The HADES experiment at GSI (Gesellschaft für Schwer-Ionenforschung)

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FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

LIP

Outline

HADES

HADES results on di-electron production

KAON physics

Conclusions

High Acceptance DiElectron Spectrometer

Installed at the SIS-18 ($E_{\mathrm{beam}} < 2$ AGeV), GSI Darmstadt

Goals:

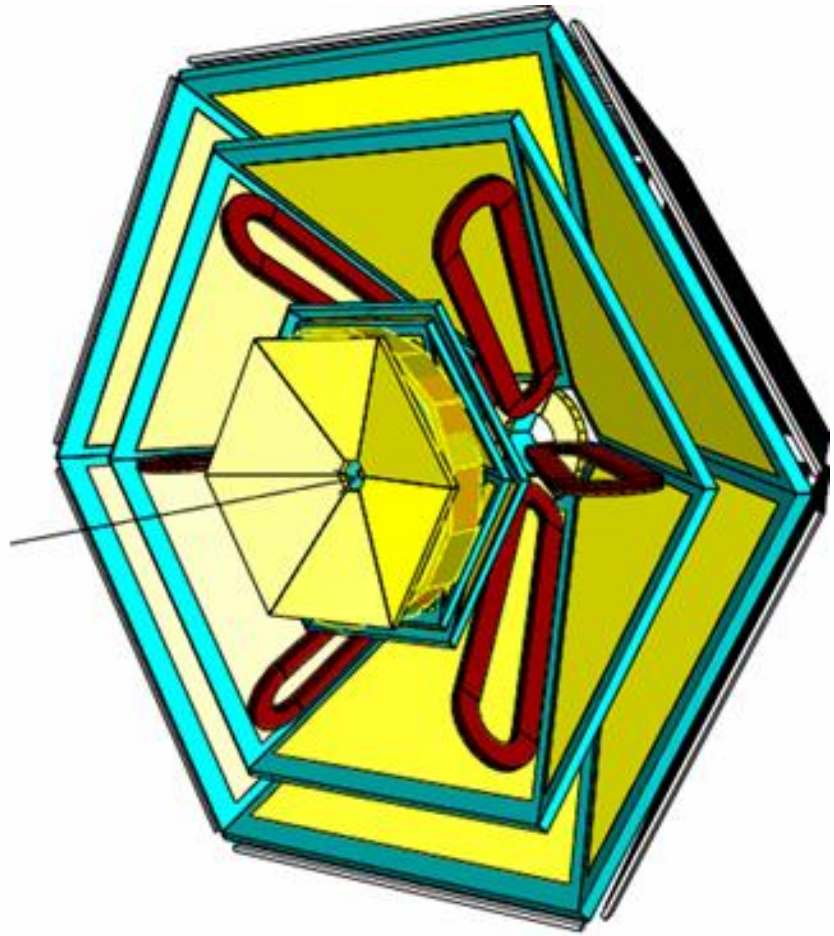
- $A - A$ collisions in search of '*in medio*' effects,
- π, $p - A$: high-precision in-medio spectroscopy,
- elementary reactions (hadron spectroscopy).

Main features:

- Low-mass vector mesons (ρ, ω, ϕ) detected via electron pair reconstruction.
- Utilises dedicated second-level trigger processors to select rare events.

Future:

- Feasibility studies for HADES at SIS-100 ($E_{\mathrm{beam}} \approx 8$ AGeV),
- and beyond at FAIR in front of the CBM detector at SIS-300 ($E_{\mathrm{beam}} \approx 30$ AGeV).



THE HADES DETECTOR

Geometry:

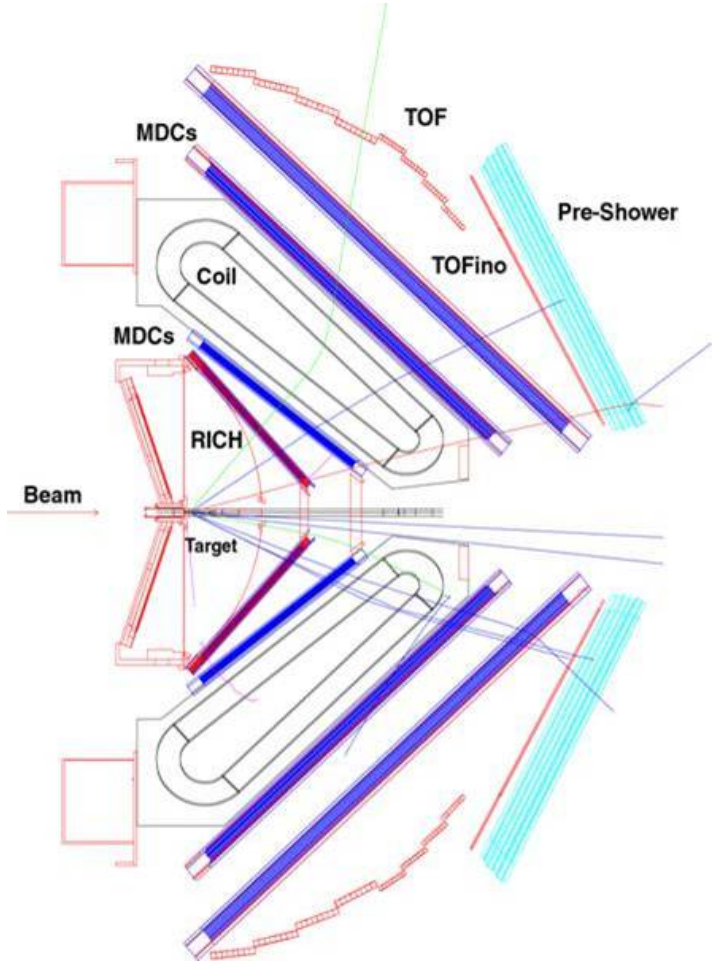
- Coverage of full azimuth and polar angles between $18^\circ - 85^\circ$,
- Pair acceptance ≈ 0.35.

Fast particle identification:

- RICH CsI solid photo cathode, C_4F_{10} radiator,
- TOF (scintillator rods),
- TOFino (scintillator paddles) temporary solution, **LIP RPC ToF wall** in the future,
- Pre-Shower 18 pad chambers and lead converters.

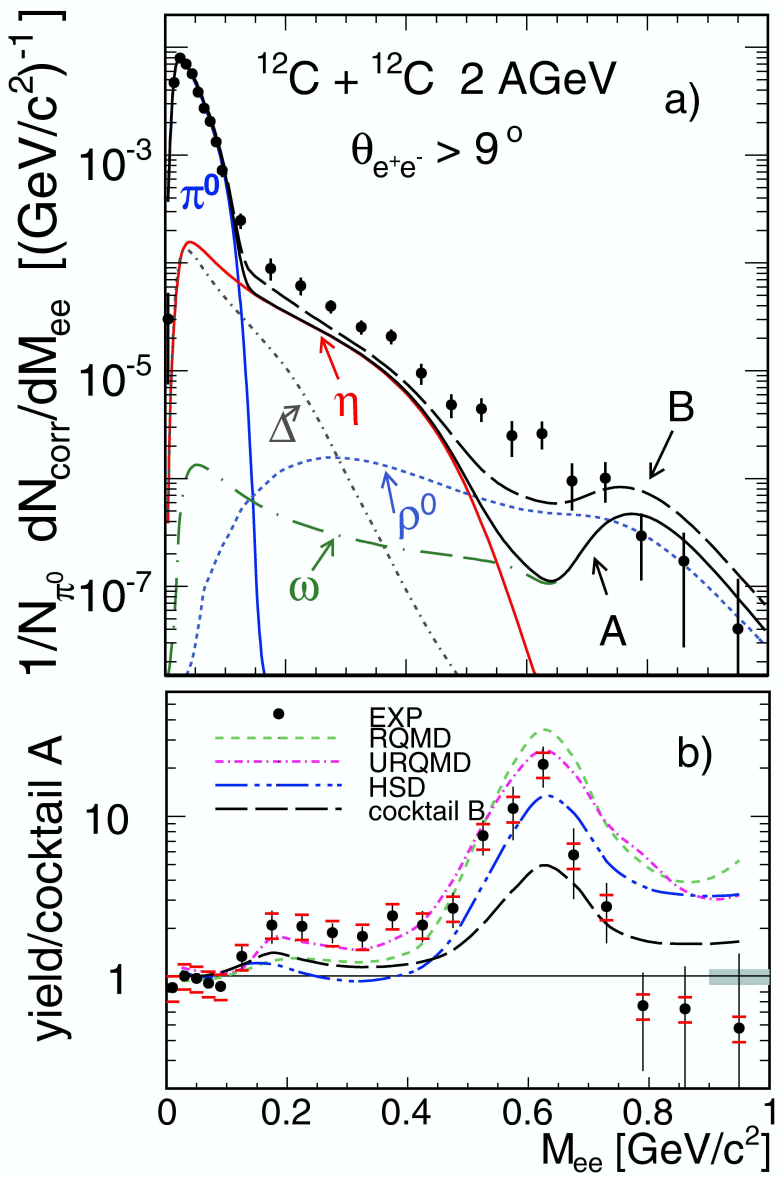
Momentum measurement:

