ITk Simulation: Digitization

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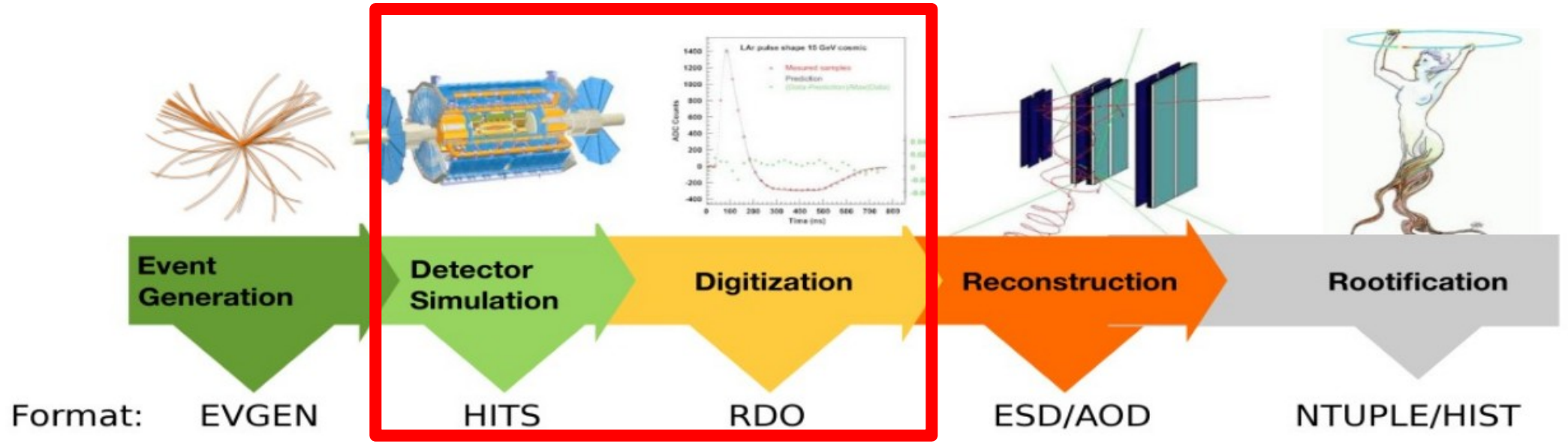
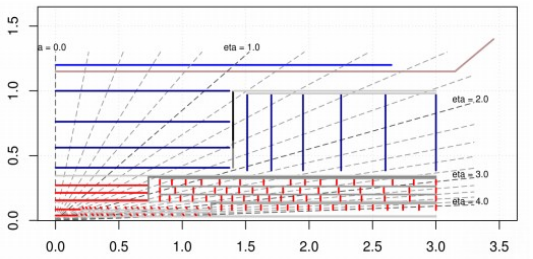
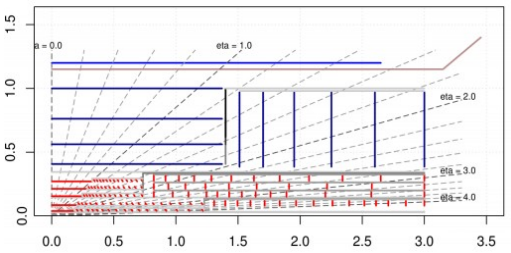
Outline

- What is FastSiDigitization?
- Status:
  - Sanity checks
  - Preliminary results
- Next steps

What is FastSiDigitization?







Different layouts

- 50x50μm²x150μm, Planar
- 50x25μm²x150μm, Planar
- 50x25μm²x150μm, 3D
- 50x25μm²x30μm, HV-CMOS
- ….

