



Laboratoire d'Anecy-le-Vieux
de Physique des Particules

Impact of the various HCAL mechanical designs on its physics performance

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SiD Meeting, 20 Avril 2010, Fermilab



In2p

Objective

Find an optimal mechanical design for HCAL which takes into account engineering as well as physics aspects

Evaluate the impact of various HCAL mechanical designs on its physics performance

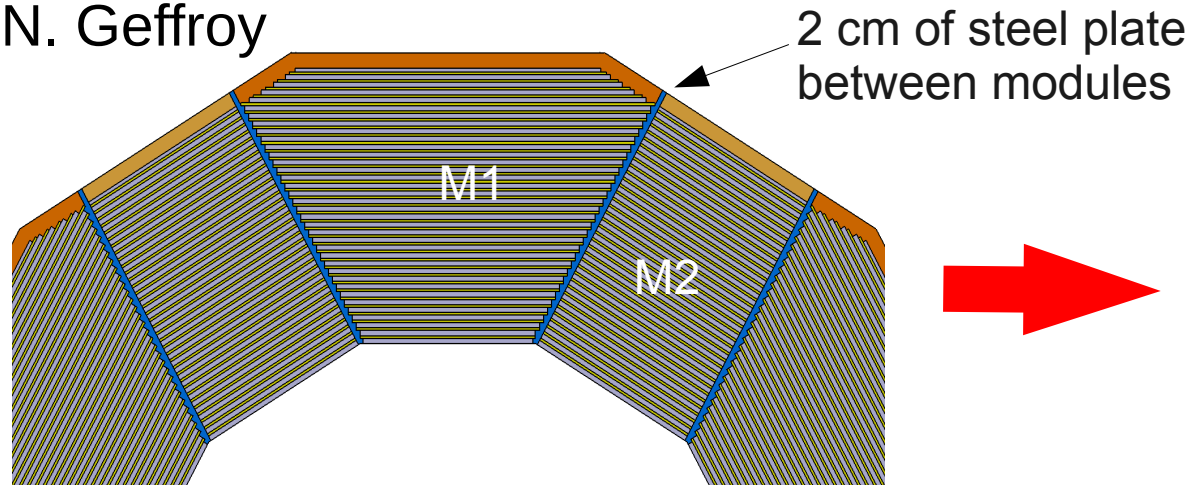
The study is focused on hadronic showers behavior close to the boundary between two HCAL modules for

- projective and non-projective geometry
- with and without supporting plate
- analog vs digital readout

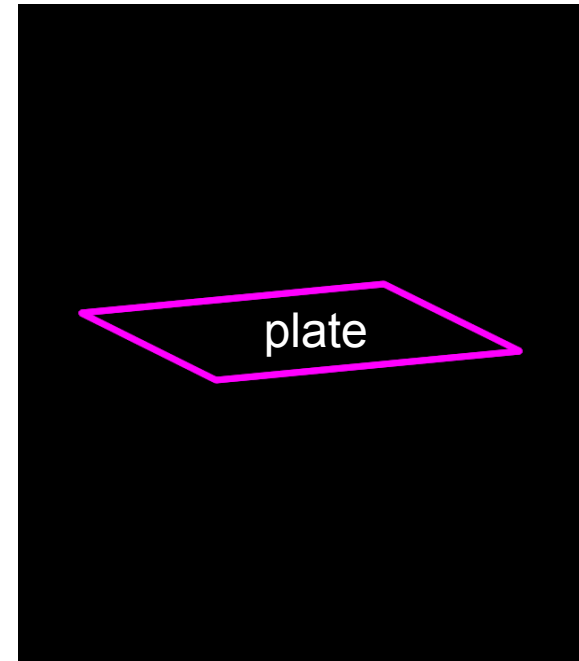
Considered geometries

SiD Lol geometry

N. Geffroy



2 HCAL Modules



Geometries:

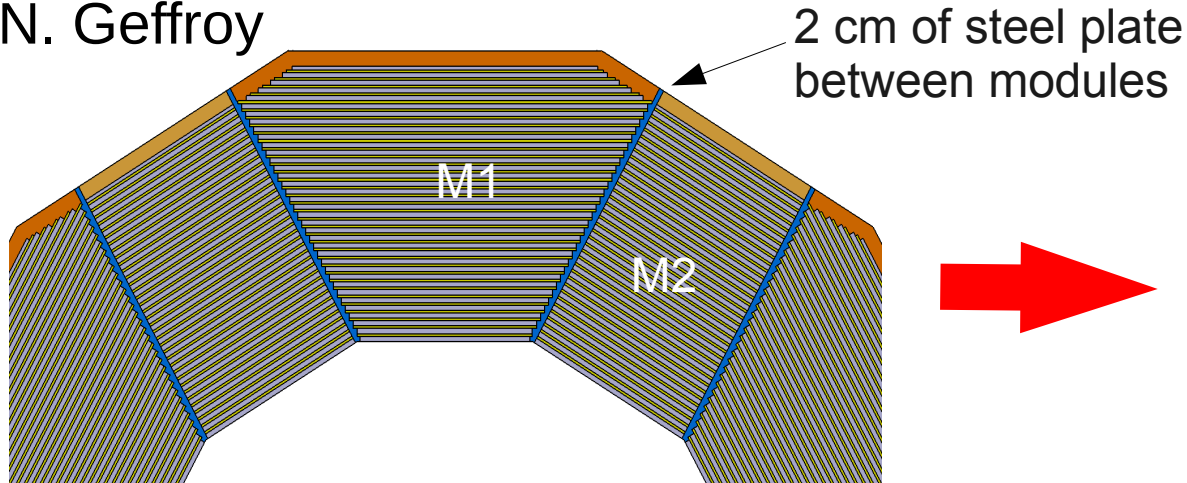
- `sid2Modules_FeAbs_NoFeP` (ref. geometry without supp. plate)
- `sid2Modules_FeAbs_1cmFeP` (1cm supporting plate)
- `sid2Modules_FeAbs_2cmFeP` (2cm supporting plate)
- `sid2Modules_FeAbs_2cmFeP_WE` - (2cm supporting plate and ECAL)

N.B. Analysis has been performed for both 40 and 80 layers detectors

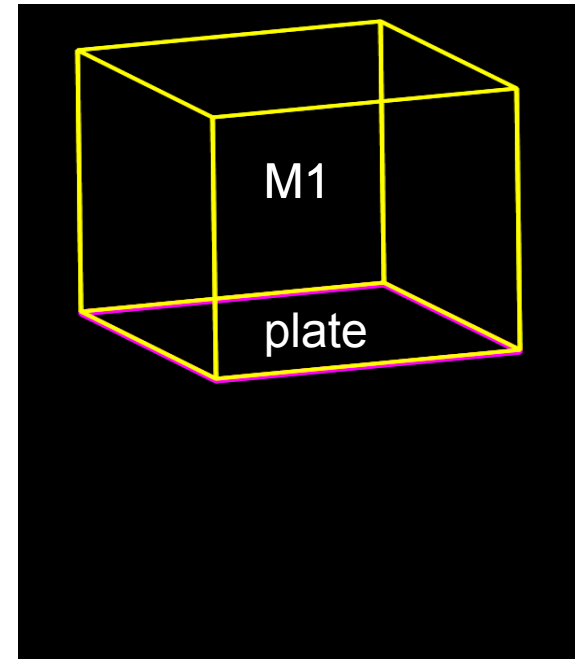
Considered geometries

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2 HCAL Modules



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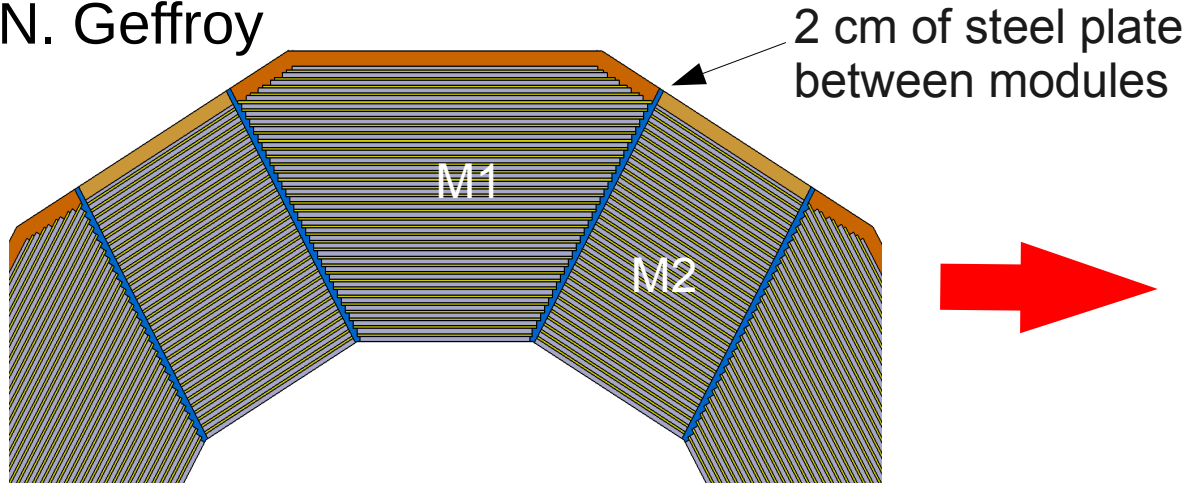
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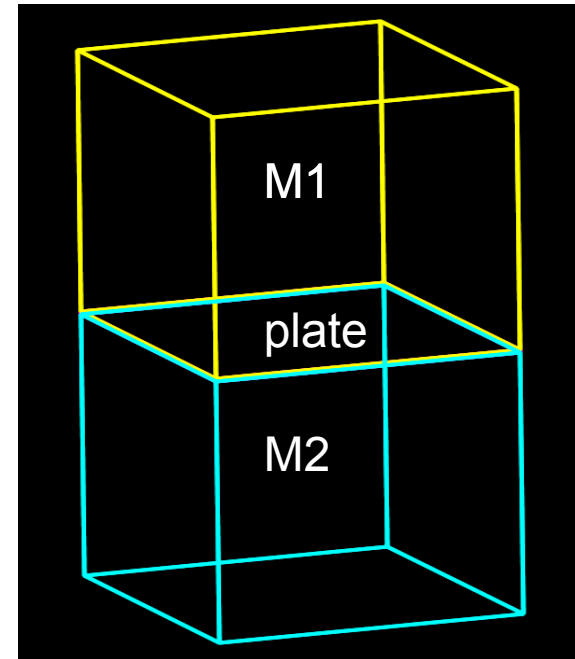
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2 HCAL Modules



