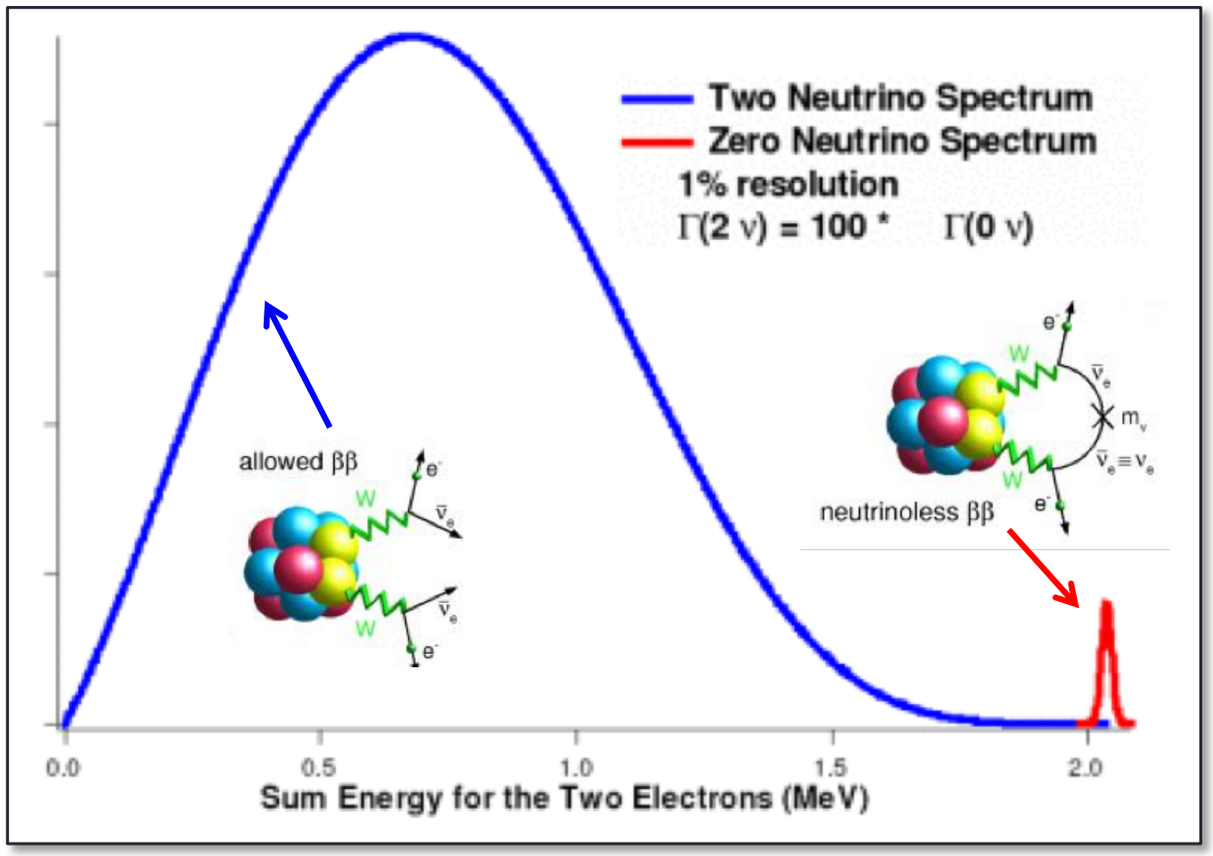
NEXT

Roxanne Guenette
Harvard University

On behalf of the NEXT collaboration

Neutrino Properties mini-Workshops
5 August 2020

Searching for neutrinoless double beta decays



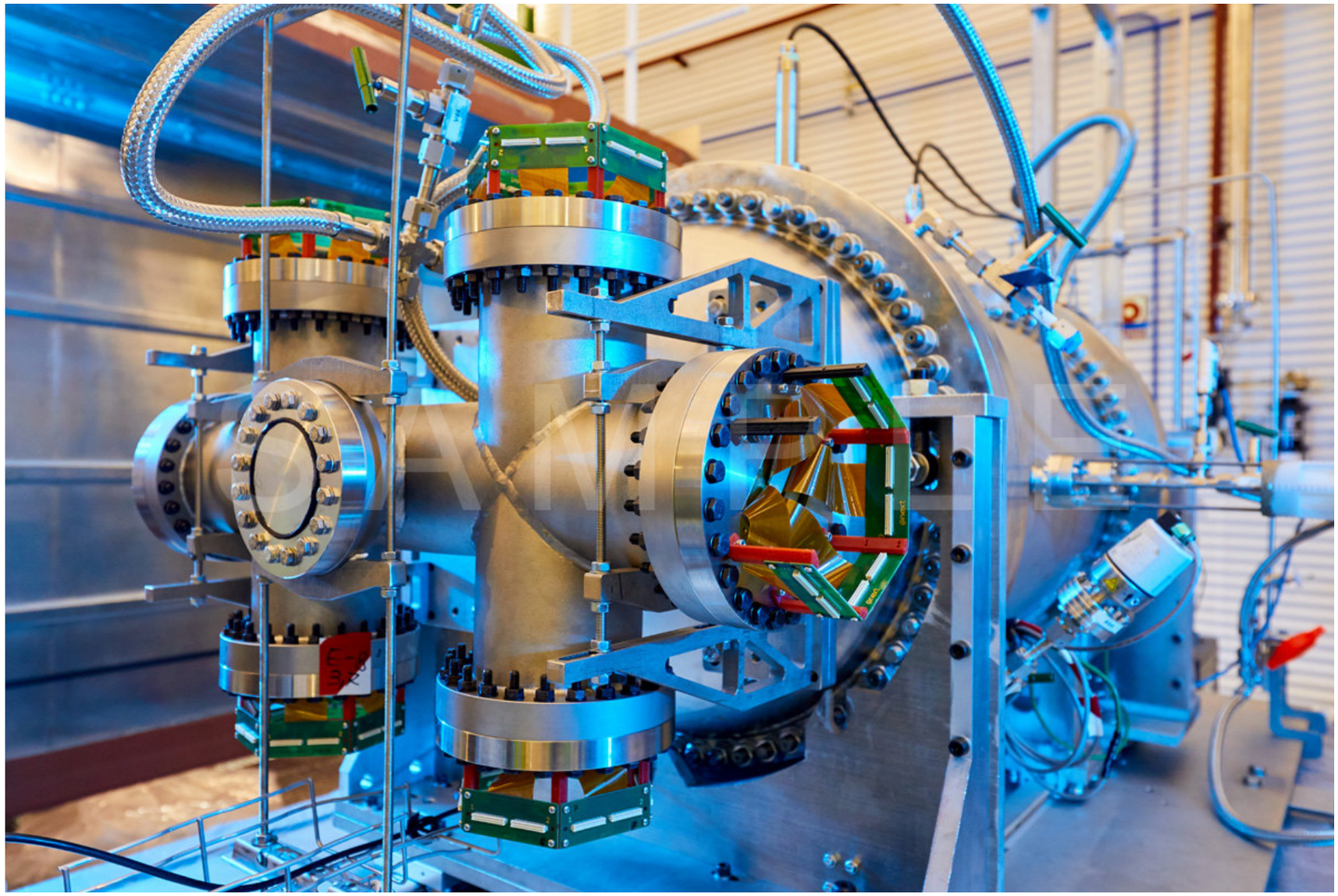
1. **Require great energy resolution**
   (to identify the $0\nu\beta\beta$ over the regular $2\nu\beta\beta$)

2. **Require extremely low background**
   (to see the very rare signal over radioactive events)

3. **Scalability**

NEXT (Neutrino Experiment with Xenon TPC)

High-pressure gas Xenon Time Projection Chamber



NEXT (Neutrino Experiment with Xenon TPC)

High-pressure gas Xenon Time Projection Chamber

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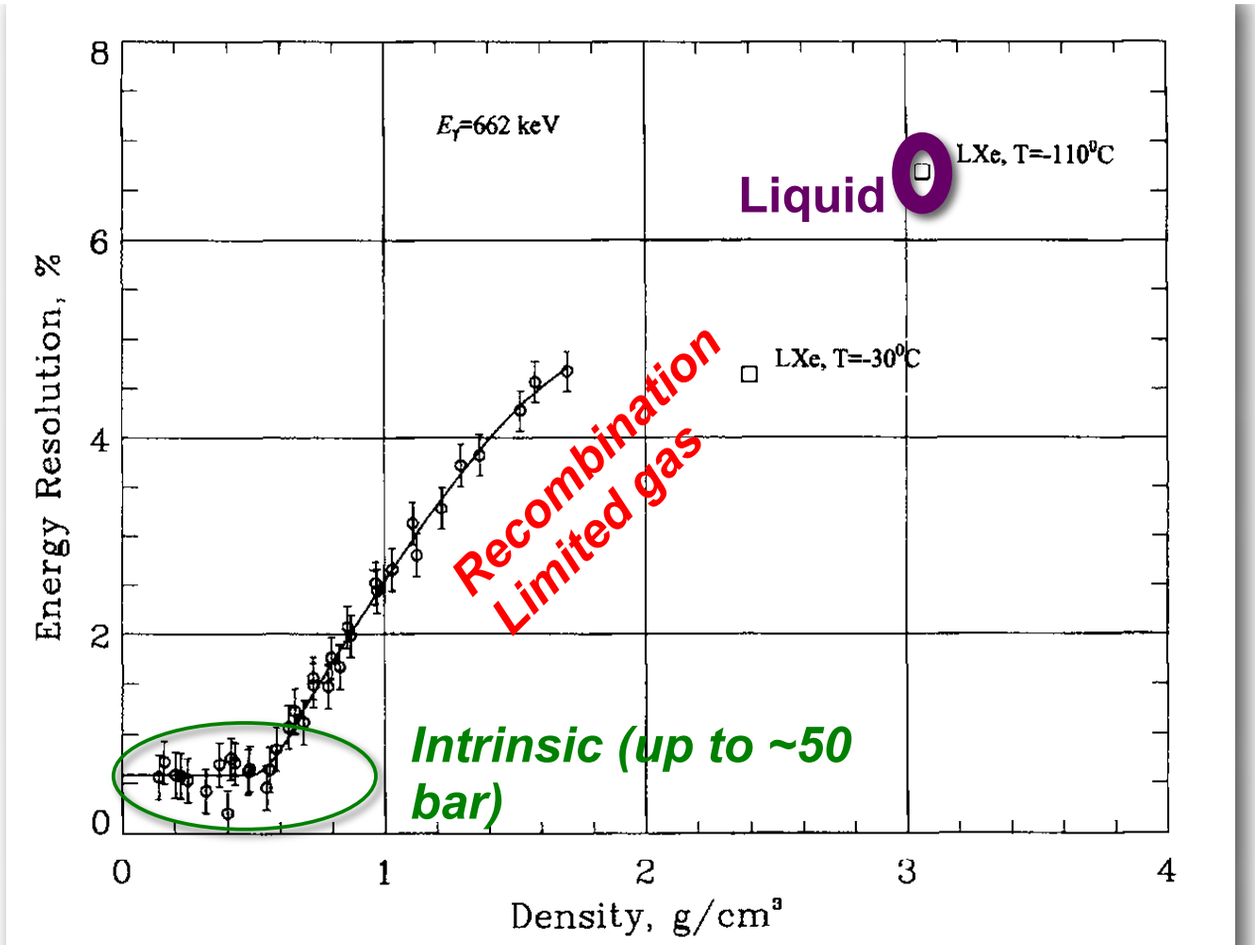
Density: Higher pressure means more isotope in same volume

