Inclusive Neutron Production

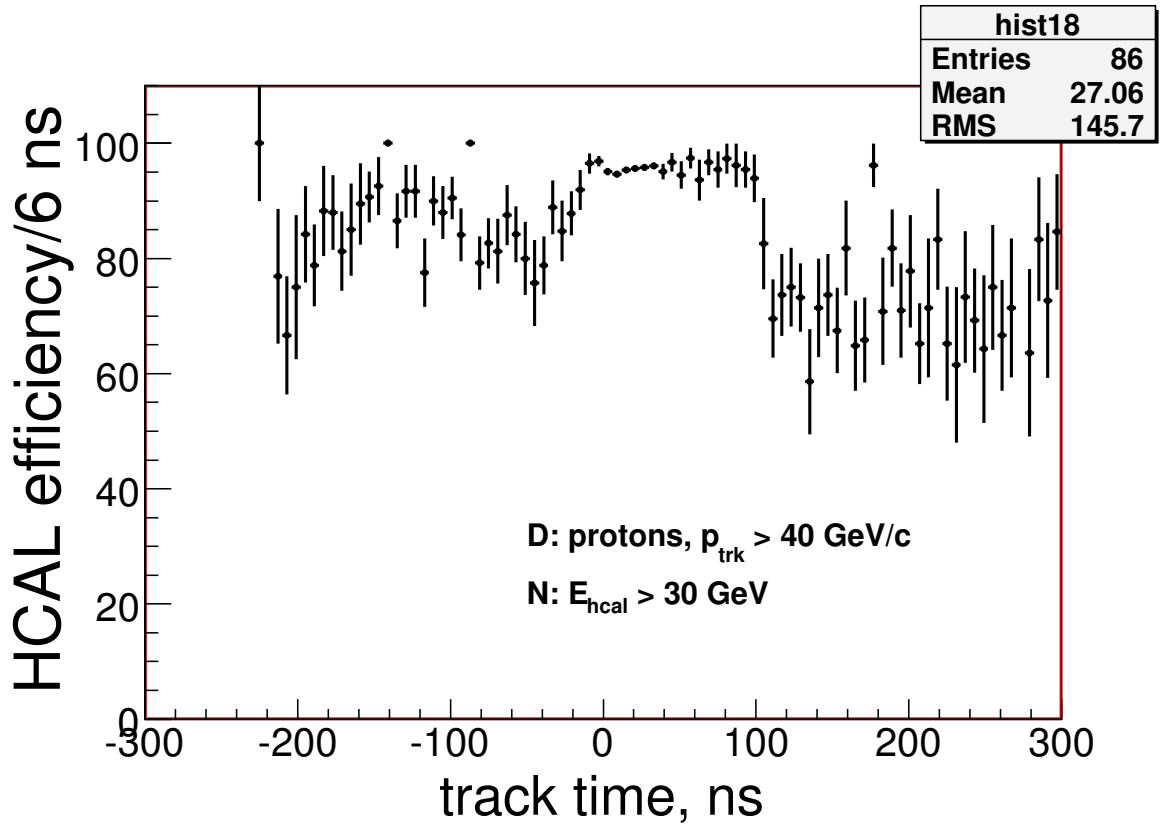
- Runs: 17090 - 17240
- Momentum - 59 GeV/c, Uranium
- Trigger - proton interactions
- Event/track selection cuts:

  - select clean events, nTrks$<$20

  - use events with single beam track

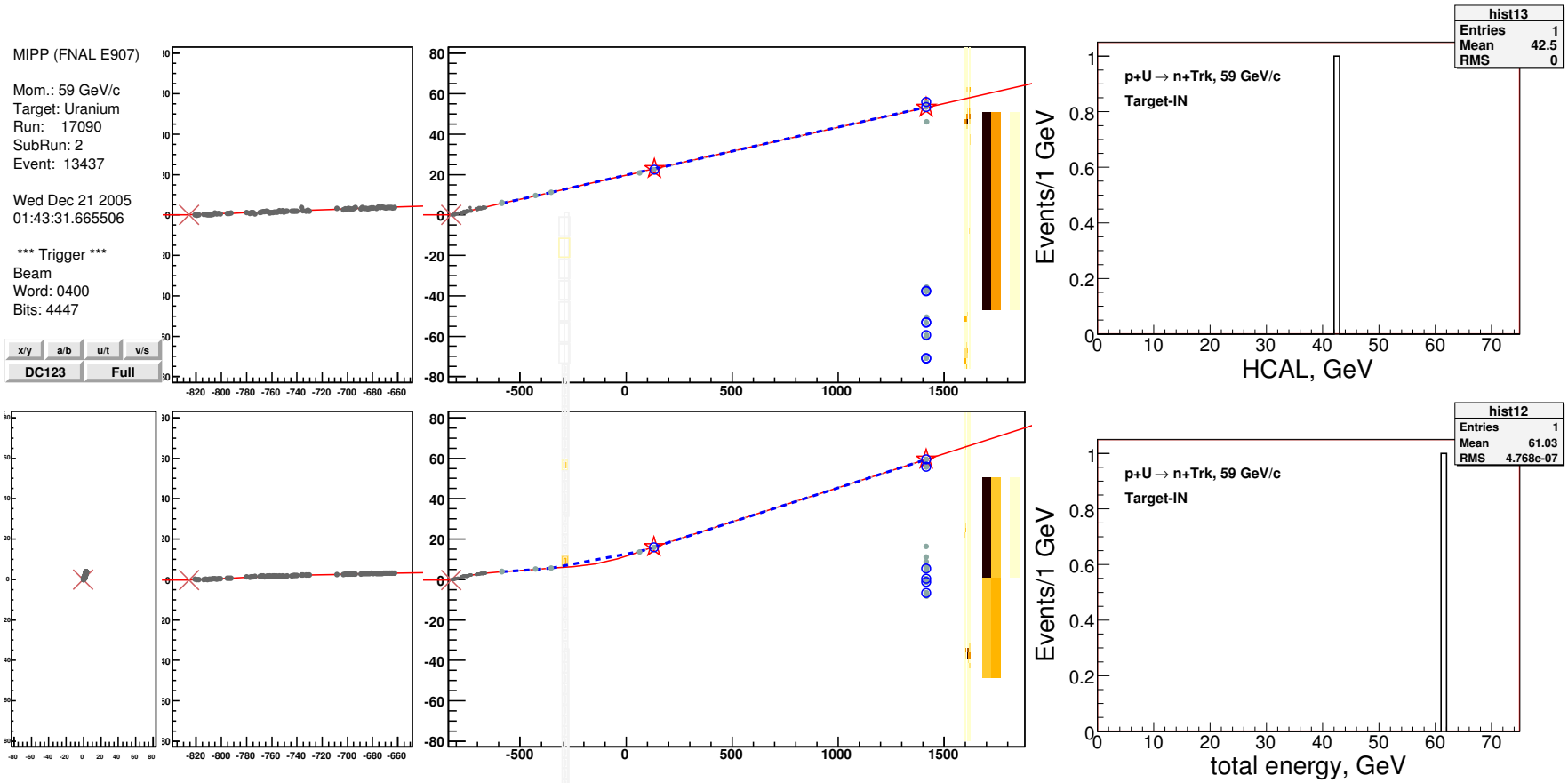
  - the vertex should be within the target sizes
  - require the good quality tracks in the vertex: reasonable nTPC hits, timing

