# Tracker Analysis

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SBS Technical Review

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# Main issues

**High background rate (~500 kHz/cm$^2$)**

- **Large low energy photons background**
- **Multiplicity/Ambiguity**
- **Pile Up**

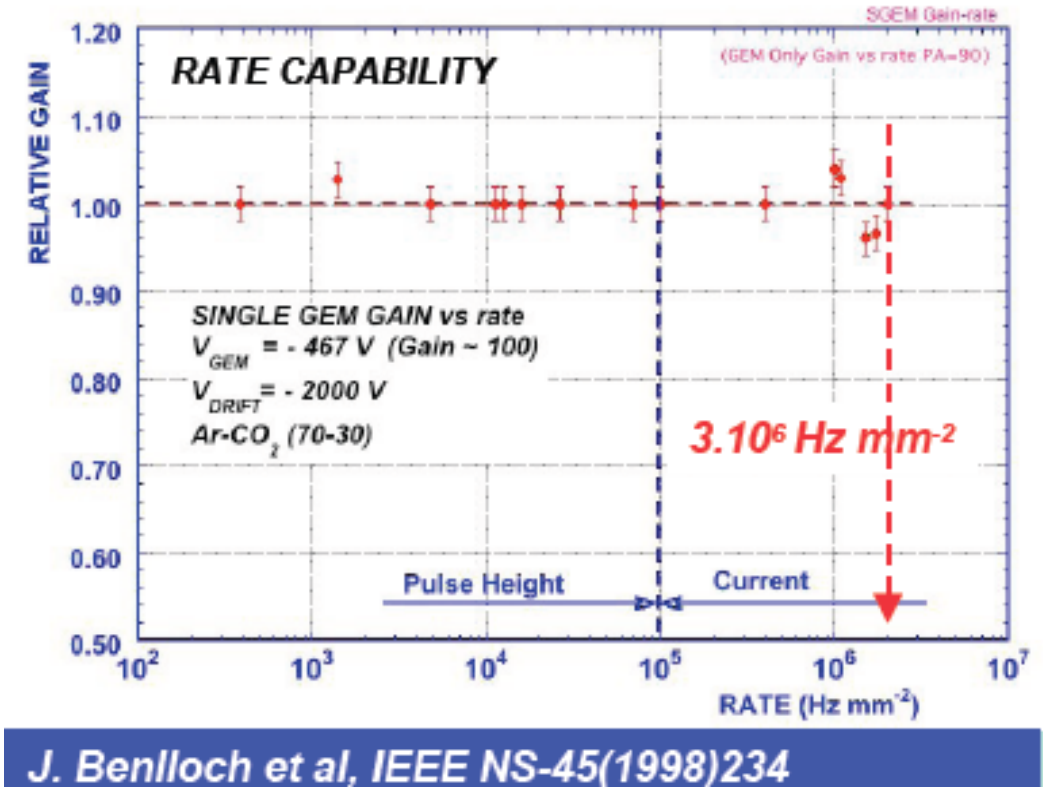
***Affect Track Reconstruction, Efficiency, …***

**Spatial Resolution (<100 μm), achievable, but may compete with the above (see later)**

**Moderate and Large Size (already discussed)**

# Intrinsic rate capability of GEM

GEM support up to several MHz/mm$^2$:




J. Benlloch et al, IEEE NS-45(1998)234

# Simple MonteCarlo

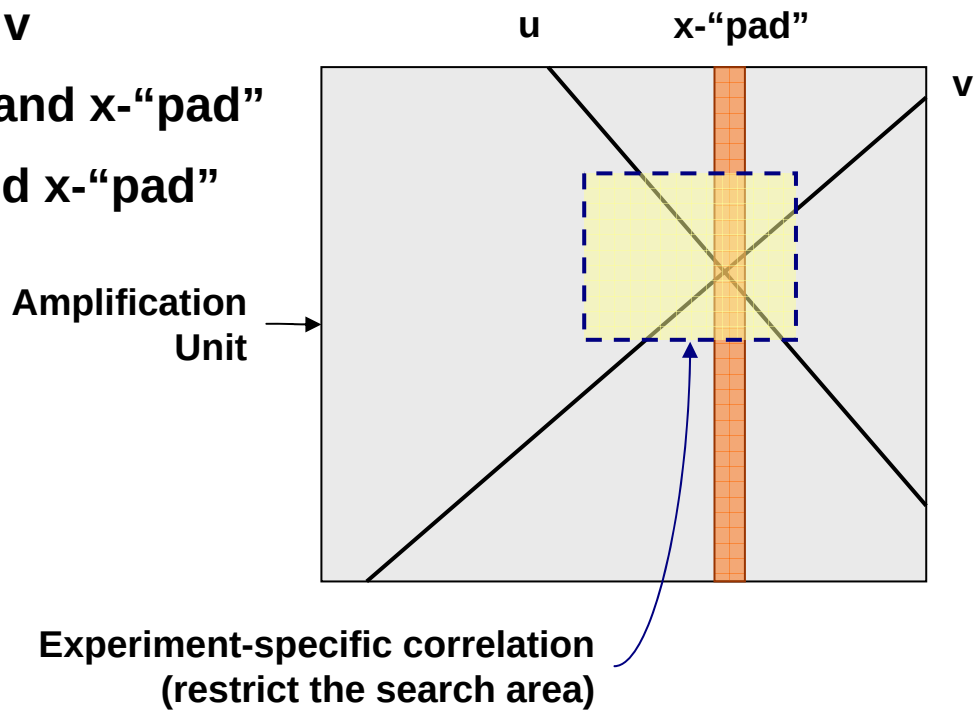
- Analysis of hits ambiguities and pile up on single chamber
- Assume uniform distribution on the chamber active area
- Multiple contiguous hits = one cluster (no cluster resolution)
- Chamber of 40x50 $cm^2$
- COMPASS 2D readout + 3rd “pad” plane on last GEM layer
- Use calibration data of COMPASS

