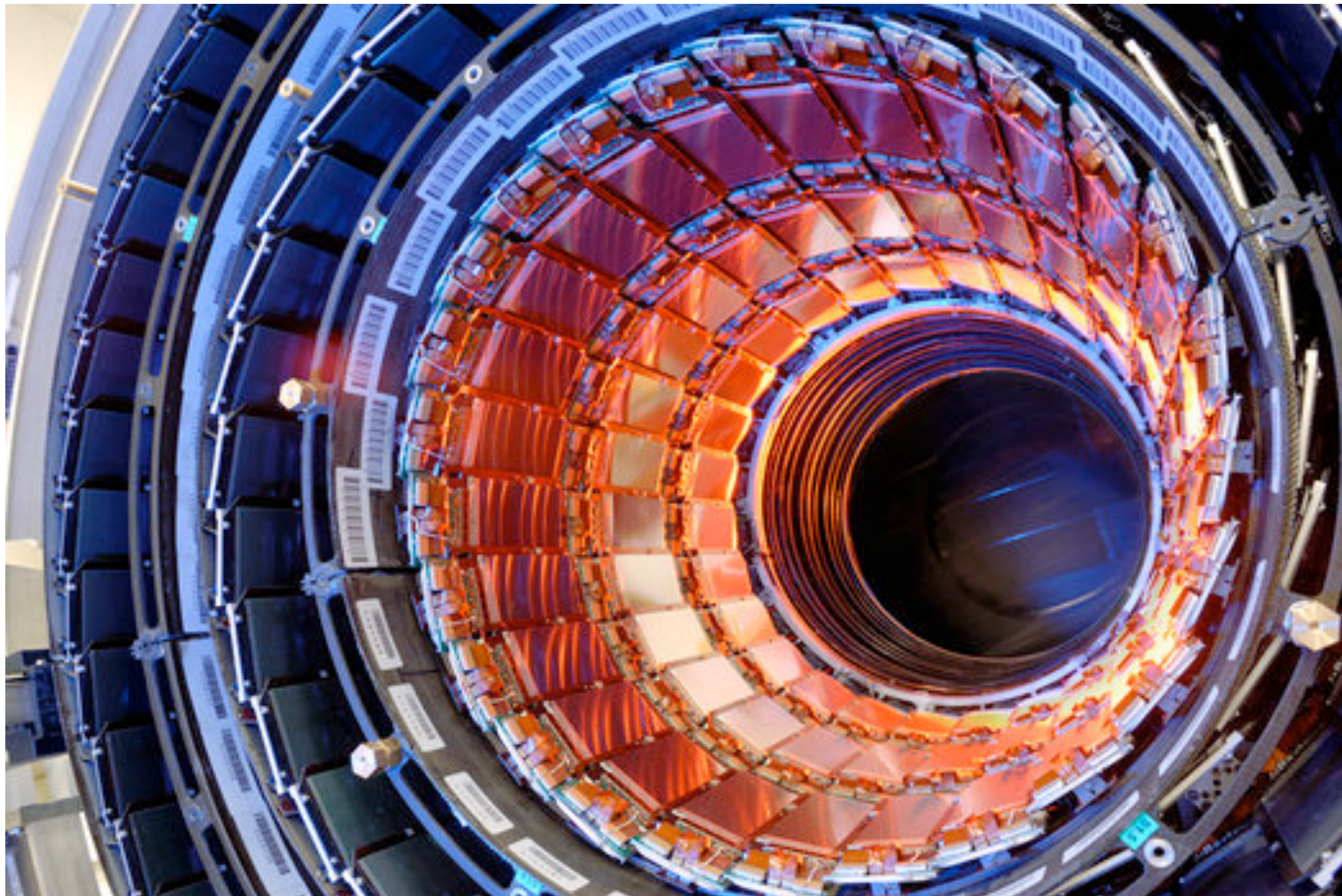
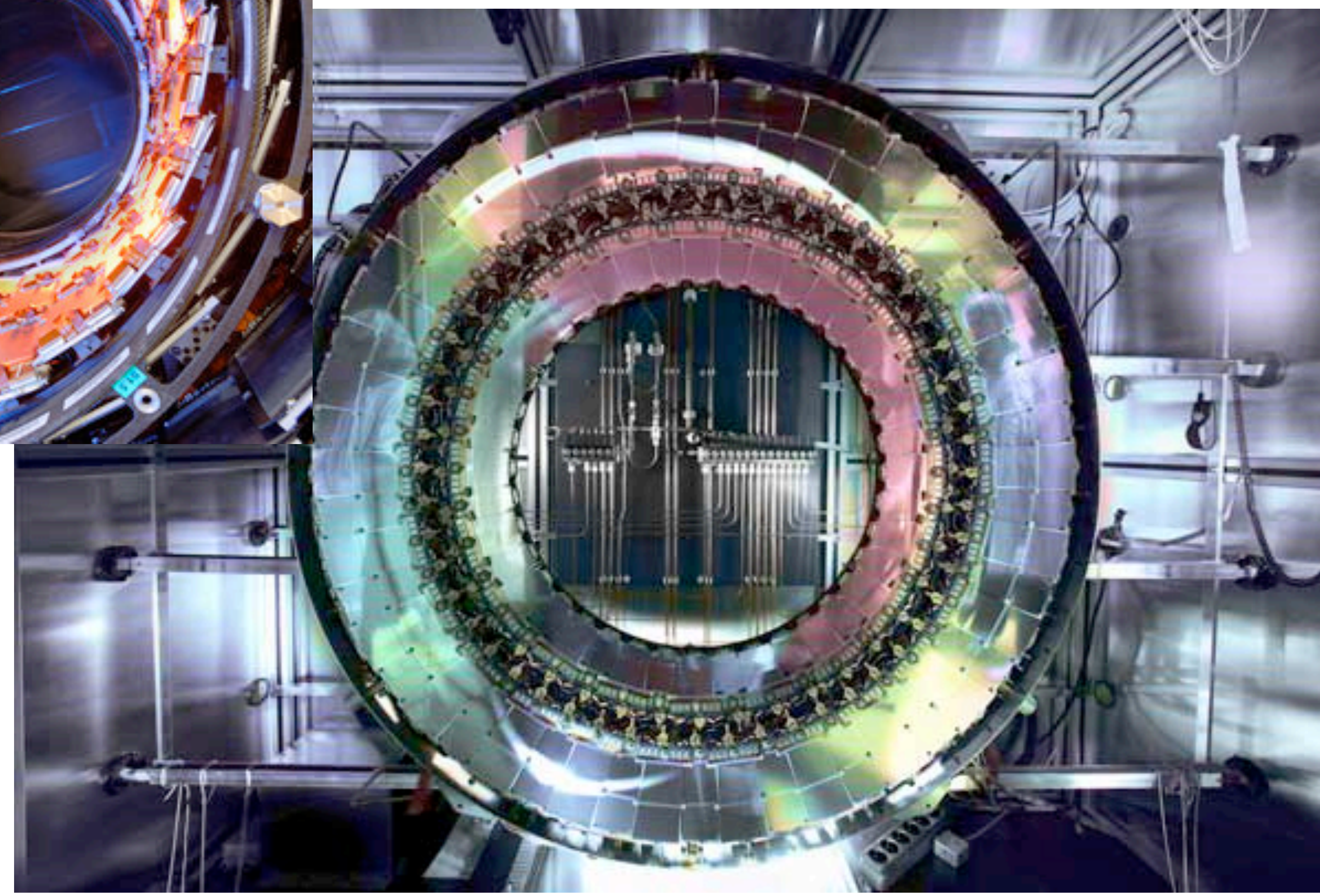
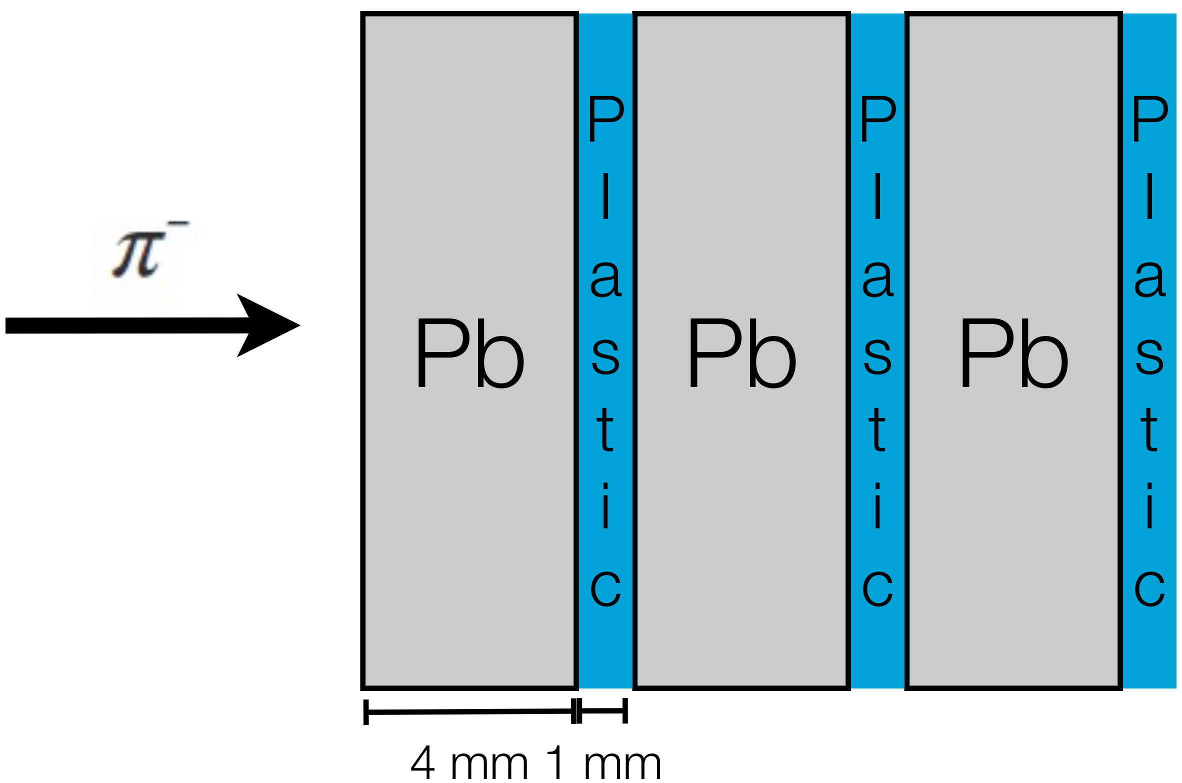