- 50x50μm²x150μm, Planar
- 50x25μm²x150μm, Planar
- 50x25μm²x150μm, 3D
- 50x25μm²x30μm, HV-CMOS
-

Different pixel sizes, thickness and technologies

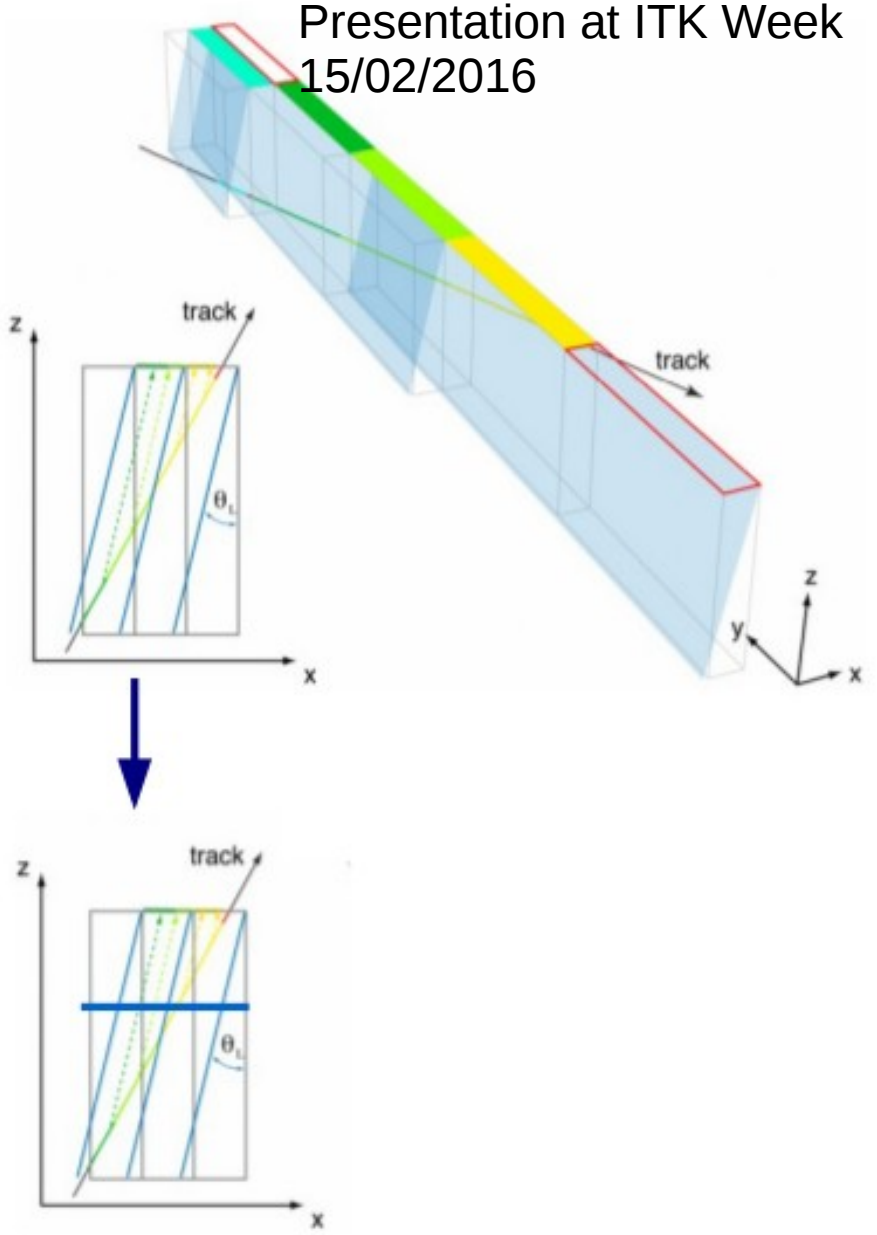
FastSiDigitization

From F. Fabbri's Presentation at ITK Week 15/02/2016

Main ideas of the algorithm:

- Read from the HIT the coordinate of entry and exit of each hit
- Ignore the simulated energy deposits
- evolving drift charge using Lorentz angle. Only geometrical charge deposition at the moment → planar
- Convert the path length in time over threshold.
- Create cluster with all pixel on a hit.

