Analysis of High Energy Events in XENON1T

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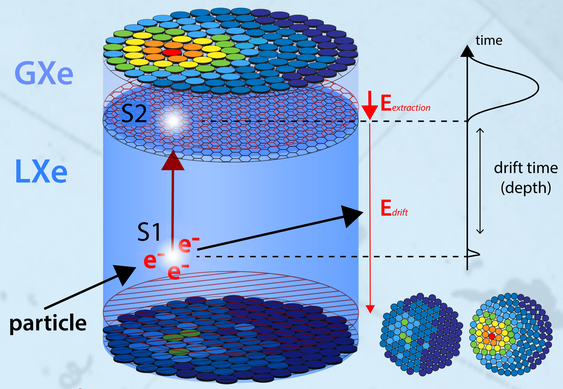
The XENON1T Experiment

- Dual-phase xenon Time Projection Chamber + PMT arrays:
  - i) Light (S1) and charge (S2) signals
  - ii) 3D position reconstruction
  - iii) Electronic/Nuclear recoil discrimination
- Leading results on the WIMP-nucleus interaction cross section ➜ Energy range [1, 12] keV_{ee}
- First observation of ^{124}Xe two neutrino double electron capture ➜ X-ray energy ~64 keV

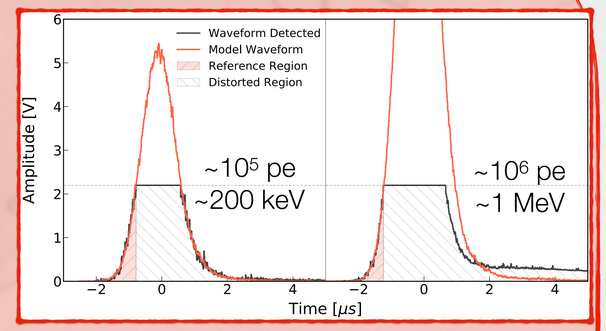
Eur. Phys. J. C (2017) 77: 881

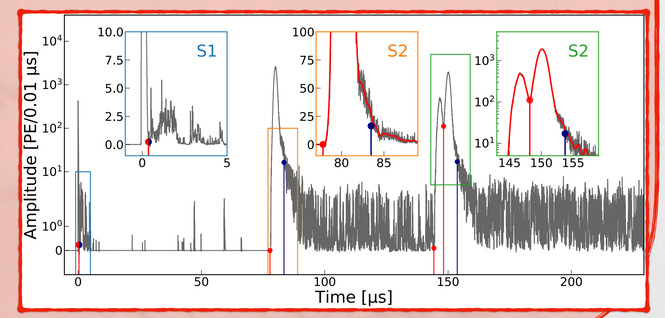


Phys. Rev. Lett. 121, 111302 (2018)
Nature 568, 532–535 (2019)

Signal Corrections

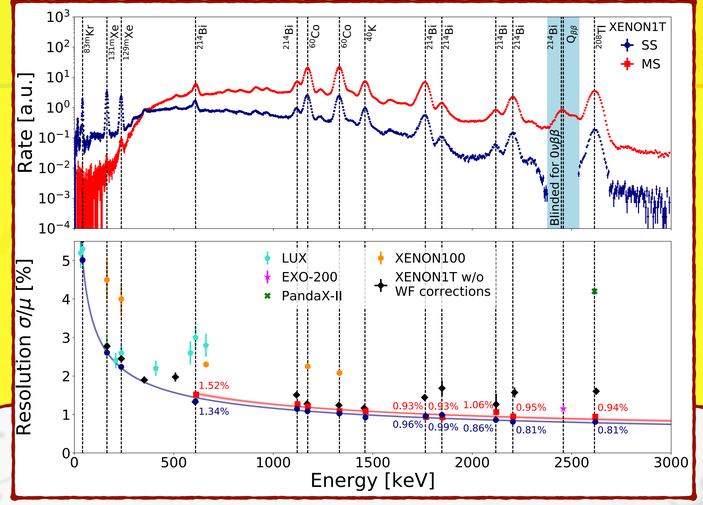
- High energies = $\mathcal{O}$(MeV)
- **Saturation correction**
  - i) For ADC saturation at 2.25 V
  - ii) On S2 signals
- **Clustering**
  - iii) To reject signals not caused by a particle interaction
  - iv) To reject/select multi-site interactions





Resolution

$\sigma/E = (0.79 \pm 0.02)\%$ at $Q_{\beta\beta}$



XENON collaboration (E. Aprile et al.), "*Energy resolution and linearity in the keV to MeV range measured in XENON1T*". arXiv: 2003.03825, submitted to EPJC

Neutrinoless Double Beta Decay

- Neutrino: Dirac or Majorana? Mass ordering?
- $^{136}Xe \rightarrow {}^{136}Ba + 2e^-$ (for two-neutrino $+2\overline{\nu}_e$)
- $Q_{\beta\beta}$ = (2457.83 ± 0.37) keV

Phys. Rev. Lett. 98, 053003 (2007)

- **Dual-phase TPC suitable for $0\nu\beta\beta$?**

$$S^{0\nu} = \frac{\ln(2)}{1.6\ @\ 90\%\ CL} \cdot \frac{\alpha}{n_\sigma} \cdot \epsilon \cdot A \sqrt{\frac{M \cdot t}{\Delta E \cdot b}}$$

Isotopic abundance; FV mass; Livetime; Background rate; Detection efficiency; Atomic mass; Resolution @ $Q_{\beta\beta}$

I. Large mass
II. High detection efficiency
III. Low background
IV. Good energy resolution

Energy Calibration

- Electron-ion recombination in liquid xenon ➜ **Anticorrelation between S1 and S2**

$$E = \left(\frac{S1}{g_1} + \frac{S2}{g_2}\right) \cdot W$$

Average energy required to produce a quantum = 13.7 eV

- Monoenergetic gamma lines used for calibration
- Light yield (LY) and charge yield (QY) ➜ photon detection efficiency (g_1) and charge amplification gain (g_2)