# CR stochastic cooling system (1-2 GHz)

Dr. Christina Dimopoulou (on behalf of Work Package 2.5.10 team)

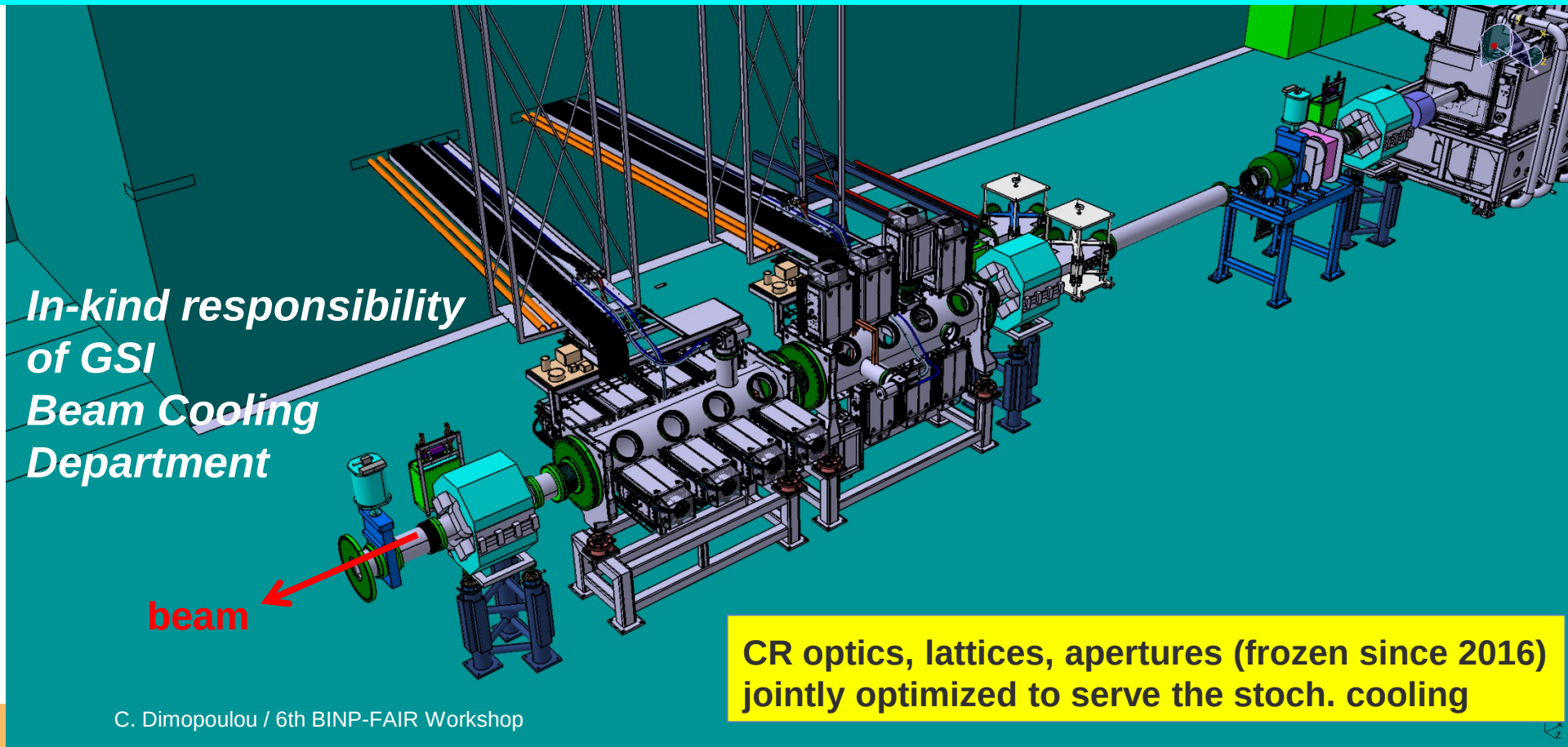
*6th BINP FAIR Workshop, April 2021*

*(zoom: 3d wave Covid-19 ☹)*

# CR & its Stochastic Cooling (SC) System

**Main task of the CR =** efficient collection & **fast** stochastic cooling of **hot secondary beams** (antiprotons,rare isotopes) coming from production targets

