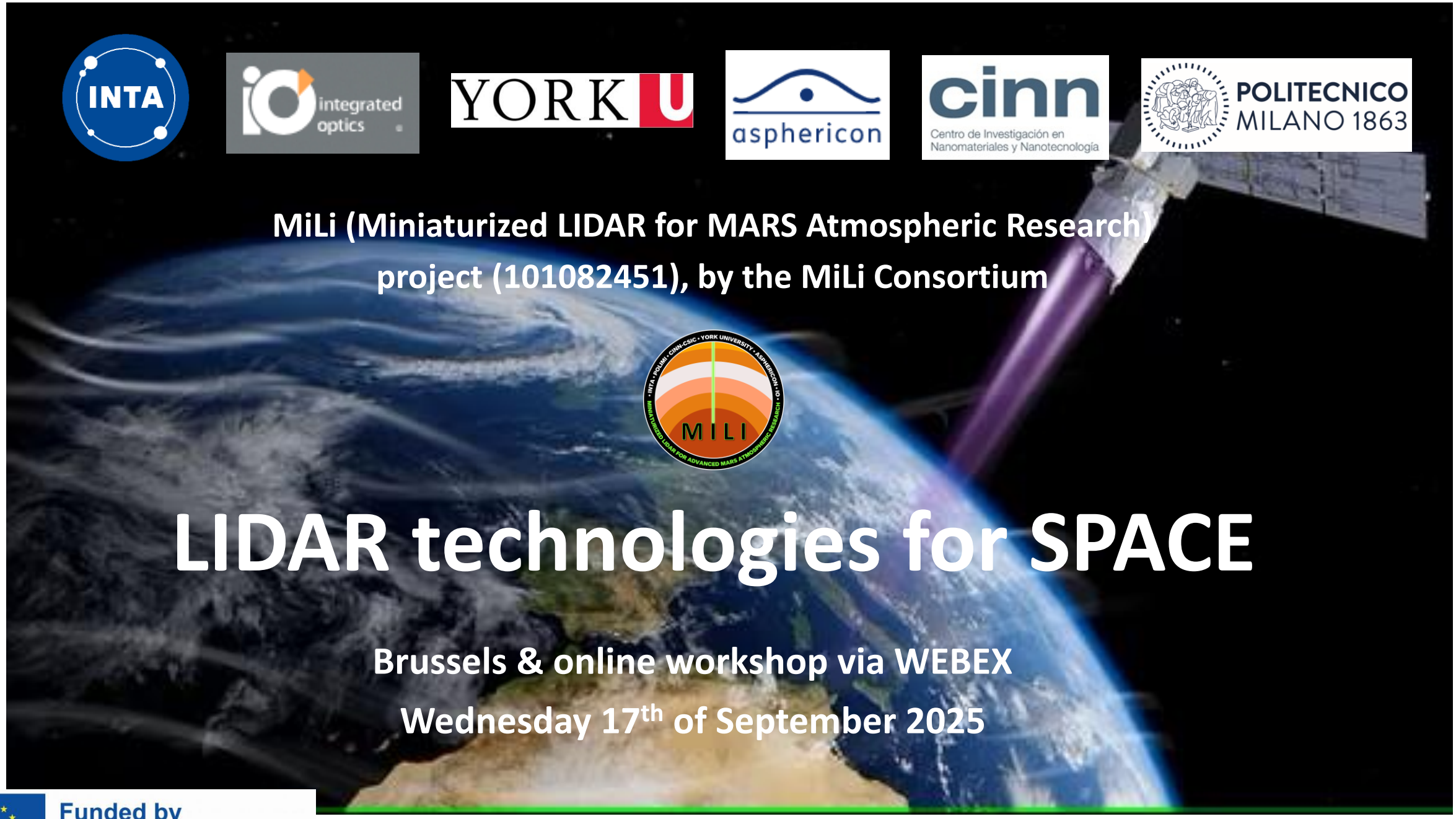

MiLi (Miniaturized LIDAR for MARS Atmospheric Research) project (101082451), by the MiLi Consortium

LIDAR technologies for SPACE

Brussels & online workshop via WEBEX

Wednesday 17th of September 2025

Funded by the European Union

Presented by Isaías Carrasco (Project Coordinator)

