The XENON Dark Matter Program at LNGS
XENON100, 1T and beyond

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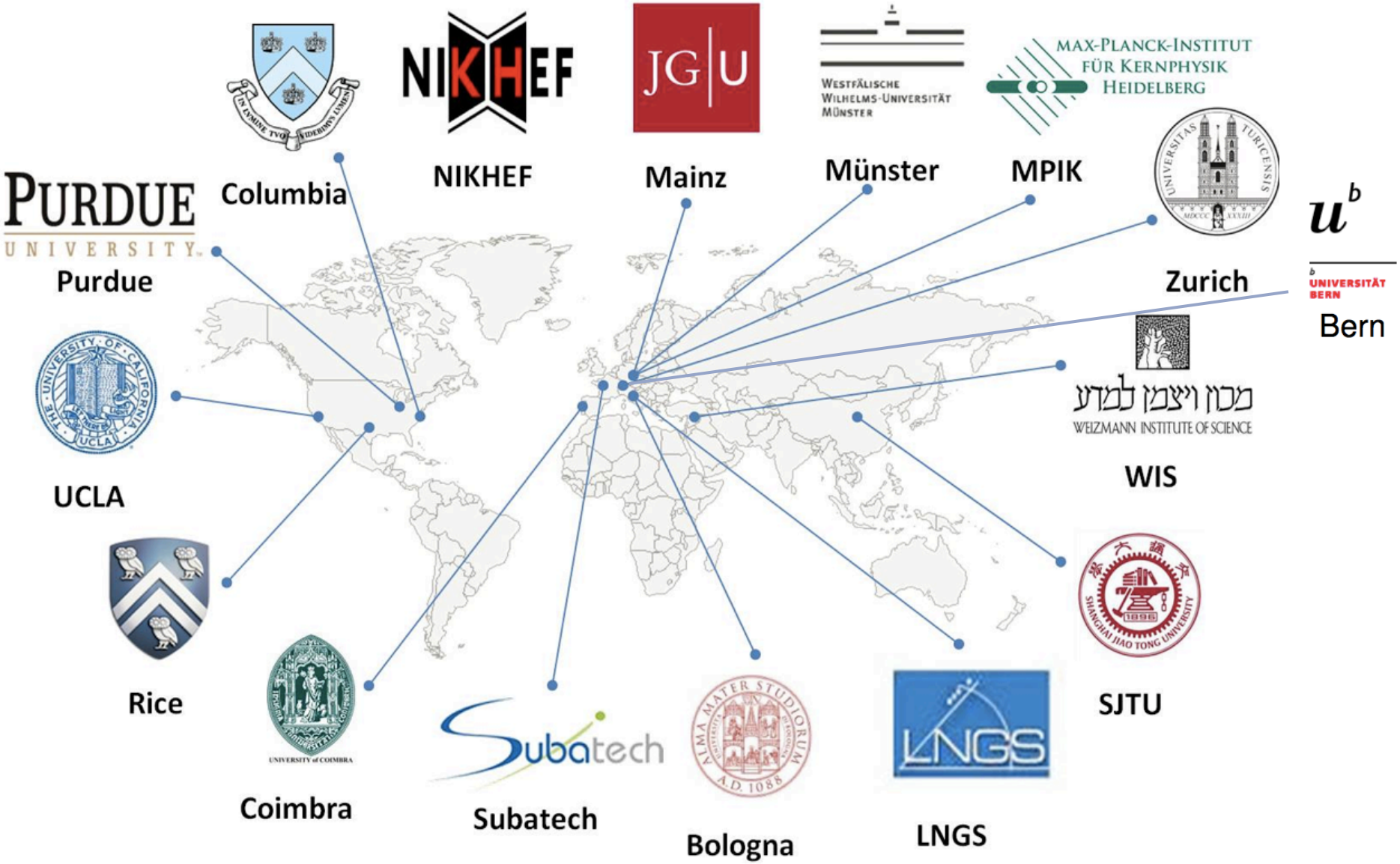
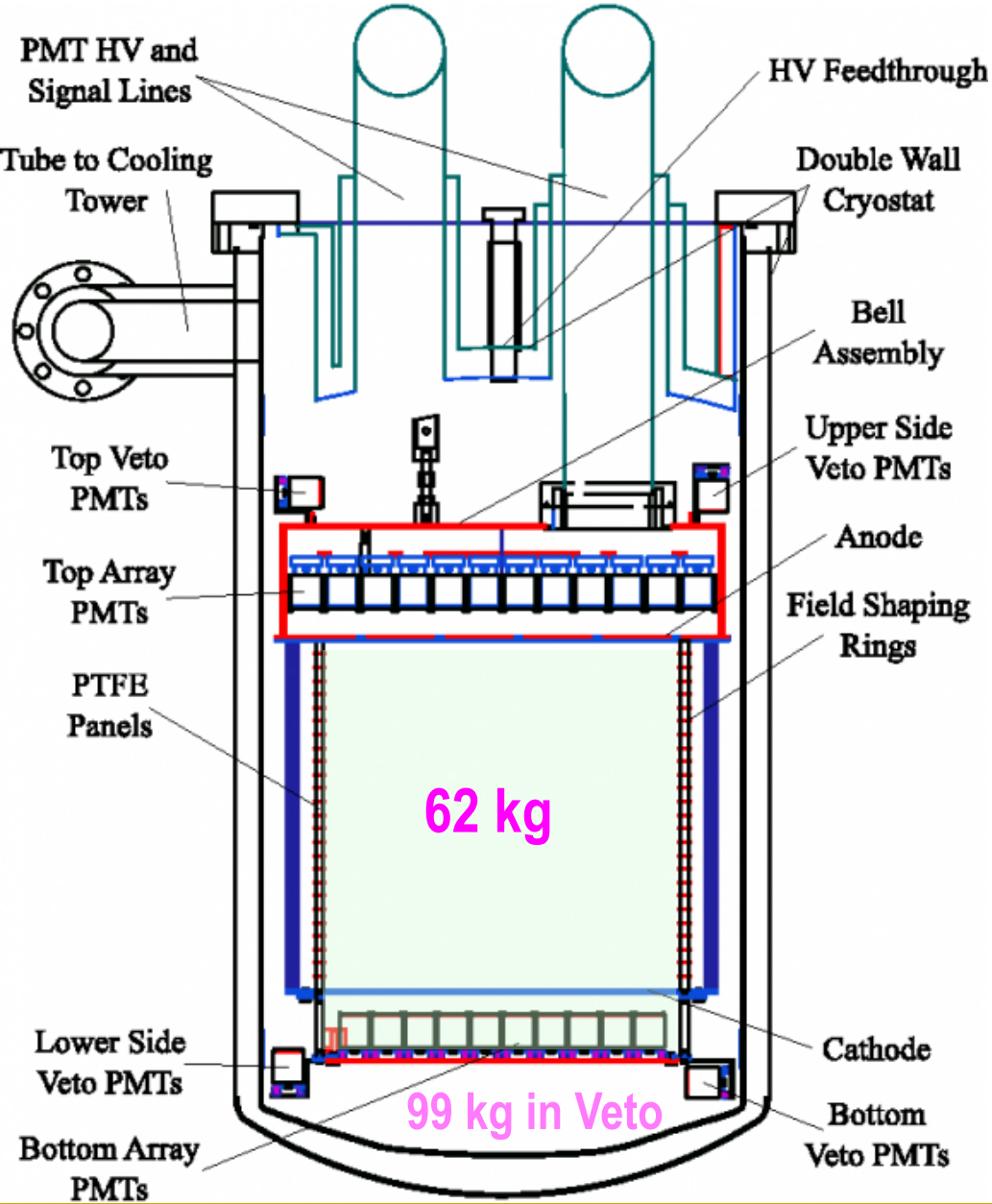
The XENON Collaboration