# Hits reconstruction

**u and v = 2 layer readout strip plane**
**X-“pad” = last HV segmented GEM layer**

**Hit ambiguity suppression:**

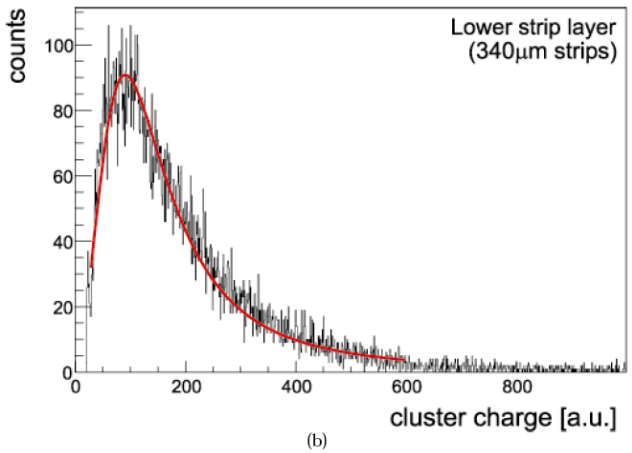
- **Signal correlation between u and v**
- **Position correlation between u/v and x-“pad”**
- **Signal correlation between u/v and x-“pad” (not included in analysis)**

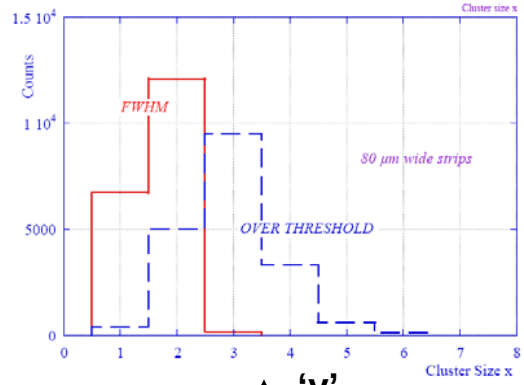



**NOTE:**
**in this context “pad” means a 3rd coordinate plane,**
**with minimum element-by-element overlap with the 2D strip plane**

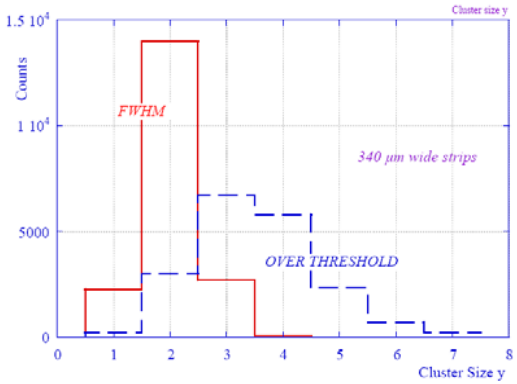
# COMPASS Real Data (CERN-EP/2002-008)

