

Study of Monolithic Active Pixel Sensors

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Outline

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 - Concepts
 - Design
- Geometry modification
- Single e-/ μ - simulation
 - Si sensitive thickness dependence
 - Cell size dependence
 - Incoming energy dependence
- Summary of status
- Future prospects

Introduction

- High granularity
 - Small cells
 - Digital Calorimetry
- Cost saving
 - Si thickness reductions
 - Direct reduction of Si volume
 - Reduction of outer sub-detector volume

MAPS concepts

- Binary readout
- Detecting individual particles after electromagnetic cascade shower
- Result in measuring single particle in a cell
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MAPS design

➤ Current design

- 1cm X 1cm cell
- 500um Si sensitive thickness
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➤ MAPS design

- 50um X 50um cell
- 15um Si sensitive thickness
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Geometry modification

Default

Upper PCB	800um
Si Sensitive	500um
Lower PCB	800um

MAPS

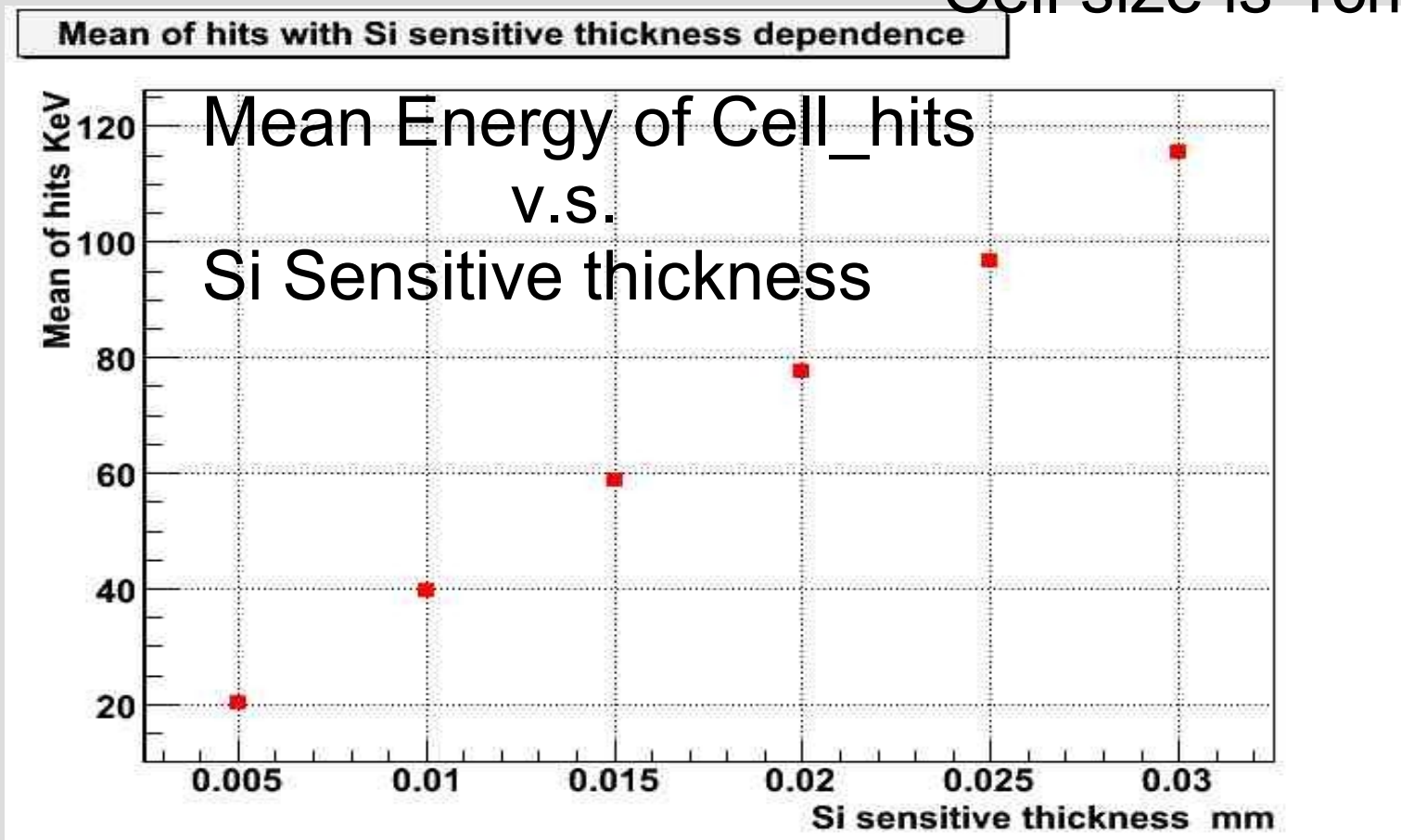
Upper PCB	800um
Si Sensitive	15um
Si Non-sensitive	485um
Lower PCB	800um

- Mokka 05-05
- Ecal02.cc (ECAL driver) is modified.
- Geant4 Adaptive GUI (GAG) output is fine.
- Energy deposit agreed with the expect.
(i.e. $15/500 = 3\%$)
- Layer position shift agreed with the expect.

