Discussion: Differences in the Bertini INC Models

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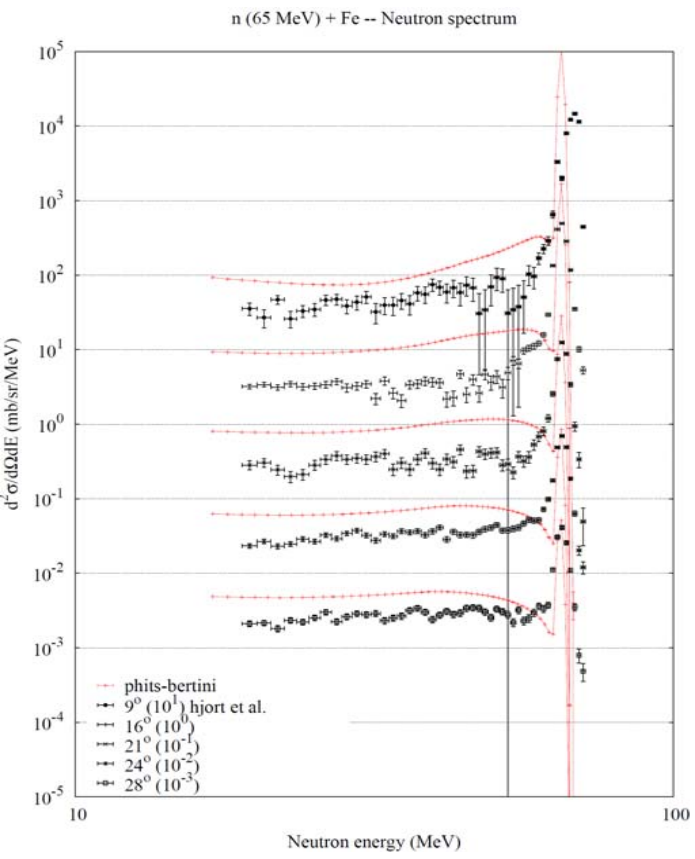
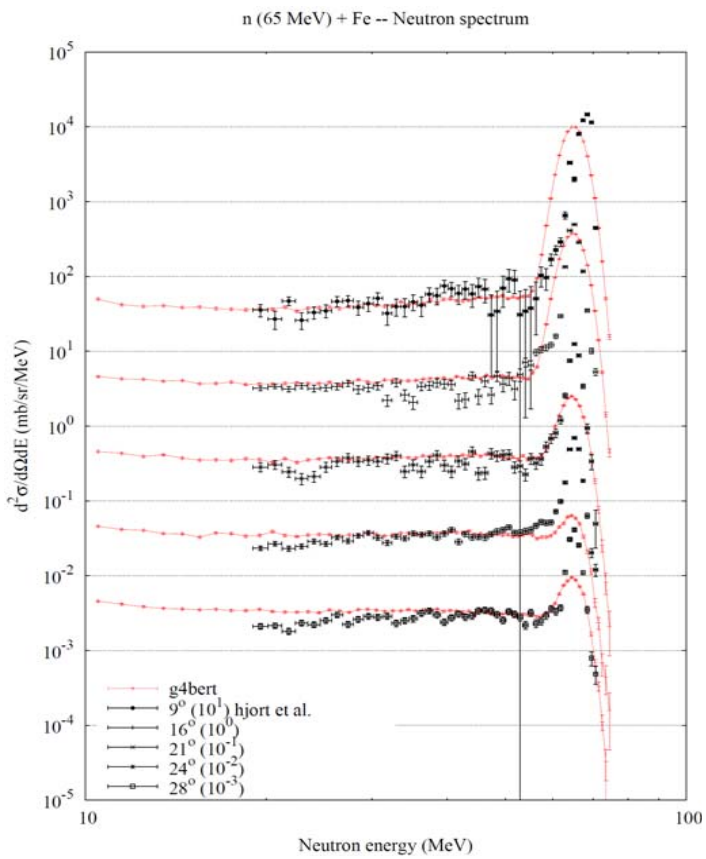
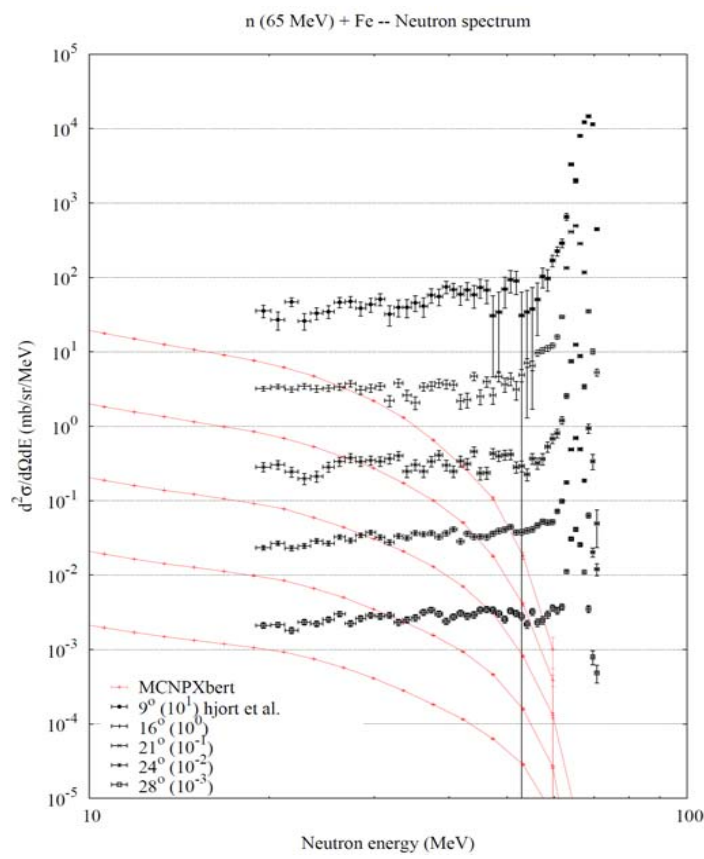
Second Advanced Workshop on Model Codes for Spallation Reactions, CEA-Saclay, France, 8-11 Feb 2010; S. G. Mashnik (convener), LA-UR-10-00650







For neutron spectra from 65 MeV n + Fe, we see a huge difference between results calculated with the versions of Bertini INC as implemented in PHITS (left plot), GEANT4 (central plot), and MCNPX (right plot); I do not understand the reason for such poor results by MCNPX with the Bertini INC (+ Dresner Evap)

