DarkSide-50

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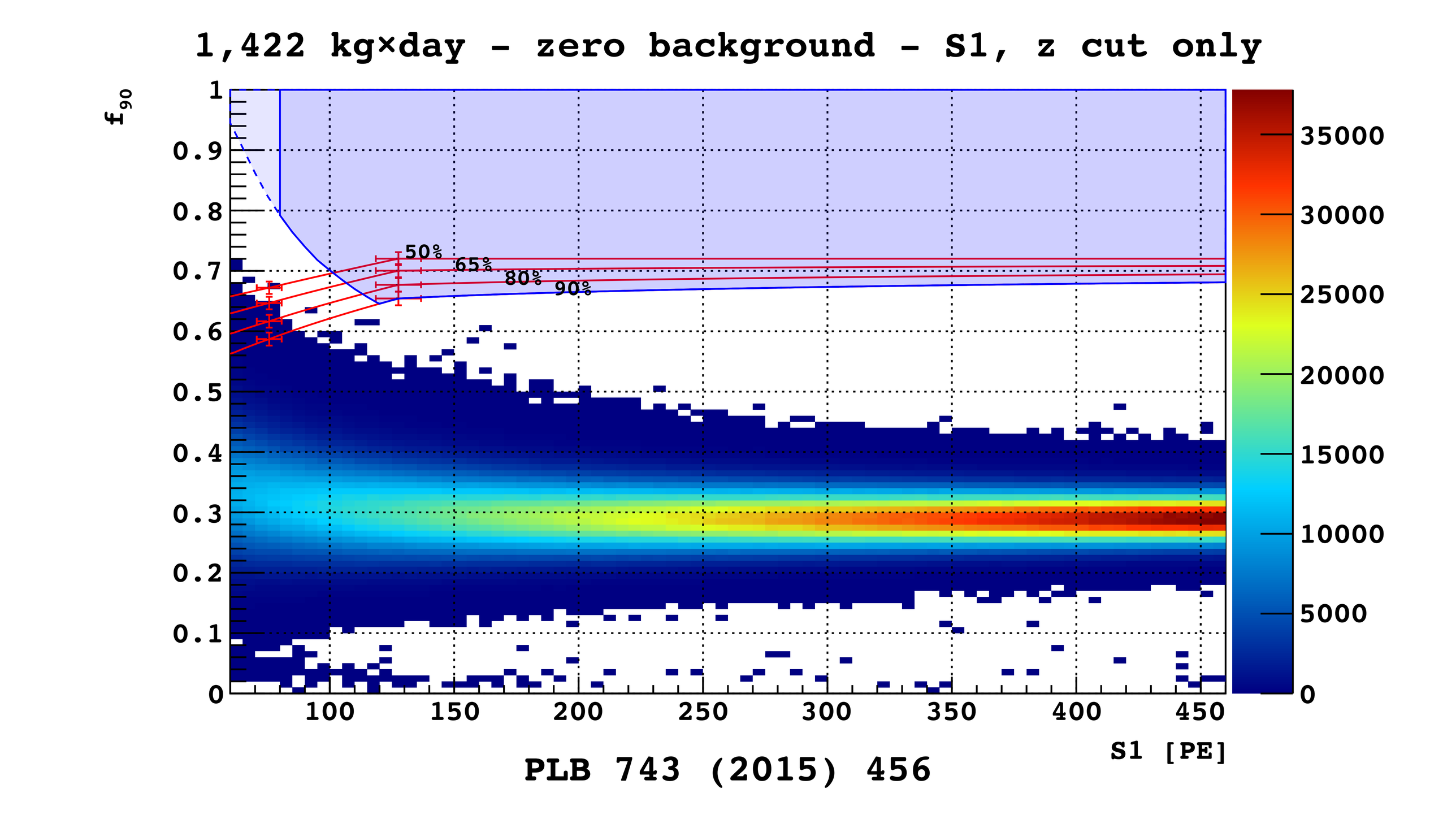
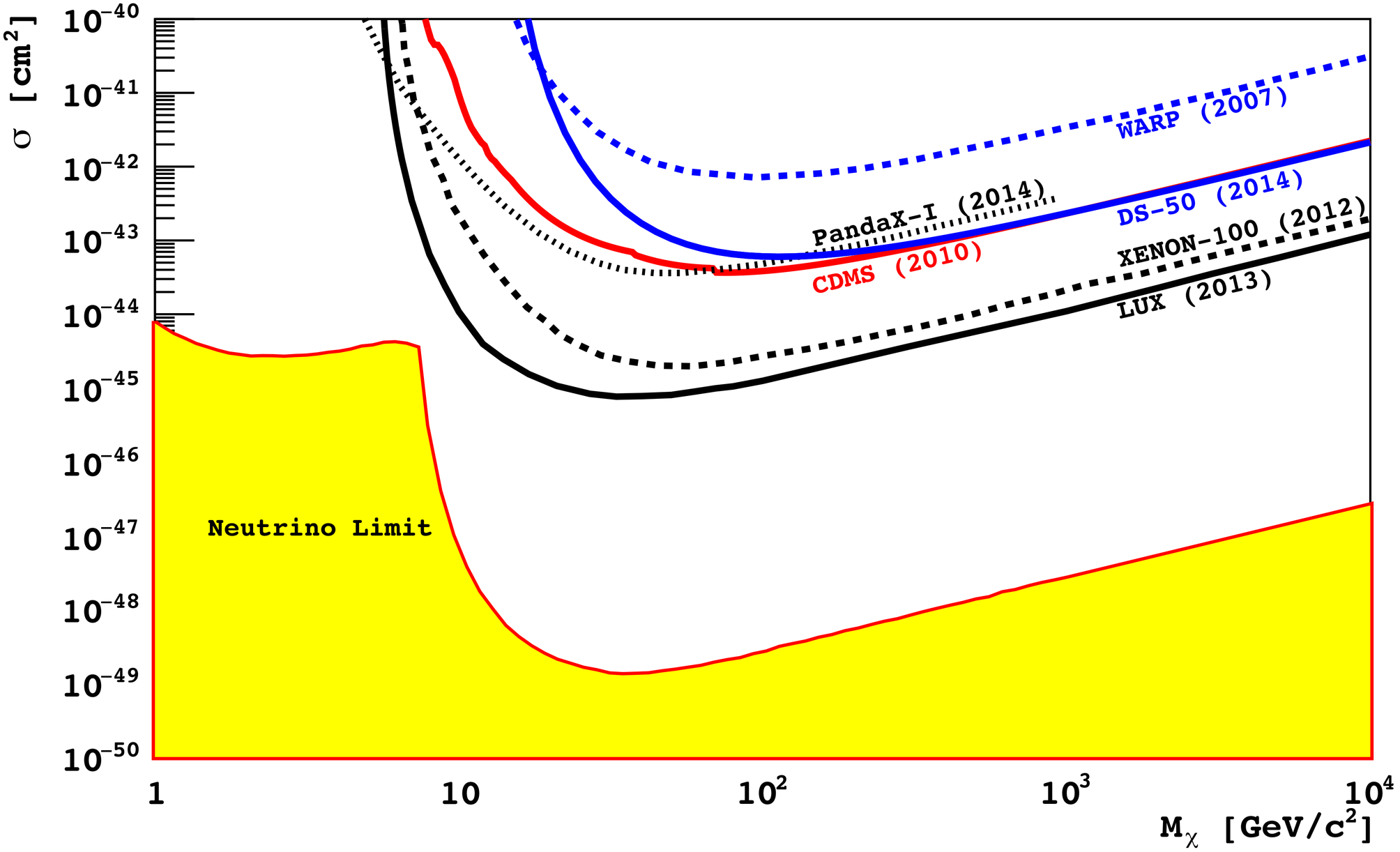
Plan of Talk

- Status of DarkSide-50
- Radioactive Source Calibration of DarkSide-50
- Neutron Veto Campaigns and Early Results
- Commissioning with Underground Argon and First Results


1,422 kg×day - zero background - S1, z cut only
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%
100
150
200
250
300
350
400
450
S1 [PE]
35000
30000
25000
20000
15000
10000
5000
0
PLB 743 (2015) 456

Third best dark matter limit at high masses



PLB 743 (2015) 456

Major Operations on DarkSide-50

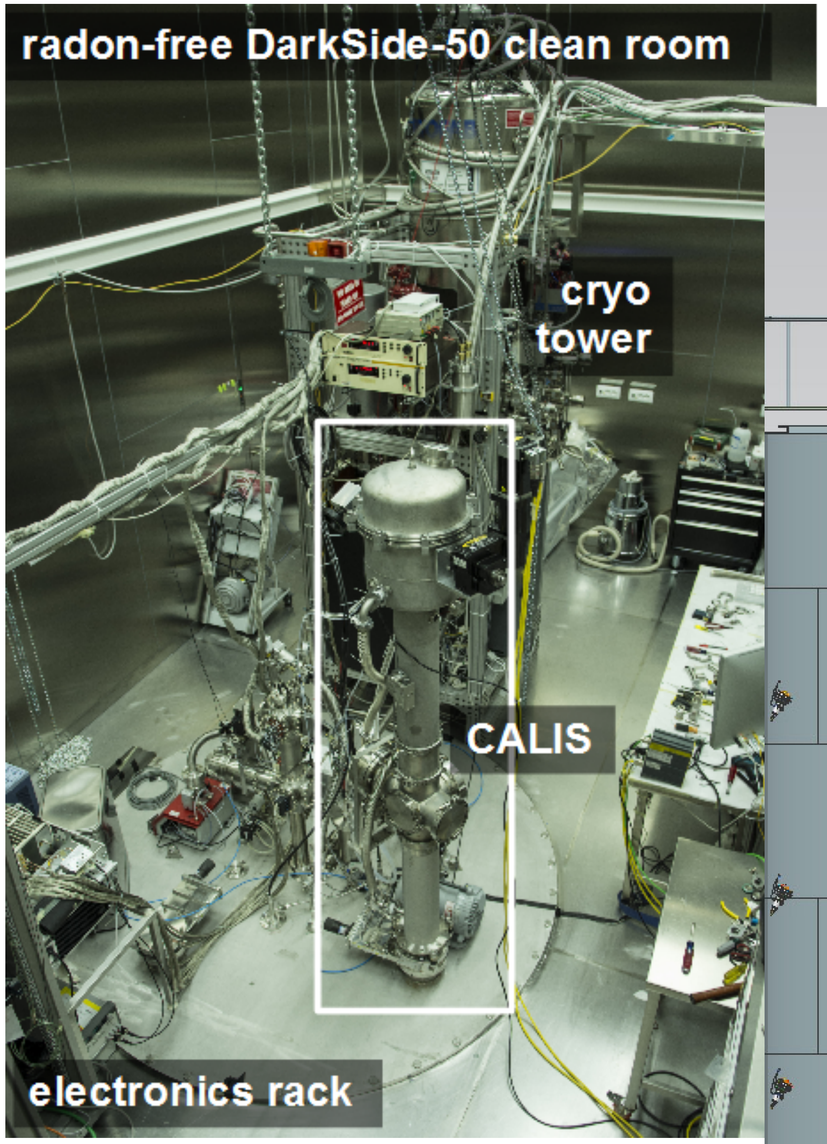
Reconstitution of the Liquid Scintillator

