



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

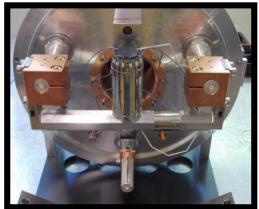
Ferran Boix Pamies, Thierry Stora for the LIEBE project

ISCC – June 2018

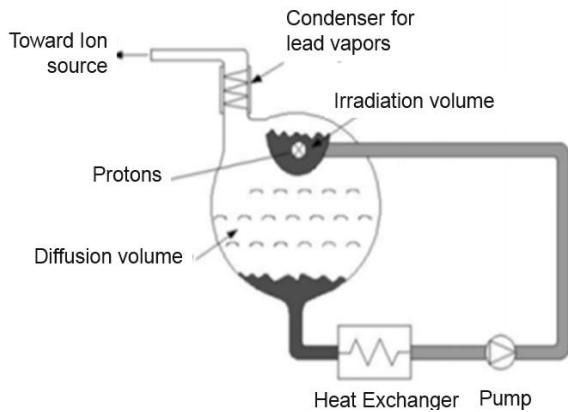


Introduction/Context

- 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



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

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

→ LIEBE (2013 →)



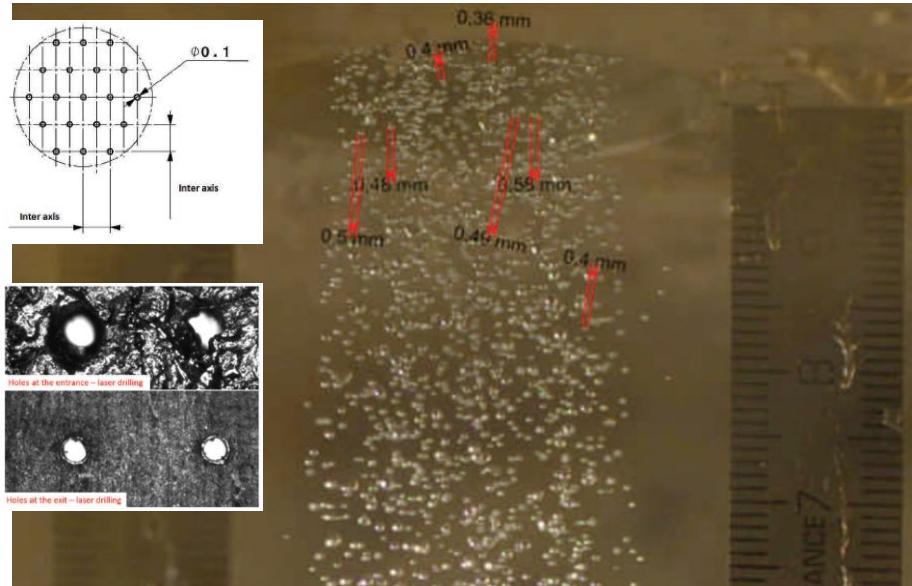
→ Lanthanum eutectic + SnCl molecular beam:
Towards 100Sn beams at HIE-ISOLDE
T. Stora et al., EMIS 2018



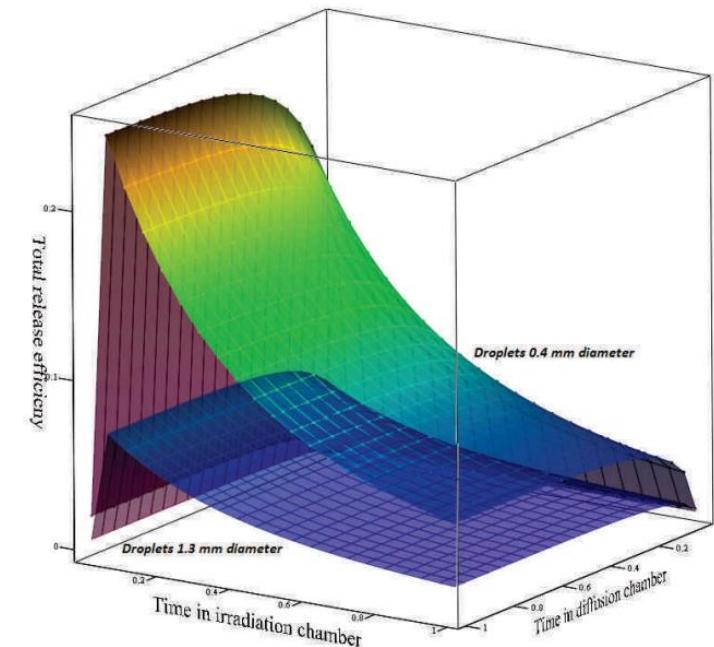
Introduction/Context

- 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** → **$Q=0.13 \text{ l/s}$**
 - **$\varnothing 0.4 \text{ mm}$** droplets → factor **5** more release

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

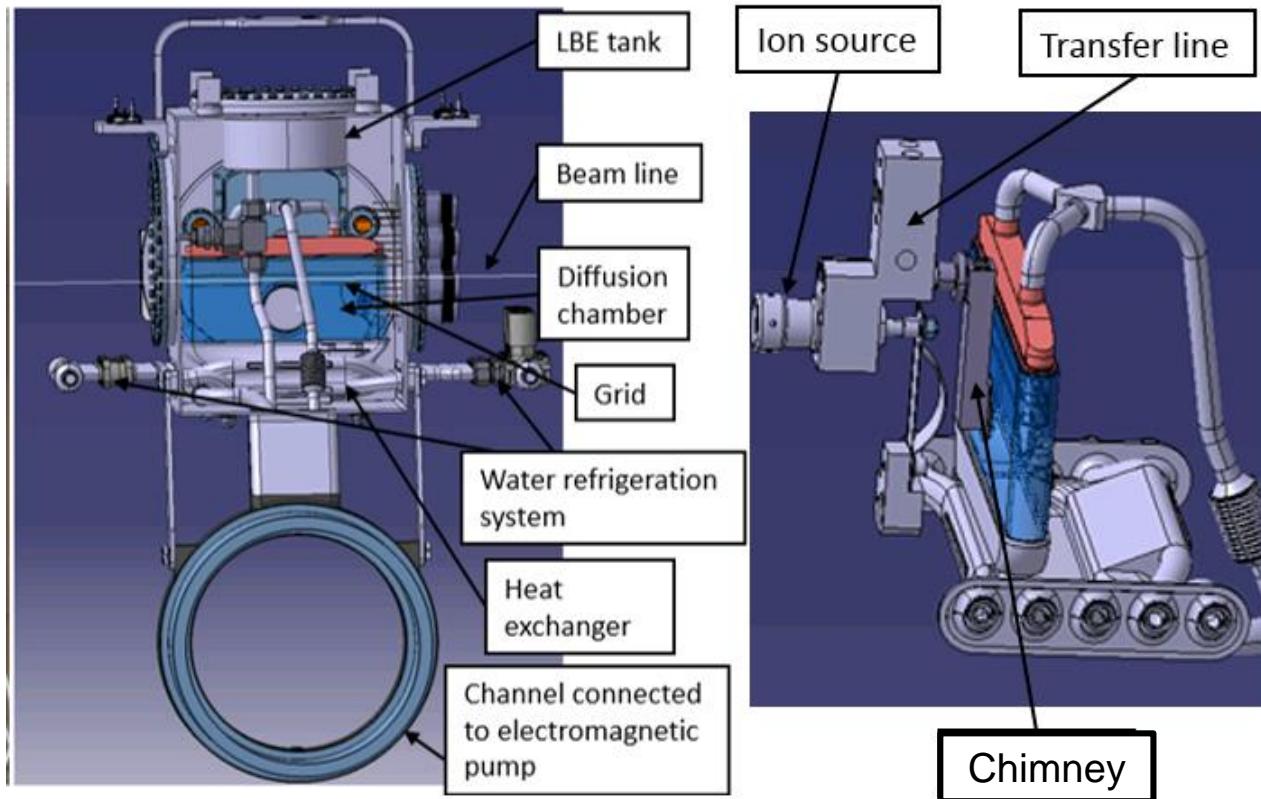
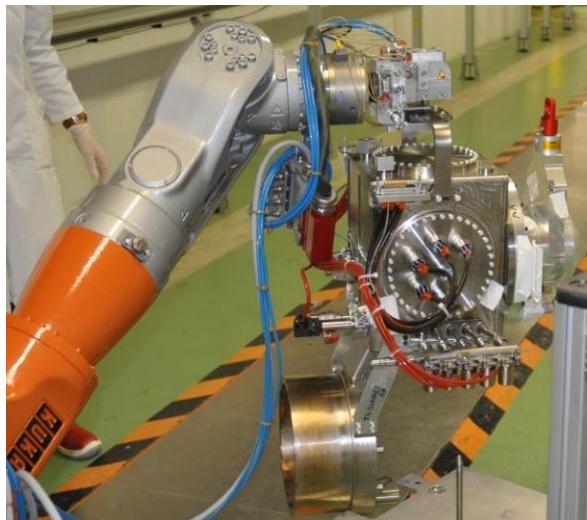


