

Summary of Parallel Session 8A: Low Energy Hadronic Physics

Alberto Ribon, Dennis Wright

16 September 2016

Validation of (p,n) Reactions at Low Energies

- Hoang Tran (CEA)
- Proposed to build low energy compact neutron source to replace medium-sized research reactors
 - need to qualify Geant4 low energy protons (<20 MeV) and neutrons by comparing to (p,n) data at 6 MeV and below
 - also compare to MCNP
- Good source for Geant4 validation
- Comparison results:
 - Geant4 factor 2 low for neutron flux
 - Angular distributions look good
 - Excellent agreement for TOF

Validation of (p,n) reactions at Low Energies

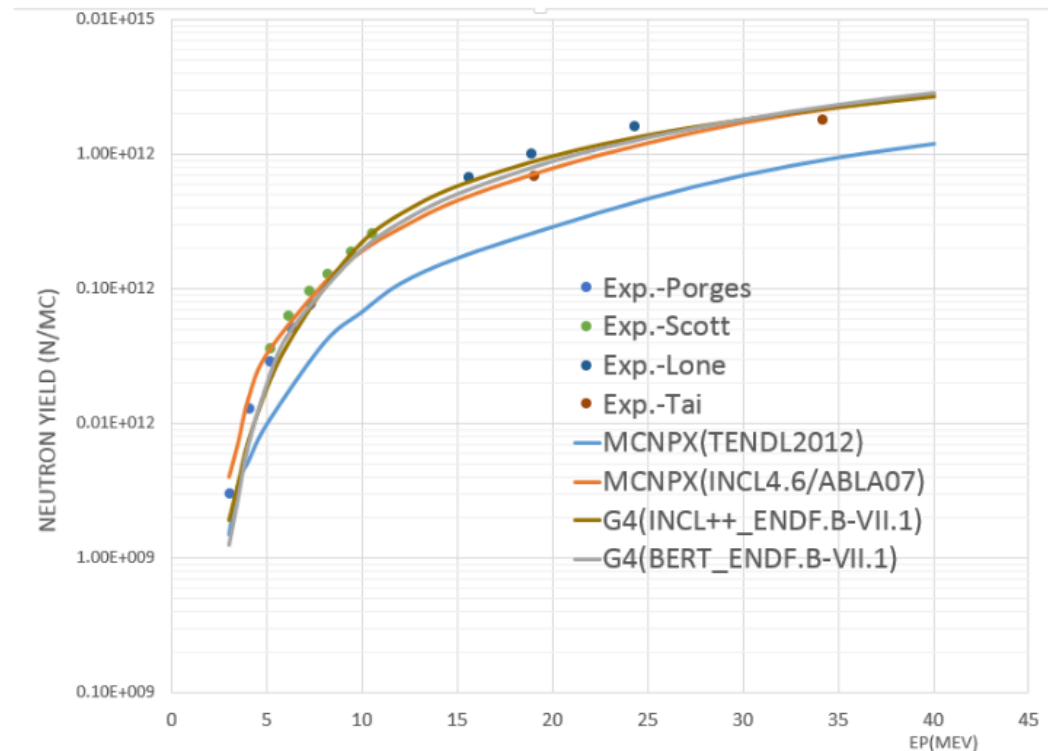
ENDF.B-VII.1 data cross section in Geant4

Beam energy (MeV)	G4(INCL++_ENDF.B-VII.1)	G4(BIC_ENDF.B-VII.1)	G4(BERT_ENDF.B-VII.1)
3	1.91E+11	1.91E+11	1.25E+11
3.5	3.68E+11	3.61E+11	2.91E+11
4.0	7.30E+11	6.67E+11	6.75E+11
5.0	1.84E+12	1.43E+12	1.99E+12
6.0	3.69E+12	2.45E+12	4.32E+12

