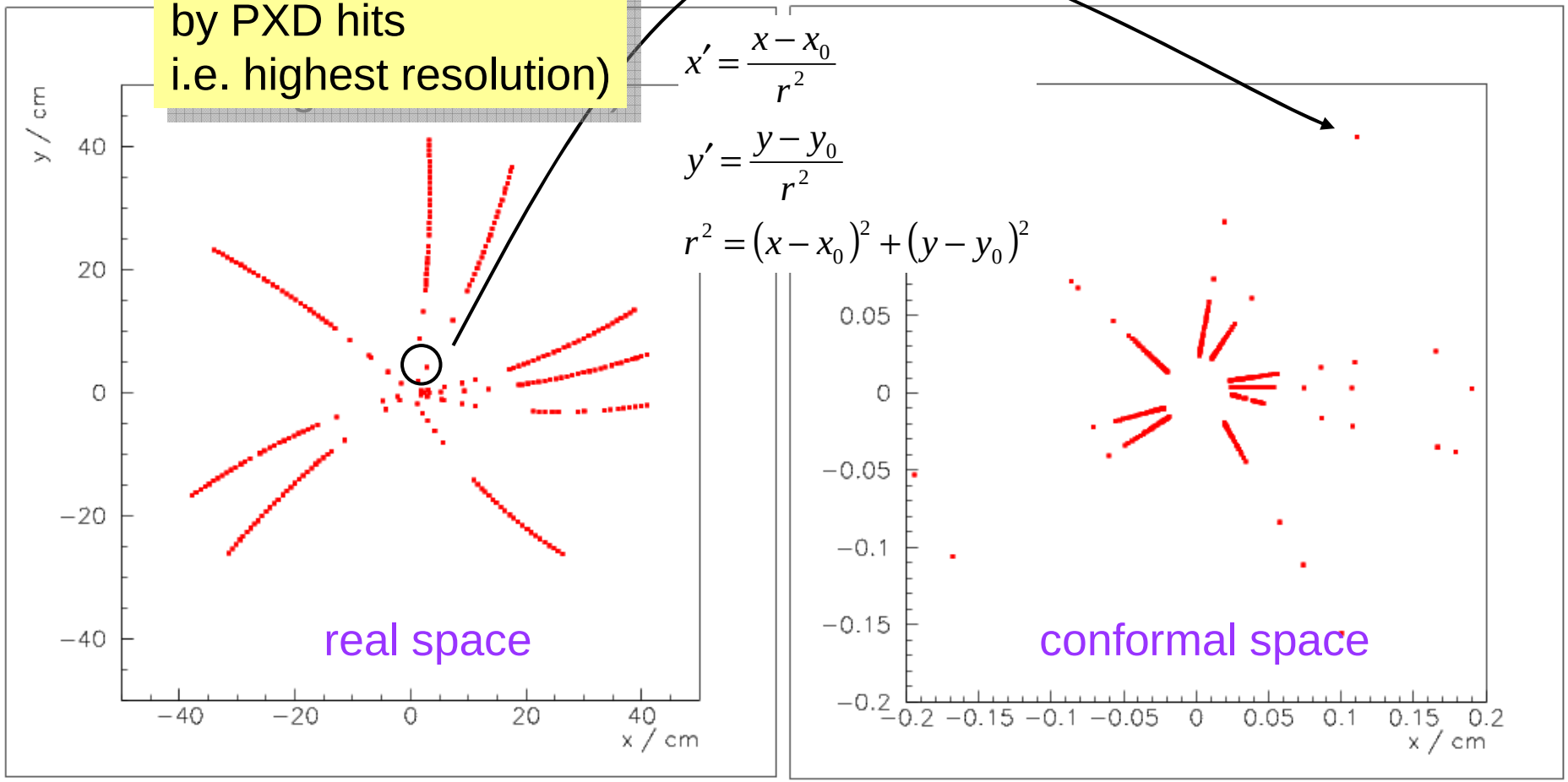
Online Track Finder and Track Fitter
Step #1: Conformal Map for Track Finding

inverse space
(lever arm constraint
by PXD hits
i.e. highest resolution)

