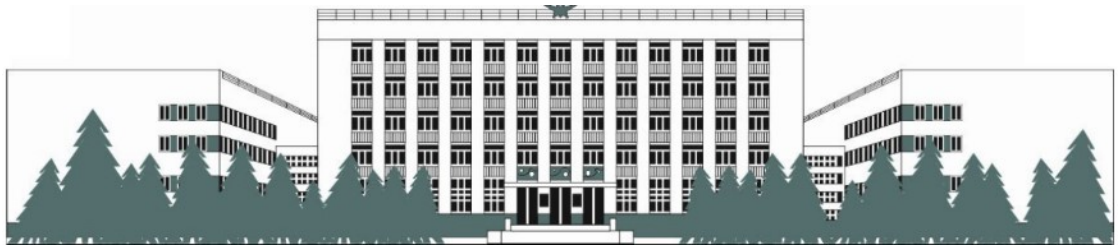
# Collector Ring Beam Diagnostics Status

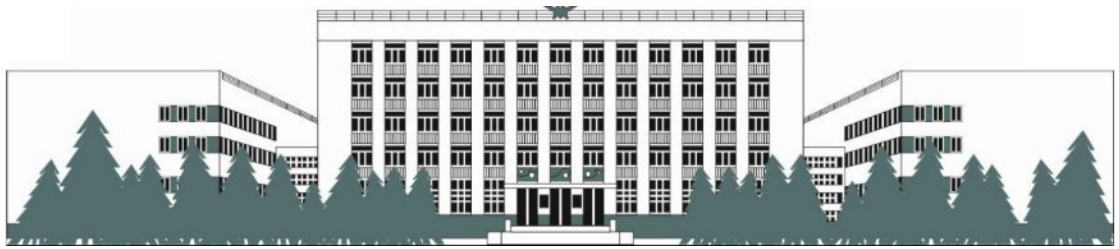


Yury Rogovsky

on behalf of the Budker INP team

10 November 2020, Novosibirsk

# Collector Ring Beam Diagnostics Status



Yury Rogovsky

on behalf of the Budker INP team

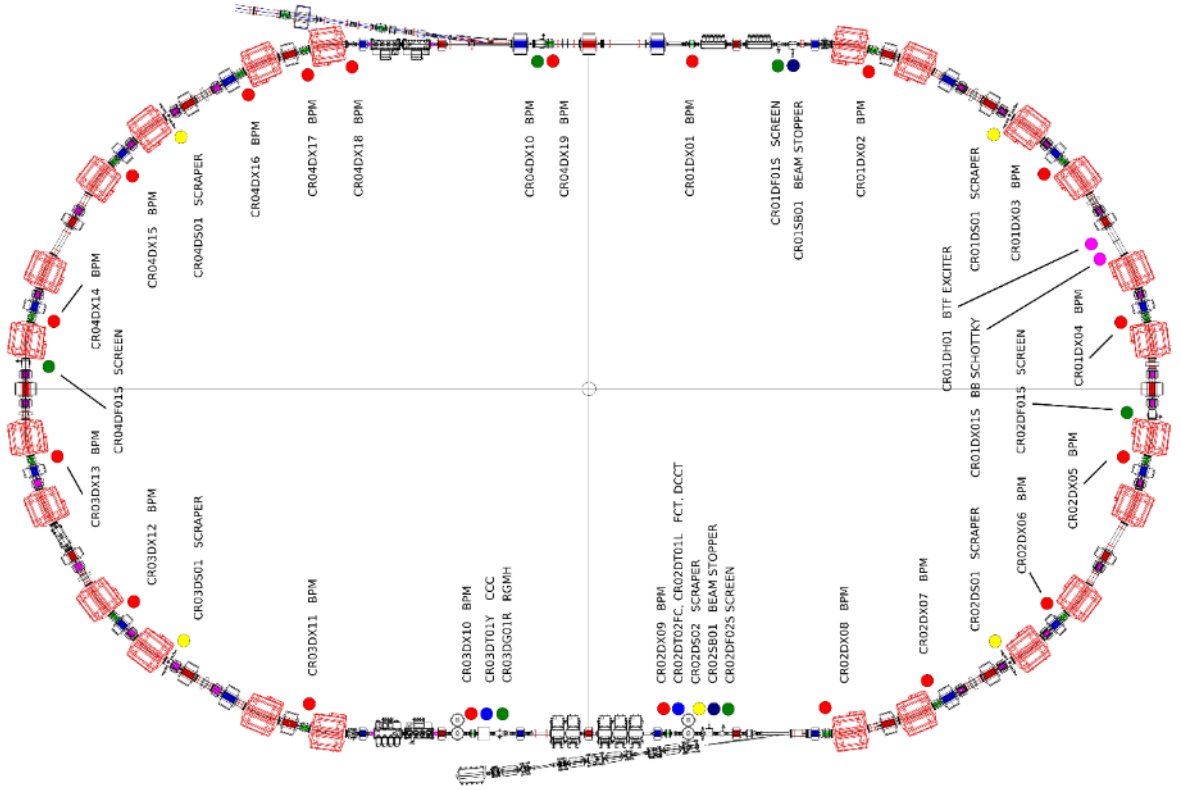
10 November 2020, Novosibirsk

**The half a year progress will be reported.**

5th BINP-FAIR Collaboration Coordination Workshop, 9-13 November 2020

# Beam Instrumentations @ CR machine

| Device | Qty | Parameter | Application |
|---|---|---|---|
| DC Transformer | 1 | DC current | Stored current, beam lifetime |
| Cryogenic Current Comparator | 1 | DC current | Stored current, beam lifetime |
| BPM | 19 | Beam center-of-mass | Closed orbit, turn-by-turn, K-modulation, lattice functions |
| BTF Exciter | 1 | Frequency of Schottky sidebands | Tune by BTF, tune by noise excitation, tune by Q-kick |
| Schottky pickup | 1 | Momentum distribution | Δp/p, tune, chromaticity |
| Fast Current Transformer | 1 | Broadband bunch structure | Longitudinal emittance, bunch gymnastics |
| Residual Gas Profile Monitor | 2 | Beam profile | Transverse emittance, injection matching |
| Beam Loss Monitor | Distri-buted | Beam loss | Mis-steering of magnets, halo detection at scrapers |
| Scintillating Screen | 5 | Beam profile | First turn diagnostics |
| Beam-Stopper | 2 | Stop the beam | First turn diagnostics |
| Scrapers | 2×4<br>2×4 | Beam size | Transverse beam size and beam alignment |




- TCR1 beam instrumentation not covered by this talk, but has the same design mainly (except one BPM @ final part which is not developed fully).
- SFRS / Pbar “lost diagnostics” – beyond the scope of this talk.

# Efforts in 2020 short overview


- Pickups – FDR done in Nov-2019. Wide prototype is under intensive study. Small prototype manufacturing is ongoing. One of TCR1 pickup still not designed yet.
- Scrapers – FDR done in Nov-2019. Docs are finalized. Wide type manufacturing is ongoing (> 80%).
- Scintillators – CDR released. FDR coming soon. Scintillating plates partially produced. Optical components are received. Manufacturing has been started (>10%). Procurement stage.
- Stoppers – CDR released. Design is finished. FDR upcoming.
- RGM – CDR docs are nearly finished. MCP will be ordered.
- FCT, DCCT – CDR, FDR released. Purchase via FAIR is assumed. Annoying item: TCR1 FCT is not contracted!

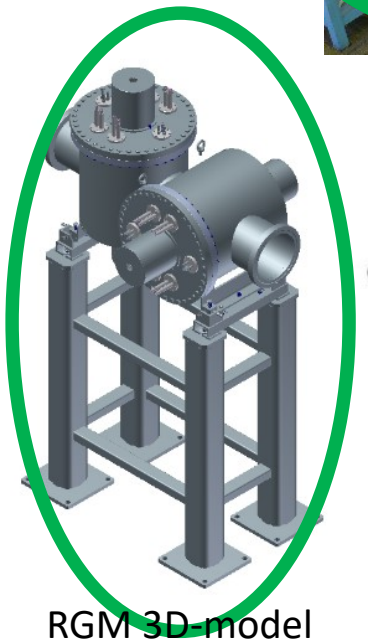
Scintillating screens: manufactured plates, received objectives & CCDs →


Wide pickup prototype

Pickup preamplifier prototype

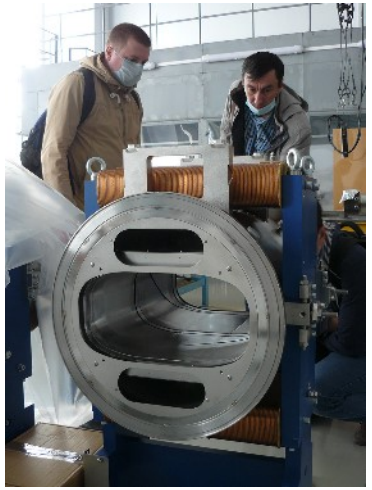
Scrapers vacuum chamber parts

Test Stand Discussions



RGM 3D-model

Scraper 3D-model



# FCT and DCCT for CR

December 2019

~120 k€

~40 k€

| | | | | |
|---|---|---|---|---|
| NPCT-CF8"-147.6-120-UHV- | 6" | DN160 NW150CF | 147.6 | 120.0 |
| NPCT-CF10"-198.4-120-UHV- | 8" | DN200 NW200CF | 198.4 | 120.0 |
| FCT-CF10"-147.6-40-UHV | 6" | DN/NW200CF | 147.6 | |
| FCT-CF12"-198.4-40-UHV | 8" | DN/NW250CF | 198.4 | |
| | | Axial length H | 40.0 | |

Now (Price List November 9th, 2020) stay the same as in April. Next year?

