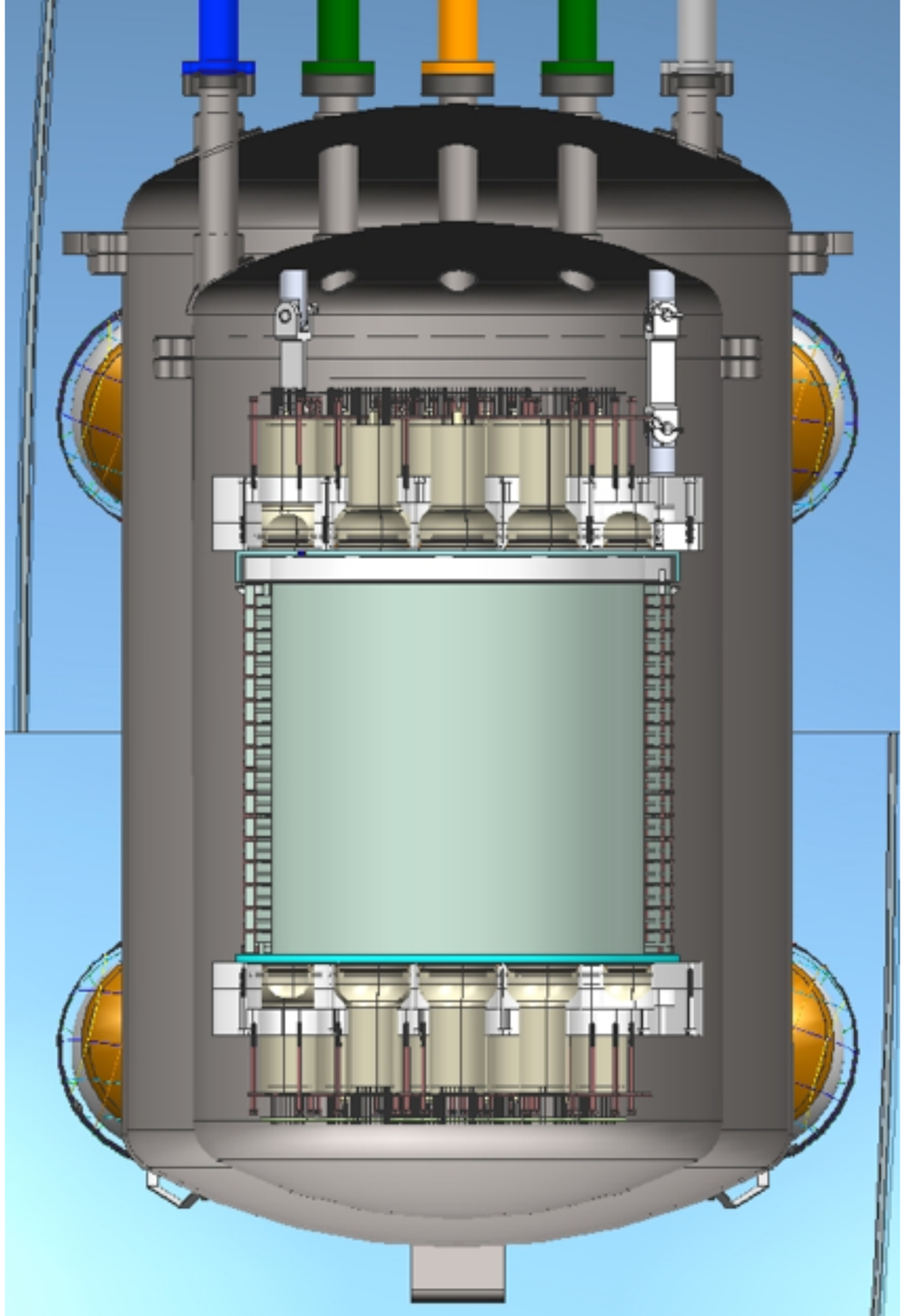
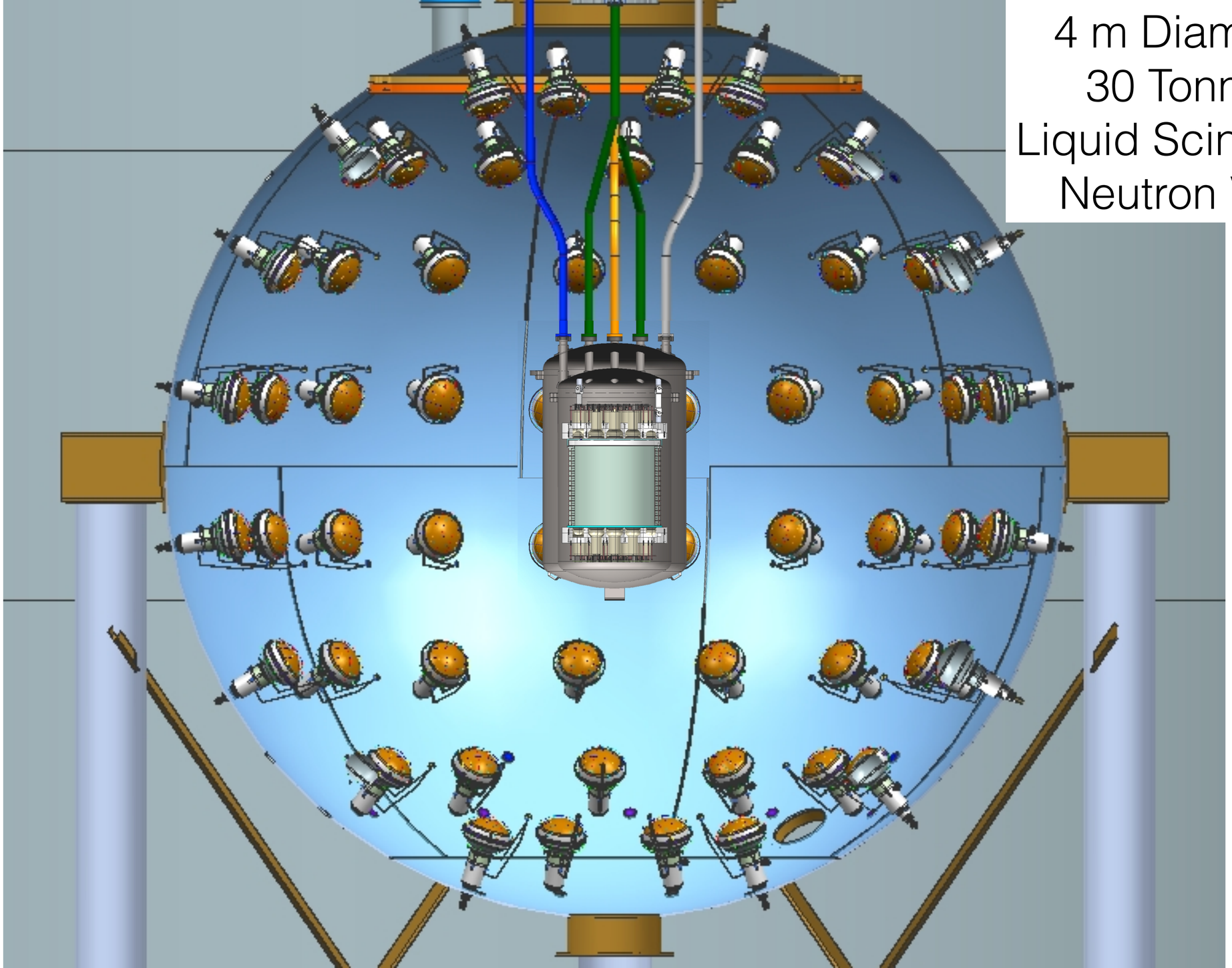
The DarkSide Program of Direct Dark Matter Searches

