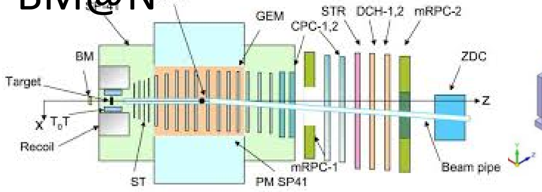
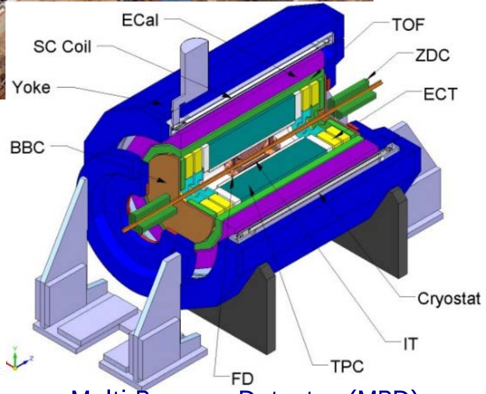
WP2: Collaboration with NICA –
Development of instrumentation for NICA and FAIR/CBM

The main objective of this work package is to develop the instrumentation for NICA and FAIR/CBM:

- To perform the prototyping, construction and installation of detectors;
- To develop the data acquisition chain, computing procedures, software packages for simulation and data analysis.

Compressed Baryonic Matter experiment (CBM)





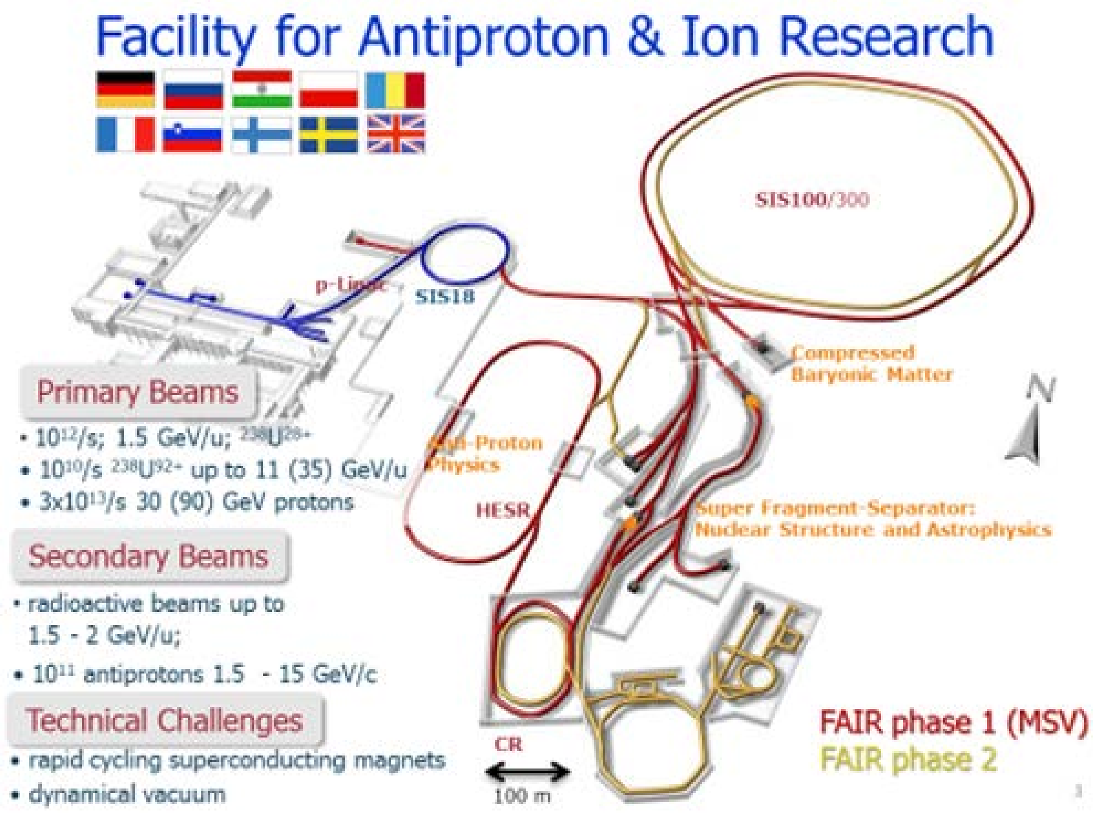
Multi Purpose Detector (MPD)

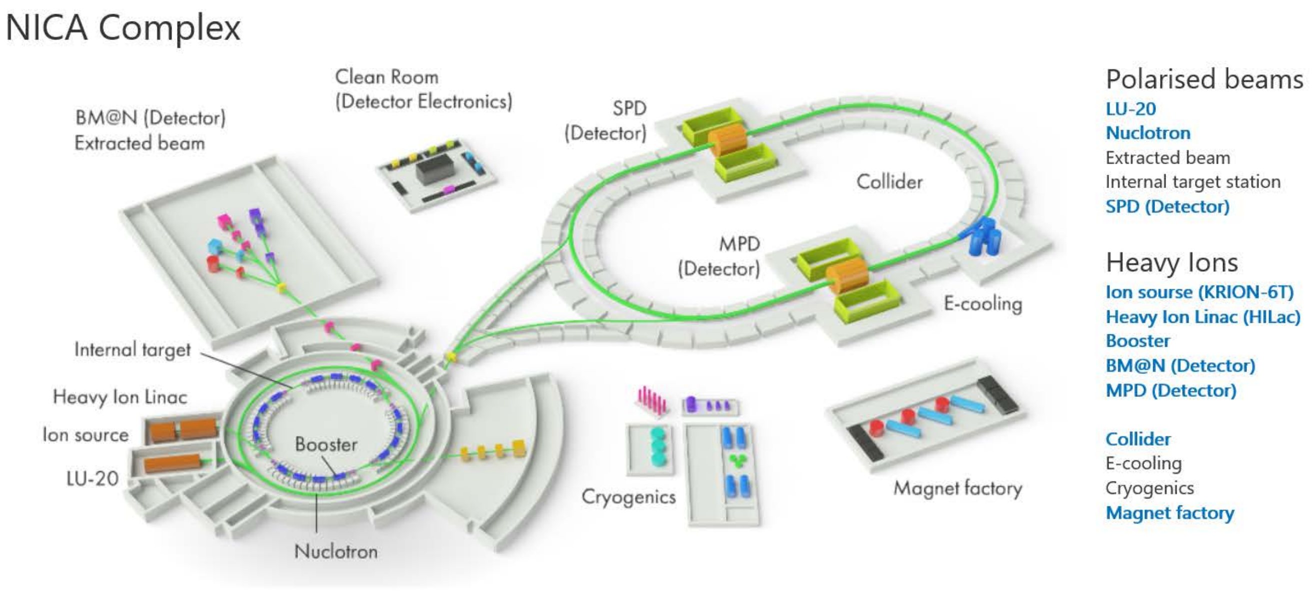
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

WP2: Collaboration with NICA – Development of instrumentation for NICA and FAIR/CBM

Scope of WP2, Status FAIR construction
Status of WP2 tasks 1-5
by Juergen Eschke, FAIR GmbH (WP leader)

Status NICA construction
and Covid-19 impact
by Yuri Murin, JINR (Co-WP leader)





Specific scope elements of the project NICA/MPD facility are expected to include:

- Injection complex,
- new superconducting Booster synchrotron (that will be located inside the yoke of the decommissioned Synchrophasotron),
- the existing superconducting heavy ion synchrotron Nuclotron (being developed presently to match the project specifications),
- collider having two new superconducting storage rings,
- new beam transfer channels.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

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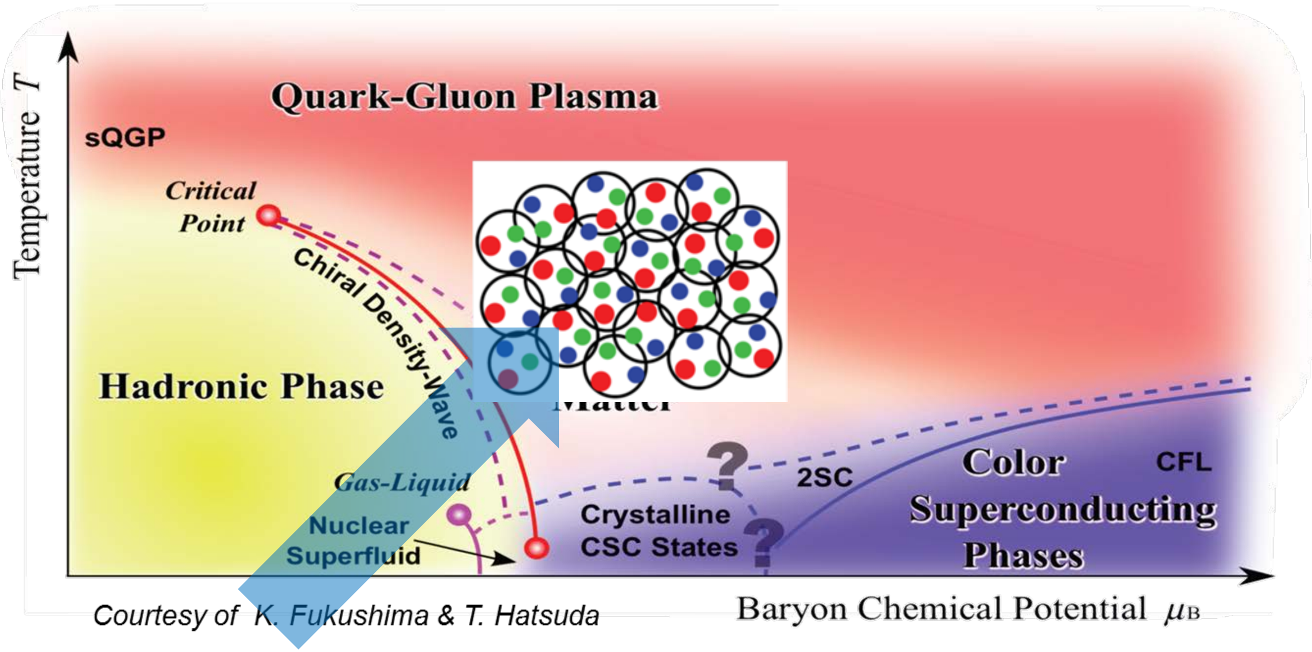
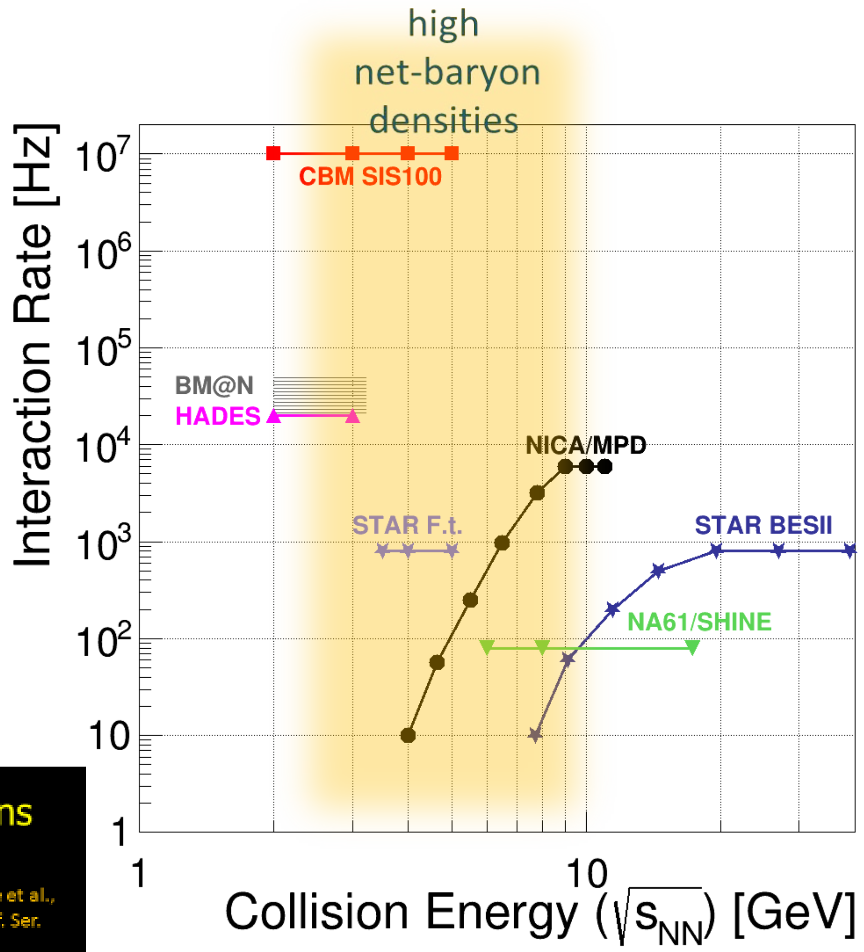
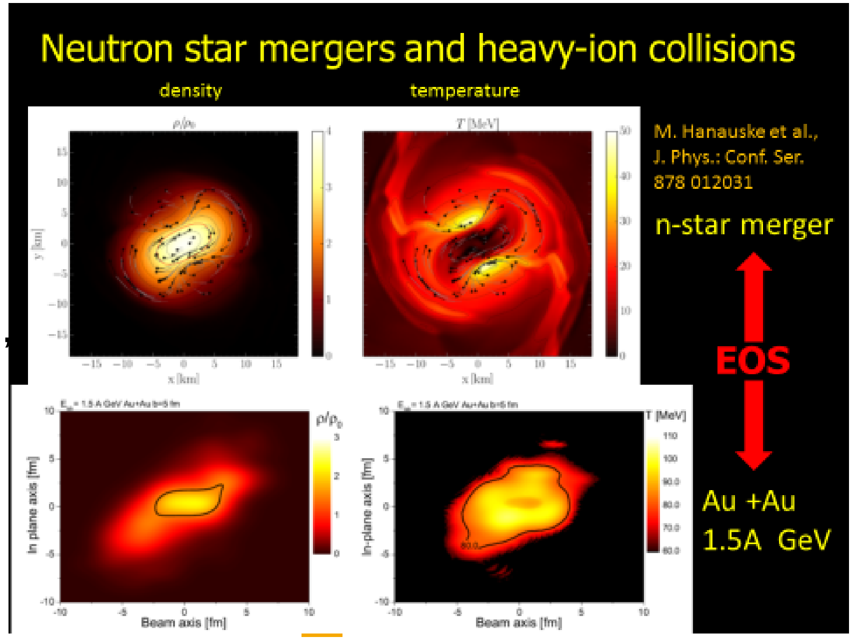
Exploring the QCD phase diagram