Images from Melanie Delonca CERN Ph.D thesis



LIEBE prototype design & completed assembly

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

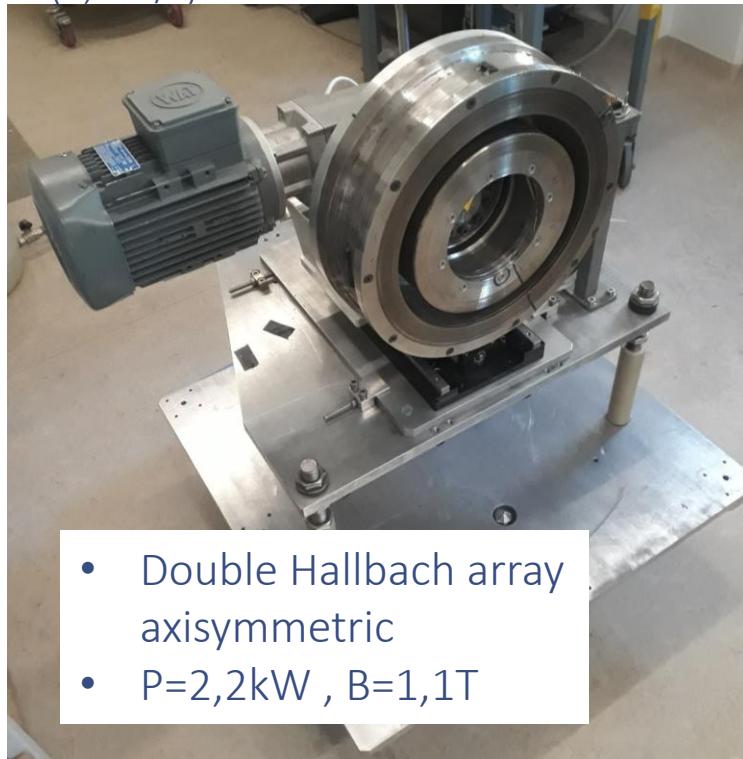




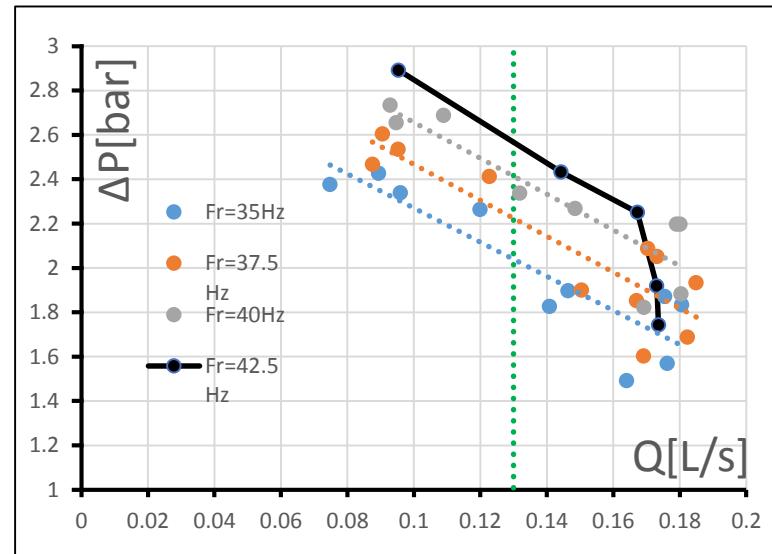
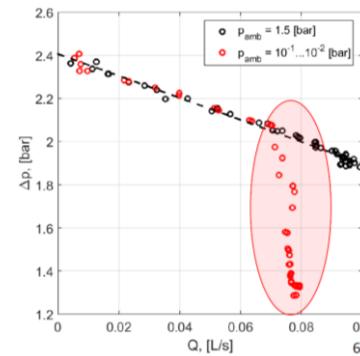
Flow assessment

- Test objectives:

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



Increased diameter: $\varnothing 10\text{mm} \rightarrow \varnothing 16\text{mm}$

