

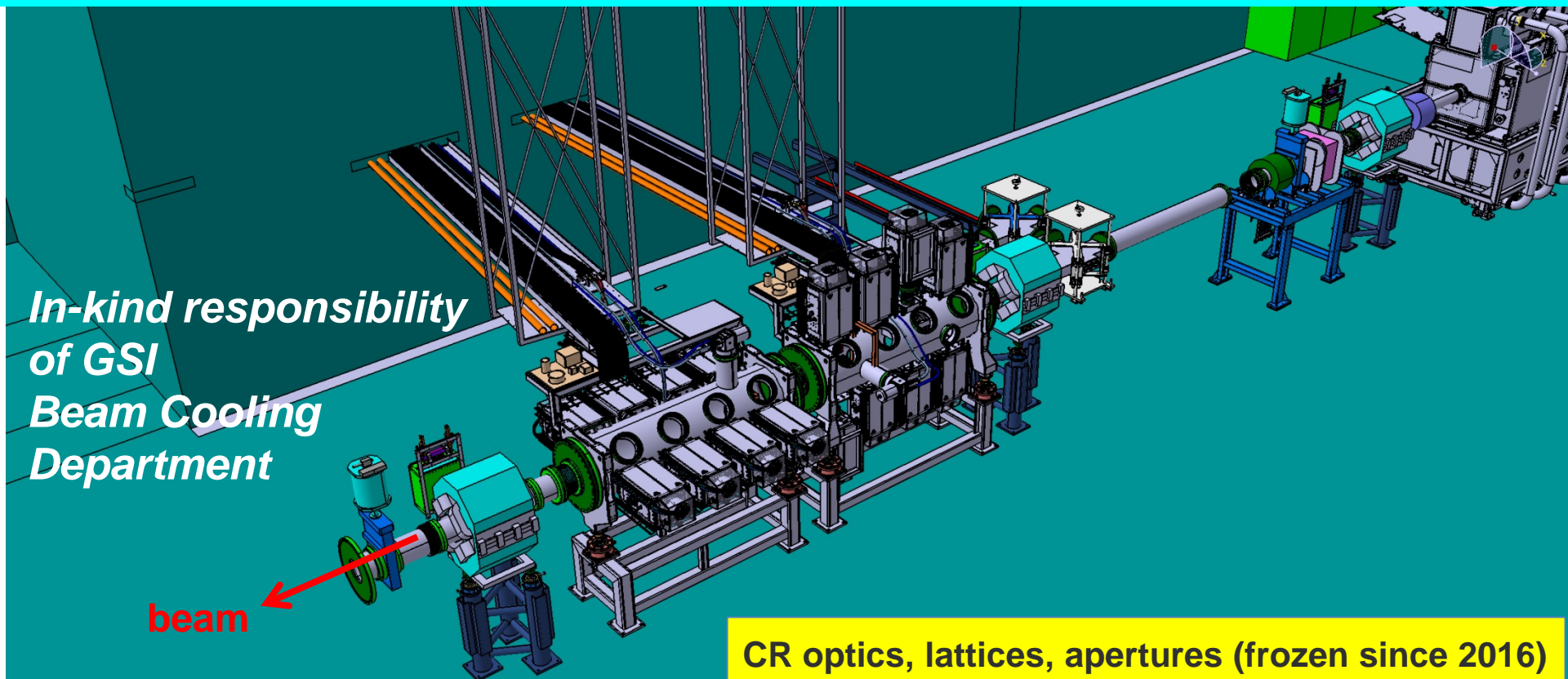
CR stochastic cooling system (1-2 GHz)

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*4th BINP FAIR Workshop
zoom: Darmstadt/Novosibirsk May 2020*

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 @ $v = 0.83c$)



