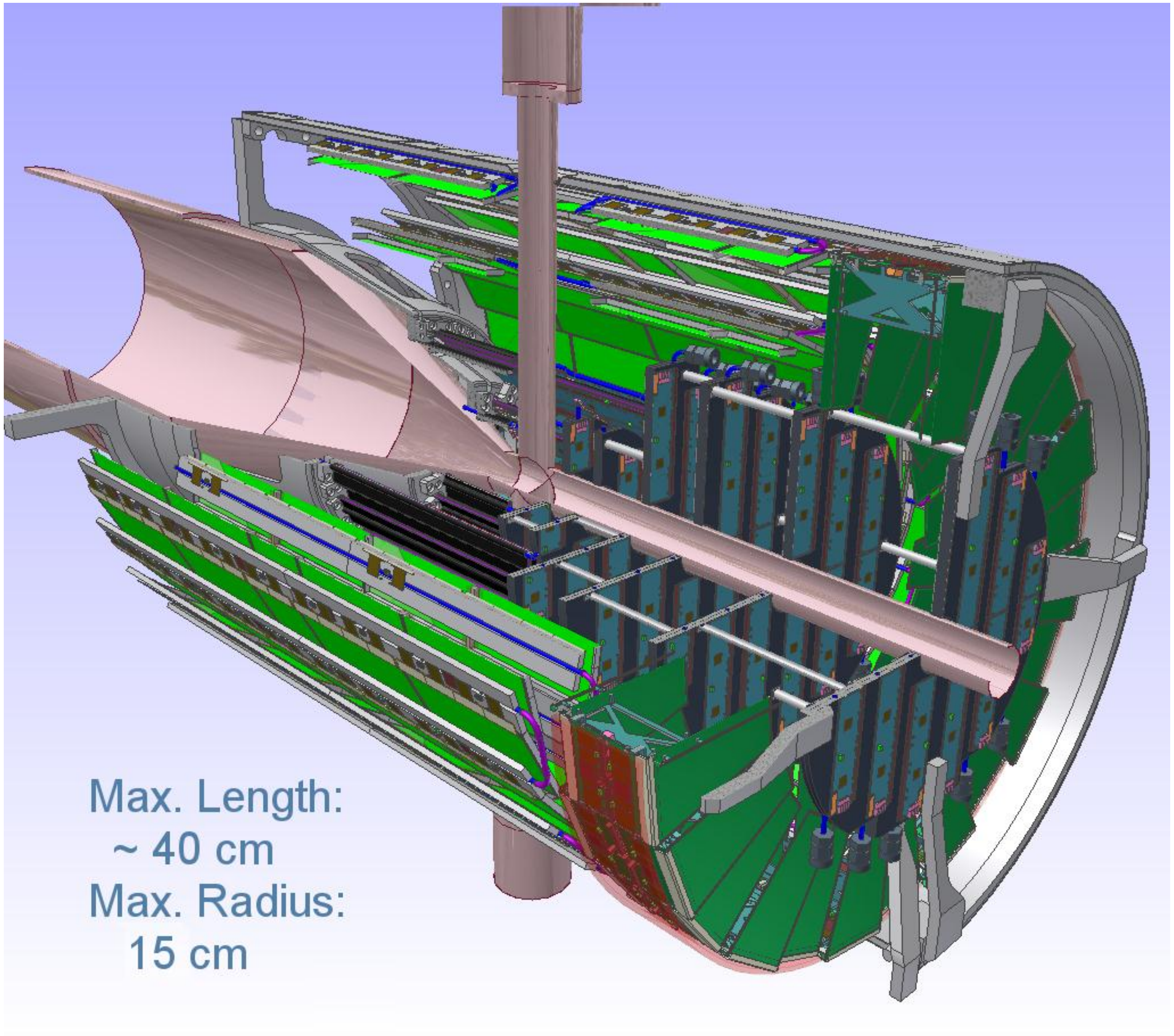
Mitglied der Helmholtz-Gemeinschaft

MVD Software and Simulation Status

PANDA Computing Week - Torino

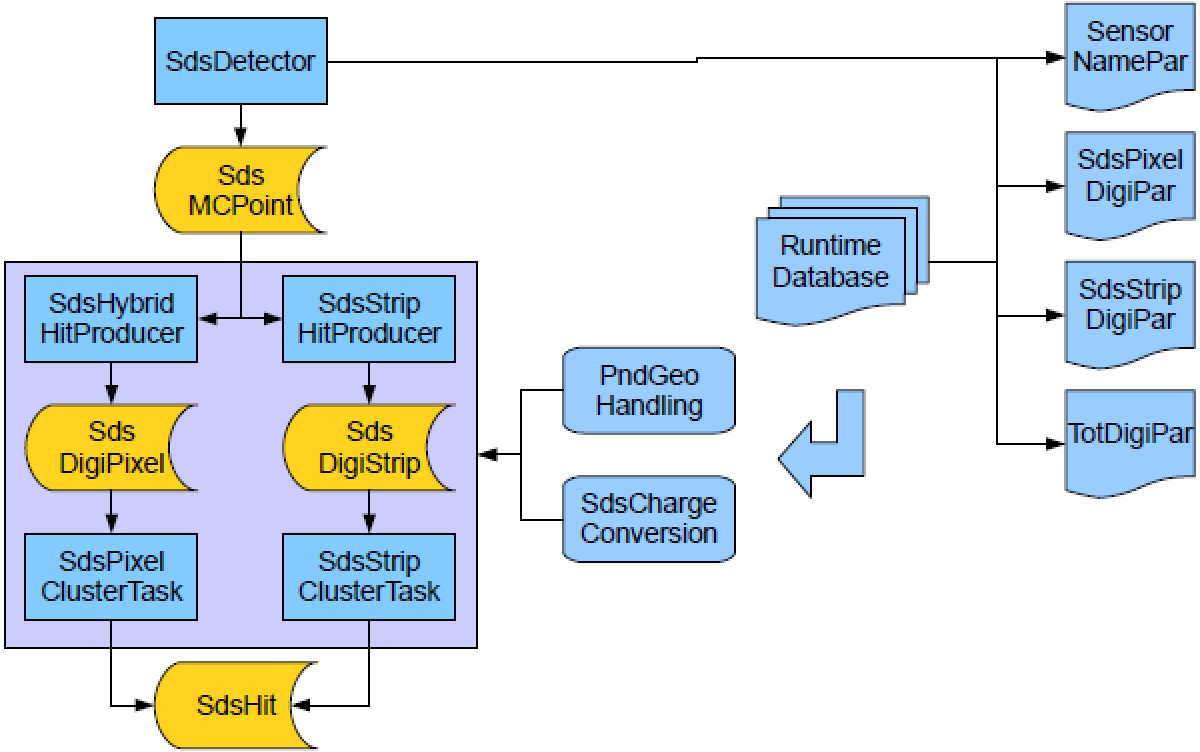
25. Juli 2012 | Tobias Stockmanns

Micro-Vertex-Detector

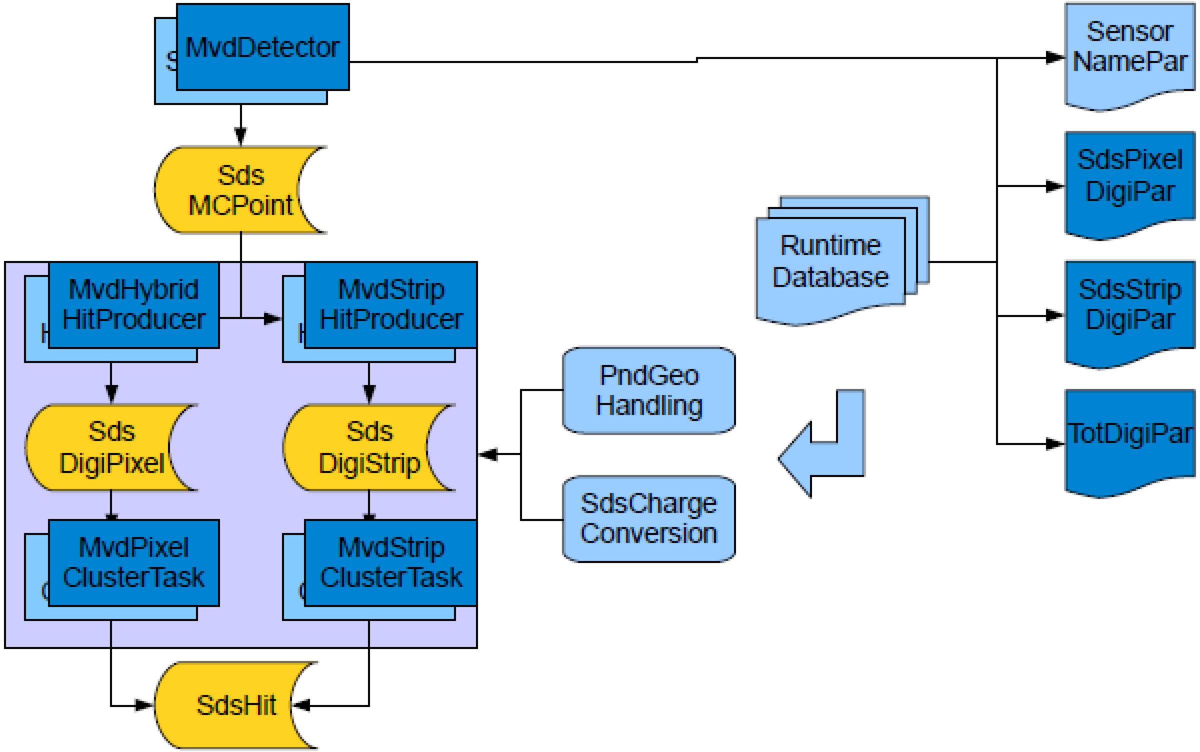


Max. Length:
~ 40 cm
Max. Radius:
15 cm

Structure of the Code – SDS base



Structure of the Code - MVD

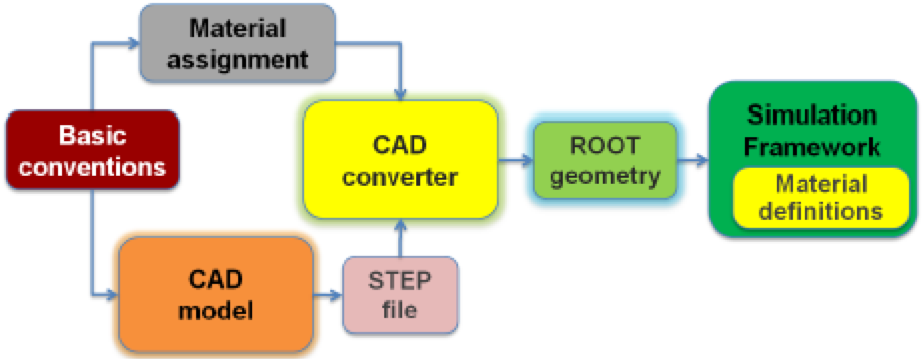


MC SIMULATION

Monte Carlo Generation – MC Points

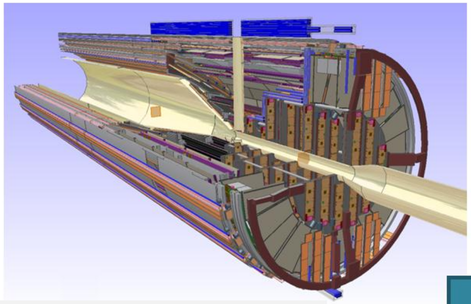
- Available in the code:
