A test for Lorentz and CPT invariance from the double-beta decay energy spectrum

Work in progress...

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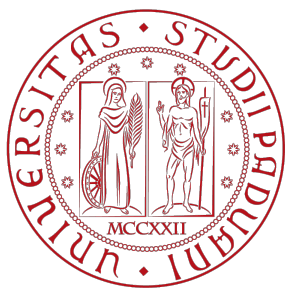


Beyond the Standard Model

- The Spontaneous Symmetry Breaking (SSB) of the Lorentz symmetry can be accomodated by many candidate theories of quantum gravity (e.g. string theory). The general framework to study this kind of phenomena is the Standard Model Extension (SME).
- Direct studies of physics at the Planck scale are currently impossible, however we can look for suppressed signals at the energy scales we can access today.
- This kind of SSB can be tested in neutrino experiments involving:
  - oscillations
  - time-of-flight measurements
  - neutrino's phase space properties $\rightarrow$ decays

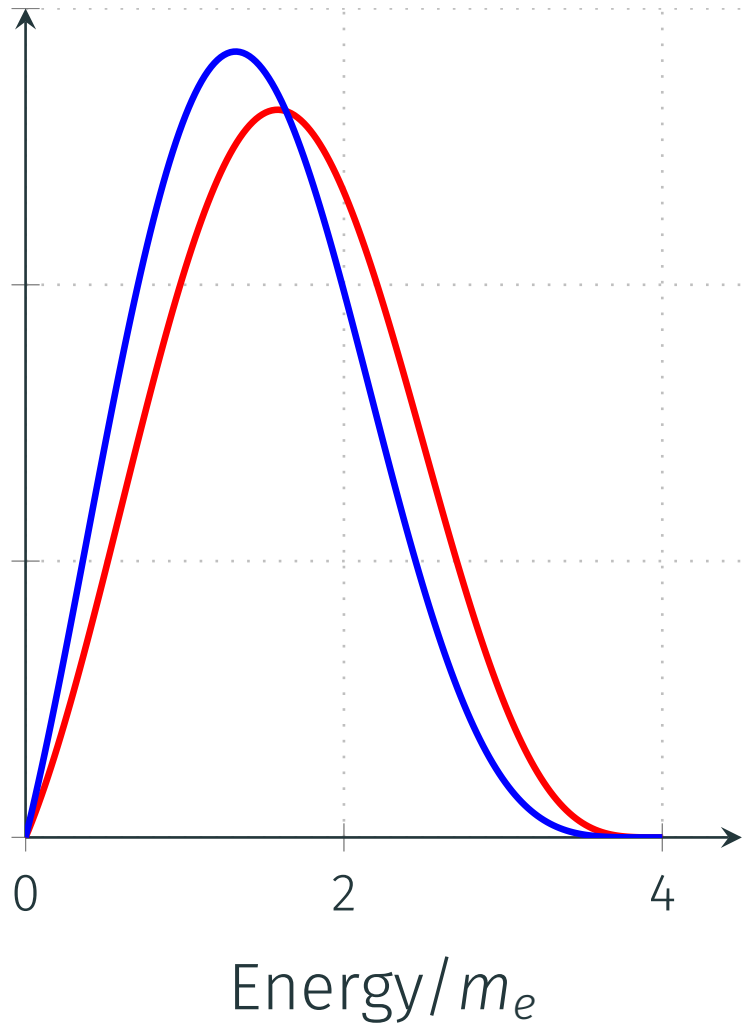
The energy spectrum of $2\nu\beta\beta$

Standard Model $2\nu\beta\beta$

$$\frac{d\Gamma}{dK} = C(K^5 + 10K^4 + 40K^3 + 60K^2 + 30)(K_0 - K)^5$$

Lorentz Violating $2\nu\beta\beta$

$$\frac{d\Gamma}{dK} = C(K^5 + 10K^4 + 40K^3 + 60K^2 + 30)10\mathring{a}^{(3)}_{\text{of}}(K_0 - K)^4$$

