Vertexing with a CMOS tracker

Hadrontherapy

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Introduction

Algorithms

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First Data

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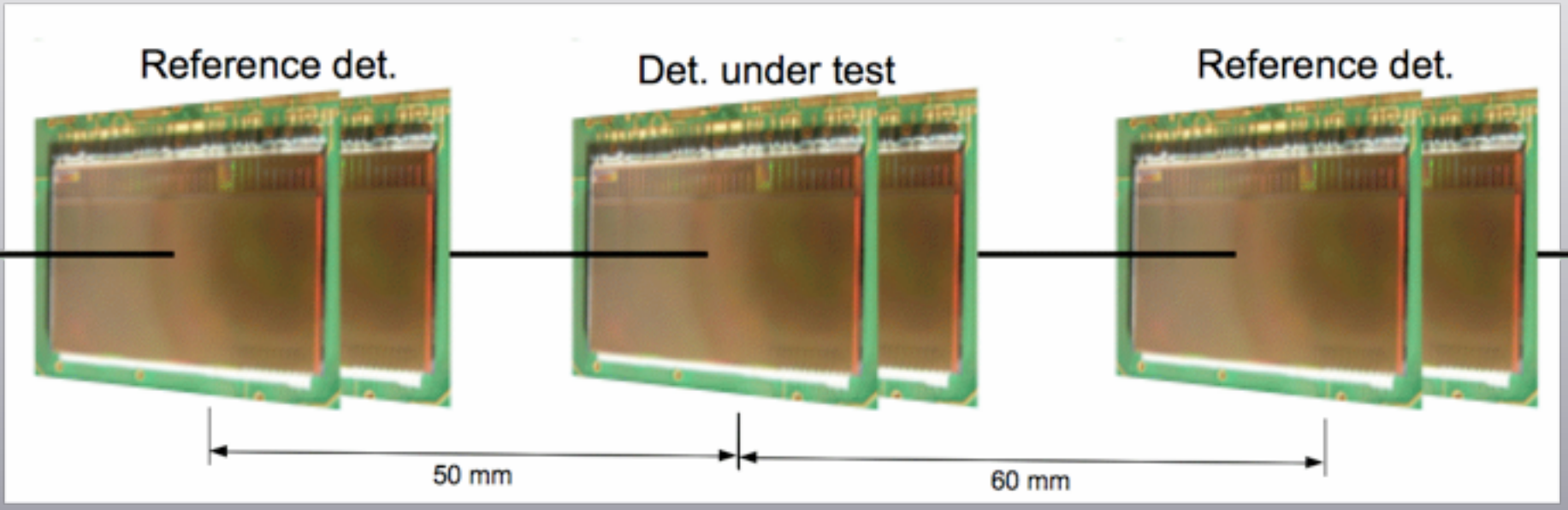
Introduction

