

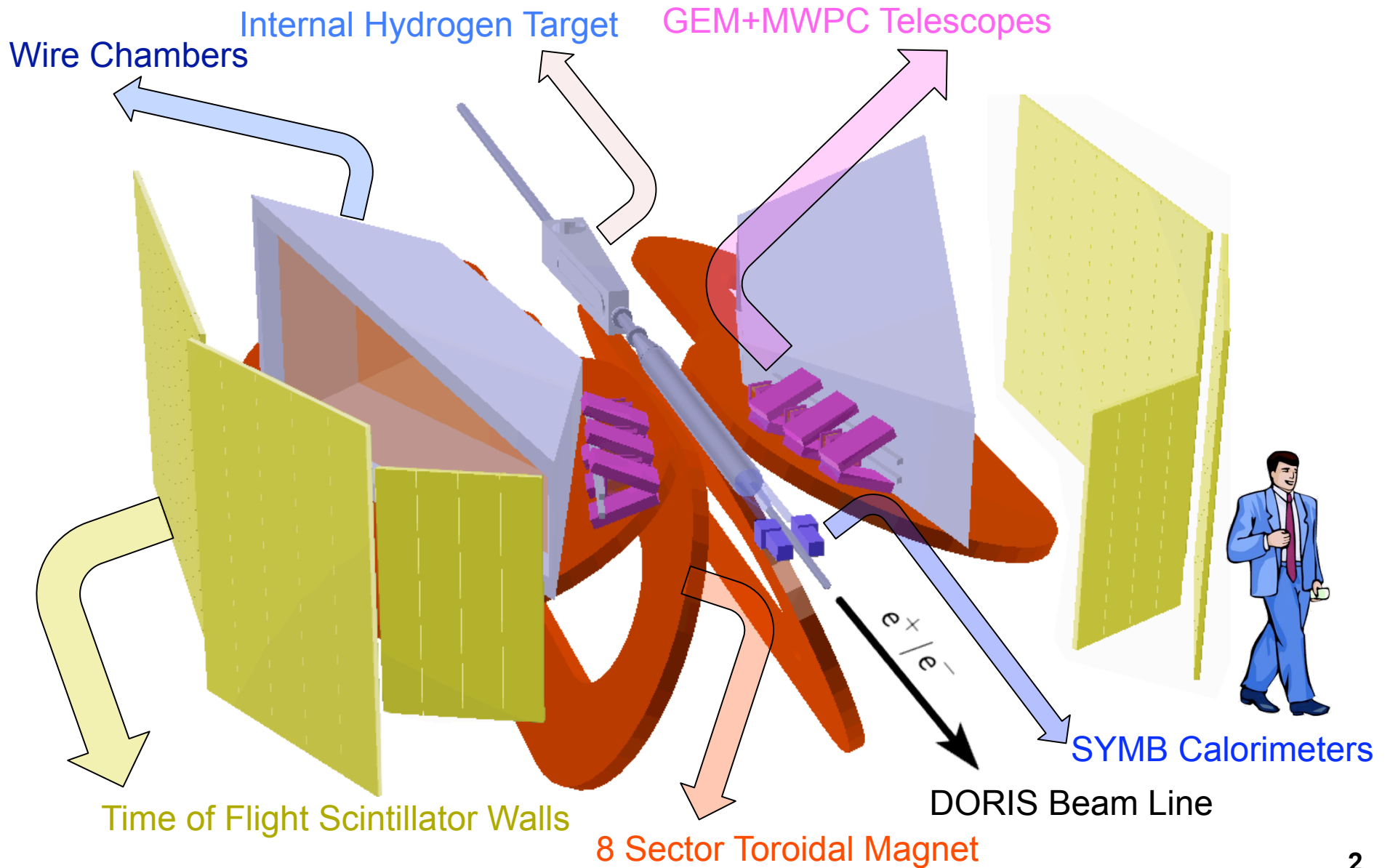
Luminosity monitoring at OLYMPUS with forward-angle elastic scattering

OZGUR ATES
HAMPTON UNIVERSITY

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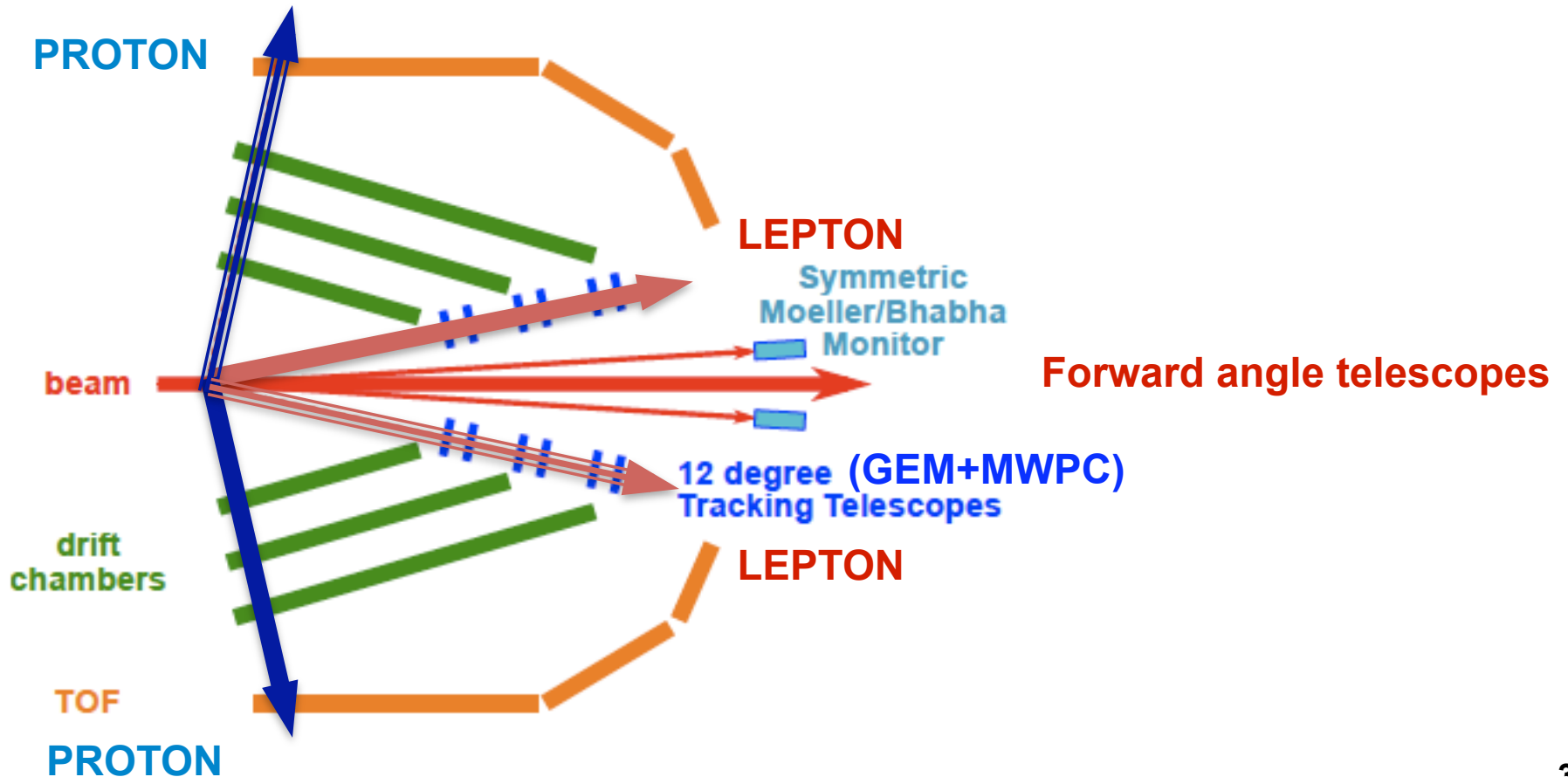
The OLYMPUS Experiment



