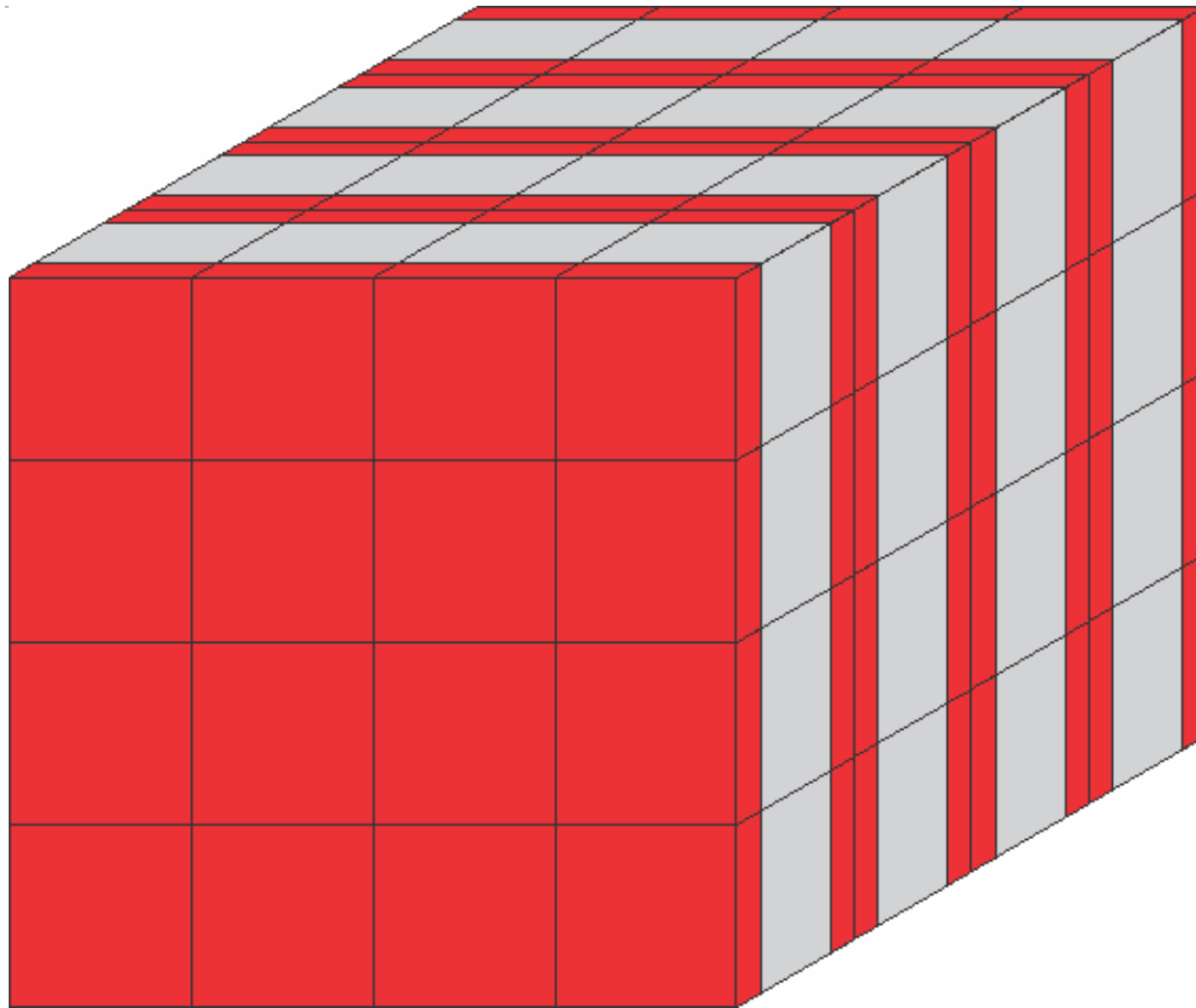


Temporal Development of EM and Had showers in DRCal

Edgar Nandayapa

07/15/2011

DRCal General Shape



Original is 30x30x30 ~ 1500x1500x1518 mm

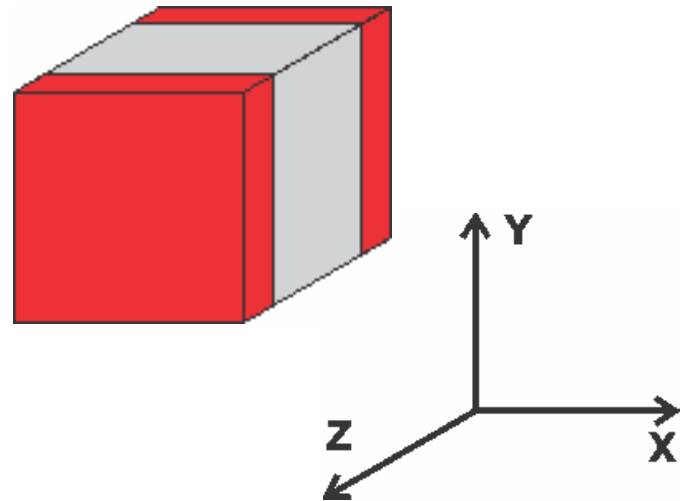
DRCal Details

- Materials:
BGO and Plastic Scintillator

- BGO is totally sampling

- Software: Geant4.9.4.p01

- Physics List: QGSP_BERT



Detector Specs

- **BGO**

- Density: 7.130 g/cm³

- RadL: 1.118 cm

- Th 22.694 cm

- lmean: 534.1 eV

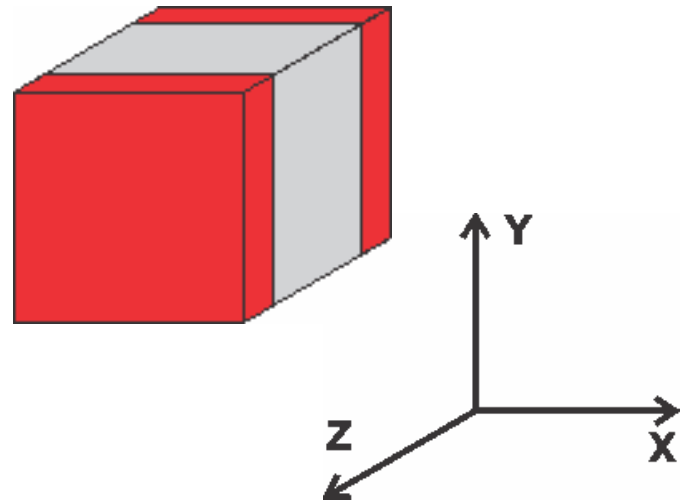
- **Silicon**

- Density: 2.330 g/cm³

- RadL: 9.366 cm

- TH: 45.753 cm

