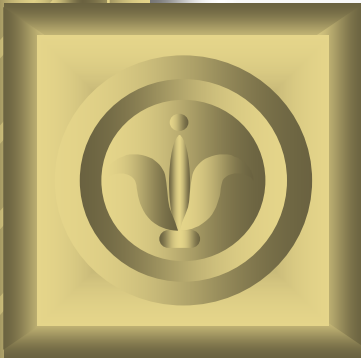


# LCDG4 at NIU

## Status and Plans



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**American Linear Collider Workshop  
Cornell University, Ithaca, NY  
July 13-16, 2003**

# Outline

- **Detector simulation status**
  - Request processing
  - SIO-server and catalog
- **LCDG4 development**
  - Geometry description thoughts
  - Non-projective calorimeter geometry
  - Preliminary results
  - Known problems
  - Plans

# LCDG4 history and status

- **Derived from LCDRoot**
- **All Gismo I/O formats supported (plus text output)**
- **Simple SD or LD variants are supported in full generality**
- **Non-projective capabilities extended**
- **Uniform response, no noise and no support structures**

# LCDG4 processing by request

- **Plenty of CPU for current level of requests (small farm at Fermilab)**
- **Request instructions available online**  
<http://nicadd.niu.edu/~jeremy/sim-guidelines.html>
- **Tell us what kind of standard events you need**
- **For non-standard events, please provide STDHEP file**

# LCDG4 Processing Statistics

## (by physics process)

# Events	Event type	Comments	Location in SIO-server
6 x 5K	Photons	2, 5, 10 GeV	Argonne
3 x 5K	Pions	0.25, 0.5, 1, 2, 5, 10 GeV	Argonne
3 x 5K	Neutrons	2, 5, 10 GeV	Argonne
5K	Z into qqbar	91 GeV	Argonne
(3 x 5K)	$\rho^+$ into $\pi^+ \gamma$	2, 5, 10 GeV	Argonne
(3 x 5K)	$\sigma^+$ into $n \pi^+$	2, 5, 10 GeV	Argonne
2K	e+e- into e+e-	91 GeV	Dhiman
2K	e+e- into $\mu^+\mu^-$	91 GeV	Dhiman
2K	e+e- into qqbar	91 GeV	Dhiman
2K	e+e- into bbbar	91 GeV	Dhiman
2K	e+e- into ZH into ( $\nu\nu\text{-bar}$ ) (bbbar)	350 GeV	Dhiman
5K	e+e- into ttbar	350 GeV	Dhiman
6 x 5 x 1K	Pions	Non-projective HCal, (2, 4, 6, 9, 12 cm <sup>2</sup> ) x x (2, 5, 10, 20, 30, 50 GeV)	Vishnu (ftp)

Total requested: 140K

Total processed: 110K



# File server and catalog

- **Processing results are available through the file server**
- **Catalog searchable online:**

<http://nicadd.niu.edu/sio/index.html>

- **Navigate on the directory structure:**

[ftp://131.156.85.170:/pub/sio\\_server/](ftp://131.156.85.170:/pub/sio_server/)

- **Naming scheme is being discussed**
- **Need appropriate User Interfaces to automate event generation and detector simulation processing**

# LCDG4 Development

- **Geometry description thoughts**
- **Non-projective HCal geometry**
  - **Implementation**
  - **Preliminary results**
  - **Known problems**
  - **plans**

# Geometry description thoughts

- **Currently: XML (LCDG4, Gismo) or MySQL (Mokka) can be used**
- **Both depend on drivers to translate geometry parameters into Geant4 calls**
- **Limited and hard to extend**
- **Other possibilities under study:**
  - **GDML is based on XML, and contains a one-to-one mapping to Geant4 solids**
  - **STEP files (☺ from CAD) for complex geometry. No Geant4 visualization ☹**

