A first walk on the DarkSide

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DarkSide Strategy

Screening and selection of detector materials

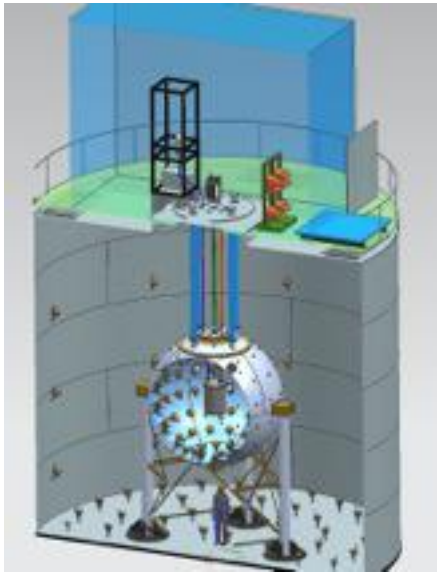
Two-Phase Ar TPC

Underground argon (UAr) with reduced (> 150) ^{39}Ar

Active Neutron veto based on a boron-loaded liquid scintillator detector

Large Shield: Water Cherenkov Detector (muon veto)

LNGS: Deep Underground site to shield Cosmic Rays



11m x 10m Water tank

2-Phase TPC

4m diameter spherical n-veto

Two-Phase Argon Time Projection Chamber
Detect **scintillation** (*S1*) and
ionization (*S2*)

Discriminates nuclear recoils (NR) vs
electron recoil (ER) background
using

Pulse **S**hape **D**iscrimination
Ratio of ionization/scintillation
3D reconstruction

Low-Radioactivity Underground Argon (UAr)
<6.5 mBq/kg of 39Ar
<1/154 of atmospheric argon (AAr)

Neutron Veto

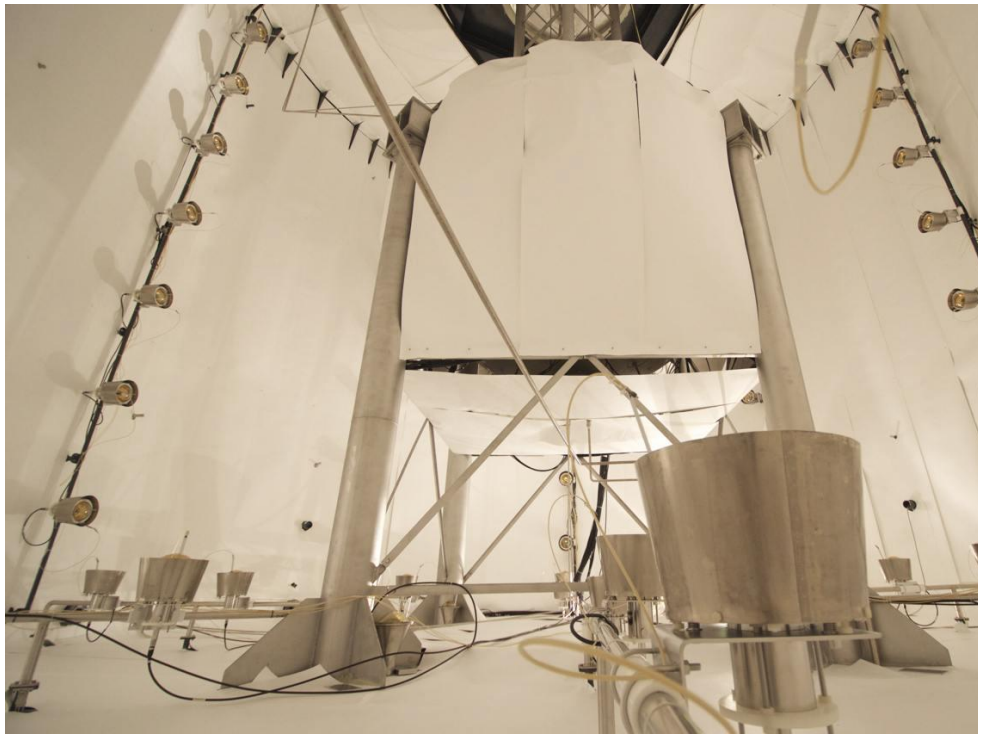
Boron-loaded
organic **Liquid Scintillator** detector

