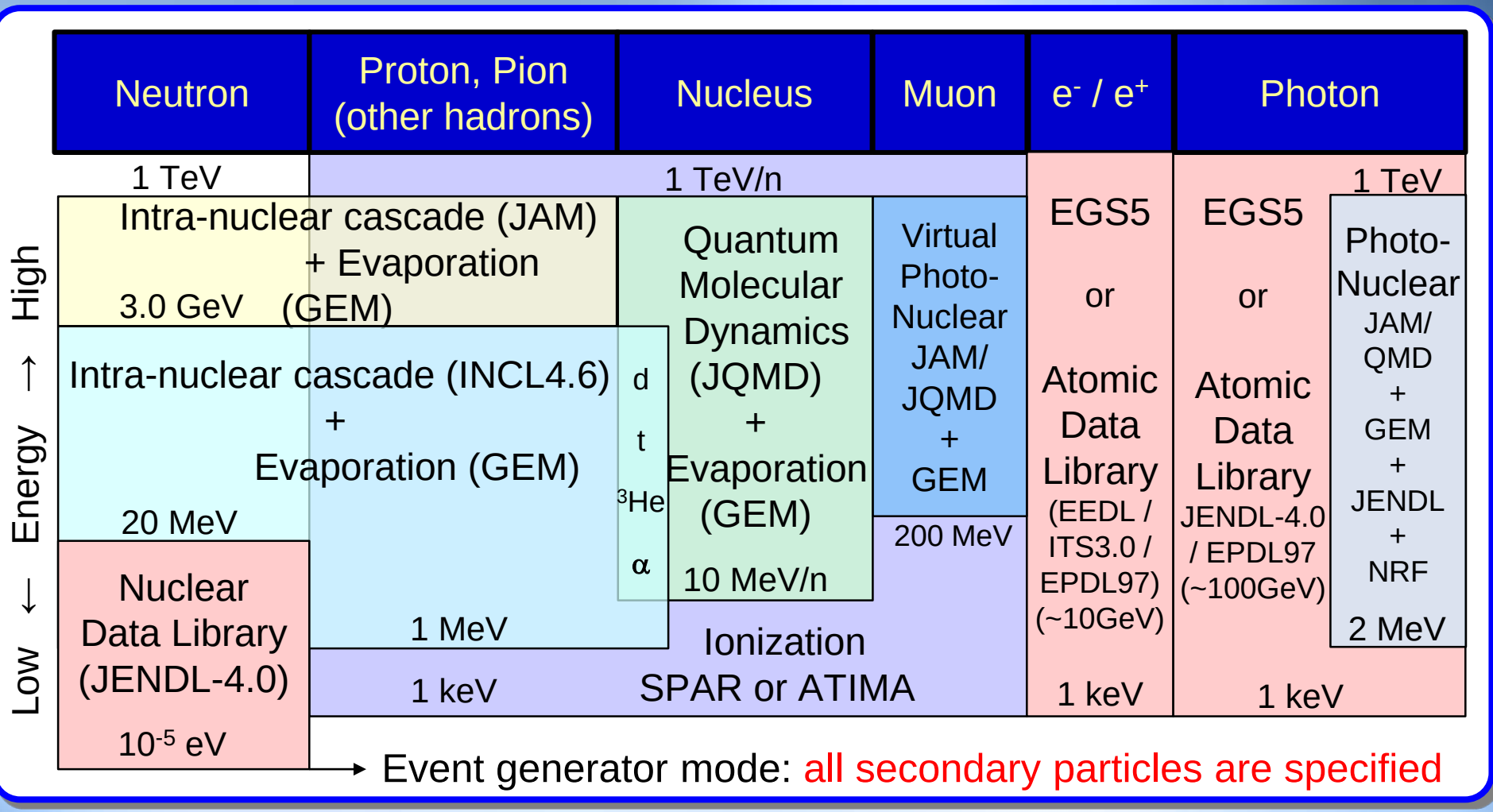
Features of PHITS2.82

PHITS development team, Dec. 25, 2015

Map of Models used in PHITS2.82



Maximum energy is extended up to 1 TeV/n by fixing bugs in high-energy nuclear reaction models

