nEXO

G.Gratta
for the EXO collaboration

"Snowmass"
SLAC, 7 Mar 2013

The EXO Collaboration

University of Alabama, Tuscaloosa AL, USA - D. Auty, M. Hughes, A. Piepke, K. Pushkin, M. Volk

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Stanford University, Stanford CA, USA - P.S. Barbeau, J. Bonatt, T. Brunner, J. Chaves, J. Davis, R. DeVoe, D. Fudenberg, G. Gratta, S.Kravitz, D. Moore, I. Ostrovskiy, A. Schubert, K. O'Sullivan, A. Rivas, A. Sabourov, D. Tosi, K. Twelker

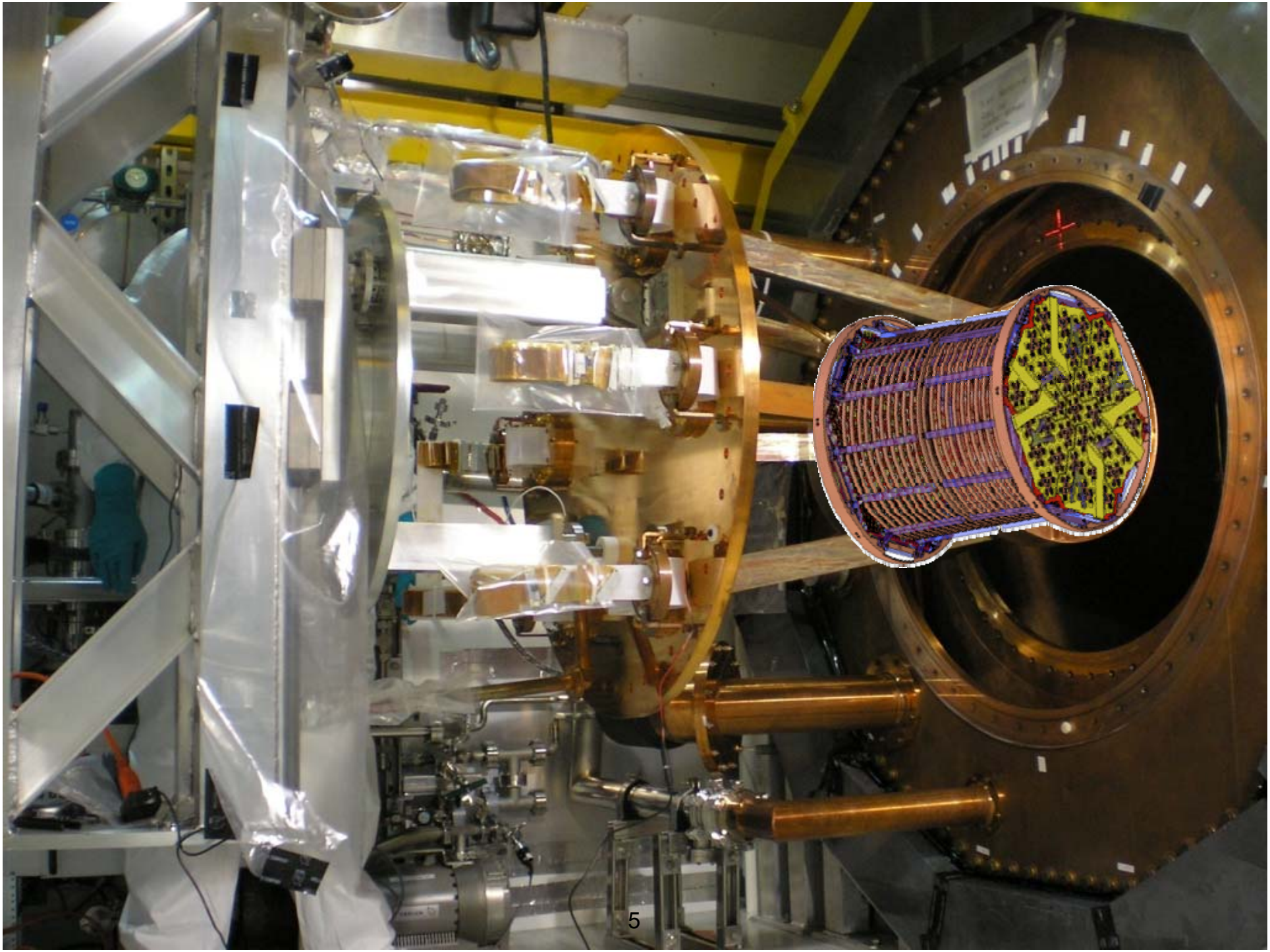
Technical University of Munich, Garching, Germany - W. Feldmeier, P. Fierlinger, M. Marino

Xe is ideal for a large experiment

- No need to grow crystals
- Can be re-purified during the experiment
- No long lived Xe isotopes to activate
- Can be easily transferred from one detector to another if new technologies become available
- Noble gas: easy(er) to purify
- ^{136}Xe enrichment easier and safer:
  - noble gas (no chemistry involved)
  - centrifuge feed rate in gram/s, all mass useful
  - centrifuge efficiency ~ Δm. For Xe 4.7 amu
- Only known case where final state identification appears to be not impossible
  → eliminate all non-$\beta\beta$ backgrounds
- ^{129}Xe is a hyperpolarizable nucleus, under study for NMR tomography… a joint enrichment program ?