<u>At high baryon density:</u>

- N of baryons >> N of antibaryons
  Densities like in neutron star mergers
- L-QCD not (yet) applicable
- Models predict first order phase transition with mixed or exotic phases
- Experiments: STAR@RHIC, NA61@CERN, CBM@FAIR, BM@N and MPD@NICA , J-PARC



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

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Status FAIR project
– civil construction progress as planned

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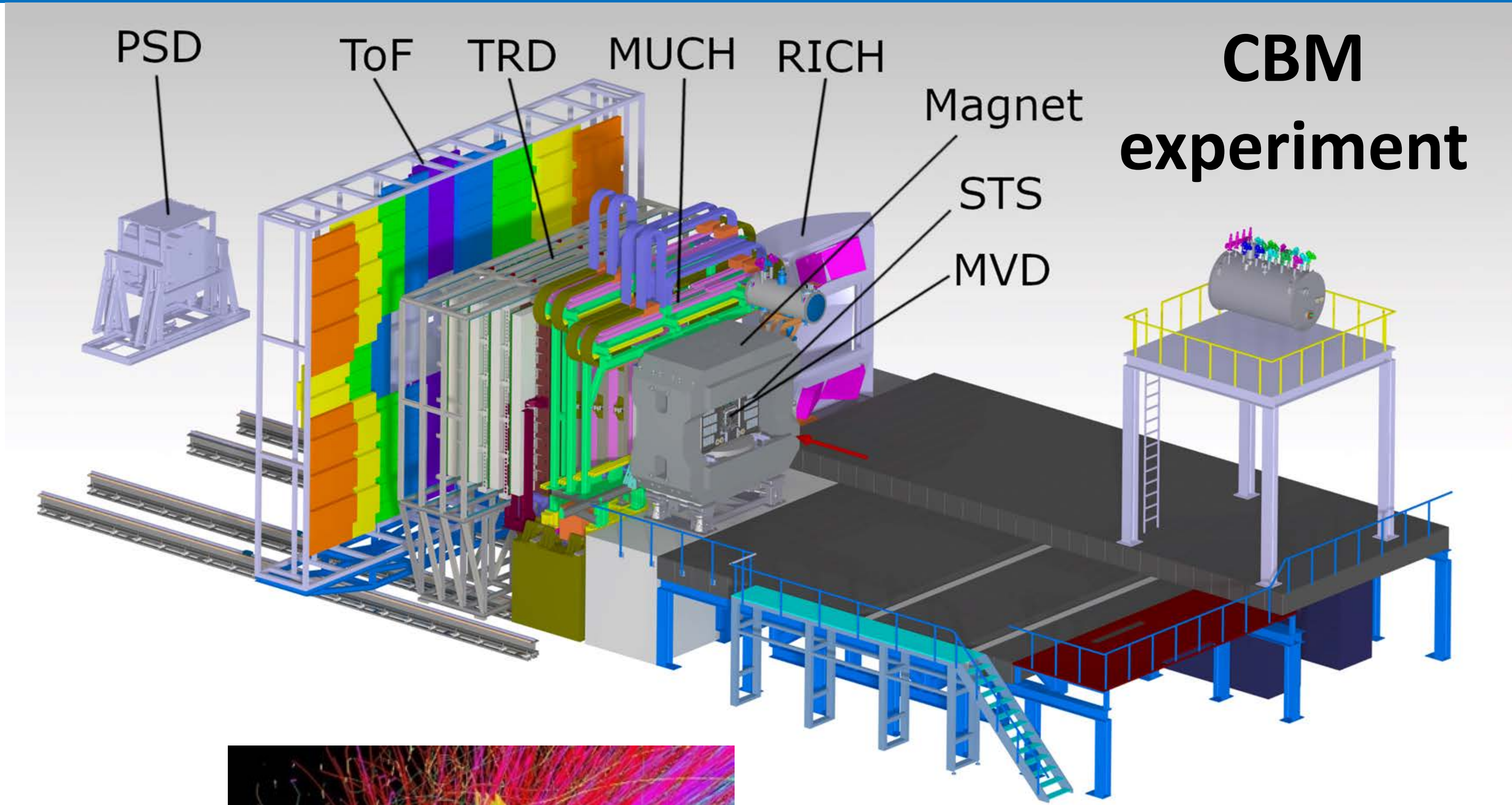
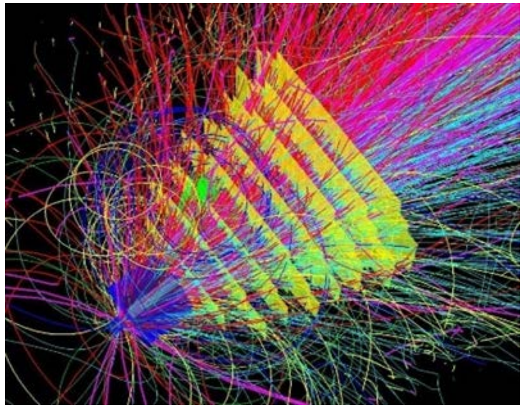
Status FAIR construction

Accelerator components are presently produced at many companies or at In-Kind providers in the FAIR shareholder countries

- SIS100: all 110 dipole magnets and all RF cavities manufactured, series production of quadrupole modules by JINR ongoing.
  2 injection septa delivered.

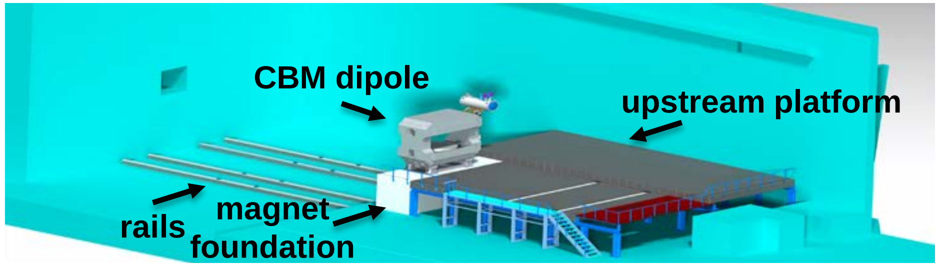




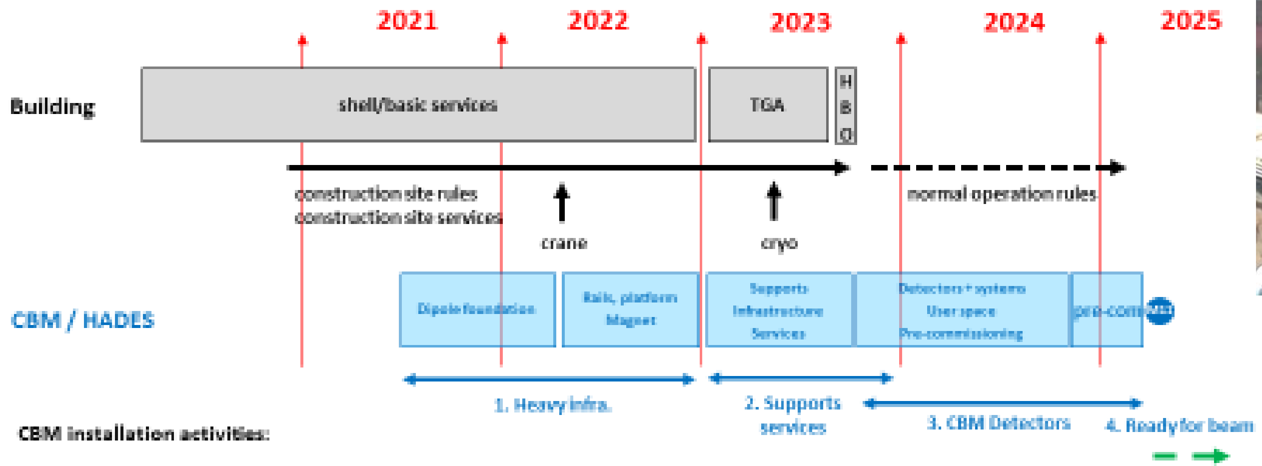
Series production of the CBM detector components has started

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

Timeline FAIR construction – CBM experiment



CBM installation – towards baseline 2021

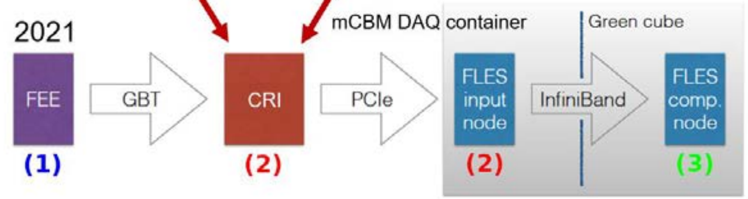


Year	CBM installation activities:
2022	1. Heavy constructions
2023	2. General services and detector supports
2024	3. CBM Detector installation, pre-commissioning
2025	4. Global commissioning w/o beam

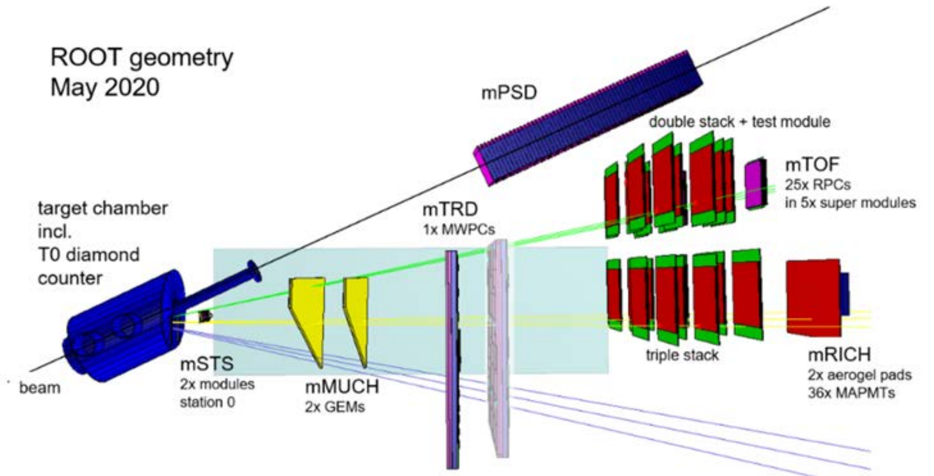
17

commissioning of CBM in 2025 / 2026

mCBM FAIR Phase-0 beam tests at GSI SIS18 under covid-19 conditions



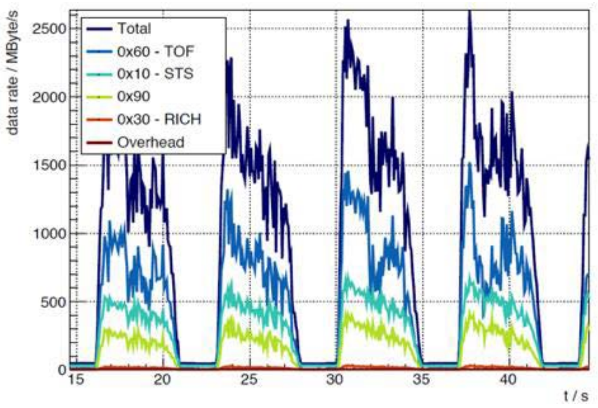
Common Readout Interface (CRI) cards in an Entry Node



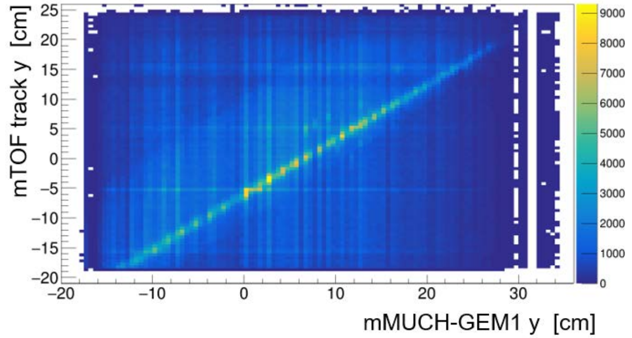
Successful data taking in several „mini" CBM test beam times in 2020 and plans for 2021/2022

- CBM slice experiment
- Realistic experimental conditions, up to 10 MHz collision rate
- Common, synchronized data transport incl. all subsystems
- Migration to the final configuration of the CBM data transport chain
- High-rate tests of detector subsystems

time correlations



Spatial correlations



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

CREMLINplus WP2 kick-off meeting https://indico.gsi.de/event/10807/

Wednesday Jul 1, 2020, 1:30 PM ⟶ 5:30 PM Europe/Berlin

ZOOM (and KBW 5.29)

Jürgen Eschke (GSI Helmholtzzentrum für Schwerionenforschung GmbH(GSI))

Description Video conference:

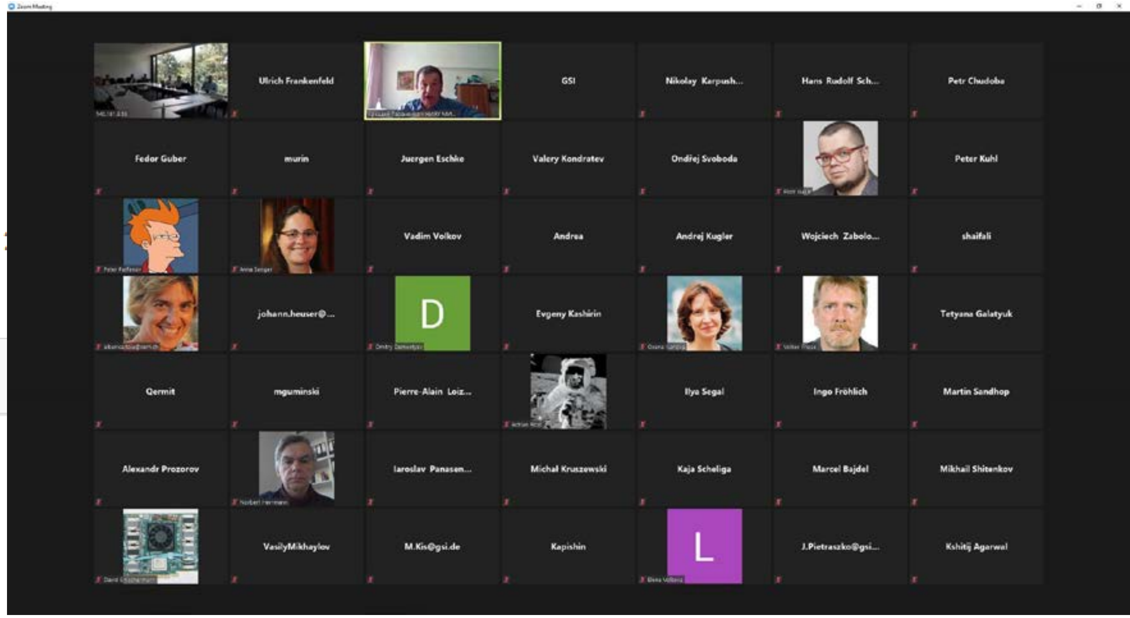
https://cern.zoom.us/j/97681608493?pwd=ZTdyMHFzUFUyNEU5aHhzcDQvRVlqZz09

