Symmetric Møller/Bhabha Luminosity Monitor for the OLYMPUS experiment

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On behalf the OLYMPUS Collaboration
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Outline

- Symmetric Møller/Bhabha Luminosity Monitor
  - Motivation
  - Detector
  - First results

OLYMPUS Experiment

e^+ and e^- beams

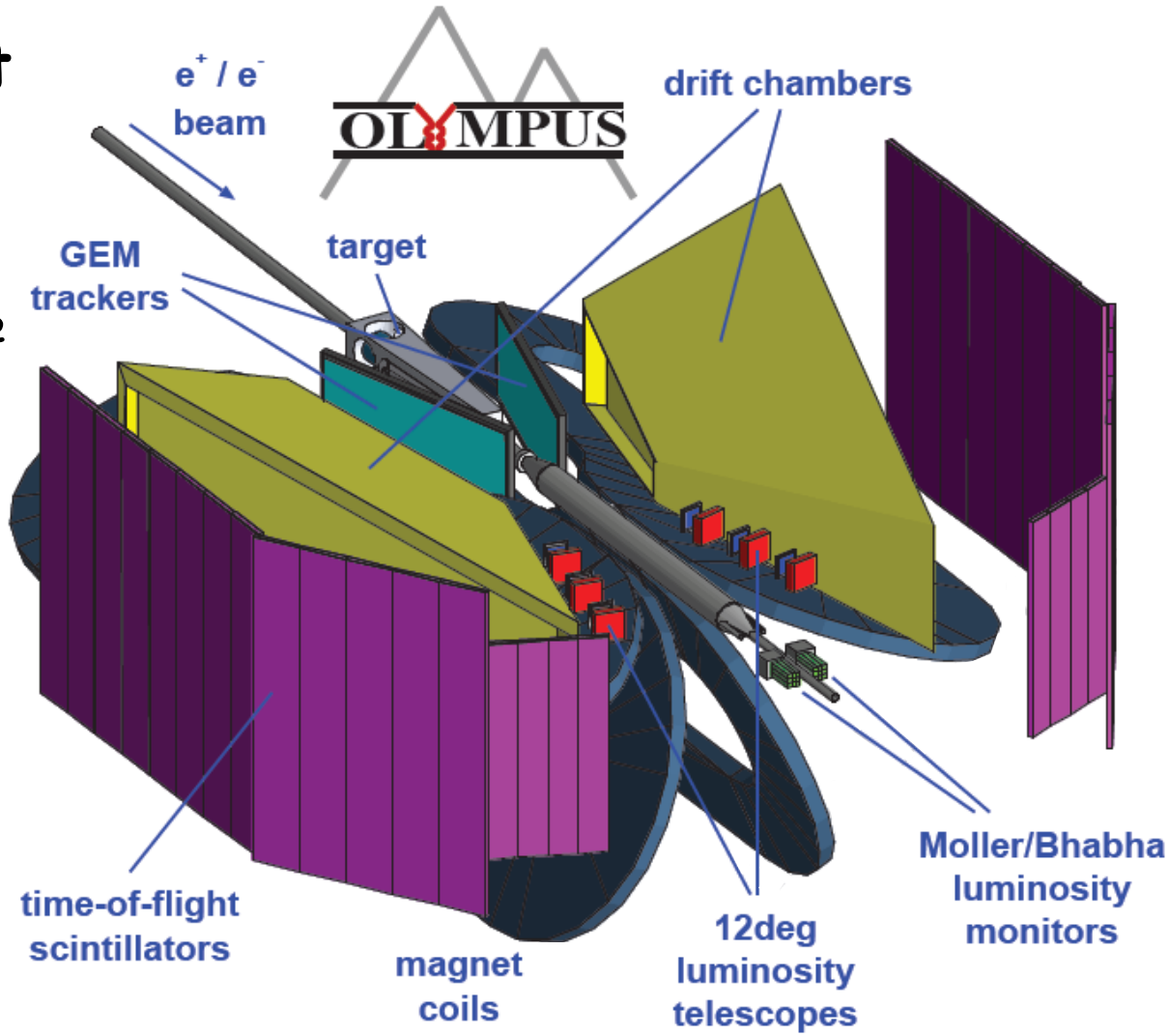
$E = 2.0$ GeV

$Q^2 = 0.6\text{-}2.2\ (\text{GeV}/c)^2$

$\varepsilon = 0.367 - 0.905$

Redundant monitoring of luminosity

Measure ratio of positron-proton to electron-proton unpolarized elastic scattering to 1% stat. + sys.



