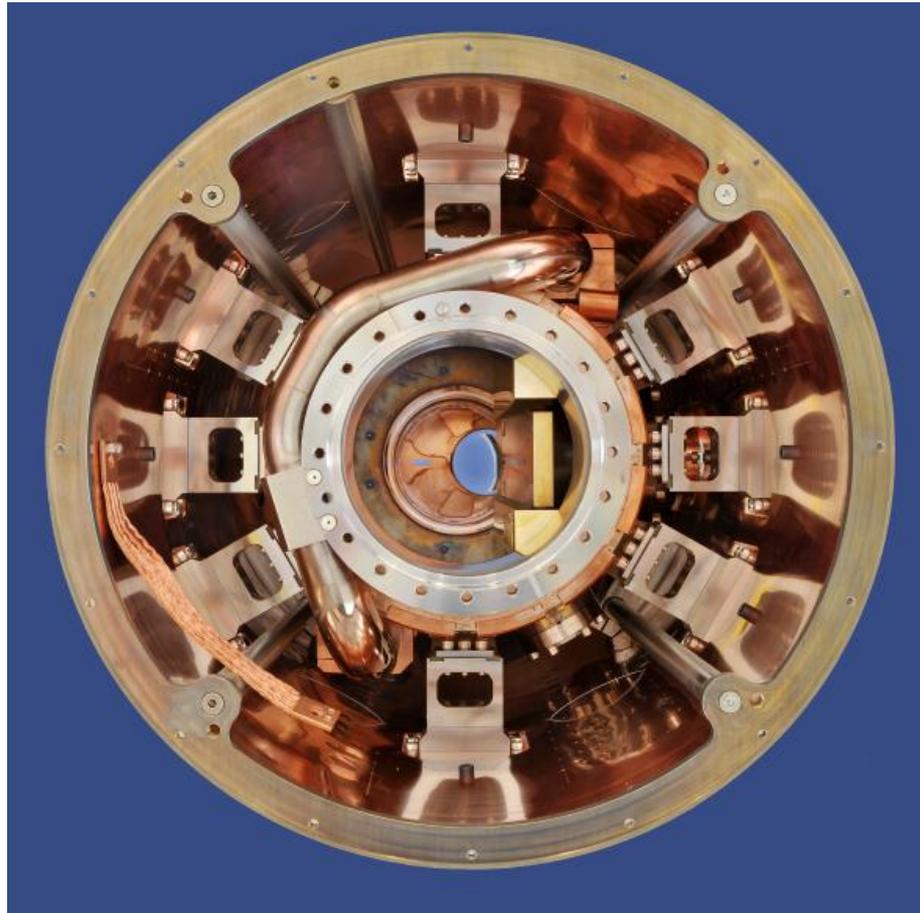


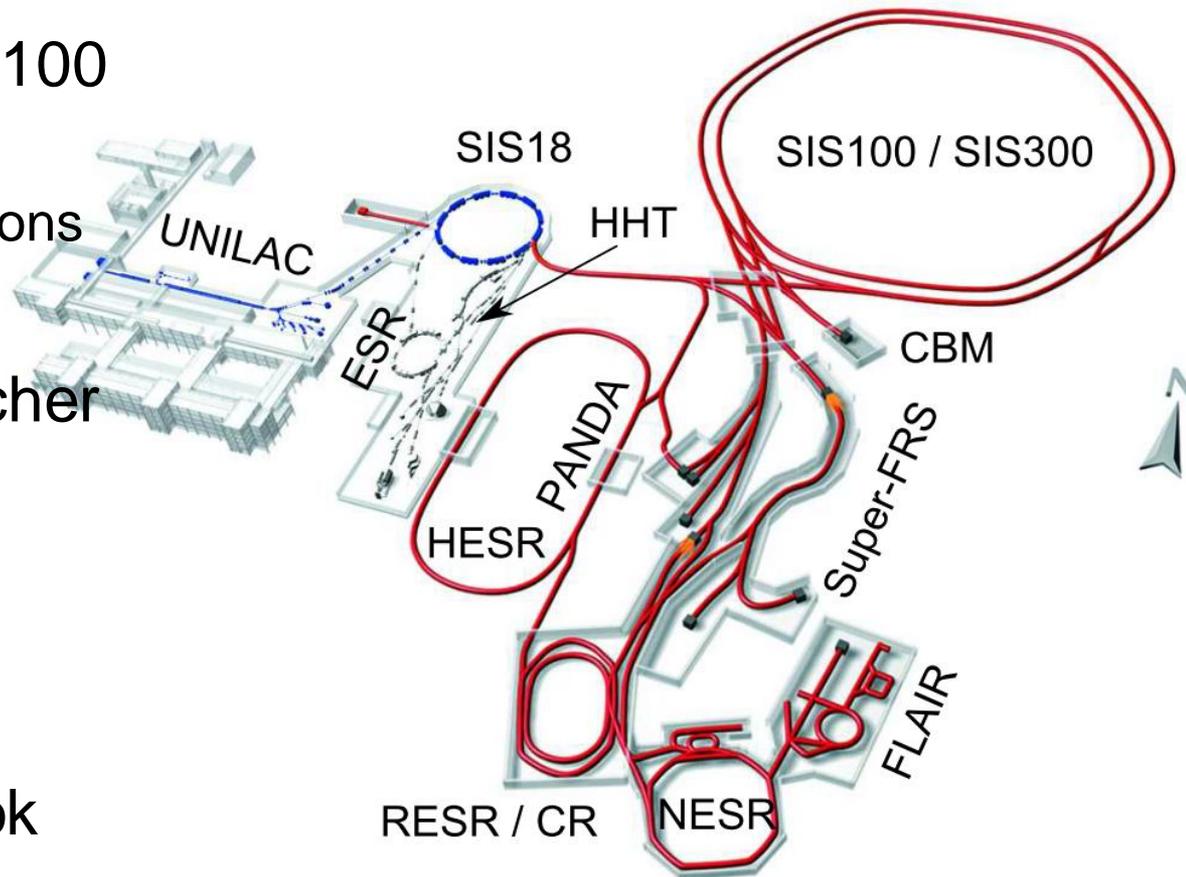
Cryocatcher for SIS100

Test Results of the Cryocatcher Prototype

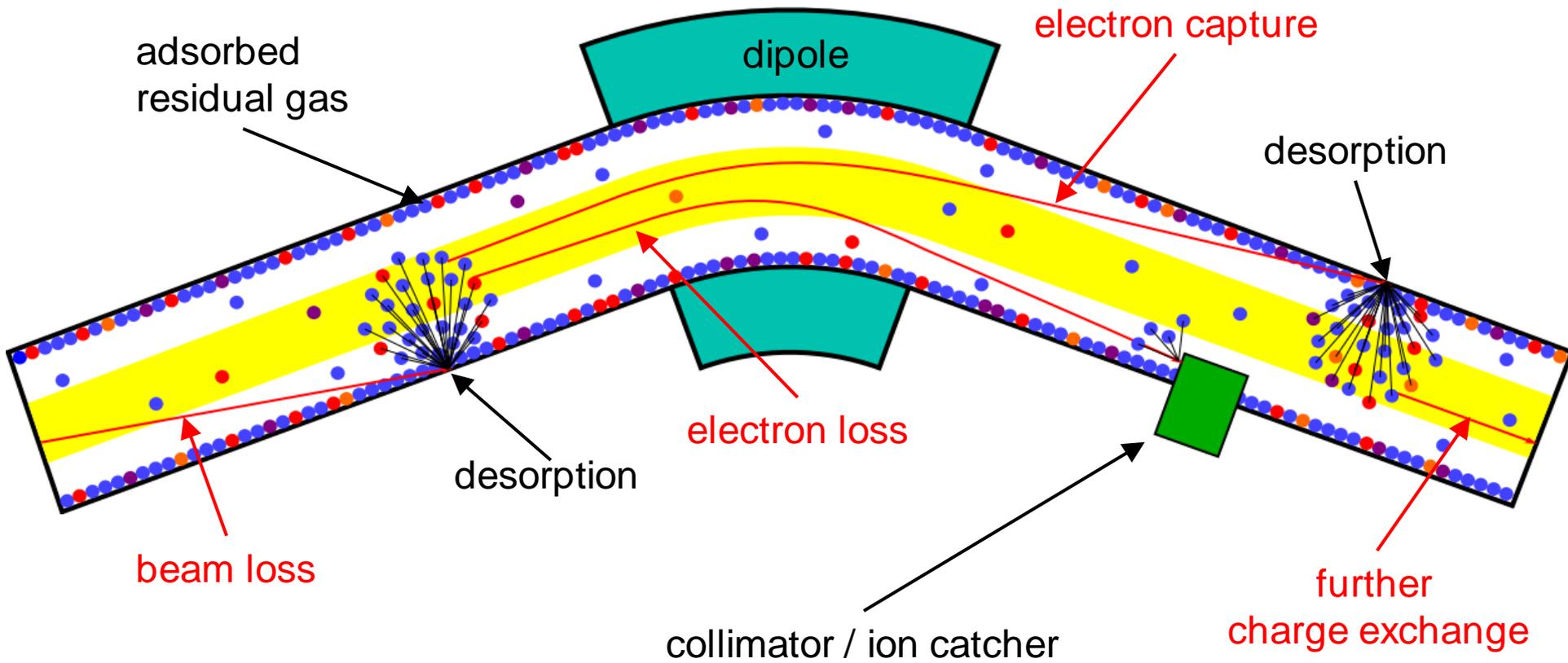


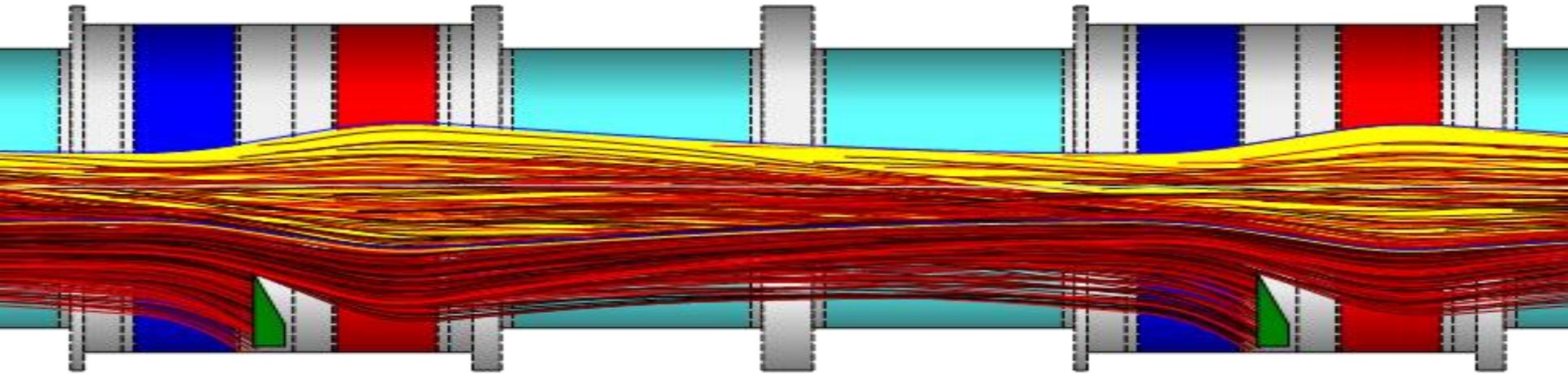
Lars Bozyk

- Introduction – Dynamic Vacuum
- Cryocatcher in SIS100
 - Requirements
 - Design considerations
- Prototype Cryocatcher
 - Test-Setup
 - Measurements
 - Results
- Summary & Outlook