Meeting-ID: 976 8160 8493

Password: 259210

This project has received funding from the European Union's Horizon
871072

Registration *You are registered for this event.* ~55 participants



- CBM/BM@N working groups established since long
- frequent WP2 task meetings take place
  (now due to corona pandemics only online)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

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WP2:
Collaboration with NICA
Development of instrumentation for NICA and FAIR/CBM

Budget 4.61 M€

8 Participants from 5 countries:

JINR, Dubna (9 FTE),
FAIR, Darmstadt (8.3 FTE),
Univ. Tübingen (1 FTE),
WUT, Warsaw (2 FTE),
Wigner, Budapest (2 FTE),
MEPhI, Moscow (4 FTE),
INR, Moscow (1 FTE),
NPI, Rez (2 FTE)

CREMLINplus **WP2:NICA-FAIR/CBM** **WP Leader: Jürgen Eschke (FAIR),** **Deputy WP Leader: Yuri Murin(JINR)**	**FAIR 7,5 FTE over 48 months (360 PM)**	**JINR 9 FTE over 48months (432 PM)**	**EKUT Tübingen 1 FTE (48 PM)**	**WUT Warsaw 2 FTE (96 PM)**	**Mephi Moscow 4 FTE (192 PM**	**Wigner Budapest 2 FTE (96 PM)**	**NPI Rez 2 FTE (96 PM)**	**INR Moscow 1 FTE (48 PM**
Task 2.1: Integration, installation, and test of Silicon trackers for NICA and CBM (FAIR, JINR, EKUT) (Taskleader: Johann Heuser, GSI)	2	4	1					
Task 2.2: Developments for the data acquisition chain, for data preprocessing and computing (WUT, FAIR, JINR) (Taskleader: Wojtek Zabolotny, WUT)	2	2		2				
Task 2.3: Development of common software packages for simulation and data analysis, participation in physics performance studies(MEPhI, FAIR, JINR, Wigner RCP) (Taskleader: Arkadiy Taranenko,MEPHI, deputy taskleader Ilya Selyuzhenkov, GSI)	2	2			4	2		
Task 2.4: Development and construction of beam monitors, target chamber and beam pipe for NICA and CBM (FAIR, JINR) (Taskleader: Peter Senger, FAIR)	1	1						
Task 2.5: Development and construction of Zero Degree Calorimeters for NICA and CBM (INR RAS, NPI CAS) (Taskleader: Fedor Guber, INR)							2	1
Coordination of joint activities	0.5							

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

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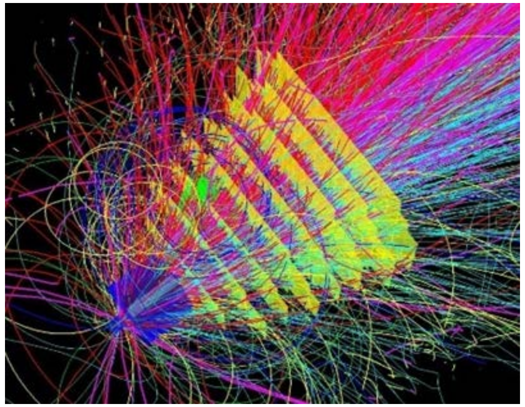
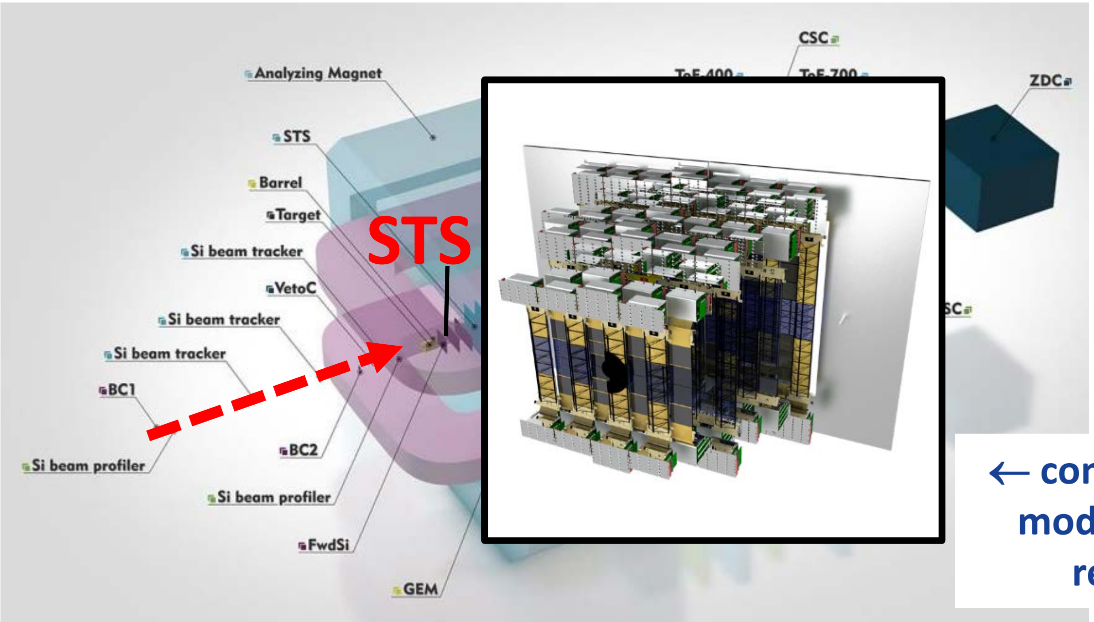
Scope of Task 2.1

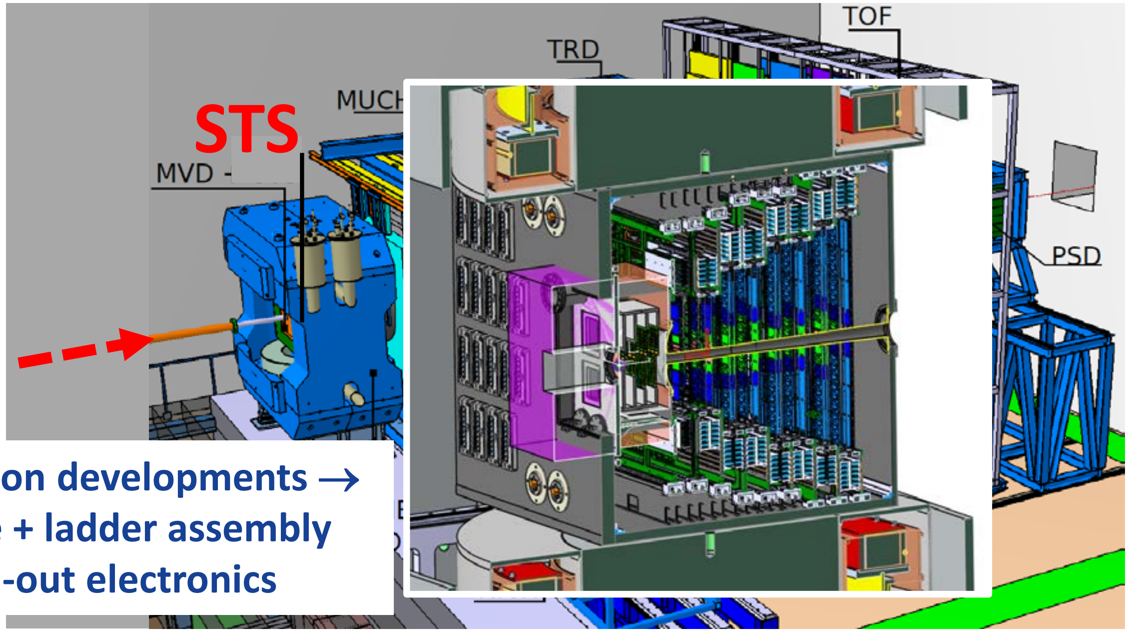


FAIR, JINR, EKU Tübingen
Taskleader: Johann Heuser, GSI

- What is it about?
  “Integration, installation, and test of ***S***ilicon ***T***racking ***S***ystems for NICA and CBM”



← common developments →
module + ladder assembly
read-out electronics



BM@N experiment at NICA

CBM experiment at FAIR

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Task 2.1 - Scientific/technical highlights I

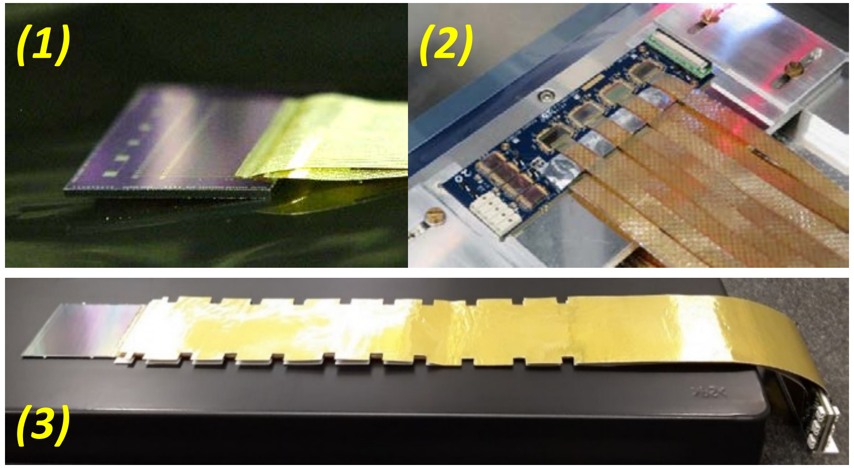
CBM STS – Module and ladder assembly established

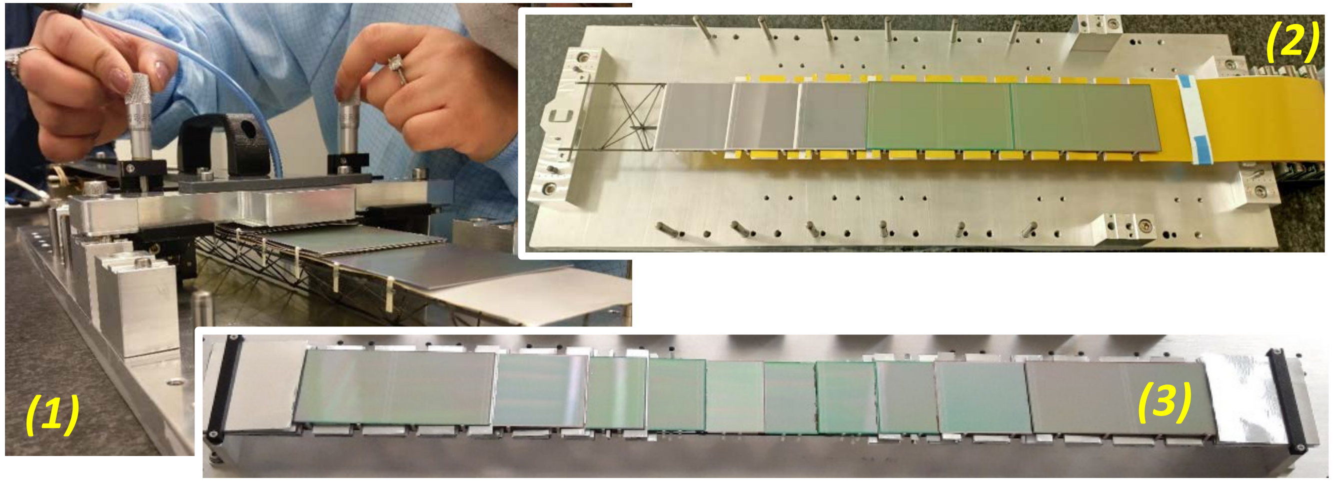
Module assembly

- bond read-out ASICs to micro-cables ***(1)***
- bond ''chip-cables'' to silicon microstrip sensor
- install ''chip-cables'' into CBM front-end board ***(2)***
- first on front side, then on back side
- install shielding layers; attach FEBs to cooling fin ***(3)***

Ladder assembly

- install carbon frame in precision fixture, attach bearings
- attach supporting L-legs for module attachment
- "left" half ladder: flip-mount innermost module, add 4 more modules ***(1) (2)***
- "right" half ladder half: same procedure
- insert FEBs into cooling box; ladder complete ***(3)***





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

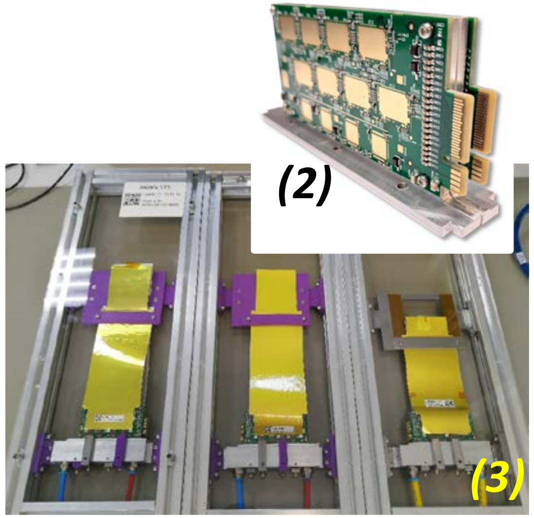
Task 2.1 - Scientific/technical highlights II