**Charge Distribution**



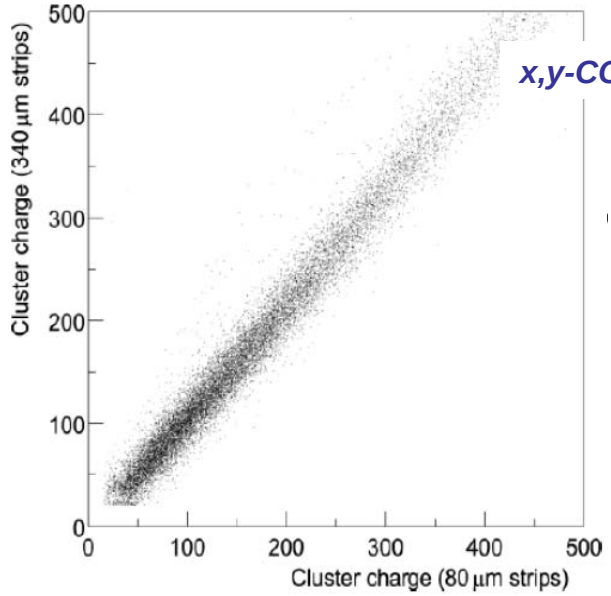



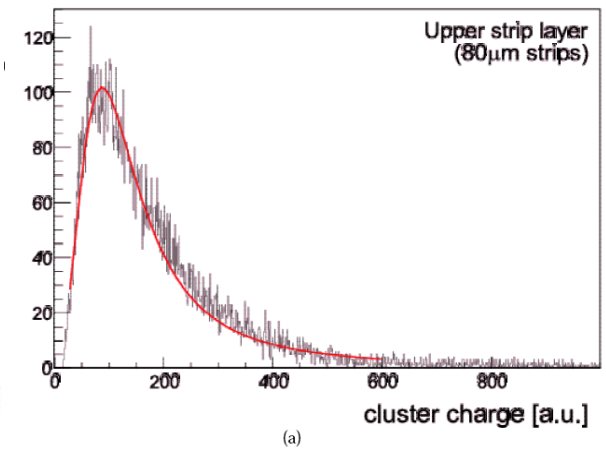

**Cluster Size Distribution**

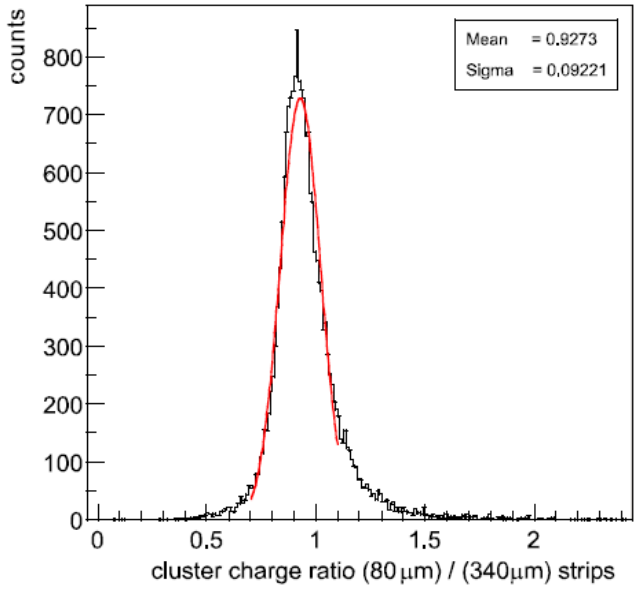



'x' 'y' 'x' 'x/y' 'y'