Funded by the European Union

Index

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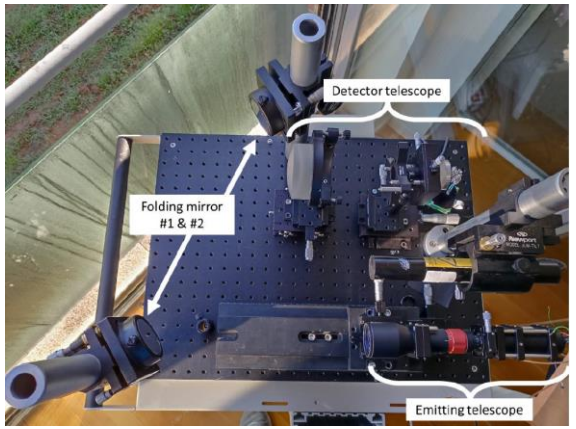
Summary of the project - Goals

1 **Light and low-power prototype of an atmospheric lidar for future planetary exploration**

KG 6 Kg < 15 W ~ -100 C ~ 20 Km

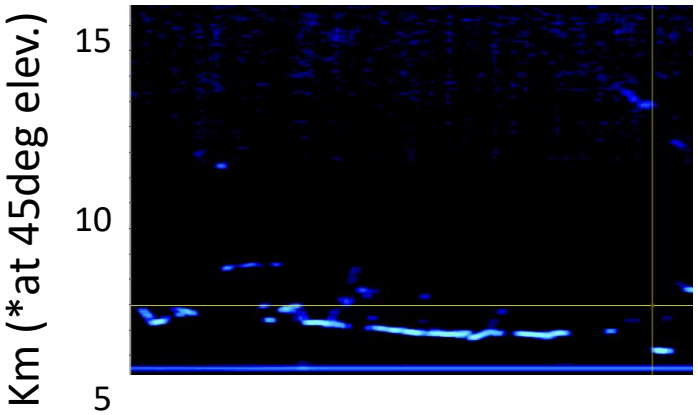


Low signal

- High energy light emission — A
- Telescope Big apertures
- Internal gain detector — B

High Background

- Narrow FoV — C
- Narrow Spectrum — A



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Summary of the project - Consortium

1 **Light and low-power prototype of an atmospheric lidar for future planetary exploration**

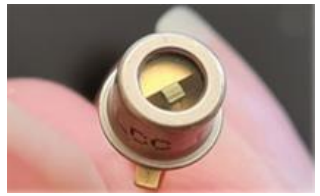
2 **Increase TRL (up to TRL-4) of enabling technologies**

KG

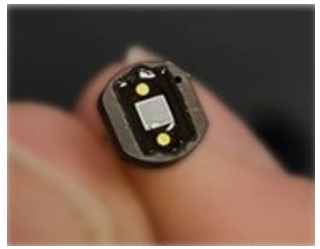
A B C D

INTA

A



B



cinn

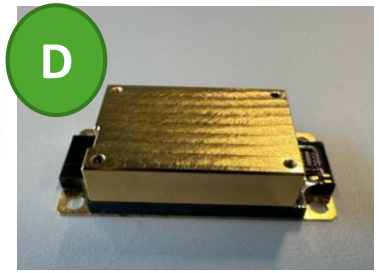
Nanomaterials & Nanotechnology Research Center

C

POLITECNICO MILANO 1863

integrated optics ®

D



YORK U

asphericon

MILI

Isaías Carrasco

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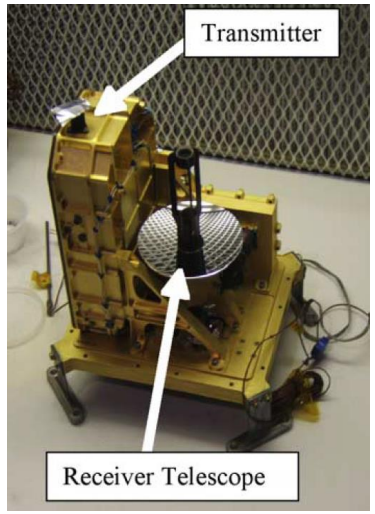
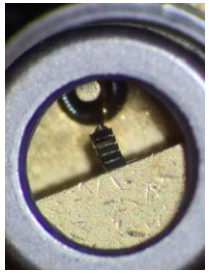
Summary of the project - State of the art

