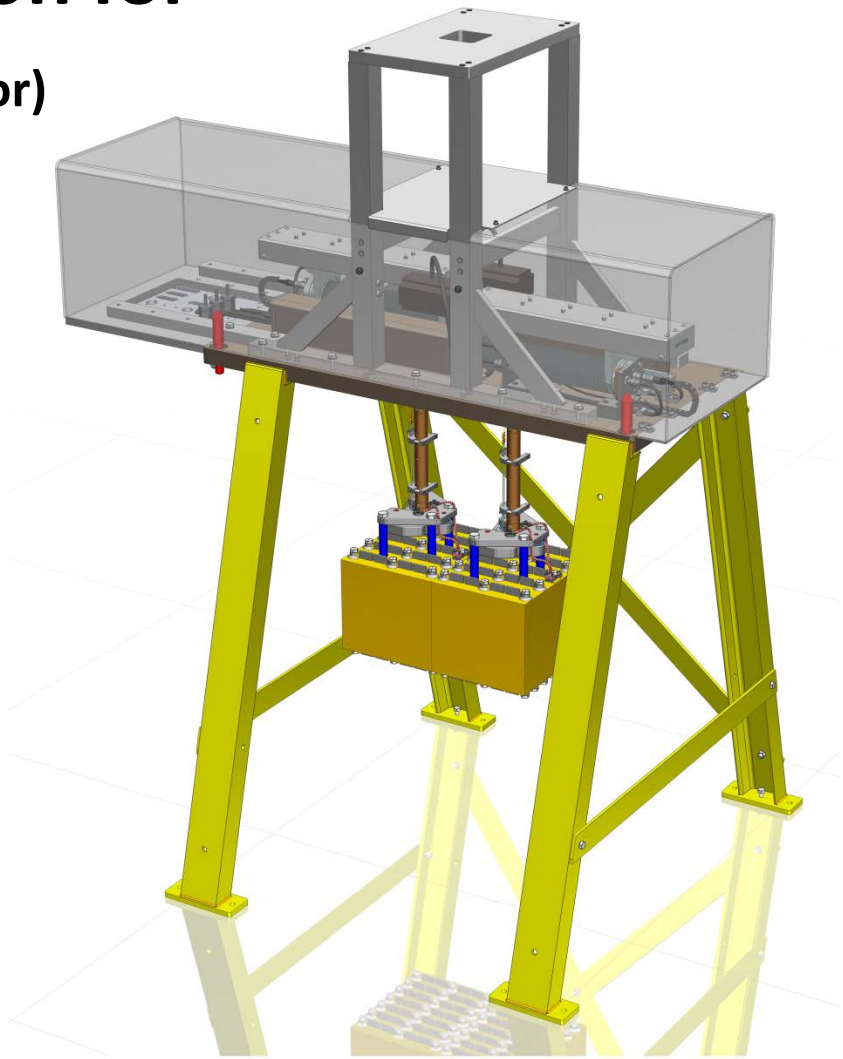
university of groningen

kvi - center for advanced radiation technology

FAIR

Slit system and target station for Super-FRS (Super FRagment Separator)



Status report

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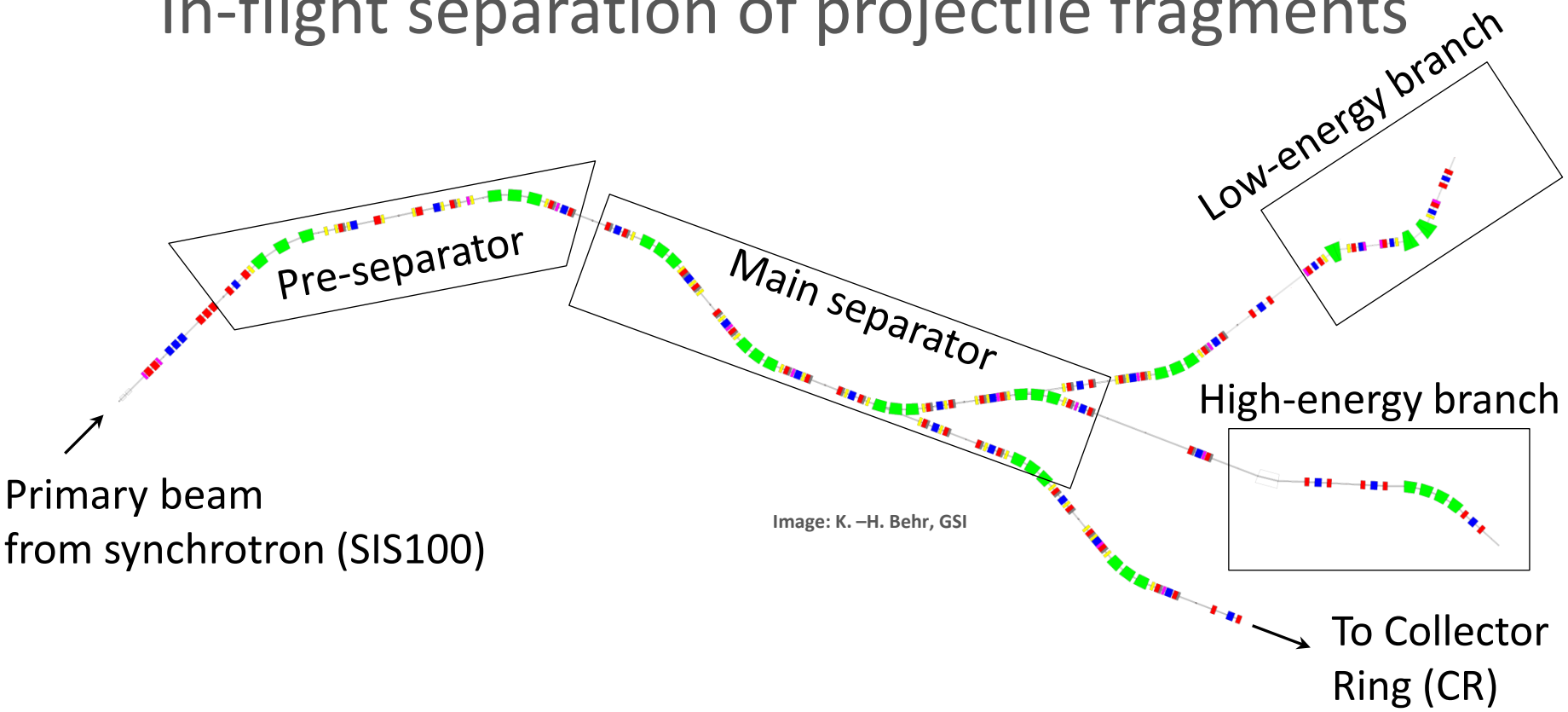
Super-FRS

