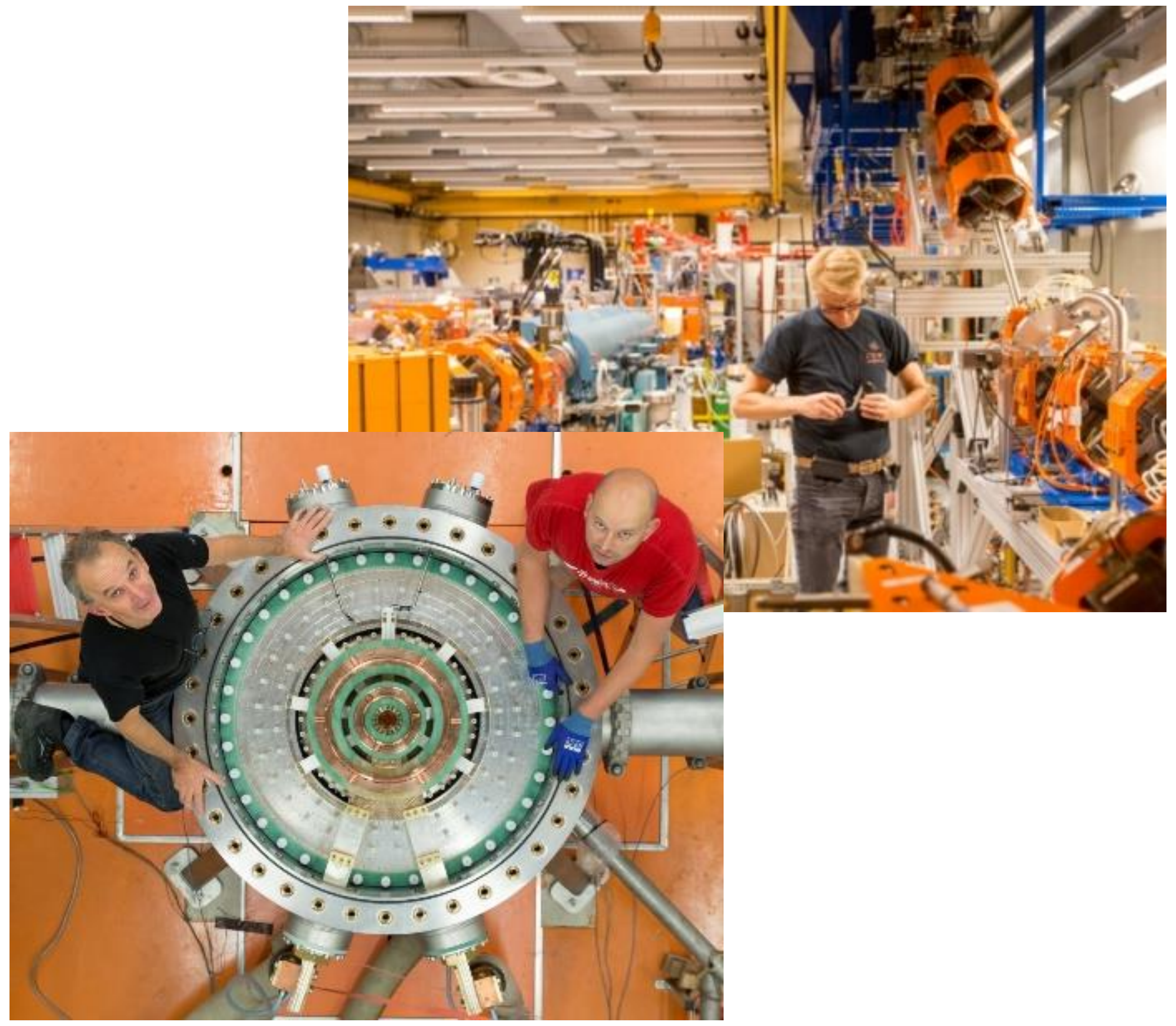
Cryogenic
&
Vacuum technologies

- ***HFML-FELIX – Martin van Breukelen***
- ***CERN – Jan Visser***
- ***Einstein Telescope – Rob van der Meer***
- ***NOVA – Ramon Navarro***

ILO-net webinar 18 May 2021

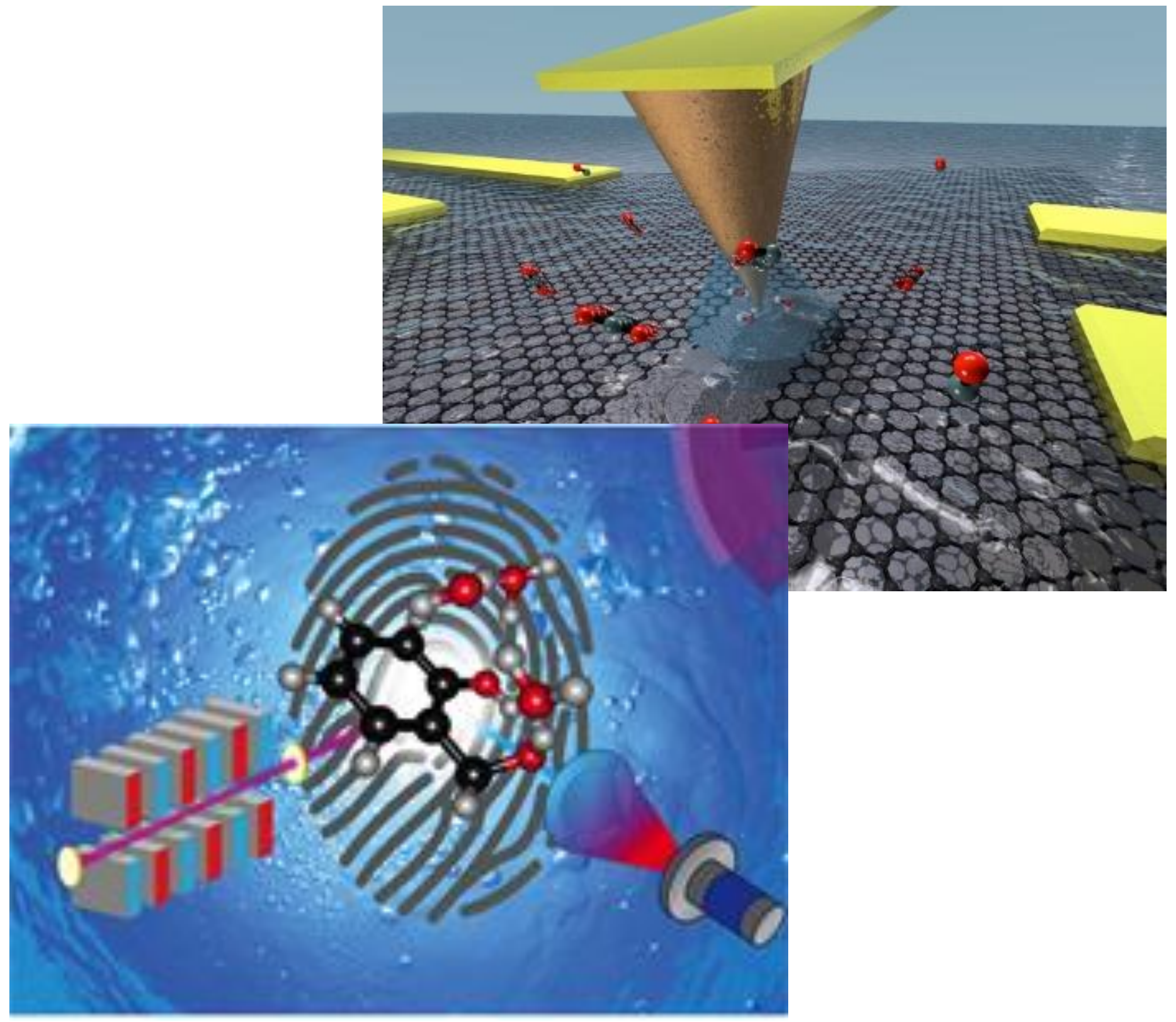

HFML FELIX

HFML-FELIX KERNACTIVITEITEN



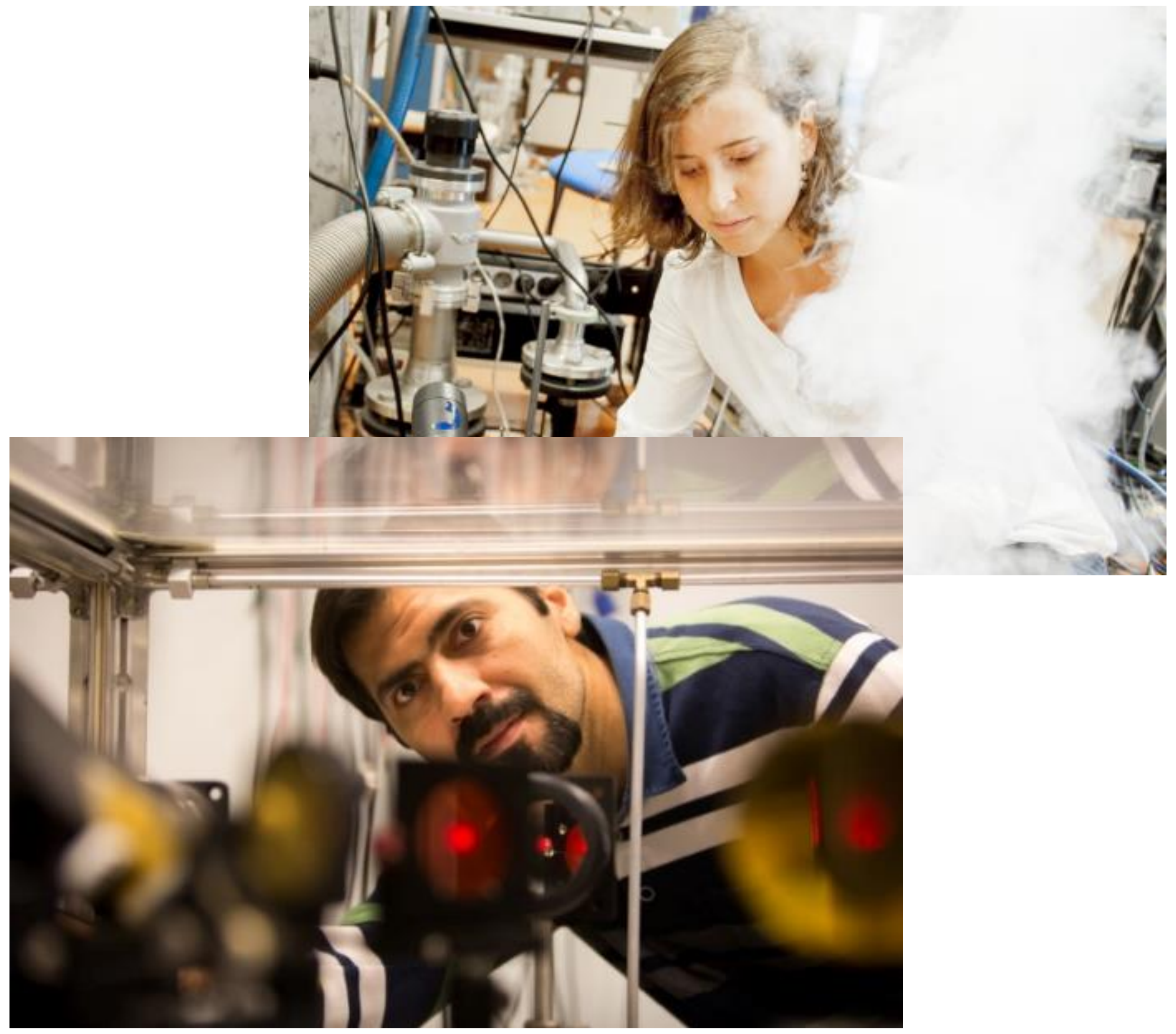
Technologie

State-of-the-art magneten, lasers & instrumentatie



Wetenschap

Sterke eigen onderzoeksprogramma’s

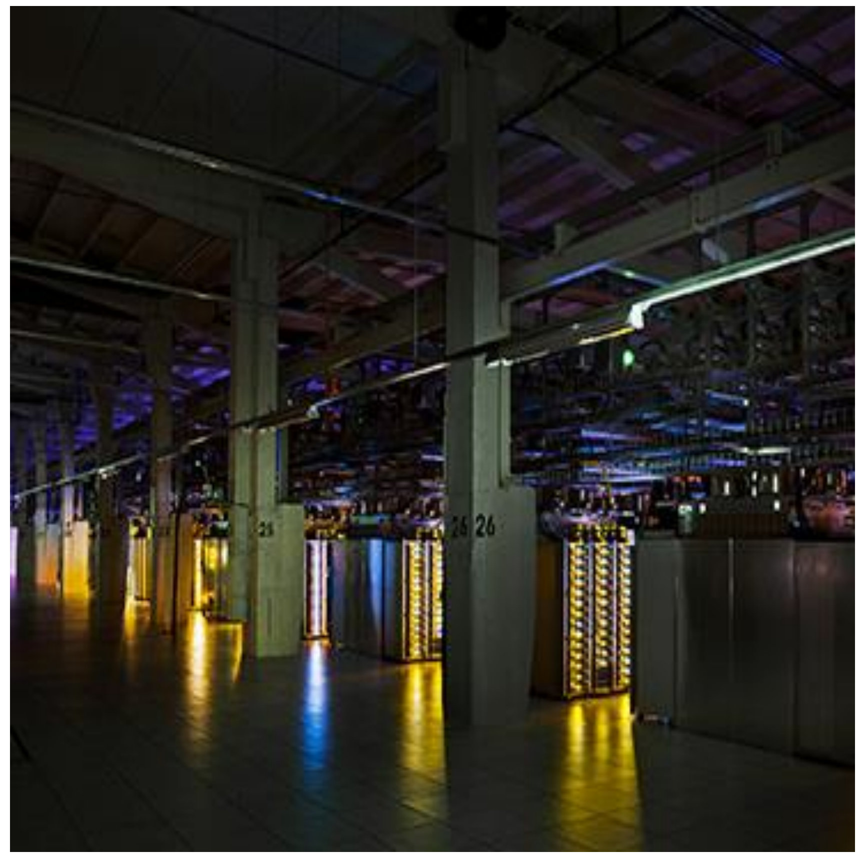


Gastenprogramma

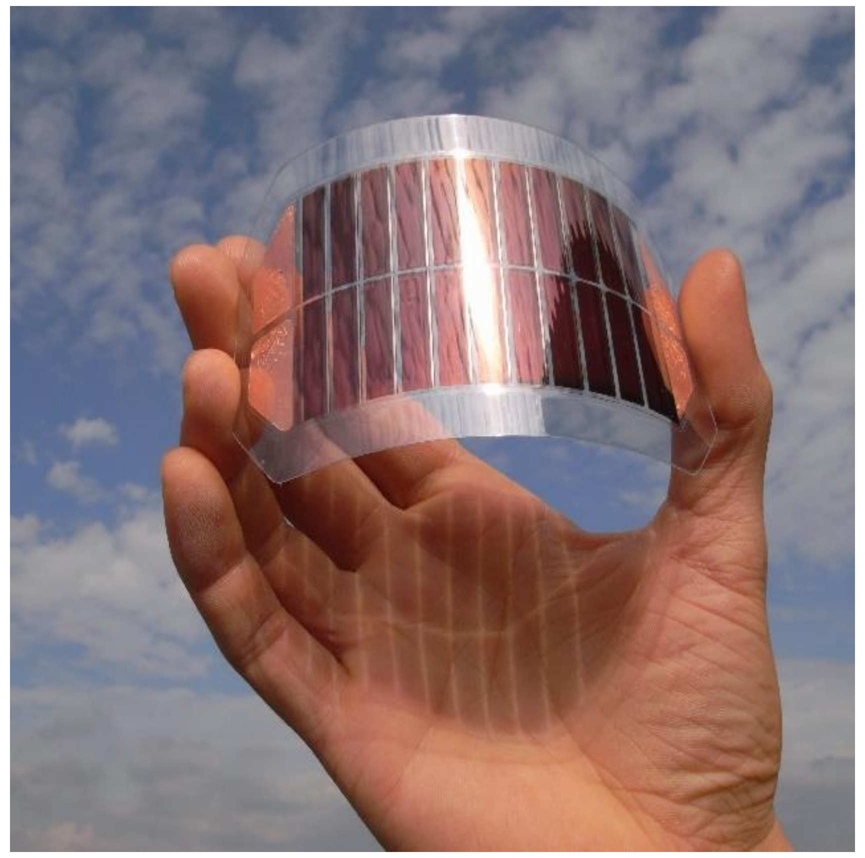
Internationaal gerenommeerde onderzoeksfaciliteit

