Summary and conclusions of the workshop

Overview of the talks

GEANT4 features:

- EMPhysics + Class II e- elastic scattering description
- Hadronic Physics models + G4ParticleHP + INCL/ABLA + BLOB's NN-drive random number generator + Light nuclear XS model (high energies)
- Various Fission models
- Radioactive decay model
- Scoring
- Biasing

Request: **help with the validation! Experts are needed for verifying that the code produces the required results.**

GEANT4 applications/virtual Monte Carlo tools:

- Toolkit for simulating lifetime studies
- Expert ROOT
- GROOT
- ENSARROOT

Nuclear reactions (broad energy range, from meV to GeVs)
A broad range of applications: underground experiments (dark matter, nuclear astrophysics), detector simulation, spallation targets and spallation neutron sources (with moderators, ultra cold neutrons), specific nuclear de-excitation models.
More neutron cross section libraries at thermal and sub-thermal neutron energies.

Nuclear structure
Alternative nuclear de-excitation models to PhotonEvaporation for addressing particular issues relevant to (n,gamma), beta-decay and dark matter search experiments.

Detector simulations
Calibration of charged particle detectors, response functions of high and low energy neutron detectors, crystalline effects (size of gamma calorimeters), environmental applications (radioactivity, dose to public).

Medical applications
Proton therapy, dose calculations (treatments, aircraft personnel...)

Energy applications
Delayed neutron calculations, criticality calculations and transients.

Other applications
Damage to electronics (failure events), design of facilities (ELI-NP, n_TOF)

Underground experiments

Involve a broad scope of models: radioactive decay (backgrounds), cosmic rays (spallation), optical transport of photons (detector construction, NEST toolkit), neutron interactions (SF and alfa-n reactions). Issues with the neutron production rates / gamma-ray veto (10 times less neutrons measured than predicted).

Requests

- **EMPhysics + Radioactive decay**

Improve the heavy ion EM transport (variation of the charge state).
Comments/questions about which nuclear structure database should be used. ENSDF? RIPL? ENDF?
Improve the situation on delayed neutrons.
Release as soon as possible the Class II e- elastic scattering model. Very important for low energy applications.

- **Hadronic Physics models + G4ParticleHP + INCL/ABLA + BLOB's driven NN random number generator + Light nuclear XS model (high energies)**

Improve the speed: XS sampling, Doppler broadening. Switch off the Doppler broadening and use XS at different temperatures?
Problems with the secondary charged particle generation? Reported differences between MCNP and GEANT4.
Photofission, fotodissociation, proton fission?. Various talks reported the need of having better data/models.

Add the statistical treatment of the unresolved resonance region.
Mix libraries with models isotopic-wise, depending on the nuclear data availability and energy ranges.
Could the idea of having a NN-based random number generator extended to other models? NN-driven event generators?

- **Fission models**

Correlated production of fragments, gammas and neutrons. LNNL model?

- **Radioactive decay model**

Impressive upgrade. Delayed neutron, proton emission, double beta decay. Validation of in-flight decay, correlated gamma emission. Very important to have a good nuclear de-excitation model for various physics applications (beta-decay, neutron capture, nuclear reactions…)

