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SI LAB
Silizium Labor Bonn

Status of DATCON

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Content

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Overview of DATCON

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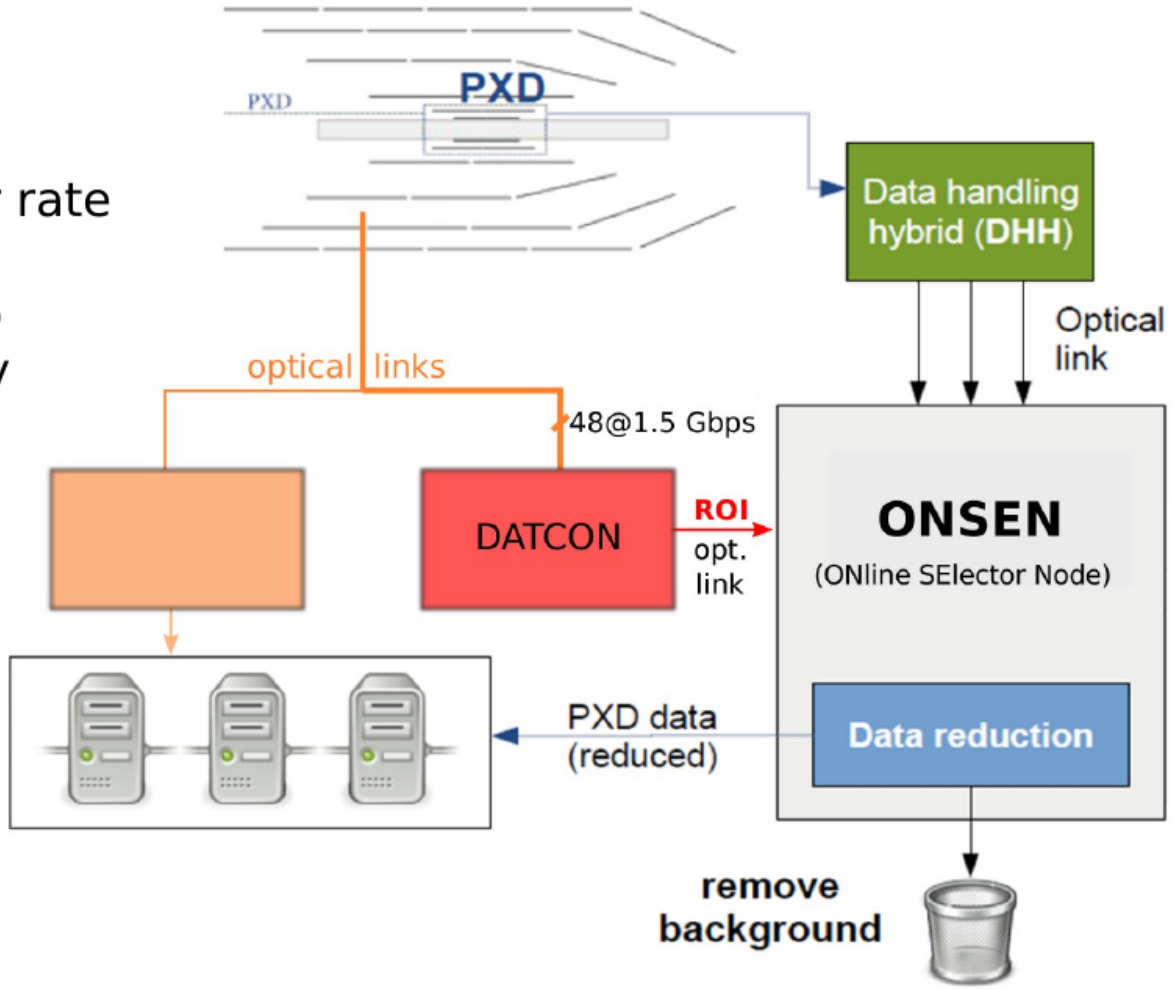
DATCON: Data Acquisition Tracking and Concentrator Online Node

- Tracking based on SVD hits only
- Performed on FPGA
- In total 14 FPGA boards:
  - 2×6 AMC get data from SVD p-side and n-side separately
  - 2 boards for actual tracking, extrapolation and ROI calculation
- Fast algorithm based on Hough Transformation (+ Hesse and Conformal Transformation)

VXD DAQ Structure

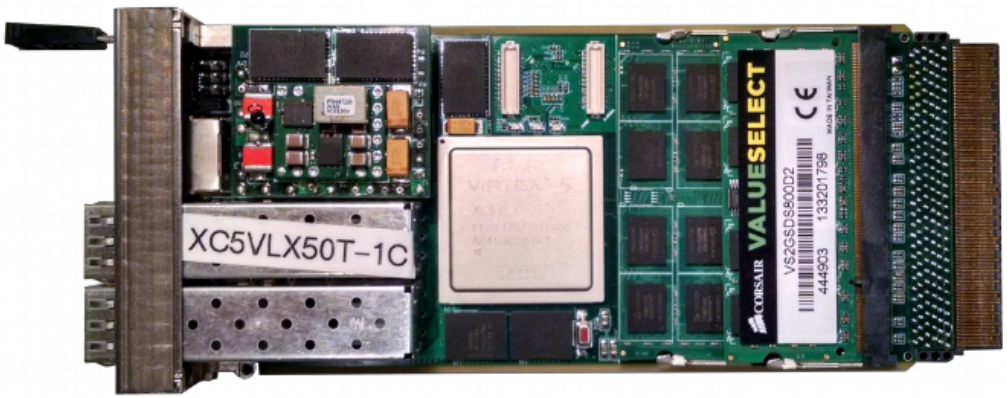
- 48 optical links from BEE
- Online tracking and ROI creation at 30 kHz trigger rate
- Sufficiently precise ROI to achieve data reduction by a factor of 10
- Using FPGAs for track reconstruction

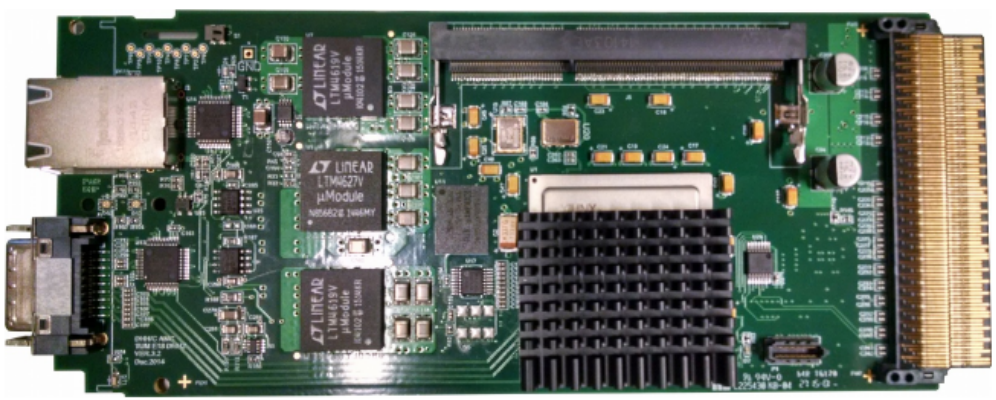


Bruno Deschamps, DPG 2016

Hardware

- Modular system based on uTCA standard
- Concentrator used for BEE data preprocessing
  - Virtex 5 vlx50
  - 2 DDR2 slots
  - Ethernet and RS232 port
  - 4 SFP cages, GTP transceivers



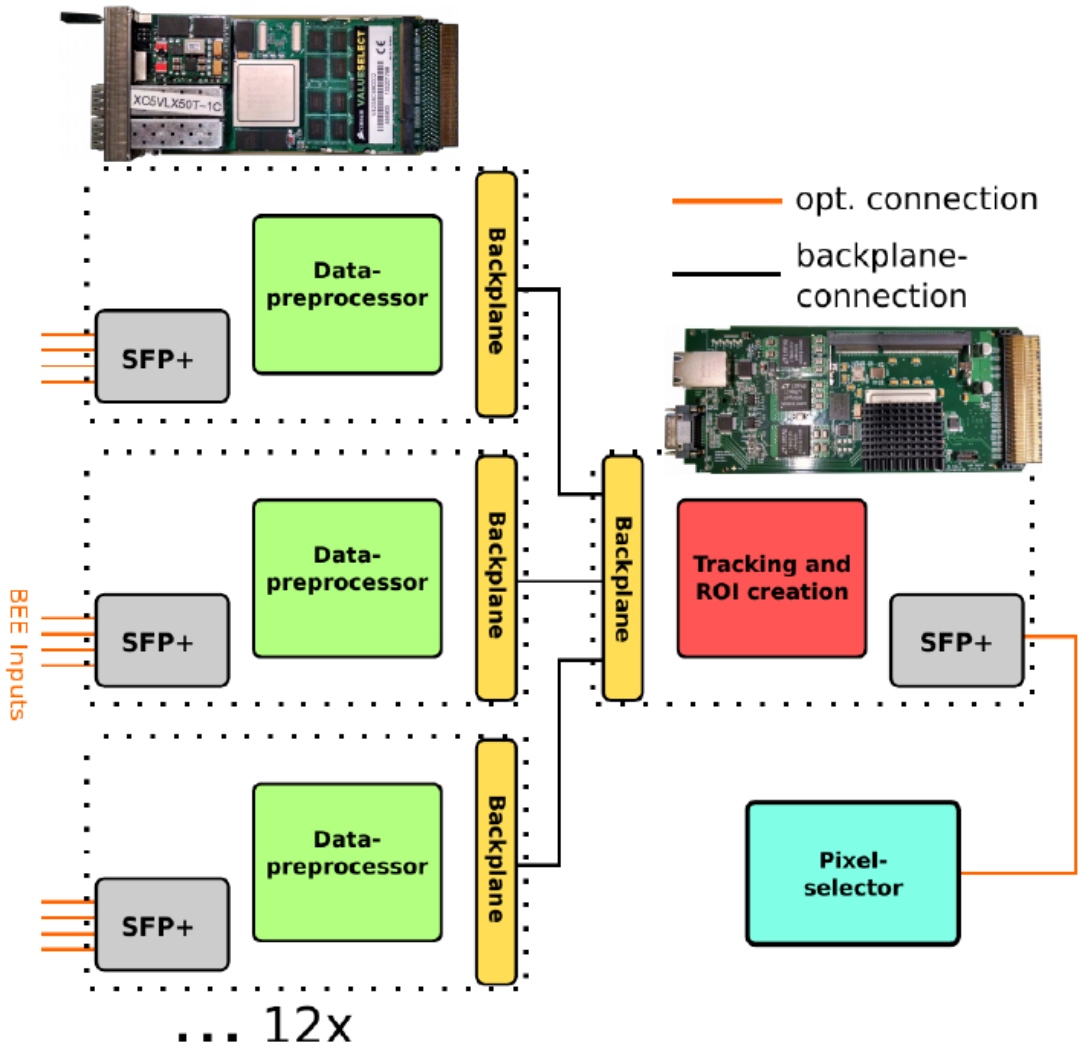


- Tracking Unit
  - Virtex 6 vlx240
  - 1 DDR3 slot
  - Ethernet port
  - InfiniBand connector
  - GTX transceivers

