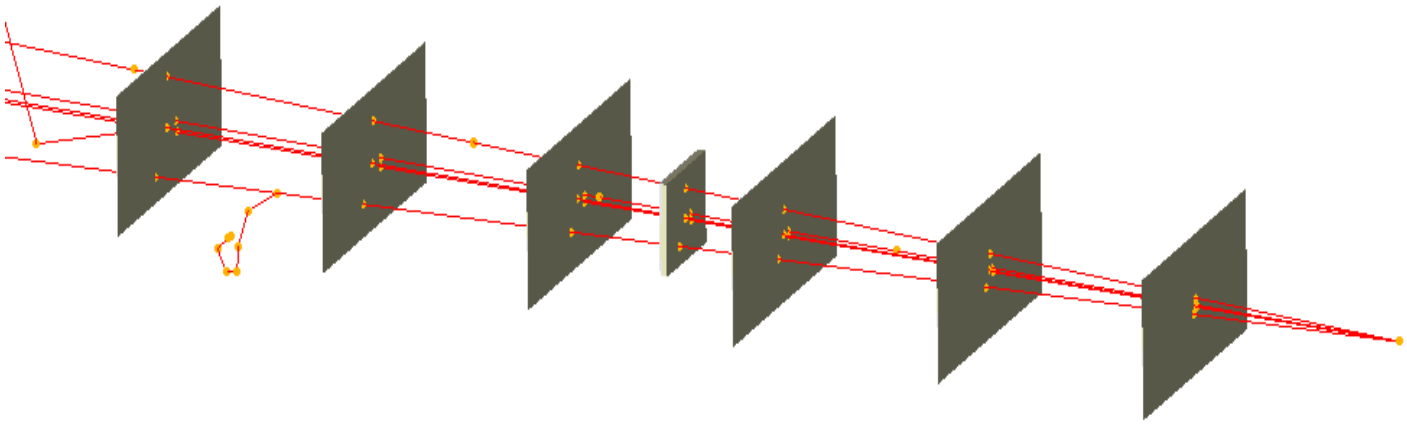
EUTelescope Workshop on testbeam data analysis and reconstruction, DESY 2013



Igor Rubinskiy

Mokka simulations for testbeam (GEANT4)

DESY, 26-03-2013

HELMHOLTZ ASSOCIATION

DESY

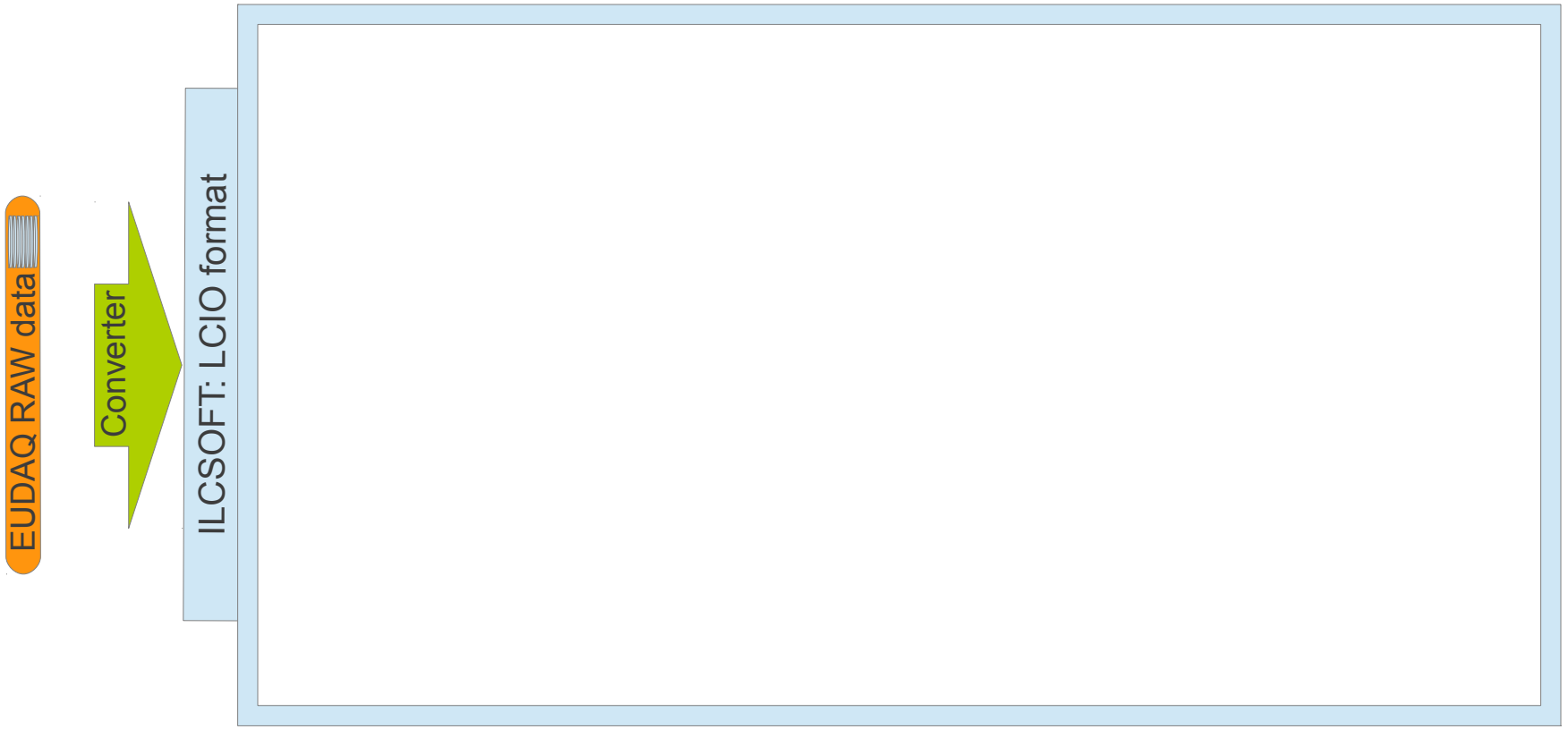
ILCSoft includes a package for full detector simulation.

- detector description in Geant4
  - define detector volumes, check that there are no overlaping volumes
  - subdetectors are nested volumes, defined relative to parent volume

- Geant4 is a library, unlike Geant3
  - one needs to write his own simulation executable based on the detector description (prev.bullet)
- options
  - ALLPIX
    - external to ILCSoft,
    - track scattering/energy deposit simulation
      + Si digitiser development
    - output: LCIO collection compatible to RAW data from EUDAQ
  - Mokka
    - part of ILCSoft,
    - track scattering/energy deposit simulation only
    - digitiser has to be implemented with a Marlin processor
      - EUTelMAPSdigi processor in EUTelescope
      - more generic → possible to use ALLPIX as shared library

EUTelescope – framework for testbeam data analysis

EUTelescope real data flow:
- start with data conversion from EUDAQ RAW format to LCIO
  - array of pixels for each plane (detector): matrix column, matrix row, (signal, timing)



Legend: Telescope + DUT data | Condition DB collections | EUTelescope library (Marlin) processors

