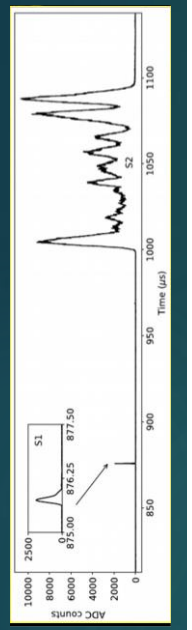
High pressure xenon electroluminescent TPC for the NEXT experiment

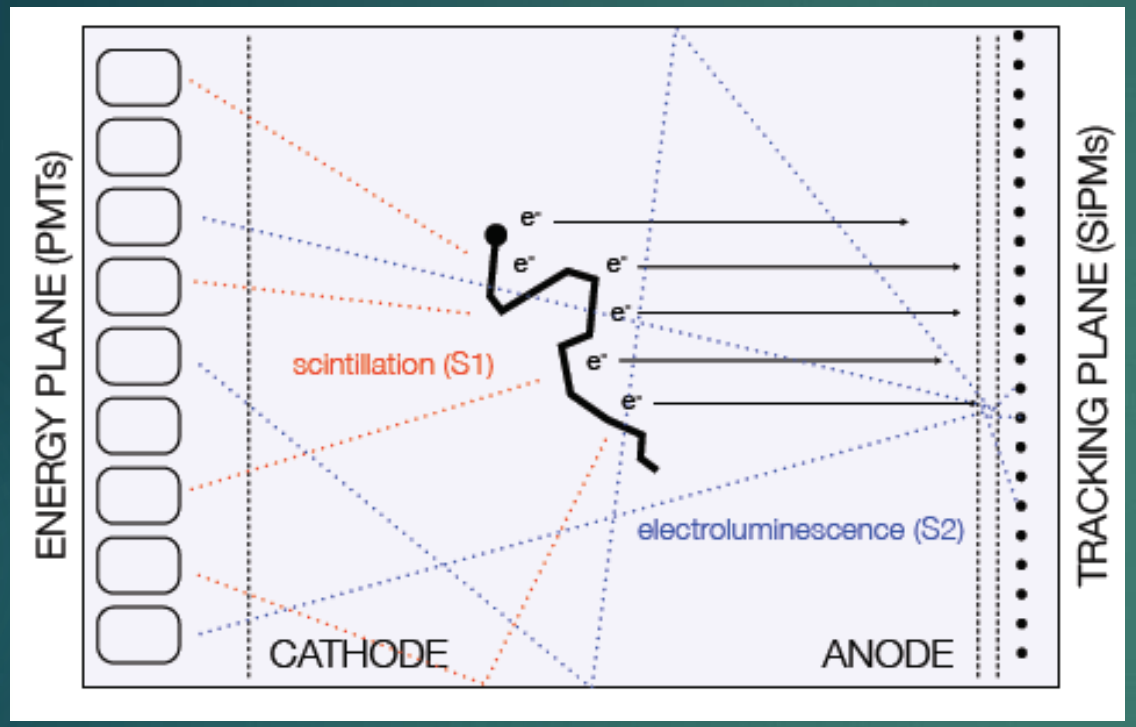
AND ITS FUTURE DEVELOPMENTS

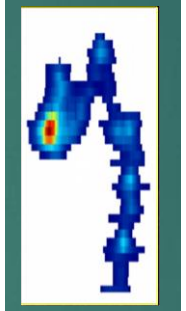
R.FELKAI (IFIC) on behalf of the NEXT collaboration

Manchester, 28-30 August 2019

Assets of the technology







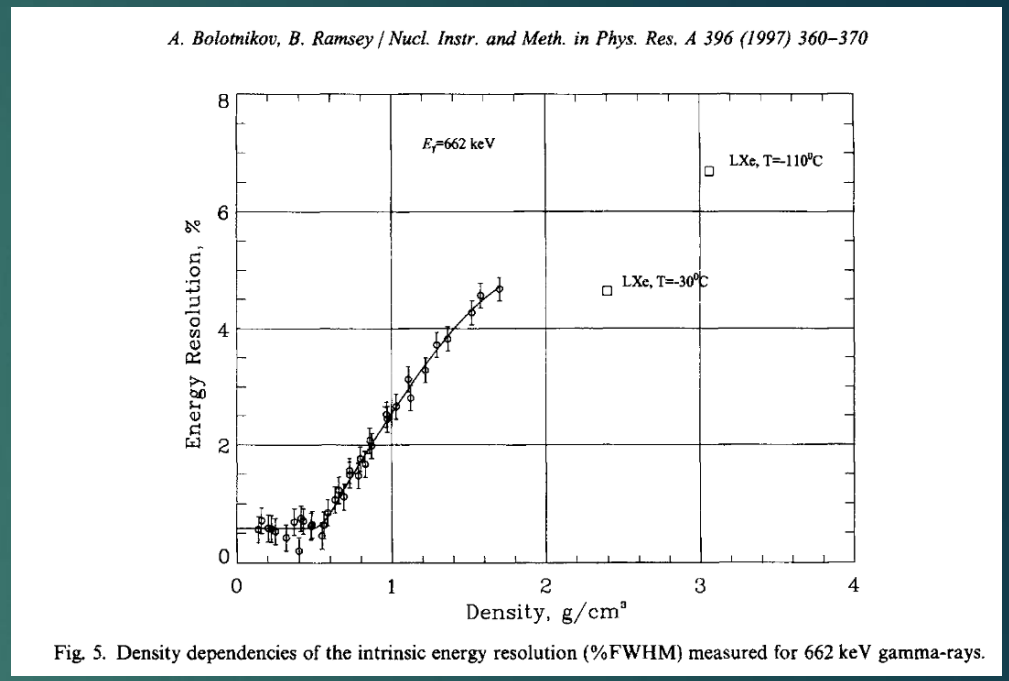
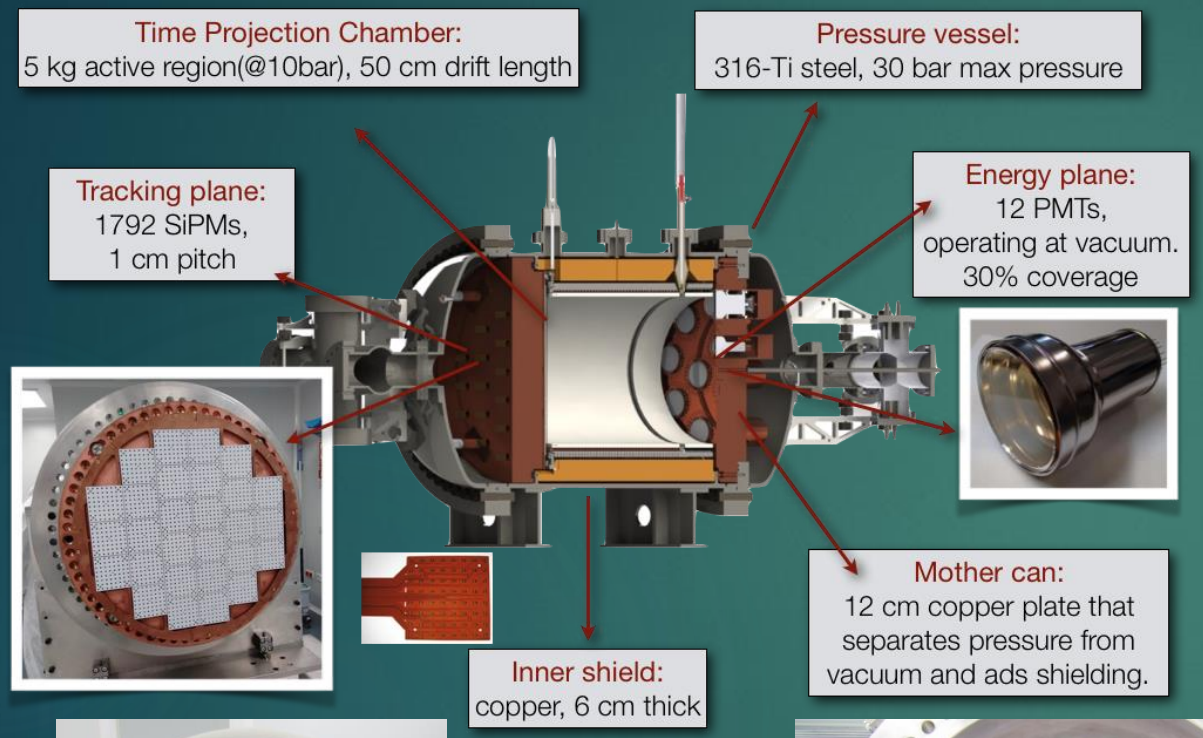