Experience

Proton (MeV)	Neutron Yield
3.05	3.04427E+11
4.09	1.30406E+12
5.17	2.91232E+12

Lone, 1992, NDN

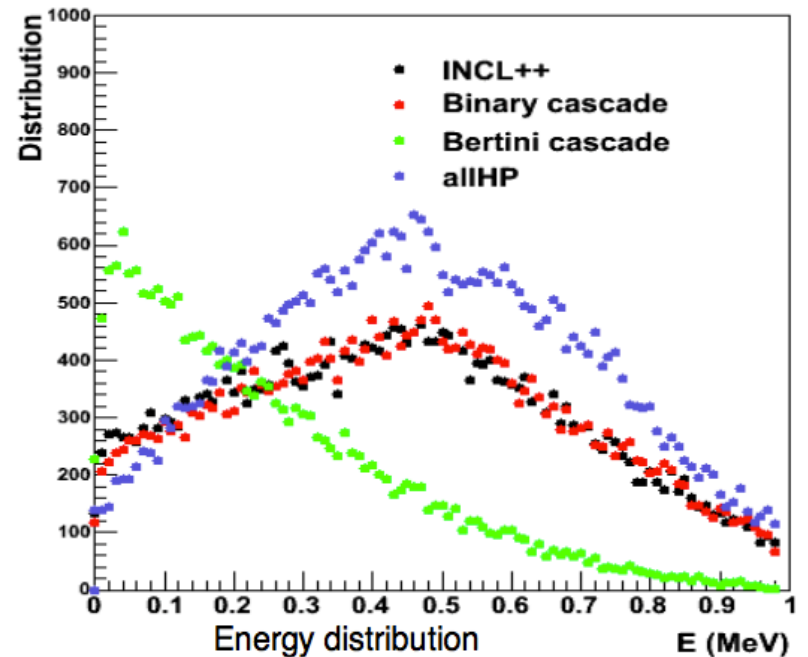
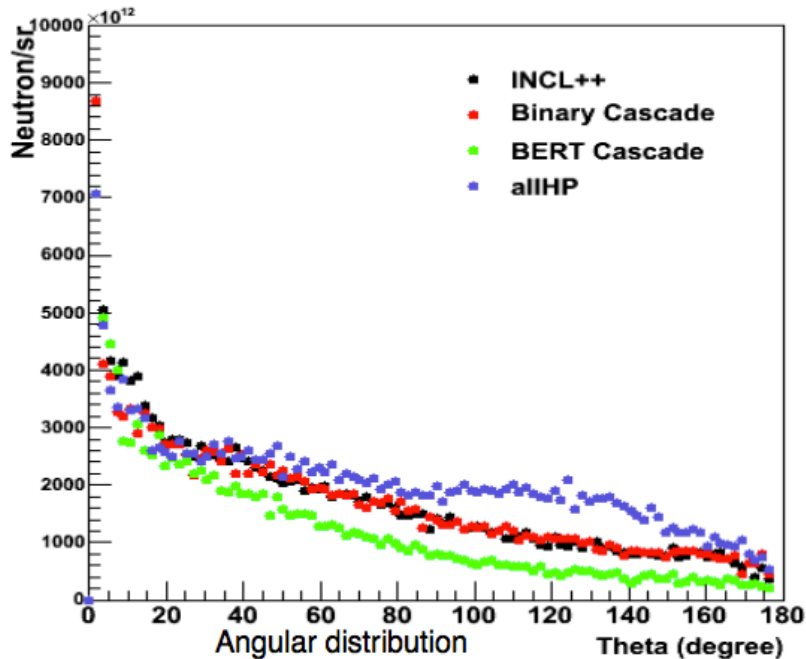


=> The simulations show a **factor 2 lower** than experimental data at low energy of proton (3 MeV – 6 MeV)