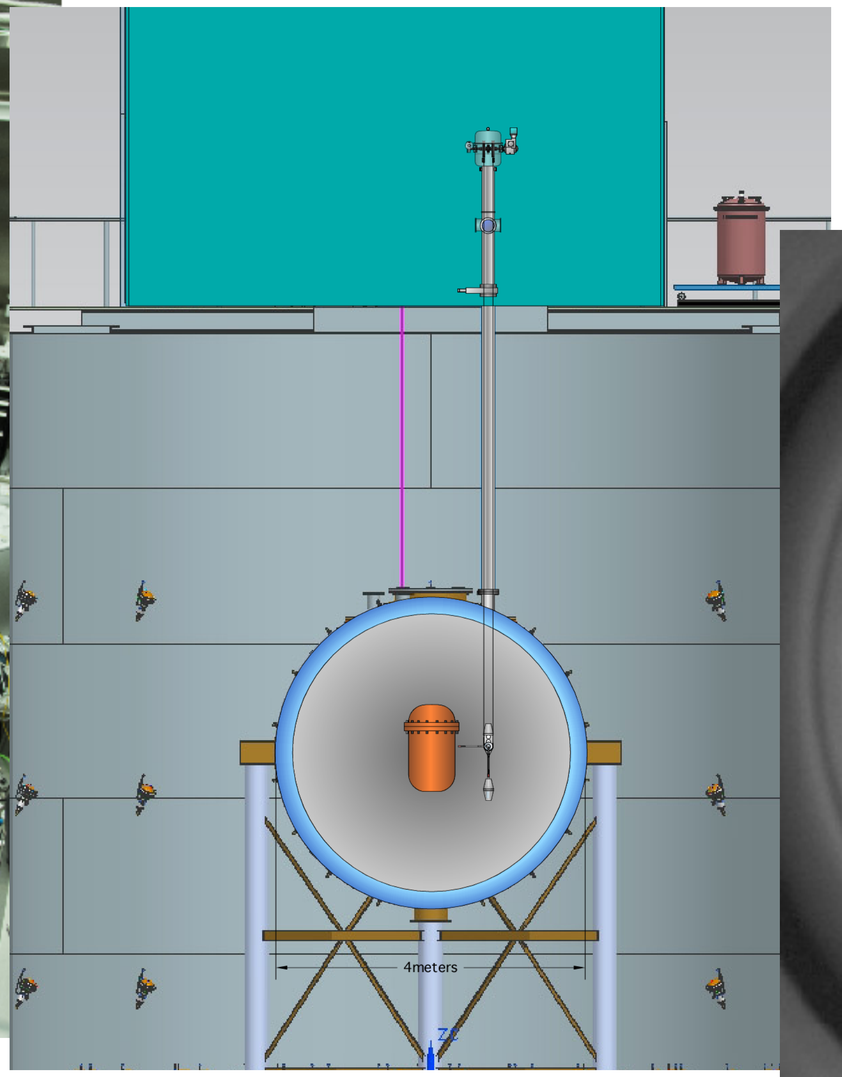
Calibration Measurements with Radioactive Sources

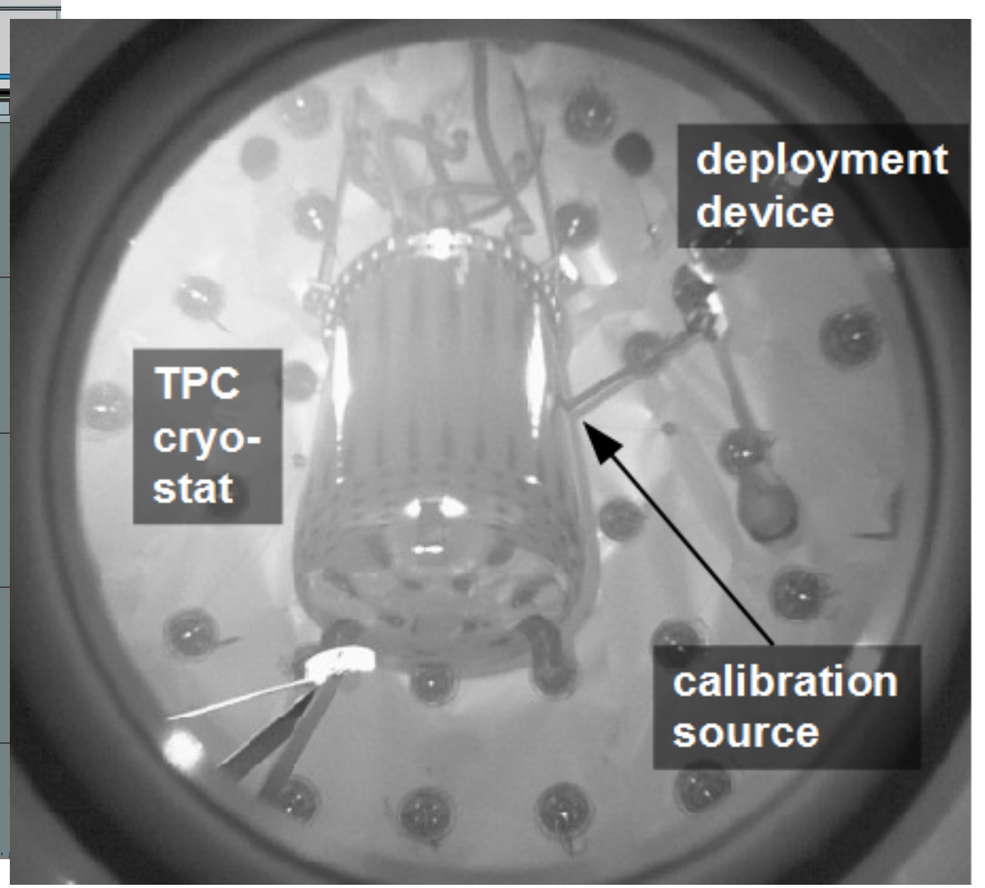
Filling of LAr-TPC with low-^{39}Ar UAr

Full detector system functioning in low background mode appropriate for extended dark matter search

CALIS - CALibration Insertion System







DarkSide-50
Calibration Campaigns

TPC-focused calibration in October-December 2014

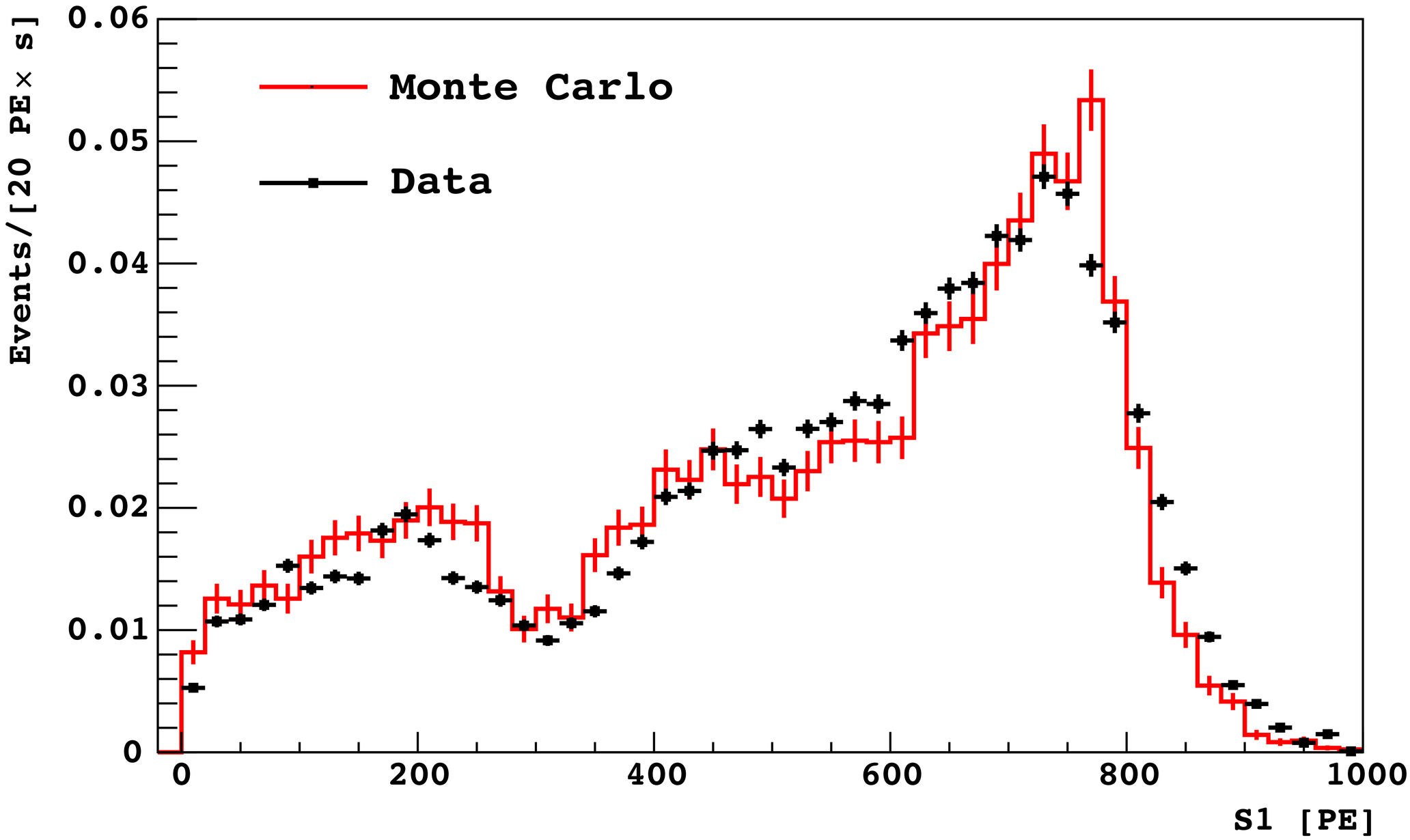
Gamma sources: ^{57}**Co** (122 keV) ^{133}**Ba** (356 keV) ^{137}**Cs** (663 keV)

