Keeping up with Xenon demand: Metal Organic Frameworks

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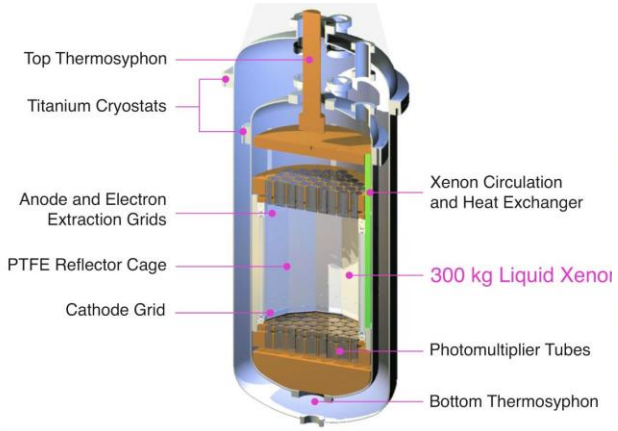
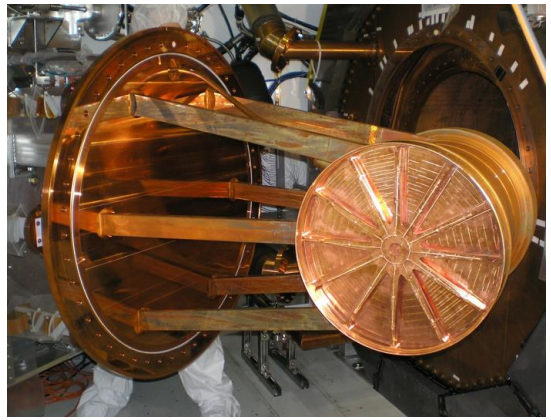
Large Xe experiments over time

LUX (2012-2016)
300 kg



XENON100

2008-2016
30 cm drift TPC
161 kg

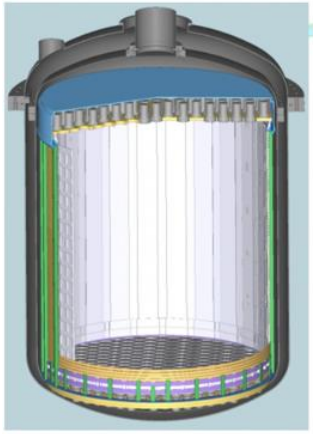


EXO200 (2011-2018)
200kg^{e}/2500kg

XENON1T

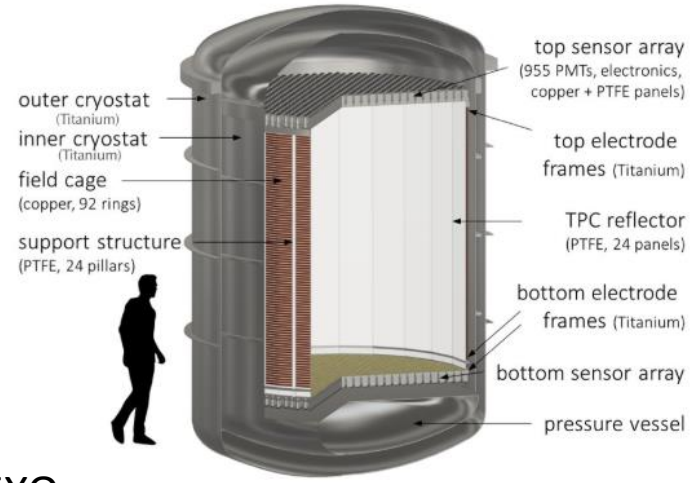
2013-2018
~100 cm drift TPC
3200 kg

XENONnT
(XENON1T Upgrade)

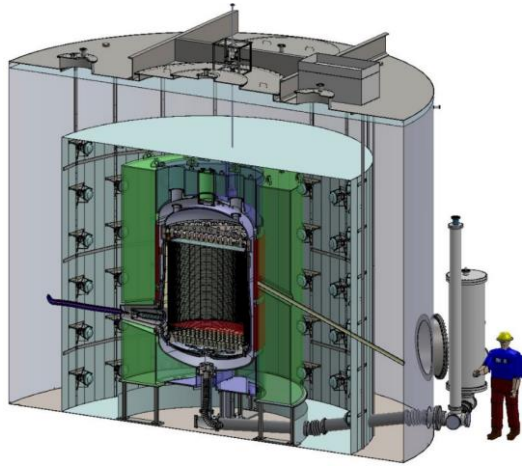


2019-2025
~144 cm drift TPC
~8000 kg

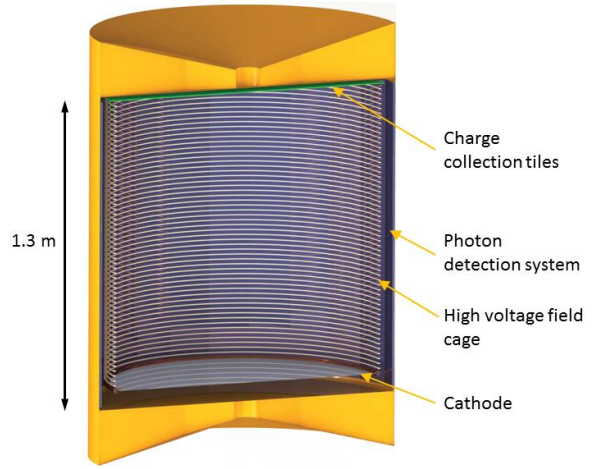
DARWIN (50,000kg)



nEXO
(5000kg^{e}/63,000kg)