Bruno Deschamps, DPG 2016

DATCON Structure

- Data Acquisition Tracking Concentrator Online Node
- 48 optical links from the SVD Fromt End Electronics (BEE)
- Expected data rate: 6 Gbps
- 12 AMC for data acquisition and preprocessing
- 2 DHE for Tracking and ROI calculation



Bruno Deschamps, DPG 2016

Extrapolation to Most Probable Hit (MPH)

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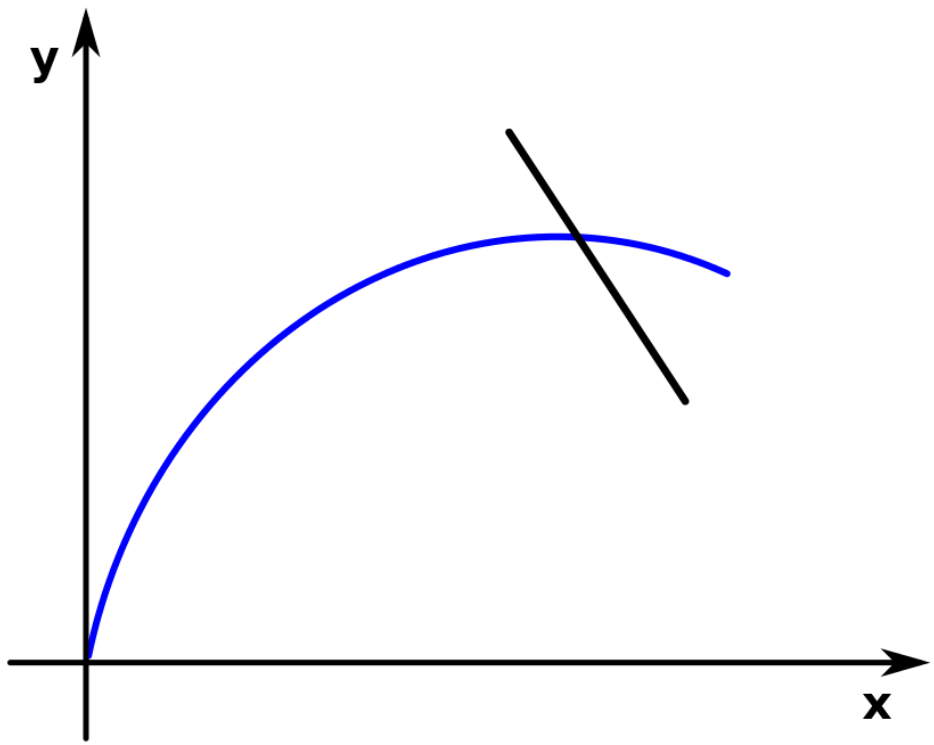
- In *x*-*y*-projection: intersection of a circle (= track) with a straight (= detector) parallel to *y* axis



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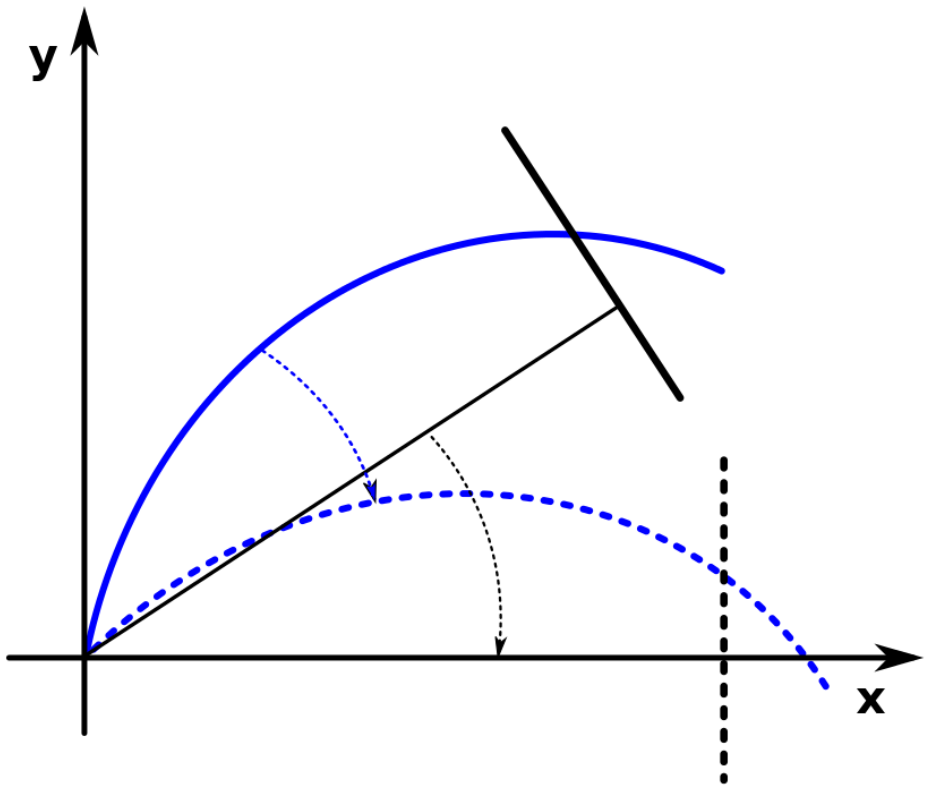

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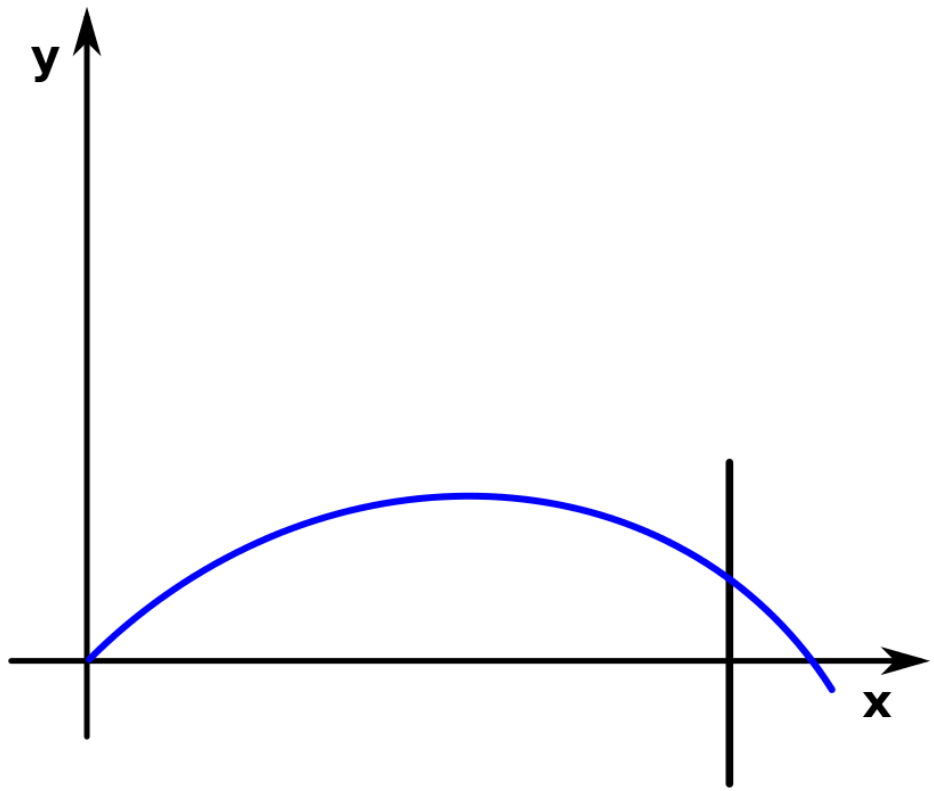

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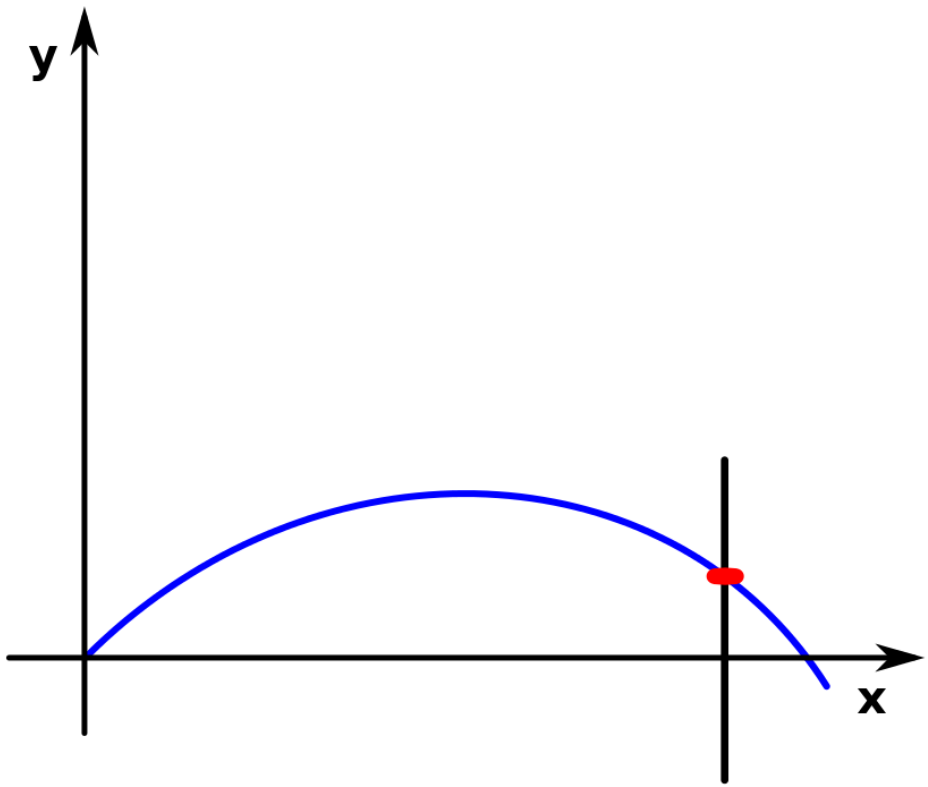