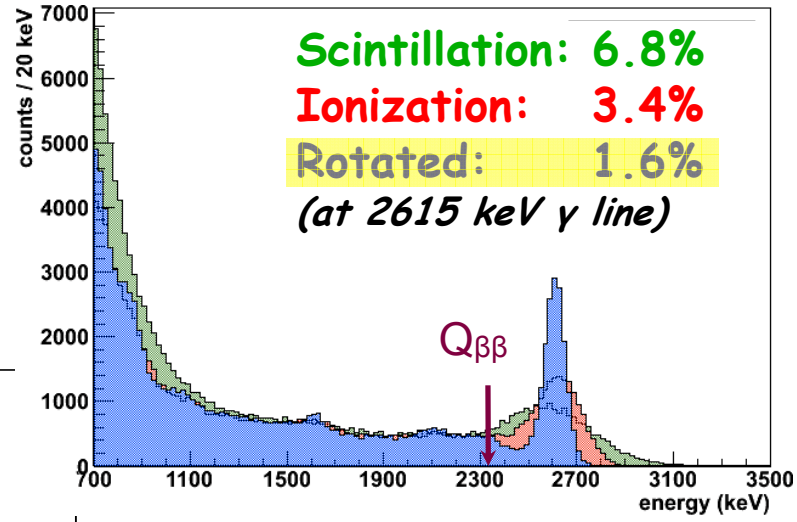
All these facts and more have been proven by the EXO-200 experiment that opened the "100kg era" as it started low background data taking in June 2011:

- discovering the 2ν mode in ^{136}Xe
  (first month of data!)
- for the first time almost entirely excluding the ^{76}Ge claim
  (first 100 days of data)
- stable data taking since fall 2011

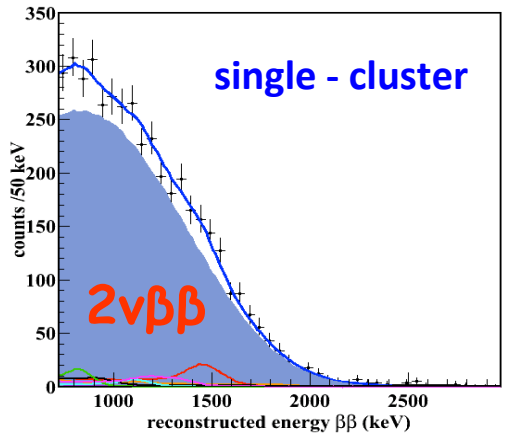


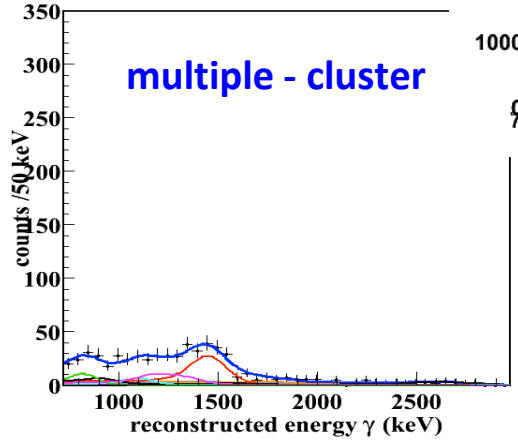
Two main tools for background identification/rejection

