MEG Run2008 陽電子スペクトロメータ

西口　創 (KEK)，他 MEG Collaboration

日本物理学会秋季大会(2008/09/20-23)，於山形大学

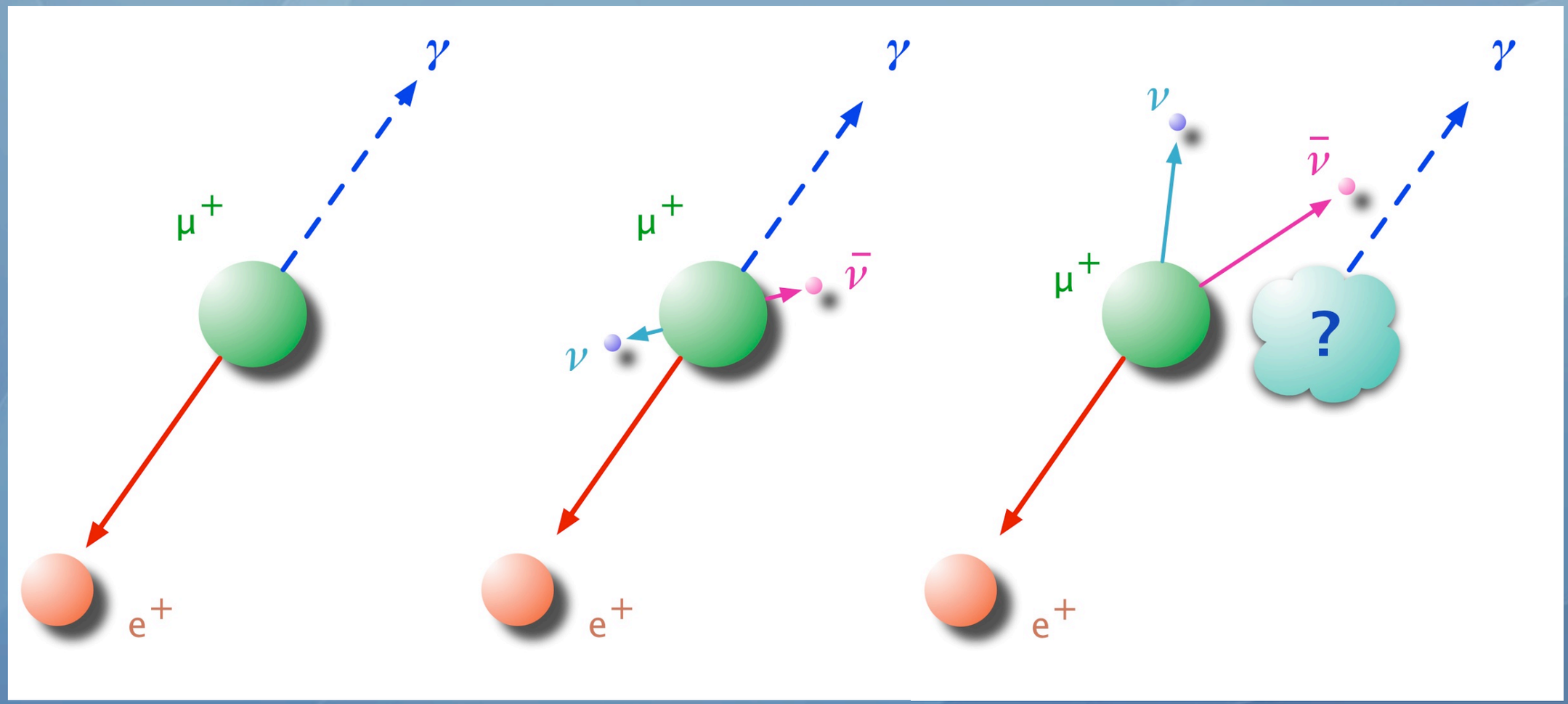
MEG
Mu-E-Gamma project group

Contents

- The MEG Positron Spectrometer
- Calibrations and Commissioning
- Performances (Resolutions & Efficiencies)
- Applications (Trace back & Extrapolation)
- Run 2008 (Commissioning Run, Result)
- Run 2008 (Physics Run, Prospects)
- Conclusion

The MEG Positron Spectrometer

Requirements for the Experiment



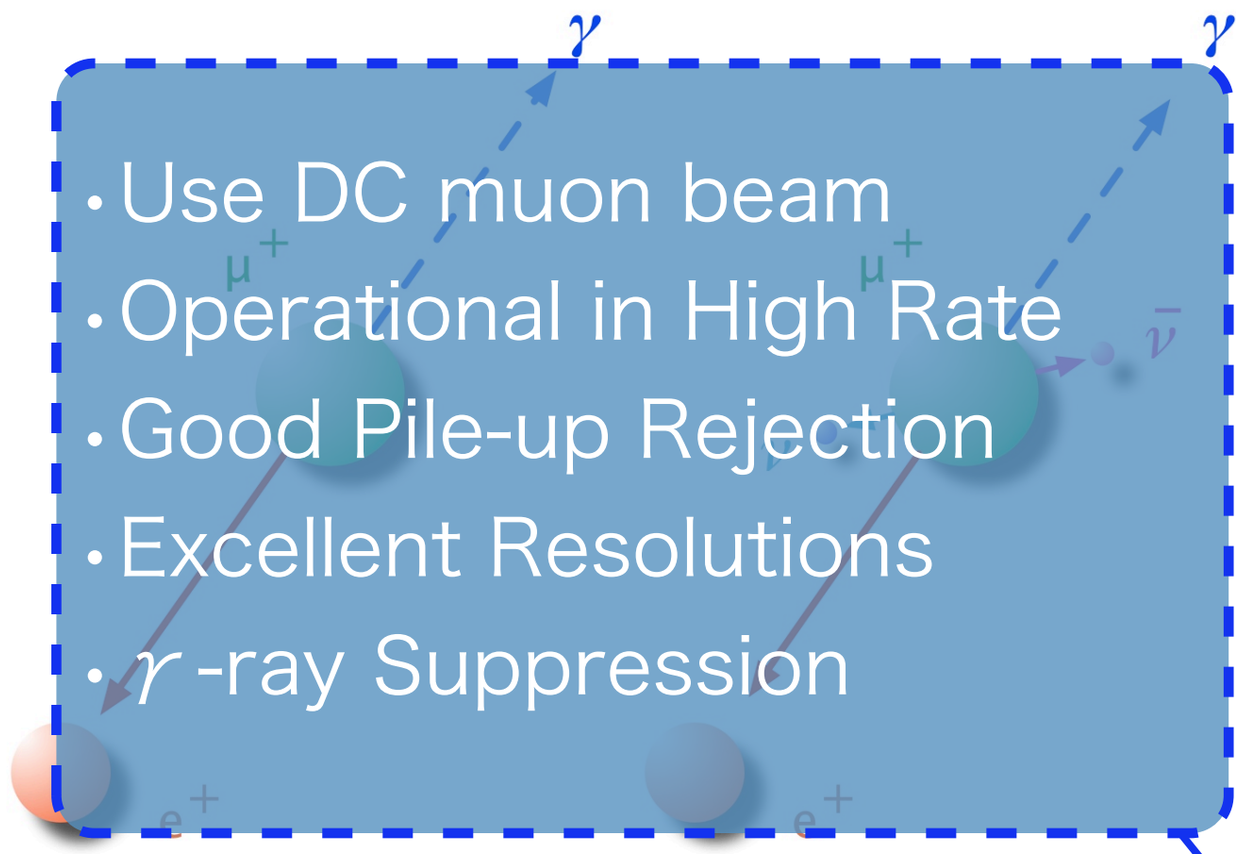
$\mu^+ \to e^+ \gamma$ signature

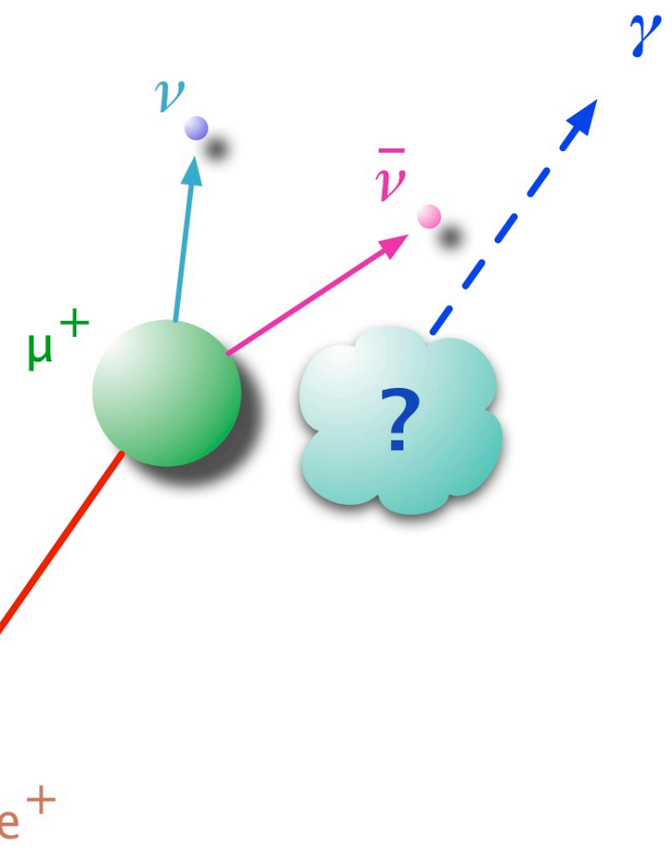
physics background

accidental background

Requirements for the Experiment

- Use DC muon beam
- Operational in High Rate
- Good Pile-up Rejection
- Excellent Resolutions
- γ-ray Suppression