GEM LUMINOSITY MONITORS

“Luminosity monitors for **LEPTON** in coincidence with **Recoil PROTON** detected in the opposite sector.”

2 GEM telescopes, 1.2msr, 12°,
R=187/237/287cm, dR=50cm, 3 tracking planes



Luminosity Monitoring

Triple Ratio:

Run the Experiment for the 2 beam particles: e^- and e^+

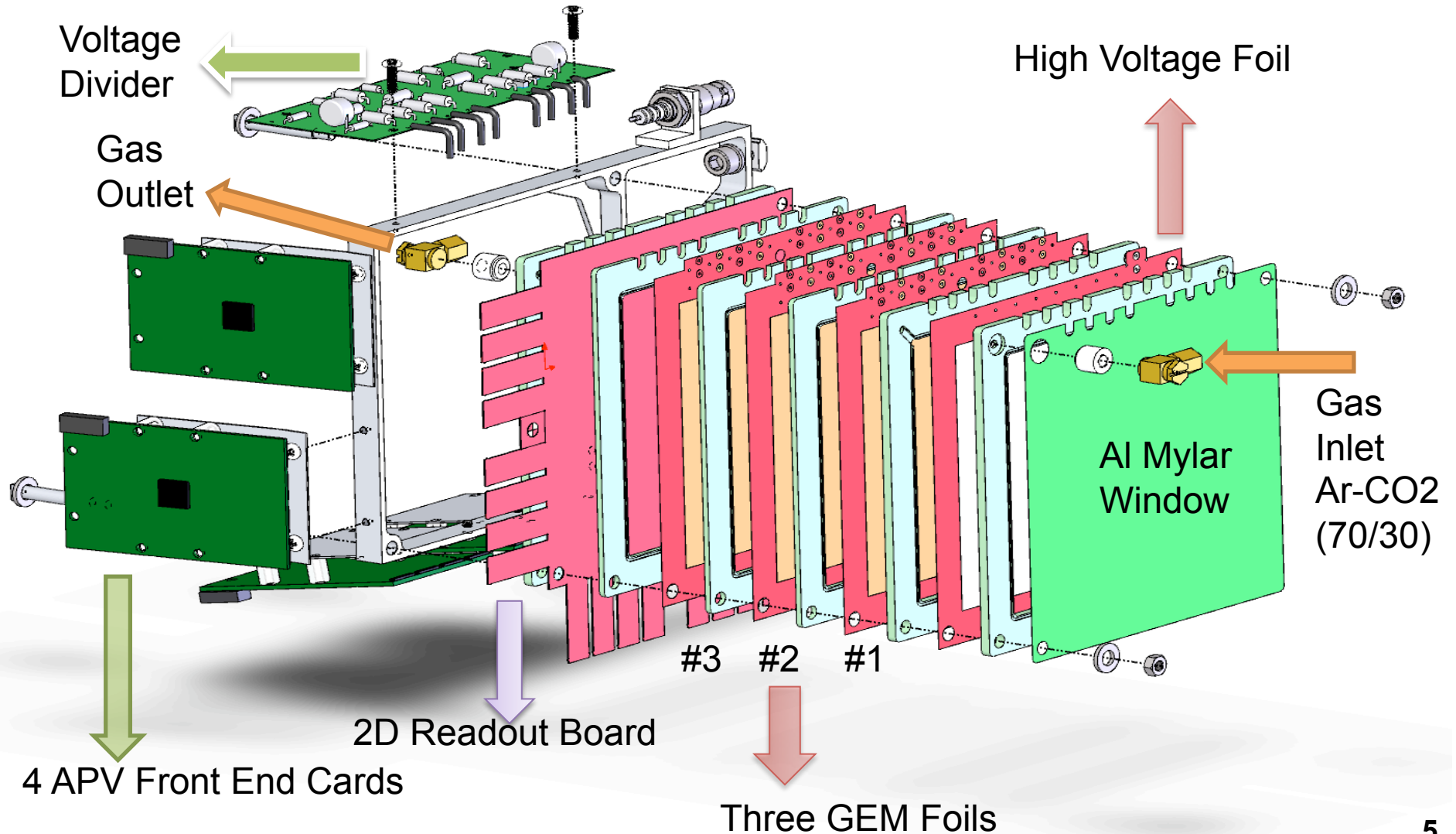
Frequent switching between e^+ and e^- to reduce systematics

$$\frac{\sigma_{e^+}}{\sigma_{e^-}} = \left[\underbrace{\frac{N_{e^+}}{N_{e^-}}}_{\text{Ratio of counts}} \bigg/ \left(\underbrace{\frac{L_{e^+}}{L_{e^-}}}_{\text{Ratio of luminosities}} \cdot \underbrace{\frac{A_{e^+}}{A_{e^-}}}_{\text{Ratio of acceptances}} \right) \right]$$

