The LIEBE - **LIquid Eutectic lead Bismuth for Eurisol** - high-power target: offline results and online scheduling

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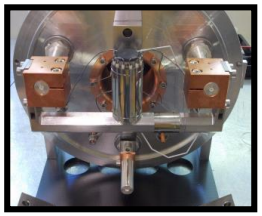
ISCC – June 2018

ENGINEERING DEPARTMENT

Introduction/Context

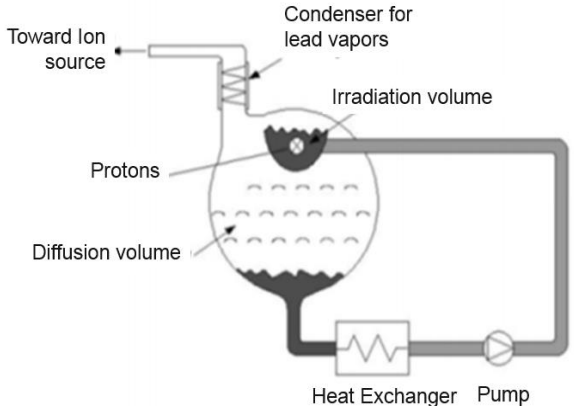
- 1st ISOL high power molten metal target demonstrator



Long tradition of operation of molten targets at ISOLDE – last development of static target: molten NaF salt

Not kept in ENSAR 2- EURISOL JRA (2012-2013)

→ LIEBE (2013 →)



Conceptual design + prelimin. tests, E. Noah et all, EURISOL-DS (2005-2009)

→ Lanthanum eutectic + SnCl molecular beam: Towards 100Sn beams at HIE-ISOLDE
T. Stora et al., EMIS 2018

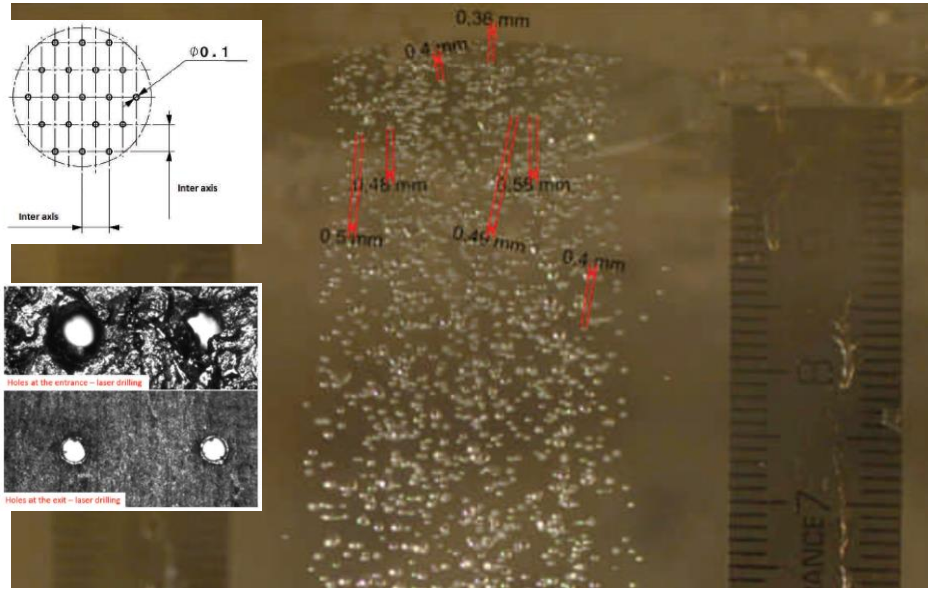
Concept → Prototype → Offline commissioning → Online tests

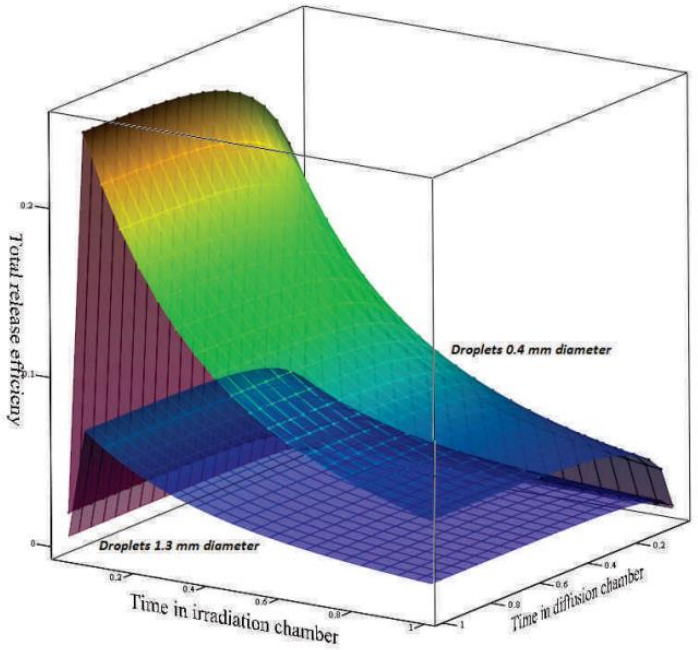
Concept

Introduction/Context

- LIEBE: LIquid Eutectic lead Bismuth for Eurisol
  - Target material: LBE
  - Operational temperature [200-600]°C
  - Targeted isotope: ^{177}Hg (130ms half-life)
  - LBE Velocity preferred: **2 m/s ⟶ Q=0.13 l/s**
  - **Ø0.4 mm** droplets ⟶ factor **5** more release

$$i = \Phi . \sigma . N . \varepsilon_{target} . \varepsilon_{source} . \varepsilon_{sep} . \varepsilon_{transport}$$