Dynamic Vacuum





$U^{28+} \rightarrow U^{29+}$

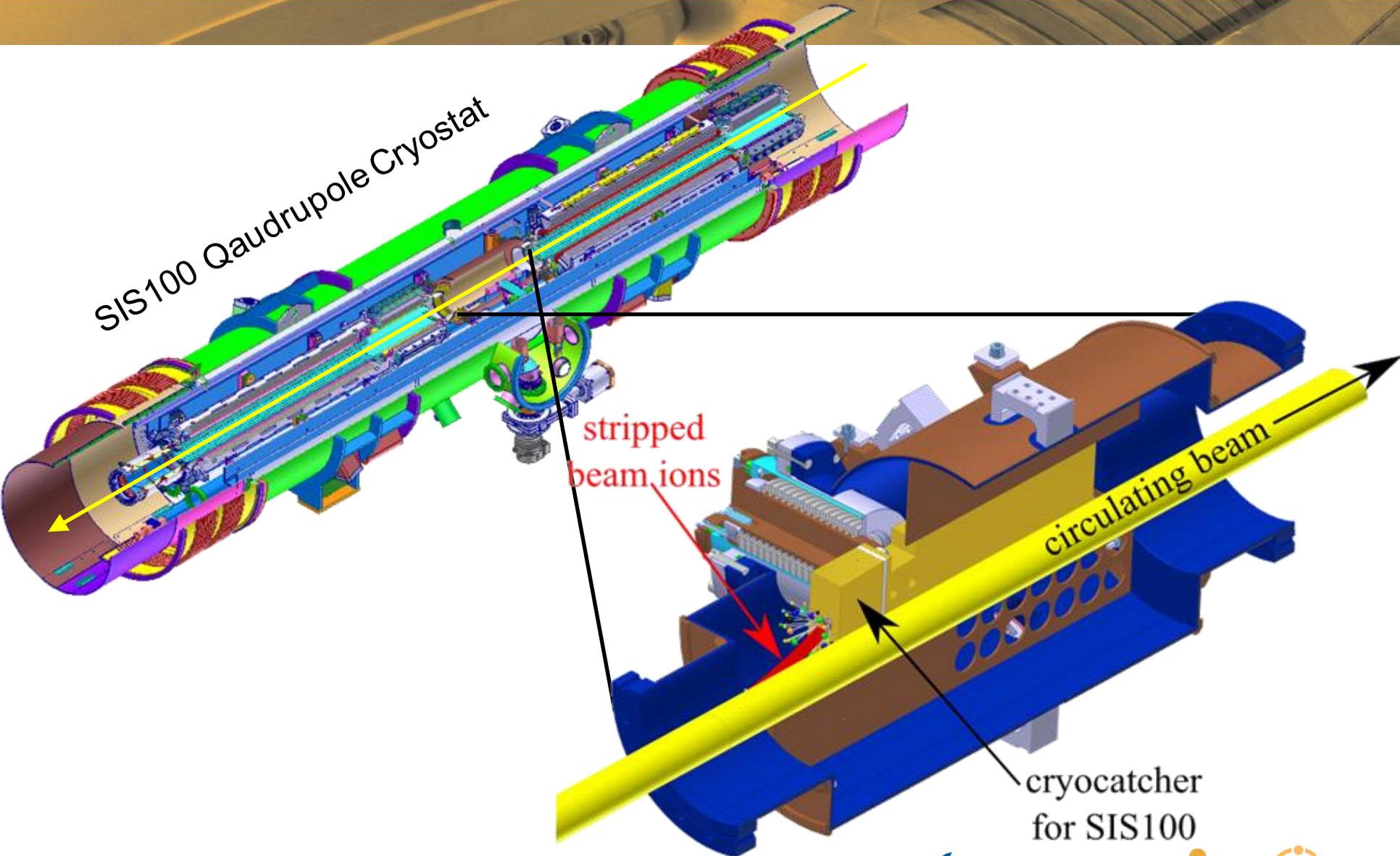
- SIS100 lattice has been **optimized** to reach a **maximum catching efficiency**
- Loss distribution is strongly localized between the quadrupoles where the **ion catcher** will be installed

Cryocatcher - Requirements

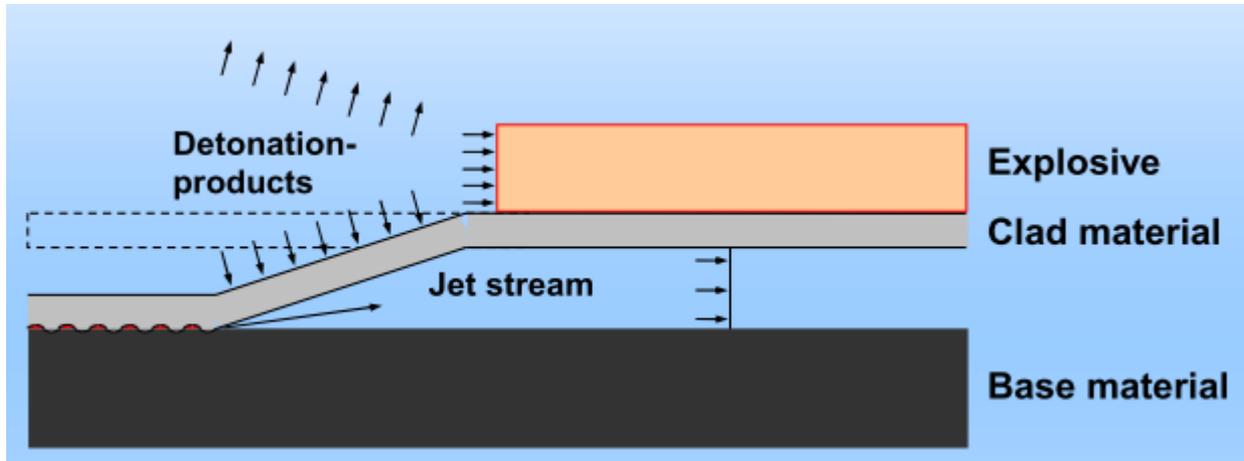
- Desorbed **gases** must be **adsorbed quickly**
- From lost ions **deposited energy** has to be removed
- Thermal **load** onto **LHe-cooling** has to be kept low
- Activation of surrounding material should be kept low
- Measurement of lost ions desirable
- Cryocatcher has to be **mounted** somehow

- Surrounding **cold chamber** acts as **cryopump** quickly removing **desorbed gases**
- Cryocatcher has to be kept at a **higher temperature** to prevent gases from **freezing out** on the surface of incidence

Cryocatcher in Quadrupole Cryostat

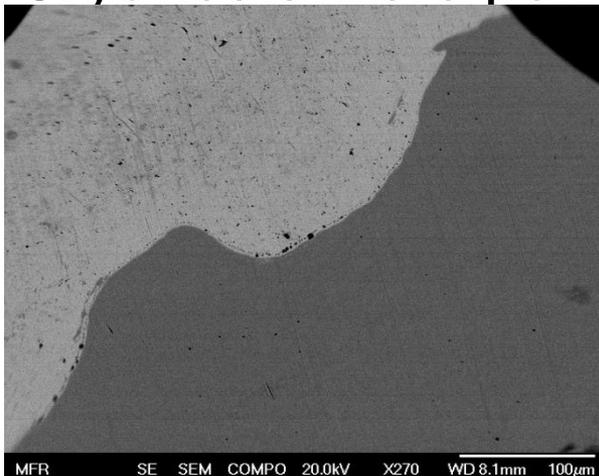


Explosive plating – Copper onto stainless steel



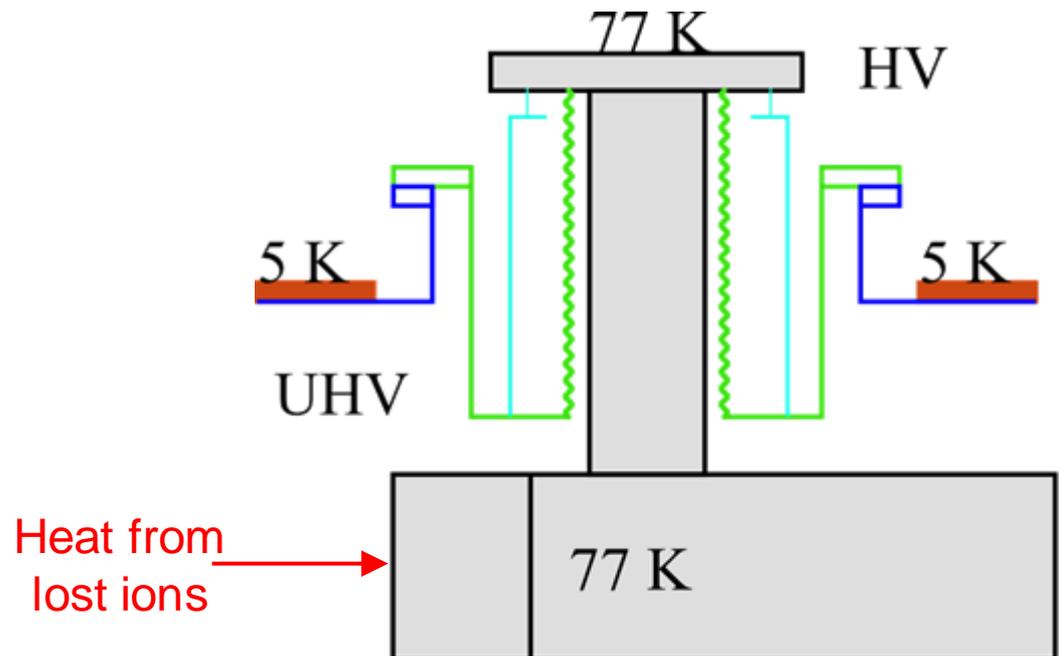
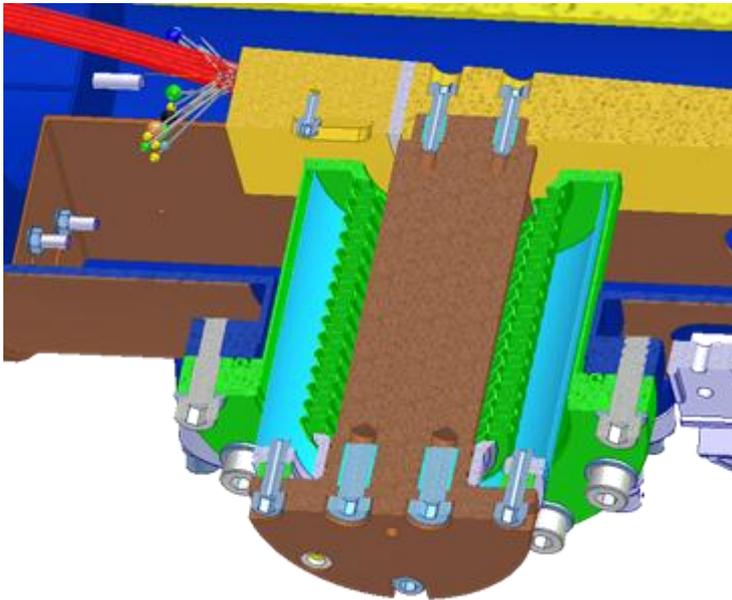
Dynaplat, 2010