- Forward-angle (high-epsilon, low-Q) elastic scattering means that the effect of two-photon exchange is minimal, hence cross sections: ($\sigma_{e^+} \approx \sigma_{e^-}$)
- Two Telescopes: Left-right symmetry = Redundancy
- Use forward rate with acceptance correction to monitor luminosity

An exploded view of a GEM detector

*Designed by MIT-BATES, constructed by Hampton University,
readout designed by INFN Rome and Genova



MWPCs (multi wire proportional chambers)
PNPI - St. Petersburg

MWPC

MWPC

MWPC

12° line

GEM

GEM

GEM

GEMs (gas electron multipliers)
Hampton University/MIT
INFN Rome, Genova

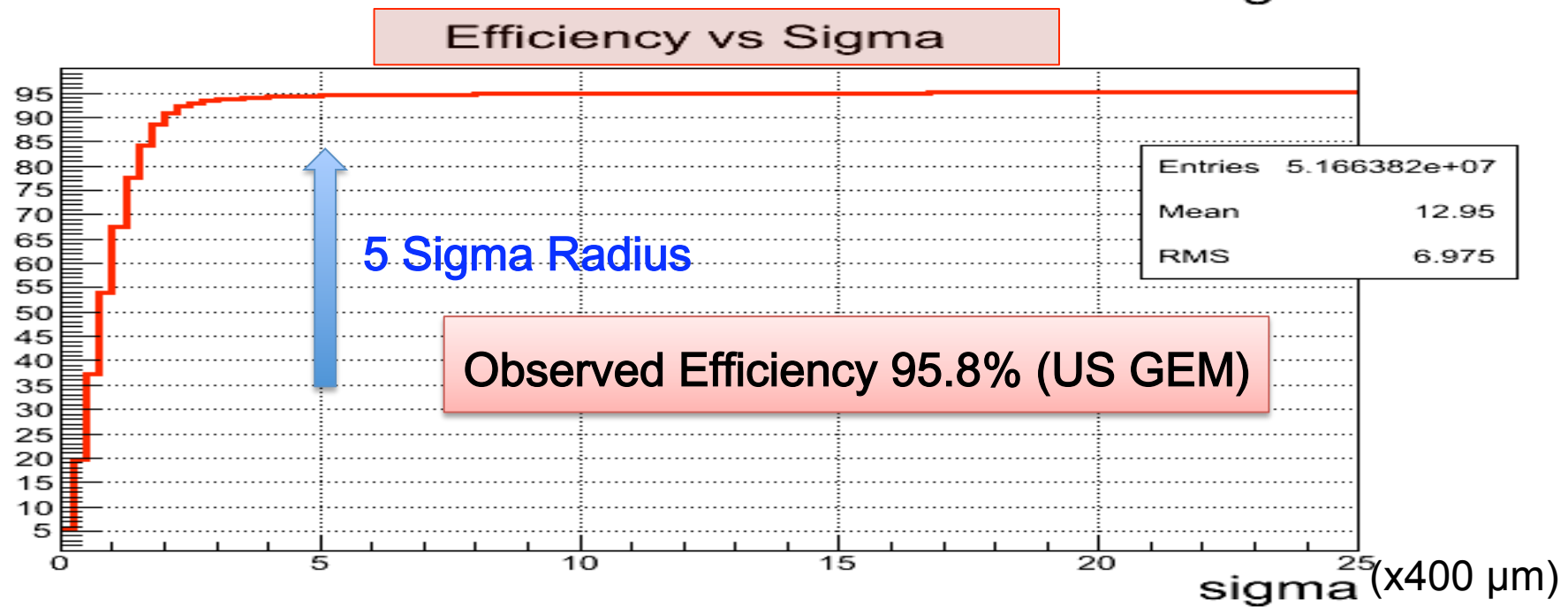
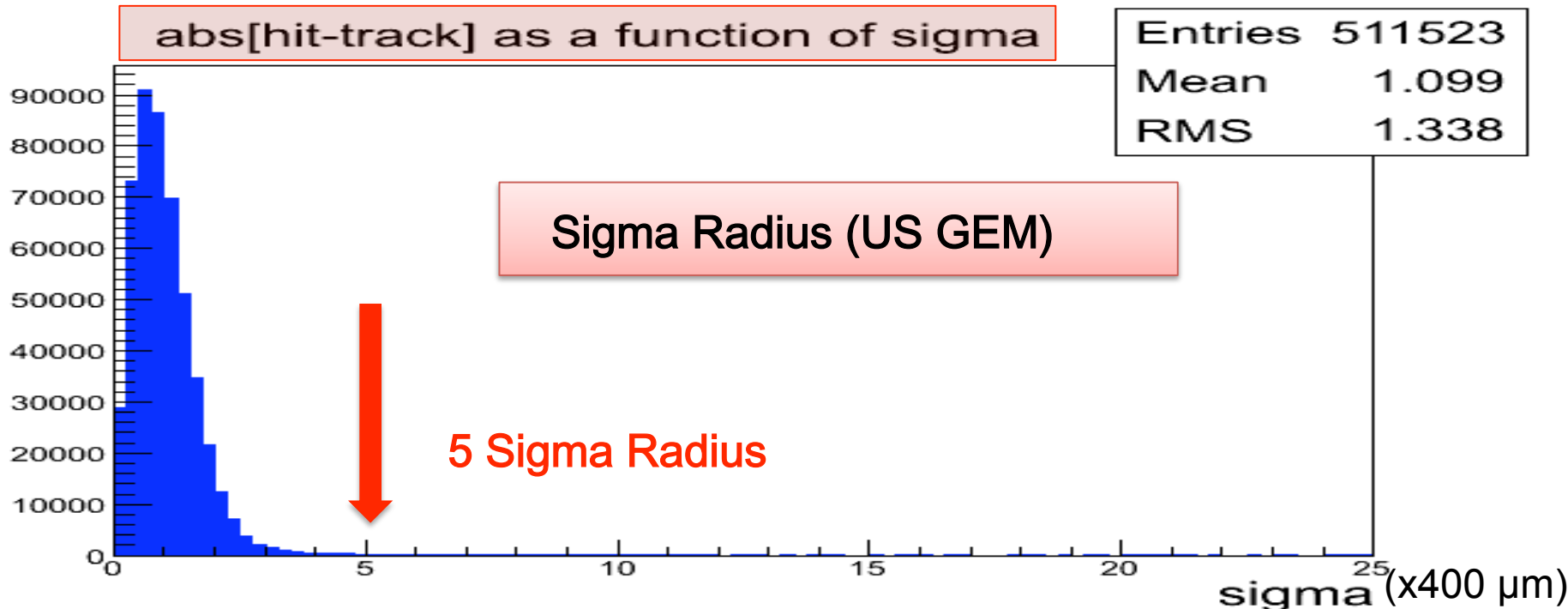
The Method For Efficiencies

