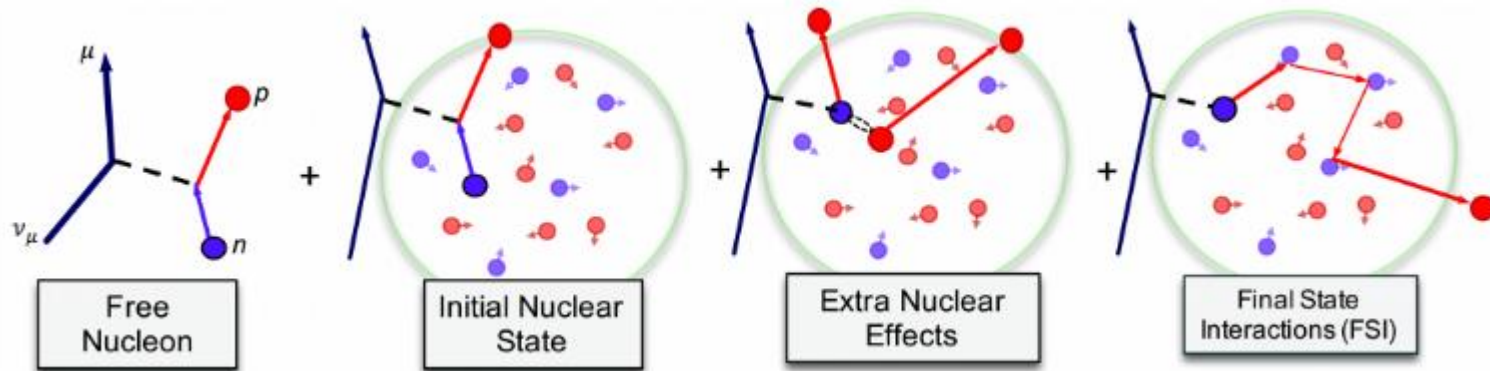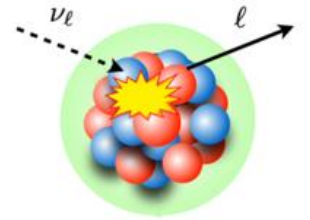# Nuclear physics for neutrino oscillations at T2K and beyond

$$N_{\nu_{\alpha\prime}}(E_\nu) = \phi_{\nu_{\alpha\prime}}(E_\nu) \times \sigma_{\nu_{\alpha\prime}}(E_\nu) \times P_{\nu_\alpha \to \nu_{\alpha\prime}}(E_\nu)$$

→ Cross-section + precise energy reconstruction from final state particles of neutrino interactions: a lot of nuclear effects to correct for
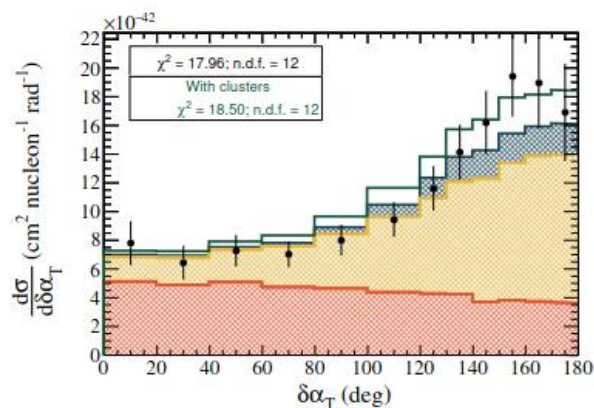

Free Nucleon + Initial Nuclear State + Extra Nuclear Effects + Final State Interactions (FSI)
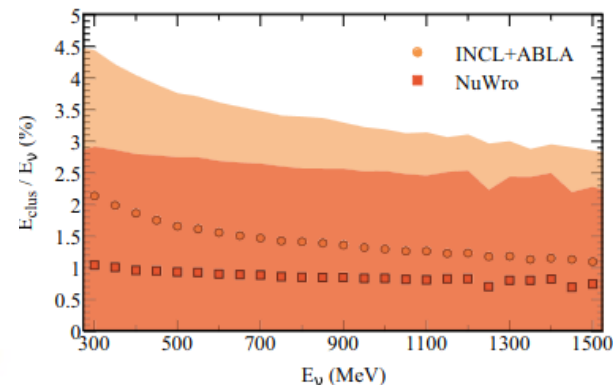
T2K work on nuclear physics