Validation of (p,n) reactions at Low Energies



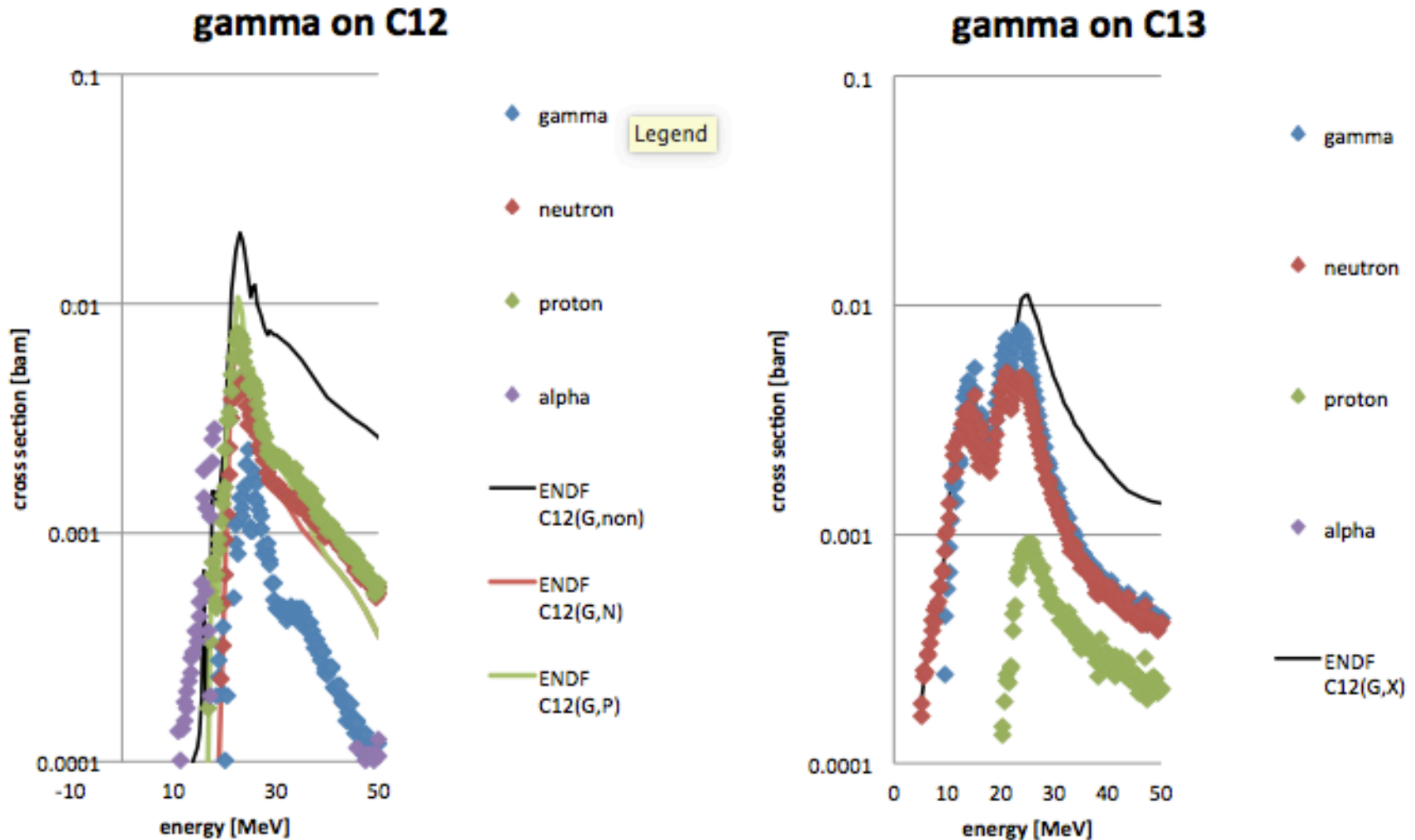
DISTRIBUTIONS OF REACTION BE(P,N) AT 3 MEV



