RECENT UPDATES IN THE DE-EXCITATION MODULE AND IN GENERAL HADRONICS

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Outline

- Cross sections
- FermiBreakUp
- Parameterisation of level density
- G4HadronicProcess
- Validation results

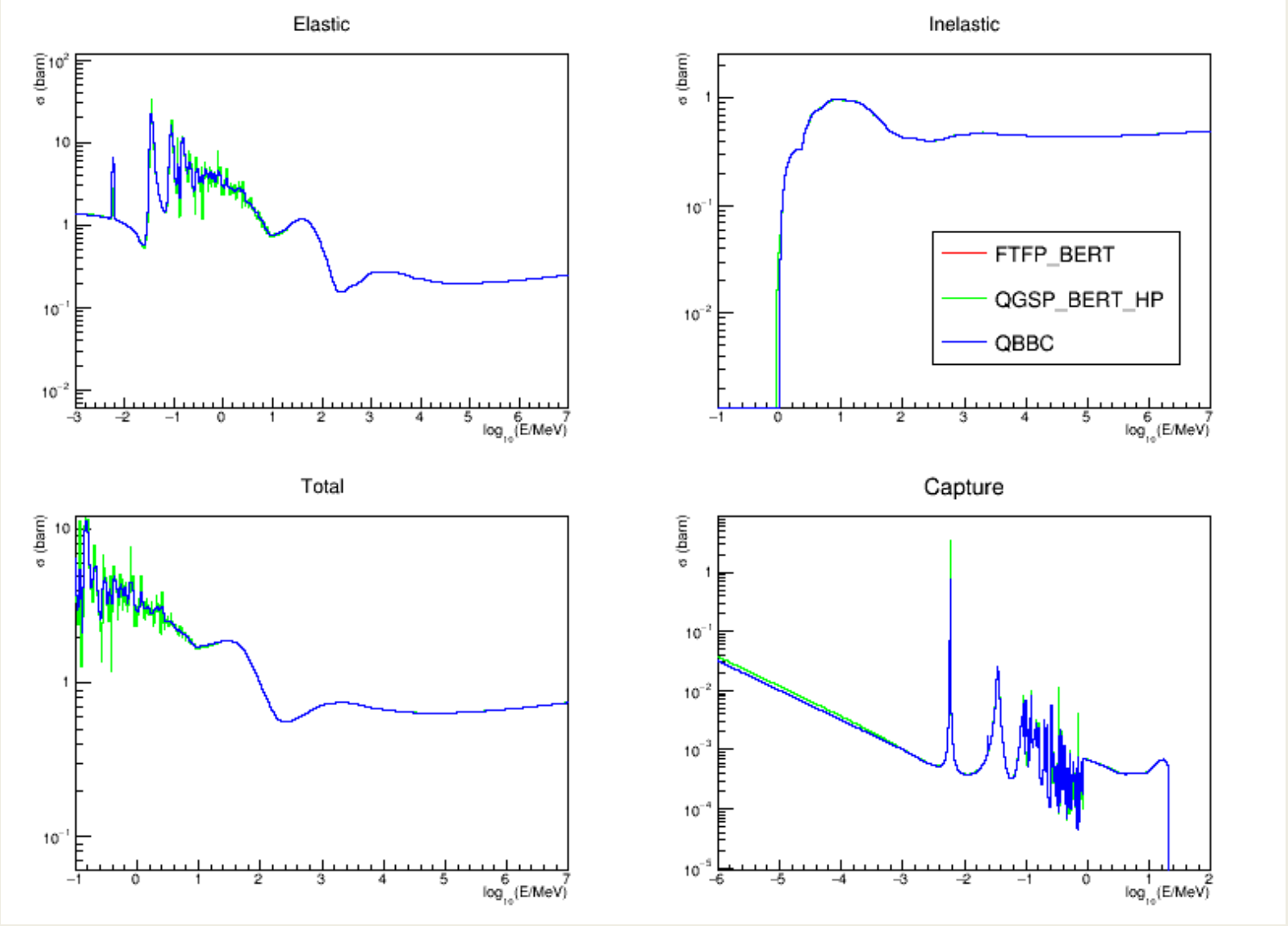
Cross sections

- Recently a new dataset G4PARTICLEXS1.0 was introduced
  - *G4NEUTRONXSDATA data set is not used anymore*
  - *G4PARTICLEXSDATA environment variable should be set*
  - *Evaluated data from ParticleHP for n, p, d, t, He3, He4*
  - *Evaluated data from LEND for gamma*
  - *Element and isotope cross sections*
  - *Cross sections are shared between threads*
  - *Neutron cross sections are used in many PhysLists*
  - *Light ion cross sections are used in QBBC*
- Majority of cross sections are modified
  - *Hadron-nucleon x-section parameterisations are inside G4HadronNucleonXsc class*
  - *BGG and GG classes use G4HadronNucleonXsc*

G4PARTICLEXS1.0

- Structure of the data set is change because of particle HP
  - *Separate directories for n, p, d, t, he3, he4 cross sections*
    - Only neutron in previous version
  - *Element x-sections from threshold to max hadronic energy (100 TeV)*
    - Physics data tables shared between threads extracted from ParticleHP
    - Glauber Gribov cross section above 20 GeV
- Added extra isotope data for 11 more elements (was 17 before)
  - *Ne, Mg, S, Cl, K, Sc, Ti, Ga, Pd, In, Pt*
  - *Limit on isotope abundance is reduced to 0.001 (was 0.01)*
