The HADES RICH Upgrade Program

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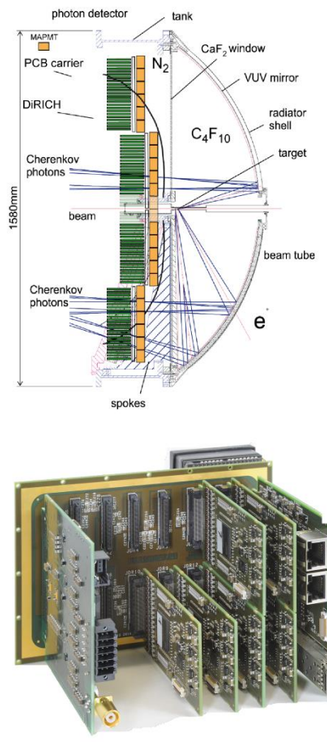
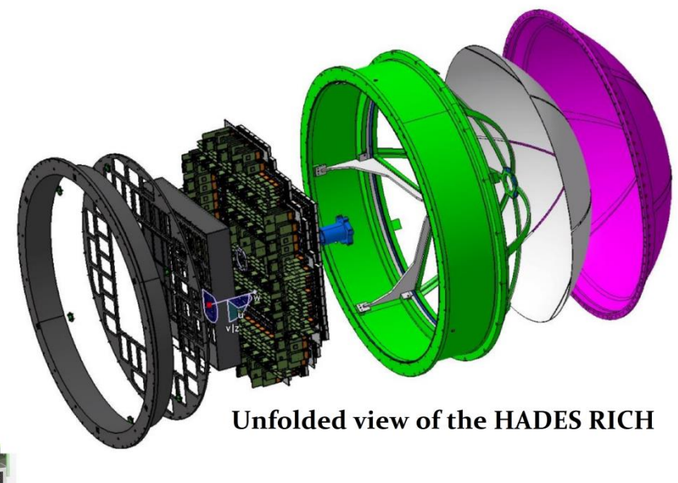
The HADES Experiment

- The HADES (High Acceptance DiElectron Spectrometer) experiment at GSI covers a broad physics program ranging from form factors of hadrons, the investigation of dense baryonic matter to π^- + p scattering and further
- It currently operates at the SIS 18 accelerator at GSI, Darmstadt as a key element of the FAIR phase 0 activities
- Upcoming beamtime of four weeks data taking starting in Aug18 and aiming to record 5B Ag+Ag collisions at 1.65 AGeV beam
- Major detector upgrades: An electromagnetic calorimeter is added (4 of 6 sectors operational for upcoming beamtime) and a RICH upgrade is performed

Sideview of the HADES RICH





Unfolded view of the HADES RICH

DiRICH concept with Backplane, 12 DiRICH-FEBs, one Powerboard and one Combinerboard

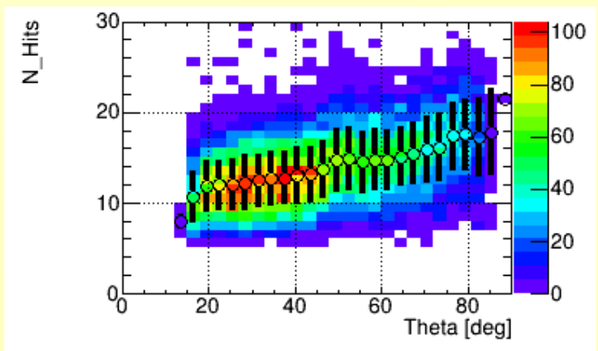
The RICH Upgrade

- Hadron blind RICH detector
- Designed for $e^{\pm}$ identification (15 MeV/c < p < 1.5 GeV/c)
- Upgrade with 428 H12700 MAPMTs considerably increases the efficiency of the detector
- The Hamamatsu H12700, 64-ch MAPMTs (6x6 mm²) show high efficiency (30-35% at 300 nm) and low dark rate (< 6.4 kHz)
- New readout electronics built for MAPMTs
- Readout concept features 12 front end boards reading out 32 MAPMT-ch each on one backplane
- One backplane combines powerhandling for 6 MAPMTs and 12 DiRICH-FEBs via Powerboard
- Data of one backplane is combined in the Combinerboard on the same backplane
- Readout only via TDC

