NC Elastic Fitter and Particle Identification

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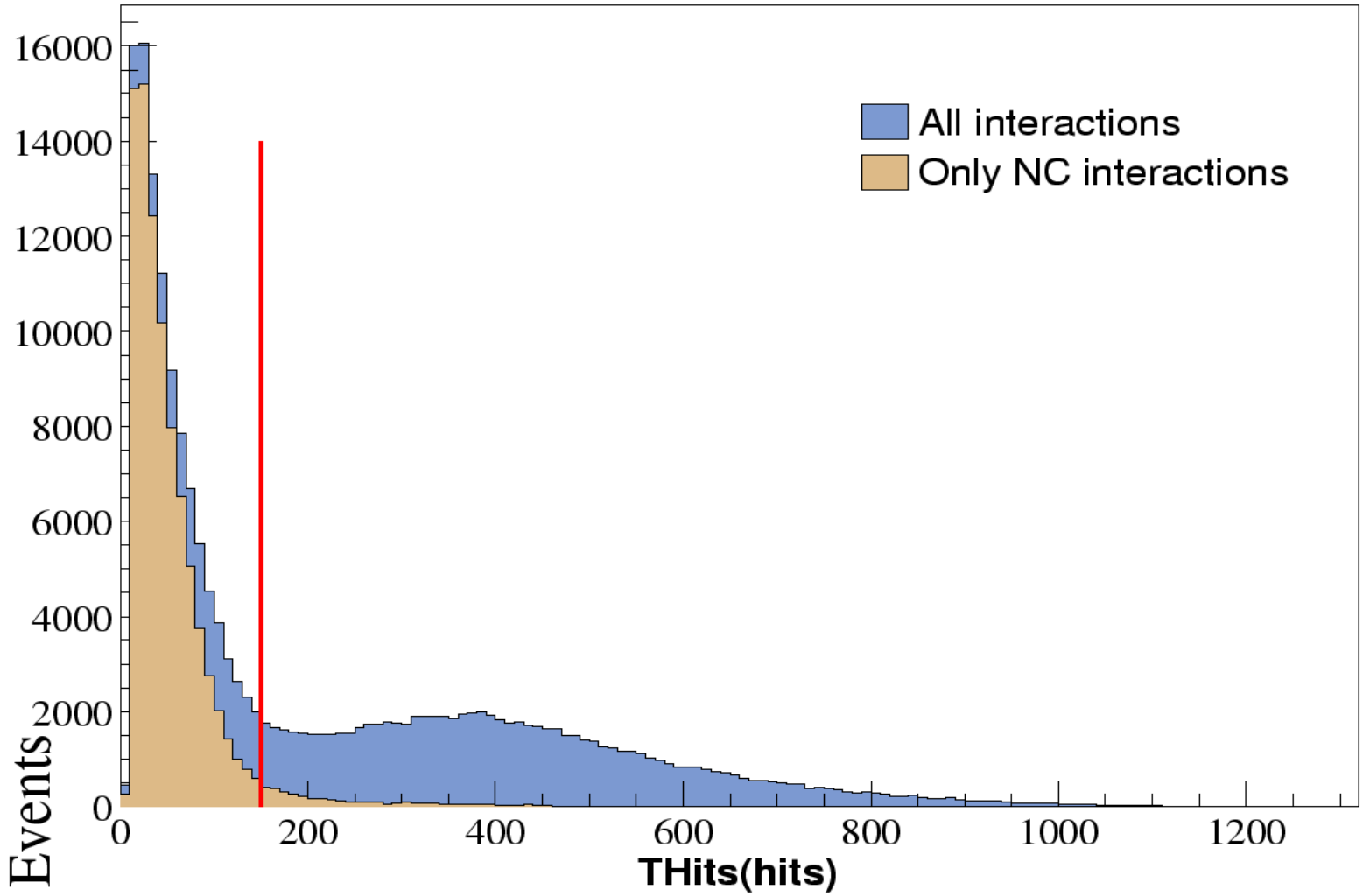
Outline

- NC elastic events overview
- NC Fitter
  - Optical model
  - Corrected time parameters
  - Performance
- PID
  - protons/electrons
  - protons/neutrons

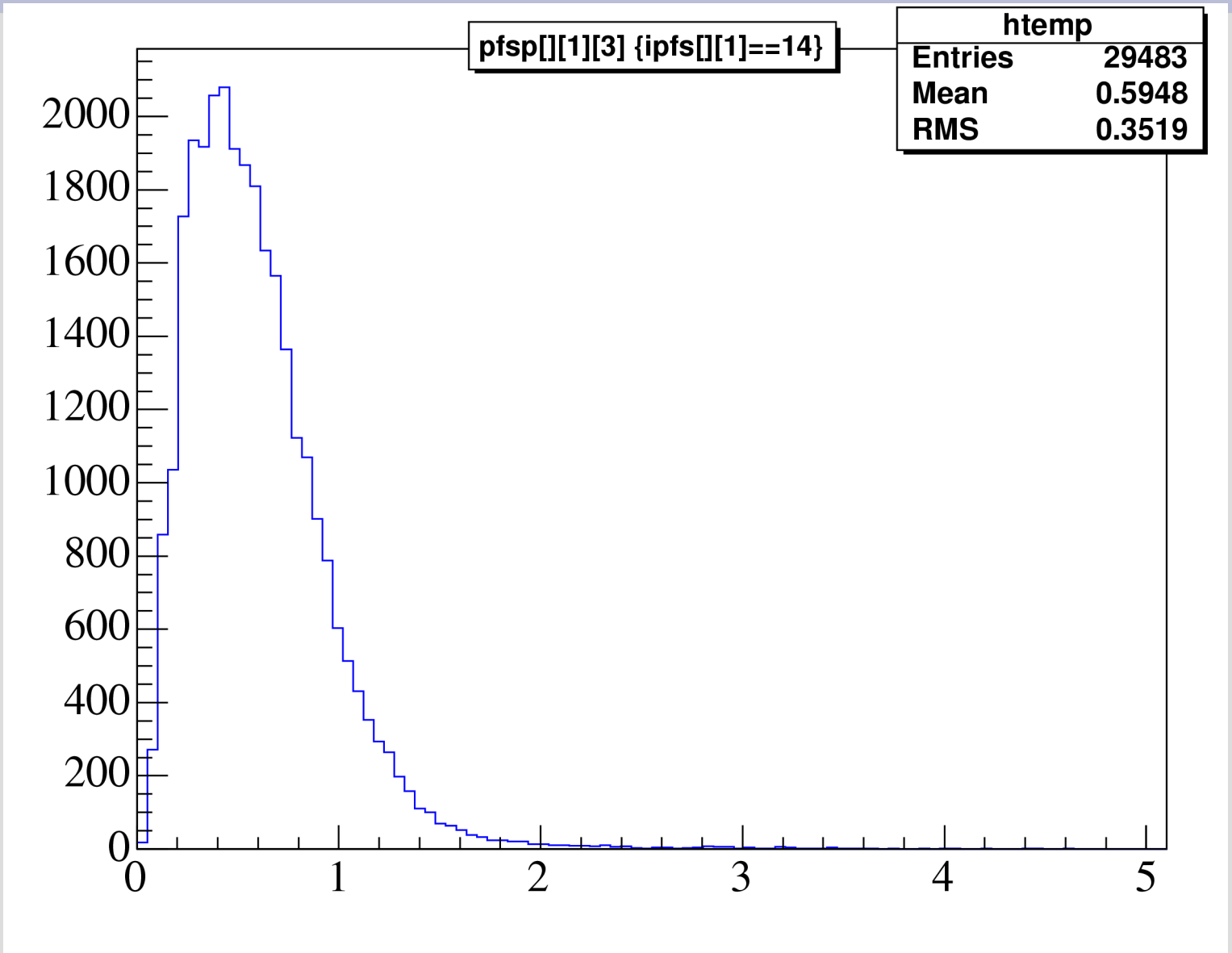
NC elastic:

$$\nu_\mu n \rightarrow \nu_\mu n$$

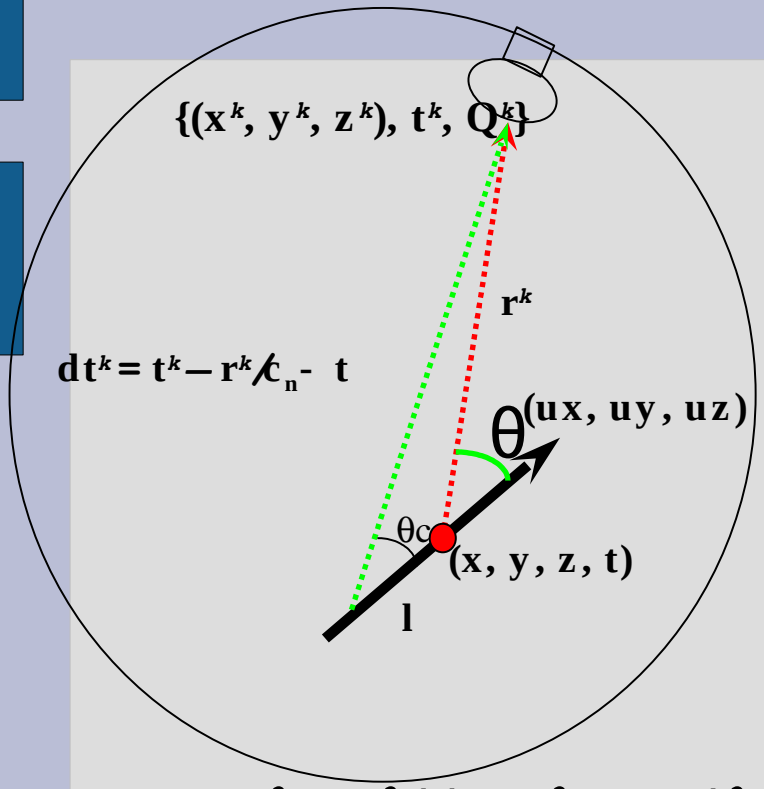
$$\nu_\mu p \rightarrow \nu_\mu p$$


All interactions
Only NC interactions
Events
THits(hits)
0
2000
4000
6000
8000
10000
12000
14000
16000
0
200
400
600
800
1000
1200

Momentum of protons



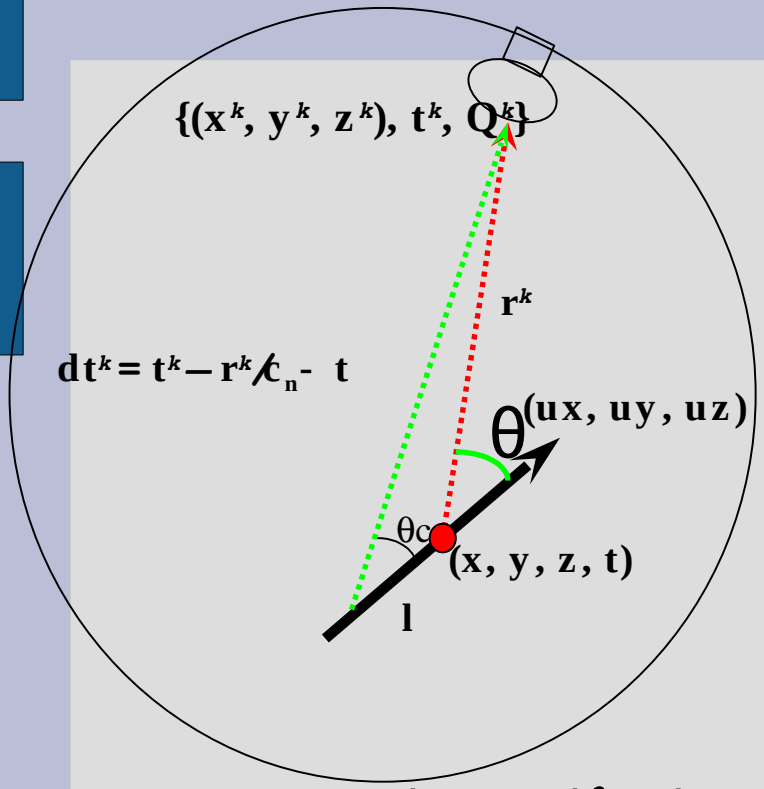
Optical model



- ***Scintillation light - (almost) isotopic***

$$\mu_i^{sci} = \epsilon_i \phi_{sci} \phi_{sci}^{corr}(r_i, \cos\alpha) \exp\left(\frac{-r_i}{\lambda_{sci}}\right) \frac{f(\cos\eta)}{r_i^2} F_{sci}(\cos\theta_i)$$

Optical model



- ***Cerenkov light - directional***

$$\mu_i^{cer} = \epsilon_i \phi_{cer} \phi_{cer}^{corr}(r_i) \exp\left(\frac{-r_i}{\lambda_{cer}}\right) \frac{f(\cos\eta)}{r_i^2} F_{cer}(\cos\theta_i)$$

