

Helix Track Finding and Track Fitting Algorithm

A FPGA tracking algorithm
for helix tracking using STT and MVD

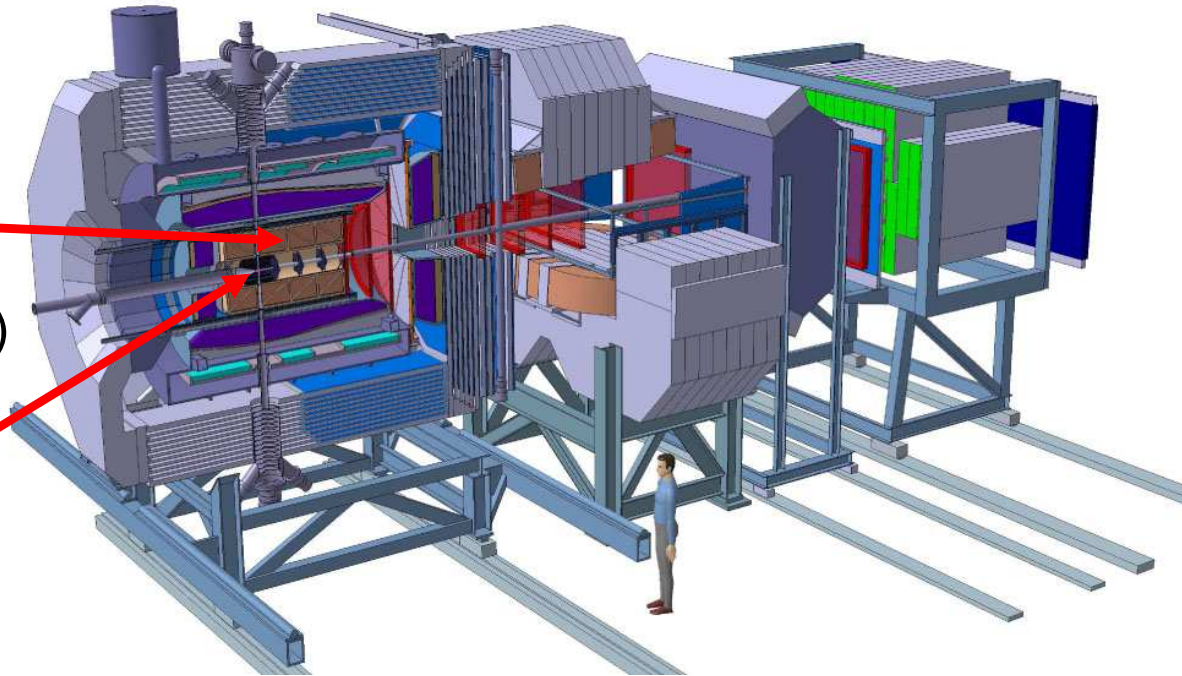
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Situation in PANDA experiment

