

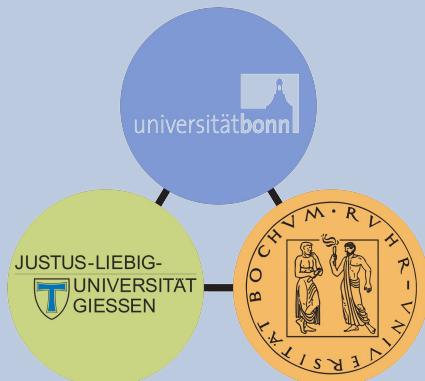
The Crystal-Barrel/TAPS-Experiment at ELSA

current status and future modifications
of the CsI(Tl) Calorimeters

Christoph Wendel

for the

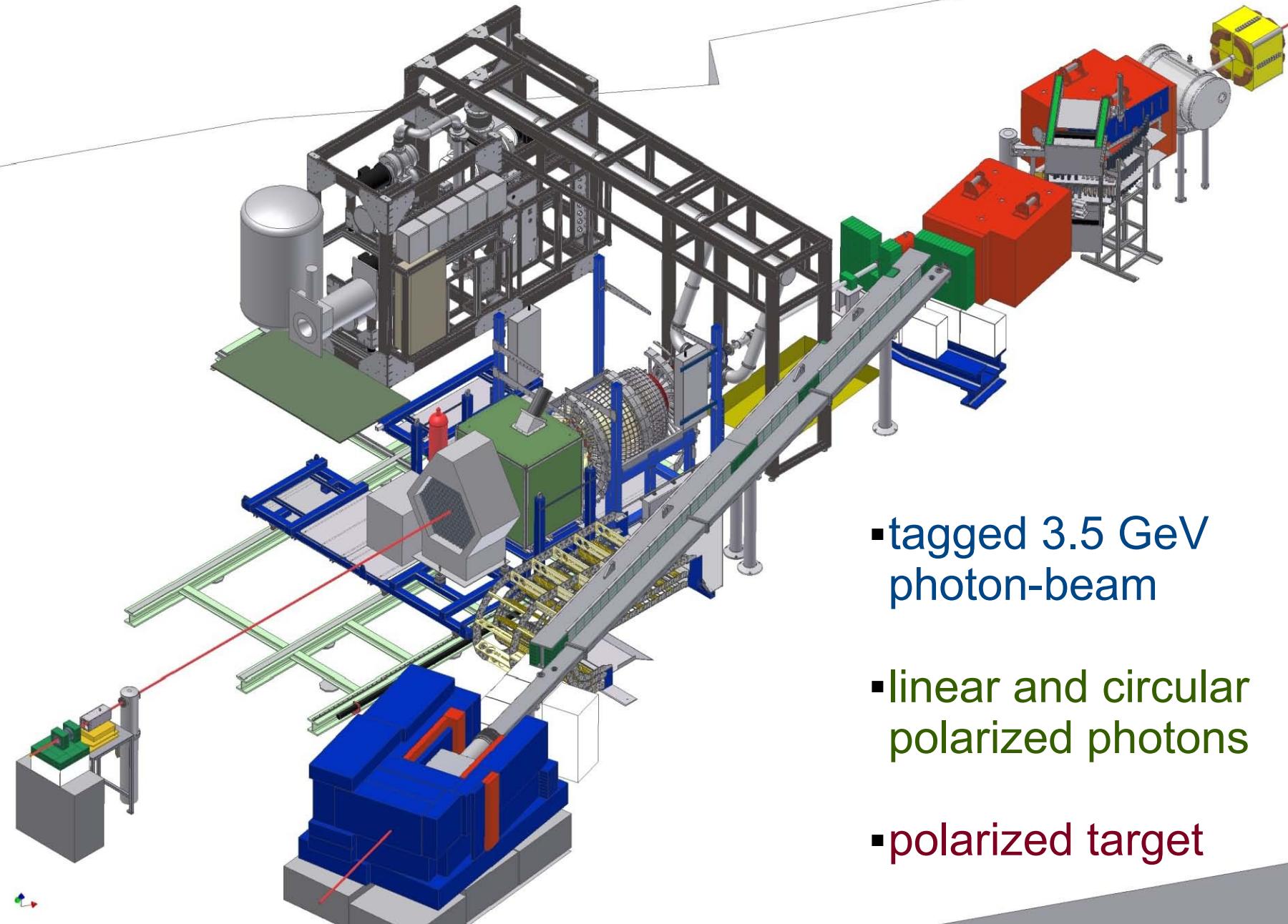
CBELSA/TAPS-Collaboration



Deutsche
Forschungsgemeinschaft
DFG

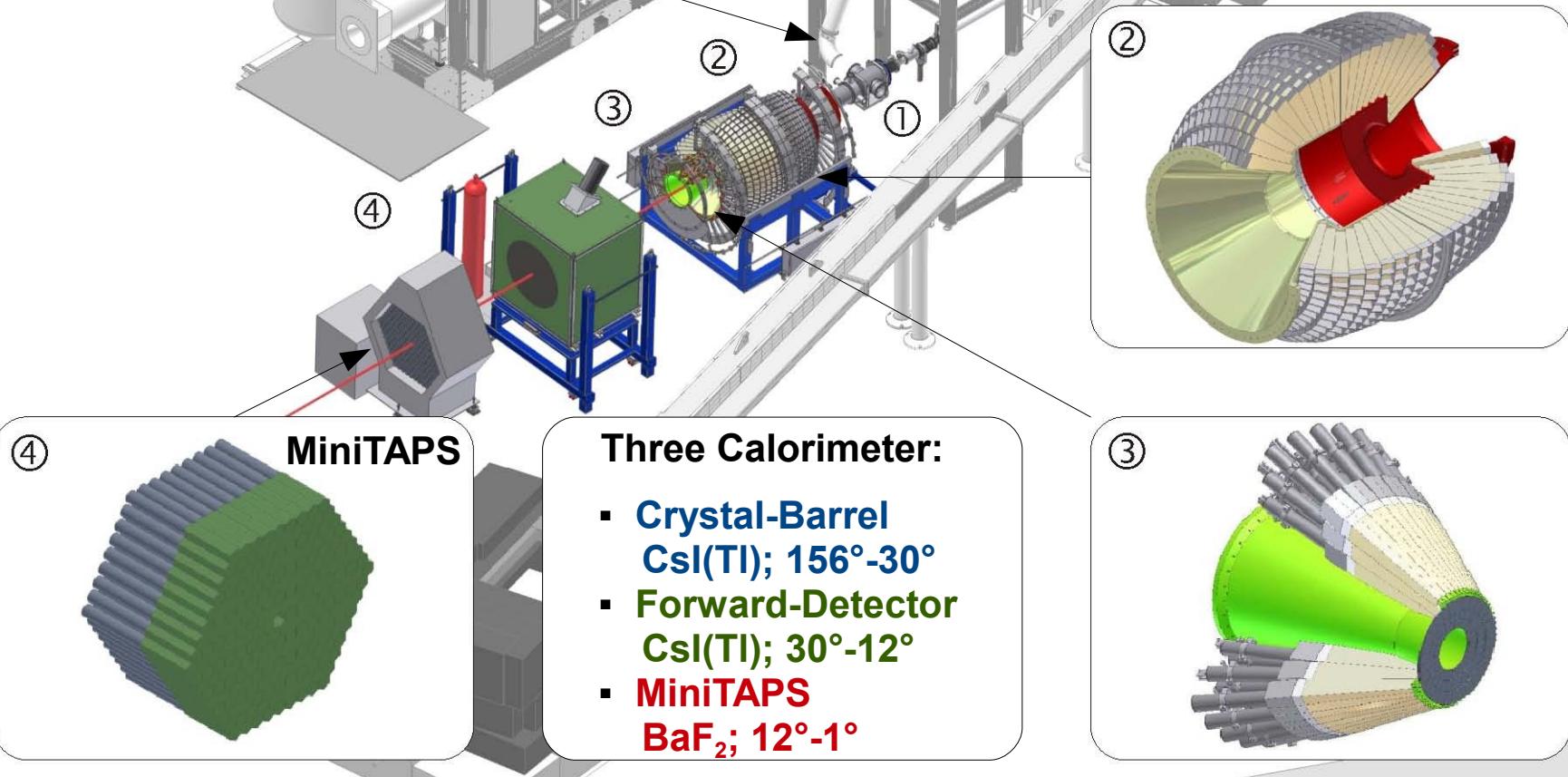
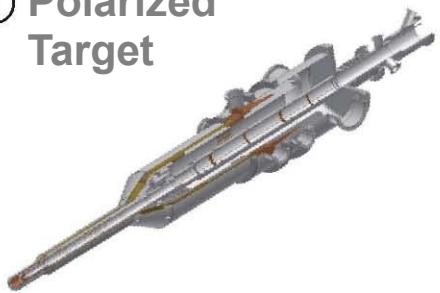
The Crystal-Barrel-Experiment at ELSA