  - MC code development finished
  - Most realistic detector model within PANDA
  - Four actual geometry files:
    - *Mvd-2.1_FullVersion.root*
    - *Mvd-2.1_Sensitive.root*
    - *Mvd-2.1_AddDisks_FullVersion.root*
    - *Mvd-2.1_AddDisks_Sensitive.root*

- Simulations done:
  - Hit rate studies
  - Radiation length
  - Radiation damage



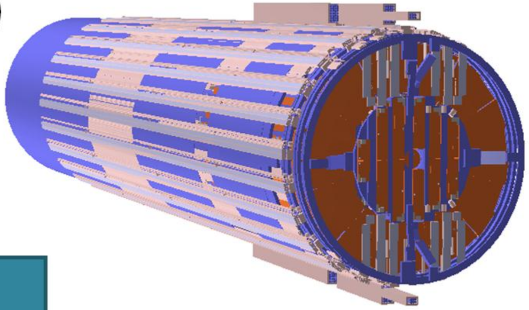
Detector description with CAD Converter

(a)



Beam pipe not included, just for illustration

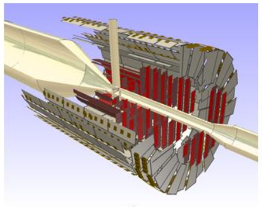
(b)



Total: 70,458 volumes

Mvd-2.1
(Full version)