Energy resolution ➔

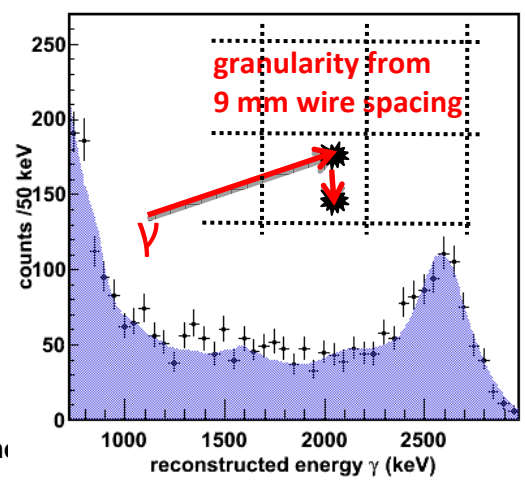


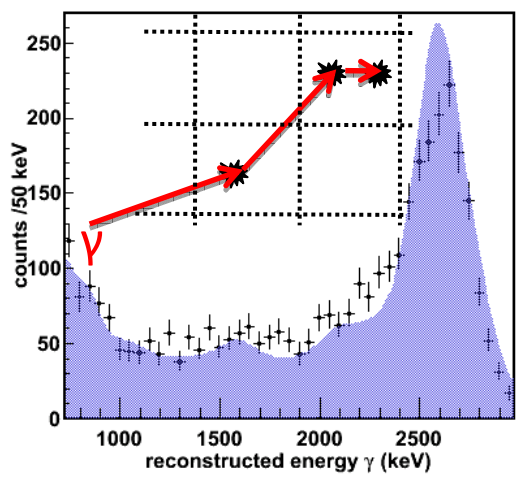
Low background data





^{228}Th calibration source

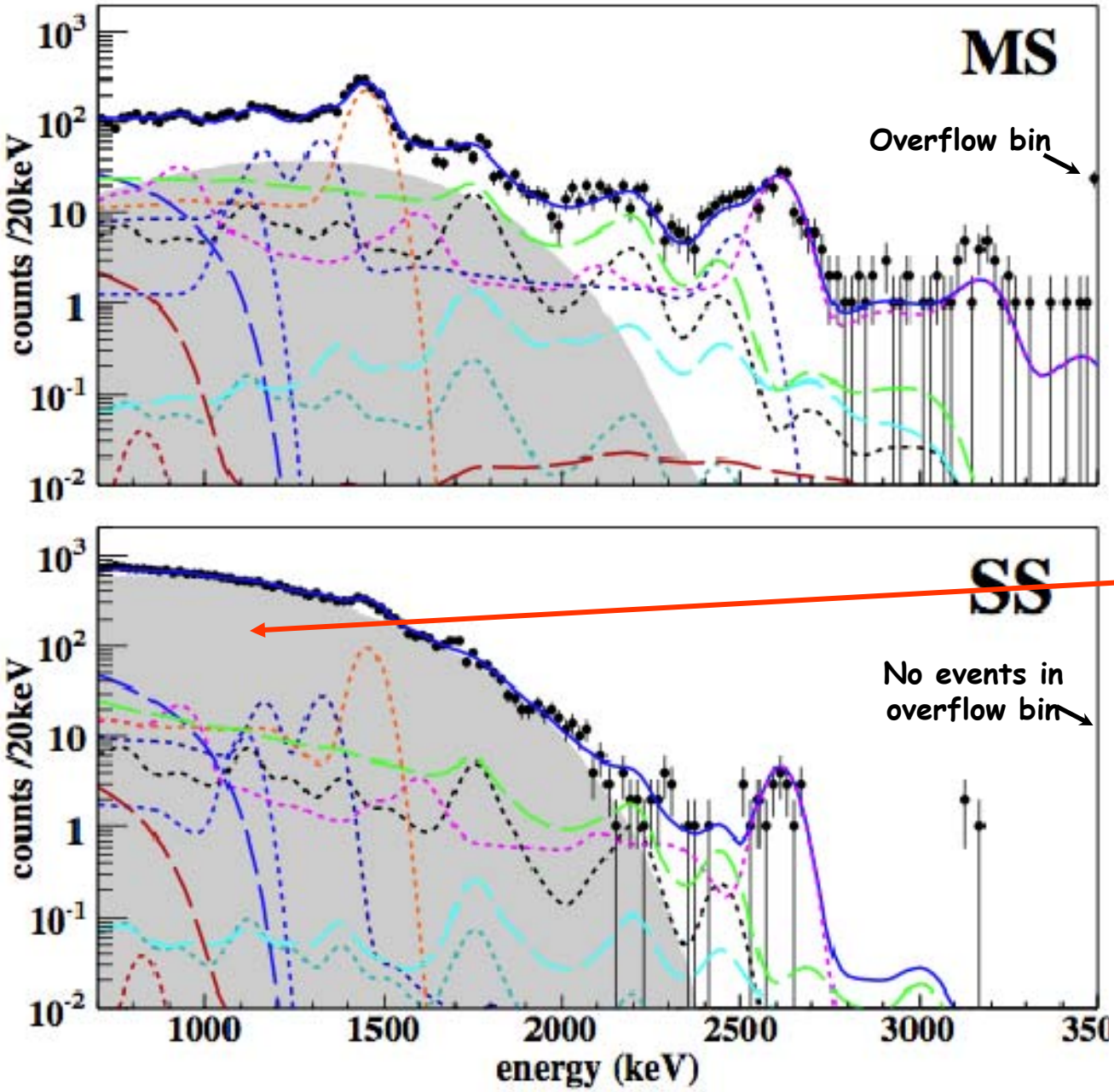




