EURIZON Annual Meeting 2023

European network
for developing new horizons for RIs

Task 2.5
Status of Forward Wall

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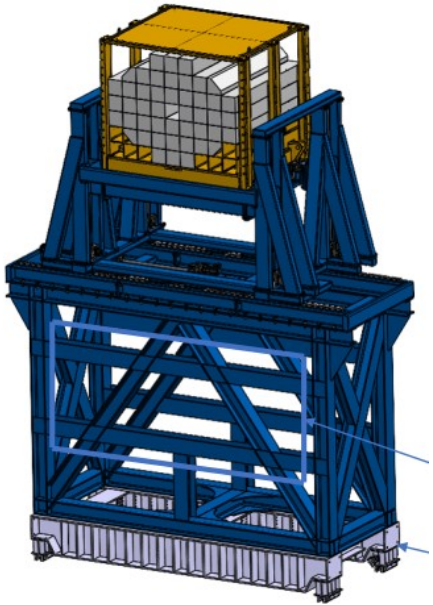
Team structure

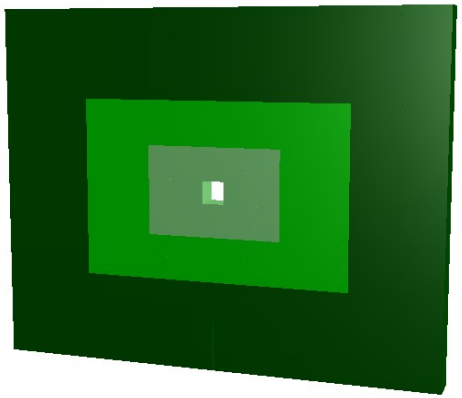
- **Czech Technical University**
  - Petr Chaloupka
  - Petr Chudoba – readout electronics
  - Radim Dvorak (starting Ph.D.) - response sim.
  - Ondrej Hofman (Msc.) – FLUKA backround studies
  - Kristyna Haismanova (Bc.) – SiPM testing
- **NPI, Řež**
  - Andrej Kugler – task leader
  - Lukáš Chlad until 31.10.2022
  - Leszek Kosarzewski since March 2023?
- **GSI** – physics performance studies
  - Ilya Selyuzhenkov
  - Lukáš Chlad since 1.11.2022
  - Oleksii Lubynets
  - Frédéric Linz

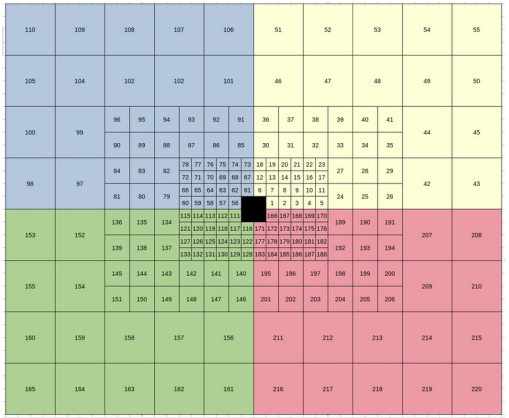
Urgent need of PSD replacement

- Projectile Spectator Detector
  - Hadronic zero degree calorimeter



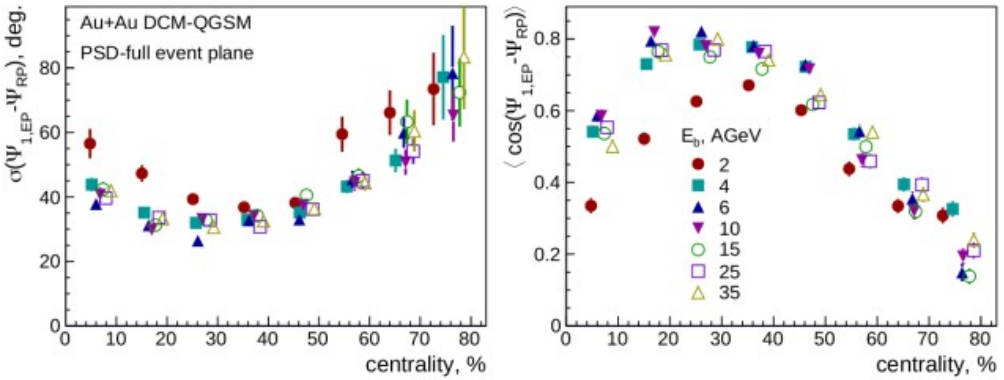
- Forward Wall
  - Scintillator hodoscope



