Monte Carlo Neutron Update

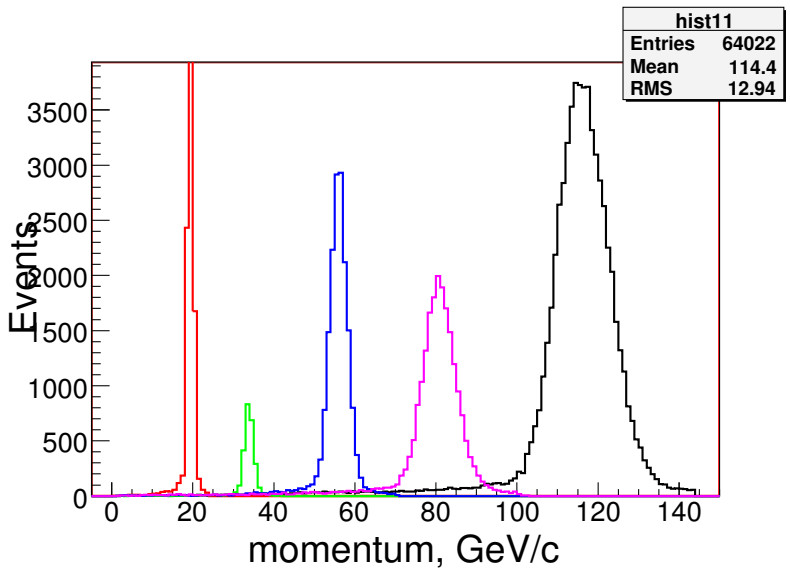
MC sample: Andre's pC interactions at 120 GeV

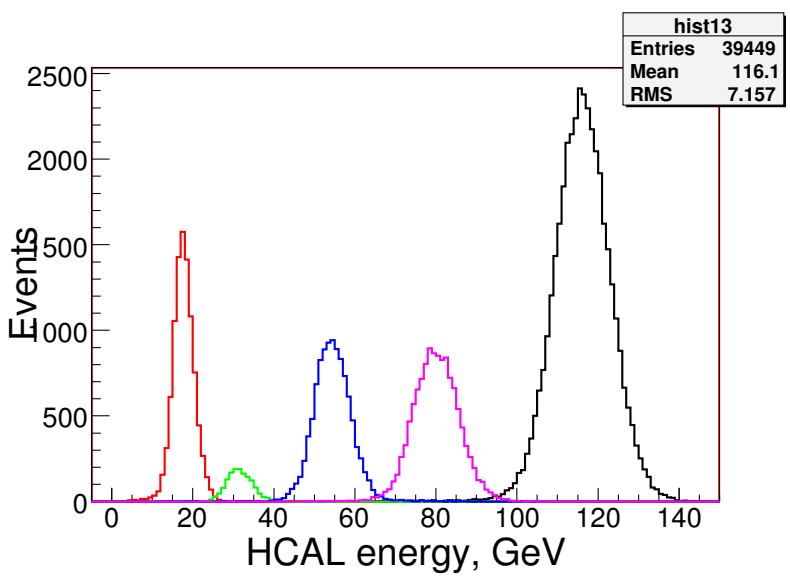
Add $\bar{n}_s$ contribution to background

Neutron momentum smearing:

- find width of E_h/p_p (real data)
- fit σ_{E_h} vs momentum (real data)
- apply σ_{E_h} for truth p_n
- redo neutron efficiency with smeared momentum
- recalculate N_n / N_p ratio

