swiss technology innovation center.

566
EMPLOYEES

46
NATIONALITIES

35%
PHD

28%
WOMEN

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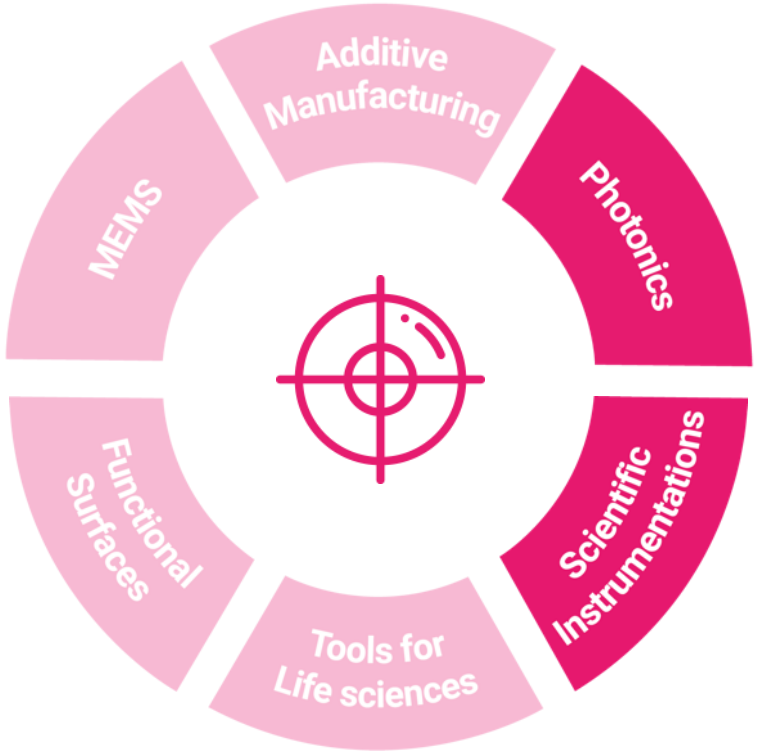
WE FOCUS ON THREE RESEARCH PRIORITIES

Digital Technologies

Precision Manufacturing



Sustainable Energy

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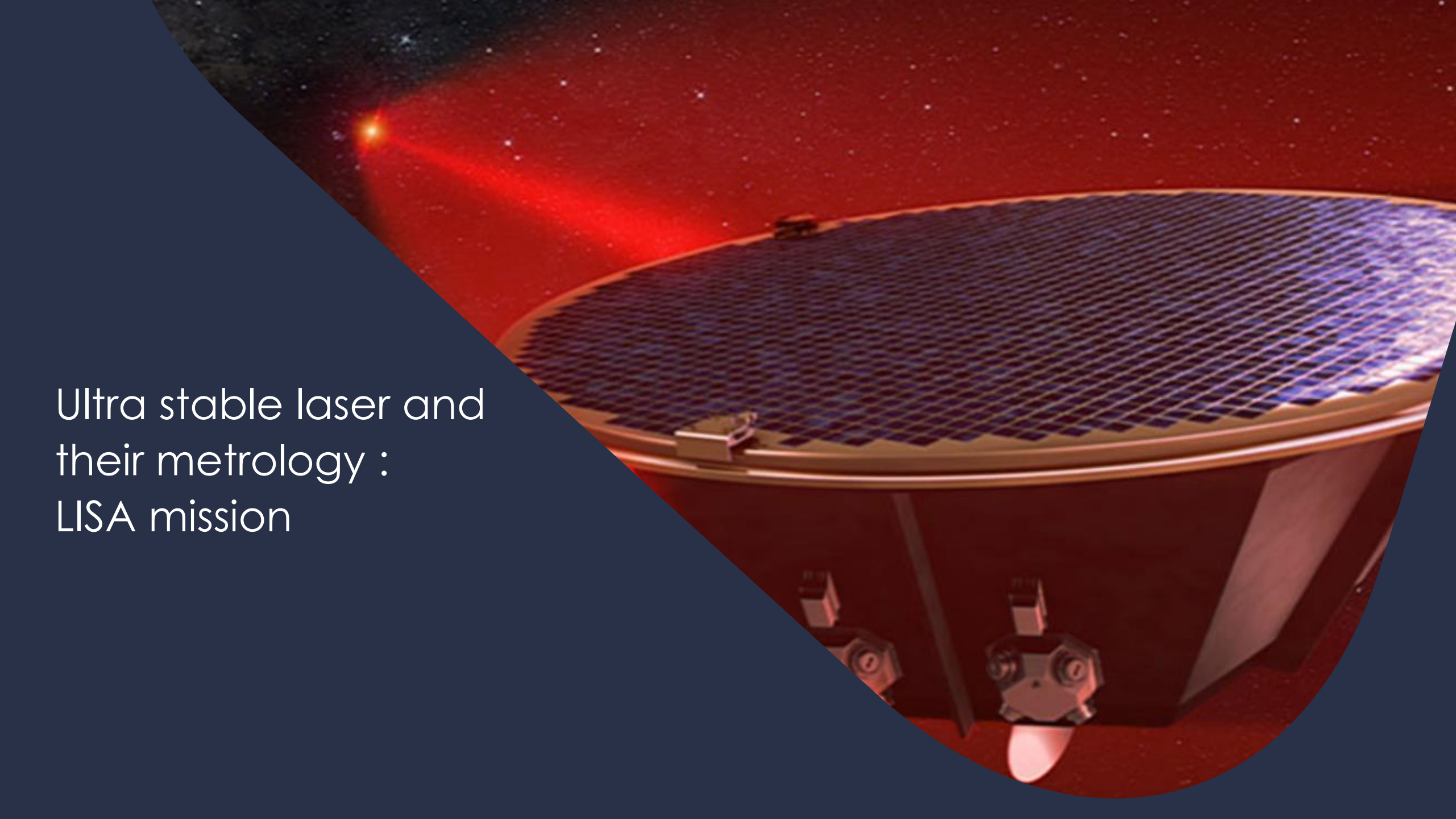
Ultra stable laser and their metrology : LISA mission



LISA mission: Laser Interferometer Space Antenna
Gravitational waves detected in space