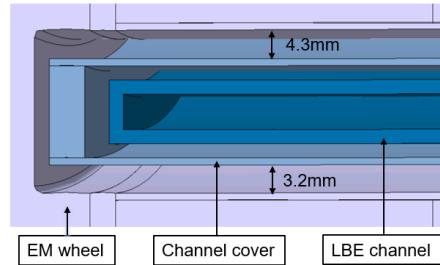


Concept

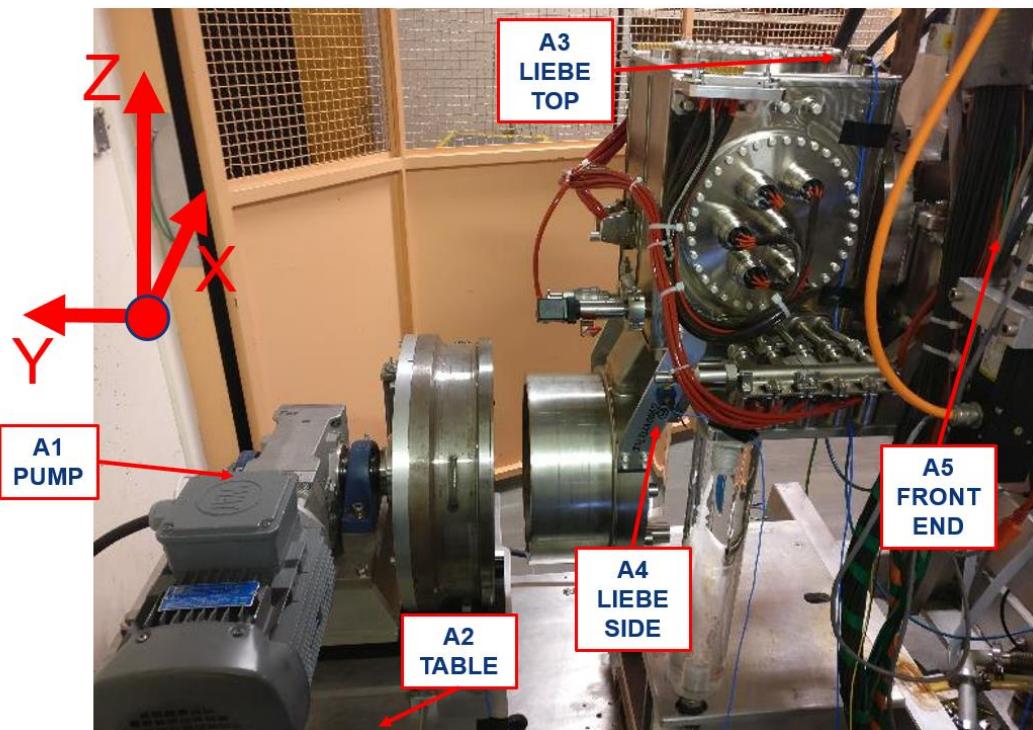
Prototype

Offline commissioning

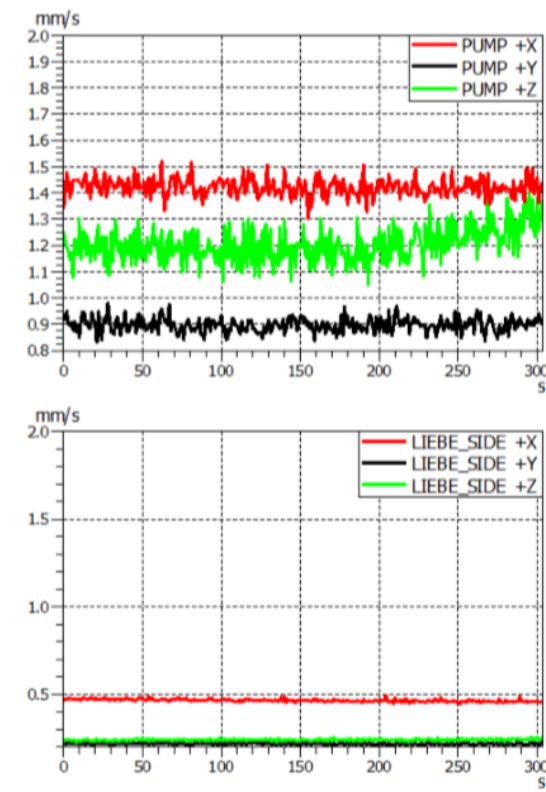
Alignment/vibration tests



Empirically measured maximum distances
in case of perfect alingment



Test setup after alignment



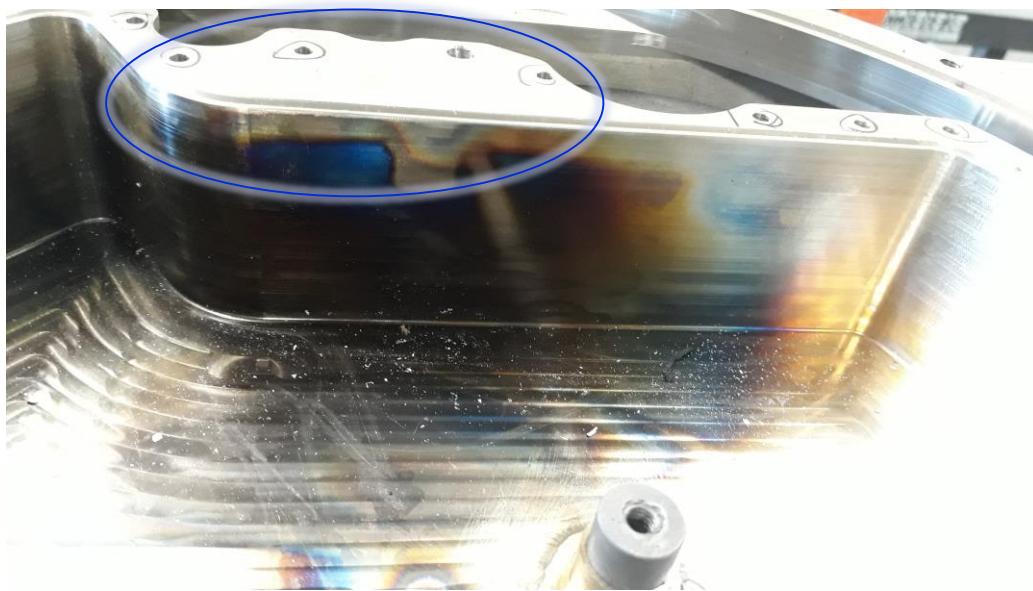
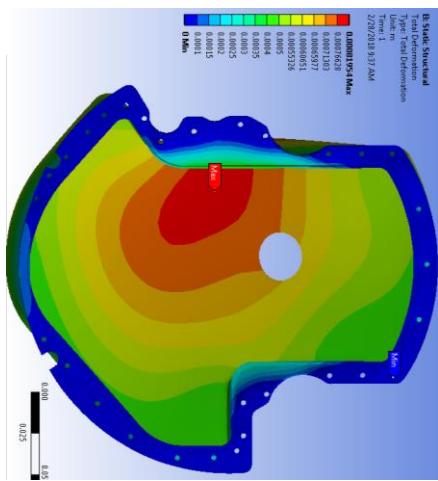
Rotor Fr= 40Hz