$$x' = \frac{x - x_0}{r^2}$$

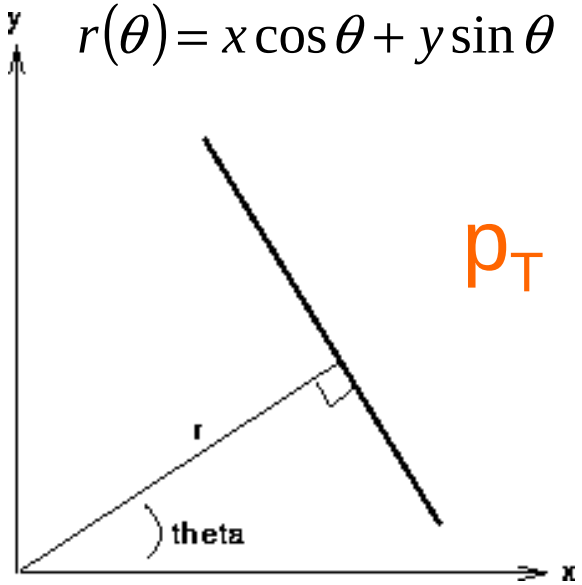
$$y' = \frac{y - y_0}{r^2}$$

$$r^2 = (x - x_0)^2 + (y - y_0)^2$$

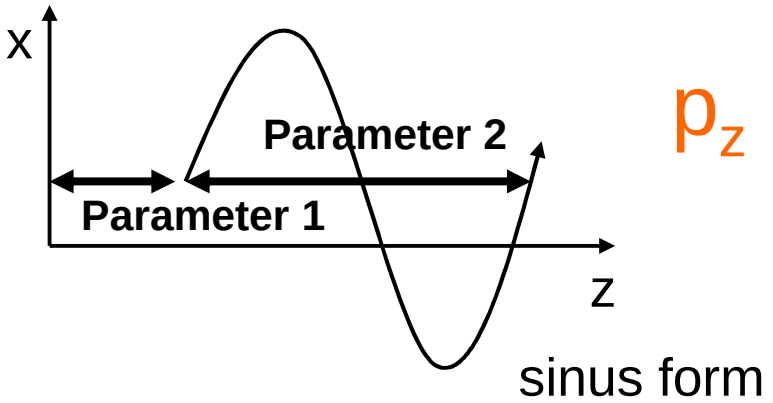


Online Track Finder and Track Fitter
Step #2: Hough Transform for Track Fitting

- **IMPORTANT:**
  our Hough space is filled with conformal coordinates!
- **fix point arithmetics (instead of floating point)**
- **24 bit (in division and multiply 48 bit)**
- **Hough space 512×512**
- **lookup table for sinus(): 128 x 16 bit**
- **p_z reconstruction is a 2nd Hough transform helix in xz space is a sinus function**