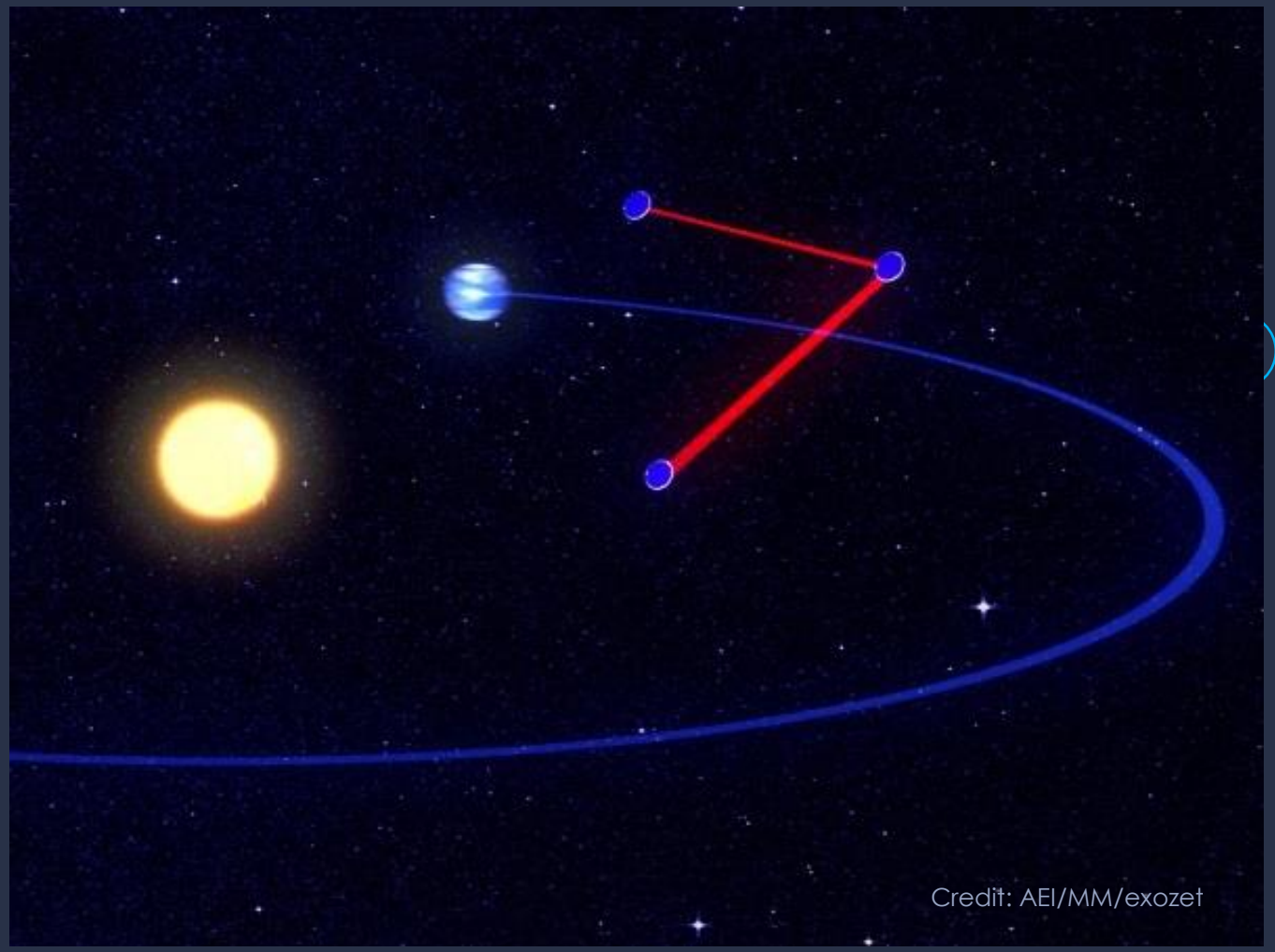
Space-based detection : LISA mission

- Detection band [0.1 mHz; 1Hz]
- Launch, planned in 2034

➢ **Space compatible laser system**

➢ **High performance requirement of laser**

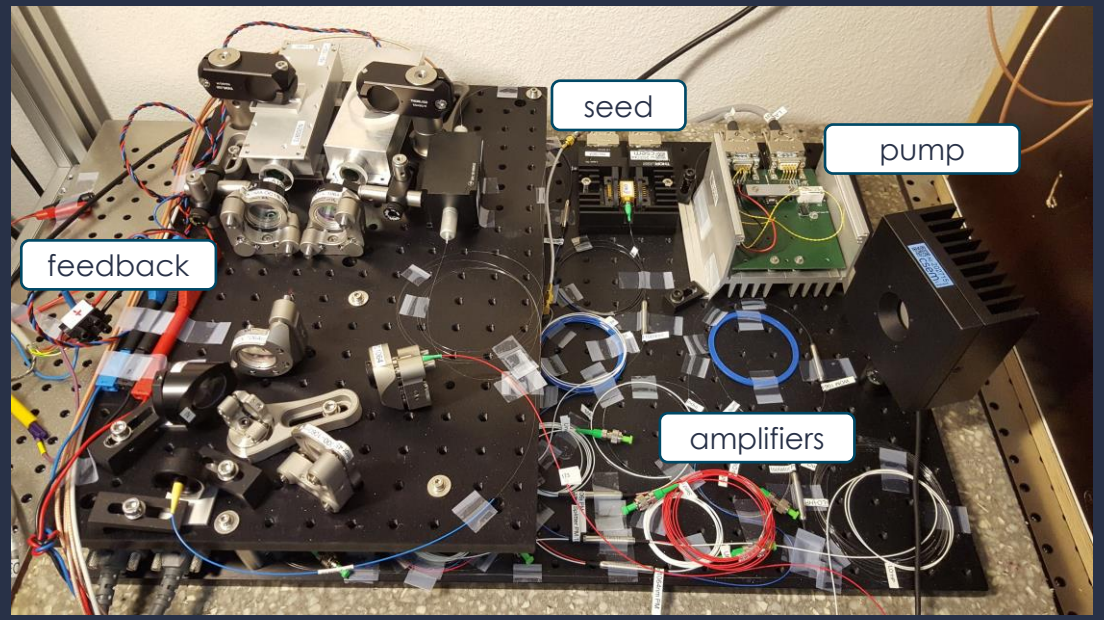
- 2W at 1064nm
- Ultra-low frequency & Amplitude noise

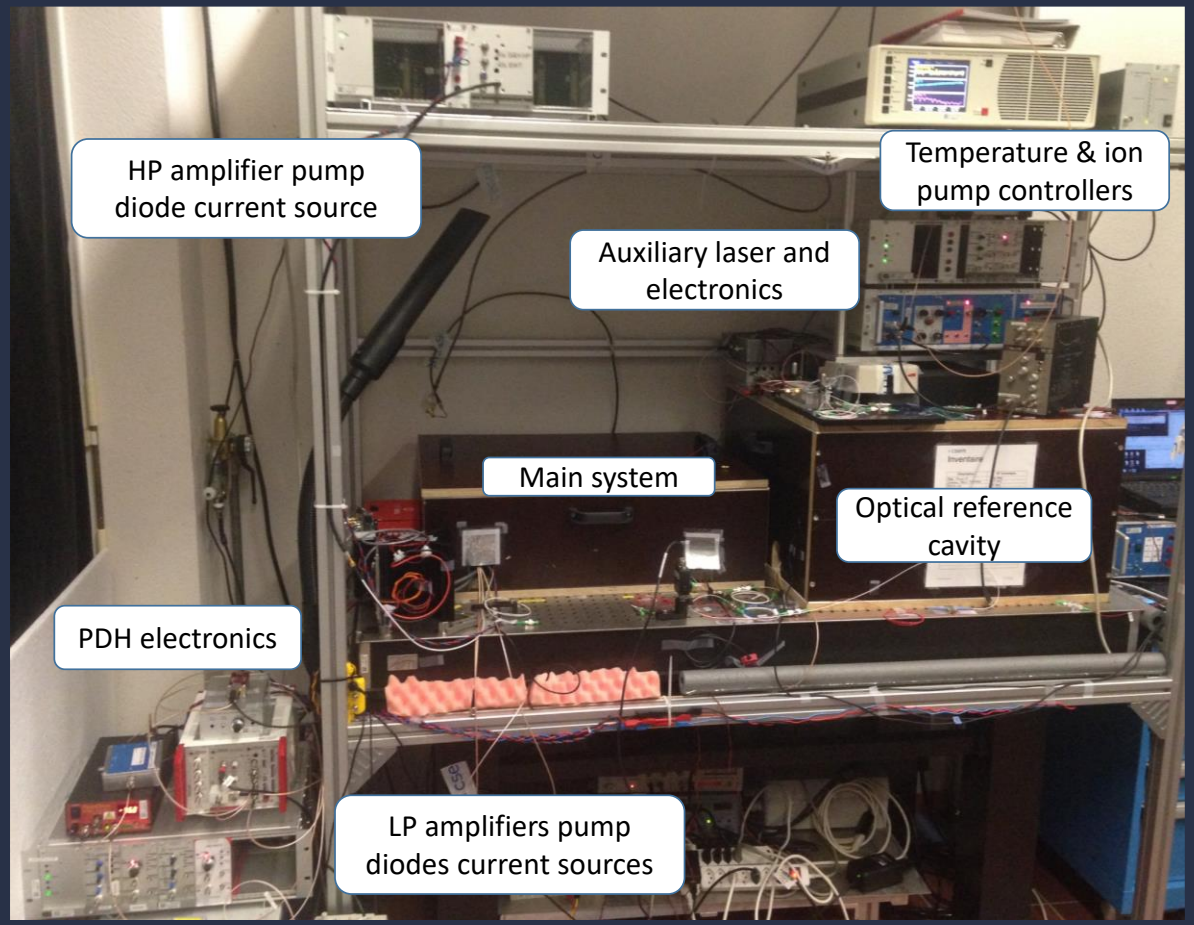


Ultra stable laser and their metrology

Full laser system (space compatible development)

