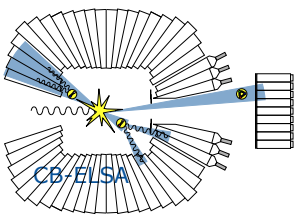
The CBELSA/TAPS Experiment

Jan Hartmann

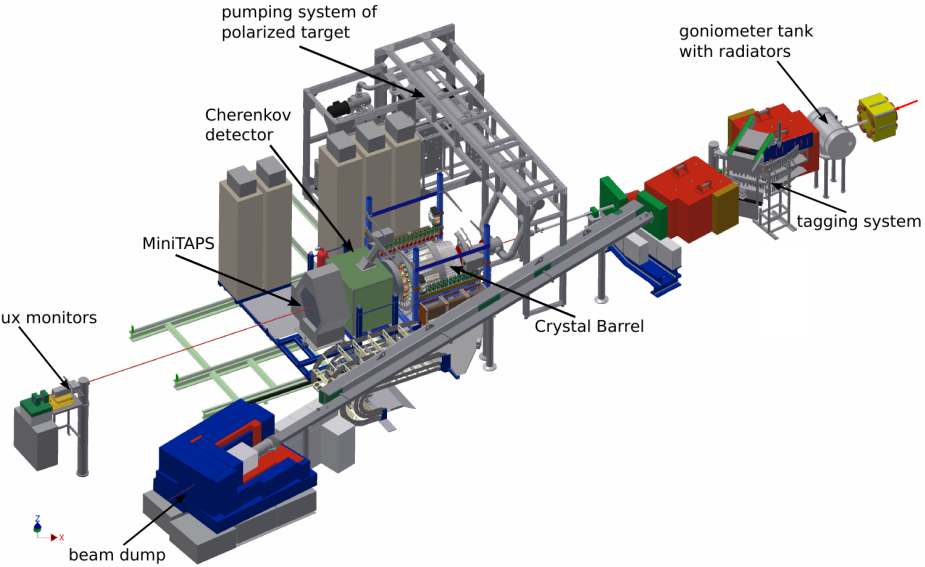
for the CBELSA/TAPS collaboration



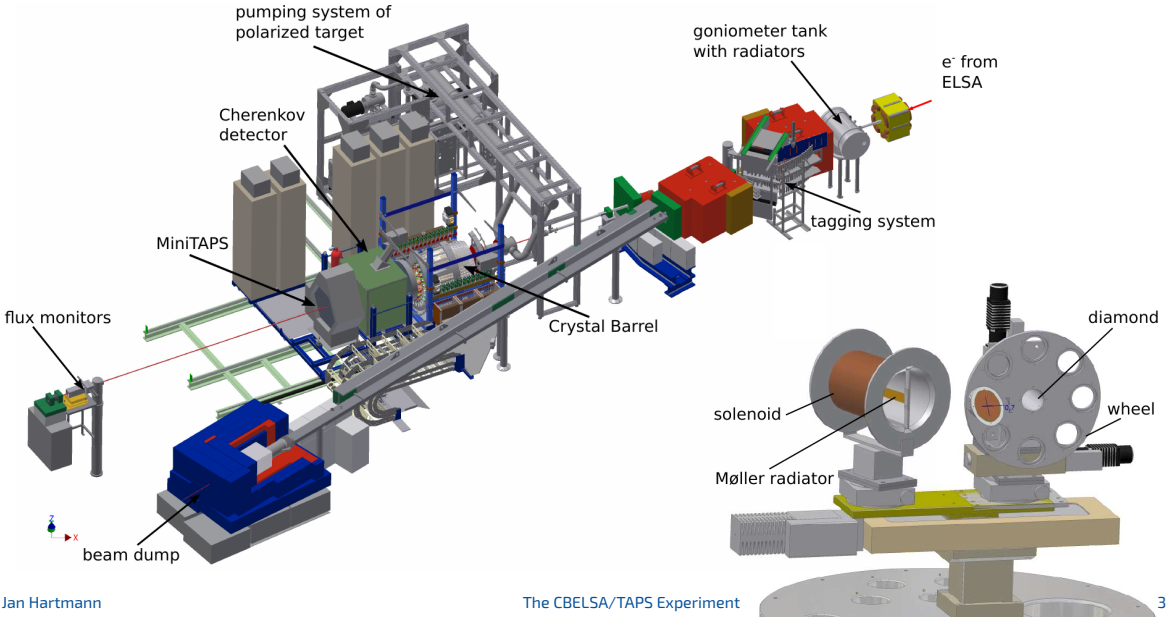
UNIVERSITÄT BONN

05.10.2021

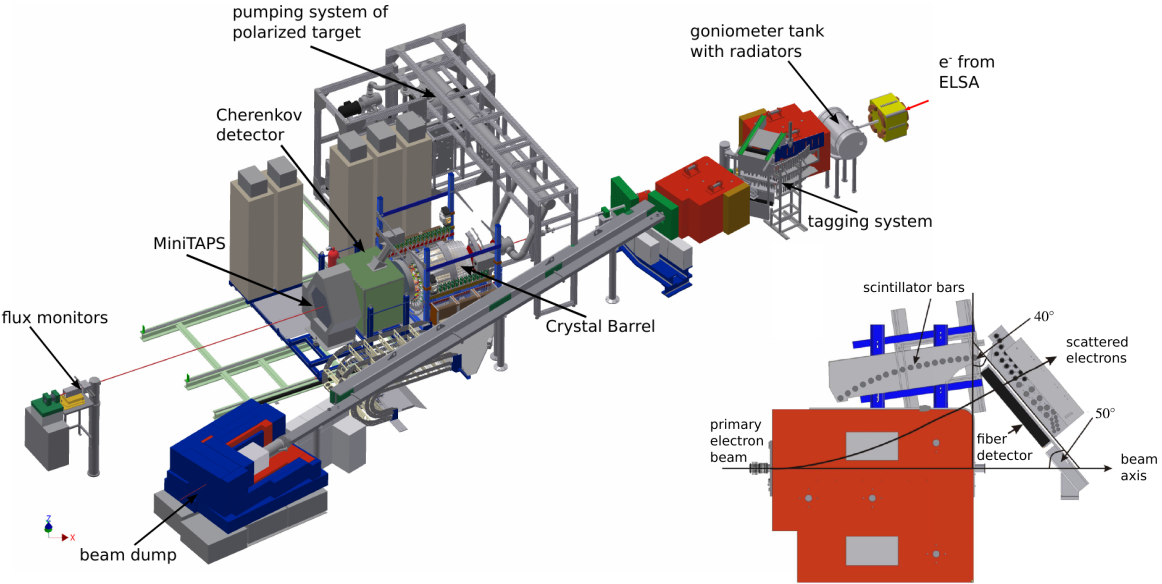
CBELSA/TAPS Experiment – Overview



CBELSA/TAPS Experiment - Goniometer



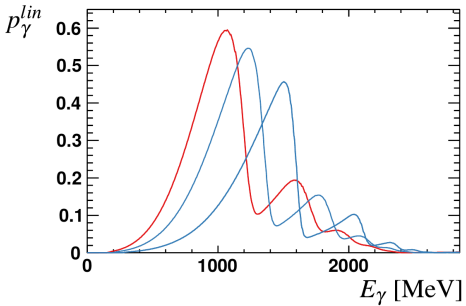
CBELSA/TAPS Experiment - Tagger



Polarized Photon Beams

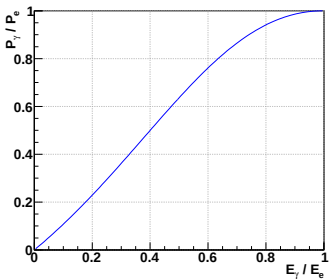
Linearly polarized photons

- diamond radiator needed
- coherent bremsstrahlung
- coherent edges at e.g.:
  1200 MeV, 1350 MeV, 1600 MeV