*Switching energies can be changed in input file of PHITS

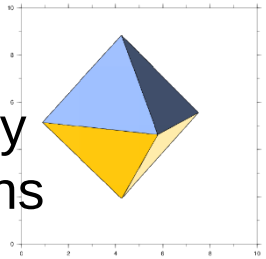
Major Upgraded Features from v2.76

- ✓ Implementation of function to read tetrahedral geometry
- ✓ Improvement of muon transport algorithm
- ✓ Implementation of nuclear resonance florescence model
- ✓ Extension of “sum tally”
- ✓ Implementation of function to read user defined cross section
- ✓ Revision of energy straggling calculation procedure
- ✓ Revision of statistical uncertainty calculation procedure using dump source
- ✓ Revision of bugs in EGS5 mode
- ✓ Implementation of point estimator tally [t-point]
- ✓ Implementation of R-θ-Z mesh in [t-track]
- ✓ Implementation of function to generate triangle prism source

Tetrahedral Geometry

✓ What's tetrahedral geometry?

A kind of 3D polygon geometry composed only by tetrahedrons



✓ What's the purpose of implementation?

Read complicated geometry such as human body

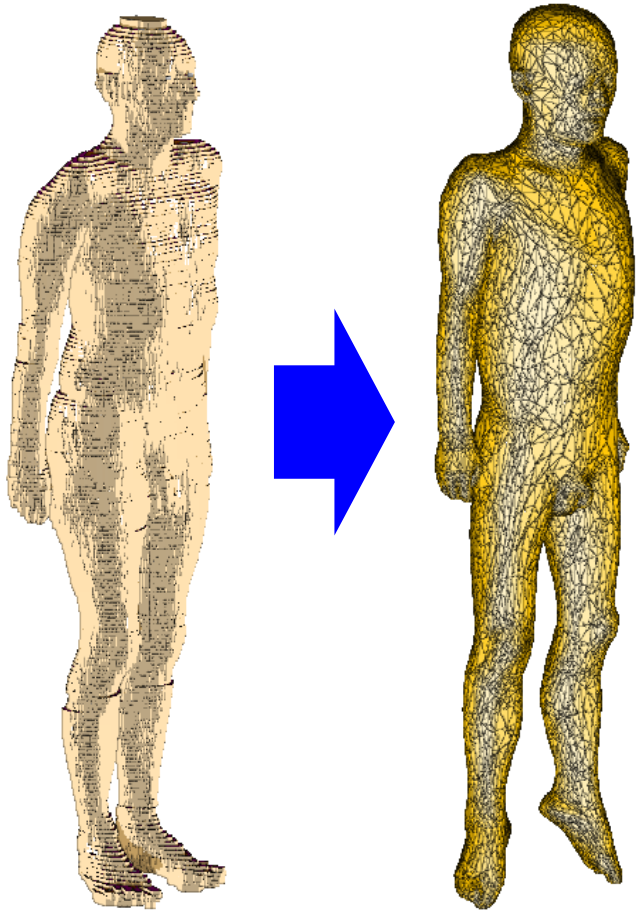
Read CAD geometry via tetrahedral geometry

✓ How to use? (see utility/TetraGeom)

Similar to voxel geometry

You have to prepare tetrahedral geometry using other software such as TetGen*

* http://wias-berlin.de/software/tetgen/



Voxel phantom (ICRP [1])

Polygon phantom (Hanyang Univ. [2])

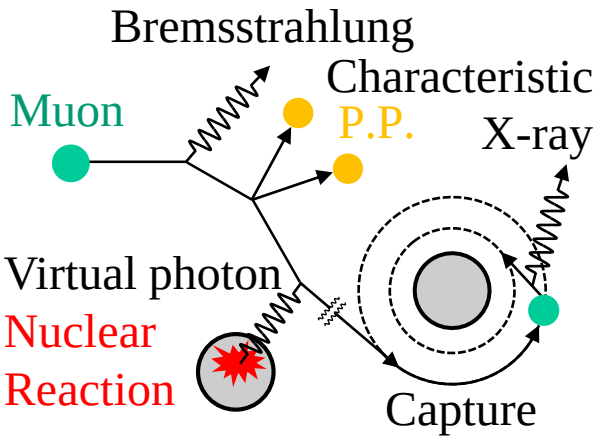
[1] ICRP Publication 110, [2] Y.S. Yeom et al. Phys. Med. Biol. 59, 3173-3185 (2014)