16 Institutions & ~100 members



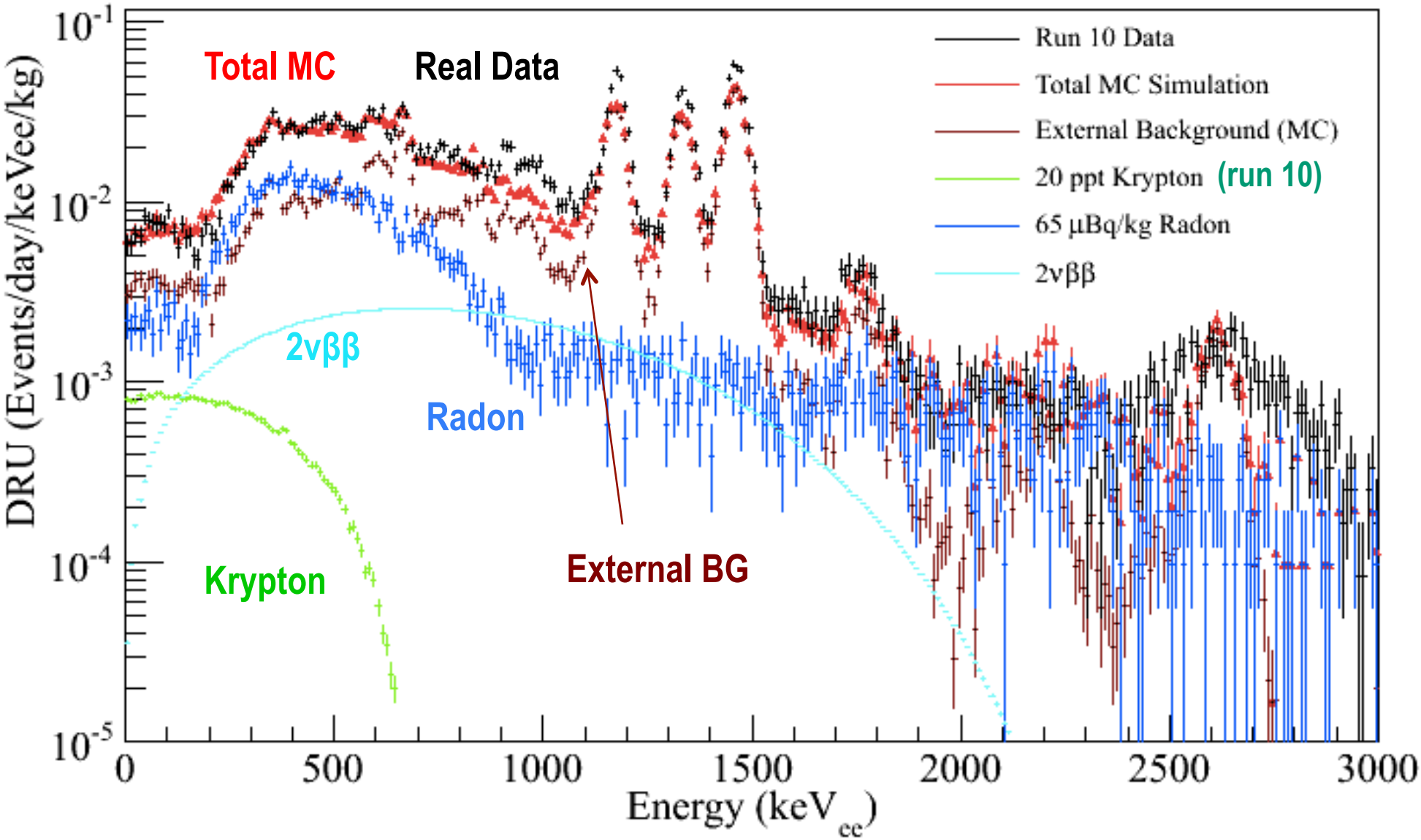
XENON100 at LNGS (G1)