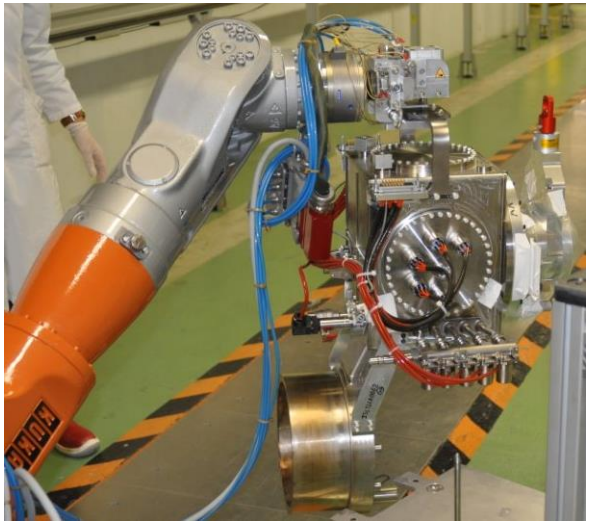


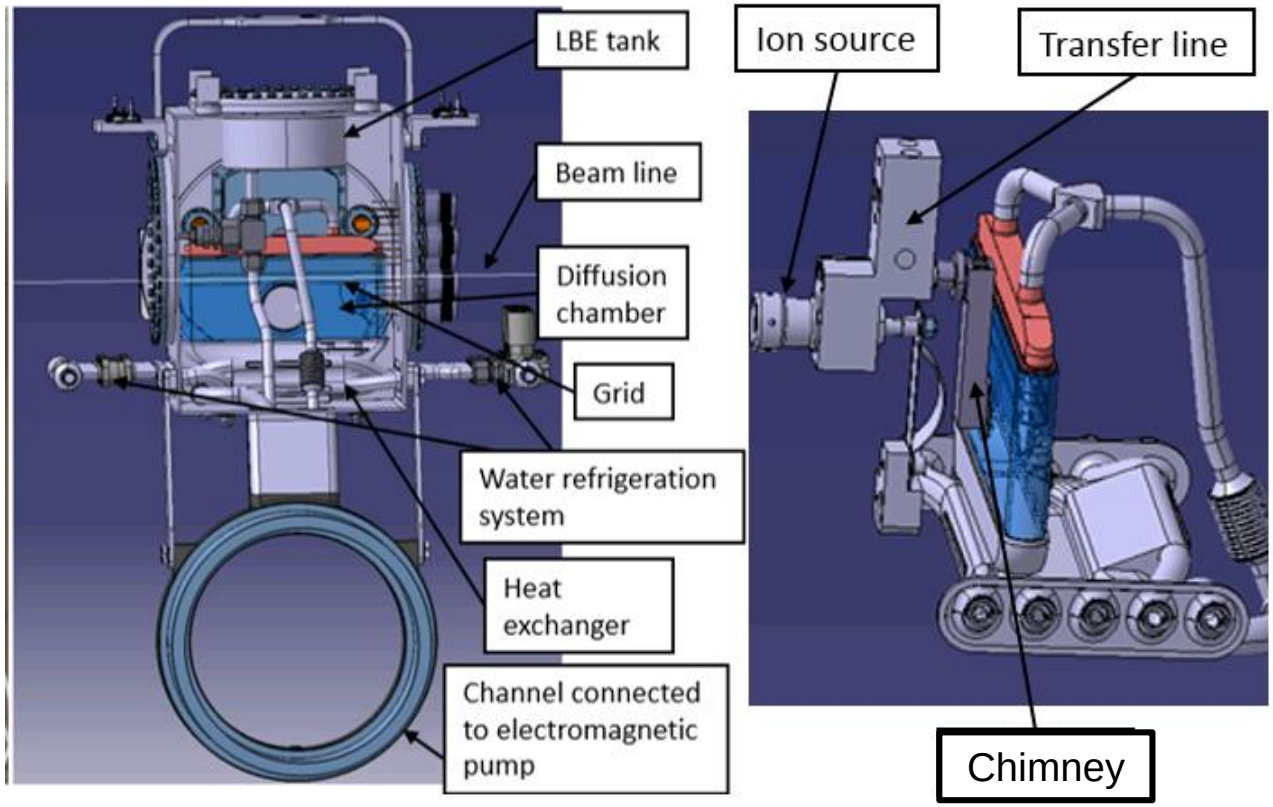
Images from Melanie Delonca CERN Ph.D thesis

Concept → Prototype

LIEBE prototype design & completed assembly

- The target:
  - Compatible with existing target handling at ISOLDE

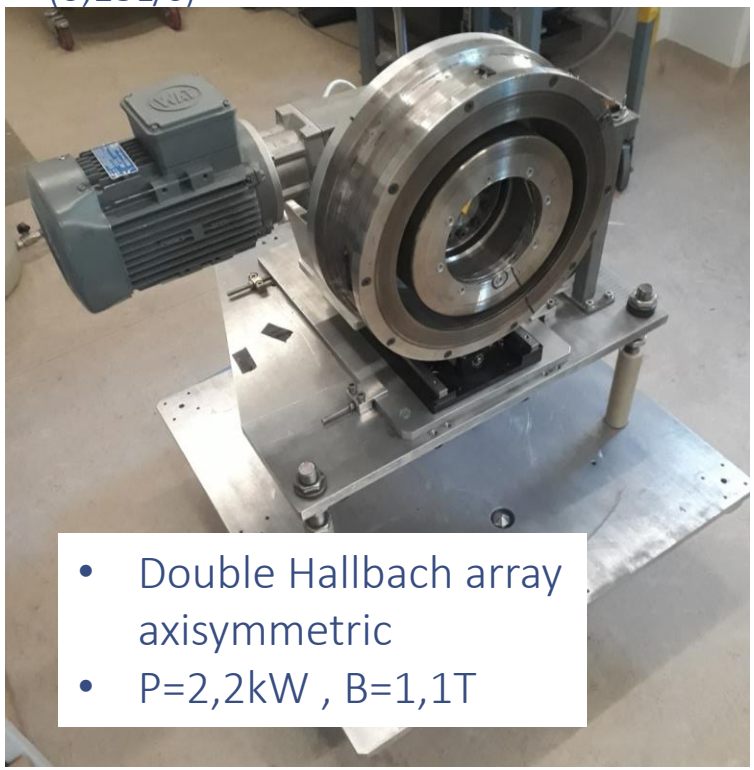




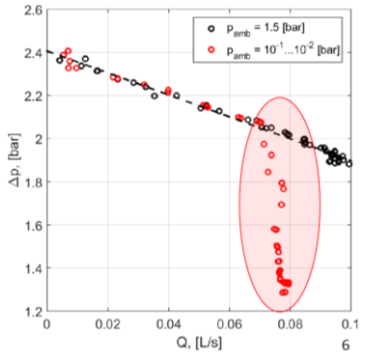
Flow assessment

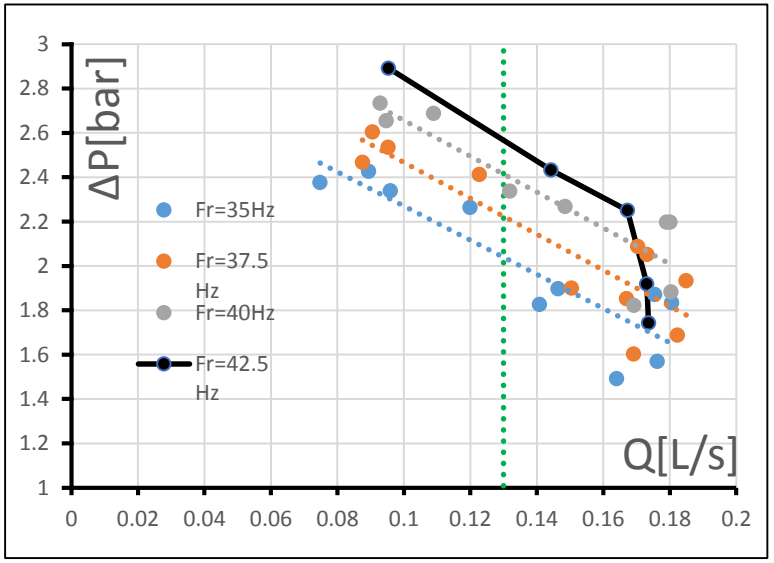
Increased diameter: Ø10mm ➡ Ø16mm

- Test objectives:
  - Operate in the absence of cavitation
  - Reach the desired flow for release optimization (0,13L/s)

