Cross Sections WG2 overview

NuFact 20|21
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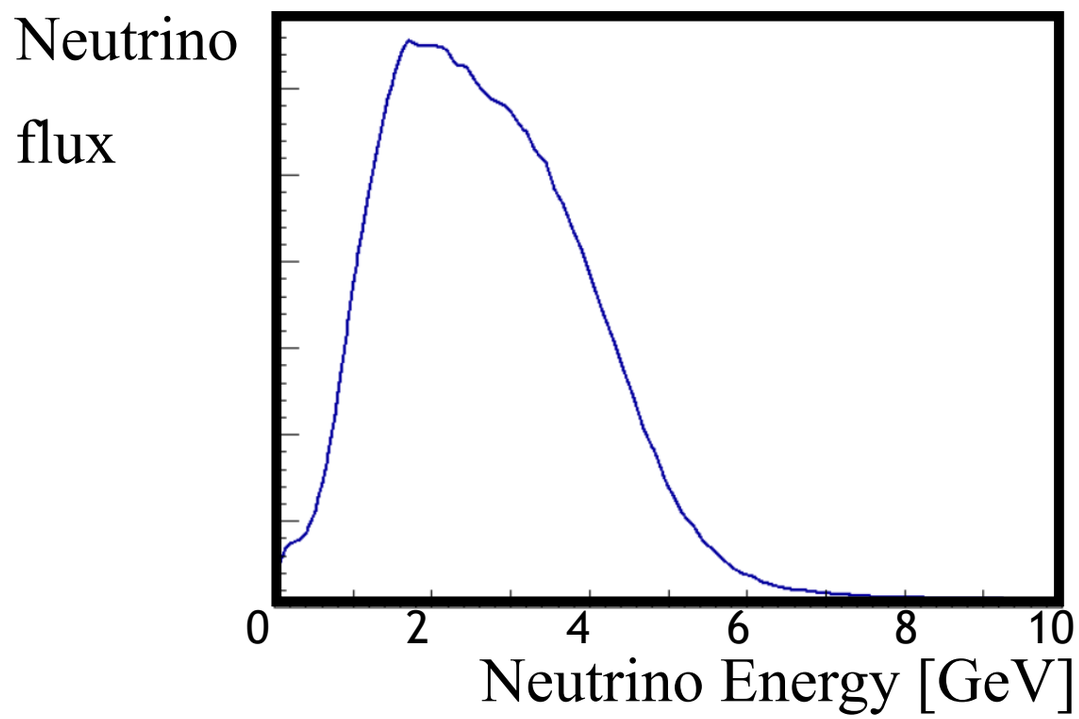
Cagliari, Italy