- CMOS: Mimosa26



CMOS MIMOSA26 ~1×2 cm^2

0.7 Mpixels each

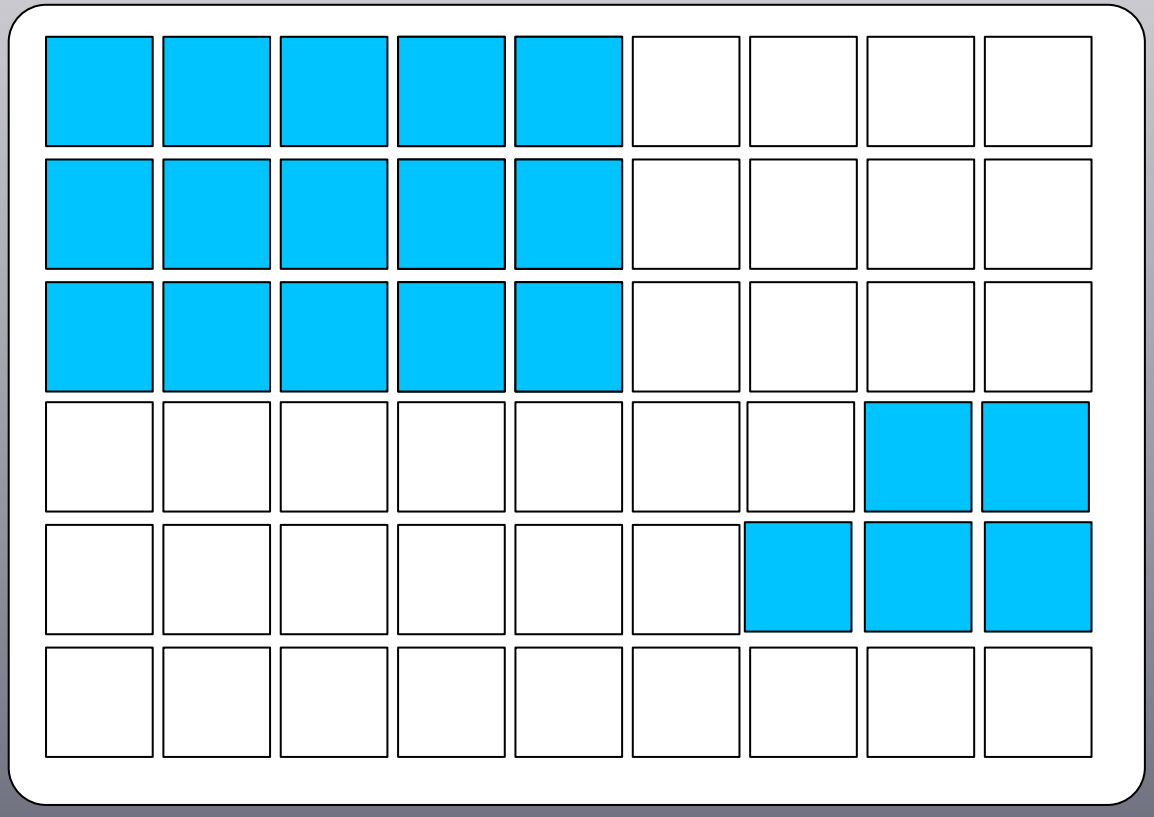
Thickness: 50 µm

Pixel size: 18,4×18,4 μm^2

Integration time: 100 µs

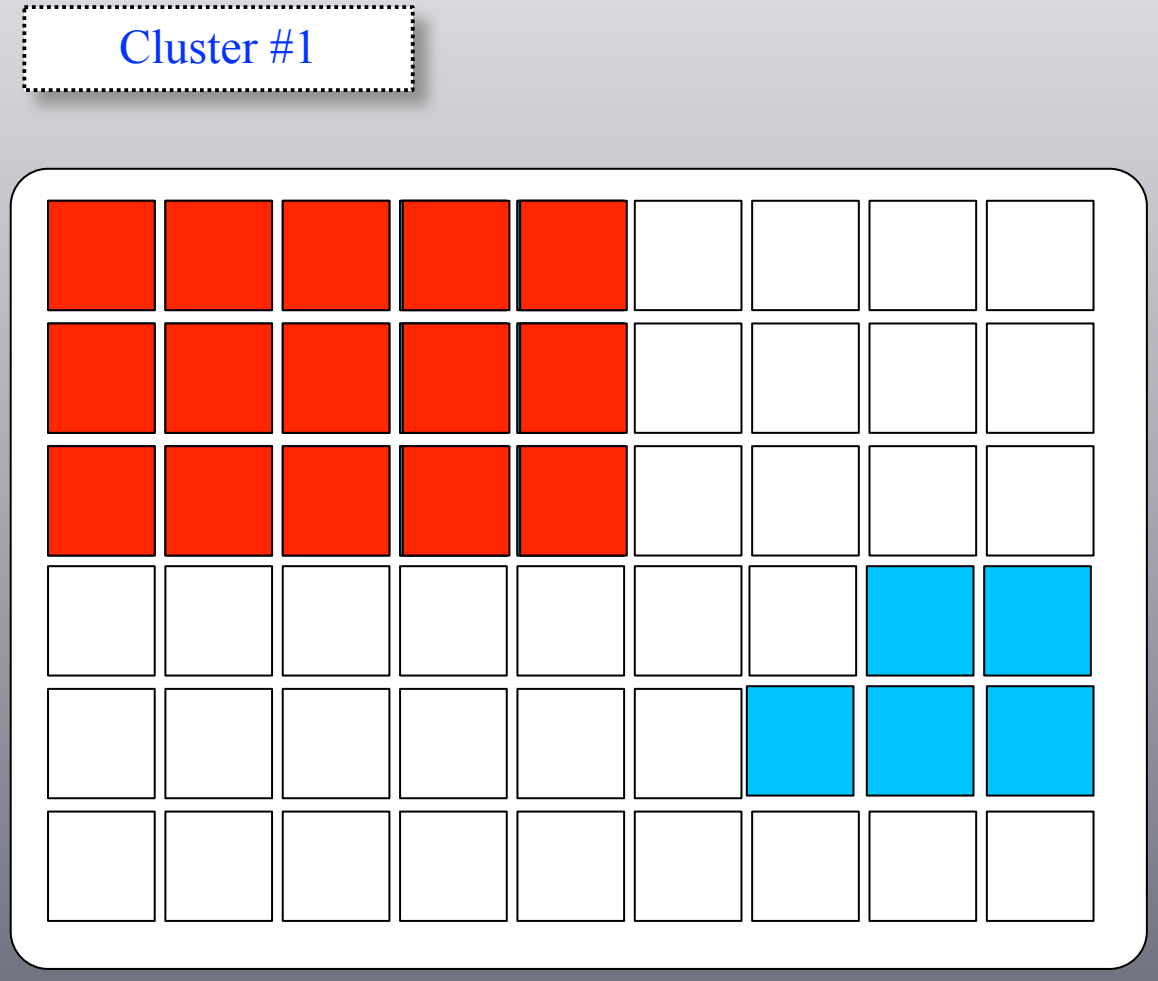
Cluster Finder

- Cluster Finder recursive



Cluster Finder

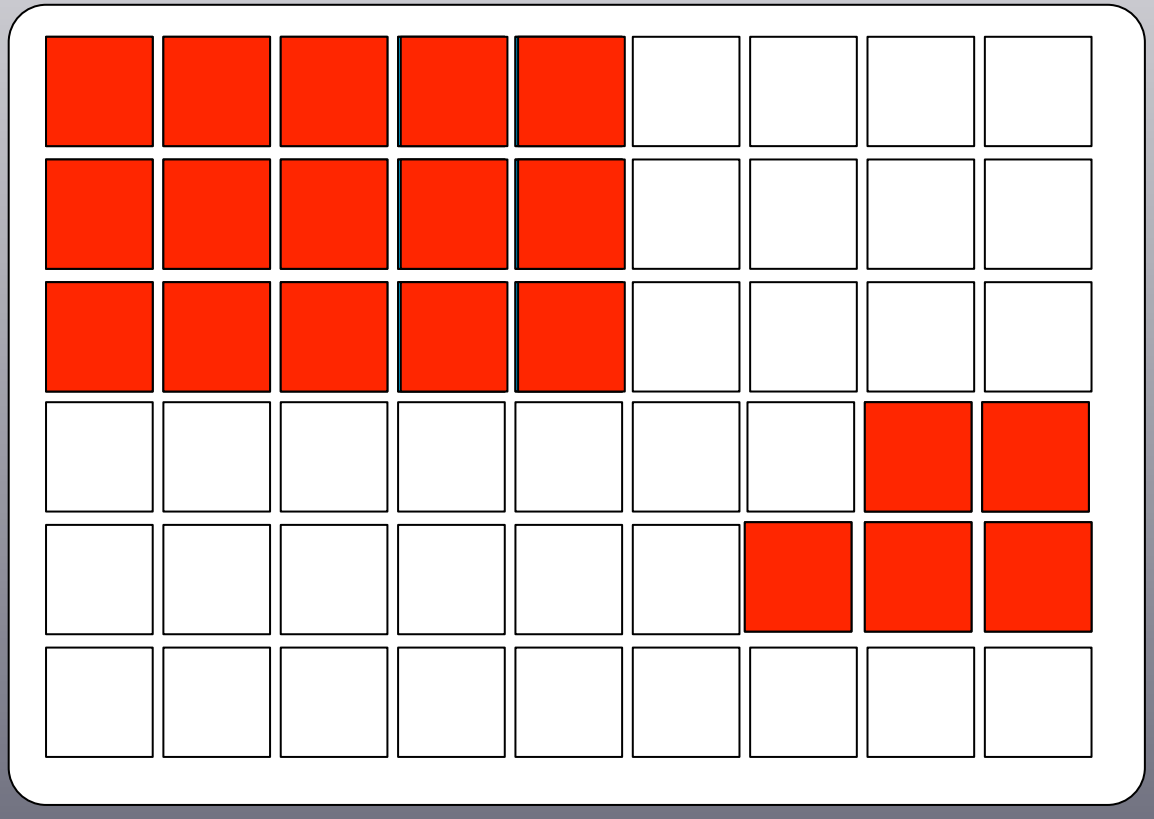
- Cluster Finder recursive



Cluster Finder

- Cluster Finder recursive

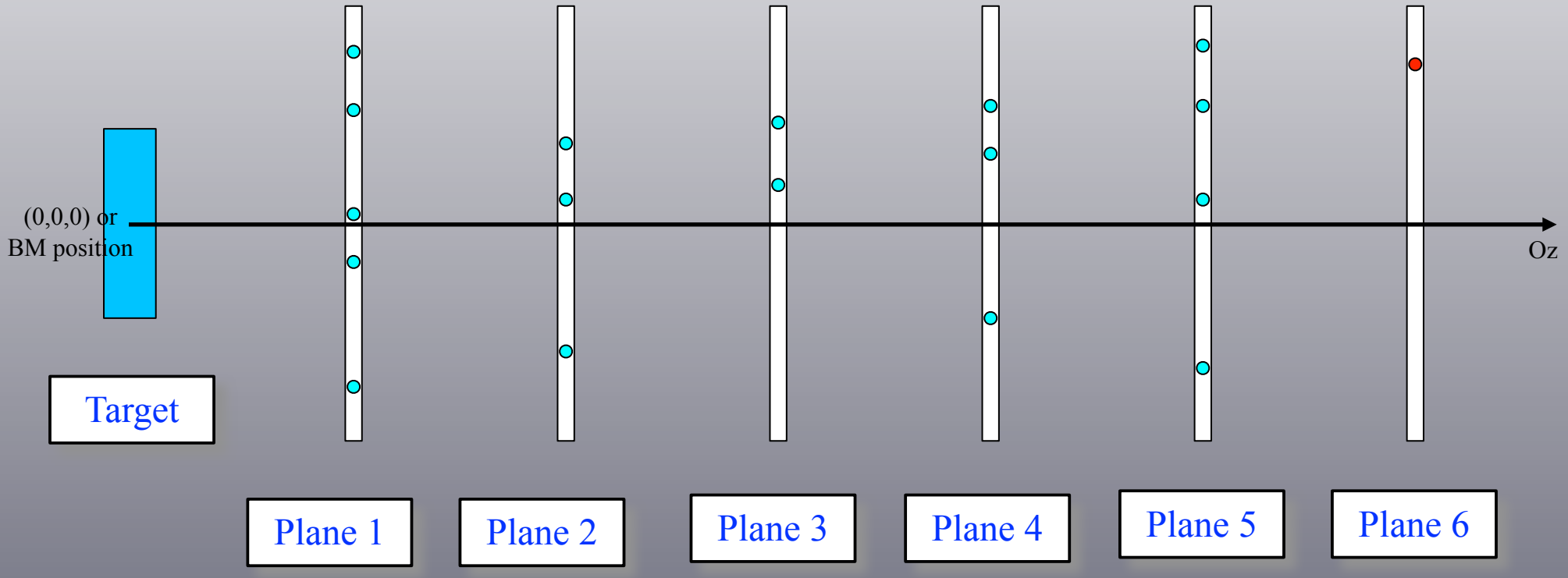
Cluster #1



Cluster #2

Tracker (local)

- Next to next local tracking



Tracker (local)

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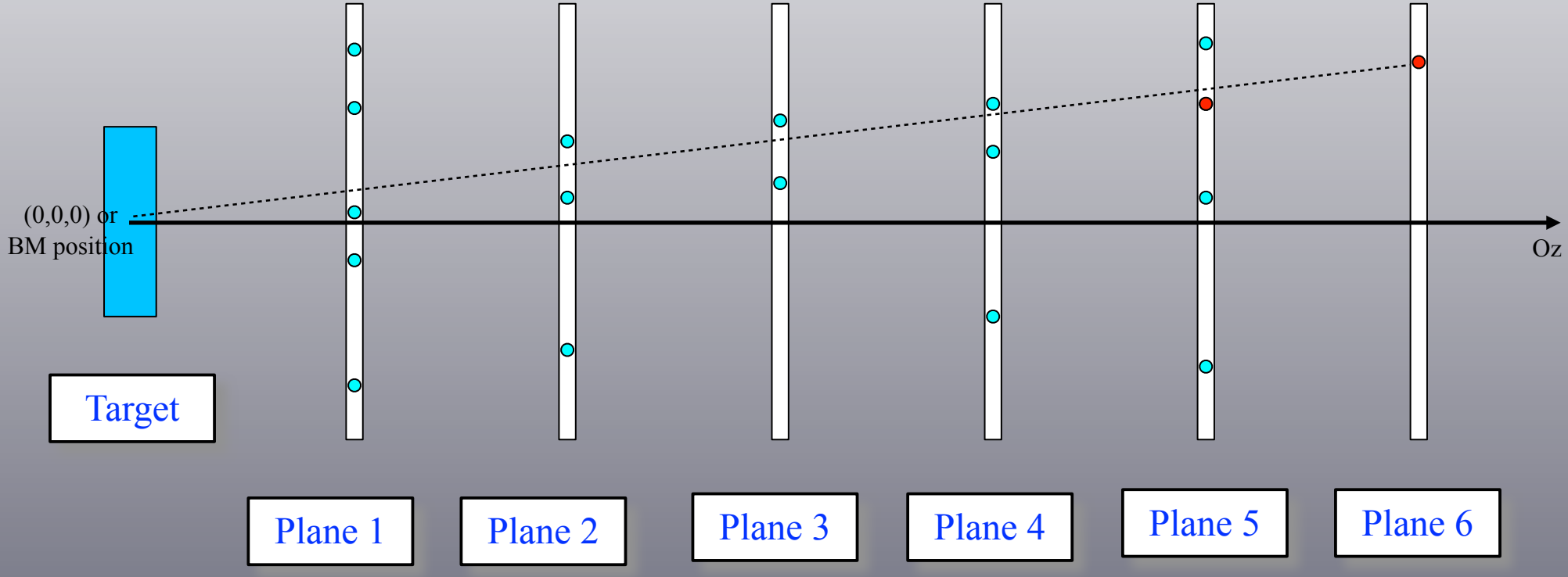
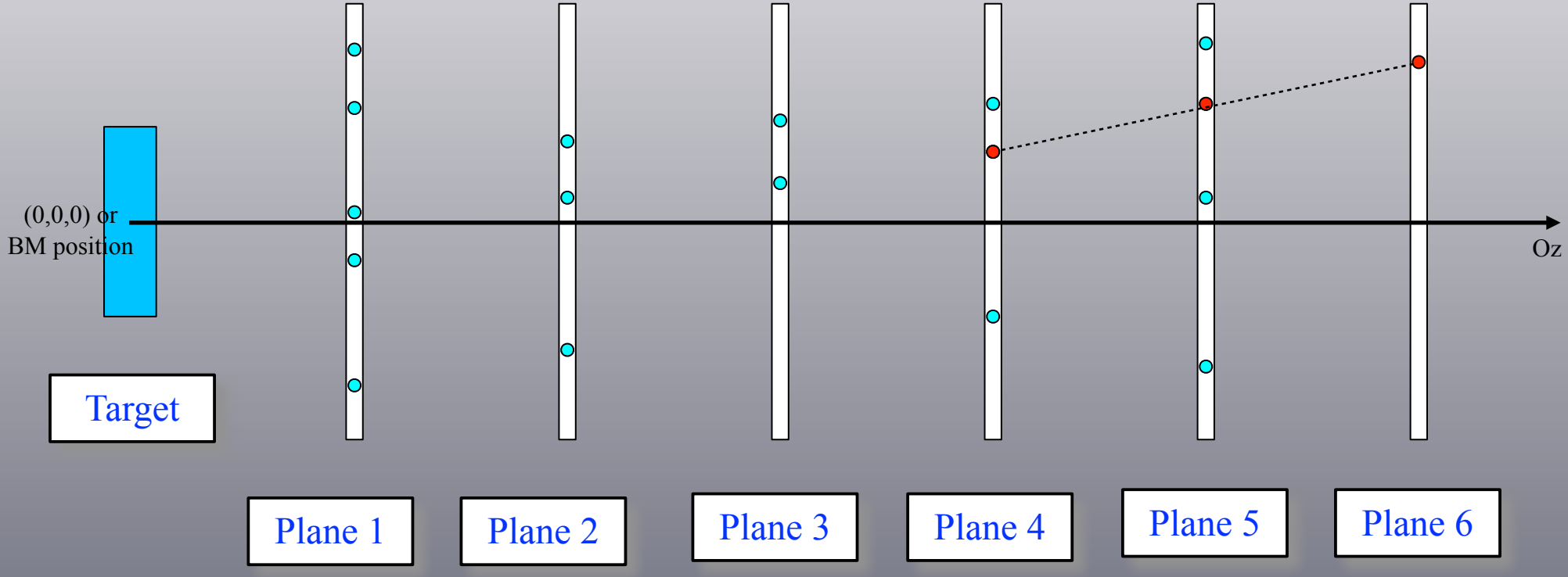


Tracker (local)

- Next to next local tracking



Tracker (local)

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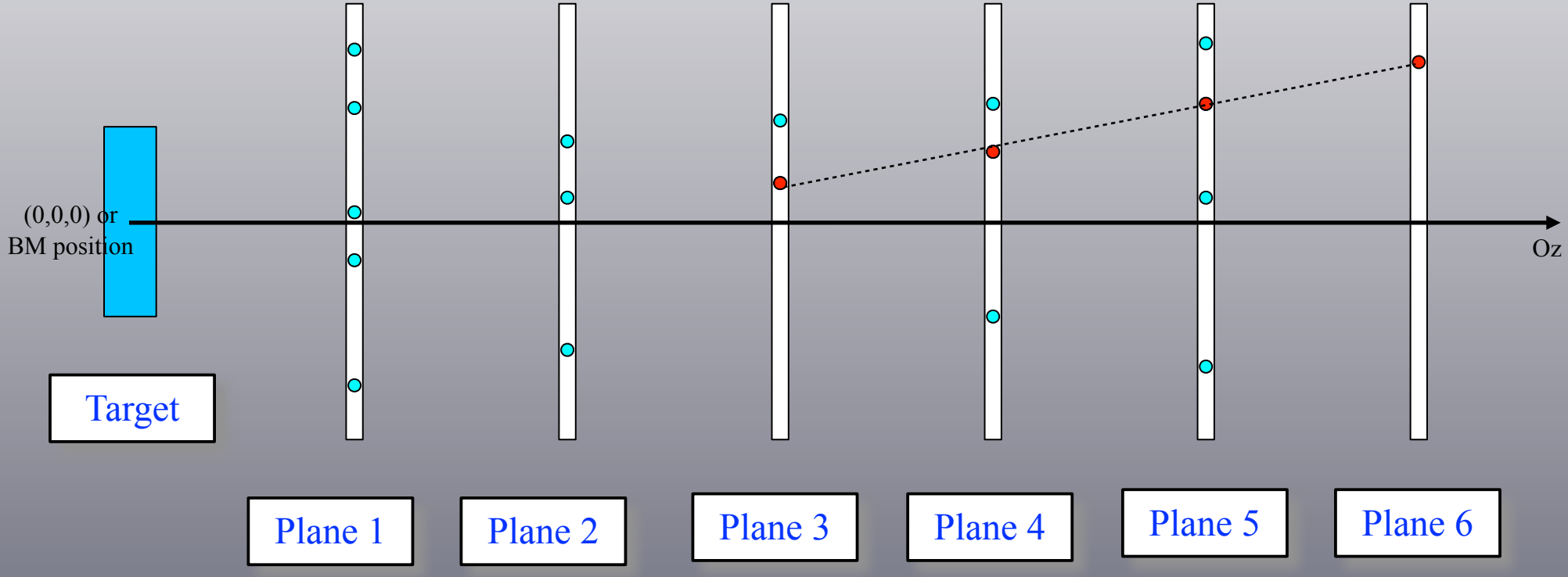

Tracker (local)