**3D stochastic cooling (band 1-2 GHz) of coasting secondary beams, max. $10^8$ ions (antiprotons @ v = 0.97c , rare isotopes @ v = 0.83c )**




**CR optics, lattices, apertures (frozen since 2016) jointly optimized to serve the stoch. cooling**

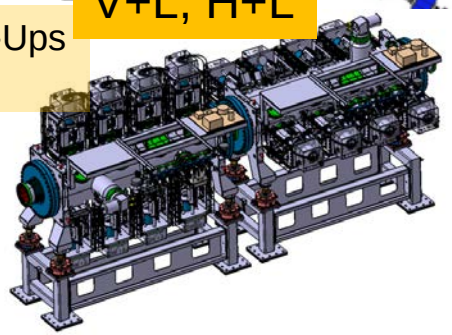
# CR Stochastic Cooling System 1-2 GHz

**CR UHV aim** for requested beam lifetimes of 100 s:
basic static P ≤ 3 ·$10^{-9}$ mbar ($N_2$ equivalent) at room temperature, **without in situ bakeout**

C=221.45 m
Bρ=13 Tm

2 cryogenic plunging Pick-Ups
(slotline electrodes)

V+L, H+L

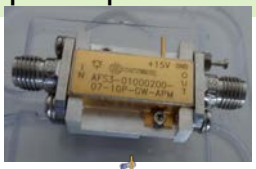


Palmer Pick-Up
Faltin elctrodes

250 W microwave
Power amps
at kickers

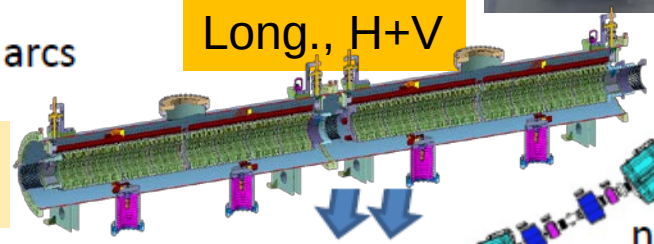
Many RF-components
and cables in the building

Low Noise Preamps
at pick-ups



Microwave damping tubes in all
quad/sextupole chambers in the arcs

Long., H+V



2 kickers FZJ
slotring electrodes

$$\eta = \frac{1}{\gamma^2} - \frac{1}{\gamma_{tr}^2}$$

η=+0.014/-0.011 pbars
η=0.18 RIBs

System bandwidth 1-2 GHz

# Kickers: Design

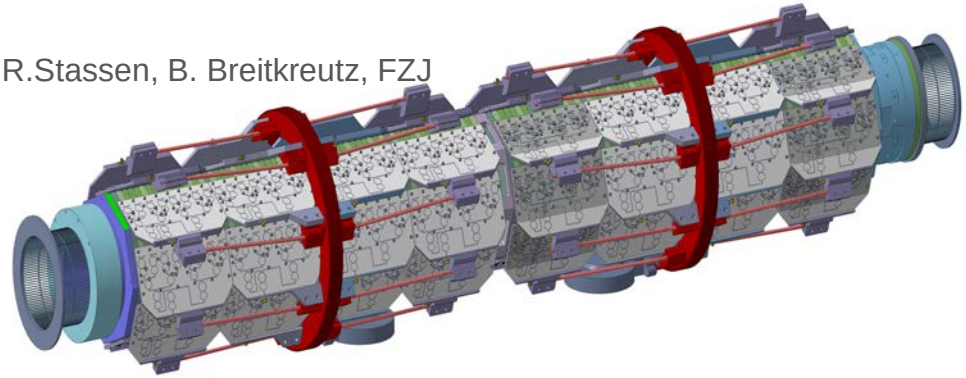
- slot-rings 1-2 GHz; 140 mm aperture
- one tank transverse cooling (H+V)
- one tank longitudinal cooling


