

The EFT Signal Model

Shaun Alsum

Recoil Energy Spectrum

- Generated by “DMFormFactor” mathematica package
- Generate an analytic energy recoil spectrum for each isotope of Xenon (isotopes = {128, 129, 130, 131, 132, 134, 136}) as well as each of the following masses:
 - masses =
{7,10,12,14,17,21,33,50,100,400,1000,4000}
- Weight the analytic spectra by their isotopic abundance and sum them together for each mass. This leaves one spectrum for each mass

Recoil Energy Spectrum

- These analytic spectra are insanely complicated and difficult (as well as unnecessary) to port to the limits code, so we bin it.
 - Spectrum is integrated (numerically) out to 350 keV (beyond our max energy range for this analysis) to obtain an energy cutoff.
 - Spectrum is then integrated in 1 keV bins from 0 until the total integrated reaches 99% of the total from 0 to 350 keV. This number is recorded and the integration then proceeds to a factor of 1.2 higher in recoil energy. (This is because the standard deviation in the s1 and s2 distributions for a single energy is typically about 6 or 7%)
 - These bins and the values of the integrals are then stored and written to file.

Recoil Energy Spectrum

- Example text output (one for each coupling)

```
o1s - Notepad
File Edit Format View Help
WIMPMass 7 maxEnergy 3
0 1 2 3 4
2.77994e3 5.63409e2 8.50473e1 8.25877e
WIMPMass 10 maxEnergy 5
0 1 2 3 4 5 6
2.57945e3 1.18577e3 4.99072e2 1.95134e2 7.06158e1 2.30975e1
WIMPMass 12 maxEnergy 7
0 1 2 3 4 5 6 7 8 9
2.34595e3 1.35115e3 7.39497e2 3.88471e2 1.96587e2 9.57703e1 4.46764e1 1.97263e1 8.06778e
WIMPMass 14 maxEnergy 9
0 1 2 3 4 5 6 7 8 9 10 11
2.12188e3 1.39444e3 8.8738e2 5.501e2 3.33303e2 1.97657e2 1.14734e2 6.51023e1 3.60004e1 1.93e1 9.94775e
WIMPMass 17 maxEnergy 12
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1.83475e3 1.35257e3 9.79428e2 6.98549e2 4.91687e2 3.41988e2 2.35219e2 1.60041e2 1.07722e2 7.17055e1 4.71713e1 3.06326e1 1.9604e1
WIMPMass 21 maxEnergy 16
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
1.54005e3 1.23252e3 9.77134e2 7.68236e2 5.99503e2 4.64671e2 3.57932e2 2.74108e2 2.08744e2 1.58106e2 1.19115e2 8.92629e1 6.65329e1
WIMPMass 33 maxEnergy 29
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
1.02285e3 8.98489e2 7.87238e2 6.88109e2 6.00099e2 5.2222e2 4.53518e2 3.93082e2 3.4006e2 2.9366e2 2.53149e2 2.17859e2 1.87184e2 :
```

