[Open] User Requirements - Nuclear Physics

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1 Illustration: Hennie Haworth/The Guardian

[Open] User Requirements

UR-66:
Fix overproduction of n and p near endpoints of reactions at 4.5 GeV

Assignee: ~~Alberto Ribon~~

- ▶ Related to Bertini Gamma-Nuclear
- ▶ Problem fixed for γ-D reactions
- ▶ More work required for other nuclei

- ▶ *First time reported as formal requirement*
- ▶ No manpower

UR-65:
Beta-delayed Neutrons : develop understanding of highly excited level densities in nucleus and model neutron decay from this region

Assignee: ~~Alberto Ribon~~

- ▶ Missing from Radioactive Decay models
    - ▶ Nucleus beta decays to highly exited level in daughter, daughter then emits neutron
    - ▶ Crucial for reactor studies

- ▶ *First time reported as formal requirement*
- ▶ (Vladimir I.) To use de-excitation module (not precompound one) will require a change in Radioactive decay class - add a possibility to call not only photon evaporation but excitation handler.
- ▶ (Alberto) In practice, we don't have enough man-power available to work on it.

Some discussions were held some years ago but no agreement on implementation was achieved. **Dataset size and handling issues**

UR-64:
GIDI - LEND Models : install new GIDI when ready and validate with updated LEND

Assignee: ~~Alberto Ribon~~

- ▶ 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 ~~is~~ *was* writing a new, redesigned version in C++. **No funding?**

- ▶ *First time reported as formal requirement*
- ▶ It is in the plan of work for 2022, but it is often postponed

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 $1\,\text{MeV/u}$.
- ▶ Carried out by Naoki Domínguez (Ph.D. student at BUAP, México), José Ramos-Méndez (UCSF).

- ▶ Project is in process.
- ▶ Naoki ~~is~~ *was* writing his thesis.
- ▶ **Maybe Pedro or Naoki -if present- can give an update?**

UR-51:
Improve electro-nuclear models
Better photo-nuclear for 15 GeV and below

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.

▶ There is progress in the e-nucleus integral XS and corrections for structure-function effects are ready to be implemented. **Already in G4.**
▶ The neutrino QE and production integral XS **were implemented in G4 in 2021**. **New QE integral XS was implemented for neutrino-A. The neutrino-A model was updated for the new QE/IN ratio.**
▶ **New $e - A$ approach will be implemented in G4 up to the end of 2022. Concerning $A(\gamma, n)$, improving of the existing models is underway.**

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 since 10.7.**
- ▶ (Marc) We need to study its effect.

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)

- ▶ A number of other problems in nuclear physics need fix. UR-49 (this) would follow
- ▶ Missing manpower to serve it.