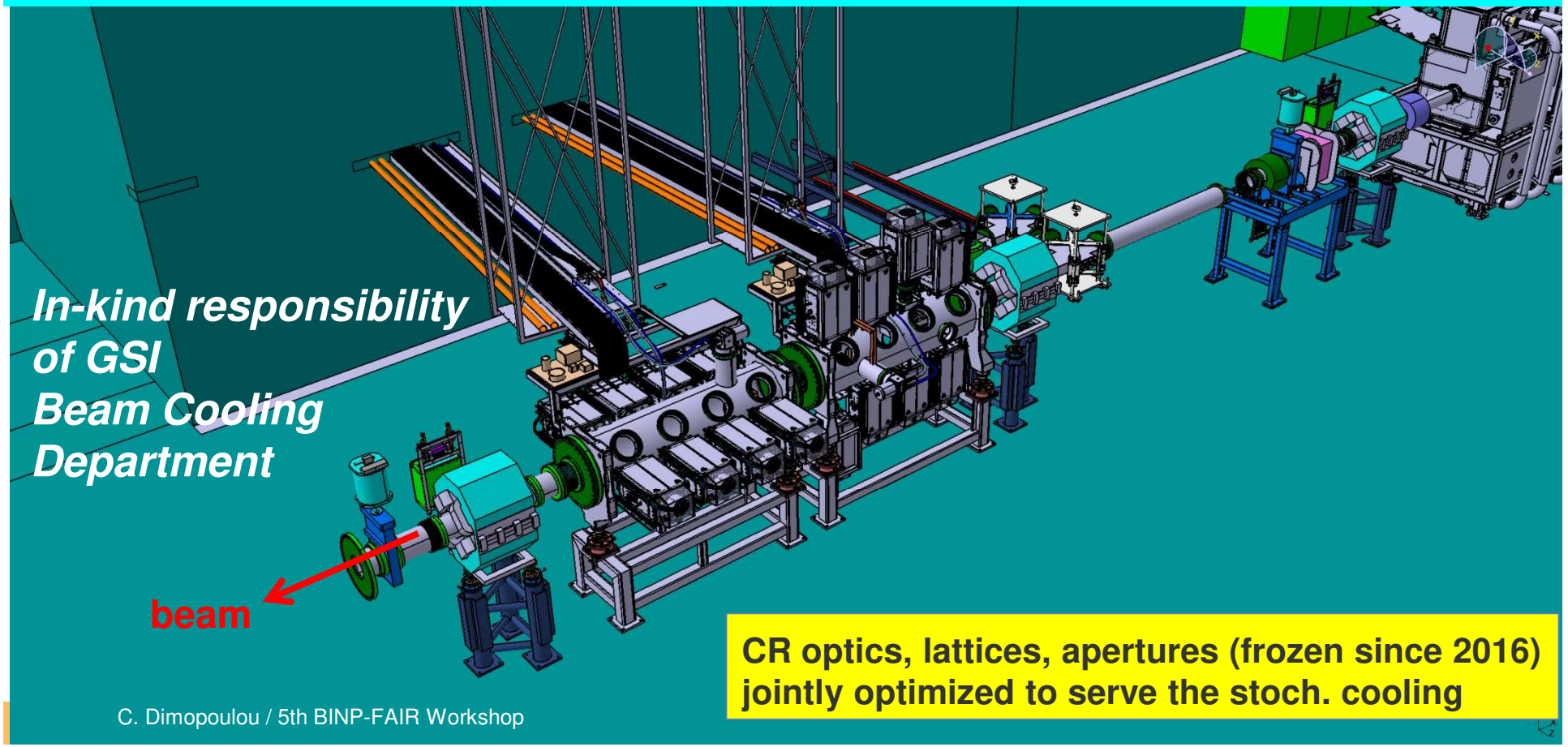
CR stochastic cooling system (1-2 GHz)

