Moira simulations for n_TOF

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Moira

Moira: bridging MC worlds

Moira (μοίρα, /ˈmi:ra/) is a new application (C++), Geant4-based, progressively incorporating all FLUKA core functionalities. It provides Geant4 Physics, while FLUKA Physics are being implemented.

Moira presents a tool to **run FLUKA** and **Geant4** with **identical geometry** configurations and draw more robust comparisons between this two well-established MC codes.

G. Hugo - Fluka-Cern status and plans, Moira, and scoring
A. Donadon Servelle - Studies driven by the Moira Framework

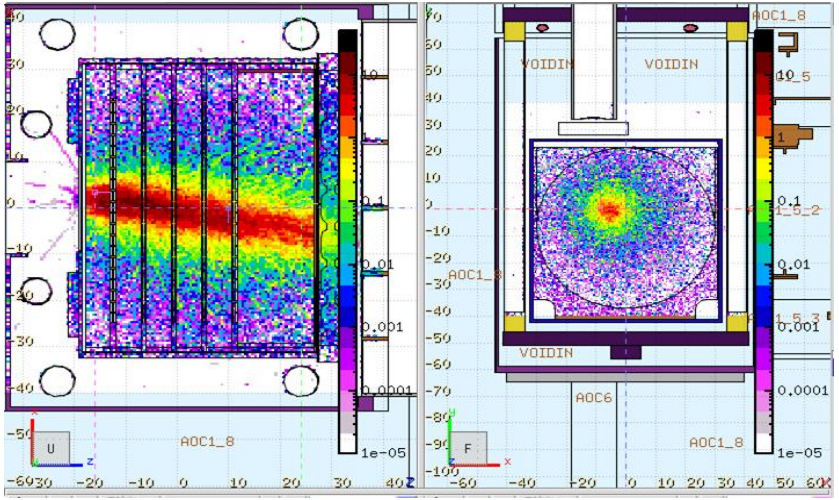
Moira: Geometry and Tracking cutoffs

Moira implements a **hybrid geometry** approach. It introduces a new FLUKA Solid in Geant4, which contains the whole FLUKA geometry. The latter is read using an external navigator based on Flair's geoviewer library, allowing the use of a FLUKA equivalent combinatorial geometry.

Tracking **cutoffs** are fully relying on **Geant4 implementation**. In Geant4 these cutoffs are defined in range (distance unit), while in FLUKA they are defined in energy. The possibility of the latter is available to the user.

Moira: Scorings

Moira provides a fully custom variety of scorings, integrating most of the scoring capabilities available in FLUKA, including:

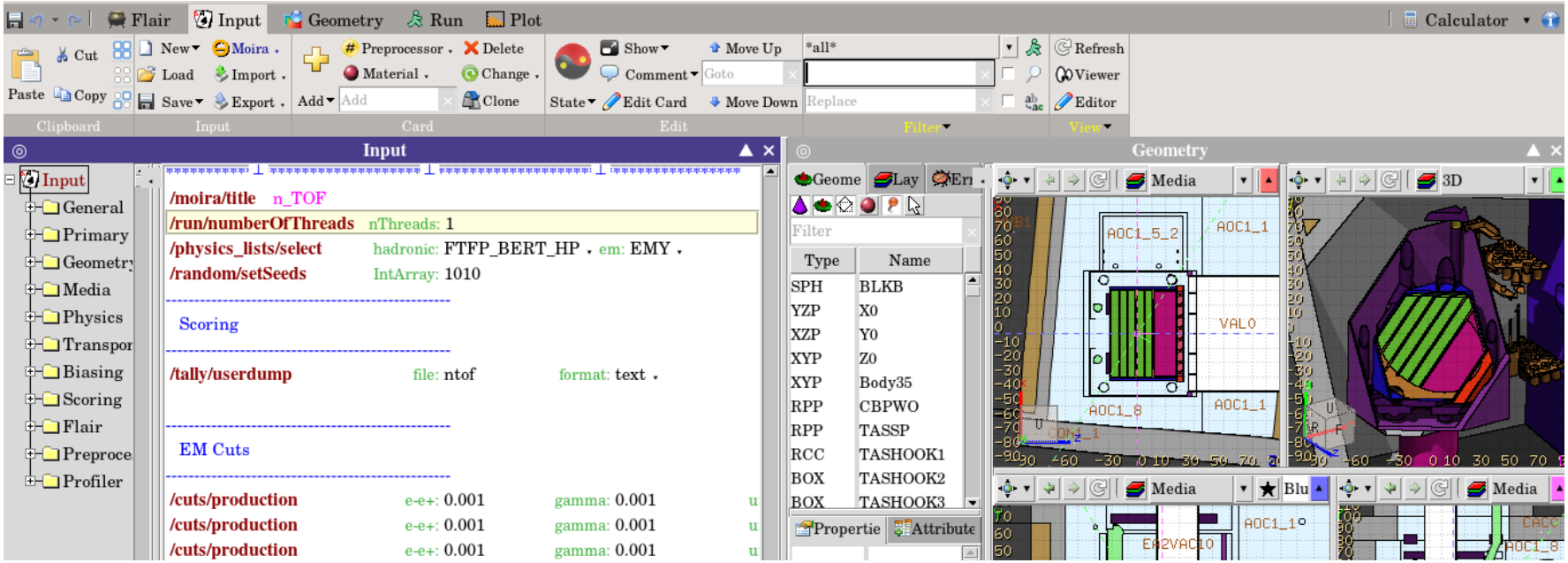


- single and double differential scorings in volumes and through boundaries.
- mesh scoring in cylindrical and cartesian.

Magnitudes: energy deposition, non-ionizing energy deposition, electromagnetic (EM) energy, particle tracks lengths, particle count, number of secondary particles and residual nuclei.

