WP2.3 highlight

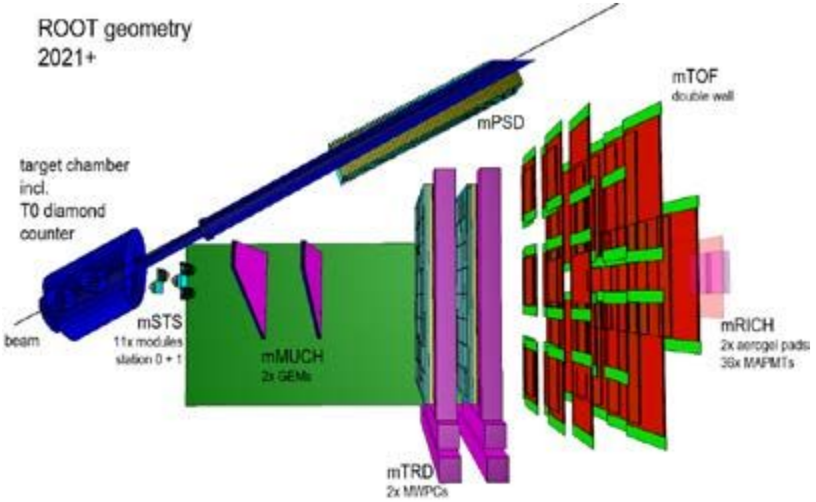
eurizon Annual Meeting 2023
09-10 February, Darmstadt, Germany

Meeting web page https://indico.desy.de/event/37137

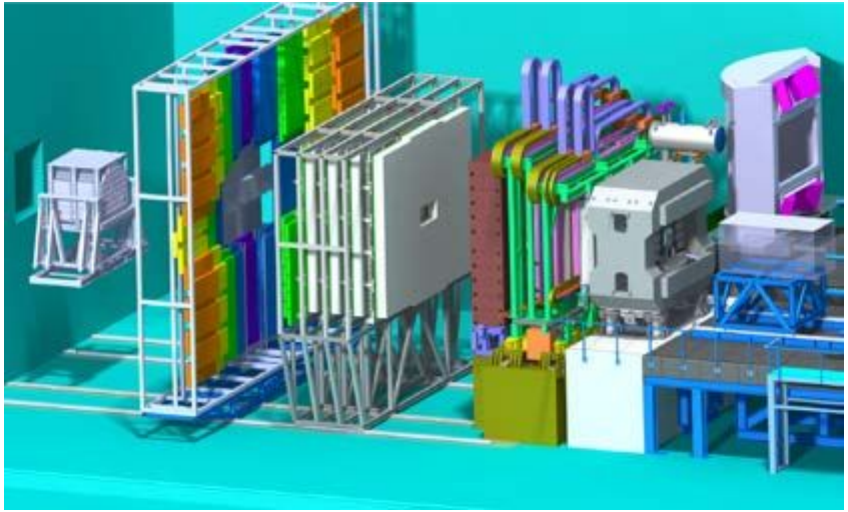
Scope of Task 2.3

Institutions: GSI/FAIR, Wigner RCP
Taskleader: Ilya Selyuzhenkov, GSI

Development of common software packages for simulation and data analysis, participation in physics performance studies of the CBM & mCBM experiments at GSI/FAIR



mCBM data taking started in 2019



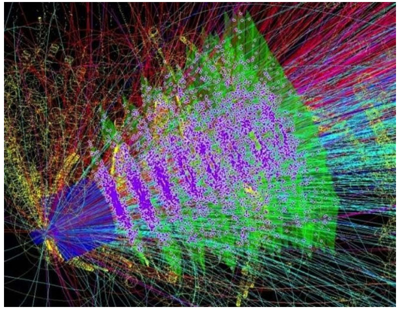
CBM operation planned for > 2028

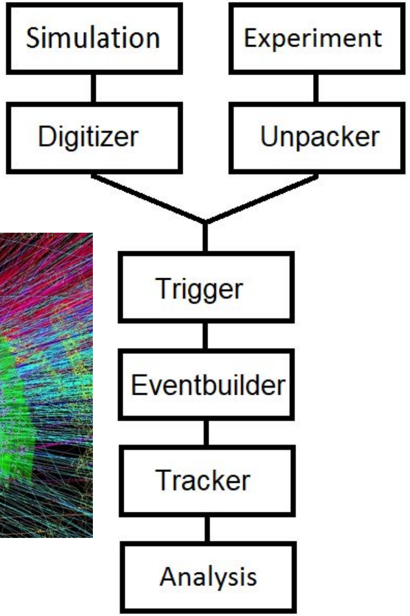
Task 2.3 - Scientific/technical highlights - I