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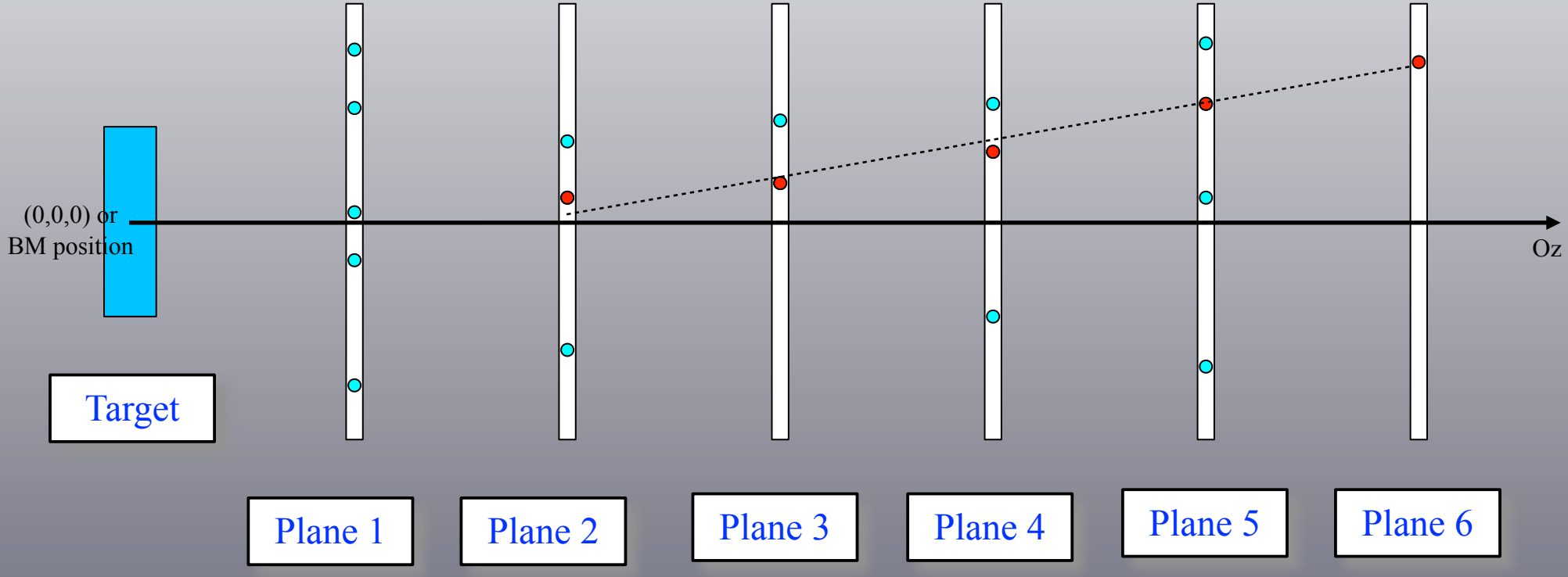
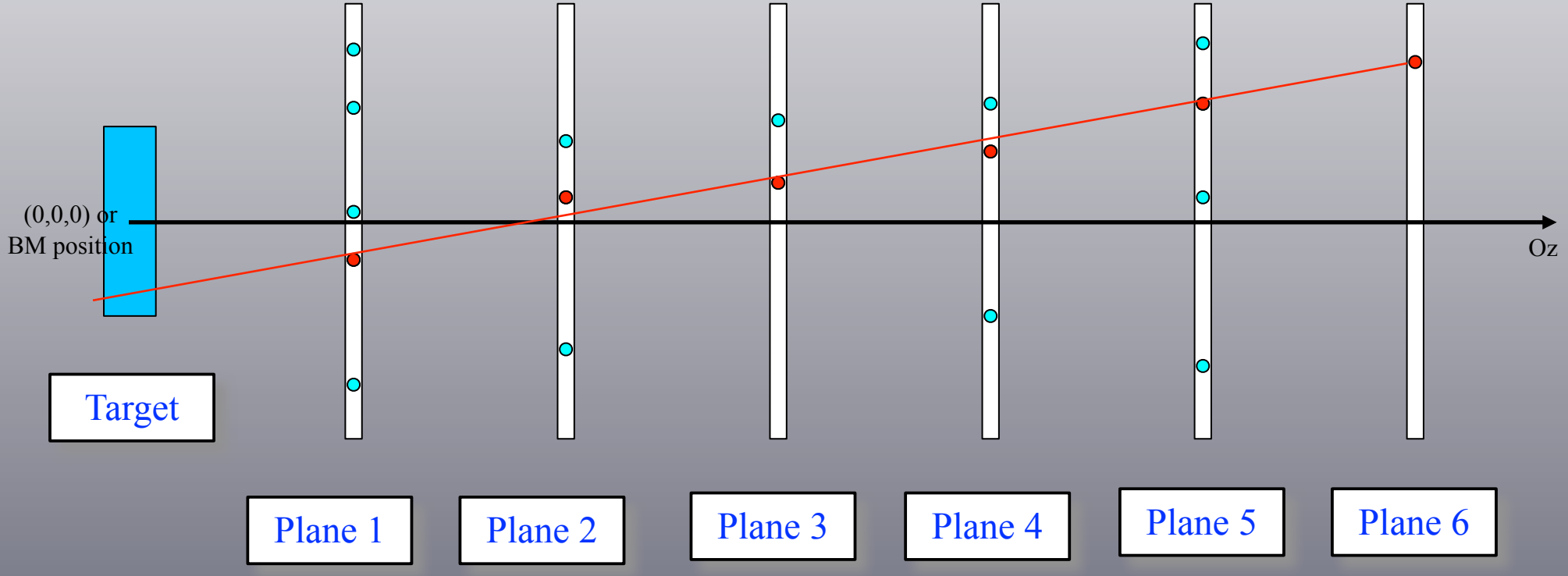


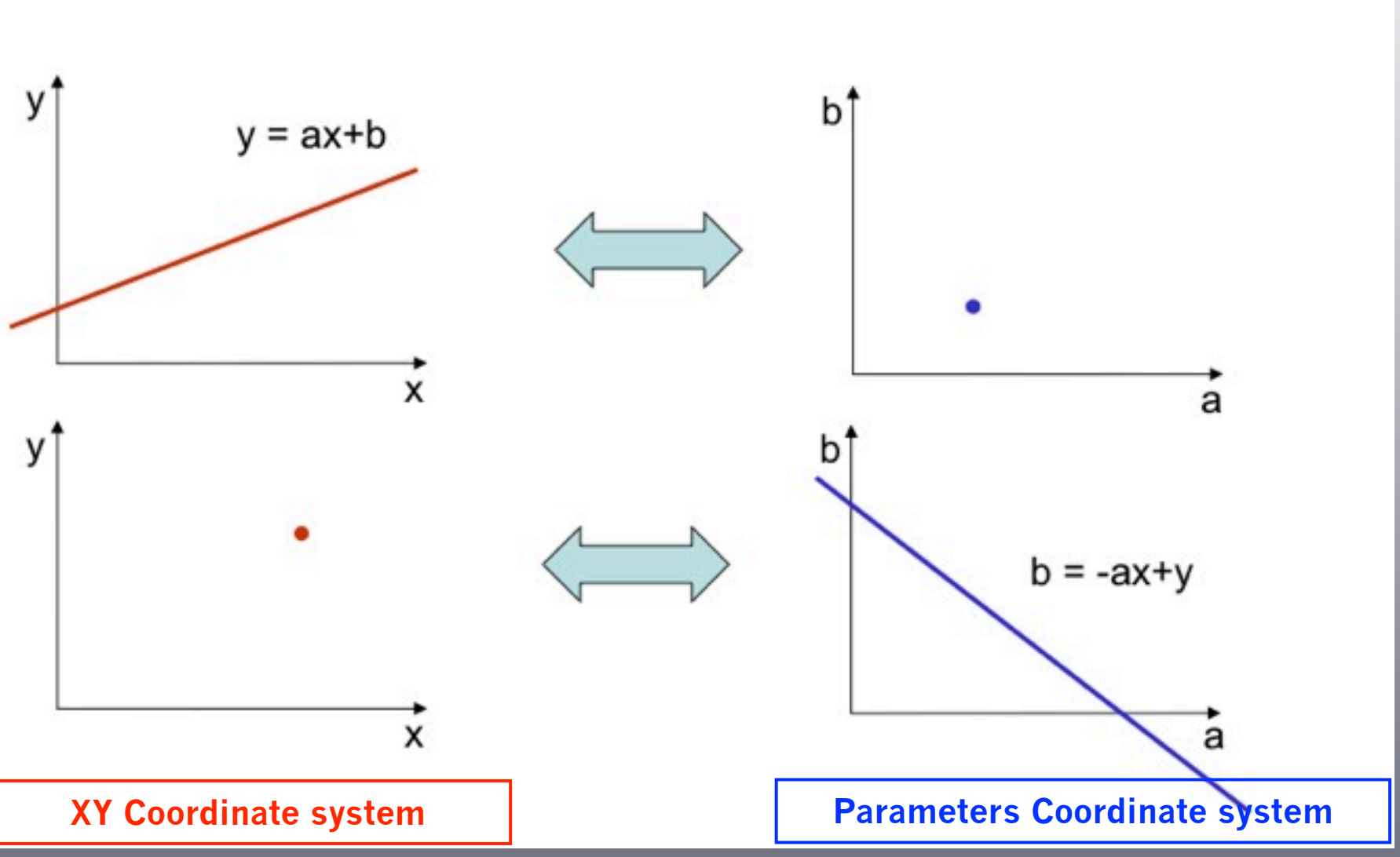
Tracker (local)

- Next to next local tracking



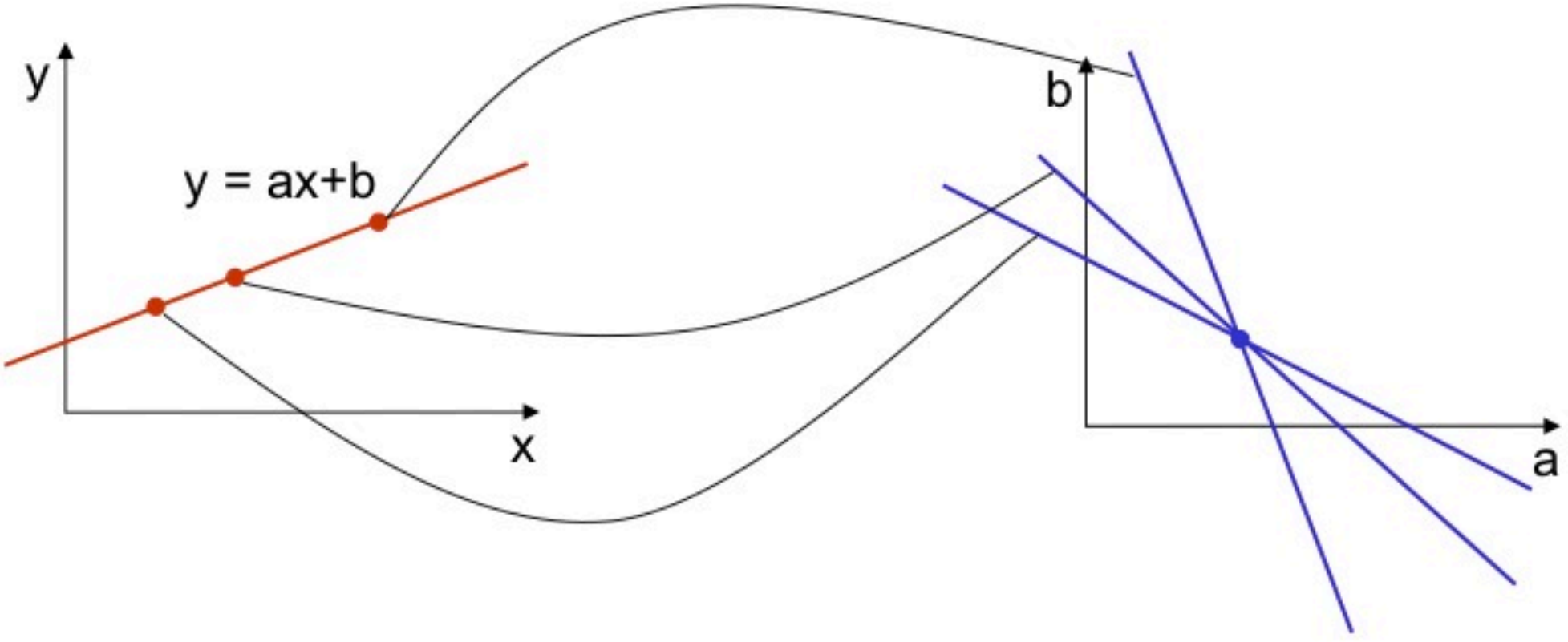
Tracker (Hough)

- Implementation of Hough algorithm (Didier Juliani)



- For each point (x,y), all the possible lines going through it are represented by a single line in (*a*,*b*) space