EUTelescope real data flow:
- start with data conversion from EUDAQ RAW format to LCIO
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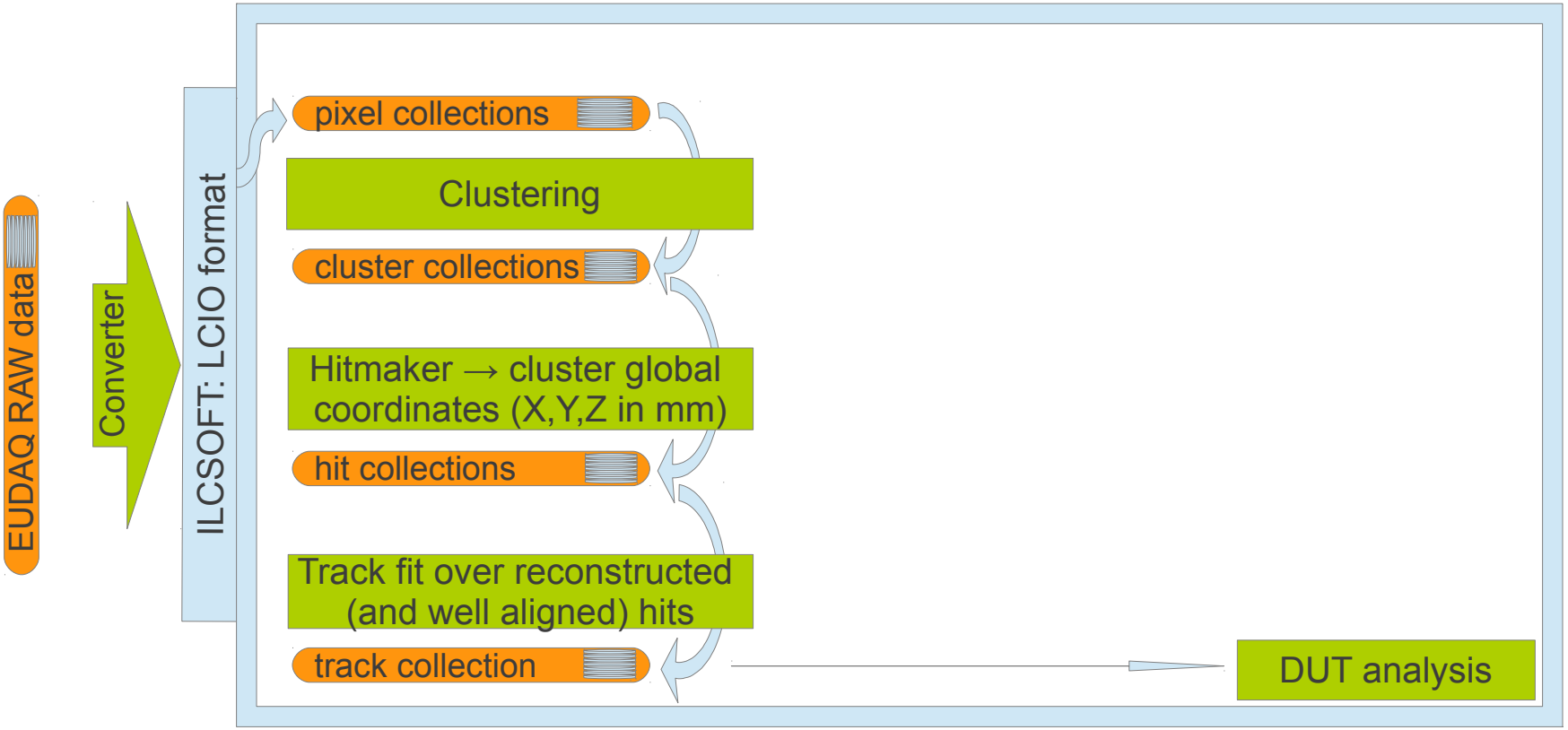
→ clustering, hitmaker, track fit



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EUTelescope – framework for testbeam data analysis

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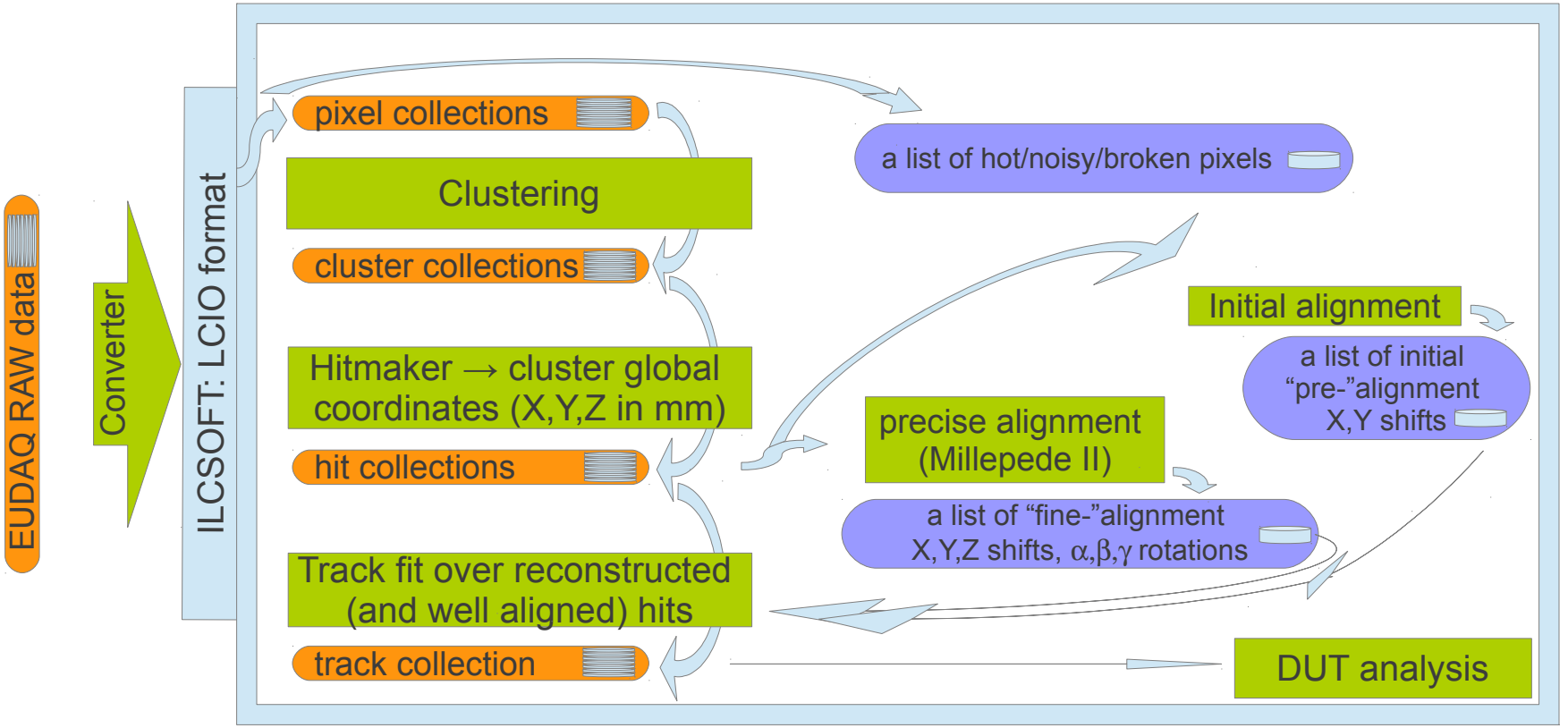
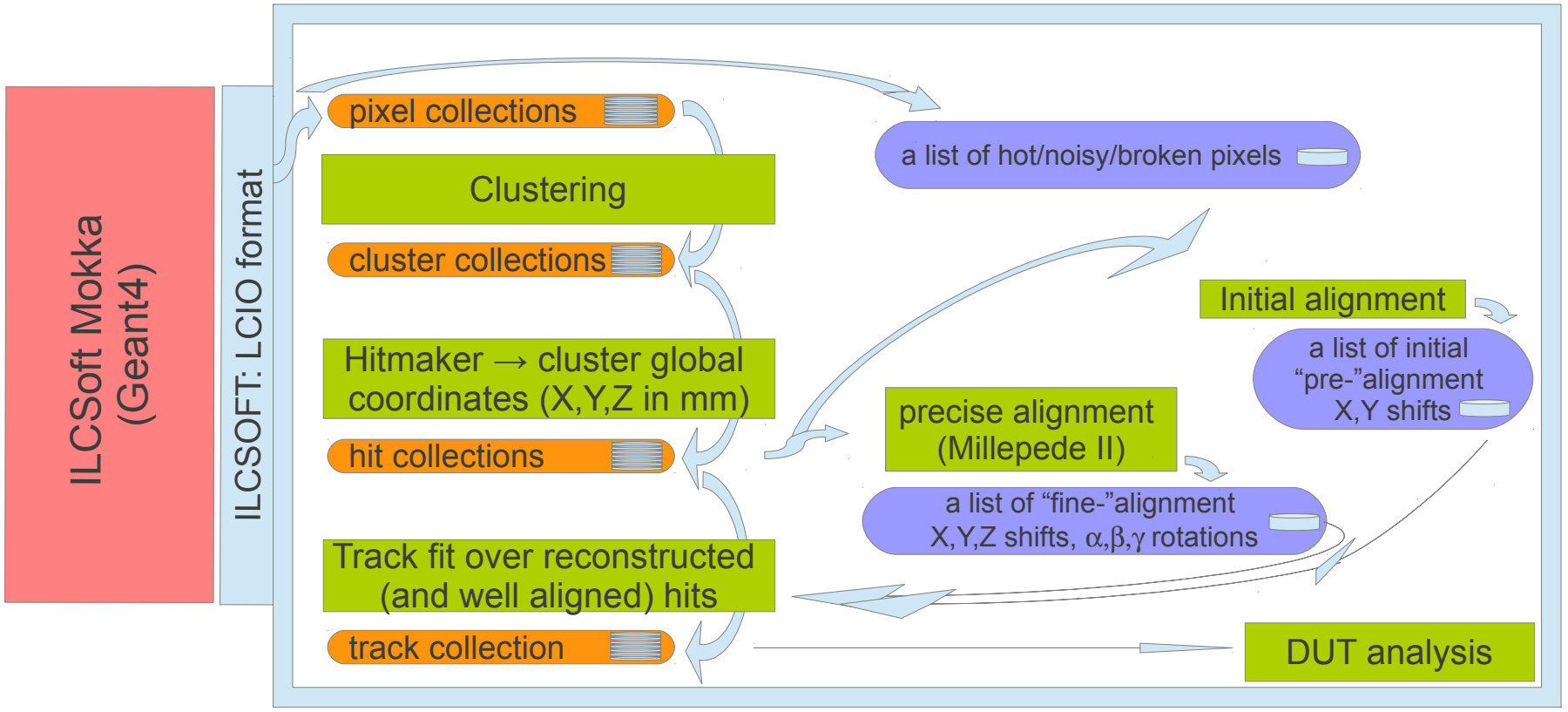
→ clustering, hitmaker, track fit: real data needs hotpixel suppresion/ alignment