- BB development (2017-2018)
- MOPA architecture
- Ultra low-frequency noise laser stabilized on cavity





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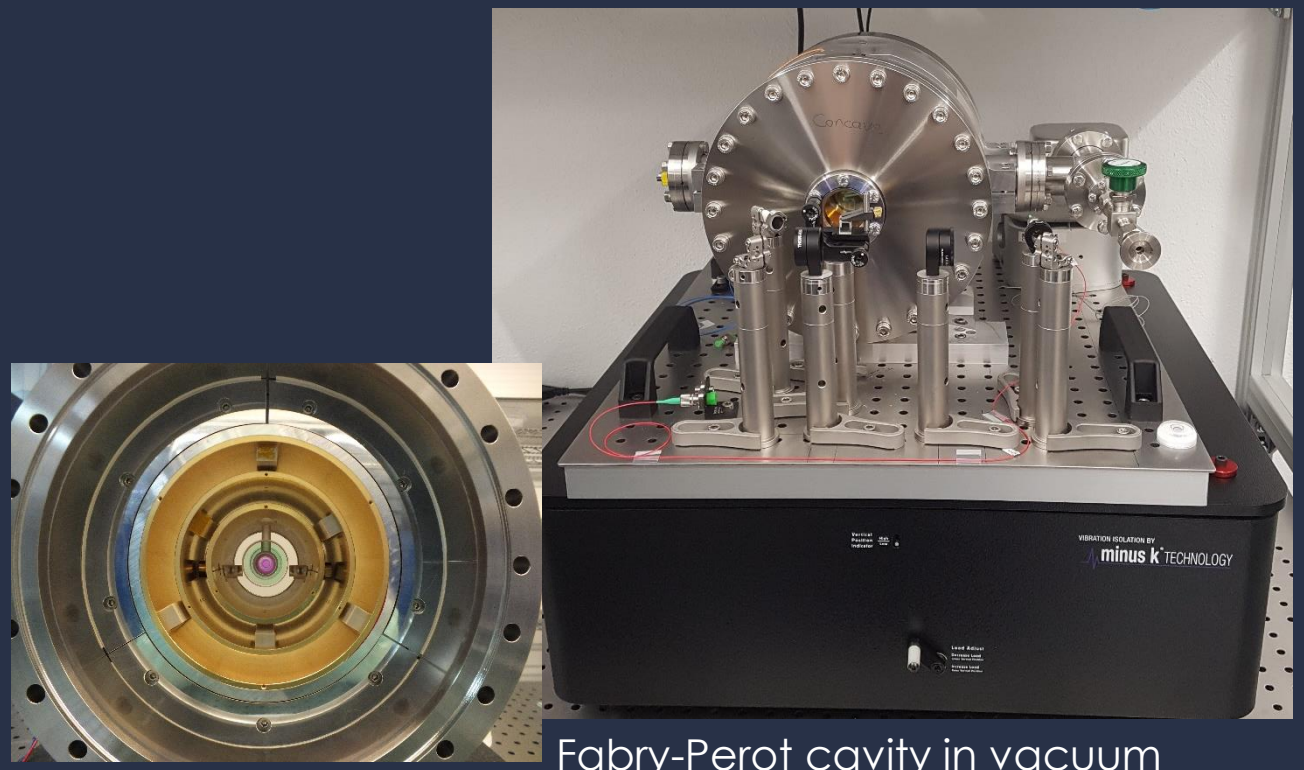
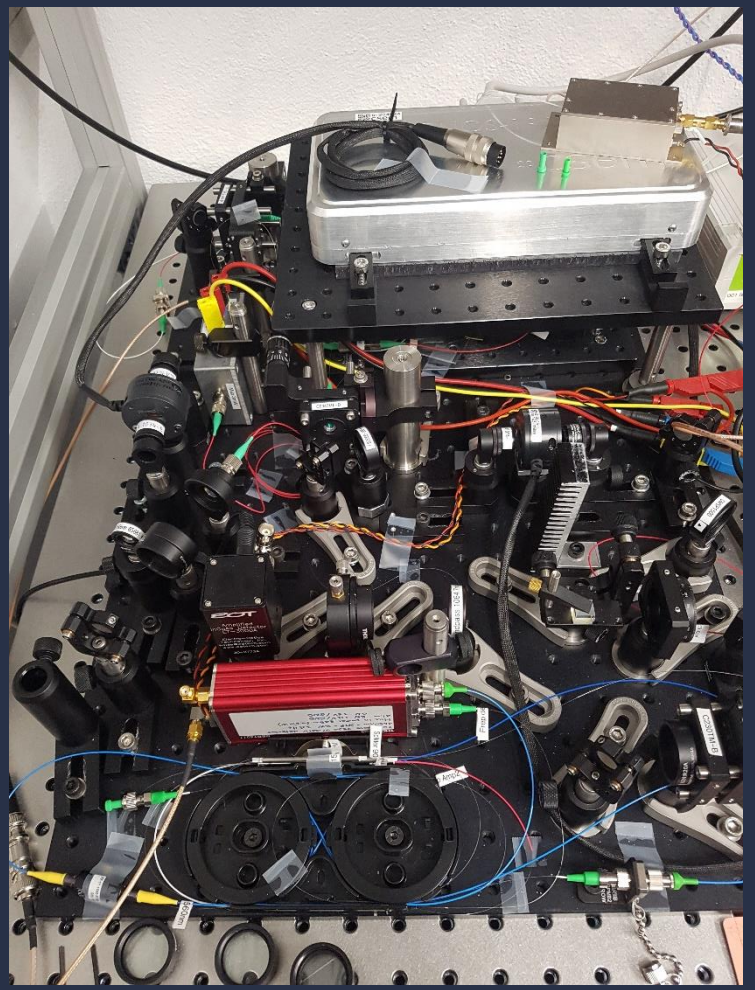
Ultra stable laser and their metrology

Laser system metrology development

- Dedicated laboratory with high stability (mechanic + thermic)
- Frequency noise measurement from 20 µHz to 10Mhz



