



Status of G4RadioactiveDecay Model

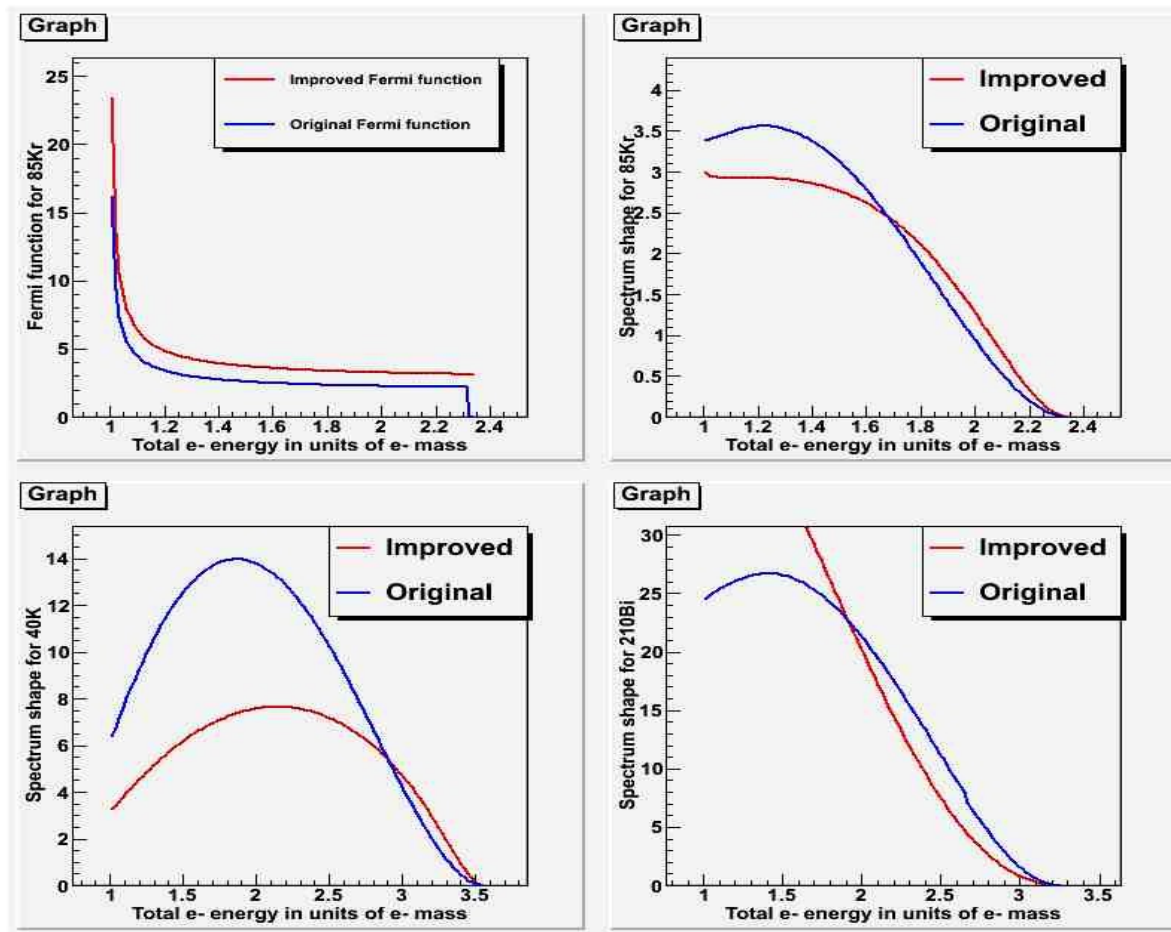
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OUTLINE

- Some modifications of the code
- Re-building of the photo-evaporation and radioactive decay database based on the most recent ENSDF (August 2012) files

Improvement of Beta decay shapes

- Forbidden Beta decay implemented in G4.9.5 release by Dennis Wright
- 1st, 2nd, 3rd forbidden and Unique 1st, 2nd, 3rd forbidden



- New macro commands

`/grdm/setRadioactiveDecayFile Z A file_name`

`/grdm/setPhotoEvaporationFile Z A file_name`

- Allow the user to provide its own data file with new experimental data without the need of changing the G4Radioactive database
- Possibility to extend the limit of validity of the radioactive decay and photo-evaporation model to $Z > 100$ and $A > 250$ (some issue with G4AtomicShells)
- First release in G4.9.5
- Some bug fixing in 2012