HFML-FELIX IMPACT

GEZONDHEID

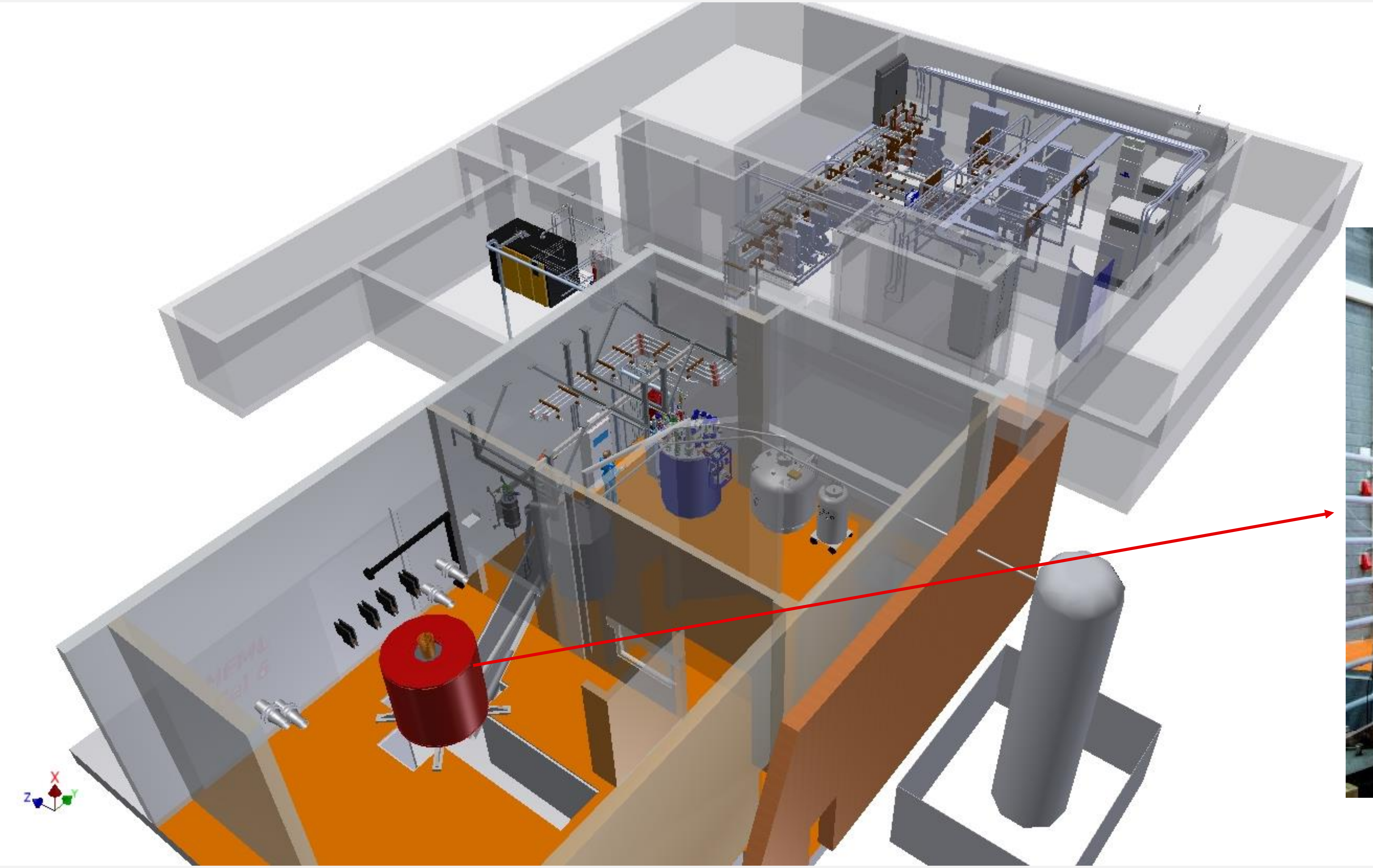


ENERGIE EN DUURZAAMHEID



NIEUWE MATERIALEN

ONTWIKKELINGSPROJECT – HYBRIDE MAGNEET



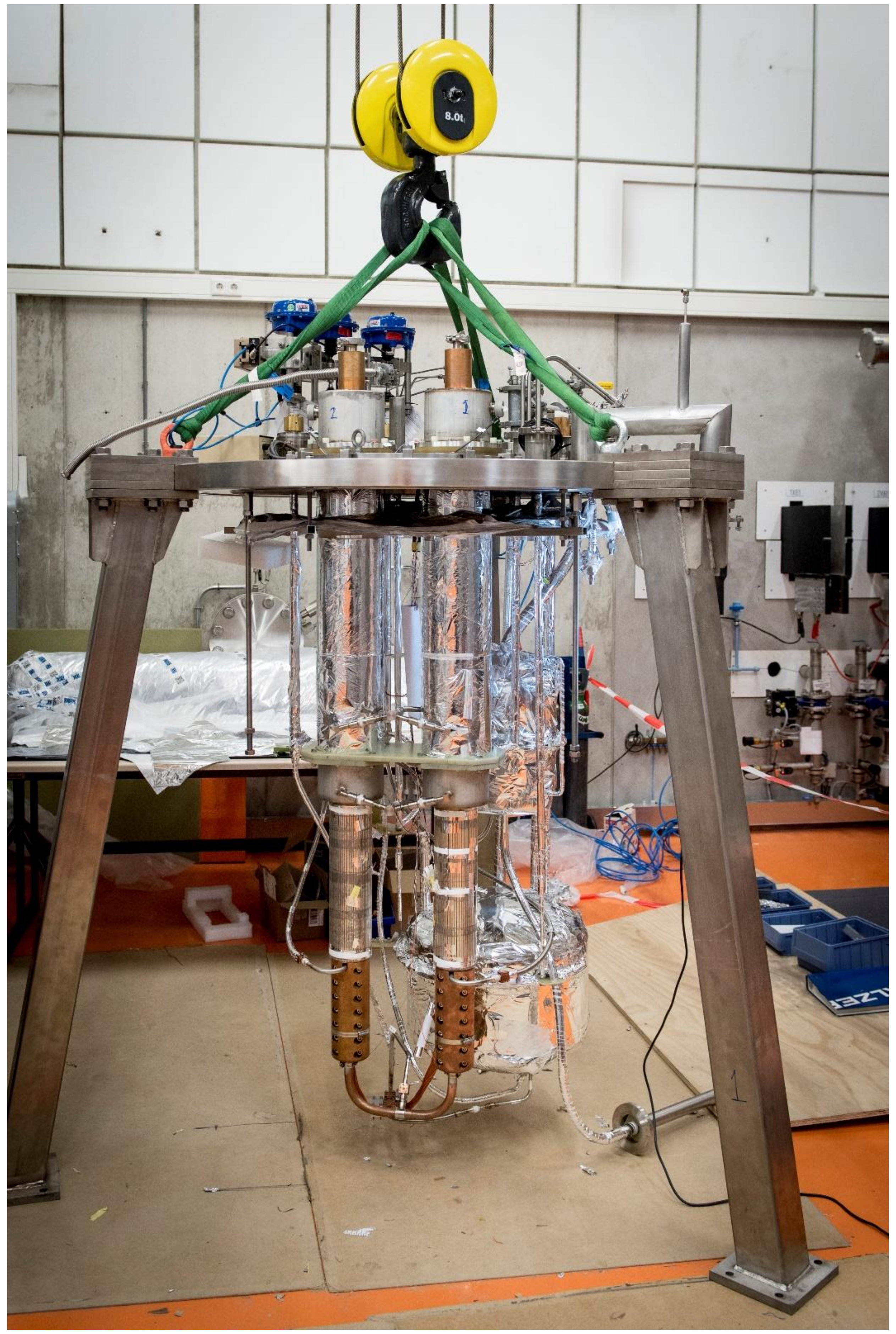
Supergeleidende spoel

ONTWIKKELINGSPROJECT – HYBRIDE MAGNEET – LN_2 FASESCHEIDER

DEMACO

ONTWIKKELINGSPROJECT – HYBRIDE MAGNEET – CURRENT LEADS

Current leads van LN_2 temperatuur naar vloeibaar Helium



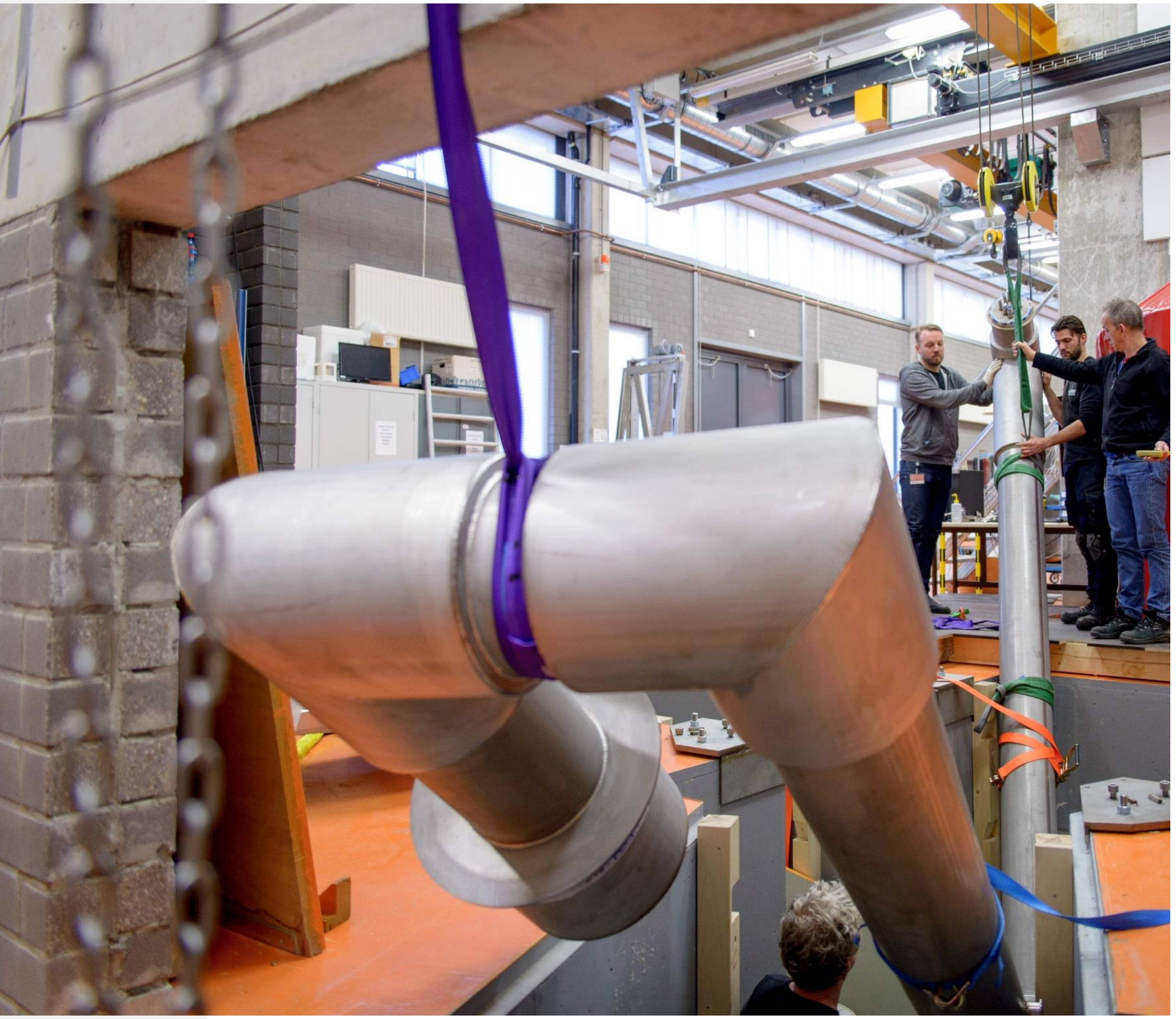
ONTWIKKELINGSPROJECT – HYBRIDE MAGNEET – VALVE BOX

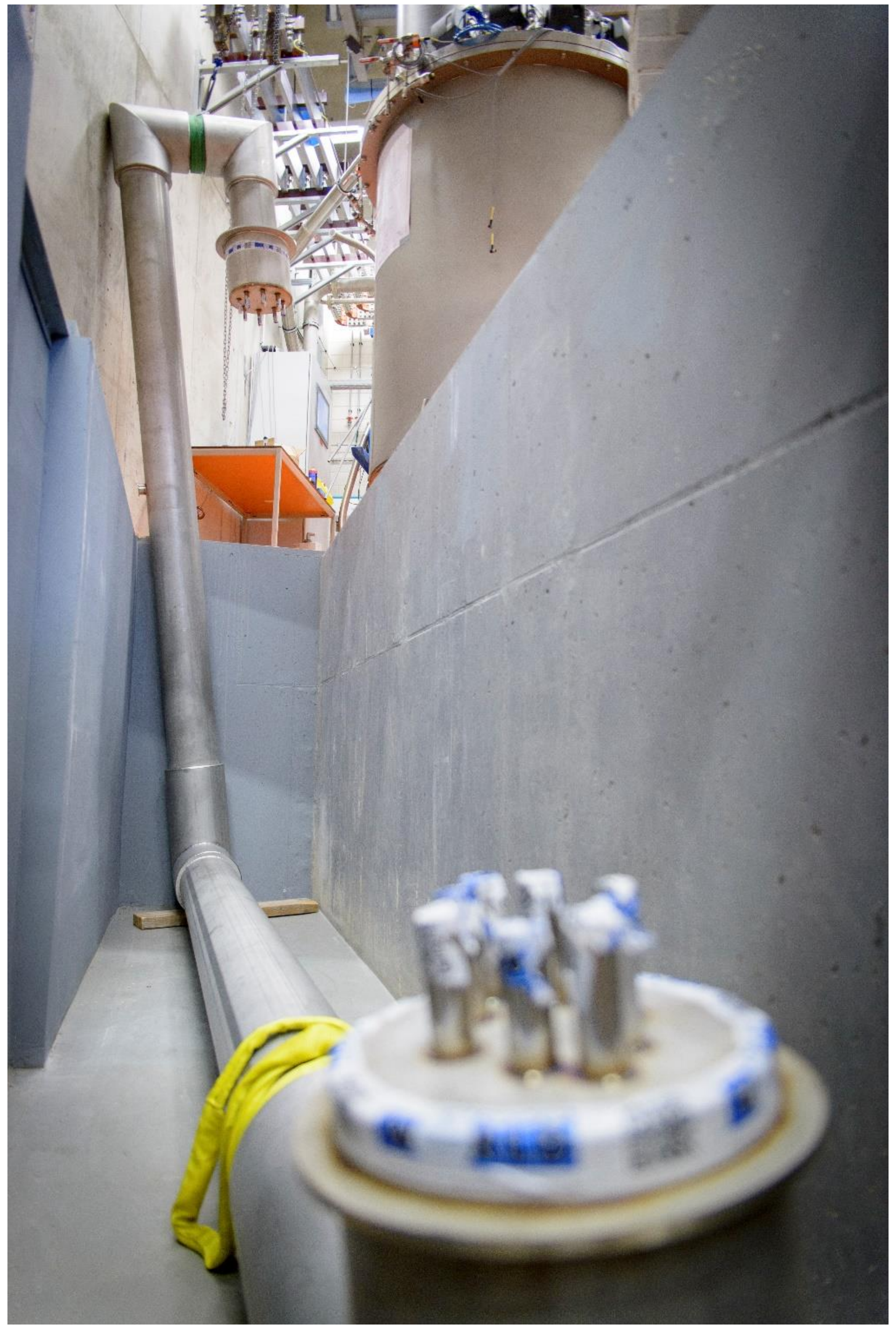
Valve box (links) is gekoppeld aan de Helium liquefier (rechts)

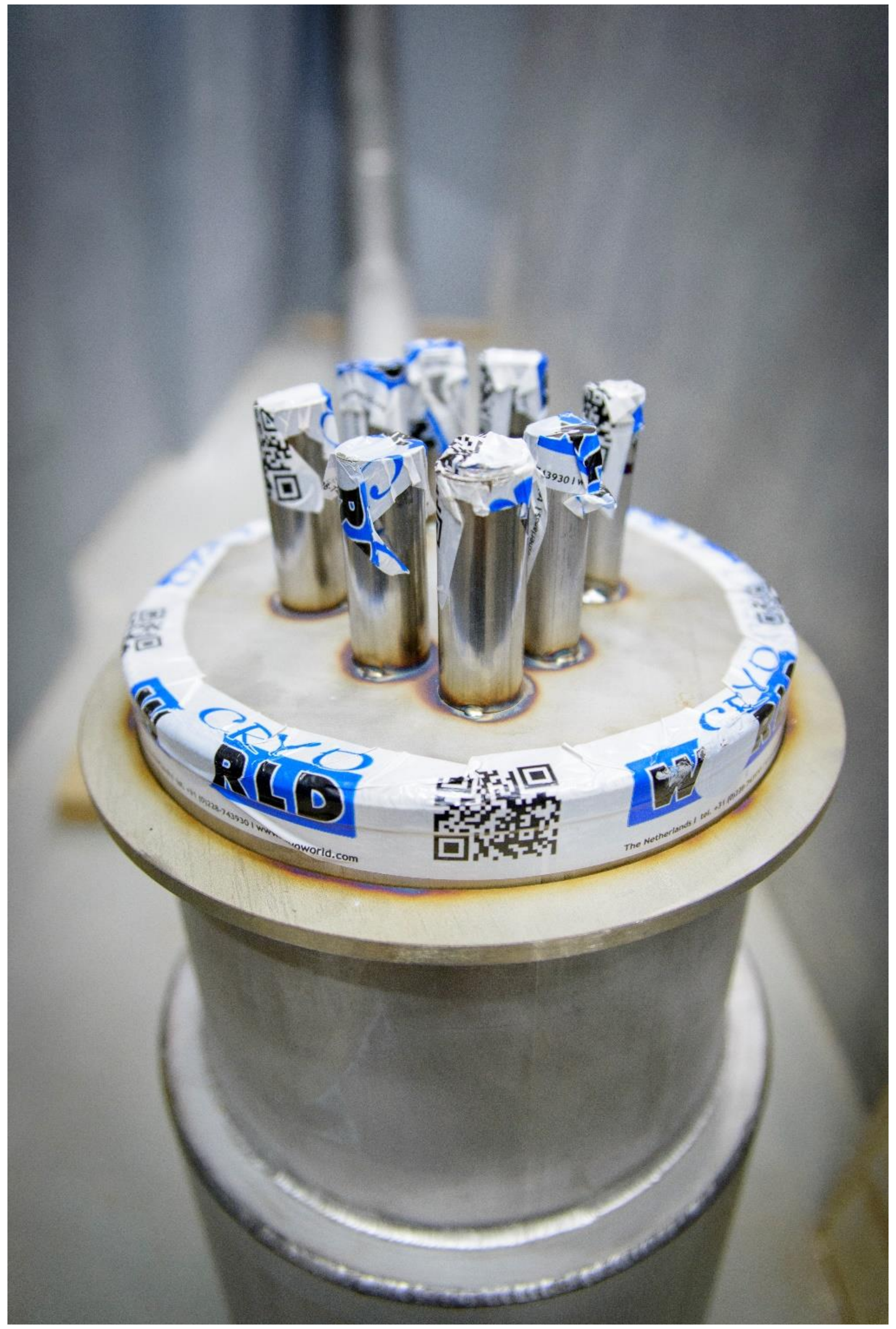
cryoworld
advanced cryogenics

ONTWIKKELINGSPROJECT – HYBRIDE MAGNEET - BUSBAR

Busbars voor de 20 kA voeding van de supergeleidende spoel







Radboud Universiteit

cryoworld advanced cryogenics

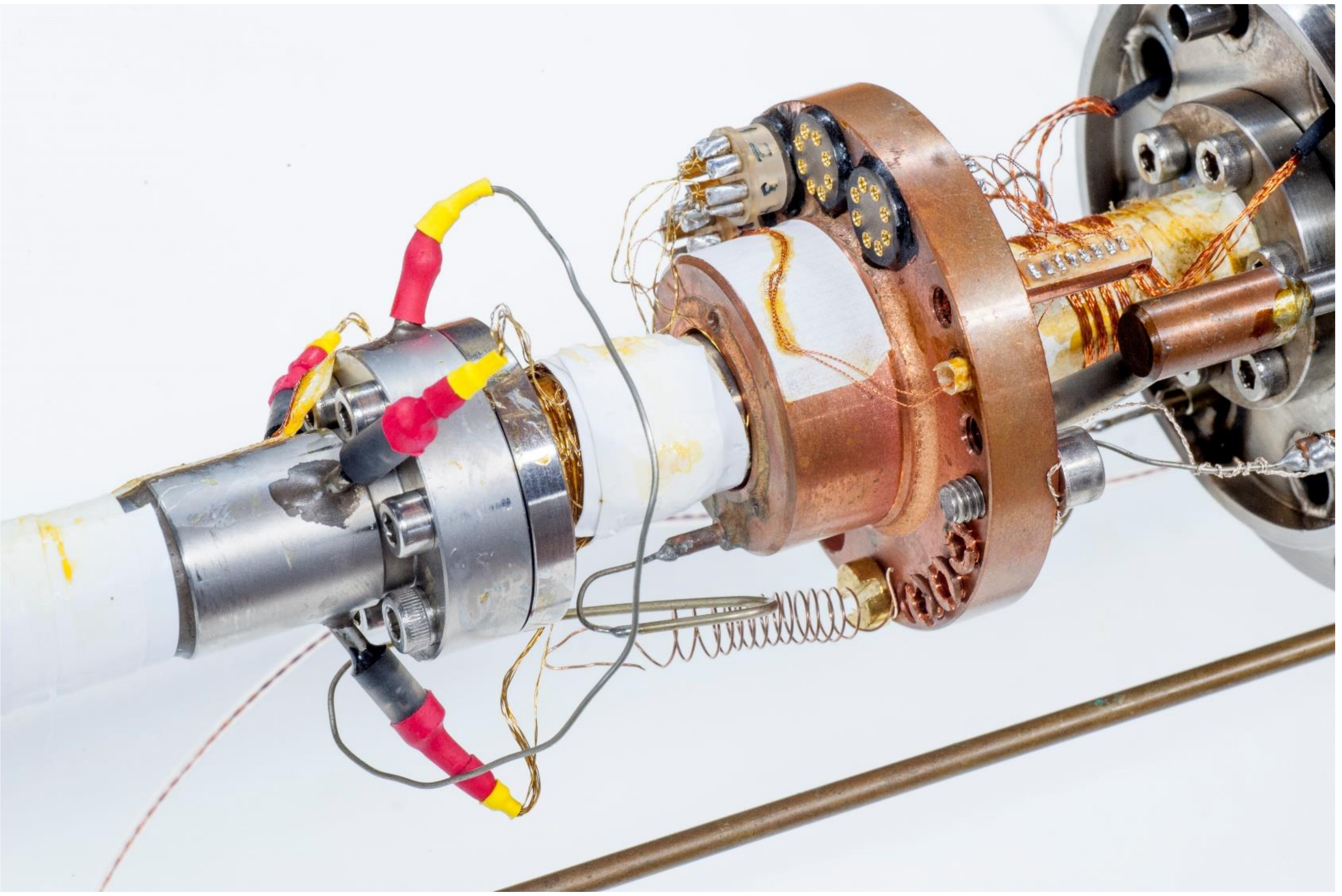
ONTWIKKELINGSPROJECT : ULTRA-LOW TEMPERATURES IN HIGH MAGNETIC FIELDS

2 phase project:

- 0.4 mK in a 14 T superconducting magnet
- 5 mK in 38 T resistive magnet

In samenwerking met Leiden Cryogenics B.V.