  Note: output is already a cluster!



Status

FastSiDigitization works since 20.3.3-X (Fall 2015) (FastSiDigitization + Reconstruction)
Using more recent release works out of the box (e.g. 20.20.2.1)

What you can do (NOW):

- Change pixel dimensions
- Change detector thickness

→ Unfortunately individually per layer is not always possibile. It depends how the geometry is made.

What it could be possible to do (FUTURE):

Change detector technology (planar implemented up to now: in the future 3D,HVCMOS,...) (using different charge deposition models)

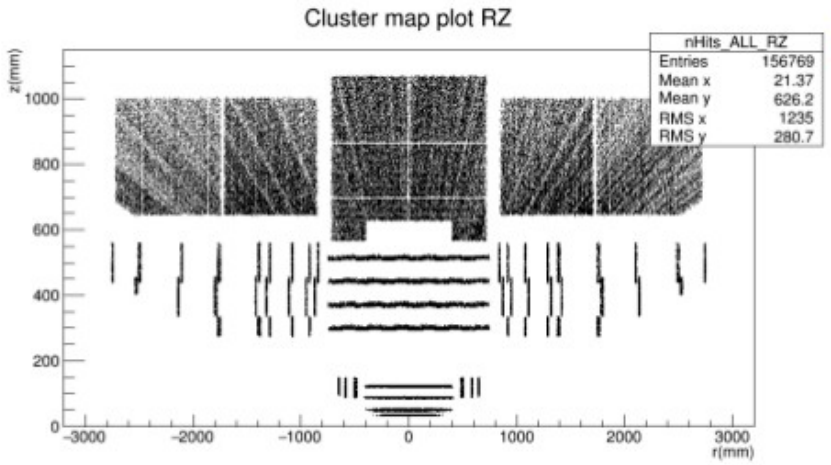
What can't be performed:

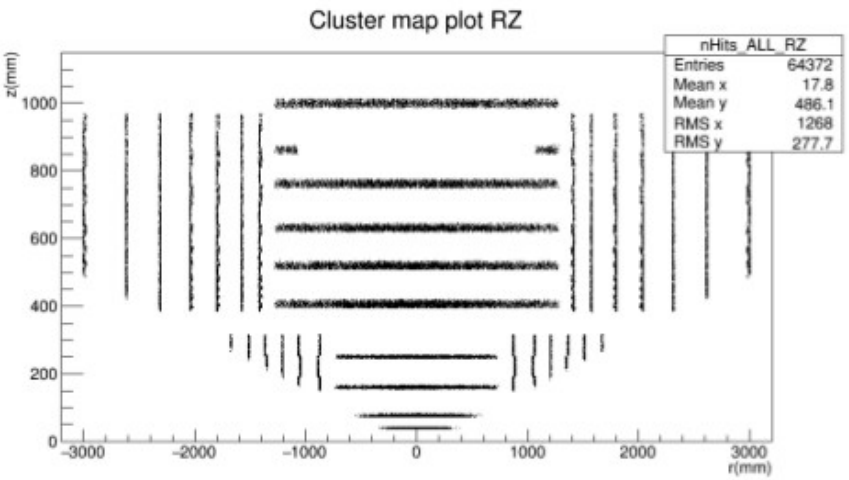
- Change layout (but switching off layers should be possible)
- Impact of reduced material on tracking (less dE/dX, X0, ….)
- Study of different clusterization algorithms (output of FastSiDigitization are already clusters)

