Calorimeter Study with Jupiter

ACFA-SIM-J/CAL GROUP

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Introduction

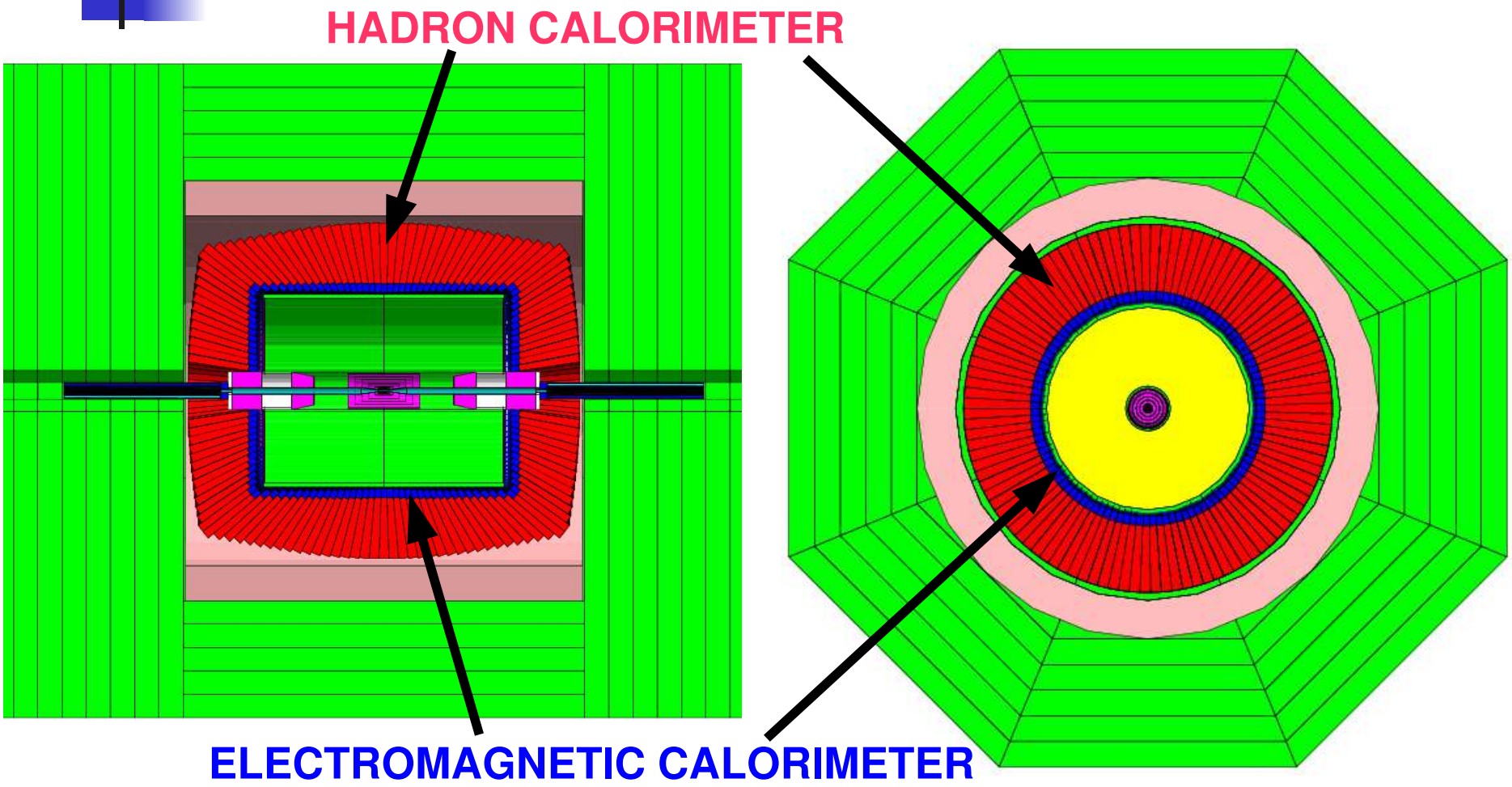
- We have started full simulation study of LC calorimeter with Geant4-based JUPITER (JLC Unified Particle Interaction and Tracking EmulatoR)
- We are now doing very preliminary performance studies as well as debugging/improving code.