First look at sampling calorimeter

Andrea Delgado

Pb4mm1mmSz Sampling Calorimeter



Pb:

$Z=82, A=207.2, \varrho=11.34 g/cm^3$

Plastic scintillator:

$C_9H_{10} \quad \varrho=1.032 g/cm^3$

$$p_{beam} = \text{momentum of the beam particles}$$

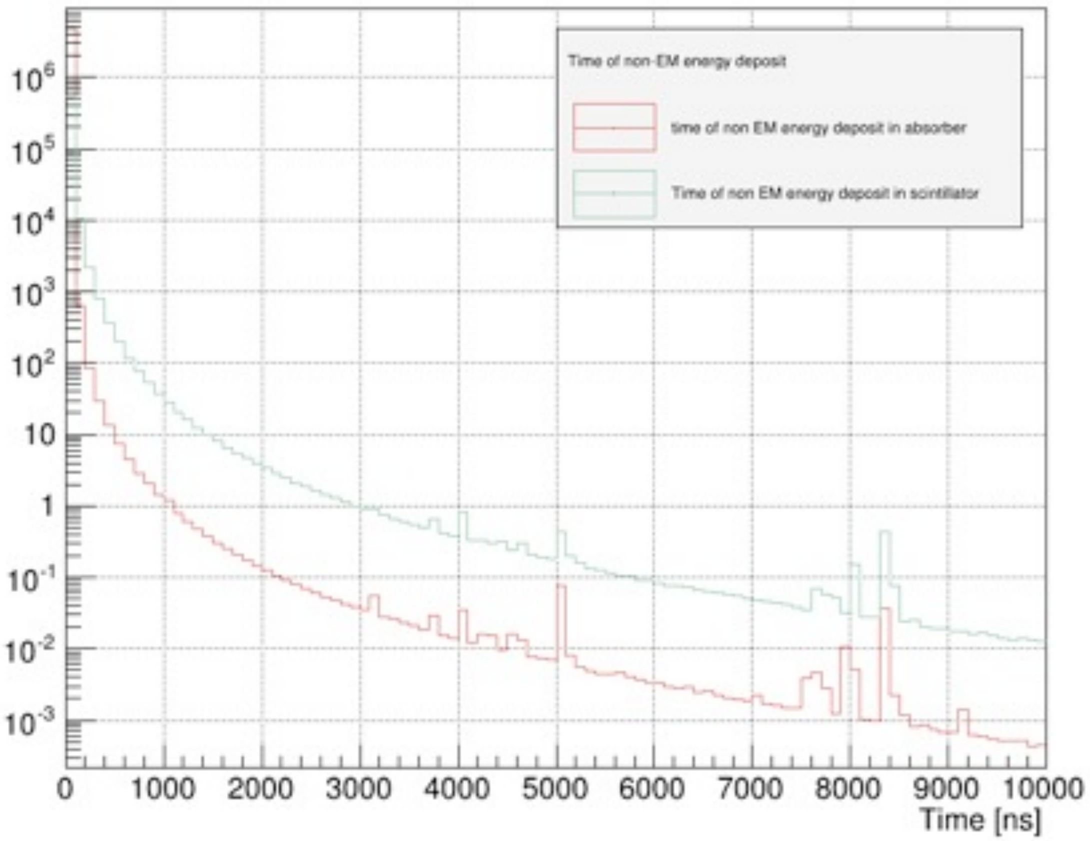
$$E_{beam} = \sqrt{p_{beam}^2 + m_{beam}^2} = \text{total energy of the beam particles}$$

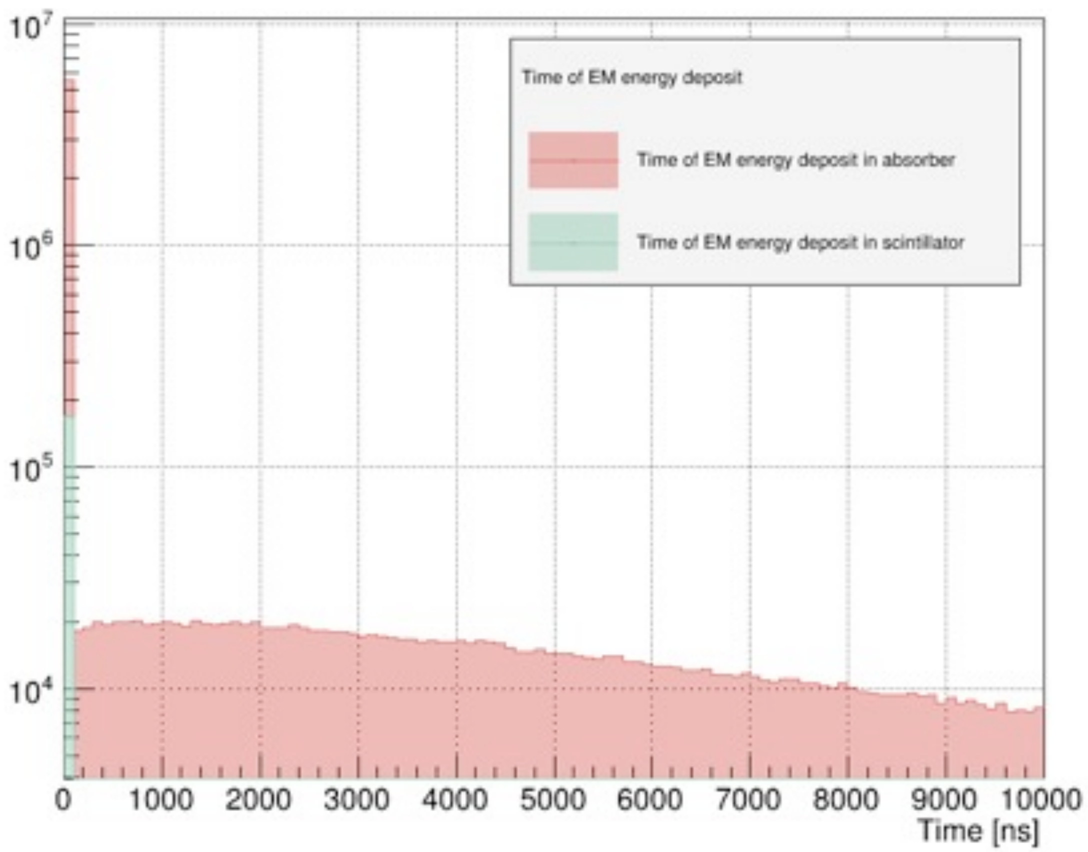
$$E_{kin} = E_{beam} - m_{beam} = \text{kinetic energy of the beam particles}$$