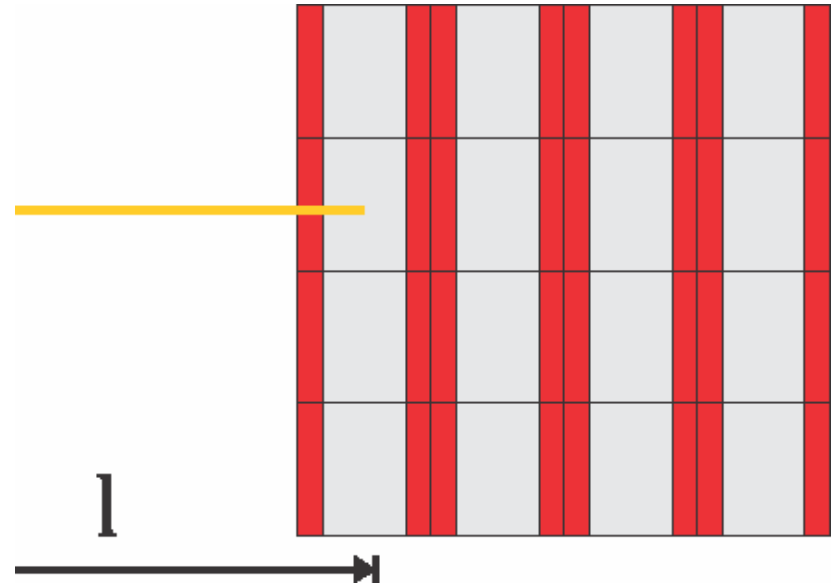
- lmean: 173.00 eV



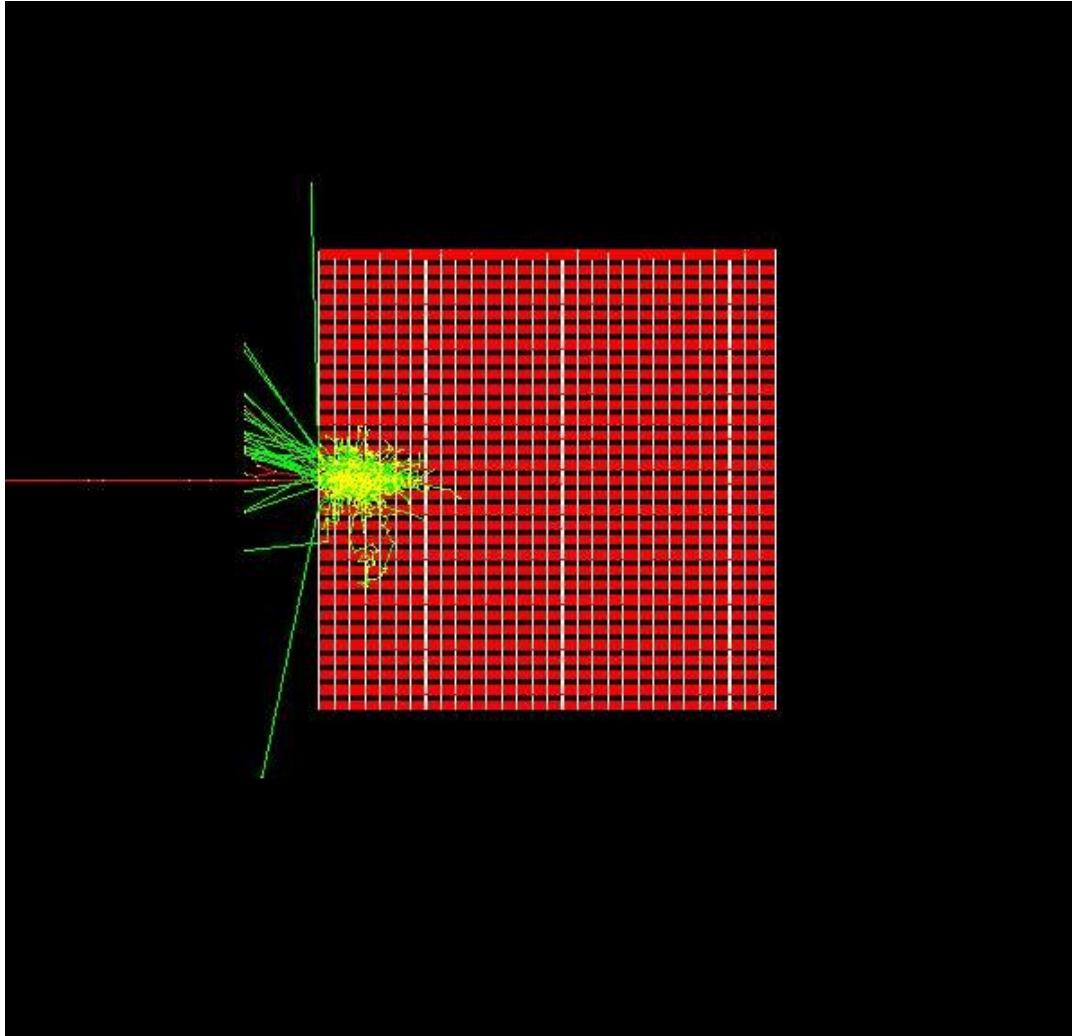
-
- Global Time
 - Edep is Energy Deposition from G4SteppingAction
 - EEM is electromagnetic energy deposition (e⁻, e⁺, γ)
 - Ehad is hadronic energy deposition (everything else)
 - Eceren is number of energetic cerenkov photons obtain from G4StackingAction

Time Correction

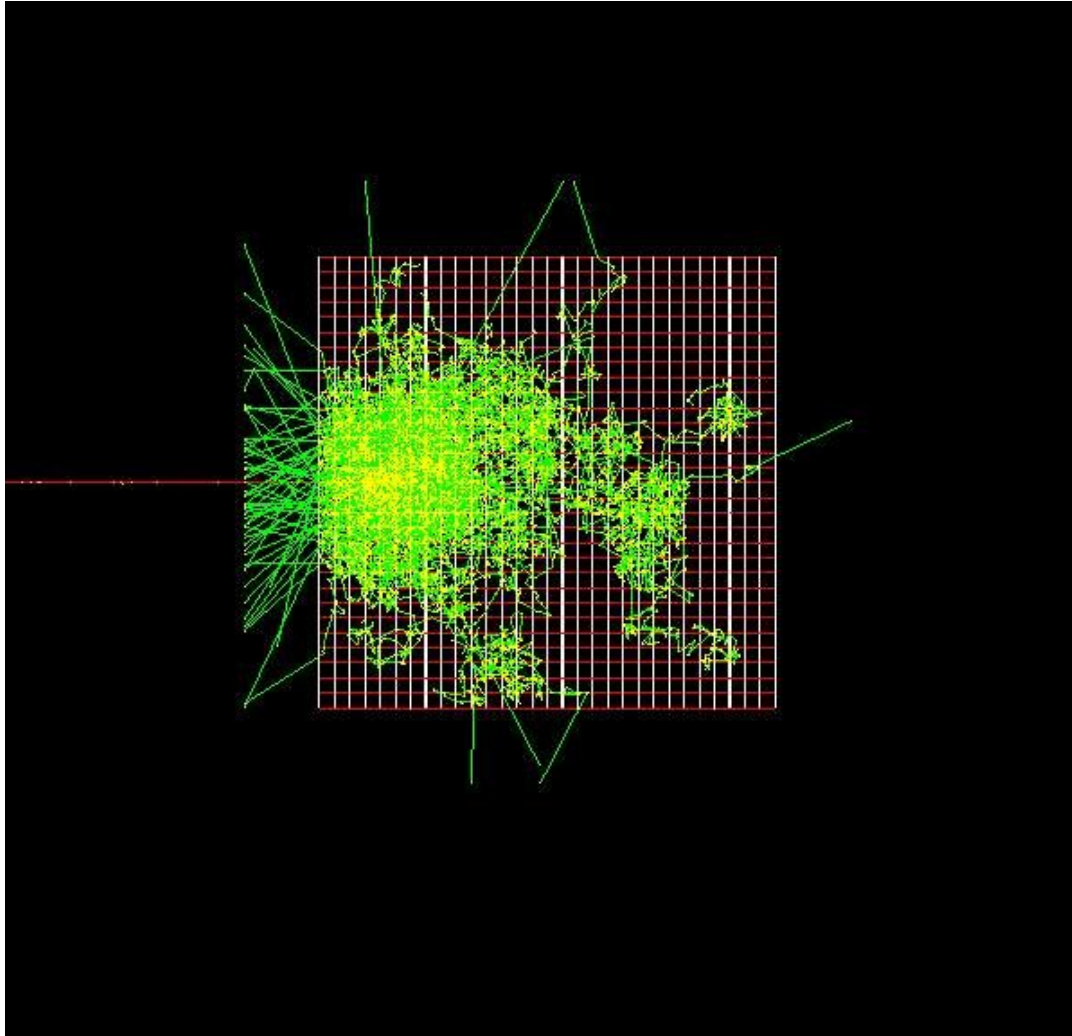
- ▶
$$t' = t_g - \frac{l}{c}$$
- ▶ t' is the corrected time
- ▶ t_g is the global time (from tracking action)
- ▶ L is the distance from the gun to the hit
- ▶ c is speed of light



