Preliminary fit for CUPID-Mo Background Model

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Data

- Two datasets used: DS 8037, 8038 (same as used for TAUP 2019)
- Channel 3 excluded (noisy)
- Cut used: "Channel != 3 && IsGamma && PSAcut && M1”

Efficiency & Exposure summary stats

- Global efficiency across all detectors, flat starting at 500 keV
  ➙ Fit threshold set at 500 keV
- Efficiencies:
  - BaseCuts: 97.1 ± 0.4 %
  - Rise + decay time (unfiltered pulse-shape): 94.7 ± 0.1 %
  - LY + NormDelay + NormBaseline: 88.3 ± 0.3 %
  - **Total efficiency** of all cuts: **81.1 ± 0.5 %**
- Total mass 3.95 kg; livetime 0.129 yr
  ➙ **Exposure: 0.51 kg·yr**

Monte-Carlo files from Pia

- "Crystals_2n2b_10M" ➔ 2νββ
- “Springs_BiPo" ➔ Only ^{214}Bi+^{214}Po simulated, not the full chain
- "Springs_40K"
- "Springs_208Tl"
- "Kapton_cables_Tl208"
- "Press_fit_Tl208"

Smearing of energy resolution

- Smearing performed using resolution scaling across all detectors:

  TMath::Sqrt([0]**2+[1]*x)

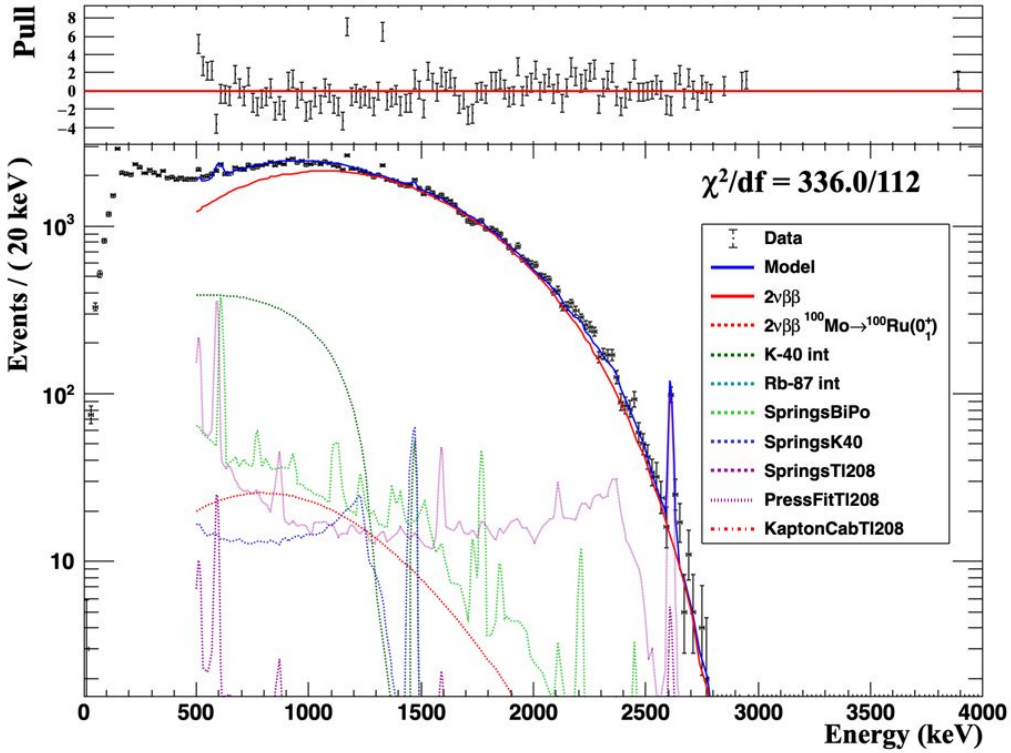
  p0 -1.61851e+00

  p1 1.84754e-02
- Channel-by-channel energy smearing to be implemented in the future

Internal Contamination

- Same MC files as used for Lumineu
- Internal contamination
  - ^{40}K
  - ^{87}Rb
  - $^{90}Y/^{90}Sr$
  - $2\nu\beta\beta$ to excited state.
- Note that these were already smeared using resolution function for Lumineu.
- For preliminary studies it probably won't matter if we take a wide enough binning, for example, 20 keV.
- We will need to use the correct smearing in future.