125 k€ and 42 k€

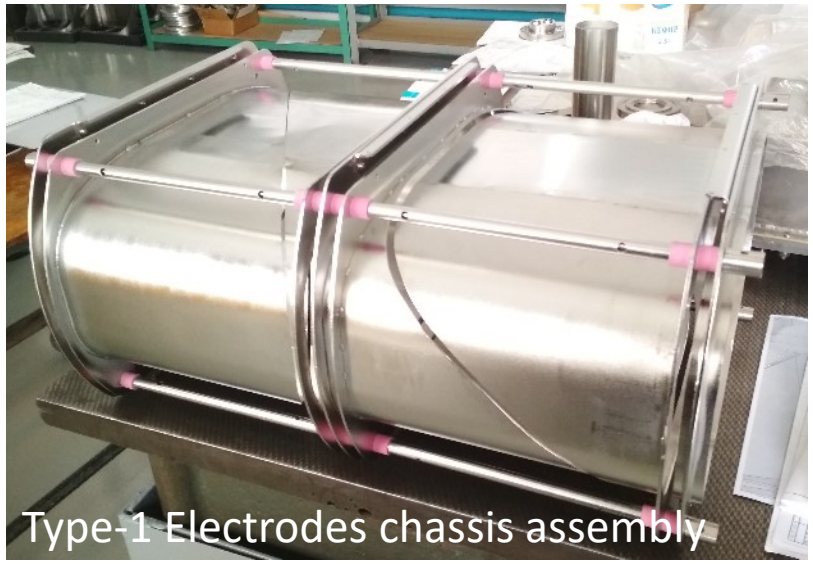
Purchase letter for FAIR preparation started.

- CDR / FDR passed.
- Commercially available devices from BERGOZ (Genève). We keep contact.
- Purchase via FAIR is assumed. Looking forward for any news or procedure.
- NB: Budker INP team must be involved in process. Not all options still available from BERGOZ. (for an additional k€ => NPCT with 2 mA range)

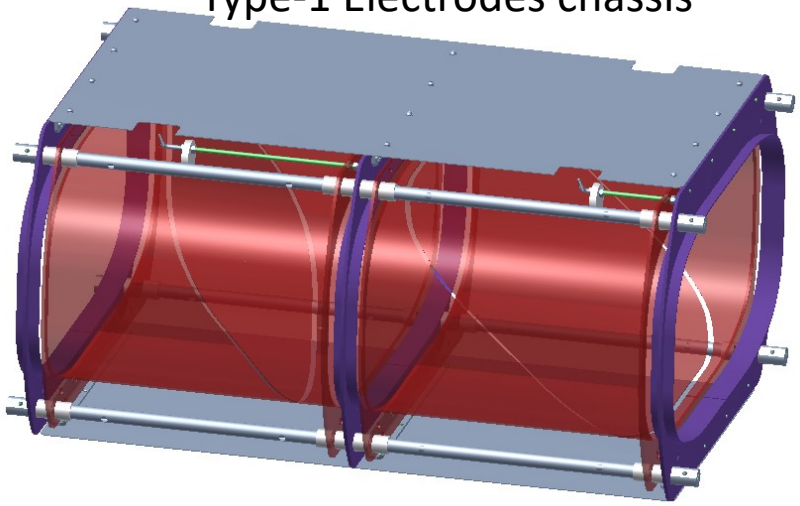
- Annoying item: TCR1 FCT is not contracted! Must by clarified this year.

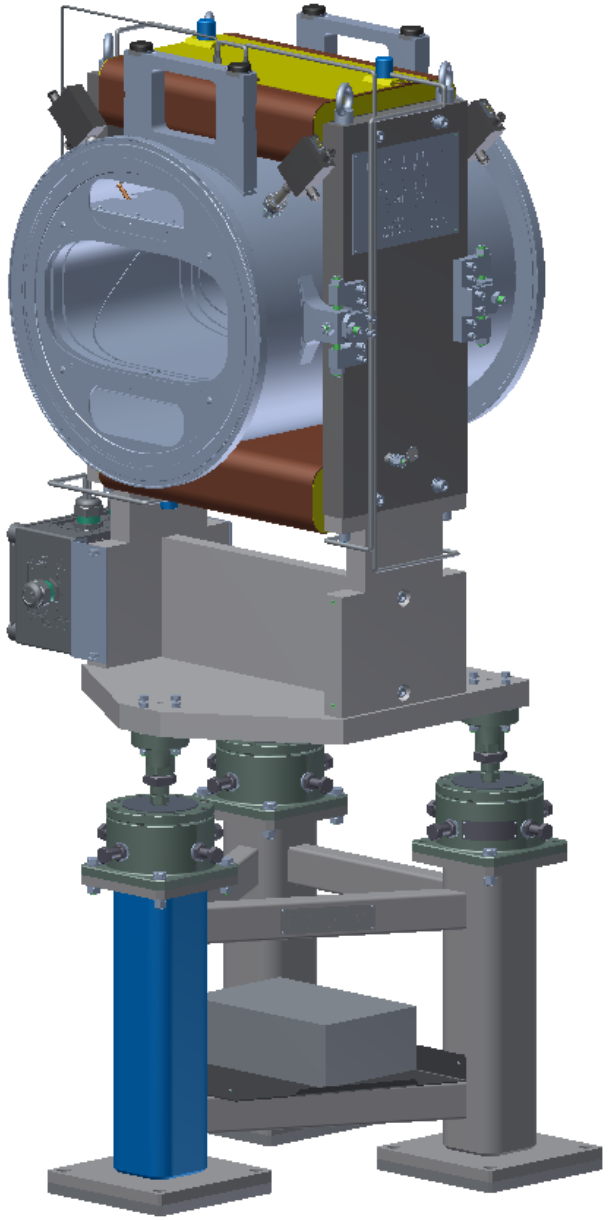
- DCCT: comes with electronics
- FCCT: amplifier required (selected one – DUPWA-1-70 by FEMTO)

# Beam Position Monitor for CR (I)


Type-1 Electrodes chassis assembly

Type-1 Electrodes chassis



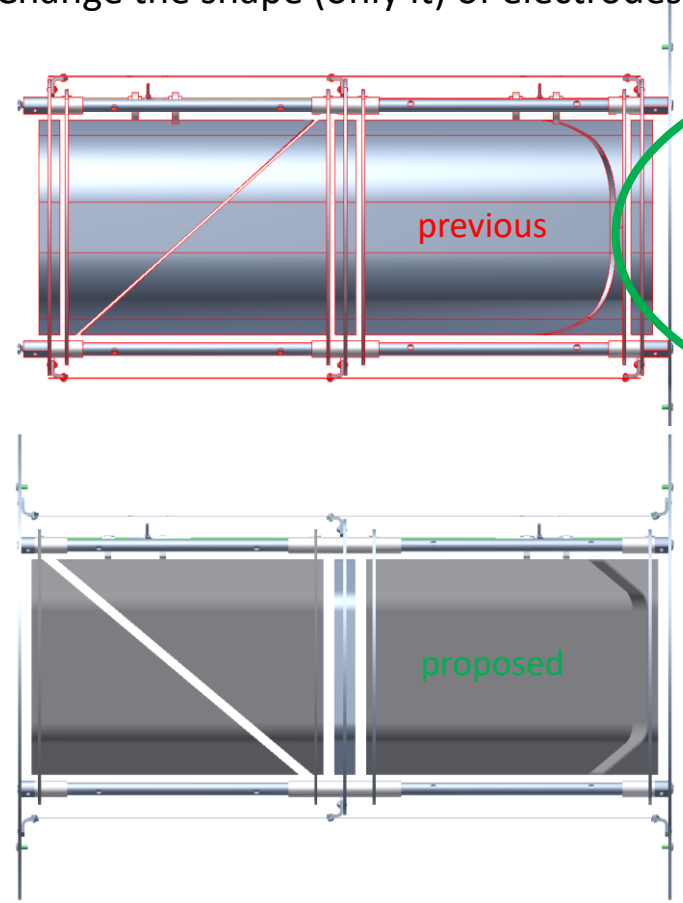


- Concept finished. Mechanical development was done. Minor changes in electrodes shape for Type-1, caused by optimization of production technology.
- All 3D Models (1,2,3) ready are ready. Procurement of most components done.
- FDR presented. FDR documents pack – 1st, 2nd internal review passed;
- Many discussions with GSI QA. FEM analysis ready for Type-1. Other in progress.
- FoS: 100% of Type-1 BPM combined with vert. dipole corrector done.
- Open questions: Libera A110 – 19pcs – not in 2nd Amendment for the "FAIR orders components for BINP“. The same for TCR1 – 5pcs.
- Minor changes in VGA control. Not finished with FZJ. Will be discussed later.

# Beam Position Monitor for CR (II)

Type-1 Electrodes was reviewed against: Mechanical stability and rigidity; Production efficiency; EM properties; Positioning and tolerances.

Change the shape (only it) of electrodes: super-elliptical => octagonal.