Fig. 5. Density dependencies of the intrinsic energy resolution (%FWHM) measured for 662 keV gamma-rays.

- Low Fano factor in gaseous xenon gives a low fundamental limit to energy resolution
- Access to the topology of the event to improve background rejection
- Relative ease for scaling to large detectors

NEXT-White (NEW)

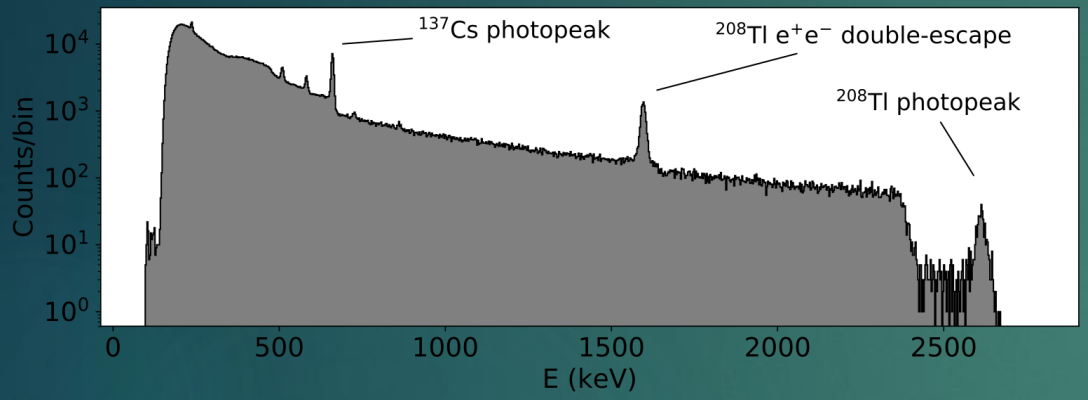


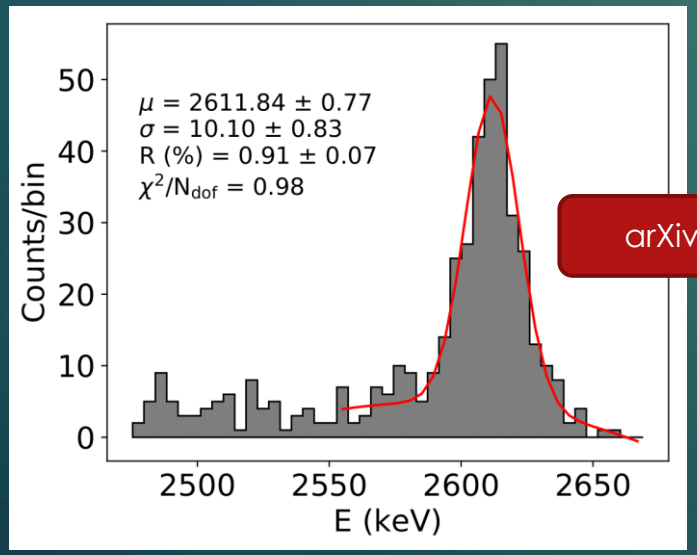
JINST 13 (2018) no.12, P12010.

- Running smoothly at the LSC since 2016
- Filled with 136-enriched xenon since February 2019
- Validation of the background model and first 2vbb measurement

Performance of NEW

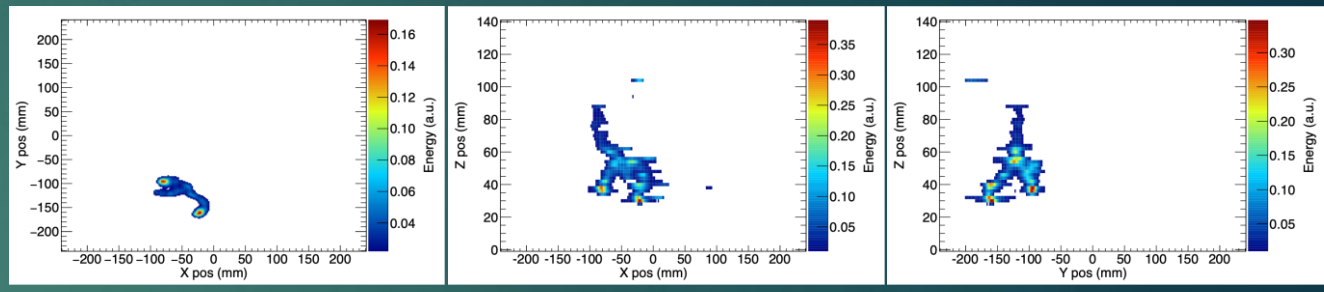
- Energy resolution below 1% FWHM at Qbb demonstrated

