MAX
Multi-Ton Argon & Xenon

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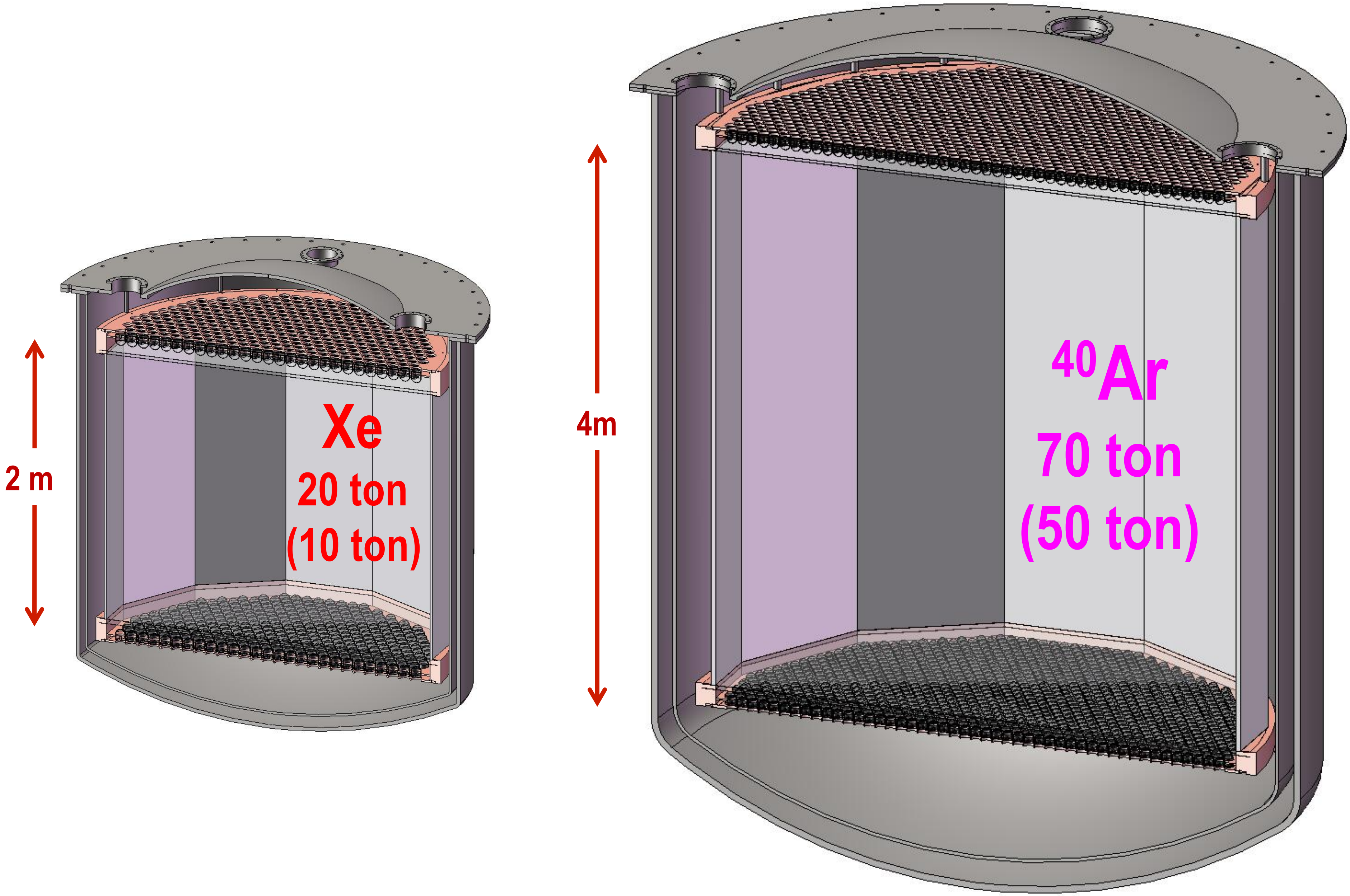
MAX - Multi-ton Argon & Xenon

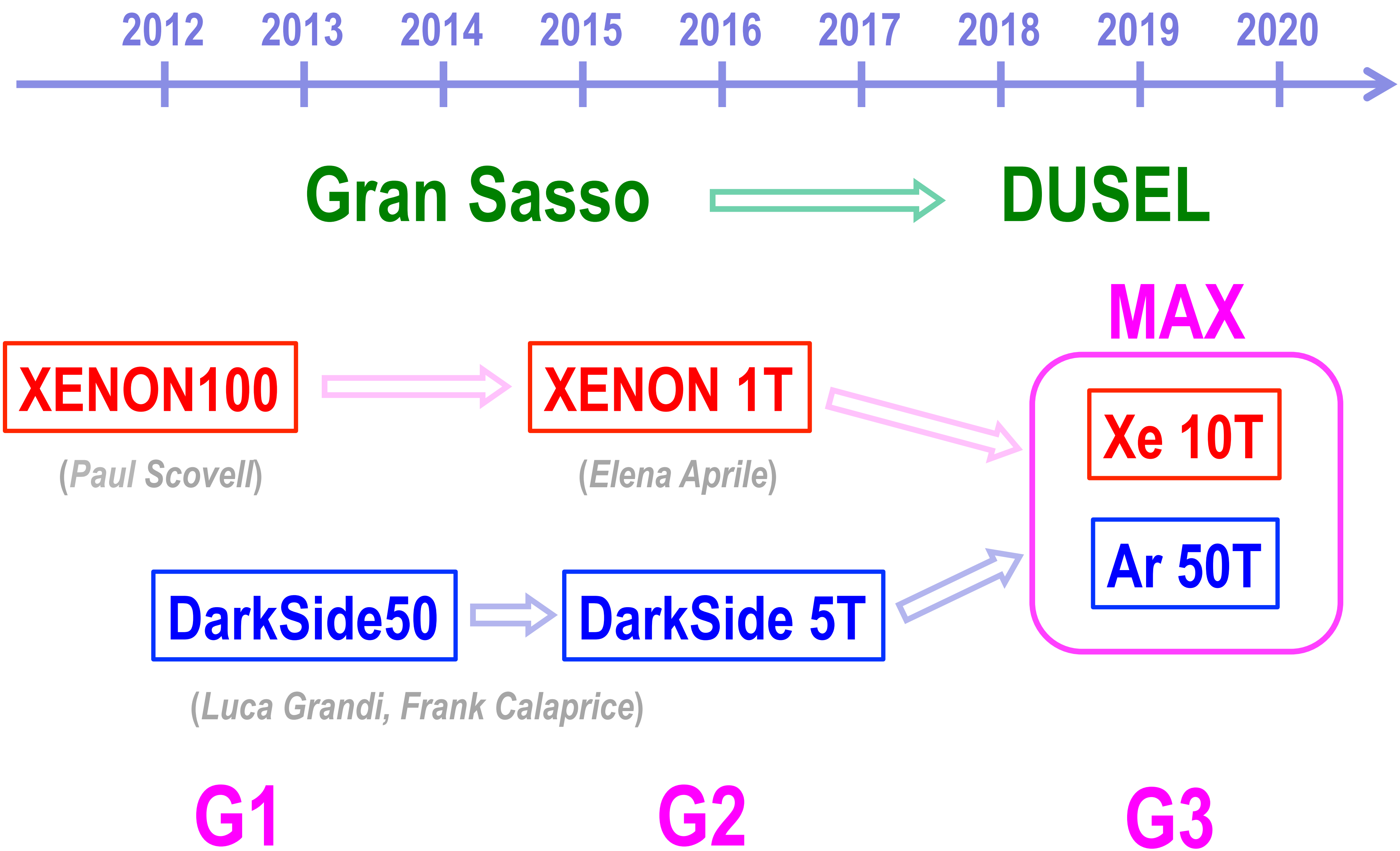
MAX Collaboration = DarkSide + XENON

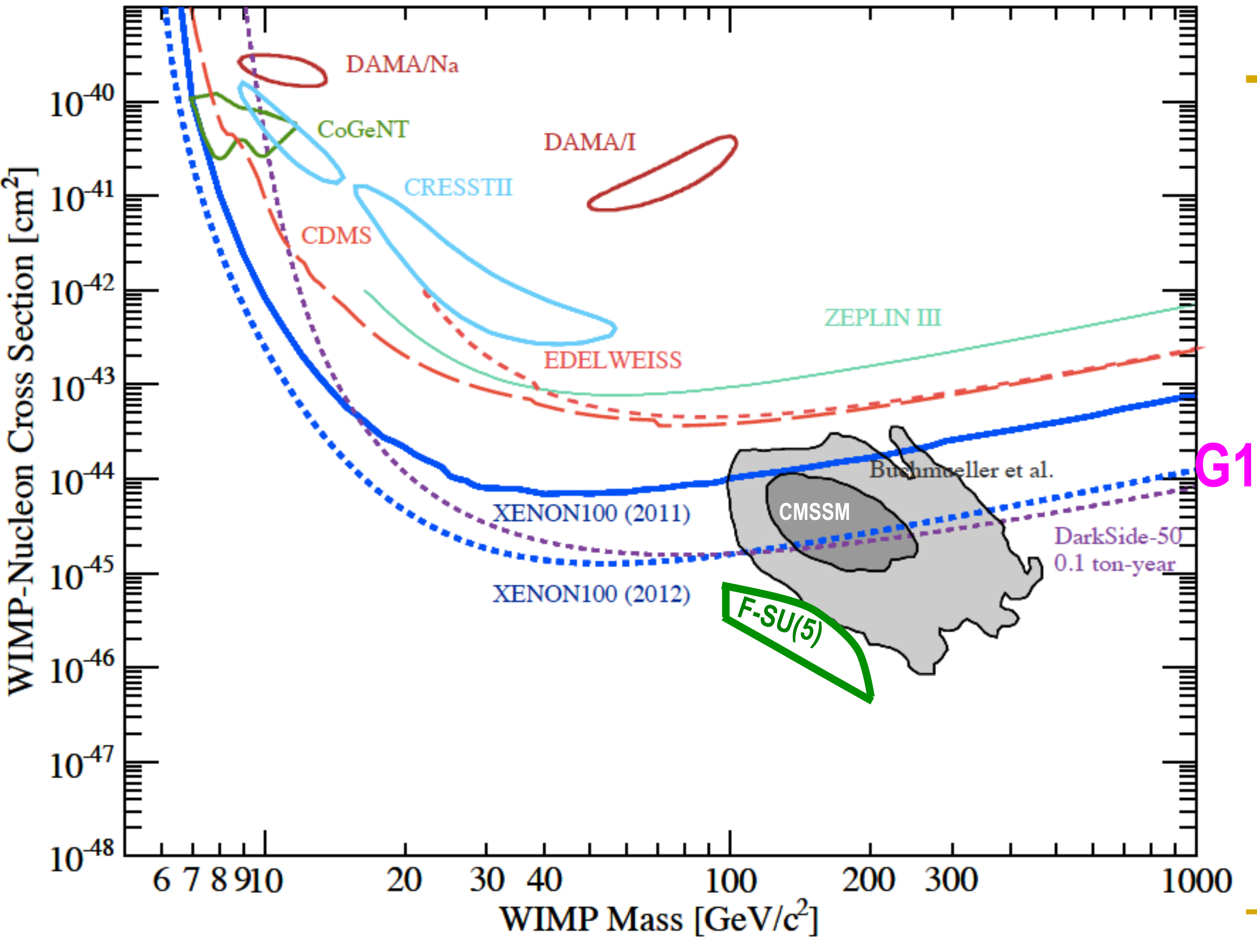
UMass Amherst, Arizona State University,
Augustana College, Black Hills State University,
Coimbra University, Columbia University, Fermilab,
University of Houston, INAF, LNG, MIT, University of Münster,
University of Notre Dame, Princeton University, Rice University,
Temple University, UCLA, University of Virginia,
University of Zürich

MAX G3 Detector (at DUSEL)

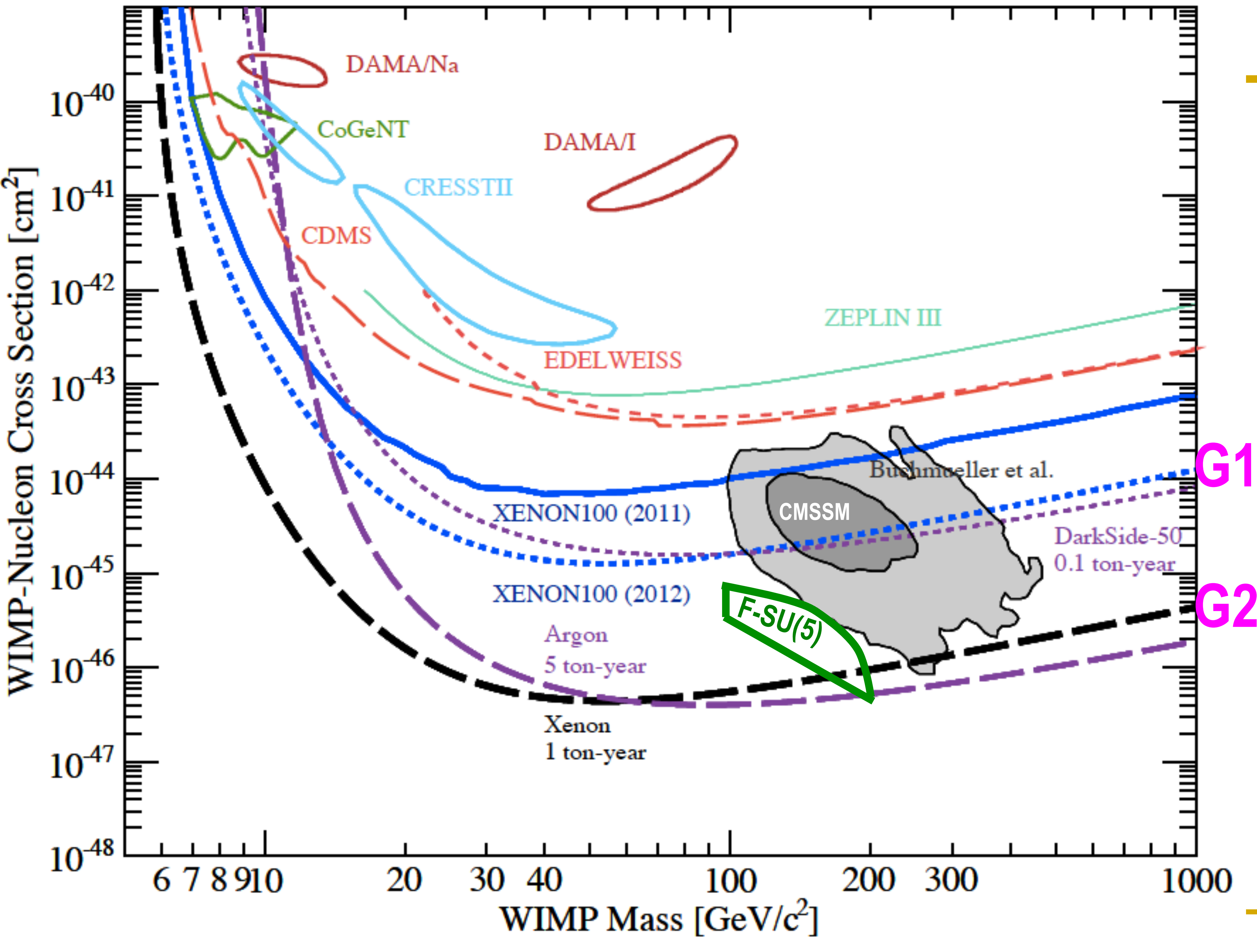


Roadmap to MAX





DAMA/Na
CoGeNT
DAMA/I
CRESSTII
CDMS
ZEPLIN III
EDELWEISS
Buchmueller et al.
CMSSM
XENON100 (2011)
DarkSide-50
0.1 ton-year
XENON100 (2012)
F-SU(5)
G1
WIMP-Nucleon Cross Section [cm^2]
WIMP Mass [GeV/c^2]
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
100
200 300
1000