GHENT UNIVERSITY — Natalie Jachowicz

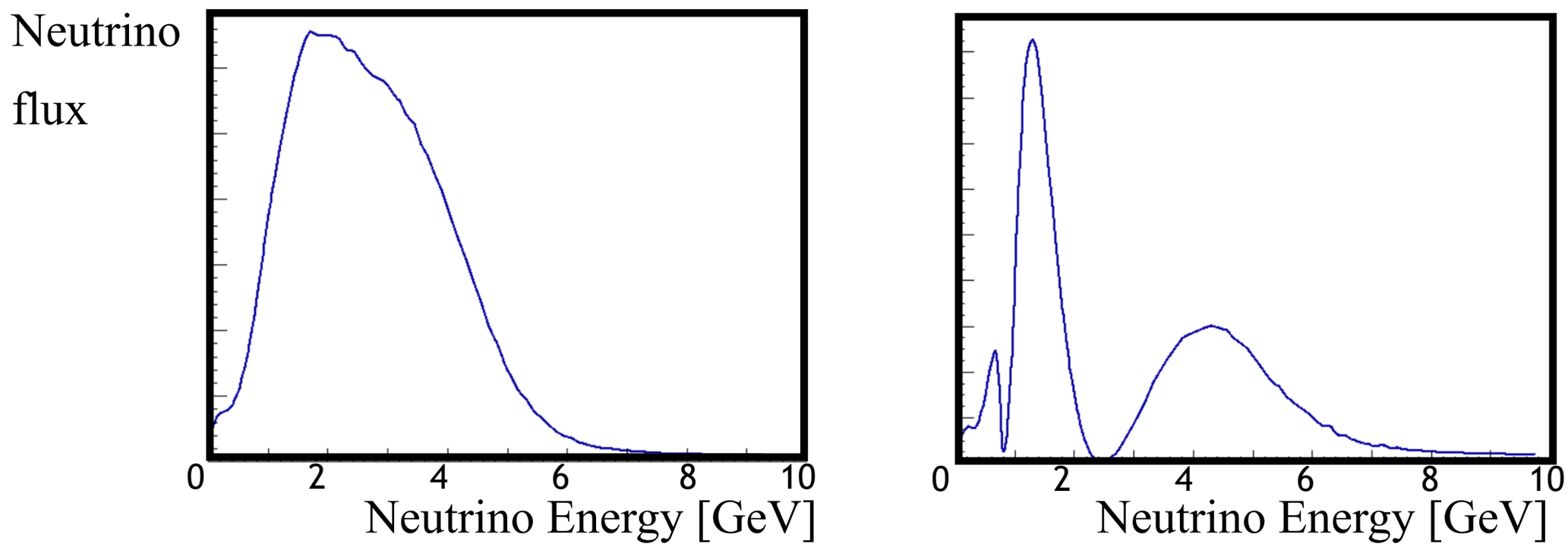
TRIUMF — Tatsuya Kikawa

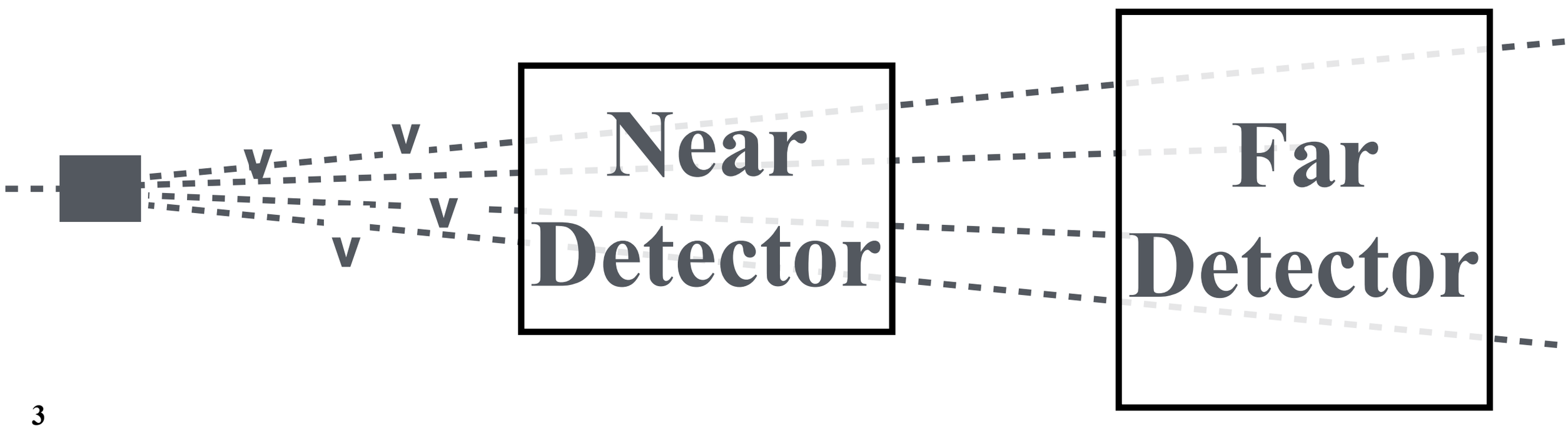
TEL AVIV UNIVERSITY — Adi Ashkenazi

Neutrino Experiments



Focusing on Neutrino Oscillations Experiments





Cross Section - a key ingredient for oscillations

$$N_{events}(E_\nu) = \int \boldsymbol{\sigma}(E'_\nu)\Phi(E'_\nu)P(E_\nu|E'_\nu)dE'_\nu$$

The flux and cross section models are convoluted.

Cross Section - a key ingredient for oscillations

$$\frac{N^{far}_{events}(E_\nu)}{N_{events}(E_\nu)} = \frac{\int \sigma(E'_\nu)\Phi(E'_\nu)P(E_\nu|E'_\nu)P_{osc}(E'_\nu)dE'_\nu}{\int \sigma(E'_\nu)\Phi(E'_\nu)P(E_\nu|E'_\nu)dE'_\nu}$$

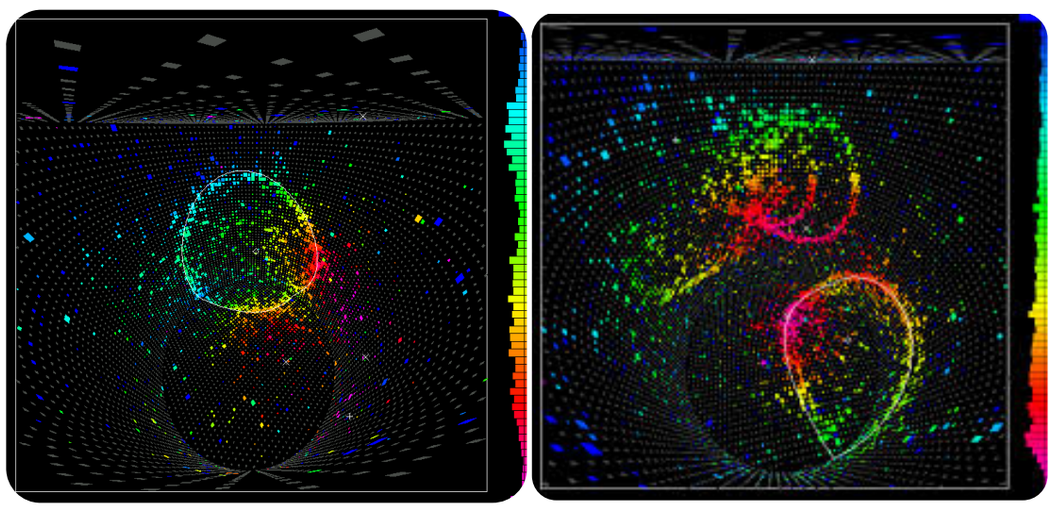
F. Sanchez @ NuPhys2015

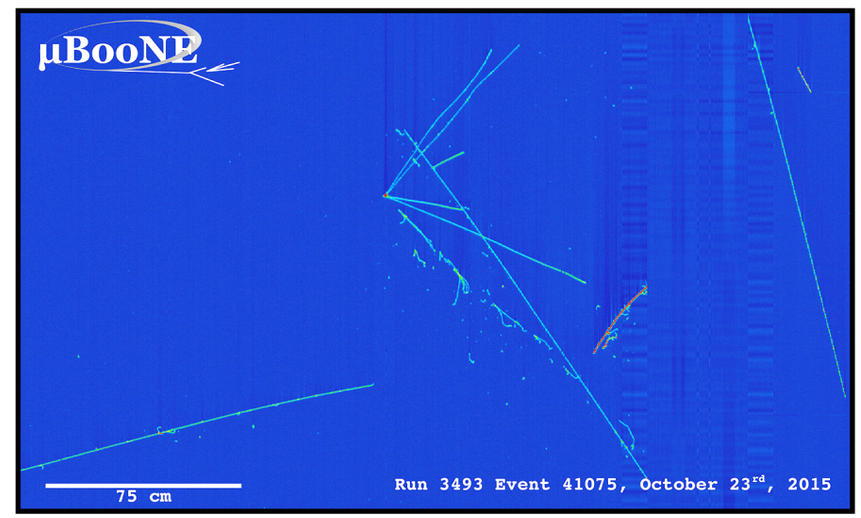
The flux and cross section models are convoluted.