Moira: Flair integration

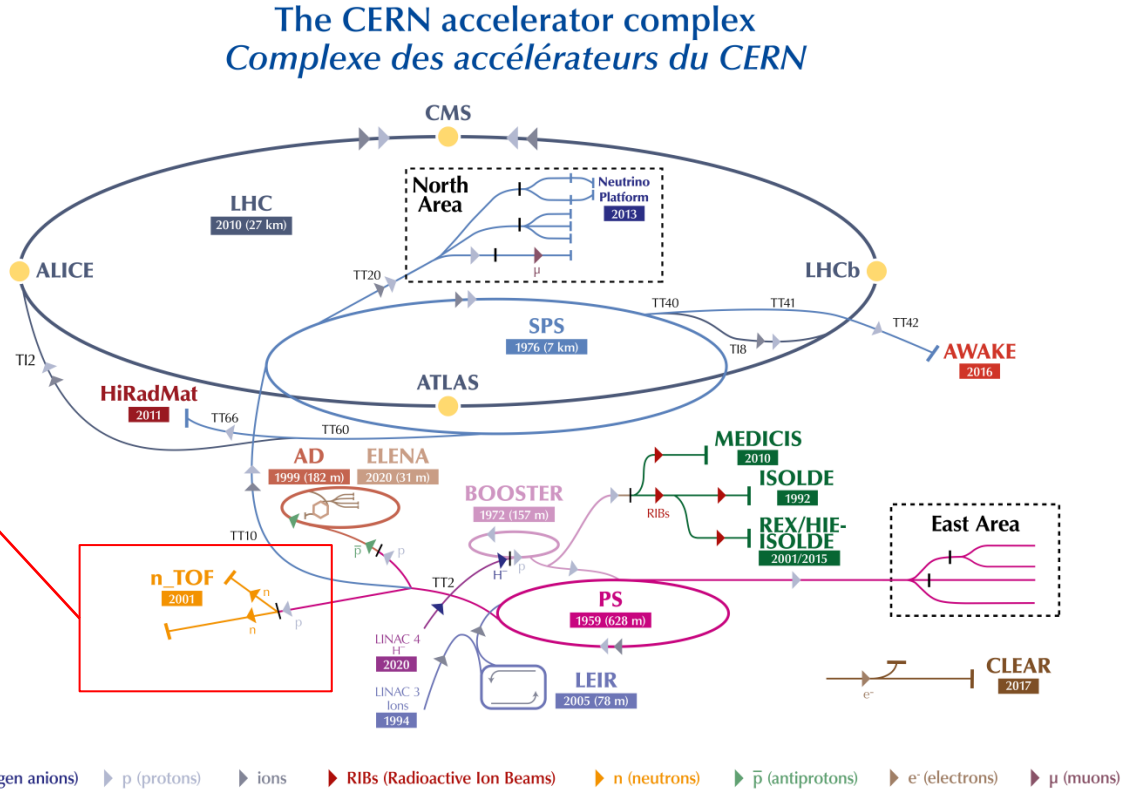
Flair, the advanced Graphical User Interface for FLUKA has been extended to integrate Moira, this is, editing input files, visualising geometry, running and post-processing results. It is also able to convert FLUKA inputs to Moira automatically.



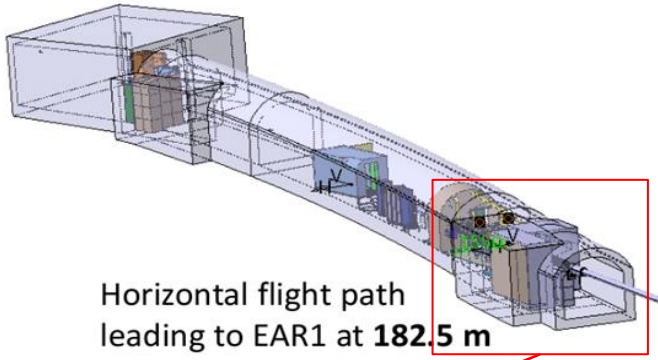
n_TOF simulations

The n_TOF Facility at CERN

The CERN PS accelerator provides **n_TOF** with a 20 GeV/c proton beam, with a repetition rate of 1.2 s, avoiding any overlapping between consecutive neutrons pulses.



Experimental Areas



Horizontal flight path
leading to EAR1 at **182.5 m**

Experimental Area 1 (EAR1)
- wide neutron energy range
- excellent time resolution

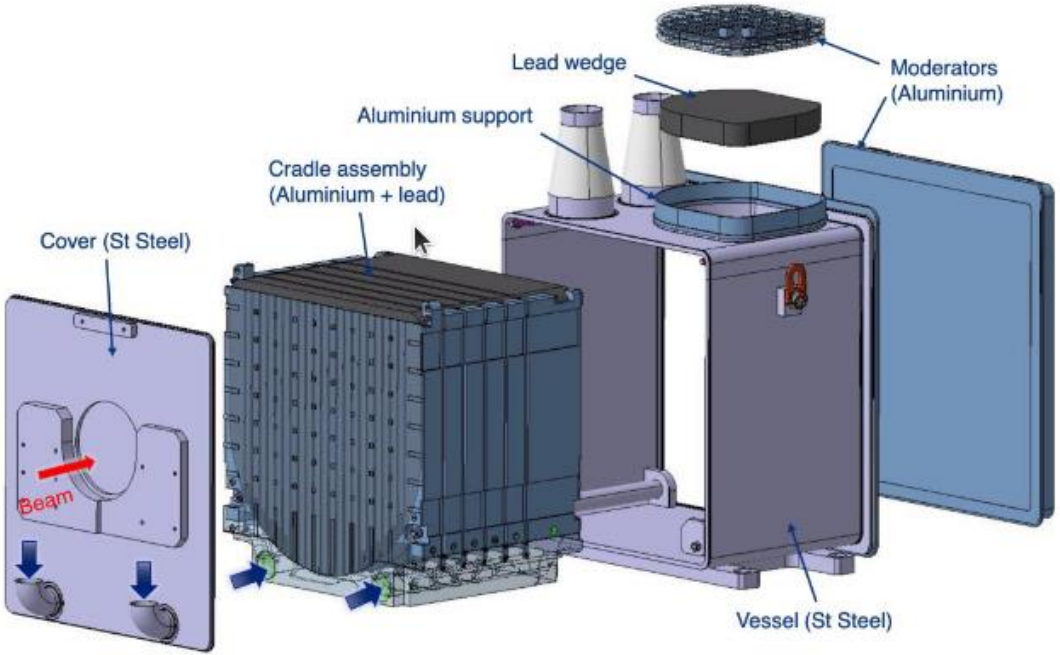
Experimental Area 2 (EAR2)
- wide neutron energy range
- high instantaneous neutron flux