p_{beam} and HCAL energy

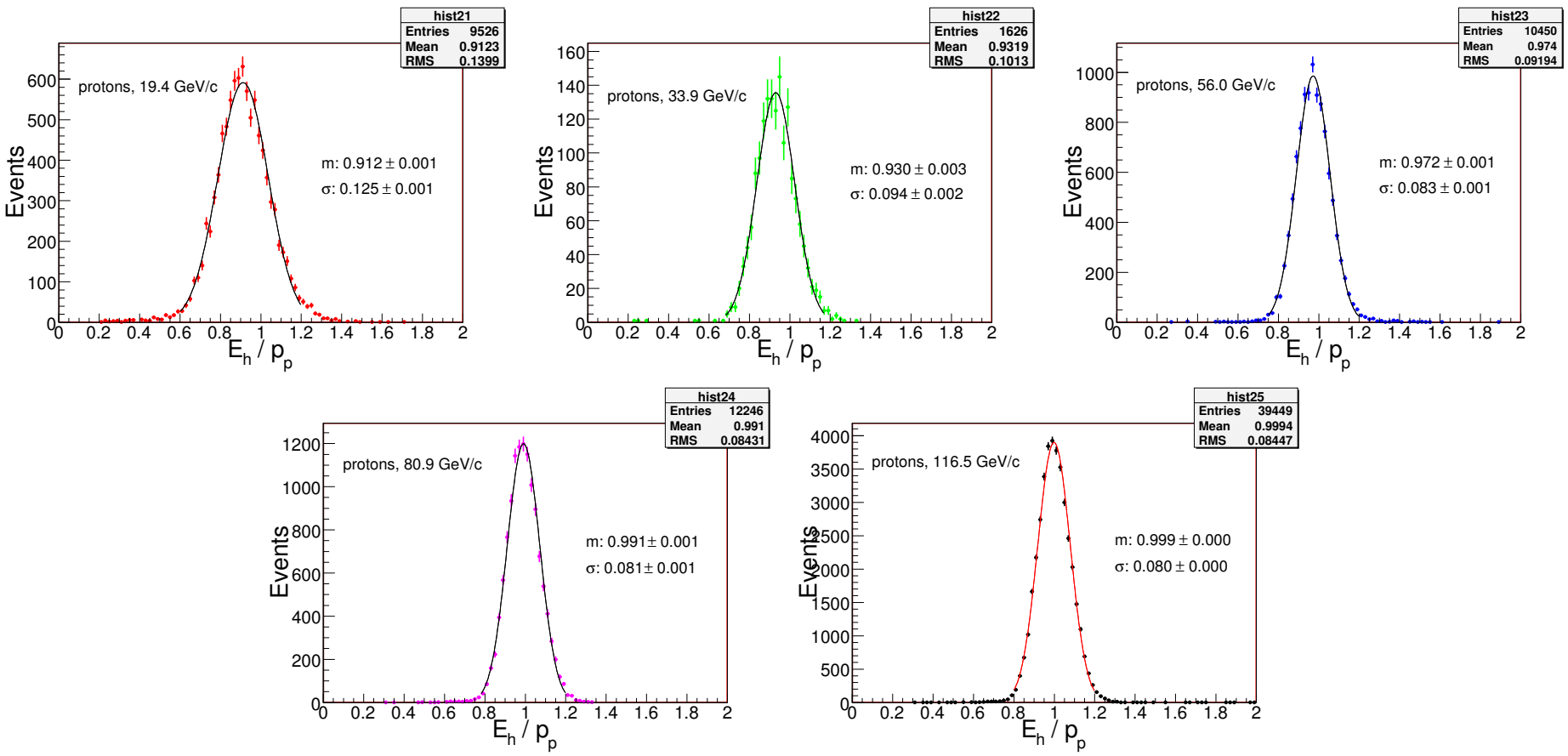




Top plot - momentum distributions of the single track straight through events. Trigger: proton beam and proton interactions. As a next steps the tracks away from peak were removed.