RICH Performance Studies in Ag+Ag simulation

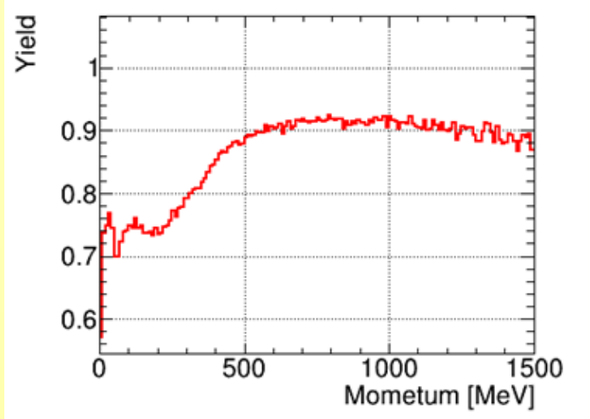
Simulation studies performed with UrQMD simulation of Ag+Ag collisions at 1.65 AGeV (upcoming beam time in Aug18) with additionally embedded signal ($\phi \rightarrow e^{\pm} e^{\pm}$) from the PLUTO event generator

- On average 12.5 converted photons (hits) per ring for signal electrons detected
- This number strongly depends on the azimuth angle θ
- Simulation gives an **integrated single electron efficiency of 84%** for signal electrons ($\phi \rightarrow e^{\pm} e^{\pm}$, originating from primary vertex)
  - ➢ We require the track to have a hit in all other detectors to reject fakes and those not being in acceptance
- With increasing azimuth angle θ efficiency increases due to a larger number of converted photons per ring resulting from a longer path in the gas radiator with rising θ
- We see a strong momentum dependence on efficiency: It is rising to high momenta and saturates at around 90%



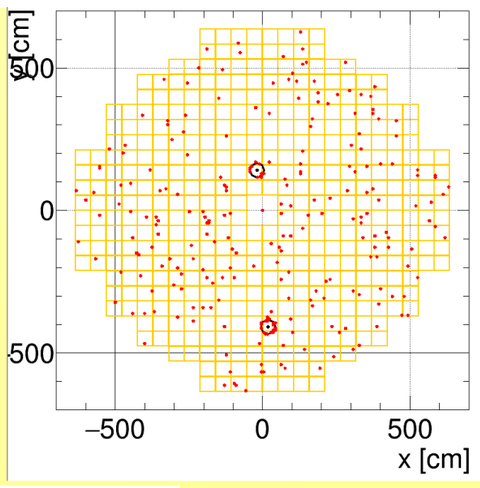
Upper: Dependence of hits per Ring on the azimuth angle θ.

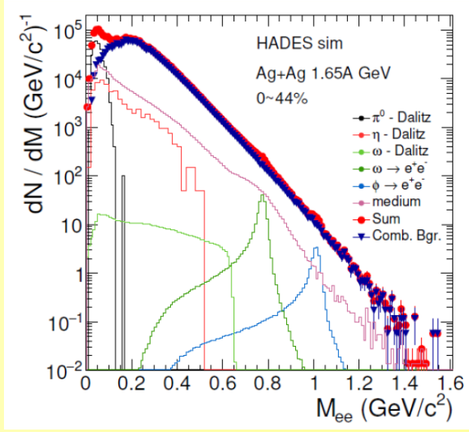
Lower: Momentum dependence of single electron efficiency

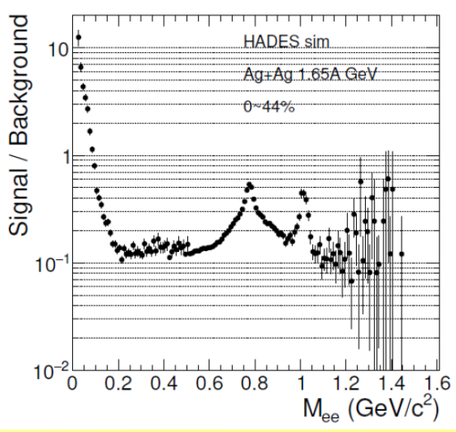


For the upcoming beamtime we aim for extracting a complete invariant mass spectrum of Di-electrons exceeding the mass of the ϕ –meson using the so far unreached background suppression in electron identification enabled by the new high performance RICH detector
→ in 5B events we expect about (depending on selection cuts):

Signal	$\pi^0 \rightarrow \gamma e^+e^-$	$\eta \rightarrow \gamma e^+e^-$	$\omega \rightarrow e^+e^-$	$\phi \rightarrow e^+e^-$
Entries	338,750	178,333	683	110