Simulations:

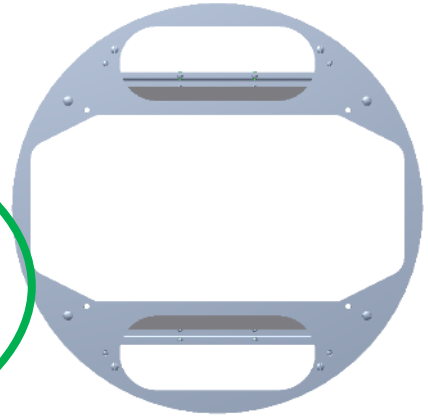
No valuable changes in freq. response @ 0 – 10 MHz;

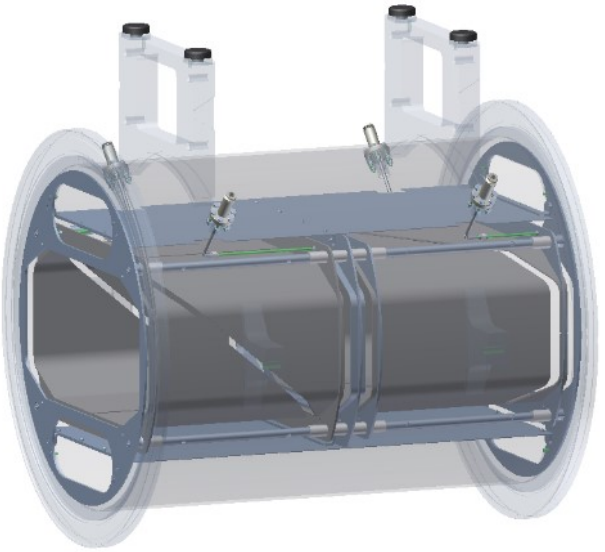
Capacity 5% lower (~150 pF);

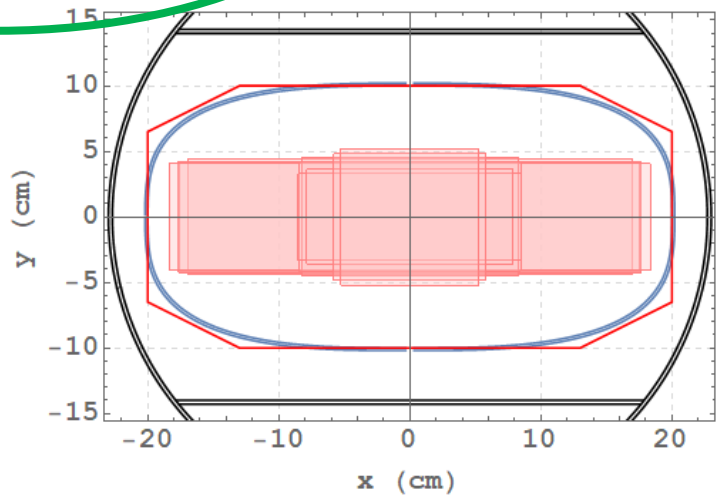
Cross-talk approx. “the same”;

All drawings for the octagonal electrodes are in production. Passed technical checks. Tooling produced. Waiting for materials.

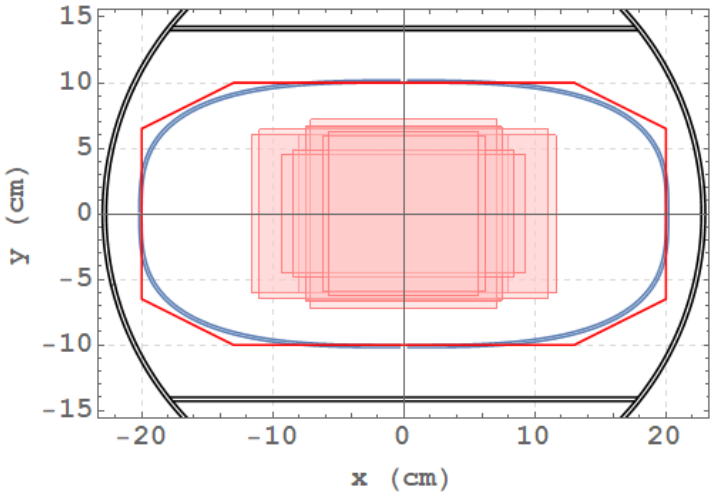
Side view







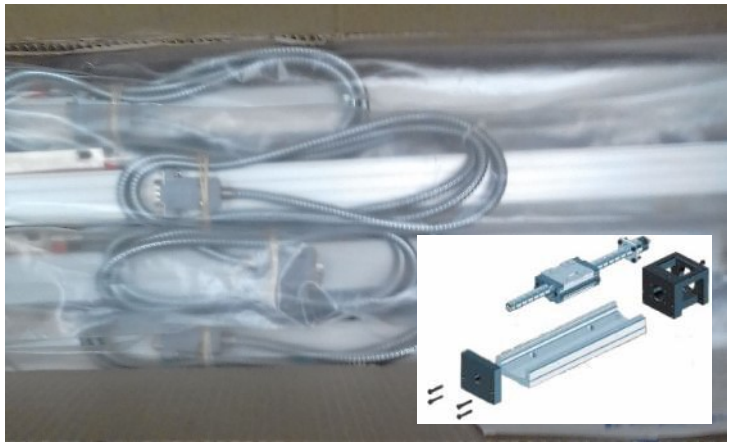

Beam shape @ BPM Type-1 for Pbar optics.
Proposed shape is shown in red color.




Beam shape @ BPM Type-1 for RIB optics.
Proposed shape is shown in red color.

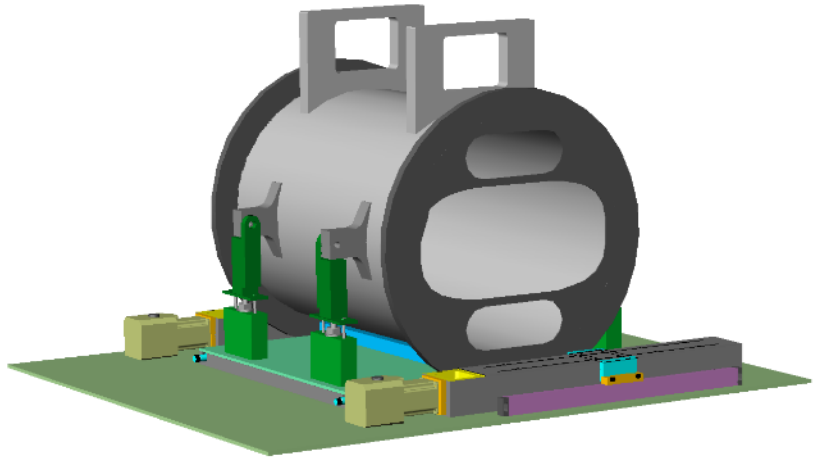
Beam shape in different BPMs shown as pink. We still fit the requirements.

# Beam Position Monitor Test Stand (I)

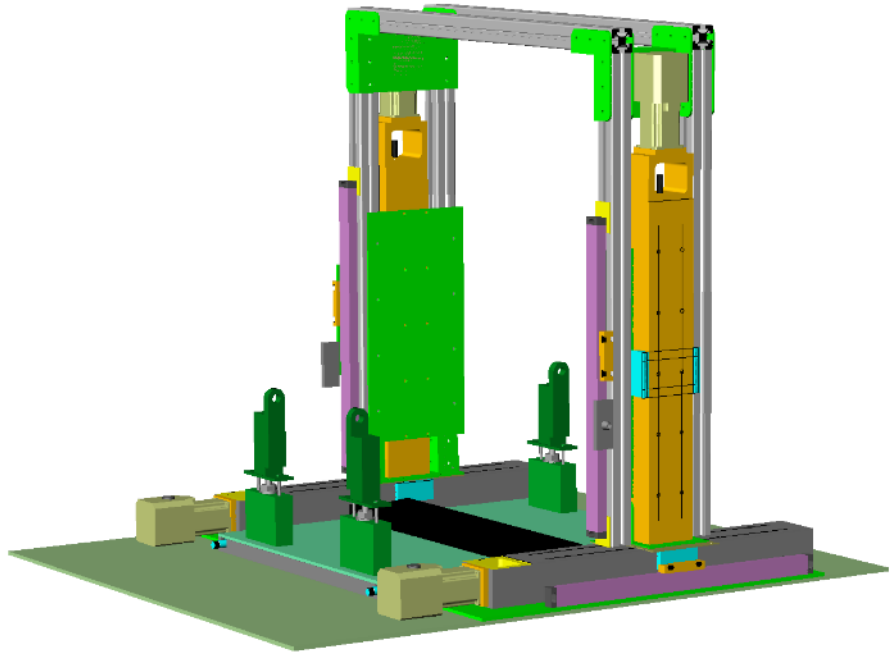



Interface to PC, RSI profile for whole stand, motors and LIR (with encoders).

DELIVERED TO BINP.



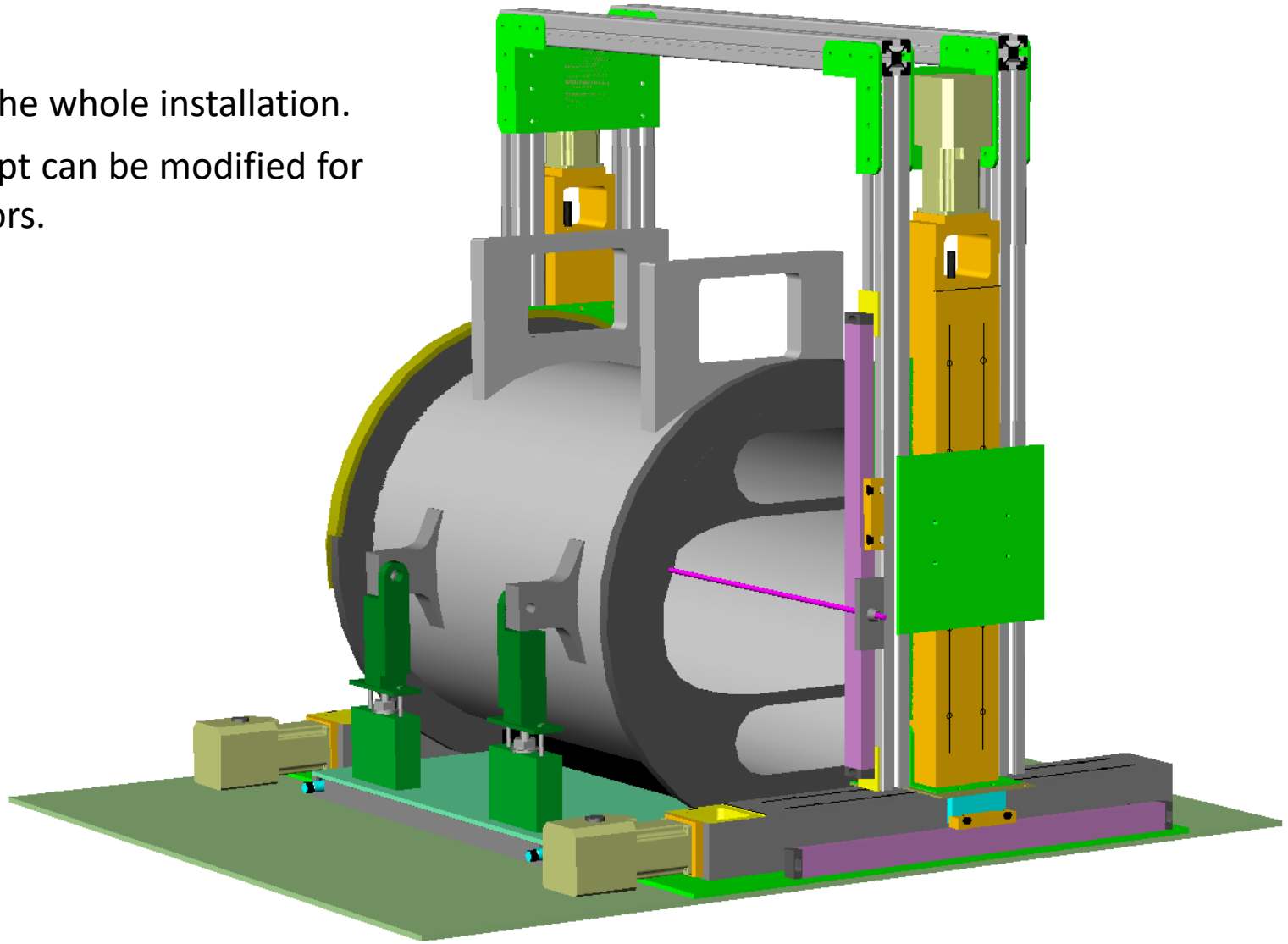
Test stand development finished.