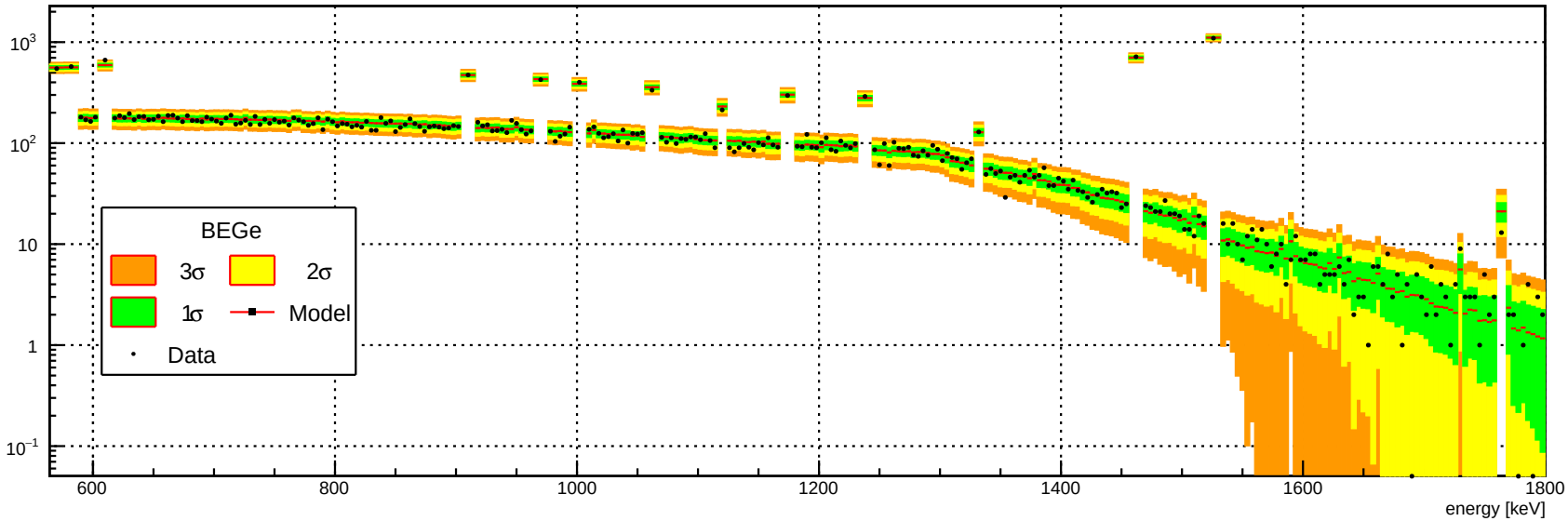


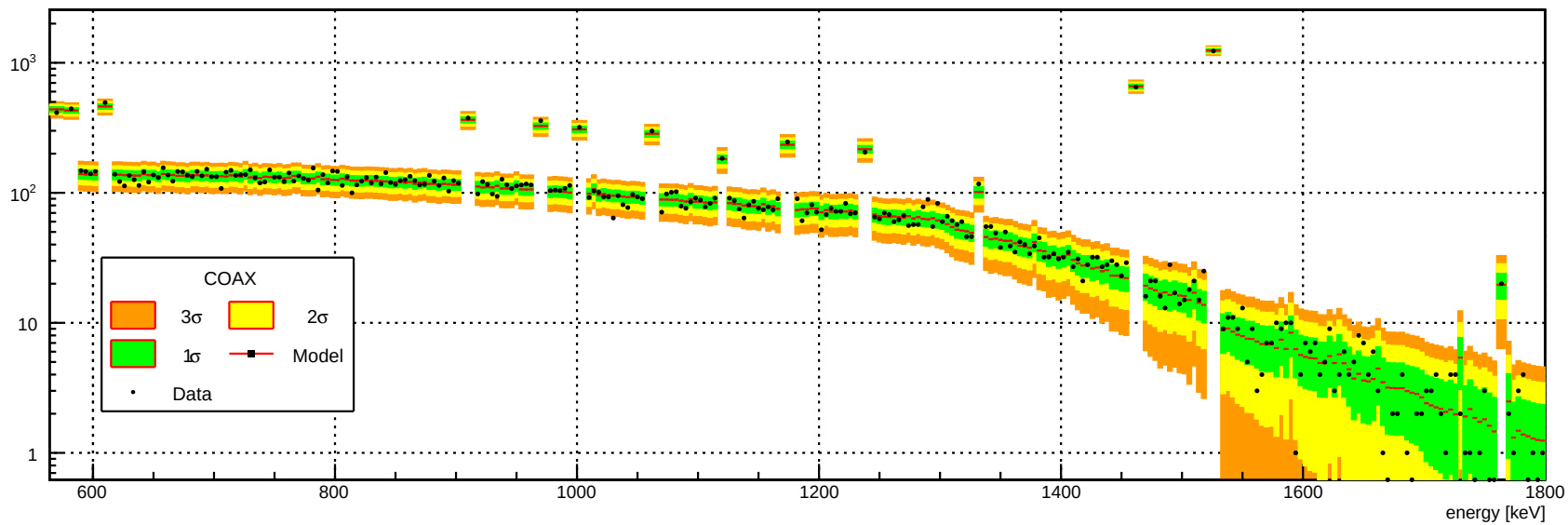
Target

Extract an upper limit for $\mathring{a}_{\text{of}}^{(3)}$ using data from `PhaseII` with a Bayesian Analysis (`BAT` package)