*In-kind responsibility
of GSI
Beam Cooling
Department*

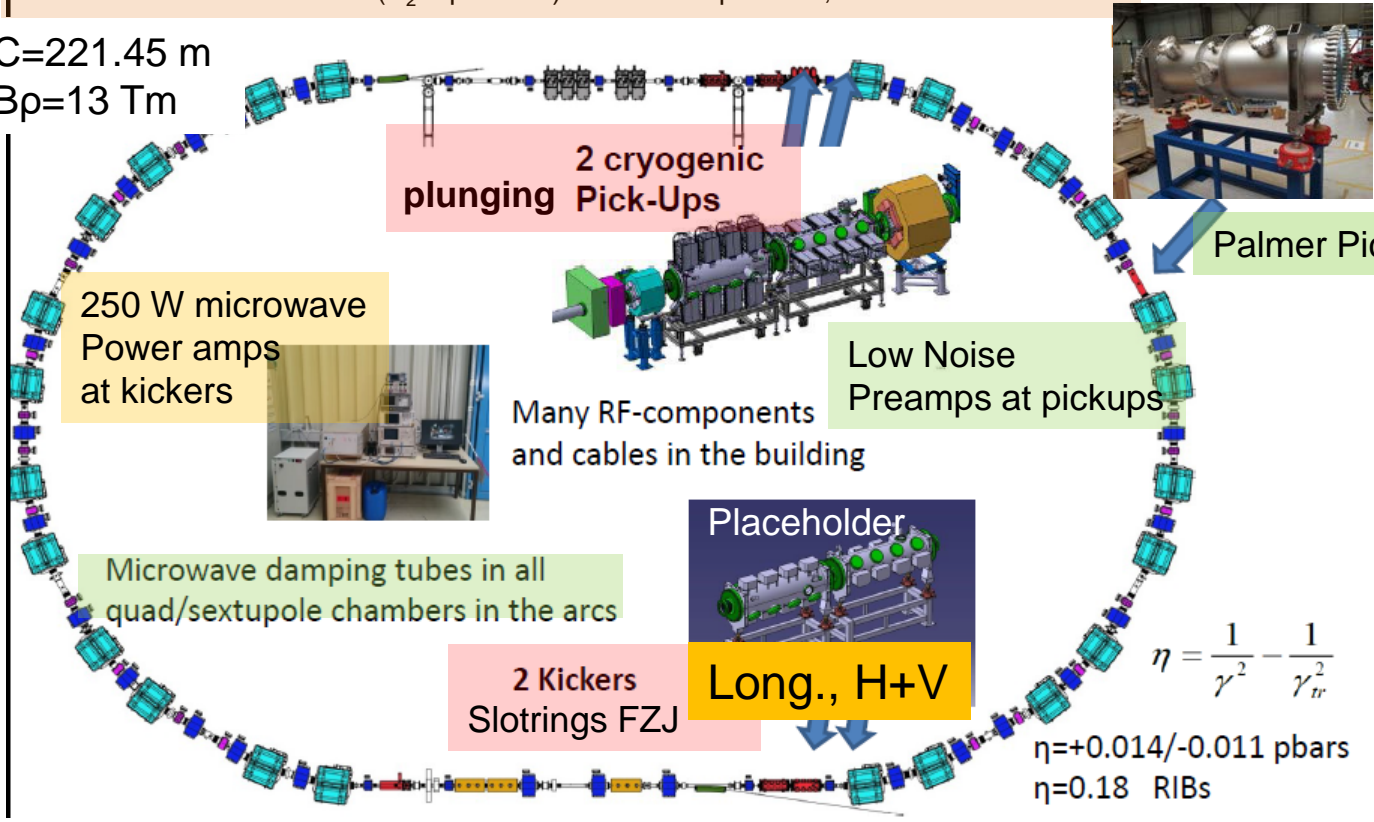
**CR optics, lattices, apertures (frozen since 2016)
jointly optimized to serve the stoch. cooling**

CR Stochastic Cooling System 1-2 GHz



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

$C=221.45$ m
 $B_p=13$ Tm



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

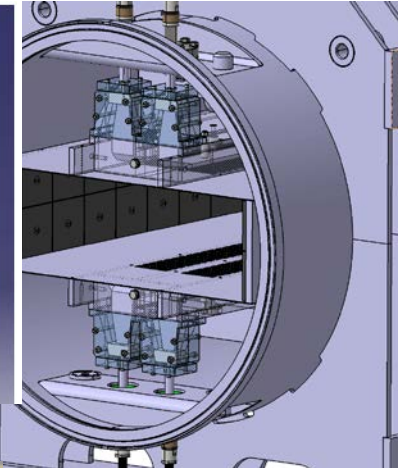
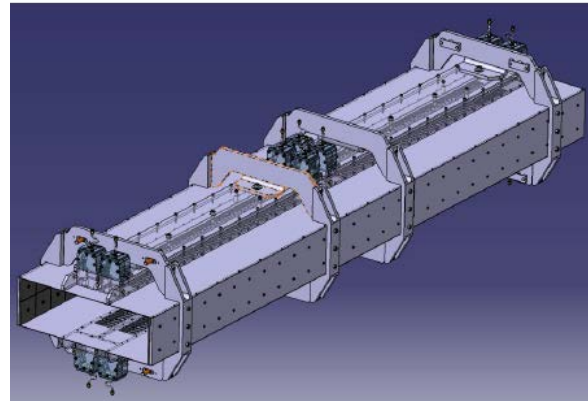
$\eta = +0.014 / -0.011$ pbars
 $\eta = 0.18$ RIBs