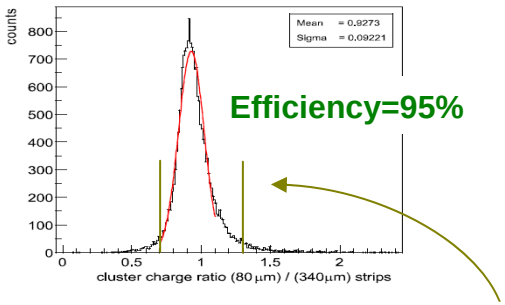
*x,y-COMPASS = u,v-SBS*

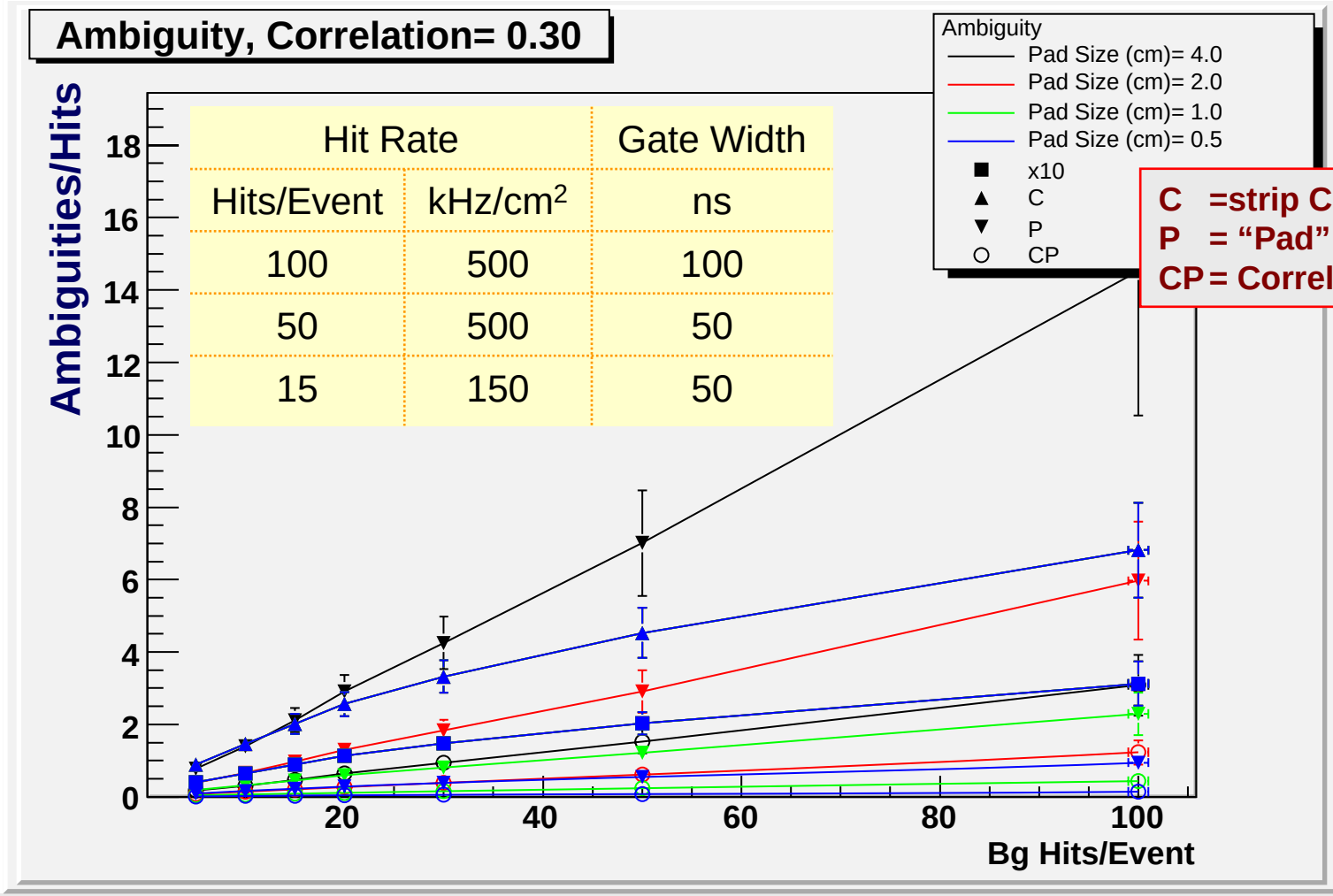


# Ambiguity vs “pad” size, suppression approach and hits oocupancy

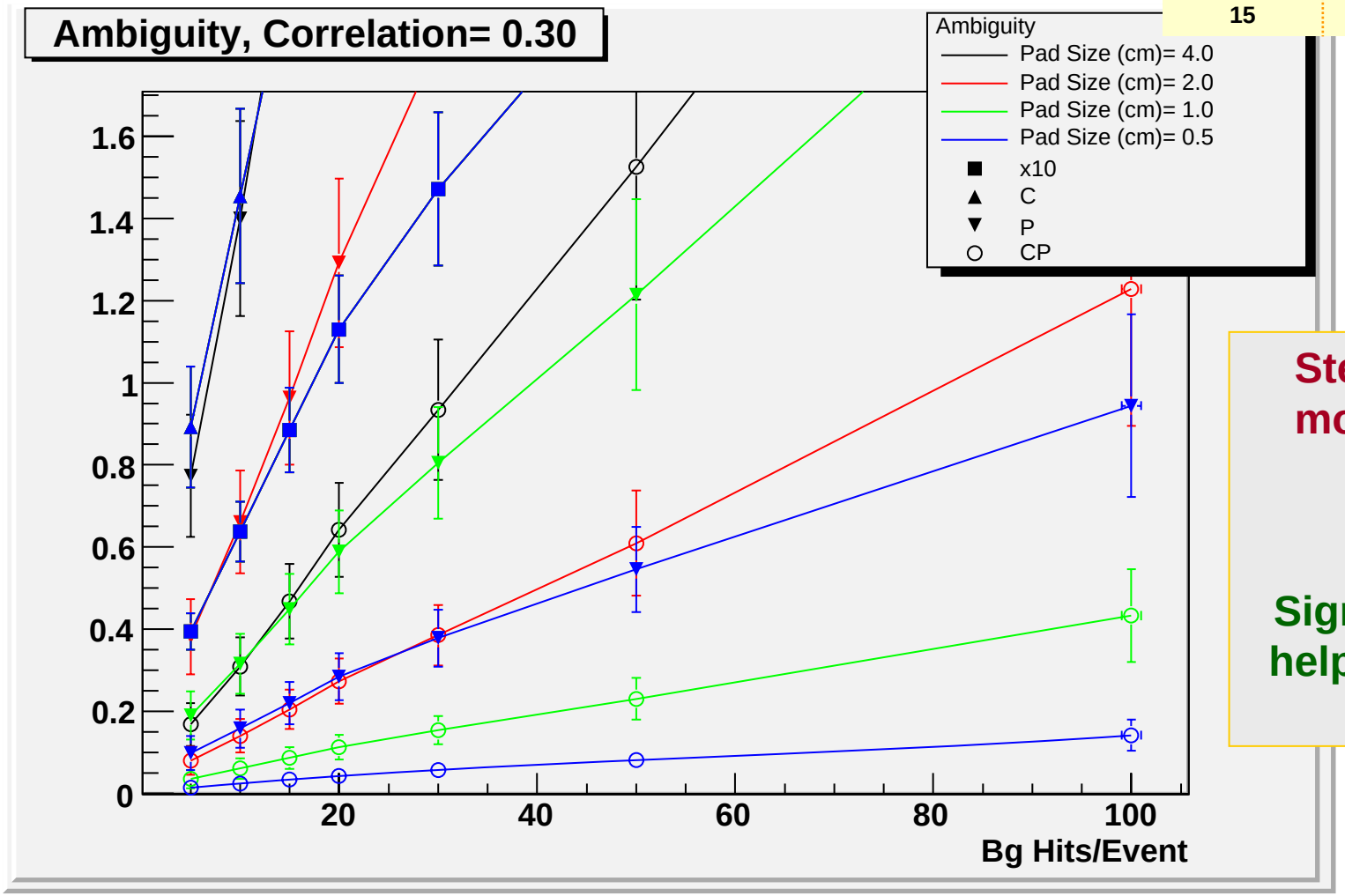



| Hit Rate | | Gate Width |
|---|---|---|
| Hits/Event | kHz/cm$^2$ | ns |
| 100 | 500 | 100 |
| 50 | 500 | 50 |
| 15 | 150 | 50 |

# Ambiguity vs “pad” size, method and hits/events (**zoomed**)

| Hit Rate | | Gate Width |
|---|---|---|
| Hits/Event | kHz/cm$^2$ | ns |
| 100 | 500 | 100 |
| 50 | 500 | 50 |
| 15 | 150 | 50 |




**Steeper behavior moving to higher pad sizes**

**Signal Correlation helps significantly (factor of 5-10)**

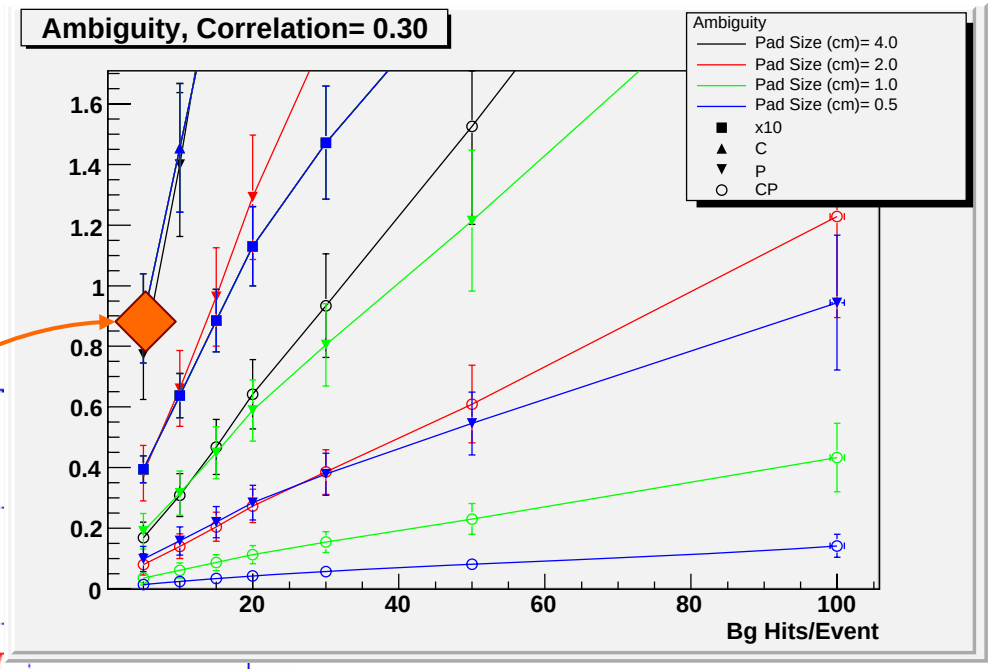
# Hit Multiplicity and Track Reconstruction at COMPASS

