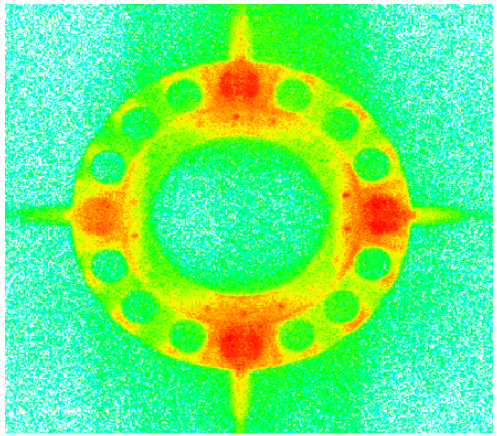
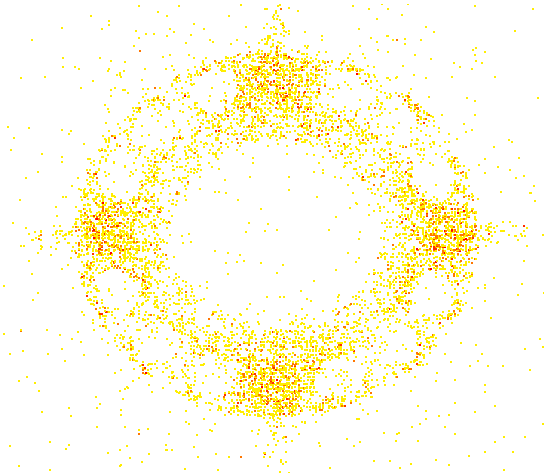




Search for missing materials in the LHCb simulation

Summer Student: Mengzhen Wang

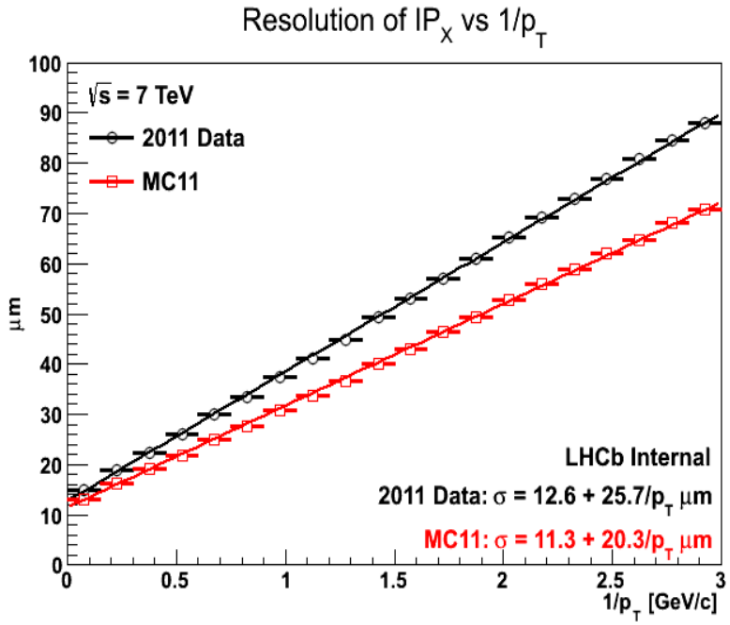
Supervisor: Jibo He

Outline

- Introduction
- Data set and selection
  - J/ψ selection
  - Reweight of Velo cluster
- Hit map MC/data comparison
- Tomography with downstream tracks
  - Hadronic interaction
  - Gamma conversion
- Tomography with T-tracks
- Summary

Introduction

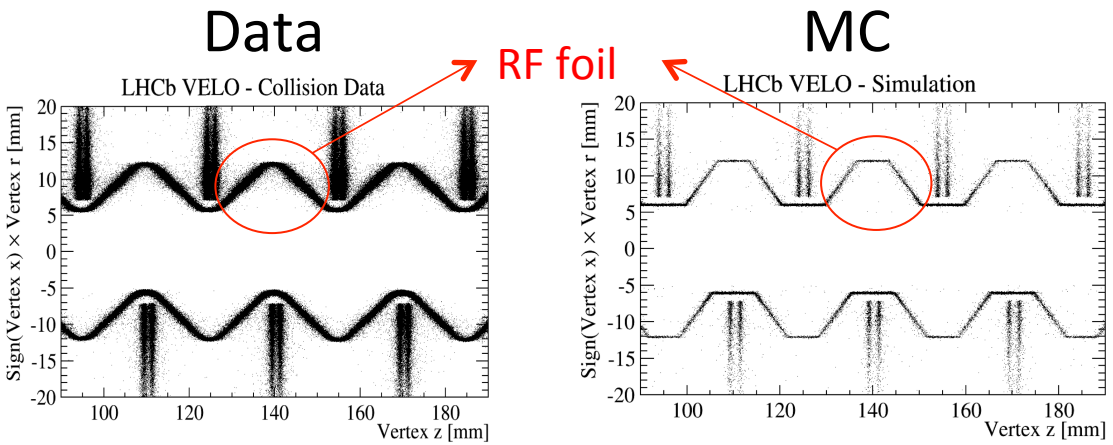
- We need well-tuned MC for
  - Online/Offline selection optimization
  - Efficiency estimate
  - Design of new detectors
- Before having well-tuned MC
  - IP smearing…

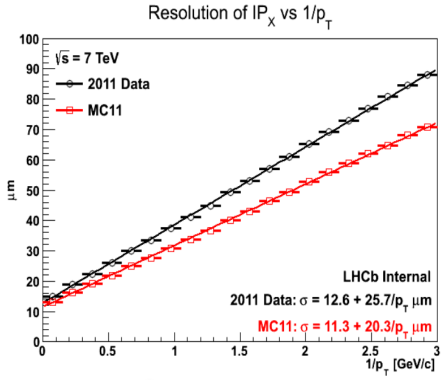


IP$_X$ resolution of data/MC [M. Alexander $_{2013.1}$]

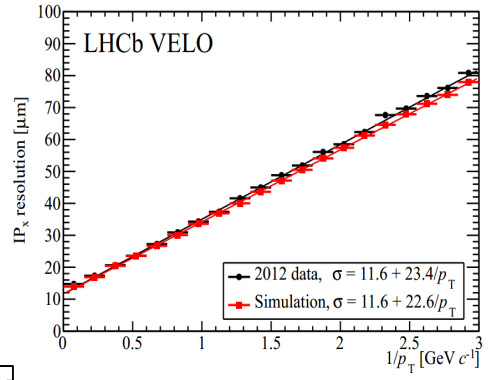
Introduction

- Tomography [VELO group$_{2014}$]



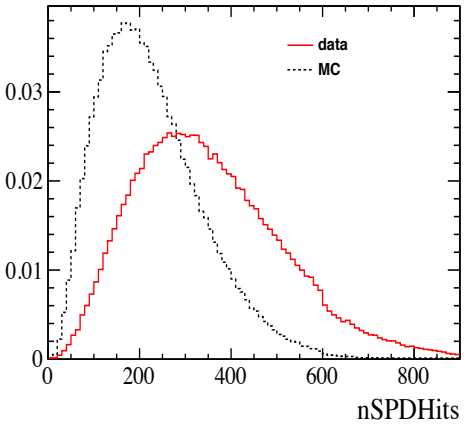


RF foil Tuned

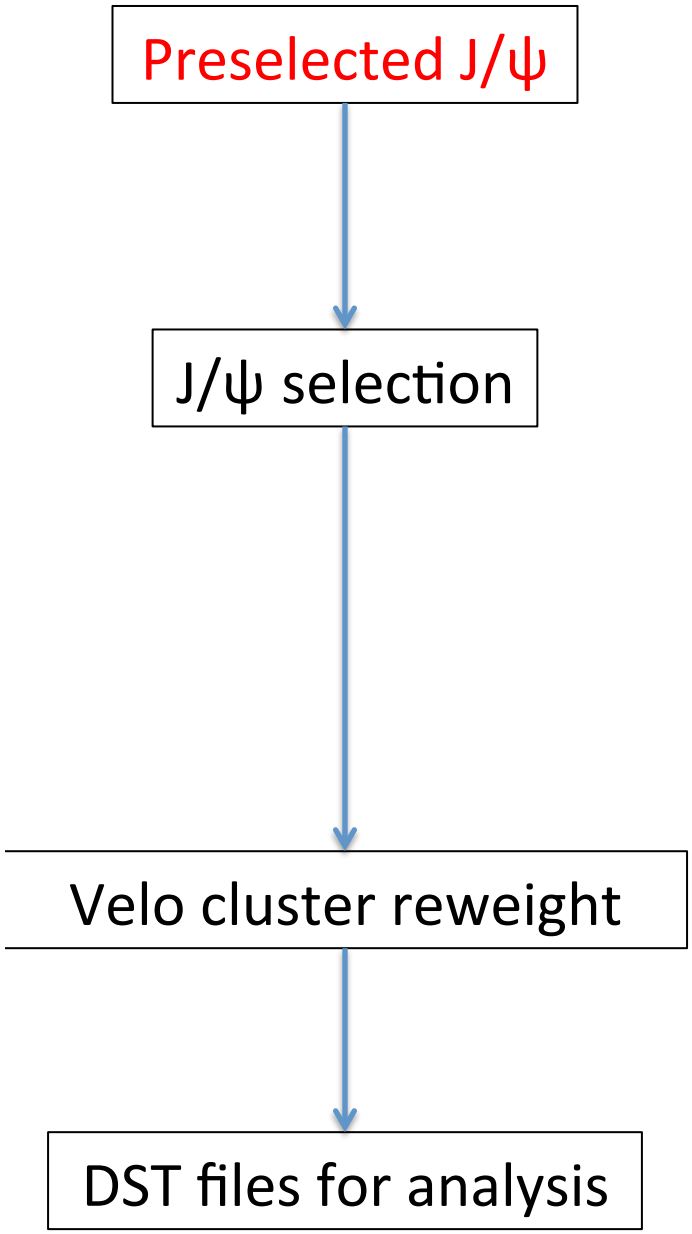


Simplified data analysis

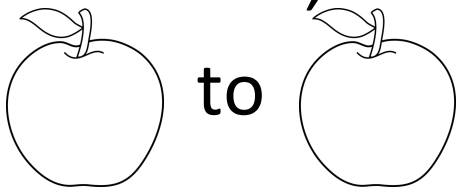
- Downstream region, e.g., SPD
  - Difficulties
    - Limited tracking
    - Weak magnetic field
  - Still an open question



Dataset for analysis



- Validate detector simulation with data, need to compare



=> disentangle from generator

  - Detached J/ψ
    - MC: $J/\psi \rightarrow \mu^+\mu^-$ (2012)
    - Data: Dimuon stream (2012)
  - Same online/offline selection

