EURIZON Annual Meeting 2023

European network
for developing new horizons for RIs

Task 2.5
Status of Forward Wall

Lukáš Chlad[1,$]
[1] Eberhard Karls Universität Tübingen, Physikalisches Institut
[$] formerly at NPI CAS Řež & FNSPE CTU Prague

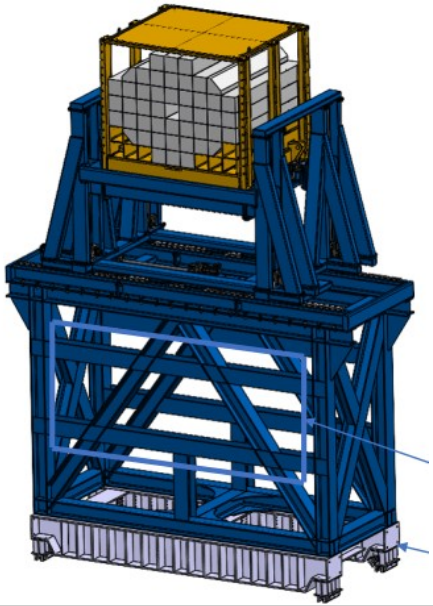
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072

Team structure

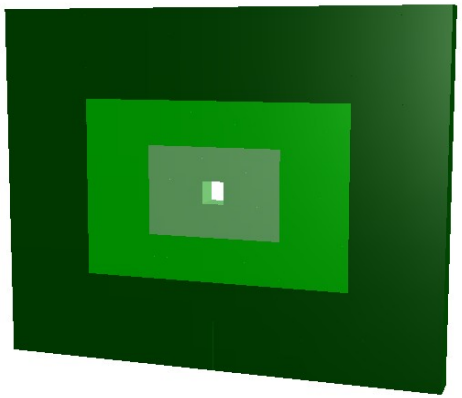
- **Czech Technical University**
  - Petr Chaloupka
  - Petr Chudoba – readout electronics
  - Radim Dvorak (starting Ph.D.) - response sim.
  - Ondrej Hofman (Msc.) – FLUKA backround studies
  - Kristyna Haismanova (Bc.) – SiPM testing
- **NPI, Řež**
  - Andrej Kugler – task leader
  - Lukáš Chlad until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