Sanity Checks

Full Digi

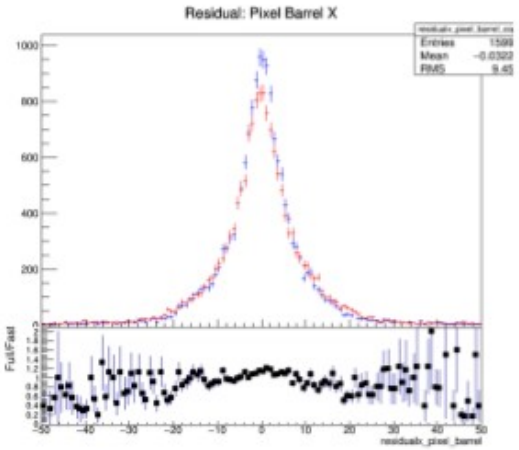
Fast Digi

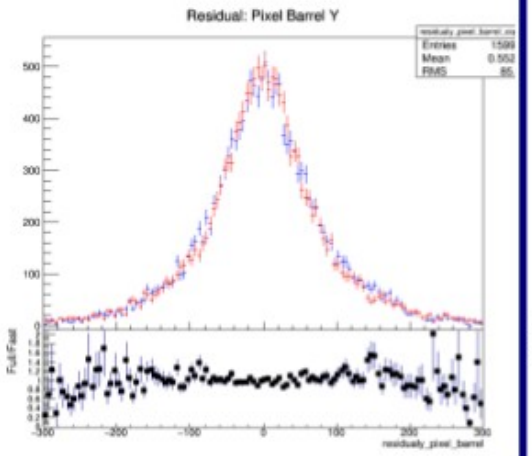


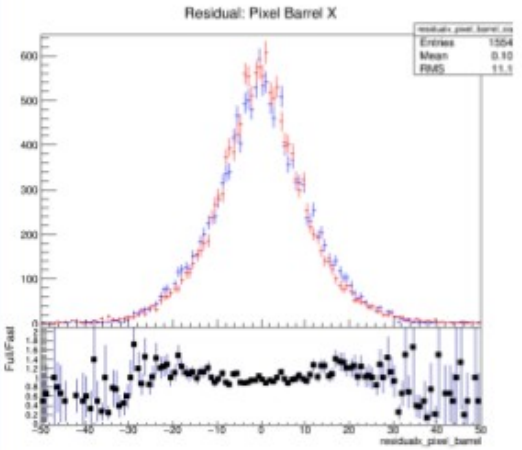


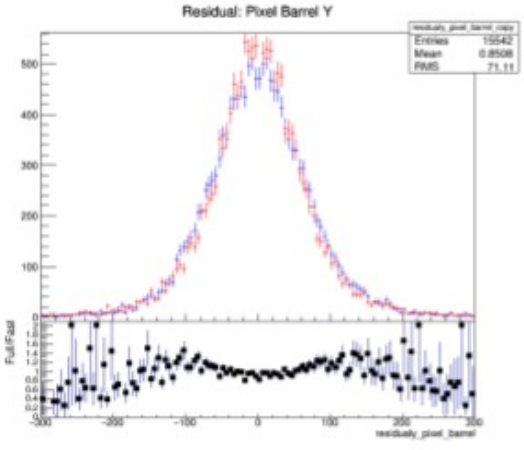
(tag: ATLAS-R2-2015-03-01-00)

(tag: ATLAS-P2-ITK-01-00-00)









Reconstructed track residuals wrt Full Reco Digitization and Fast Digitization are equivalent (100 GeV single muons)

Nightly tests in RTT

Preliminary Results: modifying Pixel Pitch

Reducing x2 size of layer2 (phi direction)