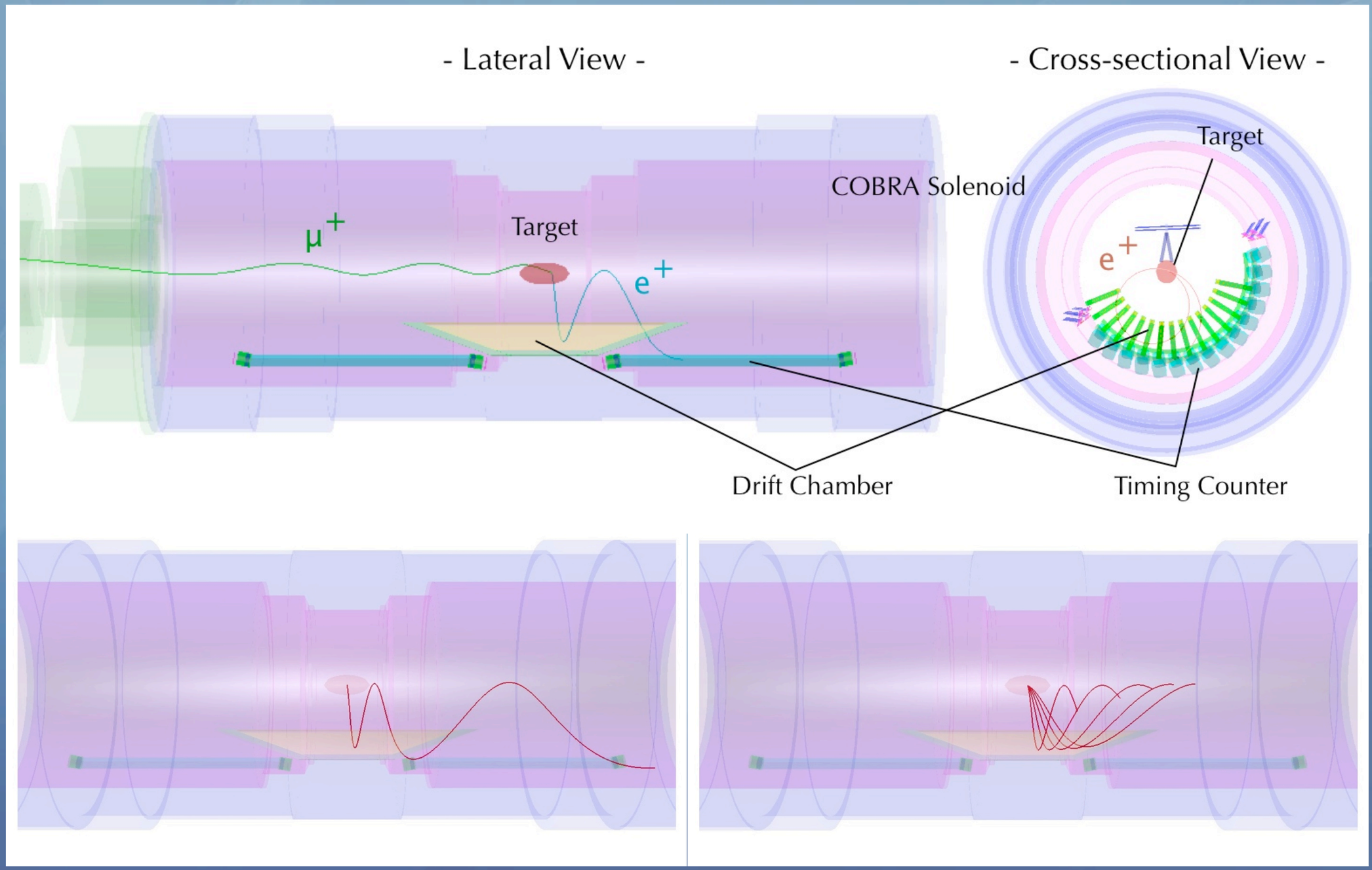


$\mu^+ \rightarrow e^+ \gamma$ signature

physics background

accidental background

The MEG Positron Spectrometer



The MEG Positron Spectrometer

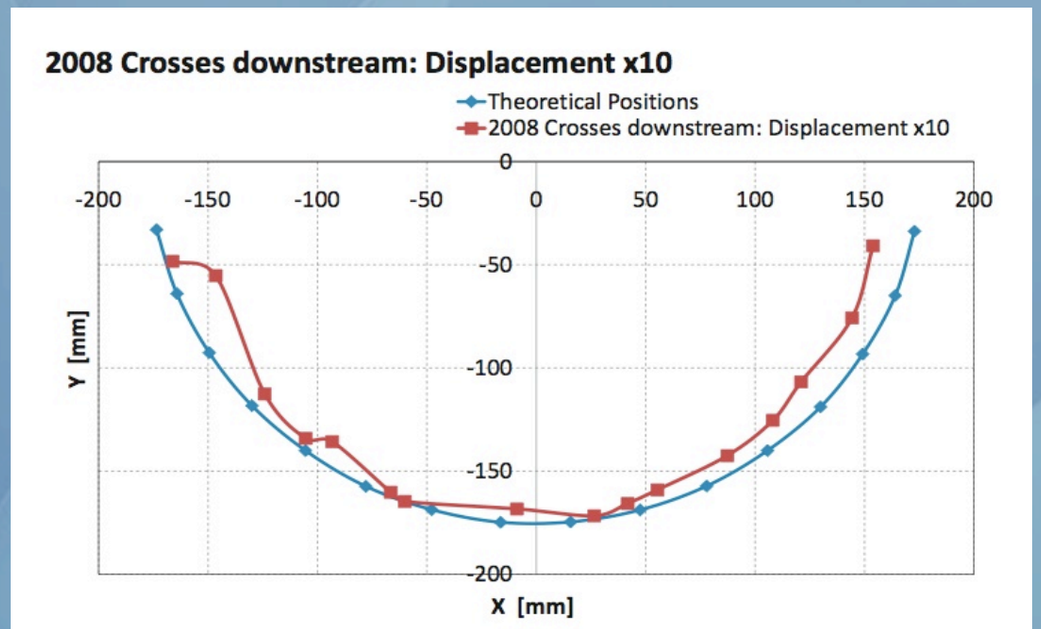
- **Must Be**
  - Operational with High Rate (~30MHz Muon Decay)
    - Graded B-field Solenoid (COBRA magnet)
    - Small Cell Drift Chamber (4.5mm cell spacing)
  - Very Light Material (*0.002X_0* in Fiducial Tracking Volume)
    - Open-frame Structure of Segmented Drift Chambers
    - Filled with Helium and Helium-based DC Active Gas
    - Very Thin Foil as a Cathode Plane
    - **No Vertex Detector / No Other Tracking Devices**
  - Very Good Timing Resolution
    - Fast Timing Counter with Track Extrapolation from Tracker
  - Very Good Vertex/Angular Resolution
    - Done by Only Trace Back from Tracker