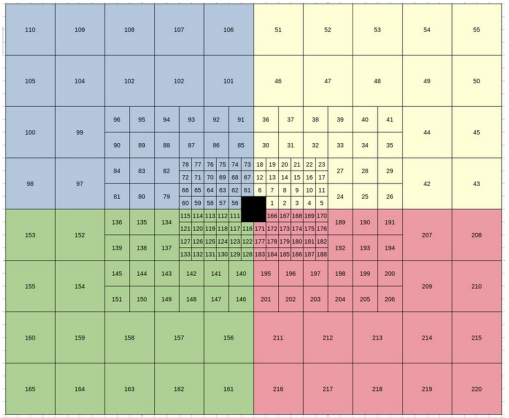
Urgent need of PSD replacement

- Projectile Spectator Detector
  - Hadronic zero degree calorimeter



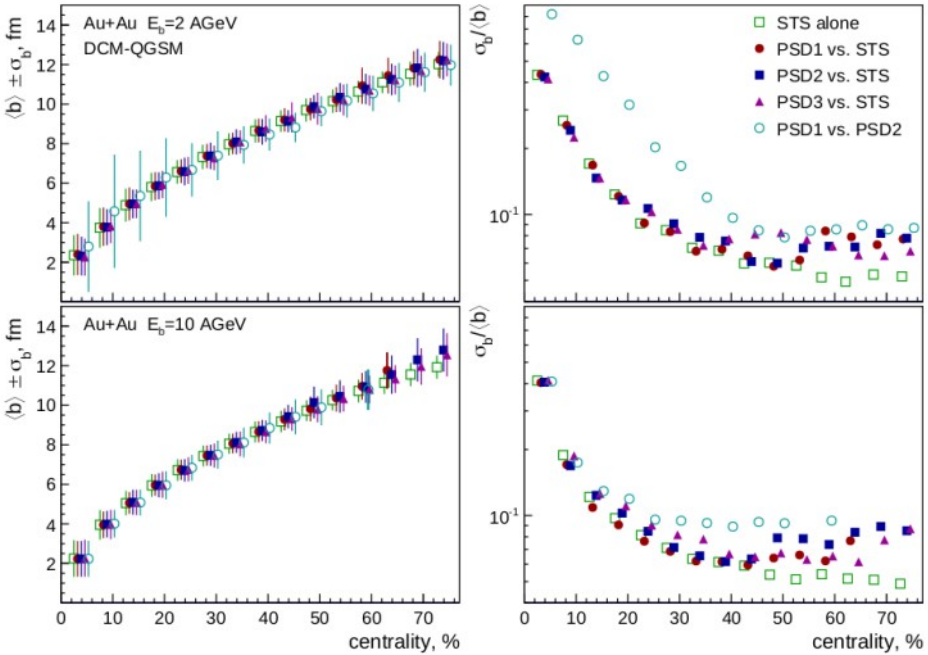
- Forward Wall
  - Scintillator hodoscope