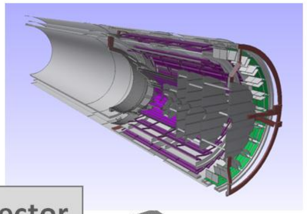
Silicon



- Sensor
- Readout chip

Silicon devices

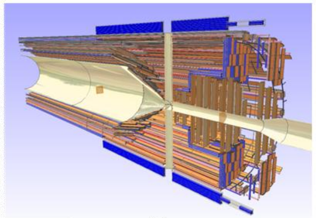
Support



- Detector module
- Upstream routing
- Layer support
- Global frame

Lightweight carbon structures

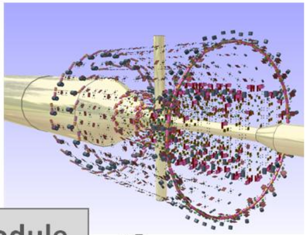
Routing



- Supply cable
- Cooling pipe
- Data cable

Service lines
Core: Water, Al, Cu

Components

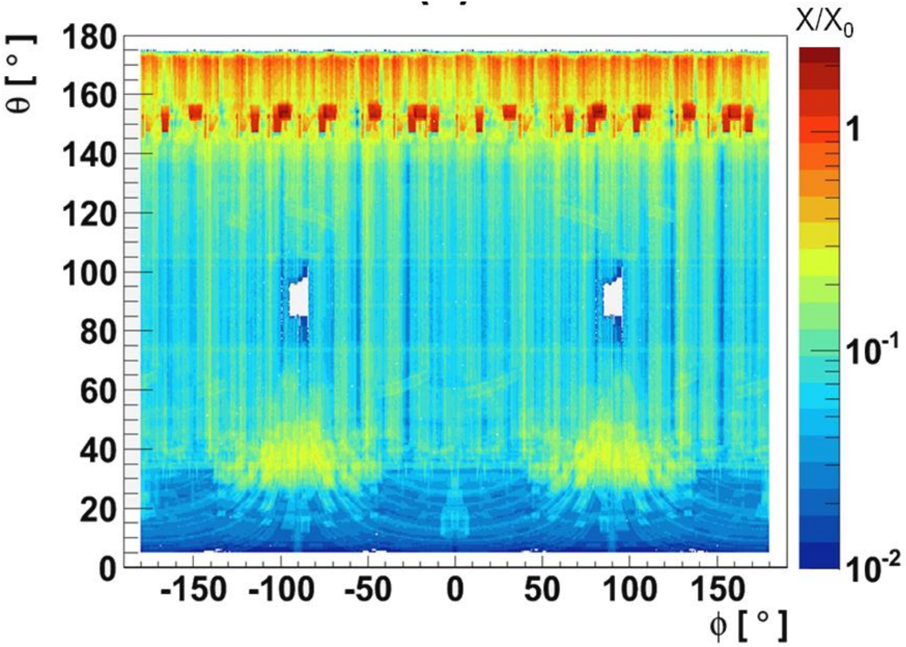


- Module controller
- SMD
- Connectors

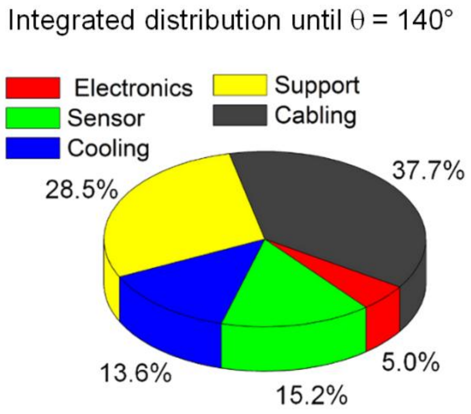
Additional parts for electronics and cooling system

Radiation length of MVD

Map of radiation length



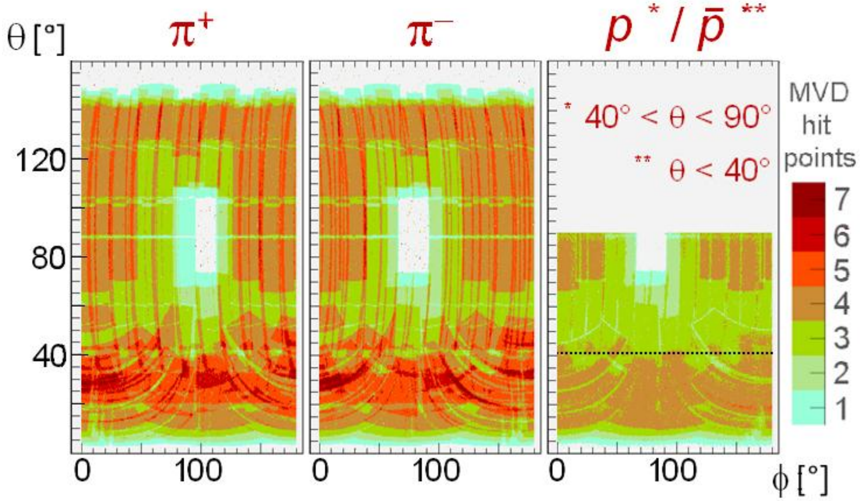
Radiation length of different detector parts



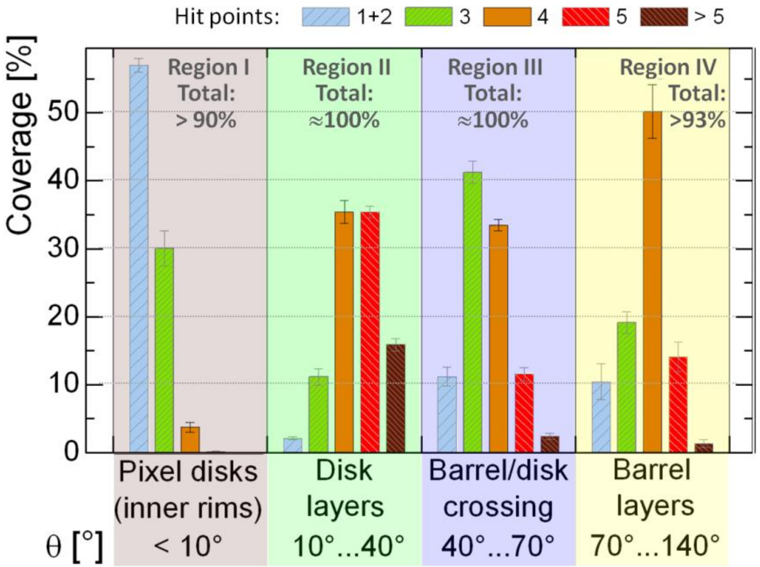
Detailed map of radiation length used for detector optimization

