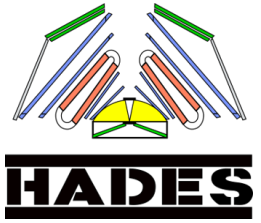
CZECH PARTICIPATION @ HADES

Lukas Chlad on behalf of HADES group at NPI of the CAS

Day with particle and astroparticle research infrastructure

October 17, 2022

HIGH ACCEPTANCE DI-ELECTRON SPECTROMETER



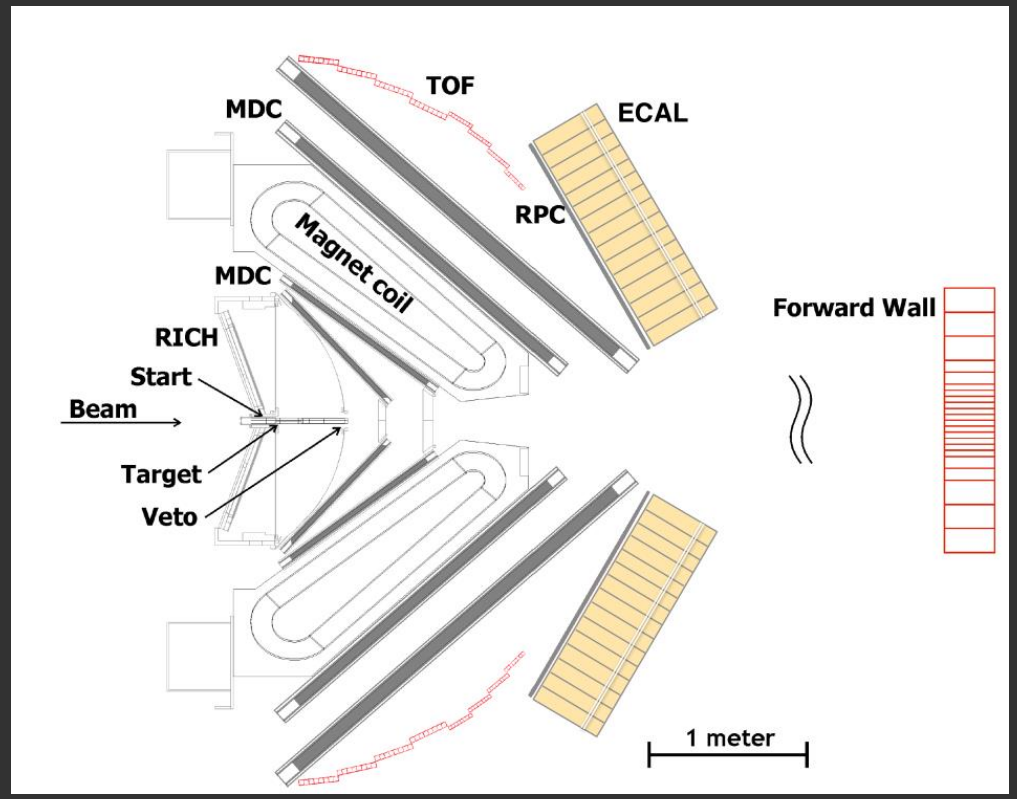
- Collaboration consists of ~130 scientist from 20 European research institutions and universities
- Started in the mid '90s with the aim to revise dilepton spectra measurements in the vector meson mass region (large acceptance, mass resolution δm/m ≈ 2%)
- Thanks to a continuous upgrade of individual parts we investigate as well subthreshold strangeness production, proton fluctuation, transverse flow etc.

Year	Colliding system	$\sqrt{s_{NN}}$[GeV]	$N_{\text{events rec.}}[\times 10^9]$
2002	$\mathrm{C}+\mathrm{C}$	2.70	0.25
2004	$p+p$	2.77	0.44
2004	$\mathrm{C}+\mathrm{C}$	2.32	0.50
2005	$\mathrm{Ar}+\mathrm{KCl}$	2.61	0.93
2006	$d+p$	2.37	0.85
2007	$p+p$	2.42	1.70
2007	$p+p$	3.18	1.18
2008	$p+\mathrm{Nb}$	1.93	4.21
2012	$\mathrm{Au}+\mathrm{Au}$	2.42	7.31
2014	$\pi^-+\mathrm{C}$	1.98	0.40
2014	$\pi^-+\mathrm{W}$	1.89	
2014	$\pi^-+\mathbf{p}(\mathrm{PE}-2\mathrm{C})$	$1.47-1.56$	1.23
2019	$\mathrm{Ag}+\mathrm{Ag}$	2.55	13.61
2022	$p+p$	3.46	41.40