The DarkSide Collaboration

October 2, 2015

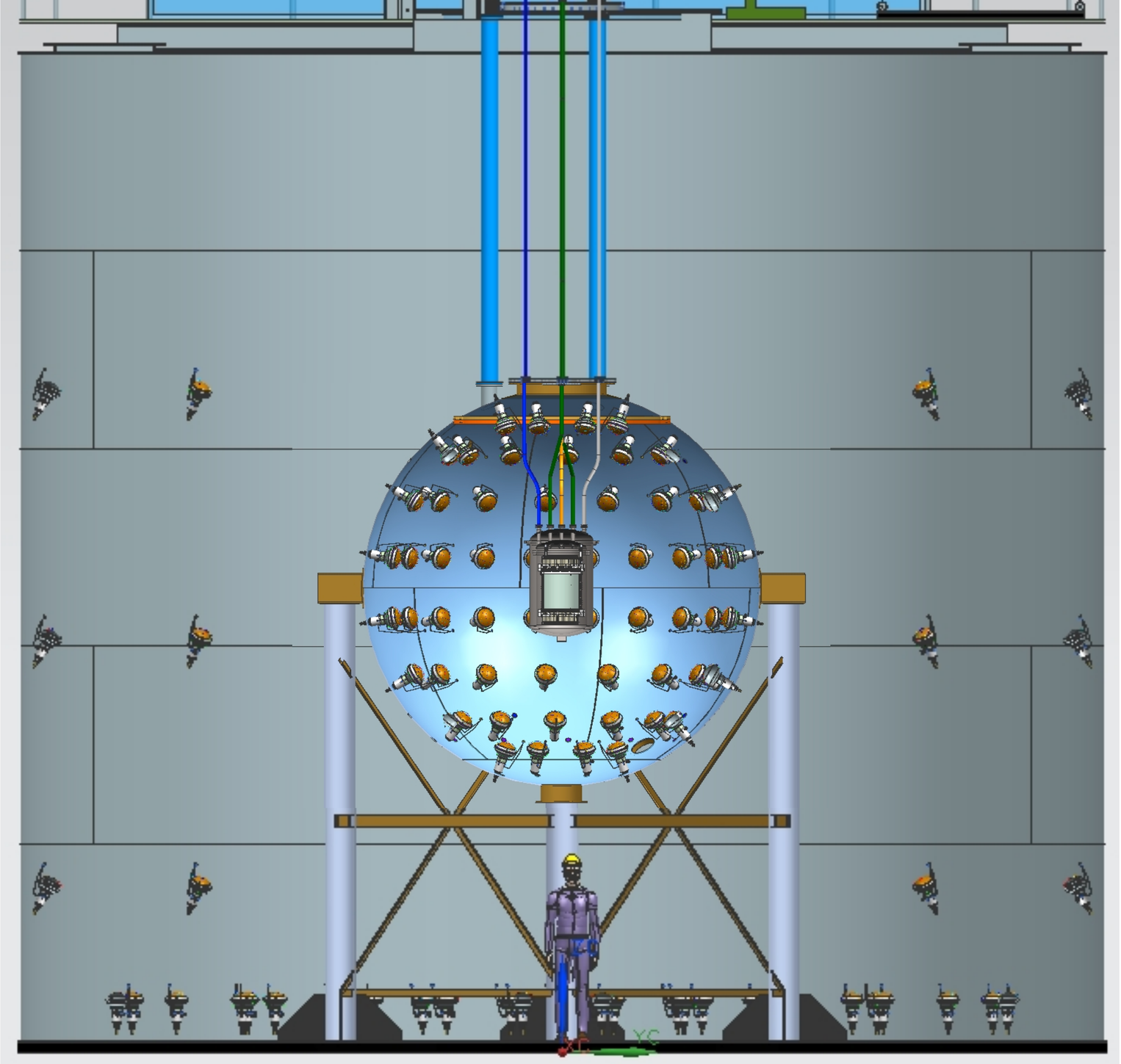
Liquid Argon TPC
153 kg ^{39}Ar-Depleted
Underground Argon
Target