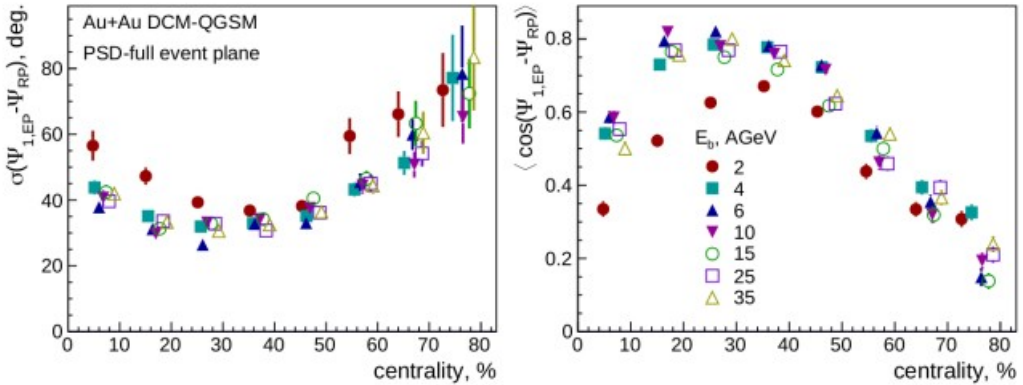


Physics expected from PSD

- Reaction plane estimation

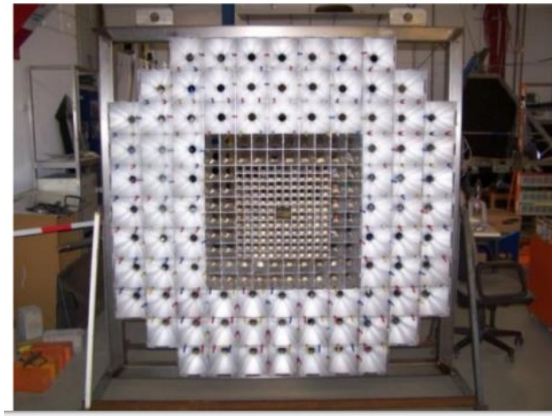


- Centrality determination

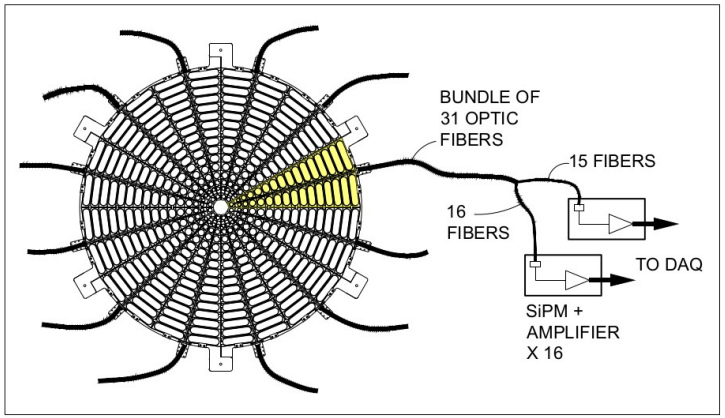


Scintillator detectors @ HI experiments

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

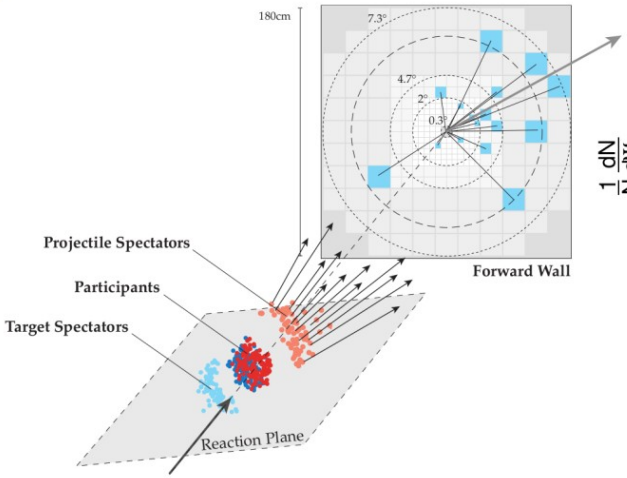


- Event Plane Detector @ STAR