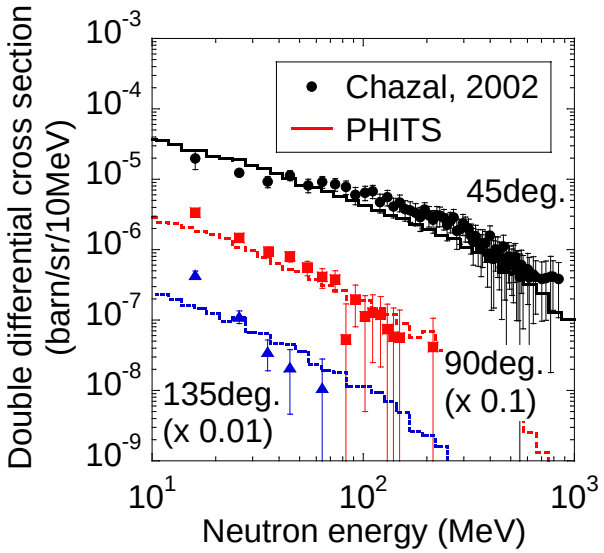
This implementation was performed under support of Prof. C.H. Kim's group of Hanyang Univ

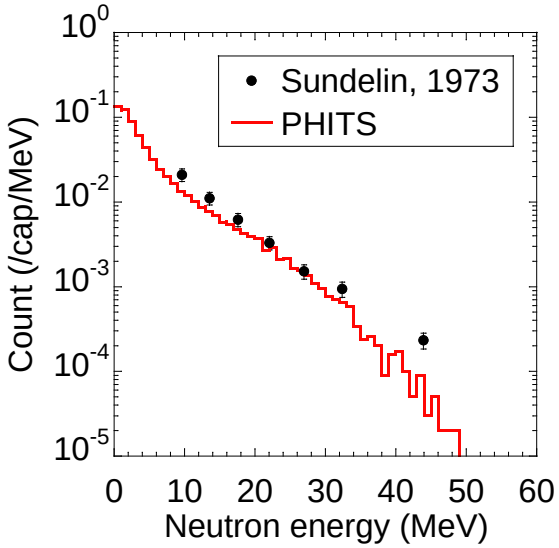
Muon Transport Algorithm

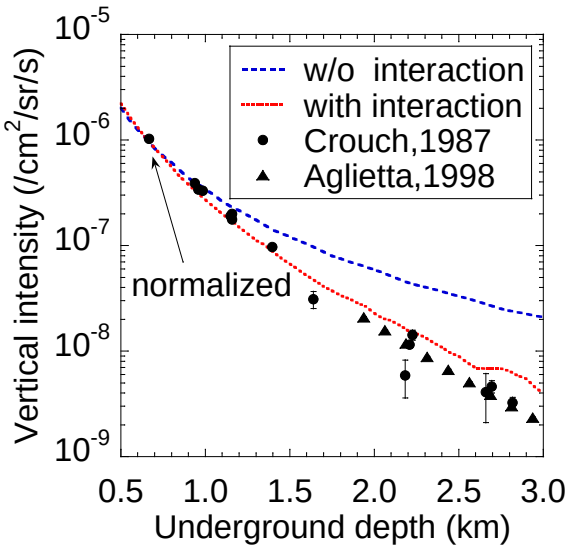
- Virtual photon interaction (ver.2.70)
- Negative muon capture reaction (ver.2.76)
- Bremsstrahlung, pair production (ver.2.80)

➡ All interaction can be considered!!







