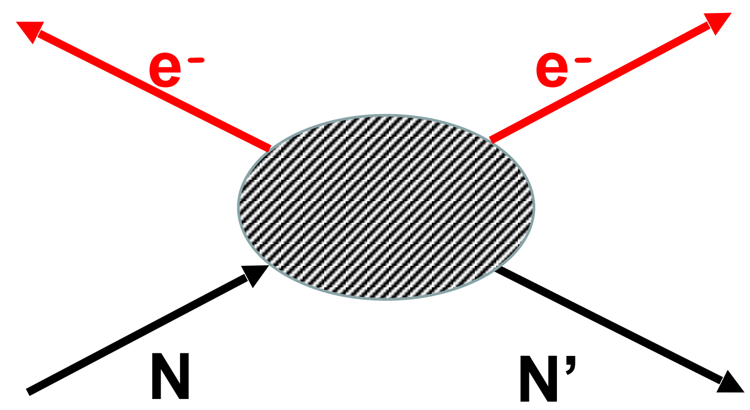
Latest results from EXO-200 and status of nEXO

J. Farine, Laurentian University, Sudbury
for the EXO–200 and nEXO collaborations

CAP SFU Burnaby 190605

“Black box” theorem*: “$0\nu\beta\beta$ decay always implies new physics”

There is no scenario in which observing $0\nu\beta\beta$ decay would not be a great discovery



➔Majorana neutrinos
➔Lepton number violation
➔Probe new mass mechanism up to the GUT scale
➔Probe key ingredient in generating cosmic baryon asymmetry

Neutrino masses have to be non-zero for $0\nu\beta\beta$ to be possible.
➔ Because the distinction between Dirac and Majorana particles is only observable for particles of non-zero mass.

Strictly speaking, this is the ONLY connection with neutrino masses relevant to discover new physics.

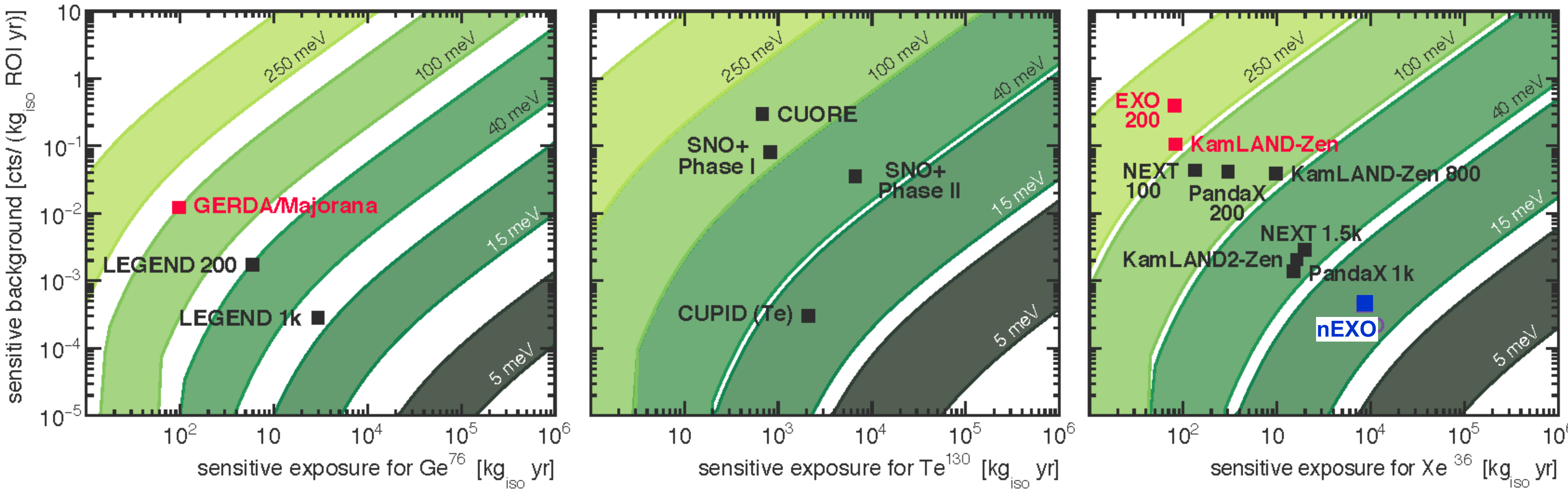
Hence it is appropriate to think of the sensitivity to new physics as scaling with $T_{1/2}$, irrespective of the neutrino mass scenarios. A $T_{1/2}$ sensitivity increase from ~10^{26} to ~10^{28} yr (~100x), should be compared, e.g., to the $\sqrt{s}$ increase from Tevatron to LHC (~20), although, admittedly, with a smaller array of channels for new physics.

* J. Schechter, and J. W. F. Valle, Phys. Rev. D25, 2951 (1982).

G. Gratta

The discovery potential was recently estimated for various proposals, assuming Type I seesaw, the free value of g_A and using a Bayesian analysis with flatly distributed priors

(Agostini, Benato, Detwiler, PRD 96 (2017) 053001
also A. Caldwell et al., PRD 96 (2017) 073001)



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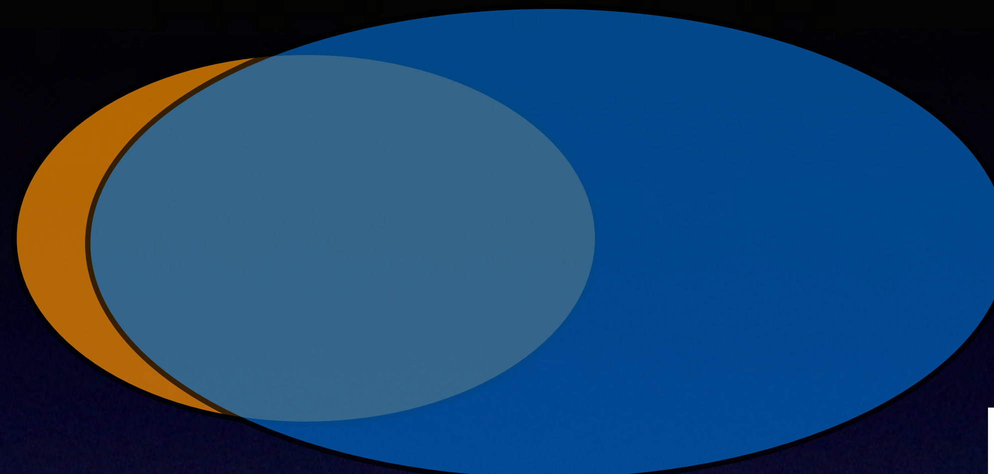
EXO programme



I. EXO-200

- 200 kg of Xe, enriched in 136Xe @ 80%
- Taking data since 2010 @ WIPP, NM USA
- Publications:

  2011 – first observations of $2\nu\beta\beta$ in ^{136}Xe

  2012 – first $0\nu\beta\beta$ results: $m_{\beta\beta} < 140$ meV

  2013 – (most) precise $T^{1/2}{}_{2\nu\beta\beta} = 2.17 \times 10^{21}$ yr

  2014 – improved sensitivity to $0\nu\beta\beta$ (Nature)
- Background at targeted / accounted levels

II. nEXO

- 5T of 90% ^{enr}Xe – probe IH
- Low risk concept based on successes from EXO-200
- SNOLAB possible host lab

III. Possible futures

- Ba tagging
- Gas

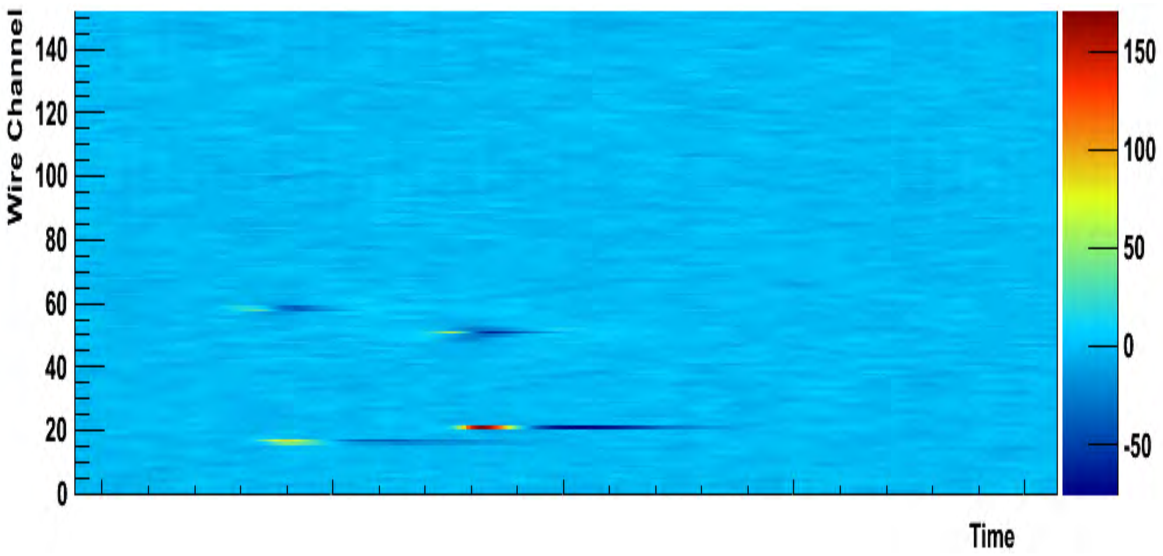
But first, probe nature at IH

Energy resolution

Particularly for large detectors, it is <u>only one</u> of the parameters used for background rejection:

- **Energy measurement (for small detectors this is ~all there is).**
- **Event multiplicity (γ's Compton scatter depositing energy in more than one site).**
- **For large, monolithic detectors, depth is powerful discriminant against background.**
- **α discrimination (from e^- / γ), possible in many detectors.**

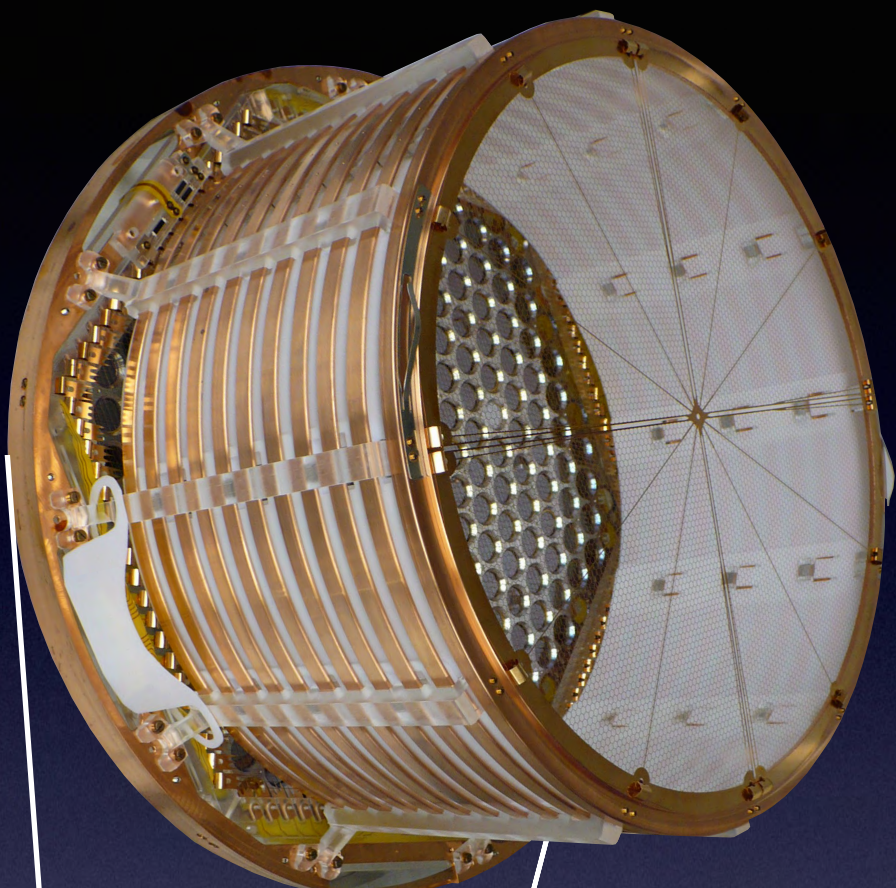
A Compton event in EXO-200

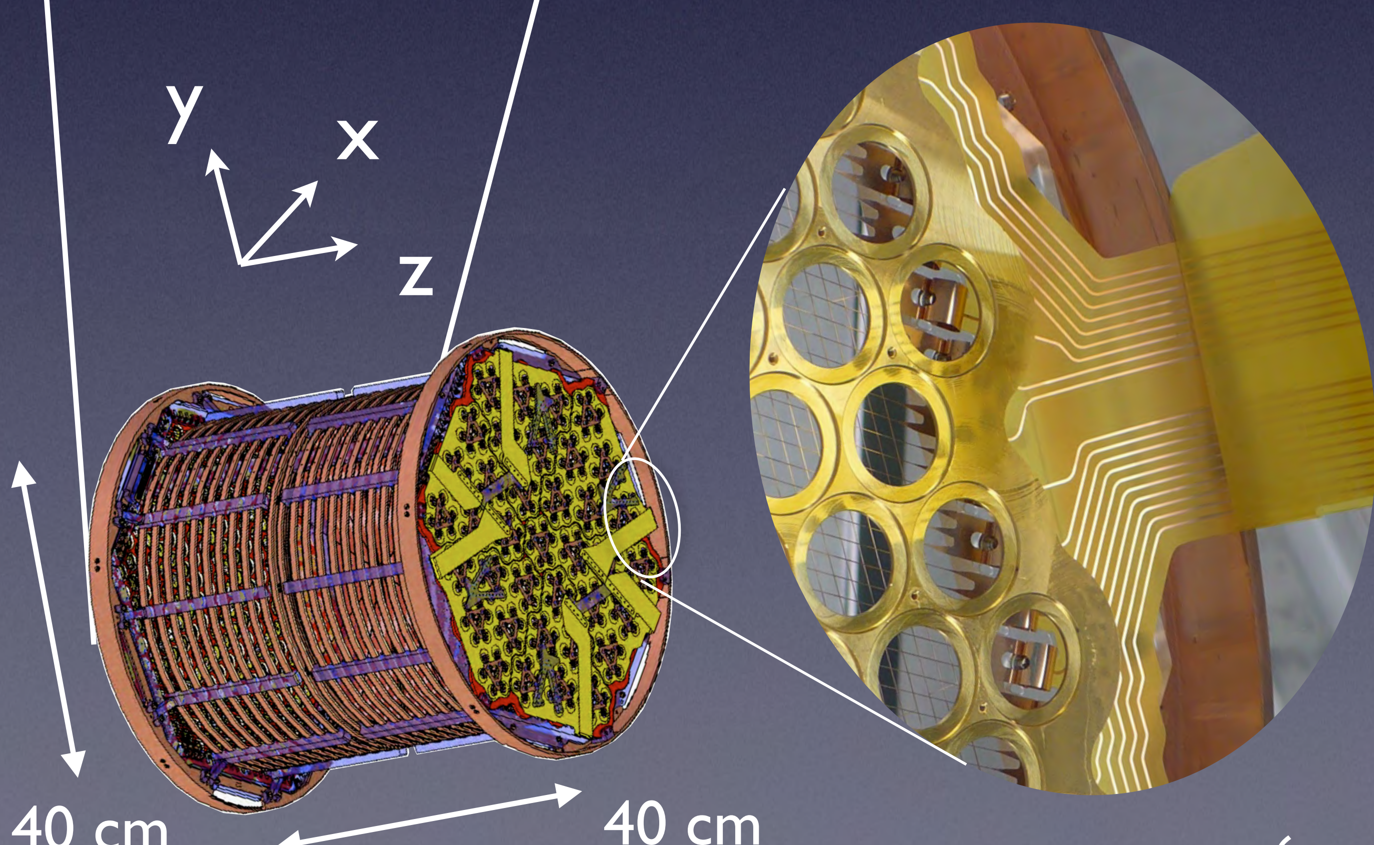


It is a real triumph of recent experiments that we now have discrimination tools in this challenging few MeV regime!

Powerful detectors use most of (possibly all) these parameters in combination, providing the best possible background rejection and simultaneously fitting for signal and background.