Fabry-Perot cavity in vacuum

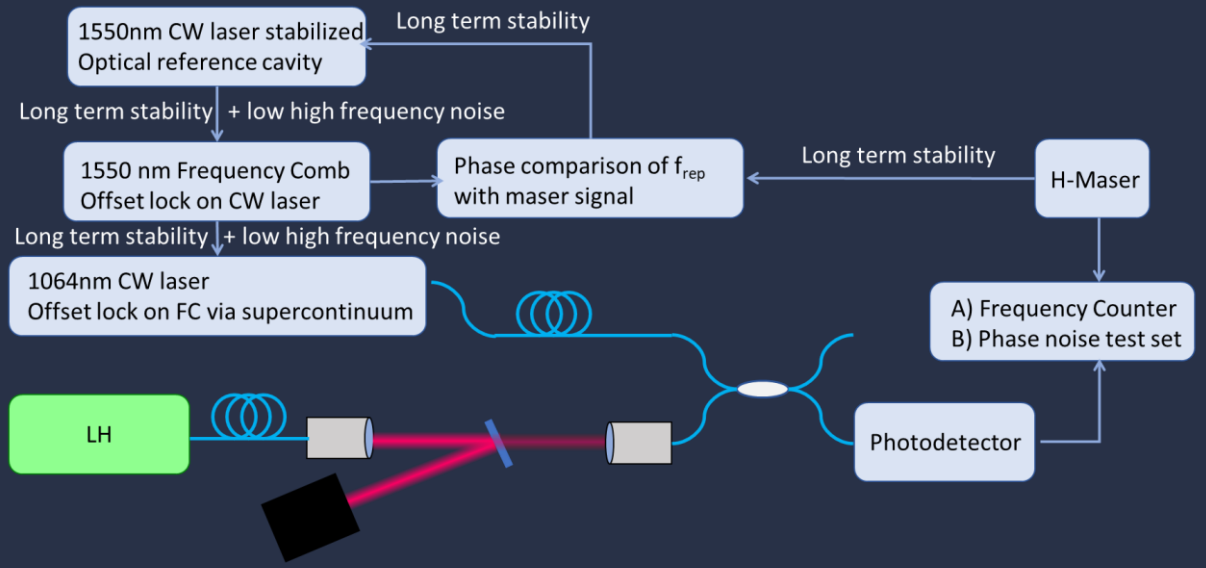


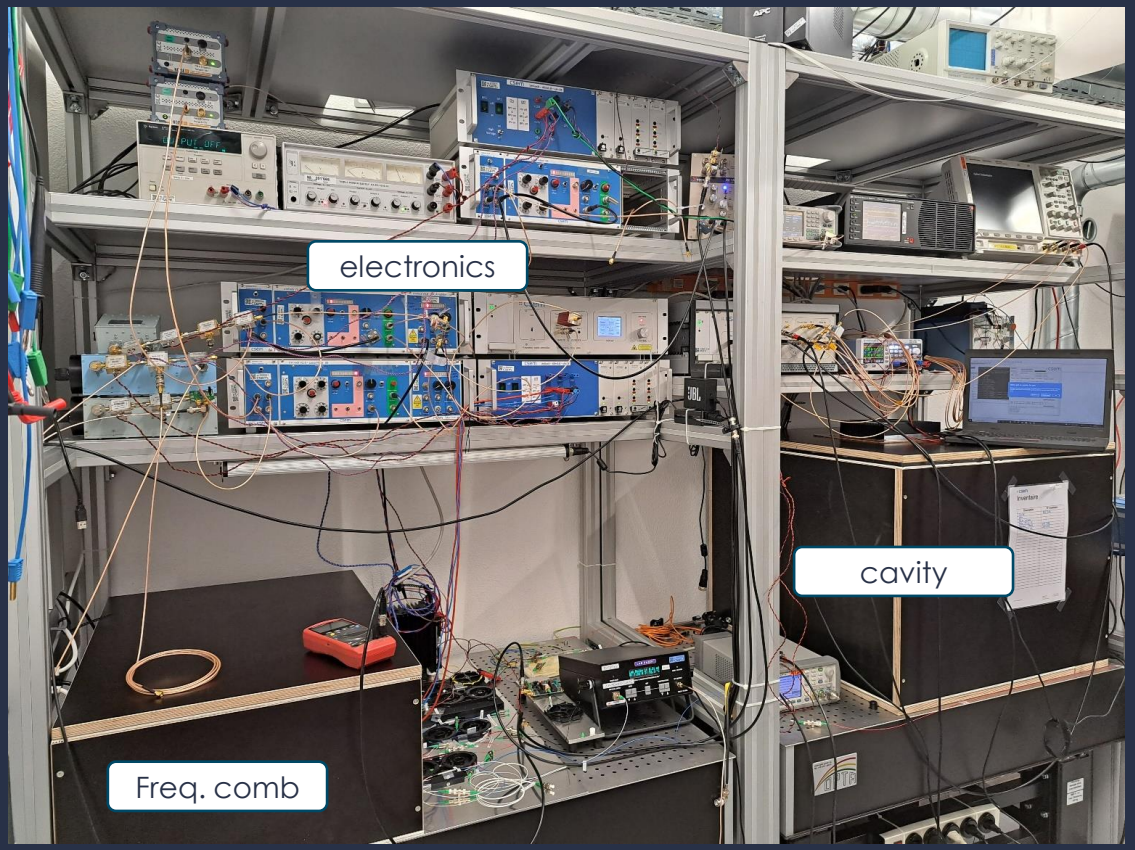
Frequency comb

Ultra stable laser and their metrology

Laser system metrology development

- Dedicated laboratory with high stability (mechanic + thermic)
- Frequency noise measurement from 20 µHz to 10Mhz
- Power amplitude noise measurement from 30 µHz to 5Ghz





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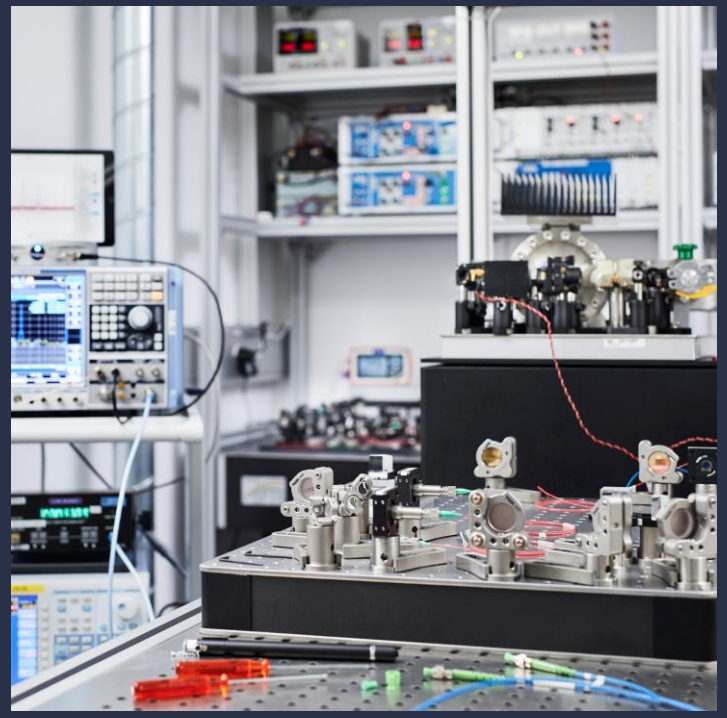
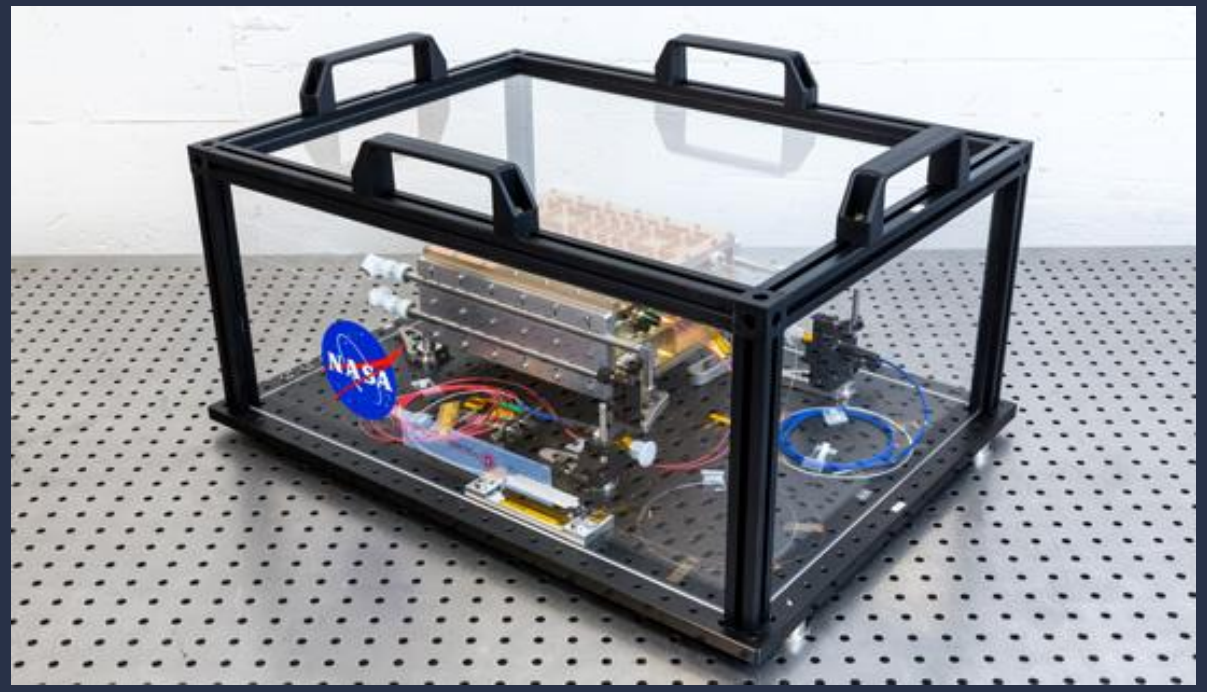
Ultra stable laser and their metrology

