Calorimeter Study with Jupiter

ACFA-SIM-J/CAL GROUP
A. L. C. Sanchez, H. Ono, A. Miyamoto, K. Fujii
H. Miyata, N. Nakajima, K. Kawagoe, S. Kishimoto
T. Takeshita, S. Yamamoto, Y. Yamaguchi, A. Yamaguchi

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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. 27X0
- **HCAL**: 130 layers (8mm Pb: 2mm Scint), approx. 6λ0
- Transverse granularity: 4cm x 4cm
- Can easily switch between GLC-3T and GLD configurations
Calorimeter View

We implemented a pointing tower geometry (ideal case).

HADRON CALORIMETER

ELECTROMAGNETIC CALORIMETER
Study with single beams

- Use JSFJ4 (Jupiter+JSF+Satellites)
- Geant4 range cut: 1 micron
- Beam in +x-axis direction
- Beam energy: 1~100 GeV
- 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

- 23.4MeV Edep for 1GeV beam

Linearity:

Graph showing the correlation between Ebeam (GeV) and ECAL Edep (MeV) with a linear trend.

Histogram showing events for different energy deposits (1GeV, 2GeV, 3GeV, 4GeV, 5GeV, 10GeV, 25GeV, 50GeV, 75GeV, 100GeV) with corresponding energy deposits in the x-axis and events in the y-axis.
CAL Response to Electrons (GLC-3T configuration)

Deviation from Linearity:
Less than 1% for all energies

Energy Resolution:
15.4% / sqrt(E) ± 0.5%

This achieves the required EM energy resolution of 15% / sqrt(E) ± 1%
Note: Geant4 range cut = 1micron
Electron Shower Containment in EMCAL

Energy Deposit Fraction in EMCAL

Shower Profile

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

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