The EXO-200 TPC





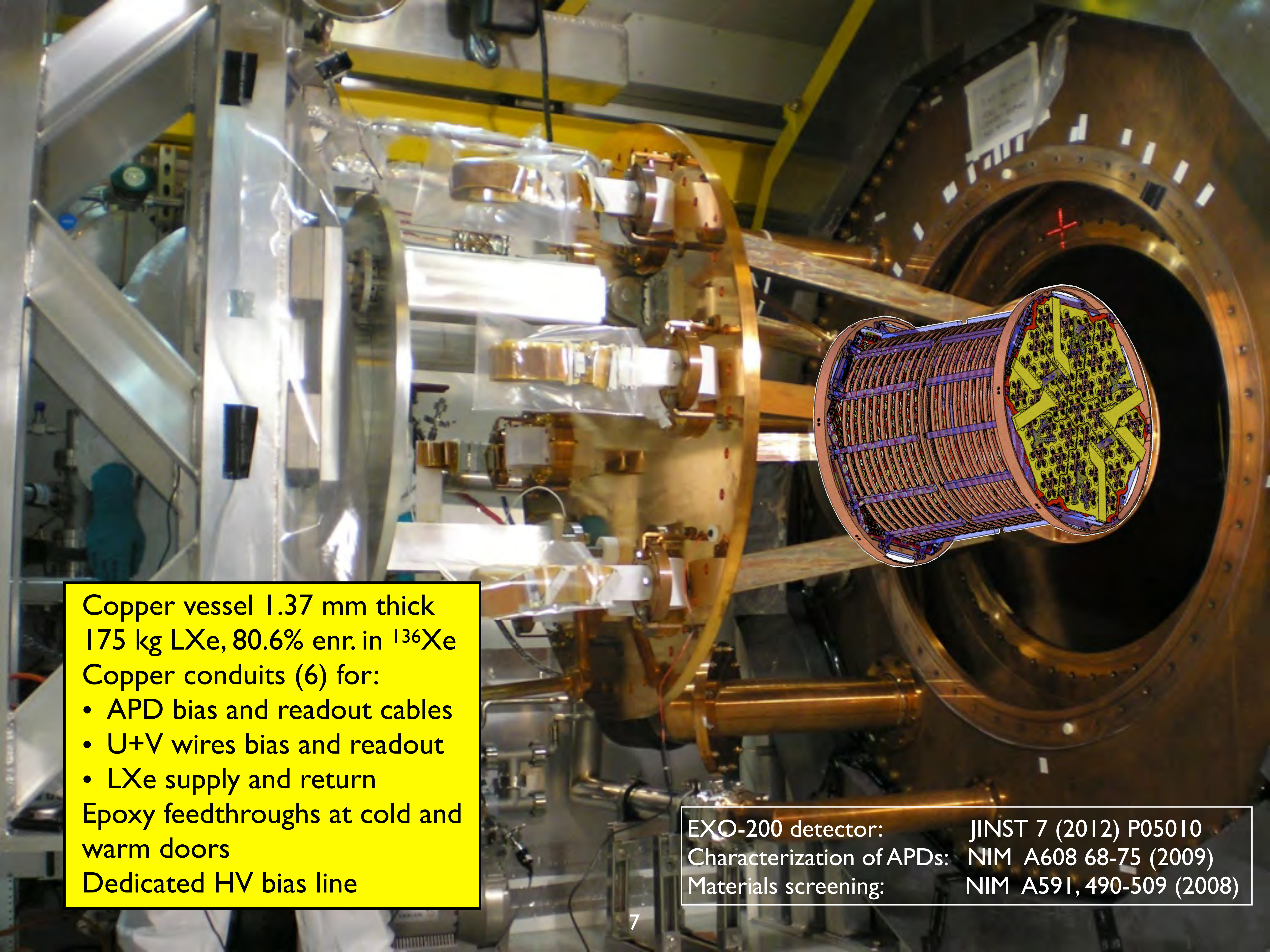
Two almost identical halves reading ionization and 178 nm scintillation, each with:

- 38 U triplet wire channels (charge)
- 38 V triplet wire channels, crossed at 60° (induction)
- 234 large area avalanche photodiodes (APDs, light in groups of 7)
- Wire pitch 3 mm (9 mm per channel)
- Wire planes 6 mm apart and 6 mm from APD plane
- All signals digitized at 1 MS/s, ±1024S around trigger
- Drift field 380 V/cm (Phase I) > 567 V/m (Phase II)

- Field shaping rings: copper
- Supports: acrylic
- Light reflectors/diffusers: Teflon
- APD support plane: copper; Au (Al) coated for contact (light reflection)
- Central cathode, U+V wires: photo-etched phosphor bronze
- Flex cables for bias/readout: copper on kapton, no glue

Comprehensive material screening program

Goal: 40 cnts/2y in $0\nu\beta\beta$ $\pm 2\sigma$ ROI, 140 kg LXe



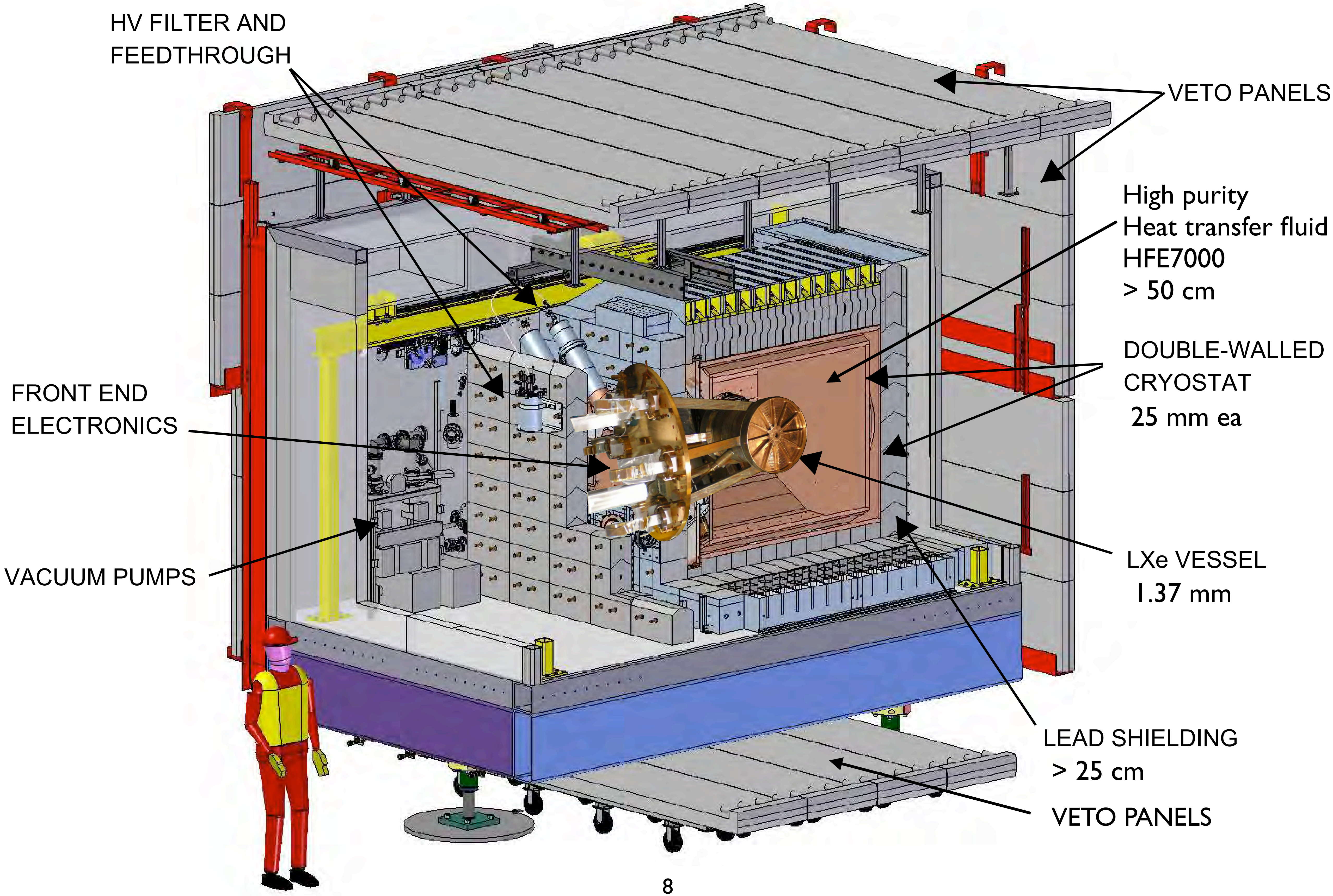
Copper vessel 1.37 mm thick
175 kg LXe, 80.6% enr. in ^{136}Xe
Copper conduits (6) for:

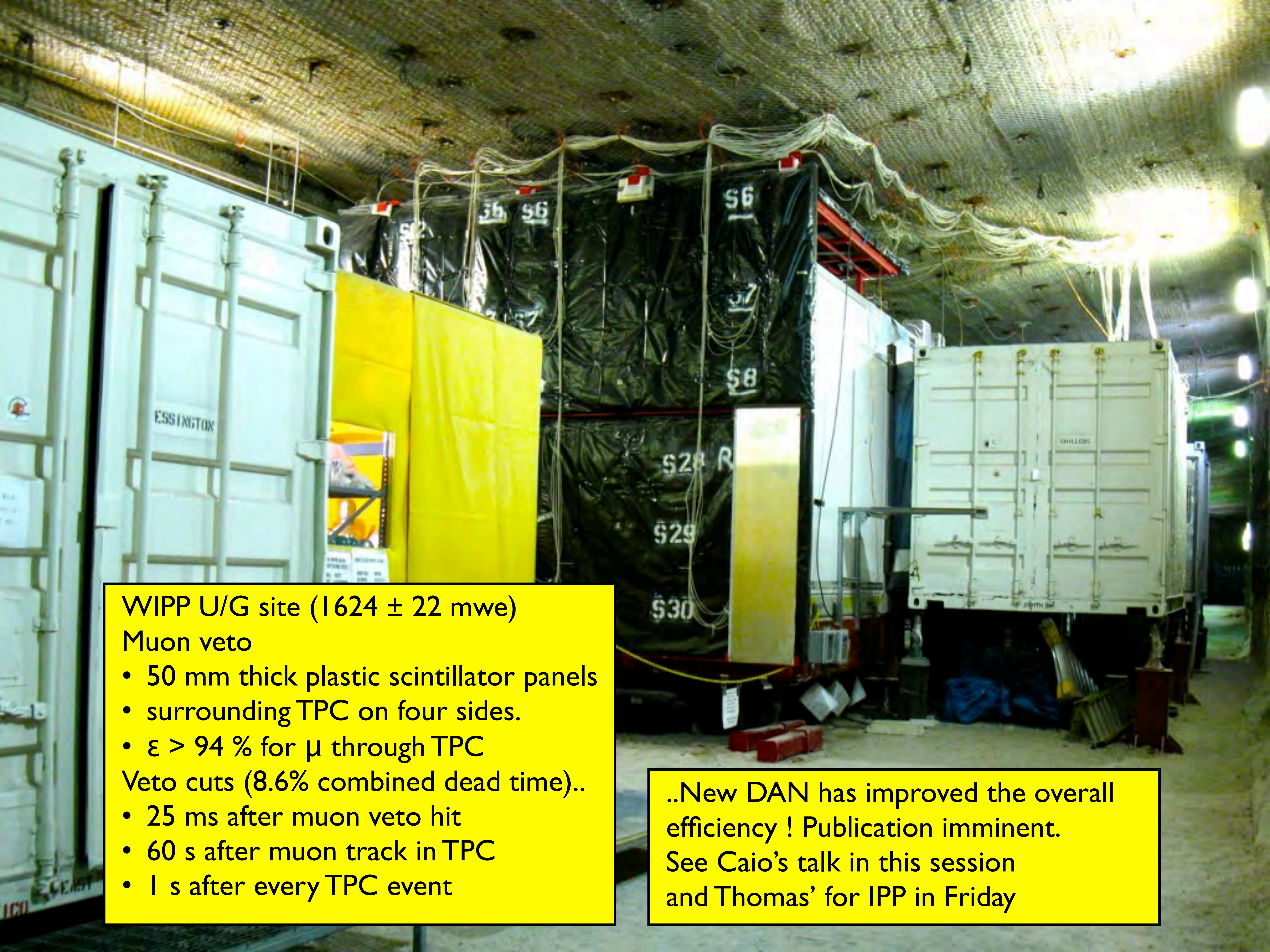
- APD bias and readout cables
- U+V wires bias and readout
- LXe supply and return

Epoxy feedthroughs at cold and warm doors
Dedicated HV bias line

EXO-200 detector: JINST 7 (2012) P05010
Characterization of APDs: NIM A608 68-75 (2009)
Materials screening: NIM A591, 490-509 (2008)

The EXO-200 Detector





WIPP U/G site (1624 ± 22 mwe)
Muon veto

- 50 mm thick plastic scintillator panels
- surrounding TPC on four sides.
- ε > 94 % for μ through TPC

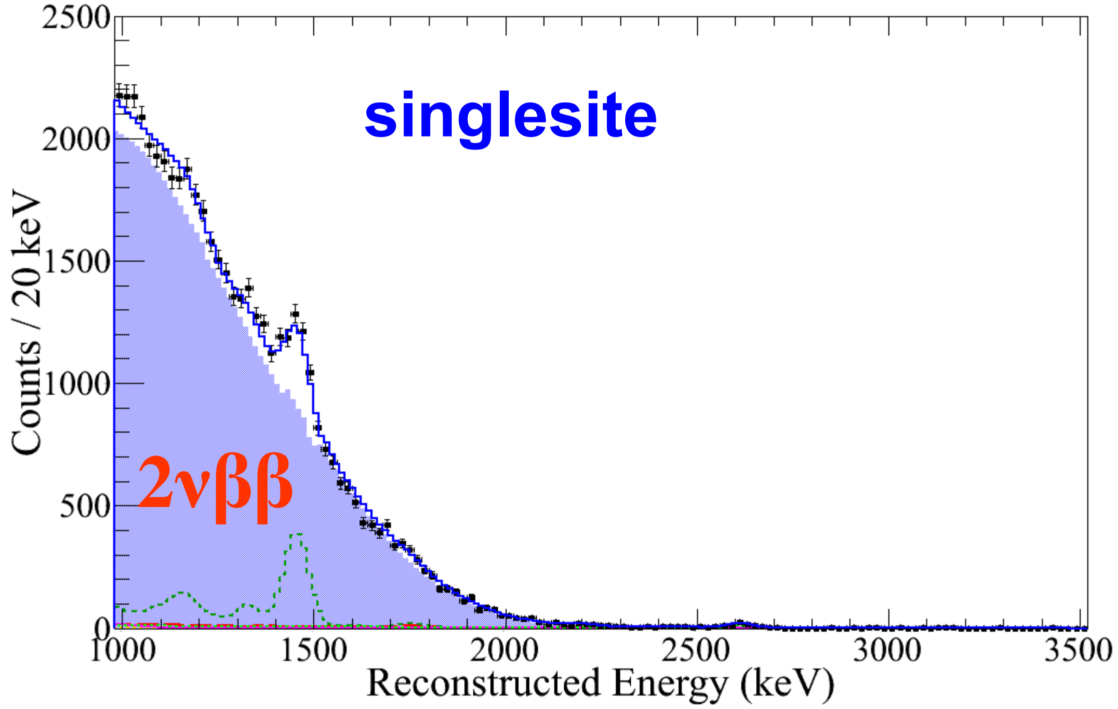
Veto cuts (8.6% combined dead time)..

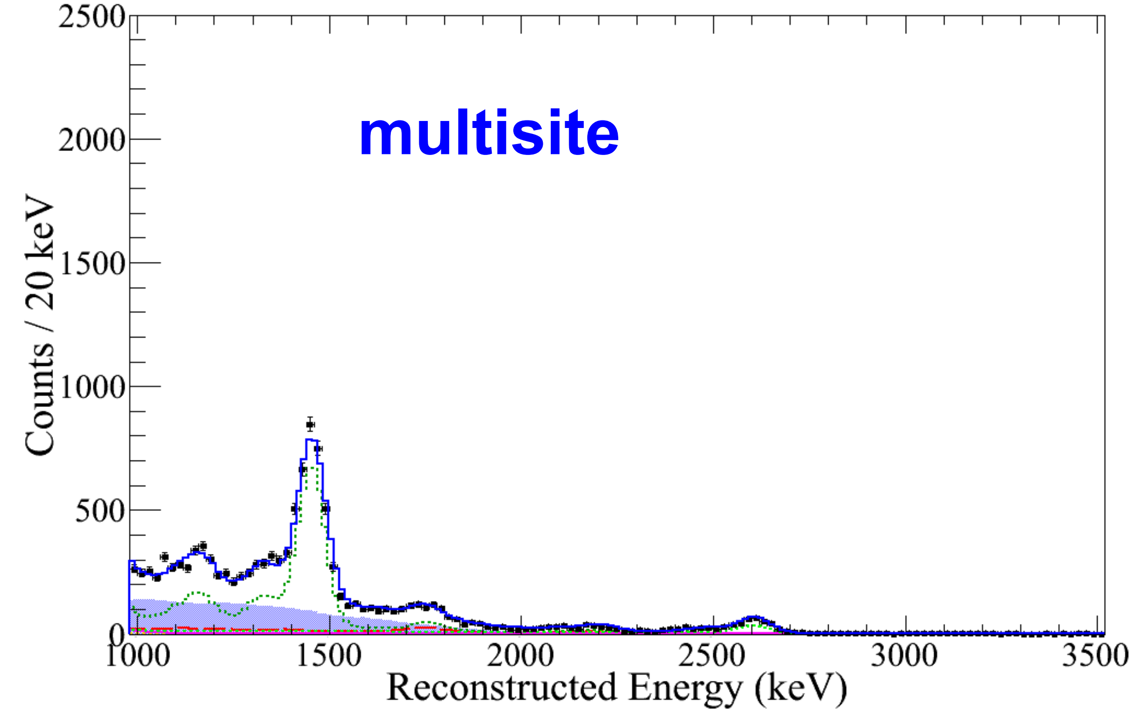
- 25 ms after muon veto hit
- 60 s after muon track in TPC
- 1 s after every TPC event

..New DAN has improved the overall efficiency ! Publication imminent.
See Caio's talk in this session
and Thomas' for IPP in Friday

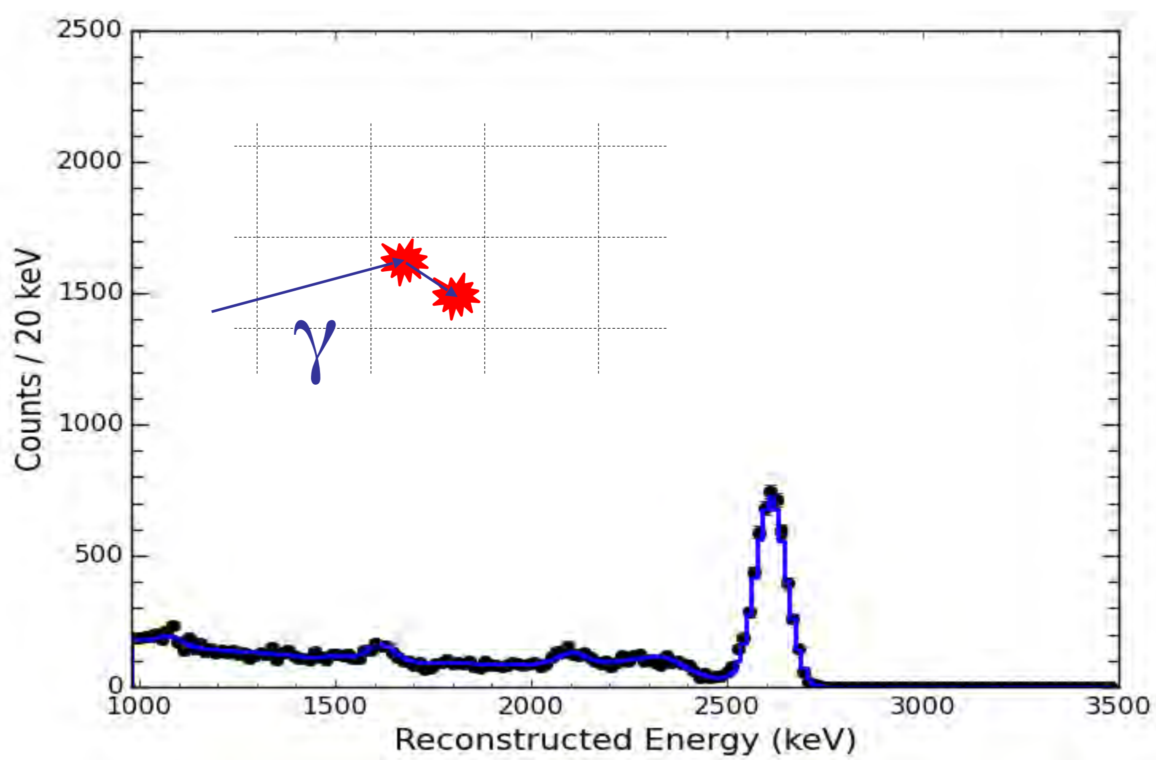
Using event multiplicity to recognize backgrounds