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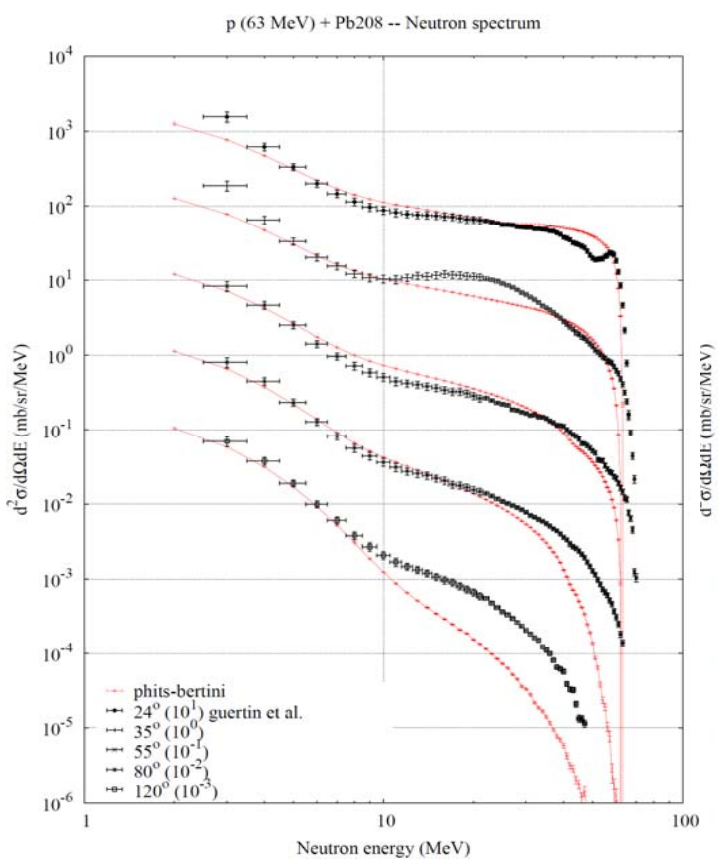
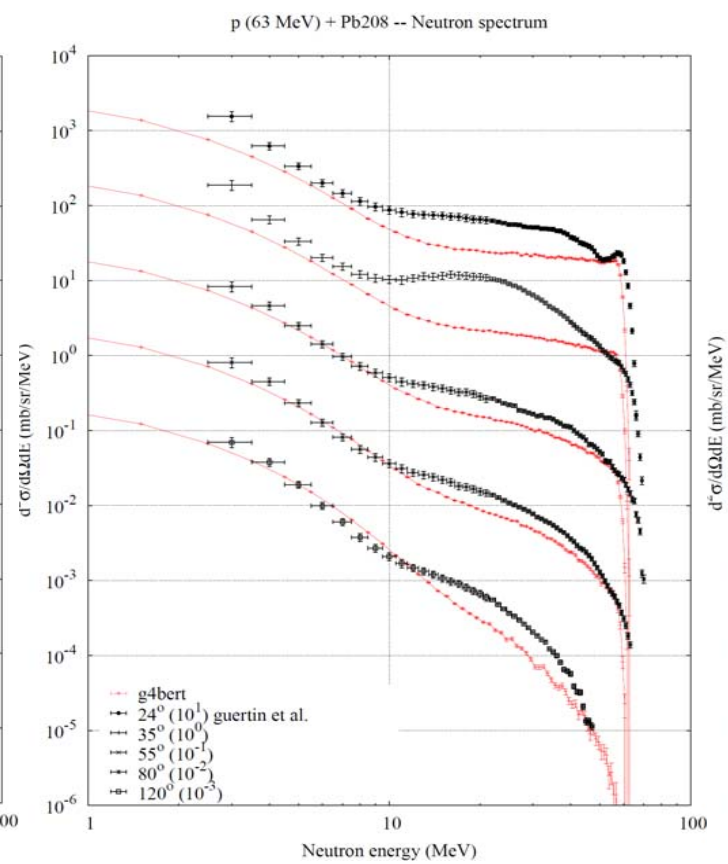
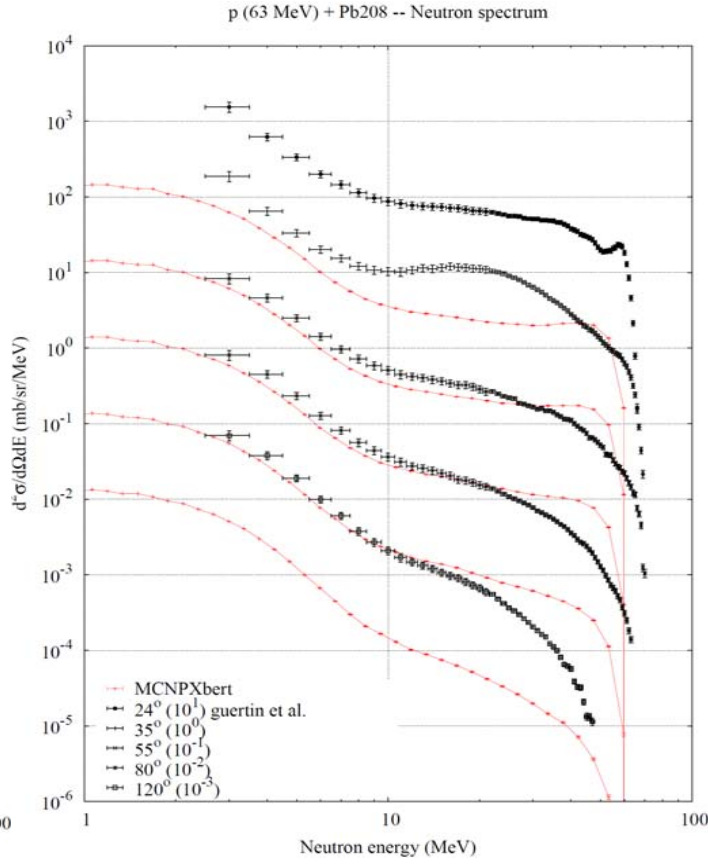
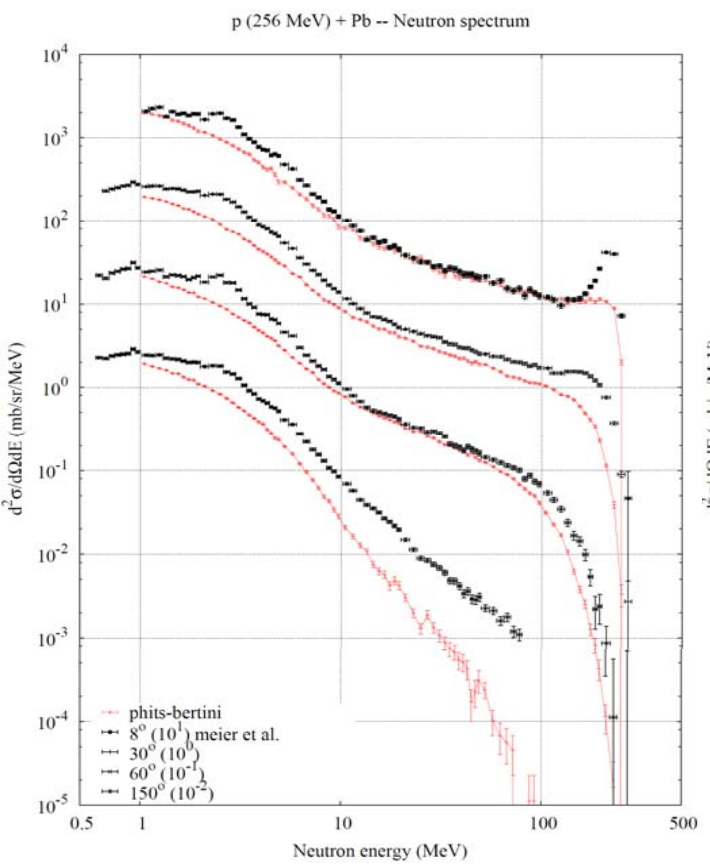
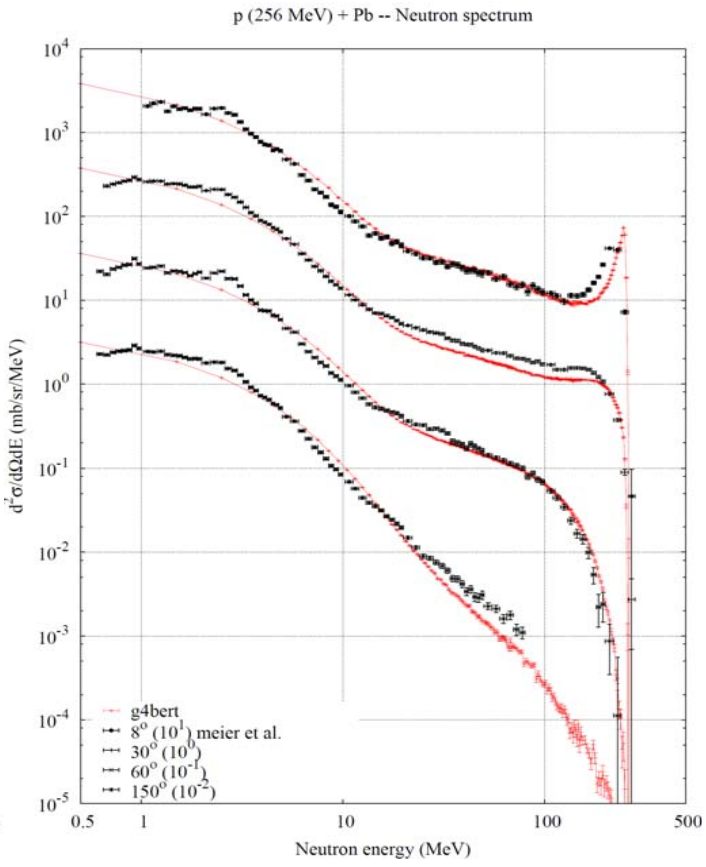