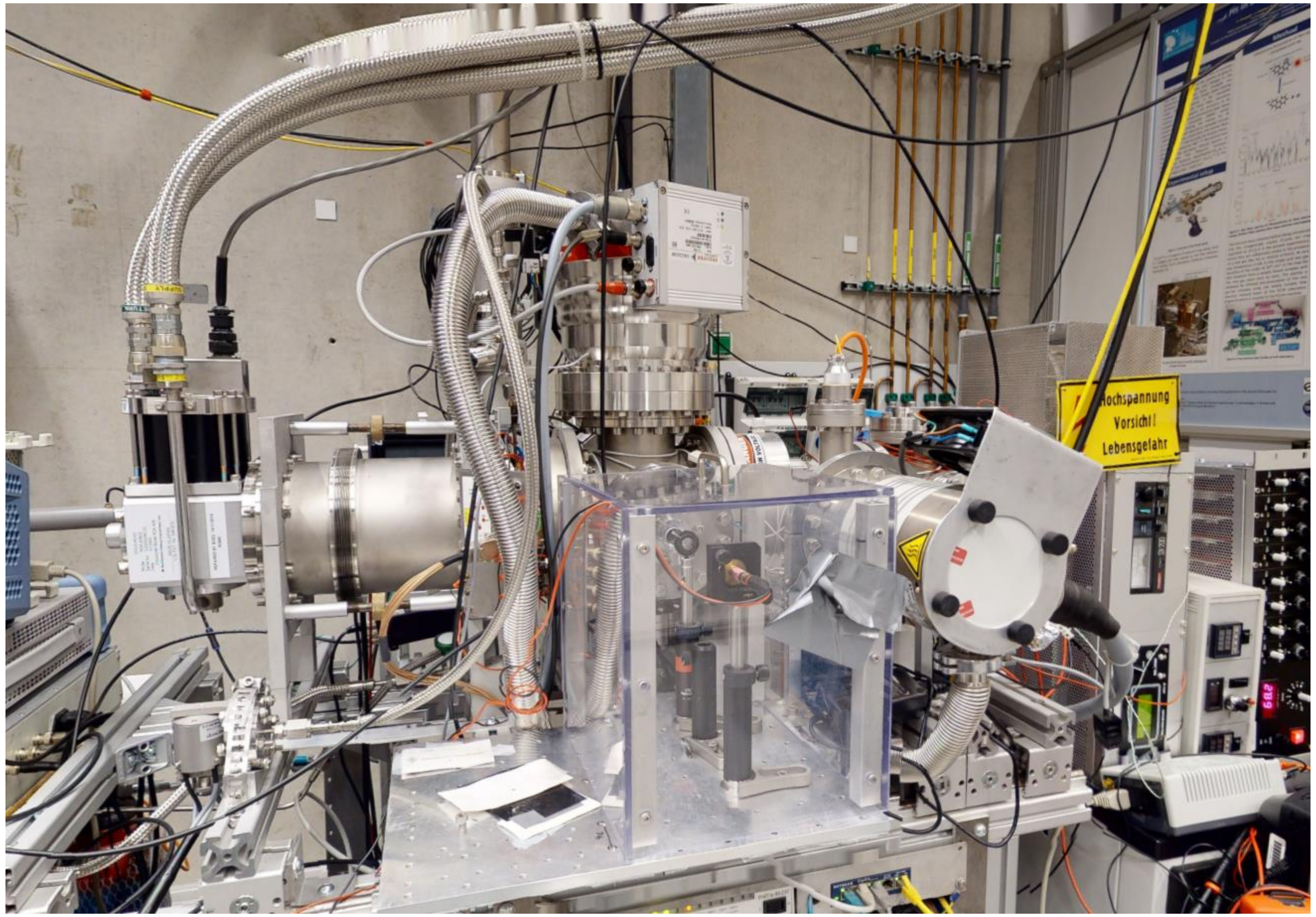
Leiden Cryogenics
Leader in Low Temperature Techniques



Huidige Helium-3 probe

ONTWIKKELINGSPROJECT: ULTRA HIGH VACUÜM KAMERS MET FELIX LICHT

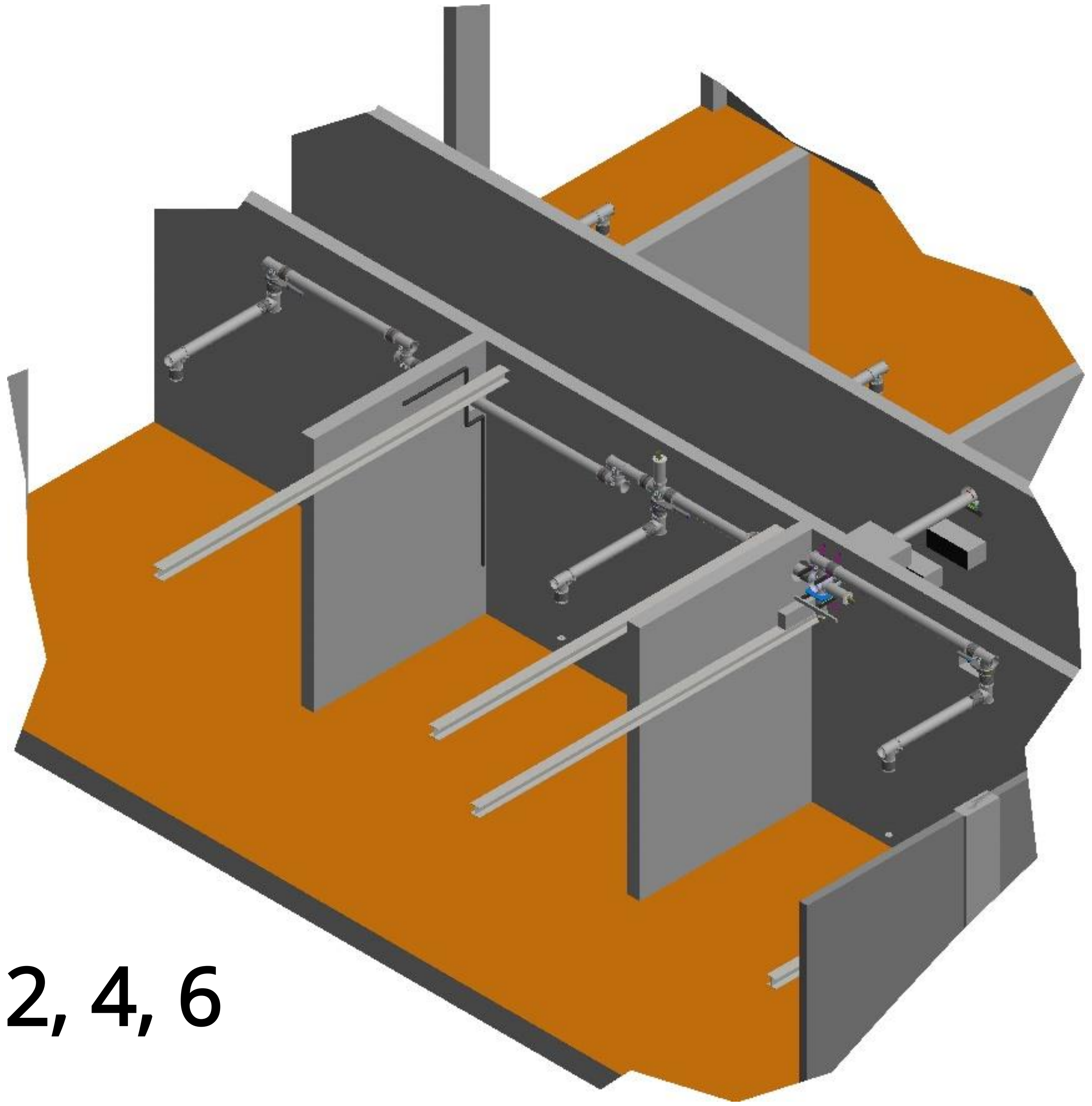
Ontwikkelen van een ultra hoog vacuüm kamer voor experimenten om oppervlakte processen te bestuderen met FELIX laser licht, inclusief absorptie, diffusie, desorptie, reacties, katalyses and molecular scattering.



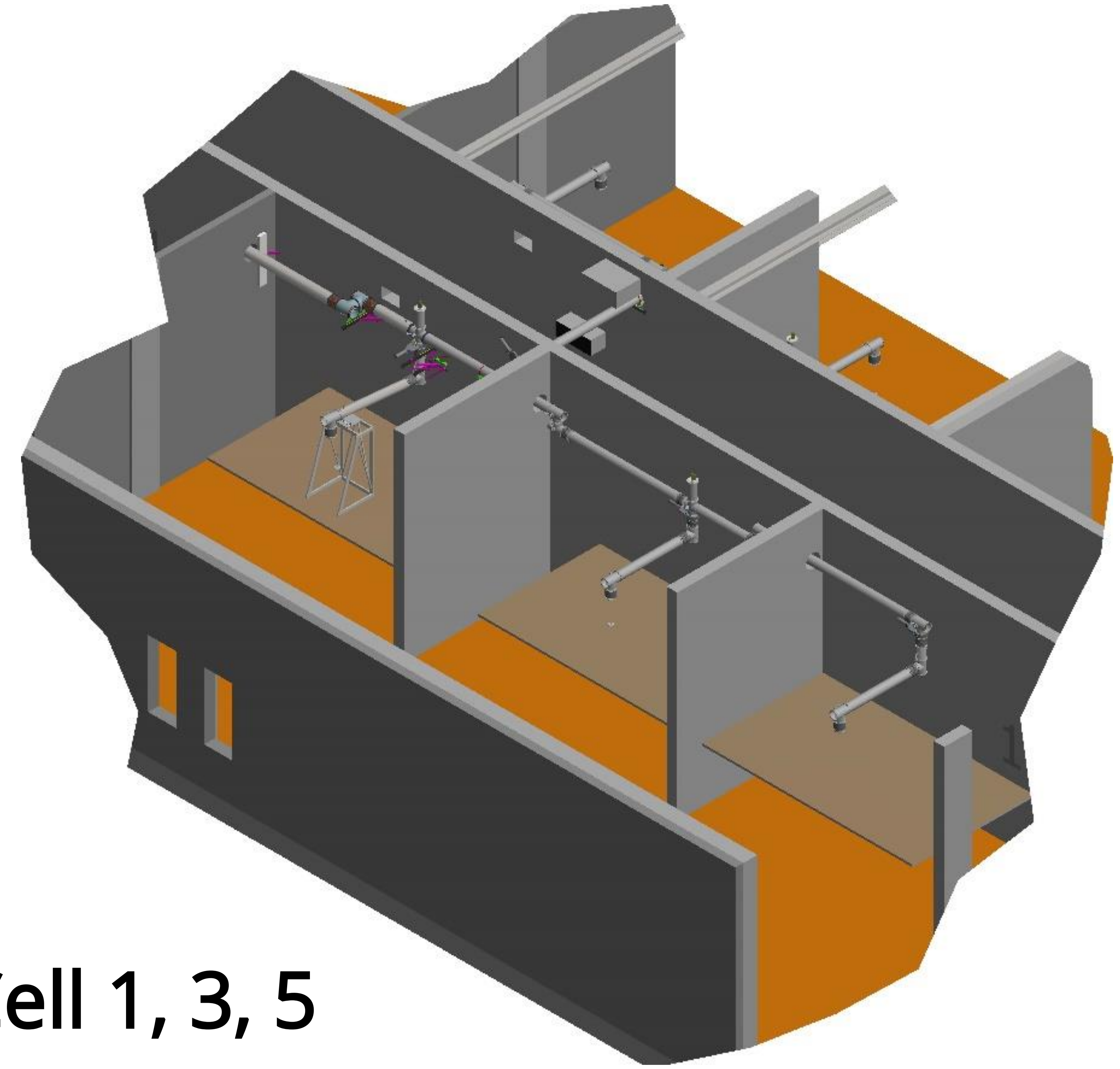
Voorbeeld van een User Station in FELIX Laboratory