HCAL efficiency vs incoming track time



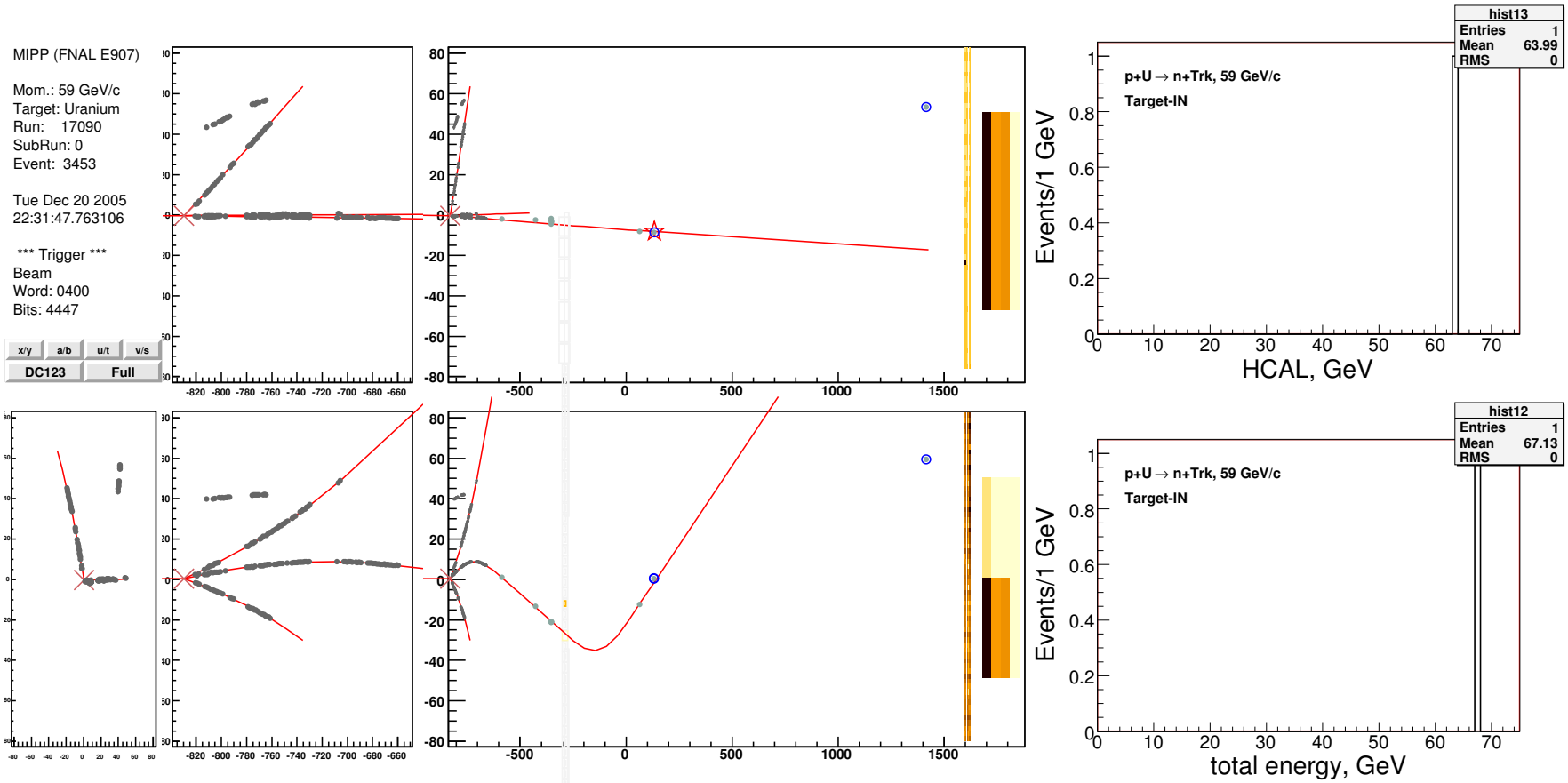
How HCAL is sensitive to the incoming track time? Plot presents the HCAL efficiency vs the track time. Denominator: good quality single track, p_{tot} >40 GeV/c, at HCAL within 0$\pm$35 cm. Numerator: energy deposition into HCAL greater then 30 GeV. Conclusion: HCAL is sensitive for off-time tracks.