Control of Systematics

What we need to be know

Super ratio:

$$\left[\frac{N_{e^+ +}/L_{e^+ +}}{N_{e^- +}/L_{e^- +}} \cdot \frac{N_{e^+ -}/L_{e^+ -}}{N_{e^- -}/L_{e^- -}}\right]^{\frac{1}{2}} = \frac{\sigma_{e^+}}{\sigma_{e^-}}$$

$e^{-/+}$ -proton unpolarized elastic scattering

Cycle of four states ij
Repeat cycle many times

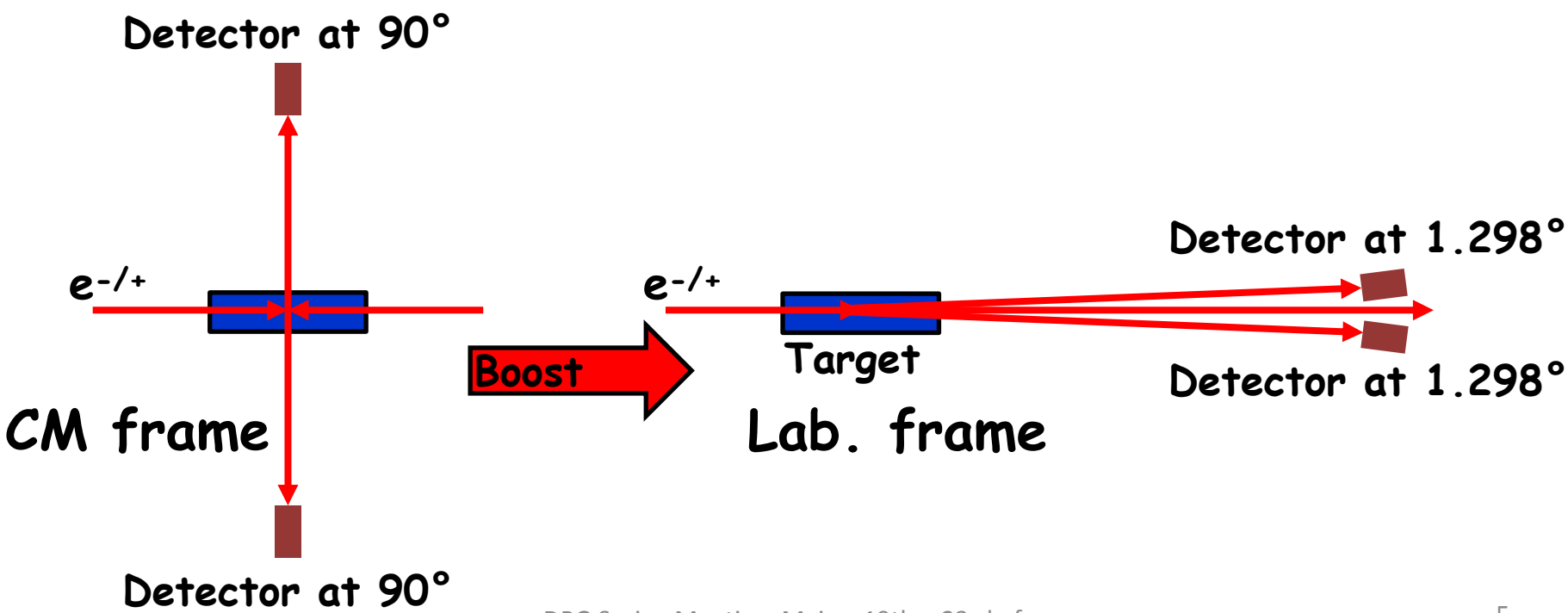
- **Change between electrons and positrons every day**
- **Change magnet polarity every 8 hours**
- **Left-right symmetry**

Symmetric Møller/Bhabha Luminosity Monitor

$$\mathcal{L} = \frac{R}{\sigma}$$

Luminosity $\mathcal{L}$ is the ratio of the measured scattering rate R and the effective cross section σ of a scattering reaction