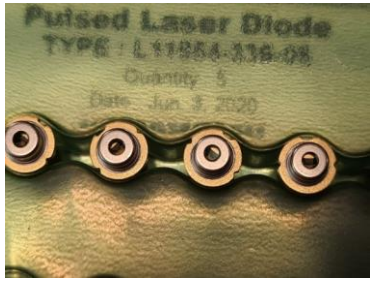
1 Lidar prototype



https://doi.org/10.1029/2007JE003002

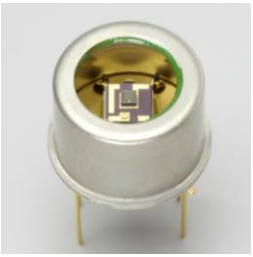
A Pulsed laser diods

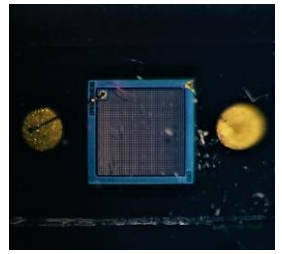




- Small size
- Low power
- Divergence
- Big emmiting areas
- Characterization for space lidar

B Silicon Photomultipliers



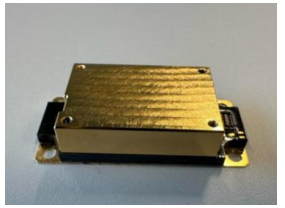


- High gain
- Moderated bias
- Crosstalk
- DCR
- Characterization for space lidar

C Ceramic structures

- Customizable CTE and other properties.
- To keep instrument aligment.

D Q-switch laser



- Lower size, weight and power.
- Higher energy.
- TRL-5.

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Index

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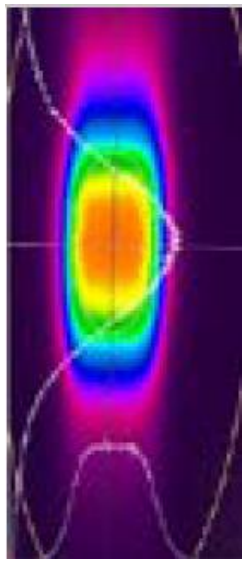
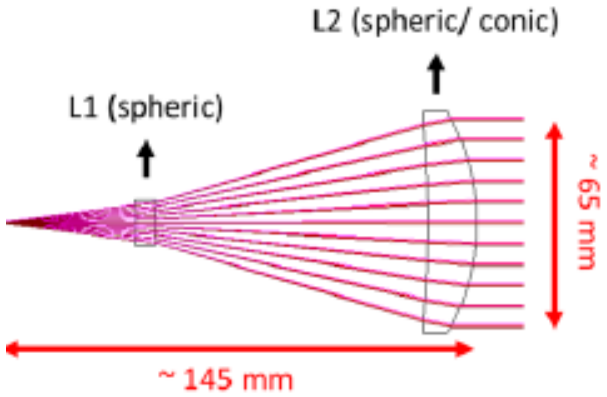
Main outcomes & challenges