List of HADES published articles

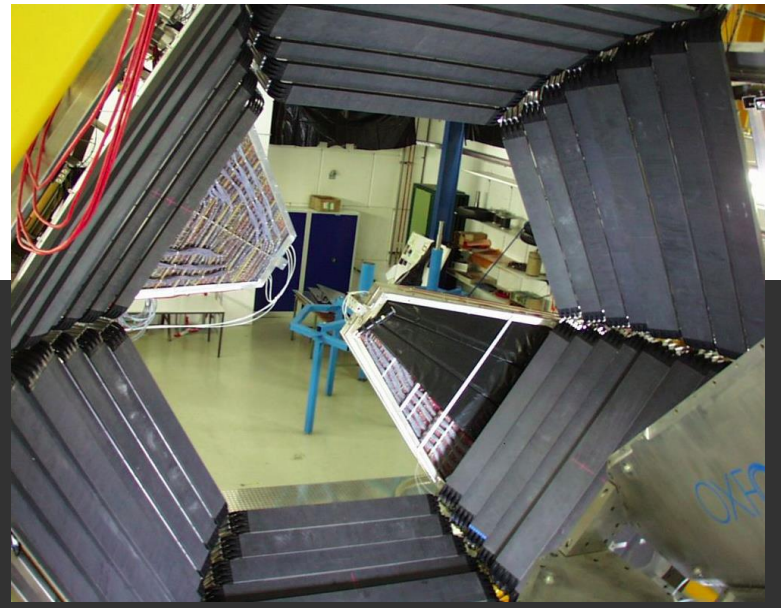
CZECH PARTICIPATION @ HADES

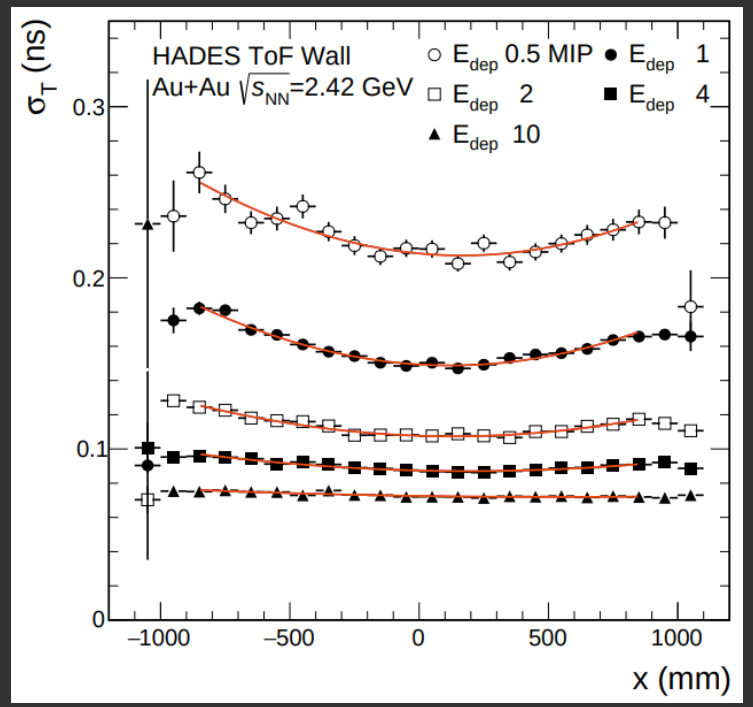
- NPI is founding member (mid '90s)
- Very active group under leadership of A. Kugler has built TOF, ECAL (with German & Polish colleagues), and FWALL (with Russian colleagues) => responsibility of their calibration
- The group importance well recognized within collaboration (A. Kugler was chairman of CB, P. Tlusty is deputy spokesperson)
- Several student thesis over the years

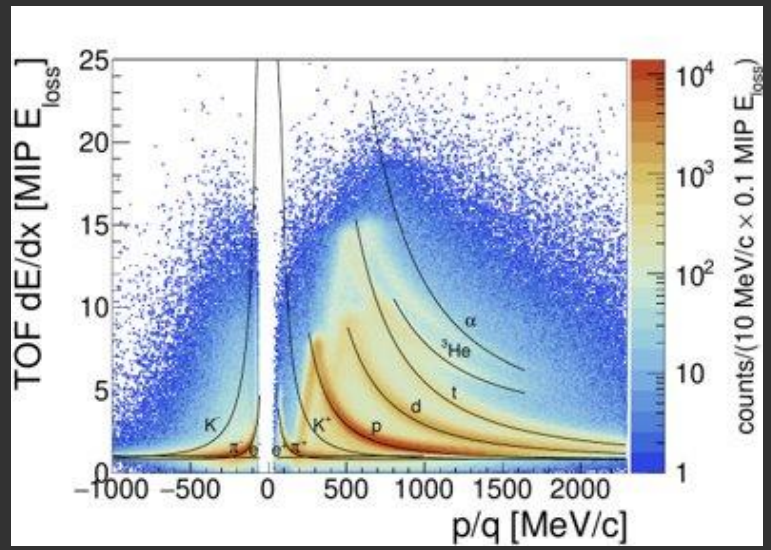


TIME OF FLIGHT DETECTOR

- Covers large polar angle (between 44° and 85°)
- Each sector consists of 8 modules, each with 8 scintillator rods (BC408) read-out by PMTs (EMI9133B) at both sides
- Calibration is divided into 2 steps
  - Time, X position shifts, E_{loss} scale
  - Detailed time-walk for virtual segments of rods
  - Usually done by students within our group
- Offers time resolution ~ 150ps and additional measurement of deposited energy







