# MICE Tracker Software

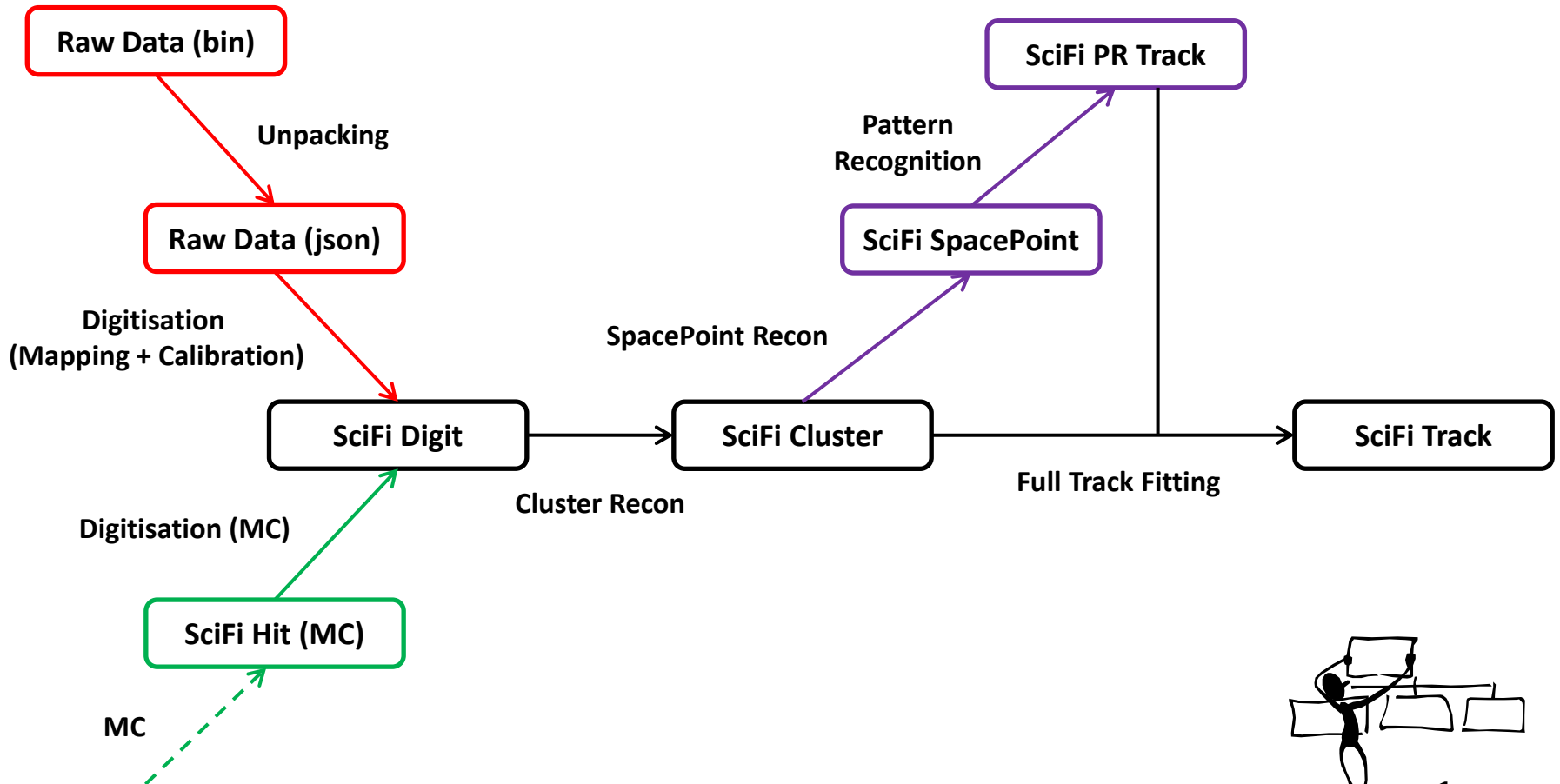## A. Dobbs CM32 9th Feb 2012

# Outline

- Software requirements
- Data flow
- Framework
- Configuration and geometry
- Monte Carlo
- Digitisation
- Reconstruction
- A few results
- Conclusion