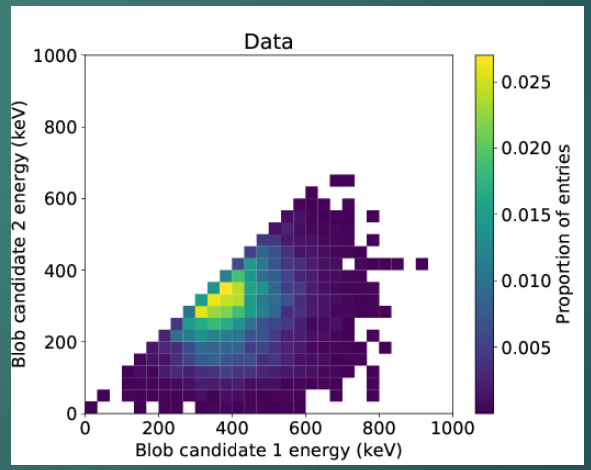


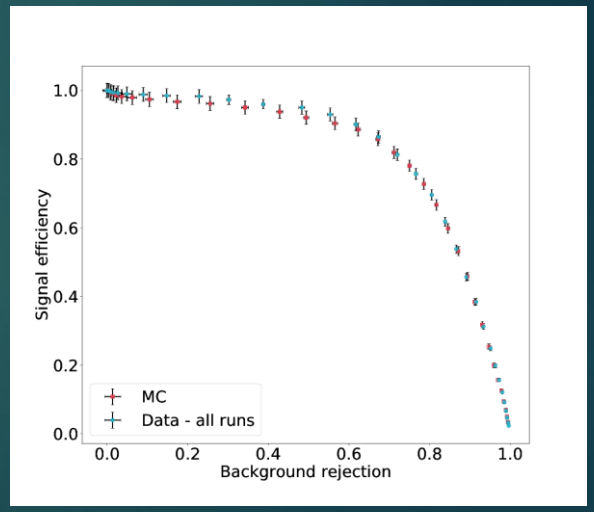


arXiv:1905.13110

- Track reconstruction and topological rejection

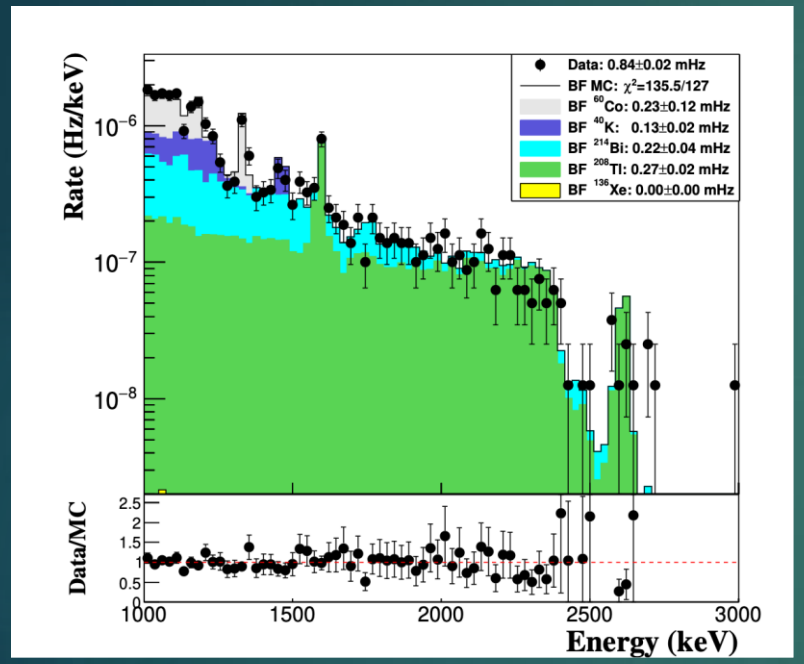




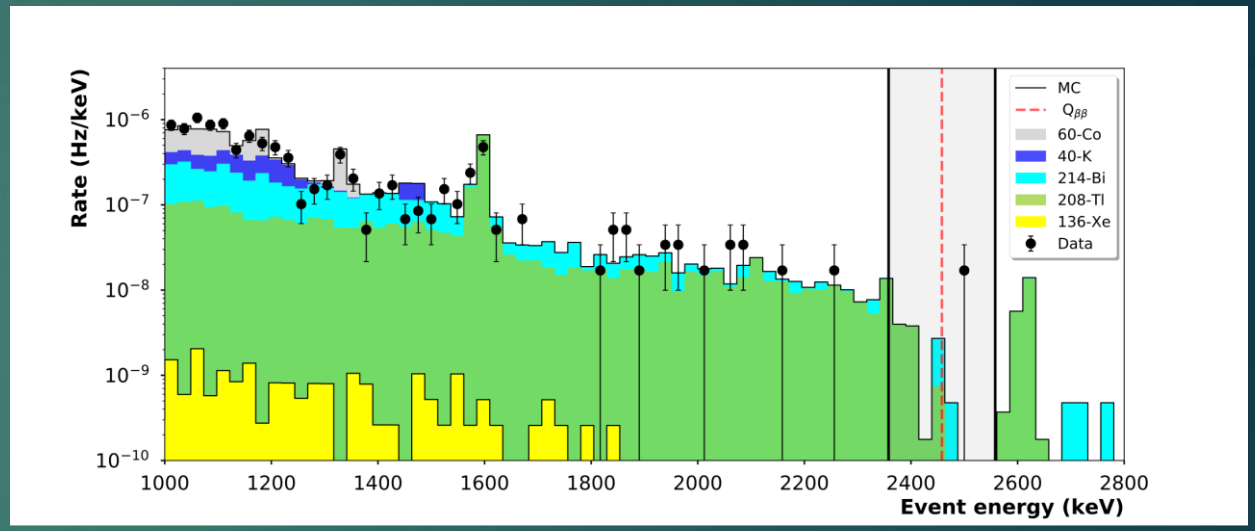


arXiv:1905.13141

Radiogenic background



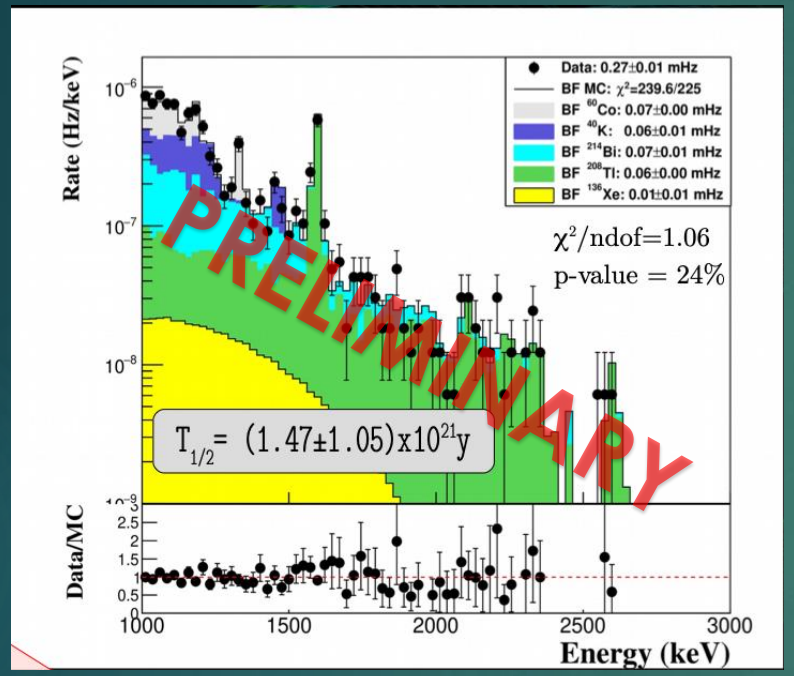
Topological selection

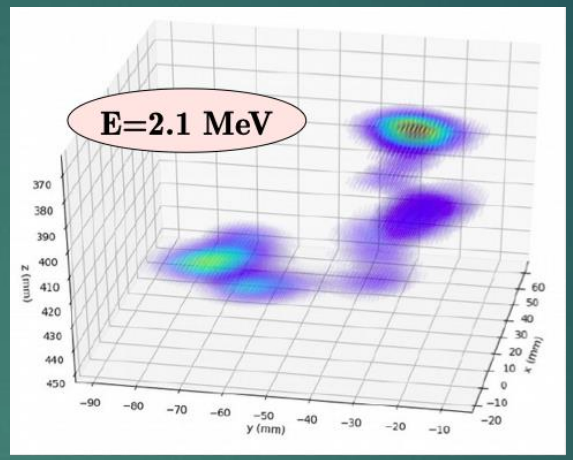


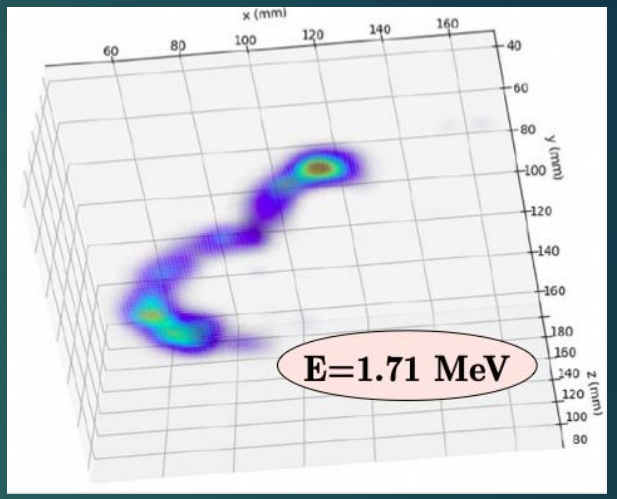
arXiv:1905.13625

- Low background data gathered with depleted Xenon
- Good agreement between the background model and the data