Legend: Telescope + DUT data | Condition DB collections

EUTelescope library (Marlin) processors

EUTelescope data flow for simulated data:
- input is coming from Mokka
  - LCIO collection of energy deposits in a sensitive layer (Detector)



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EUTelescope library (Marlin) processors

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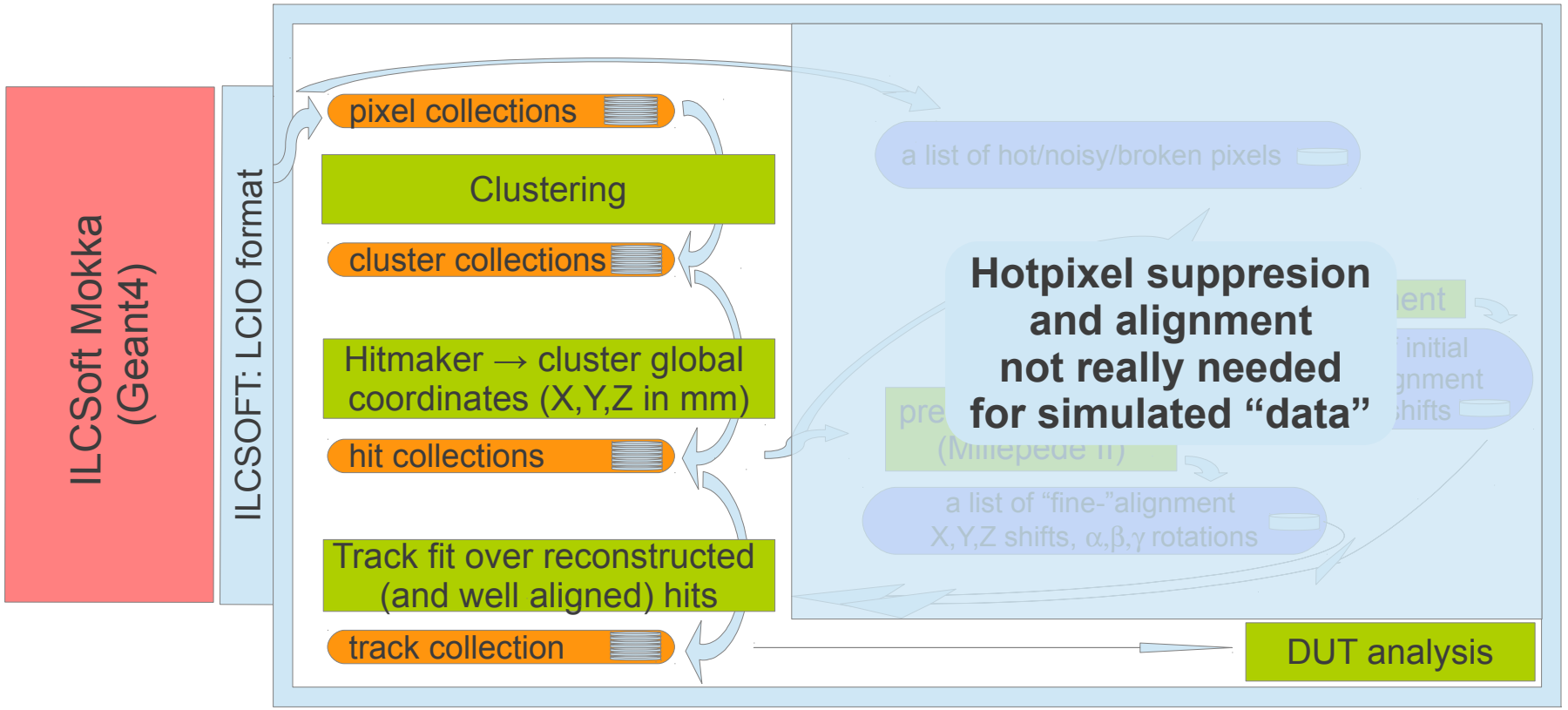