Baryon-Spectroscopy and Meson-Photoproduction

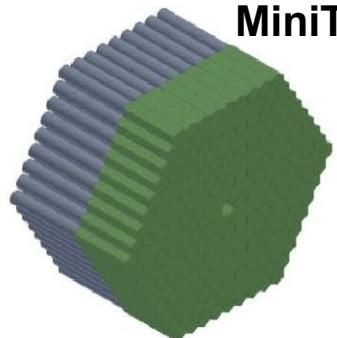


Calorimeter Overview

① Polarized Target

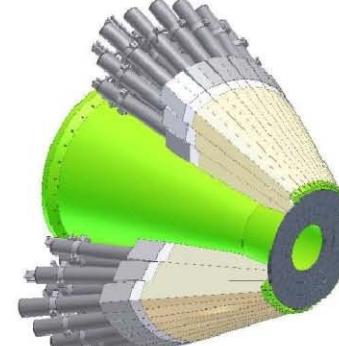


④

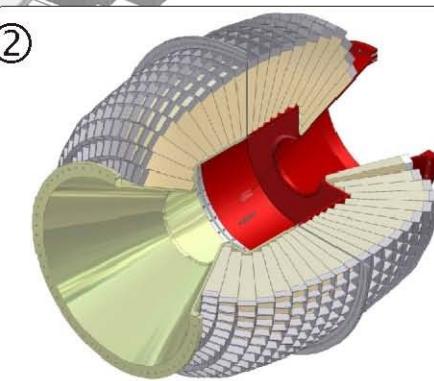
MiniTAPS**Three Calorimeter:**

- **Crystal-Barrel** CsI(Tl) ; 156° - 30°
- **Forward-Detector** CsI(Tl) ; 30° - 12°
- **MiniTAPS** BaF_2 ; 12° - 1°

③

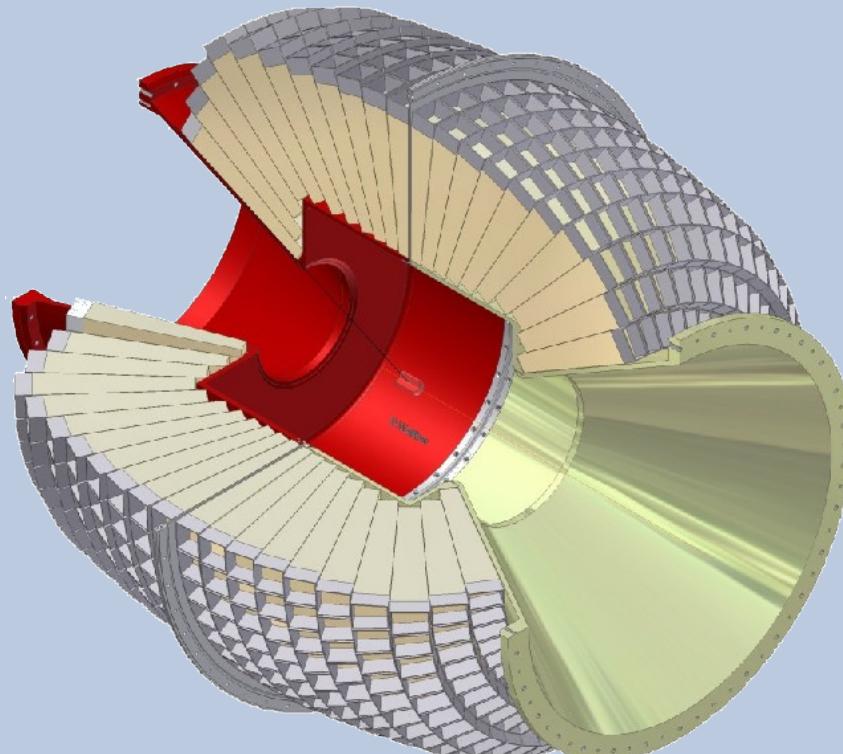
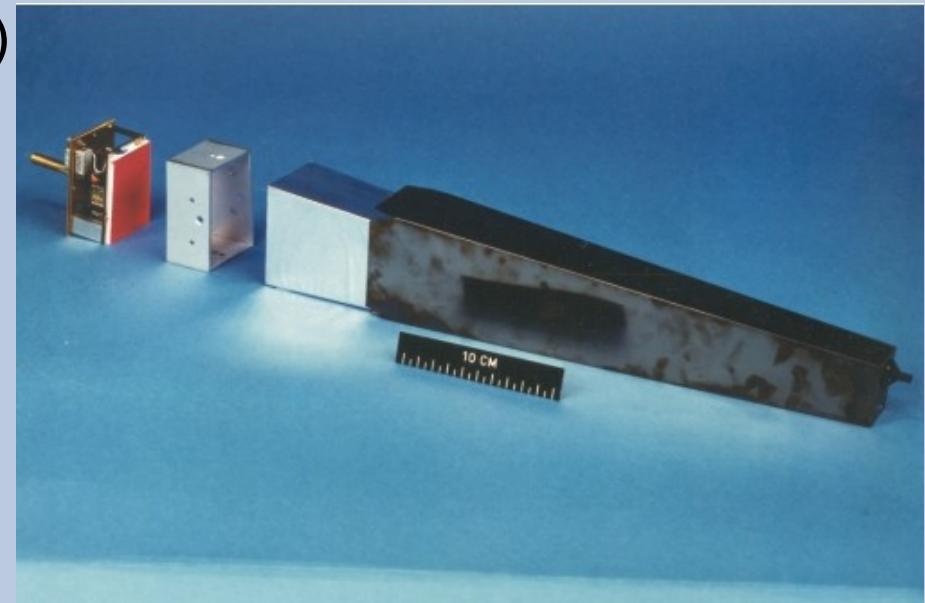