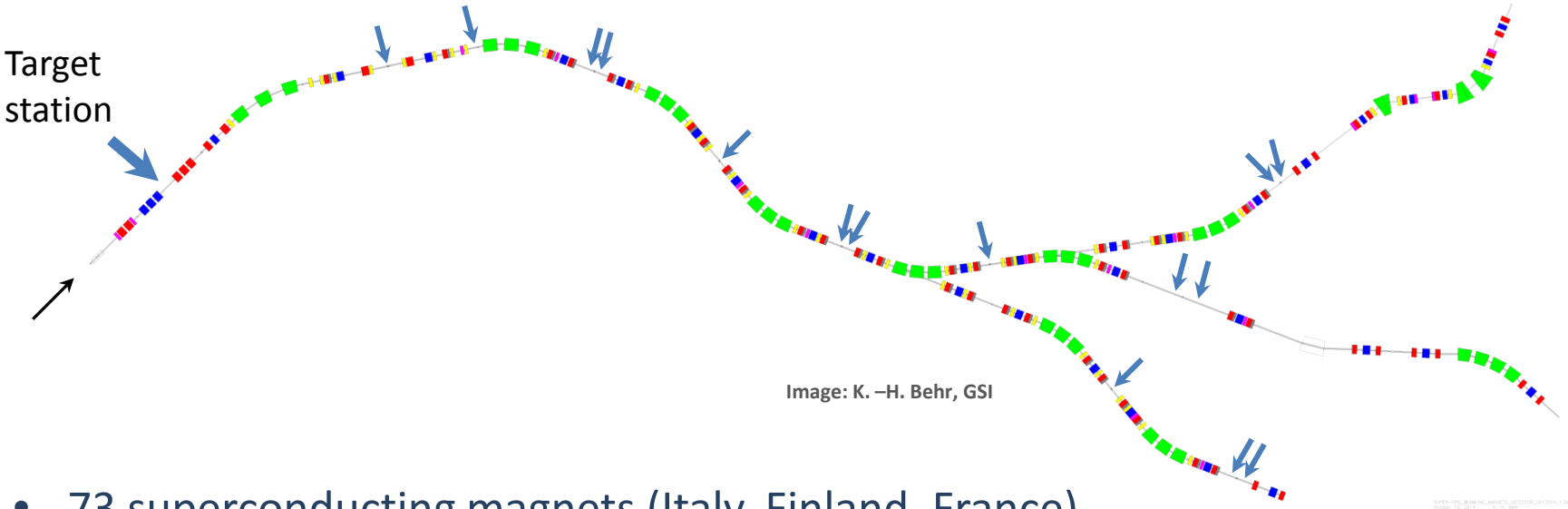
In-flight separation of projectile fragments



Facility	Max. magnetic rigidity $B\rho_{max}$ [Tm]	Momentum acceptance $\Delta p/p$	Angular acceptance	
			[mrad]	[mrad]
FRS	18	±1%	±7.5	±7.5
Super-FRS	20	±2.5%	±40	±20

Super-FRS

Components



- 73 superconducting magnets (Italy, Finland, France)
- 21 focal plane wire chambers (Russia)
- GEM-TPCs [Gas Electron Multiplier Time Projection Chambers] (Finland)
- Semiconductor time of flight detectors (Russia)
- Beam catcher (India)
- Cryogenics (Poland)
- 15 slit pairs (KVI-CART, GSI)
- Production target station (Designed by KVI-CART)

