universitätbonn

Physics

Experiment
Accelerator
Target
Tagger
Calorimeter

Future Upgrades
Time Projection Chamber
New APD Readout
Flash ADCs

Summary

Questions

The Crystal Barrel Experiment at ELSA

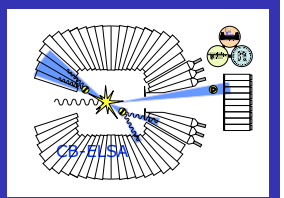
Friedemann Zenke

HISKP, University of Bonn
www.hiskp.uni-bonn.de

Bonn Cologne Graduate School of Physics and Astronomy

Funded by DFG with SFB/TR16

June 18, 2008



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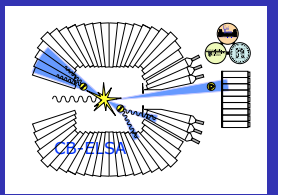
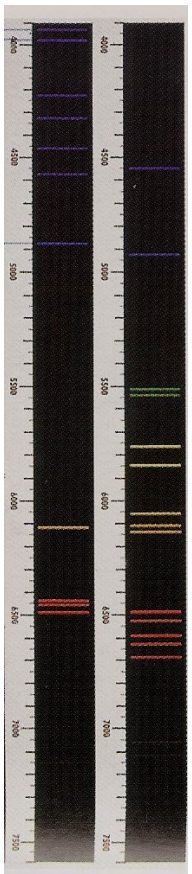
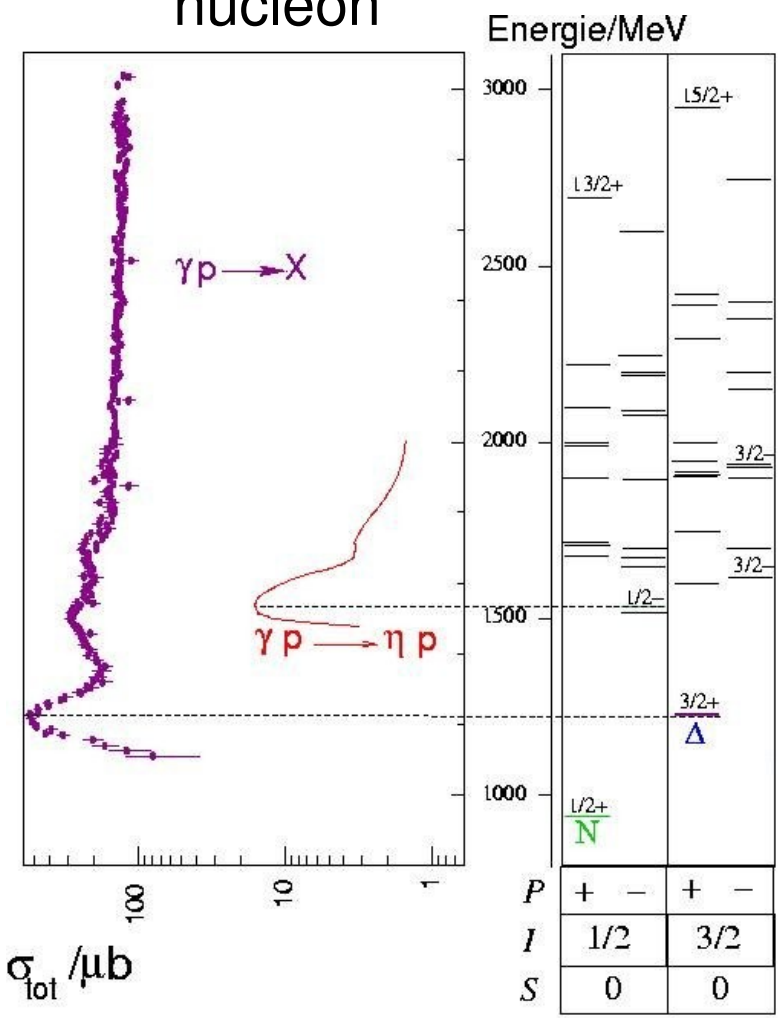