- LNA and VGA parts prototypes from FZJ delayed due to COVID.
- Production of the test stand is ongoing. About 90% ready.
- Test stand commissioning is expected in Q1 2021.

# Beam Position Monitor Test Stand (IV)

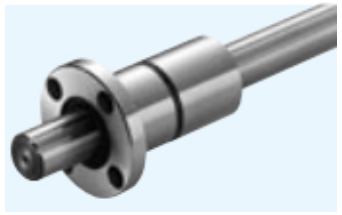
- The 3D view of the whole installation.
- The stand concept can be modified for Type-2,3 detectors.



# Beam Scraper for CR (I)

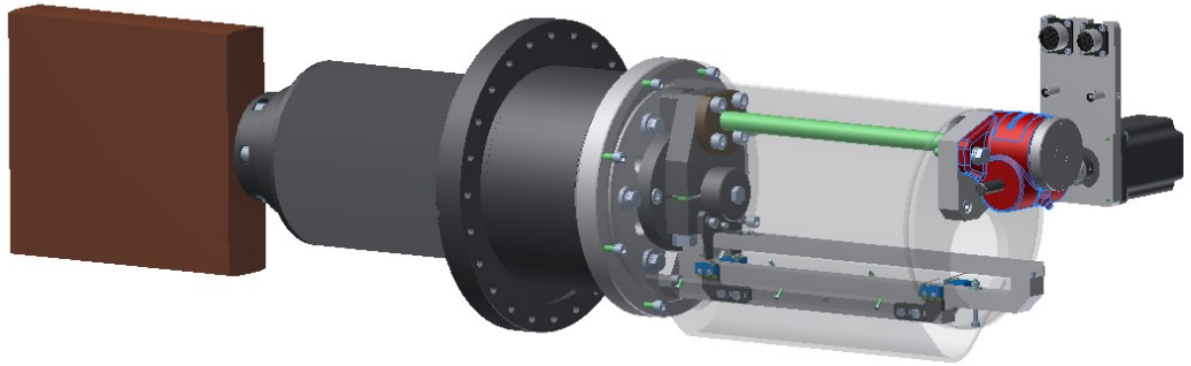
Received

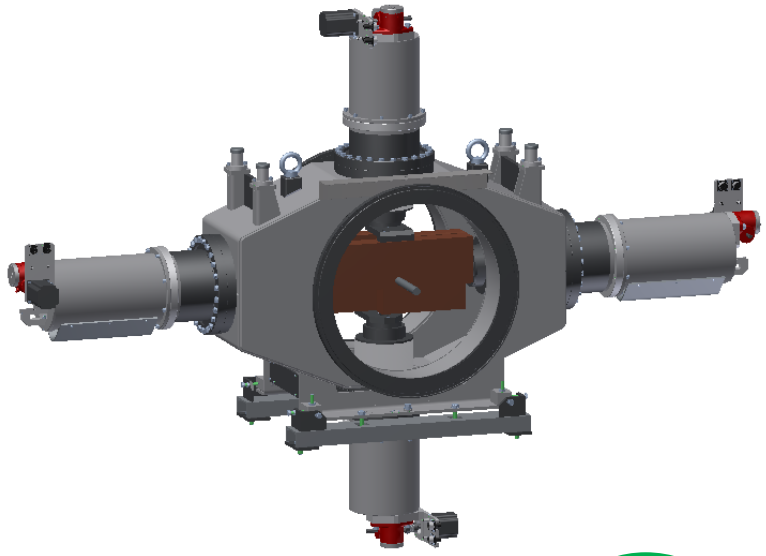
Oriental 5-phase motor. Micro Switch.



Received

Produced at BINP Workshop



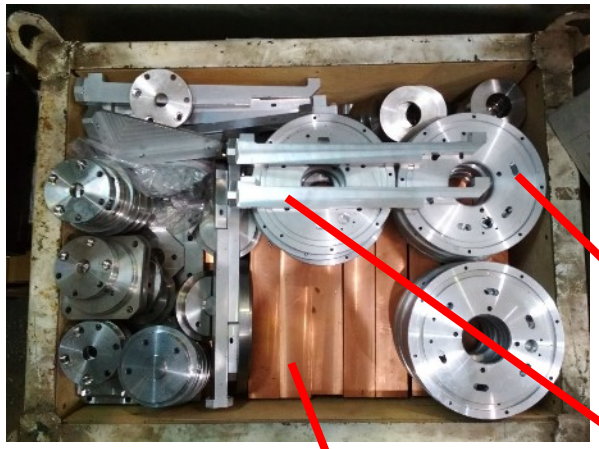


- Concept finished. Mechanical development was done.
- Model / Drawings ready. Procurement of most components done. Production.
- FDR presented. FDR documents pack – 1st, 2nd, 3rd internal review passed;
- Many discussions with GSI QA was in Spring (comments was taken into account).
- FEM analysis done (Fiducials shift less than 50 um), no valuable deformations.
- FDR for final check will be uploaded soon (after BINP QA check).
- Open questions: MBOX PDC – 5pcs – not in 2nd Amendment for the "FAIR orders components for BINP“.

| Item | # | Status |
|---|---|---|
| Standard Metric Inverted Rotating Screw Actuators: DE2626-0310, DE2626-0210, | 22 | Waiting for Delivery |
| Ball Splines SSPF Type: SSPF40A-1-430, SSPF40A-1-405 , SPF40A-1-320 | 22 | Delivered |
| Coupling): BKL/003/10/ | 22 | Delivered |
| Stepper Motor: PKP569FN24A2 | 22 | Delivered |
| Switch: S880W2G6k | 150 | Delivered |
| Linear Motion Conductive Plastic Potentiometers CFL300, CFL200 | 22 | On the way to BINP |
| Bellows Units DN102,5/150-35, DN102,5/150-50, DN102,5/150-55 | 22 | Waiting for Delivery |
| Connector Souriau Type UTG01412P 9.<br>Pin Souriau Type RM16M23K<br>Connector Souriau Type UTG0128P<br>Pin Souriau Type RM24M9K<br>Lemo Connector - Lemo PCA 0S 302 CLLC 42 | 22<br>264<br>22<br>176<br>44 | Delivered |

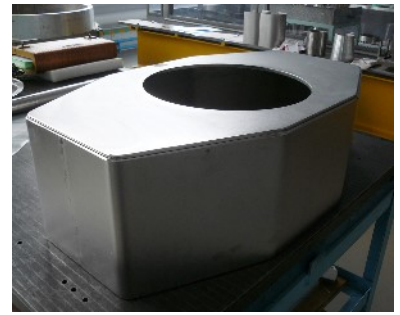
# Beam Scraper for CR (II)