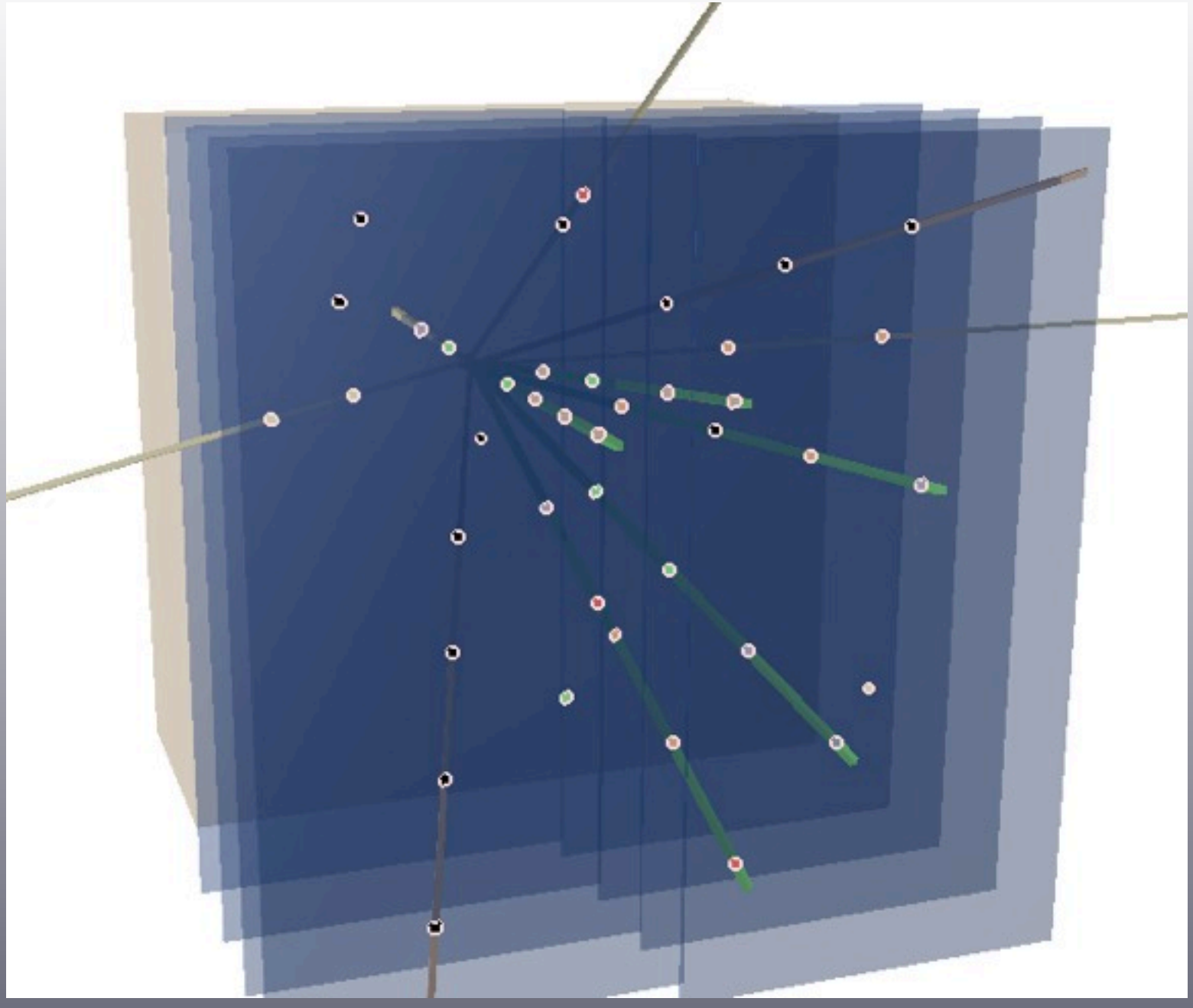
Tracker (Hough)



XY Coordinate system

Parameters Coordinate system

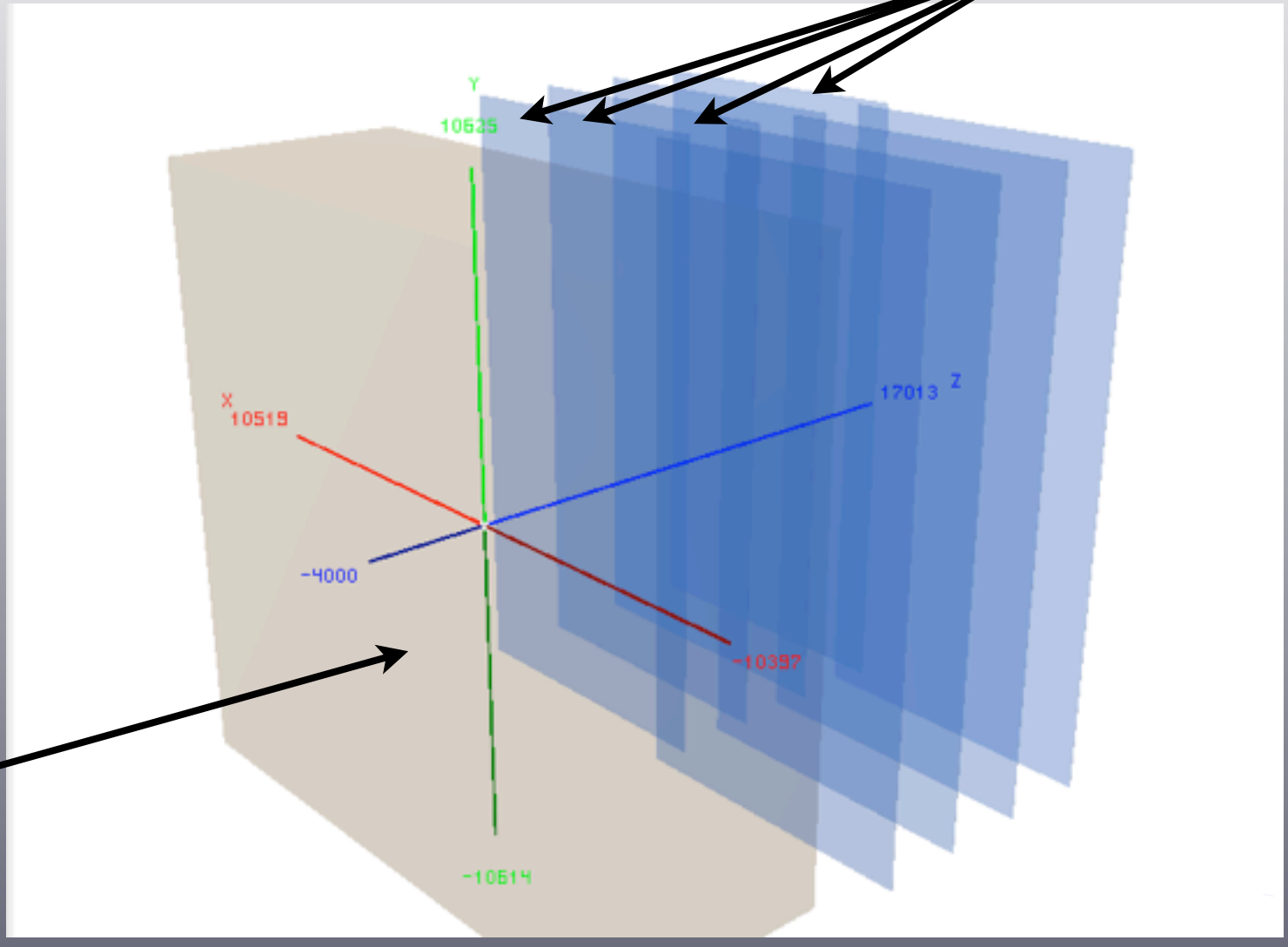
- Thus the only line in (x,y) space which goes through the 3 points is represented by the intersection point in (a,b) space.



Setup

- “First” geometry

2×4 M26 sensors



Target

Alignment Algo (i)

- Displacement in X & Y and rotation around Z axis:

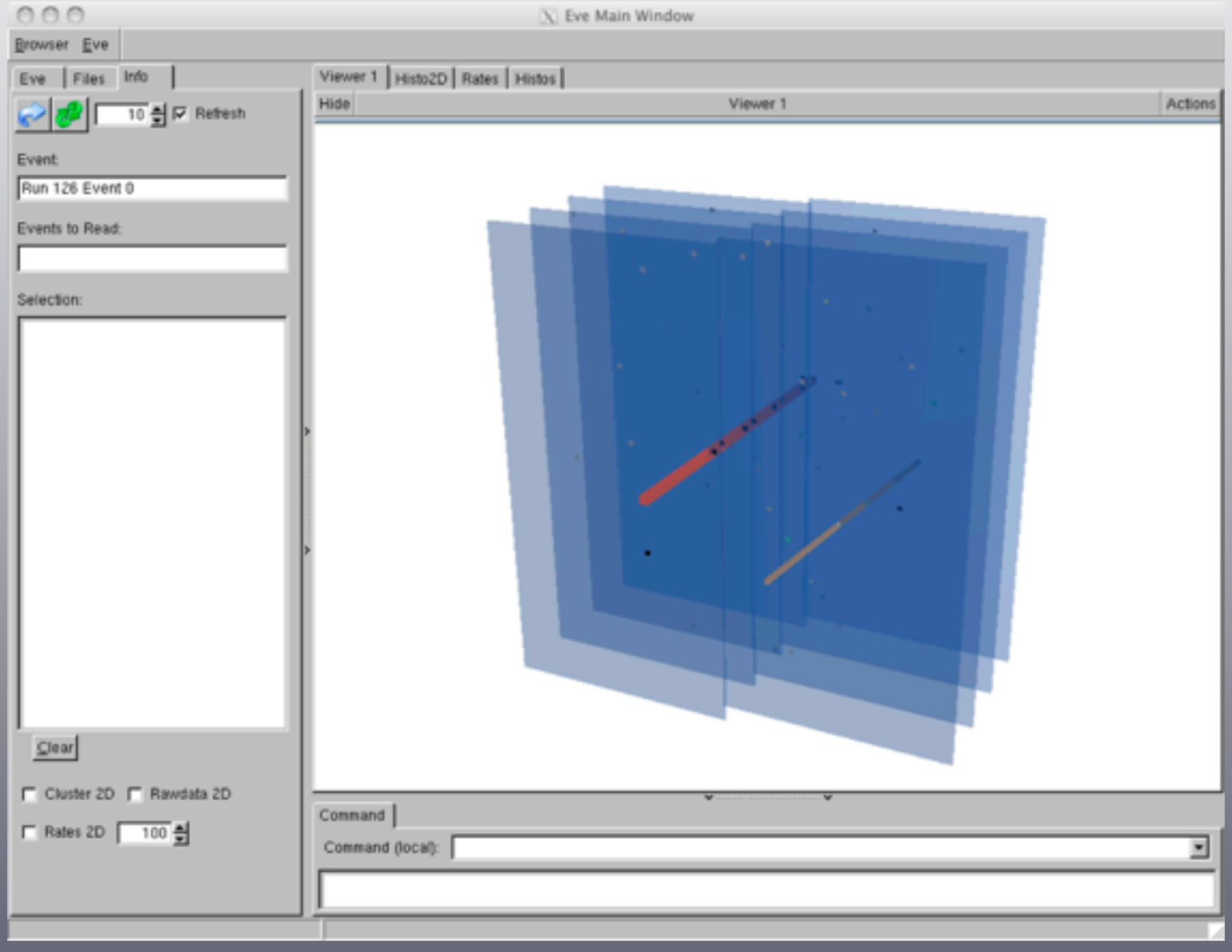
$$d_x = \Delta_x$$
$$d_y = \Delta_y + sin(\theta) \times pos_y = \Delta_y + \theta \times pos_y$$

  - d_i : distance track to cluster position
  - pos_y: position of the track in Y
  - Δ_i: offset of the sensor
  - θ: rotation angle around Z axis