ELECTROMAGNETIC CALORIMETER

- Replacement of Pre-Shower detector used for better hadron/electron suppression
- Extends the capability of HADES for photon measurement ($\pi^0/\eta \rightarrow \gamma\gamma$ or hyperon decays with γ)
- Upgrade started in 2015 to be finished this year

1 Brass envelop

2 Alu hollow housing

3 Brass plate

4 Fitting

5 End cap

6 Tyvek paper

7 Lead glass prism

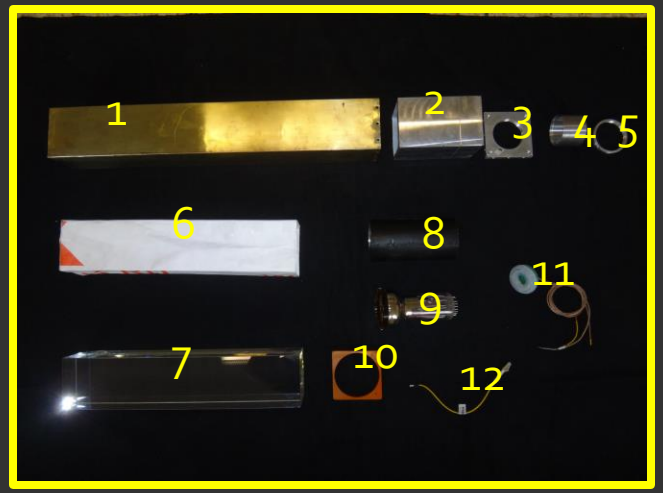
8 Magnetic shielding

9 PMT

10 Plastic plate

11 HV divider

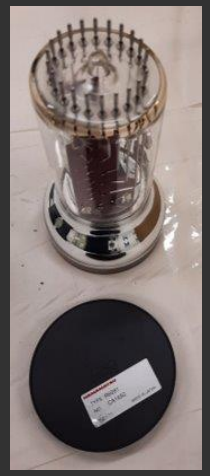
12 Optical cable

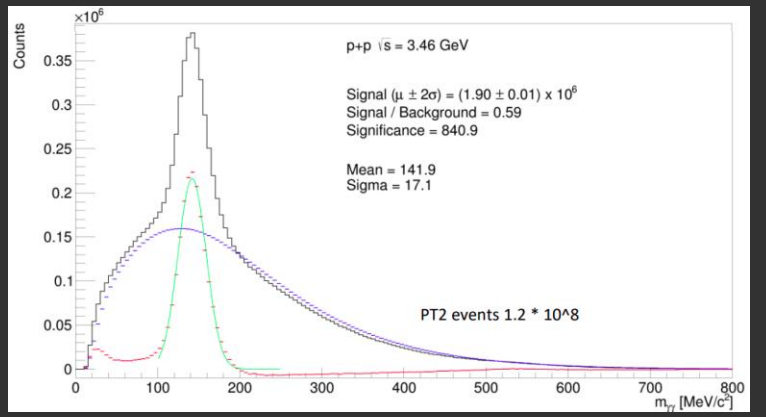


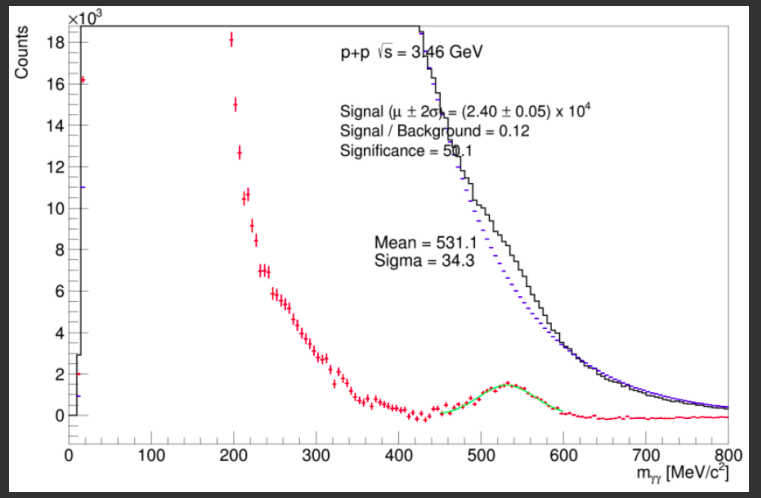
ELECTROMAGNETIC CALORIMETER

- Extends the capability of HADES for photon measurement (π^0/η->$\gamma\gamma$ or hyperon decays with γ)
- Upgrade started in 2015 to be finished this year