ONTWIKKELINGSPROJECTEN – BUNDELLIJN (VACUUM) FELIX NAAR HFML

Extension FELIX optical beamline to all 6 magnet cells @ HFML



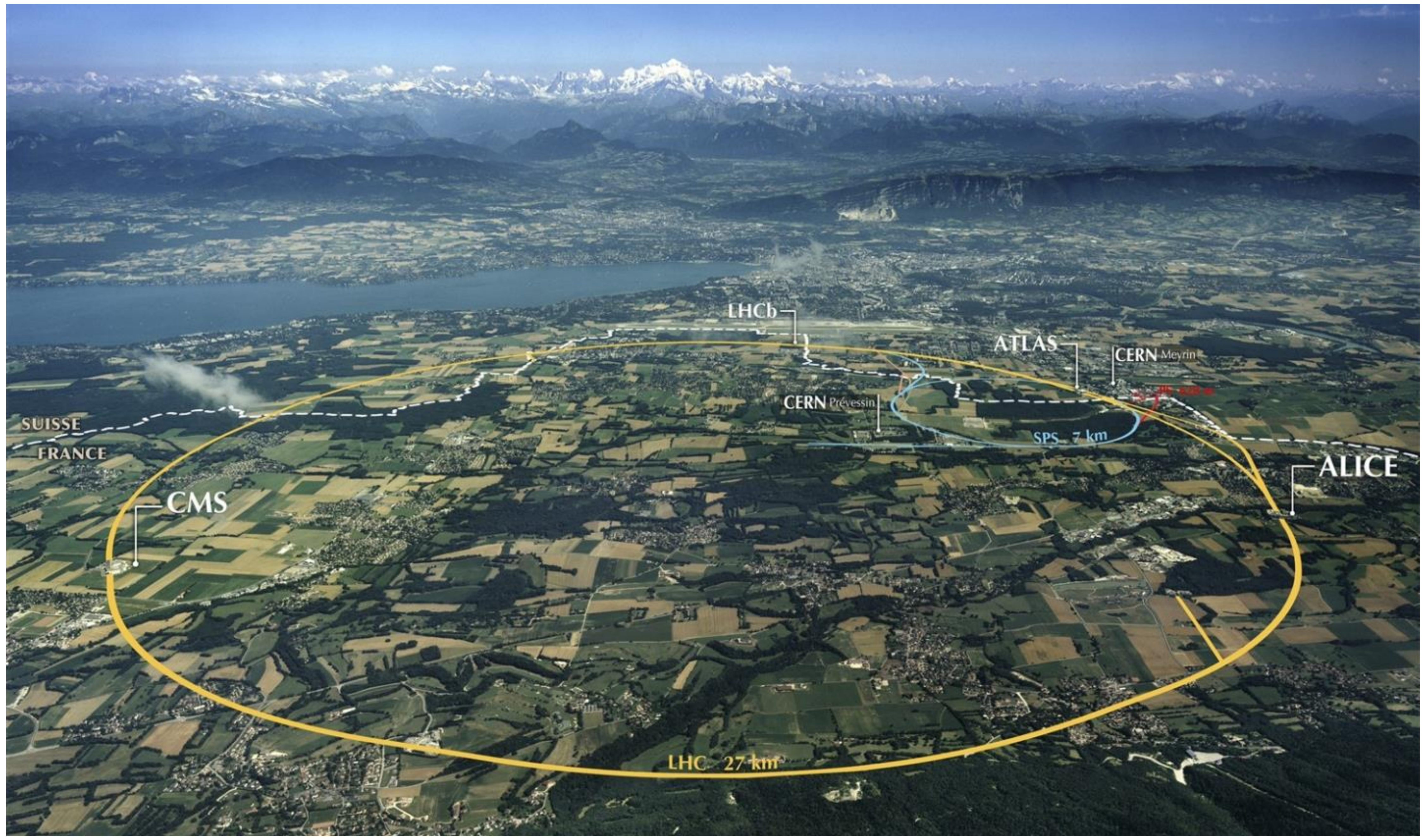
Cell 2, 4, 6

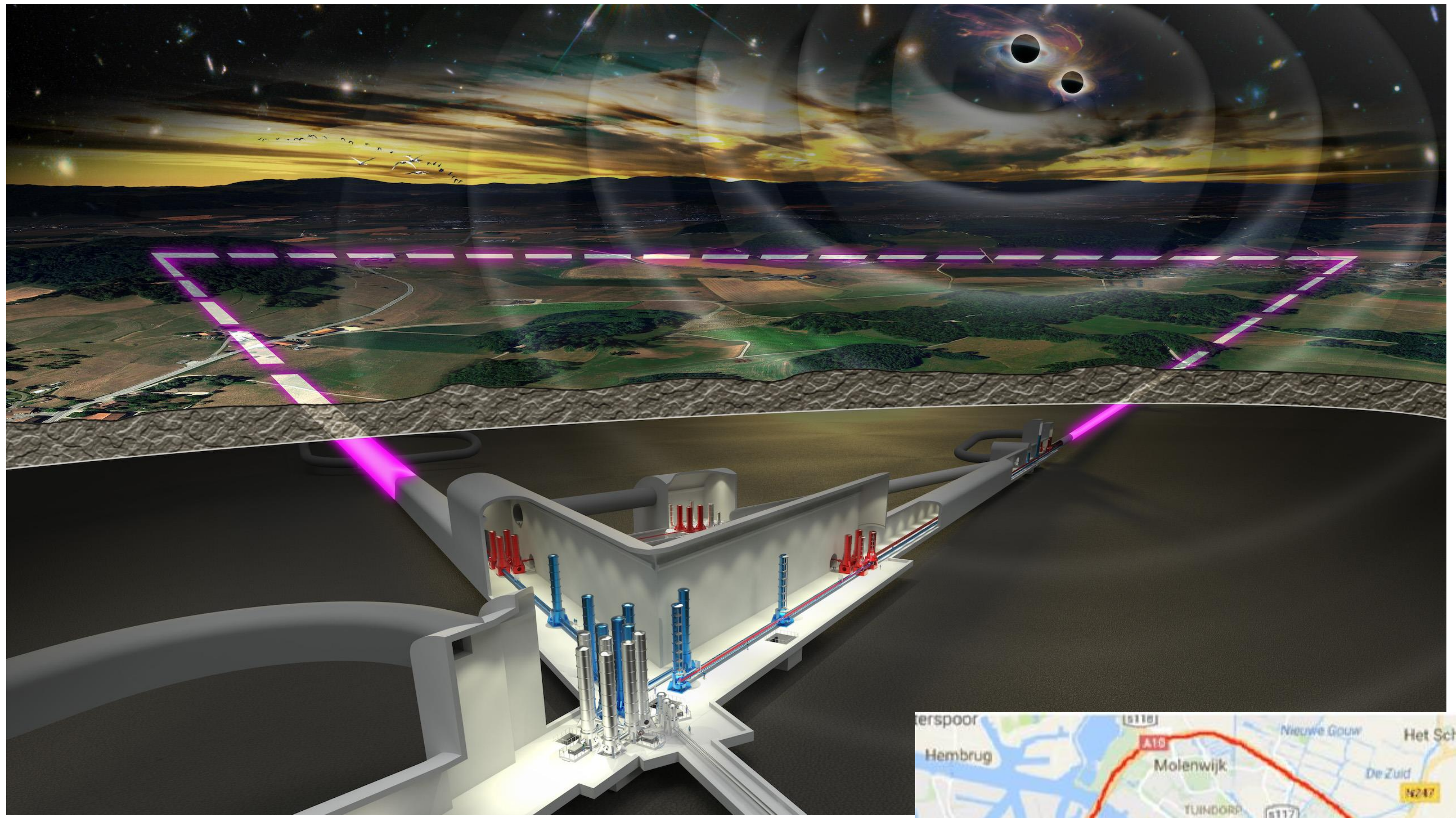


Cell 1, 3, 5

Cryogenics & vacuum
at
CERN & Einstein Telescope

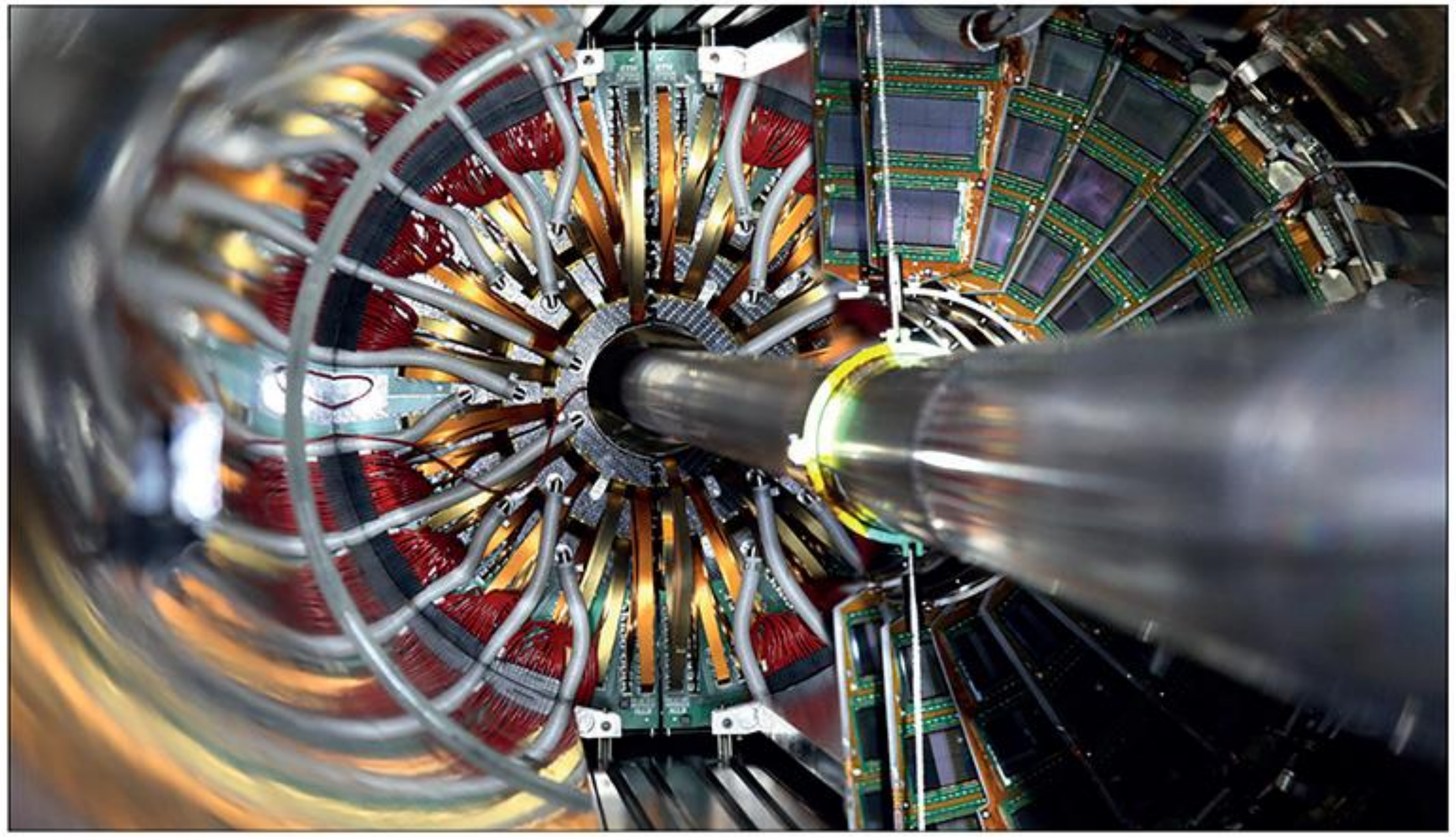
Basics

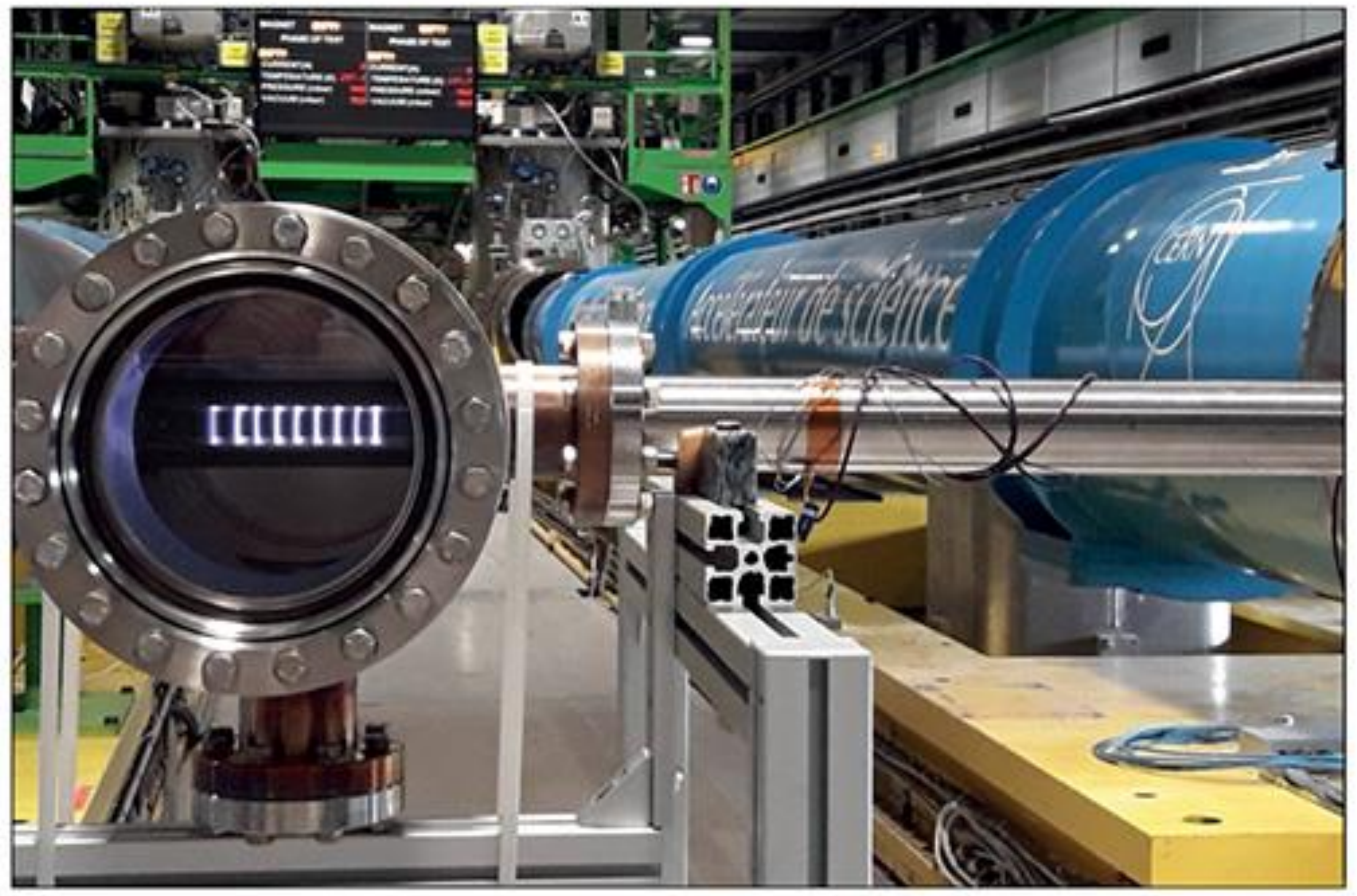


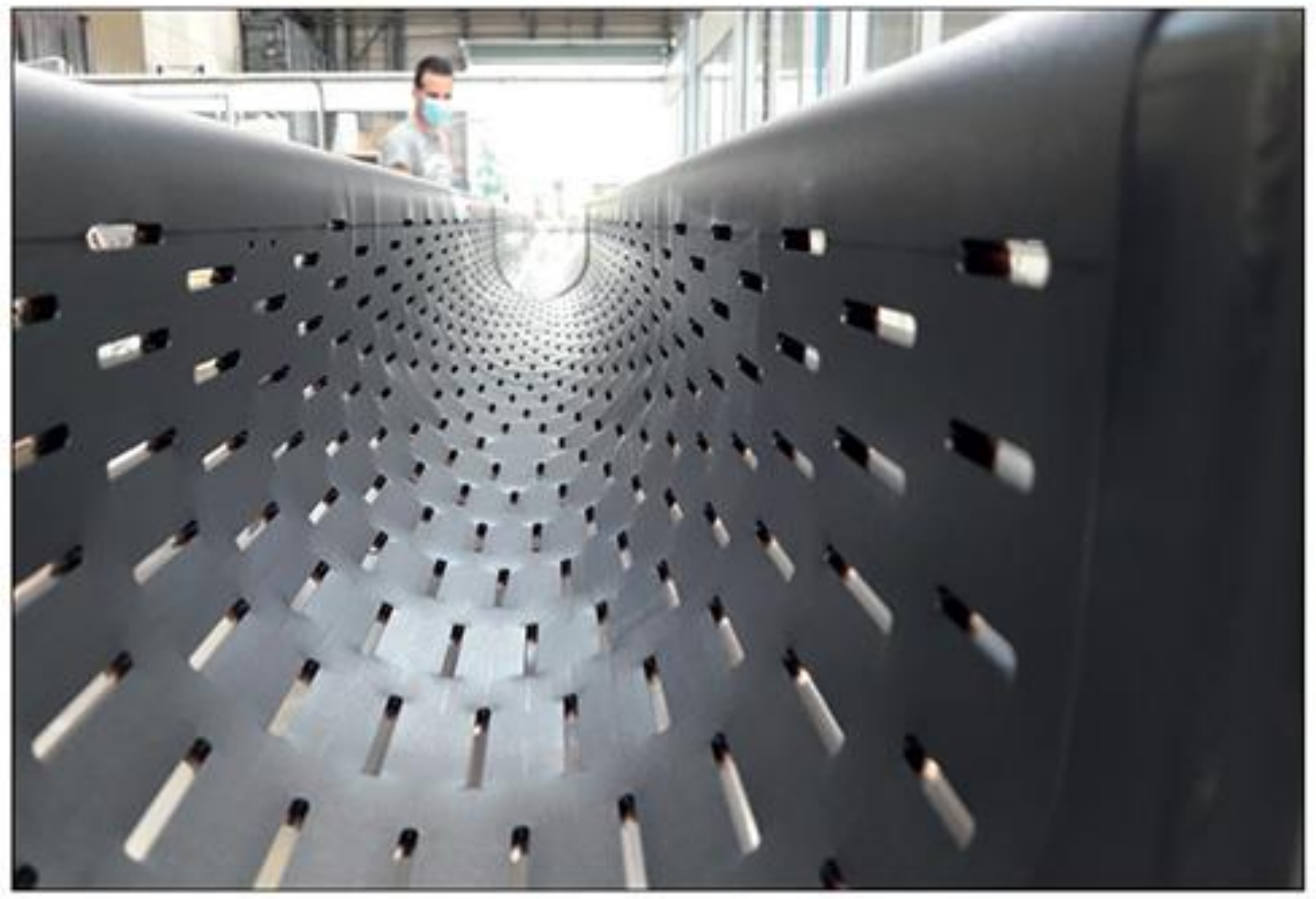


- Two of the largest vacuum systems in the world
- Both relying on excellent vacuum and cryogenic systems