KHV
CR04BK2

KL
CR04BK3


Engineering:R.Greven, ZEA-1, FZJ

R.Stassen, B. Breitkreutz, FZJ



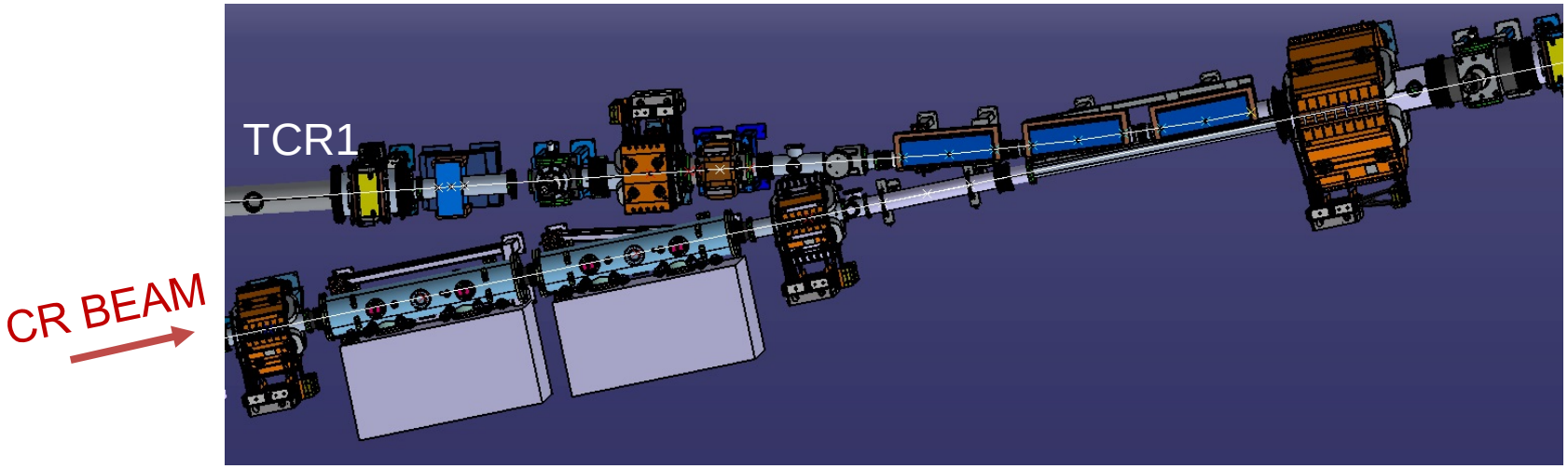
CR 2x64 Slot-ring structure (incl. splitter boards) inside one vacuum tank

Challenges:

- Space limitations close to TCR1 injection line lead to constrains for splitter board size
- Minimization of signal run-time from power amps to kickers
- Heat transfer from splitter boards

# Kickers: Integration


Tank flanges **DN 400 COF**, to flanges/bellows DN 200 CF
Top: 4-5 NEXTtorr 1000 l/s standard CR pumps;1 free port for turbo/roughing
Side: feedthrough flanges RF power signal; UHV diagnostics; assembly flanges
Bottom: flanges for water cooling pipes