A

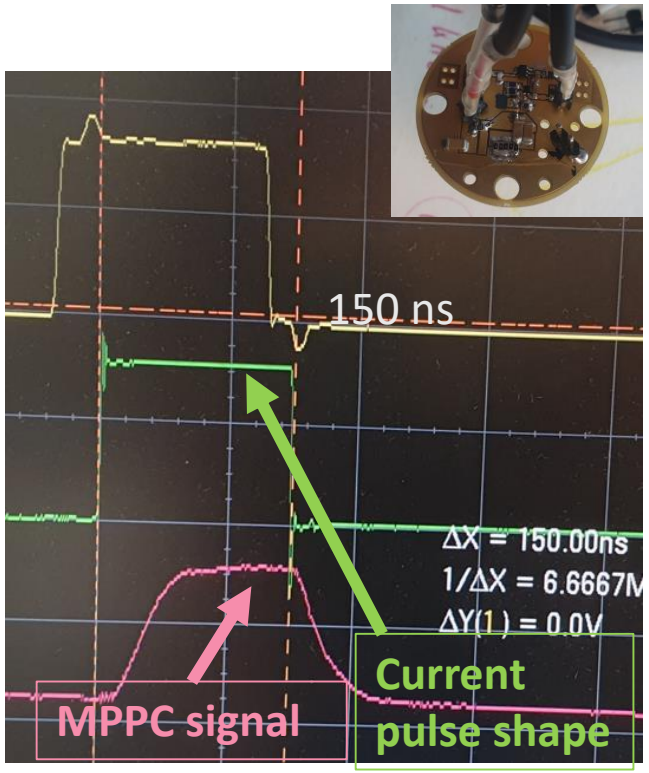
Pulsed laser diods

- **High emitting area and divergence -> collimation**

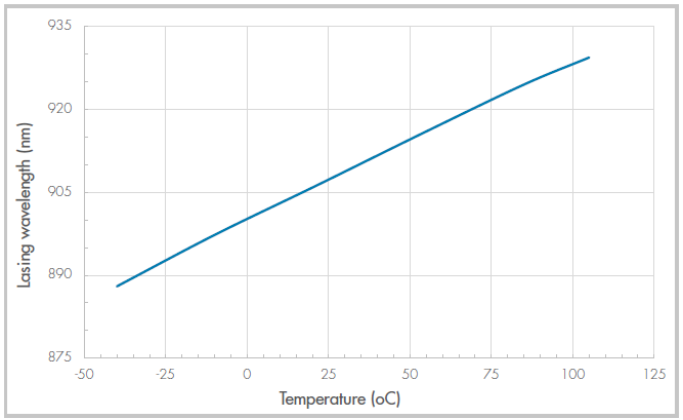


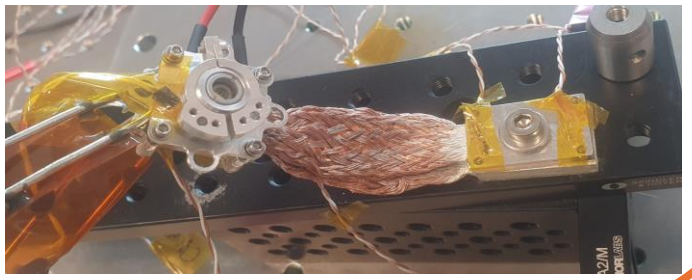


- **Low energy -> custom laser driver**



- **Wavelength thermal dependence -> characterization and thermal control**





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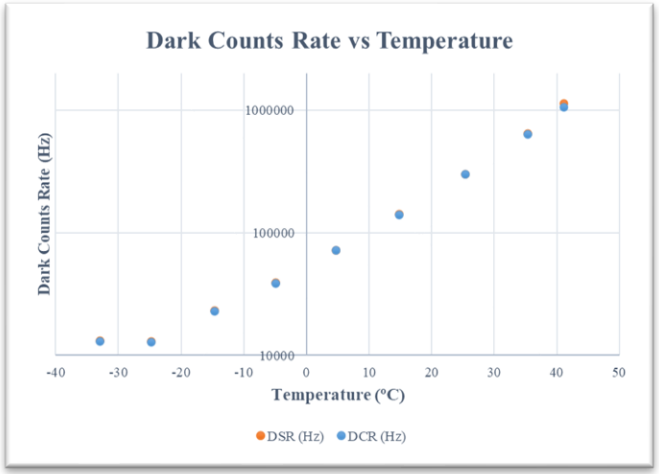
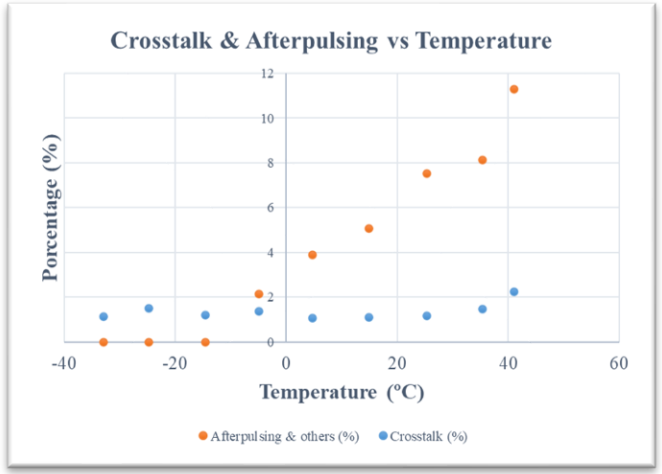
Main outcomes & challenges

