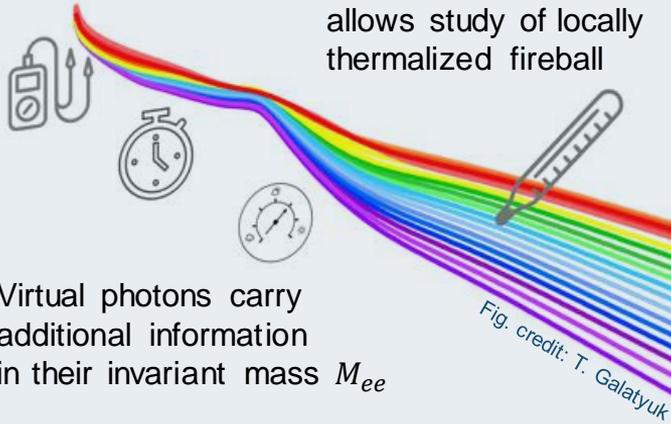


# Centrality and system size dependence of the thermal dilepton excess yield in HADES

## The promise of electromagnetic probes

Direct access to all stages in heavy-ion collisions

In particular: isolation of thermal contribution allows study of locally thermalized fireball



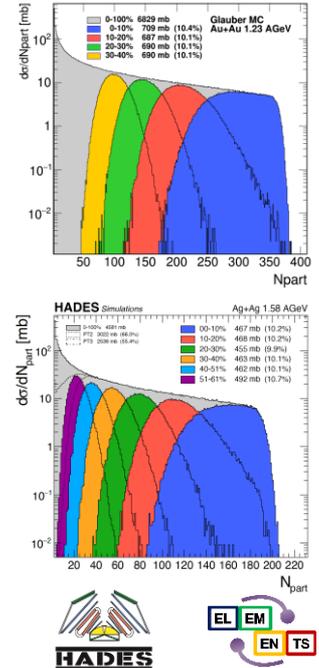
## The experimental data

$3 \cdot 10^9$  Au+Au and  $8 \cdot 10^8$  Ag+Ag selected collision events, both at  $\sqrt{s_{NN}} = 2.42$  GeV:

Same energy

Overlapping centralities with same mean number of participants  $\langle A_{part} \rangle$

**Goal**  
Establish system size, centrality dependence of thermal dileptons



# The High-Acceptance-Di-Electron-Spectrometer

## HADES key facts

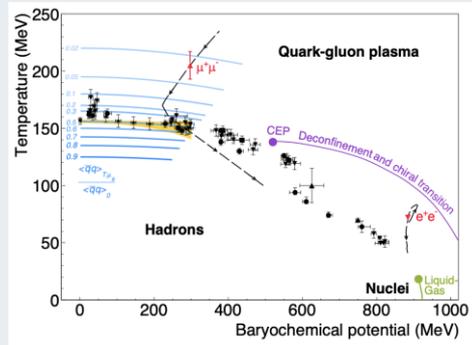
Explores region of high densities and moderate temperatures

Low-mass magnetic spectrometer

Fixed-target experiment for heavy-ion,  $p$ ,  $d$ ,  $\pi$  induced reactions in few GeV range

High rate ( $\sim 50$  kHz for  $pp$ ,  $\sim 20$  kHz for HIC)