PMT treatment – electrostatic shielding (>600 PMTs)



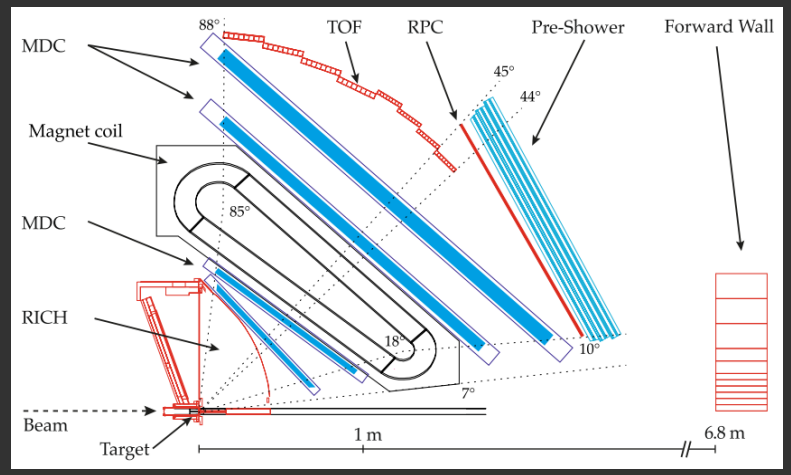


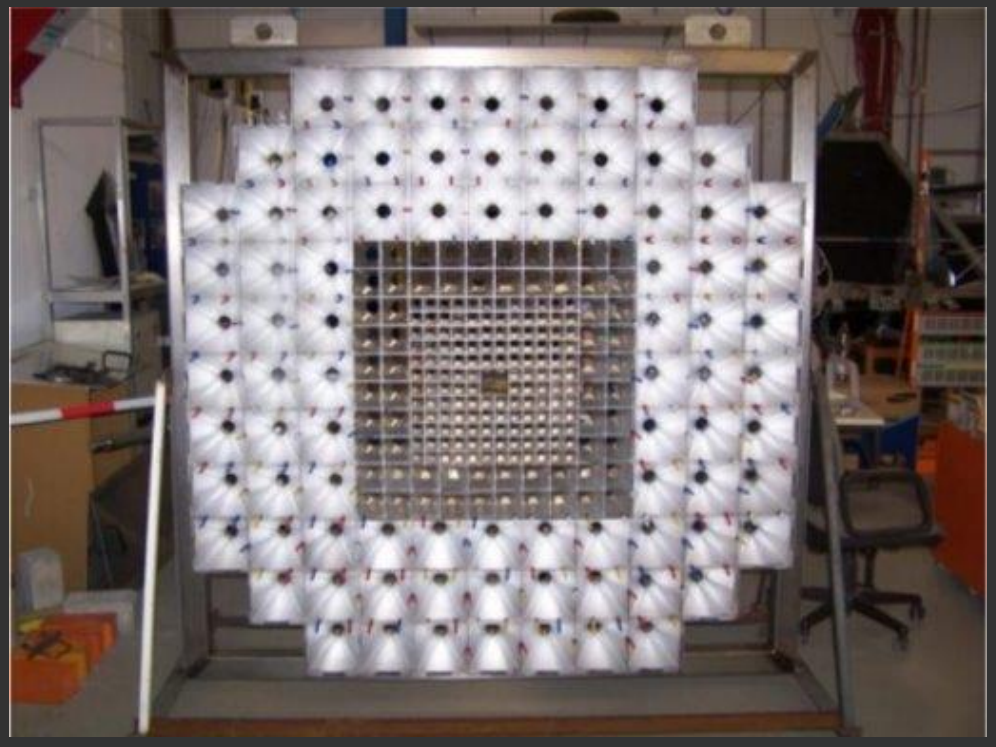


Data collected this year!

FORWARD WALL

- Size of cells 4x4, 8x8 and 16x16 cm^2
- Covering polar angle between 0.33° and 7.17° (7m distance from target)
- Provide rapidity separated measurement w.r.t. rest of HADES spectrometer
- Used for Centrality and Event Plane determination