- Super conducting toroid $B\rho = 0.36$ Tm,
- MDC multi-wire drift chamber, single-cell resolution 100 μm.

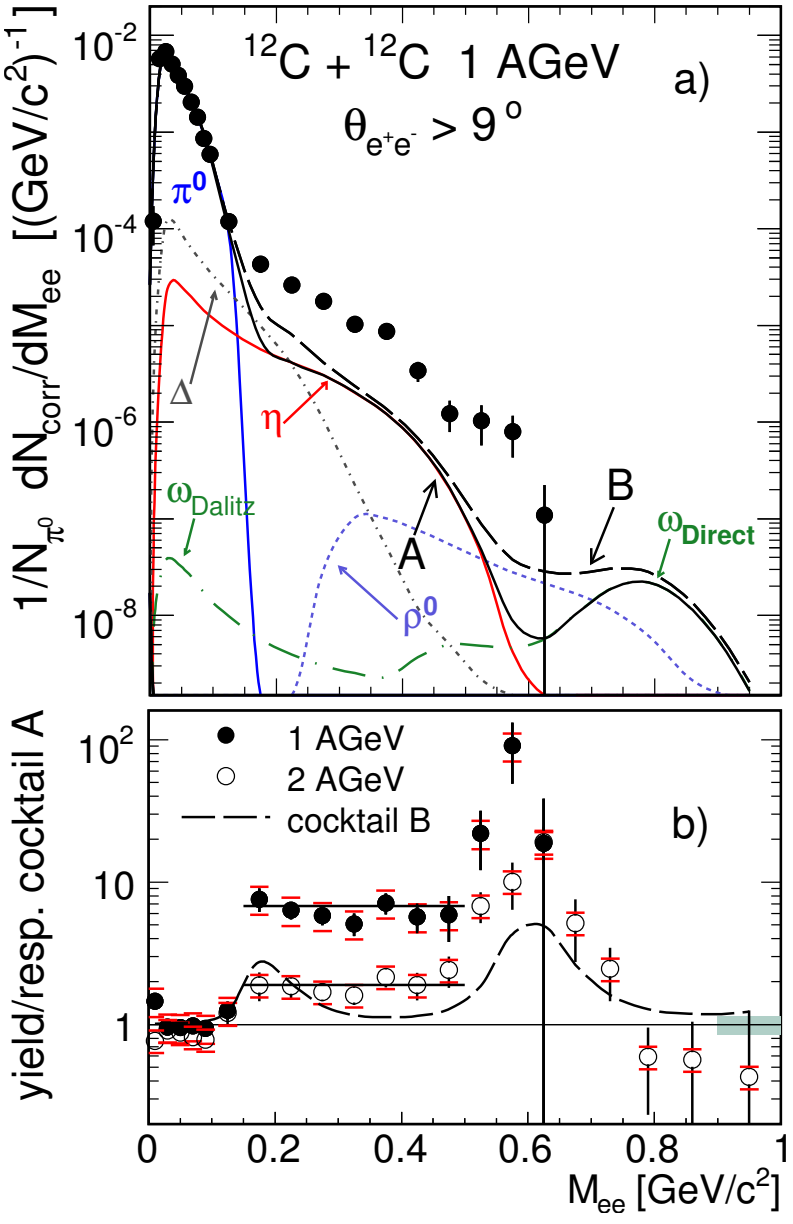


HADES RESULTS ON DI-ELECTRON PRODUCTION

(G.Agakichiev et al., PRL 98 (2007) 052302)