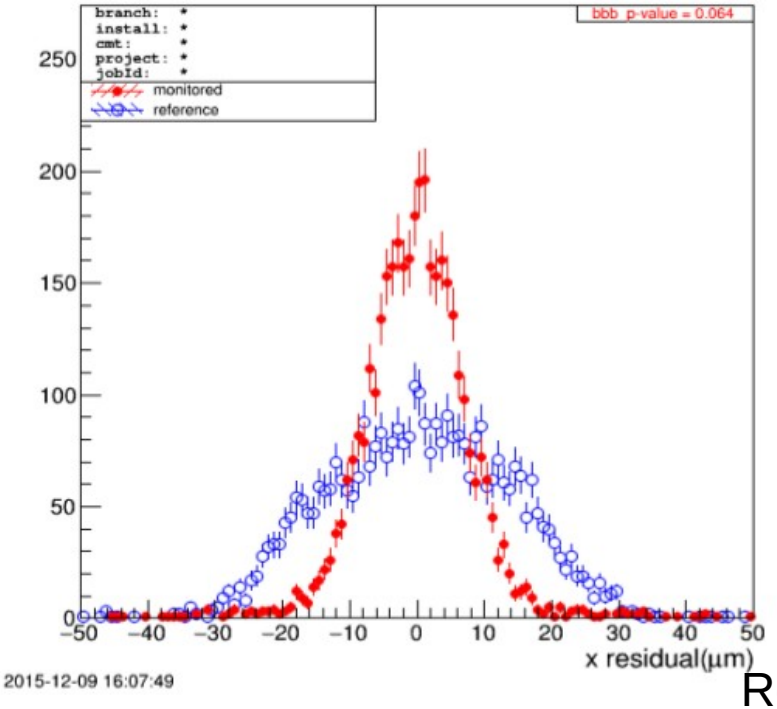
PIXELREADOUT_DATA_ID	PITCHPHI	PITCHETA	PITCHETALONG	NCHIPSPHI	NCHIPSETA	ROWSPERCHIP	COLSPERCHIP
long	double	double	double	int	int	int	int
8	[illegible]	.15	.45	1	2	[illegible]	132
9	05	.25	.45	2	2	336	80
10	.025	.15	.45	2	2	672	132