# NonP LCDG4 Implementation

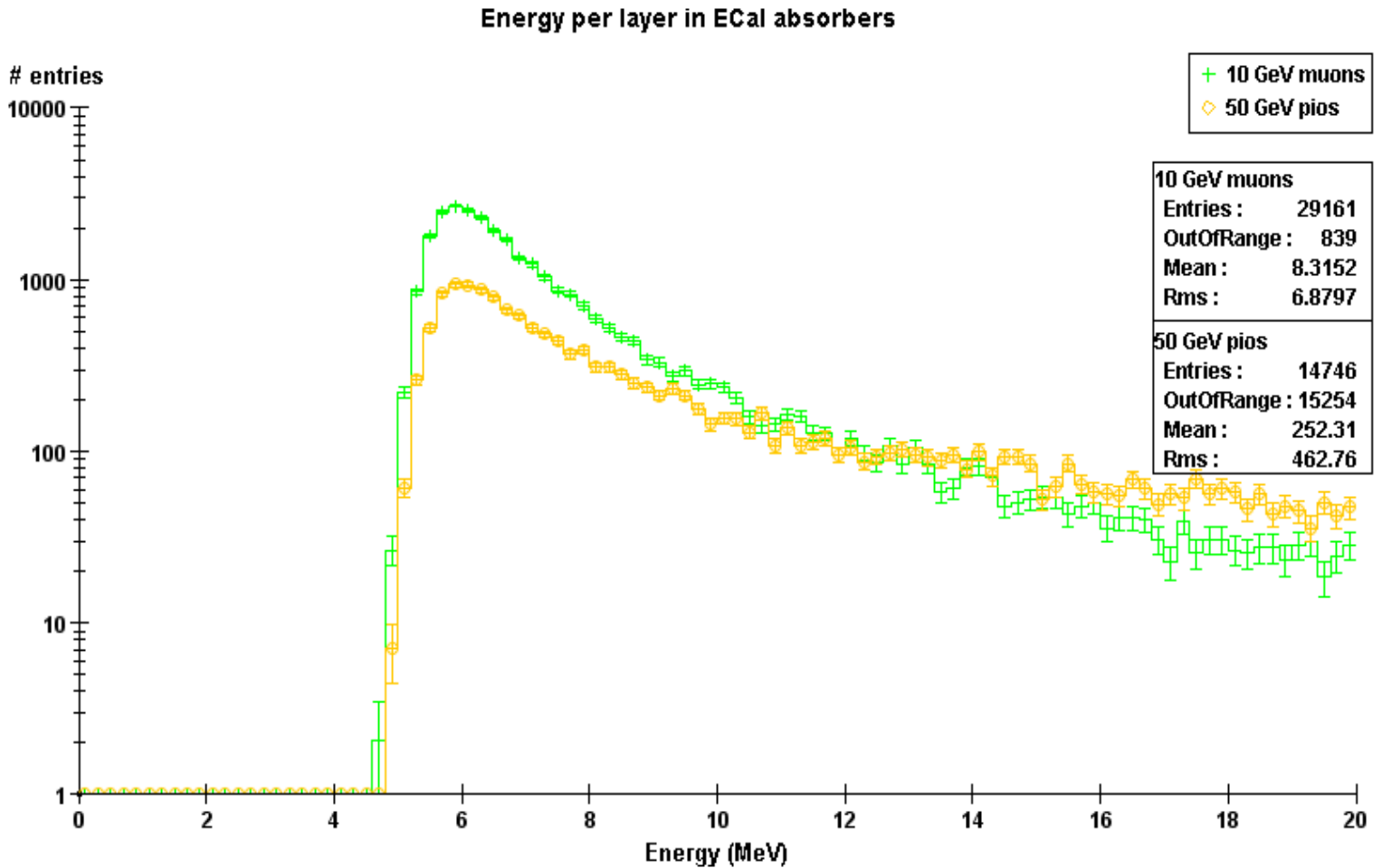
- **Based on (projective) LCDG4**
- **Fixed cell size (rectangles for now)**
- **User provides cell dimensions, and simulator adjusts slightly (few %) for integral # of cells along  $z$ ,  $\phi$**
- **Only text output for now, SIO-format expected soon**
- **Only HCal for now, but plans for NonP ECal too**
- **Hexagonal cells are also in the plans**

# Preliminary tests

- **Single particles with SDMar01 geometry:**
  - Muons, pions and electrons
  - Fixed directions in space
  - Different energies (2,5,10,20,30,50 GeV)
- **Absolute energy deposition**
  - Check with PDG-based expectations
- **Comparison with projective geometry**
  - Same energy deposition per layer
  - Number of hit cells reasonably scales with inverse of cell area (pions)