NEXT (Neutrino Experiment with Xenon TPC)

High-pressure gas Xenon Time Projection Chamber

- **Energy resolution:** Great intrinsic energy resolution in gas
- **Topology**: extended (~MeV) tracks



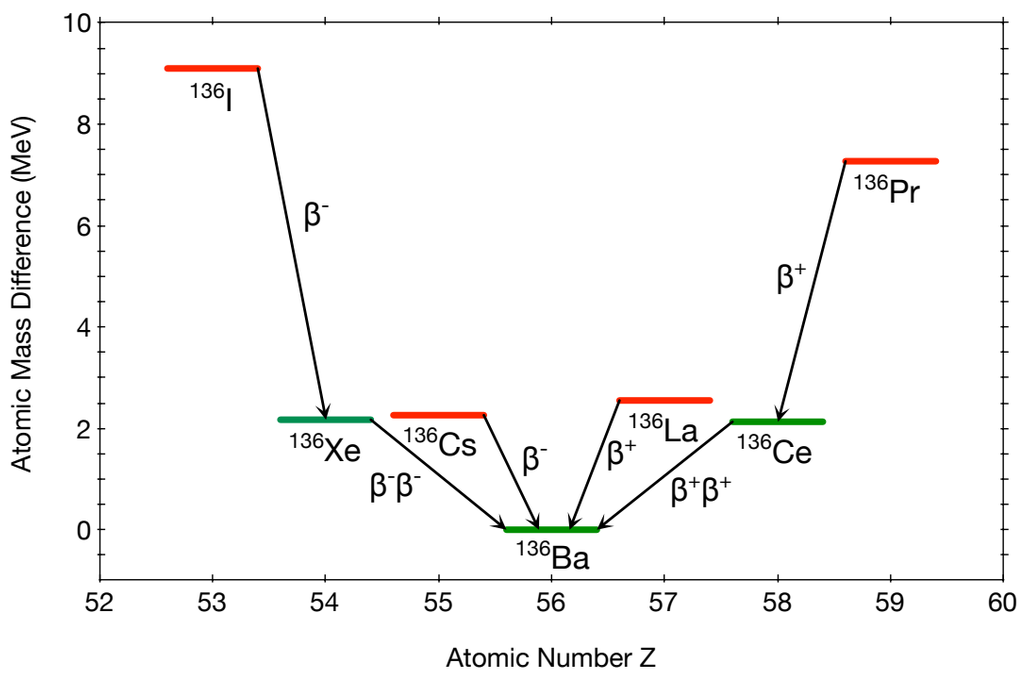
Bolotnikov and Ramsey. "The spectroscopic properties of high-pressure xenon."NIM *A* 396.3 (1997): 360-370

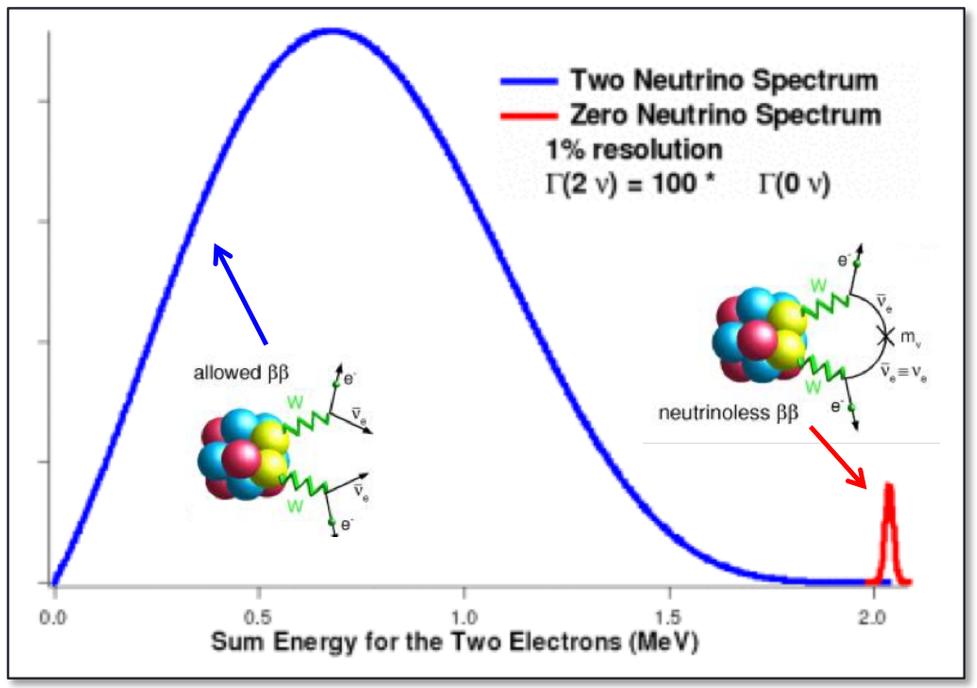
NEXT (Neutrino Experiment with Xenon TPC)

High-pressure gas Xenon Time Projection Chamber

1. **Isotope:** High enough abundance and “easy” to enrich, $Q_{\beta\beta}$ = 2.5 MeV
2. **Noble gas:** Ideally suited to detection technology (TPC)

Source = detector!





