Neutrinoless Double Beta Decay: Beyond the "Tonne-Scale"
Panel 3: “Experiments Beyond the Tonne-Scale: Background Challenges”

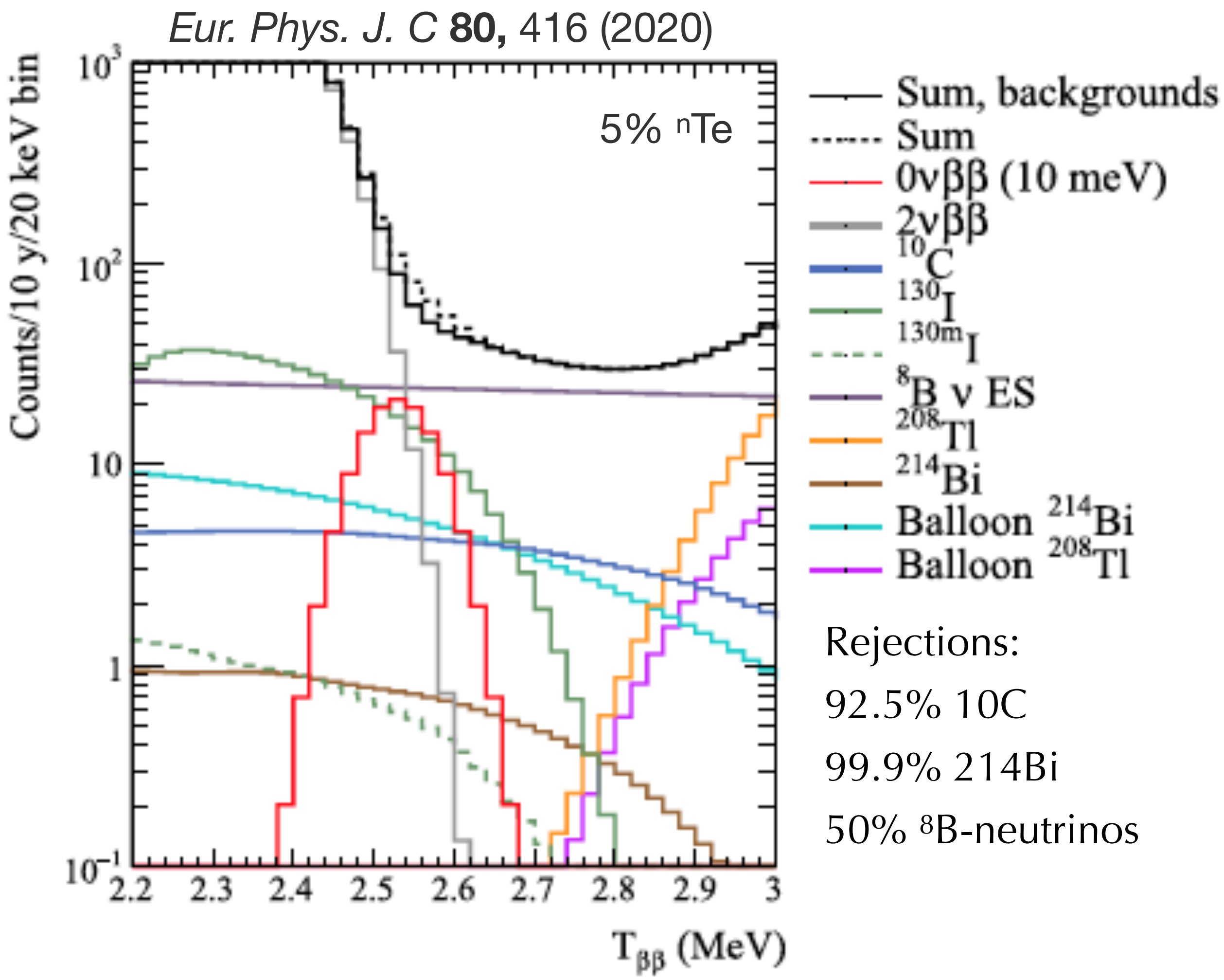
Valentina Lozza

LIP
LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS

Background challenges for future generation experiments (Liquid scintillator focus):

✳ Cosmogenic backgrounds:

- ✳ nuclides produced by n, p and muons.
  - ✳ material and experiment dependent (full spectrum vs single gammas)
  - ✳ large uncertainty in the production cross sections were the inputs for dedicated experimental campaigns (summary in Universe 2020, 6(10), 162, https://doi.org/10.3390/universe6100162)
  - ✳ Mitigation techniques include:
    - ✳ deep underground storage and experiment location
    - ✳ purification of material (if possible UG)
    - ✳ shielding during storage



Rejections:
92.5% 10C
99.9% 214Bi
50% ^{8}B-neutrinos

- ✳ ^{10}C
  - ✳ Unavoidable in liquid scintillator experiments
  - ✳ Mitigation techniques include:
    - ✳ deep underground location to reduce μ flux
    - ✳ rejection techniques based on 3-fold coincidence technique
    - ✳ rejection based on machine learning approach
    - ✳ At worse half-life sacrifice (short $T_{1/2}$)

- **(α,n) and (α,nγ) reactions**
  - in liquid scintillator experiments the contamination from ^{210}Po can be a large source of alpha particles
  - prompt neutron scattering and delay neutron capture are both a potential background source
  - Large uncertainties in reaction cross sections and disagreements among the codes available call for a measurement campaigns and code's review
    - Loi: https://www.snowmass21.org/docs/files/summaries/CF/SNOWMASS21-CF1_CF0-NF5_NF0-RF4_RF0-AF5_AF0-IF9_IF0_Shawn_Westerdale-052.pdf

- **Solar neutrinos:**
  - ^{8}B Solar neutrino's elastic scattering in the target material is potentially the largest background (together with the $2\nu\beta\beta$) in the ROI for large liquid-scintillator based experiments
    - A powerful tool for the rejection of this background is the separation between Cherenkov and scintillation light
    - Technology developments include slow scintillator, water-based scintillator, dichroicons
      - LOIs https://www.snowmass21.org/docs/files/summaries/NF/SNOWMASS21-NF10_NF5_Steve_Biller-015.pdf
      - https://www.snowmass21.org/docs/files/summaries/NF/SNOWMASS21-NF10_NF5-IF2_IF0_dichroicon-066.pdf
  - Background induced by Charge Current interactions on target DBD isotopes
    - Initial evaluation of expected rates are available in the literature: Papers: AIP Conf. Proc. 1894, 020008 (2017); https://doi.org/10.1063/1.5007633, Phys. Rev. C 89, 055501 (2014) https://doi.org/10.1103/PhysRevC.89.055501
    - A background is both the electron emitted in the reaction (from ^{8}B) and the produced nuclide
    - Tagging techniques are challenging due to the long $T_{1/2}$