Mass

Maximum energy to use in analysis

Bin Edges

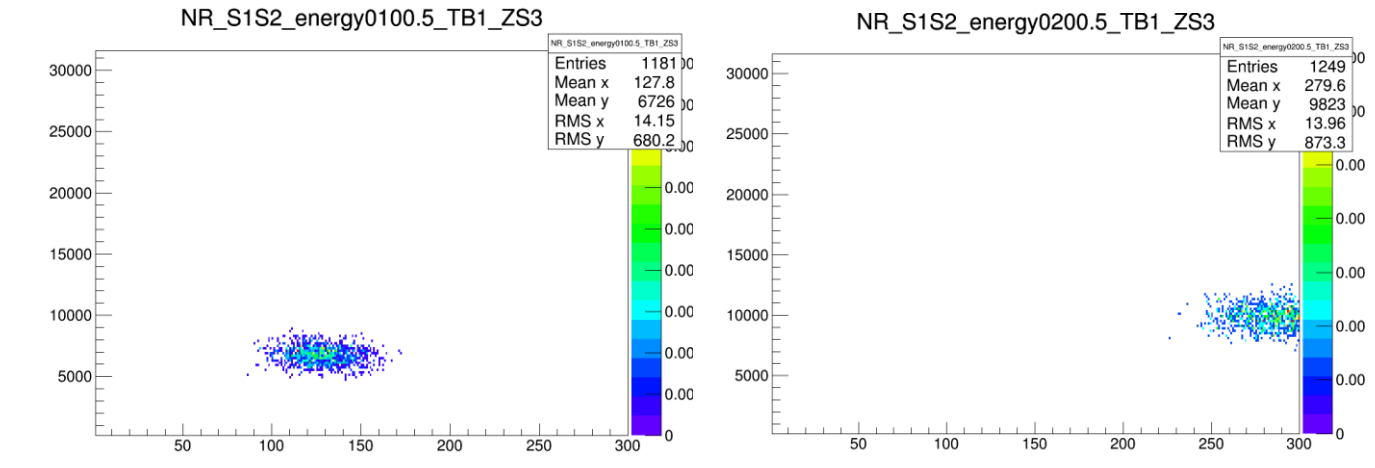
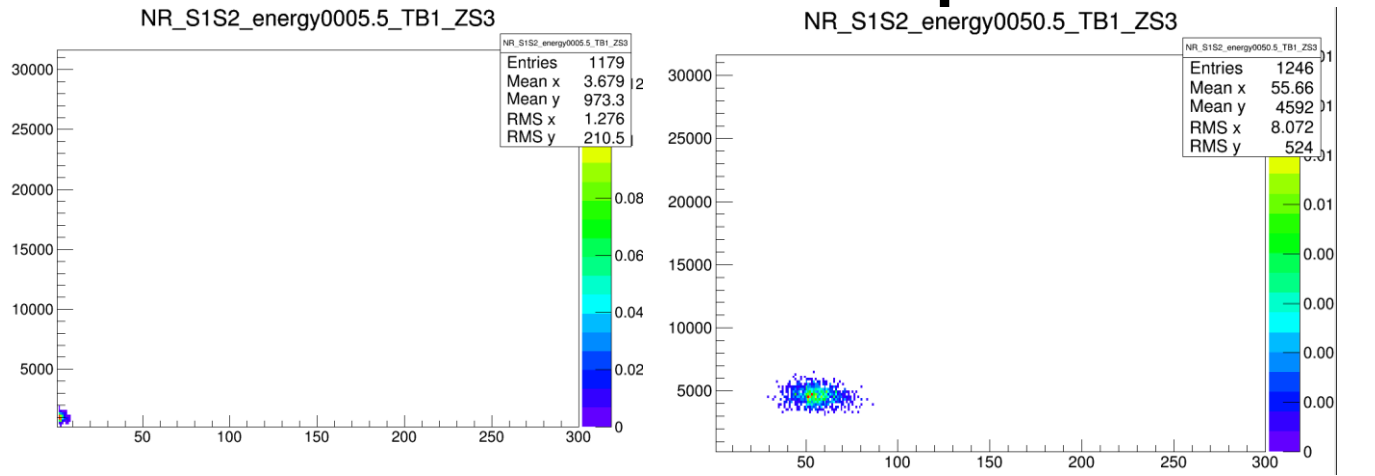
Counts per bin

Nuclear Recoil Templates

- Locations are generated randomly (uniformly) in real space.
- Locations are mapped to S2 space using JPM (electric field at the point simultaneously obtained).
- Fiducial cut applied, event is re-generated if the location does not pass.
- NEST is used to generate an s1c and s2c for the event.
- Events are sorted into z-slices based on drift time
- Events generated until each z-slice has at least 10,000 events
- This is done for each energy 0.5 keV to 350 keV in 1 keV increments for each time bin

- NR_S1S2_energy0004.5_TB1_ZS3
- NR_S1S2_energy0005.5_TB1_ZS3
- NR_S1S2_energy0006.5_TB1_ZS3
- NR_S1S2_energy0007.5_TB1_ZS3
- NR_S1S2_energy0008.5_TB1_ZS3
- NR_S1S2_energy0009.5_TB1_ZS3
- NR_S1S2_energy0010.5_TB1_ZS3
- NR_S1S2_energy0011.5_TB1_ZS3
- NR_S1S2_energy0012.5_TB1_ZS3
- NR_S1S2_energy0013.5_TB1_ZS3
- NR_S1S2_energy0014.5_TB1_ZS3
- NR_S1S2_energy0015.5_TB1_ZS3
- NR_S1S2_energy0016.5_TB1_ZS3
- NR_S1S2_energy0017.5_TB1_ZS3
- NR_S1S2_energy0018.5_TB1_ZS3
- NR_S1S2_energy0019.5_TB1_ZS3
- NR_S1S2_energy0020.5_TB1_ZS3
- NR_S1S2_energy0021.5_TB1_ZS3
- NR_S1S2_energy0022.5_TB1_ZS3
- NR_S1S2_energy0023.5_TB1_ZS3
- NR_S1S2_energy0024.5_TB1_ZS3
- NR_S1S2_energy0025.5_TB1_ZS3
- NR_S1S2_energy0026.5_TB1_ZS3
- NR_S1S2_energy0027.5_TB1_ZS3
- NR_S1S2_energy0028.5_TB1_ZS3
- NR_S1S2_energy0029.5_TB1_ZS3
- NR_S1S2_energy0030.5_TB1_ZS3
- NR_S1S2_energy0031.5_TB1_ZS3
- NR_S1S2_energy0032.5_TB1_ZS3
- NR_S1S2_energy0033.5_TB1_ZS3

Nuclear Recoil Templates



Nuclear Recoil Models

- Take the Templates and weight each energy and each time bin and z-slice and weight them by the appropriate number from the Recoil Energy Spectrum and add them together.
- Cut the S1 and S2 off at the mean values associated with the “maxEnergy” number, but add ones from higher energy to account for bleed-in.