neutron candidate with single associated track



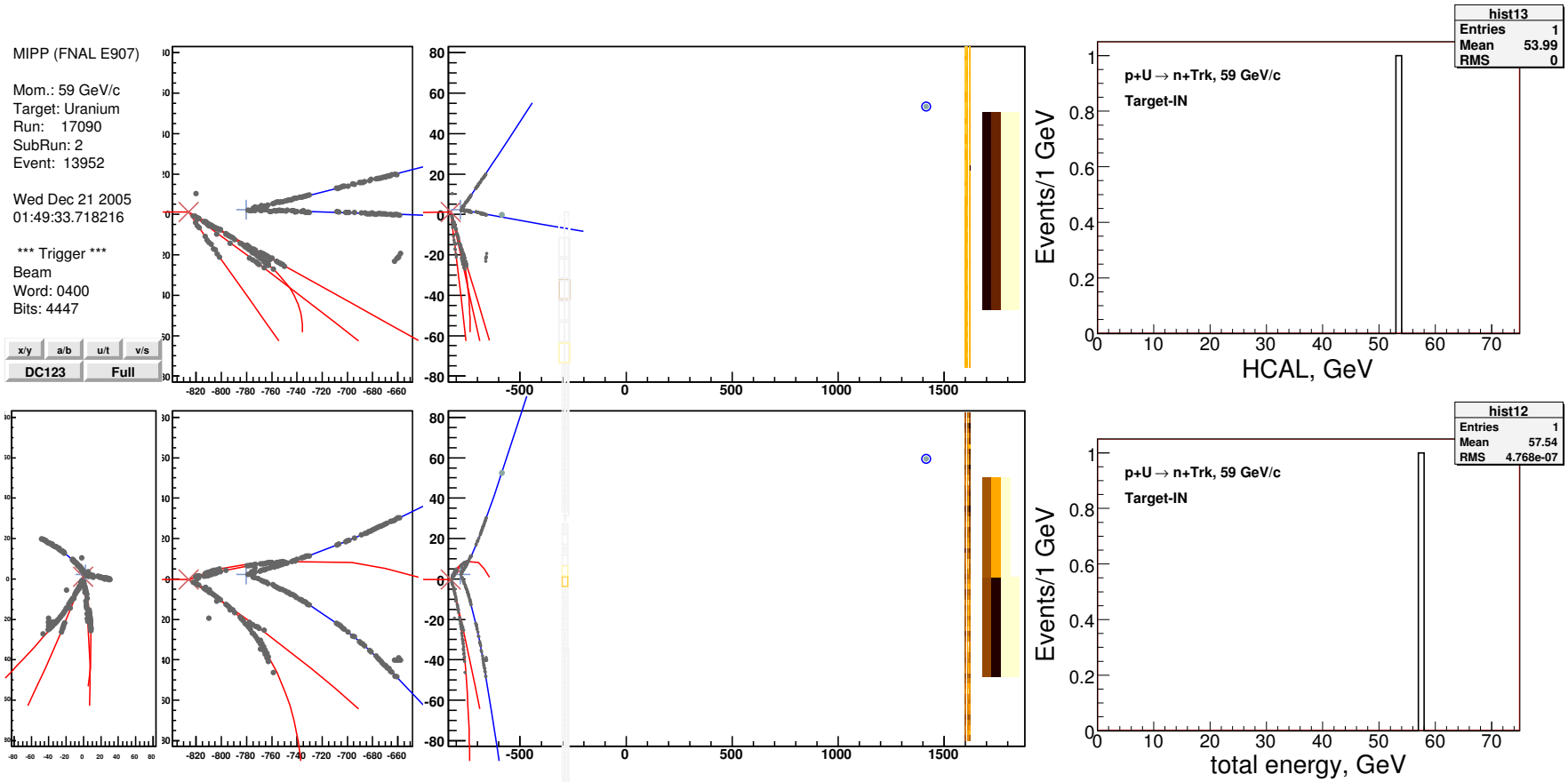
The neutron candidate event with a single associated track. Track momentum: 12.2 GeV/c, EMCAL: 6.2 GeV, HCAL: 42.5 GeV, total: 61 GeV