Astroparticle Physics 35, 573-590, 2012

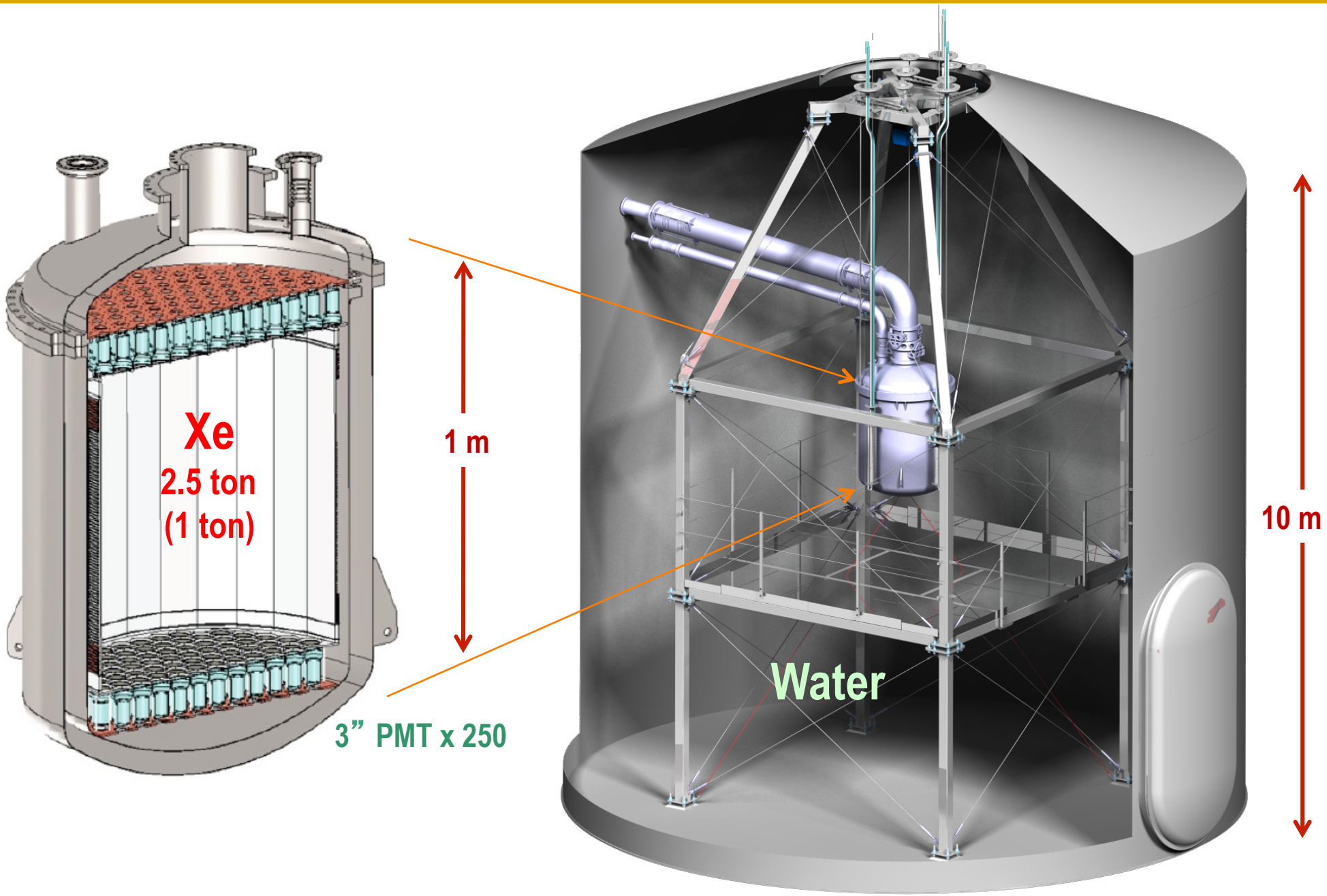


Gamma Backgrounds in XENON100

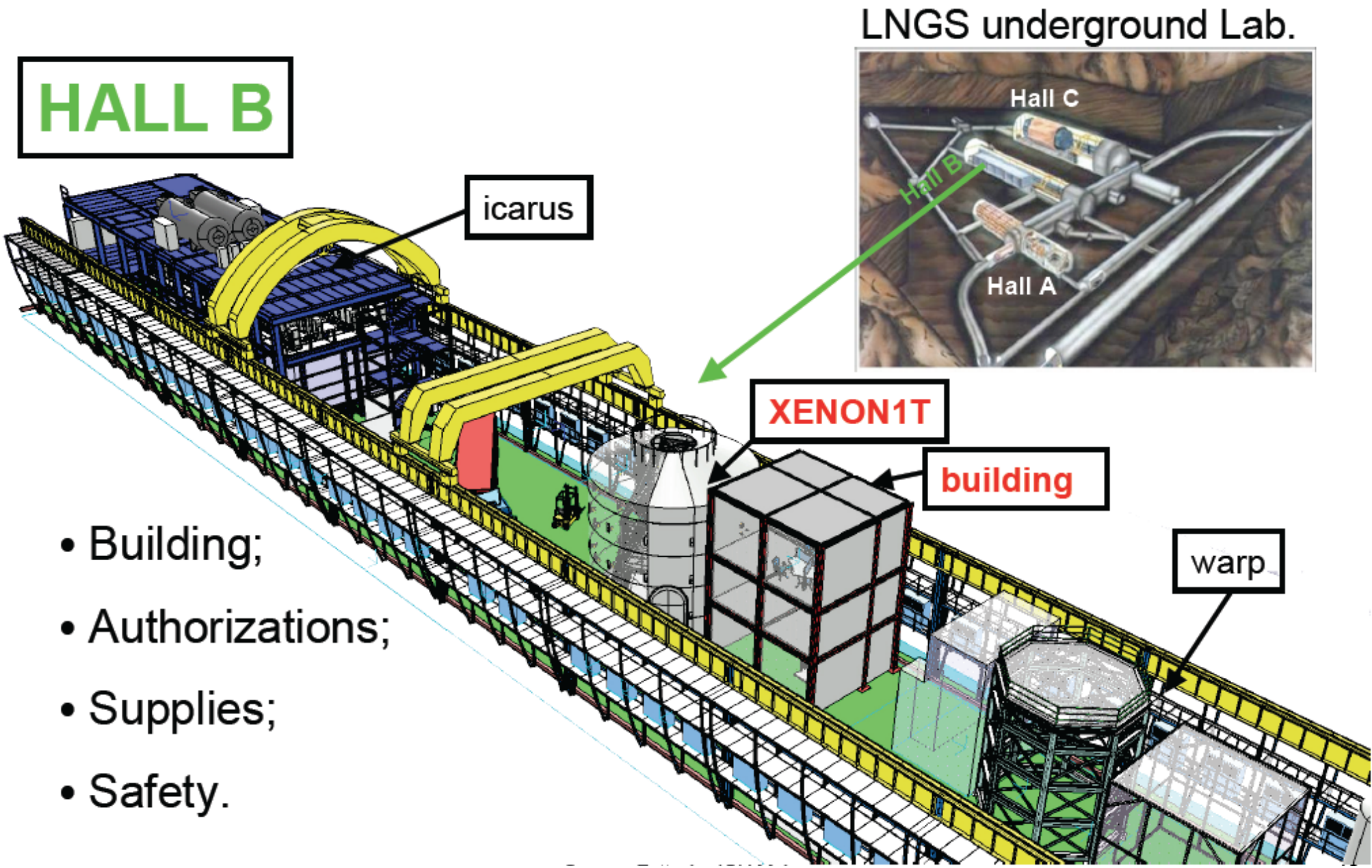
External Backgrounds: PRD 83, 082001 (2011)



XENON1T at LNGS (G2)