Concept

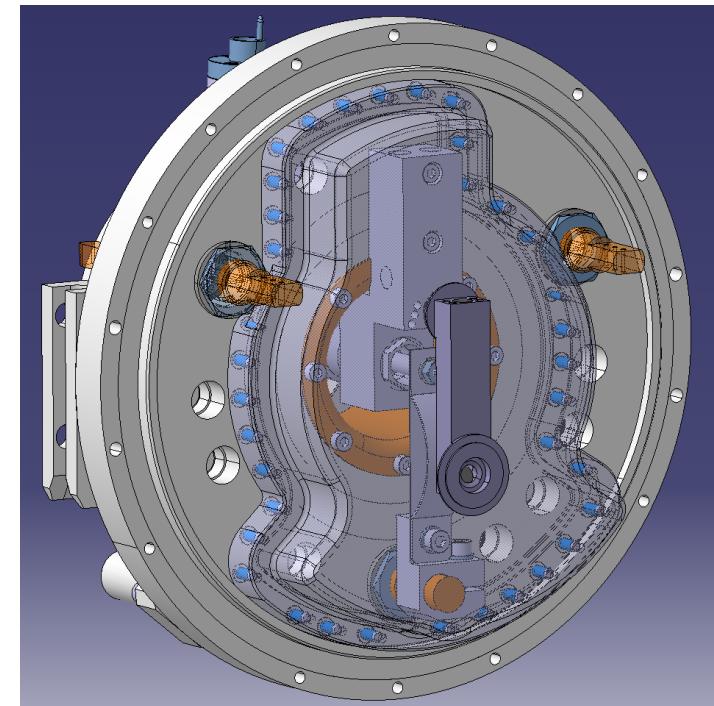
Prototype

Offline commissioning

Thermally induced leak of confinement vessel



New confinement vessel

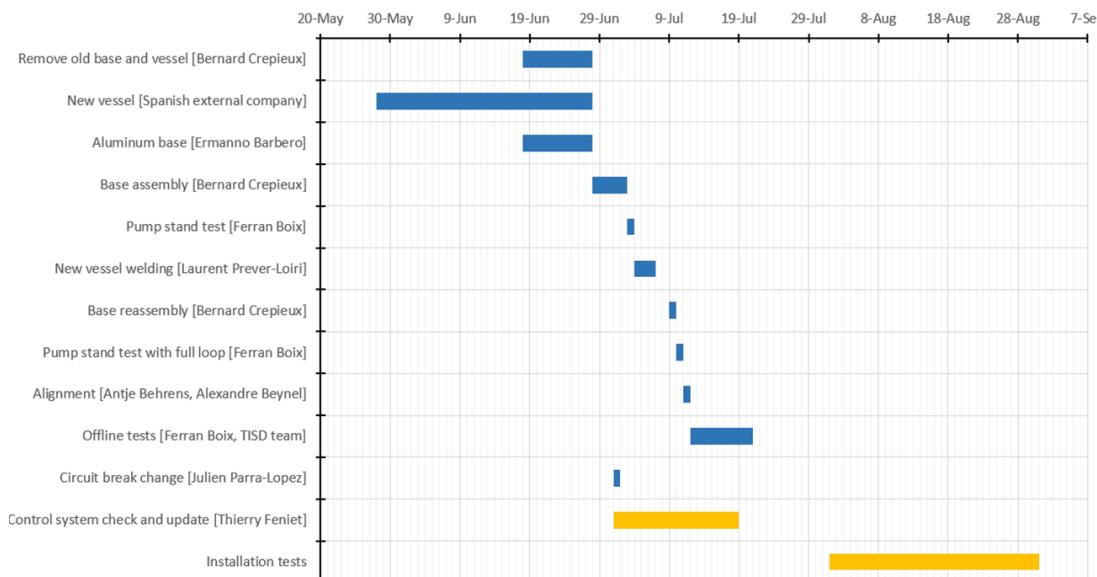




Offline commissioning: Remaining tests

- 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



TOPICS

- 1. R&D to support concepts
- 2. Target material development, material and related simulations
- 3. Post irradiation examination
- 4. Target design, validation of concept
- 5. Target healthy challenges
- 6. Target life time, irradiation, inspection, quality assurance
- 7. Development of targetry
- 8. Operation of targets
- 9. Multi-purpose use of targets and beam dump

Scientific Program Committee

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Thank you

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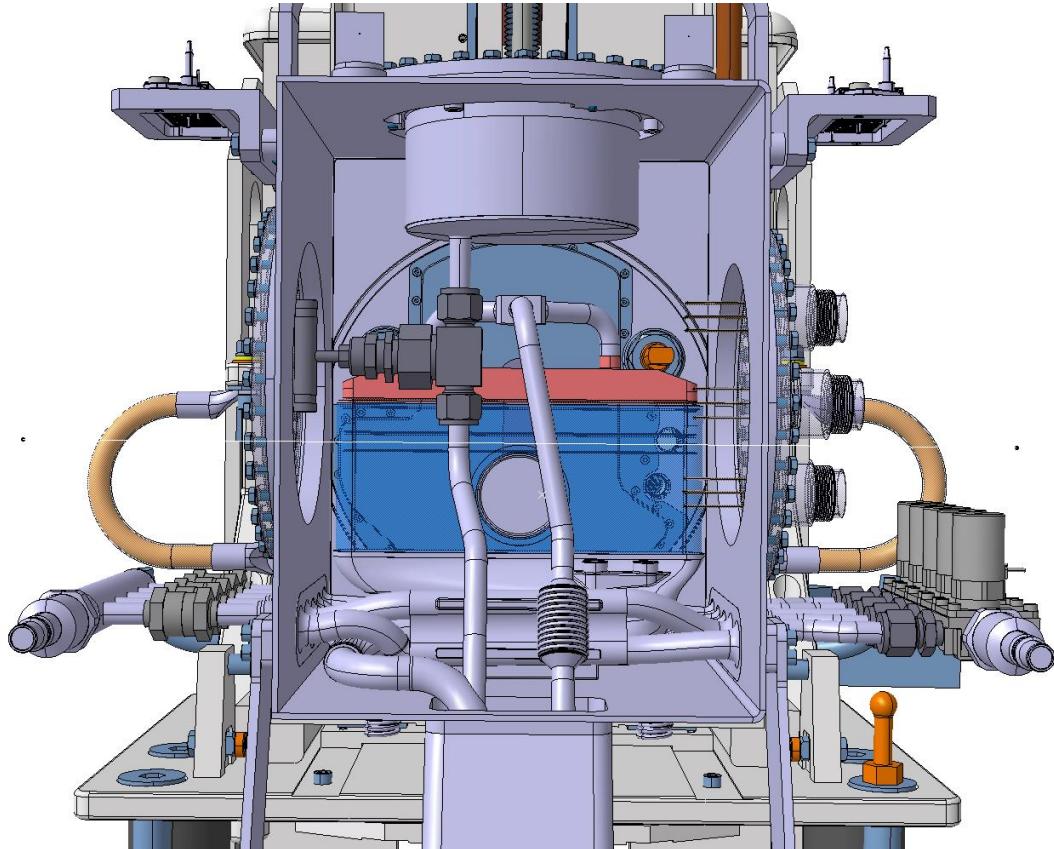
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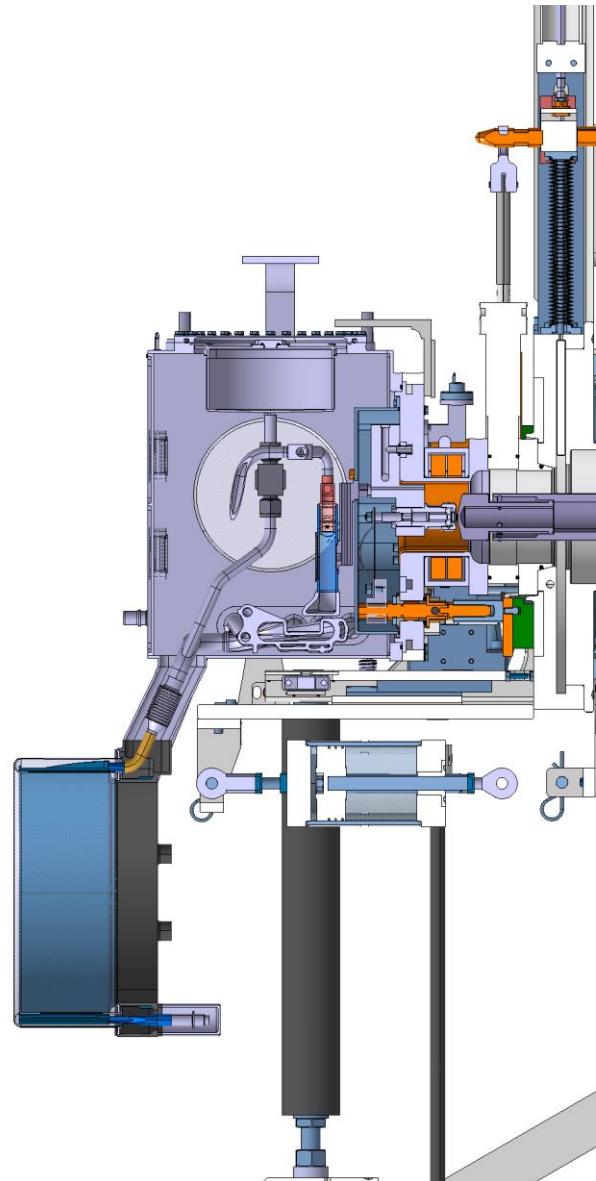