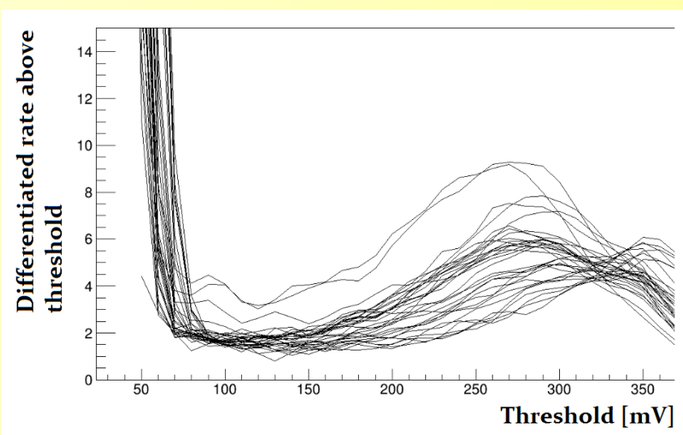


Upper: Typical event display (note: Uncorrelated photons originate from scintillation in the radiator and the CaF_2 window – upper estimation; noise level ~ 1 Hit/event)

Left: Simulated invariant mass spectrum of Di-Electrons in Ag+Ag at 1.65 AGeV for 5B events and corresponding S/B ratio from the HADES beam time proposal; improvements with more refined cuts possible (view upper table)

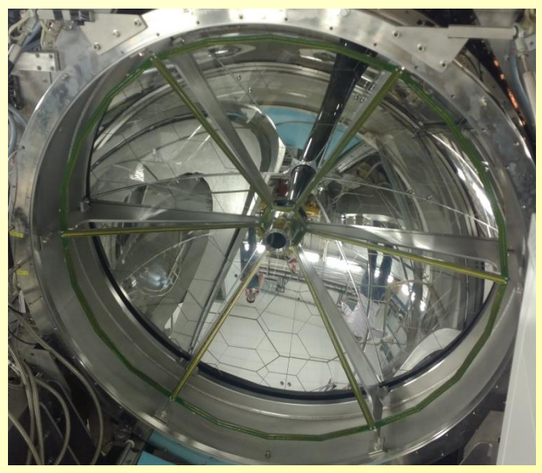
The RICH-FEB

- Readout of MAPMTs only via TDC → ToT
- Small noise-bandwidth (~10mV after pre-amplification)
- Good time resolution (see Poster 861)
- Distinction between noise, single photon hit and double photon hit via ToT is feasible, tested in test beam at COSY
- Proper signal shape of e.g. one MAPMT can be seen by a differentiated rate scan above threshold

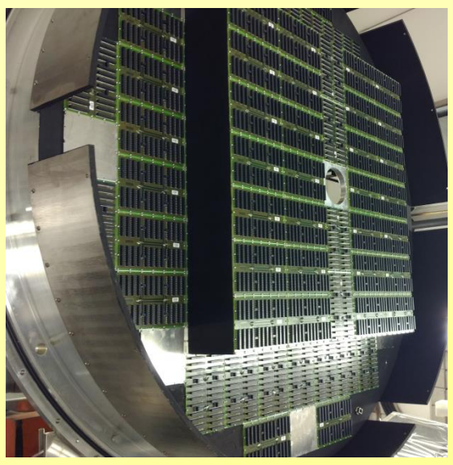


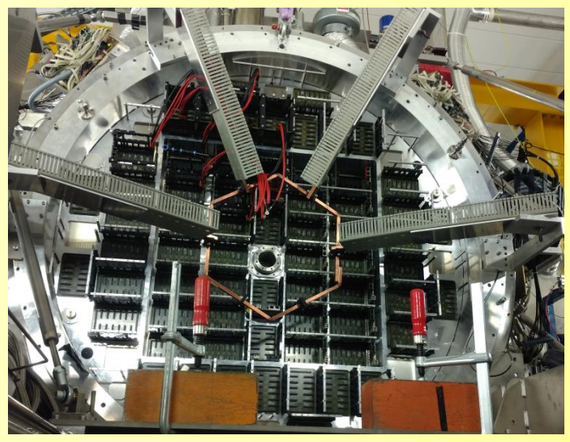
Single Photon response of 32 chs one MAPMT measured with the DiRICH-FEB via a rate scan

Current status of the RICH upgrade



Left: glass lens and mirrors after demounting of the old RICH detector





Upper: New RICH with backplanes only before the mounting

Left: Mounted new RICH – full cabling , DiRICH boards and MAPMTs to be added

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