$$E_{dep} = \text{energy deposied in the entire calorimeter volume}$$

$$E_{in} = \text{total energy released inside a (infinite) calorimeter} = \mathrm{E_{beam}} = \mathrm{E_{kin}} + \mathrm{m}$$

Time of energy deposit





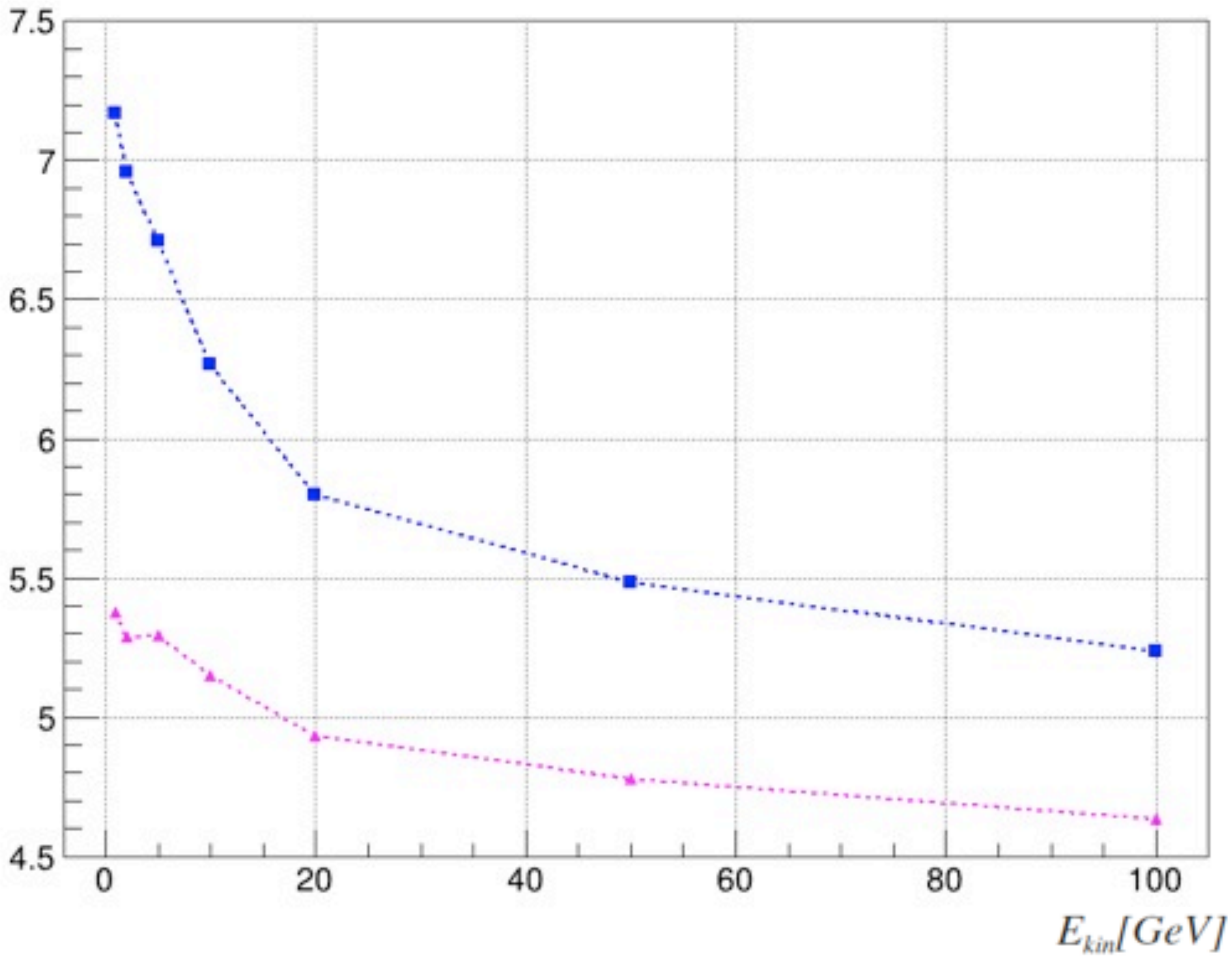
- Non- em energy (e+, e-, gamma) deposit is greater in scintillator than in absorber -> Non -em particles are stopped in the scintillator.
- Em energy deposit in scintillator is prompt.
- The long tail in the EM energy deposition distribution is due to the neutrons that take long to thermalize and get captured.
  - ➡ Many of these neutrons do not make it through the time cut of 10 microseconds.
  - ➡ Signal from neutrons could be enhanced if neutrons thermalize faster.

-> 15 GeV incident pi-
-> 1,000 events
-> FTFP_BERT Physics list
-> Pb4mmSc1mm gdml