Update of Data-driven Low Energy Nuclear Models

- Tatsumi Koi (SLAC)
- NeutronHP and ParticleHP successfully merged in V10.2
 - G4TENDL data files used in ParticleHP
 - inelastic reaction of light ions (d, t, ^3He , α) supported
 - DB files available as zlib-compressed files (561 Mb)
- G4LEND models
 - alternative to ParticleHP for n
 - can also do incident gammas up to ~ 50 MeV
 - soon to be extended to charged particles

Update of Data-driven Low Energy Nuclear Models



Update of Data-driven Low Energy Nuclear Models

- Plan new capture model based on PGAA data
 - to address poor agreement with gamma spectra from capture in some isotopes (e.g. ^{113}Cd)
- Start work on self-shielding calculations in Unresolved Resonance Region
 - currently underestimated (10 – 100%) in thick materials
 - important for cryogenic dark matter searches

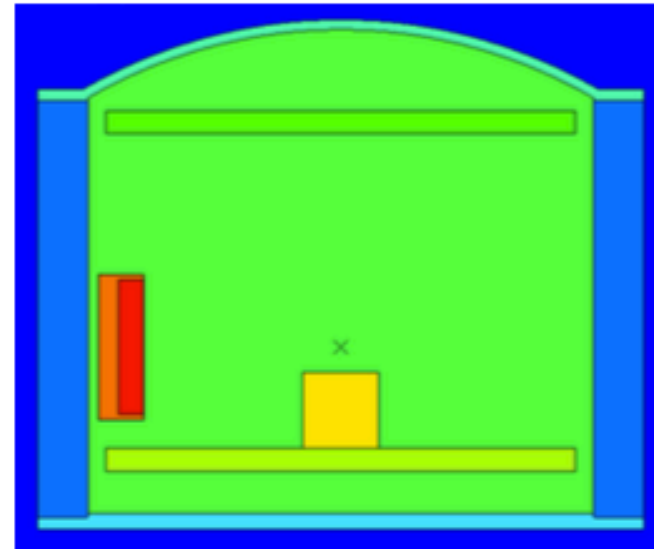
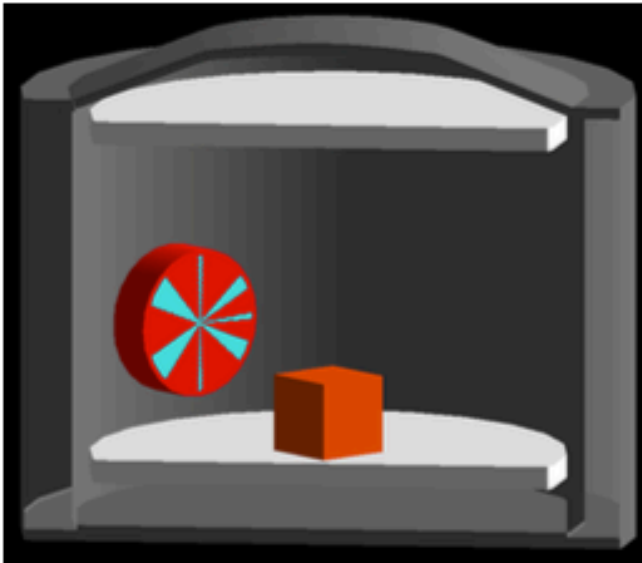
Progress on Tripoli-4/Geant4 Coupling

- Davide Mancusi (CEA)
- TRIPOLI-4: general purpose 3D MC particle transport code
 - developed at CEA-Saclay
 - used by reactor and radiation protection community
 - can be alternative to G4 NeutronHP
- New features of the coupling
 - can use Geant4 geometry and source in a TRIPOLI-4 calculation
 - delegates high energy particles, protons, etc. to Geant4
 - once neutron < 20 MeV produced, use TRIPOLI-4
 - collect scores on TRIPOLI-4 side