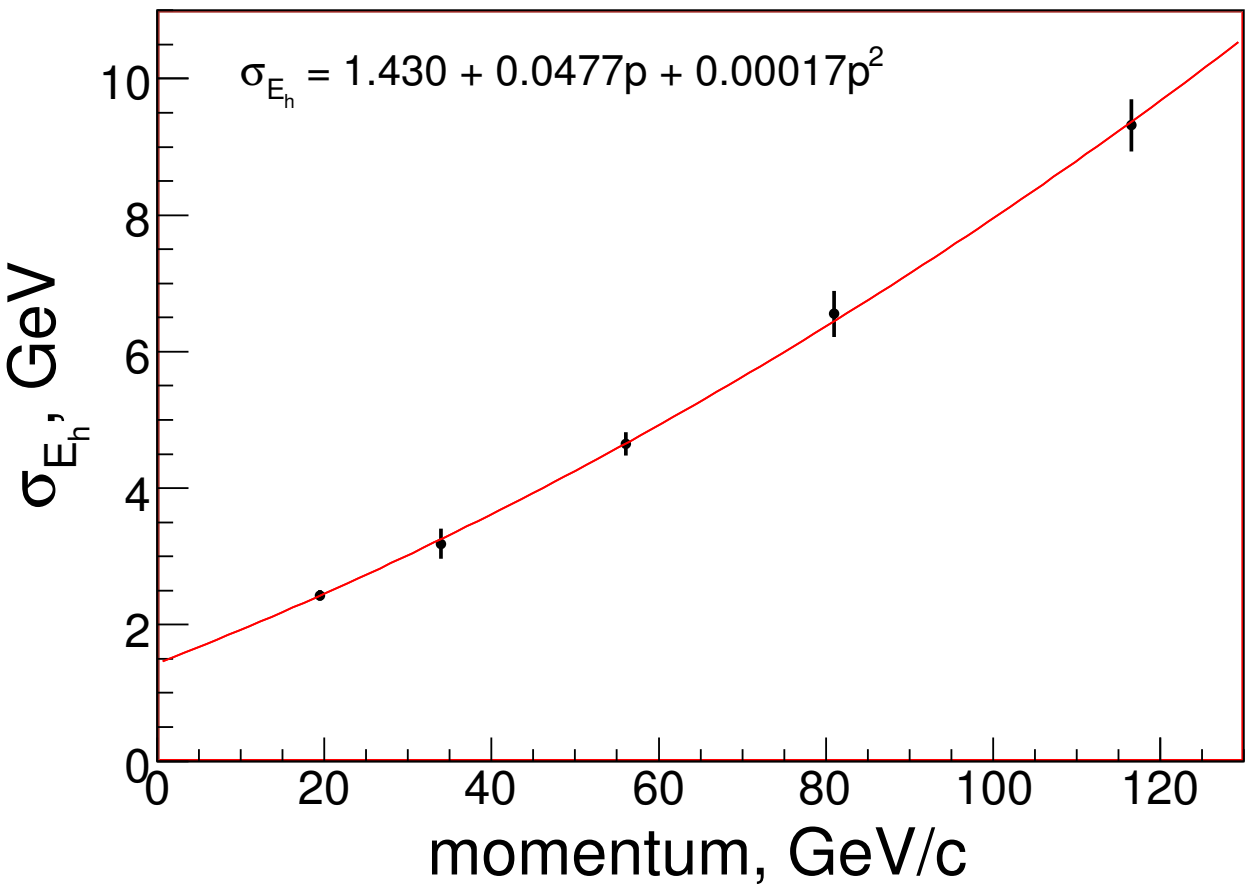
Bottom plot - HCAL energy distributions for the incoming protons. Requirement for EMCAL: E_{EMCAL} <1 GeV, which means that whole proton energy deposited to HCAL.

E_h / p_p



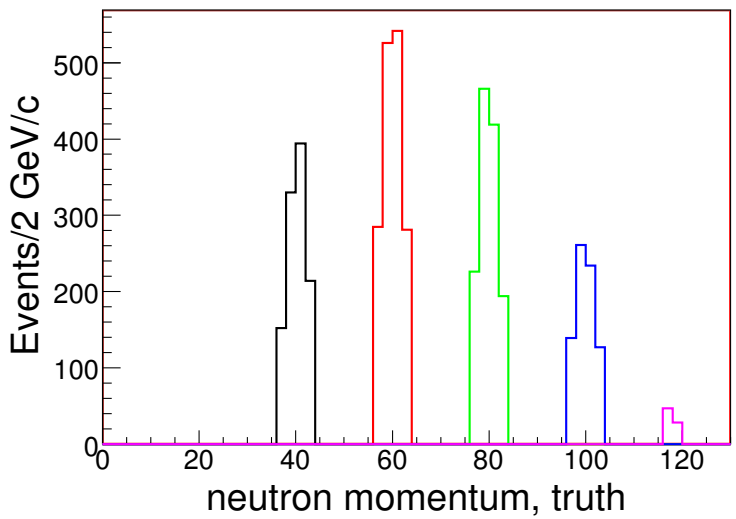
E_h / p_p ratio distributions for 20, 35, 58, 84 and 120 GeV/c protons.

energy resolution vs momentum



The HCAL energy resolution vs track momentum dependence, where each data point was calculated as $\sigma_{E_i} = \sigma_i p_i$. This plot can be used for NIM article.