neutron candidate with 3 associated tracks



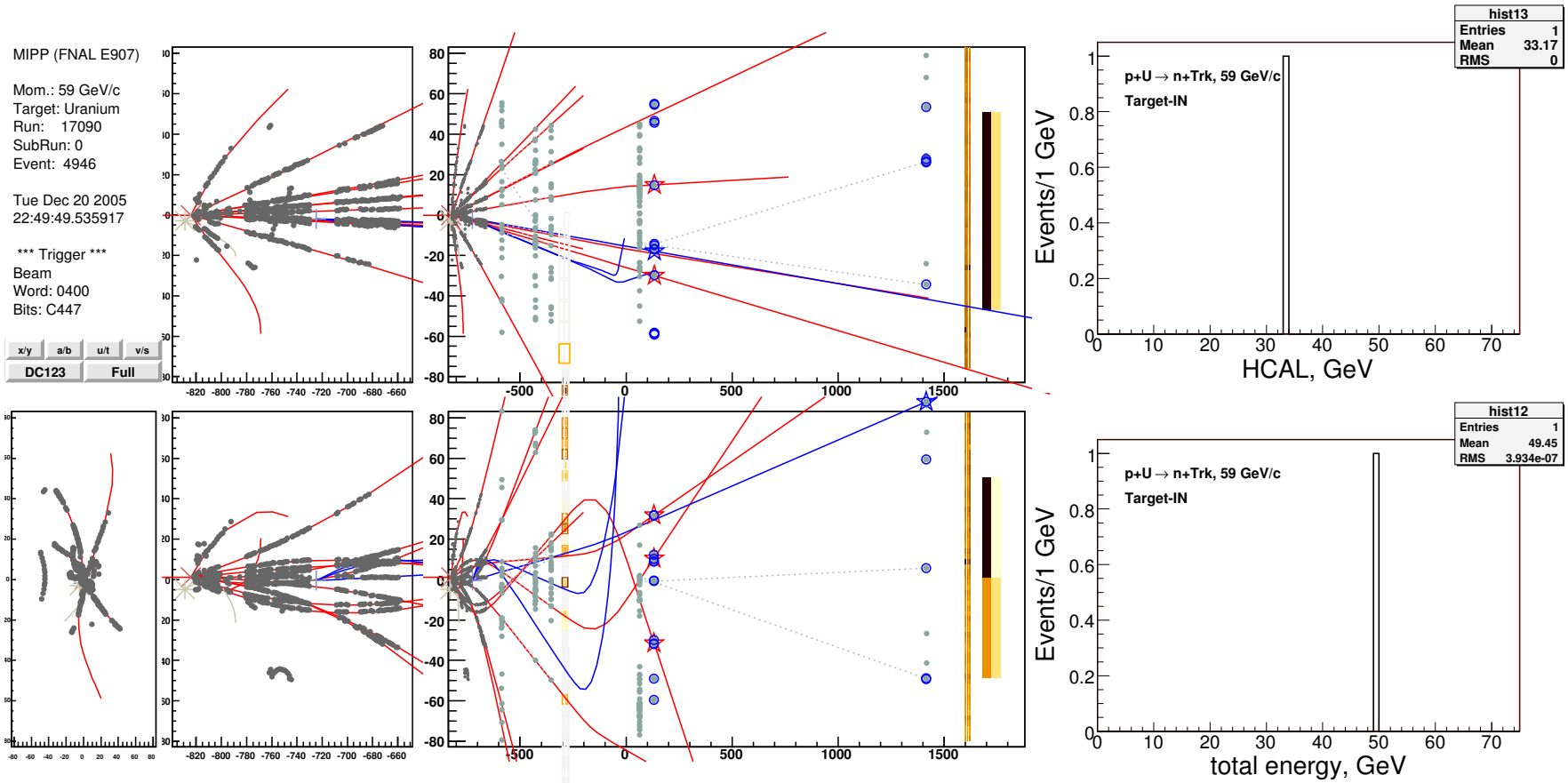
The neutron candidate event with 3 associated tracks. Tracks energy: 3.1 GeV/c, EMCAL: 0 GeV, HCAL: 63.9 GeV, total: 67 GeV