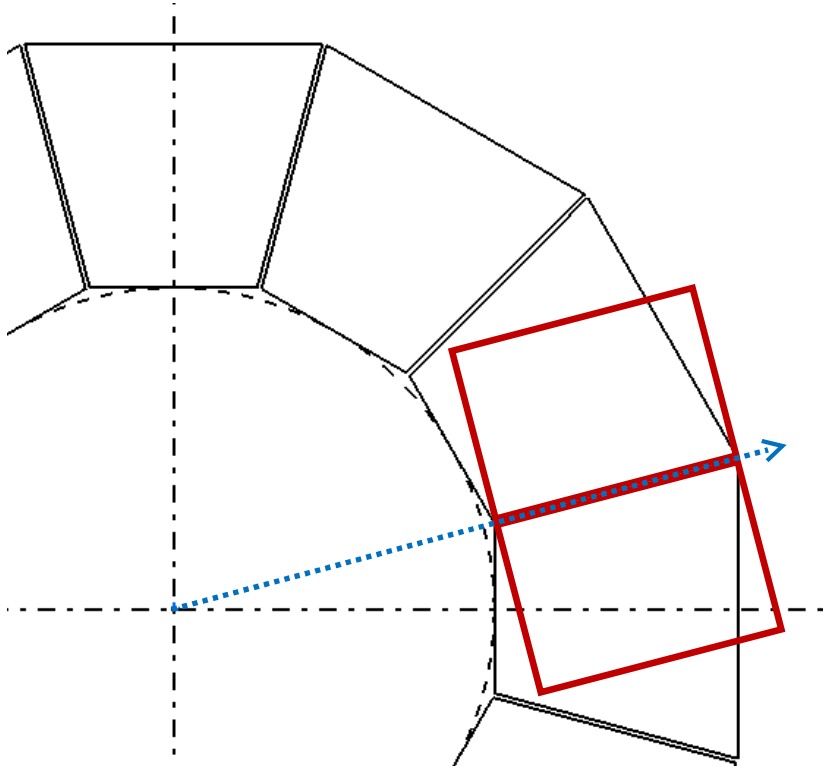
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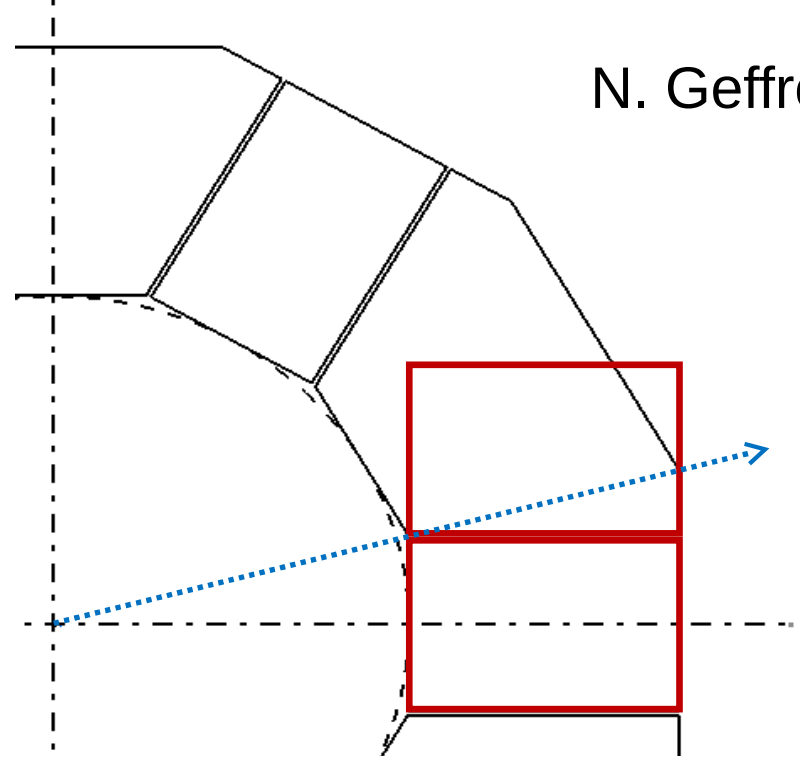
N.B. Analysis has been performed for both 40 and 80 layers detectors

Projective and non-projective geometry

Projective geometry



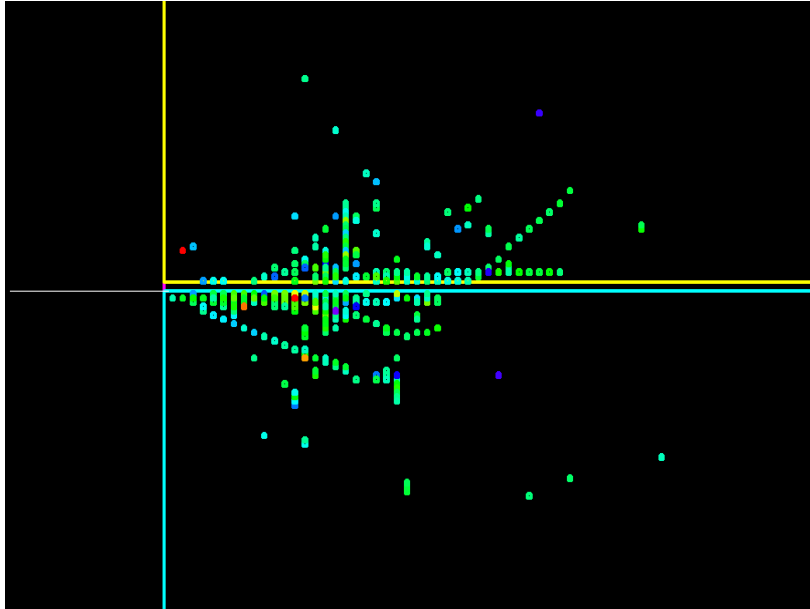
Non-projective geometry



- HCAL SiD baseline geometries:
 - Projective geometry – 12 identical calorimeter modules
 - Non-projective geometry – 6 rectangular and 6 trapezoidal modules
- Two rectangular modules are considered as a good approximation for simulation study

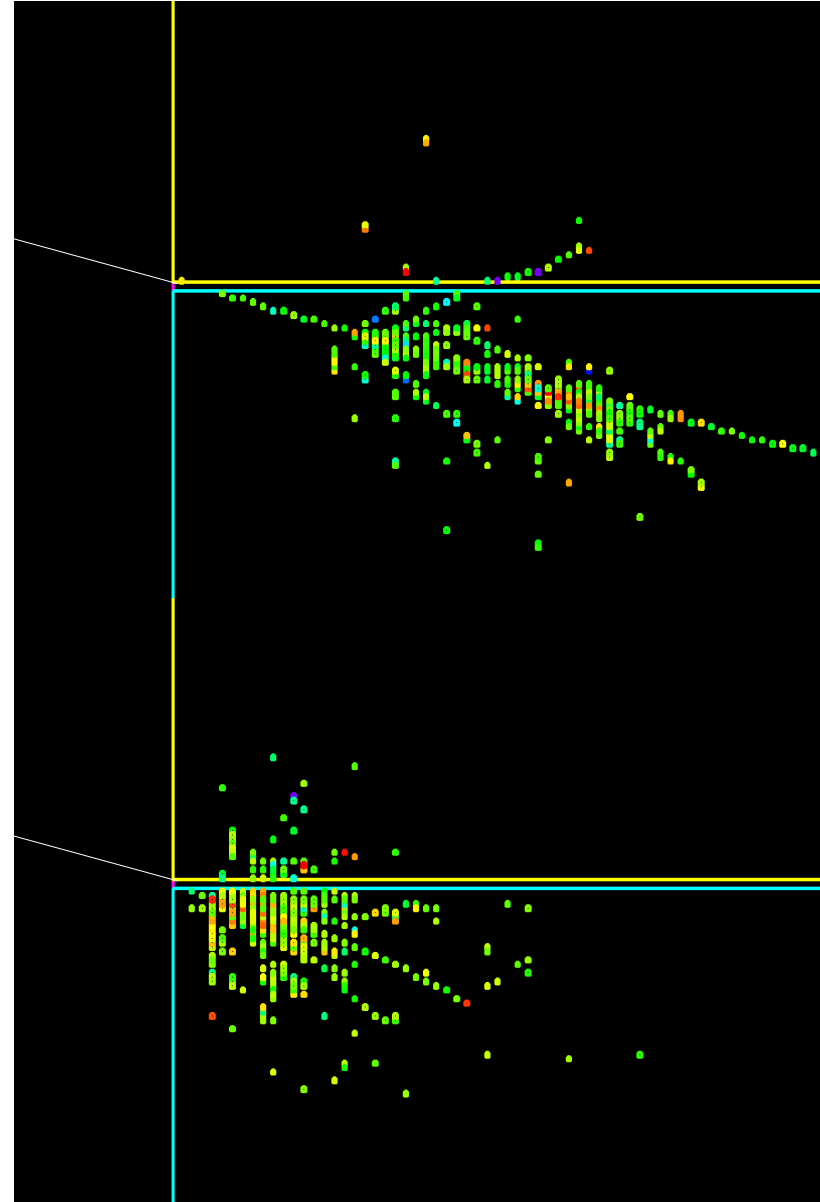
Typical events for 50 GeV pions

Projective geometry



- Particles directed as from the vertex
- Impact area restricted to 5 cm diameter around the boundary at front of the detector
- For each configuration, data have been generated for pion energies between 3 to 200 GeV