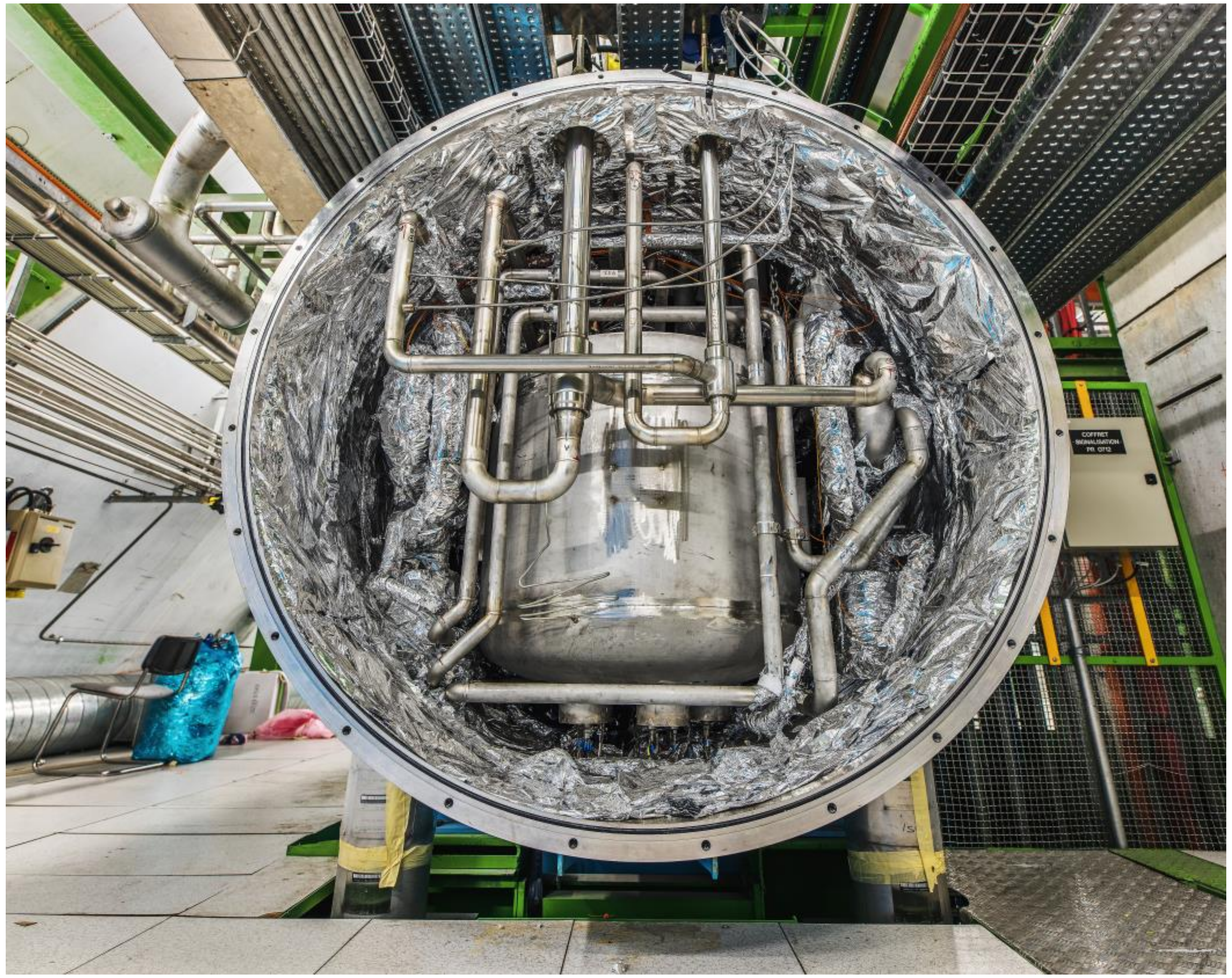
CERN - vacuum

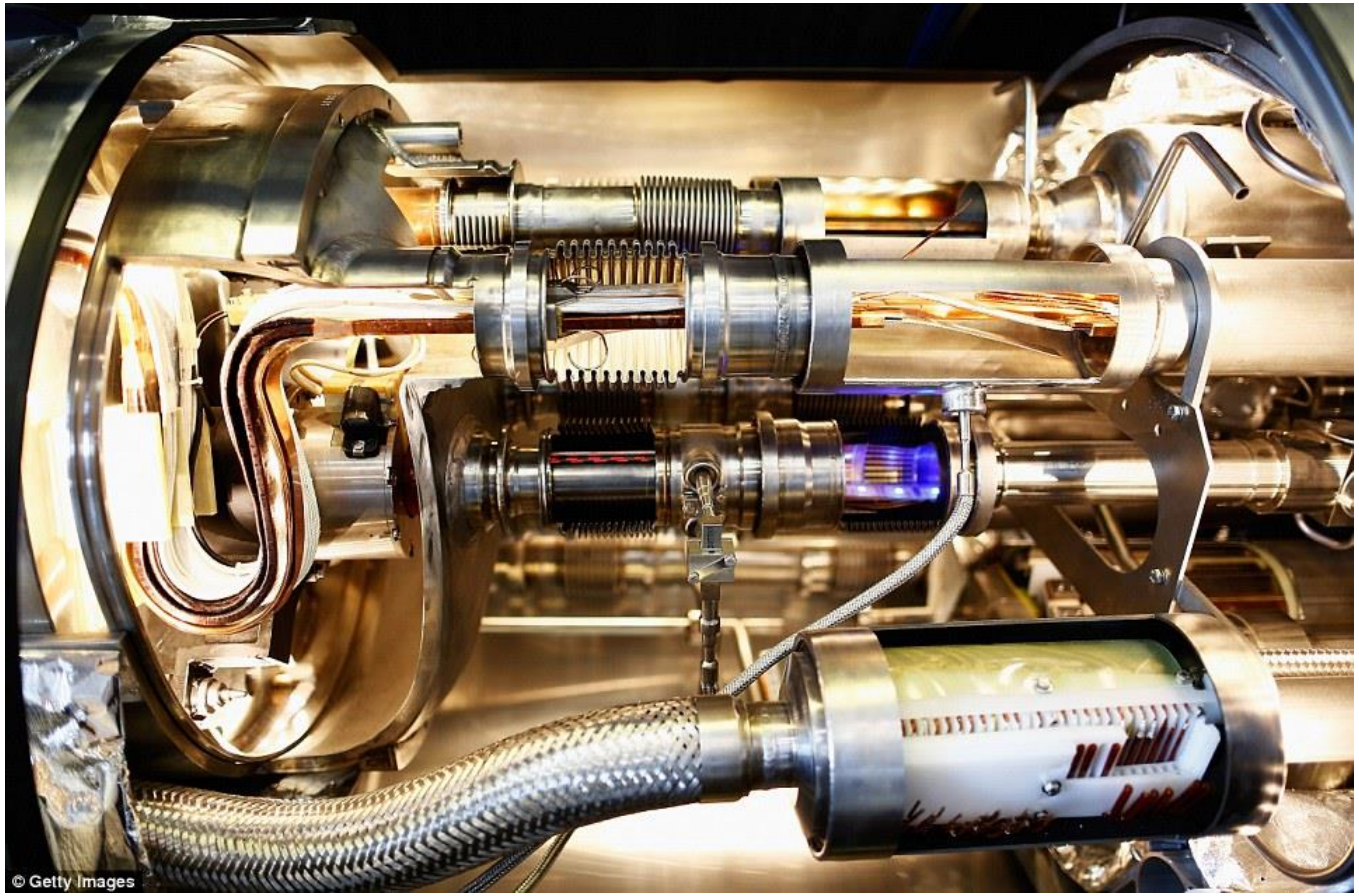




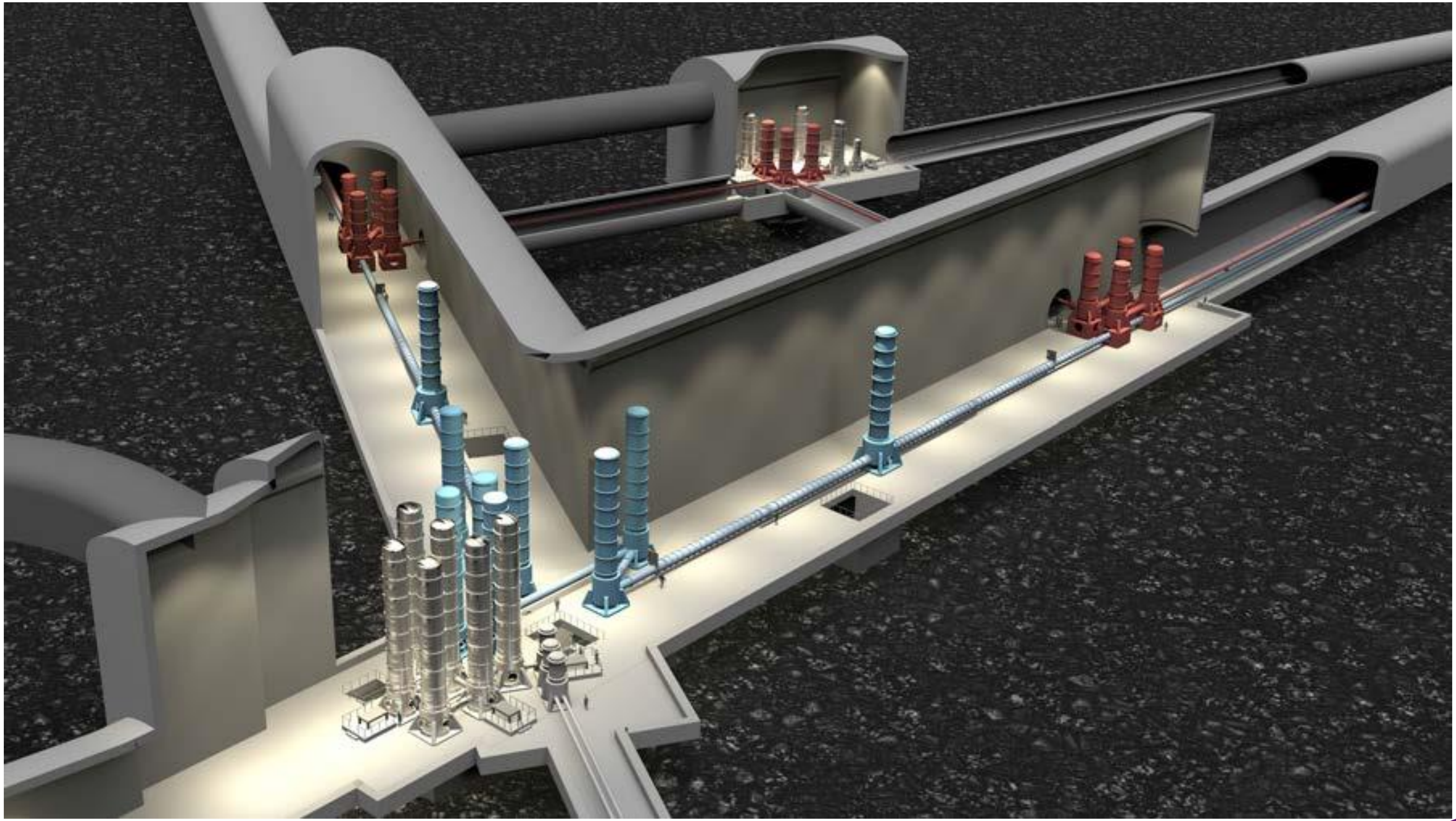


CERN - cryogenics

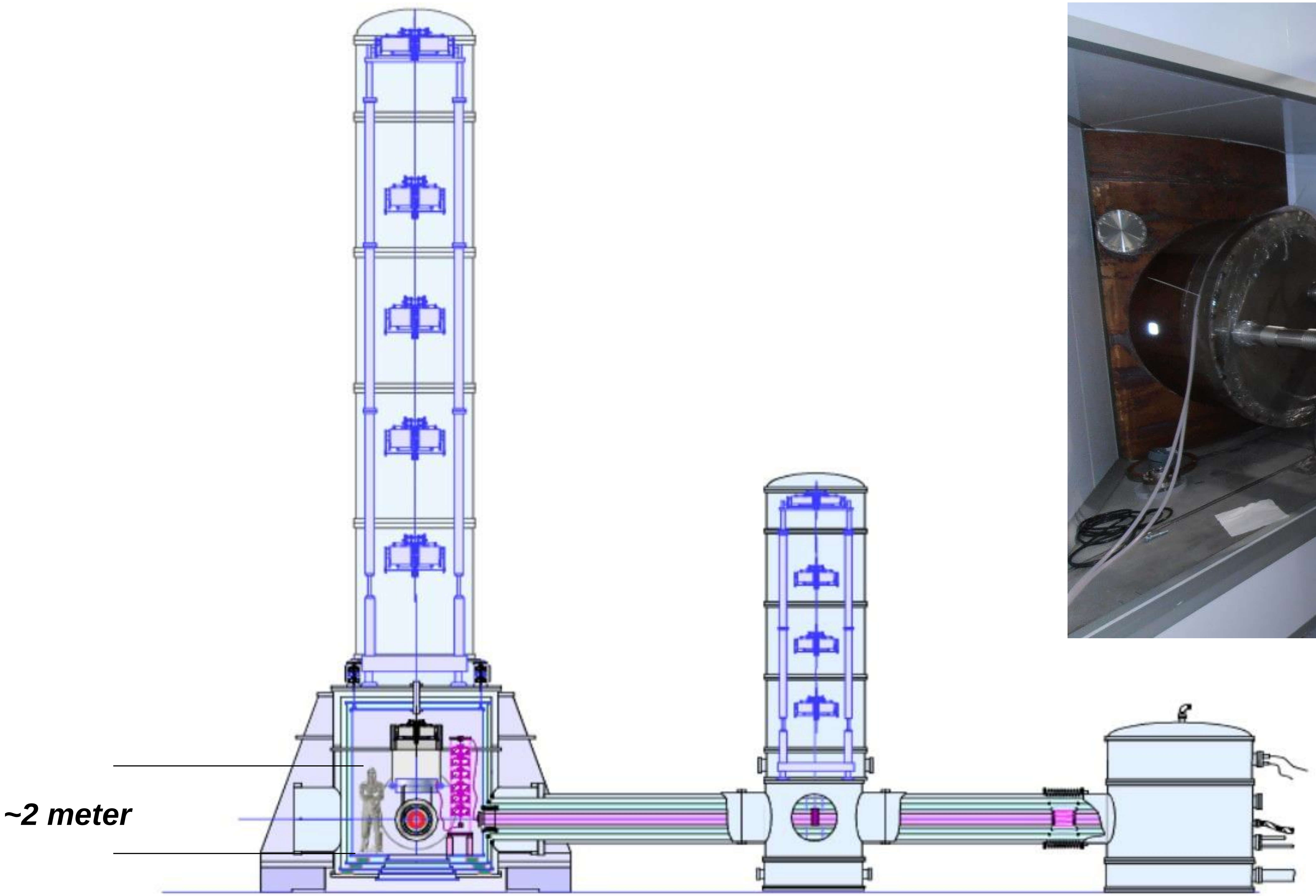


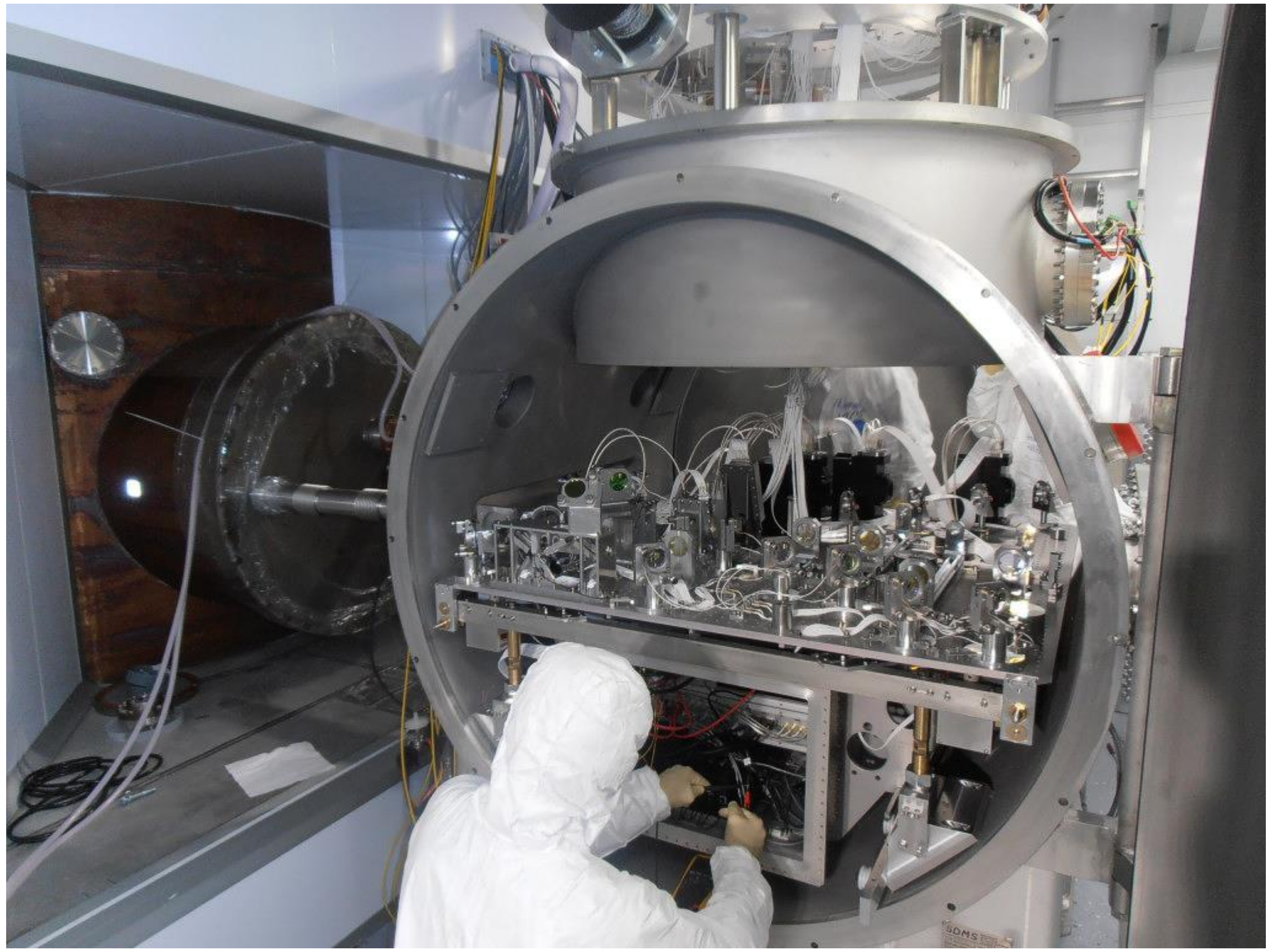


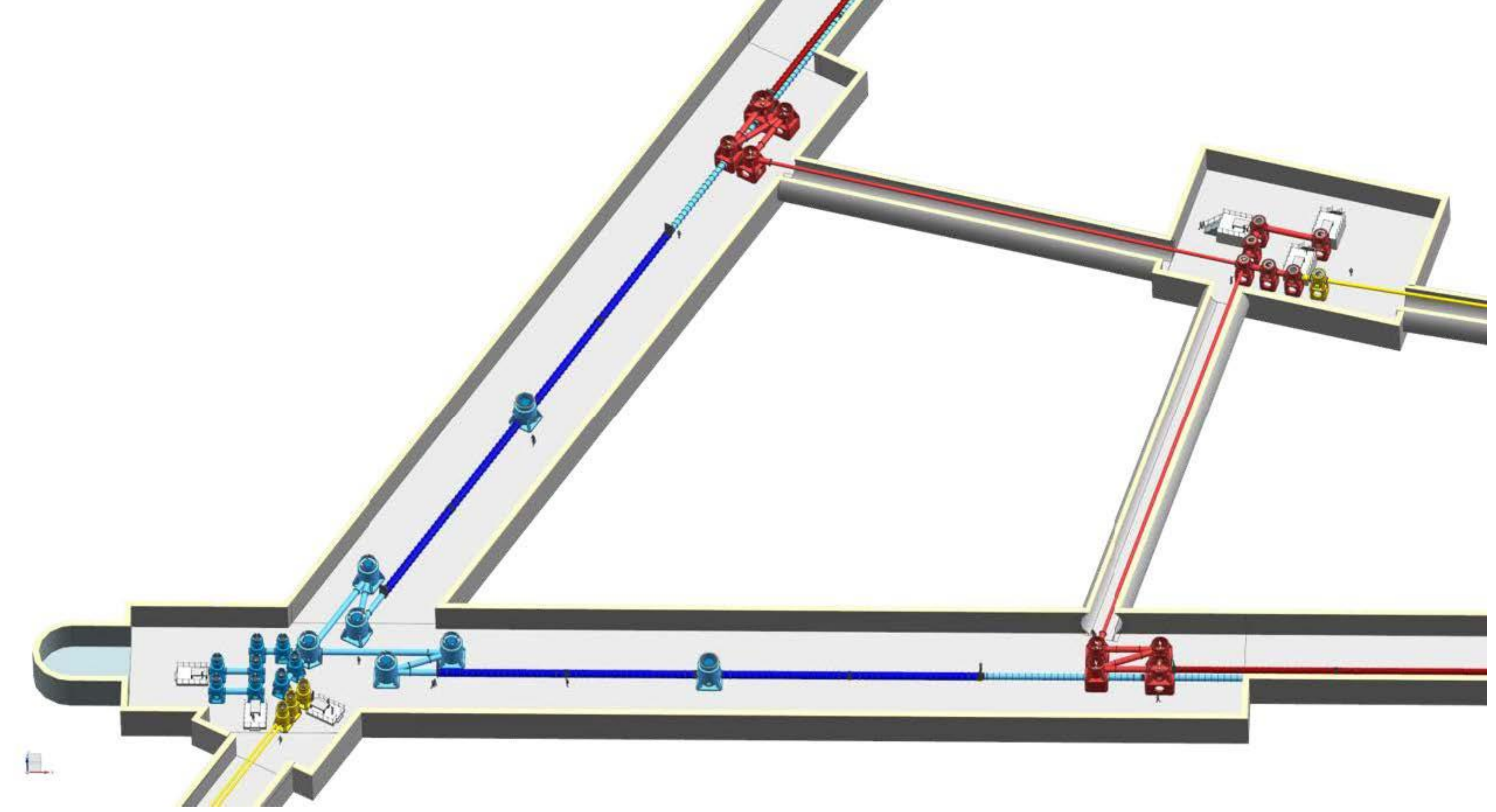
Einstein Telescope



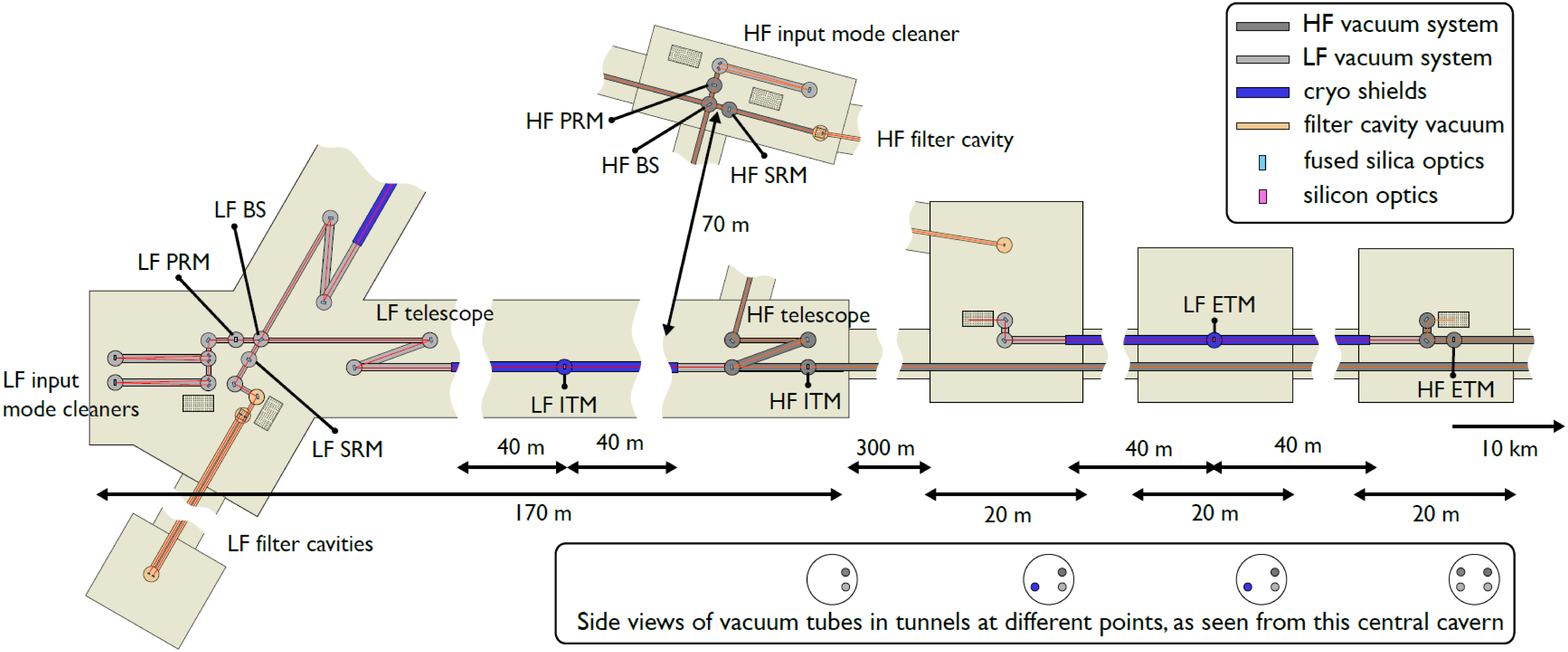
Einstein Telescope







Einstein Telescope



Einstein Telescope

ET2SMEs project

- **Cryogenics**
- *Mirror cooled at cryogenic temperature almost in absence of mechanical contact: mirror suspended in UHV environment via four thin and long fibers*
- *Large suppression of cryogenic plant vibration noise*
- *Reducing cooldown time for higher duty cycle of the telescope*
- *Manufacturing silicon monocrystalline fibers*
- *Management of ice film formation on the mirror surface*

- Catalogue of required technologies: **https://et2smes.eu/et-technologies-catalogue/**

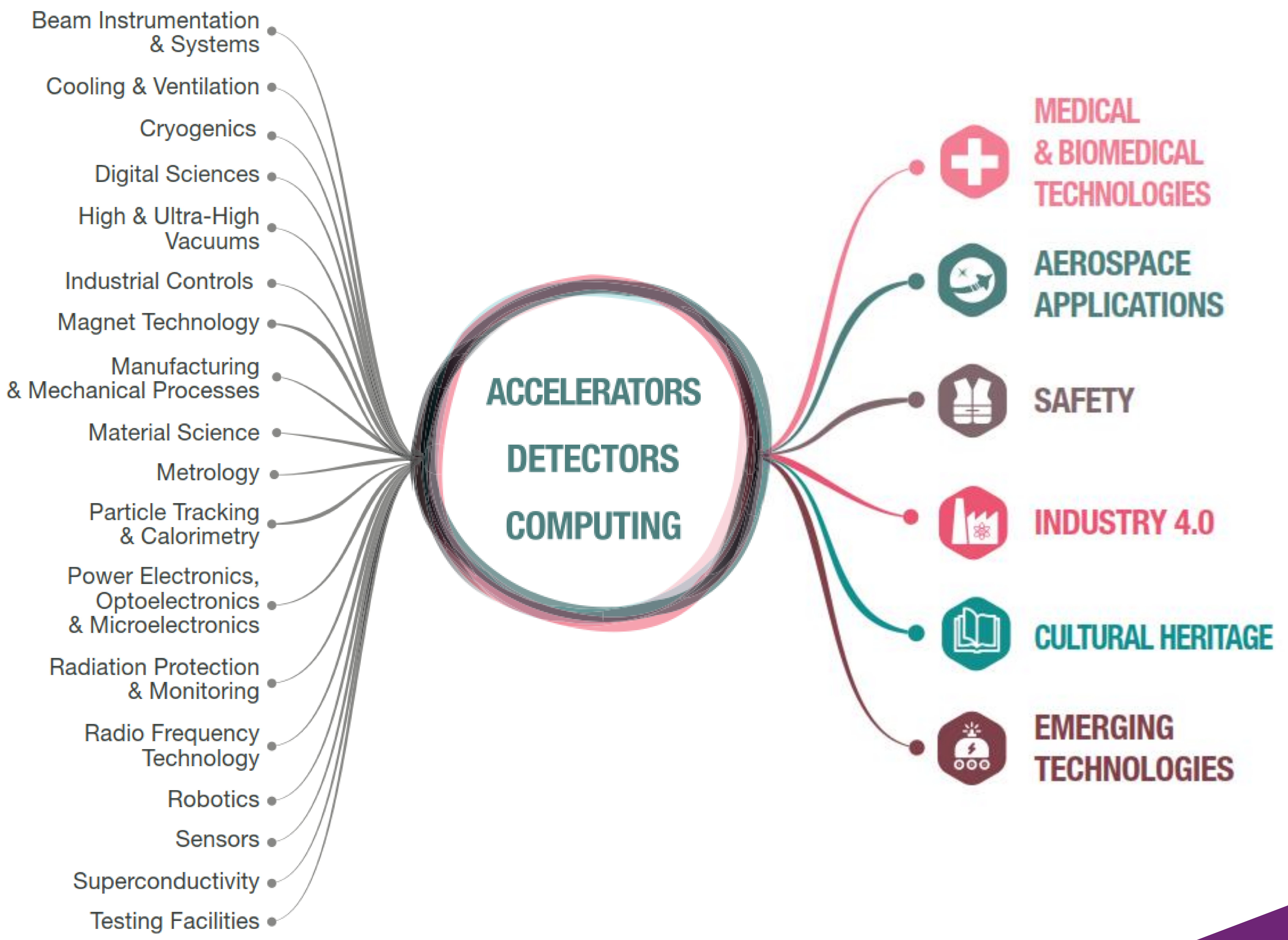
Einstein Telescope

ET2SMEs project

- **Vacuum**
- *Can a properly coated mild-steel solution be found as economic base material for the Einstein Telescope UHV vacuum tubes?*
- *Are composites a cost-effective alternative for stainless steel UHV vacuum tubes?*
- *Can a cost-effective procurement and installation scenario be found for the Einstein Telescope UHV vacuum tubes?*
- *Can synergies be identified with other 'large tube' projects such as in areas such as: oil & gas, offshore, windmills, hyperloop, hydrogen fuel cells*

