

Luminosity Monitors for the OLYMPUS Experiment

Jürgen Diefenbach
for the OLYMPUS Collaboration

Hampton University

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Motivation

Two Photon Exchange

Ratio of proton electromagnetic form factors:

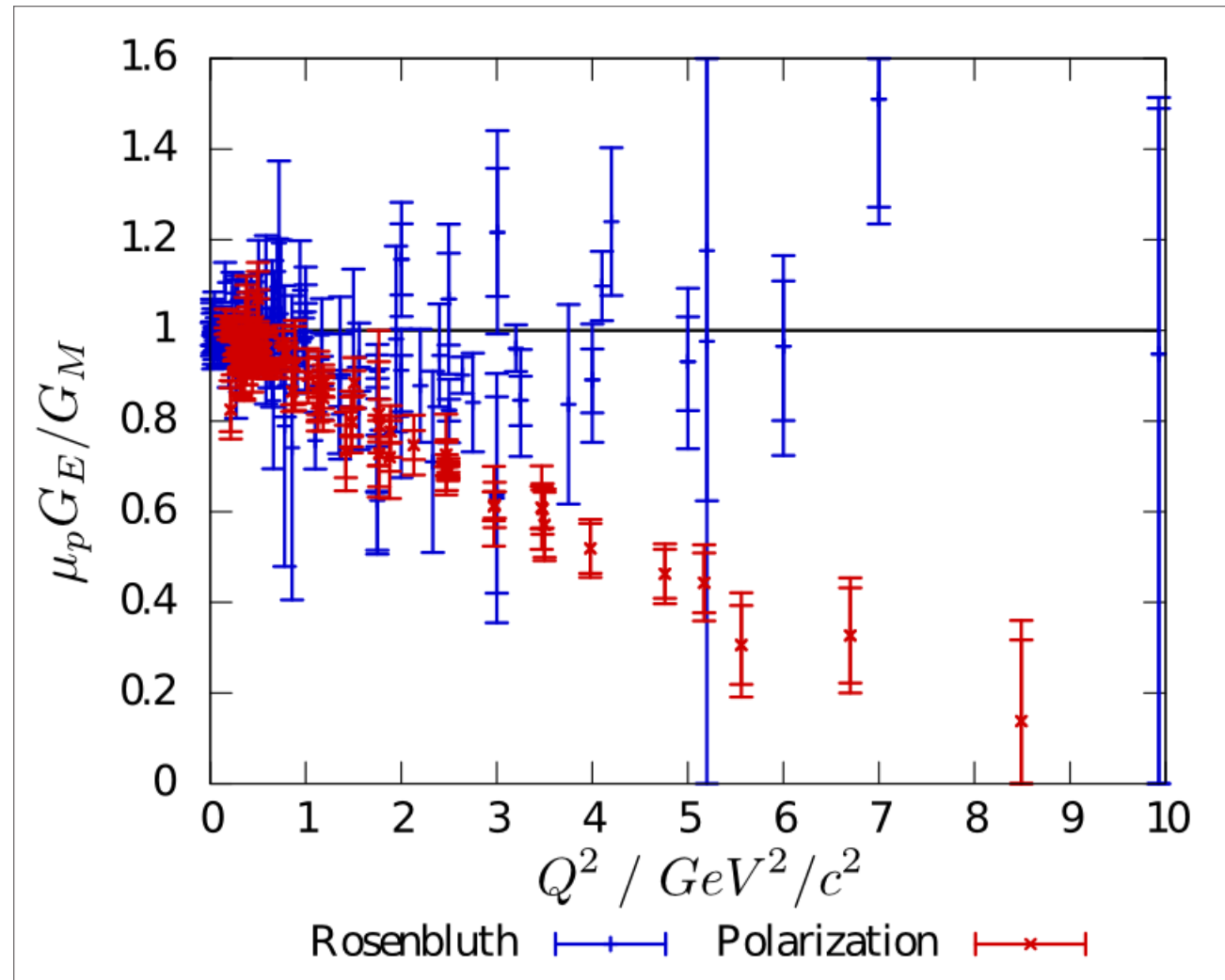
- Rosenbluth Separation
- vs.
- Polarization Transfer

Discrepancy!

