

particle_hp

status and plans

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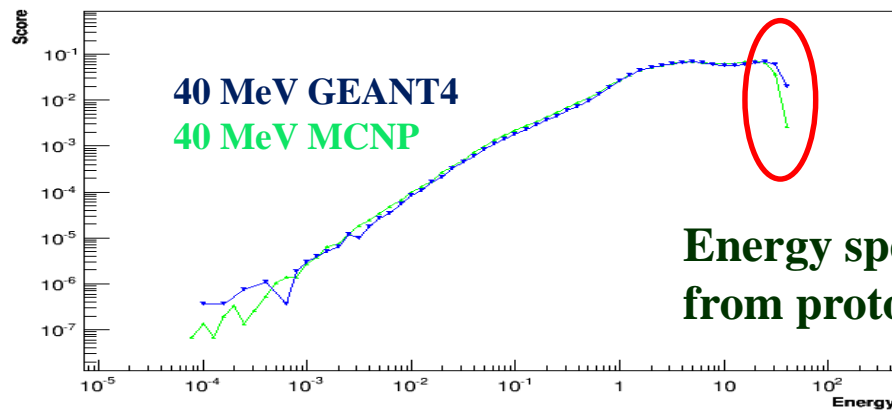
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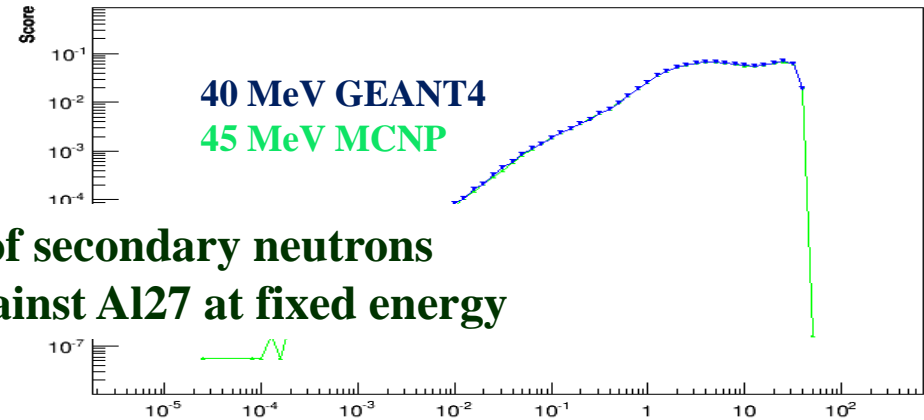
History

In Geant4 release since 10.2 (Decembre '16)

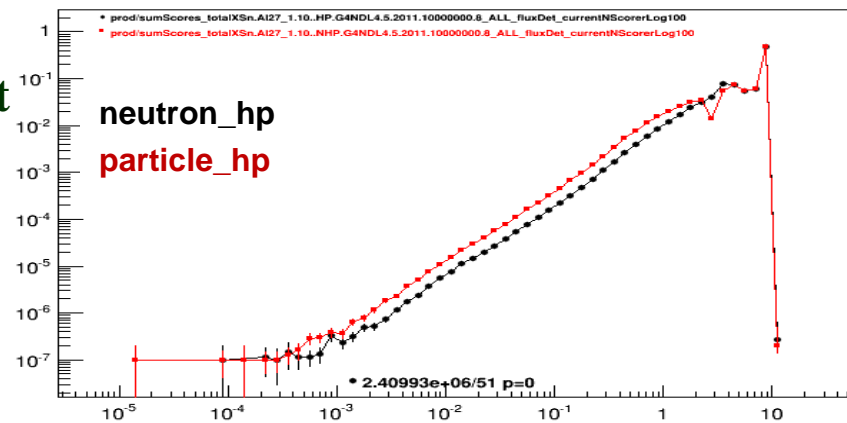
- ❖ `particle_hp` = `neutron_hp` extended for charged particles (p,d,t,He3, α)
 - + Number of particles of a type produced in an interaction was not sampled in `neutron_hp` (except for gammas): **Integer value was taken: 2.43 \rightarrow 2**
 - + Correct interpolation of tables for secondary energy spectra: **If incident particle energy is 40 \rightarrow 44.999... MeV: uses table of 45 MeV**



Energy spectra of secondary neutrons from protons against Al27 at fixed energy



Energy spectra of secondary neutrons from 10 MeV protons in thick Al27 target



Adjusting final state

User must follow “Guide for Application Developers”:

➤ **Set environmental variable**

G4PARTICLEHP_DO_NOT_ADJUST_FINAL_STATE to 1

- ✓ Do not conserve baryon number nor energy if database does not provide channel by channel data (as TENDL), but only particle yields (also happens for some isotopes in neutron_hp)

For each secondary particle DB has only average yield: number of each secondary particle is sampled independently of others

Else you would produce a wrong number of particles:

- Check that sum of atomic masses and numbers is equal than target nucleus
 - If it is bigger, resample particle yields
 - If it is smaller, create artificially new particles

What nuclear DBs are there?