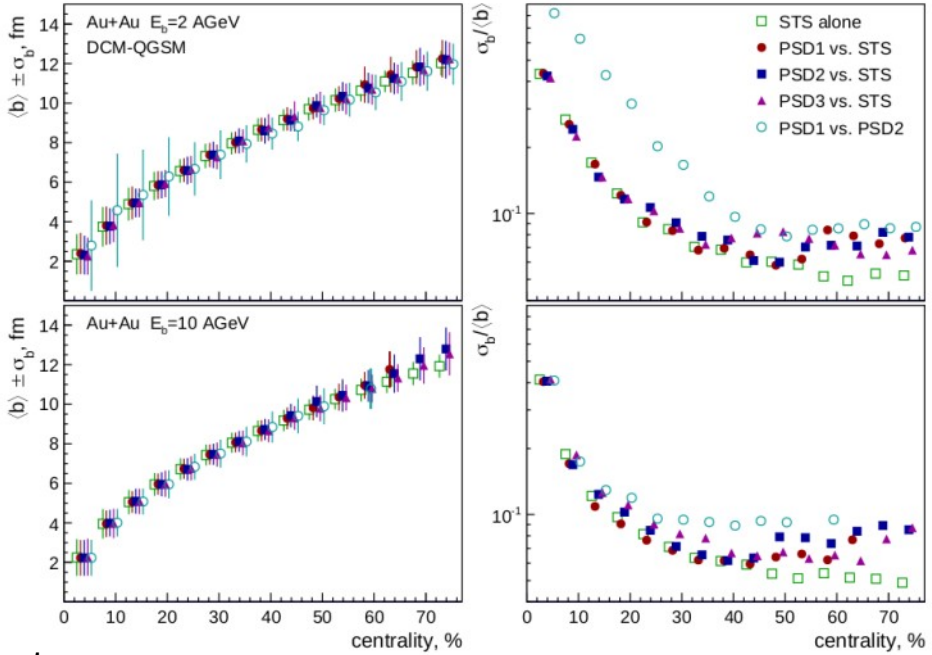


Physics expected from PSD

- Reaction plane estimation



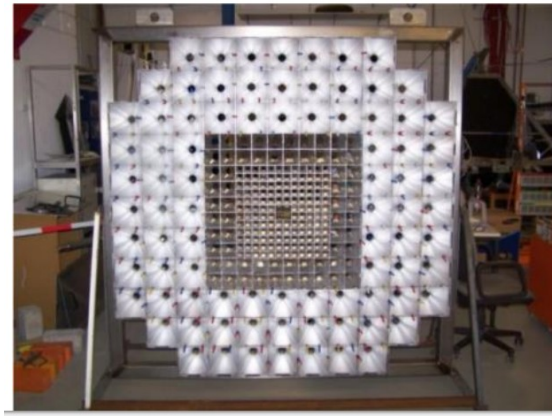
- Centrality determination



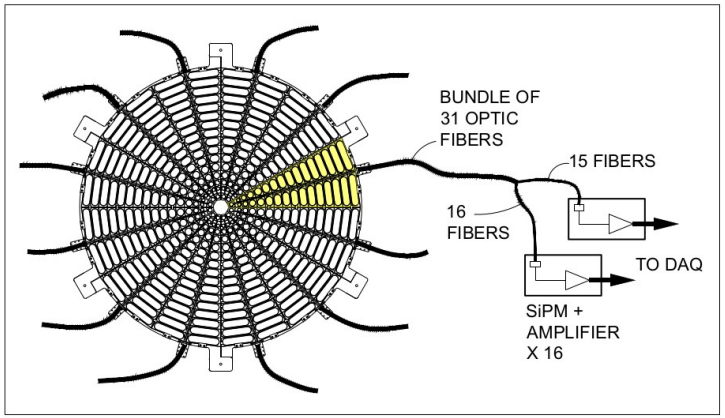
Figures from CBM-PSD Technical Design Report