Backup slides

The main loop part

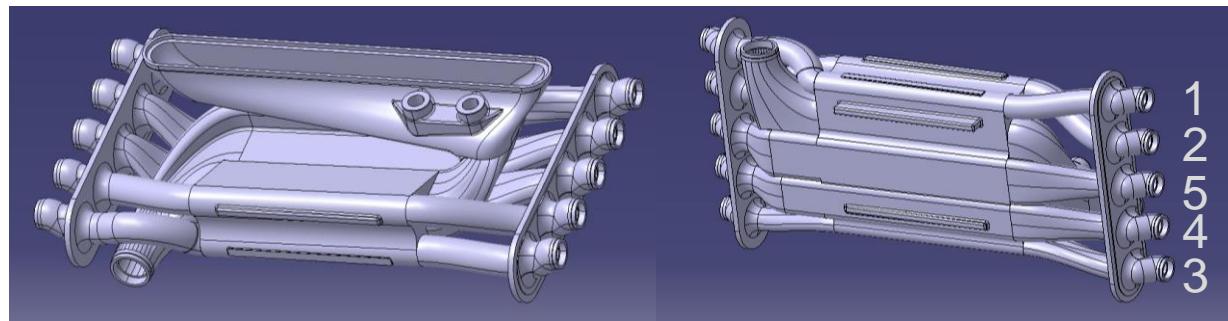


- Filling tank
- Heat Exchanger (HEX)
- Irradiation & diffusion chamber
- Hypertaks/feedthroughs
- Water connectors
- Electrovalves
- Bellows
- Extraction line and ion source -> standard VADIS ion source

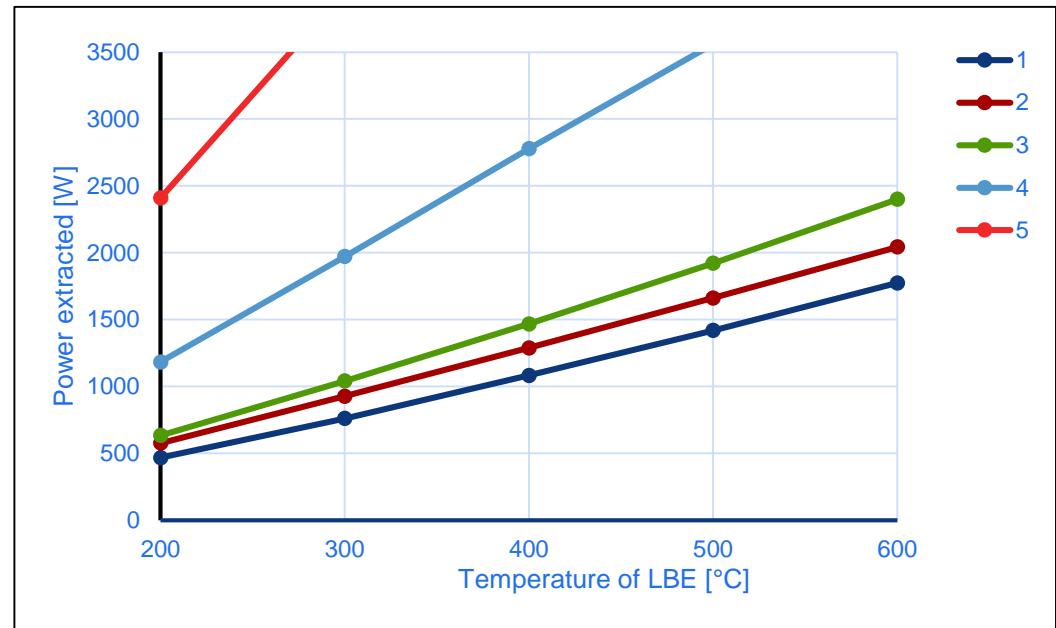
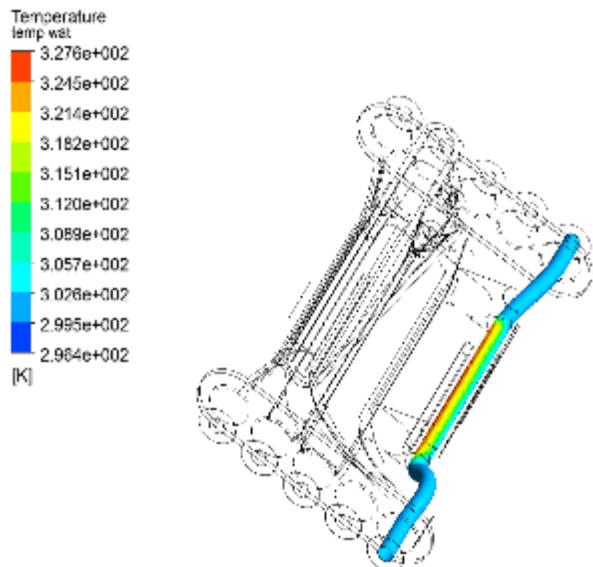