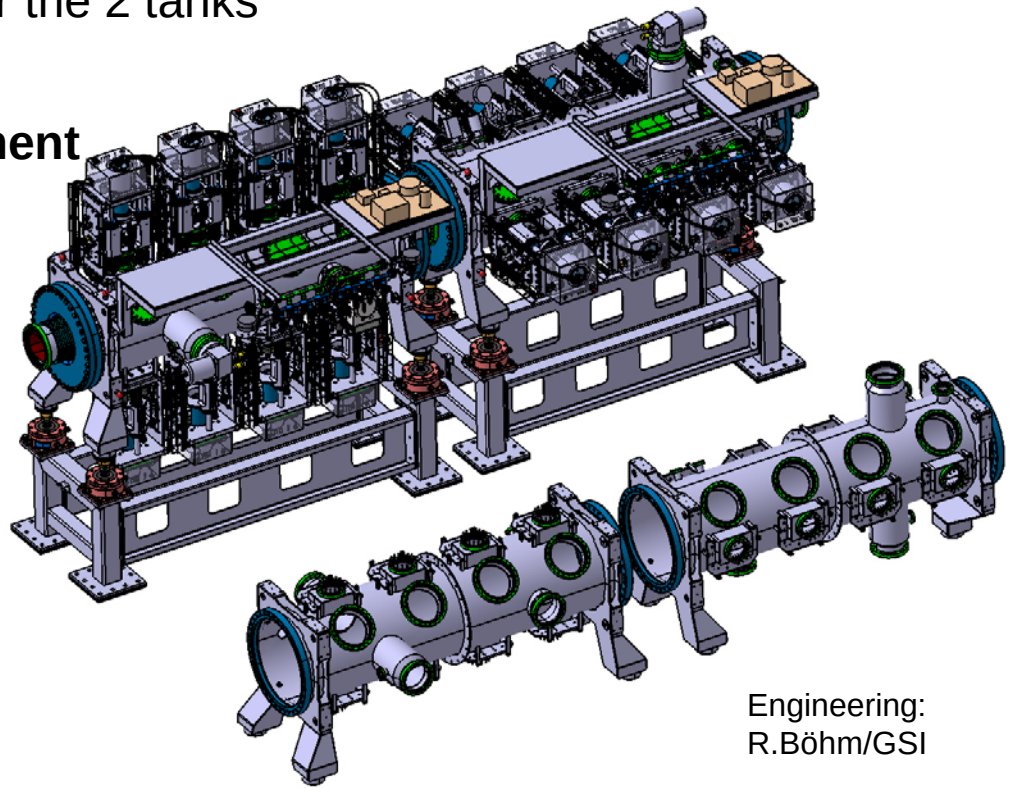
# Challenging Cryogenic Plunging Pick-Ups

Ordered 2 vacuum tanks according to GSI spec/manufacturing drawings.

Expected delivery & SAT Q3/2021

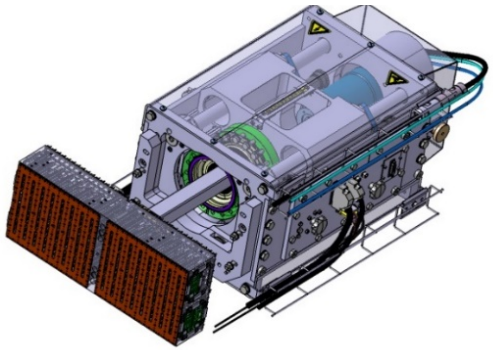
Ordered supports and assembly tools for the 2 tanks

**Finalizing 3D engineering & procurement of inner subsystems**



Engineering:
R.Böhm/GSI

16 Motor Drive Units: ready



pre-assembled in house

all parts (incl. spares) stored

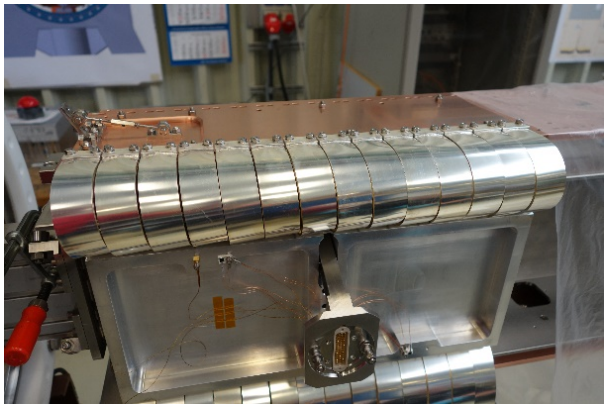
# Challenging Cryogenic Plunging Pick-Ups

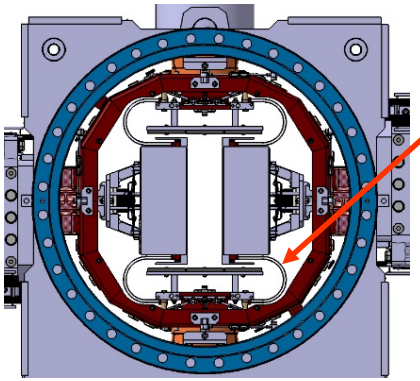
**~3500 Ag/CuBe plunging foils and their Ag/Cu holders (incl. spares)**