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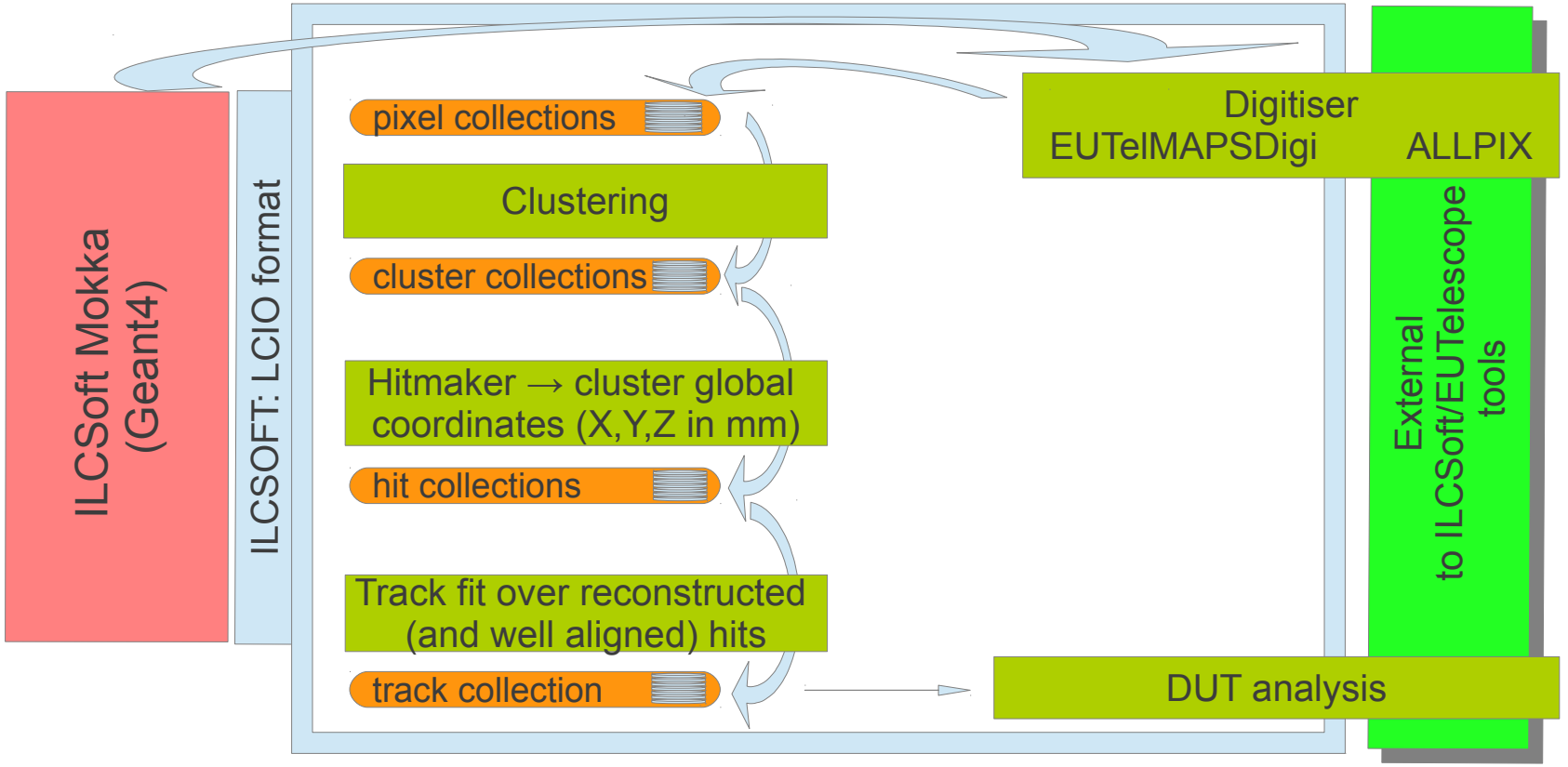


Legend: Telescope + DUT data | Condition DB collections | EUTelescope library (Marlin) processors

The GENT4 geometry discription got more material:

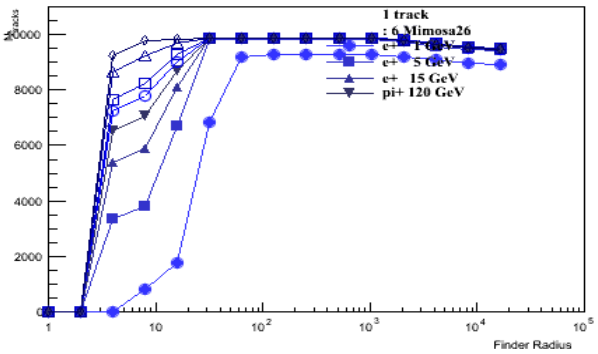
The 6 Mimosa26 setup (per every Mimosa layer)
- 2 capton foil layers 50 um thick each
- plane numbering scheme: beam direction → plane 0,1,2,3,4,5

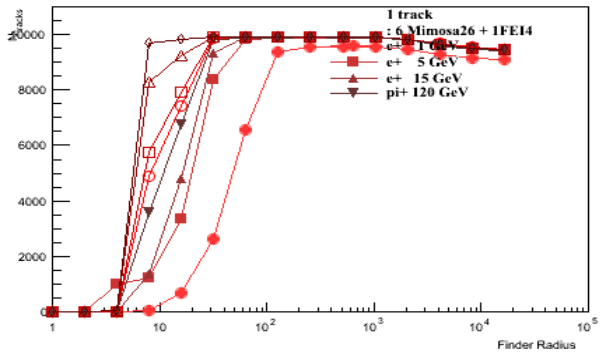
The 6 Mimosa26 + 1 FEi4 in addition to capton foil has THICK non sensitive layer
- 200 um for the chip + 300 um of Aluminium for support/cooling
- numbering scheme: beam → plane 0,1,2,20(FEI4),3,4,5

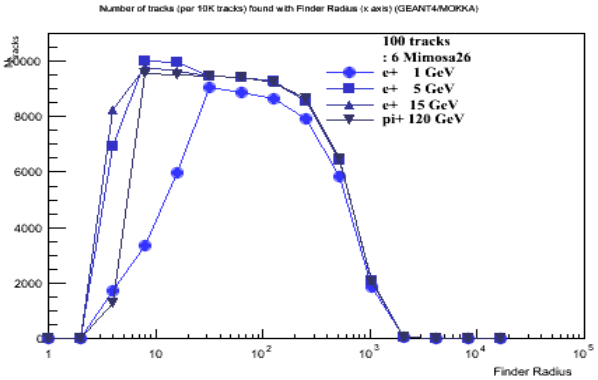
The energy range spans:

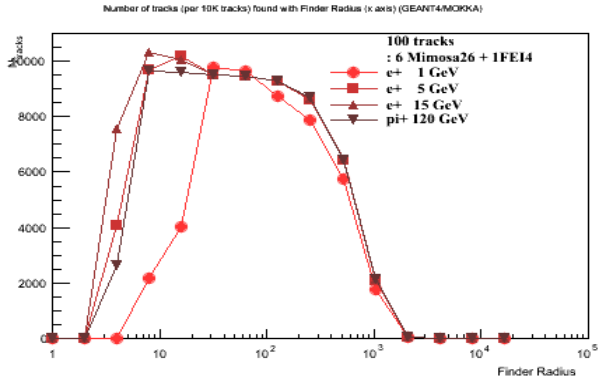
	1 track per event	100 / event	300 / event
1 GeV (e+)	x	x	x
2 GeV	x	-	-
3 GeV	x	-	-
4 GeV	x	-	-
5 GeV	x	x	x
6 GeV	x	-	-
15 GeV	x	x	x
120 GeV (pi+)	x	x	x
evts/run:	100 000	1000	334

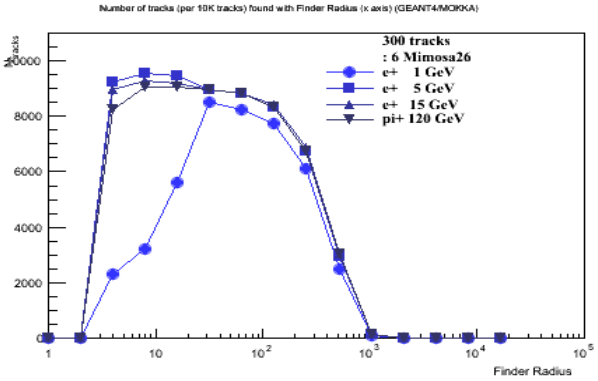
Expecting 10K tracks – blue (6Mimosa26), red (6Mimosa26+1FEI4)
Dependence on the Finder Radius (DAFFitter only)