smearing procedure in Monte Carlo

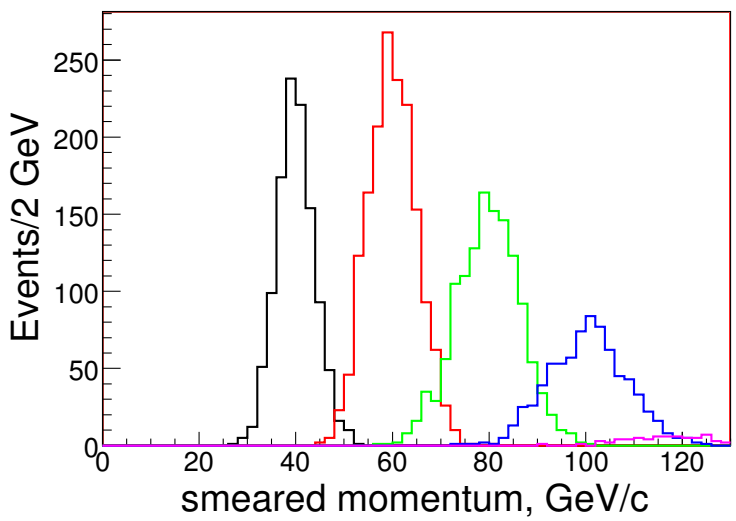


σ_{E_n} = 1.43 + 0.0477p + 0.000175p^2

$\sigma_{p_n} = \sqrt{\sigma_{E_n}^2 - m_n^2}$

Δp_i = gRandom$\longrightarrow$Gaus(0, σ_{p_n}),

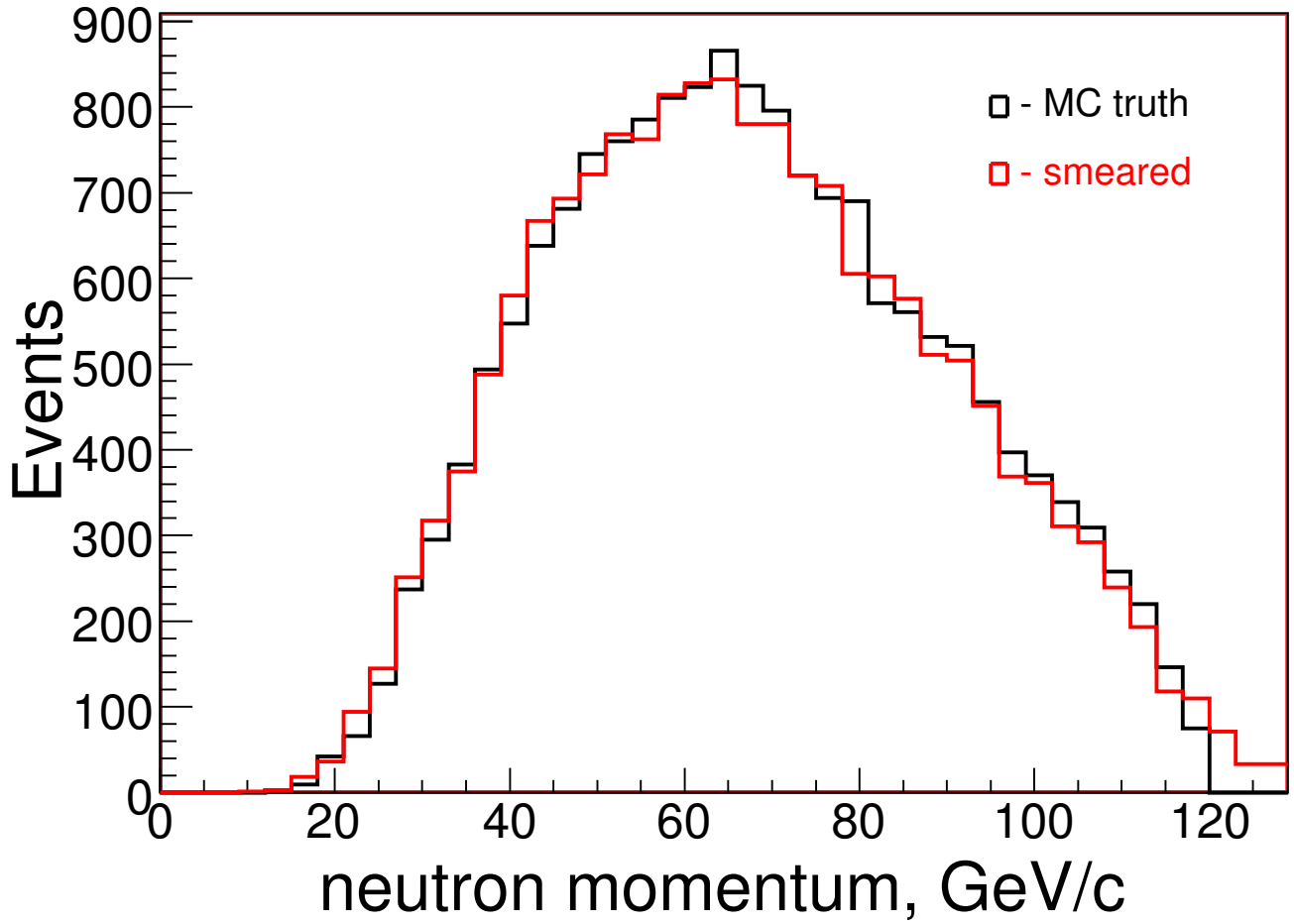
Finally: p$_{smear}$ = p$_{n,truth}$ + Δp_i