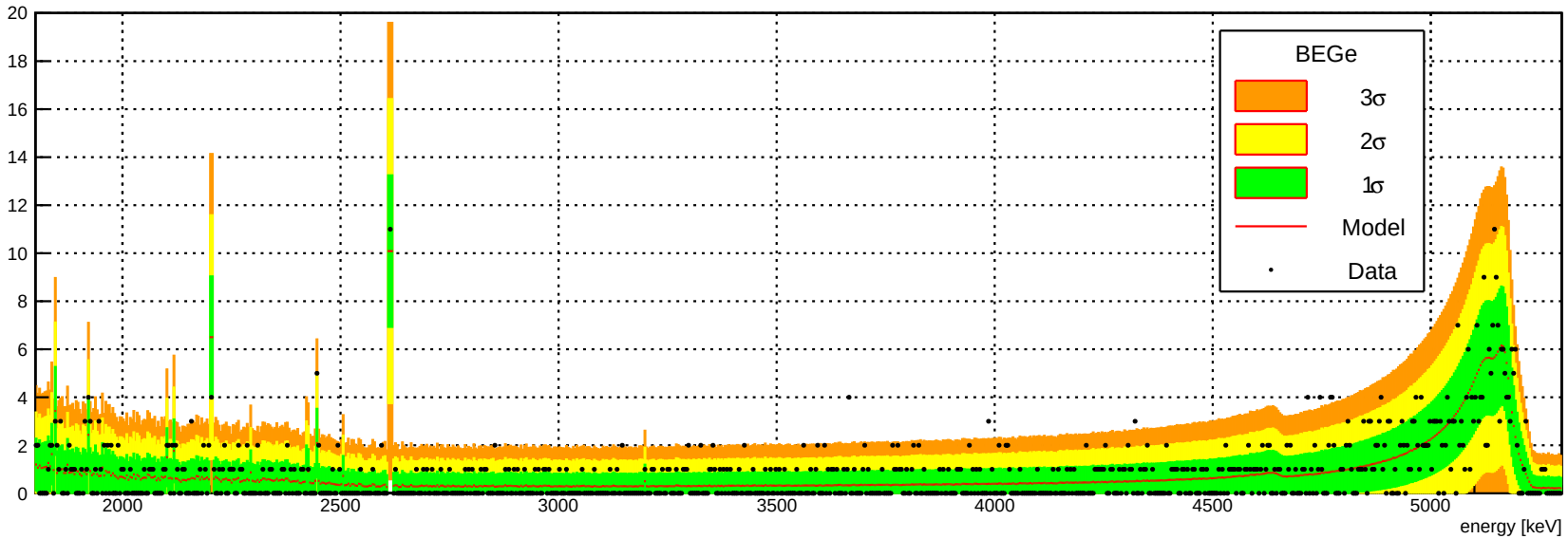
- Data from `tier3` are used (no PSD, no LAr veto).
  Runs `53-74`, excluding `66` and `68`.
- Spectra from `BEGe`s (excluding `GD02D`) and from enriched coaxials are simultaneously fitted
- A variable binning is adopted to take into account the energy resolution: bins (4 keV) containing γ lines are merged into one.
- Background model: Up to now the presence of $^{212}\mathrm{Bi}$, $^{214}\mathrm{Bi}$, $^{208}\mathrm{Tl}$, $^{214}\mathrm{Pb}$, $^{40}\mathrm{K}$, $^{42}\mathrm{K}$, $^{60}\mathrm{Co}$, $^{228}\mathrm{Ac}$ and $^{234}\mathrm{Pa}$ has been tested in different components of the experimental apparatus (work in progress...)