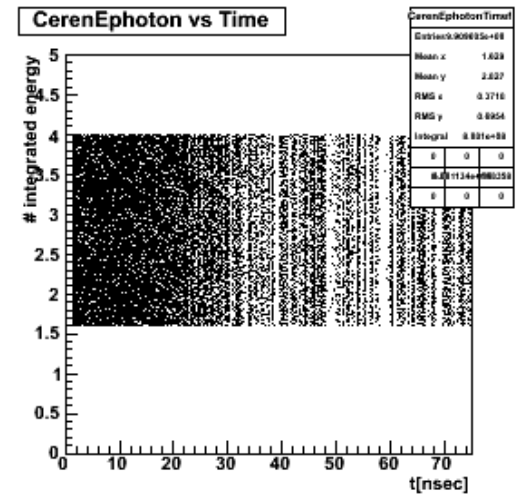
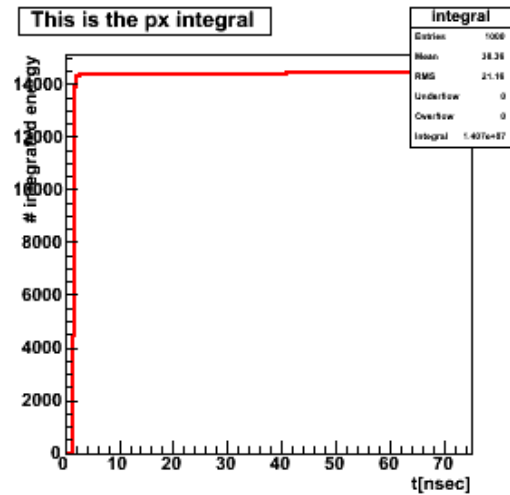
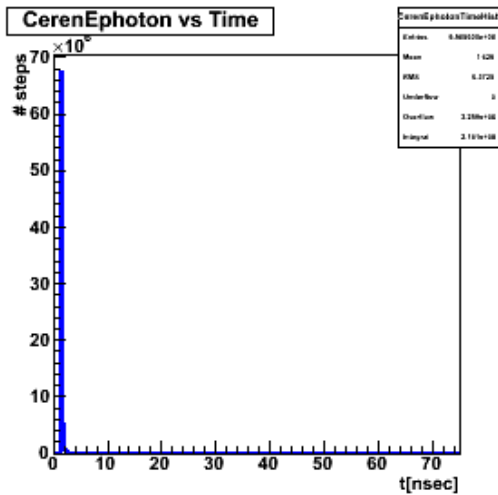
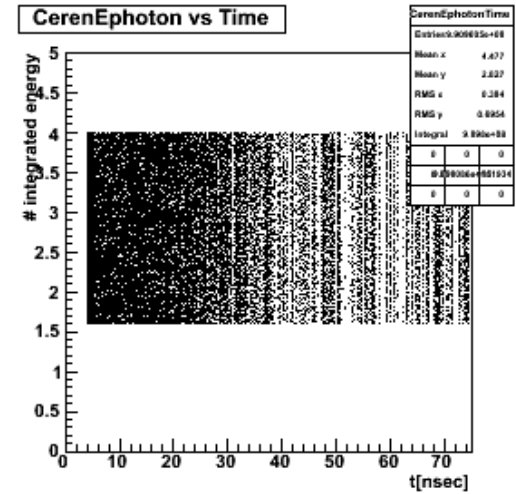
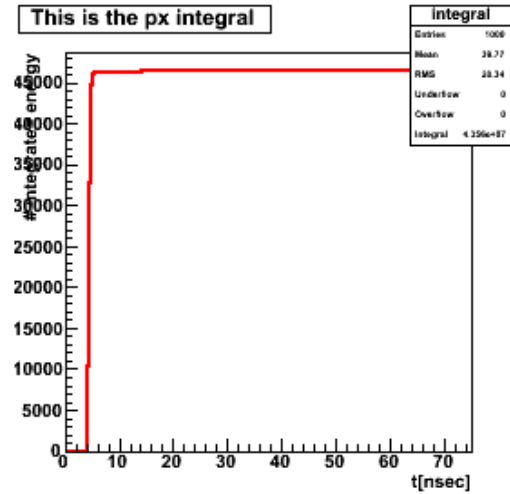
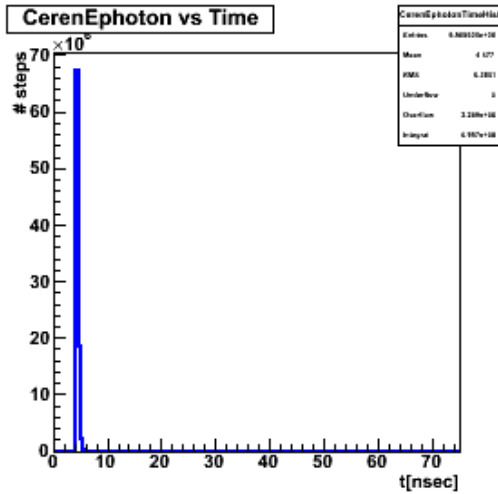
Shower electrons



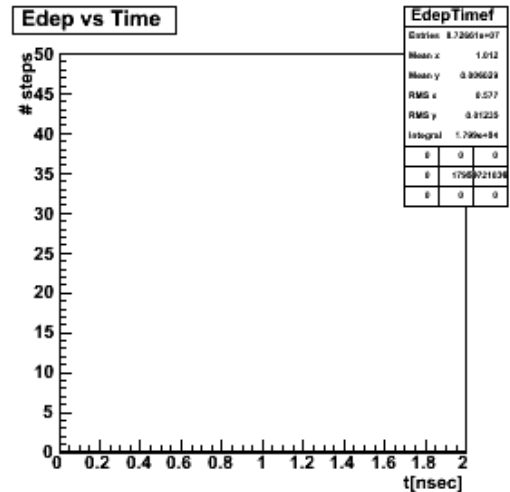
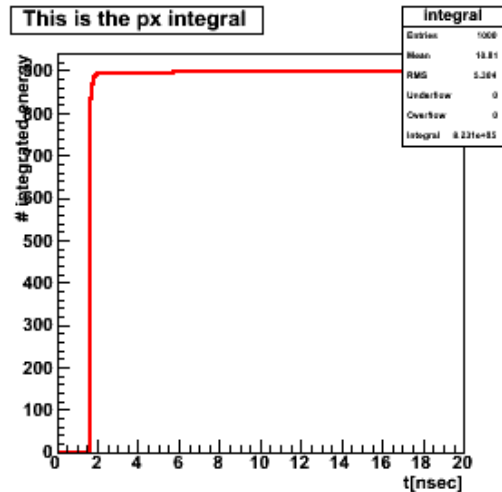
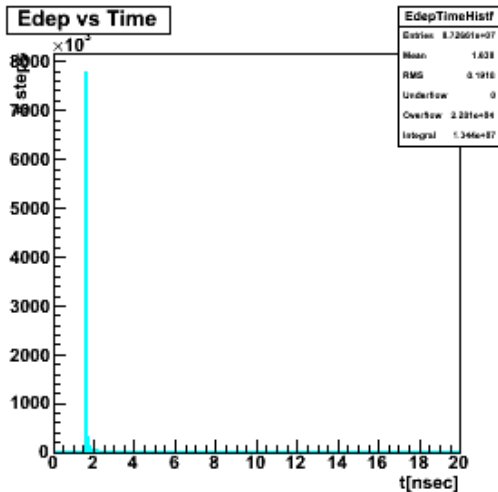
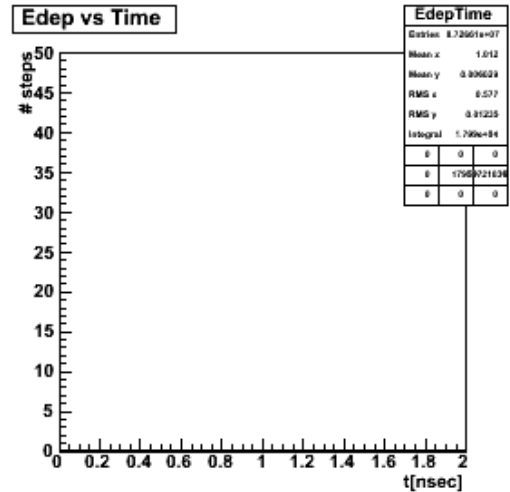
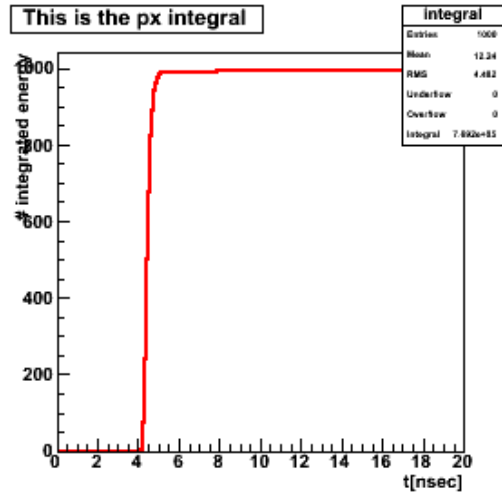
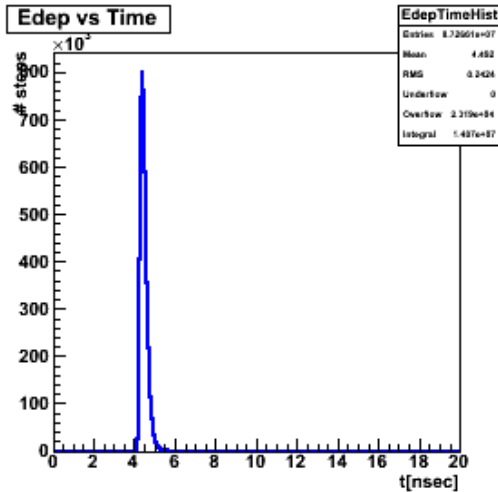
Shower from pions



