

[Open] User Requirements - Nuclear Physics



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[Open] User Requirements

UR-54:

Physics models for ions below 1 MeV/u for Boron Neutron Capture

Assignee: José Ramos-Méndez [Sebastien Incerti]

From JLab CM [Med. and Bio.] requirements session [Models - Page 12]:

- ▶ Physics models for ions below 1 MeV/u.
- ▶ Carried out by Naoki Domínguez (Ph.D. student at BUAP, México), José Ramos-Méndez (UCSF).
- ▶ Project is in process.
- ▶ Naoki is writing his thesis.

UR-51:

Improve electro-nuclear models

Assignee: Vladimir Grichine

From JLab CM requirements session [page 12]:

- ▶ Today electro-nuclear relies on Weizsacker-Williams approximation.
 - ▶ Not sufficient for high-intensity and high precision electron scattering.
 - ▶ The full, off-shell electron scattering vertex, must be implemented for nucleons within the nuclear target.
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- ▶ There is progress in the e-nucleus integral XS and corrections for structure-function effects are ready to be implemented.
 - ▶ The QE e-nucleus scattering was R&D and the approach is discussed to be applied for the neutrino QE.
 - ▶ The neutrino QE and production integral XS were implemented in G4 in the summer.

UR-50:

Improve simulation of gamma induced neutron background

Assignee: Vladimir Grichine

From Fermilab CM requirements session [Other Requirements: Dark Matter Experiments - Page 7]:

- ▶ Low energy gammas producing neutrons in various materials can be a significant background
 - ▶ Photo-nuclear process does not model this well below 30 MeV
 - ▶ An improved process using the G4LEND gamma models is required

- ▶ Alternative model to treat low-energy gamma-nuclear interactions is available in the coming release 10.7. We need to study its effect.

UR-49: Neutron self-shielding effect

Assignee: Vladimir Ivantchenko

From Fermilab CM requirements session [Other Requirements: Dark Matter Experiments - Page 7]:

- ▶ Implement simulation of neutron self-shielding effect
 - ▶ Neutron flux through a material can be significantly modified when the neutron energy is in the resonance region
 - ▶ The capture process can reduce the flux at one position in a crystal creating a kind of shadow in which the downstream atoms see a different background flux (a 10% effect)

Correction procedure is done in MCNP, not in Geant4.

2020: Need to collect publications. No activities done.

2021: Missing manpower to serve it.

[New] User Requirements¹

¹Not really new, and not formally in JIRA. Taken from UR in NP, 21 Sep. 2020, D. Wright.

Better photo-nuclear for 15 GeV and below (for JLab and EIC)

- ▶ Forward collision products especially important
- ▶ Reactions with low energy fission products
- ▶ Ultra-peripheral collision simulation

A big job not yet begun.

Electro-nuclear model improvements also required by JLab/EIC

- ▶ See UR-51

Bertini Gamma-Nuclear

- ▶ Overproduction of n and p near endpoints of reactions at 4.5 GeV
- ▶ Problem fixed for γ -D reactions
- ▶ More work required for other nuclei

GIDI - LEND Models

- ▶ Future of high precision neutrons looks like it will be GND (Generalized Nuclear Data)
 - ▶ new, simpler data format will replace ENDF
 - ▶ also includes low- to medium-energy nuclear data
 - ▶ however, not as complete as ENDF
- ▶ Current LEND models in Geant4 are based on this
 - ▶ GIDI, the interface between GND data and LEND physics models is currently written in C
 - ▶ many bugs uncovered by users and LEND validation effort
 - ▶ Livermore ^{was} ~~is~~ writing a new, redesigned version in C++.
- ▶ Requirement - install new GIDI when ready and validate with updated LEND

Missing manpower/funding to serve it.

β -delayed n -emission

- ▶ Missing from Radioactive Decay models
 - ▶ Nucleus beta decays to highly excited level in daughter, daughter then emits neutron
 - ▶ Crucial for reactor studies
- ▶ Requirement: develop understanding of highly excited level densities in nucleus and model neutron decay from this region
 - ▶ Use precompound model for n emission stage?

Some discussions were held some years ago but no agreement on implementation was achieved