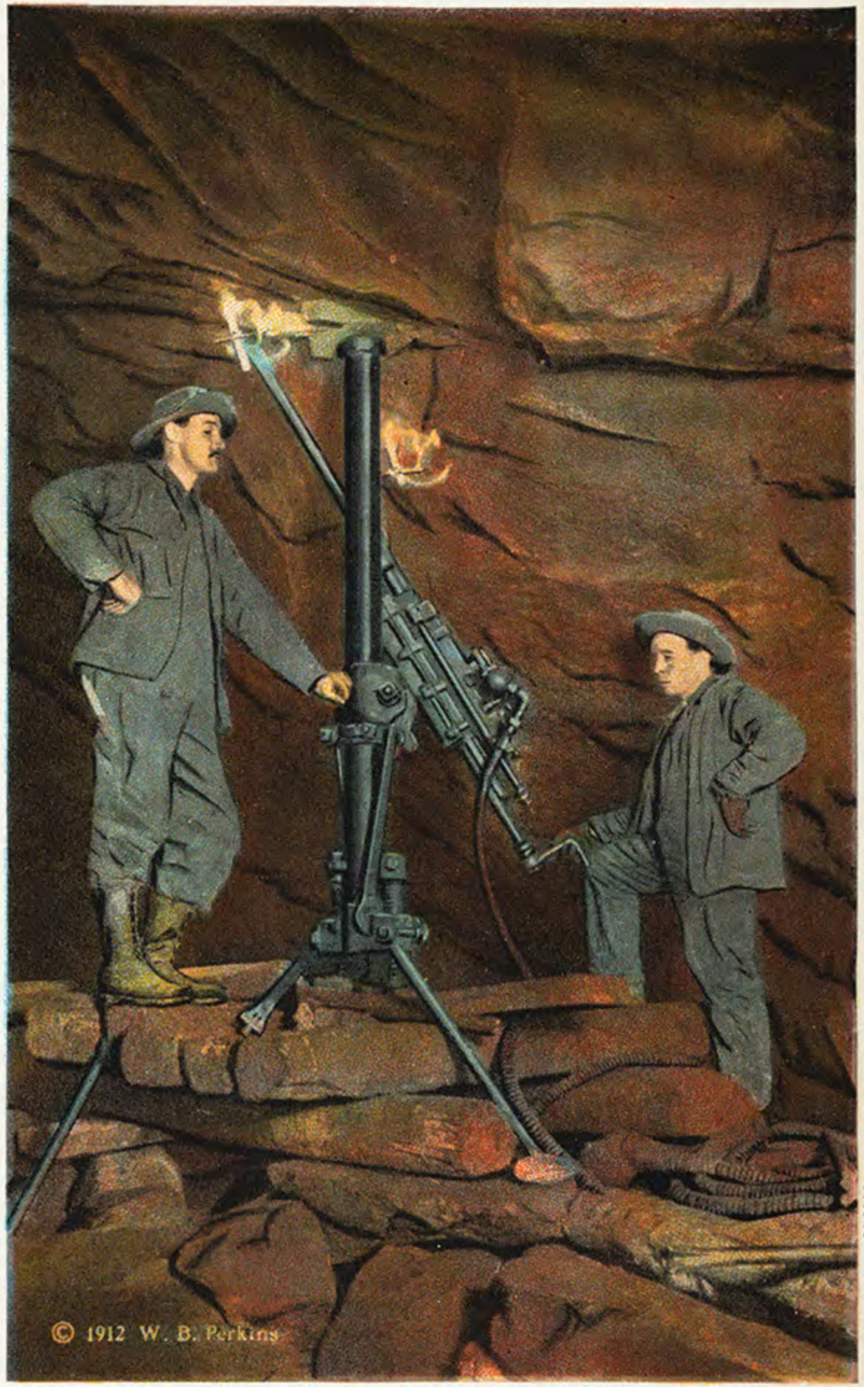


30. DRILLING WITH COMPRESSED AIR, HOMESTAKE MINE, LEAD, S. D.

The LZ Dark Matter Detector

Maria Elena Monzani
on behalf of the LZ Collaboration

SLAC NATIONAL ACCELERATOR LABORATORY

SUSY 2015, August 25

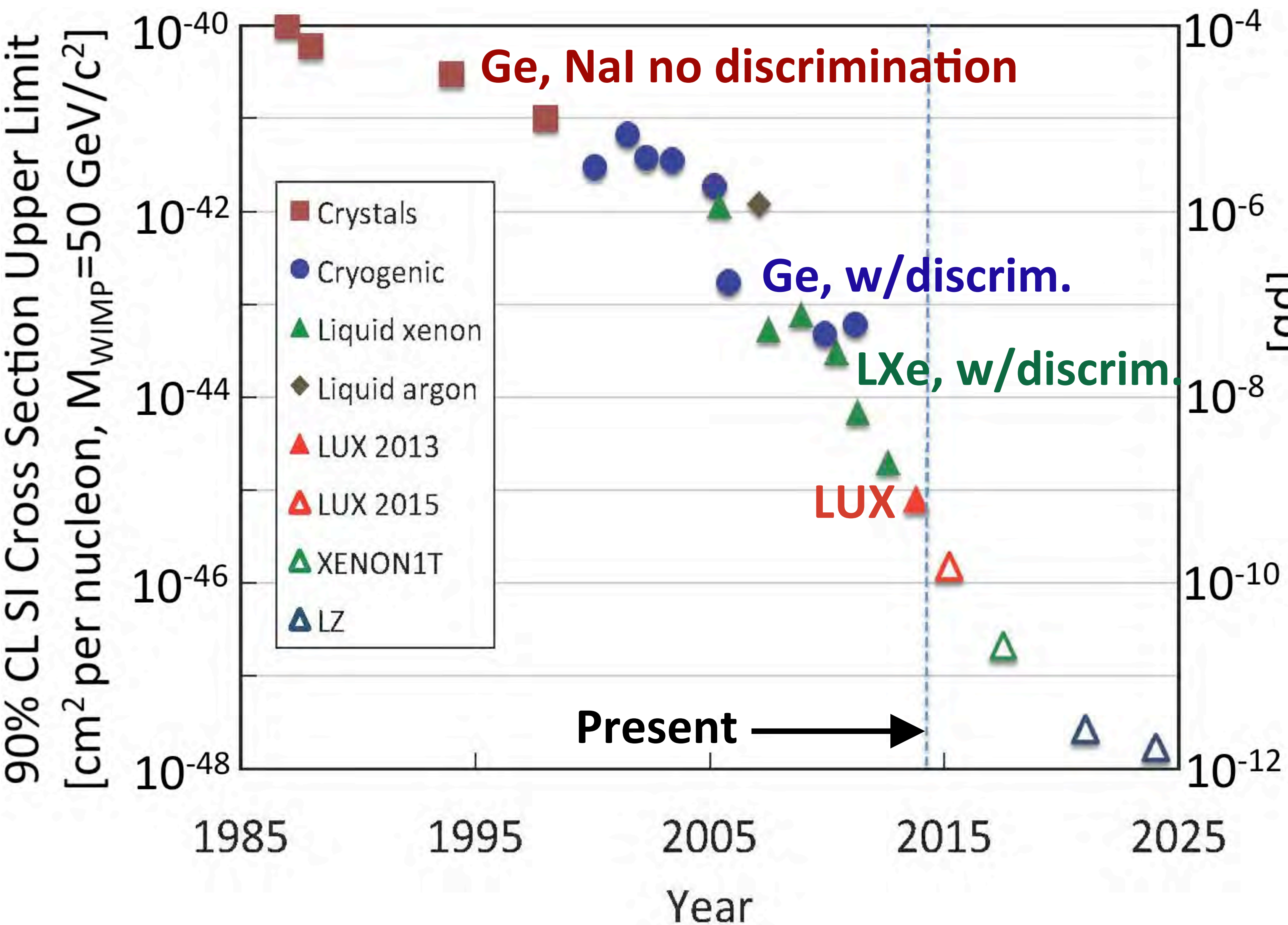
LZ = LUX + ZEPLIN (+ others)

LZ collaboration:

- currently 30 institutions
- USA, UK, Portugal, Russia
- about 185 physicists and engineers
- collaboration is rapidly expanding