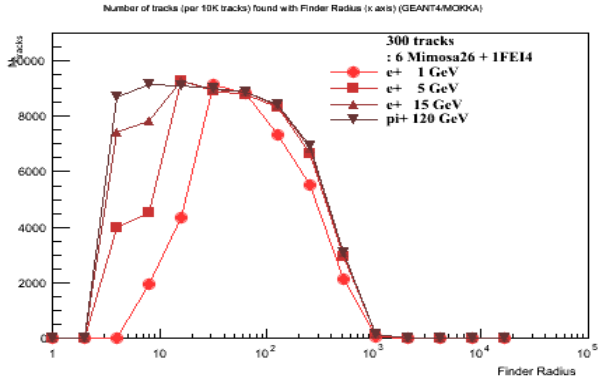




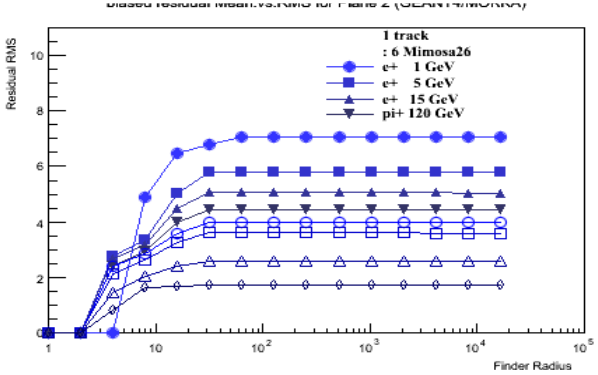


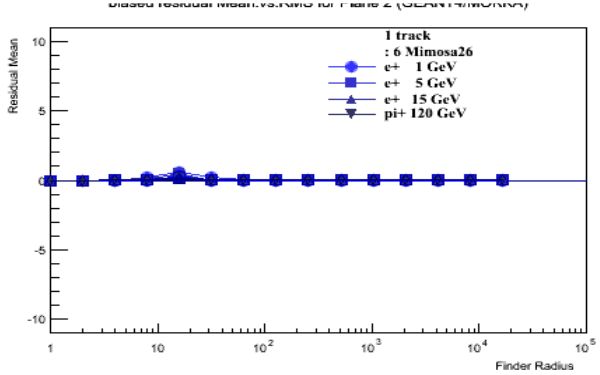


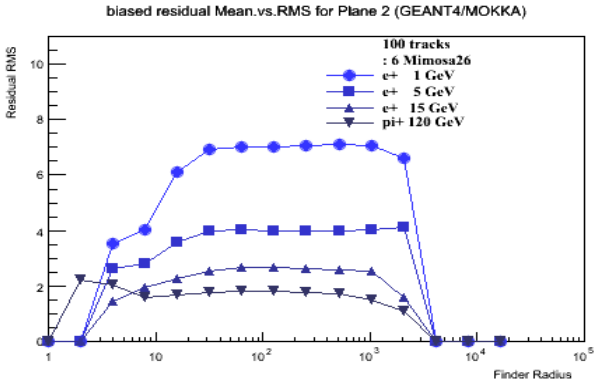


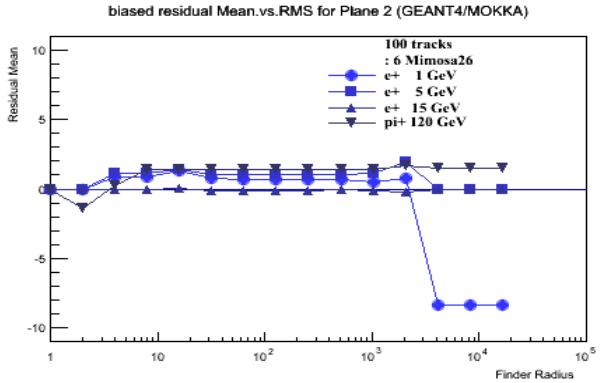


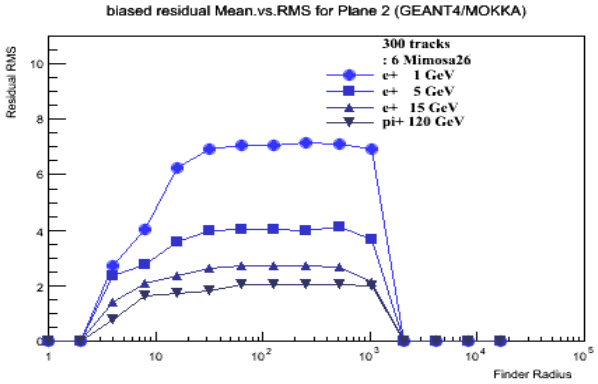
Looking at plane2 biased residuals (DAFFitter) RMS.vs.FinderRadius and Mean.vs.FinderRadius

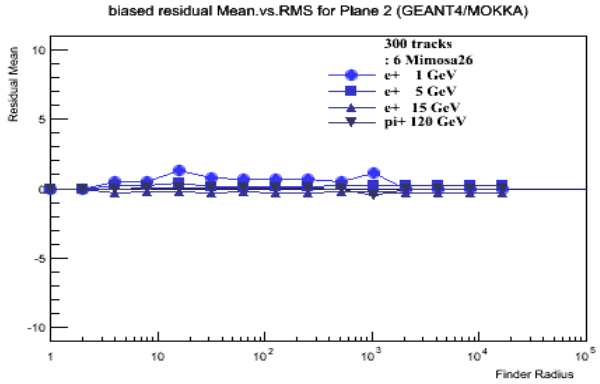






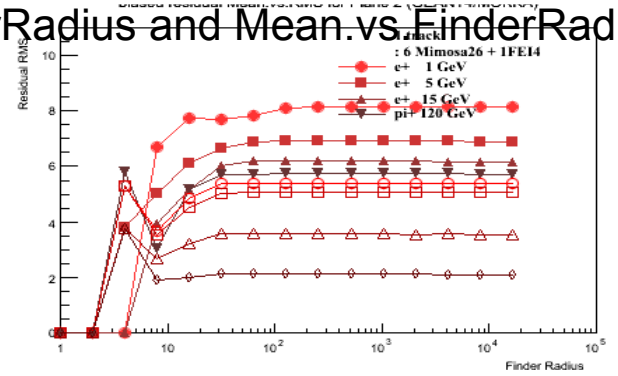


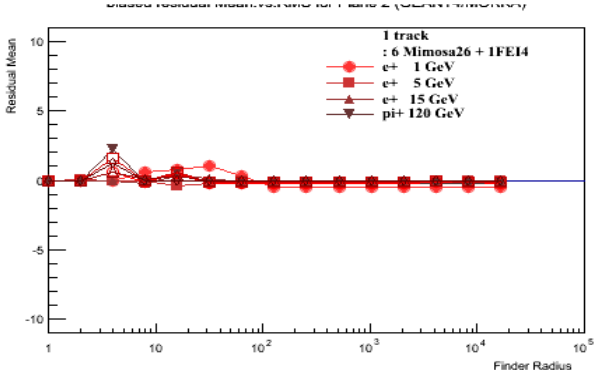


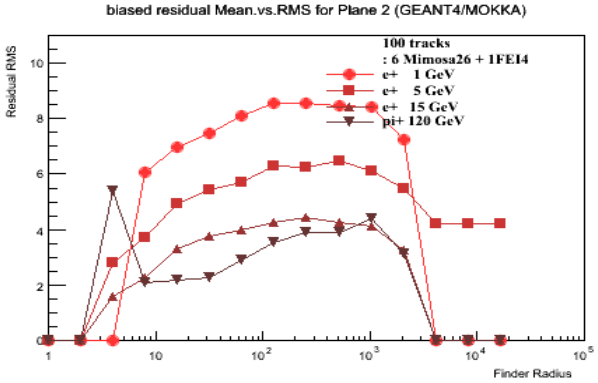


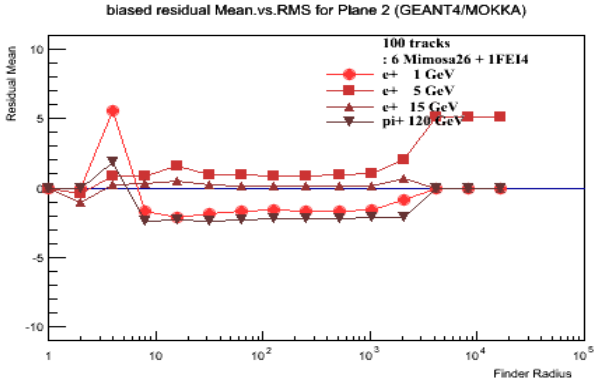
Looking at plane2 biased residuals (DAFFitter) – next to 1FEI4 in the center of the telescope