  - Read-out by WLS fibers leading to SiPMs
  - Only EP estimation



HADES experience – EP estimation

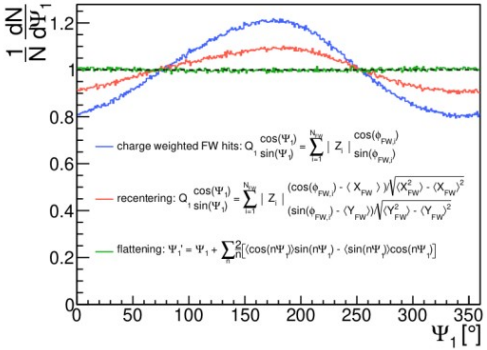
$$Q_n \cos(n\Psi_n) = \frac{1}{N_{\mathrm{FW}}} \sum_{i=1}^{N_{\mathrm{FW}}} |Z_i| \cos(n\phi_{\mathrm{FW},i})$$



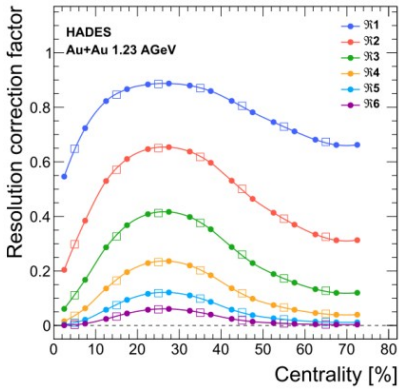
Q_{EP}

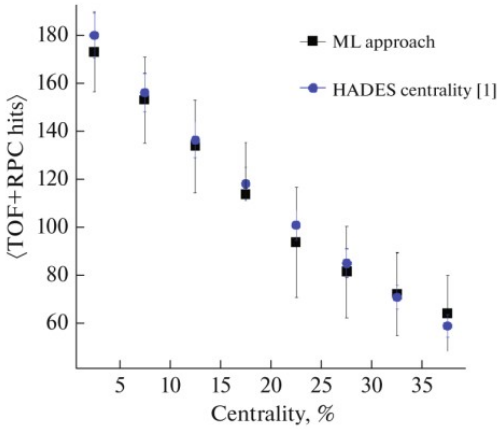
Effects of non-uniform acceptance / tilt of beam