p_T

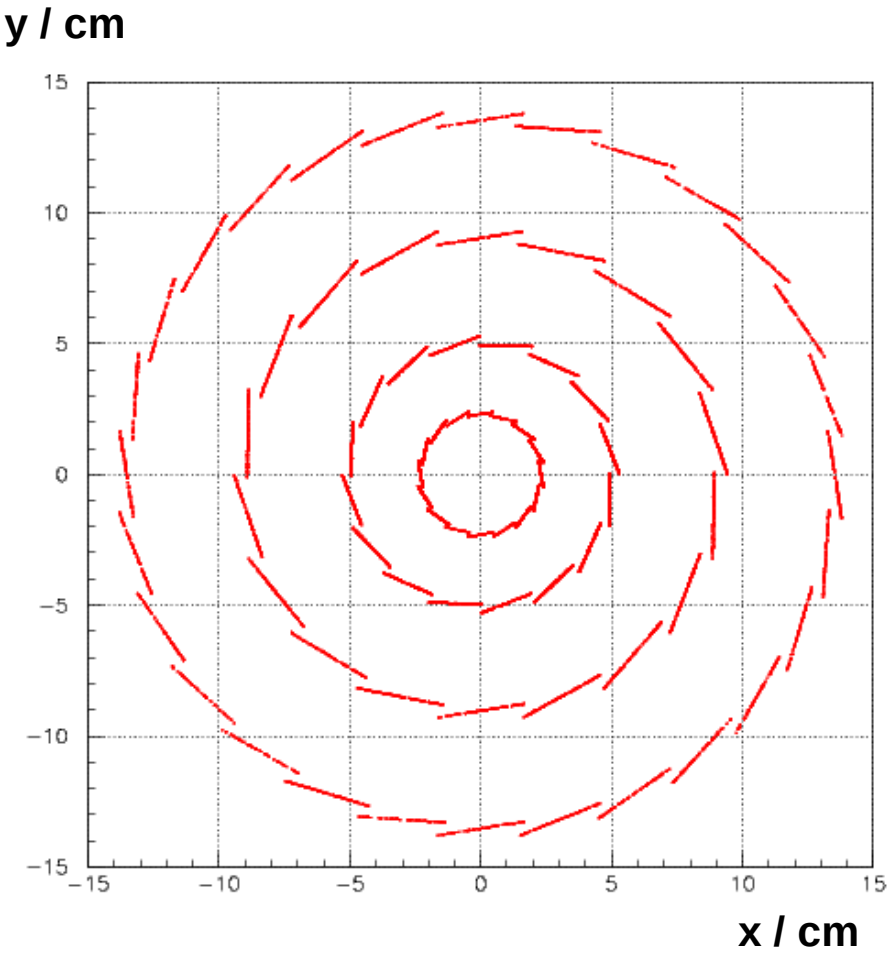


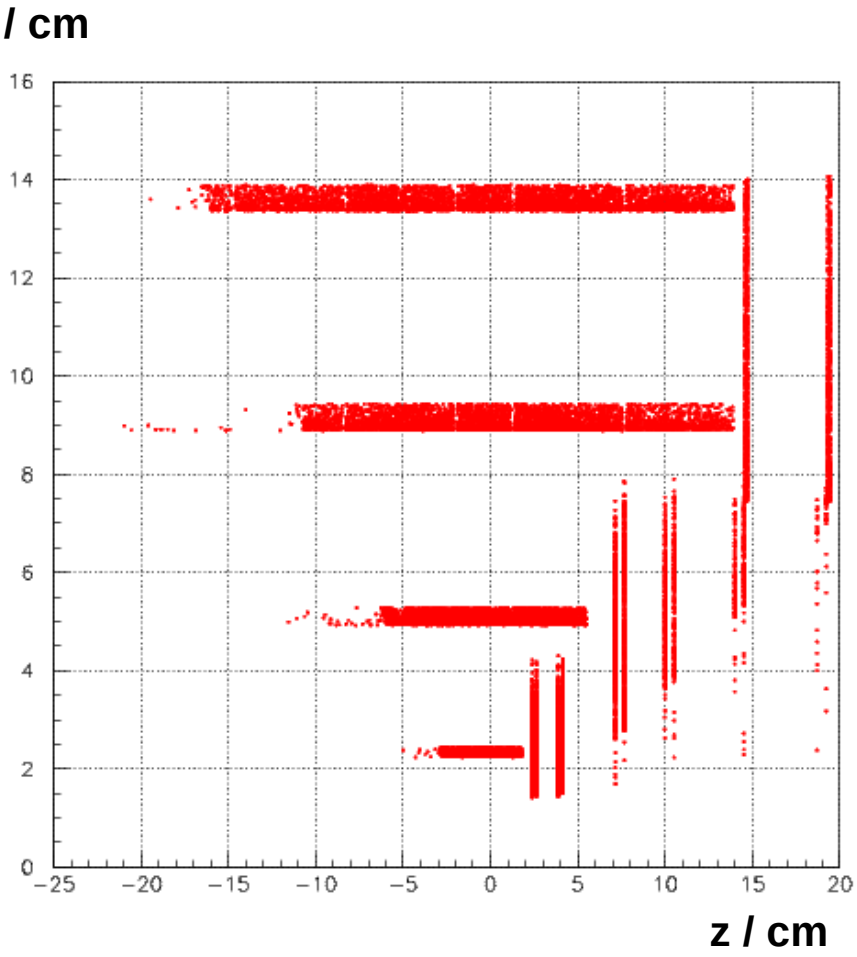
p_z

sinus form

Panda PXD+SVD geometry

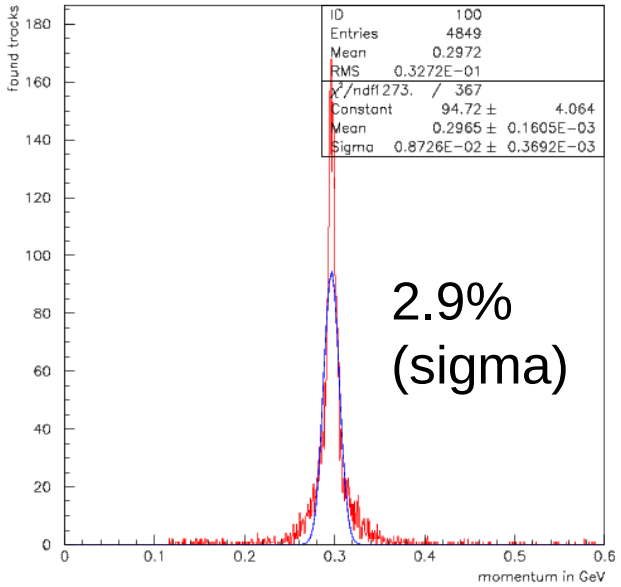
Full digitization switched on in simulation