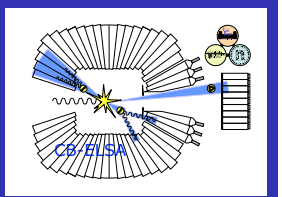
Hadron spectroscopy

atom

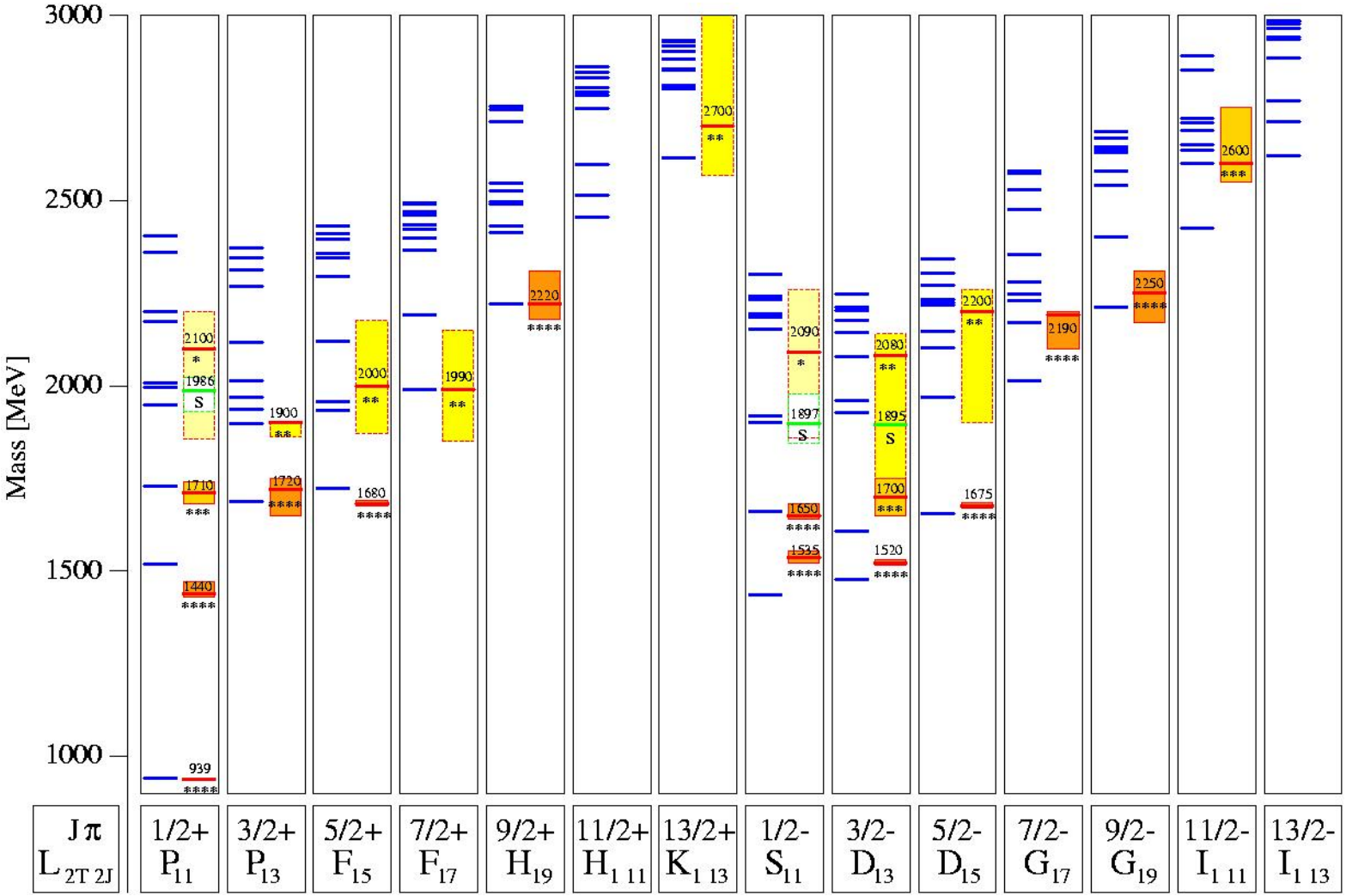


nucleon

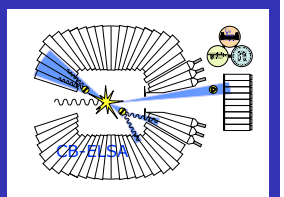




Missing Resonances

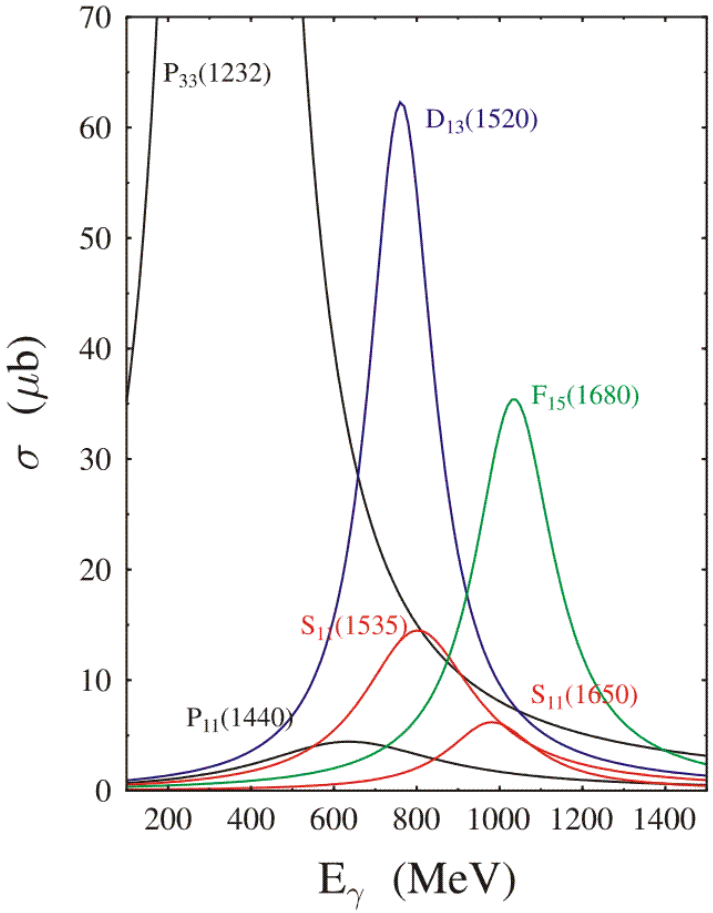


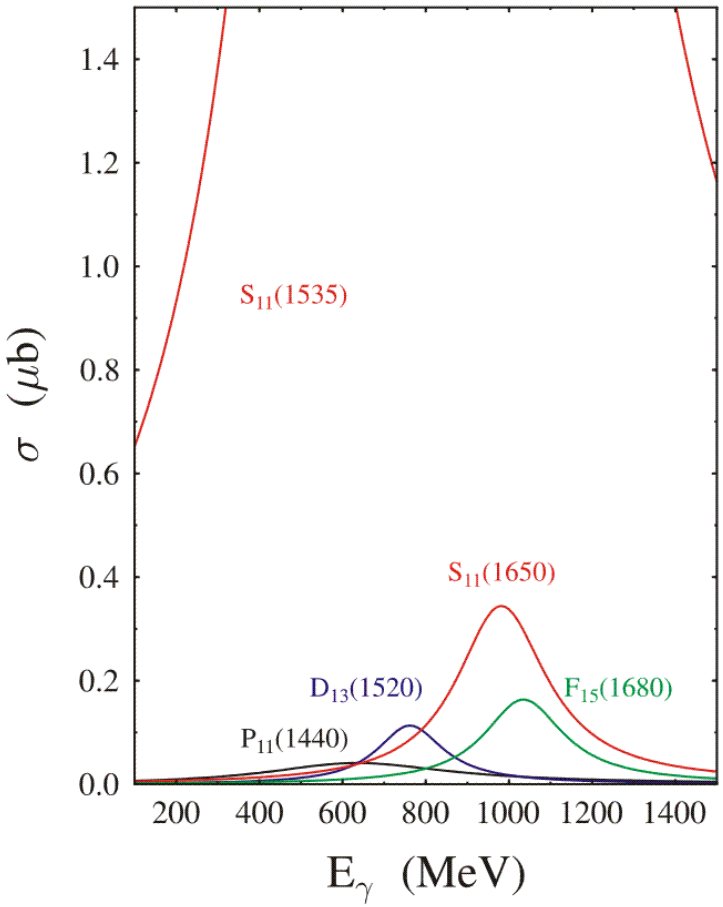
N* resonances, Löring, Metsch, Petry, EPJA 10, 395(2001)



Overlapping Resonances

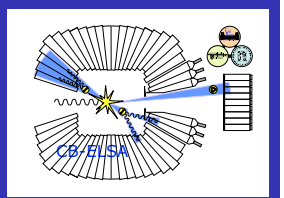
A resonance might be hidden beneath another





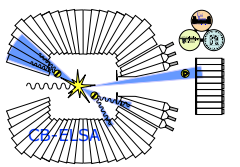
$\gamma + N \rightarrow N^* \rightarrow N + \pi$

$\gamma + N \rightarrow N^* \rightarrow N + \eta$



Polarization Variables

- Can be disentangled with help of Polarization Variables
- More in Jan's talk



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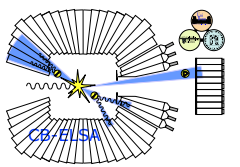