- Fixed discontinues in last bins
  - *Isotope data for E < 20 MeV*
- Fixed G4CrossSectionDataStore code
  - *Isotope selection*
  - *Integral approach – energy loss at a step is taken into account*
- New proton and light ion inelastic x-section is tested in QBBC Physics List

Neutron x-sections in Aluminum



New Fermi Break-up model

- Old G4FermiBreakUp model was based on hadrcoded data
  - *A pool of 112 states, Z < 9, A < 17*
  - *Precomputed probabilities of decay of each state from this pool into 2-, 3-, 4-body final state from this pool*
- New G4FermiBreakUpVI model fully based on data of G4GAMMALEVELDATA
  - *A pool of 260 states from data files and 399 reactions, Z < 9, A < 17 (10.4)*
  - *A pool of 380 states from data files and 991 reactions, Z < 9, A < 17 (10.5)*
  - *An extra set of 80 unphysical fragments not known from data*
    - Including very exotic states like H_8 or He_2
  - *Only binary decay chains are considered*
    - A standard Coulomb barrier computation is used
  - *Probability of the first decay is computed on fly because initial excitation of the primary fragment is not fixed*
  - *Decay product may be as a state from the main pool or from the extra set*
  - *The second decay probabilities are precomputed*
  - *Final product is always a list of states from the main pool which has no Fermi decay channel*
- The model for 10.5 is slightly slower than the old one but is more correct physically