4 m Diameter
30 Tonnes
Liquid Scintillator
Neutron Veto

10 m Height
11 m Diameter
1,000 Tonnes
Water Cherenkov
Muon Veto



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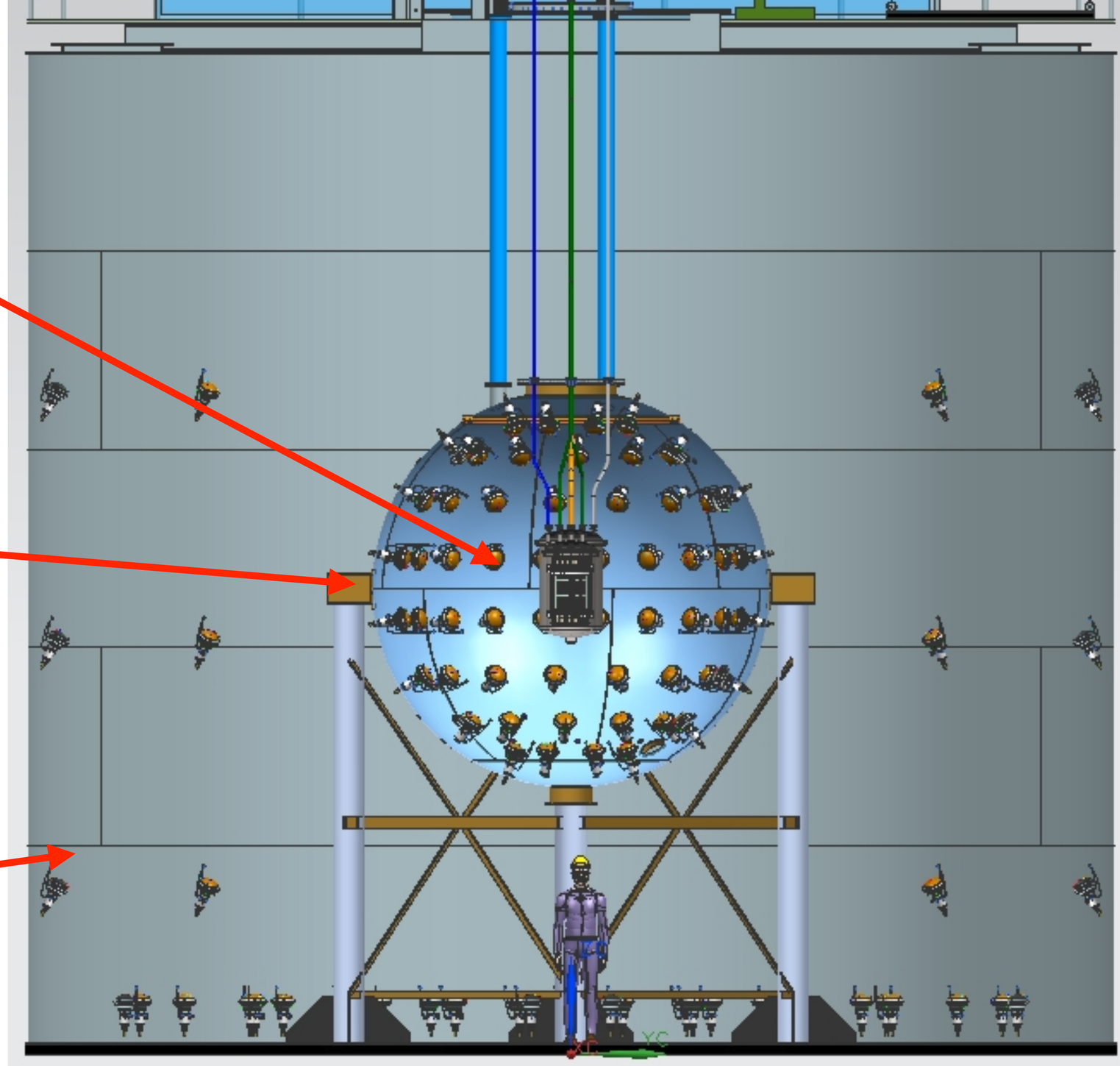
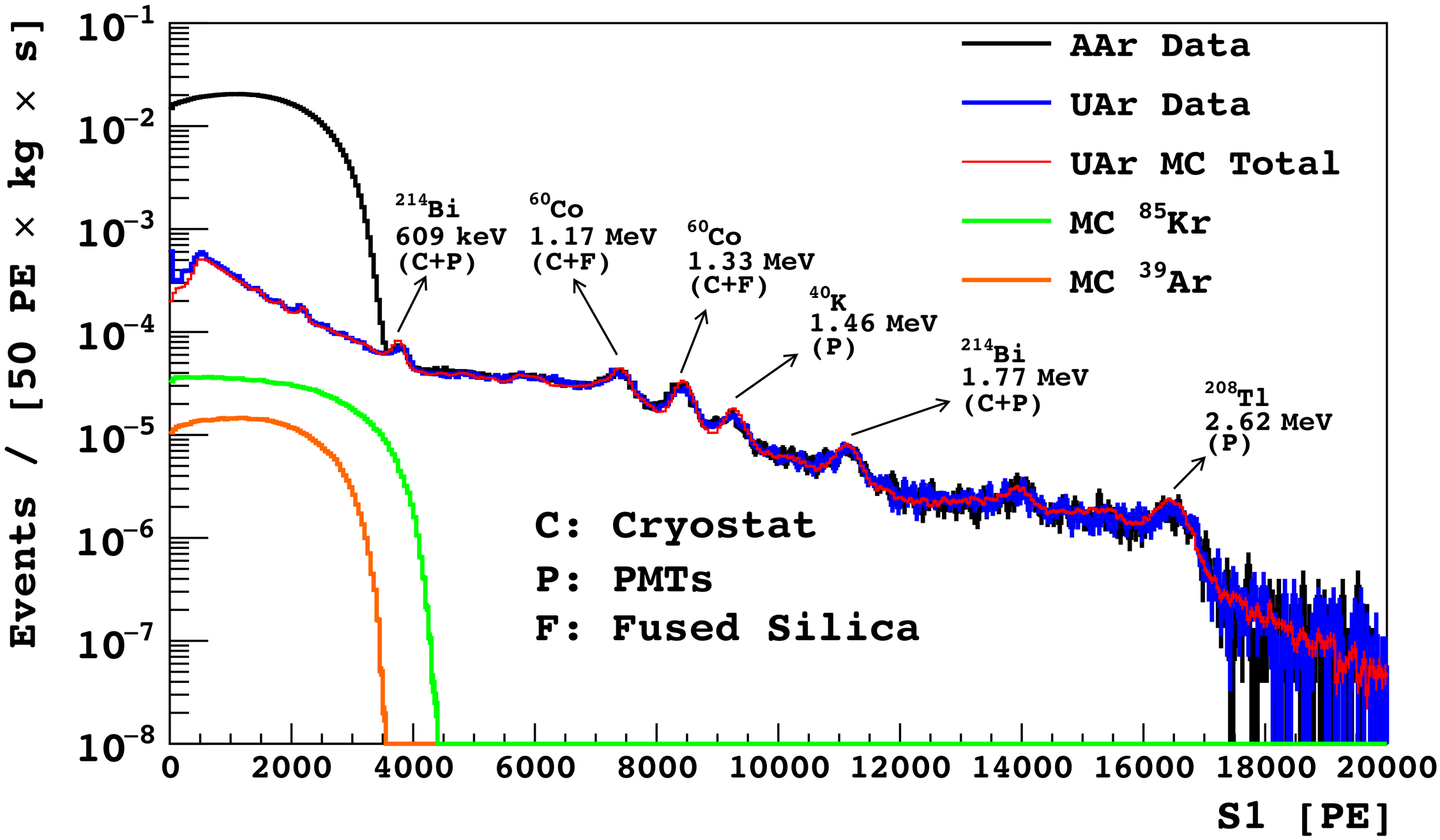
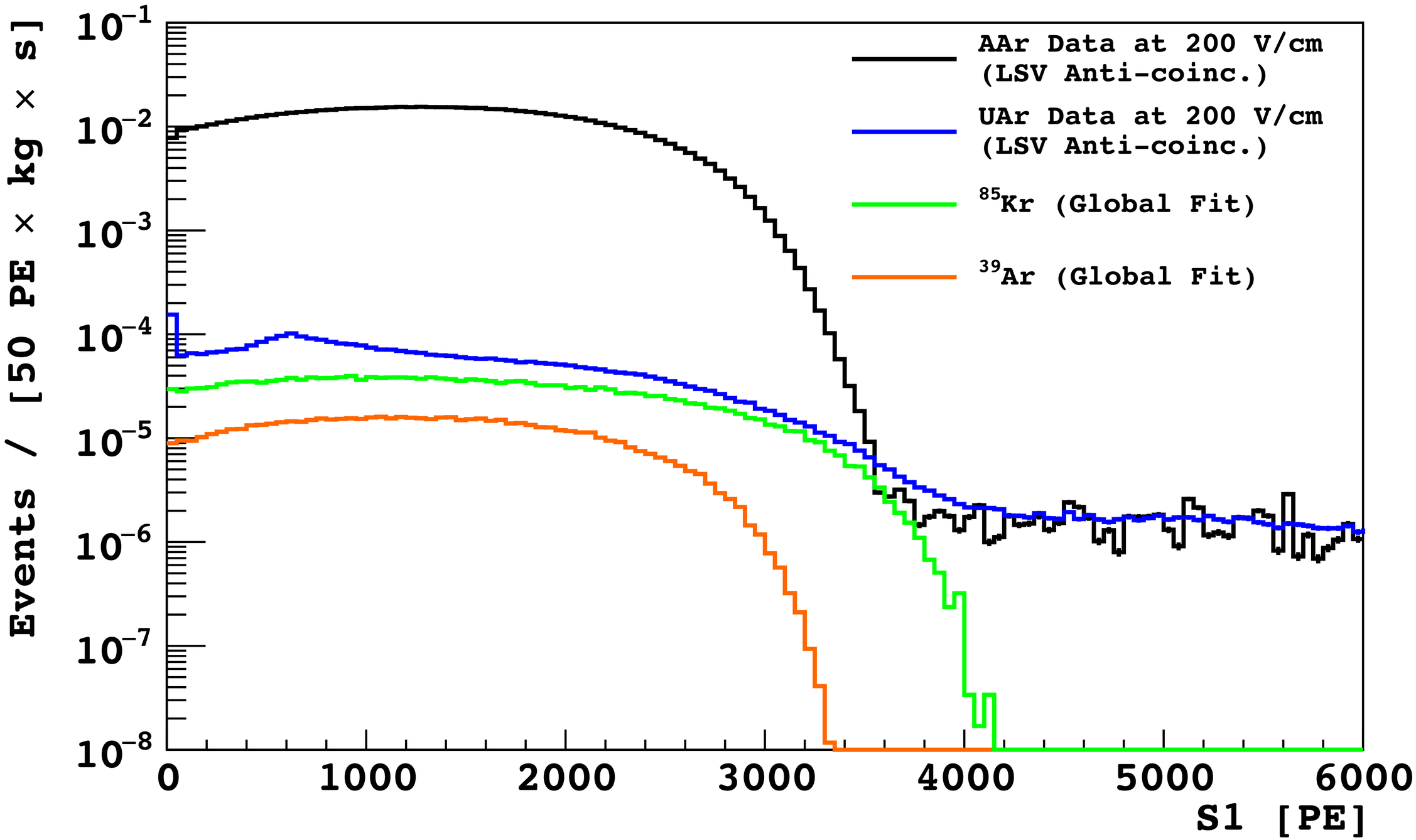
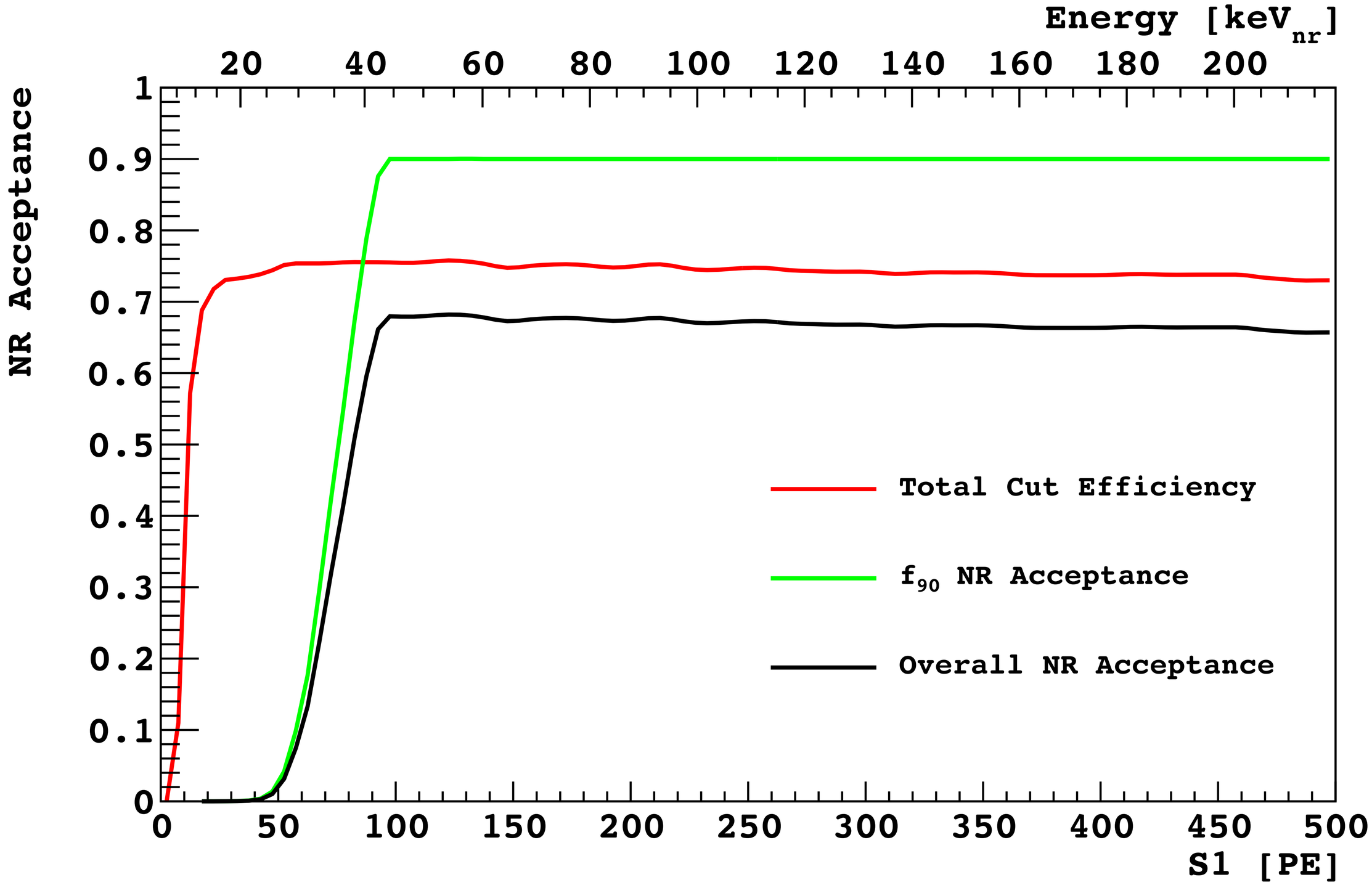