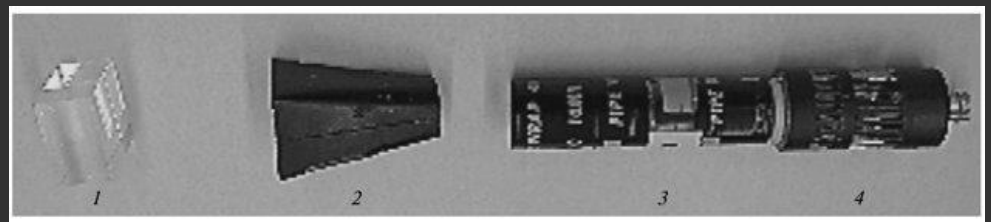
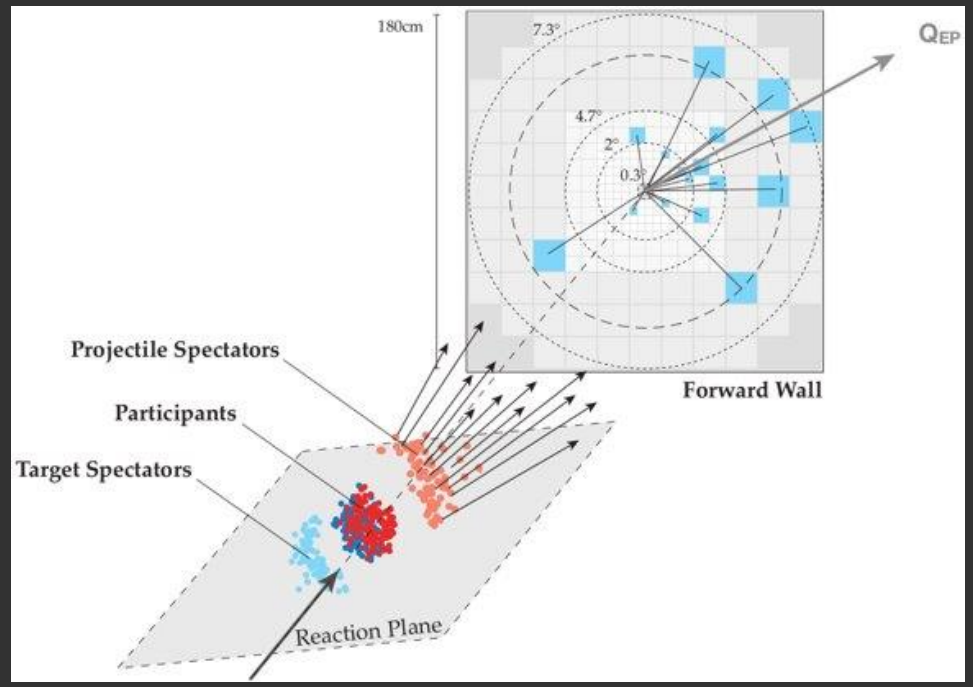


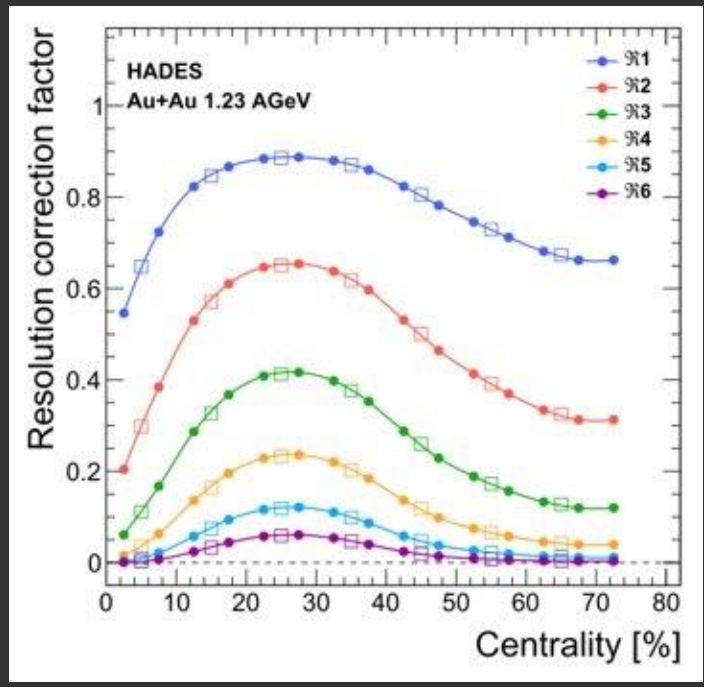
Fig. 4. Functional elements of the scintillating detector cells in the forward hodoscope: (*1*) BC408 scintillator, (*2*) air light guide, (*3*) XP2982 and XP2262 PMTs, and (*4*) HV divider.