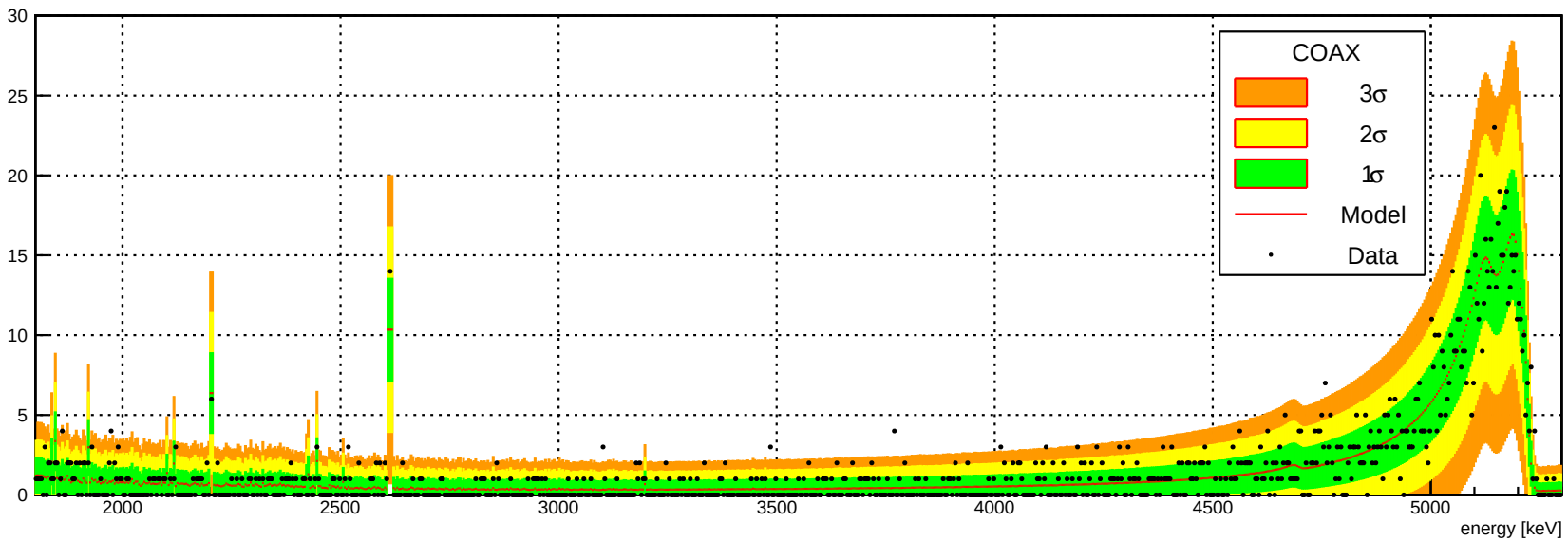
Fit results — [570 keV, 1800 keV]