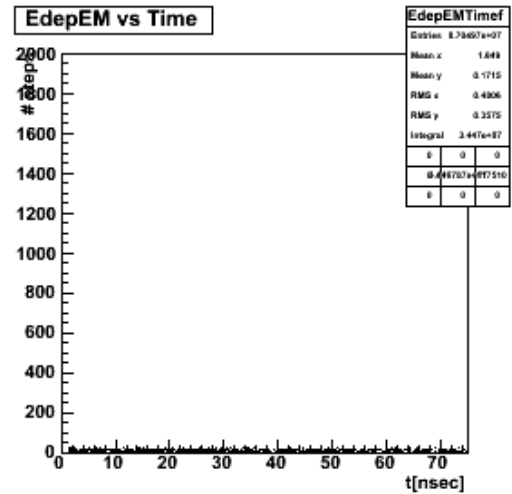
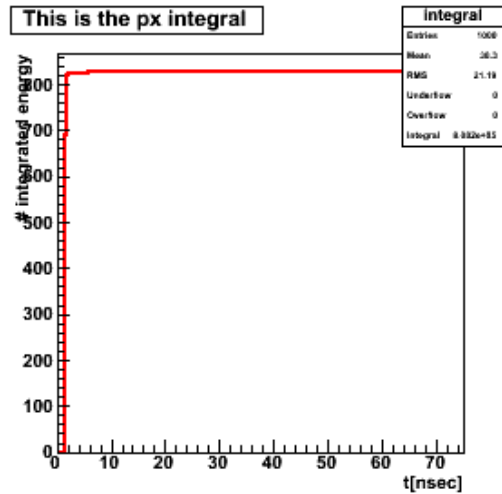
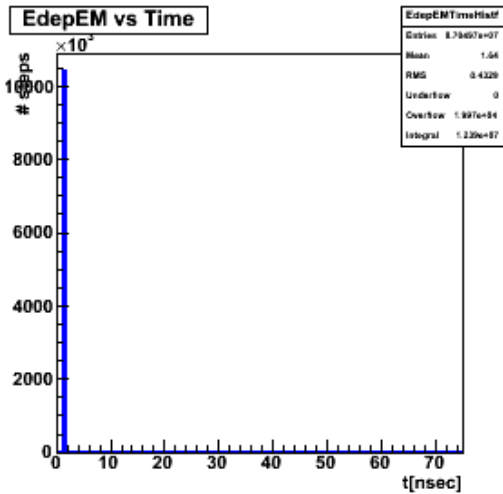
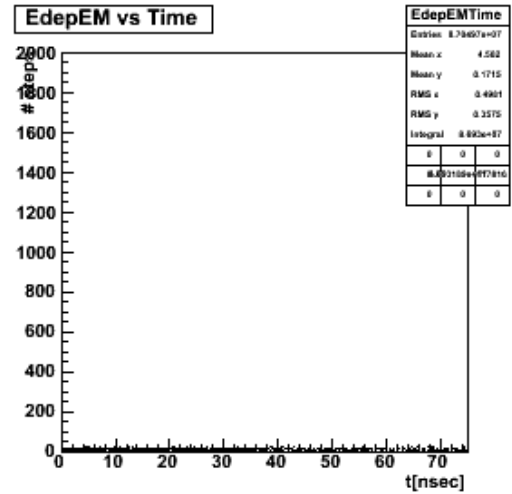
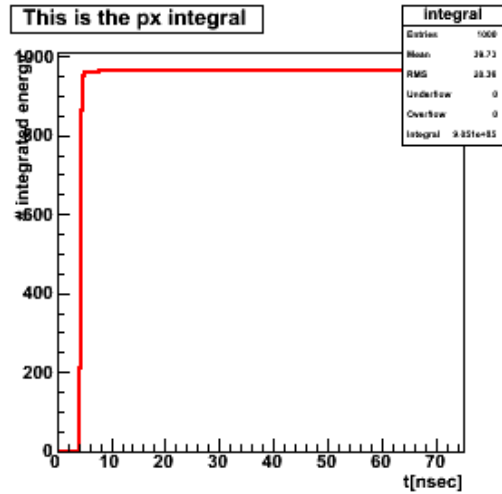
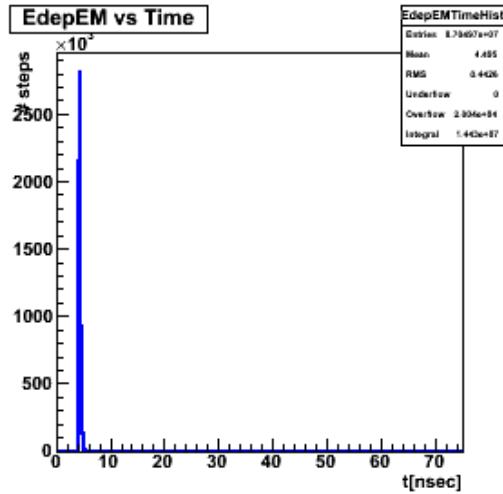
Cerenkov electrons



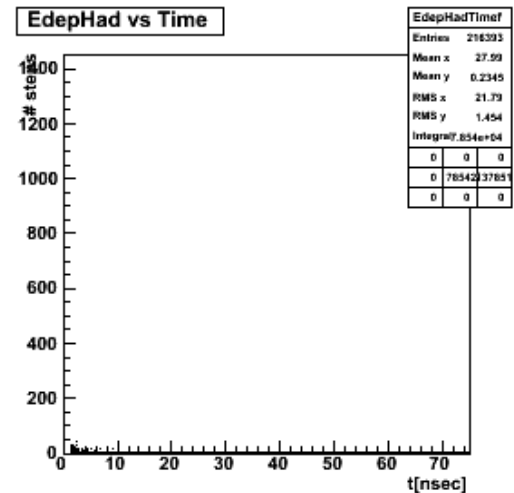
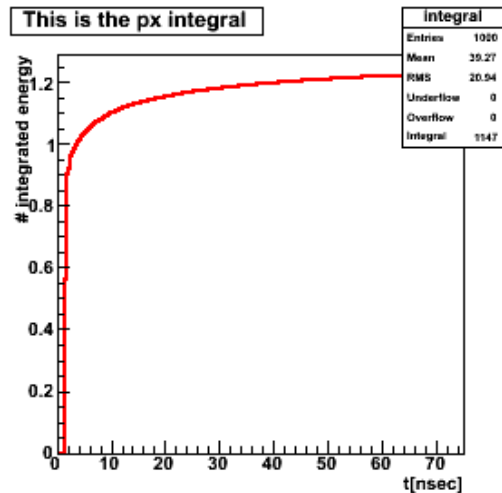
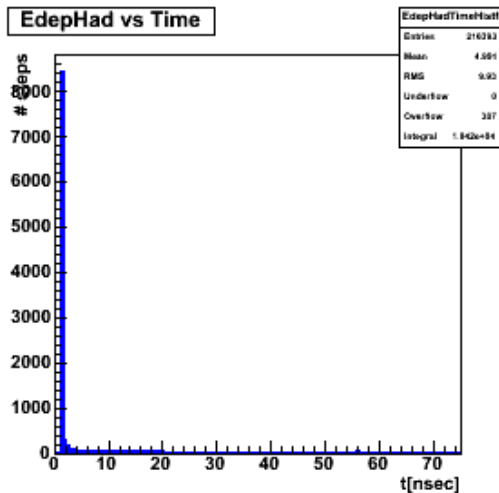
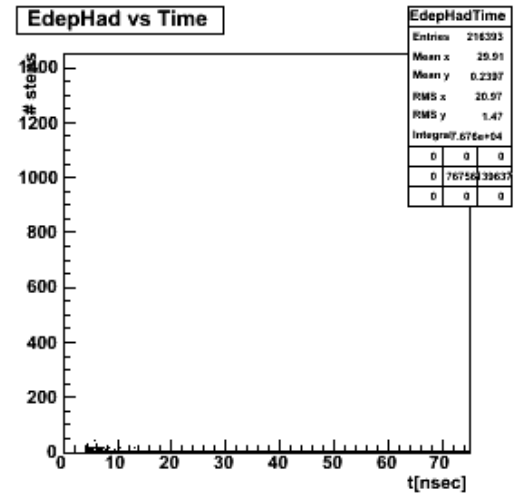
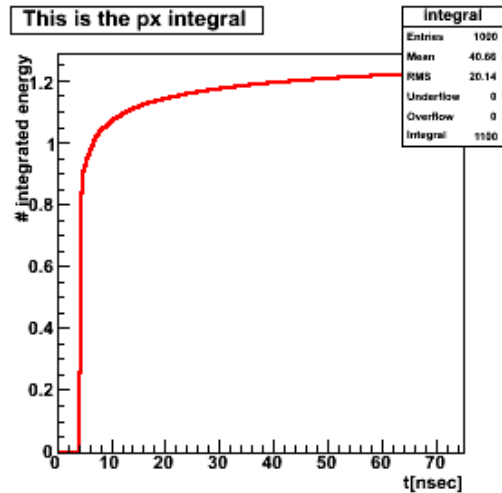
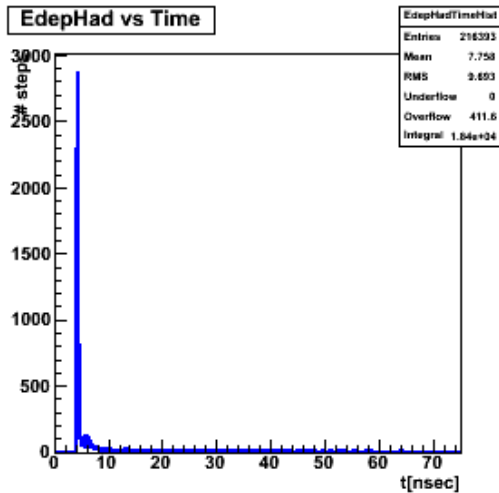
Energy Deposition electrons