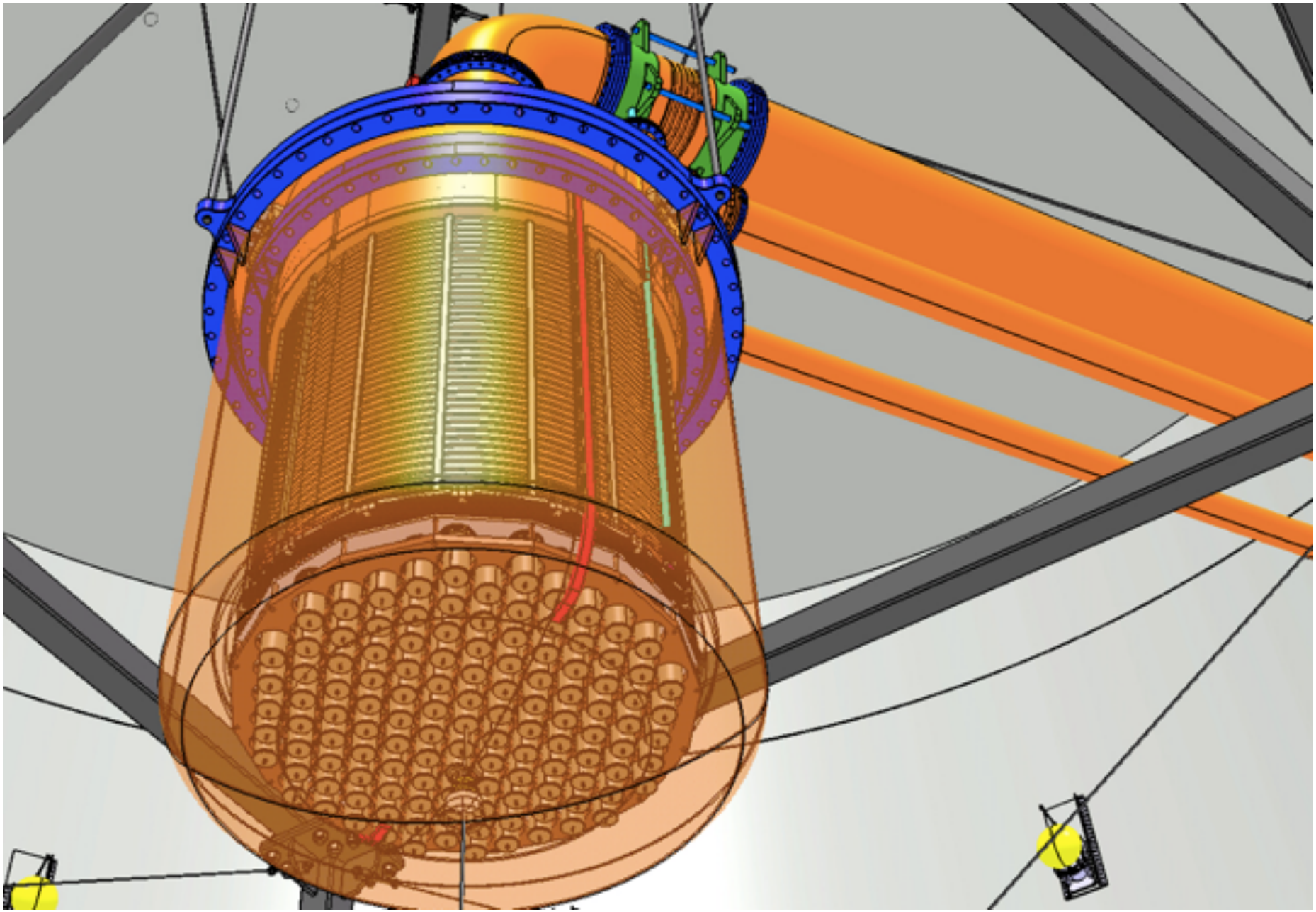


XENON1T at LNGS

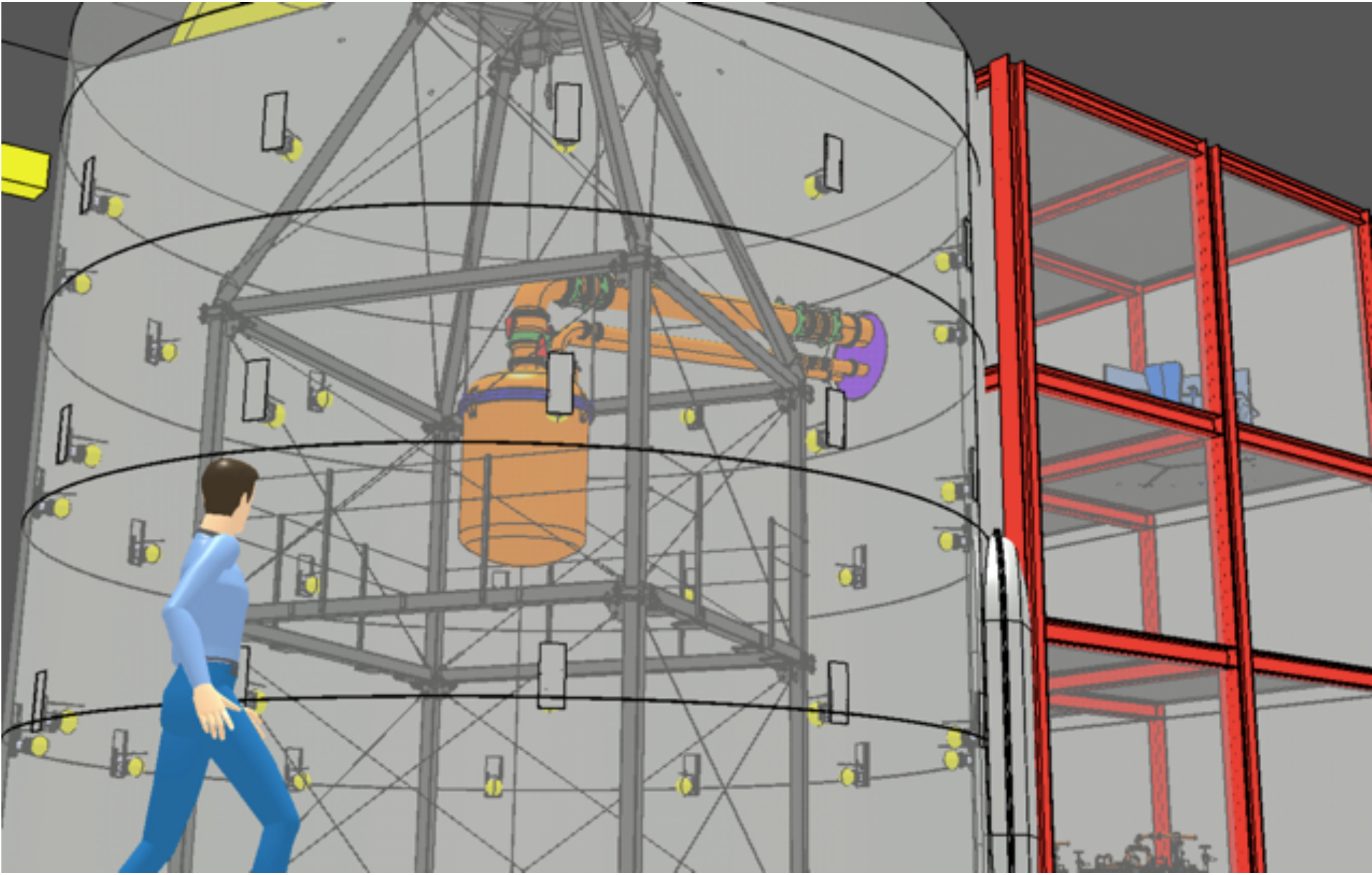


- Building;
- Authorizations;
- Supplies;
- Safety.