Hitpoints per track

Map of hitpoints per track



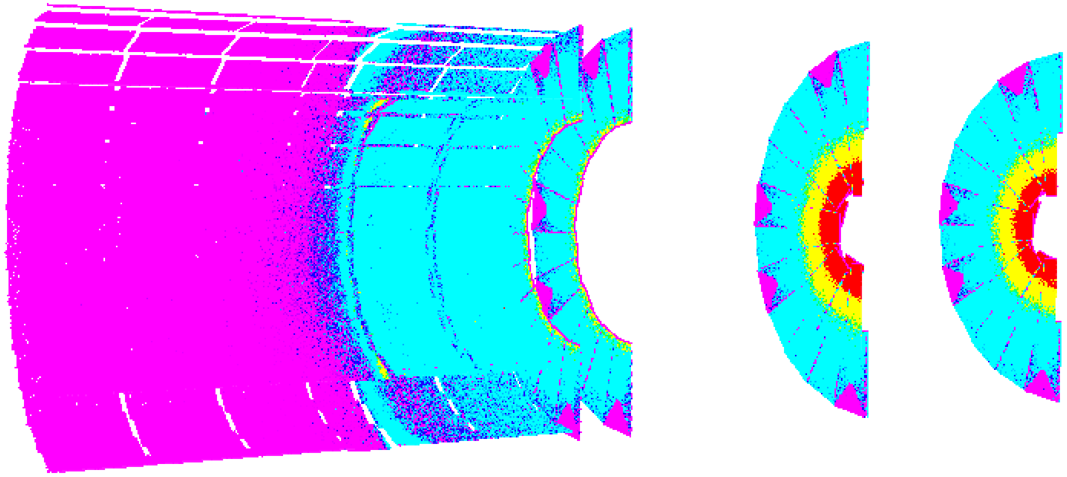
Hitpoints per track for different theta angles

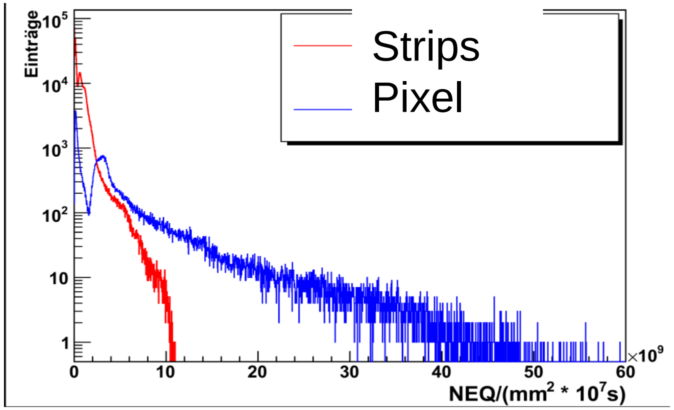


Detailed map of hitpoints per track used for detector optimization

Radiation damage

Radiation damage distrubution for 15 GeV/c on p target





Simulation of radiative environment as input for the electronics/sensor development

DIGITIZATION

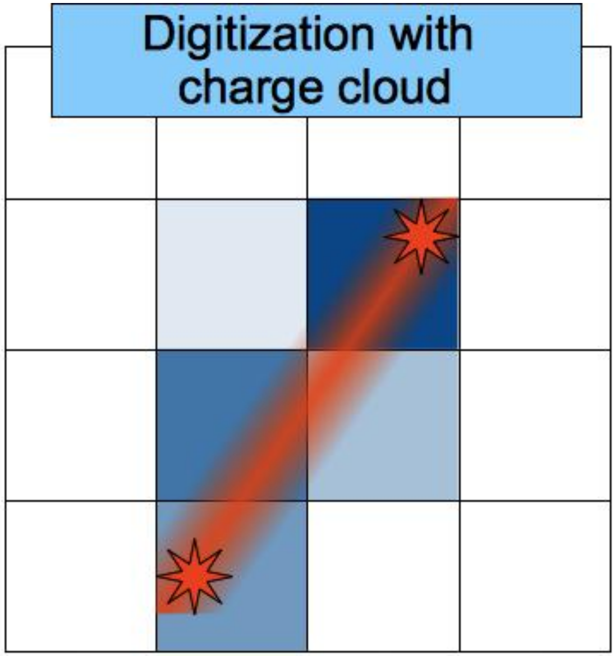
Digitization

- Available in the code:
  - Charge distribution in pixel/strip based on linear model between entry and exit point and charge diffusion
  - Triangular model of preamplifier
  - Generator for noisy hits
  - Time structure of readout

- Simulations done:
  - Count/data rates
  - Charge resolution
  - Time resolution

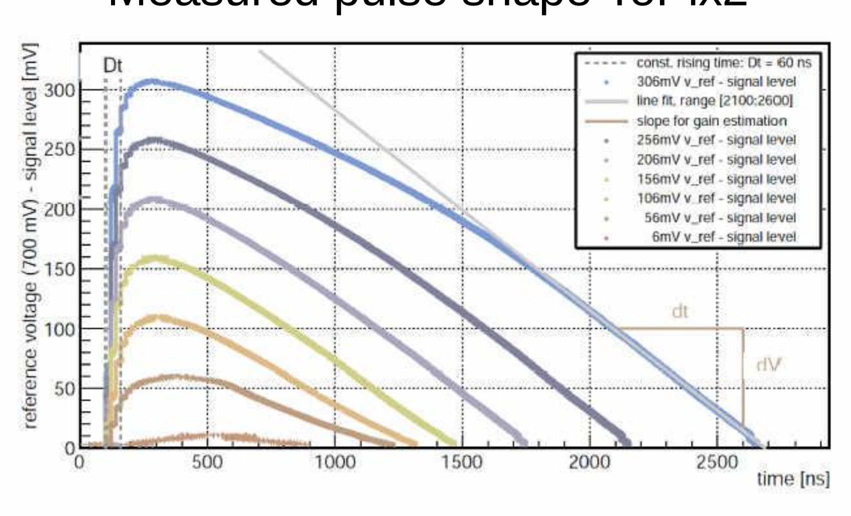
- What is missing in the code?
  - Magnetic and electric field effects for charge diffusion
  - More realistic model of preamplifier