Selection

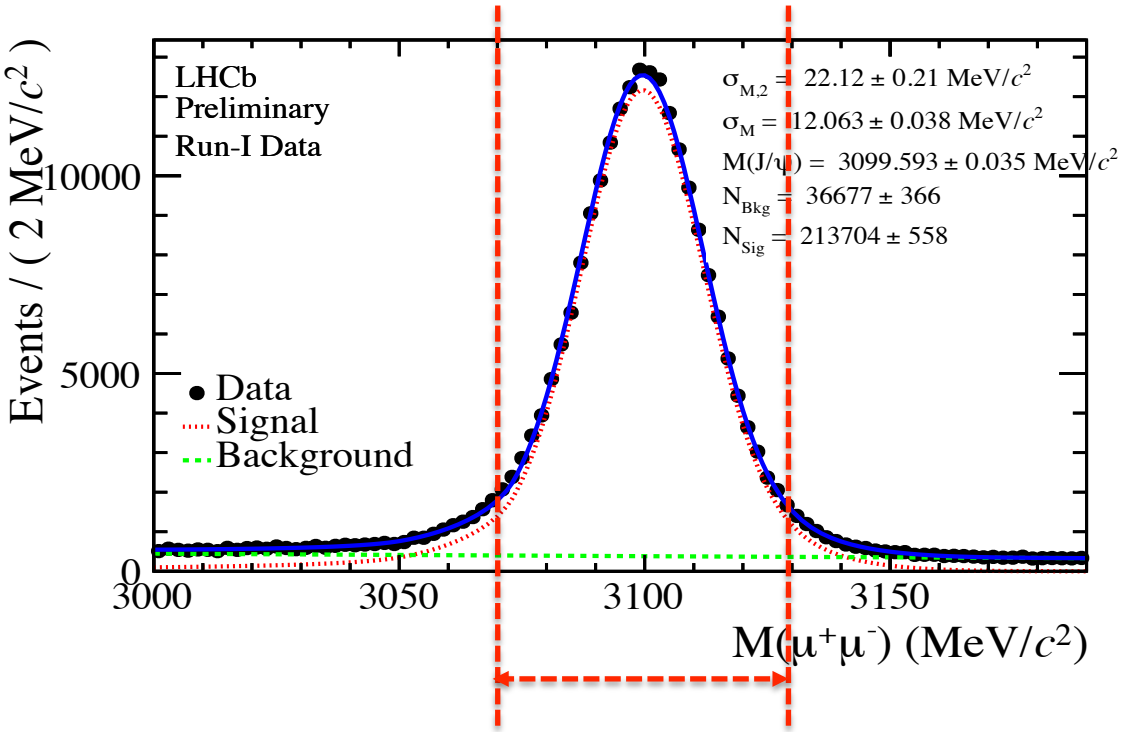
Preselected J/ψ

J/ψ selection

Velo cluster reweight

DST files for analysis

- Tighten selection to suppress bkg in data
  - f_{bkg}~ 6% in signal region



Reweight

Preselected J/ψ

↓

J/ψ selection

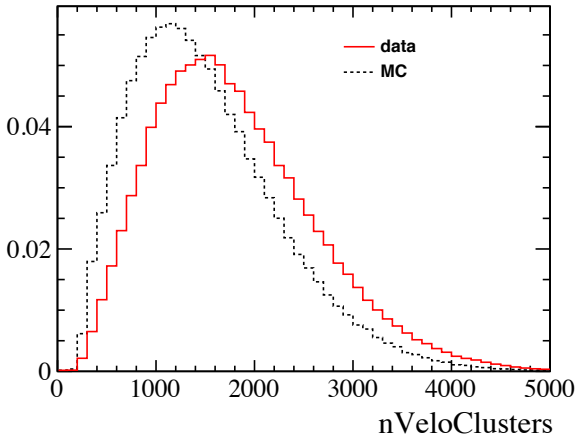
↓

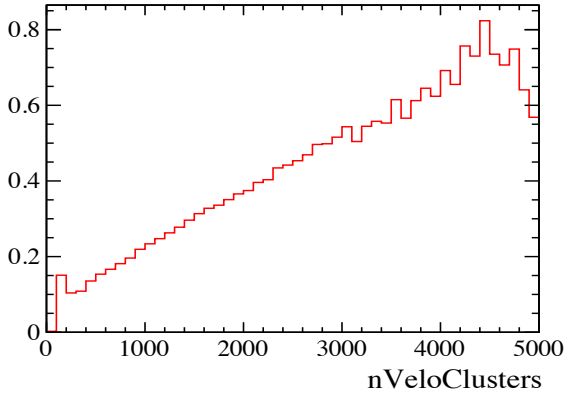
Velo cluster reweight

↓

DST files for analysis

- "Hit and reject" to reweight MC

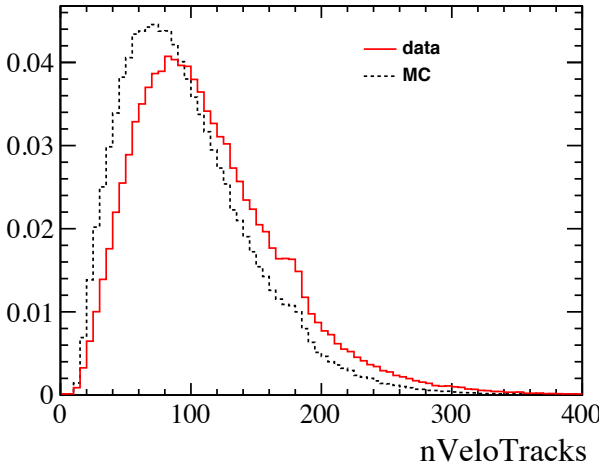


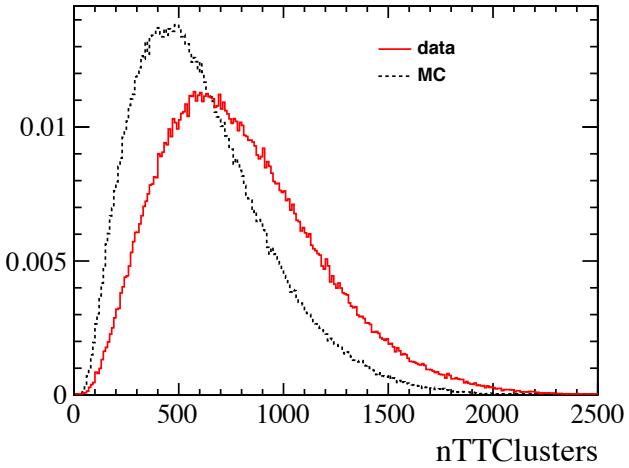


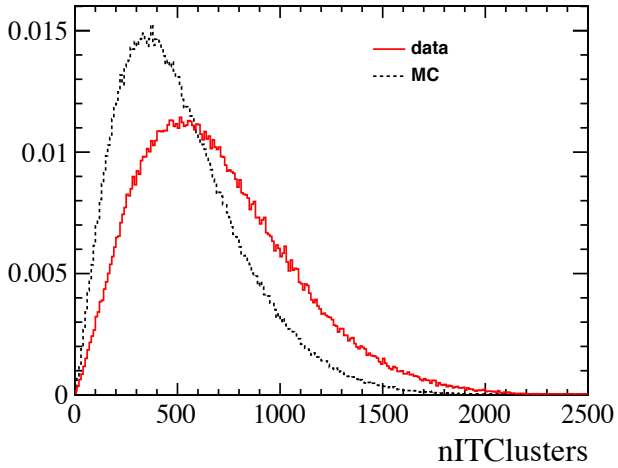
- Saved as full DST files for following analysis

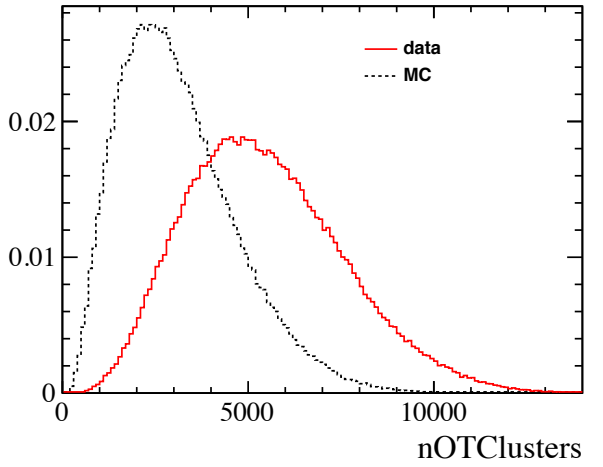
Data/MC comparison before reweighting

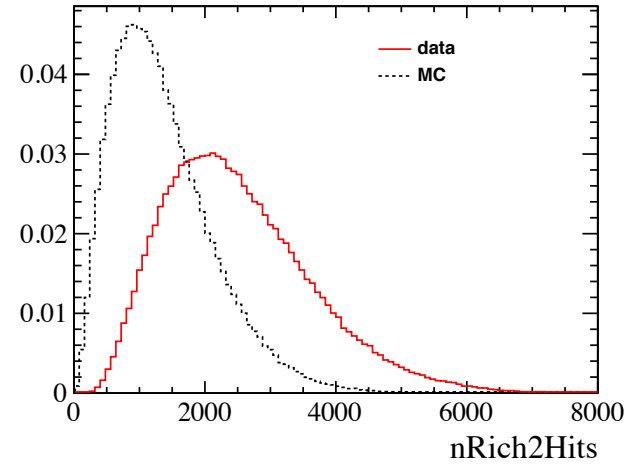
- From upstream to downstream detectors:

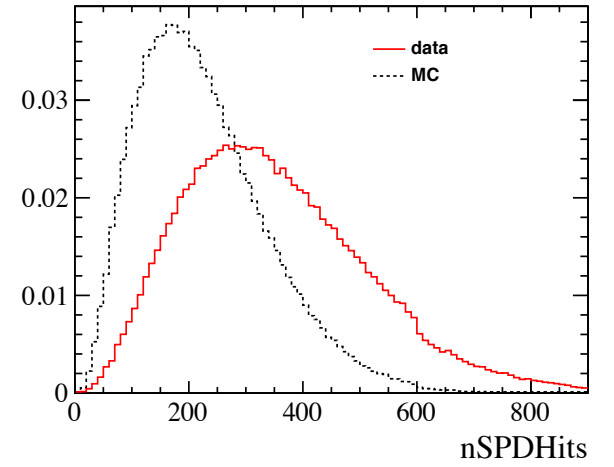






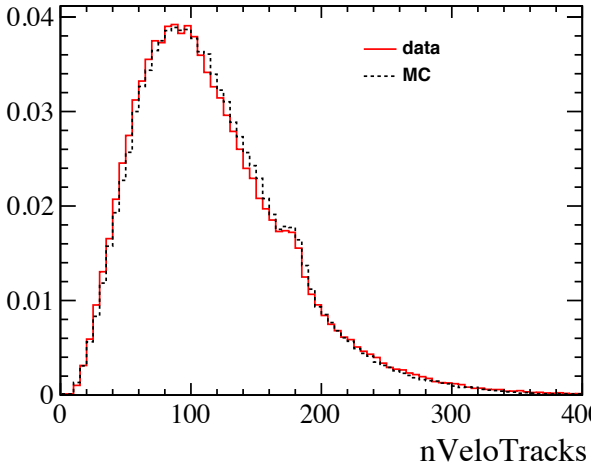


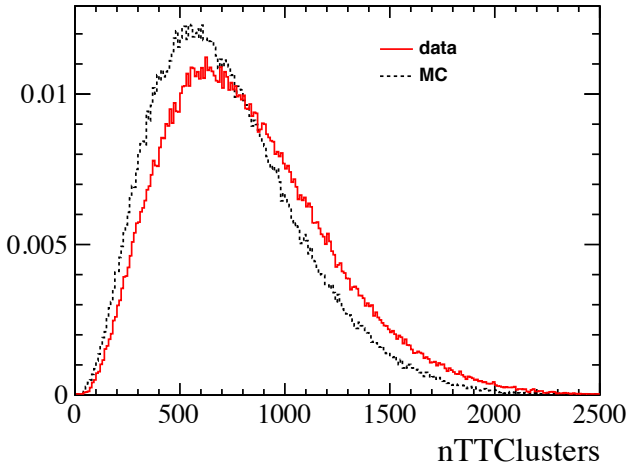


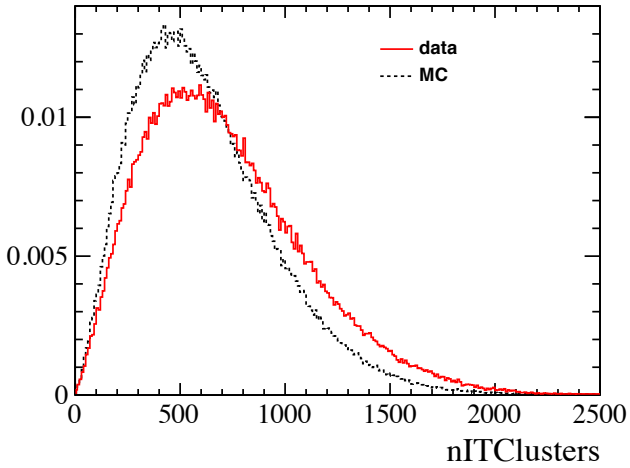


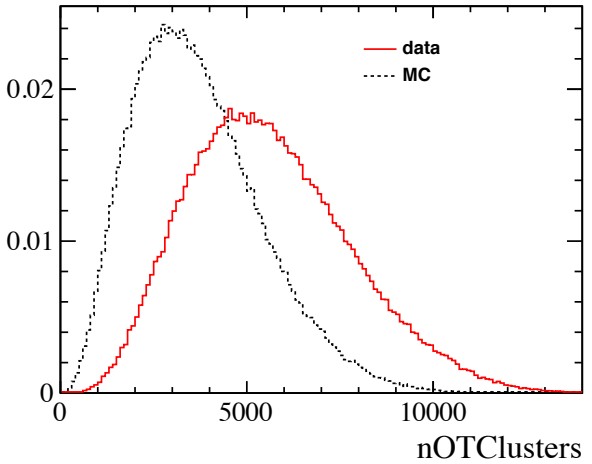
Data/MC comparison after reweighting

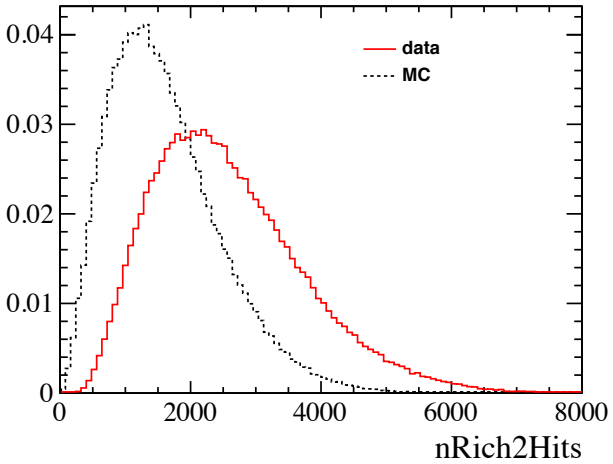
- From upstream to downstream detectors:

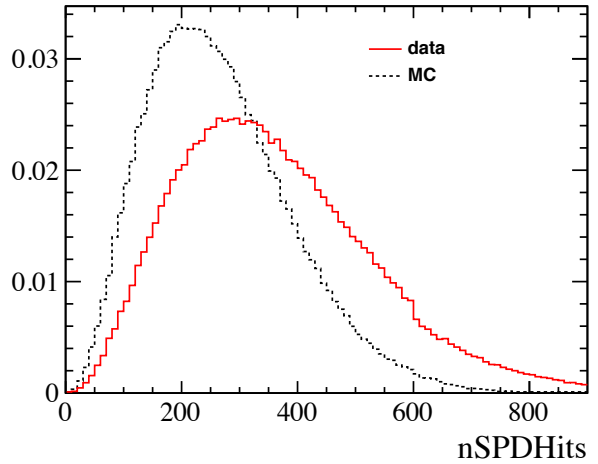






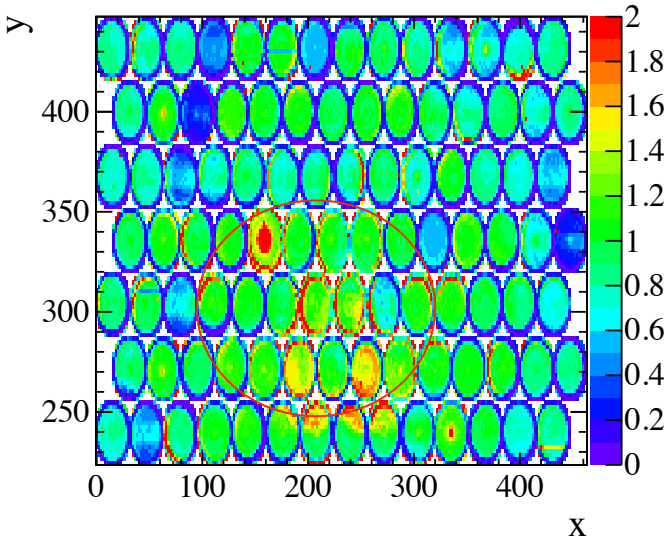




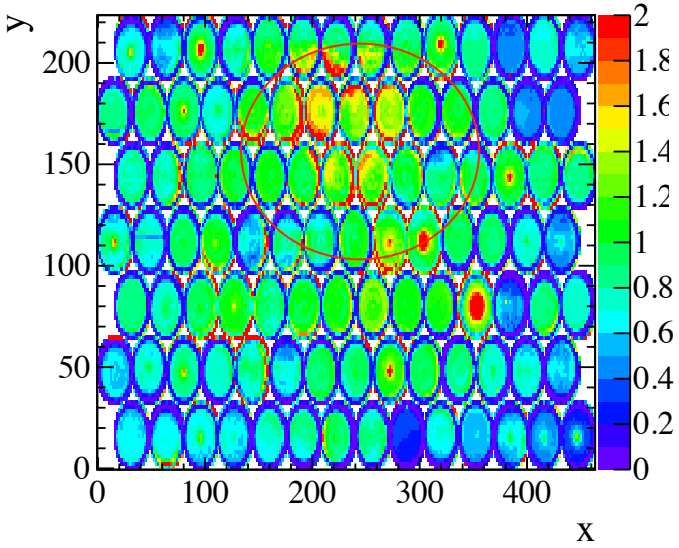


Data/MC hit map ratio for RICH1 & TT

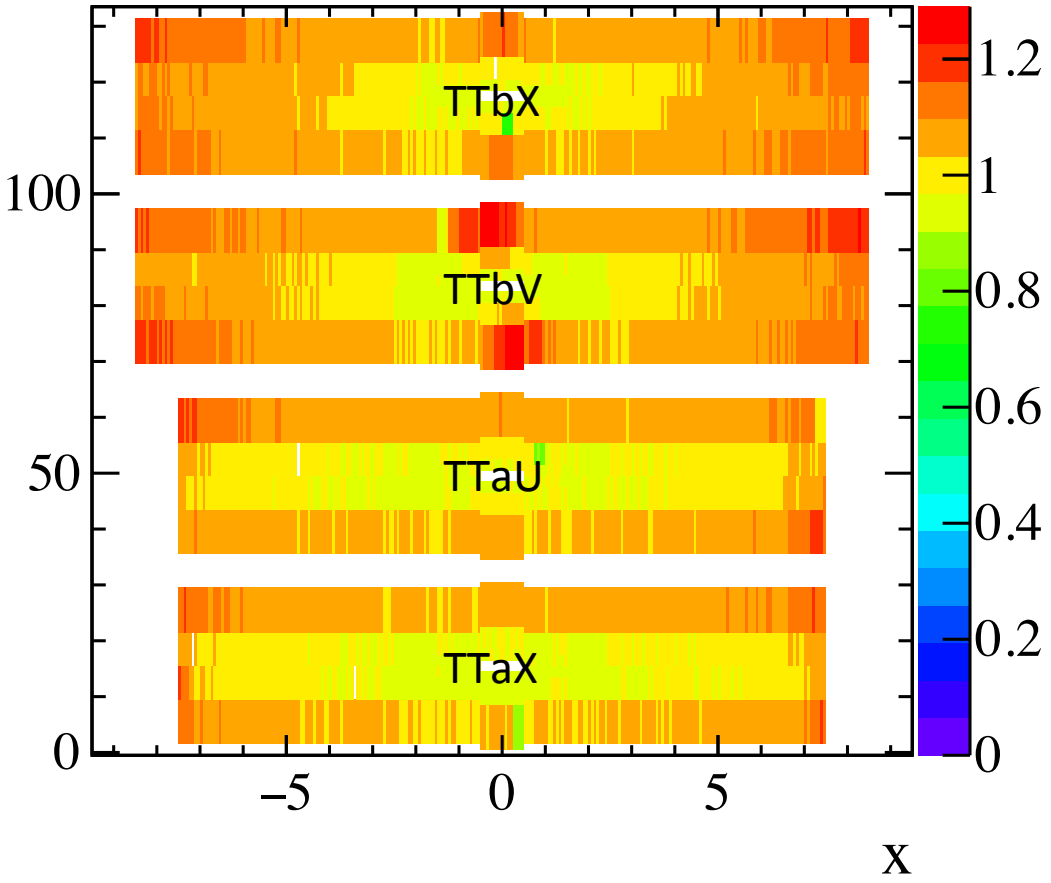
RICH1 top side



RICH1 bottom side

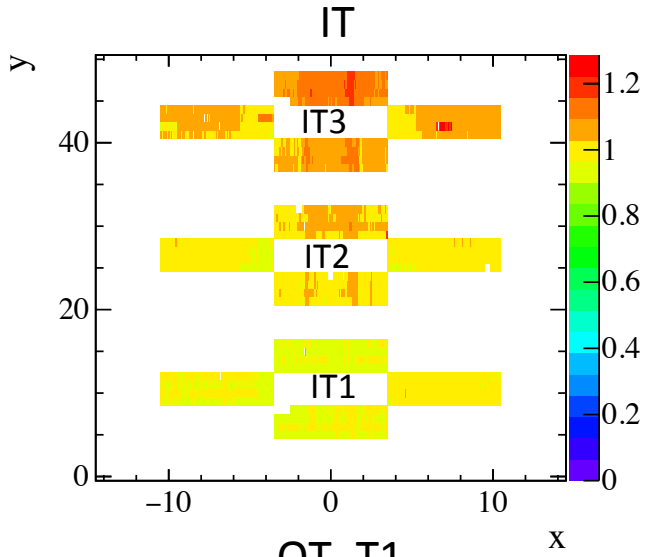


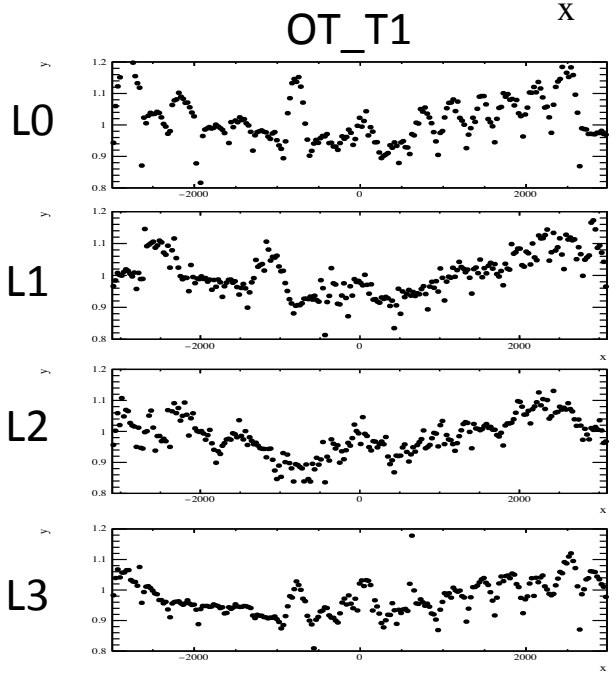
TT

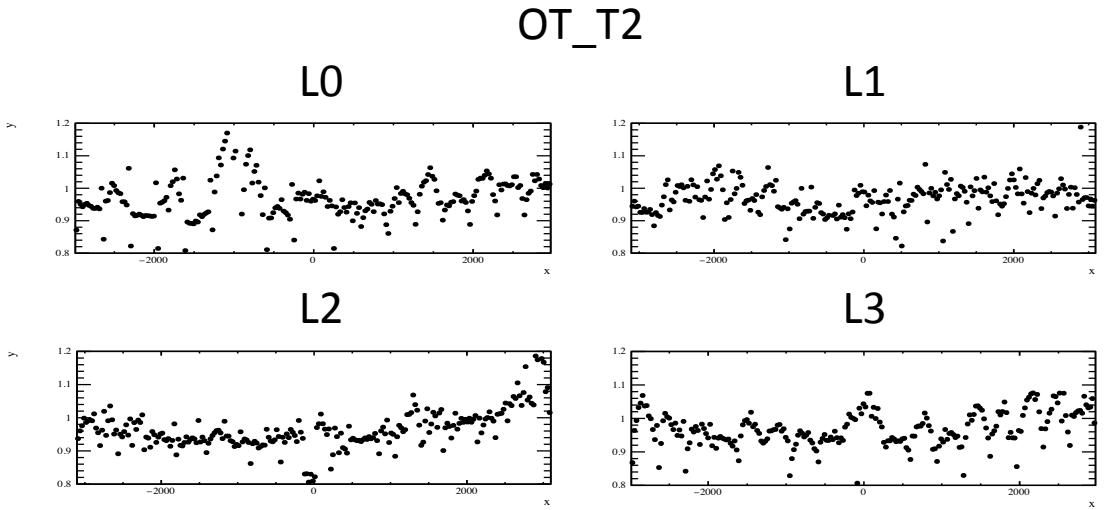


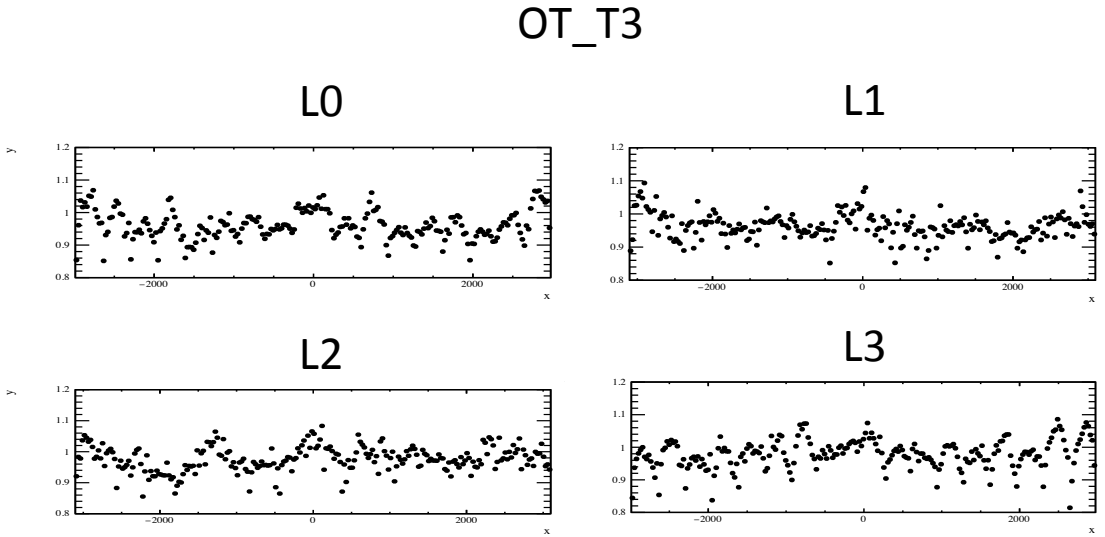
- RICH1: Small difference in central region
- TT: More hits in data for large Y