Scintillator detectors @ HI experiments

- Forward Wall @ HADES
  - Read-out by PMTs
  - Both Event-Plane estimation and Centrality Determination

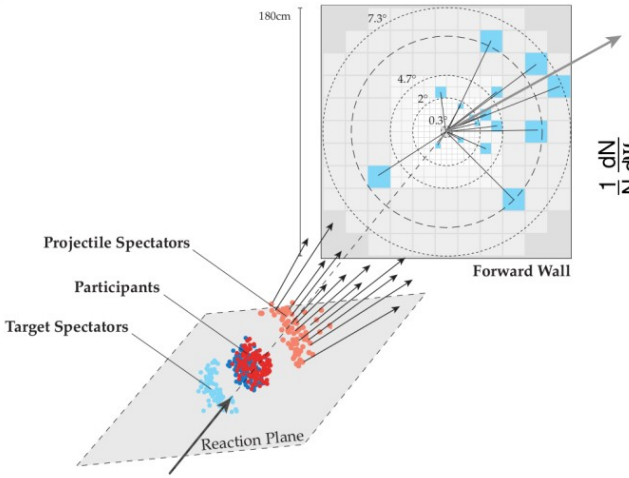


- Event Plane Detector @ STAR
  - Read-out by WLS fibers leading to SiPMs
  - Only EP estimation



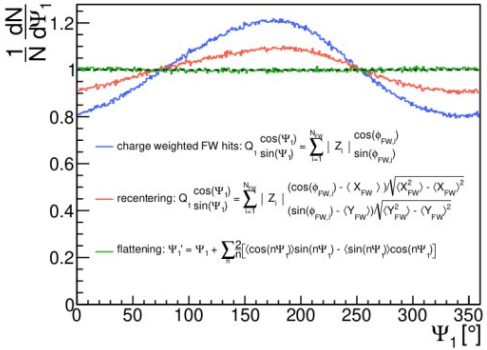
HADES experience – EP estimation

$$Q_n \cos(n\Psi_n) = \frac{1}{N_{\mathrm{FW}}} \sum_{i=1}^{N_{\mathrm{FW}}} |Z_i| \cos(n\phi_{\mathrm{FW},i})$$

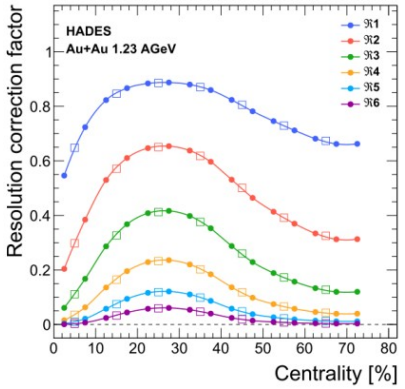


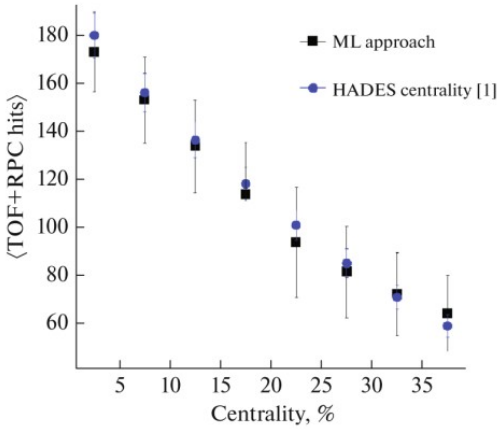
Effects of non-uniform acceptance / tilt of beam