Slit system

How slits work

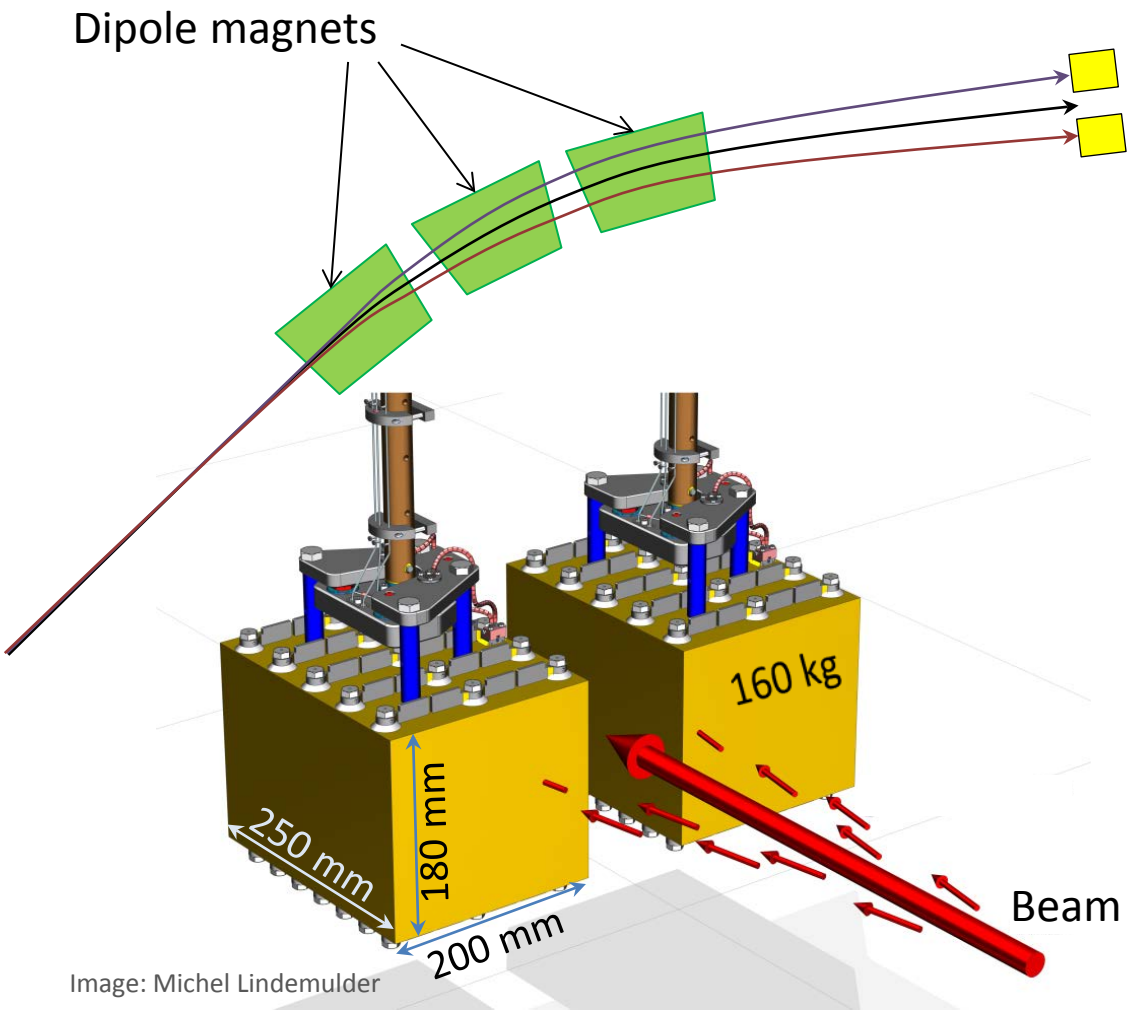


Image: Michel Lindemulder

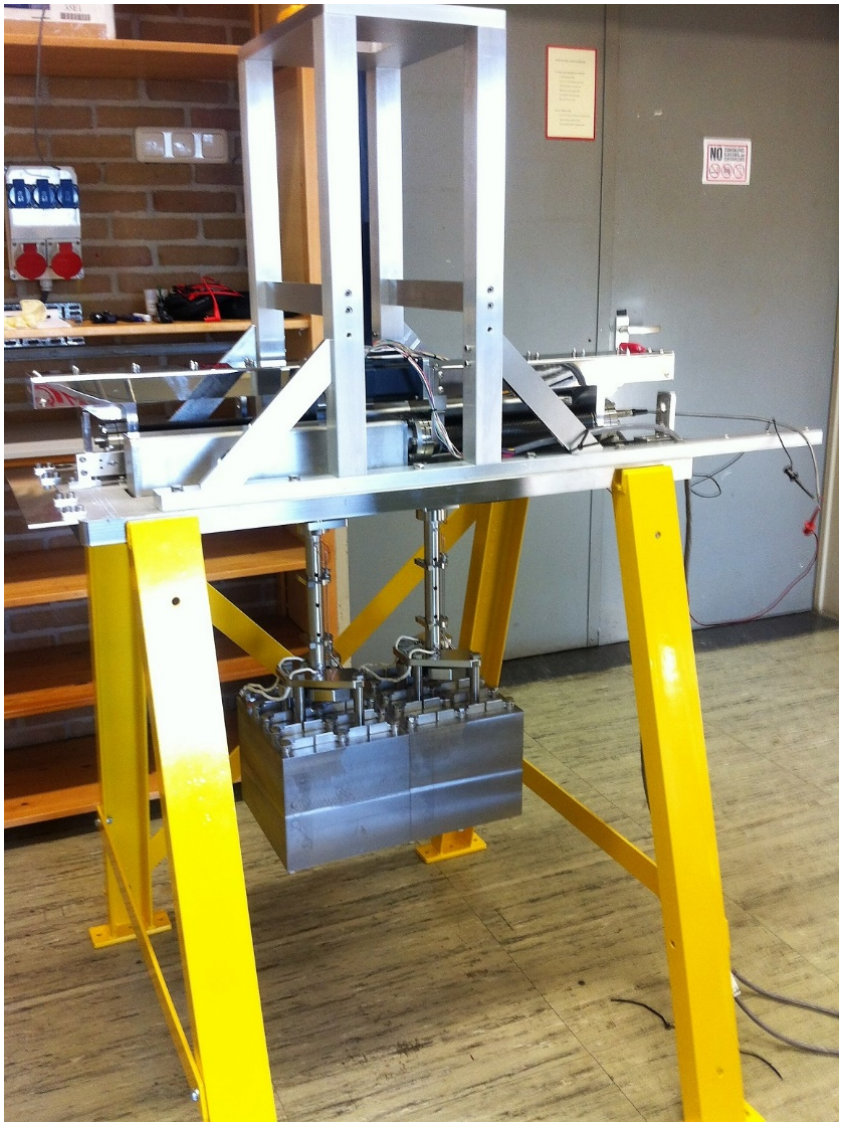
- High stopping power
- Absorbing high energy photons
- Vacuum compatible
- Heat resistant

DENSIMET®
97% tungsten
3% iron and nickel
Density 18.5 g/cm^3

- Precision
- Endurance
- Reproducibility

Horizontal slit prototype

Design verification

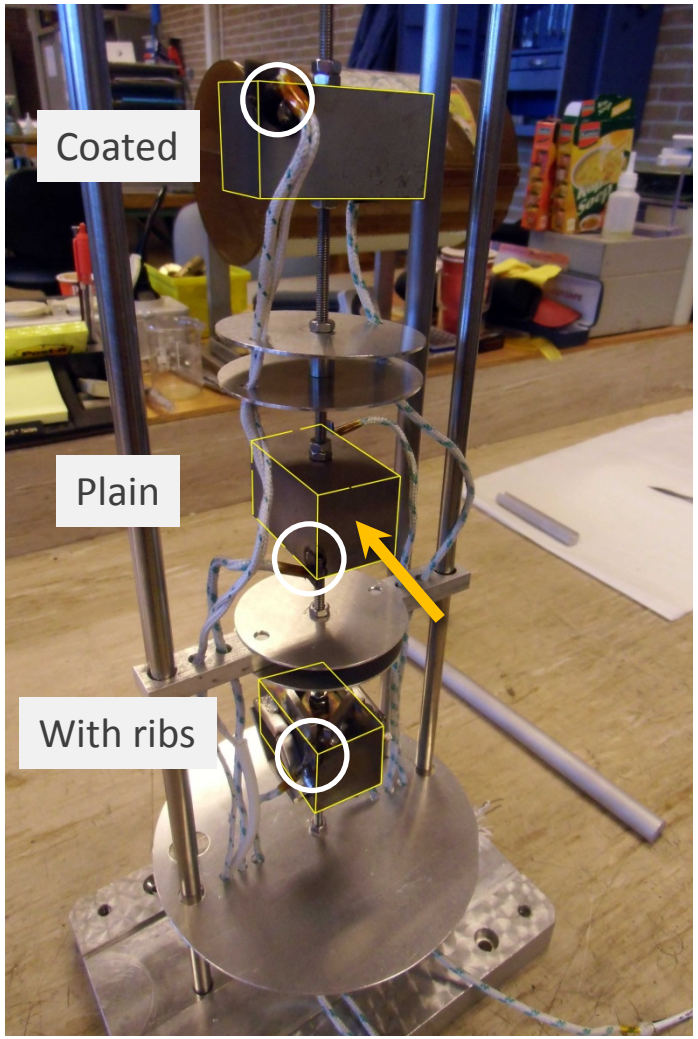


Test Completed

Specification	Test result
Integral leakage rate	6×10^{-10} mbar.l/s
Minimum gap	50 µm uniformly over the surface
Movement precision	0.1 mm
Stop switch activation	0.1 mm
Endurance	6600 open-close cycles
Heat resistance	500 W beam power absorption