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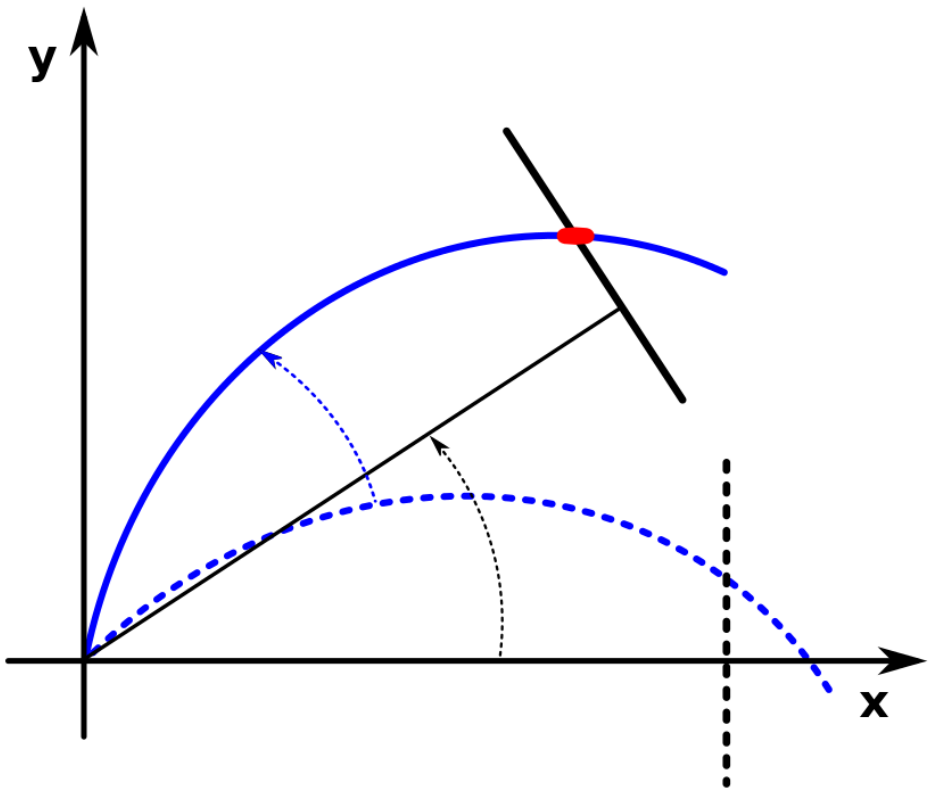

Extrapolation to Most Probable Hit (MPH)

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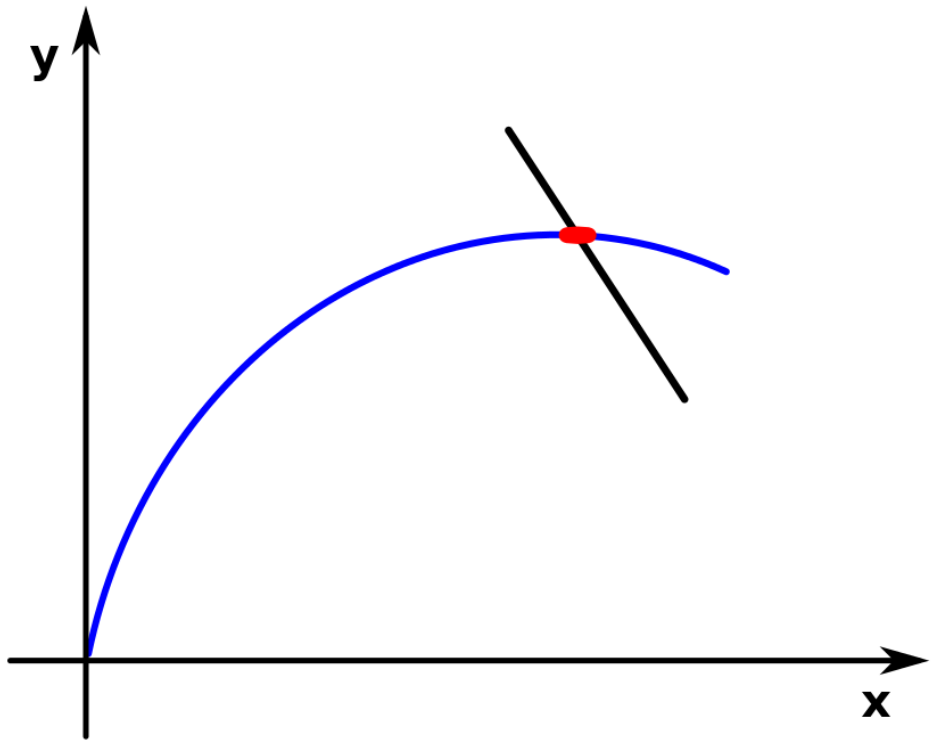

Extrapolation to Most Probable Hit (MPH)

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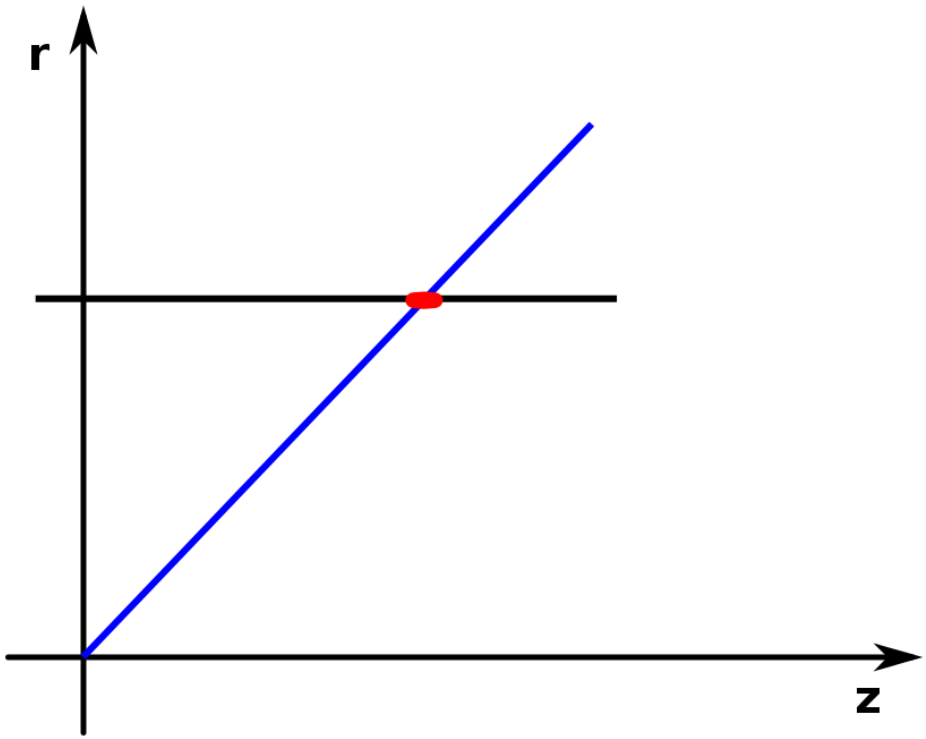
- In *x*-*y*-projection: intersection of a circle (= track) with a straight (= detector) parallel to *y* axis
- In *z*-*r*-projection: intersection of a straight (= track) with a straight (= detector) parallel to *z*-axis



Simulation Setup

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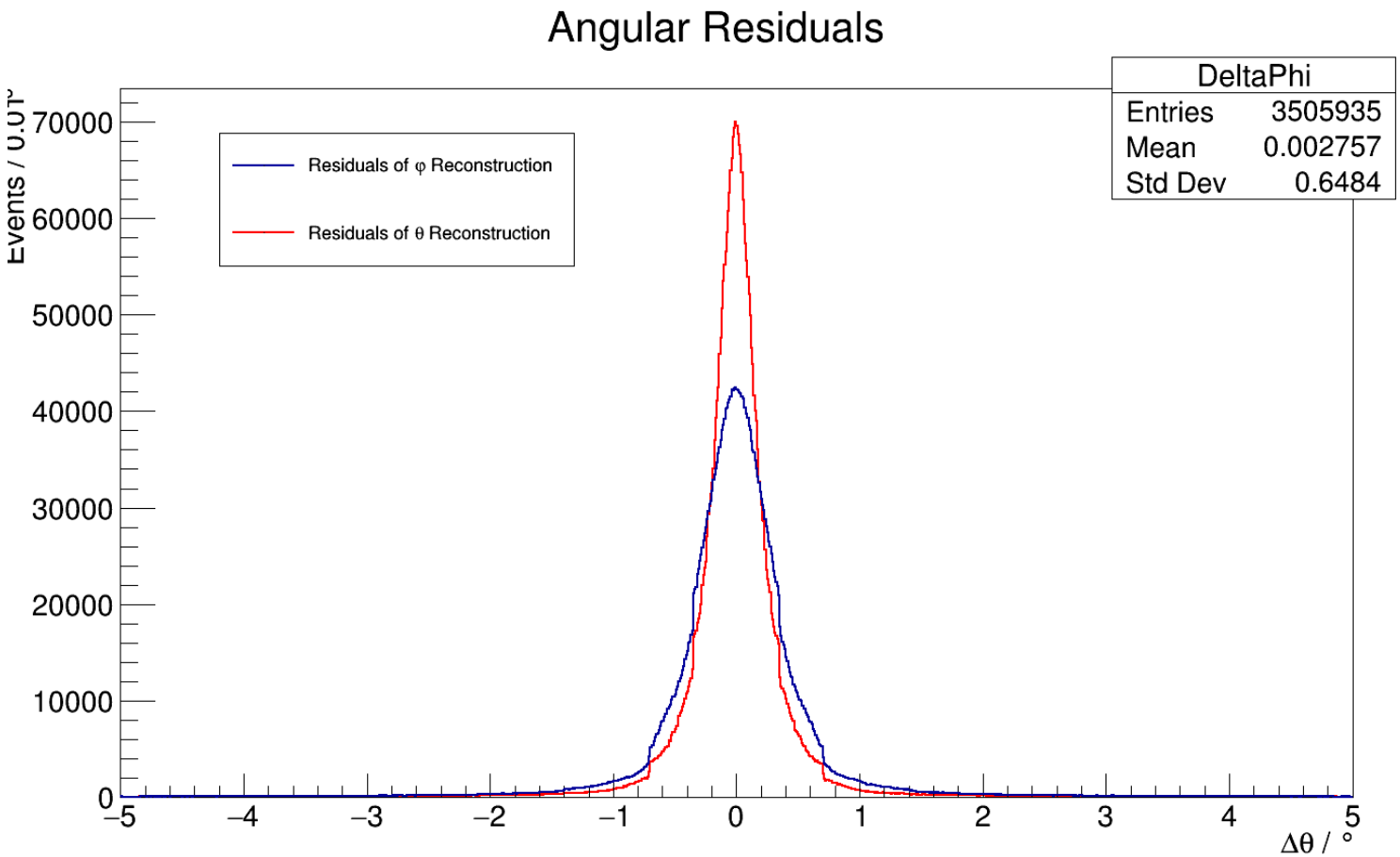
- Simulation with 400k $\Upsilon(4S)$ events and optimisation for these events (previously only electrons from (0,0,0)))
- ROI size fixed to 120×80 pixel ($u \times v$), corresponding to $(6 \times 6\,\mathrm{mm}^2)$
- Particle is reconstructed if $|\Delta\varphi_{\text{MCtrue-reco}}| < 5°$ & $|\Delta\theta_{\text{MCtrue-reco}}| < 5°$
  (Unfortunately no use of RecoTracks yet, work in progress)