Vertical flight path
leading to EAR2 at **18.2 m**

New Experimental Area (NEAR)
under commissioning

proton beam from the PS

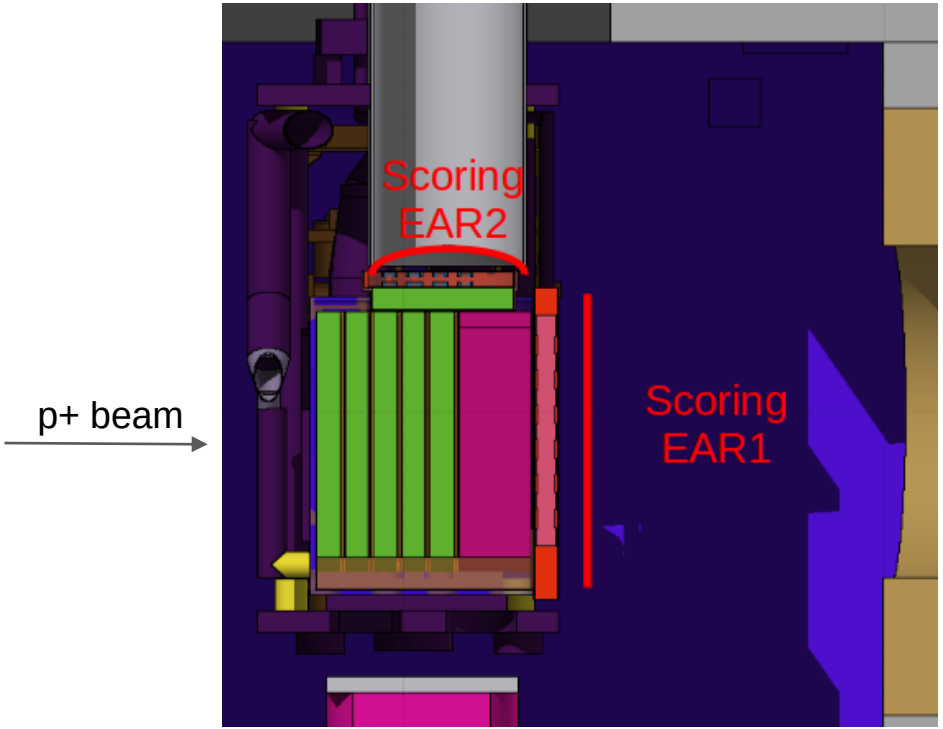
The 3rd Generation n_TOF Target



- New lead spallation target, optimised for EAR2, in terms of neutron fluence and energy resolution.
- Laminated target with nitrogen cooling system.
- Dedicated lead wedge and water moderator for EAR2.

Expected improvement in energy resolution.

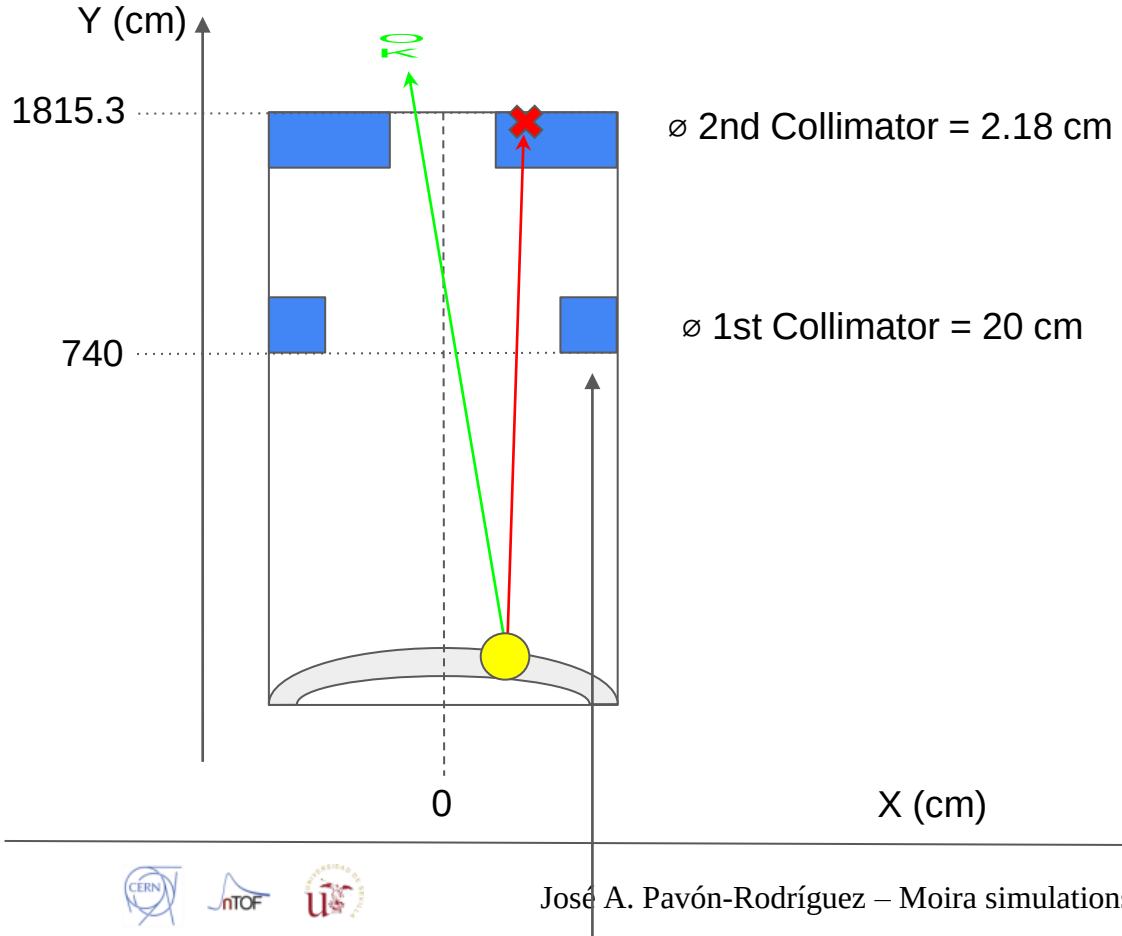
FLUKA and Geant4 geometries and scoring planes



The FLUKA geometry of the spallation target has been implemented in detail using the Flair interface.

For the first time, profiting from the Moira application, the exact same geometry has been used to run GEANT4.

