Large core Si/SiO_2 fiber draws

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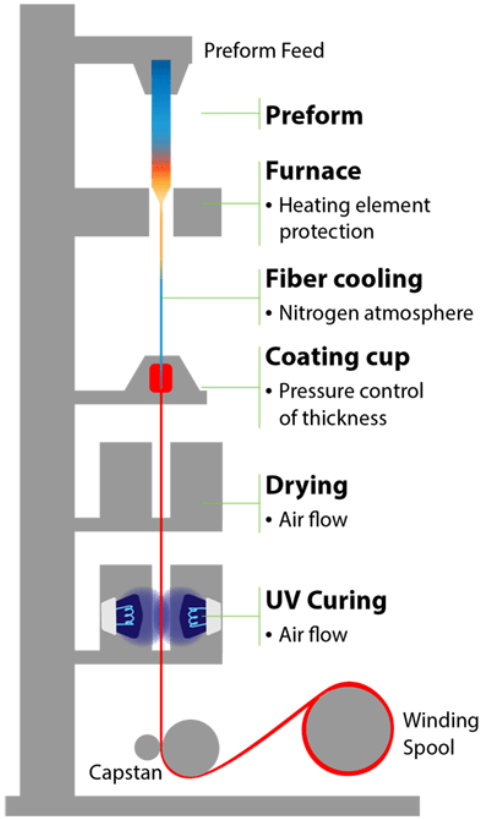
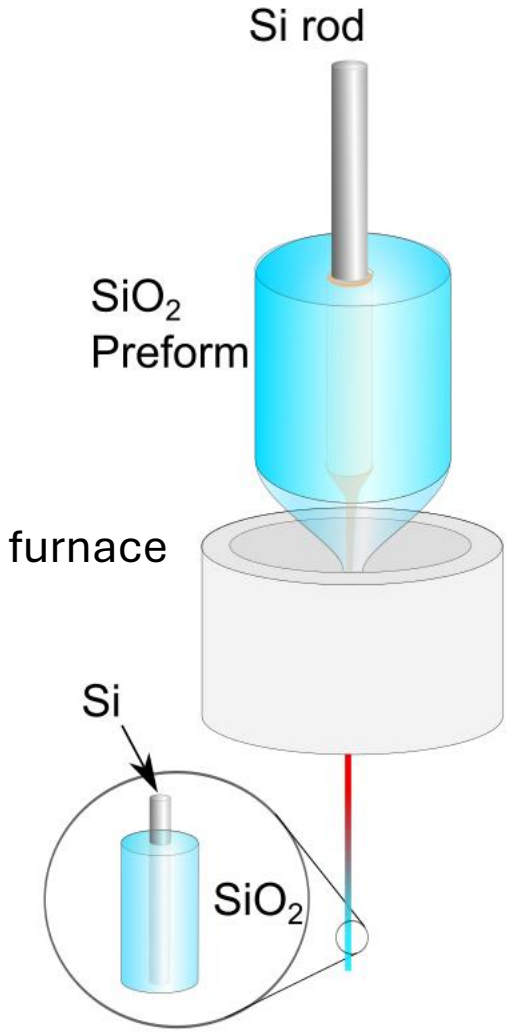


Silica molds silicon, gives smooth surface
prior work on smaller diameters:
CO_2 laser annealing recrystallizes Si

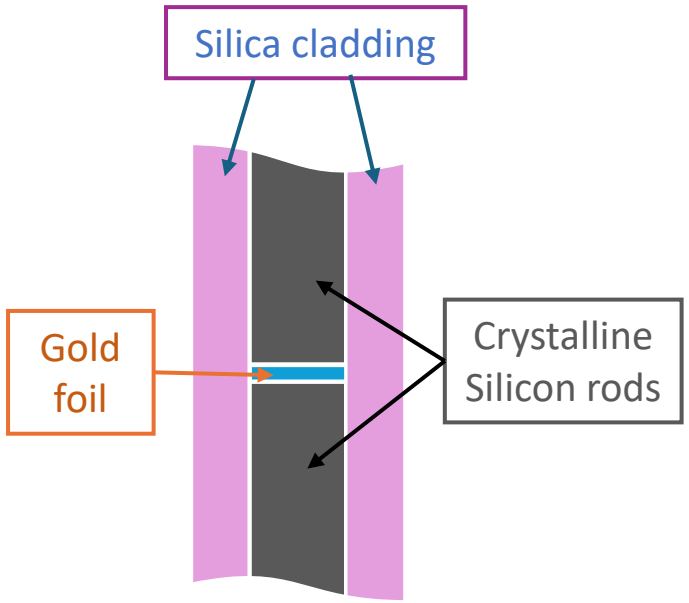
Two draws

1) 30mm OD silica with 8 mm ID
6 mm silicon rod
> **1 mm core** after draw

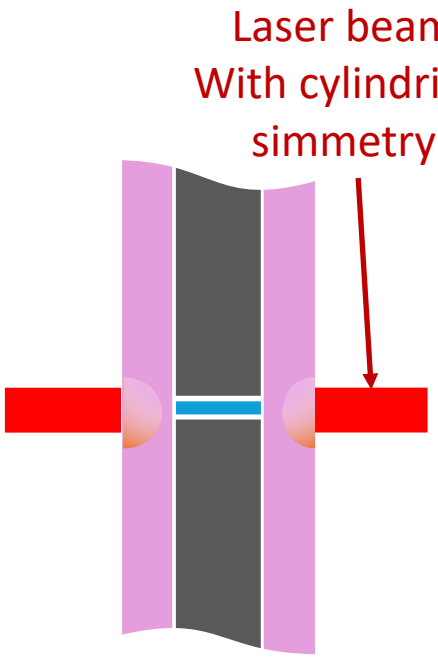
2) 30 mm OD silica with 12 mm ID
6mm silicon pieces
>> **core size > 2 mm**



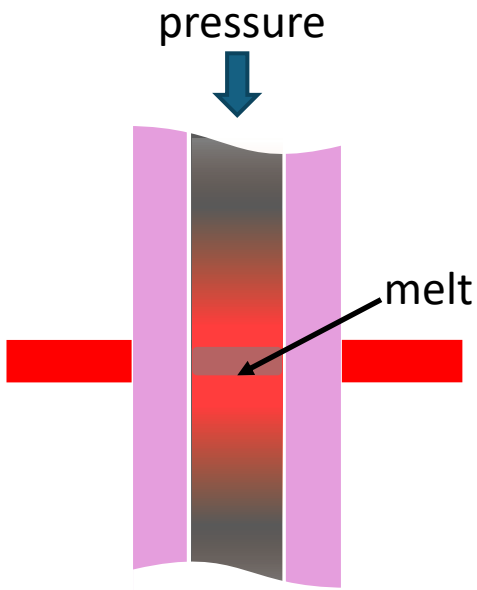
A laser based method to weld silicon using a metal-semiconductor alloy