Double beta search with NEW







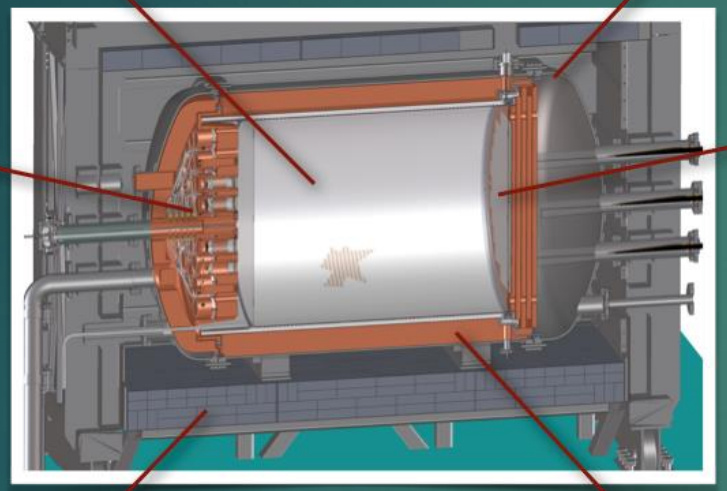
- Data taking with enriched xenon (91%) currently ongoing since February
- First NEXT measurement of double beta decay lifetime!

NEXT-100

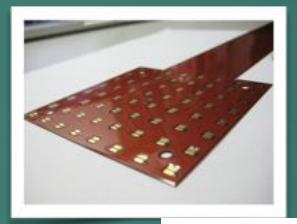
Time Projection Chamber:
100 kg active region, 130 cm drift length

Pressure vessel:
stainless steel,15 bar max pressure

Energy plane:
60 PMTs,
30% coverage

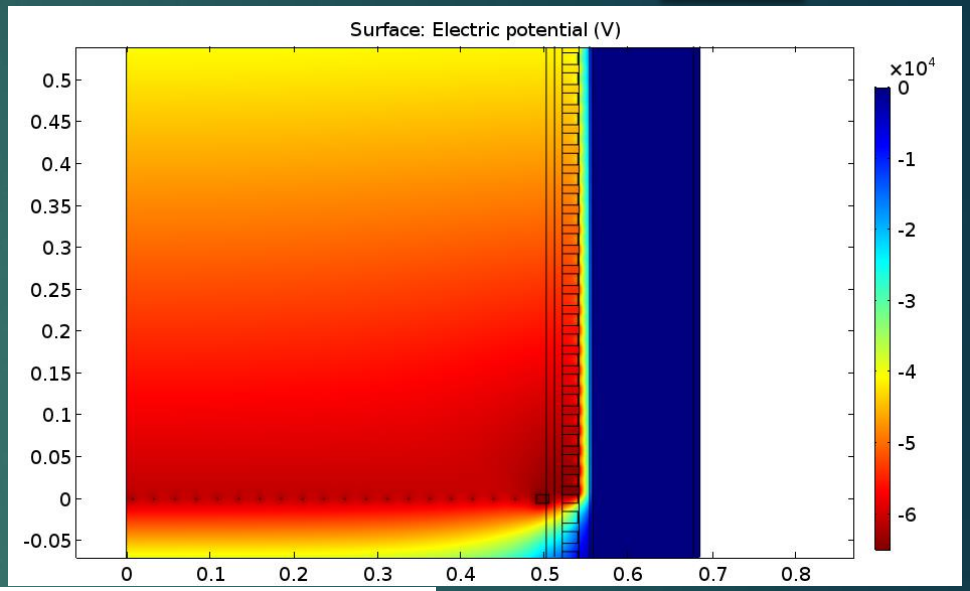


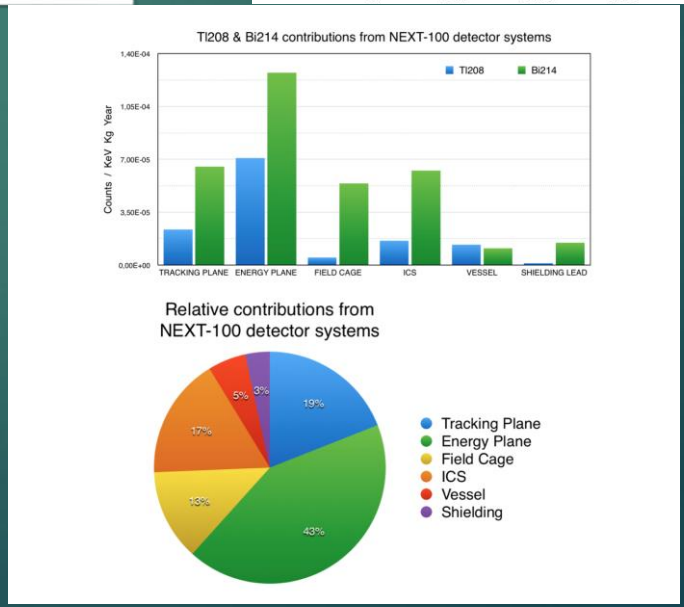
Tracking plane:
7,000 SiPMs,
1 cm pitch?