Dominik Smith, Volker Friese

Online software for CBM

Goal: Make readout chain „online ready“





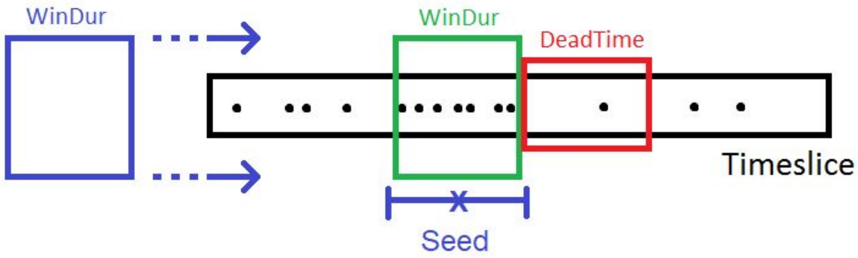
- Implement „algo“ classes in cbm::algo namespace
- Smallest (algorithmically) possible detector unit (parallelizable)
- ROOT-free, optimize for speed, separate monitoring

Unpacking:

- Translate detector messages to universal format.
- In cbm::algo: One unpacker per timeslice component.
- Completed: STS, MUCH, TOF, Tzero
- Ongoing: TRD

Triggering:

- „Time cluster trigger“ algorithm in cbm::algo
- Shift „sliding window“ through digi stream
  Trigger when digi count exceeds threshold

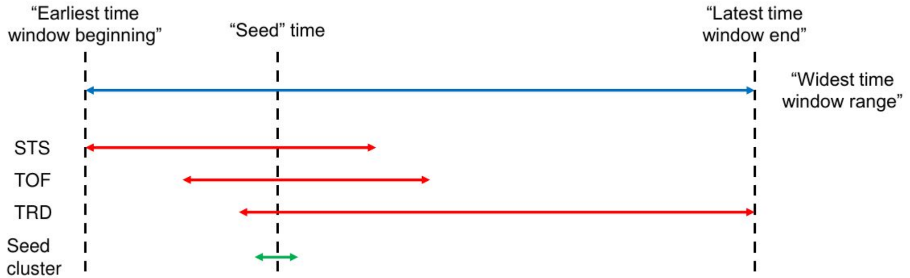


Task 2.3 - Scientific/technical highlights - I

Dominik Smith, Volker Friese

Event building:

- „Time window eventbuilder“ in cbm::algo
- Collect digis from time intervals around trigger
- Separate window boundaries for detectors.

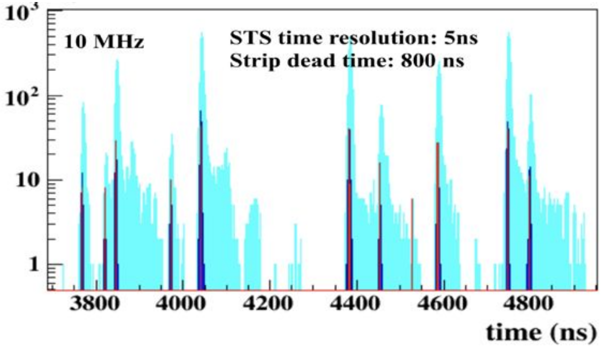


Event selector:

- Accept / reject events based on cuts.
- Currently implemented in cbm::algo: minimum number of fired TOF stations / STS layers

Hit finding:

- Intermediate step: Reconstruct physical hits from digis
- New class: "HitFinderTof“ in cbm::algo (Based on CbmTofSimpleClusterizer)
- ROOT-free except ROOT::Math classes (Rotation3D, XYZVector, not TObject!)
- One object per RPC



FAIR MQ: (Message Queuing Library and Framework)

- System for large-scale („online“) data processing (asynchronous message passing)
- Completed: MQ devices for unpackers, trigger, eventbuilder