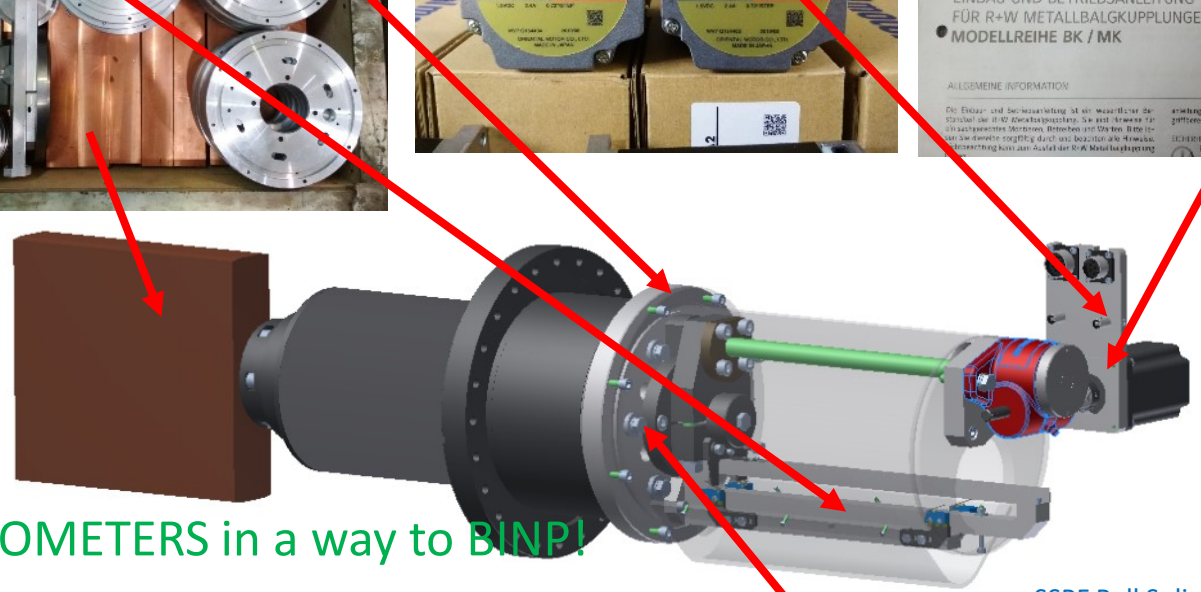
Produced at BINP

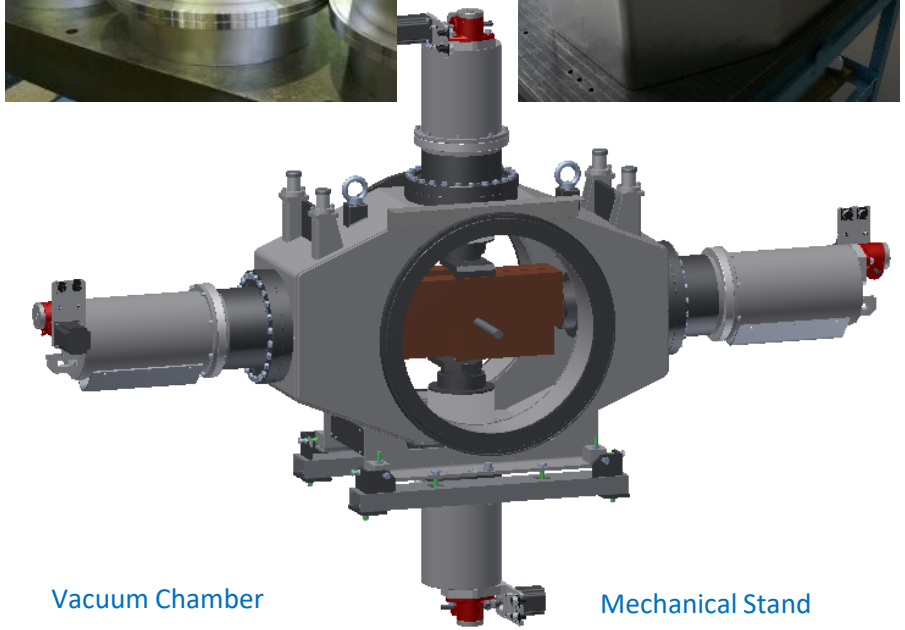


Stepper Motor


Mechanical Coupler





POTENCIOMETERS in a way to BINP!

From **Carles Sadurni (**MEGATRON Elektronik Manager):

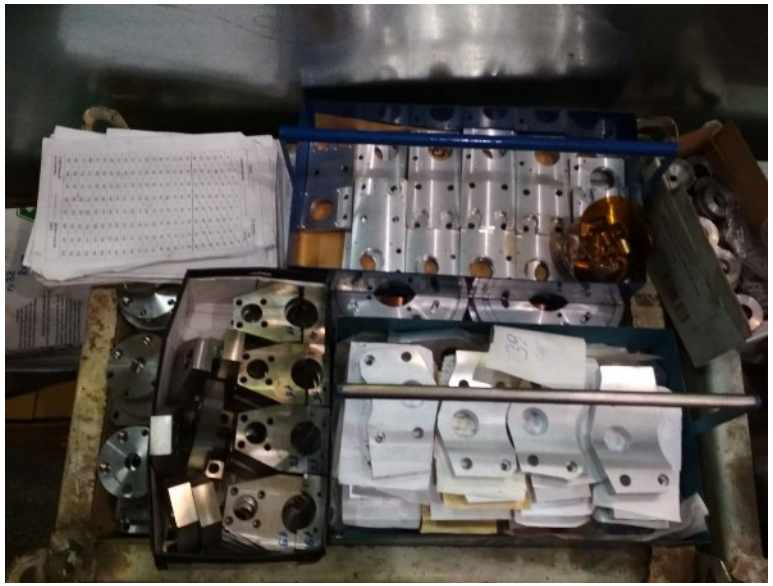
"Our distributor in Russia (Elcompribor) did buy from us 8 pieces of the CFL 200 and 14 pieces of the CFL 300, which were sent on October the 7th to them. I assume they have already been delivered to the BINP in Russia, so unless this is a different subject, I don't understand where the problem lays: We have already quoted und delivered the items."

SSPF Ball Spline

Vacuum Chamber

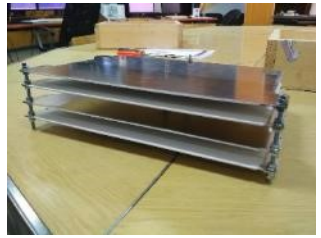

Mechanical Stand

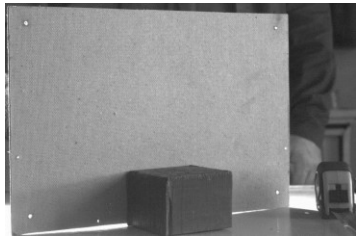
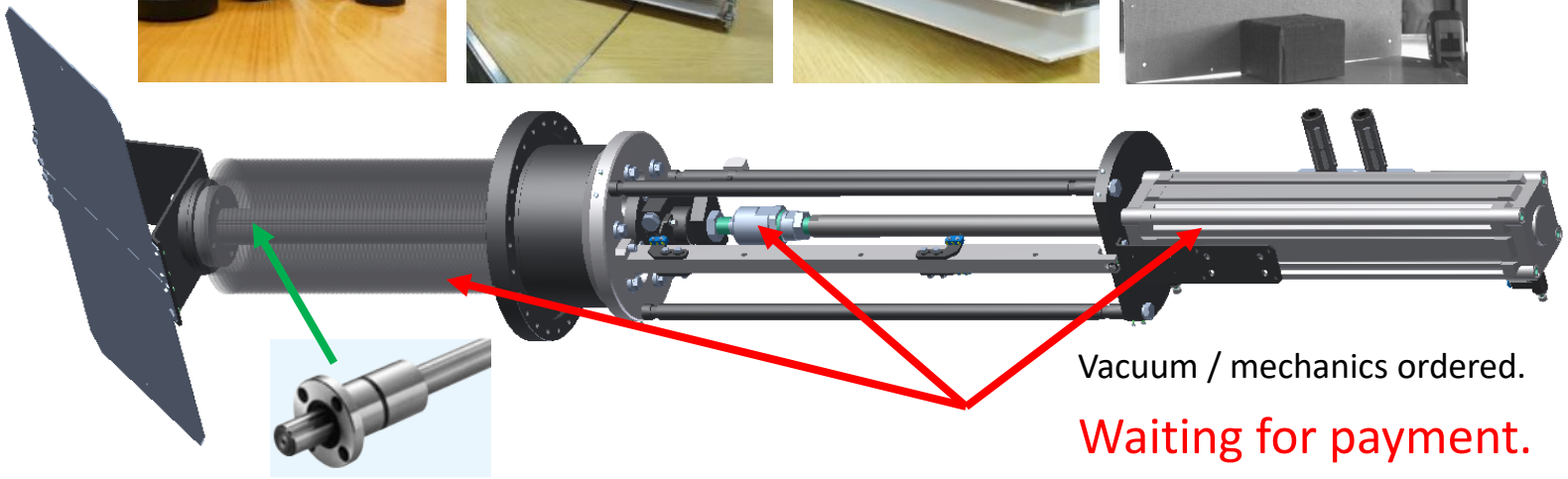
# Beam Scraper for CR (III)



All these stuff produced at 2020

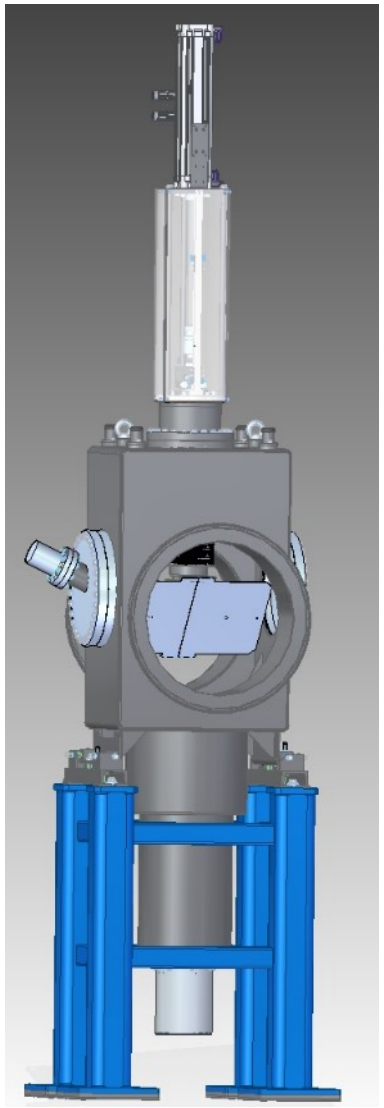
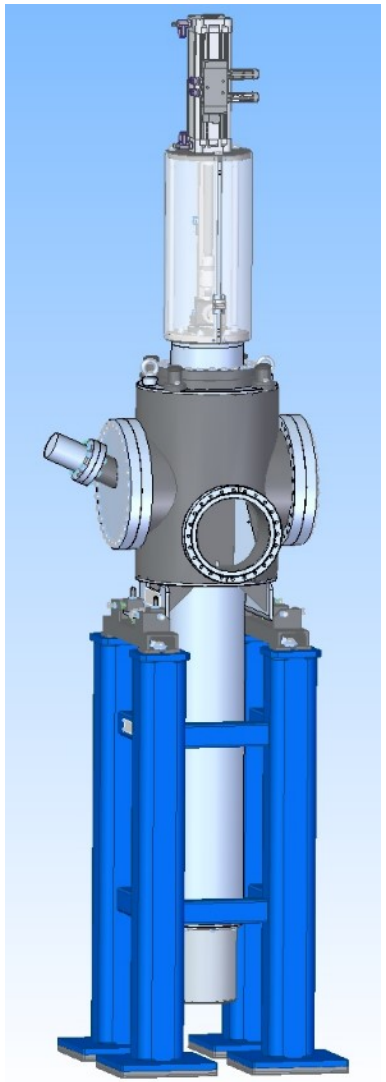
# Scintillating Screen for CR (I)