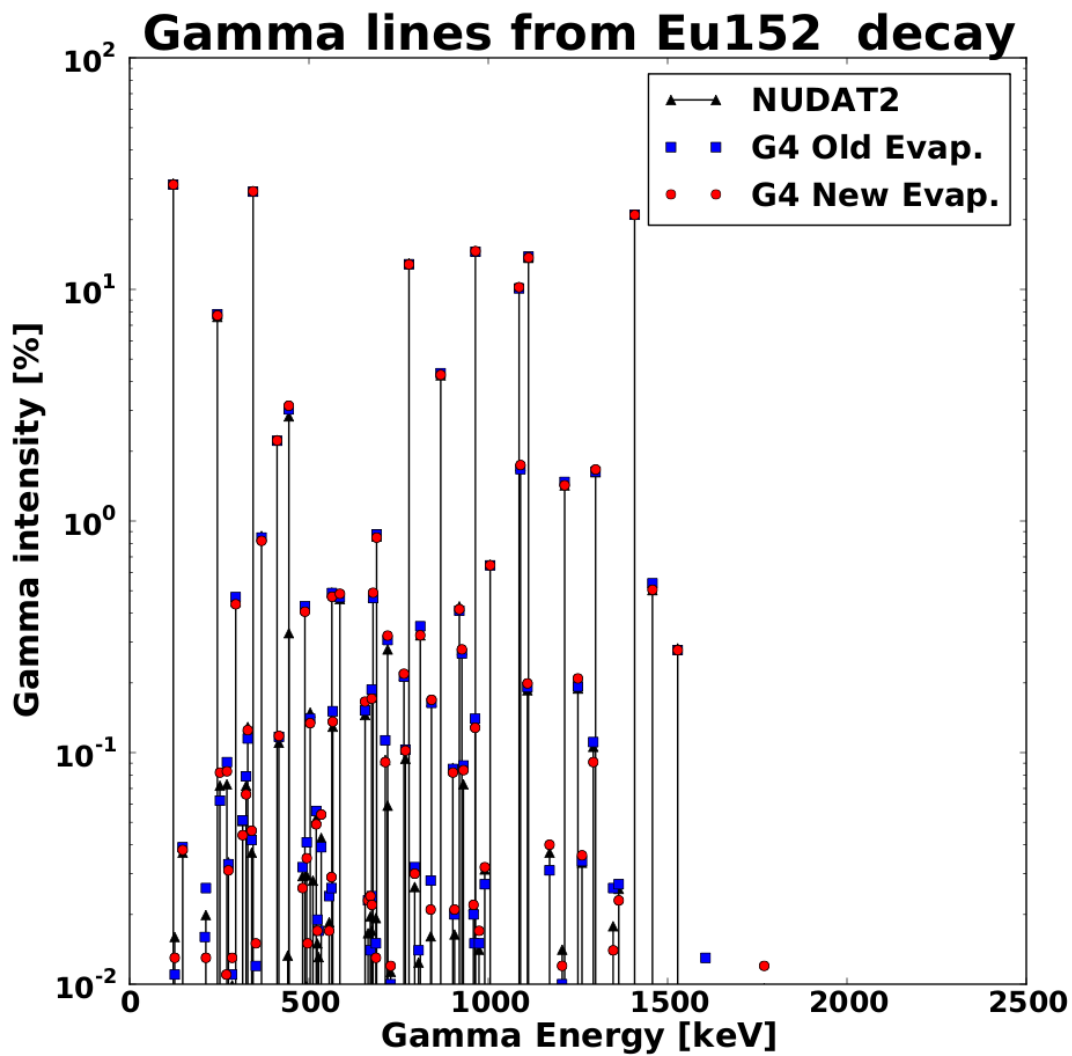
The situation up to now

- T1/2 of excited isotopes in G4RIsootopeTable was taken only from the radioactive decay database
- When not provided the half time was set to $1e-20$ s
- Not all metastable states are defined in the radioactive decay database
- For many metastable states and excited states in general the half time is therefore wrong in G4RIsootopeTable