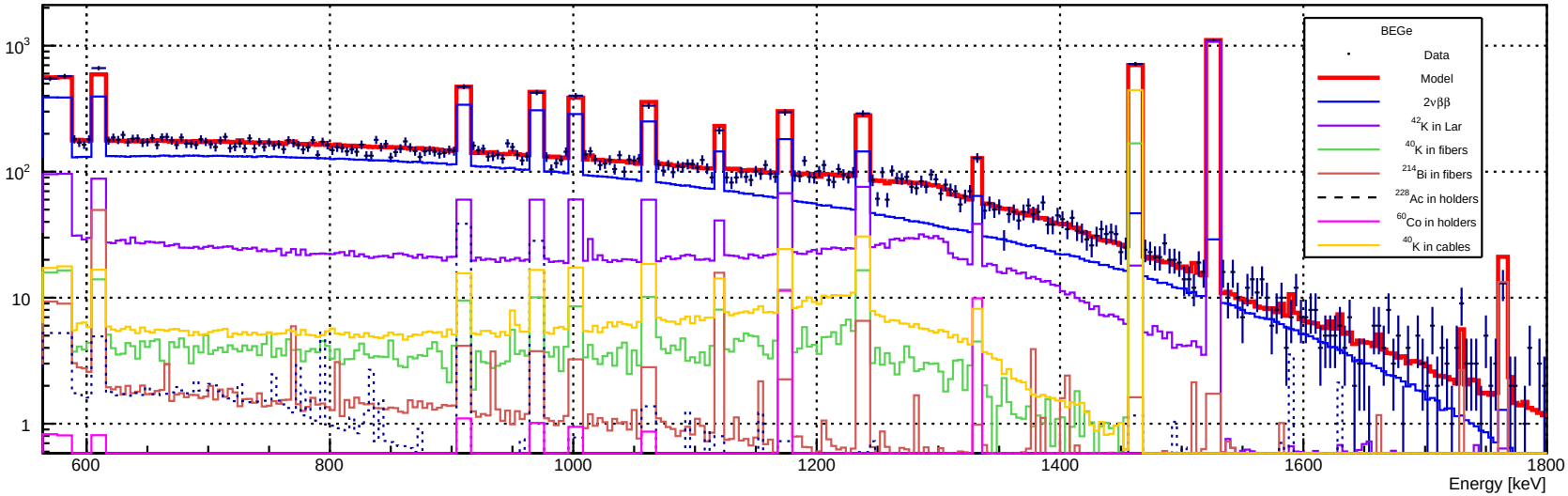


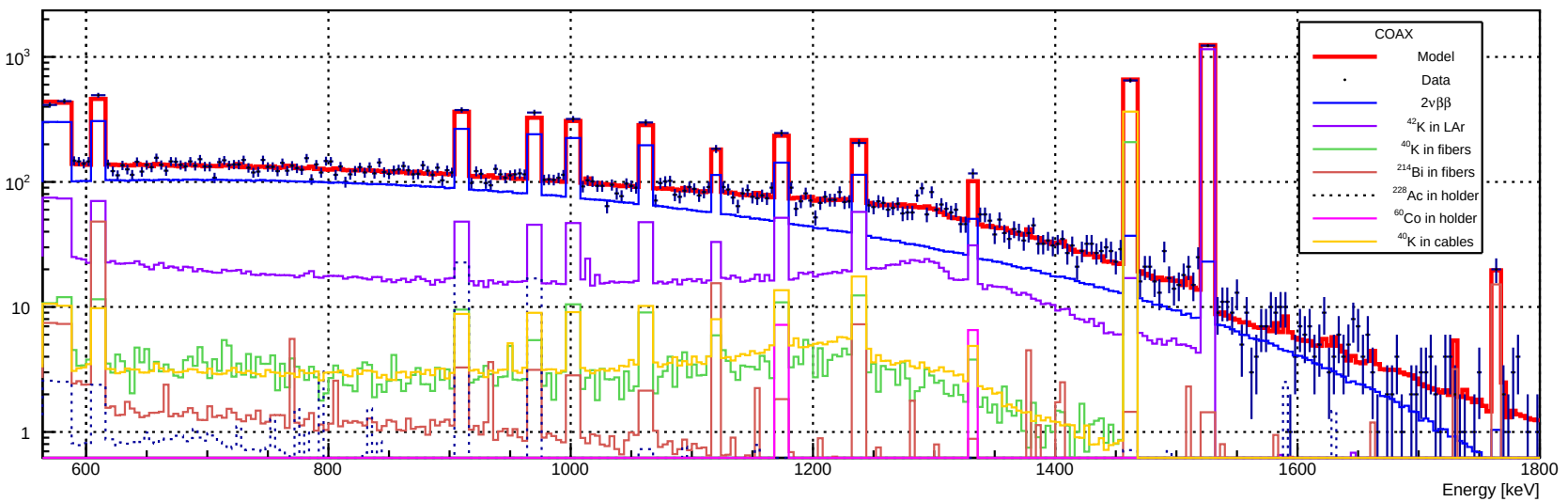
Fit results — [1800 keV, 5300 keV]