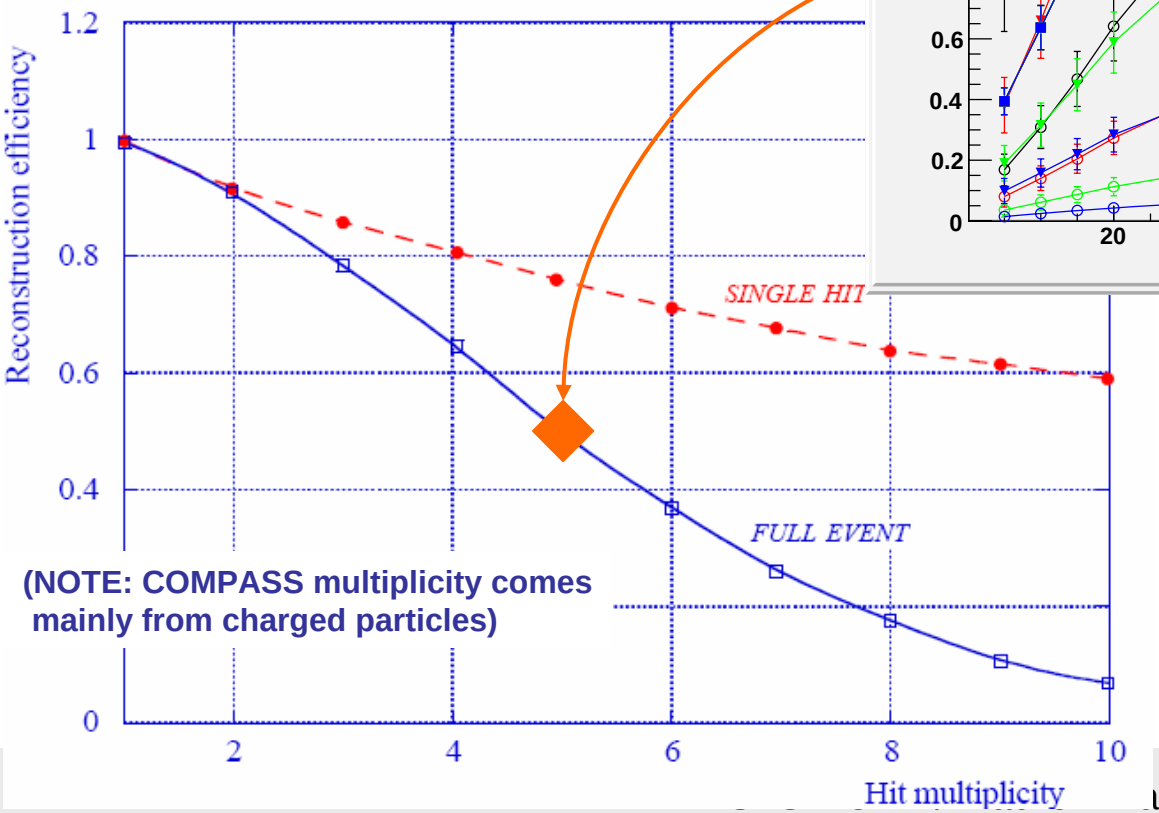
**VERY ROUGH ESTIMATION**

**Ambiguity/Hits Multiplicity ~ 1**

⇩

**50% reconstruction efficiency**




**(NOTE: COMPASS multiplicity comes mainly from charged particles)**

**Reduce ambiguity below ~ 20 % should be fine**

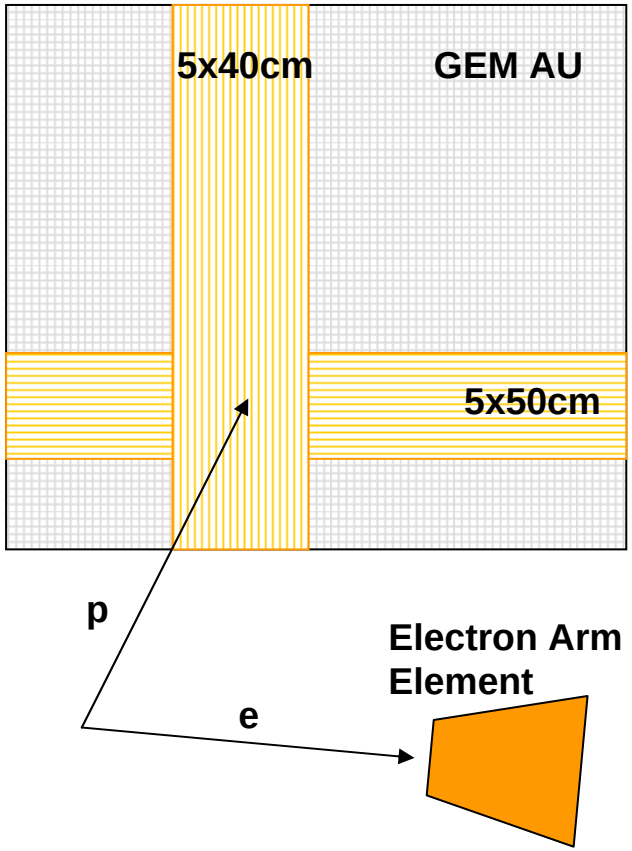
**"pad" of 1cm² would be excellent but not easily doable:**
***0.2 mm pitch on 50 cm GEM***