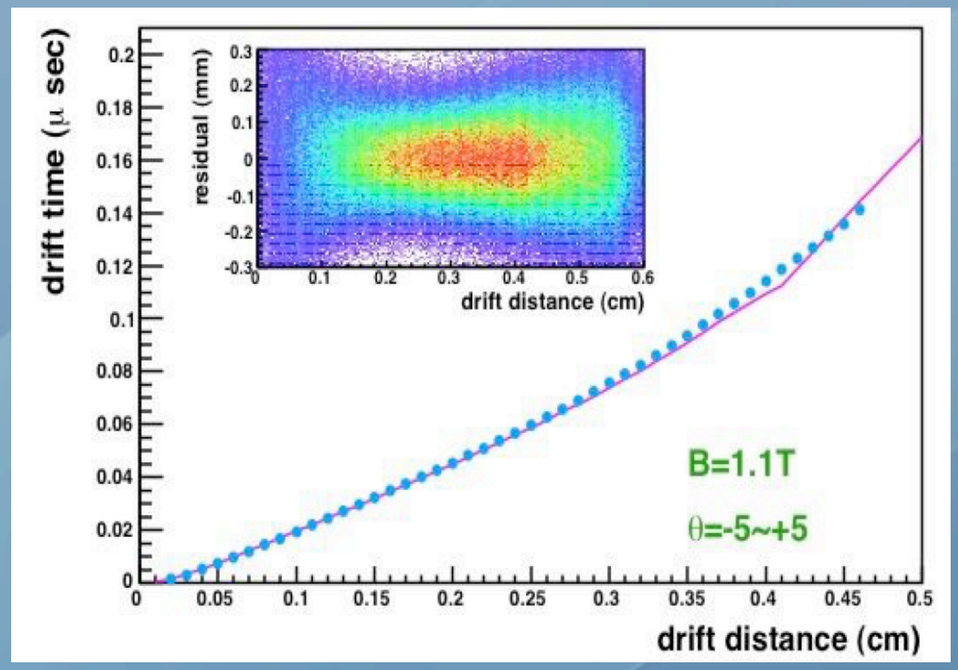
Calibrations & Commissioning

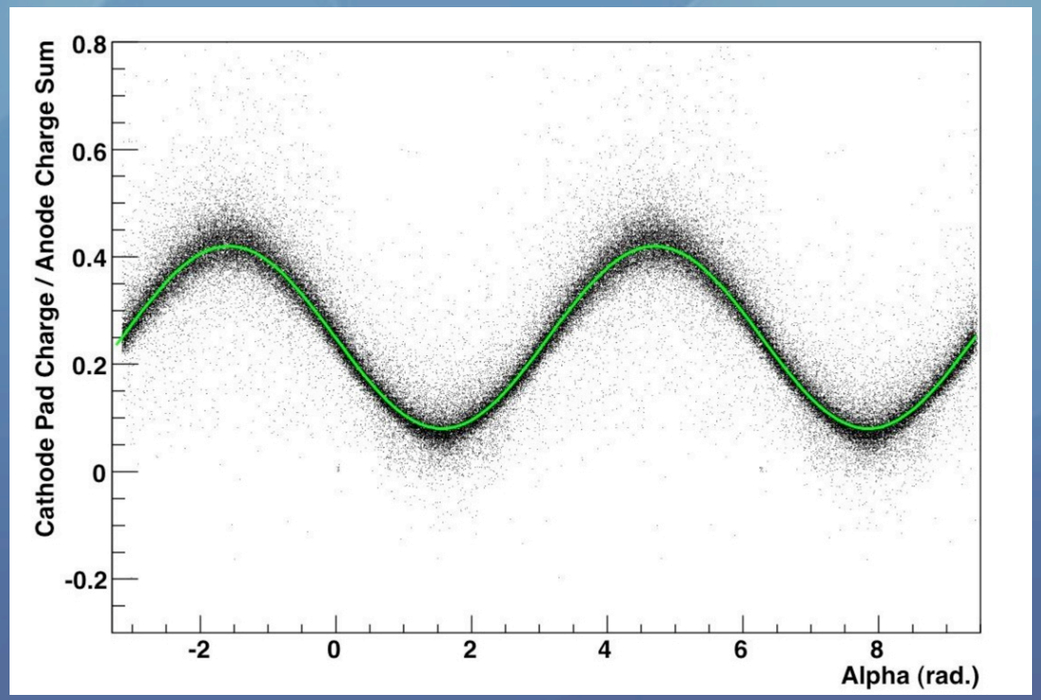
Calibrations

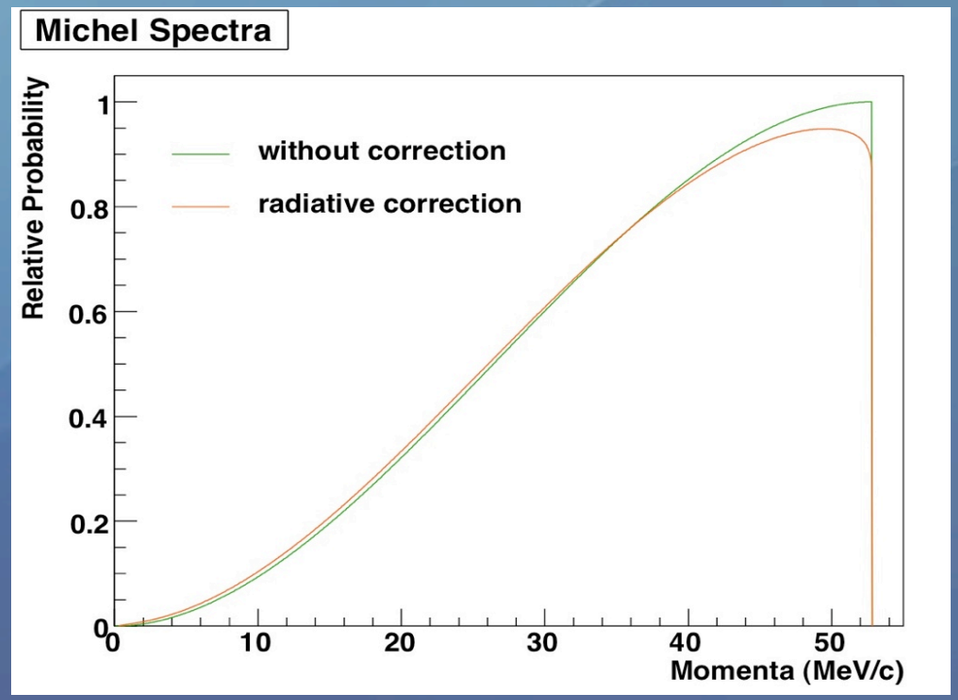
- We need several calibration methods for the e^+ spectrometer
  - For Drift Chamber
    - Wire Misalignment (By using Michel e^+ tracks)
    - Timing Pedestal (By fitting arrival-time distribution)
    - Time-to-Distance (By using Michel e^+ tracks)
    - Absolute Momentum (By fitting Michel Spectrum)
    - Target Position (By extrapolating track from DC)
  - For Timing Counter
    - Gain calibration in Magnetic field
    - Relative Timing Calibration with LXe photon detector

Calibrations - Cont. -







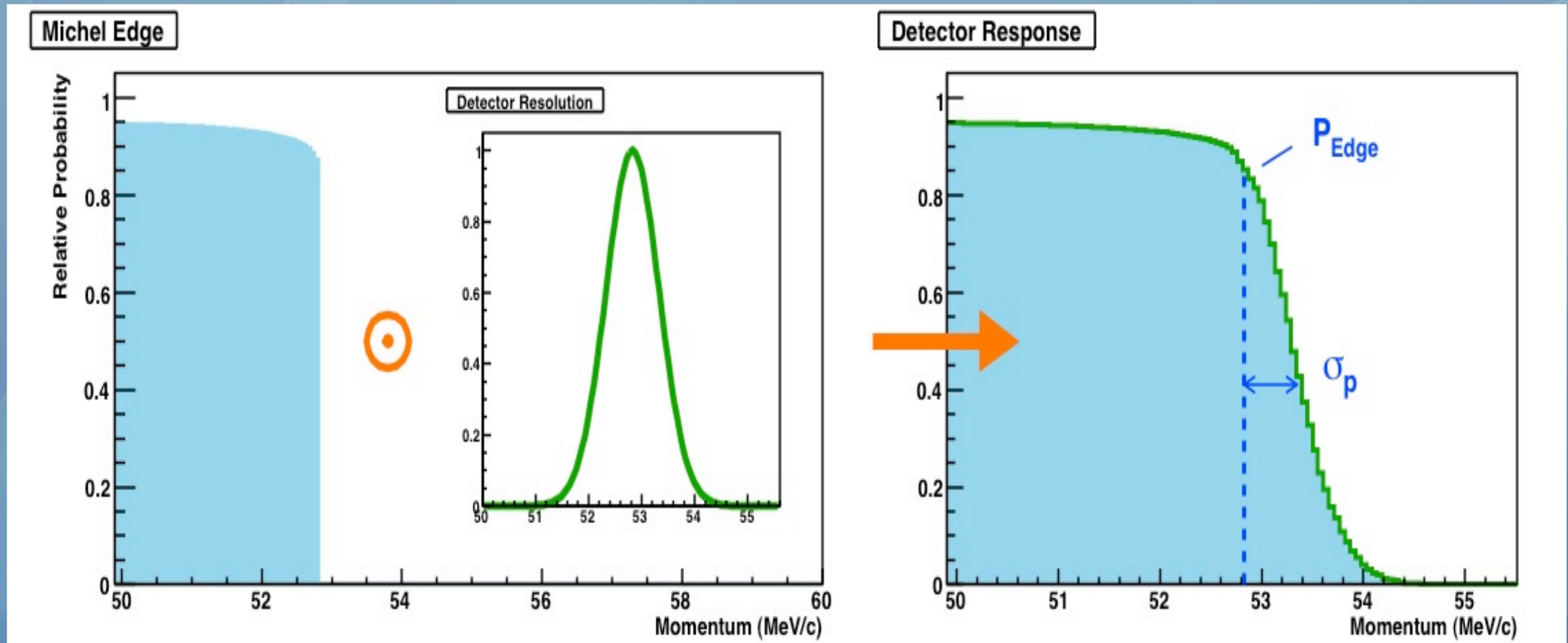


Commissioning

- The # of hardware components of the spectrometer is strongly limited
  - in consequence, operation and readout are made challenging and difficult.
    - *eg*. (in 2007) Several chambers were not operational due to defective protection for pure helium. Many channels were not connected properly at the patch-panel system due to defective contacts.
  - Such many N/A channels affect drastically on not only the chamber operation but also the analysis.
    - It was necessary to add air doping
    - Tracking resolution/efficiency were affected by small number of measured points
  - **It is NECESSARY to have a careful commissioning run.**
- For the "MEG Run 2008", we had a dedicated run period, called "Michel Run" in the *runup* to the Physics Run.
  - Michel Run = "commissioning", "calibrations", "performance estimation", and "background estimation"