PRC 55 (1997) 1420

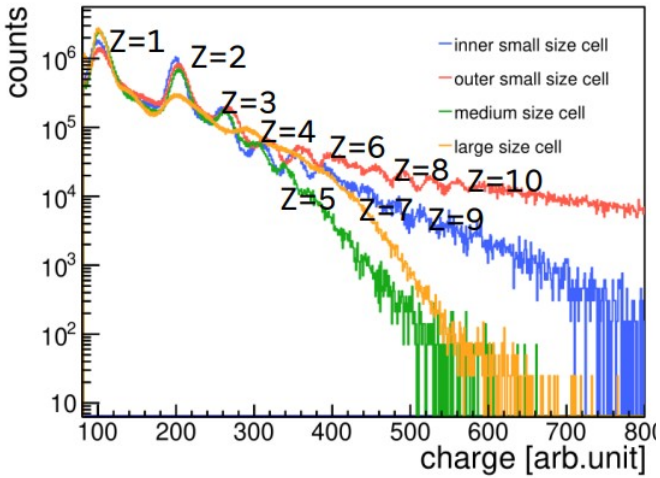


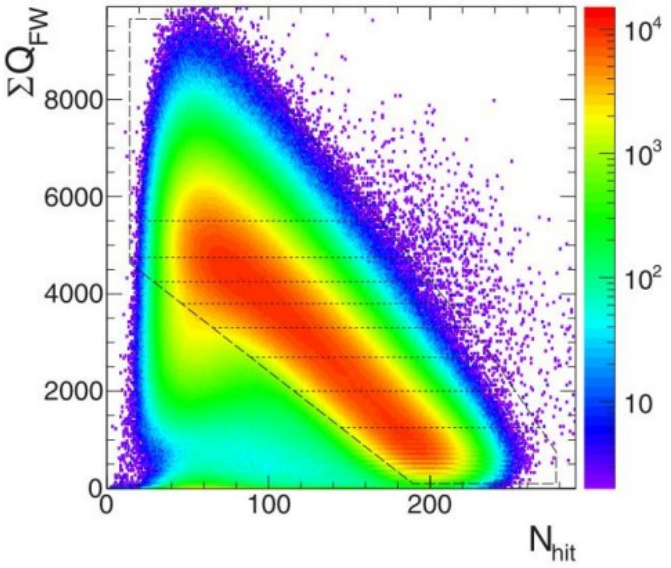
Arxiv 2208.02740

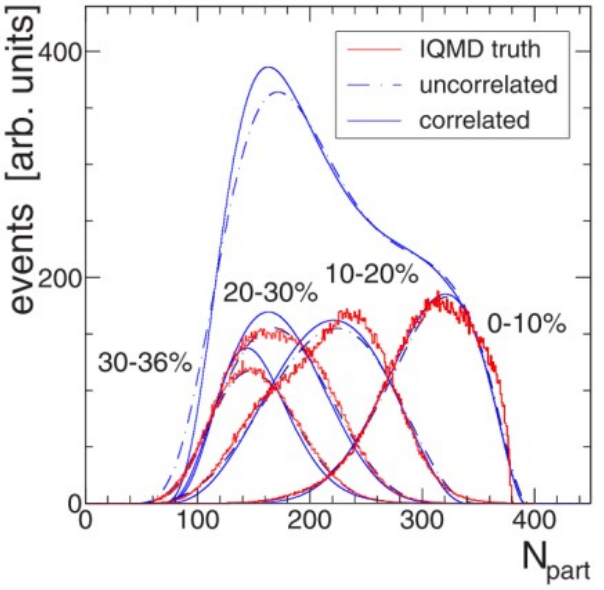




HADES experience – Centrality determination

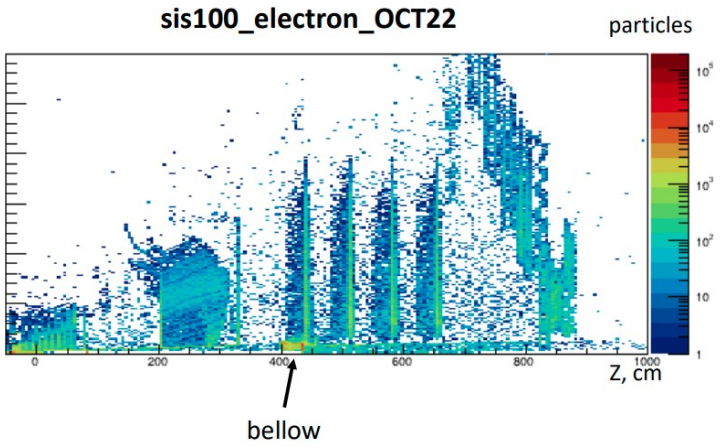


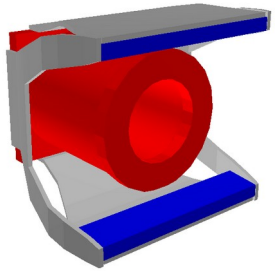




Forward Wall challenges

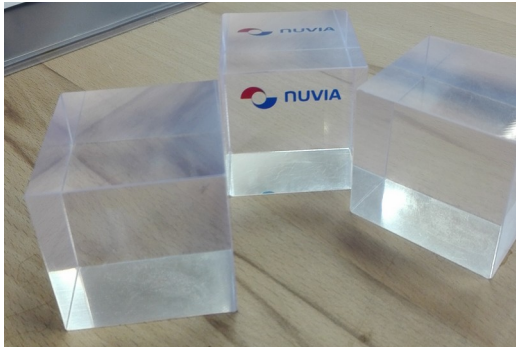
- Radiation hardness
  - Large dose expected (very high rates up to 10 MHz collisions, heavy fragments detection necessary)
  - Importance of FLUKA beam pipe simulations
  - Sensitive electronics can be positioned further away using the optical fibers guiding light
- Fast read-out
  - Due to high rates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

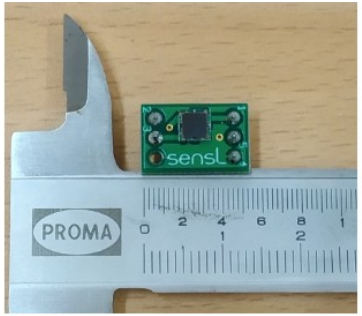




Module components

- Scintillator material
  - plastic ZnS scintillator - not rad. hard, cheap replaceable
  - LYSO crystal (offered from Juelich) - 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)