Based on (symmetric) Møller (e-e-) and Bhabha (e+e-) scattering



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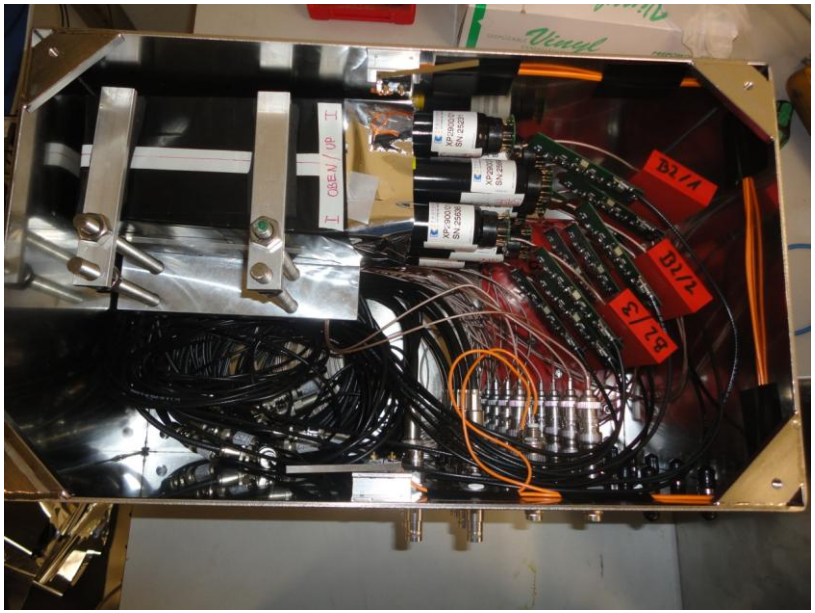
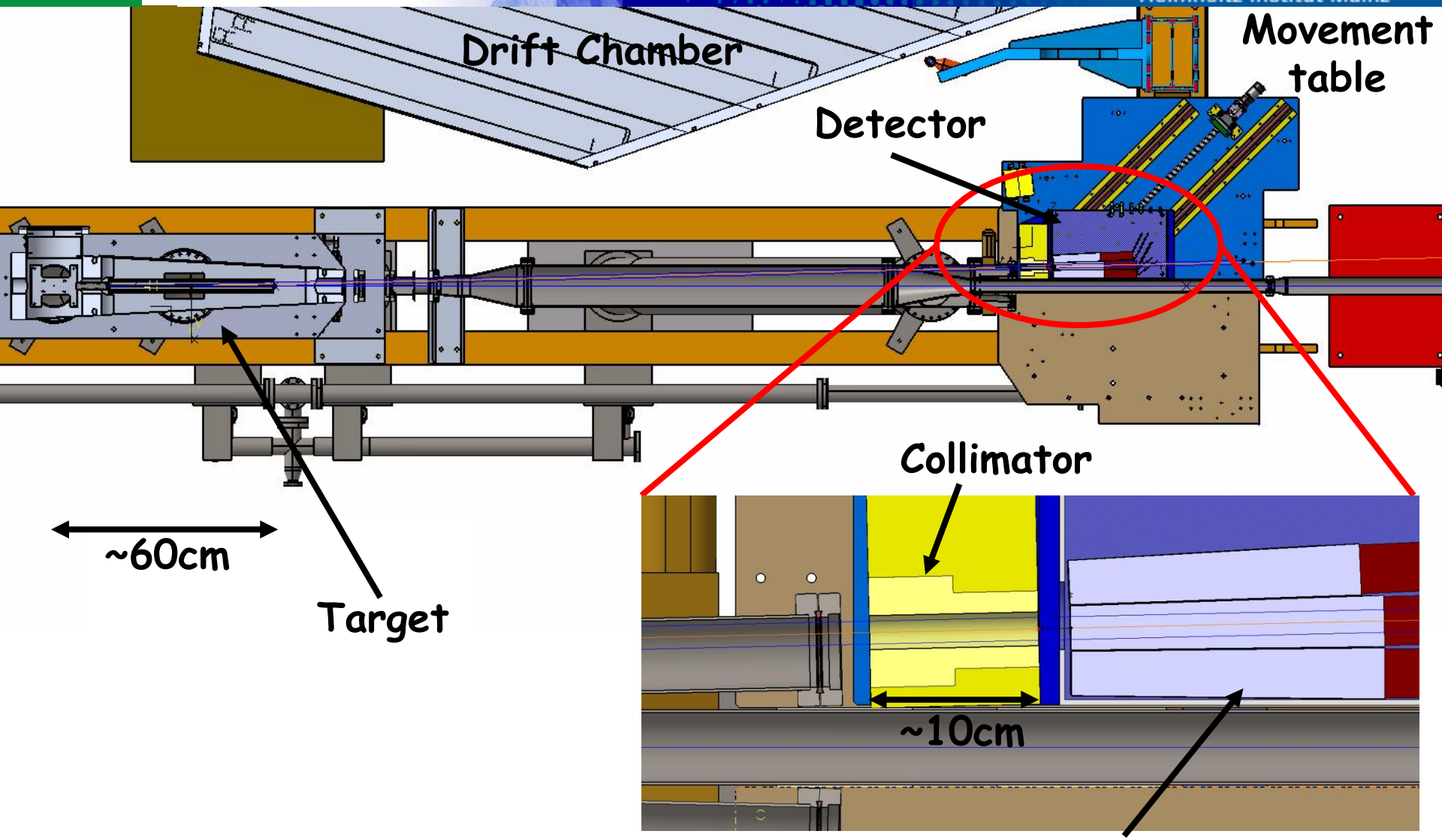
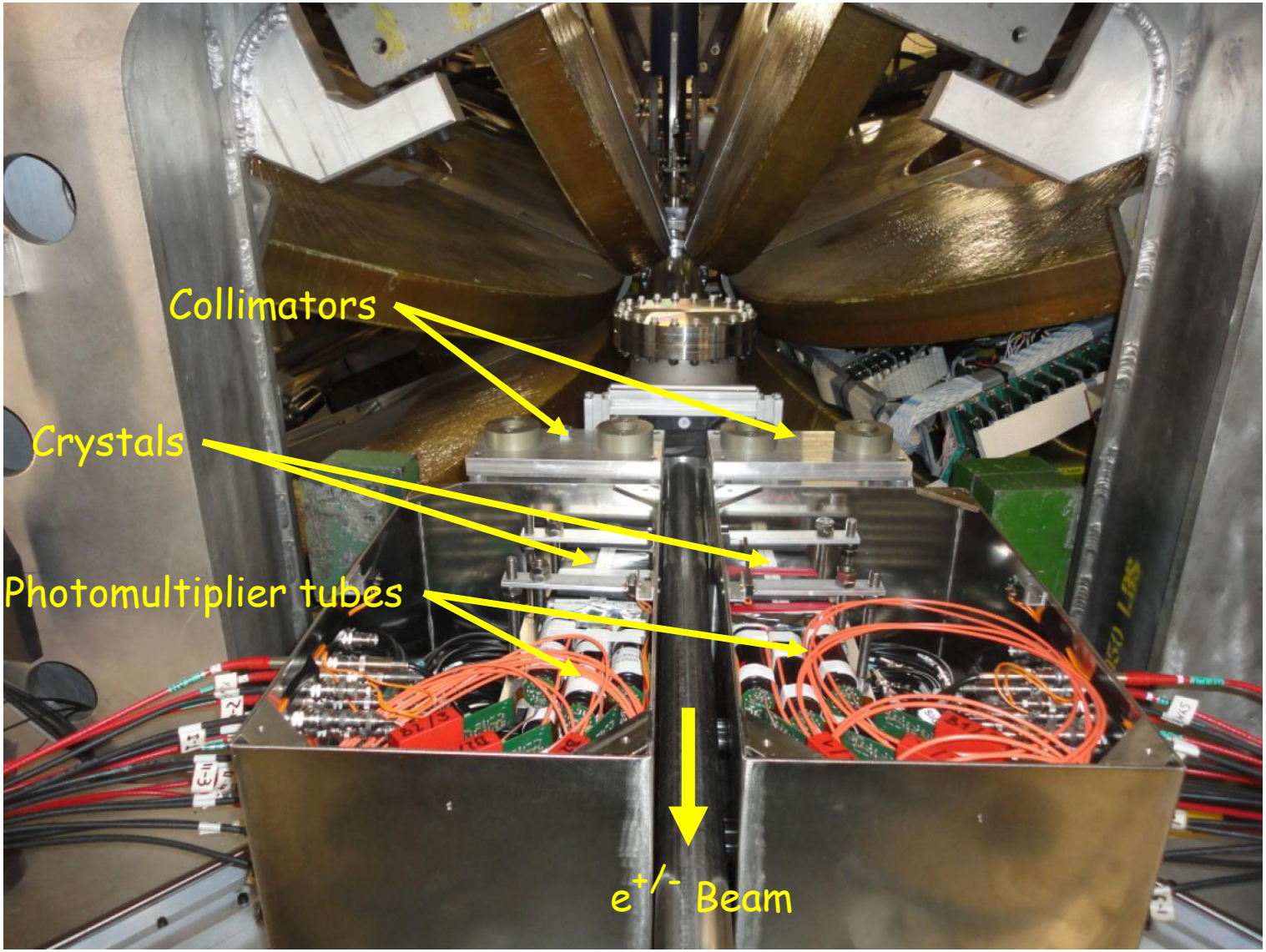


