

# kton-scale Xe TPCs for $0\nu\beta\beta$

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- While ton-scale experiments have significant discovery potential, it is possible that detectors capable of reaching  $10^{30}$  yrs will ultimately be needed to fully cover allowed parameter space
- An exposure of  $\sim 3$  ktonne-yr is needed to observe 10 events if  $T_{1/2} \sim 10^{30}$  yrs

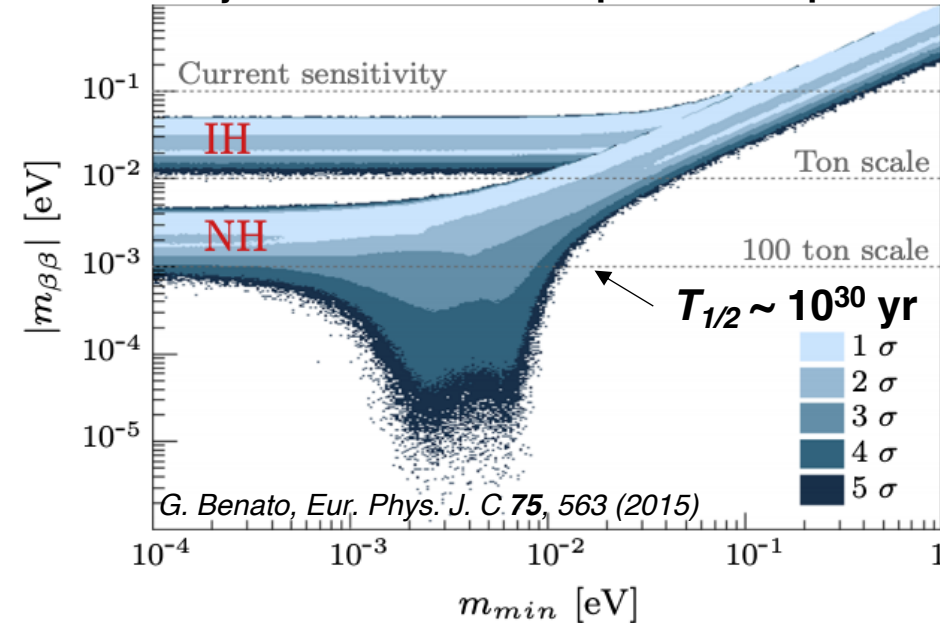
## Primary challenge is to procure $^{136}\text{Xe}$ in required quantities:

- Existing supply chain (steel industry) suitable for  $\sim 5$  ton, but not for 0.1-1 kton
- Direct capture from air (adsorptive techniques) may present alternative path
  - Xe market price  $> 10^5$  times minimum thermodynamic separation cost
  - Direct capture of Xe on small scale for tracking radioisotopes is standard technique
- R&D effort exists, but pace could be accelerated substantially (industrial production of adsorbents, leverage  $\text{CO}_2$  capture developments)
- Could decouple scientific demand from industry, and enable medical technologies for lung imaging and anesthesia

## Xe TPCs present an attractive path to reaching $10^{30}$ yr if Xe could be procured with viable cost:

- Advantages relative to liquid scintillators:
  - Energy resolution  $\lesssim 0.5\%$   $\rightarrow$  avoid  $2\nu\beta\beta$  backgrounds  $\sim \sigma^6$
  - Detector fully consists of  $^{136}\text{Xe}$   $\rightarrow$  avoid solar  $\nu$  backgrounds
  - High purity of Xe (self-shielding) and in situ purification ( $^{222}\text{Rn}$  biggest challenge)

Majorana mass allowed parameter space:



Investments in Xe procurement technologies may provide path to  $10^{30}$  yrs ( $m_{\beta\beta} \sim 1$  meV)!