# Track Reconstruction

- Minimize Multiplicities/Ambiguities
- Maximize number of planes
- Exploit other detector responses and experiment peculiarities (e.g. GEP5 elastic scattering implies strong correlation between the electron and proton kinematics)
- Implement performing Reconstruction Algorithm

# Track Reconstruction in GEP5

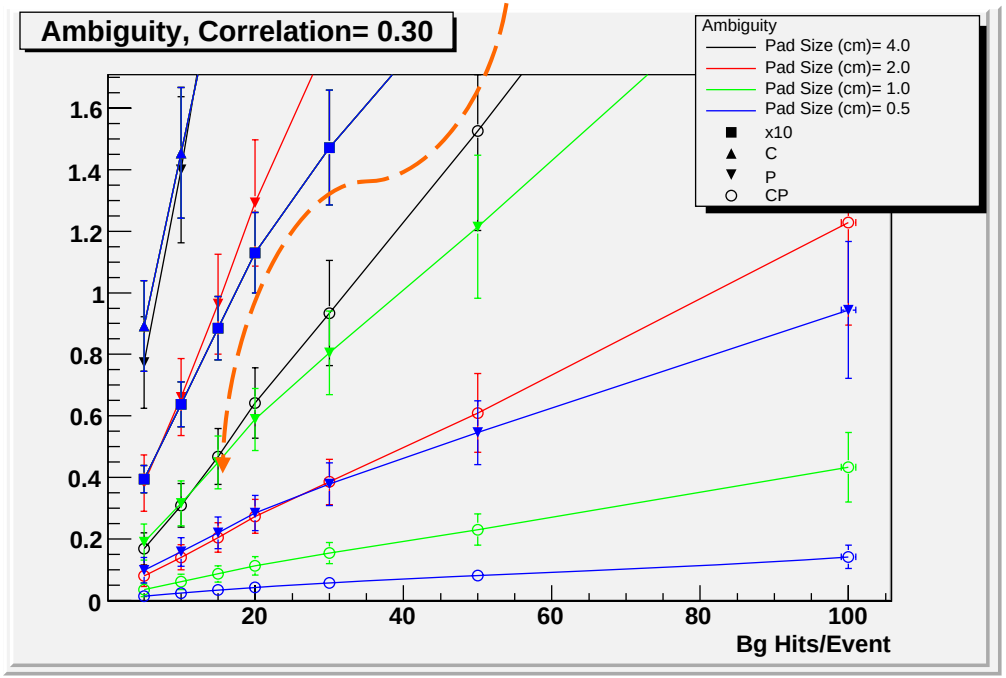
## Exploit correlation between e and p arms