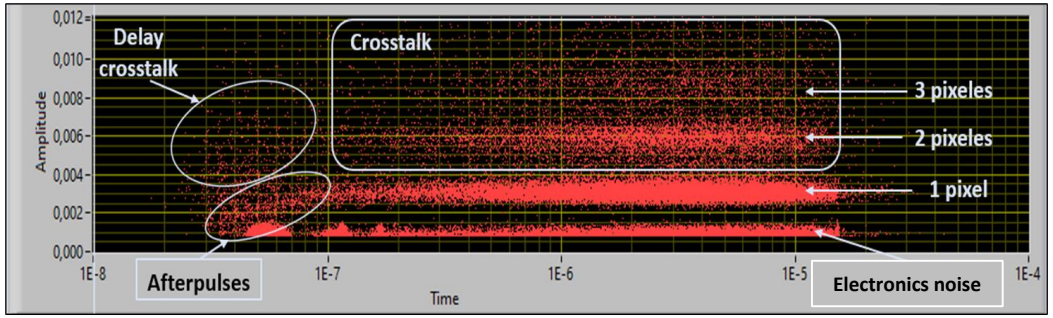
B

Silicon Photomultipliers

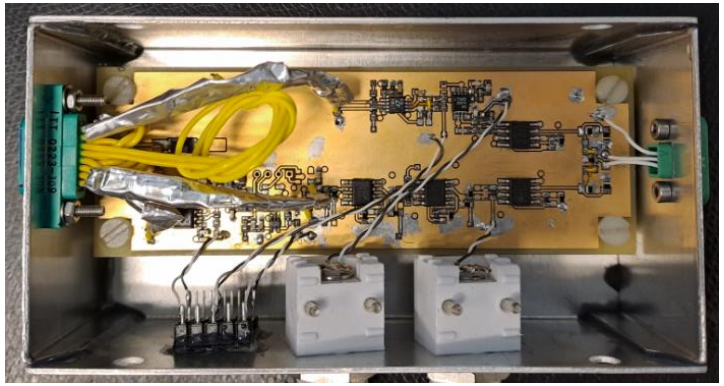
- **Screening and characterization**

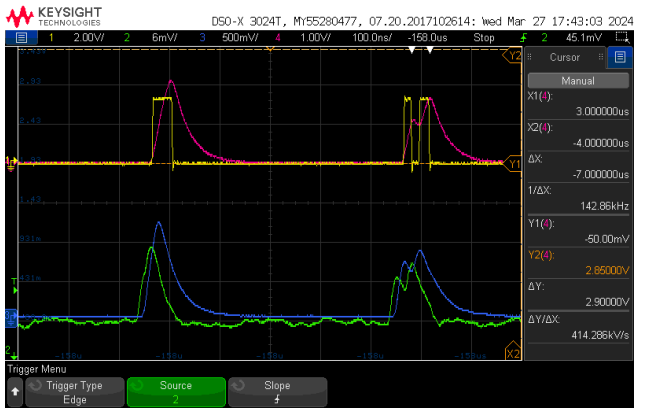






- **Development of custom electronics**





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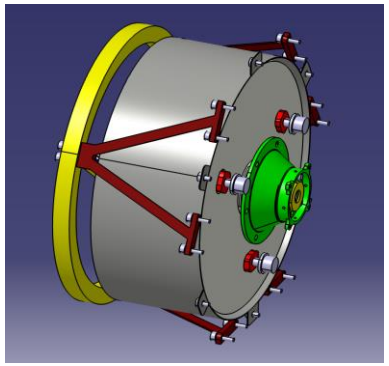
Main outcomes & challenges

C

Ceramic structures

- **Outcomes:**
  - New zero CTE material composition.
  - New technology used (Spark Plasma Sintering).
  - Spacers and spider (complex shape) produced for Mili prototype.



- **Challenges:**
  - Machining is still a challenge.