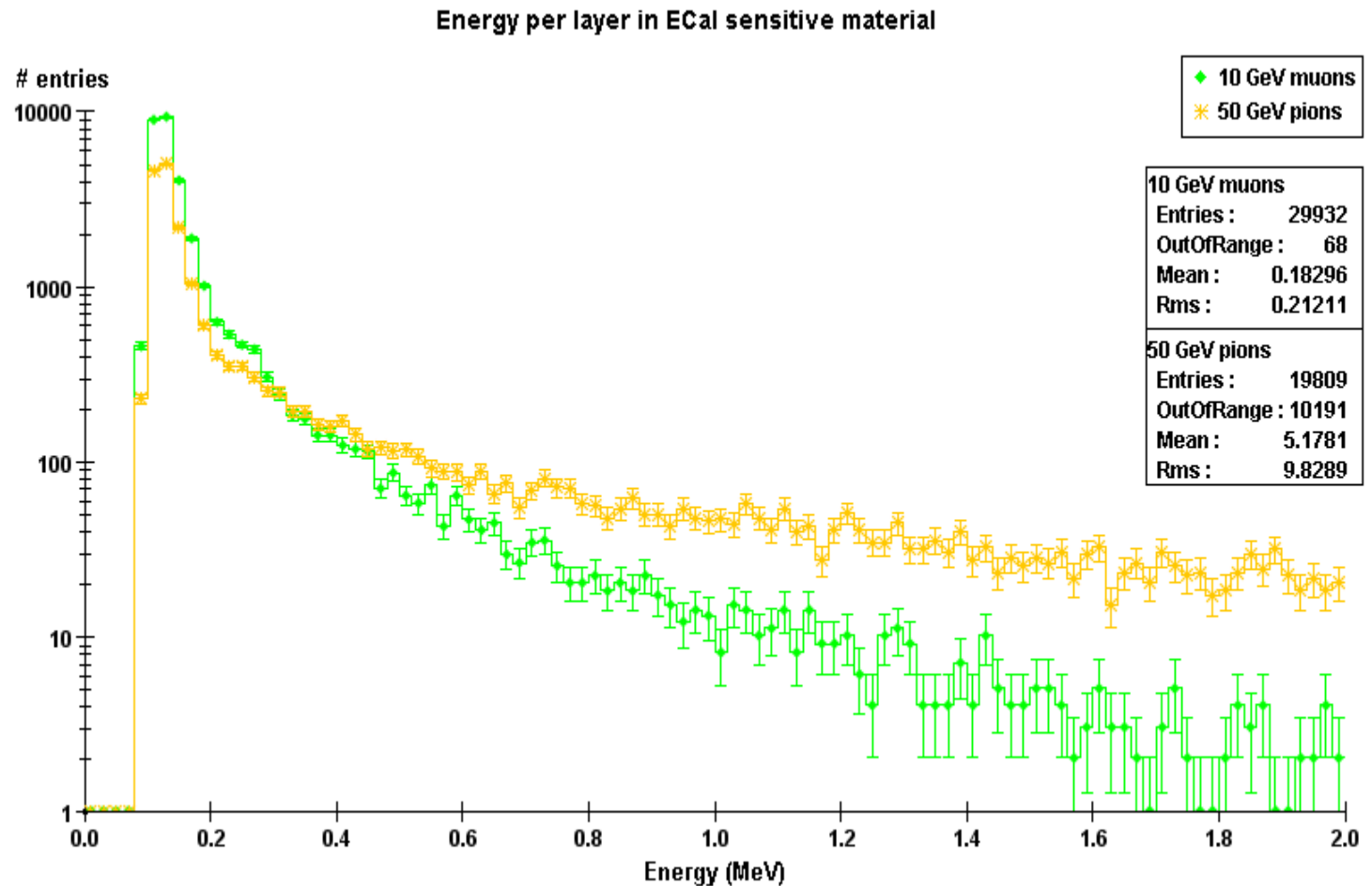
# Energy in ECal absorber

Estimate about 8.7 MeV for 10 GeV muons



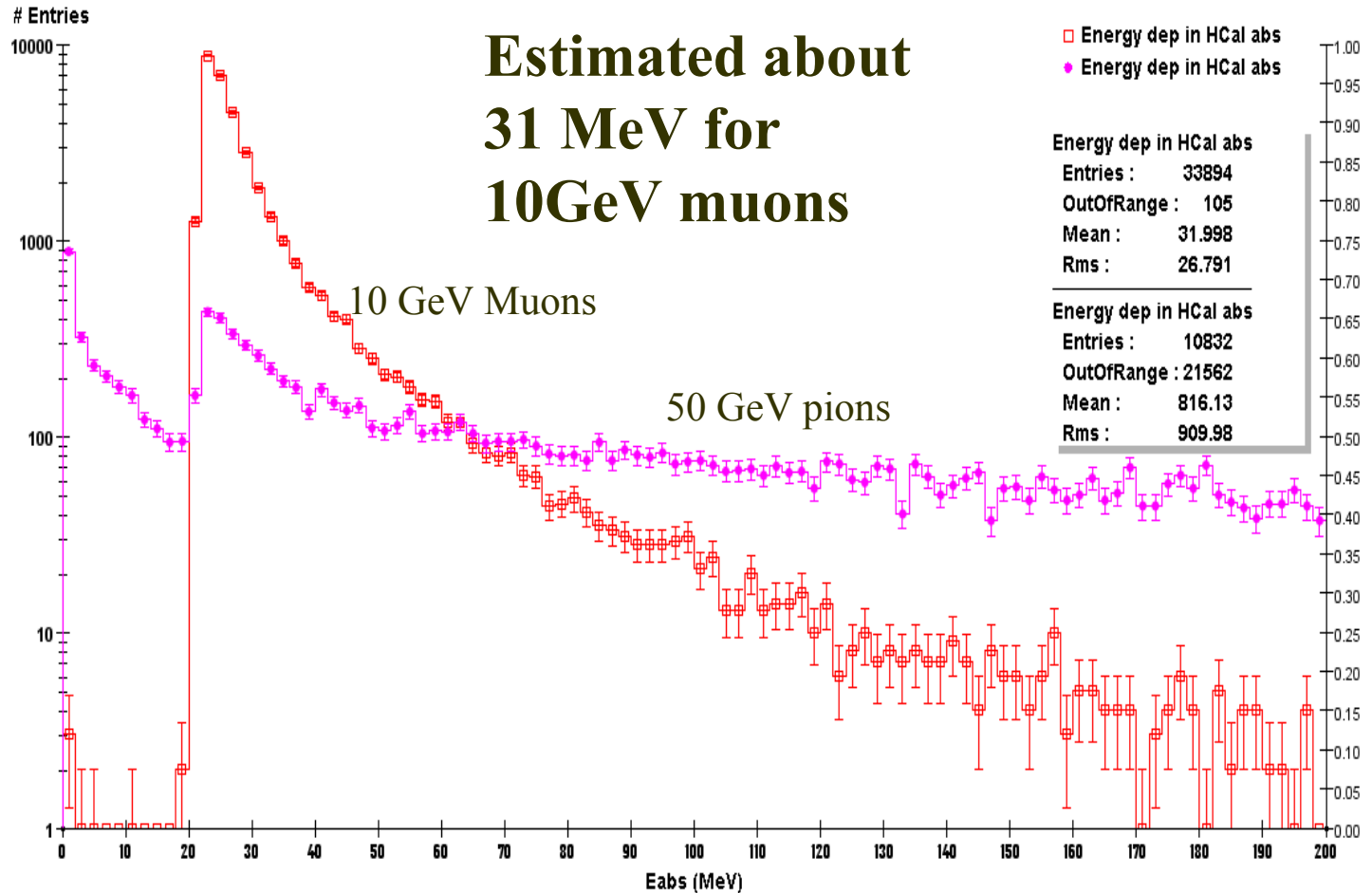
# Energy in Ecal sensors

Estimate about 0.2 MeV for 10 GeV muons