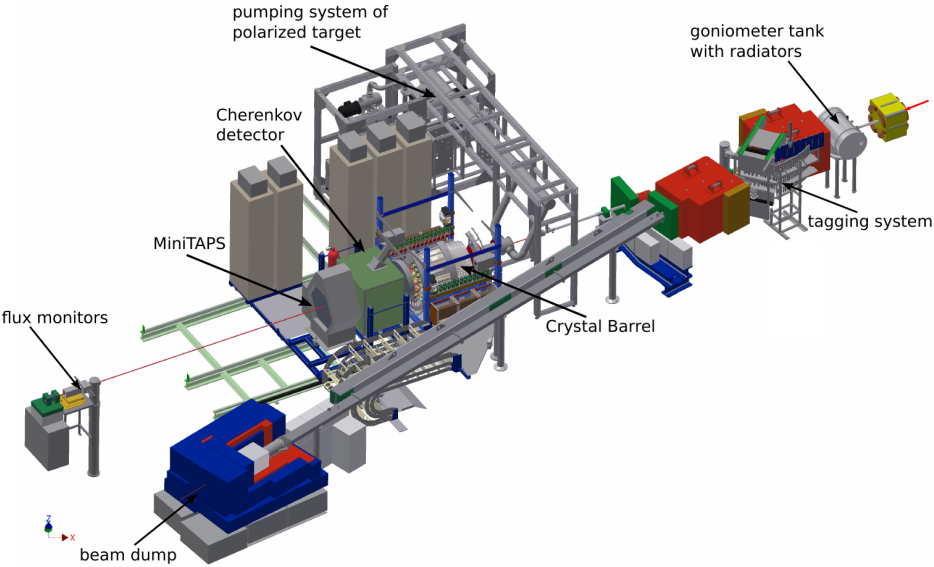


Circularly polarized photons

- long. polarized electrons needed
- helicity transfer to photons
- Measurement of electron polarization using Møller polarimeter

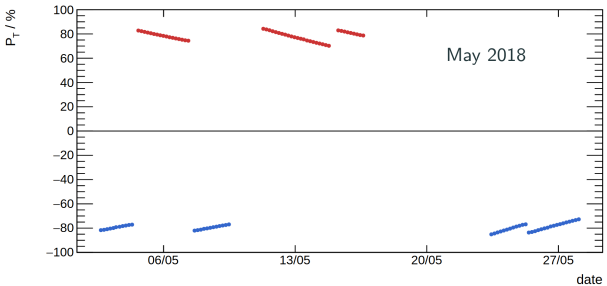


CBELSA/TAPS Experiment - Polarized Target

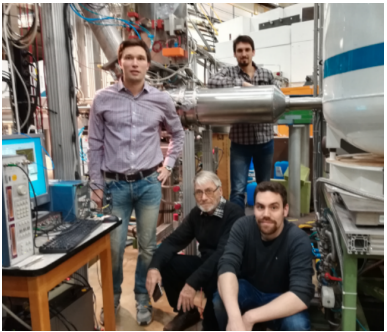


Polarized Target

- Dynamic Nuclear Polarization
- max. pol. degree: $\approx 85\,\%$
- relaxation times: $> 1000\,\mathrm{h}$
- polarized protons: butanol
- polarized deuterons (neutrons): D-butanol