Data/MC hit map ratio for T-stations





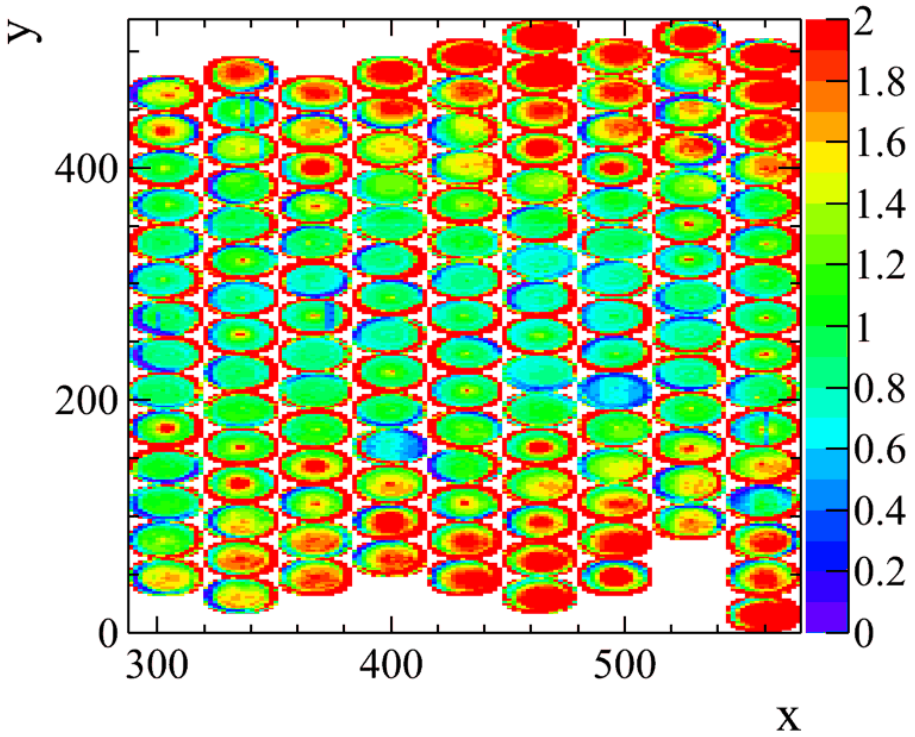




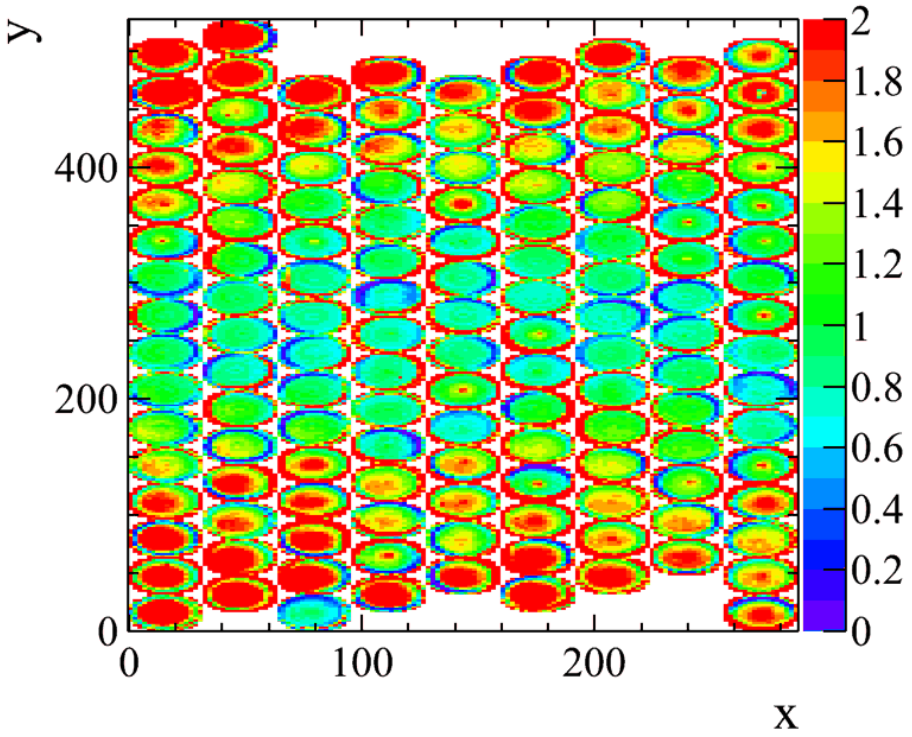
- IT: More hits in data for downstream

Data/MC hit map ratio for RICH2

RICH2 left side



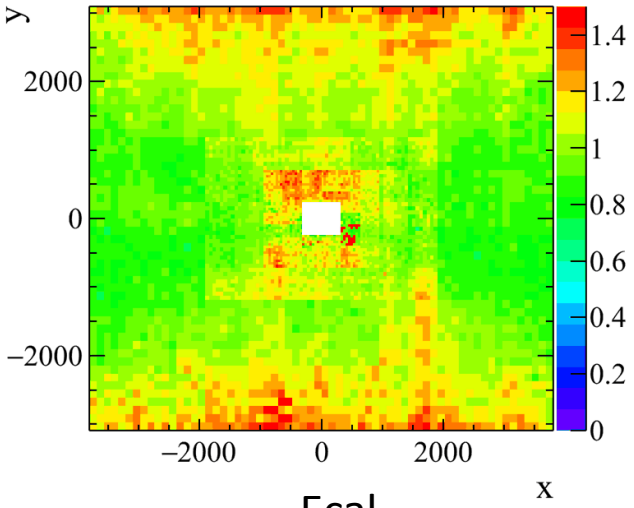
RICH2 right side



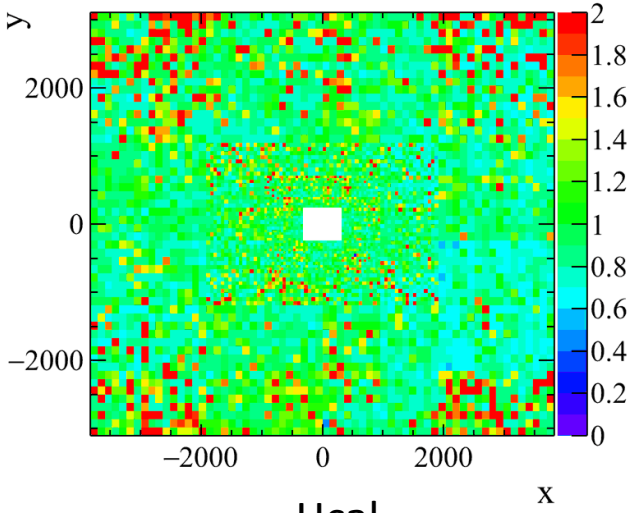
- More hits in data for large Y

Data/MC hit map ratio for Calorimeters

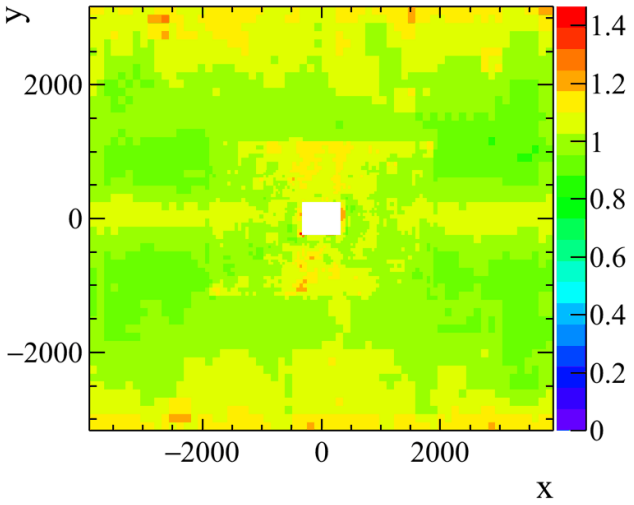
SPD



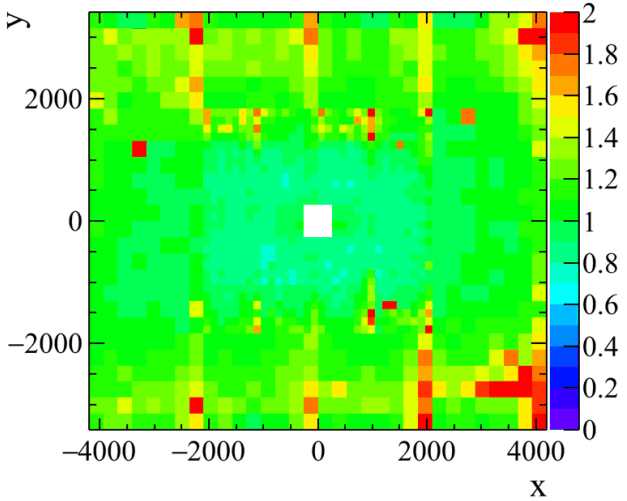
PRS



Ecal



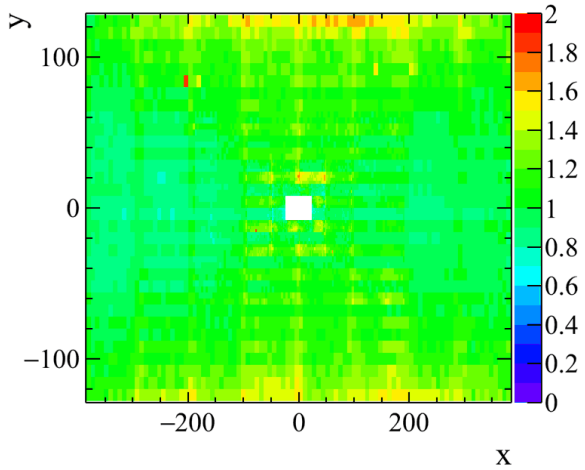
Hcal



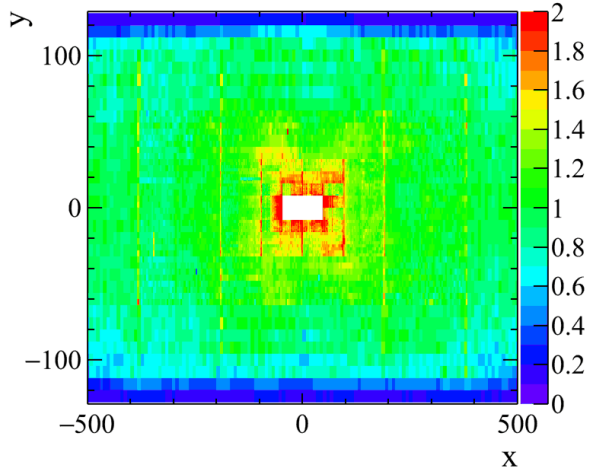
- More hits in data for large Y

Data/MC hit map ratio for Muon-Stations

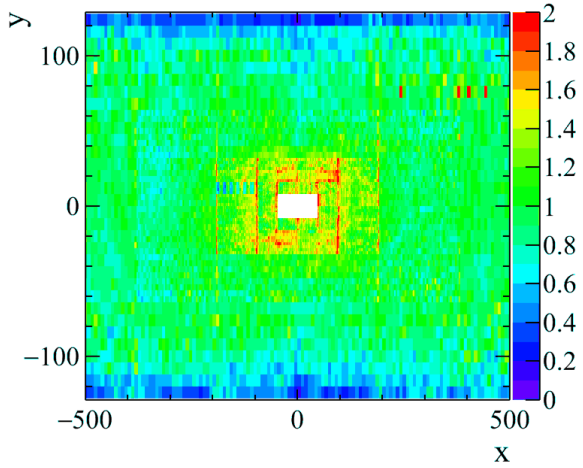
M1



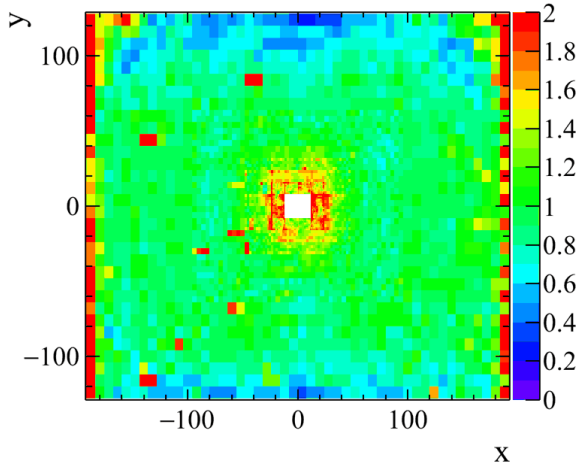
M2