→ possible explanation:

two-photon exchange

accessible in $\frac{\sigma(e^+p)}{\sigma(e^-p)}$



Determine ratio of elastic cross sections:

$$R = \frac{\sigma(e^+p)}{\sigma(e^-p)} = 1 + \frac{4\text{Re}(M_{1\gamma}^\dagger M_{2\gamma})}{|M_{1\gamma}^2|}$$

OLYMPUS:

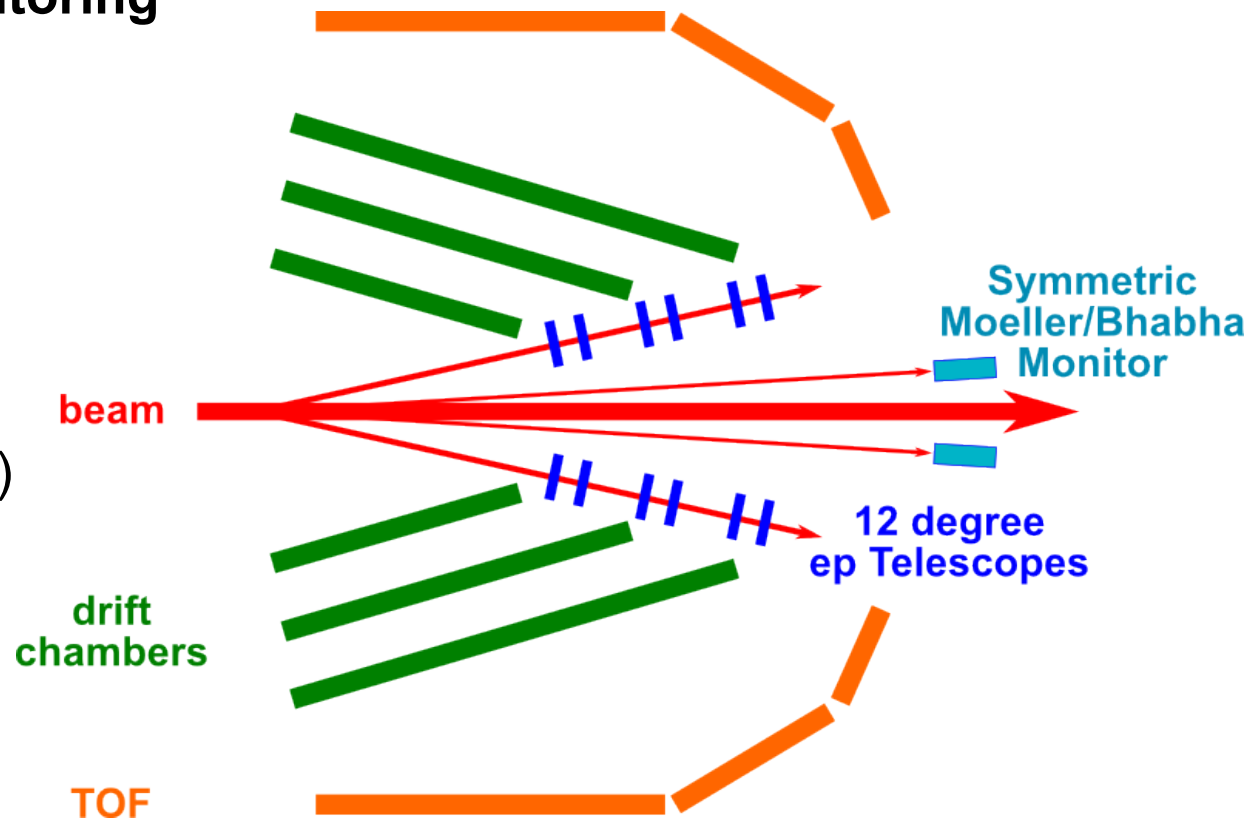
- left/right symmetric detector setup
- change beam species once per 24h
- Toroid: one quadruplet (+ – – +) or (– + + –) per 24h