- Catalogue of required technologies: https://et2smes.eu/et-technologies-catalogue/

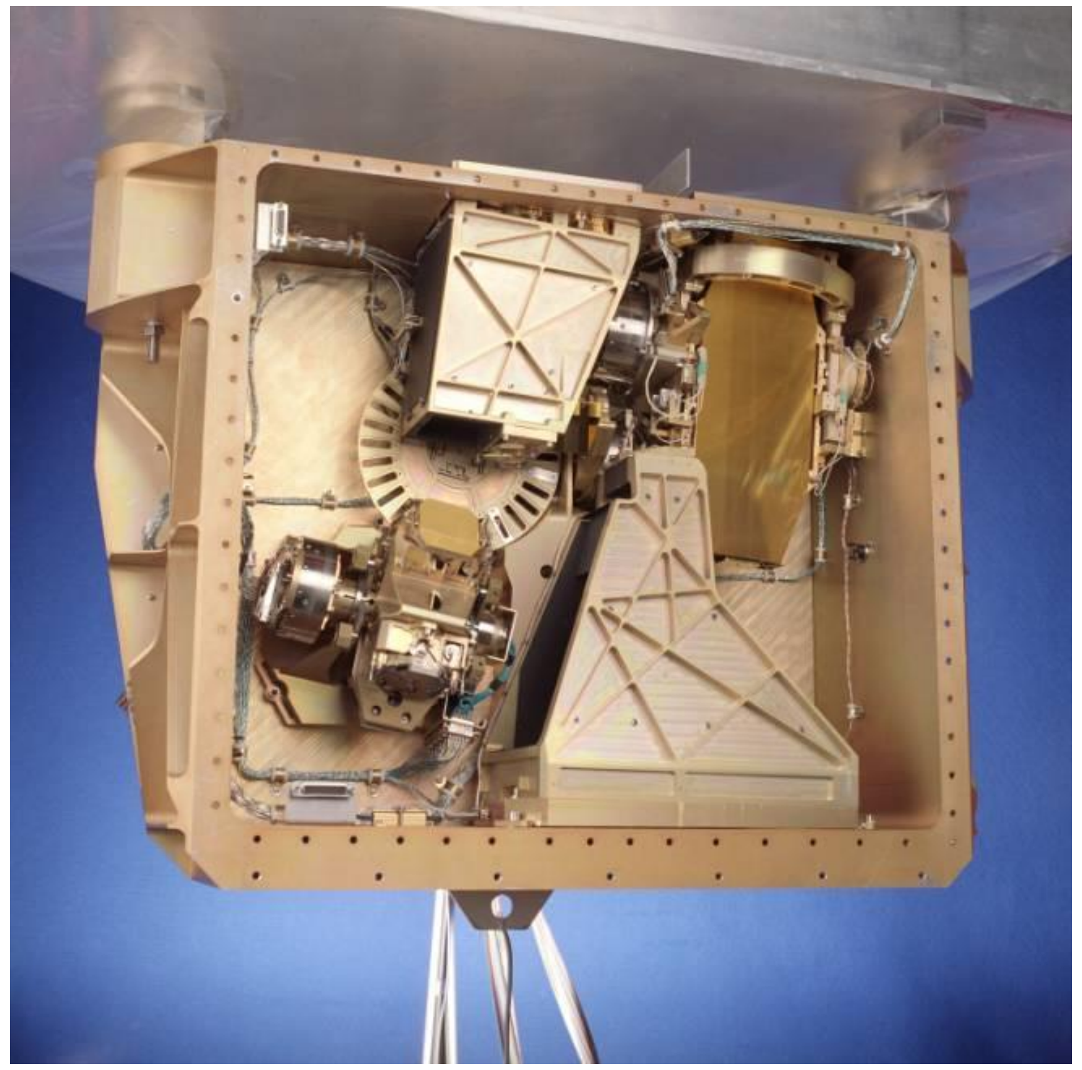
Technology domains

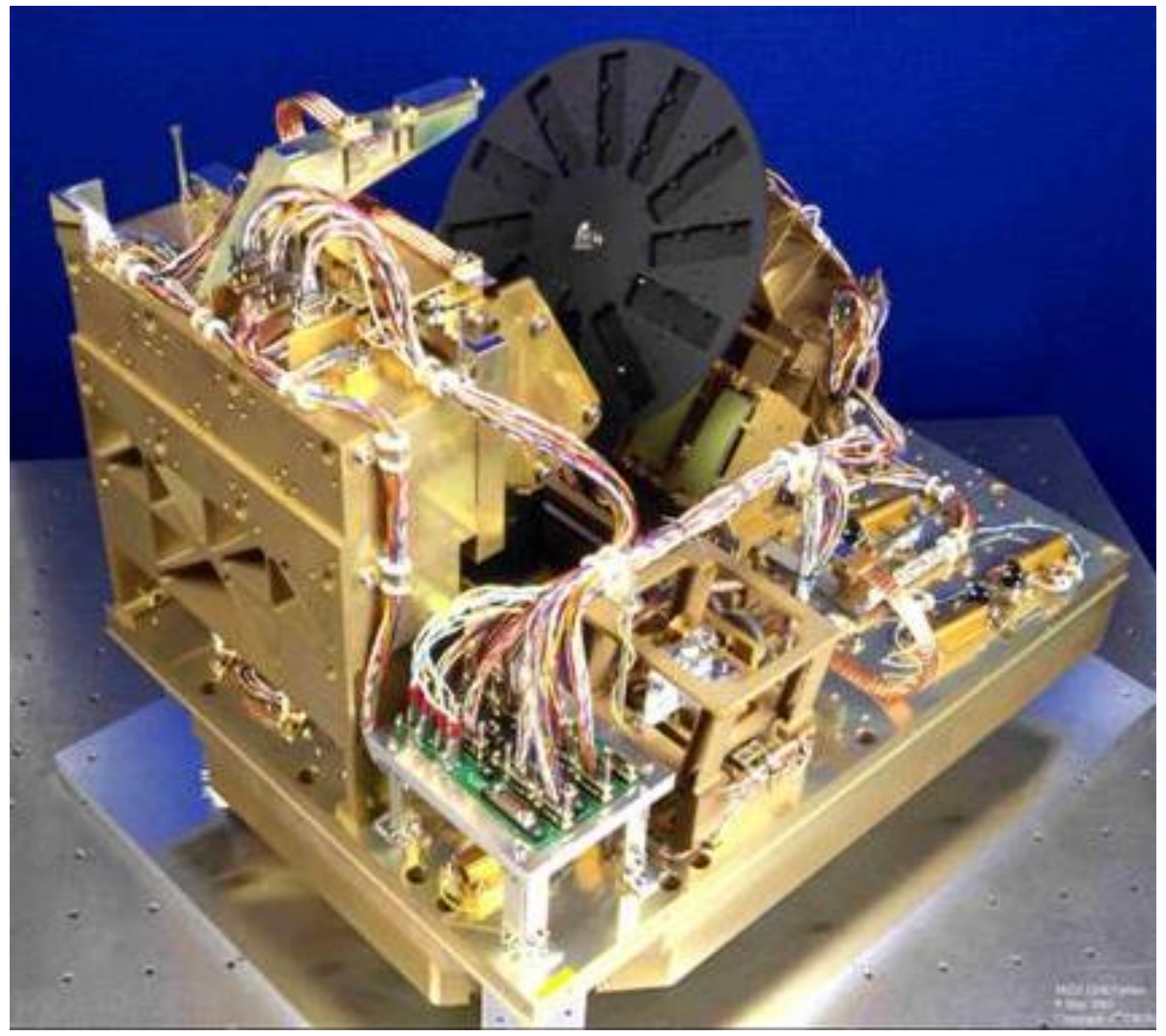


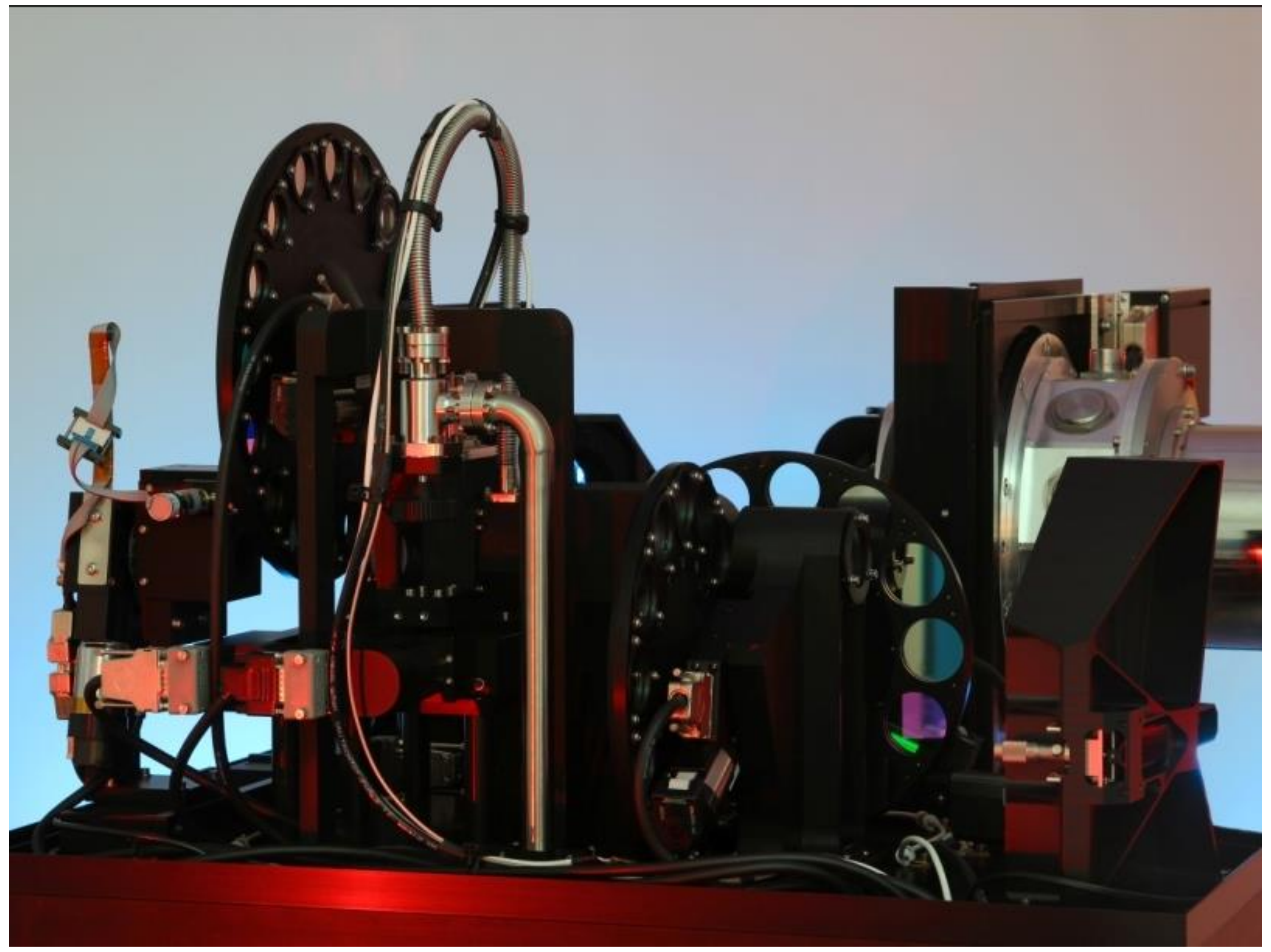
Cryogenic Mechanisms

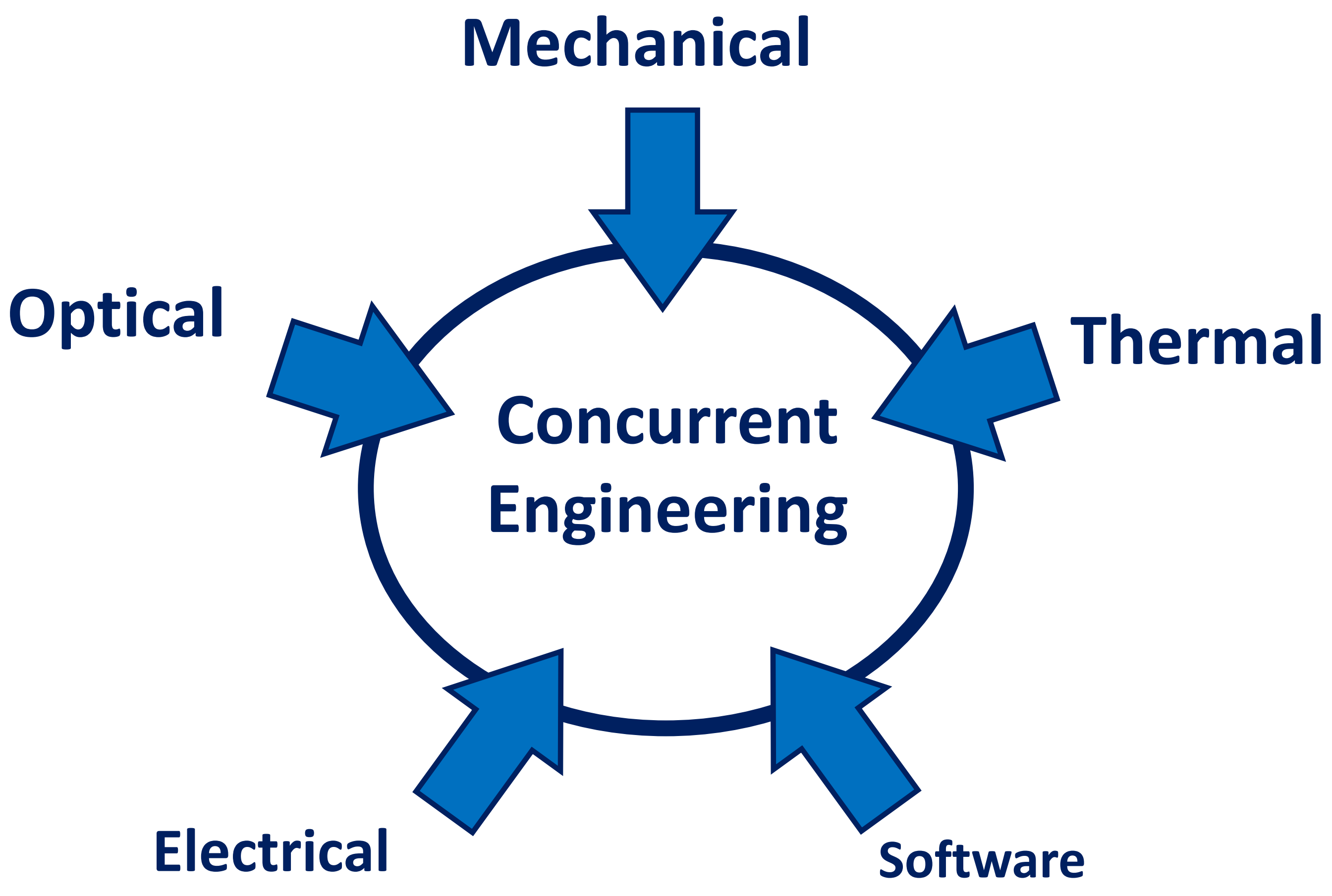
Optical Infrared Instrumentation

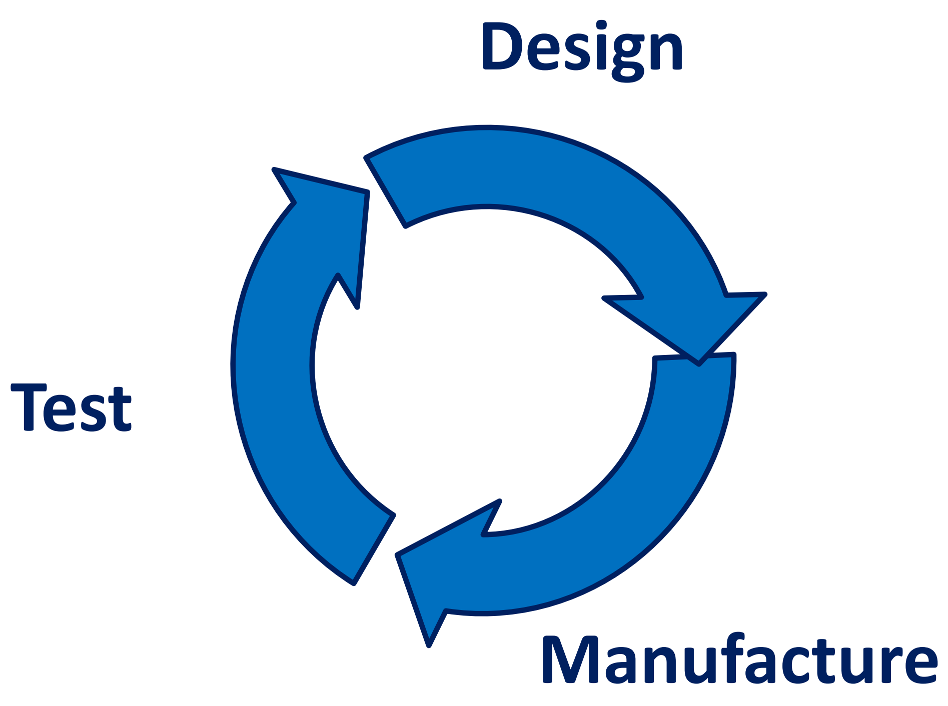
Spectrography | Interferometry | Polarimetry