Task 2.3 - Scientific/technical highlights - II

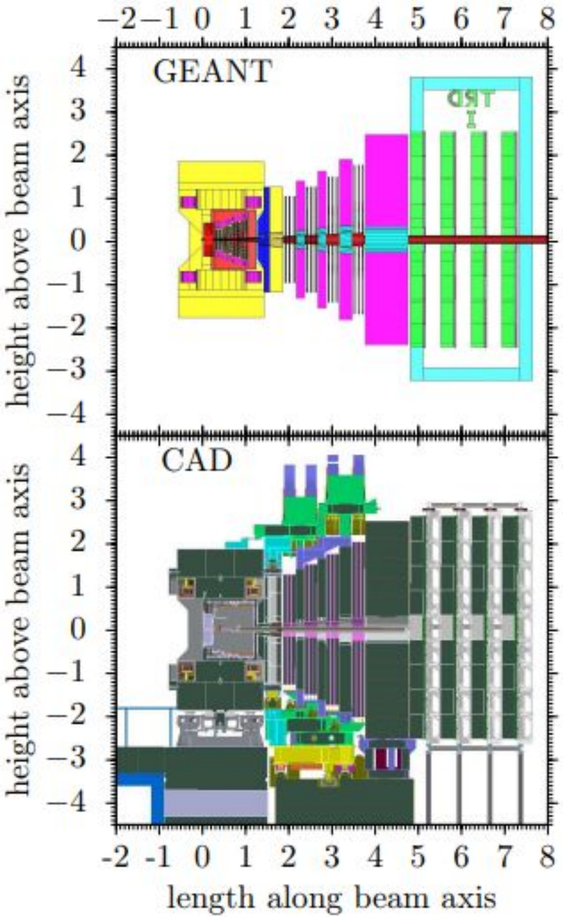
Eoin Clerkin, Patrick Dahm

Goal:
Bring simulation geometries in line with engineering design;
Improve simulation accuracy for physics performance studies

- Accurately match the engineering CAD geometries with GEANT geometries used for physics performance studies
- Coordinate the work of Detector and Simulation teams to provide a consistent integration of all detector geometries

Status / Delivered

- Many improvements to all simulation geometries across all CBM detectors and passive materials at each development cycle
- Maintain different CBM setup configurations within CBMROOT with incrementally improved geometries for new CBMROOT releases
- Process the detector subsystems change requests, imposed by ongoing performance studies and detector design developments

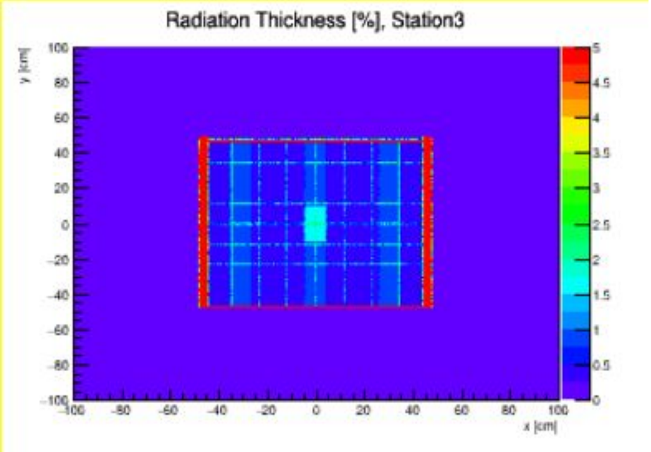


Task 2.3 - Scientific/technical highlights - II

Eoin Clerkin, Pierre-Alain Loizeau

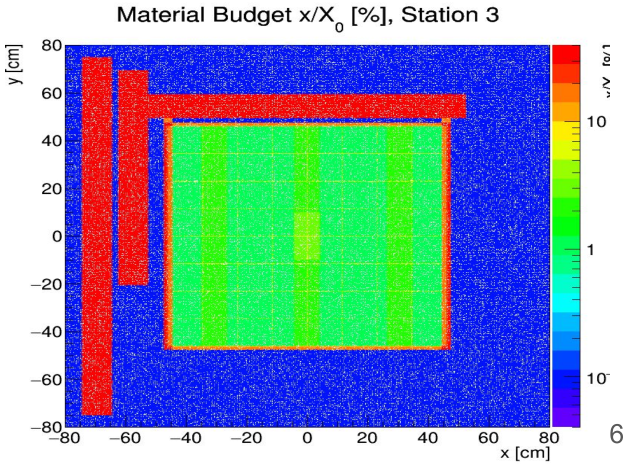
Goal:
Developed robust algorithms for precise calculations of the material budget for CBM and mCBM experiments

- Material budget maps are used in CA tracking algorithm and are generated in addition to the existing simulation geometries
- Existing algorithms to extract the maps are being expanded and developed to include additional sources of material



Delivered

- Developed macros to extract precise material budget maps in 3D, Made available in the CBMROOT NOV22 release
- Automatized (gitlab CI) validation of the future new geometries in prepared for the CBM repository
- Updated/regenerated mCBM material budget maps all mCBM detector subsystems