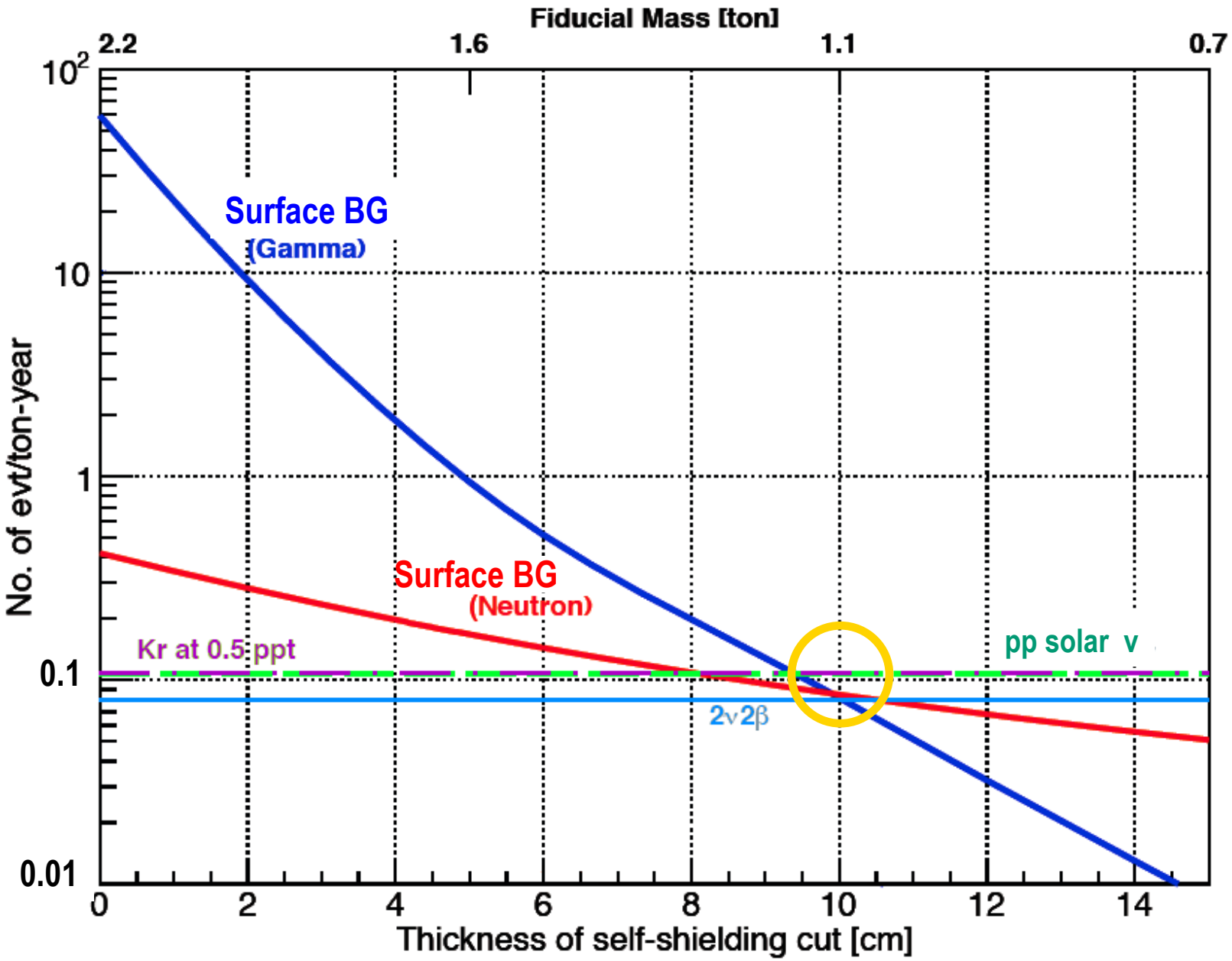
XENON1T Cryostat



XENON1T Detector



Expected Background in XENON1T

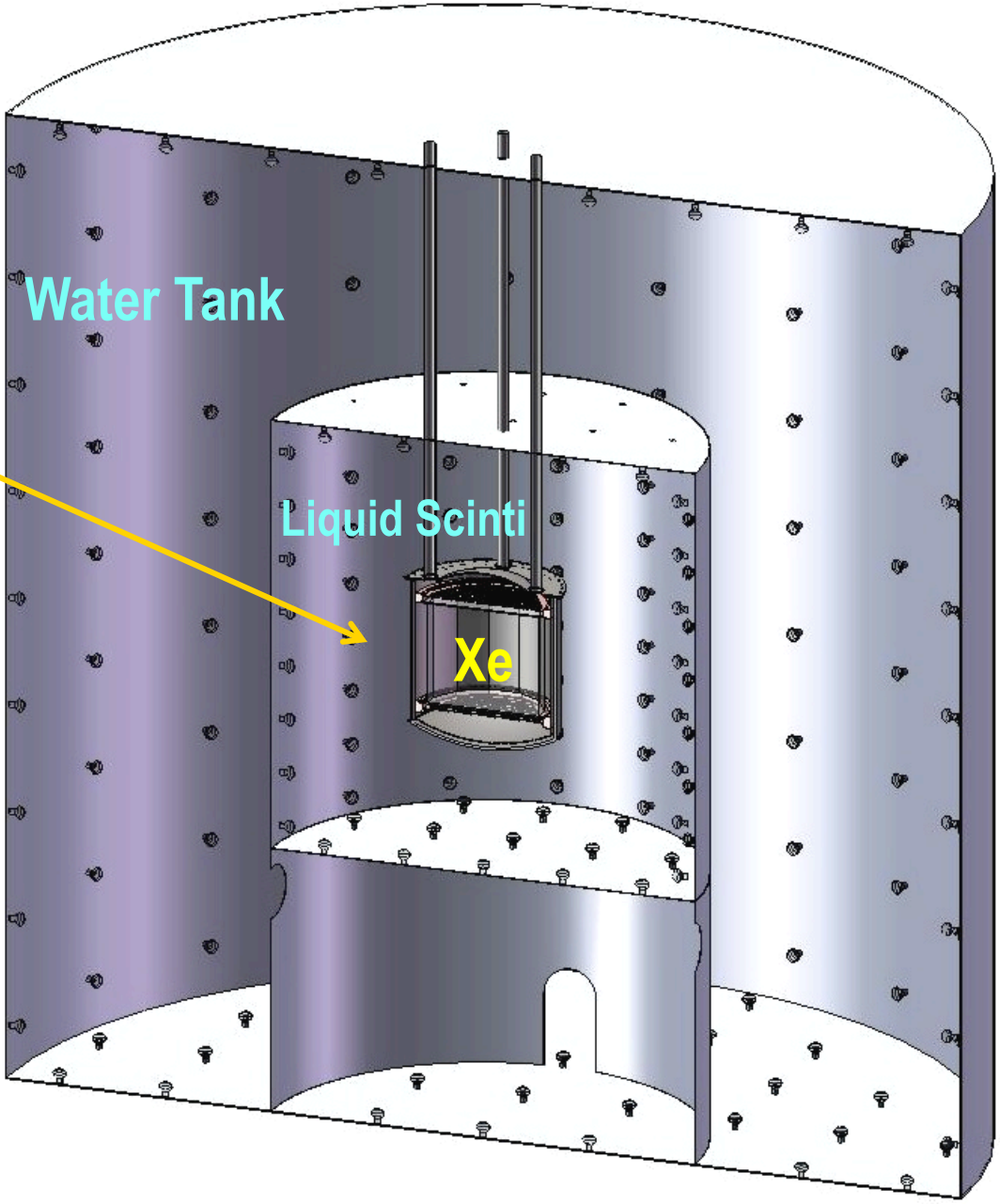


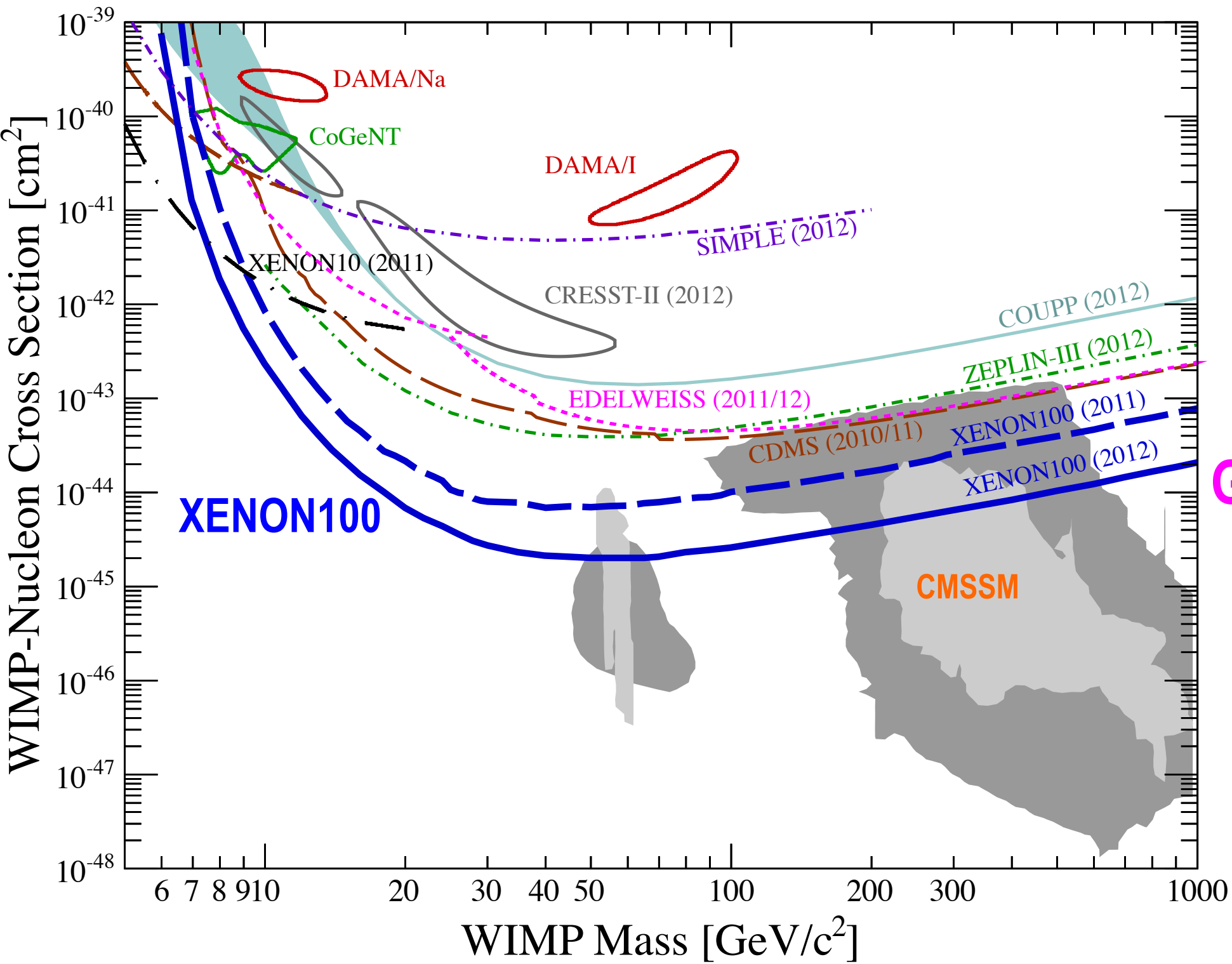
XENON1T: Summary

- **Detector**
  - 1m drift TPC with 2.5 ton LXe target (1 ton fiducial)
  - Shield: 10 m x 10 m Water Cherenkov Muon Veto
  - Gamma Background: 1×10^{-5} /keVee/kg/day
- **Sensitivity**
  - 2×10^{-47} cm^2 at 50 GeV with 2 ton-years
  - Gamma + Neutron Backgrounds < 1 event
- **Capital Cost**
  - 13 M$ (50% US and 50% non-US)
  - All secured and funded
- **Schedule**
  - Construction started in Fall 2012
  - Science run projected to start in 2015