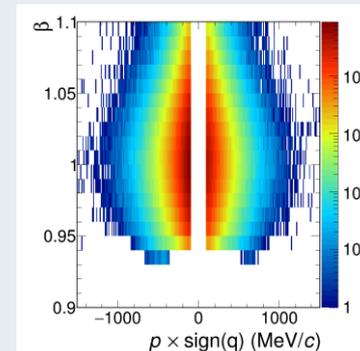
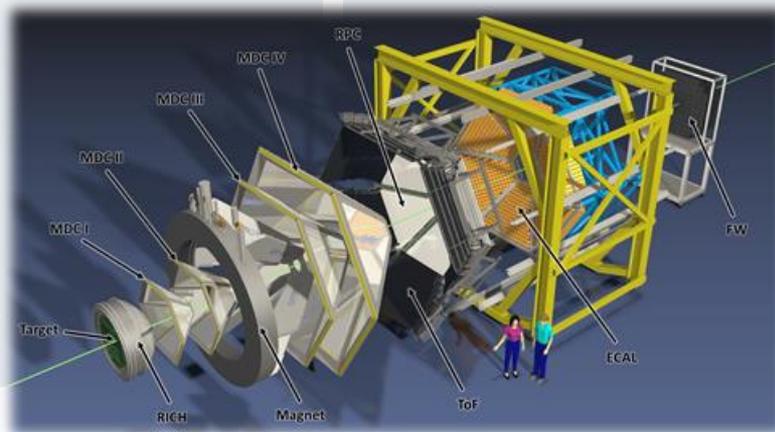
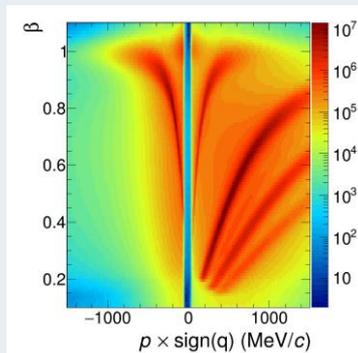
Large acceptance:  $0^\circ < \varphi < 360^\circ$ ,  $18^\circ < \theta < 85^\circ$



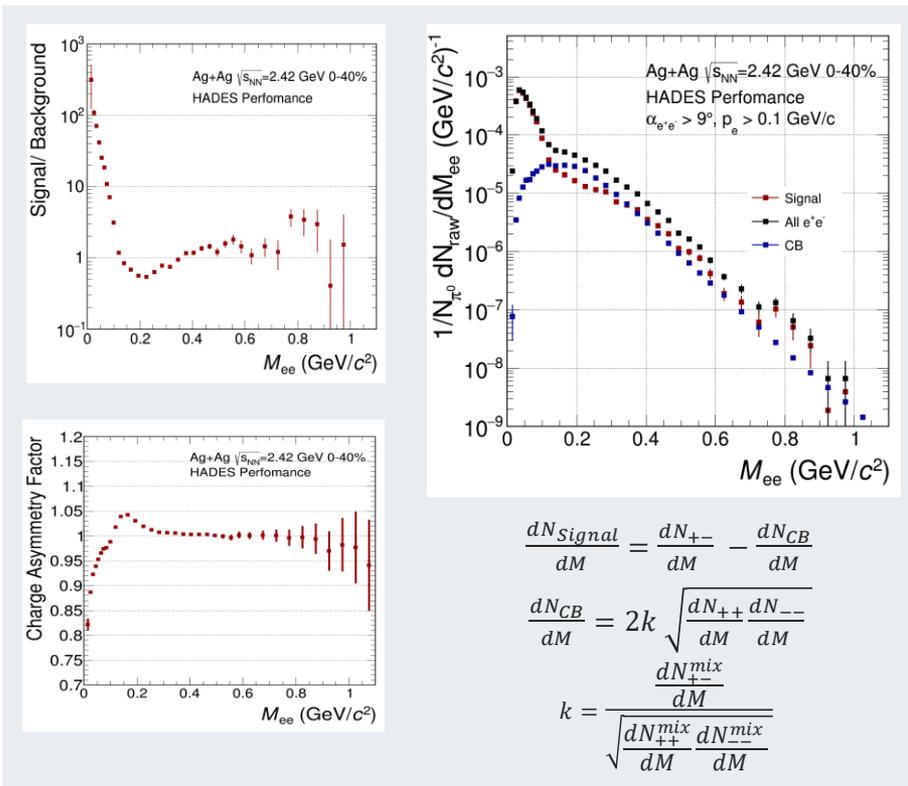
## Particle identification

Dedicated detector components provide multiple  $e^\pm$  selection criteria:

- Electromagnetic Calorimeter
- Ring-Imaging-Cherenkov detector (RICH)
- Velocity  $\beta$