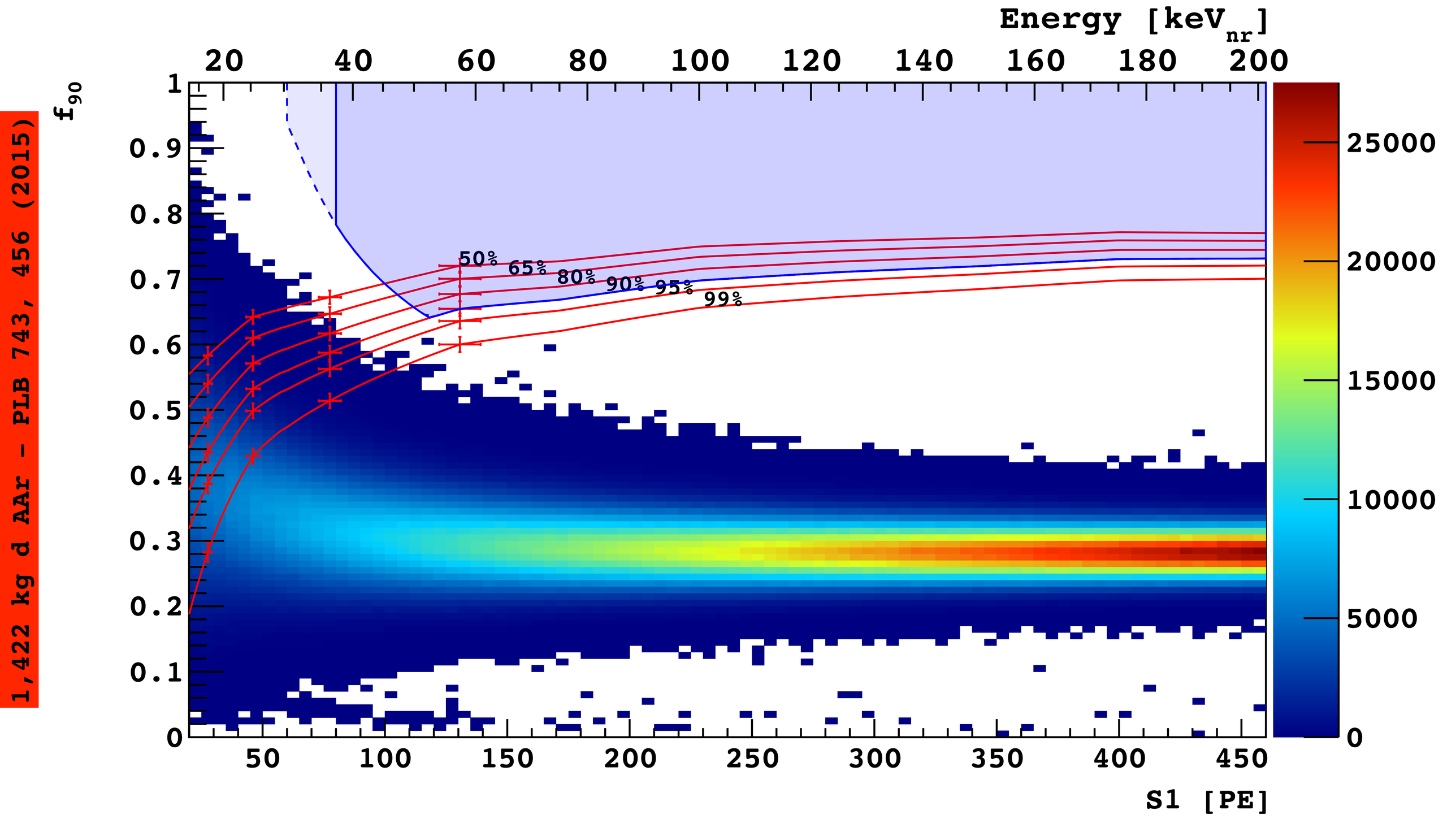
DarkSide-50 Milestones

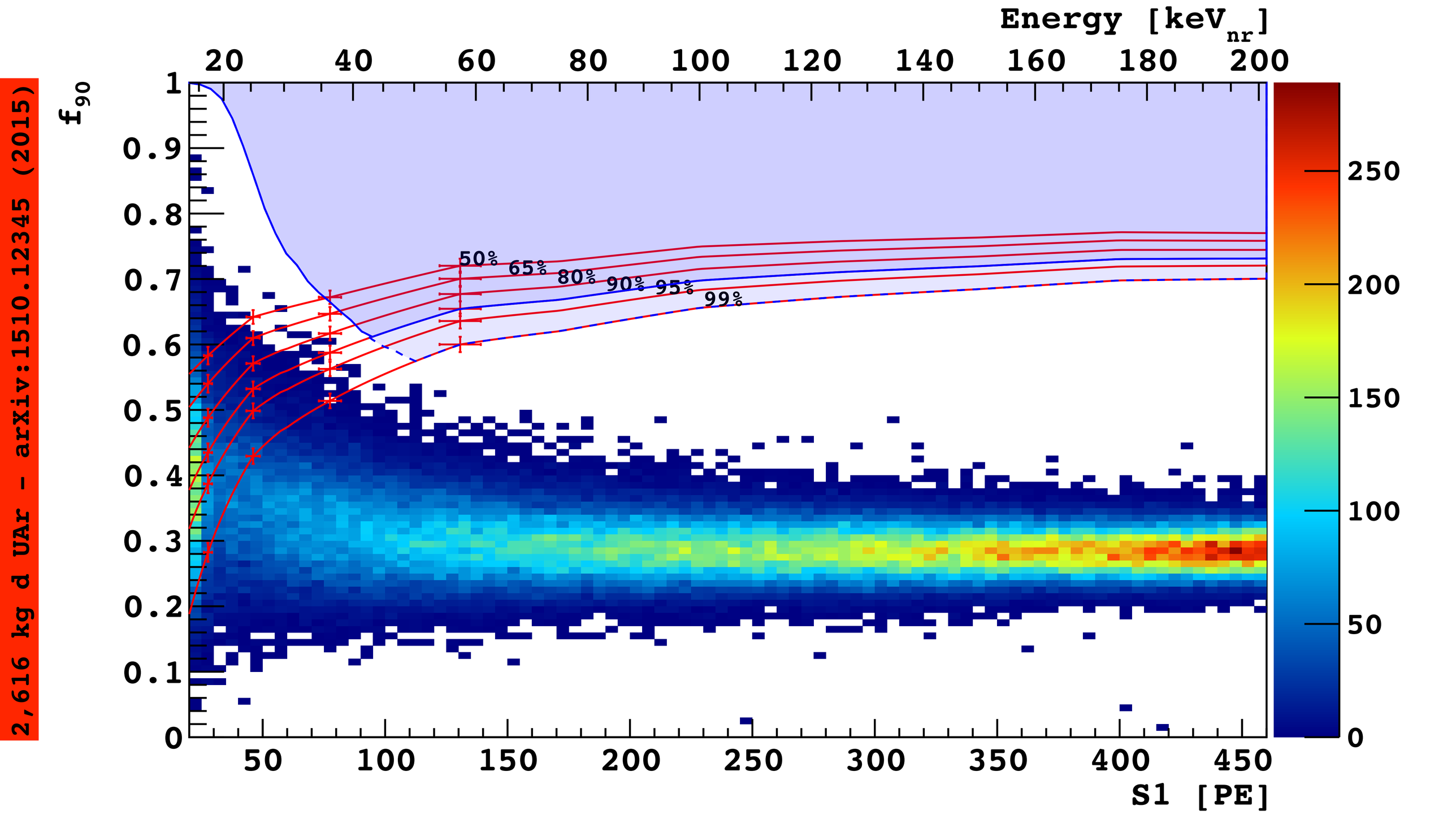
- Oct 2013: three detectors commissioned, cryostat filled with AAr
- Oct 2014: WIMP search results with 1422 kg d AAr exposure
- Fall 2014: Calibration campaign
- Winter 2014: Refurbishment of LSV, ^{14}C rate from 150 kHz to 0.3 kHz
- Apr 2015: cryostat drained and filled with 153 kg of UAr
- Oct 2015: WIMP search results with 2616 kg d UAr exposure