Single e- simulation (1.a)

(Si sensitive thickness dependence)

20 GeV single electron
Cell size is 1cm X 1cm

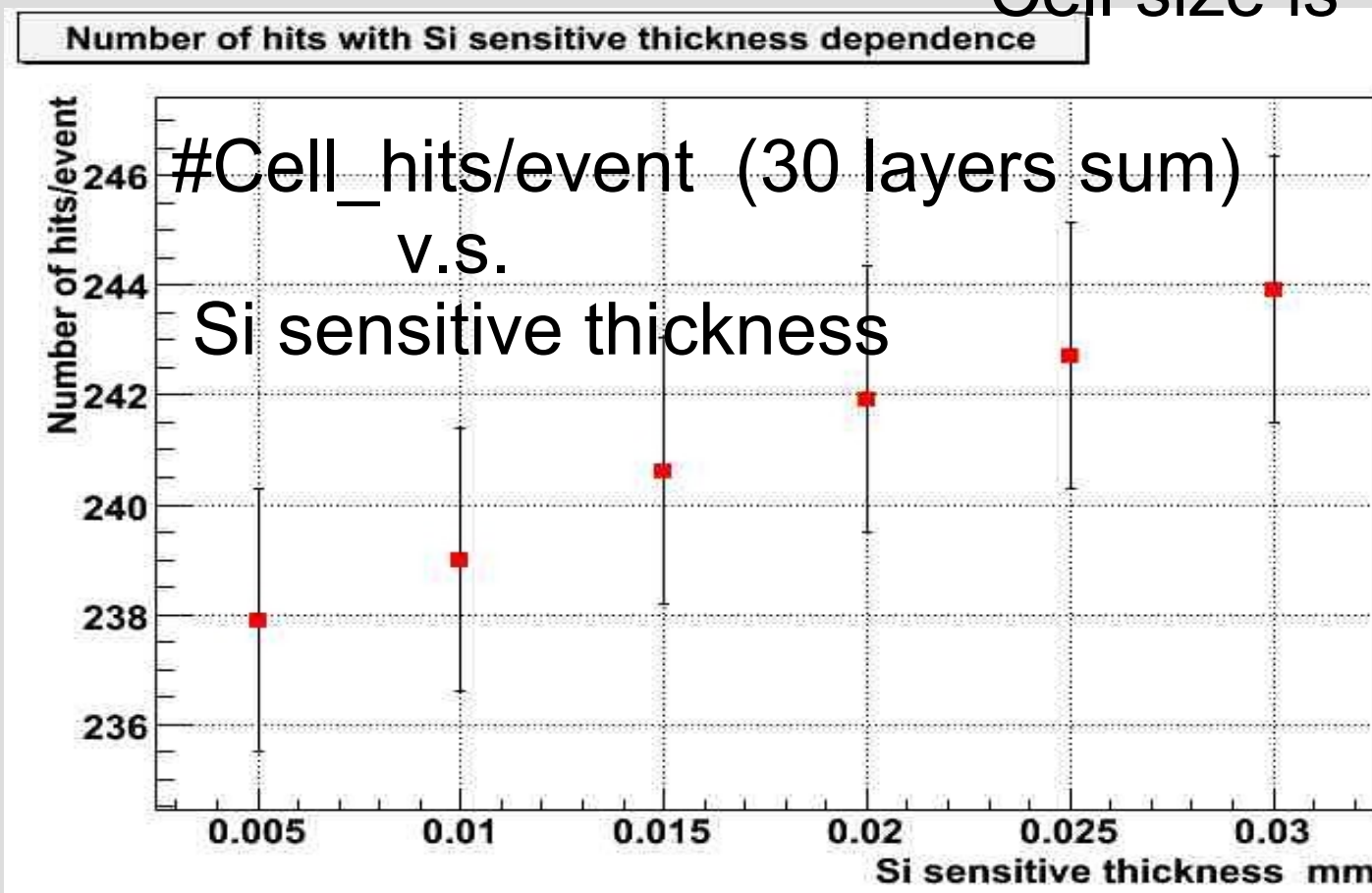


Good linearity

Single e- simulation (1.b)

(Si sensitive thickness dependence)