In-beam test of cooling at KVI-CART

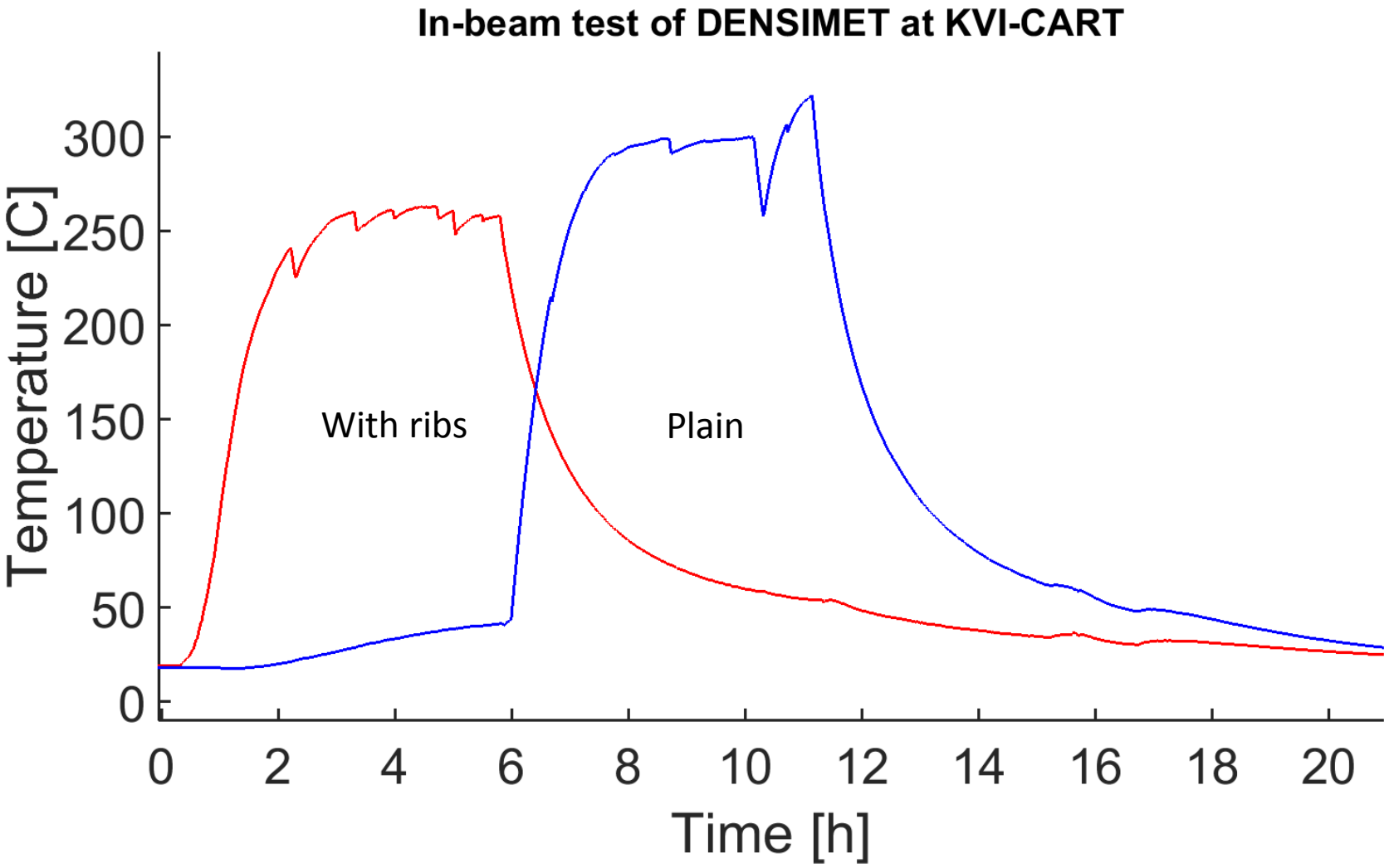
Heat dissipation through radiation



- Irradiation of three small blocks
  - Beam: $^{20}Ne^{5+}$ at 30 MeV/u
  - Current: 180 nA
  - Beam power: 21.6 W
- Dimensions
  - Coated: $25 \times 25 \times 50$ mm^3
  - Plain: $30 \times 30 \times 50$ mm^3
  - With ribs: $30 \times 30 \times 50$ mm^3
- Temperature measurement
  - 6 K-type thermocouple
  - Calibrated using boiling and ice water