②



The Crystal-Barrel-Calorimeter

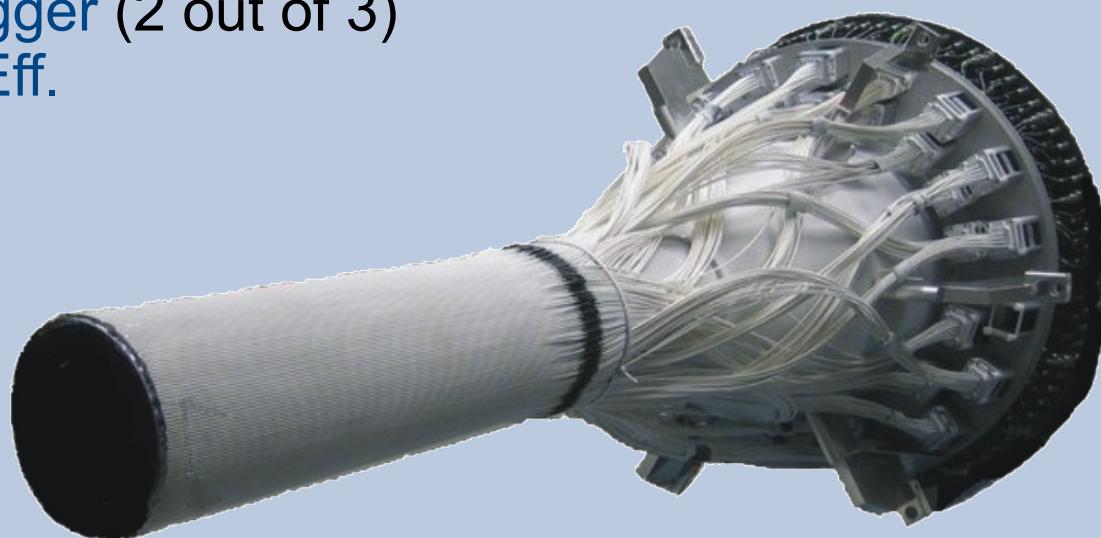
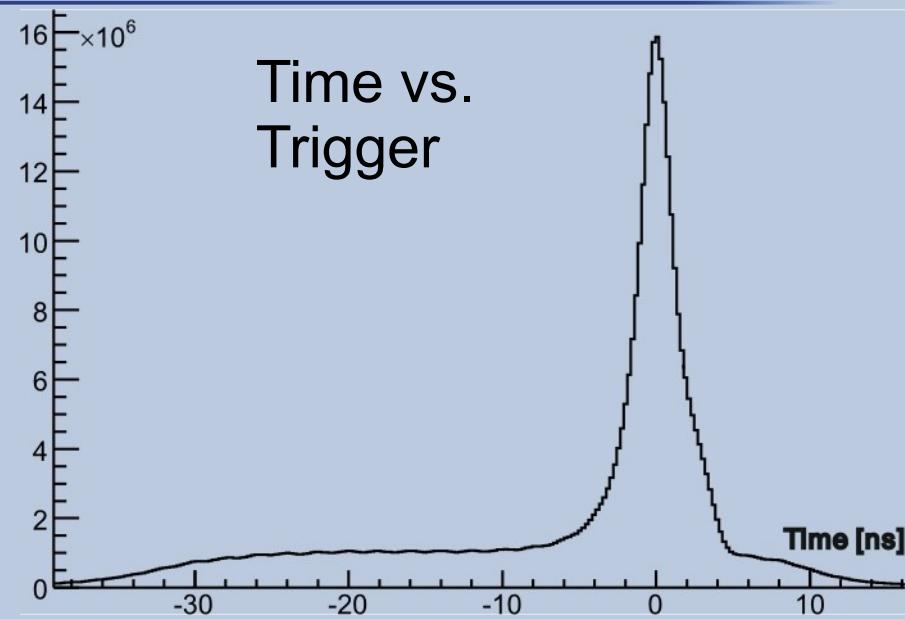
- 1230 CsI(Tl) Crystals ($\theta: 156^\circ - 30^\circ$)
- $\Delta\theta: 6^\circ \quad \Delta\varphi: 6^\circ \quad l=30\text{cm} / 16 X_0$
- photodiode readout via WLS with integrated preamplifier
- signal-shaper
- 12-Bit dual range ADC
1 MeV – 150 MeV / 1.2 GeV



- no 1st level trigger capability
- no timing information
- gated cellular logic cluster-finder as 2nd level trigger ($>15\text{MeV}$; $\sim 5\mu\text{s}$)
- reconstructed angular resolution $\sim 1^\circ$ (for photons)
- energy resolution
 $\sigma E / E = 2.5\% / E[\text{GeV}]^{0.25}$
(5% (100 MeV) ; 2.5% (1 GeV))