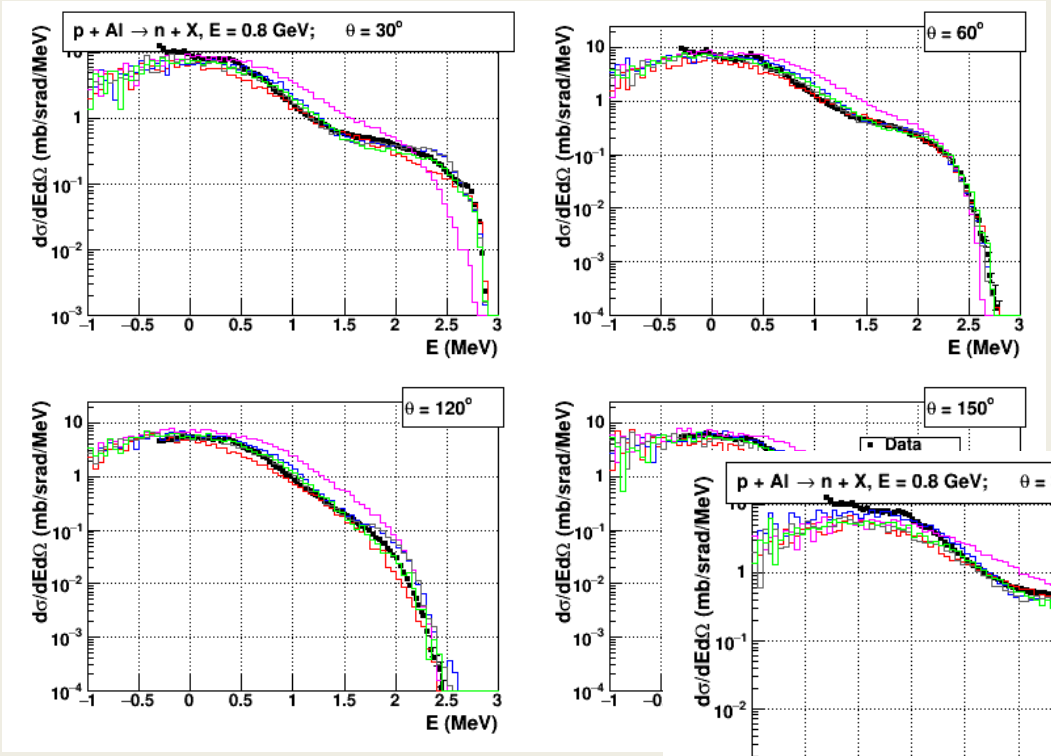
De-excitation module: parameterisation of level density

- For long time a simplified level density parameterization was used: Ld = 0.1*A
- In literature several fits to nuclear level data are published
- For Geant4 10.5 a variant was chosen from A.Mengoni and Yu. Nakajima, JNST 31 (1994) 151
  - $Ld = \alpha \bullet A \bullet (1 + \beta/A^{1/3})$
  - It turned out, that in order to have reasonable results, the same parameterisation should be used in evaporation, fission, photon evaporation
  - There is a new option in G4DeexPrecoParameters Get/Set LevelDensityFlag
  - The new default Ld = 0.075*A

G4HadronicProcess

- The rare crash was observed in the new FragTest when run a huge statistics
- Dmitri Constantinov dubugg the issue and identify that the dynamic mass of neutron produced by the Binary cascade may be 931 MeV
- For 10.5 a protection was added to G4HadronicProcess, which affect all hadronic models
  - *For any secondary dynamic mass is set to be on mass shell*
  - *If a computed 4-vector mass is different from the mass shell more than for 1.5 MeV ç-vectom momentum is recomputed using mass from the mass shell and the energy*