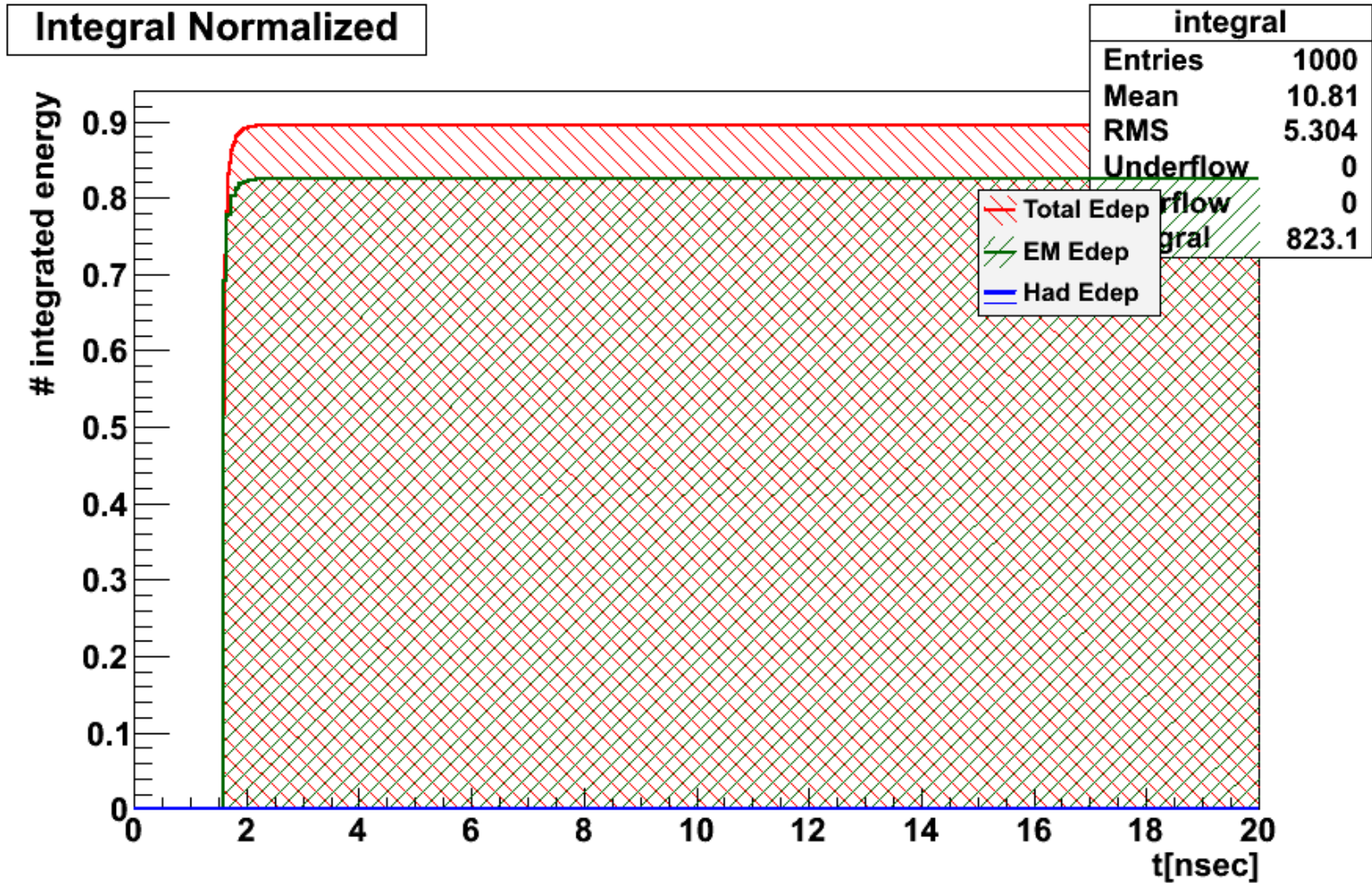
Edep EM electrons



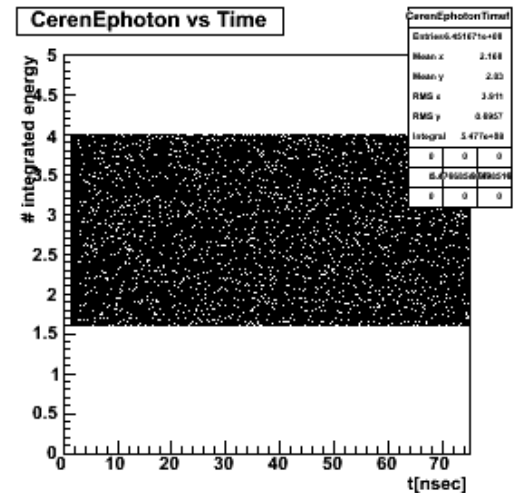
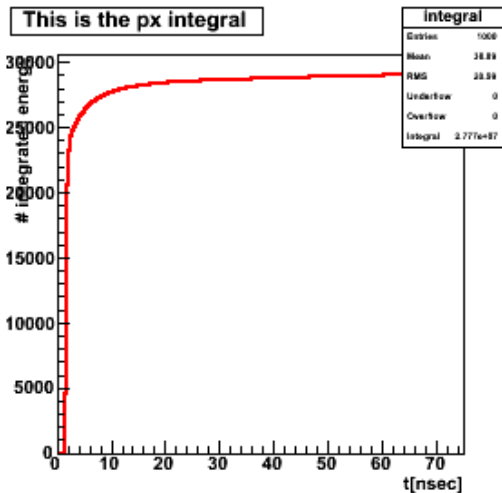
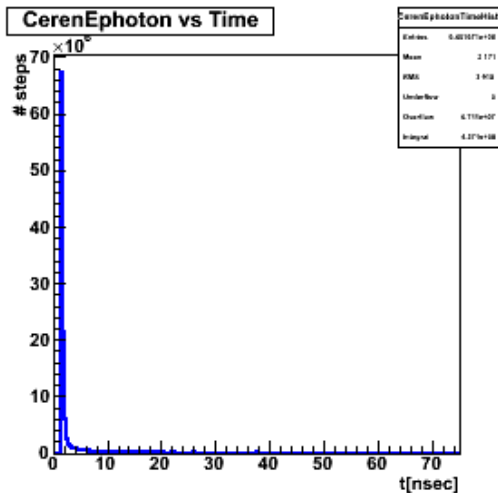
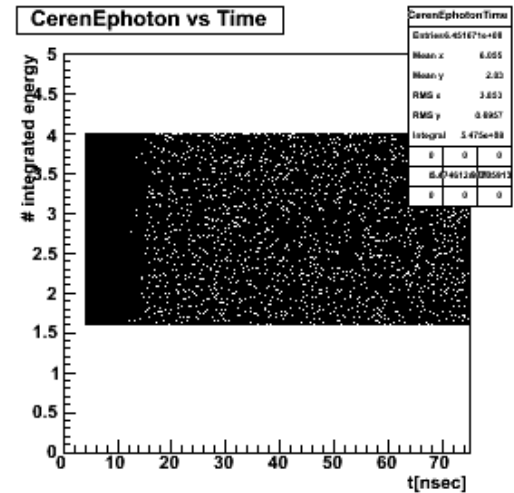
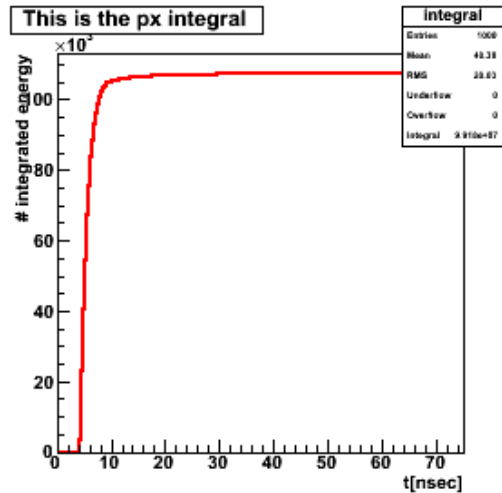
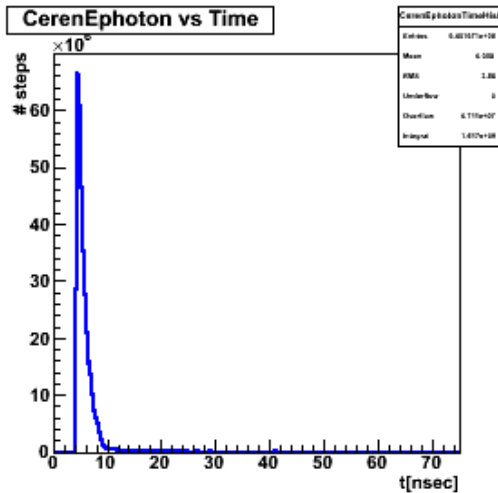
Edep Had electrons