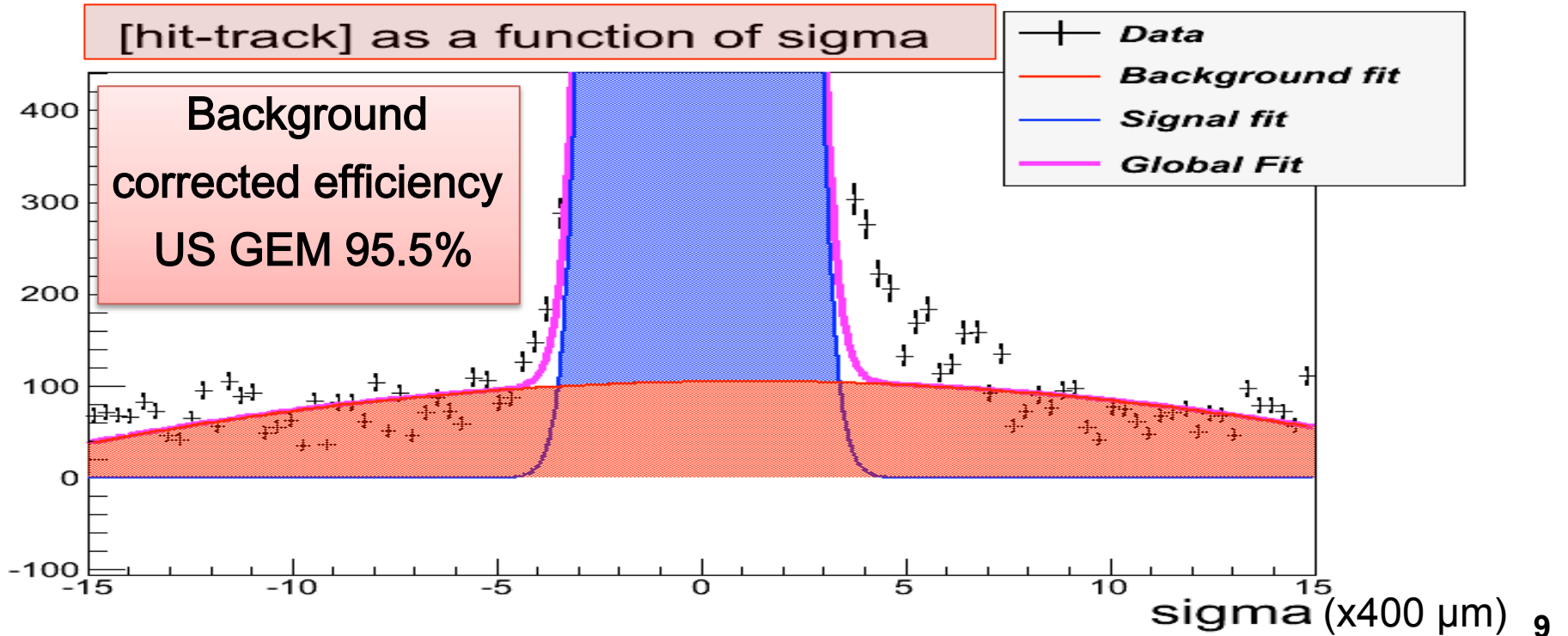
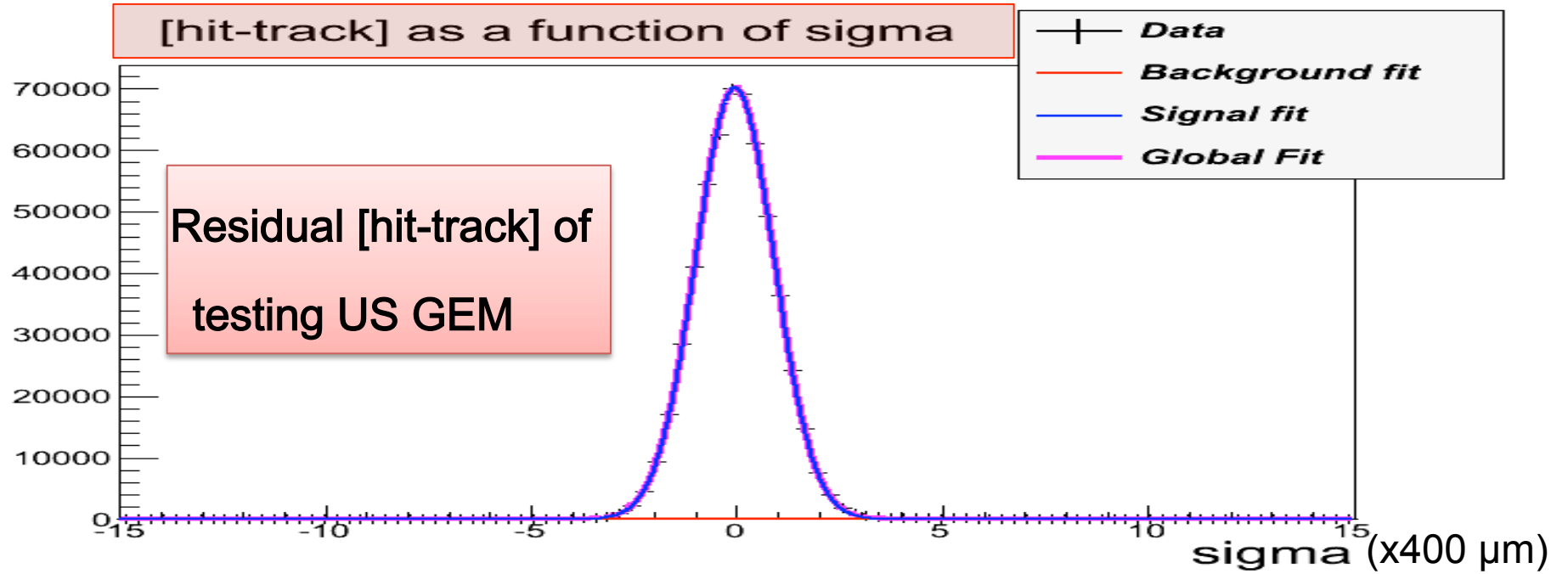
- Fitting 5 out of 6 elements together with MWPC chambers
- Vicinity search for the testing element within 5 “sigma” radius if there is hit closer to track projection in the 2D areas.