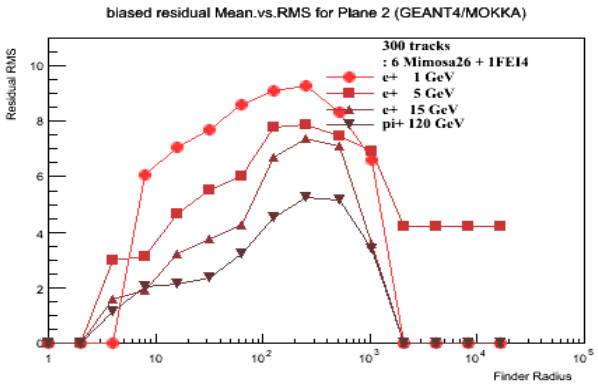
RMS.vs.FinderRadius and Mean.vs.FinderRadius

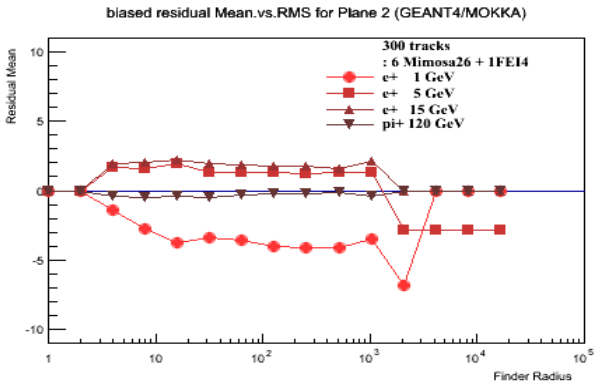




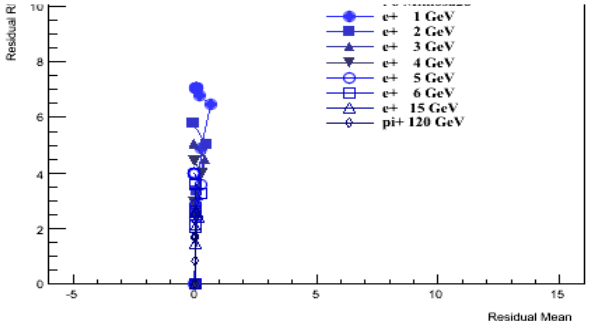


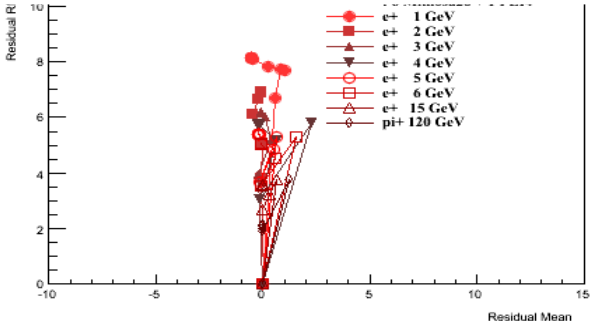


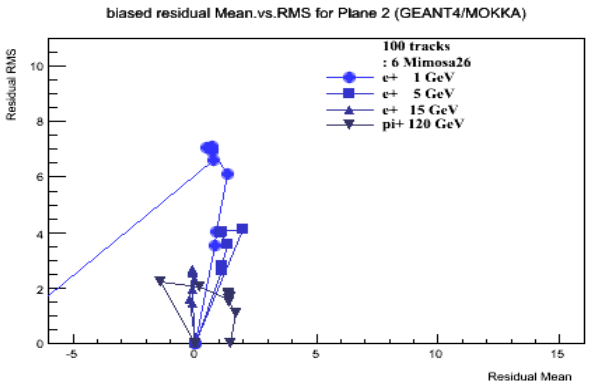


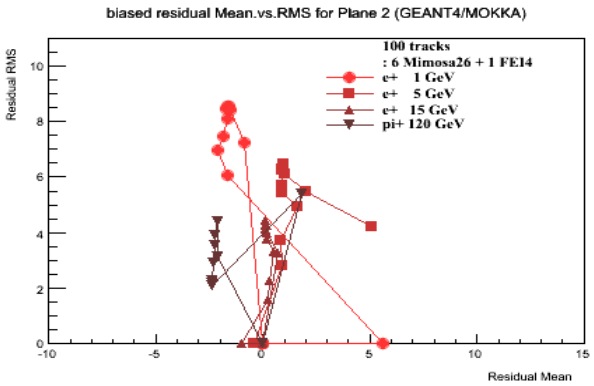


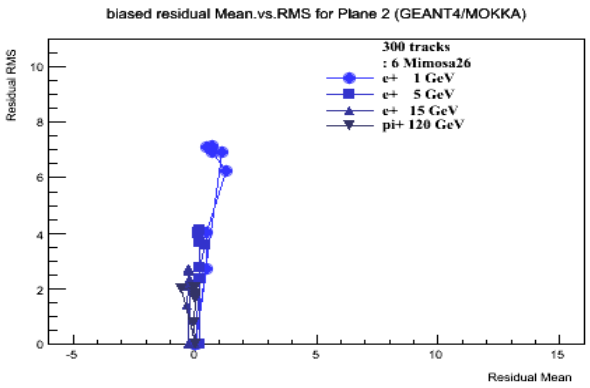
Looking at plane2 biased residuals scatter plot RMS.vs.Mean
- one energy contains also points for different Finder Radius (see slides 4,5)