The cross section will not cancel out
Different cross section between near/far detector due to differences in energies

It is a large and limiting uncertainty for oscillation analyses.
Crucial for extraction of the oscillation parameters.

Incoming neutrino Energy Reconstruction





Cherenkov detectors:

Assuming QE interaction

Using solely the final state lepton

$$E_{QE} = \frac{2M\epsilon + 2ME_l - m_l^2}{2(M - E_l + |k_l| cos\theta)}$$

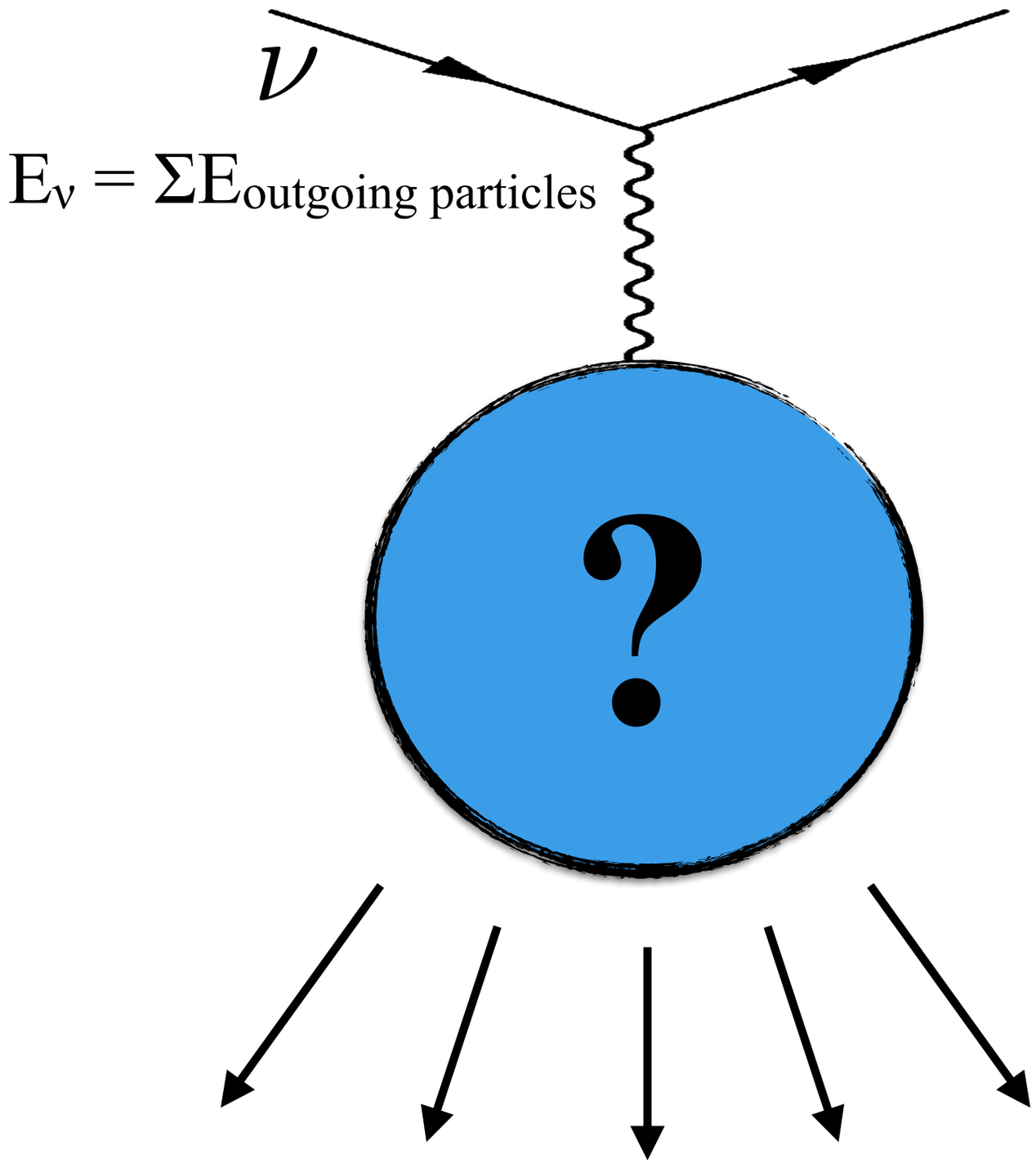
Tracking detectors:

Need good hadronic reconstruction

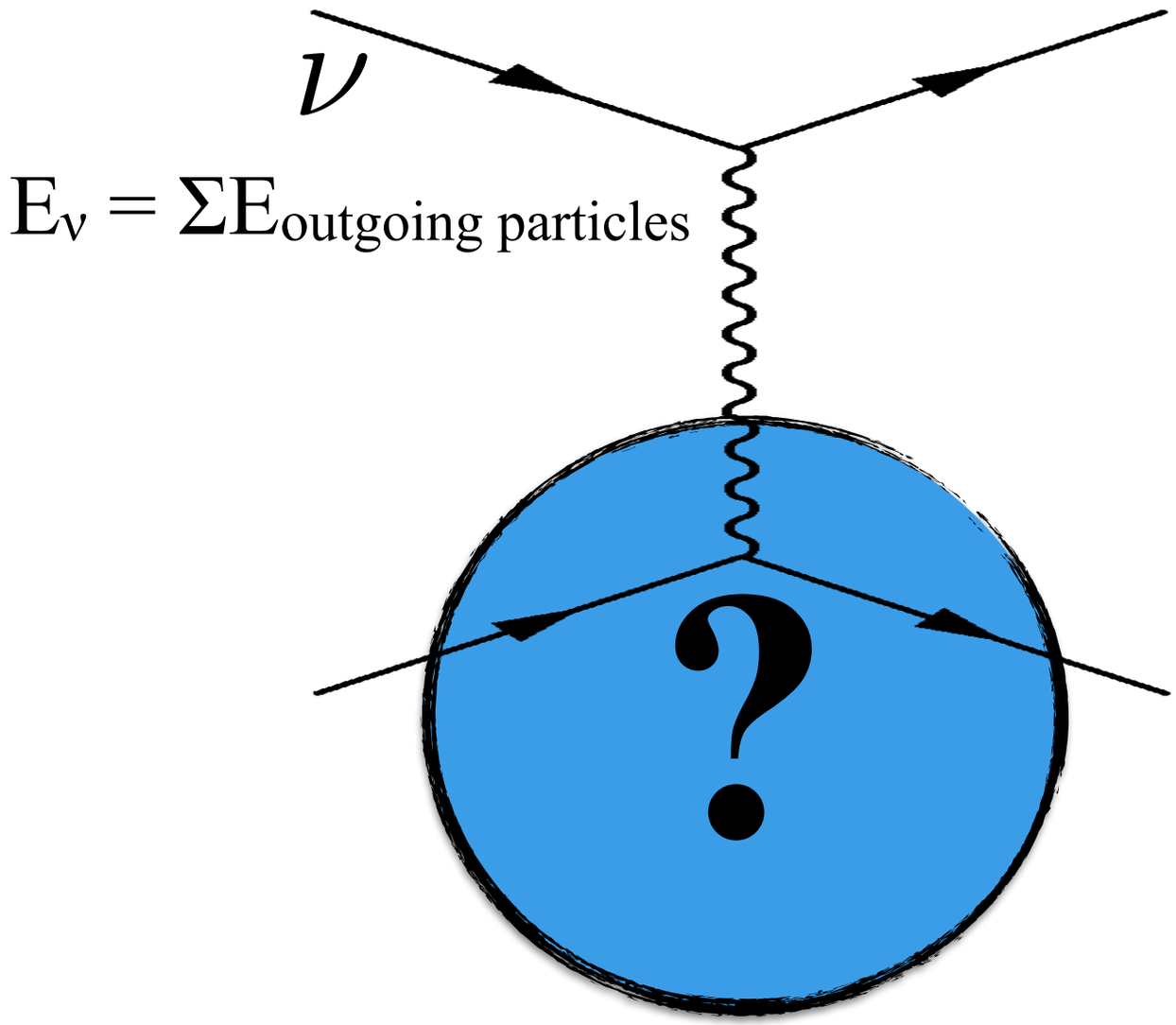
$$E_{\mathrm{cal}} = E_l + E_p^{\mathrm{kin}} + \epsilon$$

ϵ is the nucleon separation energy ~ 20 MeV

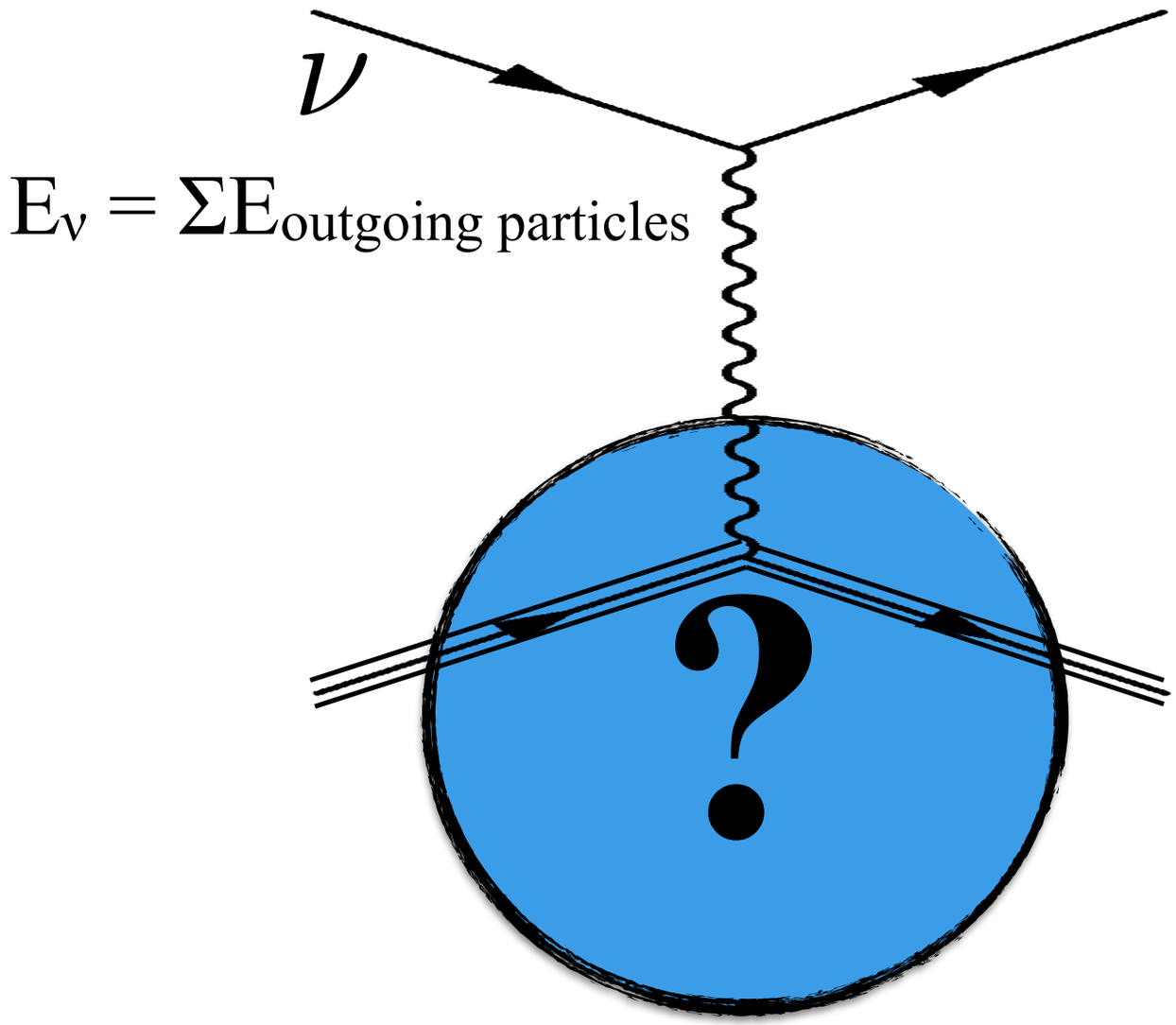
E_ν Reconstruction: Interaction Modeling