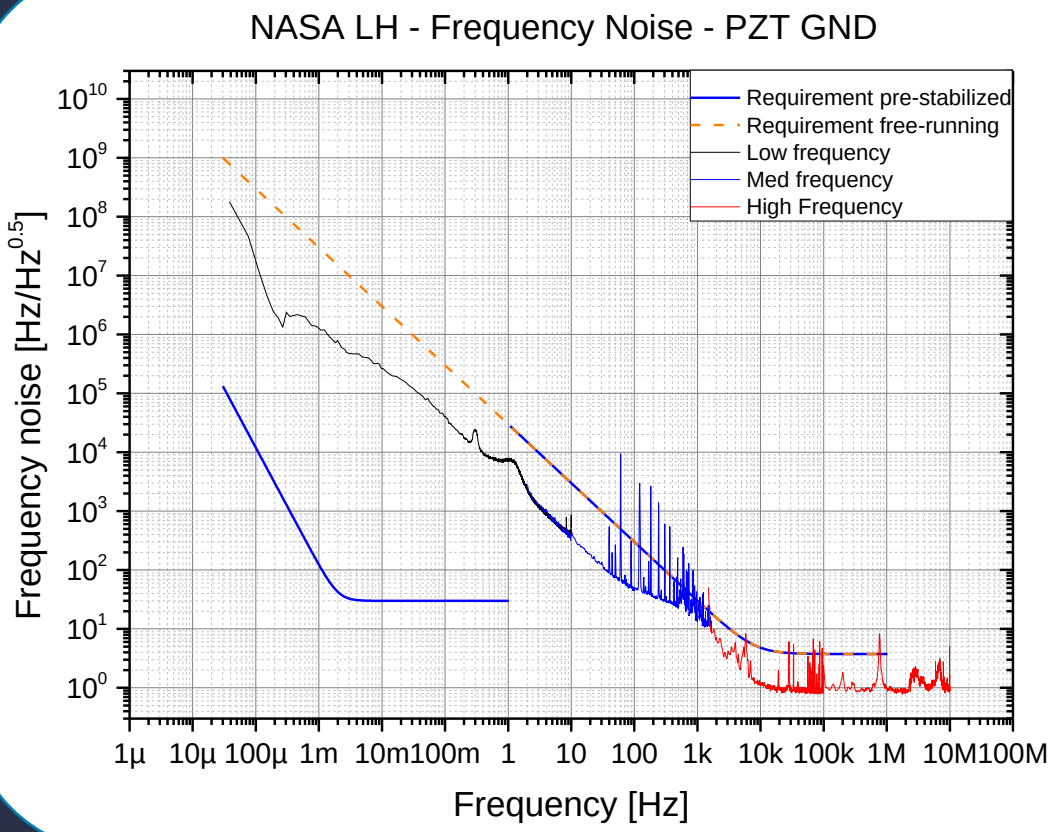
Laser system metrology development

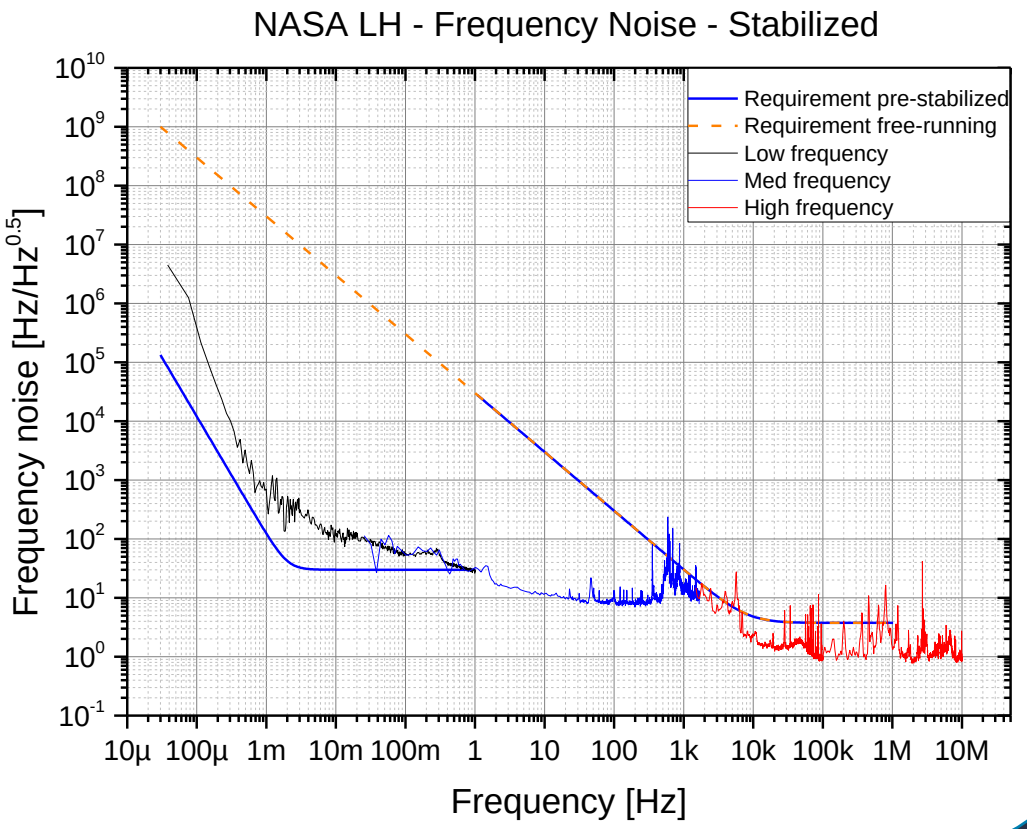
- NASA LH measurement





Frequency noise





Measurement not limited by the reference setup

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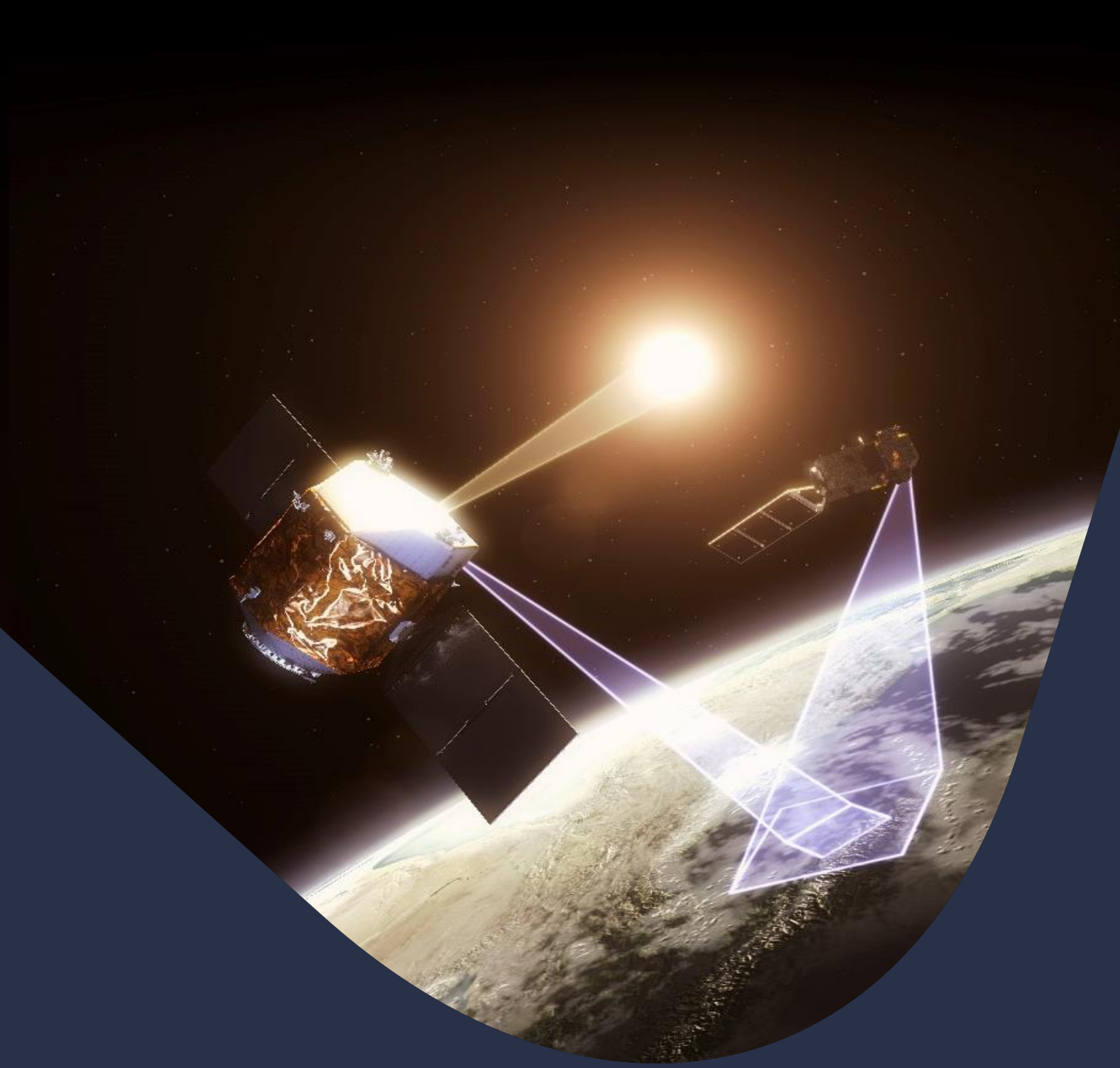
Photodiode metrology: TRUTHS mission



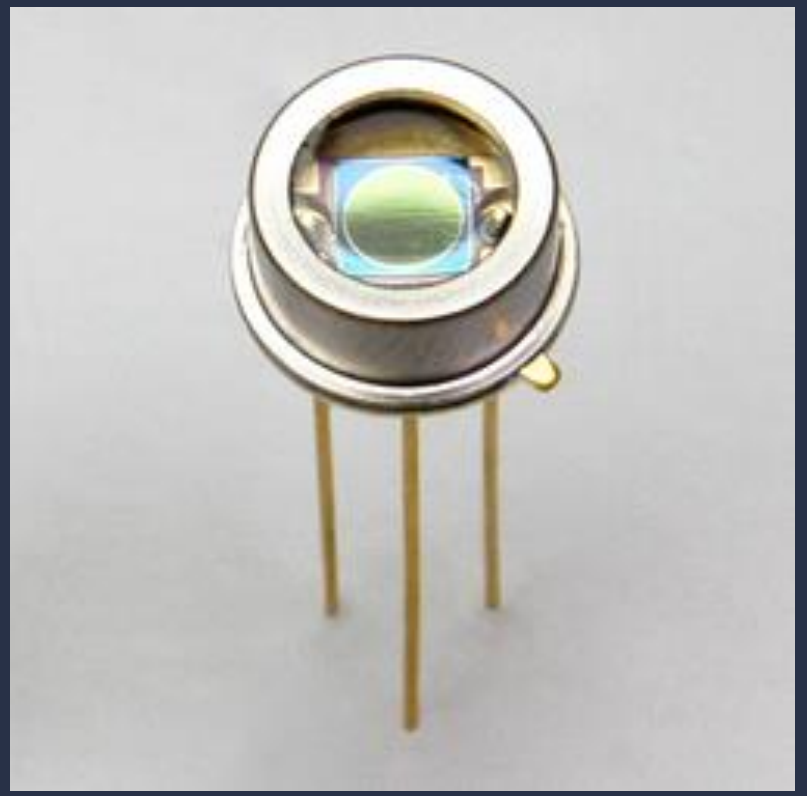