Top plot illustrates the events with selected momentum (truth) within $\pm$3 GeV.

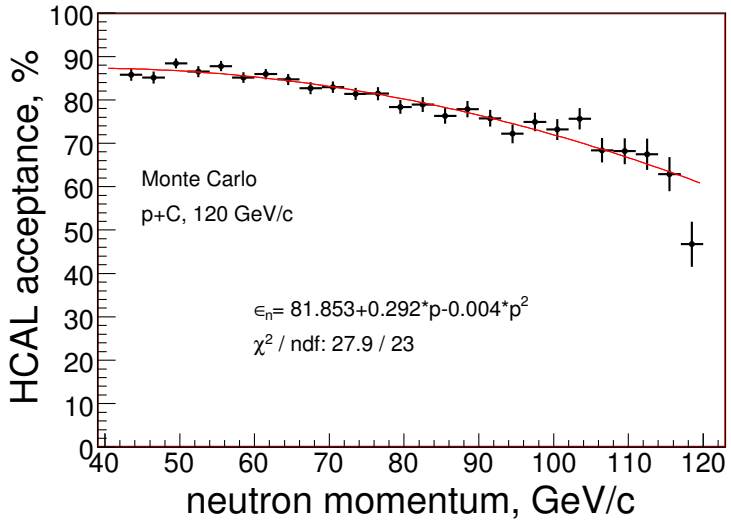
Bottom plot illustrates what happens after smearing applied.

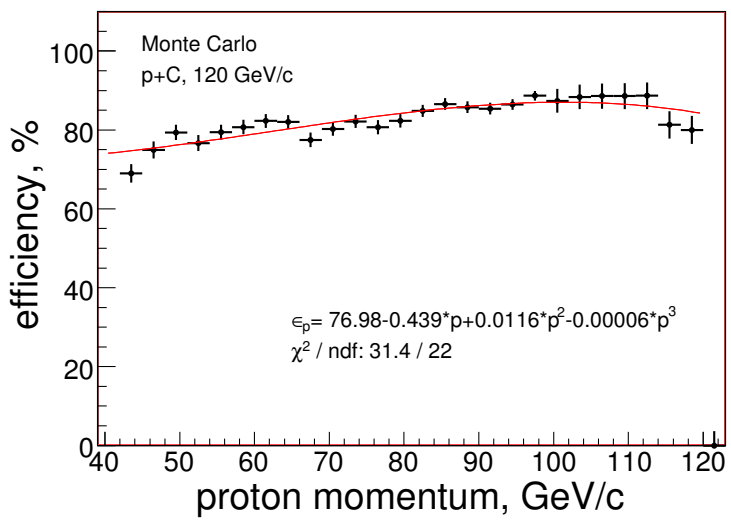
Monte Carlo: truth spectrum vs smeared



Black plot - Fluka neutron production spectrum, red plot - smearing applied.

