

*DIRC 2017*

*V. Patel*

*Overview*

*H12700  
MAPMTs*

*HADES test  
box*

*COSY beam  
test*

# *HADES RICH upgrade and CBM RICH concept*

Vivek Patel

*for HADES and CBM Collaborations  
Bergische Universität Wuppertal*

DIRC2017: Workshop on fast Cherenkov detectors

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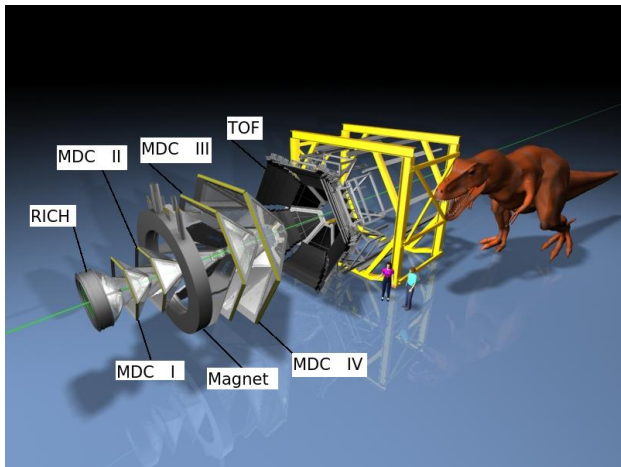
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High Acceptance Di-electron Spectrometer(HADES) at  
GSI(SIS 18)

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- HADES RICH is in operation since 2000.
- Upto now: Reflective CsI photocathode and MWPC readout for photon detection, RICH is hadron blind with  $C_4F_{10}$  gas radiator .
- Photon detector is being upgraded with H12700 MAPMTs from Hamamatsu.
- A new readout electronics is developed in a joint effort of HADES,CBM & PANDA collaboration, based on TRB project.

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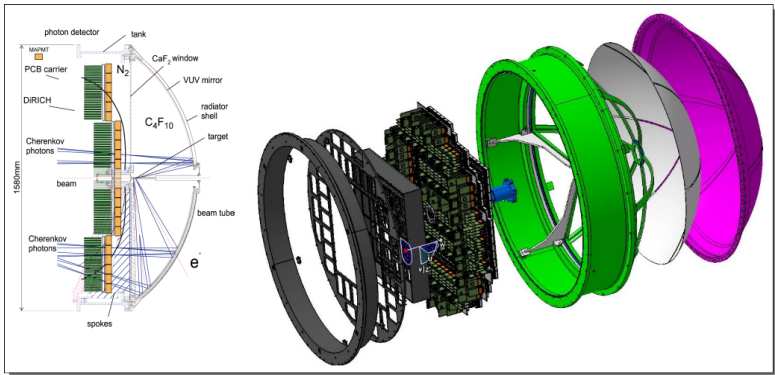
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Schematic diagram of HADES RICH upgrade

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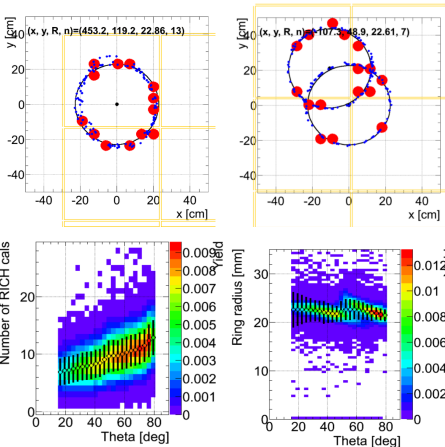
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- Monte Carlo simulations of the upgraded HADES RICH detector.
- **Blue dots:** photons hitting the PM. **Red points:** registered photons.
- 7 to 15 detected photons per Cherenkov ring.
- Short radiation length:  $\sim 35\text{-}70\text{cm}$  depending on  $e^\pm$  polar emissions.

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- H12700 is 64 Channel MAPMT developed by Hamamatsu, Japan.
- It is a modified version of the H8500 MAPMT for detecting single photons.

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- Detailed quality control of each and every MAPMT is important for both HADES and CBM RICH.
- There are various criteria set for these MAPMTs to be suitable for their use in HADES & CBM.
- Important criteria are : Dark rates, Quantum efficiency, gain in channels etc.
- Dedicated test bench for Quality Assessment.