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Argon
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Xenon
1 ton-year
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G2
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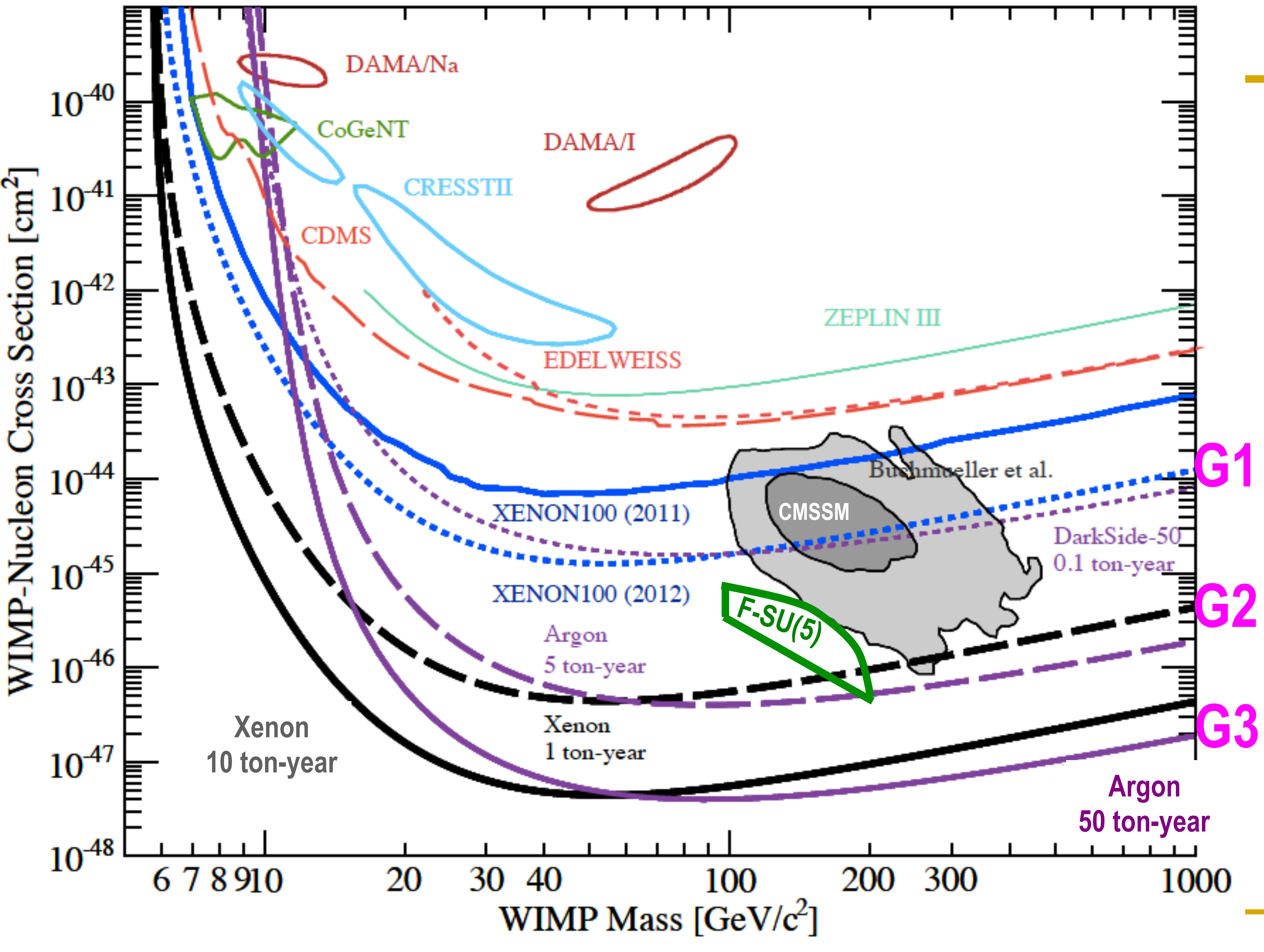

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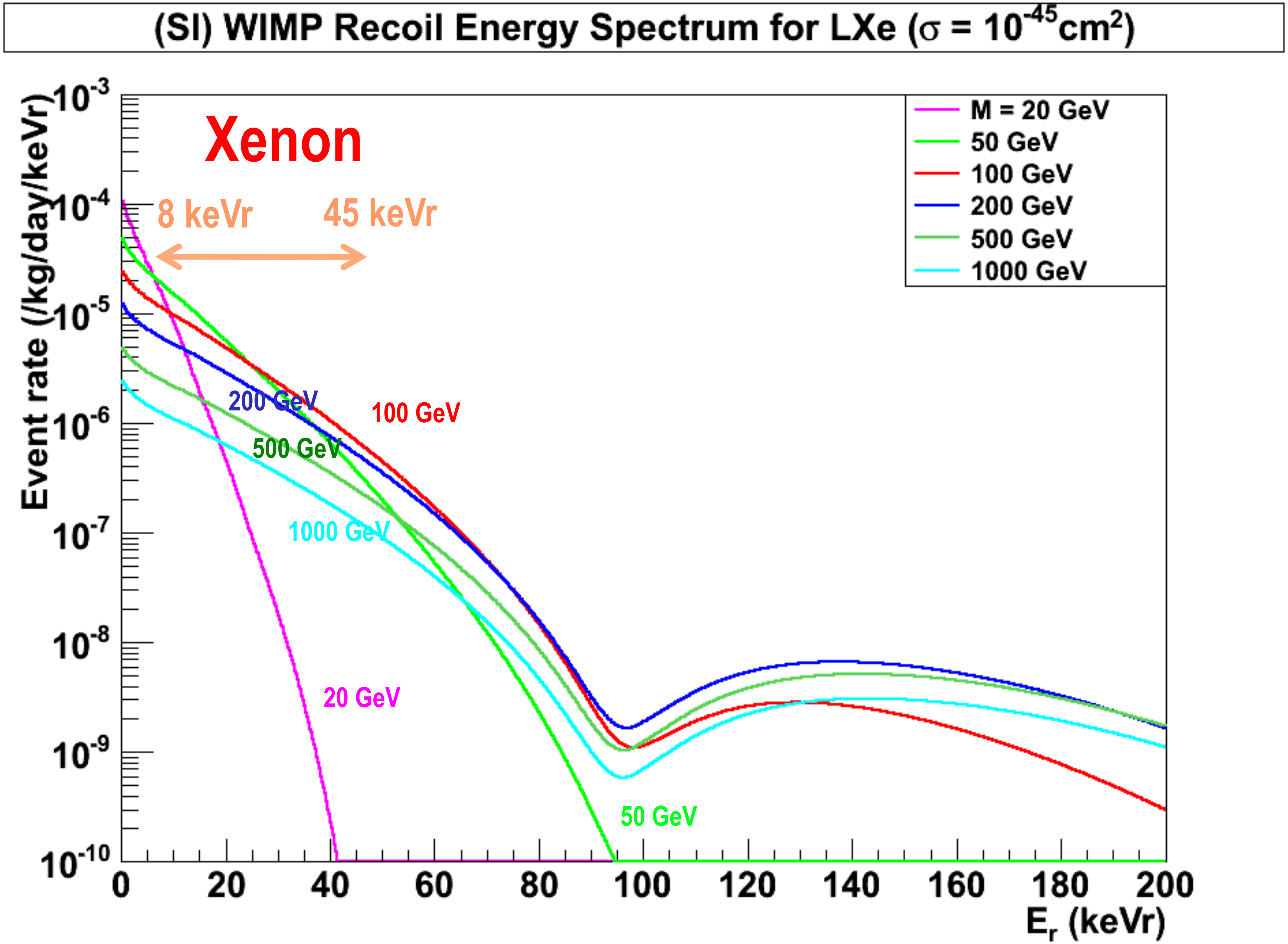
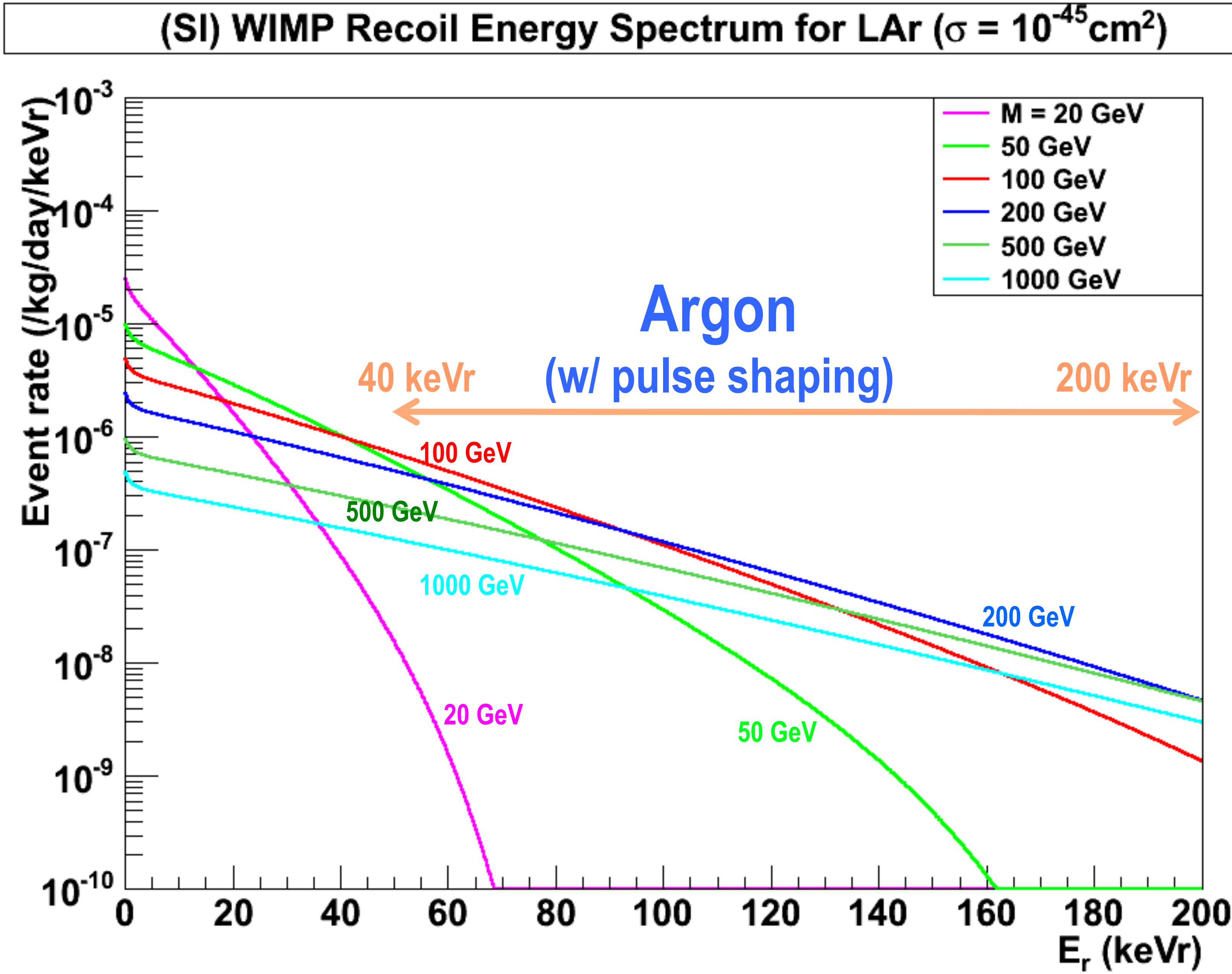
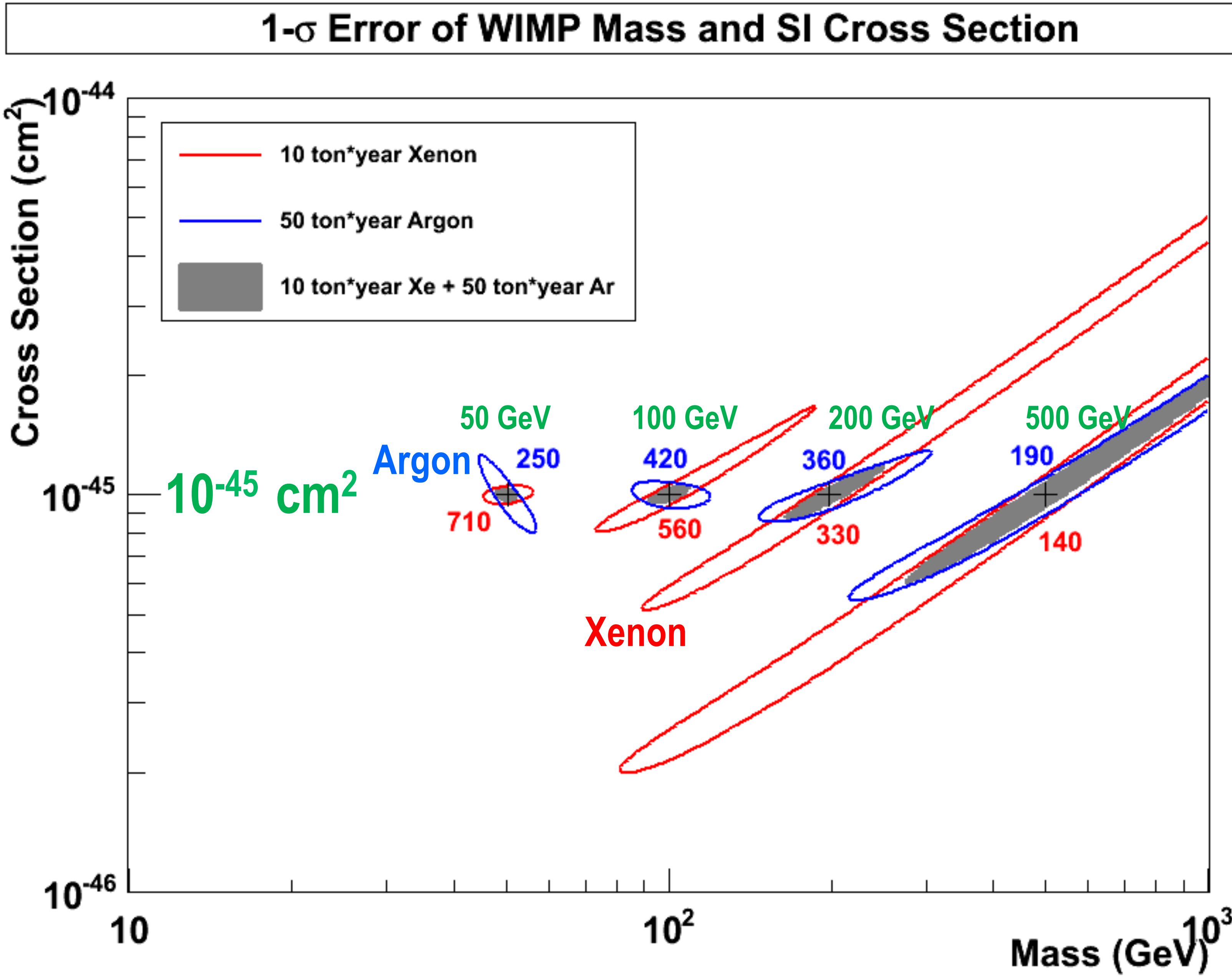
(SI) WIMP Energy Spectrum for LXe
(Cross Section = 10^{-45}cm^2)