Dr. Christina Dimopoulou

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

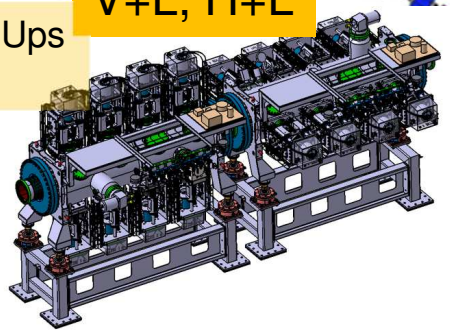
CR Stochastic Cooling System 1-2 GHz

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

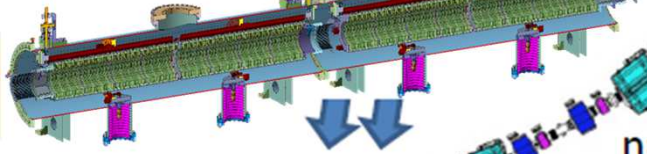
250 W microwave
Power amps
at kickers

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

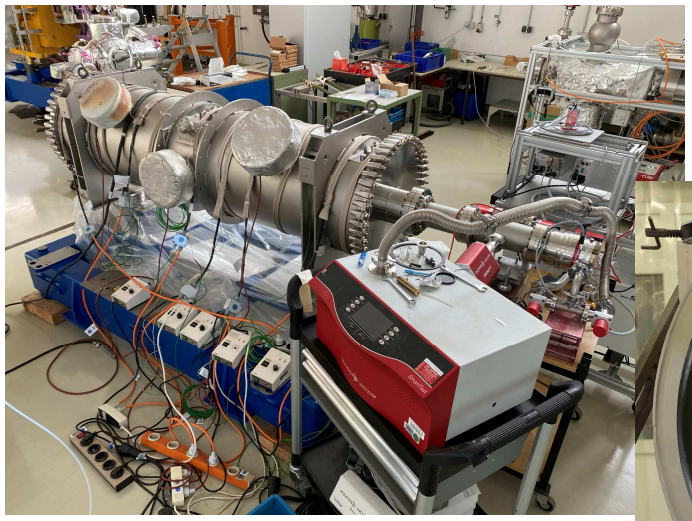
Status November 2020 at a glance

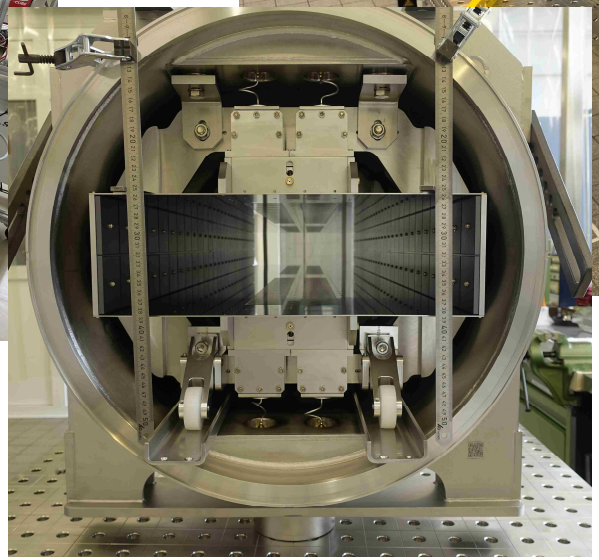
2.5.10	**CR Stochastic Cooling System**
2.5.10.1.1	Cryogenic Plunging Pick-ups *>>ongoing (see following slides)*
2.5.10.1.1	Palmer Pick-up *>>assembled at FZJ, ready for installation at COSY*
2.5.10.1.2	Kickers *>>ongoing FZJ design, pending FZJ-GSI contract*
2.5.10.2.1	Low Noise Preamplifiers *>> ½ series delivered, SAT in 2020*
2.5.10.2.2.1	Power Amplifiers 1-2 GHz *>>SAT ongoing (28/34 delivered, 9 passed SAT, keep provider)*
2.5.10.2.3	RF Signal Processing
2.5.10.3	Instrumentation
2.5.10.5	Microwave Damping CR Chambers *>>series tubes: ceramics delivered, coating will follow* *>> mechanics ongoing (holders, assembly tooling)* *>> preparing UHV-benchmarking of tubes in the BINP quad chamber*