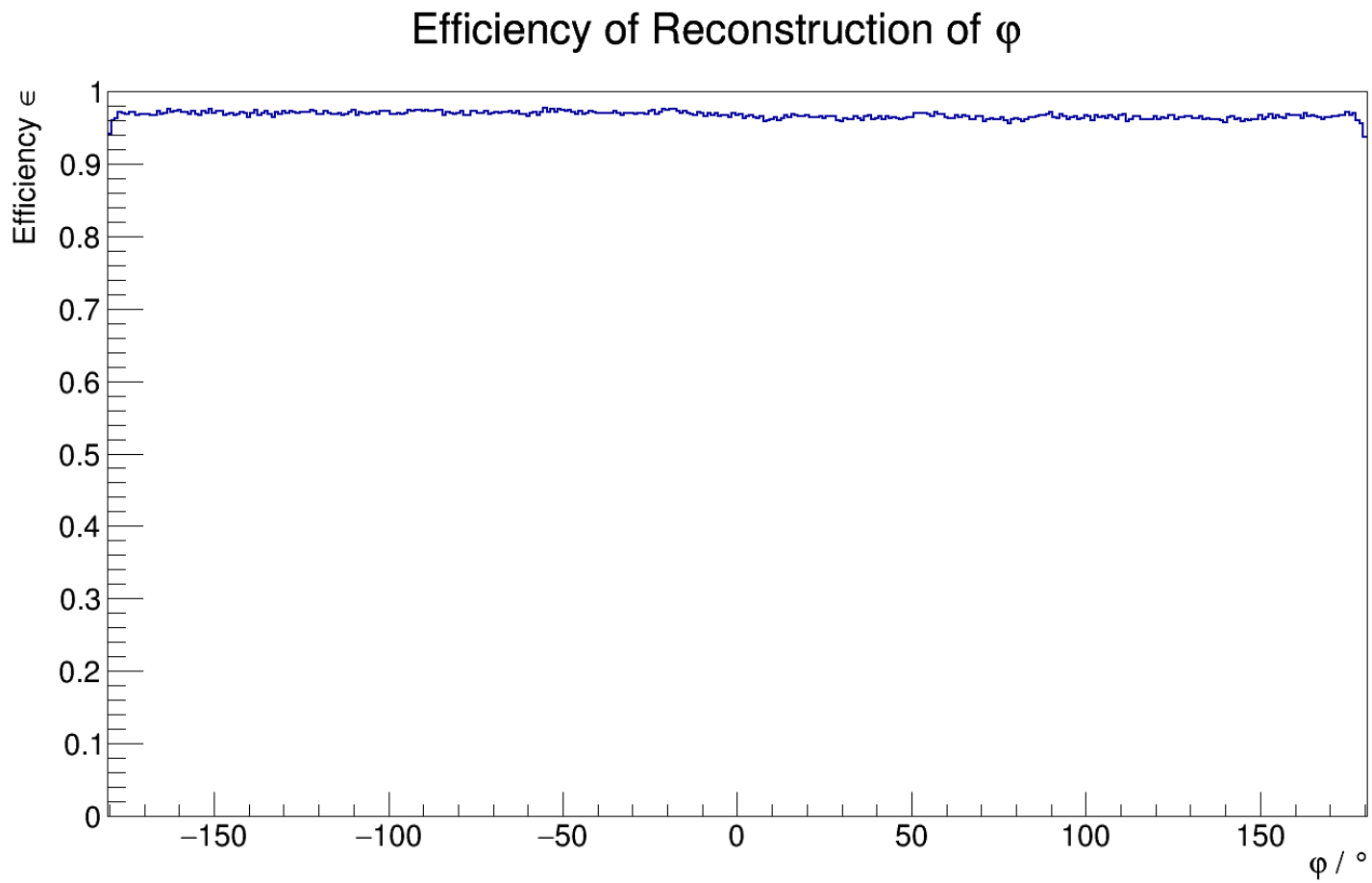
Angular Residuals

Most reconstructed tracks have a deviation of less than 1° compared to the MCParticle



Efficiency of φ Reconstruction

High and uniform reconstruction efficiency of φ over the whole azimuthal angle



Efficiency of θ Reconstruction

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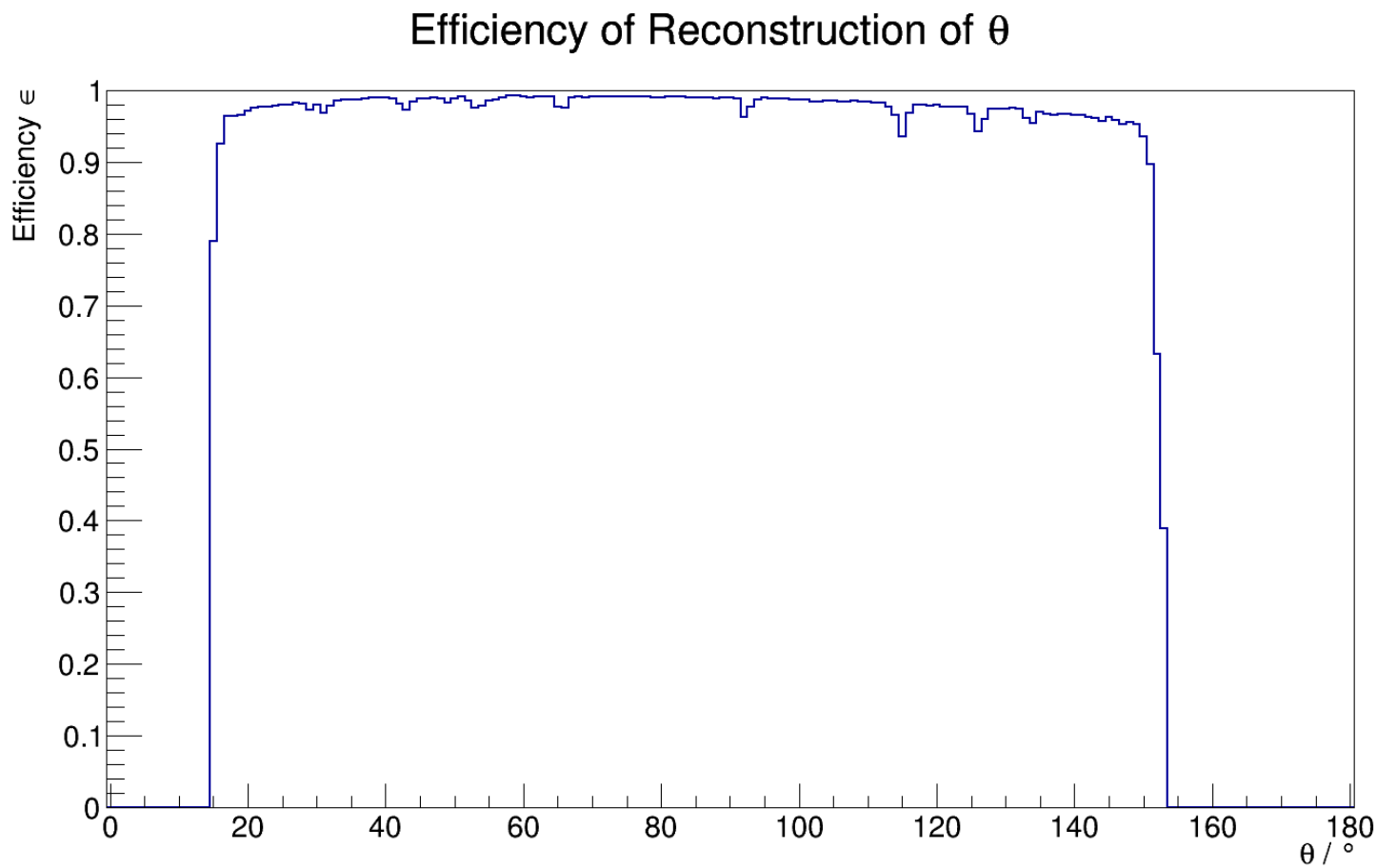
High and uniform reconstruction efficiency of θ over the complete SVD acceptance region



Efficiency of θ Reconstruction vs φ

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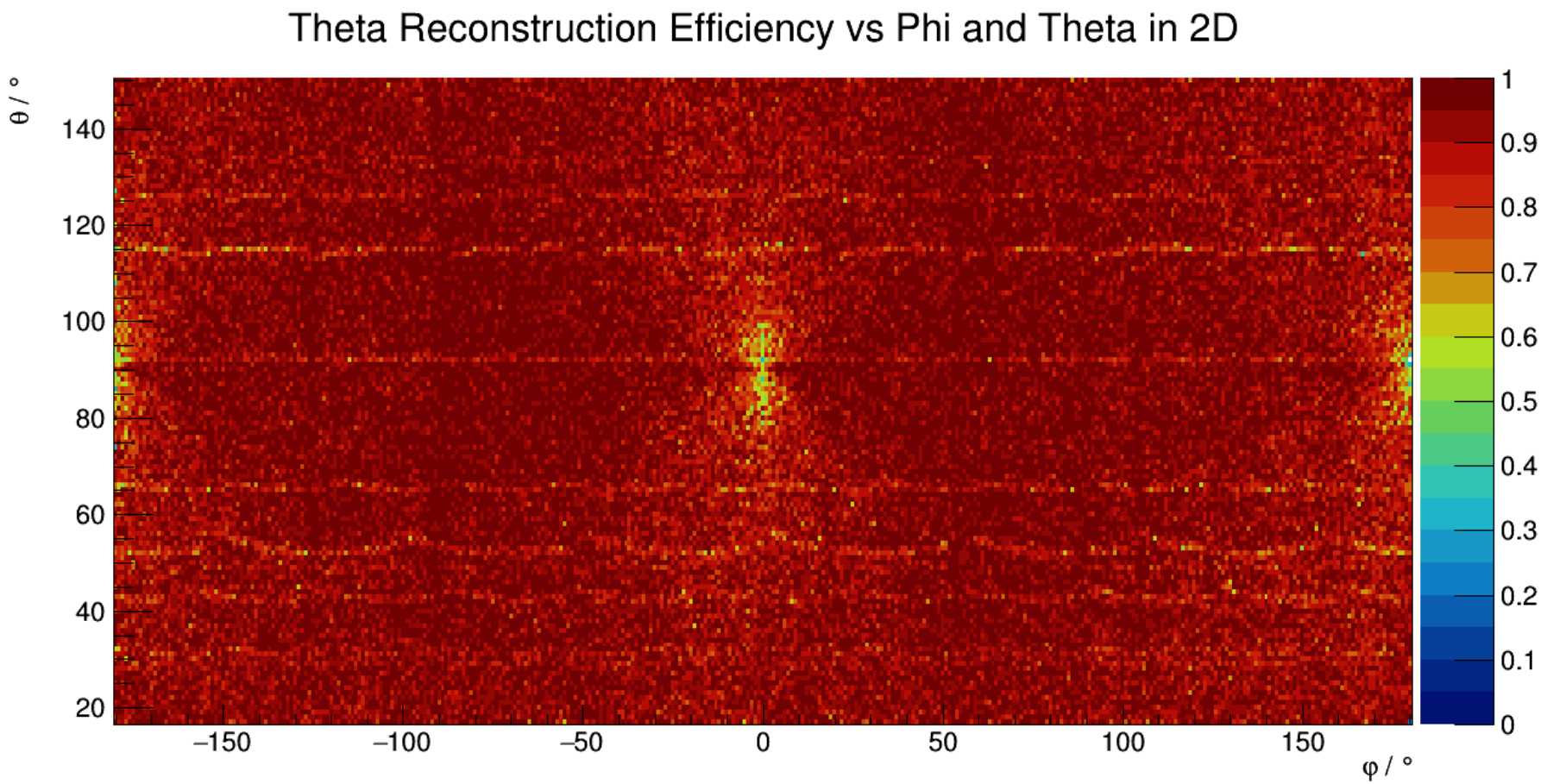
Old algorithm: decreased efficiency in certain regions



