

A Geant4 physics list for spallation and related nuclear physics applications based on INCL and ABLA models

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Geant 4



ABSTRACT

We have introduced INCL [1] intra-nuclear cascade model in Geant4 9.2 [2]. The INCL model is well established for targets heavier than Aluminium and projectile energies from ~ 150 MeV up to 2.5 GeV ~ 3 GeV [3].

We present a new Geant4 physics list, based on INCL and ABLA models, prepared for nuclear physics applications in the domain of accelerator driven systems and EURISOL project.

GEANT4 PHYSICS LISTS

A unique feature of Geant4 is to *decouple physics models, cross sections, and processes* using abstract interfaces, and manage the usage of different options with so-called the physics lists.

- Physics lists allow users to find good balance between various goals (e.g. CPU time requirements vs. accuracy of results).
- Also, the Geant4 physics system can be easily extended.

```
template<class T>
class TQGSP_INCL_ABLA< T >
```

Physics list QGSP_INCL_ABLA

Use case

This list is mainly intended for use with energies less than 3 GeV. This is useful for e.g. spallation studies and Accelerator Driven Systems (ADS) applications.

Usage

The physics list can be activated in a simulation application by giving it as part of the user initialization to the run manager.

```
G4RunManager *runManager = new G4RunManager;
G4VUserPhysicsList *physics = new QGSP_INCL_ABLA;
runManager->SetUserInitialization(physics);
```

Hadronic models

The list uses INCL/ABLA intra-nuclear cascade and de-excitation models in the energy range 0 - 3 GeV. Above these energies QGSP model is used.

See also:

HadronicPhysicsQGSP_INCL_ABLA
G4InclAblaProtonBuilder
G4InclAblaNeutronBuilder
G4InclAblaPionBuilder

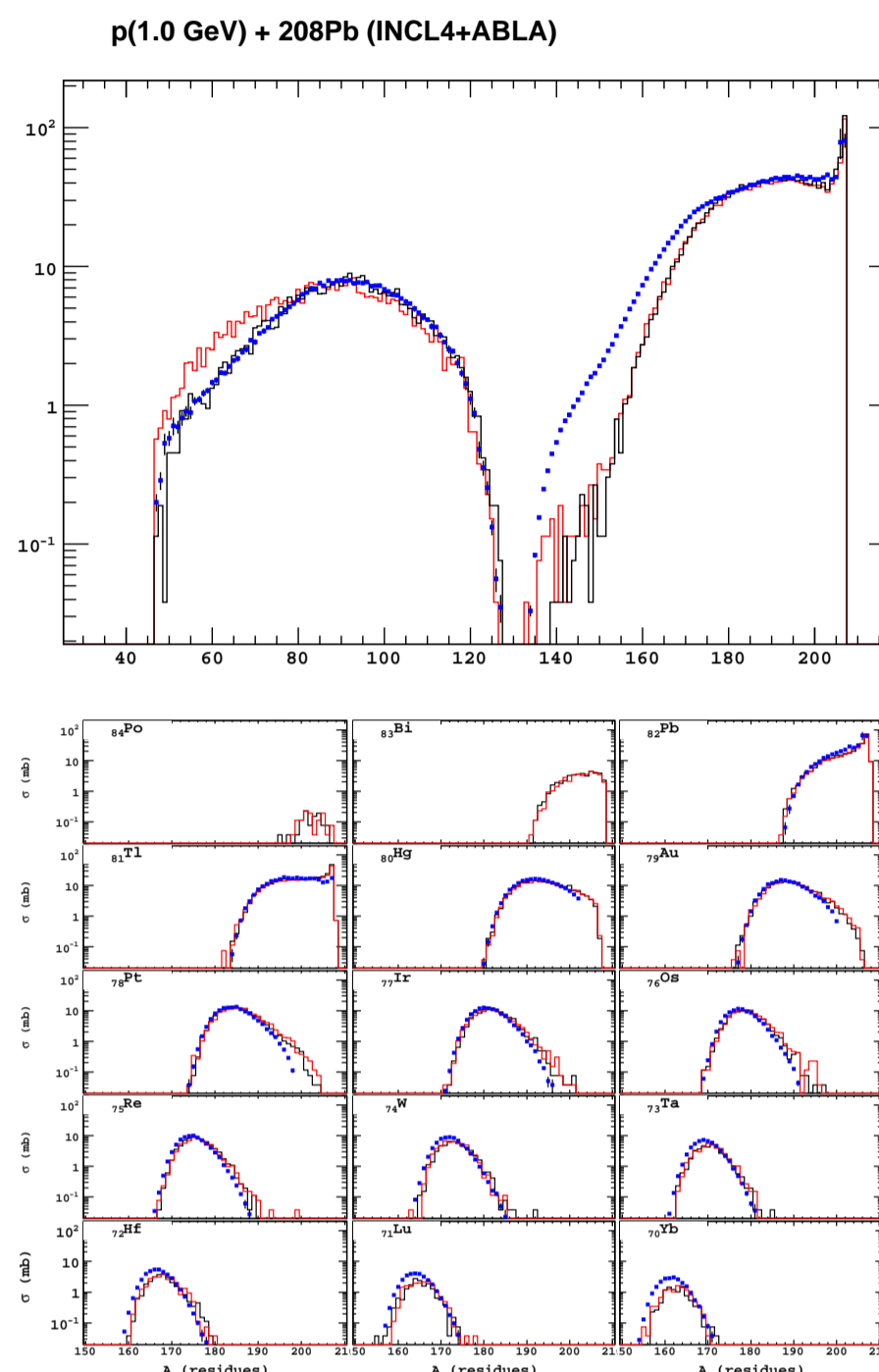
Definition at line 74 of file QGSP_INCL_ABLA.hh.