Calorimeter configuration

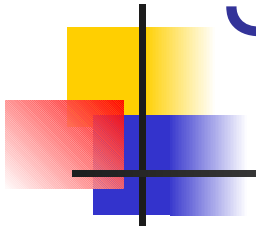
- EMCAL: 38 layers (4mm Pb: 1mm Scint), approx. $27X_0$
- HCAL: 130 layers (8mm Pb: 2mm Scint), approx. $6\lambda_0$
- Transverse granularity: 4cmx4cm
- Can easily switch between GLC-3T and GLD configurations

Calorimeter View

We implemented a pointing tower geometry (ideal case).



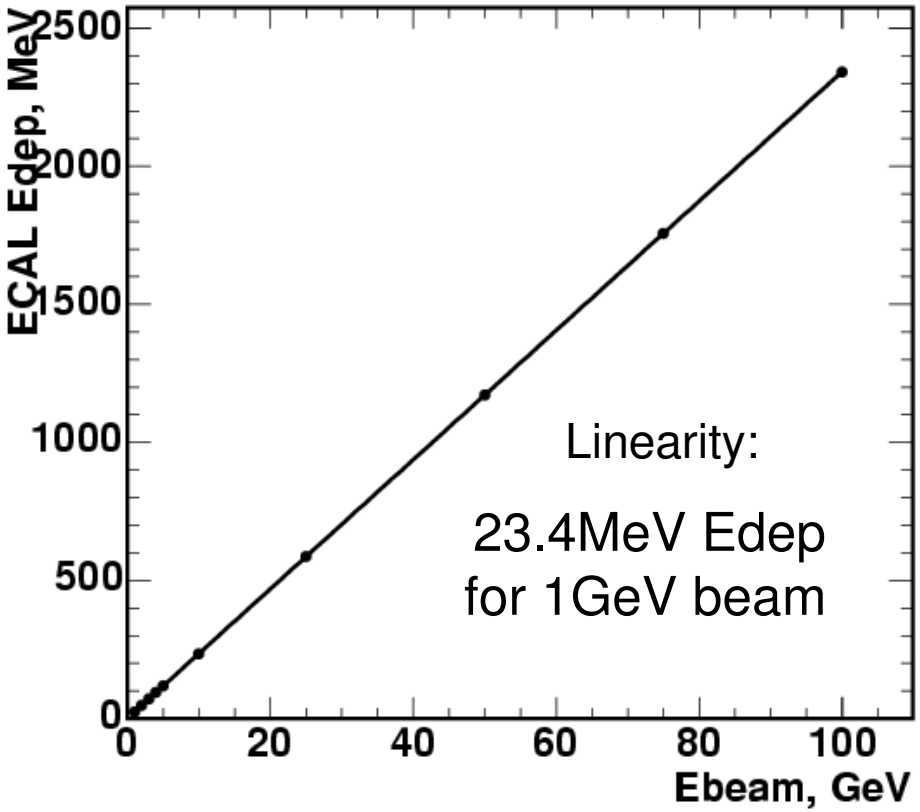
Study with single beams