# Software requirements

- Built within MAUS framework

- Unpack real data from DAQ using MAUS unpacker

- Digitise real data

- Create reasonable Monte Carlo data

- Digitise MC data

- Reconstruct MC and real data

- Final output: particle tracks in JSON format for use by the Analysis group

# Data flow



Raw Data (bin) → **Unpacking** → Raw Data (json) → **Digitisation (Mapping + Calibration)** → SciFi Digit

SciFi Hit (MC) → **Digitisation (MC)** → SciFi Digit

**MC** → SciFi Hit (MC)

SciFi Digit → **Cluster Recon** → SciFi Cluster

SciFi Cluster → **SpacePoint Recon** → SciFi SpacePoint → **Pattern Recognition** → SciFi PR Track

SciFi Cluster → **Full Track Fitting** → SciFi Track

# Framework

- C++ class based system
- Single interface to JSON format data provided on a spill-by-spill basis by MAUS
- Interface currently being used written by Ed, to be replaced with interface written by Alex Richards when ready (JSON ⇔ C++ ⇔ ROOT)
- 3 *mappers* used in MAUS to call tracker algorithms:
  - Real data digitisation
  - MC digitisation
  - Reconstruction
- Geometry and Configuration data to be extracted from CDB

# Configuration and Geometry

- Currently using data from Mice Modules in legacy G4MICE code in MAUS
- This needs verifying or replacing (believed to be effecting reconstruction efficiency)
- Final system is to query CDB and pull down config data for relevant run / data / etc
- Uses an API either based on Python with C++ wrapper or possibly a native C++ interface using SOAP to CDB
- Data is then stored in memory as classes (Geometry class, Configuration class, etc)
- Team of Oleg, Ken, Anthony, and Matt Robinson

# Monte Carlo

**SciFi Hit (MC)**

MC
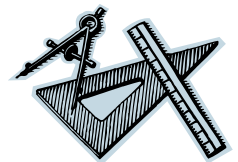
- MC produces SciFiHits (truth) which has been reconstructed up to SciFiDigits...

- ... but displays some strange features
  - Hits distribution in stations is odd
  - Some questions over energy deposition
  - Current suspicion is that problem lies in the digitisation...

- Paul Kyberd leading the effort with Anastasia and Stefania (+ Ed + Me)

# MC Scattering Analysis

Very Preliminary!