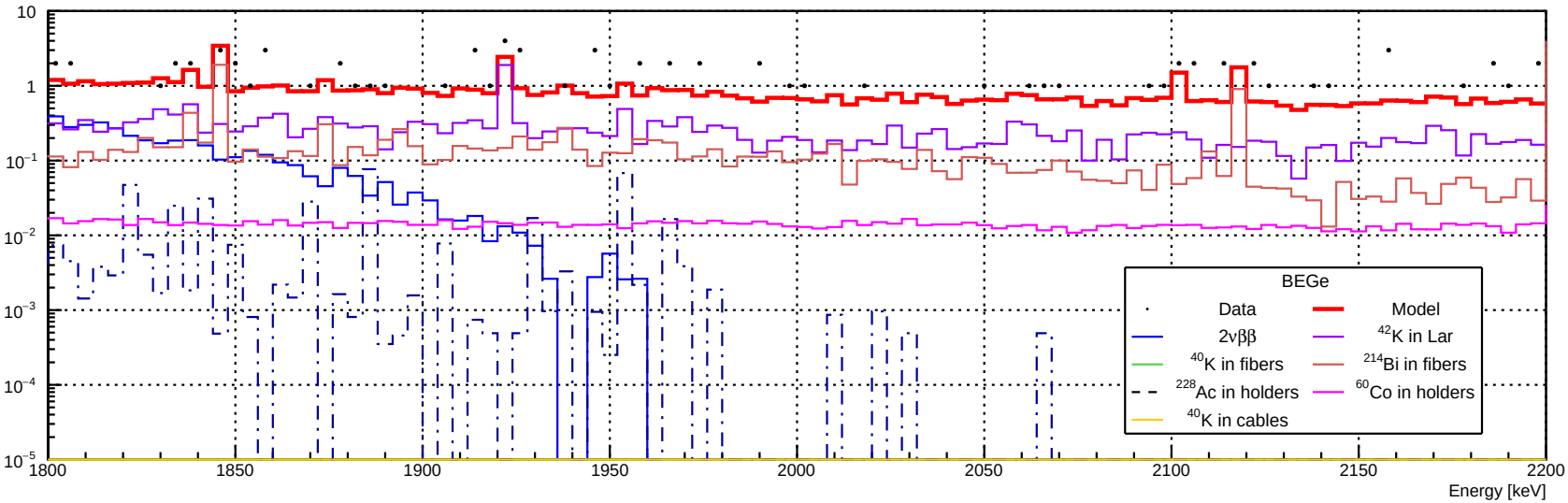


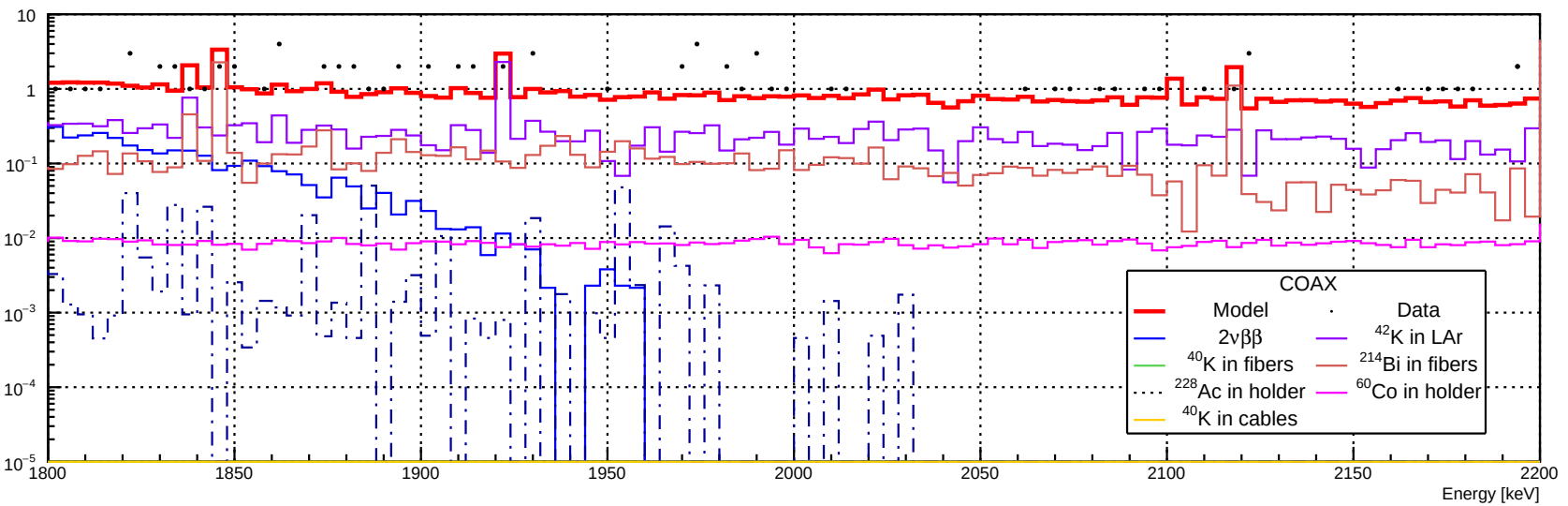
Background sources — [570 keV, 1800 keV]