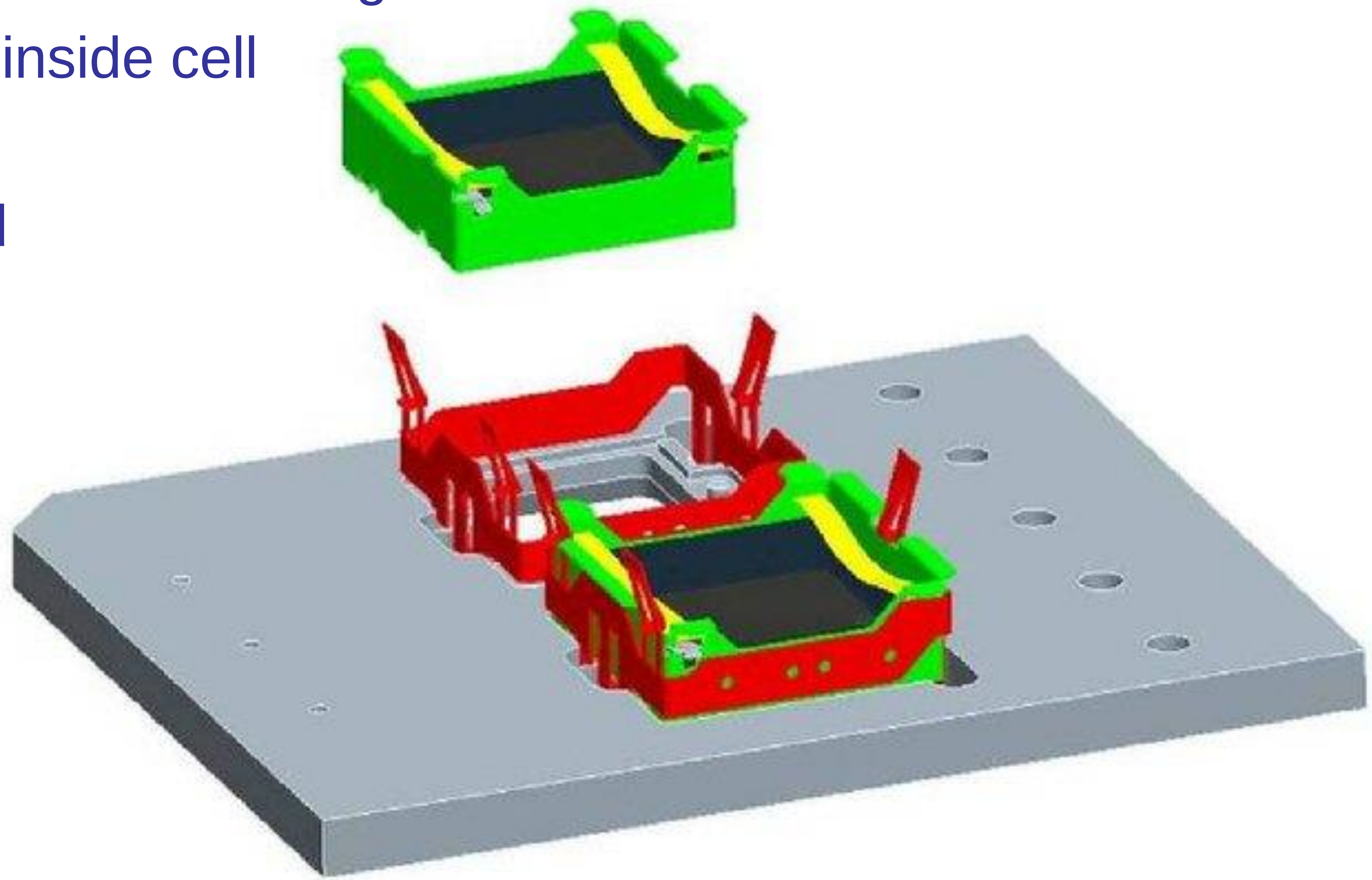


Various types of Mechanisms

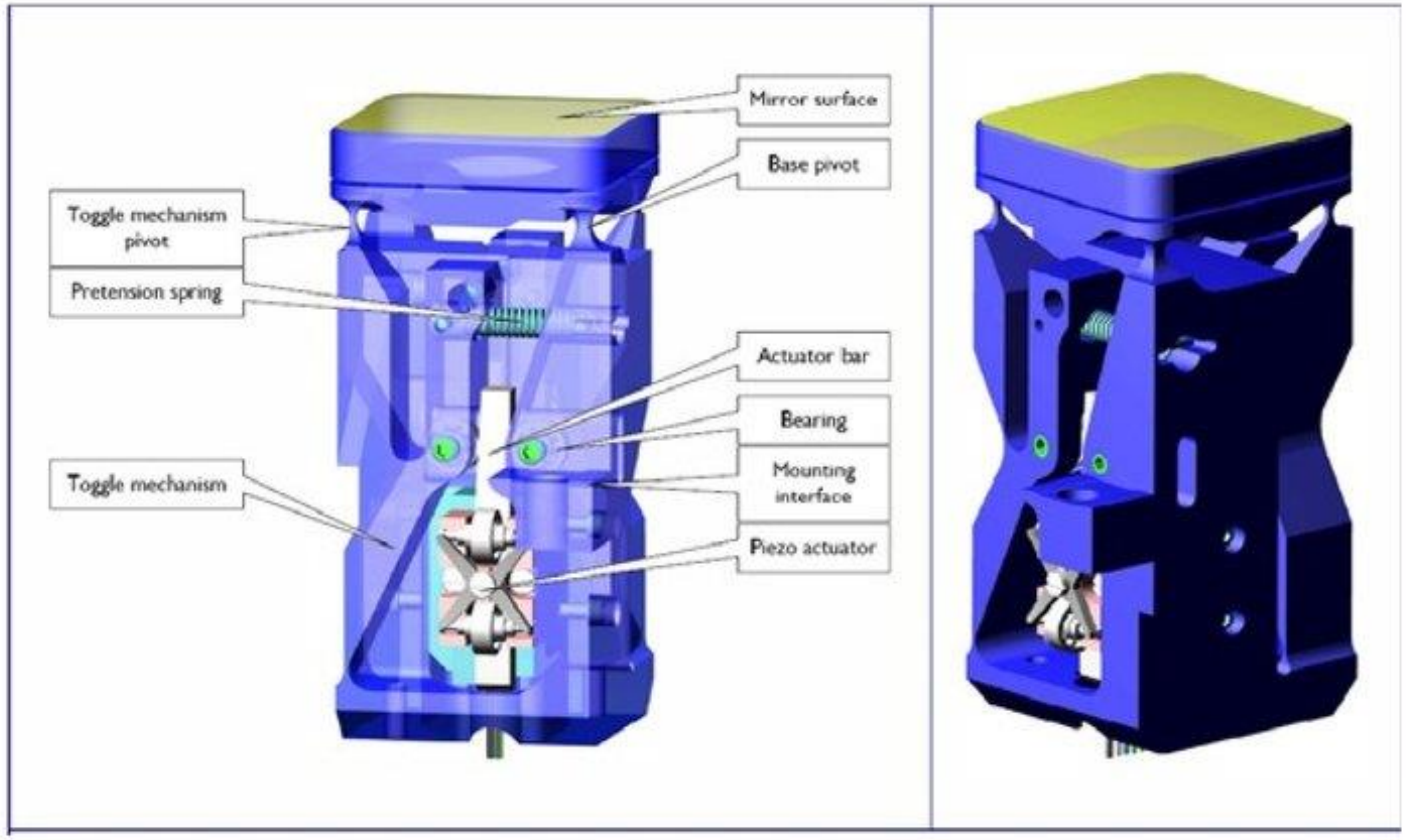
- No adjustment strategy
  - Cannot move
- Alignment Mechanisms
  - Operated once / a few times
- Mode Switching Mechanisms
  - Operated regularly, but most of the time static
- Continuous Motion Mechanisms
  - Continuous operation, feedforward & feedback loops

No adjustment strategy: Mirror clip

- Advantages:
  - isostatic kinematic mounting
  - one hand, single click mounting
  - optics protected inside cell
  - fast assembly
  - no tools required



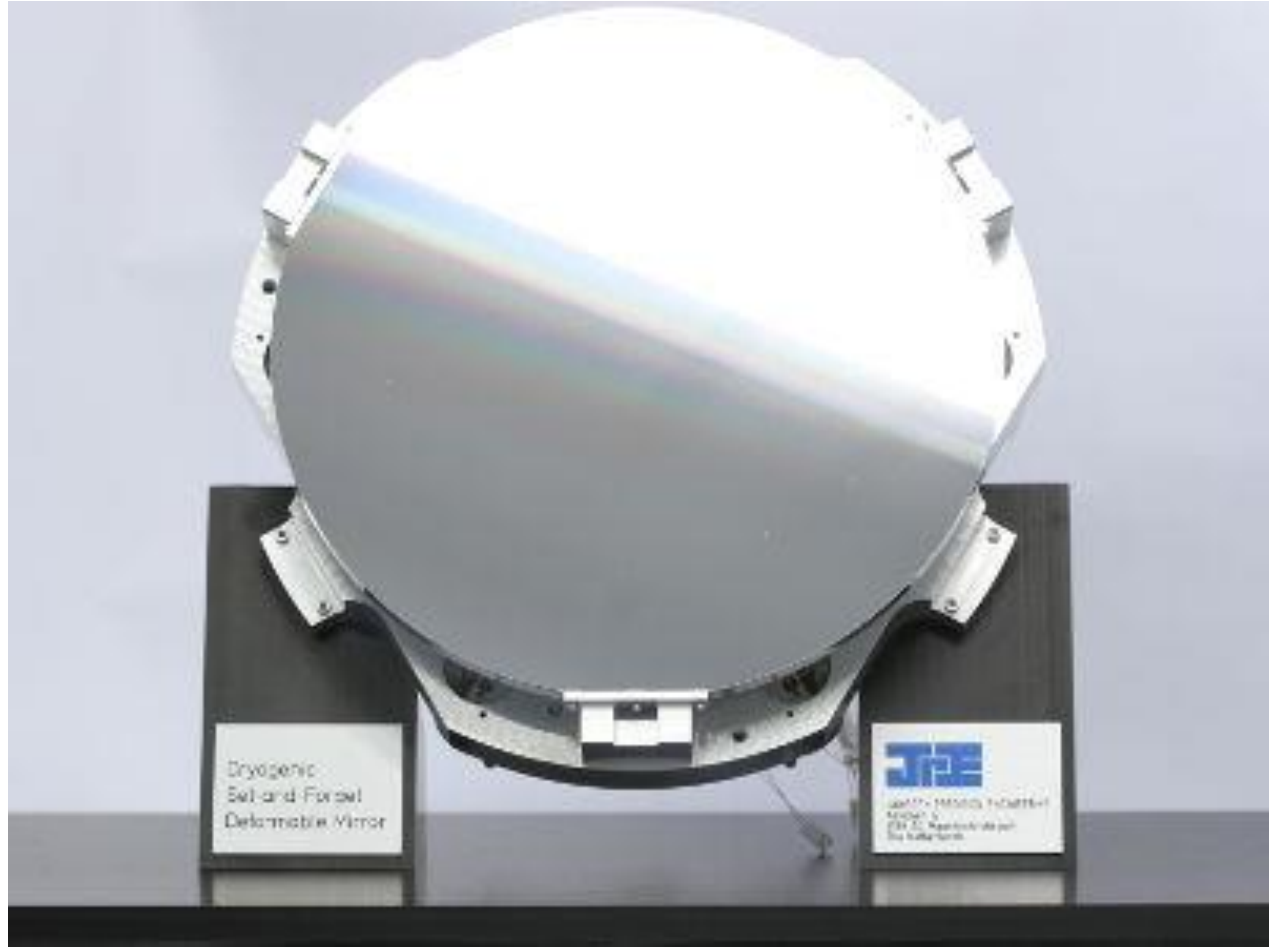
Alignment Mechanisms
Tip-Tilt Mirror mechanism

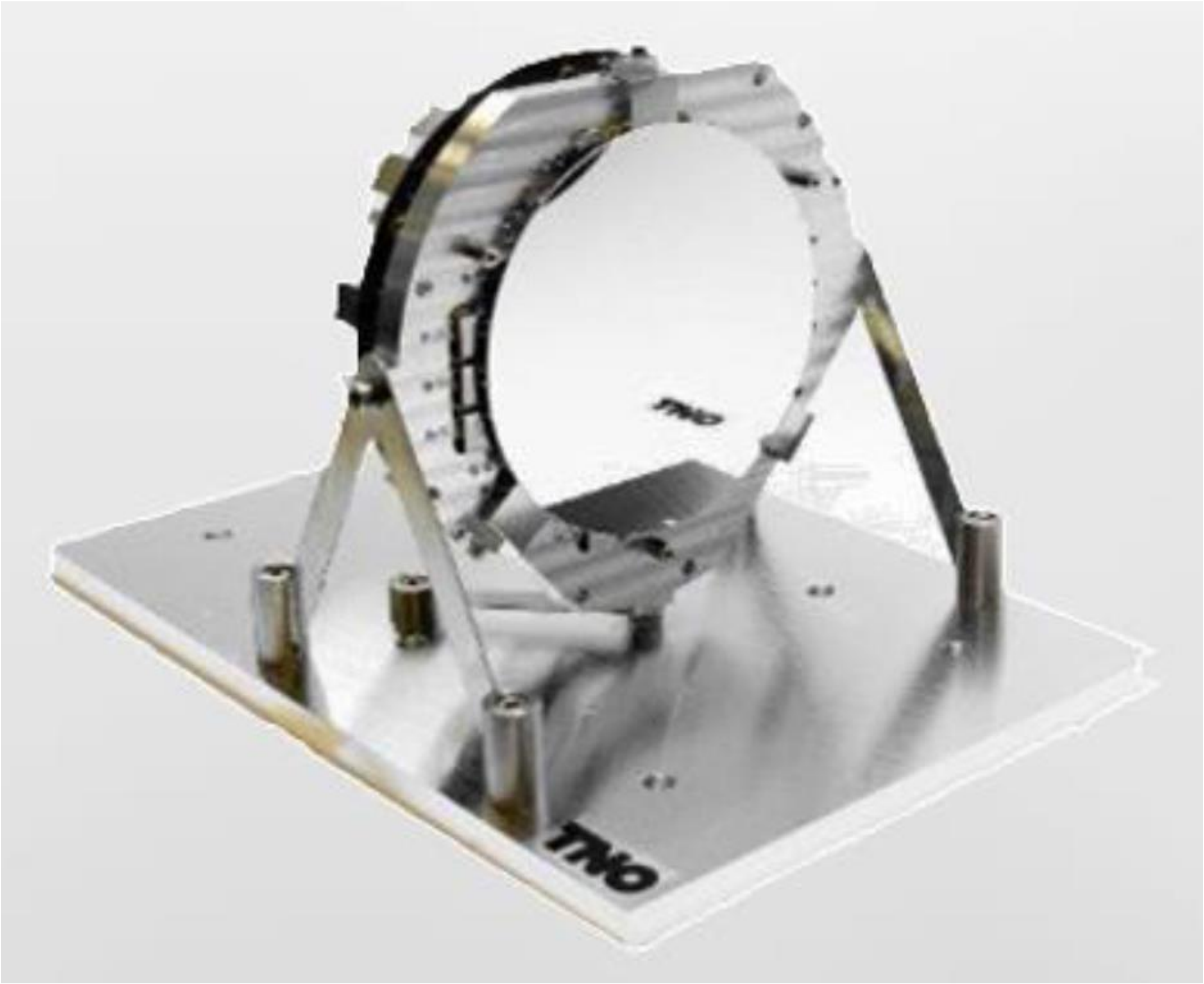


- large actuator reduction factor
- self braking Piezo motors
- orthogonal Rx and Ry actuation integrated in the design.
- Monolithic, stability, works at any temperature