Preliminary Fit in [500,4000] keV range



- Fit recipe identical to Lumineu analysis (20 keV binning)
- Don't have simulation for ^{60}Co
  ➡ Poor chi-square
- Fit does not converge if I include ^{90}Sr/^{90}Y but we are also missing simulations for lower energies
- $T_{1/2} = (7.101^{+0.033}_{-0.032}) \cdot 10^{18}$ y
  ➡ Close to Lumineu value
- More MC available as of today

```
EDM = 0.000820307
-log(L) at minimum = -497898
final value of floating parameters
  1) RooRealVar::          f2b2nu = 139730 +/- (-654.77,630.343)
  2) RooRealVar::         fK40Int = 19973.5 +/- (-826.297,801.473)
  3) RooRealVar:: fKaptonCabTl208 = 0.0150719 +/- (-0.0150719,1368.64)
  4) RooRealVar::   fPressFitTl208 = 10894.8 +/- (-1414.18,951.308)
  5) RooRealVar::     fSpringsBiPo = 6510.63 +/- (-887.136,915.702)
  6) RooRealVar::      fSpringsK40 = 1787.89 +/- (-946.662,1021.47)
  7) RooRealVar::    fSpringsTl208 = 413.741 +/- (-285.5,554.444)
```

New simulations available as of today

Internal contaminations:

- 2b2n_10M.root ➜ 2νββ ^{100}Mo 0+ ➜ 0+, in one single LMO crystal
- crystal_k40_10M.root ➜ ^{40}K in one single LM crystal
- Crystal_bi210.root ➜ ^{210}Bi in one single LM crystal
- Crystal_pb210.root ➜ ^{210}Pb in one single LM crystal

External (far) contaminations:

- External_Bi214.root ➜ ^{214}Bi in 300K screen
- External_Pb214.root: ➜ ^{214}Pb in 300K screen
- External_Tl208.root ➜ ^{208}Tl in 300K screen
- External_Pb212.root ➜ ^{212}Pb in 300K screen

New simulations available as of today

External (close) contaminations:

- Springs_208Tl.root ➜ ^{208}Tl in springs
- Springs_40K.root ➜ ^{40}K in springs
- Springs_BiPo.root ➜ ^{214}Bi-^{214}Po in springs
- Kapton_conn_cable_tl208.root
  ➜ ^{208}Tl in kapton connectors on EW detectors; kapton cables on 3 support columns
- Kapton_conn_cable_bi212.root
  ➜ ^{212}Bi-^{212}Po in kapton connectors on EW detectors; kapton cables on 3 support columns
- Kapton_conn_cable_bi214.root
  ➜ ^{214}Bi in kapton connectors on EW detectors; kapton cables on 3 support columns
- Brass_screws_tl208.root
  ➜ ^{208}Tl in brass screws on columns supporting the bolometer-plates
- Brass_screws_bi212.root
  ➜ ^{212}Bi-^{212}Po in brass screws on columns supporting the bolometer-plates

Missing Background components

- ^{60}Co
- ^{137}Cs
- Generate the entire U/Th chain instead of generating individual background components and adding them together later on (assuming secular equilibrium)?
  ➜ Delayed coincidence analysis might help understanding if we need full chains
- We prefer to first focus on getting the fit right in [500,4000] keV range, unless we are confident that we understand efficiency below 500 keV.

Plans for near future (after Christmas)

- Switch to BAT (or STAN)
  ➜ Internally use Markov Chain, thus automatically provides non-approximated parameter correlations
  ➜ Machinery at a good stage, will take a few weeks to further test and debug
- Use new simulations
- Run missing simulations
- Use all available statistics
- Fix energy resolution smearing
- Implement efficiency curve on MC
- Split spectra by tower or by channel
- Include fit of α spectrum?