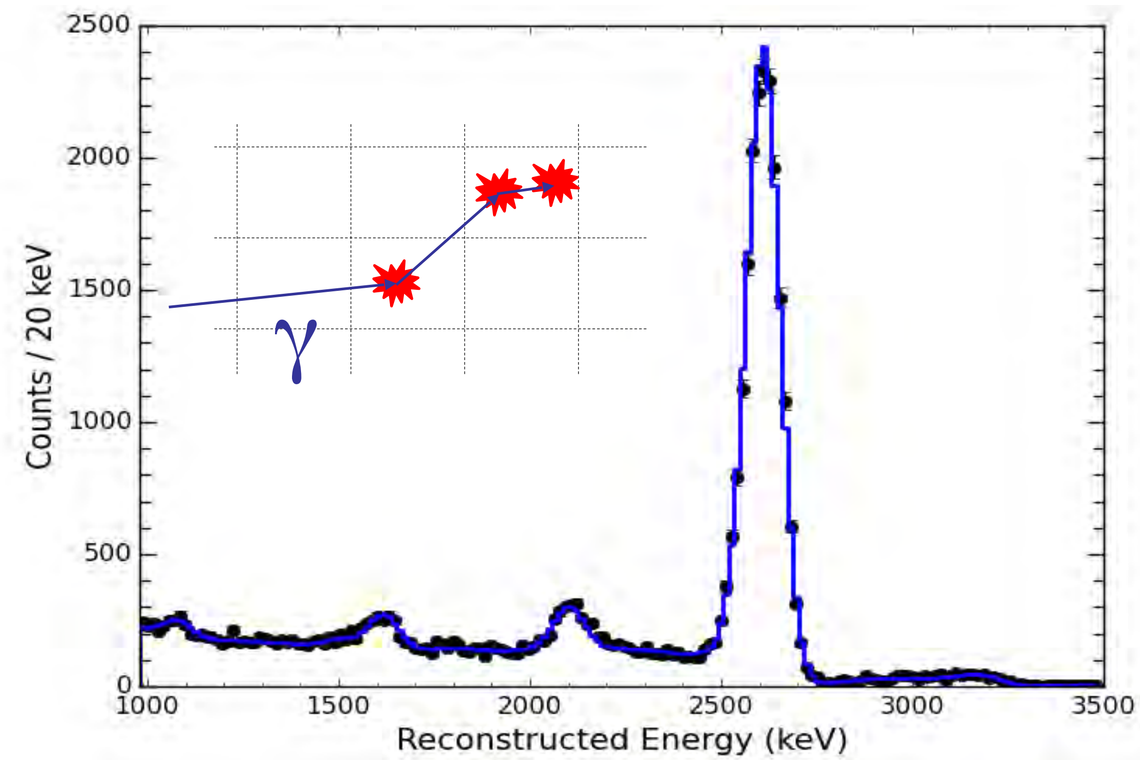
Low background data





^{228}Th calibration source





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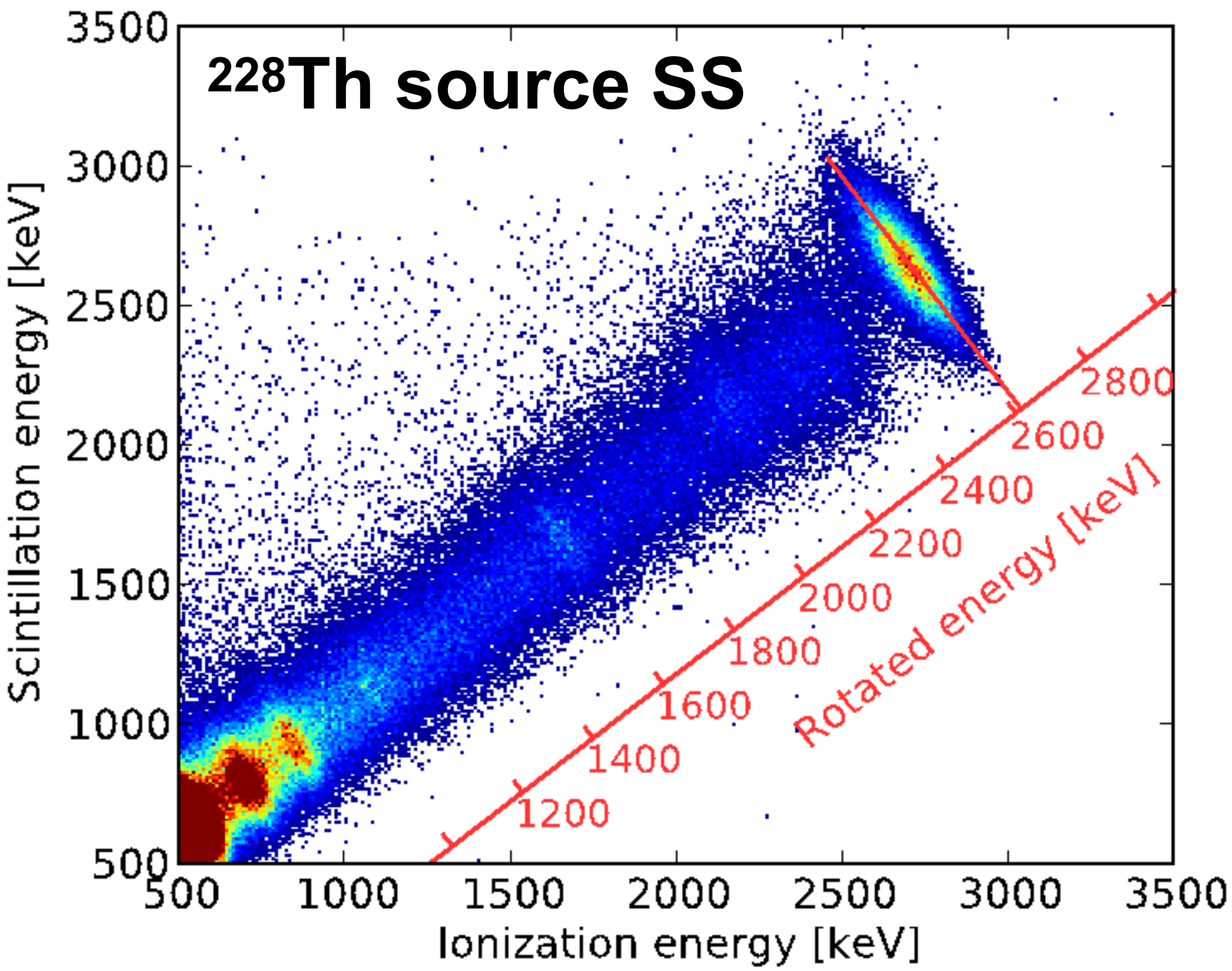
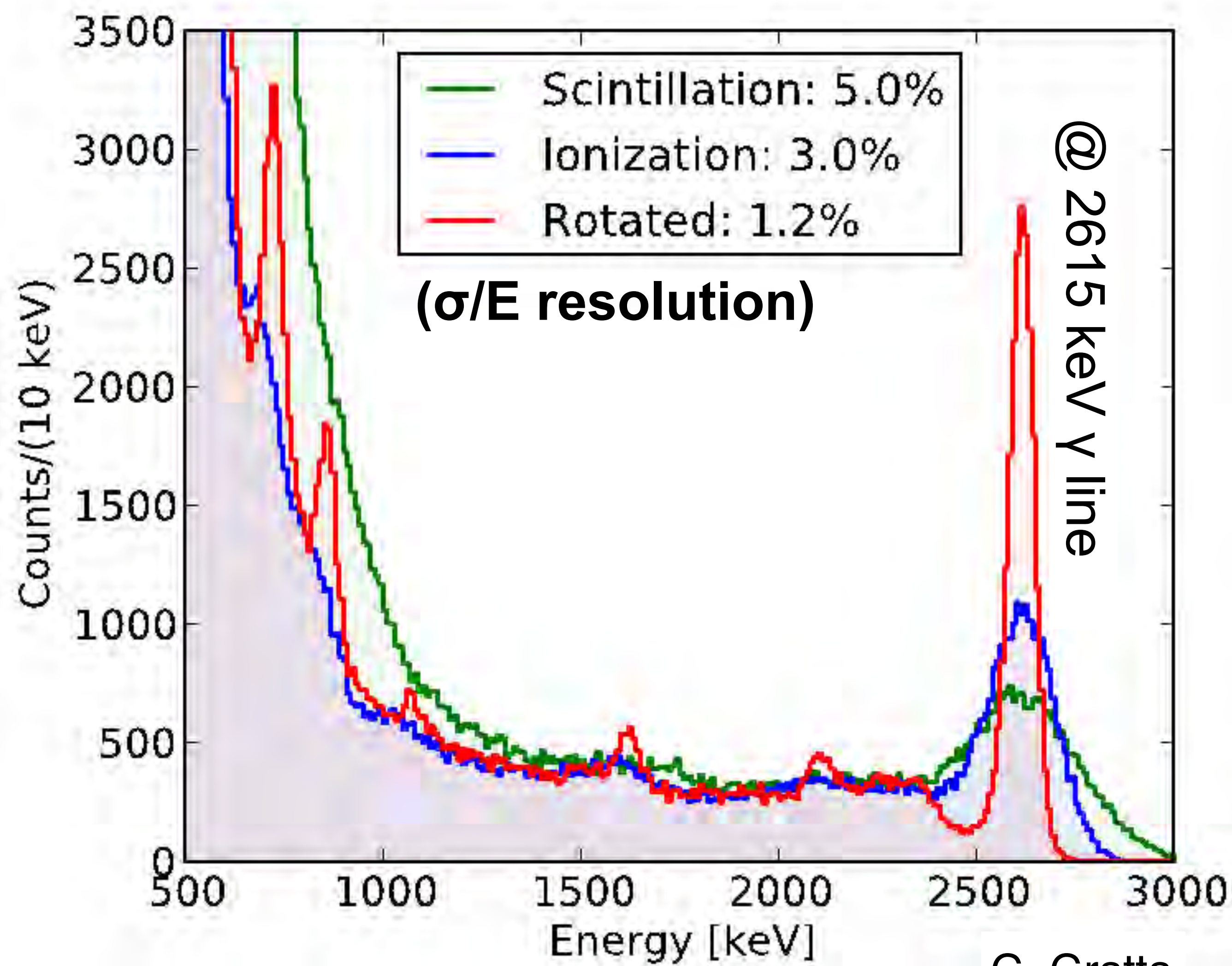
Combining Ionization and Scintillation



Anticorrelation between scintillation and ionization in LXe known since early EXO R&D

E.Conti et al.
Phys Rev B 68 (2003) 054201

By now this is
a common technique in LXe



Rotation angle chosen to optimize energy resolution at 2615 keV

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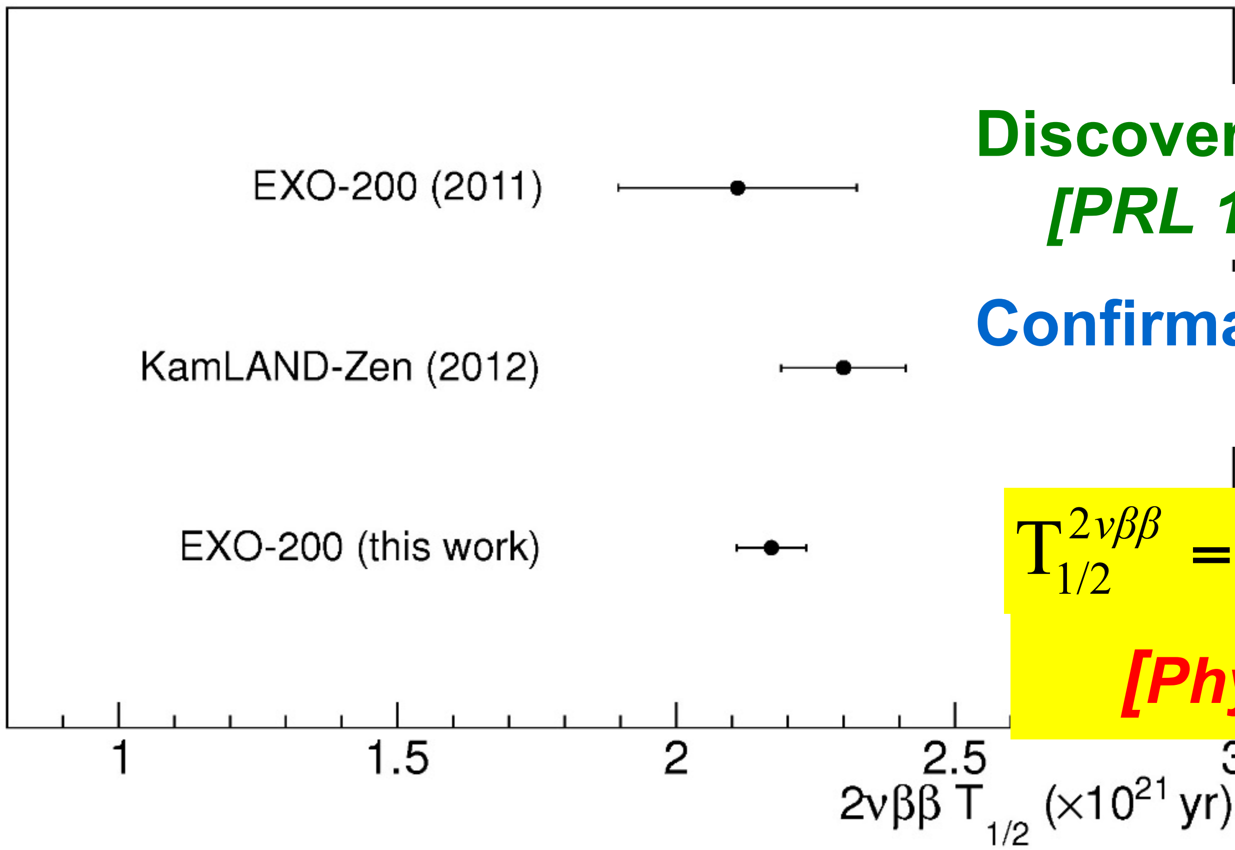
2-neutrino half lives



Discovery of 2ν mode in ^{136}Xe
[PRL 107, 212501 (2011)]

Confirmation by KamLAND-Zen
[PRC 85, 045504 (2012)]

$$T_{1/2}^{2\nu\beta\beta} = \left(2.165 \pm 0.016^{\text{stat}} \pm 0.059^{\text{syst}}\right) 10^{21}\ \text{yr}$$

[Phys. Rev. C 89 (2014) 015502]

At 2.7%, this is still the best measurement of any 2ν mode* and the longest 2ν half life.

*** Recent measurements in ^{130}Te and ^{76}Ge have almost-as-good accuracies**

> Caio will provide an update on recent data analysis improvements (same session)

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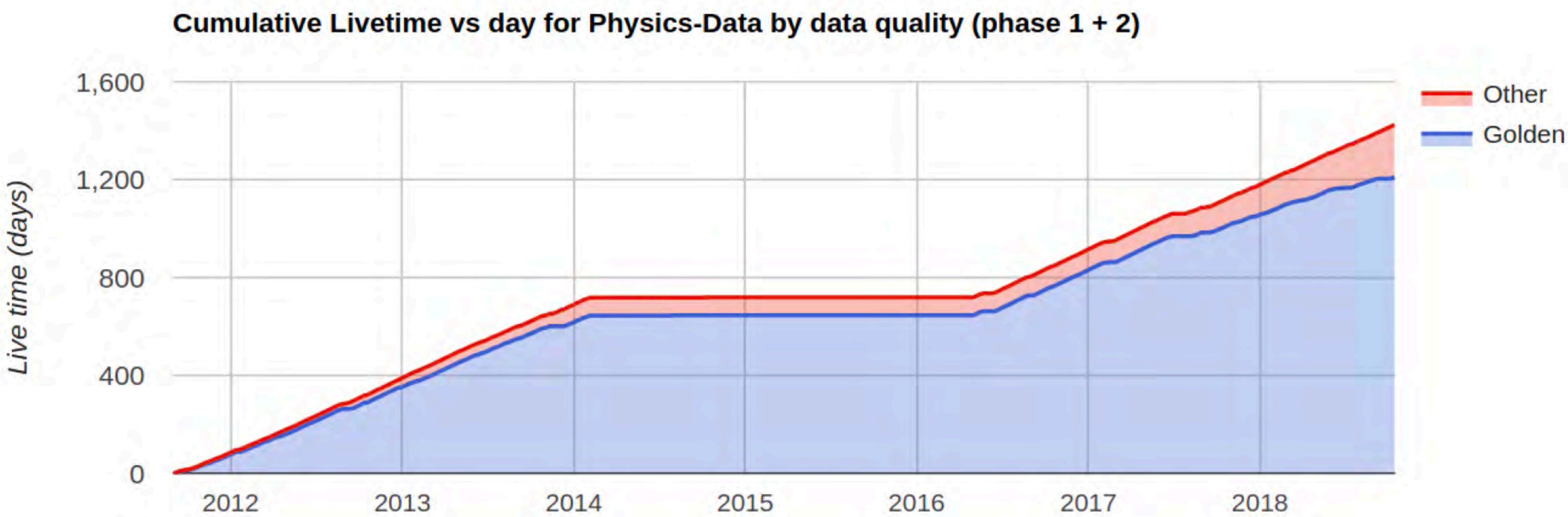
EXO-200 successfully completed its operation in 2018