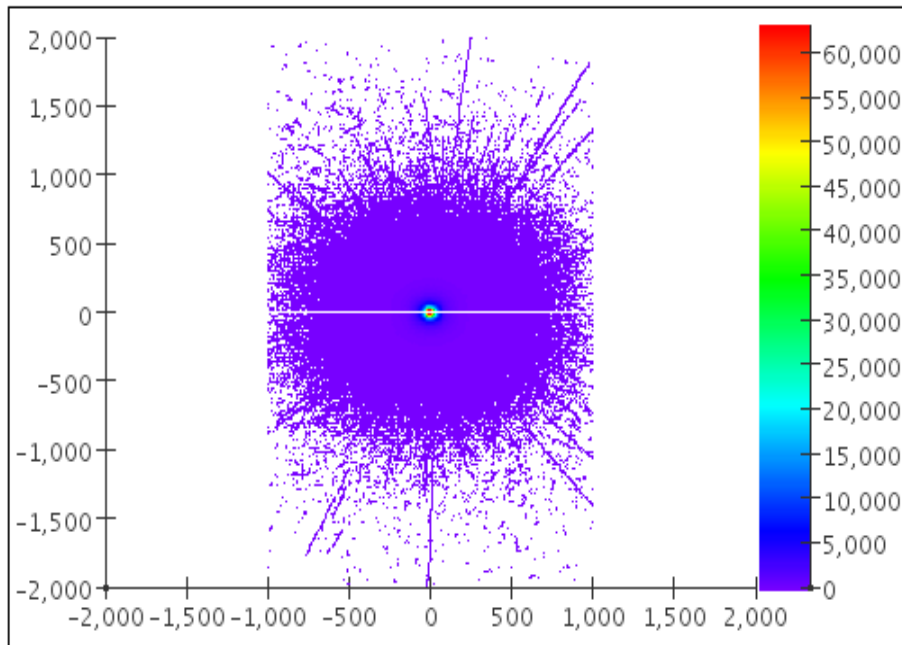
Non-projective geometry



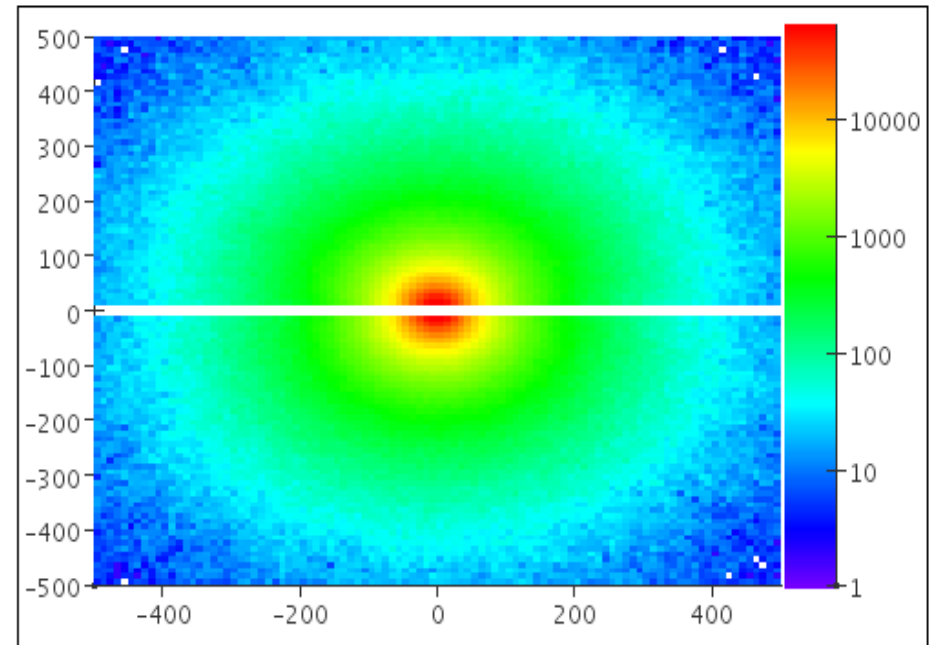
Projective geometry

Number of hits versus cell id number

sid2Modules_FeAbs_2cmFeP_Pro_pi-_50GeV.aida - Pro



sid2Modules_FeAbs_2cmFeP_Pro_pi-_50GeV.aida - Pro



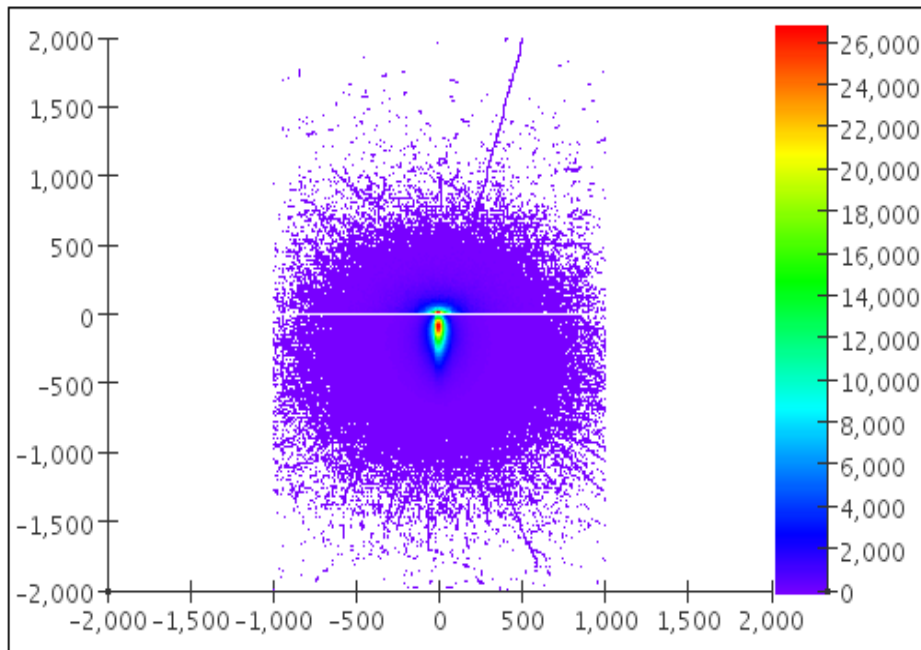
Configuration:

- 2 cm Fe plate between modules with 80 layers
- 50 GeV pions, 10k events
- 0.5 MIP readout threshold

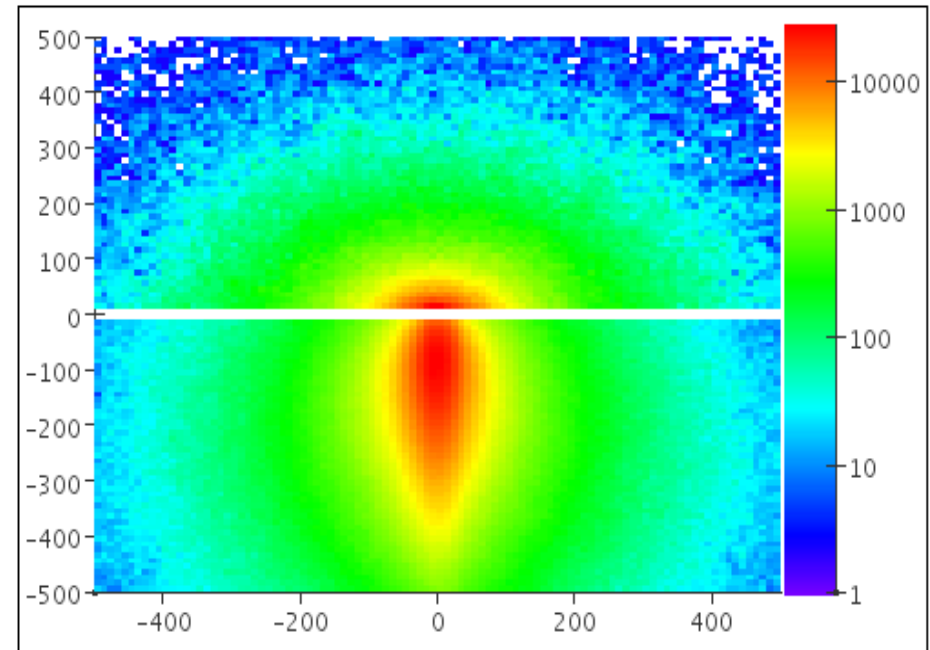
Non-projective geometry

Number of hits versus cell id number

sid2Modules_FeAbs_2cmFeP_NonPro_pi-_50GeV.aida - NonPro



sid2Modules_FeAbs_2cmFeP_NonPro_pi-_50GeV.aida - NonPro

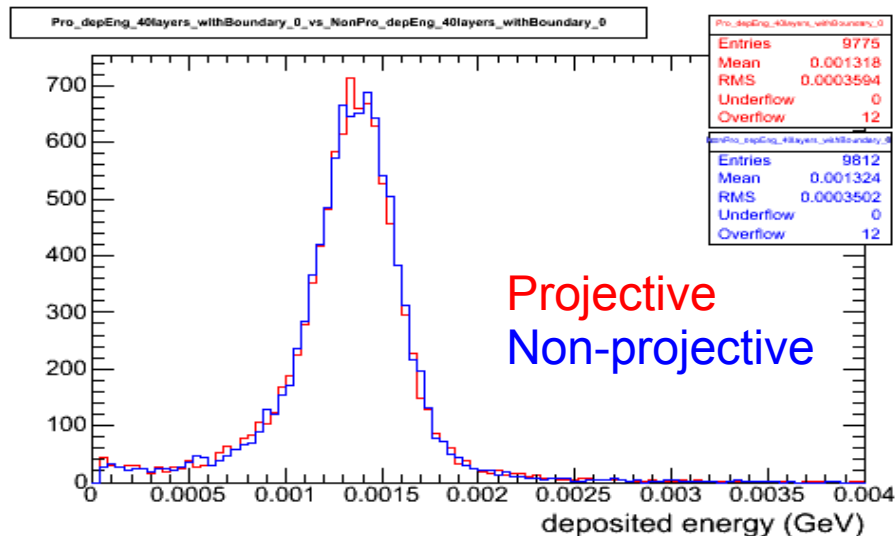


Configuration:

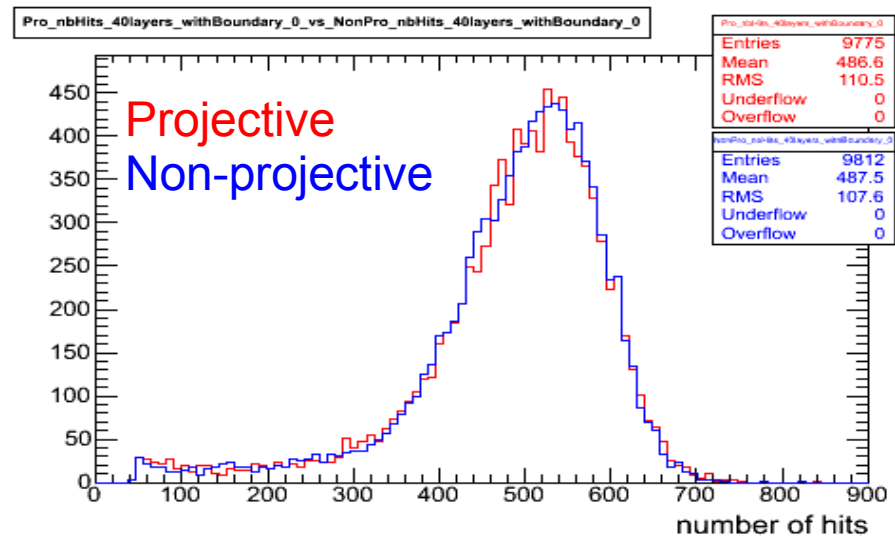
- 2 cm Fe plate between modules with 80 layers
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Projective vs non-projective

Analog readout



Digital readout



Configuration:

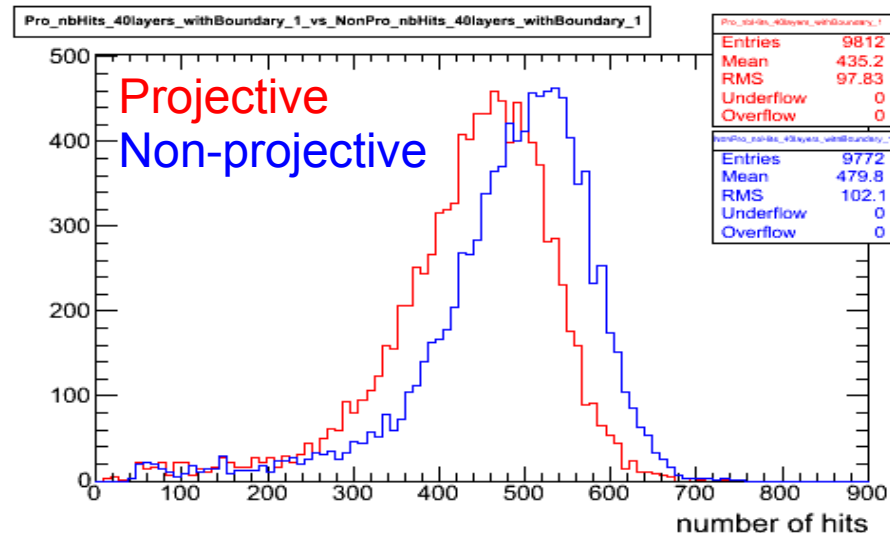
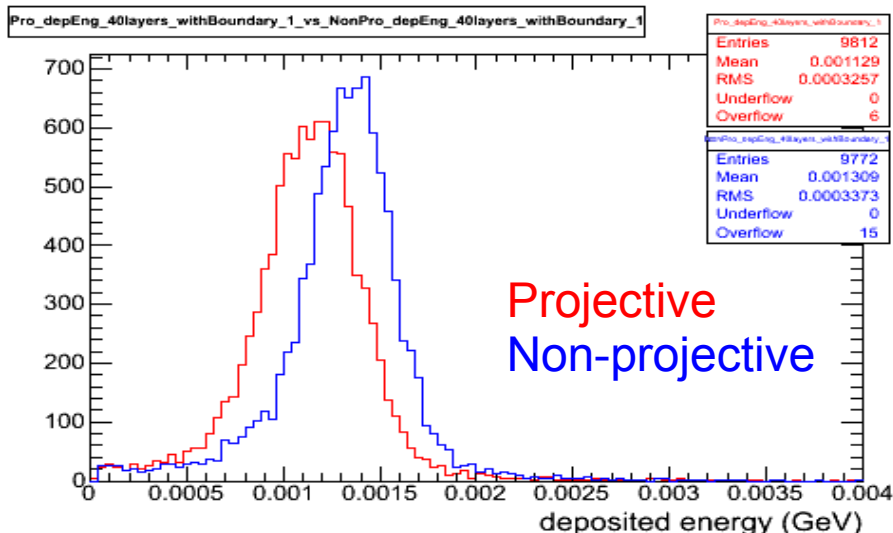
- no Fe plate between modules with 40 layers – reference geometry
- 50 GeV pions, 10k events
- 0.5 MIP readout threshold
 - Analog readout – deposited energy in calorimeter in GeV units
 - Digital readout – number of hits (fired cells) in calorimeter

Projective vs non-projective

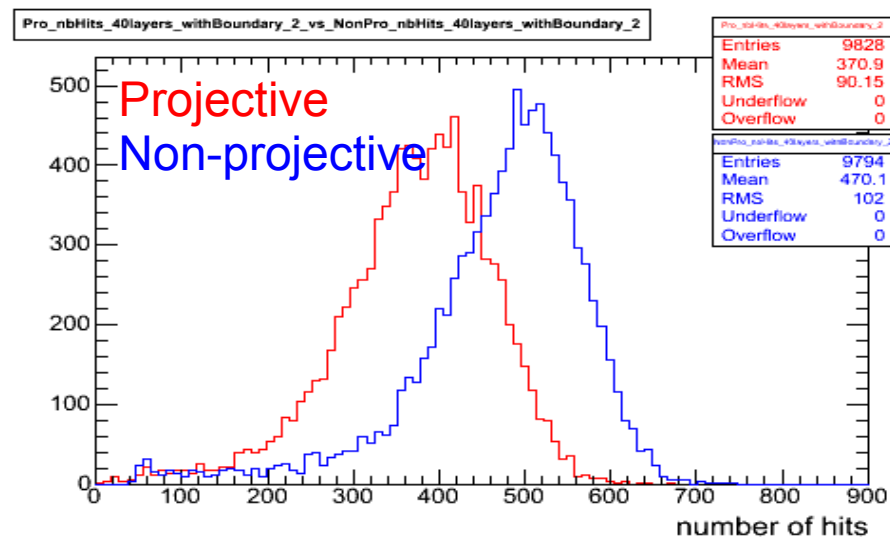
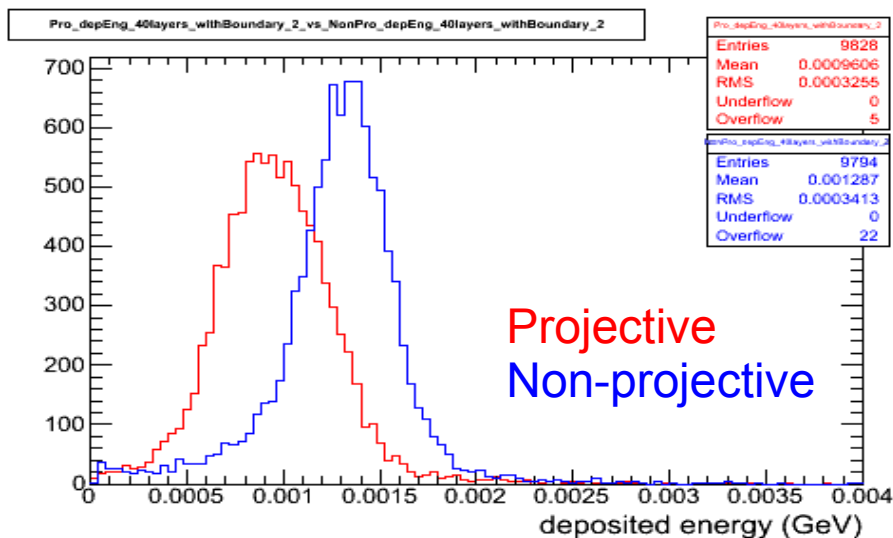
Analog readout