Neutron production 800 MeV



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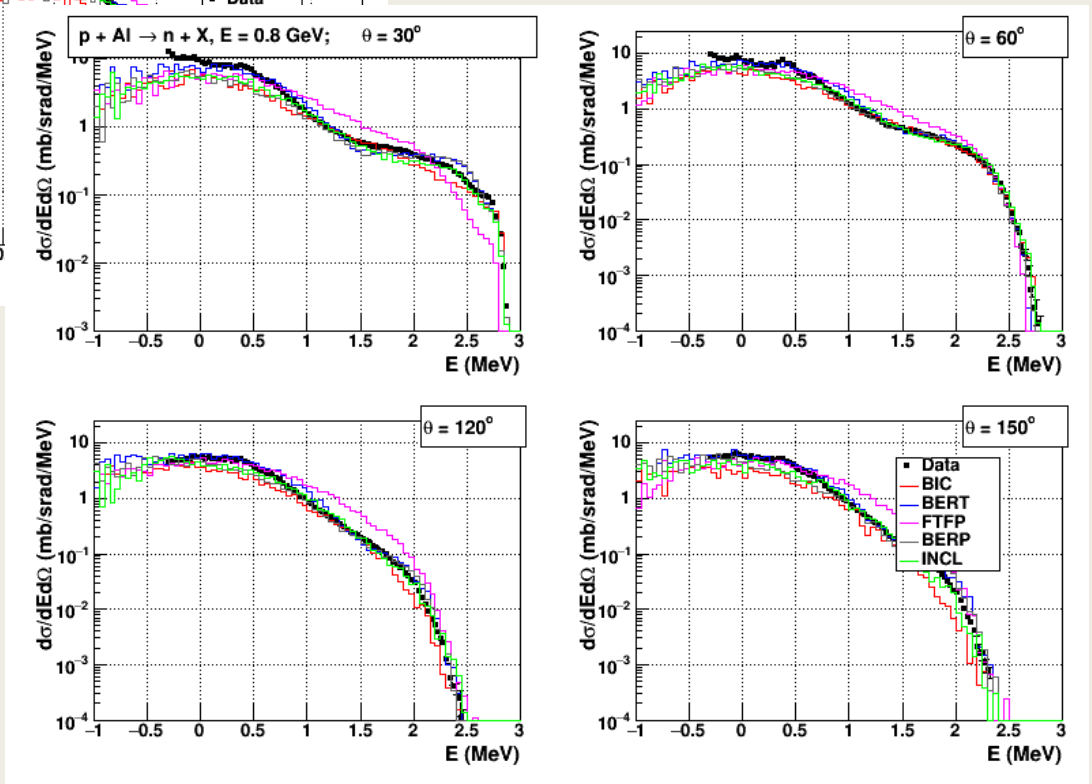

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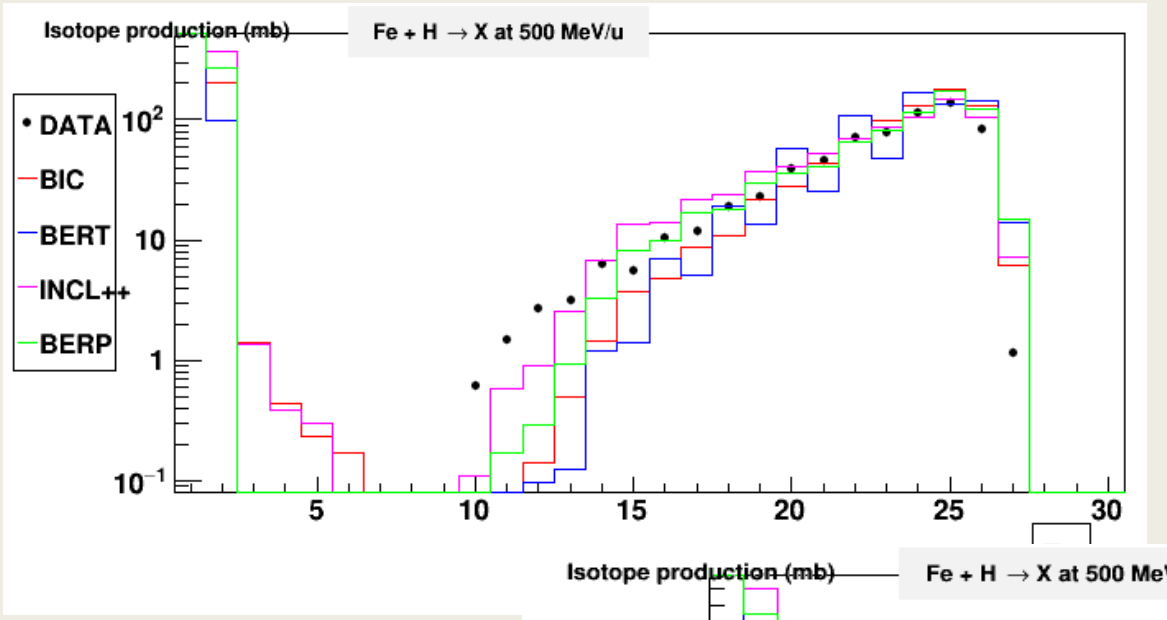
Isotope production at 0.5 GeV