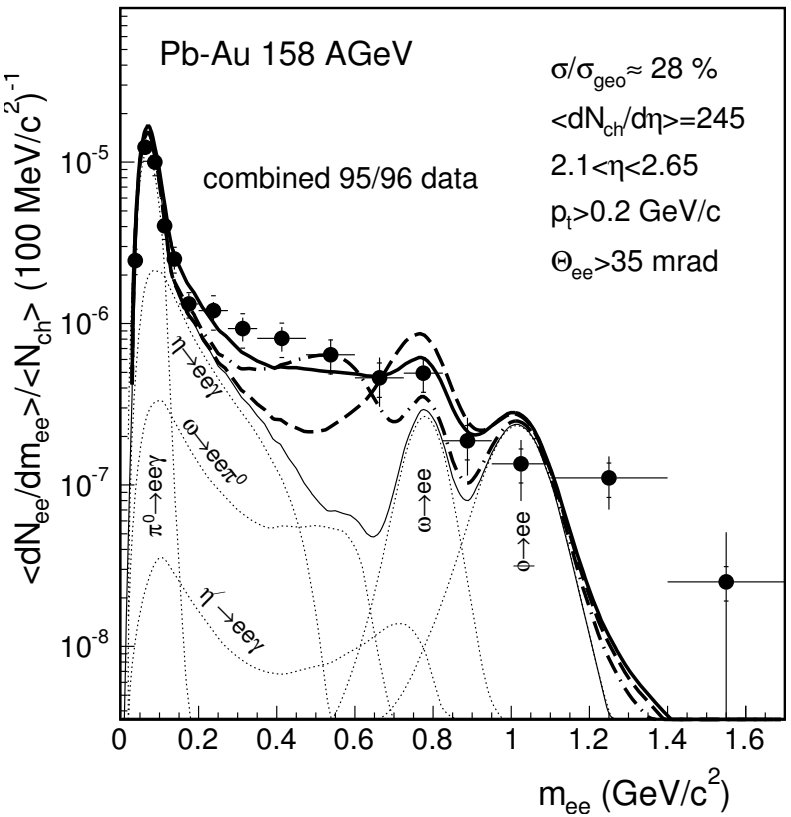
(G.Agakichiev et al., PLB sub.)



DI-ELECTRON PRODUCTION AT HIGHER ENERGIES

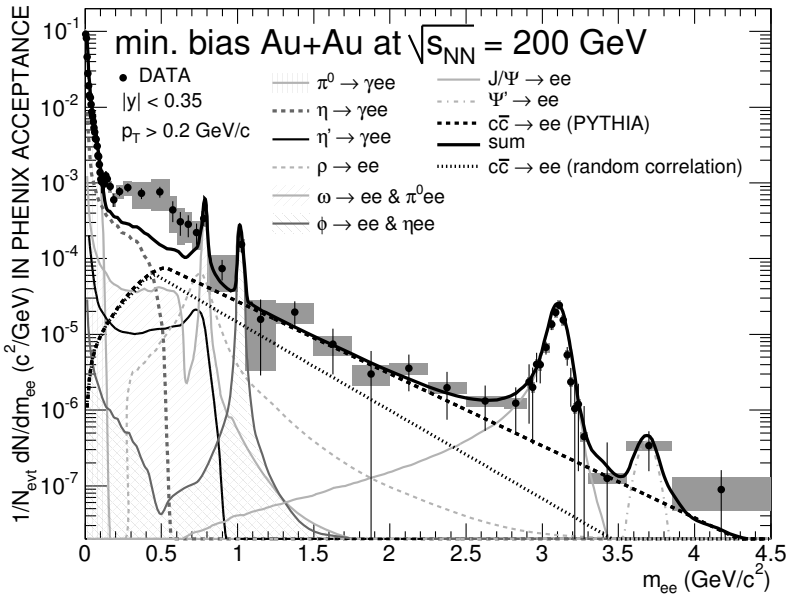
CERES @ SPS

(G.Agakichiev et al., EPJ C 41 (2005) 475)