- PbF_2 crystals used in the measurement in parity violation experiment at MAMI (A4)

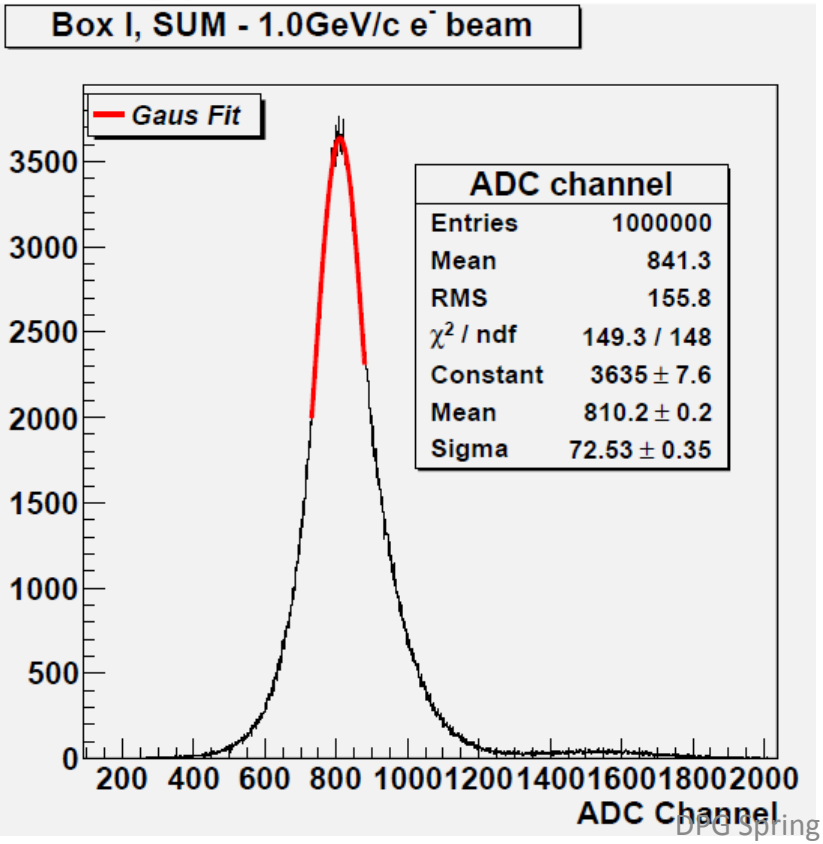
- Two array of PbF_2 crystals with a small scattering angles located between toroidal coils and beam line quadrupole