30 tons: 50% PC and 50% TMB
Readout by 110 PMTs

Passive **shield** against neutrons and gammas

Efficient **tagging of neutrons** via n-capture:
gamma + alpha (94%) and alpha (6%)

Designed to host DS-50 and DS-G2



Water Cherenkov Muon detector

1000 tonnes of pure water
Readout by 80 PMTs

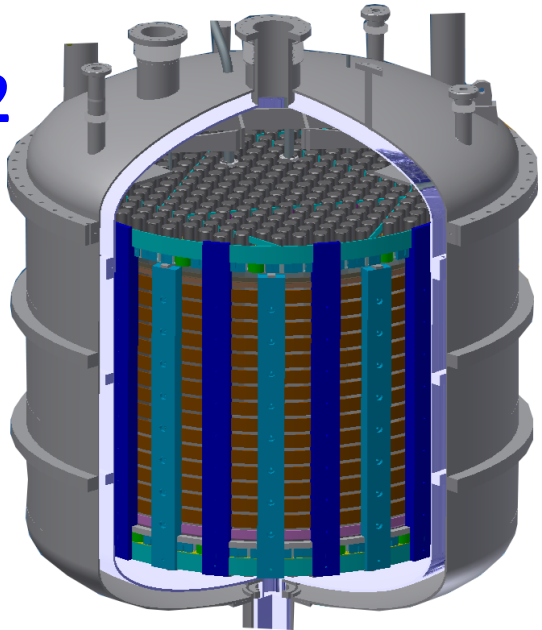
Passive **shield**
against neutrons and gammas

Detects **muons**
to **tag cosmogenic backgrounds**

Designed to host DS-50 and DS-G2

The Staged DarkSide Projects @ LNGS

DS G2



DarkSide-10 (2010-2012) Prototype

DarkSide-50 (2013-2016) G1 detector
sensitivity 10^{-45}cm^2

DarkSide-G2 (from 2016) 5 tons
sensitivity 10^{-47}cm^2

and **Beyond …**

Status and Program

Ongoing dark matter search
with **atmospheric Argon**
*Soon to be released: 2000 kg * day exposure*

^{39}Ar statistics equivalent to
23 years of DarkSide-50 with UAr
0.3 years of DarkSide-G2 with Uar

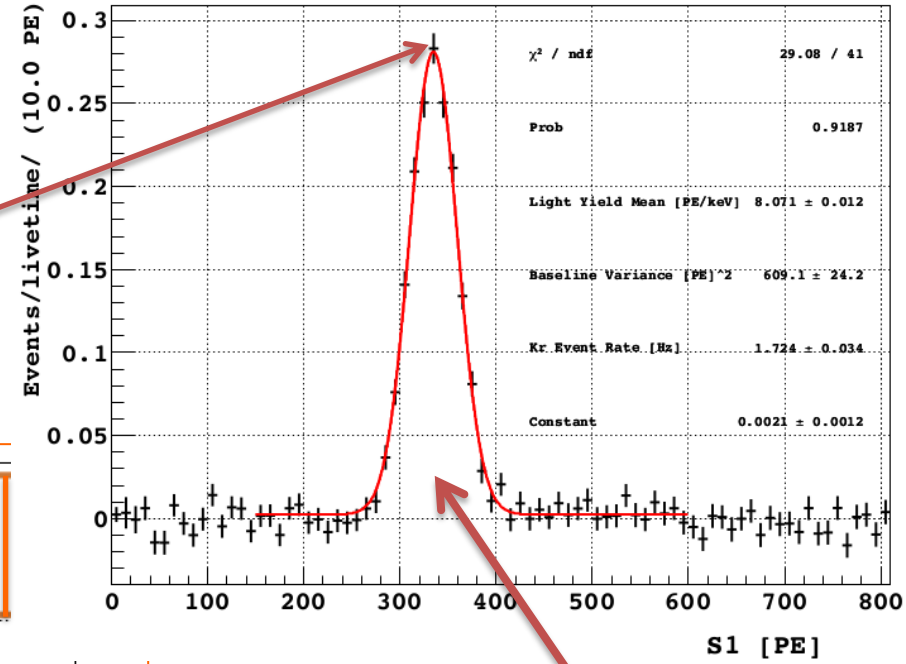
Spike with ^{39}Ar foreseen in 2013
Goal to collect 39Ar statistics equivalent to
few year of DarkSide-G2 with Uar