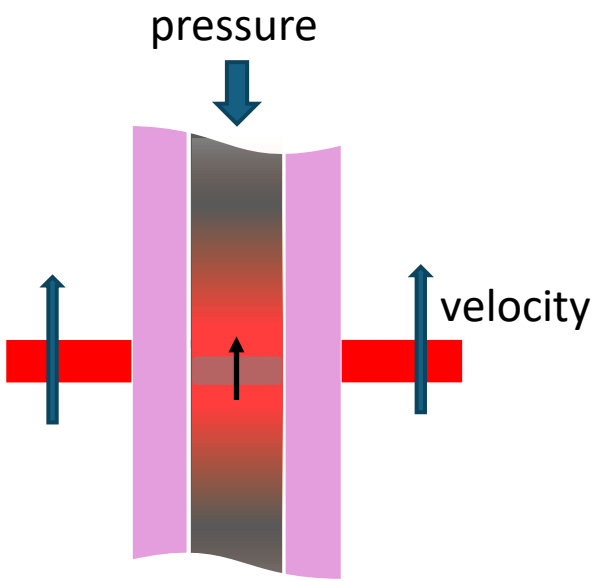
Sample preparation



The laser beam starts to heat the silica without reaching its melting point



The silicon and the gold are heated and they form a eutheptic alloy that melt under 1000 °C [1]

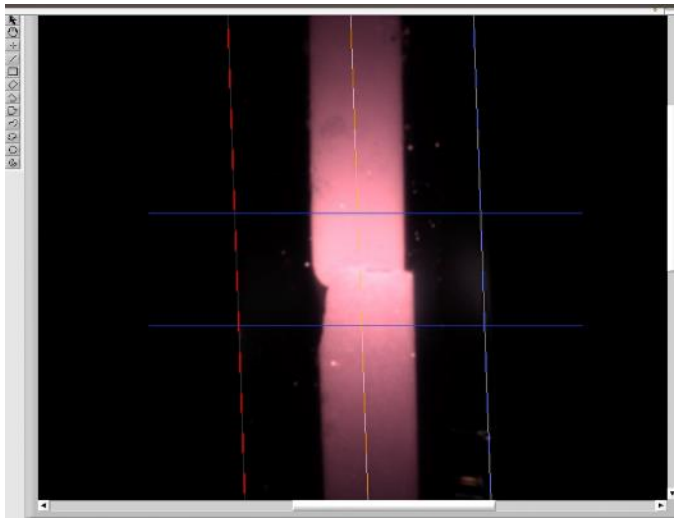


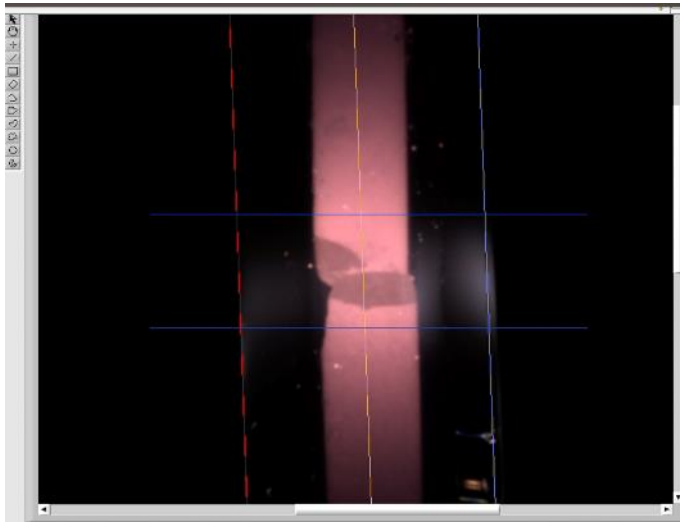
The beam position is moved up to melt silicon; The gold thermo-migrates, following the beam position

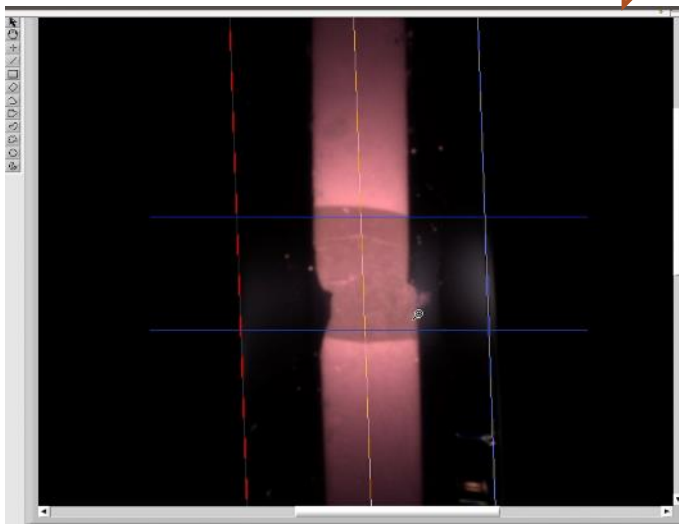
[1] Song et Al. *Nat Commun* **13**, 2680 (2022)

Gold-silicon alloy melting point

POWER INCREASING







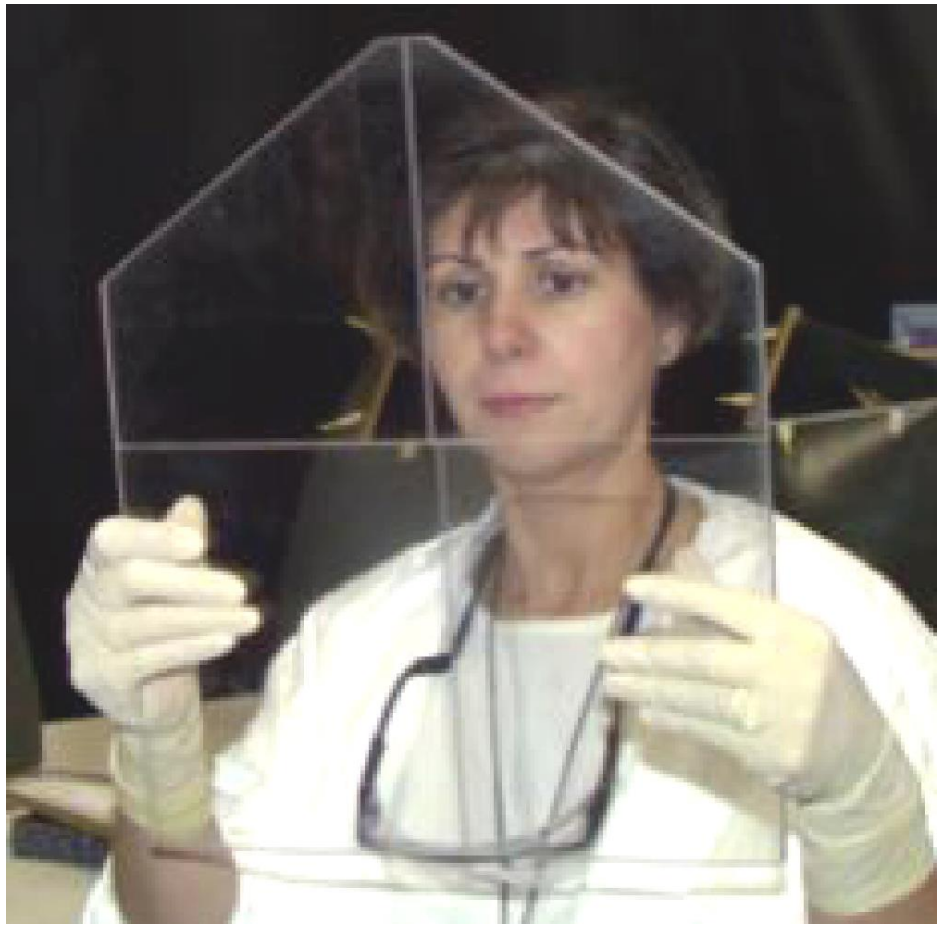
Starting the heating process the silicon starts to emit.
Increasing the power, a darker region is visible (state transition). The dimension of this area is related to the laser power.
Laser Power: 24W; Silica cladding diameter: 3mm; silicon diameter: 1mm