LZ collaboration meeting, Alabama, April 2015

Moore's Law of Direct Detection



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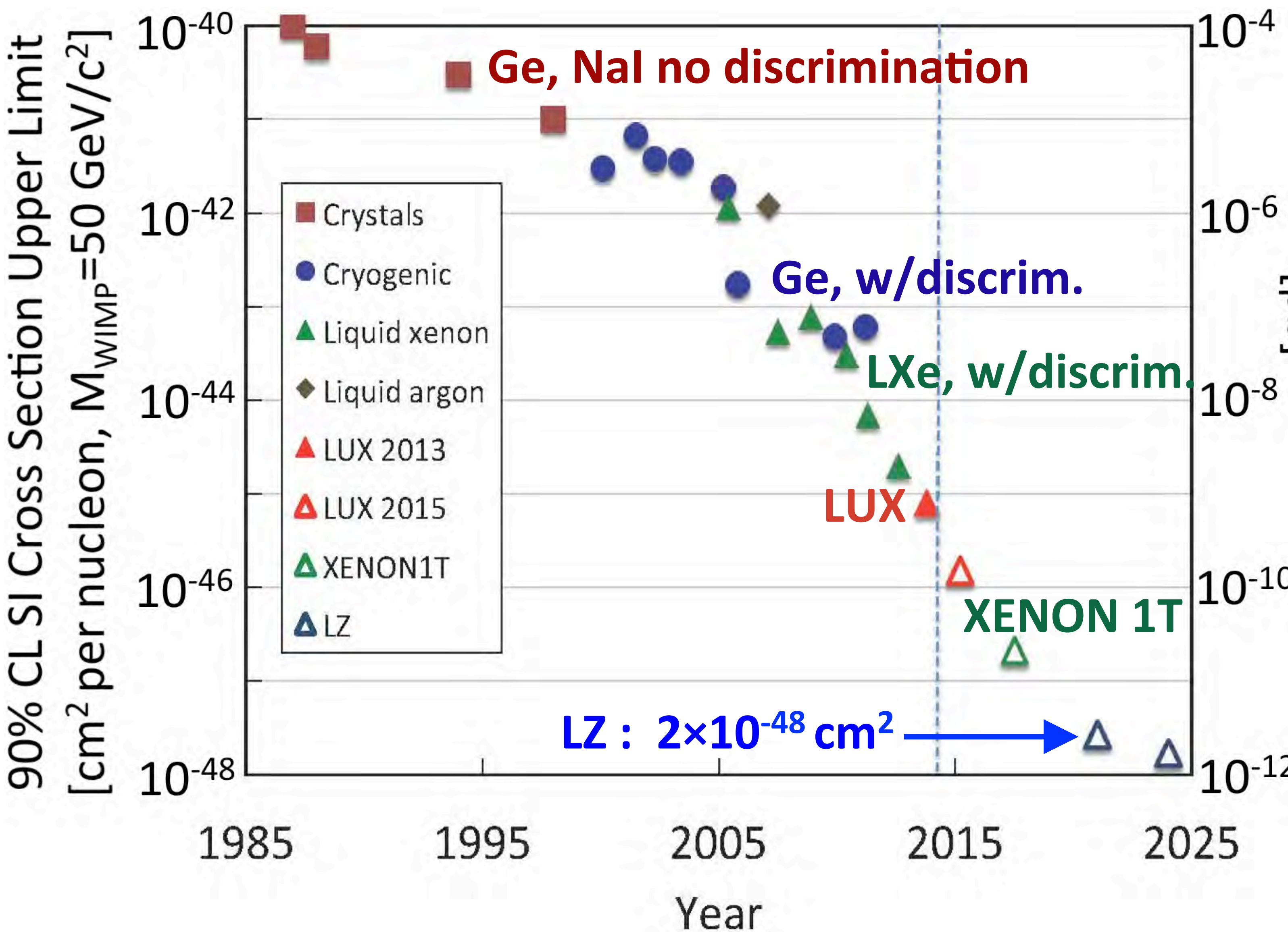


Go big or go home!

Liquid detectors: "easy" scaling

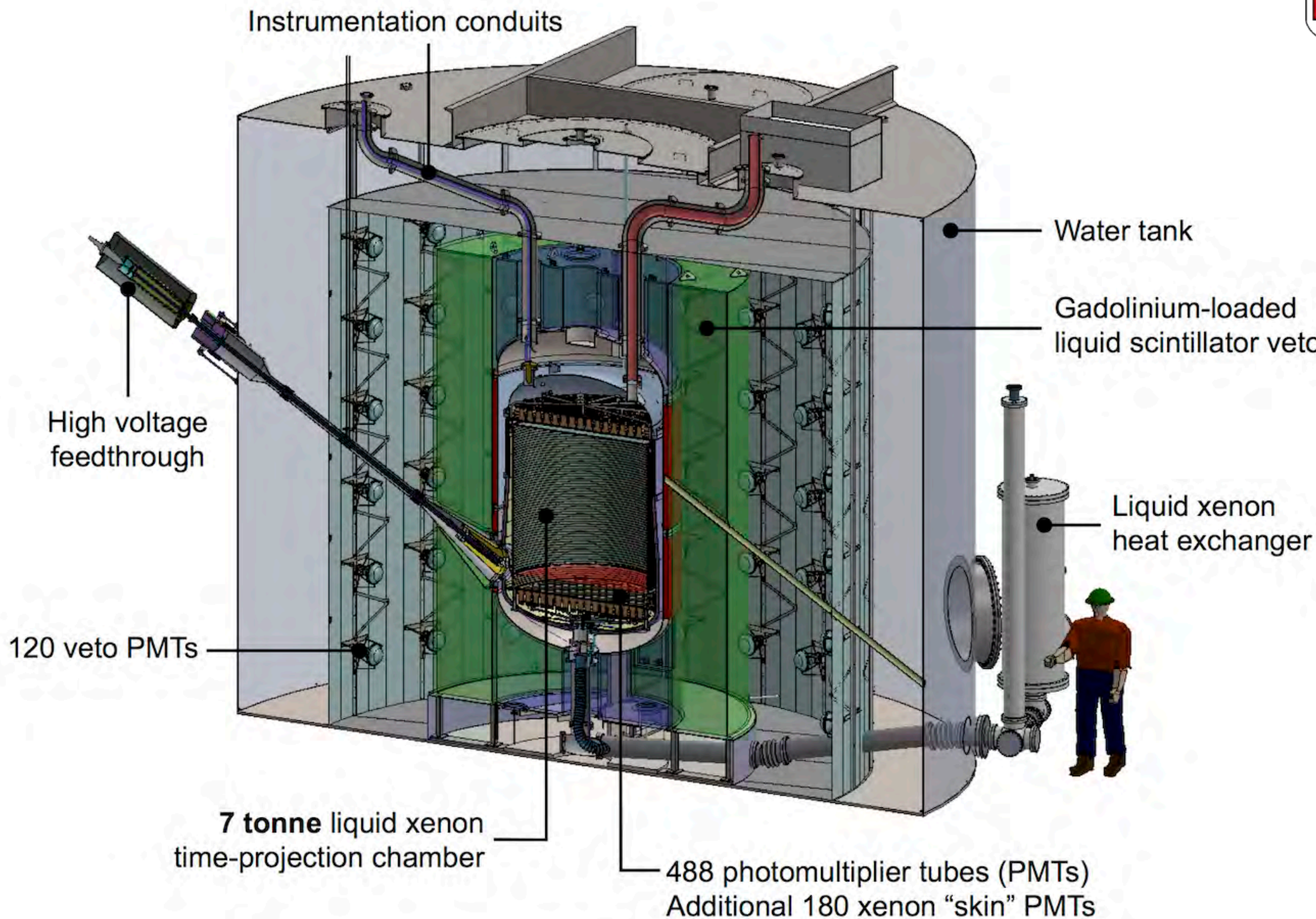
- Scale up ~50x in Target Mass
- Gain ~400x in Sensitivity