Outer shield:
lead, 20 cm thick

Inner shield:
copper, 12 cm thick



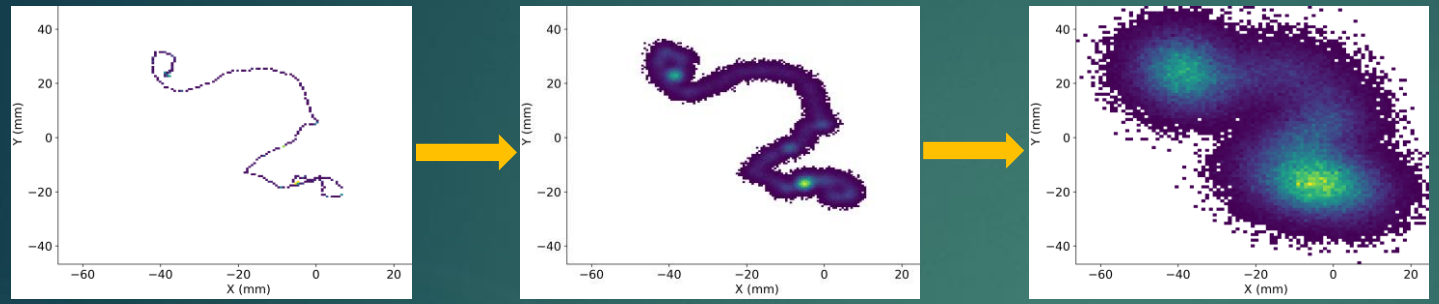


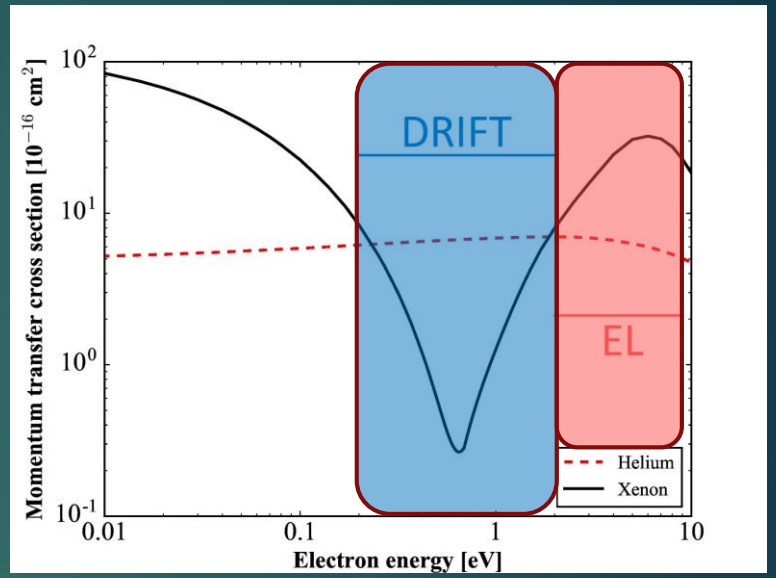
- Assembly to begin in 2020

Towards a tonne scale detector

- The next generation of double beta decay experiment requires to increase the target mass by an order of magnitude while reducing the background by an order of magnitude.
- With a bigger detector comes a longer drift distance. The diffusion of the secondary electrons can smear the topological features of the tracks.
- Identifying the barium resulting from a decay would give us a quasi-background free experiment.
- All of that while addressing the technical challenges coming when scaling up the technology (high voltage components, number of channels etc…)

NEXT-HD: Low diffusion gas mixture

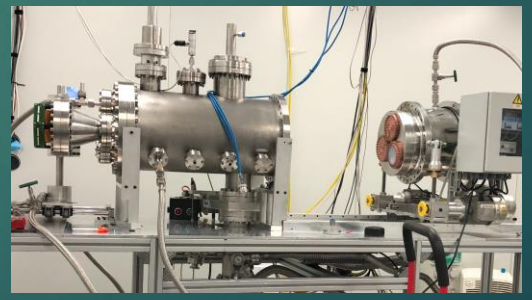




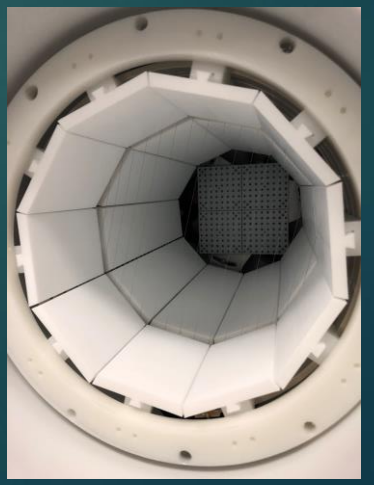
- Reduce the diffusion of pure xenon while keeping its energy resolution

Nucl.Instrum.Meth. A905 (2018) 82-90.

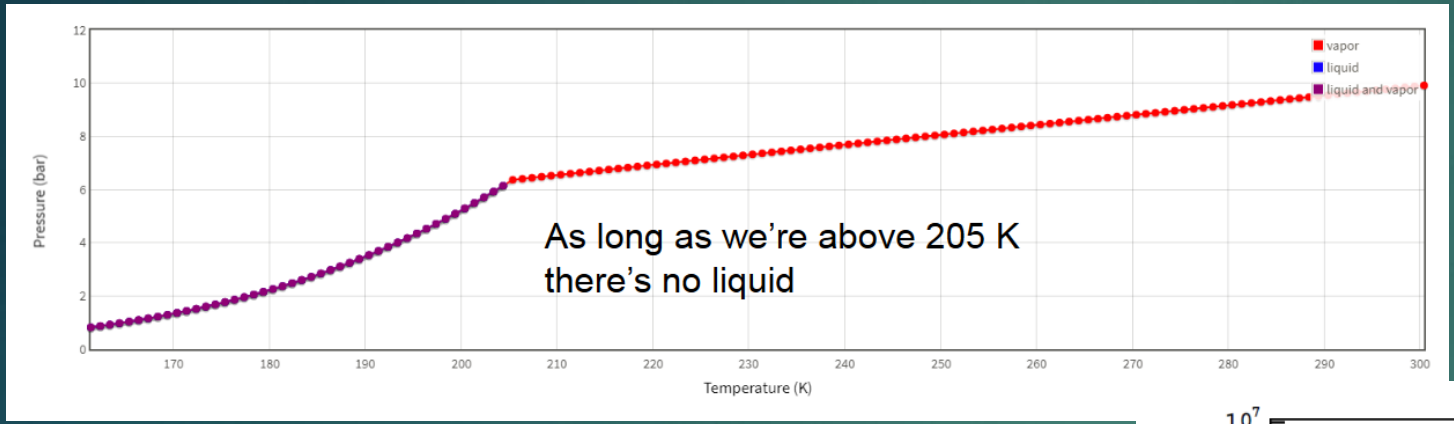
- CH4/Xenon or Helium/Xenon (see other NEXT talks about that)