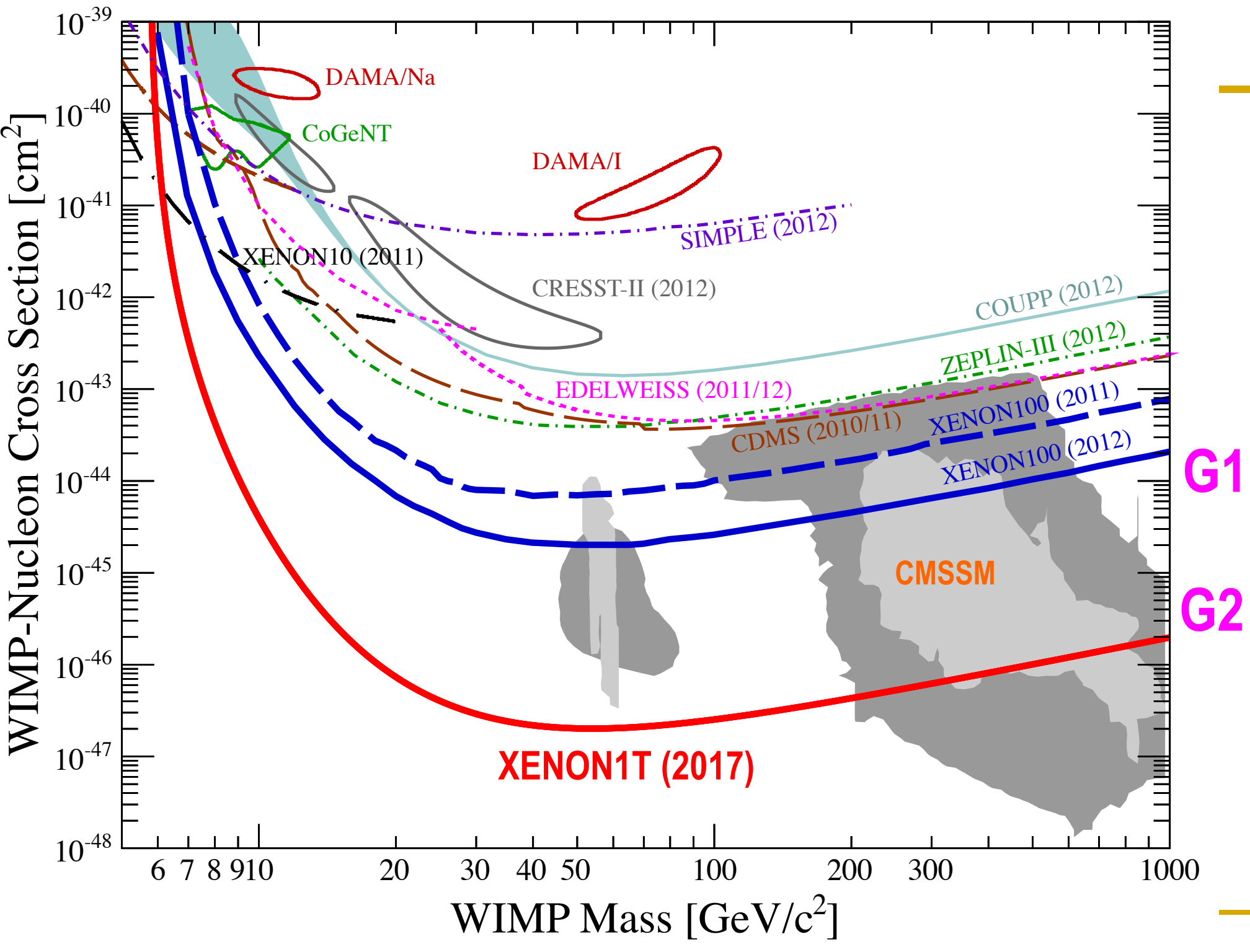
A Possible XENON 10T (G3)

- **Detector**
  - 2 m drift TPC
  - ~20 ton Xe target
  - ~10 ton fiducial
- **Schedule**
  - Construction 2018 - 20
  - Data taking in 2021 – 25
- **Parallel studies with Ar**
  - DARWIN, MAX




DAMA/Na
CoGeNT
DAMA/I
SIMPLE (2012)
XENON10 (2011)
CRESST-II (2012)
COUPP (2012)
ZEPLIN-III (2012)
EDELWEISS (2011/12)
CDMS (2010/11)
XENON100 (2011)
XENON100 (2012)
XENON100
CMSSM
WIMP-Nucleon Cross Section [cm^2]
WIMP Mass [GeV/c^2]
10^{-39}
10^{-40}
10^{-41}
10^{-42}
10^{-43}
10^{-44}
10^{-45}
10^{-46}
10^{-47}
10^{-48}
6 7 8 9 10 20 30 40 50 100 200 300 1000