by Paul Kyberd

| thetaEx | |
|---|---|
| Entries | 1946 |
| Mean | 0.00299 |
| RMS | 0.002282 |

Entries

Scattering Angle (rad)
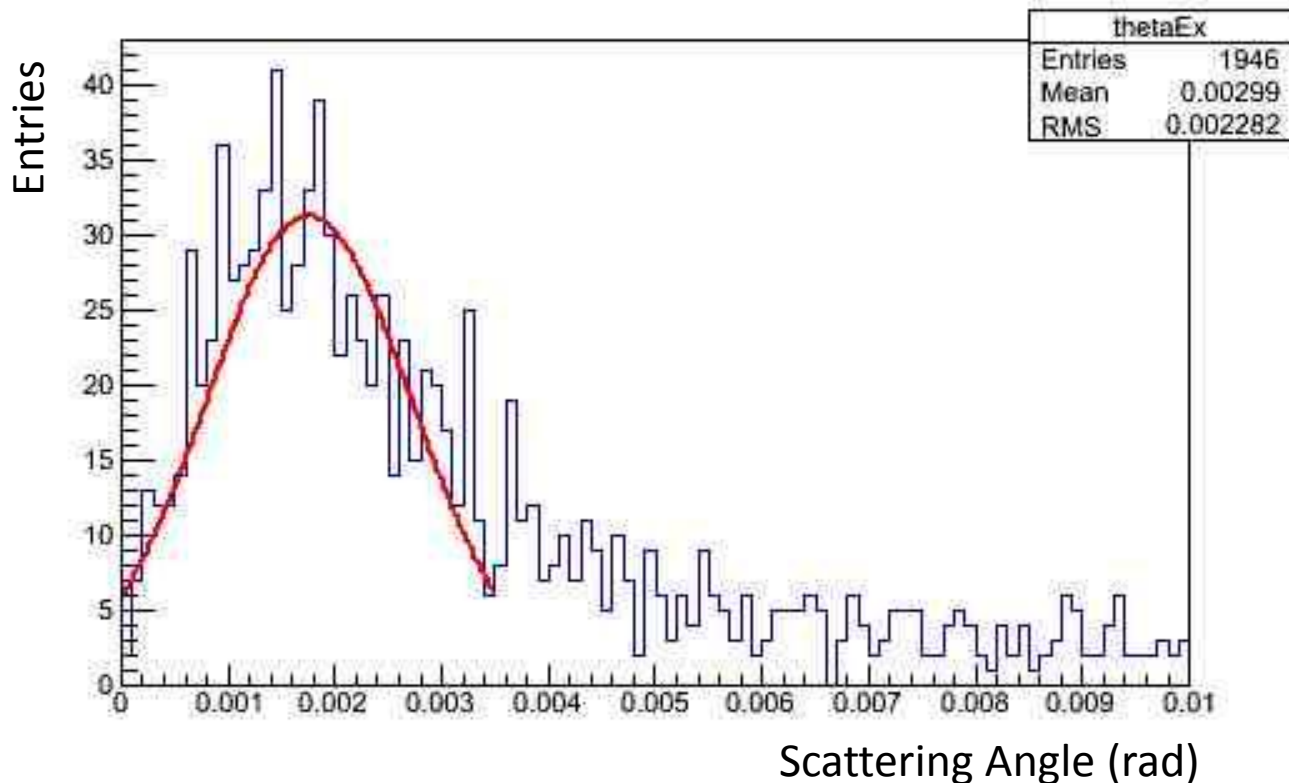
- Gaussian fit in red, mean of 1.75 mrad
- RMS of the whole distribution is 2 mrad
- Calculation based on the Gaussian approx to the ms is 1.90 mrad
- Tail expected from physics and the way plot was produced
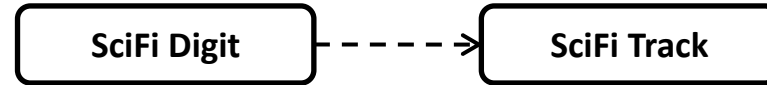- Agreement is surprisingly (suspiciously?) good

# Digitisation

- Real data unpacking, mapping and calibration all working and producing SciFiDigits...

- ...although mapping and calibration will probably need to be redone when we move to MICE hall

- MC SciFiHits also producing SciFiDigits but remains suspect

Raw Data (json)

Digitisation
(Mapping + Calibration)

SciFi Digit

Digitisation (MC)

SciFi Hit (MC)

# Reconstruction
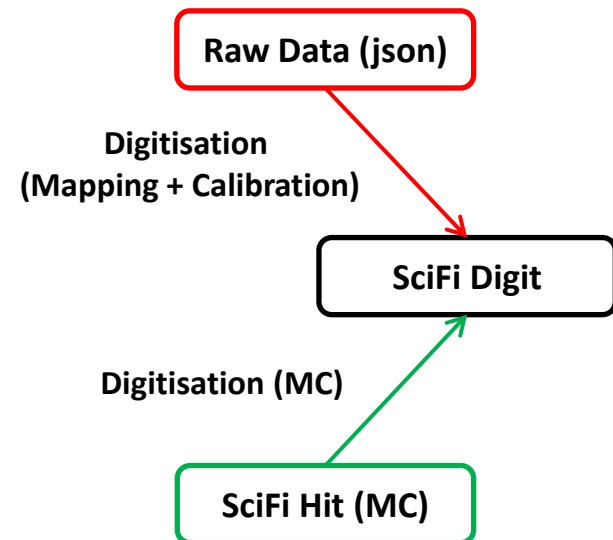
| SciFi Digit | - - - - → | SciFi Track |

- One master TrackerRecon class which calls further classes for ClusterRec, SpacePointRec, PatternRecognition...