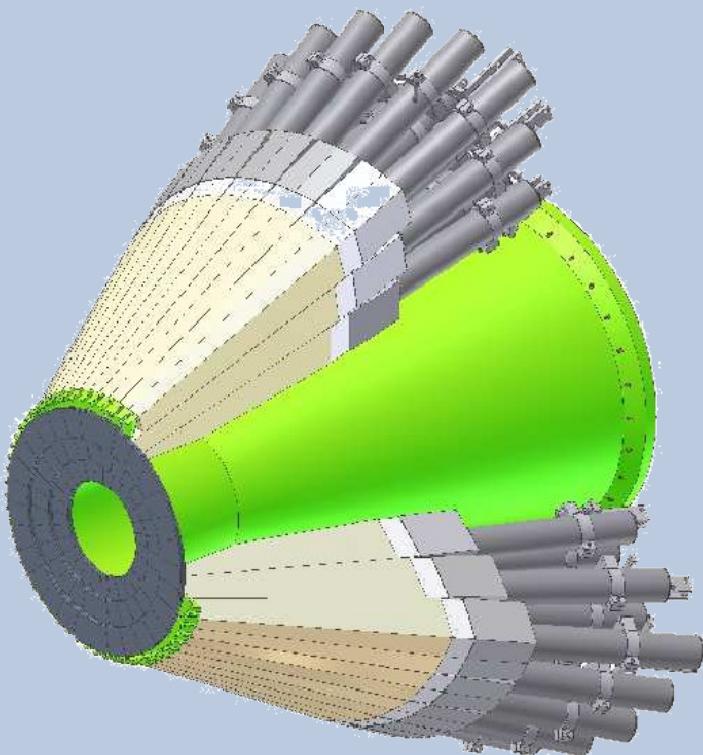
Crystal-Barrel – Charge Identification

- 513 scintillating fibres (2 mm)
- three layers, parallel and $\pm 25^\circ$ twisted
- multi-anode PMT readout
- angular resolution $0,4^\circ(\theta)$ and $0,1^\circ (\varphi)$
- charge ID with $\sigma(t)=0.9$ ns
- MultiHit TDC
- 1st level trigger (2 out of 3) with 98% Eff.



The (new) 30° Forward-Calorimeter

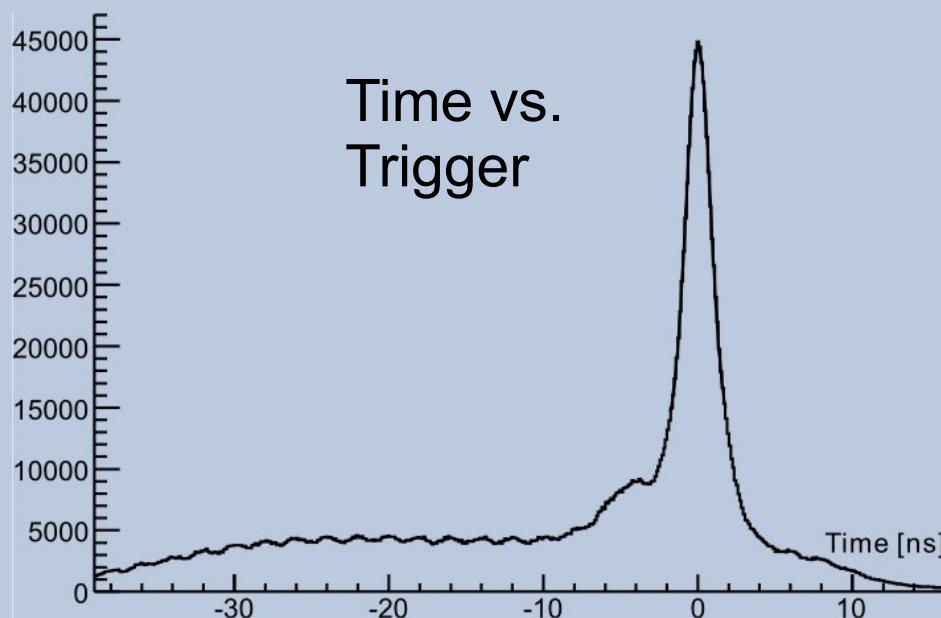
- 90 CsI(Tl) Crystals (θ : 30°-12°)
- $\Delta\theta$: 6° $\Delta\varphi$: 12°
- PMT readout
- driver – shaper combination,
differential signal transmission
- 12-Bit dual range ADC
1 MeV – 250 MeV / 2 GeV



- risetime-compensating discriminators; $\sigma(t)=1.3$ ns
- MultiHit TDC
- free running clusterfinder (SRAM lookup-table)
1st level trigger (<70 ns)