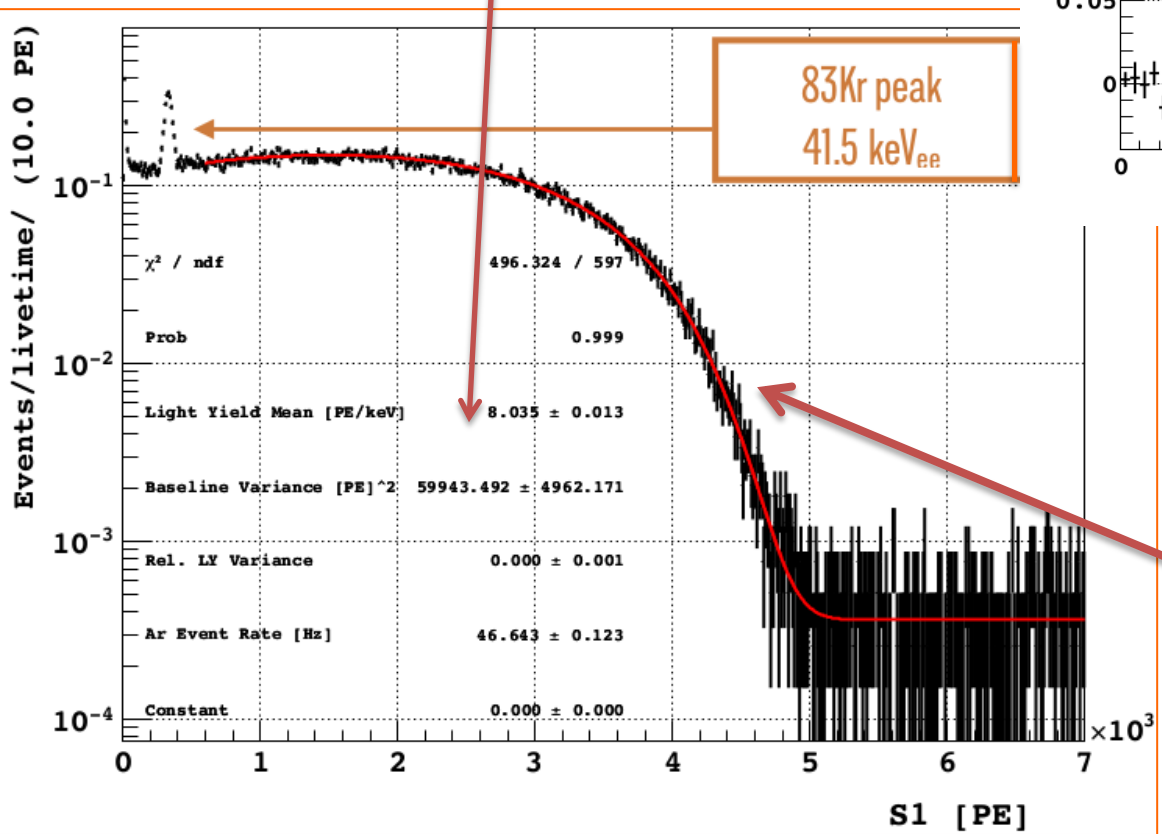
DarkSide-50 **TPC calibration** foreseen in Summer 2013
Deployment of new source manipulator
Use of gamma and neutron sources