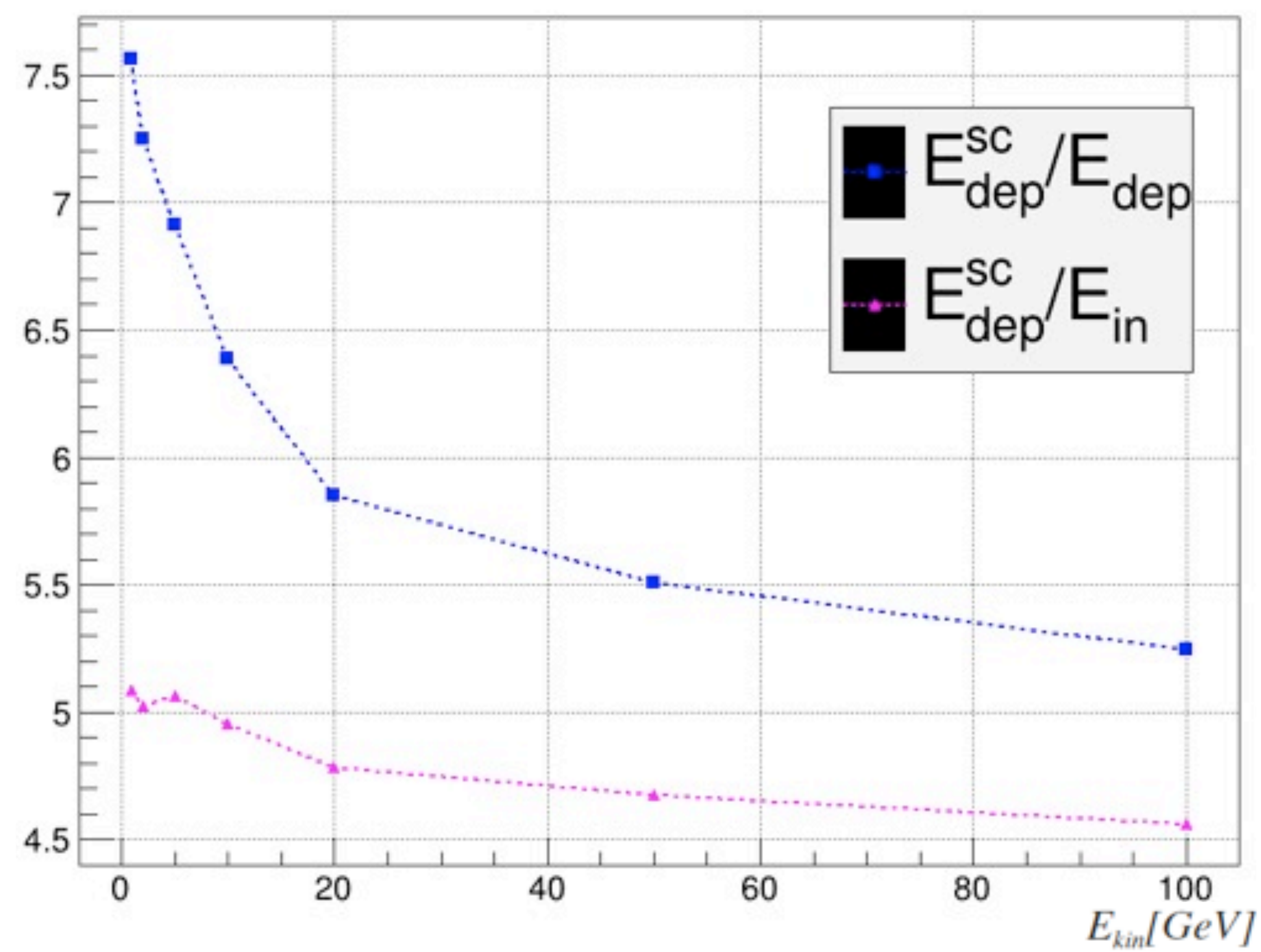
What happens if we apply a 100 ns time cut?

- How does it affect energetic resolution?
- Important for neutrons contributing to signal generation in neutron capture processes.

Sampling fraction (scintillator)