G1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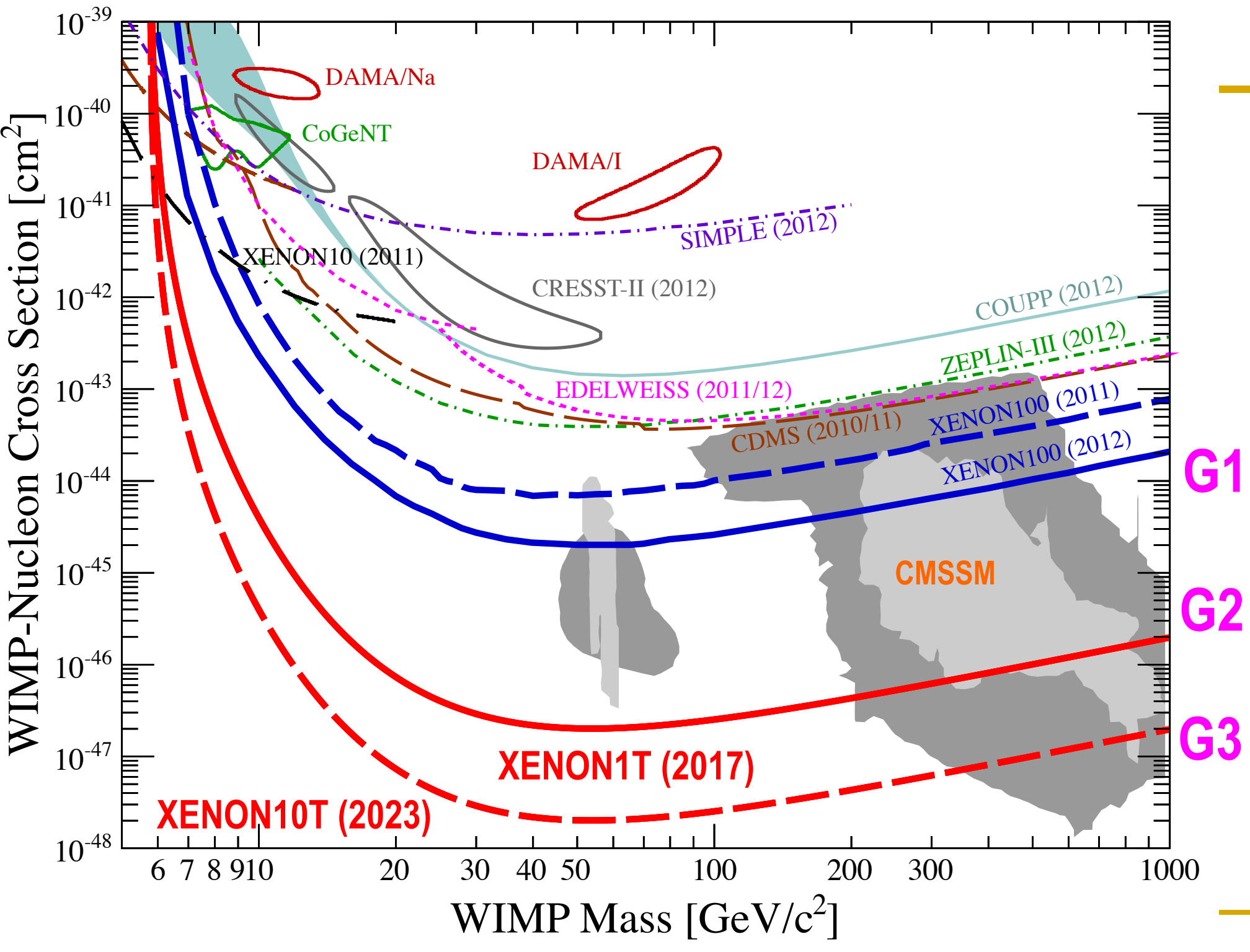
XENON100 (2011)
XENON100 (2012)
CMSSM
XENON1T (2017)
G1
G2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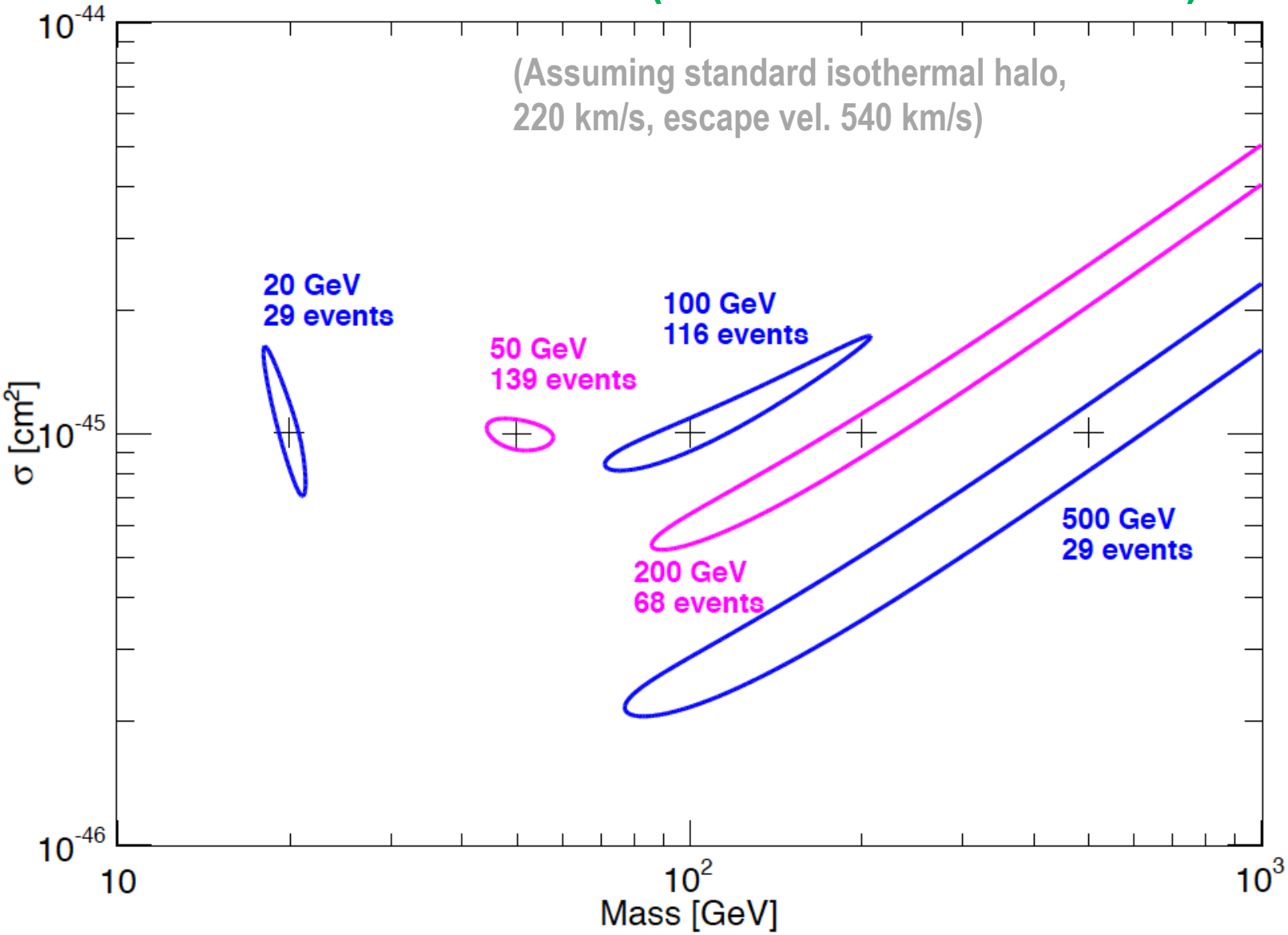
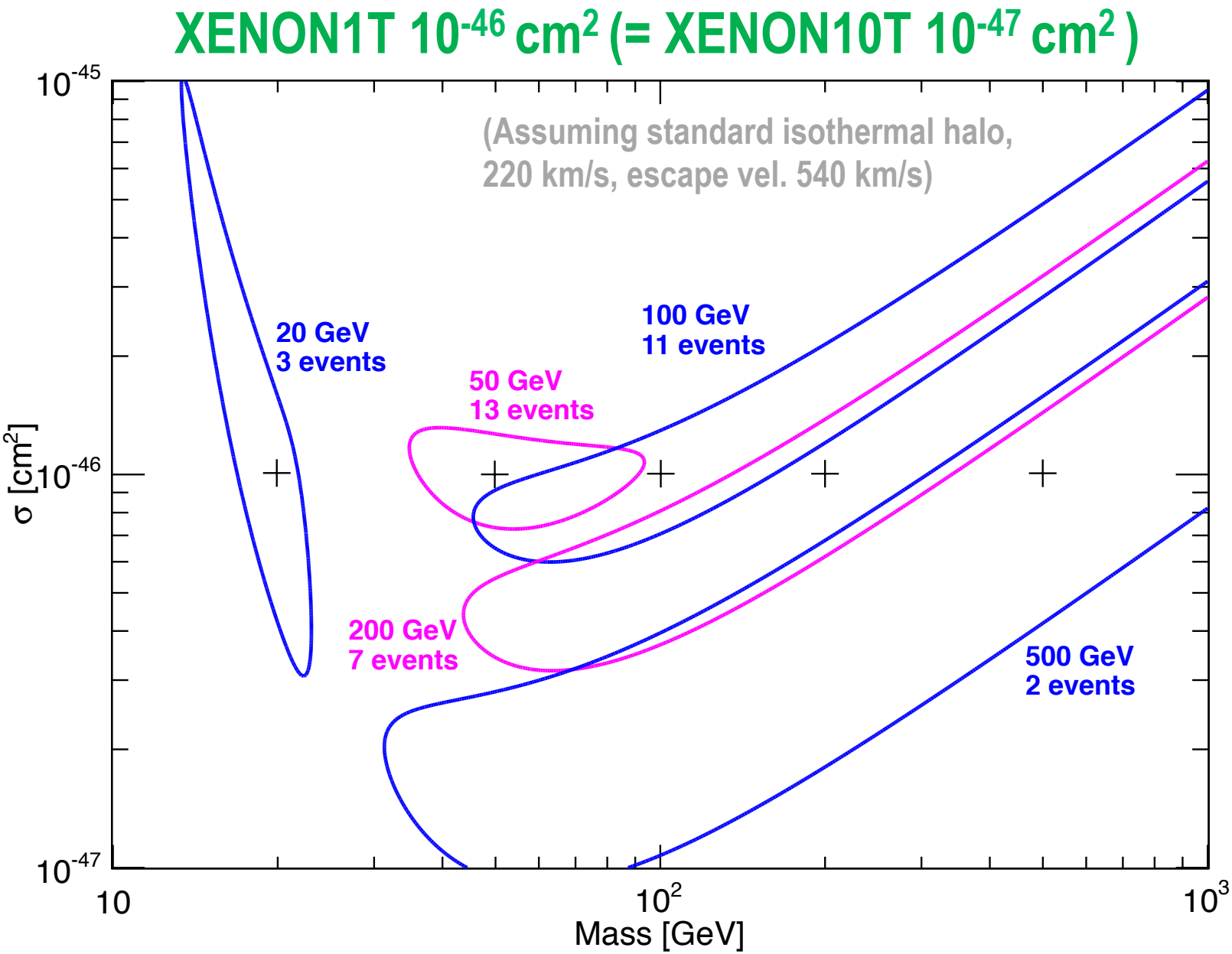
CDMS (2010/11)
XENON100 (2011)
XENON100 (2012)
CMSSM
G1
G2
G3
XENON1T (2017)
XENON10T (2023)