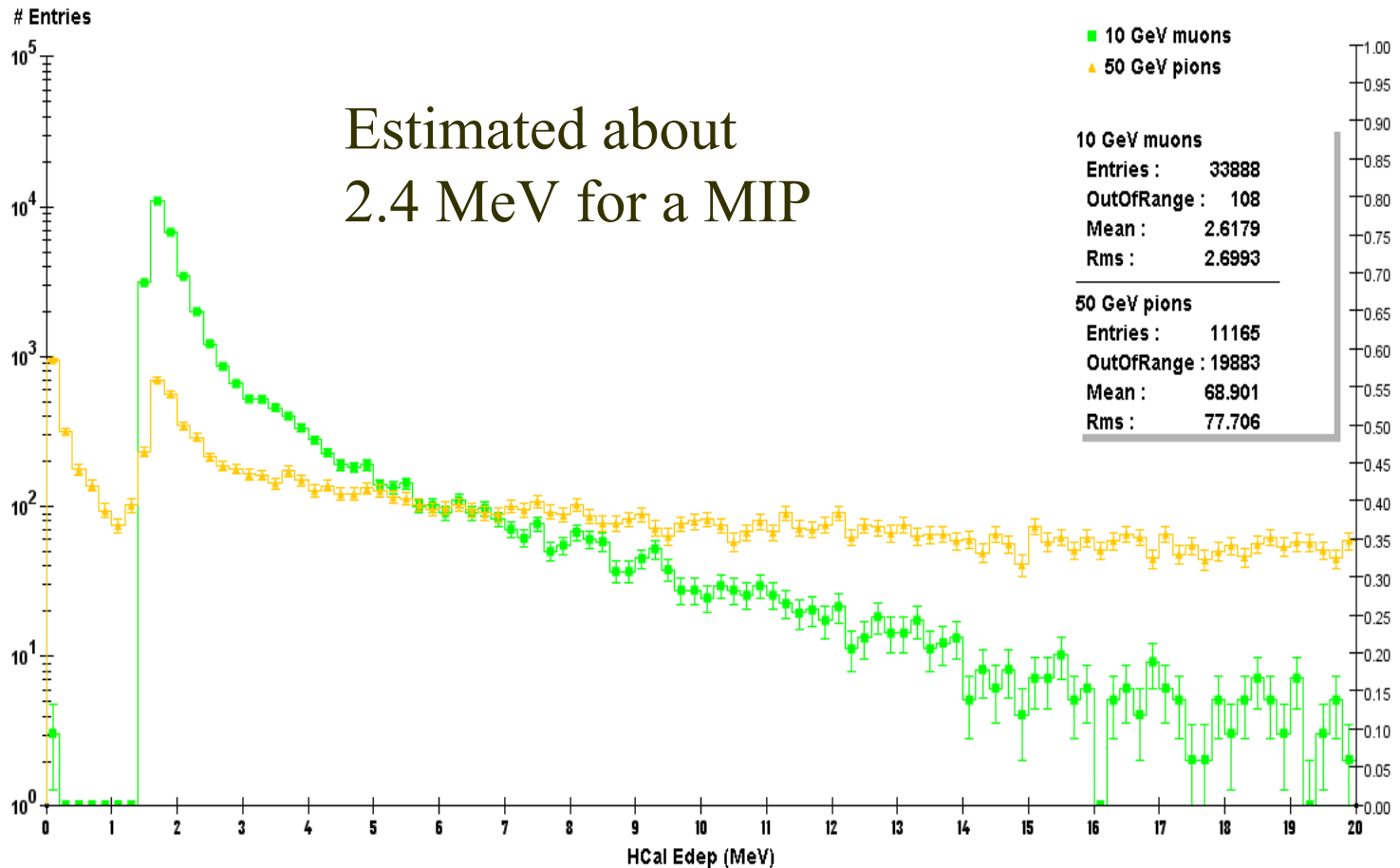
# Energy in HCal absorber

Energy deposited in HCal absorber layers



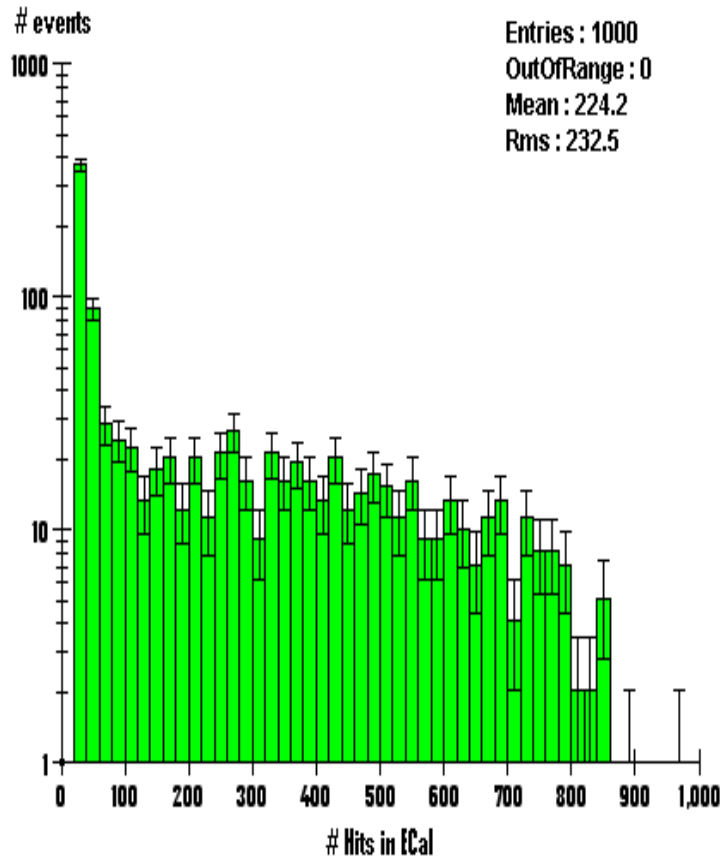