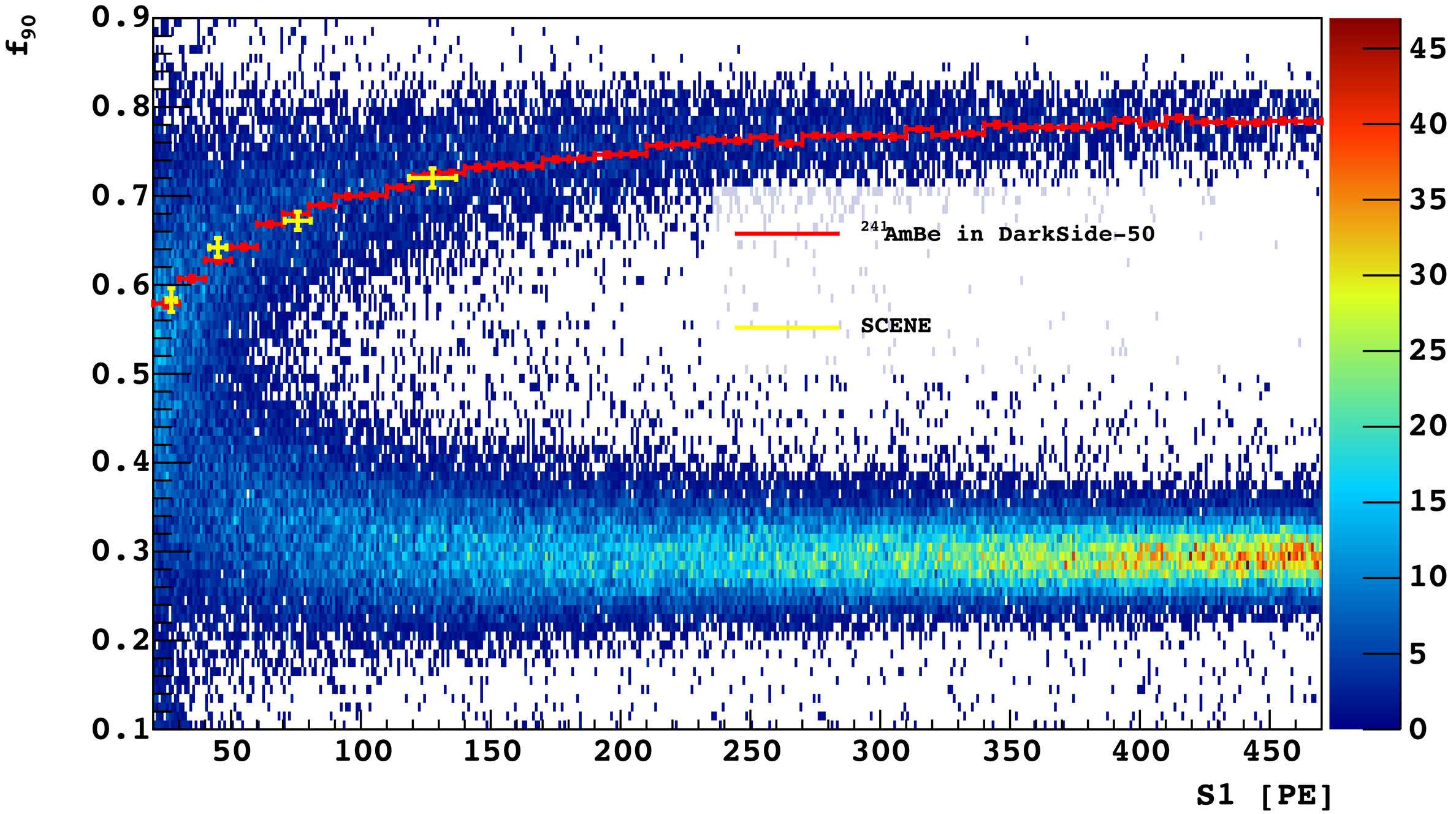
Neutron sources: **Am-Be** with and without collimator

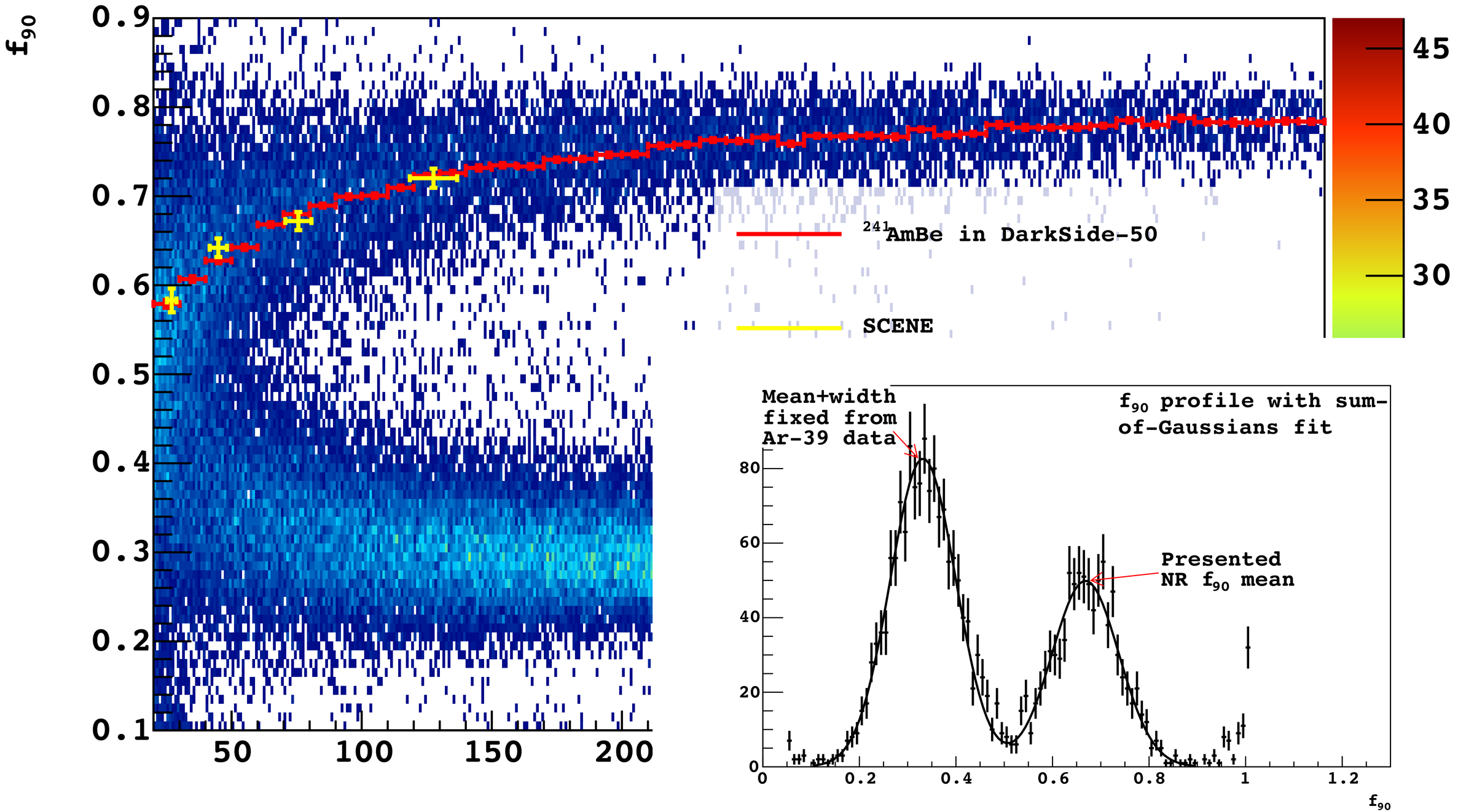
Different **drift fields**: null, 100 V/cm, 150 V/cm, 200 V/cm

Understanding of detector, tuning of Monte Carlo
Agreement between DS-50 and extrapolated SCENE acceptance curves

DATA-MC comparison: ^{57}Co source next to the cryostat




f_{90}
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
50
100
150
200
250
300
350
400
450
S1 [PE]
^{241}AmBe in DarkSide-50
SCENE
45
40
35
30
25
20
15
10
5
0


f_{90}
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
50
100
150
200
45
40
35
30
^{241}AmBe in DarkSide-50
SCENE
Mean+width
fixed from
Ar-39 data
f_{90} profile with sum-
of-Gaussians fit
Presented
NR f_{90} mean
80
60
40
20
0
0
0.2
0.4
0.6
0.8
1
1.2
f_{90}