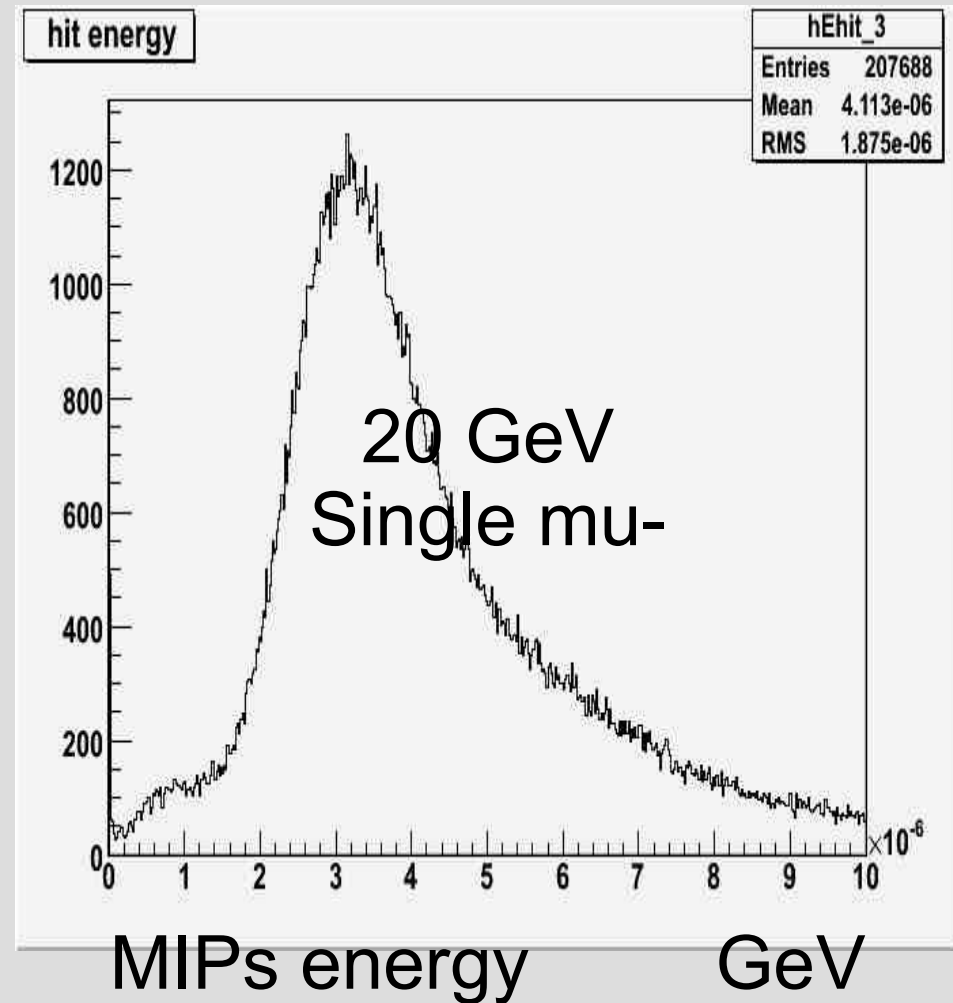
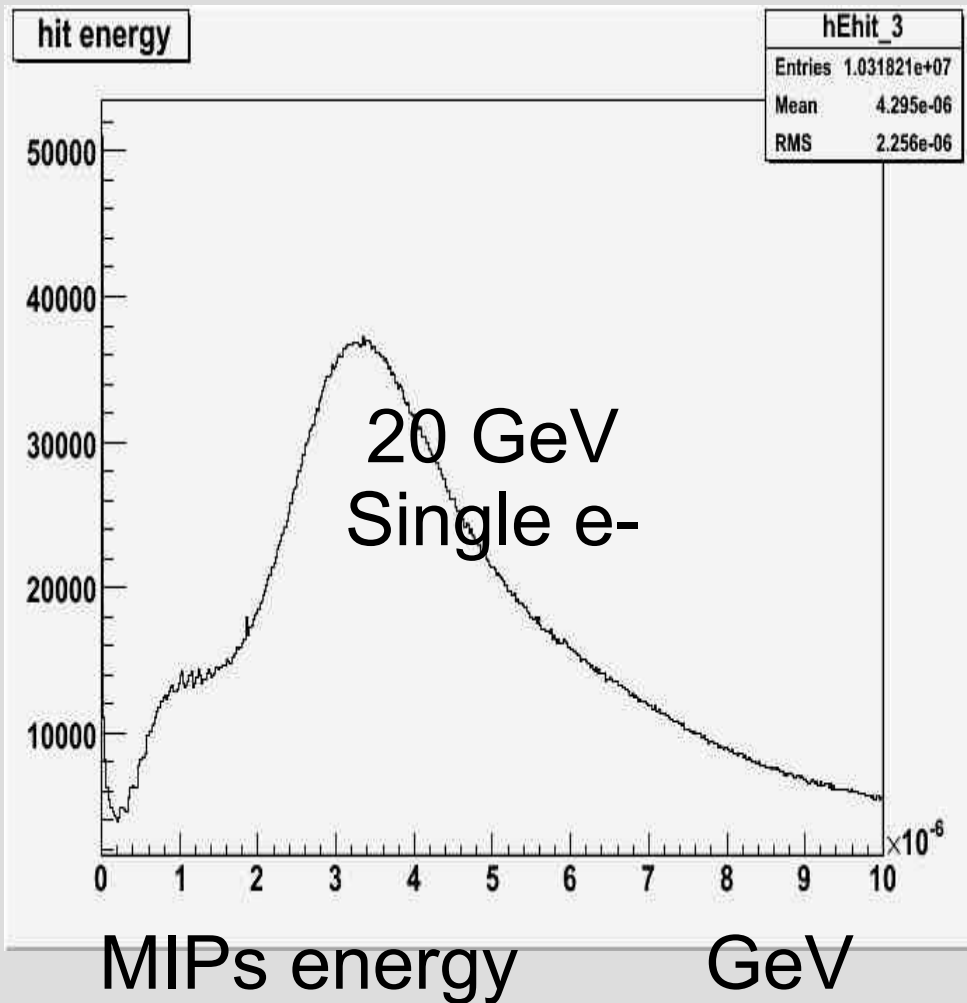
20 GeV single electron
Cell size is 1cm X 1cm