The (new) 30° Forward-Calorimeter

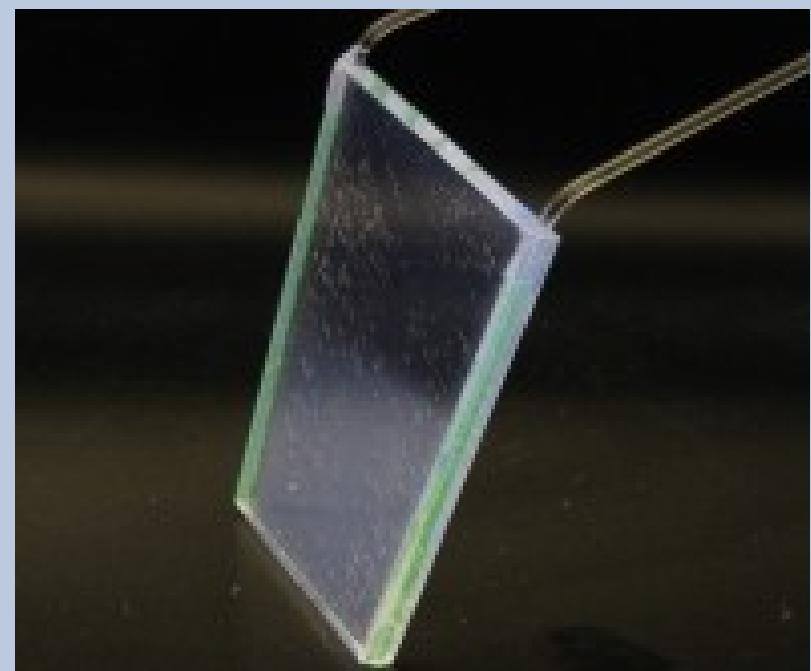
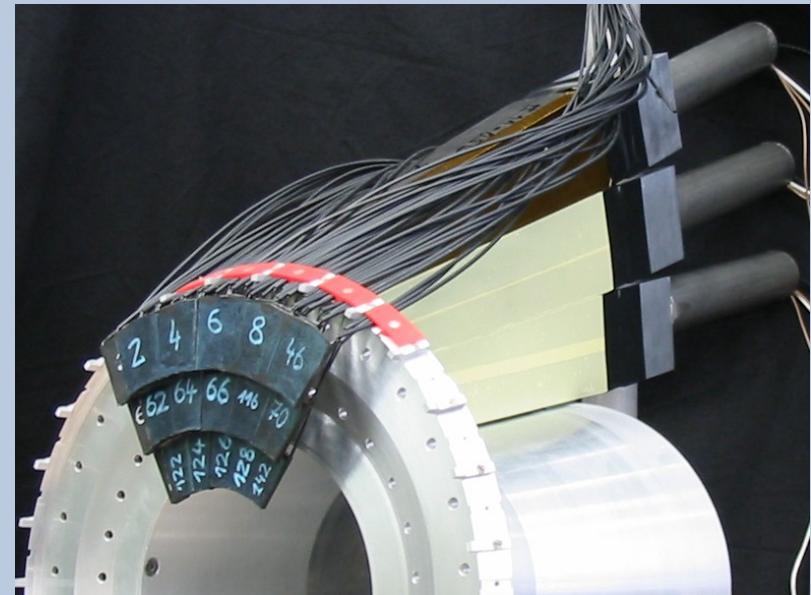
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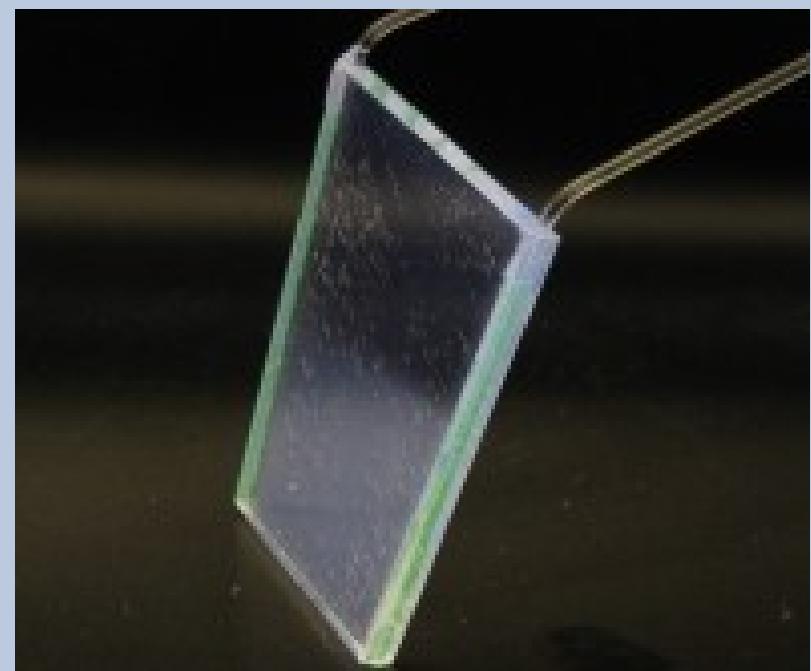
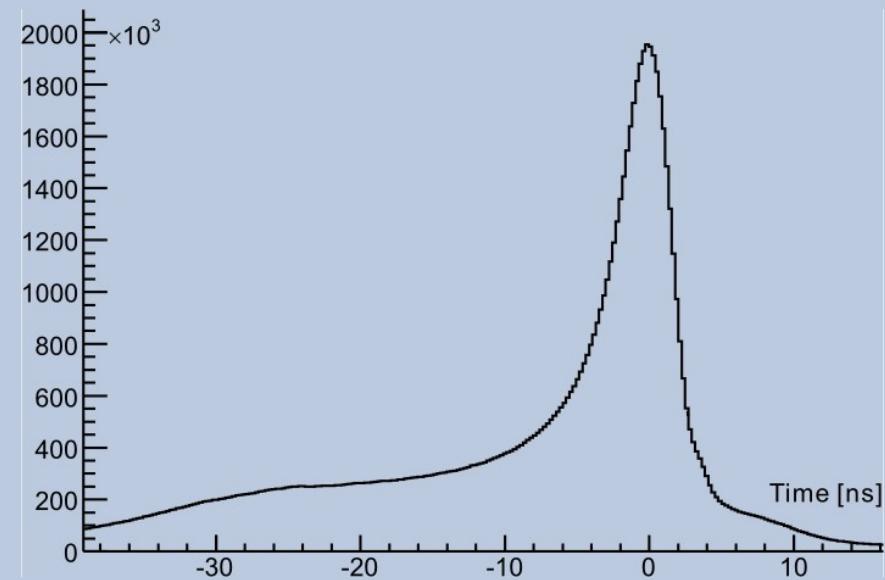
Forward-Detector – Charge Identification

- 180 plastic scintillator tiles (3 mm), with the solid angle of the crystals
- two layers, shifted by $\varphi_{\text{Cry}} / 2$ doubled φ resolution & noise reduction
- double WLS-readout (1 mm)
- spliced and thermoformed CWG (60° bend with $r = 5$ mm)
- multi-anode PMT readout
- 6° angular resolution
- charge ID with $\sigma(t)=1.7$ ns
- 1st level trigger capability (< 50 ns) with 95% Eff.