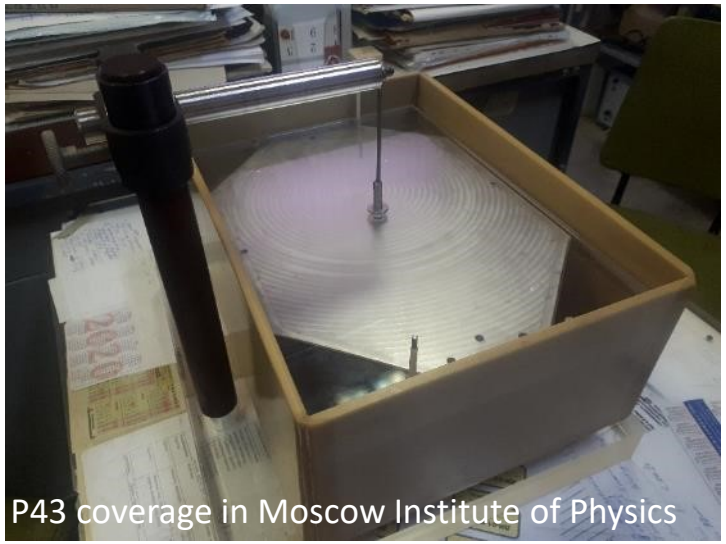
Vacuum / mechanics ordered.

Waiting for payment.

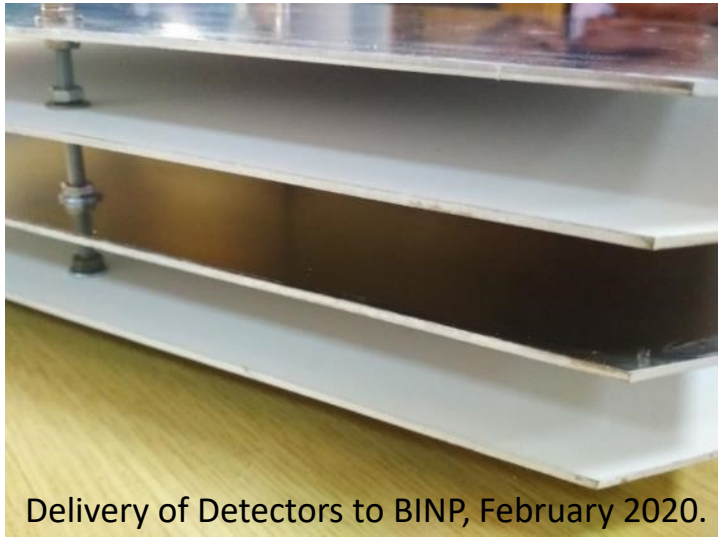
- Concept finished. Mechanical development was done.
- Model / Drawings ready. Procurement of few components done.
- CDR presented. FDR documents pack – 1st, 2nd 3rd, internal review passed;
- Many discussions with GSI QA was in Spring (comments was taken into account).
- FEM analysis in final stage (~ no problems). Production of parts was started.
- FDR for final check will be uploaded soon (after BINP QA check).
- Components: IDS UI-5240SE camera and Computar MG1616FC objective lens is “standard” solution for FAIR. FESTO pneumatic cylinder is well-known.

# Scintillating Plates for CR (II)

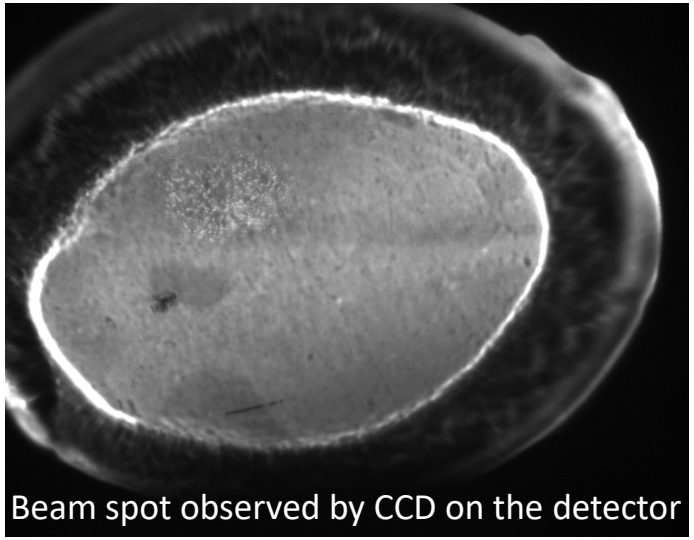


P43 coverage in Moscow Institute of Physics named after A.M. Prokhorov, December 2019.

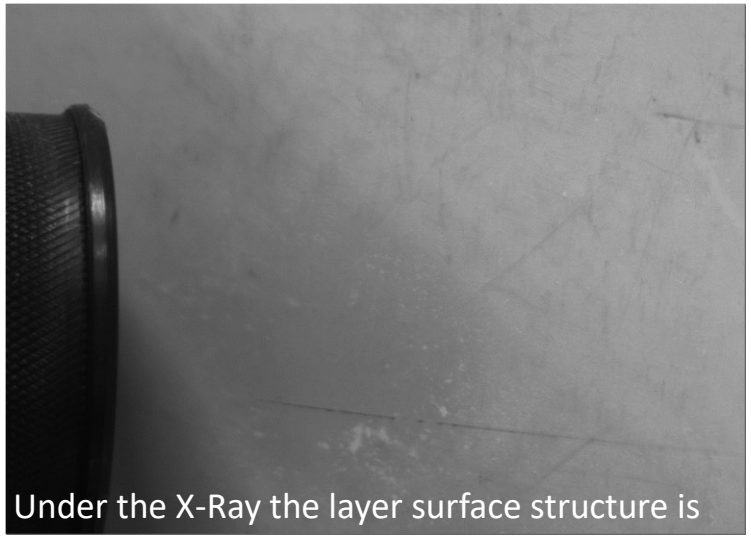
- Quality tests of the P43 coverage was performed in August at BINP.
- Phosphor coverage thickness is about 100 um (1.2-1.4 g / $cm^2$).
- Test was done with defocused electron beam: 0.5 mA, E = 60 keV as well as X-Ray beam E= 40 keV (see figures below).
- The photon flux looks enough for the operations even at low intentions @ CR.
- Next pack of Detectors Type-2 delivery (from Moscow) still delayed due to COVID restrictions.
- We are looking for possibilities of detector / screen production in a local area (in institutions around the BINP).



Delivery of Detectors to BINP, February 2020. First pack for Type-1. Delayed due to COVID.



Beam spot observed by CCD on the detector surface. Typical transverse size ~10 cm.

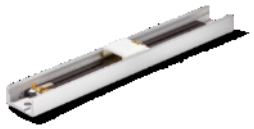


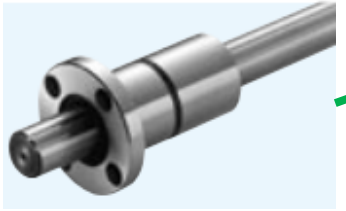
Under the X-Ray the layer surface structure is viewed also. This method reveals some points.

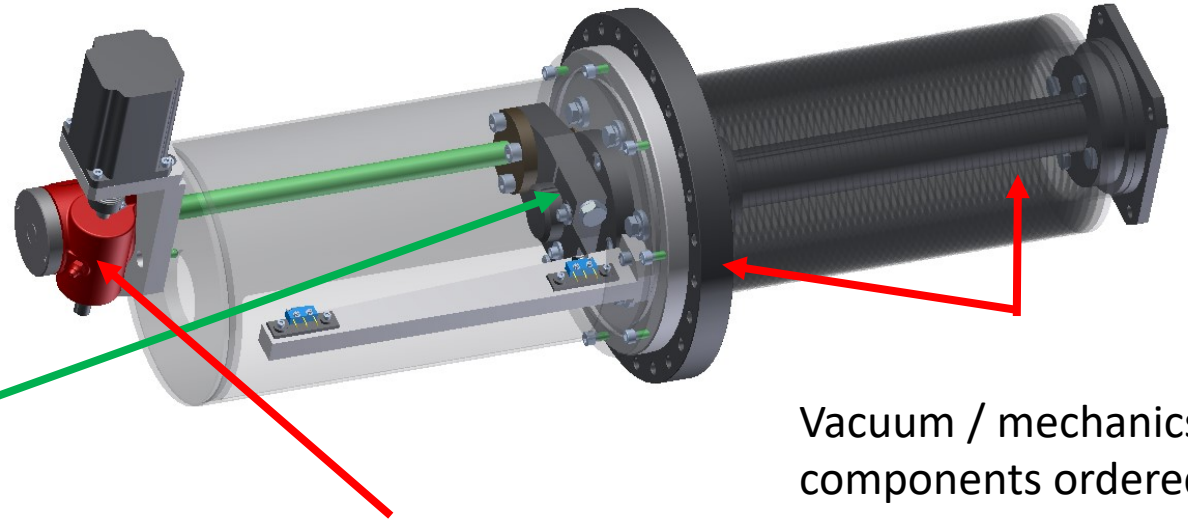
# Beam Stopper for CR (I)

Received

Oriental 5-phase motor.
Micro Switch. Ball Spline.
Potentiometer.