Only a few % dependence

Single e-/μ- simulation

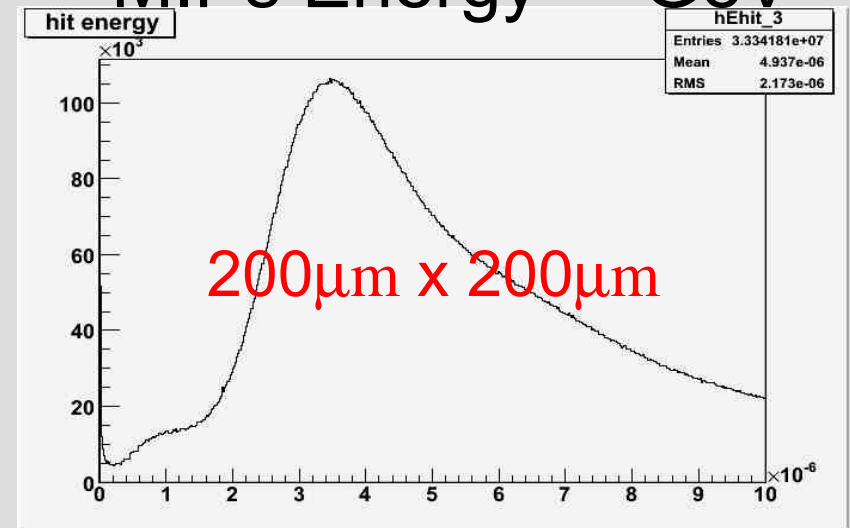
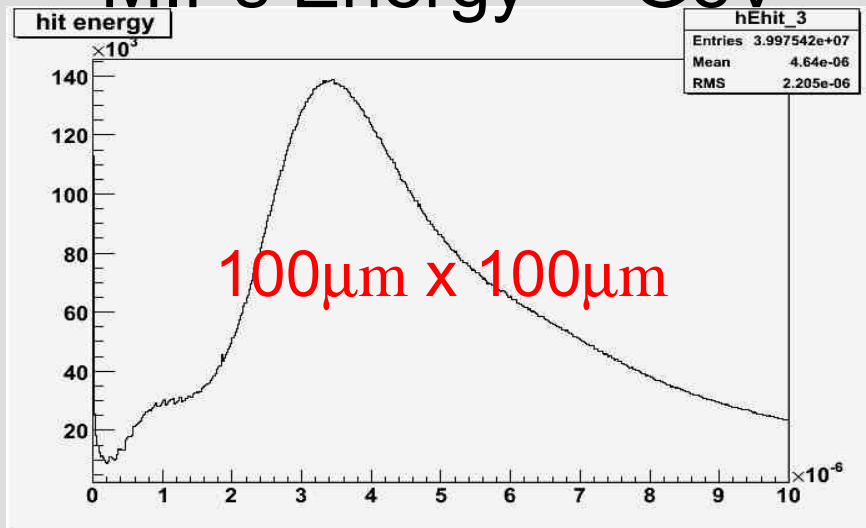
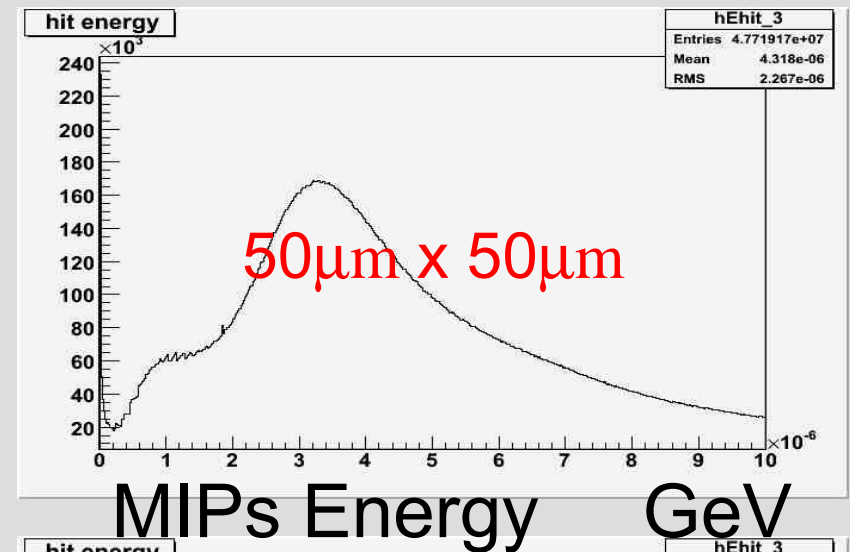
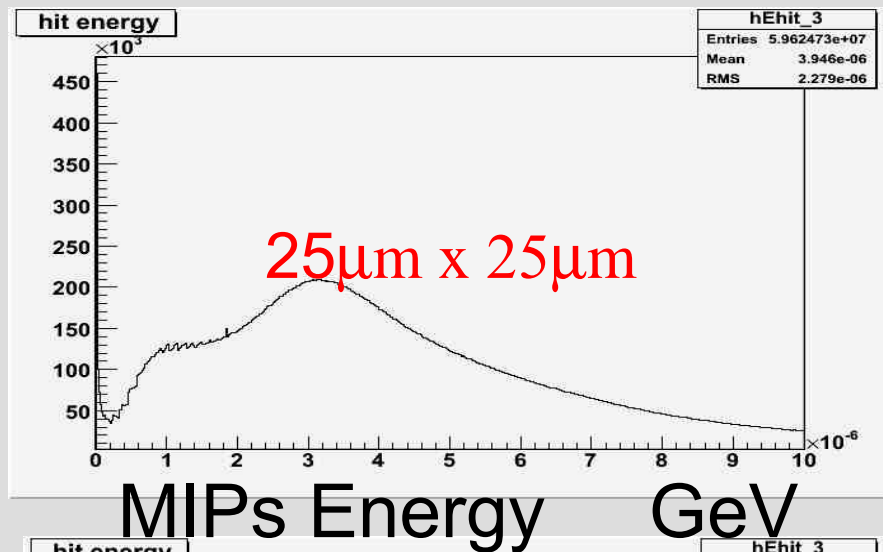
15um Si sensitive thickness
50um X 50um cell size