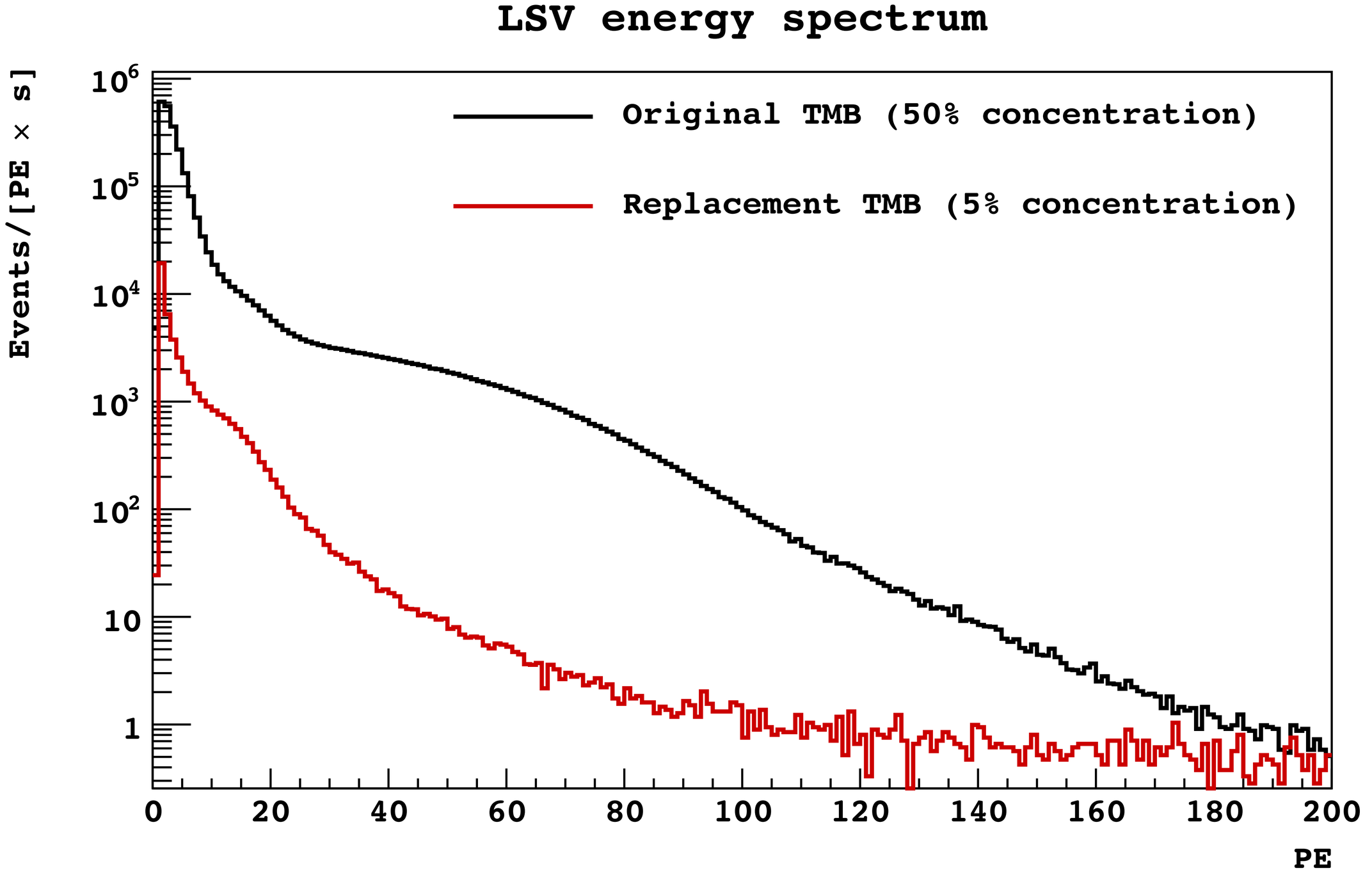
Liquid Scintillator Veto reconstitution

Removing high-^{14}C **TMB** (June, 2014)

Re-distill PC, restore **PPO** (Dec 2014, Feb 2015)

Add radiopure TMB at 5% concentration (Jan 2015)

^{14}C activity decreased from 150 kBq to 0.3 kBq
Much strict neutron veto cuts than in 50-days AAr campaign


LSV energy spectrum
Original TMB (50% concentration)
Replacement TMB (5% concentration)
Events/[PE × s]
10^6
10^5
10^4
10^3
10^2
10
1
0
20
40
60
80
100
120
140
160
180
200
PE

Liquid Scintillator Veto neutron calibration

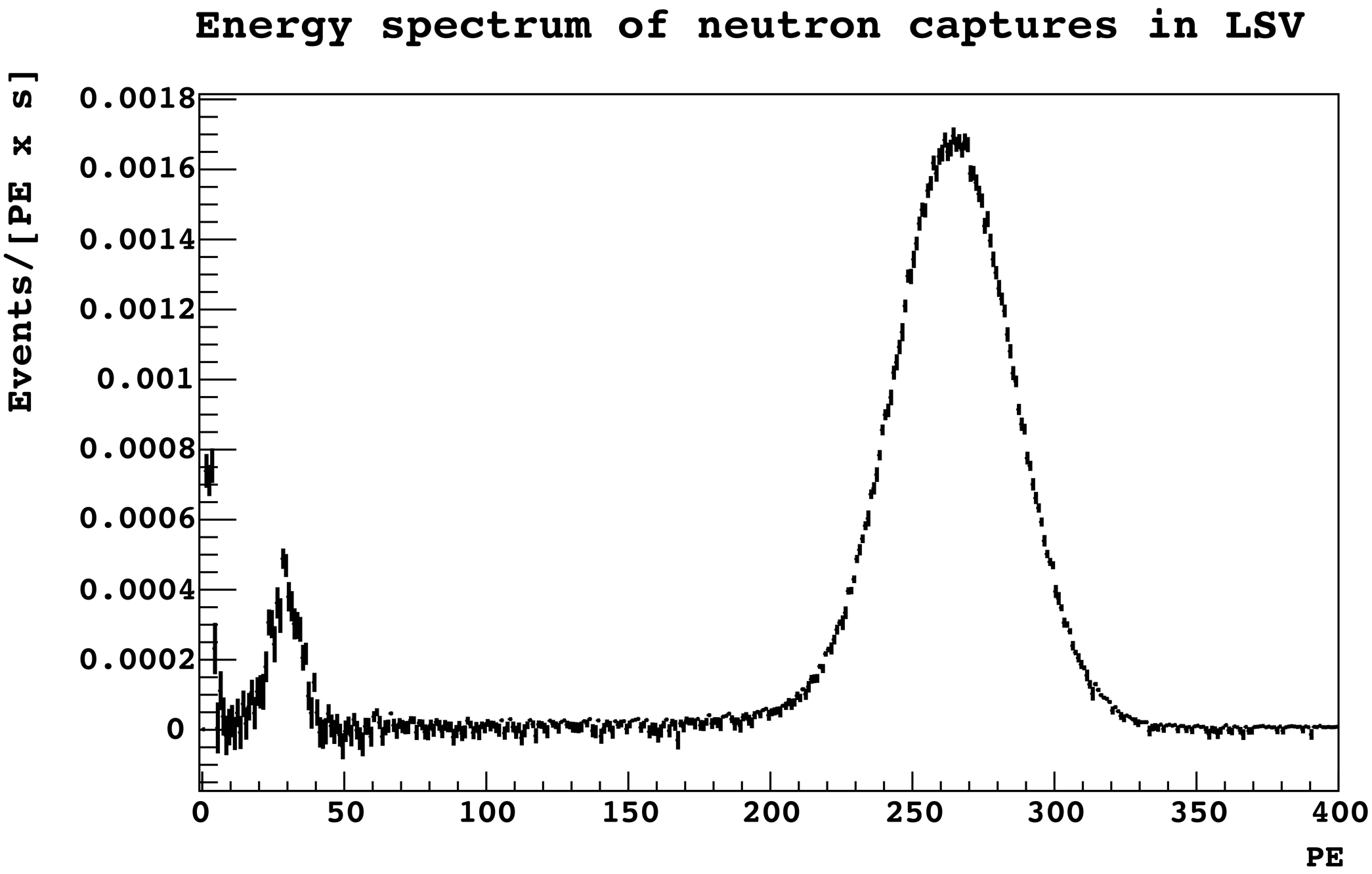
Goal - observe neutron captures on **^{10}B**

^{10}B + n —> ^{7}Li + **α** (*1775 keV*) **6.4%**

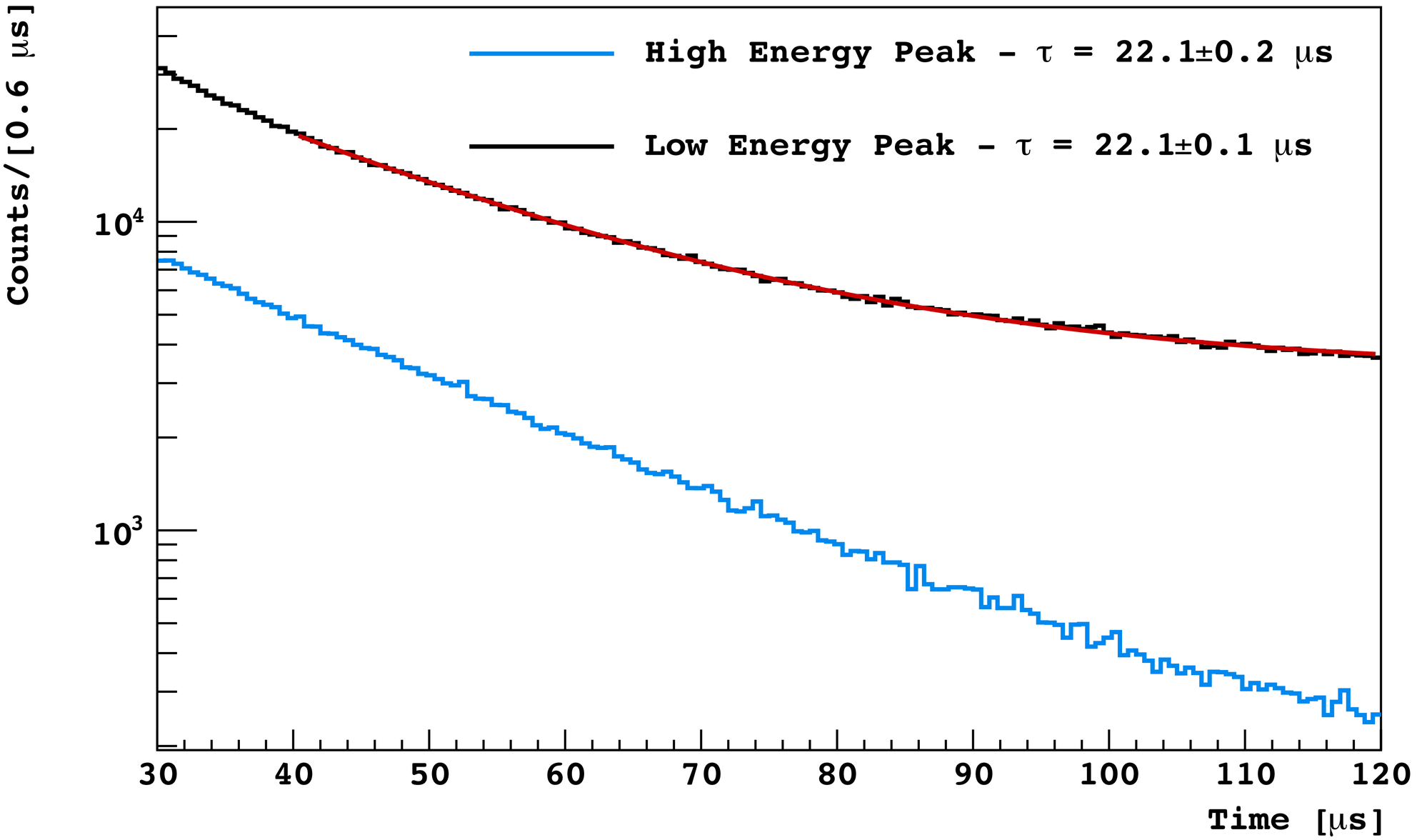
^{10}B + n —> ^{7}Li* + **α**, ^{7}Li* —> ^{7}Li + **γ** (*478 keV*) **93.6%**

