Identifying n signatures in LArTPC

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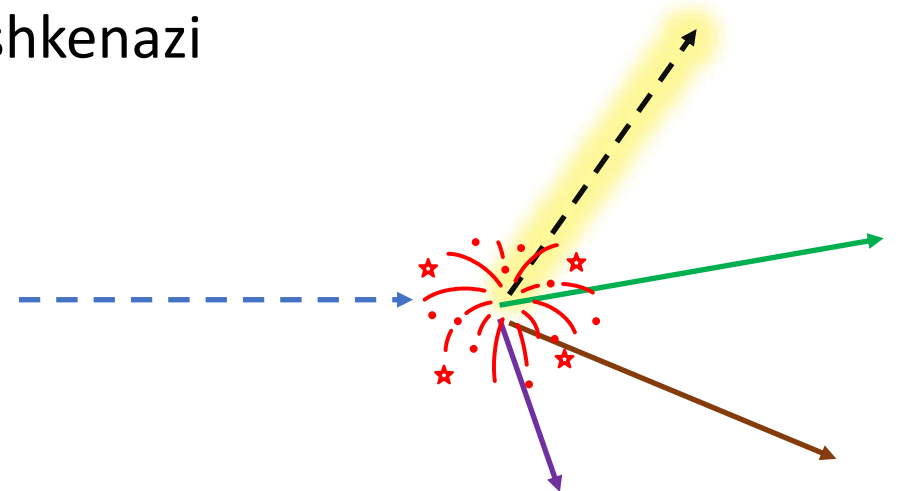
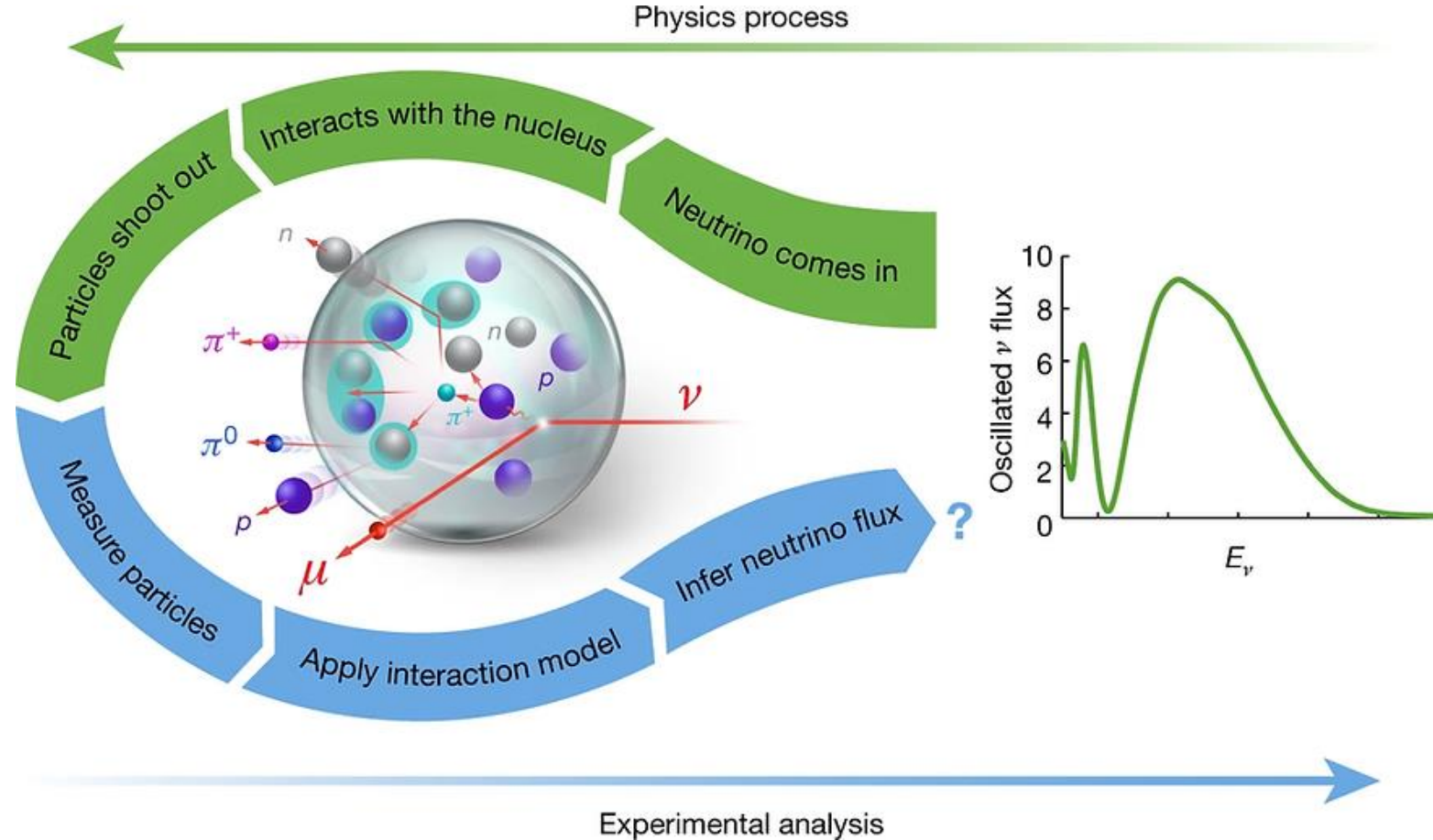Summer Project Sep. 2022