Performances

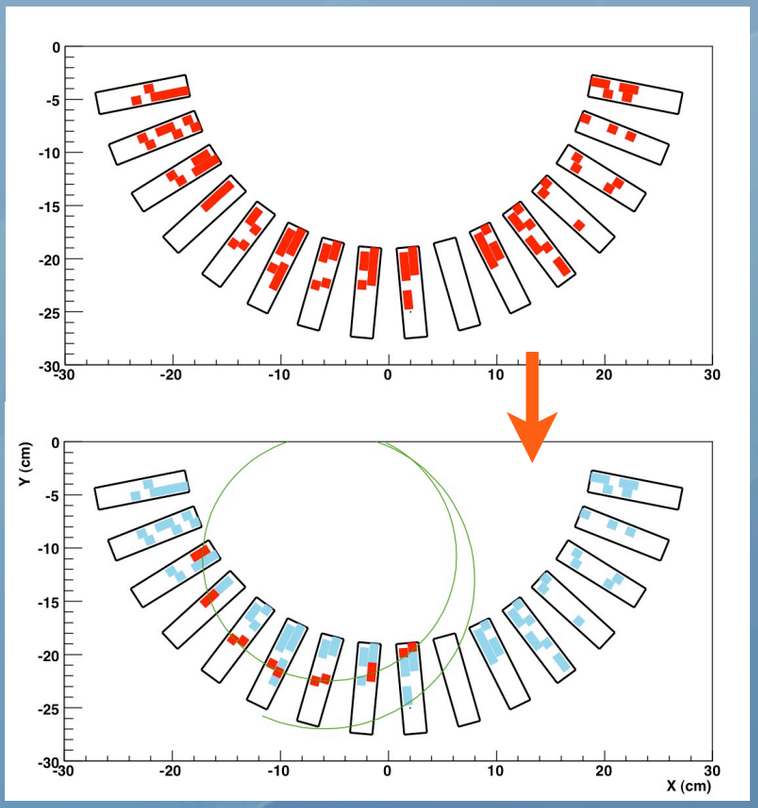
Momentum Resolution

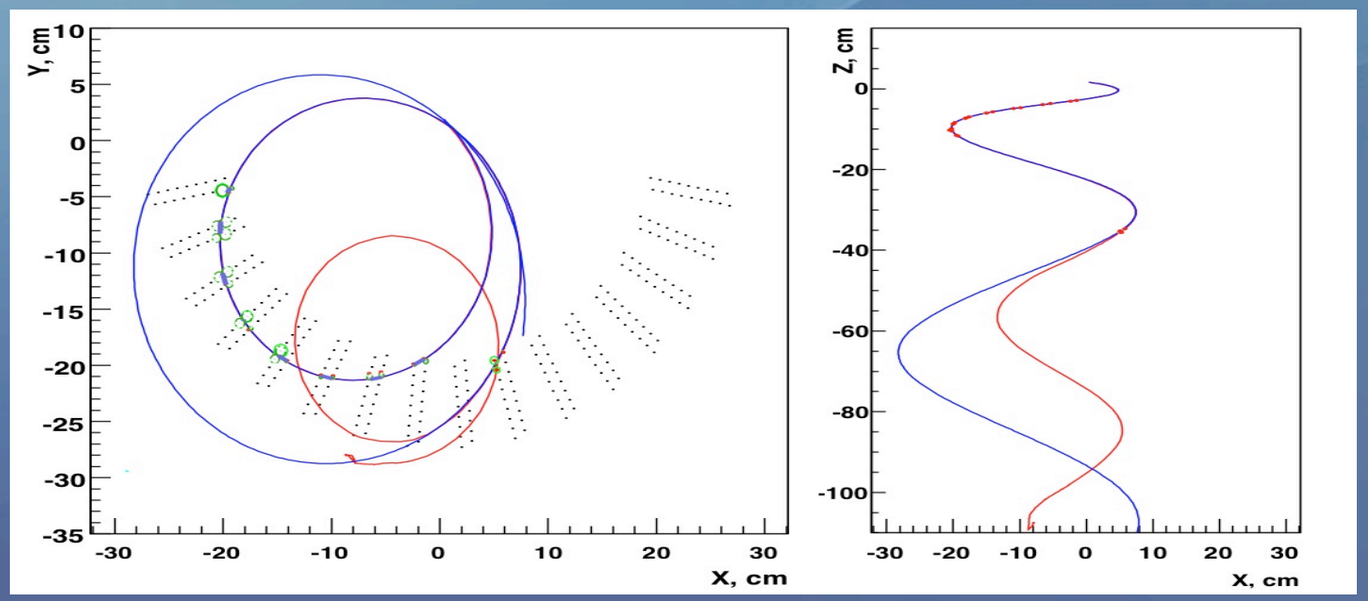


- Endpoint is fitted to the convolution of “response function” and “Gaussian”, with three free parameters; “P_{edge}”, “ σ_p” and “Normalization”.
- We need “response function”, could be produced by MC
  - taking into account “DC real situation”, “Trigger Condition” and “Radiative correction to the Michel spectrum”.

Efficiencies

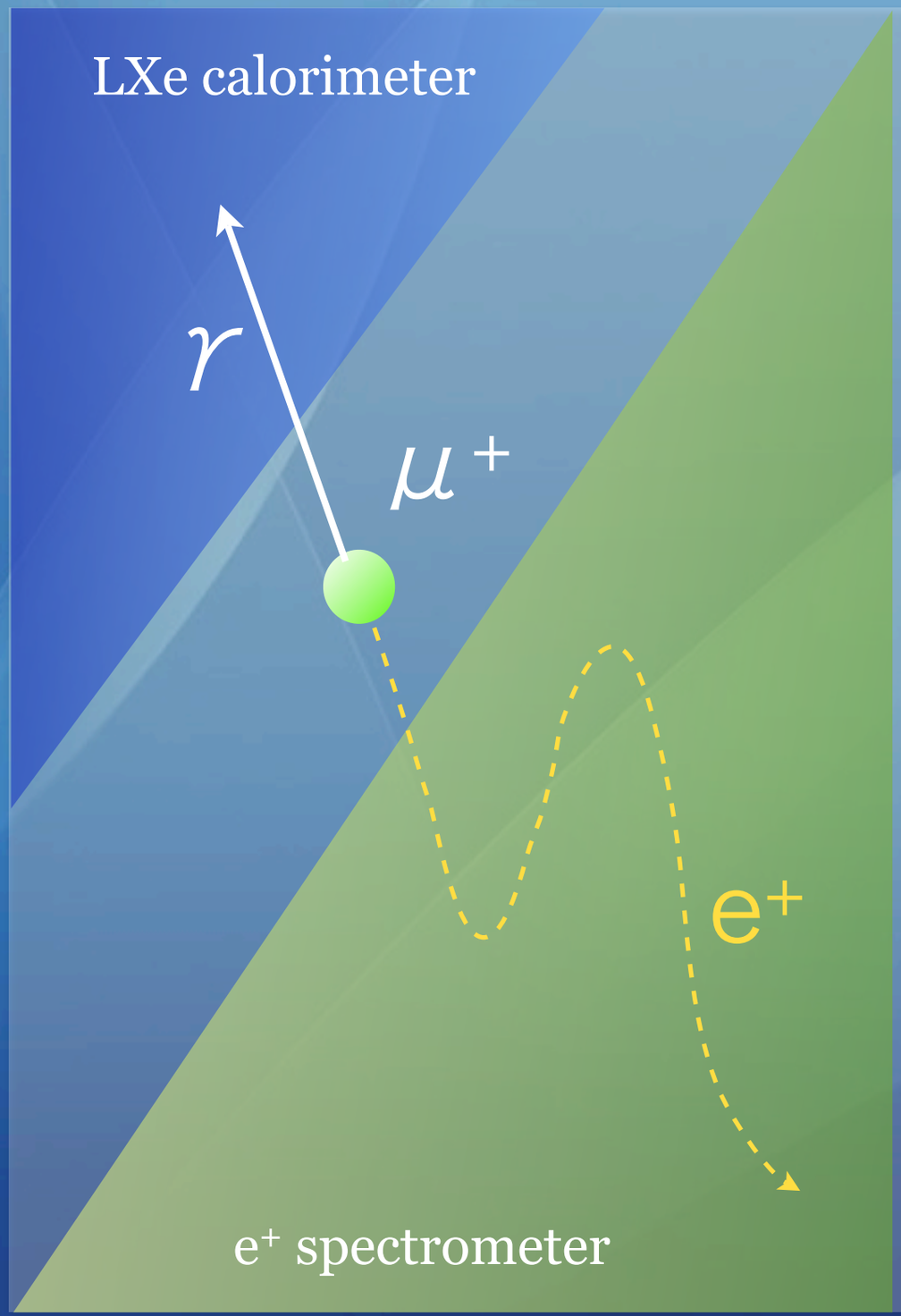
- DC Intrinsic Efficiency (~100%)
- Track Find/Reconstruction Efficiency
  - Design : ~50% (for all event)
  - Design : ~98% (for acceptable event)
- Spectrometer Efficiency
  - Design : ~65%
    - due to DC elec.





