CBM

Compressed Baryonic Matter experiment at FAIR

Measurement of the p-terphenyl decay constant using WLS coated H12700 MAPMTs and the fast FPGA based CBM/HADES readout electronics

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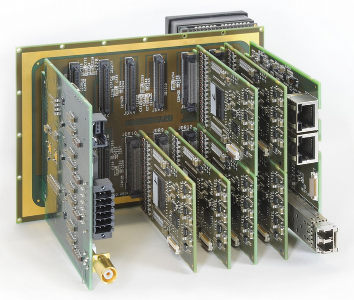
Beamtime@COSY: Motivation

- Test of the CBM and HADES RICH readout electronics under realistic beam conditions, verification of the electronics for mass production for HADES.
- Enhancement of photon detection in the UV region with p-terphenyl wavelength shifter coating and measurement of the decay constant with two different methods. (See details in: NIM A 783 (2015) p.43)



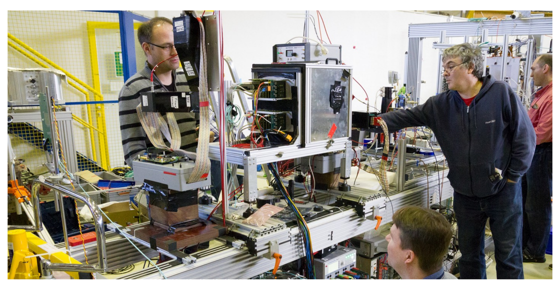


Figure (I): COSY beamtime prototype box (middle) with opened readout electronics side.

- Measurement of the timing precision of the readout and of Cherenkov rings with low noise due to application of time-over-threshold cut.

Timing Precision

- Temperature dependence of FPGA-TDCs is corrected by the application of a linear calibration in software to each of the 704 channels individually.
- Inner channel delay correction.
- Calibrated data ate filtered by applying a
  - Time-range cut
  - Time-over-Threshold cut
  - Ringfinder
  - Ring-Center cut

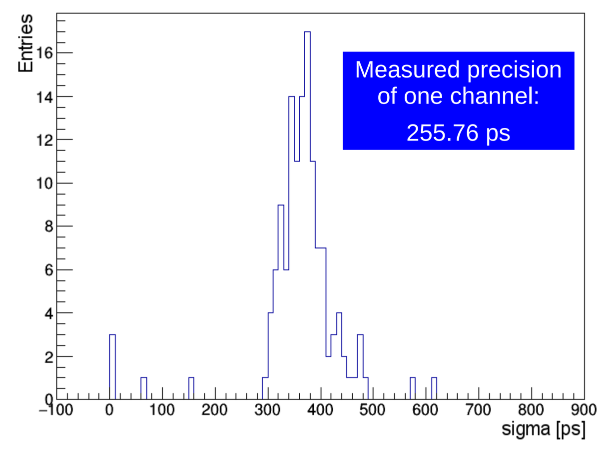


Figure (II): Distribution of folded precision between two channels in the same DiRICH.

- Leading edge time of Channel N and N-1 in the same DiRICH are compared.
- Mean of all sigma values from channel combinations with sufficient statistics is σ = 361,7 ps (see Fig. II).
- Time precision after unfolding the two channels is 255.76 ps (threshold: 80mV).
- Precision is dominated by MAPMTs, not by the DiRICH electronics (~30 ps).

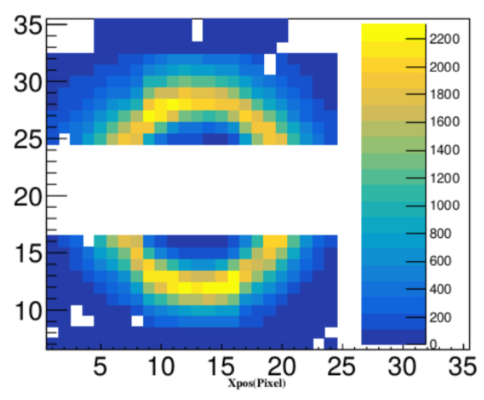


Figure (III): Typical integrated 2d hit map obtained with this setup.

Fluorescence Intensity Measurement

- Time-resolved fluorescence intensity measurements with the Hamamatsu Quantaurus-Tau system have been performed.
- All measurements were done with an excitation wavelength of 280 nm.
- Time resolved fluorescence intensity is measured for three different emission wavelengths (see Fig. VII).

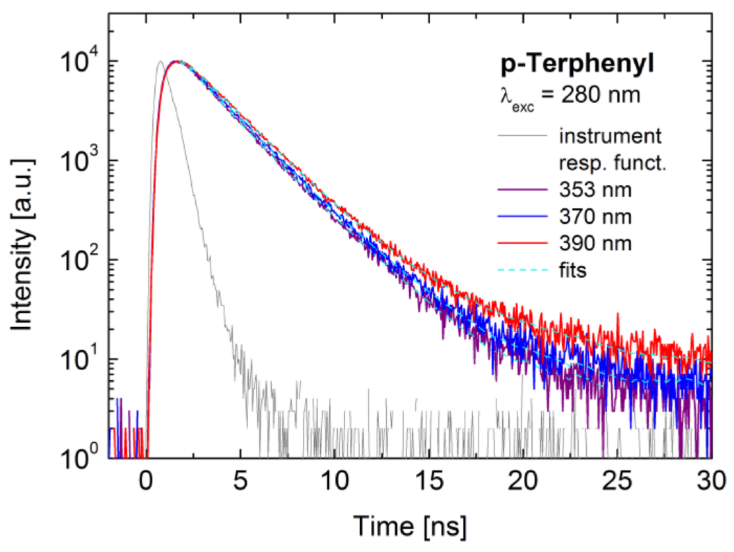
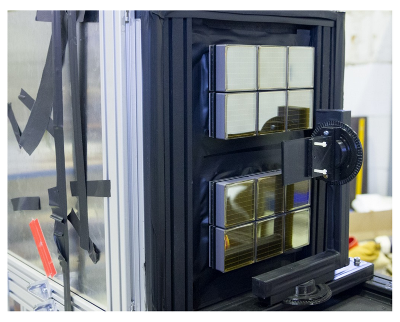


Figure (VII): Fluorescence intensity measurement with the Hamatsu Quantaurus-Tau system.