Optical model

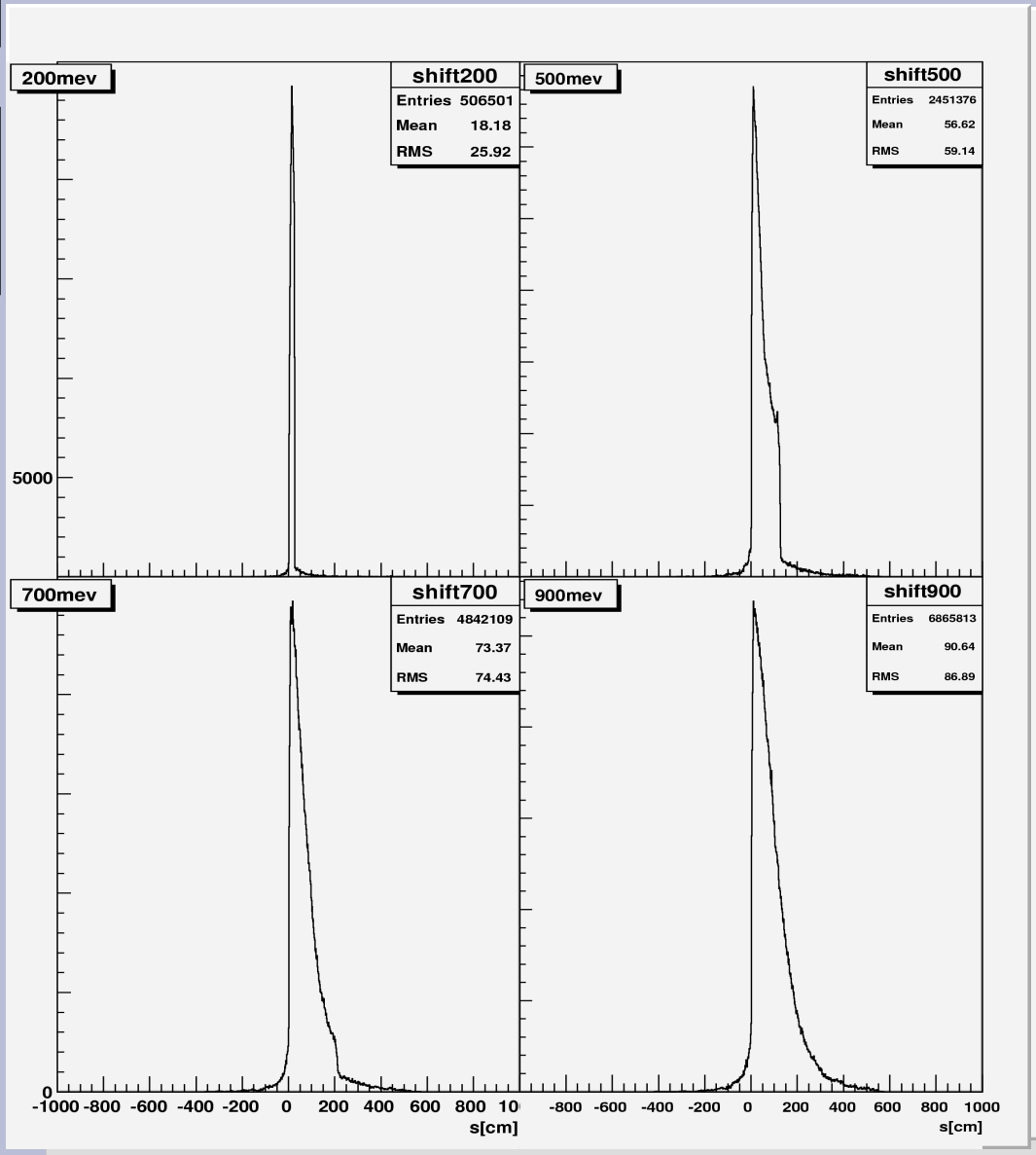
Sample of events:

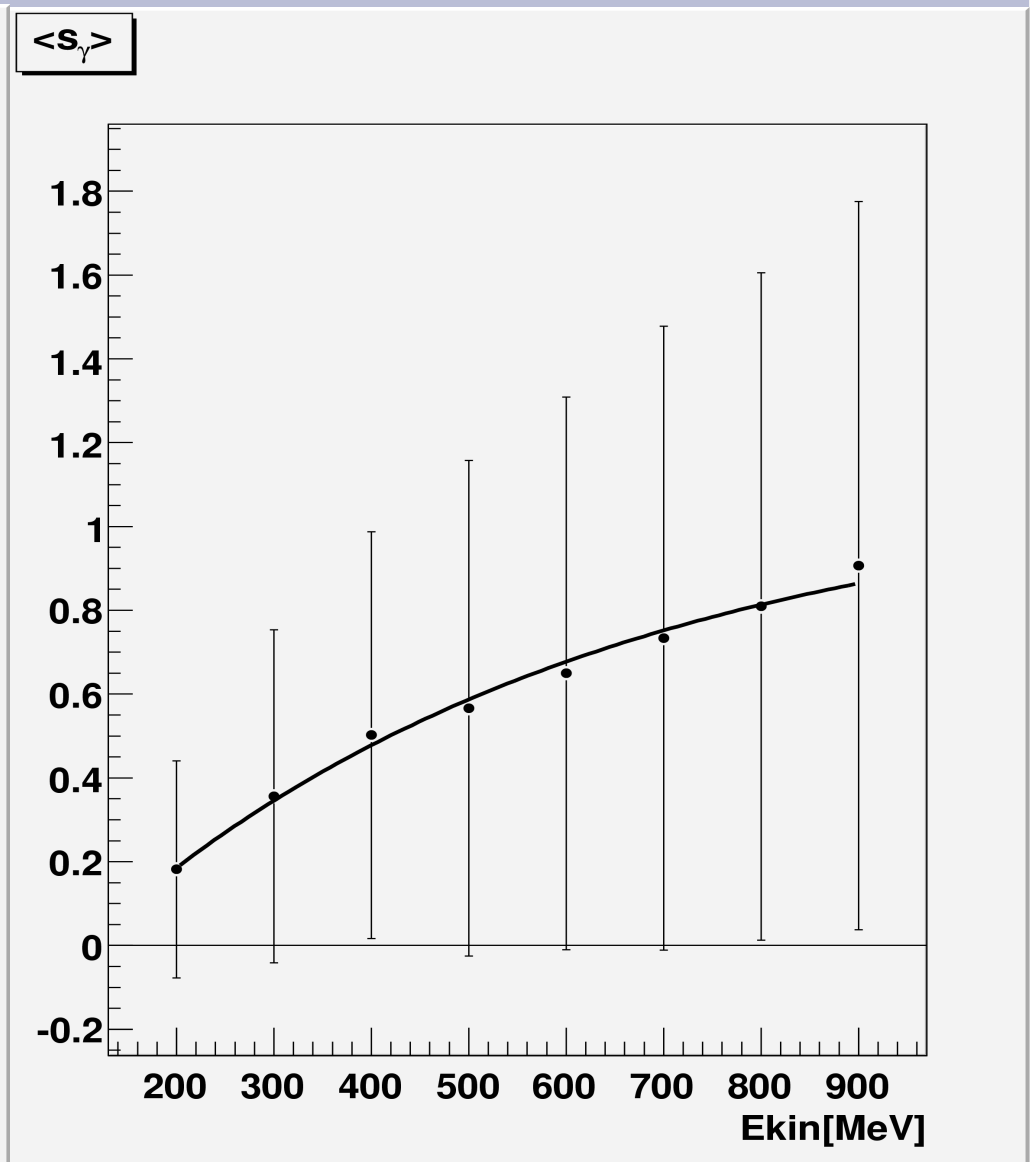
100-800 MeV isotropic protons R<610cm

Turning off different components of the light in MCThrouhgDAQ, we divide samples into 3 subsamples:

- Full Sample (everything)
- Cerenkov Sample(no scintillation, fluorescence,UVF)
- Scintillation Sample(no cerenkov,UVF)