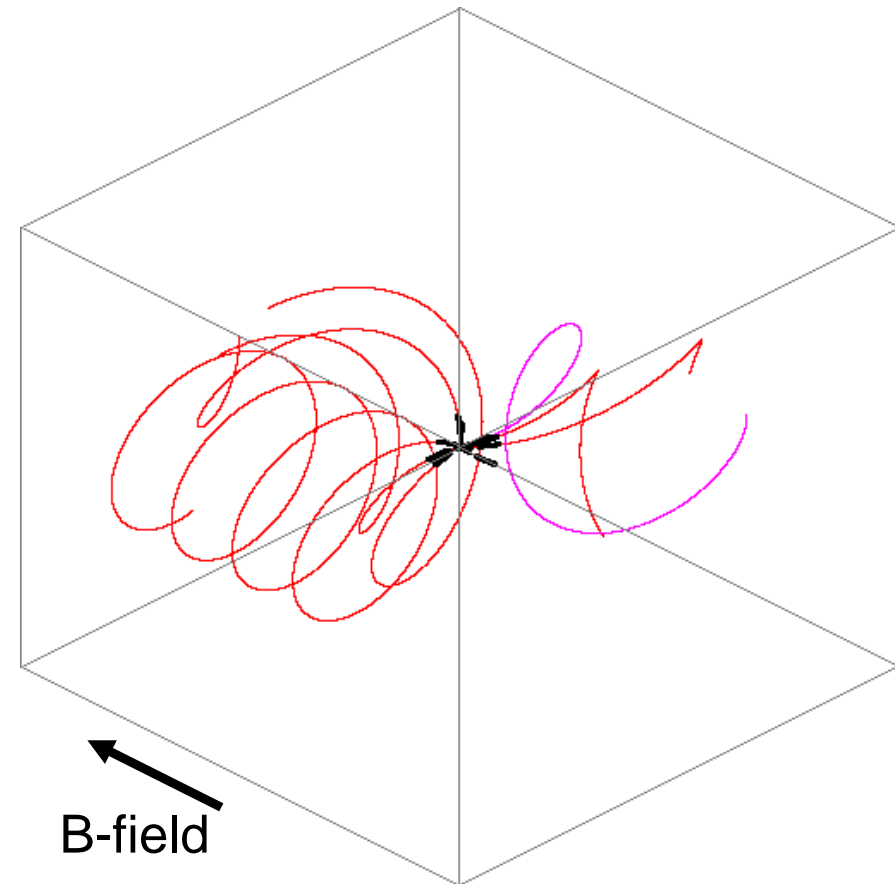
Straw Tube Tracker (STT)
or
Time Projection Chamber (TPC)
Micro Vertex Detector (MVD)



- Simulated data with PANDARoot framework
- Uses digitized hit data for STT and MVD detector

PANDA Specifics

- Target Spectrometer
(forward detectors not used in the moment)
- Homogenous $B_z=2$ T
(Solenoid)
- TOSCA field maps
incl. overlap region
solenoid-dipole
- Charged particle tracks
can be described as a helix