JANSSEN PRECISION ENGINEERING

Deformable Mirrors





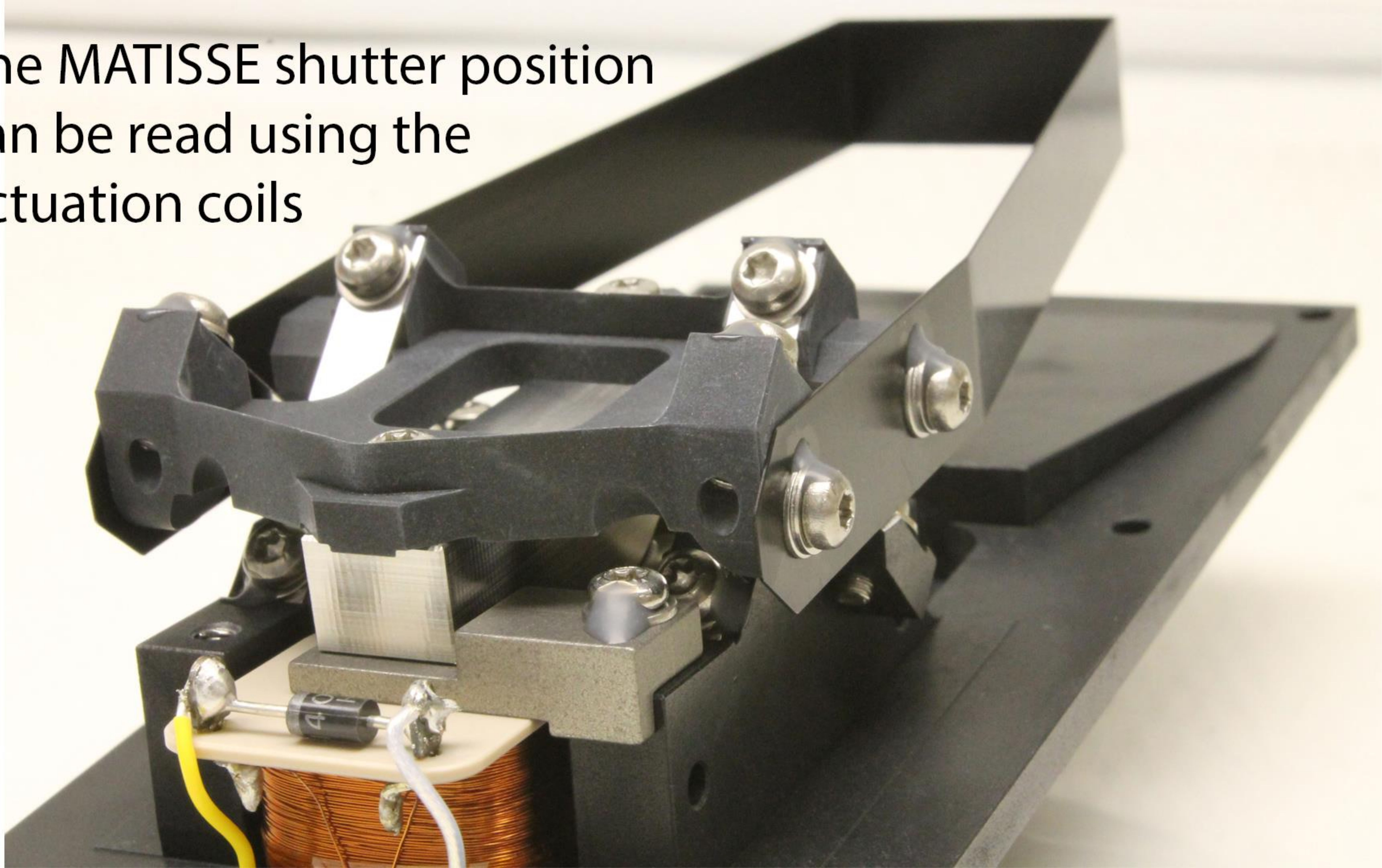
JANSSEN PRECISION ENGINEERING

TNO

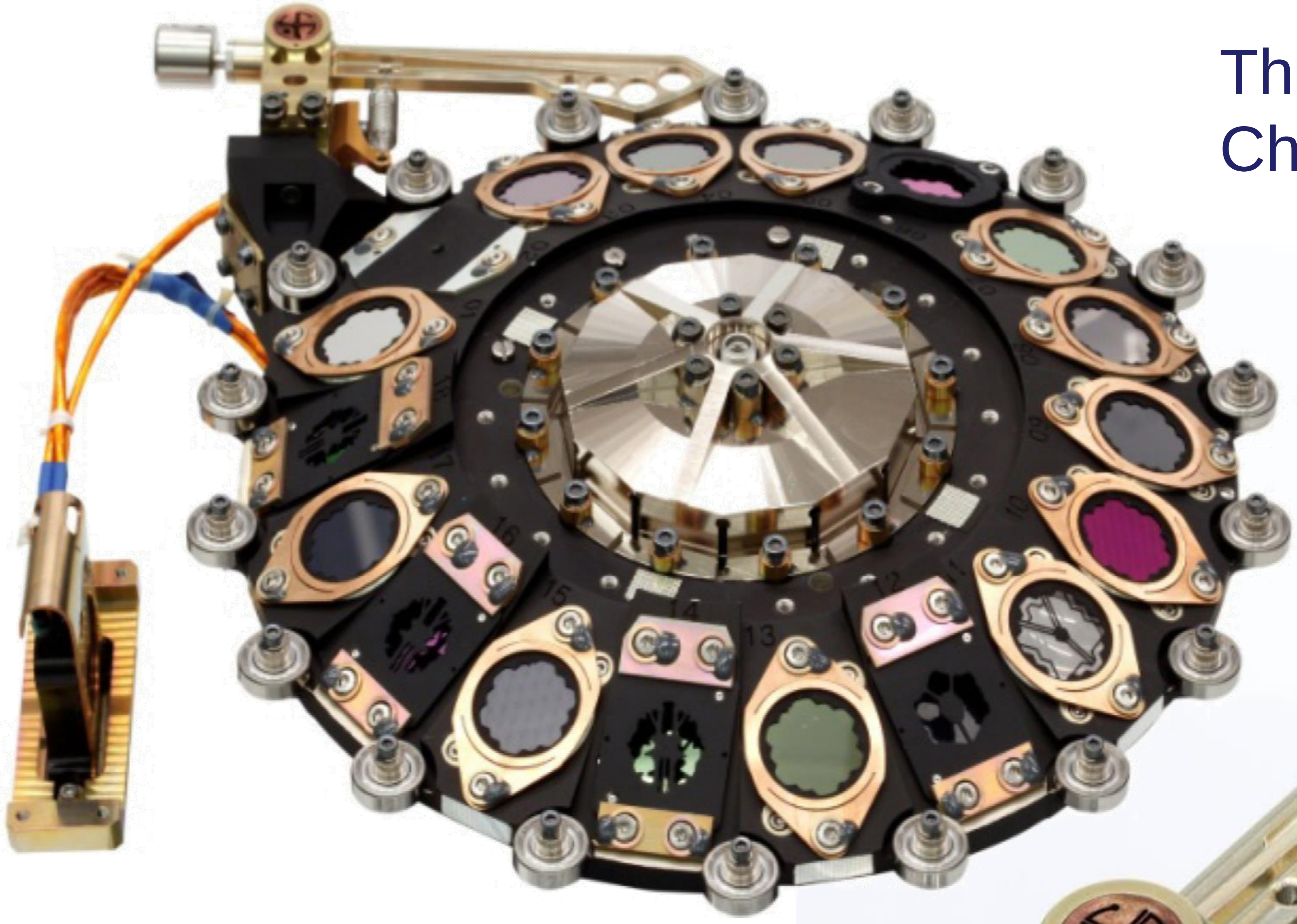
- Dozens of actuators

Mode Switching Mechanisms
Cold Shutter

The MATISSE shutter position can be read using the actuation coils

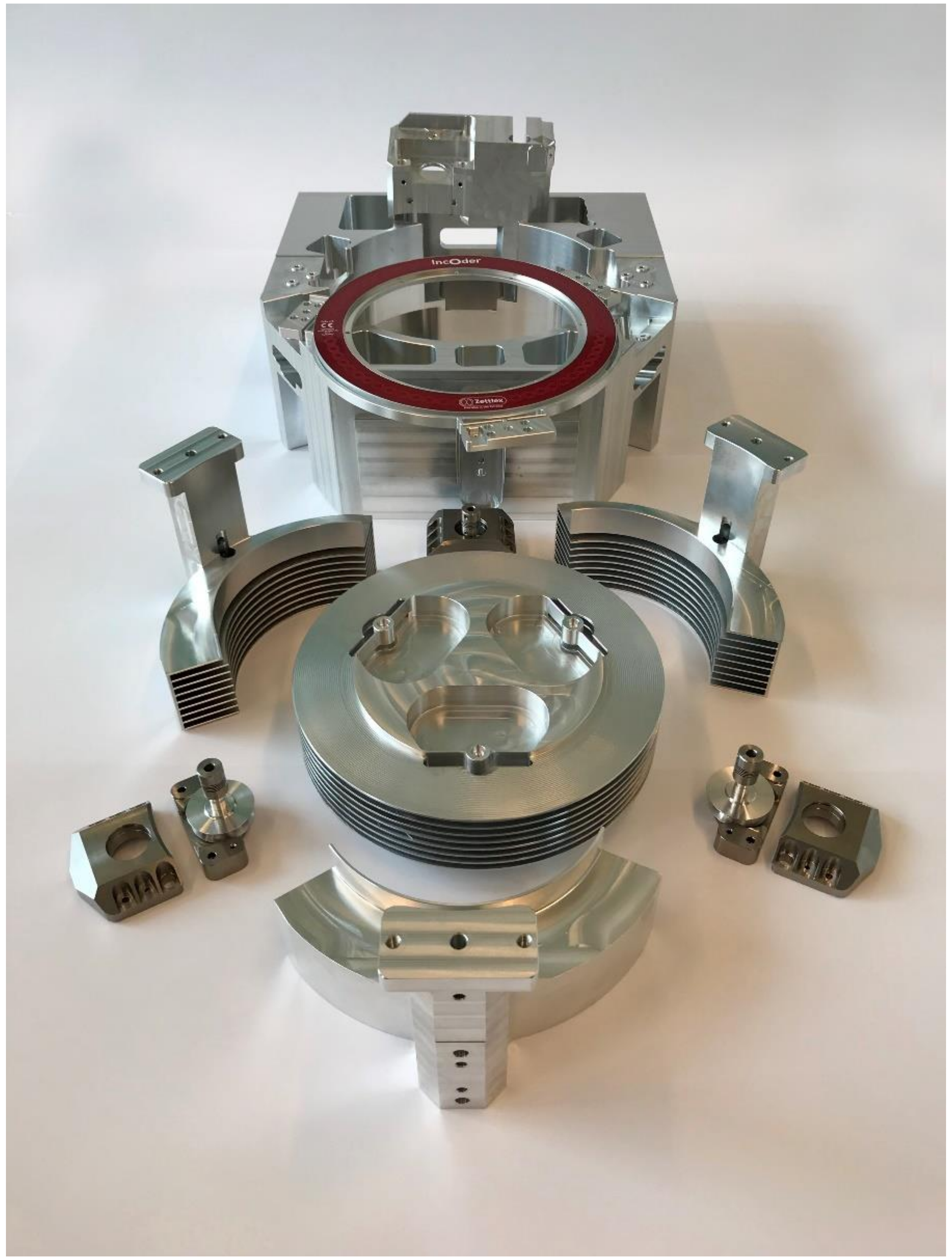


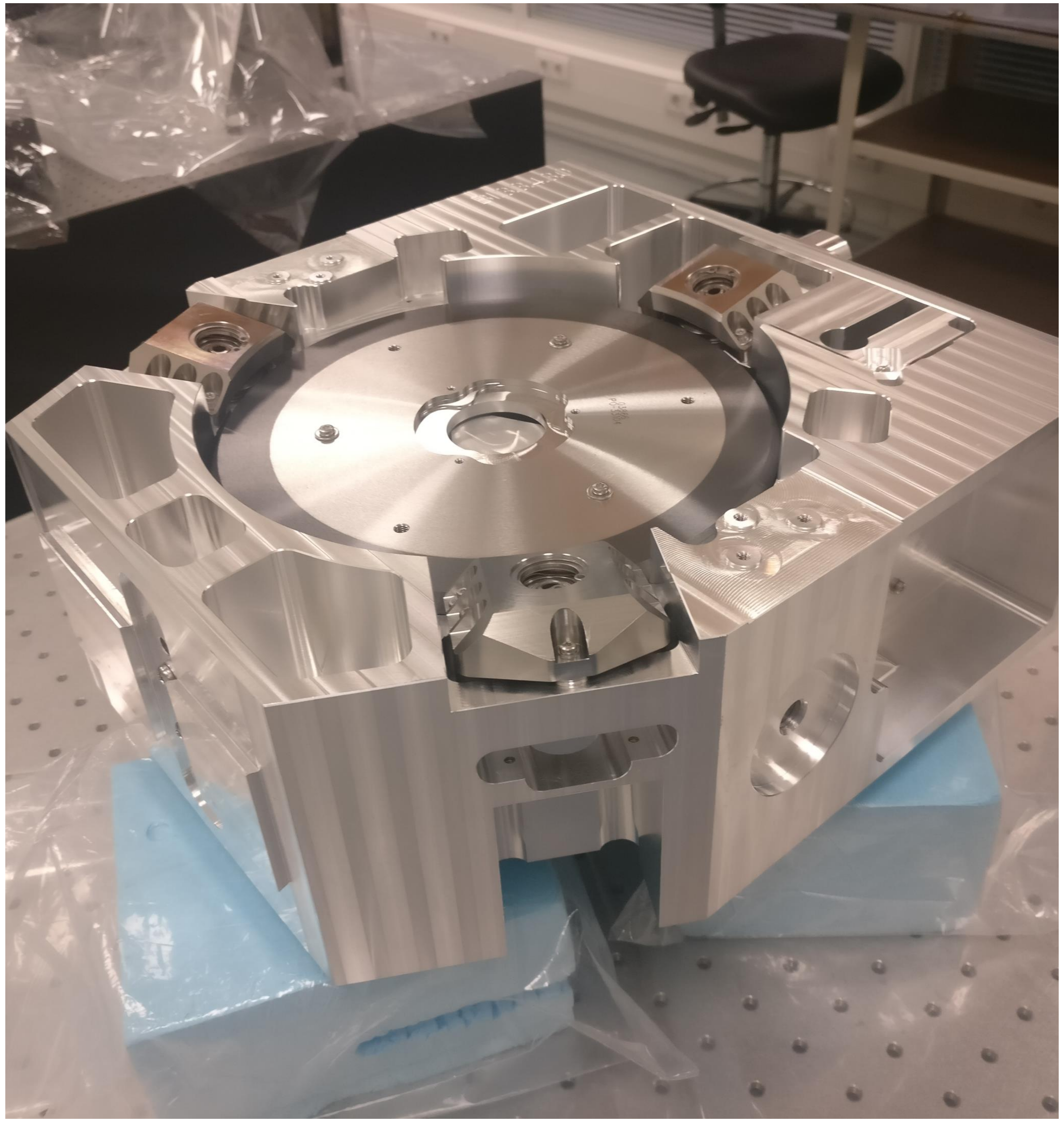
Rotating Mechanism



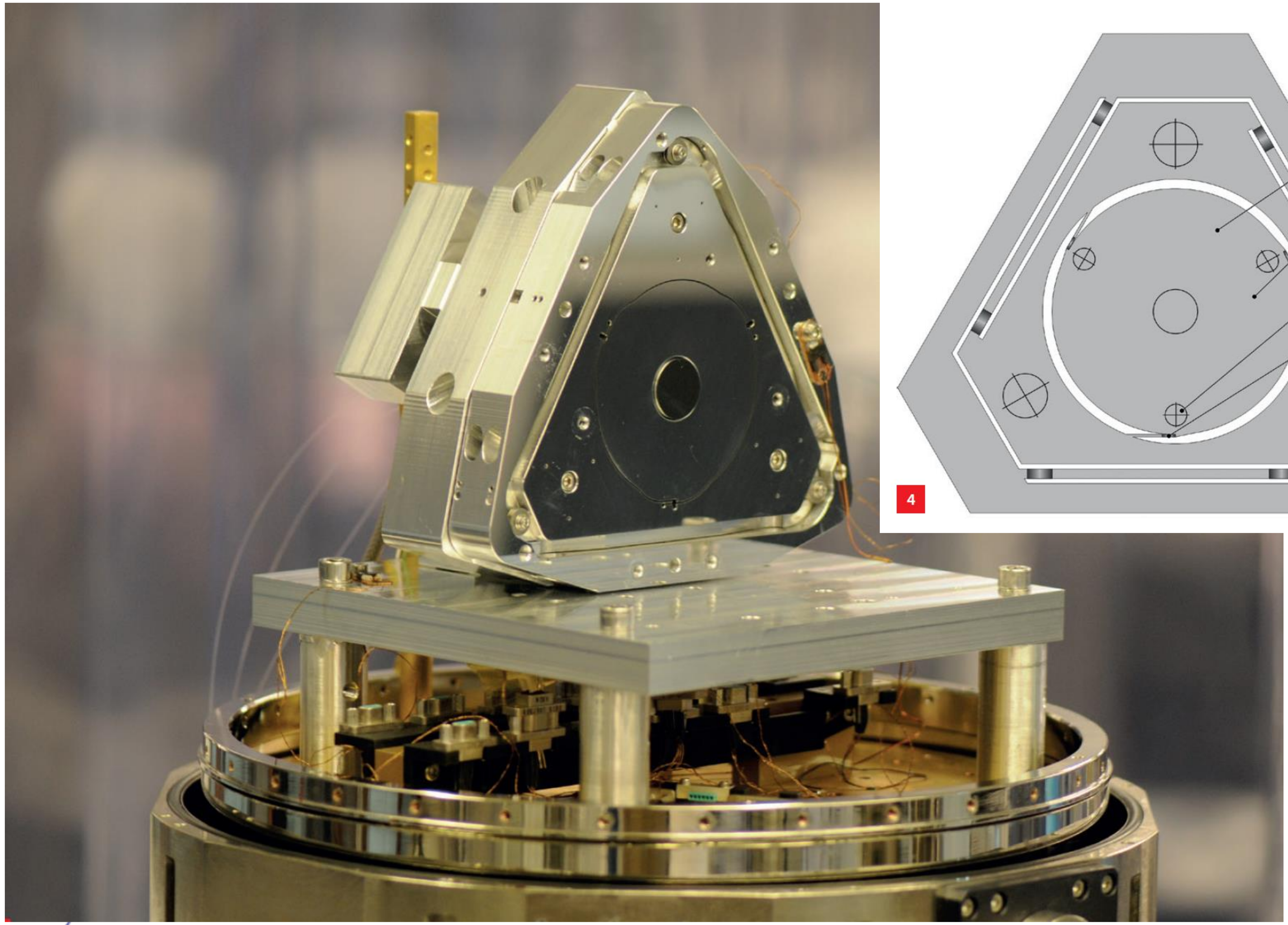
The JWST MIRI FM Wheel Mechanisms
Characterisation for Open Loop Drive (MPIA)

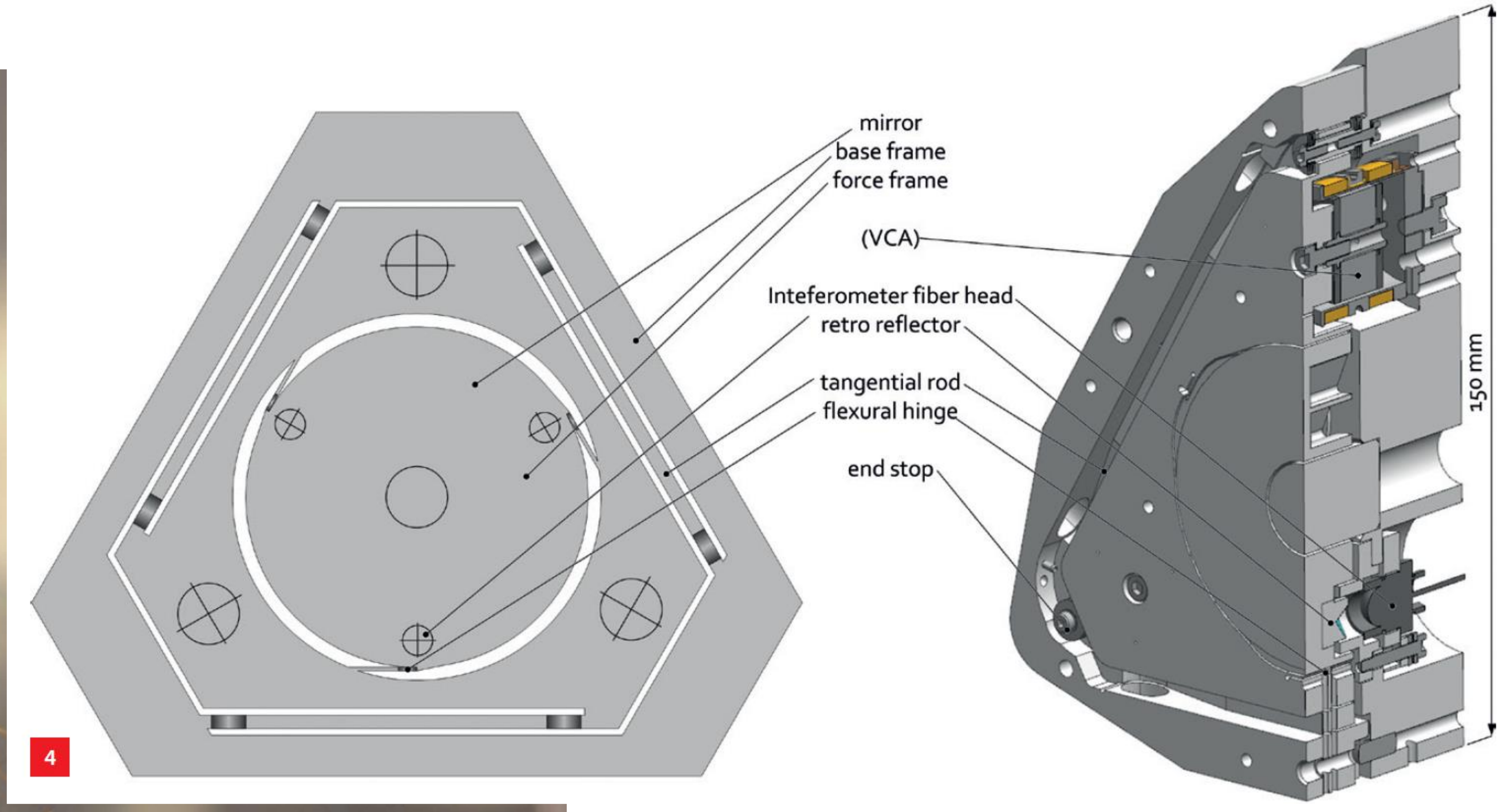
Continuous Motion Mechanisms
MICADO ADC





METIS Chopper





SRON Netherlands Institute for Space Research

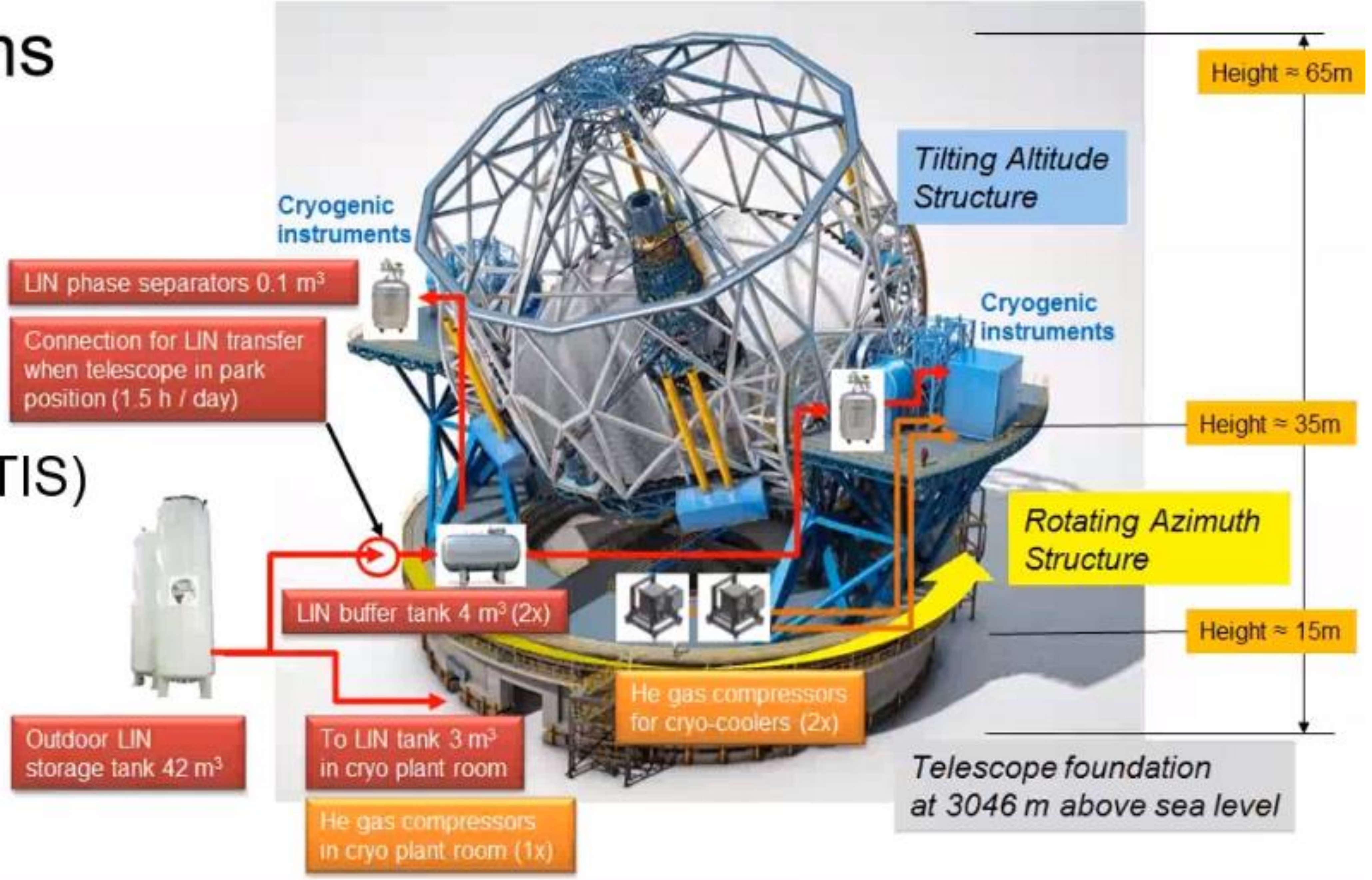
TNO

university of groningen

JANSSEN PRECISION ENGINEERING

ELT cryogenic infrastructure (ECIS) - overview

- ECIS contains of 2 sub-systems
  - LIN infrastructure
  - Cryo-cooler infrastructure
  - INS may have interfaces with:
    - Both sub-systems (HARMONI, METIS)
    - LIN infrastructure only (MICADO)
    - Cryo-cooler infrastructure only (currently none)
    - None of both (MAORY, *PDS*)
    - Tbc for HIRES and MOSAIC
  - Current baseline concept avoids cryogenic lines in telescope cable wraps -> main design driver



The ELT cryogenic infrastructure functional concept. LIN infrastructure in red. Cryo-cooler infrastructure in orange.

Questions?

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