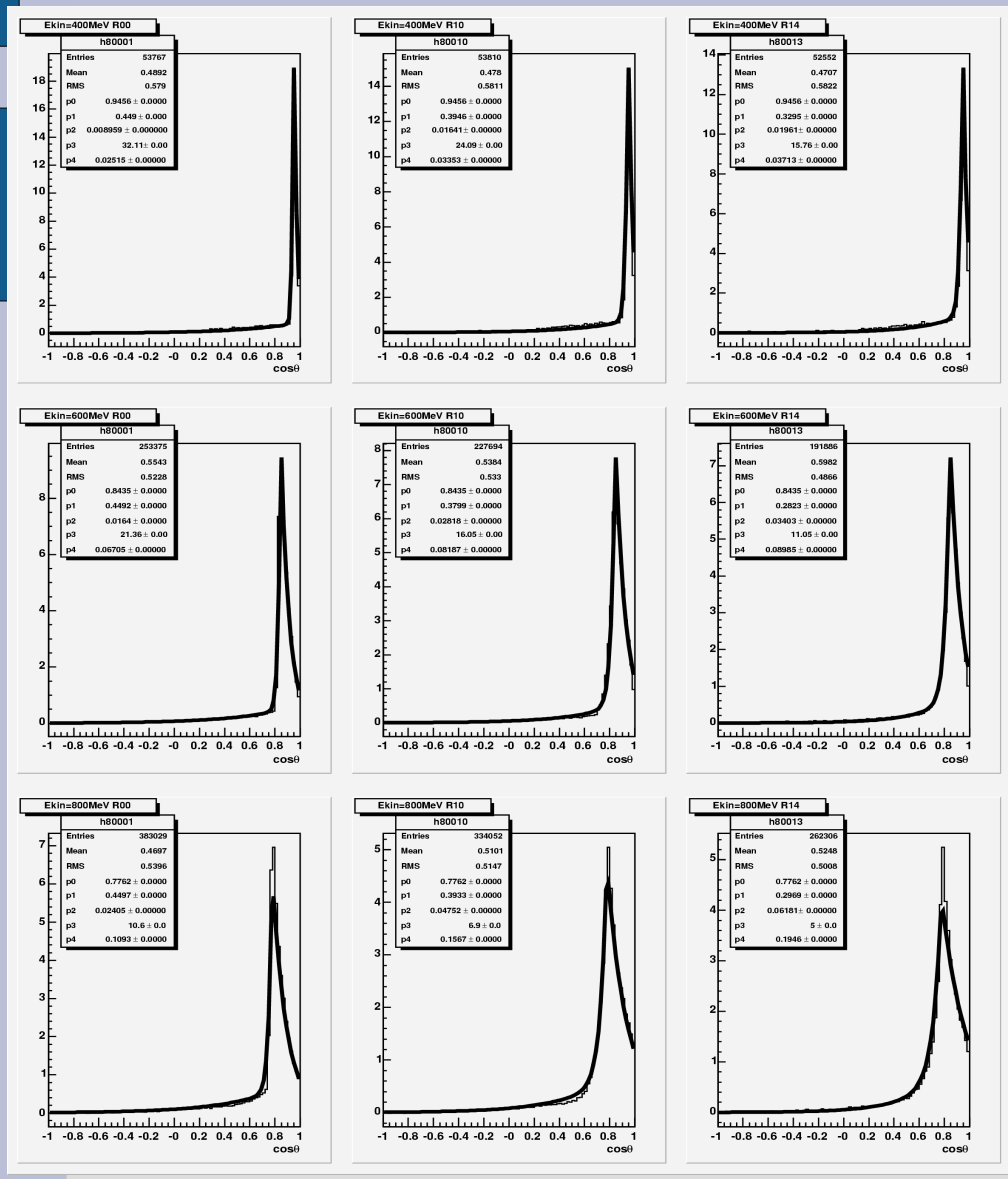
Event vertex

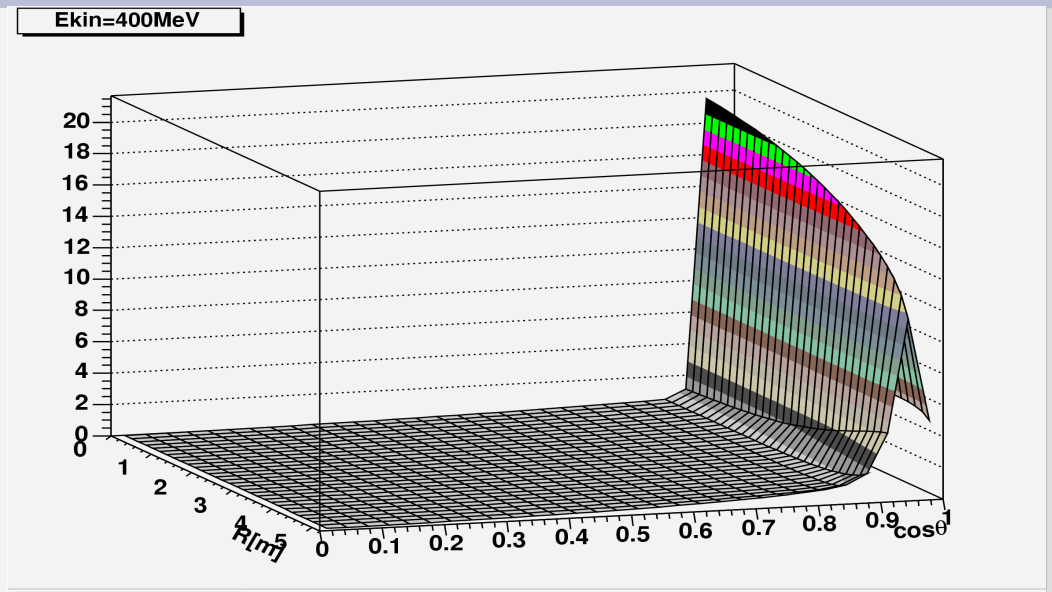


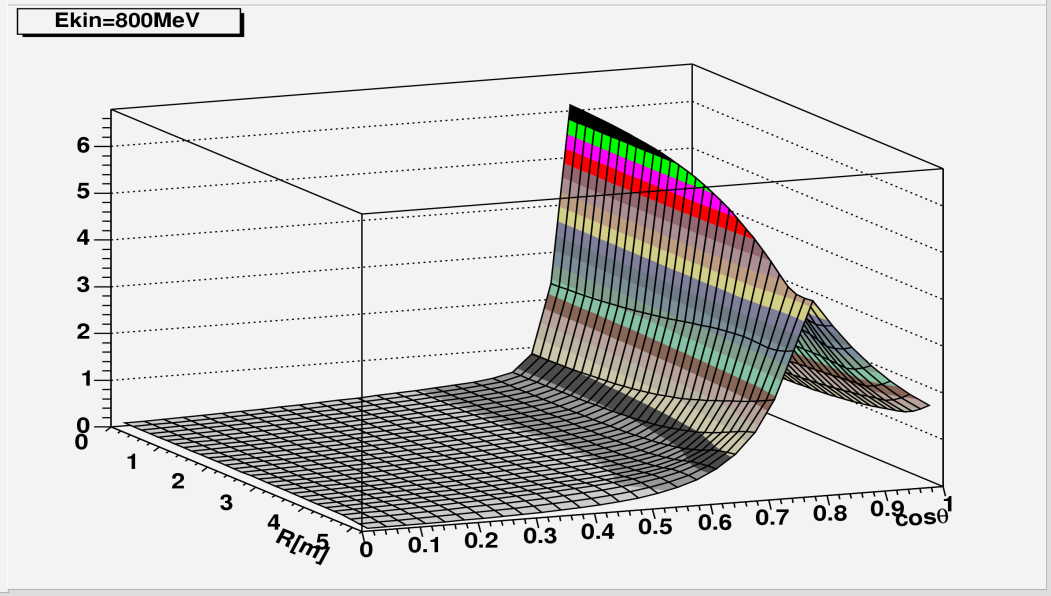


Optical model

$$F_{cer}(\cos\theta)$$

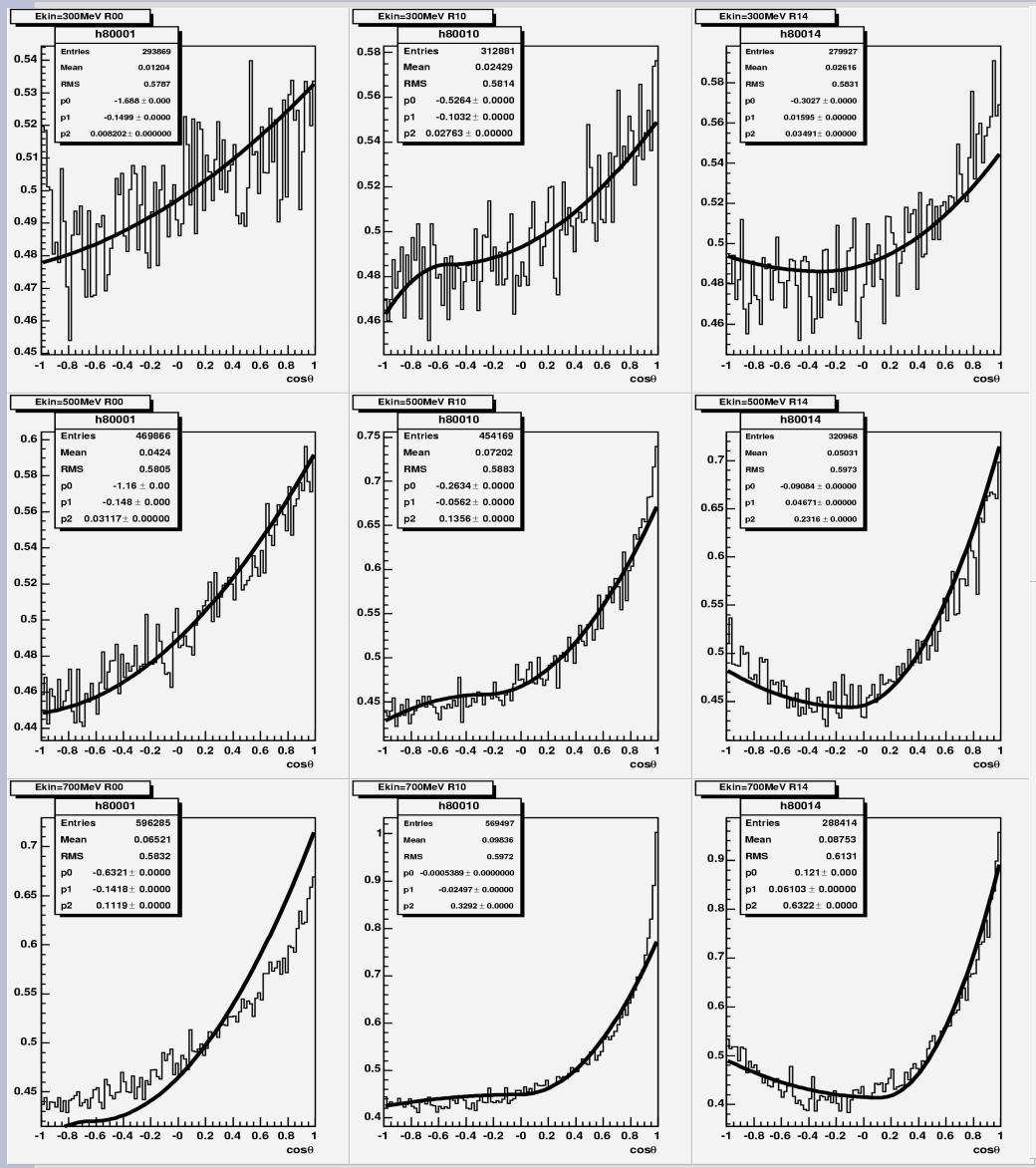


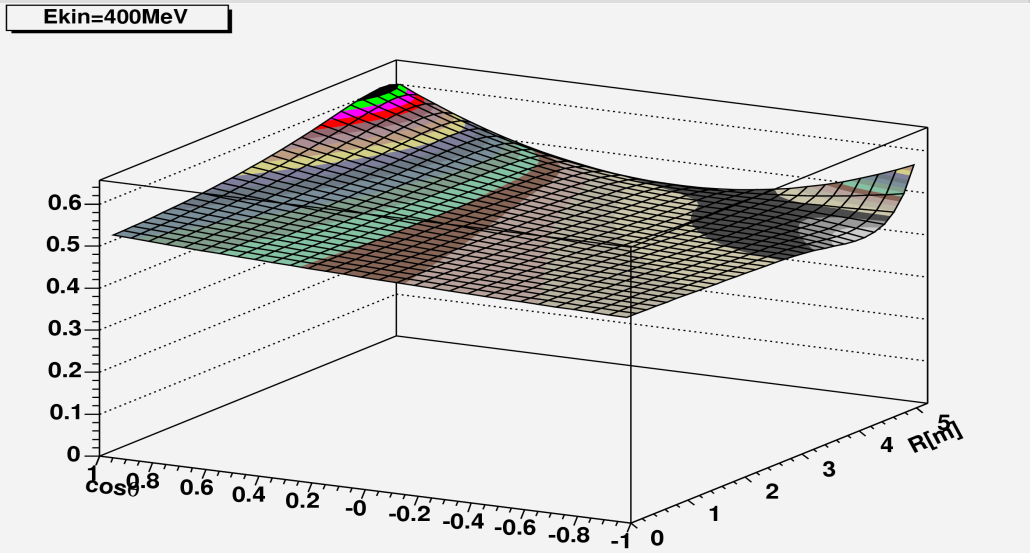


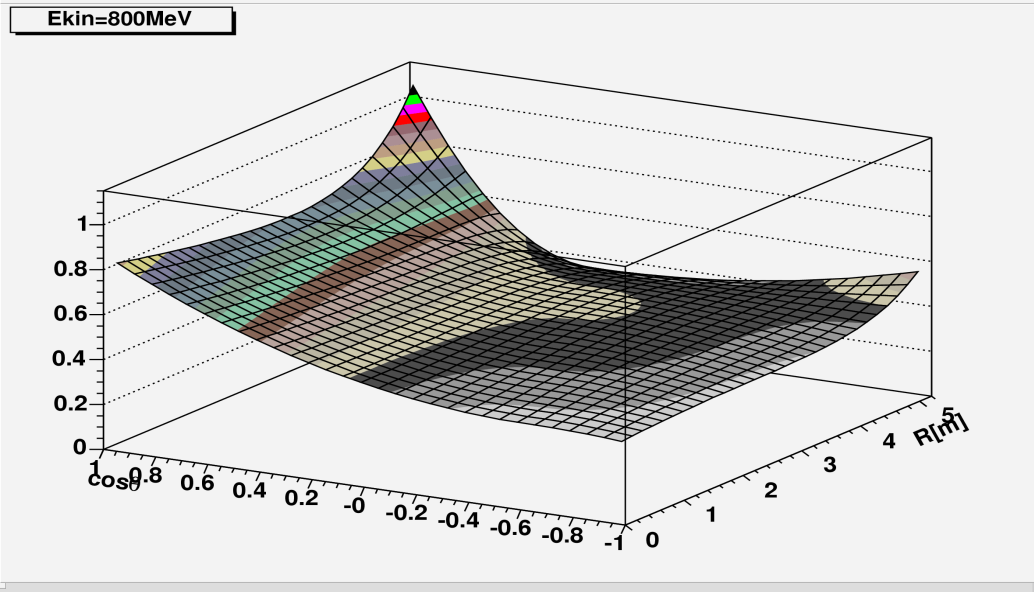


Optical model

$$F_{sci}(\cos\theta)$$

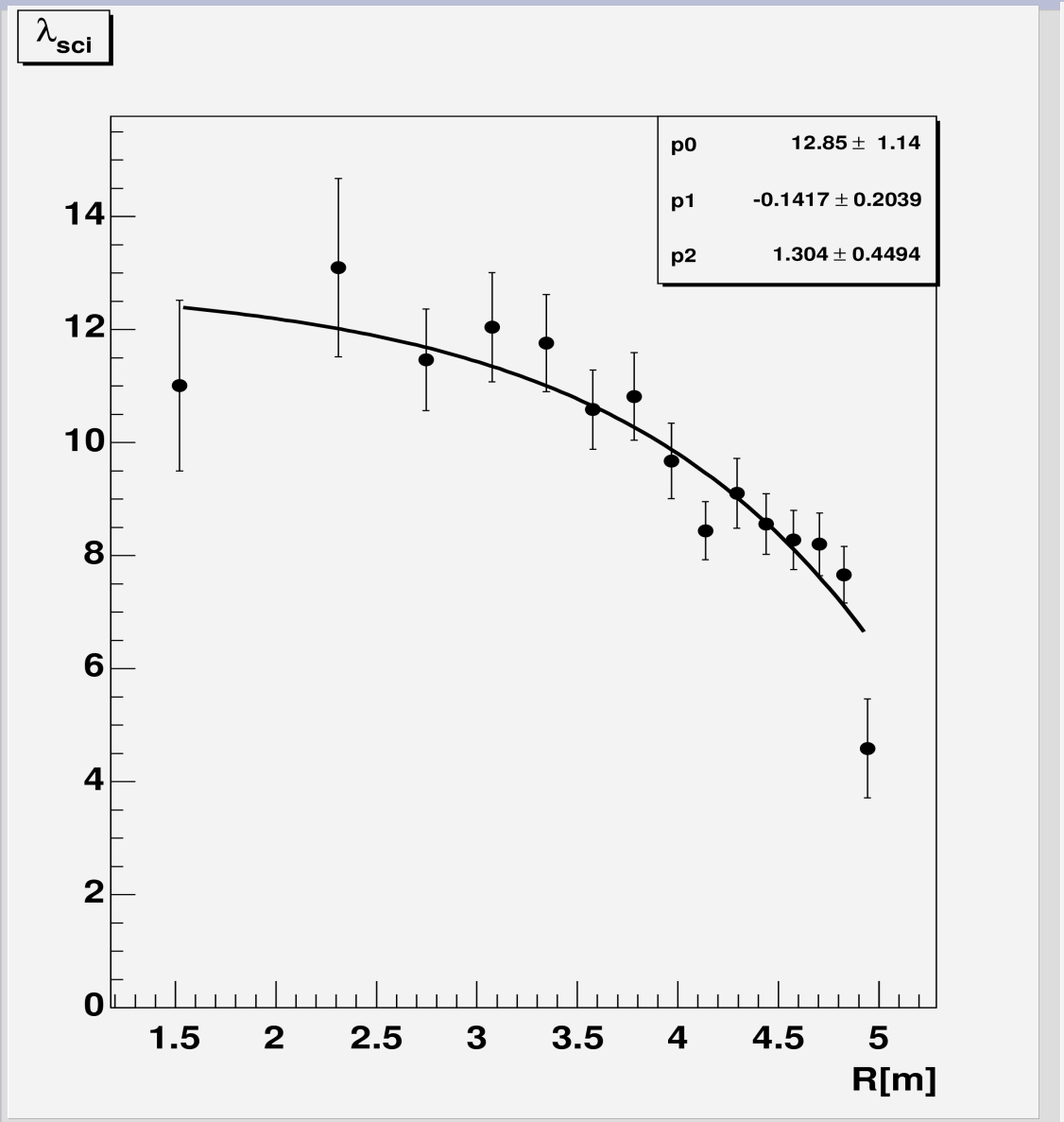


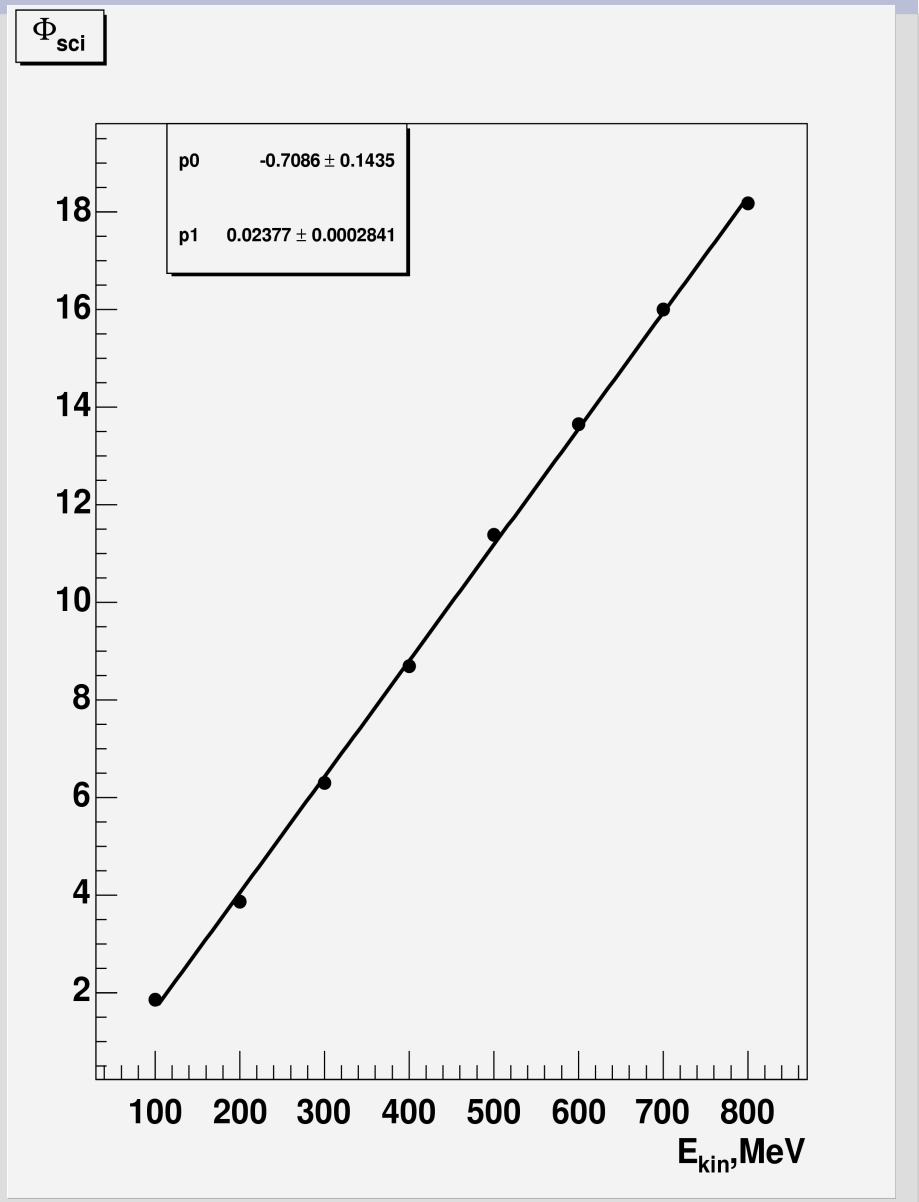