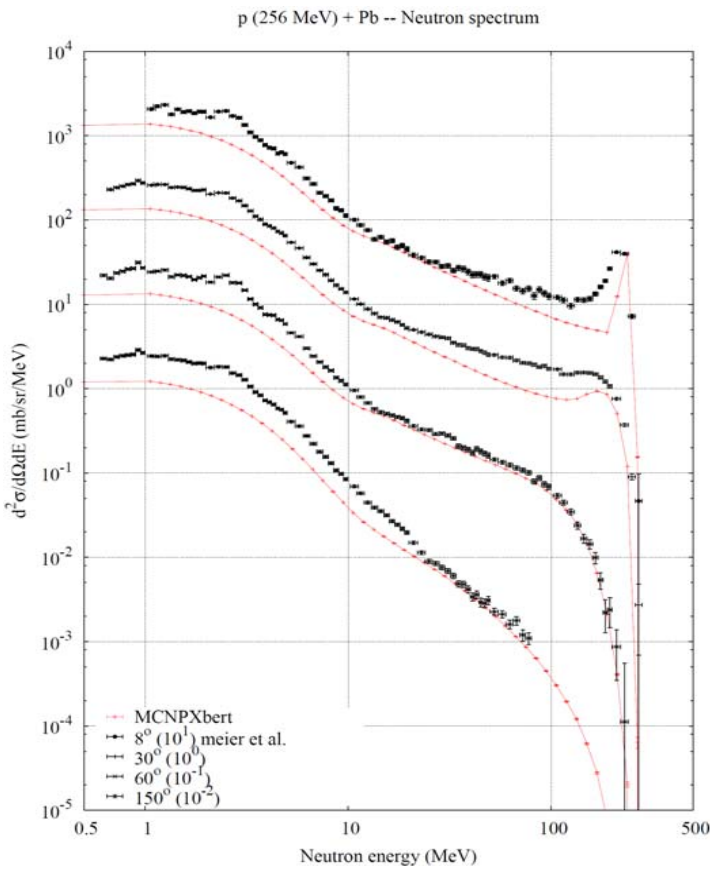




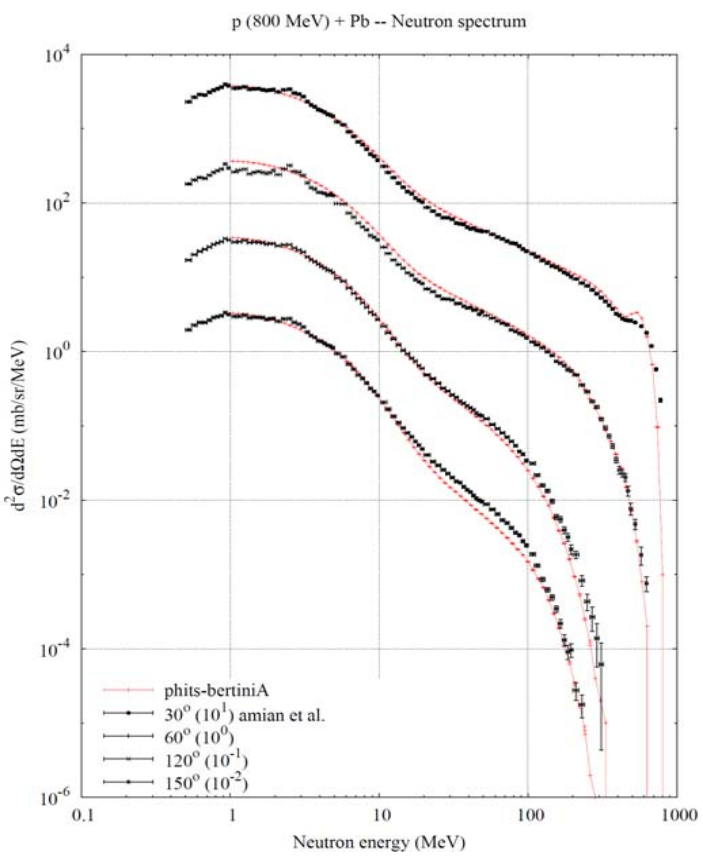
For neutron spectra from similar low-energy reactions induced by protons, the agreement between calculations is better but the results by MCNPX with the Bertini INC (+ Dresner Evap) look like they are divided by 10; an error in the MCNPX input?