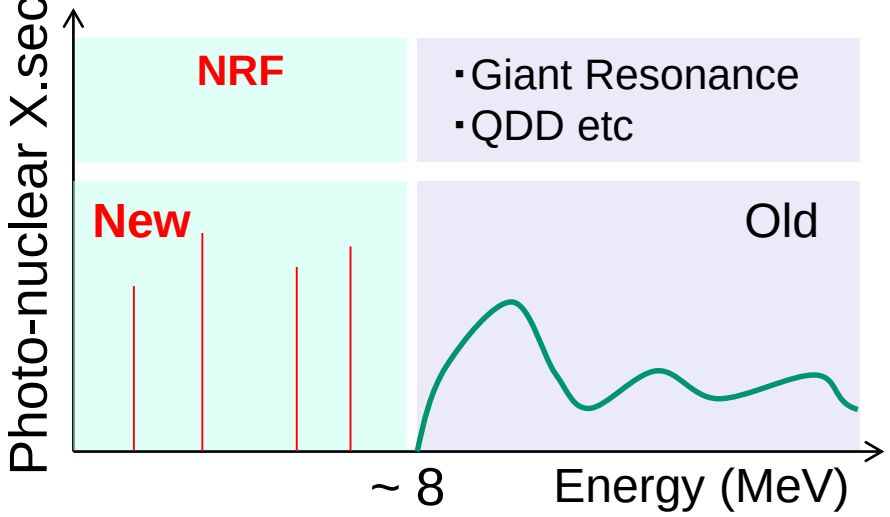


^{12}C(μ,n) @ 190GeV/c **^{40}Ca(μ$^-$,n) @ captured** **Under ground Muon**

Nuclear Resonance Florescence (NRF)

What's NRF?

Nucleus can absorb photon with energy equivalent to its excite level, and emit gamma-ray with certain energies (a kind of photo-nuclear reaction)



Application

- ✓ Estimation of radioactivity after food irradiation
- ✓ Detection of nuclear material

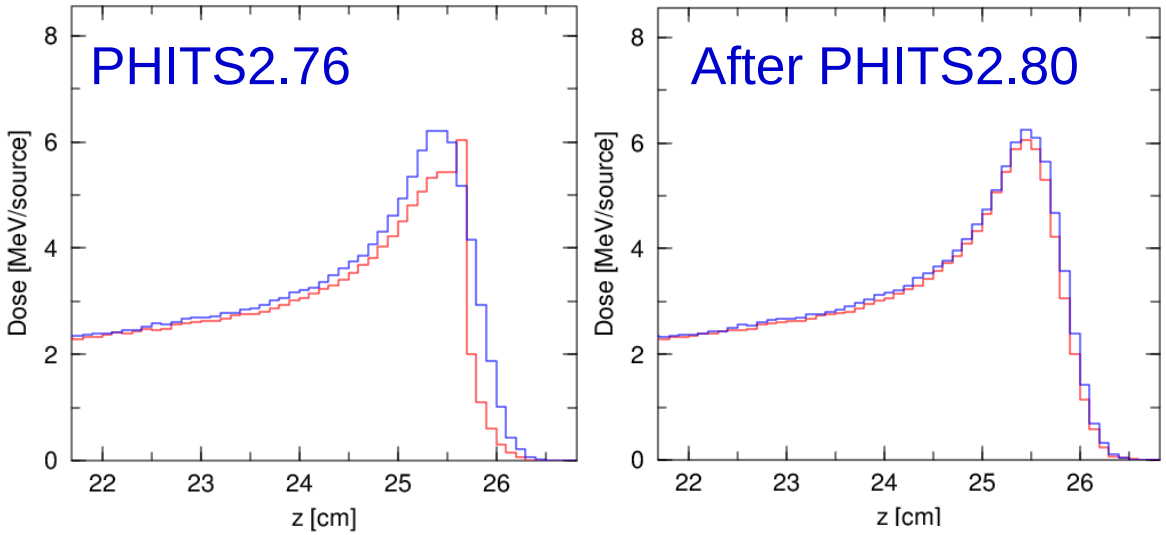
How to use

1. Set ipnint = 2 in [parameters] section
2. Set polarization direction in [source] section (for polarized photon)
3. Set igamma = 3 if you would like to calculate isomer production

Absorption levels are mostly taken from ENSDF (http://www.nndc.bnl.gov/nudat2/)