- Minimizing of distances

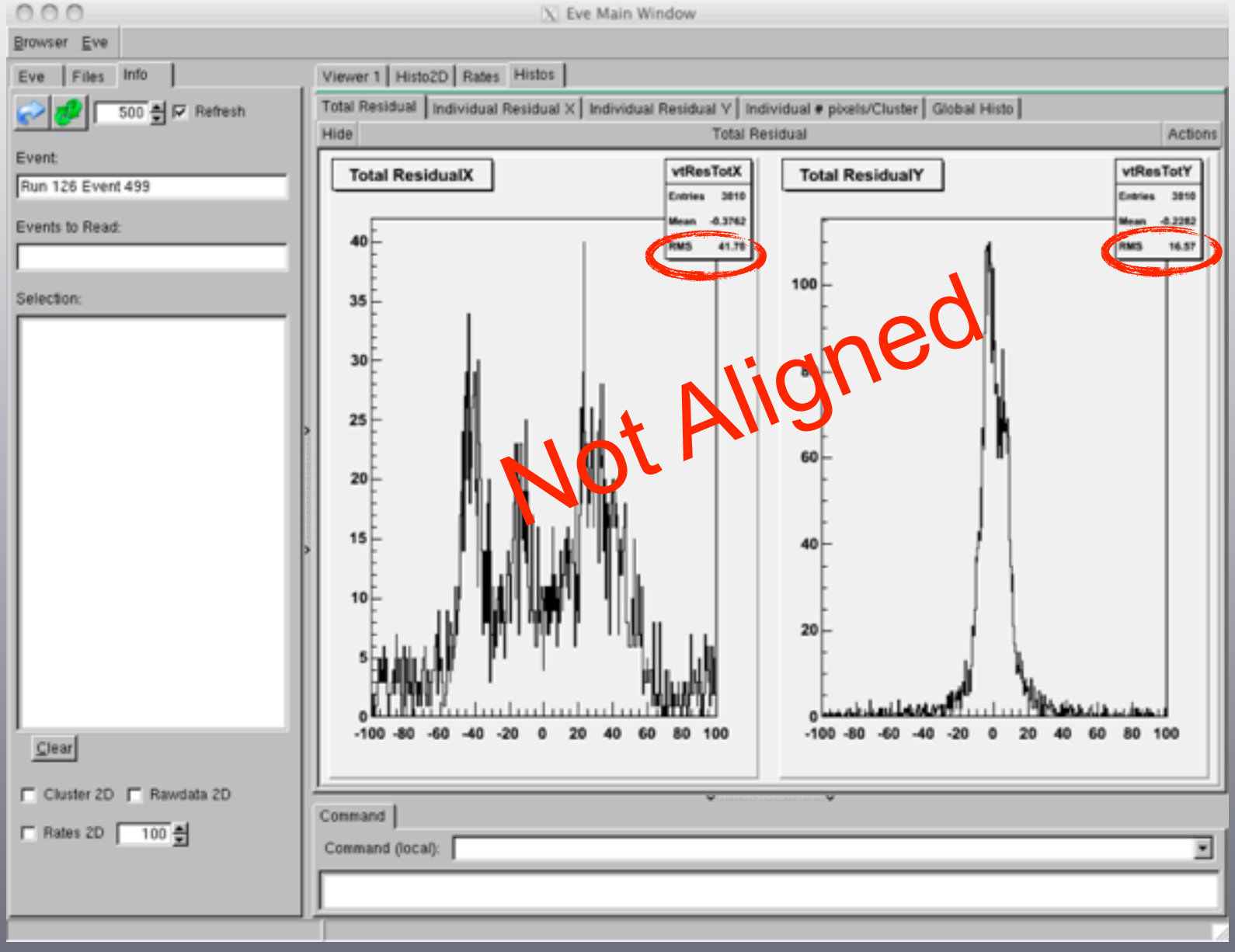
Alignment Algo (ii)

- Using straight tracks hitting all planes: ~4000evts



Results (i)

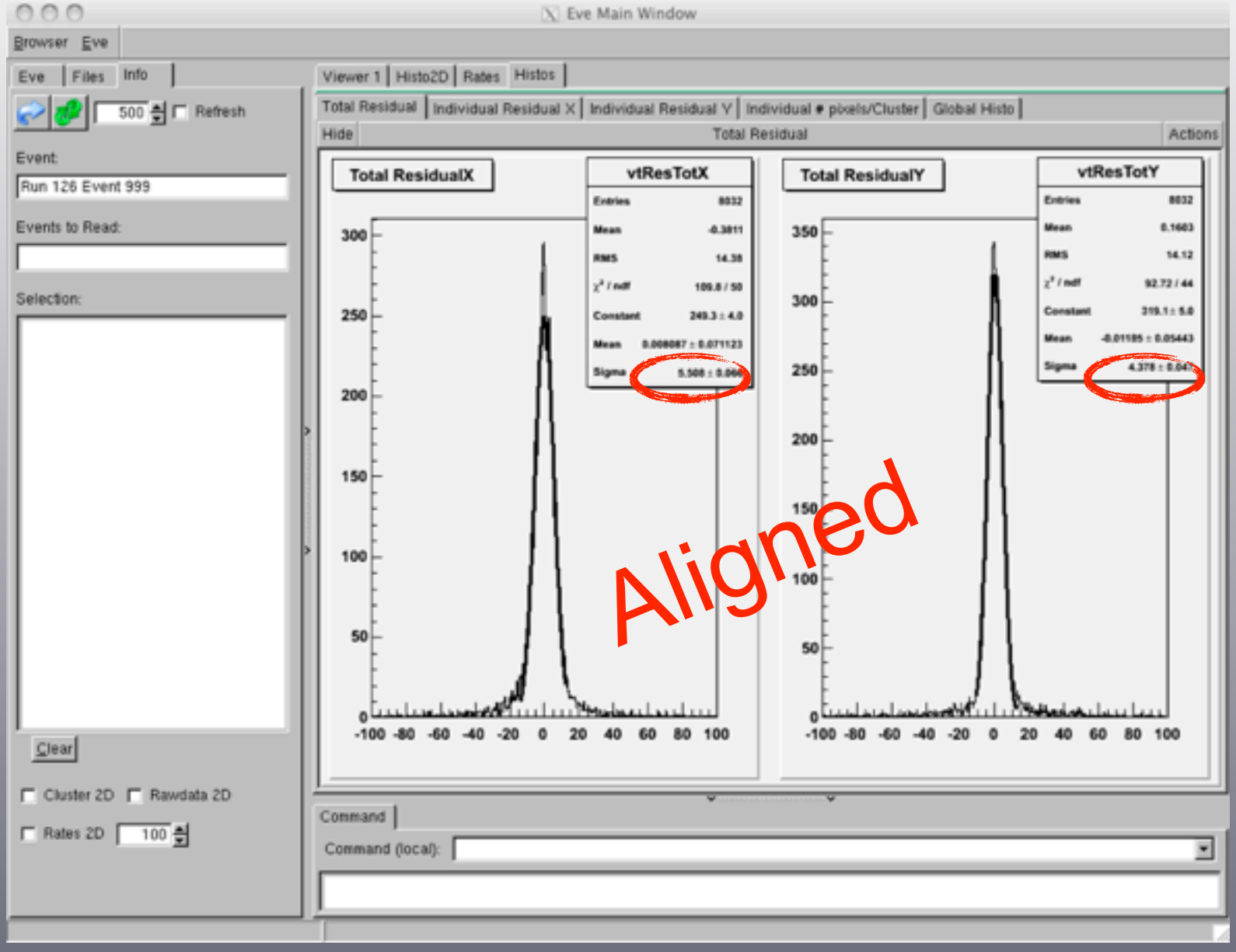
- Residuals



Results (ii)