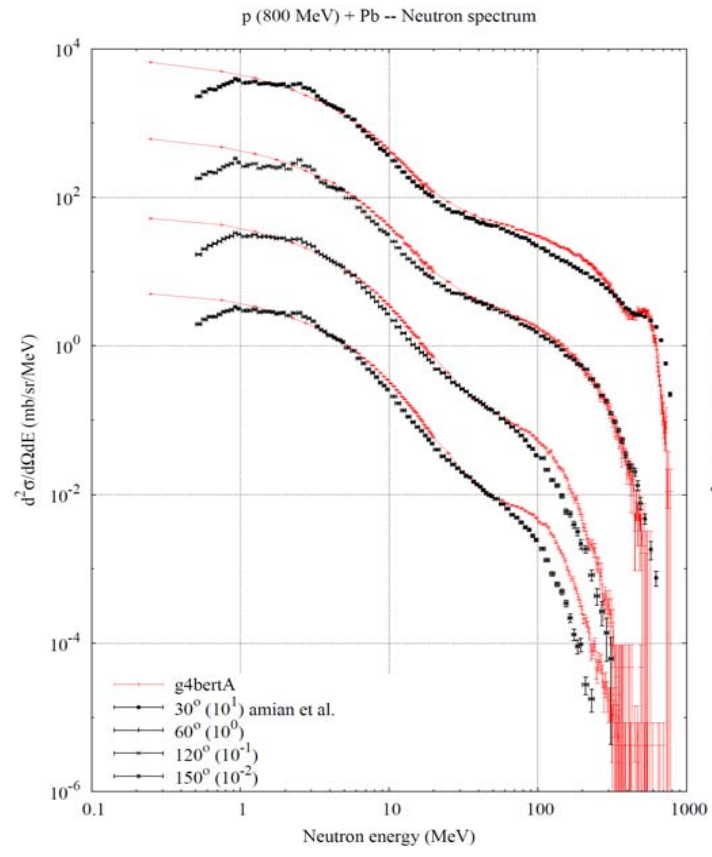


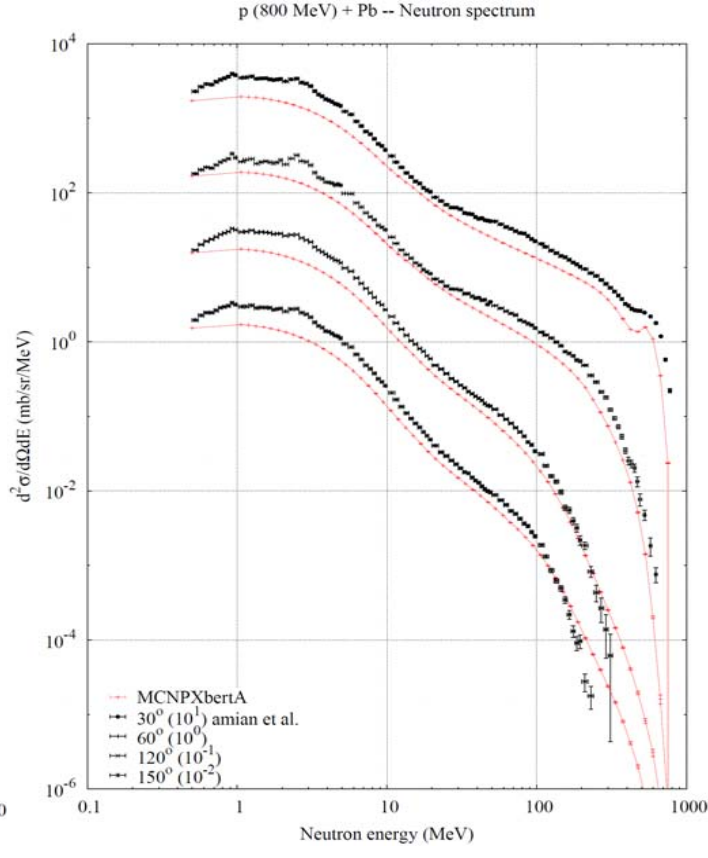




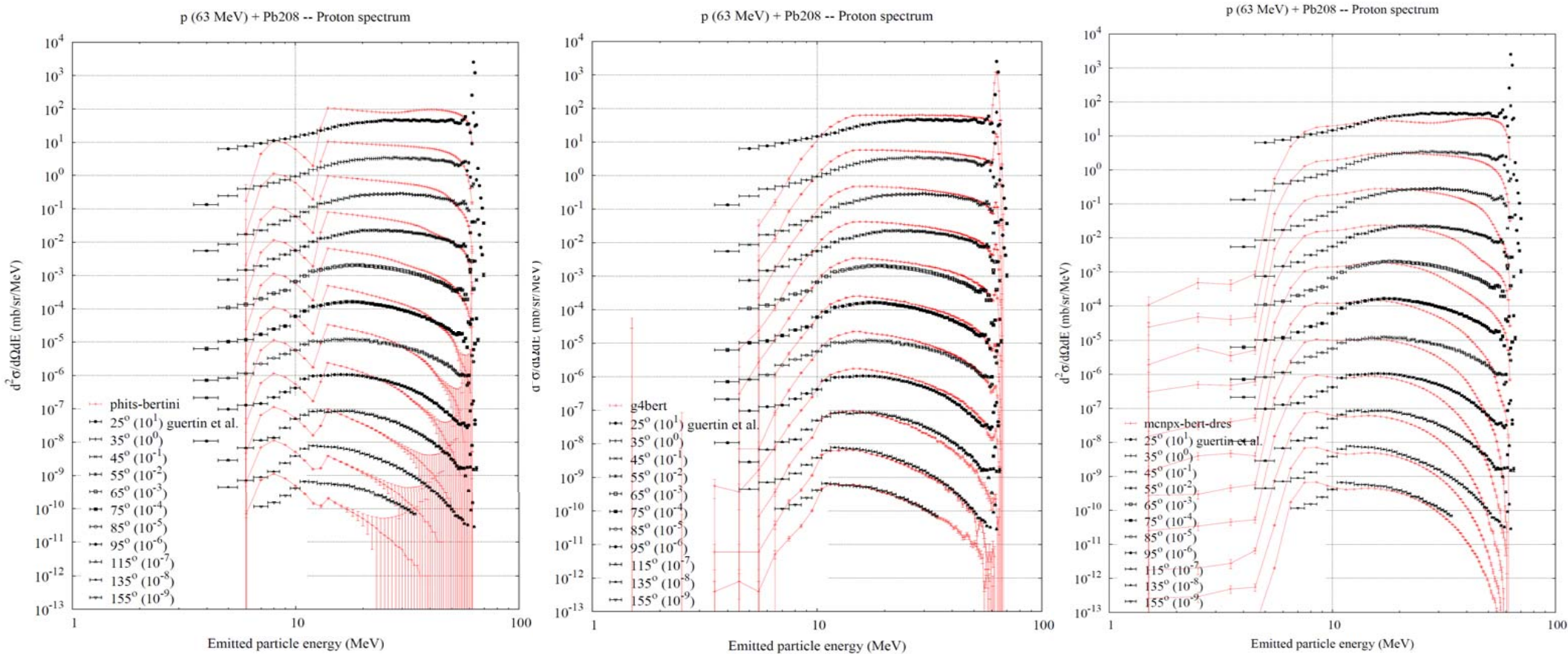
For neutron spectra from similar reactions induced by protons at higher energies (256 MeV p + Pb), the agreement between calculations is even better and the factor of 10 for the MCNPX results disappears; use of a correct MCNPX input in this case?