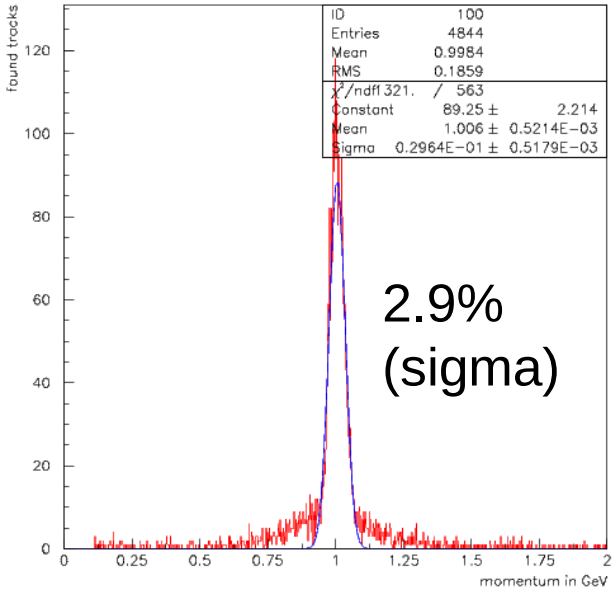


Online Track Finder and Track Fitter Momentum Resolution

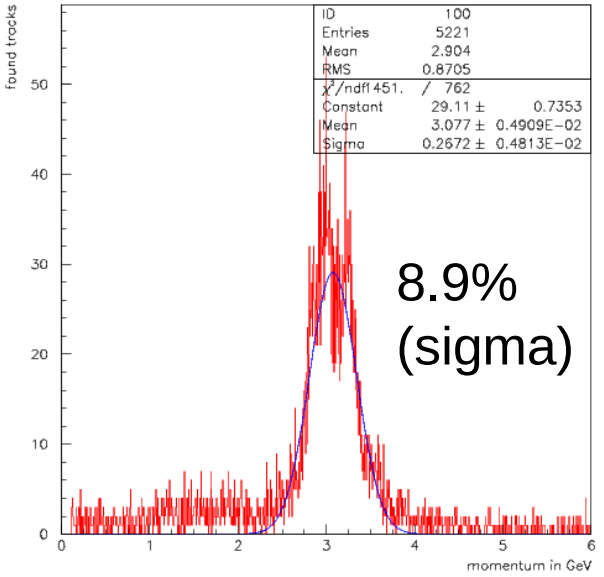
p=0.3 GeV



p=1 GeV



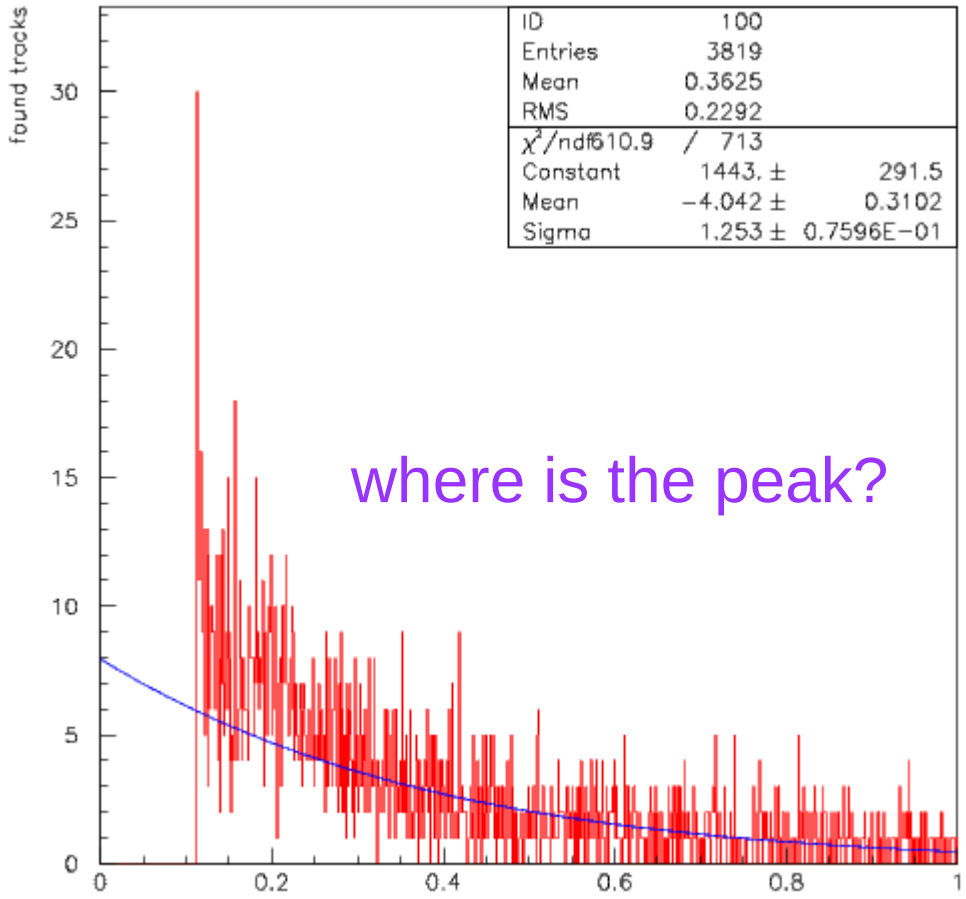
p=3 GeV



Final results for Panda
(for PDX, SVD **+ Straw Tube Tracker, ≤ 30 hits on track**)