Measurement of cross section ratio to 1%
→ **Measure luminosity ratio to <1%**

Importance of Luminosity Monitoring

→ **two independent systems**

- 12 degree Tracking Telescopes:
elastic ep scattering (12°)
redundancy:
3 GEMs (100mm x 100mm)
3 MWPCs (105 mm x 105mm)
- Symmetric Moller/Bhabha calorimeters:
elastic ee scattering (1.28°)
pure QED → calculable
+ elastic ep possible (single arm)



All subsystems tested at DESY Testbeam 22, summer 2011

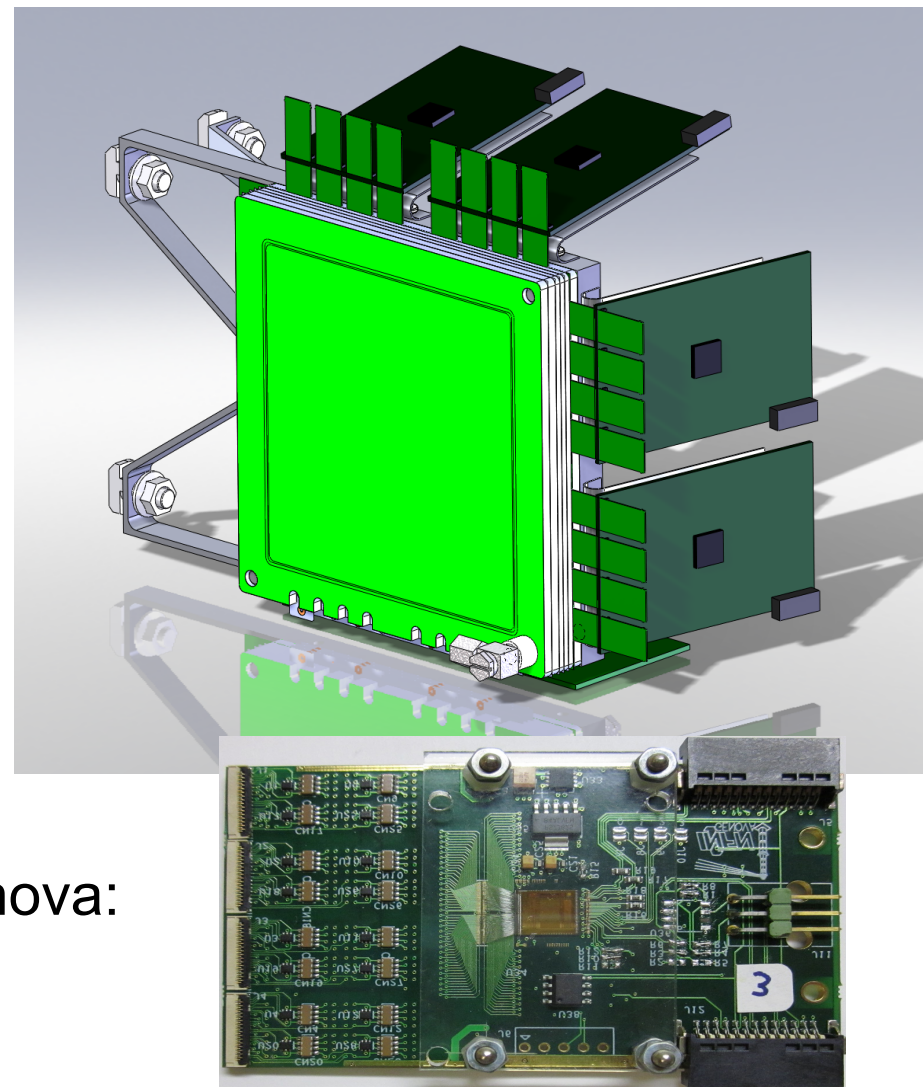
Triple GEM detectors

- collaboration Hampton U. / MIT
- detectors built at H.U.