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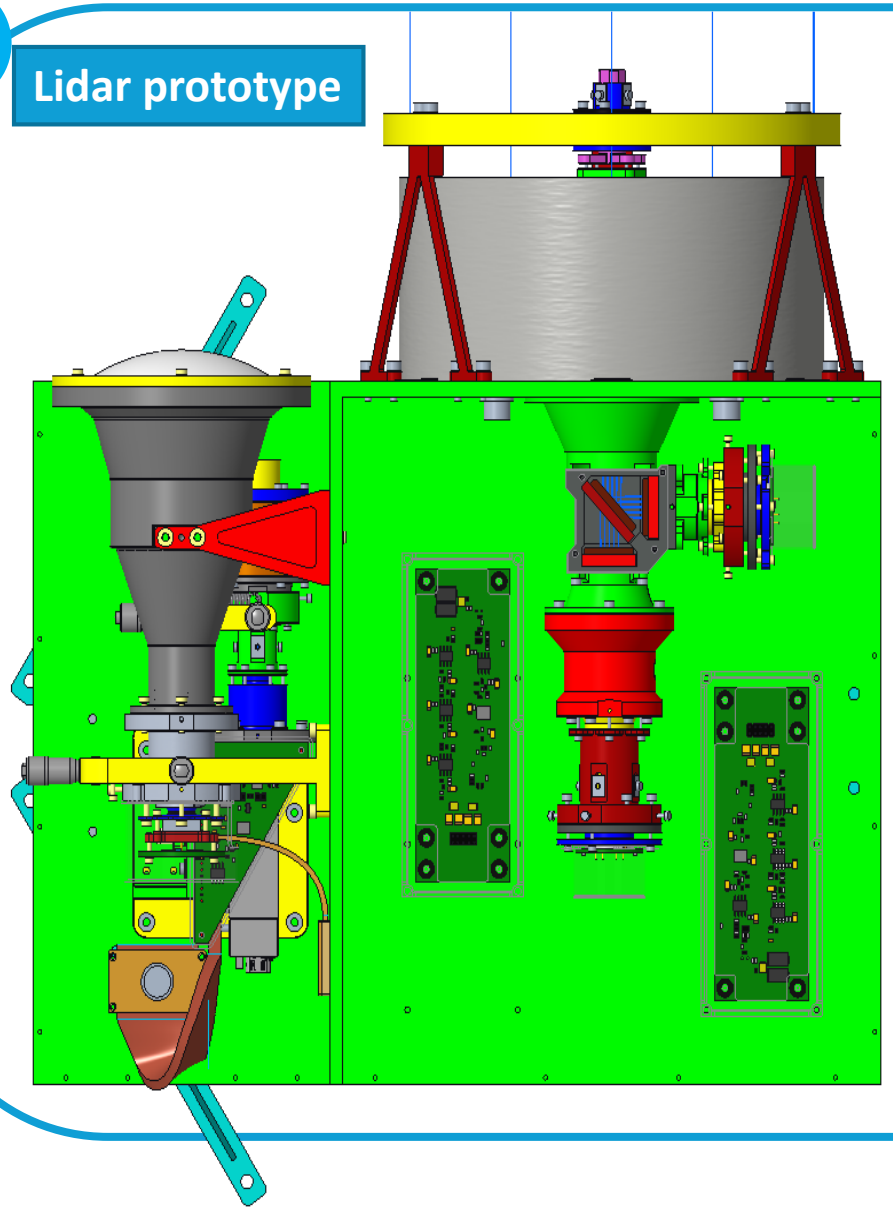
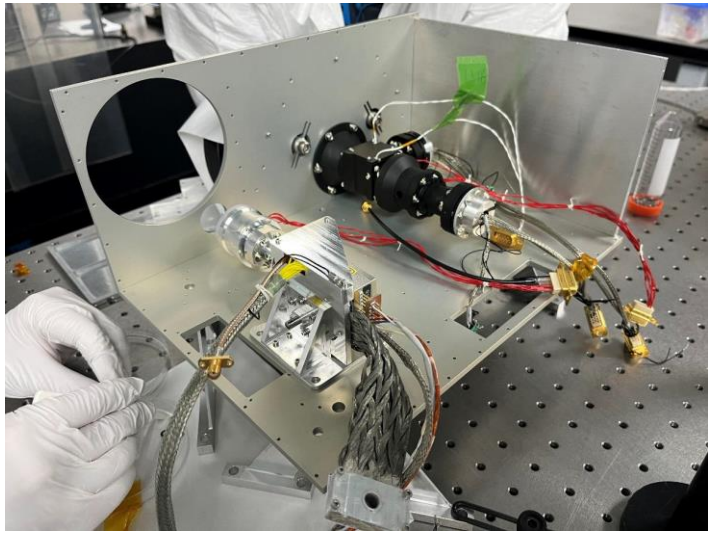
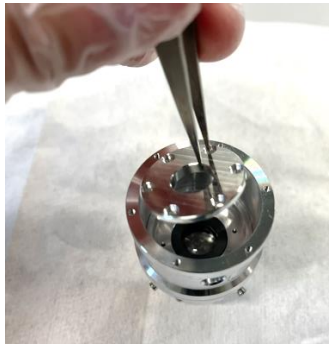
Main outcomes & challenges

1

Lidar prototype







- Design and annalysis:
  - 2β+1δ lidar prototype.
  - Showed nigh-time operation up to 20 km (5 km daytime).