Switch to Underground Argon foreseen at end of 2013

ER Light yield at null field

Light Yield ~ *8 PE/keV$_{ee}$*
at **null field**



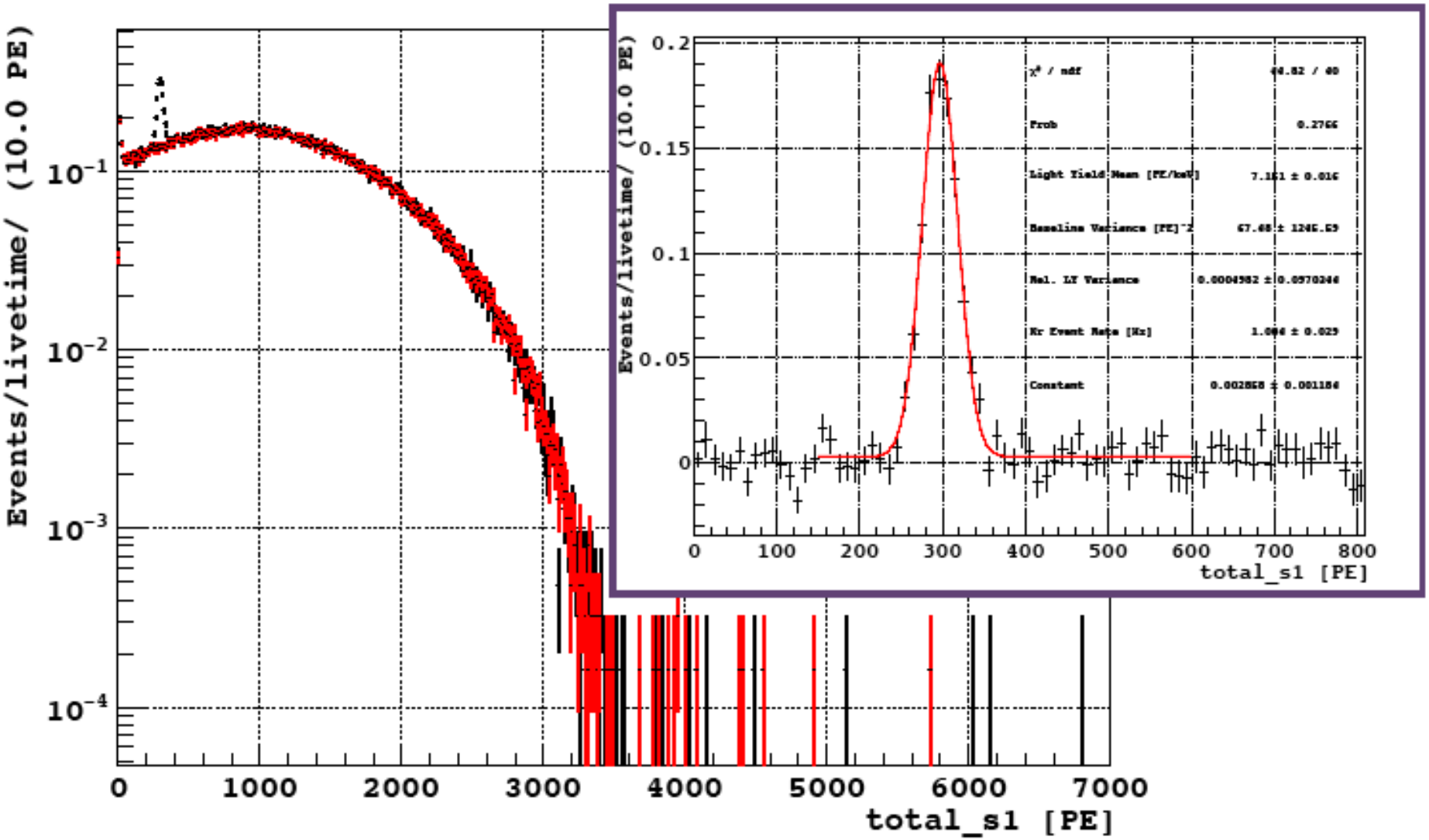


83Kr peak
41.5 keV$_{ee}$

^{83m}**Kr** peak
41.5 keV, $T_{1/2}$=1.83h

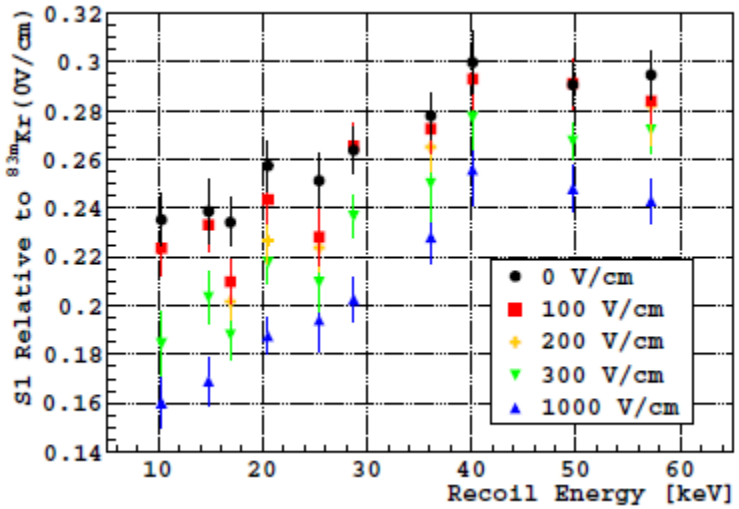
^{39}Ar spectrum
565 keV end
point

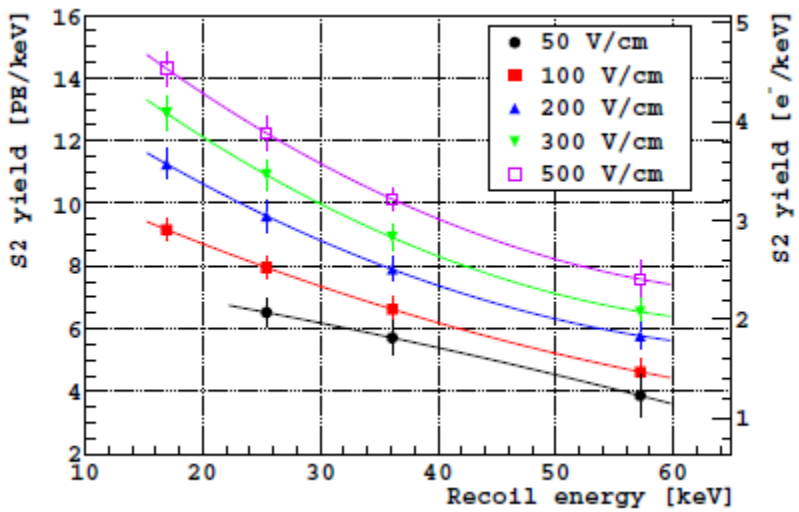
ER Light Yield at 200 V/cm



7 PE/keV$_{ee}$ at **200 V/cm**

NR calibration at 200 V/cm





SCENE

SCintillation **E**fficiency of **N**oble **E**lements

Study **response** of Ar TPC to **single nuclear recoils**

SCENE collected samples of single nuclear recoils in a **small TPC resembling DS-50 one**

Extrapolated quantities of interest to present analysis, **evaluated systematics**