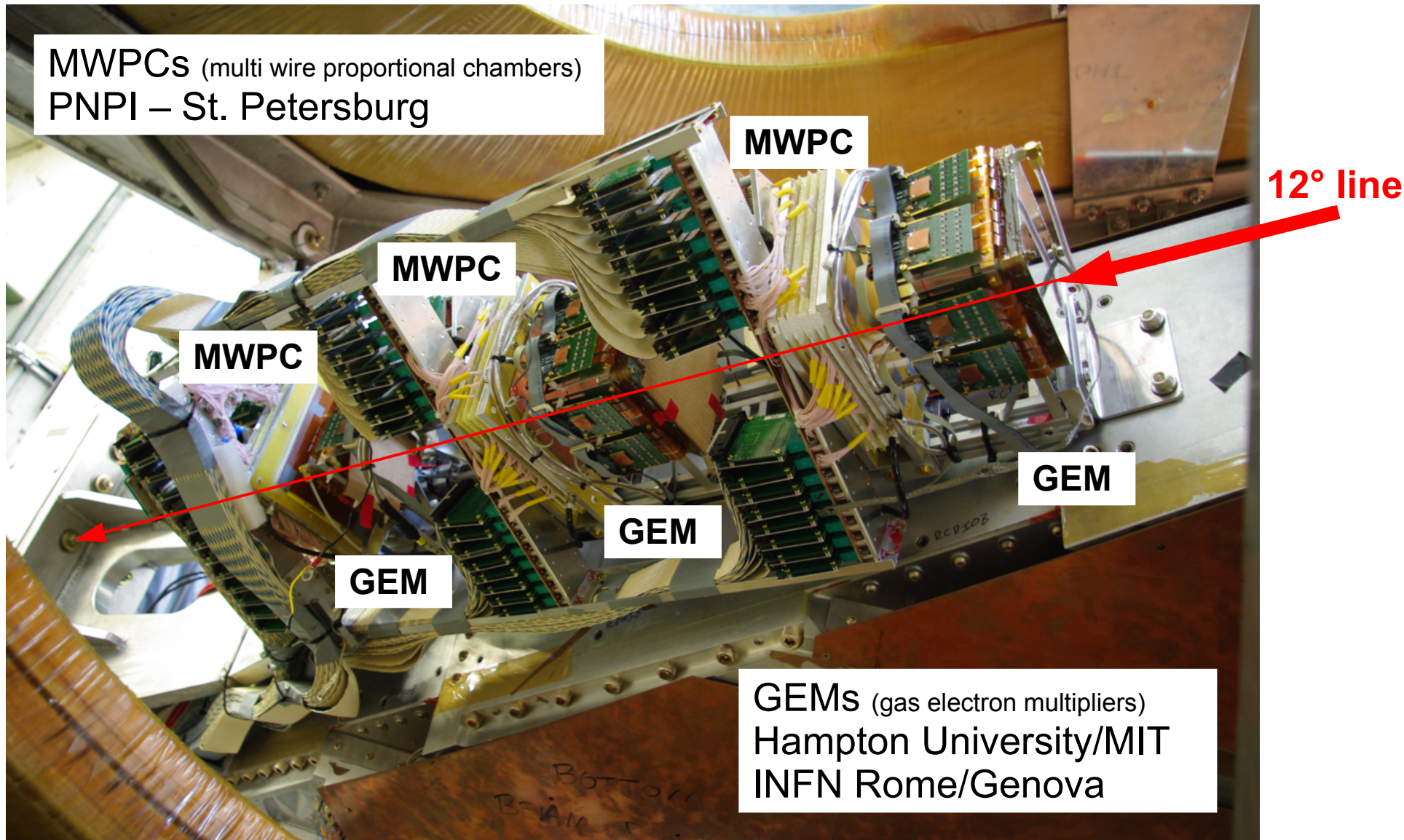
100mm x 100mm active area
400 μ m readout pitch