(SI) WIMP Energy Spectrum for LAr
(Cross Section = 10^{-45}cm^2)



1-σ Error of WIMP Mass vs SI Cross Section (10 ton*year Xe and 50 ton*year Ar)



1-σ Error of WIMP Mass vs SI Cross Section
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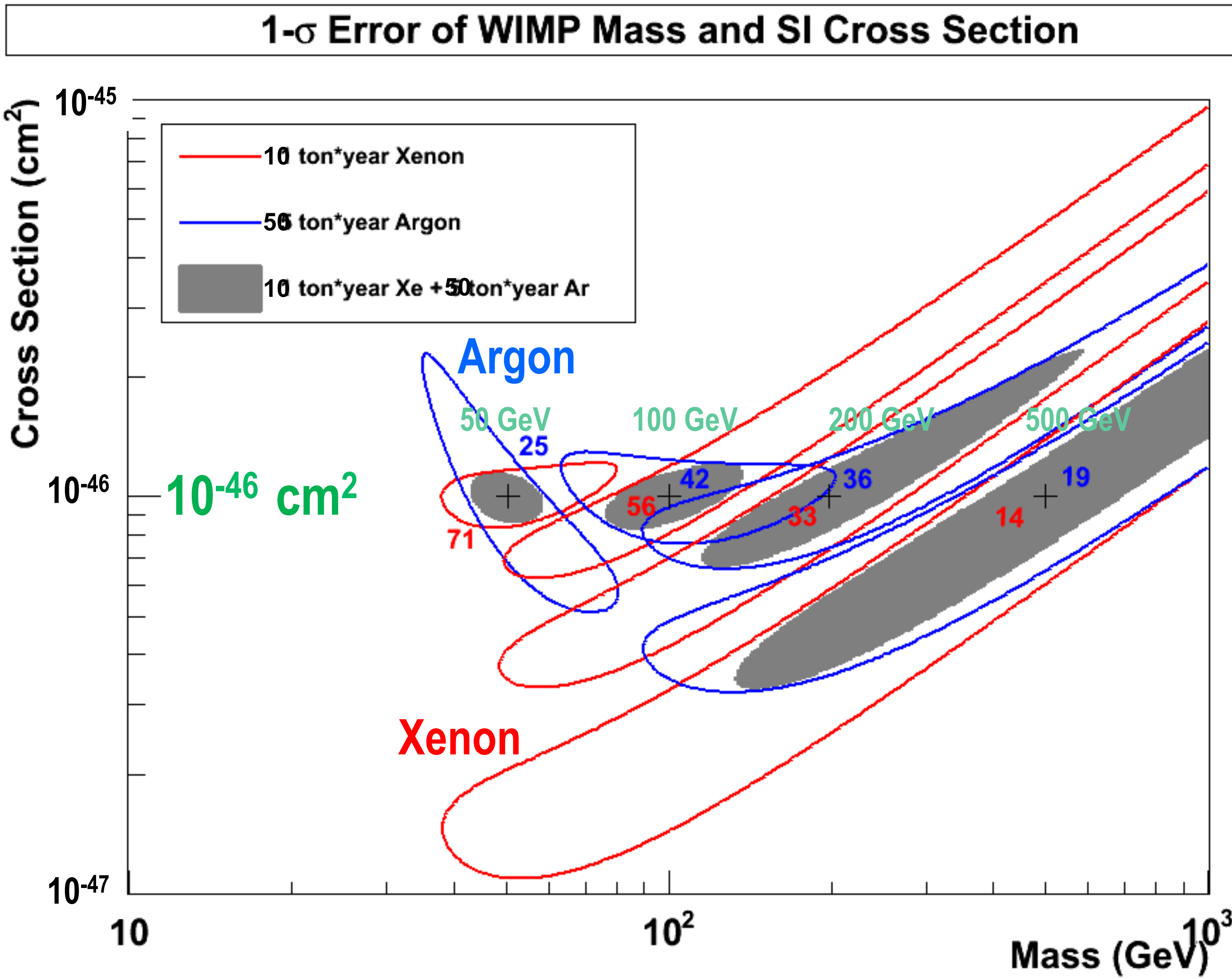

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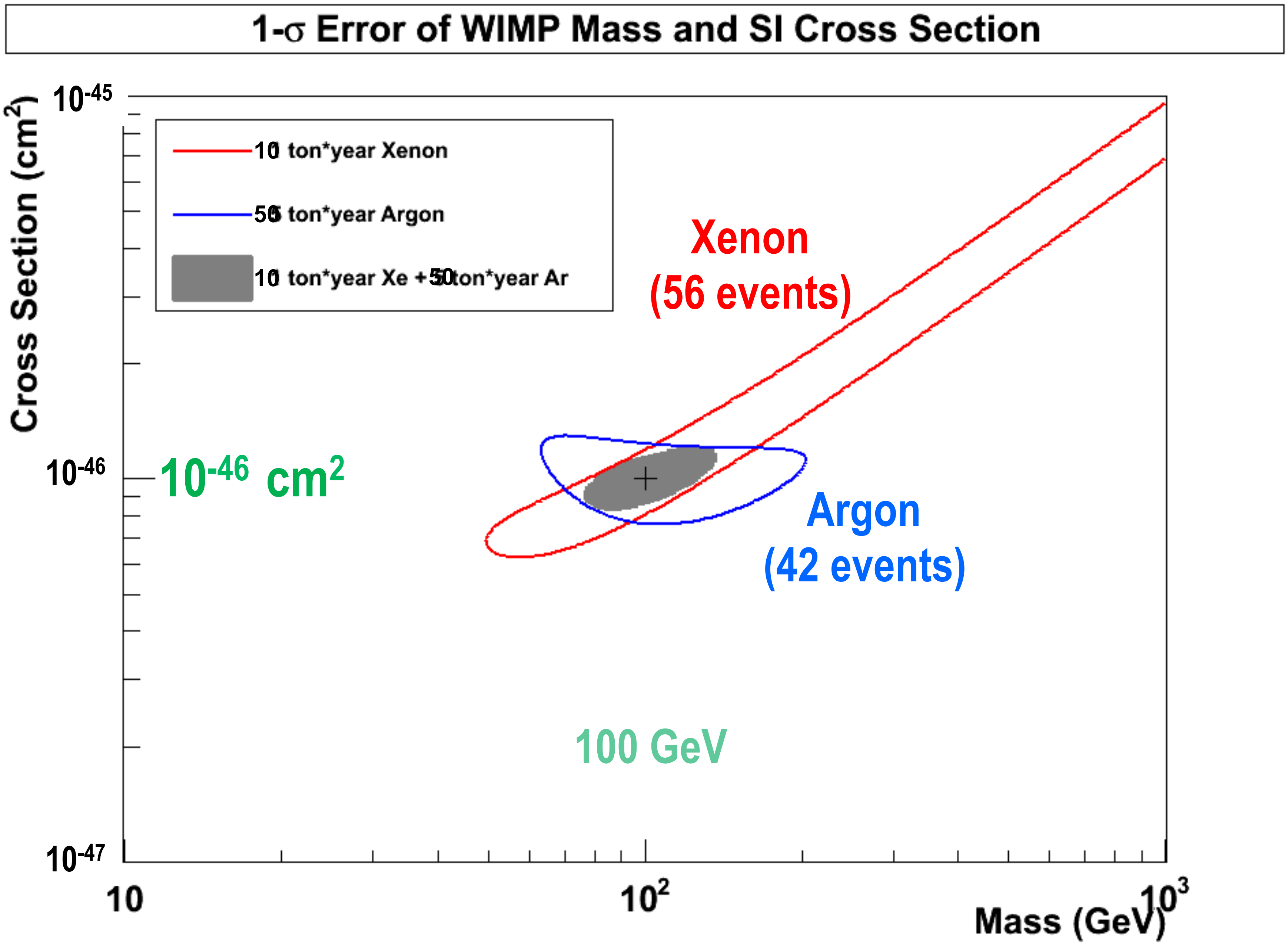

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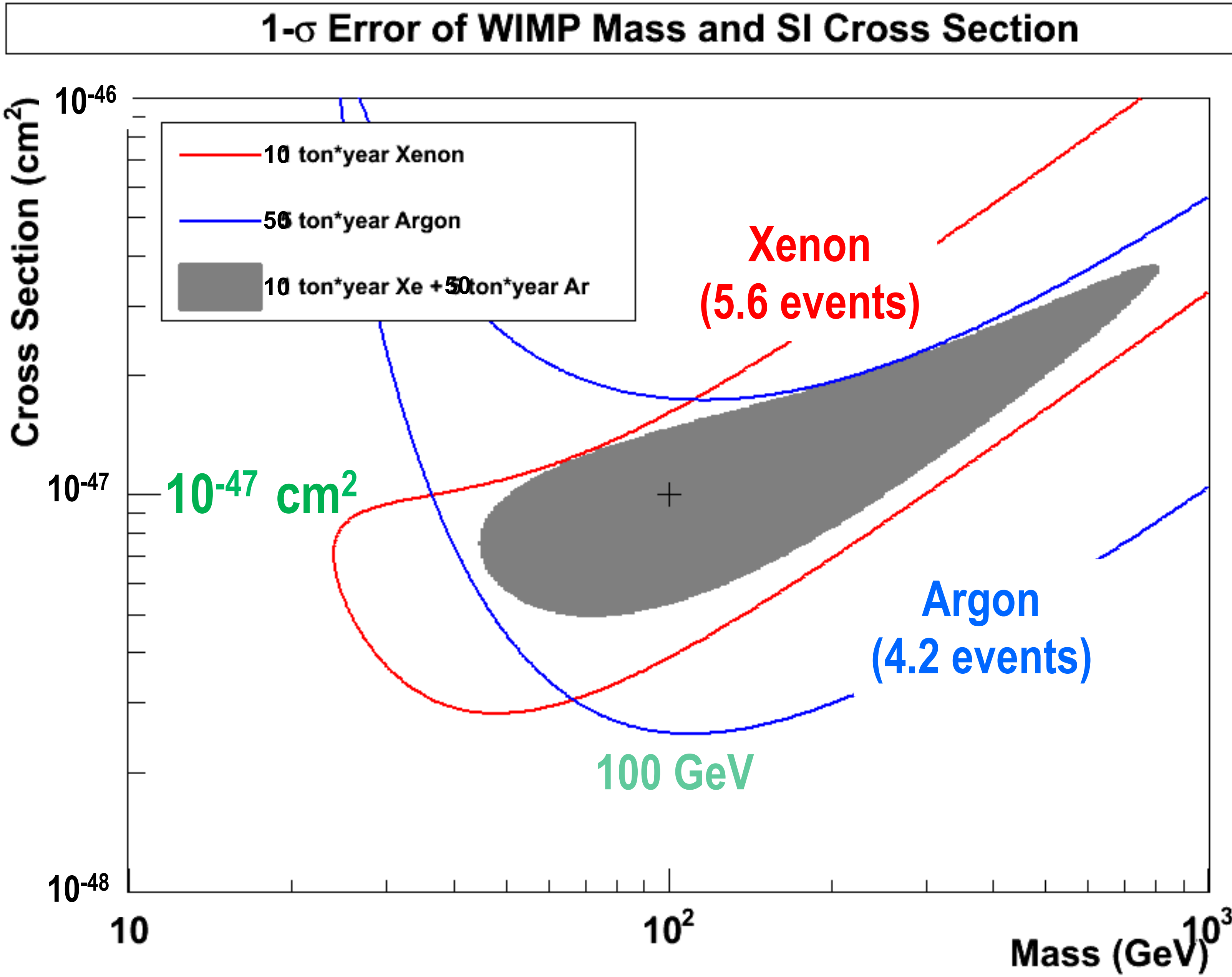

(SI) WIMP Energy Spectrum for LXe
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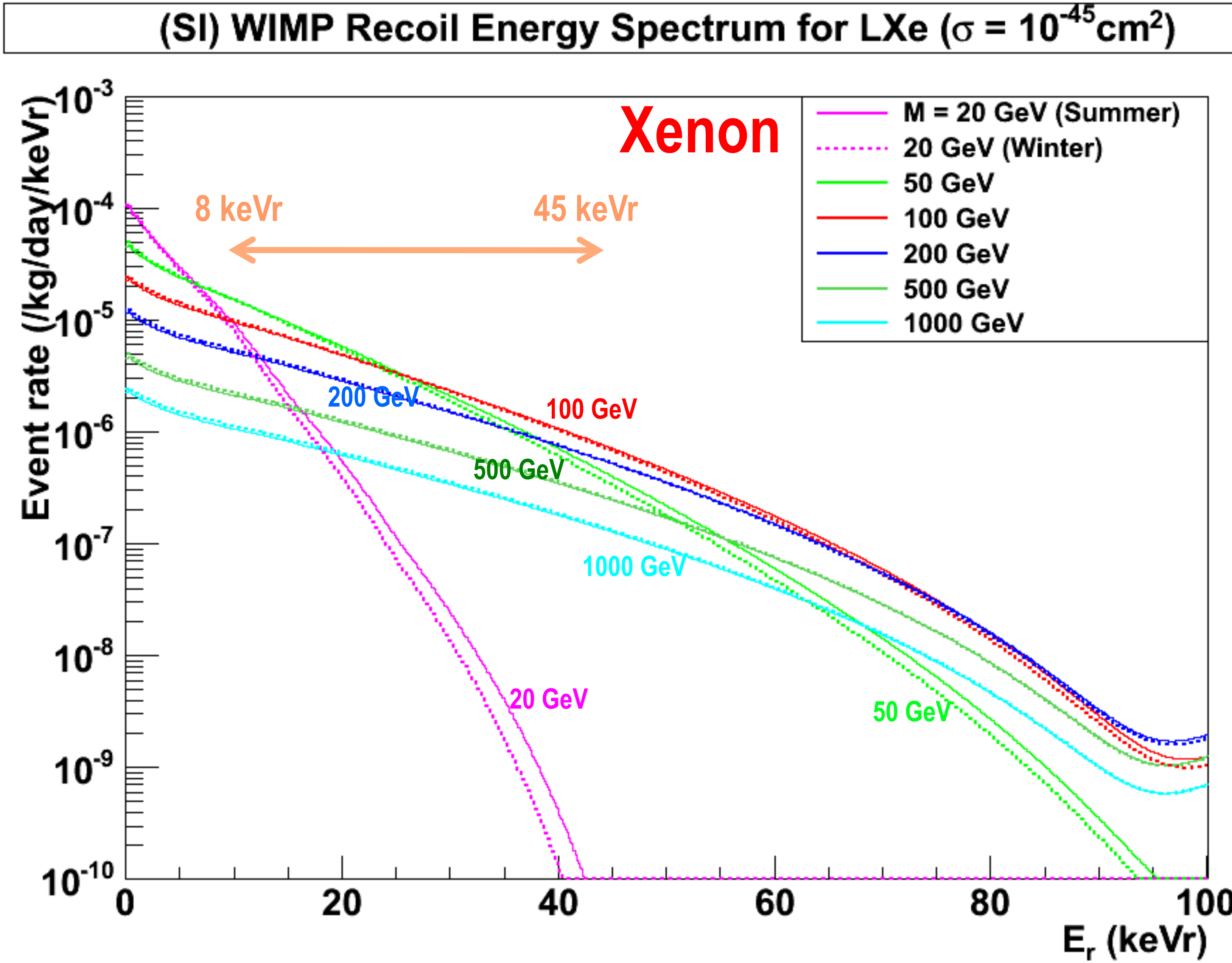