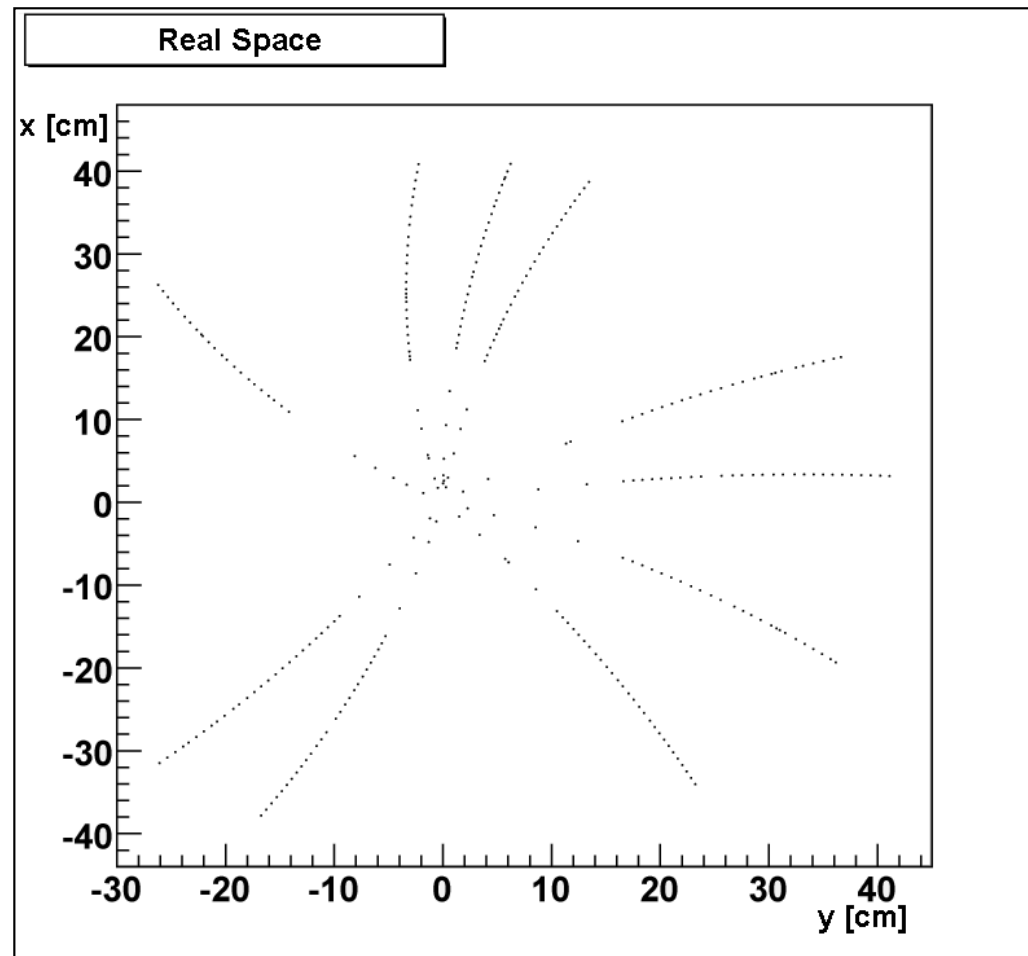


PANDA Specifics

- In x,y plane, tracks can be described as circles

- Problem:
many circles with different radii and different centers
- Solution:
conformal mapping

10 muons with 1 GeV
simulated on PANDA root framework



Conformal Mapping

- Angle preserving, not length preserving
- Easier tracking for lines
→ transform circles to straight lines

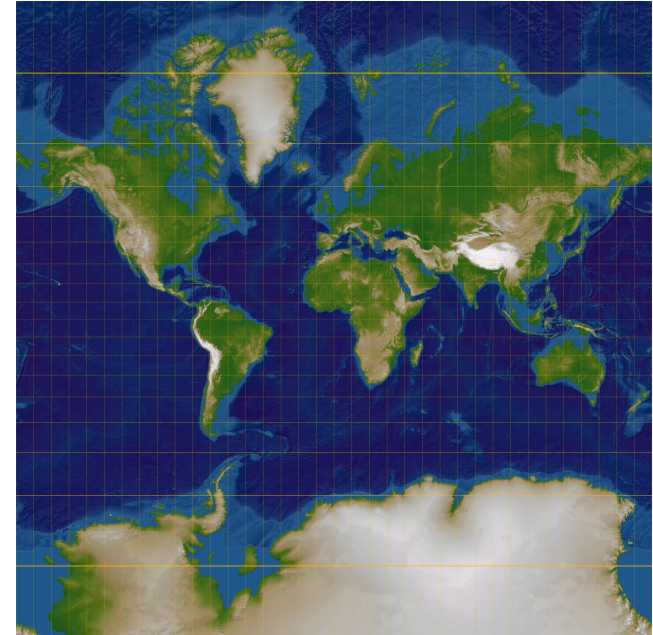
- Transformation:

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

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

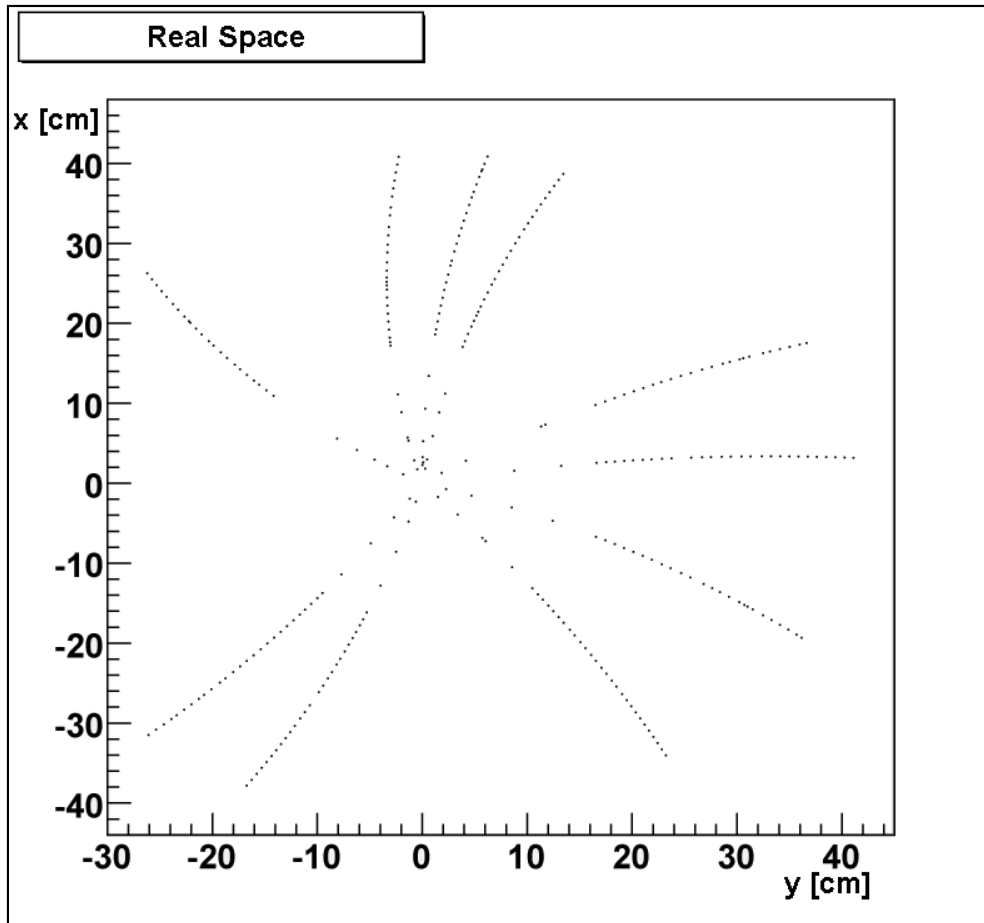
$$r^2 = (x - x_0)^2 + (y - y_0)^2$$

- Reference point (x_0, y_0, z_0) must be on the circle

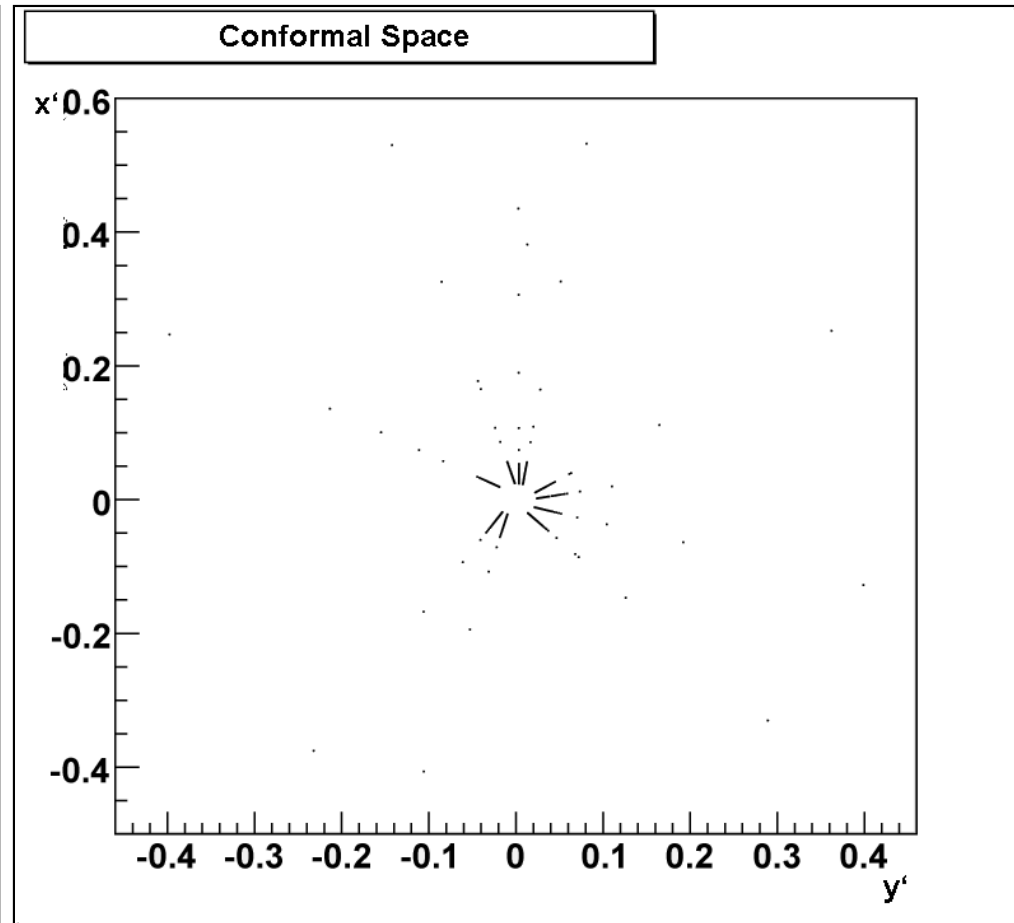