Digitization

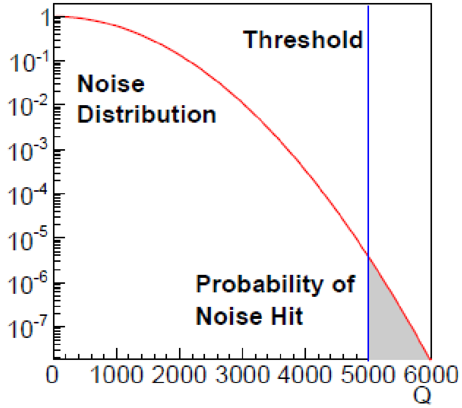


Digitization with charge cloud

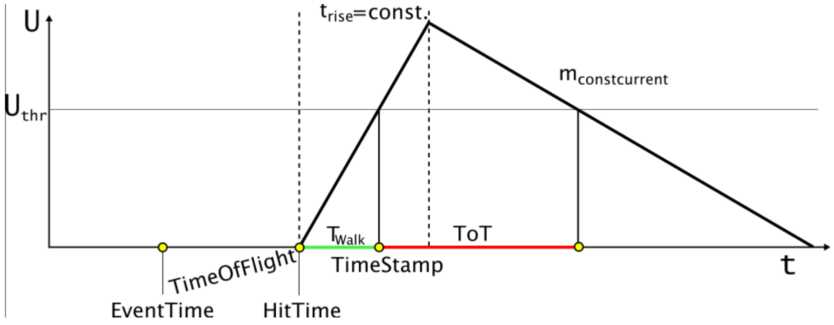
Measured pulse shape ToPix2



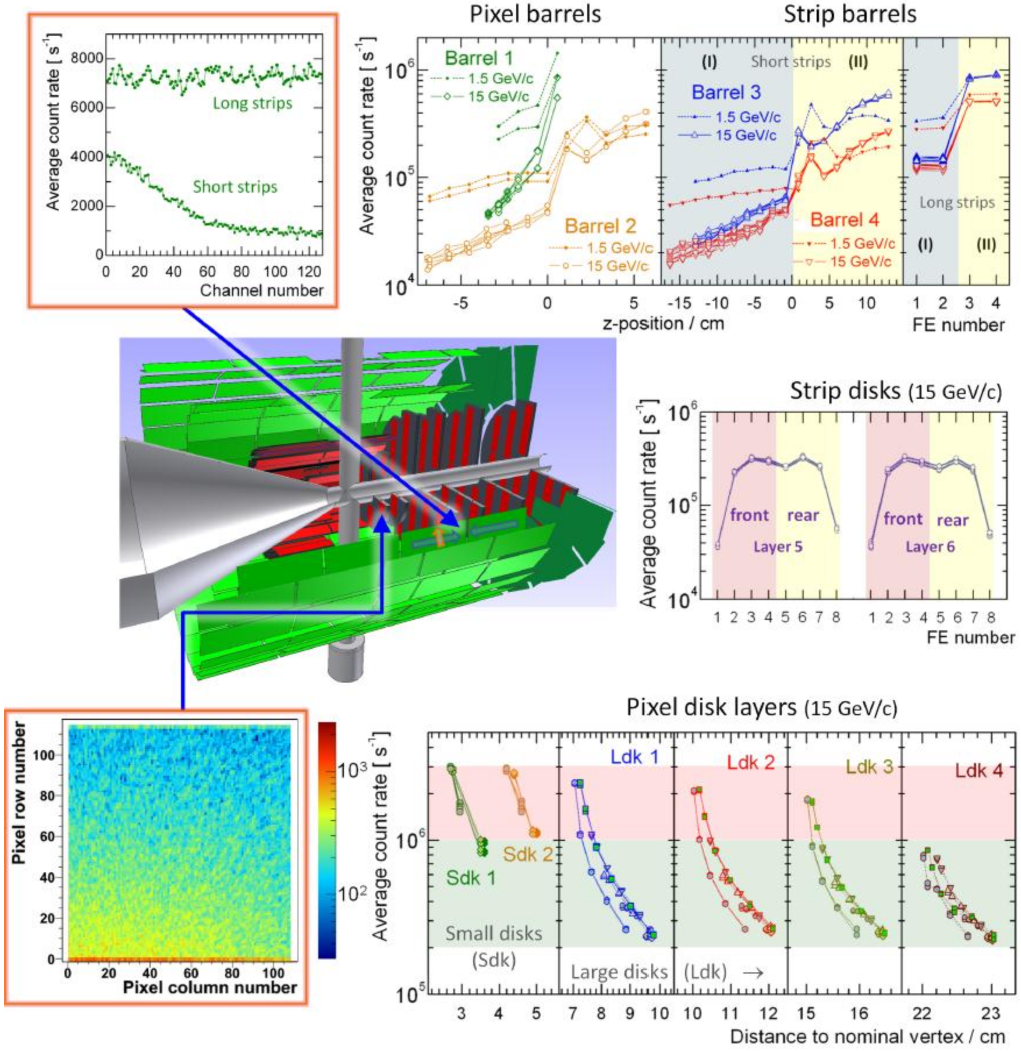
Noisy pixel generation



Preamp model pandaRoot



Count rate studies



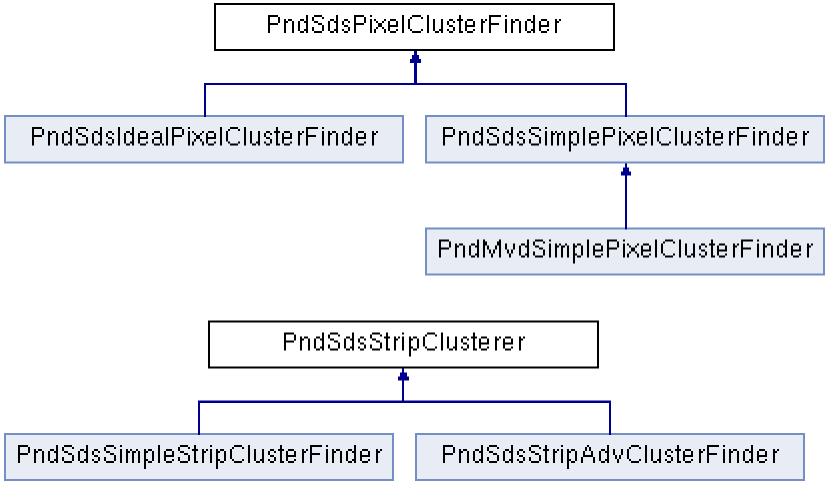
Simulation of the count / data rates for the complete MVD, sensors, FE, pixel

Open point: realistic time structure for different targets

RECONSTRUCTION

Reconstruction - Clusterizer

- Available in the code:
  - Ideal Cluster Task
  - Radius Pixel Cluster Task
  - Next Neighbors Strip Cluster Task
- Simulations done:
  - Test of functionality
- What is missing in the code?
  - Time information in cluster finder task for pixels
- What simulations should be done?
  - Time based clusterization


PndSdsPixelClusterFinder
PndSdsIdealPixelClusterFinder
PndSdsSimplePixelClusterFinder
PndMvdSimplePixelClusterFinder
PndSdsStripClusterer
PndSdsSimpleStripClusterFinder
PndSdsStripAdvClusterFinder

Reconstruction – Point Reconstruction

- Available in the code:
  - Ideal Reconstruction Task
  - Charge weighted back mapping
  - Head-/Tail-Algorithm
  - η-Distribution

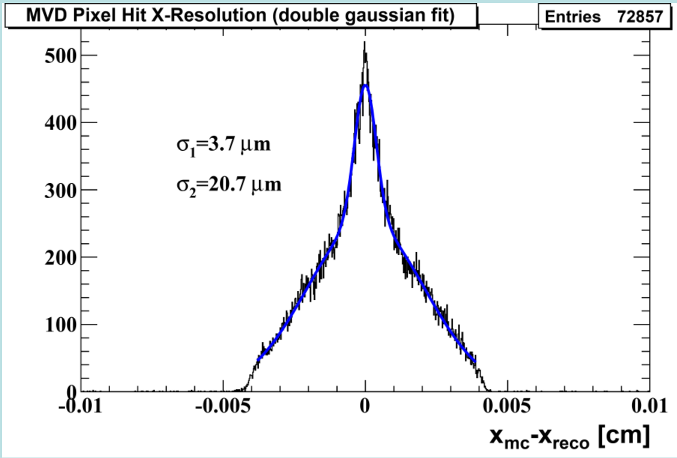
- Simulations done:
  - Point resolution of single hit
  - Energy resolution of cluster