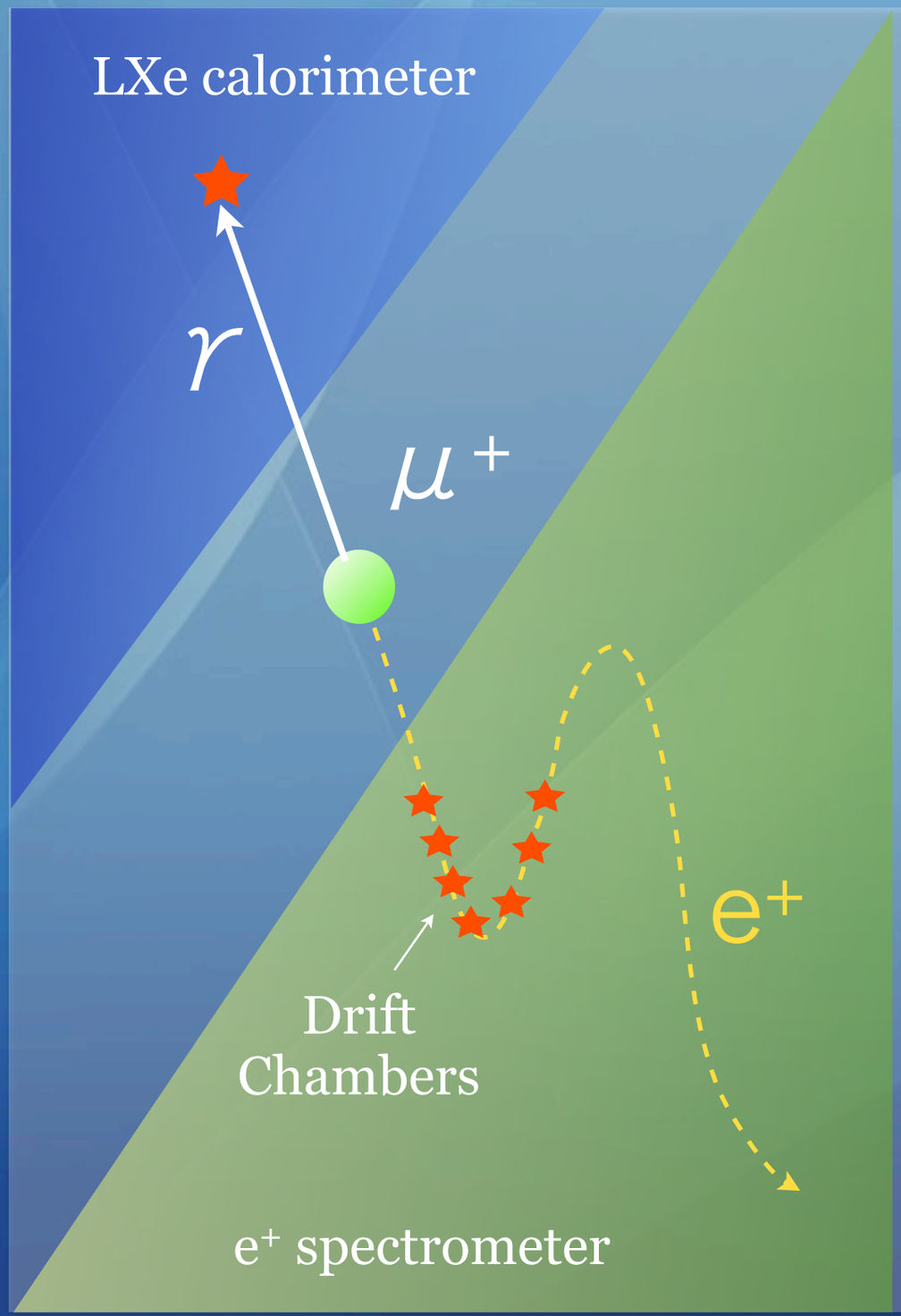
- Applications

Track Extrapolation (1)



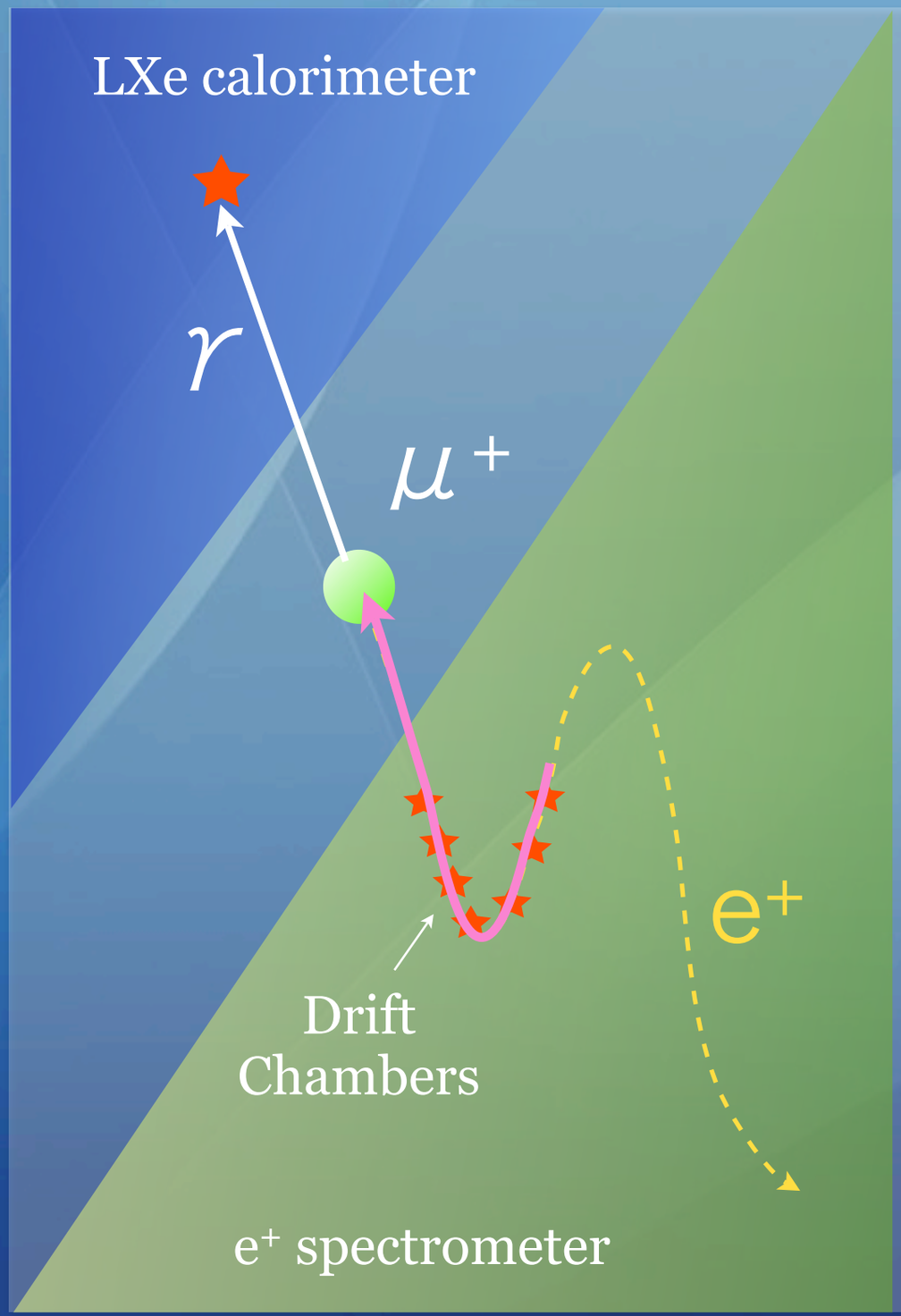
- Towards Stopping Target
  - Vertex Reconstruction
    - No Vertex Detector
    - Angular Blind to LXe
    - Only Track Extrapolation can reconstruct
  - e^+ Emission Angle Reconstruction
- Both are Necessary to judge Signal

Track Extrapolation (1)



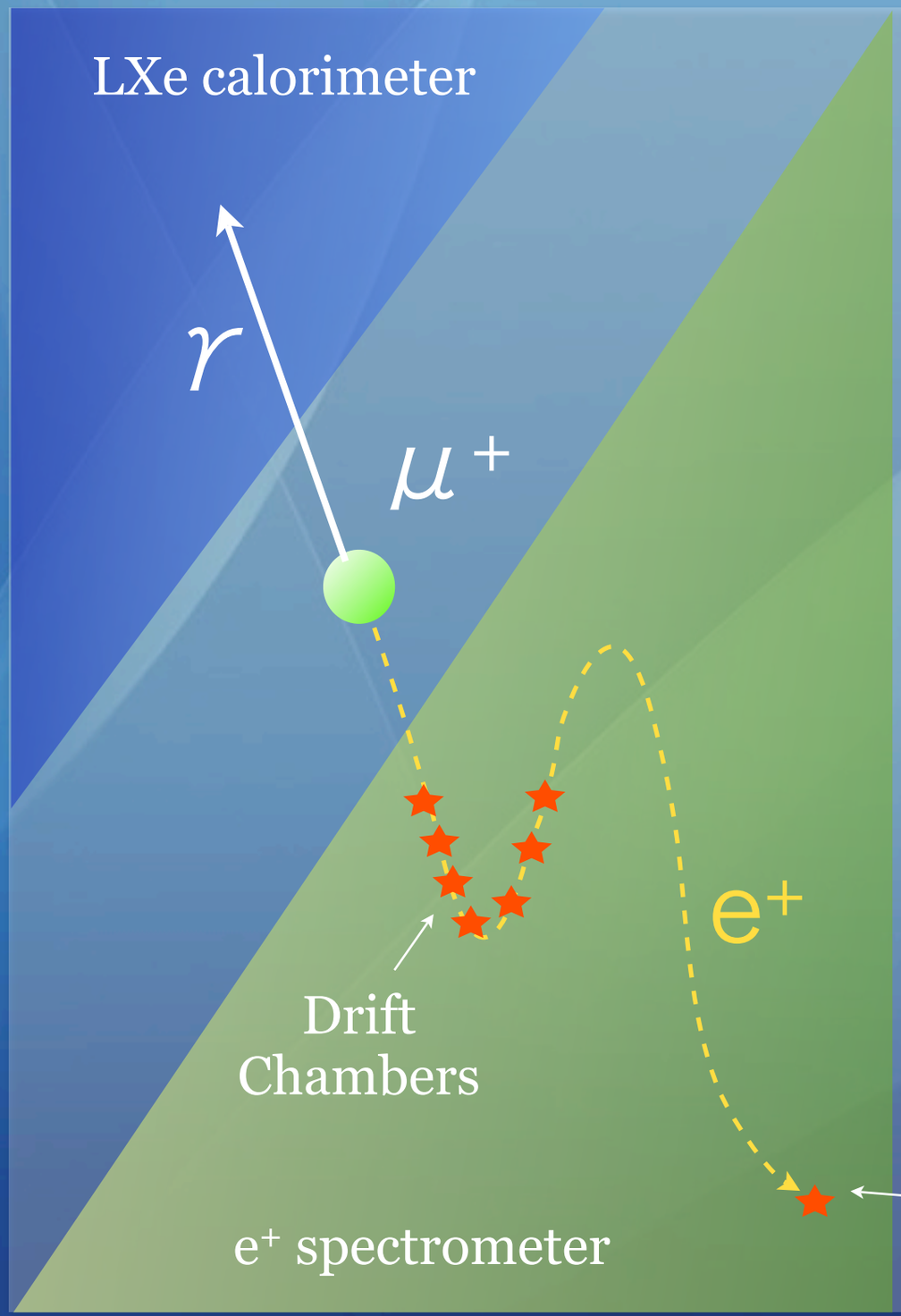
- Towards Stopping Target
  - Vertex Reconstruction
    - No Vertex Detector
    - Angular Blind to LXe
    - Only Track Extrapolation can reconstruct
  - e^+ Emission Angle Reconstruction
- Both are Necessary to judge Signal