“sigma” = sigma of residual [hit-track]
about 400 μm .

- Binomial Probability
 - If detected (success)
 - If not seen (inefficiency)

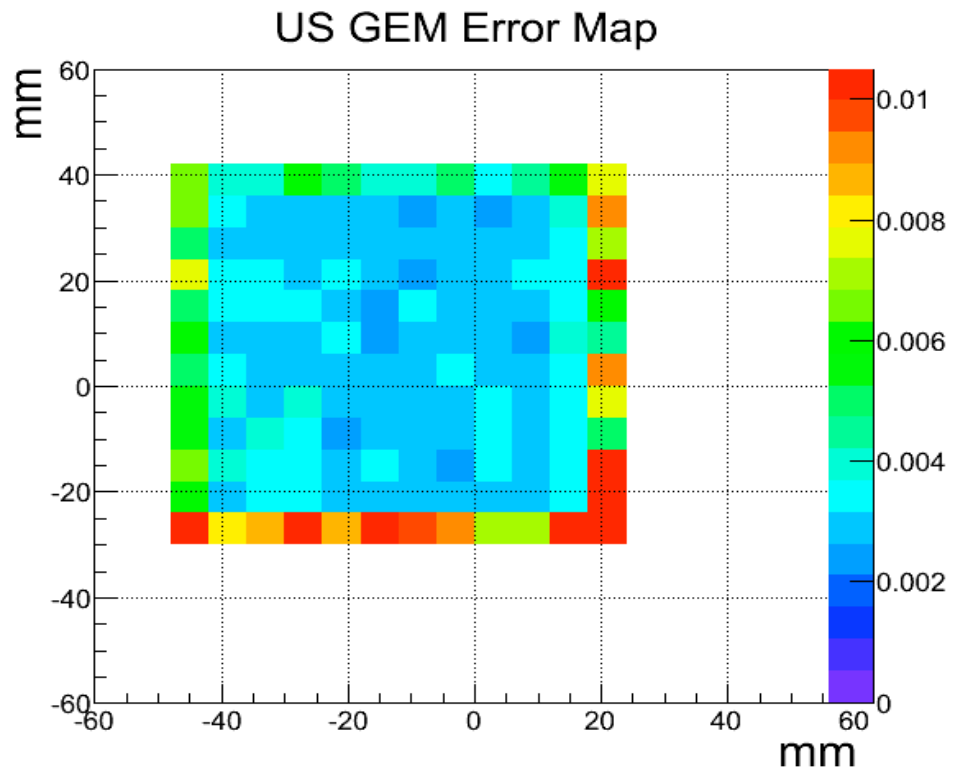
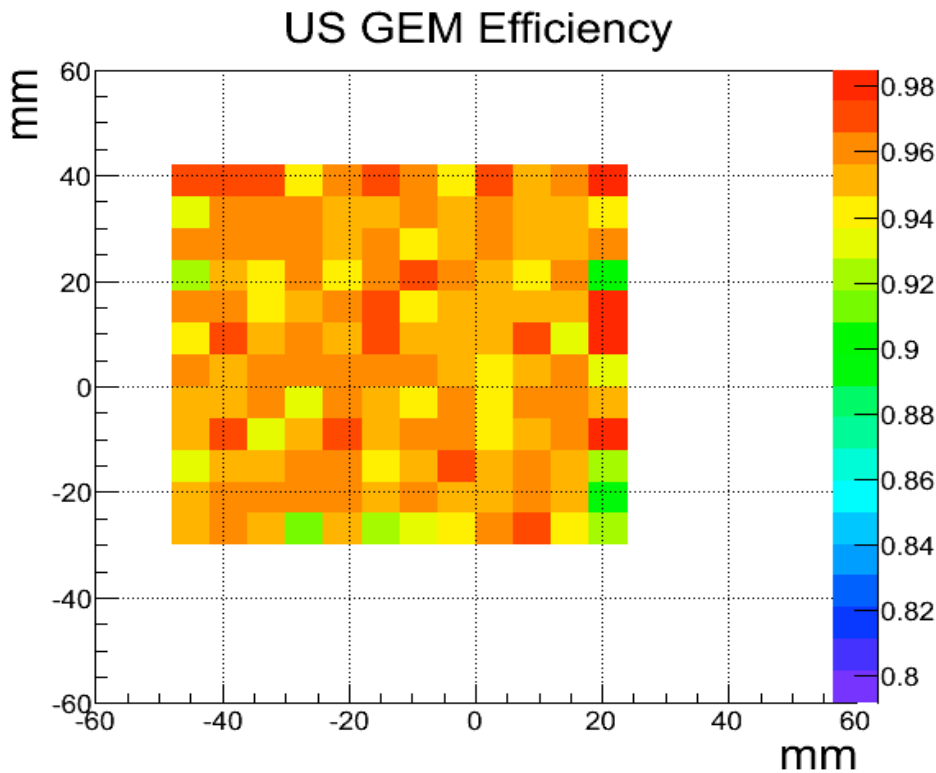