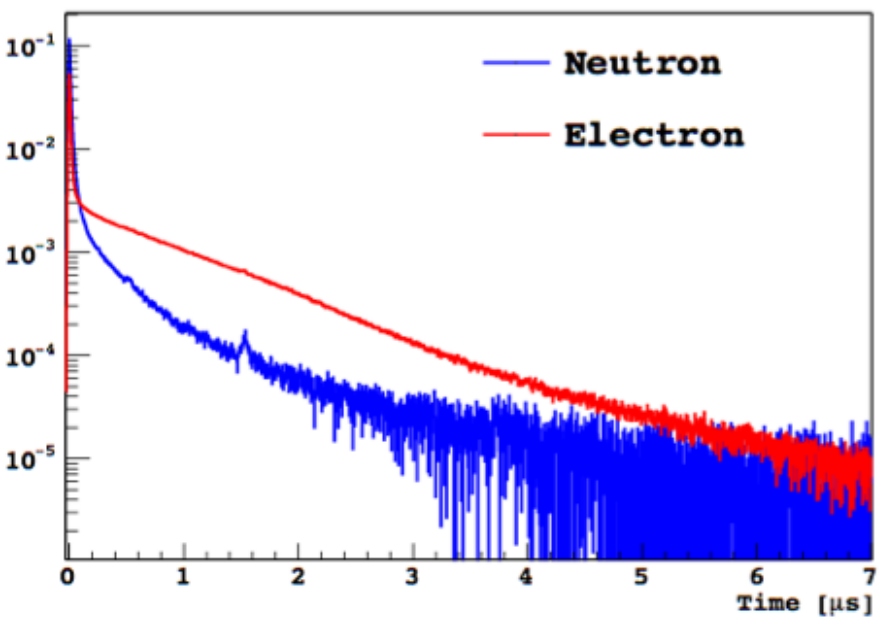
SCENE new results *1406.4825*

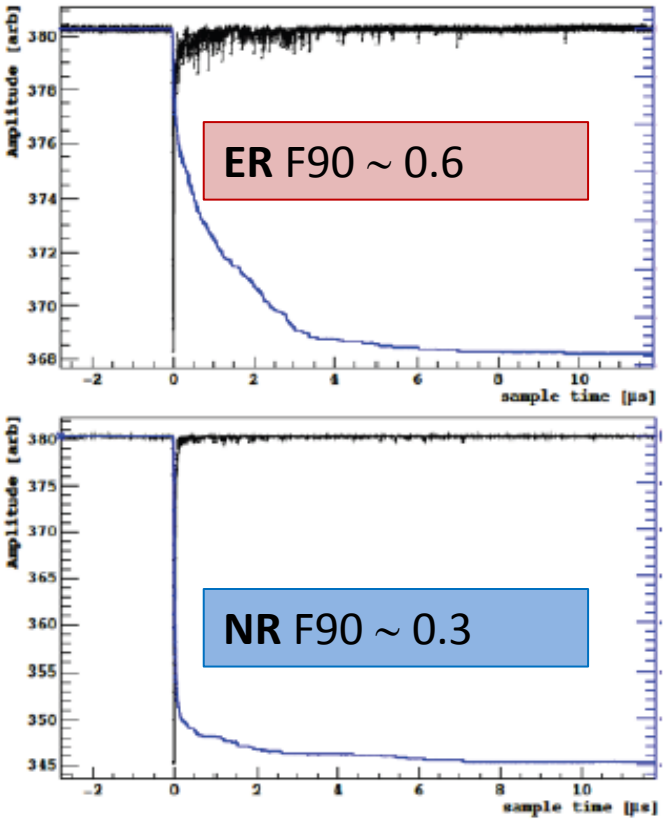
Pulse Shape Discrimination: F90

Scintillation in Argon through formation of Ar_2* dimers *can be formed as singlet (6 ns) or triplet (1.5 μs)*