Pattern recognition ➔

"Sn

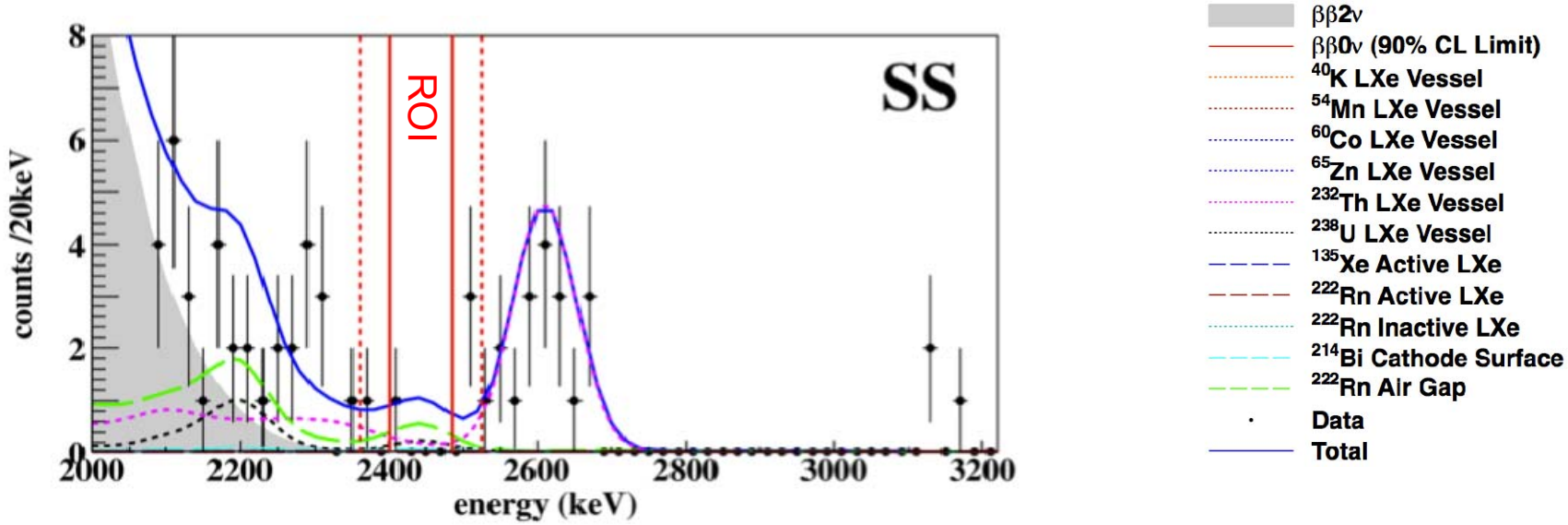
These tools at work



~22,000 2νββ events !

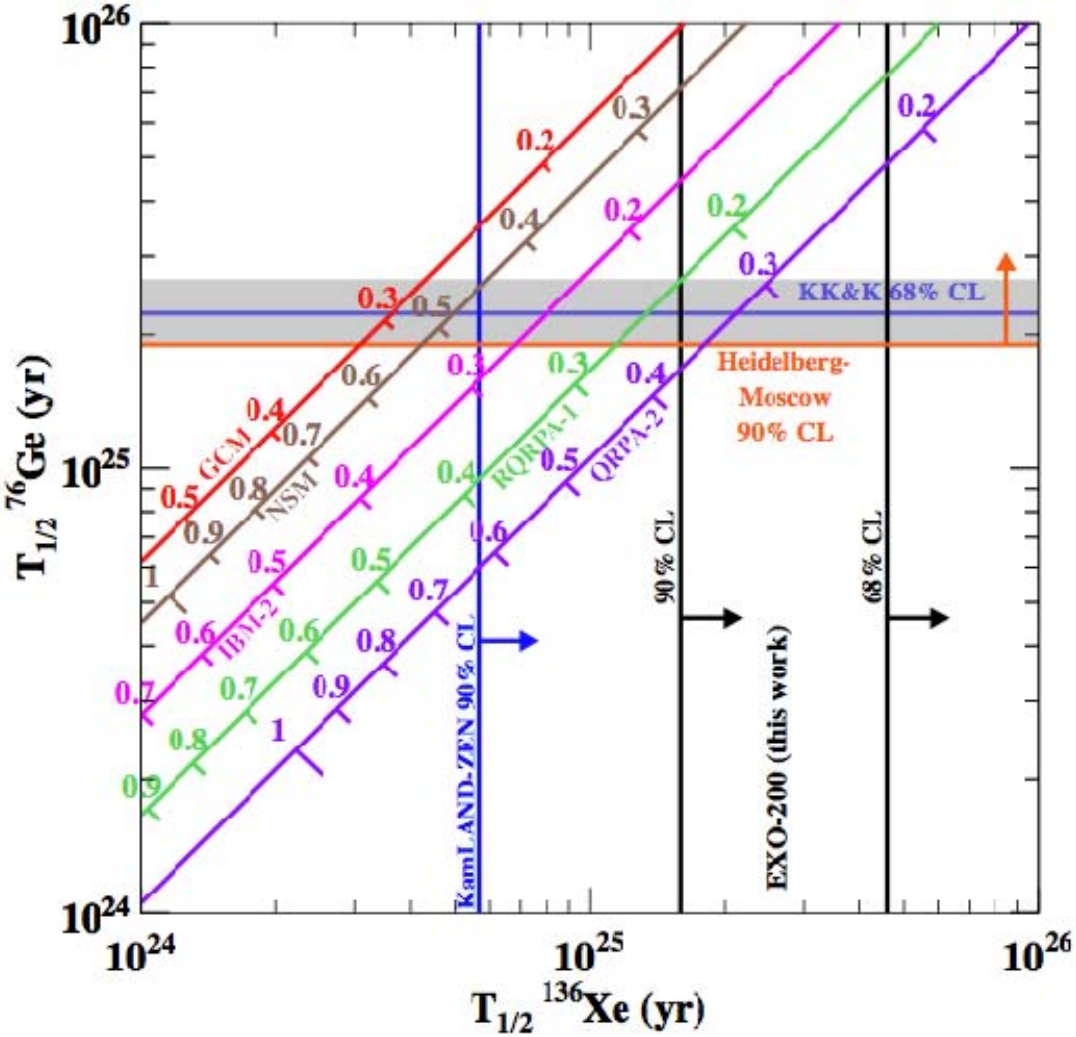
This is a mode that until Aug 2011 we did not know existed!