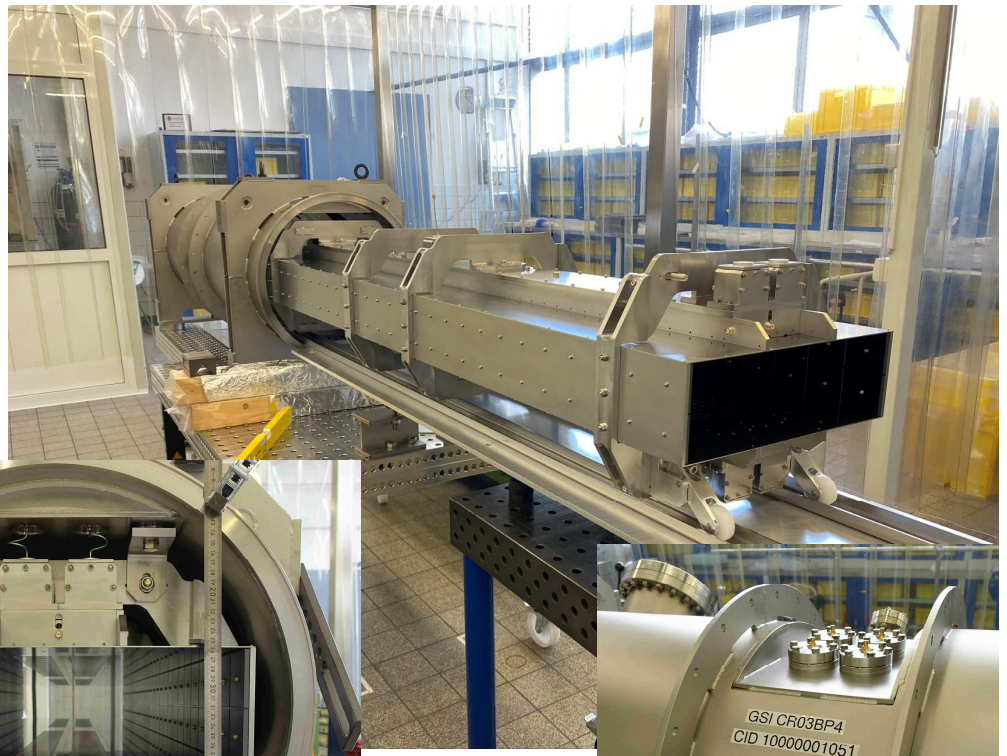
Palmer Pick-Up

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

- Assembled at ZEA-1 (FZ Jülich) in summer 2020
- Vacuum tests completed FZ Jülich
- Ready for Installation at COSY

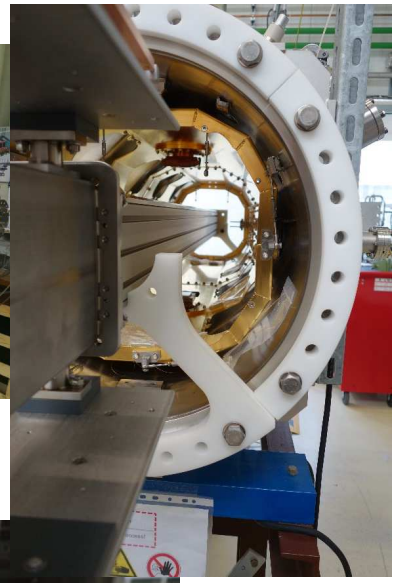






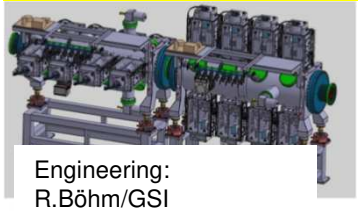
2021: its RF response will be tested with 0.83 c protons at COSY

Challenging Cryogenic Plunging Pick-Ups

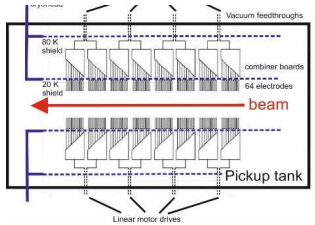


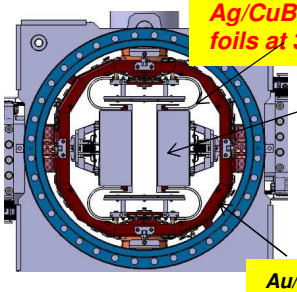
Ag/CuBe plunging foils

Cryogenic plunging pick-ups.



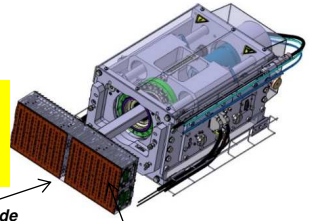
Engineering:
R.Böhm/GSI



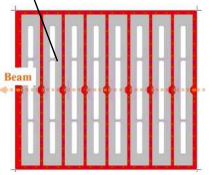


Flexible Ag/CuBe foils at 30 K

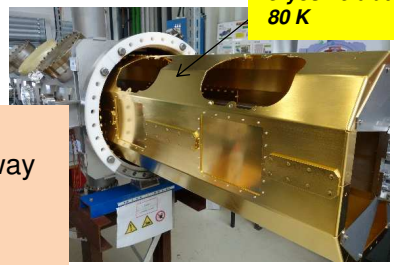
*Assembly of the electrode mounted to the **linear motor drive unit**.*



Electrode double-module



Au/Cu cryoshield at 80 K



Slot-line electrode module on Al2O3 ceramic substrate.