FORWARD WALL

- Charged spectators position measurement is converted to Event Plane (our best guess of the true Reaction Plane)

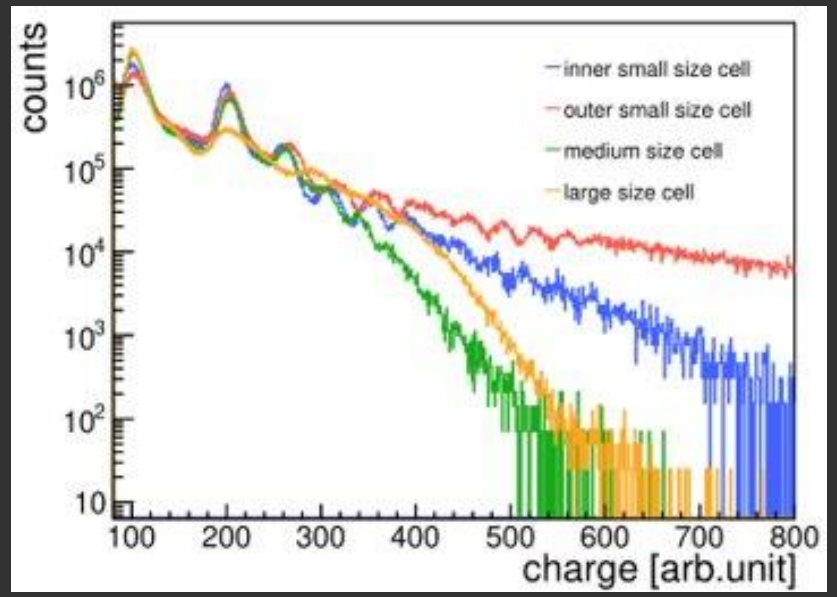


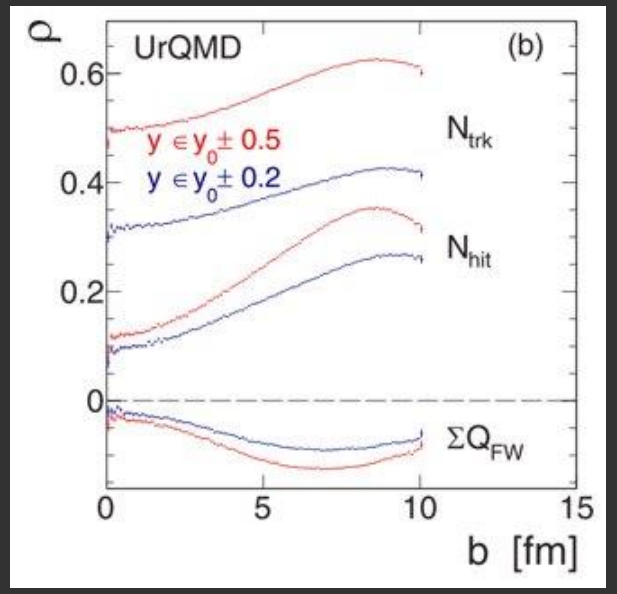
- Very good resolution of the azimuthal angle of EP allows to measure up to 6th order transverse flow harmonic (PRL 125, 262301 (2020))

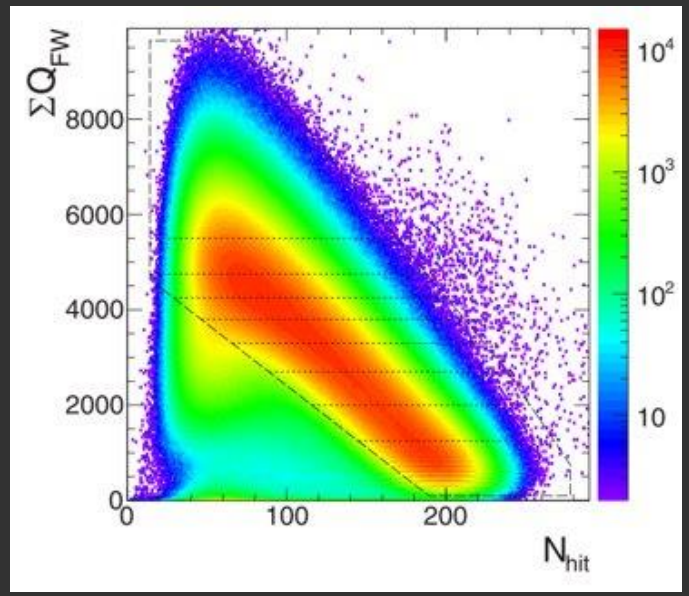


FORWARD WALL

- Centrality usually determined with Glauber MC and $N_{TOF+RPC}$ hits
- Not possible for some applications (net-proton number fluctuation)
- Sum of spectator charge could be well used