- What is missing in the code?
  - Additional reconstruction algorithms

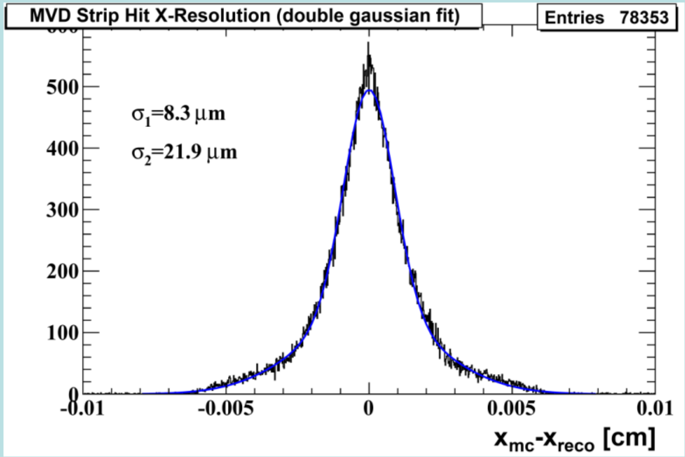
- What simulations should be done?

Point resolution for single 1 GeV/c Pi$^+$

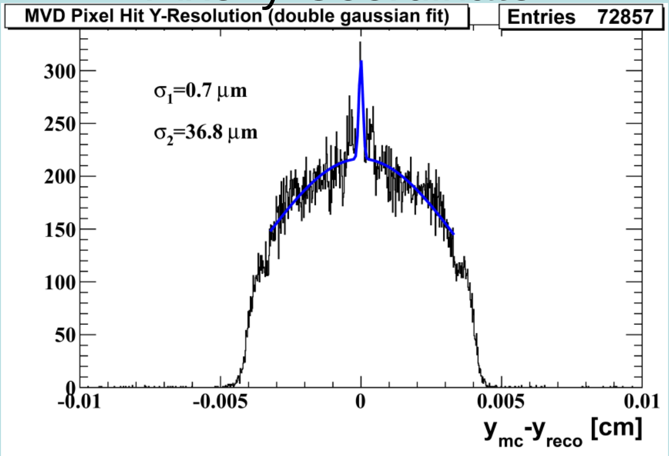
Pixel x-Coordinate



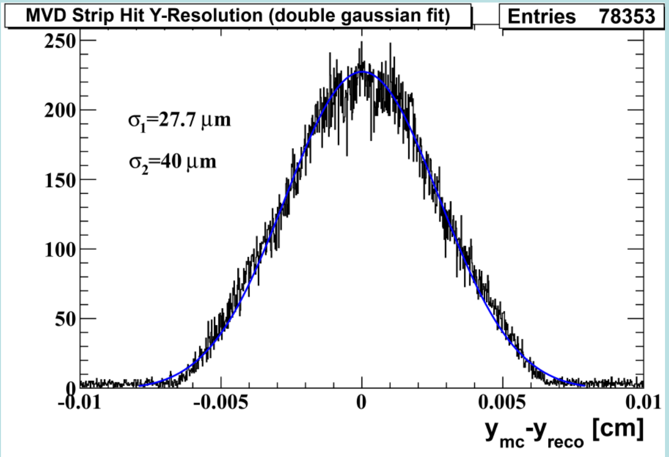
Strip x-Coordinate



Pixel y-Coordinate



Strip y-Coordinate



Point resolution depends on ratio of single / multiple hits

Reconstruction – Additional tools

- Available in the code:
  - TimeWalk correction
  - PID with MVD
  - DAQ-Interface for testbeam data

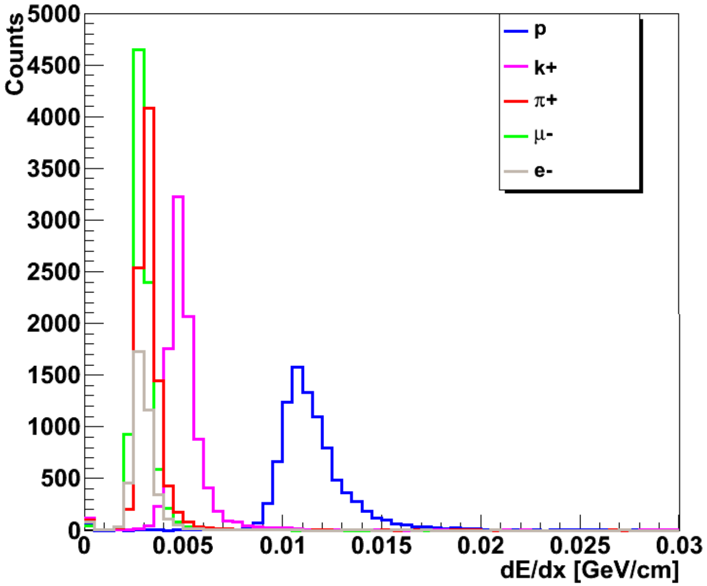
- Simulations done:
  - Time resolution after TimeWalk correction
  - PID capabilities of MVD
  - Analysis of testbeam data

- What is missing in the code?
  - Comparison of time resolution measurements between test beams and simulation

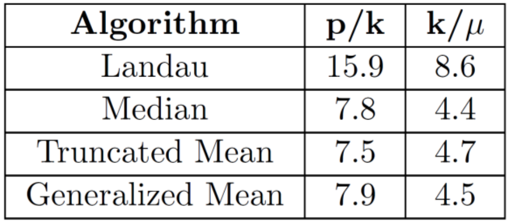
- What simulations should be done?
  - PID capabilities with thinner sensors
  - Time based reconstruction