Conformal Mapping

- Real space



- Conformal space

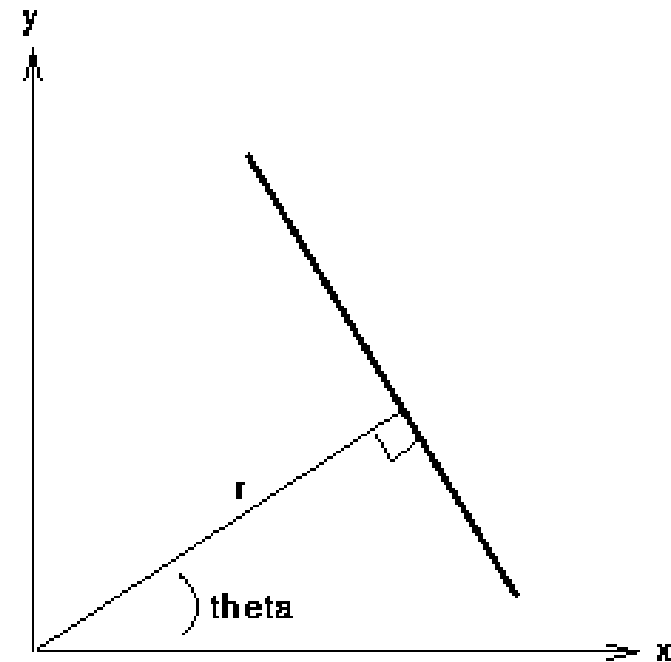


Hough Transformation

- Line tracking with Hough transformation
- Take all possible lines through a point in conformal space
- Describe it with parameters r and θ