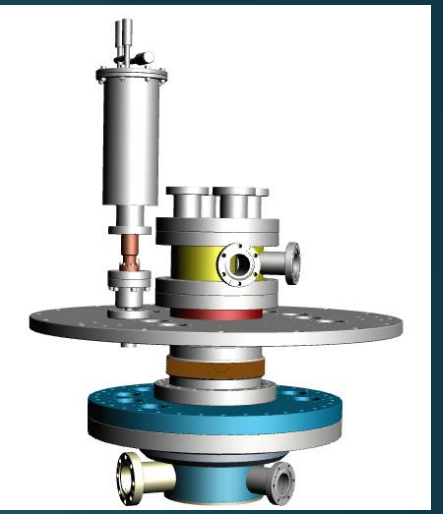
NEXT-Demo++ in Valencia



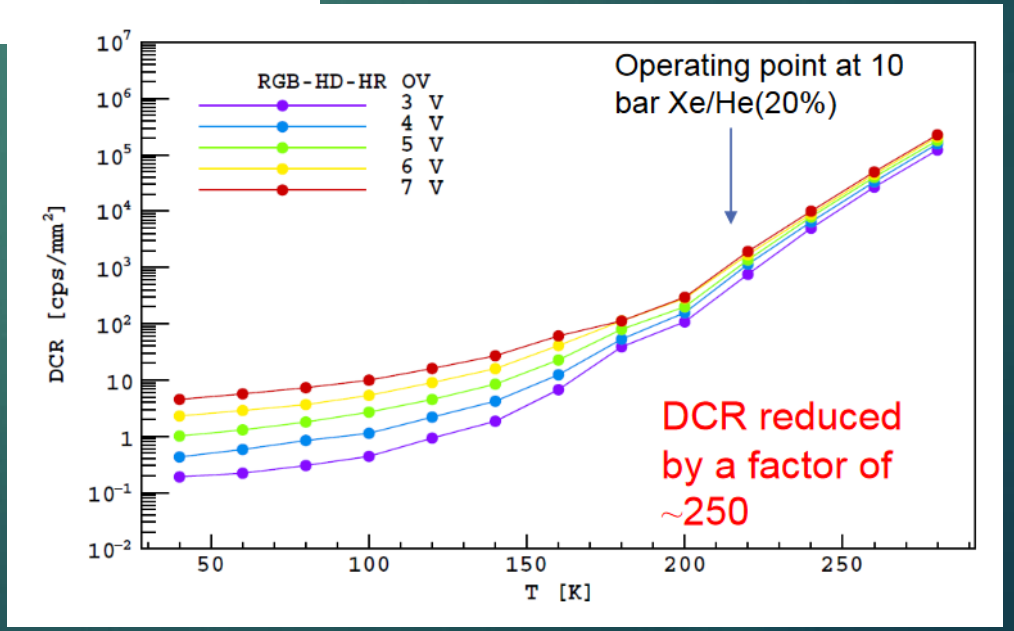
NEXT-HD: Cold gas and ultra radiopure sensors



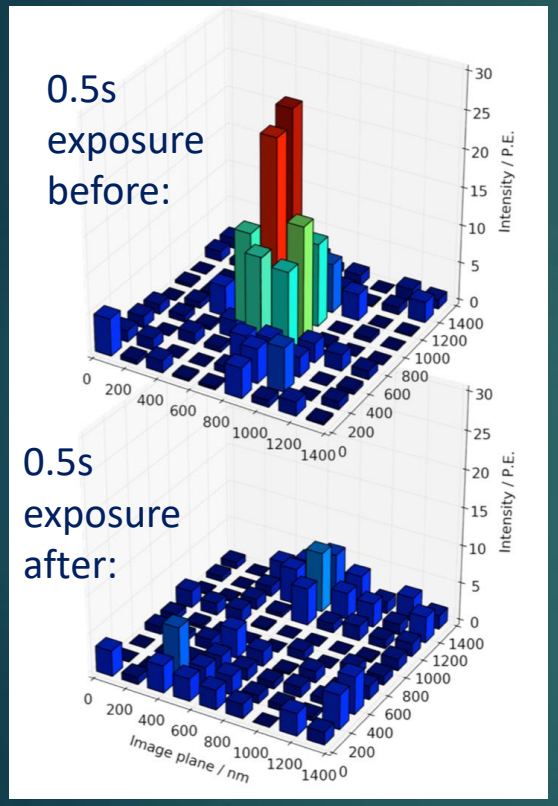
Axolotel project at BGU



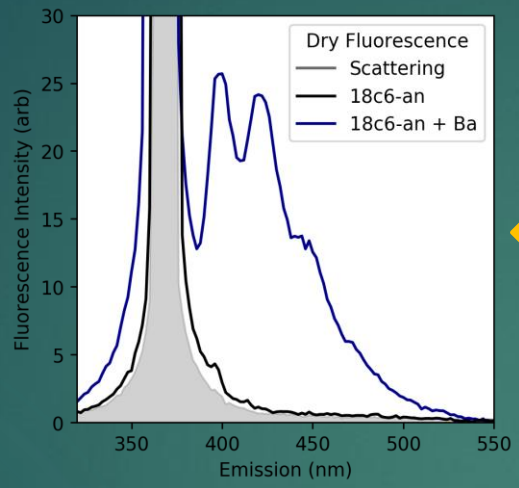
- Less pressure for the same density
  Or more target mass at same pressure
- Can replace PMTs with ultrapure SiPMs