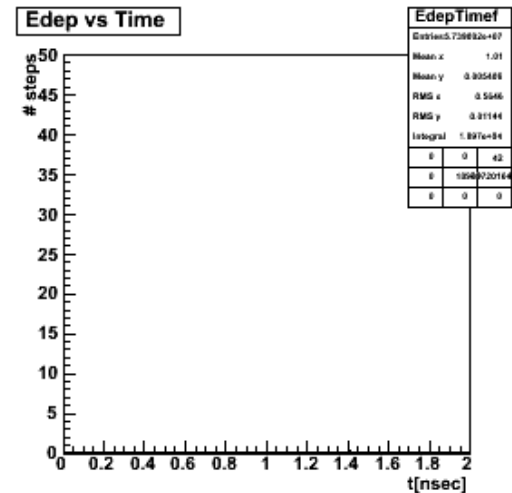
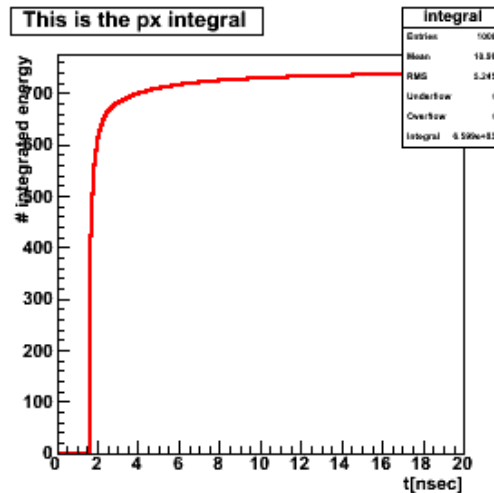
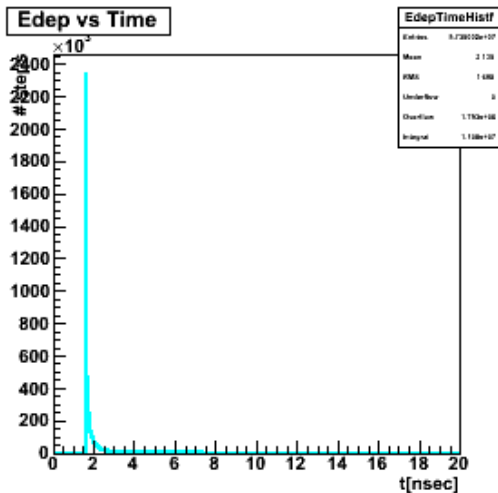
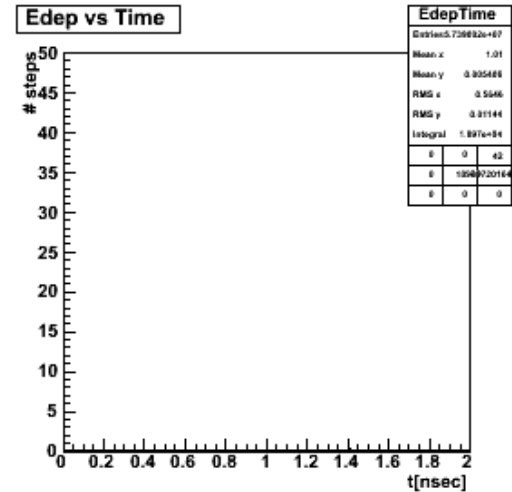
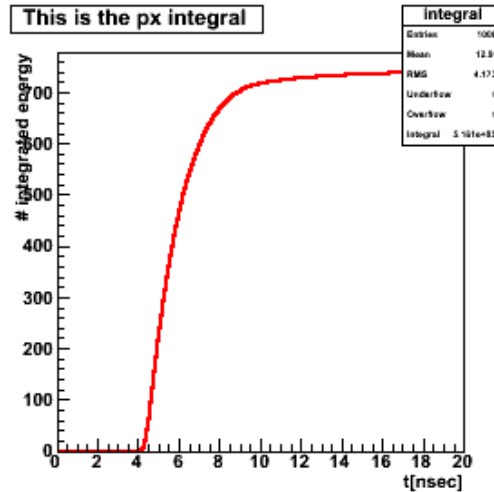
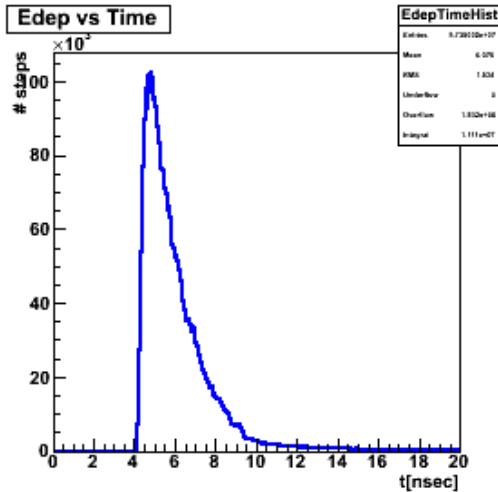
Integral of Energy over time of Electrons