Forward-Detector – Charge Identification

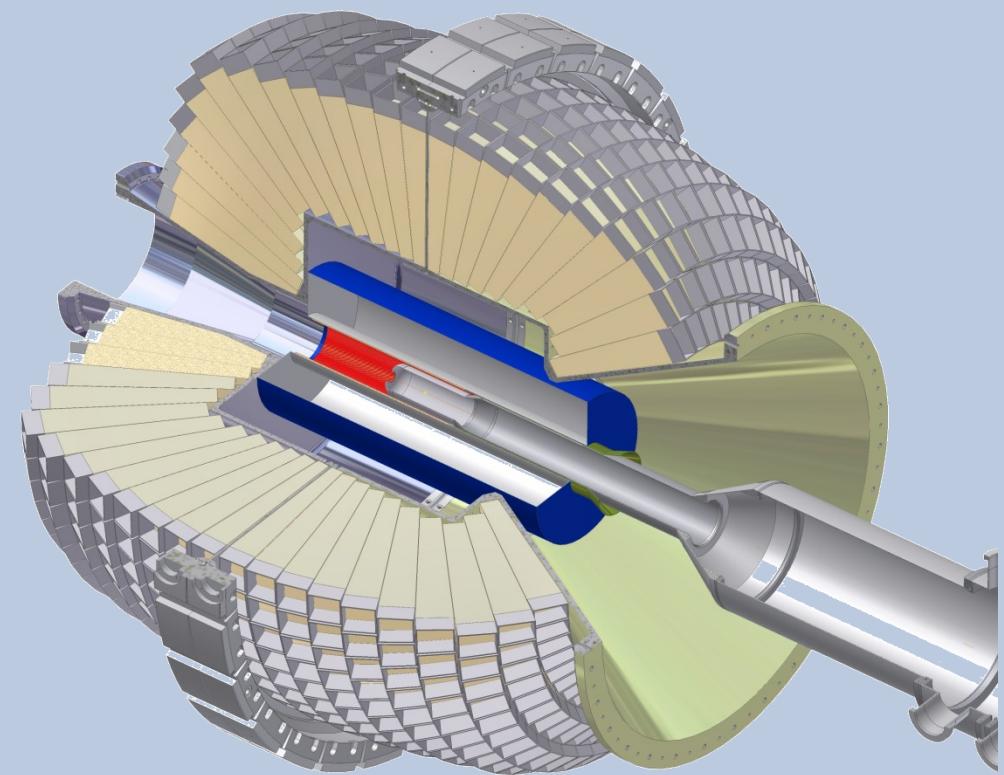
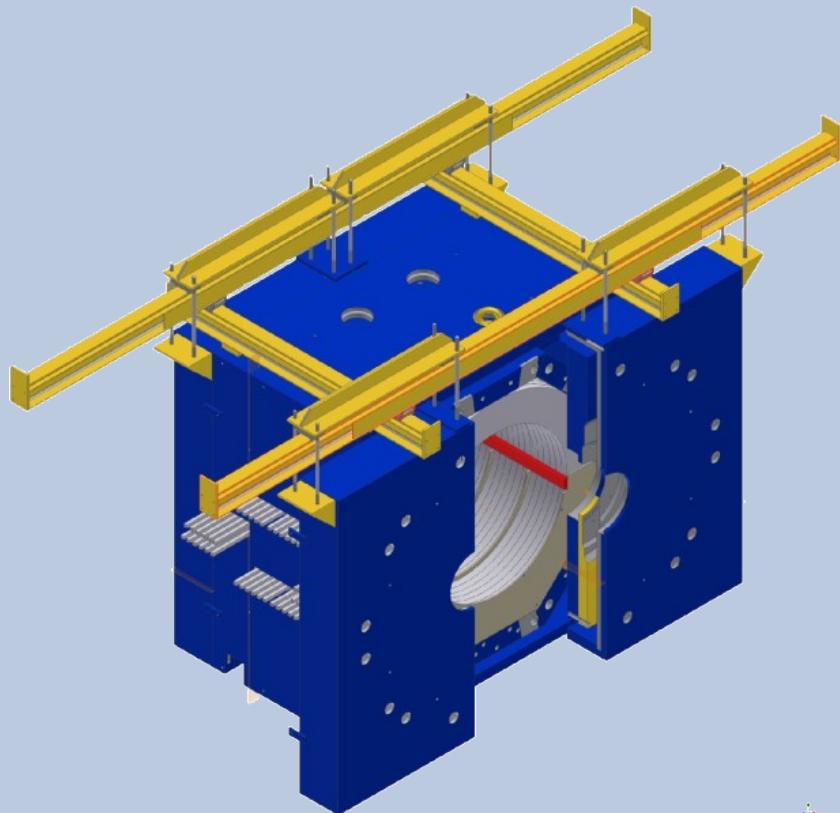
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Future Modifications

Starting 2010

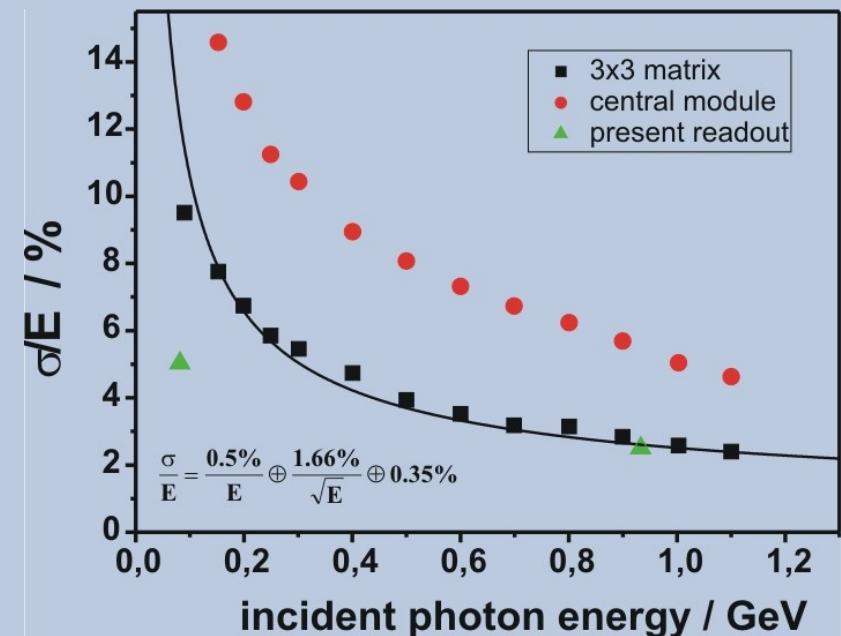
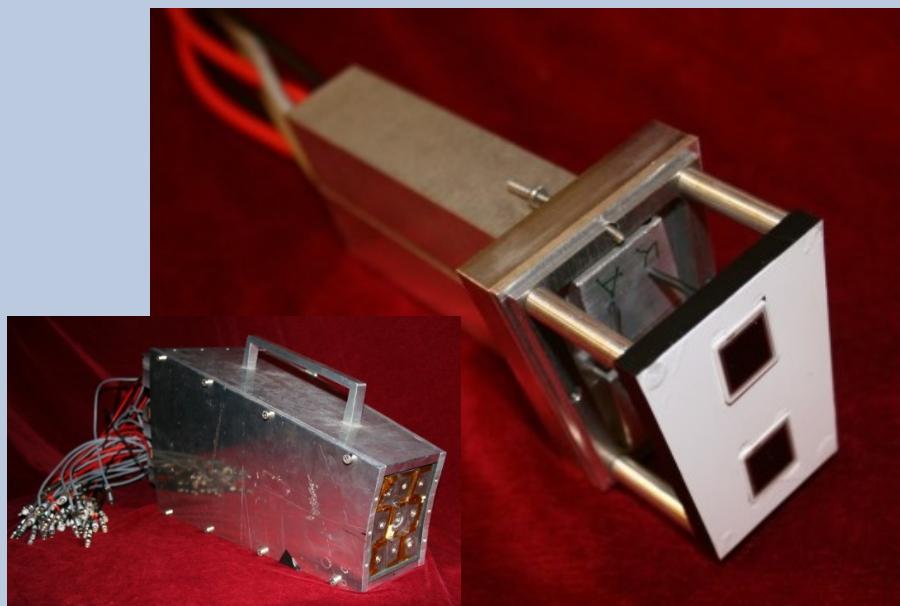
- 300 mm TPC replacing the Inner-Detector (PANDA Prototype)
- superconducting coil with 2.5 T
- (re)combination of Crystal-Barrel and Forward-Detector
- new readout inc. 1st level trigger capability on all crystals
- sampling ADC readout