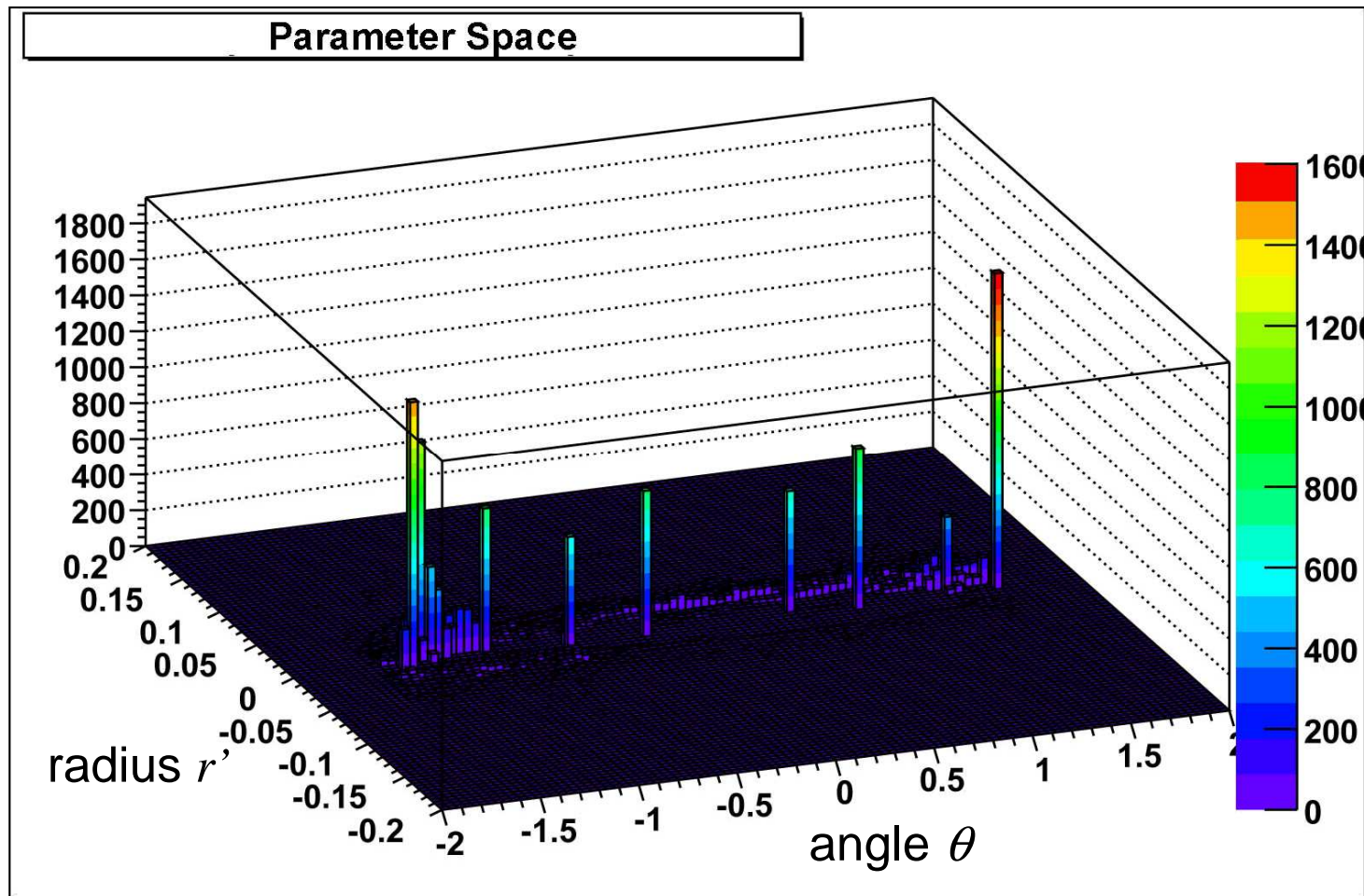
$$r(\theta) = x \cos \theta + y \sin \theta$$

- Add it as a count to a r - θ -matrix (parameter space)