TRUTHS mission
Photodiode metrology

Truths mission :

- Absolute radiometer
- Hyperspectral imaging spectrometer
- On-board calibration system

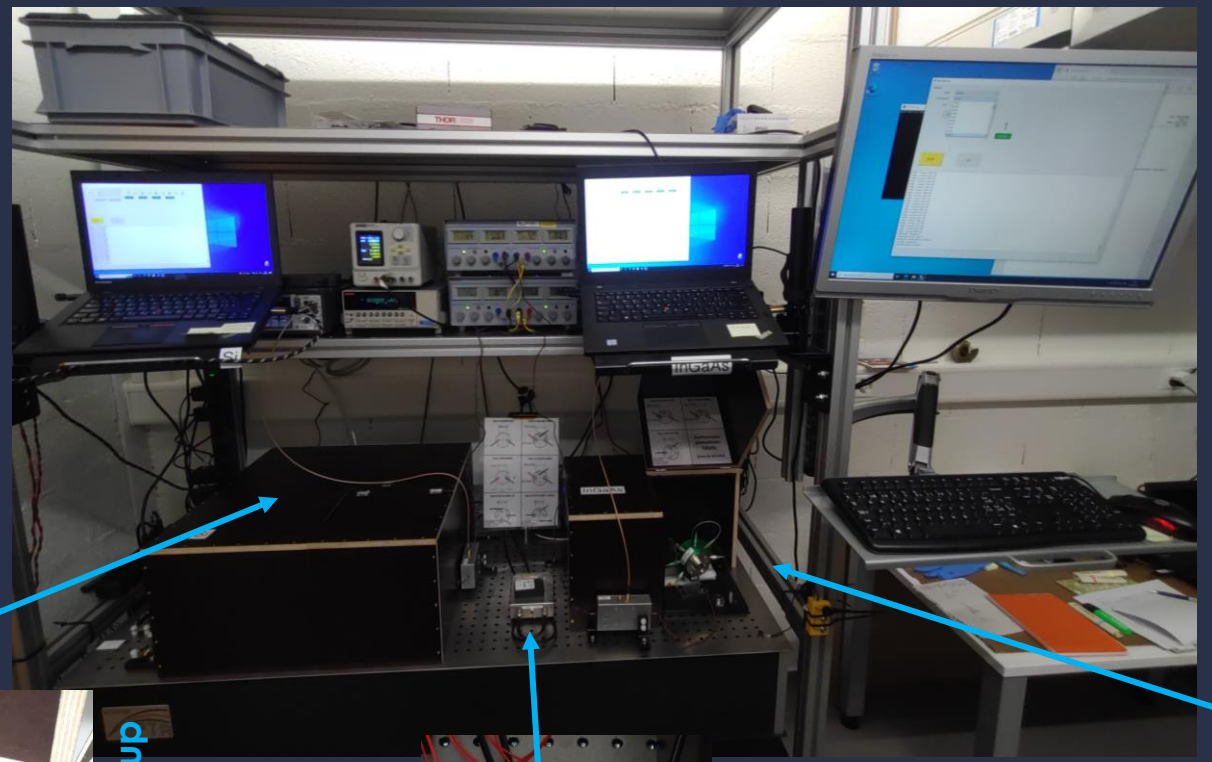
CSEM contribution

- Performance measurement of photodiode (for calibration system)
- Environmental test of the photodiode
- More than 100 PD testes before and after environmental test