Efficiency of θ Reconstruction vs φ

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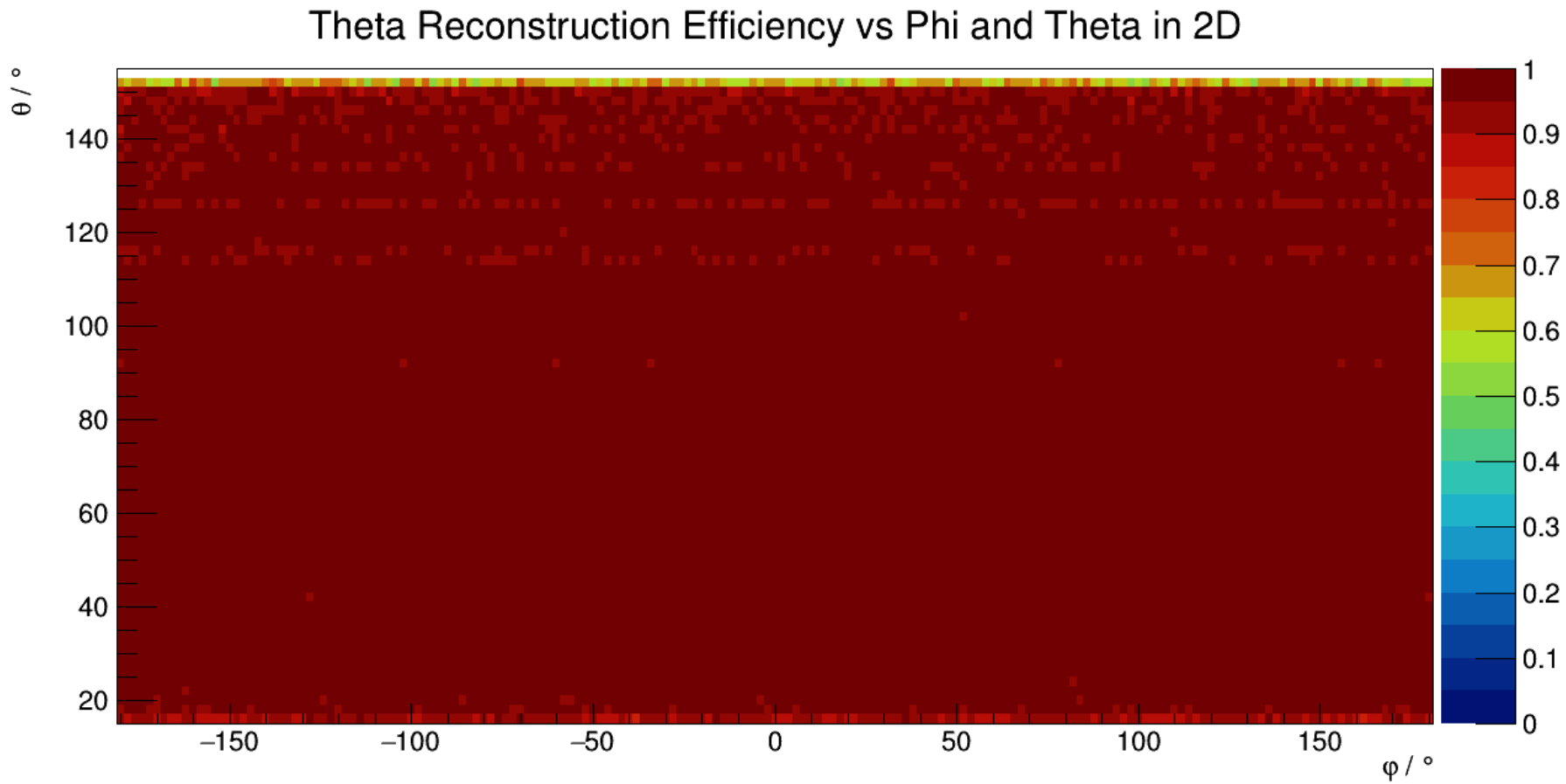
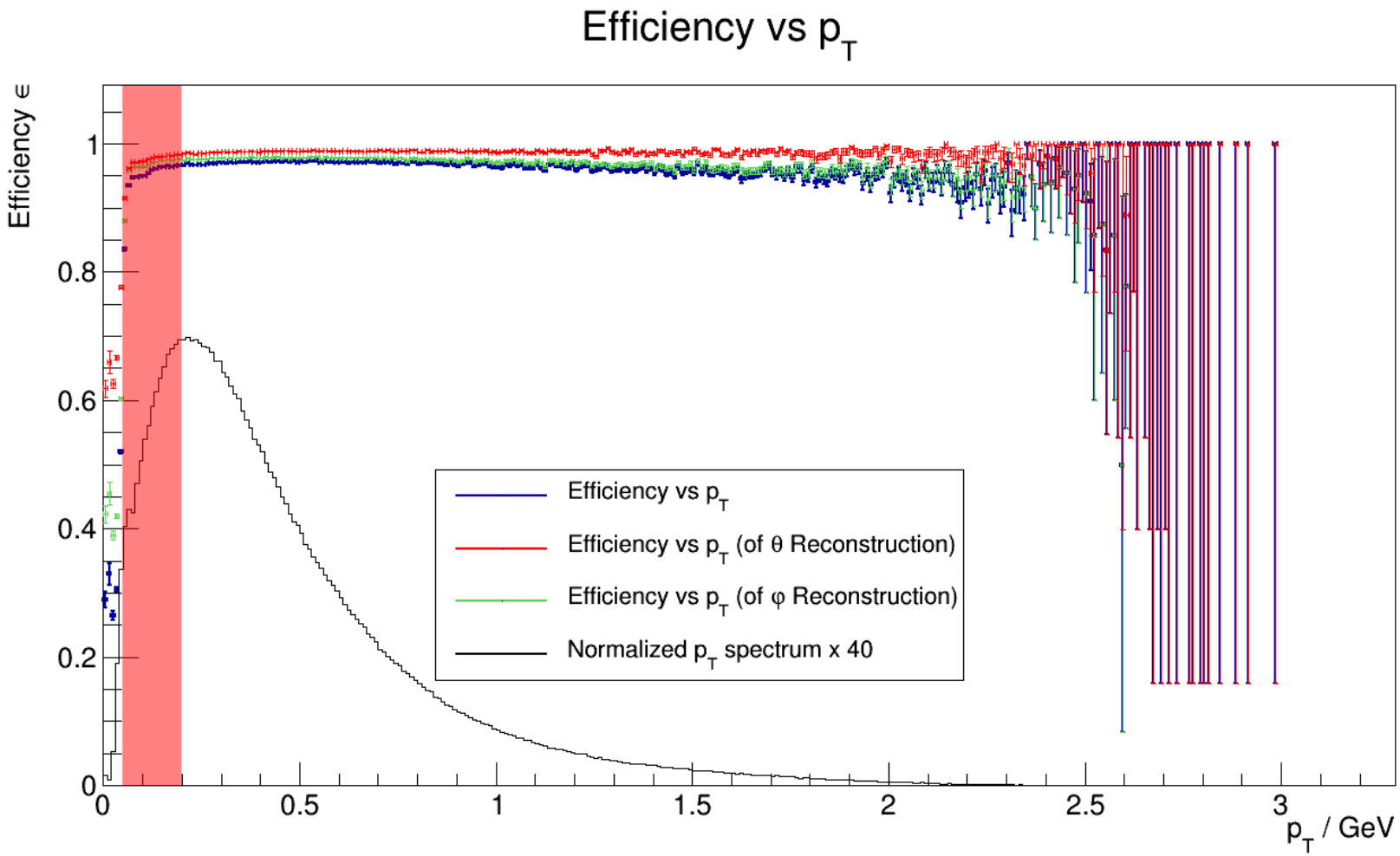
Uniform reconstruction efficiency of θ in the whole detector



Reconstruction Efficiency vs p_T



Reconstruction Efficiency per Event

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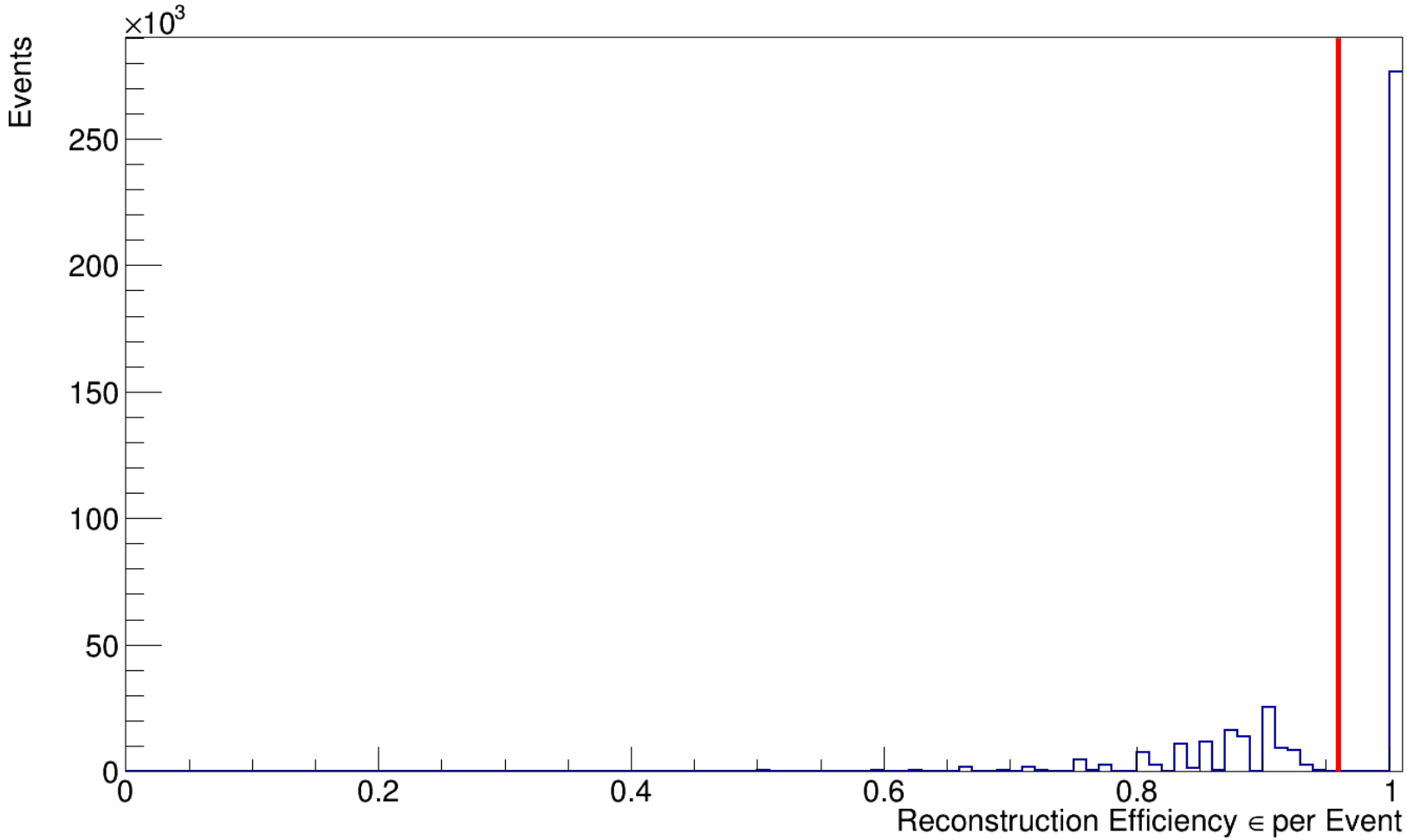
In 70% of the events all tracks are reconstructed, mean is 96%



