

Adding Isotope Decay Chains to RAT 0.1

- My first RAT coding project, so I've probably made some conceptual mistakes.
- Based on code provided me by Joe Formaggio, previously GEANTified by Jason Detwiler.

What I did

- Cleaned up the code; now uses CLHEP, strings, vectors, namespaces
- Class `RAT::DecayChain` requires an input file. By default, it's `./data/beta_decay.dat`, but you can place the file in another directory by setting the environment variable `$RATDecayDataDir`.
- Added `decaychain` as a generator:
`/generator/add decaychain ISOTOPE:POSITION[:TIME]`
- For example:
`/generator/add decaychain 208Tl:fill`

Sample debug output

(heavily edited)

15 primaries in decay chain ^{232}Th

```
alpha time=-244.741 ms , p(x,y,z)=-121.513 -48.7633 -113.023 MeV
e-     time=-96.7043 ms , p(x,y,z)=86.2018 -109.427 77.7332 keV
gamma time=-96.7043 ms , p(x,y,z)=-2.80572 2.31063 5.6284 keV
e-     time=-96.6643 ms , p(x,y,z)=-592.331 -338.542 -3.12321 keV
gamma time=-96.6643 ms , p(x,y,z)=23.7441 -416.46 -874.619 keV
alpha time=-953.856 mus, p(x,y,z)=-27.4535 139.124 -142.646 MeV
alpha time=-116.48 mus, p(x,y,z)=-163.644 65.4084 -106.597 MeV
alpha time=-116.48 mus, p(x,y,z)=135.841 156.481 -63.0593 MeV
alpha time=-116.48 mus, p(x,y,z)=5.0202 -124.547 187.183 MeV
e-     time=-106.24 mus, p(x,y,z)=216.895 222.968 79.0828 keV
gamma time=-106.24 mus, p(x,y,z)=-114.75 54.6315 -201.935 keV
alpha time=-512 ns , p(x,y,z)=-4.47769 -204.851 -58.7612 MeV
e-     time=0 ps , p(x,y,z)=-1.40245 0.0668151 -0.569783 MeV
gamma time=0 ps , p(x,y,z)=-126.379 -415.473 -389.123 keV
gamma time=0 ps , p(x,y,z)=0.170466 -1.71834 -1.96326 MeV
```

Limitations

- All isotopes are assumed to decay at rest at their starting position; there's no drift or recoil.
- There's no time window; if an isotope decays 100 years after the previous decay, it's still passed on to RAT and written normally.
- Negative times (see previous page): Is this what we want? Start decaying at $t=t_0$? Or implement some other time functionality?

Next step

- Add/revise in RAT (should I just do this?):

```
include/RATDecayChain_Gen.hh
```

```
include/DecayChain.hh
```

```
include/BetaFunction.hh
```

```
include/FermiFunction.hh
```

```
src/RATDecayChain_Gen.cc
```

```
src/DecayChain.cc
```

```
src/BetaFunction.cc
```

```
src/FermiFunction.cc
```

```
src/RATGSim.cc
```

```
data/beta_decay.dat
```

- Use this to do some physics.
- Auger electrons - I will definitely need help to include this; my physics is too rusty.