ELectron Stretcher Accelerator

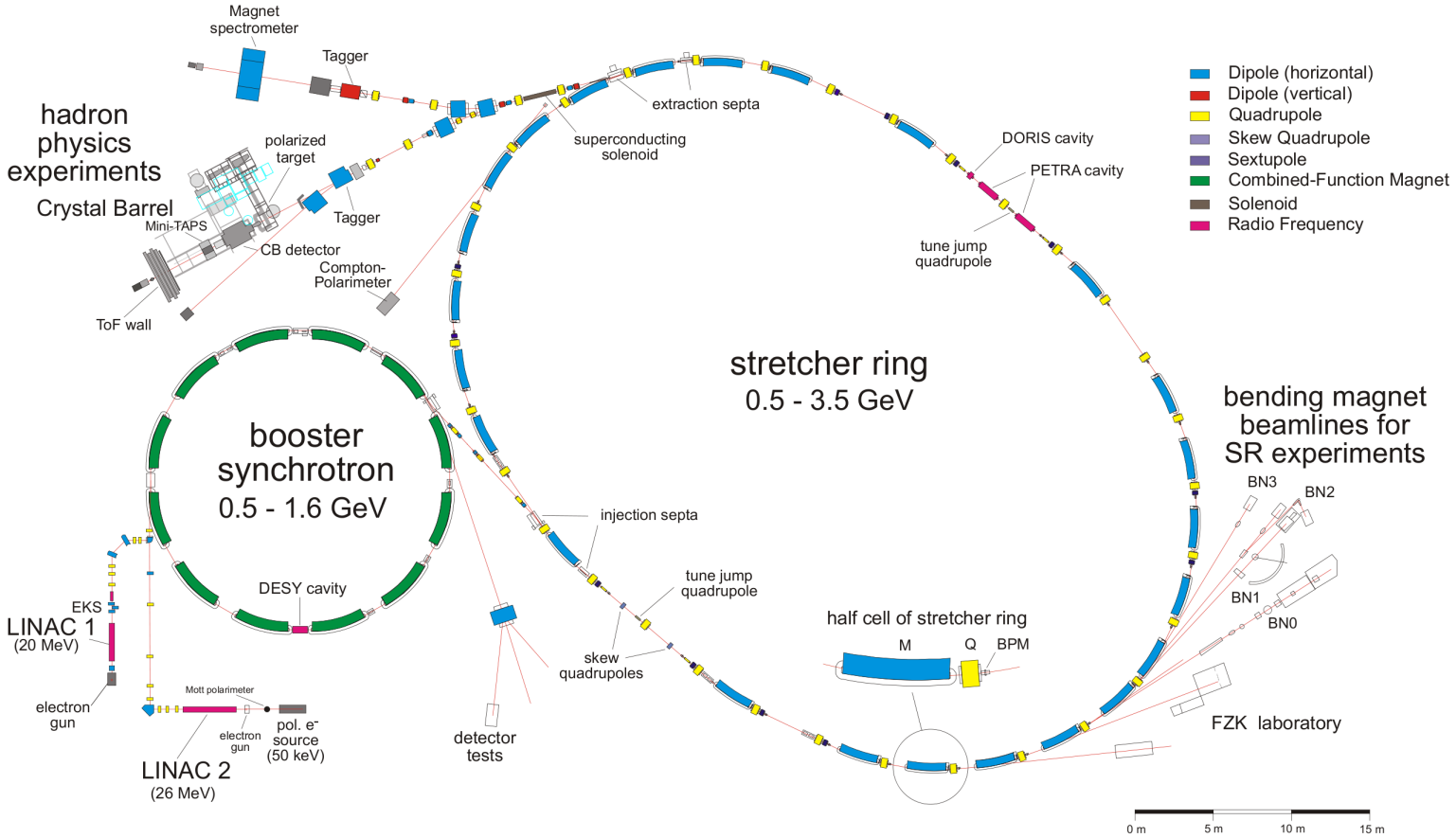
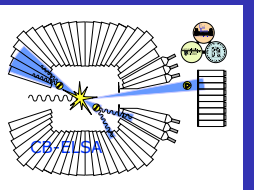
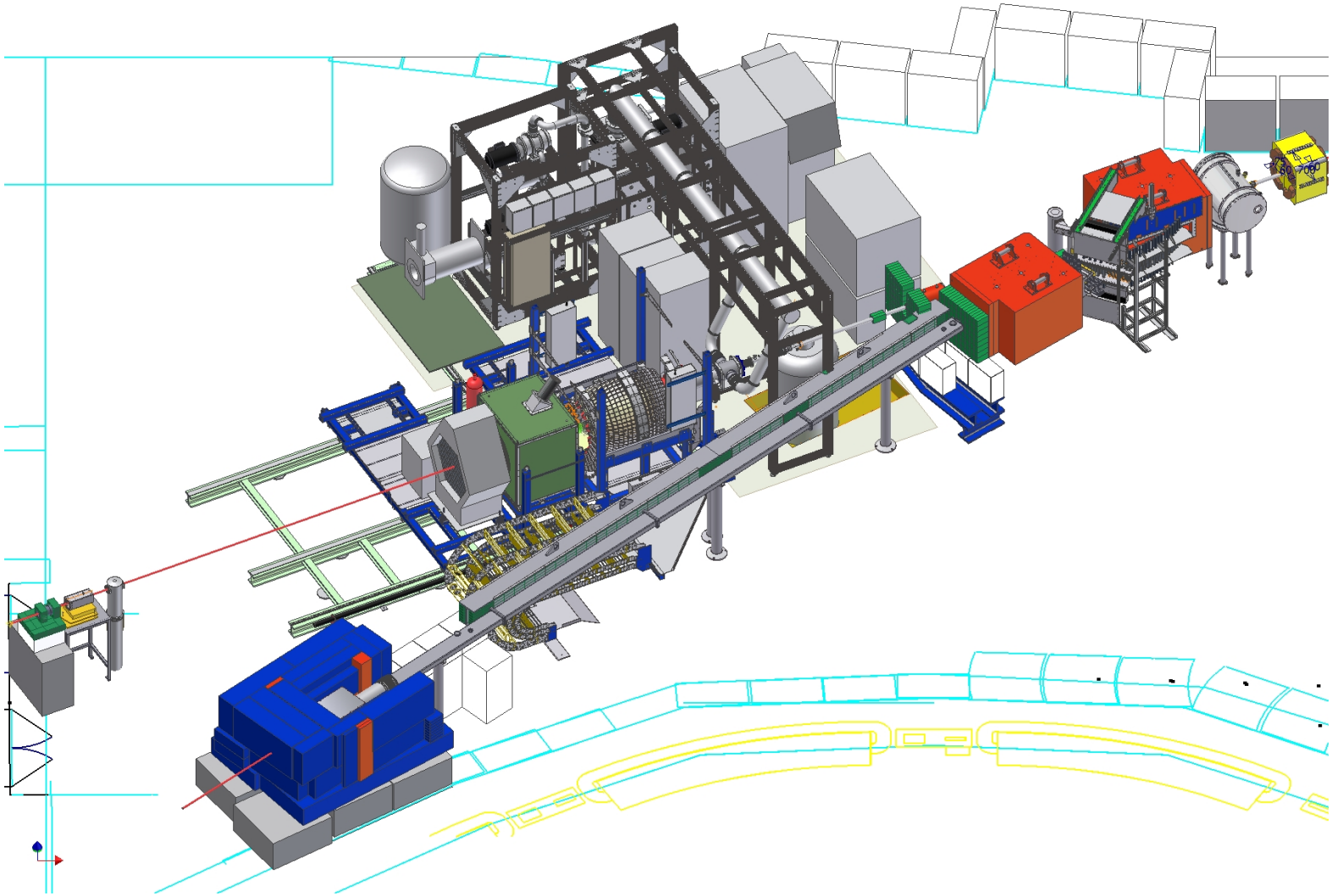
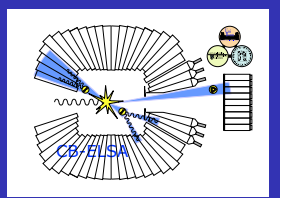


Figure: University of Bonn, CW polarized electron accelerator



Experimental Area Overview





The Bonn Frozen Spin Polarized Target

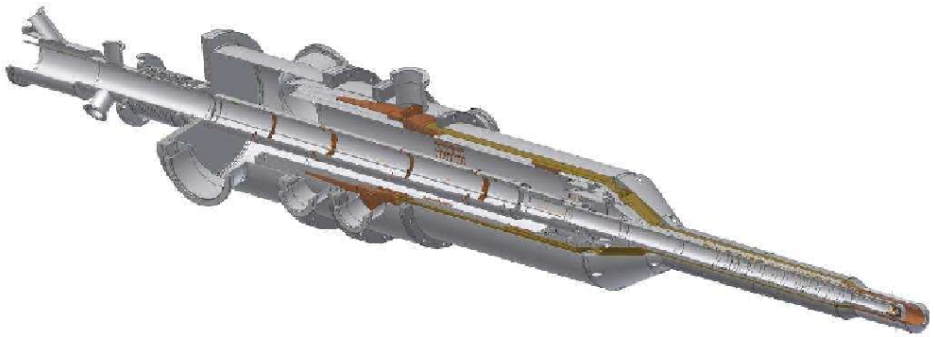
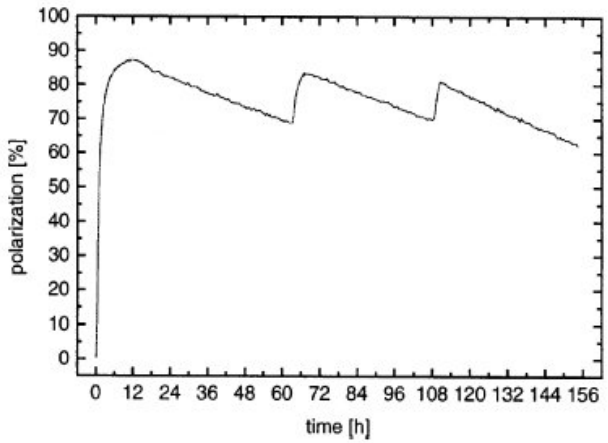
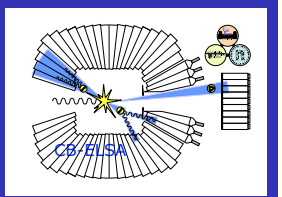