Isaías Carrasco

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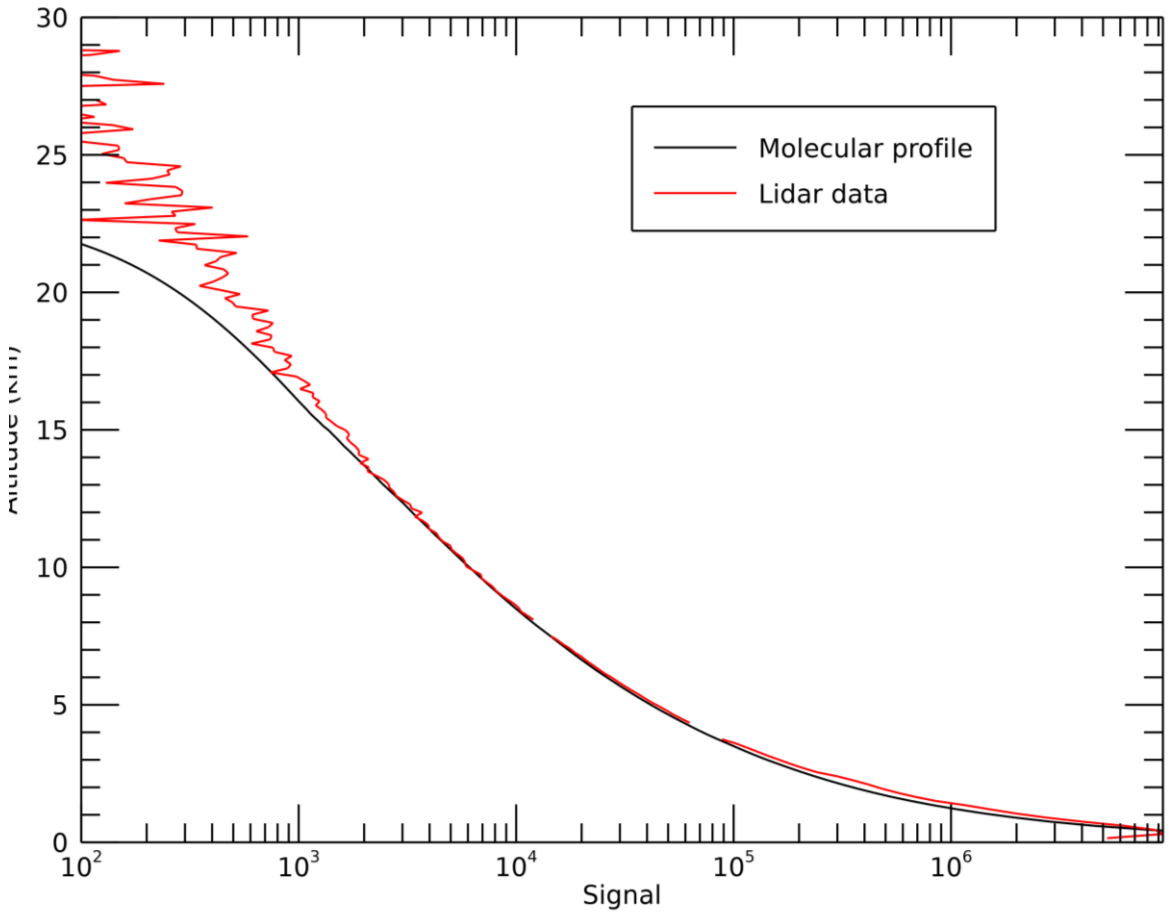
Main outcomes & challenges

1

Lidar prototype



- Outstanding outcomes:
  - Showed 20 km range.
  - Straylight blocking factor of above 10^-7 at 45 degrees angles.
- Challenges (lessons learnt):
  - Integration
  - EMC

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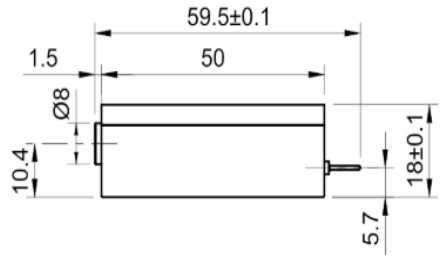
Main outcomes & challenges

D

Q-switch laser prototype

- **Outcomes:**
  - New laser prototype > 100 uJ and 1 KHz.
  - Good beam quality and pulse stability.
  - Lower SWaP (Size, Weight and Power) than existing solutions.
  - Tested under termal, vibration, vacuum and radiation



- **Challenges:**
  - Limiting factors for increase energy:
    - Optical coating LIDT.
    - Balance SWaP.
  - Temperature related limiting factors:
    - Thermal loading of gain crystal (limits repetition rate).
    - Temperature sensitivity (heaters need).
  - Integration (due to compactness) and mechanical stability.