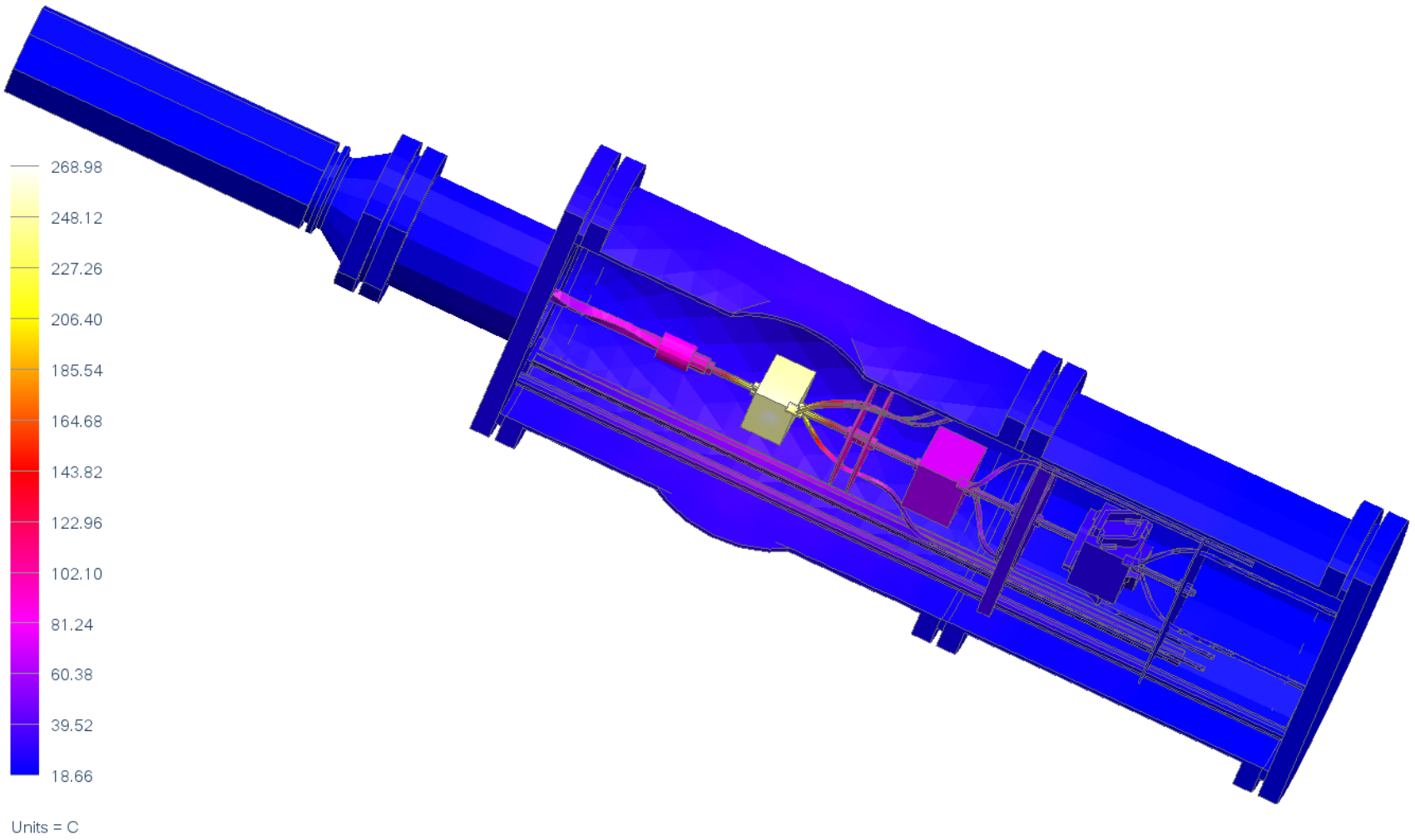
Temperature measurement

Two thermocouples per block



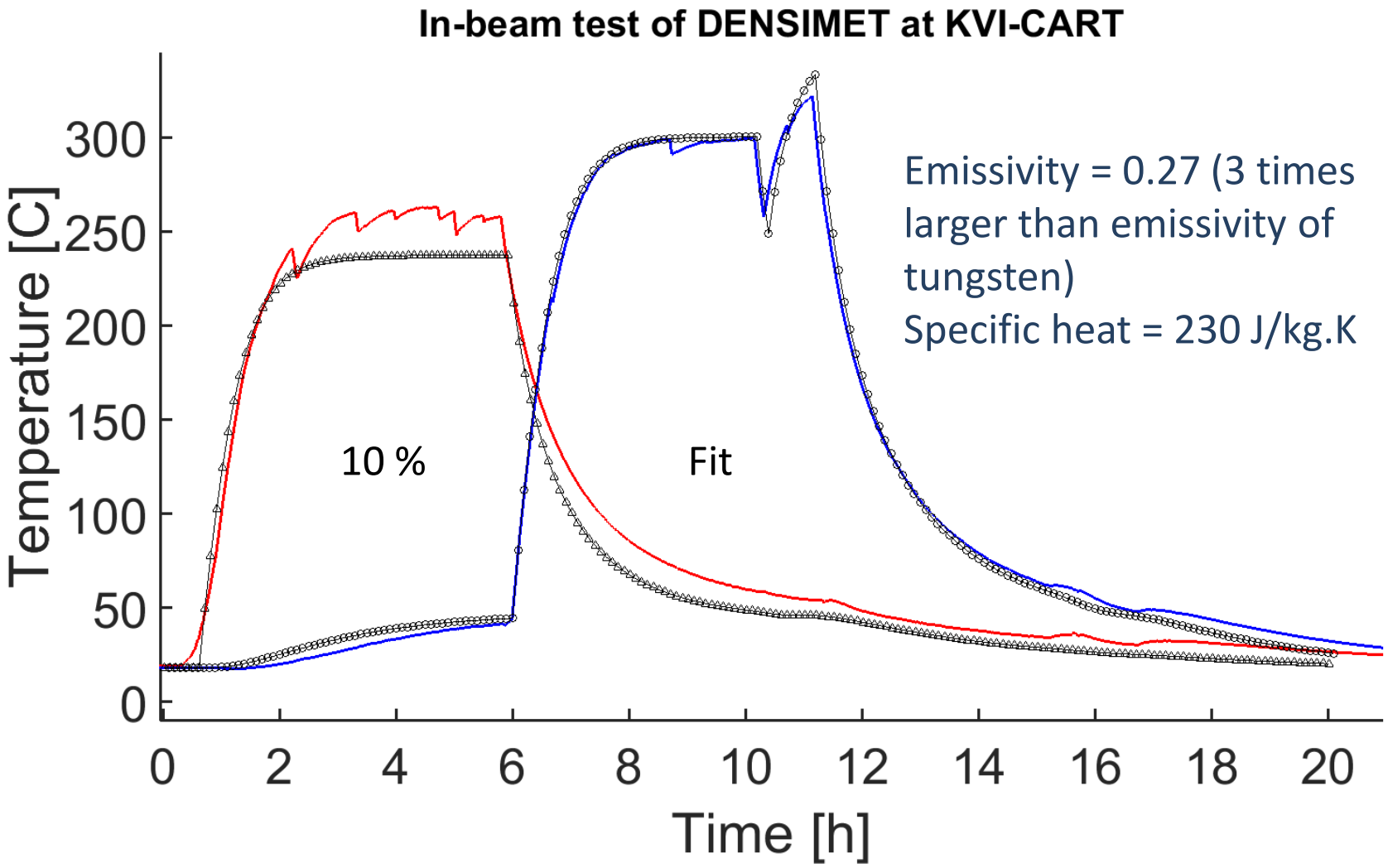
Heat transfer simulations

Using Siemens NX®



Heat transfer simulations

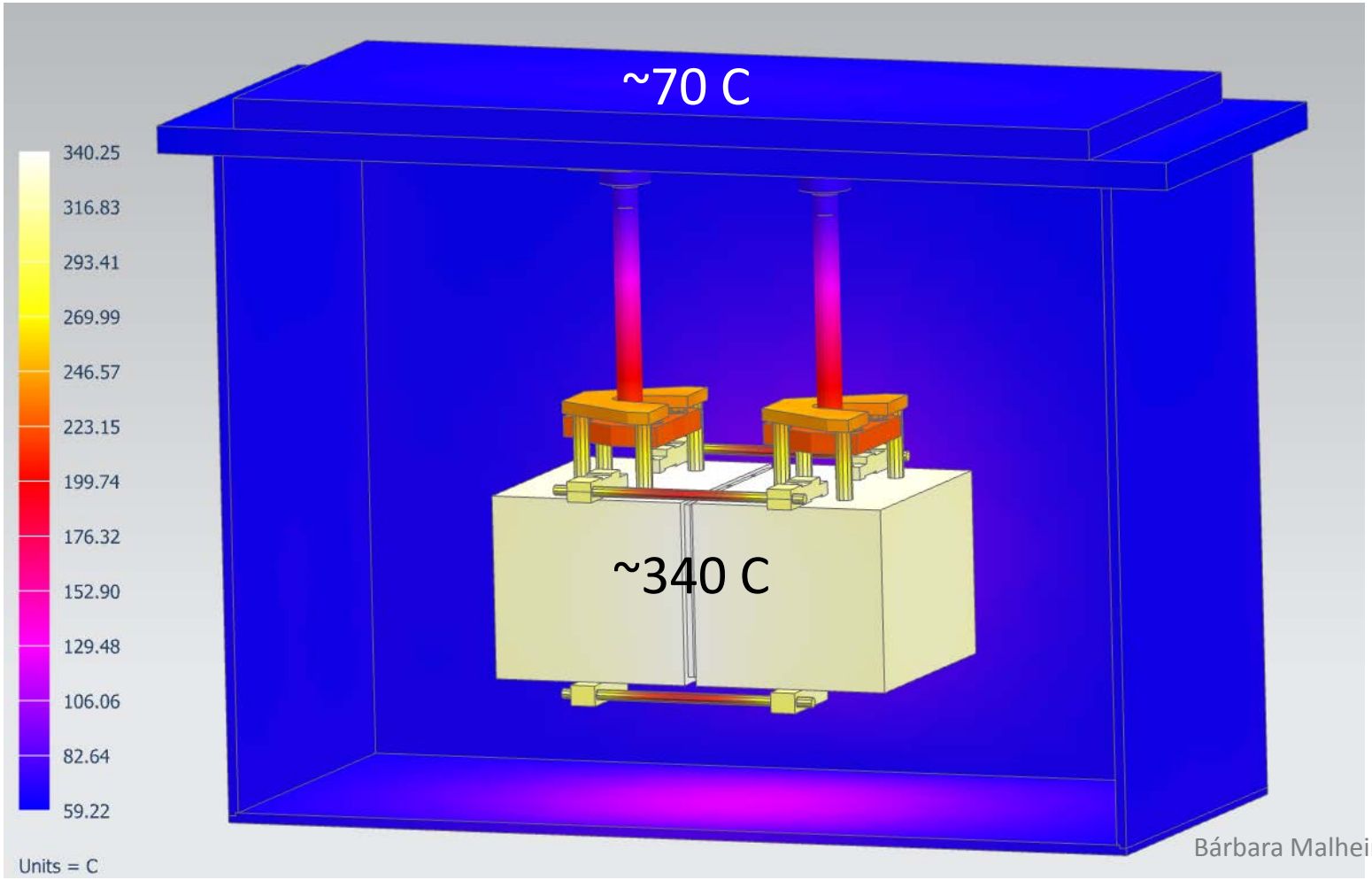
for the test setup



Heat transfer simulations

for the horizontal slit system