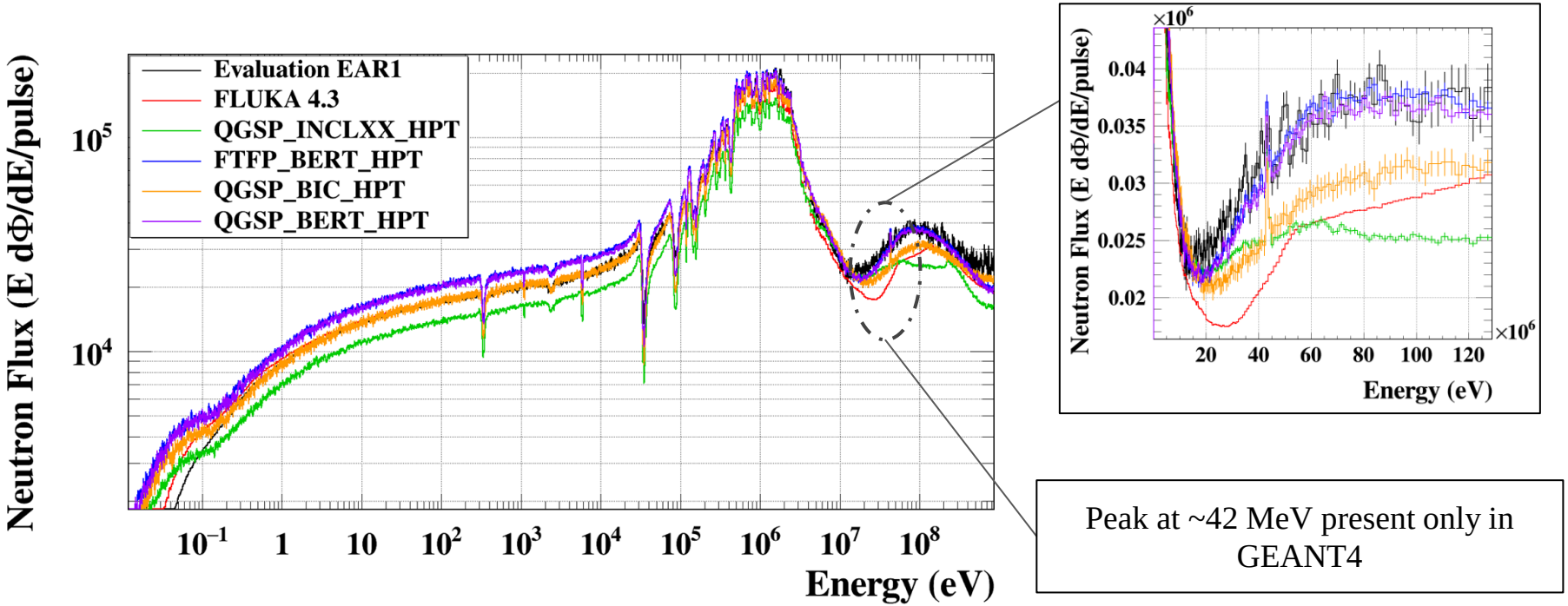
Optical transport and comparison with experimental data



An optical transport of neutrons is performed from the scoring plane to the experimental area, this is, a propagation in a straight line taking into account the initial direction of the neutrons at the scoring plane.

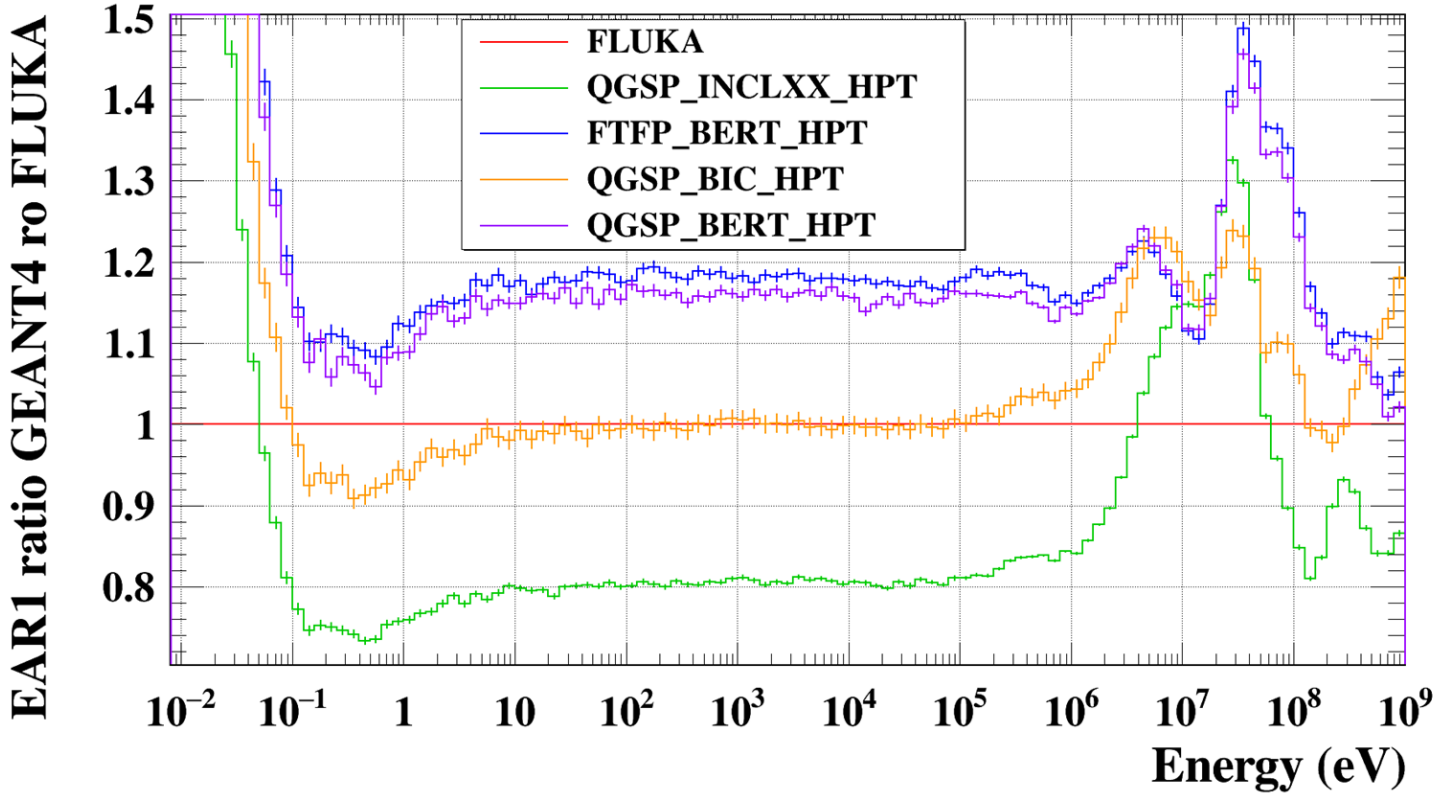
The collimating elements are considered as obstacles, in such a way that if a neutron hits them, is discarded, otherwise is considered for the final simulation.