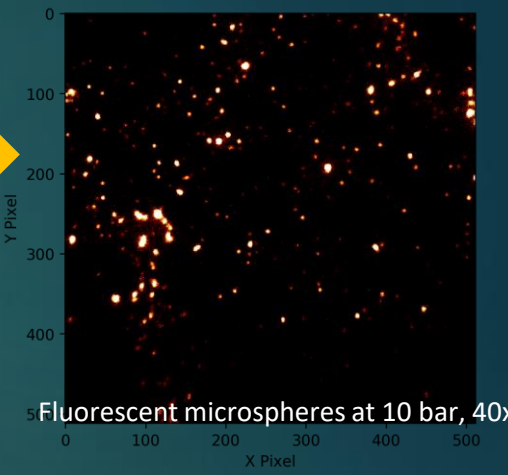
NEXT-BOLD: Barium tagging



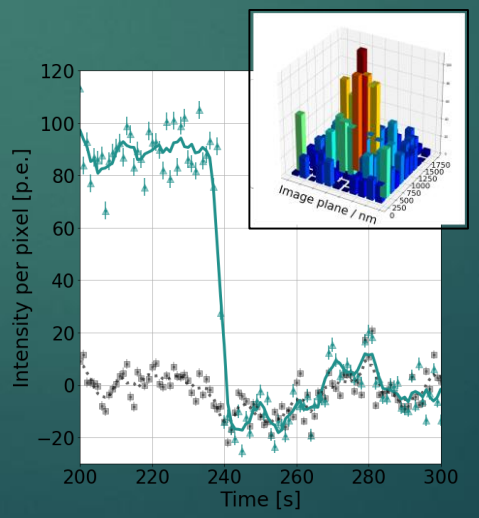
Wet phase Single Molecule Fluorescent Imaging (SMFI)

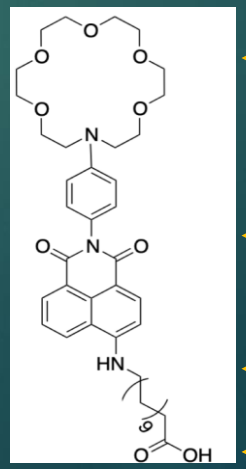


- First demonstration of dry fluorescent response to barium ions using custom-designed crown-ether based molecule
- Development of high-pressure microscopy for single molecule imaging in the gas phase
- Single molecule sensitivity with dry-phase fluorophore with surface tether for monolayer



Fluorescent microspheres at 10 bar, 40x





Receptor (18c6)

Dye (napthalimide)

Linker (c9)

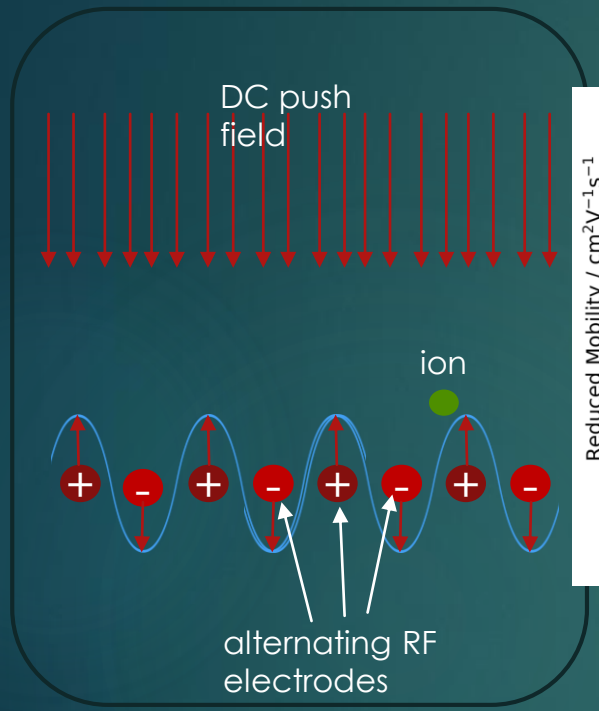
Anchor (COOH)

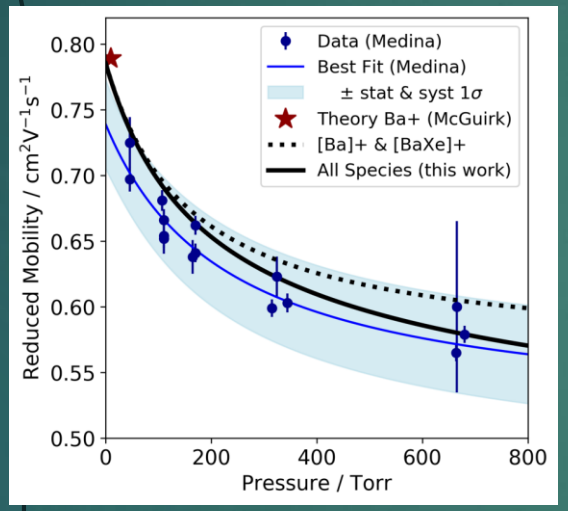
arXiv:1904.05901, submitted to Nature Sci. Rep.

Phys.Rev.Lett. 120 (2018) no.13, 132504

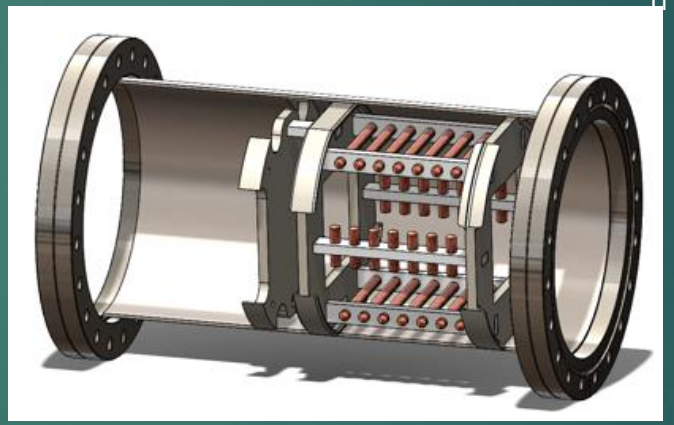
UTA and DIPC

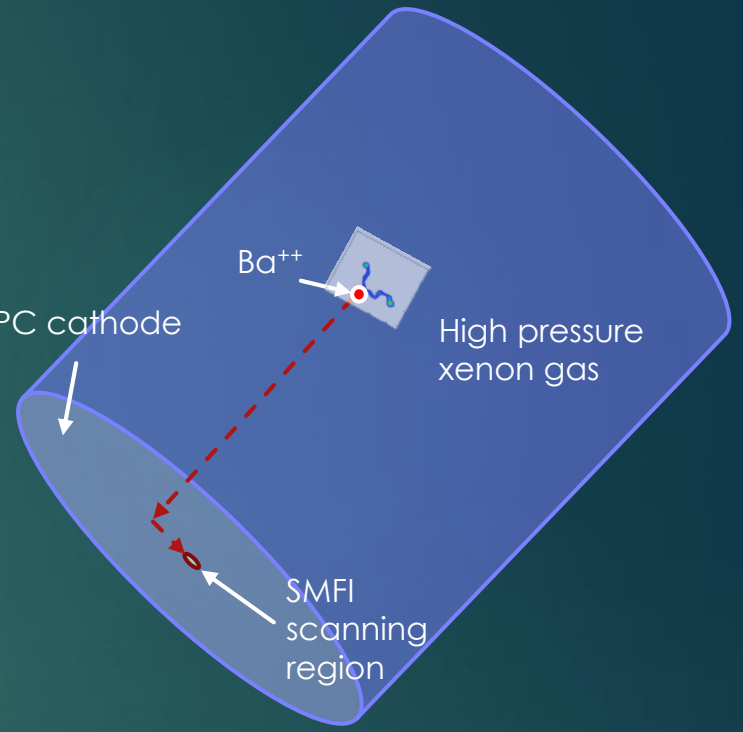
NEXT-BOLD: RF Carpet (Cathode based delivery system)