System bandwidth 1-2 GHz

2.5.10	CR Stochastic Cooling System
2.5.10.1.1	Cryogenic Plunging Pick-ups >> <i>ongoing (see following slides)</i>
2.5.10.1.1	Palmer Pick-up >> <i>ready, assembly for beam test at FZJ</i>
2.5.10.1.2	Kickers >> <i>FZJ design ongoing, FZJ-GSI collaboration contract underway</i>
2.5.10.2.1	Low Noise Preamplifiers >> <i>ordered, exp. 2020</i>
2.5.10.2.2.1	Power Amplifiers 1-2 GHz >> <i>SAT series ongoing (18/34 delivered, 4 passed SAT, decision OK or provider change ~ August)</i>
2.5.10.2.3	RF Signal Processing >> <i>ongoing</i>
2.5.10.3	Instrumentation
2.5.10.5	Microwave Damping CR Chambers >> <i>ordered series tubes, exp. 2020</i> >> <i>underway mechanics, joint GSI-BINP vacuum tests in quad chamber</i>

Palmer Pick-Up

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



Test assembly GSI



Tank & inner structure ready, accepted Jan. 2020
PU now being assembled in Jülich,
its RF response will be tested with 0.83 c
protons at COSY in 2020-2021

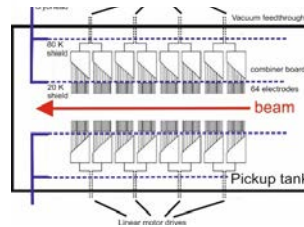
Challenging Cryogenic Plunging Pick-Ups



Cryogenic plunging pick-ups.

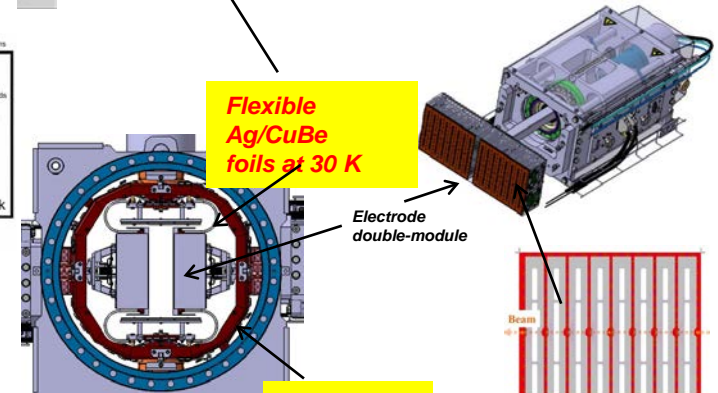


Engineering:
R. Böhm/GSI

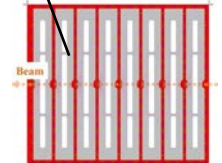


Assembly of the electrode mounted to the linear motor drive unit.