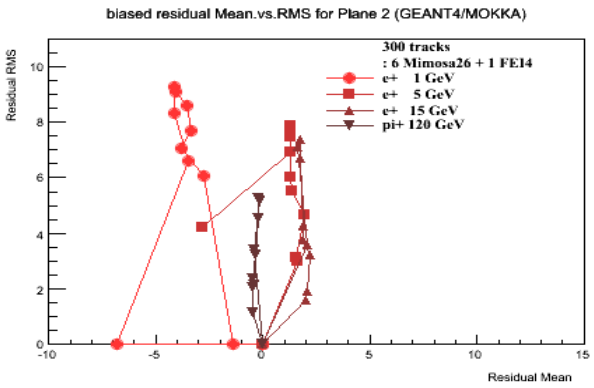


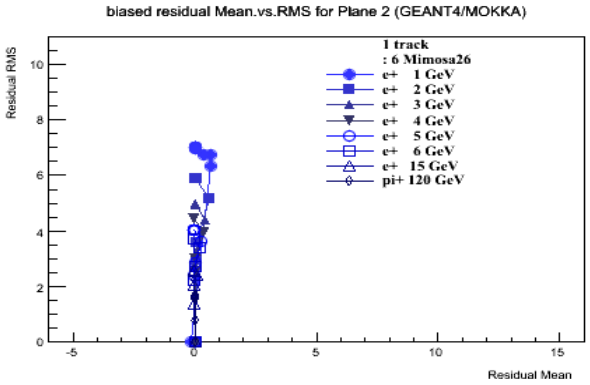


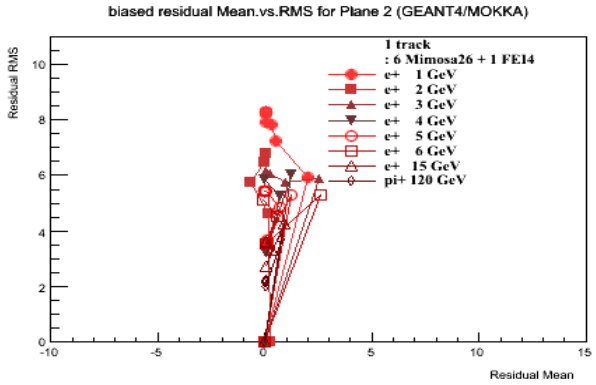


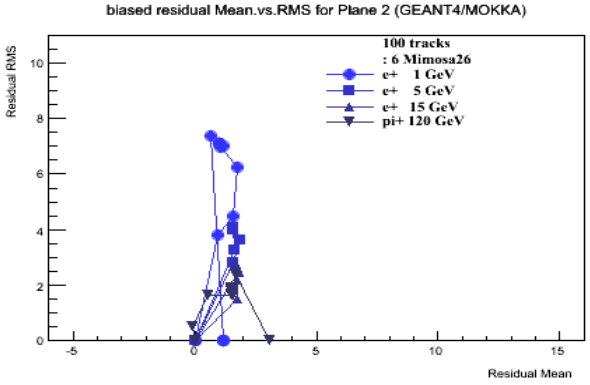


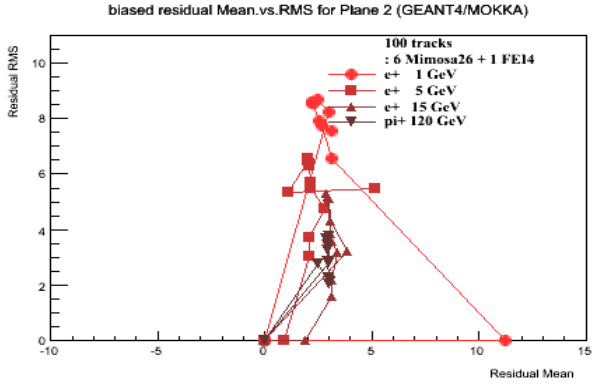





biased residual Mean.vs.RMS for Plane 2 (GEANT4/MOKKA)
1 track
: 6 Mimosa26
e+ 1 GeV
e+ 2 GeV
e+ 3 GeV
e+ 4 GeV
e+ 5 GeV
e+ 6 GeV
e+ 15 GeV
pi+ 120 GeV
Residual RMS
Residual Mean


biased residual Mean.vs.RMS for Plane 2 (GEANT4/MOKKA)
1 track
: 6 Mimosa26 + 1 FE14
e+ 1 GeV
e+ 2 GeV
e+ 3 GeV
e+ 4 GeV
e+ 5 GeV
e+ 6 GeV
e+ 15 GeV
pi+ 120 GeV
Residual RMS
Residual Mean


biased residual Mean.vs.RMS for Plane 2 (GEANT4/MOKKA)
100 tracks
: 6 Mimosa26
e+ 1 GeV
e+ 5 GeV
e+ 15 GeV
pi+ 120 GeV
Residual RMS
Residual Mean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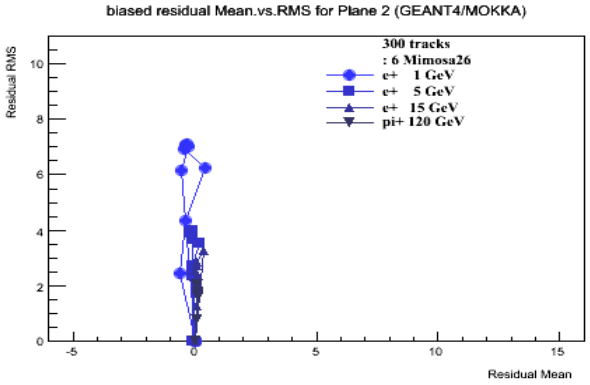
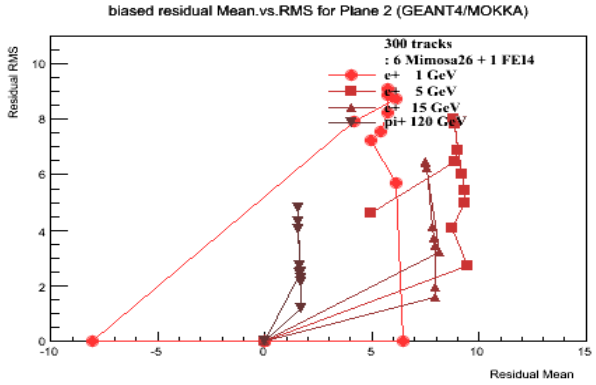
Residual Mean

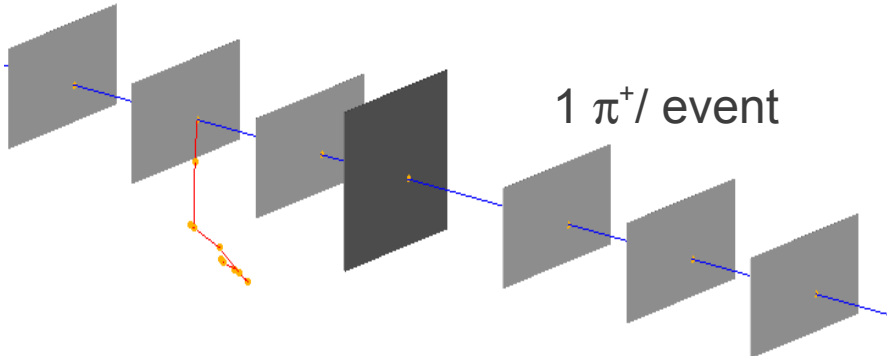

biased residual Mean.vs.RMS for Plane 2 (GEANT4/MOKKA)
300 tracks
: 6 Mimosa26
e+ 1 GeV
e+ 5 GeV
e+ 15 GeV
pi+ 120 GeV
Residual RMS
Residual Mean


biased residual Mean.vs.RMS for Plane 2 (GEANT4/MOKKA)
300 tracks
: 6 Mimosa26 + 1 FE14
e+ 1 GeV
e+ 5 GeV
e+ 15 GeV
pi+ 120 GeV
Residual RMS
Residual Mean

Track reconstruction tests on Simulated data

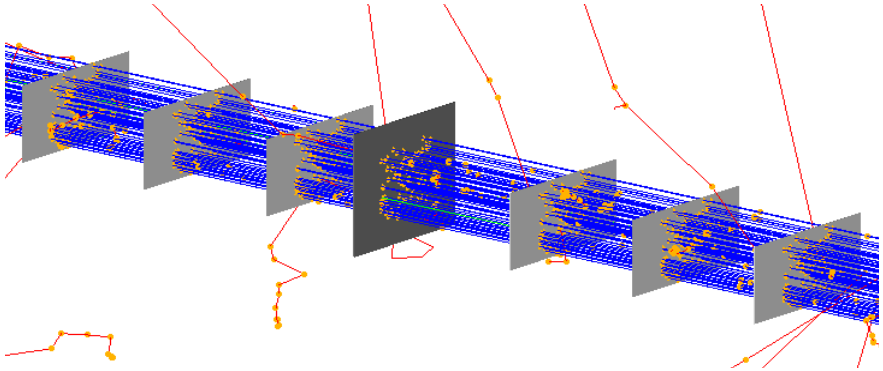
ILCSoft::Mokka - GEANT4 simulation

Tracking efficiency studies for a variaty of beam energies and multiplicity
Fixed configuration: 6 Mimosa26 (6x50 μm Si) and 1 DUT (1x500 μm Si)