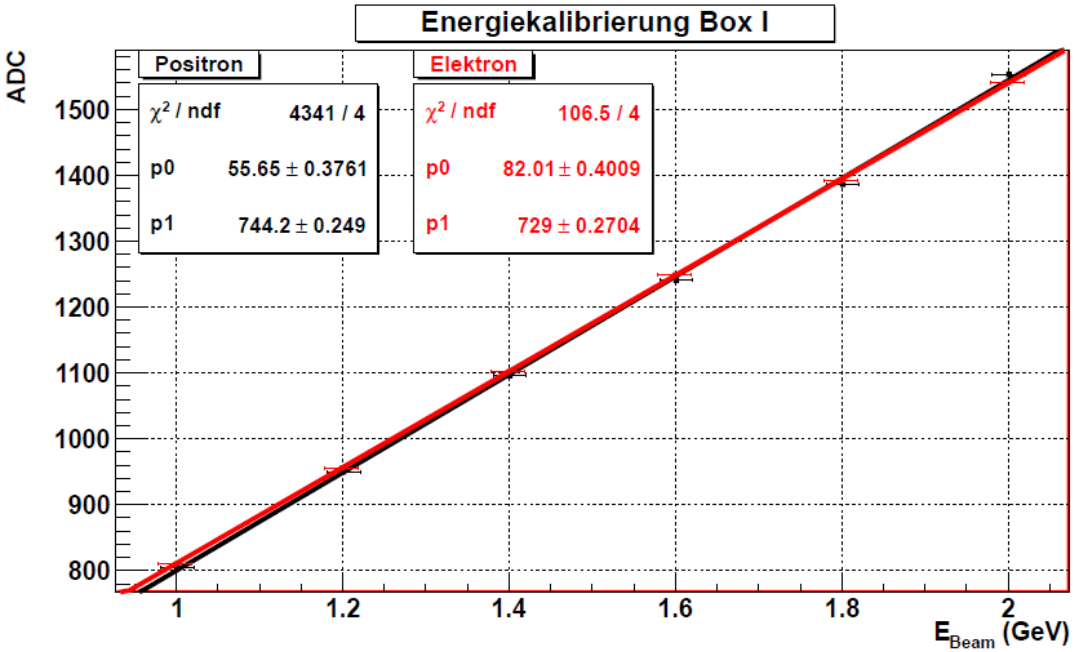

Drift Chamber
Movement table
Detector
Collimator
~60cm
Target
~10cm
PbF_2 crystals


Collimators
Crystals
Photomultiplier tubes
$e^{+/-}$ Beam

energy calibration

center the beam on the center crystal
sum the energy from all crystals
energy calibration for different beam types





energy resolution

$$\sigma_E = \sigma_{P.E.} + \sigma_{Elec.Noise} + \sigma_{ShowerFluc}$$

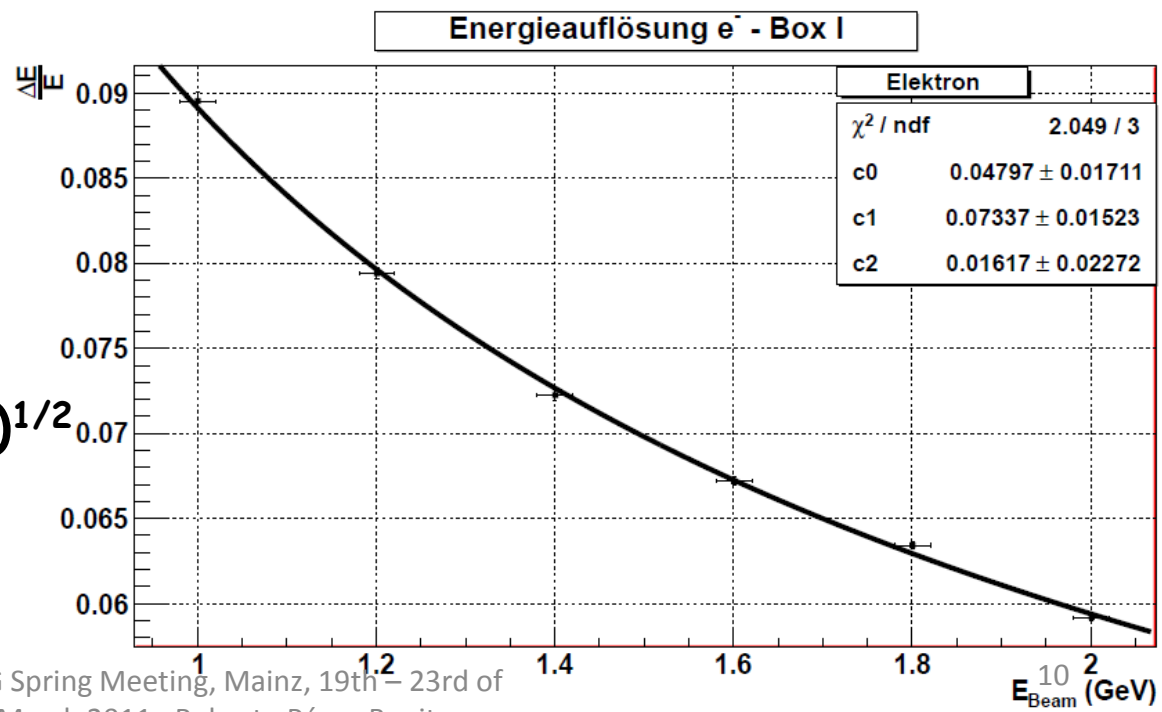
$$\sim \sqrt{E} \qquad \sim const. \qquad \sim E$$

$$\left(\frac{\sigma_E}{E}\right)^2 \approx \left(\frac{a}{\sqrt{E}}\right)^2 + \left(\frac{b}{E}\right)^2 + c^2$$