Flexible Ag/CuBe foils at 30 K

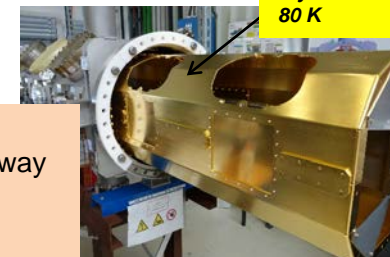


Electrode double-module



Slot-line electrode module on a substrate

Au/Cu cryoshield at 80 K



Milled module body with pick-up board & combiner board

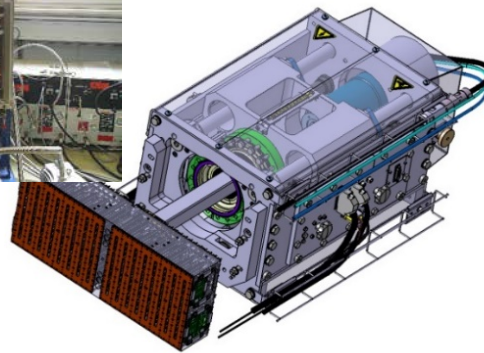
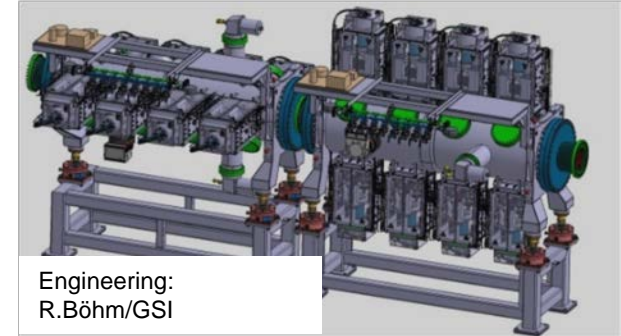
Ag/CuBe plunging foils

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

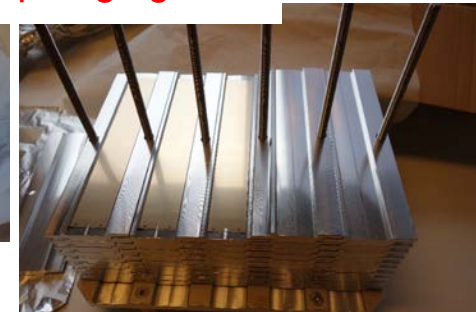
Finished benchmarking activities in GSI prototype pickup tank (2013-2019)

Challenging Cryogenic Plunging Pick-Ups

- Finalizing 3D engineering of tanks and inner subsystems.
- 2020: Order 2 vacuum tanks according to GSI manufacturing drawing.
- In parallel procurements/manufacturing of standalone subsystems:
(e.g. 16 motor drive units, ~2500 plunging Ag/CuBe foils, electrode modules)



~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

**2020: procurement/manufacturing mechanical parts
in house preassembly, storage**

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

Manufacturing still technically risky

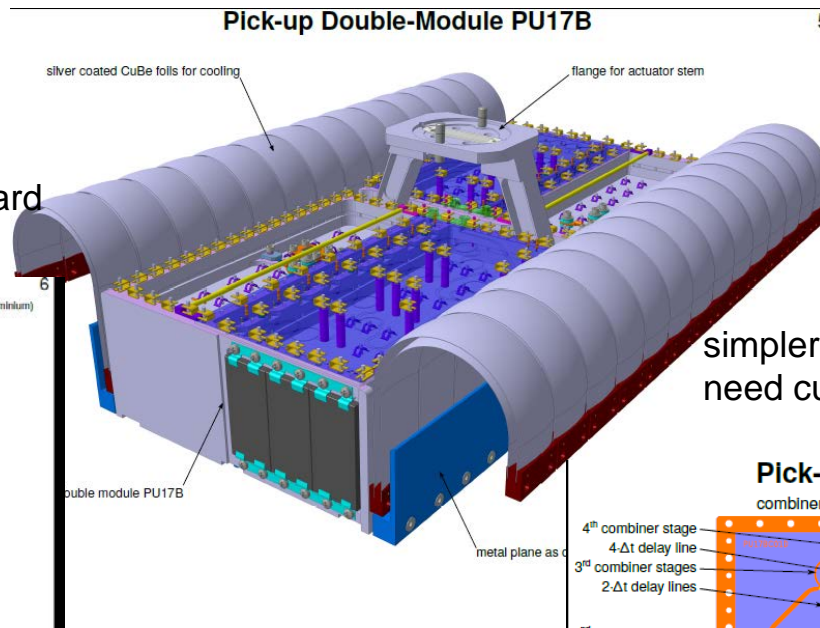
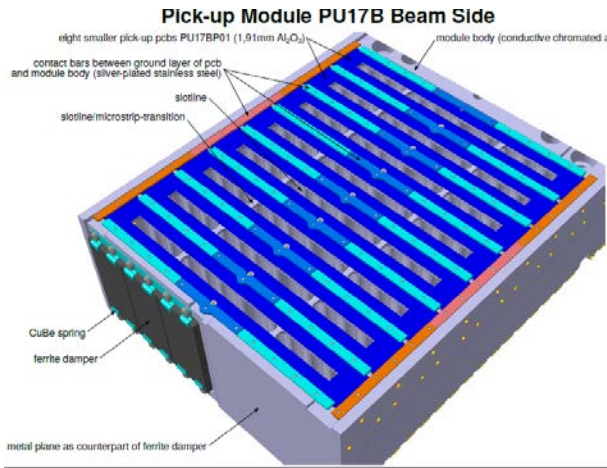
- thermal treatment CuBe in vacuum oven at GSI TechLAB
- galvanic Ag-plating (1 provider, manually), procedure for high numbers pending
- UHV soldering of foils on holders (1 successful provider), procedure for high numbers pending