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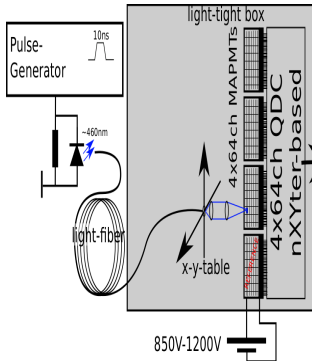
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- Test bench is a light tight box.
- At a given time one can test 3 MAPMT with respect to one reference MAPMT.
- Triggered light-source emitting "single" photons ( $\sim 1\gamma/10$  pulses)
- Light fiber guides photons to specific XY point on MAPMT.  
*Optical fiber + focussing optic ( $\sim 0.5$  mm)*
- Self-triggered readout-scheme based on n-XYTER-ASIC

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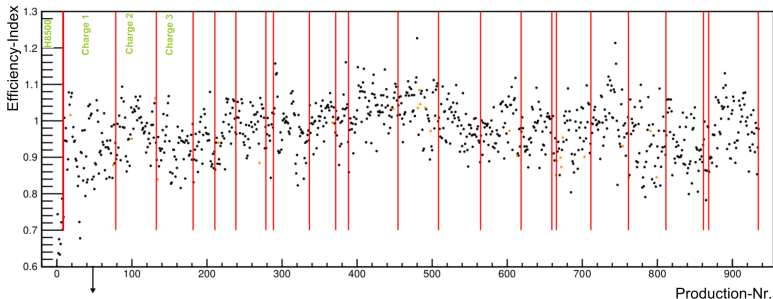
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## Efficiency-Index of MAPMTs



- Efficiency: Fraction of detected pulses correlated to light pulse
- Efficiency-Index: MAPMT-efficiency scaled to average efficiency of the reference MAPMT
- Average efficiency of the H12700 about 1.4-times higher than that of the H8500
- The average Efficiency-Index of all H12700 is 0.97 with a width of 0.07 (RMS)

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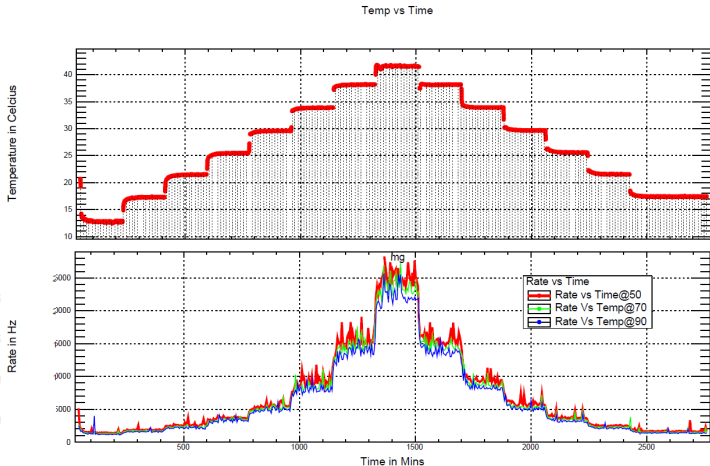
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Time evolution of dark rate as a function of temperature

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Prototype of all readout modules are successfully tested ...!!

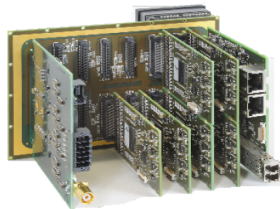
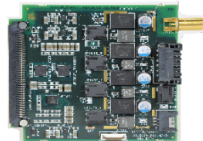
**DiRICH-**



**Combiner**



**Power  
module**



Photography: G. Otto (GSI)

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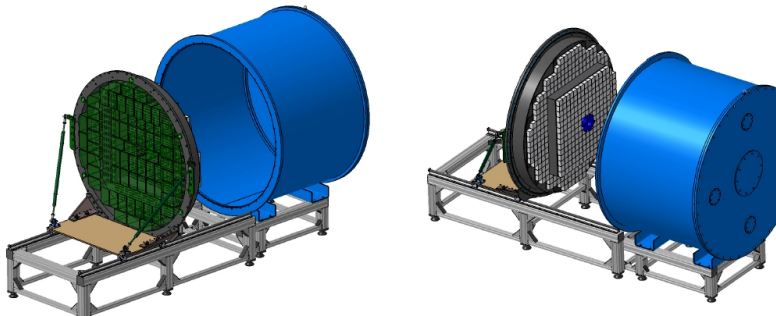
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HADES test box in HADES cave, GSI

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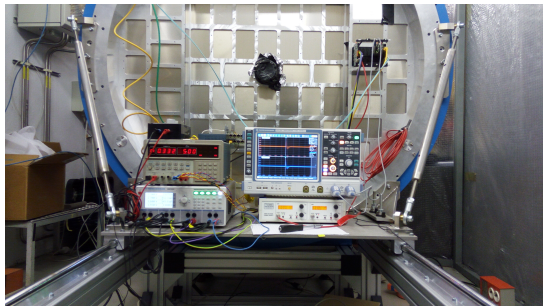
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- Analog part of DiRICH has been tested in HADES testbox.
- Single module with two active probes (i/p impedance 0.8pF) connected to two channels at the output of preamp.
- The signals from preamp thus can be visualized using an oscilloscope (4GHz-R&S oscilloscope).