- total: 9 GEMs
6 installed + 3 spares

- readout electronics by INFN Rome/Genova:
VME modules (control and digitization)
APV-25 frontend cards



12 Degree ep Telescopes

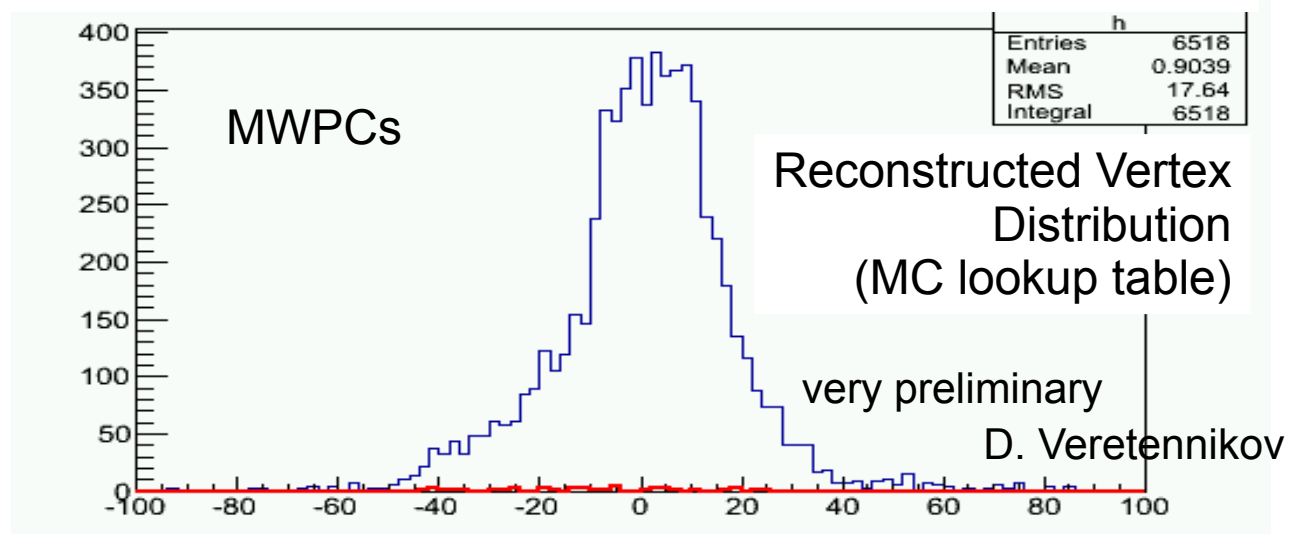
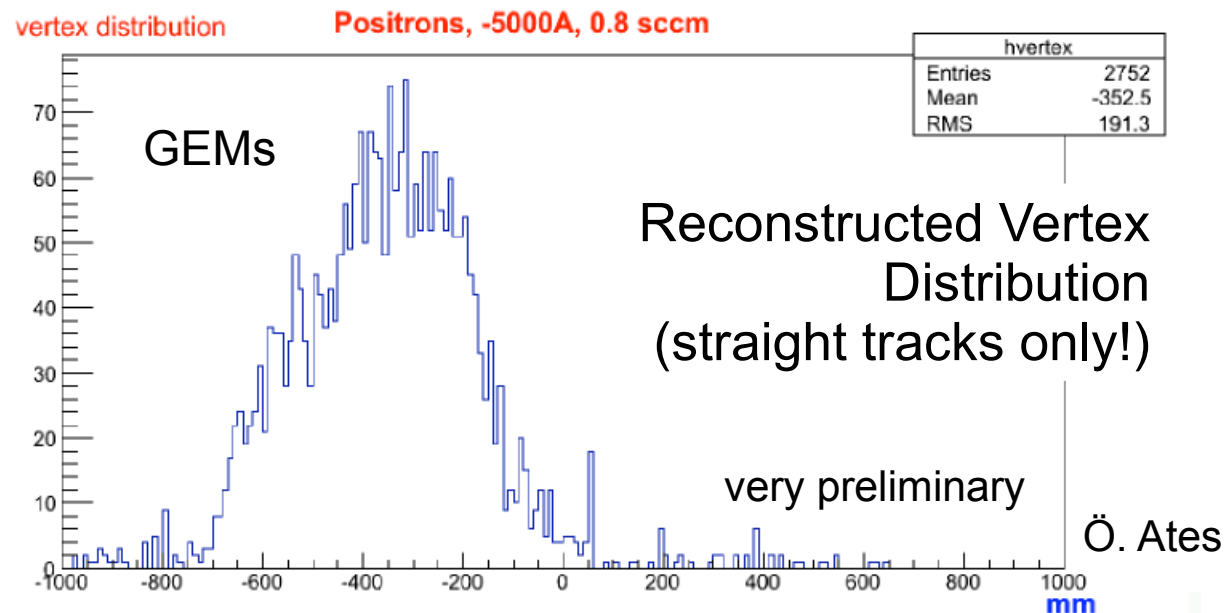