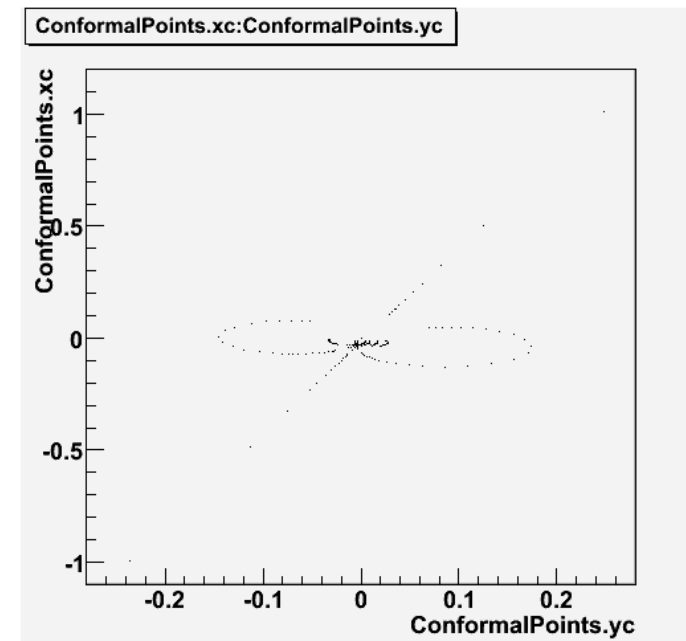
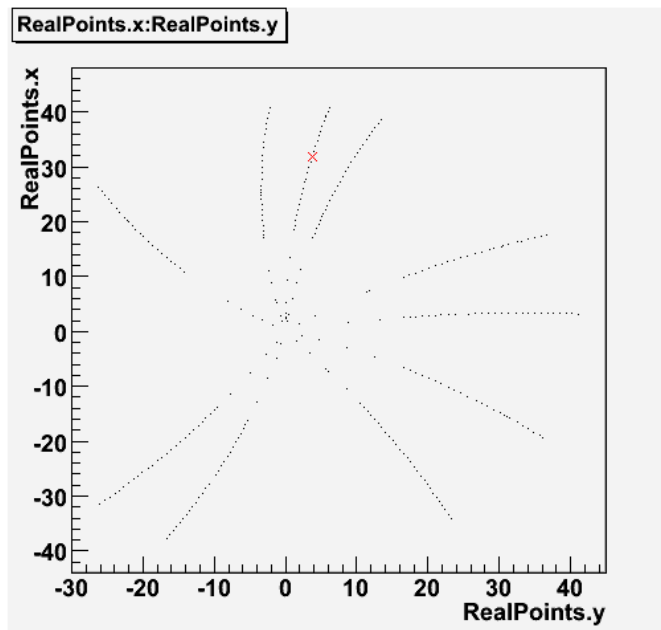
Hough Transformation

- Find peaks to get track parameter



Secondary Vertex

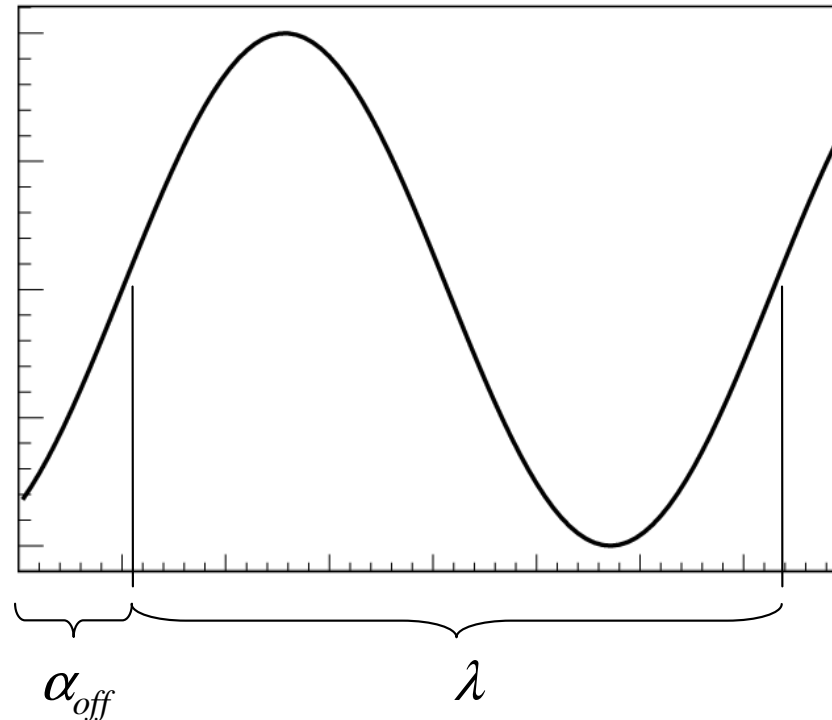
- Problem: one reference (x_0, y_0, z_0) gives only tracks through this point
- Solution: reiterate with each hit point as reference point