BM@N STS – Module assembly established, ladders being finalized

Module assembly

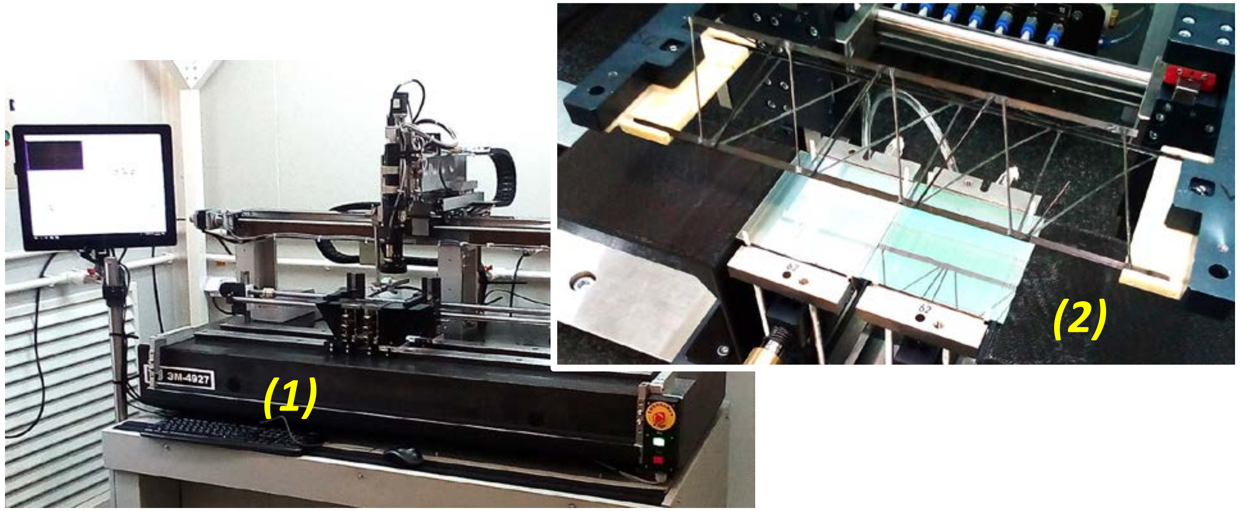
- same assembly steps as CBM STS modules
- JINR-made mechanical fixtures, GSI in-situ chip test setup
- install ''chip-cables'' ***(1)*** into BM@N front-end board ***(2)***
- first on front side, then on back side
- install shielding layers; attach FEBs to fin; final modules ***(3)***

(1)



Ladder assembly

- assembly tool and procedure differs from CBM-STS
- assembly bench being finalized in Belarusian industry ***(1)***
- test assembly carried out with ladder segment ***(2)***



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

Task 2.1 - Scientific/technical highlights III

- CBM-STS Project Retreat on module and ladder assembly (Feb. 2020)
  - teams from Germany, Russia, Poland
  - resume of development status, identification of open issues
  - most issues were resolved till Fall 2020, laying the base for project reviews

- Reviews towards STS production readiness
  - FAIR-Expert Committee Experiments #13 (Oct. 2020), reviewing:
    - module and ladder assembly
    - logistics for distributed construction
  - Module and ladder Engineering Design Review (Dec. 2020)

Recommendation:

- on good track
- start pre-production
- demonstration of few full-size ladders operating stably under realistic cooling conditions

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

Task 2.1 - Achievements and outlook

BM@N

Achievements

- CBM front-end boards adapted to BM@N.
- Module assembly workflow established at JINR.
- Operated in test station, meets requirements.
- Ladder assembly technique under finalization.

Outlook

- Due to pandemic restrictions in Belarus and Russia: assembly of the BM@N ladder prototype (MS6) is delayed by two quarters.
- We expect the task to assemble the first prototype BM@N STS ladder with functional modules to be accomplished in Quarter 2, 2021 (Month 18).

CBM

- All CBM module and ladder components available to start (pre-)series assembly in 2021.
- Module and ladder assembly established at GSI.
- Half-size detector ladders assembled ("mini-STS").
- Full-size ladder assembly under finalization.

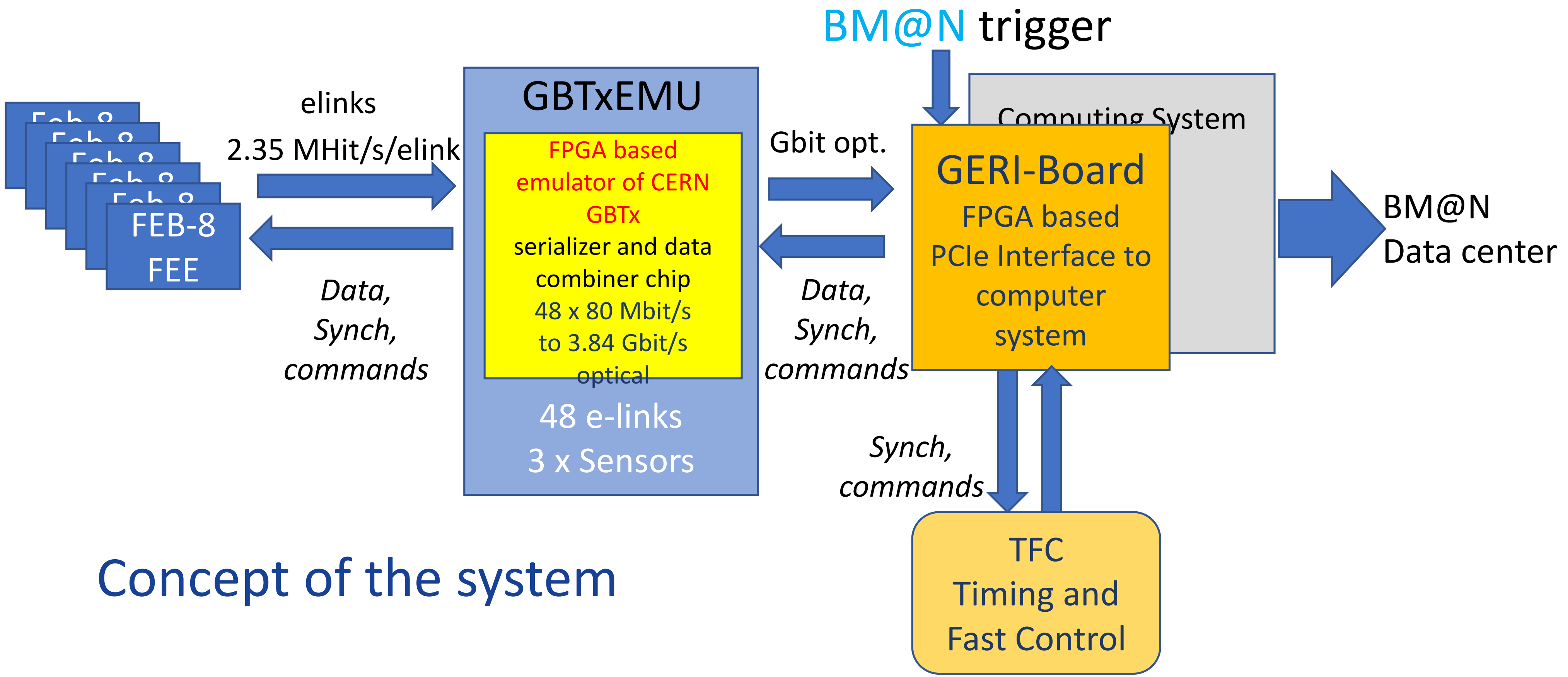
- Due to restrictions at GSI-FAIR, some teamwork is delayed by several weeks but ongoing. Components from industry/workshops arrived timely.
- Ladder assembly is being advanced from half-ladders to full-size ladders. D2.1 and MS7 will be achieved as planned by Month 24.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

Scope of Task 2.2

WUT, FAIR, JINR
Taskleader: Wojtek Zabolotny, WUT

Developments for the data acquisition chain, for data preprocessing and computing

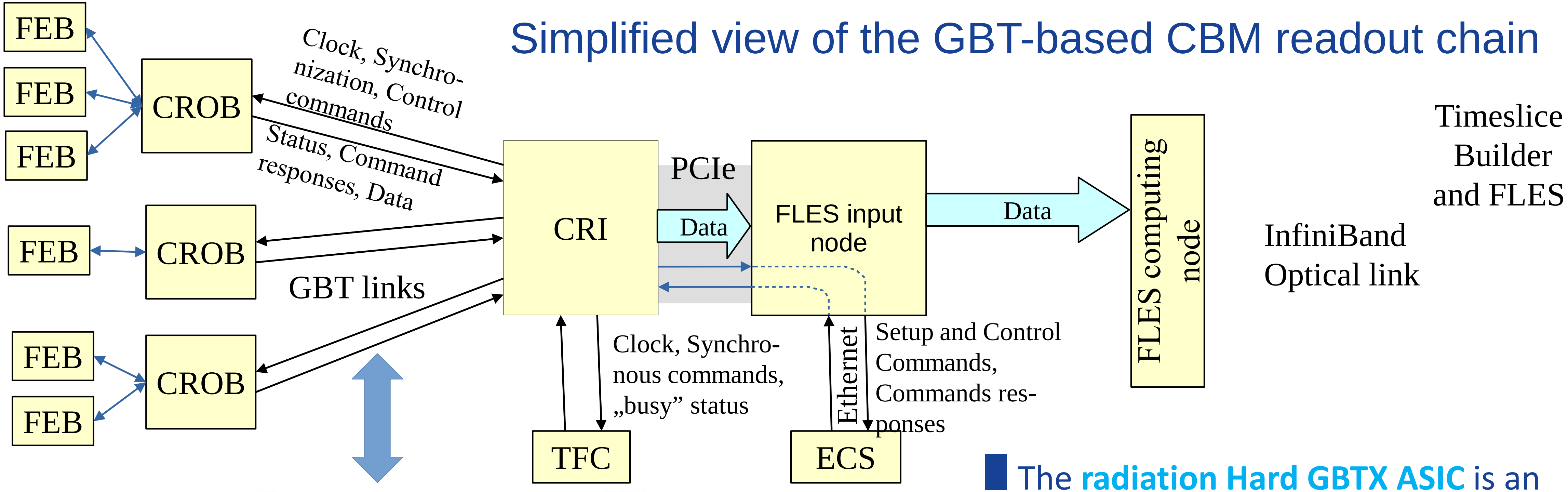


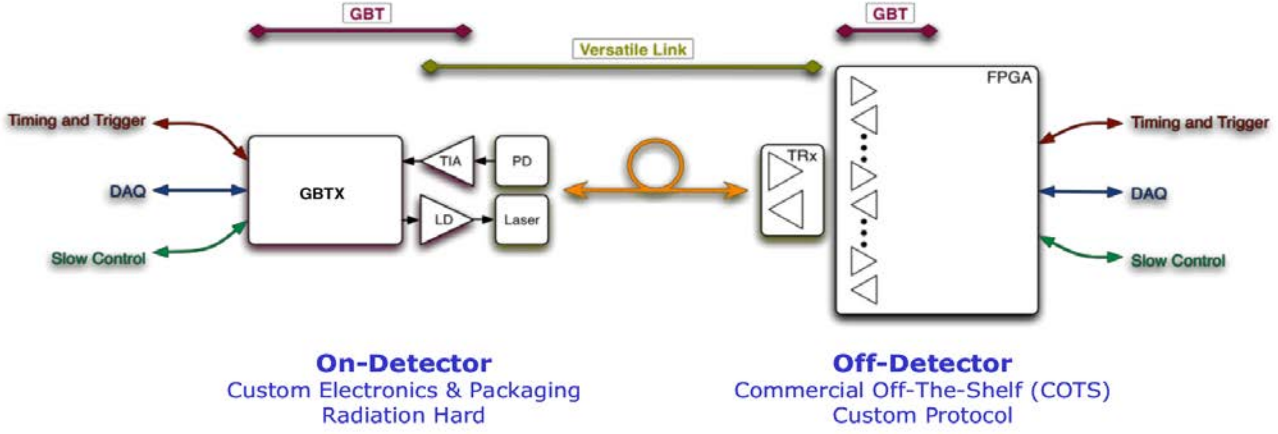
Concept of the system

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

Task 2.2 – Introduction – why we need GBTxEMU?

Simplified view of the GBT-based CBM readout chain





- The **radiation Hard GBTX ASIC** is an essential component of the GBT link
- Due to export restrictions it can't be used in many countries, including Russia and China
- It must be replaced with an FPGA-based functional equivalent

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Task 2.2 - Scientific/technical highlights I

- The GBTxEMU board is prepared as a controller and data concentrator card for the readout chain
  - The GBTxEMU board is used for tests of STS readout components performed in JINR.
  - The GBTxEMU firmware is improved based on tests performed in JINR.
  - The new, 3U EuroCard compatible board for GBTxEMU has been designed in JINR, successfully manufactured and tested (picture on the right).