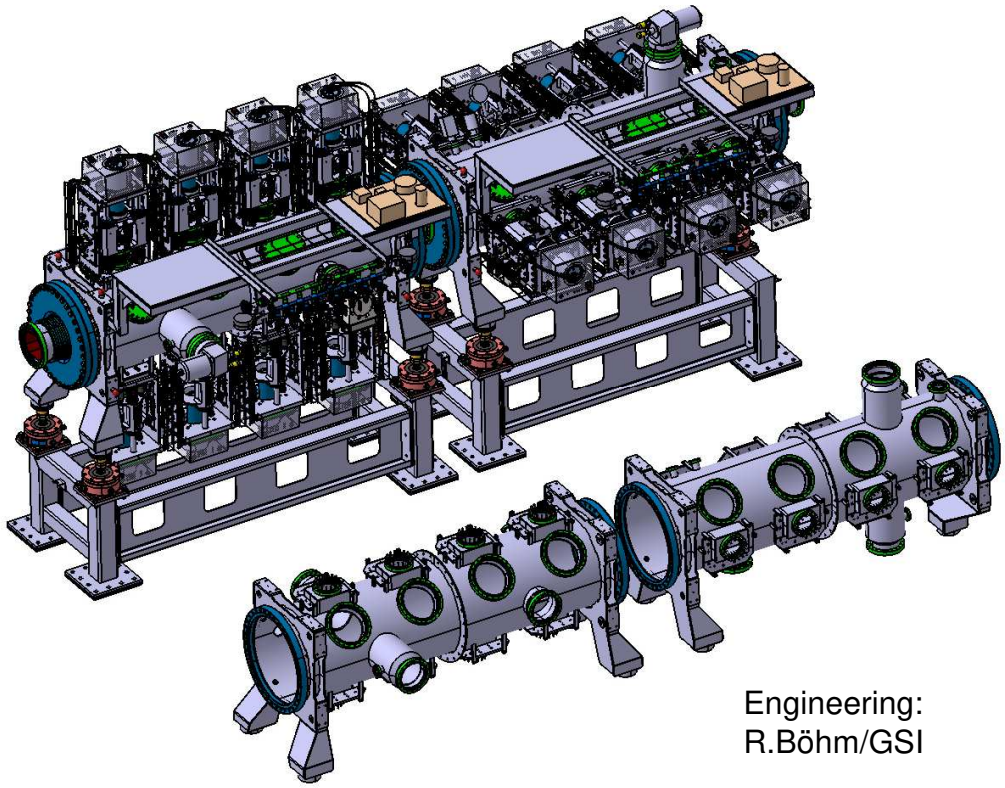
Milled module body with pick-up board & combiner board

Cryotest DONE to benchmark the concept
-mechanical assembly: OK, improvements underway
-vacuum/cryo performance: passed
-temperature distribution (electrodes ≤ 40 K) : satisfactory, reduced complexity

Finished benchmarking activities in GSI prototype pickup tank (2013-2019)

Challenging Cryogenic Plunging Pick-Ups

- Finished 3D engineering of tanks
- Detailed Spec released, tendering 2 vacuum tanks according to GSI manufacturing drawings.
- Expected delivery & SAT Q3/2021



Engineering:
R.Böhm/GSI

Finalizing supports and assembly tools

for the 2 tanks

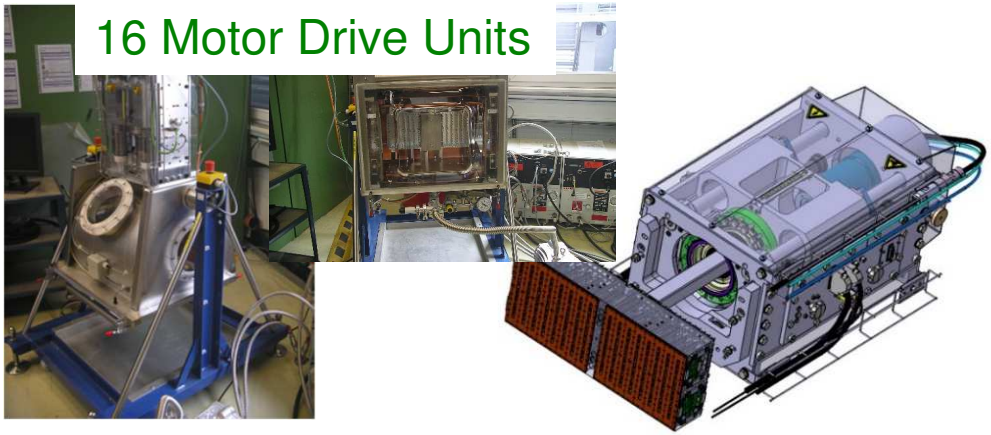
Finalizing 3D engineering of inner subsystems

Challenging Cryogenic Plunging Pick-Ups

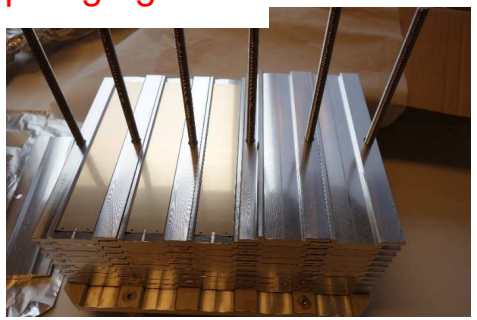
- In parallel procurements/manufacturing of standalone subsystems:

(e.g. motor drive units, plunging Ag/CuBe foils, electrode modules)

16 Motor Drive Units



~2500 Ag/CuBe plunging foils



Linear motor drives synchronously move electrode modules

from ±80 to ±10 mm towards beam axis.

costly parts (motors, absolute positioning, vacuum, RF cables) ready

mechanical parts: >95% manufactured, ready

Nov. 2020: start in house pre-assembly, storage

Concept ready: prototypes, durability test, vacuum test passed.