From 100 Hits/Event on the whole chamber unit

⇩

~ 15 Hits/Event




**Additional track ambiguity suppression may be required (next slide)**

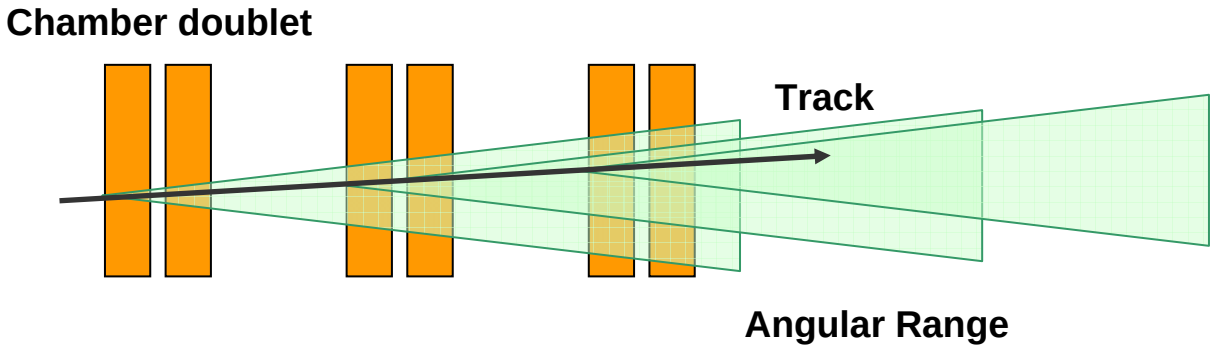
# Tracker Chambers Configuration

**“Chamber Doublet” will help reconstruction algorithm**

**restricting the search of combined hits**

**in smaller area ~ angular_range x doublet_distance**

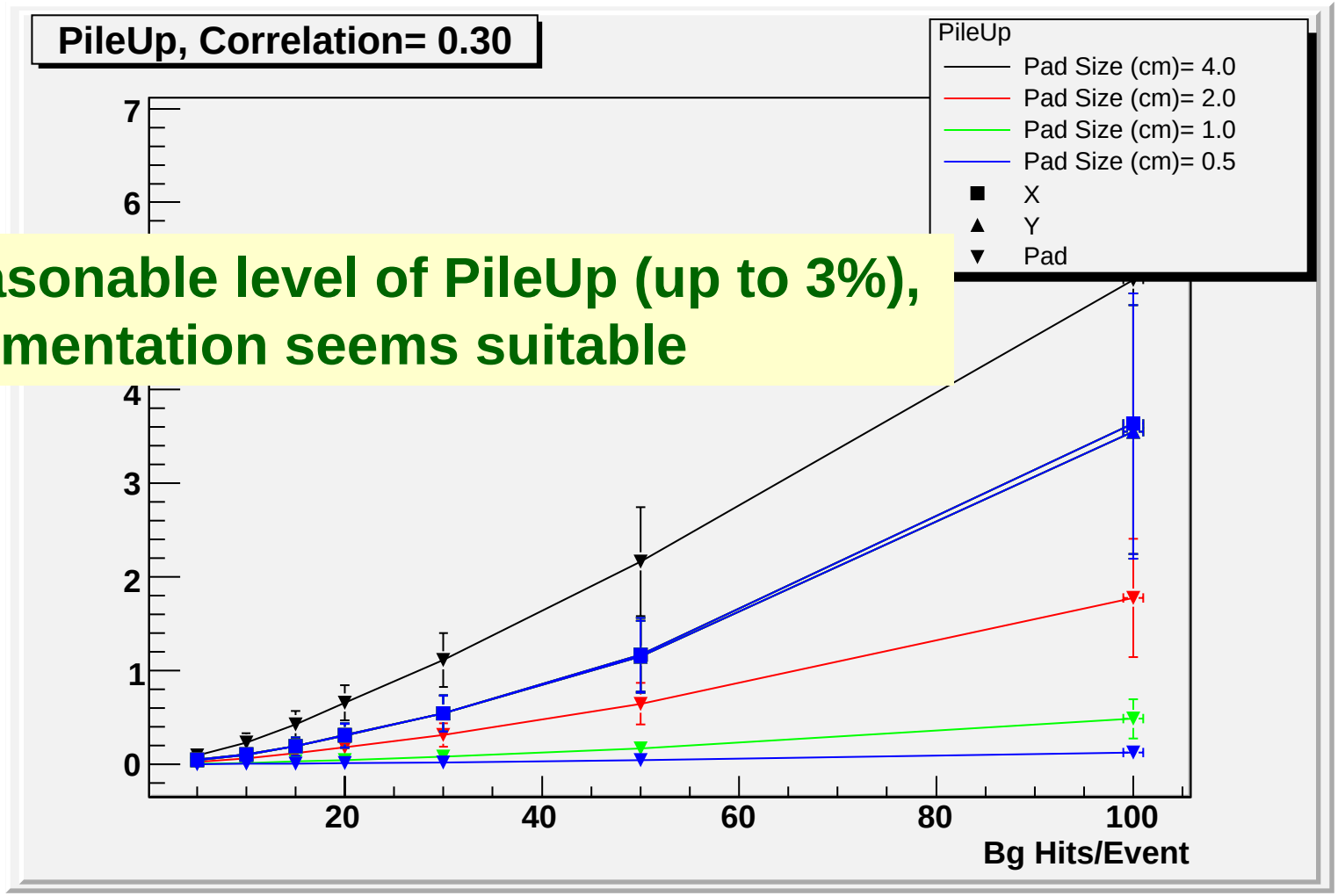
**then projecting the candidate track on next doublet …**




**Signal correlation & 3rd plane & Experiment specificity & Chamber configuration ⇨ *seem adequate to face the high background***

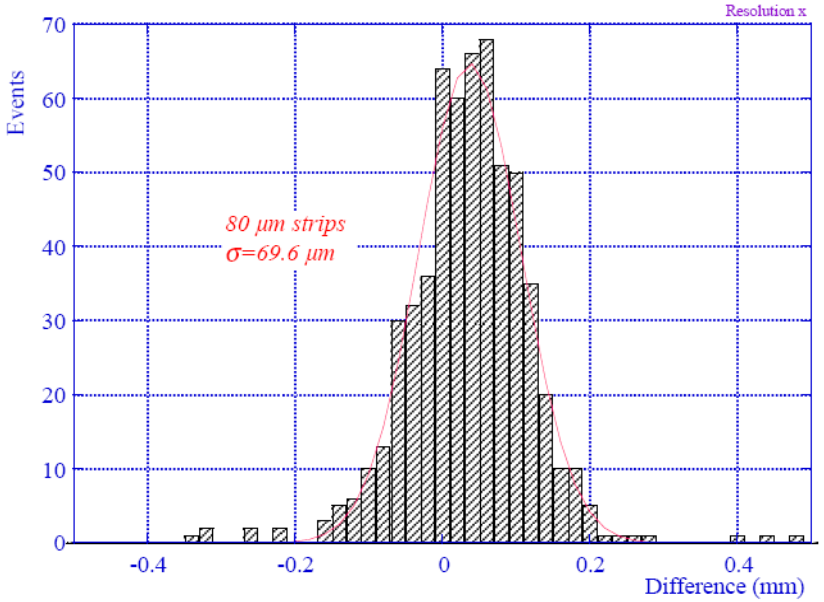
**Detailed analysis with full MonteCarlo is under development**