- For the first tests of the triggered data acquisition, the setup based on GBTxEMU and AFCK-based DPB boards is being prepared.
  - The concept of the triggered acquisition in the old DPB firmware is elaborated and is being implemented

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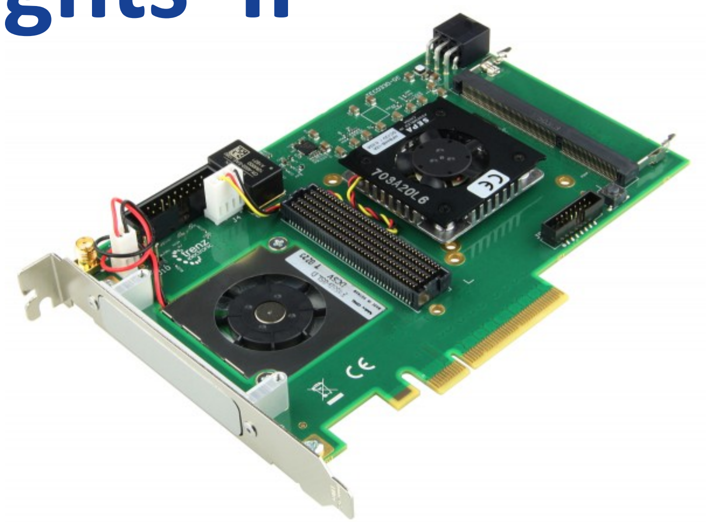
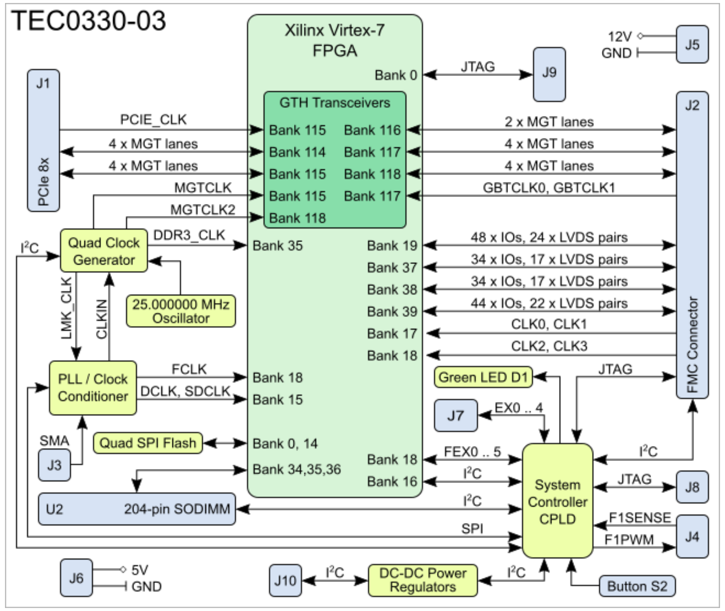
Task 2.2 - Scientific/technical highlights II

- The commercially available Trenz TEC0330 board has been selected as GERI prototype
  - The first blocks of the firmware for GERI have been developed
    - The GBT-FPGA core needed for GBTxEMU communication has been successfully ported.
    - The initial version of the PCIe core including the DMA engine has been implemented and used for throughput tests.
  - Certain problems requiring hardware modifications have been identified, the required modifications have been introduced and successfully tested
    - Providing the recovered clock feedback for jitter cleaner,
    - Replacement of fixed frequency crystal oscillator with VCXO.





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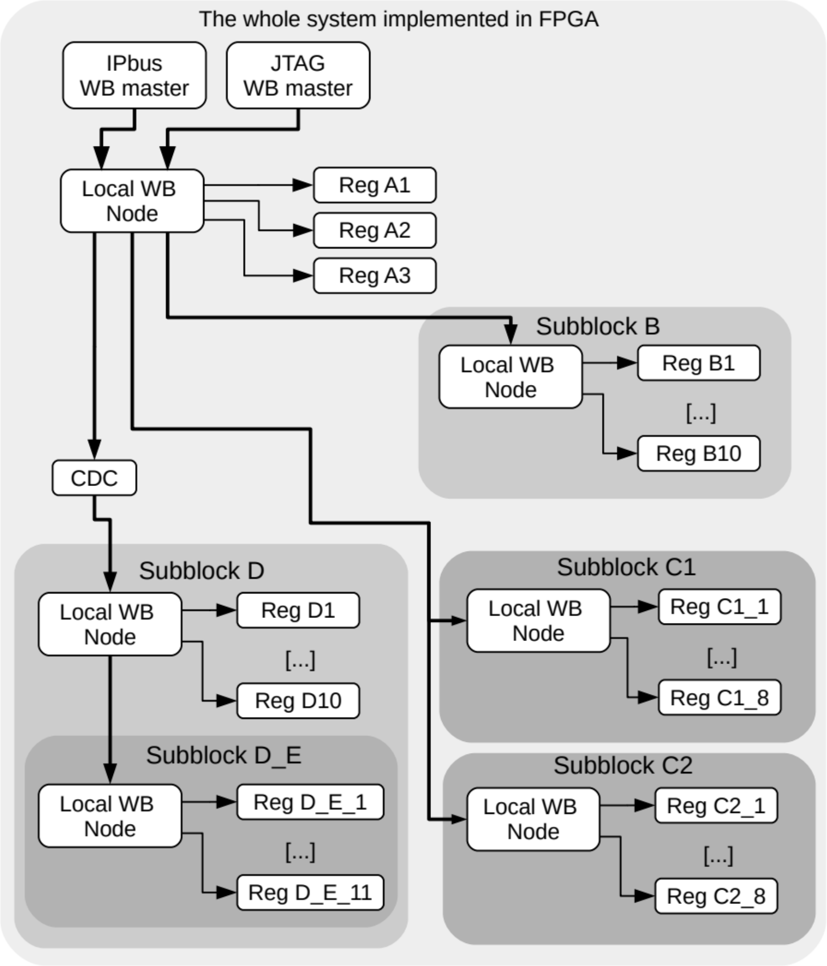
Task 2.2 - Scientific/technical highlights III

- The firmware development for BM@N is tightly coupled with the development of firmware for CBM, to fully utilize the synergy. Of course the developed blocks must be adapted to the specific features of the BM@N.
  - The HCTSP block for communication with SMX FEE ASICS is under development
  - The control system based on an open-source AGWB system and Wishbone bus is under development
- Also the BM@N-specific firmware blocks are prepared
  - The dedicated PCIe block with the DMA engine oriented on the triggered data acquisition
  - The BM@N-compatible TFC system
- The control software developed for CBM must be ported to BM@N
  - Initial tests may be done with Python scripts directly supported by AGWB

AGWB-based control system in FPGA



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

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Task 2.2 - Achievements and outlook

Achievements

- The first milestone to be reached is „Components of the STS data acquisition chain tested“, scheduled for 24th month of the project
  - The selected HW components should enable creating of the demonstrator version of the readout chain.
  - The tests setups have been created in WUT, GSI and JINR.
  - The remote access to the test setups in GSI and JINR reduces negative consequences of the pandemic.
  - Current status of the firmware development allows data acquisition, however, certain problems still must be resolved (e.g. loss of data in certain conditions).
  - The most important concepts of the final solutions are developed and are awaiting implementation and testing.
  - It seems that the timely achievement of the first milestone should be possible,
- The hiring procedure at WUT and GSI has been completed
  - Due to COVID-related lockdown hiring in WUT was delayed (until 15.05.2020), and due to insufficient funding the specialists were hired only for ¾ FTE (supplemented with contribution of other WUT staff)

Outlook

- Tests of the triggered data acquisition should be performed before 6.2021 (possibly earlier)
- The fully functional implementation of the basic GERI firmware including the basic PCIe core with DMA and control interface should be available before 10.2021 (possibly earlier)
- The tests and improvements of the created FW together with accompanying SW should be continued until 2.2022

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Scope of Task 2.3

MEPhI, GSI/FAIR, JINR, Wigner RCP

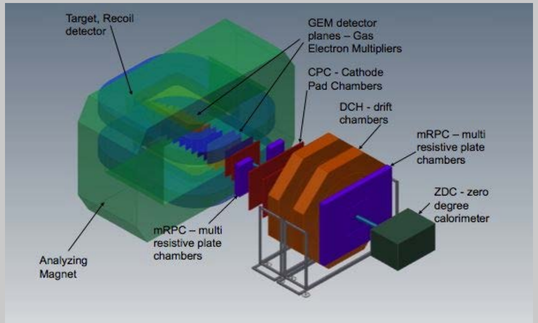
Taskleader: Arkadiy Taranenko,MEPHI,
Deputy taskleader Ilya Selyuzhenkov, GSI

Development of common software packages for simulation and data analysis, participation in physics performance studies

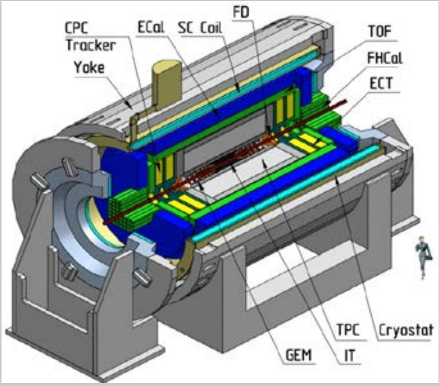
MPD & BM@N experiments at NICA

← common development → of software packages for simulation and data analysis

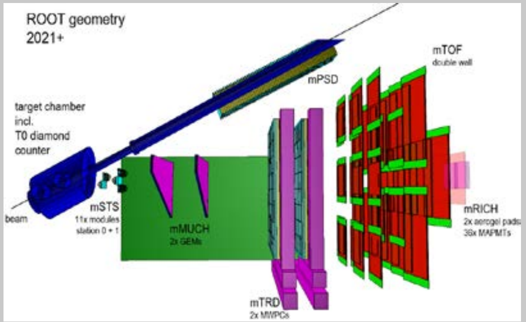
CBM & mCBM experiment at GSI/FAIR



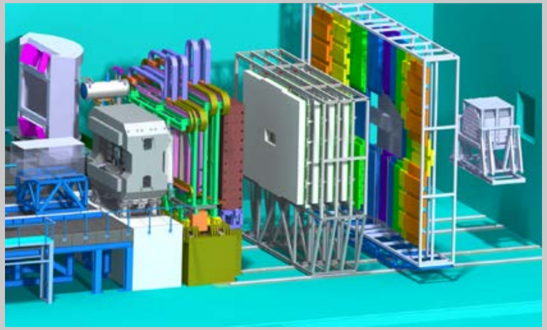
BM@N: data taking started in 2018



MPD data taking will start in 2023



mCBM data taking started in 2019



CBM operation ready in 2025

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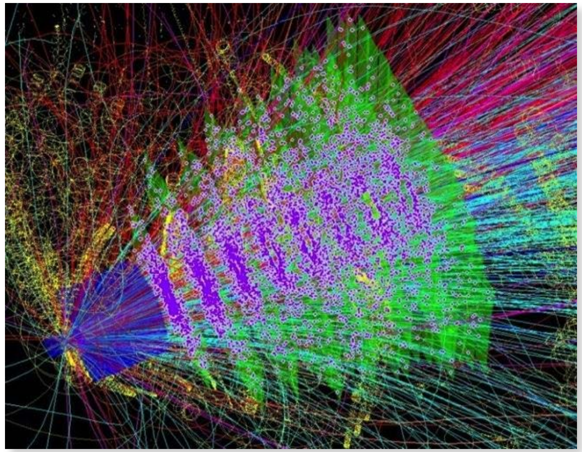
Task 2.3 - Scientific/technical highlights III

Raw event builder for CBM experiment at FAIR



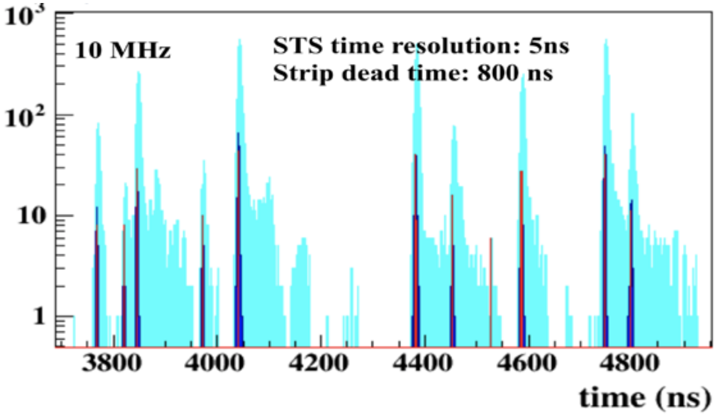
Goal

Develop an algorithm to construct raw events

- collections of digis to be used at low interaction rates.
- Algorithm applicable for online and offline analysis (CBM and mCBM)
- provide QA tools to assess its performance using simulated data

Deliverable

CbmAlgoBuildRawEvents code which receives std::vector of digi objects and produces std::vector<CbmEvent>.



Status

- Event building with separate time windows per detector subsystem (similar to "streaming to triggered" event builder of eTOF@STAR).
- Implemented in CbmRoot. Tested and fully operational.

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Task 2.3 – Scientific/technical highlights IV
Accuracy of Simulation

Goal: To bring our simulation geometries in line with engineering design in order to improve simulation accuracy.

Deliverable: Default geometries updated and distributed by APR 2021 CBMROOT software release.

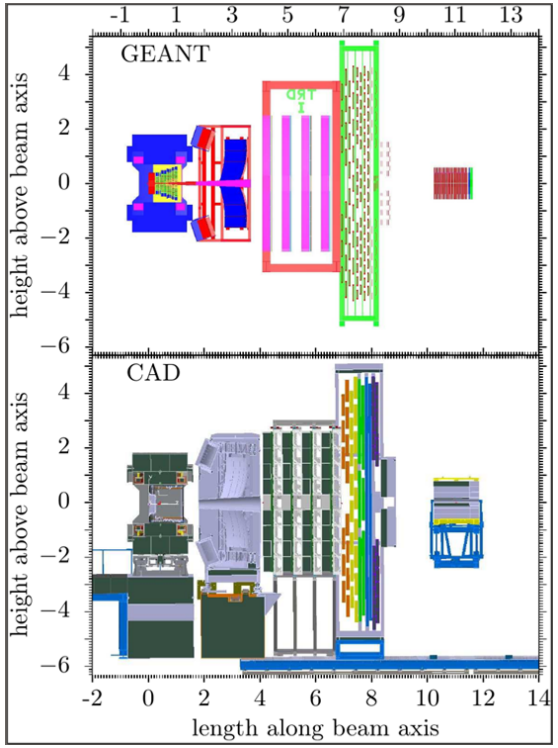
Status: Subsystem length and placement along the beam axis now match. Increment updates to **CAD** and **GEANT** geometries an ongoing process.

Task 2.3 – Scientific/technical highlights V
Geometry Database

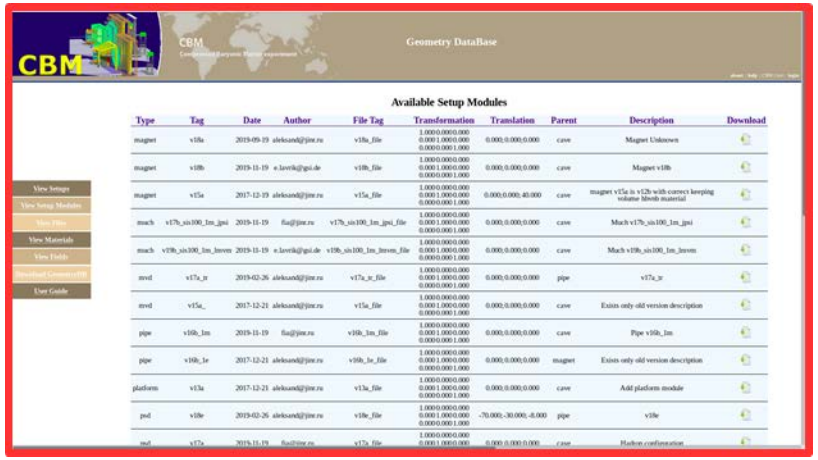
- Geometry production for accurate experiment simulation requires an incremental improvements and amendments to facilitate technical and physics decisions.