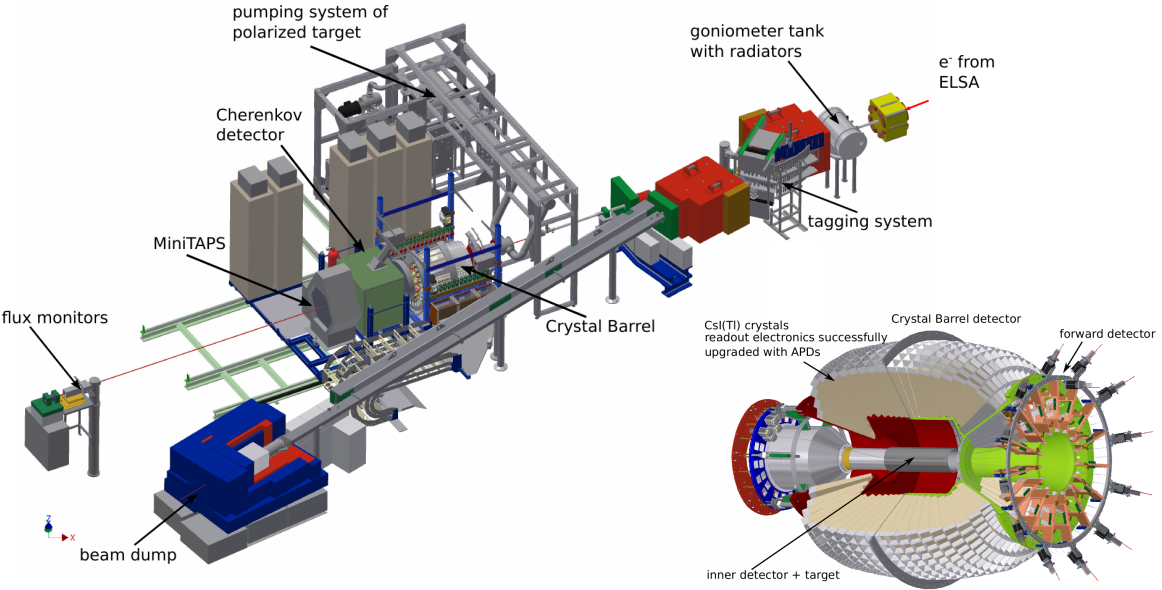


target crew:



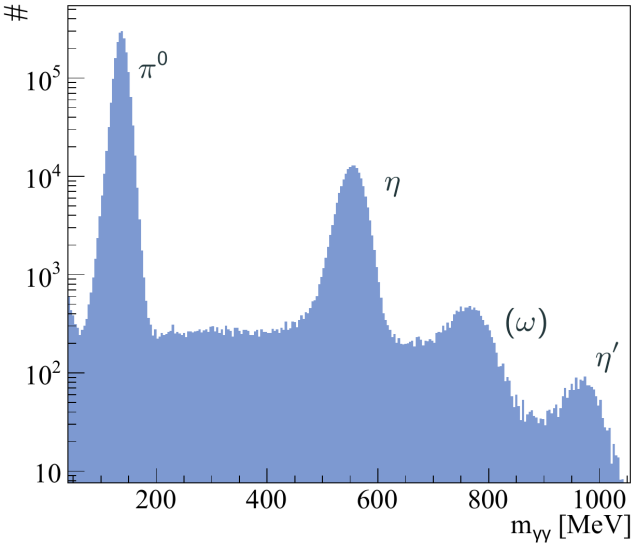
Bonn: H.Dutz, S.Runkel, ...
Bochum: G.Reichertz, W.Meyer, ...
Dubna: Y.Usov, ...
Mainz: A.Thomas, ...

CBELSA/TAPS Experiment - Central Detector



Detector Performance

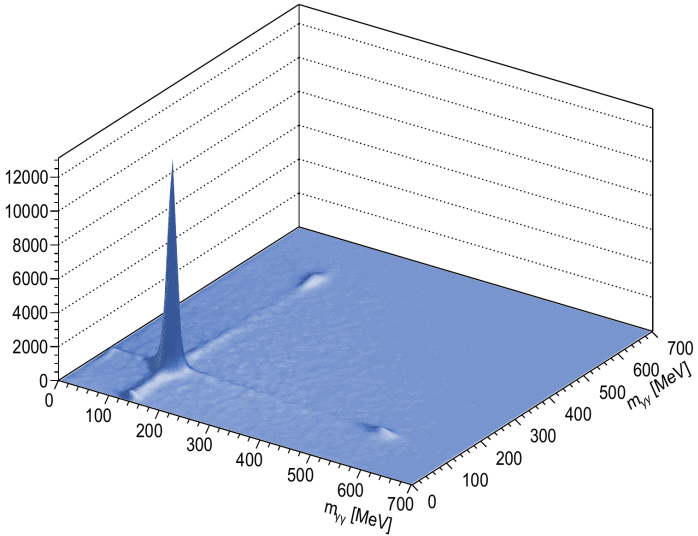
Photoproduction of neutral mesons: $p\gamma\gamma$ final state



- low background
- π^0 width: $\sigma = 6.9\,\text{MeV}$

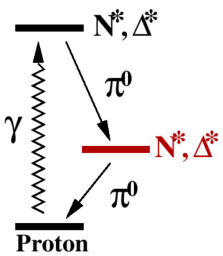
Detector Performance

Photoproduction of multiple neutral mesons: $p4\gamma$ final state



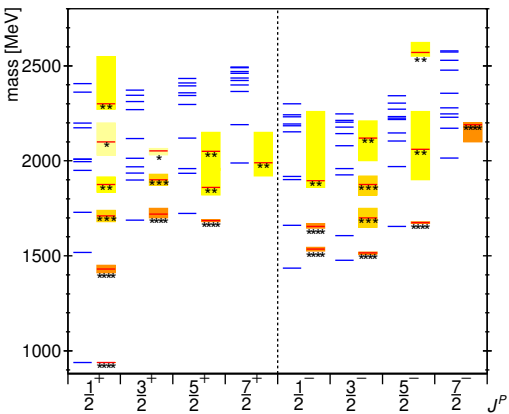
- $\gamma p \rightarrow p\pi^0\pi^0$
- $\gamma p \rightarrow p\pi^0\eta$