Optical model

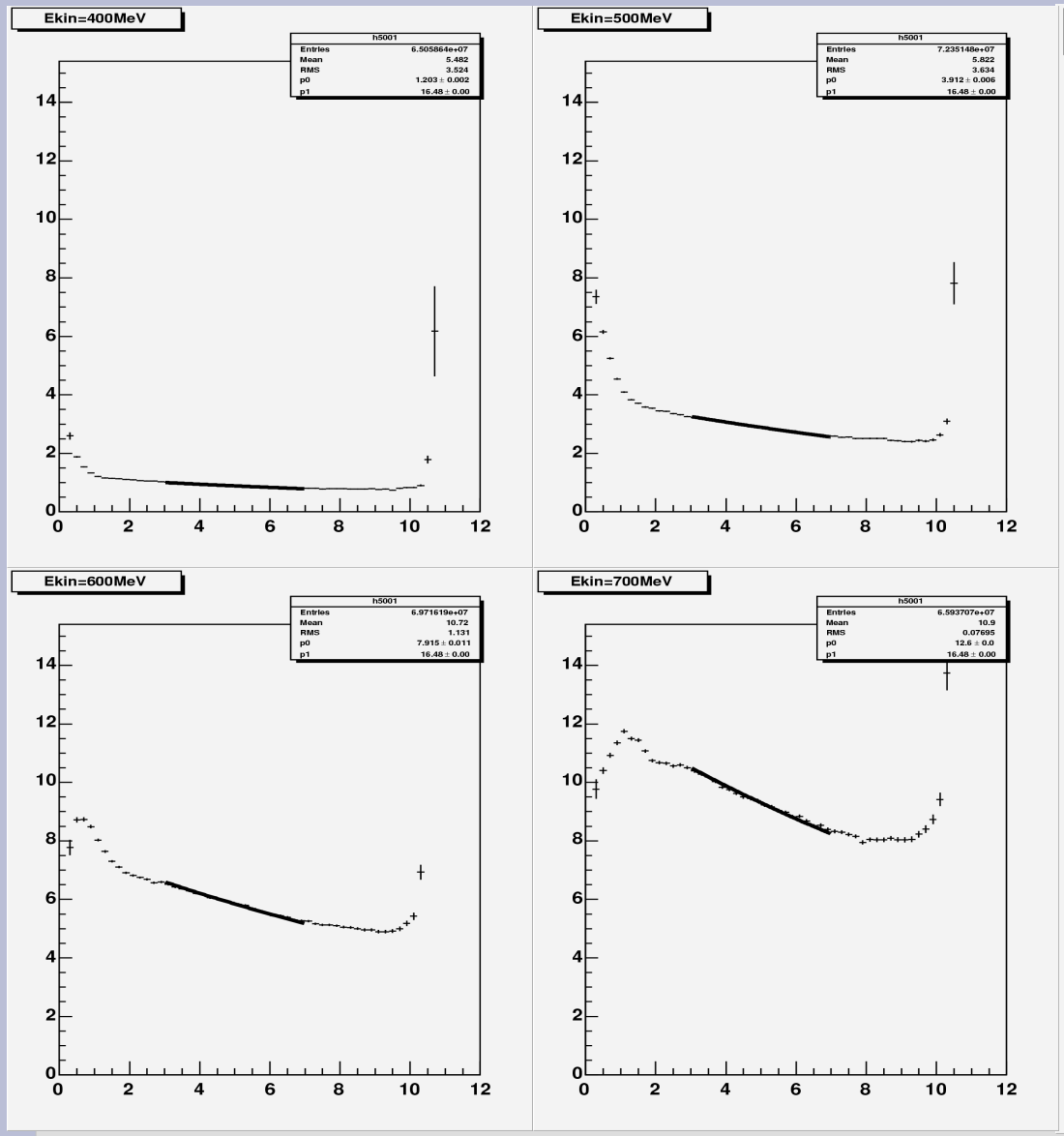
$$\lambda_{sci}(R)$$

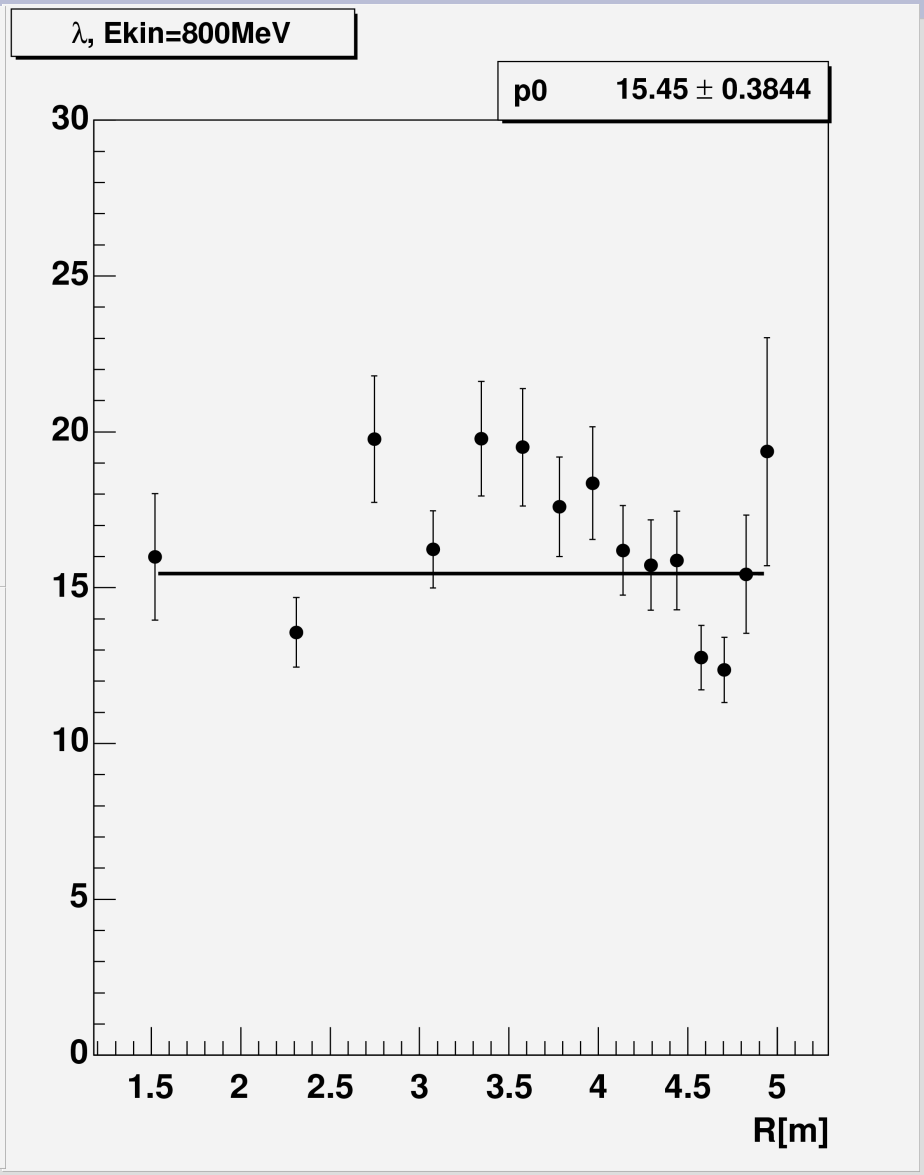




Optical model

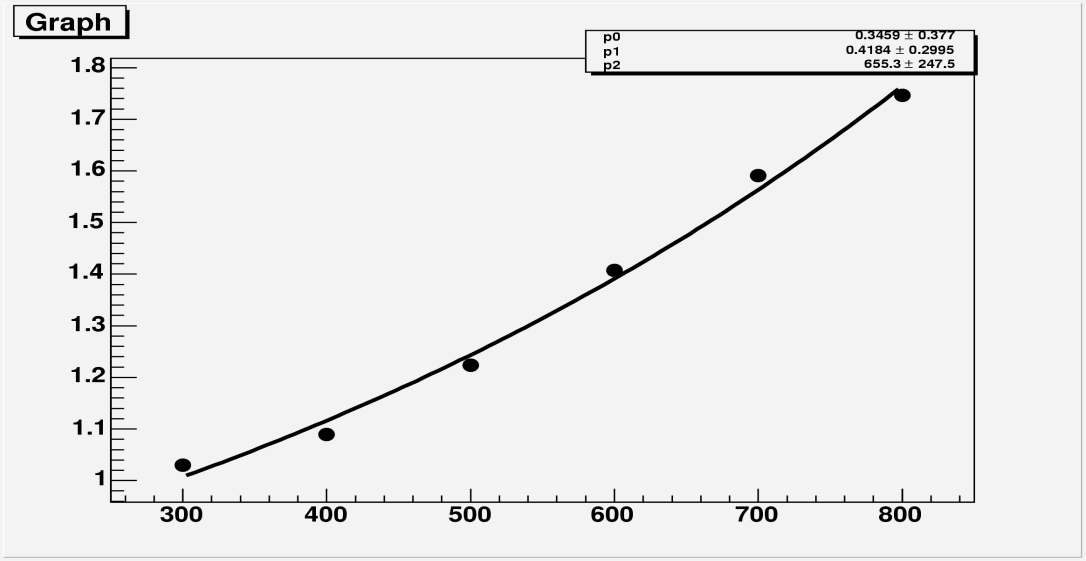
$$\lambda_{cer}$$

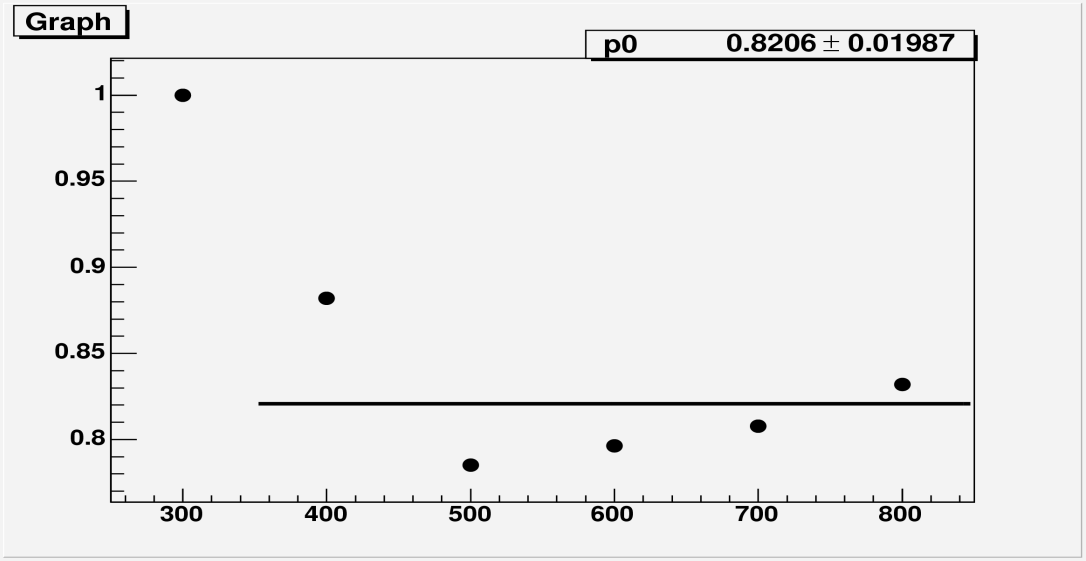




Optical model

Correction to the fluxes





Correction is due to some light(UVF, fluorescence) has been removed when creating Cerenkov and Scintillation samples.