Manufacturing still technically risky

- thermal treatment CuBe in vacuum oven GSI TechLAB: done
- 2500 Cu-holders: procurement done

2021:

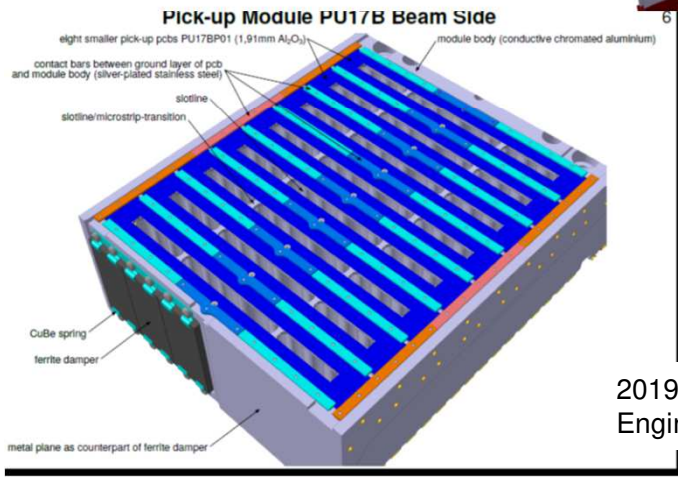
- galvanic Ag-plating (1 provider, manually), procedure for high numbers pending

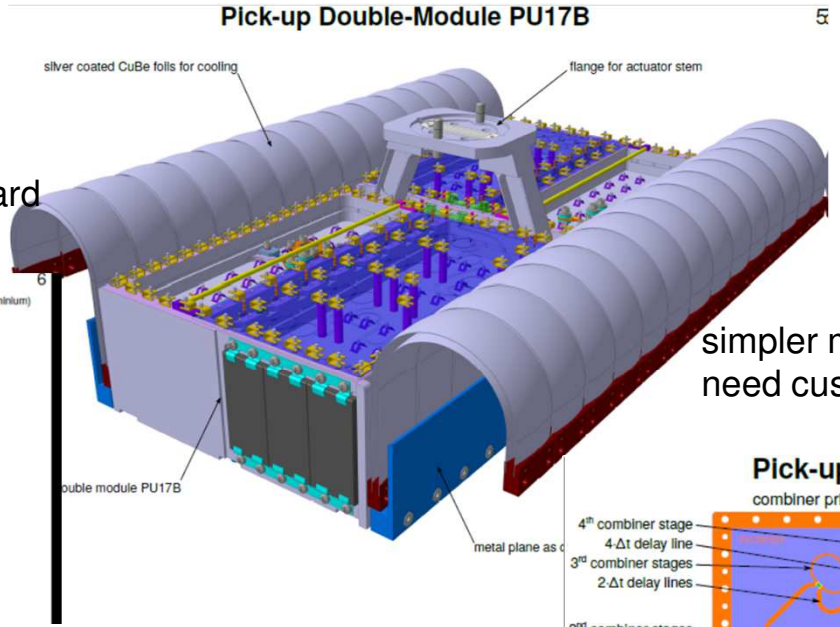
- UHV soldering of foils on holders (1 succesful provider), procedure for high numbers pending

Slotline electrode module:
re-design for simplicity and feasibility with providers

8 single slot PCB
with one hole and 3 slots

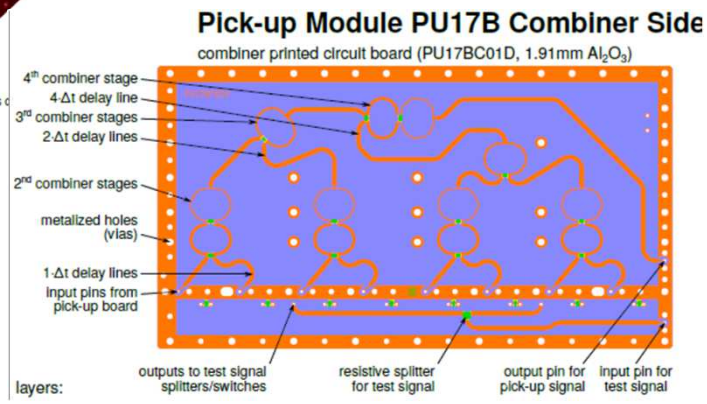
simplified combiner board
less holes,
temp. sensor/heater out of the board





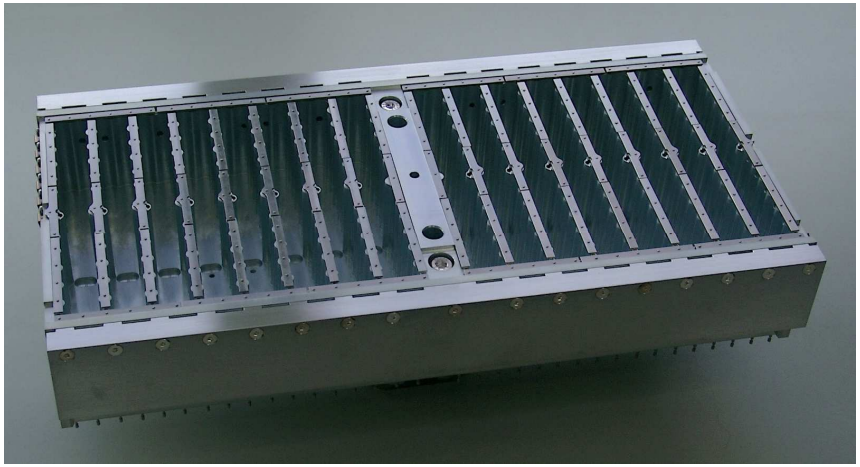
2019 C. Peschke
Engineering: M.Meister/GSI