# Energy in HCal sensitive layers

Energy deposited in HCal absorber layers

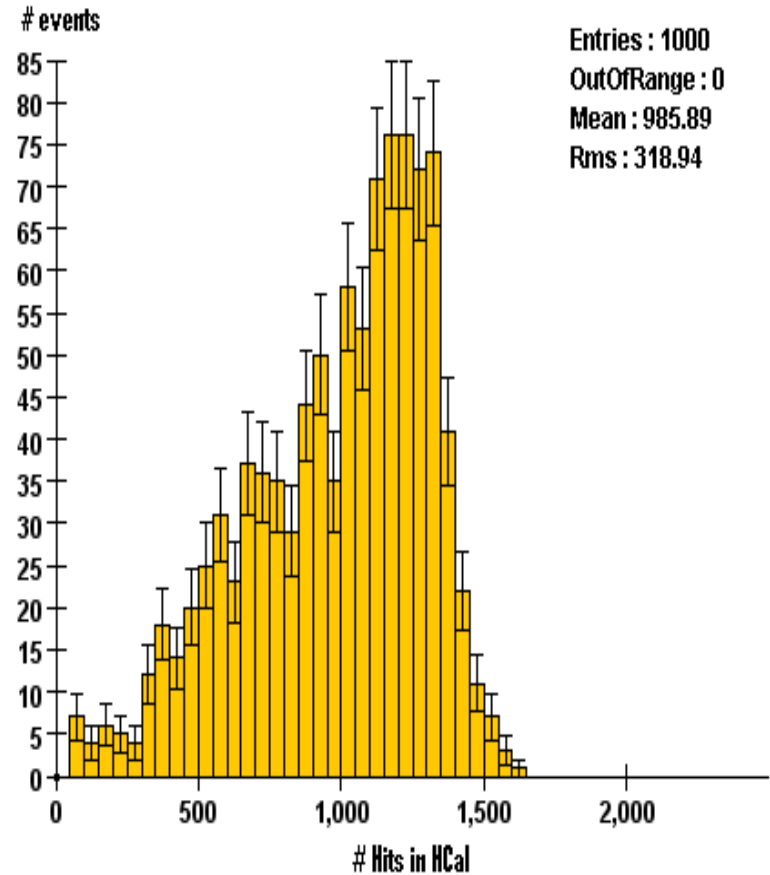


# Comparison to Proj LCDG4 and Gismo

Number of ECal hits - 50 GeV pions

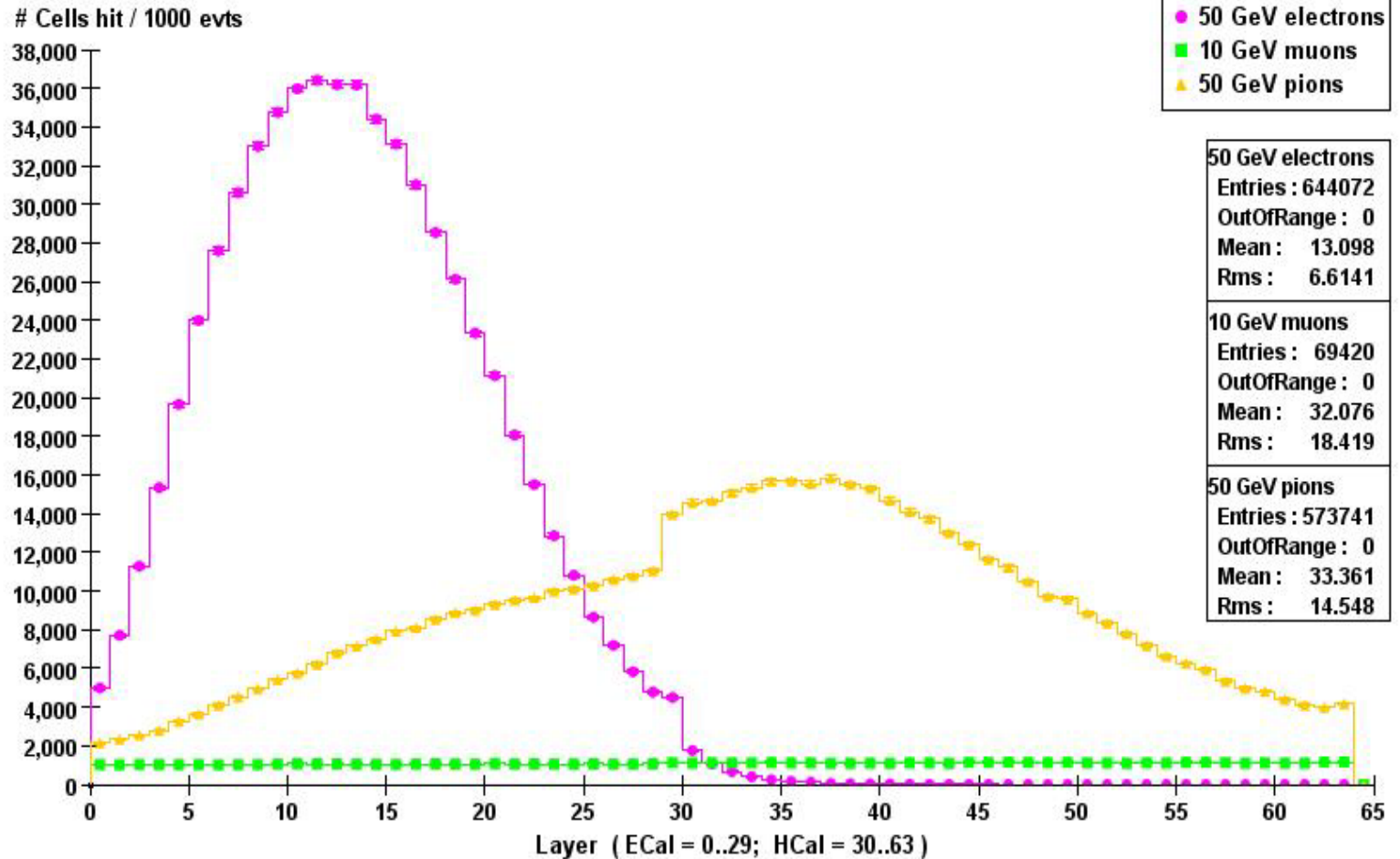