LZ

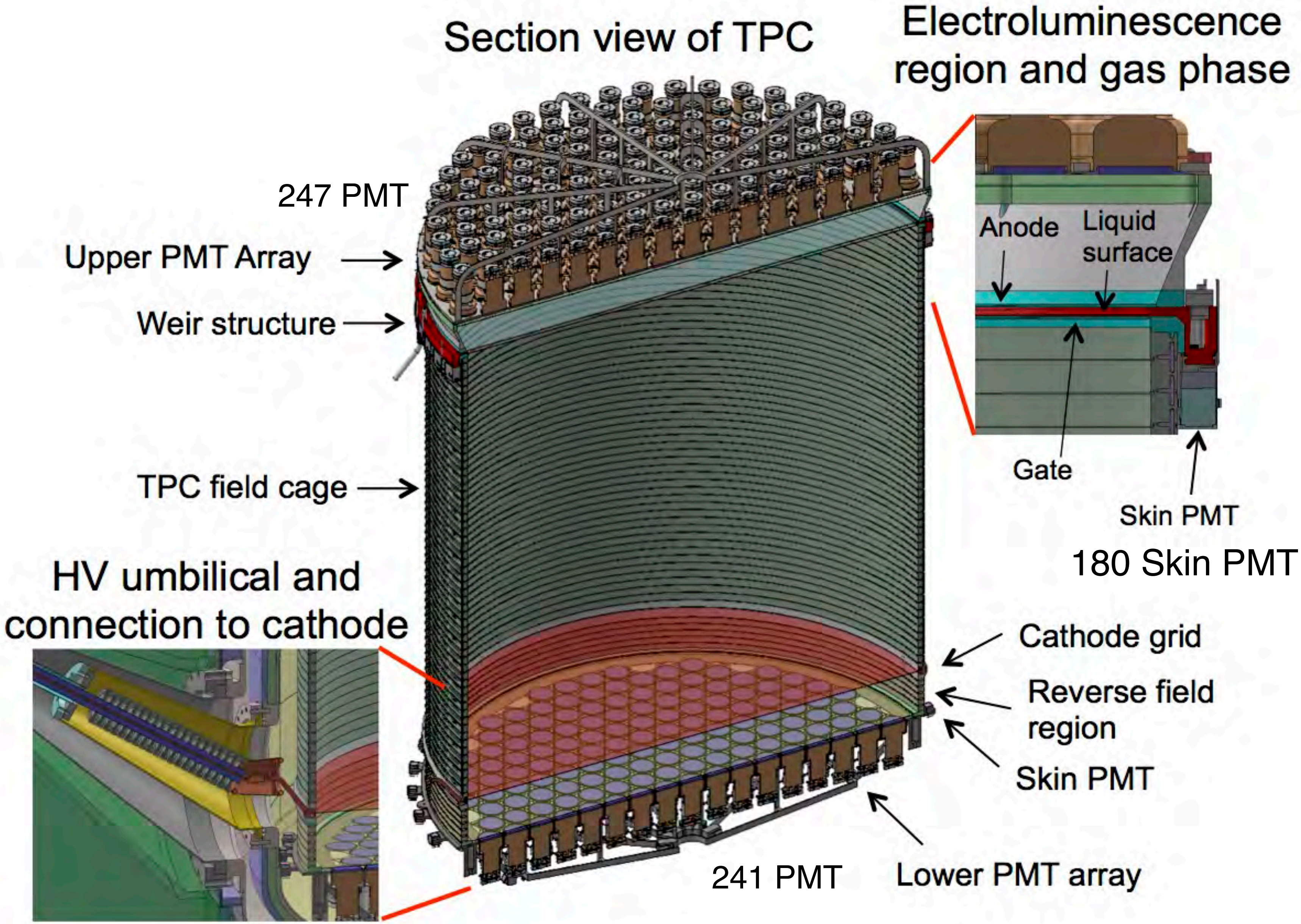
Total Xe mass – 10 T
Active Mass – 7 T
Fiducial Mass – 5.6 T