LIEBE: Heat Exchanger

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

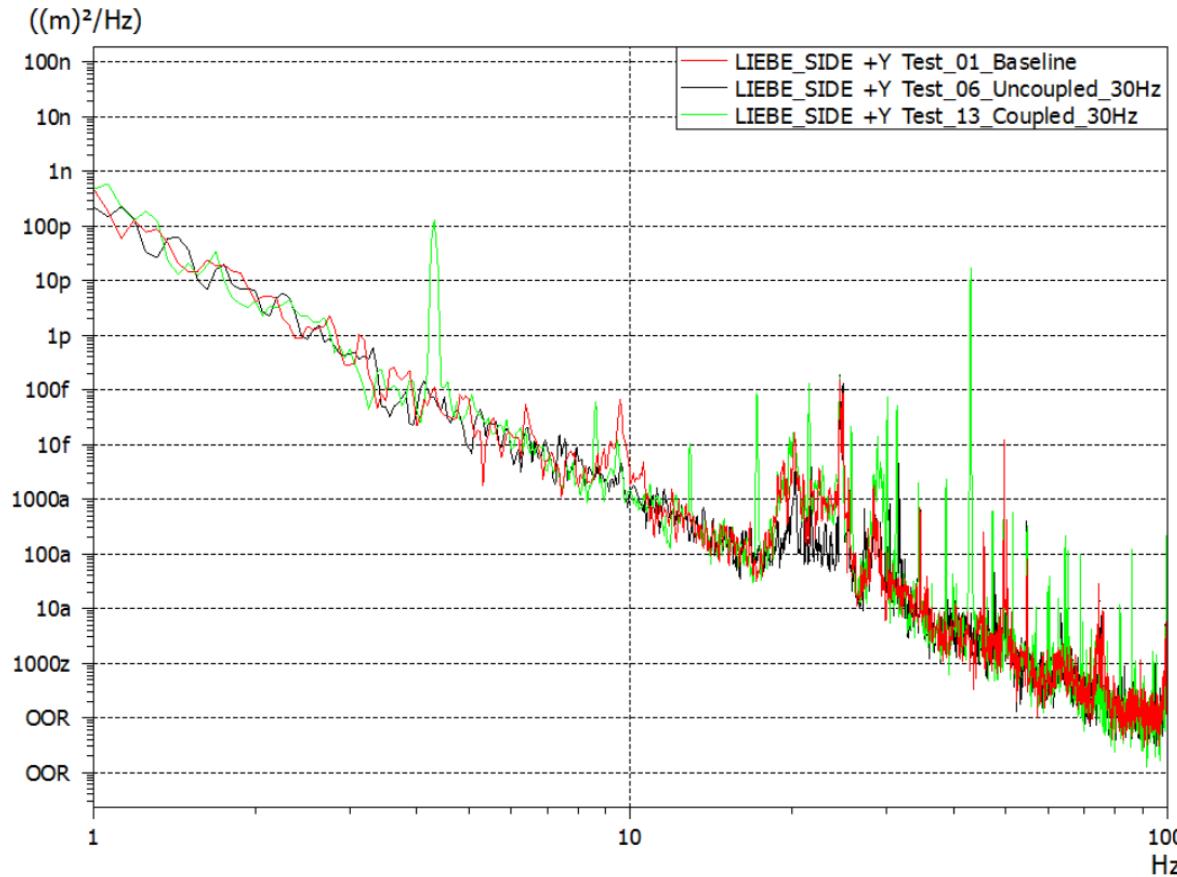


3D printed steel Heat Exchanger



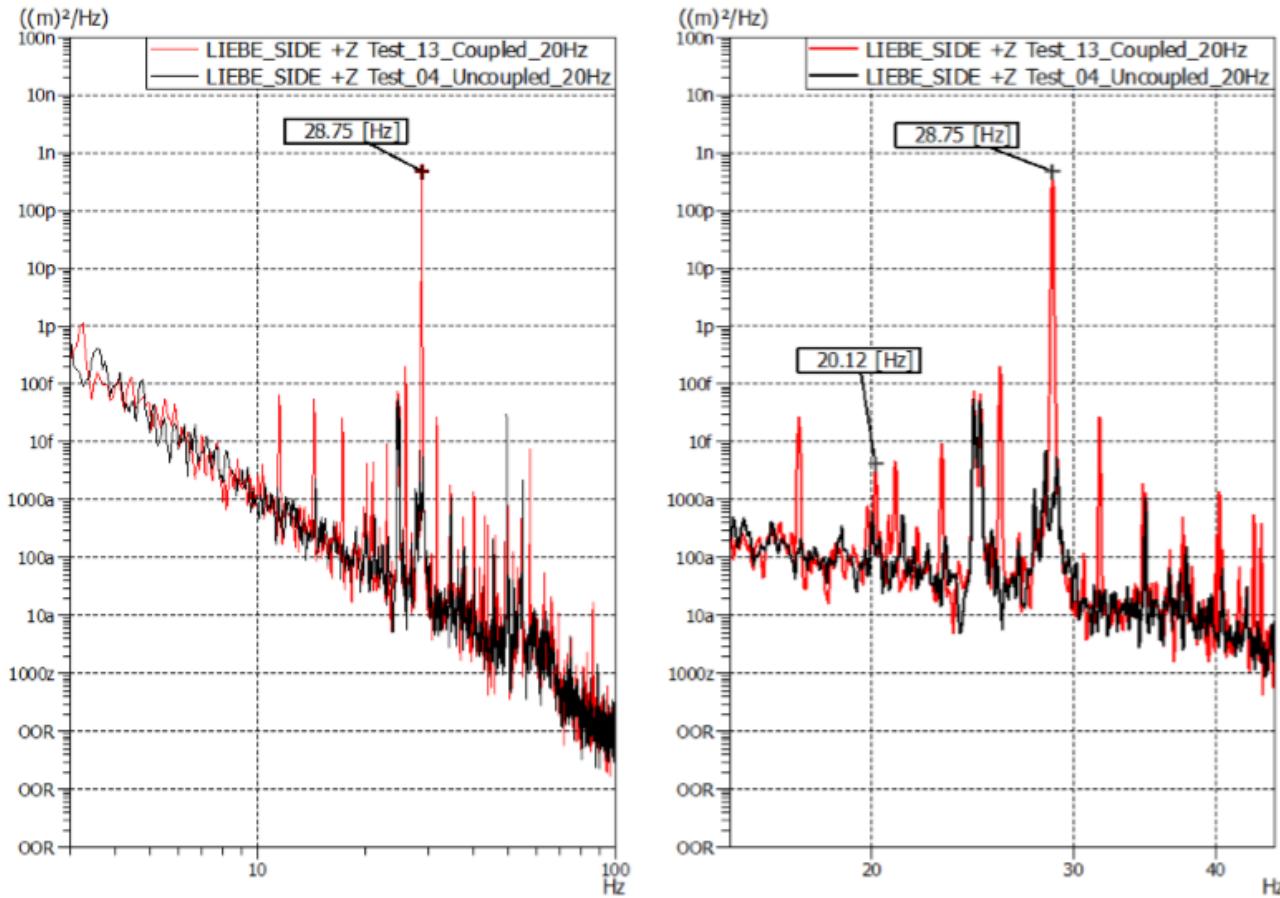
Offline commissioning: Alignment/vibration tests

- Results:



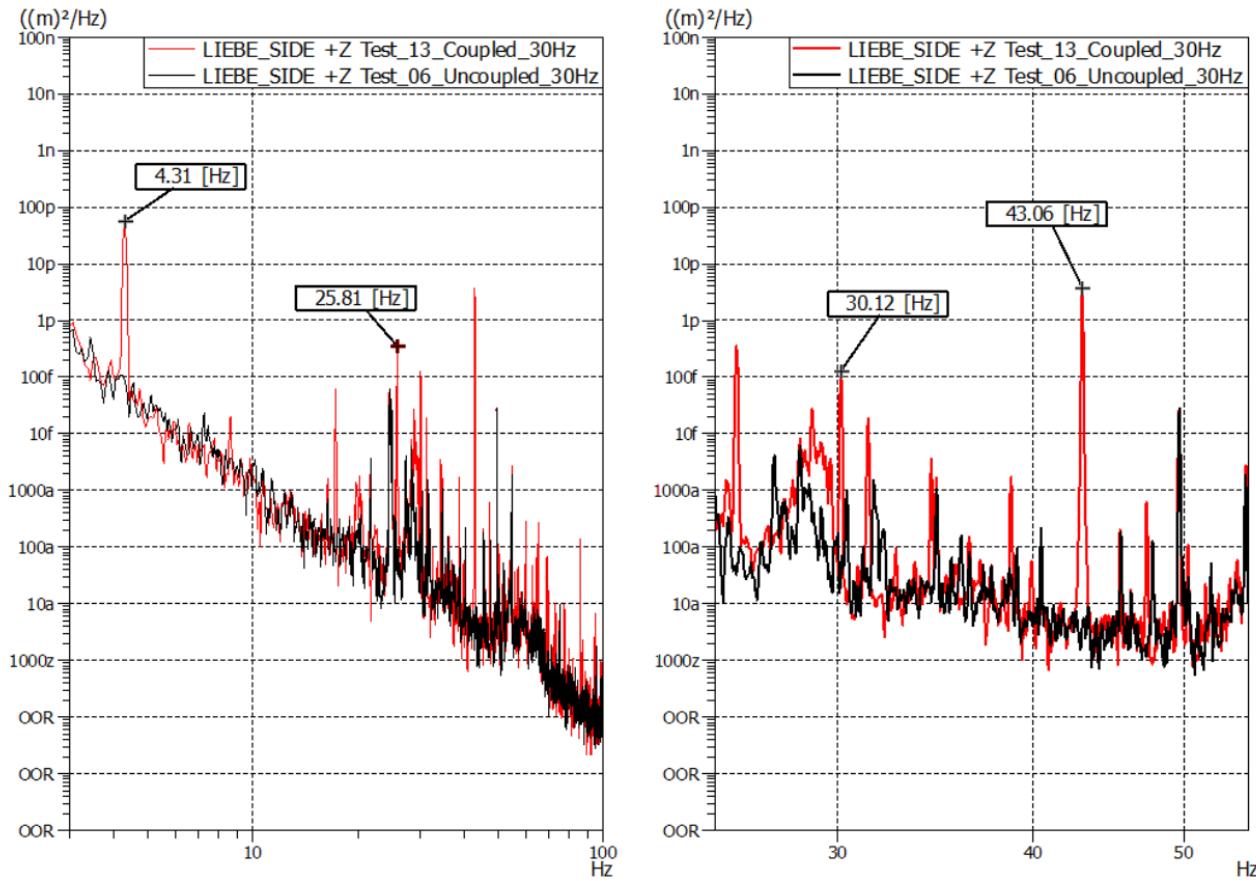
Displacement Power Spectral Density comparison, Rotor Fr=30Hz, EM Wheel Fr= 4,11Hz direction +Y