PHENIX @ RHIC

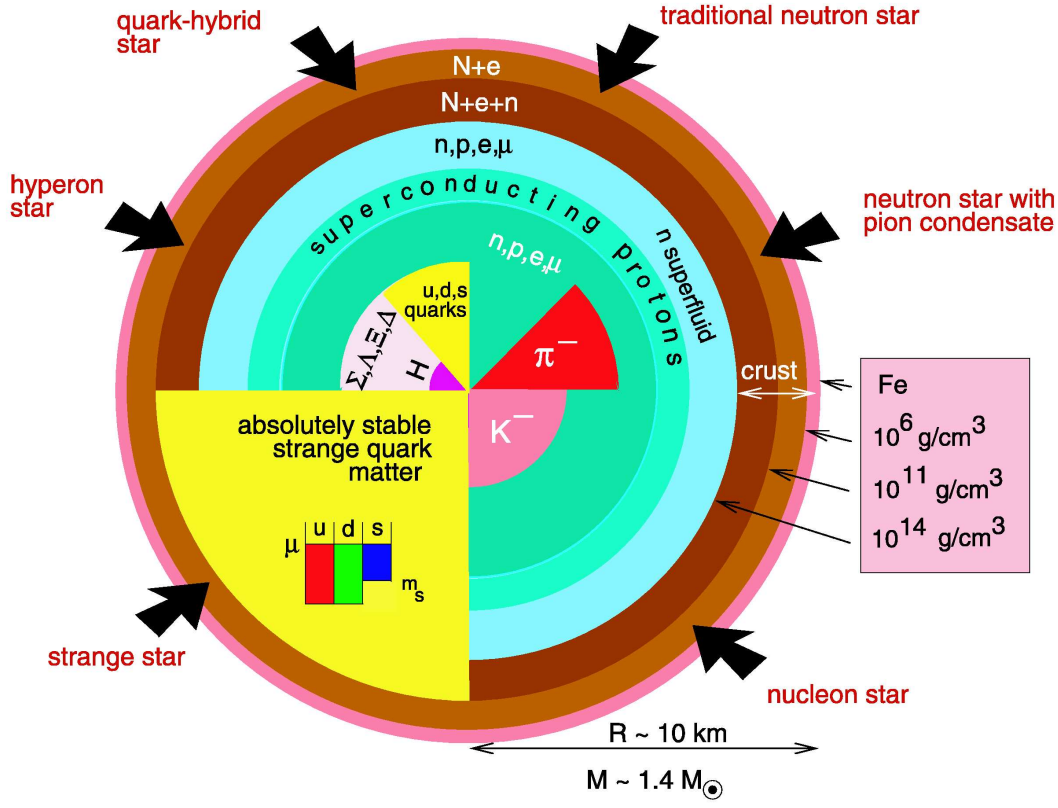
(S.Afanasiev et al., PRL sub.)



- CERES results can be explained including pion annihilation in the dense fireball $\pi^+ \pi^- \leftrightarrow \rho \longrightarrow e^+ e^-$.
- The ρ properties are modified in the medium (G.Q.Li et al., PRL 75 (1995) 4007), but CERES data are not sensitive to the different scenarios (G.Chanfray et al., PRL 76 (1996) 368).

π/K CONDENSATION IN DENSE NUCLEAR MATTER ?