E_ν Reconstruction: Interaction Modeling

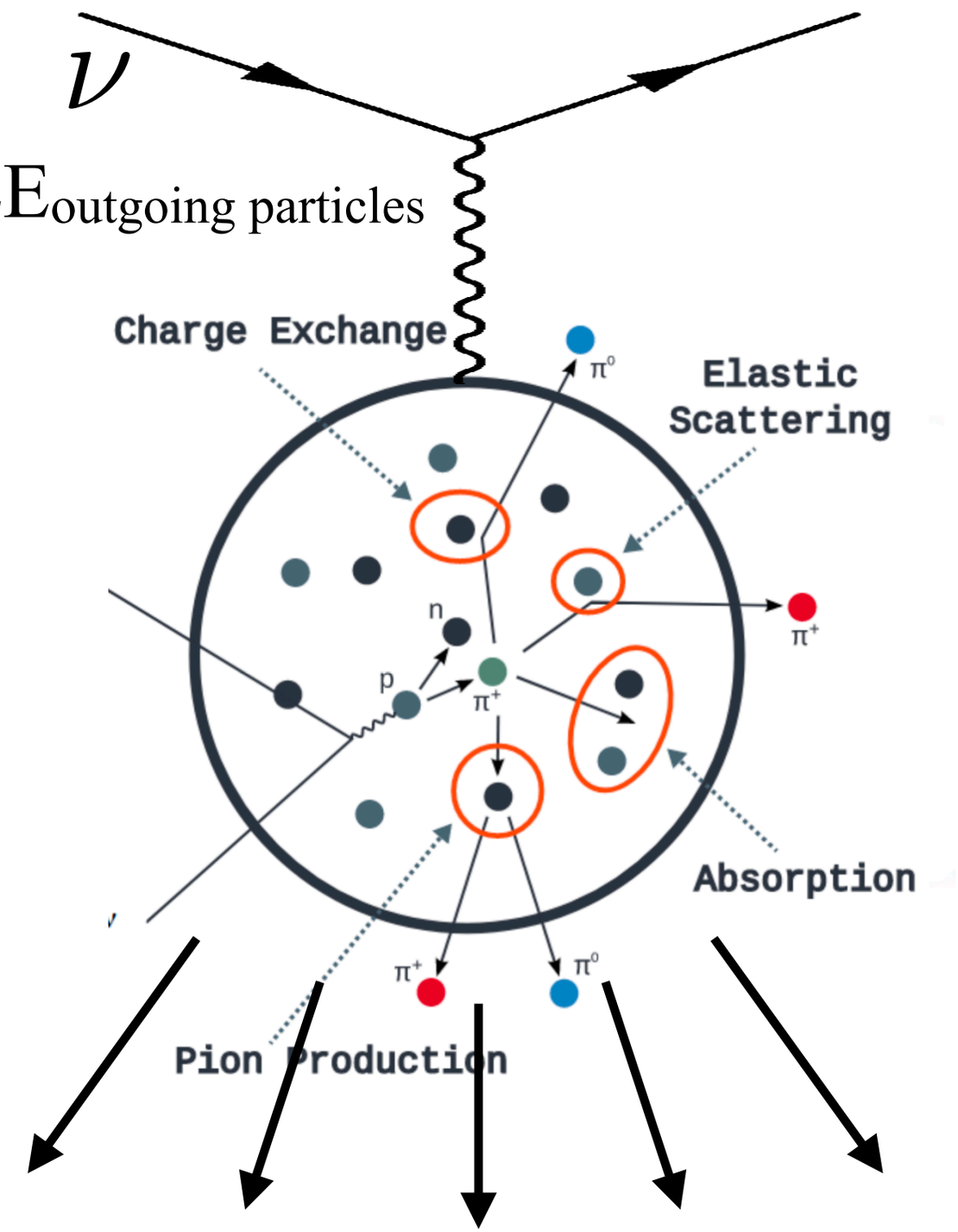


E_ν Reconstruction: Interaction Modeling

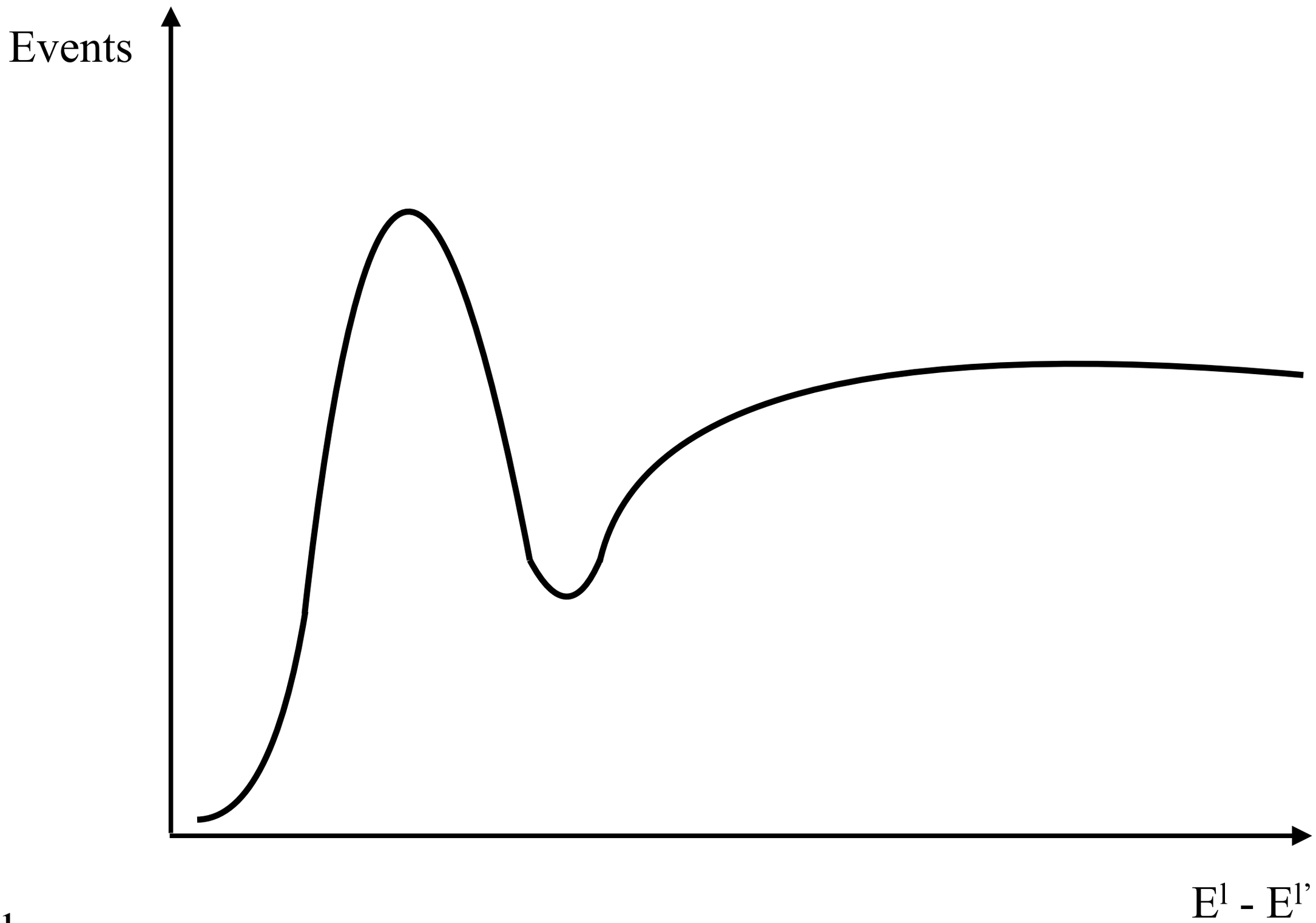