At even higher energies (800 MeV p + Pb), the agreement between calculations by PHITS and GEANT4 is even better, but the MCNPX results are below the data by ~20%; a problem with the MCNPX input or with the inelastic cross section by MCNPX?



Proton spectra from similar reactions (63 MeV p + Pb -> p) calculated by different versions of the Bertini INC also do not agree very well with each other; For this particular reaction, the results by PHITS look the most problematic, MCNPX does not show serious problems, while the GEANT4 results are the best, due to the improved version of the Bertini INC in GEANT4 (A. Heikkinen, N. Stepanov, and J. P. Wellisch, nucl-th/0306008)

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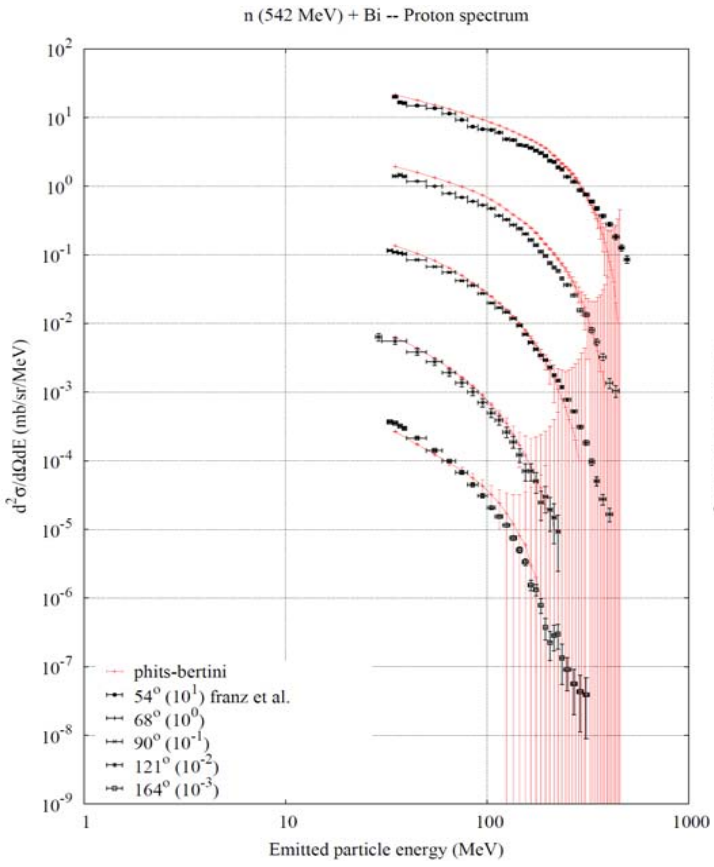
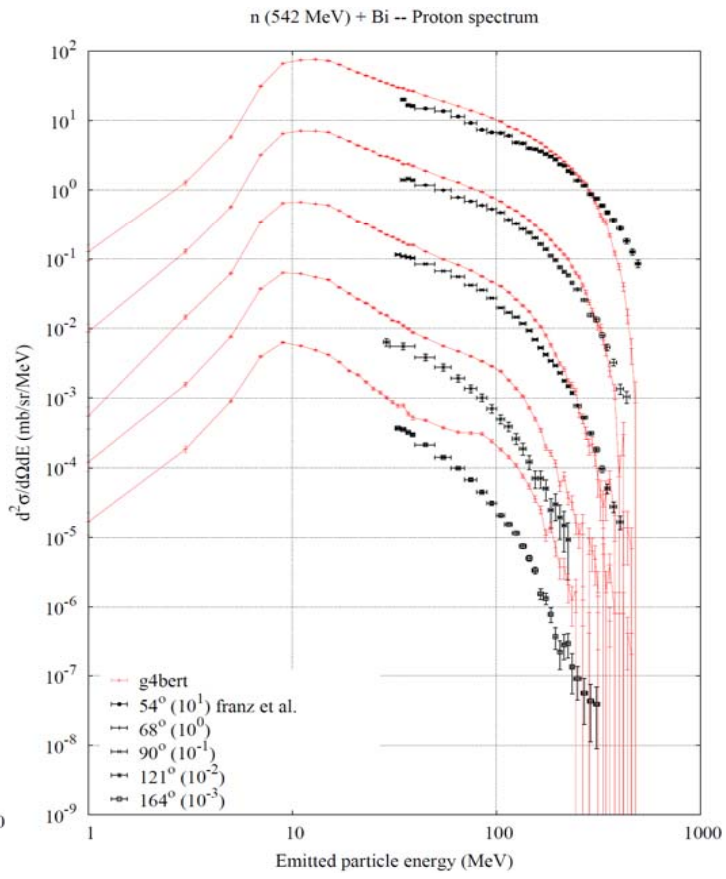
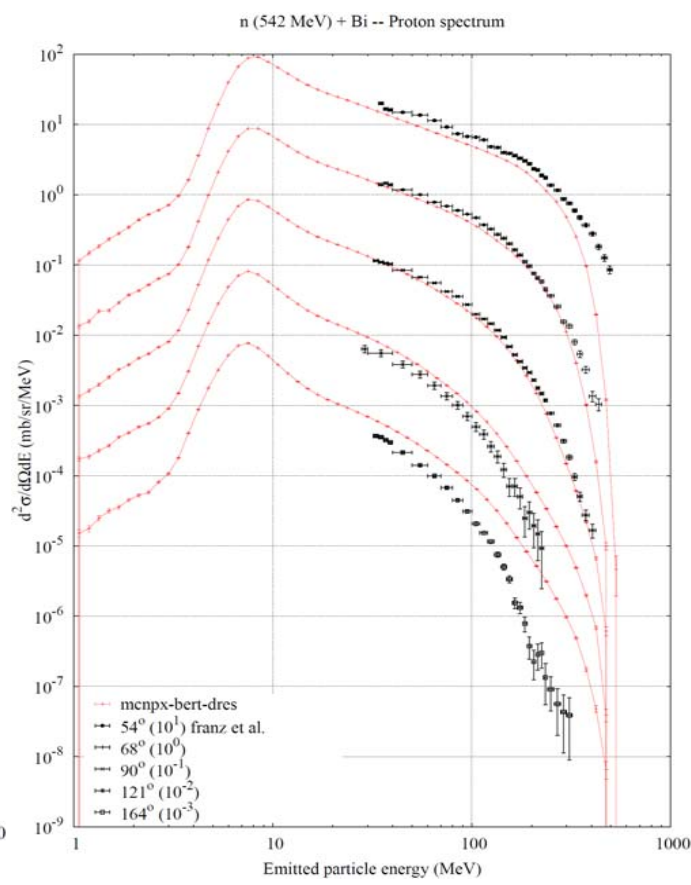
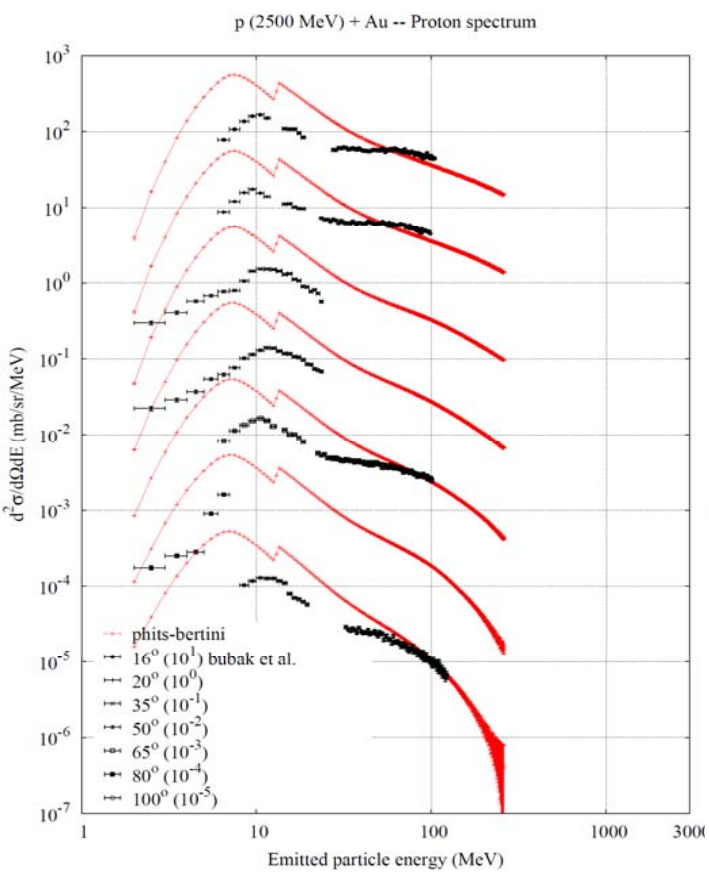
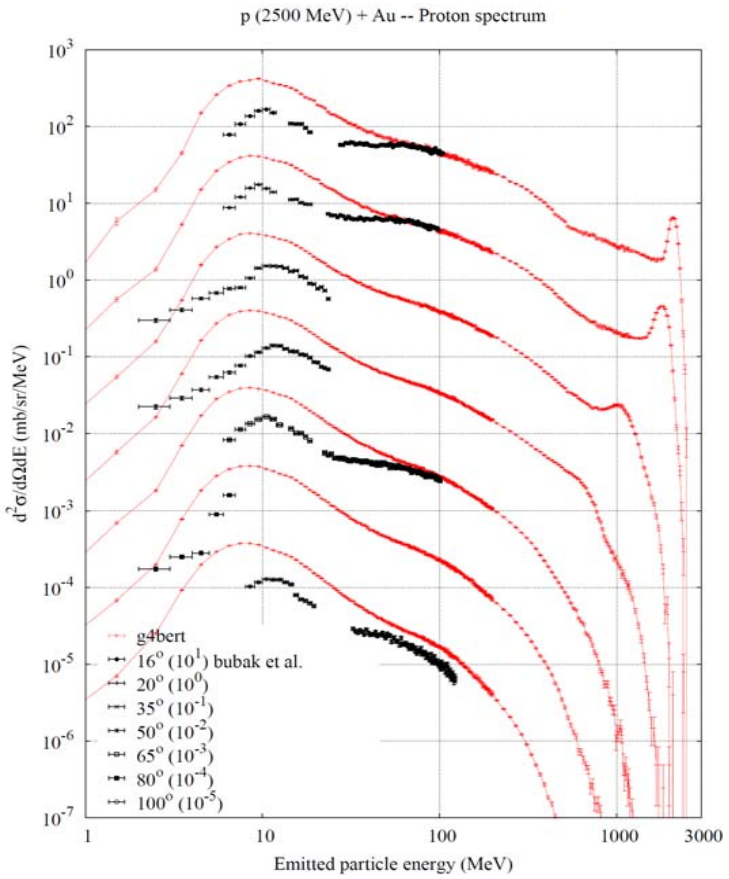