PRC 55 (1997) 1420

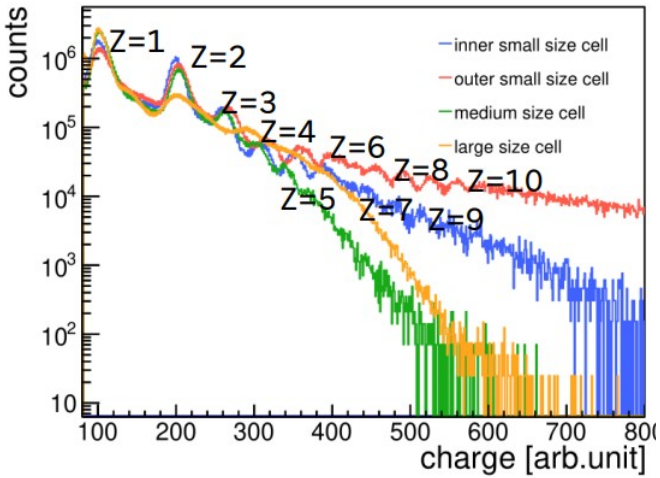


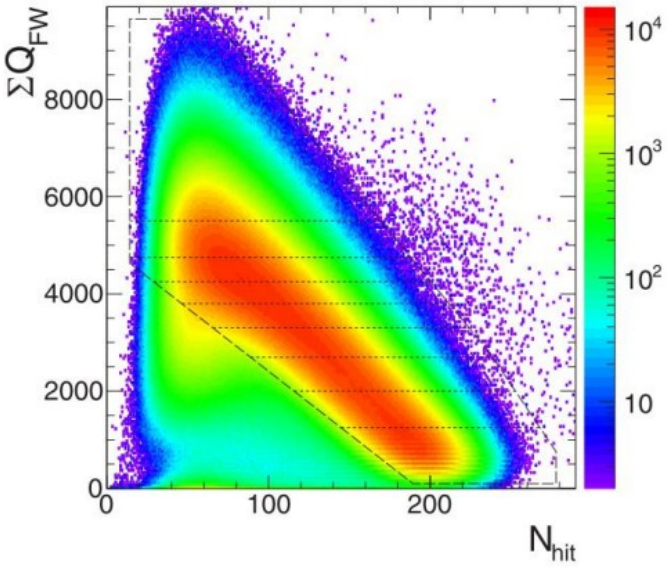
Arxiv 2208.02740

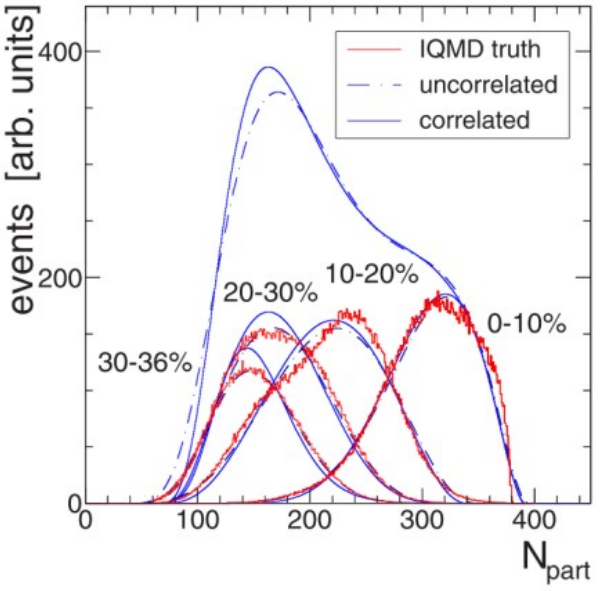




HADES experience – Centrality determination

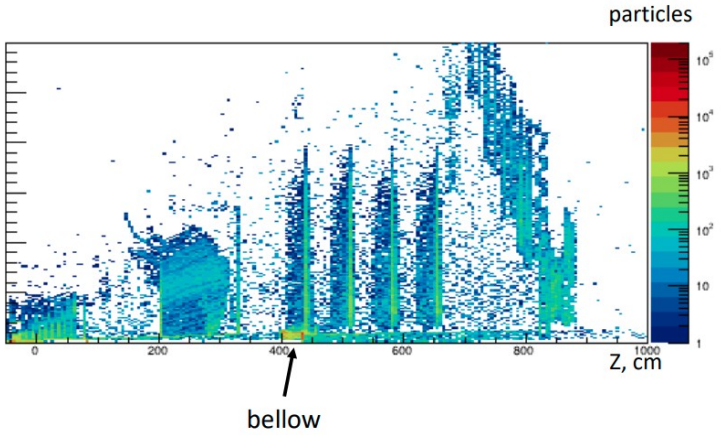


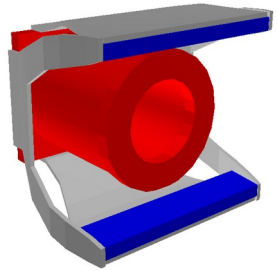




Forward Wall challenges

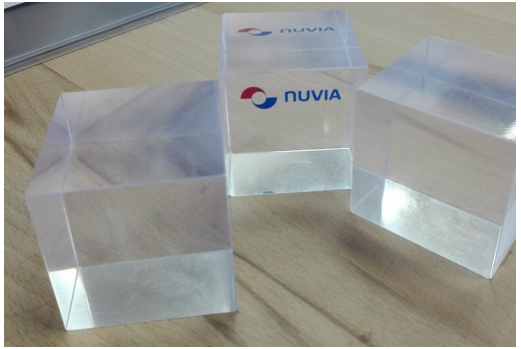
- Radiation hardness
  - Large dose expected (very high rates up to 10 MHz collisions, heavy fragments detection necessary)
  - Importance of FLUKA beam pipe simulations
  - Sensitive electronics can be positioned further away using the optical fibers guiding light
- Fast read-out
  - Due to high rates
- Reasonable budged and Time constrain to have detector ready first day of CBM operation

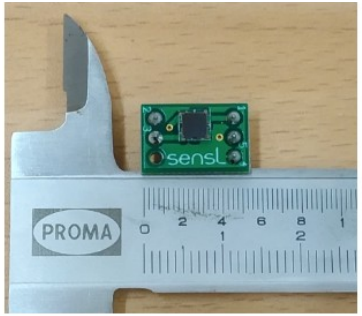




Module components

- Scintillator material
  - Plastic ZnS scintillator - not rad. hard, cheap replaceable
  - Possibly LYSO crystal - central part
- Light guide fibers
  - Direct attachment to scintillator (CALICE, HADES iTOF)
  - WLS + optical fibers (STAR EPD)
- SiPMs
  - Hamamatsu (heavily tested for PSD)
  - ON Semiconductor (in cooperation with eRHIC detector development)