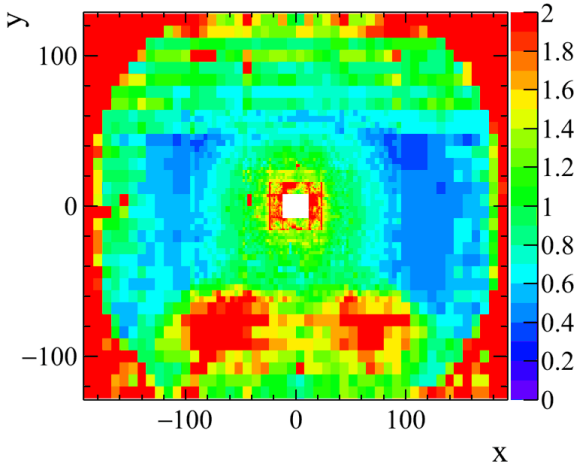
M3



M4

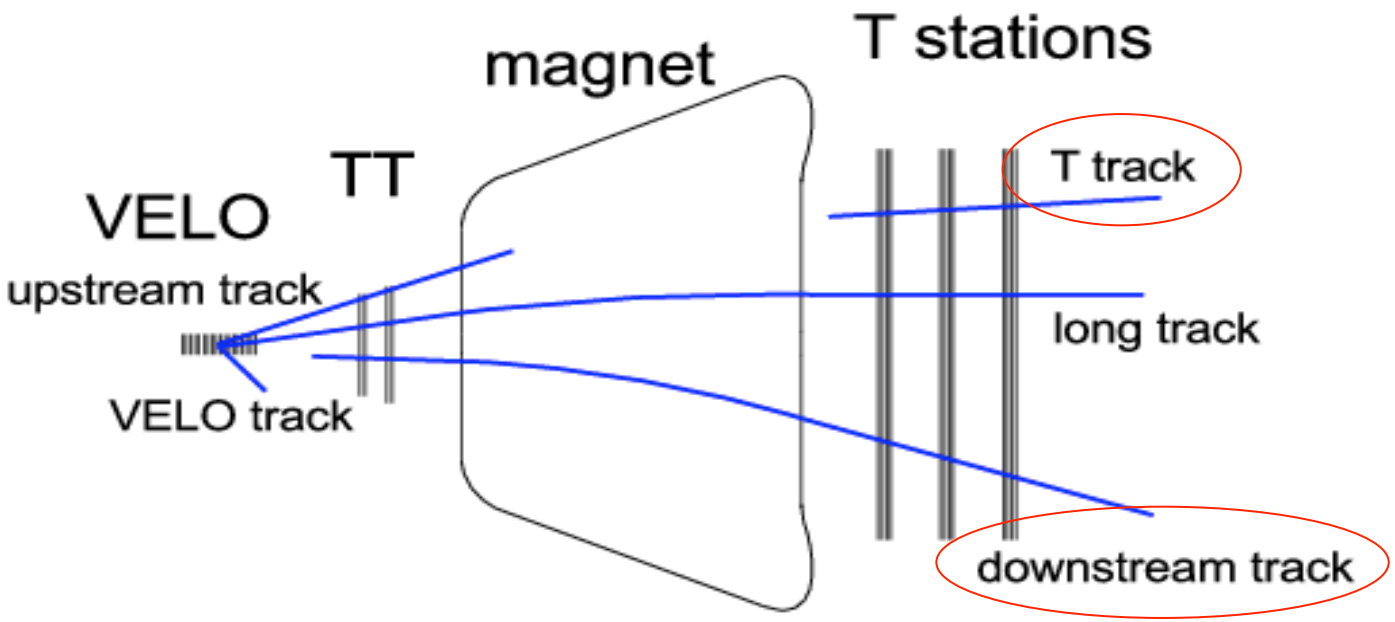


M5



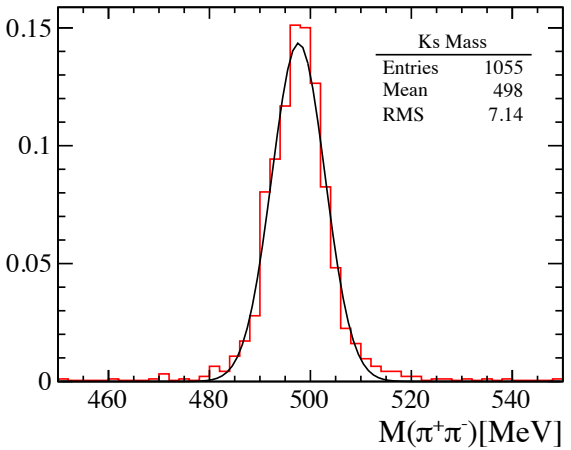
Tomography

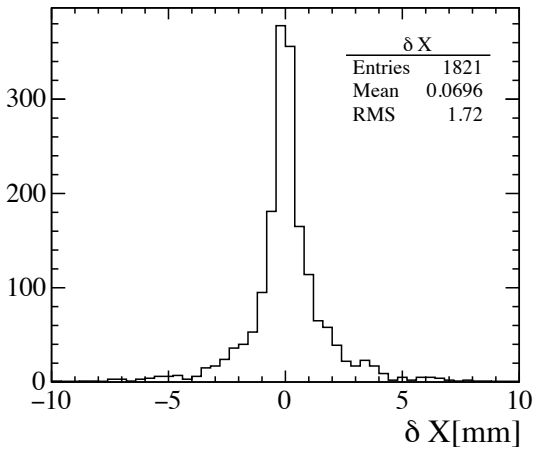
- With downstream tracks
  - To compare with previous studies
  - Hadronic interaction & gamma conversion
- With T-tracks
  - To study material budget in downstream areas in detail
  - Hadronic interaction

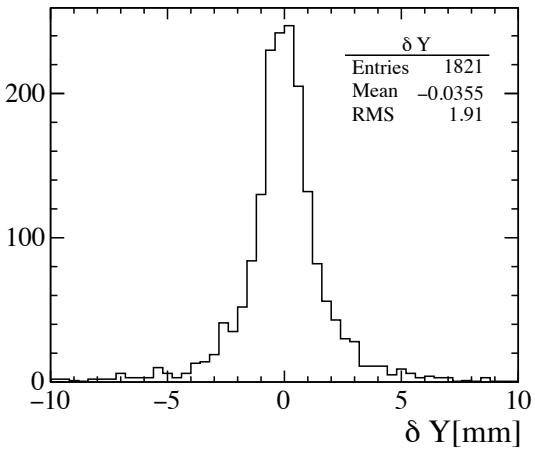


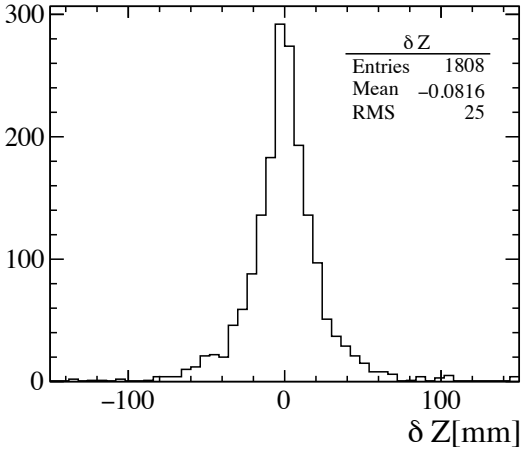
Tomography with downstream tracks

- Hadronic interaction: 2 tracks combination
- Selection criteria
  - Require not from PV; Ks, Λ vetoed.
  - Signal purity (MC): 10%
- Selected vertices:
  - MC: 1.6×10^5 Data: 2×10^6
- Spatial resolutions (MC, for $K_S \rightarrow \pi^+\pi^-$)
  - σ_X/σ_Y ~2mm σ_Z~25mm