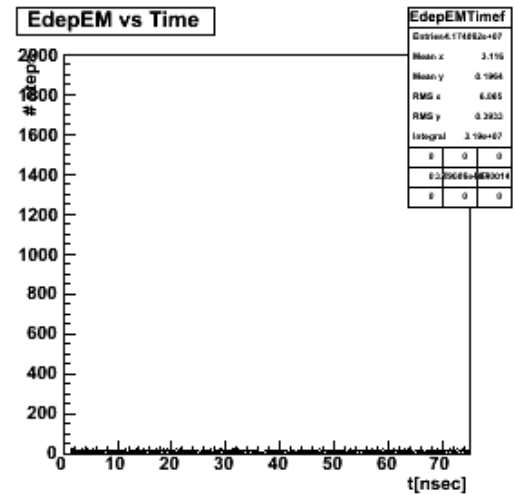
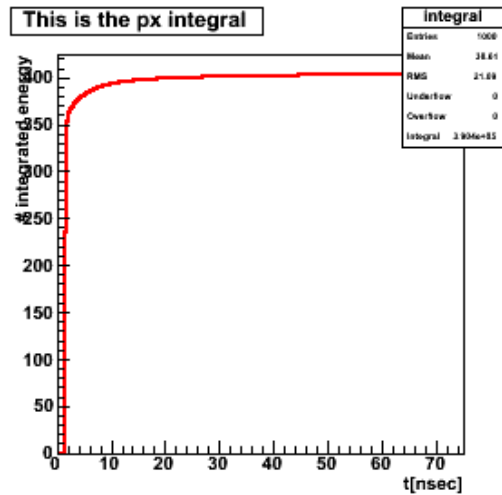
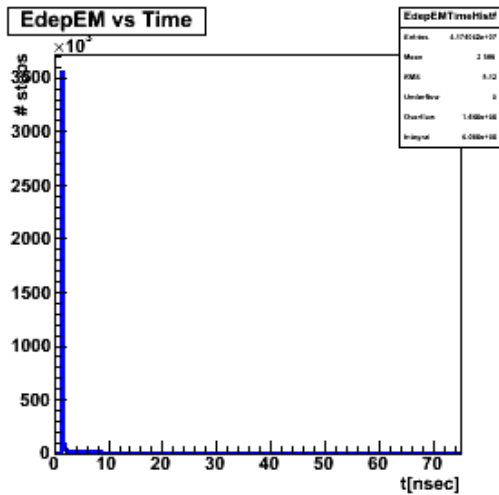
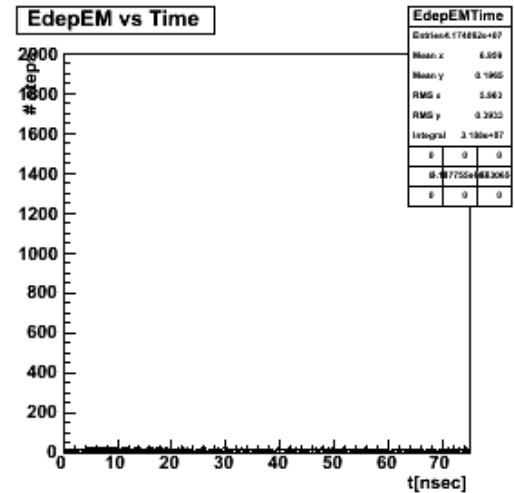
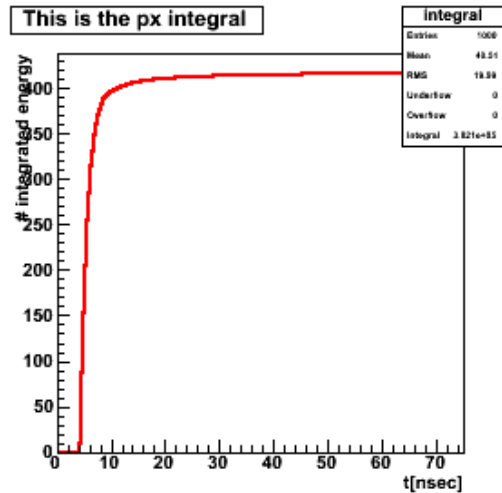
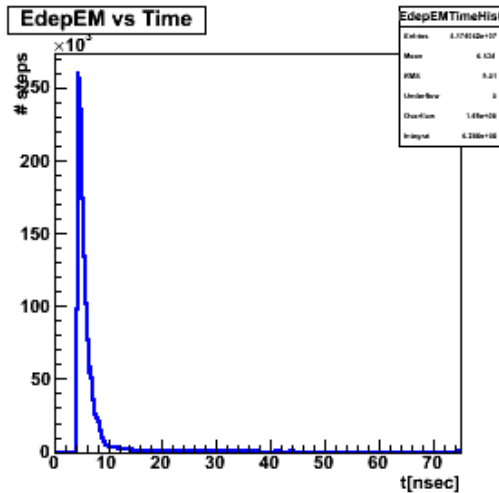
Cerenkov Pions



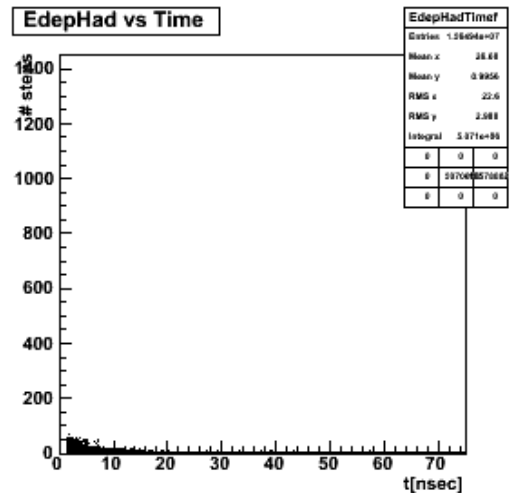
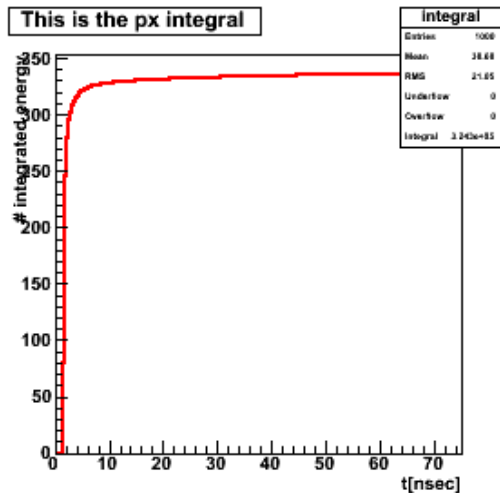
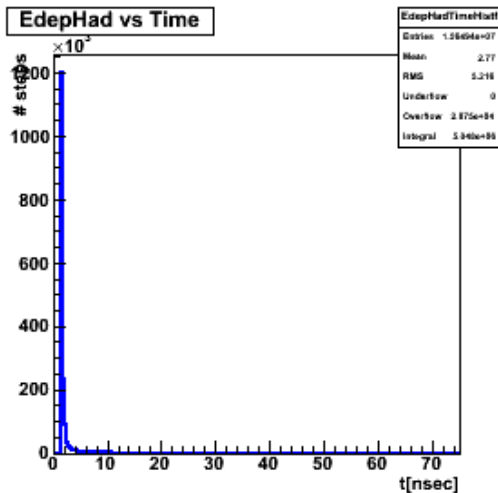
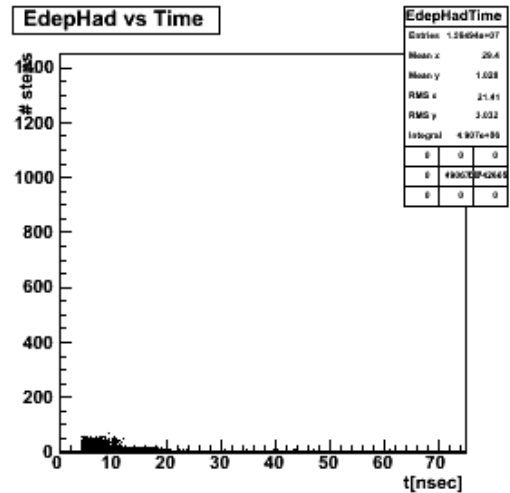
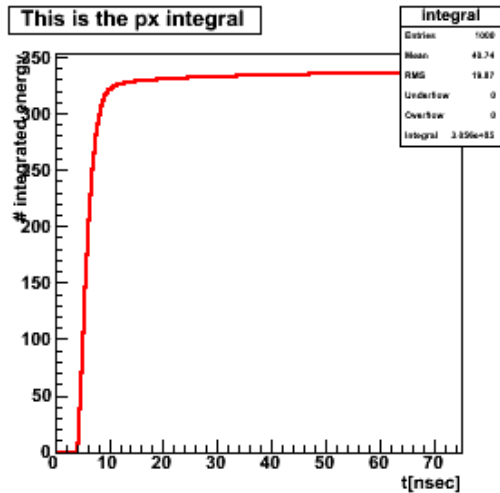
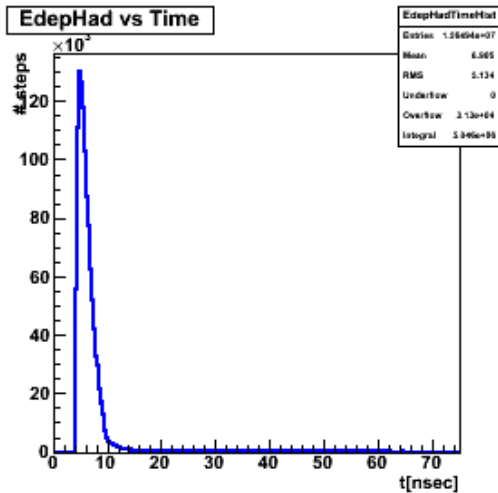
Energy Deposition Pions