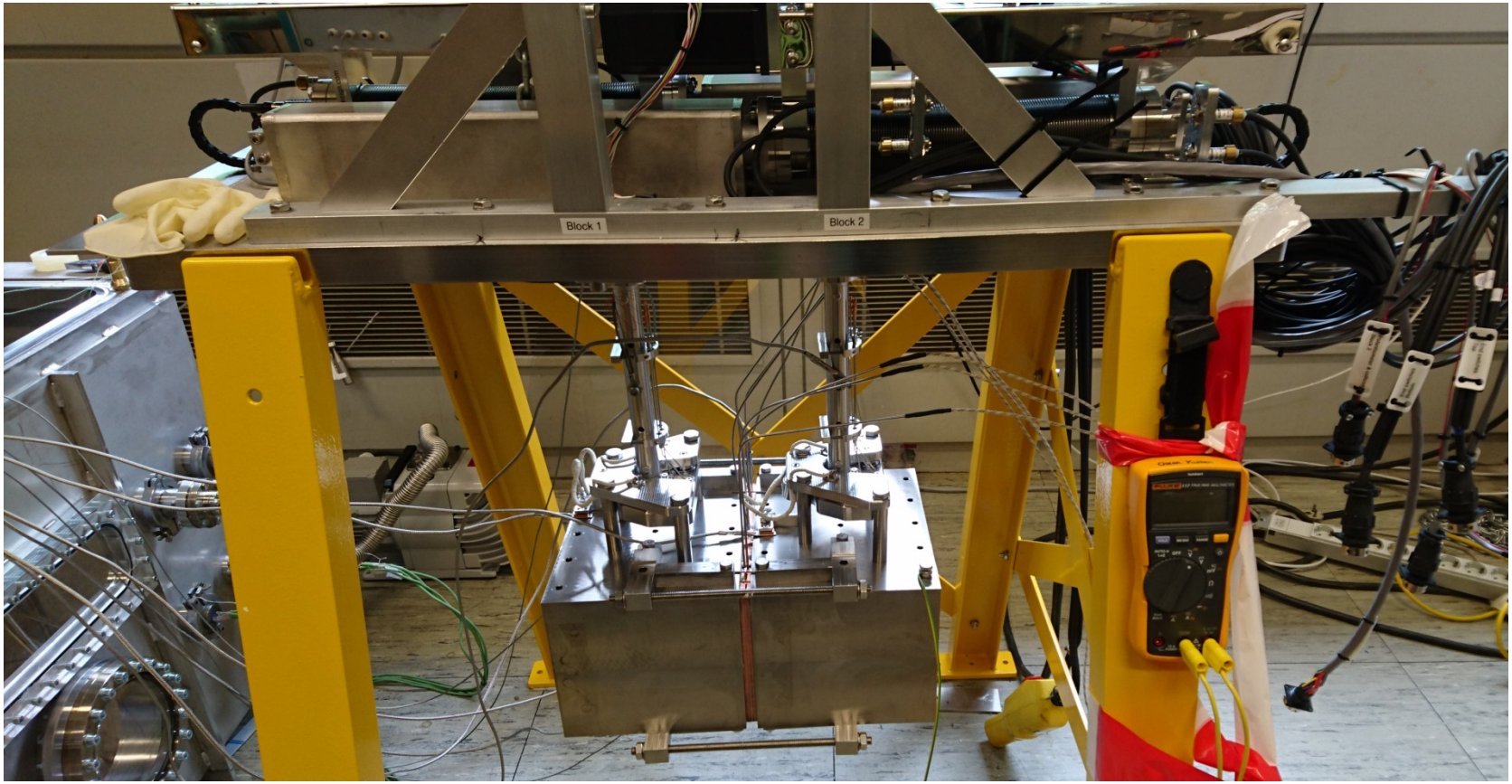
Steady state at 1300 W



Bárbara Malheiros

Heat experiment in vacuum

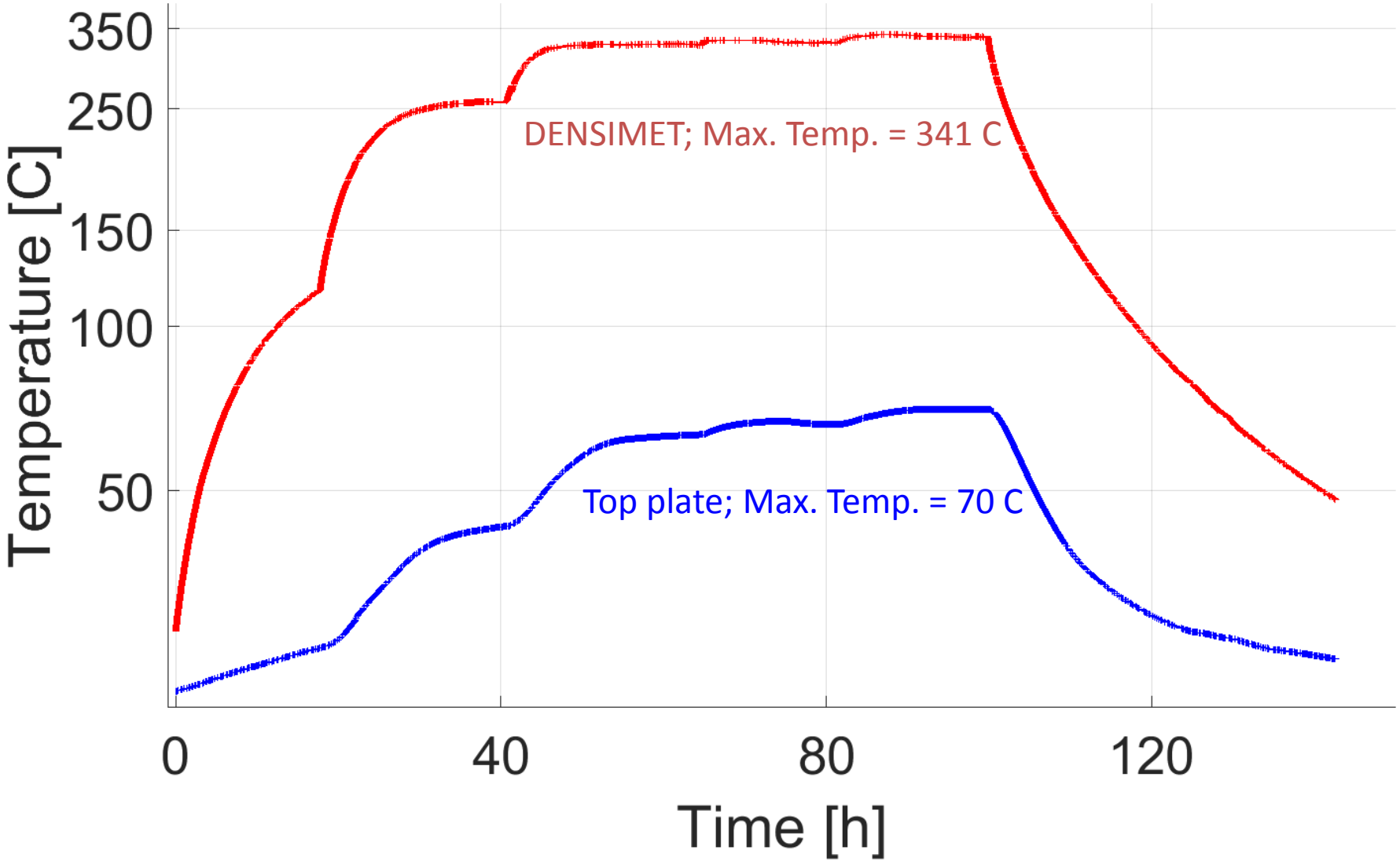
for the horizontal slit prototype



- 3 heating rods embedded in a copper plate
- Expected beam power at Super FRS 500 W
- Applied power up to 1300 W (650 W per block)
- 16 thermocouples