1 cm Fe plate between modules, 50 GeV pions

Digital readout

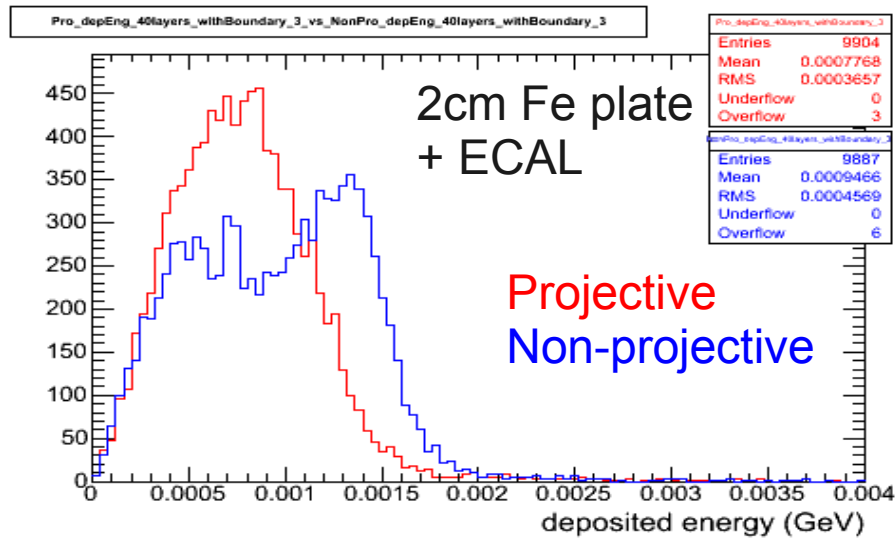


2 cm Fe plate between modules, 50 GeV pions

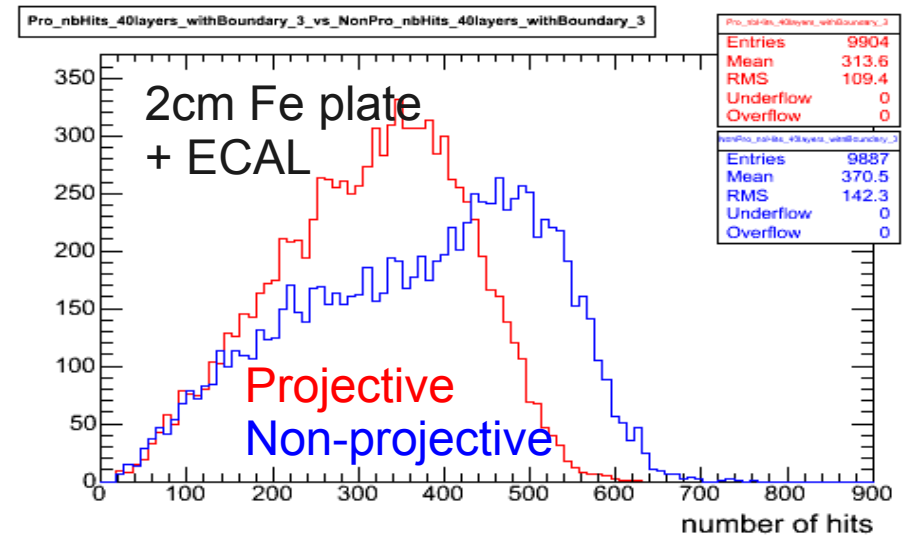


Projective vs non-projective

Analog readout

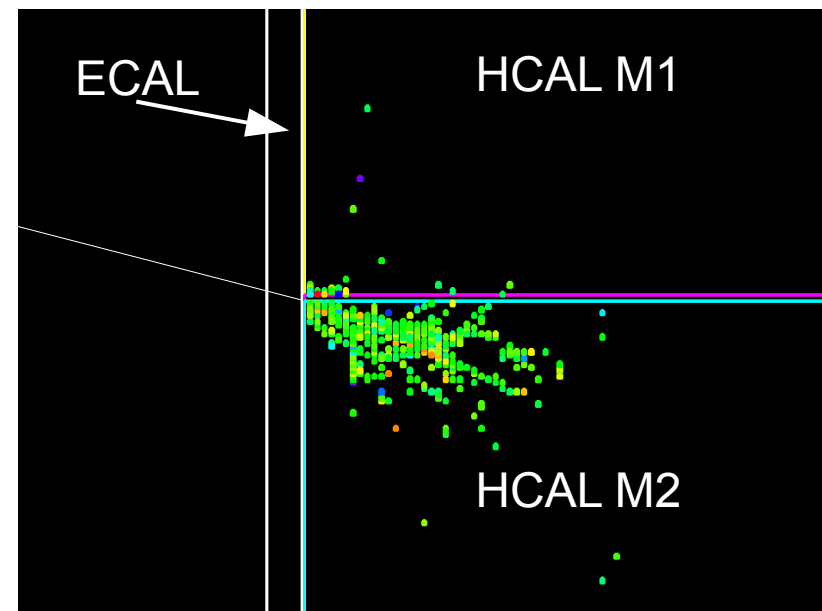


Digital readout



Configuration:

- SiD W ECAL ($\sim 1 \lambda$) is placed in front of HCAL
- ECAL is passive (has no readout)
- 50 GeV pions