Figure: Schematic of Polarized Target Cryostat

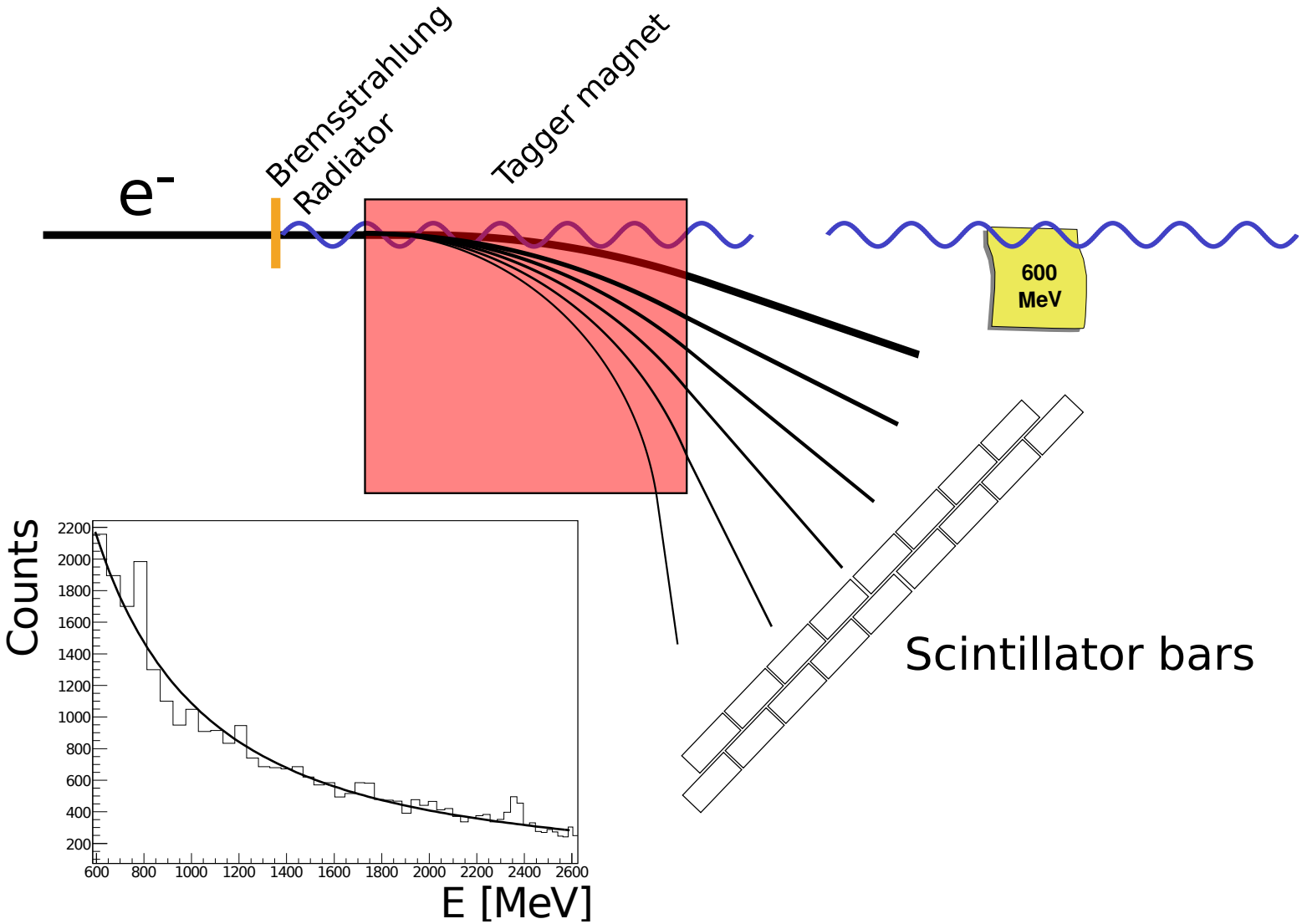
- Butanol frozen spin target
- Polarization up to 90%
- Decay times $>$ 200h

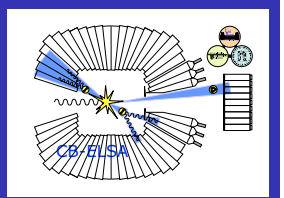


Ch. Bradtke et al. NIM A436 p. 430 (1999)

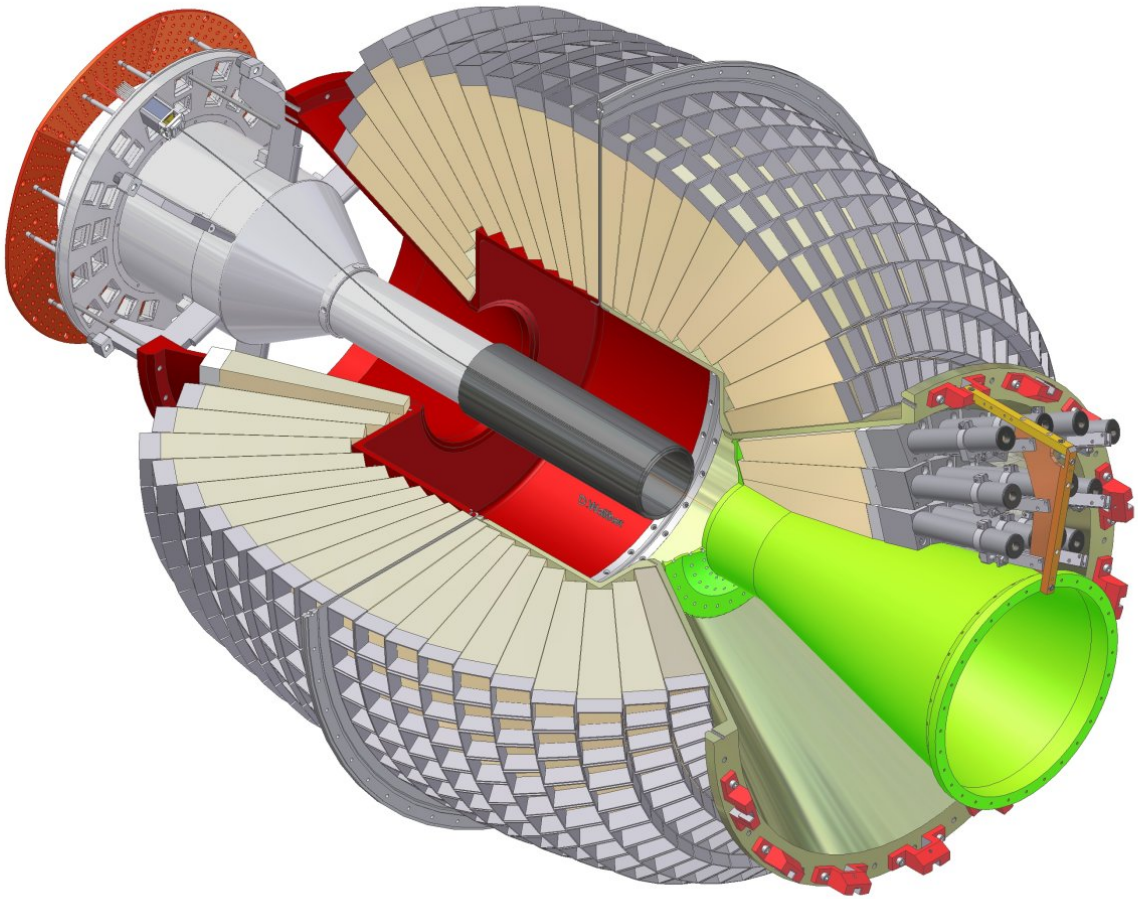


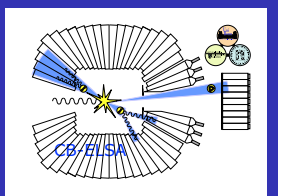
Tagging Photons





Crystal Barrel - Full Assembly





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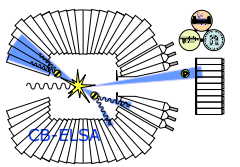
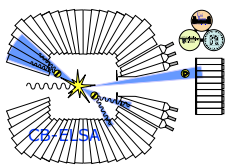