- Chamber will be coated with copper
- Cryo-tests were performed with test-sample

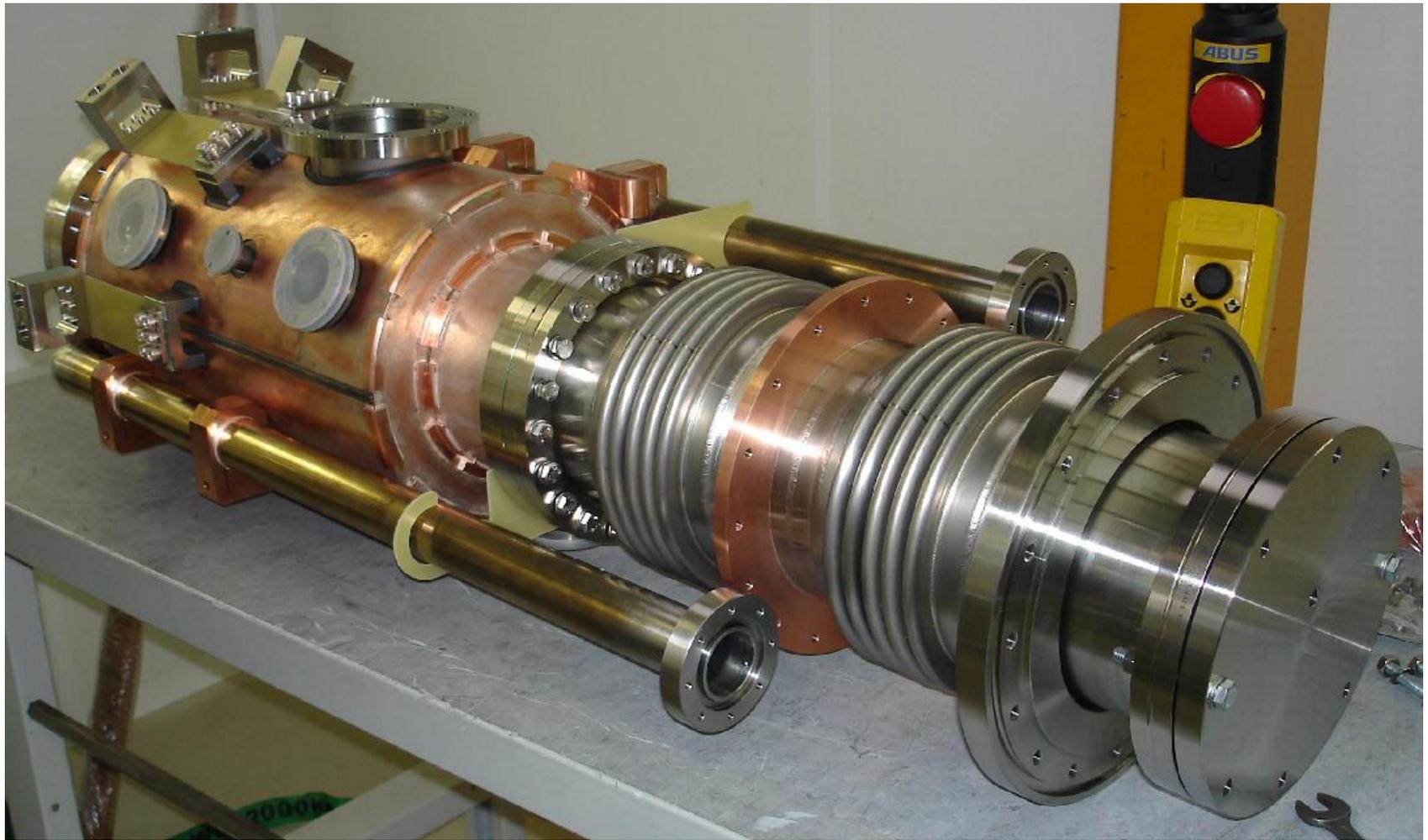


Cryocatcher - Mounting

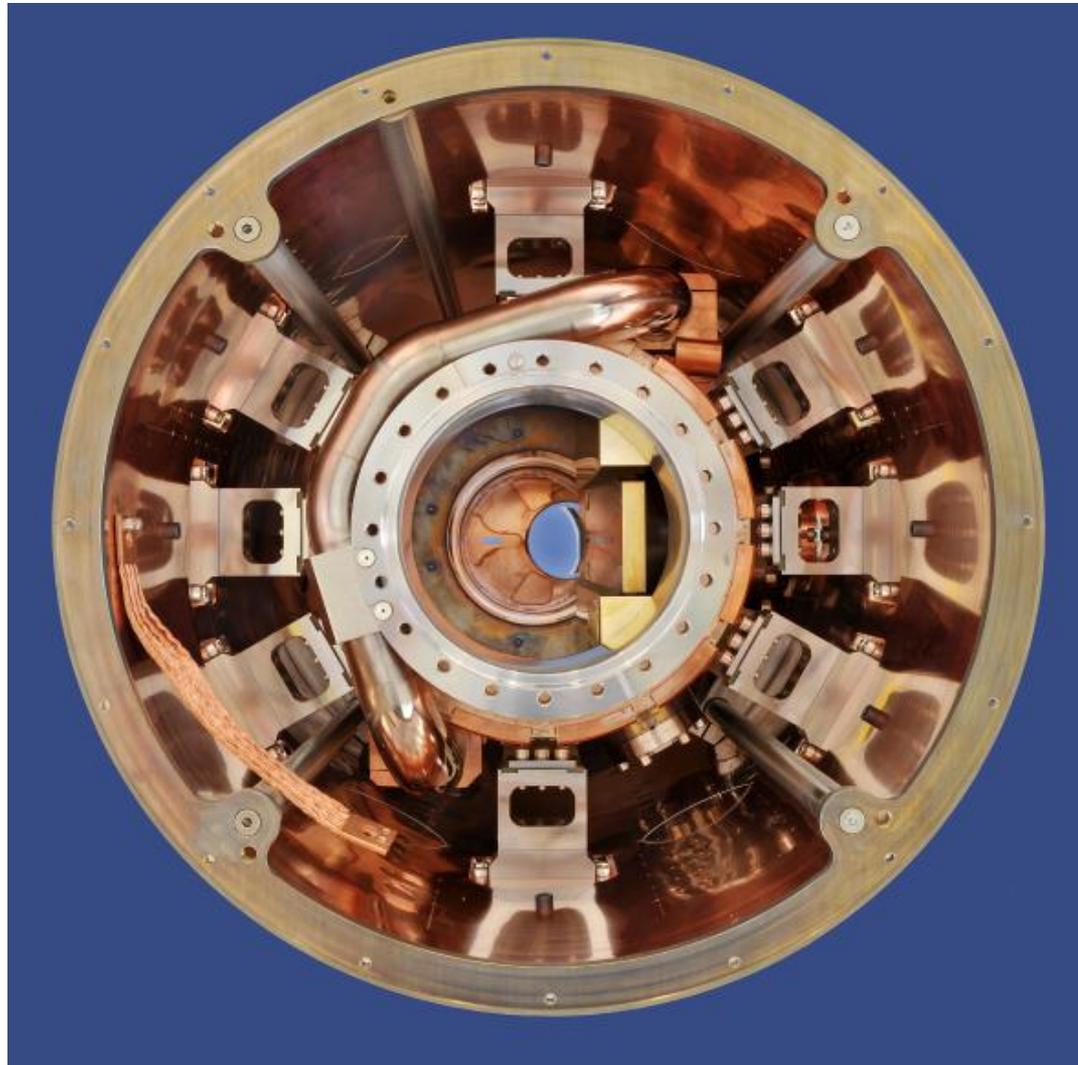
- Keep cryocatcher at higher temperature (e.g. 77 K)
- Direct deposited energy from lost ions into thermal shield cooling (cheaper) instead of magnet cooling
- Keep load onto LHe low
- Fit into cryostat