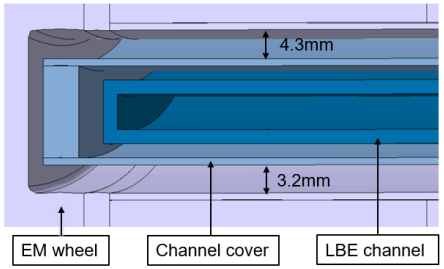


- Double Hallbach array axisymmetric
- P=2,2kW , B=1,1T

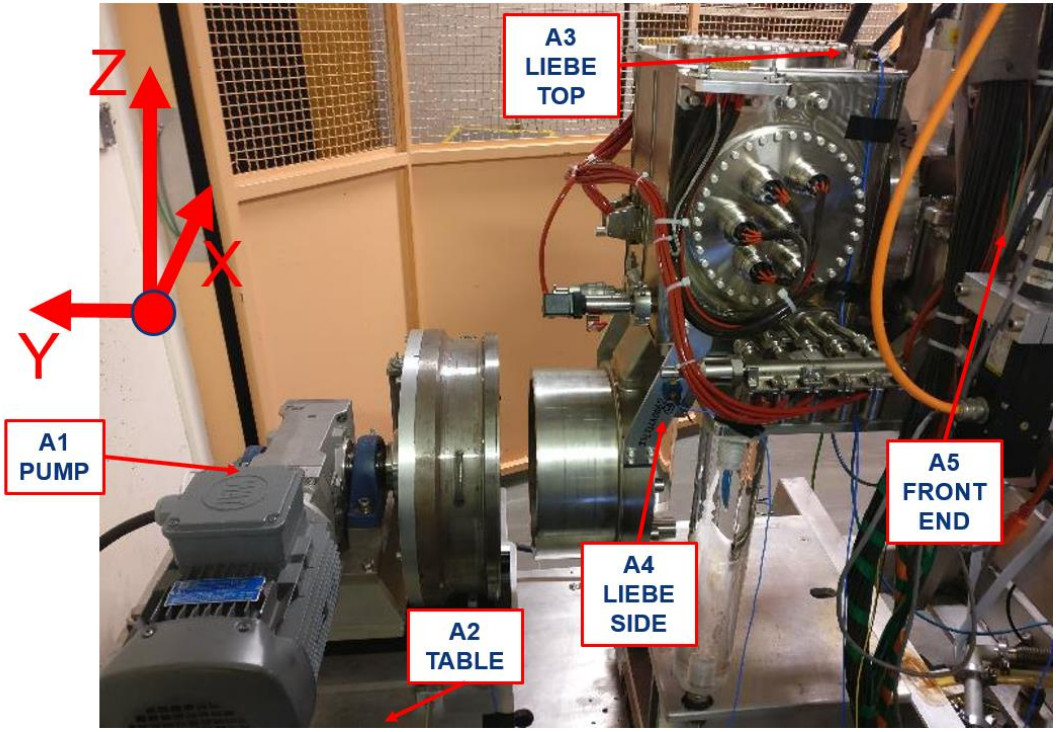




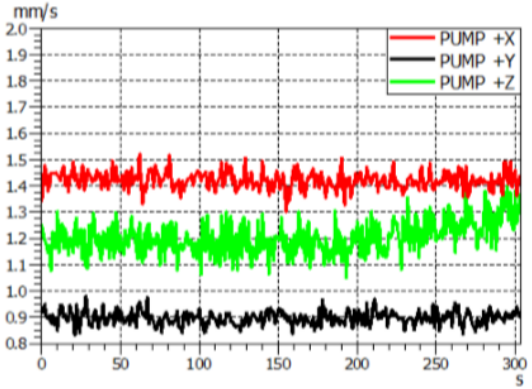
Alignment/vibration tests

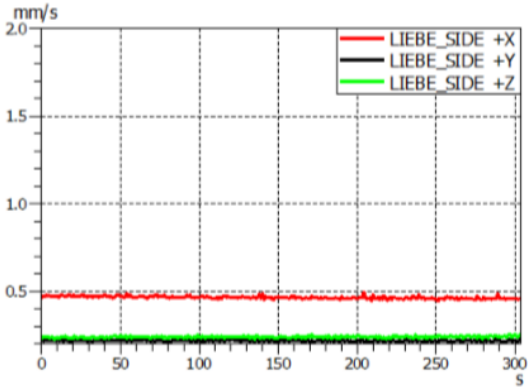


Empirically measured maximum distances in case of perfect alingment



Test setup after alignment

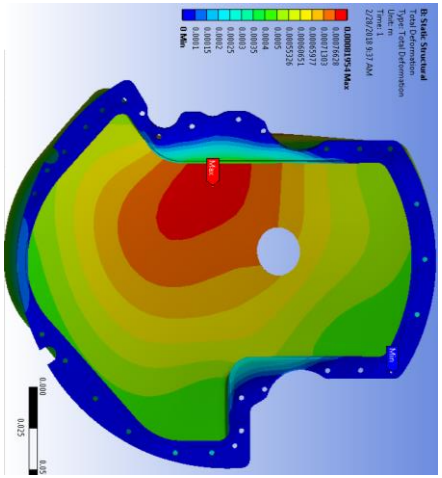


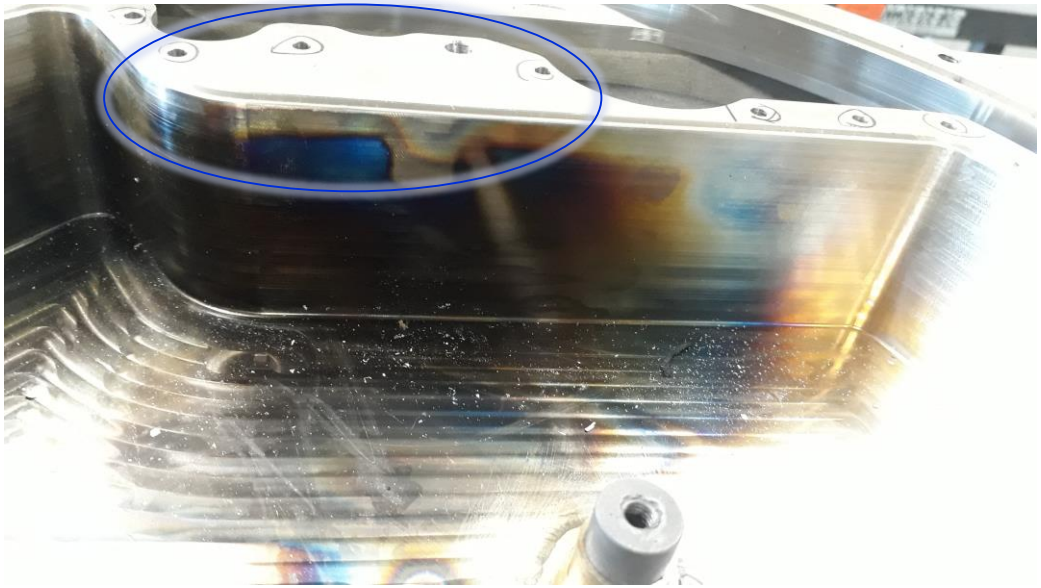


Rotor Fr= 40Hz

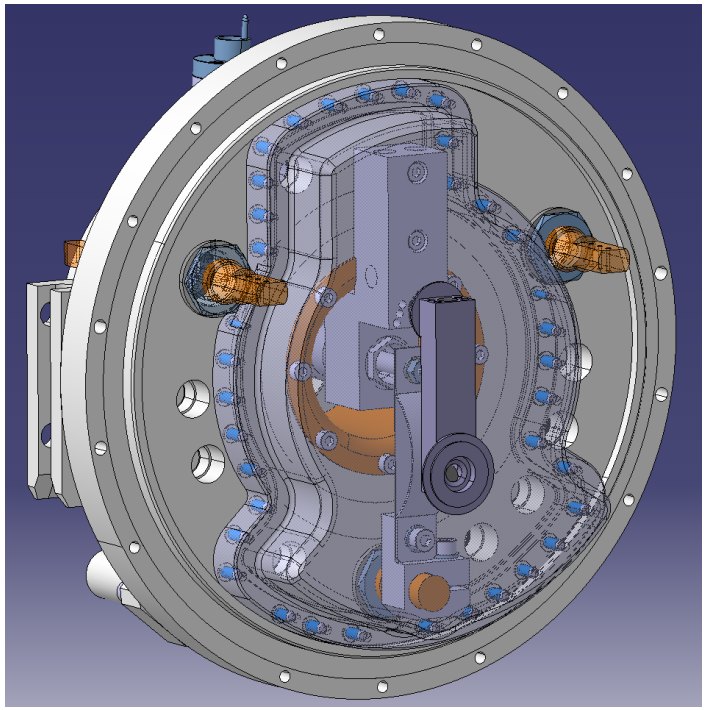
Concept → Prototype → Offline commissioning