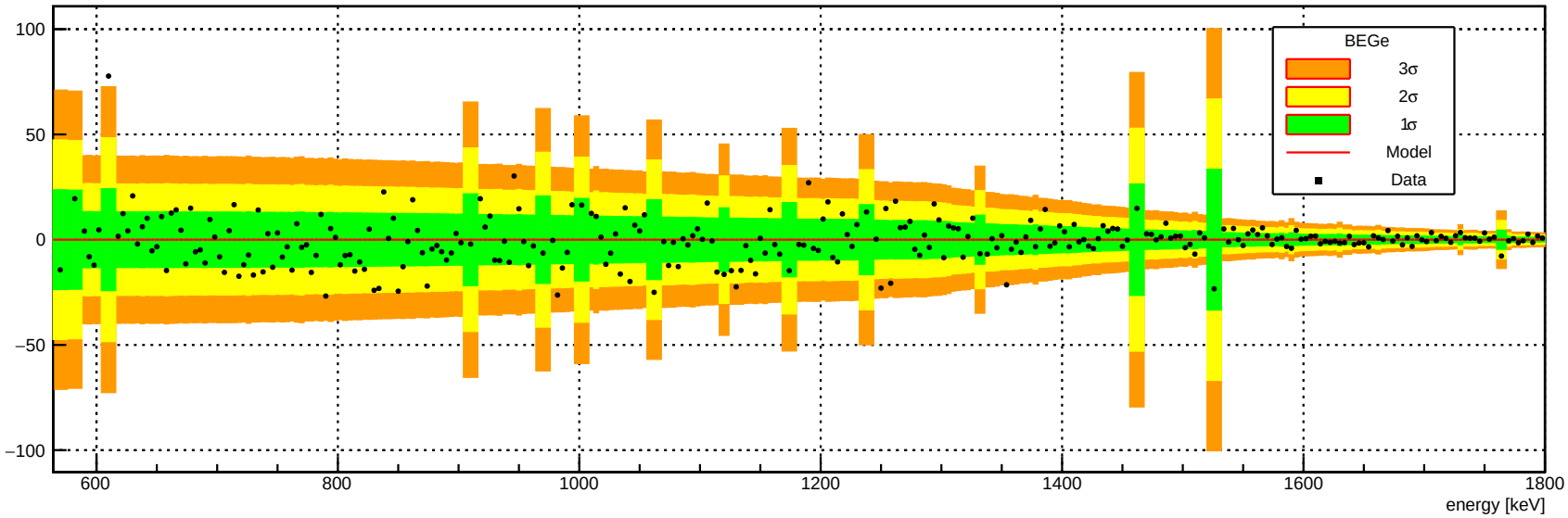


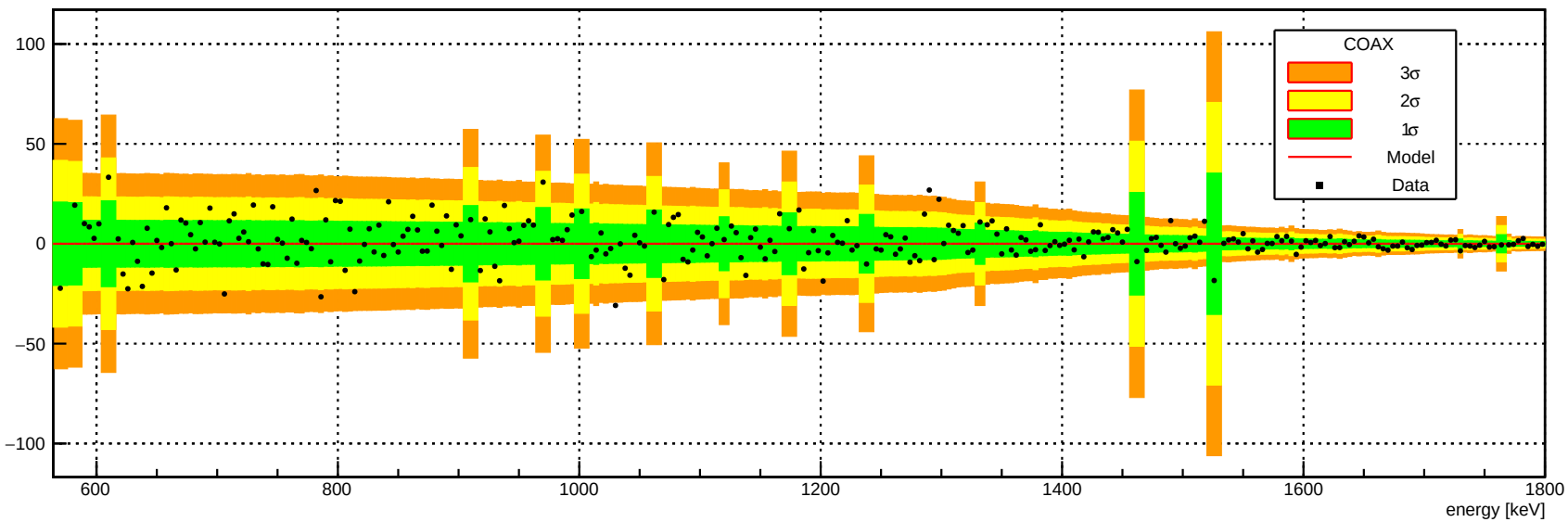
Background sources — [1800 keV, 2200 keV]