Cryocatcher chamber & CWT



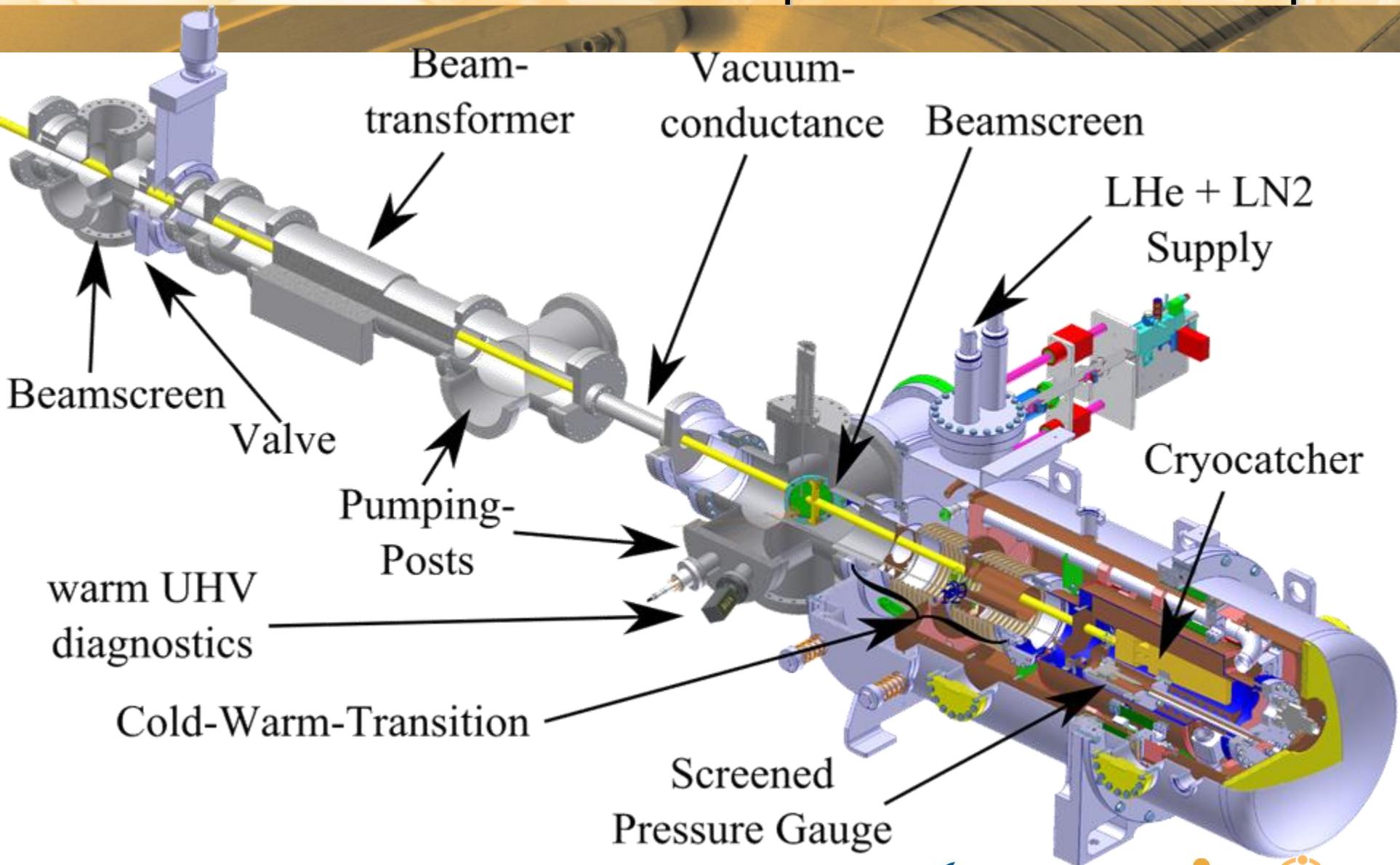
Cryocatcher Prototype



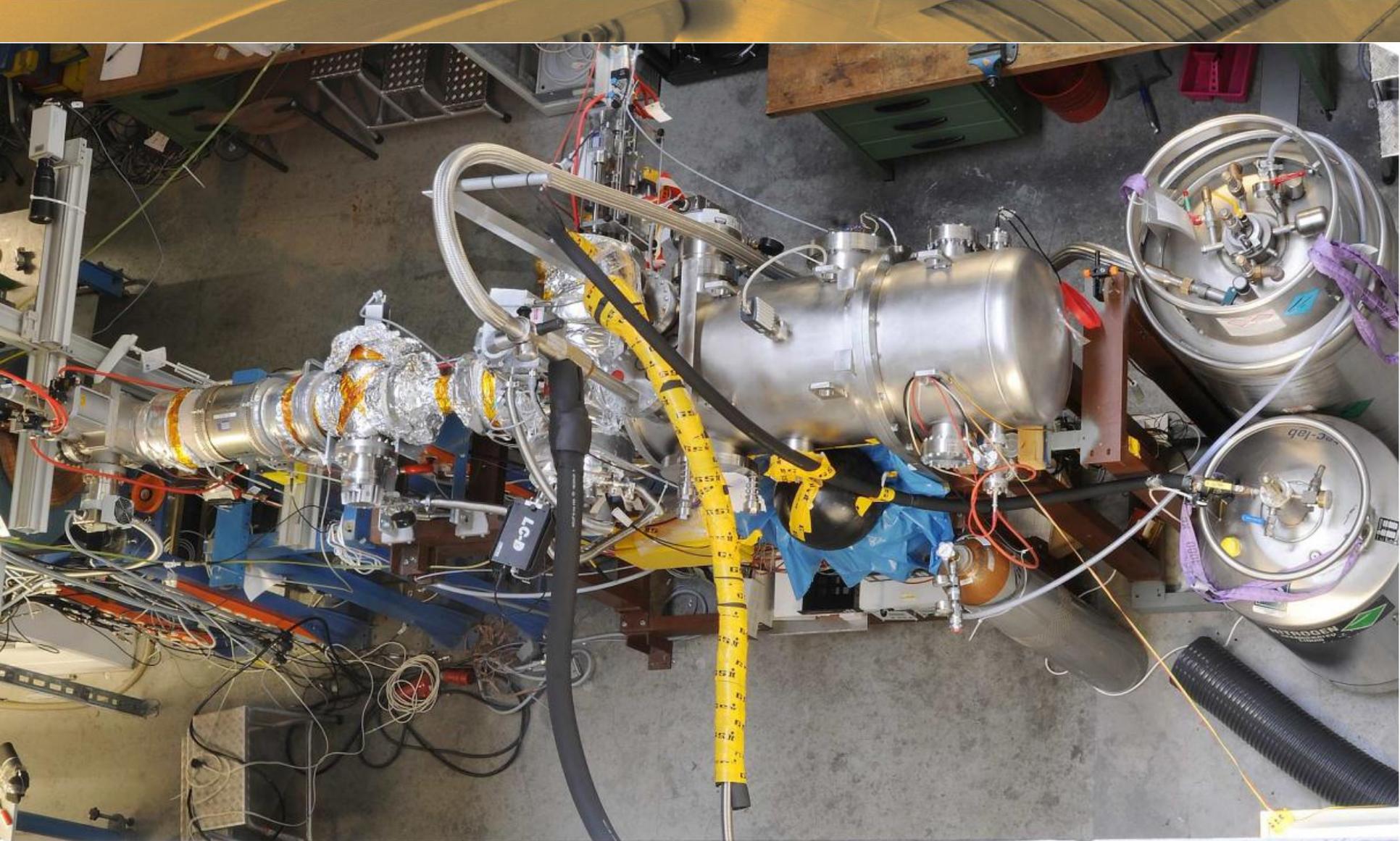
Cryocatcher Prototype



Experimental Test Setup



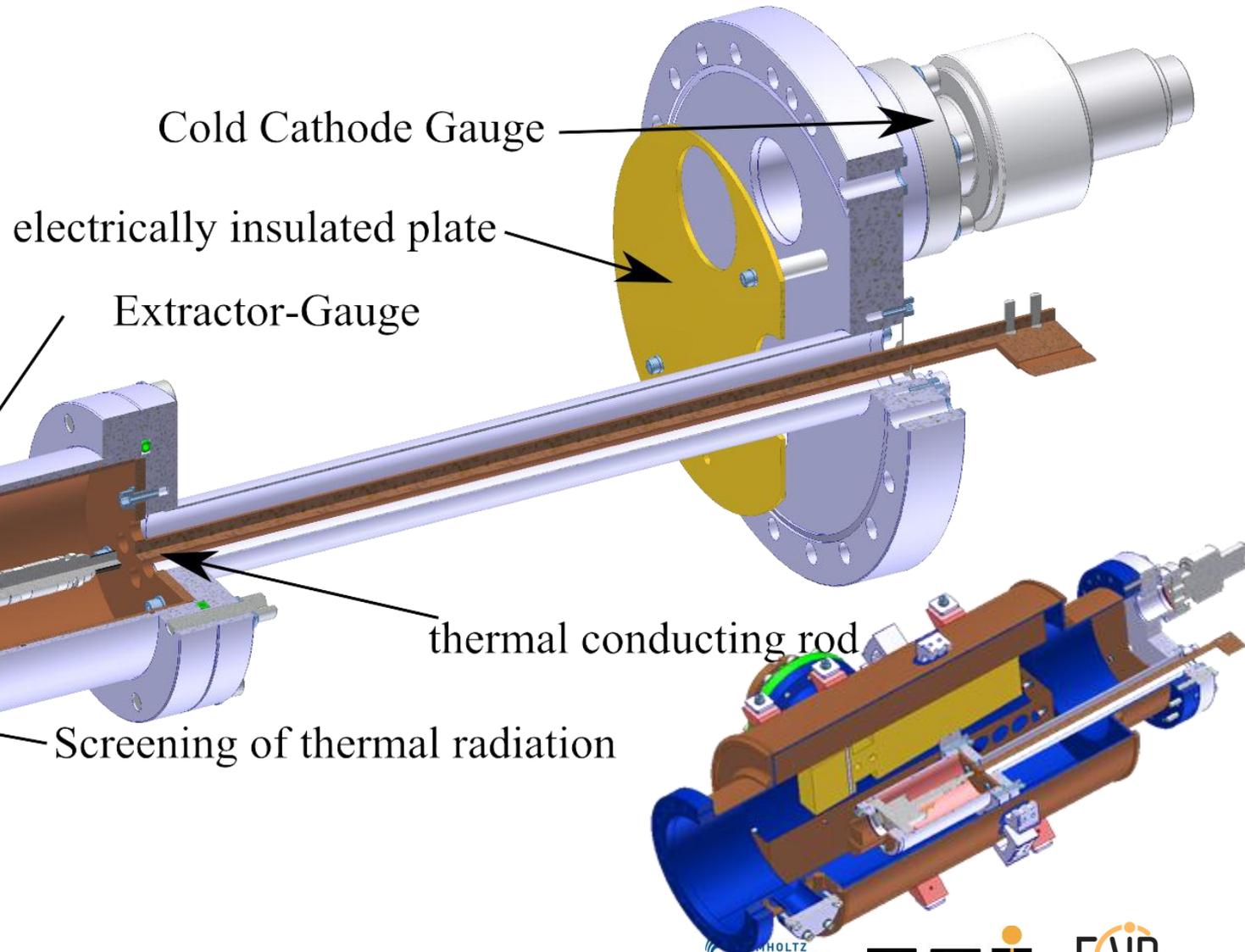
Experimental Test Setup



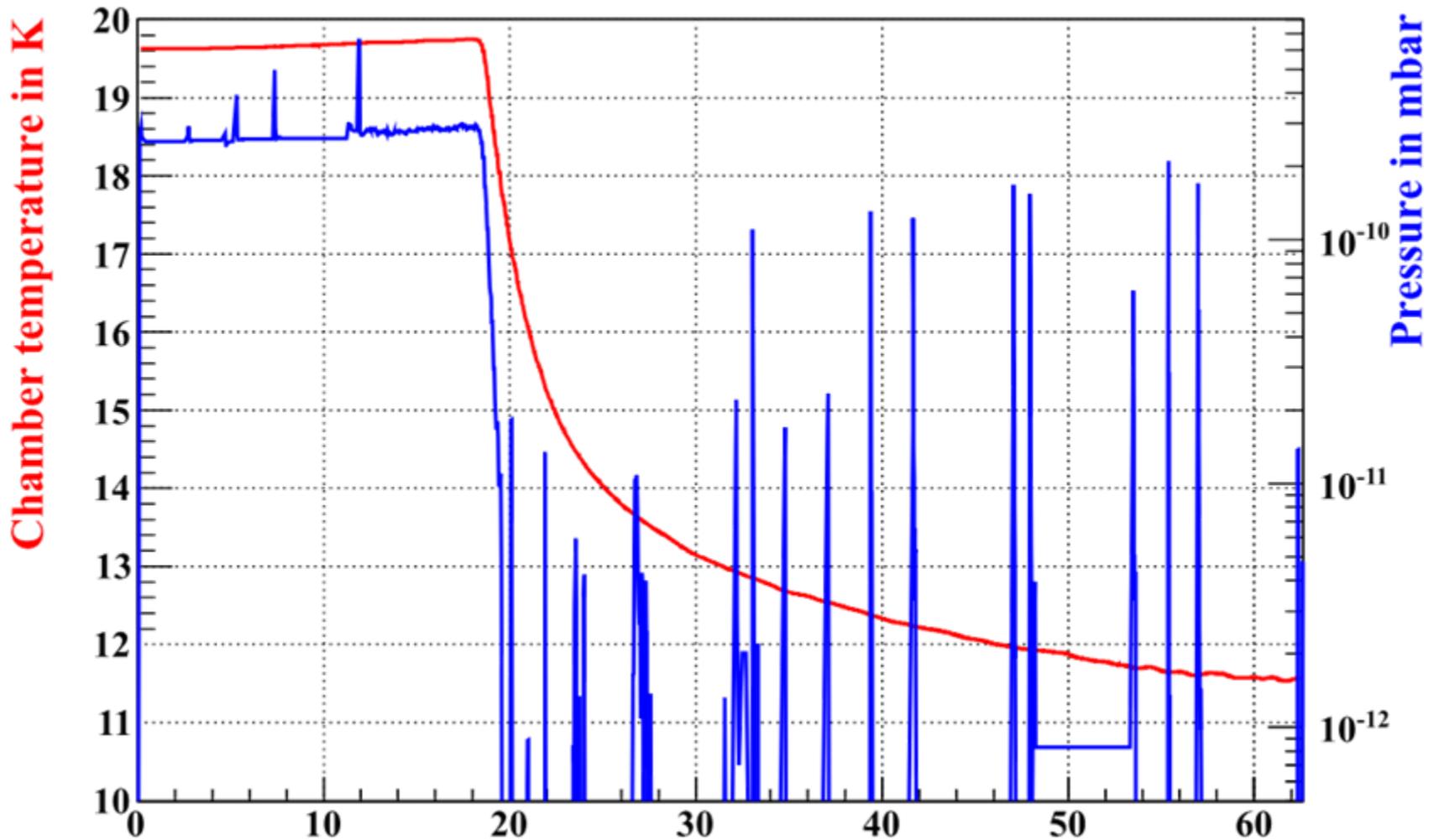
Measurements at the cryocatcher prototype

- Pressure measurements