neutron candidate with 6 associated tracks



The neutron candidate event with 6 associated tracks. Tracks energy: 3.5 GeV/c, EMCAL: 0 GeV, HCAL: 53.9 GeV, total: 57.5 GeV. It looks like that this event also associated with $\Lambda^o \rightarrow \bar{p}\pi^+$ decays (pair of blue tracks, the vertex displaced by 40 cm).

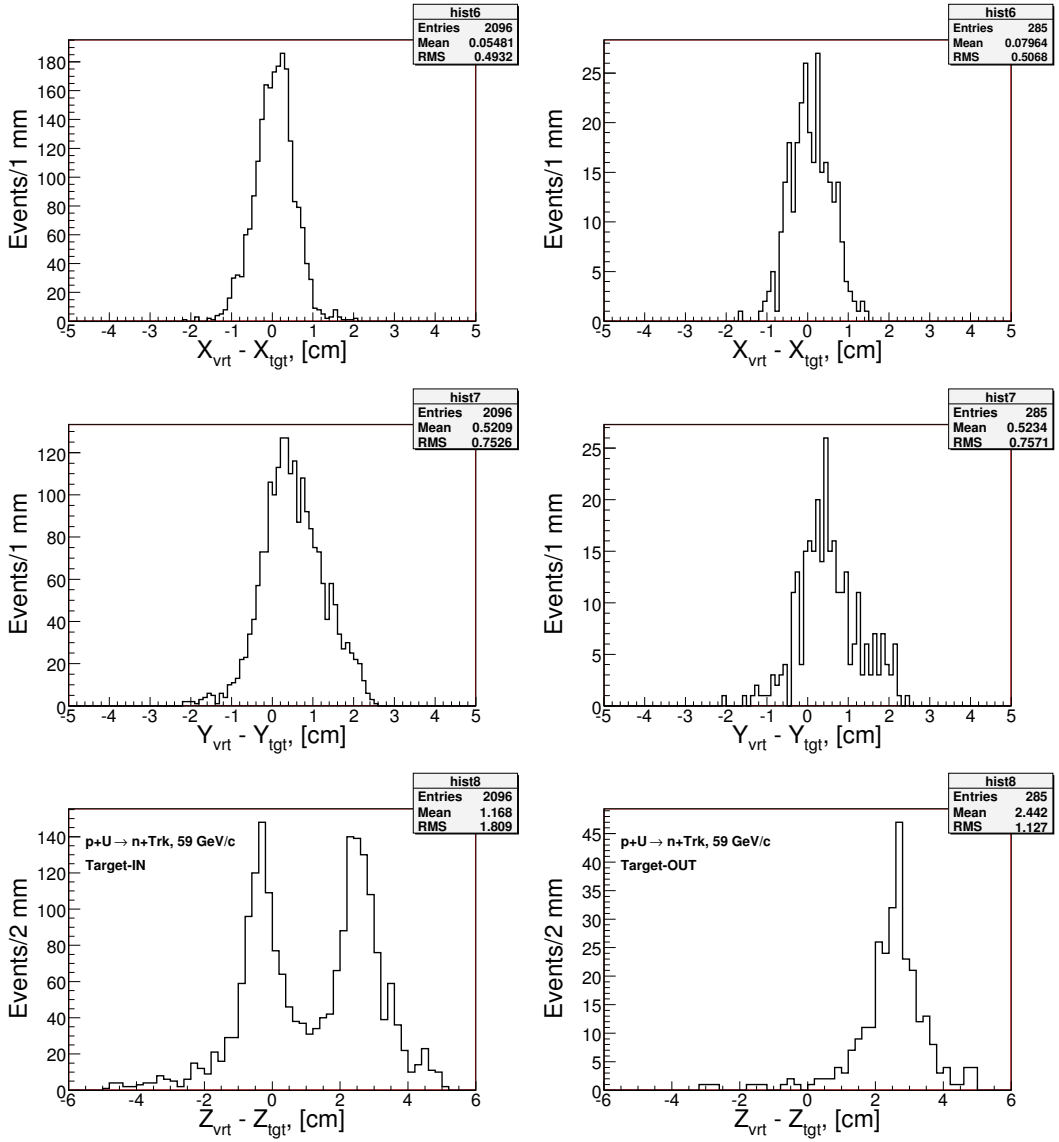
neutron candidate with 10 associated tracks