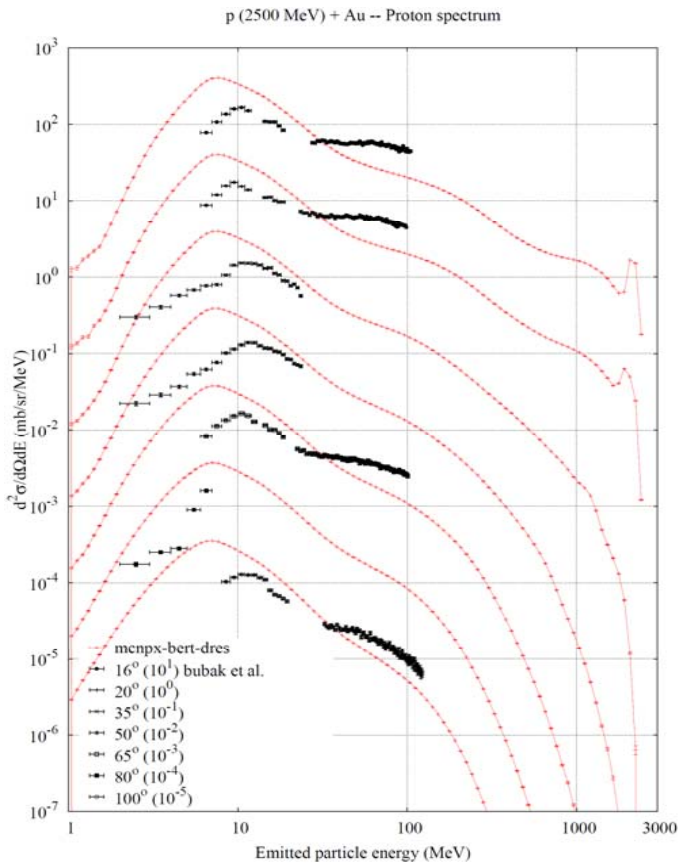




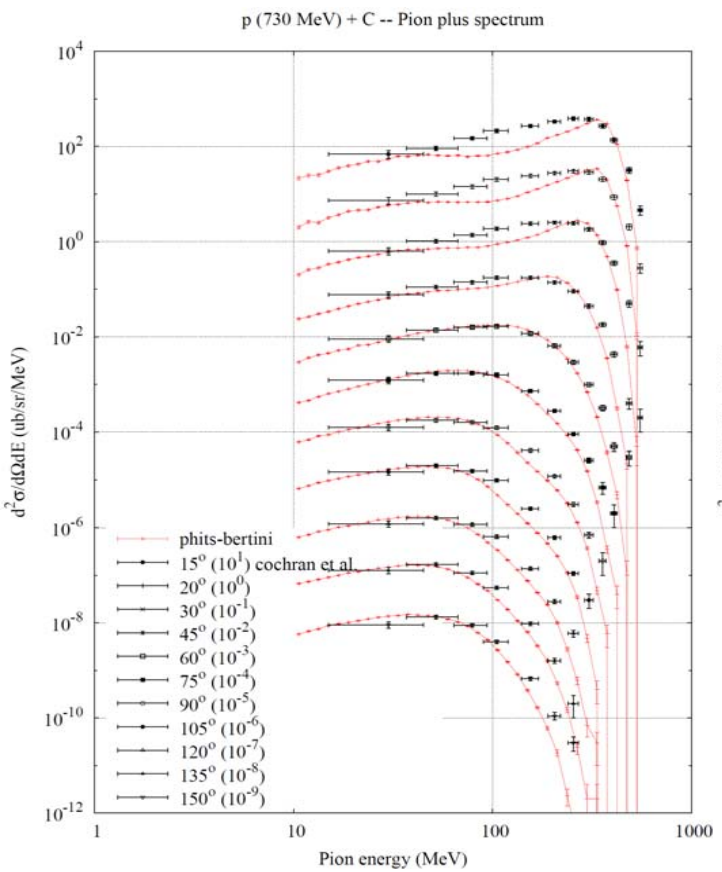
On the contrary, proton spectra from the reaction 542 MeV n + Bi calculated with PHITS look the best, the MCNPX results are reasonably good, while the GEANT4 results agree not very well with these data; probably, due to some problems with the preequilibrium model for this reaction in GEANT4 rather than with the Bertini INC.