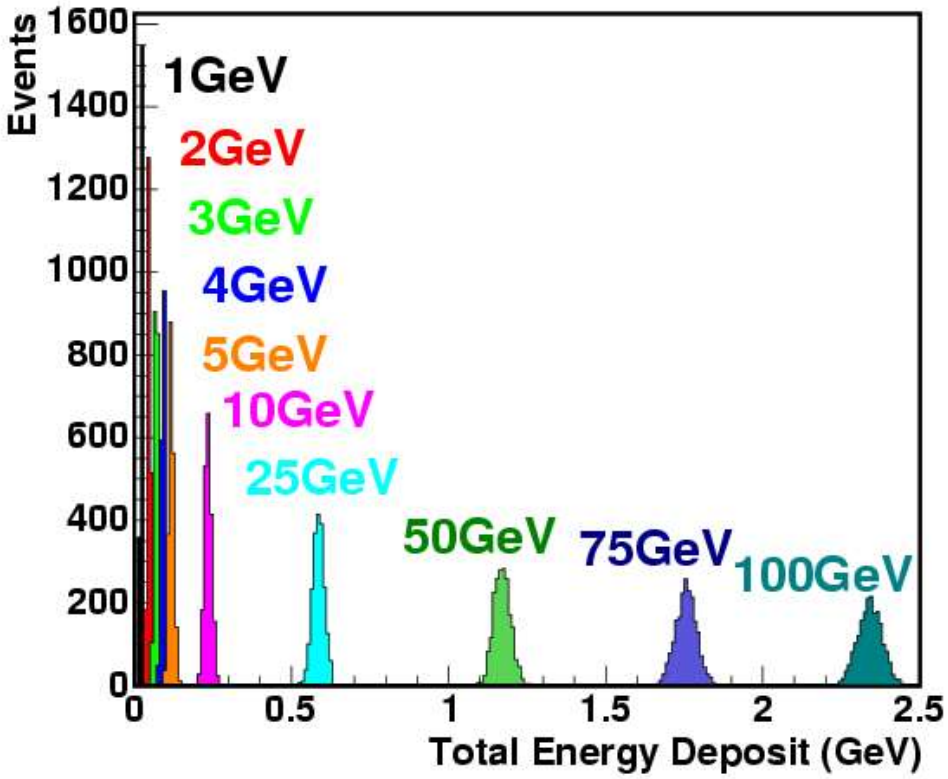


- Use JSFJ4 (Jupiter+JSF+Satellites)
- Geant4 range cut: 1micron
- Beam in +x-axis direction
- Beam energy: 1~100GeV
- Particles: e-, pi-
- Number of events: 2000 for each energy
- Only the CAL is switched on

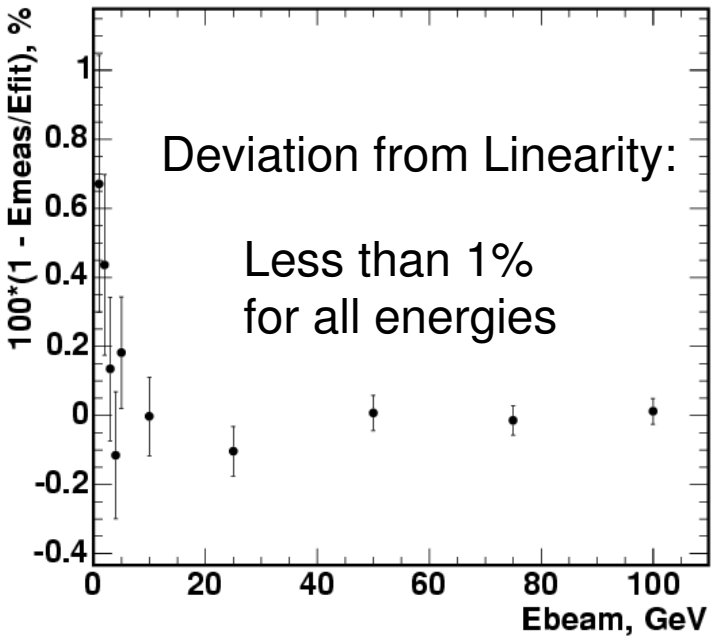
CAL Response to Electrons (GLC-3T configuration)

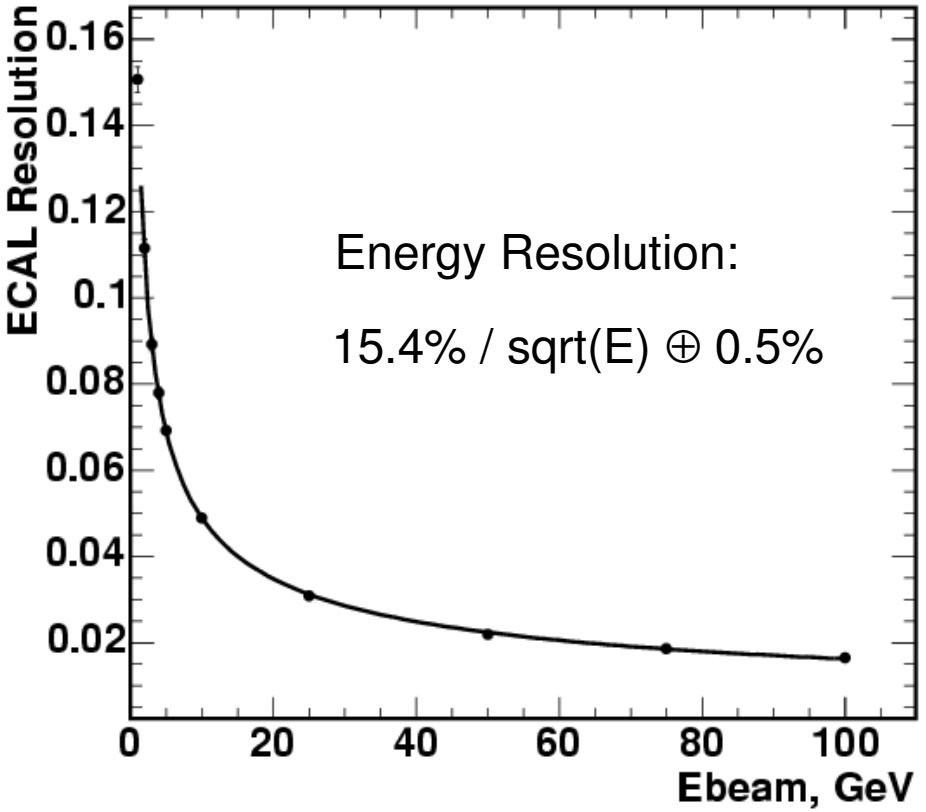
Total Energy Deposit
to EM Calorimeter
for 1~100GeV electrons