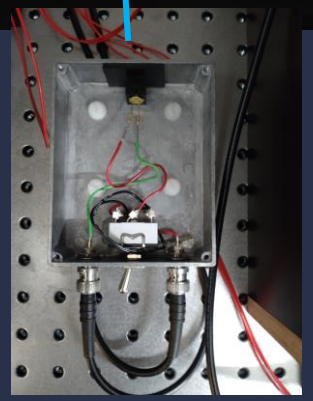


TRUTHS mission
Photodiode metrology

Development and automatization of two test bench

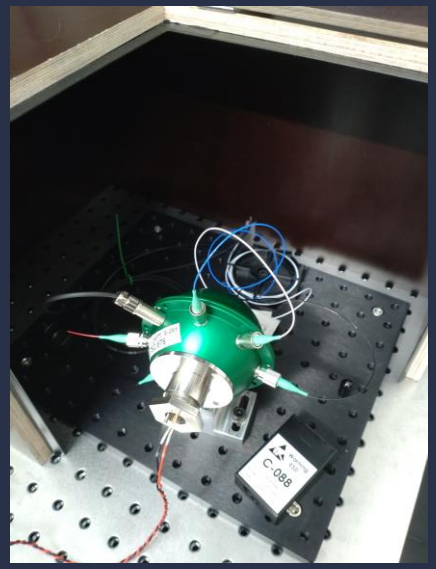


Si performance setup



Dark current setup

InGaAs performance setup



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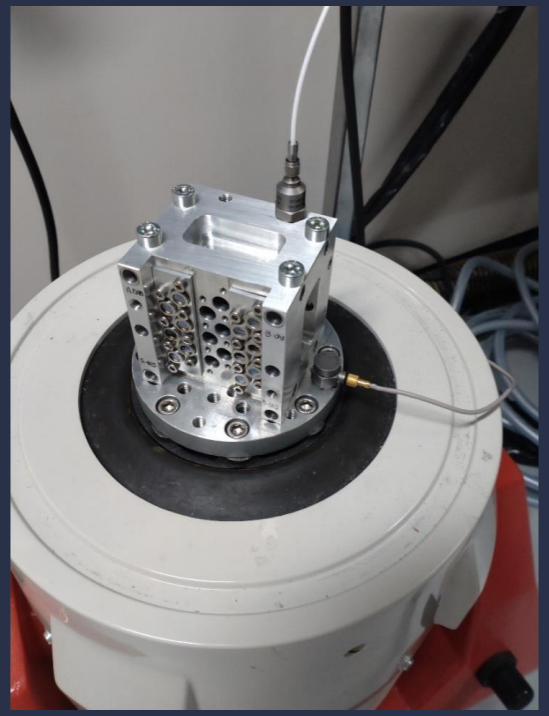
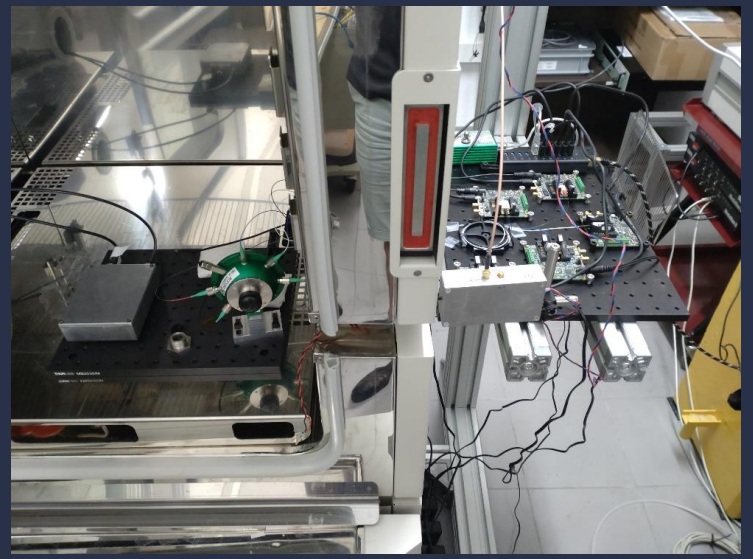
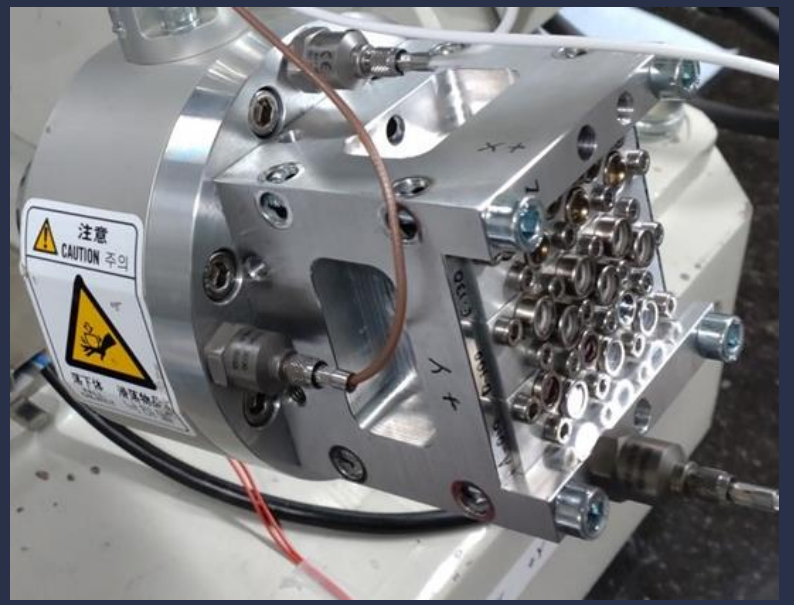
TRUTHS mission
Photodiode metrology



Vibration test (inhouse)



Thermal test and thermal cycling (inhouse)



Shock test (inhouse)