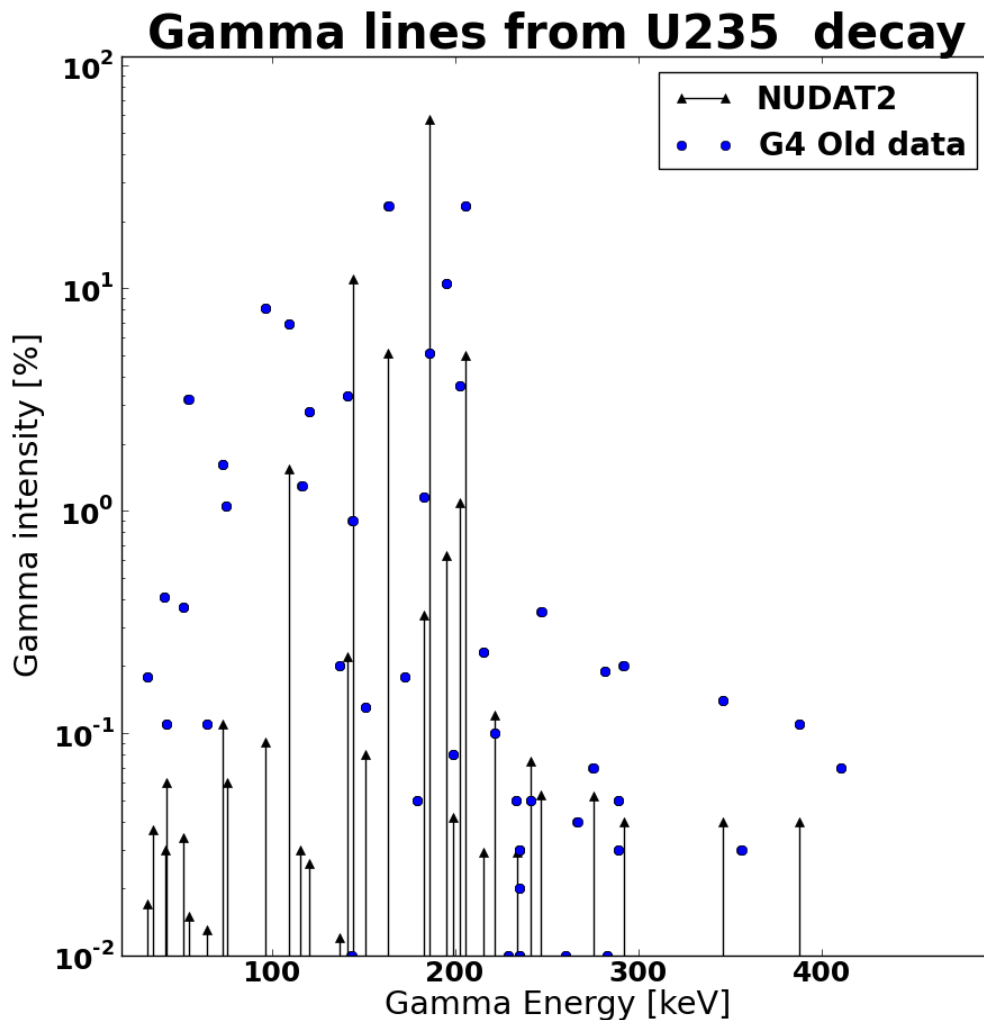
The improvement

- When a metastable or excited state is not found in the radioactive decay database it is looked for in the photo-evaporation database

Old database working well most of the cases



But some very tricky cases



- Rebuilding of the radioactive decay and photo evaporation database from most recent version of ENSDF
- Development of PYTHON functions to download, read, and interpret ENSDF files and to produce the RADDECAY and PhotoEvaporation database
- Use intensity of radioactive products (gamma lines, alphas) as given by NUDAT2 to check the output of the radioactive decay model
- Improvements compared to previous versions of the database:
 - Nuclear levels in the two databases are now identical
 - Better estimation of gamma intensity and internal conversion coefficients
 - New treatment of X+, Y+, .. levels
 - Adding all ENSDF known forbidden beta decays in the Radioactive decay database
 - Add spontaneous fission in the radioactive decay database for Cf252
interface spontaneous fission model to G4Rad decay still needed