Number of HCal hits - 50 GeV pions



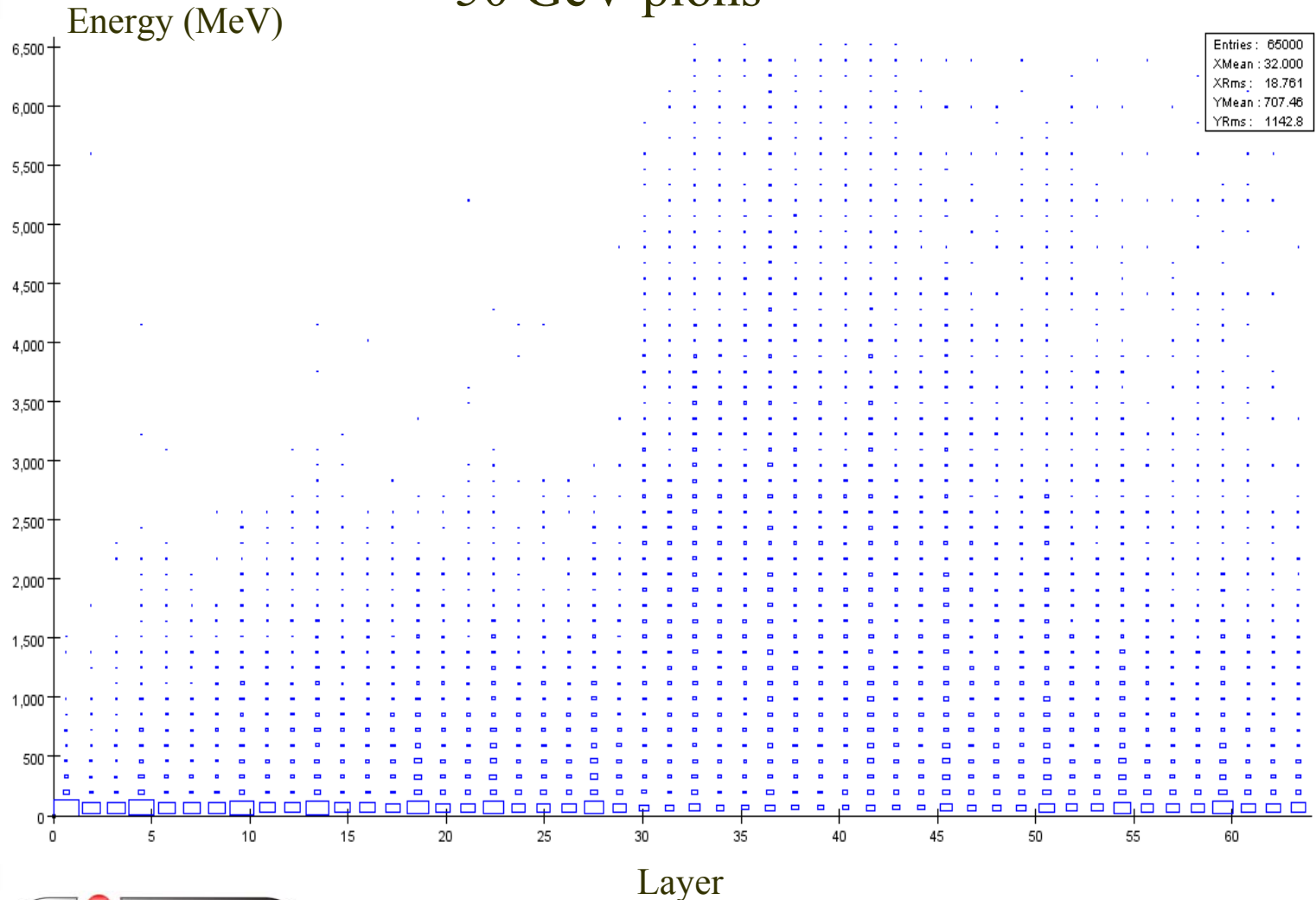
# Hit distributions per layer

Number of cells above threshold per layer - ECal: 80 keV; HCal: 700 keV