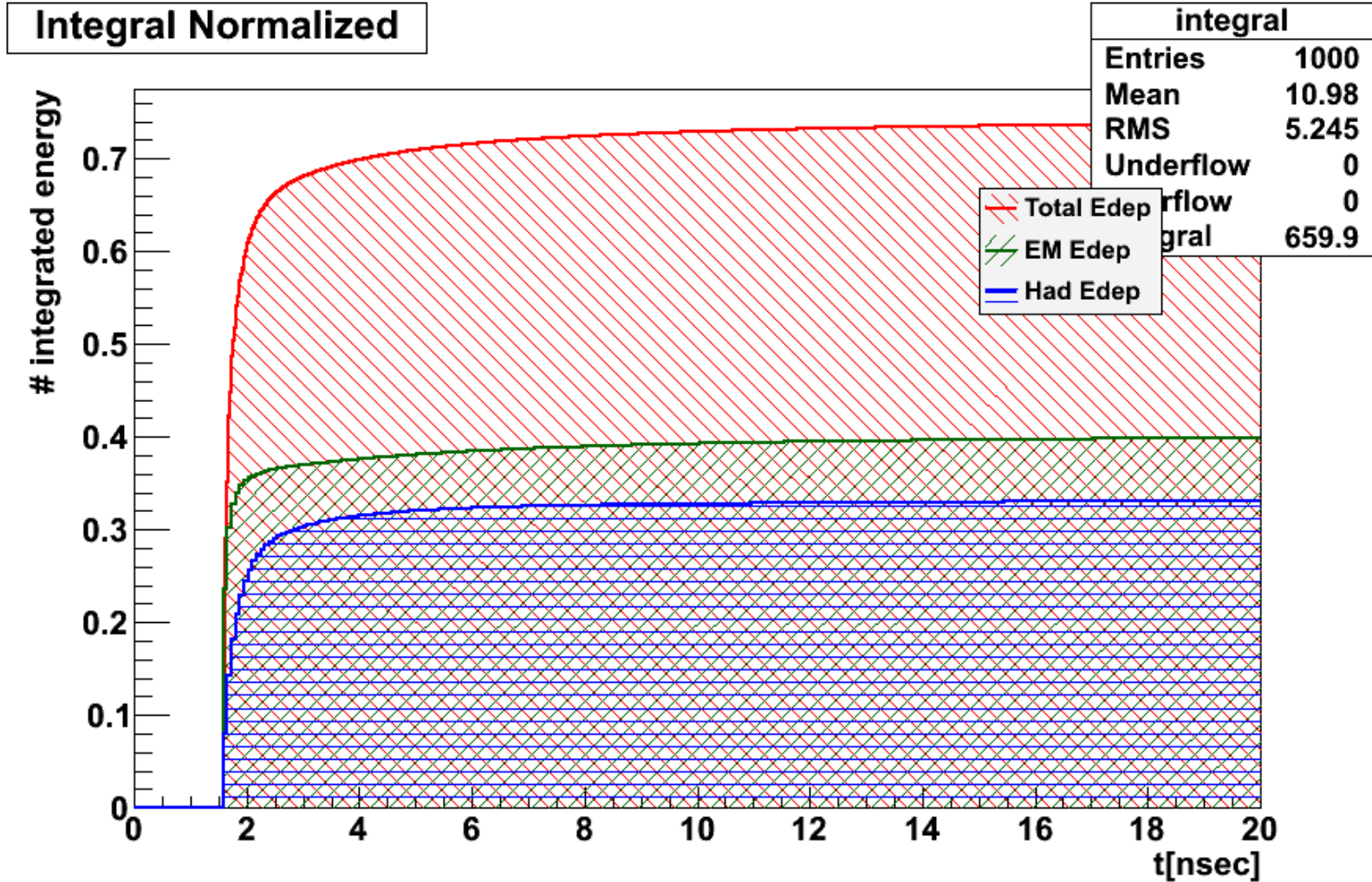
Edep EM Pions



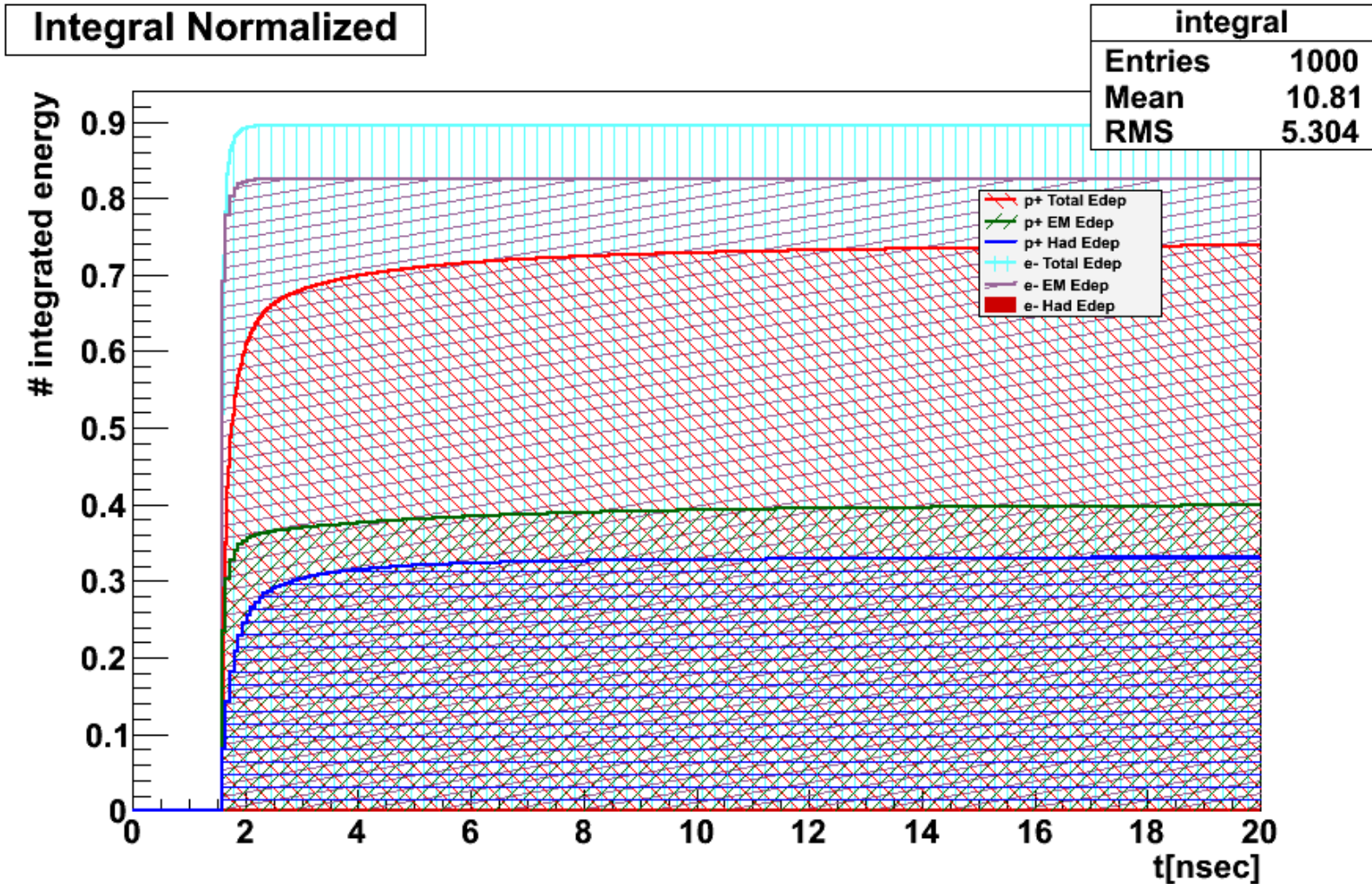
Edep Hadrons Pions



Integral of Energy over time of pions



Integrated shower of energy as a function of time and corrected time



Conclusions

- Shower developed in 6 nanoseconds to its maximum for EM and for Had in e- and pi-.

Future Work

- ▣ Use of different physics list (now QGSP_BERT)
- ▣ Use of different materials (PbWO4, W, Iron..)
- ▣ Sampling with active layer of plastic scintillator to see the effect of neutrons.
- ▣ Study the different physics process contributing to the signal
- ▣ Modify the Hit-class to include timing information