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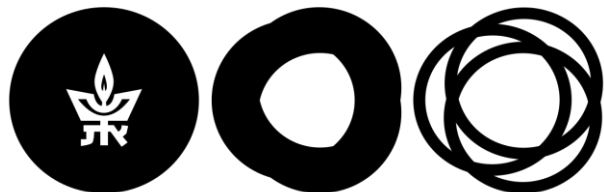
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# Identifying n signatures in LArTPC

- n are invisible in LArTPC, and they can carry a large amount of the momentum transfer. Ignoring them biases the reconstruction

Identifying n signatures in LArTPC

- We identify n signature in LAr scintillation following (n,p) or γ-production, in three steps:

  1. Characterize n and γ interactions in LAr
  2. Study scintillation provoked by n and γ using the protoDUNE detector
  3. Identify n signatures based on scintillation

Step 1: Understanding n and γ interactions in LAr

Geant4 simulator – example of a neutron interacting in LAr
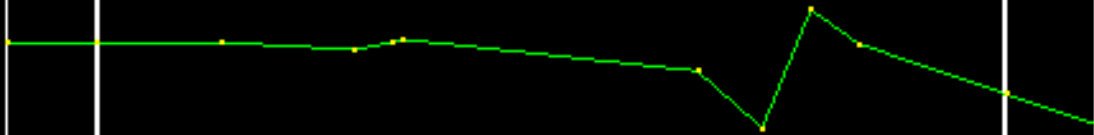
☑ Literature survey

☑ Compilation of a simplified Geant4 simulator to highlight dominant interactions