Background counts in ±1,2 σ ROI



	Expected events from fit			
	±1 σ		±2 σ	
^{222}Rn in cryostat air-gap	1.9	±0.2	2.9	±0.3
^{238}U in LXe Vessel	0.9	±0.2	1.3	±0.3
^{232}Th in LXe Vessel	0.9	±0.1	2.9	±0.3
^{214}Bi on Cathode	0.2	±0.01	0.3	±0.02
All Others	~0.2		~0.2	
Total	4.1	±0.3	7.5	±0.5
Observed	1		5	
Background index b ($kg^{-1}yr^{-1}keV^{-1}$)	$1.5 \cdot 10^{-3} \pm 0.1$		$1.4 \cdot 10^{-3} \pm 0.1$	

Limits on $T_{1/2}^{0\nu\beta\beta}$ and $\langle m_{\beta\beta} \rangle$



From profile likelihood:

$T_{1/2}^{0\nu\beta\beta} > 1.6 \cdot 10^{25}$ yr

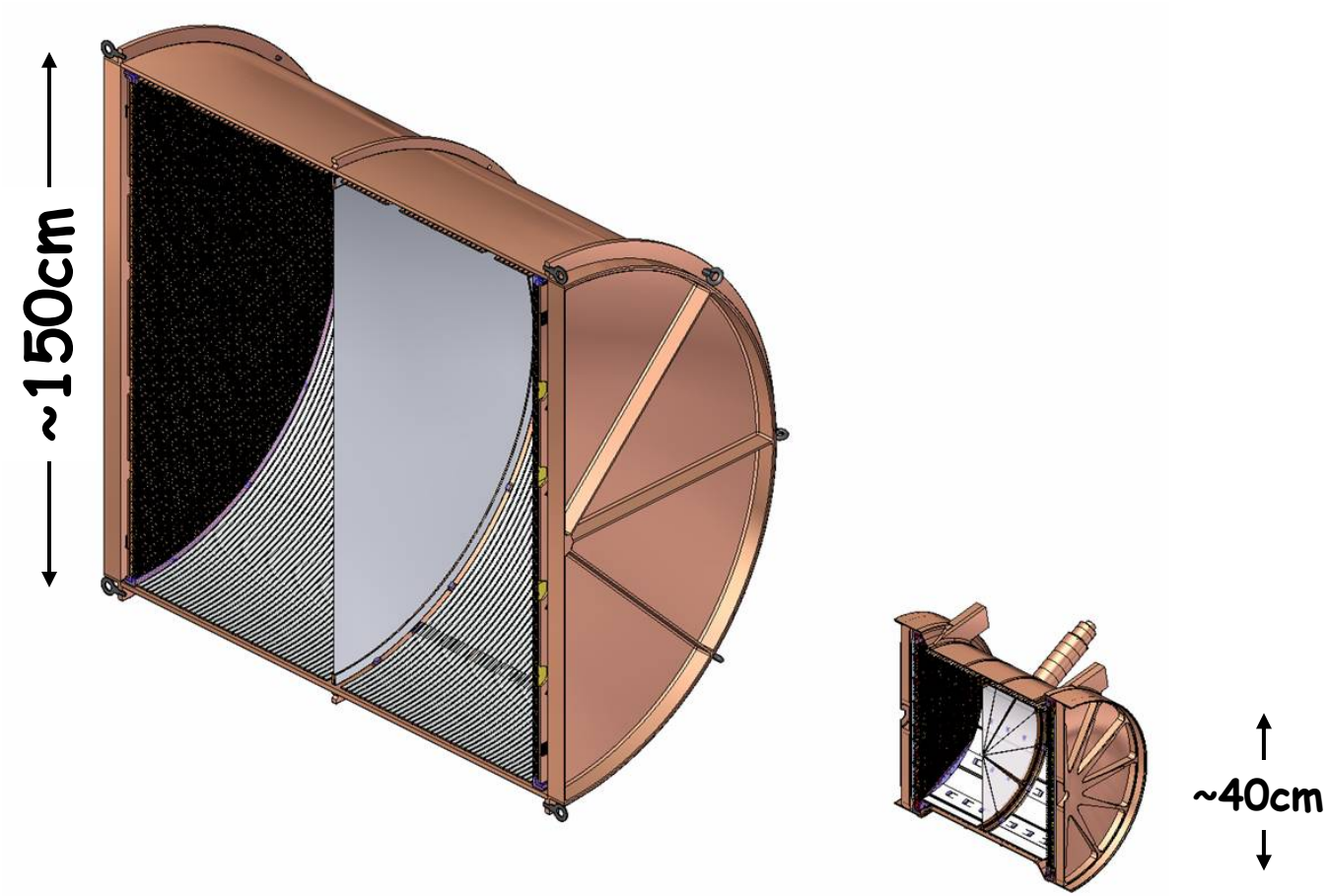
$\langle m_{\beta\beta} \rangle < 140–380$ meV

(90% C.L.)