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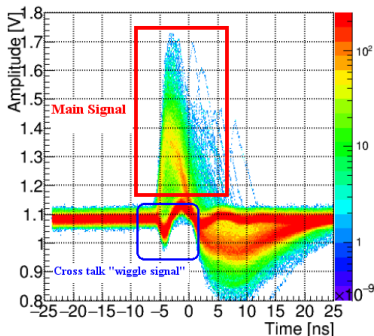
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## MAPMT signal

- After preamplification
- Directly before discrimination+TDC inside FPGA.
- Picosecond pulse laser(600nm) inside the test setup to generate single photons. Courtesy: PANDA group

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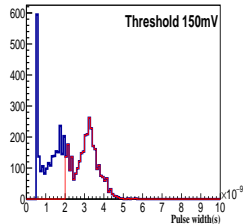
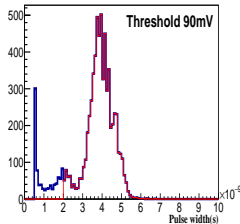
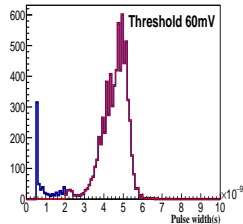
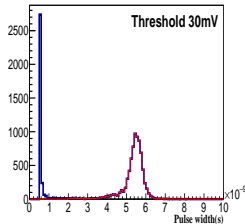
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ToT(Pulse width)(blue:no ToT cut red:ToT > 2ns)



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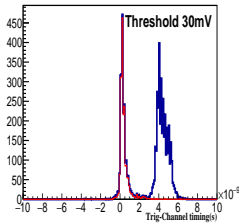
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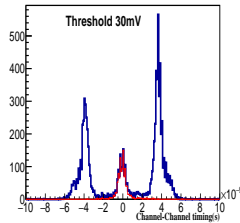
Leading edge timing (blue: no ToT cut red: ToT > 2ns)

Timing: Trig-Channel

Channel1-Channel2



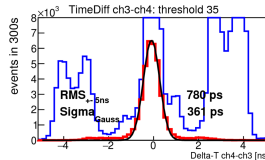
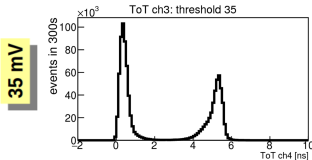
RMS=450ps  
Gauss fit=350



RMS=560ps  
Gauss fit=450

**Time-over-Threshold**

**Time-diff ch1-ch2**



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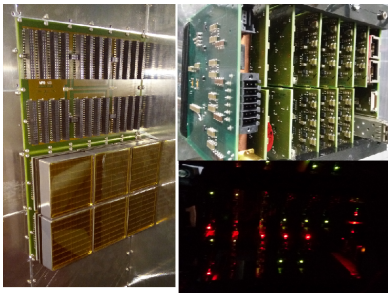
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- For full system tests we have installed two modules of 3x2 in HADES test box.
- It consists of 12 MAMPMTs and 24 DiRICH modules.
- A laser(600nm) act as source of single photons.
- Data from all the DiRICH is studied using GO4.

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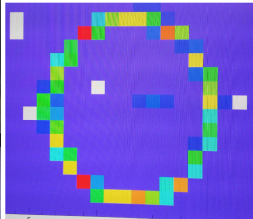
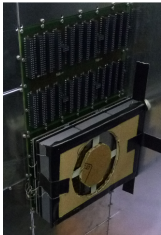
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- A mask was used to cover the PMT plane. It was created such that roughly one pixel is exposed to the laser.
- Whole system can be operated remotely including high voltage supply.
- The data collected from all the DiRICH can be studied both individually and collectively using ROOT and GO4.