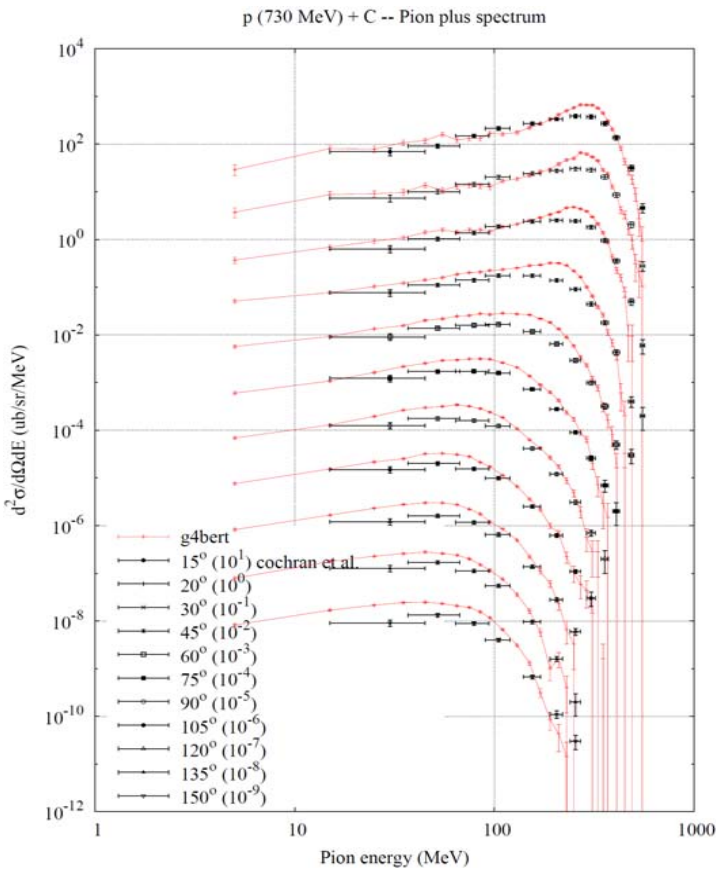


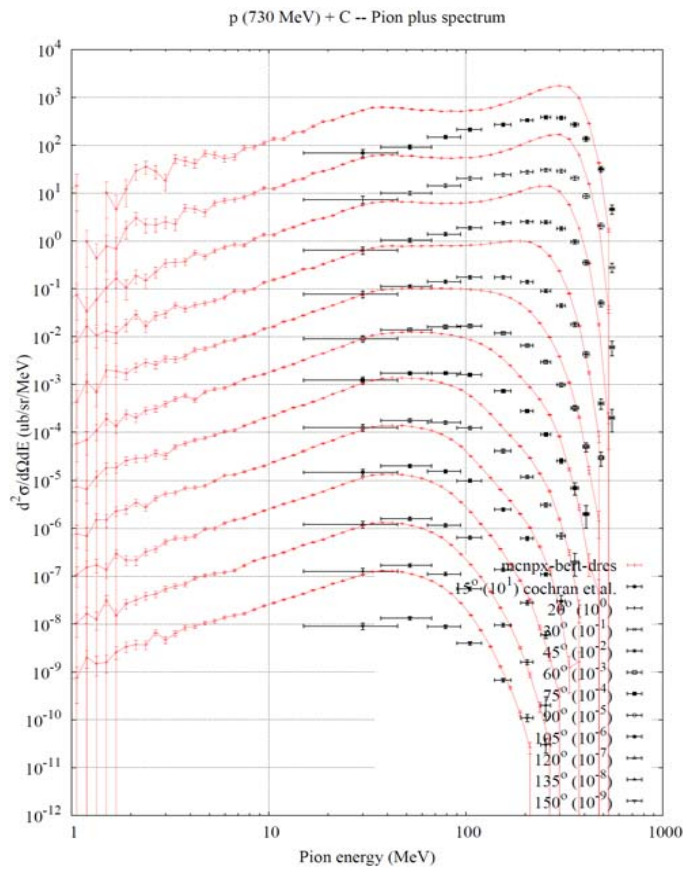




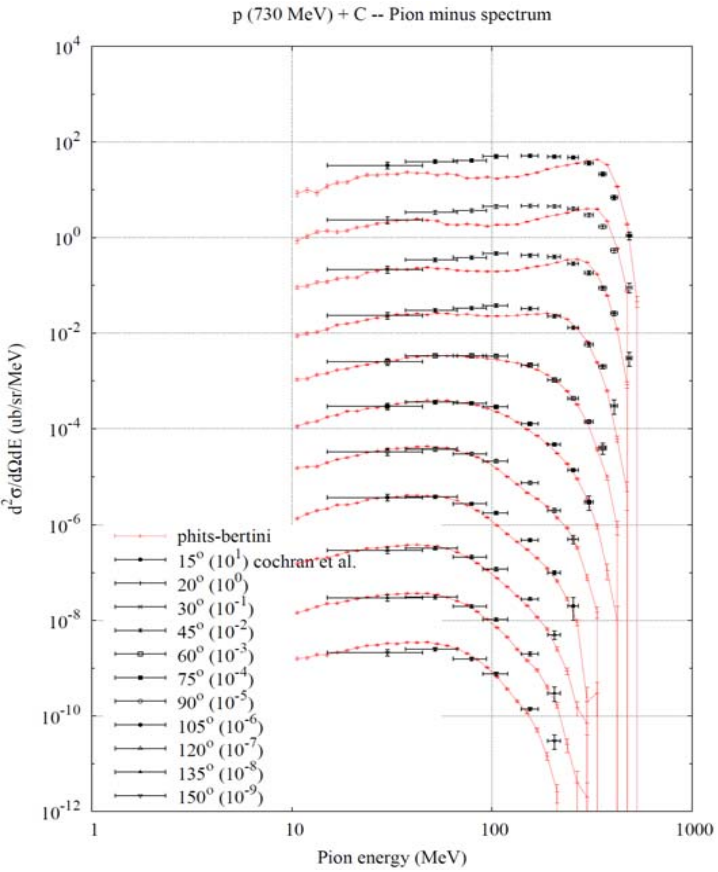
Finally, proton spectra from the reaction at the highest energy considered by our Benchmark, 2.5 GeV p + Au, calculated with PHITS and GEANT4 agree well with each other in the region above evaporation, while the MCNPX results are below the data by a factor of two; this is probably due to the reaction cross section used by MCNPX rather than with the Bertini INC.

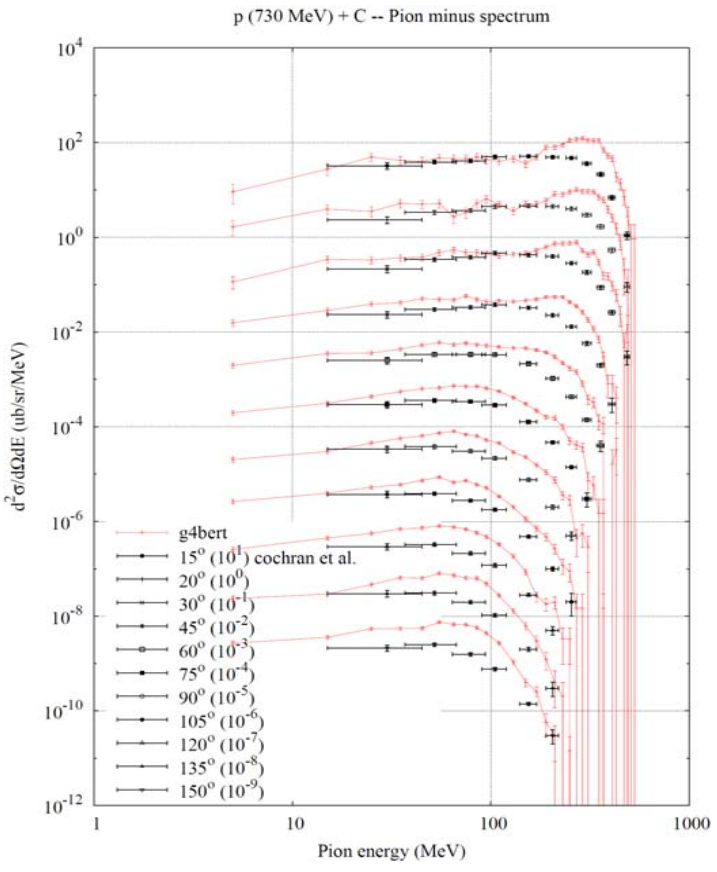


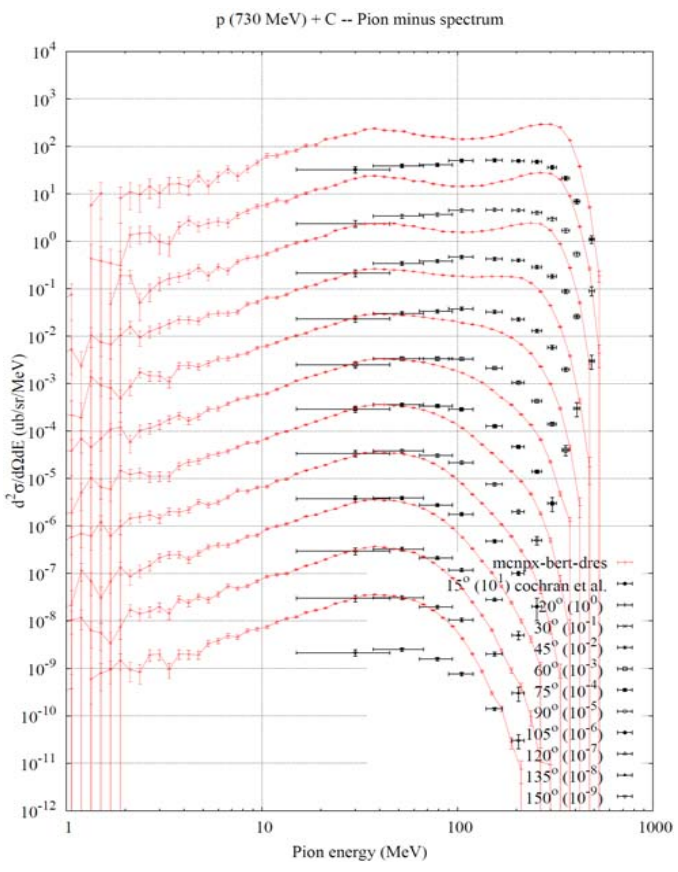




Pions are produced only during the INC, so pion spectra are the best characteristics to look at to try to understand the difference in the versions of the Bertini INC used by different transport codes. The biggest difference in the π^+ spectra calculated by different versions of the Bertini INC can be seen for the reaction 730 MeV p + C; MCNPX again provides some surprises.







Similar disagreement and problems can be seen also for the spectra of π^- emitted from the same reaction, 730 MeV p + C.

I do not understand all these differences and I assume that some of them may be "false", i.e., are caused by the transport codes or poor inputs rather than by the versions of the Bertini INC.