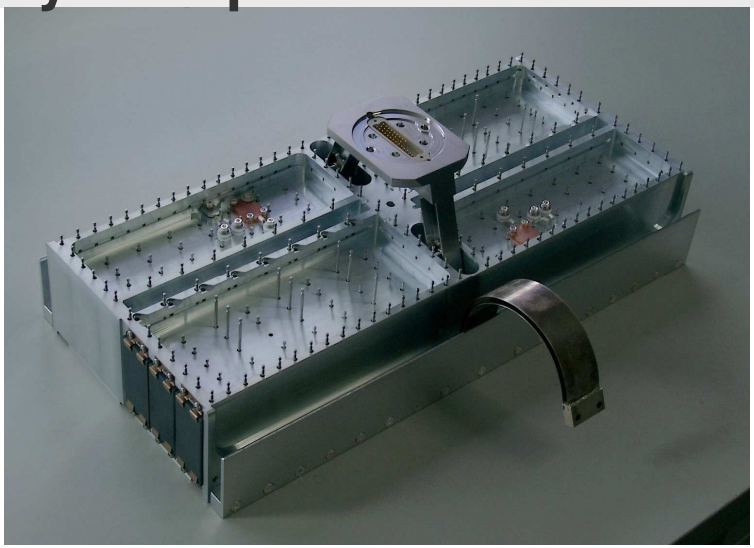
simpler module body
need custom-made CuBe springs

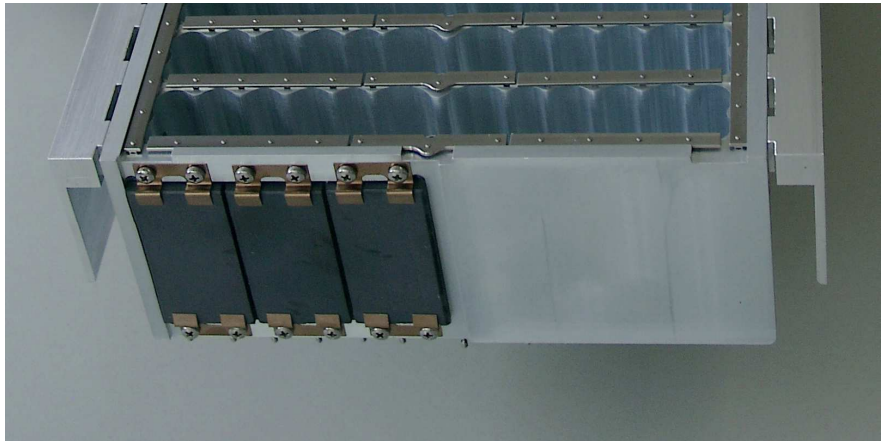


2020: tendering metallised ceramic boards,
full scope (pre-series/series/spares)

Slotline electrode module: re-design for simplicity and feasibility with providers







Prototype module: engineered, manufactured & successfully assembled
(without ceramic electrodes)