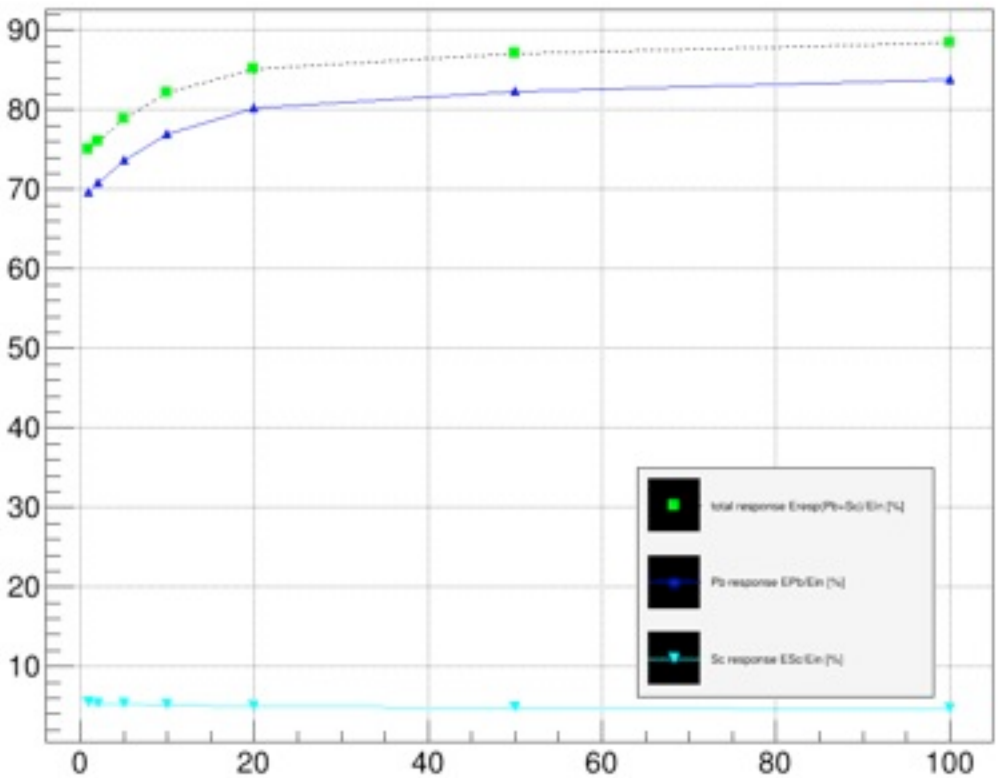
No time-cut



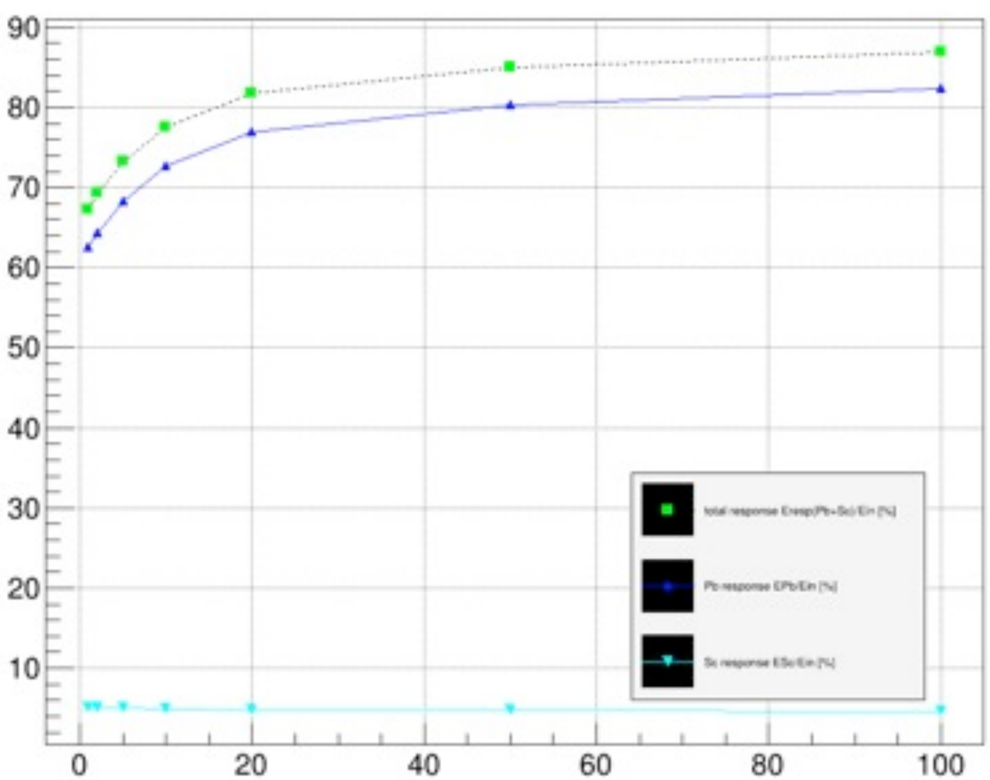
100ns time-cut

Time-cut study

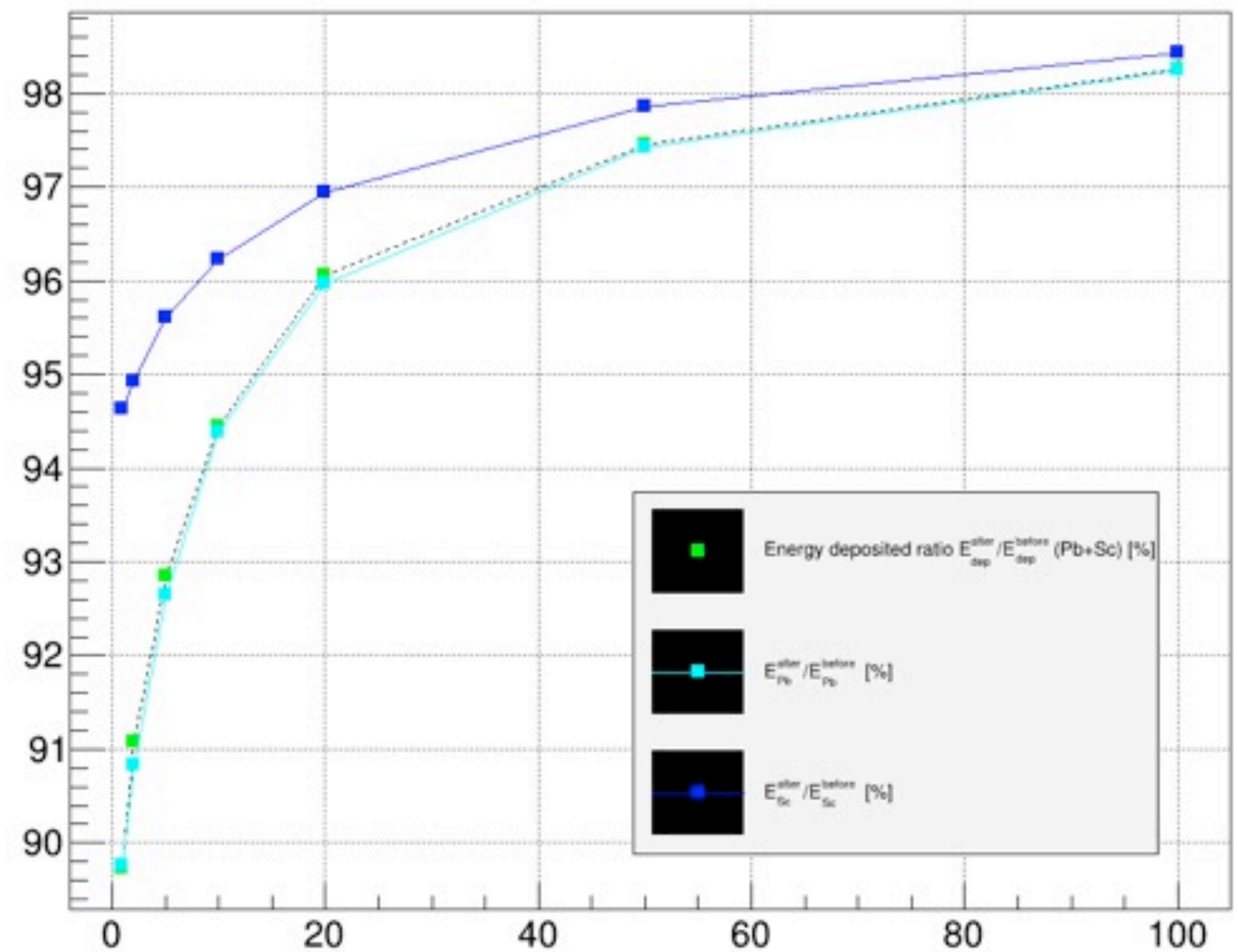
Energy response before time-cut



Energy response after 100 ns time-cut

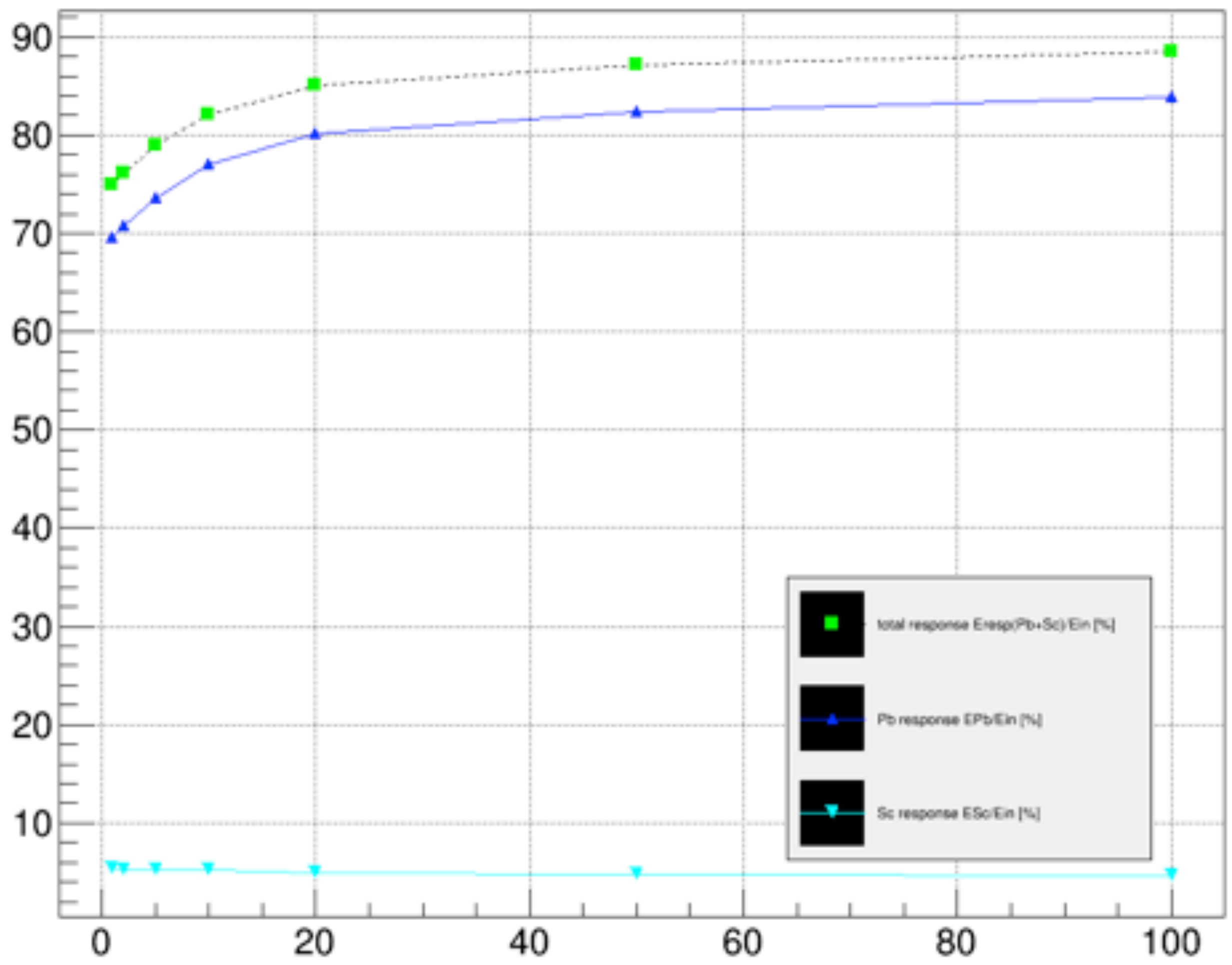


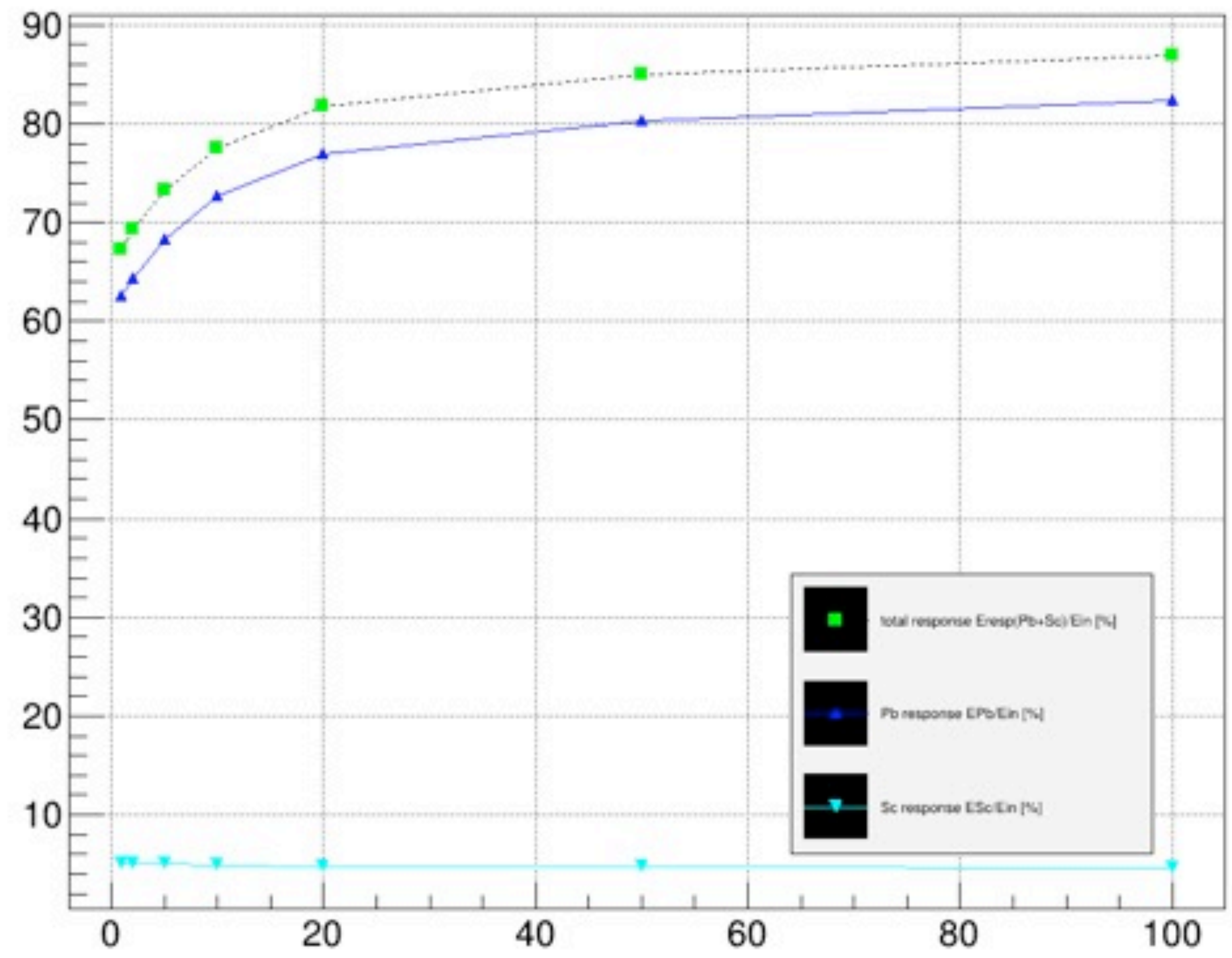
Ratio of responses before and after time cut



- Time cut not very important in scintillator, where the difference in deposited energy goes from ~6% at 1 GeV to ~1.5% at 100 GeV.
- For the absorber, this difference is more dramatic at low energies, it goes from ~10% at 1GeV to 2% at 100 GeV.

Ratio of energy deposited in scintillator/absorber to Ein (%)