- The emission wavelengths are associated with two maxima and a shoulder in the emission spectrum of the dip-coated WLS films.
- After taking into account the instrument response function, a two exponential fit could be applied for all curves.
- For fluorescence in the main maximum at 353 nm, τ_1 = 0.8 ns and τ_2 = 2.3 ns are deduced.

Beamtime@COSY: Prototype

- Proximity focussing setup with 3mm quartz plate as radiator; proton beam of 1.6 GeV/c momentum
- 12 Hamamatsu H12700 multi anode photomultipliers (MAPMTs) are used.
- 24 DiRICH modules with 768 channels in total.
- Data acquisition with TrbNet.
- DABC is used as eventbuilder.



Wavelength Shifter Coating

- MAPMT plane was measured with
  - full plane WLS coating.
  - upper half plane WLS coating.
  - without WLS coating.
- WLS increases the number of Cherenkov photons by approx. 20% over whole threshold range (without cuts).

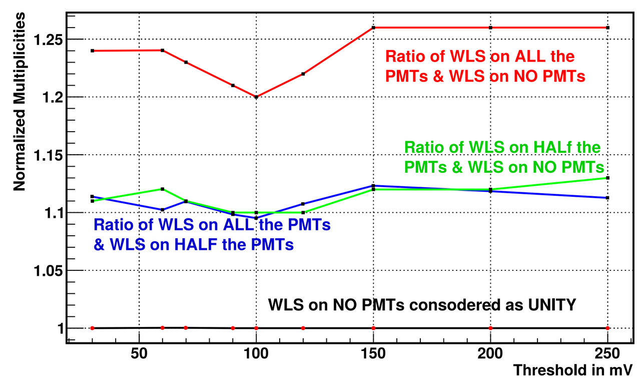


Figure (IV): Cherencov photon increase due to WLS coating.

- Consistency check with half coated MAPMT plane compared to full- and uncoated MAPMT plane.

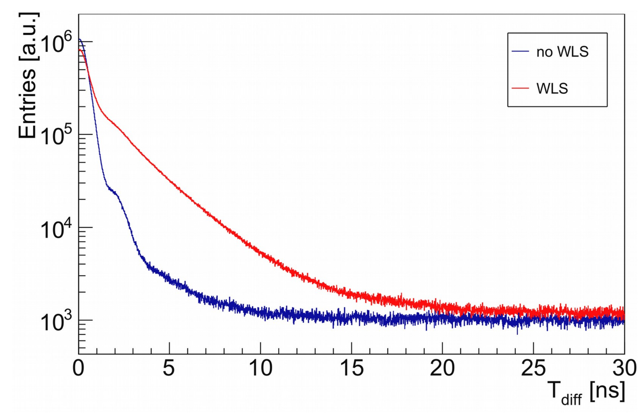


Figure (V): T_{diff} distribution with and without WLS coating.

- WLS decay constant is measured by calculating the time differences of all hits in a ring to the earliest hit in the ring.

$$T_{diff} = T_{ref} - T_{hit}$$

- Distribution of the time difference T_{diff} for a full WLS coated MAPMT plane is compared to an uncoated MAPMT plane, which shows the time behaviour of the WLS coating (Fig. V).
- Decay constant is extracted (Fig. VI) by applying a two exponential fit between 1.5ns and 40ns.

$$A \cdot \exp(t / \tau_1) + B \cdot \exp(t / \tau_2)$$

- The fast decay constant τ_1 is measured with 2.37 ns and stays constant over the complete threshold range.

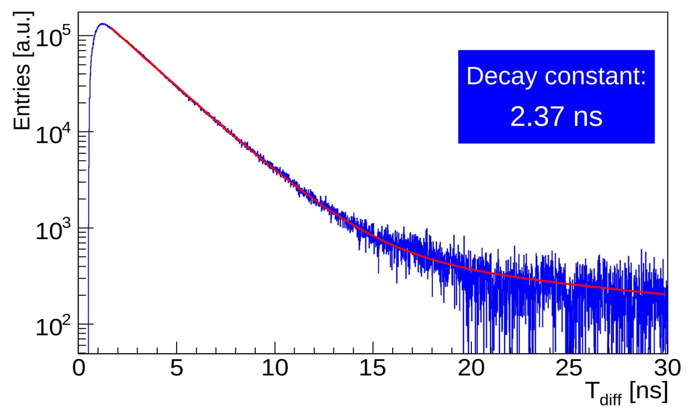


Figure (VI): Difference between WLS and no WLS measurements (blue) with a two exponential fit (red).

- τ_2 is unstable in dependence of the threshold.
  - It is most likely from background and thus connected to the threshold.
  - It gives a small contribution of 2% to the data.

- The relative intensity of the second component is twice as large as for the first component.
- For 370 nm and 390 nm similar results were obtained.
- The beamtime data is not sensitive in the region of the fast decay constant of 0.8 nm and thus not measured.
- The results from both measurement methods with a value of 2.3 ns respectively 2.37 ns are in very good agreement for the slow time component of WLS coating.

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Supported by BMBF 05P15RGFCA and BMBF 05P15PXFCA