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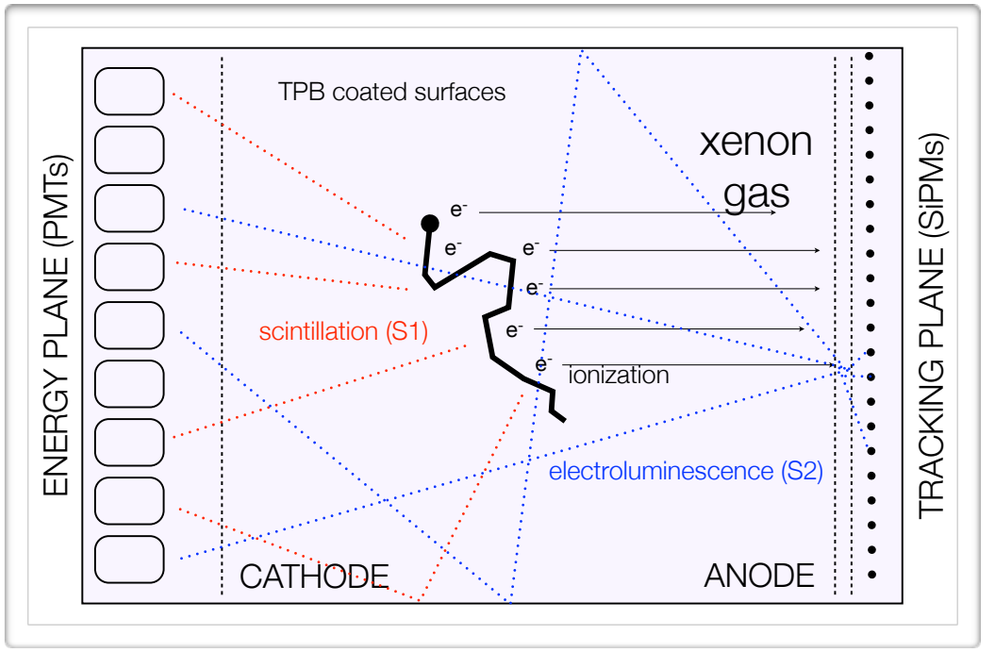
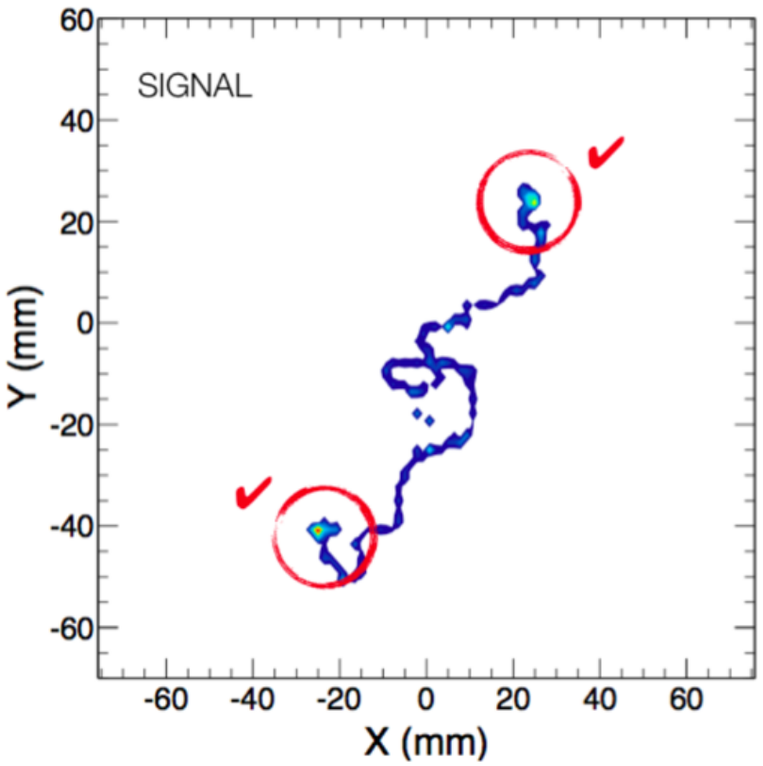
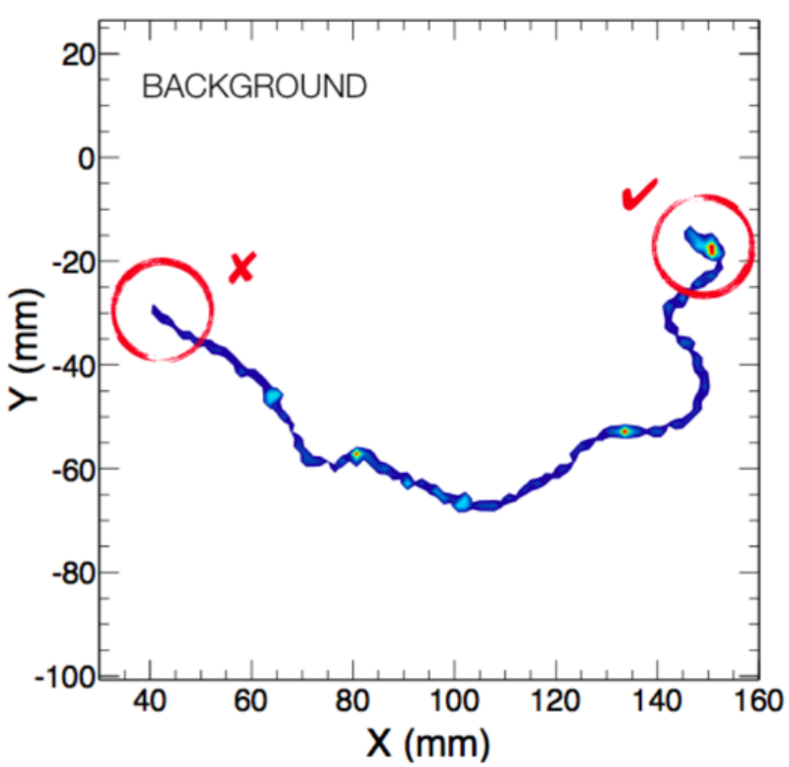
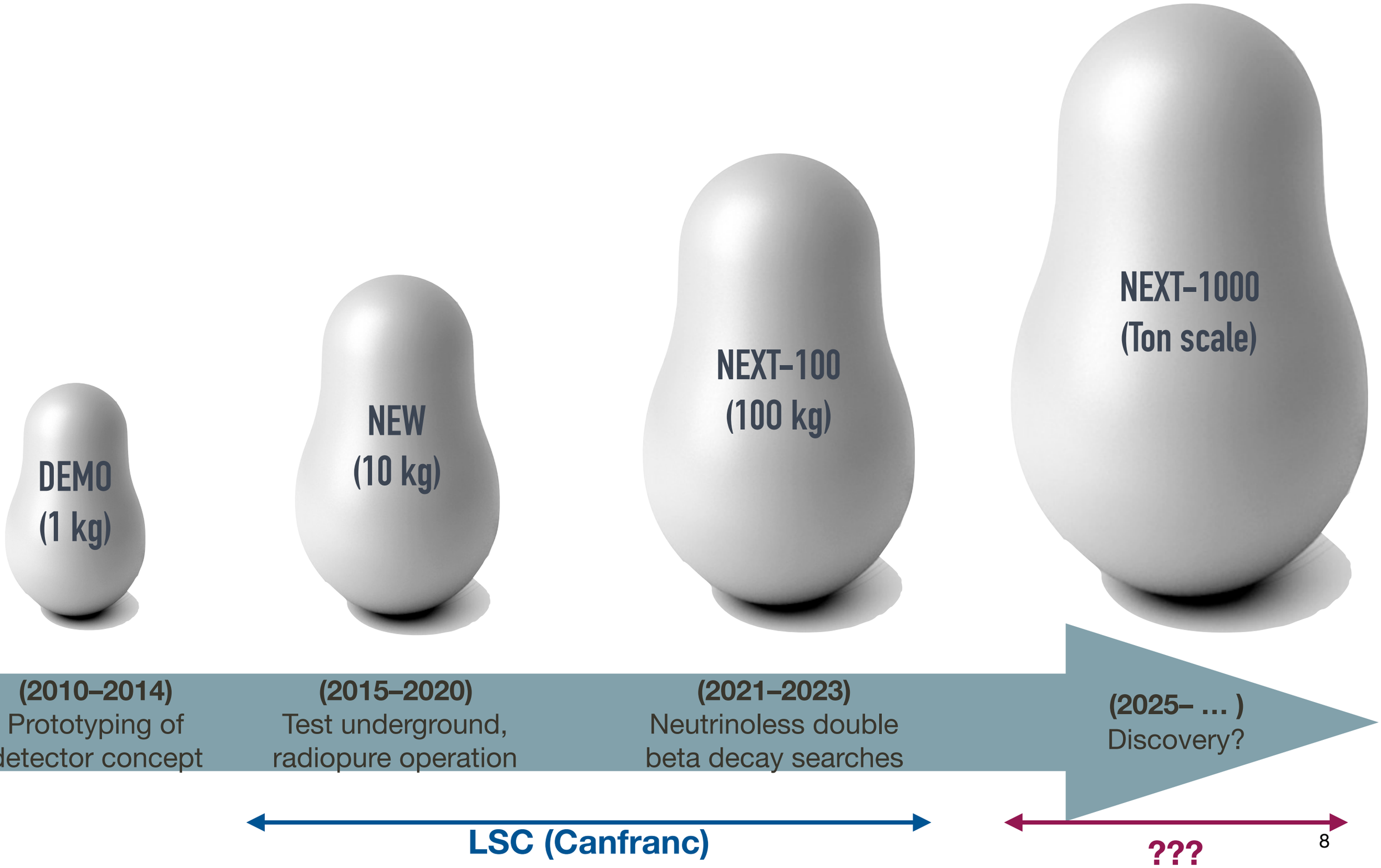