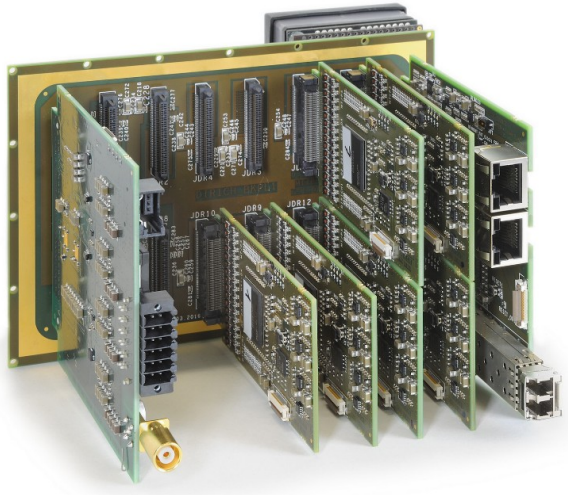


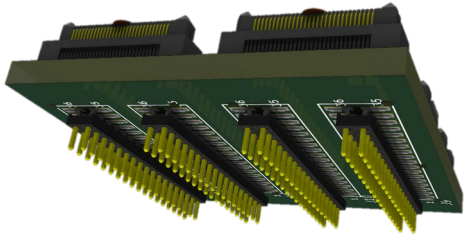


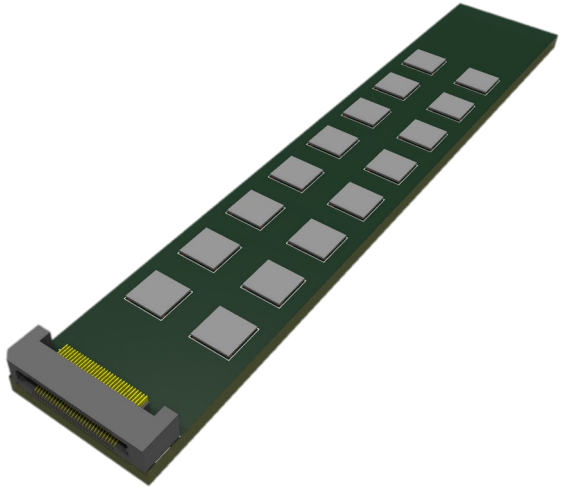
Test board

Read-out electronics

- Use as much GSI developed technology as possible
  - Developed DiRICH boards concentrators
  - New board holding SiPM and convetor board to match DiRICH

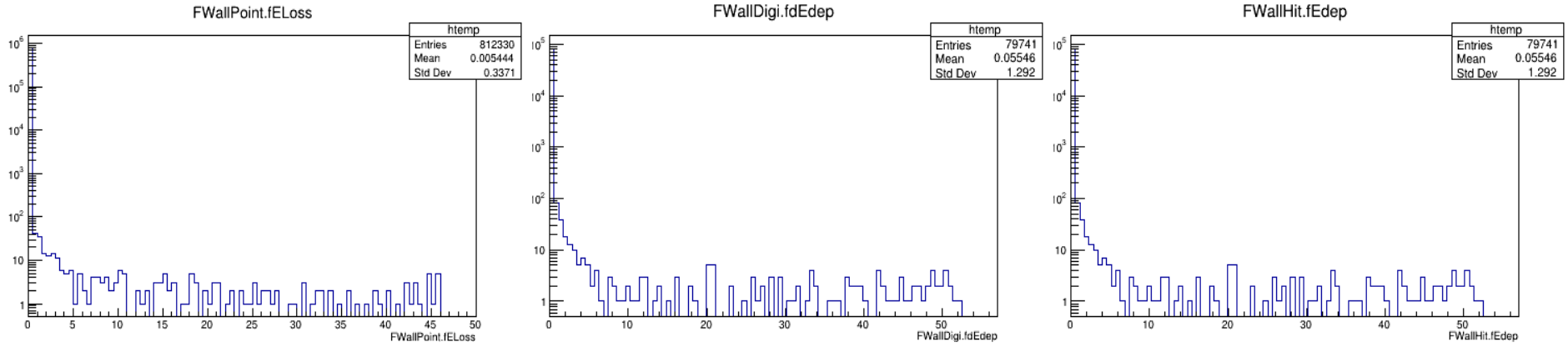






Software development

- Necessity to optimize design of FWALL
- Set of simulations need to be carried out => functional chain (**transport, digitization, hit reconstruction,** physics performance analysis)



Plans for 2023

- Simulate radiation conditions and perform tests (probably next year @mCBM) of scintillator material & SiPM
- Study the influence of beam-pipe (especially the bellow)
- Optimize design (size and position of scintillator cells, size of detector and beam-hole)
- Finalize and review design of read-out electronics
- Collaborate with eRHIC colleagues on SiPM testing

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