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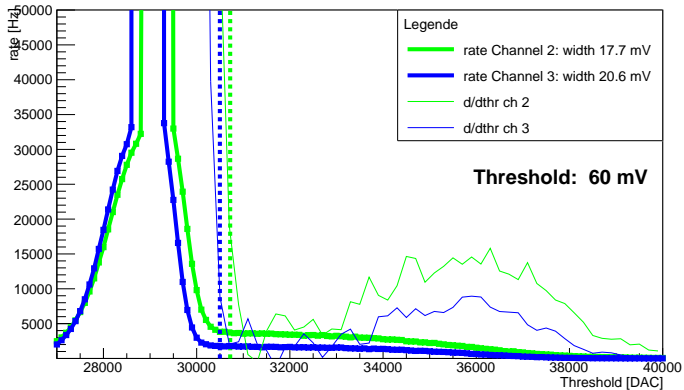
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Threshold scan



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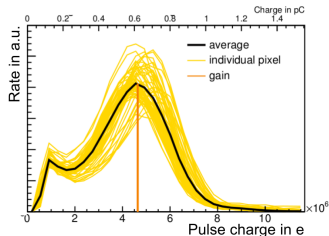
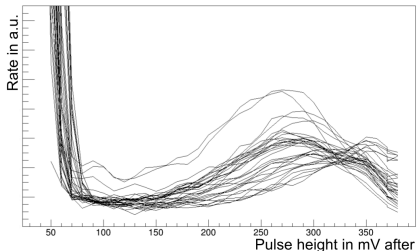
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## Comparing the ADC-spectra of one MAPMT measured with the DiRICH and a classical ADC

**Left side:** Pulse height distributions derived from the rate measurements for different thresholds using one DiRICH (32ch)

- The difference in hit rates for two different thresholds equals the frequency of pulses registered with a pulse height between those two threshold values

**Right side:** Pulse charge distribution measured with a classical integrating-ADC (64 ch)



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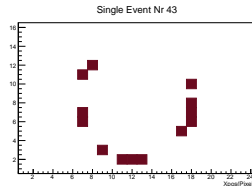
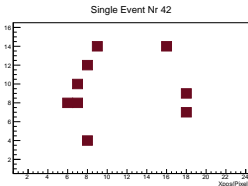
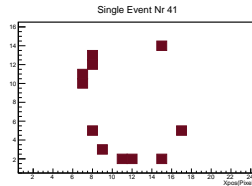
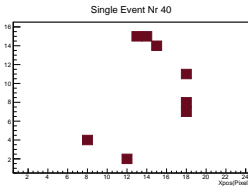
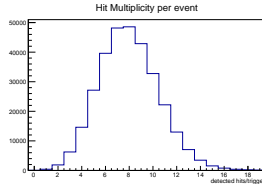
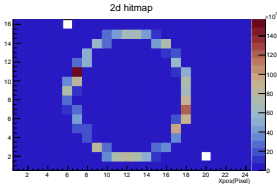
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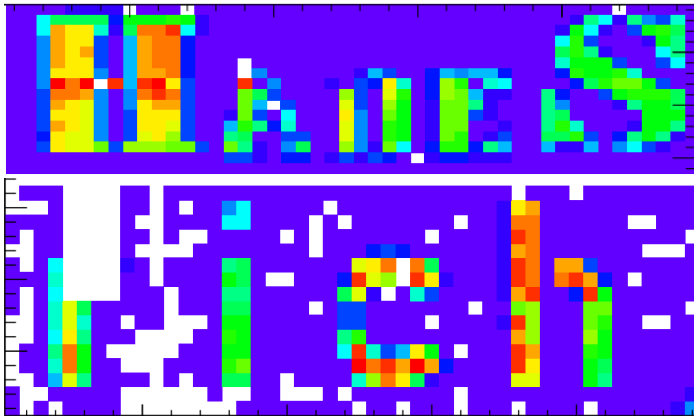
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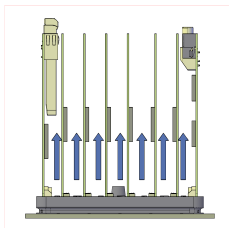
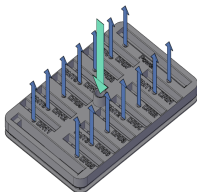
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- 30 W per 3x2 PMT module (12x Dirich, 1x Combiner, 1x Power (DCDC)) HADES: 74 modules – > up to 2.2 kW.
- Mask of plastic with integrated air tubing Central socket for the Air supply, compressed air generator Escape holes for each module
- Serves double purpose:
  - (i) Light shield on top of backplane
  - (ii) Distribution of cooling air