# PileUp

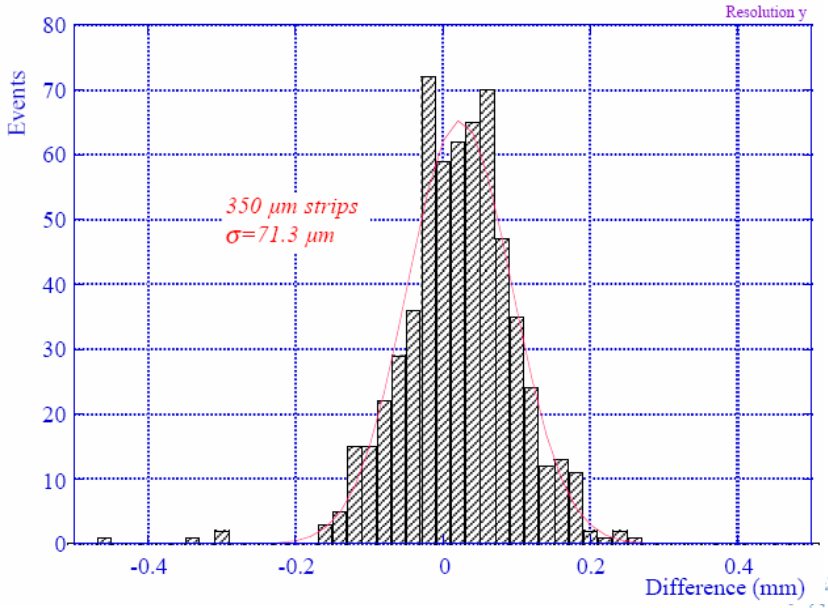



**Reasonable level of PileUp (up to 3%), segmentation seems suitable**

# Spatial Resolution / COMPASS



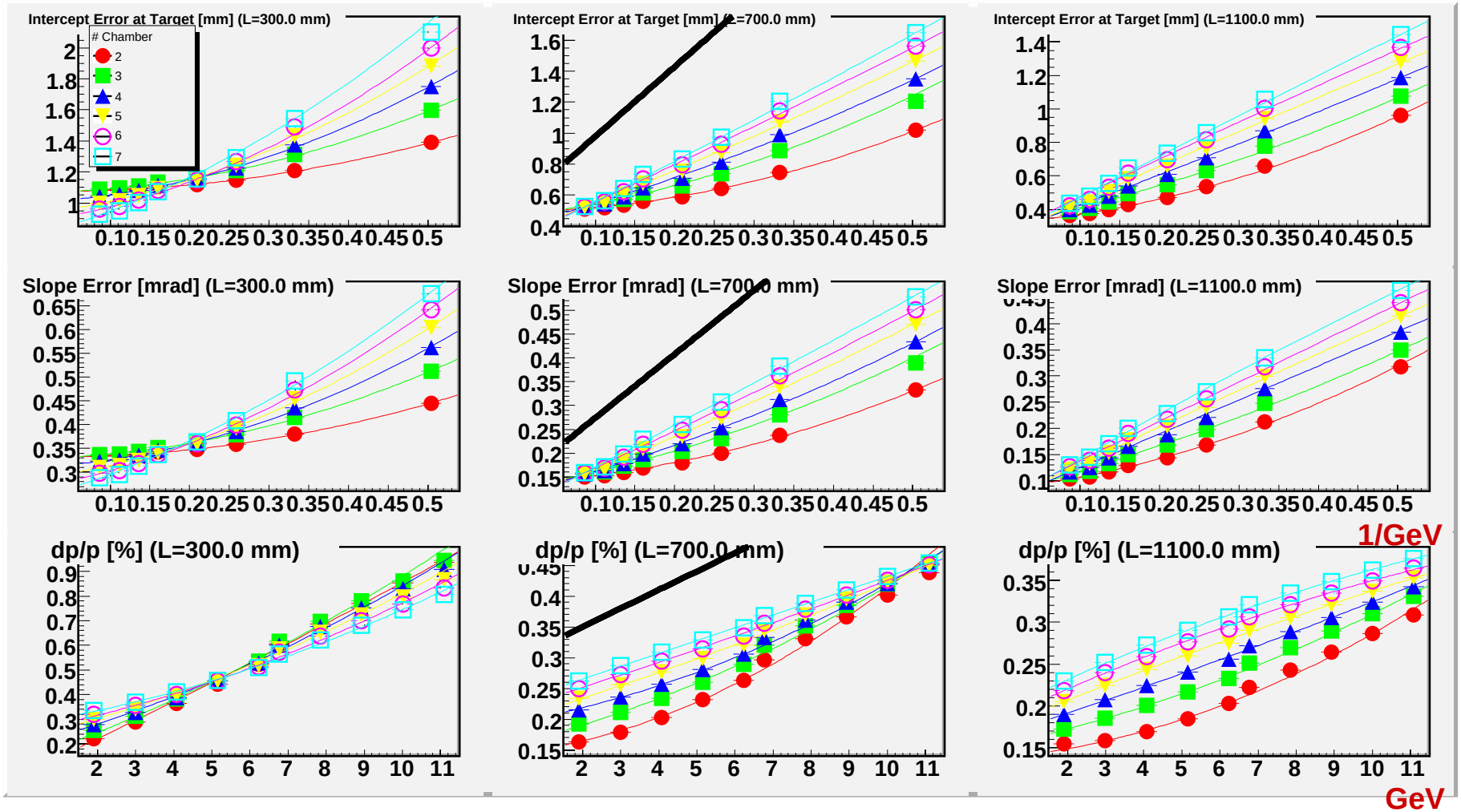

**< 100 μm not an issue if analogue readout is used (according to COMPASS data)**



# Resolutions vs Tracker Length, #chambers and Momentum

**Include Multiple Scattering and Measurement Error**

**L = tracker length**




**Current design: addition of 1 chamber degrade resolution up to ~ 10%**

# Conclusions

- Most critical issues have been investigated at the conceptual level, with analytical and Montecarlo analyses
- Possible (effective) solutions have been identified
- Additional analysis (full Montecarlo + Reconstruction) under development to optimize the details of the tracker