- Robust permanent storage of geometry which stores legacy and current geometries is vital.

- Both the BM@N experiment at NICA and the CBM experiment at FAIR have the same software challenge.



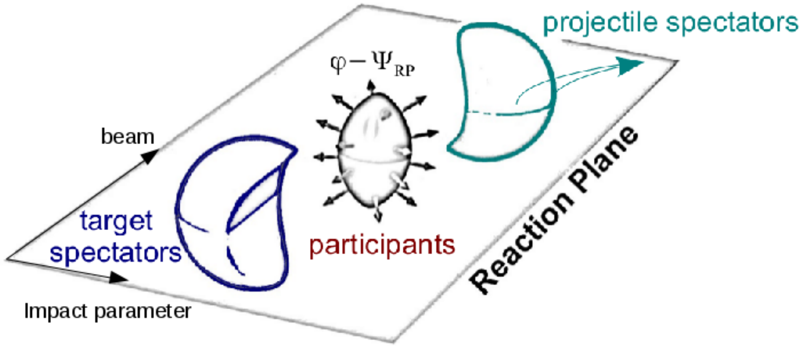
Geometry database developed for BM@N and being implemented for CBM



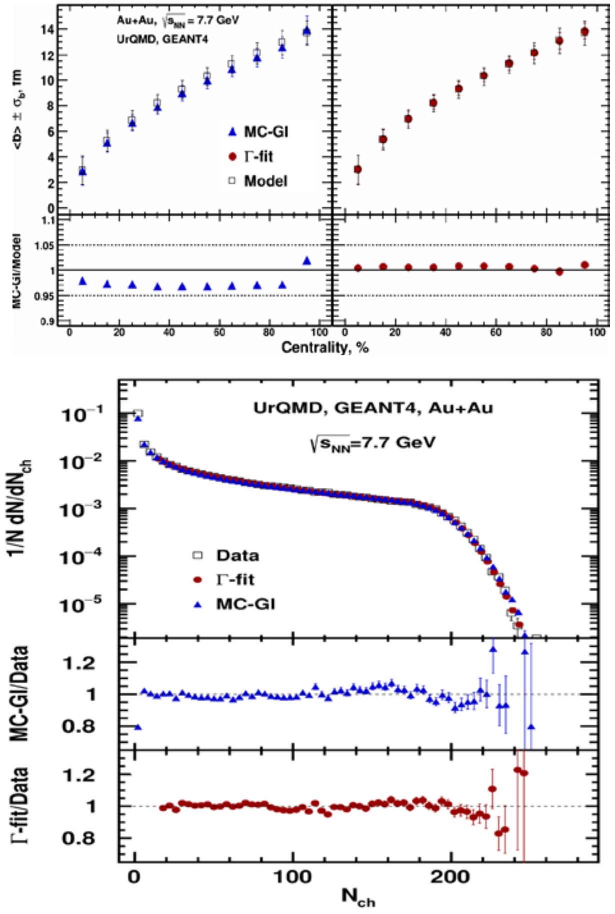
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

Task 2.3 - Scientific/technical highlights I

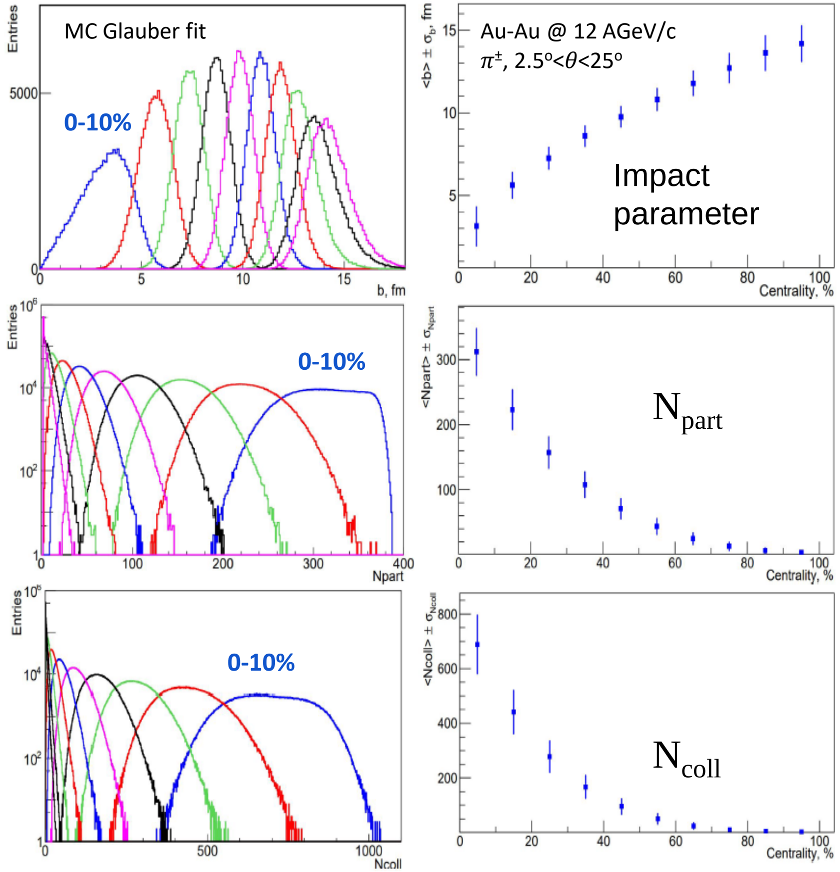
Common framework for centrality determination



MPD @ NICA



CBM @ FAIR



Estimate the impact parameter range in heavy-ion collisions
- using MC Glauber approach (MC-Gl)
- Bayesian inversion method (Γ-fit)

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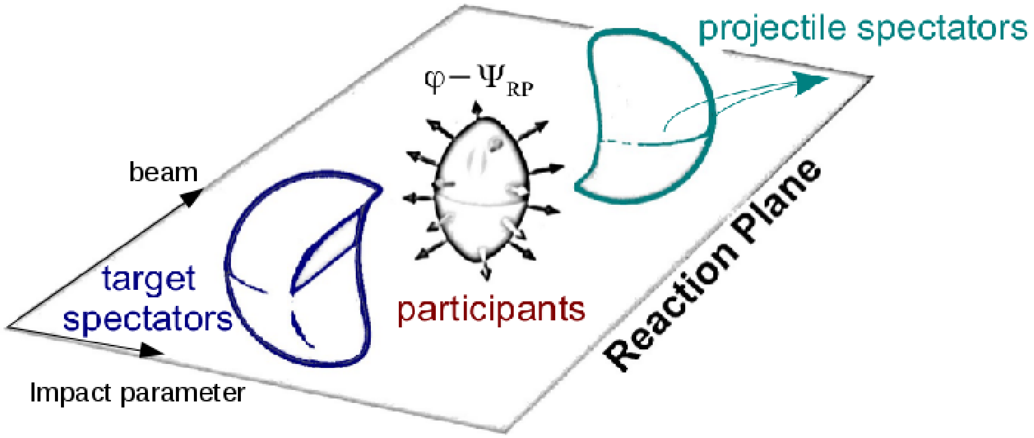
Task 2.3 - Scientific/technical highlights II

Physics performance studies for anisotropic flow measurements

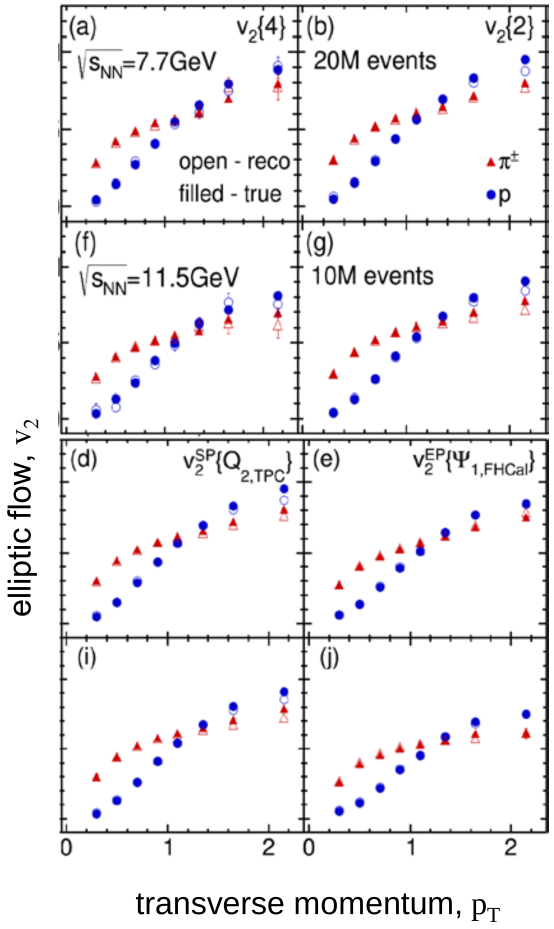


$$\rho(\varphi-\Psi_{RP}) = \frac{1}{2\pi}\left(1+2\sum_{n=1}^{\infty} v_n \cos\left(n(\varphi-\Psi_{RP})\right)\right)$$

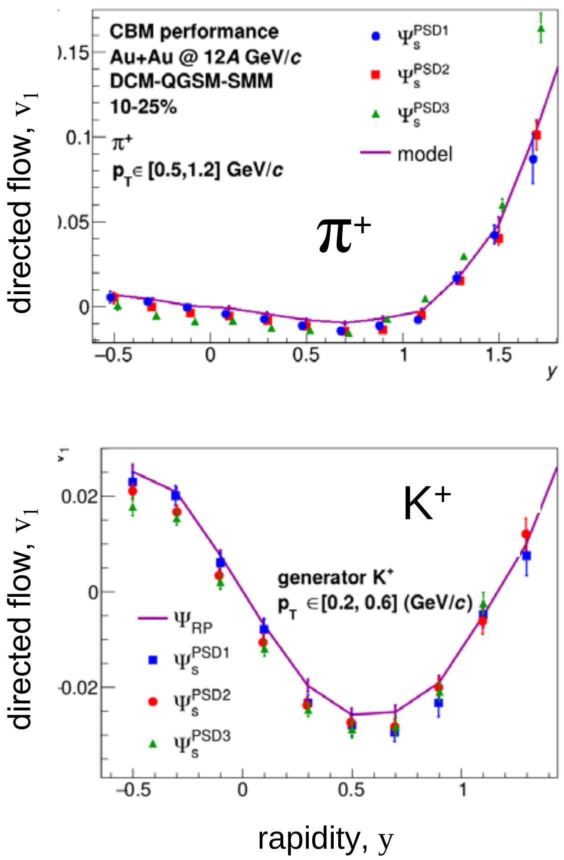
$$v_n = \langle \cos[n(\varphi-\Psi_{RP})]\rangle$$

Reconstructed and generated **directed**(v_1) and **elliptic**(v_2) **flow signals** of pions, kaons and protons have a good agreement for different analysis methods

MPD @ NICA



CBM @ FAIR



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Task 2.3 - Scientific/technical highlights IV

The series of International Workshops aims to promote scientific exchange and development of novel ideas in the area of Development of common software packages for simulation and data analysis and physics performance studies at future FAIR and NICA experiments.

- 2020: **Workshop on analysis techniques for centrality determination and flow measurements at FAIR** and NICA, August 24-28, 2020 – 107 participants from 12 countries, http://indico.oris.mephi.ru/event/181
- 2020: **Workshop on tracking, reconstruction, and physics performance studies at FAIR and NICA,** December 08-10, 2020, 154 participants from 14 countries, http://indico.oris.mephi.ru/event/209
- 2021: **Workshop on physics performance studies at FAIR and NICA** , August 16-20, http://indico.oris.mephi.ru/event/221

Presentation of the results at the major physics conferences and workshops:

- 2020: 15 presentations at ICNFP2020, ICPPA2020, Nucleus 2020, AYSS 2020 and meetings of collaborations CBM, MPD and BM@N

List of deliverables for WP2: task 2.3

- D2.5 Simulation results for selected observables, Report , due date (in months) : 24
- D2.6 Physics performance for major observables , Report , due date (in months) : 48

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

WP2.4: Development and construction of beam monitors, target chamber, and beam pipe for NICA and CBM.

(Participants: JINR, GSI/FAIR - Taskleader: Peter Senger, FAIR)

Deliverables:

- D2.7: Design of beam monitors, target chamber, and beam pipes (M12)
  Completed in Jan. 2021. Report was submitted.
- D2.8: Beam monitors, target, chambers, beam pipes constructed and installed (M48)

Target chamber, beam pipe:

- Design studies and radiation simulation performed for BM@N/NICA and CBM
- Prototype for BM@N beam pipe with integrated target under construction.
- Engineering design and optimization for CBM ongoing.