Oct. 2018: End of physics data taking

Nov. 2018: Detector calibration campaign, including special sources

Dec. 2018: Detector decommissioning

Feb. 2019: Packed equipment leaving WIPP, on its way to SLAC for



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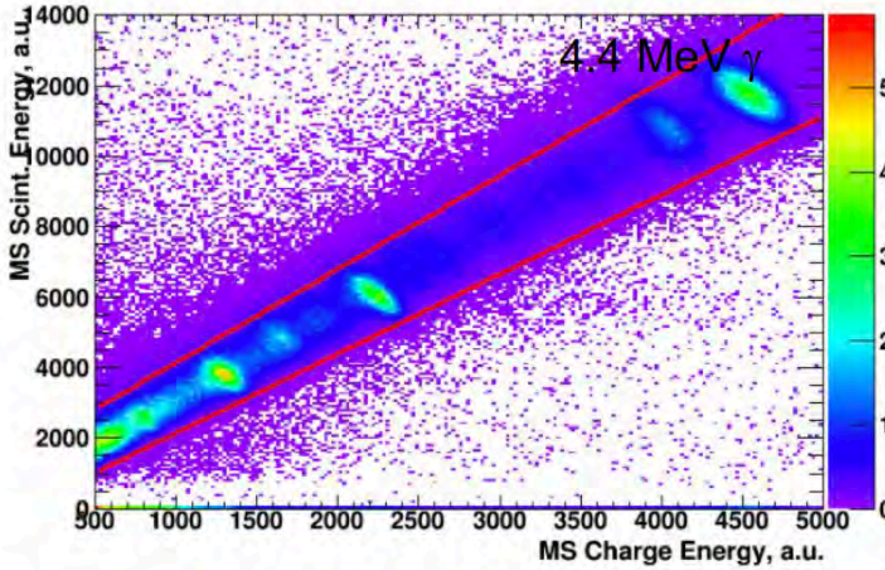
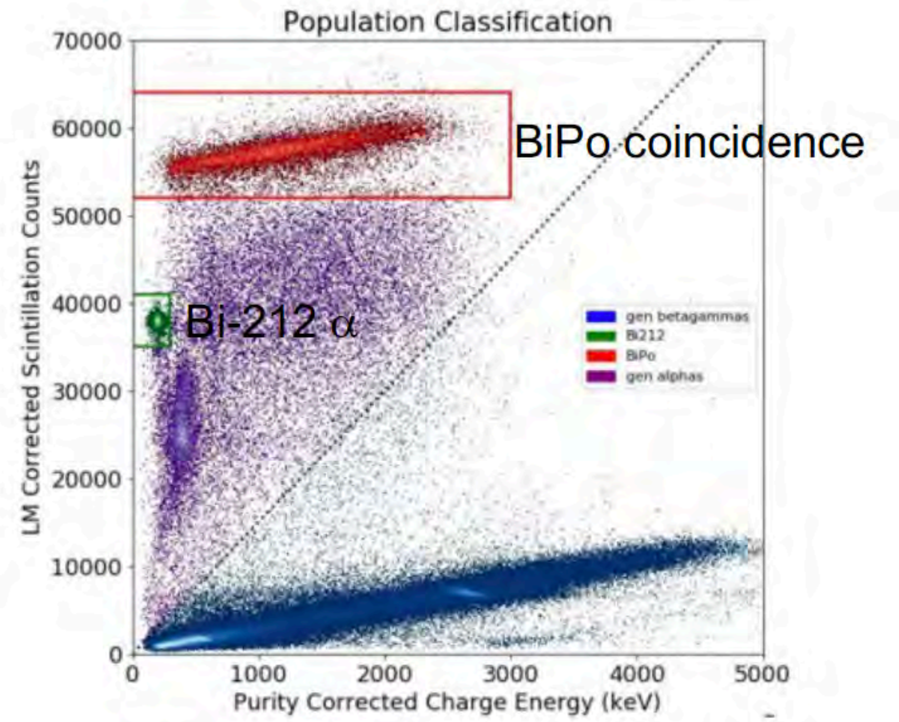
End-of-Run Calibration Campaign

- **AmBe neutron source**
  - Calibration of high energy region and ^{137}Xe β spectrum.
- **Internal ^{220}Rn and ^{222}Rn sources**
  - High statistics lightmap
  - Tracer for Xe flow studies
  - Feasibility study for nEXO
- **Low electric field, high gain APD runs**
  - LXe physics studies
  - Data can be used to improve NEST simulation
- **High voltage test**
  - Increased the cathode voltage from -12 kV to -25 kV after training
  - Highest field (> 1kV/cm) achieved among all large scale LXe detectors

> this data will inform the detailed design of nEXO



AmBe neutron source data



^{220}Rn internal source data

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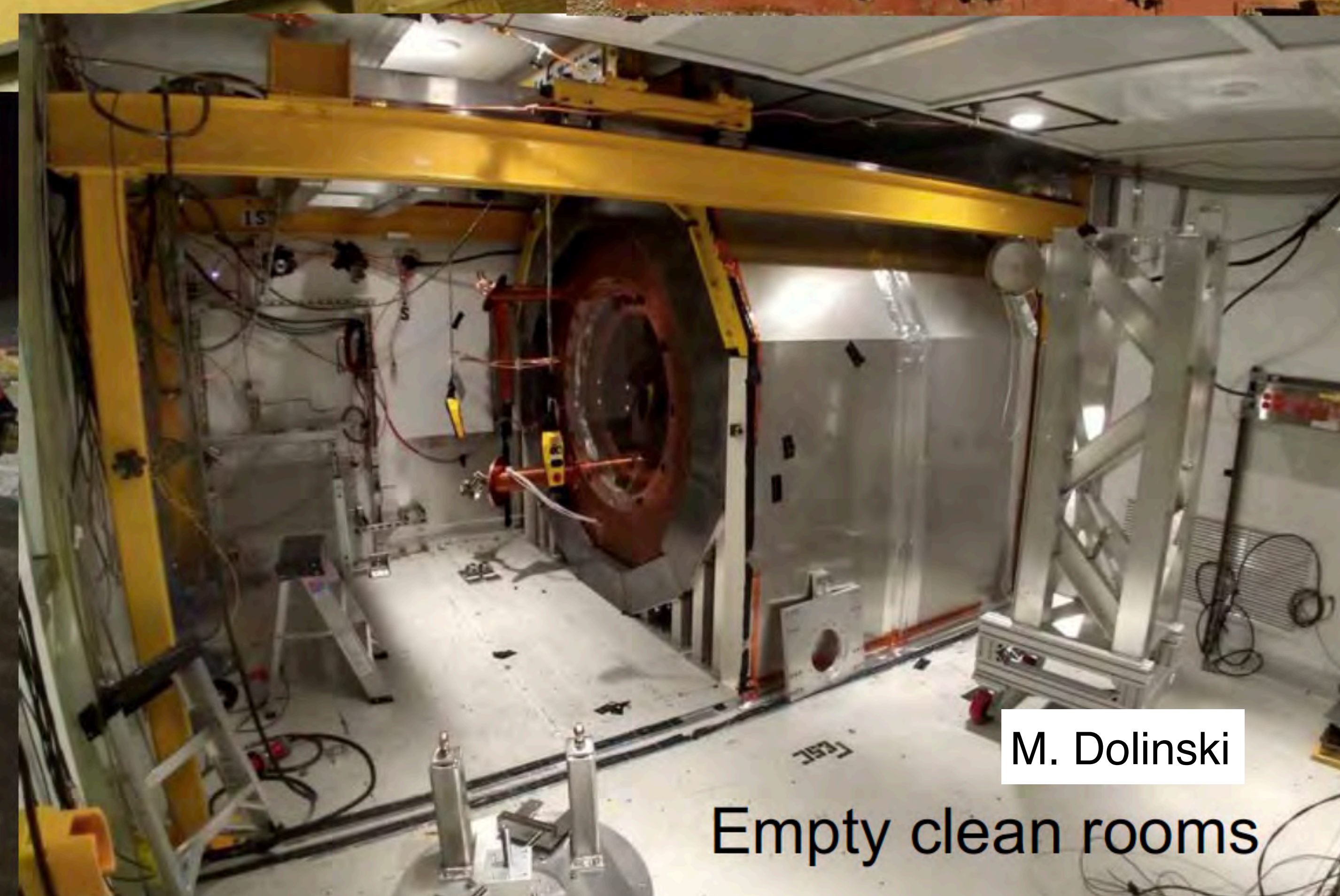
Detector Decommissioning

Lead wall removal

Packed Xe plumbing

Packed Xe Bottles

Veto panel removal



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Empty clean rooms

Some statistics

- ~ 3,600 days underground occupancy at WIPP
- ~ 260 kg yr exposure of ^{136}Xe
- 30 publications, 27 Ph.D. theses **and counting**
- 10032 runs taken, ~ 100 TB data recorded
- ~ 100 Shifters, ~ 23,000 shifts taken (onsite/remote)
- 73318 daily log entries
- ~ 4500 cups of coffee underground

~ 60,000 ^{136}Xe $2\nu\beta\beta$ decay observed

Truck departing WIPP

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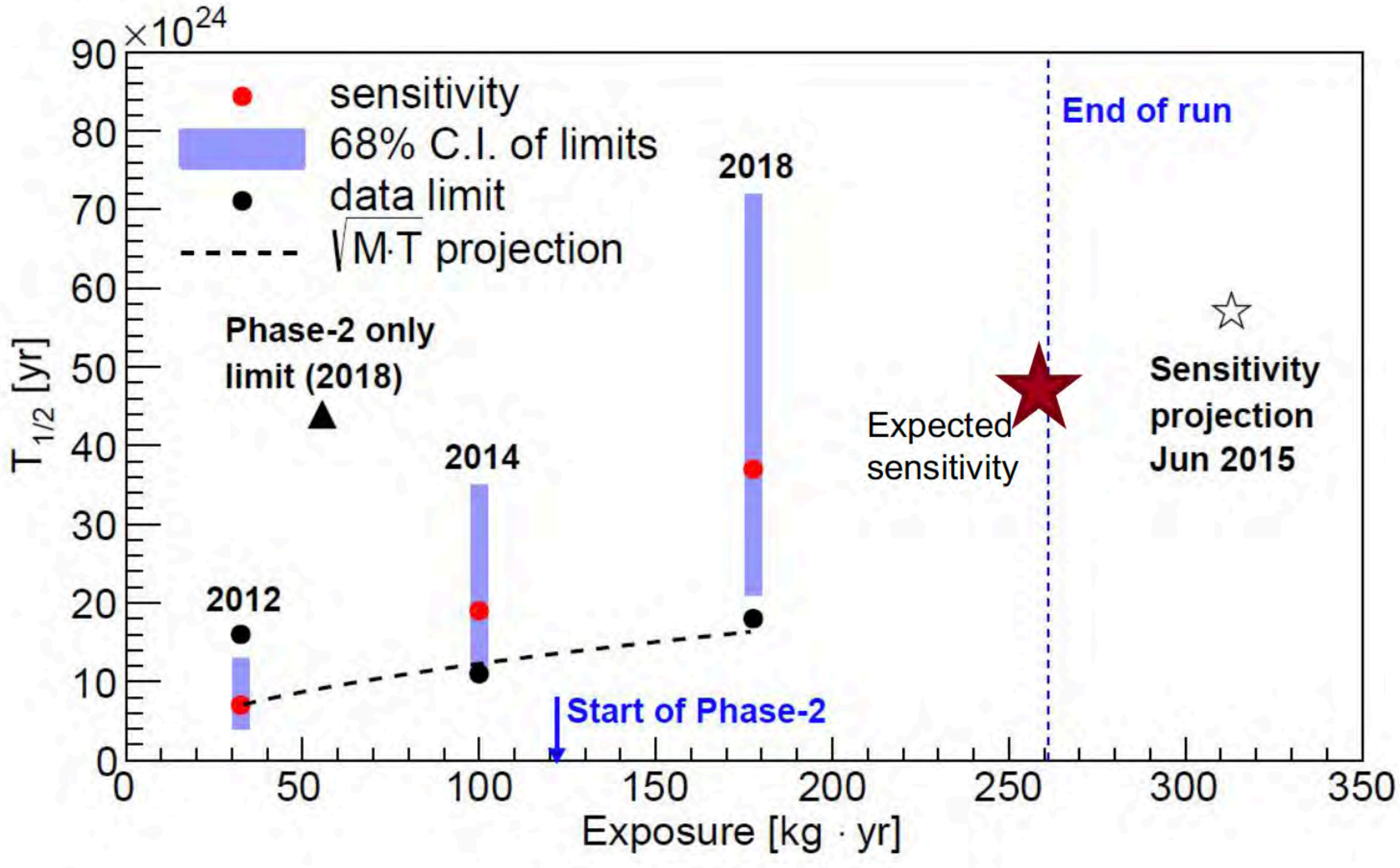
EXO-200 $0\nu\beta\beta$ Sensitivity

	Sensitivity (yr)	90% CL Limit (yr)	$\langle m_{\beta\beta} \rangle$ (meV)
PRL 109, 032505 (2012)	0.7×10^{25}	1.6×10^{25}	
Nature 510, 229 (2014)	1.9×10^{25}	1.1×10^{25}	
PRL 120 072701 (2018)	3.8×10^{25}	1.8×10^{25}	147-398



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EXO-200 publications to date

- In preparation: "Search for Neutrinoless Double-Beta Decay with the Complete EXO-200 Dataset"
- S. Delaquis et al. "Deep Neural Networks for Energy and Position Reconstruction in EXO-200" 2018_JINST_13_P08023
- J.B. Albert et al. "Search for nucleon decays with EXO-200" PRD 97 (2018) 072007
- J.B. Albert et al. "Search for $0\nu\beta\beta$ Decay with the Upgraded EXO-200 Detector" PRL 120 (2018) 072701
- D.S. Leonard et al. "Trace radioactive impurities in final construction materials for EXO-200" NIMA 871 (2017) 169
- J.B. Albert et al. "Searches for Double Beta Decay of 134Xe with EXO-200" PRD 96 (2017) 092001
- J.B. Albert et al. "Measurement of the Drift Velocity and Transverse Diffusion of Electrons in Liquid Xenon with the EXO-200 Detector" PRC 95 (2017) 025502
- C.G. Davis et al. "An Optimal Energy Estimator to Reduce Correlated Noise for the EXO-200 Light Readout" JINST 11 (2016) P07015
- J.B. Albert et al. "Cosmogenic Backgrounds to $0\nu\beta\beta$ in EXO-200" J. Cosmol. Astropart. Phys. 4 (2016) 029
- J.B. Albert et al. "First Search for Lorentz and CPT Violation in $\beta\beta$ Decay with EXO-200" PRD 93 (2016) 072001
- J.B. Albert et al. "Search for $2\nu\beta\beta$ decay of 136Xe to the 0_1+ excited state of 136Ba with EXO-200" PRC 93 (2016) 035501
- J.B. Albert et al. "Measurements of the ion fraction and mobility of alpha and beta decay products in LXe using EXO-200" PRC 92 (2015) 045504.
- J.B. Albert et al. "Investigation of radioactivity-induced backgrounds in EXO-200" PRC 92 (2015) 015503
- J.B. Albert, et al. "Search for Majoron-emitting modes of $\beta\beta$ decay of 136Xe with EXO-200" PRD 90 (2014) 092004
- J.B. Albert, et al. "Search for Majorana neutrinos with the first two years of EXO-200 data" Nature 510 (2014) 229
- J.B. Albert, et al. "An improved measurement of the $2\nu\beta\beta$ half-life of 136Xe with EXO-200" PRC 89 (2014) 015502
- M. Auger, et al. "Search for Neutrinoless $\beta\beta$ Decay in 136Xe with EXO-200" PRL 109 (2012) 032505
- M. Auger, et al. "The EXO-200 detector, part I: Detector design and construction" J. Inst 7 (2012) P05010
- A. Dobi, et al. "Xenon purity analysis for EXO-200 via mass spectrometry" NIM A 675 (2012) 40
- N. Ackerman, et al. "Observation of Two-Neutrino $\beta\beta$ Decay in Xe-136 with EXO-200" PRL 107 (2011) 212501
- A. Dobi, et al. "A Xenon Gas Purity Monitor for EXO" NIM A 659 (2011) 215
- F. LePort, et al. "A magnetically-driven piston pump for ultra-clean applications" Rev. Sci. Inst. 82 (2011) 105114
- R. Neilson, et al. "Characterization of large area APDs for the EXO-200 detector" NIM A 608 (2009) 6875
- D. Leonard, et al. "Systematic study of trace radioactive impurities in candidate construction materials for EXO-200" Nucl. Ins. Meth. A 591 (2008) 490

University of Alabama, Tuscaloosa AL, USA — M Hughes, O Nusair, I Ostrovskiy, A Piepke, AK Soma, V Veeraraghavan
University of Bern, Switzerland — J-L Vuilleumier
University of California, Irvine, Irvine CA, USA — M Moe
California Institute of Technology, Pasadena CA, USA — P Vogel
Carleton University, Ottawa ON, Canada — I Badhrees, R Gornea, C Jessiman, T Koffas, D Sinclair, B Veenstra, J Watkins
Colorado State University, Fort Collins CO, USA — C Chambers, A Craycraft, D Fairbank, W Fairbank Jr, A Iverson, J Todd
Drexel University, Philadelphia PA, USA — MJ Dolinski, P Gautam, EV Hansen, YH Lin, Y-R Yen
Duke University, Durham NC, USA — PS Barbeau, J Runge
Friedrich-Alexander-University Erlangen, Nuremberg, Germany — G Anton, J Hoessl, P Hufschmidt, T Michel, M Wagenpfeil, S Schmidt, G Wrede, T Ziegler
IBS Center for Underground Physics, Daejeon, South Korea — DS Leonard
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ITEP Moscow, Russia — V Belov, A Burenkov, M Danilov, A Dolgolenko, A Karelin, A Kuchenkov, V Stekhanov, O Zeldovich

The EXO-200 Collaboration

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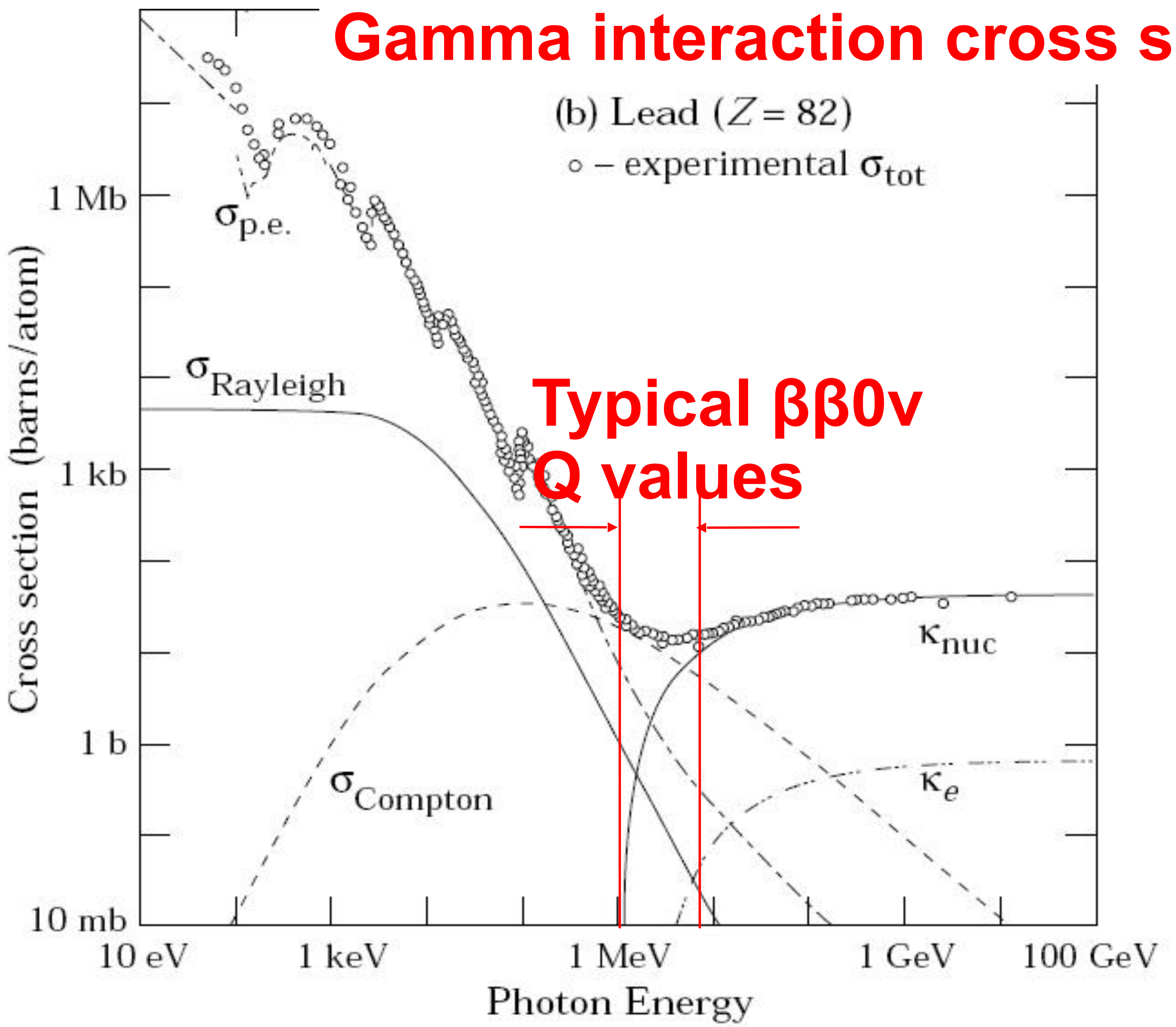
SLAC National Accelerator Laboratory, Menlo Park CA, USA — M Breidenbach, R Conley, J Davis, S Delaquis, A Johnson, LJ Kaufman, B Mong, A Odian, CY Prescott, PC Rowson, JJ Russell, K Skarpaas, A Waite, M Wittgen
University of South Dakota, Vermillion SD, USA — A Larson, R MacLellan
Stanford University, Stanford CA, USA — J Dalmasson, R DeVoe, D Fudenberg, G Gratta, M Jewell, S Kravitz, B Lenardo, G Li, A Schubert, M Weber, S Wu
Stony Brook University, SUNY, Stony Brook, NY, USA — K Kumar, O Njoya
Technical University of Munich, Garching, Germany — P Fierlinger
TRIUMF, Vancouver BC, Canada — J Dilling, R Krücken, Y Lan, F Retière, V Strickland
Yale University, New Haven CT, USA — A Jamil, Z Li, D Moore, Q Xia

Shielding a detector from ~MeV γs is difficult!