The neutron candidate event with 10 associated tracks. Tracks energy: 16.1 GeV/c, EMCAL: 0.2 GeV, HCAL: 33.2 GeV, total: 49.5 GeV

59 GeV/c, Uranium: interaction coordinates

Left plots - target-IN, right plots - target-OUT.



The interaction point distributions relative to the target center. All events passed the selection cuts - they all are inclusive neutron candidate events.

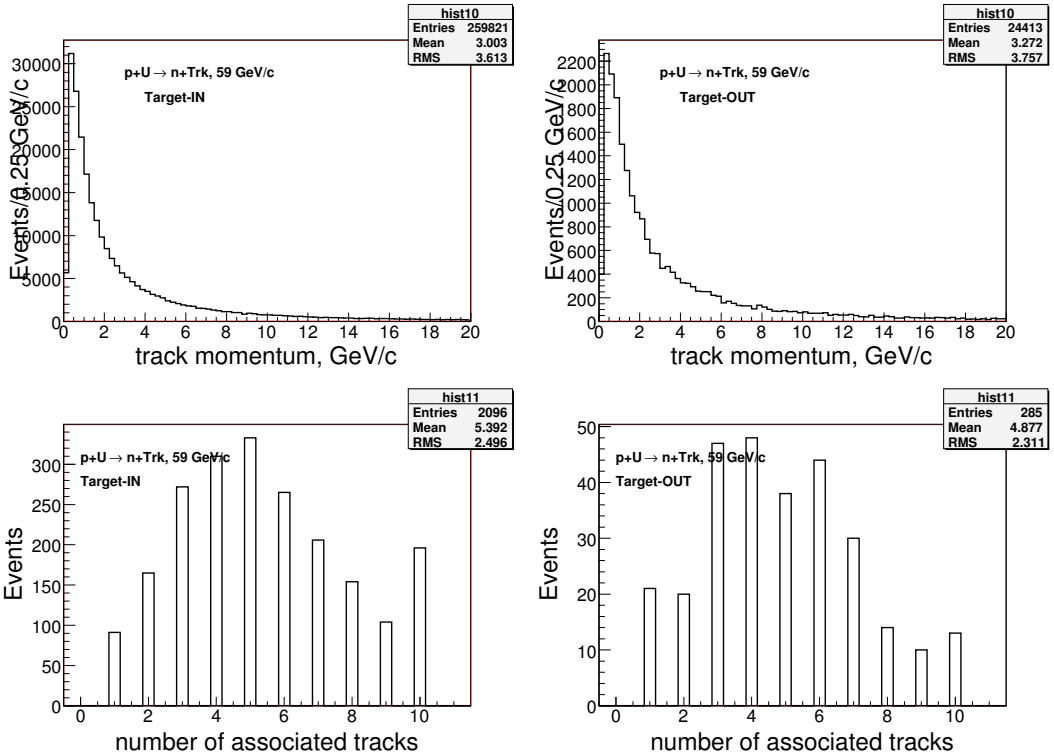
Top - the reconstructed vertices position in X direction.

Middle - the reconstructed vertices position in Y direction.

Bottom - the reconstructed vertices position in Z direction. The peak at z=0 represents the interactions with the Uranium target, the peak at z=2.5 cm represents the interactions with the trigger counter.