# Total energy per layer (comparison to LCDG4proj and GISMO)

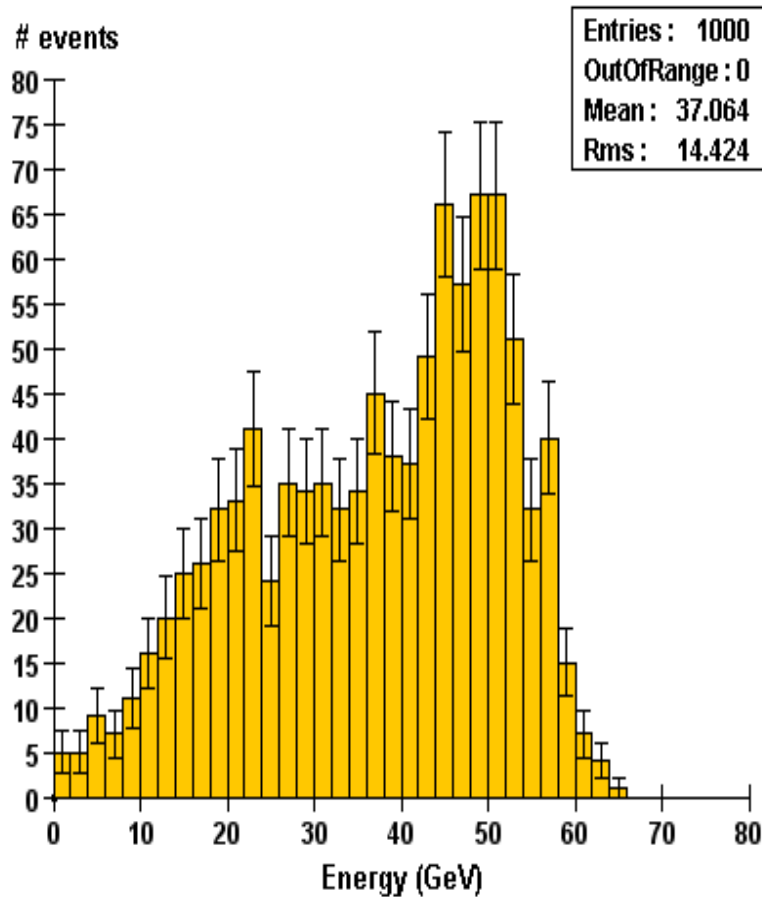
50 GeV pions



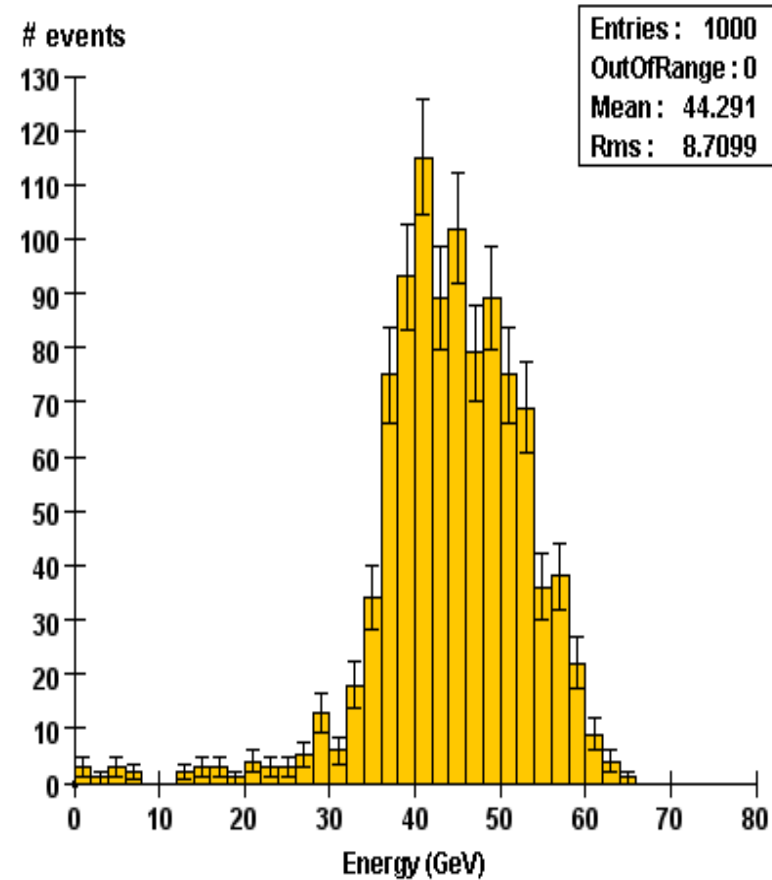
# Total energy

(based on GISMO sampling fractions)