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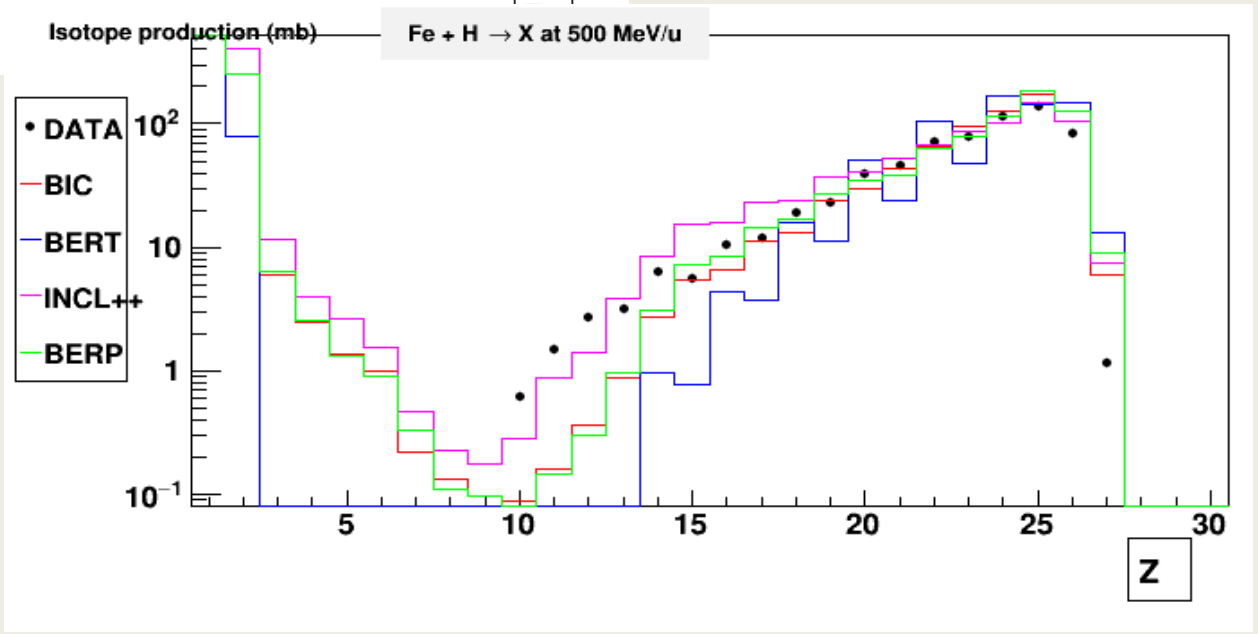

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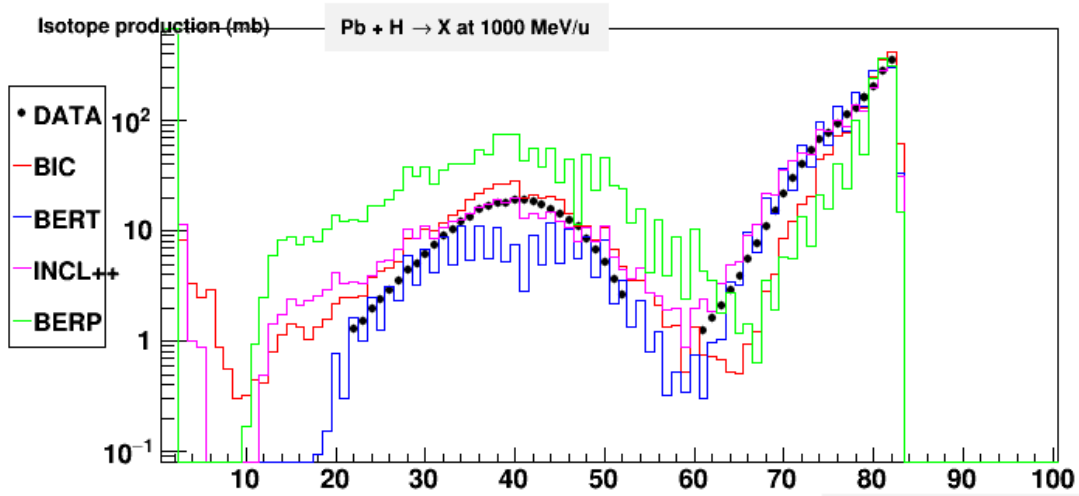
Isotope production at 1 GeV