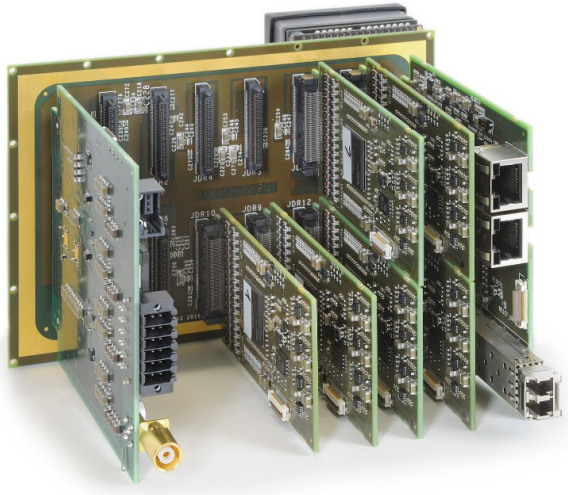


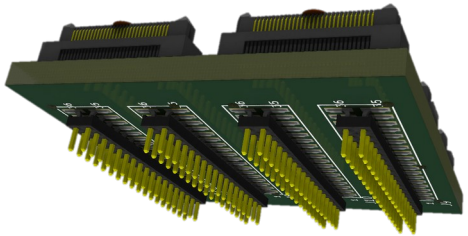


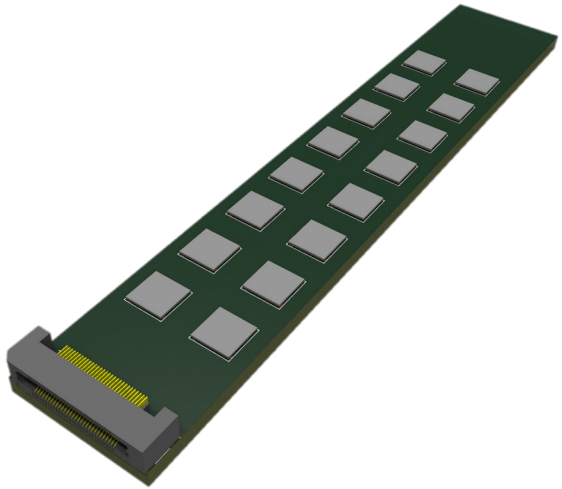
Test board

Read-out electronics

- Reuse as much as possible
  - Use DiRICH boards concentrators
  - Board holding SiPM and convetor board to match DiRICH

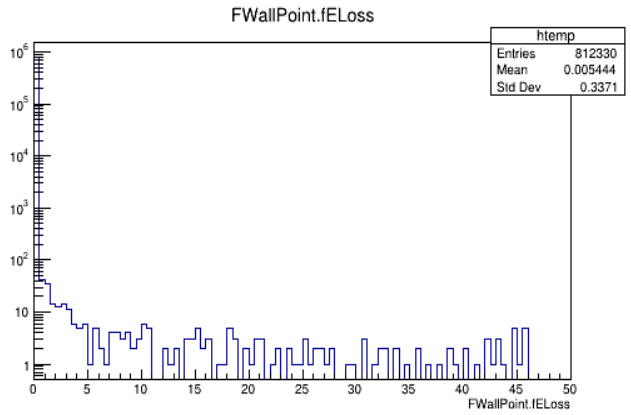


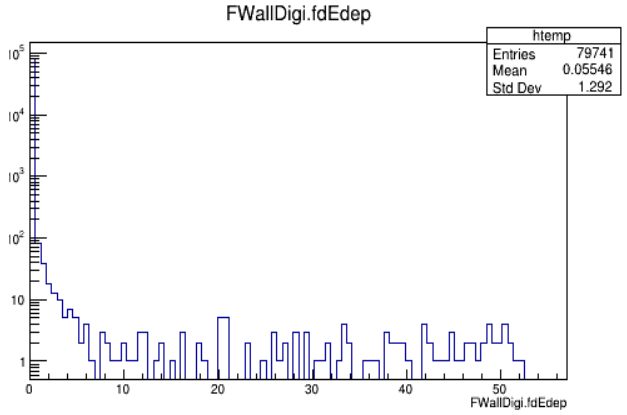


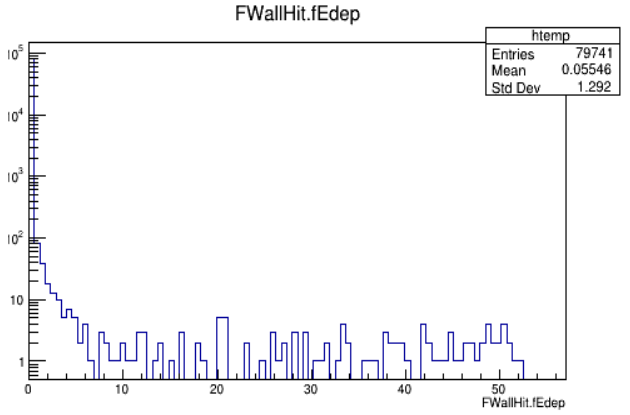


Software development

- 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

eurizon

European network
for developing new horizons for RIs

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