Corrected US GEM Efficiency with Binomial Errors

95.5% +/- 0.3%



GEM Efficiency and Resolution Table

EFFICIENCIES (‘%’ percentage)	US GEM	MI GEM	DS GEM
LEFT SECTOR	96.0% +/- 0.3%	94.8% +/- 0.3%	95.8% +/- 0.4%
RIGHT SECTOR	95.5% +/- 0.3%	94.4% +/- 0.4%	96.2% +/- 0.4%

RESOLUTIONS (‘μm’ micrometer)	US GEM	MI GEM	DS GEM
LEFT SECTOR (X Axis)	76.0 +/- 0.5	78.8 +/- 0.5	73.8 +/- 0.4
RIGHT SECTOR (X Axis)	78.0 +/- 0.4	74.4 +/- 0.5	72.1 +/- 0.3

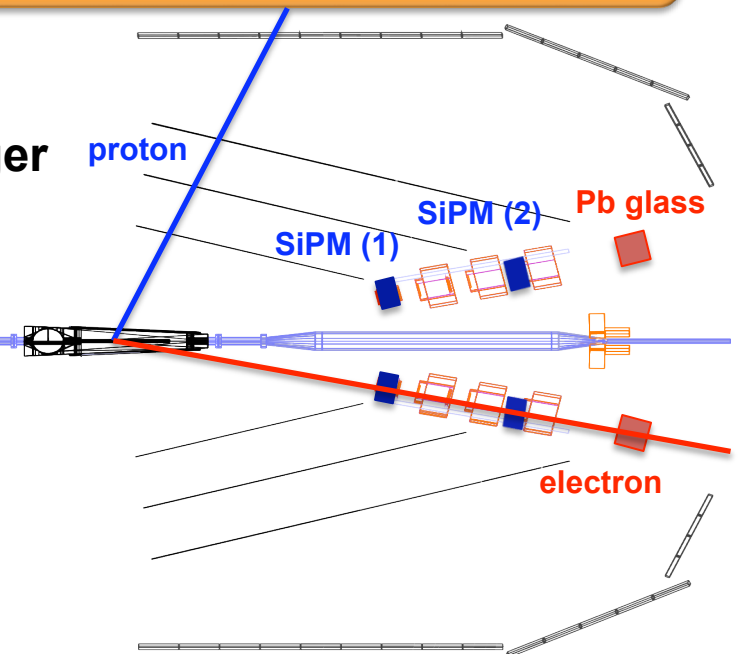
12-degree Trigger Efficiencies for Right Sector

The Two Alternative Lumi Events:

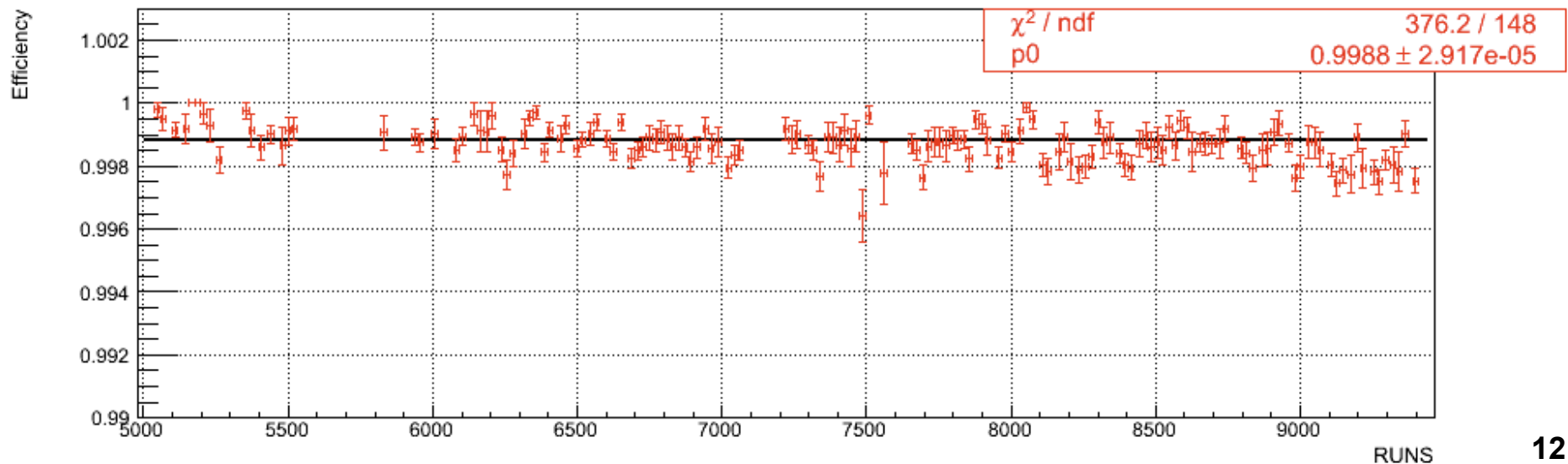
- Lumi Trigger (Coinc. SiPM) & Opposite TOF Trigger
- Lead Glass Trigger & Opposite TOF Trigger

Trigger Efficiency Monitoring by Lead Glass:

- Project Tracks onto 12-degree Scintillators
- Lumi Trigger Fired = Efficiency
- If Missing Lumi Trigger = Inefficiency