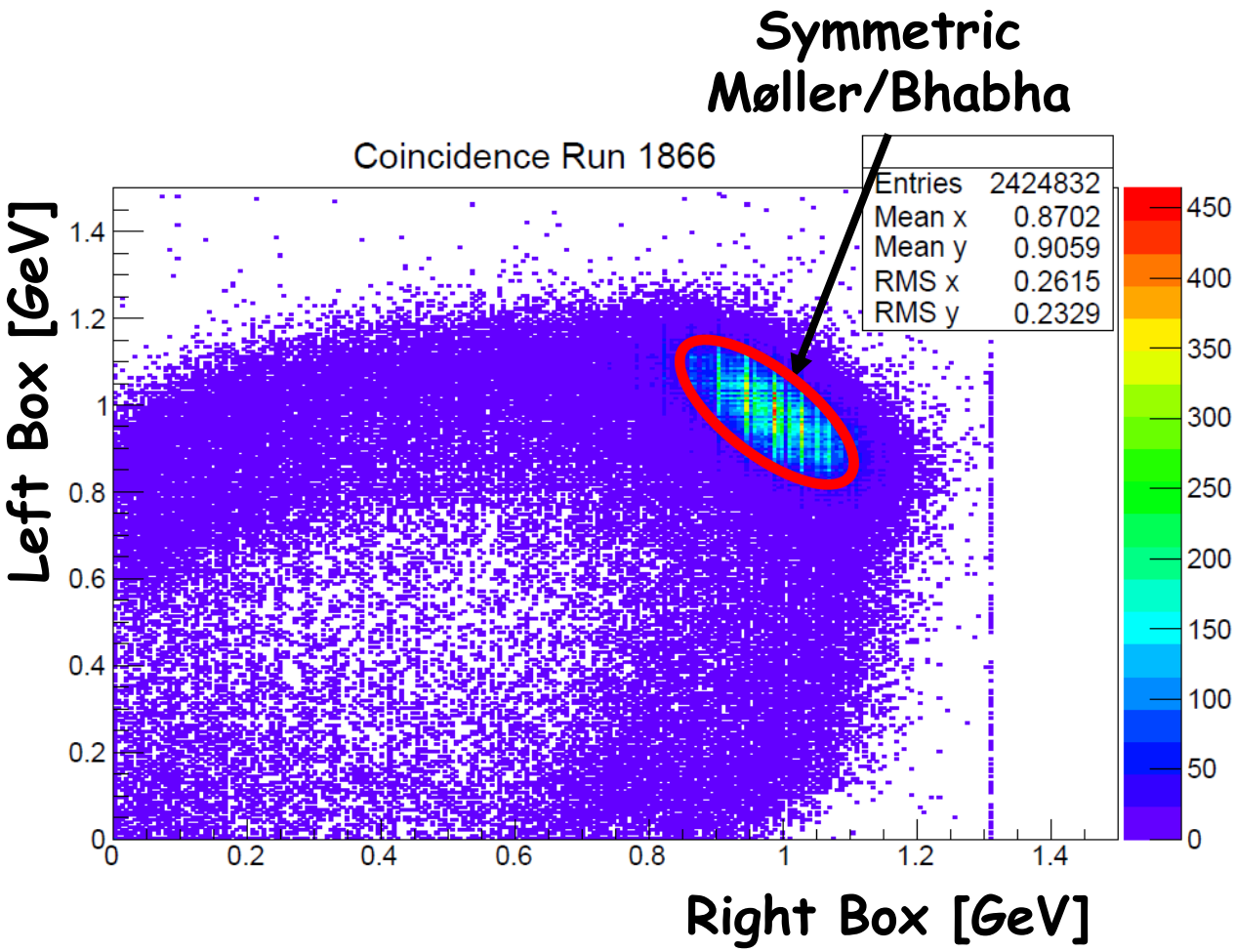
C1= a = 7.34±1.52 %.GeV

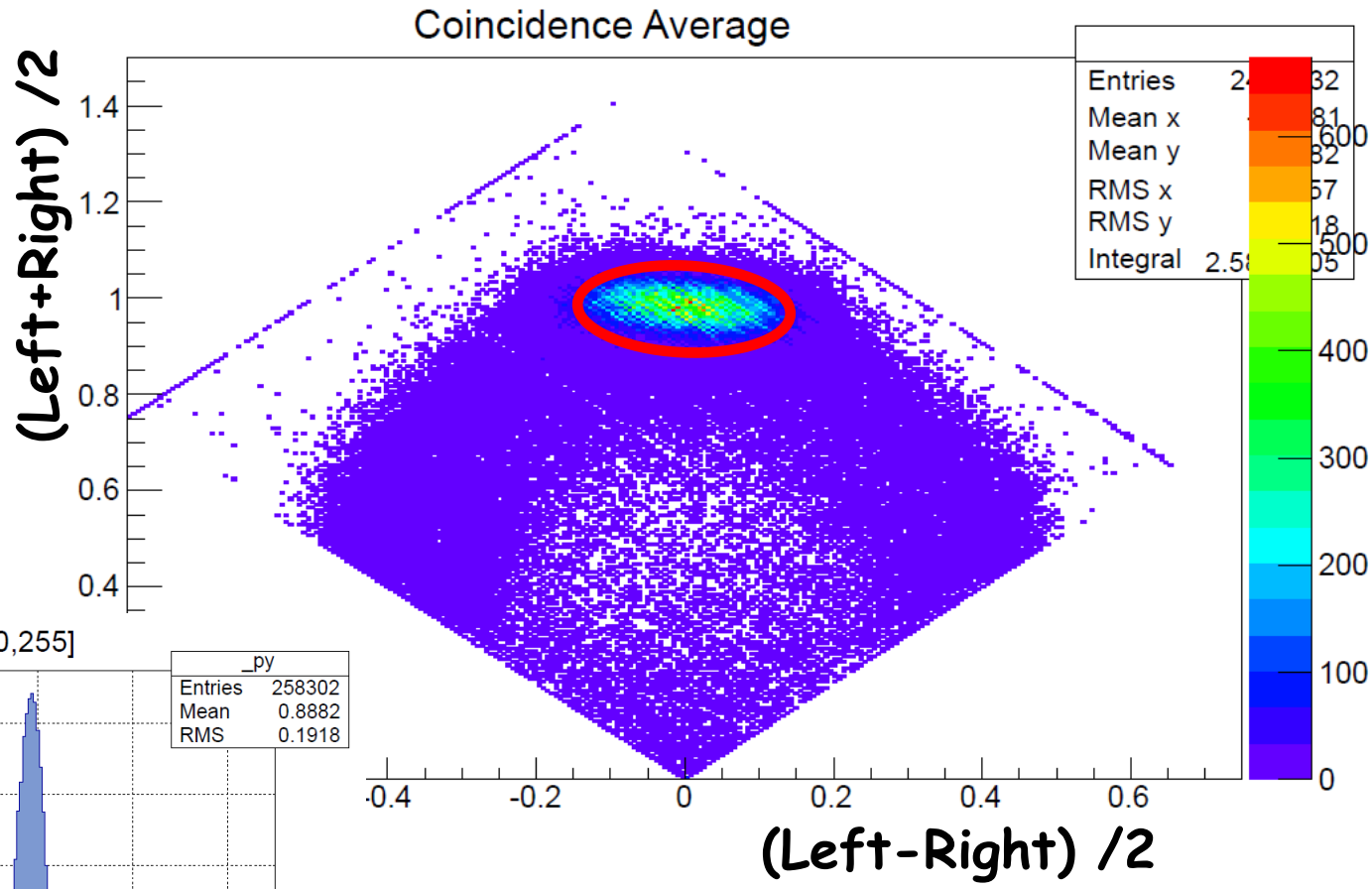
C0= b = 4.80±1.71 %.(GeV)$^{1/2}$

C2= c = 1.62±2.27 %

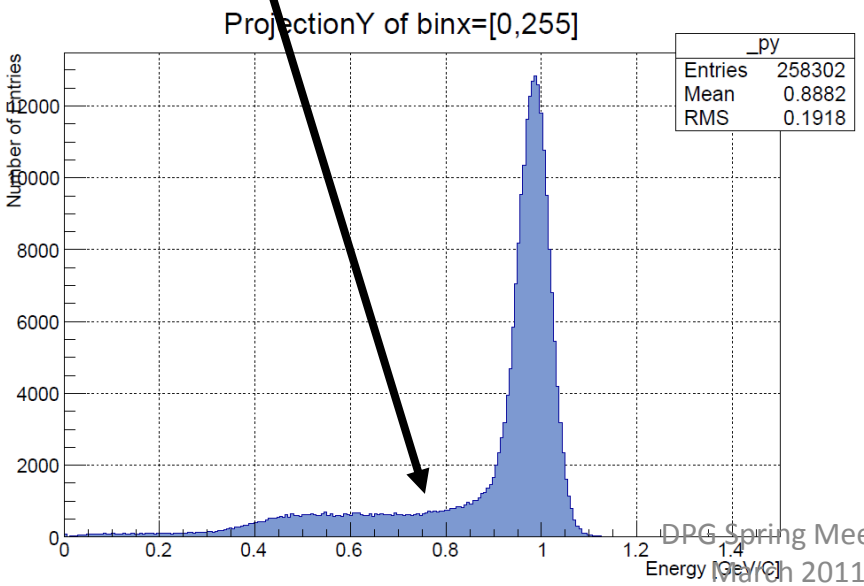


First results

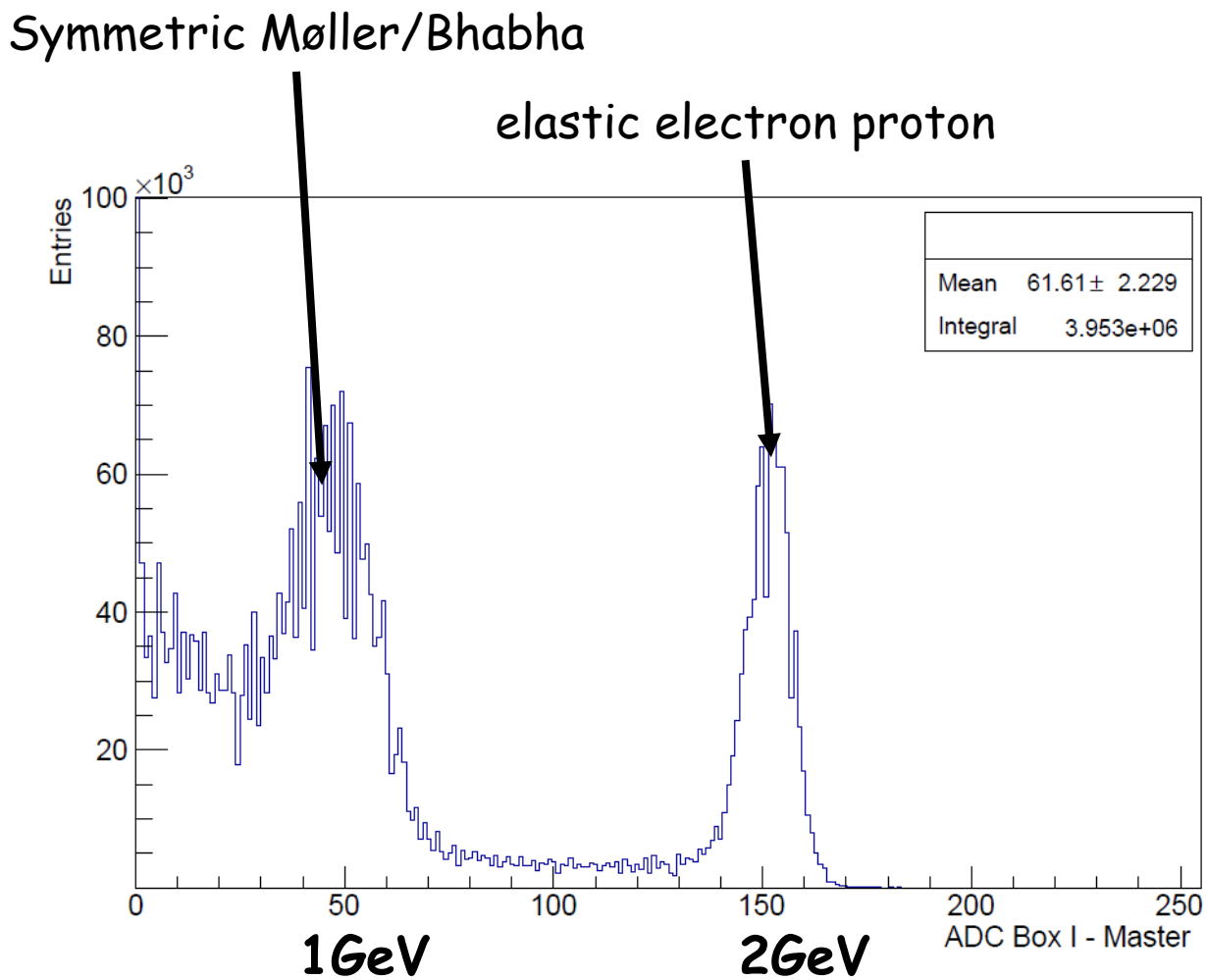




Small portion of background



other crosschecks



Summary

- Olympus Experiment set up and put into operation
- Initial data taken successfully
- Symmetric Møller/Bhabha working perfectly
- Huge amount of data need to be analyzed

THANKS

Parameter	
mittlerer Strahlstrom	$j_{Strahl} = 110\,\mathrm{mA}$