Task 2.3 - Scientific/technical highlights - II

Dennis Pfeiffer, Eoin Clerkin

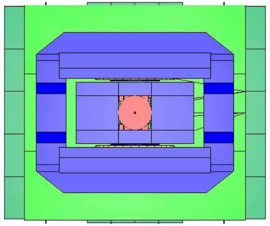
Goal

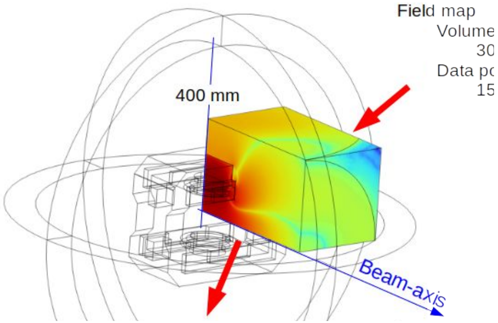
Provide magnetic field maps for CBM magnet configurations

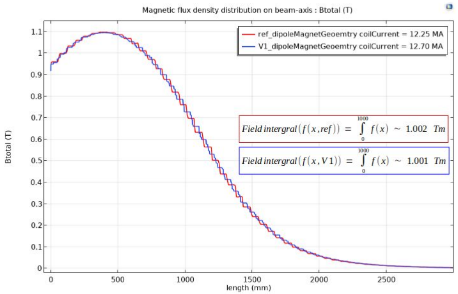
- Magnet modifications require a new geometry and B-field maps Imposed by the development of the new CBM magnet and redesign of the STS
- Previously only one magnetic field map was used for all CBM configurations despite the differences, such as magnet field clamps, RICH shielding box, and iron MUCH absorbers

Delivered

- Magnet geometry according to the new magnet specification
- Prepared dedicated field maps for CBMROOT NOV22 release:
  1) Magnet without field clamps
  2) Magnet with field clamps
  3) Magnet with field clamps & RICH shielding box
  4) Magnet without field clamps & MUCH absorbers
- (in progress) higher granularity and smoothed B-field maps





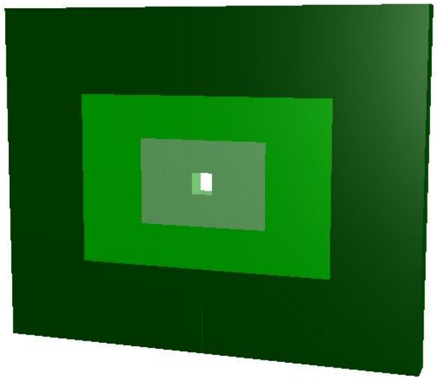


Task 2.3 - Scientific/technical highlights - III

Lukas Chlad, Ilya Selyuzhenkov

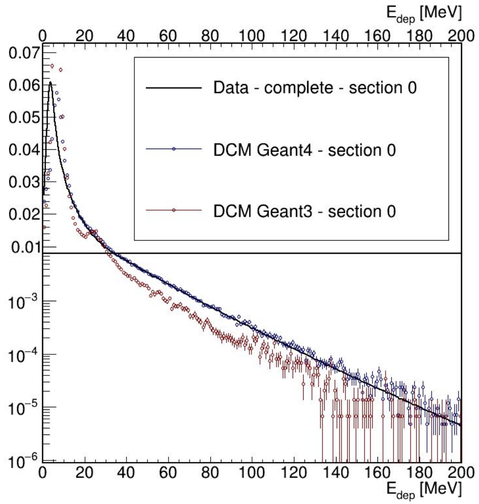
Monte-Carlo studies for new CBM Forward detector

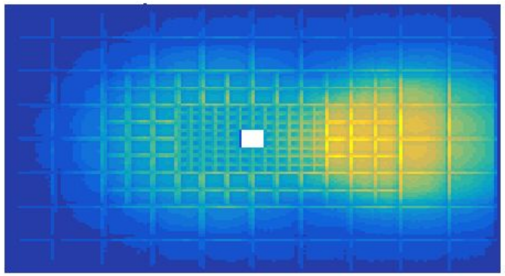
- Spectator fragments detection
  for beam momenta pbeam = 3.3−12 AGeV/c
- Operation at beam intensities up to 10^9 Au ions per second
- Reaction plane determination with an accuracy better than 40 degree
- Determination of collision centrality classes with an accuracy better than 10%



Simulations

- DCM-QGSM-SMM
  model with fragments
- Geant4
- Operational background from
  Beam paprticles and
  detector materials (beam pipe, etc)





Task 2.3 - Scientific/technical highlights - IV

Gábor Balassa, György Wolf

Hypernuclei production with a modified coalescence model in BUU transport

- Aim: Describing single and double-strange hypernuclei in moderate energy (few A GeV incident energies) heavy ion collisions using Boltzmann-Uehling-Uhlenbeck (BUU) model off-shell transport & coalescence at the final stage