- These operate on container classes such as SciFiDigits, SciFiClusters, SciFiSpacePoints...

- Bundled together in a SciFiEvent class

- **Working all the way up to space points and (almost) in the trunk** (great effort from Ed Santos)

- Pattern Recognition starting to produce first straight tracks in class based framework

# Cluster and SP Recon

| SciFi Digit | → | SciFi Cluster |
|---|---|---|

**Cluster Recon**

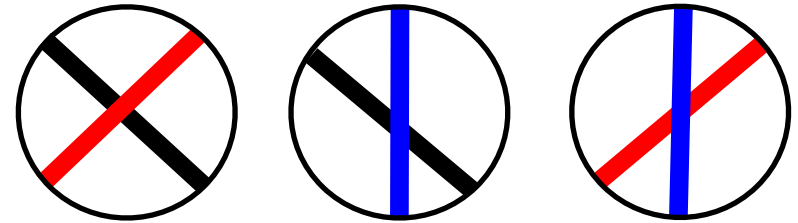| SciFi Cluster | → | SciFi SpacePoint |
|---|---|---|

**SpacePoint Recon**
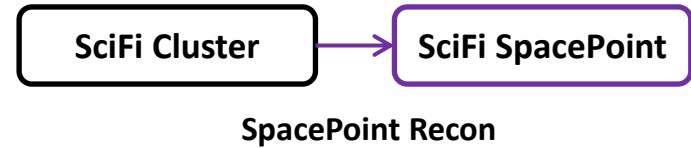
## SciFi Plane

~10% region of overlap:

Muons crossing in this region will deposit energy in two different channels. We must sum the energy deposit in both before applying cuts based on the number of photo electrons
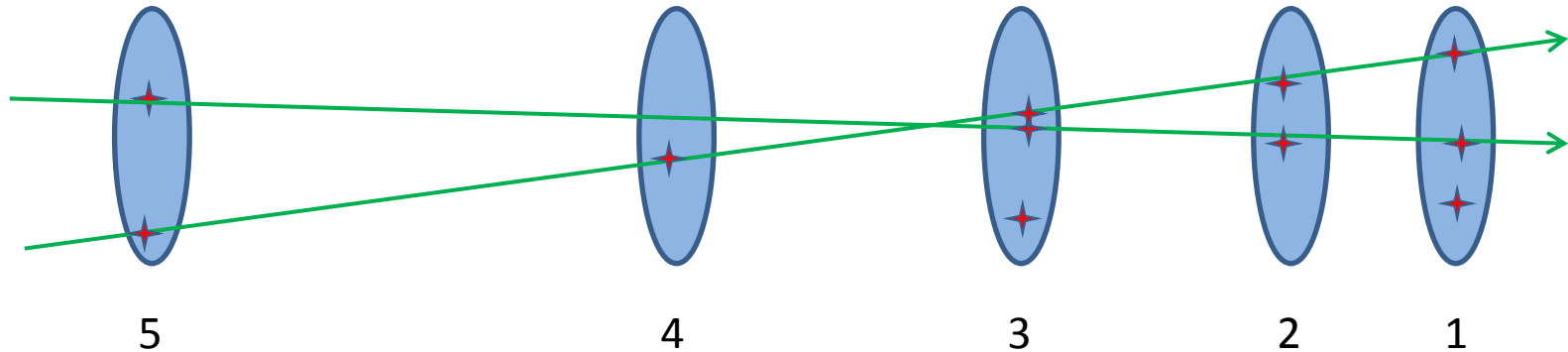
→ Clustering

The position of a space-point is calculated by averaging the crossing position of the 3 possible cluster combinations.
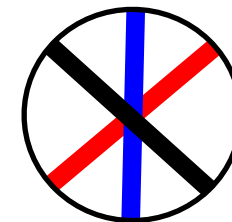
Thanks to Ed for this slide

# Pattern Recognition (Straight)



- Draw a straight line between pair of space points in outer and inner most stations

- Check how far space points in intermediate station vary from the line ("road cuts")

- If enough points pass the road cuts, fit a line (linear least squares) with best matches