Progress on Tripoli-4/Geant4 Coupling



THE APOLLON ENCLOSURE



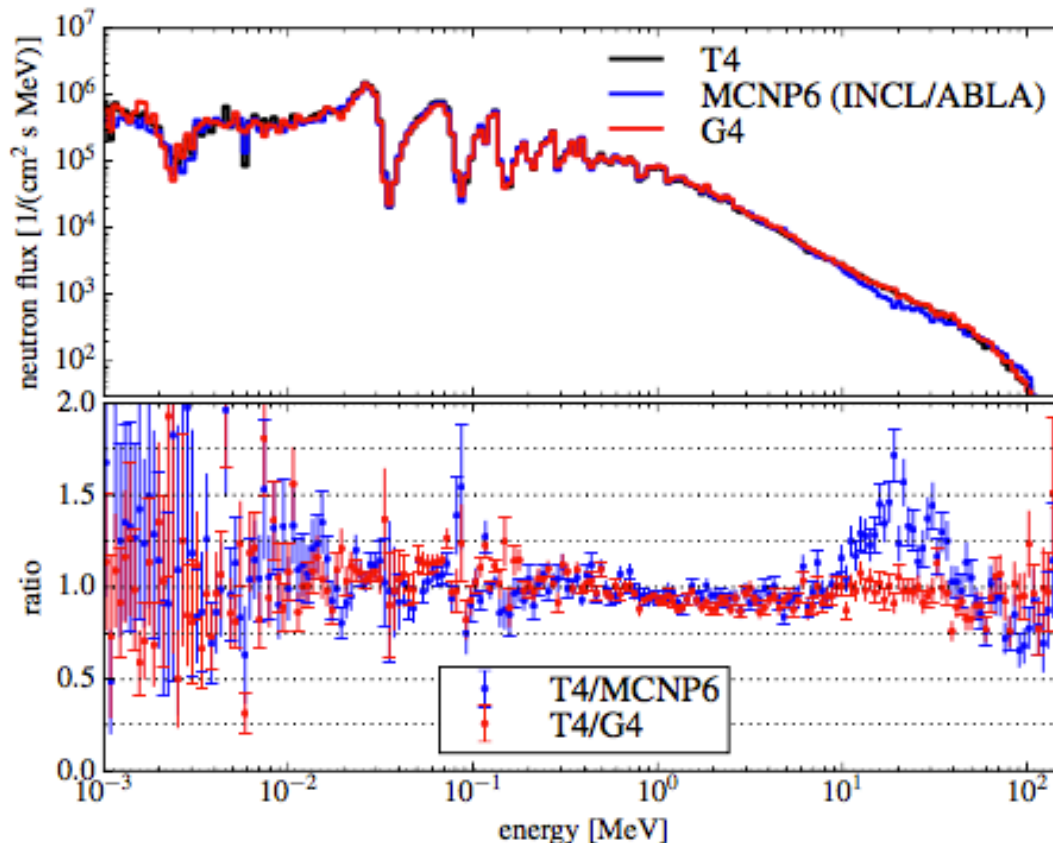
APOLLON

- ▶ high-intensity **laser** (10^{16} W!)
- ▶ proton + electron source
- ▶ neutron + photon outgoing fluxes

Progress on Tripoli-4/Geant4 Coupling



OUTGOING NEUTRON FLUX



- ▶ T4 and G4 in **excellent** agreement
- ▶ same high-energy sector
- ▶ T4/MCNP6 $\pm 50\%$ at **high energy**
- ▶ comparable to nuclear-reaction-model uncertainty

Discussion

- Large number of environment variables for ParticleHP
 - needs to be managed more simply in Cmake
 - plan to be developed at next hadronic meeting (in 10 days)
- Degradation of energy response and shower shape in calorimeters due to FTF tuning since 10.1
 - but improved thin-target description
 - agreed to revert FTF to 10.1 version for release 10.3
 - but also need development version – exactly how to perform fork to be determined at next hadronic meeting