EAR1 simulations and experimental results

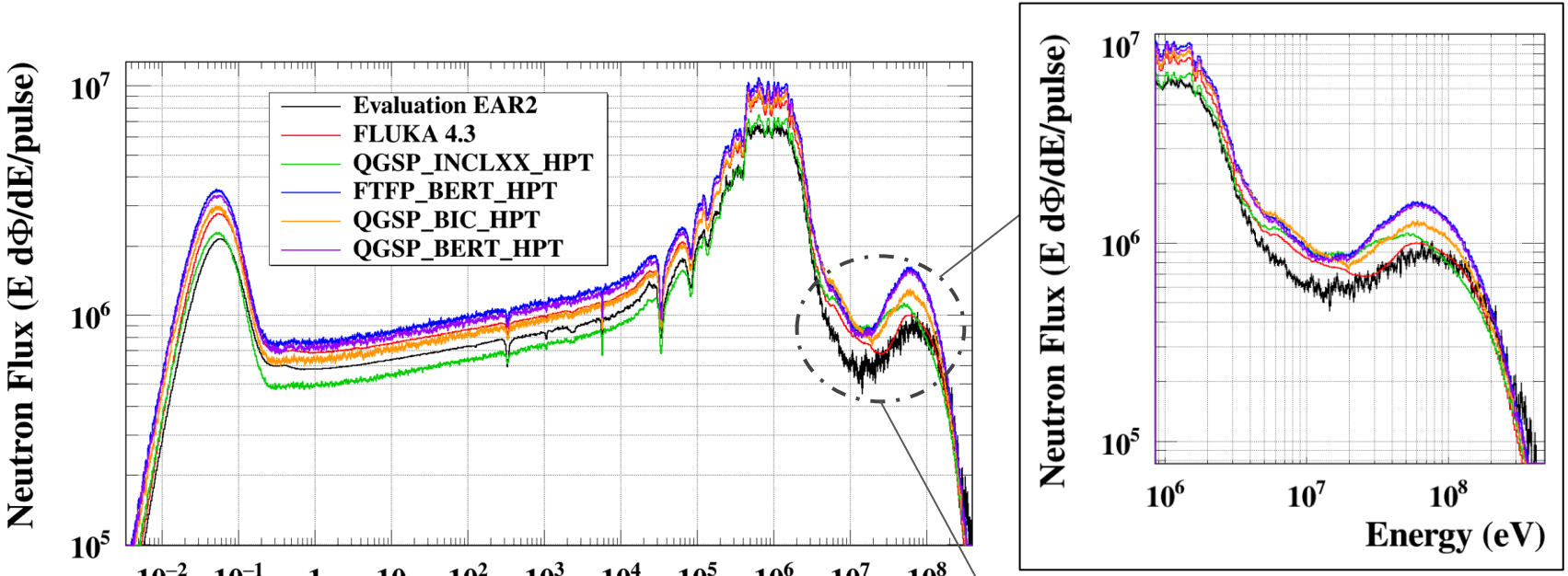


All physics lists incorporate **G4ThermalNeutrons** (< 4 eV)

EAR1 ratio GEANT4 to FLUKA



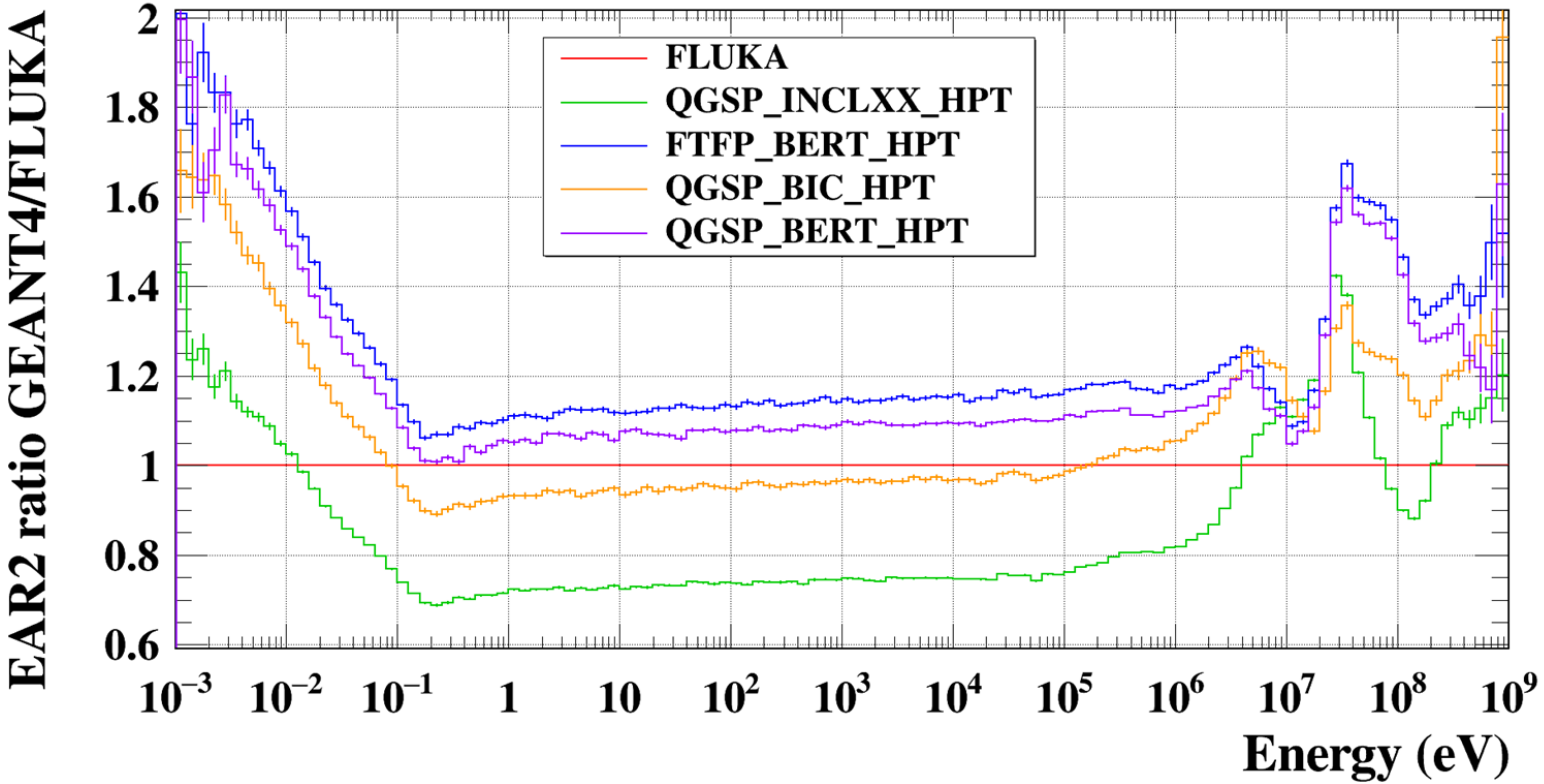
EAR2 simulations and experimental results