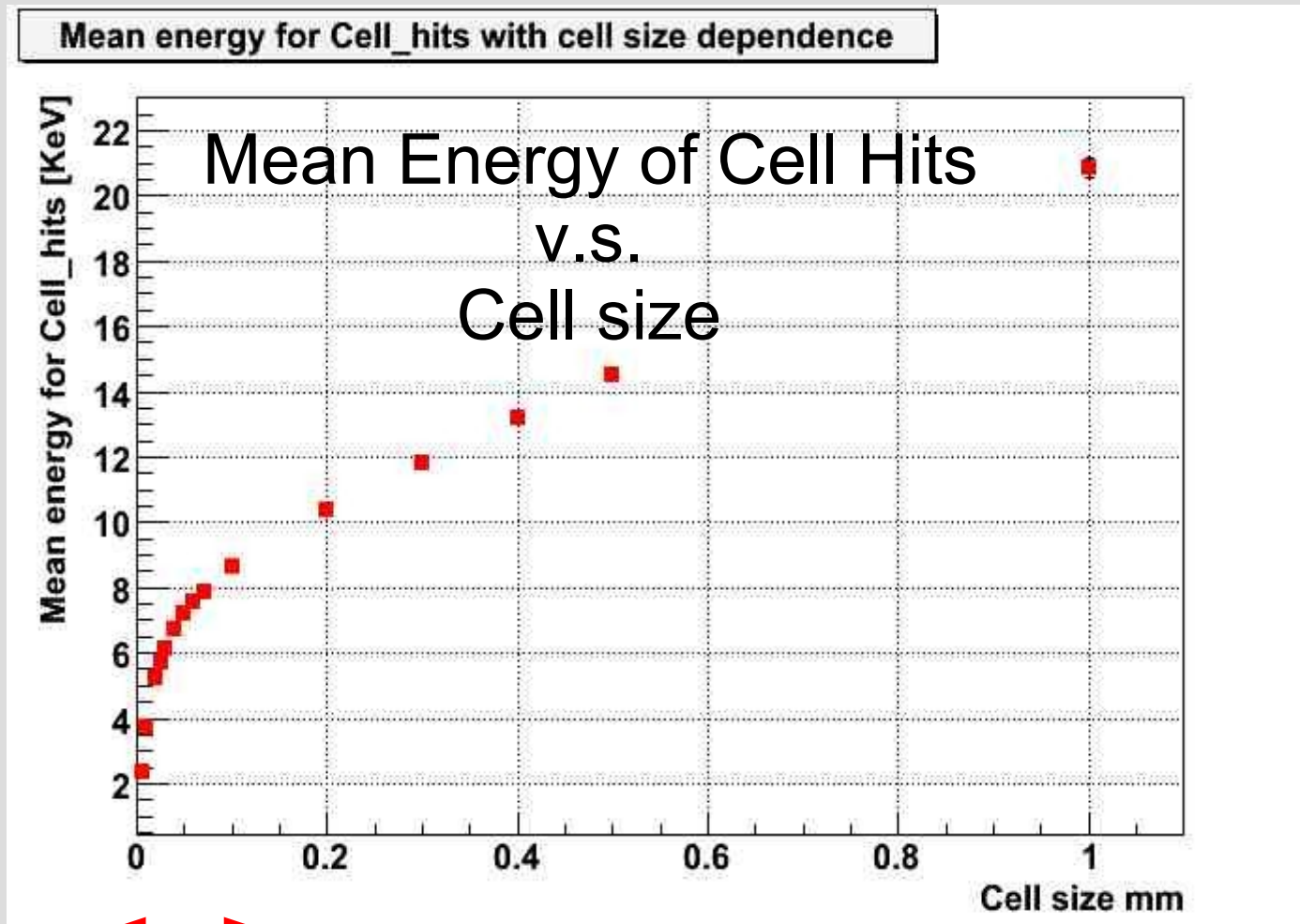
Single e- simulation (2.a)