No time-cut

$$f(x) = p_0 + p_1 x$$

100ns time-cut

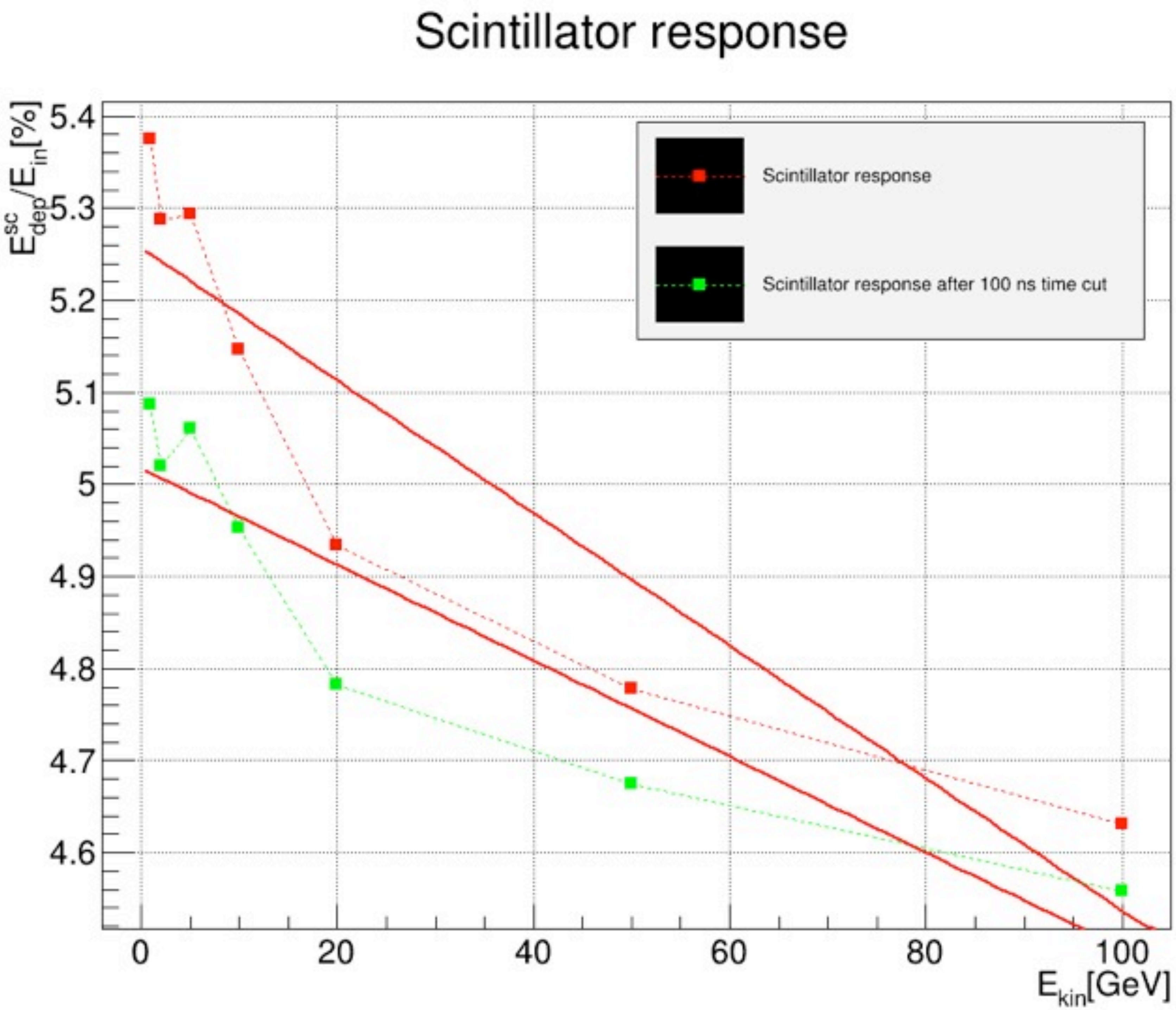
$$p_0 = 5.2567 \pm 0.061014$$

$$p_1 = -0.007202 \pm 0.001414$$

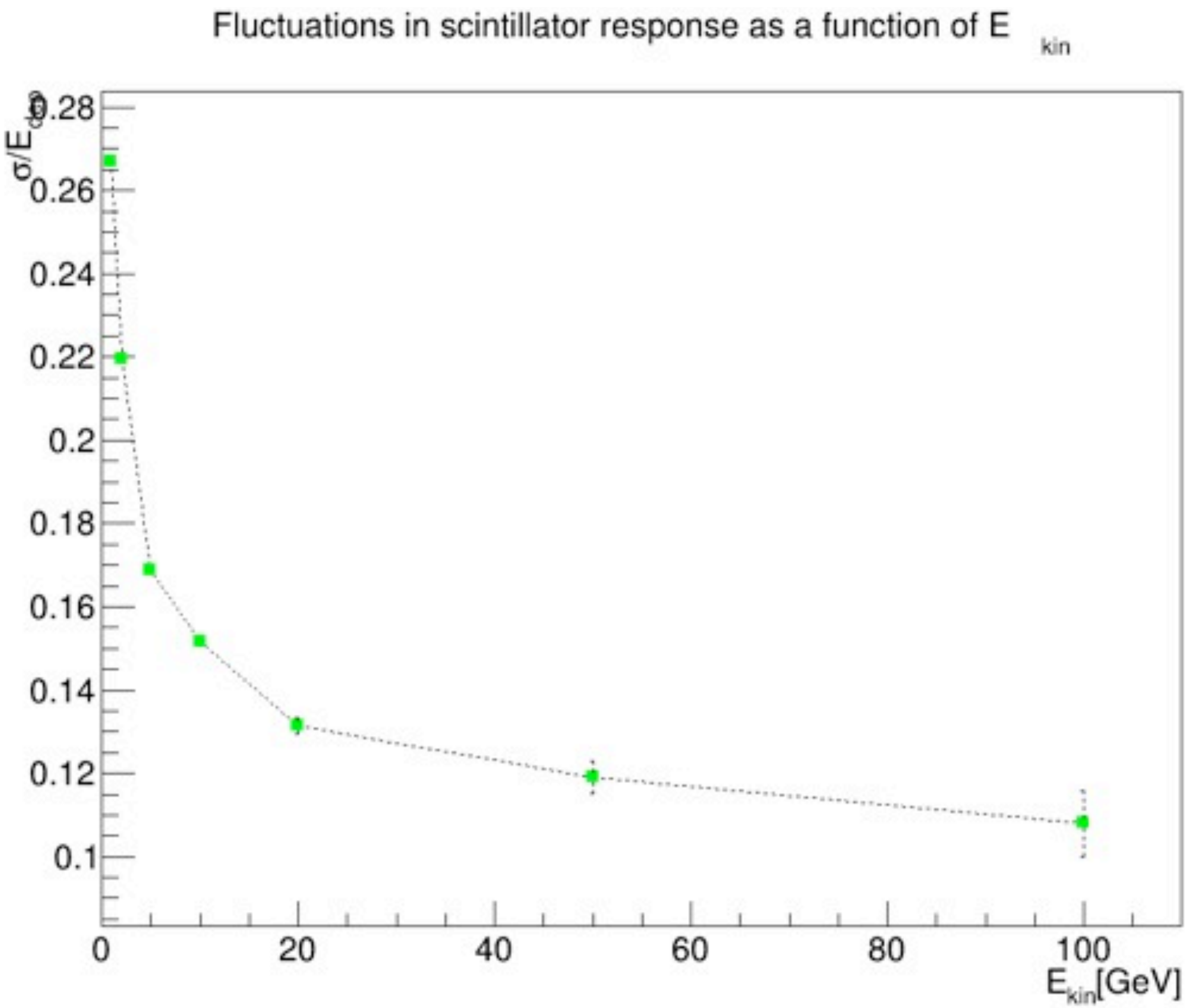
$$p_0 = 4.9677 \pm 0.0040239$$

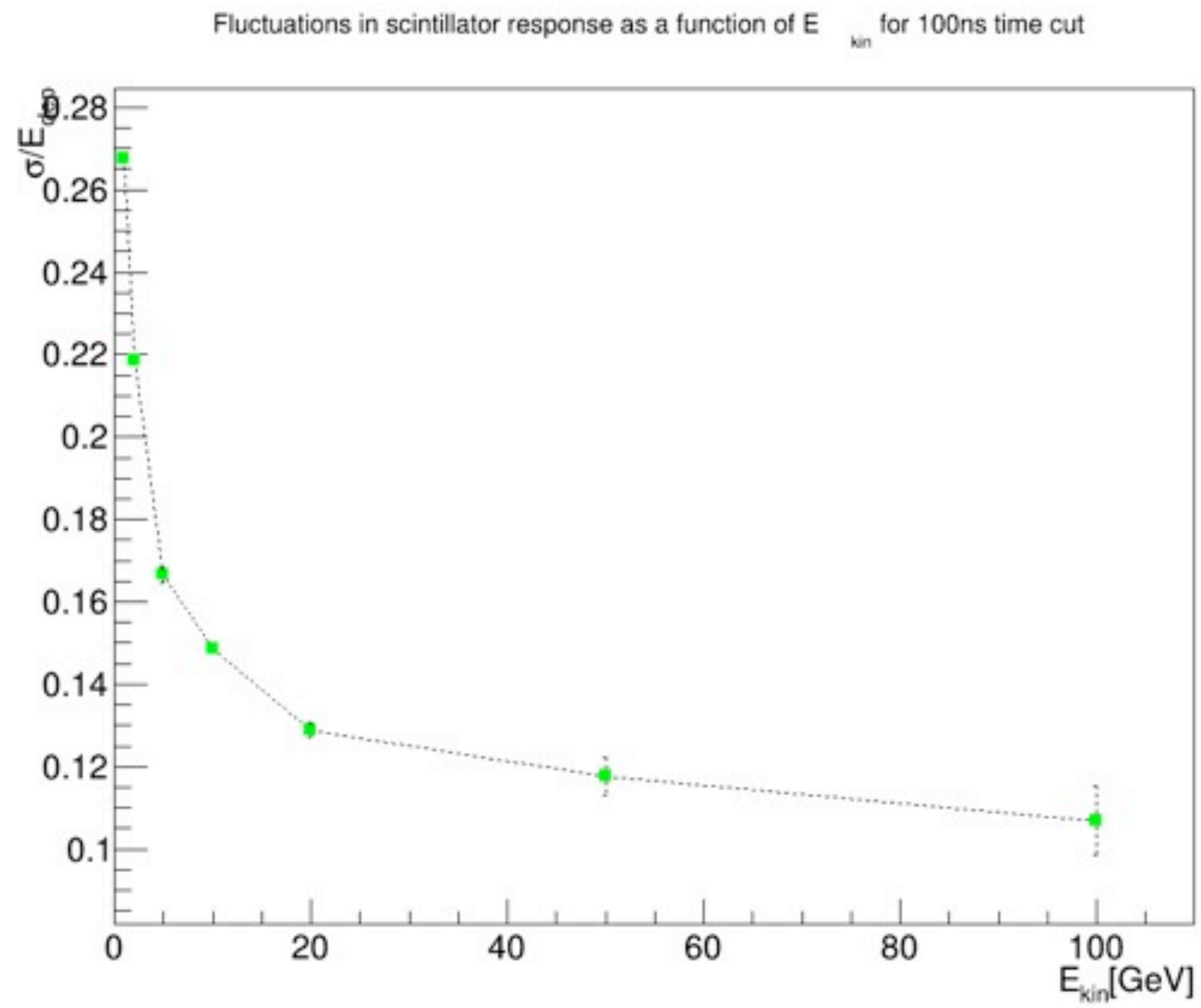
$$p_1 = -0.0044603 \pm 0.0006808$$

Is scintillator response linear with kinetic energy?