Sapphire connection methods

impex high tech

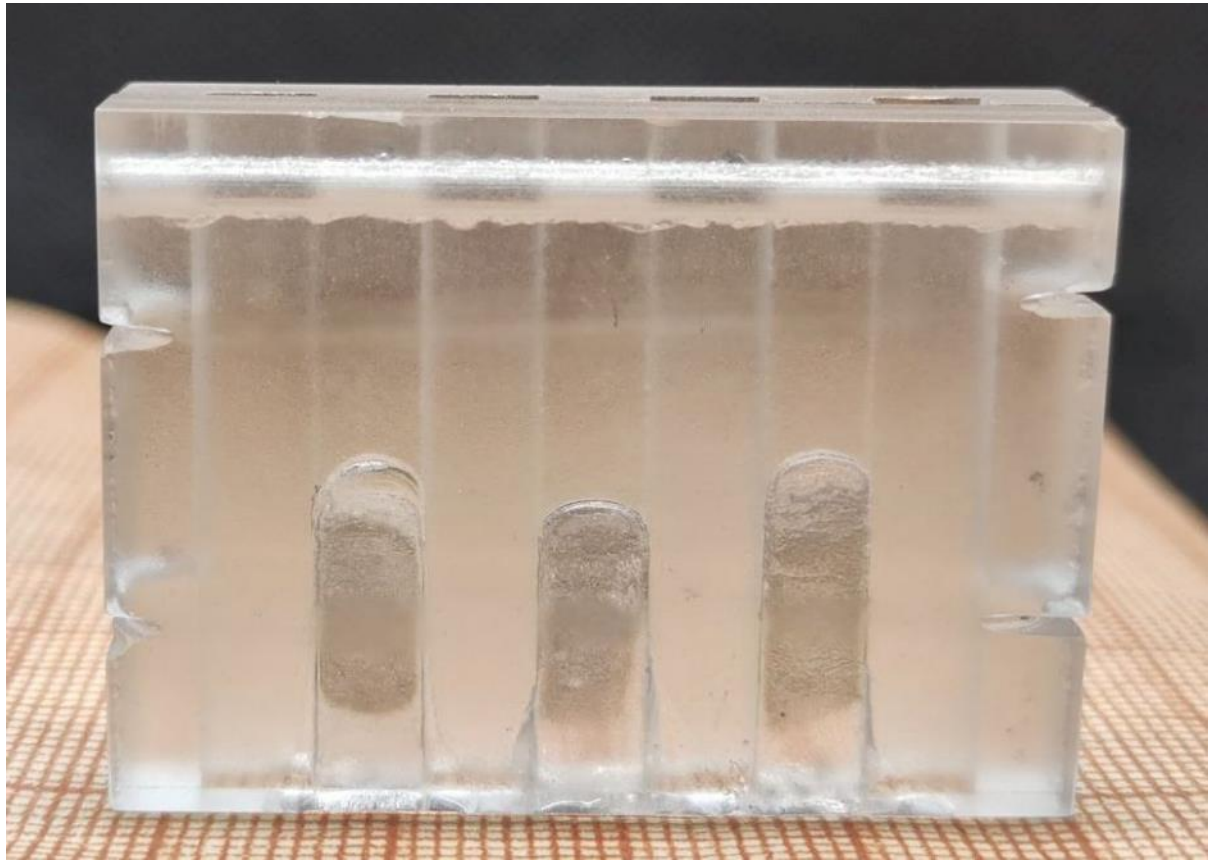
Institute for Single Crystals

- Methods of connection sapphire components and their features
- Testing capillary effect for sapphire melt in sapphire crystal in different configuration and size of channel
- Theoretical Model of Joining Sapphire Blanks by Melt
- Process of Melt Rising in a Capillary Channel
- Defects in the Melted Part of the Crystal
- Joining Sapphire Crystals with Different Vertical Gradients



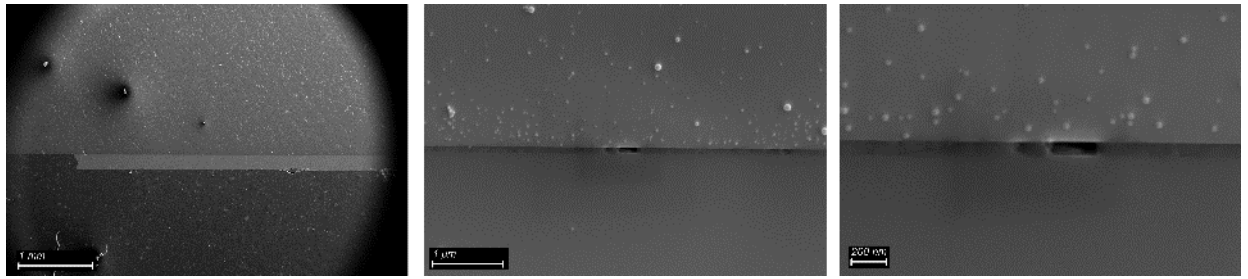
https://www.impex-hightech.de/
https://www.isc.kh.ua
https://scinn-eng.org.ua/ojs/index.php/ni/index