Offline commissioning: Alignment/vibration tests



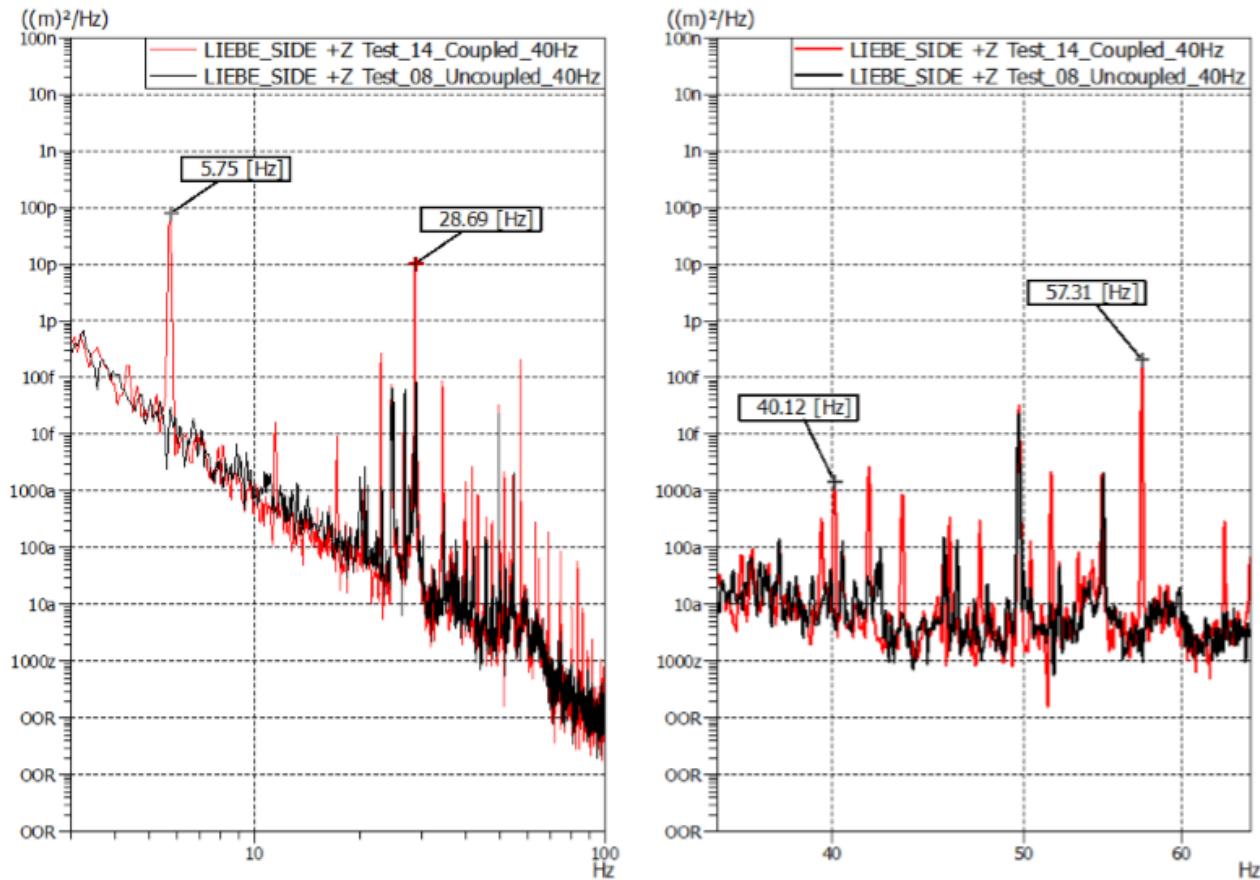
Displacement Power Spectral Density comparison, Rotor Fr=20Hz, EM Wheel Fr= 2,75Hz direction +Z

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

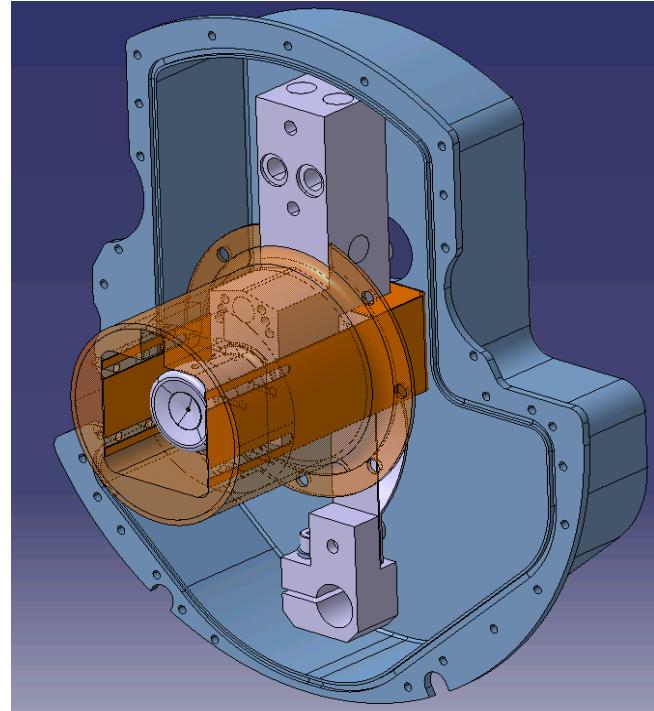
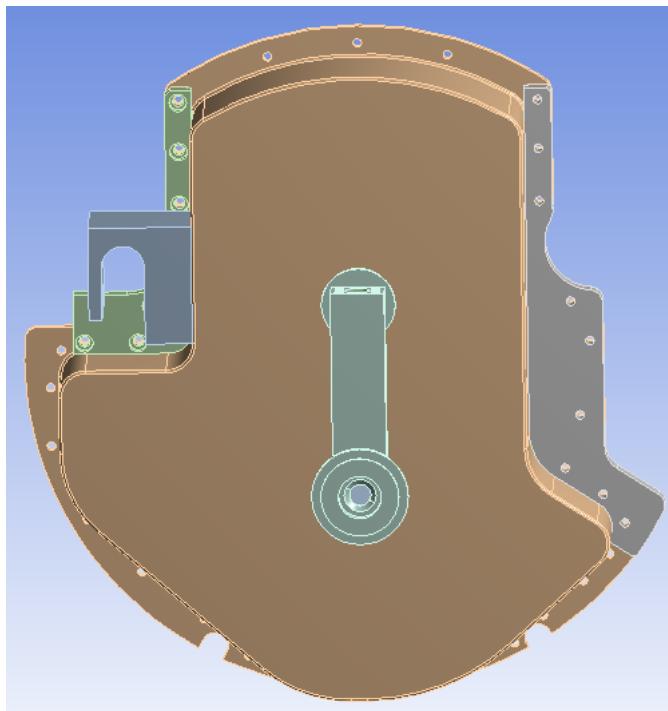


Displacement Power Spectral Density comparison, Rotor Fr=40Hz, EM Wheel Fr= 5,48Hz direction +Z

Offline commissioning: Leak issue

- Attempts to solve it:

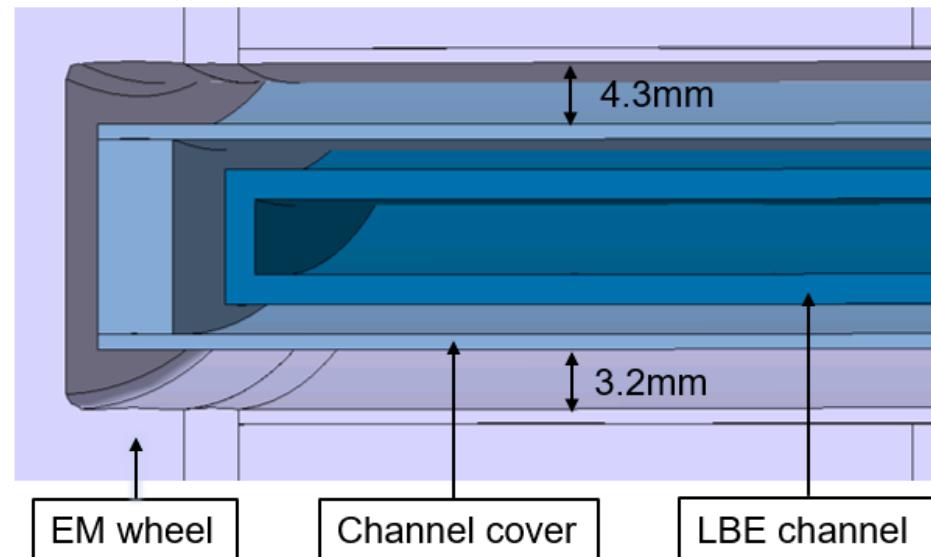
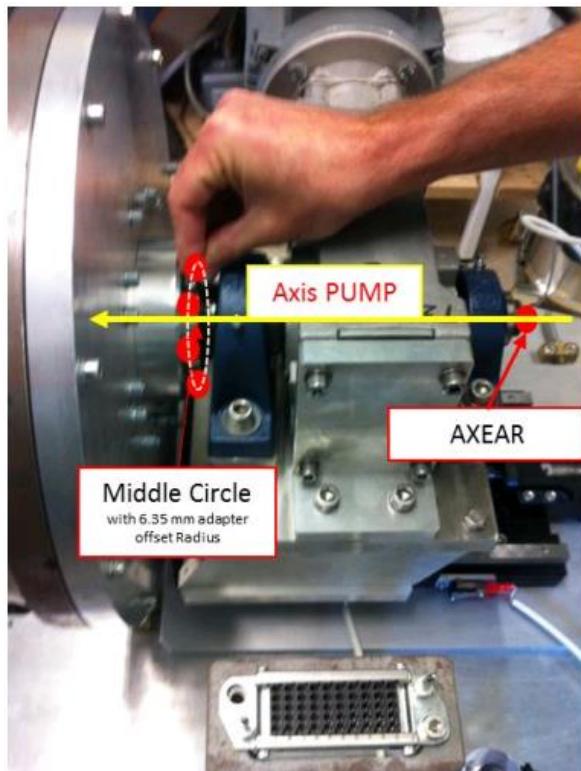
- Increasing sealing pressure
- Shielding the ion source
- Only able to operate the source up to 1900 °C



Offline commissioning: Alignment/vibration tests

- Alignment tests:

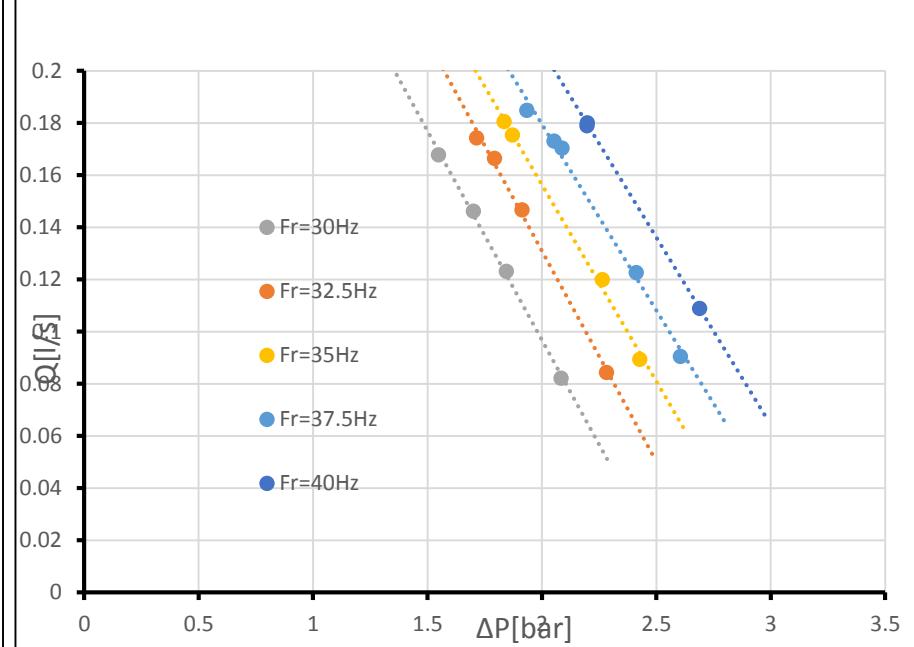
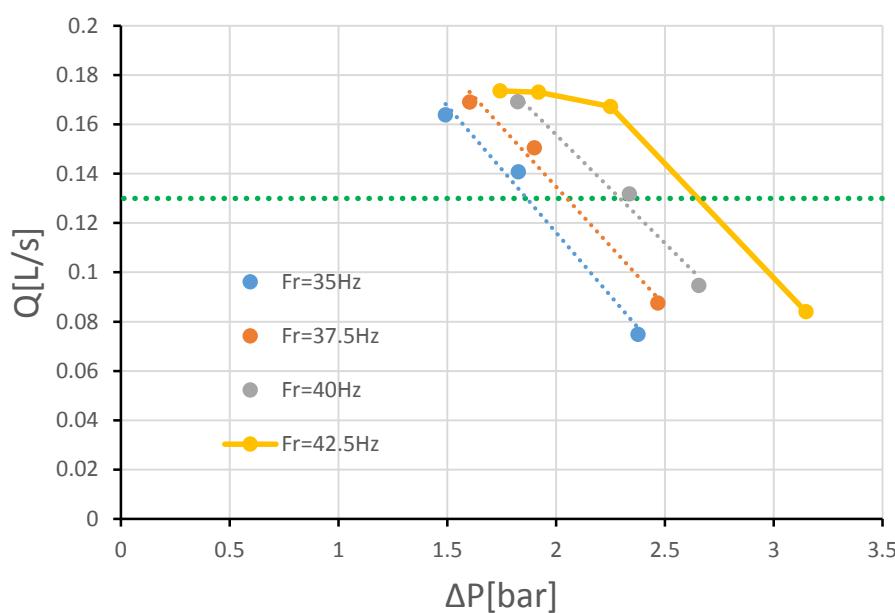
- Cylinder axis and pump axis are on the same line within 0.1mm



Best fit distances between EM pump and target

Measurement of the EM pump axis

Offline commissioning: Flow assessment



Offline commissioning: Alignment/vibration tests

VIBRATION SEVERITY PER ISO 10816					
	Machine		Class I small machines	Class II medium machines	Class III large rigid foundation
	in/s	mm/s			
Vibration Velocity V _{rms}	0.01	0.28			
	0.02	0.45			
	0.03	0.71			good
	0.04	1.12			
	0.07	1.80			
	0.11	2.80		satisfactory	
	0.18	4.50			
	0.28	7.10		unsatisfactory	
	0.44	11.2			
	0.70	18.0			
	0.71	28.0		unacceptable	
	1.10	45.0			