F90: fraction of S1 *in first 90 ns*

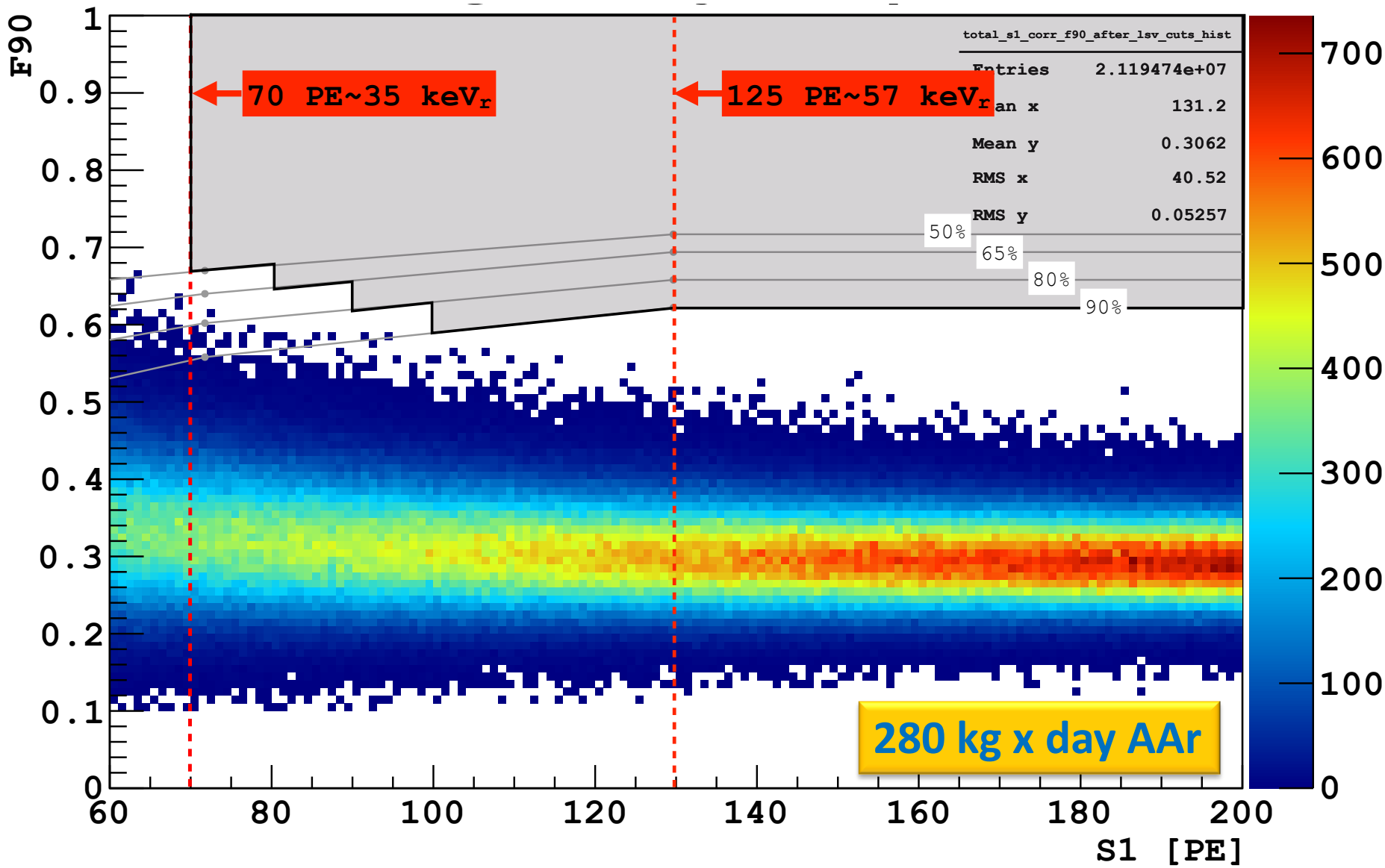
Ratio of singlet and triplet correlated with ionization density *function of energy, particle and field*