59 GeV/c,Uranium: momentum and multiplicity

Left plots - target-IN, right plots - target-OUT.



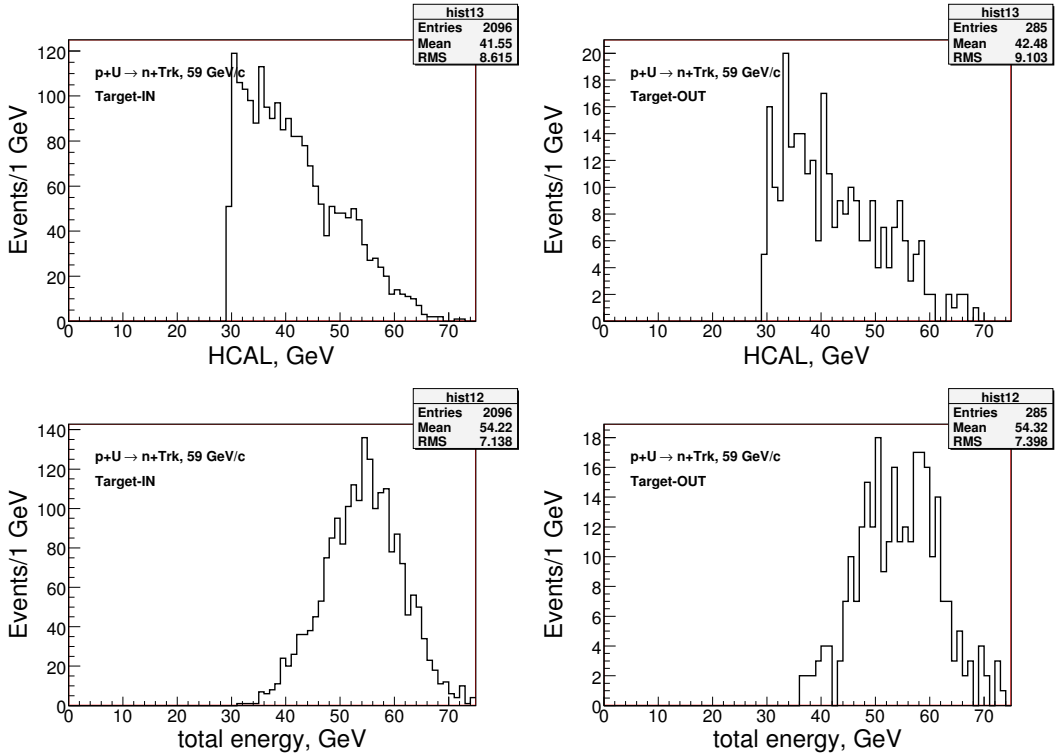
Data: all events passed the selection cuts - they all are inclusive neutron candidate events.

Top - the momentum distributions of the tracks.

Bottom - the track multiplicity distributions. The data under the number 10 represents $N_{trk} \geq 10$ cases.

59 GeV/c, Uranium: HCAL and total energy

Left plots - target-IN, right plots - target-OUT.



Data: all events passed the selection cuts - they all are inclusive neutron candidate events.

Top - the deposited energy distributions into HCAL. Cut: consider the events when the deposited energy is greater than 0.5*p_{beam}

Bottom - the total energy of the system:

- - sum of the all track energies in the vertex (using pion hypothesis)
- - add deposited energy into EMCAL (associated photons?)
- - add deposited energy into HCAL
- - subtract the energy of the charged track if it pointing to the HCAL

Inclusive neutron production yield

	U + Sci	Sci only
proton beam triggers	22339	5577
incident protons (scaled using prescale)	35206264	8789352
interaction trigger candidates	2096	285
scaled interaction candidates	23336	3135
yield (x 10^{-4})	6.63$\pm$0.14	3.57$\pm$0.21

Table 1: Yield of the inclusive neutrons with 59 GeV/c proton beam on Uranium and Scintillator targets. The final yield on Uranium target: 3.06$\pm$0.30 $\times$ 10^{-4}