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Flash imaging LiDAR

Space

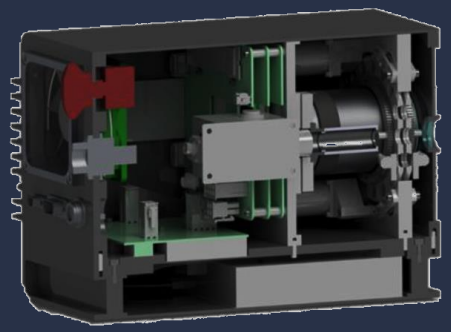
& Bathymetric

Applications

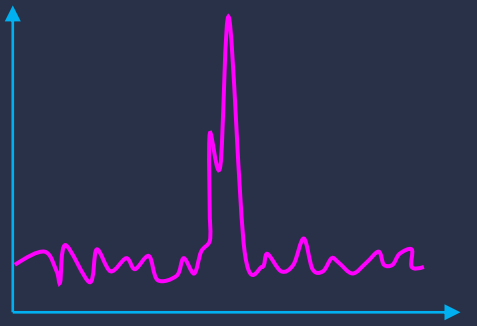
AIRSWIM

Flash imaging LiDAR

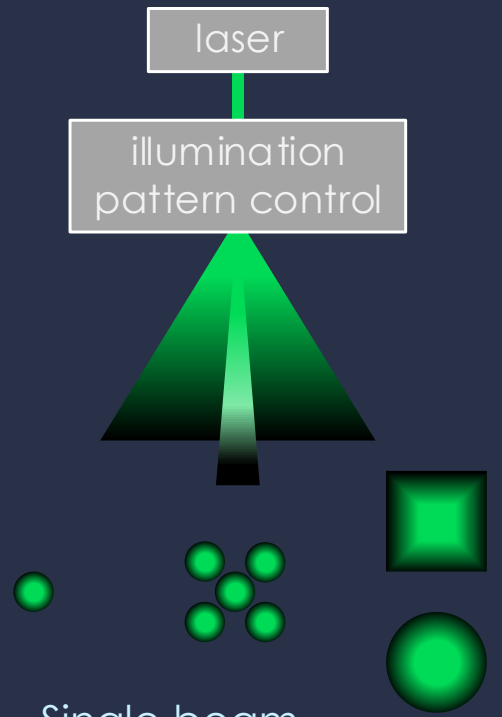
System design



Time-gating & multiple echoes

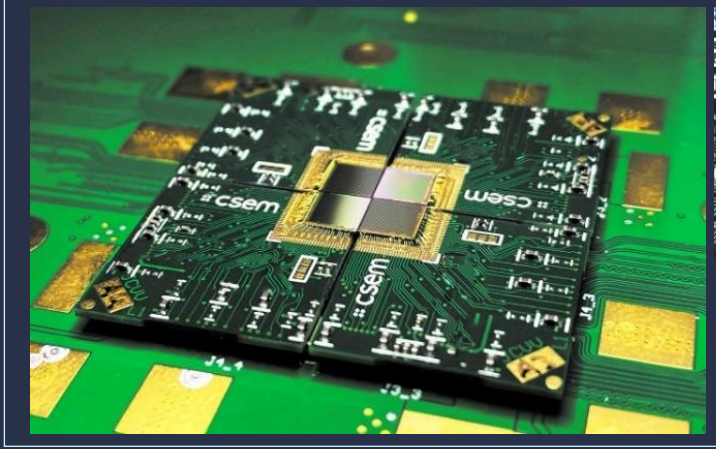


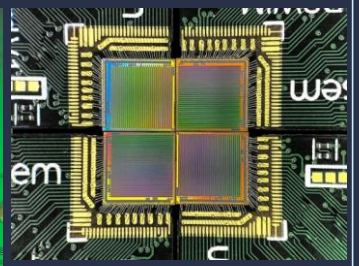
Illumination pattern control



- Single beam
- Multiple beams
- Large field-of-view

Focal plane: time-of-flight detectors





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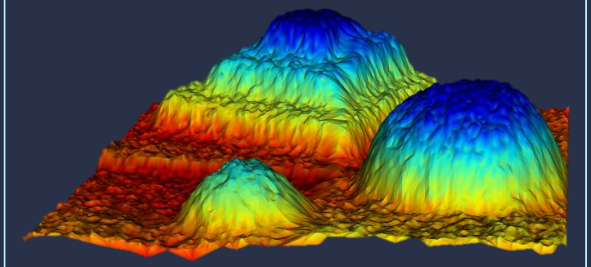
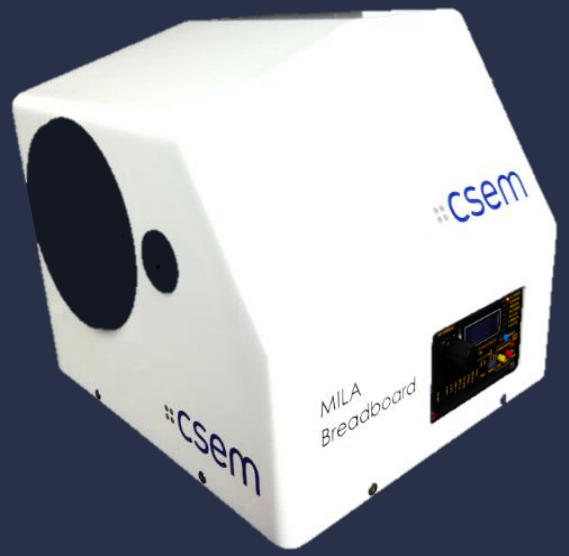
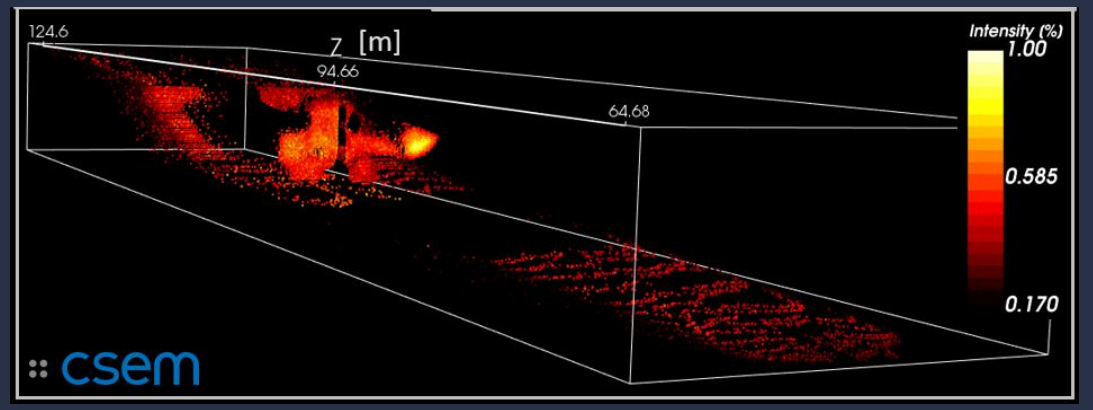
Processing



Landing application - High-end development

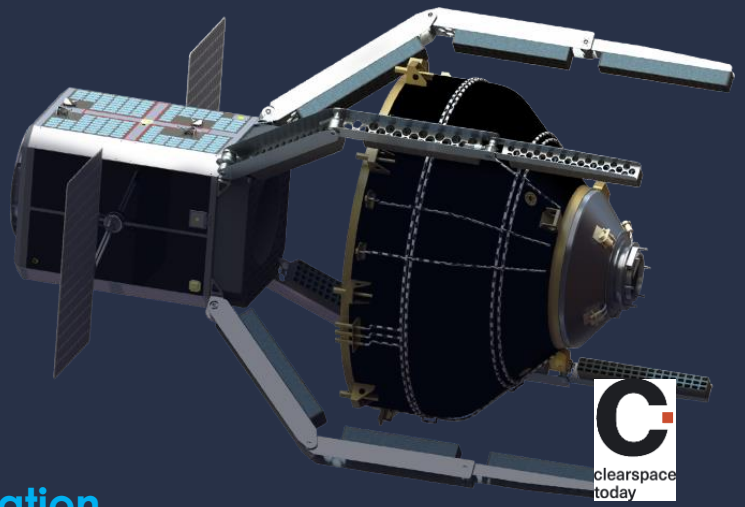
- **Mila**





Rendez-vous application – New Space

- **RemoveDEBRIS**
  - Launch with SpaceX in April 2018



- **ADRIOS**
  - Launch: 2025
  - **Further miniaturisation**
  - **Embedded processing**, i.e. system-on-chip

Confirmed potential for **future commercialisation** (in-orbit maneuvers)

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Conclusions and outlook

- Laser sources and space photonics metrology
- System-level testing: space environment & micro-vibrations
- Flash lidar

➢ *Push the performances to new paradigms*

Thank you for your attention!

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T +41 32 720 52 94

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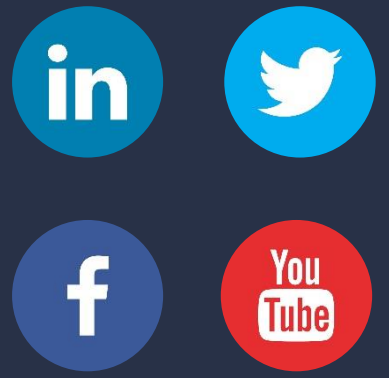

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