redo ϵ_n and ϵ_p

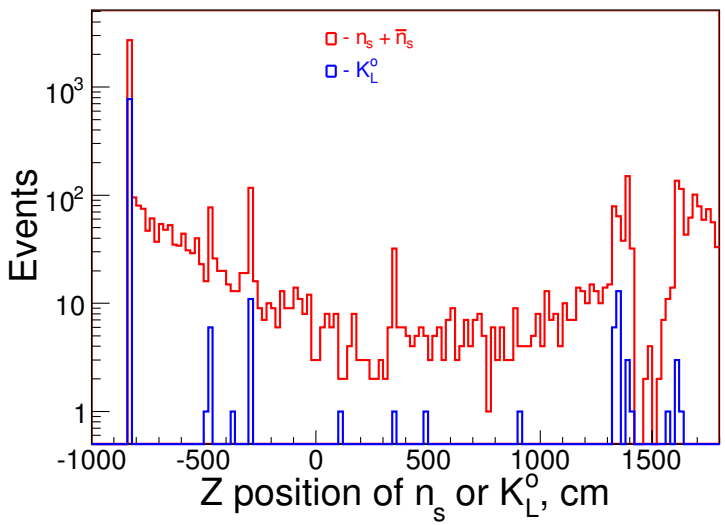


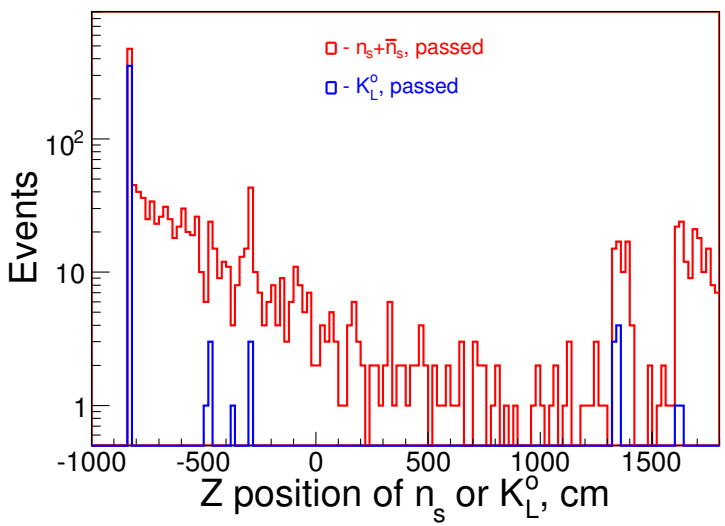


Top plot - HCAL acceptance vs neutron momentum. Previous calculation based on Monte Carlo truth value of p_n, now - smeared p_n.

Bottom plot - proton reconstruction and identification efficiency vs proton momentum. Previous calculation based on Monte Carlo truth value of p_p, now - the reconstructed p_p value.