German project with funding code EP201456

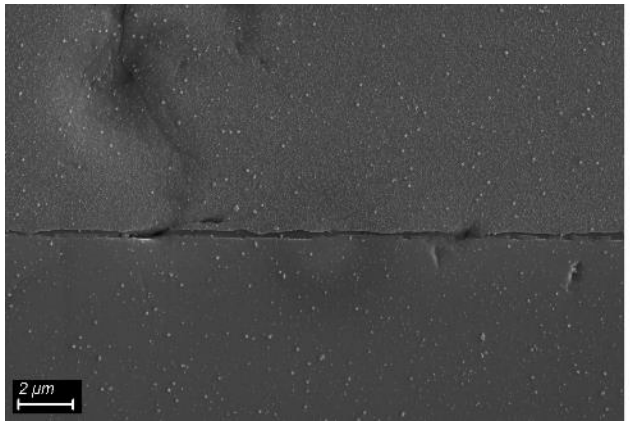


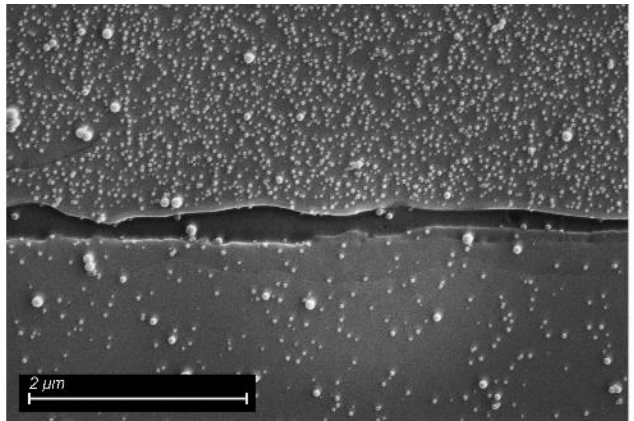
Testing capillary effect for sapphire melt in sapphire crystal in different configuration and size of channel

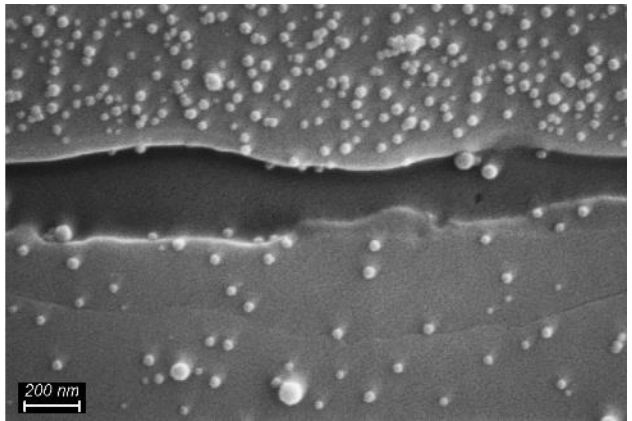
The simultaneous presence of the same substance in both solid and liquid states in the system can last for a relatively short time until equilibrium is reached.



The experiment was conducted in a thermal zone at a temperature below the melting point, where superheated melt was introduced to contact the crystalline blanks