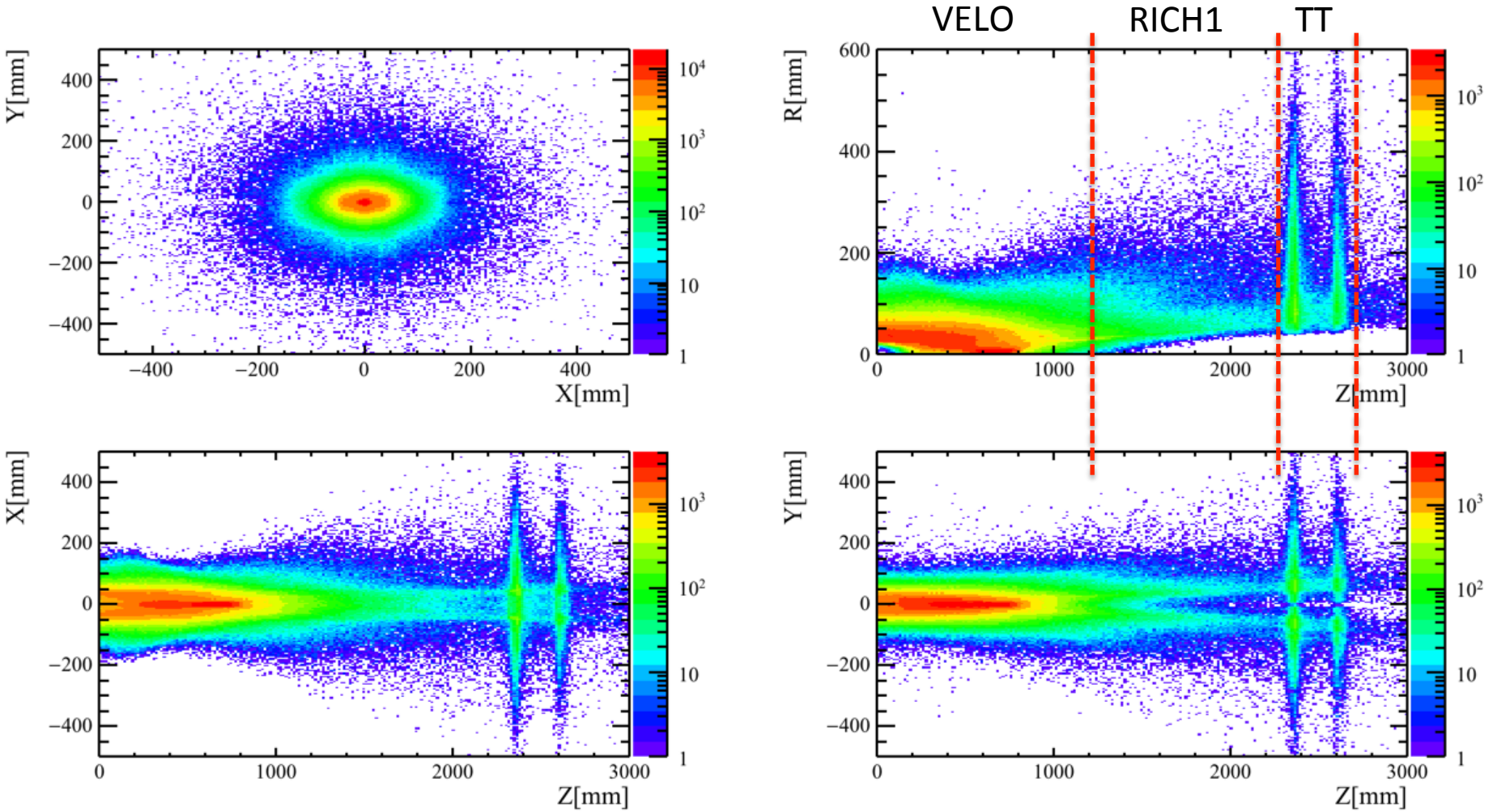








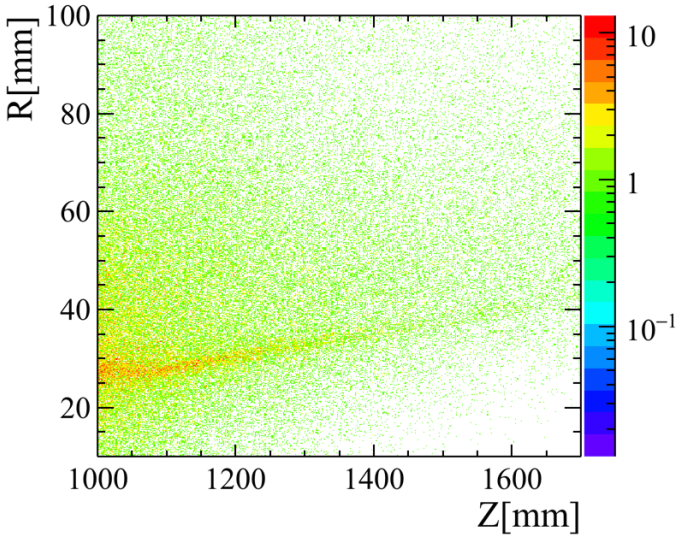
Hadronic interaction vertices distribution

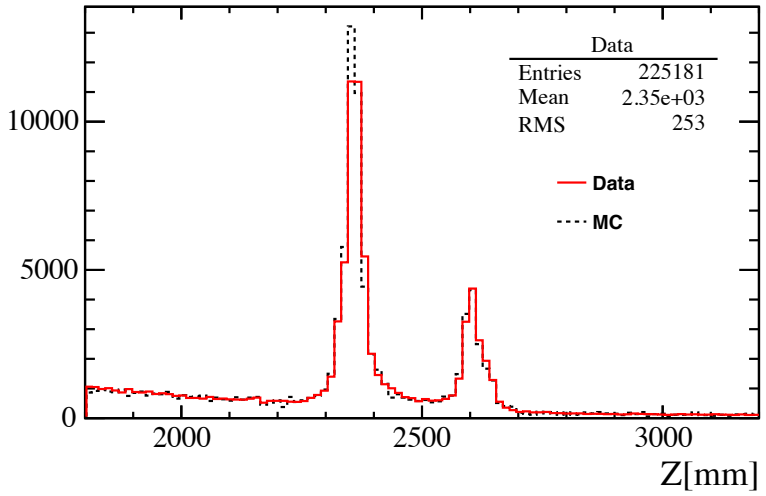


- TT clearly seen, but details in VELO and RICH1 is unclear

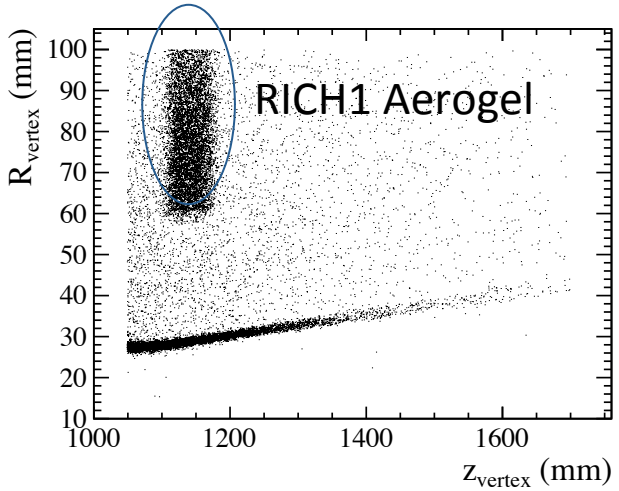
Comparison to previous studies

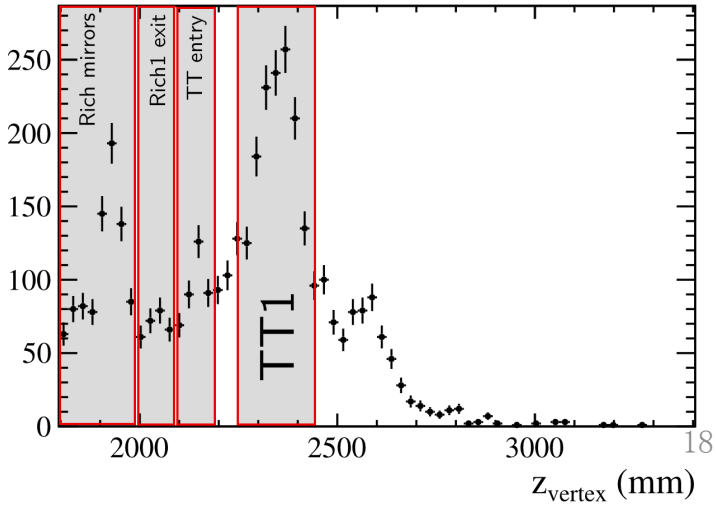
- My work (2 tracks combination)





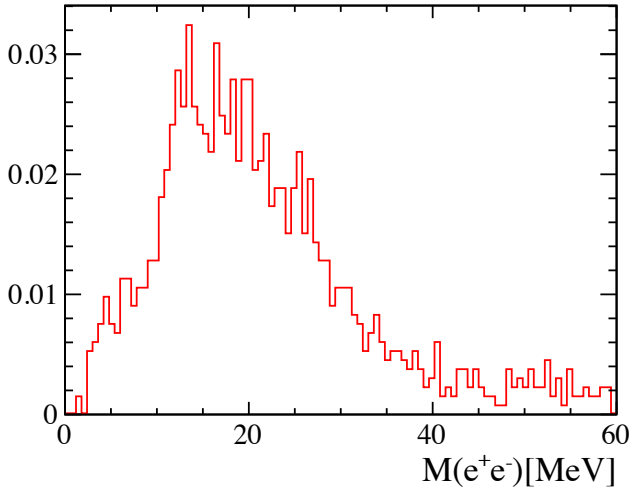
- Victor Coco's talk[2012.10](at least 4 tracks)

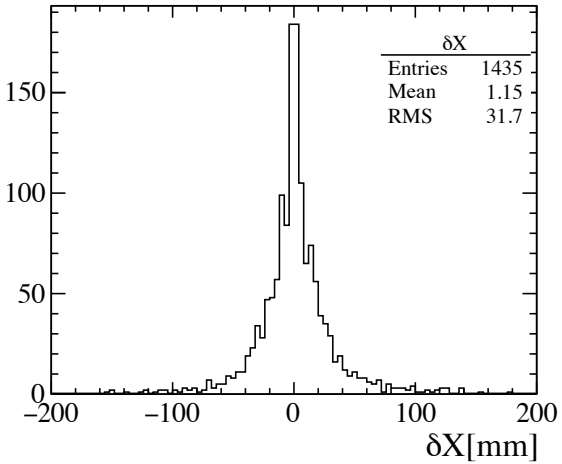


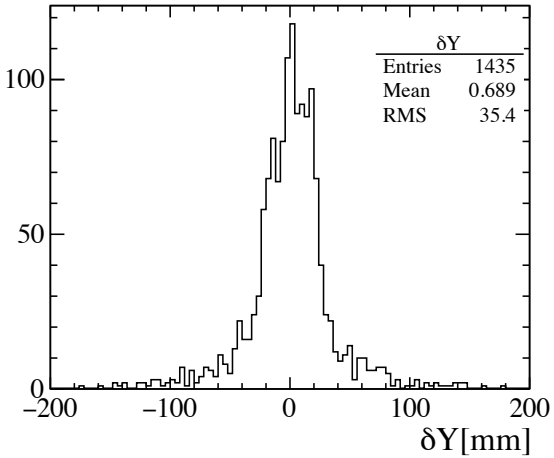


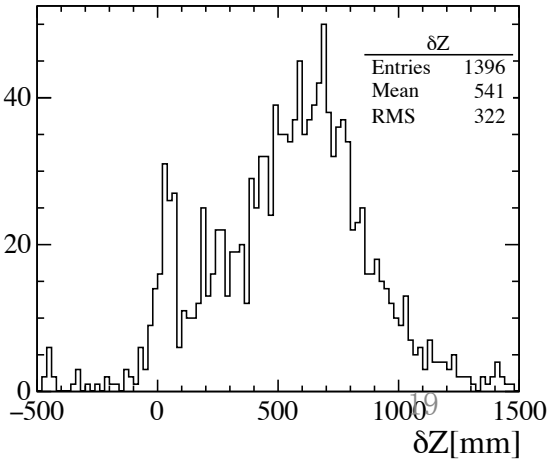
Tomography with downstream tracks

- Gamma conversion: electron-positron combination
- Selection criteria
  - Mass cut (<30MeV)
  - Signal purity (MC): 37%
- Selected vertices:
  - MC: 2.8×10^3 Data: 7×10^6
- Spatial resolutions from MC
  - σ_X~32mm σ_Y~36mm σ_Z~320mm (biased)