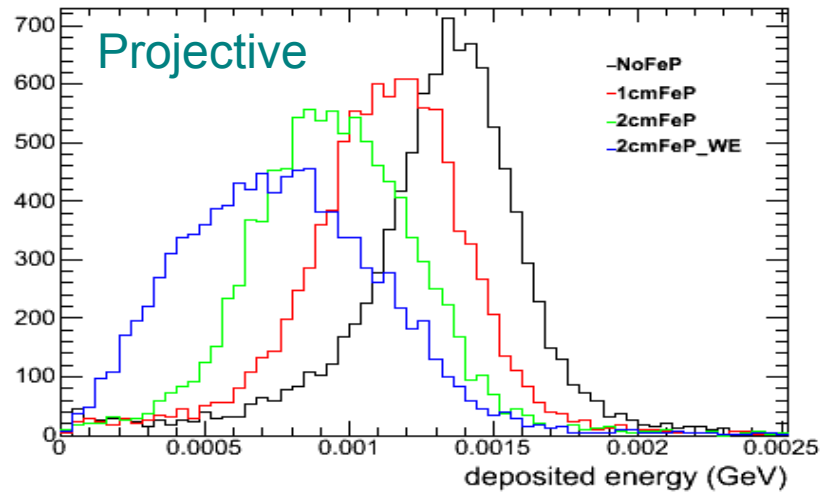


Projective vs non-projective, all the geometries, with boundary cells

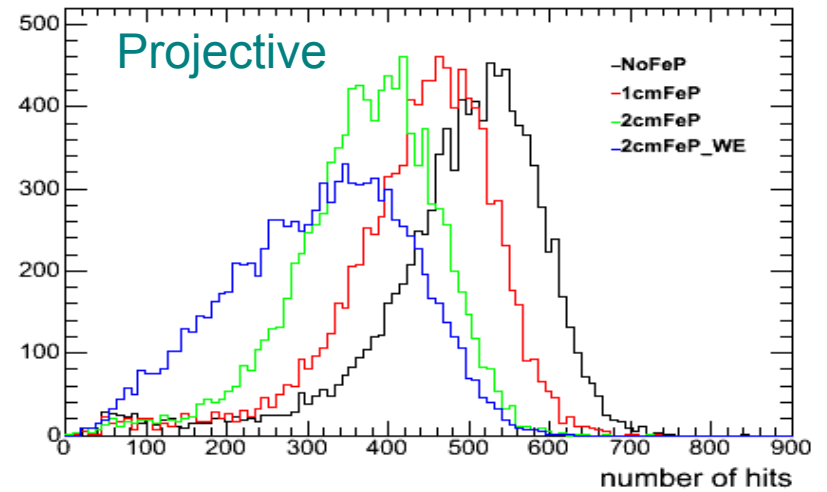
Analog readout

Digital readout

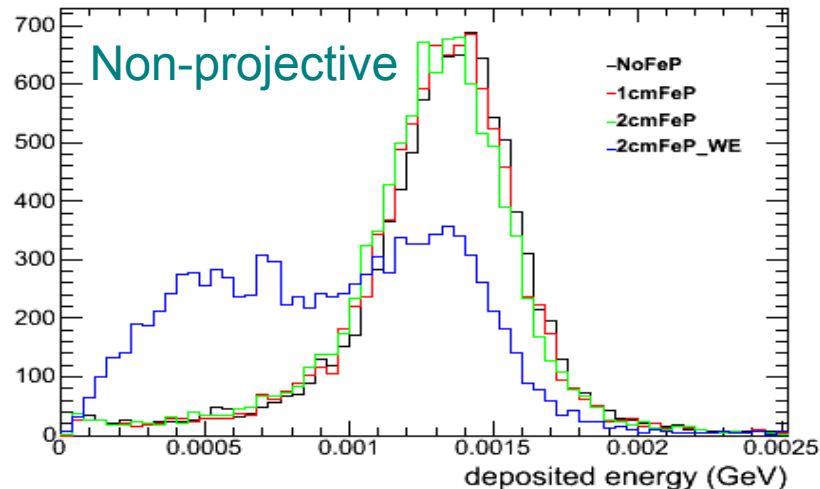
Pro_depEng_40layers_withBoundaryCells



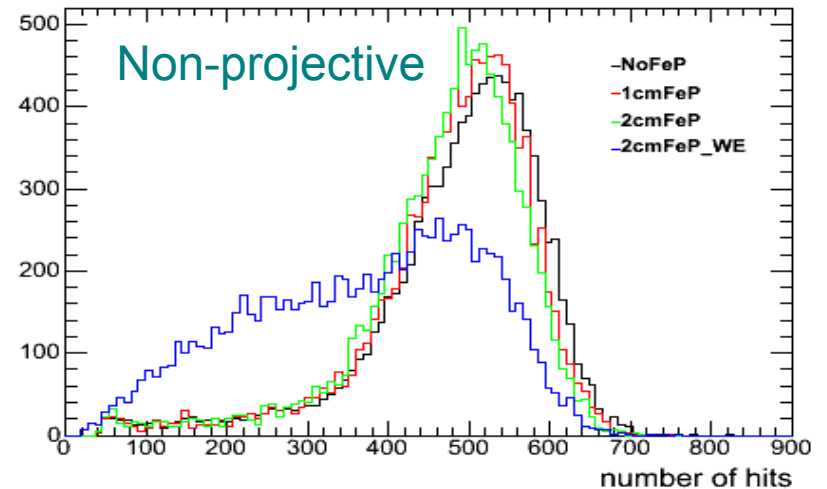
Pro_nbHits_40layers_withBoundaryCells



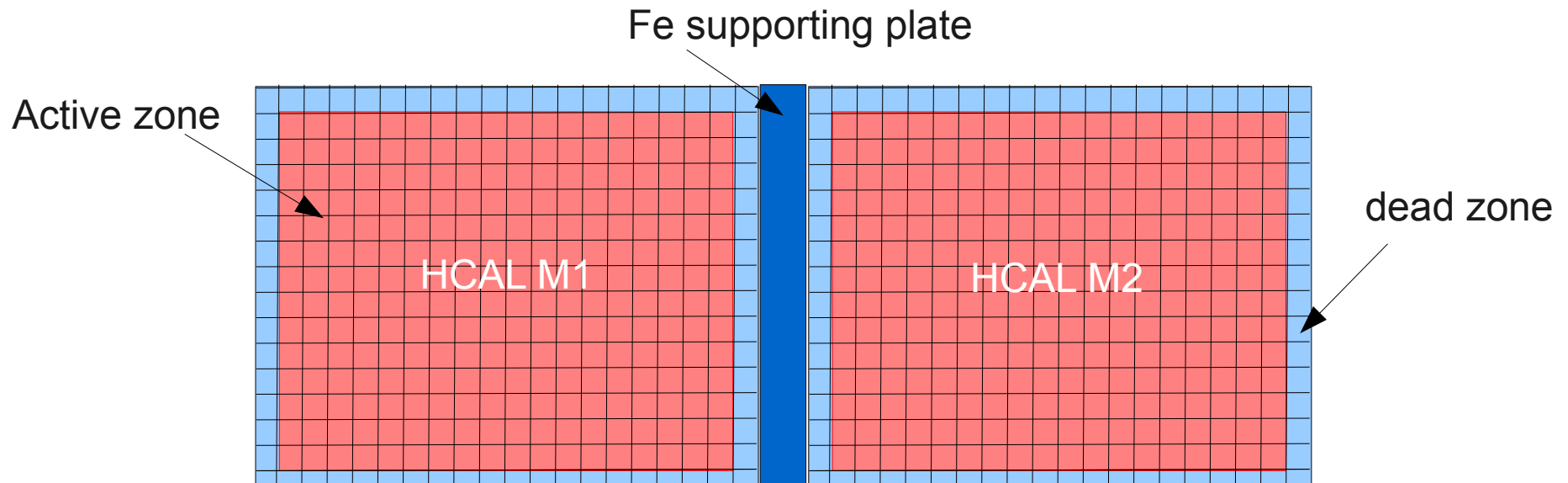
NonPro_depEng_40layers_withBoundaryCells



NonPro_nbHits_40layers_withBoundaryCells



Impact of the dead zone along the modules boundary



It is expected to have ~ 1 cm dead zone around Micromegas detector.
In order to quantify the impact of such a dead zone, several configurations have been studied:

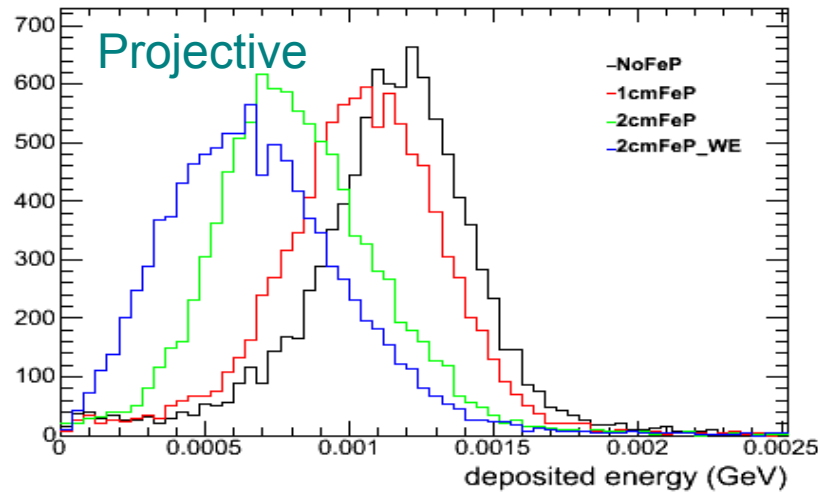
- No dead zone along the boundary (0 Cell lines excluded)
- 1 cm dead zone (1 Cell line excluded)
- 2 cm dead zone (2 Cell lines excluded)
- ...

Projective vs non-projective, all the geometries, without boundary cells

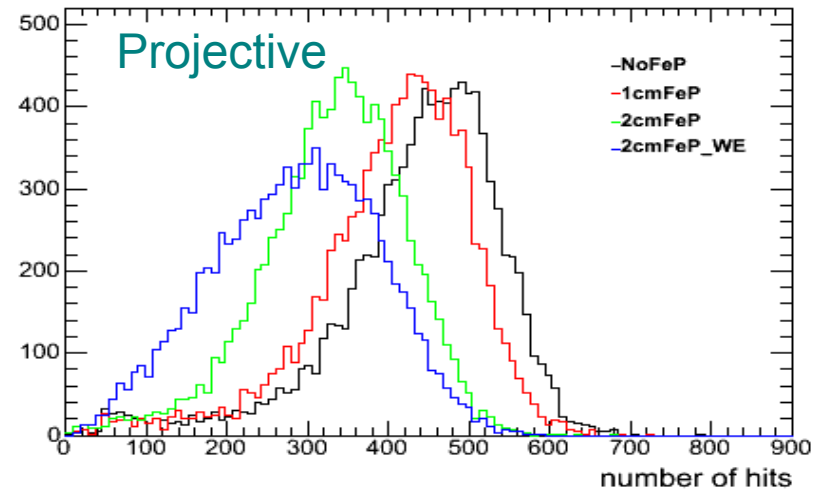
Analog readout

Digital readout

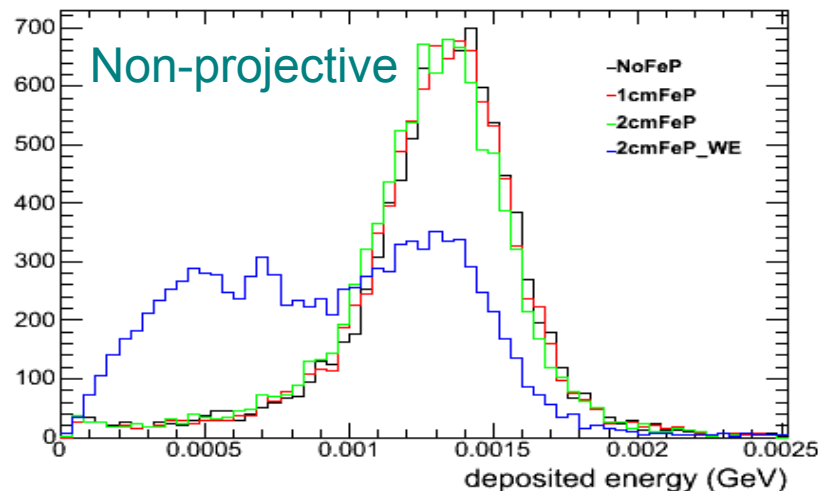
Pro_depEng_40layers_withoutBoundaryCells



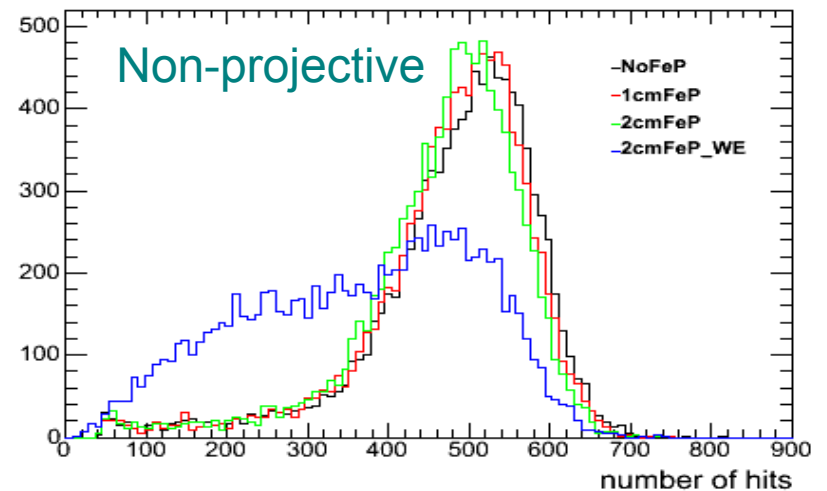
Pro_nbHits_40layers_withoutBoundaryCells