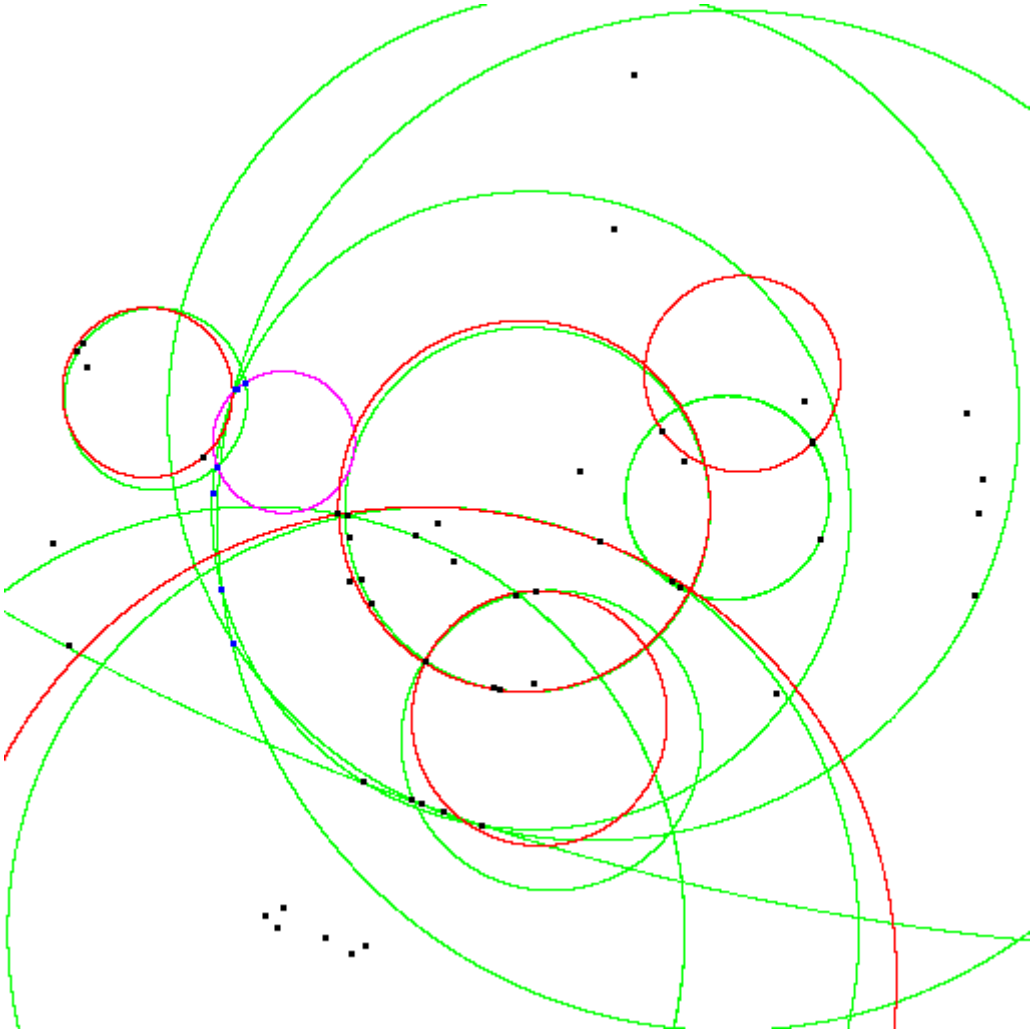
- Efficiency ~10% lower than offline, over whole pT range
- Momentum resolution factor ~2.5 worse than offline
- Outlier hits ~6.2% (not assigned to any track)

Momentum Resolution
p=100 MeV, MVD Stand-Alone (no STT)
(also Test for Belle II Pixel Detector Trigger)