E_ν Reconstruction: Interaction Modeling

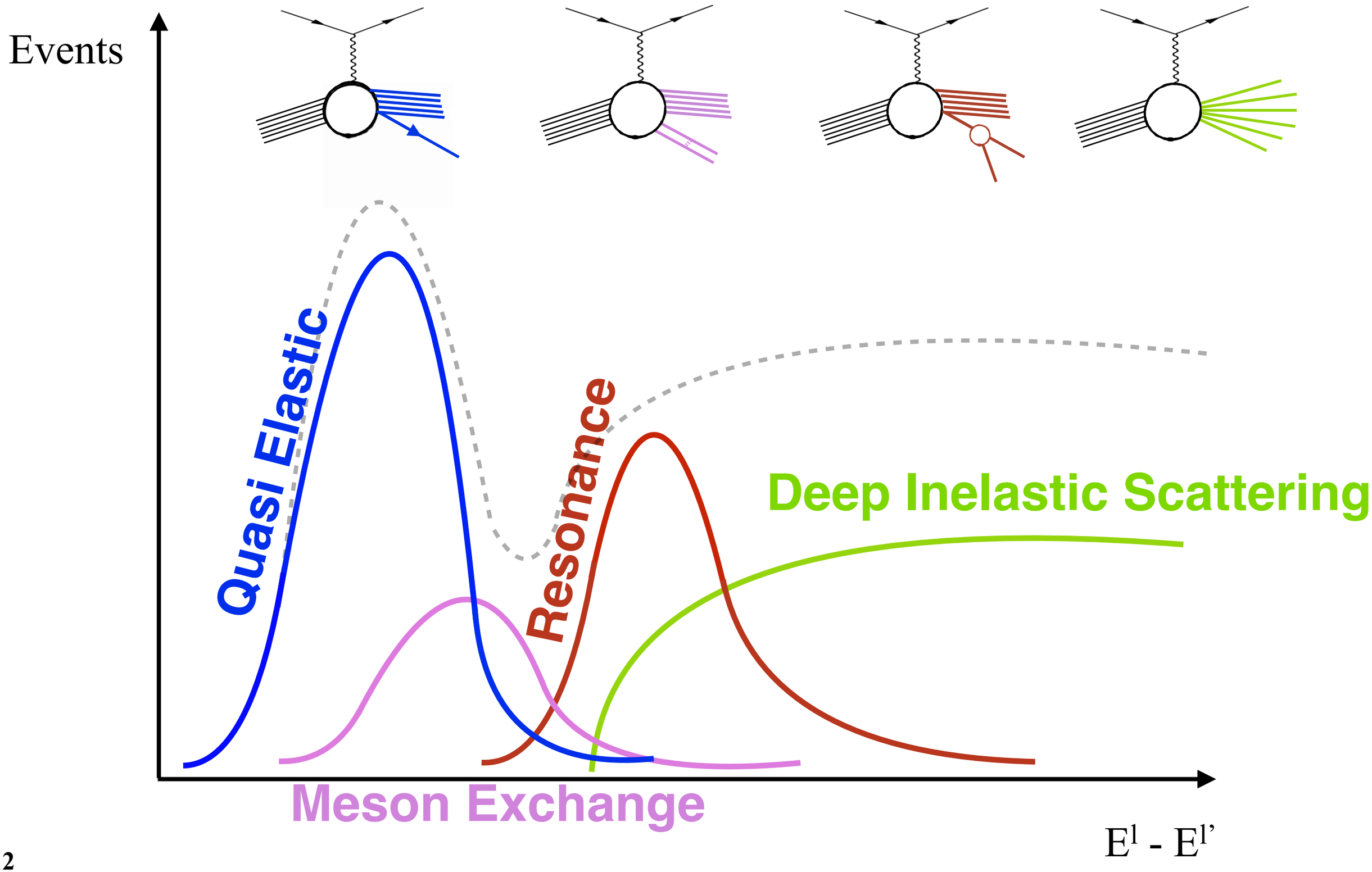
$$E_\nu = \Sigma E_{\text{outgoing particles}}$$