Example:
γ interaction length in Ge is 4.6 cm, comparable to the size of a germanium detector.

Shielding ββ decay detectors is much harder than shielding Dark Matter ones

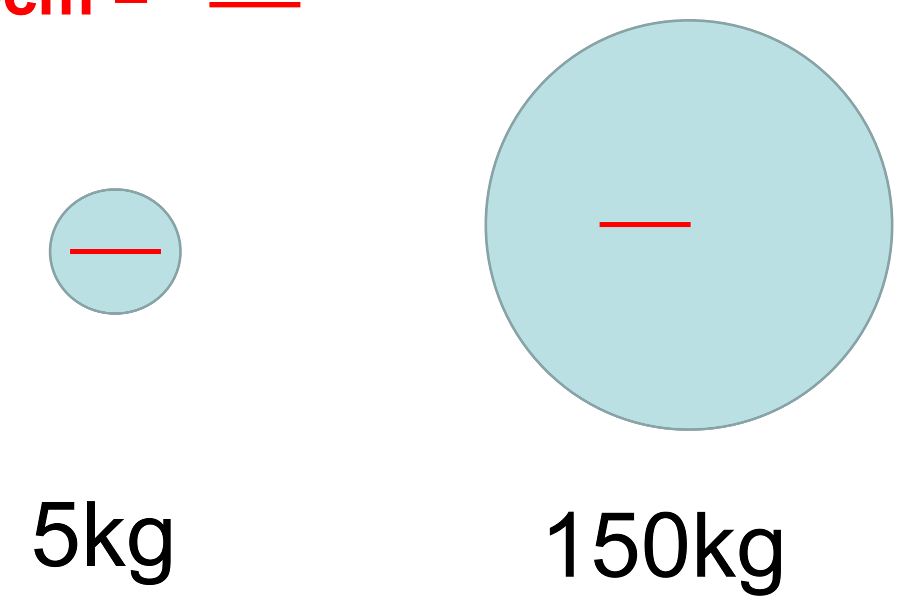
We are entering the "golden era" of ββ decay experiments as detector sizes exceed int lengths

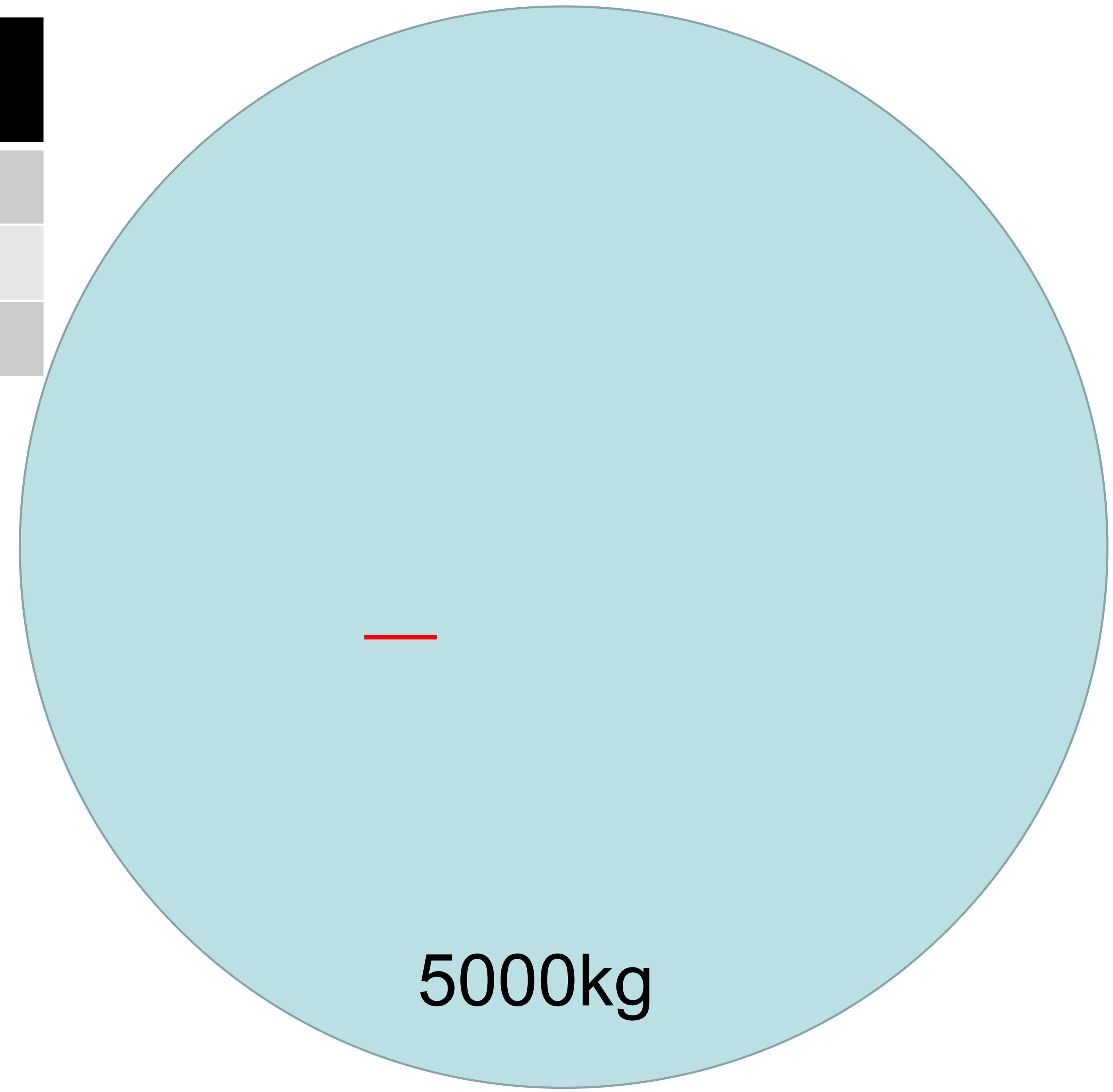
G. Gratta

Moving forward, monolithic is key

LXe mass (kg)	Diameter or length (cm)
5000	130
150	40
5	13

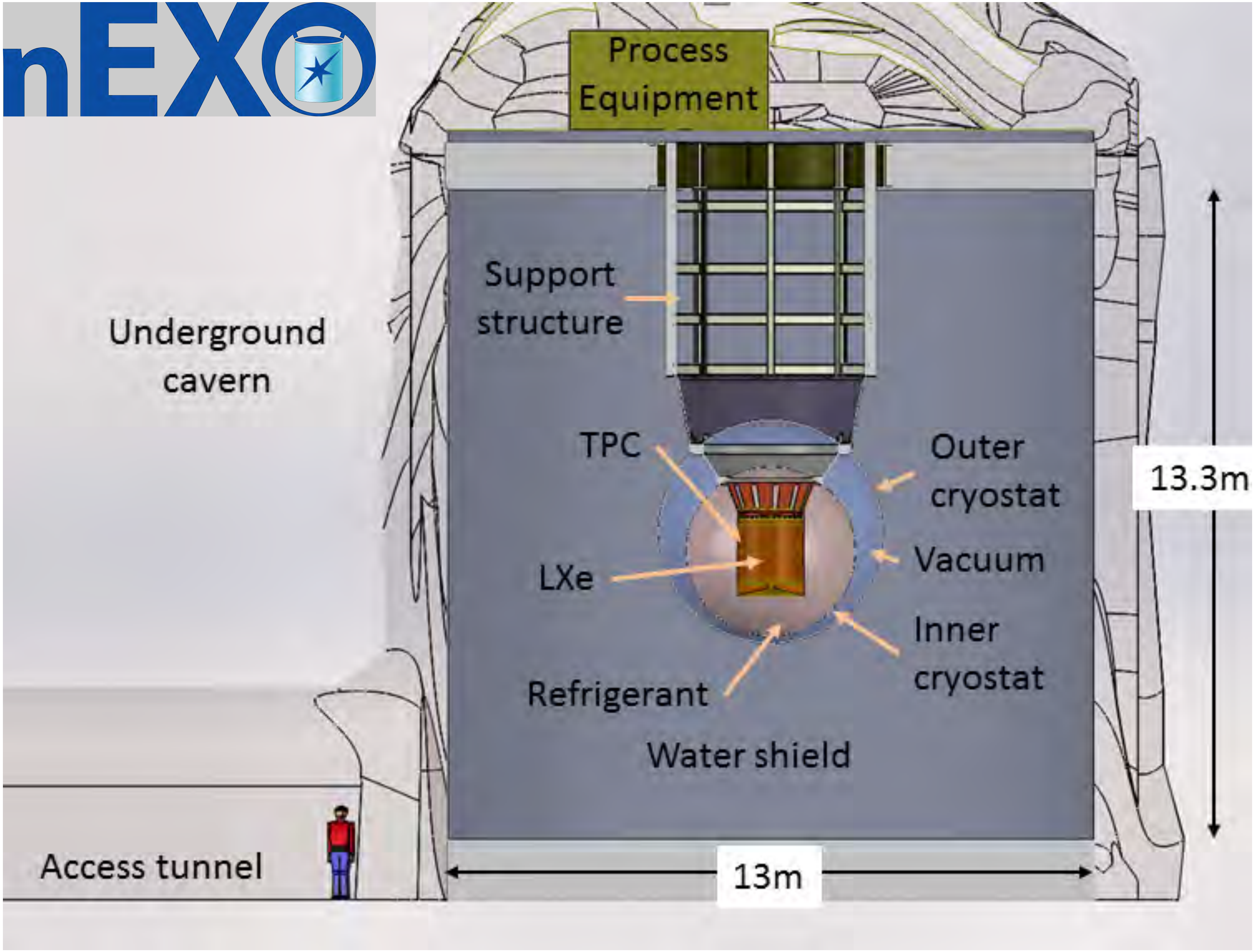
2.5MeV γ attenuation length 8.5cm = —





The current estimate of the nEXO sensitivity relies only on materials already tested for radioactivity and on hand (although not necessarily in sufficient amount)

Preliminary artist view of nEXO in the SNOLAB Cryopit



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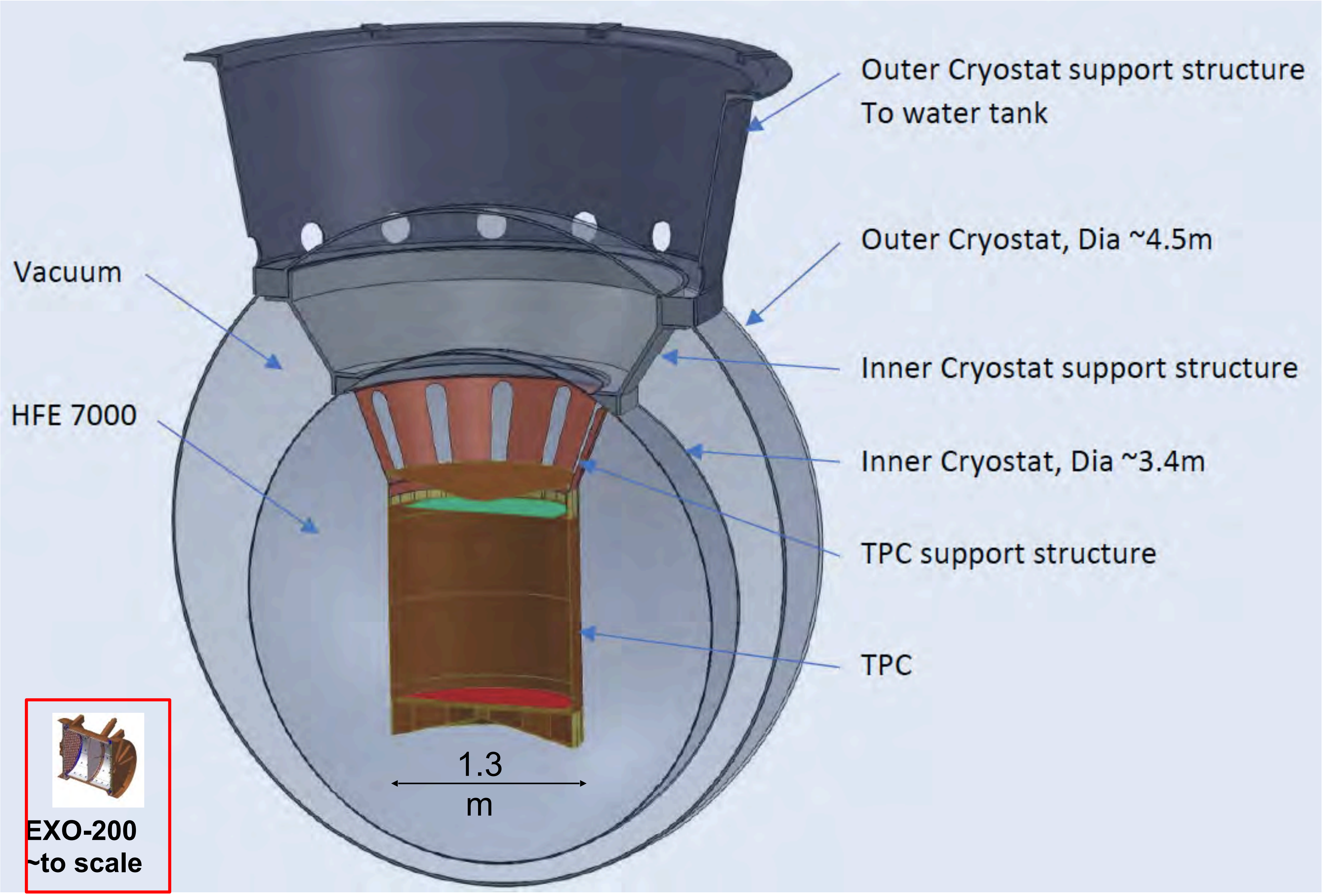
The nEXO TPC



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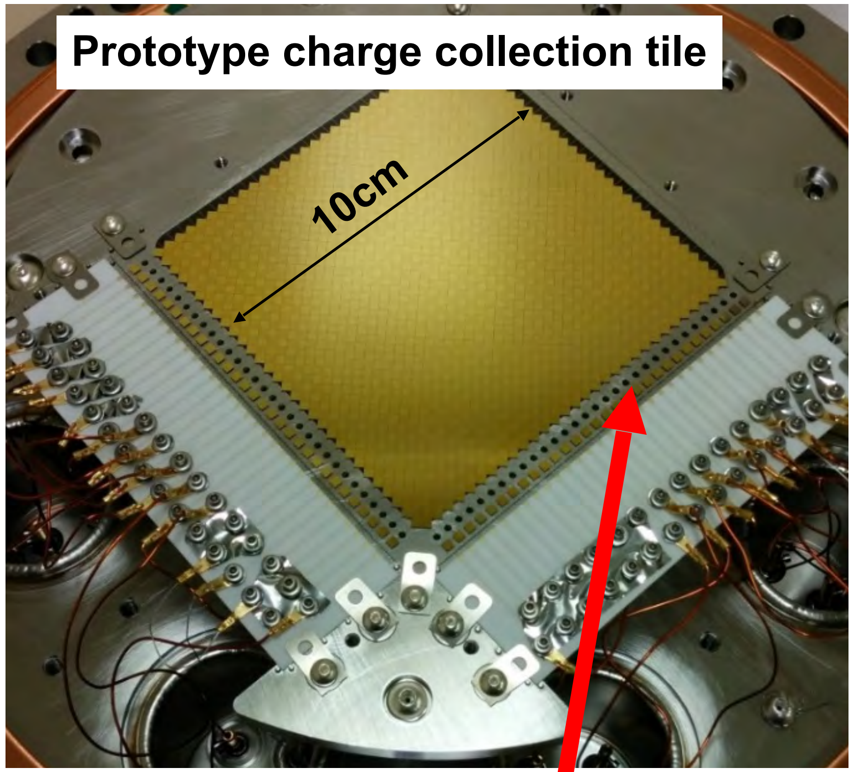
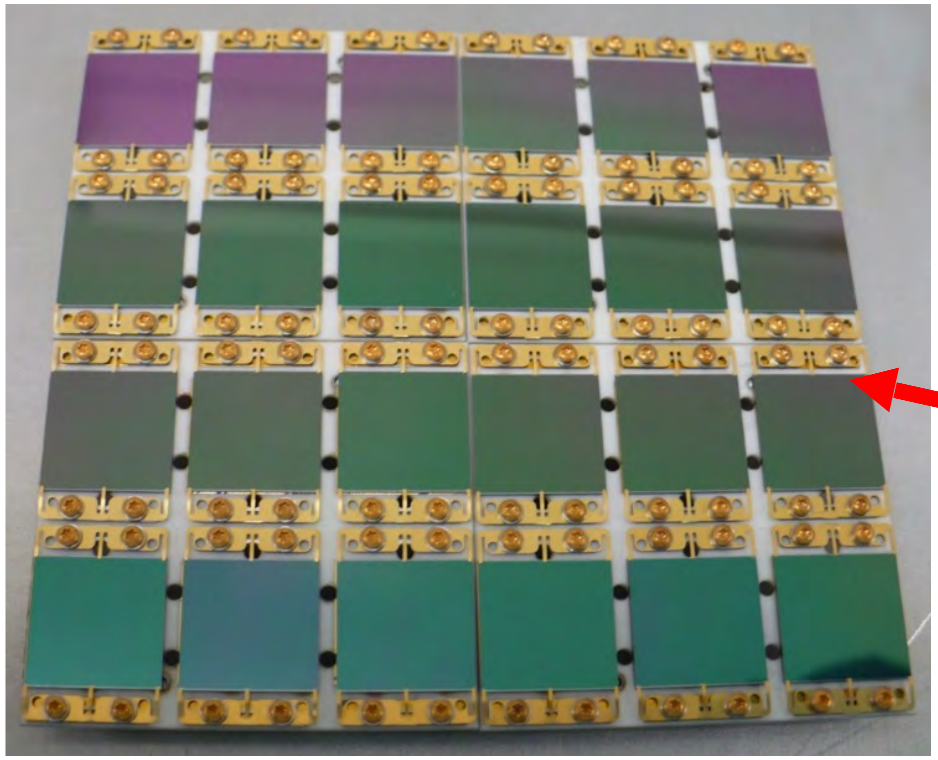
Main technical changes on the EXO-200 theme