MPH Residuals

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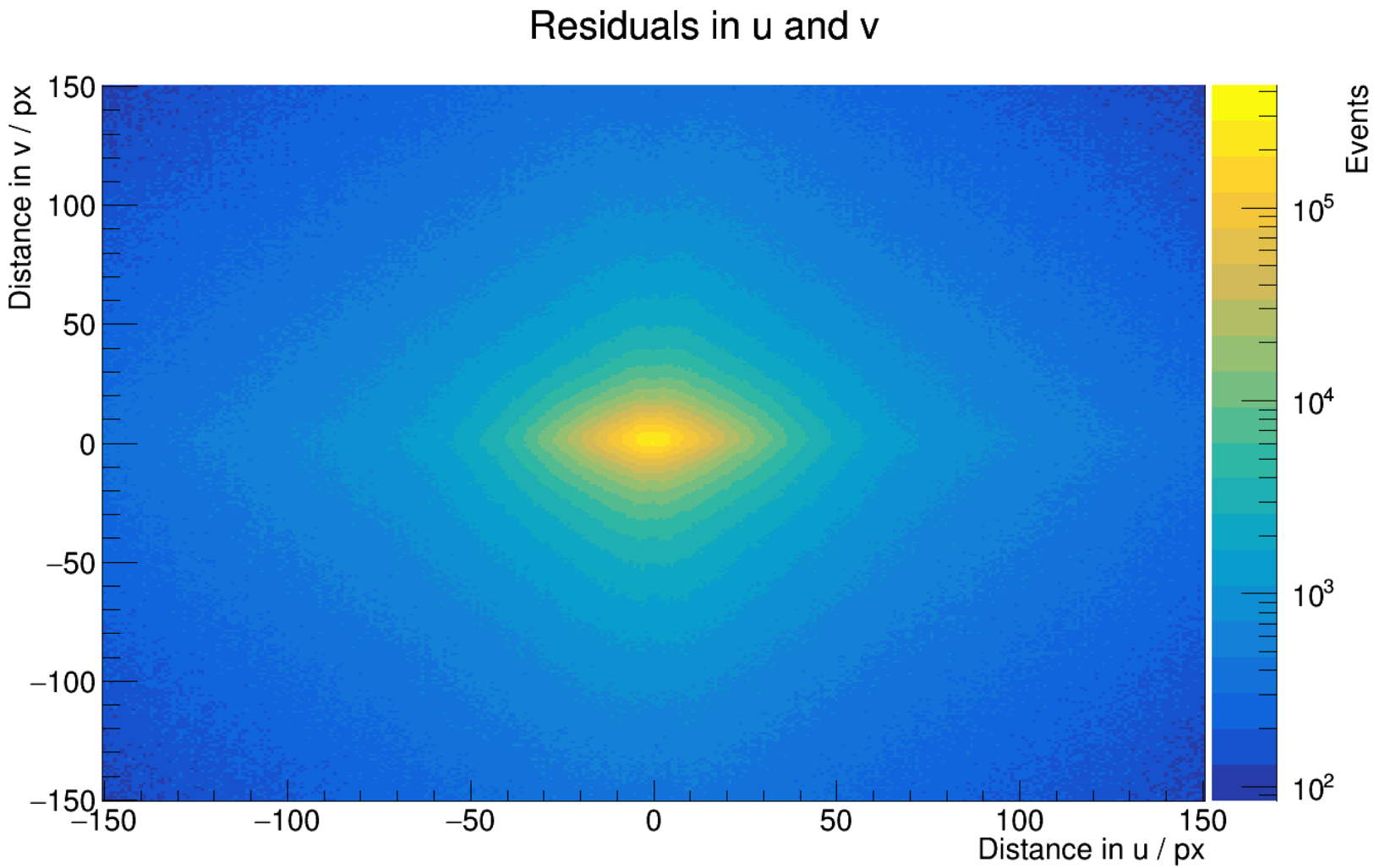
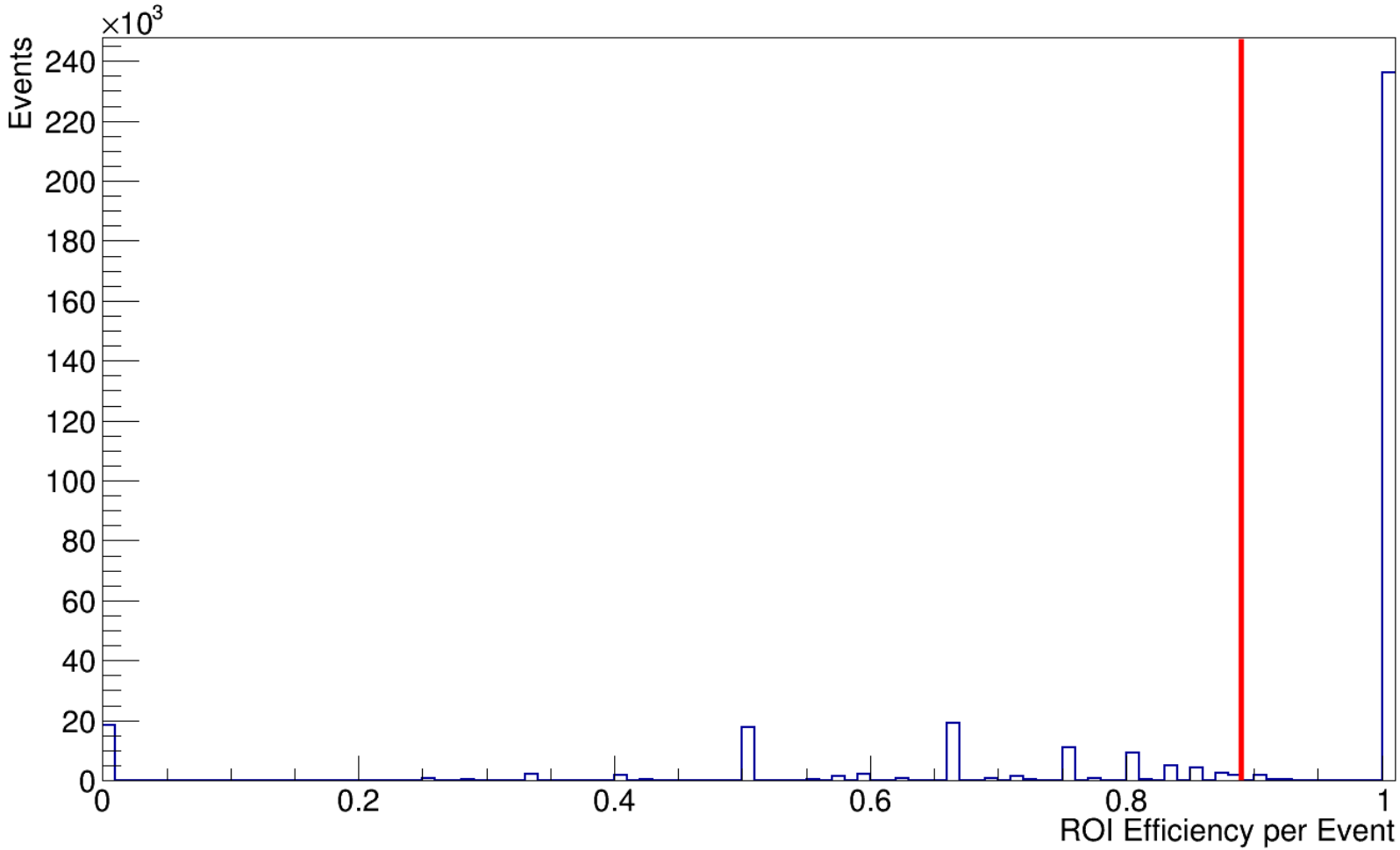
Distance between MPH and MCParticle true hit



ROI Efficiency per Event

High ROI efficiency, mean at 88%, median at 100%.
“Strange” events with no hit inside ROI need further investigation