LUX

LZ Overview


Instrumentation conduits
Water tank
Gadolinium-loaded
liquid scintillator veto
High voltage
feedthrough
Liquid xenon
heat exchanger
120 veto PMTs
7 tonne liquid xenon
time-projection chamber
488 photomultiplier tubes (PMTs)
Additional 180 xenon “skin” PMTs

The Xenon TPC Detector



Selected Experimental Challenges

- **Backgrounds, backgrounds, backgrounds:**
  - **External (PMT, Cryostat, etc.): select materials carefully**
  - **Internal (Kr + Rn): Kr removal by charcoal chromatography**
  - **Cosmogenic (muons etc.): experiment deep underground**
  - **Cosmogenic (neutrinos): ER/NR selections, will graze floor**

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  - Self-shielding necessary (Xe100-LUX: fiducial fraction ~1/2)
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- **High-voltage requirements:**
  - No Xe detector (to date) achieved design HV specifications

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How to maximize the WIMP target mass?

- **Two-component outer detector:**
  - **0.75 m thick Gd-loaded scintillator**
  - **instrumented Xenon "skin"**
  - **tag neutrons and gammas**

***in-situ* monitoring of residual backgrounds!!!**

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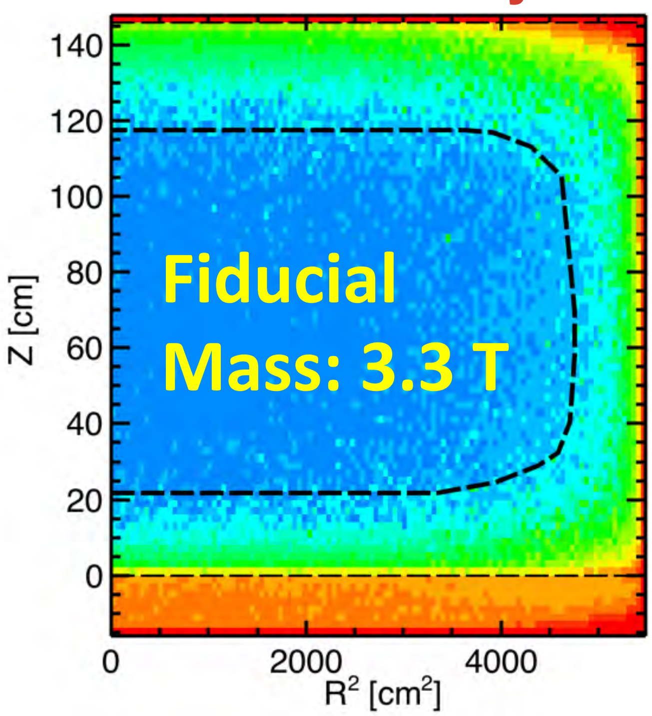
in-situ **monitoring of residual backgrounds!!!**

Xe-TPC Only



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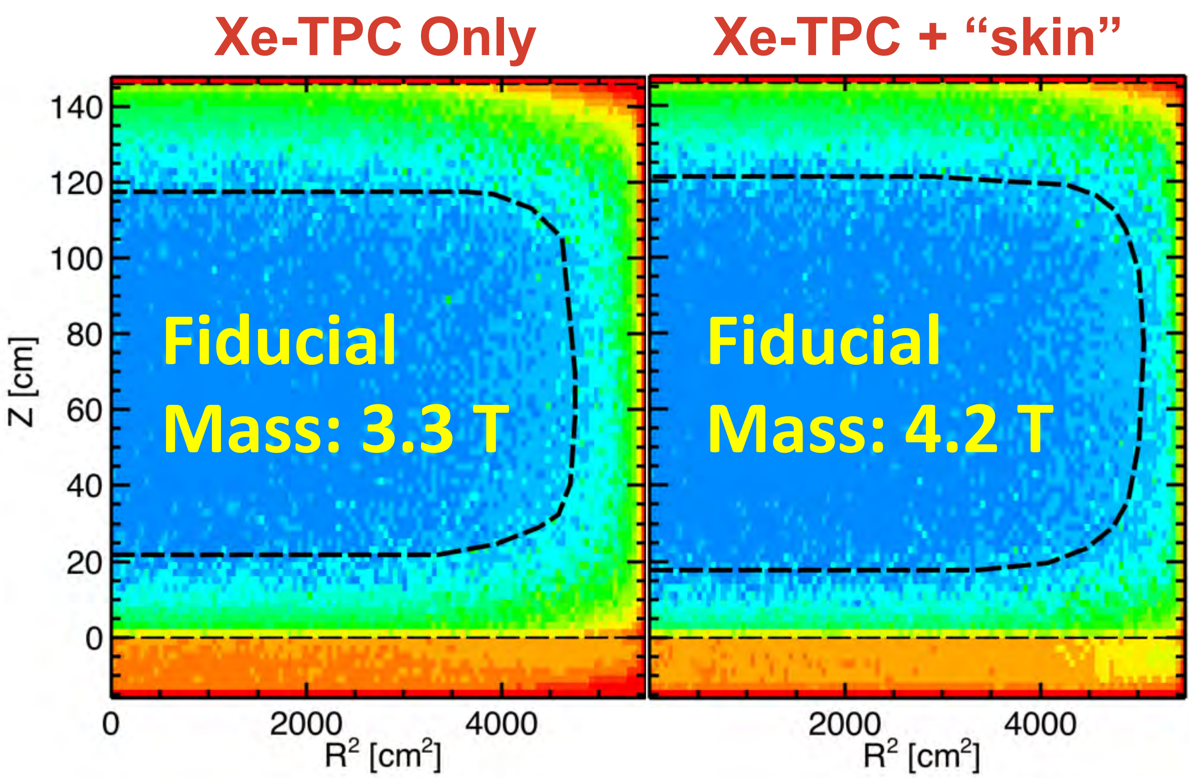