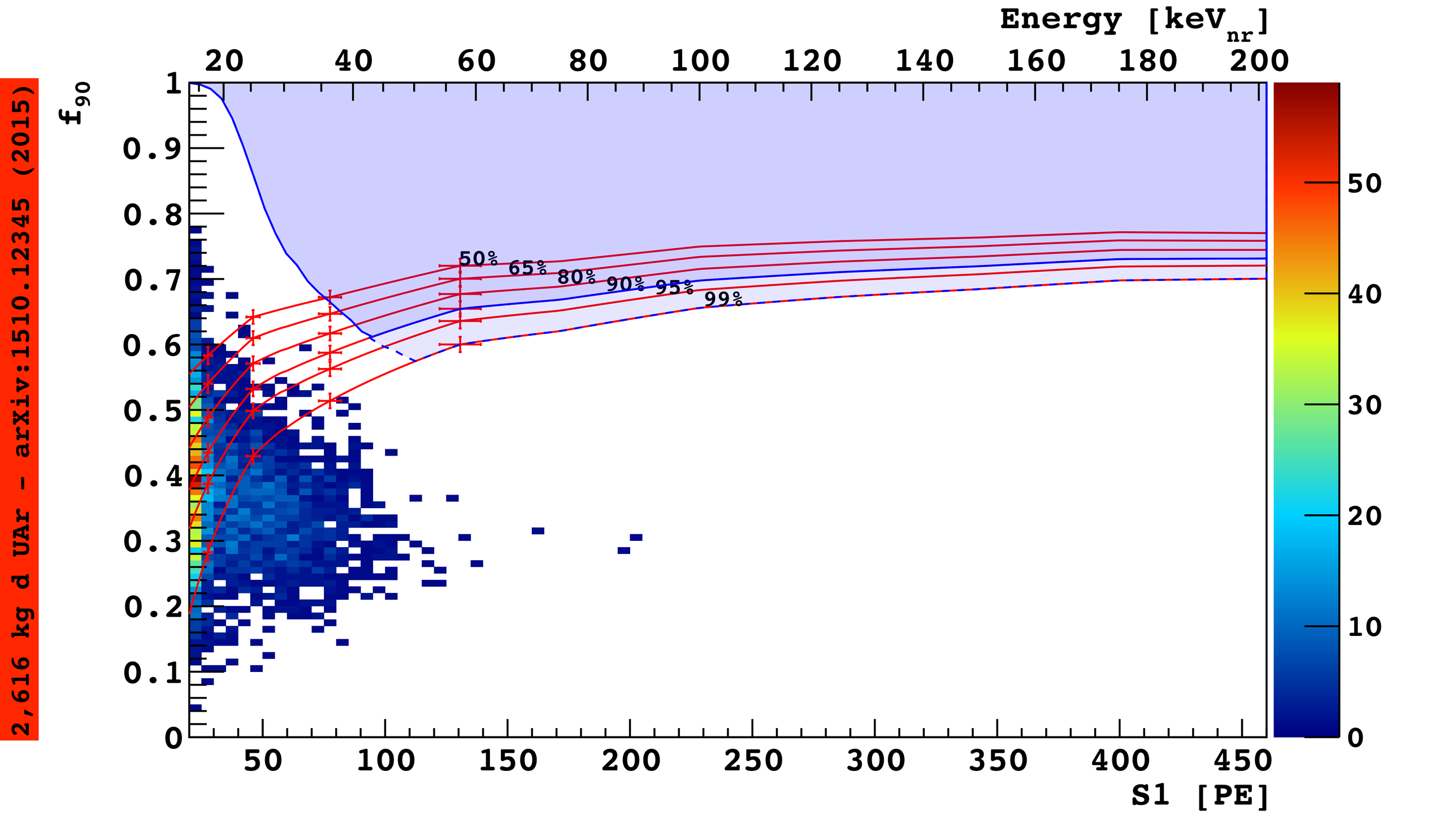

AAr Data
UAr Data
UAr MC Total
MC ^{85}Kr
MC ^{39}Ar
^{214}Bi
609 keV
(C+P)
^{60}Co
1.17 MeV
(C+F)
^{60}Co
1.33 MeV
(C+F)
^{40}K
1.46 MeV
(P)
^{214}Bi
1.77 MeV
(C+P)
^{208}Tl
2.62 MeV
(P)
C: Cryostat
P: PMTs
F: Fused Silica
Events / [50 PE × kg × s]
S1 [PE]
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000