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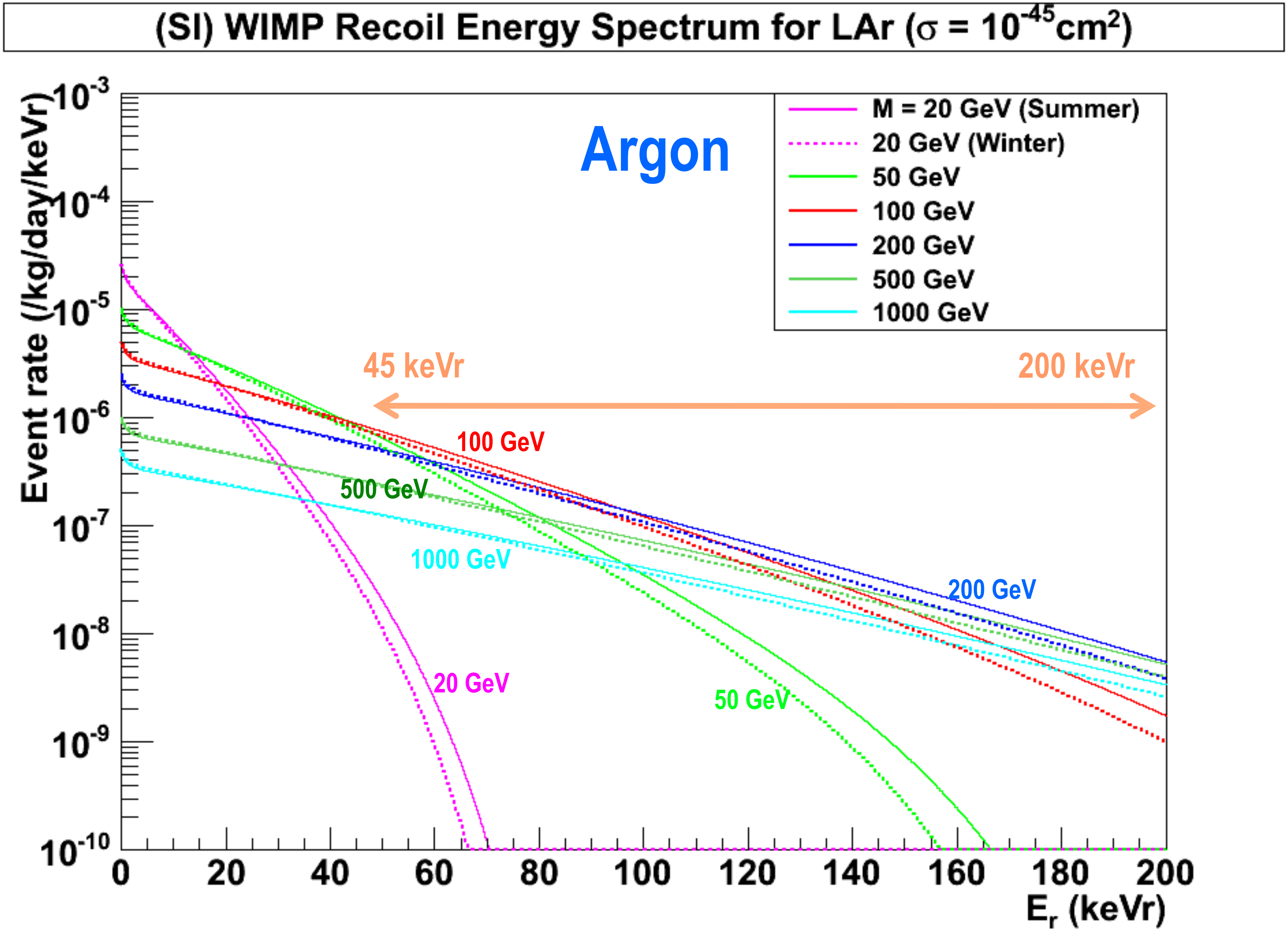
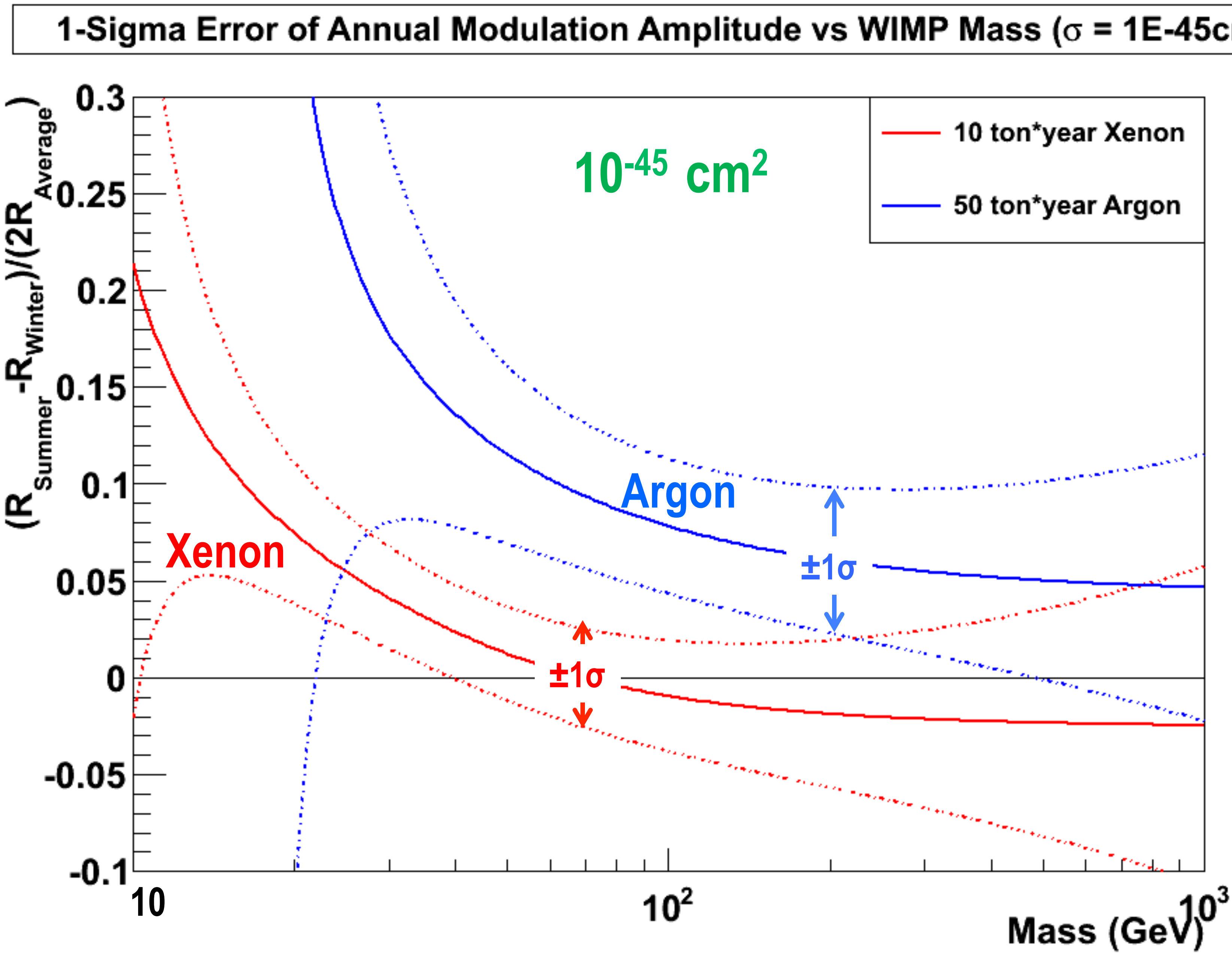
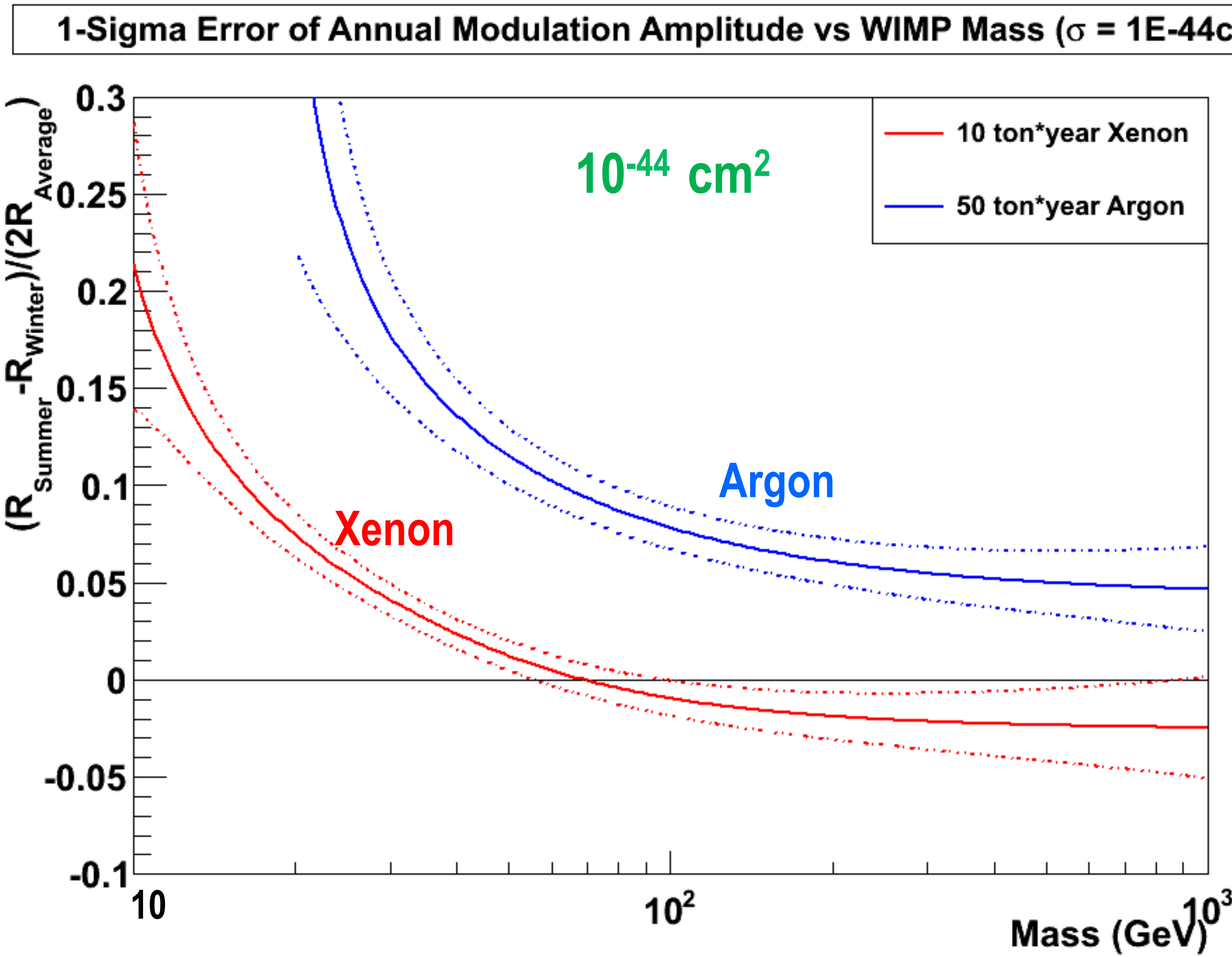
(Cross Section = $10^{-45}cm^2$)