z-Direction

- Find z-component with an different Hough transformation for each found track

x-z projection of helical track



and get parameter α_{off} (offset) and λ (pitch)

Results

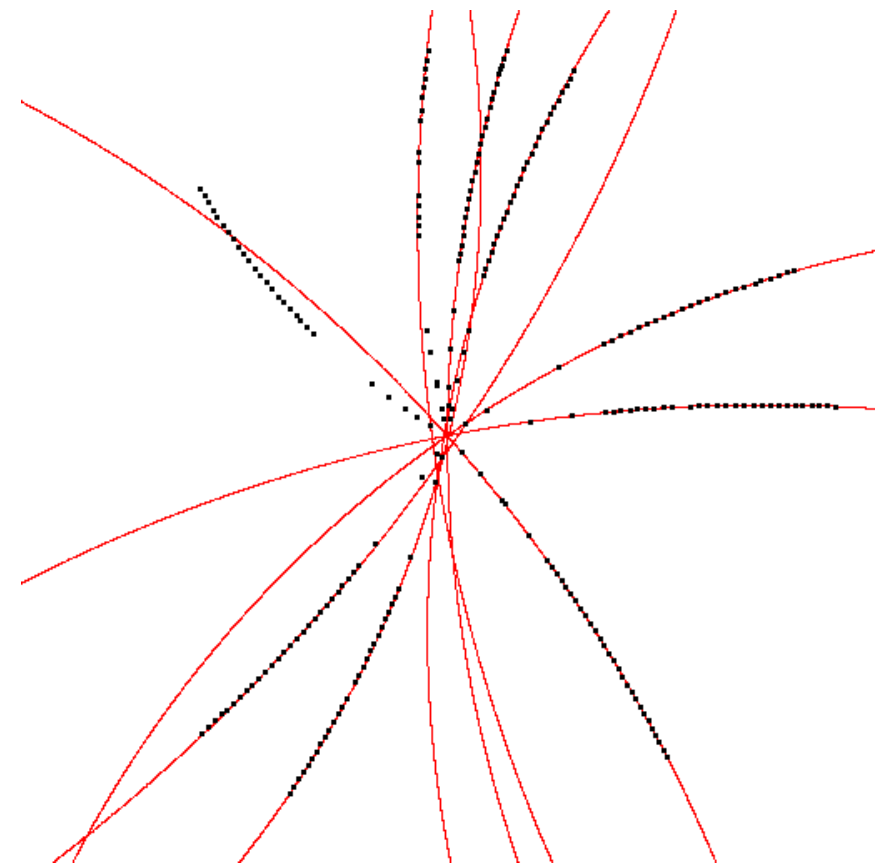
- Algorithm gets back helix parameters after back-transformation to real space:

x_c, y_c center of helix

r radius

α_{off} offset

λ pitch



found tracks

Future

- Testing and optimizing algorithm in the PANDARoot framework
- Implementation to an FPGA Platform
 - Fix point instead of float
 - 24 bit (in division and multiplikation 48 bit)
 - Hough space of 512×512 indices
 - Lookup Table for sinus: 128 indices with 16 bit

Thank you