PID

Median distribution of tracks at 500 MeV/c



Separation power at 500 MeV/c

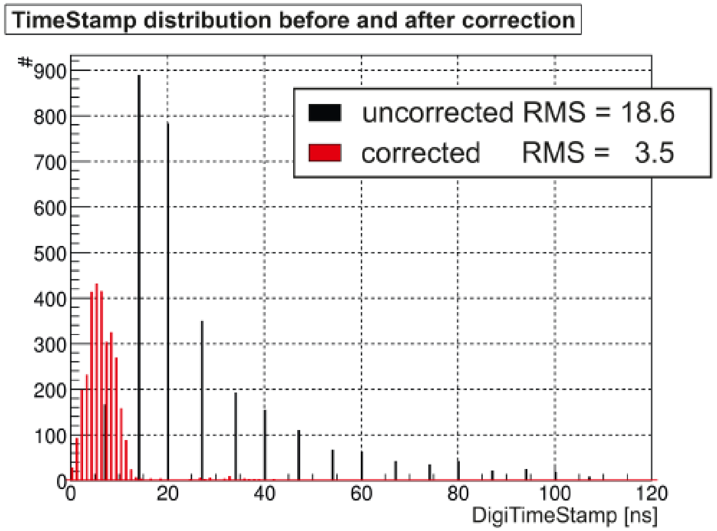


Algorithm	p/k	k/μ
Landau	15.9	8.6
Median	7.8	4.4
Truncated Mean	7.5	4.7
Generalized Mean	7.9	4.5

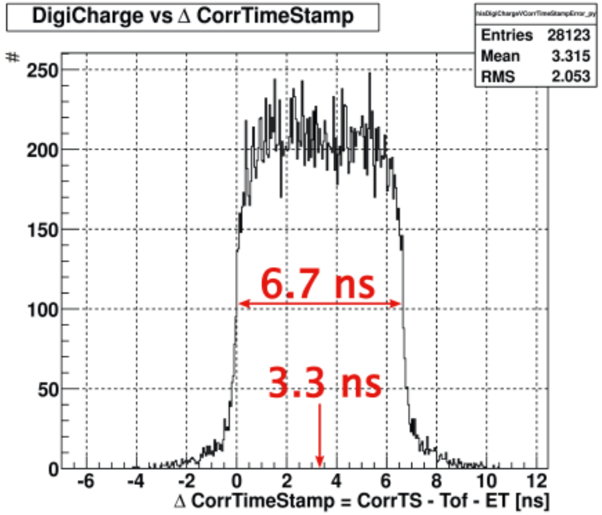
Different PID algorithms tested for momenta below 600 MeV/c

Time resolution of MVD

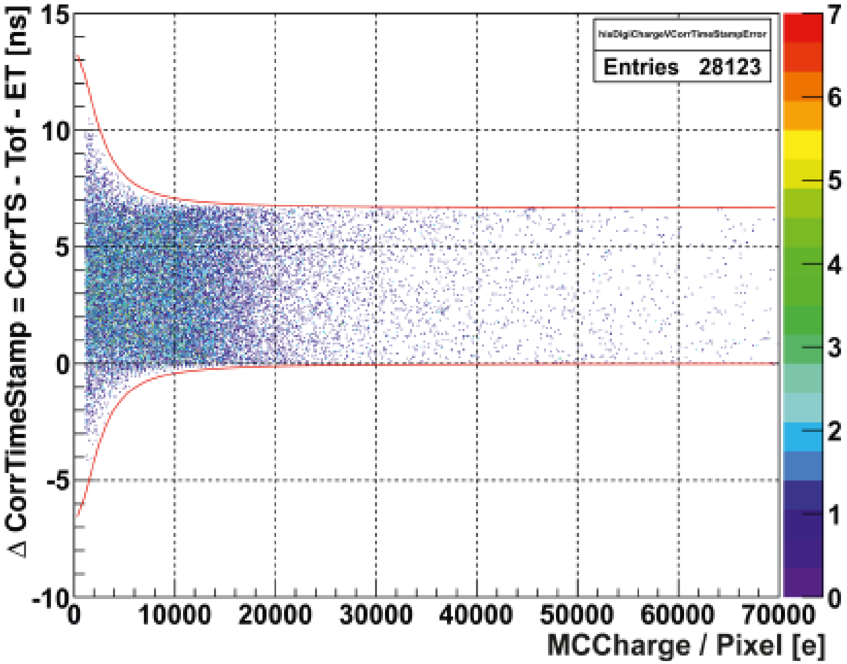
Time distribution before and after correction



Timing error vs. deposited charge



Timing error vs. Deposited charge



Reconstruction – TrackFinding

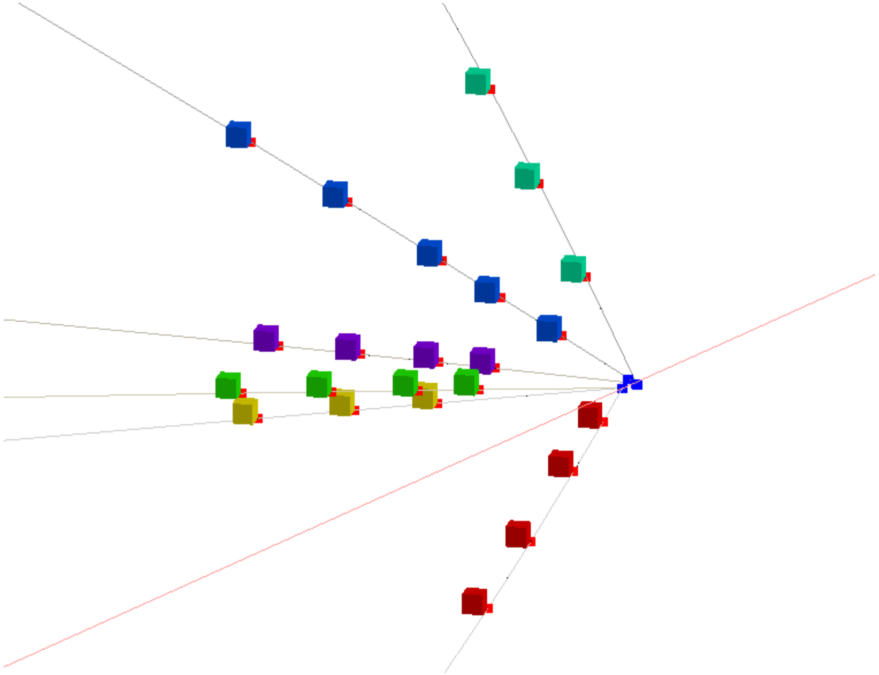
- Available in the code:
  - Ideal Track Finder
  - Riemann Track Finder
  - Combined MVD+CT+GEM Track Finder

- Simulations done:
  - Track finding efficiency with different parameter settings for track finders