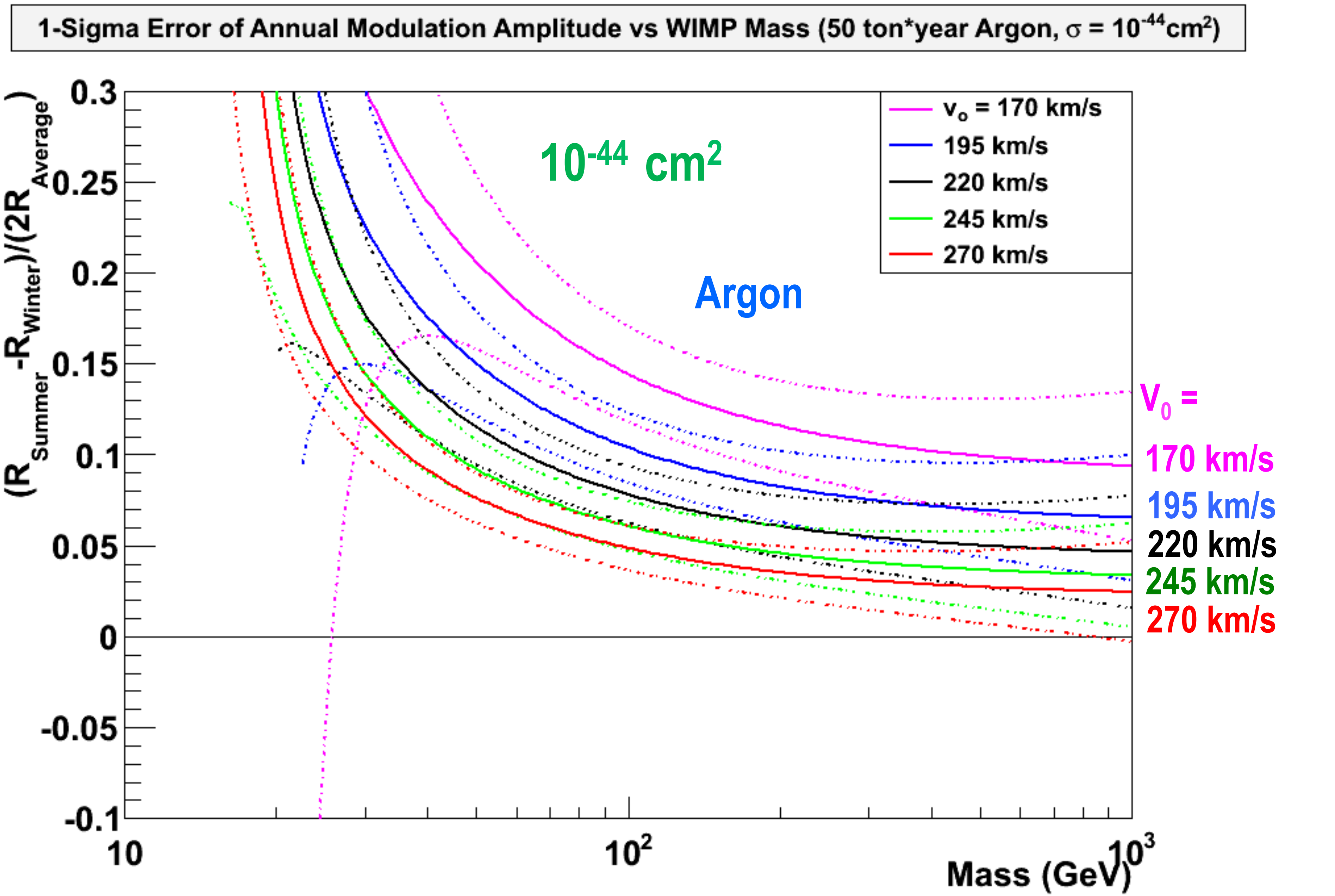
±1σ Error of Annual Modulation Amplitude vs WIMP Mass
(10 ton*year Xe and 50 ton*year Ar, Cross Section = 10^{-45}cm^2)



±1σ Error of Annual Modulation Amplitude vs WIMP Mass
(10 ton*year Xe and 50 ton*year Ar, Cross Section = 10^{-44}cm^2)



$\pm 1\sigma$ Error of Annual Modulation Amplitude for various WIMP velocities
(50 ton*year Ar, Cross Section = $10^{-44}cm^2$)

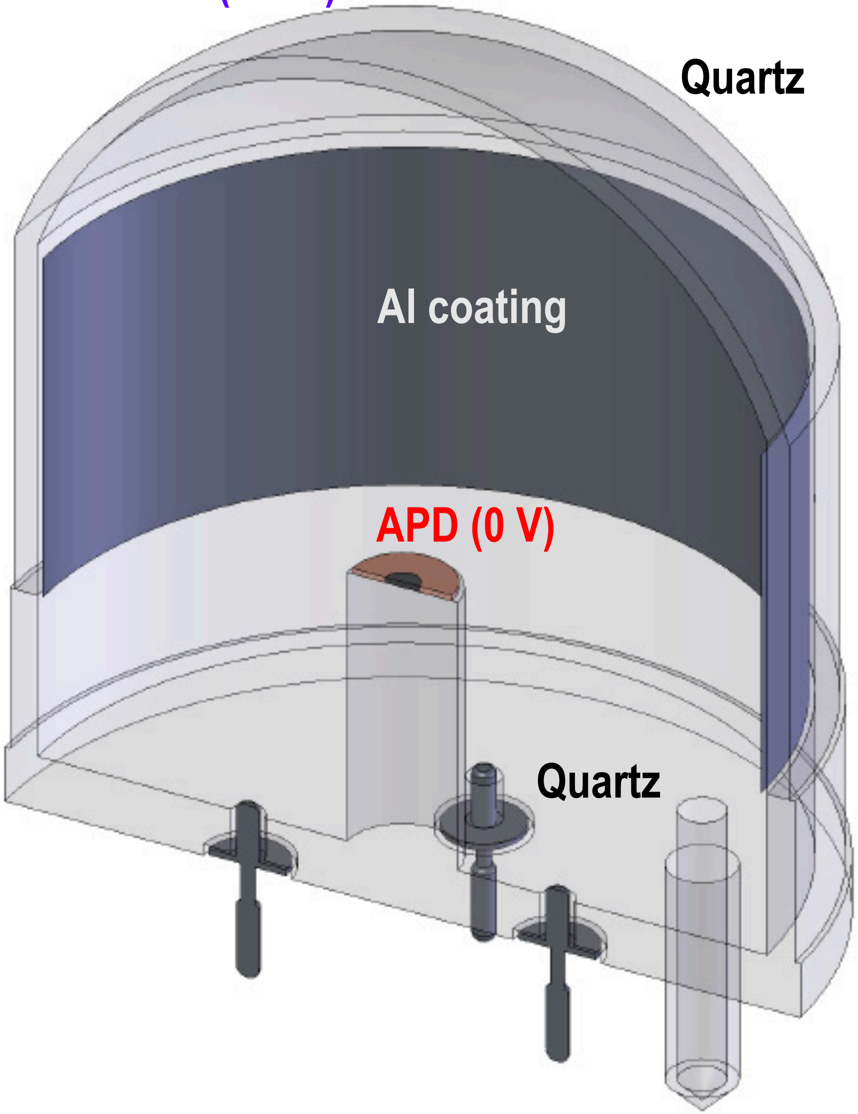


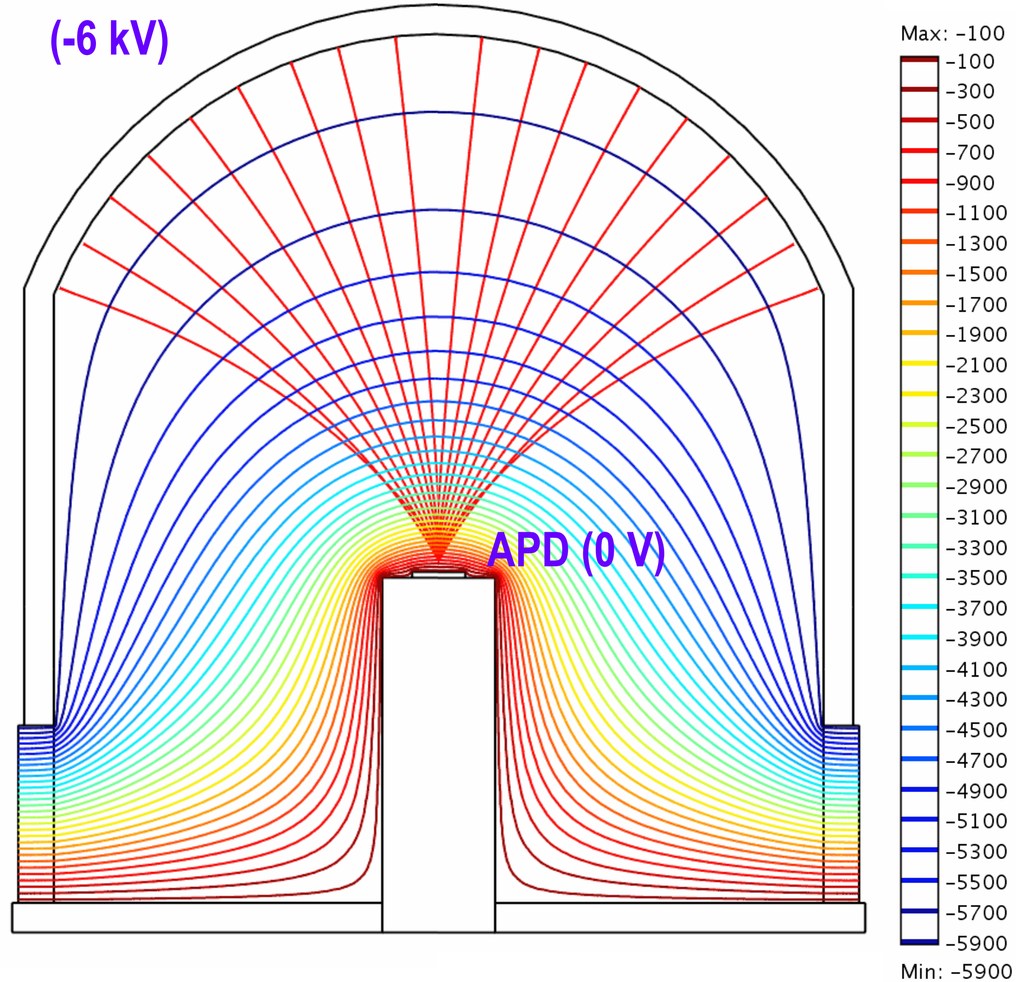
Technological Challenges

- **External Backgrounds**
  - Deep underground – DUSEL 4850 ft
  - > 5 m water shielding – Water Tank (15 m)
- **Detector Materials**
  - Photon Detectors – QUPID
  - Cryostat – Titanium
  - Others – Copper, PTFE…
- **Purity of Liquid Xe/Ar**
  - Radon (< 0.3 mBq / ton)
  - ^{39}Ar (> 100 depletion) – Depleted Ar
  - ^{85}K (< 0.2 ppt in Xe) – 1 event / 10 ton-year
- **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
- **Neutron Active Veto**
  - Boron doped Liquid Scintillator

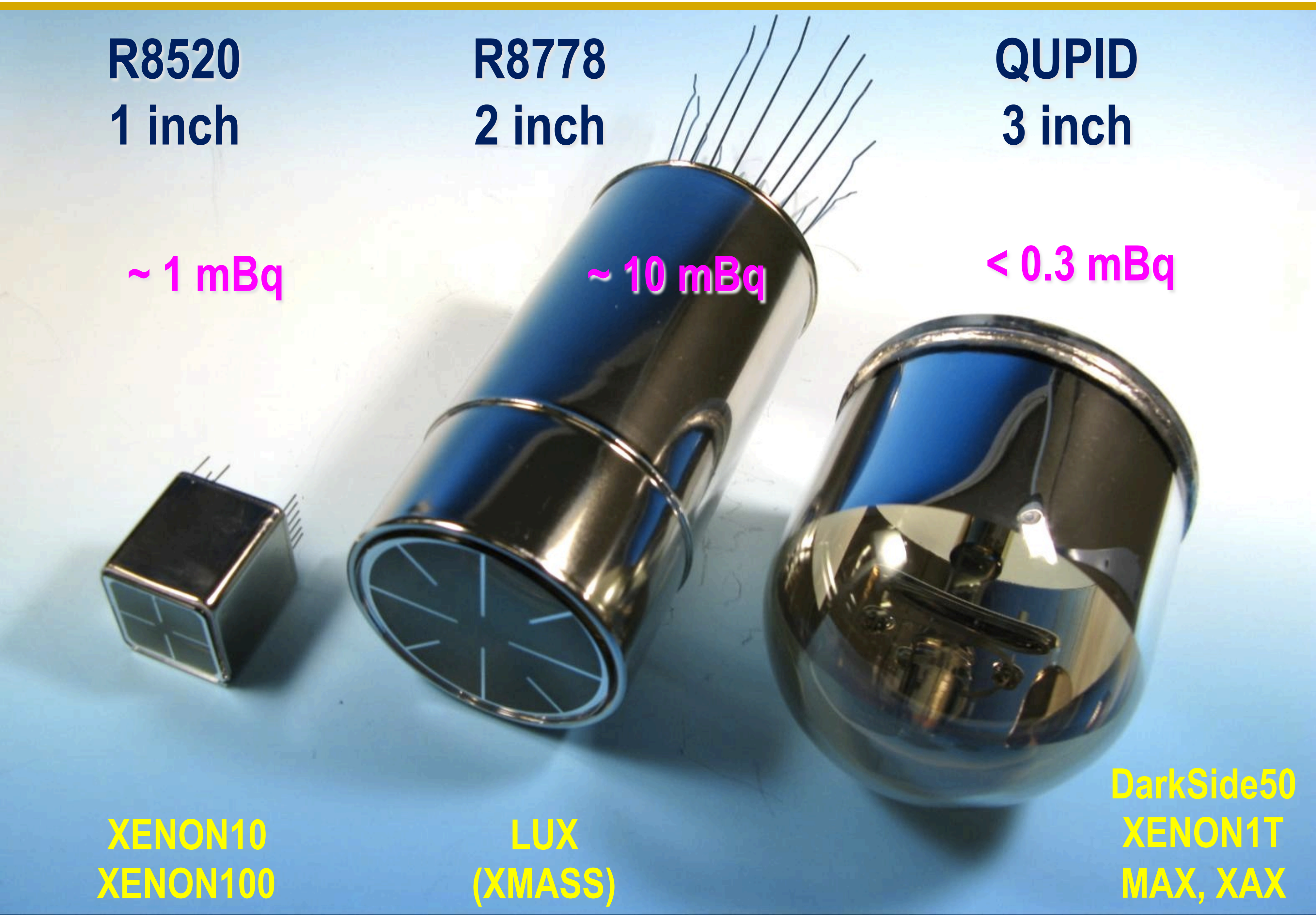
QUPID (QUartz Photon Intensifying Detector)