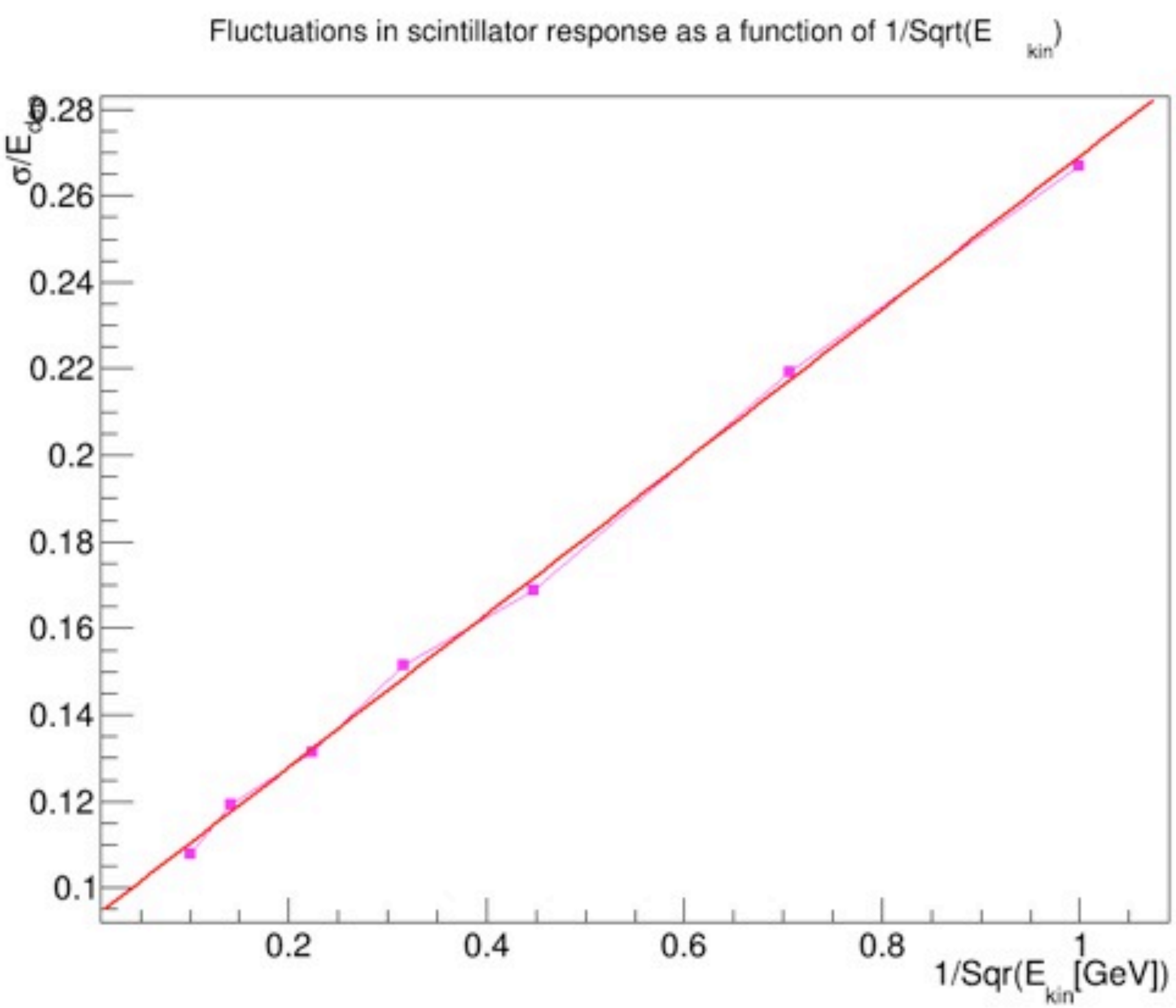


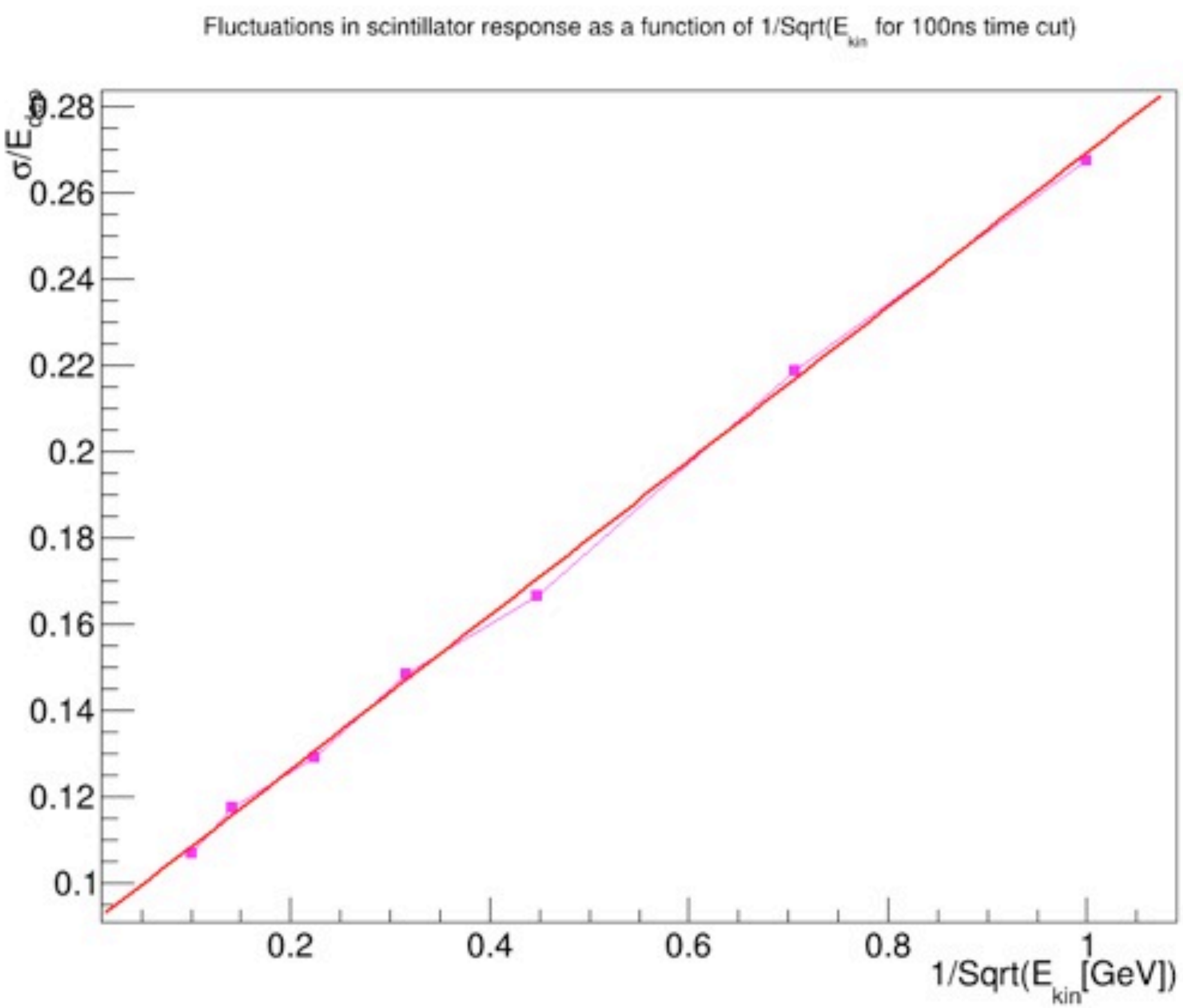
What about energetic resolution?





What about energetic resolution?





po = 0.0928425 +/- 0.00164473
p1 = 0.17548 +/- 0.00317369

po = 0.0873467 +/- 0.0014723
p1 = 0.18328 +/- 0.00291982

Summary

- A study of the time distribution of energy deposition as it is important for energetic resolution and could be a factor we can modify to enhance neutron signal contribution.
- After applying a 100 ns timecut, energy response in scintillator is decreased by about 3% in the low kinetic energy range for a single incident charged pion. For incident particles with larger kinetic energies, this time cut does not seem to make a great difference.
- Overall, energetic resolution does not seem to be affected in a dramatic way by the time cut.