Track Extrapolation (1)



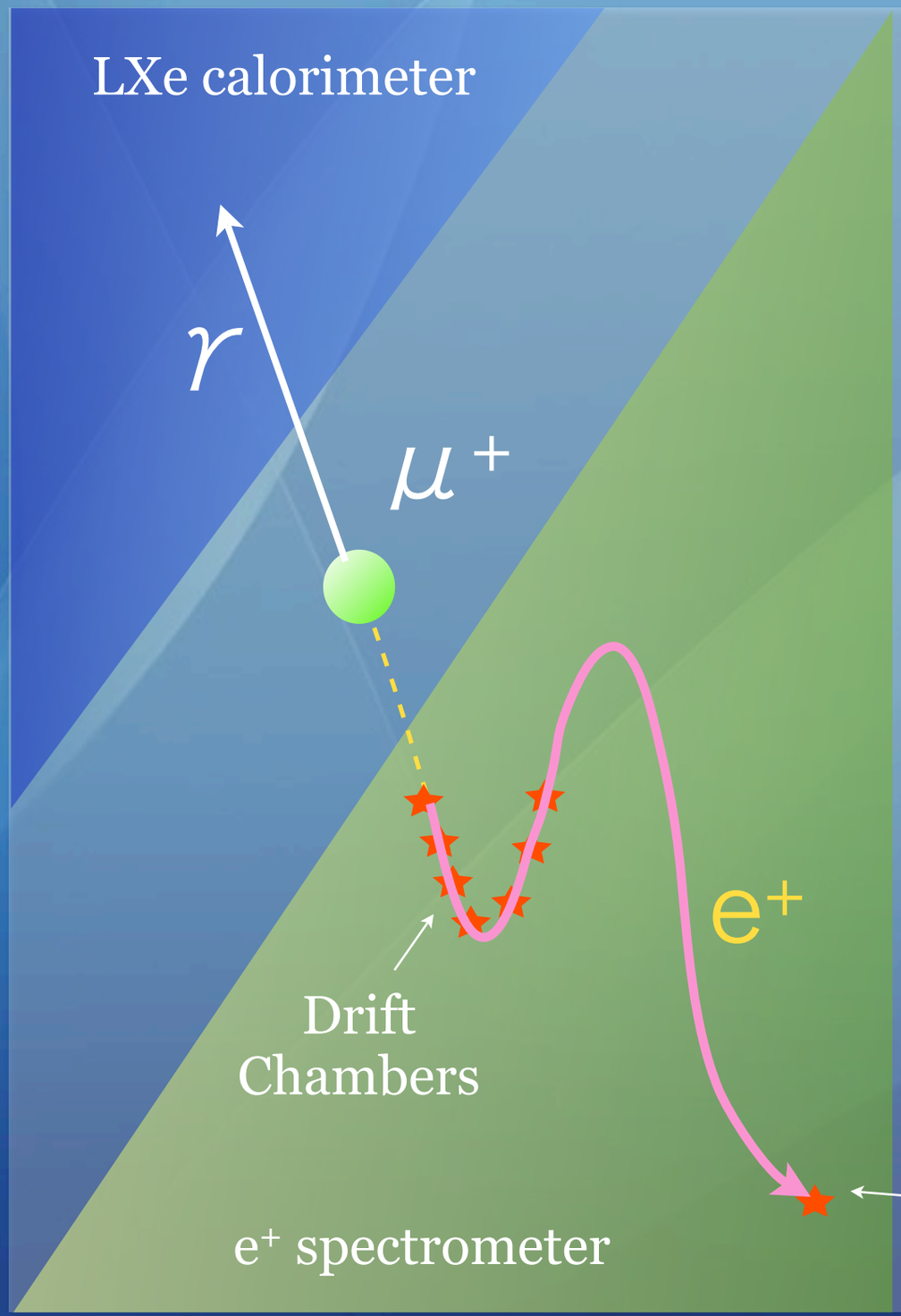
- Towards Stopping Target
  - Vertex Reconstruction
    - No Vertex Detector
    - Angular Blind to LXe
    - Only Track Extrapolation can reconstruct
  - e^+ Emission Angle Reconstruction
- Both are Necessary to judge Signal

Track Extrapolation (2)



- Towards Timing Counter
  - Flight-Length correction
    - Triggering Time given by TC
    - Muon Decay Time is unknown
  - Impact Position Reconstruction
    - DC-TC Matching is required
  - Both are Necessary to judge Signal

Track Extrapolation (2)

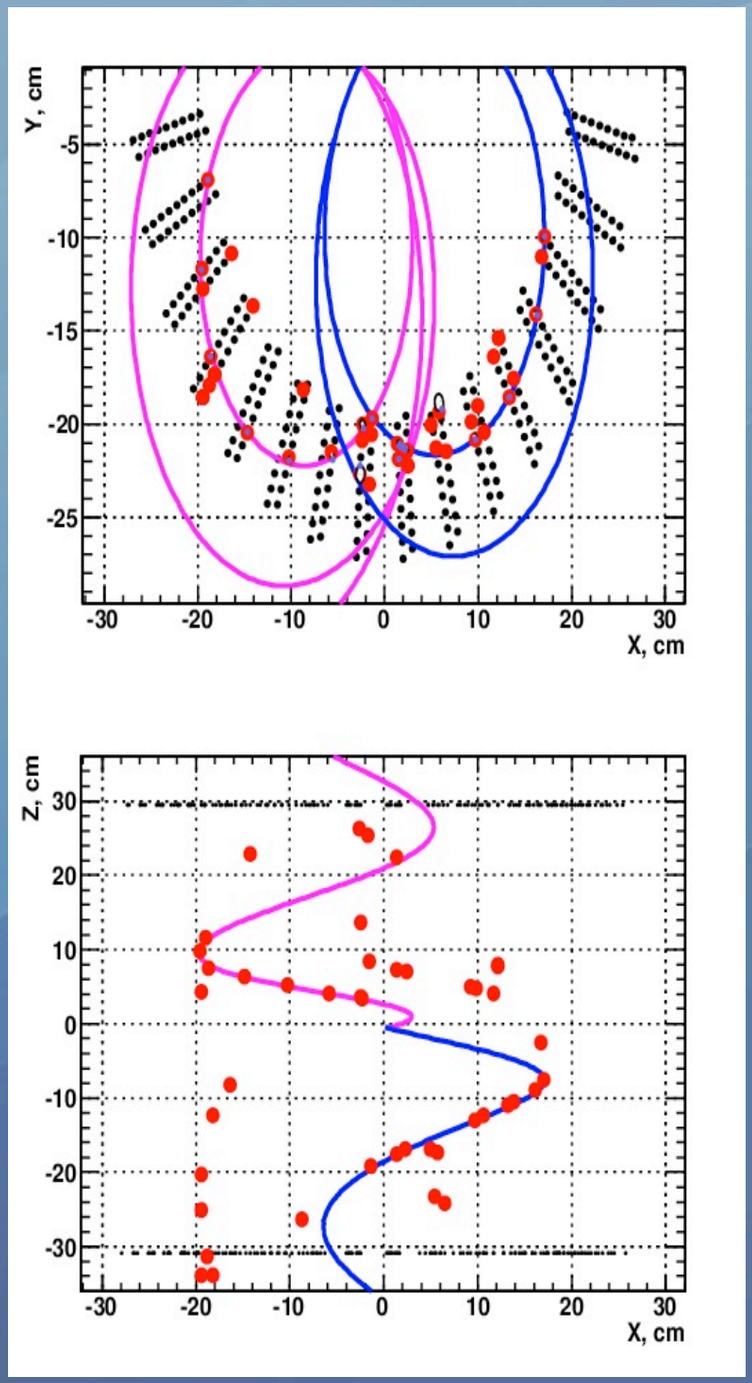


- Towards Timing Counter
  - Flight-Length correction
    - Triggering Time given by TC
    - Muon Decay Time is unknown
  - Impact Position Reconstruction
    - DC-TC Matching is required
  - Both are Necessary to judge Signal

- Run2008 (Commissioning Run)