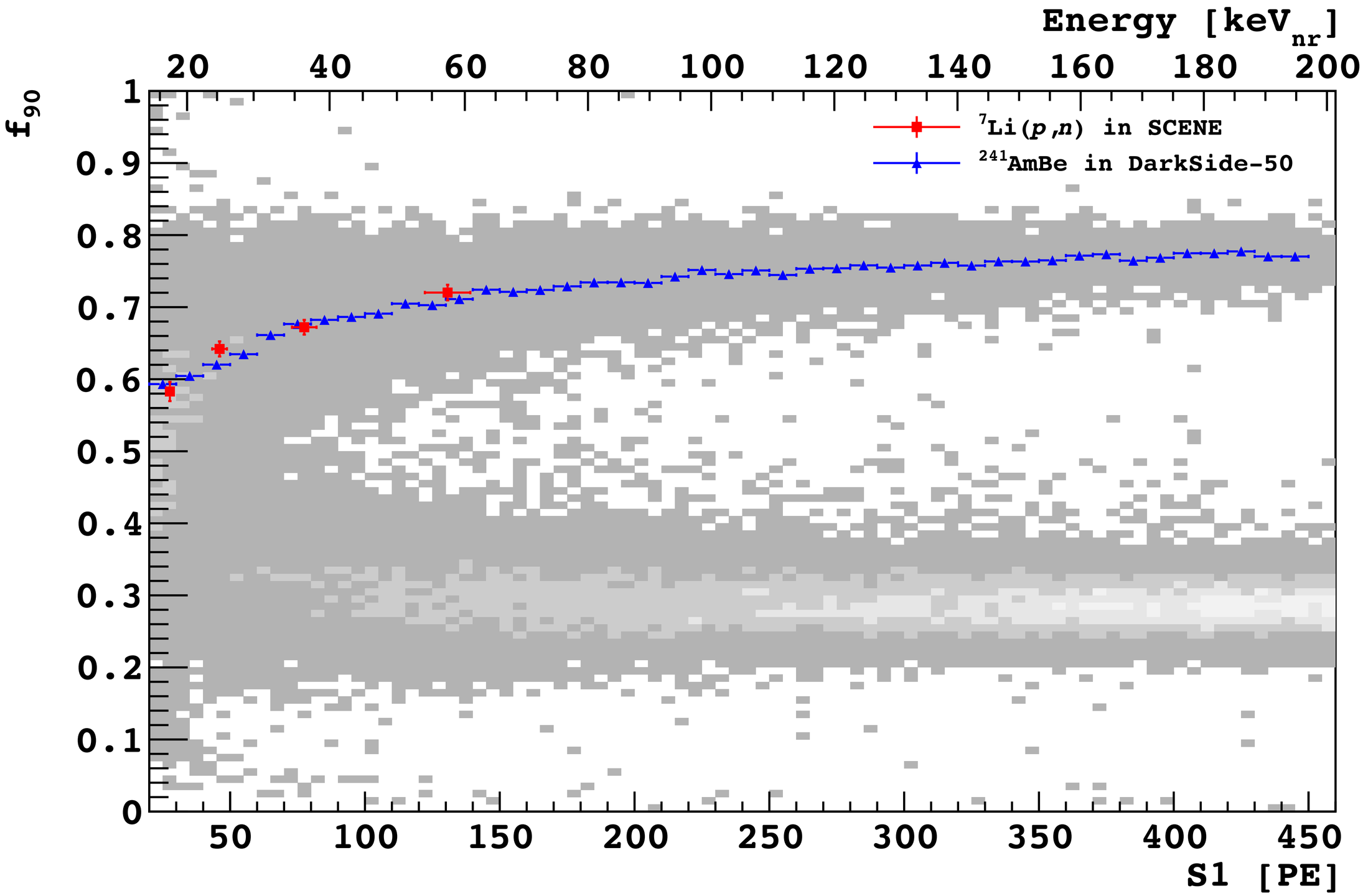

AAr Data at 200 V/cm
(LSV Anti-coinc.)
UAr Data at 200 V/cm
(LSV Anti-coinc.)
85Kr (Global Fit)
39Ar (Global Fit)
Events / [50 PE × kg × s]
S1 [PE]
10−1
10−2
10−3
10−4
10−5
10−6
10−7
10−8
0
1000
2000
3000
4000
5000
6000

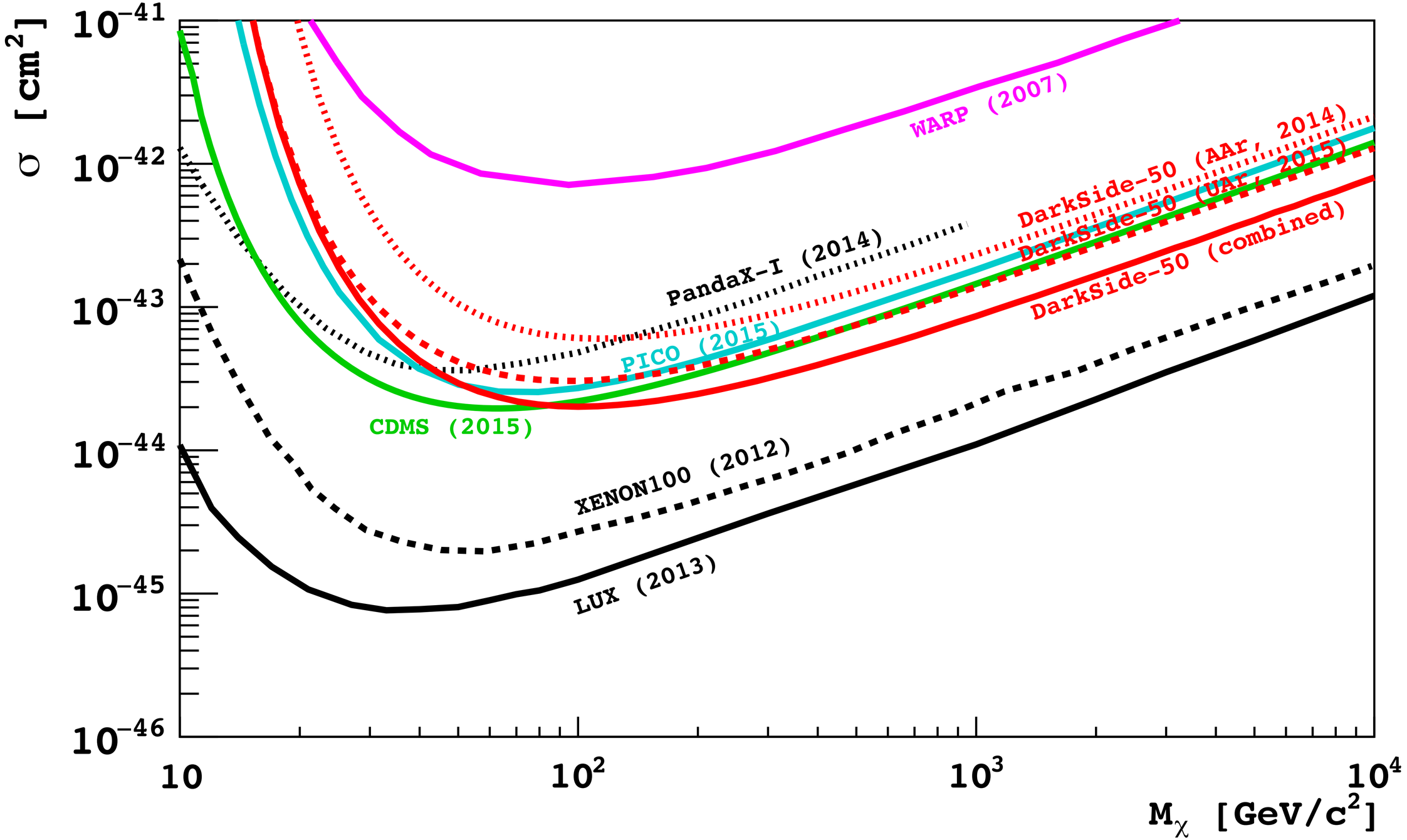

Energy [keV$_{nr}$]
20
40
60
80
100
120
140
160
180
200
NR Acceptance
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300
350
400
450
500
S1 [PE]
Total Cut Efficiency
f_{90} NR Acceptance
Overall NR Acceptance