1 π^+/ event

100 e^+/ event



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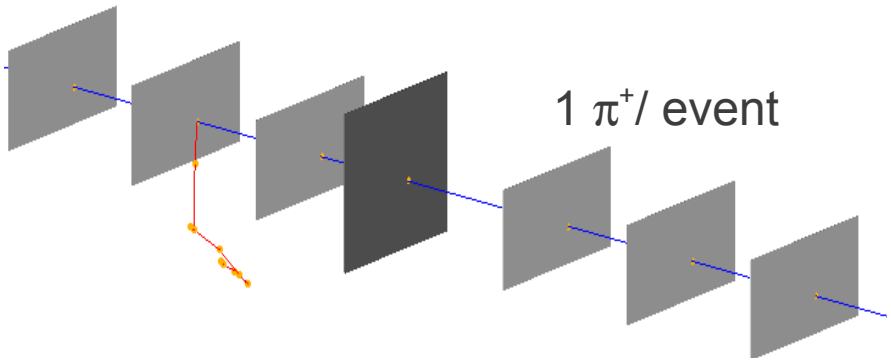
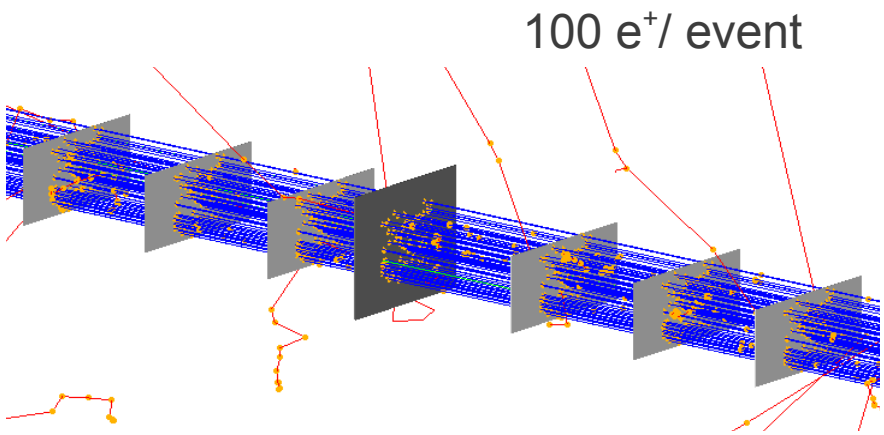




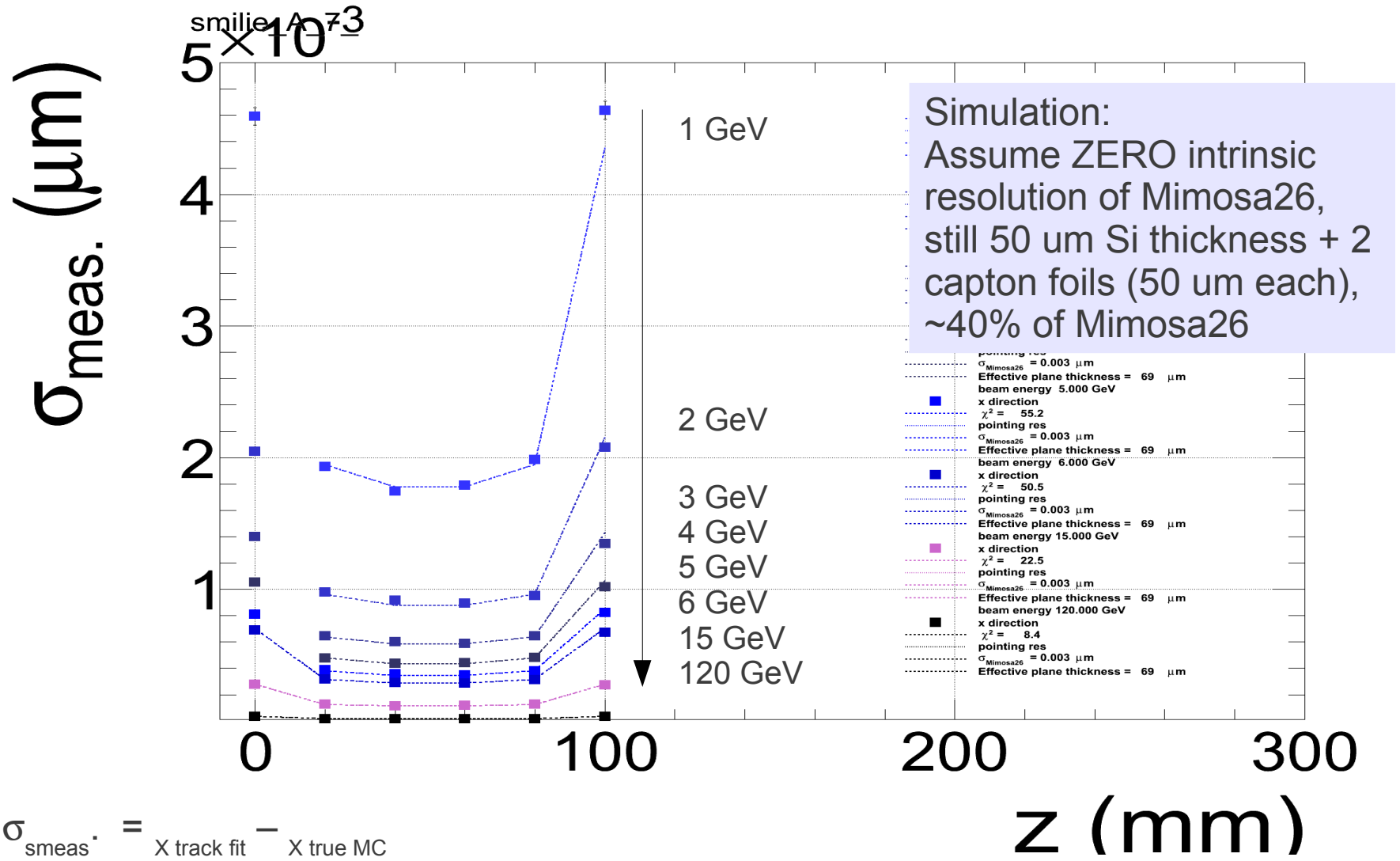
Tests with DAF fitter (EUTelDafFitter)

track reconstruction efficiency table: versus beam energy and multiplicity

location	particle type	beam energy, GeV	N particles per spill (=per event)		
			1	100	300
Bonn / DESY	e	1	90-95	80-95	50-90
SLAC	e	5	>98	85-95	70-90
SLAC	e	15	>98	85-95	70-90
CERN	pi	120	>98	85-95	70-90

Tracks with better χ^2 – least efficient

Unbiased residuals - “smilie” plot



$\sigma_{smeas.}$ = X track fit − X true MC

Known installation pitfalls

- tests on Ubuntu 12.04 64 bit

- ILCSoft v01-15
  - Geant4 9.5.p02
    - compilation cmake based
    - packages Coin3D, SoXt for nice visualisation (option)
    - xerces for xml parcser (option)
  - Mokka
    - v08-00-03
    - needs MySQL server 5.0.x (not 5.5!)

- ALLPIX, few preparations
  - apt-get install libxerces-c2-dev libssl-dev libboost-dev swig
  - need g++ <=4.4,
    - g++ 4.5 or 4.6 does not work
      - complains for invalid xerces references

Summary:

- Mokka as simulation framework is a bit of more work on deploying and supporting MySQL database
- DAF fitter track reconstruction 99% for 1 track per event is at 90-95 % (100 tracks/event) and goes down to 80-90 % for 300 tracks per event.

Current (tentative) plan:

- include Geant4/Mokka as optional package
- develop EUTelescope processor based on ALLPIX digitiser library
- prepare more test cases with well defined testbeam geometries
  - known energies and material distribution
    ranging from 1 GeV electrons to 120 GeV pions
    For beam lines Bonn, DESY, SLAC,CERN)
  - nightly control over the reconstruction chain performance
- add more tests with alignment and tracking GBL
- contributions are welcome!