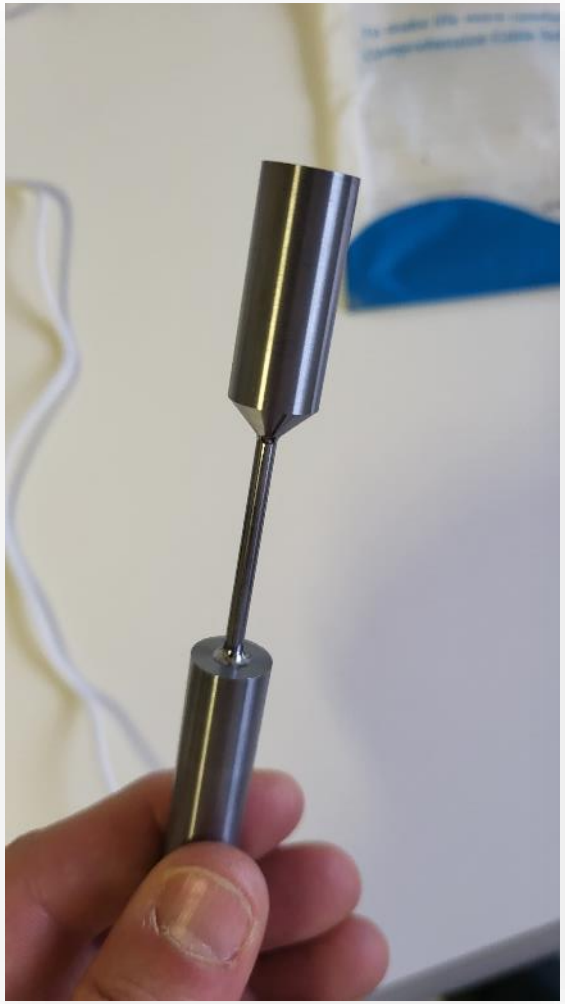






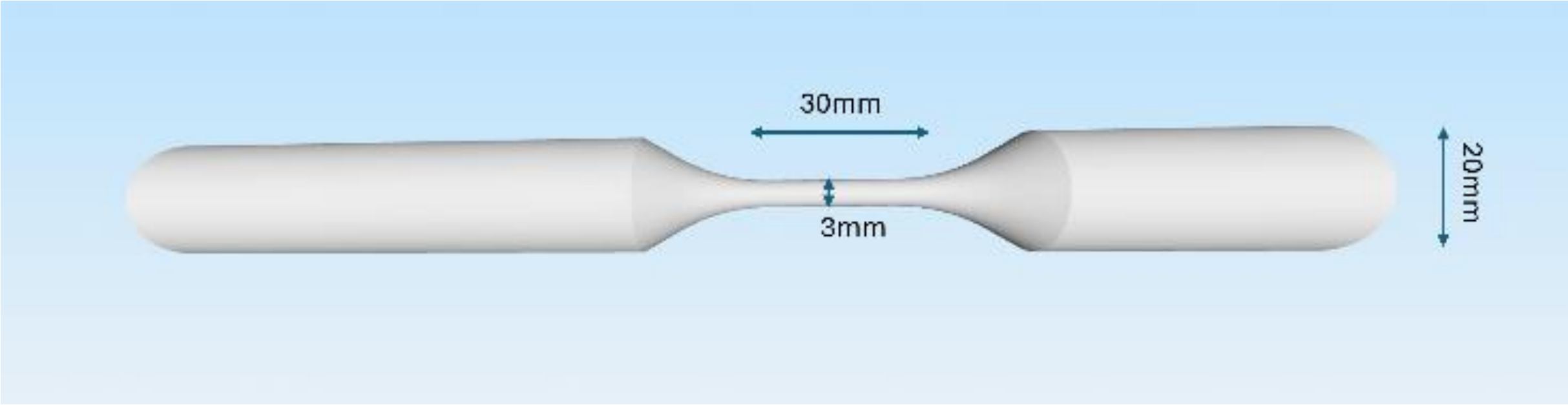
Fluxures/Joints

SILICON JOINTS



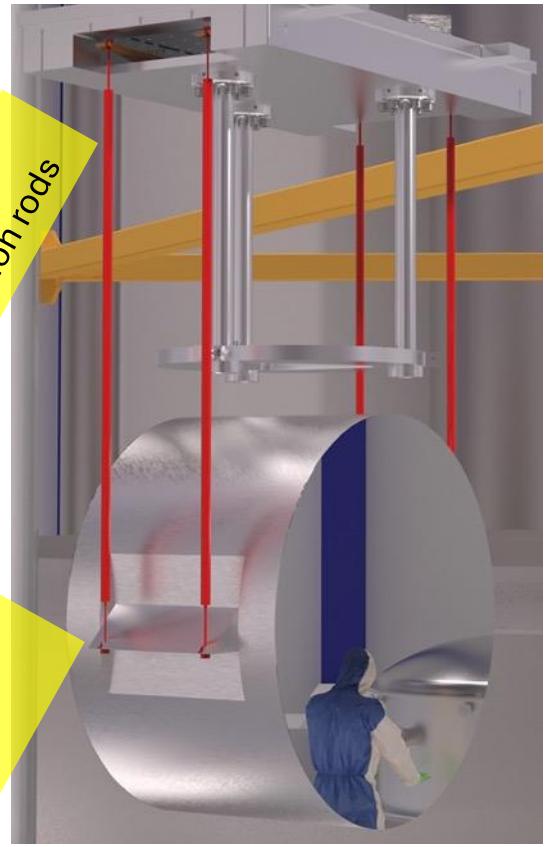
EFIBER project

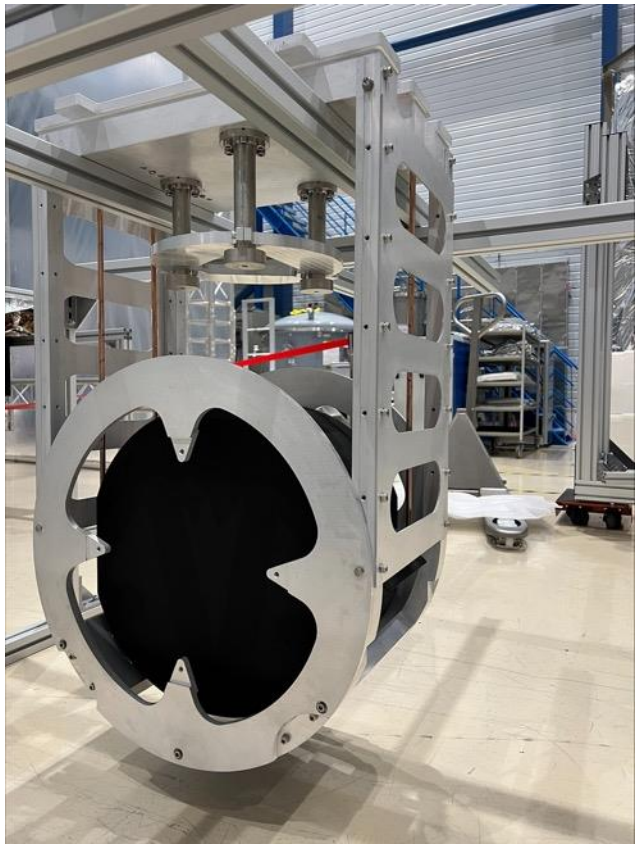
The project, aimed to produced optimized joints, has been just submitted.



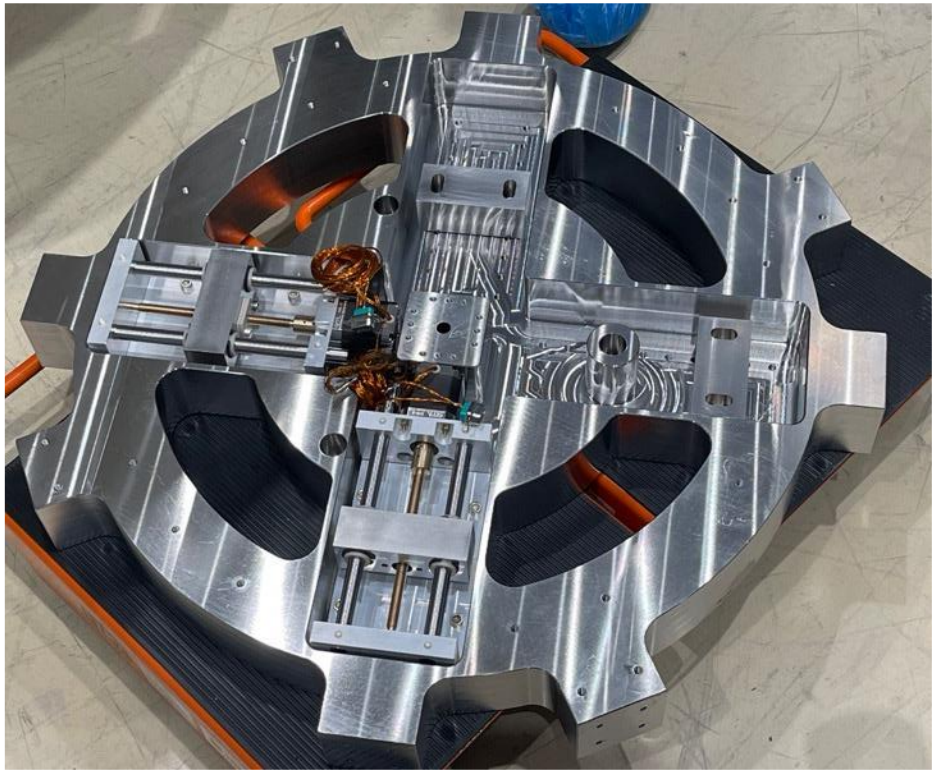
E-TEST

- Crucial technology aspect for ET: no proven solution exists
- Four machined samples delivered
- Silicon mirror ordered (delivery end of 2024)