Pre-series ceramic electrodes expected Q2/2021

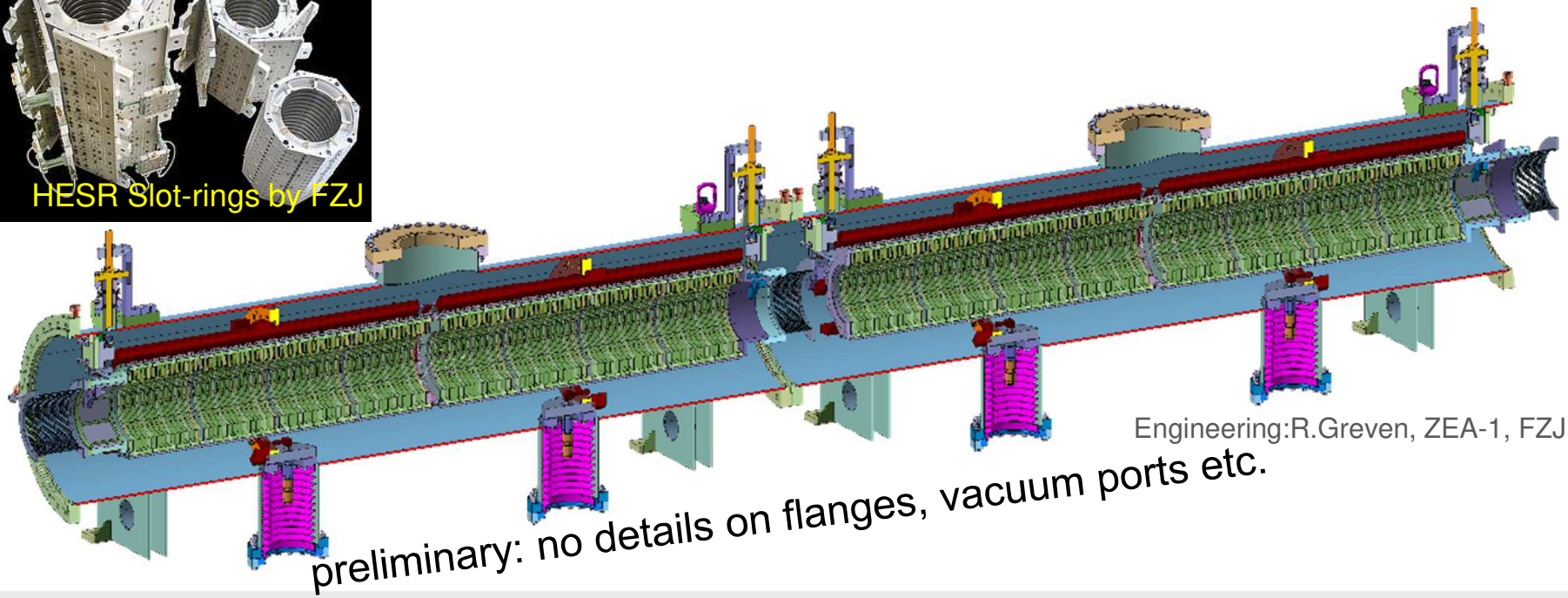
Kickers: Design

- HESR-like slot-rings
- CR04BK2 tank transverse cooling (H+V), 2x64 rings
- CR04BK3 tank longitudinal cooling, 2x64 rings

Challenges:

- Space limitations close to CR injection line lead to constrains for combiner board size
- Minimization of signal run-time from PAs
- Heat transfer from combiner boards


HESR Slot-rings by FZJ


Engineering:R.Greven, ZEA-1, FZJ

preliminary: no details on flanges, vacuum ports etc.

Microwave Damping-
Coated Ceramic Absorbers

140 coated ceramic tube modules inside all hexagonal quad/sextupole vacuum chambers

2021: test assembly mechanics,
joint activity BINP+GSI: full UHV test inside BINP prototype quad chamber.

joint contribution of UHV equipment !
(CR-type NexTorr pumps, valves, diagnostics)

GSI Beam Cooling invites/welcomes A.Krasnov's team to GSI
(after end of Covid restrictions)

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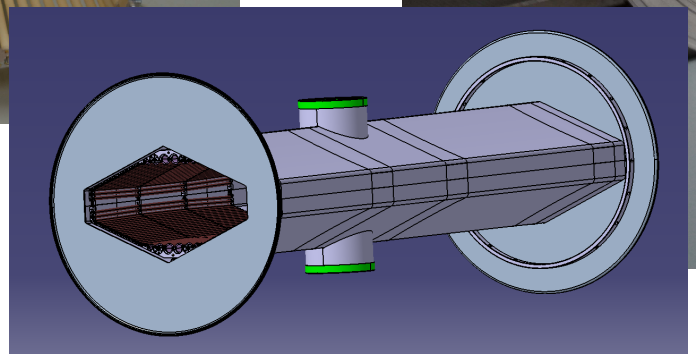


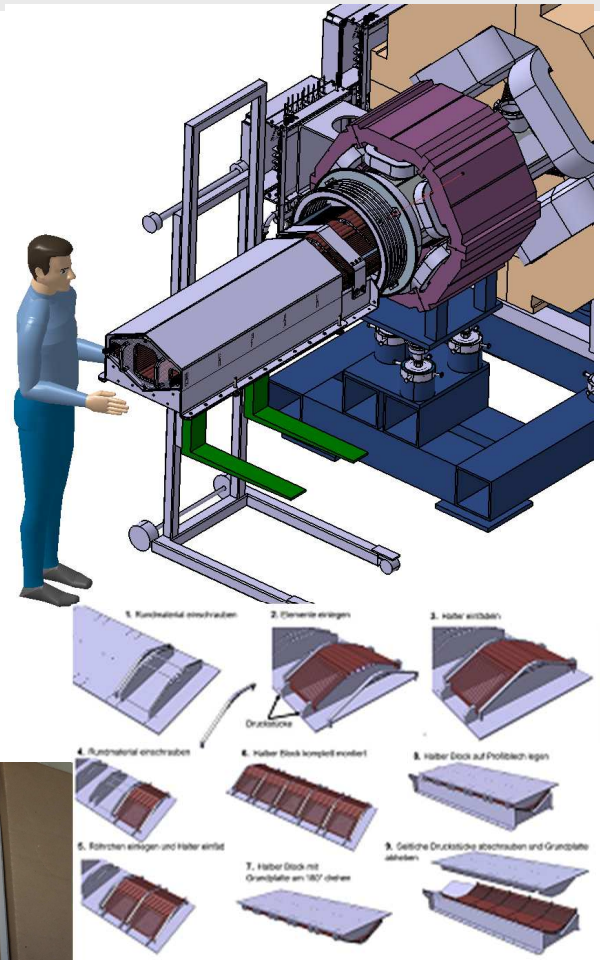
Microwave Damping-
Coated Ceramic Absorbers