Thermally induced leak of confinement vessel



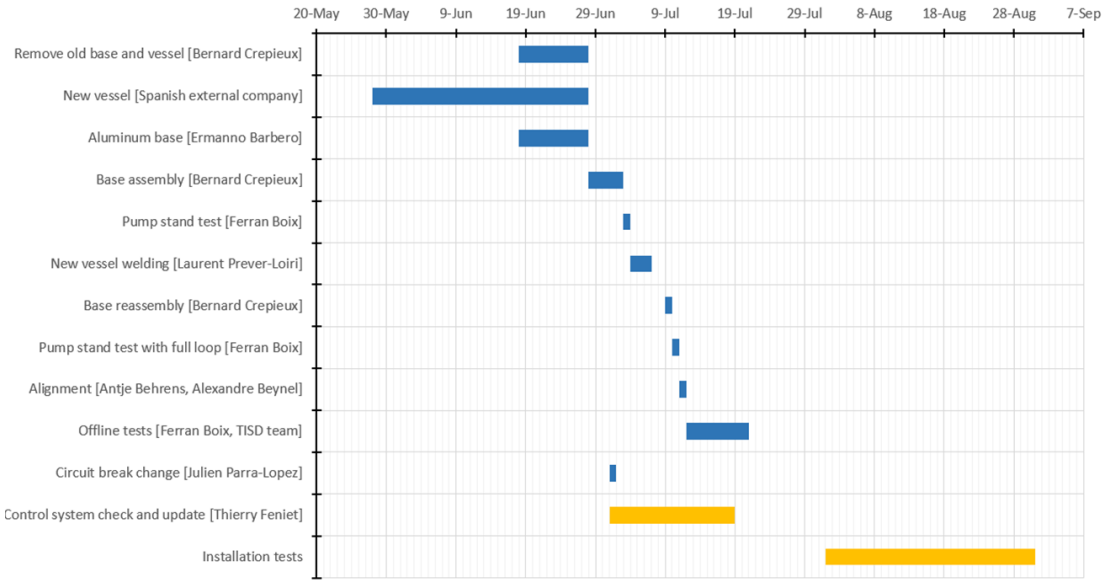


New confinement vessel



Offline commissioning: Remaining tests

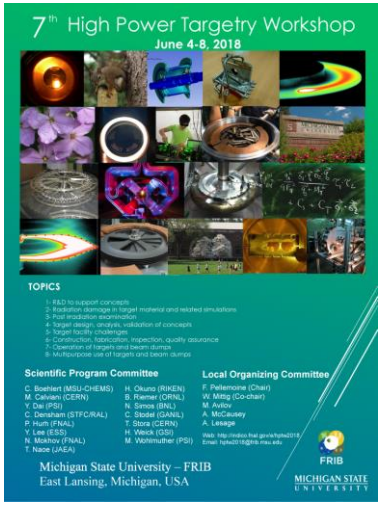
- Full operation of the loop at offline mass separator:
  - Thermal control (Heat exchanger)
  - Safety measures:
    - Pressure sensor
    - Accelerometer
  - Mass scans



Conclusions

- Prototype and offline commissioning:
  - Flow developed by the EM pump : within specification
  - Vibration : within specification
  - Target handling & optimization : within specification

  →New base design for leak-tight confinement vessel
- Full offline test at separator / August / before operation review /September
- Online tests on GPS in November



Thank you

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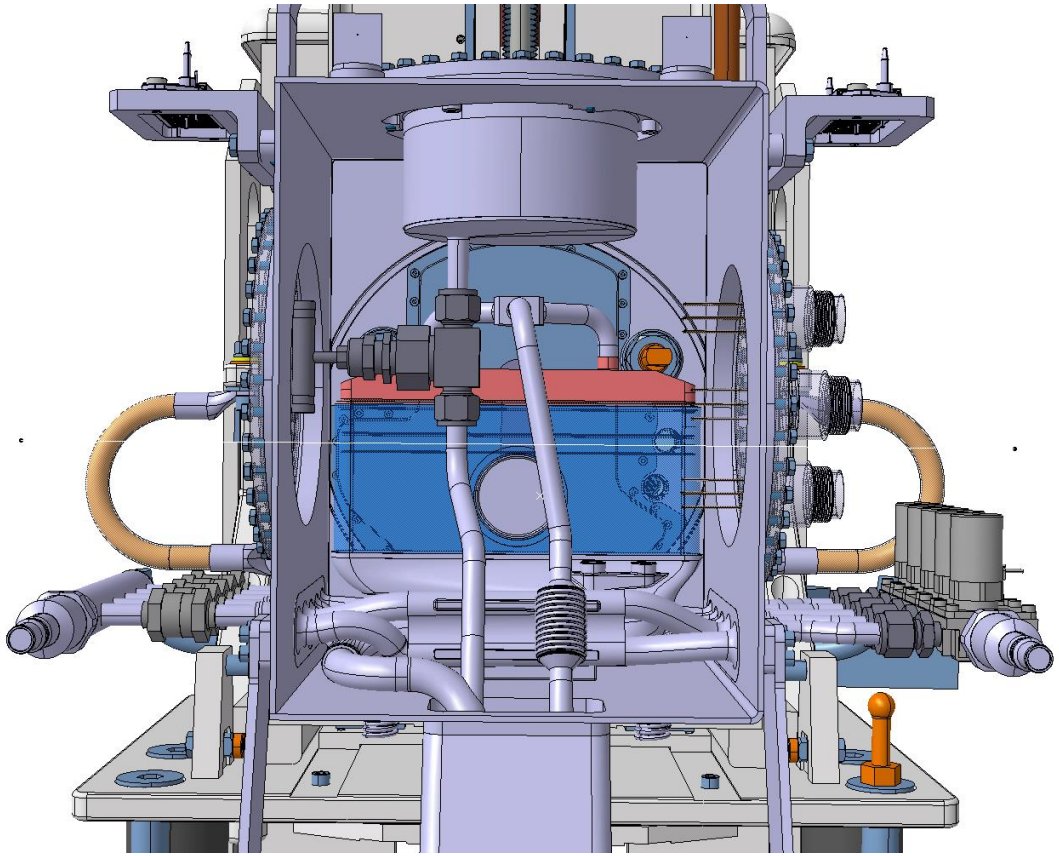
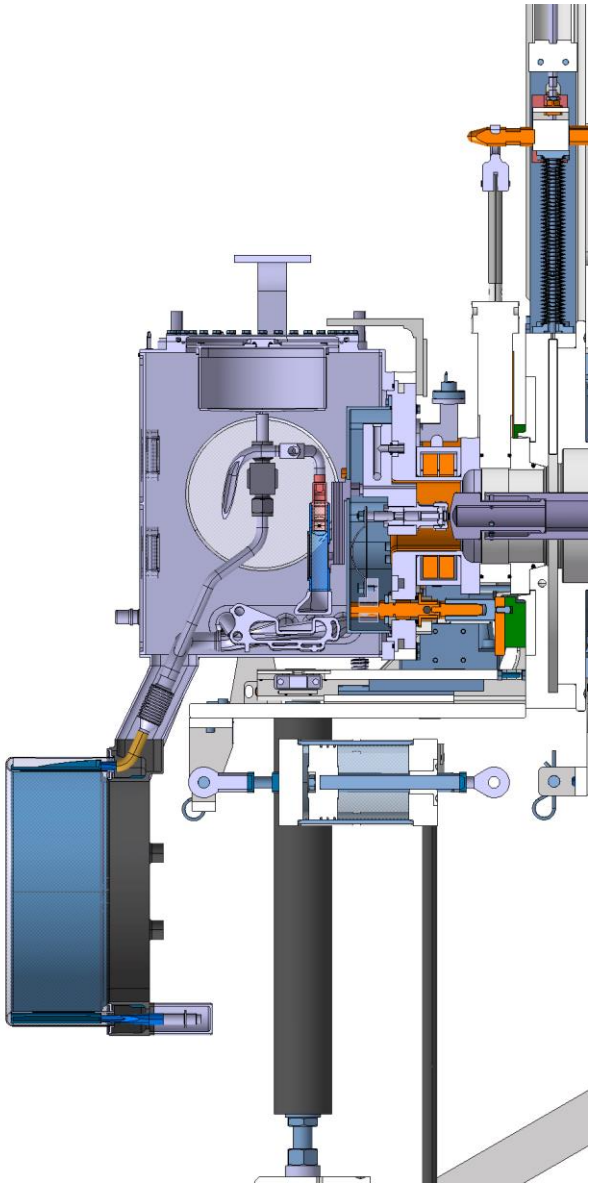
EN-SMM : Thierry Feniet, Antje Behrens, Alexandre Beynel
EN-HE : Jean Louis Grenard
BE-OP : Pascal Fernier
SINP, IPUL, SCK.CEN : Susanta Lahiri, Kalvis Kravalis, Donald Houngbo,