A NEW PHYSICS LIST

We have implemented a new physics list called QGSP_INCL_ABLA with spallation physics in mind.

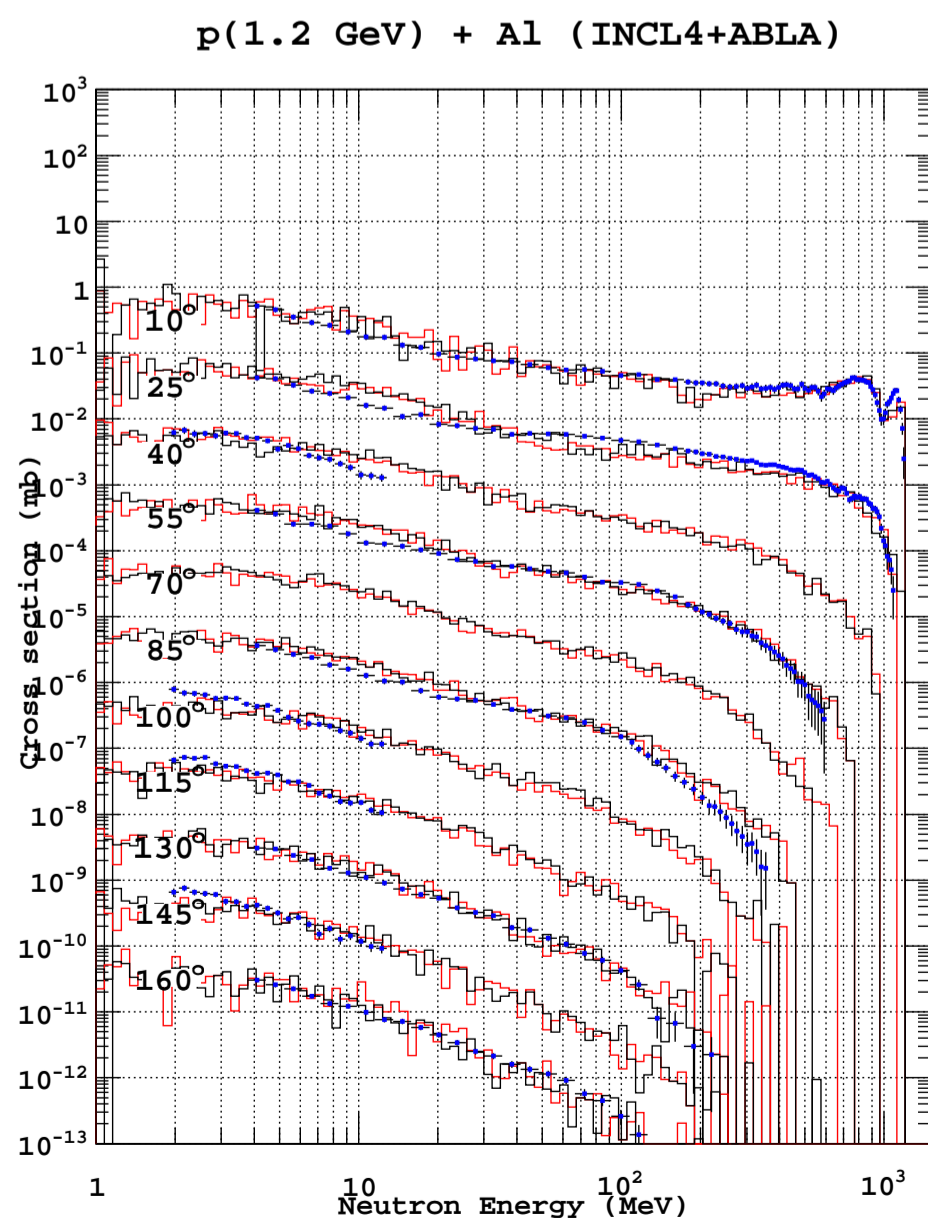
It uses INCL/ABLA models for proton, neutron and pion inelastic interactions in the energy range 0 - 3 GeV.