(Cell size dependence)

100GeV single e-
15 μ m Si sensitive thickness



Single e- simulation (2.b) (Cell size dependence)

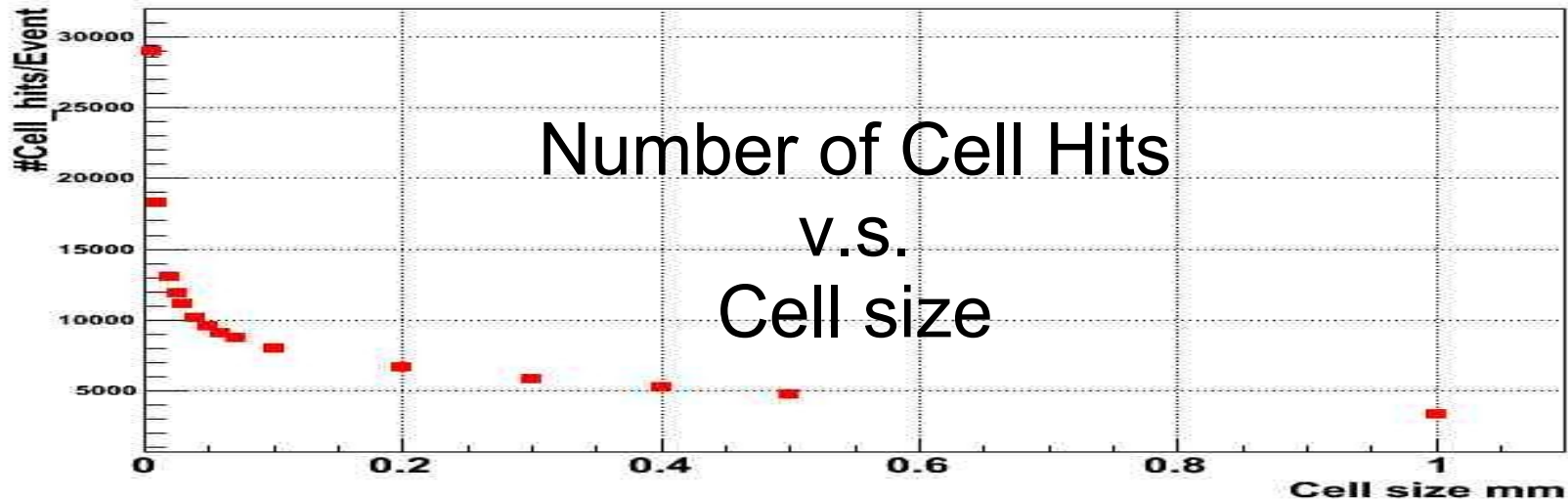


One MIP per cell and
Charge sharing by neighbour cells

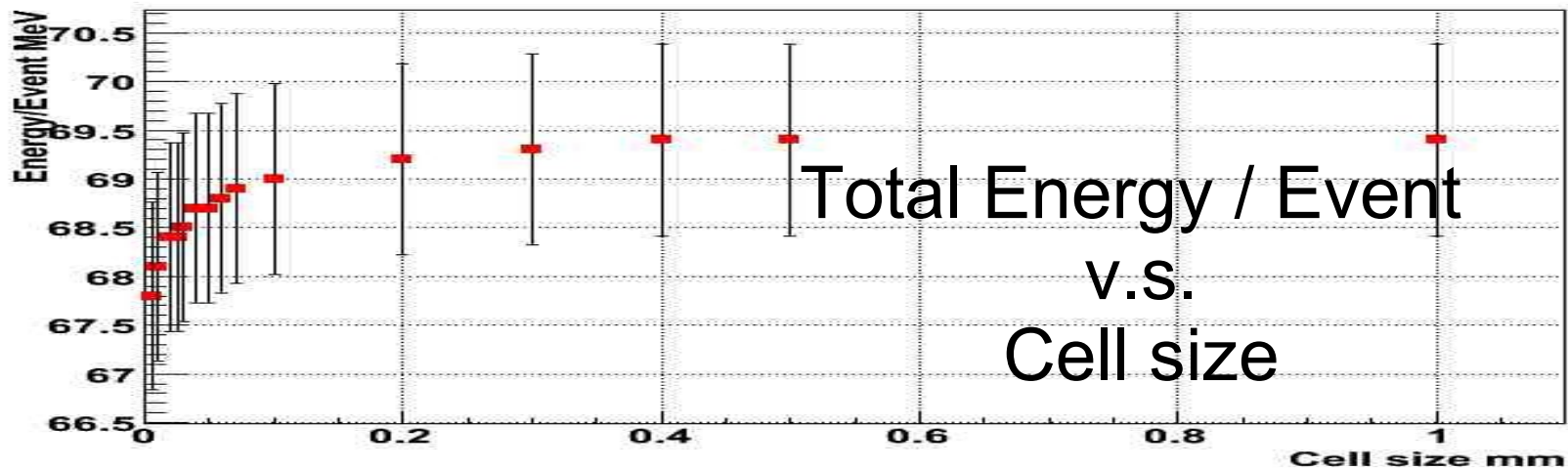
Single e- simulation (2.c)