Data Reduction Factor per Event

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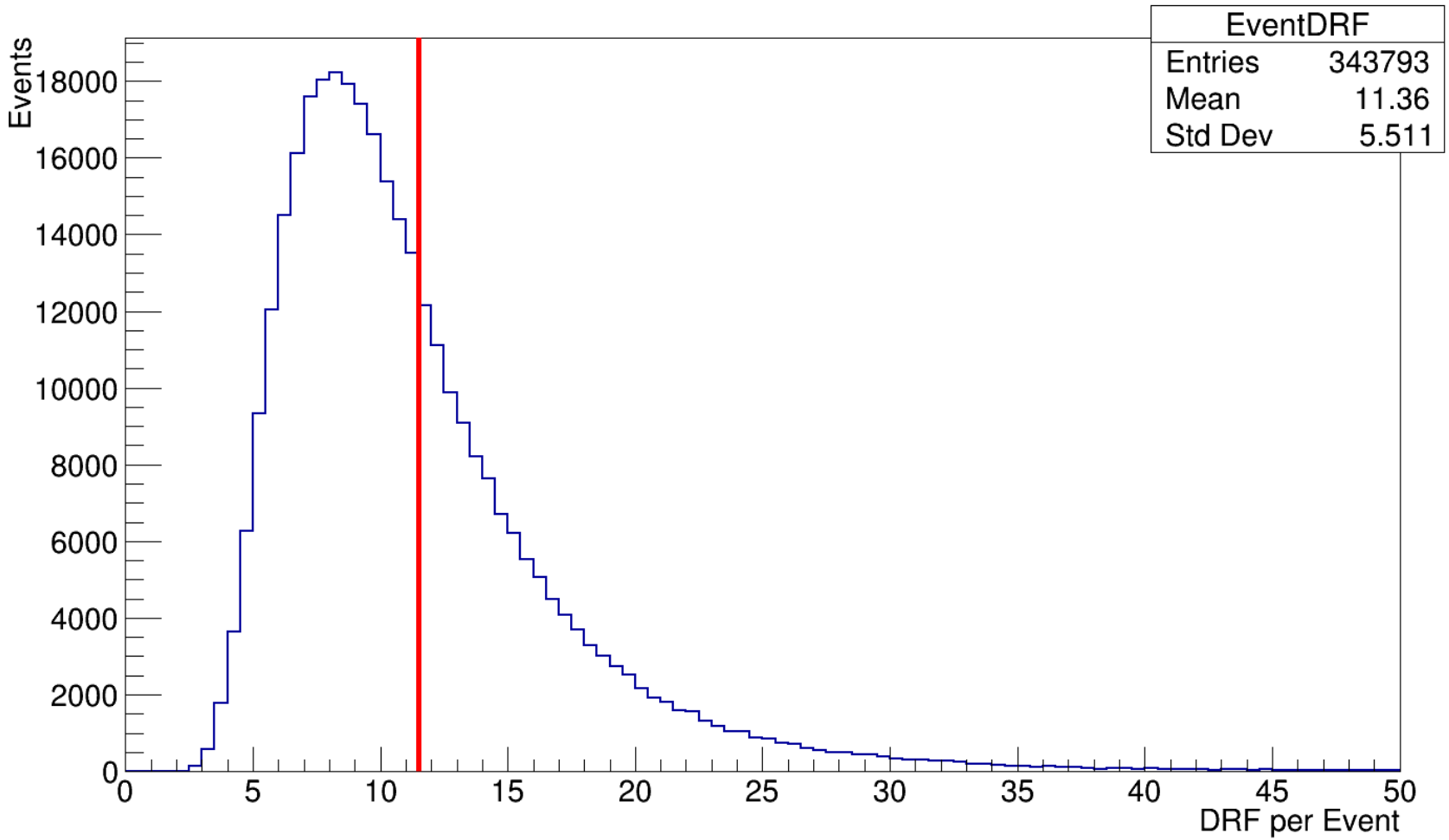
Mean DRF of 11.4, median at 10



Conclusions and Outlook

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- (Fast) Hough Transformation is suitable for fast track reconstruction in Belle II
- Track reconstruction efficiency of 96% (tracks from close to the interaction point)
- ROI efficiency of 88%, median at 100%
- Data Reduction Factor (DRF) of 10 is achieved
- Possible improvements:
  - Usage of second coordinate of θ Hough Space
  - Analytical calculation of intersections in Hough Space
    - More precise track reconstruction $\Rightarrow$ smaller ROI
    - Less fake tracks $\Rightarrow$ better DRF
  - ROI size varying with p_T $\Rightarrow$ better DRF

Backup

PDG codes of the charged-stable particles

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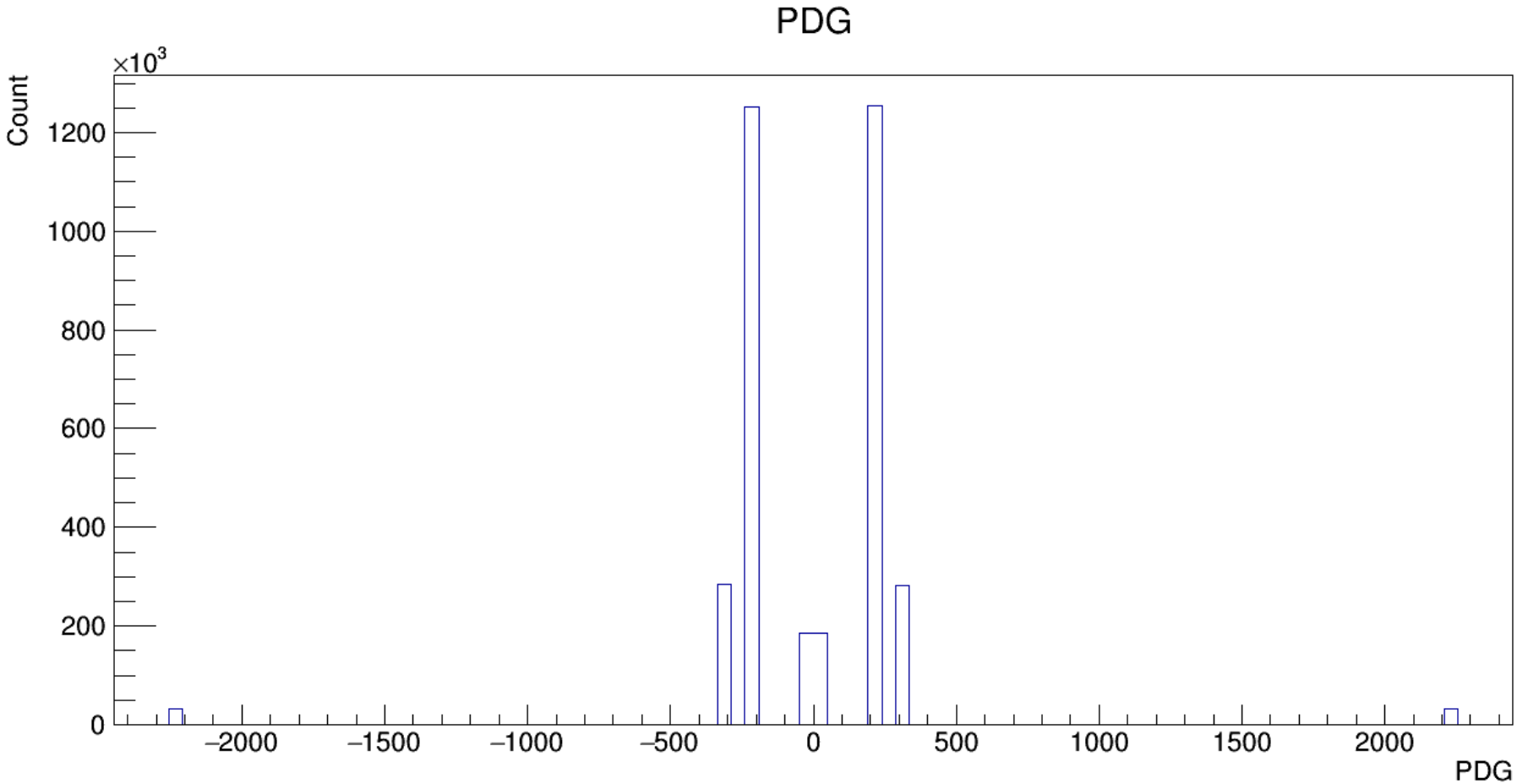
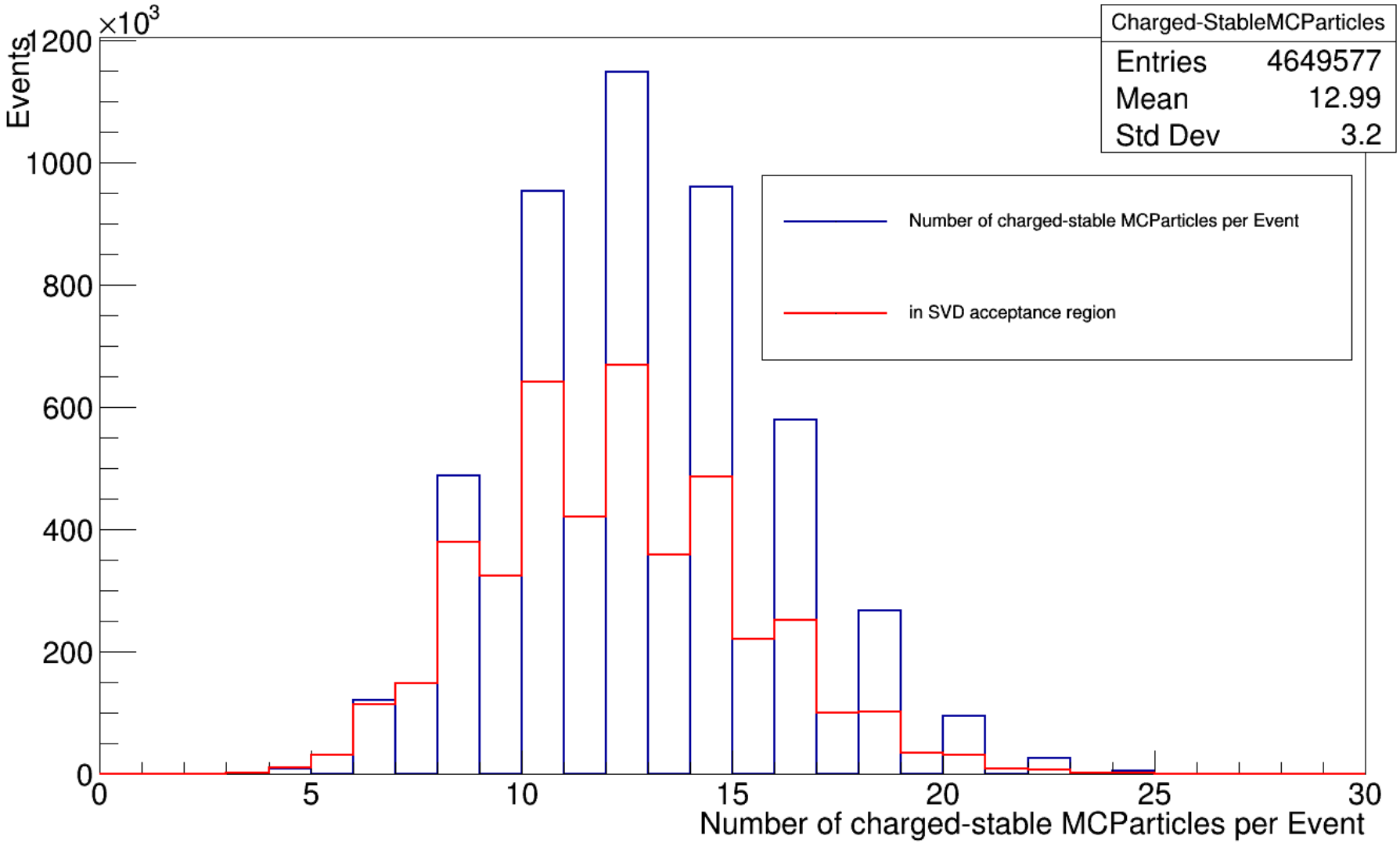
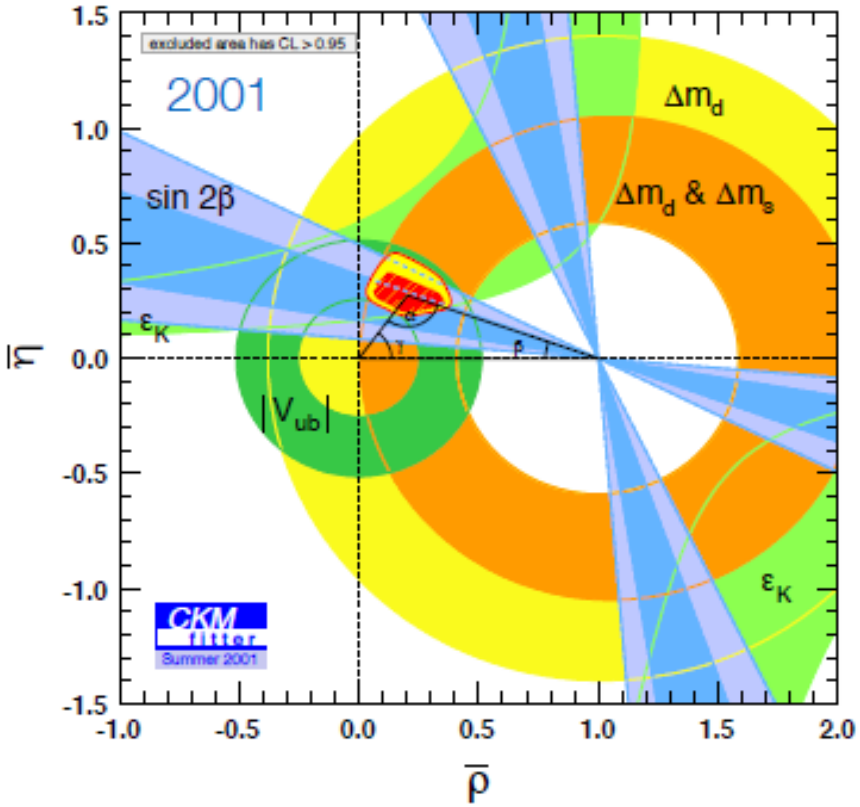
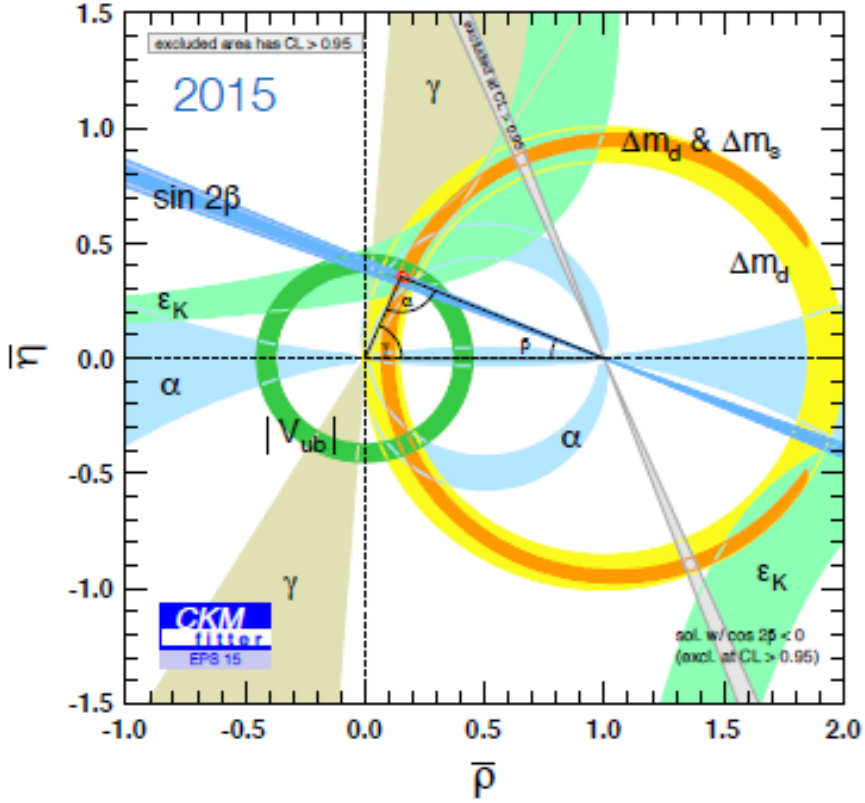