Backup slides

The main loop part

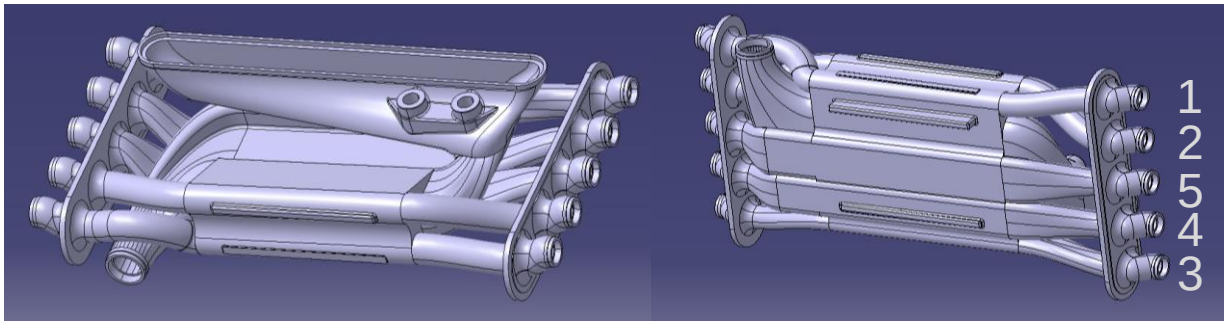




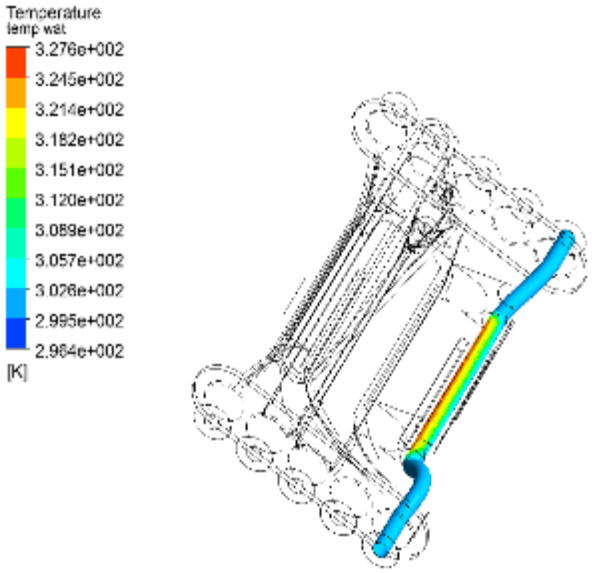
- Filling tank
- Heat Exchanger (HEX)
- Irradiation & diffusion chamber
- Hypertaks/feedthroughs
- Water connectors
- Electrovalves
- Bellows
- Extraction line and ion source -> standard VADIS ion source

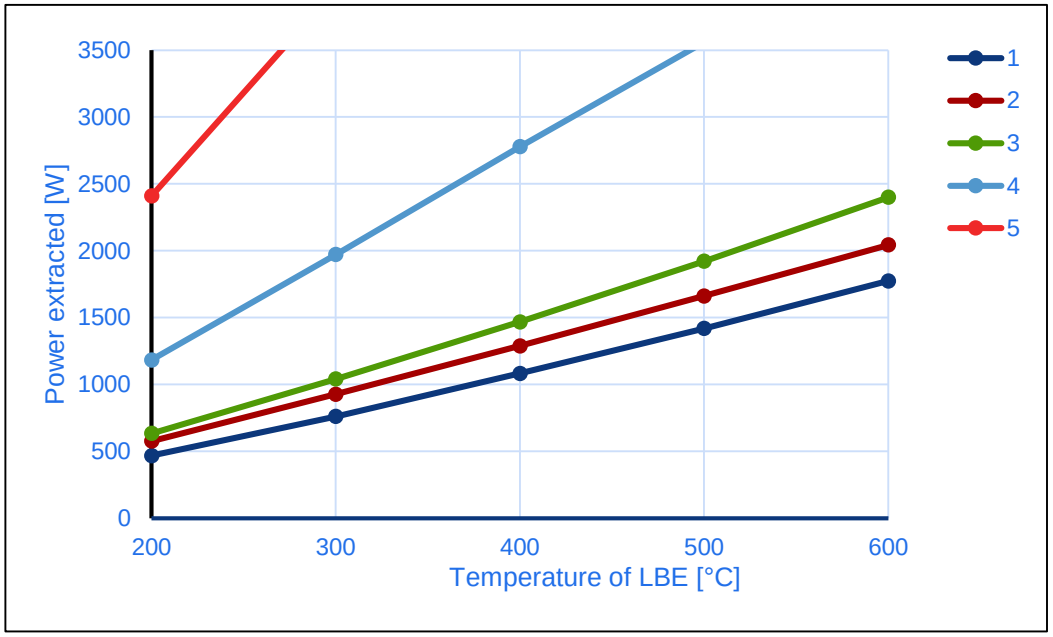
LIEBE: Heat Exchanger

- 5 LBE temperatures (200-600degC)
- CFX Calculations of the heat exchanged for every channel