Layer 0
Layer 2 e 3
Layer 1

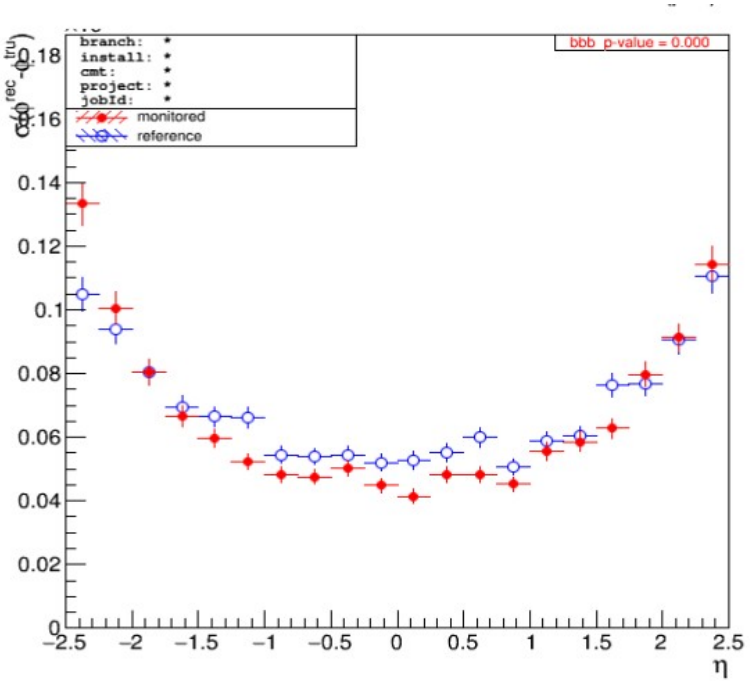
0.025

672

100 GeV single muons



Residual in φ for Layer2

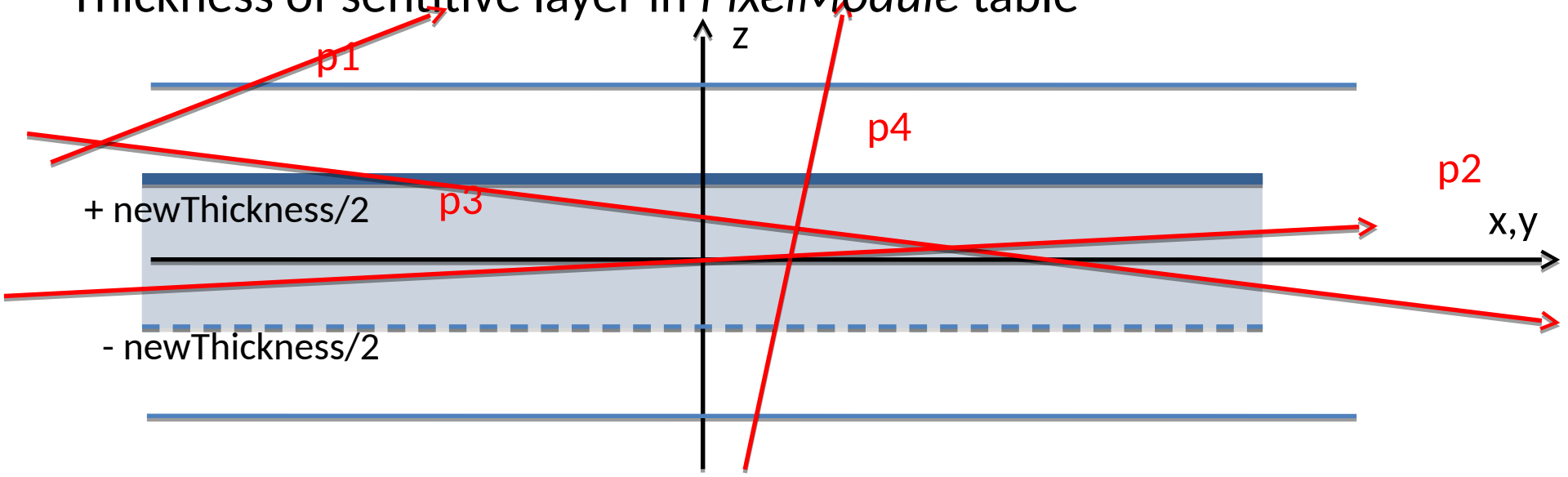


Reference (LoI)