☐ Simulate n and γ in protoDUNE measurement conditions

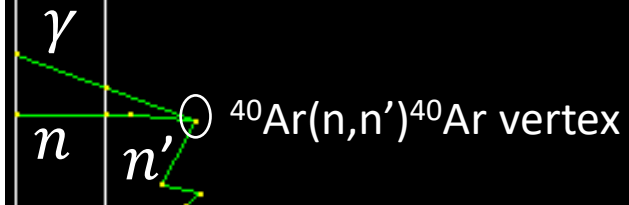Example of a protoDUNE event [M.Fani LANL(2020)]
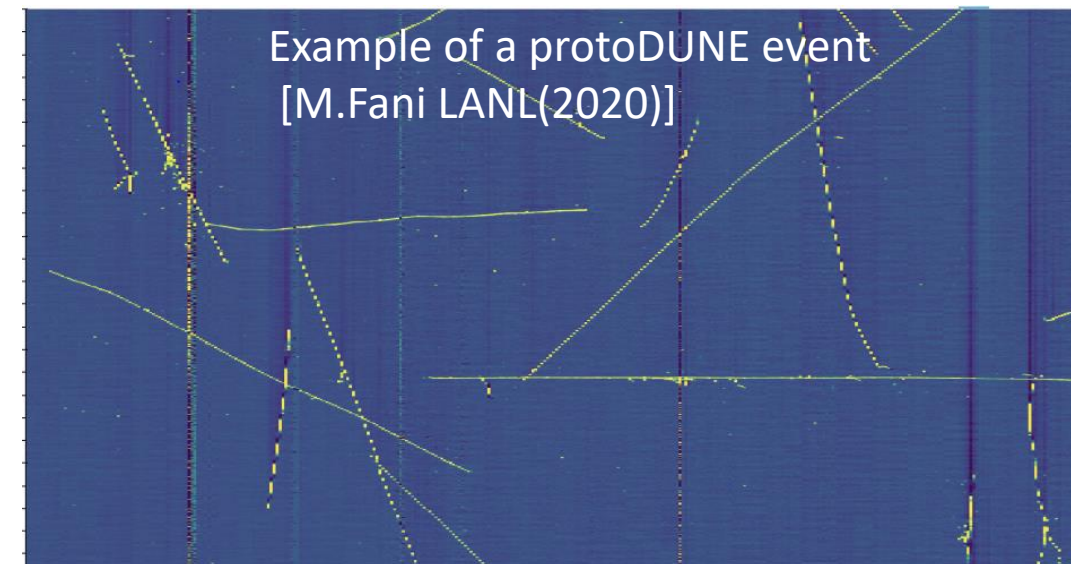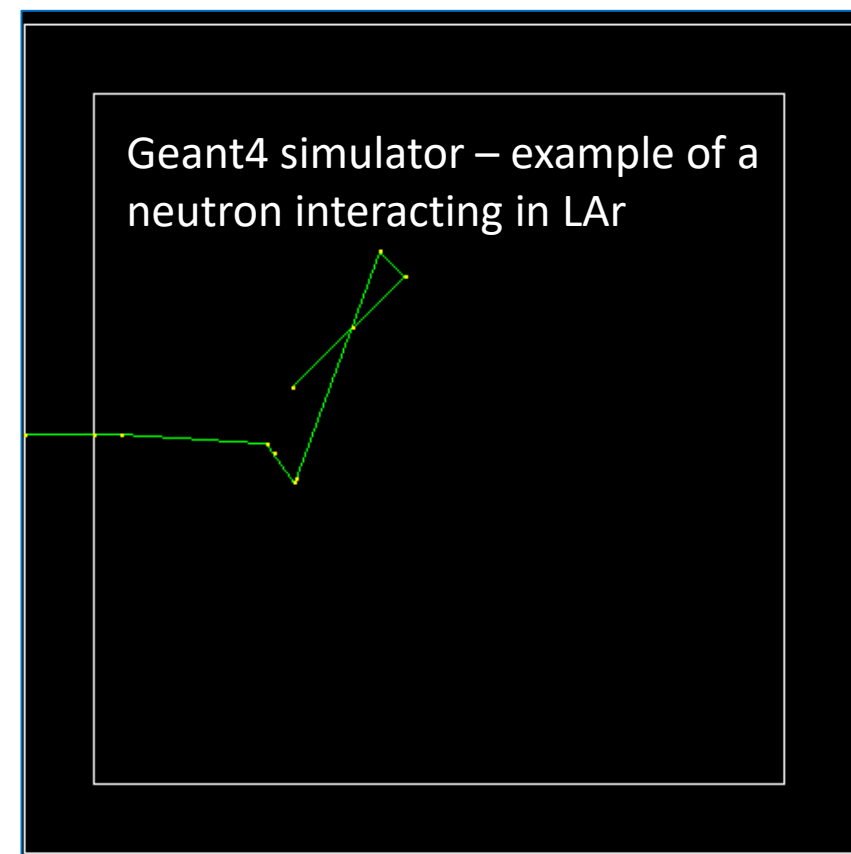
Lessons learned So Far