Current Status and Intended Upgrades

Current deficits

- No good charge particle tracking
- No time information from single CsI crystal
- Main calorimeter not in first level trigger



Current Status and Intended Upgrades

Current deficits

- No good charge particle tracking
- No time information from single CsI crystal
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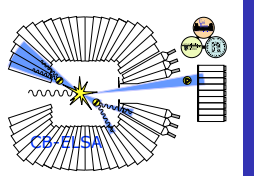
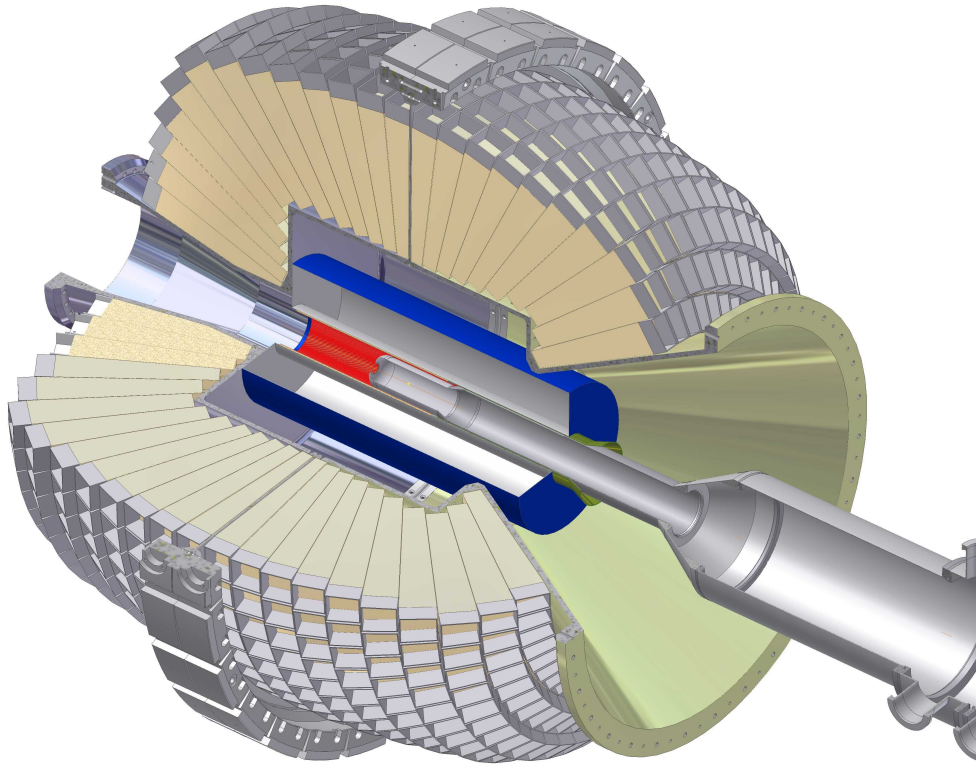
Intended changes

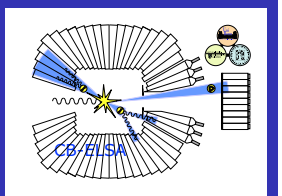
- New time projection chamber (TPC) in combination with new superconducting solenoid and existing iron return yoke
- New single crystal readout, new first level trigger



Upgrade: Time Projection Chamber



- Planned upgrades
  - Insert TPC into calorimeter
  - Add superconducting magnet to setup
- Track and momentum reconstruction on charged particles



Upgrade: New APD Light Readout

1. Speed up crystal light readout to gain trigger opportunity on Barrel
2. Replacing current QDCs by Flash-ADCs to increase both readout rates and energy resolution

Currently testing new Light Readout with two Large Area Avalanche Photo Diodes
my thesis

- Energy
- Time

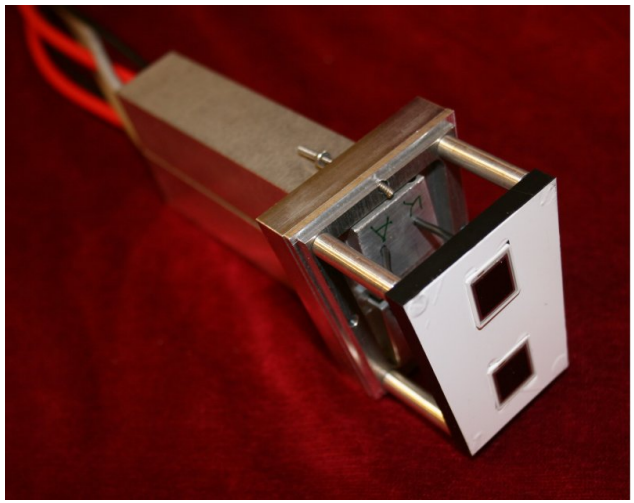
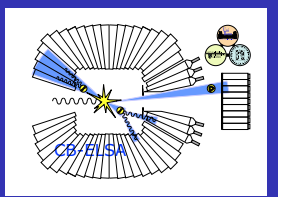


Figure: Crystal end cap with new APD readout



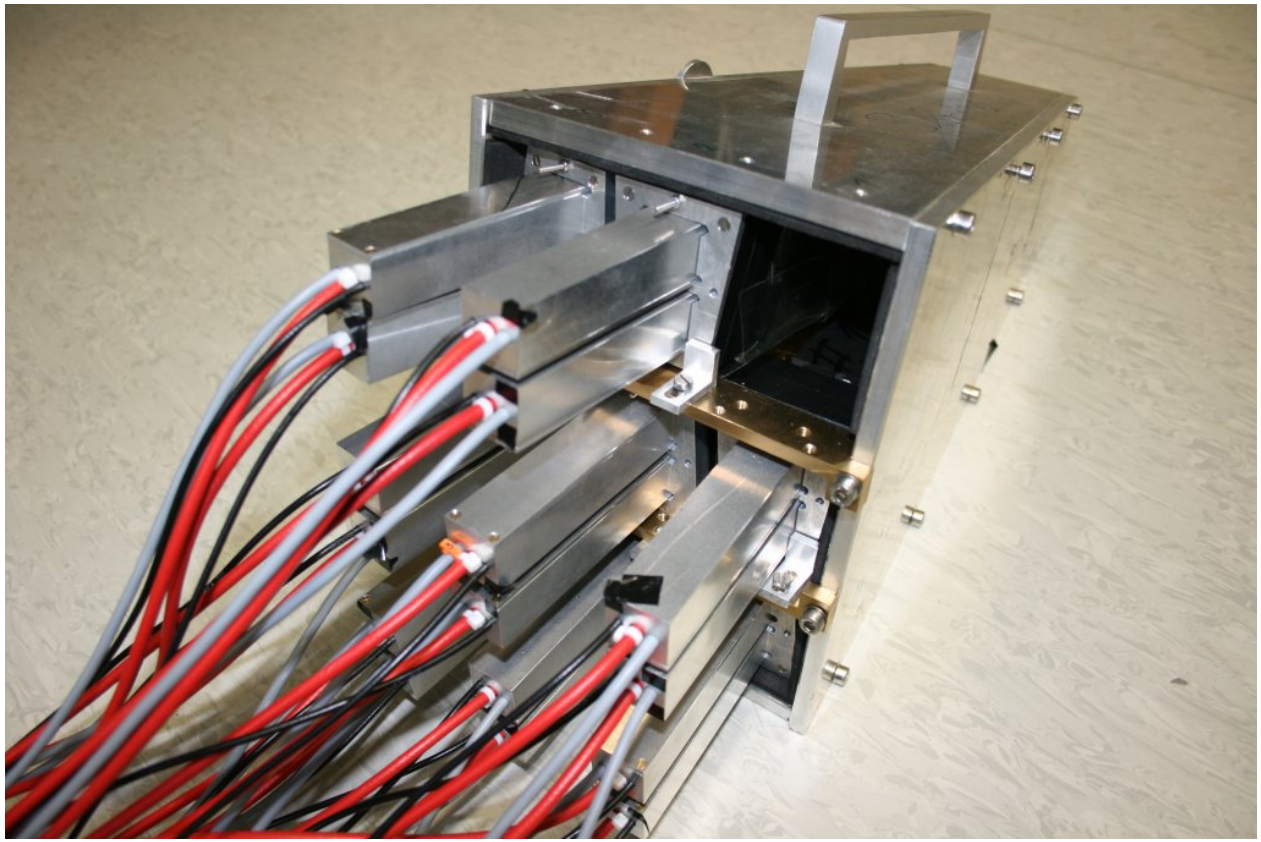
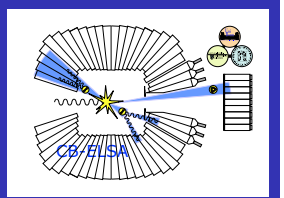