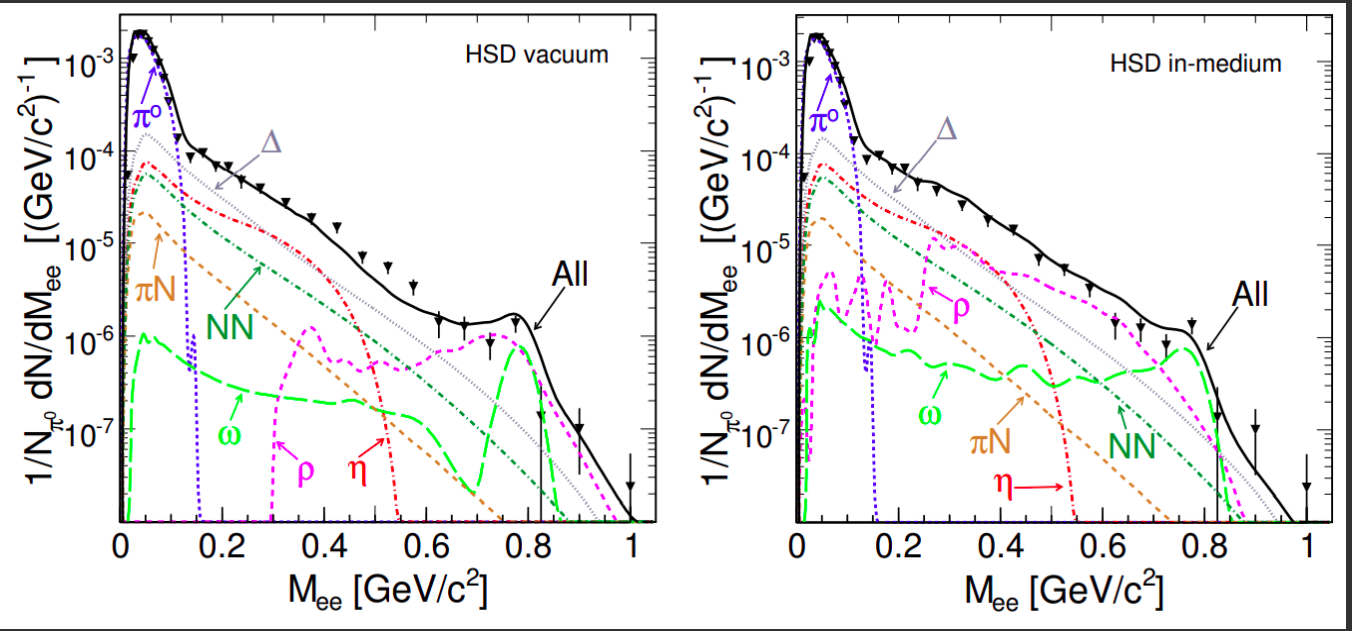




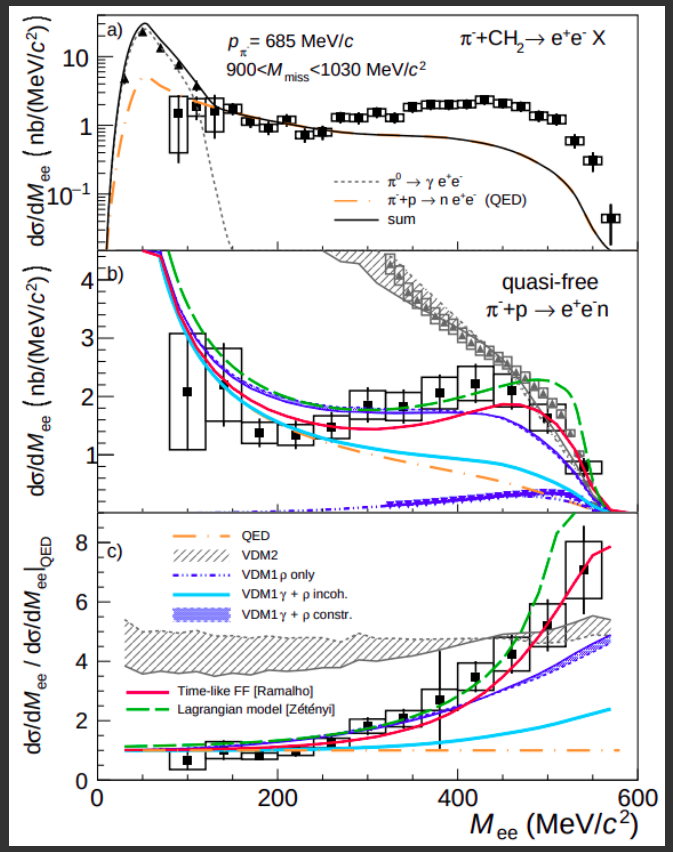


PHYSICS ANALYSIS - DILEPTONS

- In-medium hadron properties at medium-heavy ion collisions Ar+KCl @ 1.76A GeV

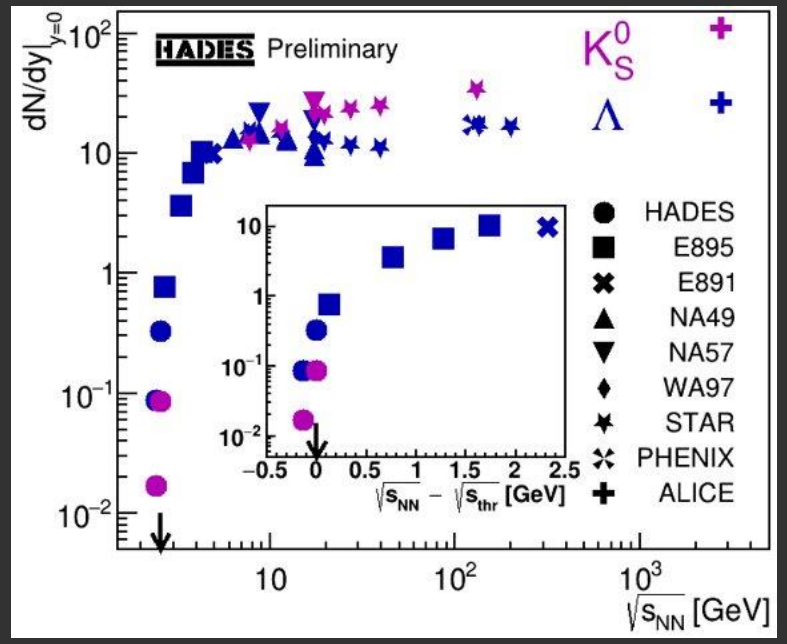


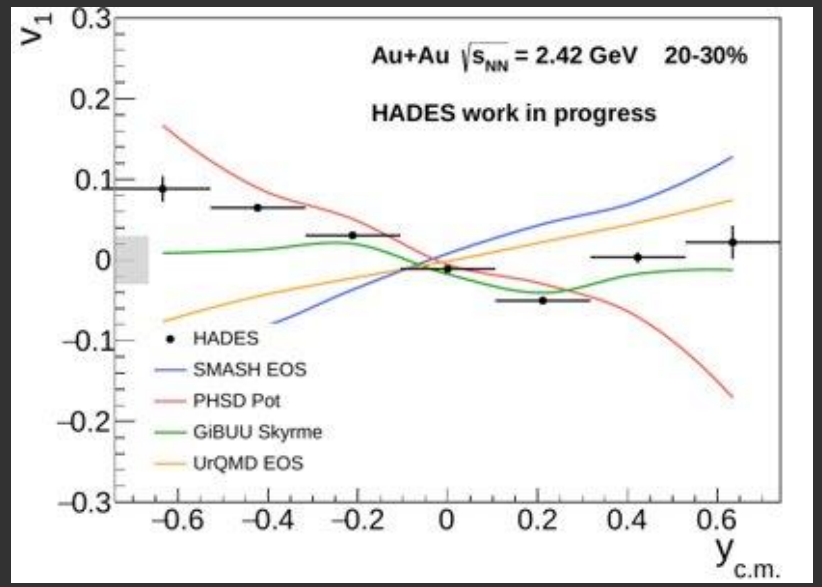
- First information on the timelike electromagnetic structure of baryons in the second resonance region