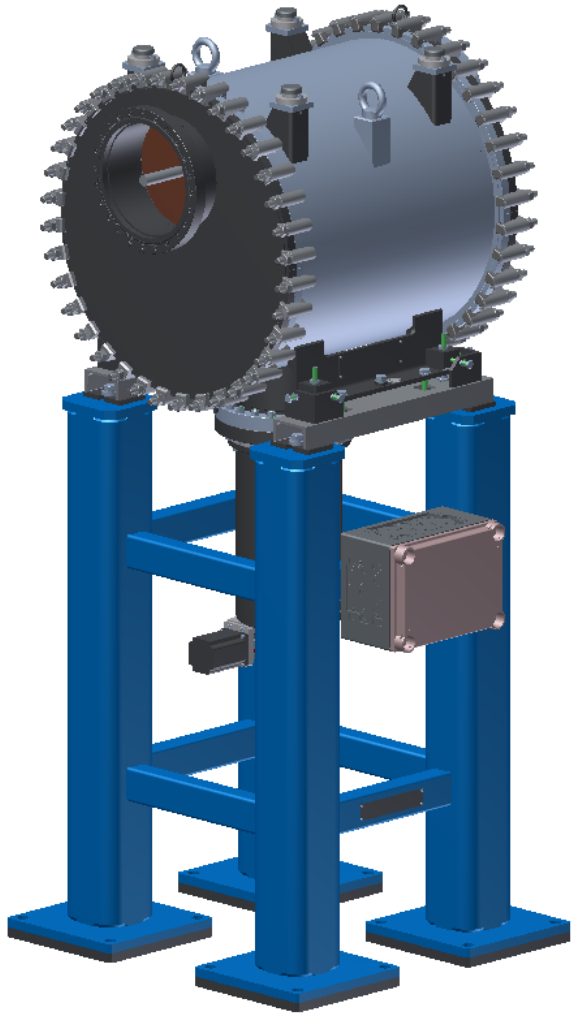


Vacuum / mechanics components ordered.

Expected in Q1 2021

Delivery delayed due to COVID

Waiting for Reduction Gear



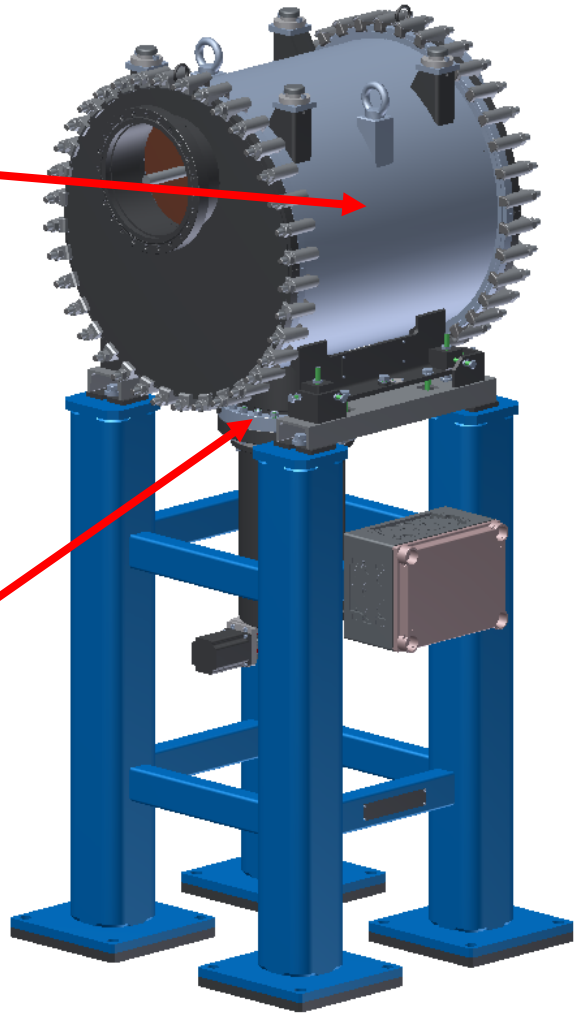
- Concept finished. Mechanical development was done. Minor changes last time.
- Features: Sensitive to bunch charge (80 mV for $10^7$ pBar @ 20 pF).
- Model / Drawings ready. Procurement of most components done (see pictures).
- FDR documents pack – 1st and 2nd internal review passed.
- FEM: Stress analysis on final stage.
- Production started (see pictures).
- Open questions: MBOX PDC – 2pcs – not in 2nd Amendment for the "FAIR orders components for BINP“.

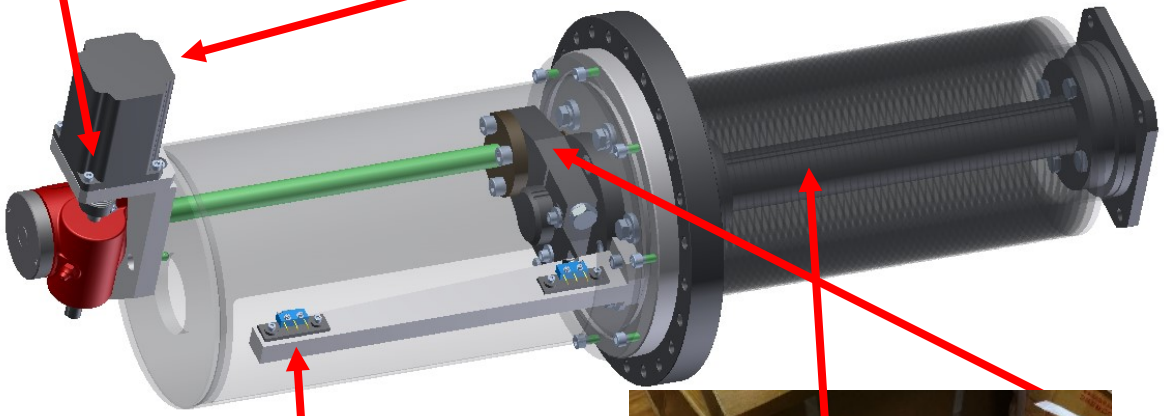
# Beam Stopper for CR (II)

Mechanical Coupler


Stepper Motor

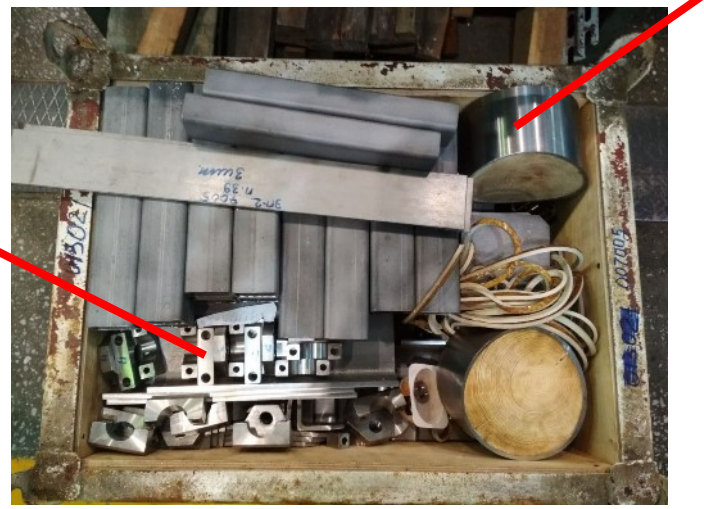

Future Vacuum Chamber





End Switches and Connectors

SSPF Ball Spline



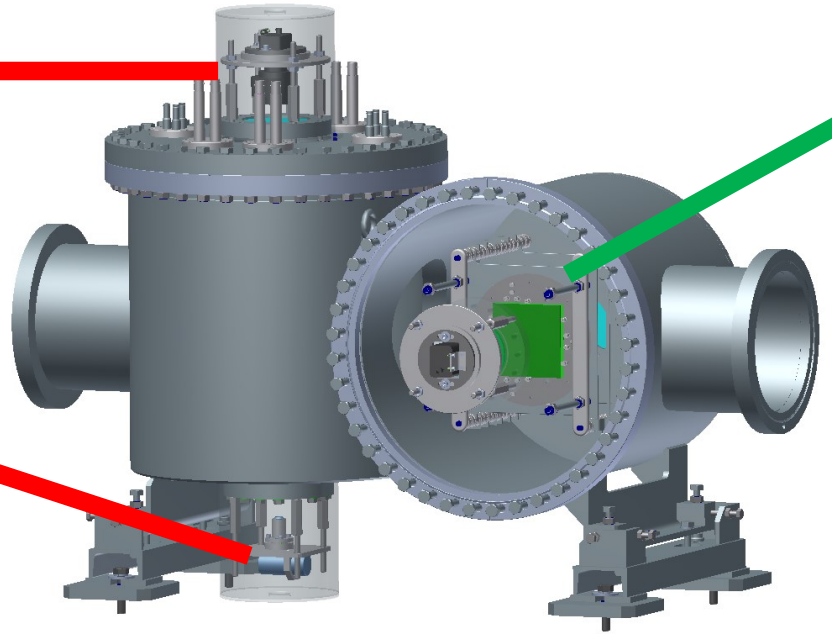
Mechanical Parts

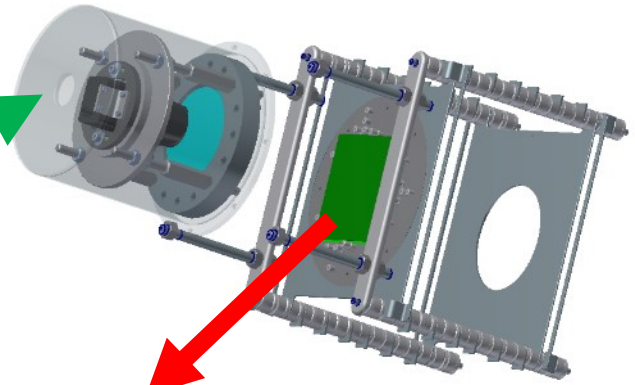
# Residual Gas Monitor for CR (I)

Camera

Calibration


Prosilica GE680 CCD camera






MCP detector
100 x 100 mm

HAMAMATSU
PHOTON IS OUR BUSINESS

L7293 deuterium lamp (L2D2 lamp)

HAMAMATSU
PHOTON IS OUR BUSINESS


C9598 power supply deuterium UV lamp

For Electric Field Box + Detector 8-channel High Voltage power supply is needed.

Matsusada Precision

RA/RB series power supply modules up to 40 kV DC.