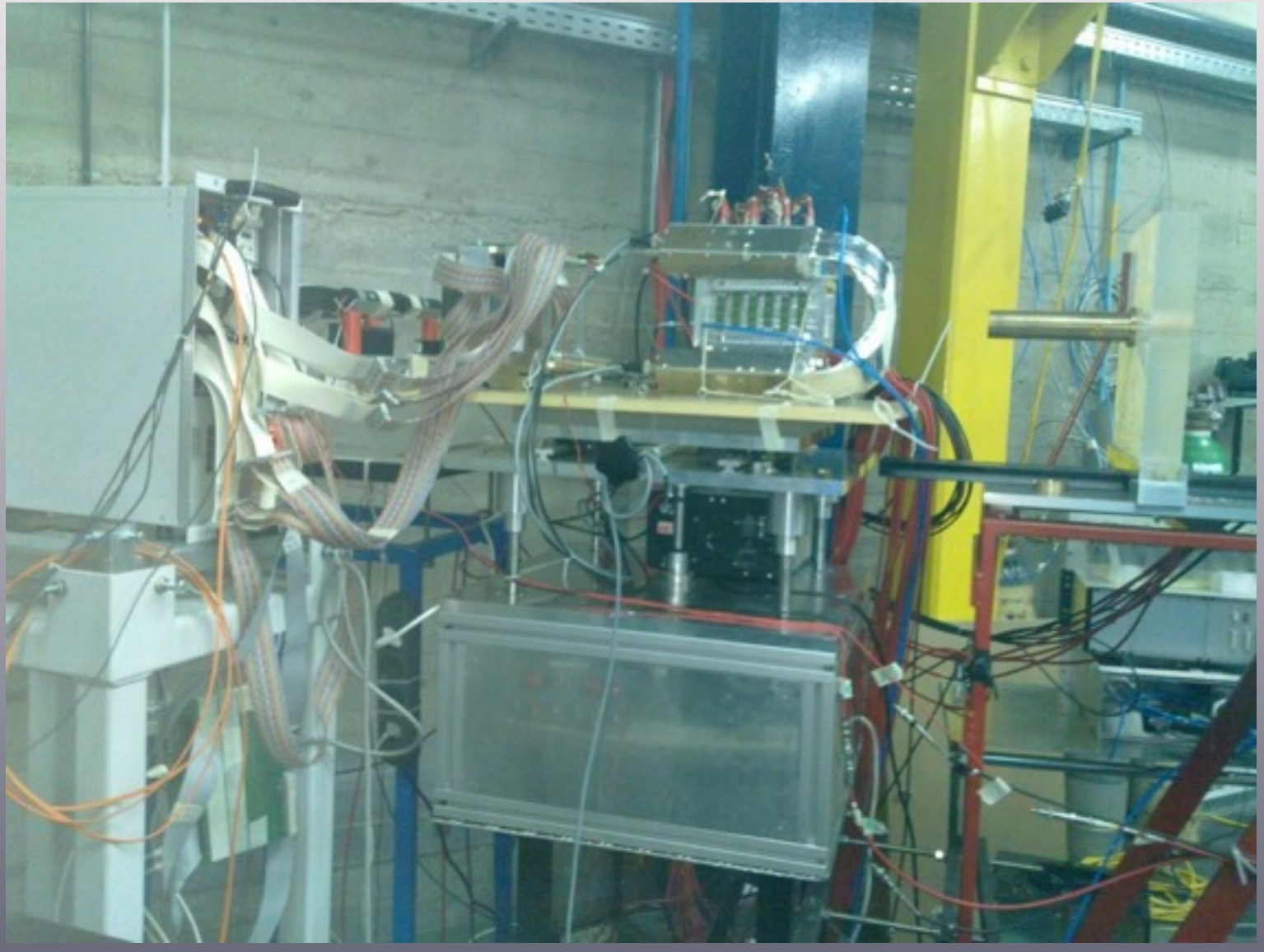
- Residuals

  σ ~ 5 µm



Catania

- Beam p, 12C @ 80MeV



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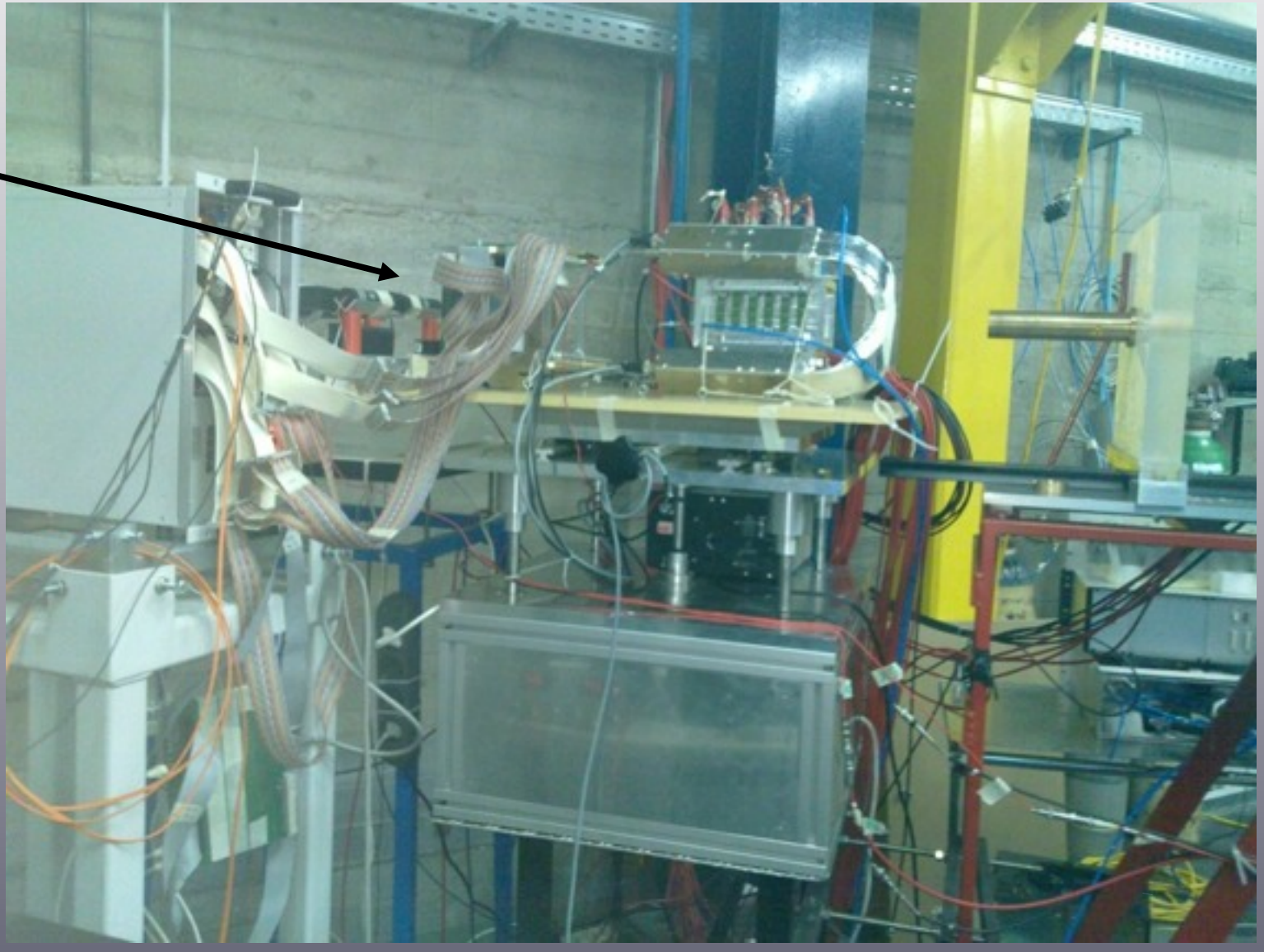
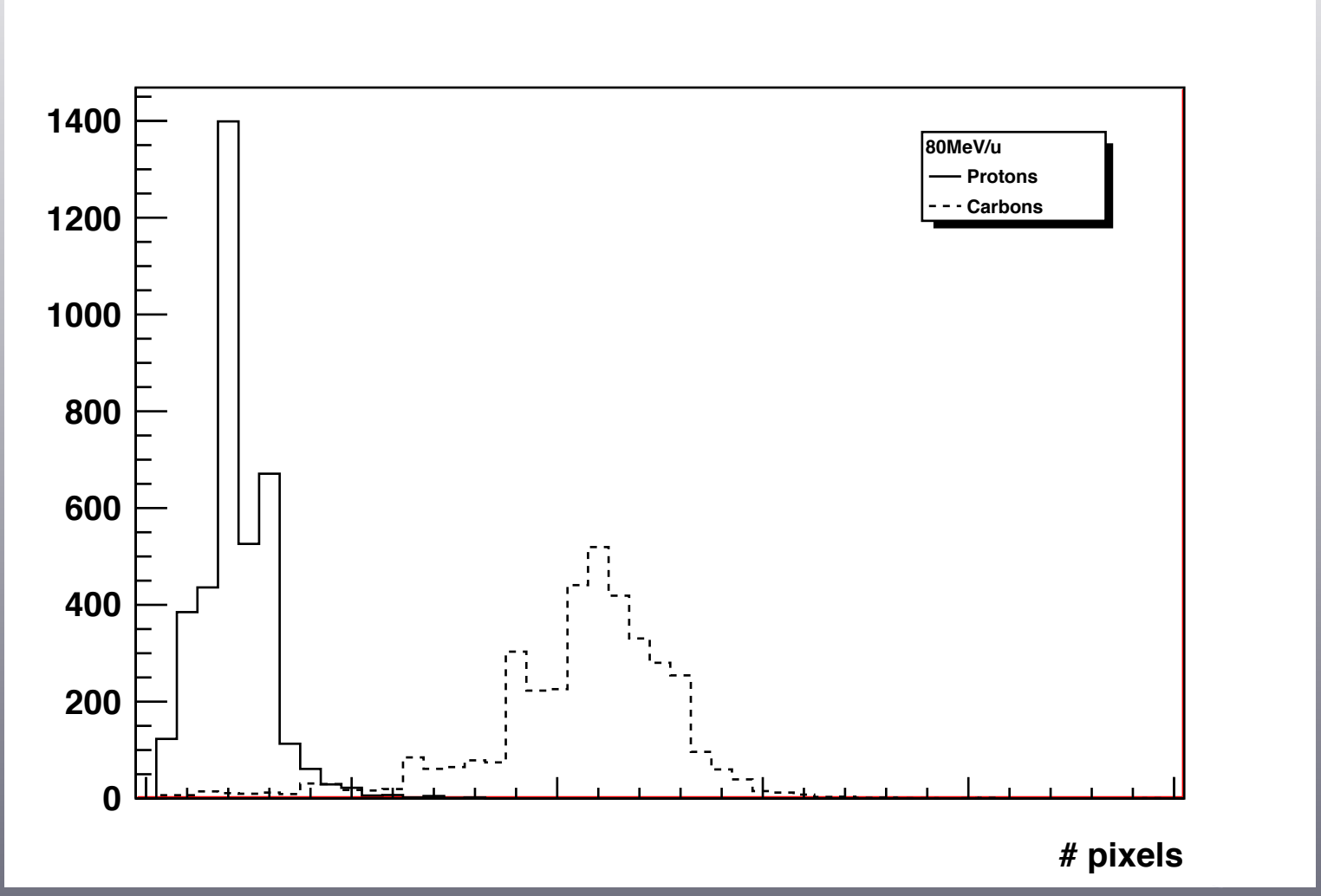