Pitch 25μm for Lay 2 and 3

Φ Resolution vs η

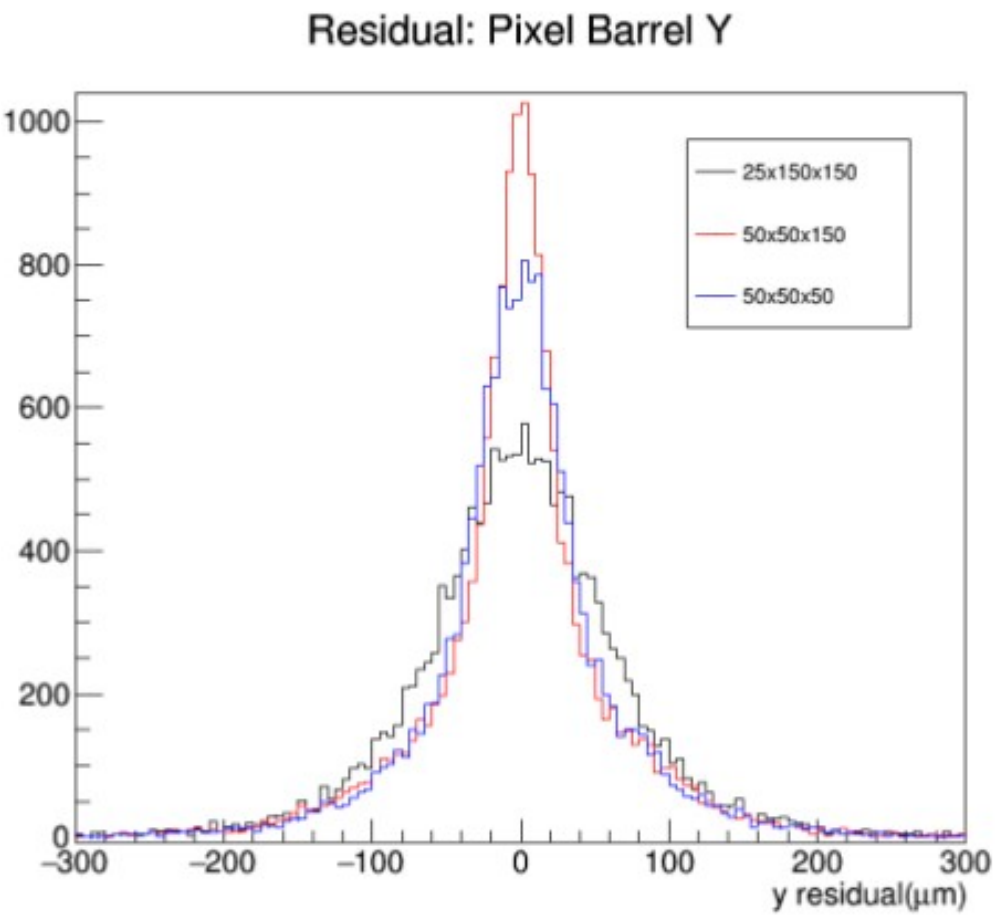
Changing thickness

Preliminary application to HV-CMOS
Thickness of sentitive layer in *PixelModule* table