arXiv:1103.3689

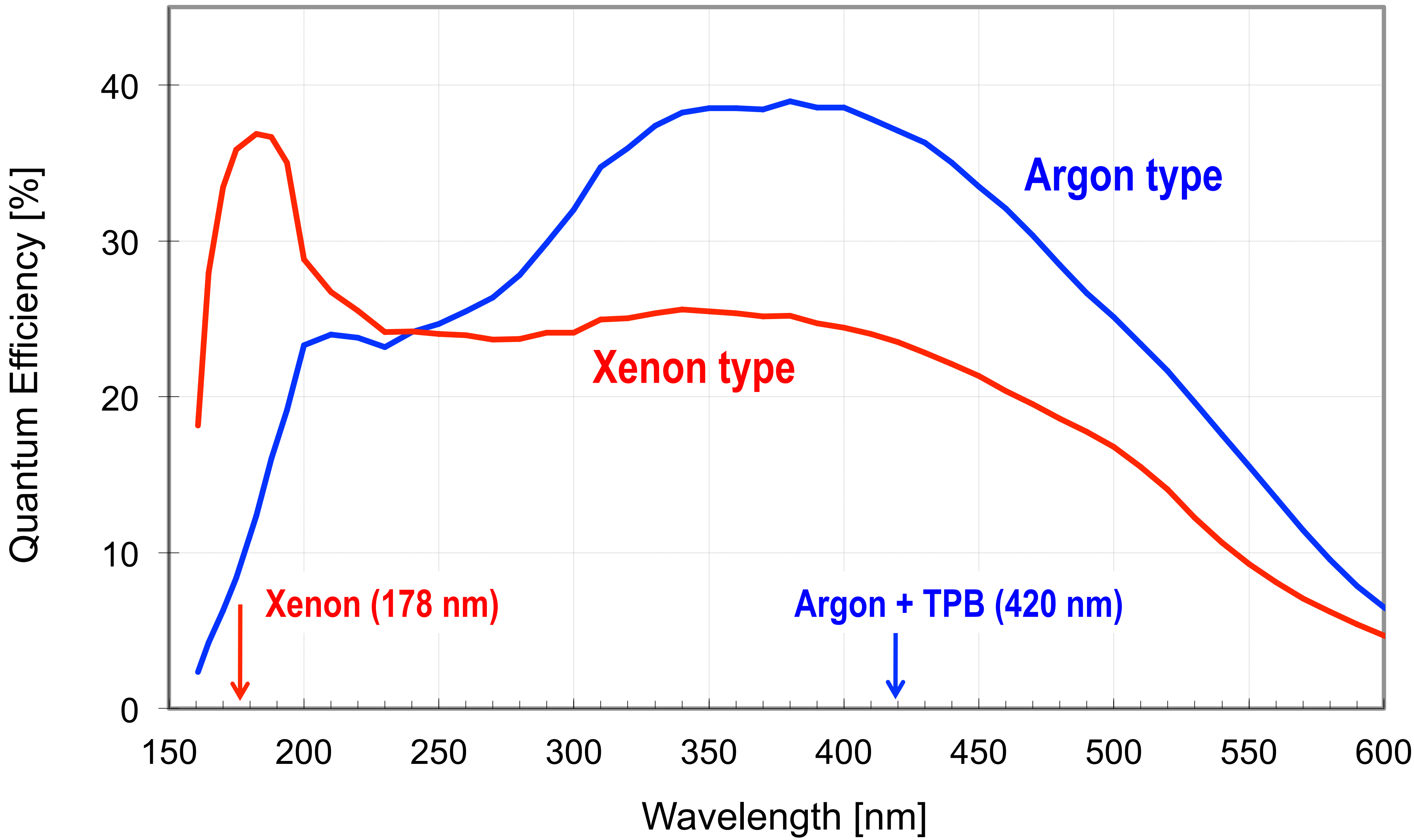




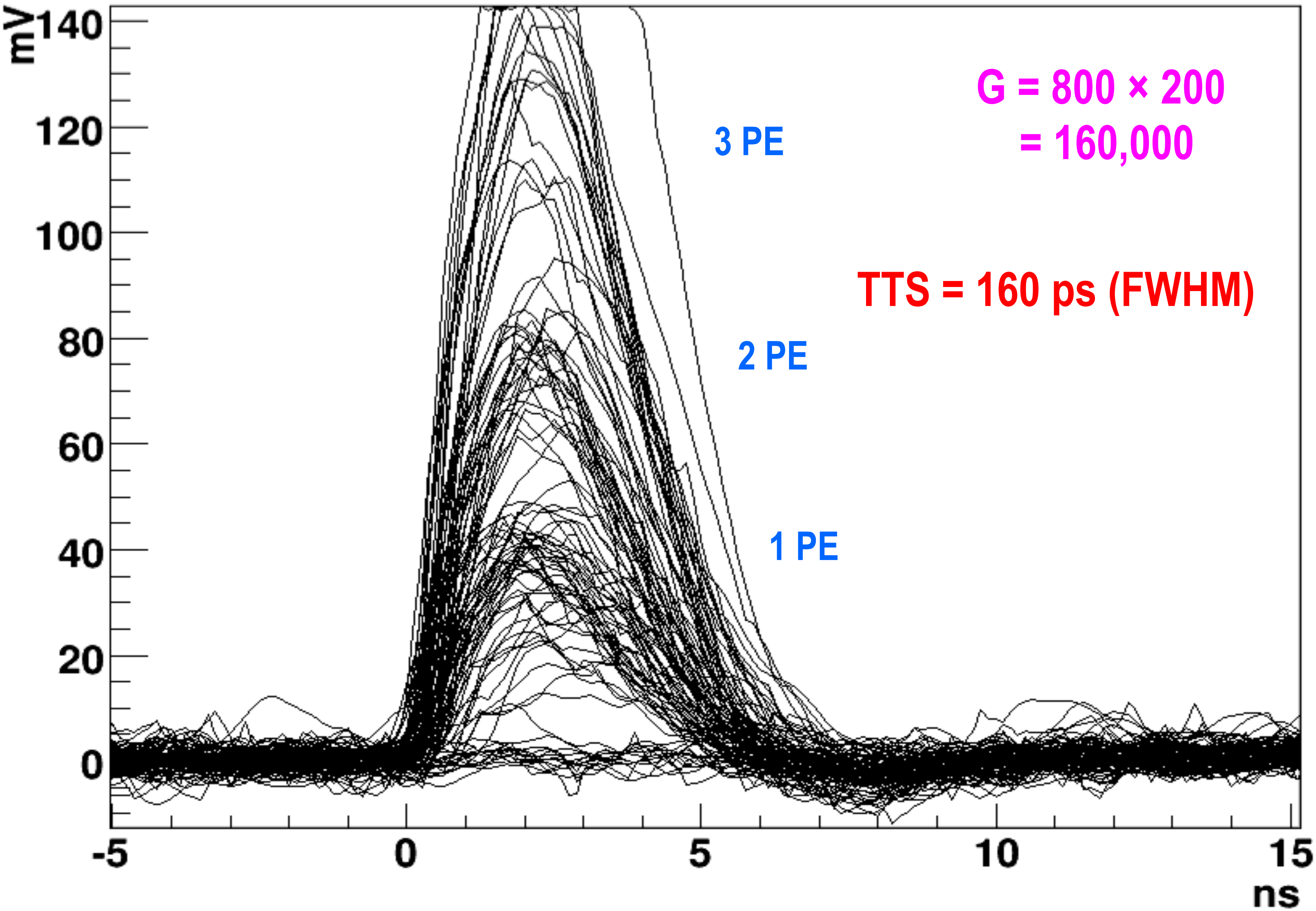
Comparison of Low-radioactive Photon Detectors from Hamamatsu



QE of two types of QUPID



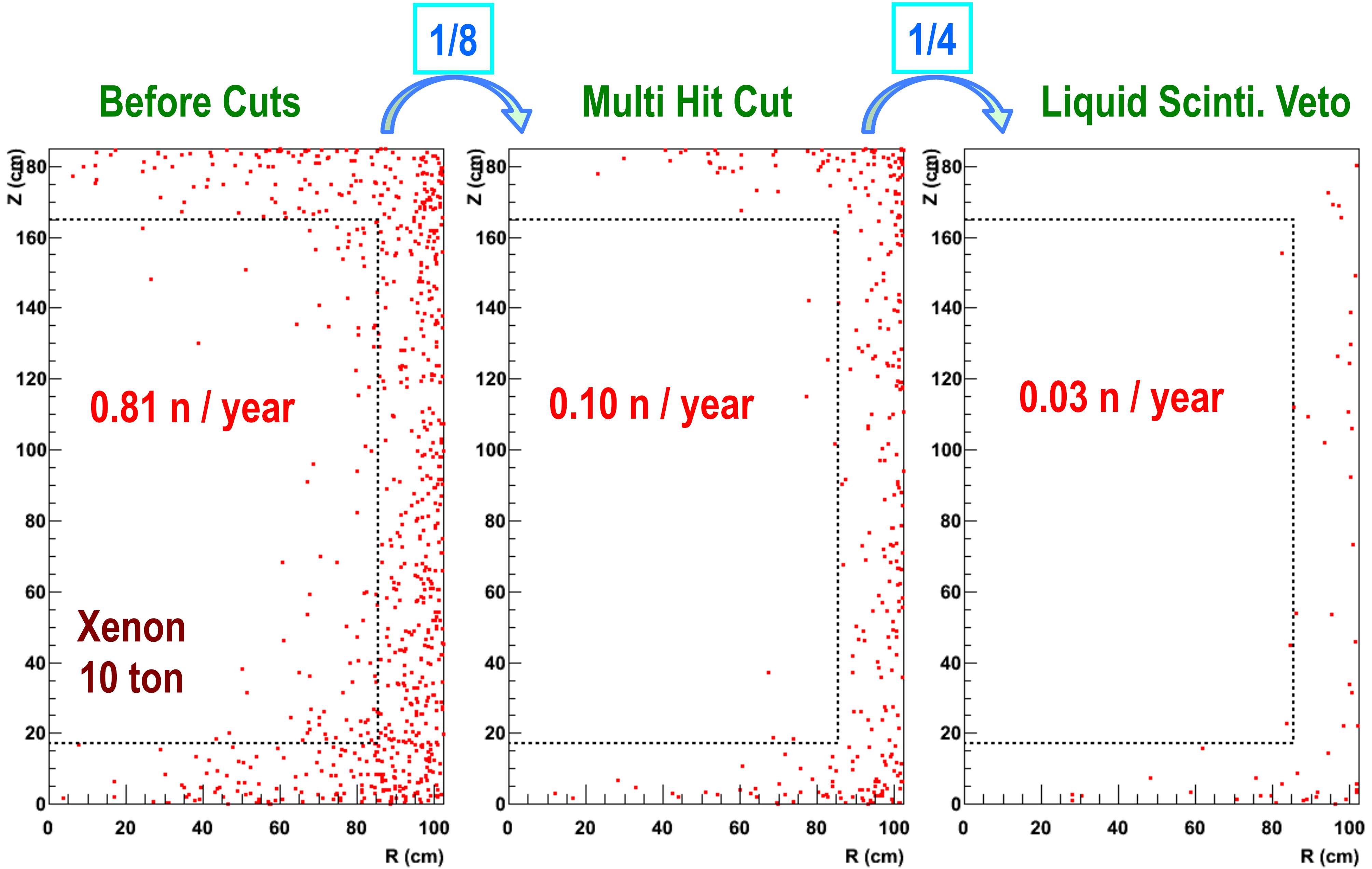
1, 2 and 3 PE Distribution with 2 m cable




7 QUPID with Holder
Tested in both Xe and Ar at UCLA
Ready for DarkSide 10

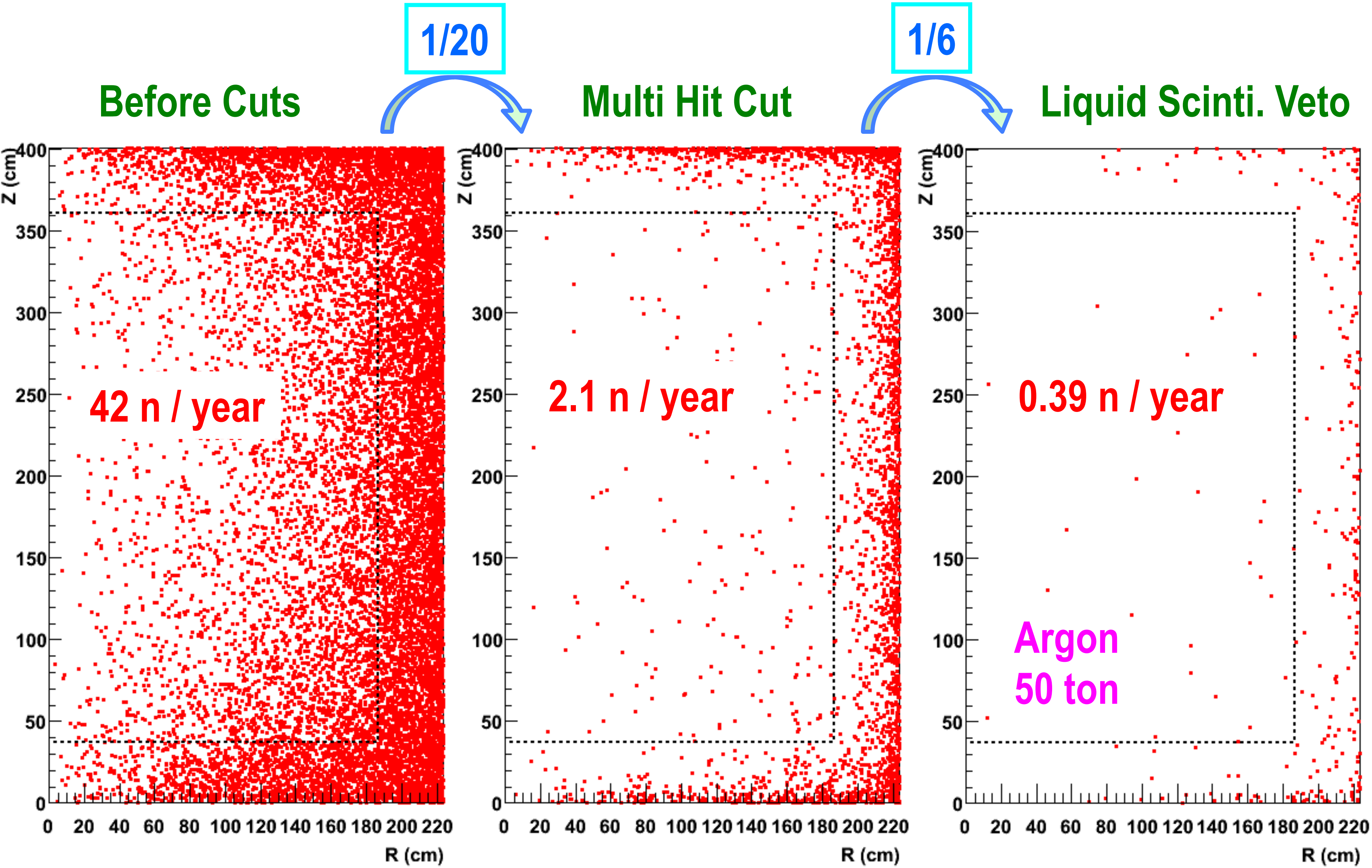
Xe 10 ton Neutron Background (100 Years)