Catania

- Beam p, 12C @ 80MeV

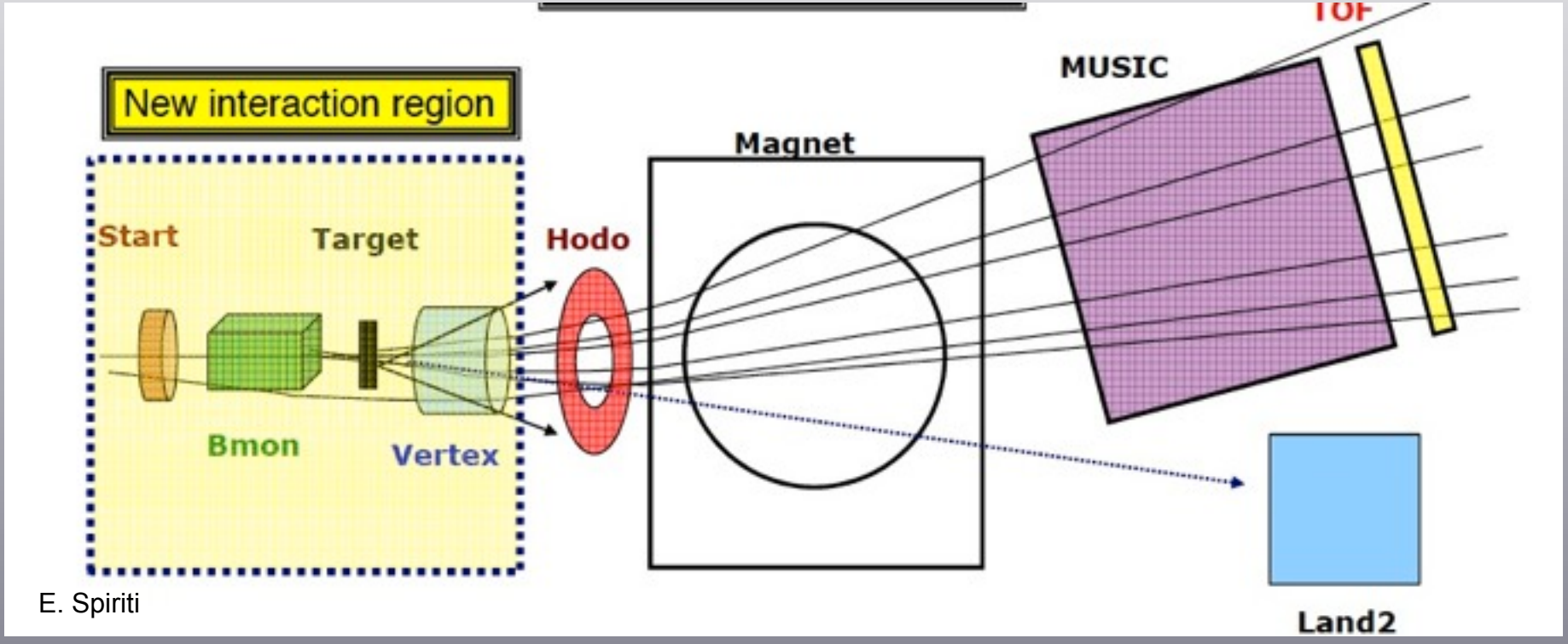
Protons/Carbons @ 80MeV/u

- Number of pixels per cluster



First experiment

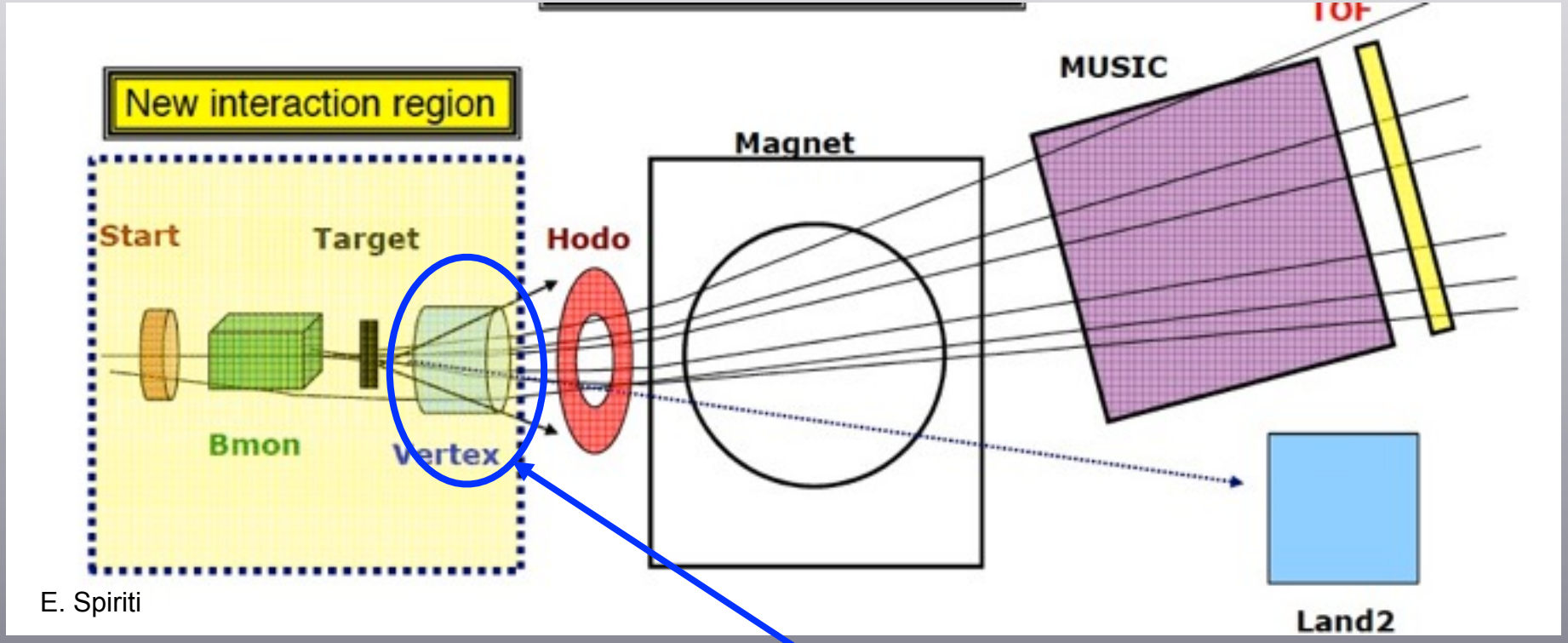
- $^{12}C+^{12}C$ @ 400 MeV/u



E. Spiriti

First experiment

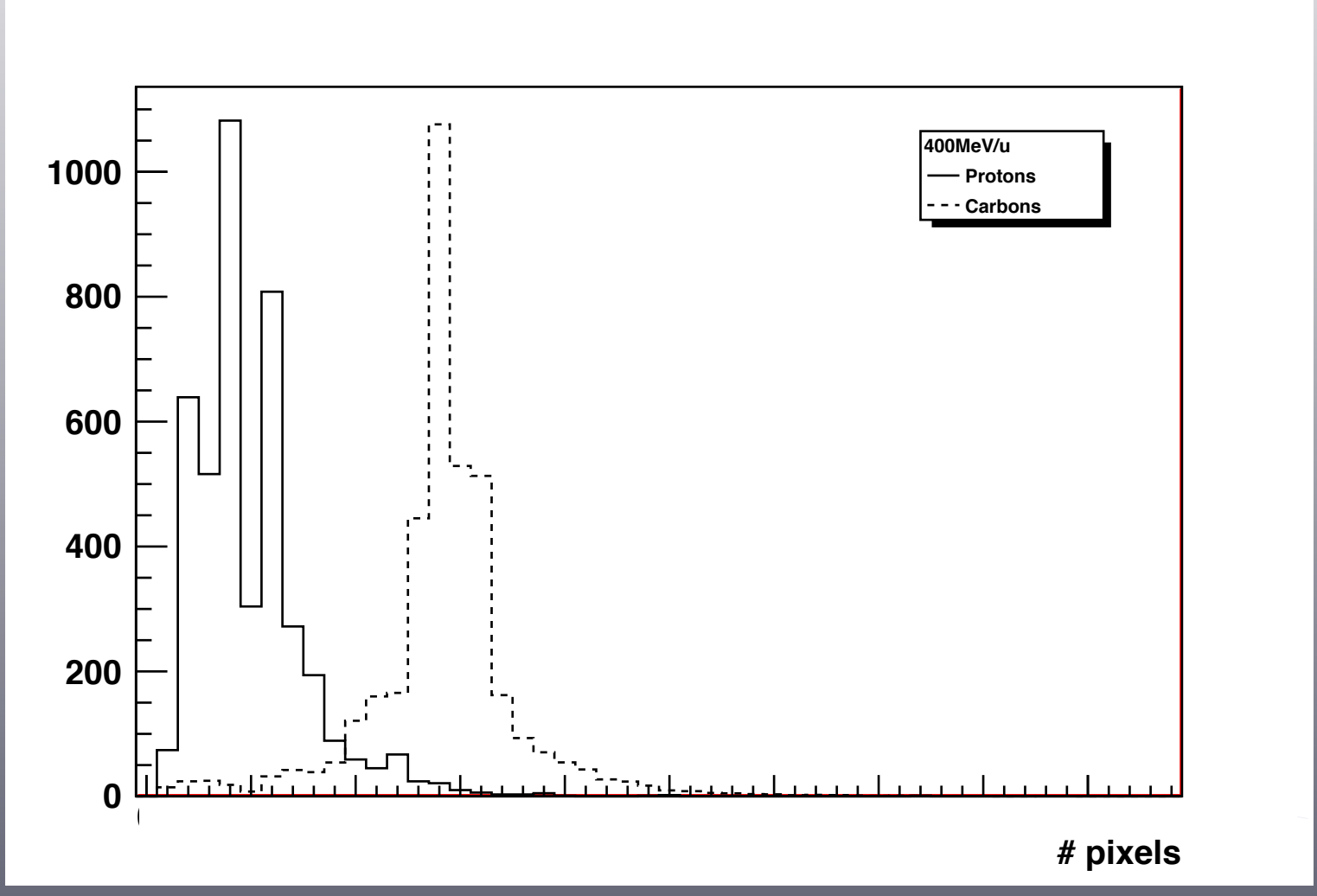
- $^{12}C+^{12}C$ @ 400 MeV/u



VTX detectors

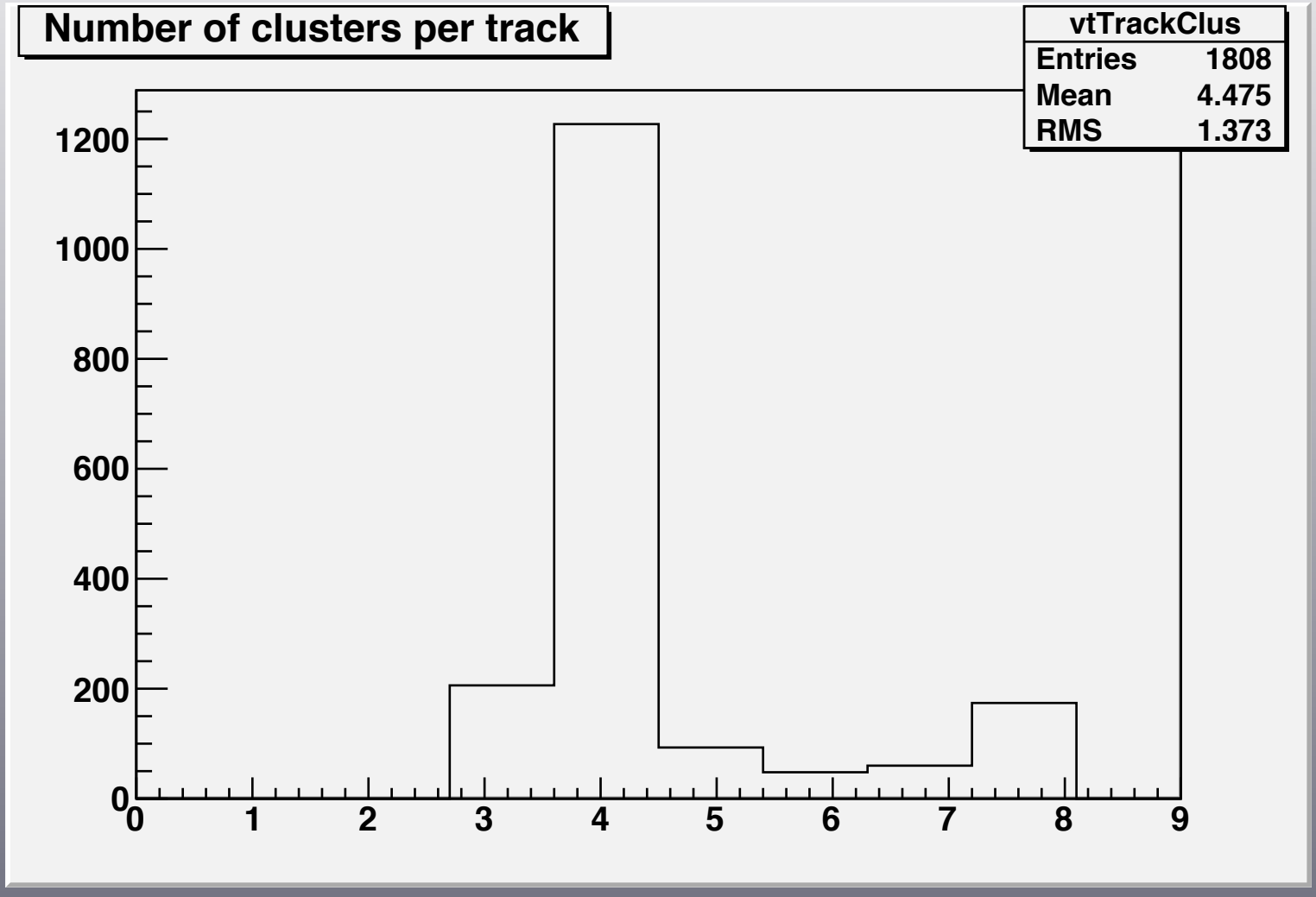
Global Plots (i)

- Number of pixels per cluster



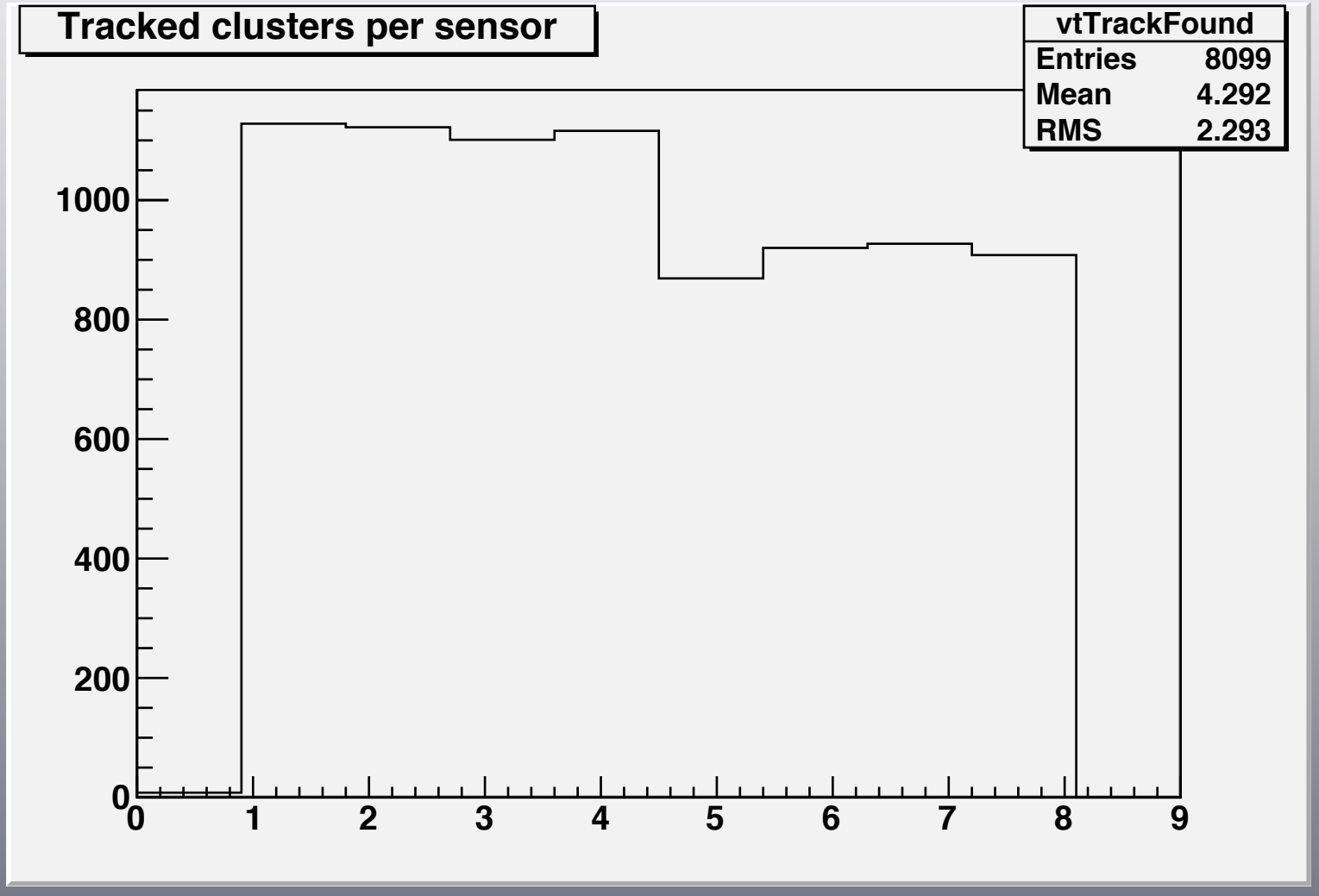
Global Plots (ii)

- Number of clusters per track



Global Plots (iii)