 - Static pressure
 - Heavy ion induced pressure rise in the cryocatcher chamber
- Temperature measurements
 - Temperature models
 - Thermal loads
 - Dependence of residual gas pressure from chamber temperature
 - Transition temperatures
- Electrical measurements of ion currents

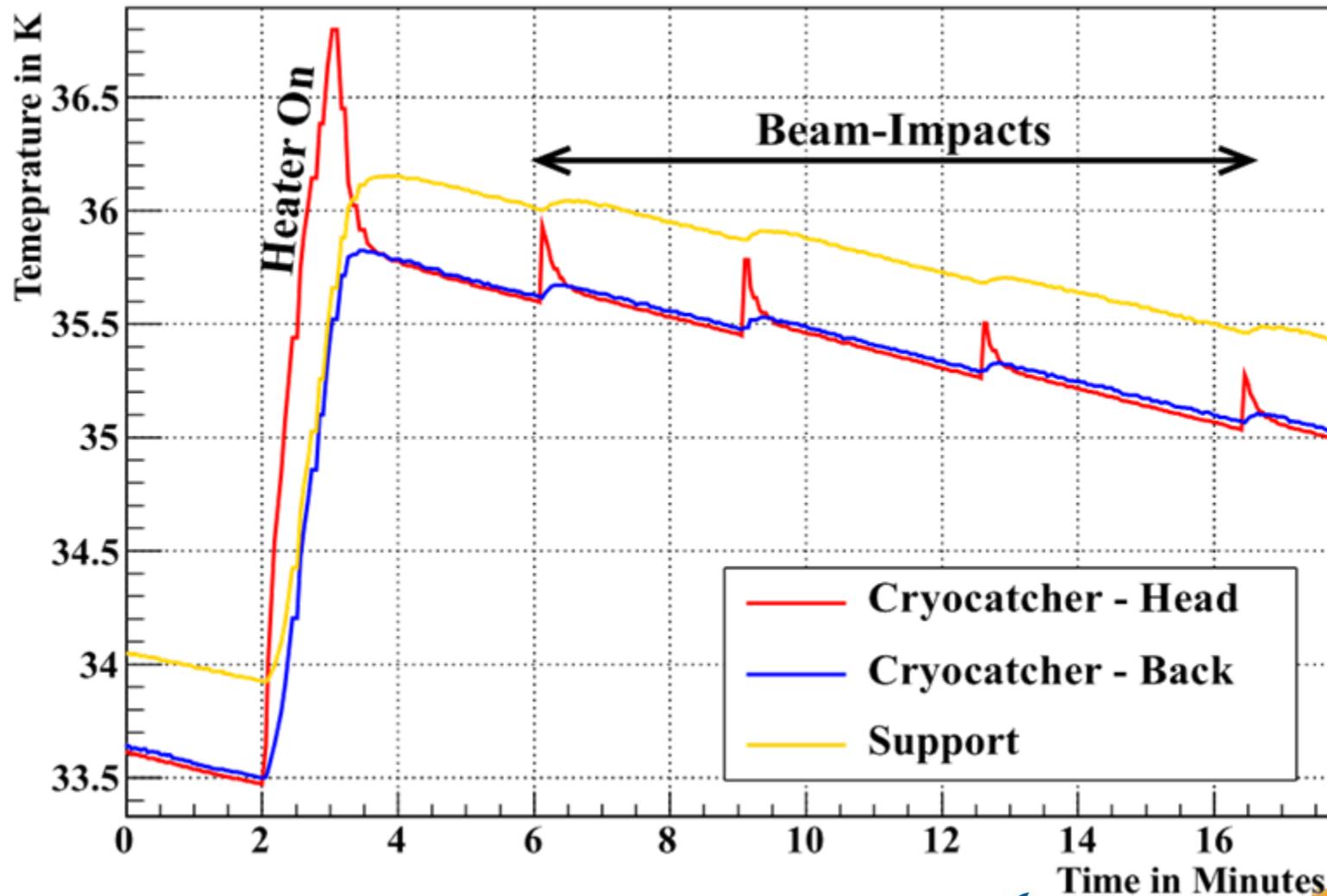
Cryocatcher Prototype – Pressure Measurement