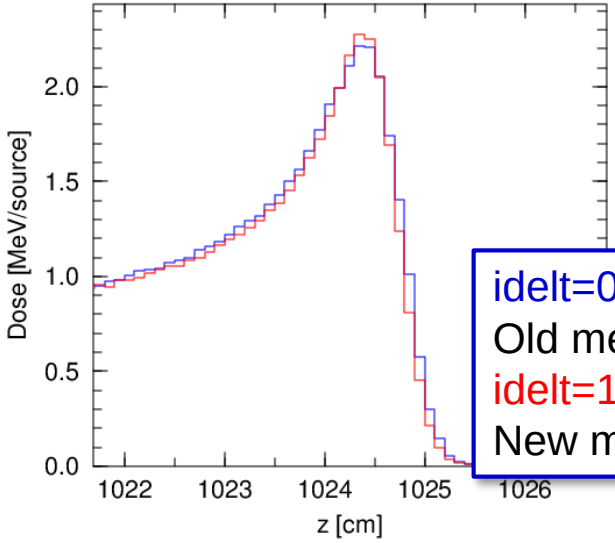
Revision of Energy Straggling

Problem on calculating energy straggling in large material



Depth-dose distribution around 200 MeV proton

Blue: 1mm x 280 cells
Red: 28cm x 1 cell



idelt=0:
Old methd
idelt=1:
New method

Reduce computational time in air

Calculation of depth-dose distribution for 200 MeV in 10 m air

idelt=1(new option): Determine maximum flight path / event based on g/cm^2

Reduce computational time by factor 1.6

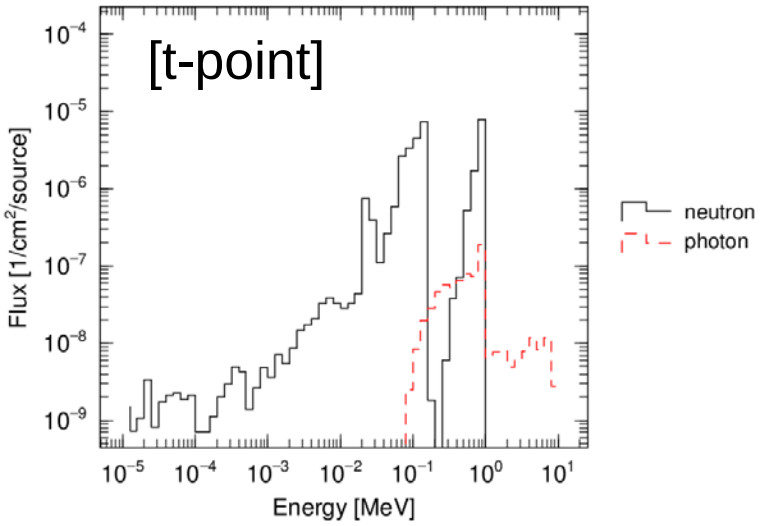
Point Tally [t-point]

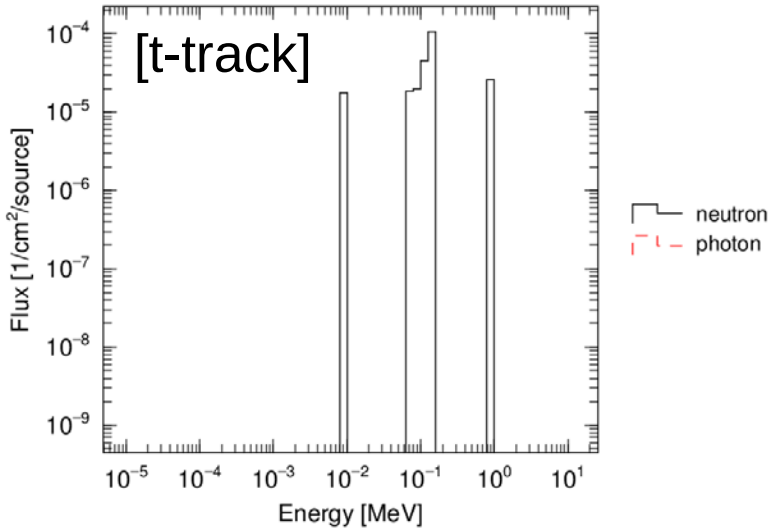
What's point tally?

Estimate particle fluence at a certain point (or line)
Effective when tally region is very small in comparison to whole geometry

Simulation Condition

- ✓ Simulation using only nuclear and atomic data libraries
- ✓ Only fluence of neutron and photon can be estimated
- ✓ Neither event-generator and EGS5 mode cannot be used





Neutron and photon fluence calculated by [t-point] and [t-track] for similar conditions