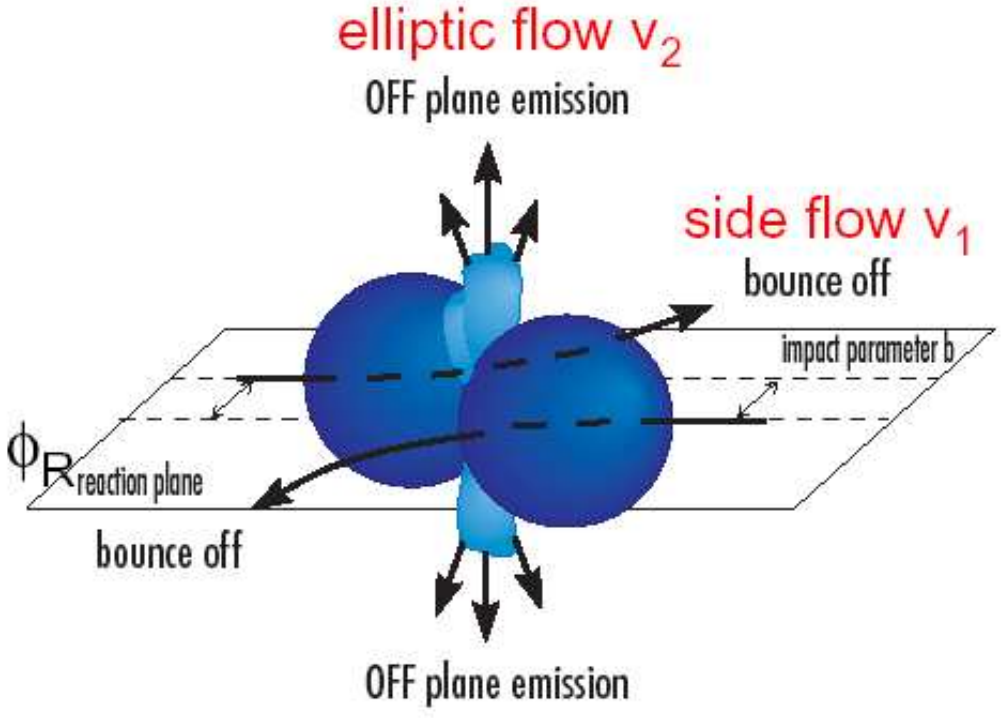
- π-condensation in neutron stars was first considered by A.B. Migdal (Zh. Eksp. Teor. Fiz. 61 (1971) 2210) and R.F. Sawyer (PRL 29 (1972) 382 "..large contributions from many-body forces ..").
- K^--condensation was first considered by D.B. Kaplan and A.E. Nelson (PLB 175 (1986) 57).
- G.Q. Li et al., (PRL 79 (1997) 5214) predicted a lowering of the upper bound for stability from 2 to 1.5 $M_\odot$ in case of K^- condensation. Cyg X-2 was the first reported LMXB (J. Casares et al., ApJ 493 (1998) L39) with an estimated mass of 2 $M_\odot$. Recently, a pulser with an estimated mass of 2.1 ± 0.2 $M_\odot$ has been reported (D.J. Nice et al., astro-ph/0508050).



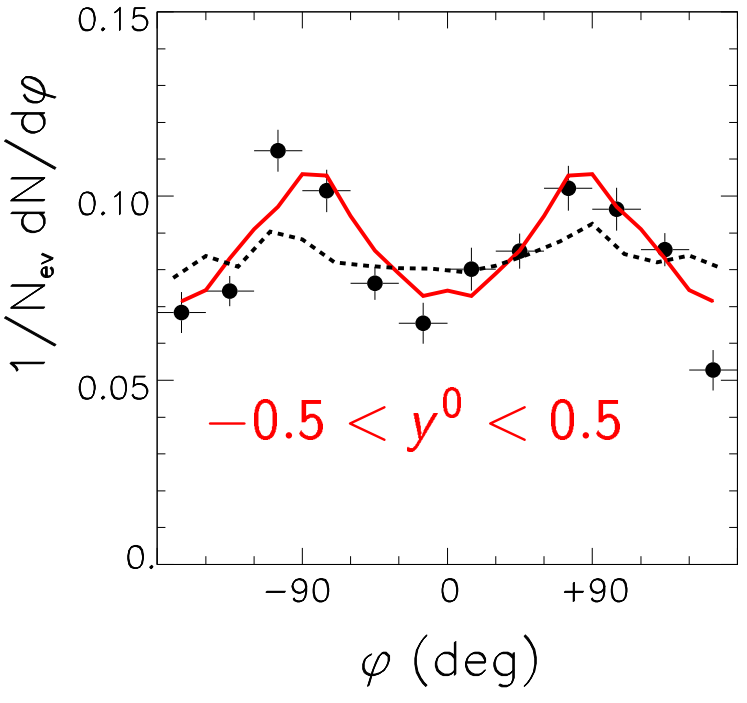
F. Weber, J. Phys. G 27 (2001) 465

K^+ FLOW AND SQUEEZE-OUT

The K^+'s are preferentially directed AWAY from regions of high nucleon density. The anisotropy of their phase space population, with respect to the reaction plane, shows both an out-of-plane enhancement (Y. Shin et al., PRL 81 (1998) 1576) as well as an in plane anti-flow (P. Chrochet et al., PLB 486 (2000) 6).