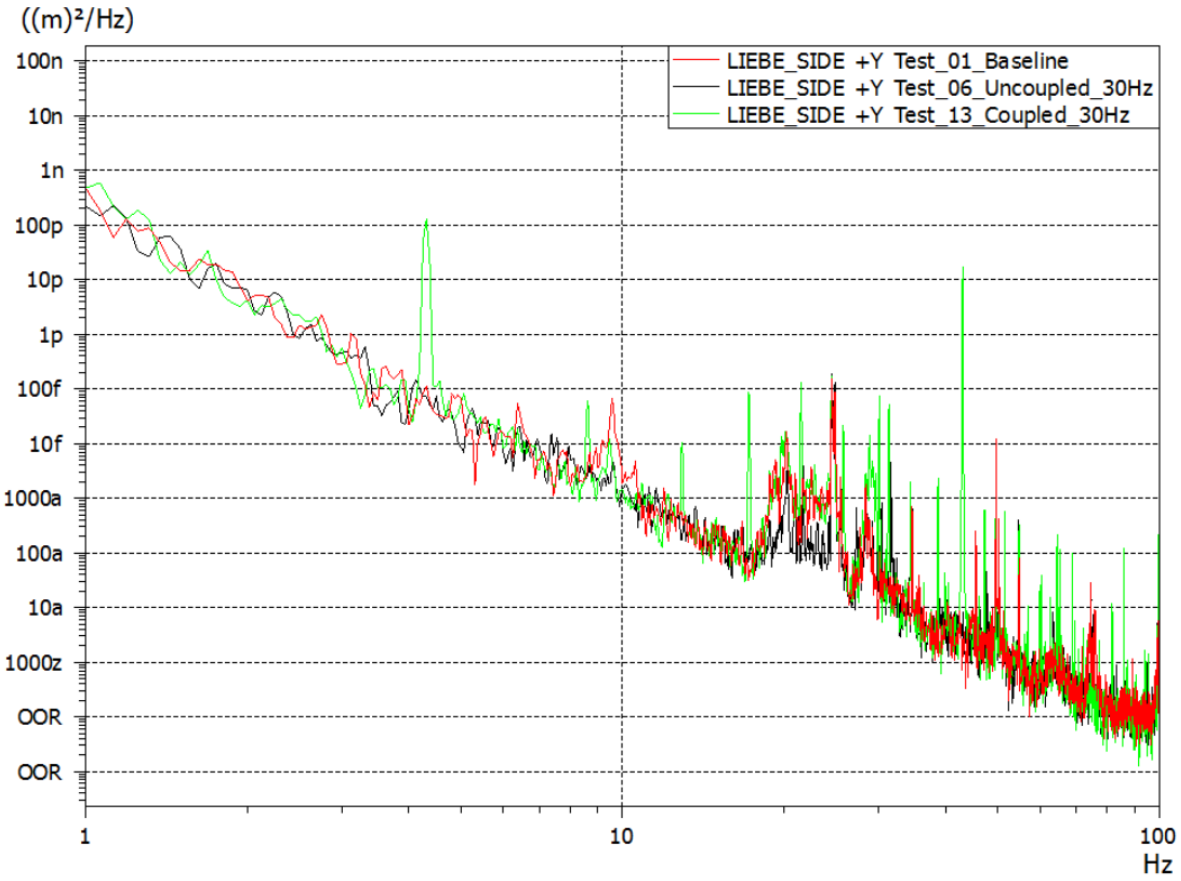
3D printed steel Heat Exchanger





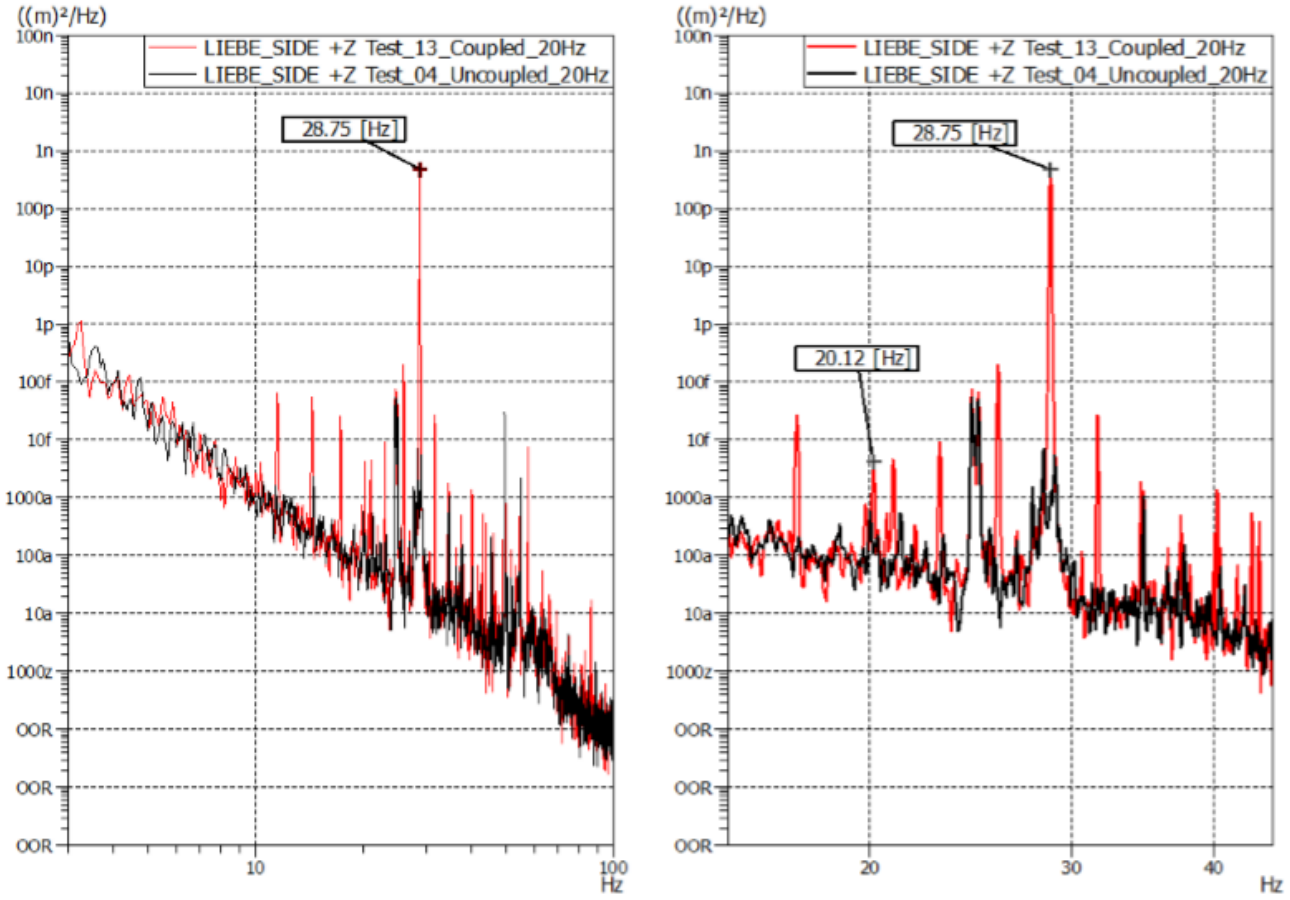
Offline commissioning: Alignment/vibration tests

- Results:



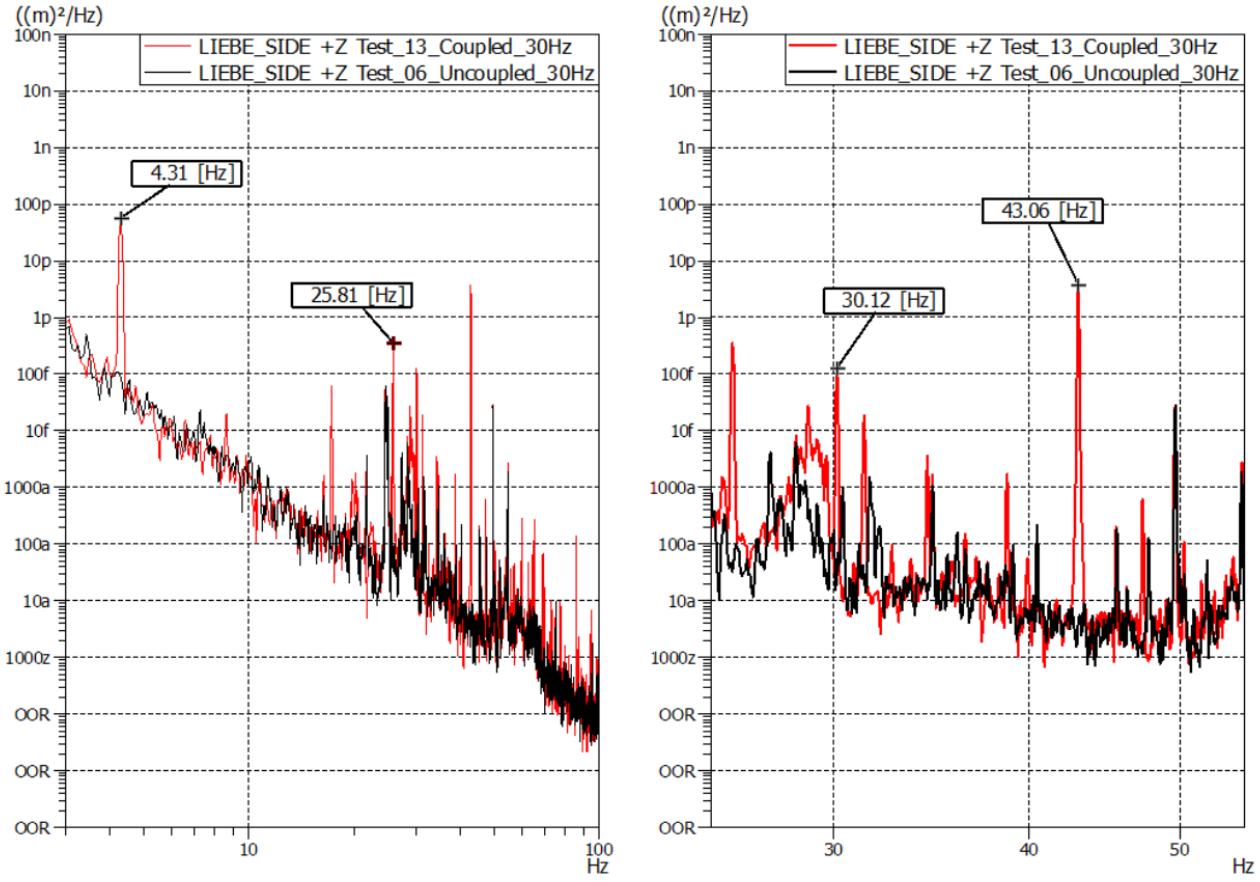
Displacement Power Spectral Density comparison, Rotor Fr=30Hz, EM Wheel Fr= 4,11Hz direction +Y