NonPro_depEng_40layers_withoutBoundaryCells



NonPro_nbHits_40layers_withoutBoundaryCells

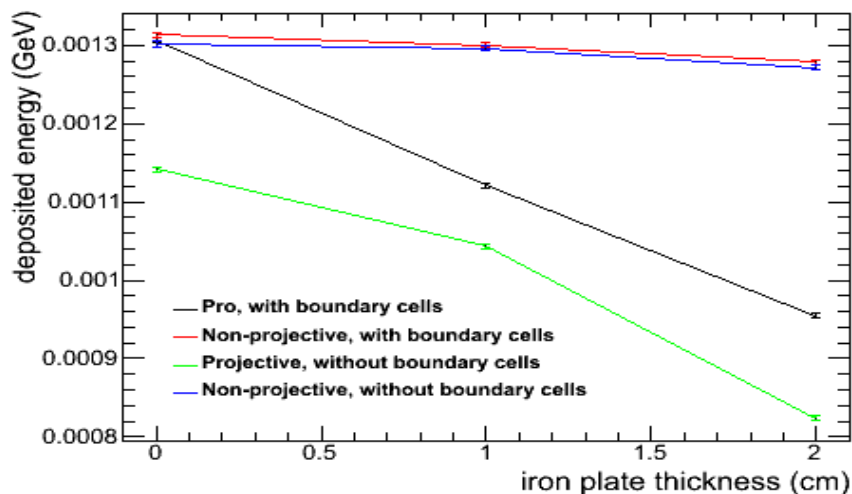


Calorimeter response and resolution vs iron plate thickness

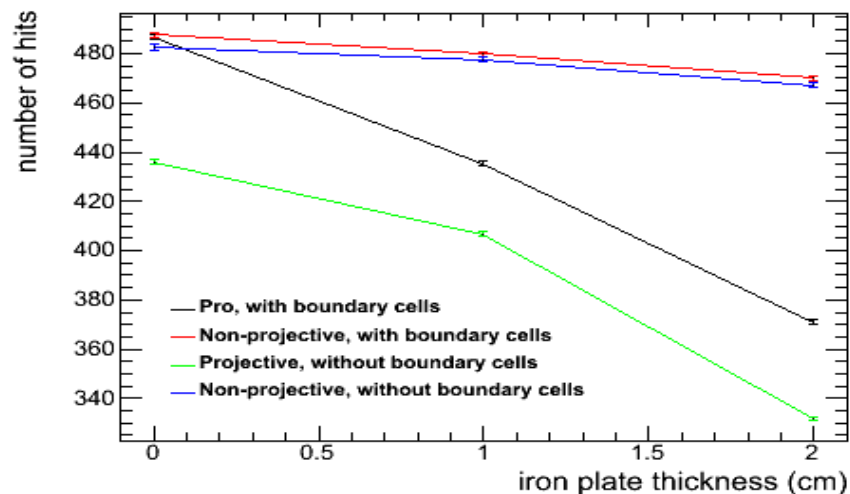
Analog readout

Digital readout

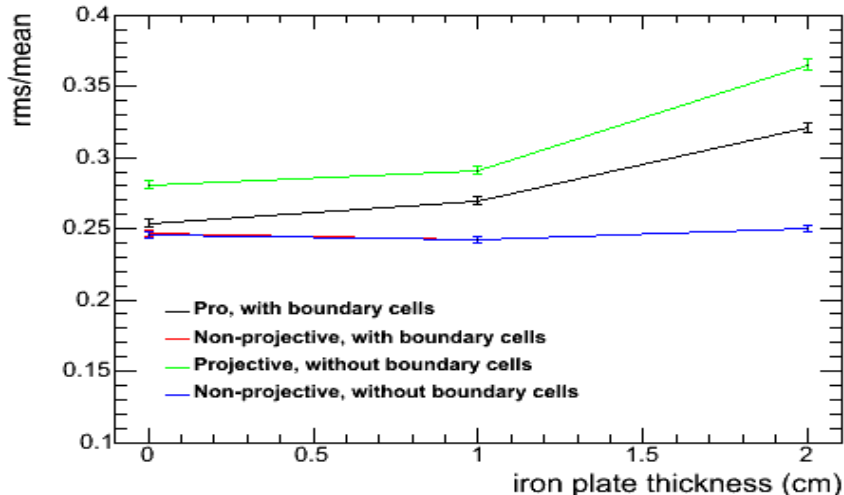
depEng_40layers



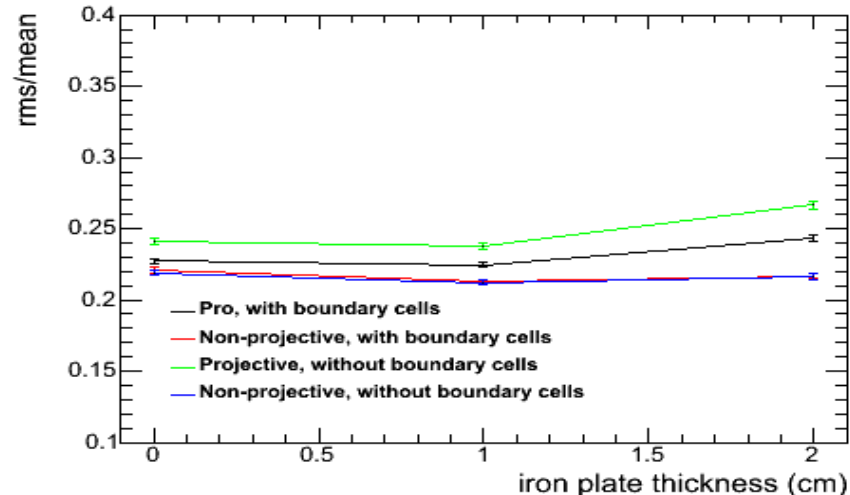
nbHits_40layers



depEng_40layers



nbHits_40layers

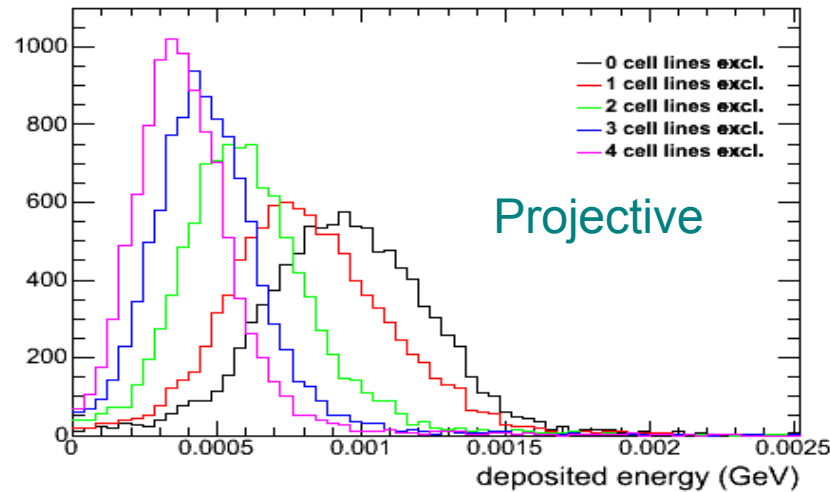


Projective vs non-projective geometry for different number of excluded cell lines