Future Calorimeter Readout APD

Avalanche Photo Diodes

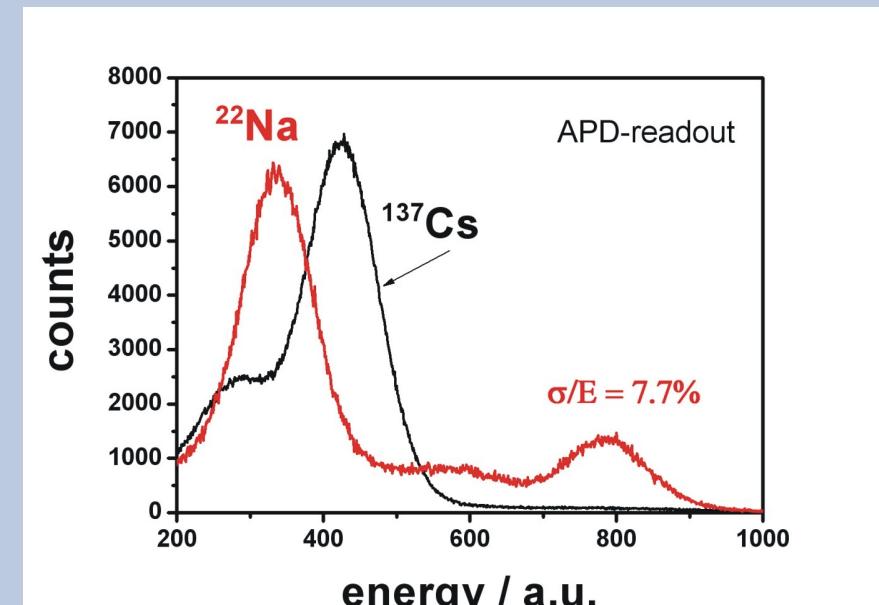
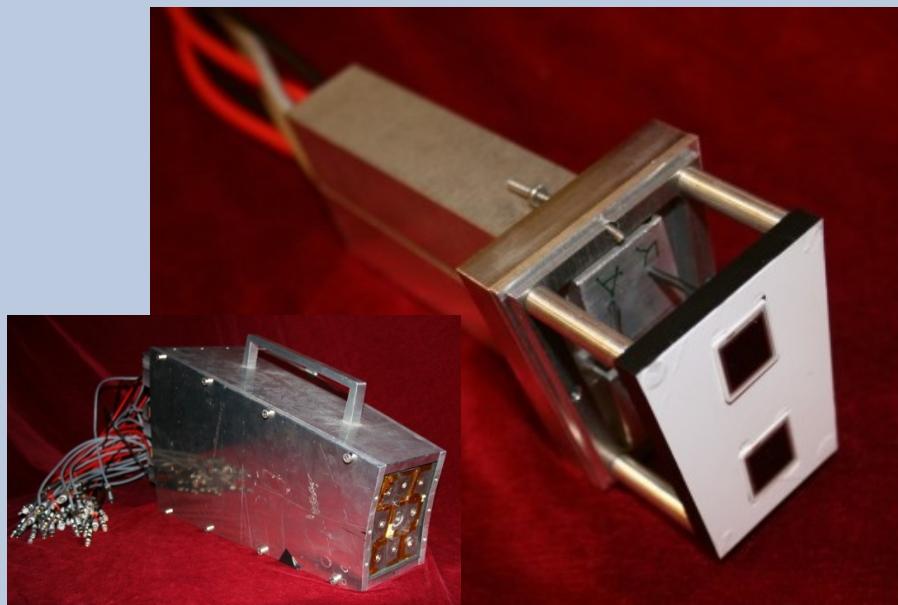
- complete redesign of the crystal endcaps
- two PANDA - APDs mounted to the crystal (10mm x 10mm)
- integrated preamplifier, not yet optimized for CsI(Tl)
- energy determination and timing with the APD
- time resolution $\sigma(t) = 1.8$ ns
(1.3 ns with PMT)
- energy resolution (test)
 $\sigma E / E = 0.5\% / E + 1.66\% / \sqrt{E} + 0.35\%$
(10% (100 MeV) ; 2.5% (1 GeV))
(5% (100 MeV) ; 2.5% (1 GeV) with PD)
- challenge:
temperature stability (~ 0.1 K)



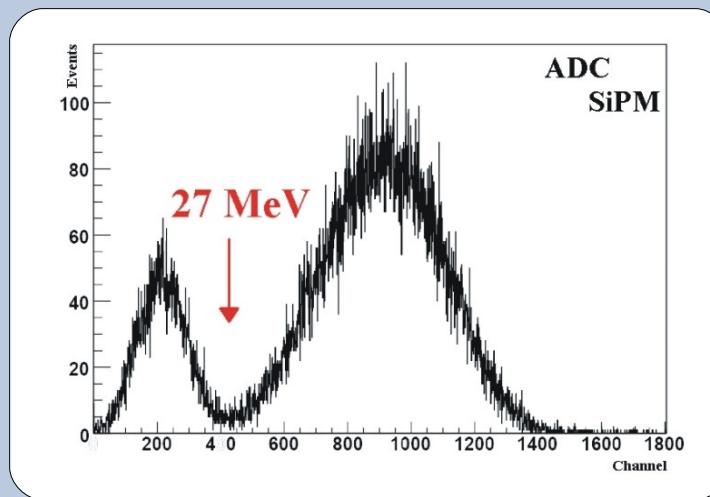
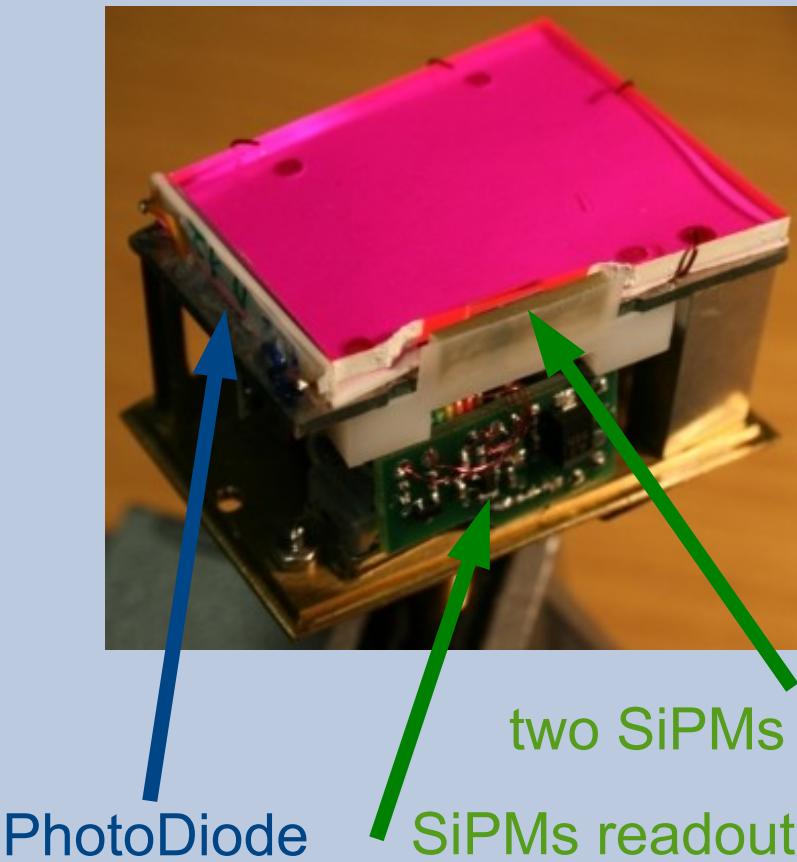
Future Calorimeter Readout APD