Scintillation **quenching** - *1775 keV* **α** equivalent to *50-60 keVee*

Both channels detected
Signals well above LSV detection threshold


Energy spectrum of neutron captures in LSV
Events/[PE x s]
0.0018
0.0016
0.0014
0.0012
0.001
0.0008
0.0006
0.0004
0.0002
0
0
50
100
150
200
250
300
350
400
PE

Time distribution of neutron captures in LSV



Underground Argon

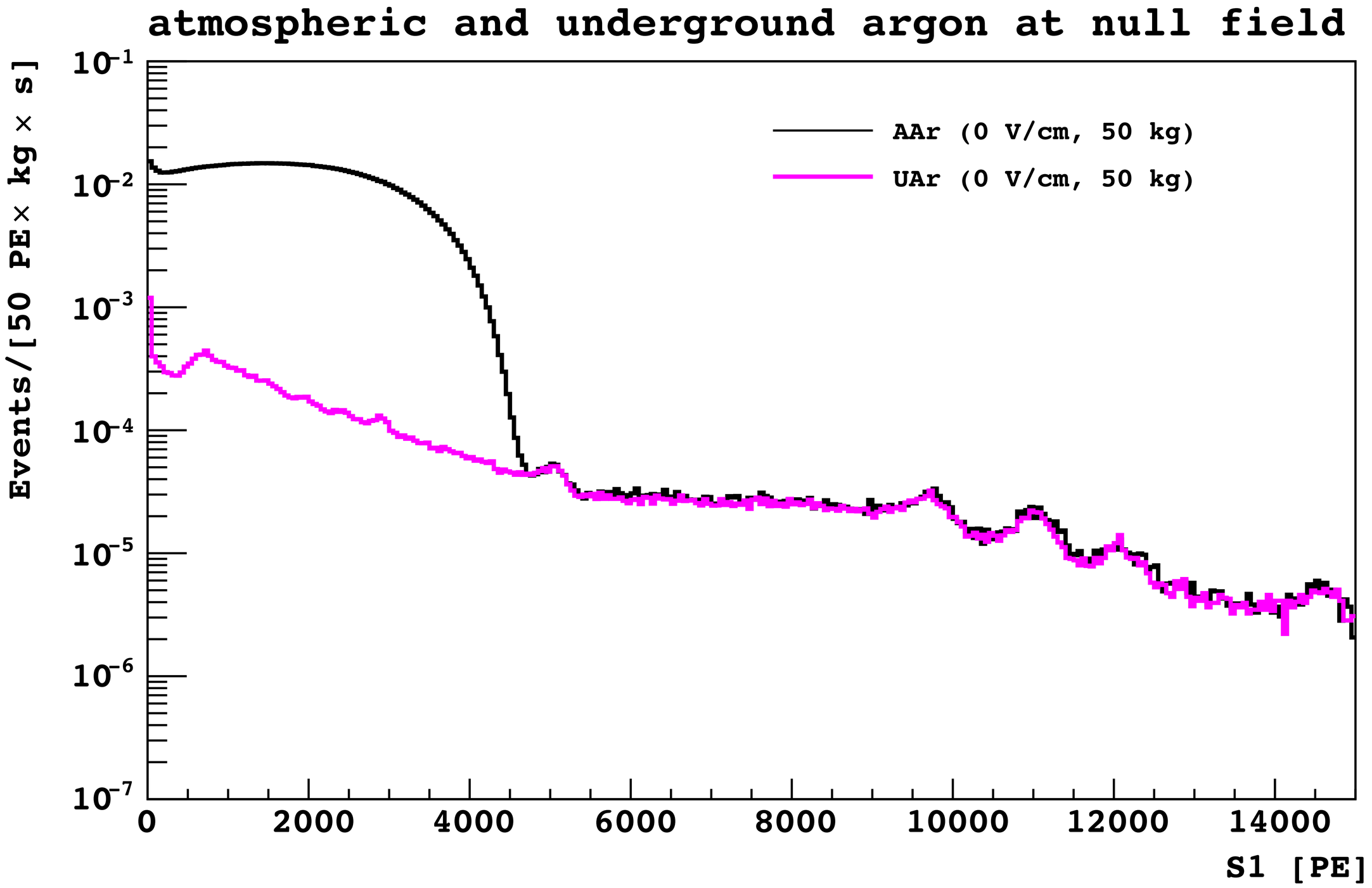
AAr draining (Mar 18 - 22, 2015)

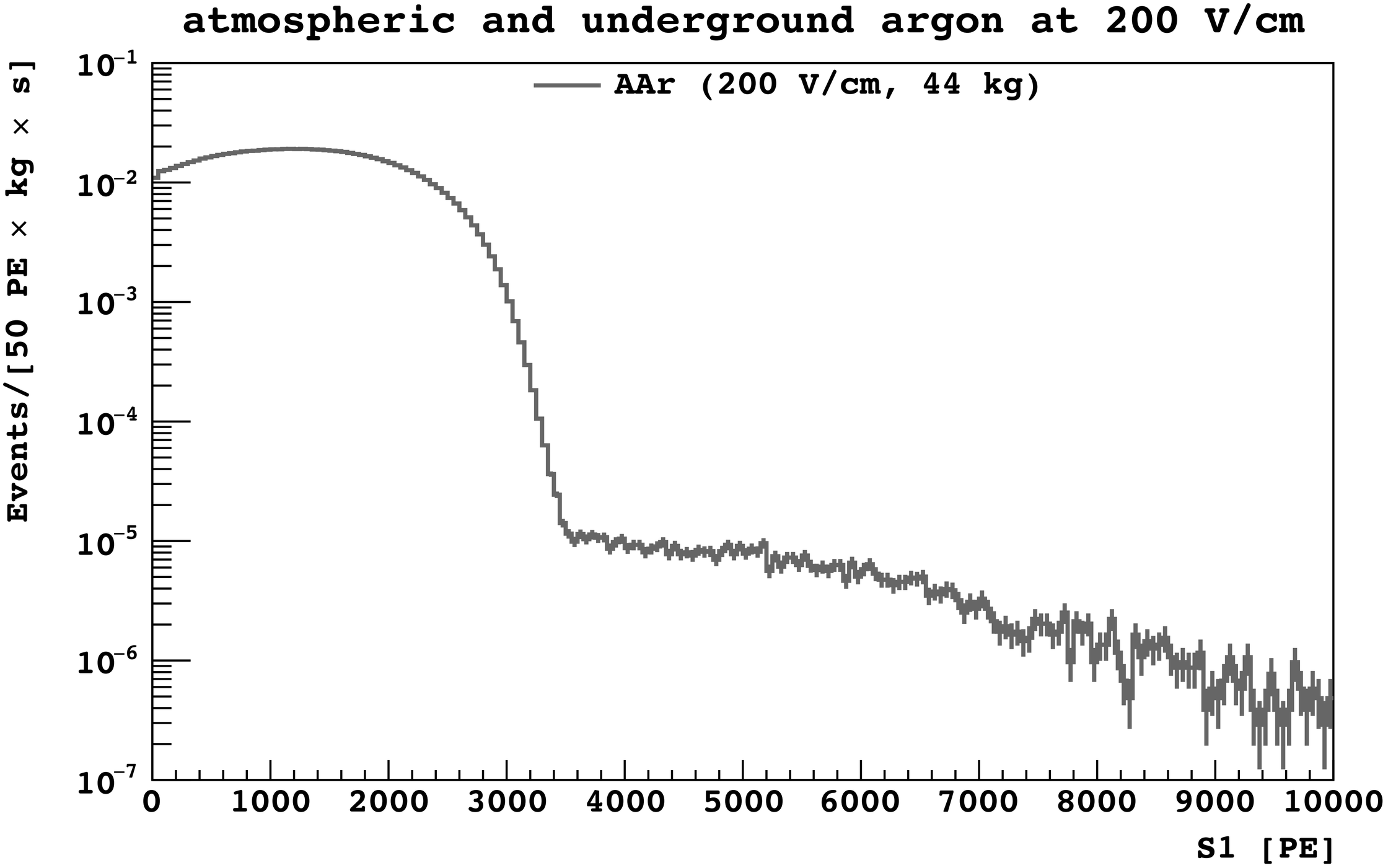
UAr filling (Mar 25 - Apr 1, 2015)