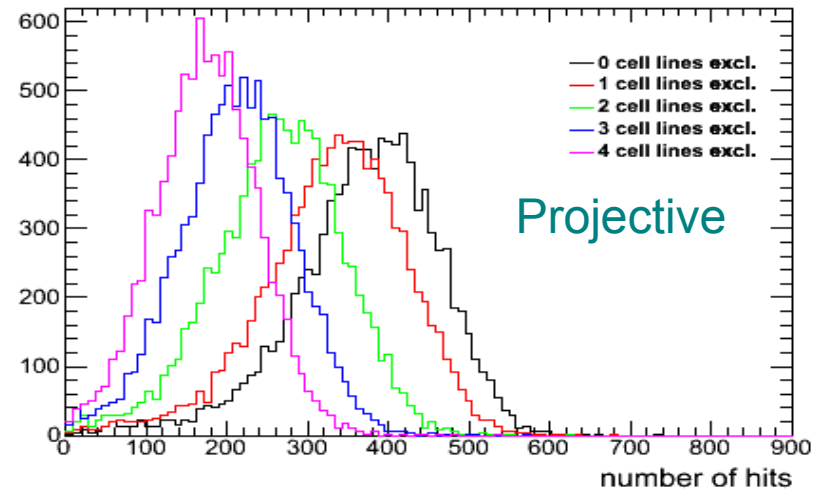
Analog readout

Digital readout

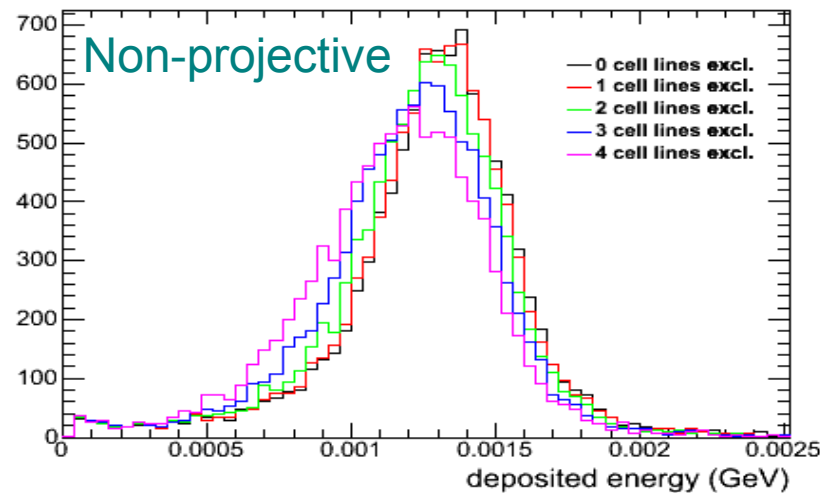
Pro_depEng_40layers_2cmFeP



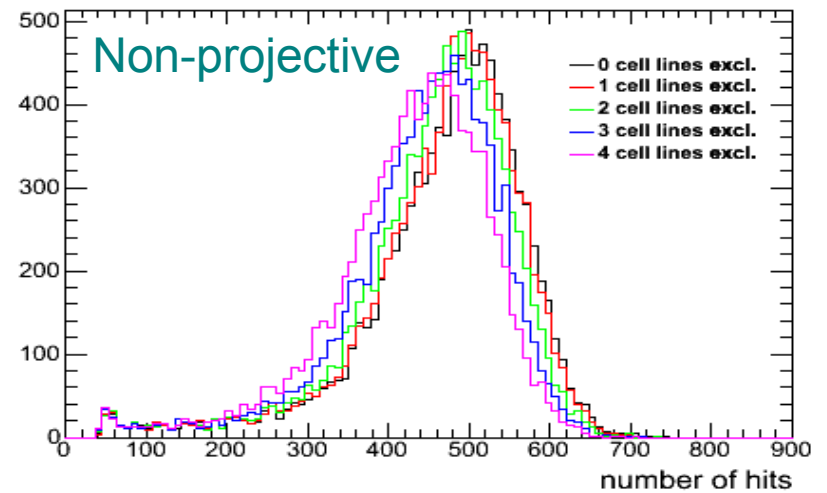
Pro_nbHits_40layers_2cmFeP



NonPro_depEng_40layers_2cmFeP



NonPro_nbHits_40layers_2cmFeP

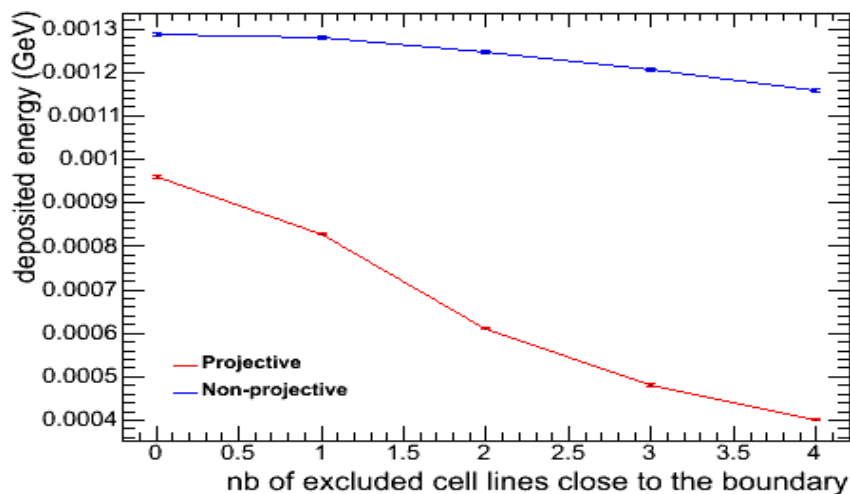


Calorimeter response and resolution vs number of excluded cell lines

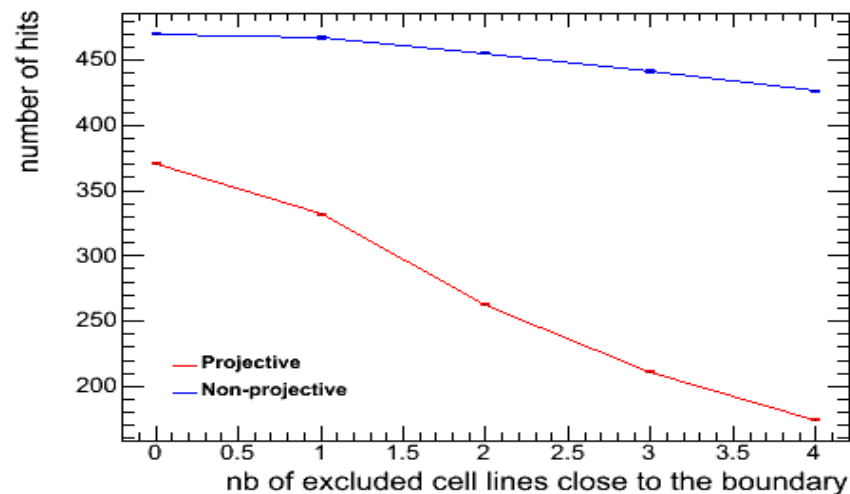
Analog readout

Digital readout

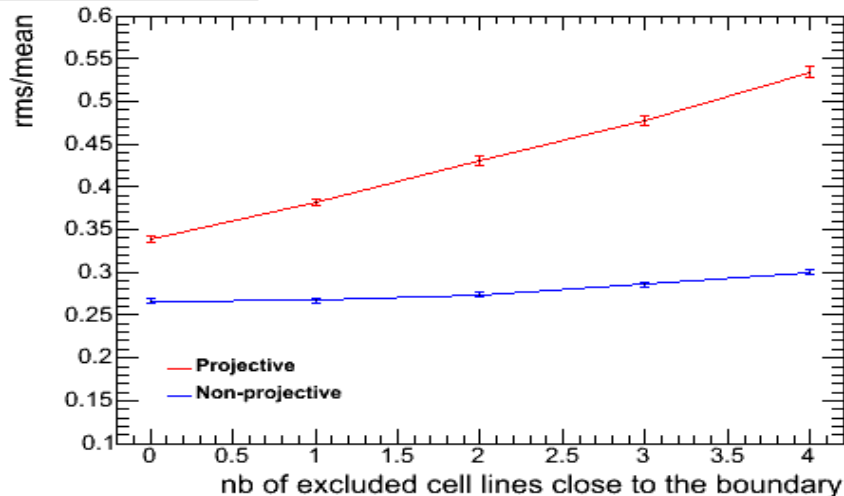
depEng_40layers



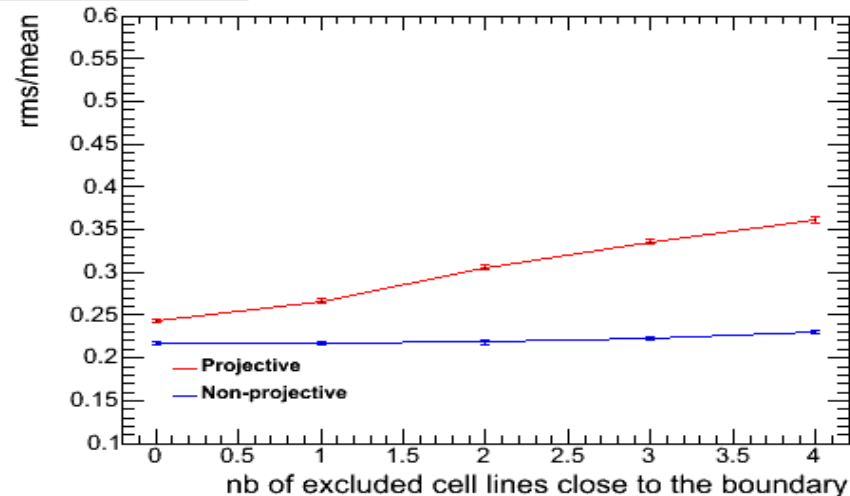
nbHits_40layers



depEng_40layers

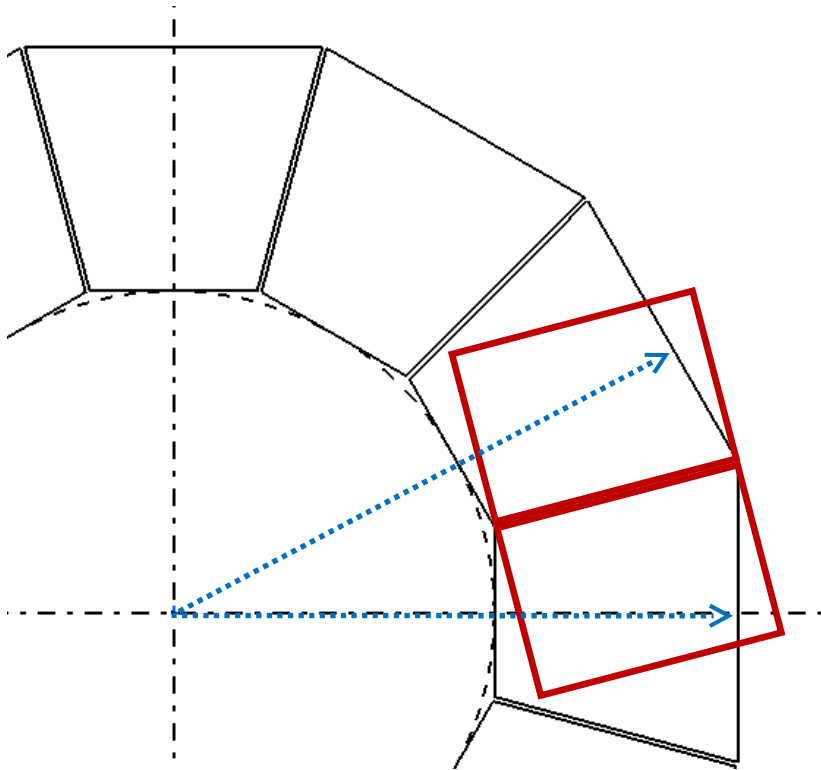


nbHits_40layers

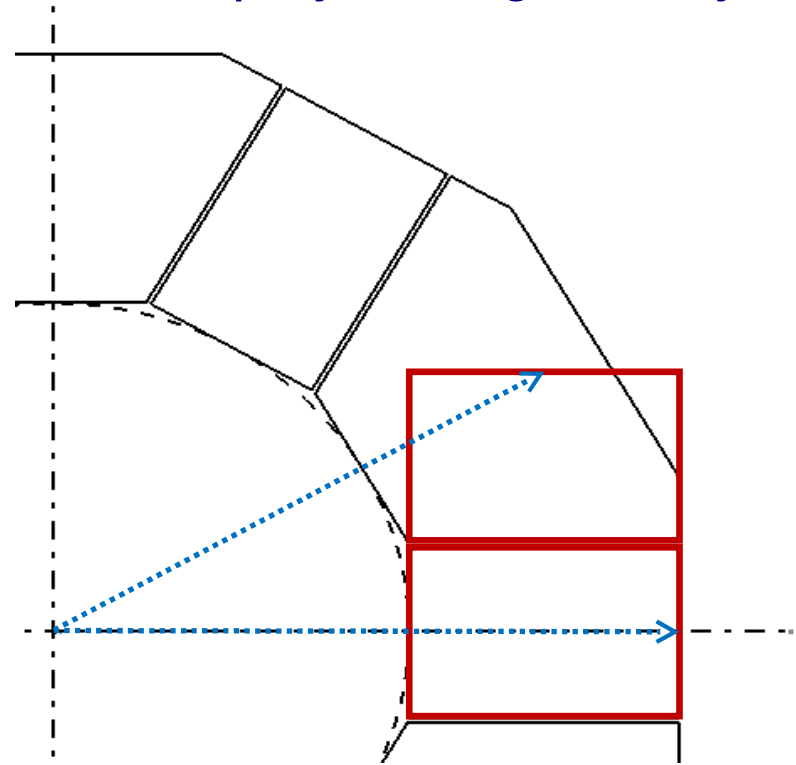


New vertex angle to be studied

Projective geometry



Non-projective geometry



- Presented study shows large difference between projective and non-projective geometry due to the plate between modules
- This depends also on the vertex angle. In case of the small angle, the projective geometry is in disadvantage
- In order to put more equal conditions for both geometries, the impact angle need to be larger as proposed on the picture

Conclusions and outlook

For studied set-up (beam directed to the boundary (+-2.5 cm)):

- The impact of the iron plate between modules is clearly seen and it is significant for the projective geometry
- The effect is larger for analog readout in comparison with digital readout
- Performance degradation for configuration without readout cells close to the modules boundary is not dramatic if only one cell line is excluded.

The above mentioned items going to be check for lager vertexes angles