Marionette



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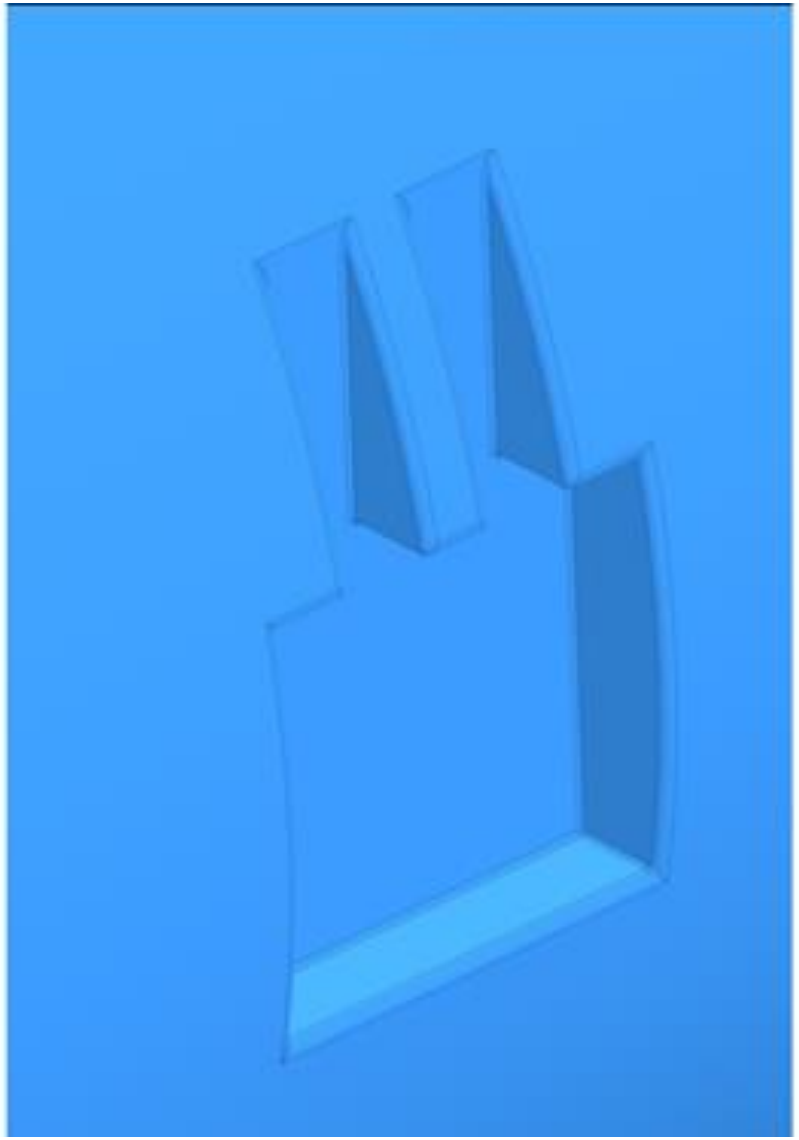
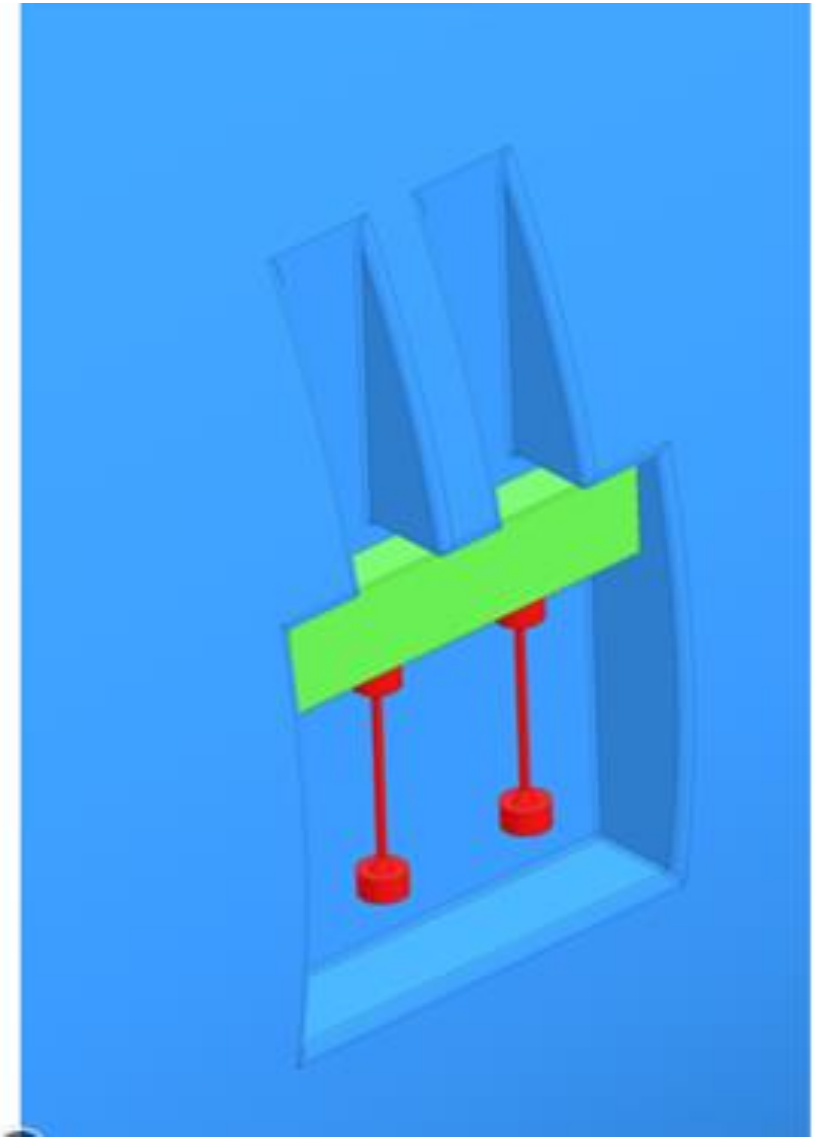
Precision Mechatronics Laboratory