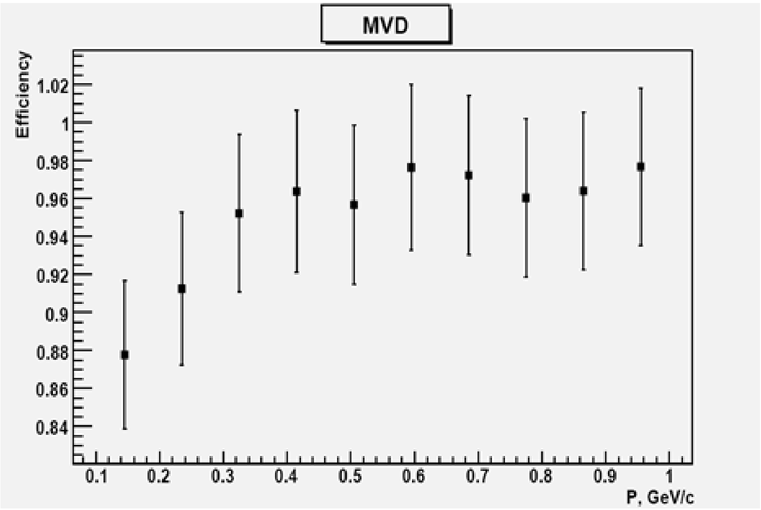
- What is missing in the code?
  - Improvement of speed for Riemann Track Finder
  - Finding of particles with (strongly) misplaced vertices
  - Forward track finding

- What simulations should be done?
  - Test of new algorithms / parameter sets
  - Evaluation of different track finding strategies

Riemann Track Finder



Efficiency for tracks with more than three points in MVD



Very good efficiency of above 95 % of possible tracks
Track finding possible for delayed tracks

Reconstruction – TrackFitting

- Available in the code:
  - Riemann (Pre-)Fit
  - Combined MVD+CT+GEM (Pre-)Fit
  - Kalmanfilter Fit
  - Ideal Forward Tracking

- Simulations done:
  - Momentum resolution

- What is missing in the code?
  - Realistic Forward Tracking

- What simulations should be done?
  - Test of forward tracking once a realistic forward fitter is available

Reconstruction – Vertex Finding / Fitting

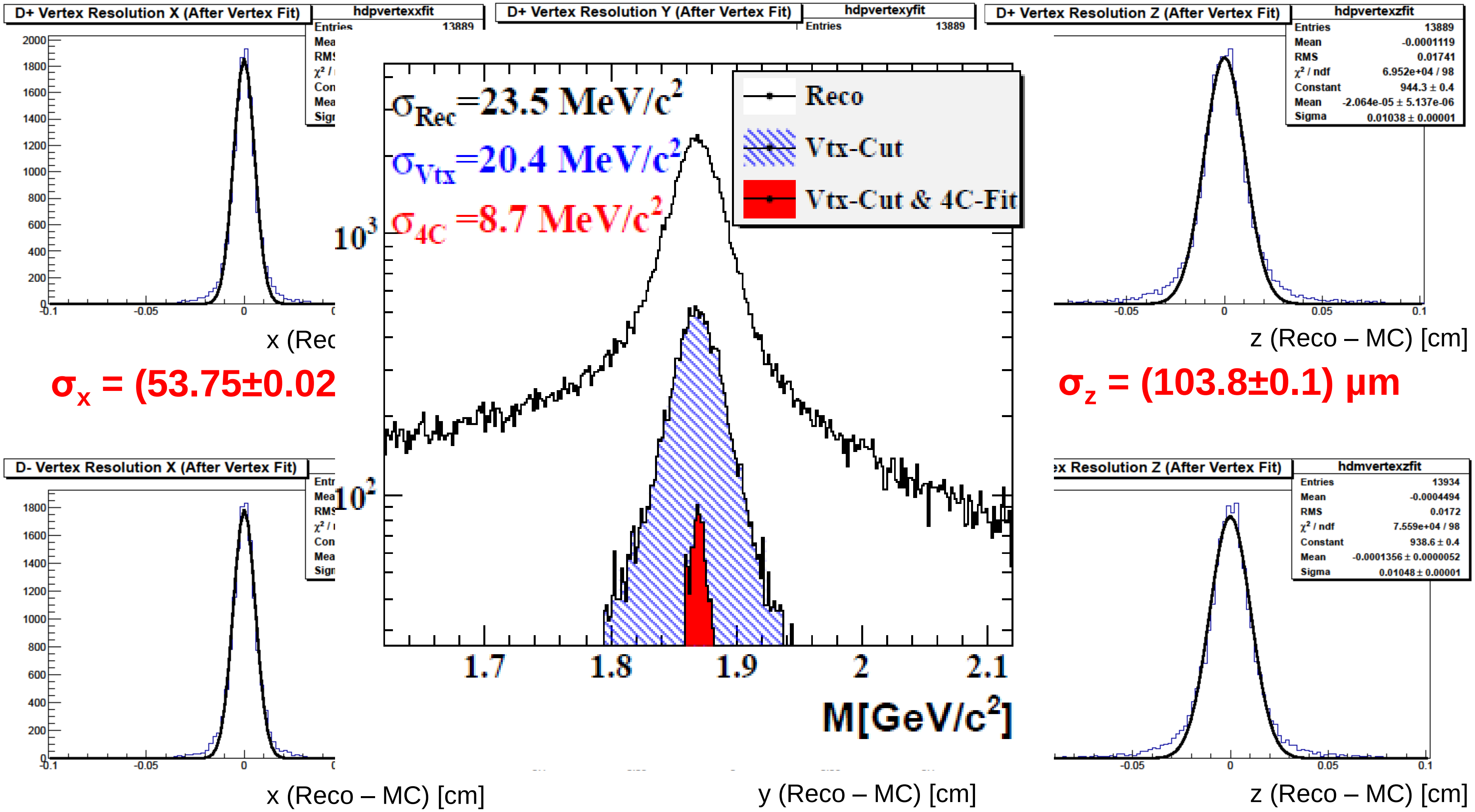
- Available in the code:
  - Kinematic (Vertex) Fitter as part of Rho
  - POCA Finder
  - Linearized Fitter

- Simulations done:
  - Tests of fitters/finders done
  - Use of fitters for physics simulations

- What is missing in the code?
  - Improve performance of vertex fitter
  - Different (faster) algorithms

- What simulations should be done?
  - Validation of fitters

D-Meson Vertex Resolution (MVD + STT, after Vertex Fit)



σ_x = (53.75±0.02

σ_z = (103.8±0.1) μm

σ_x = (56.63±0.02) μm

σ_y = (53.86±0.02) μm

σ_z = (104.8±0.1) μm

Reconstruction – Event Reconstruction

- Available in the code:
  - Event Mixing of different signals with background data
  - Time based simulation as part of FairRoot
  - No need to redo lengthy MC transport simulation (old data can be reused)

- Simulations done:
  - Test of functionality

- What is missing in the code?
  - Implementation of time based simulation in subdetectors
  - Algorithms to handle time stamps in reconstructions
  - Algorithms to do Event Building

- What simulations should be done?
  - Redo digitization / reconstruction / analysis

Summary

- The code of the MVD is in very good shape
- Most of the necessary tools are available and the needed simulations were done
- Some smaller optimizations of the code are on their way

- Open points:
  - Forward tracking
  - Time ordered simulation
  - Refactorization