- Effort carried by UTA and ANL





- Experimental study of the drift properties of barium ion in high pressure
- Test of an RF carpet with a barium ion beam in ANL this year! Up to 1 bar

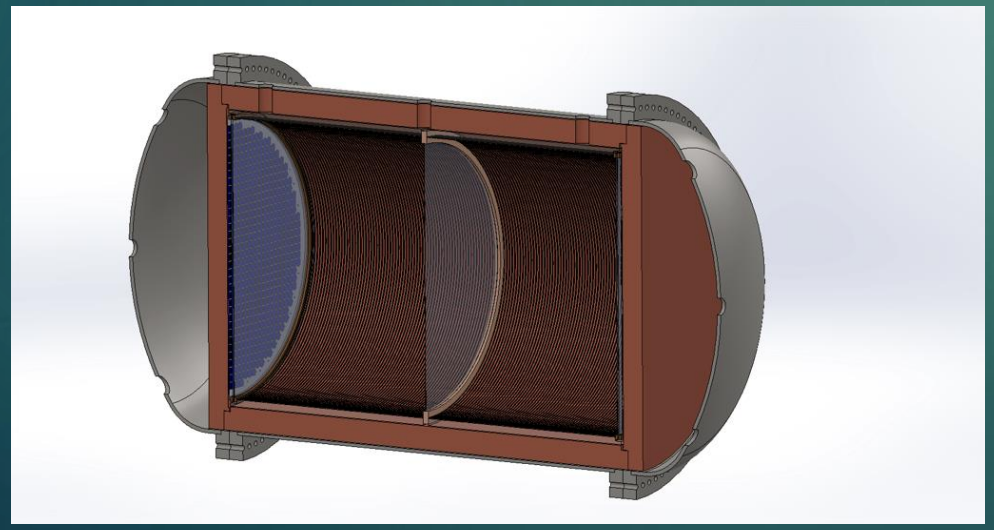
What has to be demonstrated:

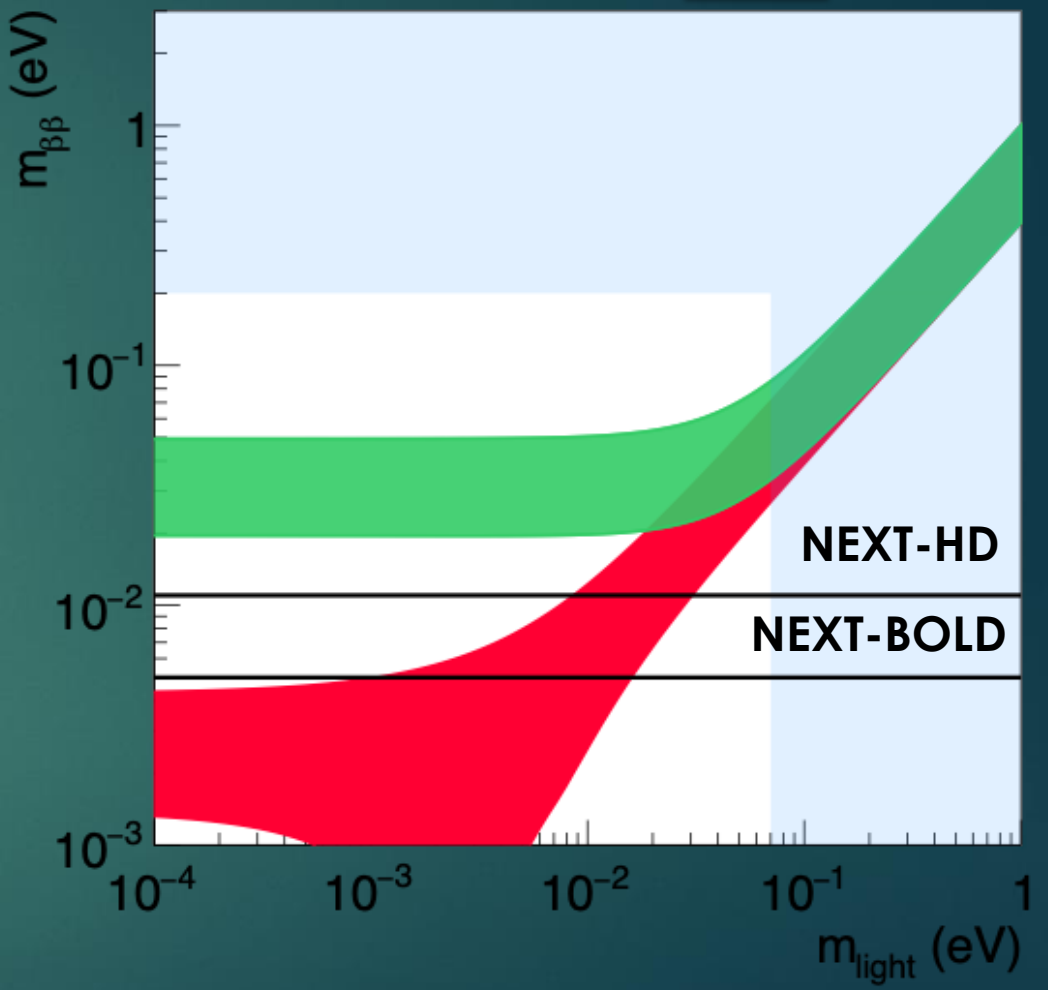
- Operation at high pressure
- With Xenon as a buffer gas
- High push field

Staged approach

- Phase 1 HD based on improving existing technology
  Improve topological background rejection
  Lower radioactive background (all SiPMs)

- Phase 2 BOLD: based on Barium tagging to reach a virtually background free experiment.





The NEXT Collaboration

USA

University of Texas Arlington · Argonne National Laboratory · Harvard · Fermilab · Texas A&M · Iowa State University · Pacific Northwest National Laboratory

Spain

DIPC · IFIC Institut de Física Corpuscular · Universitat de Girona · USC Universidade de Santiago de Compostela · Universidad de Zaragoza · Universitat Politècnica de València

Portugal, Israel, Colombia

U C · universidade de aveiro · Ben-Gurion University of the Negev · UAN Universidad Antonio Nariño

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