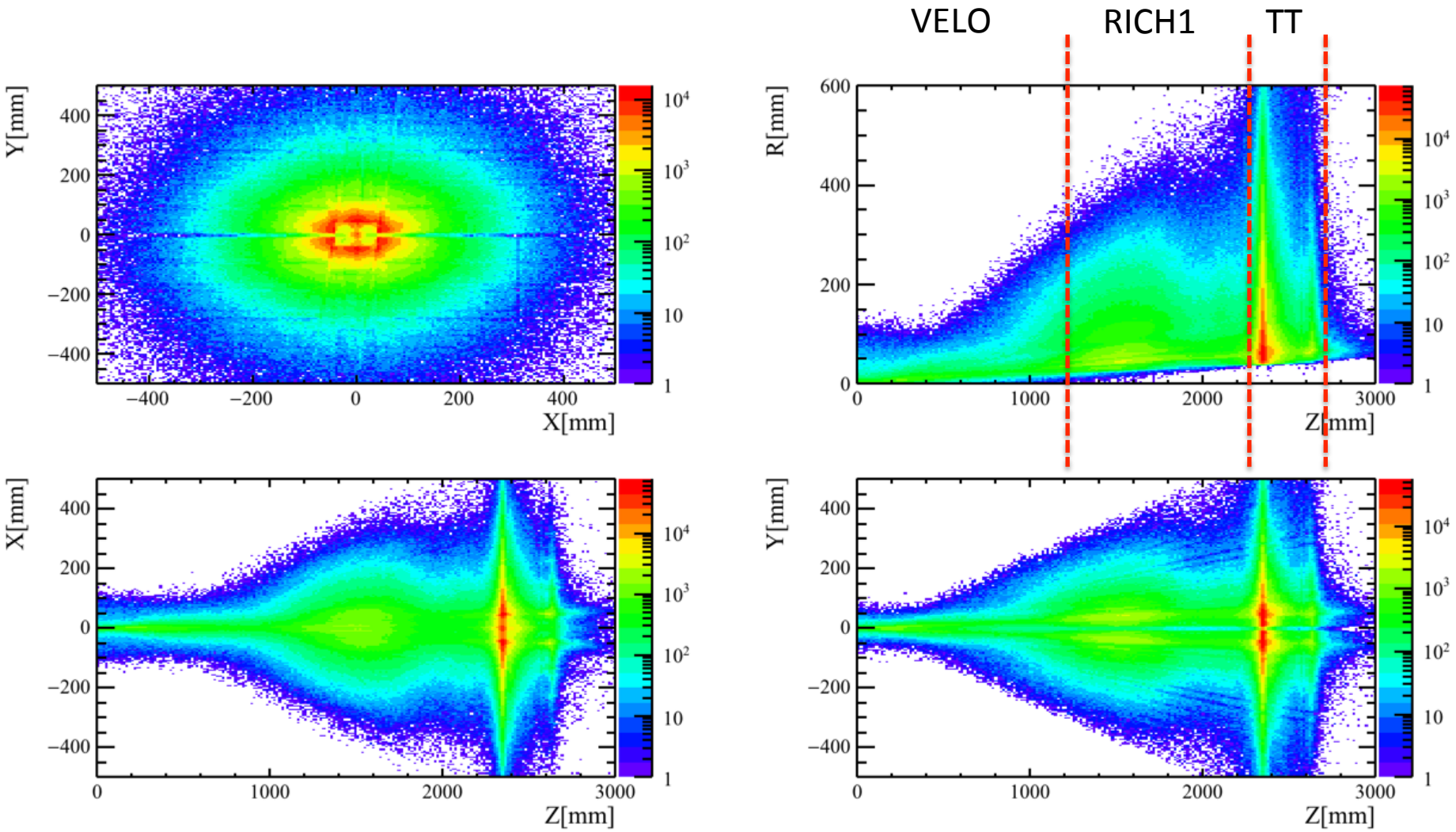






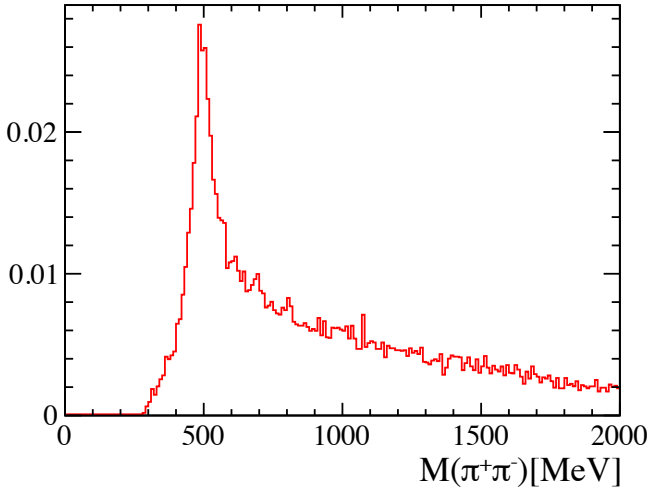


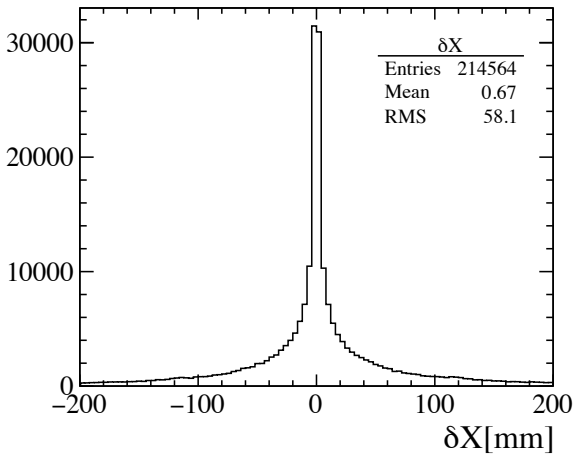
Gamma conversion vertices distribution

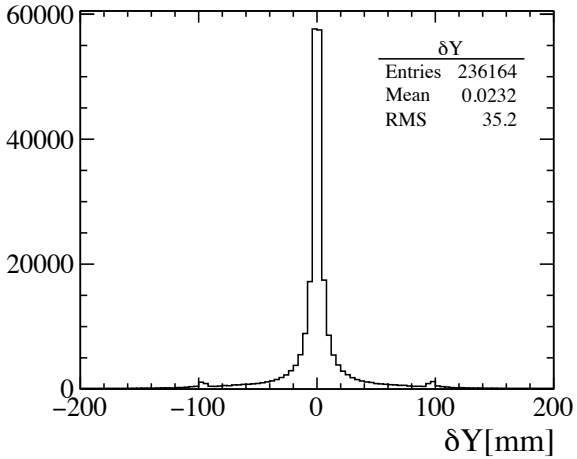


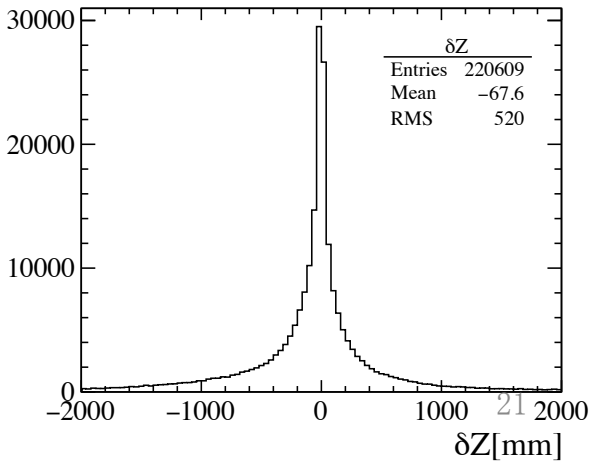
Tomography with T-tracks

- Hadronic interaction: 2 tracks combination
- Selection criteria
  - Require not from PV
  - Signal purity (MC): 14%
- Selected vertices:
  - MC: 6.3×10^5 Data: 9.5×10^7
- Spatial resolution from MC
  - σ_X~58mm σ_Y~35mm σ_Z~520mm