CAL Response to Electrons (GLC-3T configuration)

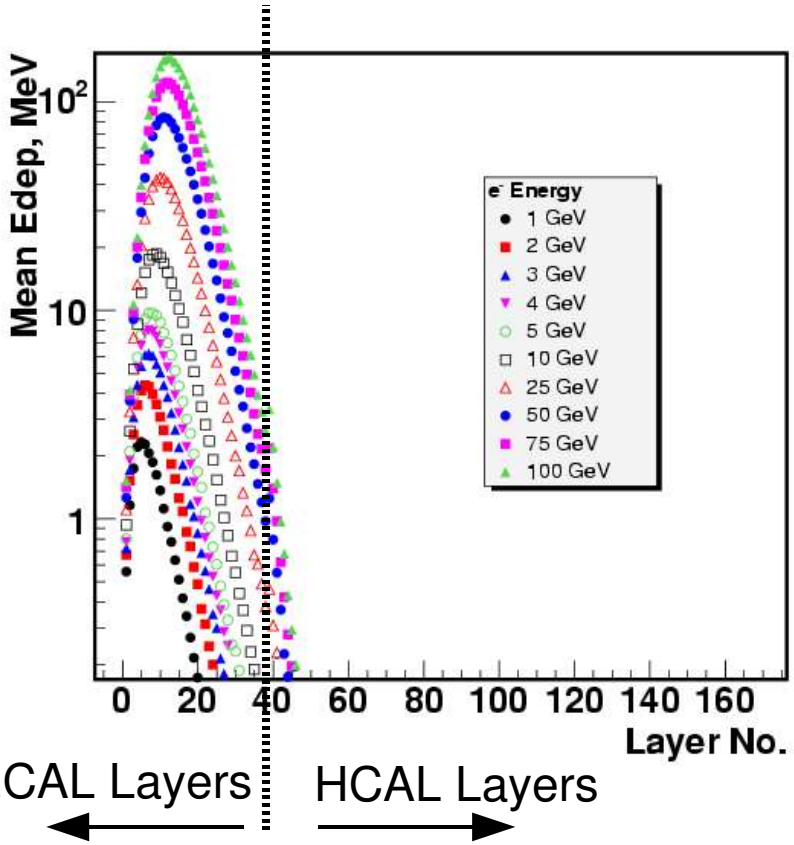




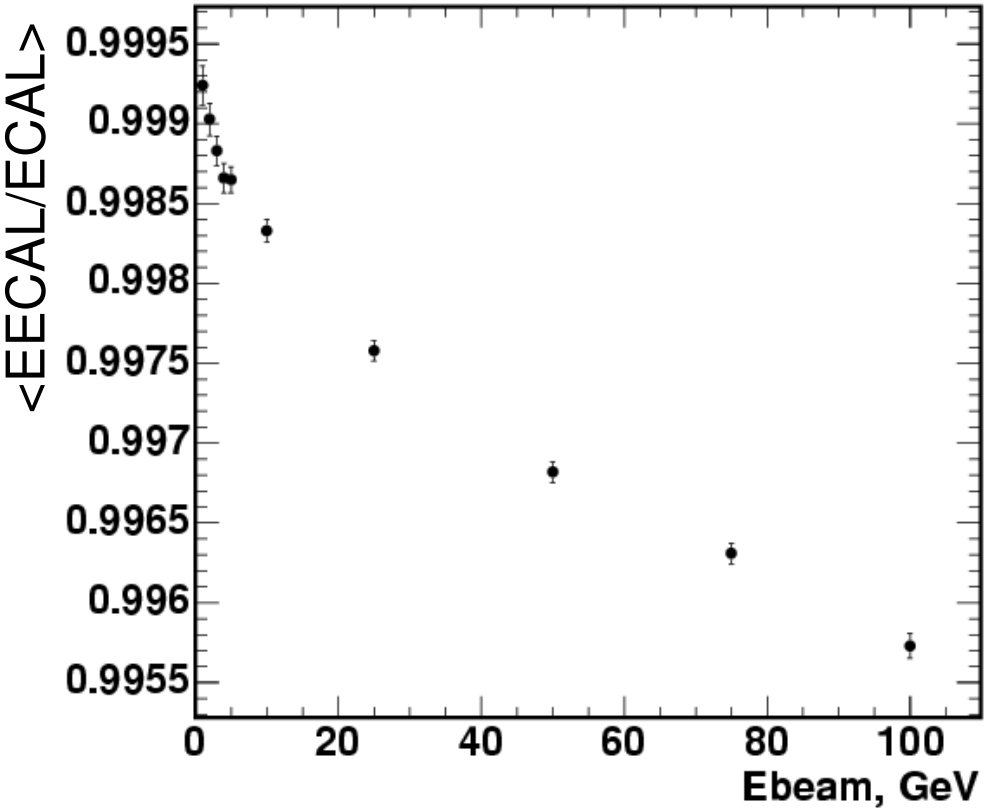
This achieves the required EM energy resolution of 15% / sqrt(E) ⊕ 1%
Note: Geant4 range cut = 1micron