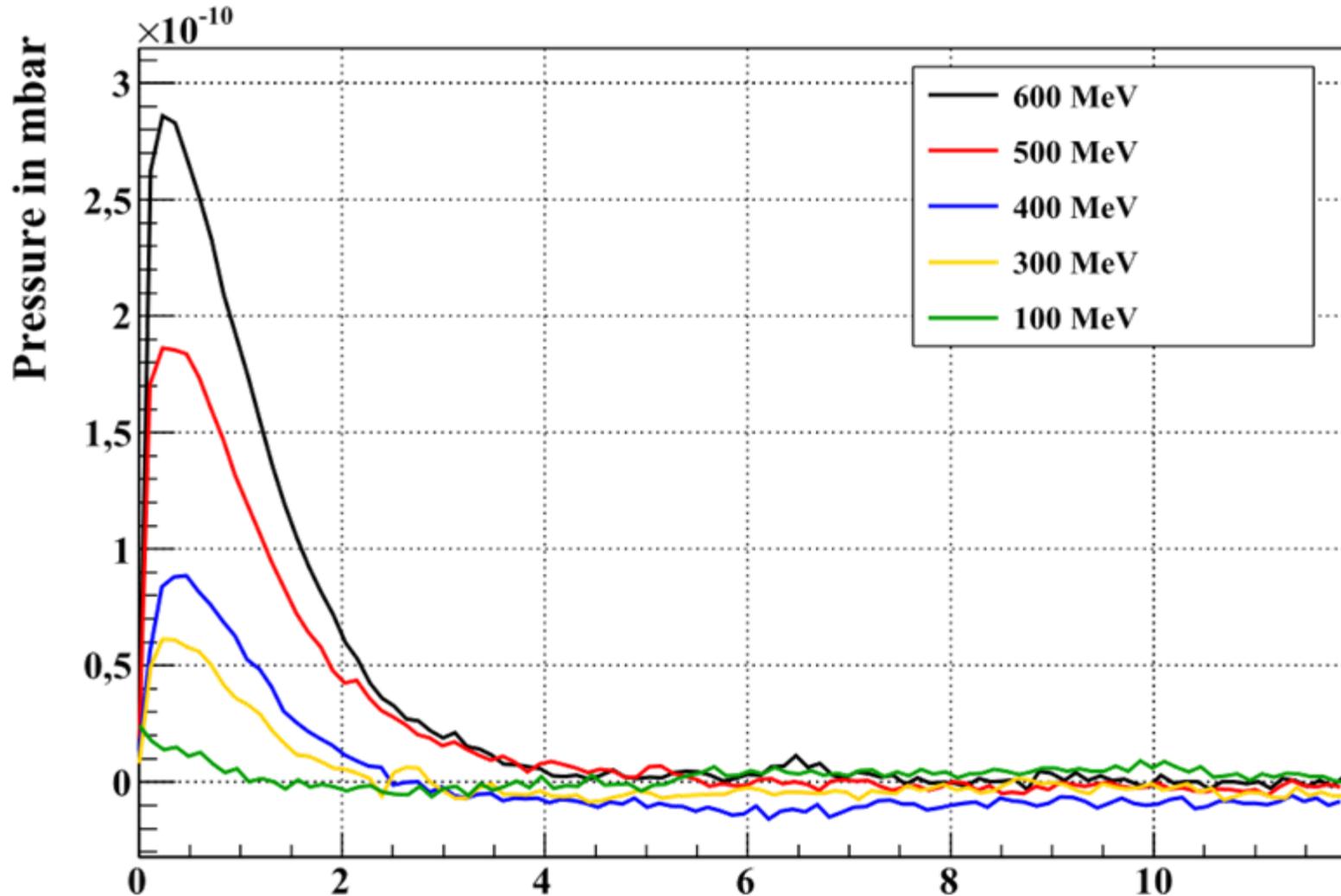
LHe-Cooldown



Cryocatcher Temperature during Beam Impacts

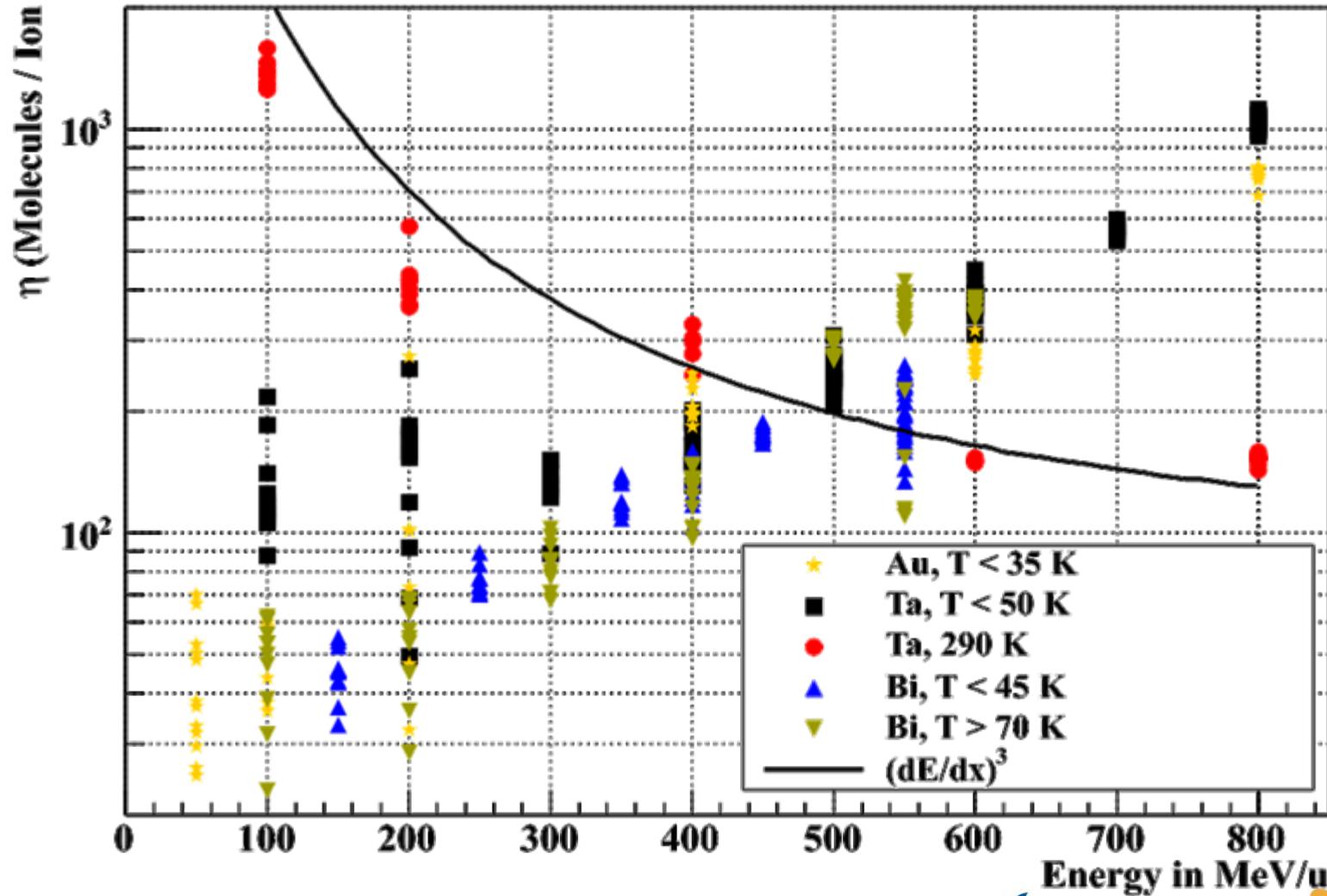


Fast beam triggered Pressure Measurement

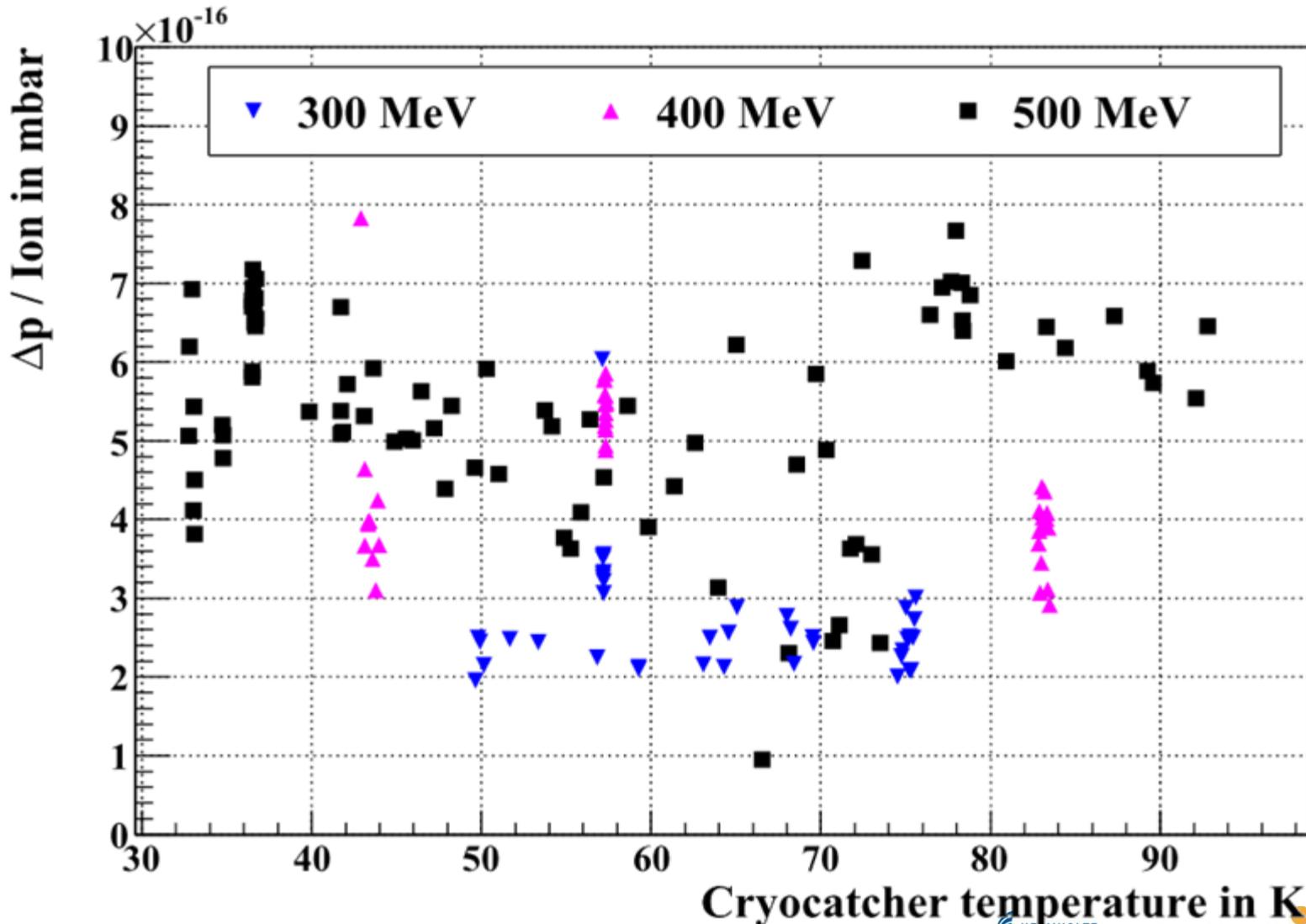


$2 \cdot 10^9$ Bi-particles

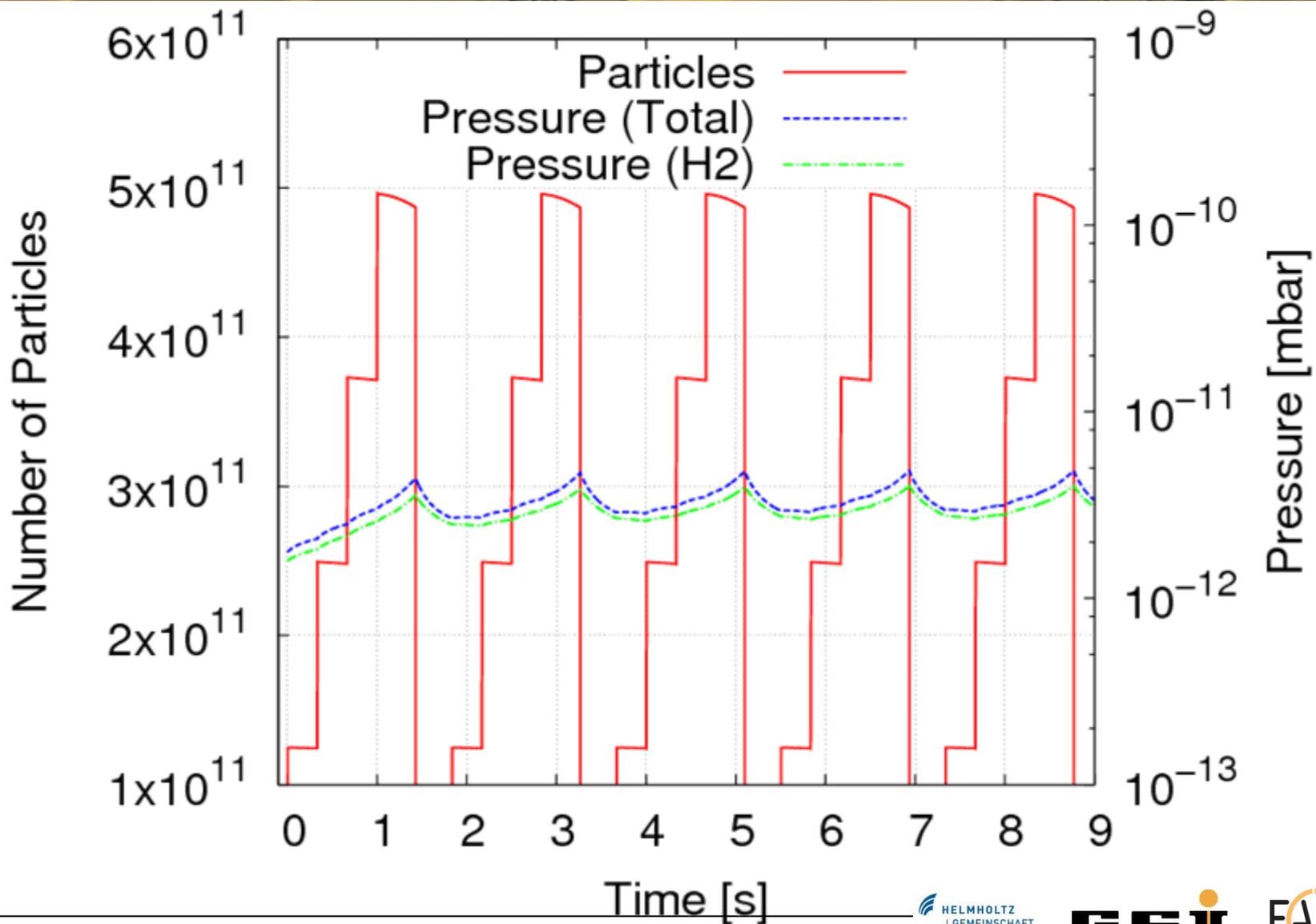
Desorption Yields



Pressure Rise – Temperature dependence



SIS100 cycle simulation



- SIS100 prototype cryocatcher has been designed, constructed and built
- Test setup has been taken into operation and tests with LHe and heavy ion beam have been performed
- Cooling-concept showed the desired results in temperature and pressure.
- Cryogenic heavy ion induced pressure rise has been investigated, new energy scaling found
- Simulation verified the SIS100 cycle stability with measured desorption yields.
- SIS100 cryocatcher can be specified on basis of successful prototype

Thank You!