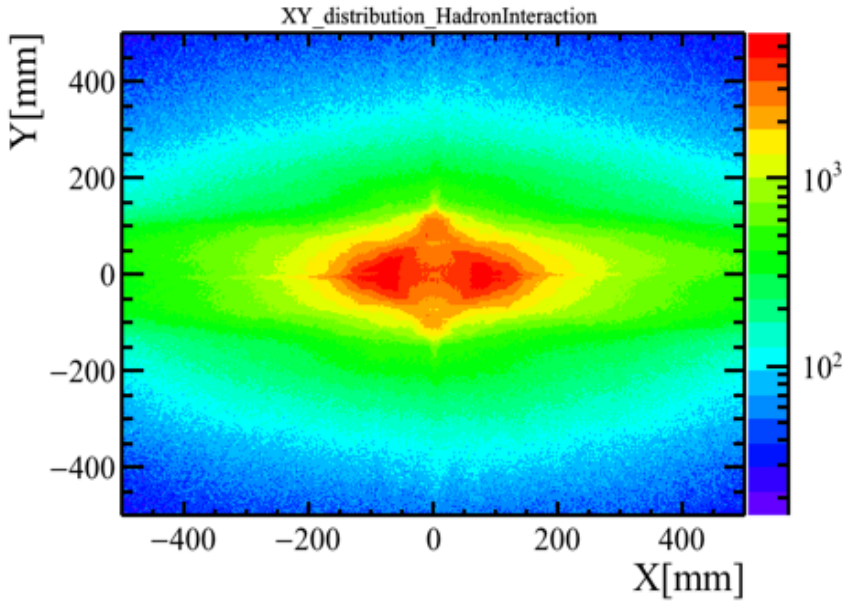


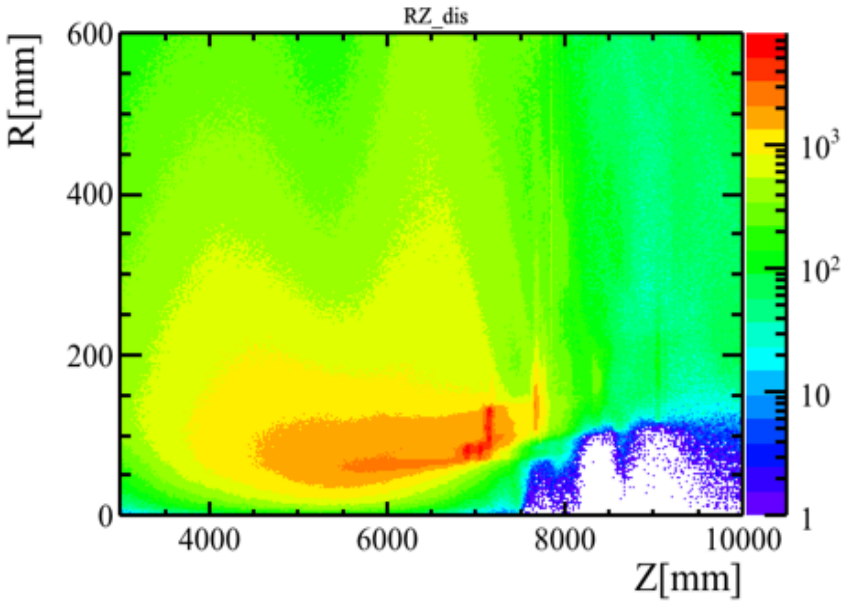


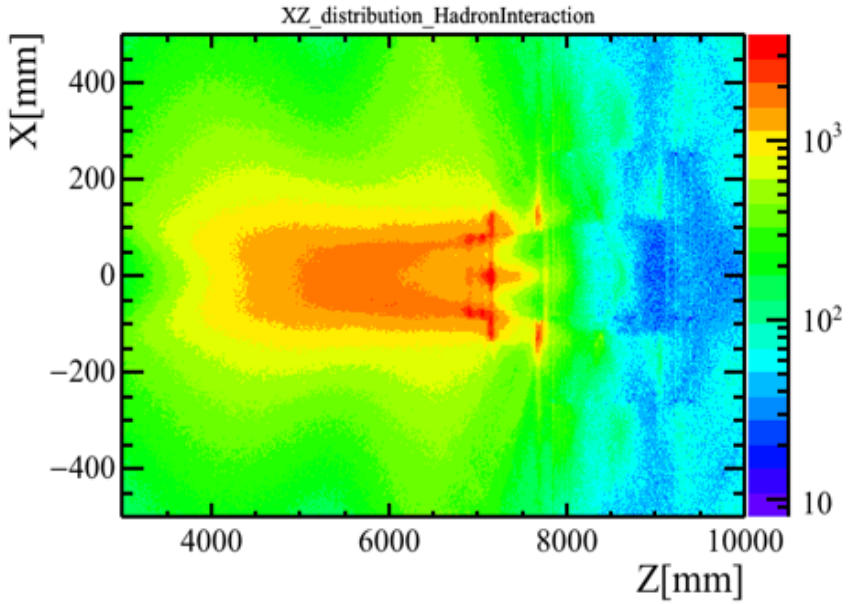


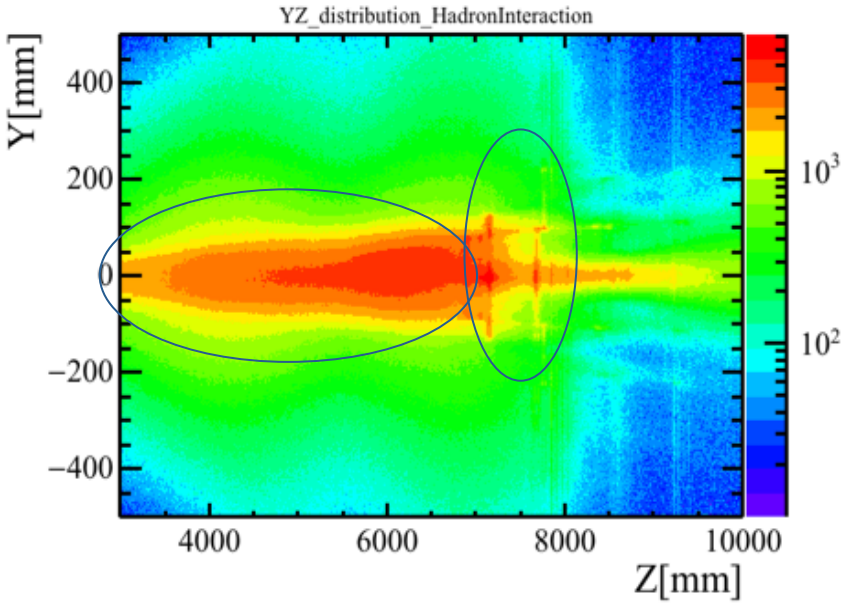


Hadronic interaction vertices distribution

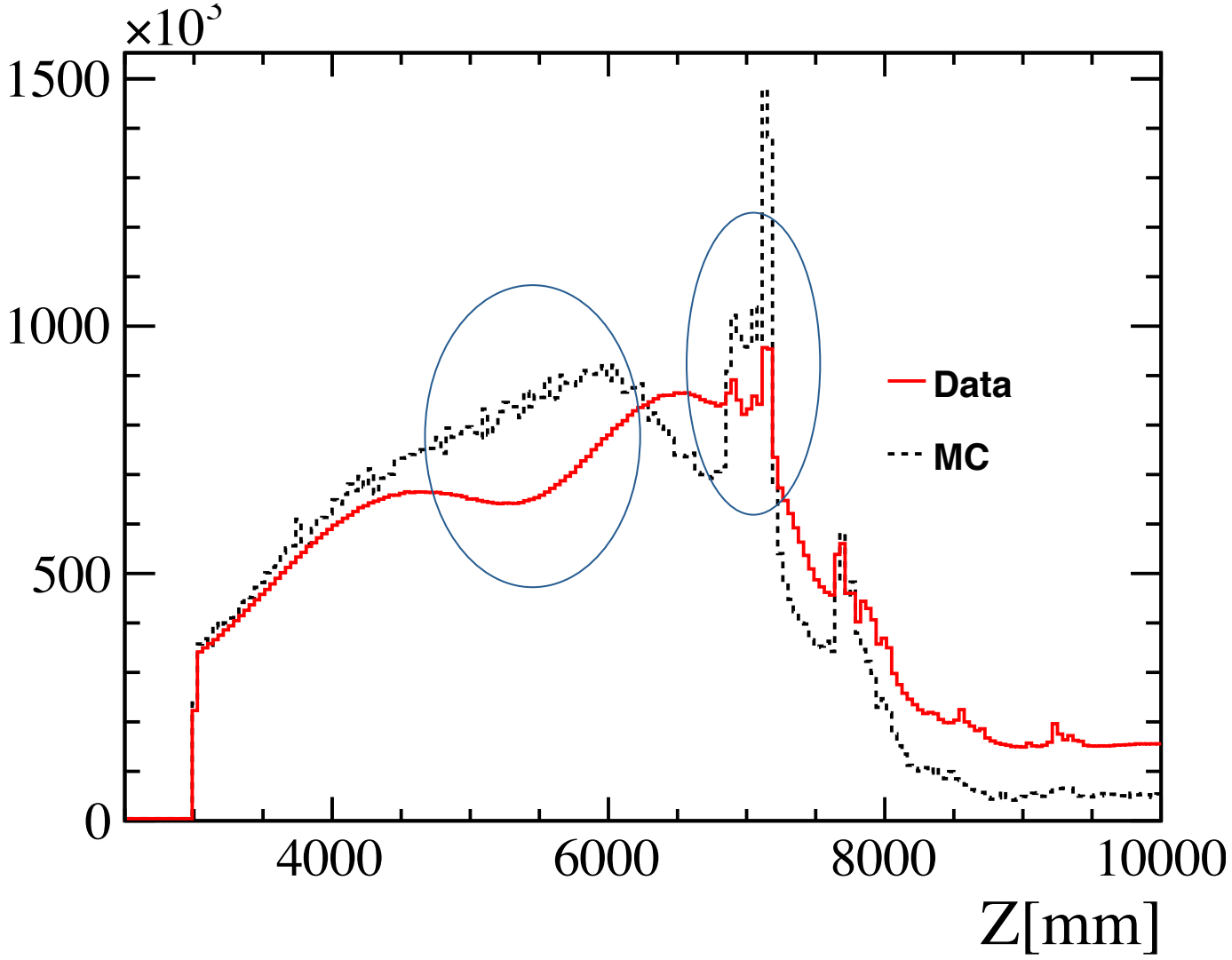






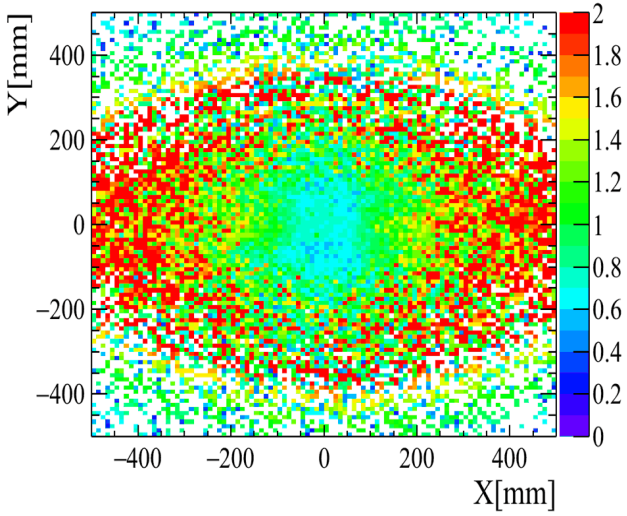


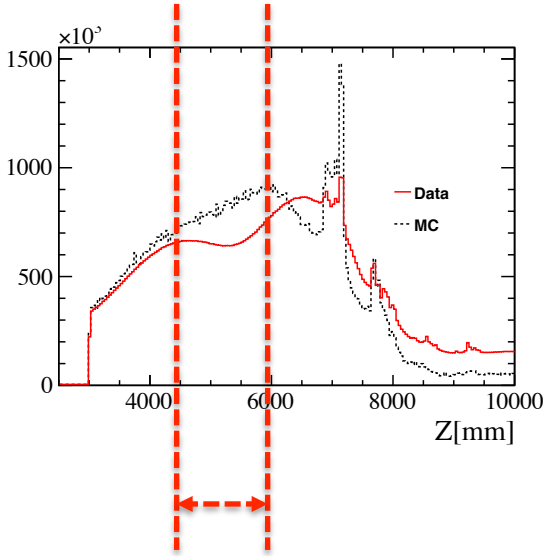
Hadronic interaction vertices z-distribution

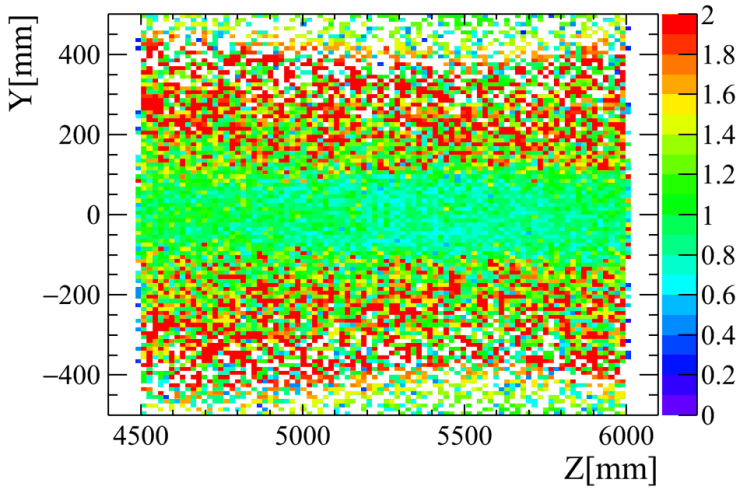


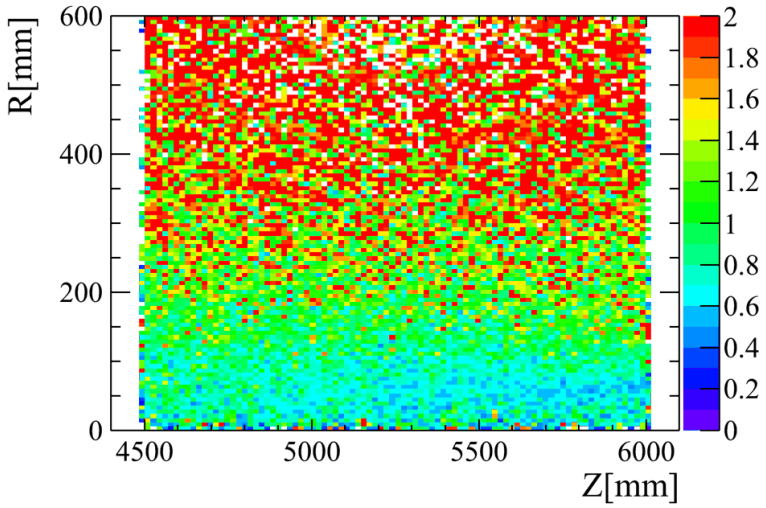
Zoom in for Z axis： 4500mm~6000mm

- (normalized)data/MC ratio distribution



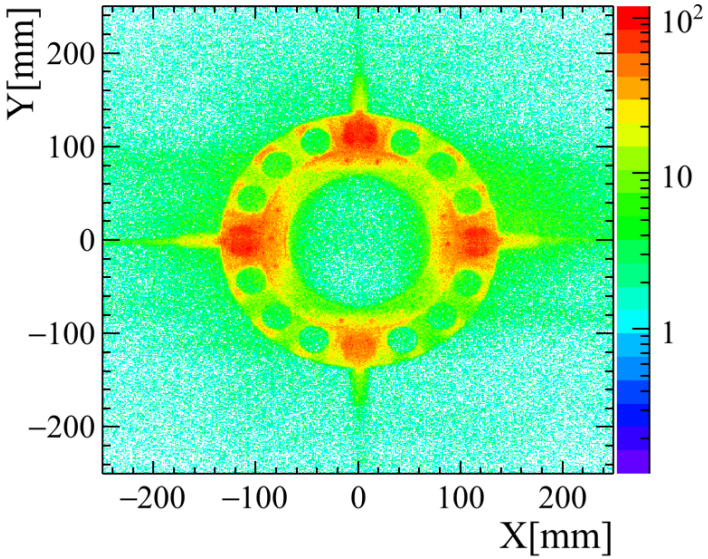




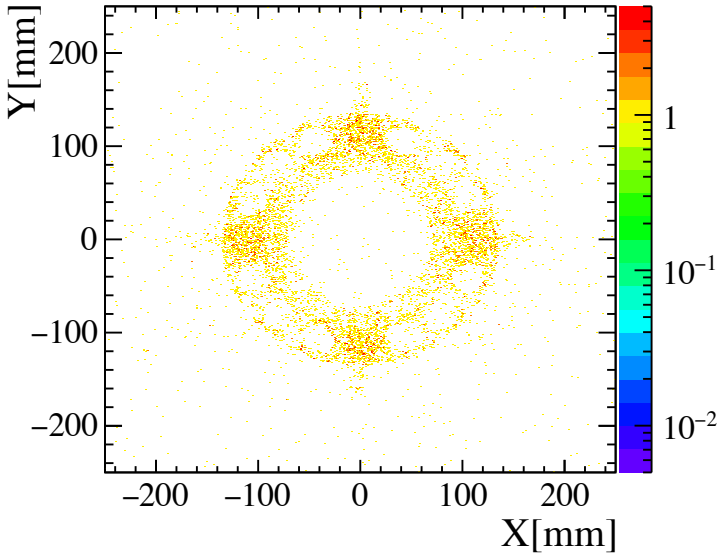


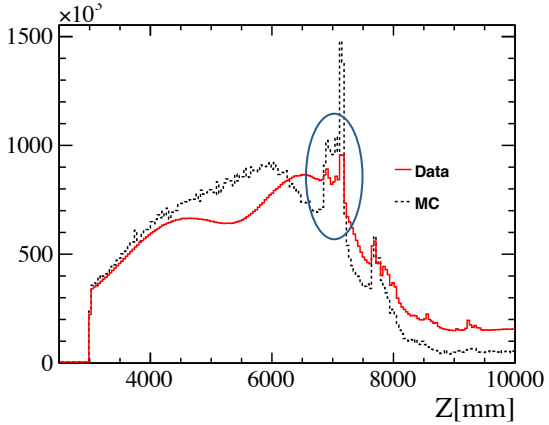
Zoom in for Z axis: S3F of beam pipe

Data



MC





Z: 7100mm~7200mm

Summary

- Dataset selection & reweight
- Hit map comparison
  - More hits in data for large Y
- Tomography with downstream tracks
  - Hadronic interaction
  - Gamma conversion
- Tomography with T-tracks, hadronic interaction
  - Vertices z-distribution difference of data/MC
  - Some details visible, feasibility proved
- Outlook
  - Larger dataset, more optimized selection, numerical analysis

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  - Calo: Stephane Monteil, Olivier Deschamps
  - Muon: Giacomo Graziani