**CuBe foils thermally treated in vacuum oven GSI TechLAB**

2021-2023: galvanic Ag-plating (1 provider, manually), procedure for high numbers pending


UHV soldering of foils on holders (1 succesful provider)



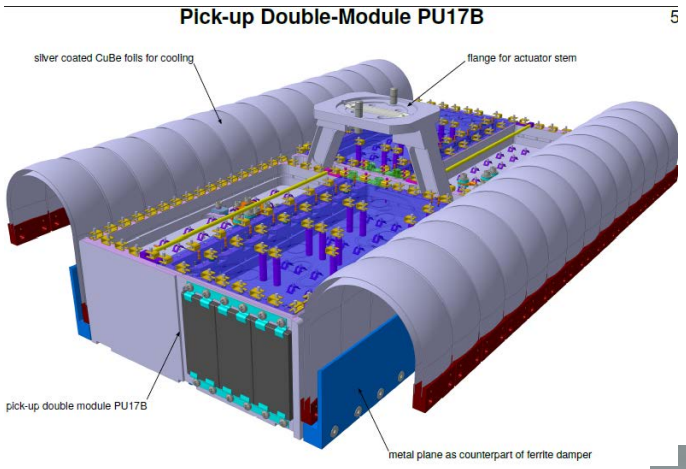


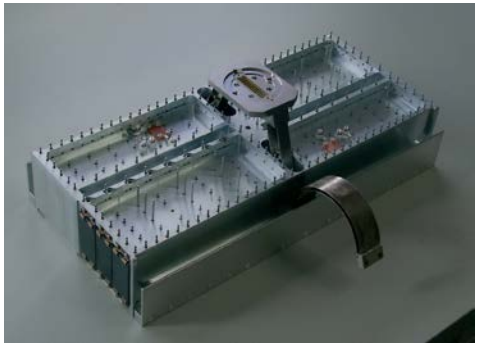
***Flexible Ag/CuBe foils at 30 K***

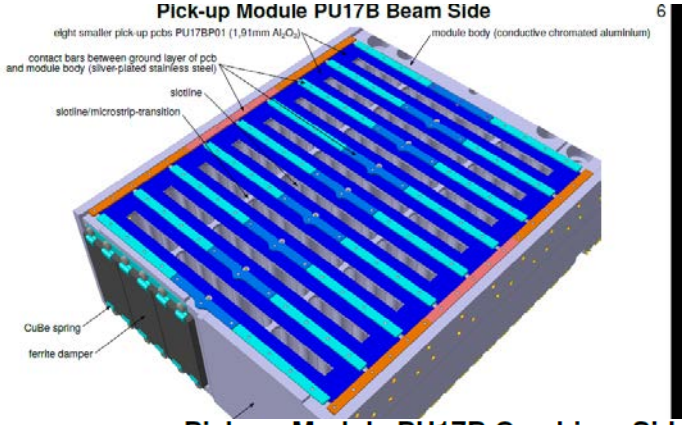
# Slotline electrode module

-re-designed, feasible by providers
-contract for full scope (pre-series, series, spares) metallised ceramic RF boards
-Prototype module: ready (without ceramic electrodes)
pre-series ceramics Q3/2021
full assembly & RF tests Q3-Q4/2021

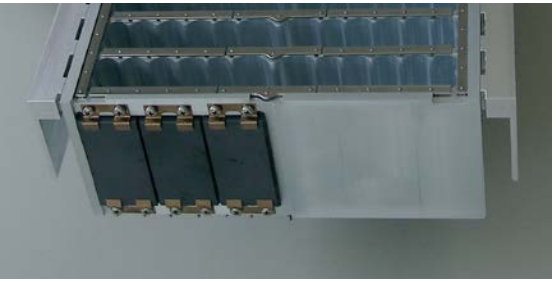
*8 single slot PCB*
*with one hole and 3 slots*