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 $\sigma E / E = 0.5\% / E + 1.66\% / E^{0.5} + 0.35\%$
(10% (100 MeV) ; 2.5% (1 GeV))
(5% (100 MeV) ; 2.5% (1 GeV) with PD)
- challenge:
temperature stability (~ 0.1 K)



Future Calorimeter Readout SiPM



Silicon PhotoMultiplier

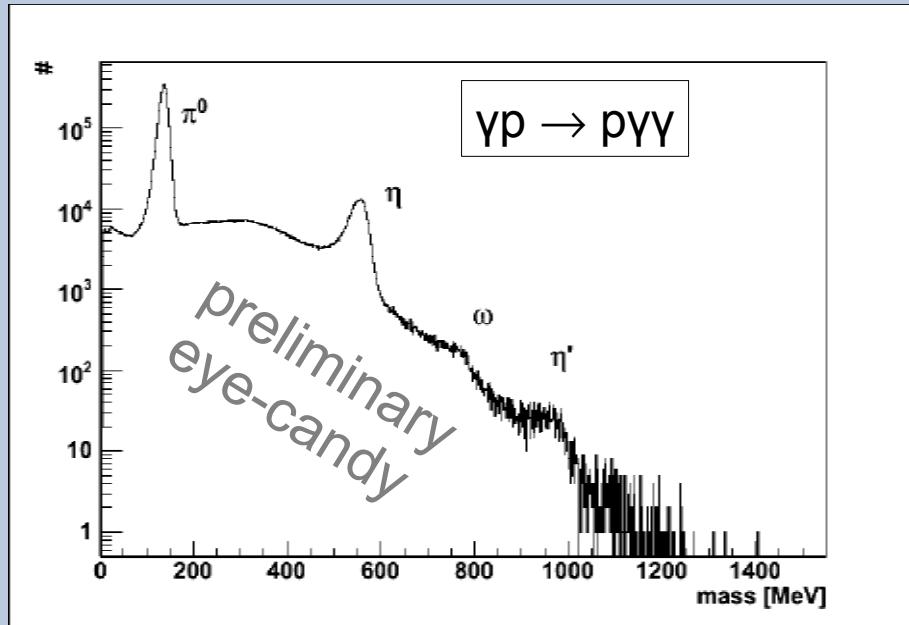
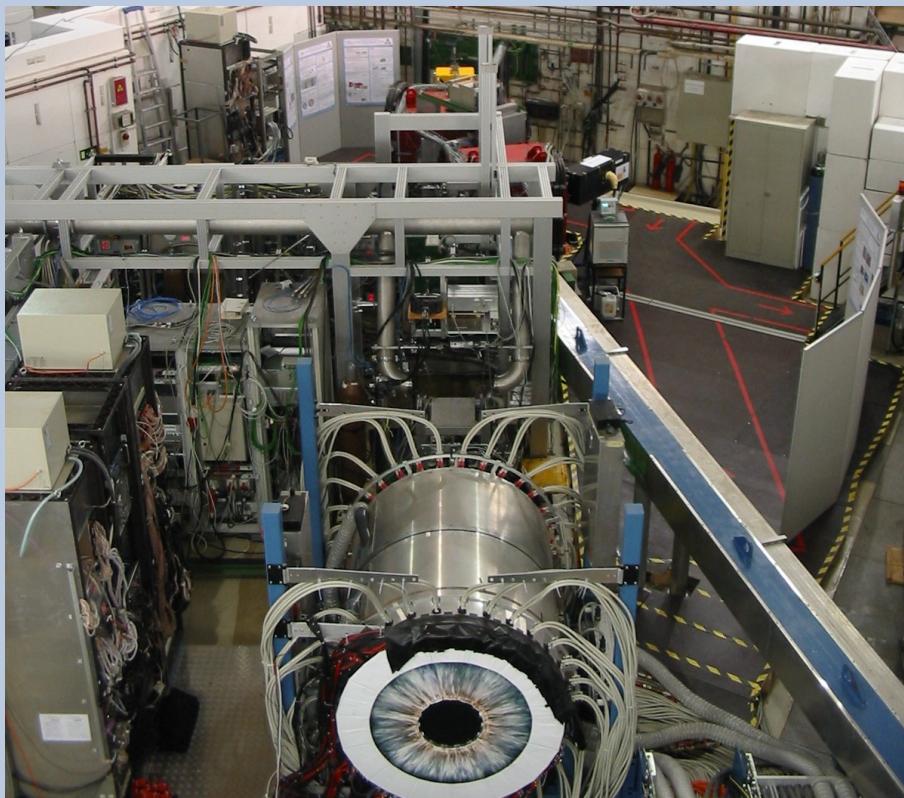
- modification of the current crystal endcaps
- two SiPMs added to the WLS (3 mm x 3 mm), 5k pixel each
- energy determination with PD, timing with SiPM
- threshold 27 MeV, $\sigma(t)=12$ ns
(20 MeV / 1.3 ns with PMT)
- challenge:
high noise level



Summary

Current Performance

- Crystal-Barrel up and running
- currently taking double polarization data
- two years of datataking ahead



Outlook

- major redesign of the crystal readout underway
- two 3 x 3 arrays of the crystals ready and competing (SiPM vs. APD)
- Crystal-Barrel will continue to provide excellent data for the study of strong QCD