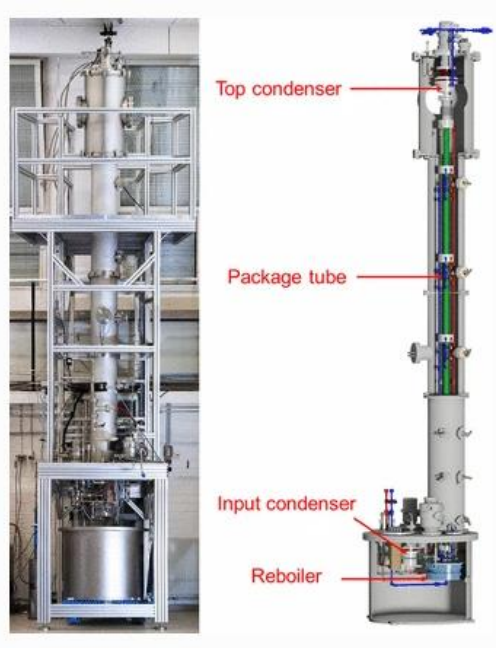
LZ 7300kg



Xe production

- Present: Parasitic process on oxygen/nitrogen production
  - Limited number of facilities bother to further separate Xe in “waste”
    - Tuned to steady-state market demand (medical/industrial)
  - Production rate vs new projects
    - Annual world production ~100,000 kg [1]
    - nEXO/DARWIN buying ~60,000kg each?
- Direct from Air xenon extraction:
  - MOF can target Xe specifically in atmosphere
    - Xe is ~0.1ppm in atmosphere (1 kg Xe in 2e9 liters air)
  - Significant electrical-power for blowers to process 1e11 m3 air
    - cheep/free at National Labs (~MW)
  - Further refining of Xe possible within projects
    - i.e. removing Kr from Xe at sub ppb levels…

Xenon1T distillation column

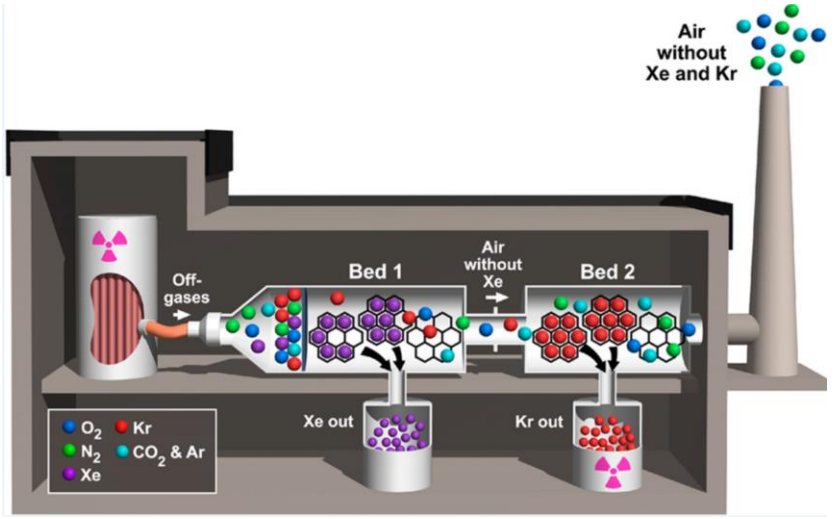


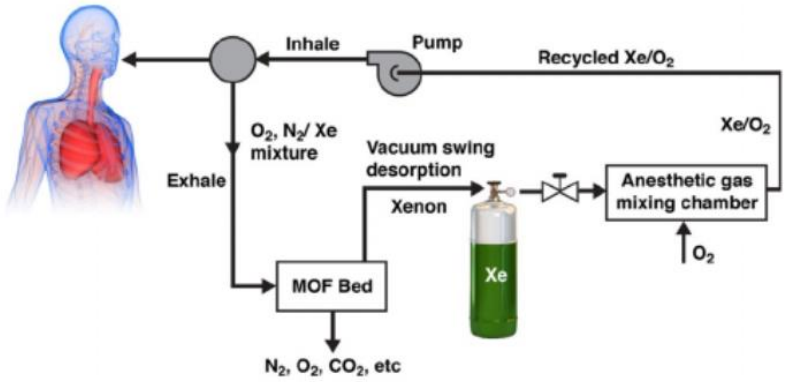
LZ gas chromatography

[1] https://www.prnewswire.com/news-releases/global-xenon-gas-market-volume-to-grow-from-17-2-million-liters-in-2018-to-21-9-million-liters-by-2024--300879848.html

MOF xenon recovery status

- MOF investigations on smaller scales
  - Filter out Xe from nuclear reactors [1]
  - Recover Xe exhaled in anesthesia [2]
  - Reduce costs at production plants [3]
- LOI topic to explore how MOFs could produce ~10T/yr.
- Potential for gas-chromatography for Rn/Xe and Kr/Xe removal.
- Over 20k results searching MOF xenon on google scholar





[1] https://doi.org/10.1038/ncomms11831
[2] https://chemistry-europe.onlinelibrary.wiley.com/doi/abs/10.1002/chem.201702668
[3] https://doi.org/10.1021/jacs.9b03422
[4] https://doi.org/10.1021/ar5003126