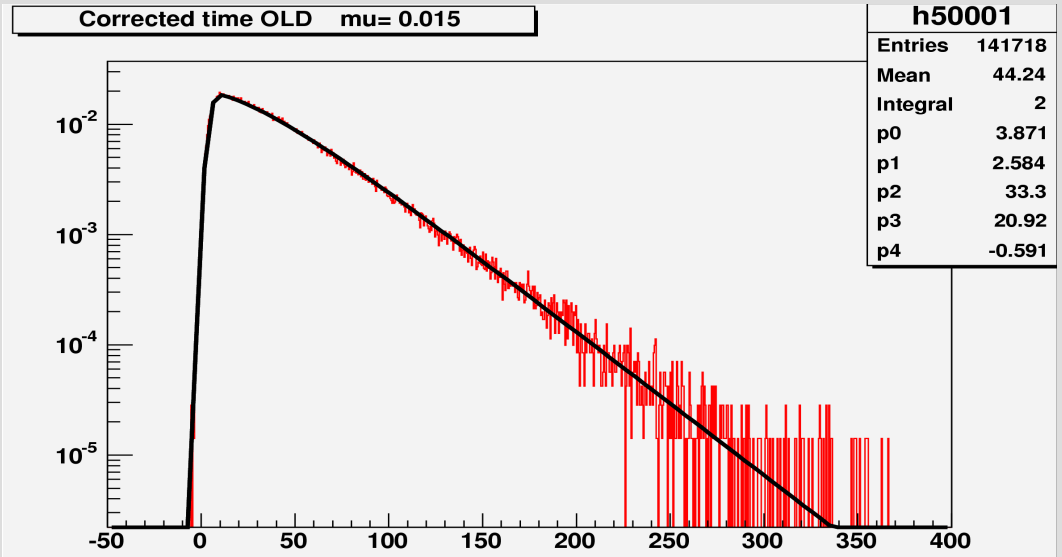
And also due to the presence of isotropic light in the Cerenkov sample.

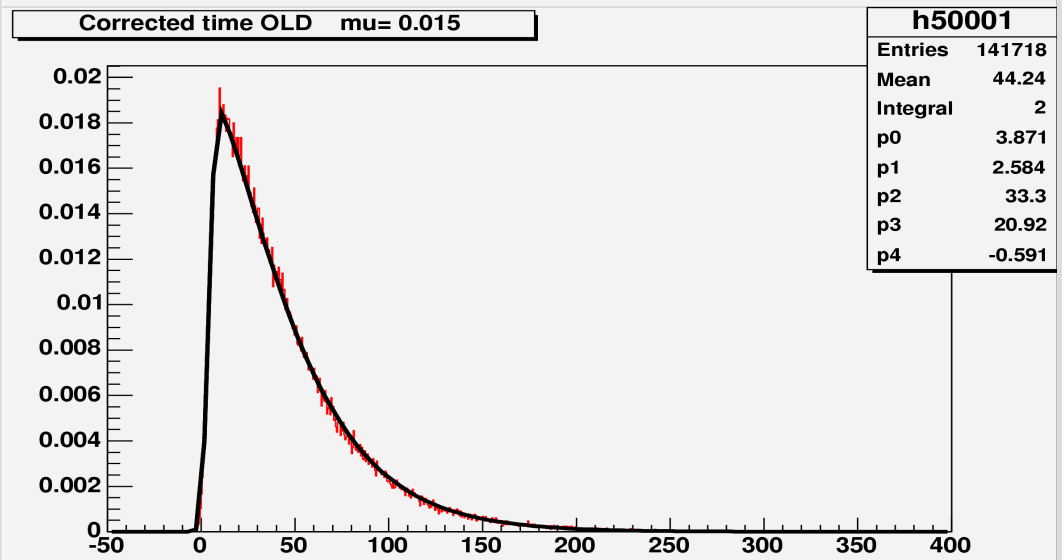
So, we have a model to predict charge on a pmt...

- Charge Likelihood
- μ is an input parameter for Time Likelihood

Time likelihood

Scintillation



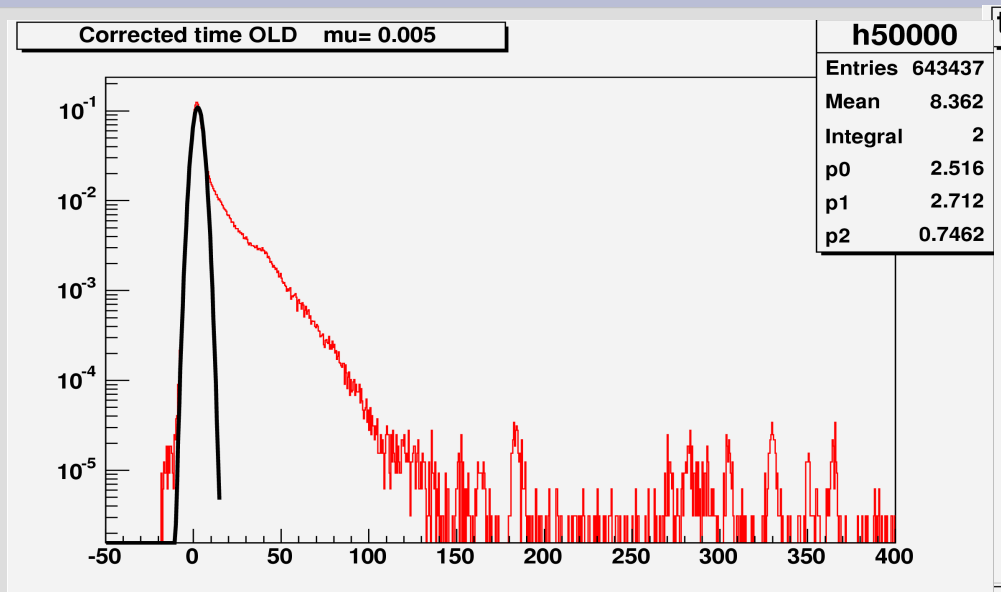


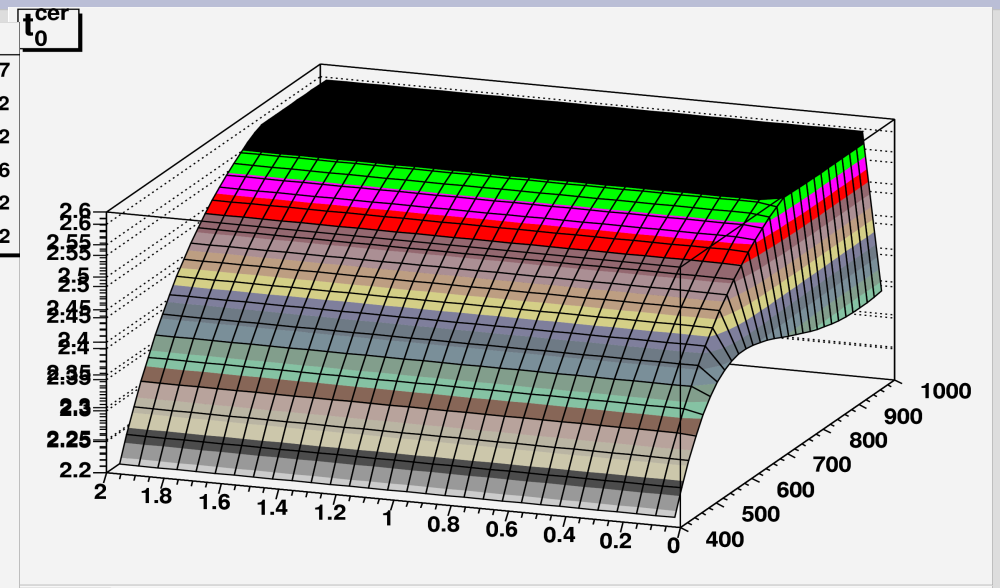
$$t_0, \sigma, \tau_1, \tau_2, P_{prompt}(\mu)$$