- If fit passes chi^2 test, accept track
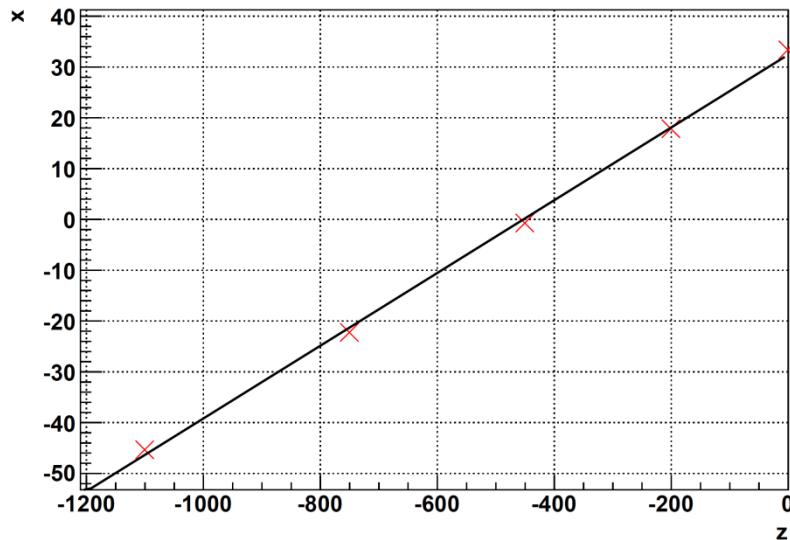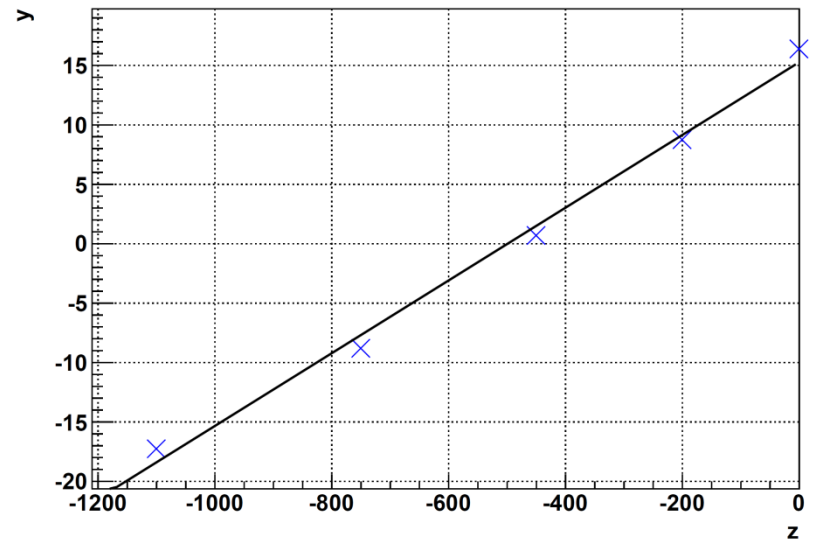
- Loop round again using unused space points