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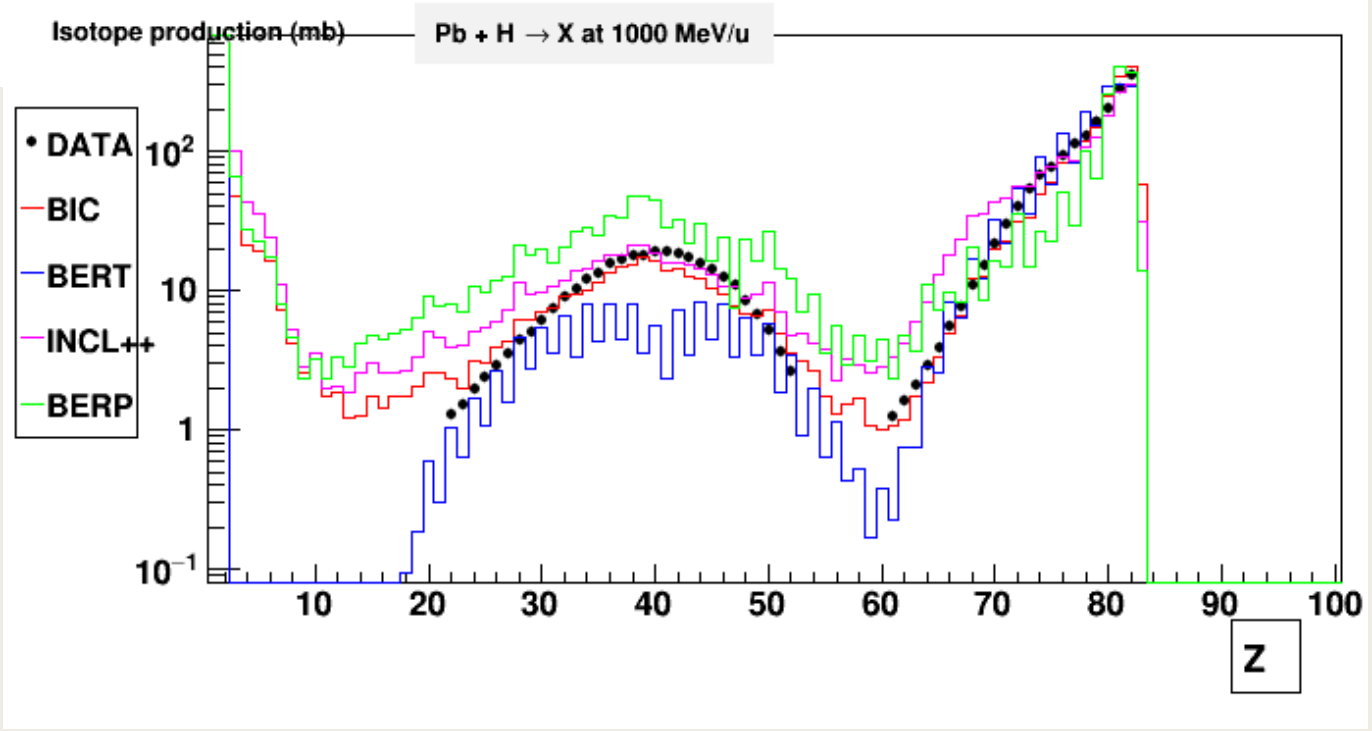

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