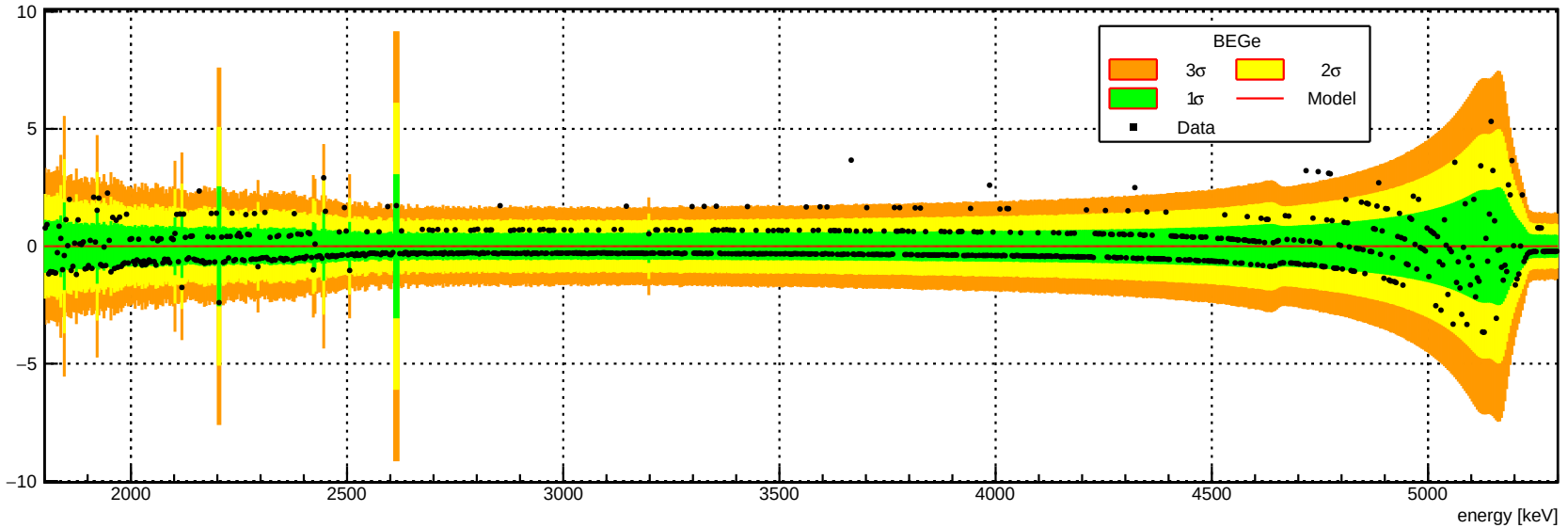


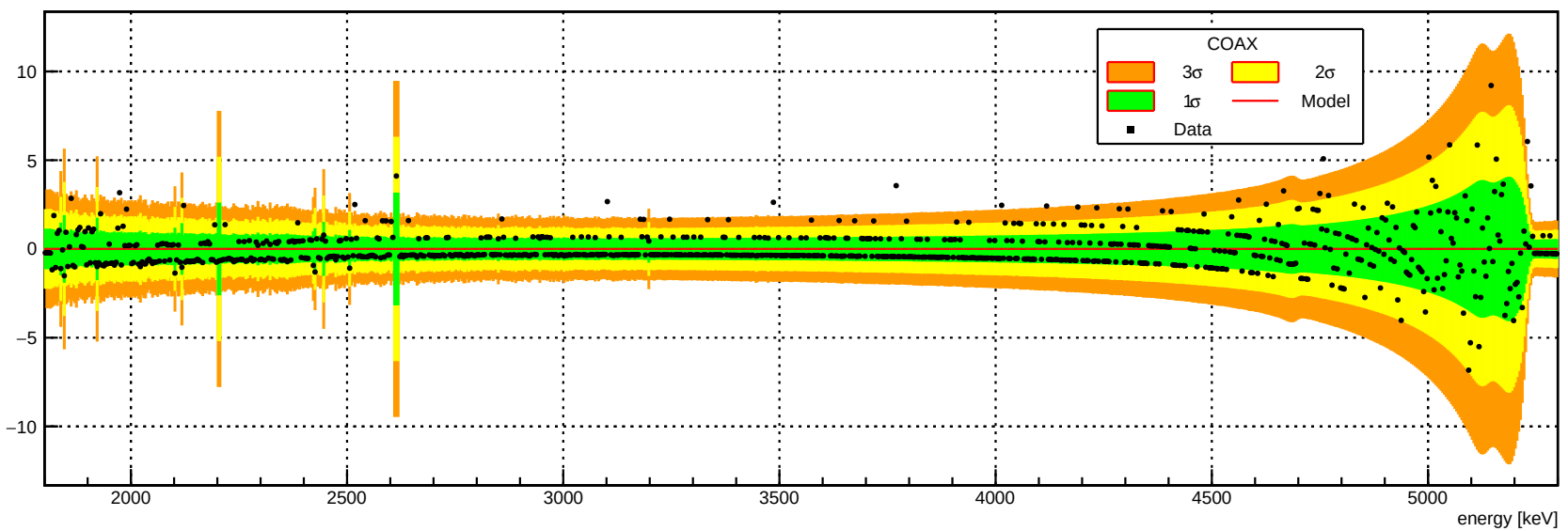
Residuals — [570 keV, 1800 keV]





Residuals — [1800 keV, 5300 keV]





Results (preliminar!)

- p-value: ~ 0.3

Some parameters:

- $2\nu\beta\beta$ half-life: $1.90 \cdot 10^{21}$ yr
- $^{42}\mathrm{K}$ in LAr: $1.7 \cdot 10^{-4}$ Bq/kg
- $^{40}\mathrm{K}$ in fibers: 0.33 Bq/kg
- $^{228}\mathrm{Ac}$ in holders: $3.1 \cdot 10^{-4}$ Bq/kg

Coming soon:

- The fit was performed assuming flat priors for all parameters, but existing knowledge on activities can be used to constraint the analysis...
- Include data from runs > **74**
- Add the Lorentz violating component