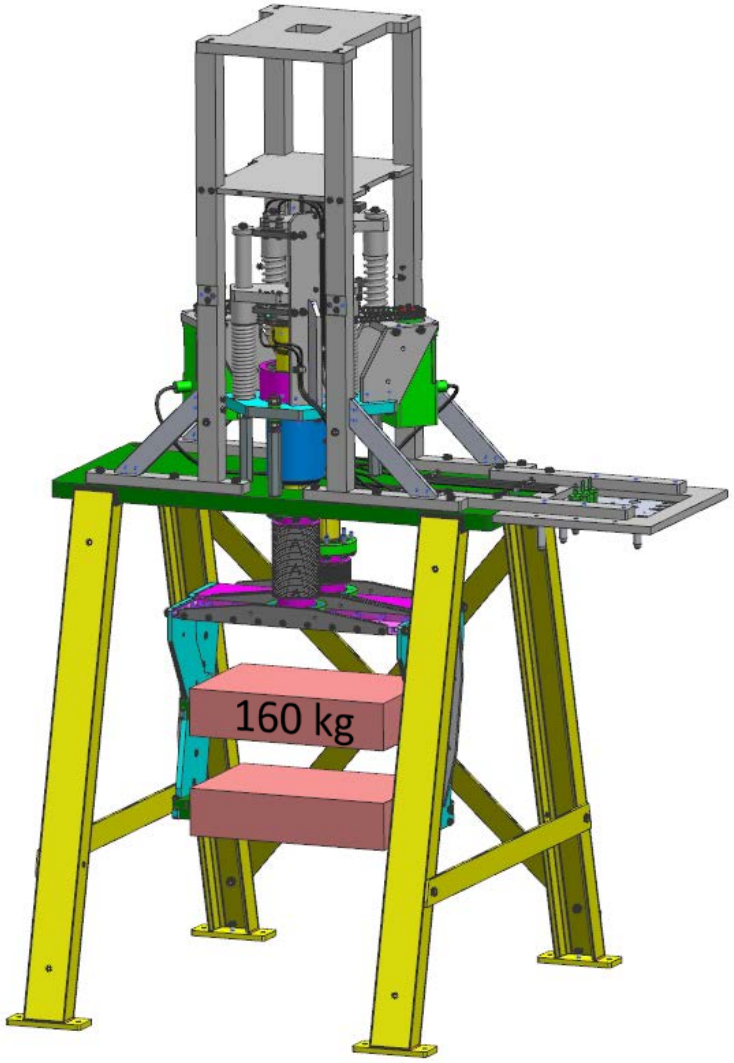
Heat experiment

Thermocouple output



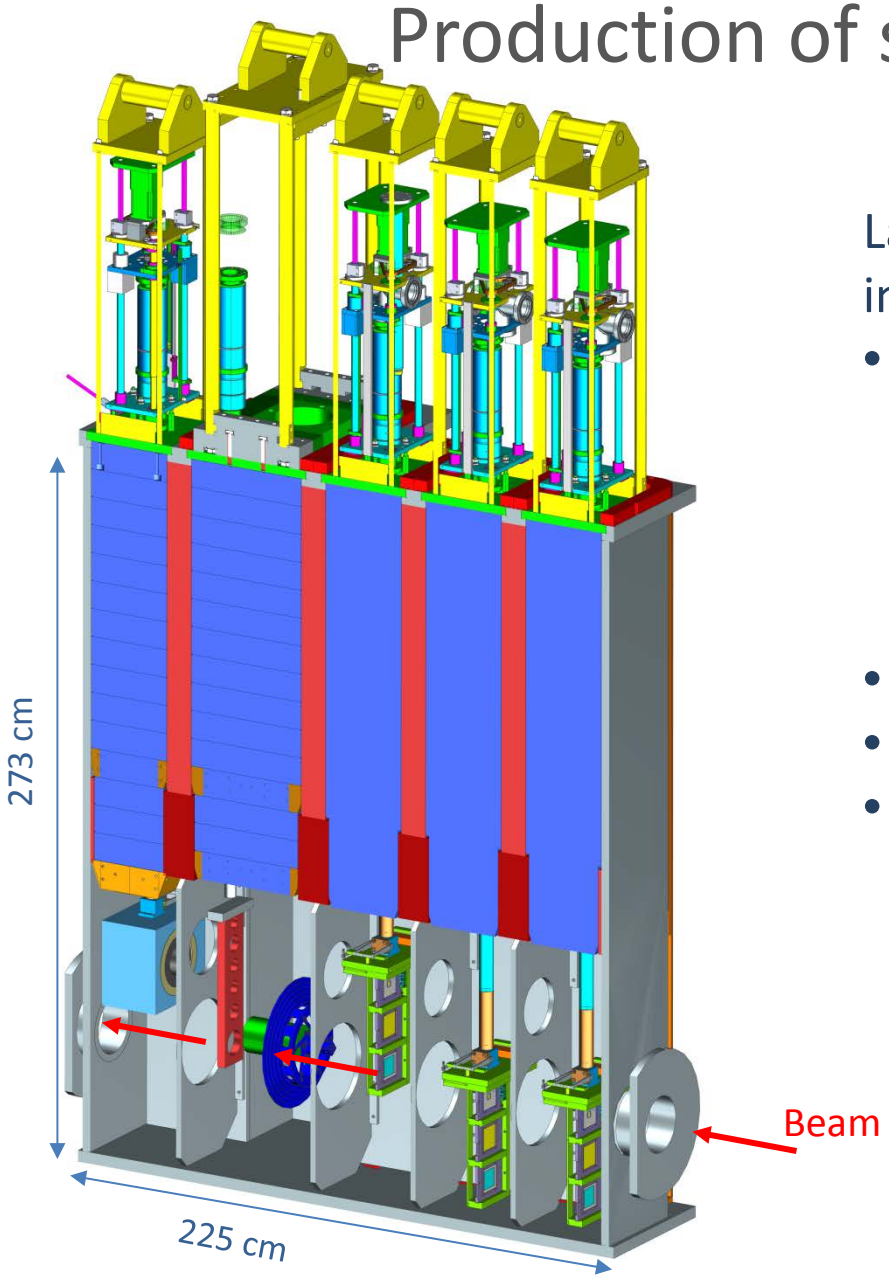
Vertical slit prototype

Design verification



Target Station

Production of secondary ions

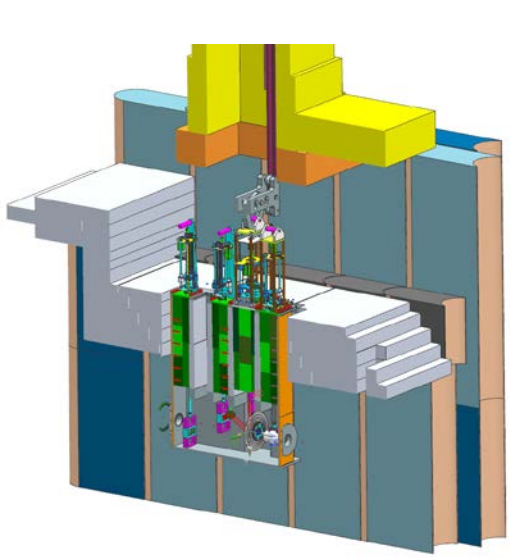


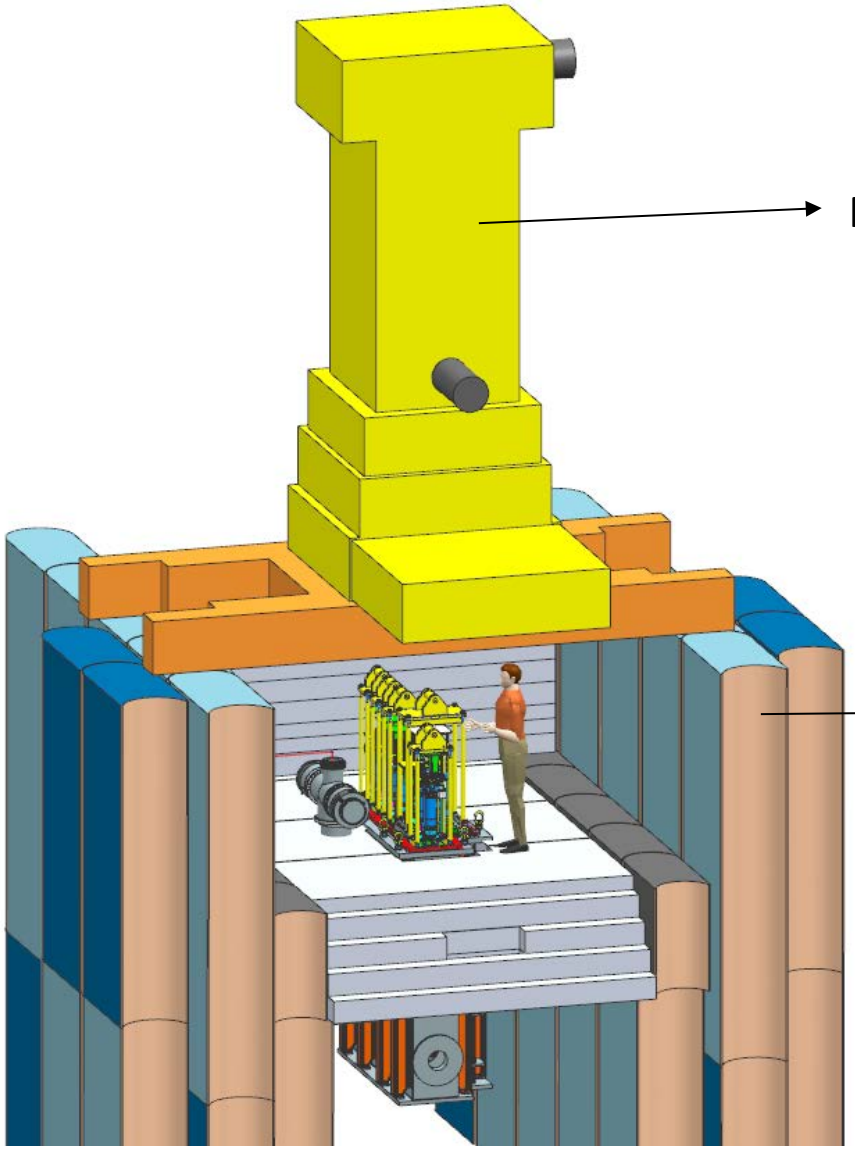
Large vacuum chamber with 5 plugs, including:

- Target wheel:
  - Diameter: ~70 cm
  - Material: graphite
  - Multiple steps with different thicknesses
- Target ladder
- Beam diagnostic detectors
- Collimator

Target Station