Slotline electrode module:

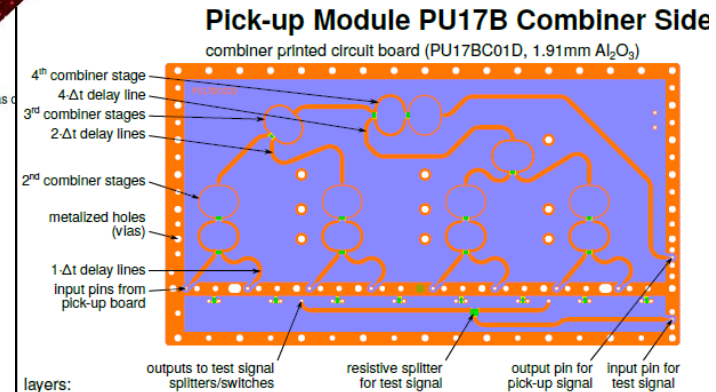
re-design for simplicity and feasibility with providers,
 2020: tender full scope (preseries/series/spares)

8 single slot PCB
 with one hole and 3 slots

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



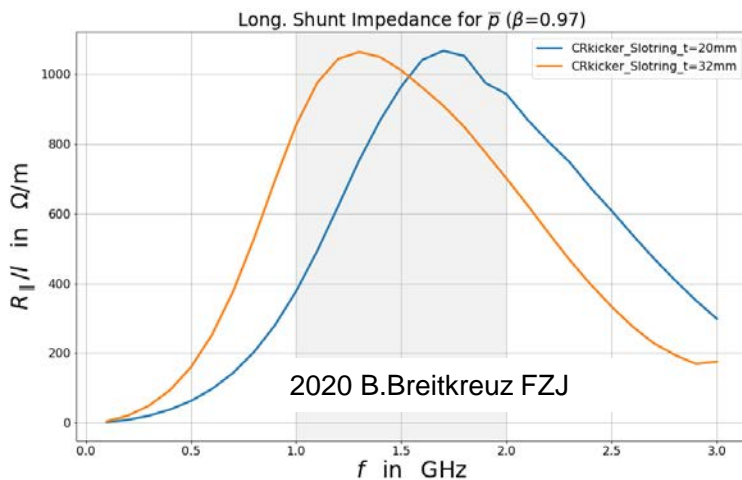
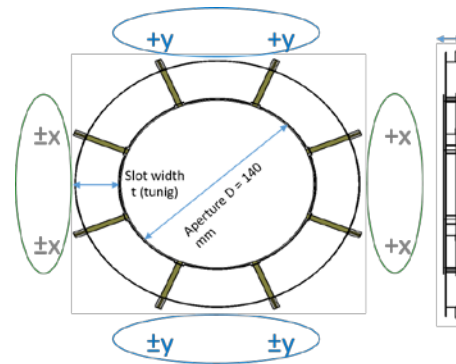
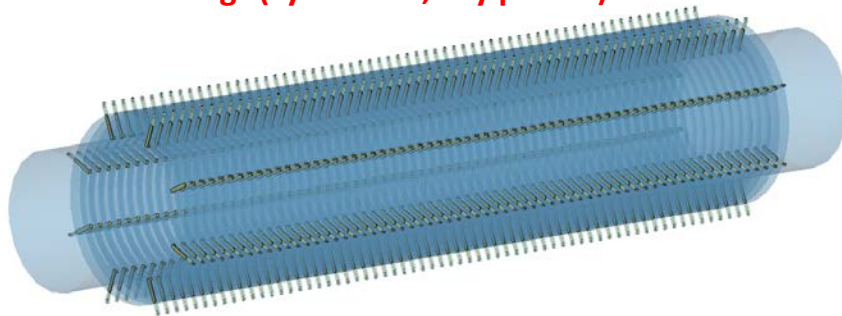
simpler module body
 need custom-made CuBe springs



2019 C. Peschke
 Engineering: M.Meister/GSI

Decision to adopt the well-proven FZJ slot-ring concept.
 The HESR slot-ring can be adapted to CR case (beam aperture, 1-2 GHz band).