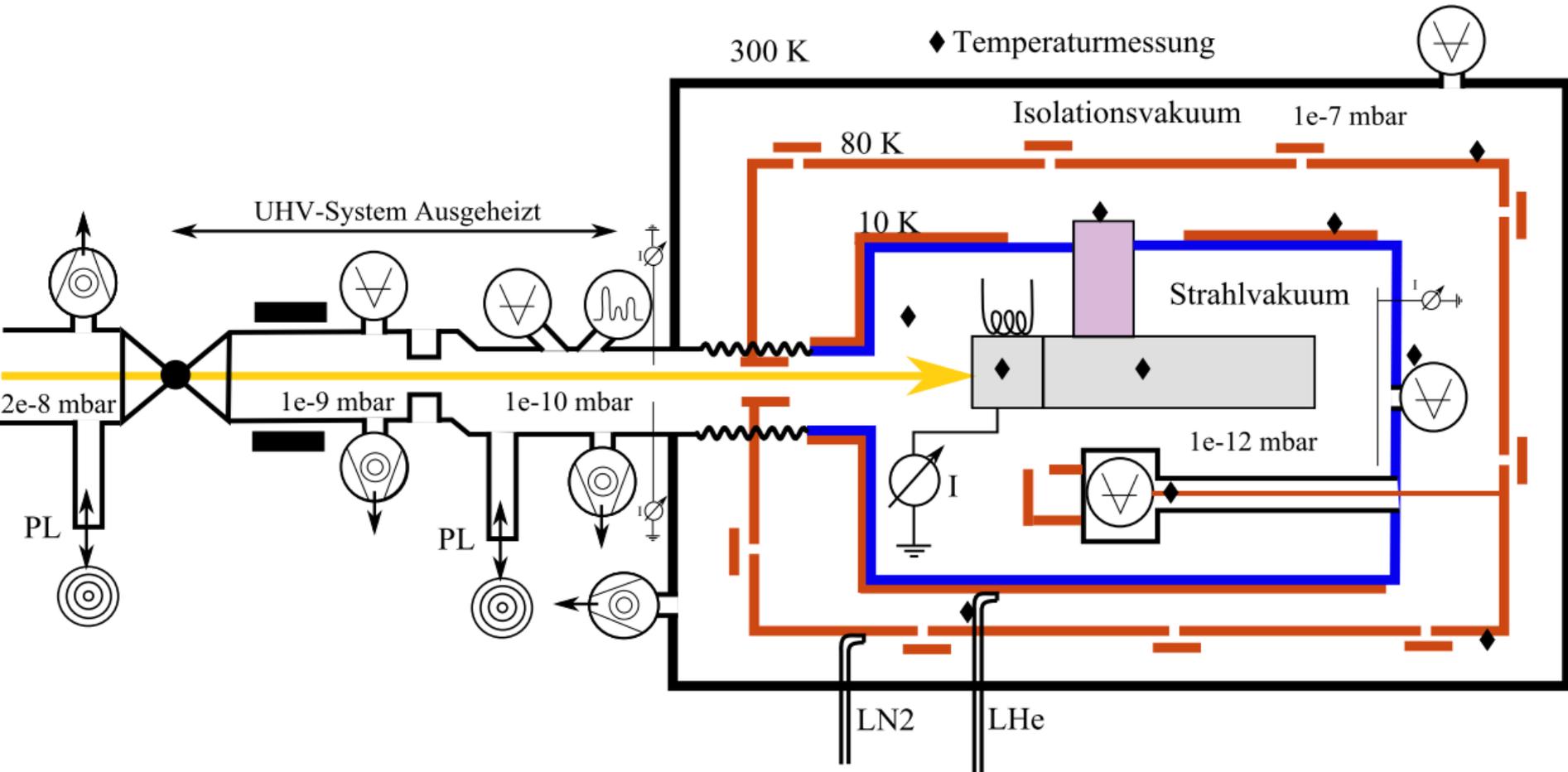
Questions?

Many thanks to several GSI-groups:

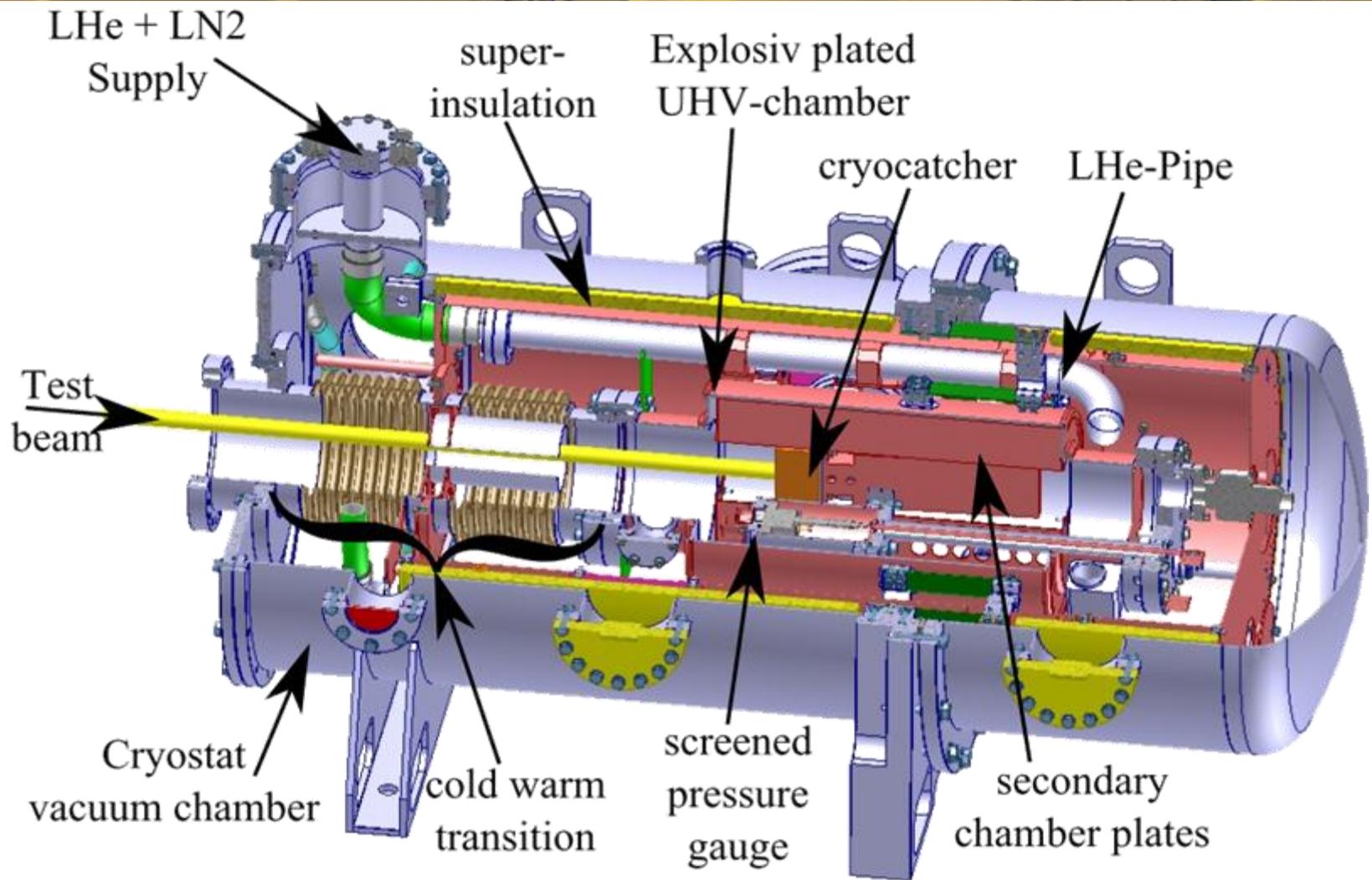
- Synchrotron group
- Vacuum group
- Beam diagnostics group
- Cryo-magnet group
- Central services

Backup Slides

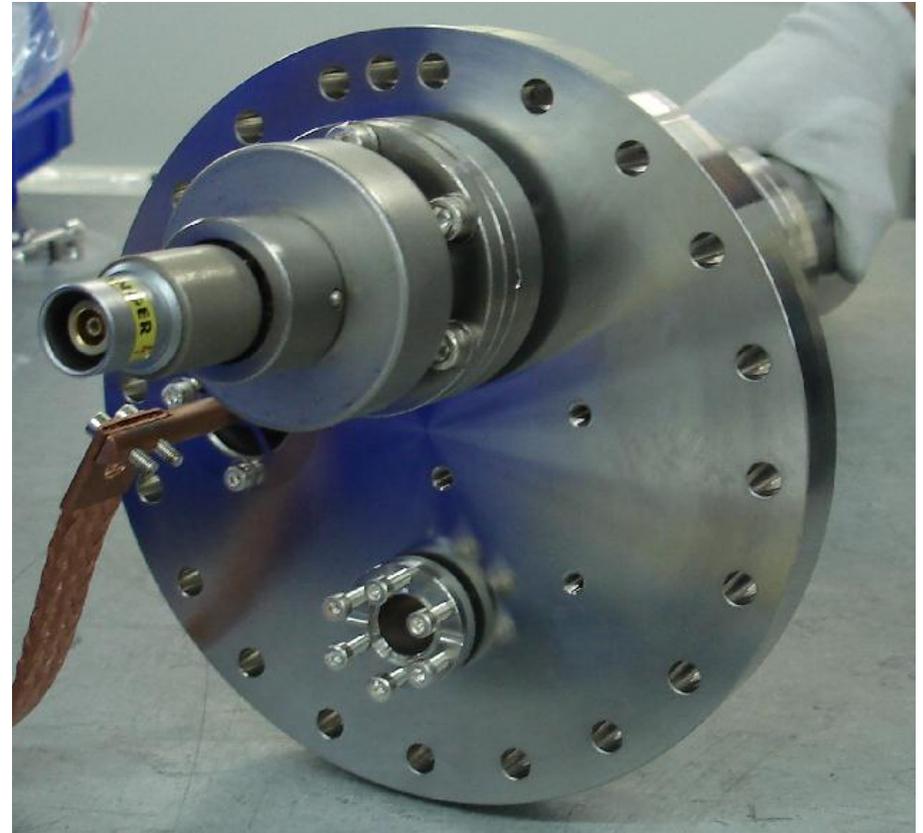
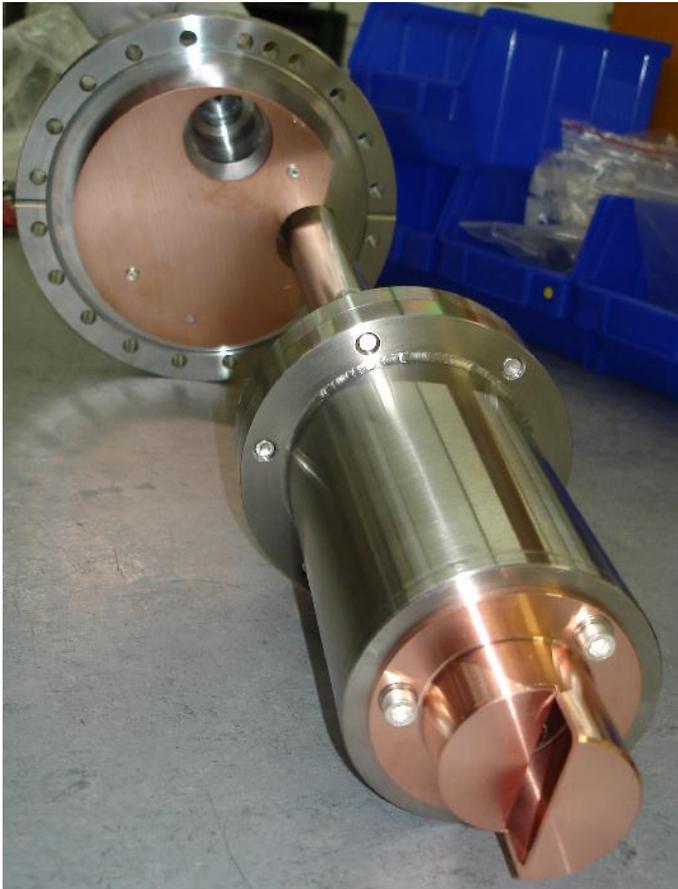
Scetch of the prototype test setup