Topology: TPC offers high quality images of events

The NEXT project



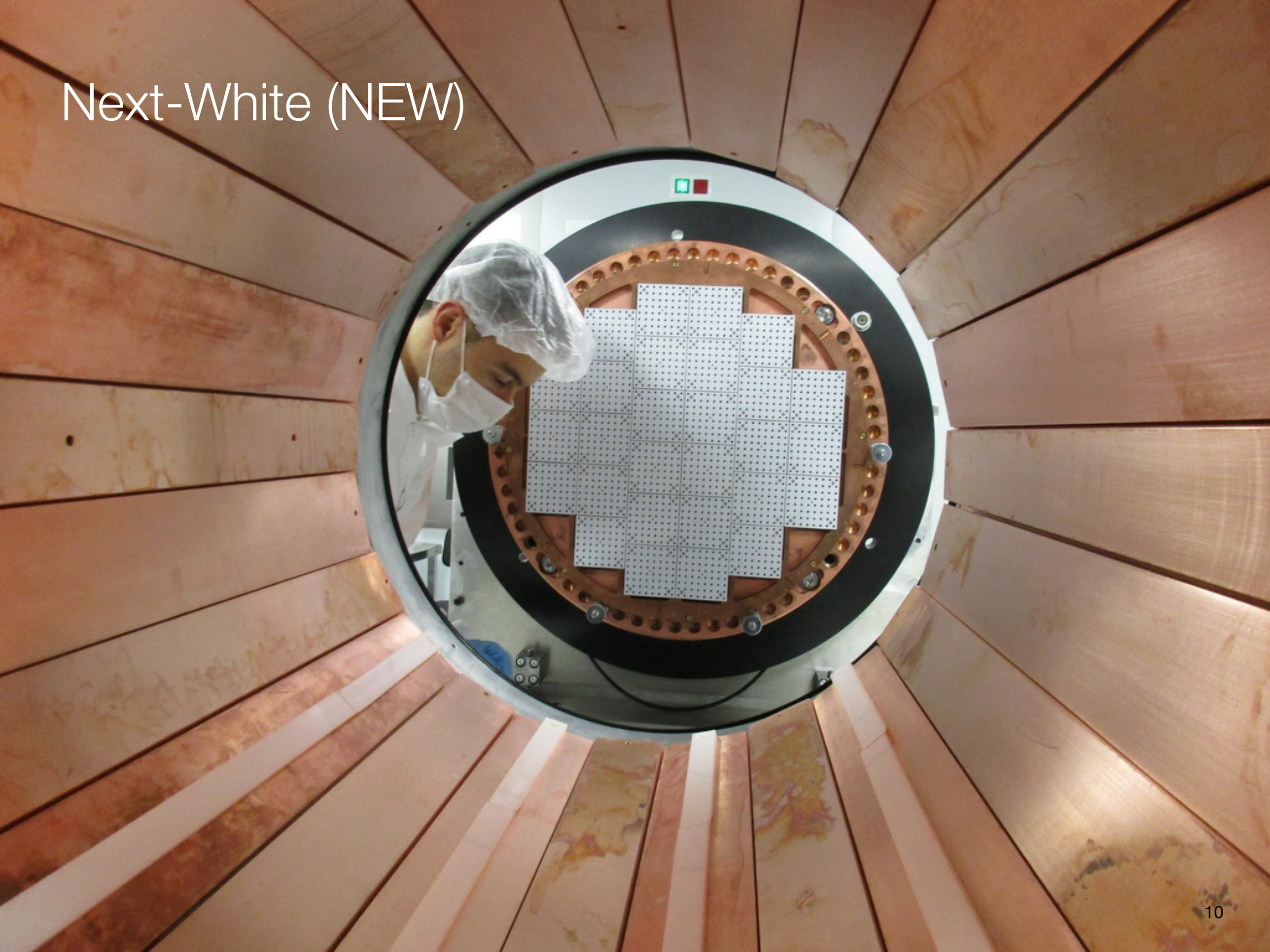
The NEXT project

Many new results

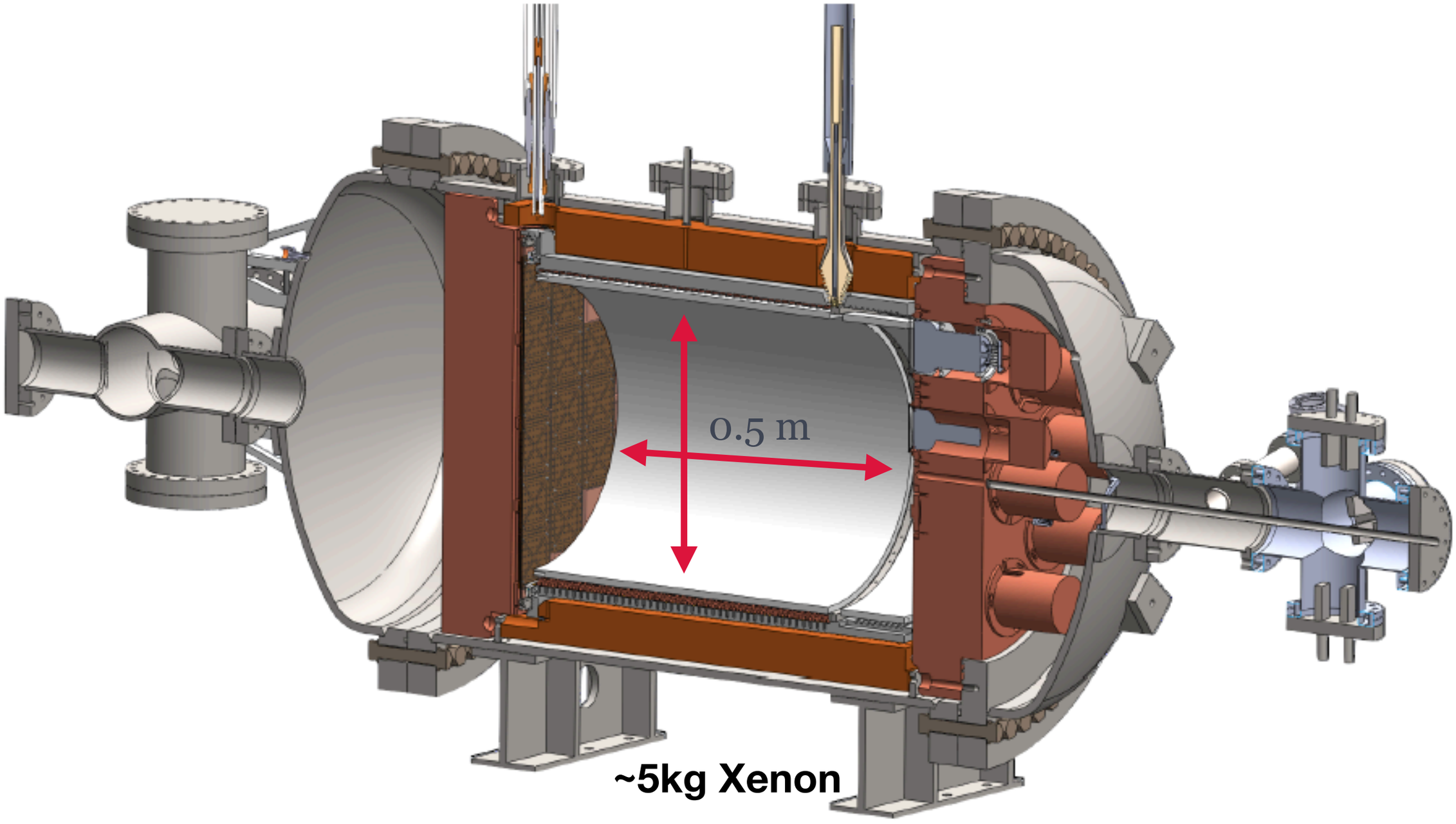
Demonstration of technology

Under construction

Next-White (NEW)

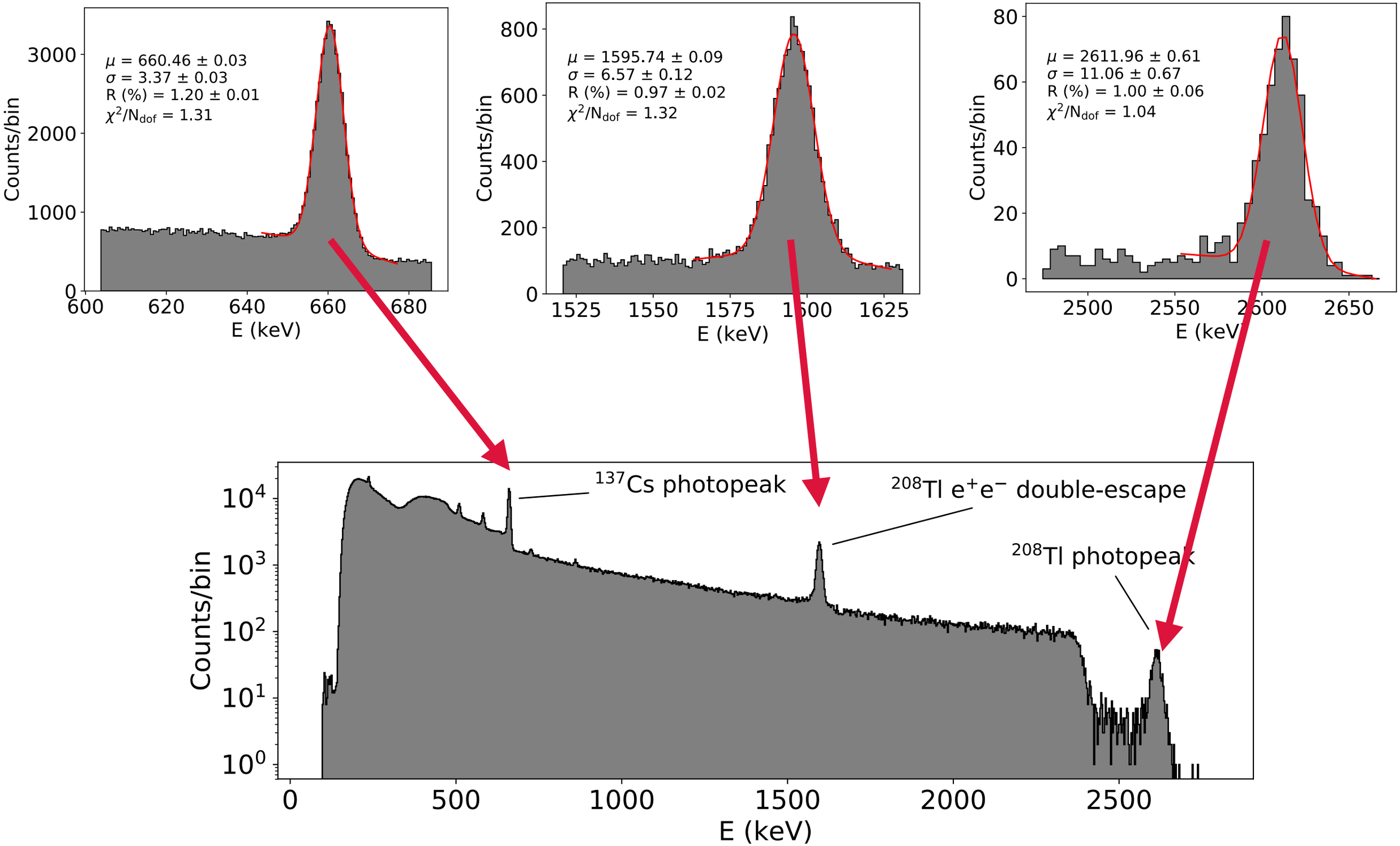


NEW detector



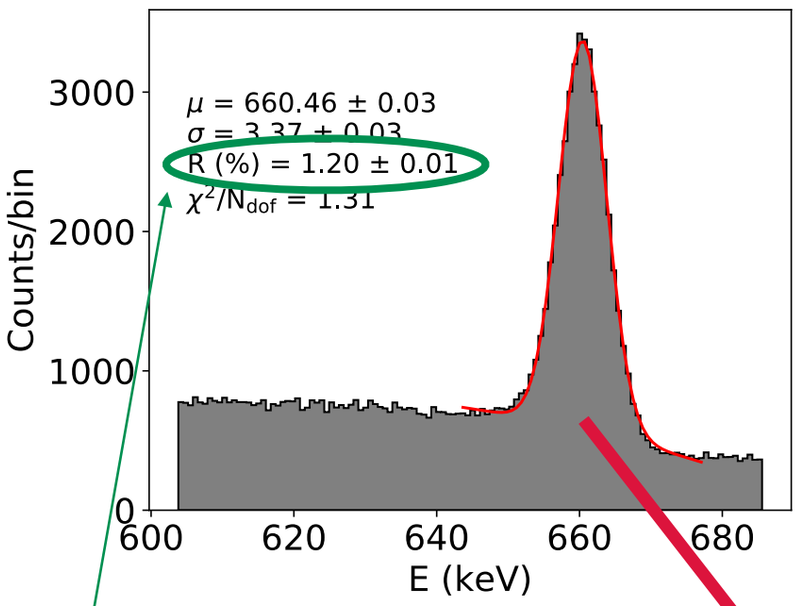
***NEXT Collaboration*, JINST 13 (2018) 012, P12010**

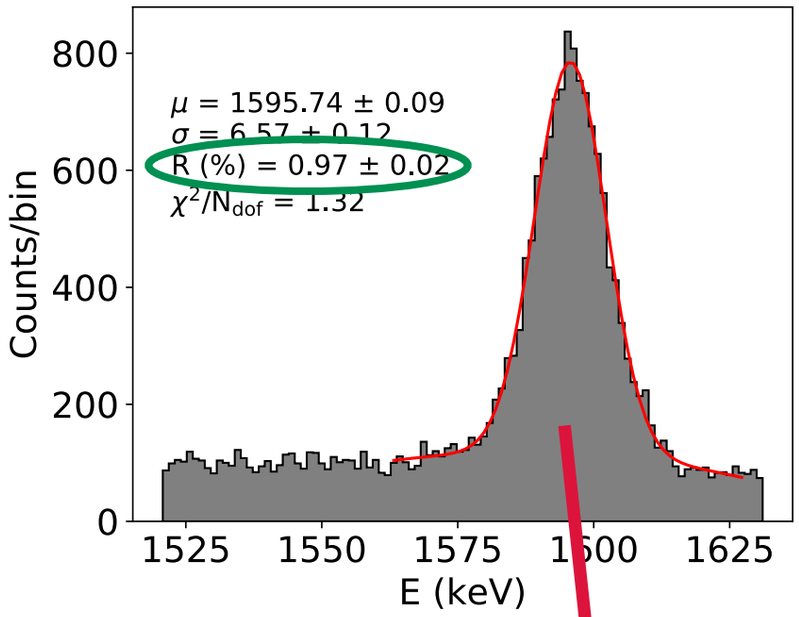
NEW energy resolution (calibration sources)

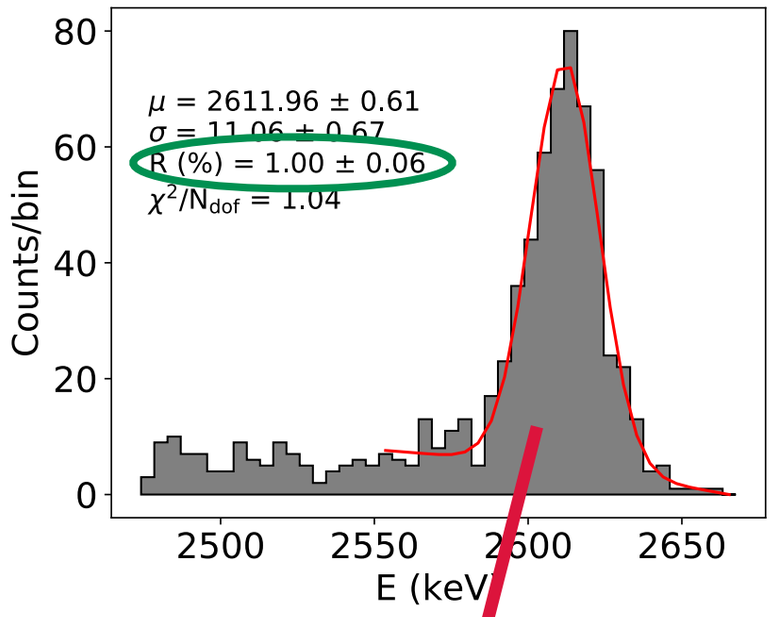


NEXT Collaboration, *JHEP* 10 (2019) 230

NEW energy resolution (calibration sources)