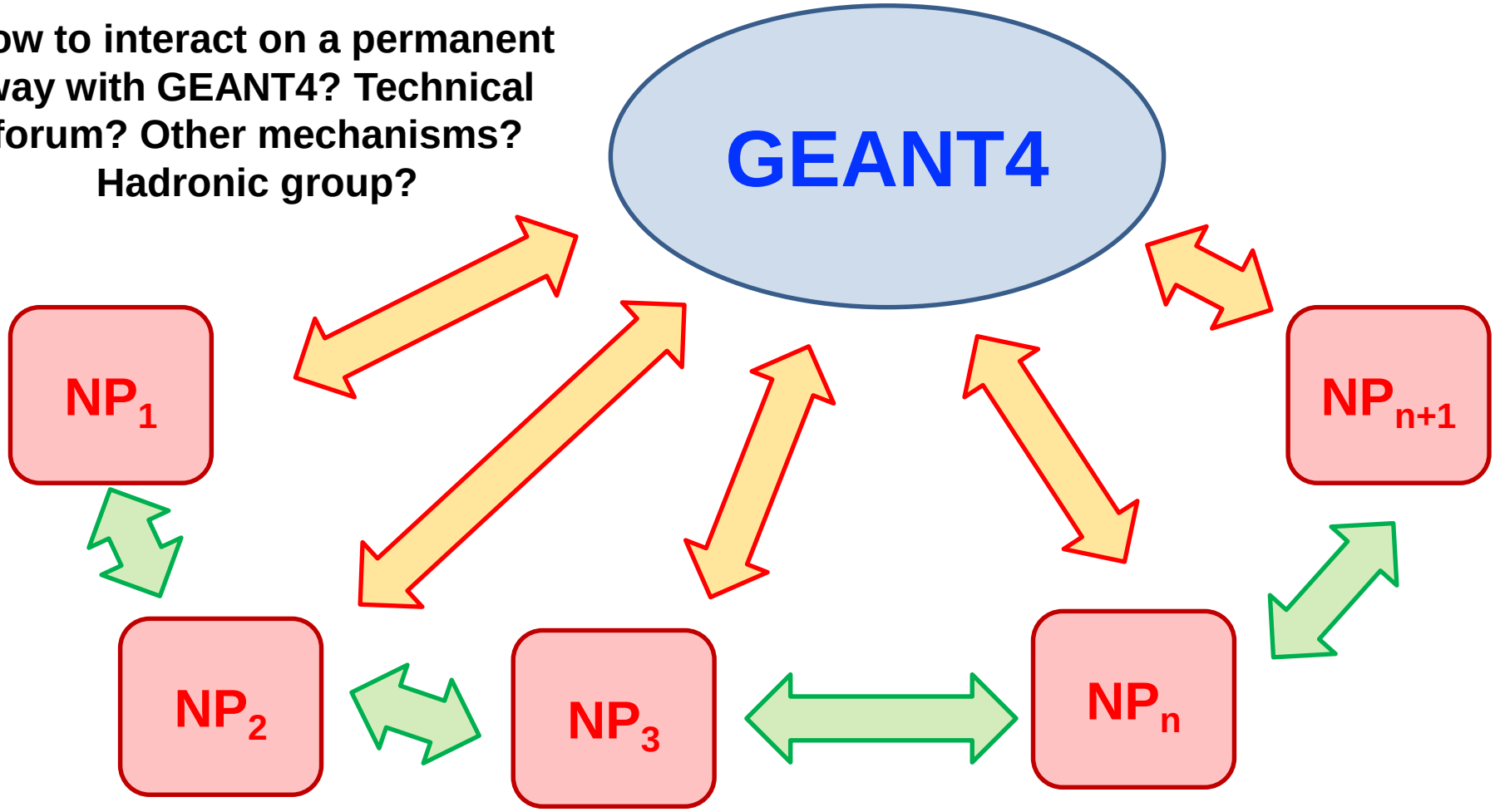
- **Scoring**

Adding energy bins to the mesh tallies.

- **Biasing**

More comprehensive documentation + examples.

How to interact on a permanent way with GEANT4? Technical forum? Other mechanisms? Hadronic group?



New collaborations between NP_i

GEANT4 is a gift: completely free code developed by many (usually overworked) volunteers (look at the licence agreement). Despite the huge efforts made by the developers, it requires additional validation and work from the users.

How could nuclear physicists help?

- Validation of models: difficult to know all the models and create a suitable GEANT4 application for validation. Experimental data / experience acquired in experiments that can be delivered to GEANT4. Follow the G4_med example and create an application that can be run easily by non-GEANT4 experts.

- Release pieces of code developed for specific applications and addressing some of the requested features.

- Documentation: writing down what has been learned can help other. Please send us your notes. They may become part of a “manual”.