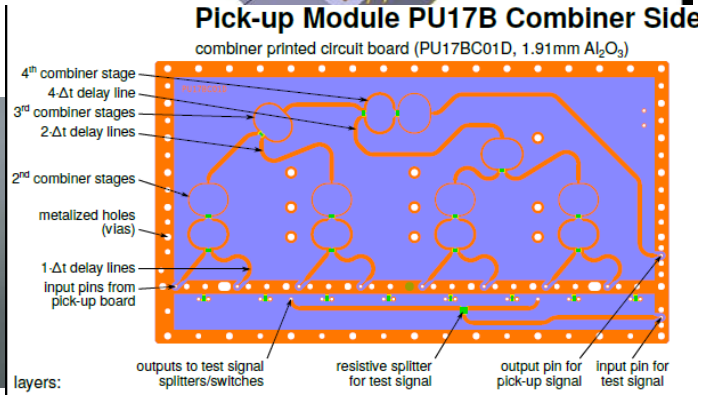





2019 C. Peschke
Engineering: M.Meister/GSI

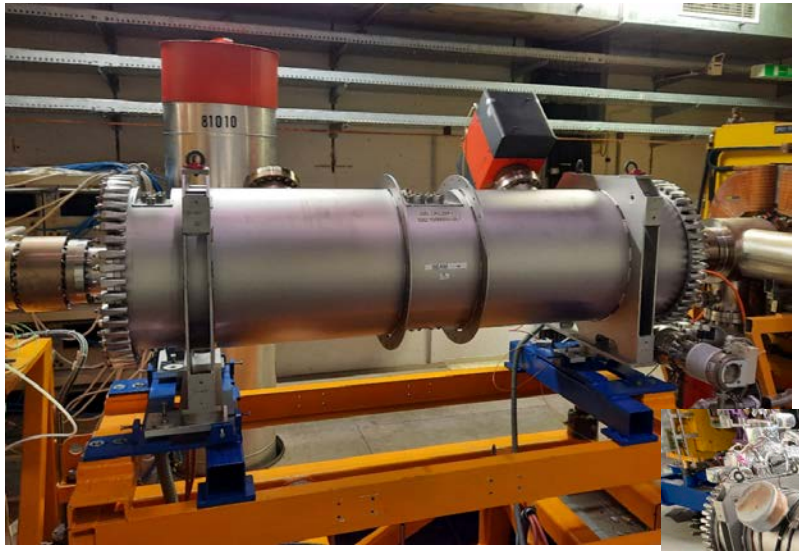


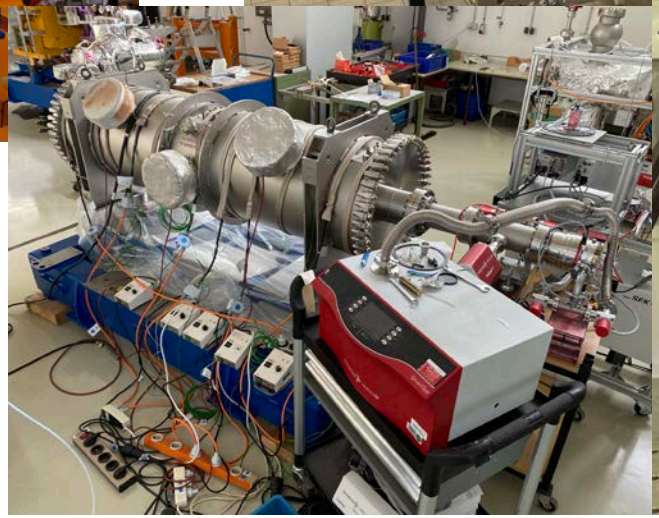


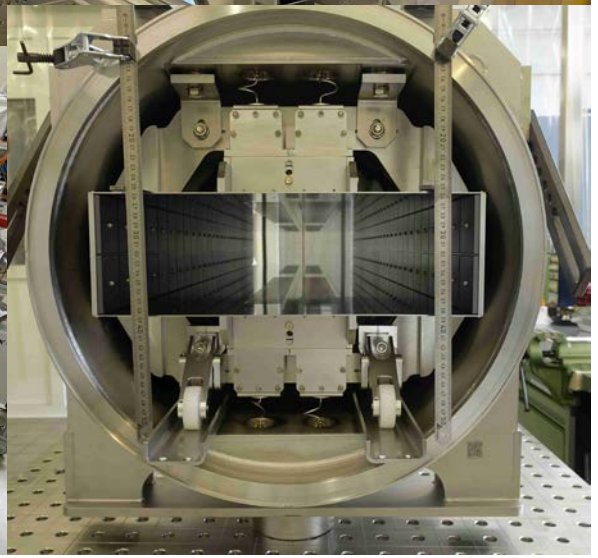