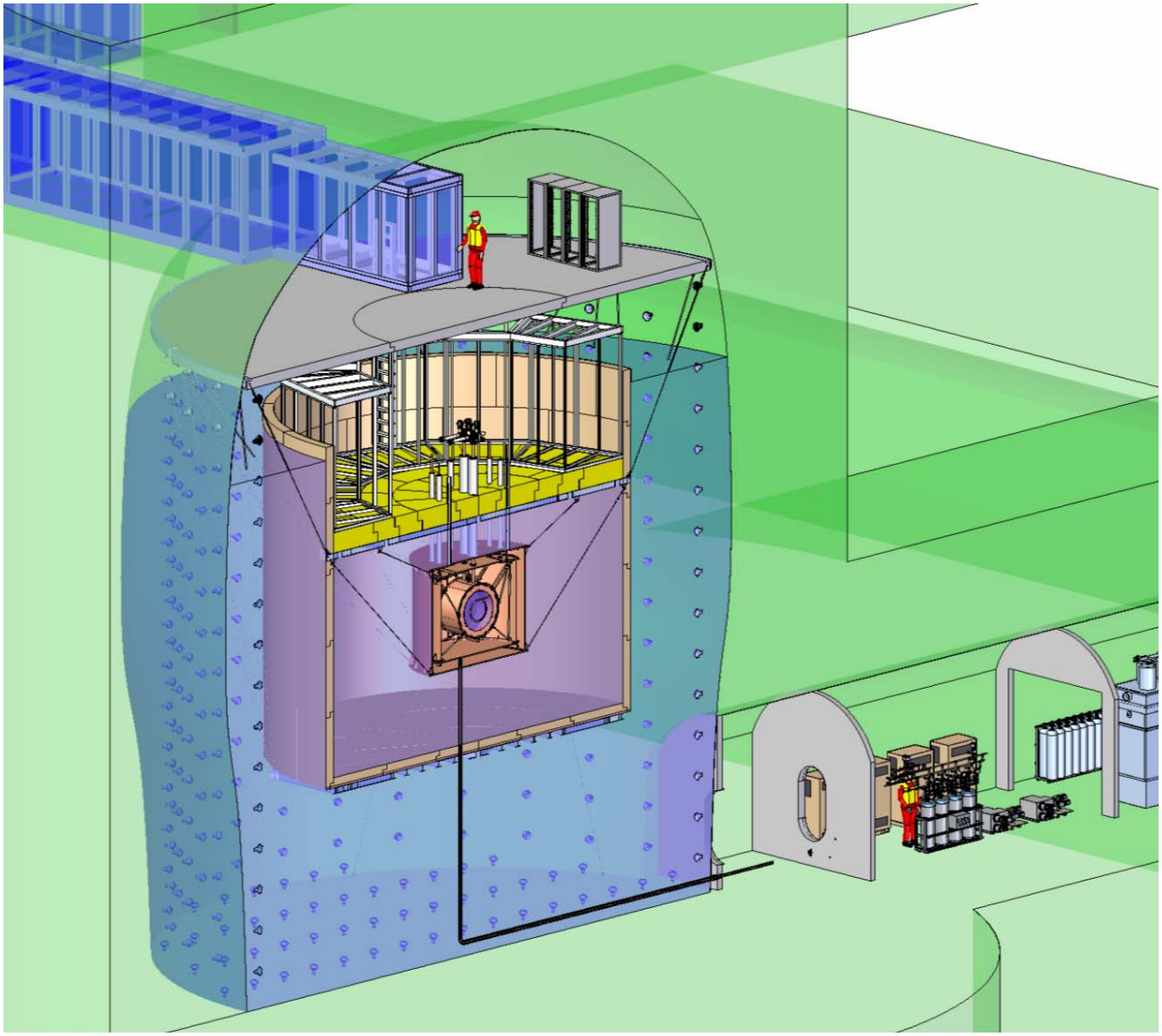
Phys Rev Lett 109 (2012) 032505

nEXO @SNOlab

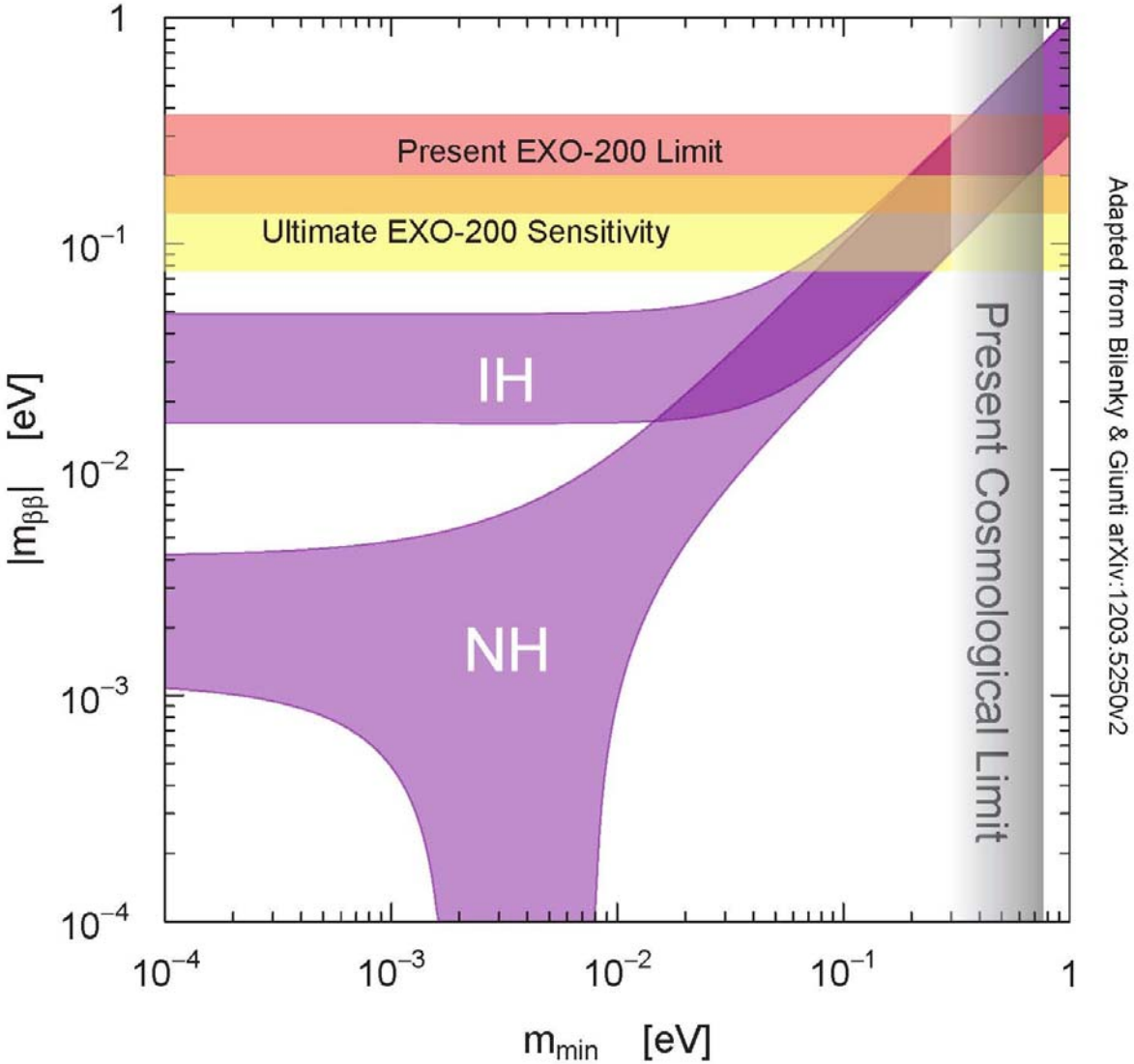
- 5 tonne LXe TPC "as similar to EXO-200 as possible"
- Provide access ports for a possible later upgrade to Ba tagging