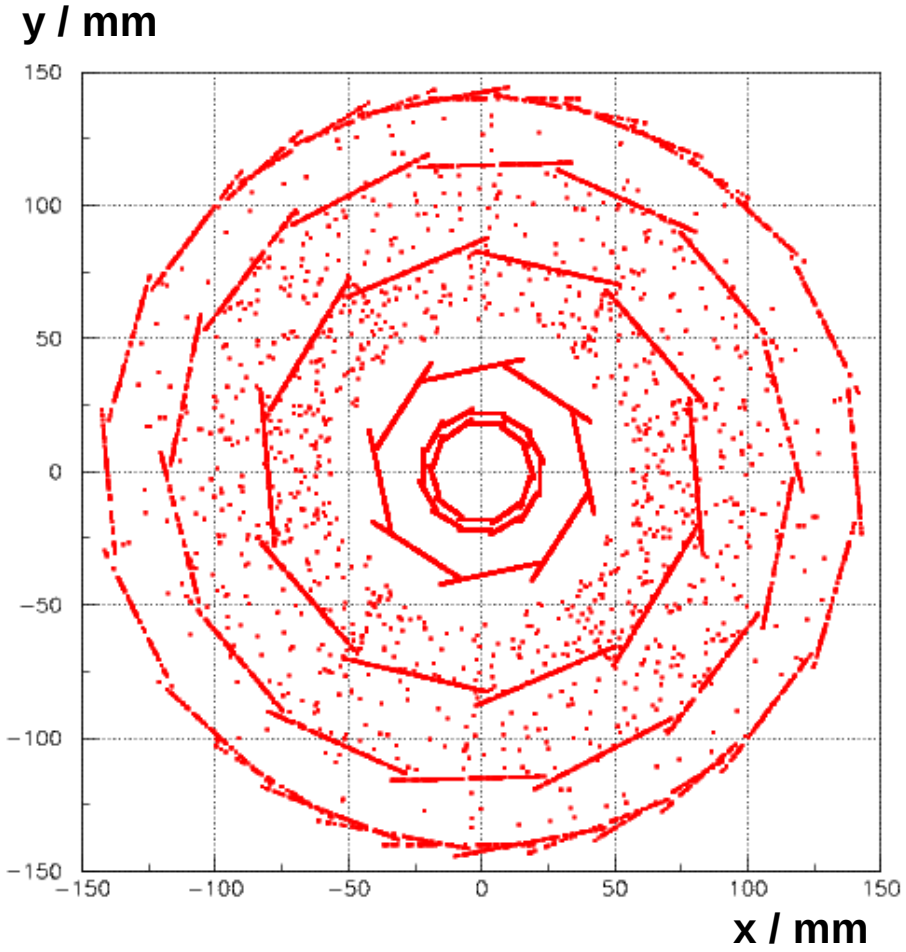


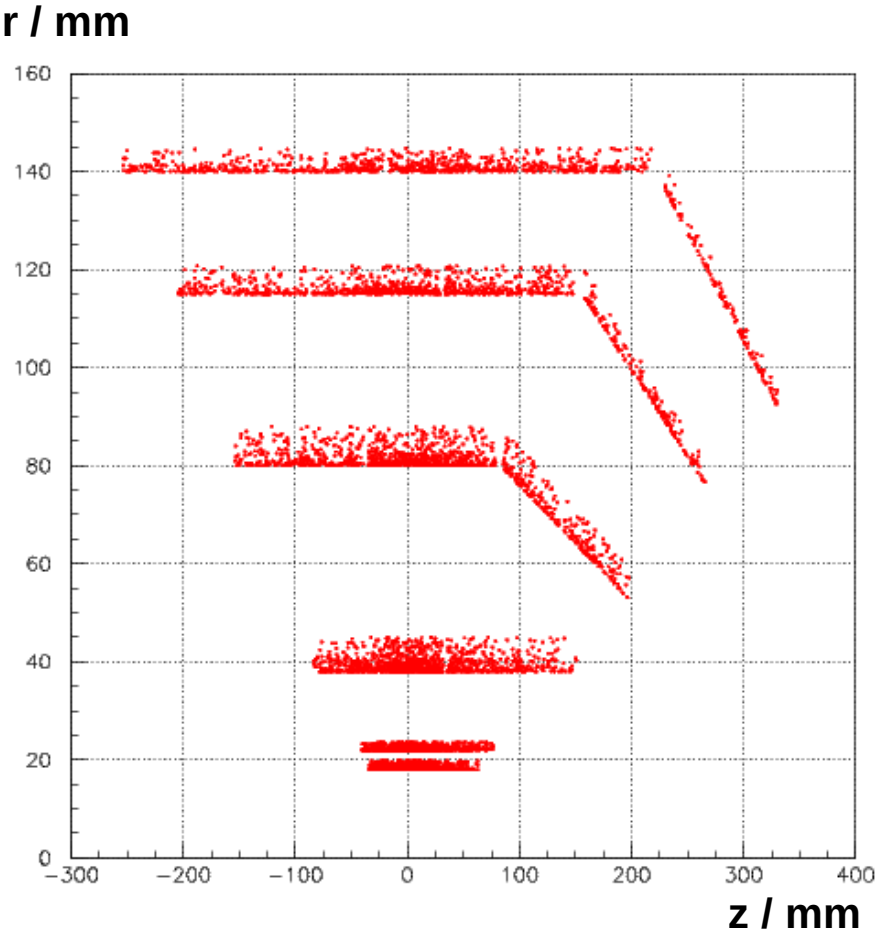
10 Tracks with p=100 MeV, MVD only
Real Space xyz Hits