Toroid magnetic field

→ bending of lepton tracks

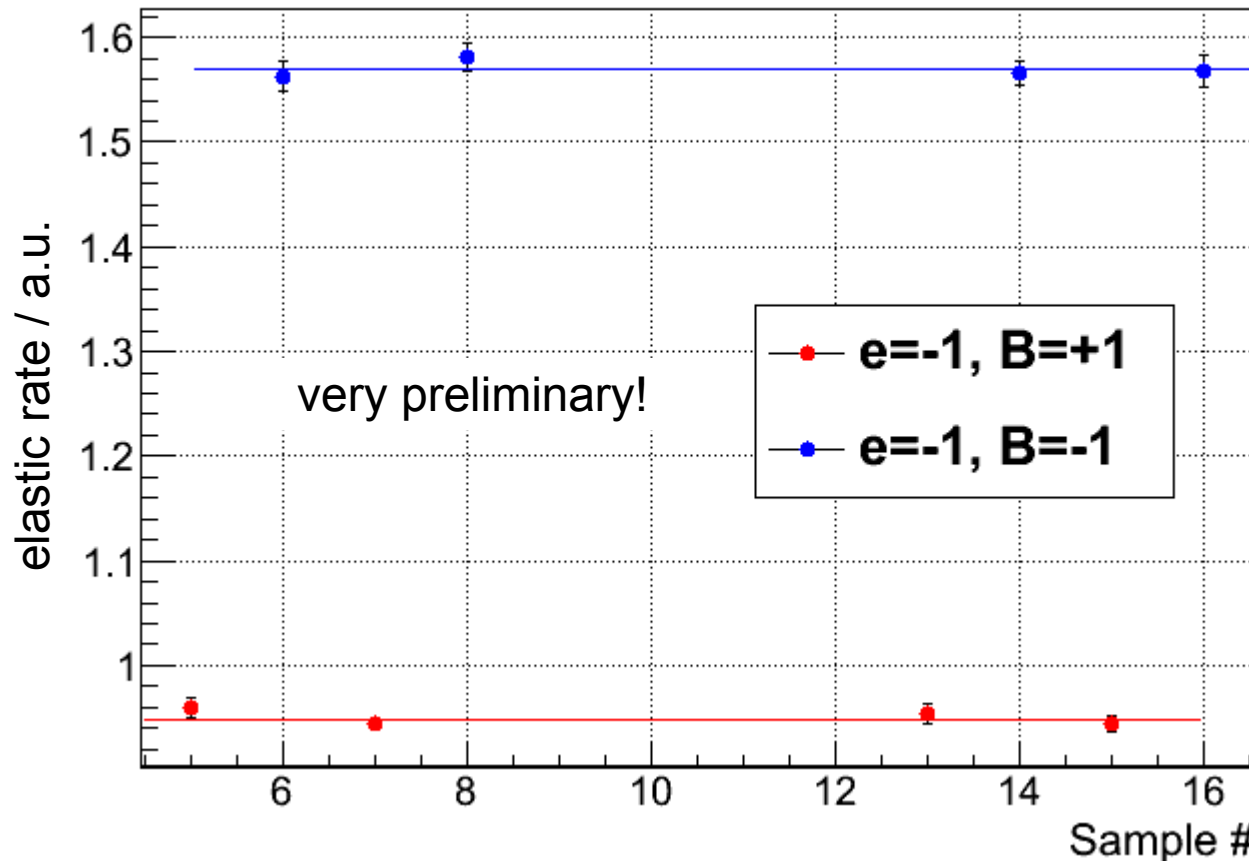
straight line “tracks”