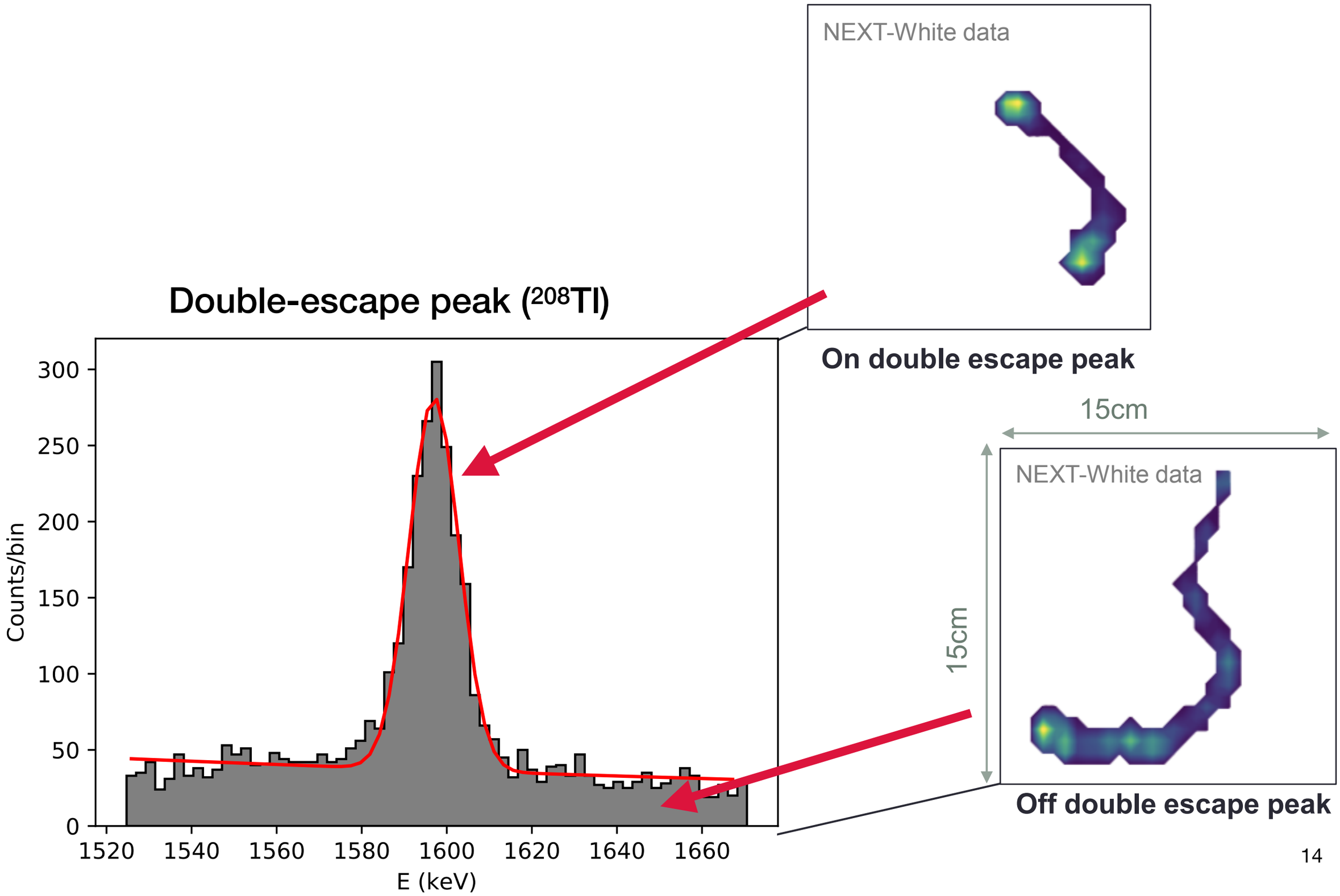




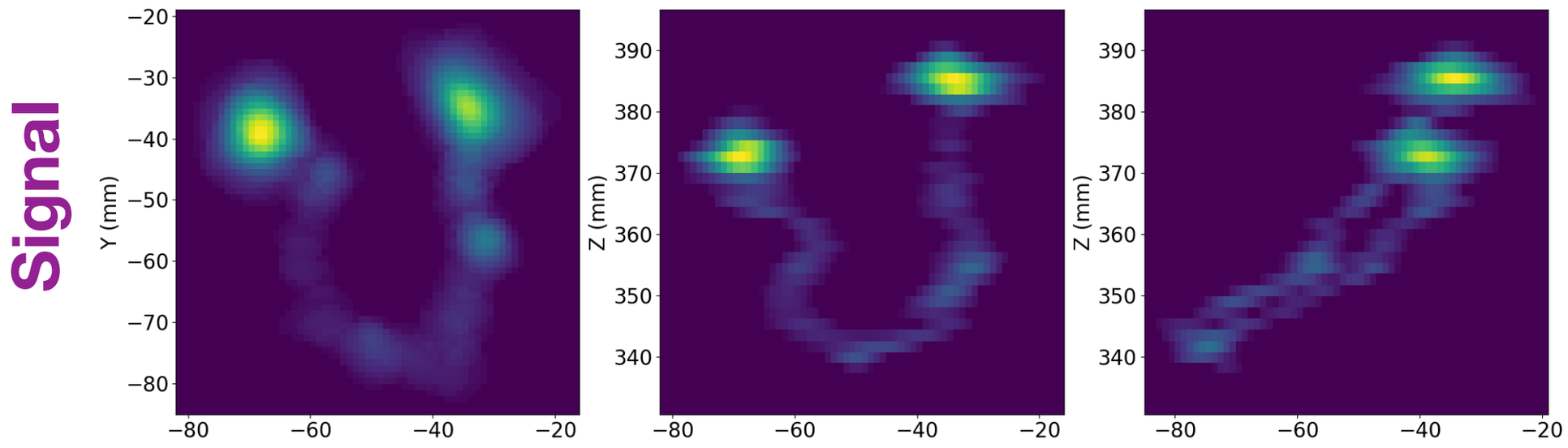
* R = FWHM

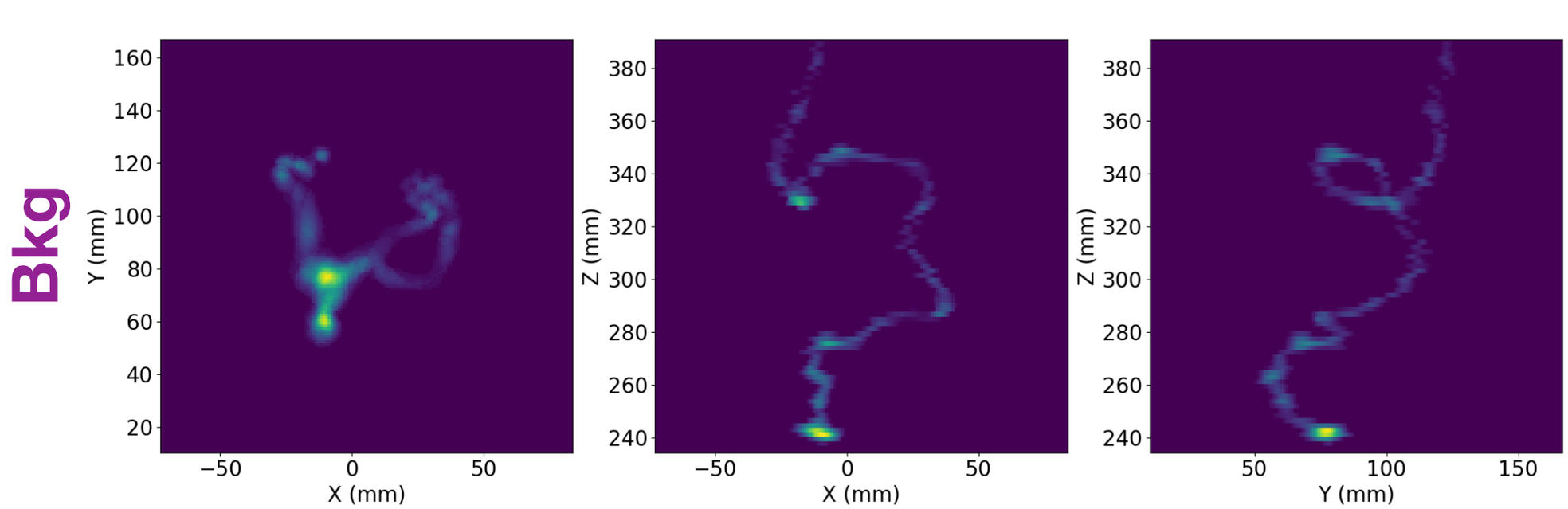
NEXT Collaboration, *JHEP* 10 (2019) 230

NEW topology



NEW topology





Traditional cut-base analysis

~70% efficiency

~20% bkg contamination

NEXT Collaboration, *JHEP* 10 (2019) 052

Improvement with DNNs

~5% bkg contamination

Publication in prep.