# Reconstructing the dilepton signal

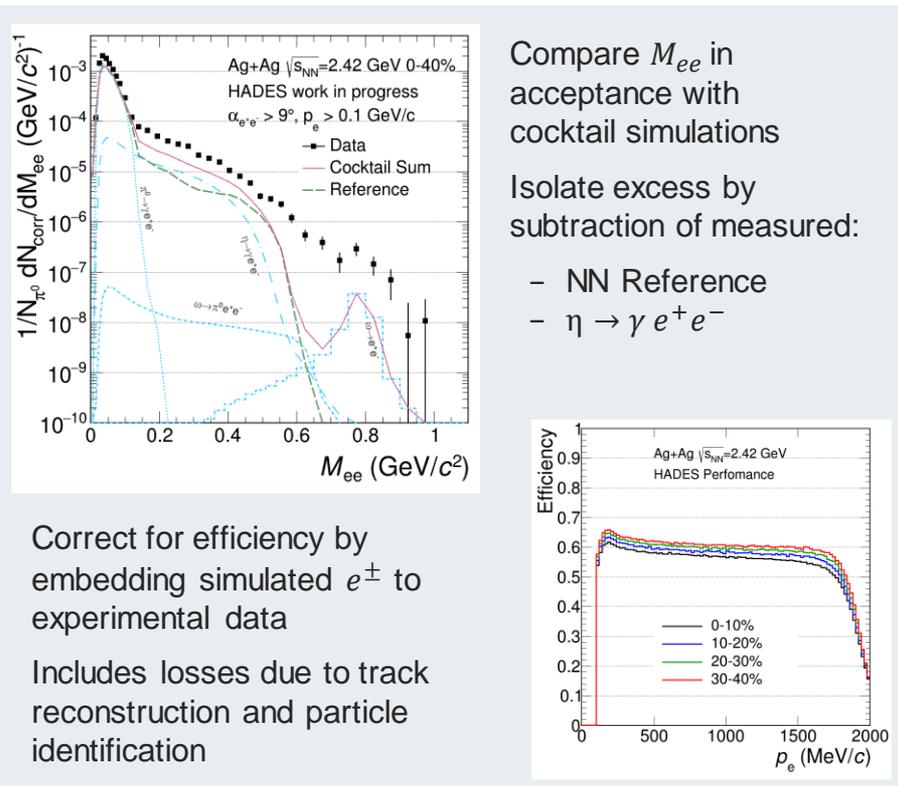


$$\frac{dN_{Signal}}{dM} = \frac{dN_{+-}}{dM} - \frac{dN_{CB}}{dM}$$

$$\frac{dN_{CB}}{dM} = 2k \sqrt{\frac{dN_{++}}{dM} \frac{dN_{--}}{dM}}$$

$$k = \frac{\frac{dN_{+-}^{mix}}{dM}}{\sqrt{\frac{dN_{++}^{mix}}{dM} \frac{dN_{--}^{mix}}{dM}}}$$

# The mass spectrum in acceptance



Compare  $M_{ee}$  in acceptance with cocktail simulations

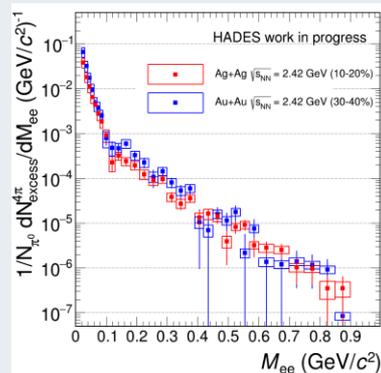
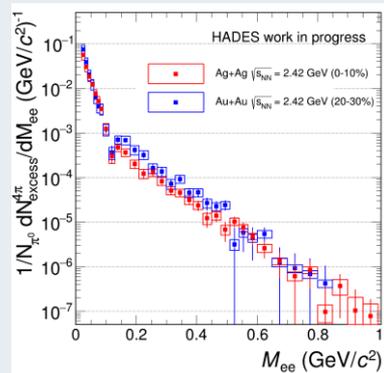
Isolate excess by subtraction of measured:

- NN Reference
- $\eta \rightarrow \gamma e^+ e^-$

Correct for efficiency by embedding simulated  $e^\pm$  to experimental data

Includes losses due to track reconstruction and particle identification

# Acceptance corrected excess yield



Extract observables in dominant mass region of in-medium  $\rho$

## Chronometer

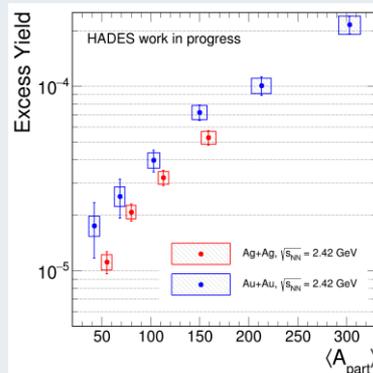
$$N_{\text{excess}} = \int_{0.3 \text{ GeV}/c^2}^{0.7 \text{ GeV}/c^2} \frac{dN}{dM} dM$$