- BUU included: Hadronic degrees of freedoms with many resonances
  Momentum dependent mean field for baryons
  Coulomb effects for charged particles
  Pauli exclusion, off-shell propagation, etc…
  Collisions of nuclei, proton, pion, antiproton

- Coalescence model:
  - Extension of the collisional criteria
  - The interaction range is given by the corresponding total cross sections
  - Parameters: coalescence time + probability for a cluster to stay together

Task 2.3 - Scientific/technical highlights - IV

Gábor Balassa, György Wolf

- Coalescence time is fitted to the low energy FOPI data for charged multiplicities
- NN cross sections obtained from low energy Cugnon parametrization

$$b = \sqrt{R_{12}^2 - \frac{h_{12}^2}{v_{12}^2}},$$

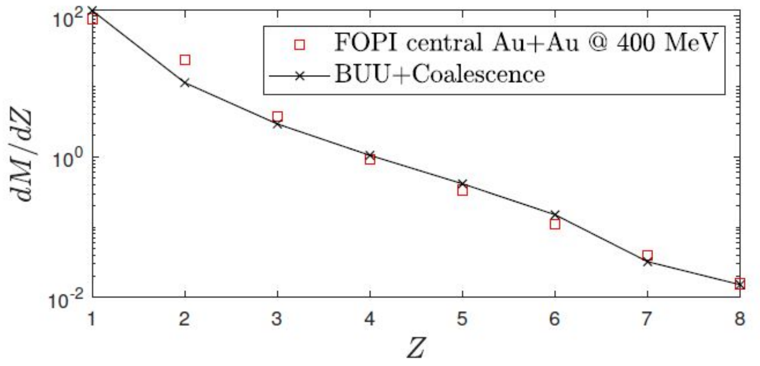
$$R_{12}^2 = -(x_1 - x_2)^2 - \left(\frac{p_1(x_1 - x_2)}{m_1}\right)^2$$

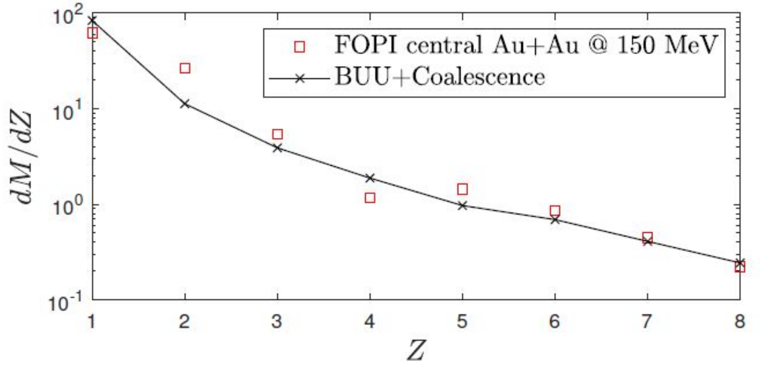
$$h_{12} = \frac{p_1(x_1 - x_2)}{m_1} - \frac{p_2(x_1 - x_2)m_1}{p_1 p_2}$$

$$v_{12} = 1 - \left(\frac{m_1 m_2}{p_1 p_2}\right)^2,$$

$$\tau_1 = -\frac{p_1(x_1 - x_2)}{m_1} + \frac{h_{12}}{v_{12}^2}$$

$$\tau_2 = \frac{p_2(x_1 - x_2)}{m_2} + \frac{h_{21}}{v_{12}^2}$$

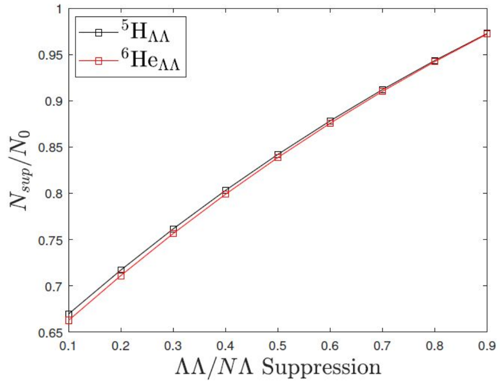




Task 2.3 - Scientific/technical highlights - IV

Gábor Balassa, György Wolf

- Hypernuclei production in 0-10% central Au+Au collisions
- ΛN interaction strength from measurements
- ΛΛ interaction strength estimated from:
  - ΛΛ=ΛN
  - ΛN=k*ΛN , k<1



- The energy dependence and expected yields are comparable with other calculations