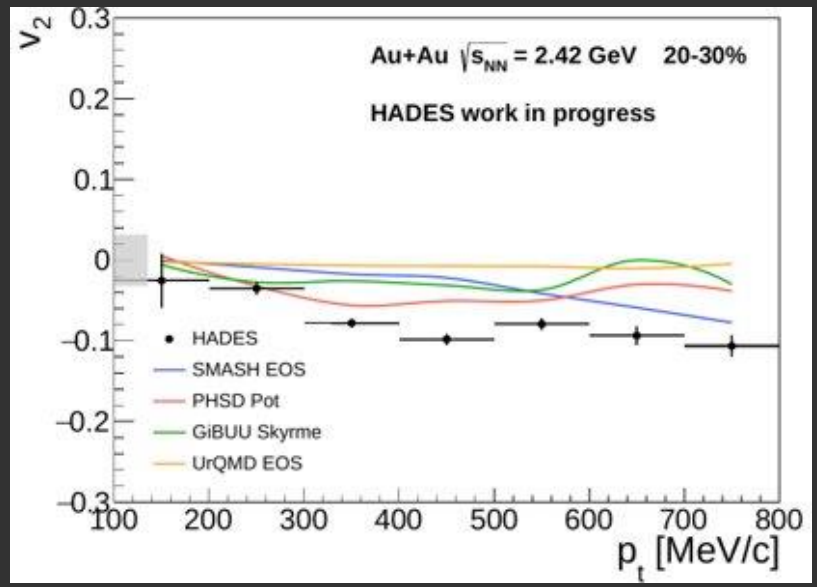


PHYSICS ANALYSIS - STRANGENESS

- At SIS18 energy region sub-threshold collisions
- Allows to have a strong sensitivity for different effects allowing strange hadron production in heavy-ion collisions
- Kaon flow considered to be a good probe of in-medium potentials







THANK YOU FOR YOUR ATTENTION!