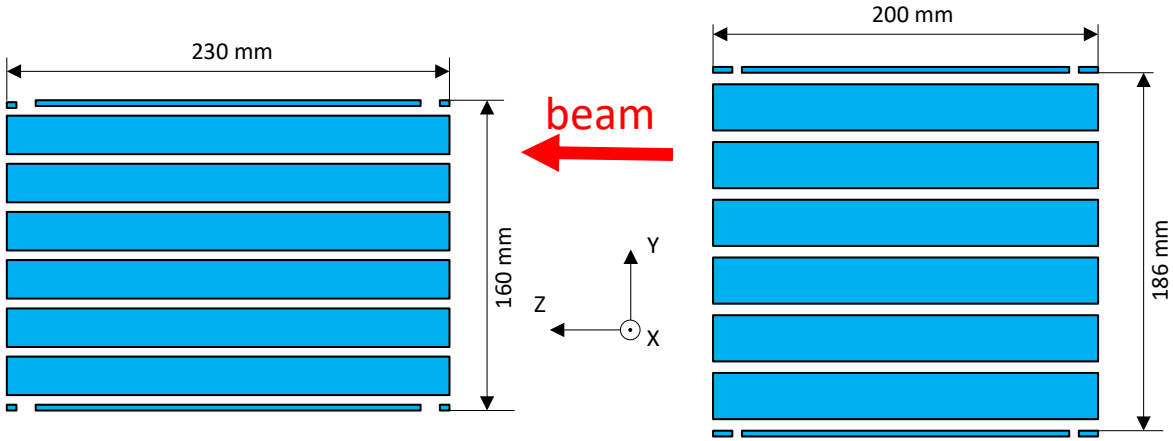
- Concept finished. Mechanical development was intensive for the last year (except MCP / Phosphor screen detector surroundings).
- CDR documents pack – 1st and 2nd internal review passed.
- Model / Drawings 90% ready. Procurement of components – AFAP.
- Restrictions: Aperture 160 mm (chamber diameter), Bunch size 140 mm as in Specification, Detector size (MCP + Scintillator) 100-110 mm (biggest available on the shell). Negotiations was slow due to COVID situation.

# Residual Gas Monitor for CR (II)

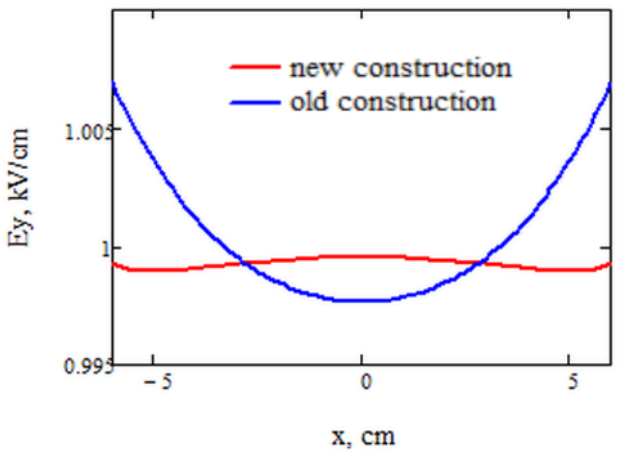
Revision of construction was performed.

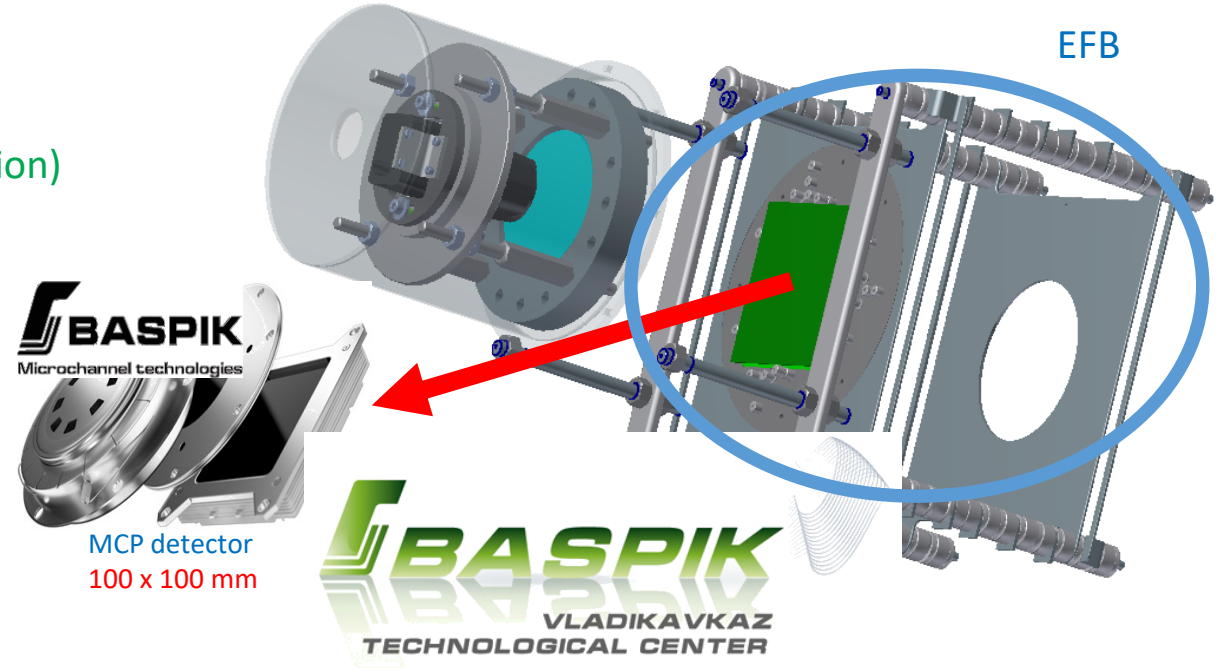
Optimization of the EFB was made (sizes and geometry).

Obtained filed homogeneity ≈$10^{-3}$ instead of ≈$10^{-2}$ (better spatial resolution)




Old Side view of the EFB New



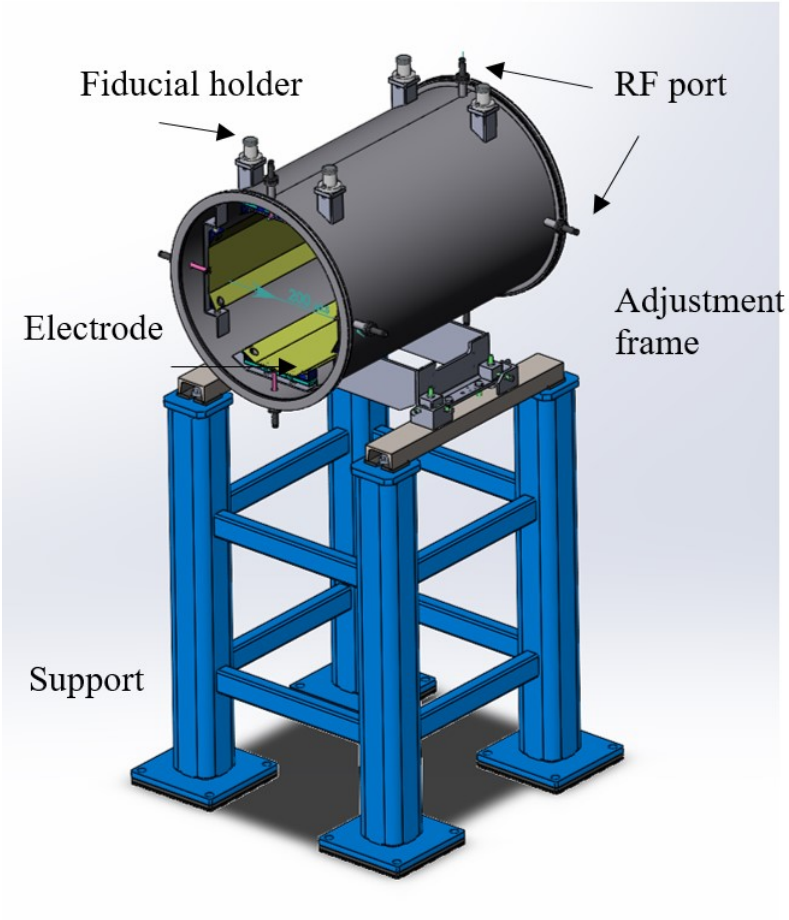




- Negotiations was continued in September 2020. Drawings was sent do BASPIK.
- MCP size is 100x100 mm (max size provided by firm, one of the biggest in market).
- Detector consists of stack of two MCPs and phosphor screen of K-67 (analog of P-43)
- BASPIK already ordered P43 layer for tests (will be delivered to Vladikavkaz till December)
- Invoice will be sent to BINP next week (6 k€ / detector). Contract preparation will be started.
- Estimated time of the detector production is Q1 of 2021 (if we order it tomorrow).
- Mechanical design of the Detector surroundings will be continued.

Vladikavkaz Technological Center "BASPIK" is the scientific, technological, industrial and innovative center, specializing in microchannel and fiber-optic technologies.

# CR beam instrumentation in tunnel designed GSI / ITEP

CDR of Schottky noise detector (ITEP, Russia In-Kind)




Dedicated talk by Dmitry Lyakin will be during Session 2 @ 10:55, 10.11.2020

The FAIR CCC prototype (GSI In-Kind) tests will be done at CRYRING facility. Next steps depends on those results.

Private Communication: O. Dolinskii, October 2020. Thanks.

# Summary

- Sub-packages for CR Beam Instrumentation one by one goes forward from design phase to the manufacturing phase.
- The documentation / models / drawings matching that are needed for milestones passage takes significantly more time than we expected.
- Various managing efforts still needed (not all done yet).
- Nearest FoS CR BD delivery (Type-1 Scraper, Type-1 Screen) shifted and expected @ FAIR site in Q4 2021.
- FoS Type-1 BPM also shifted to the Q1 2022. Proposed octagonal electrodes must be produced and well tested @ Stand.
- FDR for Scrapper and Screen waits for BINP QA check.
- Thanks to all BINP BD team and BINP employers involved for a good job!

Thank you for your attention!