FRAGMENT YIELD



Fragment production of the INCL and ABLA [4, 5, 6] models. Black and red histograms are the results from the original FORTRAN version and new C++ implementation, respectively. Data is from Ref. [7].

NEUTRON PRODUCTION



Double-differential for neutron production cross section from Geant4 INCL and ABLA models. Black and red histograms are the results from the original FORTRAN version and new C++ implementation, respectively.

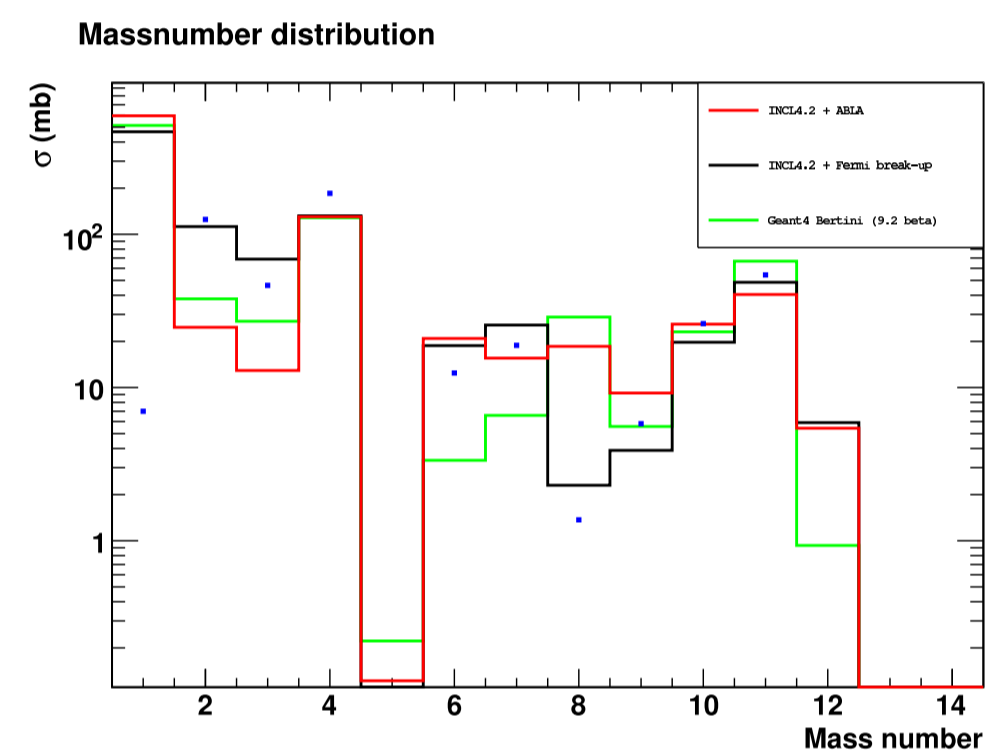
Data is from Ref. [9].

LIGHT TARGETS

We have introduced a cut to choose between ABLA and Fermi break-up for light targets. So, INCL can now be used with the Geant4 Fermi break-up model.

Currently, INCL interface provides Fermi break-up [8] for remnant nuclei lighter than $A = 13$ and ABLA for heavier elements.

1 GeV PROTON ON CARBON



CARBON PROJECTILES

Carbon beams are of particular interest for medical applications of Geant4, and recently, a Carbon projectile support has been added to the INCL cascade.

An ongoing work is to improve of the physics models for the treatment of light ion beams up to Carbon.

References

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