Total energy in HCal - 50 GeV pions

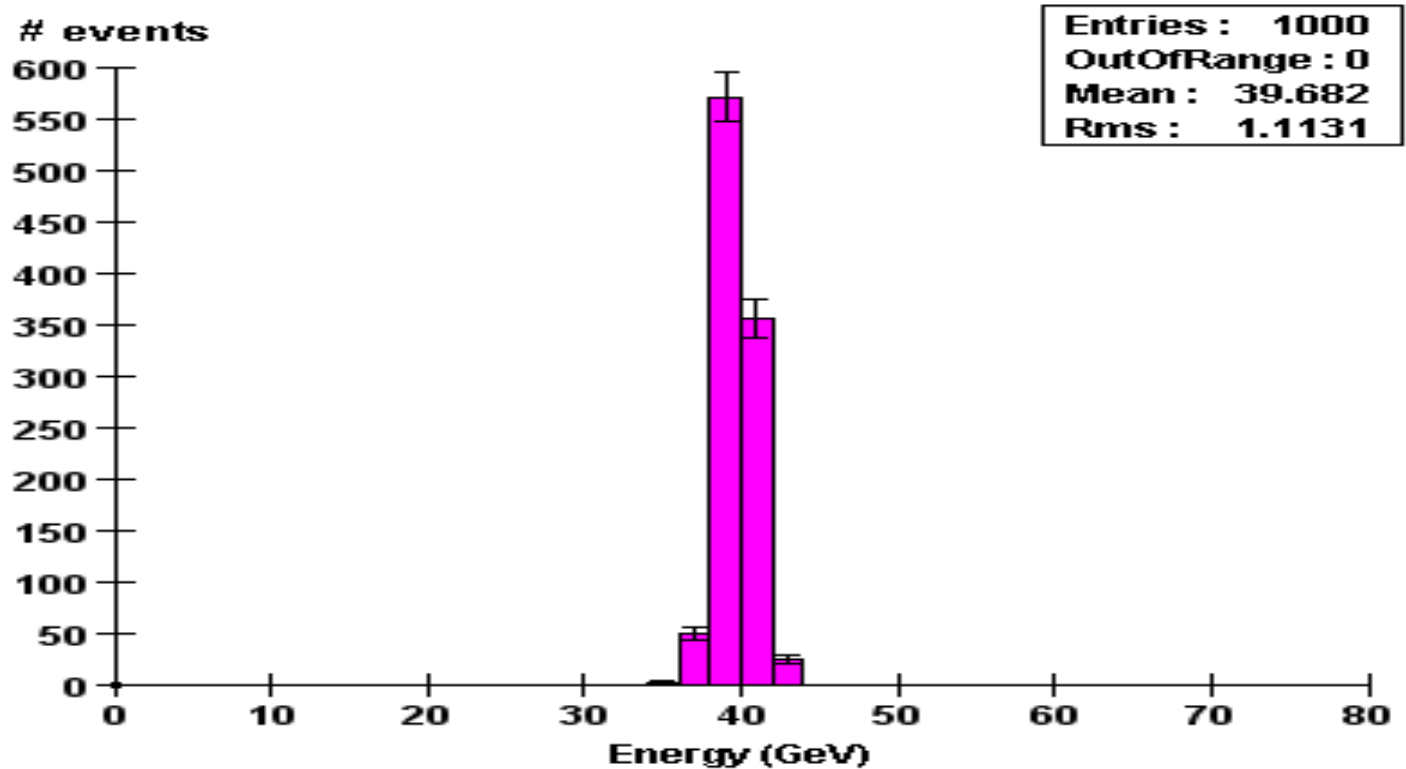


Total energy (ECal+HCal) - 50 GeV pions



# Checking EM sampling fraction

Total energy (ECal+HCal) - 50 GeV electrons



Based on GISMO sampling fractions  
(a reevaluation is needed!)

# Known problems in LCDG4

- **Around 20% disagreement with Gismo in absolute values of live energies in ECal**
- **ECal hit positions (x,y,z) were not being reported at the cell center**
- **Double counting was causing wrong live energies in ECal**
- **Last two bugs have been fixed, but some recent samples need to be reprocessed.**

# Short-term goals

- **Compare LCDG4 and Ties' LCD-Mokka for identical detector geometries – cross check (in order to certify mutual results)**
- **SIO output for NonP LCDG4 (along with JAS3 plug-in)**
- **General LCDG4 code cleanup**
- **Improve utilization of built-in features of Geant4 toolkit**
- **Evaluate available options for geometry description (XML, MySQL, STEP-based CAD, GDML)**

# Mid-term Plans

- **Phase-out Gismo once Geant4-based LCD results are certified**
- **Coherent design document for a Geant4 simulation package before coding effort**
- **Deep LCDG4 class restructuring and/of fusion with Mokka in SD and geometry**
- **Parametrized simulation?**  
It depends on volume of requests and parametrizability of algorithms

# Conclusions

- **Non-projective geometry implemented in LCDG4**
- **Preliminary NonP results encouraging – to be extended and incorporated soon**
- **JAS3 analysis classes for text-format input available for general use (JAS tutorials?)**
- **All known LCDG4 bugs have been fixed**
- **Gismo / Geant4 discrepancies for energy depositions need to be understood**
- **Geant4-based simulations to be certified soon – you can help as a tester**