Online Track Finder finds detector geometry



Belle II PXD+SVD Simulated Hits





simulated hit data provided by Zdynek Drasal

digitization not switched on yet

Results, Belle II PXD+SVD, Momentum Resolution, Stand Alone Tracking

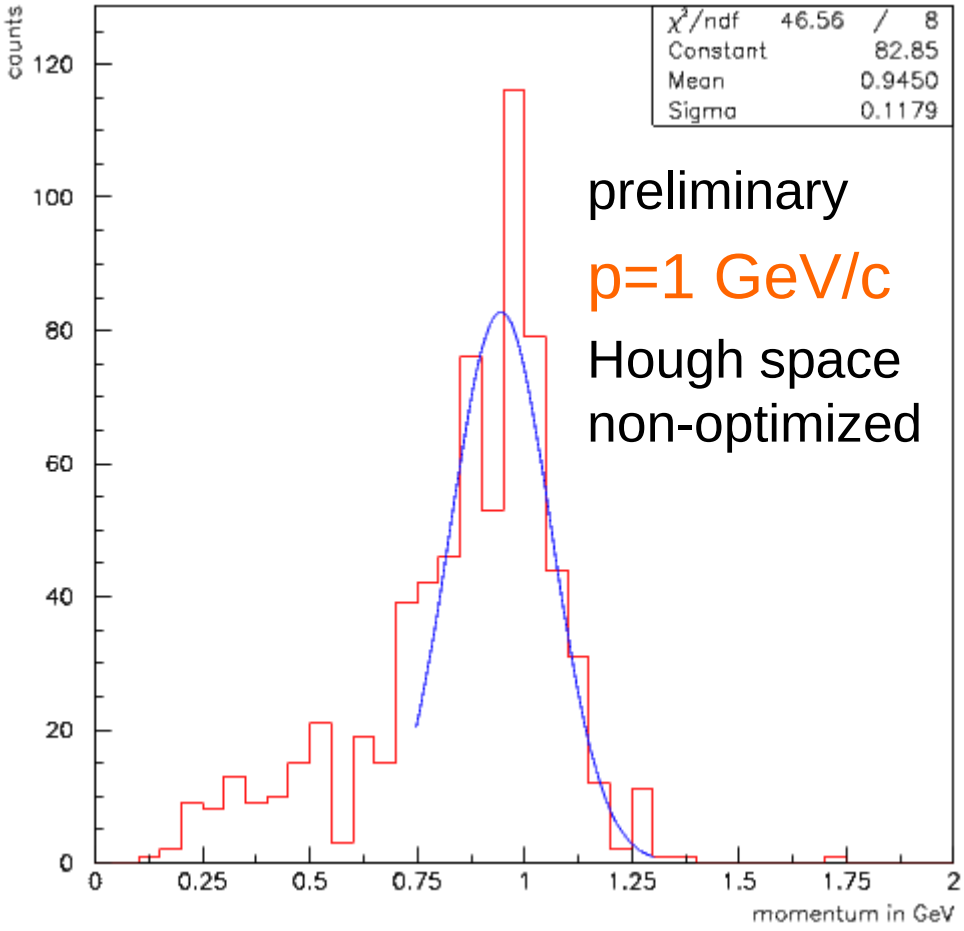
(0,0,0) required

$\geq$ 3 hits required

2 issues:

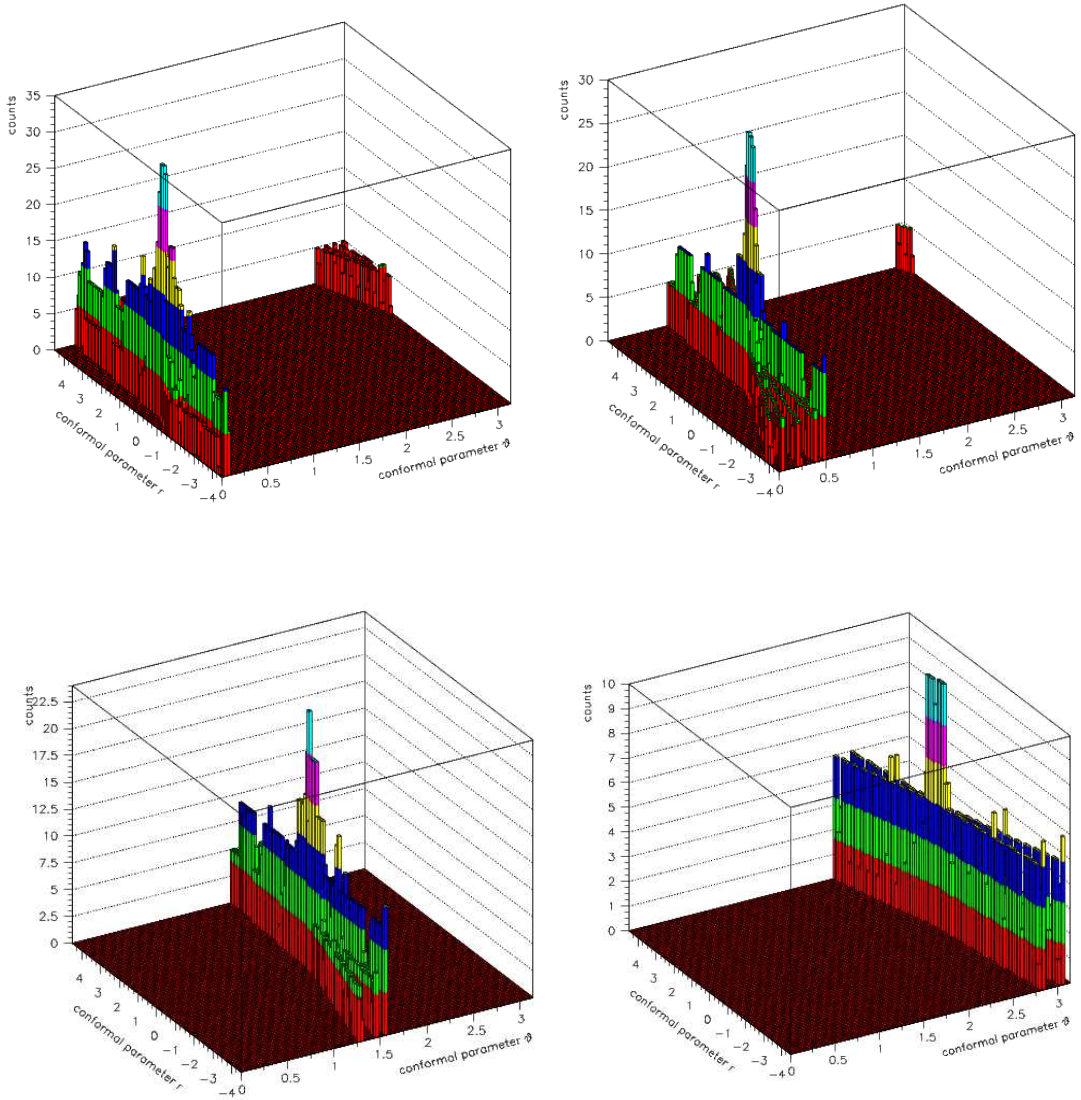
1. Efficiency only ~25%
   because Hough space
   non-optimized
   (see next slide)

   Hough peak cut
   >4 entries
   will be reduced
   in the next step
2. Why is reconstructed
   momentum wrong?
   (see next slide)



Hough Space event-by-event

- there is a peak in Hough space in every event ➨ (if $\geq$ 3 hits)
- optimize efficiency
  we must find the peak (i.e. adjust threshold)
- optimize p_T^{fitted}
  there are tilted (diagonal) structures in Hough space (different from Panda case)
  > shifts peak center-of-gravity
  > gives wrong pT
  > checking ongoing (maybe from tilted SVD modules?)



How can we buffer for 5 seconds?

- Compute node has only
  2 GB DDR2 RAM per 1 FPGA
- Per 1 FPGA, this is sufficient to buffer
  $\leq$ 3 s @ 30kHz
- How can we buffer longer?
  > ATCA „memory module“?
- e.g. RadiSys ATCA-4500
- Processor Xeon L5518 2.13 GHz
  quad-core
  Red Hat Enterprise Linux
- up to **64GB DDR3 RAM**
  (8 DIMM array)
- Official price quotation
  from german RadiSys subsidiary
  3.929,- US$
  without RAM