γ intensity and total internal conversion coefficient

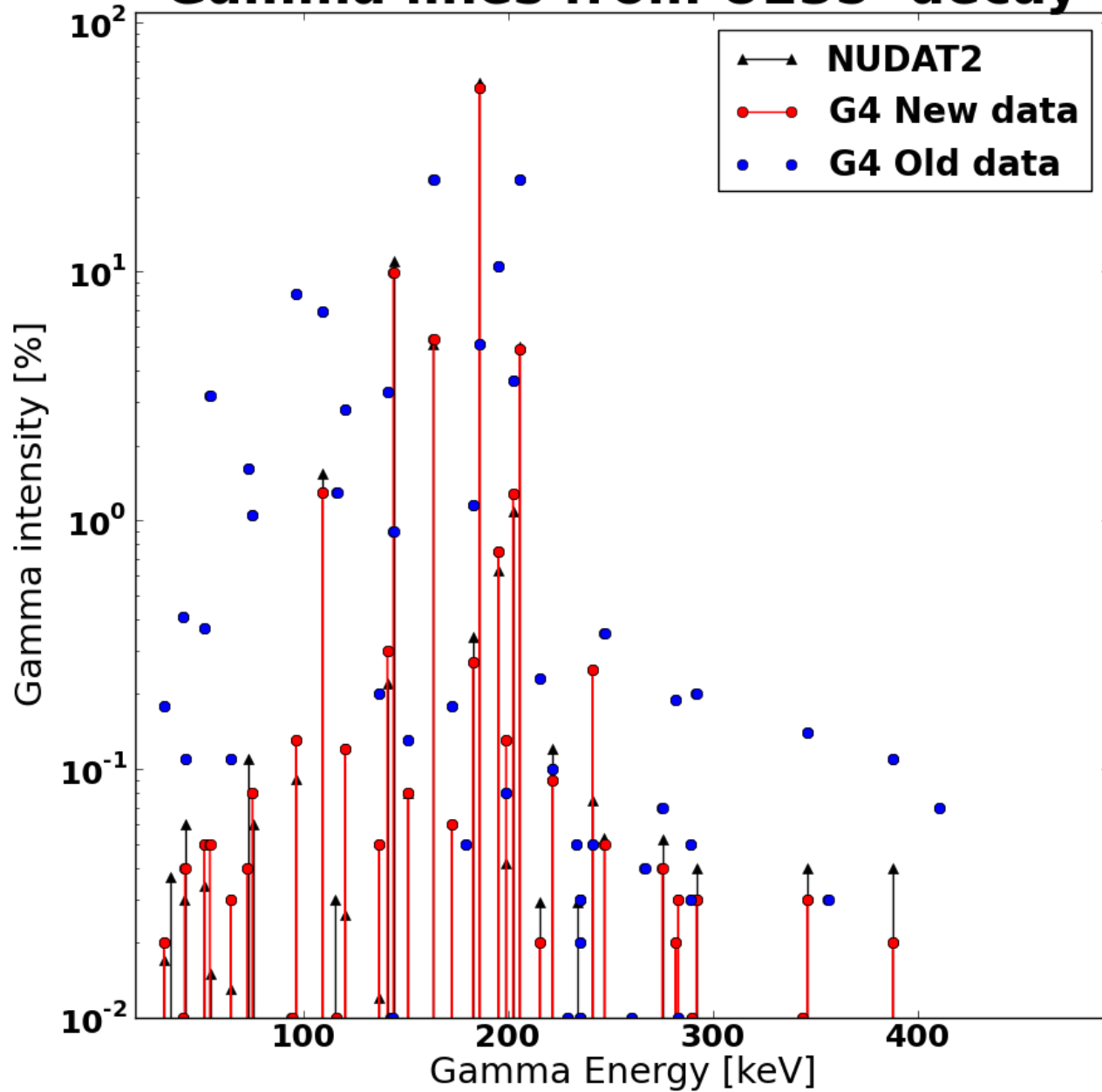
- Most discrepancies between G4 radioactive decay module and nudat2 for gamma line intensities are due to undetermined gamma intensity in the photo evaporation database or approximated internal conversion coefficient (ratio between conversion e- intensity and gamma intensity)
- In some cases gamma intensity or total internal conversion coefficients are not provided in “[Adopted Levels and Gammas](#)” ENSDF files while they can be found in or deduced from “[Radioactive Decay](#)” ENSDF files