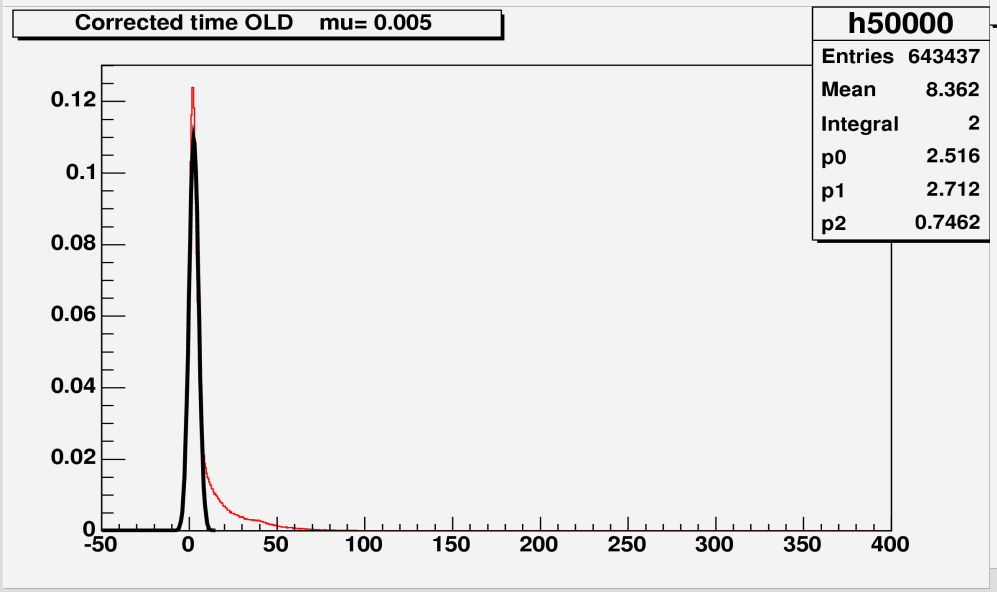
Time likelihood

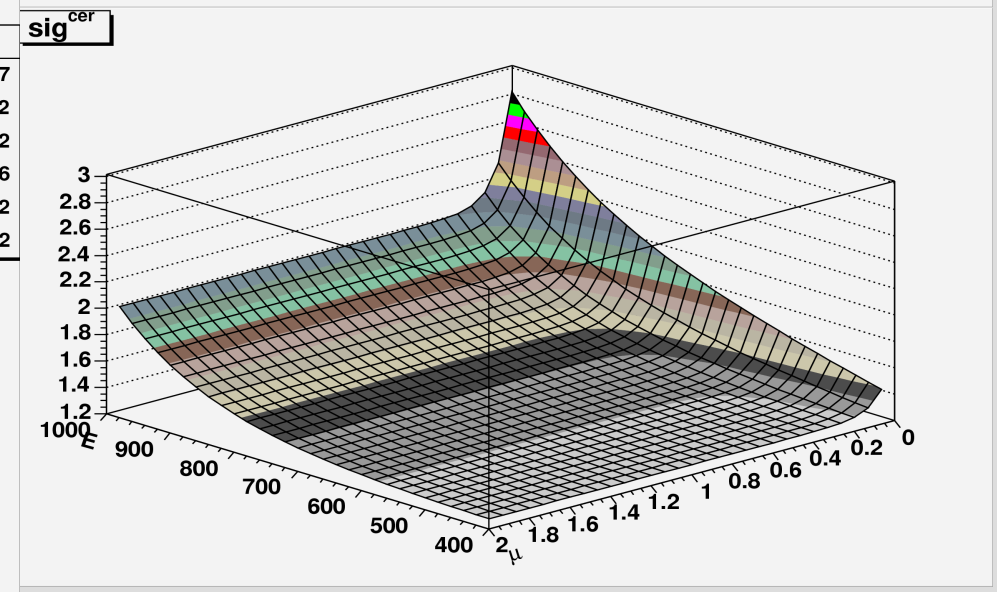
Cerenkov

$$t_0^{cer}, \sigma^{cer}(\mu, E)$$



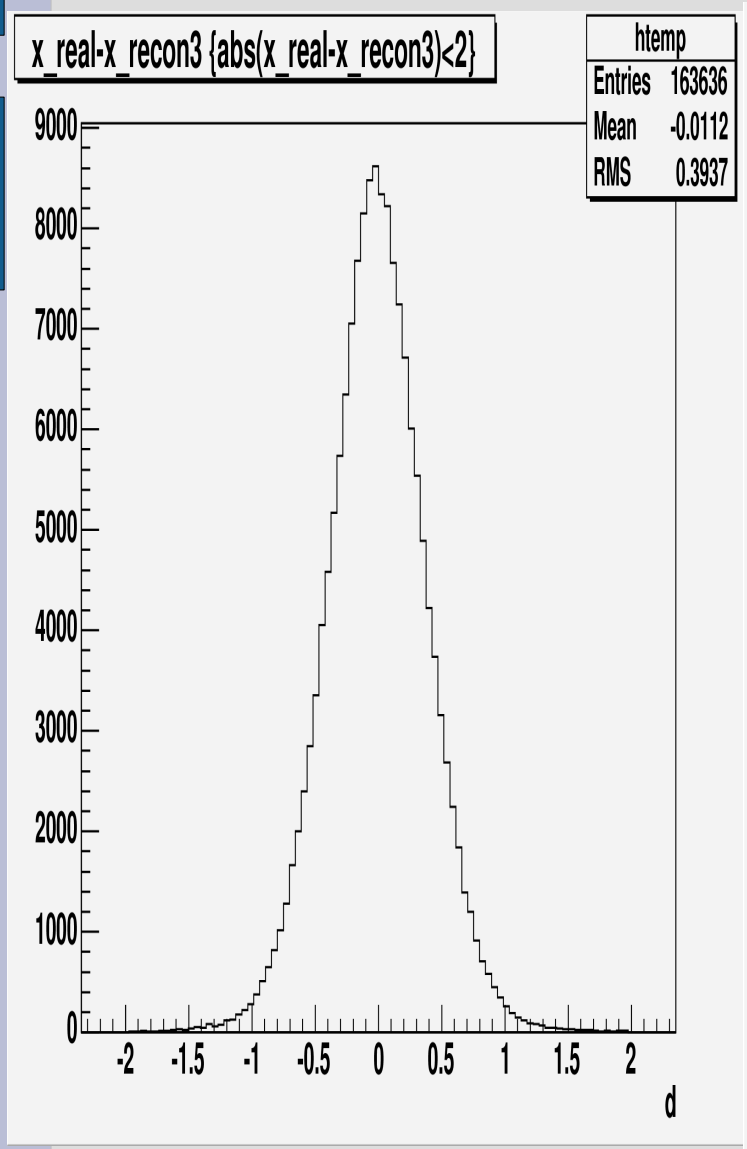


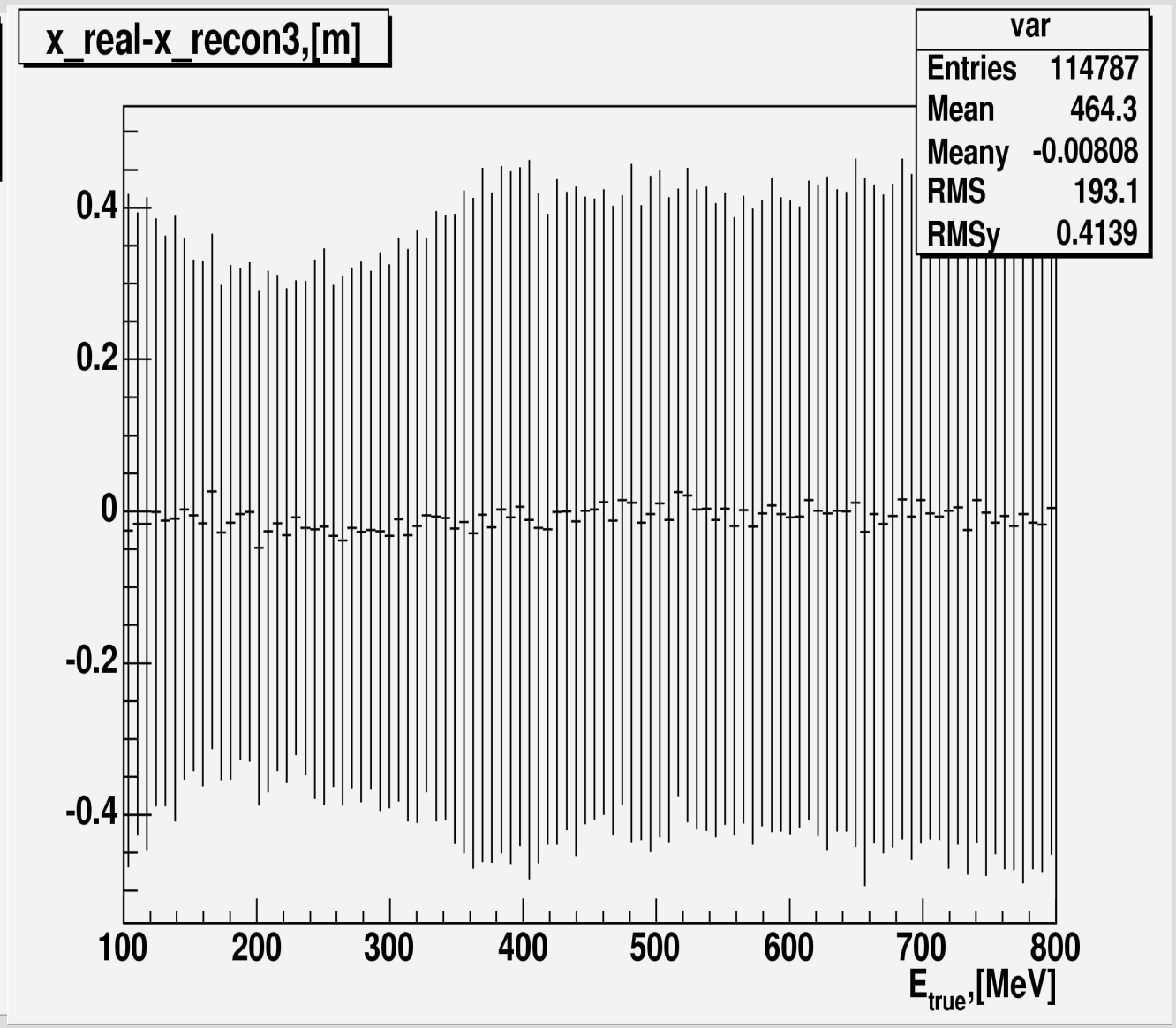




Reconstruction performance

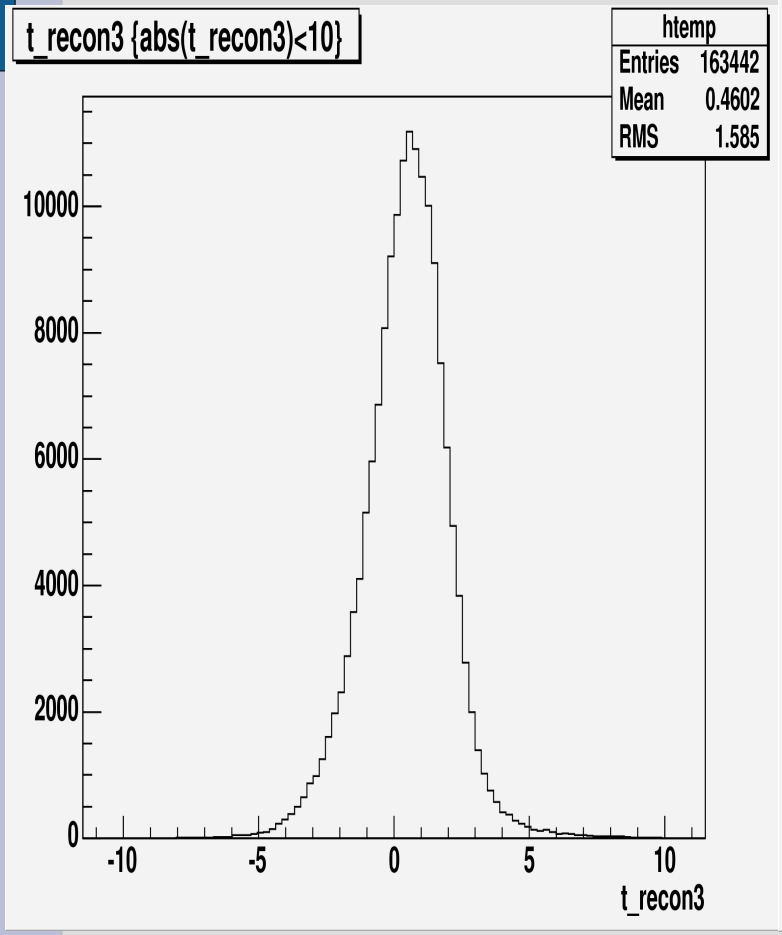
Position

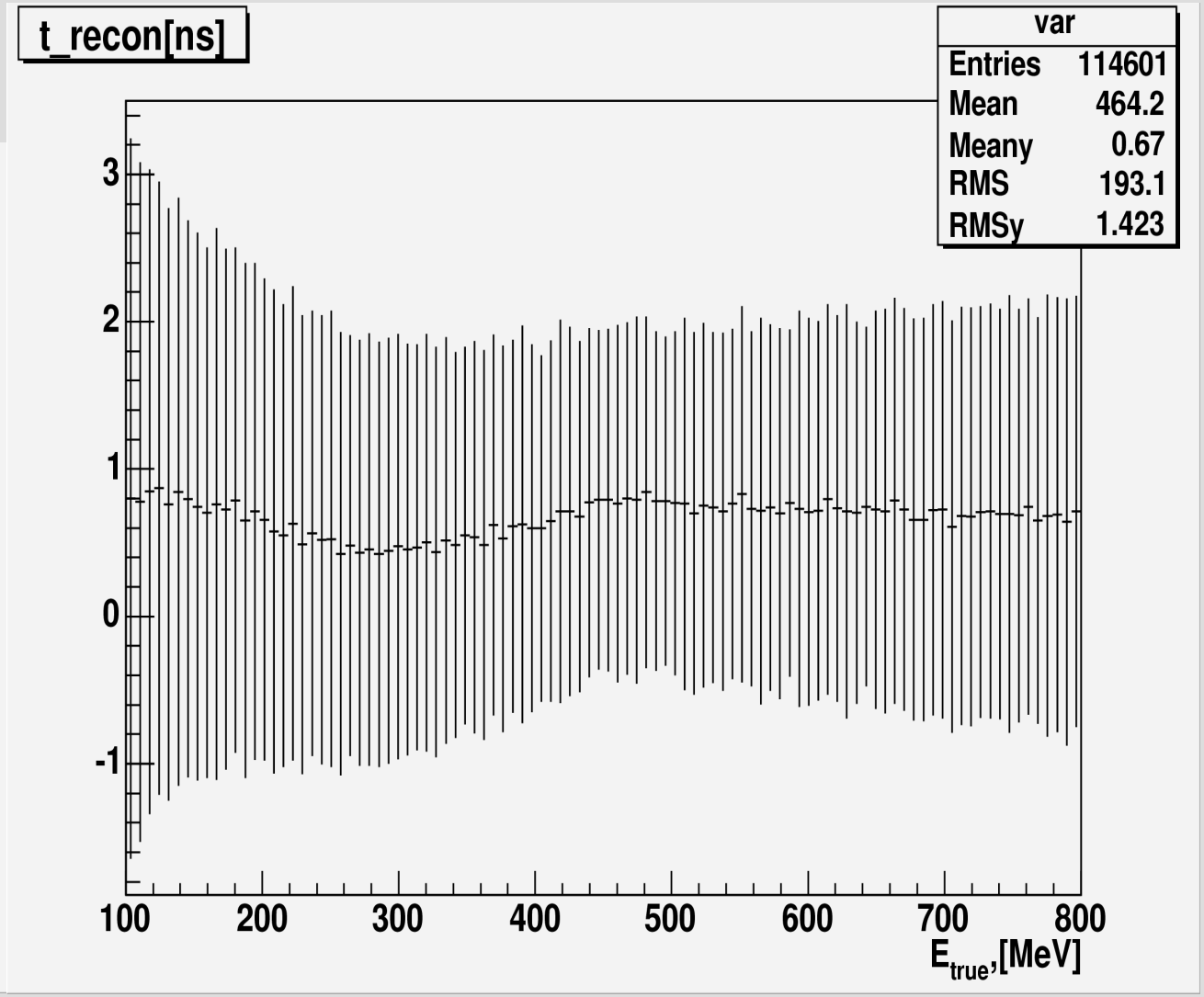




Reconstruction performance

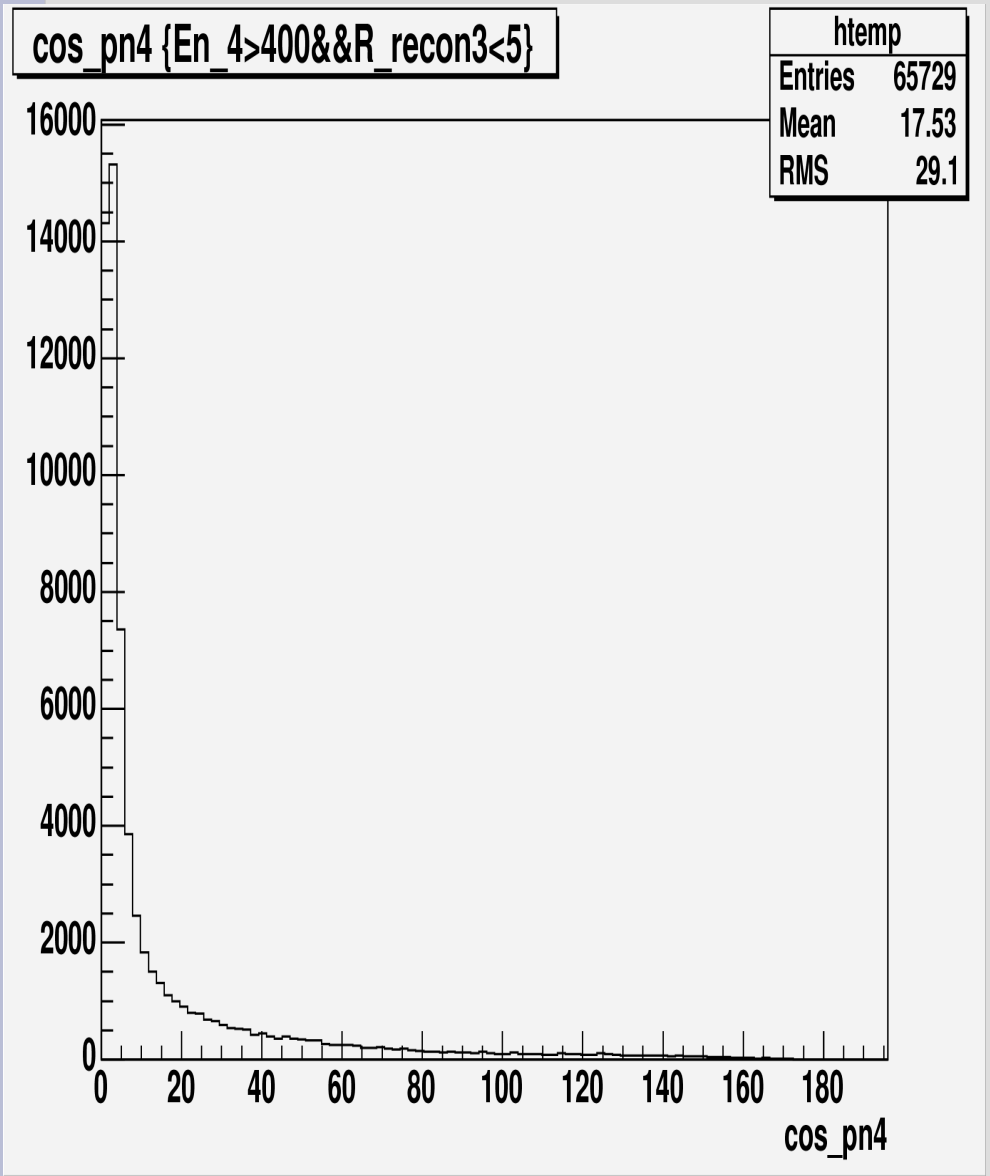
Time