Summary of NEW results

1. **Great energy resolution** ✓

With several calibration sources (different energies), energy resolution better than 1% FWHM at $Q_{\beta\beta}$ is achieved

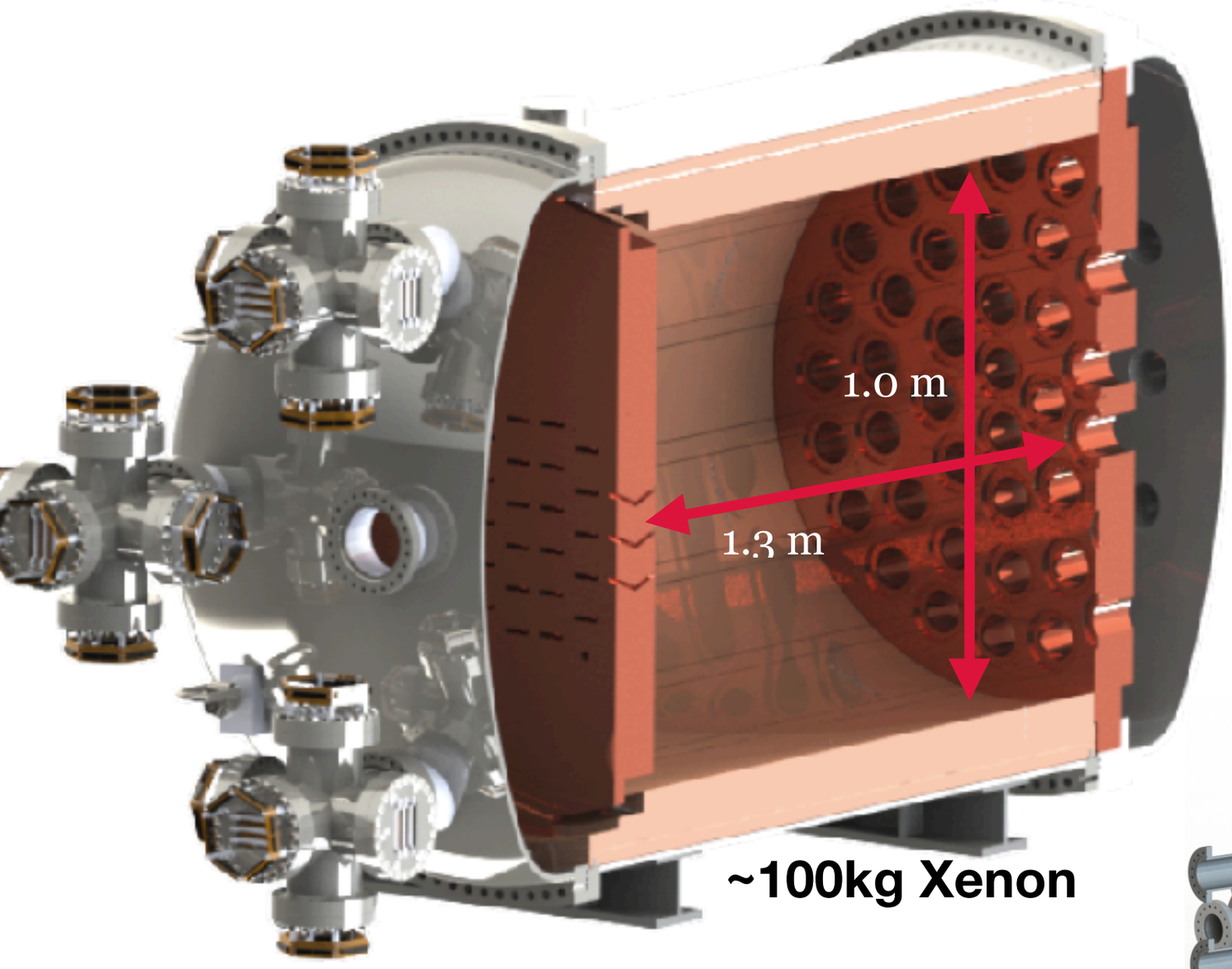
2. **Low background** ✓

- Backgrounds measured in NEW and used for future predictions
- Identification of potential improvements