Prototype 2018:
UHV outgassing rate OK

2020:
-mechanical concept (preseries holders, frames, assembly tooling): engineered, manufacturing underway

-For 140 modules ordered ~13000 series ceramic tubes and their coating (by NiCr sputtering).
Ceramics delivered, UHV outgassing tests
Coating follows, expected by Q1/2021

2021-2022:
series mechanics, storage of modules

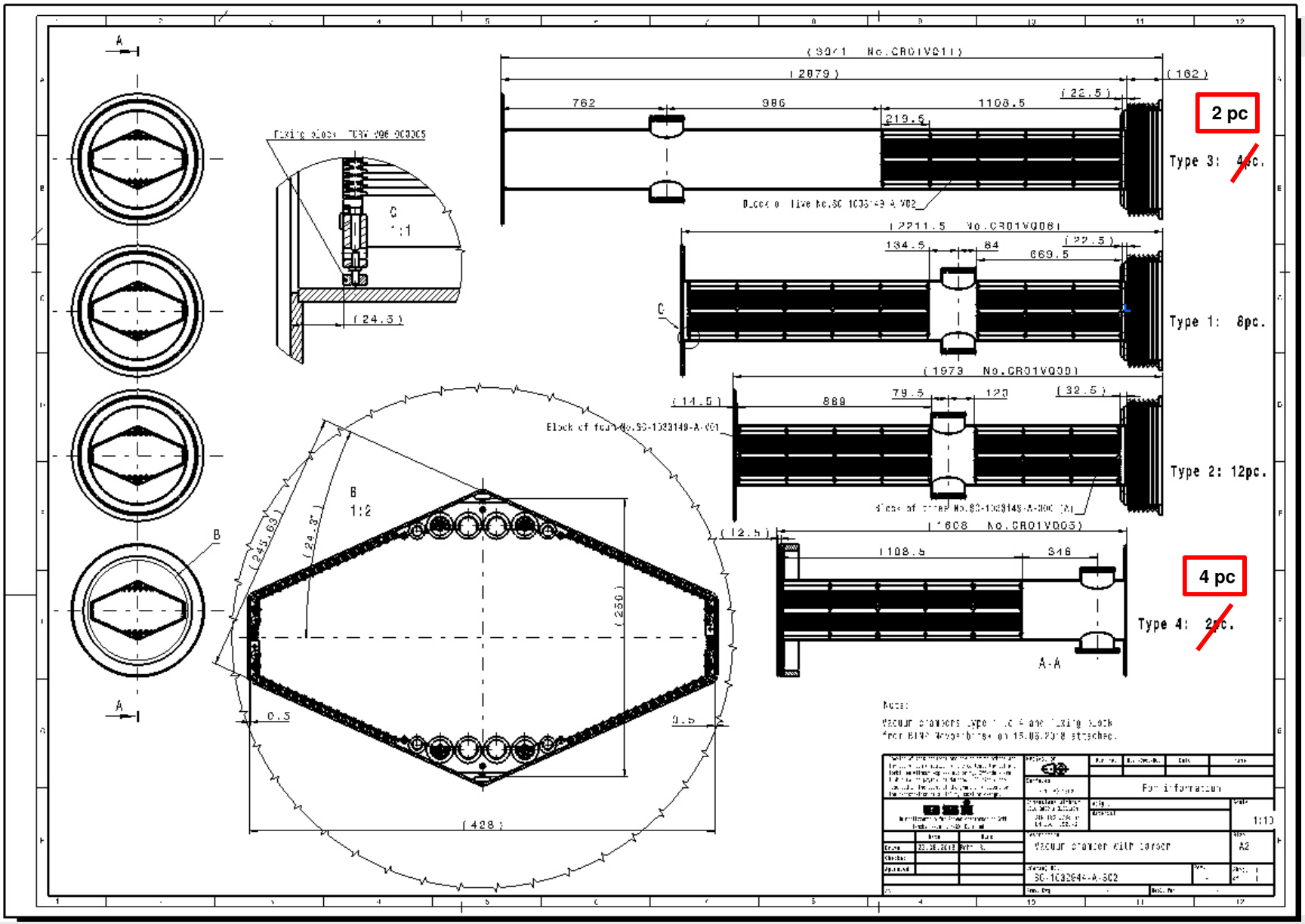


Engineering:
R.Böhm/GSI

Neu! **MW Elemente im CR Nr. SC-1032944-A-S02 (max. 5èr Block)**

2018

Zeichnung an BINP gesendet im Nov.



Спасибо за внимание !

Thank you for your attention!