production Z position of neutrals

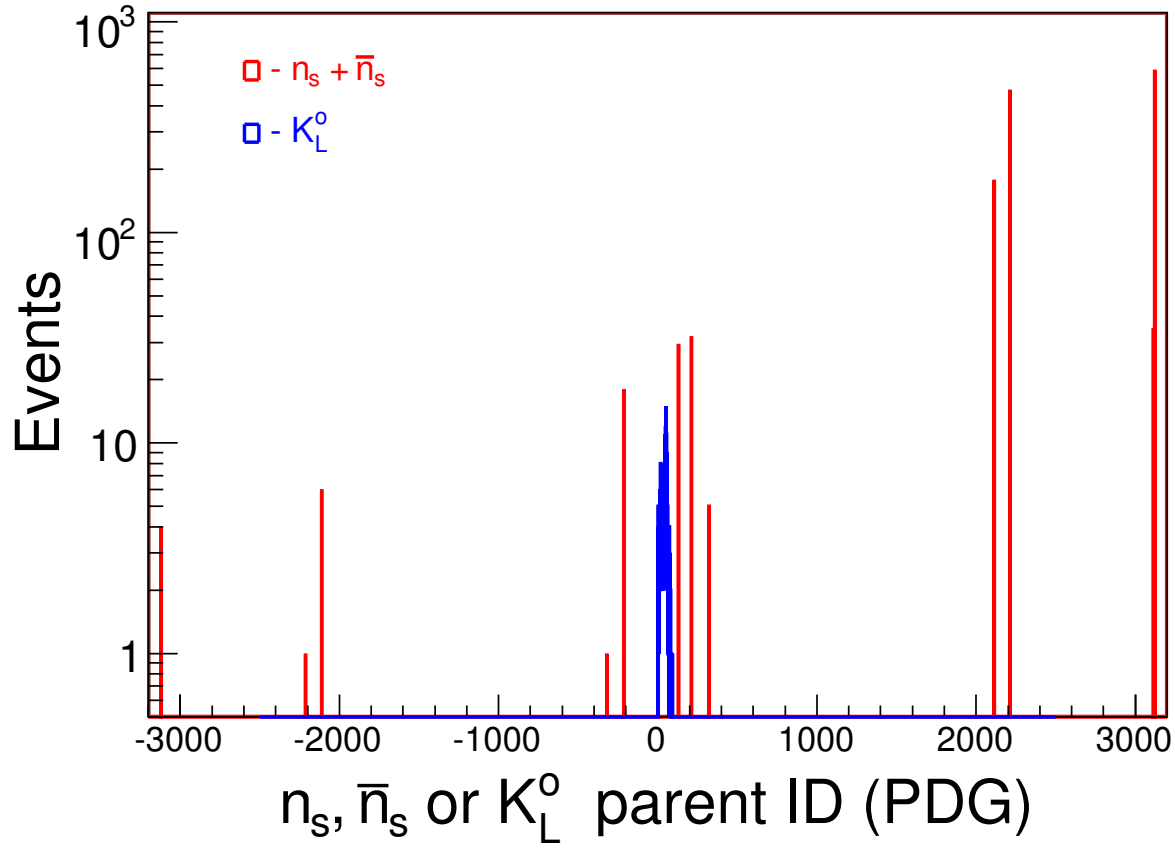




Top plot - production Z position of neutrals. Red plot - secondary neutrons and anti-neutrons. Blue plot - K^o_L production.

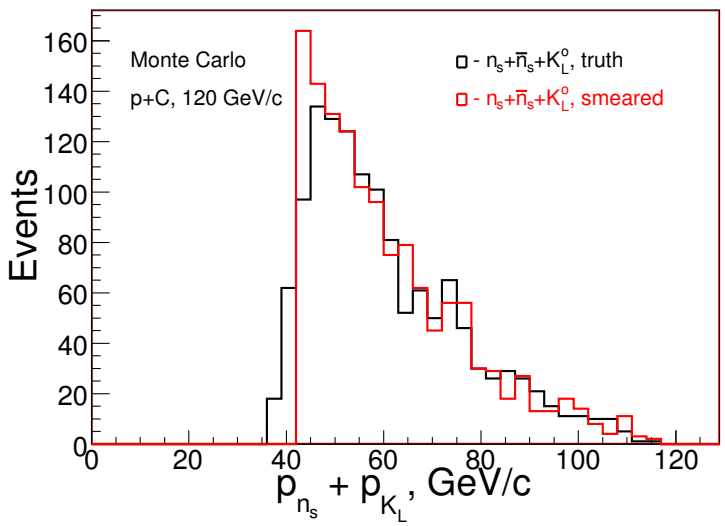
Bottom plot - Z position of those neutrals which survived the inclusive neutrals selection cuts, mainly the energy balance requirement and at least 1 charged track with p_{tot} >1 GeV.

neutrals parent ID

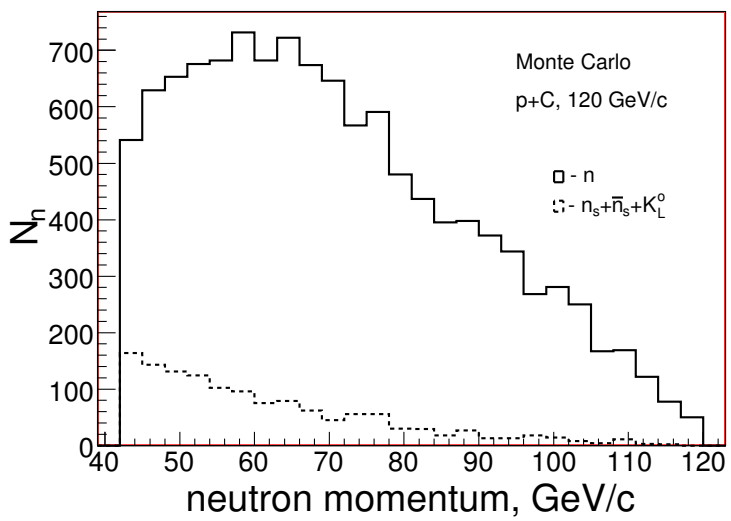


Parent ID of the neutrals, which pointing into HCAL fiducial and passed the inclusive neutrals selection requirements.

smearing of neutrals



Top plot - momentum sum spectrum of all neutrals. Black plot - Monte Carlo truth info, red - smeared plot with minimal momentum requirement.