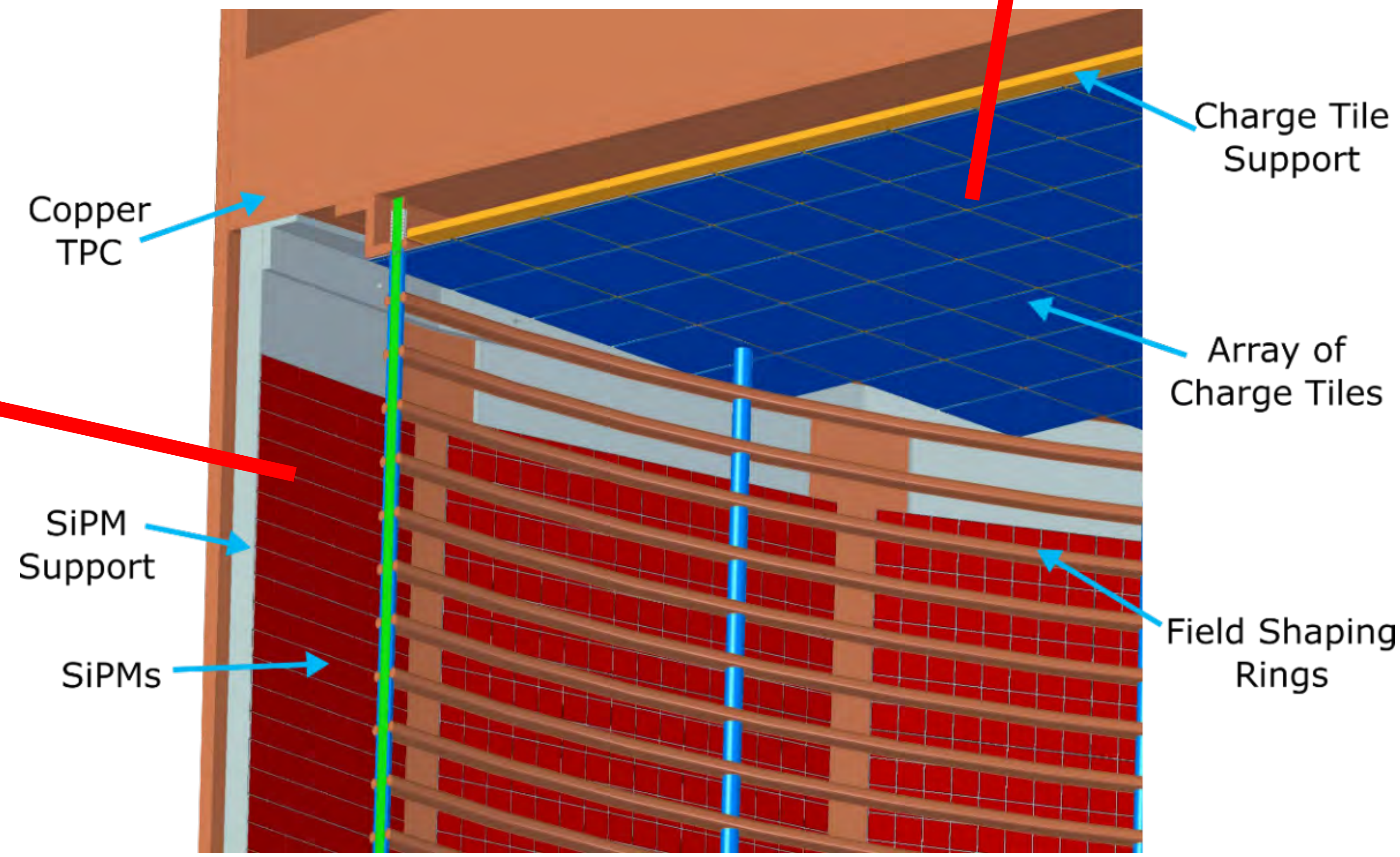
- Only one drift volume
- ASIC electronics in LXe
- Silica substrate charge collection tiles
- VUV SiPMs (~4.5m²)
- Little plastics in the TPC (Sapphire, Silica)



Prototype VUV SiPM array (FBK)



~6cm



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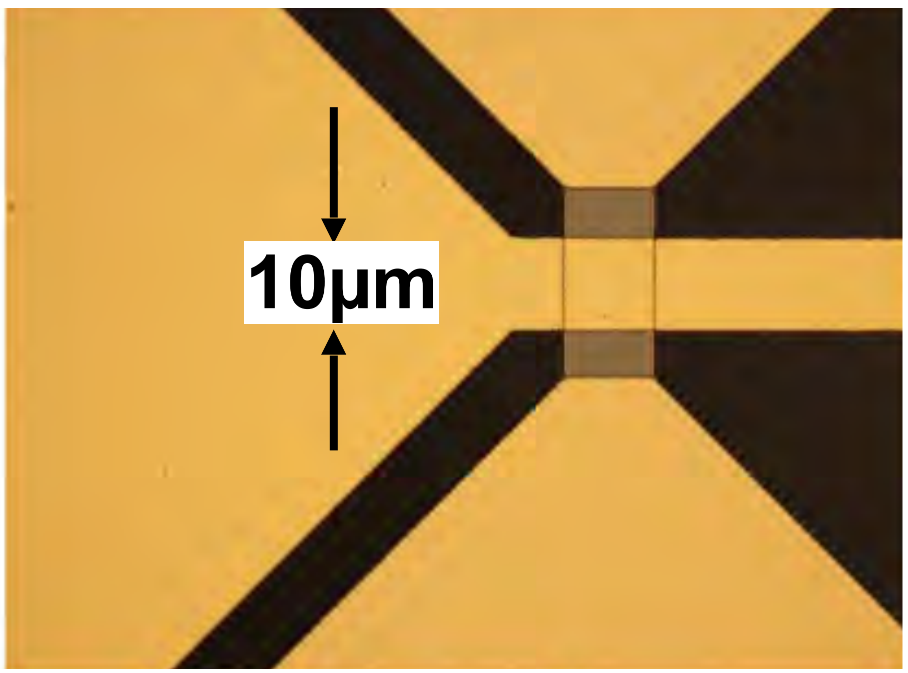
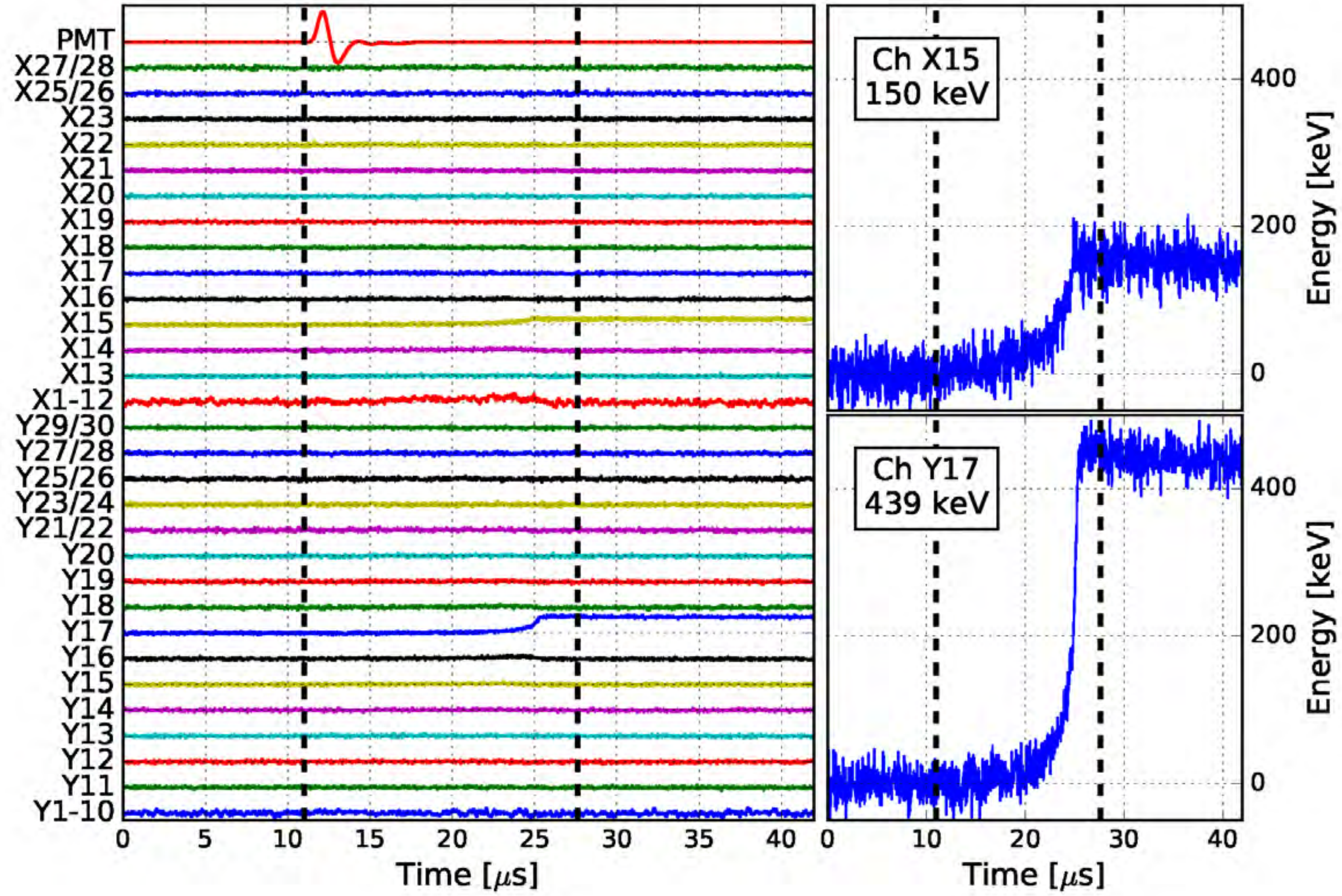
Test of prototype tiles in LXe is ongoing





Max metallization cover with min capacitance:

80 fF at crossings
0.86 pF between adjacent strips

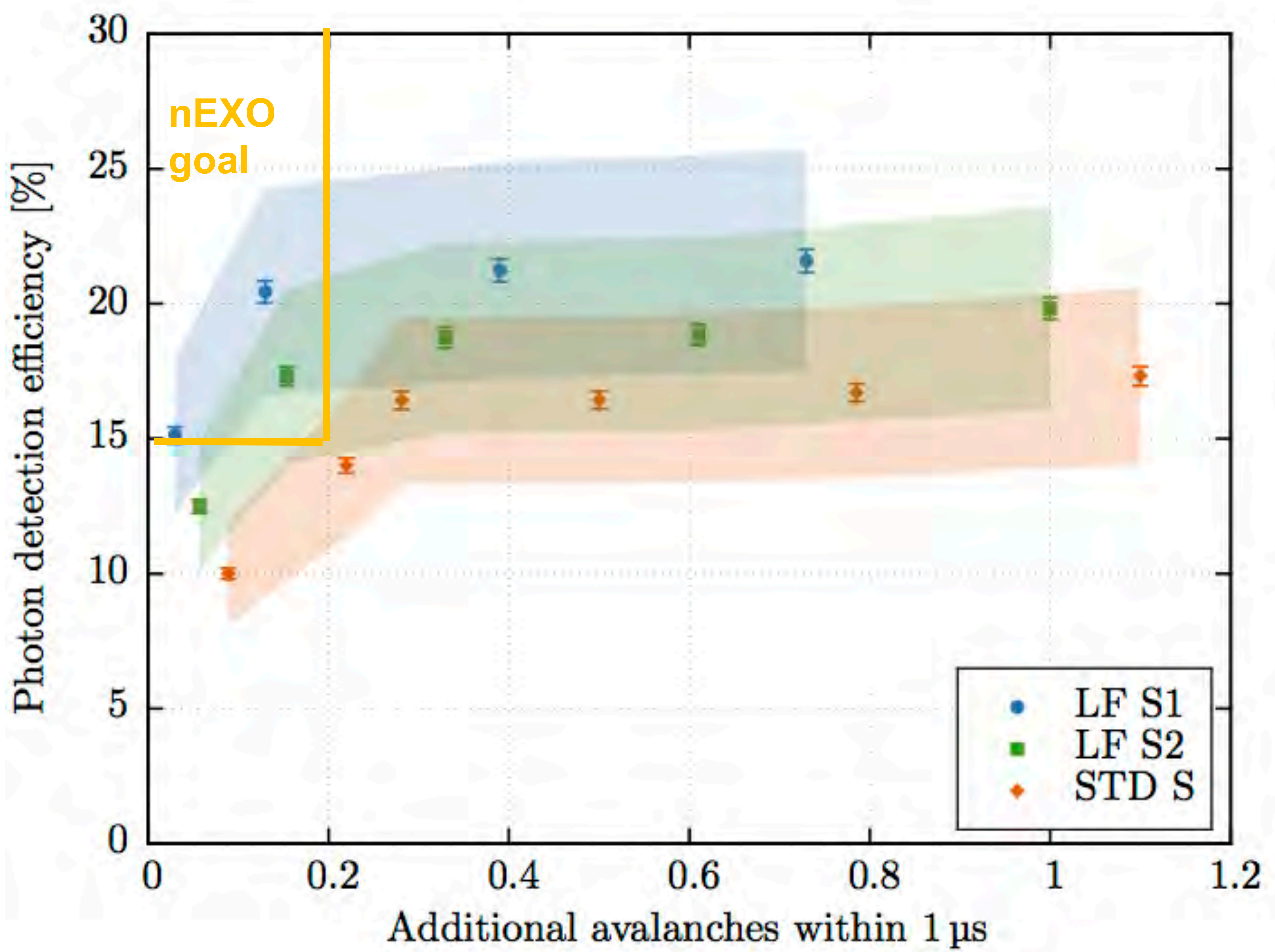
Pulse shape is unusual, because of the absence of a shielding grid, but state of the art resolution for charge only has been achieved.

M.Jewell et al., "Characterization of an Ionization Readout Tile for nEXO", *J.Inst. 13 P01006 (2018)*

G. Gratta

After the first round of R&D, some 1cm² VUV devices now match our desired properties, with a bias of ~30V

(as opposed to the 1500V of EXO-200 APDs)



"VUV-sensitive Silicon Photomultipliers for Xenon Scintillation Light Detection in nEXO" arXiv:1806.02220 (2018)

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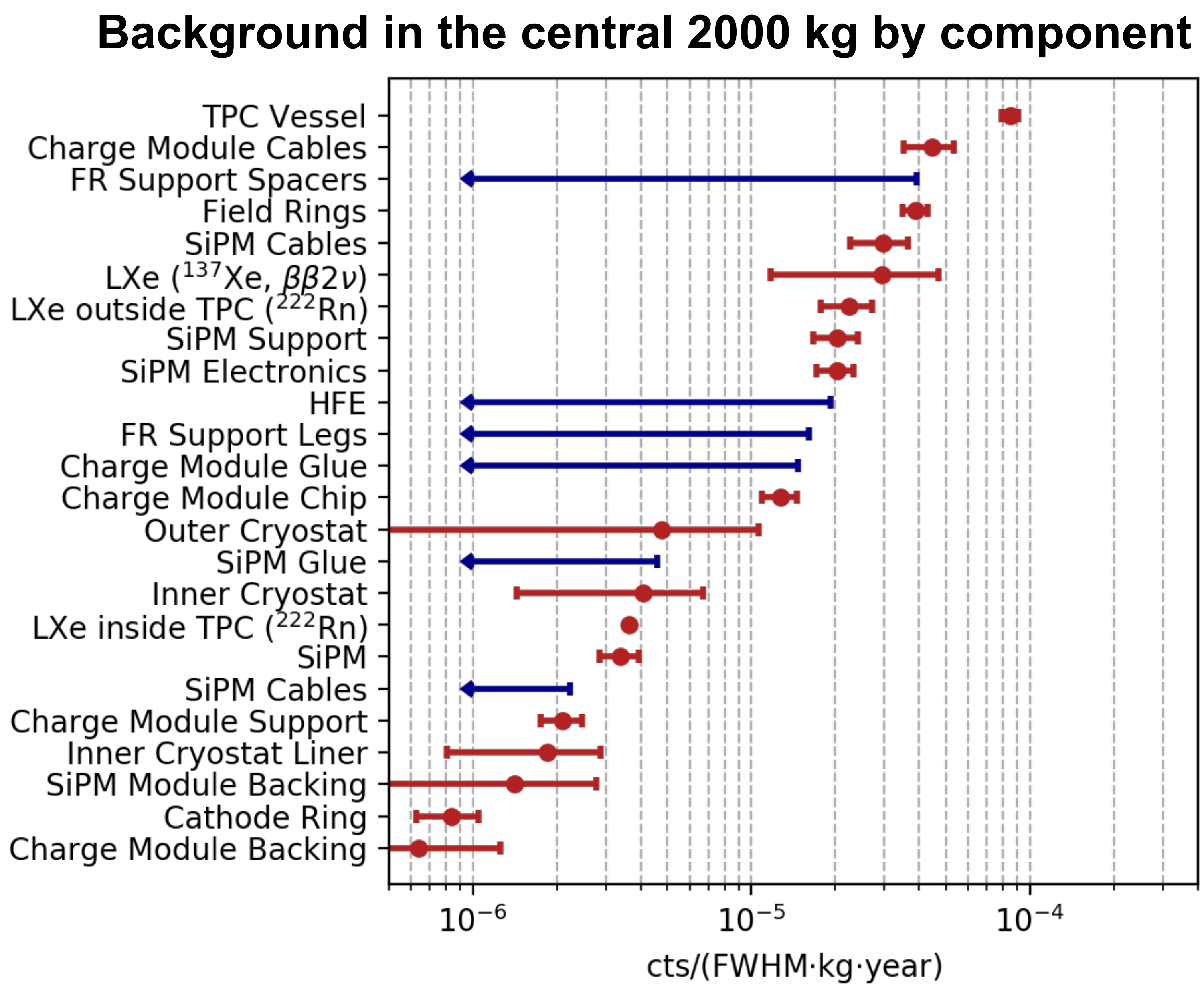
nEXO sensitivity and discovery potential