nEXO in the SNOlab Cryopit with Xe and HFE Systems on Lower Level



EXO-200 and nEXO projected sensitivities



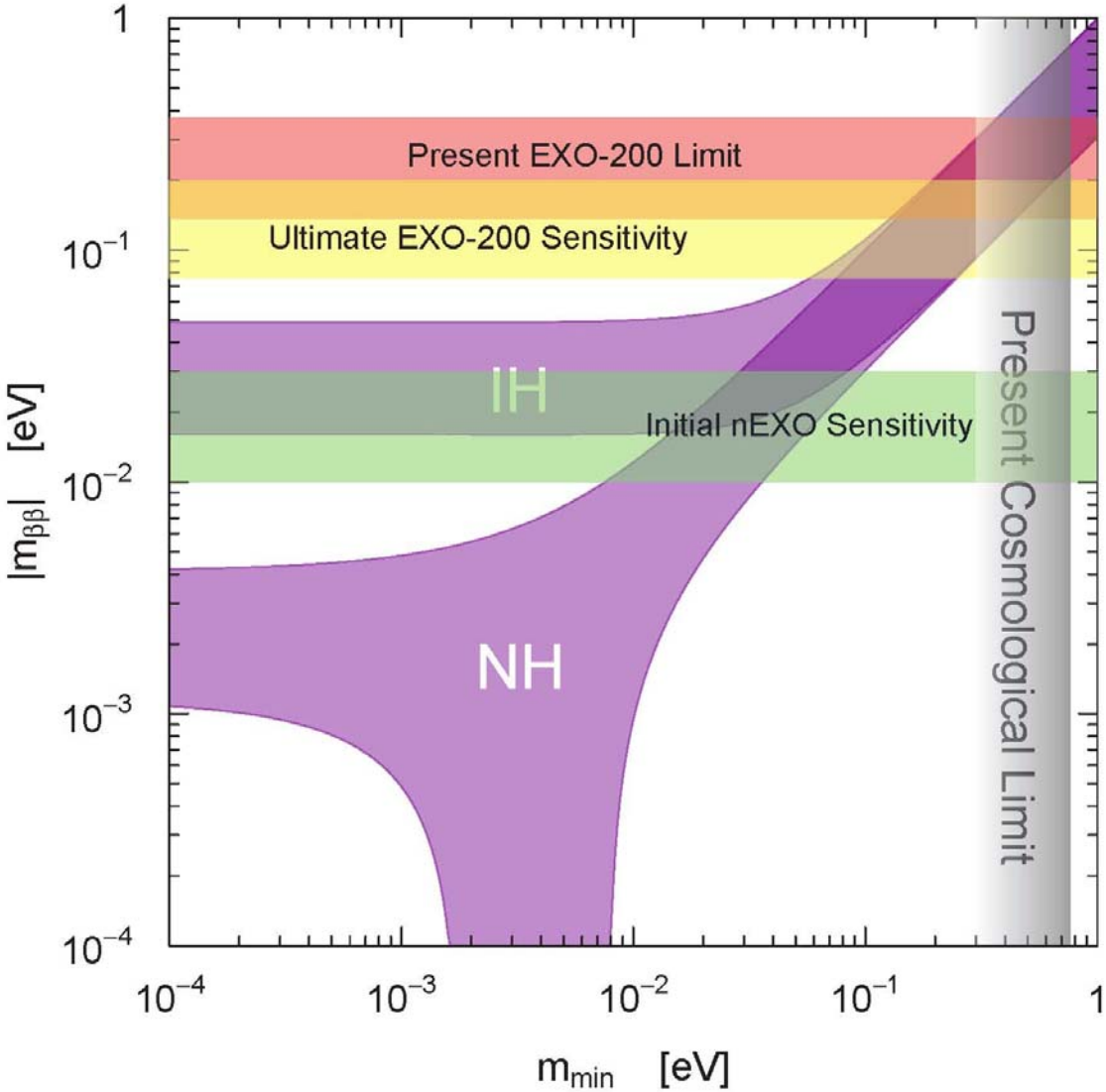
Adapted from Bilenky & Giunti arXiv:1203.5250v2