Beam monitors:

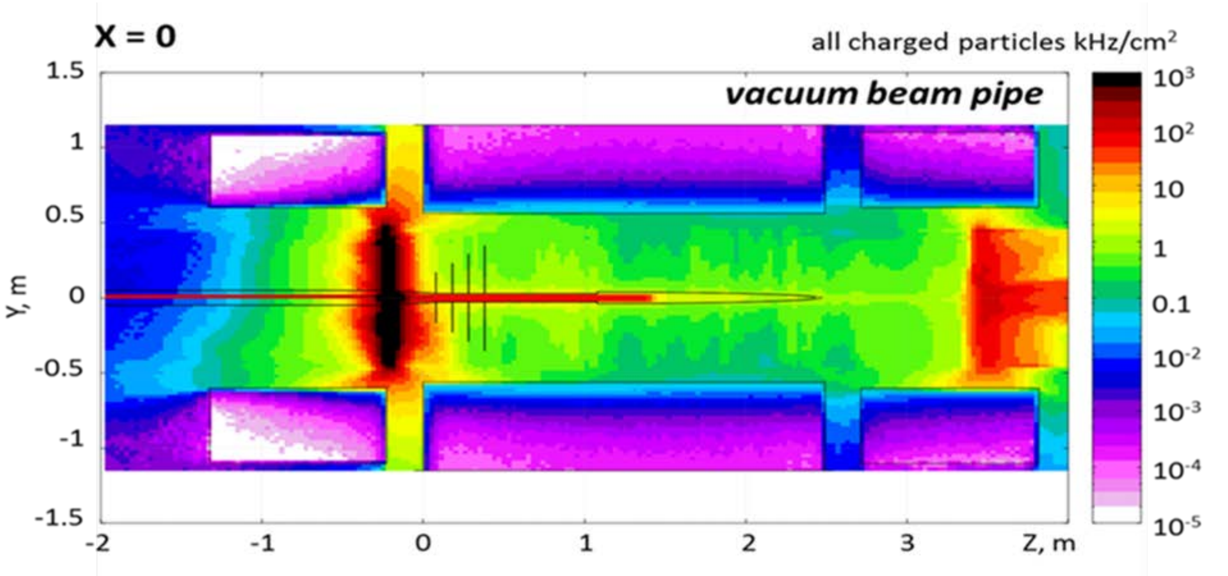
- Design of T0 (Start) Diamond detector, beam halo detector, read-out electronics and mechanical integration for CBM developed
- Evaluation of a new detector technology for in-beam detectors ongoing

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

Beam pipe simulations for BM@N and CBM

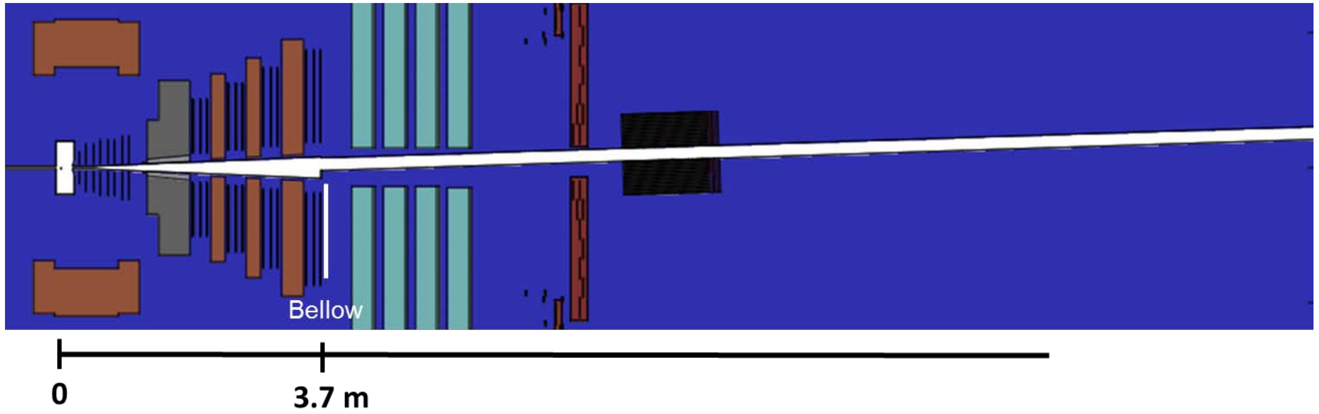
FLUKA calculations for BM@N:

- Demonstrating the need for an evacuated beam pipe ($2 \cdot 10^6$ Au ions/s, E_{kin}= 5A GeV).
- Performance studies for a carbon beam pipe with integrated target and fixed curvature



CBM beam pipe studies:

- Momentum resolution requires highest possible magnetic field
- Depending on beam rigidity and magnetic field, the beam pipe has to be pivoted after the conical part under vacuum conditions
- Solution: bellow and shifting mechanism



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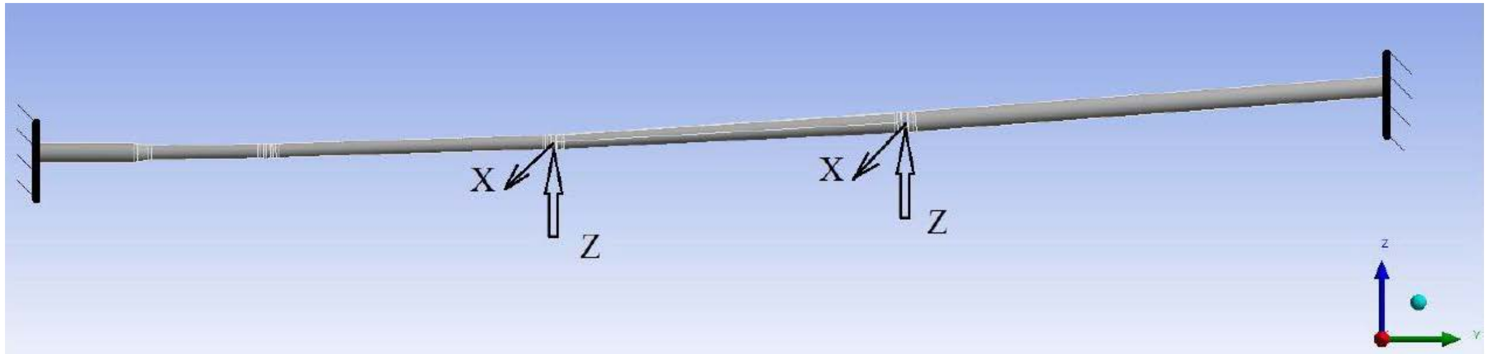
Engineering design of the beam pipe for BM@N and CBM

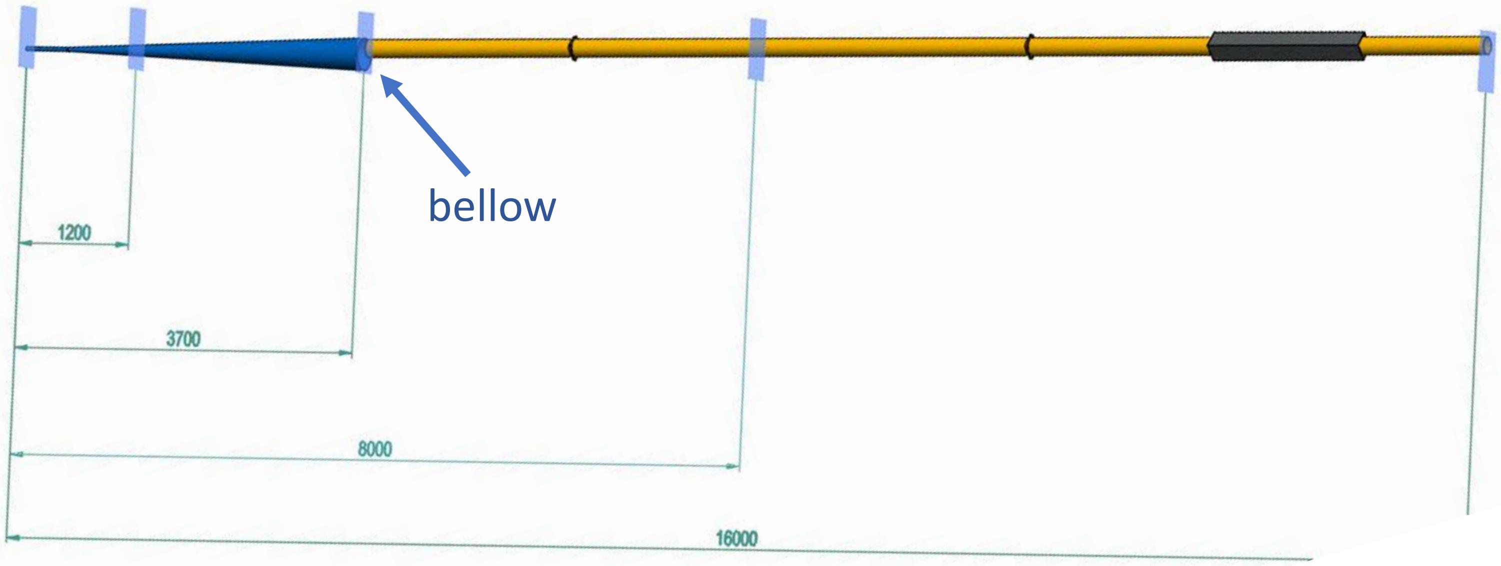
BM@N beam pipe:

- composed of several carbon fiber tubes with fixed inclination angle
- Beam deflection adapted to pipe curvature by the magnetic field



CBM beam pipe:

- Carbon fiber tubes with different shapes
- Conical pipe through STS, RICH/MUCH
- Bending mechanism (bellow)
- Cylindrical pipe to PSD and beam dump



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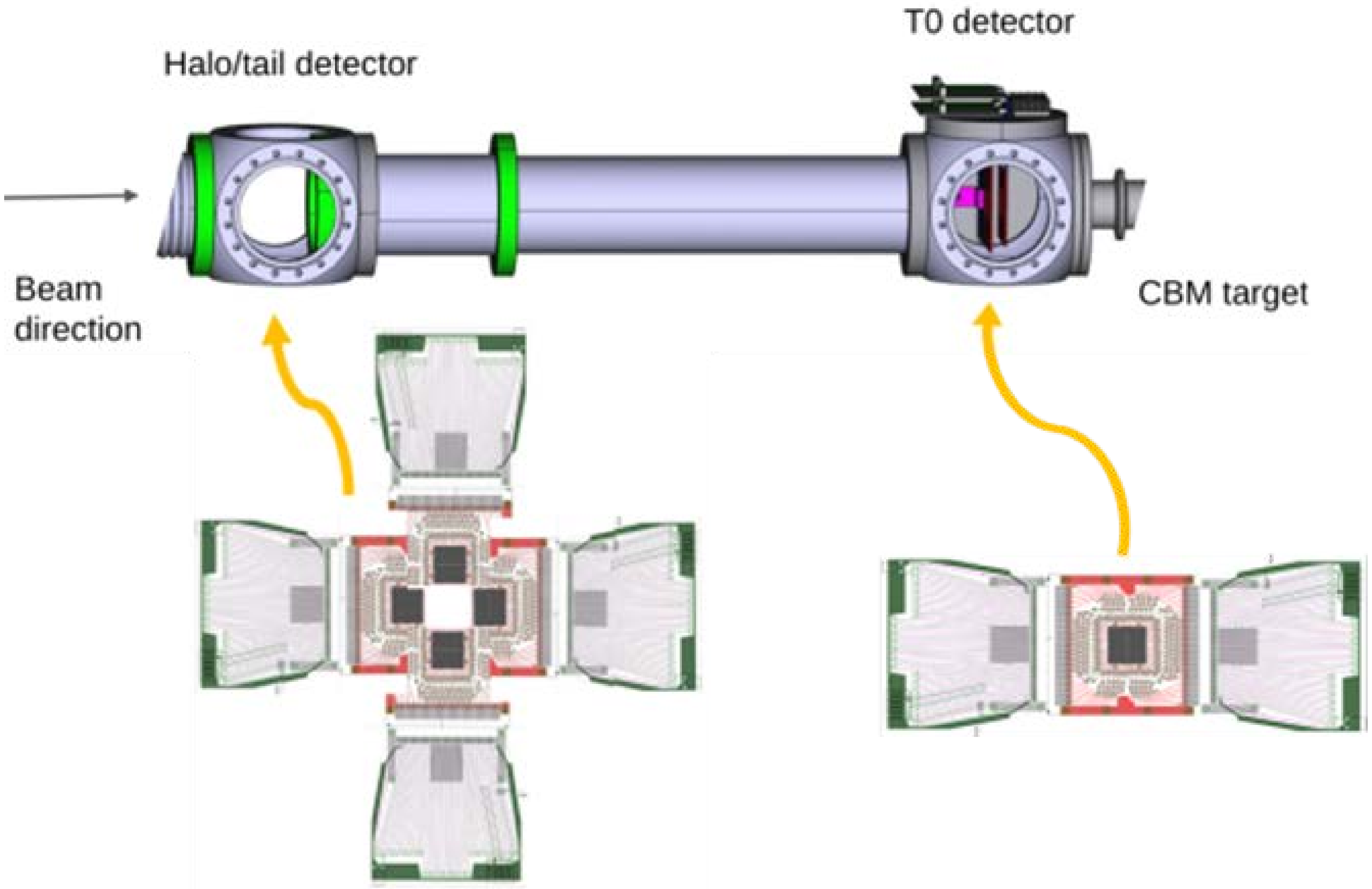
Status of Beam monitors / T0 counters

Detector concept for CBM Day-1:
Two (pcCVD diamond, double-sided strip metallization) separate stations for HALO + T0, ~1 m upstream of the CBM target, mechanics based on standard vacuum components

pcCVD high purity diamond sensors ready for metallization
Sliced, polished, optically inspected (GSI DL), high quality material with thickness of 80±3 µm
Time resolution < 50 ps
Position resolution < 0.5 mm



Read-out concept with two independent readout chains

Sensor + FEE
- CBM TOF or RICH readout → CBM DAQ → T0 measurement
- TRB3 based readout → beam monitoring (beam abort system)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

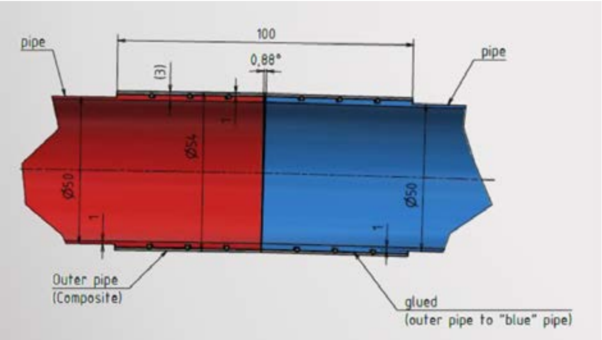
Achievements

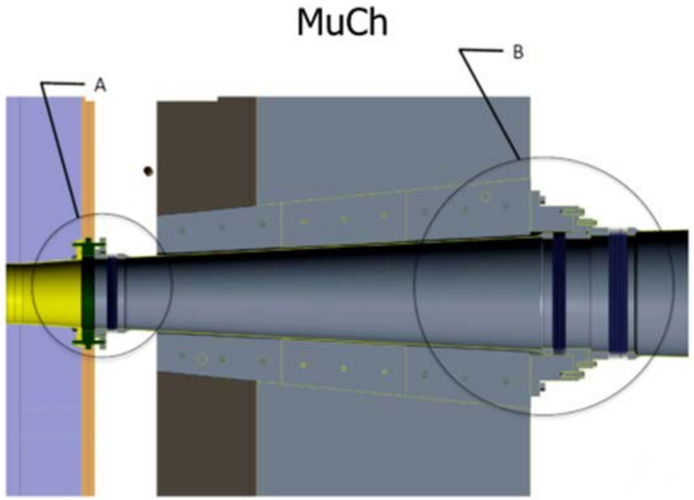
- Deliverable D2.7 (M12) accomplished
- 2.5 persons hired

Outlook

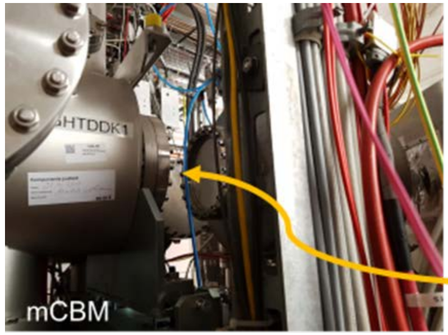
Beam pipe BM@N
- Prototyping of beam pipe sectors and coupling technology

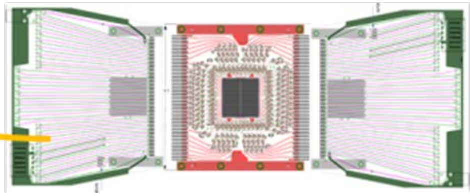
Beam pipe CBM
- Design of detector specific segments





Beam monitors
- Finalize sensor metallization concept
- Test various read-out chains
- Preparation for tests with mCBM





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Scope of the Task WP2.5 -
Design and construction of Zero Degree Calorimeters for NICA and CBM

(Participants - INR RAS and NPI - Taskleader: Fedor Guber, INR RAS)

- Deliverable D2.9 “Design of ZDC detector modules”.
  Completed in Jan. 2021. Report was submitted.
- Details on the next page.