Figure: Array of CsI(Tl) crystals with new APD readout for testing purposes



First Performance Results: Energy Resolution

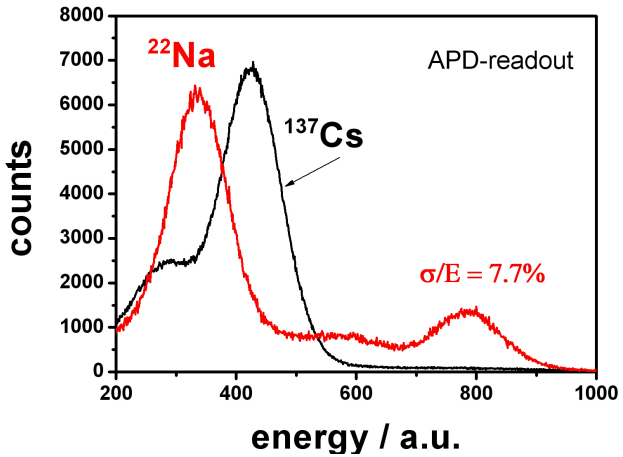


Figure: Low E energy spectrum recorded with new APD readout kept at -20^{o}C

for reference:

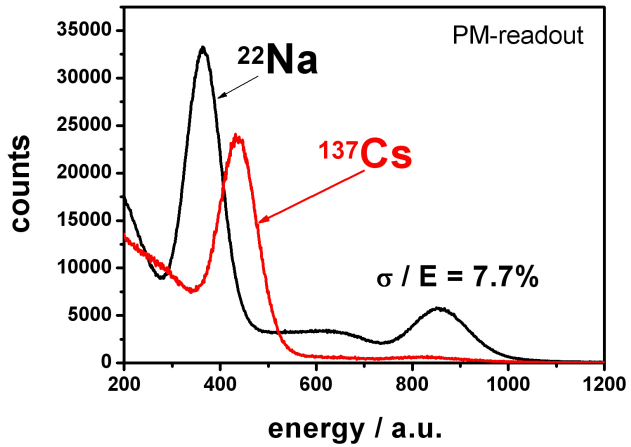
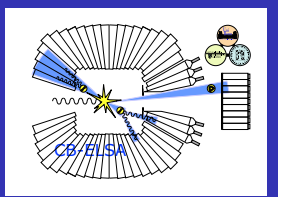


Figure: Reference spectrum taken with PMT

currently $\sigma_{\pi_0} = 8$MeV



First Performance Results: Time Resolution

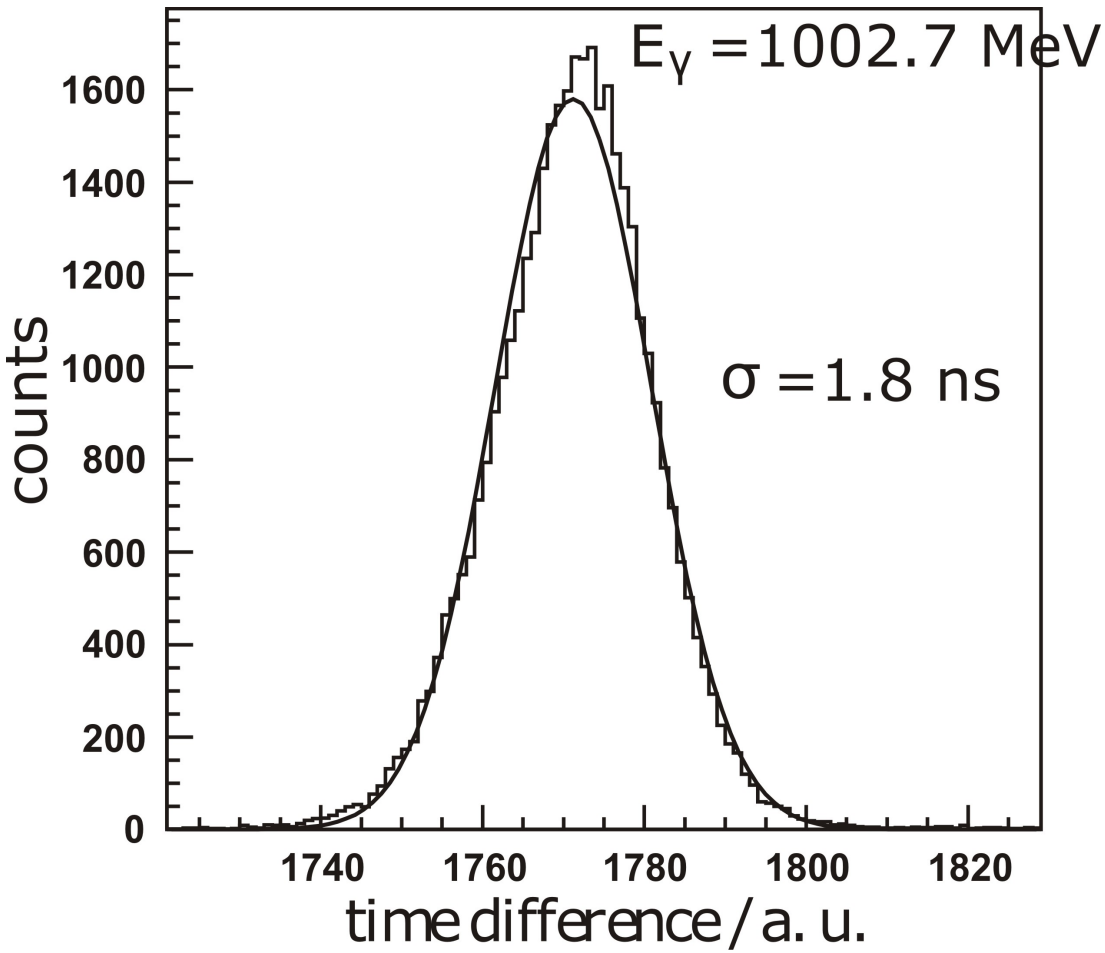
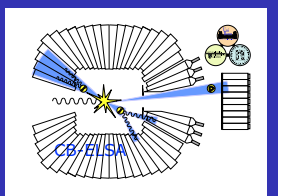