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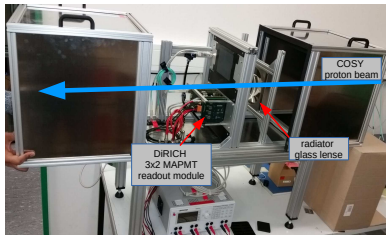
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- Cosy RICH test box for beam test in November 2017
- At the moment used for lab tests
- Fully equipped two 3x2 modules(12 MAPMTs)
- A reflective glass radiator of thickness 2.4cm at center.
- Focal length-30cm, Ref- $n$  - 1.51(for visible light)
- Coating Material - Aluminium with layer of  $MgF_2$

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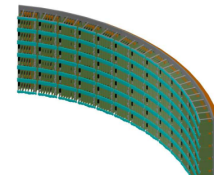
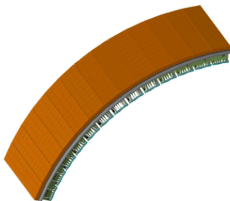
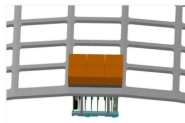
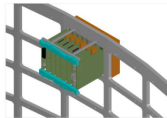
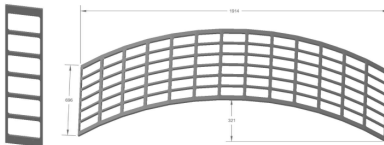
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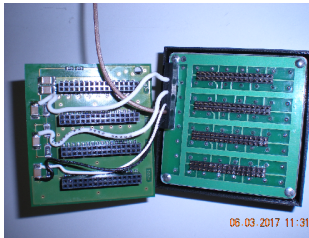
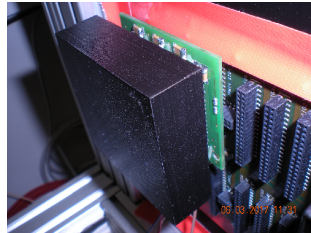
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- MCPs and MAPMTs have slightly different pinning and connector positions (and size).
- Adapter allows to put MCPs on "standard" 3x2 backplane for first tests.
- Adapter includes passive Voltage Divider.
- HV supply via backplane possible ("tested" up to 1900V).

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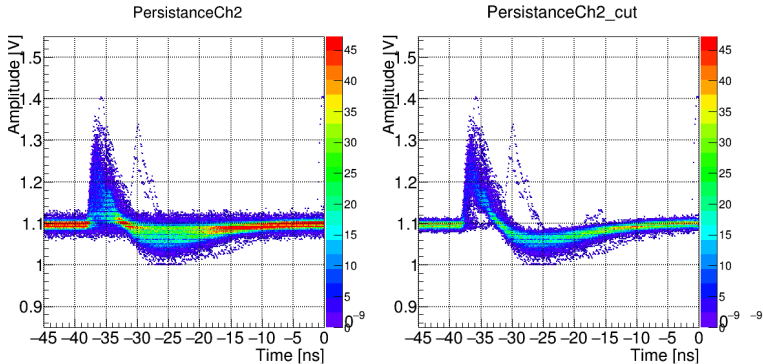
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Persistence plot of MCP signal on Oscilloscope

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## HADES UPGRADE

- Photon detector of HADES RICH will be replaced by 430 H12700 MAPMT and TRB3.
- A new developed DIRICH based readout system is developed and successfully tested.

## H12700 MAPMTs

- QC of MAPMTs is on going in Wuppertal. Hamamtsu has delivered around 900 MAPMTs and QA test are done for each of them. Delivery will end in September 2017.

## READOUT ELECTRONICS

- Tests shows the concept of DIRICH will work and it will provide reliable solution for all future experiments. (more details in M. Traxler's talk tomorrow.)

## COSY BEAM TEST

- A prototype box is ready for beam test of MAPMT and readouts at COSY, Jülich in November 2017

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- 1** Overview – CBM RICH readout electronics - Christian Pauly - CBM Collaboration Meet Tübingen(Sep-2016)
- 2** The DIRICH development - Recent measurements - Christian Pauly - CBM Collaboration Meet Darmstadt(Mar-2017)
- 3** Upgrade of HADES RICH photon detector with H12700 MAPMTs - RICH 2016
- 4** Talk - Dennis Pfeifer - CBM Collaboration Meet Darmstadt(Mar-2017)
- 5** Single photon test bench for series tests of HAMAMATSU H12700 MAPMTs“, J. Förtsch for CBM Collaboration, Nucl. Instr. Meth. (2017) in press