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Index

1. Summary of the project

2. Main outcomes & technological challenges

3. Explotaition & EU supply chain challenges

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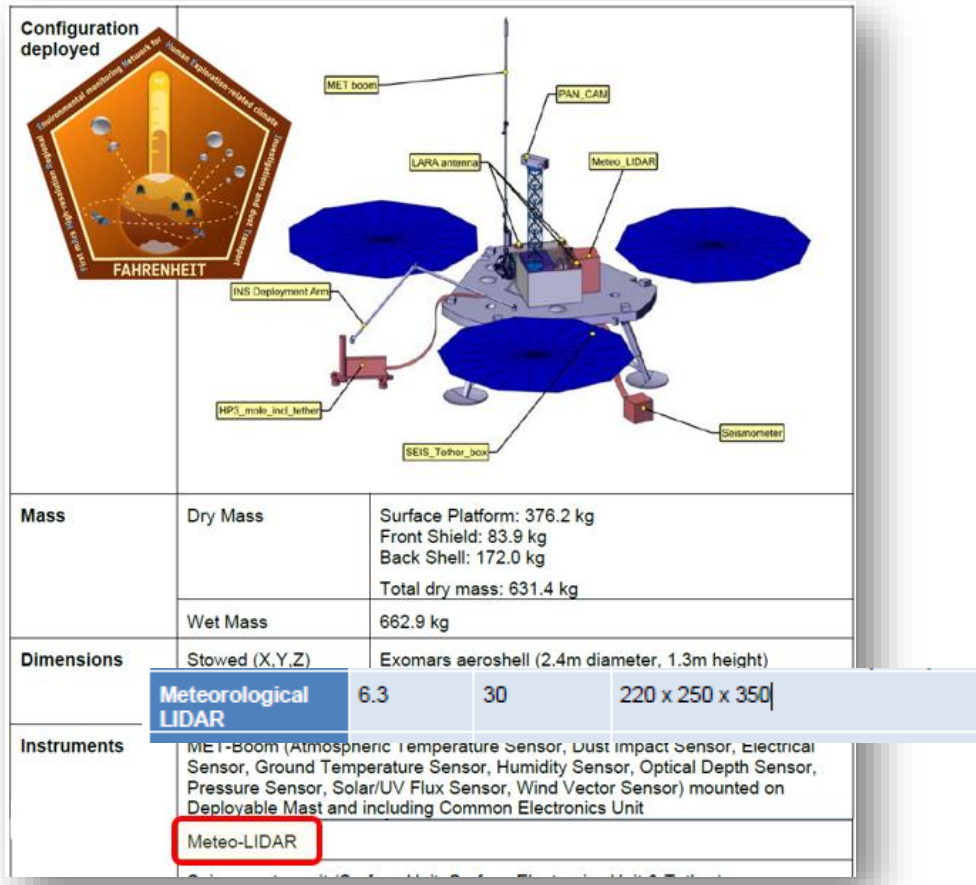
Exploitation & Industrial uptake

- **Space missions:**

1 Lidar prototype: ESA lander for atmospheric studies on Mars

B Detectors: LightShip - SpotLight

- Joint proposal preliminary selected for an atmospheric lidar.



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Exploitation & Industrial uptake

- **Other markets oportunities:**

1 Atmospheric lidar for terrestial usage (focussed on space usage).

C Zero CTE materials in other applications: metrology, lithography and optics (limited to simple shape components).

D New Q-switch prototype:

  - Potential application on industrial usages (precisión metrology, materials processing, spectroscopy).
  - Adaptable to IO comercial product line.

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EU supply chain challenges

- **Main barriers and oportunities:**

A Lack of space grade lasers.

B Lack of detectors with good tolerance to radiation.

C Few European producers of ultra-stable ceramics.

D Long manufacturing time and lack of space grade components (suggest to increase investon in manufacturing of radiatino qualified components in EU).

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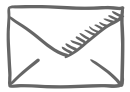
Thanks!



https://cordis.europa.eu/project/id/101082451


https://mili4mars.eu/


carrascobi@inta.es (Project Coordinator)