(Cell size dependence)

#Cell_hits/Event with cell size dependence



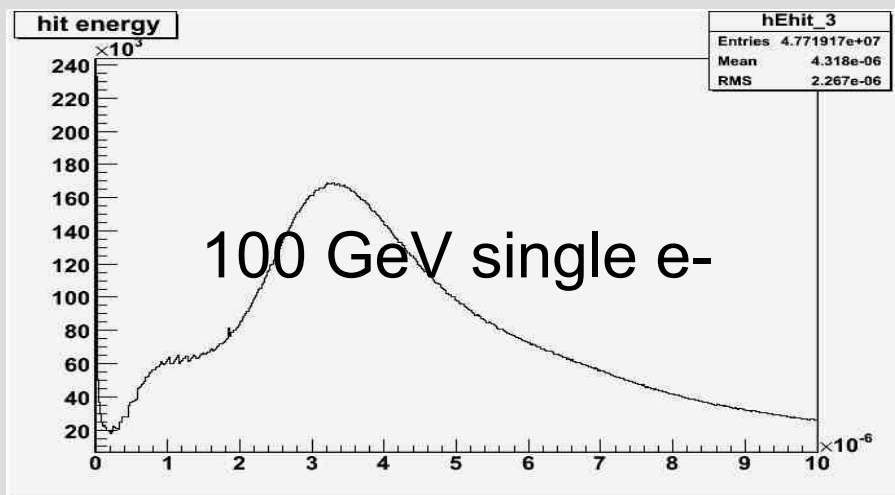
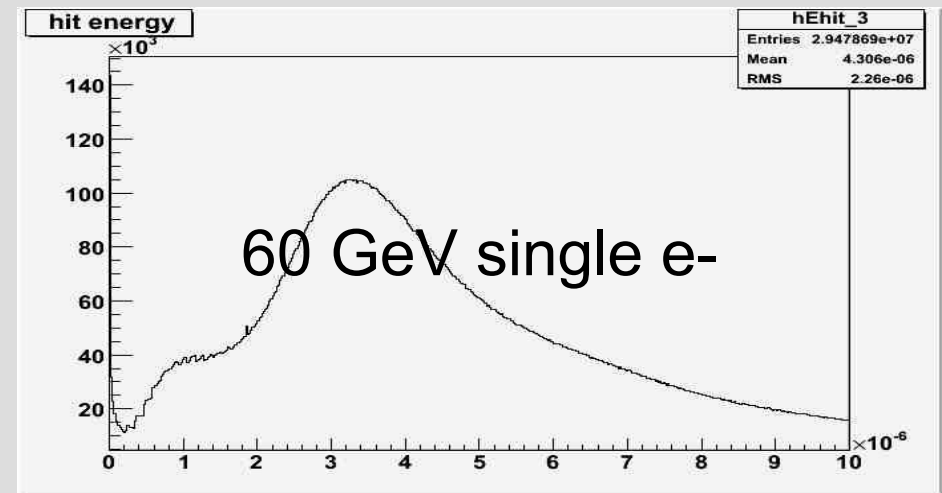
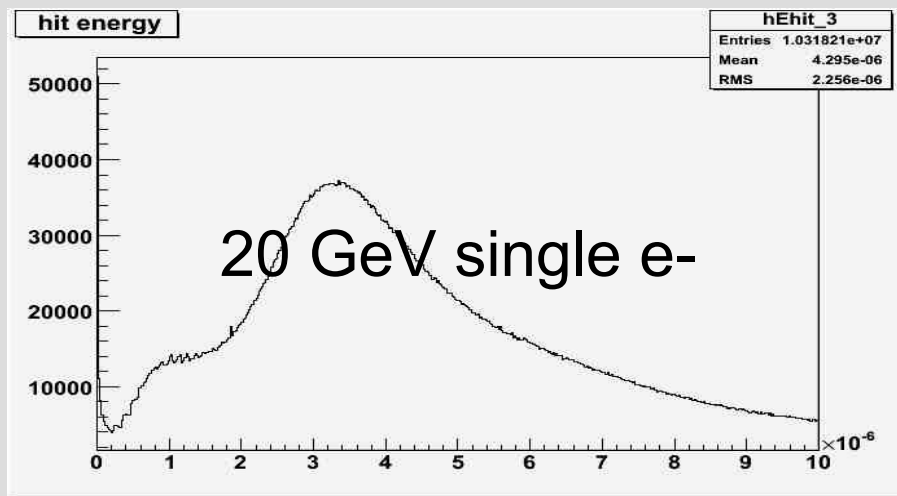
Energy/Event with cell size dependence



Single e- simulation (3)

(Incoming energy dependence)

15um Si sensitive thickness
50um X 50um cell size



Mean of peak is independent
of incoming energy.