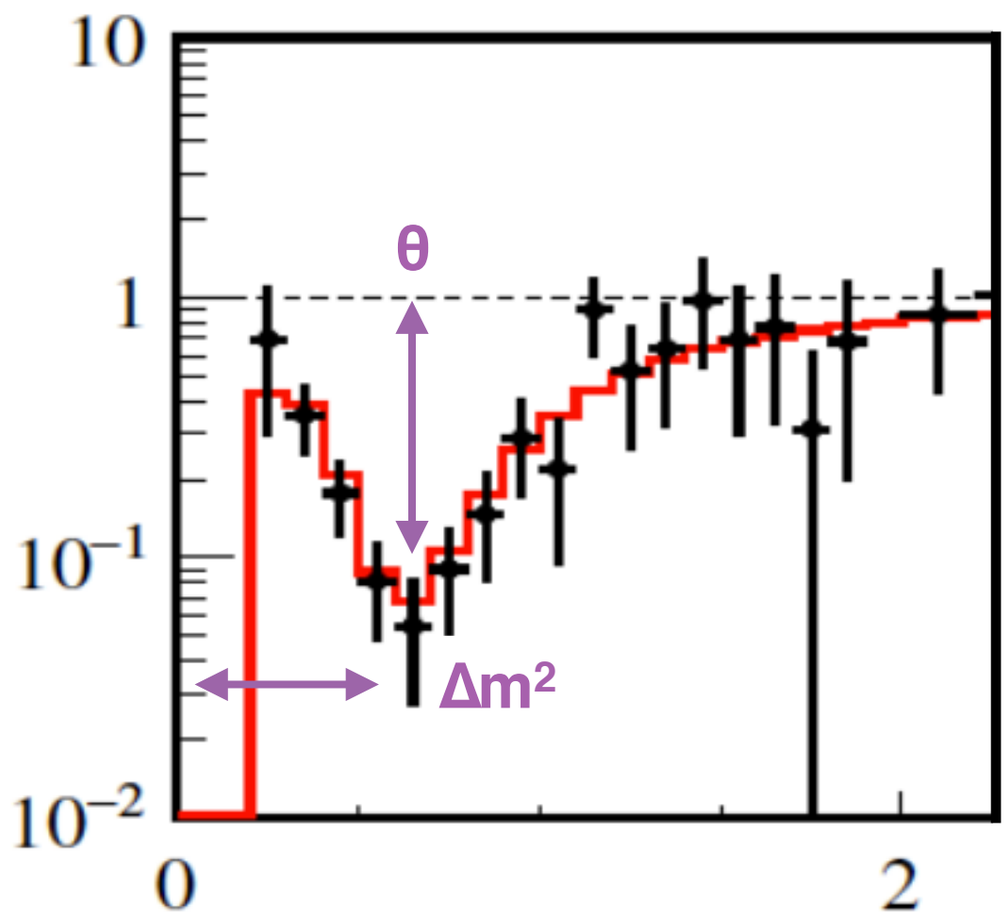
E_ν Reco Requires Interaction Modeling



E_ν Reco Requires Interaction Modeling

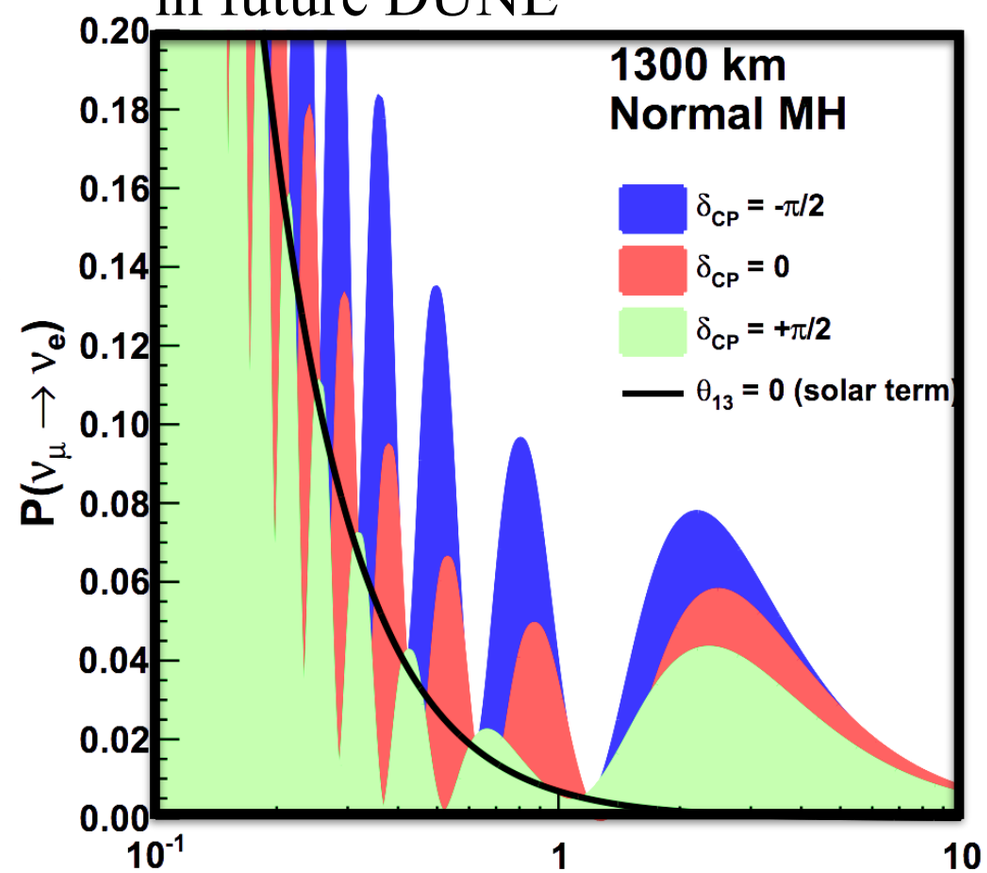


Next generation - High Precision Challenge



Neutrino Energy [GeV]

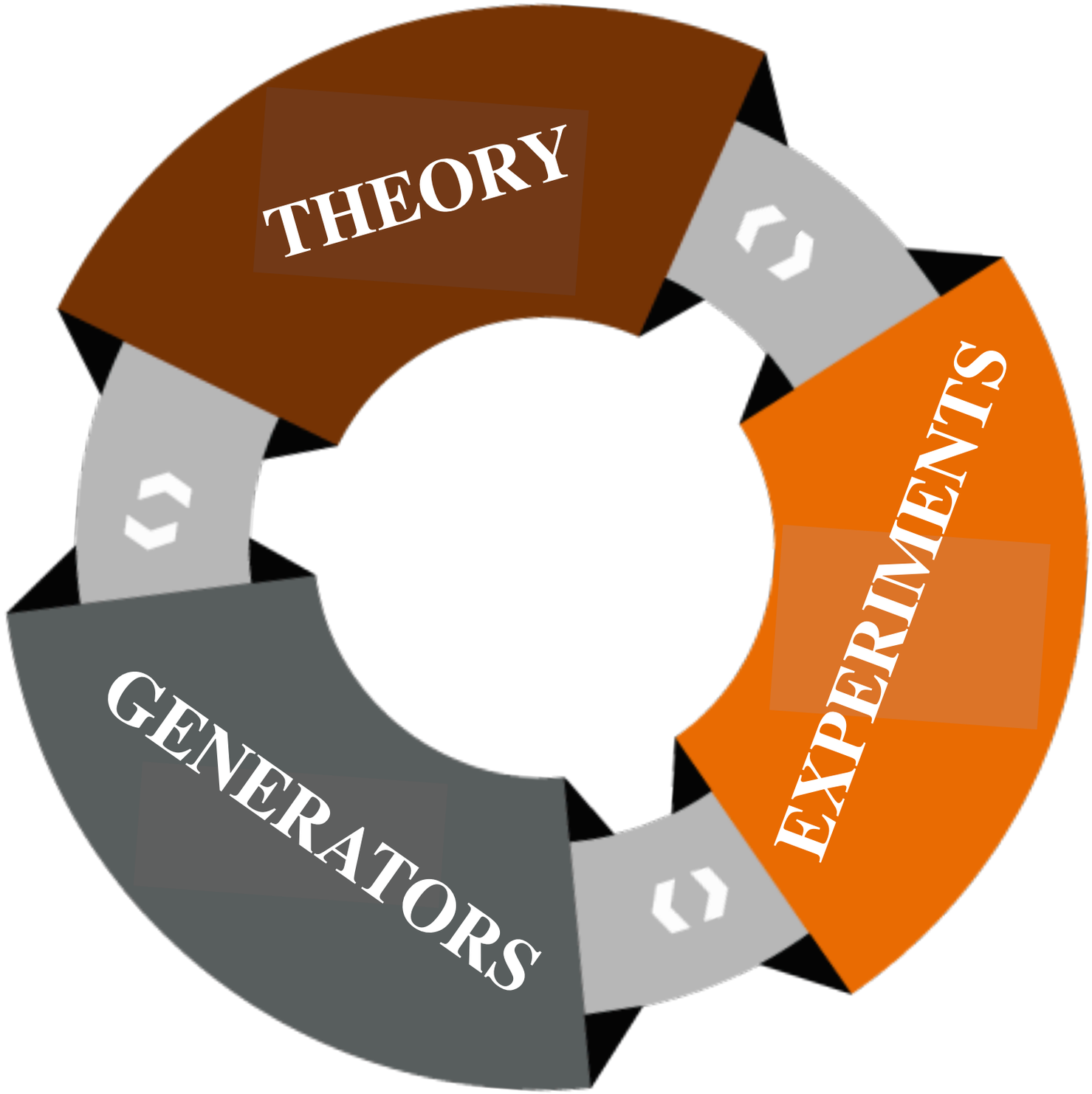
Simulation of oscillation effects in future DUNE



Neutrino Energy [GeV]

Need to improve modelling and reduce uncertainnities

WG2 Cross Section Focus



WG2 Cross Section Goals

Experimental Cross section results

Theory input - new models

Generators strategies

WG2 Cross Section Goals

Experimental Cross section results

10 talks

Theory input - new models

7 talks

Generators strategies

4 talks including

+ **Joint session with Oscillation WG1**

Oscillation experiments share their modelling issues

+ **Joint session with Detector WG5**

New experiments with CS input

Planeries WG2

Towards exclusive CS measurements & modelling - Maria Benedetta Barbaro

Shallow and deep inelastic scattering - Jorge G. Morfin

Input from nuclear community - Lawrence Weinstein

SBN Program & μBooNE - Maurizio Bonesini

MINERvA - Michael Kordosky

essνsb - Budimir Klicek

Thank you