Strahlenergie	$\mathrm{E}_{Strahl} = 2\,\mathrm{GeV}$
Targetdichte	$\rho_{Target} = 3 \cdot 10^{15}\,\mathrm{Atome/cm^2}$
Luminosität	$\mathrm{L} = 2 \cdot 10^{33}\,\frac{1}{cm^2 s}$
abgedeckter Winkelbereich	$20^\circ \leq \theta_p \leq 80^\circ$
ε	$0{,}35 \leq \varepsilon \leq 0{,}9$

Tabelle 2.1: In der Tabelle sind die wichtigsten Parameter des Olympus-Experiments aufgeführt.

Die gemessene Auflösung $\frac{\Delta E}{E}$ ist gegen die Strahlenergie aufgetragen. In den Fitparametern sind die Parameter $a = p_0$, $b = p_1$ und $c = p_2$ abzulesen. Die Parameter besitzen die Einheit $[a] = \% \cdot GeV$, $[b] = \% \cdot \sqrt{GeV}$ und $[c] = \%$.

	Box I e^-	Box I e^+	Box II e^-	Box II e^+
a (elektronisches Rauschen)	4,80±1,71	3,94±0,46	2,54±4,01	7,25±1,53
b (statistische Schwankung)	7,33±1,52	7,94±0,15	8,43±1,67	5,22±2,85
c (Schauerfluktuation)	1,62±2,27	0±1,14	1,13±4,11	3,20±1,51

Tabelle 6.3: Die Tabelle zeigt die Ergebnisse der Energieauflösung. Die Werte wurden den Abb. 6.3.4 und 6.3.5 entnommen und zur besseren Übersicht zusammengetragen.

SYMB Rate versus Current