Electron Shower Containment in EMCAL

Shower Profile

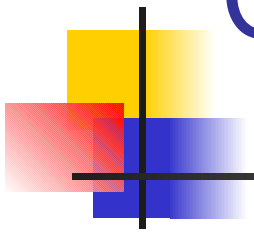


Energy Deposit Fraction in EMCAL



EM shower due to electron is well contained in EMCAL for 99% of events.

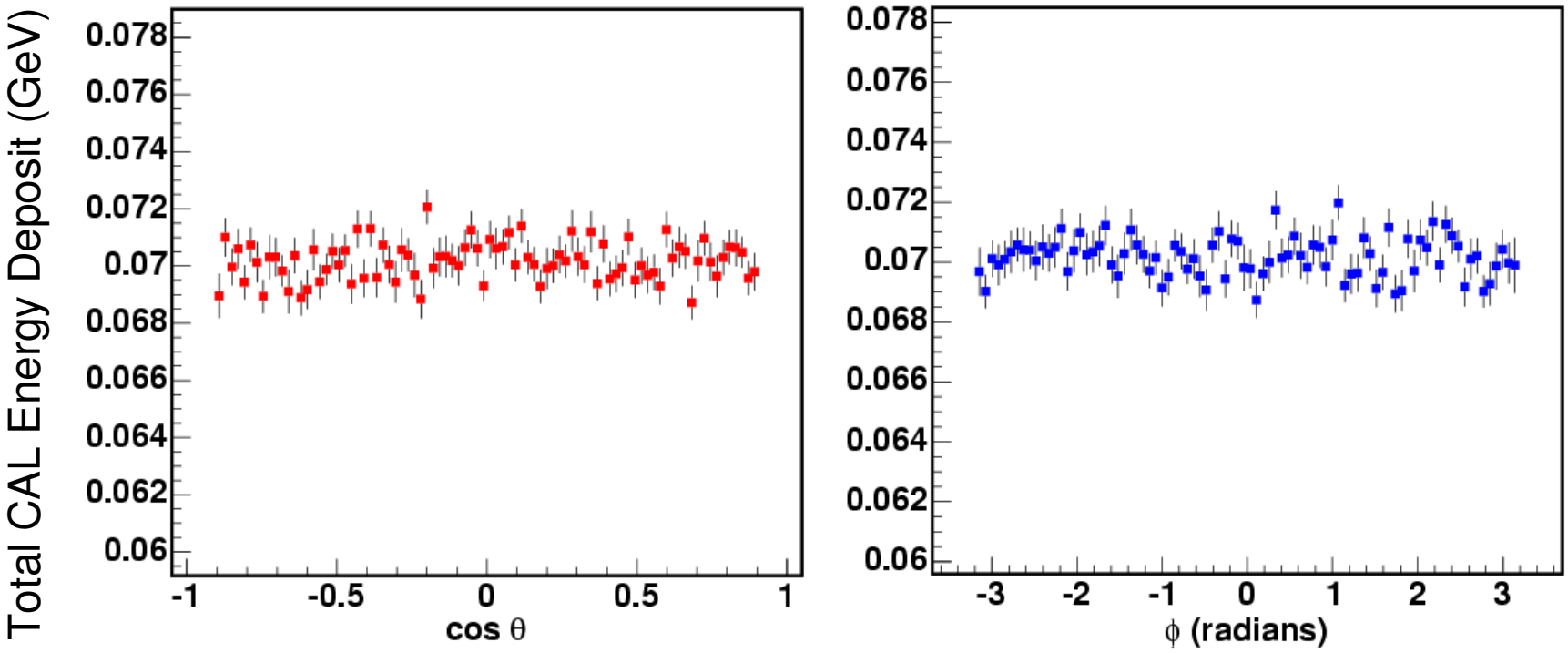
Check for Angular Effects



- We checked if energy deposit has angular dependence $\Rightarrow$ should be none!
- 10K events of 3GeV electrons using J4ParticleBeam, random direction
- |Cos(theta)|<0.9, GLD-V1 configuration