Examples of 2.5 MeV neutron interaction sequence in LArTPC

n enters the detector, scatters elastically multiple times and exits the detector.
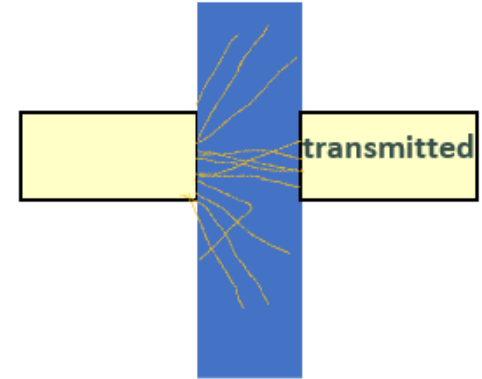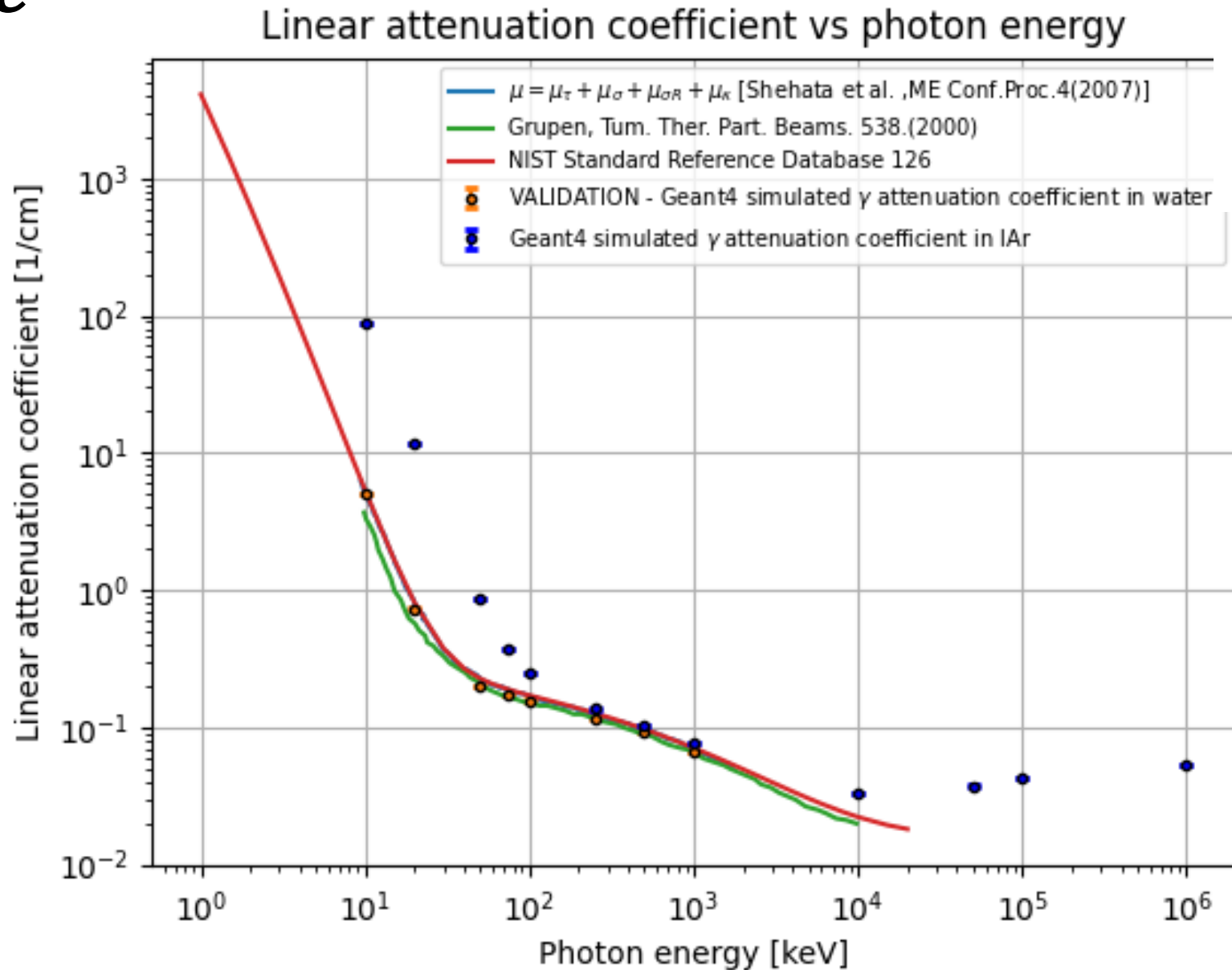

n captured on Ar and performs $^{40}Ar(n,n')^{40}Ar$ process.

γ

n

n'

$^{40}Ar(n,n')^{40}Ar$ vertex

Linear Attenuation Coefficient

$$I(x) = I_0 \cdot e^{-\mu x}$$

transmitted

Linear attenuation coefficient vs photon energy

Legend:
- $\mu = \mu_\tau + \mu_\sigma + \mu_{\sigma R} + \mu_\kappa$ [Shehata et al. ,ME Conf.Proc.4(2007)]
- Grupen, Tum. Ther. Part. Beams. 538.(2000)
- NIST Standard Reference Database 126
- VALIDATION - Geant4 simulated γ attenuation coefficient in water
- Geant4 simulated γ attenuation coefficient in IAr