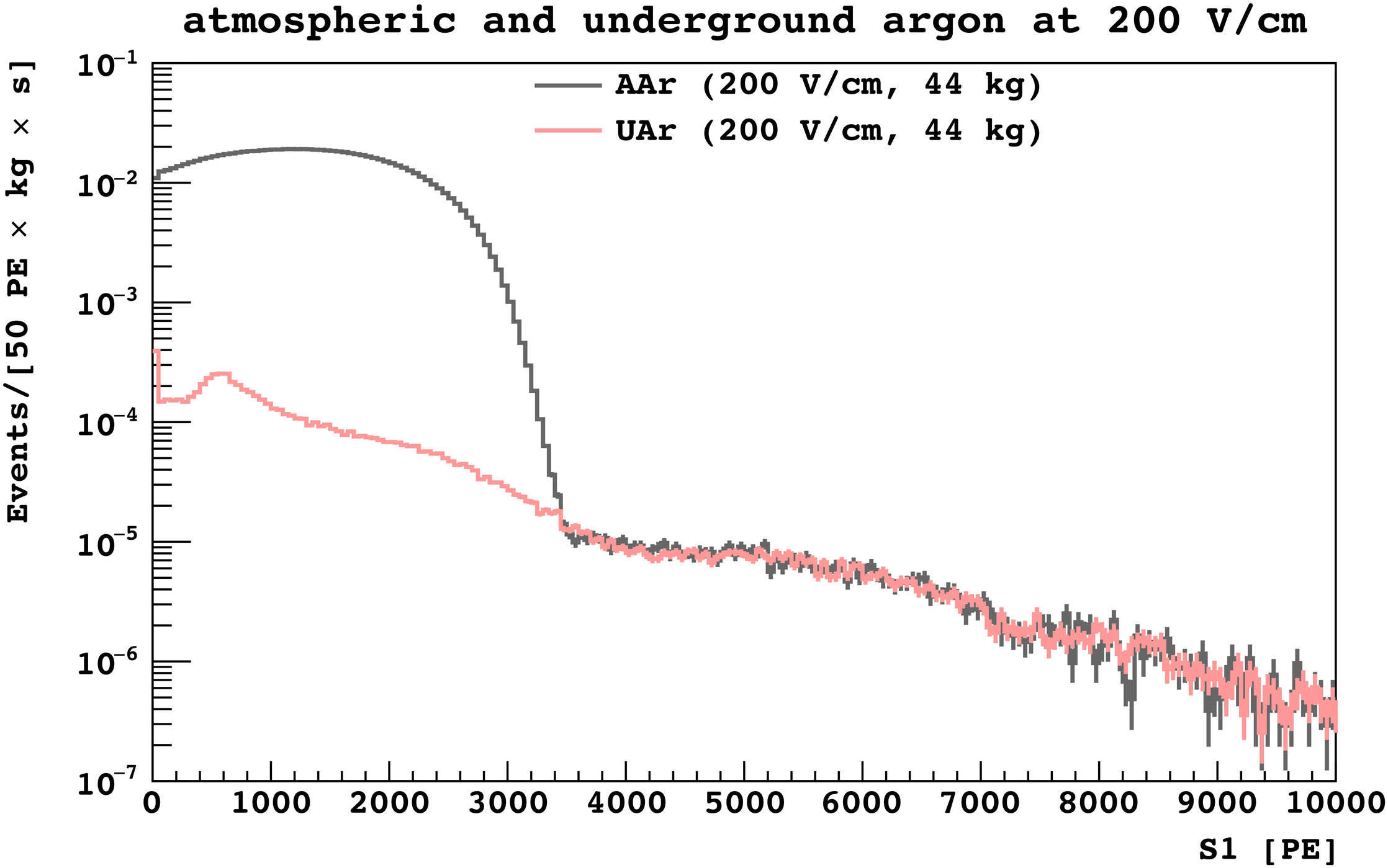
Re-commissioning of the detector: light yield, electron lifetime, **^{39}Ar**

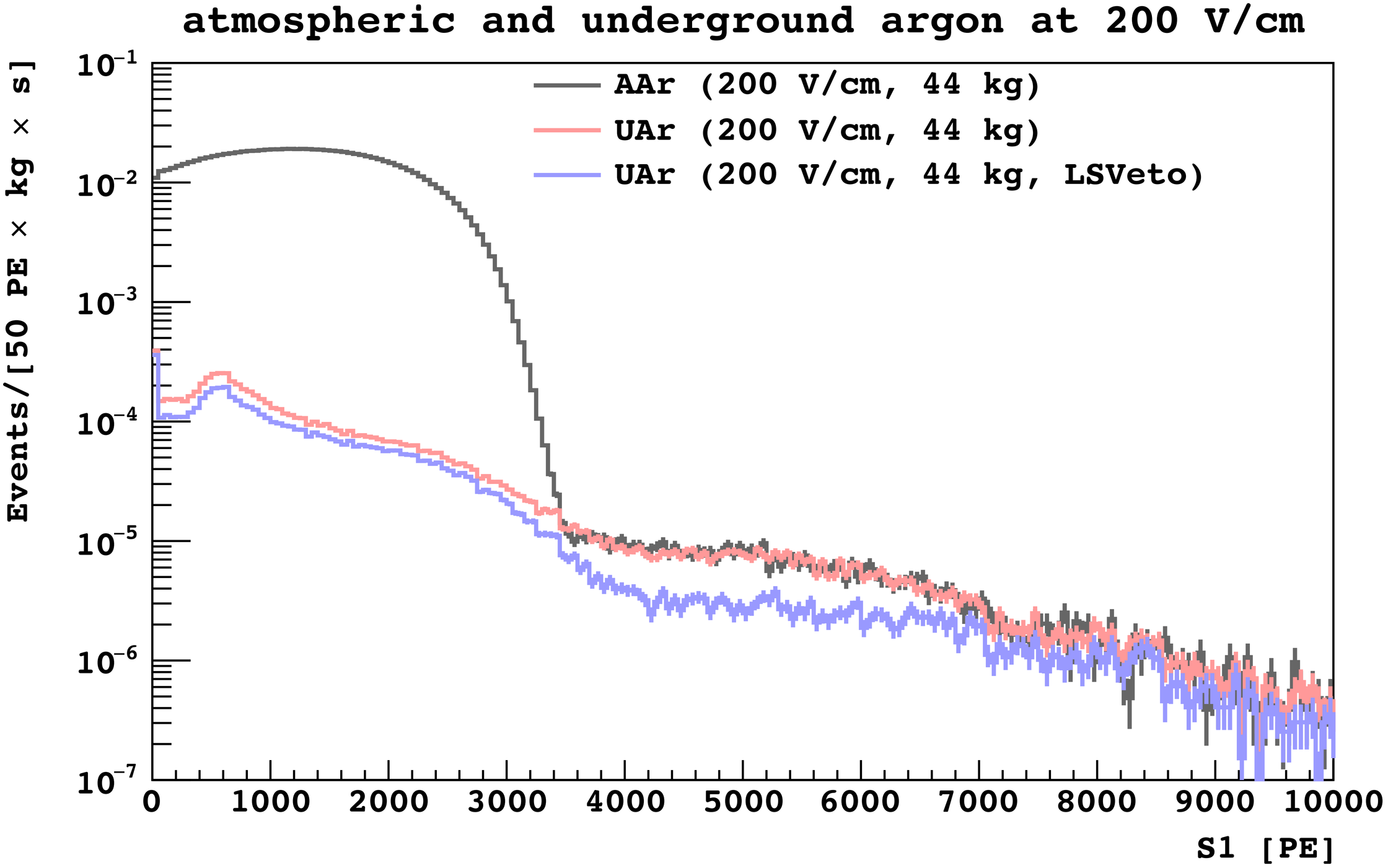
Concentration of ^{39}Ar in UAr at least 300 times lower than in AAr

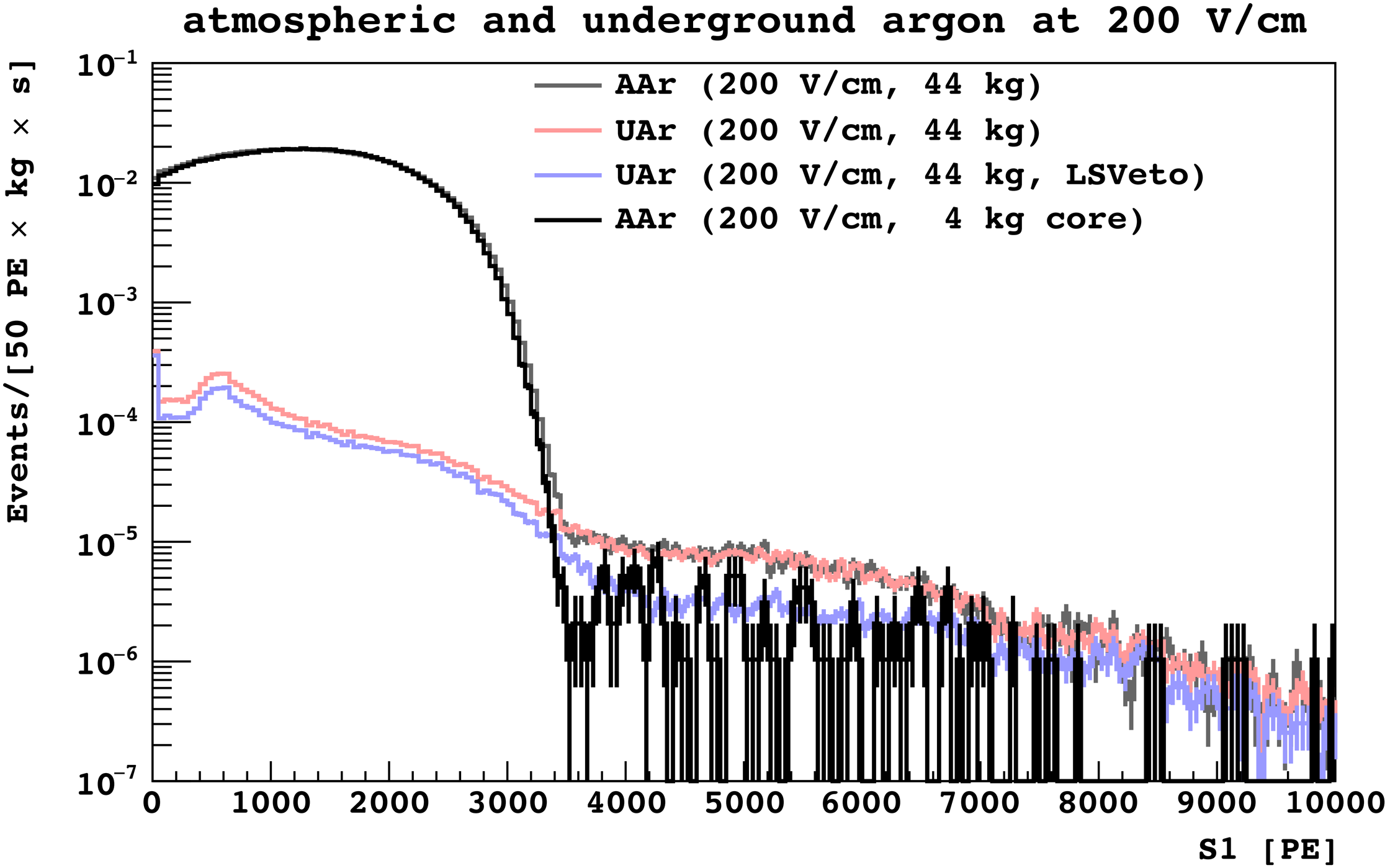
Low level of ^{39}Ar allows extension of Darkside program to ton-scale detector