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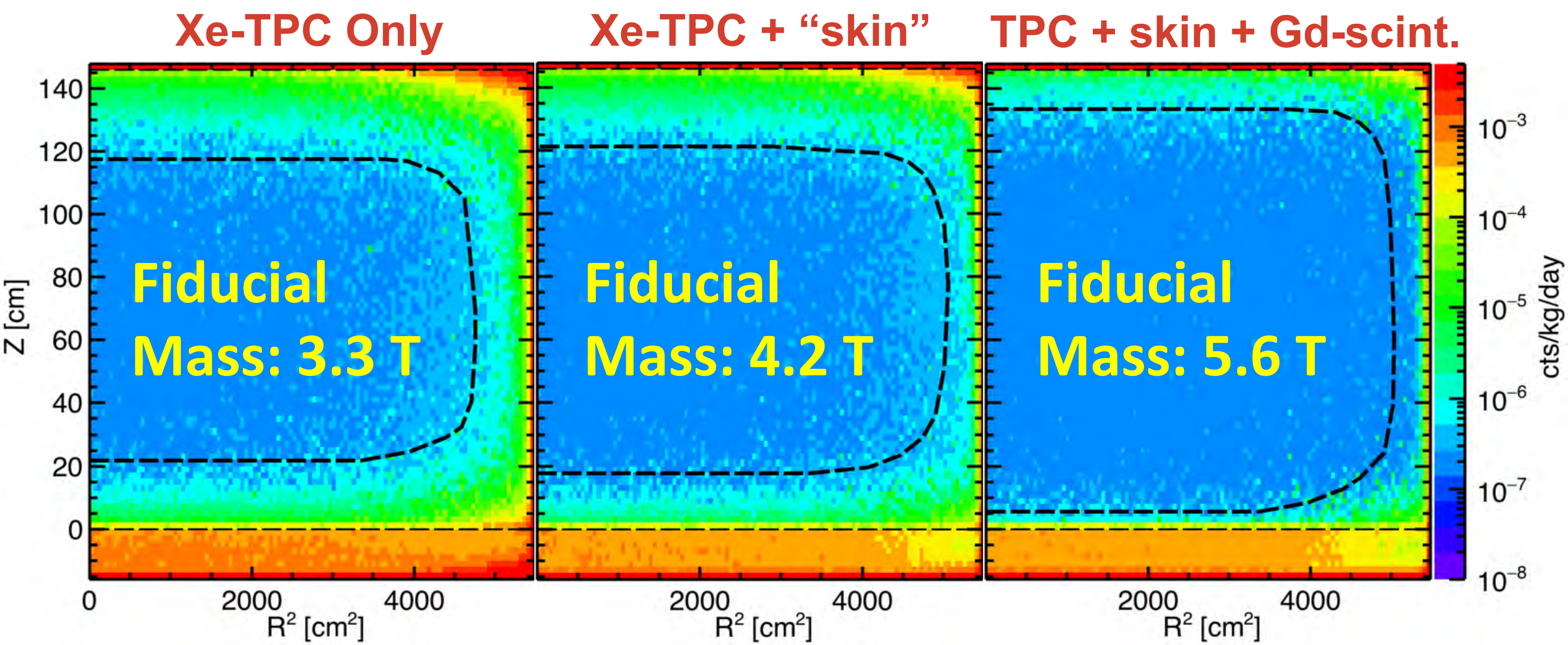

Backgrounds, backgrounds, backgrounds

Expected backgrounds for 5.6 T fiducial - 1,000 days

	ER	NR
WIMP background events (99.5% ER discrimination, 50% NR acceptance)	1.96	0.41
Total ER+NR background events	2.37	

Backgrounds, backgrounds, backgrounds

Expected backgrounds for 5.6 T fiducial - 1,000 days

							ER	NR
Total events							391.5	0.82
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Backgrounds, backgrounds, backgrounds