1-σ Error of WIMP Mass vs SI Cross Section

XENON1T 10^{-45} cm^2 (= XENON10T 10^{-46} cm^2)



1-σ Error of WIMP Mass vs SI Cross Section



Summary of XENON100, 1T and 10T

	(Unit)	XENON100	XENON1T	XENON10T
0) Schedule				
Construction	Year	2007 - 2009	2012 - 2014	2018 - 2020
Data Taking	Year	2010 - 2013	2015 - 2018	2021 - 2025
1) Xenon Mass				
Total	kg	162	3,500	25,000
Active Target	kg	62	2,500	20,000
2) *Fiducial*	kg	34	1,000	10,000
3) Gamma Background (before S2/S1)	keVee/kg/day	5.E-03	1.E-05	1.E-05
4) *S2/S1 Rejection*		99.75%	99.75%	99.75%
Expected Background (aftr S2/S1)				
Gamma	events	0.79	0.4	4
Neutrons	events	0.17	0.1	0.1
5) Energy Threshold	keVnr	6.6	4.0	4.0
Exposure	ton-year	0.02	2	20

Summary of XENON100, 1T and 10T

	(Unit)	XENON100	XENON1T	XENON10T
6) Sensitivity (SI)				
M = 5 GeV	cm^2	6.E-44	5.E-46	5.E-47
M = 10 GeV	cm^2	7.E-45	7.E-47	7.E-48
M = 100 GeV	cm^2	3.E-45	3.E-47	3.E-48
M = 1,000 GeV	cm^2	2.E-44	2.E-46	2.E-47
M = 10,000 GeV	cm^2	2.E-43	2.E-45	2.E-46
Sensitivity (SD- Neutron)				
M = 10 GeV	cm^2	4.E-38	4.E-40	4.E-41
M = 100 GeV	cm^2	5.E-40	5.E-42	5.E-43
M = 1,000 GeV	cm^2	4.E-39	4.E-41	4.E-42
M = 10,000 GeV	cm^2	4.E-38	4.E-40	4.E-41
Sensitivity (SD - Proton)				
M = 10 GeV	cm^2	1.E-36	1.E-38	1.E-39
M = 100 GeV	cm^2	1.E-38	1.E-40	1.E-41
M = 1,000 GeV	cm^2	8.E-38	8.E-40	8.E-41
M = 10,000 GeV	cm^2	8.E-37	8.E-39	8.E-40

Technological Challenges for 10 Ton

- **External Backgrounds**
  - Deep underground – LNGS (or equivalent)
  - > 4 m water shielding – Water Tank (~10 m)
- **Detectors**
  - Low-Radioactivity Photon Detectors – R11410-21, QUPID, GPM
  - Liquid Scintillator Neutron Veto – Gd or B doped
  - HV Feed-through – 200 kV
- **Purity of Liquid Xe**
  - Krypton (< 0.5 ppt in Xe) – 1 event / 10 ton-year
  - Radon (< 0.3 mBq / ton)
- **Physics Backgrounds in Xe**
  - pp-chain solar neutrinos – 1 event / 10 ton-year
  - 2v Double beta decays from ^{136}Xe – 1 event / 10 ton-year

⇩

- International Consortium (with Ar) – DARWIN, MAX