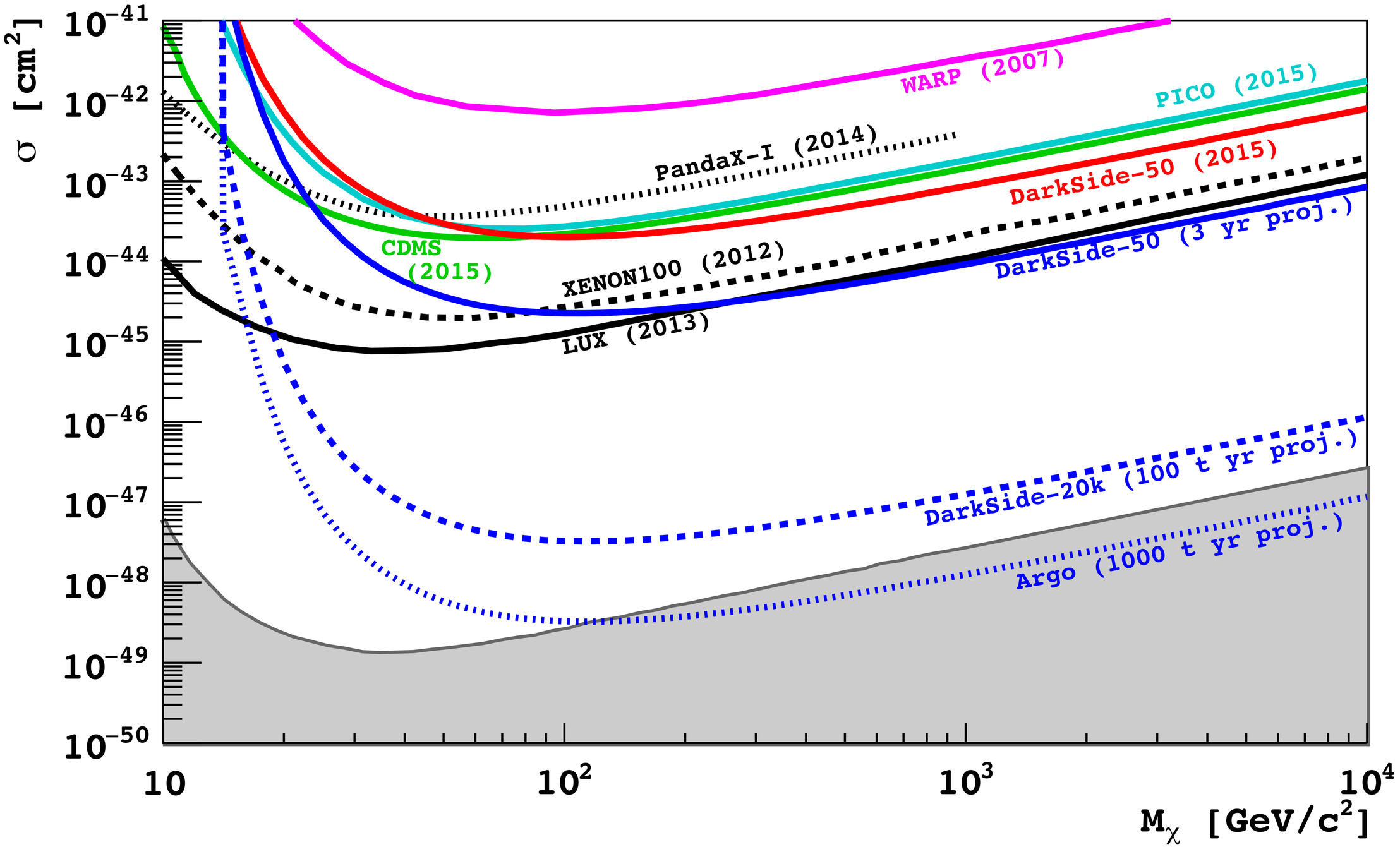

1,422 kg d AAr - PLB 743, 456 (2015)
Energy [keV$_{nr}$]
20
40
60
80
100
120
140
160
180
200
f_{90}
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
50%
65%
80%
90%
95%
99%
50
100
150
200
250
300
350
400
450
S1 [PE]
25000
20000
15000
10000
5000
0


2,616 kg d UAr - arXiv:1510.12345 (2015)
Energy [keV$_{nr}$]
20
40
60
80
100
120
140
160
180
200
f_{90}
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
50%
65%
80%
90%
95%
99%
50
100
150
200
250
300
350
400
450
S1 [PE]
250
200
150
100
50
0


2,616 kg d UAr - arXiv:1510.12345 (2015)
Energy [keV$_{nr}$]
20
40
60
80
100
120
140
160
180
200
f_{90}
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
50%
65%
80%
90%
95%
99%
50
100
150
200
250
300
350
400
450
S1 [PE]
50
40
30
20
10
0


Energy [keV$_{nr}$]
20
40
60
80
100
120
140
160
180
200
f_{90}
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
^{7}Li(p,n) in SCENE
^{241}AmBe in DarkSide-50
50
100
150
200
250
300
350
400
450
S1 [PE]


σ [cm²]
10⁻⁴¹
10⁻⁴²
10⁻⁴³
10⁻⁴⁴
10⁻⁴⁵
10⁻⁴⁶
10
10²
10³
10⁴
M_χ [GeV/c²]
WARP (2007)
DarkSide-50 (AAr, 2014)
DarkSide-50 (UAr, 2015)
DarkSide-50 (combined)
PandaX-I (2014)
PICO (2015)
CDMS (2015)
XENON100 (2012)
LUX (2013)


σ [cm²]
10⁻⁴¹
10⁻⁴²
10⁻⁴³
10⁻⁴⁴
10⁻⁴⁵
10⁻⁴⁶
10⁻⁴⁷
10⁻⁴⁸
10⁻⁴⁹
10⁻⁵⁰
10
10²
10³
10⁴
M_χ [GeV/c²]
WARP (2007)
PICO (2015)
PandaX-I (2014)
DarkSide-50 (2015)
CDMS (2015)
XENON100 (2012)
DarkSide-50 (3 yr proj.)
LUX (2013)
DarkSide-20k (100 t yr proj.)
Argo (1000 t yr proj.)

DarkSide-20k

20-tonnes fiducial dark matter detector
start of operations at LNGS within 2020
100 tonne×year background-free search for dark matter

Argo

300-tonnes depleted argon detector
start of operations at LNGS within 2025
1,000 tonne×year background-free search for dark matter
precision measurement of solar neutrinos

DarkSide-20k and Argo LoI Signatories

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The End