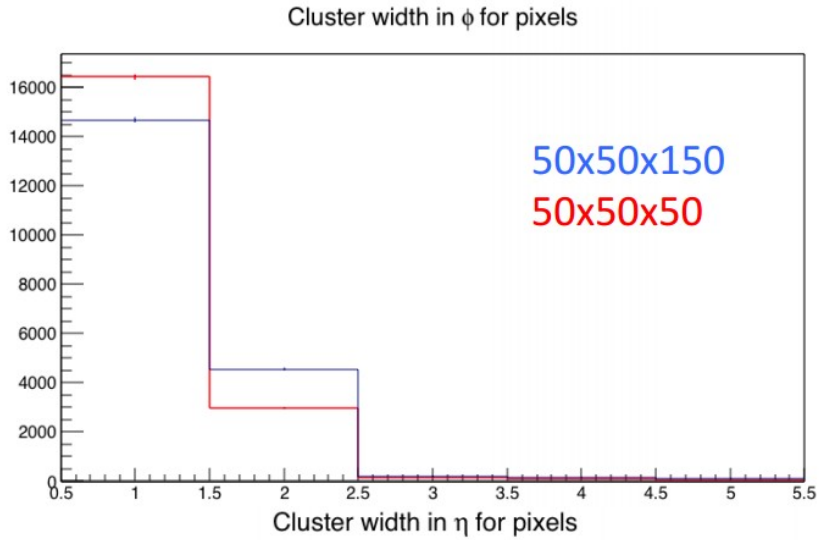


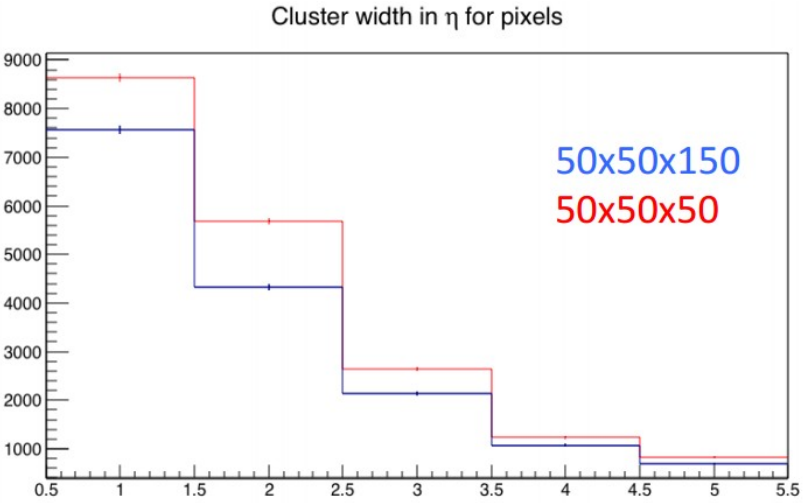
Modify Start/End coordinates according to the new (smaller) thickness. Local coordinates of sensitive layer between +/-NewThickness/2. NEW CODE: p1 deleted, p2 untouched, p3 change local entry only, p4 change both local entry local exit. Path within sensor assumed to be LINEAR

Modifying detector thickness



Cluster width





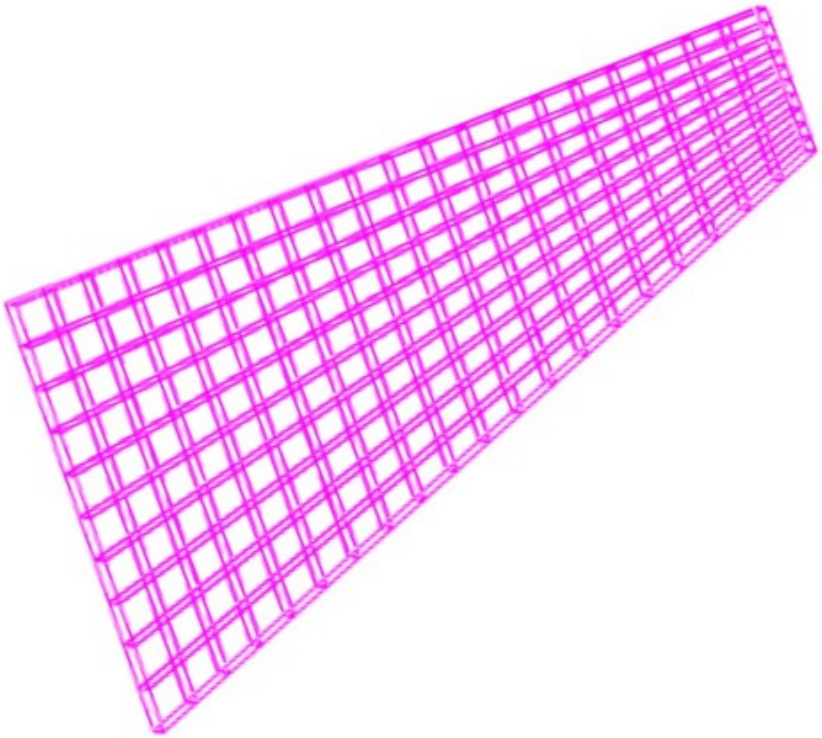
We know also how to switch off B field for Lorentz angle

Further developments

- Some code rewriting with new classes will make the code more modular (development in release 20.20)
- → Factorization of geometrical part from the cluster creation
- → Improve flexibility and speed of the algorithm

  It will make possible to study clusterization algorithms

  Possibility to use FastSiDigitization in FastSimulation chain



Next Steps

- FastSiDigitization is Yet Another Tool for Itk simulation and performance. Two main steps ahead of us:
- Study Physics performance
  - Different realistic layouts with different pixels sizes
  - Evaluate tracking performance with realistic physics samples (with and without pileup)

    → Fruitfful to increase collaboration with other italian groups (PI, GE, CS and LE)
- Further developments:
  - Implement additional detector technologies: 3D, HVCMOS, monolithic, ... (is there something different except detector thickness?)
  - Use FastSiDigitization in Fast Simulation chain
- In parallele with FastSiDigitization Signals and thresholds modifying thickness (also in collaboration with Marseille group)