Cryocatcher Prototype



Cryocatcher Prototype – Pressure Measurement



Heat loads onto Cryocatchers

Table 1: Predicted average beam energy deposition on the ion catchers within each sector of SIS100 for a cycle with fast (FX) and slow extraction (SX). The differing numbers for sector 5 during slow extraction are given in brackets.

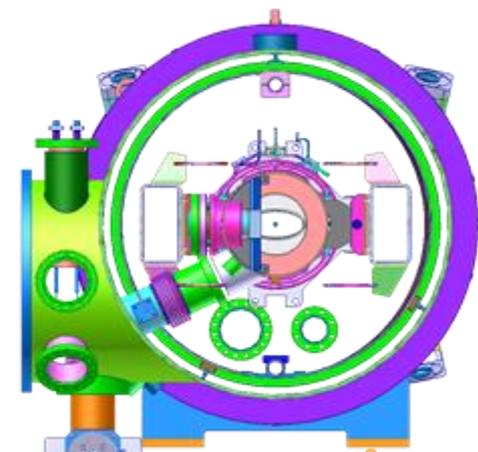
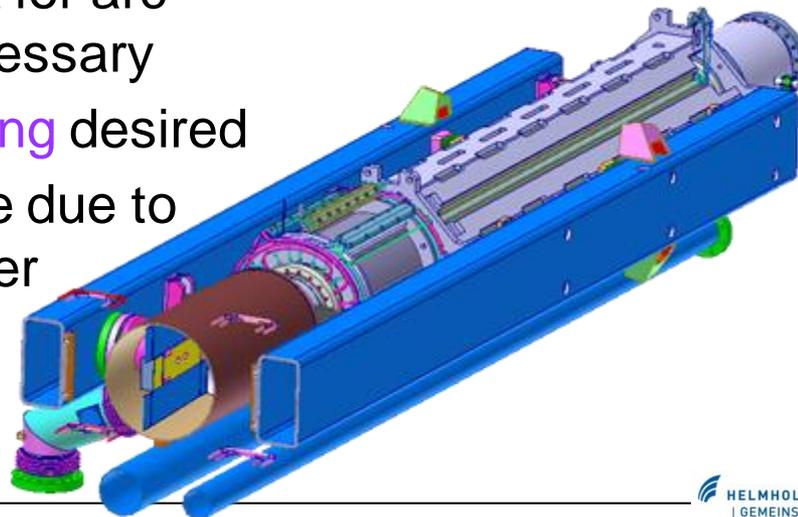
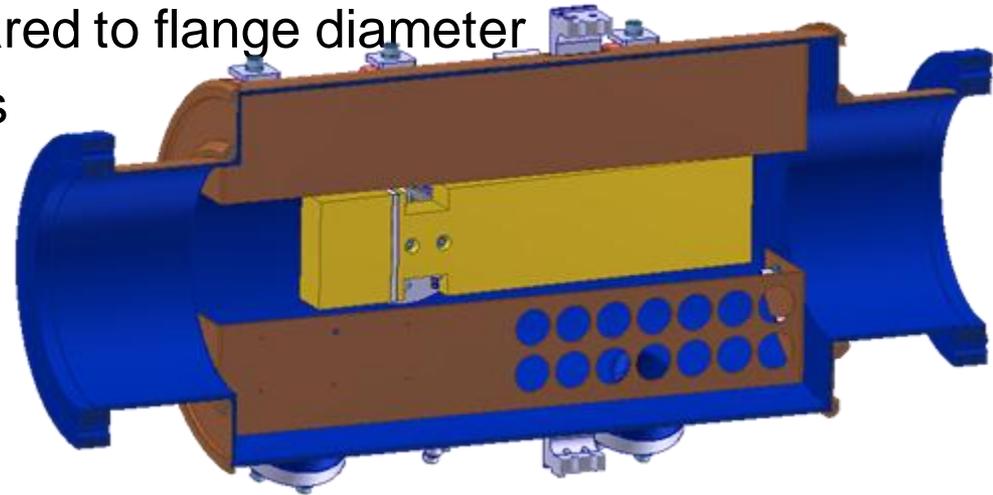
Ion Catcher	Load (FX) [W]	Load (SX) [W]
1	0.5	1.5 (3.1)
2	1.4	3.8 (16.7)
3	1.1	1.9 (3.7)
4	0.6	1.2 (1.4)
5 – 10	0.6	1.2

Counter Measures for Dynamic Vacuum

- Avoid all kind of **beam losses**
 - Especially at the beginning of an acceleration cycle (injection)
- Lower average static residual gas pressure
 - Reduce probability for **charge exchange**
- Increase **pumping speed** at loss positions
 - Damping of **self amplification** by fast removal of gas desorption
- Install **special low desorption ion catcher** at loss positions for **controlled catching** of **beam loss**
 - Damping of **self amplification** by minimizing gas desorption
 - Desorption yield is lowest for **perpendicular incidence**
 - **Activation** and radiation damage of magnets by ionization beam loss are **reduced**

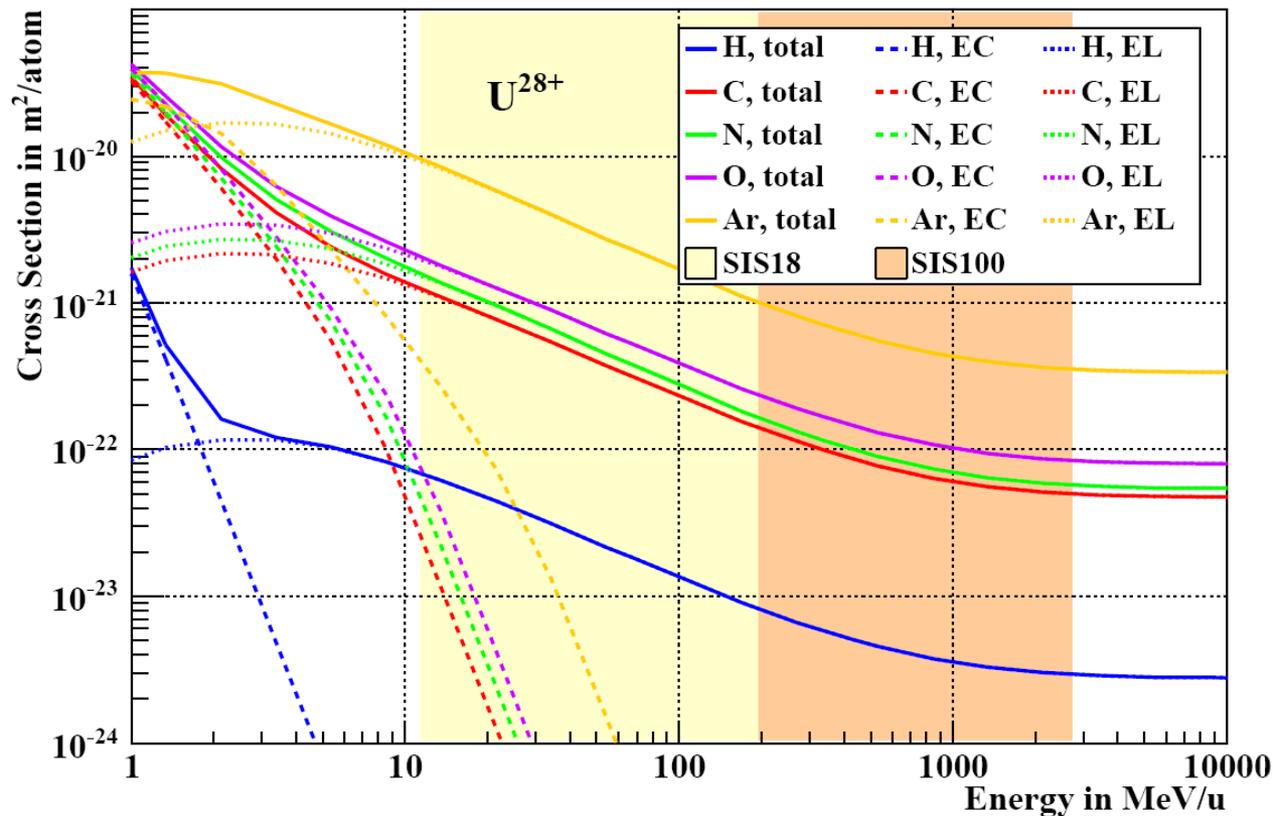
Cryocatcher - Chamber

- Inspired from SIS18 ion catcher:
 - Increased diameter compared to flange diameter
 - Secondary chamber plates to reduce vacuum conductance to beam axis
- Additional requirements:
 - Pumping port for arc roughing necessary
 - Passive **cooling** desired
 - Limited space due to common girder



Ionization Loss Mechanisms

- Cross section for charge exchange depends on energy, ion, charge state and residual gas composition



Thermal Conductivities