Check for Angular Effects

3GeV electron beam, 10K events

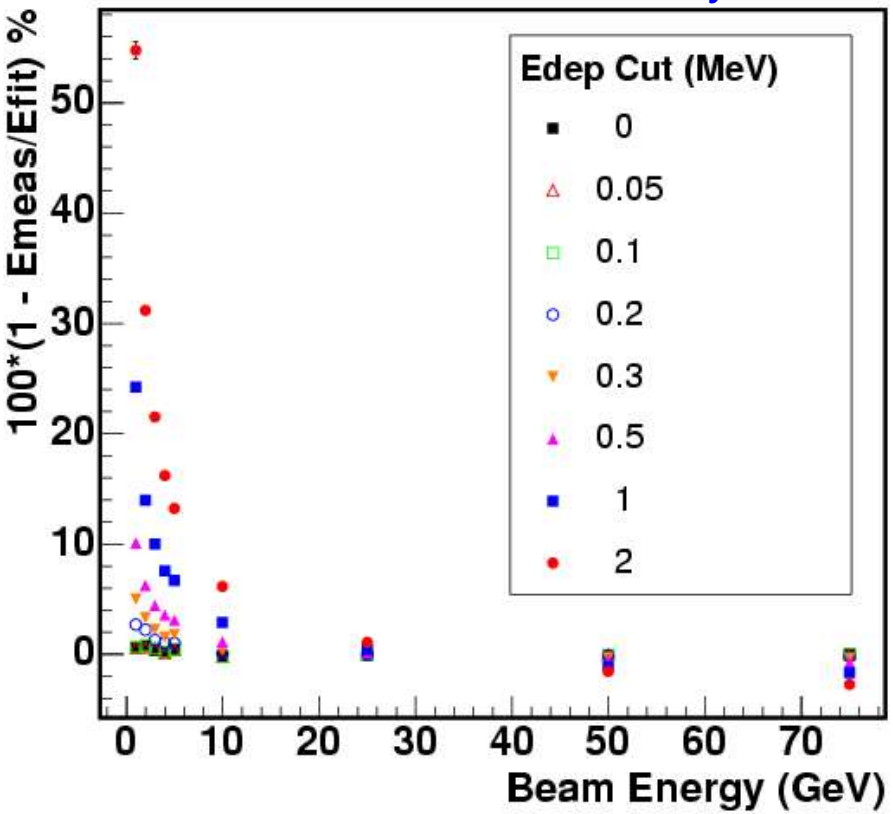


No angular dependence is observed.