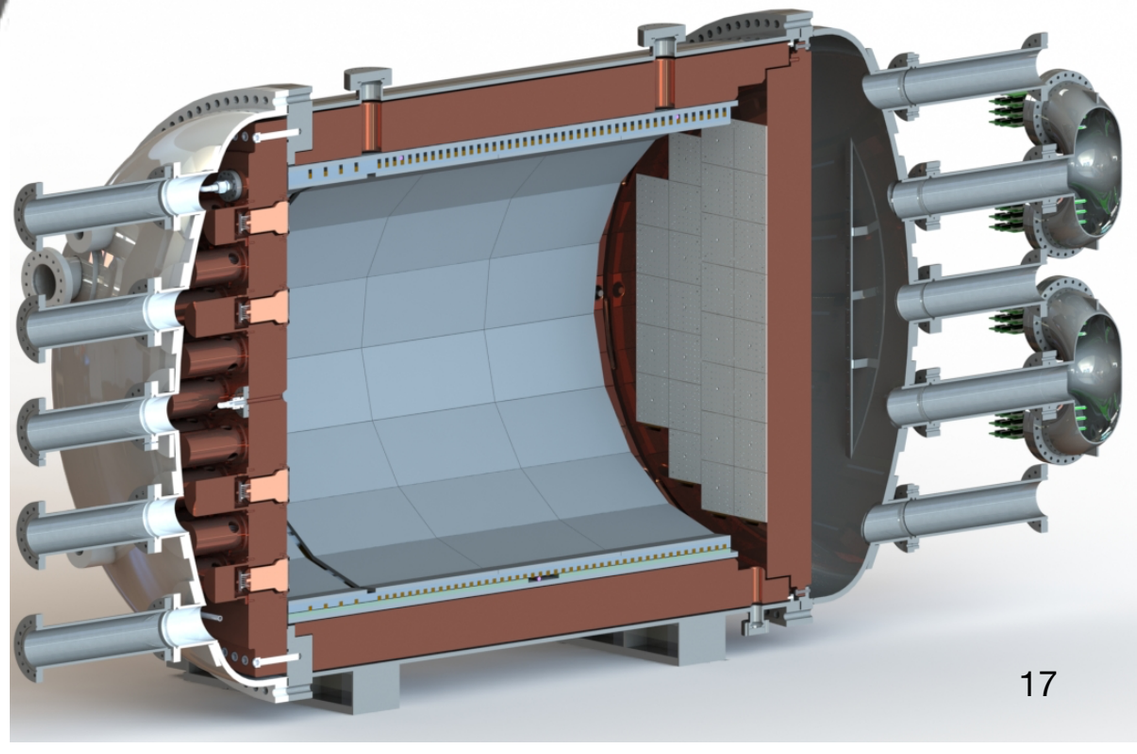
3. **Scalability**

- NEXT-100

NEXT-100

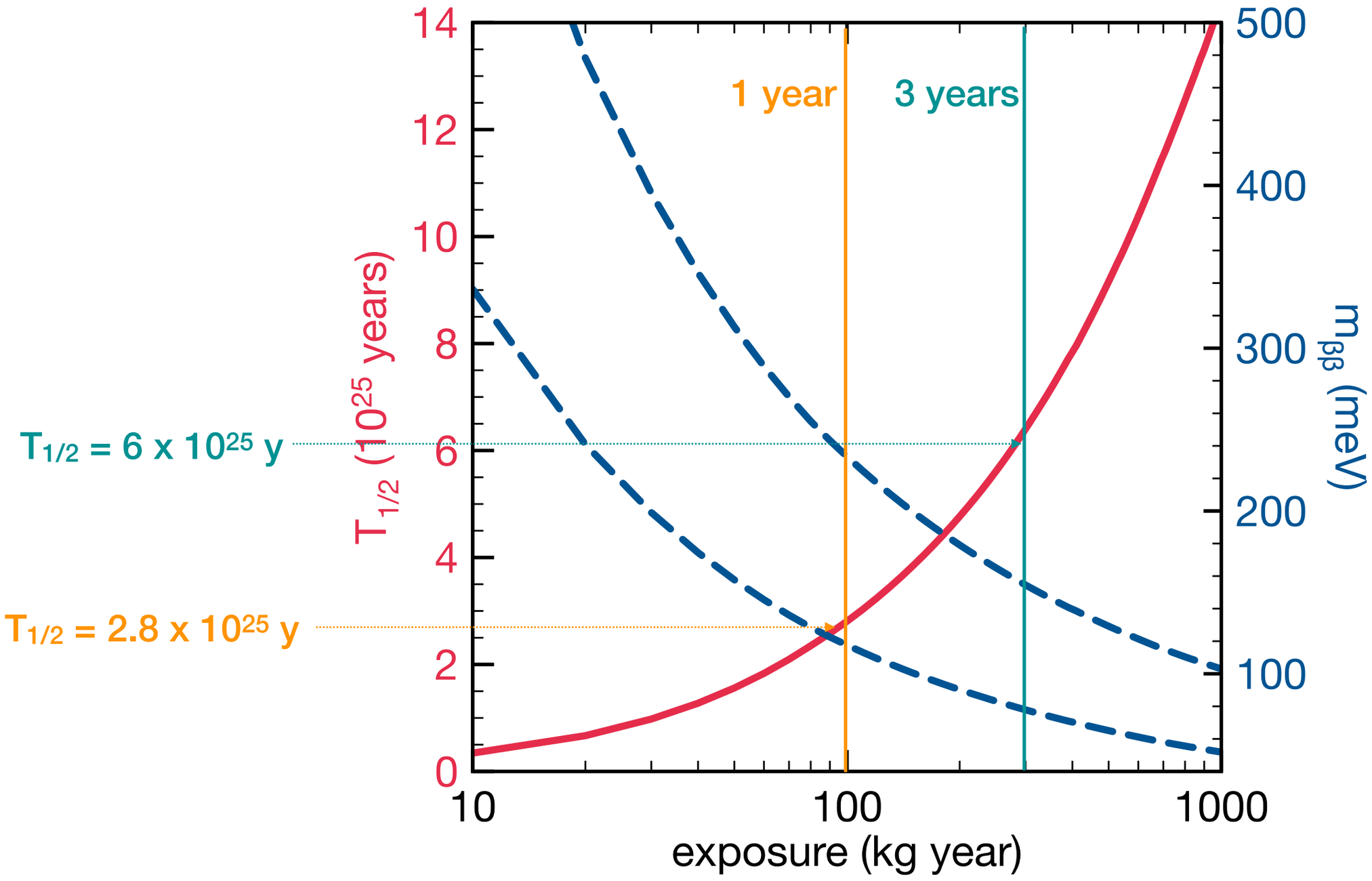


- Design complete
- Construction expected to start in the Fall



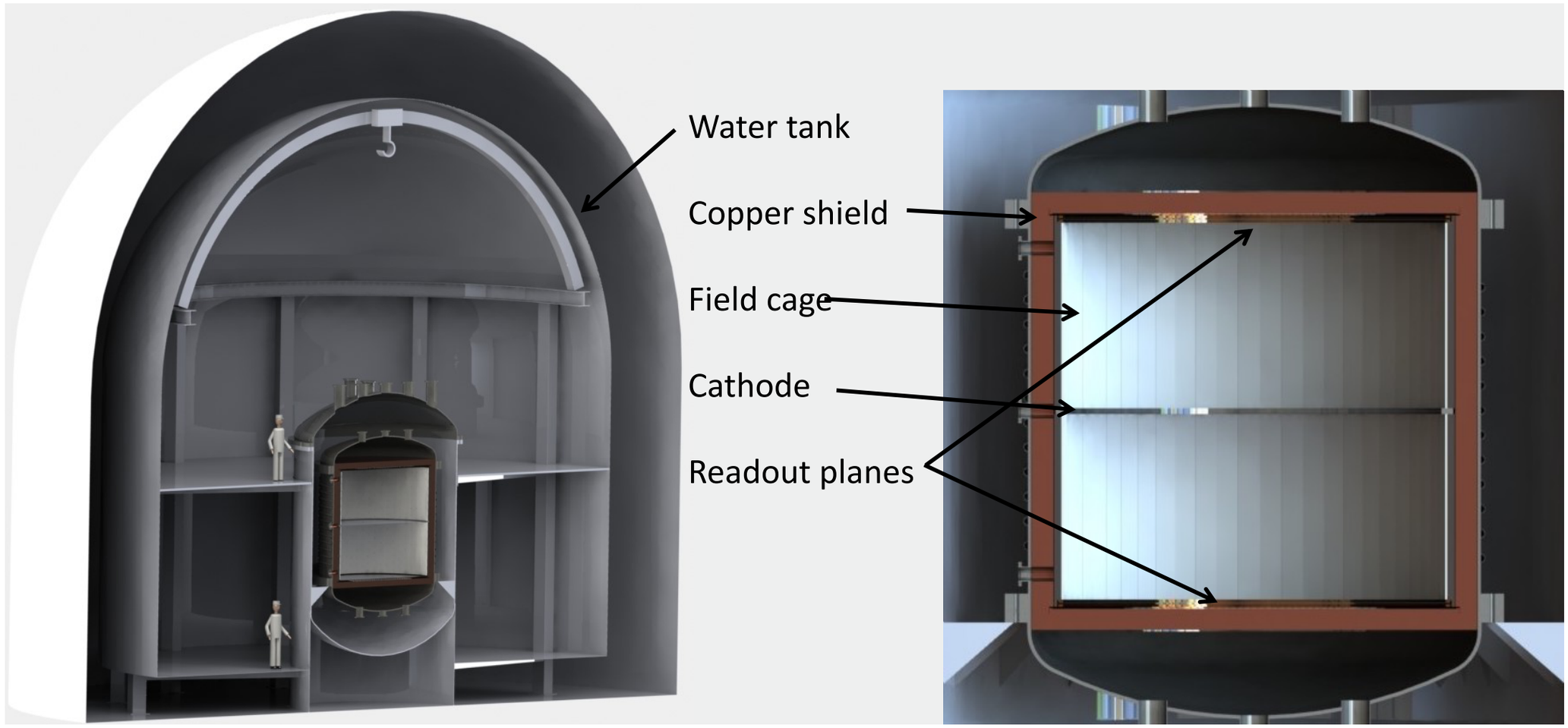
NEXT-100 Technical Design Report (TDR). Executive Summary, JINST 7 (2012) T06001.

NEXT-100 sensitivity



NEXT Collaboration, *JHEP* 1605 (2016) 159

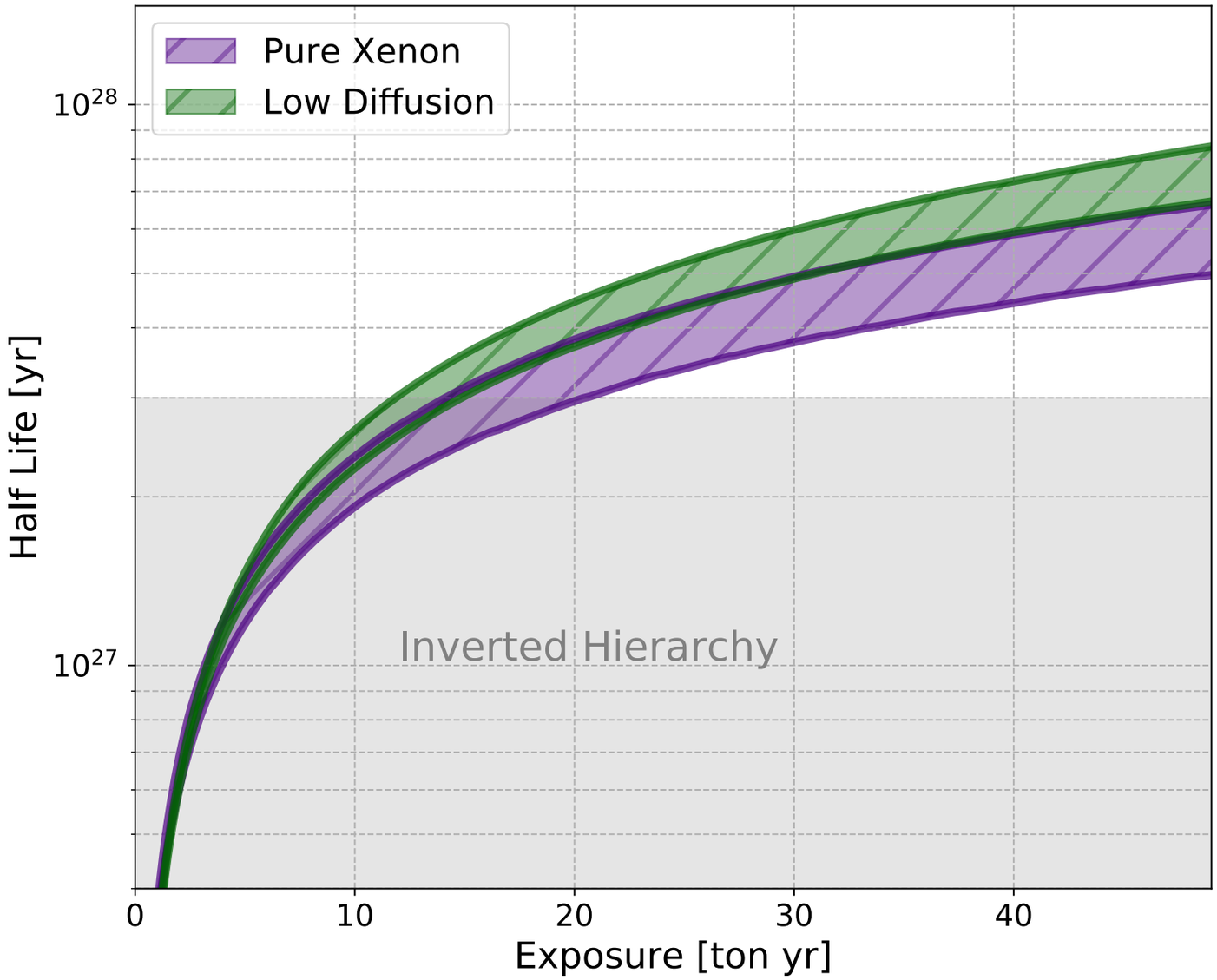
NEXT-HD (ton-scale for the inverted hierarchy)

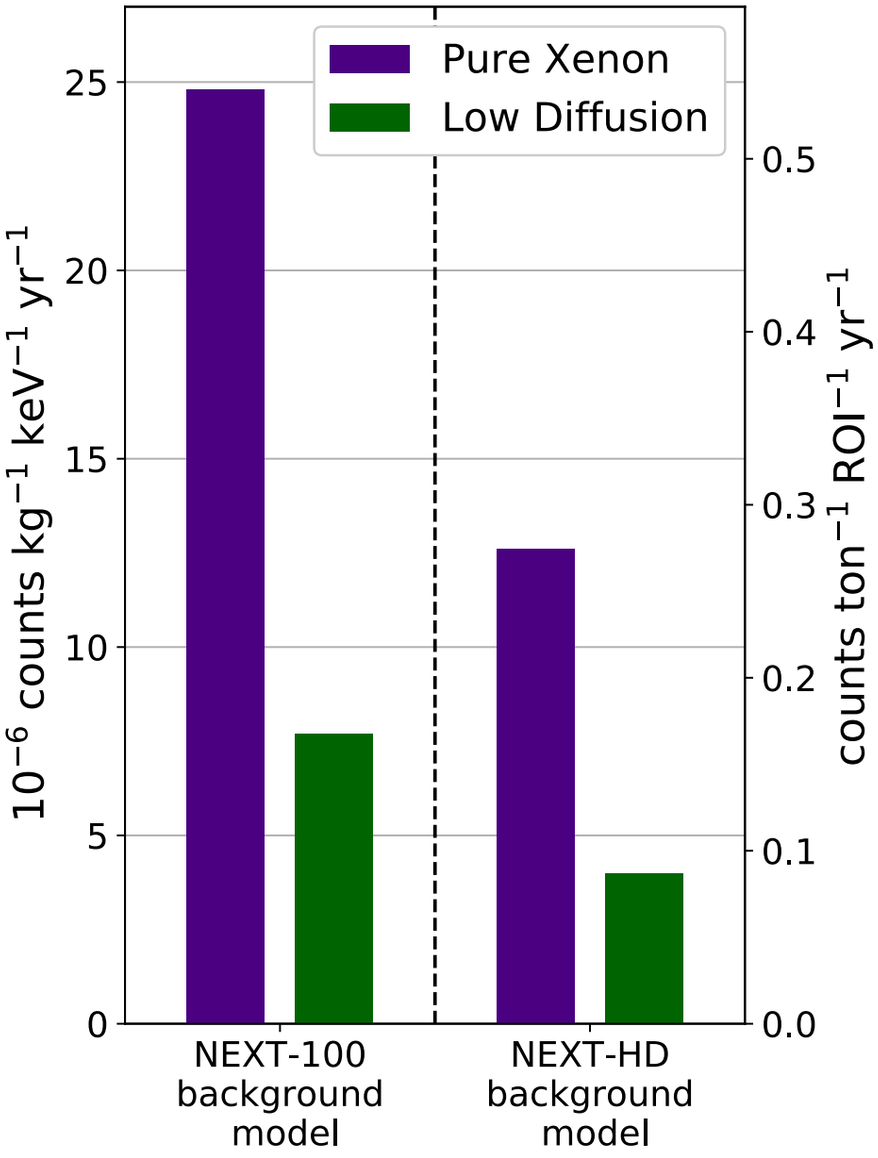


- 1-ton module(s)
- Symmetric detector (2.6m diameter, 1.3m drift)
- Only SiPMs (no PMTs)