Expected backgrounds for 5.6 T fiducial - 1,000 days

								ER	NR
Neutrinos (ν-e, ν-A)								271	0.5
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	ER	NR
Dispersed radionuclides (Rn, Kr, Ar)	54.8	-
^{136}Xe $2\nu\beta\beta$	53.8	-
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Total events	391.5	0.82
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Expected backgrounds for 5.6 T fiducial - 1,000 days

ER NR

Item	Mass kg	U mBq/kg	Th mBq/kg	^{60}Co mBq/kg	^{40}K mBq/kg	n/yr	ER cts	NR cts
R11410 PMTs	93.7	2.7	2.0	3.9	62.1	373	1.24	0.20
R11410 bases	2.7	74.6	29.1	3.6	109.2	77	0.17	0.03
Cryostat vessels	2,140	0.09	0.23	≈0	0.54	213	0.86	0.02
OD PMTs	122	1,507	1,065	≈0	3,900	20,850	0.08	0.02
Other components	-	-	-	-	-	602	9.5	0.05
Total components							11.9	0.32
Dispersed radionuclides (Rn, Kr, Ar)							54.8	-
^{136}Xe 2νββ							53.8	-
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Xenon detector prototyping

- **Extensive program of prototype development underway**
- **Three general approaches:**
  - **Testing in liquid argon, primarily of HV elements, at Yale and soon at LBNL**
  - **Design choice and validation in small (few kg) LXe test chambers in many locations: LLNL, Yale/UC Berkeley, LBNL, U Michigan, UC Davis, Imperial College, MEPhI**
  - **System test platform at SLAC, Phase I about 100 kg of LXe, TPC prototype testing to begin in a few weeks**

SLAC Noble Liquid Test Platform

- High voltage validation
- Purification (Kr removal)
- Fundamental properties
- Integrated system test