clearly observed



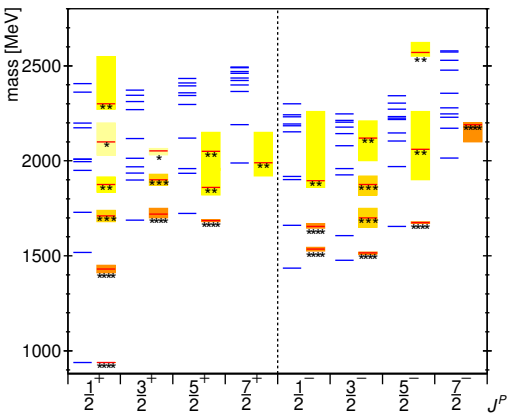
Baryon Spectroscopy

Quark Model: Missing resonances?



Baryon Spectroscopy

Quark Model: Missing resonances?



- resonances confirmed/established
- precise determination of resonance parameters

	overall	$N\gamma$	$N\pi$	$\Delta\pi$	$N\sigma$	$N\eta$
$N(1440)\ 1/2^+$	****	****	****	***★	***	
$N(1520)\ 3/2^-$	****	****	****	***★	★★	***★
$N(1535)\ 1/2^-$	****	****	****	*★★	★	****
$N(1650)\ 1/2^-$	****	****	****	***	★	***★
$N(1675)\ 5/2^-$	****	****	****	***★	★★★	*
$N(1680)\ 5/2^+$	****	****	****	***★	★★★	*
$N(1700)\ 3/2^-$	***	**	***	***	★	*
$N(1710)\ 1/2^+$	****	****	****	*		***
$N(1720)\ 3/2^+$	****	****	****	*★★	★	*
$N(1860)\ 5/2^+$	**	*	**		★	★
$N(1875)\ 3/2^-$	***	**	*★	*	**	★
$N(1880)\ 1/2^+$	**★	**	*	★★	★	★
$N(1895)\ 1/2^-$	**★★	****	*	★	★	**★★
$N(1900)\ 3/2^+$	***★	****	**	**	★	*
$N(1990)\ 7/2^+$	**	**	**			★
$N(2000)\ 5/2^+$	**	**	*	★★	★	*
$N(2040)\ 3/2^+$	*		*			
$N(2060)\ 5/2^-$	**★	***	**	★	★	*
$N(2100)\ 1/2^+$	*★★	**	*★★	★★	★★	★
$N(2120)\ 3/2^-$	**★	***	**	★★	★★	
$N(2190)\ 7/2^-$	****	****	****	★★★★	★★	★
...						

★ : PDG-upgrades based on the Bonn-Gatchina-PWA including the CBELSA/TAPS data

+ further decay modes: $N\omega, N\eta', N(1520)\pi, \ldots$ not listed here

+ results on Δ^*-resonances

Summary

CBELSA/TAPS experiment:

- ideal detector for neutral particles in the final state
- (almost) complete coverage of the solid angle
- polarized photon beams (linear & circular)
- polarized proton or deuteron target (longitudinal & transverse)

Physics program

- focus on baryon spectroscopy
  $\rightsquigarrow$ spectrum, properties and nature of baryon resonances
- very unrestrictive trigger condition ($\geqslant 2$ particles measured in final state)
  $\rightsquigarrow$ large data set available for analyses
  - $\vec{\gamma}\vec{p} \to \pi^0 p, \eta p, \eta' p, \omega p, \pi^0\pi^0 p, \pi^0\eta p, \pi^0\omega p, \pi^0\pi^0\pi^0 p, K^0\Sigma^+, K^0\pi^0\Sigma^+, \ldots$
  - $\vec{\gamma}\vec{n} \to \pi^0 n, \eta n, \eta' n, \omega n, \pi^0\pi^0 n, \pi^0\eta n, \pi^0\omega n, \pi^0\pi^0\pi^0 n, K^0\Lambda, K^0\Sigma^0, \ldots$