Blue bands are 68%CL from oscillation experiments for "Inverted" and "Normal" Hierarchy

The EXO-200 "Present limit" is the 90%CL envelope of Limits (for different NMEs) from PRL 109 (2012) 032505

The EXO-200 "Ultimate" sensitivity: 90%CL for no signal in 4 yrs livetime with new analysis & Rn removal

EXO-200 and nEXO projected sensitivities



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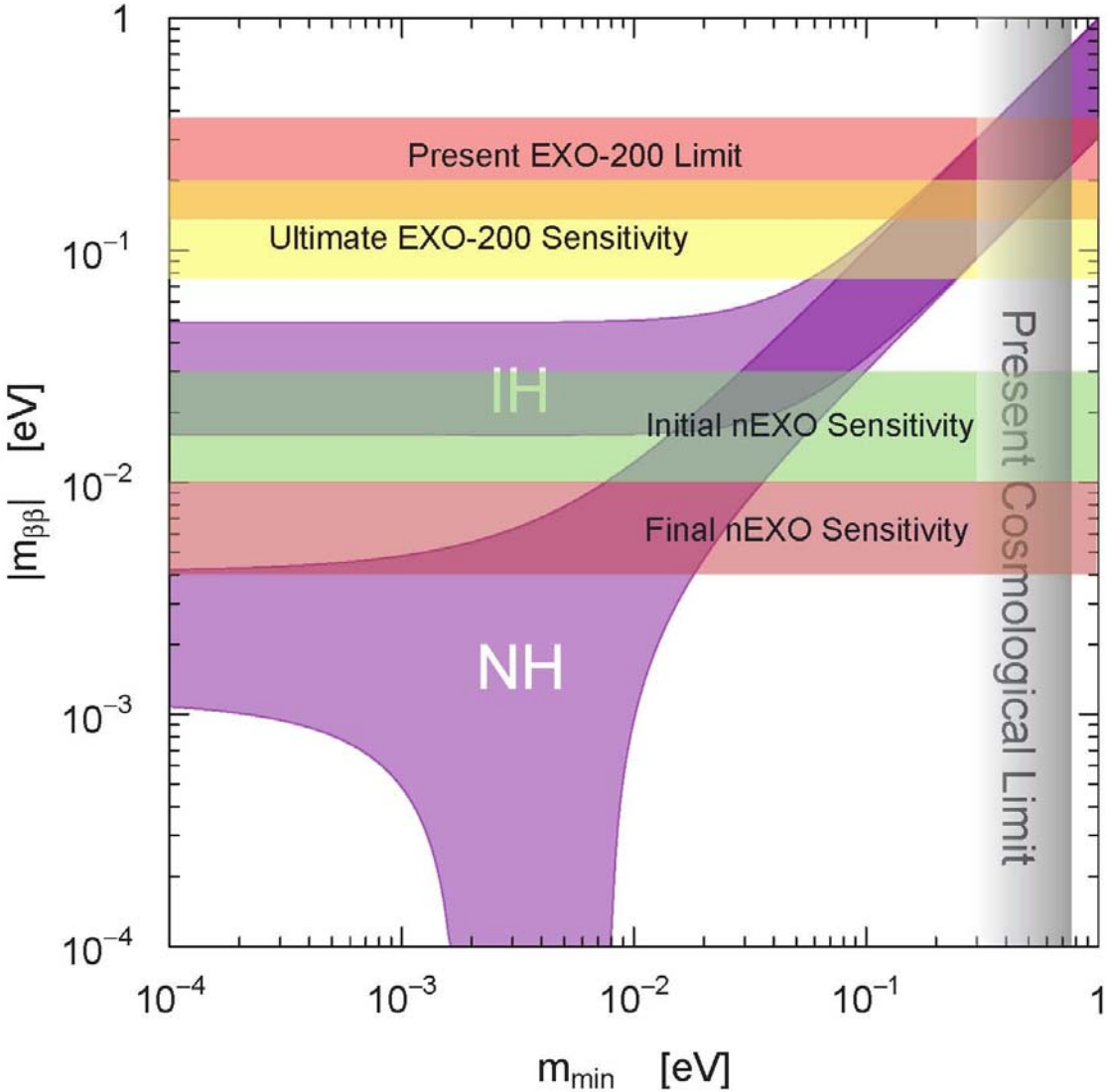

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The EXO-200 "Ultimate" sensitivity: 90%CL for no signal in 4 yrs livetime with new analysis & Rn removal

The "Initial nEXO" band refers to a detector directly scaled from EXO-200, including its measured background and 10yr livetime.

The "Final nEXO" band refers to the same detector and no background other than 2v

Conclusions

- nEXO is based on existing the well proven technology
- nEXO is the right detector to explore the inverted hierarchy
- If properly supported can be ready quickly
- It can be another US-led success
- If Ba tagging R&D successful it can be upgraded to reach part of the normal hierarchy
- Indecision and delays will not make it happen!

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