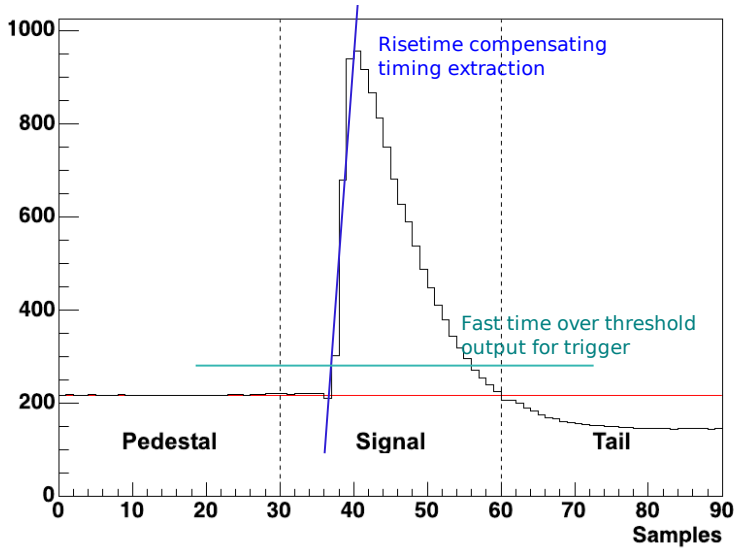
Figure: Time resolution measurement with tagged photon beam

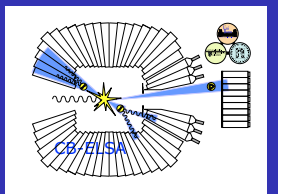


Flash ADCs

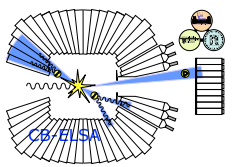
and On-The-Fly FPGA Based Feature Extraction

- Extraction of
  - Energy
  - Pedestal
  - Tail
  - Further information
- Extraction of Time
  - via Constant fraction
  - or via optimized risetime compensating scheme
- Generation of a fast signal for trigger





- Exciting hadron spectroscopy is happening at Bonn
- Capabilities for double polarization experiments
- Several improvements planned
  - Charged particle identification planned: TPC, magnetic field
  - More efficient readout: more efficient trigger, better energy/time resolution



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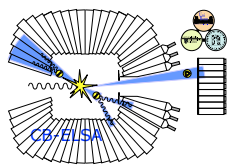

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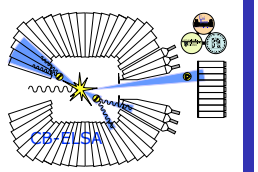

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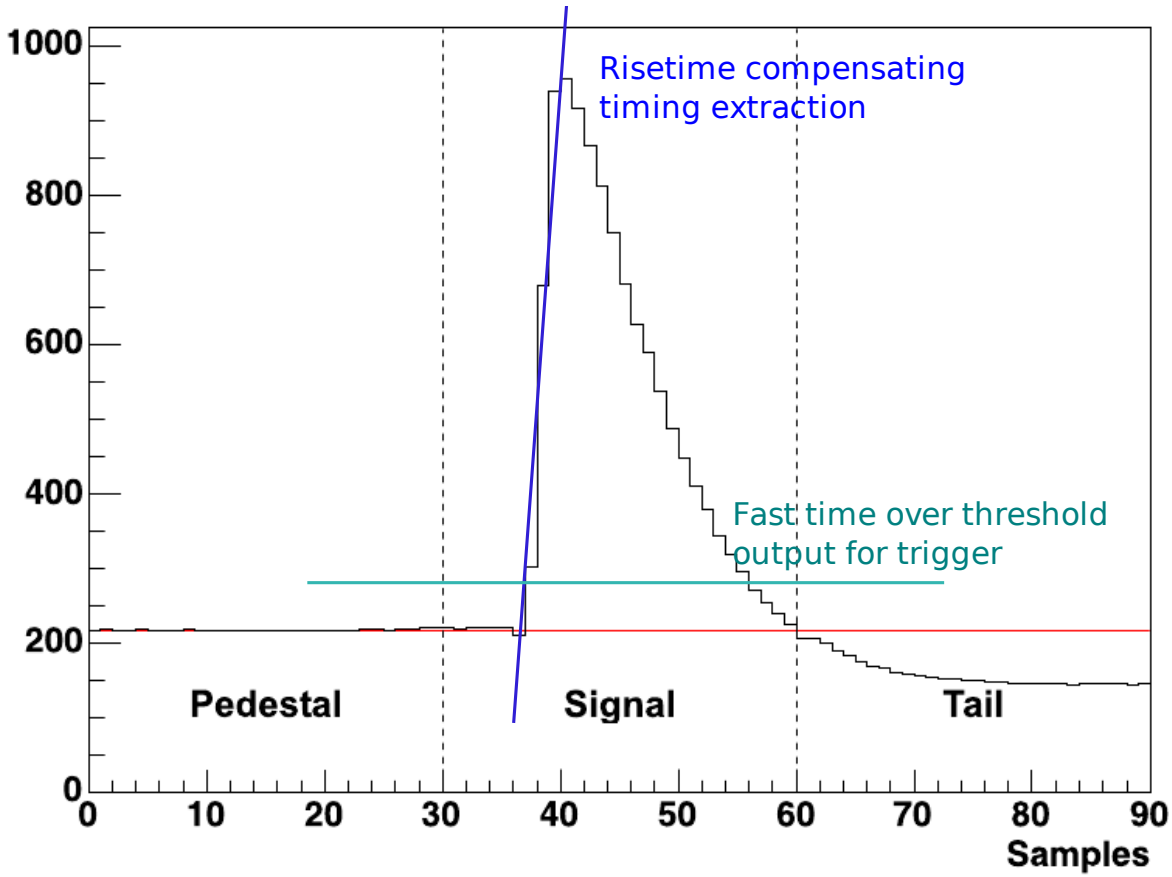
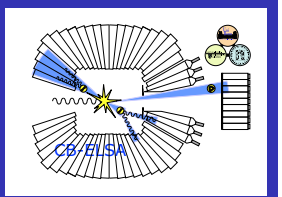
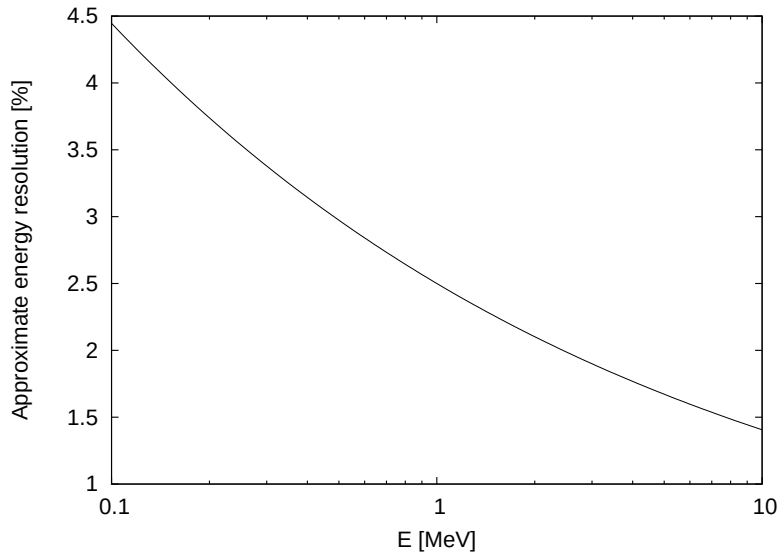
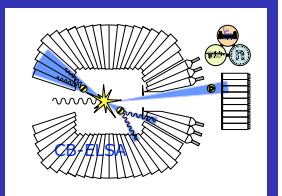




Energy resolution

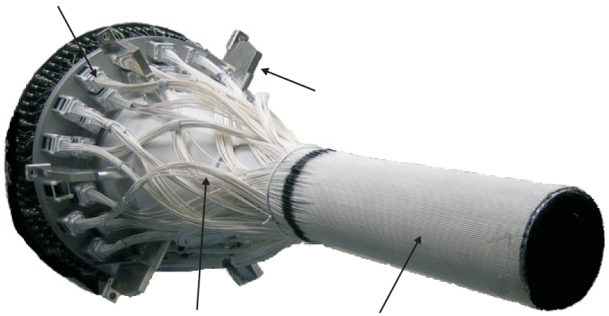
- $\sigma(m_{\pi_0}) = 8\text{MeV}$
- Overall energy resolution like $\approx \frac{2.5\%}{\sqrt[4]{E[GeV]}}$