What goes in the model is:
- **the geometry,**
- **the radioactivity measured on existing materials (some from EXO-200, some “freshly” measured)**
- **physics well known to GEANT (mainly γ transport)**



”Sensitivity and Discovery Potential of nEXO to 0νββ decay"
Phys. Rev. C 97 (2018) 065503 arXiv:1710.05075

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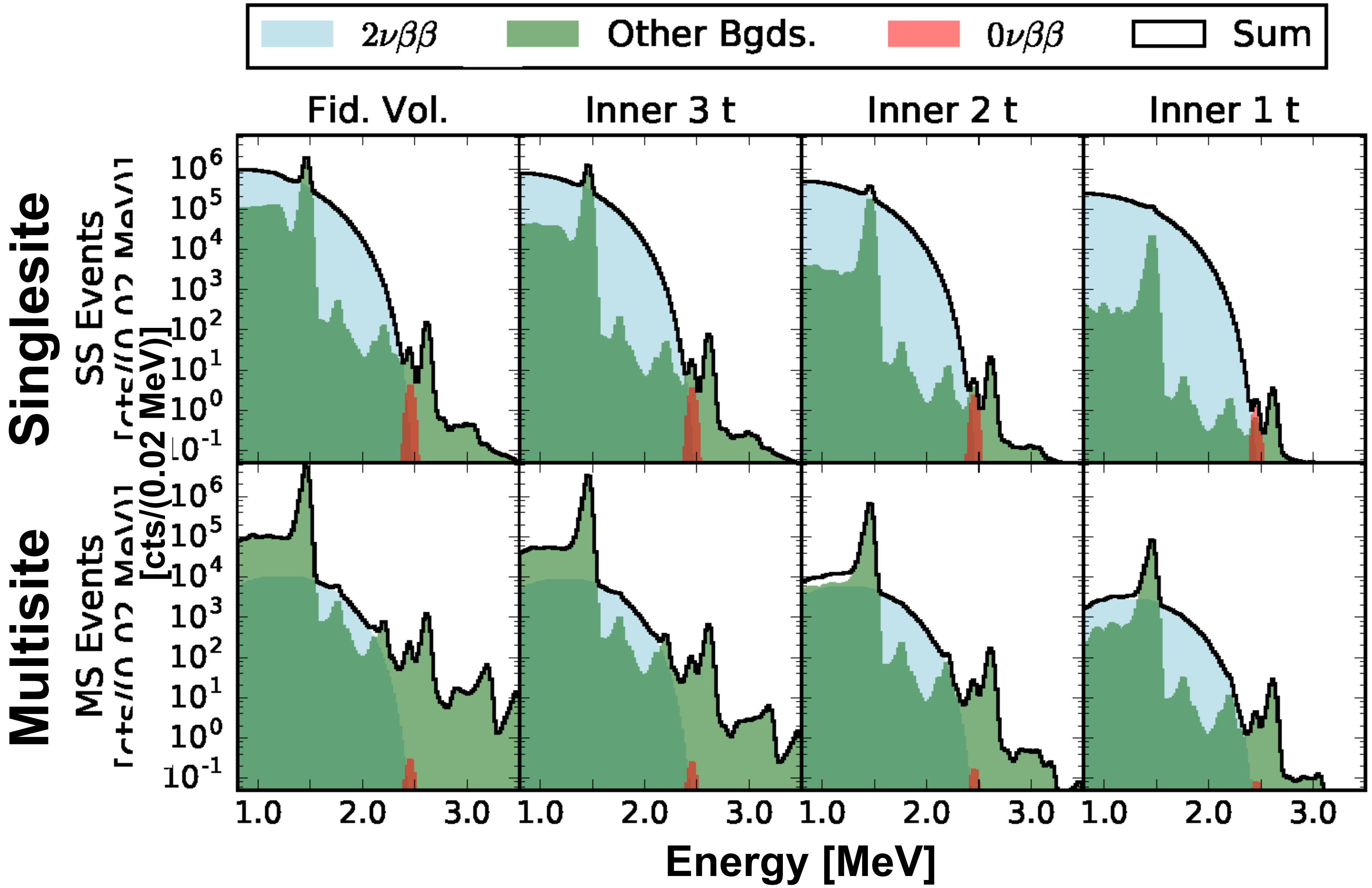
Particularly in the larger nEXO, background identification and rejection fully use a fit considering simultaneously energy, e-γ and α-β discrimination and event position.

➔ ***The power of the homogeneous detector, this is not just a calorimetric measurement!***



Corresponding to 10 yr data, with $0\nu\beta\beta$ $T^{1/2}=5.7\times10^{27}$ yr

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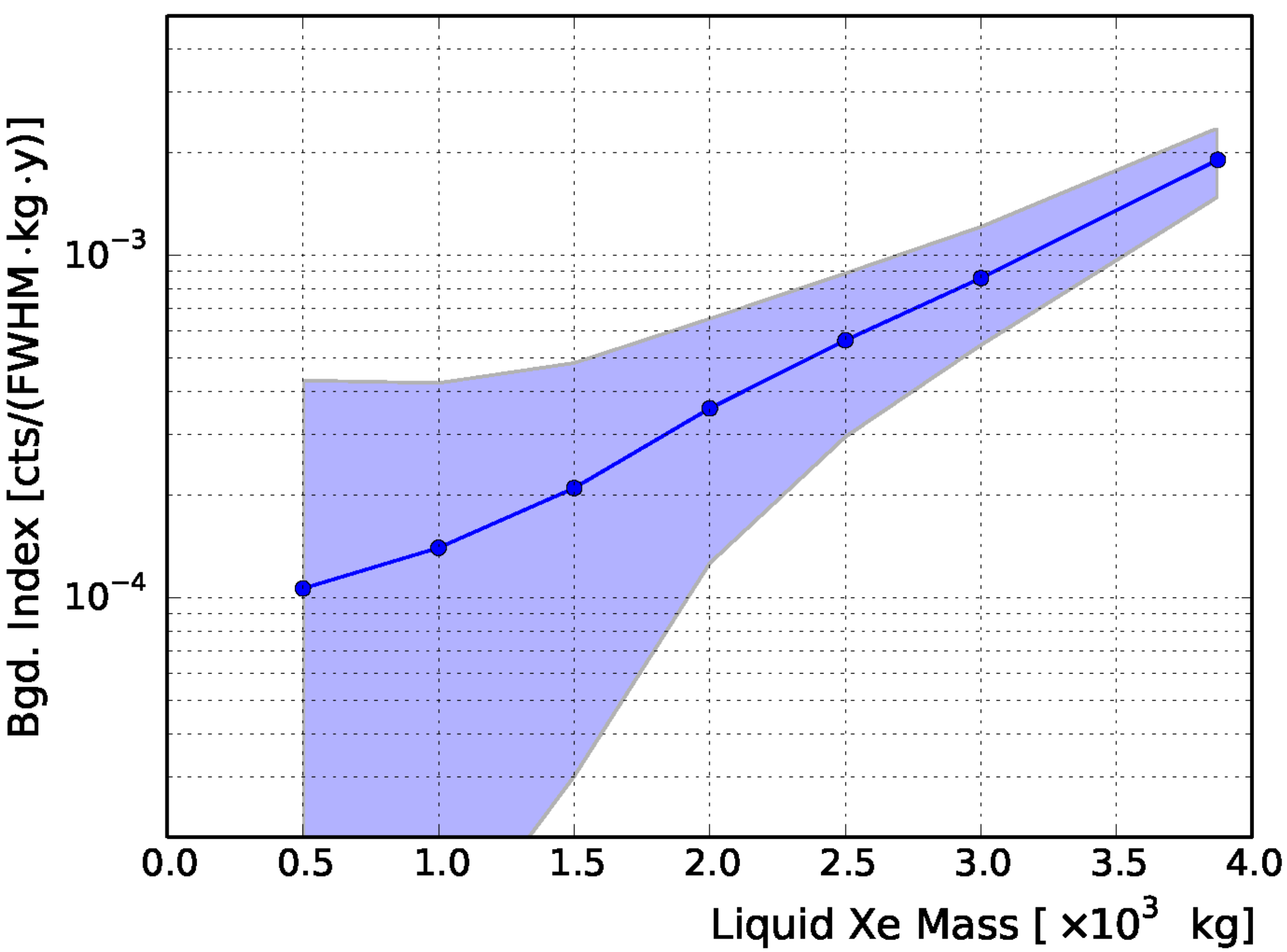
So, a simple "background index" is not the entire story.

-The innermost LXe mostly measures signal
-The outermost LXe mostly measures background
-The overall fit knows all this (and more) very well and uses all the information available to obtain the best sensitivity

Nevertheless, for the aficionados of "background index", here it is, as a function of depth in the TPC. For the inner 3000 kg this is better than 10^{-3} (kg yr FWHM)$^{-1}$



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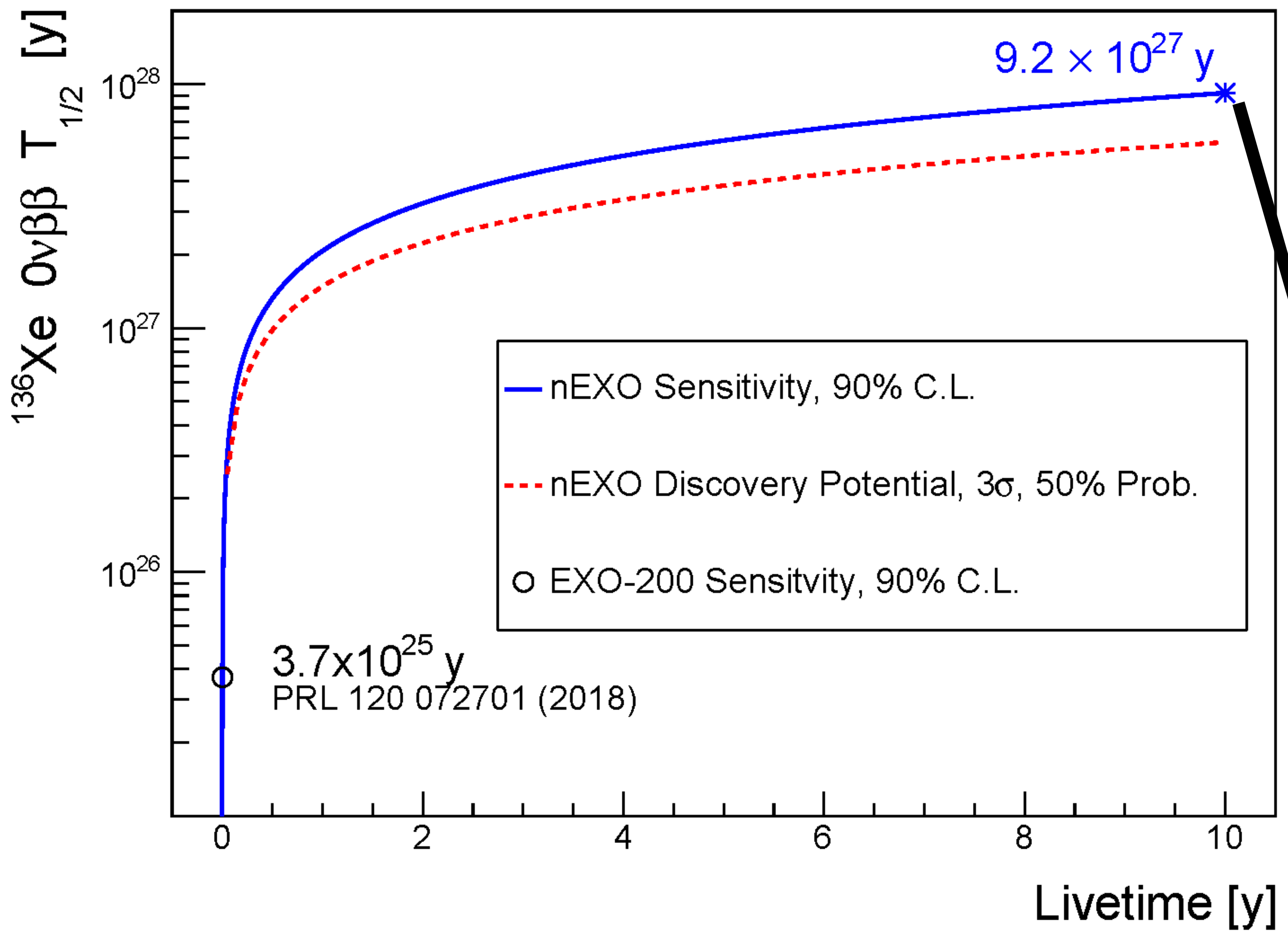
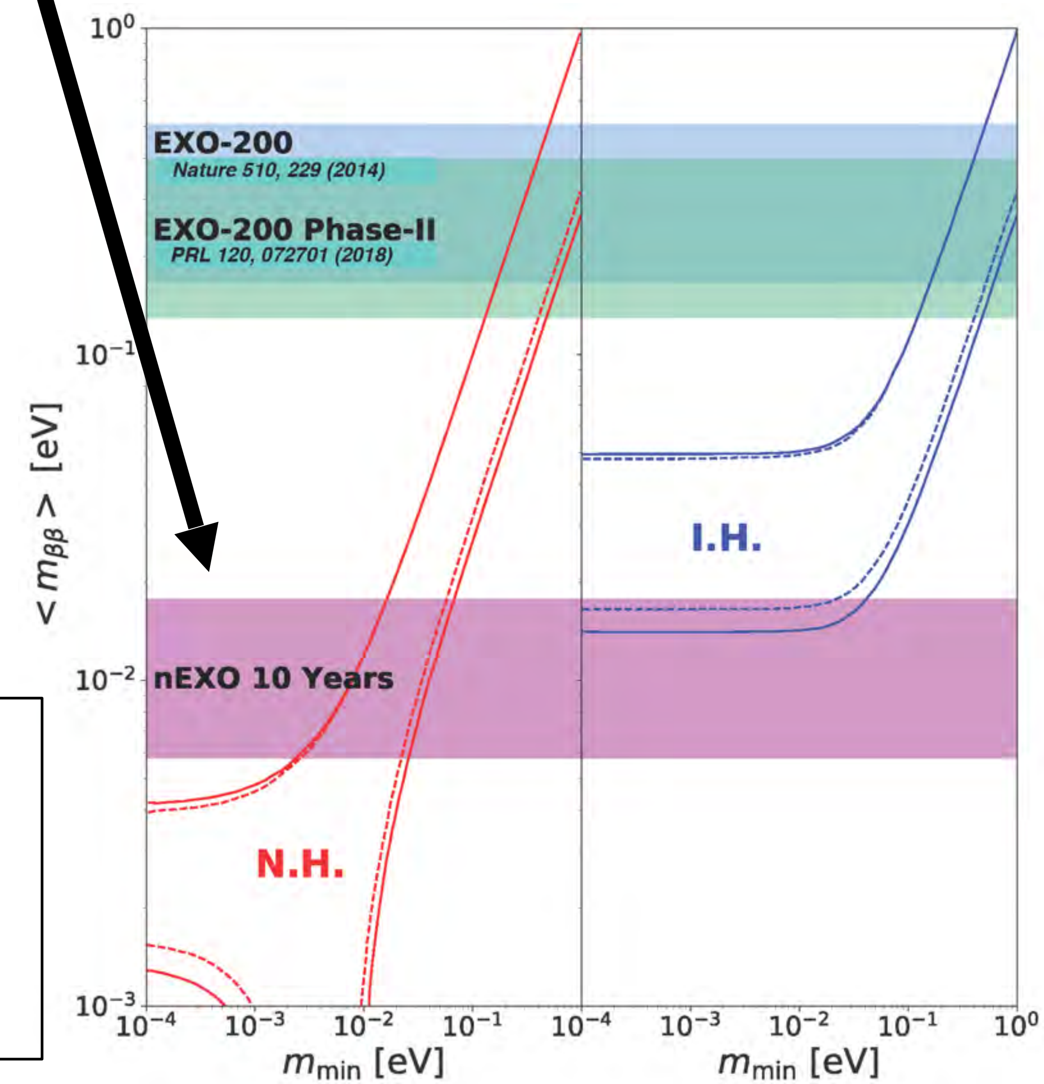
Sensitivity as a function of time for the baseline design





- $g_A = g_A^{free} = -1.2723$
- Band is the envelope of NME:
  - EDF: T.R. Rodríguez and G. Martínez-Pinedo, PRL 105, 252503 (2010)
  - ISM: J. Menendez et al., Nucl Phys A 818, 139 (2009)
  - IBM-2: J. Barea, J. Kotila, and F. Iachello, PRC 91, 034304 (2015)
  - QRPA: F. Šimkovic et al., PRC 87 045501 (2013)
  - SkyrmeQRPA: M.T. Mustonen and J. Engel PRC 87 064302 (2013)

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nEXO publications to date

they describe the detector, the experiment's sensitivity and some results from the R&D

- "Imaging individual Ba atoms in solid xenon for barium tagging in nEXO" *
  Nature 569, 203–207 (April 2019)
- "Study of Silicon Photomultiplier Performance in External Electric Fields"
  2018_JINST_13_T09006 (September 2018)
- "nEXO pCDR"
  arXiv:1805.11142 (May 2018)
- "Sensitivity and Discovery Potential of nEXO to 0νββ decay"
  Phys. Rev. C 97 (2018) 065503 arXiv:1710.05075
- "Imaging individual Ba atoms in solid xenon for barium tagging in nEXO"
  arXiv:1806.10694 (Jun 2018)
- "VUV-sensitive Silicon Photomultipliers for Xenon Scintillation Light Detection in nEXO"
  arXiv:1806.02220 (2018)
- "Characterization of an Ionization Readout Tile for nEXO"
  J.Inst. 13 P01006 (2018)
- "Characterization of Silicon Photomultipliers for nEXO"
  IEEE Trans. NS 62, 1825 (2015)

* Not nEXO baseline, nevertheless very exciting

Recent developments

- As per Nov'18, DOE has given CD-0 to "tonne-scale double-beta decay"
- This is not specifically nEXO, and does not involve funding
- But it allows the national labs to increase the intensity of their support
- SNOLAB is very engaged and contributes to the preparation of a CFI Proposal with engineers and project management

- The collaboration is growing: welcome Erica Caden (SNOLAB) and Simon Viel (Carleton)