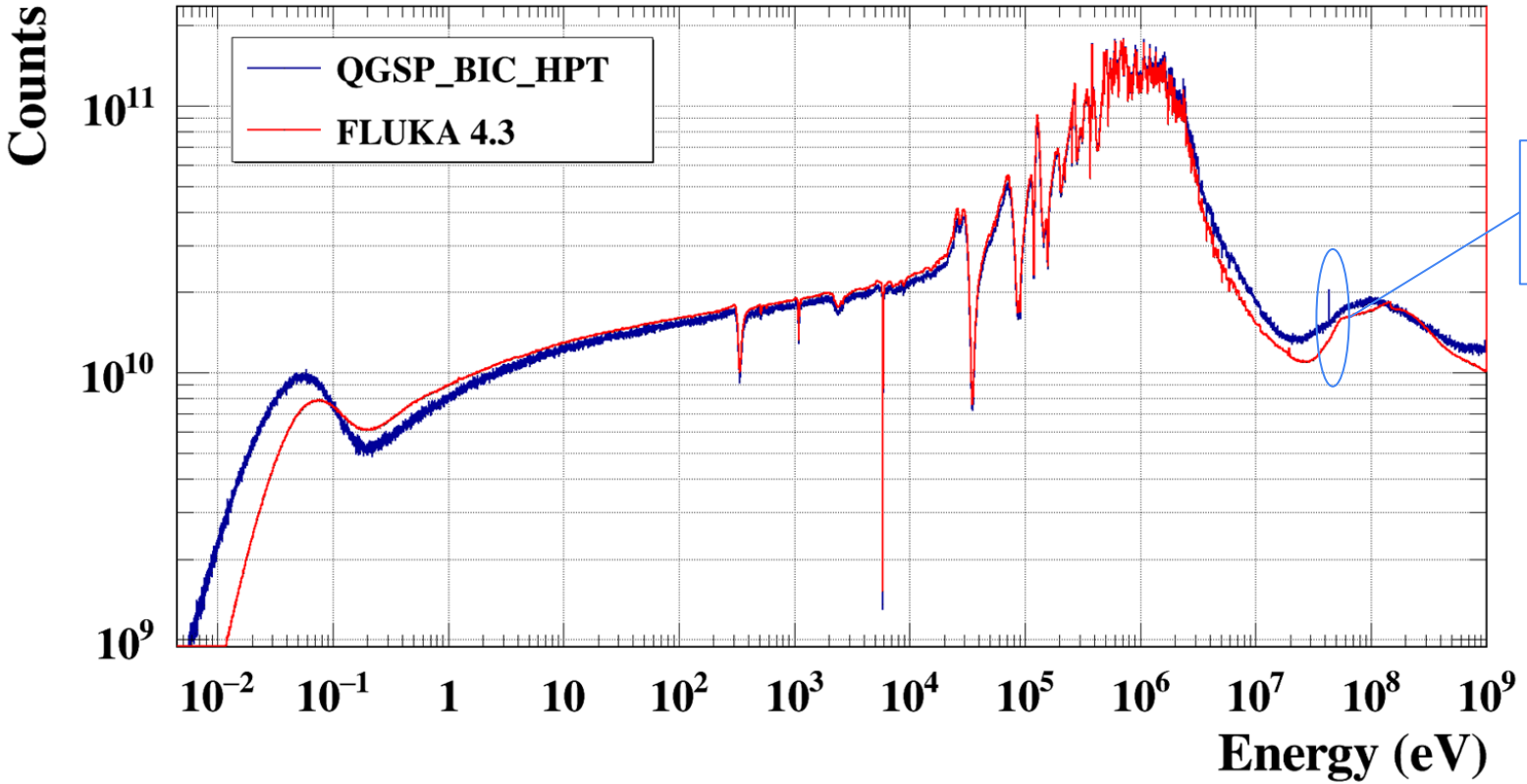
Important differences in shape at high energies

All physics lists incorporate **G4ThermalNeutrons** (< 4 eV)