arXiv:1107.1295



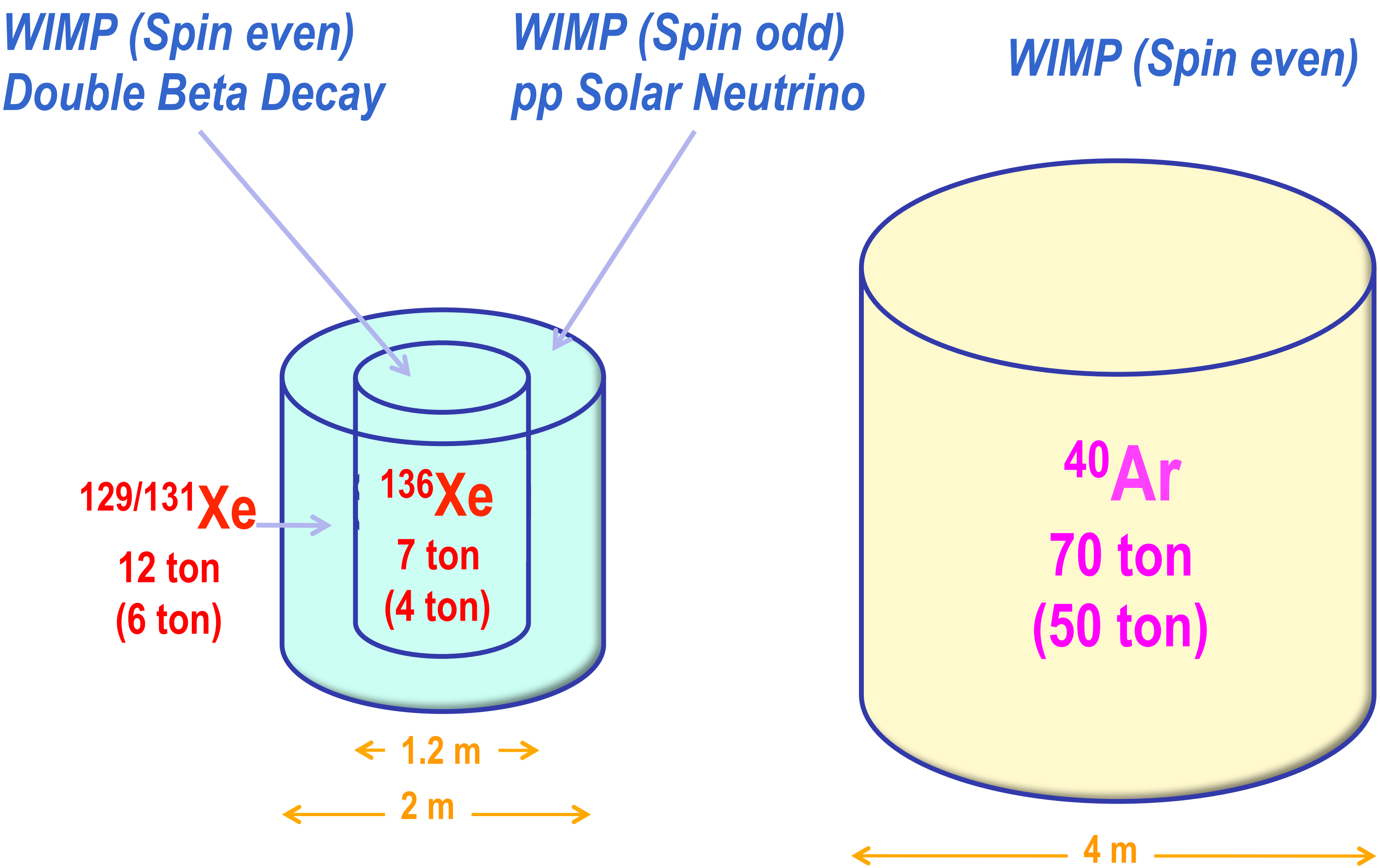
Ar 50 ton Neutron Background (100 Years)

arXiv:1107.1295

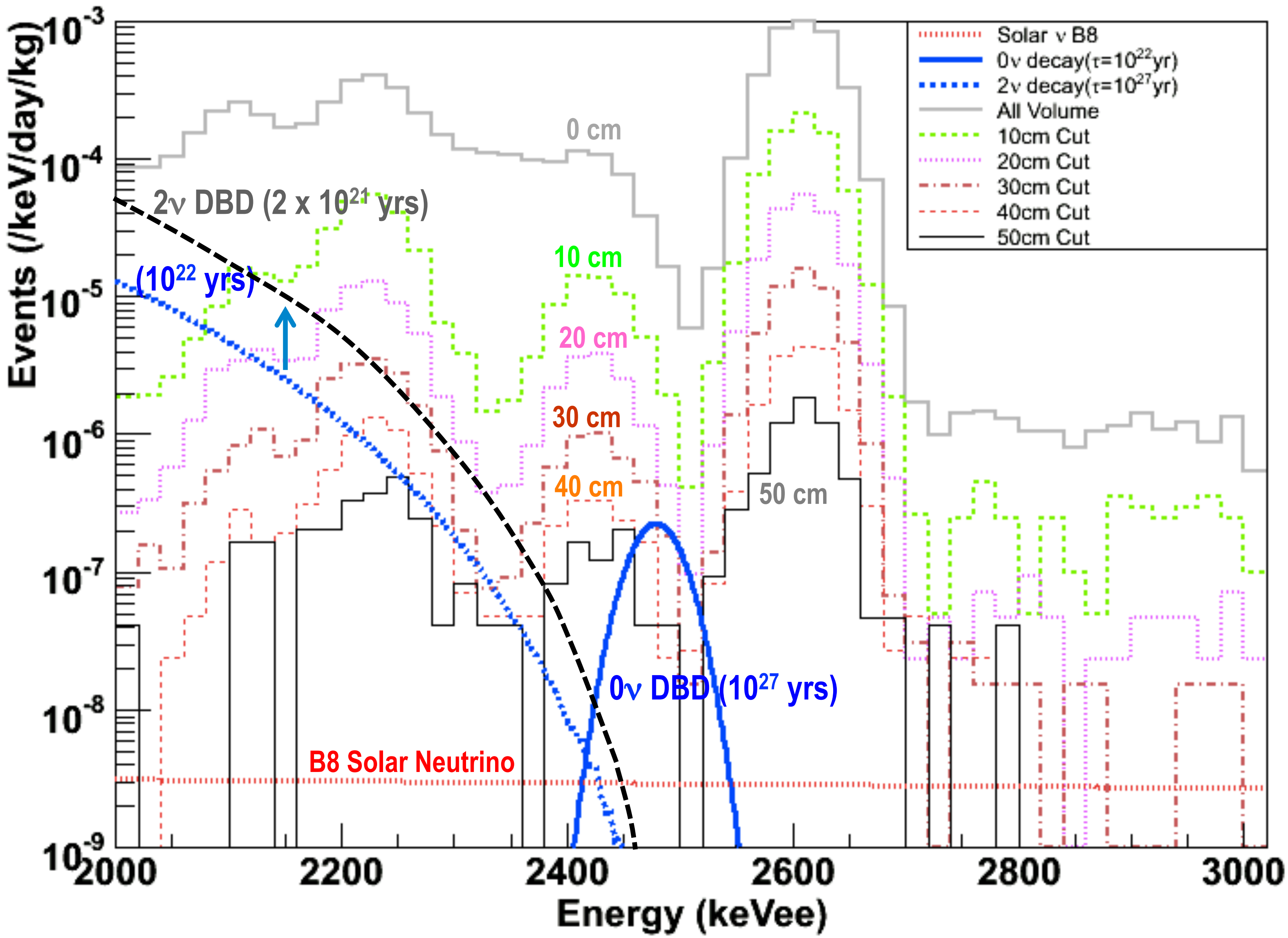


XAX (Xenon-Argon-Xenon)

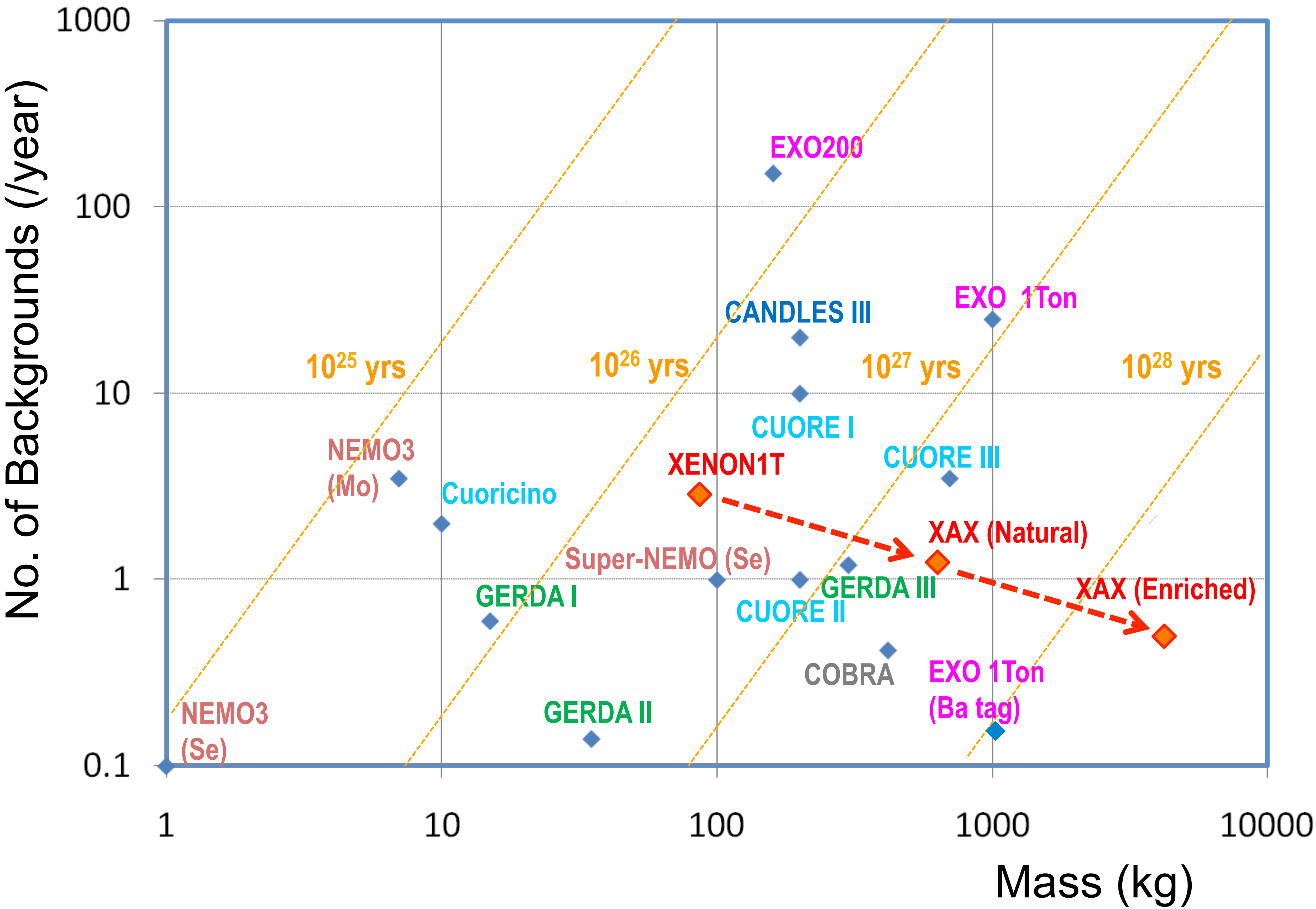
arXiv:0808.3968



^{136}Xe Double Beta Decay and Gamma Background (1 mBq / QUPID, 2m Xenon Detector)

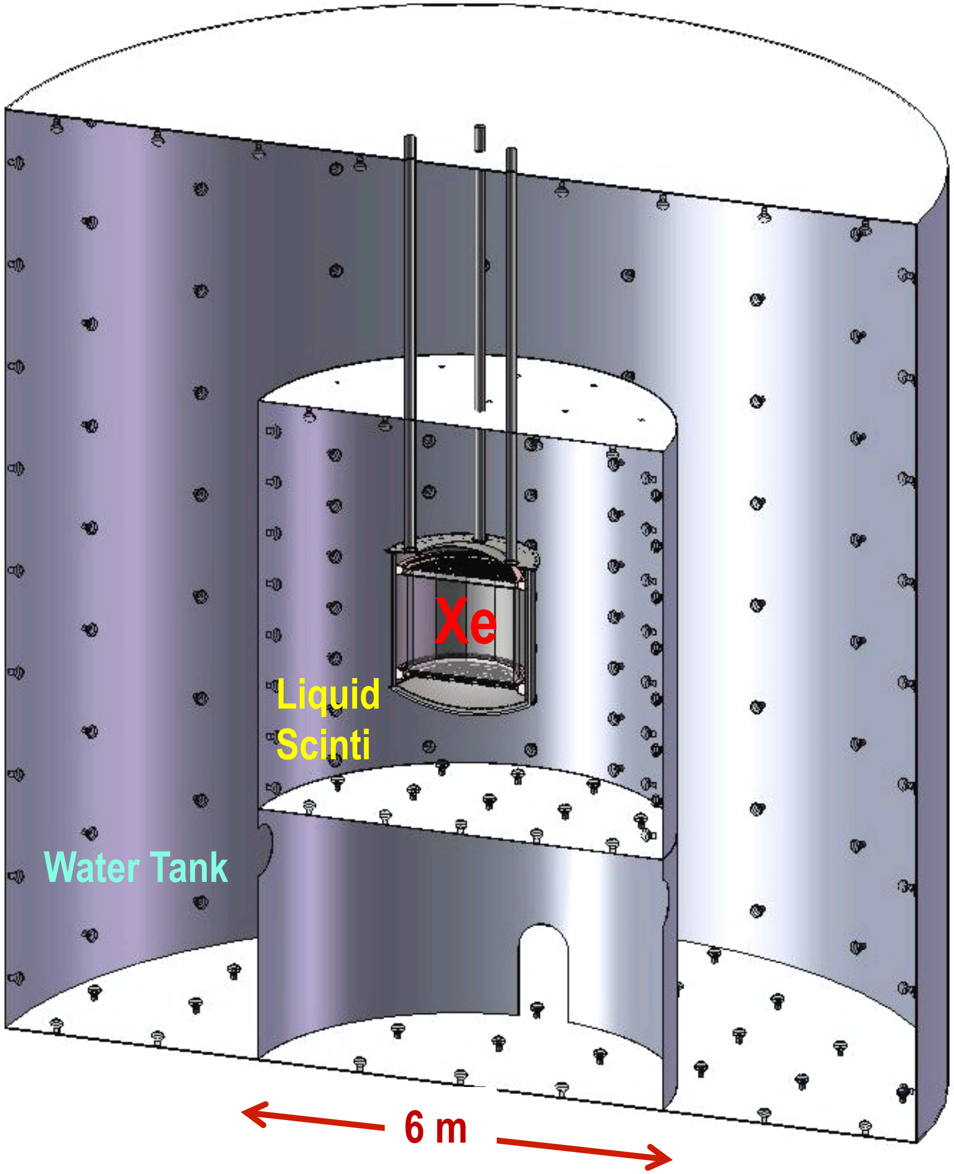


Double Beta Decay Experiments (with 0.1 mBq QUPID)