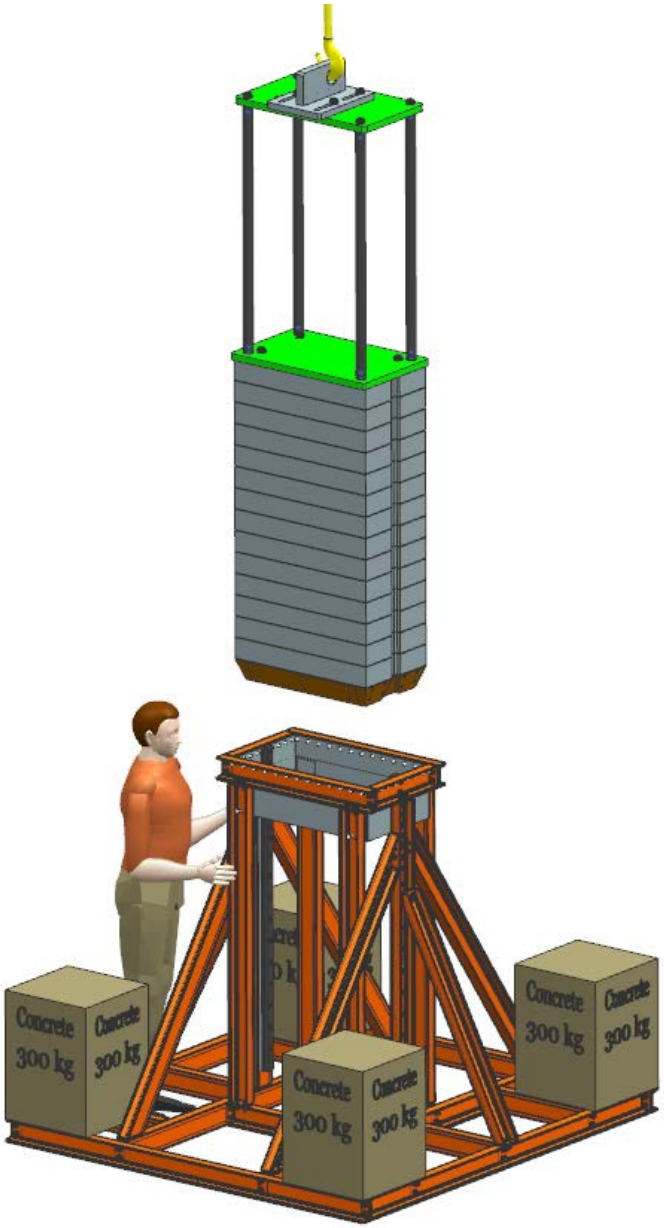
Inserting and removal of a plug





Target Station

Plug test



Inserting and removing a full-size plug with a tolerance of less than 1 mm.

Target wheel plug:

- Dimensions: 42 × 78 × 150 cm^3
- Weight: **4.5 tons**

Summary

Slit system:

- The design of the horizontal slit prototype is verified.
- Series production of 9 horizontal slits has been started.
- The vertical slit is being tested.

Target station:

- Design in progress.
- Production of a test plug has been started.

Thank you for your attention!