Offline commissioning: Alignment/vibration tests



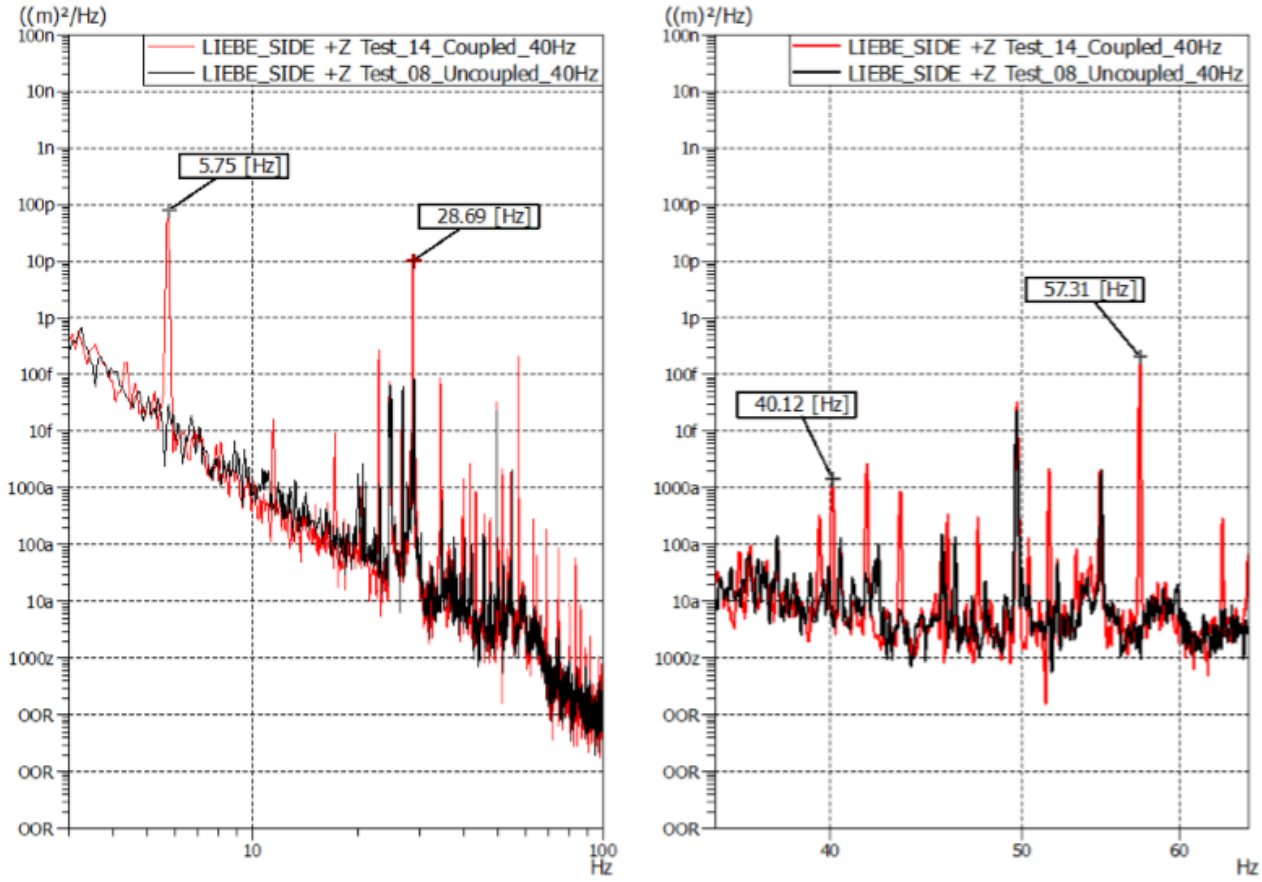
Displacement Power Spectral Density comparison, Rotor Fr=20Hz, EM Wheel Fr= 2,75Hz direction +Z

Offline commissioning: Alignment/vibration tests



Displacement Power Spectral Density comparison, Rotor Fr=30Hz, EM Wheel Fr= 4,11Hz direction +Z

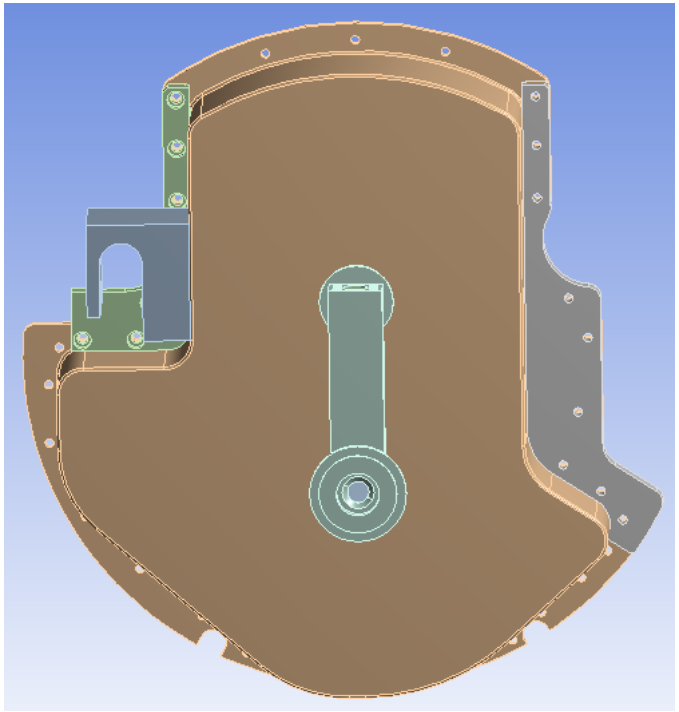
Offline commissioning: Alignment/vibration tests

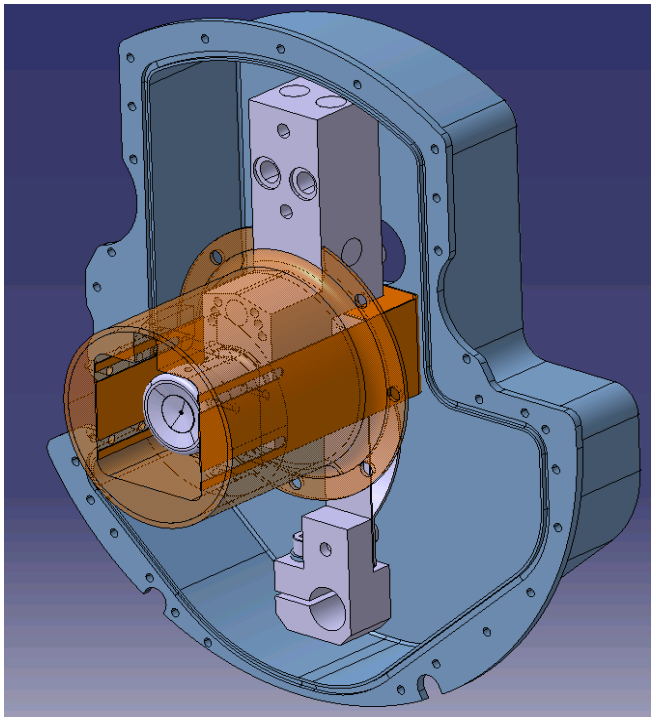


Displacement Power Spectral Density comparison, Rotor Fr=40Hz, EM Wheel Fr= 5,48Hz direction +Z