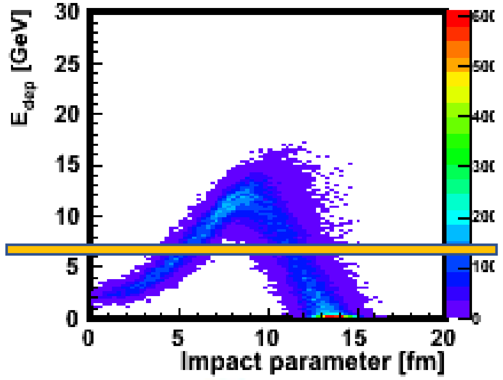
- Deliverable D2.10 (Report M48) "Beam tests of the FHCal for BM@N and construction of the PSD for CBM“
- Development of methods for centrality determination in heavy-ion collisions by forward hadron calorimeter with beam hole at the center at BM@N and CBM experiments.
- The FHCal performance study at the BM@N beams.
- Optimization of the PSD beam hole size and PSD position at the CBM for the best physics performance.

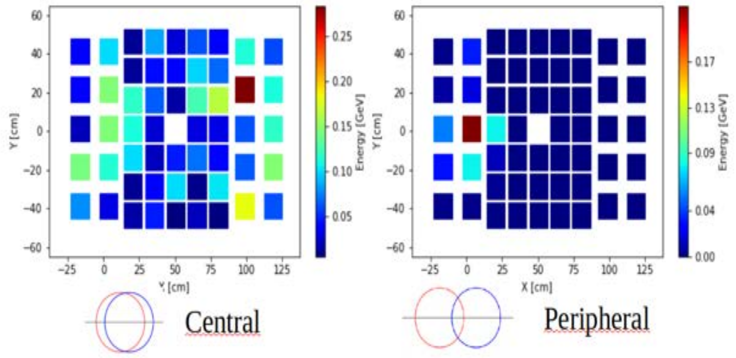
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

Development of methods for centrality measurements with forward hadron calorimeters at the CBM and BM@N experiments

- The FHCal at the BM@N and the PSD at the CBM have the beam hole in the center for the beam transmission to the beam dump. The hole is necessary to avoid radiation damages of modules in central pert of calorimeters

FHCAl at BM@N Au+Au, 4.5 AGeV





Due to non monotonic behaviour of total energy deposition in the calorimeter from the impact parameter of nucleus-nucleus collision the centrality can not been determined from this dependence.

New approaches to measure centralities with forward hadron calorimeters at the BM@N and CBM experiments are developed.

In particular, the use of Machine Learning methods based on difference of energy depositions in calorimeter modules as function of centrality is considered.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

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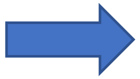
Forward Hadron Calorimeter (FHCal) at the BM@N/NICA and Projectile Spectator Detector (PSD) at the CBM/FAIR

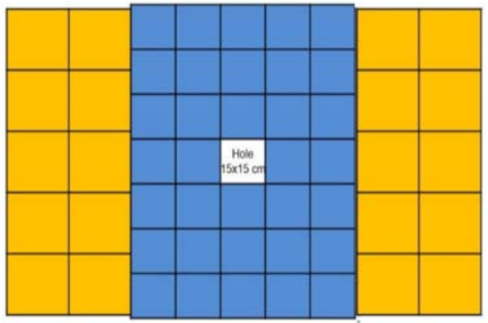
The FHCal and the PSD will be used to measure the centrality and the orientation angle of the reaction plane in the nucleus-nucleus collision.

ZDC@BM@N

2020

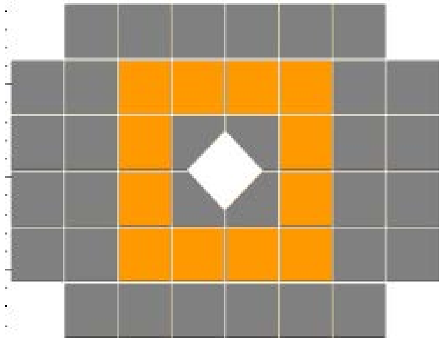


FHCAL@BM@N



34 inner MPD type modules
+ 20 outer CBM modules.
The beam hole 15x15 cm².

PSD@CBM



44 modules
The beam hole 20x20 cm².

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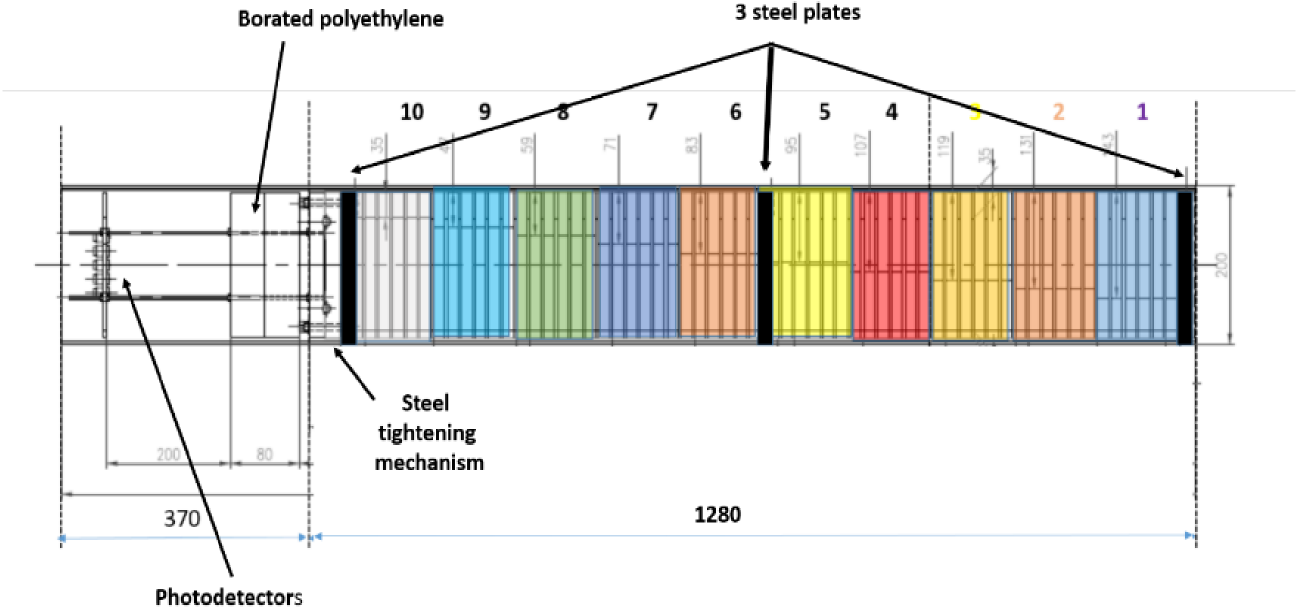
Structure of the calorimeters module



Sampling lead/scintillator PSD modules with sampling ratio 4:1.

PSD nodules - transverse size 20x20 cm^2, 5.6 nuclear interaction lengths.

MPD/NICA modules - transverse size 15x15cm^2, 4 nuclear interaction lengths.

Light collections – 6 WLS fibers from 6 sequentially scint. tiles combined into one optical connector at the end of module.

Light readout with Multi-Pixel Photon Counters: 10 MPPC (3x3 mm^2)/PSD module (7 MPPC/MPD module)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

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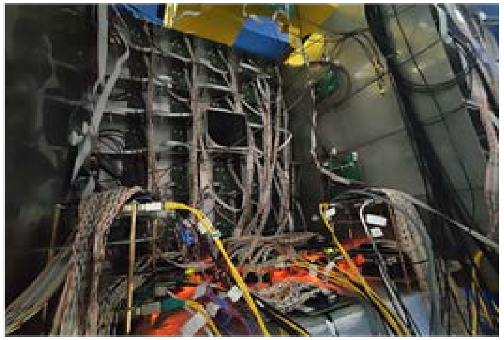
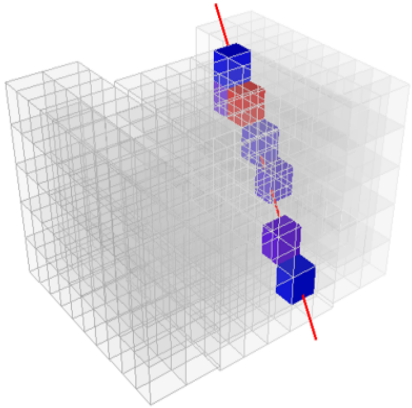
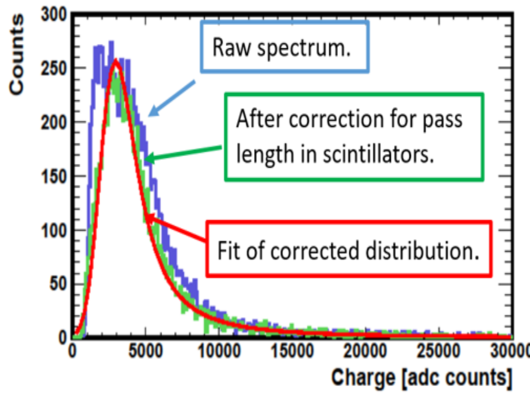
Achievements in 2020: Task WP2.5
"Development and construction of FHCal for NICA and PSD for CBM"

(Participants - INR RAS (1 FTE) and NPI (2 FTE))

- **FHCal at the BM@N was completely assembled, including the installation of FEE boards with photodetectors in all calorimeter modules and readout electronics.**
- **The method of energy calibration of the FHCal module sections with cosmic muons by exploiting the longitudinal and transverse segmentation structure of the hadron calorimeter was developed and tested.**
- **The DCS hardware and software to control the parameters of the FHCal modules has been developed.**

Deliverable D2.9
"Design of ZDC detector modules" (report) completed in Jan. 2021.

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Task WP2.5: Next actions

- Up to the end of 2021 the FHCal at the BM@N will be commissioned and calibrated on cosmic muons to be ready to first physics runs with light ions starting from 2022.
- The presence of a beam hole in hadron calorimeters at the BM@N and CBM setups is a significant problem for their use to determining the centrality in nucleus-nucleus collisions and requires the development of unique approaches like machine learning, energy asymmetry etc.
- New developed methods of centrality determination with forward hadron calorimeters at the BM@N and at the CBM experiments will be tested using first BM@N experimental data.
- Optimization of the PSD beam hole size and PSD position at the CBM for the best physics performance, design of new PSD central modules.

Task WP2.5 is a good example of synergy between BM@N and CBM experiments.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

WP2 Summary and Outlook Task 1 to 5

CREMLINplus **WP2:NICA-FAIR/CBM** WP Leader: Jürgen Eschke (FAIR), Deputy WP Leader: Yuri Murin(JINR)	FAIR 7,5 FTE over 48 months (360 PM)	JINR 9 FTE over 48months (432 PM)	EKUT Tübingen 1 FTE (48 PM)	WUT Warsaw 2 FTE (96 PM)	Mephi Moscow 4 FTE (192 PM	Wigner Budapest 2 FTE (96 PM)	NPI Rez 2 FTE (96 PM)	INR Moscow 1 FTE (48 PM
Task 2.1: Integration, installation, and test of Silicon trackers for NICA and CBM (FAIR, JINR, EKUT) (Taskleader: Johann Heuser, GSI)	2	4	1					
Task 2.2: Developments for the data acquisition chain, for data preprocessing and computing (WUT, FAIR, JINR) (Taskleader: Wojtek Zabolotny, WUT)	2	2		2				
Task 2.3: Development of common software packages for simulation and data analysis, participation in physics performance studies(MEPhI, FAIR, JINR, Wigner RCP) (Taskleader: Arkadiy Taranenko,MEPHI, deputy taskleader Ilya Selyuzhenkov, GSI)	2	2			4	2		
Task 2.4: Development and construction of beam monitors, target chamber and beam pipe for NICA and CBM (FAIR, JINR) (Taskleader: Peter Senger, FAIR)	1	1						
Task 2.5: Development and construction of Zero Degree Calorimeters for NICA and CBM (INR RAS, NPI CAS) (Taskleader: Fedor Guber, INR)							2	1
Coordination of joint activities	0.5							

- The work in WP2 is on track
  - There are no major shift of milestones and deliverables
  - The recruitment is almost complete
  - The future milestones and deliverables will be reached, if no unforeseen obstacles occur

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In person Collaboration Meetings of NICA experiments (BM@N, MPD) and CBM experiment at FAIR

4th Collaboration Meeting (Dubna, October 2019)
of the BM@N Experiment at the NICA Facility

Hopefully soon possible again !

34th CBM Collaboration Meeting, Kolkata, October 2019

NICA Days and 4th MPD collaboration meeting, Warsaw, October 2019

FAIR

Thank you for your attention!