Y-axis: Linear attenuation coefficient [1/cm]

X-axis: Photon energy [keV]

n - ⁴⁰Ar Cross Section Decomposition
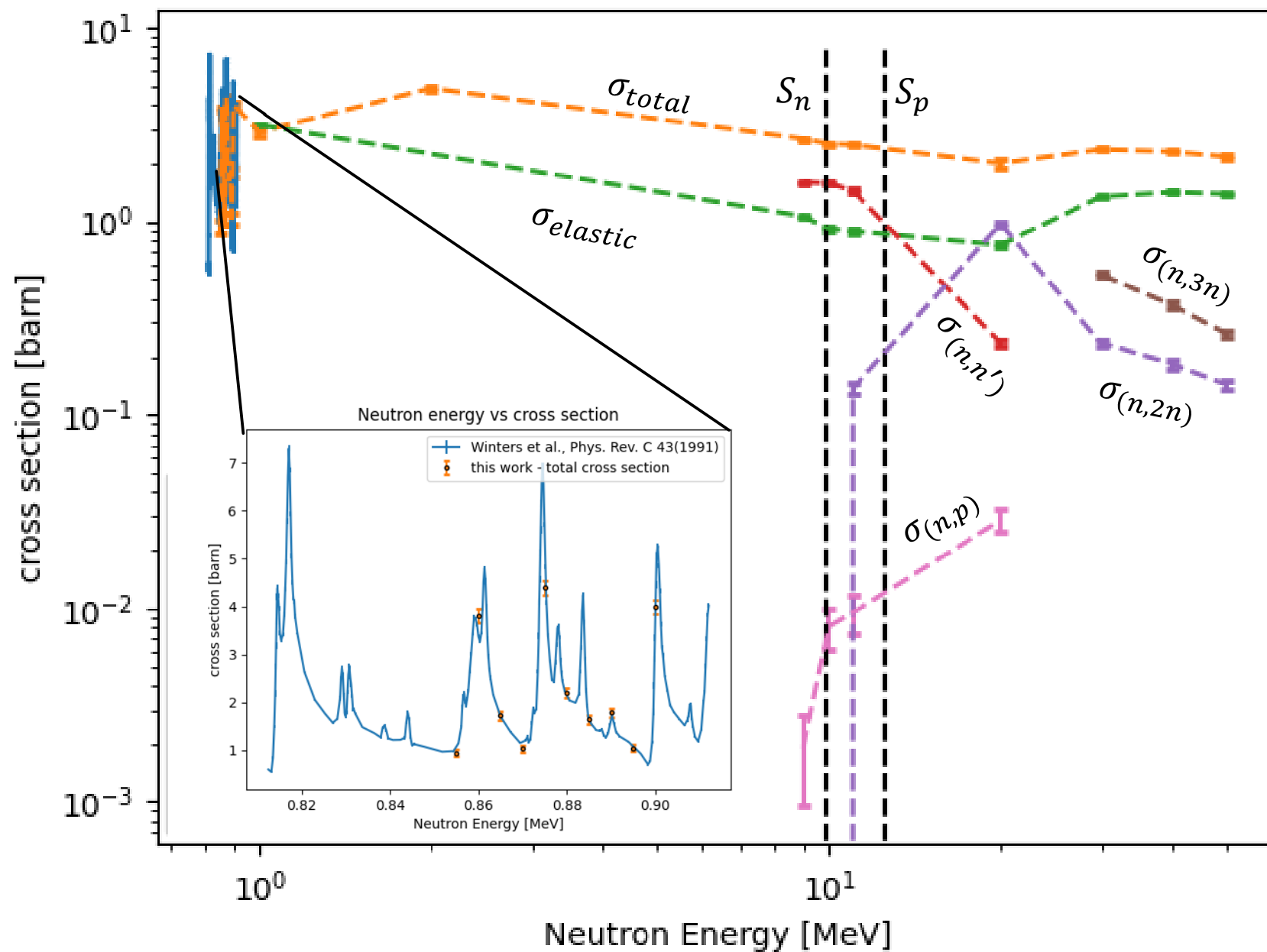
Summary

☑ Literature survey

☑ Compilation of a simplified Geant4 simulator to highlight dominant interactions

- We validated our Geant4 simulator vs. well established data from the literature

- Next : **simulate n and γ in protoDUNE measurement conditions to help guide us in analysing protoDUNE data taken with DD generator**