Publications on nuclear physics models for neutrino oscillations **with Jennifer2 contributions :**
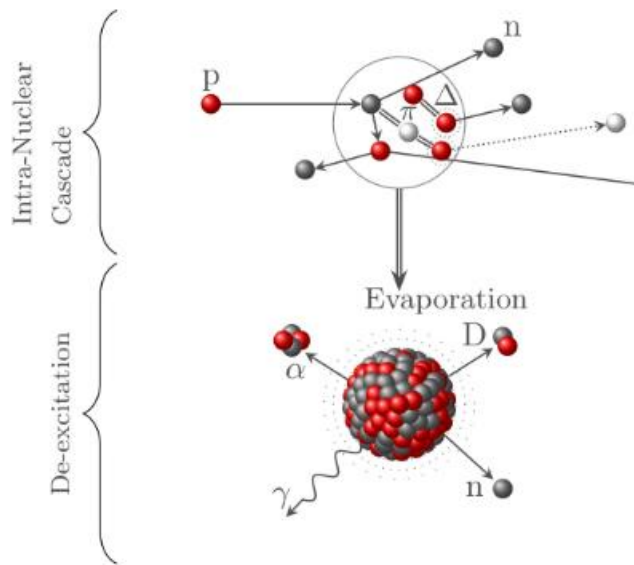
First ever simulation of nuclear cluster production in neutrino interactions at LBL energy : use INCL model ported from hadron scattering

Change the kinematics of ougoing leading nucleon (comparison to Minerva data)

Fraction of energy going to sub-leading nucleons and nuclear cluster

T2K work on nuclear physics

Publications on nuclear physics models for neutrino oscillations **with Jennifer2 contributions :**

Systematic evaluation of impact of nuclear effects on the difference between $\nu\mu$ and νe cross-section

Jennifer2 work on nuclear physics

And a lot more papers...

Benchmarking intranuclear cascade models for neutrino scattering with relativistic optical potentials - Phys.Rev.C 105 (2022) 5, 054603

Comparison of validation methods of simulations for final state interactions in hadron production experiments - Phys.Rev.D 104 (2021) 5, 053006

Superscaling variable and neutrino energy reconstruction from theoretical predictions to experimental limitations - Phys.Rev.D 109 (2024) 7, 073001

The Ghent Hybrid Model in NuWro: a new neutrino single-pion production model in the GeV regime

Angular distributions in Monte Carlo event generation of weak single-pion production - Phys.Rev.D 103 (2021) 5, 053003

….

And participation to major events in the domain (conferences, workshops, Snowmass LoI, ...)

Electron-nucleus scattering in the NEUT event generator – NuFact2022 (talk and proceedings)

Snowmass 2021: Event Generators for High-Energy Physics
Experiments, Neutrino-induced Shallow- and Deep-Inelastic Scattering

Summary of TENSION workshops : eg, Comparisons and challenges of modern neutrino-scattering experiments - Phys.Rev.D 105 (2022) 9, 092004

….

T2K workshops dedicated to neutrino-nucleus xsec

Latest one : 3 days in June 2023 at Mainz

Belle II physics weeks and Flavour Factory workshops during JENNIFER2 project life (and support to participation)

Belle II Physics Week (Oct 28-Nov 1 (Mon-Fri), 2019, KEK, Japan)

2022 Belle II Physics Week, Nov 28-Dec 3 (Mon-Sat), 2022, in Valencia (Spain) and online

KEK-FF 2023 & KM50, Feb 9, 10, 11, 2023 at KEK

Belle II Physics Week, Oct. 30-Nov. 3, 2023 at KEK

planned: Physics Week Oct 14 - 18, 2024 at KEK

Milestone of separate neutrino and flavour physics workshop definitely met .....

Joint theory and generators workshop to be organized by end of project

Organize a small workshop together with final J2GM in 2025

- Quark Flavour physics: CKM and beyond
- Lepton Flavour physics: PMNS and beyond
- Dark sector

Hard to include neutrino-nucleus interactions but…..let's try.

To be discussed with reference people in JENNIFER2.