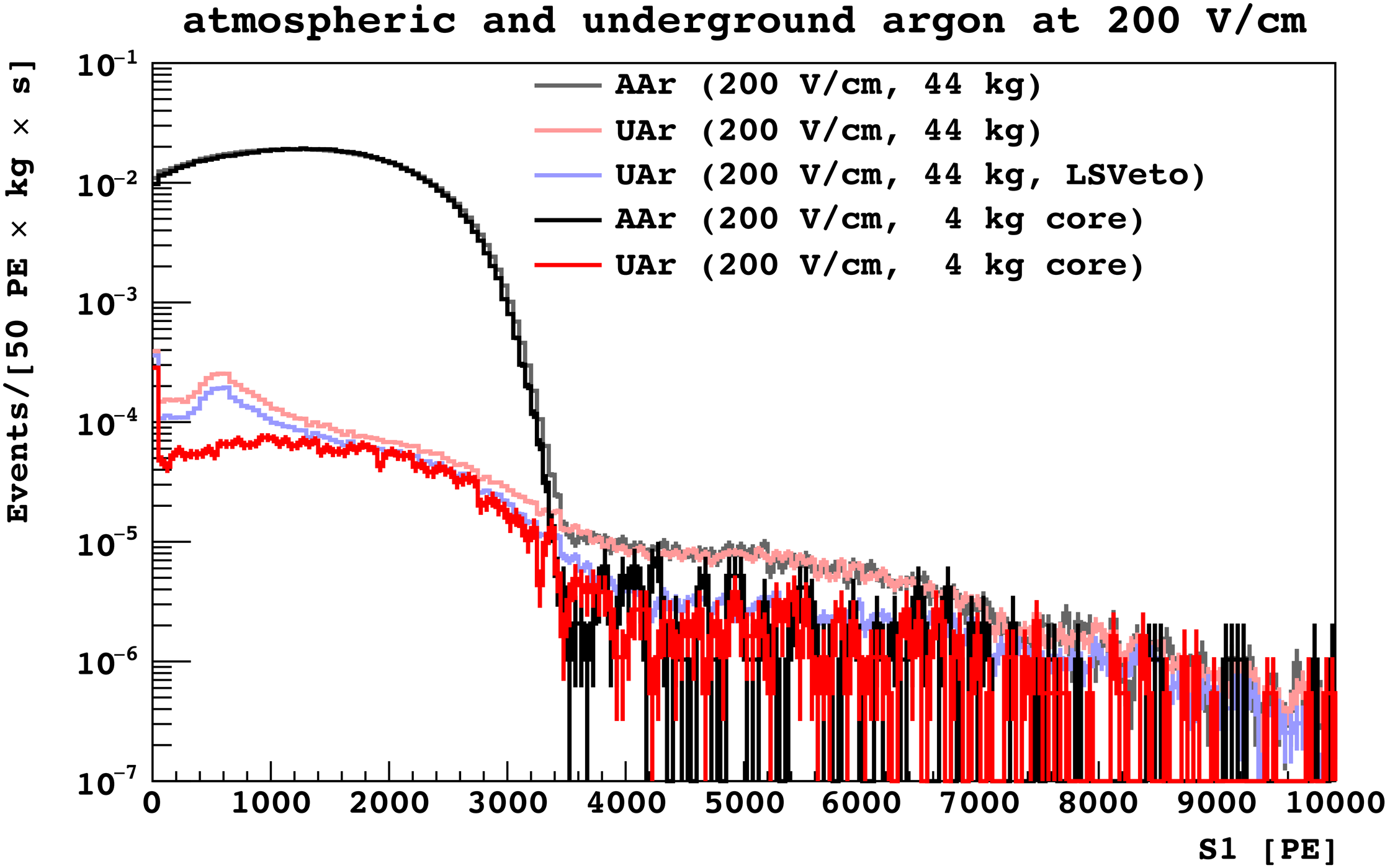

atmospheric and underground argon at null field
AAr (0 V/cm, 50 kg)
UAr (0 V/cm, 50 kg)
Events/[50 PE × kg × s]
S1 [PE]
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
2000
4000
6000
8000
10000
12000
14000

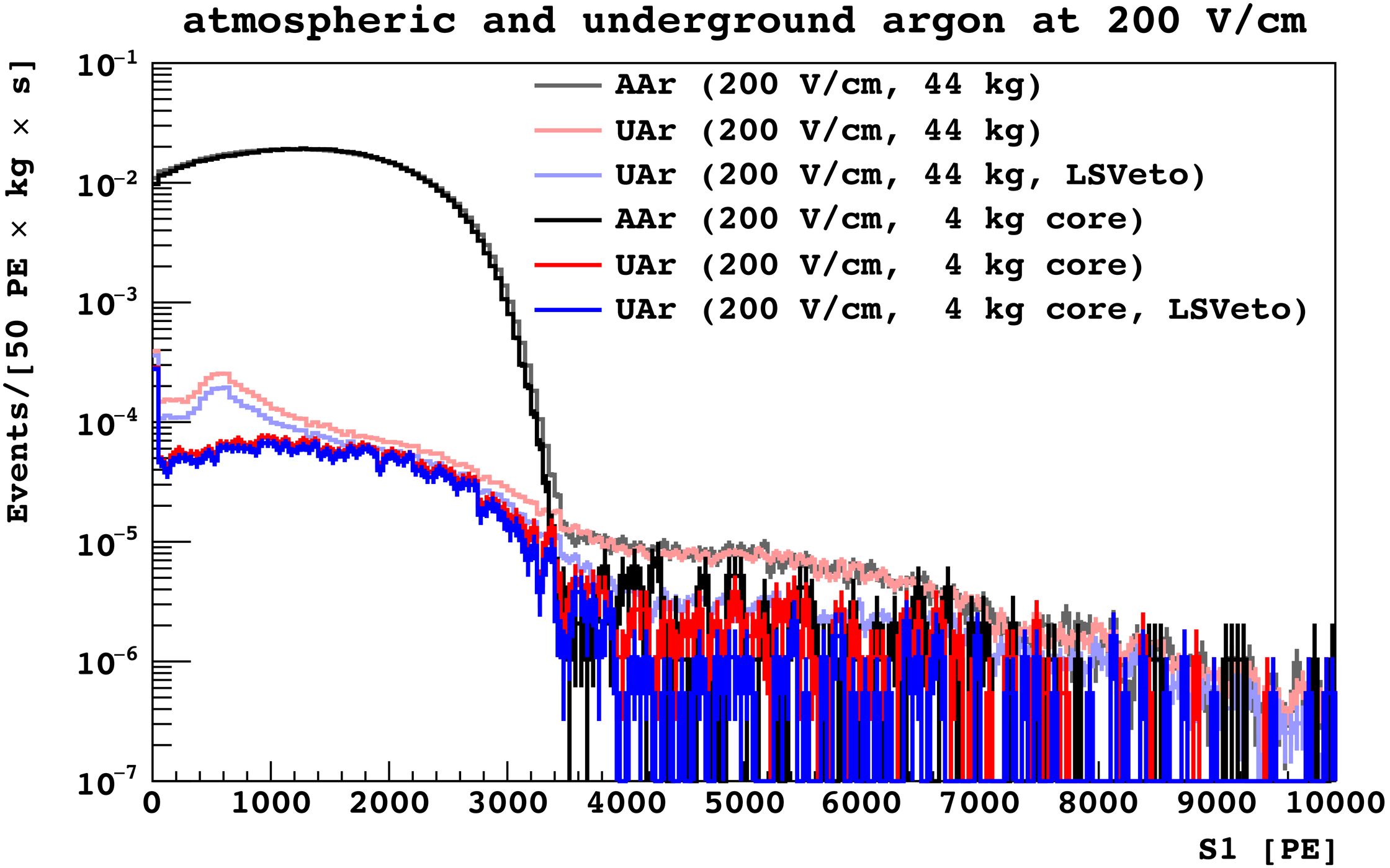

atmospheric and underground argon at 200 V/cm
AAr (200 V/cm, 44 kg)
Events/[50 PE × kg × s]
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
S1 [PE]

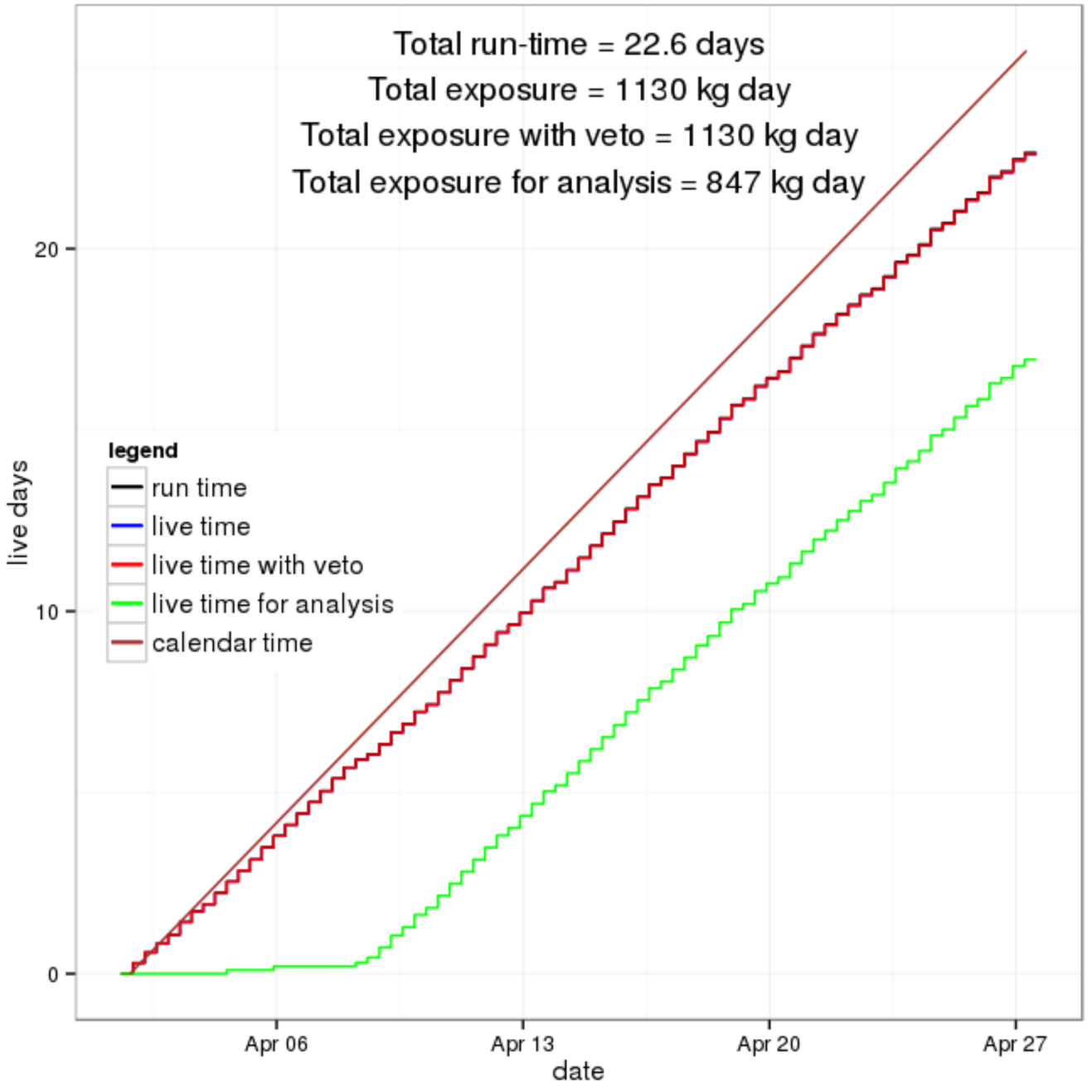

atmospheric and underground argon at 200 V/cm
AAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg)
Events/[50 PE × kg × s]
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
S1 [PE]