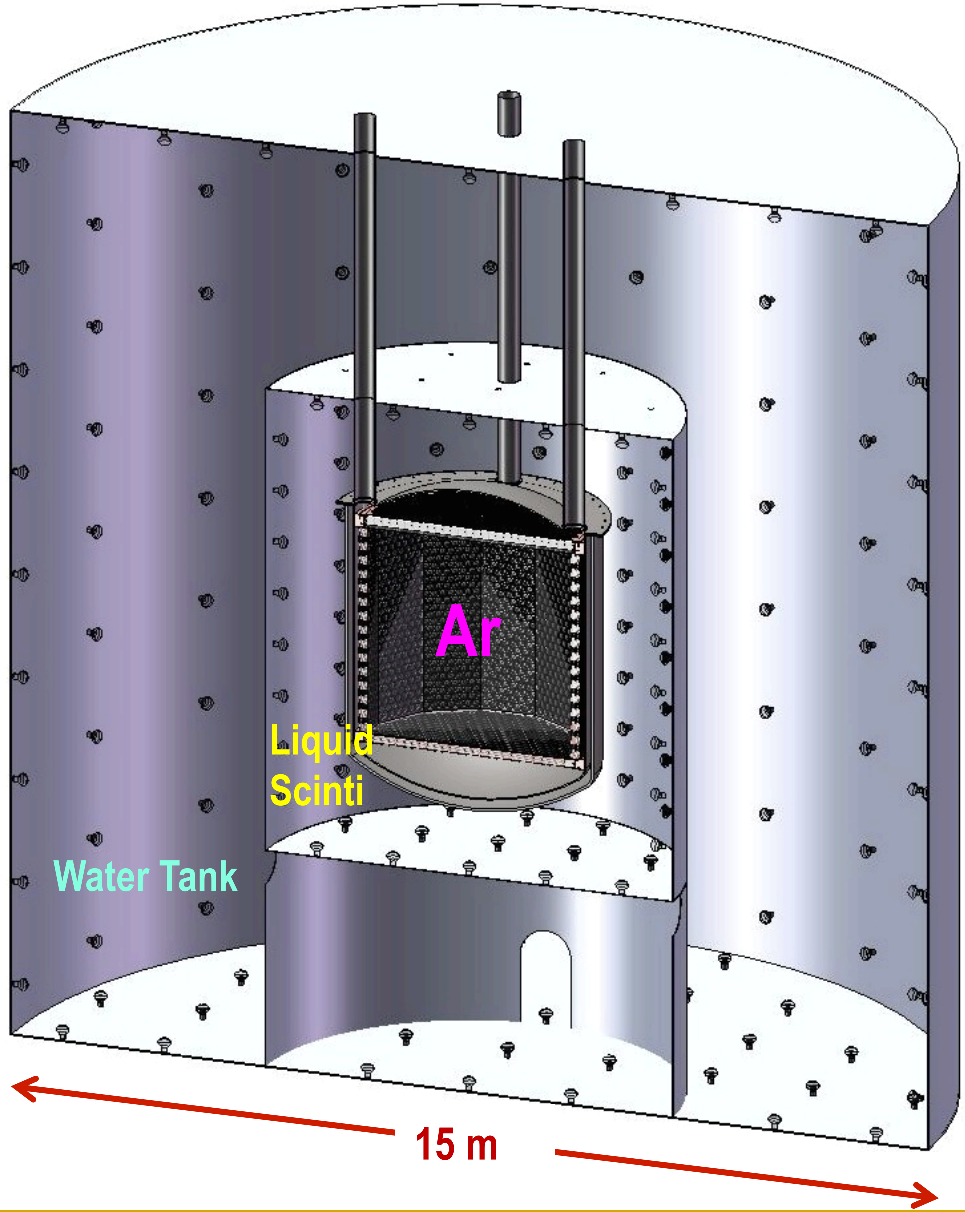


MAX G3 Detector (at DUSEL)

Xe 20 ton (10 ton)

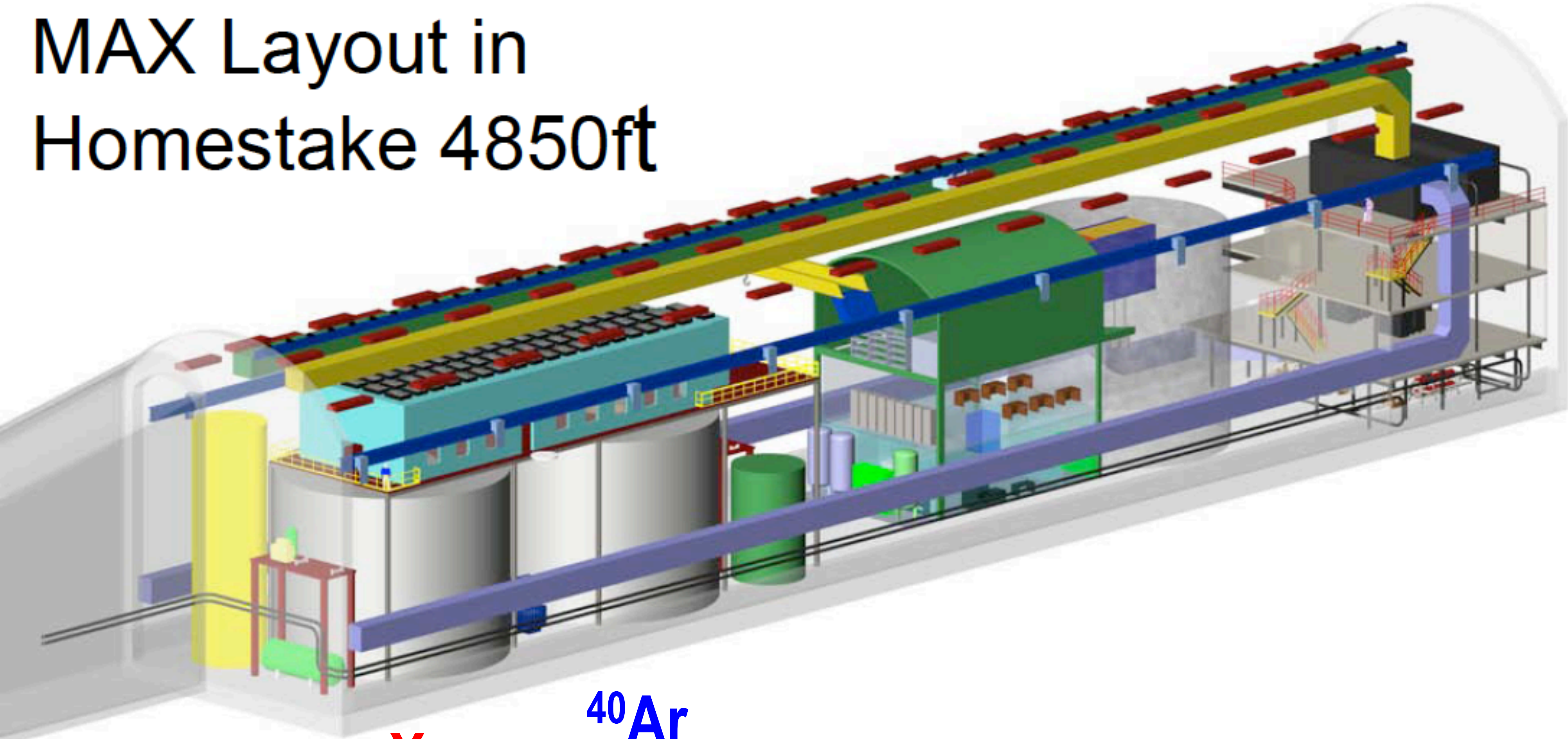


^{40}Ar 70 ton (50 ton)



MAX G3 Detector (at DUSEL)

MAX Layout in
Homestake 4850ft

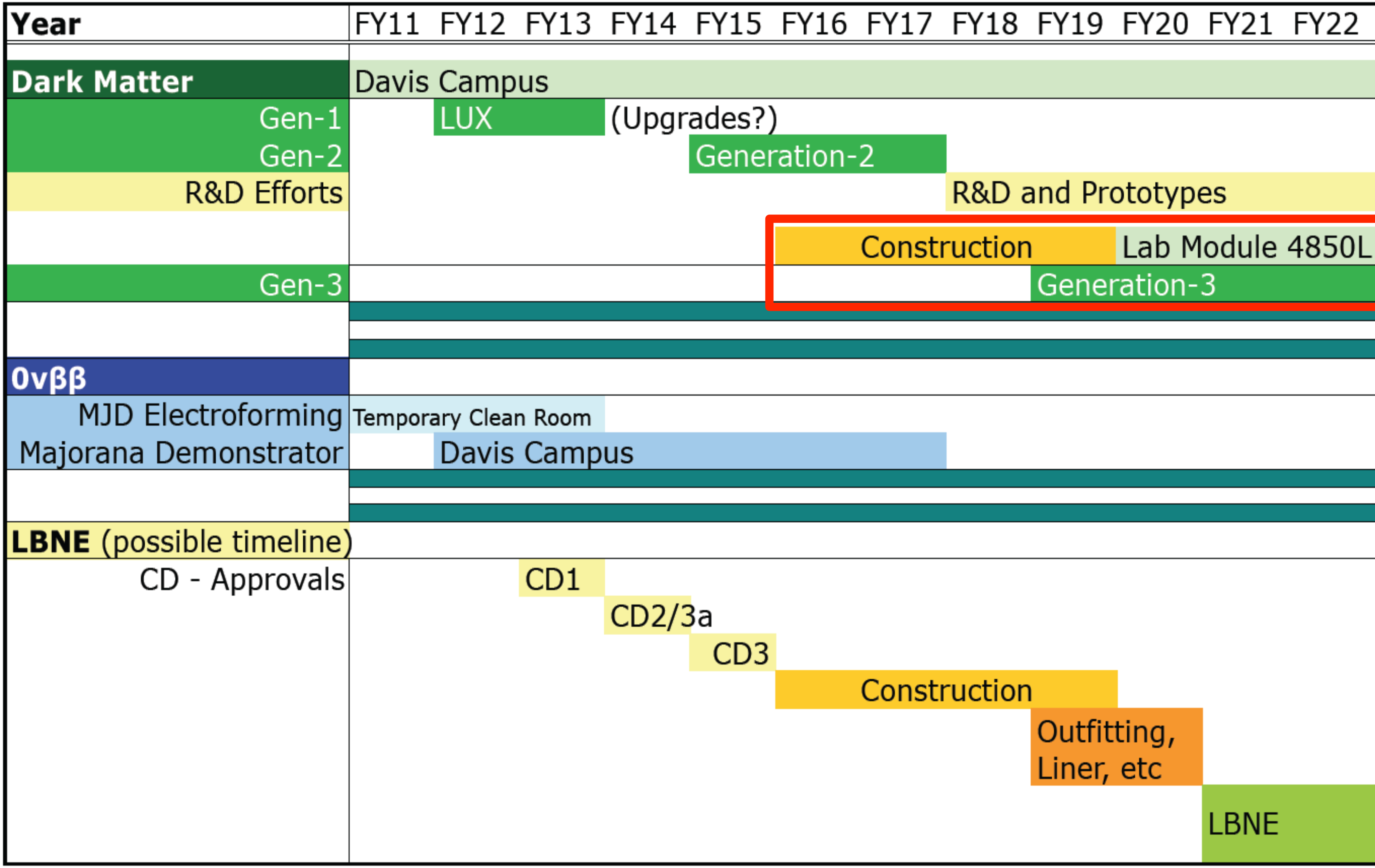


Xe
20 ton
(10 ton)

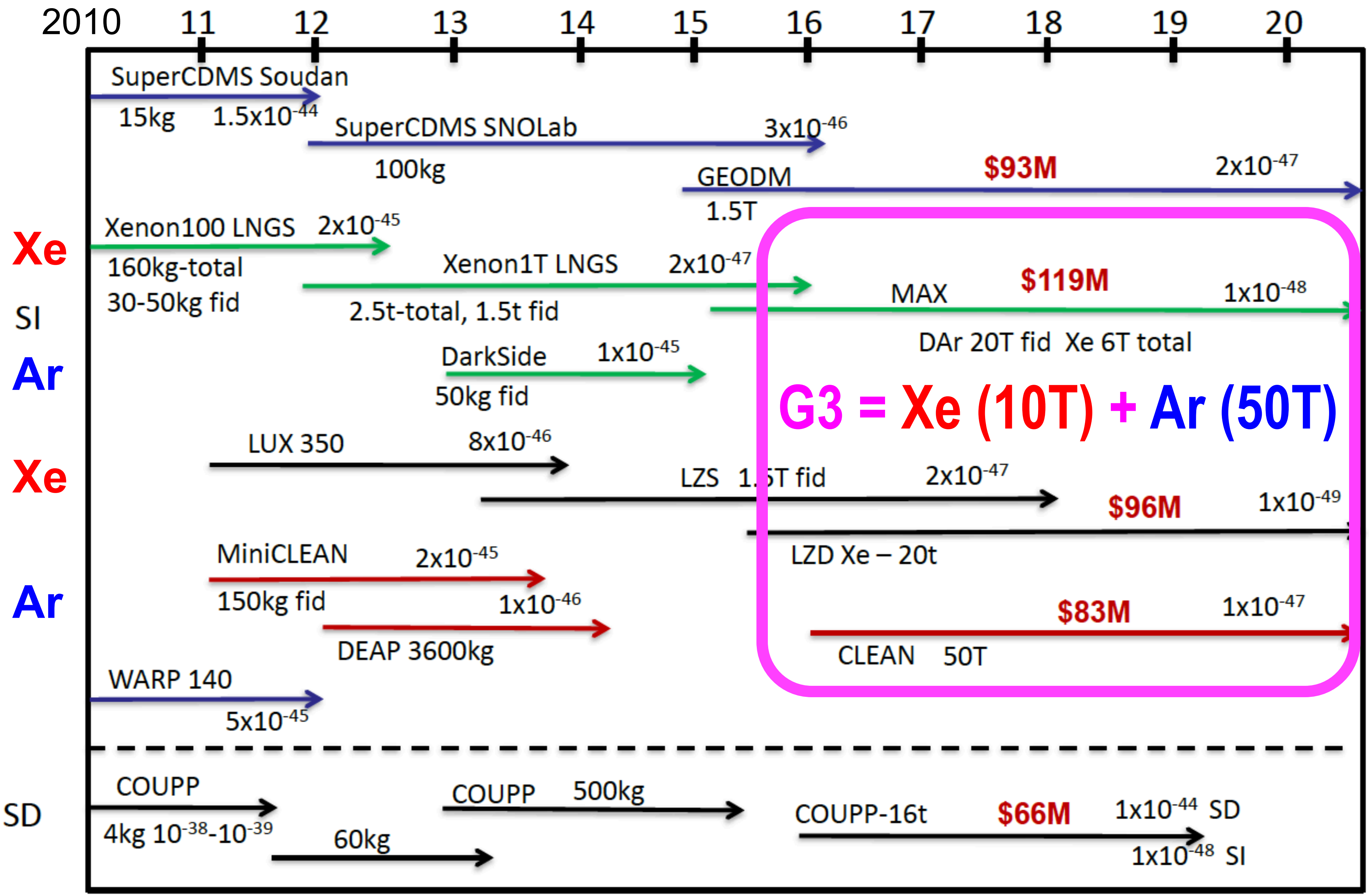
^{40}Ar
70 ton
(50 ton)

Schedule at DUSEL

Kevin Lesko



US Dark Matter Programs



Conclusions

- **MAX**
  - 10 Ton Xe + 50 Ton Ar at DUSEL
  - Joint efforts by XENON and DarkSide collaborations (currently at LNGS towards G2)
- **Science cases**
  - Sensitivity down to 10^{-48} cm^2
  - Precision measurements if > 10^{-46} cm^2
  - Possibility to combine with 0ν Double Beta Decays → XAX