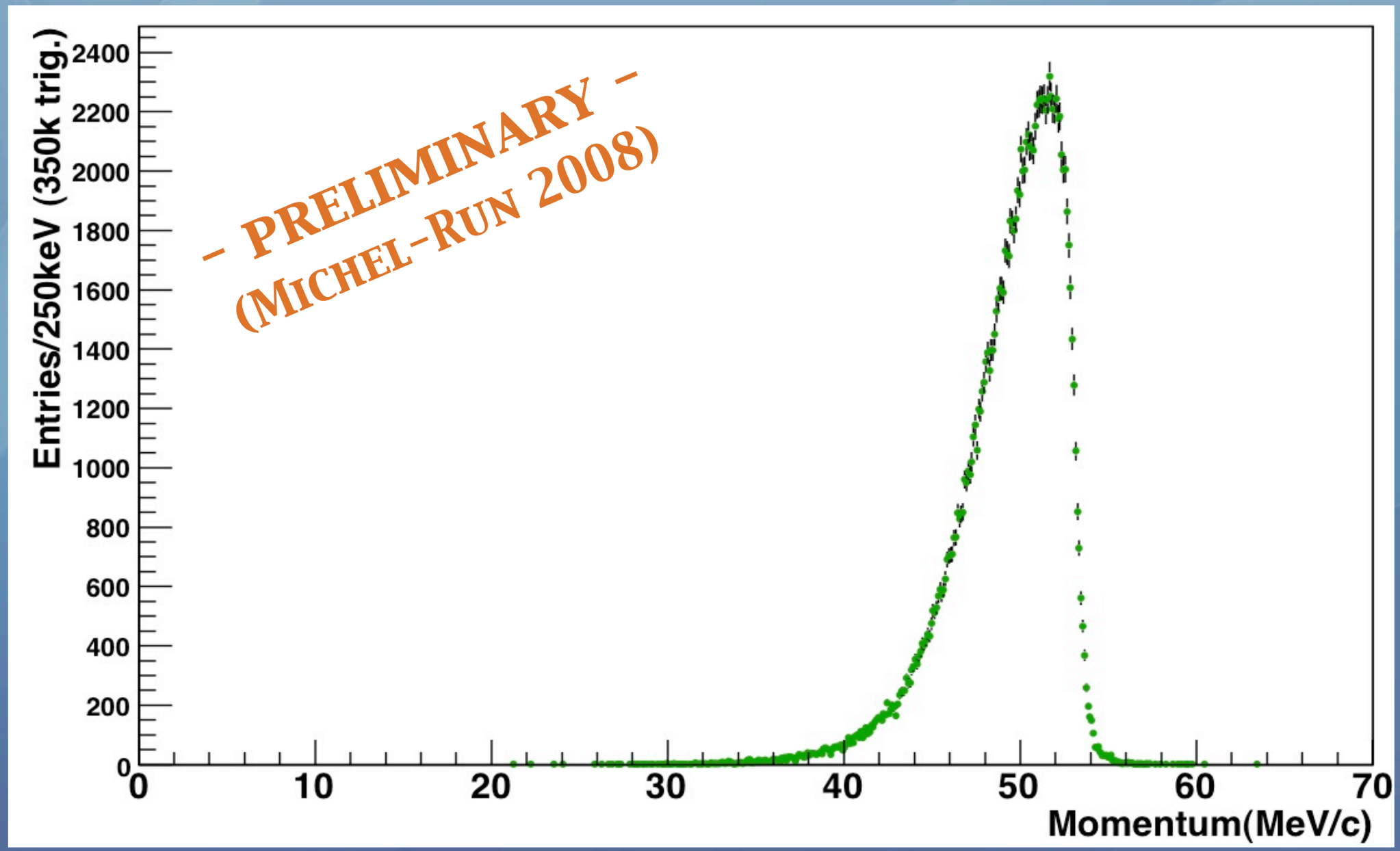
pre- Run 2008 (Commissioning Run)

- 16-18/July 2008, we took "Michel Run" for calibration/commissioning
  - 534 runs in total, ~3M events were acquired
  - Two settings of muon-beam intensity were prepared same as 2007
    - normal : 3×10^7 muon/sec (346 runs,~1.6M events)
    - low : 1×10^6 muon/sec (188 runs, ~1.3M events)
- DC conditions were very stable (much better than 2007)
  - most of planes were applied by 1840v w/ o any trips
  - it was necessary to add an air contamination to avoid unwanted discharge



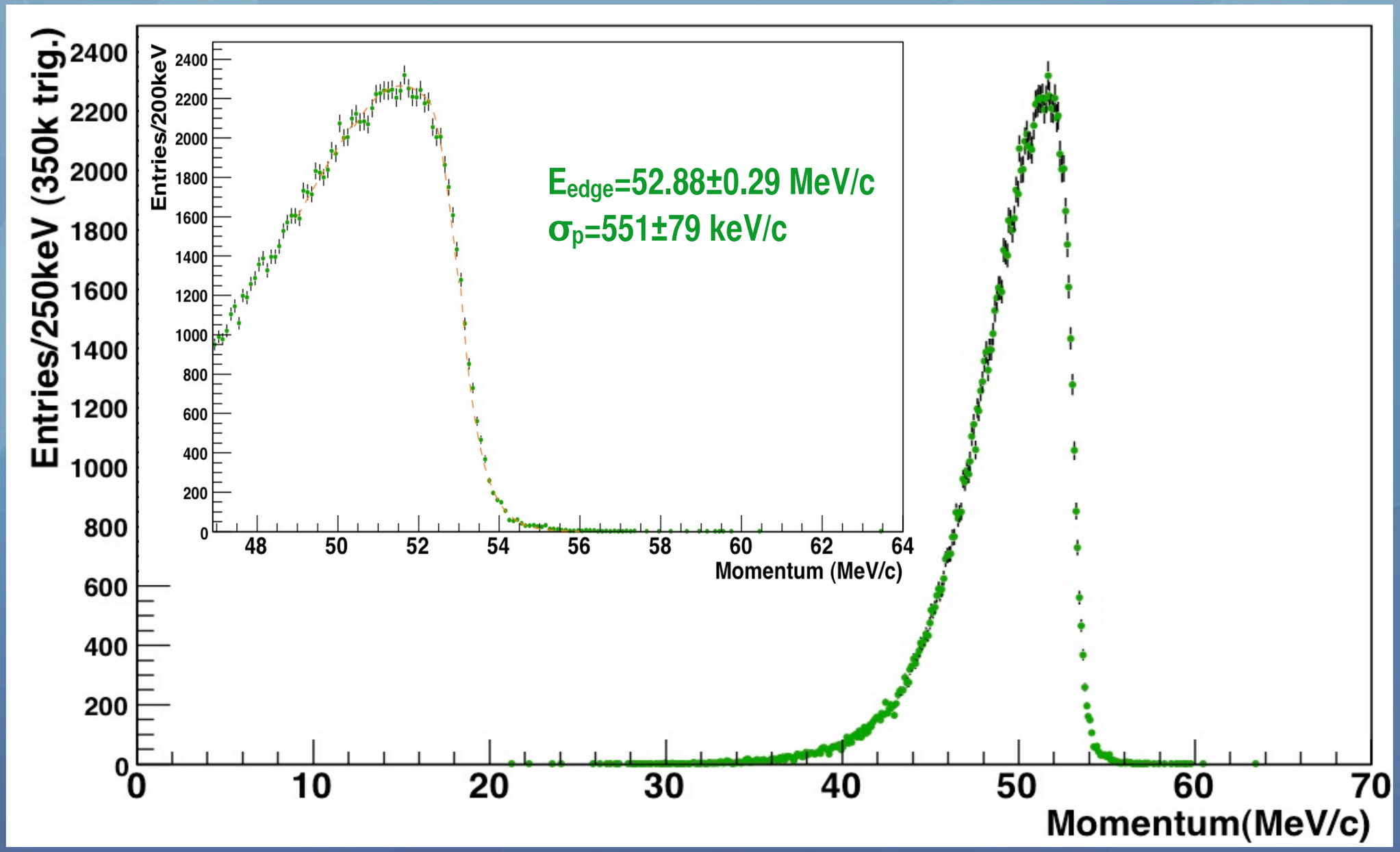
Run 2008 (Performances/Resolution)

- Reconstructed Michel Spectrum and Estimated Momentum Resolution



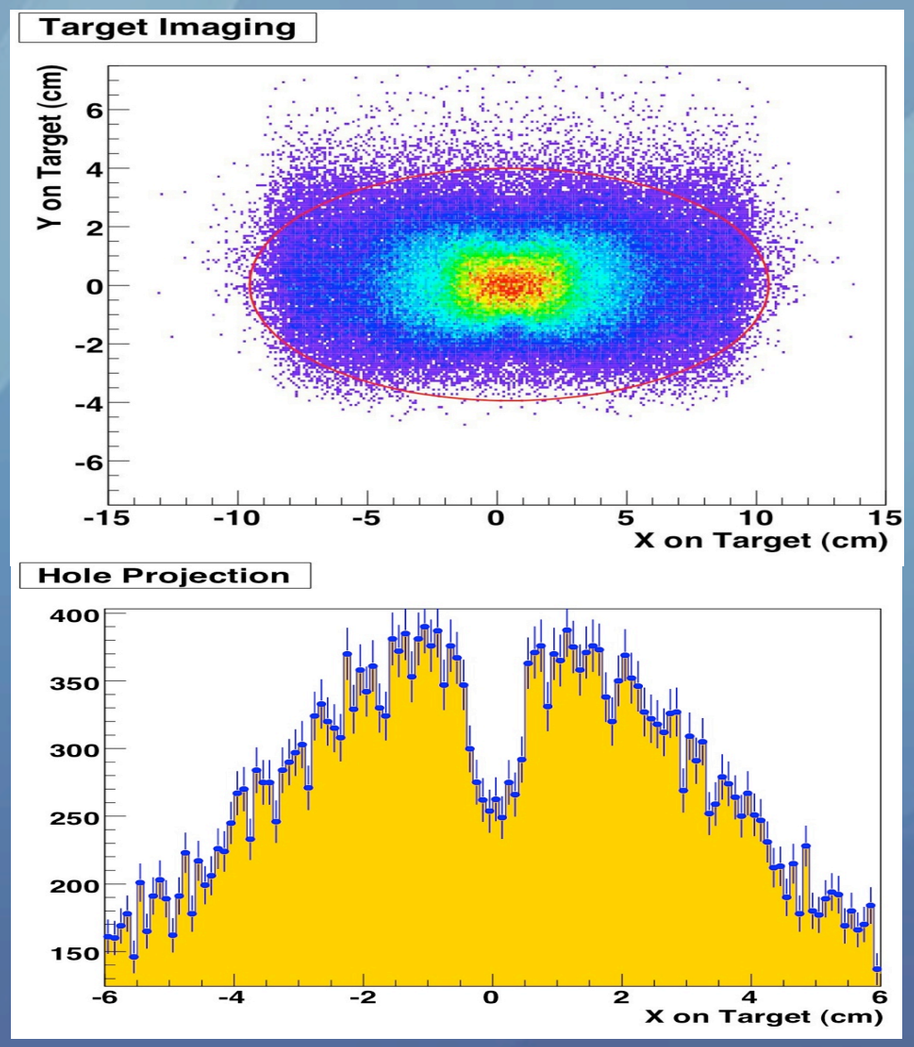
Run 2008 (Performances/Resolution)