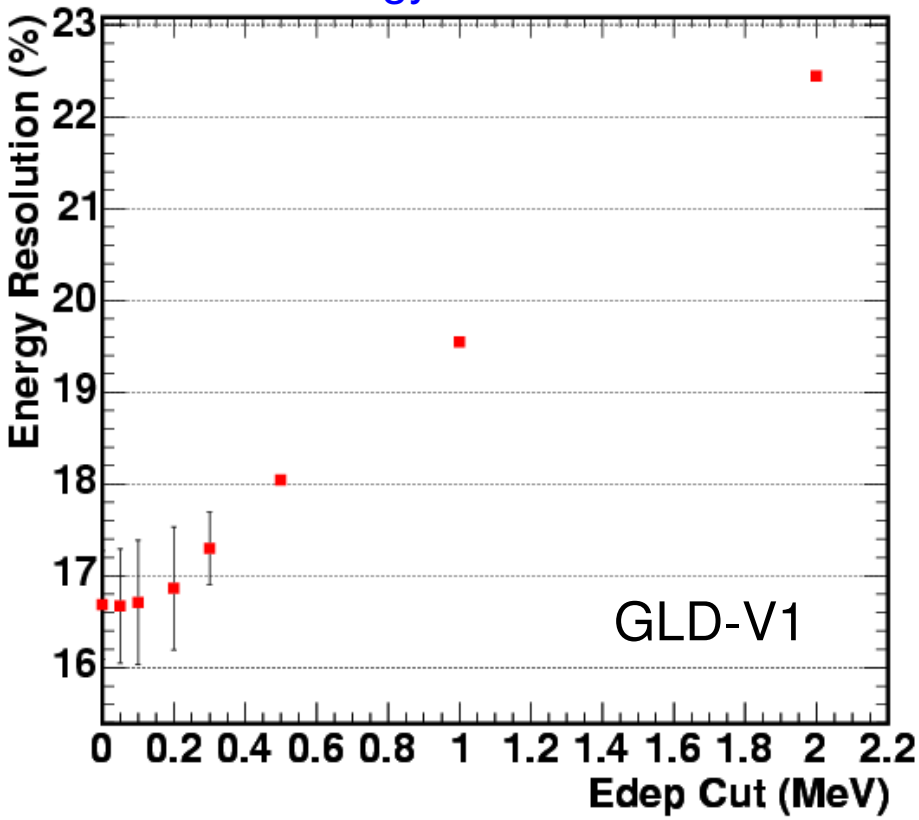
Cut on Energy Deposit

- Rejection of hit cells having low energy deposit to determine effect of noise cut