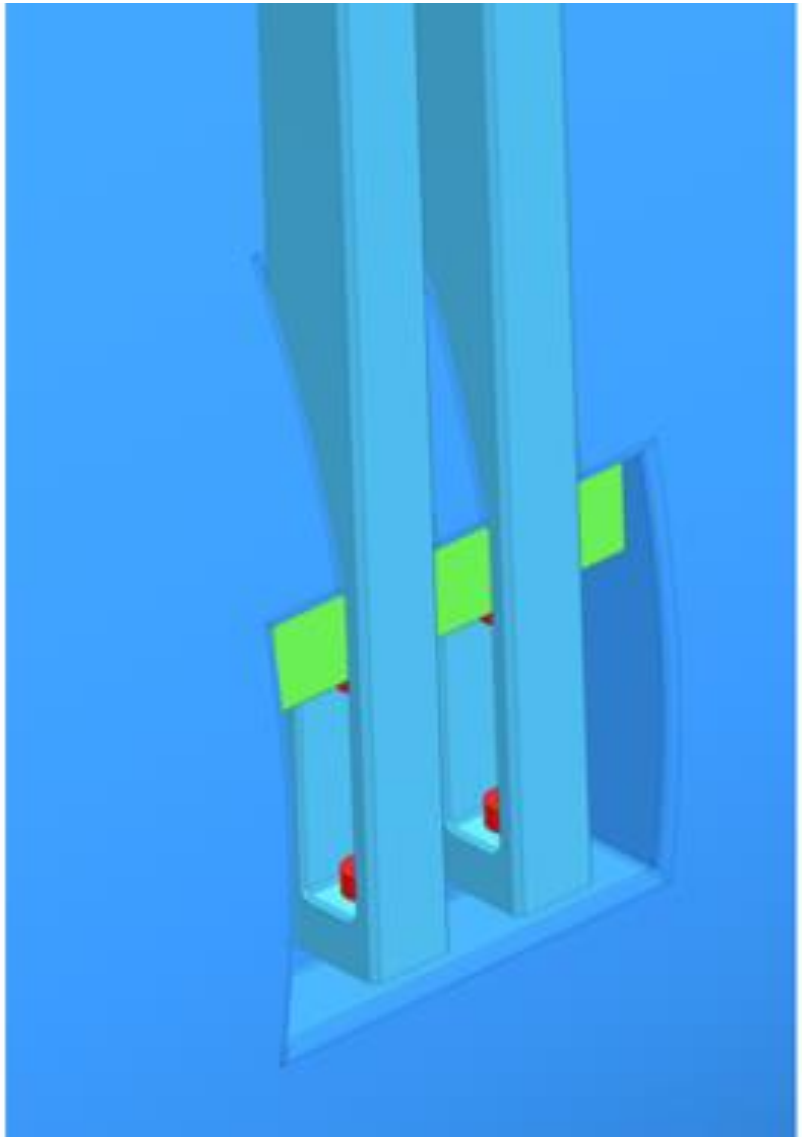
Nikhef

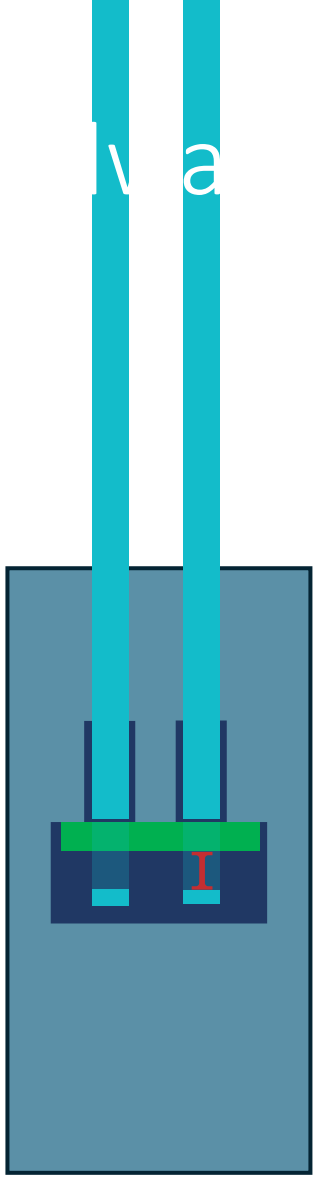
CSL CENTRE SPATIAL DE LIÈGE

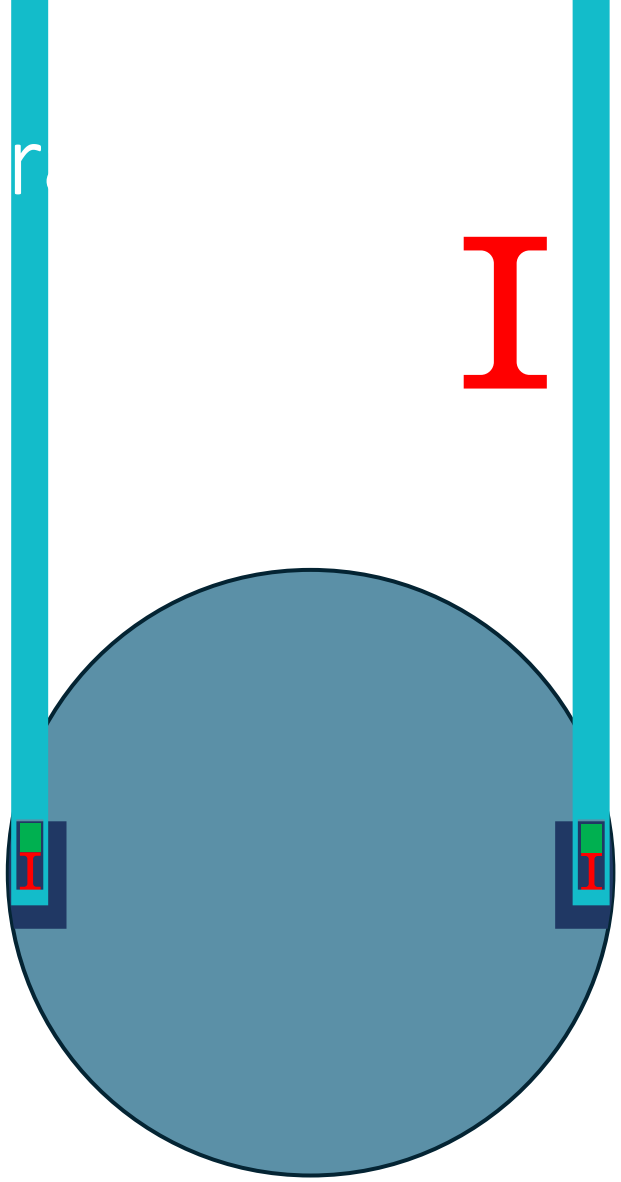
UCLouvain







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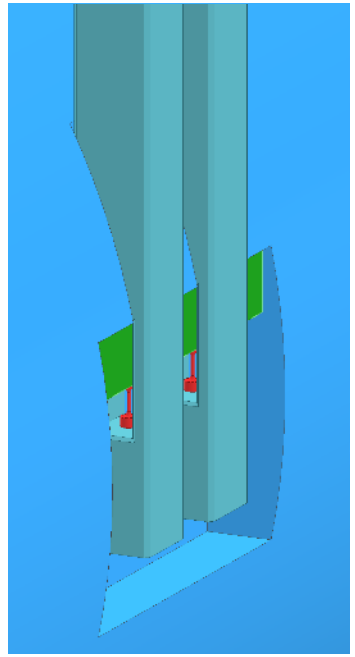
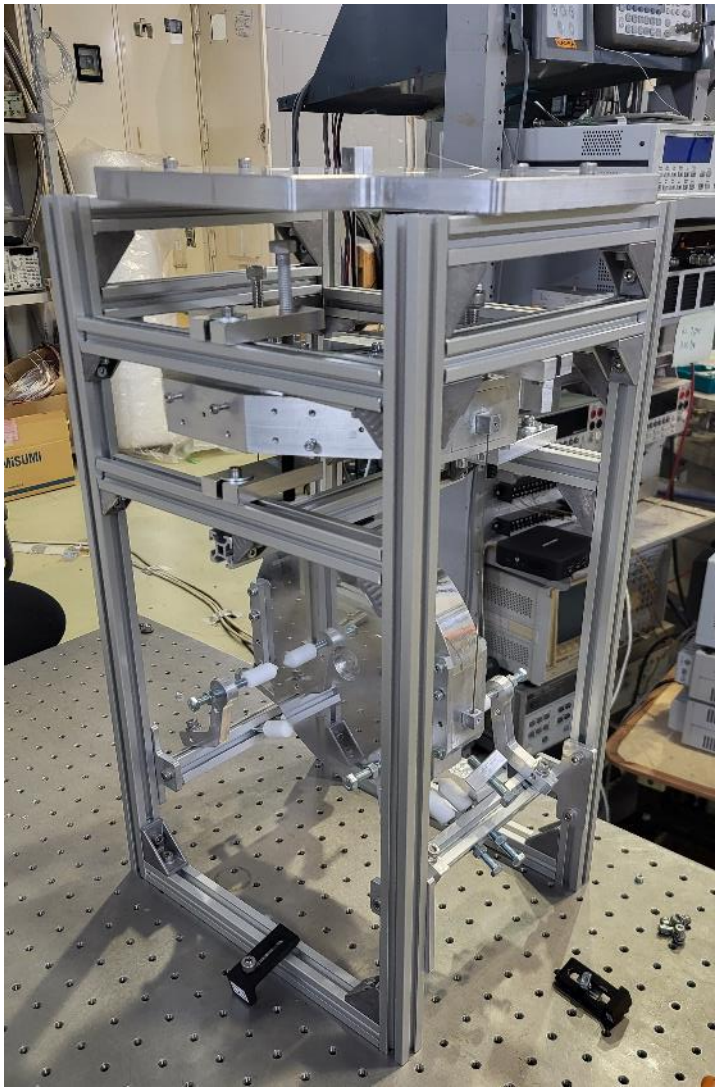