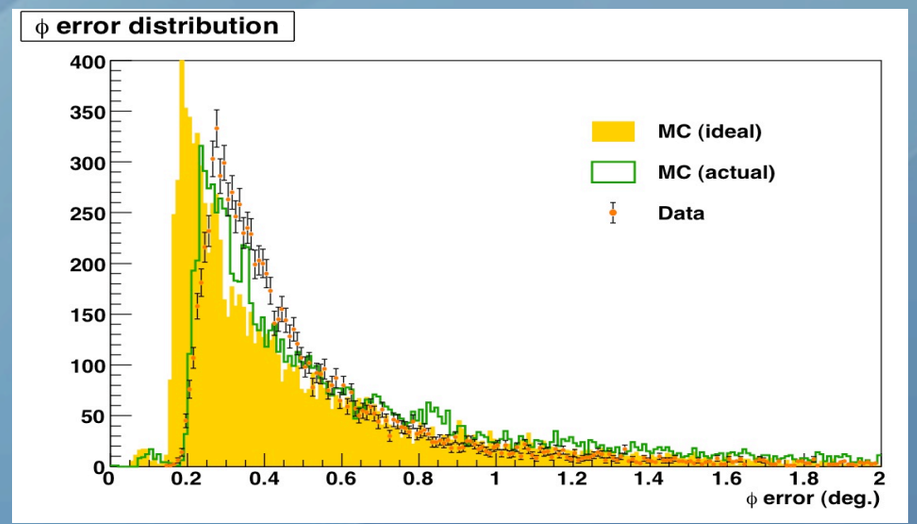
- Reconstructed Michel Spectrum and Estimated Momentum Resolution

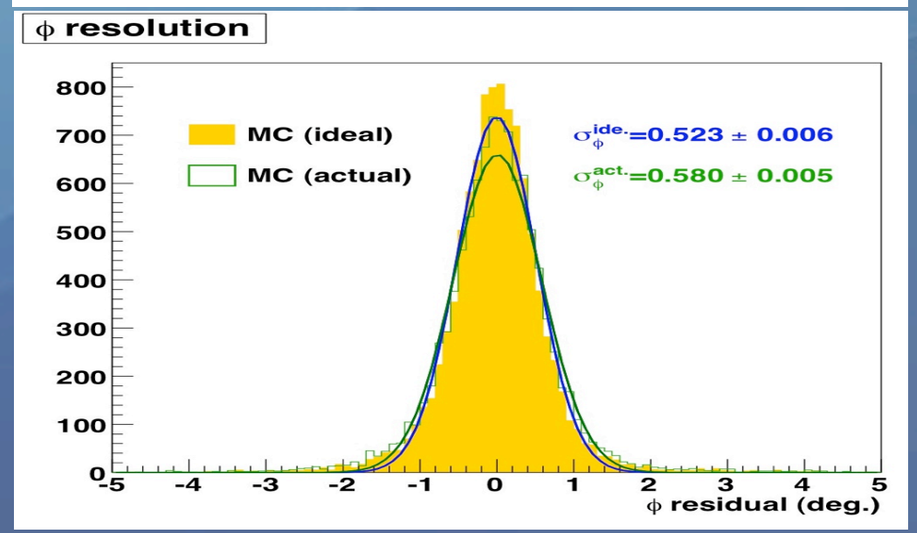


Run 2008 (Extrapolation/Resolution)

- Vertex Resolution
  - $\sigma_{x,y}$ = 1.8 mm
- Angular Resolution
  - σ_{φ} = 0.6-7 deg.
  - σ_{θ} = 0.3-4 deg.







Run 2008 (Performances/Efficiencies)

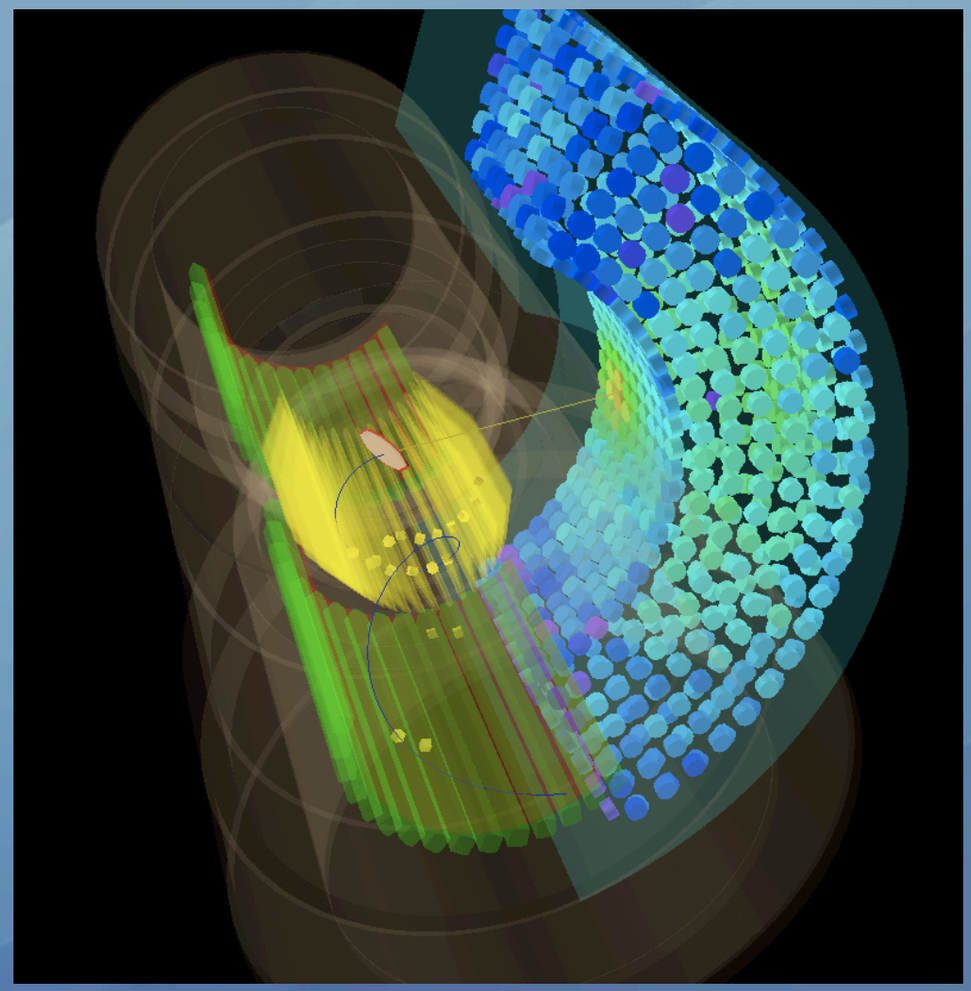
- Efficiency Staging:
  - 1. Track Finding Eff. / 2. Track Fitting Eff. / 3. Event Selection Eff.
- Denominator Definition:
  - e^+ which contains more than 6 hits is counted as denominator
  - e^+ which achieves radius larger than 6-th cell is counted as denominator
- Summary of preliminary reconstruction efficiencies with 2 beam rate

	Track Finder	Track Fitting	after χ^2 cut	(after xy/ $\theta\phi$ cut)
Michel 2008	98/97%	72/70%	65/60%	(45/32%)

- Run2008 (Physics Run)

Run 2008 (Physics Run)

- MEG Physics Run Started on September 12th (last week !)
- We will continue 12 weeks of beam time till Christmas shutdown.
- Now we are trying:
  - trigger optimization
  - offline process starting
    - pre-selection study
    - PDF refining for MLH
  - background estimation
  - (detector studies)



Run 2008 (Physics Run)

- Spectrometer Prospects in Run 2008 (12 weeks beam-time).

resolution		condition	
Energy resolution	2.2%	Acceptance	9%
Angular resolution	14.5%	Muon Rate	3×10^7 /sec
Timing resolution	127ps	Efficiency	~50%

- According to the easy estimation, better sensitivity than current experimental upper limit can be expected

- Consideration based on the background estimation will be presented in the next talk (「MEG Run2008 バックグラウンド」内山雄祐)

Conclusion

- MEG Starts the First Physics Run in this year !!!
- We had a dedicated run period, called “Michel Run” in the *runup* to the Physics Run.
  - Detector Calibration (Drift Chamber, Timing Counter)
  - Spectrometer Calibration (Momentum, Timing)
  - Performance Estimation (Resolution, Efficiency)
  - Background Estimation
- Even this year’s (not perfect, very short) condition can achieve better sensitivity than the current experimental upper limit.
- now, physics data-taking is running !!

backup slides