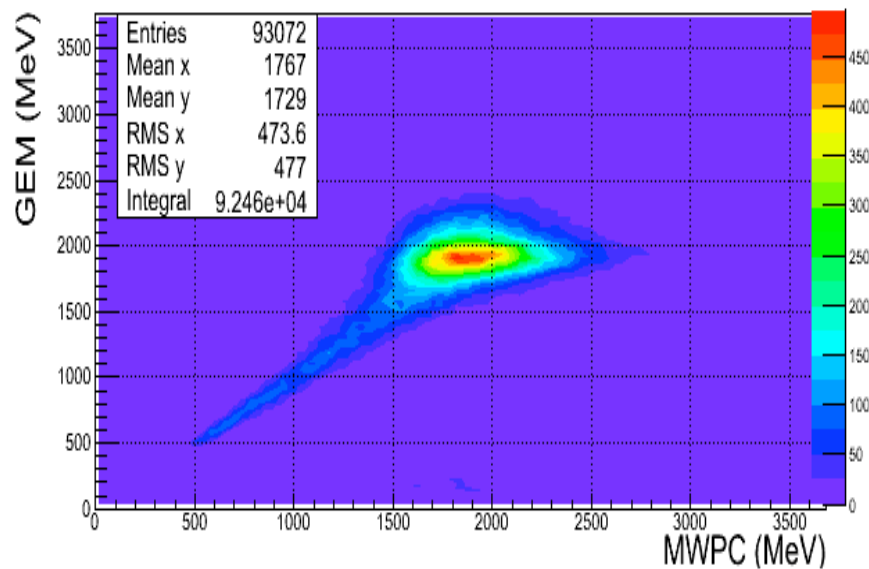


SiPM Coincidence Efficiency Right Sector

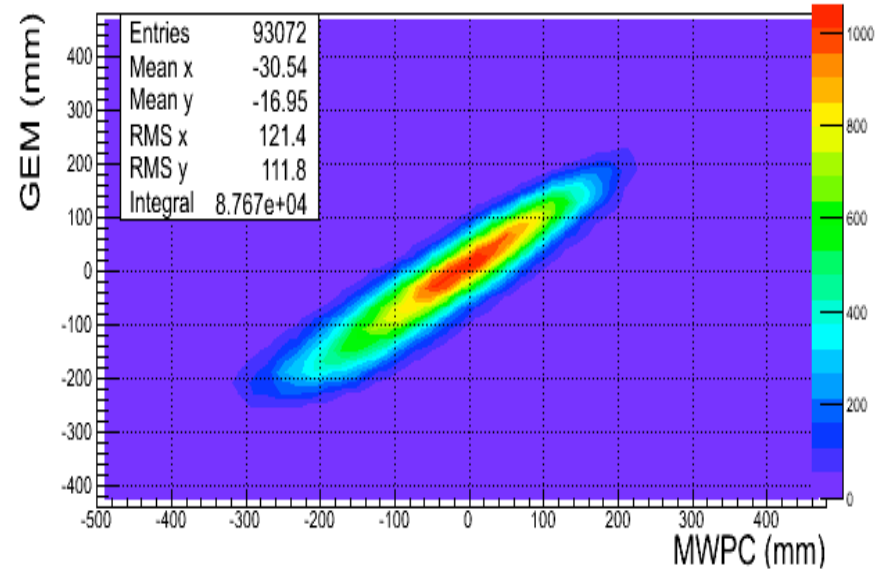


2D Comparison Plots: GEMs vs MWPCs

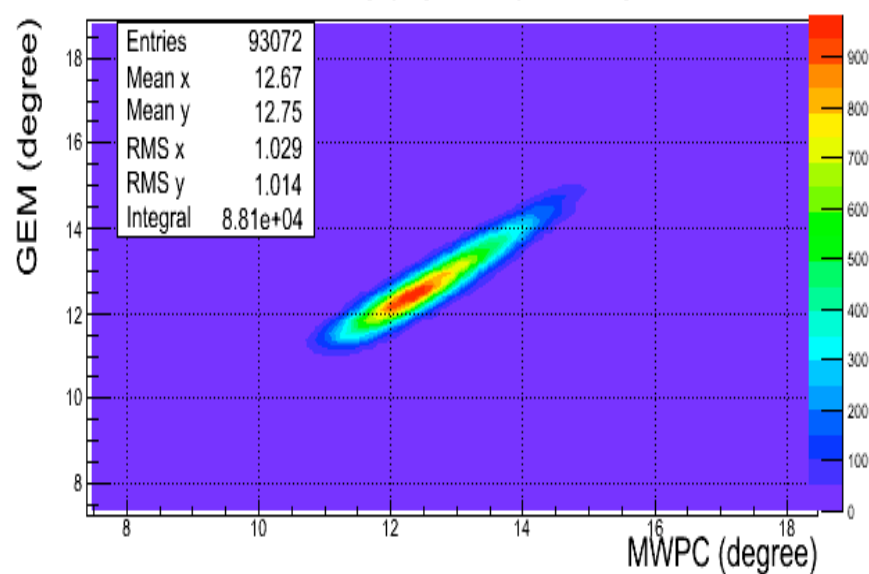
Momentum GEM vs MWPC



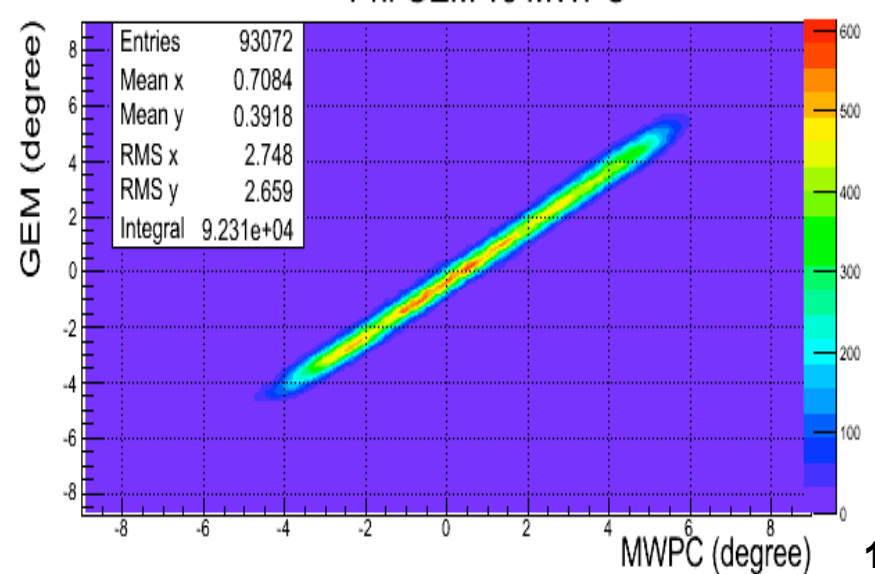
Z Vertex GEM vs MWPC

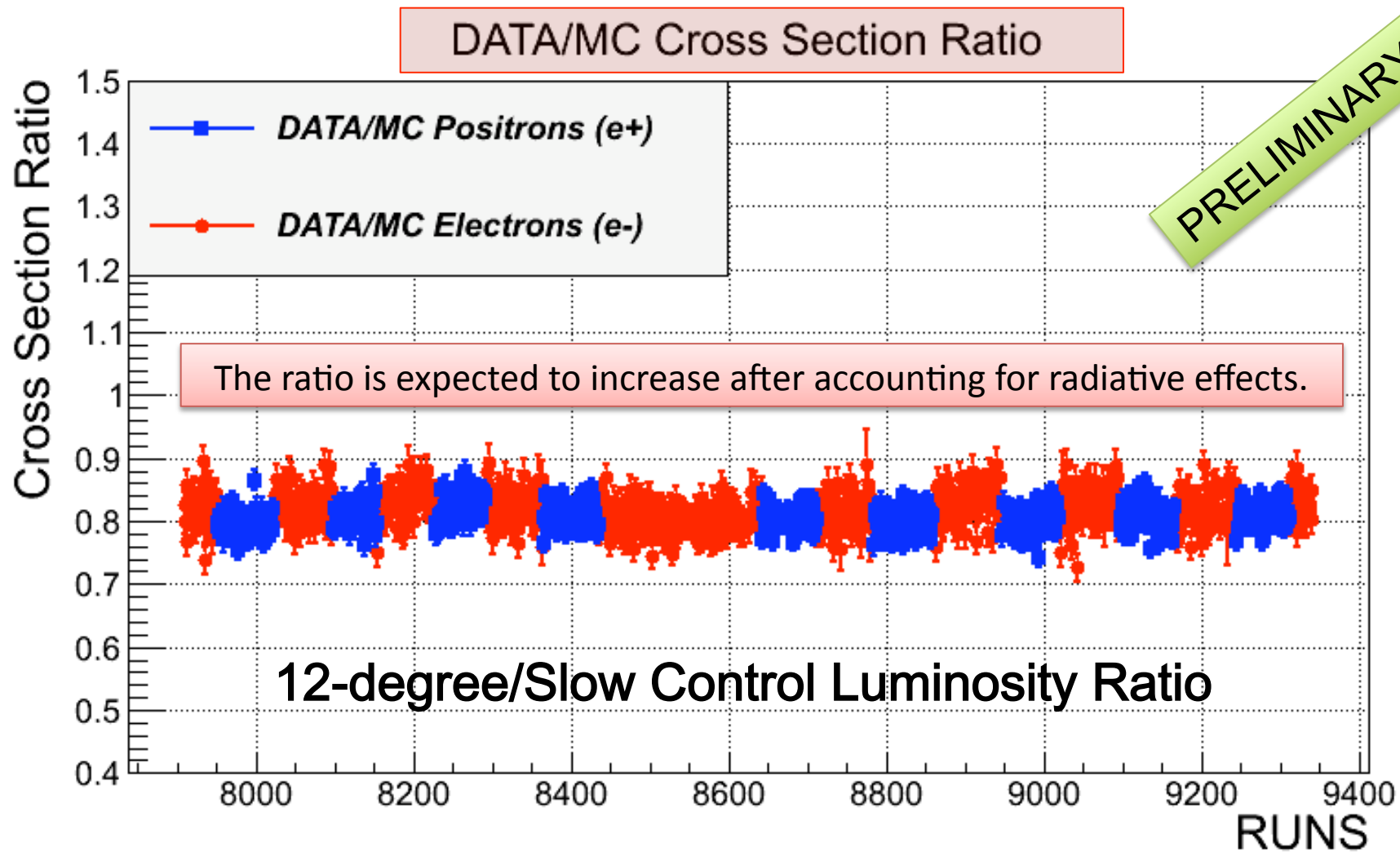


Theta GEM vs MWPC



Phi GEM vs MWPC





$$\frac{L_{\text{exp}(e^\pm)}}{L_{\text{SC}(e^\pm)}} = \frac{\sigma_{\text{exp}(e^\pm)} \star}{\sigma_{\text{MC}(e^\pm)}} = \frac{\left(N_{\text{exp}(e^\pm)} / L_{\text{SC}(e^\pm)} \right)}{\sigma_{\text{MC}(e^\pm)}} = \frac{N_{\text{exp}(e^\pm)}}{\left(\sigma_{\text{MC}(e^\pm)} / L_{\text{SC}(e^\pm)} \right)} = \frac{N_{\text{exp}(e^\pm)}}{N_{\text{MC}(e^\pm)}}$$

SUMMARY

- ✓ OLYMPUS collected good data in Feb 2012 and Oct 2012 - Jan 2013.
- ✓ The 12-degree GEMs and MWPCs have performed very well.
- ✓ Analysis is underway with 2 independent tracking codes, improved optical survey of detector, target and beam position, and improved magnetic field measurements.
- ✓ The first preliminary 12-degree GEM luminosity measurements have been determined.
- ✓ Olympus aims to determine two photon contribution to ep elastic scattering with 1% precision.