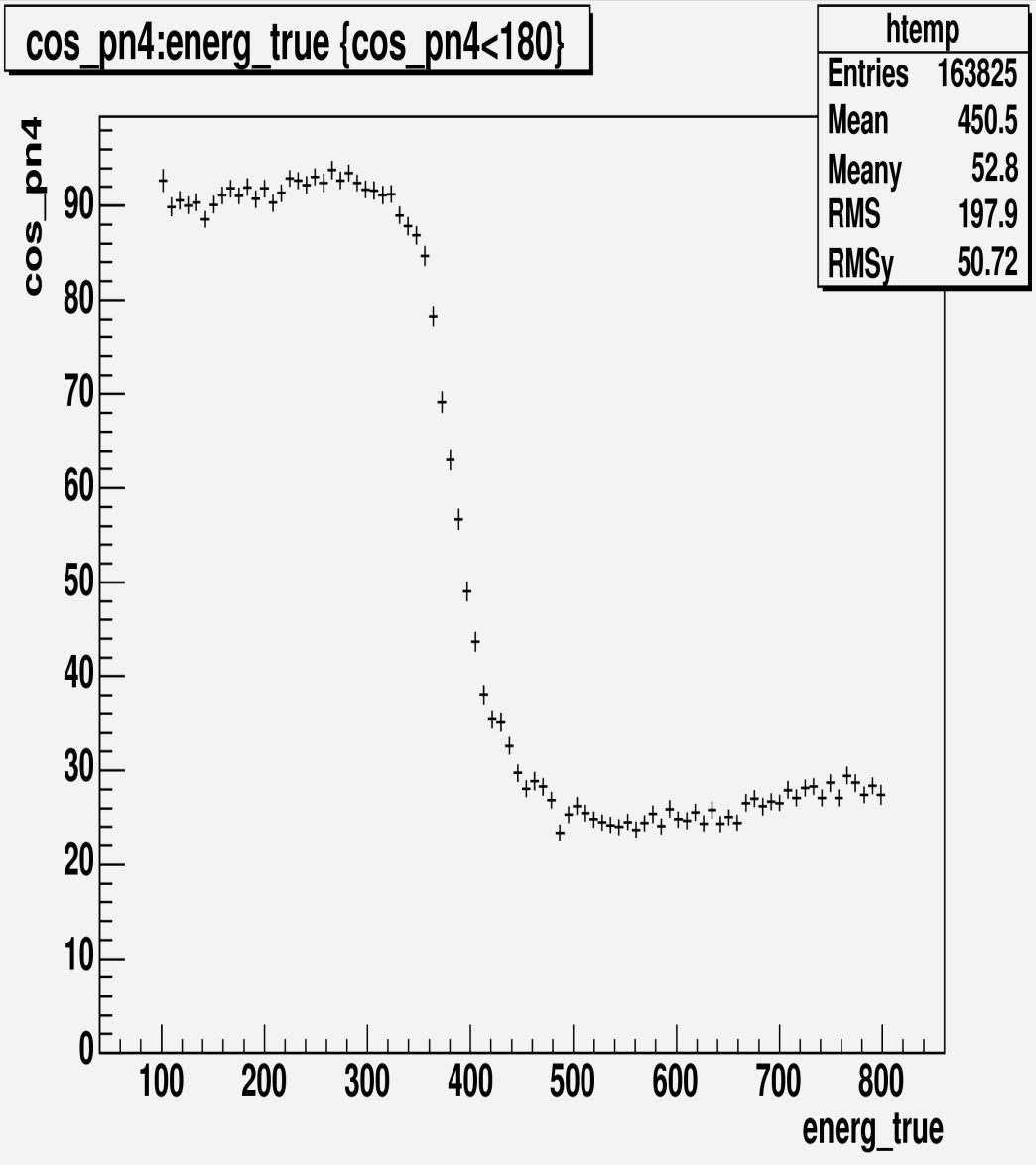




Reconstruction performance

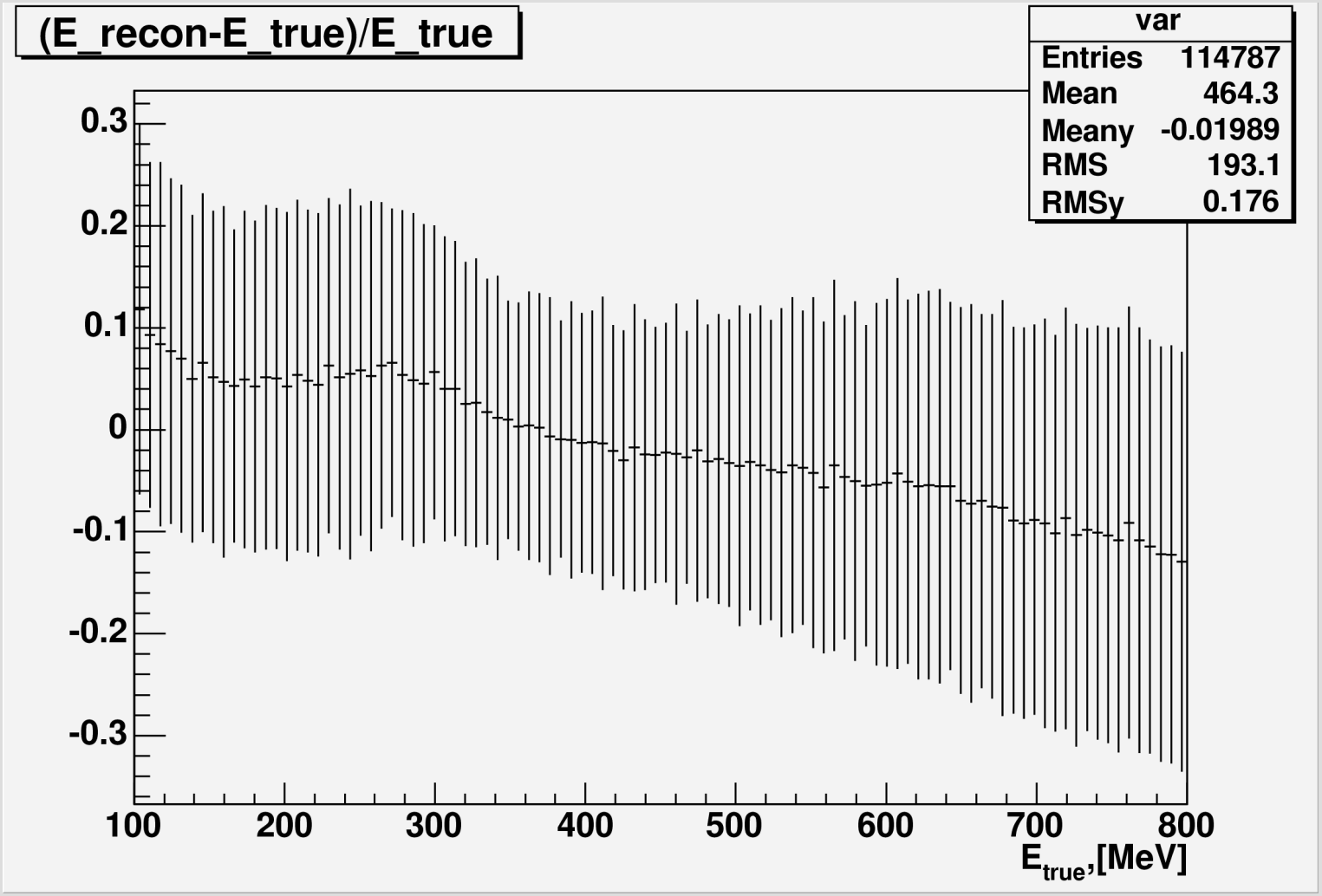
Direction





Reconstruction performance

Energy



Particle identification

After the reconstruction, we fill PID variables like

- nhits,μ,q in different cosθ, t_{corr} ,ring sharpness bins
- charge, time likelihoods under electron and proton reconstructions
- Visible energy, reconstructed energy under different hypotheses
- Reconstructed position, direction under different hypotheses