# Palmer Pick-Up

Palmer pick-up (Faltin rail electrodes) for precooling of RIBs

- Installed at COSY



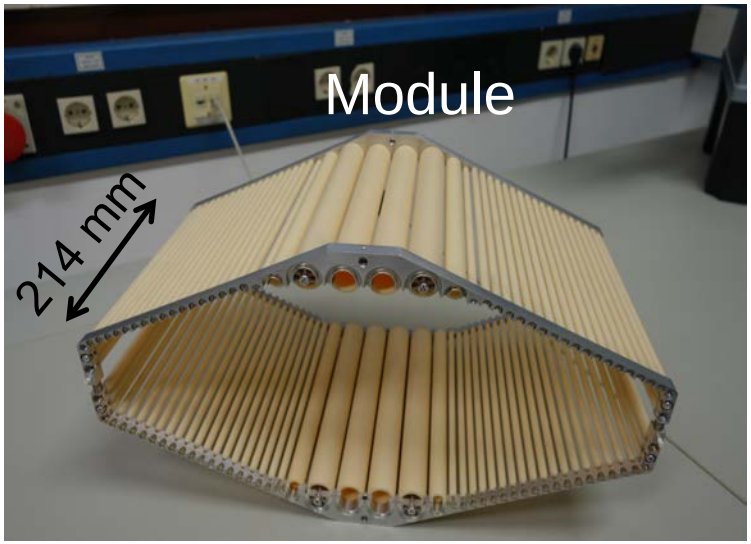




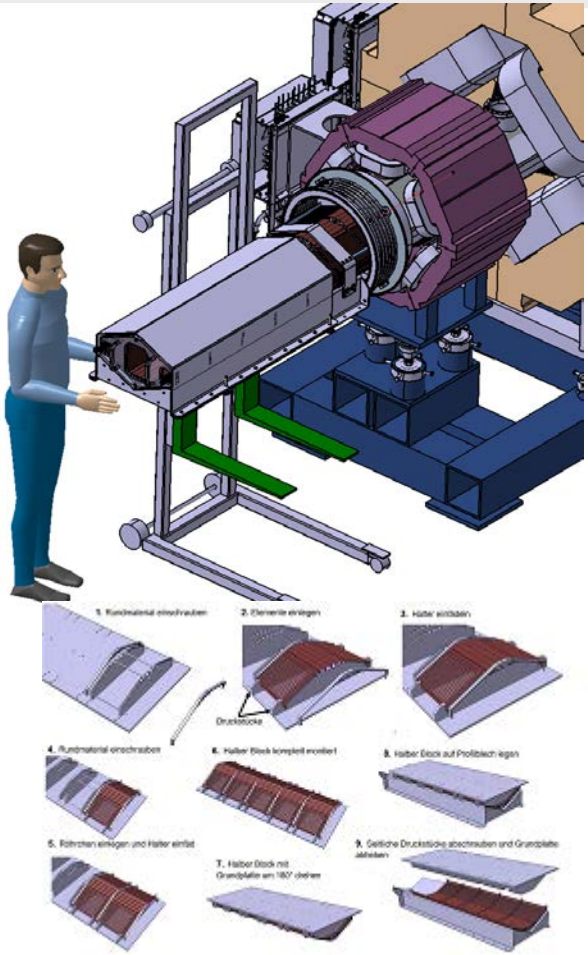
**2021-2022: its RF response will be tested with 0.83 c protons at COSY**