Marionetta suspension prototype



Work at ICRR

1. Crystalline suspension phase I: aluminum substrate and marionetta with aluminum wires

- to test the suspension assembly procedure and define the necessary tools
- to test the controls at room temperature and at cryogenic temperature

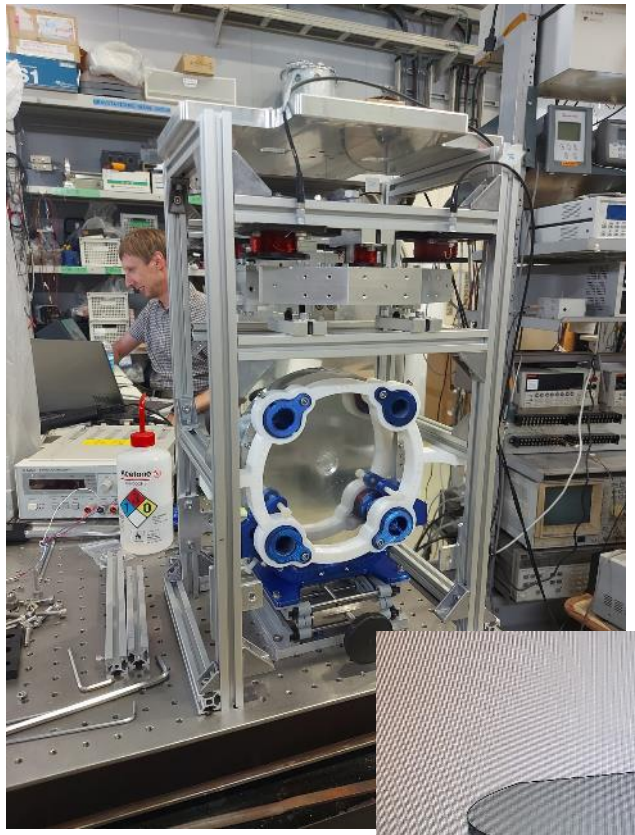
2. Crystalline suspension phase II: aluminum substrate and marionette with silicon inserts and silicon fibers

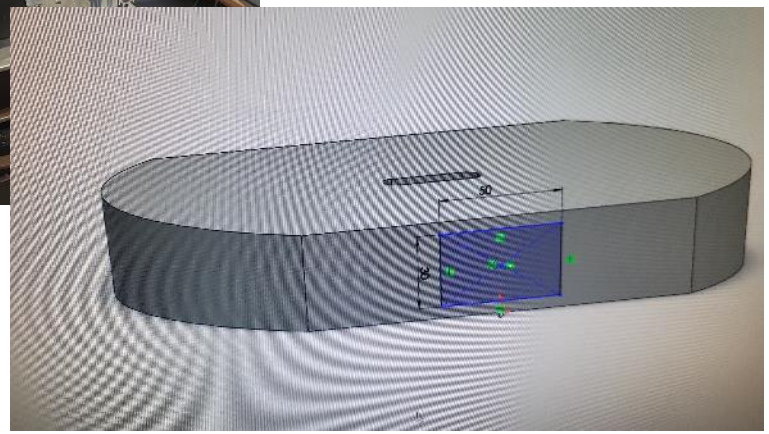
- Specifications and needs to be defined

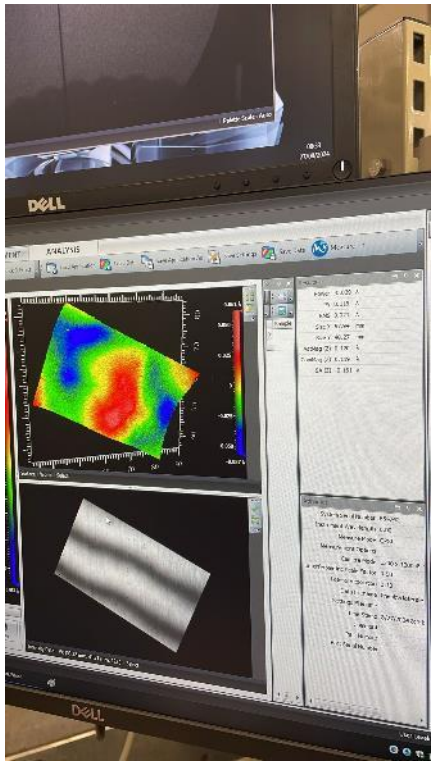
Work at ICRR

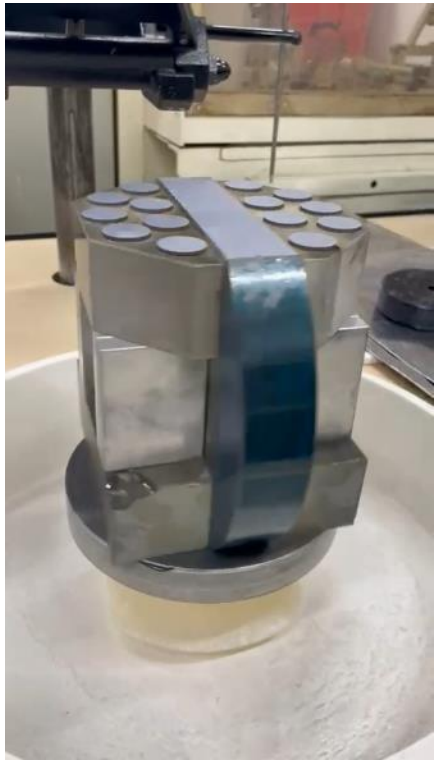
3. Crystalline suspension phase III: everything in silicon

- Specifications and needs to be defined









Characterizations

A more complete description can be found in the contributions of the GRASS24 Workshop:

https://agenda.infn.it/event/40538/contributions/

Summary

- Fused silica is a mature technology for ET-HF and CE. Work is focussing on specific engineering to handle larger masses & ear/anchor design
- Stress corrosion results in vacuum look very promising for lifetime of fibres at high stress

- Sapphire fibres can be grown and welded with CO2 laser. Thermal conductivity and mechanical loss look very promising
- Initial modelling suggests sapphire fibres (with silicon optic) is close to meeting ET-LF requirements

- A reliable technique for growth of silicon fibres has been developed. The process is reproducible with low fibre-to-fibre variation
- As-grown Si-fibres have high structural perfection and purity, low diameter variation and good surface quality. Median tensile stress is higher than typical for untreated Si. Further investigation needed
- The research on growing of tailored-shaped Si fibres and Si-welding for fibre attachment purpose is ongoing