SciFi PR Track

Pattern Recognition

SciFi SpacePoint
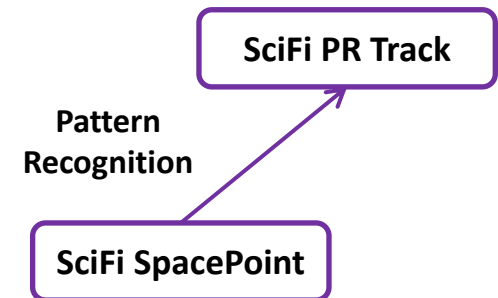
# Some Results: SP Visualisation
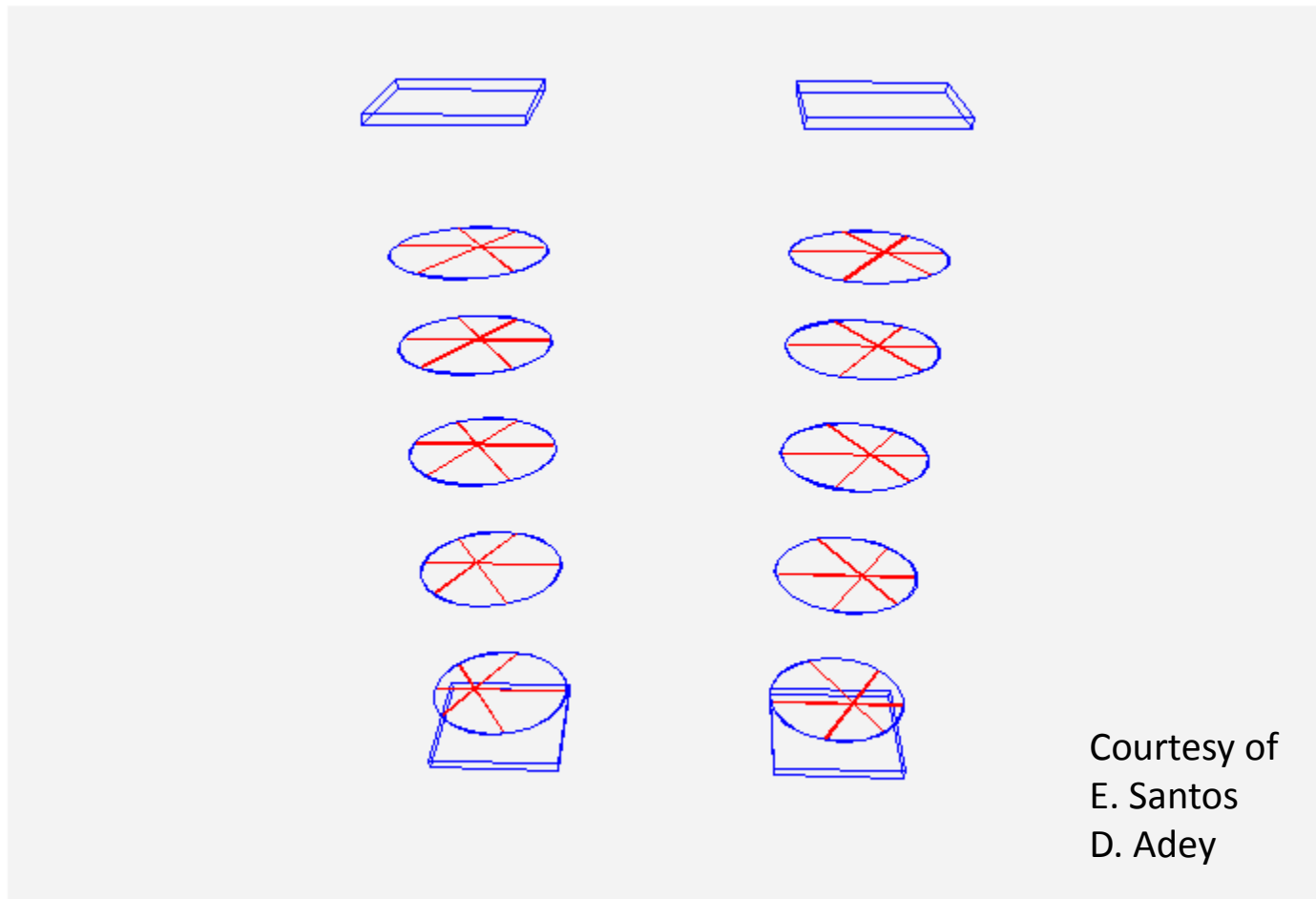


Courtesy of
E. Santos
D. Adey

# Some Results: Cosmic PR



Black lines are 5 point Pattern Recognition tracks and the crosses are the space points used to form them. Units of [mm] in tracker coordinate system.

# Conclusion

- Tracker software is proceeding well

- Lots of progress since last CM

- Geometry and Configuration needs to be validated, finished and then used

- MC needs to be validated / fixed

- Proceed with implementing higher level reconstruction

# Thanks

- David Adey
- Anastasia Belozertseva
- Summer Blot
- Yordan Karadzhov
- Paul Kyberd
- Ken Long
- Oleg Lysenko

- Stefania Riccardi
- Alex Richards
- Chris Rogers
- Ed Santos
- Anthony Wilson