# Microwave Damping-
# Coated Ceramic Absorbers

**Preseries mechanics (holders, assembly tooling): ready**





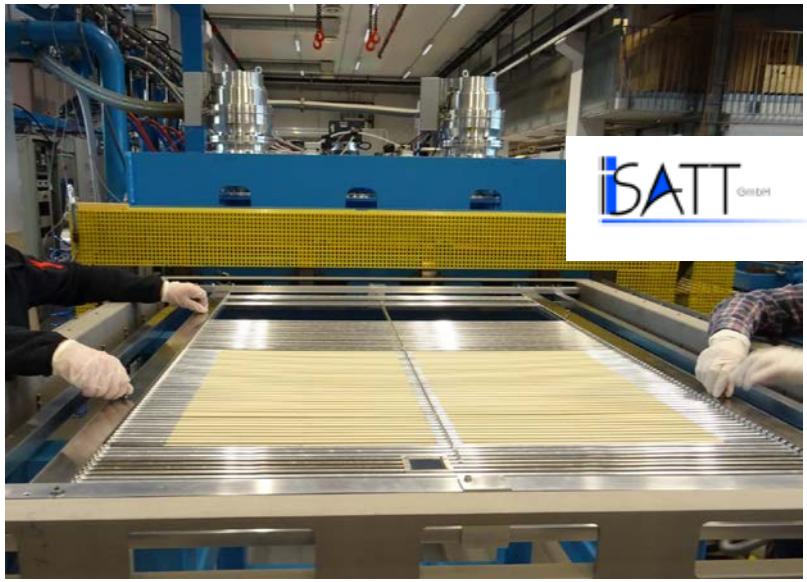


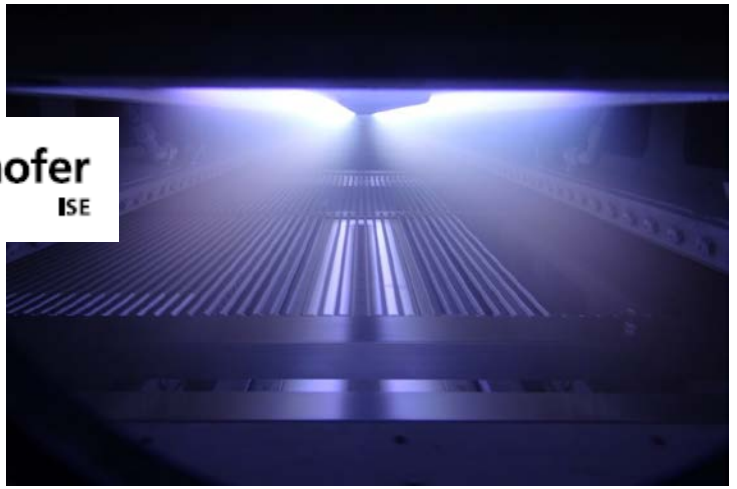
Engineering:
R.Böhm/GSI

Q4/2021-Q1/2022: testing assembly mechanics + UHV benchmarking with modules inside BINP chamber.

# Microwave Damping- Coated Ceramic Absorbers

**For 140 modules: ~15000 series ceramic tubes coated by NiCr sputtering**






# Status April 2021 at a glance

| | |
|---|---|
| **2.5.10** | **CR Stochastic Cooling System** |
| 2.5.10.1.1 | Cryogenic Plunging Pick-ups *>>ongoing (see following slides)* |
| 2.5.10.1.1 | Palmer Pick-up *>> at COSY for beam test, FDR prepared* |
| 2.5.10.1.2 | Kickers *>>FZJ designs towards CDR, pending FZJ-GSI contract* |
| | |
| 2.5.10.2.1 | Low Noise Preamplifiers *>>SAT of series done, FDR prepared* |
| 2.5.10.2.2.1 | Power Amplifiers 1-2 GHz<br>*>>SAT ongoing (34/34 delivered, 15 passed SAT, FDR released)* |
| 2.5.10.2.3 | RF Signal Processing |
| 2.5.10.3 | Instrumentation |
| | |
| 2.5.10.5 | Microwave Damping CR Chambers<br>*>>series tubes: ~15000 coated ceramics tubes delivered*<br>*>> prototype mechanics done (holders, assembly tooling)*<br>*>> Q4/2021: assembly+UHV testing of tubes inside BINP quad chamber* |

Спасибо за внимание !

Thank you for your attention!