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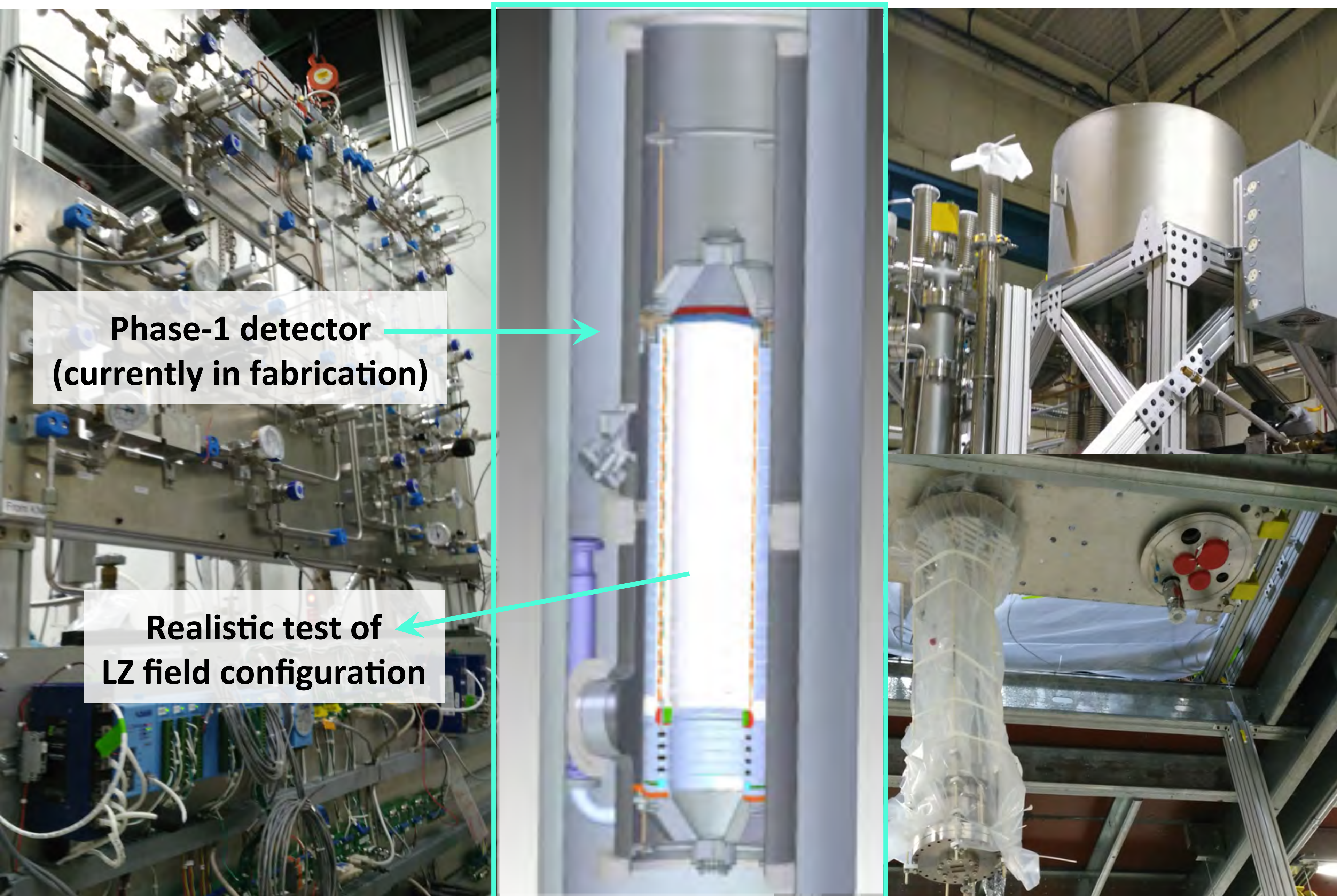
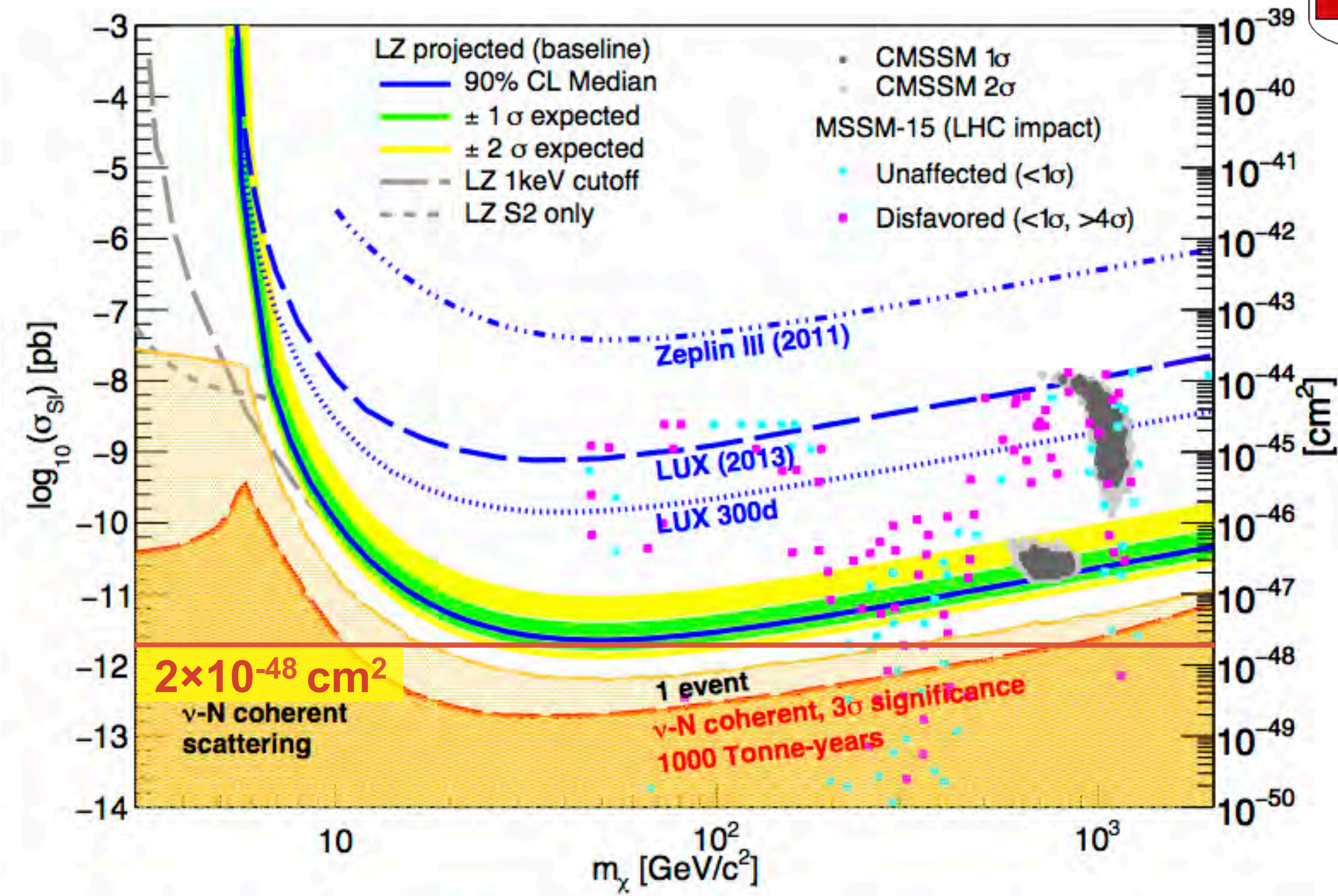


Expected Sensitivity Reach of LZ



Conclusions

- **LZ detector selected for G2 phase:**
  - **DOE CD-1/3a approval in April 2015**
  - **April 2016: CD-2/3b review expected**
  - **June 2017: surface assembly at SURF**
  - **July 2018: underground installation**

- **Extensive prototyping program underway**
- **LZ benefits from excellent LUX calibrations and understanding of backgrounds**

- **LZ science run to start in 2019:**
  - **Spin-Indep. sensitivity: 2×10^{-48} cm^2**
  - **3 years run, 5.6 tons fiducial volume**
  - **sensitivity limited by neutrino-induced backgrounds**