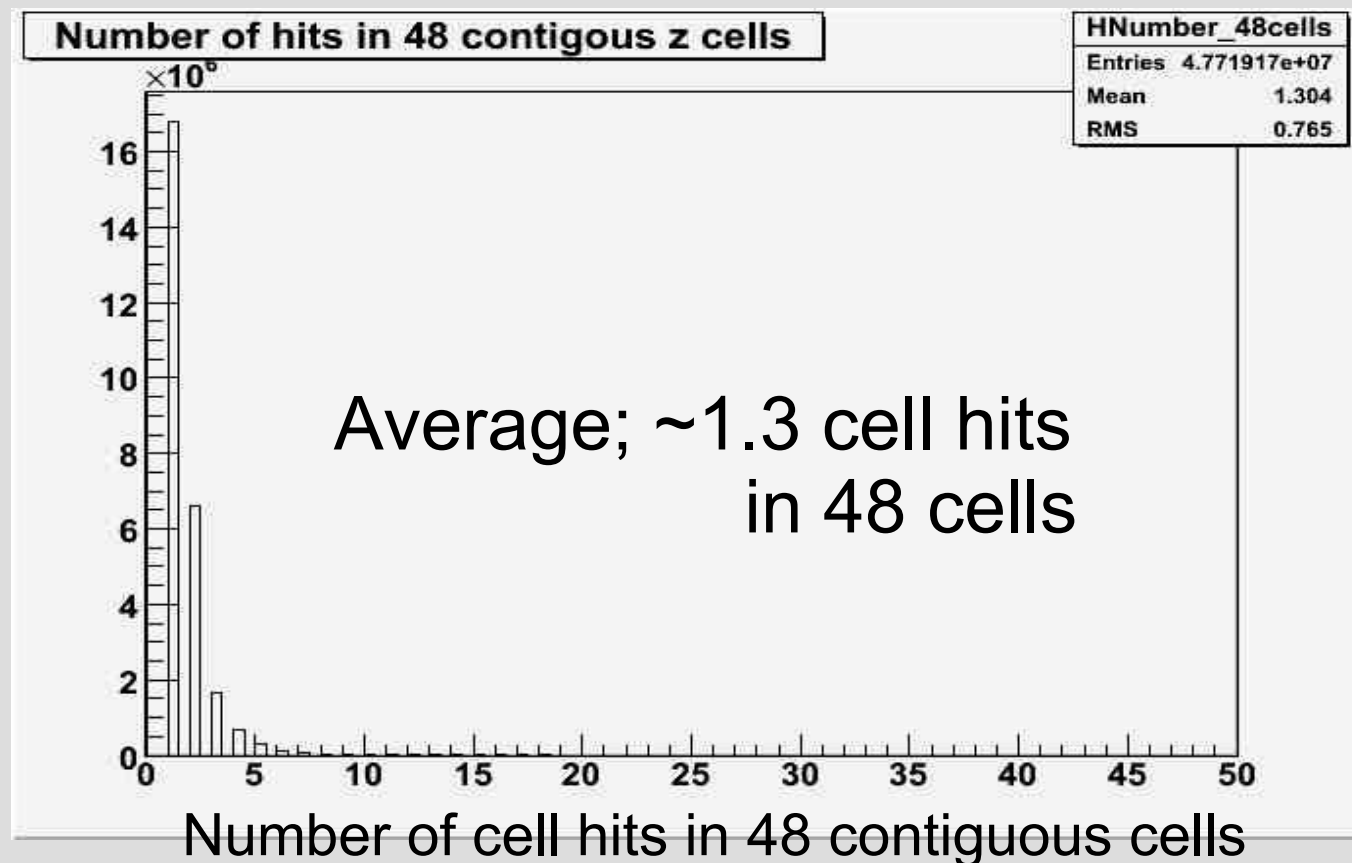
→ **One MIP per cell**

Cell hit number is proportional to incoming energy.

Readout by 48 contiguous cells (One option)

#cell hit in 48 contiguous cells

100GeV single e-



Total energy also increased 30% compared with single cell.

Summary of status

- MAPS geometry is implemented
- Each cell has only one MIP
- Charge sharing by neighbour two cells
- 50um X 50um cell seems to be optimized.

Future Prospects

- Clustering algorithm development
 - It can be developed only with topology. (i.e. Each cell hit's energy is identical.)
 - Saving CPU consumption in this Tela pixel algorithm is important.
- Resolution studies after clustering study