Using these variables, we can construct input variables for Boosting to separate samples of signal and background

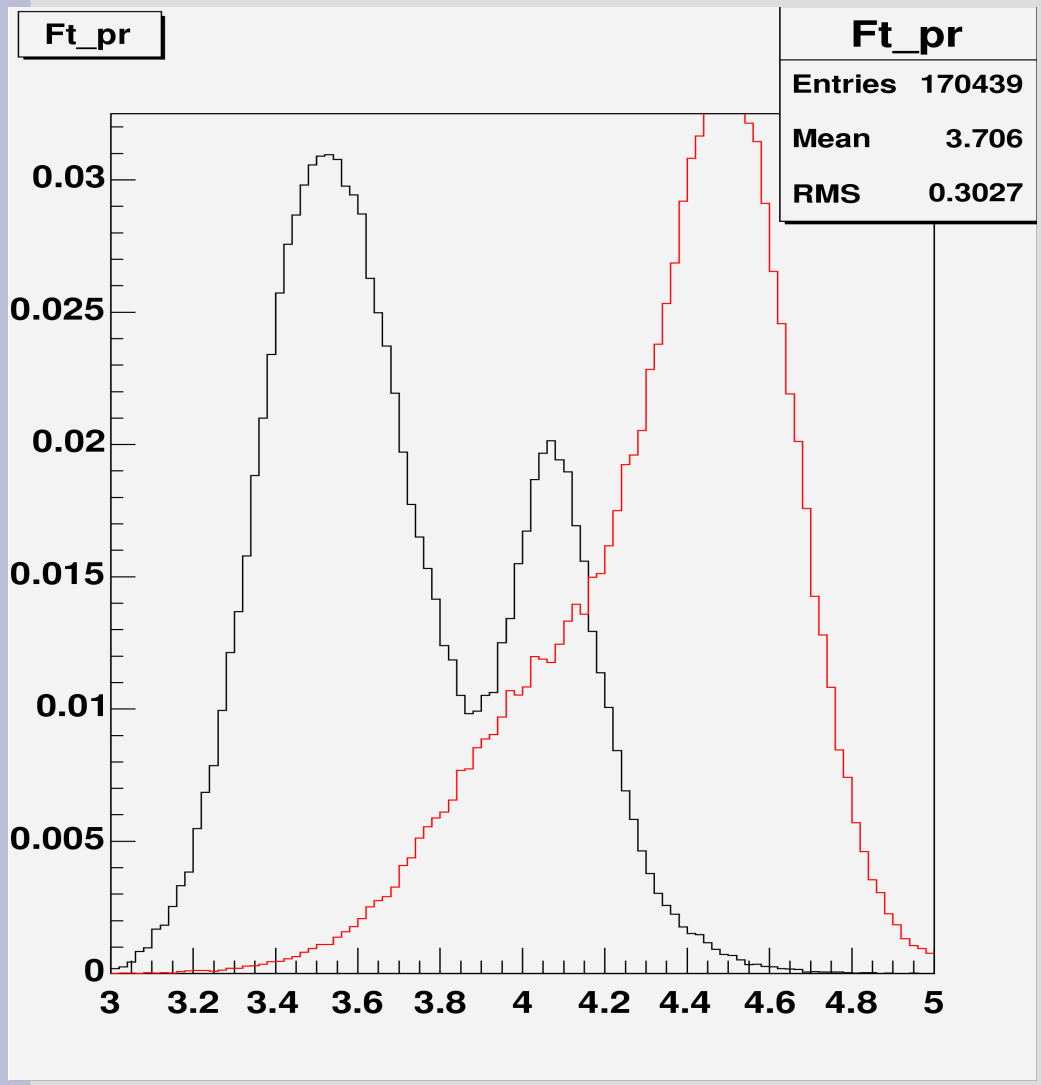
Particle identification

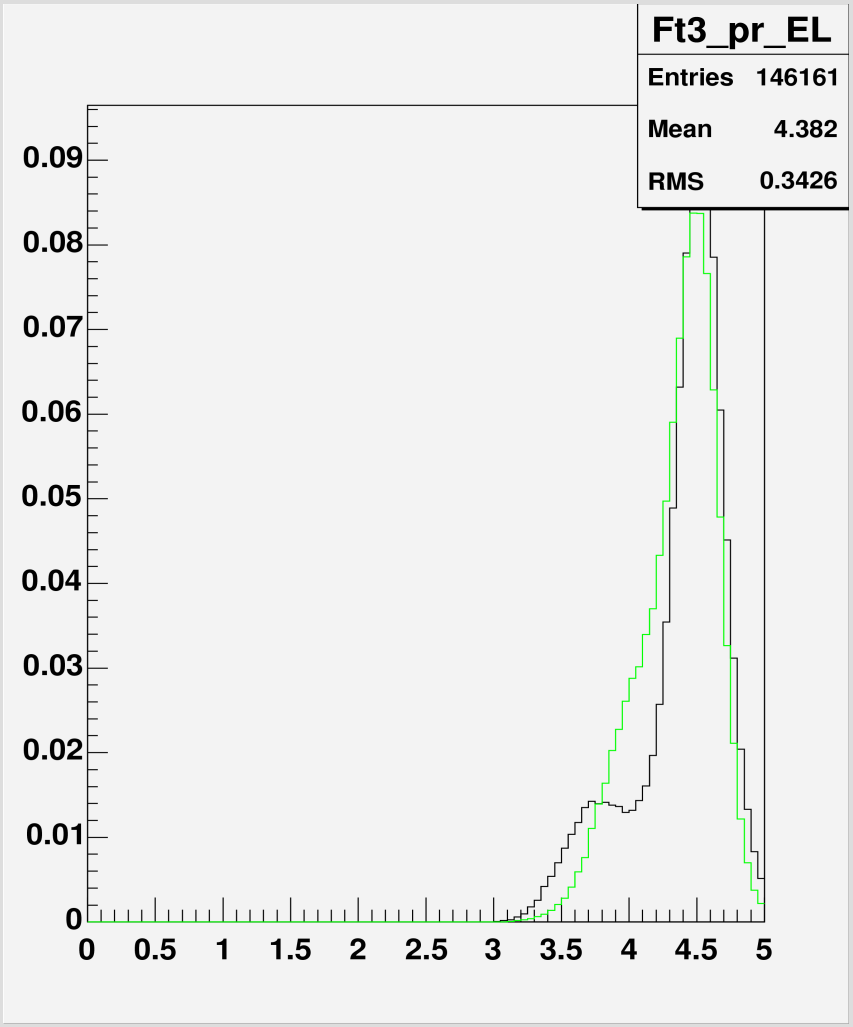
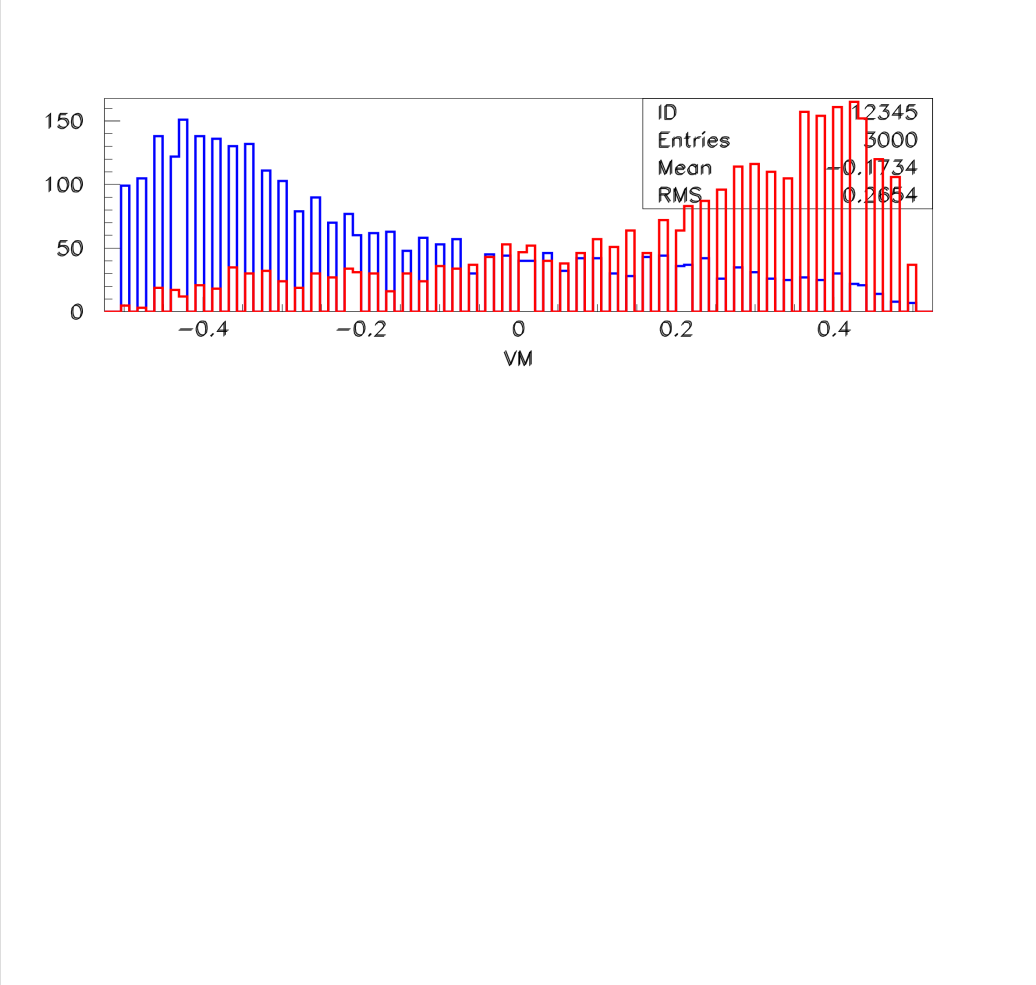
Testing samples

Protons 100-800MeV
Electrons 8.5-181MeV
Neutrons 100-1000MeV

Particle identification

proton/electron



Particle identification

proton/neutron