Offline commissioning: Leak issue

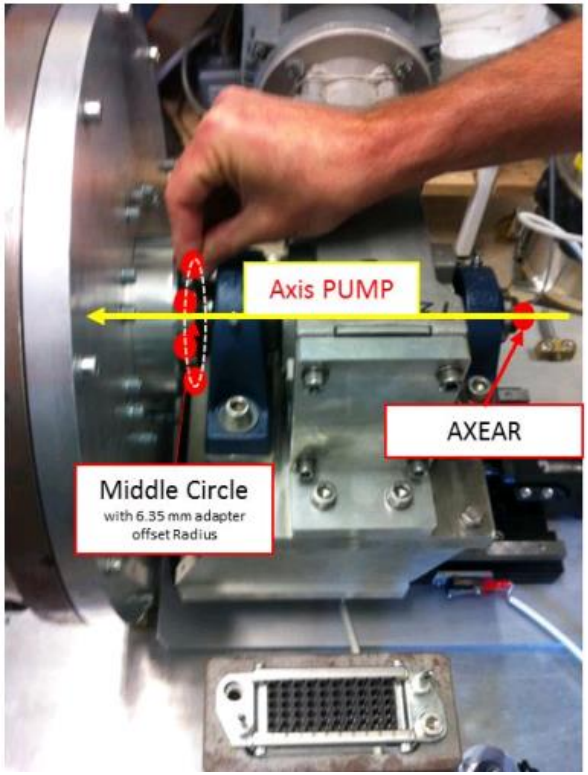
- Attempts to solve it:
  - Increasing sealing pressure
  - Shielding the ion source
  - Only able to operate the source up to 1900 ºC



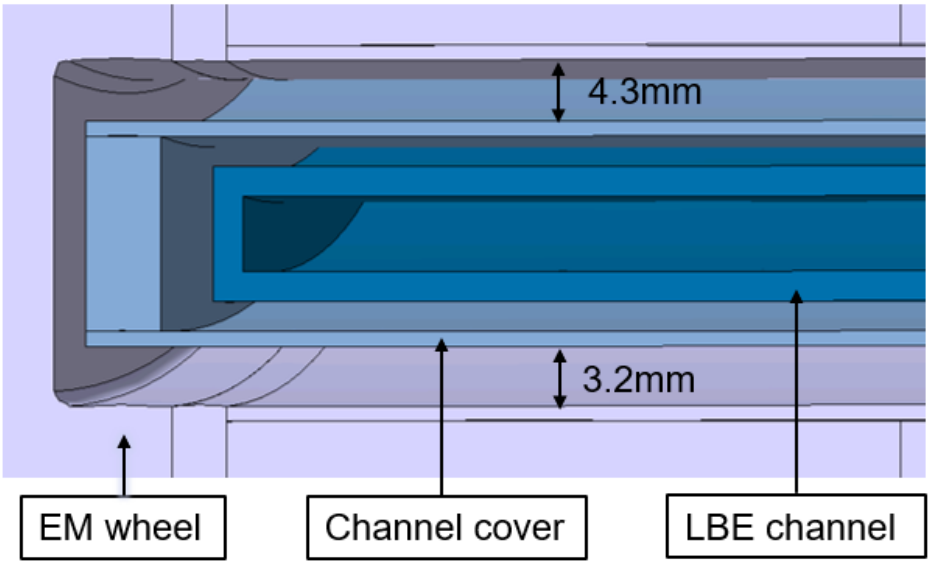


Offline commissioning: Alignment/vibration tests

- Alignment tests:
  - Cylinder axis and pump axis are on the same line within 0.1mm

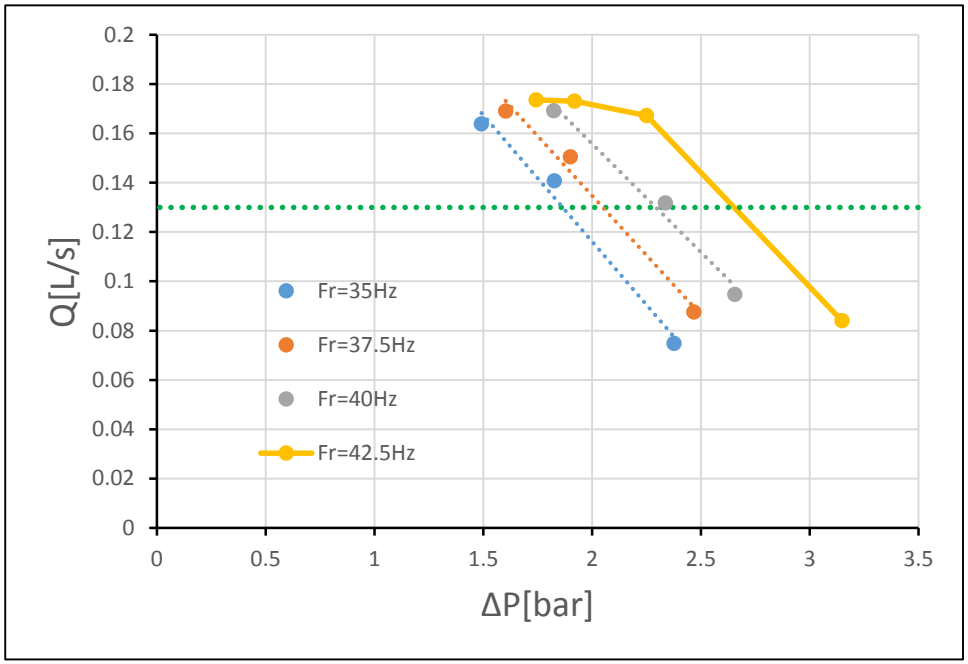


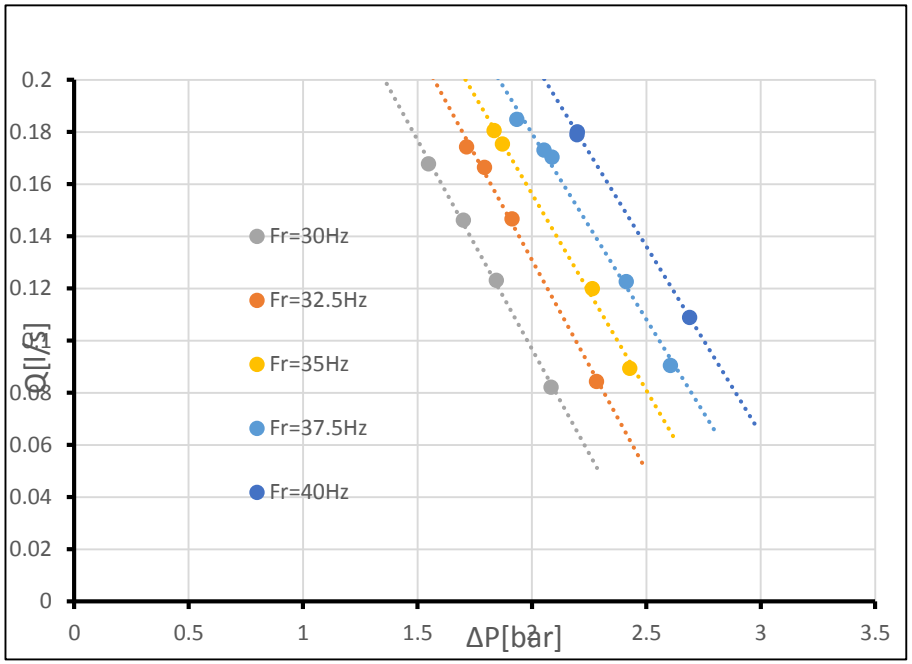
Measurement of the EM pump axis



Best fit distances between EM pump and target

Offline commissioning: Flow assessment





Offline commissioning: Alignment/vibration tests