- Number of cluster per sensor

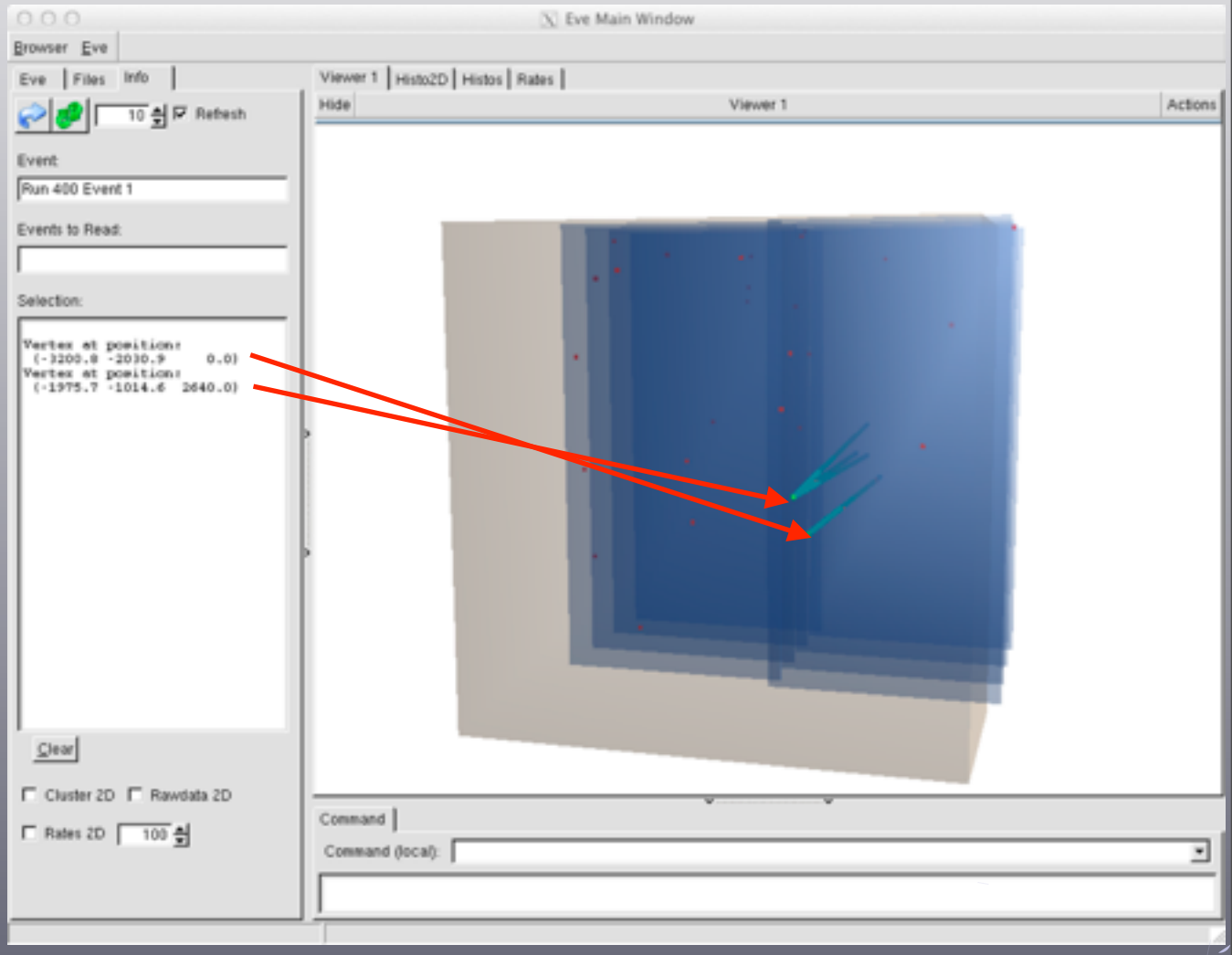


- Homogeneous efficiency
- Inefficiency < 0.1 %

Vertexing (i)

- New algorithms implemented (Regina Rescigno):
  - based on distance criteria
  - based on probability distributions

⇒ disentangle pileup vertices

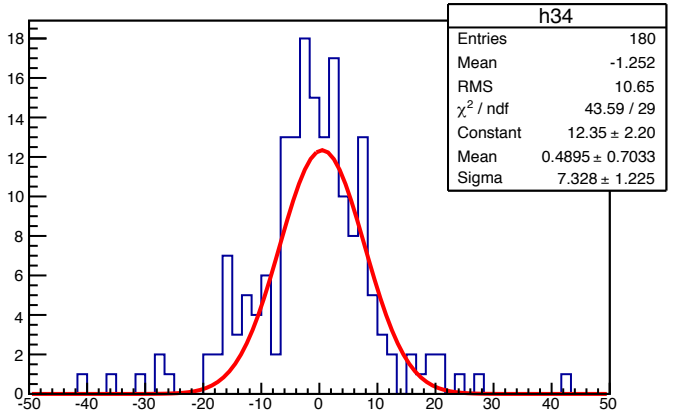


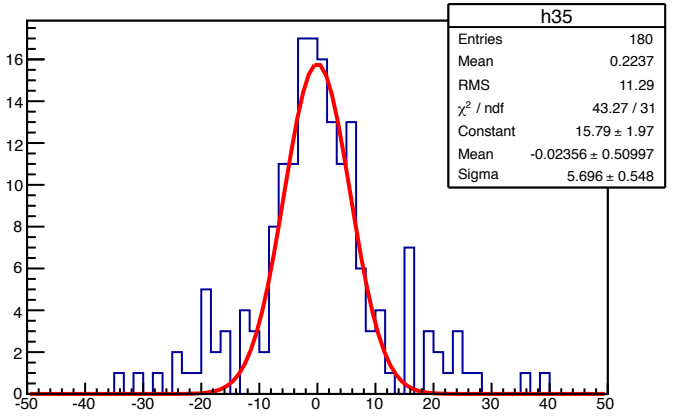
Vertexing (ii)

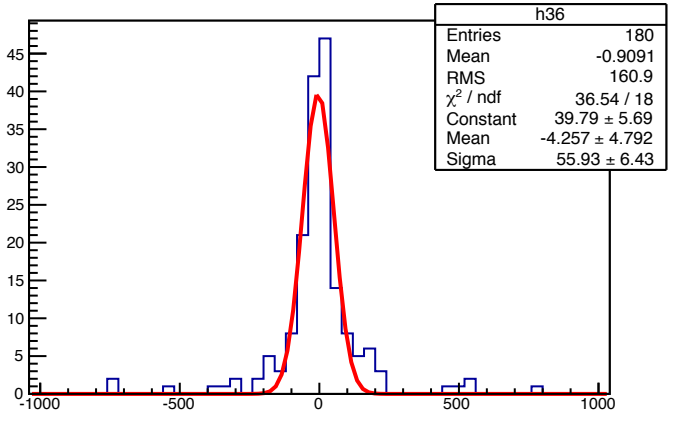
- Comparison with MC (Regina Rescigno):

  - Residuals for reconstructed vertex minus MC one

  (MC intrinsic residual 2 times better than in real)







- Resolution XY: ~6 microns
- Resolution Z: ~ 50 microns

Conclusions

- Tracker with CMOS working
  - Clustering ✔
  - Tracking ✔
  - Vertexing ✔

Outlook

- Developing a simulation toolkit based on GEANT4 + Root + reconstruction (under svn for versioning & Cmake for dependancies)

  - Modular geometry (BM + Vtx with Cmos + target + beam)
  - Cmos Digitizer for non-MIPs
  - Output of Geant in root file
  - Reconstruction from root/Pxi files

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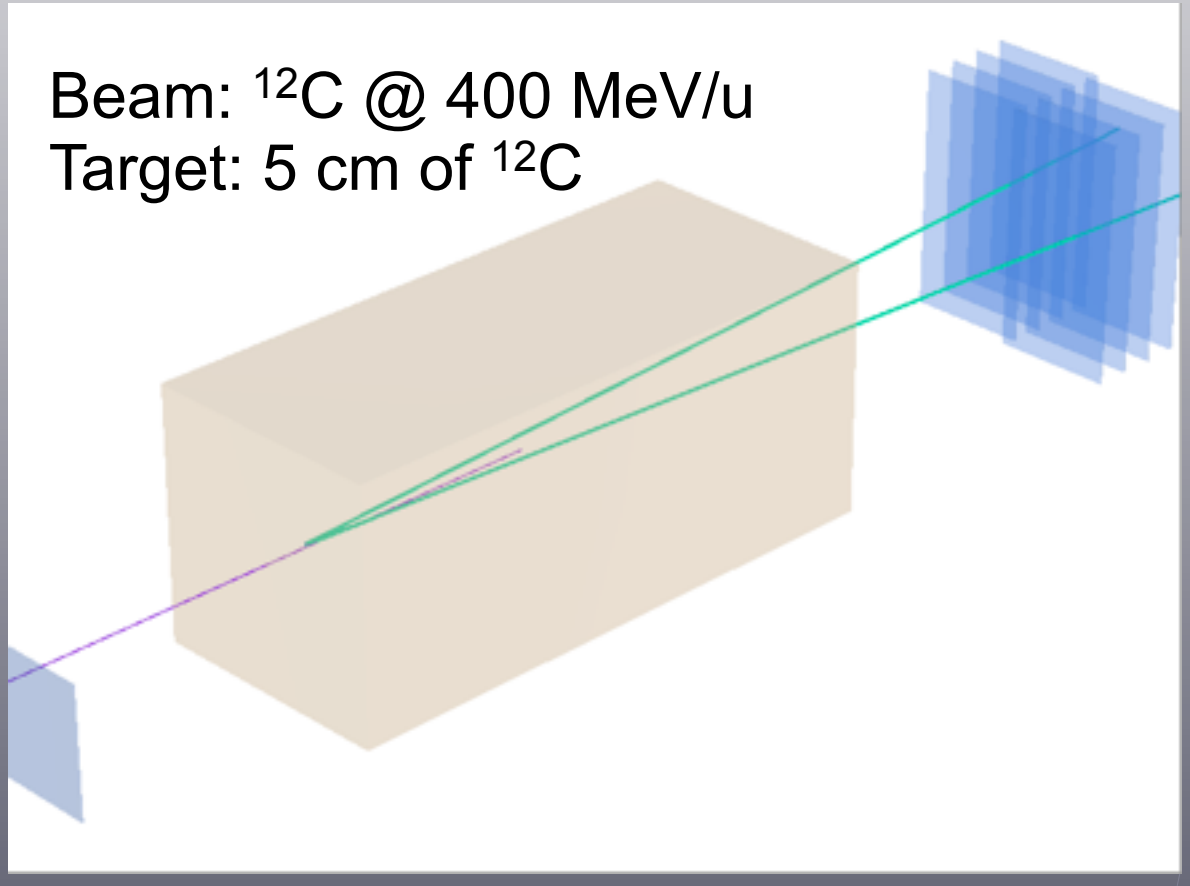

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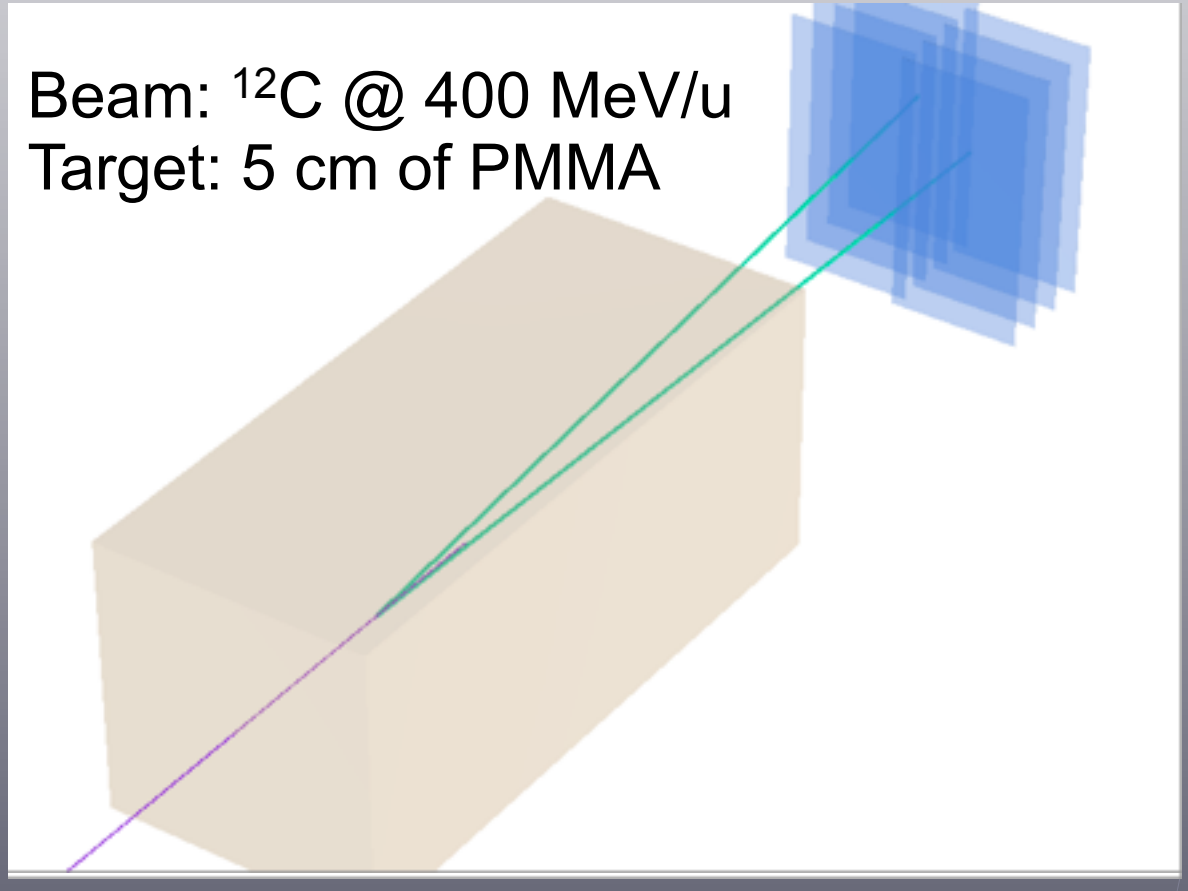

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