Bottom plot - the inclusive neutron distribution (black) and the background neutrals: secondary neutrons, anti-neutrons and K^o_L.

calculation outline

Data: $N_n = N_{hcal} / \epsilon_n$, where N_{hcal} - what measured by HCAL and ϵ_n it's acceptance

Data: $N_p = N_{p,reco} / \epsilon_p$, where $N_{p,reco}$ is reconstructed protons and ϵ_p it's efficiency

Data: $N_n / N_p \longrightarrow$ plot

MC: $N_{n,prod} = N_{n,passed} / \epsilon_n$, neutron production spectrum

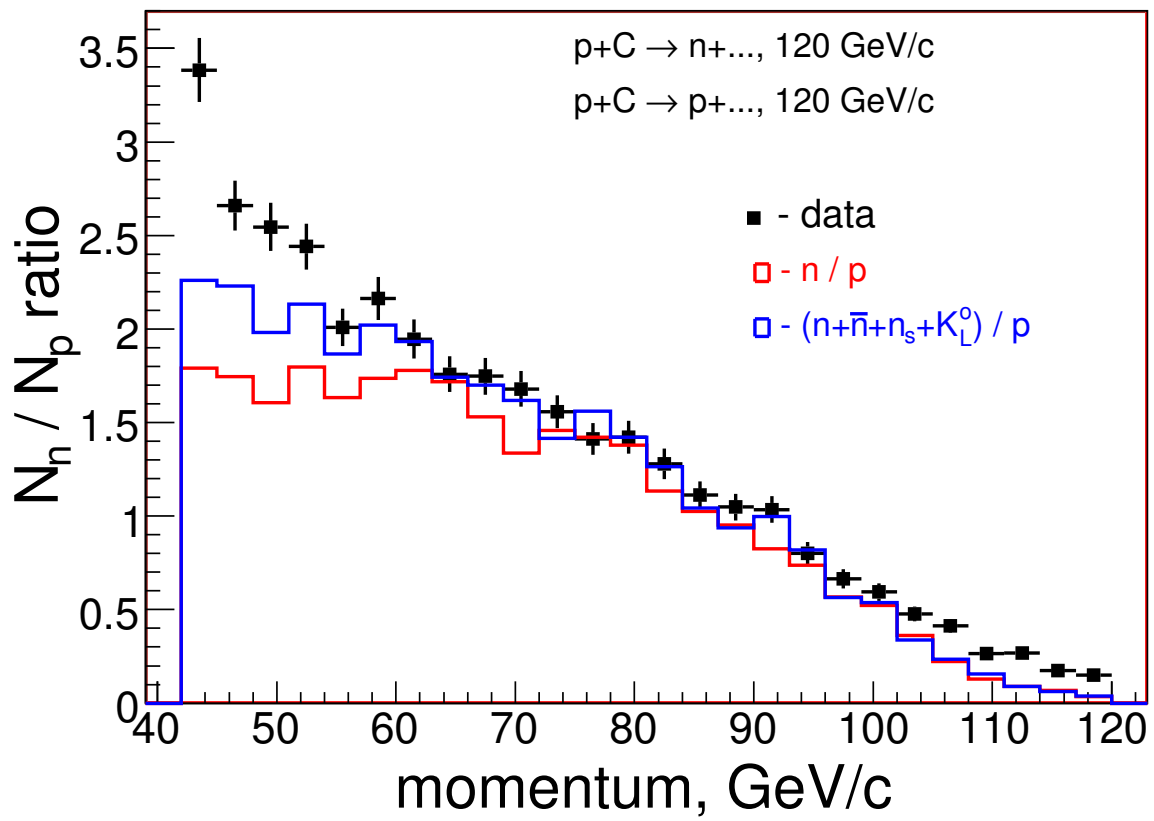
MC: $N_{p,prod} = N_{p,passed} / \epsilon_p$, proton production spectrum

MC: $N_{n,prod} / N_{p,prod} \longrightarrow$ plot

Monte Carlo neutrals (background estimation):

- consider secondary neutrons, anti-neutrons and K_L^o from any sources
- check for HCAL fiducial
- calculate combined momentum
- apply momentum smearing
- check for: at least 1 charged track with $p_{tot} > 1$ GeV, energy balance, minimal momentum
- $(N_{background} + N_{n,passed}) / \epsilon_n \longrightarrow$ neutron + background production spectrum $\longrightarrow$ plot

N_n / N_p ratio



N_n / N_p ratio for inclusive neutrons and protons. Red plot - Fluka n/p ratio prediction. Blue plot - Monte Carlo (Fluka + Geant) (n + $\bar{n}$ + n_s + K_L^o) / p prediction.