Number of charged-stable particles



Unitarity Triangle





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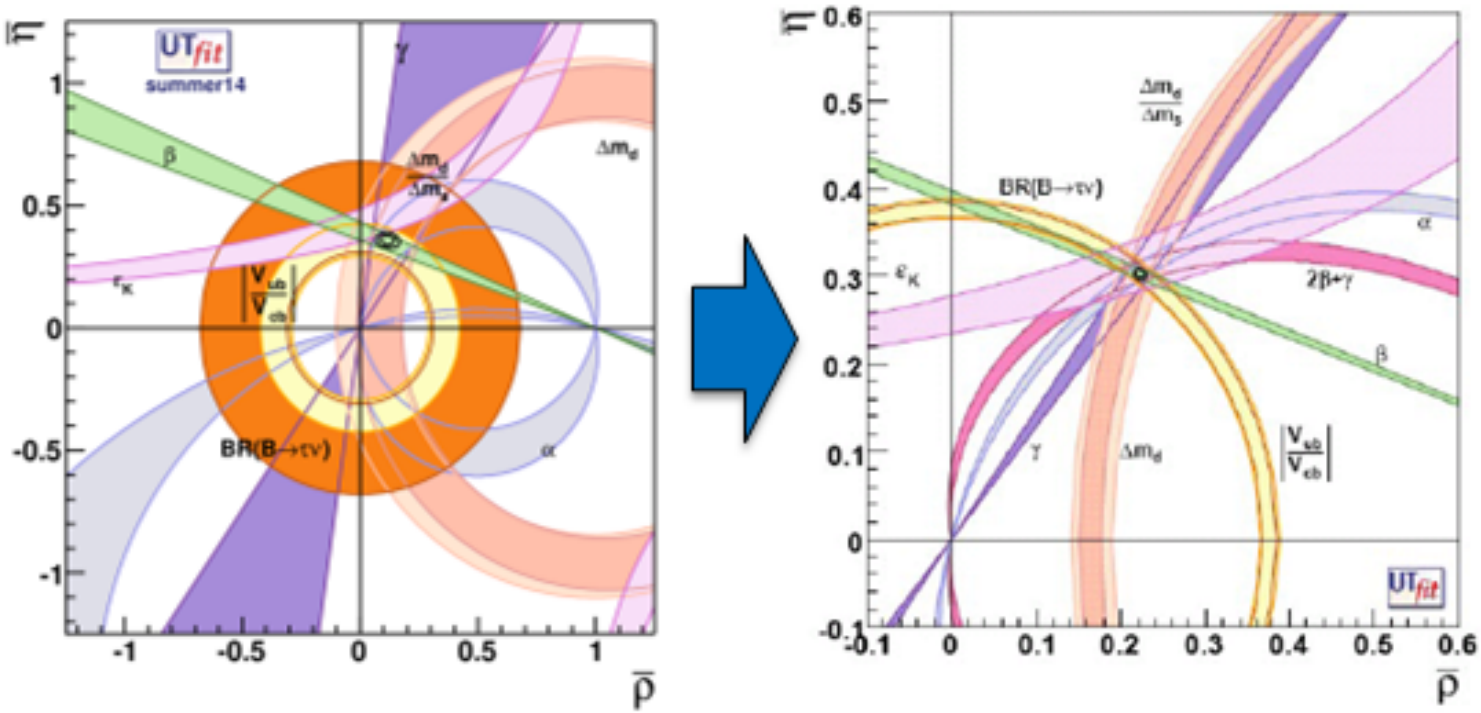

ROI size parameter sweep

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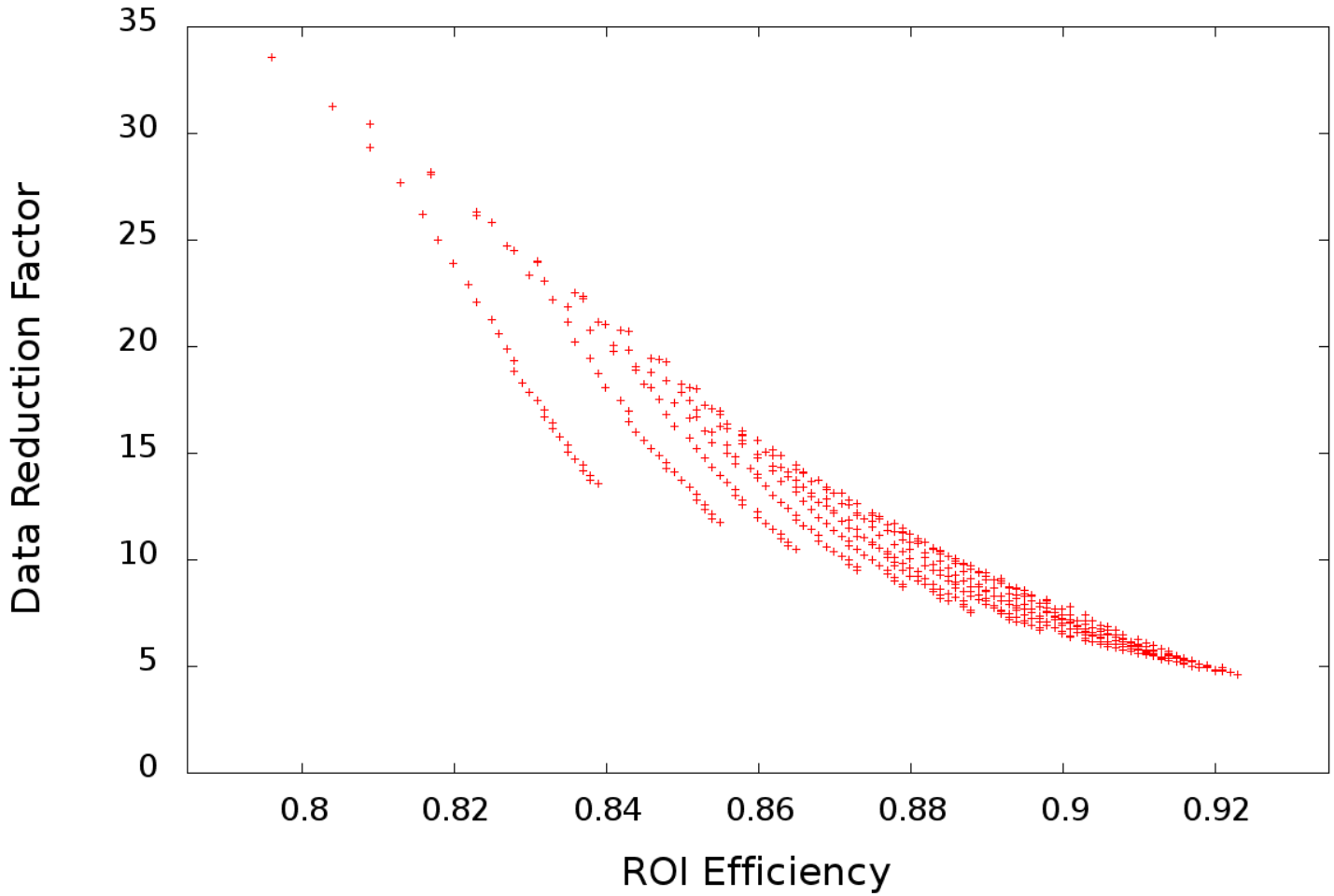

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