ENDF-VII:

- Uses only experimental data
- Only a few isotopes (p:48, d:5, t:3, He3:2)
- Only p → X reactions (MT=5)
 - double differential spectra of resulting particles (n,p,d,...), without channel information (n,nn,np,nna,...)
- Up to 150 MeV for p (d: 50 MeV, t: 20 MeV, He3: 20 MeV)
- ENDF format

TENDL:

- Uses some experimental data + TALYS calculations
- All isotopes (2400)
- All channels (also available a DB with only p → X reactions)
- Up to 200 MeV
- ENDF format

IAEA medical database:

- Only experimental data
- Only a few reaction channels of a few isotopes
- Only channel cross sections
- Simple text format

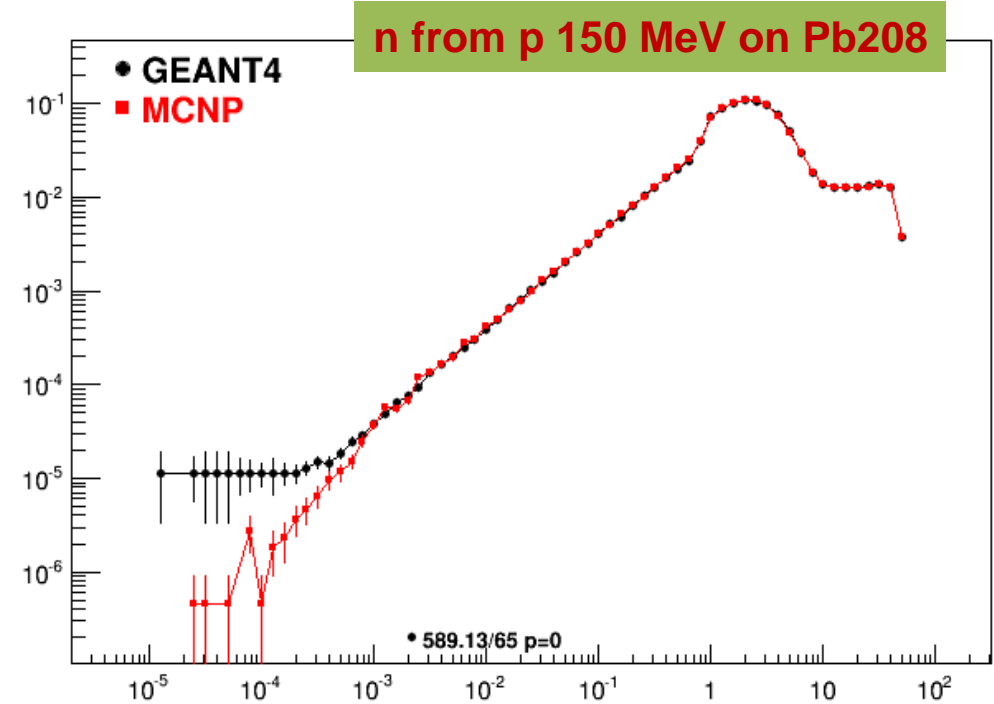
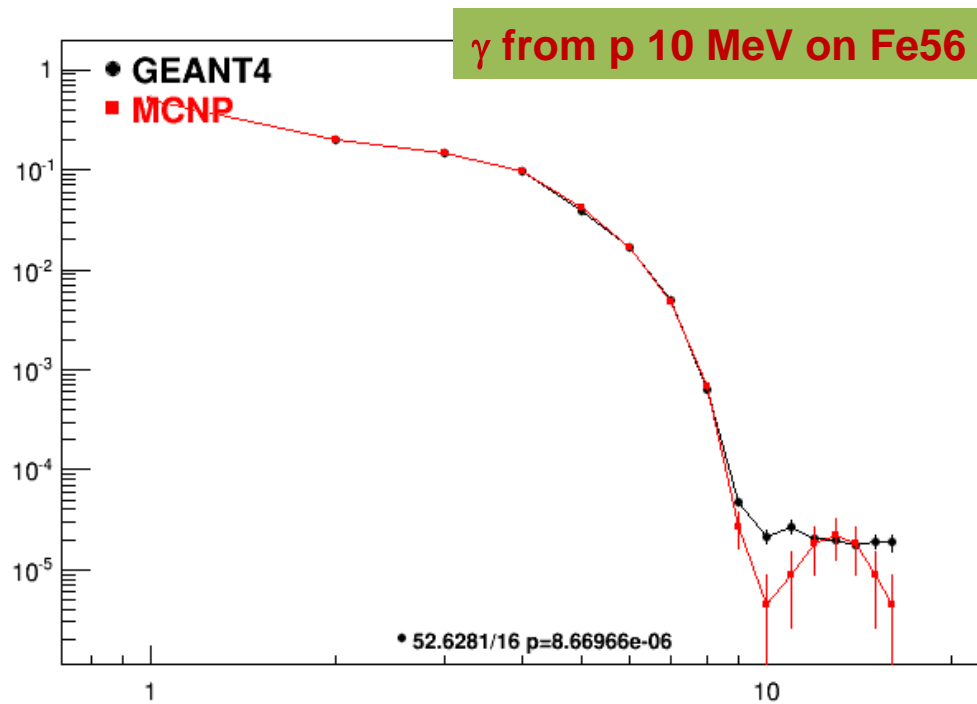
IBANDL database:

- Only experimental data
- Not all isotopes
- Many experimental measurements channel by channel
- Low energy (up to a few MeV)
- Own format

Validation

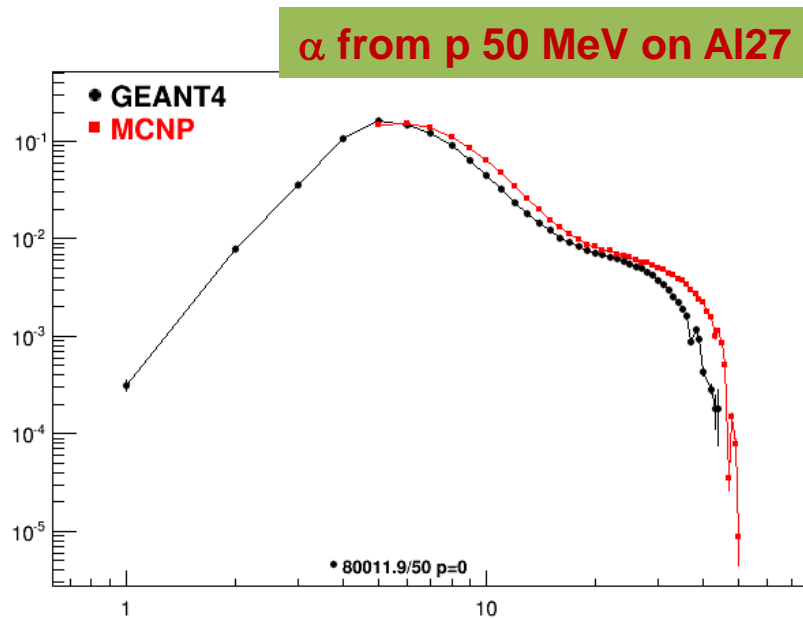
- ✓ Check that cross used by Geant4 = cross sections as read in database
- ✓ Compare secondary spectra with MCNP:
 - * Cross sections
 - * Double differential spectra of resulting particles

😊 Good match for n and γ

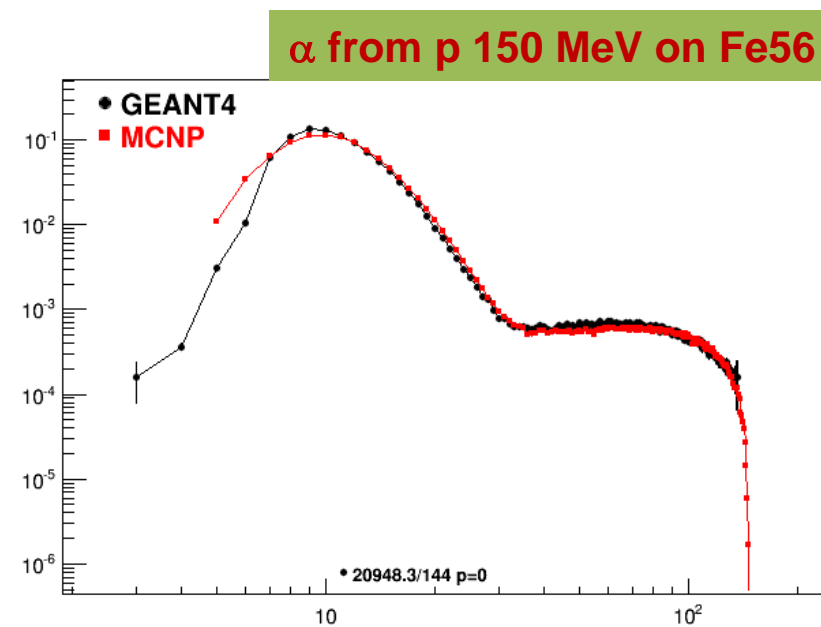


Validation

☹️ Bad match for charged particles



Interference



❑ For each isotope, for each secondary particle type, for each incident energy data for secondaries:

➤ GEANT4 uses **3** parameters

- Energy
- Probability
- Angle parameter

➤ MCNP uses **5** parameters

- Energy
- Probability
- Cumulative probability $\sum_{k=0}^n (P_{k-1} - P_k)/2$
- Angle parameter
- Interference correction?

Good idea, GEANT4 calculates the cumulative probability on the fly, for each interaction!

Plans

Emilio Mendoza:

- Takes care of update the G4TENDL database with the new versions of TENDL (one per year)

Pedro Arce:

- Takes care of code maintenance / user support
- ❖ **No manpower for implementing the missing interference for charged secondary particles**

□ Our requests:

Make G4PARTICLE_DO_NOT_ADJUST_FINALSTATE = 1 default

= 0 : wrong number of secondary particles

= 1 : no energy conservation