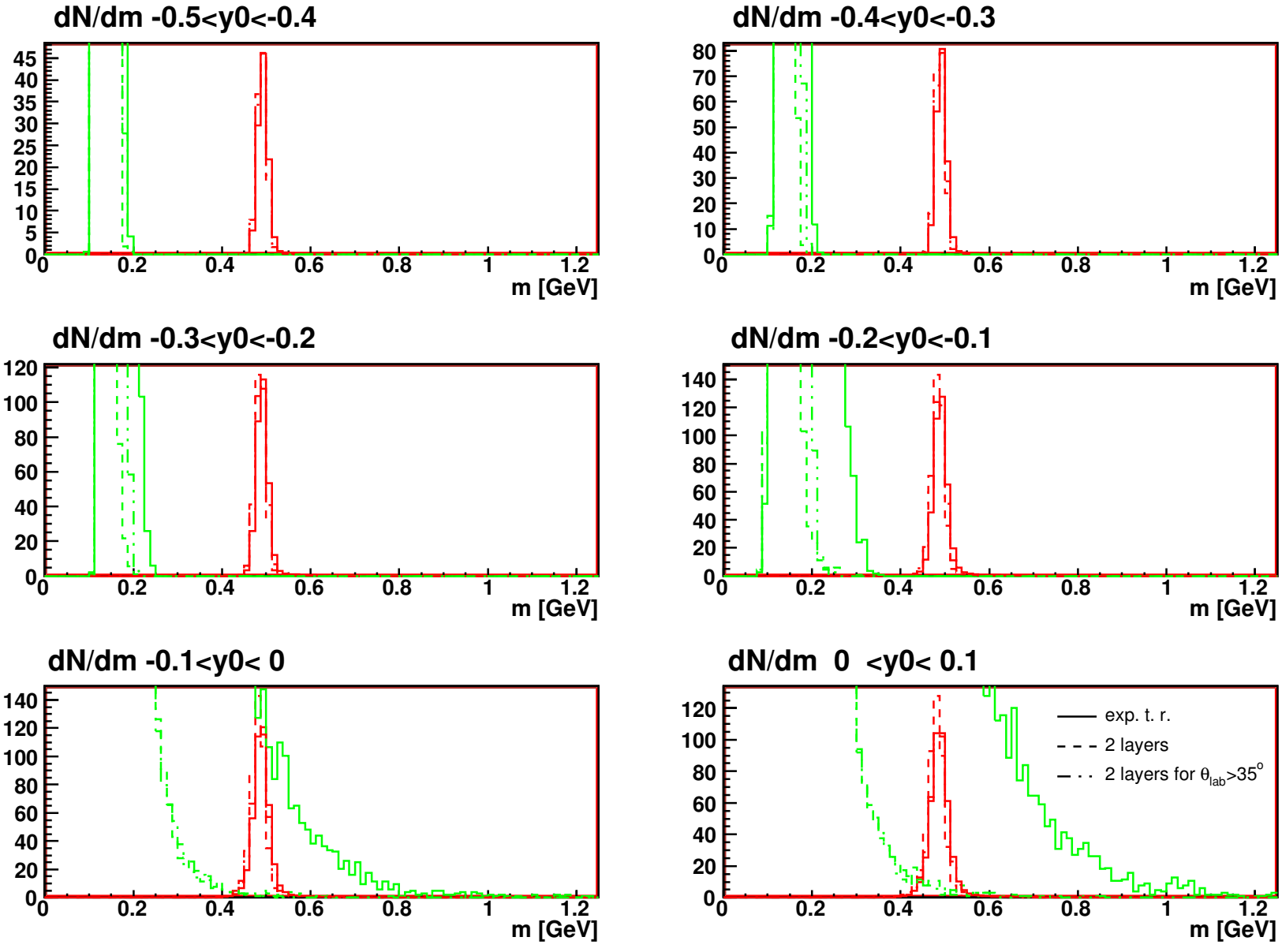


(Y. Shin et al., PRL 81 (1998) 1576)



If this behaviour is due to a repulsive in-medium potential, the K^- are expected to exhibit exactly the opposite trend (W. Cassing et al., Phys. Rep. 308 (1999) 65).

K^- IDENTIFICATION WITH THE RPC WALL



CONCLUSIONS

- The HADES experiment has released the final results for di-electron productions in $C + C$ at 1.0 and 2.0 AGeV.
- The 'DLS puzzle' is confirmed and currently no theoretical calculation can explain the data. More work is necessary to clarify the issue, as well as new data on elementary reactions (pp and pd).
- The measured performances from the 2005 RPC test-beam could be adequate for K^+/K^- identification up to mid-rapidity, if a double layer redundancy is employed.
- Detailed simulations studies are under way to asses the effects of cell occupancy and reaction plane resolution on the minimum detectable flow signal.