FZJ slot-rings (cylindrical, x+y planes)



2 tanks

- CR04BK2 with 128 rings for transverse cooling (both x+y planes)
- CR04BK3 with 128 rings for longitudinal cooling

Microwave Damping-Coated Ceramic Absorbers



**Prototype 2018:
UHV outgassing rate OK**



2020:

-mechanical concept (holders, frames, assembly tooling) underway

**-Tubes for 140 modules ordered =
~13000 series ceramic tubes and their
coating (by NiCr sputtering).
Delivery end 2020.**

2021-2022: assemble, store all modules

Microwave Damping-Coated Ceramic Absorbers

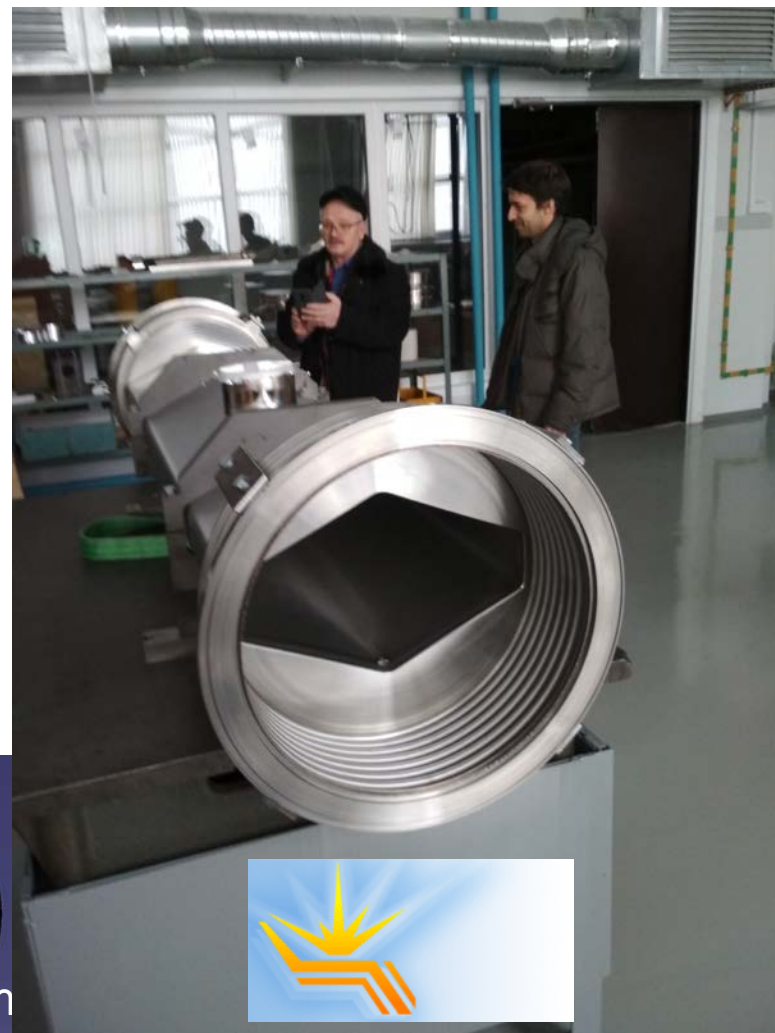


140 coated ceramic tube modules inside all hexagonal quad/sextupole vacuum chambers

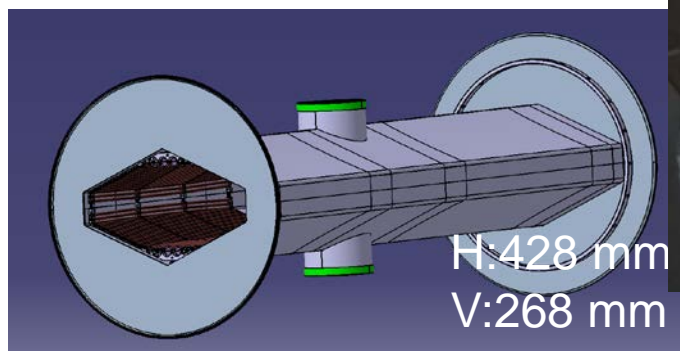
-Q3-4/2020: test assembly, full UHV test inside BINP prototype chamber.



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CR Stochastic Cooling WP идет по правильному пути

- деньги на закупки текут
- склады наполняются
- идут разные сложные проверки и испытания
- GSI конструкторский отдел, цеха поддерживают по возможности
- контракт сотрудничества с опытной группой FZJ, чтобы вовремя получить надежные kicker systems



Thank you for your attention!