lookup table using MC

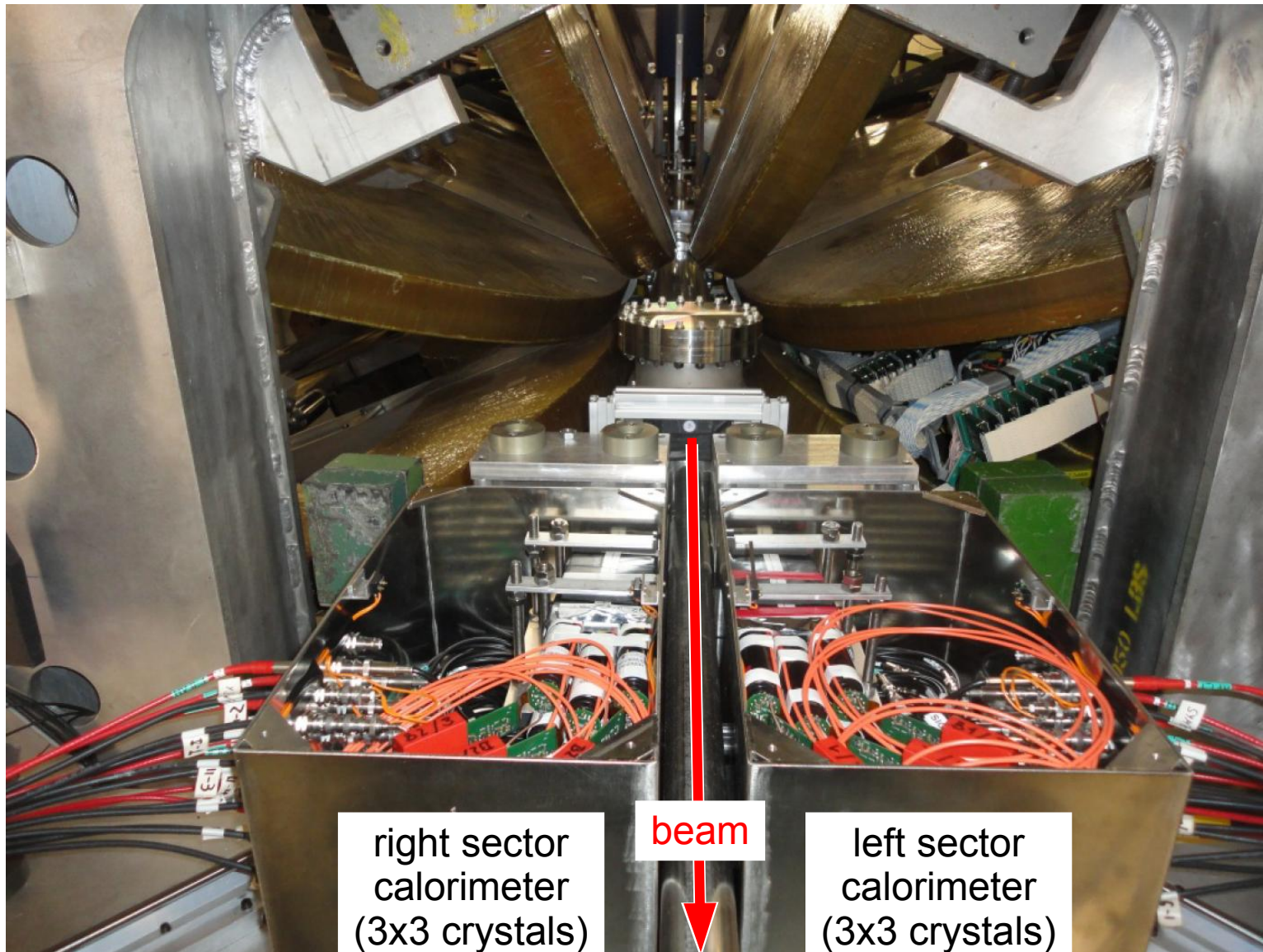


Elastic track candidates seen by 12° GEMs

12 degree LumiGEM rates @ nominal Lumi / a.u.



Ratio matches expectation from Monte Carlo



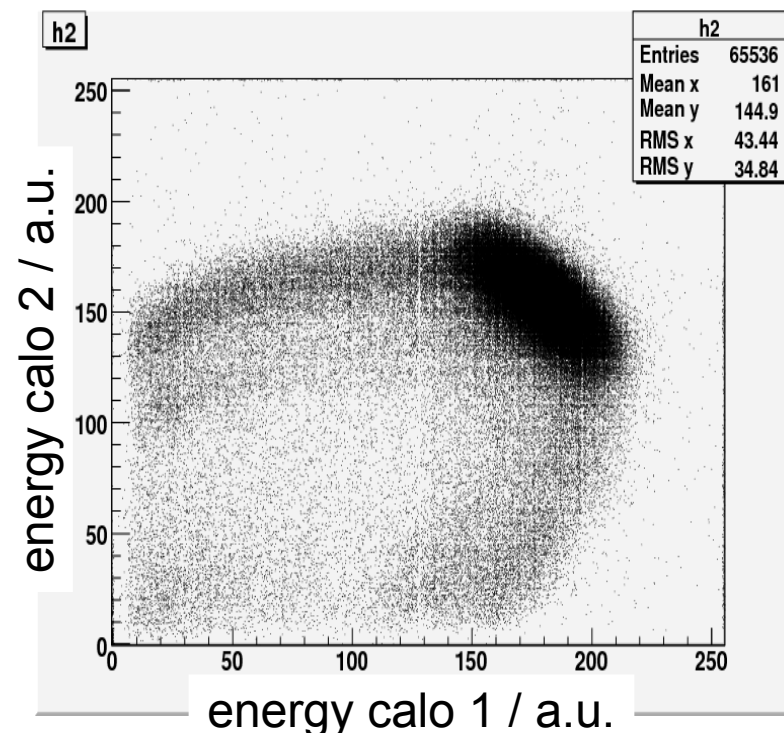
R. B. Perez

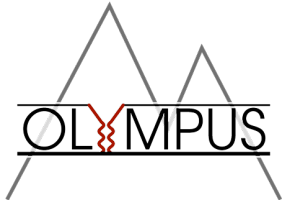
SYMB calorimeters:

- lead fluoride: pure Cherenkov, radiation hard
- fast (20ns deadtime) readout electronics
→ at OLYMPUS quasi deadtime free (96ns bunch spacing)

Detector modules/Electronics from / based on
A4 parity experiment @MAMI/Mainz

- fast: ~kHz rate
- 1 GeV left & 1 GeV right
→ low background
- em calorimeter
→ sensitive to photons (annihilation)
- 2 GeV either left or right: elastic ep
→ cross check of Moller/Bhabha





Summary and Outlook

OLYMPUS will determine the two-photon exchange to elastic ep scattering with unprecedented precision

Measurement of cross section ratio:

→ Measurement of ratio of luminosities $<1\%$ crucial!

Two independent luminosity monitors:

- 12 degree tracking telescopes (elastic ep)
- 1.28 degree calorimeters (Moller/Bhabha)

First production beamtime:

- all systems operational
- preliminary analysis shows: systems behave linearly
systems agree on luminosity changes
- currently checking ratios (e^+/e^- and B^+/B^-), efficiencies, and understanding systematics

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