Features of PHITS3.00

PHITS development team, Aug. 2017

Map of Models Recommended to Use in PHITS

	Neutron	Proton, Pion (other hadrons)		Nucleus	Nucleus Muon e ⁻ / e ⁺ P		Pho	oton
_	1 TeV		1 TeV/u				_1 TeV	
 High 	Intra-nuclea + Ev 3.0 GeV	ar cascade (JAM) aporation (GEM)	Quantum Molecular Dynamics (JQMD) t t Evaporation (GEM)	Quantum Molecular Dynamics	Virtual Photo- Nuclear JAM/			Photo- Nuclear
Energy –	Intra-nuclear o Eva 20 MeV	Evaporation (GEM)		JQMD + GEM	EGS5	EPDL97 or EGS5	JAM/ QMD + GEM +	
→	Nuclear	1 MeV	α	10 MeV/u	200 Mev			JENDL + NRF
Low	Data Library	1 keV		ATIMA		1 keV	1 keV	
	(JENDL-4.0) 0.1 meV	 Event generator mode all secondary particles are specified 				*Track structure 1 meV	*Only in water	

Transport photons and low-energy neutrons in default setting

✓ Track-structure mode was implemented (applicable only to e⁻/e⁺ in water)

Major Upgraded Features in v2.88

Upgrade Points from v2.82

- Implement Weight Window Generator function
- Develop output option for a 3D-viewer ParaView
- Set ATIMA for default stopping power calculation model
- Improve "sum tally" function
- Improve muon and pion nuclear interaction models
- Implement radioisotope source function
- Develop JAMQMD
- Implement neutron decay process
- Revise some bugs in the EGS5 algorithm

Weight Window Generator

What can do with Weight Window Generator [t-wwg]?

Automatically determine the effective settings of [weight window]
 Help users to easily perform deep penetration calculation



Deep penetration calculation using [t-wwg] & [Weight Window] (history numbers are the same for all trial)

Output Function for ParaView

What's ParaView (http://www.paraview.org)?

- ✓ Open-source, multiplatform data analysis and visualization application
- Capable of drawing tally outputs in 3D picture & animation

How to activate the function?

Simply add "vtkout = 1" in a tally with "mesh = xyz"





Sample picture of ParaView

ICRP voxel phantom visualized by ParaView

See lecture¥advance¥paraview in more detail

RI Source Function

What can do with RI source function?

- ✓ generate photon sources with energy spectra of radioisotope (RI) decay by simply specifying the activity and name of the RIs
- ✓ consider activities from daughter nuclides by setting a decay time
- ✓ use nuclear decay database DECDC*

RI source (e-type = 28) Mono & continuous energy source (e-type = 22)



Input formats for representing ¹⁵²Eu with activity of 100 Bq

Photon flux from ¹⁵²Eu

*A. Endo et al., JAERI 1347 (2005); equivalent to ICRP Publication 107

Recent Upgrades: PHITS3.00

Not Registered in OECD/NEA yet

Upgrade Points from v2.88

- Development of JAMQMD2.0
- Development of track-structure mode
- Consideration of electro-magnetic field in EGS5 mode
- Extension of RI source function applicable to α and β decays
- Development of xyz-mesh source generation function
- Implementation of automatic termination function by CPU time and standard deviation
- Development of volume calculation tally [t-volume]
- Implementation of sum-up function in [t-deposit]
- Extension of reaction channel in [counter], [t-star], & [t-product]
- Implementation of epsout = 2 option to draw error bar in ANGEL
- Introduction of weight window bias function [t-wwbg] & [ww bias]
- Revision of input format

Track-structure Mode

What is track-structure mode

- ✓ All ionization and excitation events are explicitly considered
 - \rightarrow In contrast to continuous slowing down approximation (CSDA)
- ✓ Particle trajectory in microscopic scale (~ nm order) can be calculated
 - $\rightarrow 1 \mu m$ resolution is minimum when CSDA is used
- Computational time becomes extremely long



Trajectories of 4 keV electrons simulated by EGS5 mode (upper) and track-structure mode (lower)

(see recommendation/trackstructure)

Length unit can be changed by ANGEL parameter "cmum"

Currently applicable only to e⁻ & e⁺ in water, but plan to extend to other cases

Electro-magnetic field in EGS mode



水中に100MeV電子を入射した際の電子・陽電子フラックス

- Definition of the electro-magnetic fields is the same as previously
 - \rightarrow Define in [magnetic field] or [electromagnetic field],
 - Set imagnf / ielctf = 1 in [parameters] (see lecture/advanced/option)
- Effective only when EGS mode is activated
- Be careful for generating too many secondary particles when high electric field is applied

Revision of Input Format

Major revision points

- ✓ "c" becomes unusable as comment marks in [material]
 - \rightarrow If you set "icommat=1" in [parameters], "c" is regarded as comment
- ✓ "file(1)" is introduced to specify the PHITS installation folder name. If you set this parameter, you do not have to specify other input file names
 → Each "file" parameter overwrite the setting when they are specified
- A new parameter "nucdata" is introduced to automatically adjust emin(2) and dmax(2) parameters suitable for JENDL-4.0
 - \rightarrow Basically you do not have to specify emin(2) & dmax(2)
- ✓ "negs" becomes the control parameter for electromagnetic transport
 - → negs = -1: Transport only photon based on EPDL97 (default) negs = 0: Ignore electron, positron, and photon transport negs = 1: Transport electron, positron, and photon based on EGS5
- ✓ "s-type" in [source] needs not to be changed by energy type
 - \rightarrow automatically judge mono-energetic or energy-distributed sources

*Basically, you do not have to modify your input file suitable for new version

*Exceptions: Define elements in [material] whose nuclear data are not evaluated → nucdata = 0 Use "c" as a comment remark in [material] → icommat = 1