atmospheric and underground argon at 200 V/cm
AAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg, LSVeto)
Events/[50 PE × kg × s]
S1 [PE]
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000


atmospheric and underground argon at 200 V/cm
AAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg, LSVeto)
AAr (200 V/cm, 4 kg core)
Events/[50 PE × kg × s]
S1 [PE]
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000


atmospheric and underground argon at 200 V/cm
AAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg, LSVeto)
AAr (200 V/cm, 4 kg core)
UAr (200 V/cm, 4 kg core)
Events/[50 PE × kg × s]
S1 [PE]
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000


atmospheric and underground argon at 200 V/cm
AAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg)
UAr (200 V/cm, 44 kg, LSVeto)
AAr (200 V/cm, 4 kg core)
UAr (200 V/cm, 4 kg core)
UAr (200 V/cm, 4 kg core, LSVeto)
Events/[50 PE × kg × s]
S1 [PE]
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000

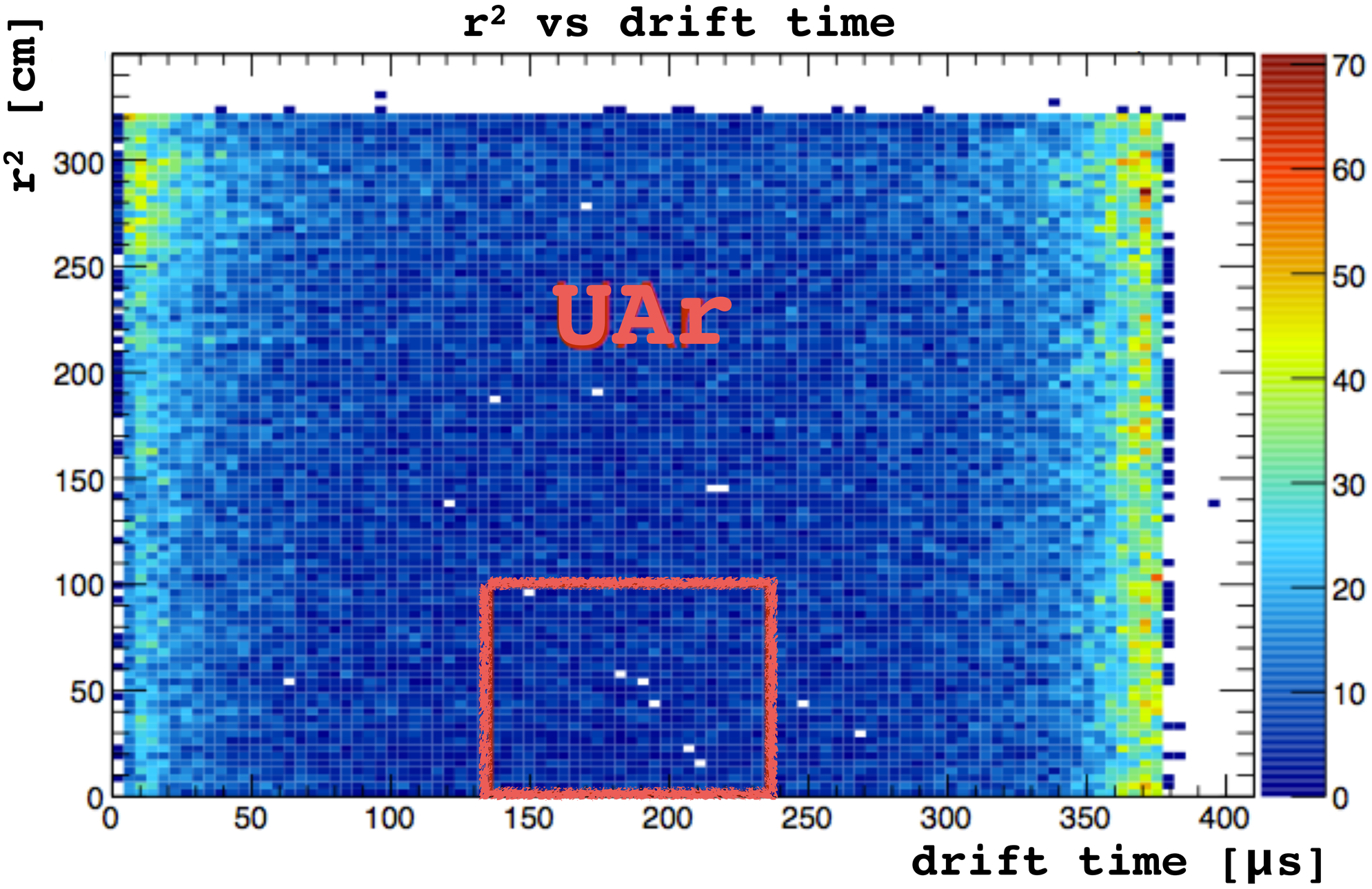

Total run-time = 22.6 days
Total exposure = 1130 kg day
Total exposure with veto = 1130 kg day
Total exposure for analysis = 847 kg day
legend
run time
live time
live time with veto
live time for analysis
calendar time
live days
20
10
0
Apr 06
Apr 13
Apr 20
Apr 27
date

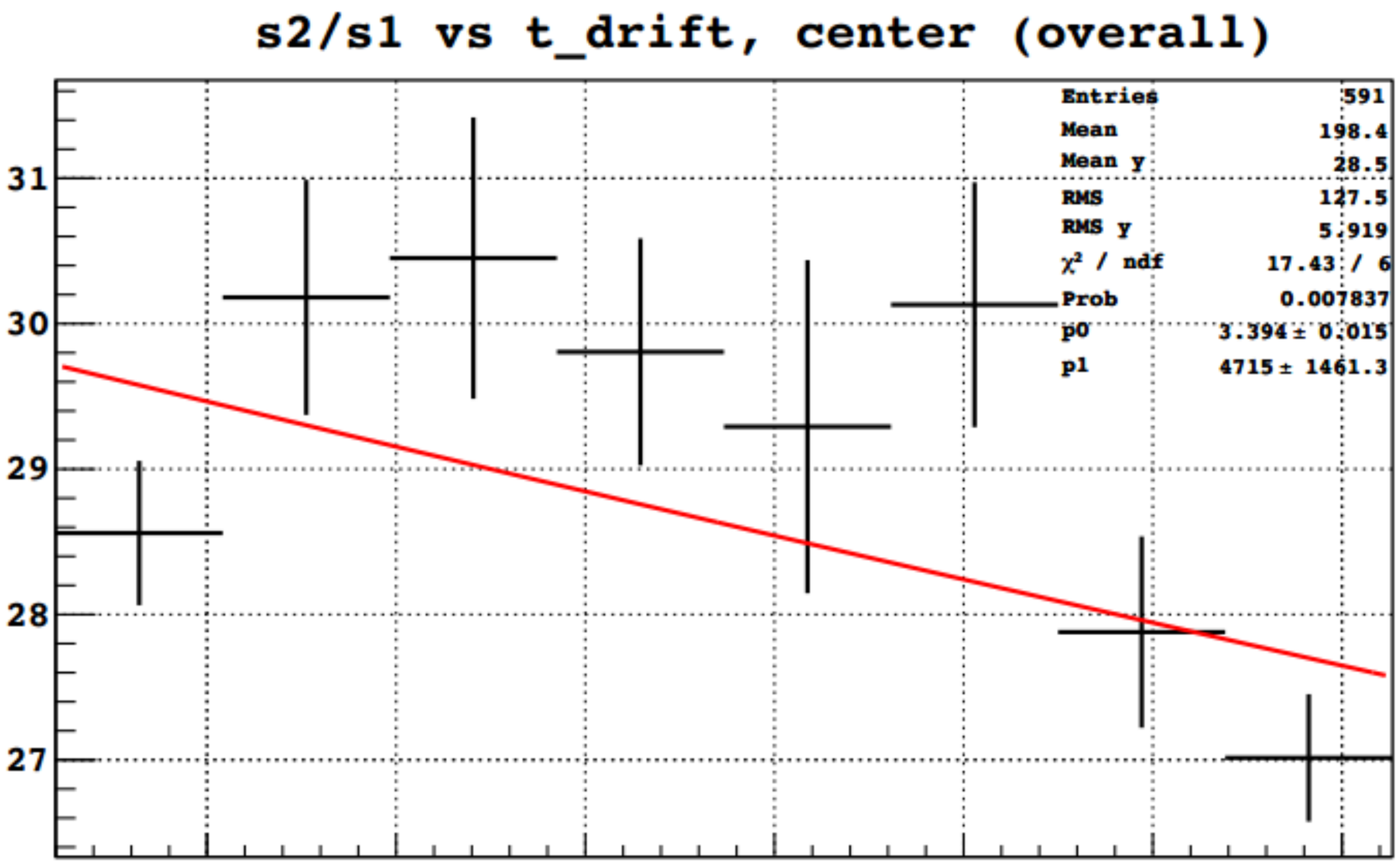
DarkSide-50 status and outlook

- Third best dark matter limit with AAr exposure of 1,422 kg×day
  - Only liquid noble dark matter experiment background-free
  - Rejection better than $1 \div 1.6 \times 10^7$
- **Detector** in **final configuration**
  - Underground argon isotopic depletion **300 or better**
  - TMB problem fixed, veto at design **99.5%** neutron rejection
  - **UAr science run started**

The End

Backup


r² vs drift time
r² [cm]
drift time [μs]
UAr
0
50
100
150
200
250
300
350
400
0
10
20
30
40
50
60
70



electron lifetime > 4 ms