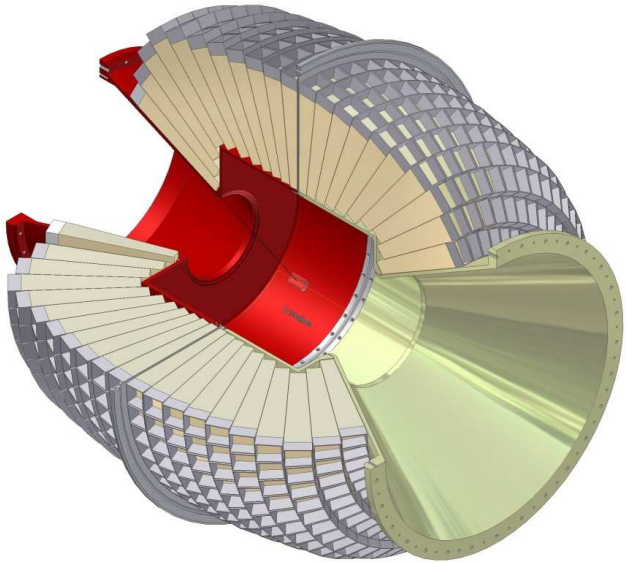
The Crystal Barrel Detector

Inner detector

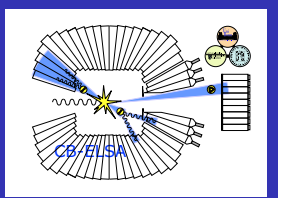


- 513 scintillating fibres in 3 layers
- Charged particle identification

A high precision calorimeter

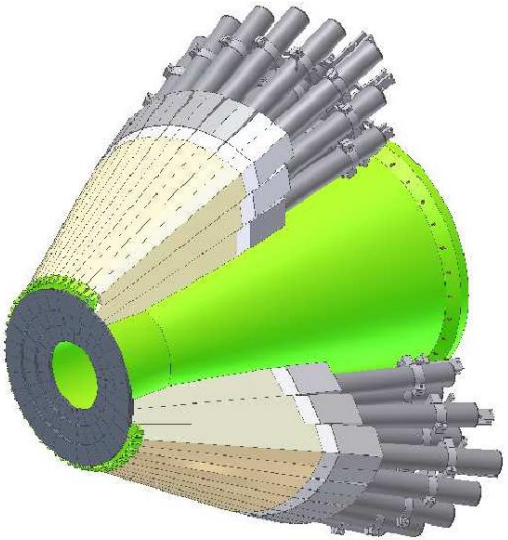


- 1280 CsI(Tl) crystals
- Read out by photo diodes
- θ coverage 30^o to 156^o



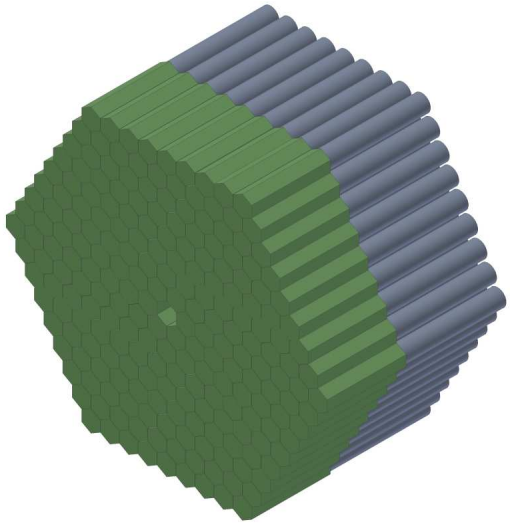
Detection in Forward Direction

Forward plug

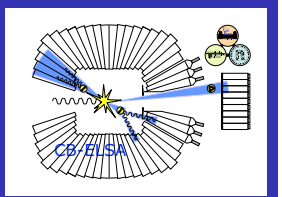


- 90 CsI(Tl) crystals
- 180 front side plastic scintillators
- 12^o - 30^o coverage in θ

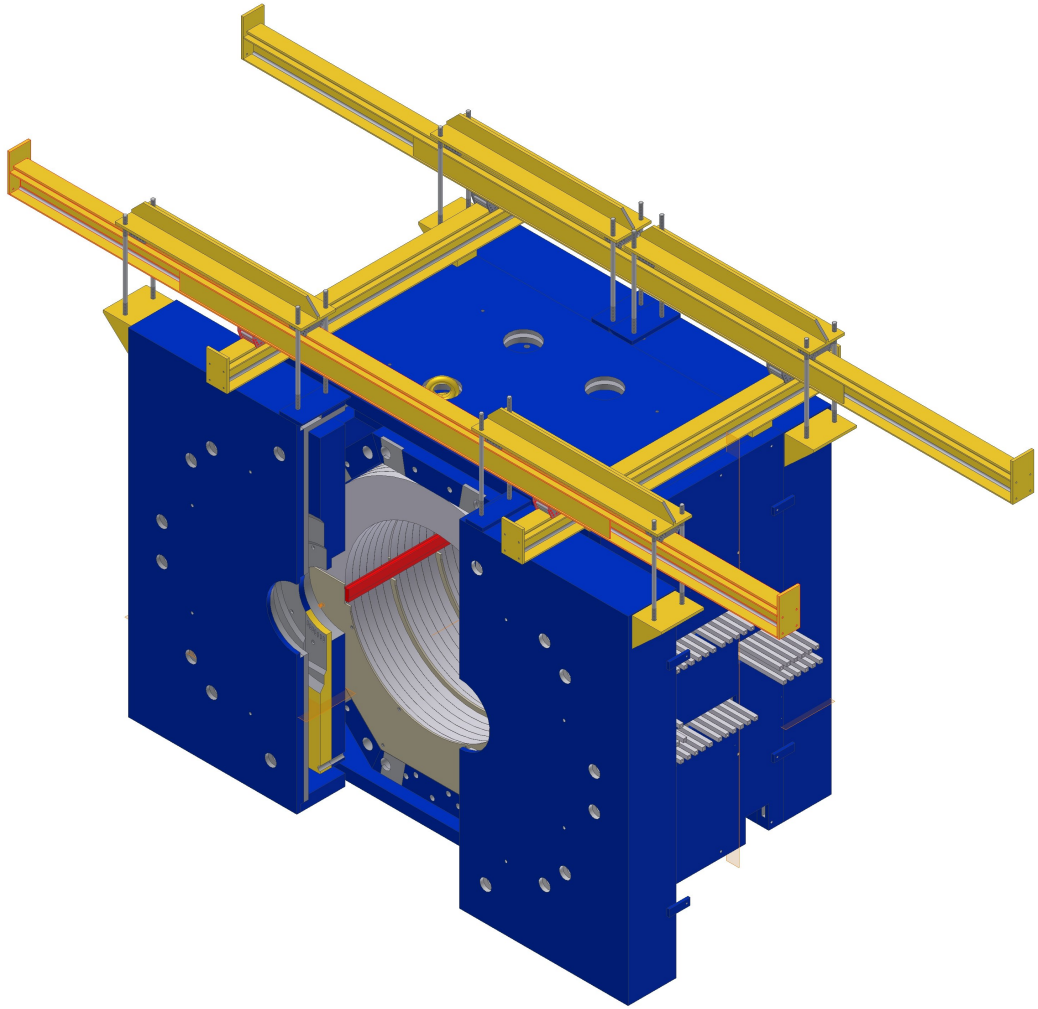
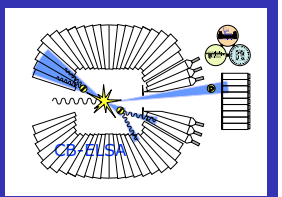
Mini TAPS



- 216 BaF_2 crystals
- 2^o - 12^o in θ



Upgrade: Return Yoke and Magnet



- Superconducting solenoid (2.5 T)
- Use of existing return yoke from CB@LEAR