NEXT Collaboration, arXiv:2005.06467

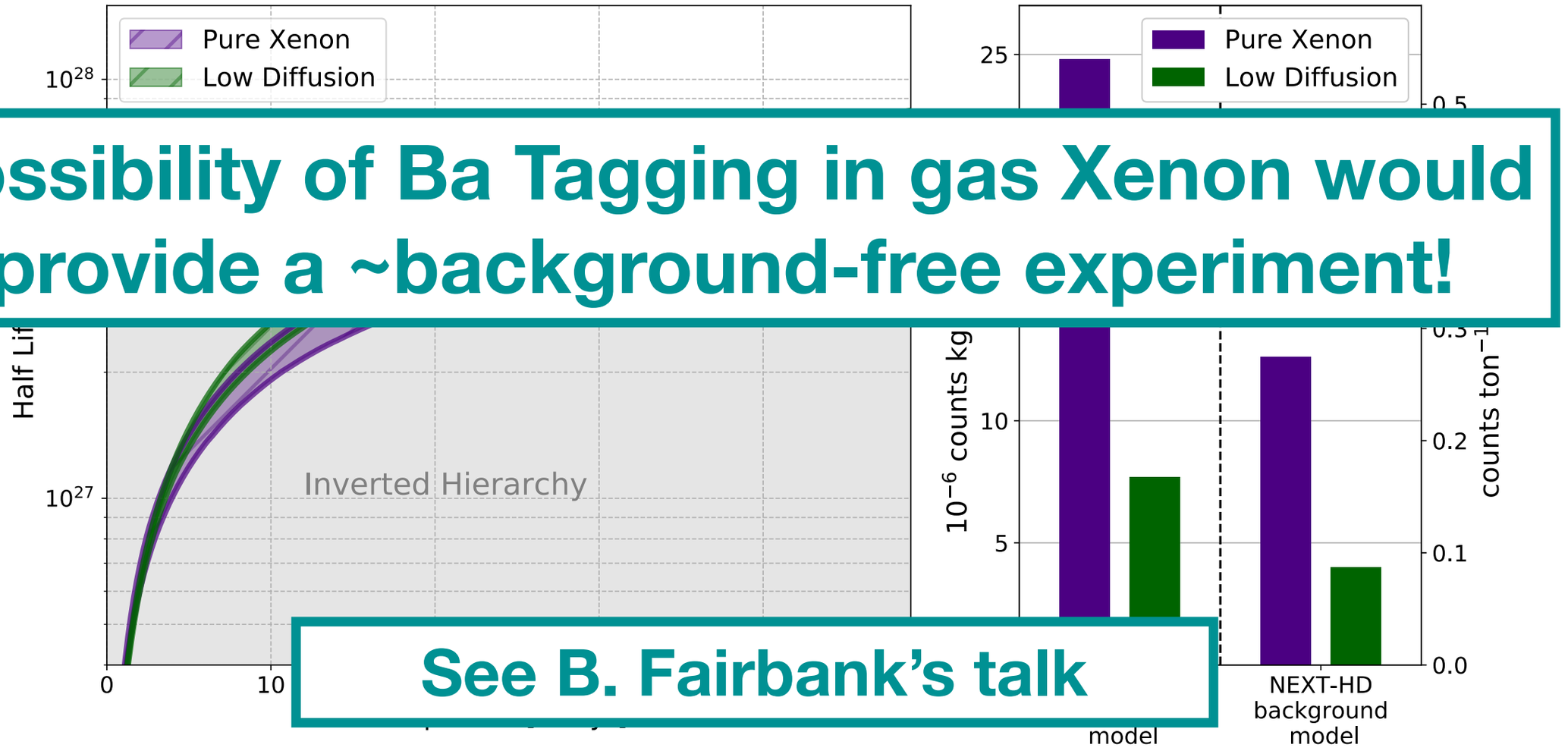
NEXT-HD (ton-scale for the inverted hierarchy)





NEXT Collaboration, arXiv:2005.06467

NEXT-BOLD (ton-scale for the normal(!) hierarchy)



Possibility of Ba Tagging in gas Xenon would provide a ~background-free experiment!

See B. Fairbank's talk

NEXT Collaboration, arXiv:2005.06467

Summary

- HPGTPCs have unique advantages for neutrinoless double-beta decay searches

- NEW demonstrated that topology selection and great energy resolution can be achieved

- NEXT-100 construction will soon be underway, will demonstrate scalability and will have sensitivity similar to current generation of experiments

- The ton-scale is really where we want to go and NEXT proposes a staged approach with potential to reach near the normal mass ordering phase space

Summary

- HPGTPCs 

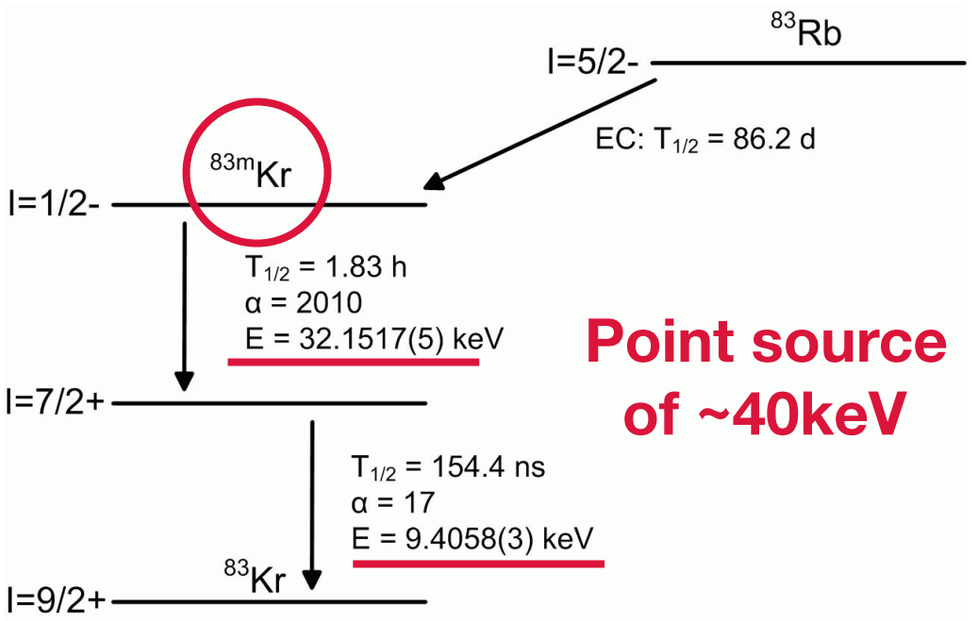
pless double-beta decay sear

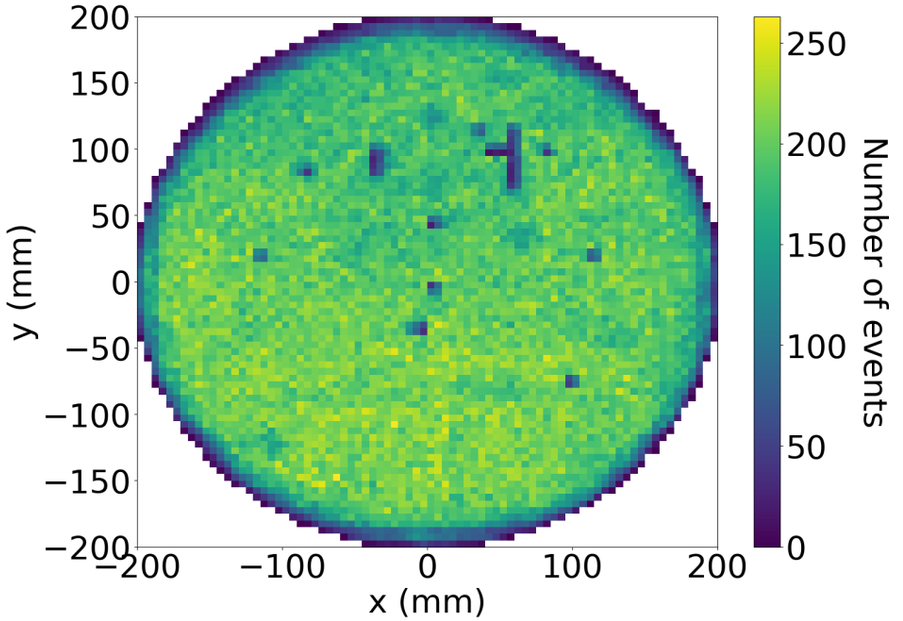
- NEW demo d great energy resolution

- NEXT-100 will demonstrate scalability a rrent generation of experiment

- The ton-scale is really where we want to go and NEXT proposes a staged approach with potential to reach near the normal mass ordering phase space

NEW calibration with Krypton-83m





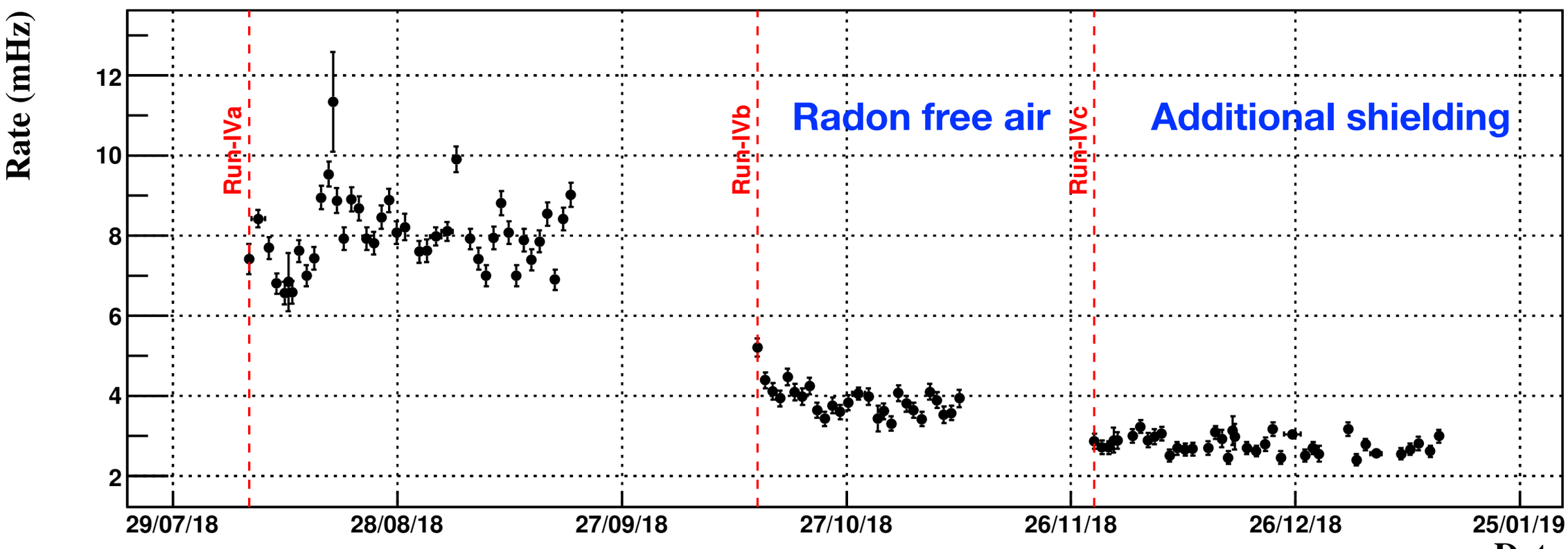
NEXT Collaboration,
JINST **13** (2018) P10014

NEW backgrounds

Low-background data taking proceeding after detector calibration campaign. NEXT background model assessed using these data.

Several improvements in the setup have reduced backgrounds by a factor of ~4:

- New radiopure components in detector.
- Radon-free air introduced in lead shielding.
- Additional layer of shielding added.



NEXT Collaboration, *JHEP* 10 (2019) 051