- We are also appreciative for the strong support from the McDonald Institute

> See Thomas's talk at the Friday IPP AGM for more details

nEXO

Collaboration meeting
Colorado State University
January 2019

Canadian Groups

University of Alabama, Tuscaloosa AL, USA --- M Hughes, O Nusair, I Ostrovskiy, A Piepke, AK Soma, V Veeraraghavan
University of Bern, Switzerland — J-L Vuilleumier
Brookhaven National Laboratory, Upton NY, USA — M Chiu, G Giacomini, V Radeka, E Raguzin, S Rescia, T Tsang
University of California, Irvine, Irvine CA, USA — M Moe
California Institute of Technology, Pasadena CA, USA — P Vogel
Carleton University, Ottawa ON, Canada — I Badhrees, B Chana, M Elbeltagi, D Goeldi, R Gornea, C Jessiman, T Koffas, B. Veenstra, S. Viel, C Vivo-Vilches, J Watkins
Colorado State University, Fort Collins CO, USA --- C Chambers, A Craycraft, D Fairbank, W Fairbank Jr, A Iverson, J Todd
Drexel University, Philadelphia PA, USA --- MJ Dolinski, P Gautam, E Hansen, YH Lin, E Smith, Y-R Yen
Duke University, Durham NC, USA — PS Barbeau, J Runge
Friedrich-Alexander-University Erlangen, Nuremberg, Germany --- G Anton, J Hoessl, T Michel, M Wagenpfeil, T Ziegler
IBS Center for Underground Physics, Daejeon, South Korea — DS Leonard
IHEP Beijing, People's Republic of China — G Cao, W Cen, Y Ding, X Jiang, P Lv, Z Ning, X Sun, T Tolba, W Wei, L Wen, W Wu, J Zhao
IME Beijing, People's Republic of China — L Cao, X Jing, Q Wang
ITEP Moscow, Russia — V Belov, A Burenkov, A Karelin, A Kobyakin, A Kuchenkov, V Stekhanov, O Zeldovich
University of Illinois, Urbana-Champaign IL, USA --- D Beck, M Coon, J Echevers, S Li, L Yang
Indiana University, Bloomington IN, USA --- JB Albert, SJ Daugherty, G Visser
Laurentian University, Sudbury ON, Canada — K Bolduc, E Caden, B Cleveland, A Der Mesrobian-Kabakian, J Farine, C Licciardi, JF Ménard, A Robinson, M Walent, U Wichoski
Lawrence Livermore National Laboratory, Livermore CA, USA --- J Brodsky, M Heffner, A House, S Sangiorgio, T. Stiegler
University of Massachusetts, Amherst MA, USA --- S Feyzbakhsh, D Kodroff, A Pocar, M Tarka
McGill University, Montreal QC, Canada --- S Al Kharusi, T Brunner, L Darroch, Y Ito, T Nguyen, D. Chen, T McElroy, K Murray, T Totev,
University of North Carolina, Wilmington, USA — T Daniels
Oak Ridge National Laboratory, Oak Ridge TN, USA — L Fabris, RJ Newby
Pacific Northwest National Laboratory, Richland, WA, USA — I Arnquist, EW Hoppe, JL Orrell, G Ortega, C Overman, R Saldanha, R Tsang
Rensselaer Polytechnic Institute, Troy NY, USA — E Brown, K Odgers
Université de Sherbrooke, Sherbrooke QC, Canada --- S Charlebois, D Danovitch, H Dautet, R Fontaine, F Nolet, S Parent, JF Pratte, T Rossignol, N Roy, G St-Hilaire, J Sylvestre, F Vachon
SLAC National Accelerator Laboratory, Menlo Park CA, USA --- S Delaquis, A Dragone, G Haller, LJ Kaufman, B Mong, A Odian, M Oriunno, PC Rowson, K Skarpaas
University of South Dakota, Vermillion SD, USA --- T Bhatta, A Larson, R MacLellan
Stanford University, Stanford CA, USA --- J Dalmasson, R DeVoe, D Fudenberg, G Gratta, M Jewell, S Kravitz, B.Lenardo, G Li, M Patel, A Schubert, M Weber, S Wu
Stony Brook University, SUNY, Stony Brook NY, USA --- K Kumar, O Njoya
Technical University of Munich, Garching, Germany --- P Fierlinger
TRIUMF, Vancouver BC, Canada --- J Dilling, G. Gallina, P Gumplinger, R Krücken, Y Lan, F Retière
Yale University, New Haven CT, USA — A Jamil, Z Li, D Moore, Q Xia

EXO /related presentations at CAP

Monday 03 June 2019 – M1-8 – DNP

11:45 [2520] nEXO's Outer Detector: Status and Prospects AL KHARUSI, Soud

12:00 [2735] A linear quadrupole ion trap for barium tagging in nEXO LAN, Yang

Wednesday 05 June 2019 – W1-11 – DNP

10:45 [2725] Latest results from EXO-200 and status of nEXO FARINE, Jacques (this talk)

11:30 [2699] EXO-200 Results LICCIARDI, Caio > new DAN methods

11:45 [2664] Characterization and development of a new SiPM with high VUV sensitivity for the nEXO Experiment GALLINA, Giacomo

Wednesday 05 June 2019 – W1-7 – DAPI/PPD

11:00 [2490] 3D digital SiPM for medical imaging, particle physics and quantum key distribution PRATTE, Jean-Francois

12:00 [2533] Analog Electronics and SiPM Characterization for LOLX DE ST. CROIX, Austin

Thursday 06 June 2019 – R2–5 – DAPI/PPD

14:00 [2499] Goals and Scope of the Light-Only Liquid Xenon Project MCELROY, Thomas

Friday 07 June 2019 – IPP AGM

09:00 nEXO project update BRUNNER, Thomas > more on activities, demographics in Ca

PM – SiPM Workshop – Fabrice Retiere

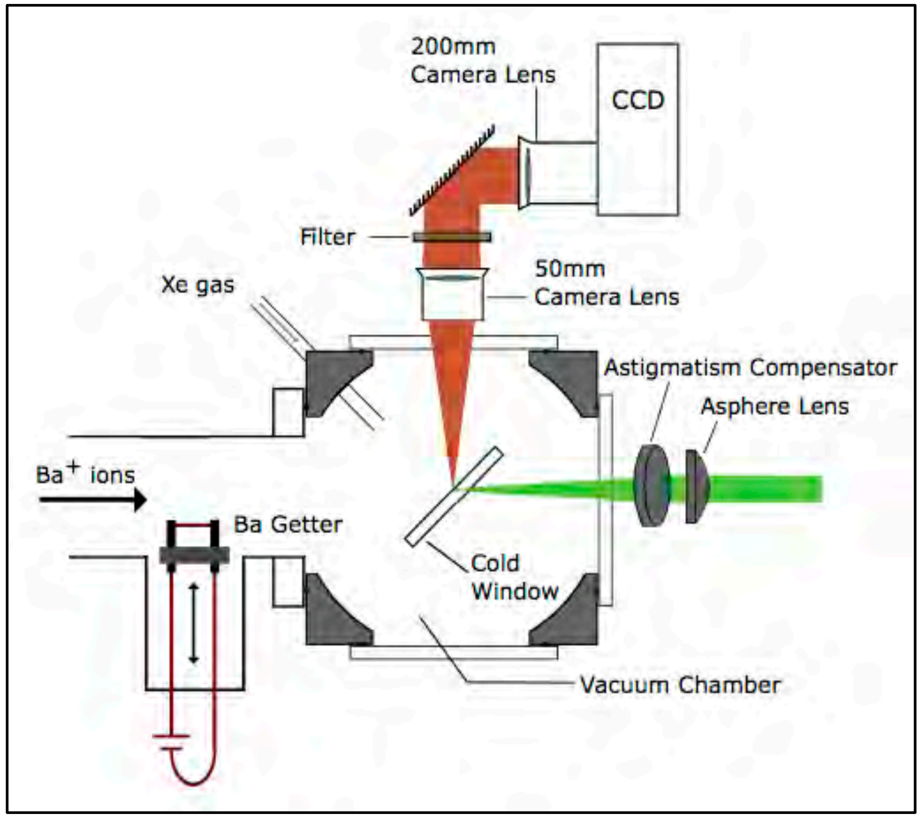
Conclusions

- EXO-200 was the first 100kg-class experiment to run and demonstrated the power of a large and homogeneous LXe TPC.
- A final $0\nu\beta\beta$ result is imminent
- This is clearly the way to go for tonne-scale detectors, as the power of the technique will further improve with increasing size.
- R&D in progress to finalize the design of nEXO, a 5-ton detector that will drastically advance the field, entirely covering the inverted hierarchy and with substantial sensitivity to the normal one.
- New and exciting results from the Ba tagging effort (not part of the nEXO baseline) suggest that there may be a path for a future upgrade beyond nEXO.
- nEXO design is maturing rapidly, with the pCDR design document posted and a detailed sensitivity analysis published some time ago
- DOE CD-0 mission need established

Thank You

backup slides

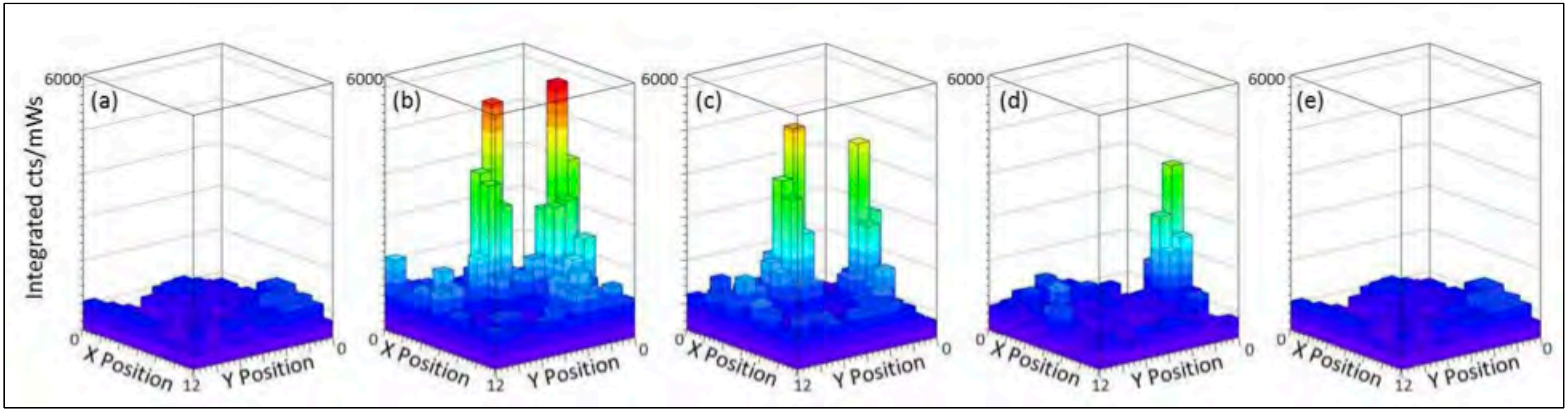
In fact, ^{136}Xe presents the possibility to confirm a ββ decay even by retrieving and tagging spectroscopically the Ba atom in the final state.



This is not necessary for nEXO to reach its design sensitivity and, indeed, it is not part of the design presented in the pre-CDR.

Nevertheless the "physics component" of this technique was recently demonstrated, including the ability to delete "old" Ba atoms with essentially no "memory effect".

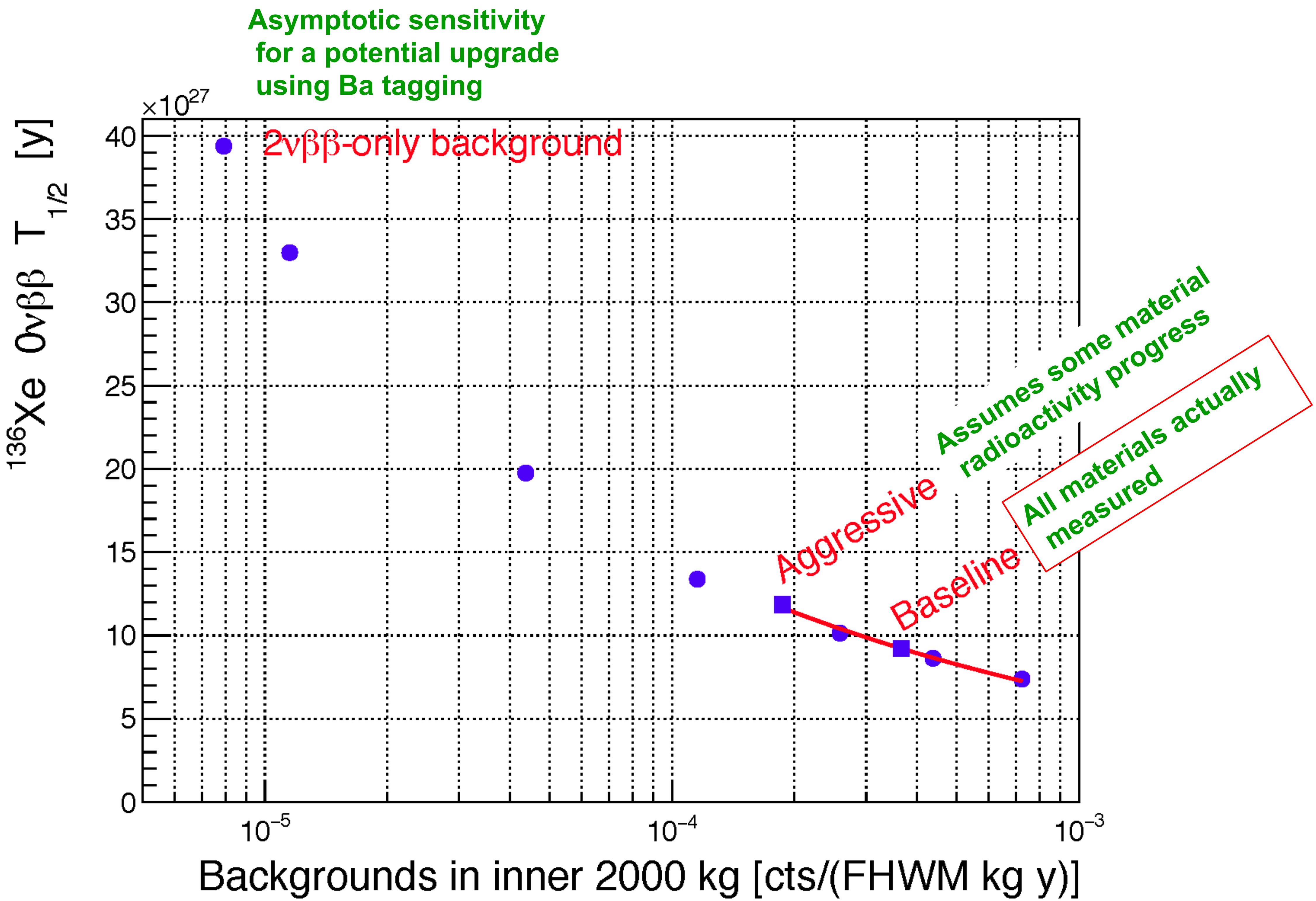
Plenty of engineering will be required to turn this result into a practical upgrade path for nEXO.



C.Chambers et al.
arXiv:1806.10694 (Jun 2018)

G. Gratta

How does the sensitivity scale with background assumptions?



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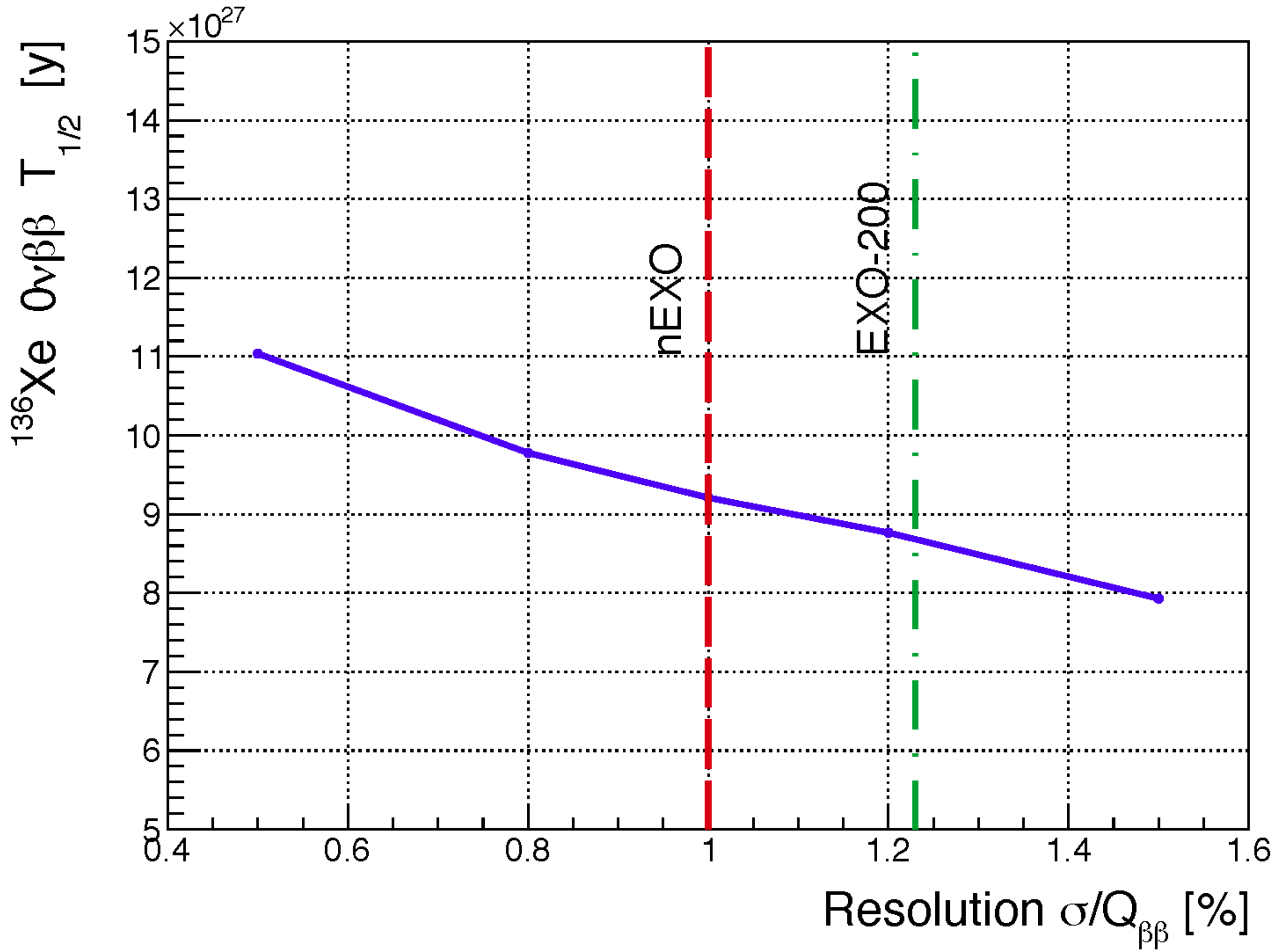
…and with energy resolution



G. Gratta