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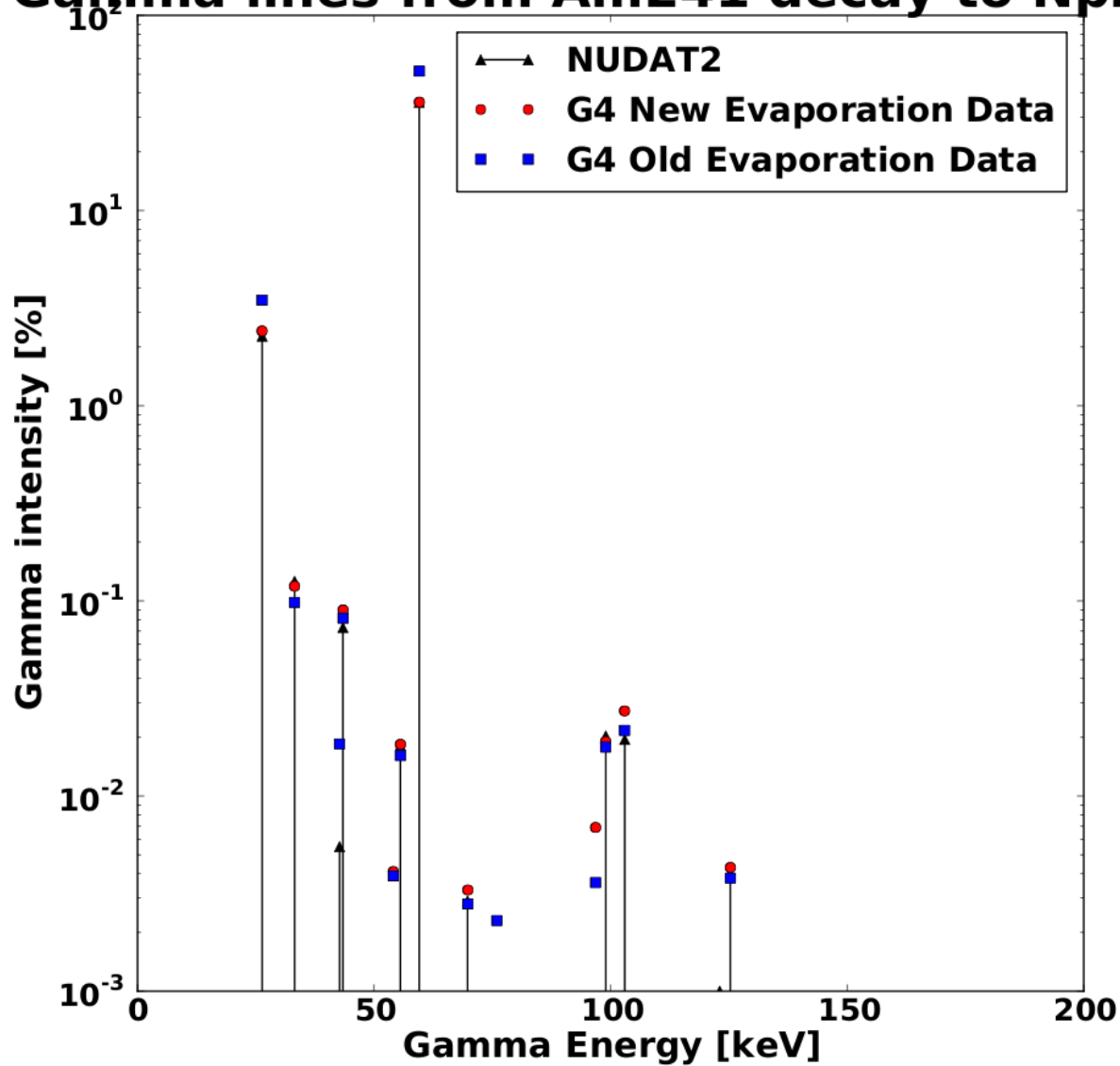
231TH L 205.309 2 (7/2-) B
231TH G 19.595 2
231TH G 19.59 [M1,E2] 1.0E+4 10 61 3 B
231TH G 109.16 2 30 1
231TH G 109.16 2 1.54 5 [E1] 0.0946
  
```

- BRICC is used for computing total conversion coefficients if not provided in the ENSDF files and partial conversion coefficients (distribution of shell e-)

Gamma lines from U235 decay



Gamma lines from Am241 decay to Np237



Treatment of +X, +Y, +.. levels

Example of +X level for ^{234}Pa in ENSDF

234PA	L	0.0		4+		6.70	H		5		
234PA	L	73.92		2	(3+)						
234PA	L	73.92+X			(0-)	1.159	M		16		M1
234PA	G	10		LT							S
234PA	L	103.42+X			(2-)	0.5	NS		LT		
234PA	G	29.49		2	0.24			2	E2	4.40E3	C

- 73.92 and 73.92+X levels appear as two different levels with same energy of 73.92 keV in the old database
- In the new database +X,+Y,... are set to 5,10,.. keV
- 73.92 and 73.92+X levels appear now as 73.92 and 78.92 keV level
- 73.92+X to 73.92 decay is now correctly handled