Deviation from Linearity



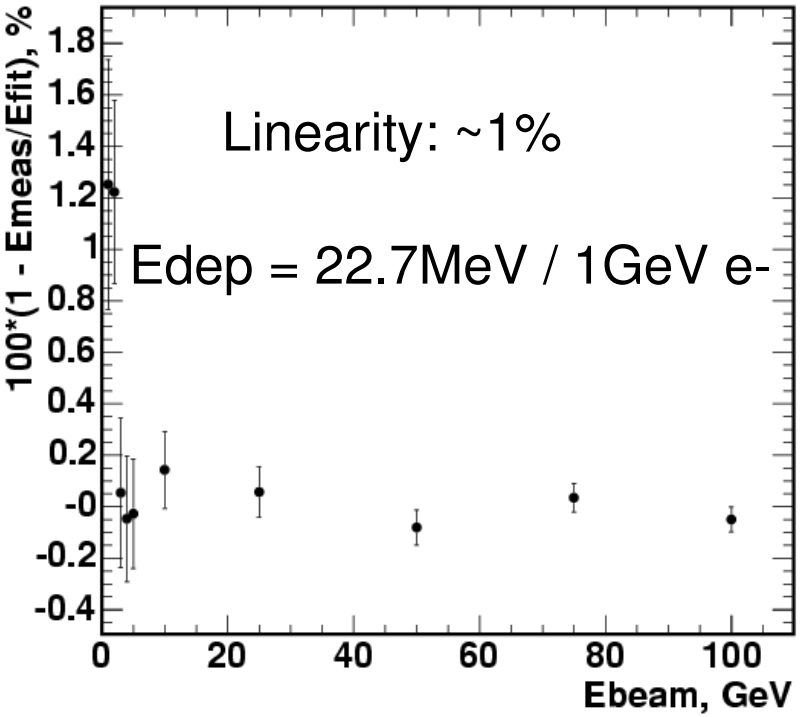
Energy resolution

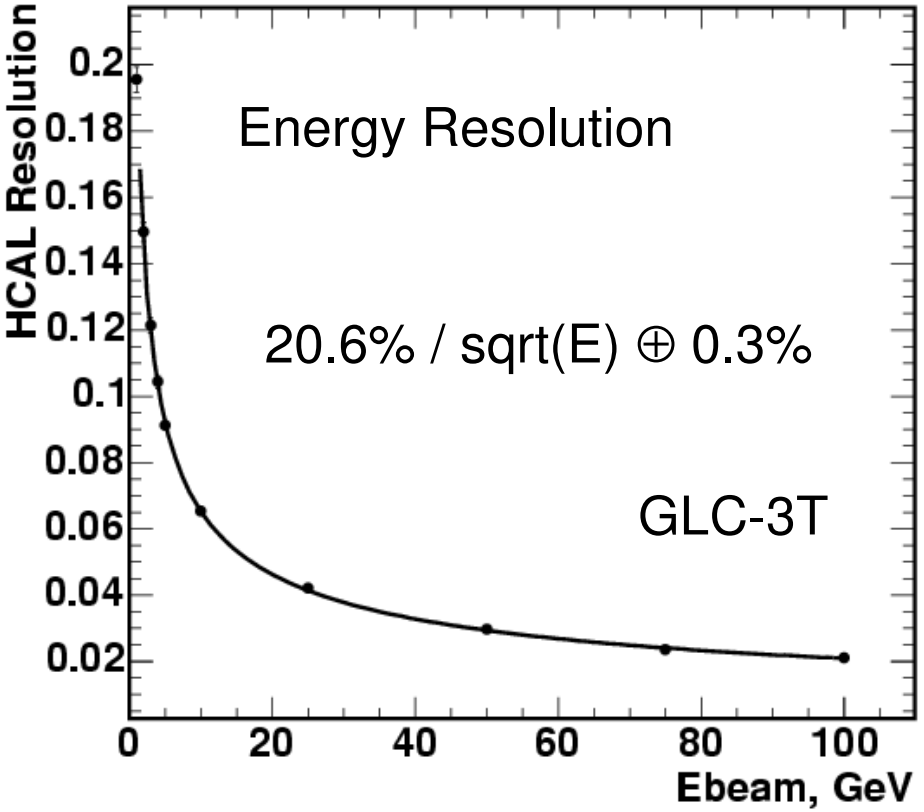


The linearity suffers for lower, particularly for low energy electron beams with higher noise cut.

HCAL Response to Electrons

EMCAL “removed” by setting the materials to air.

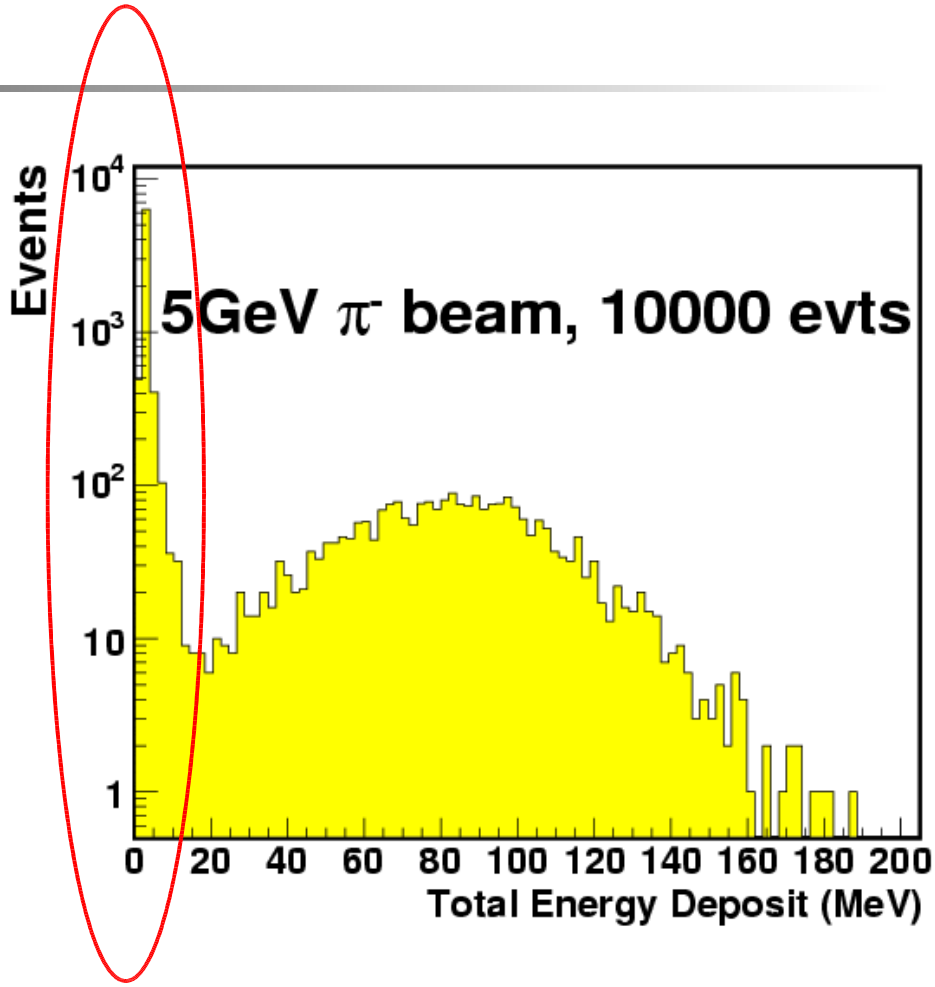




The HCAL response to electrons is worse than EMCAL.

CAL Response to Pions

40%~70% (increases with beam energy) of pions show MIP-like behavior.
This is not reasonable.
The cause is still to be determined.



Future Plan

- Ultimate goal:
  - Study Higgs Physics with JUPITER, particularly the effect of CAL configuration
- To Do/Currently Doing:
  - Still some checks are needed before serious physics studies can be done
    - Investigate cause of pion behavior, etc.
  - Make JUPITER faster!
  - Test particle flow algorithms