## Thermometer

$$\frac{dN}{dM} \propto M^3 \exp\left(-\frac{M}{T}\right)$$


**Before final:** Investigate systematic uncertainties due to:

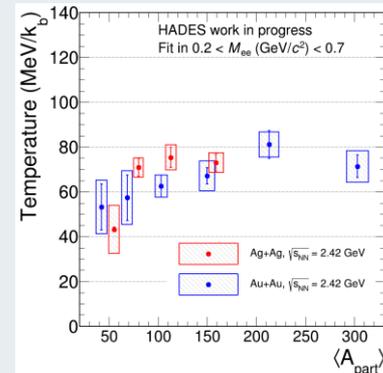
- Cocktail subtraction
- Possible carbon contamination from collisions with structure material around target in peripheral collisions



Current results indicate a consistently higher yield for the larger overall system

Fit  $\propto \langle A_{\text{part}} \rangle^\alpha$  gives:

- $\alpha^{\text{Au+Au}} = 1.34 \pm 0.09$
- $\alpha^{\text{Ag+Ag}} = 1.42 \pm 0.14$



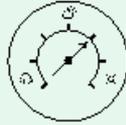
Ag+Ag temperatures still subject of systematic uncertainties

Dependence on  $\langle A_{\text{part}} \rangle$  as well as overall system size is less pronounced

# First Insights: Analysis of Dilepton Anisotropy and Flow Coefficients

High statistics data Ag+Ag  $\sqrt{s_{NN}} = 2.55$  GeV allows for multidifferential flow analysis

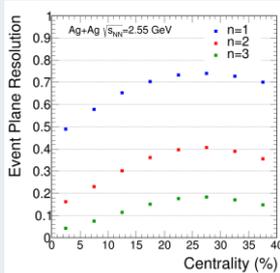
Opens possibility to study collective behavior



## Analysis procedure

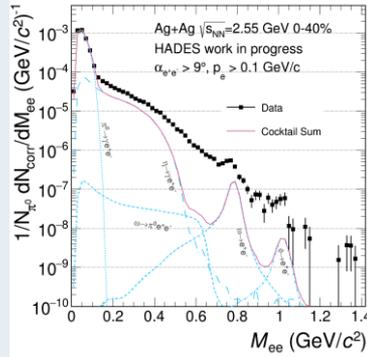
Event plane  $\Psi_{RP}$  reconstructed via modified total transverse momentum transfer technique [1]

Event plane resolution  $R_n$  estimated via Ollitrault method [2]

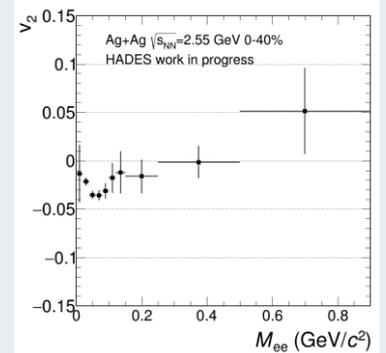
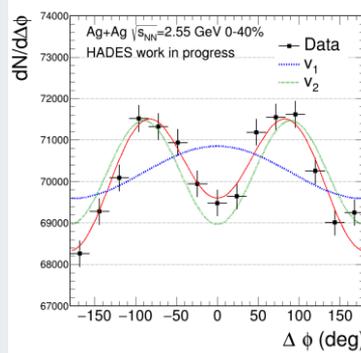


$$\frac{dN}{d\Delta\phi} \propto 1 + 2 \sum_{n=1}^{\infty} v_n \cos(n \Delta\phi)$$

$$\Delta\phi = \varphi_{ee} - \Psi_{RP} \quad v_n = \frac{v_n^{obs}}{R_n}$$



## Elliptic flow



For  $M_{ee} < 0.14$  GeV/c<sup>2</sup> dilepton signal is dominated by  $\pi^0$  Dalitz decay  $\rightarrow v_2(\pi^0)$  consistent with  $v_2(\pi^{+/-})$

$v_2$  close to zero at higher masses  $\rightarrow$  supports the idea that dileptons serve as penetrating probes in the hot and dense medium

**Ongoing work**

- Isolation of thermal contribution
- Determination of systematic uncertainties