EAR2 ratio GEANT4 to FLUKA

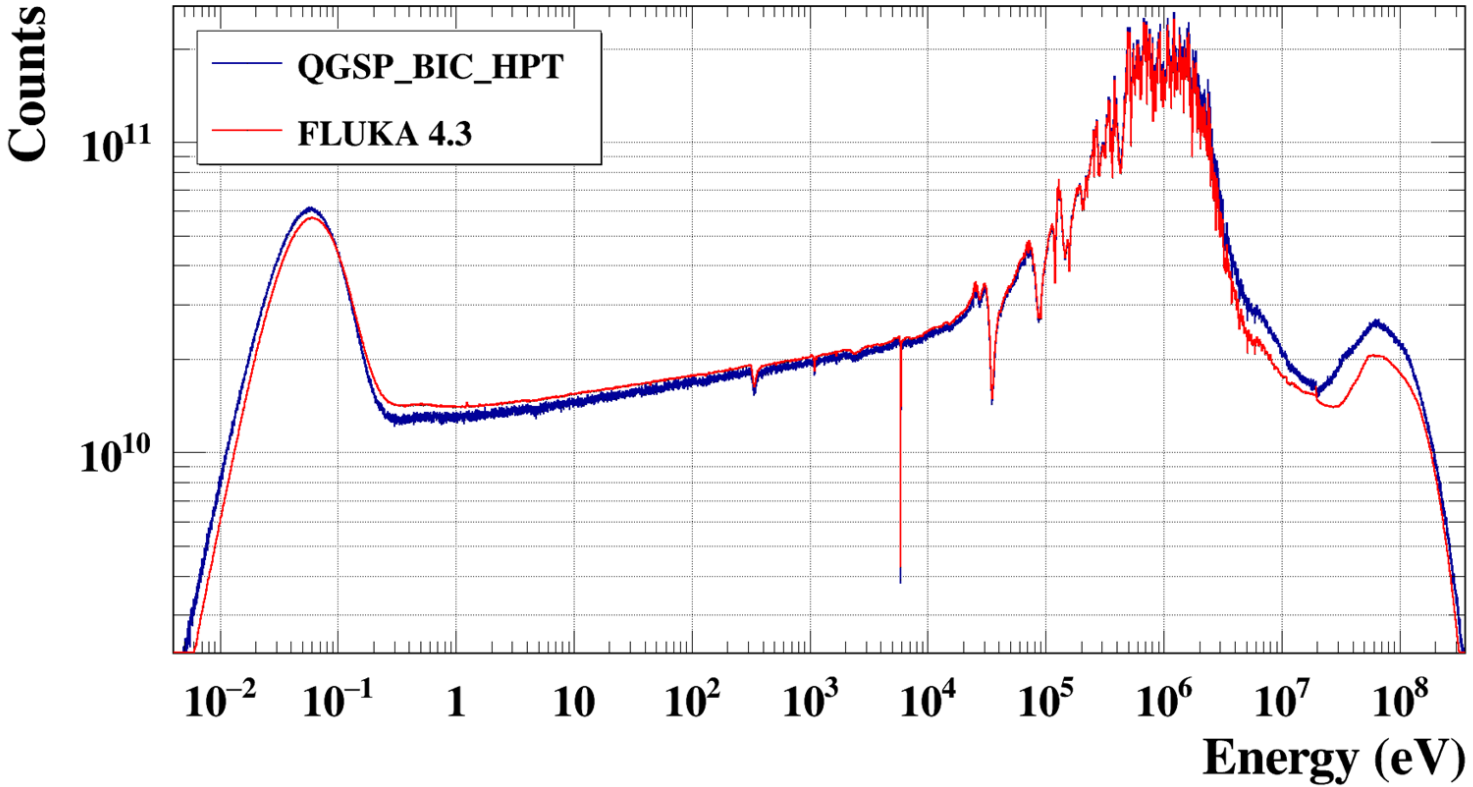


FLUKA and Geant4 simulations at EAR1scoring plane

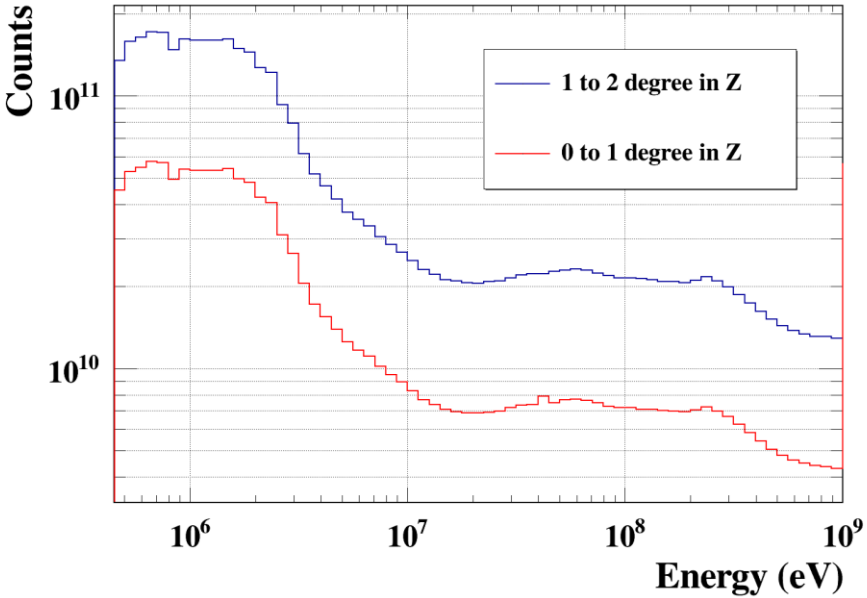


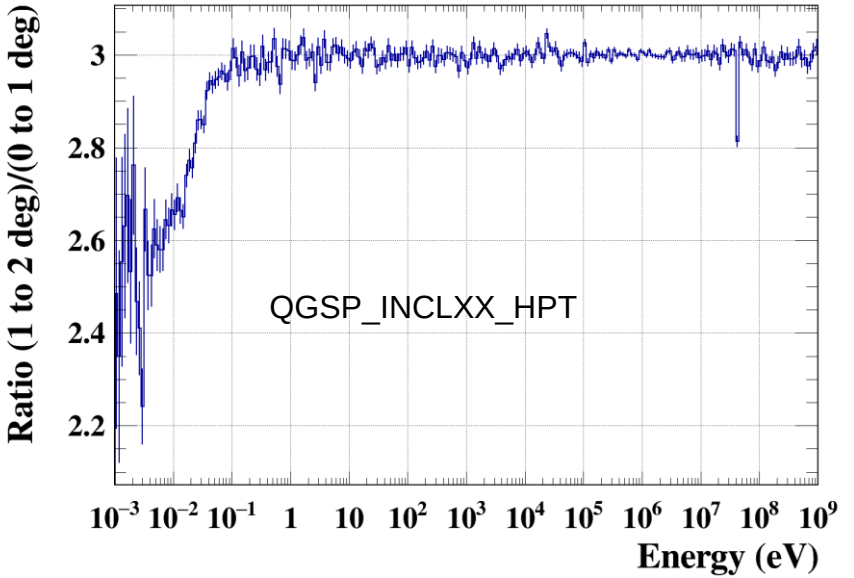
Peak at ~ 42 MeV in GEANT4

FLUKA and Geant4 simulations at EAR2 scoring plane



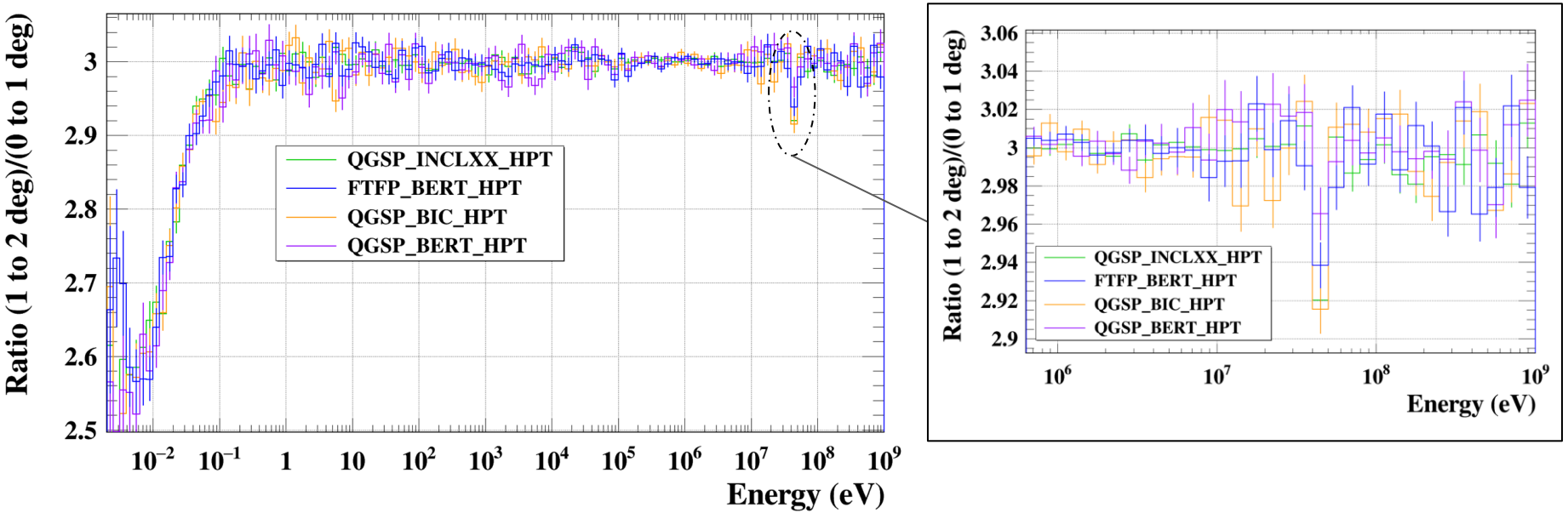
Origin of the ~42 MeV “peak”





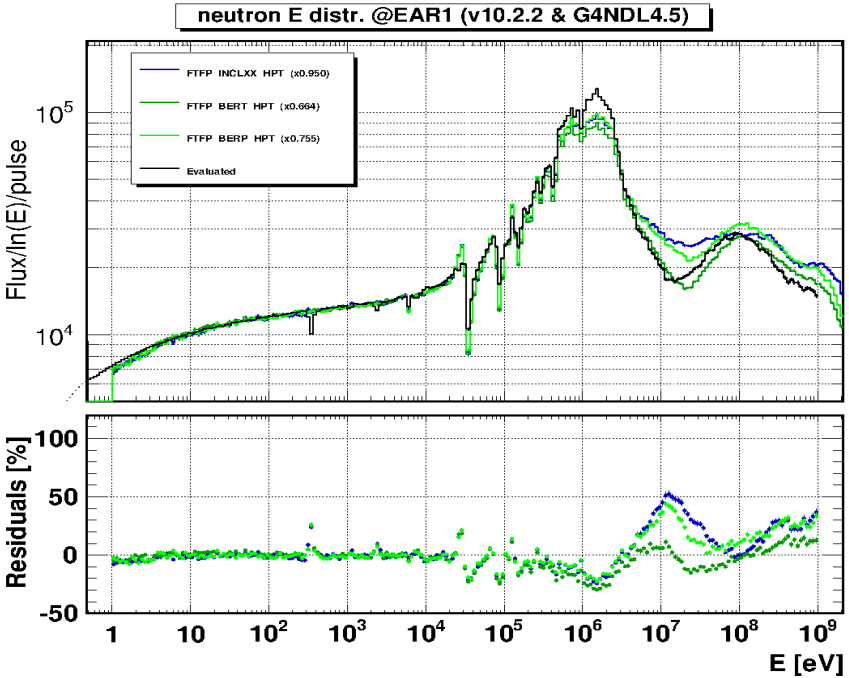
Seems to be essentially due to neutrons emitted below 1 deg w.r.t. proton beam.

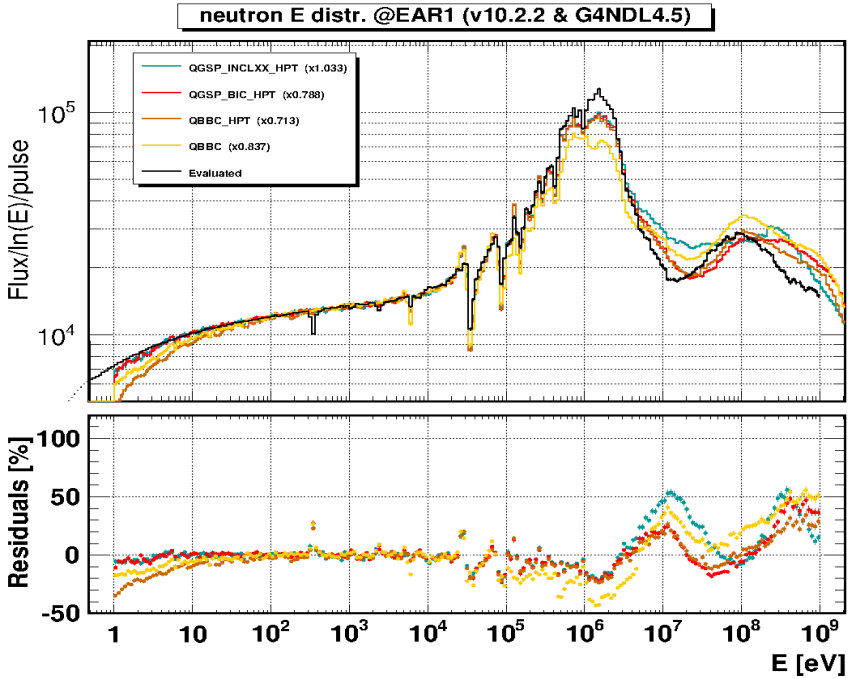
Origin of the ~42 MeV “peak”



Seems to be essentially due to neutrons emitted below 1 deg w.r.t. proton beam.

Geant4-10.2.2 simulations of previous n_TOF target (#2)





No “peak” observed at ~40 MeV in the previous simulations done (**10.2.p02**)

(See talk @ Ferrara 2016 CM)

Summary and conclusions

- The Moira application for Geant4 simulations with FLUKA inputs has been presented.
- The first ever simulations of the exact same n_TOF geometry have been carried out with Geant4, and preliminary results have been shown together with experimental measurements.
- A first look suggests important differences above 20 MeV, in particular in EAR1 a peak at ~42 MeV is observed in GEANT4, whereas in FLUKA and experimental data is not present, nor in previous version 10.2.p02.

References

- Fluka-Cern status and plans, Moira, and scoring
- Studies driven by the Moira Framework