Pulse Shape F90 vs S1

3x10^7 events. Z-cut (drift time) only, no x-y, no S2/S1

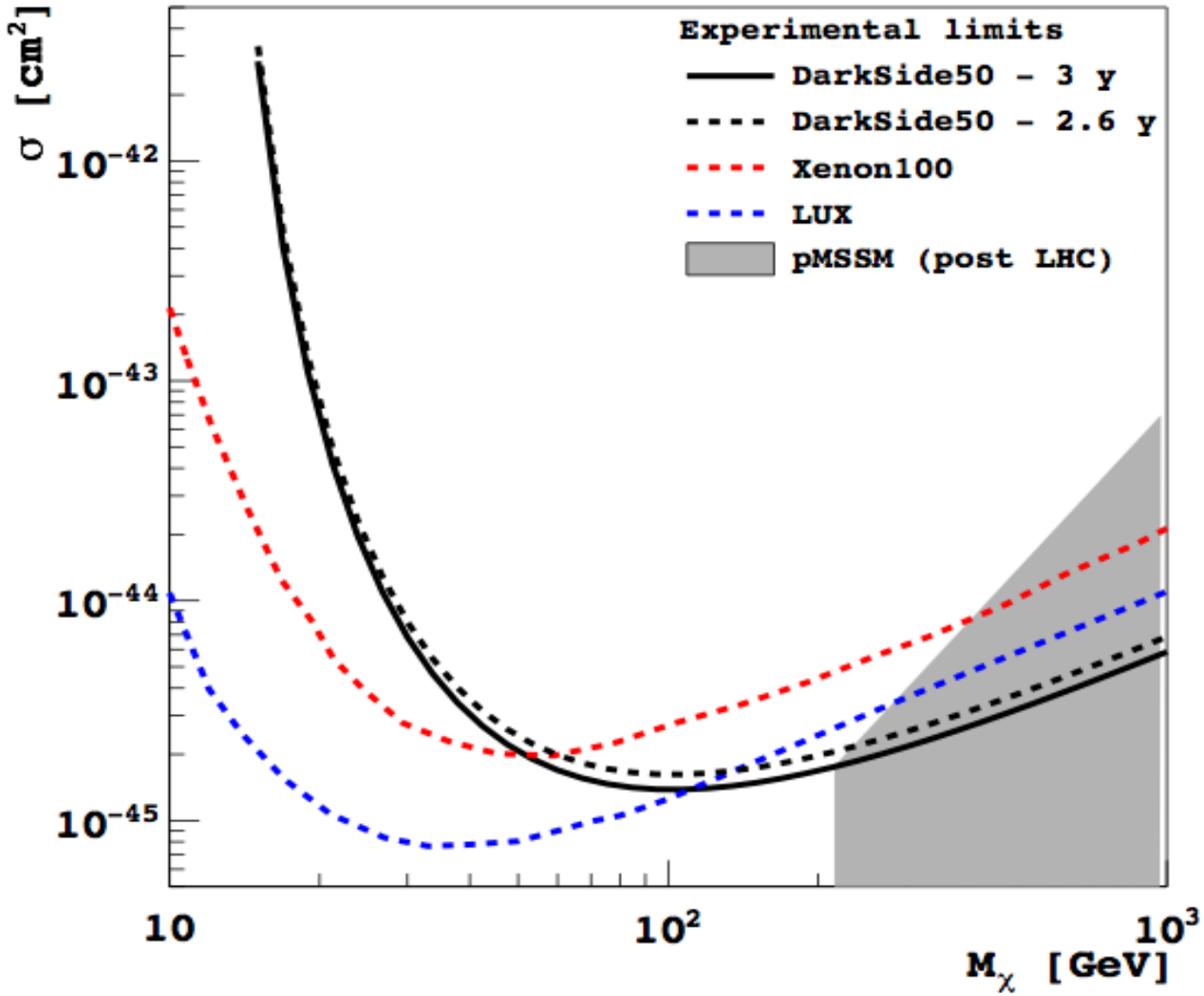


DS-50 Expected Sensitivity with Underground Argon

Threshold 35 keVr
Fiducial 44.1 kg

Z-cut only
no x-y
no S2/S1

Using F90 curves measured from SCENE @200 V/cm



Conclusions and Outlook

DS-50 detector is running @ LNGS since Oct 2013

LAr TPC successfully **commissioned**
Neutron and **Muon Vetoes** successfully **commissioned**

Ongoing distillation to separate PC from TMB
Plan to use new TMB with low ^{14}C content

Collected **^{39}Ar statistics** equivalent to
(at present upper limit) 23 years of DS-50 with UAr
results will be released soon

Plan to **calibrate** DS-50 and to further study PSD until
End of 2013 when we will **switch to UAr**
and to **WIMP search** mode

The DarkSide Collaboration

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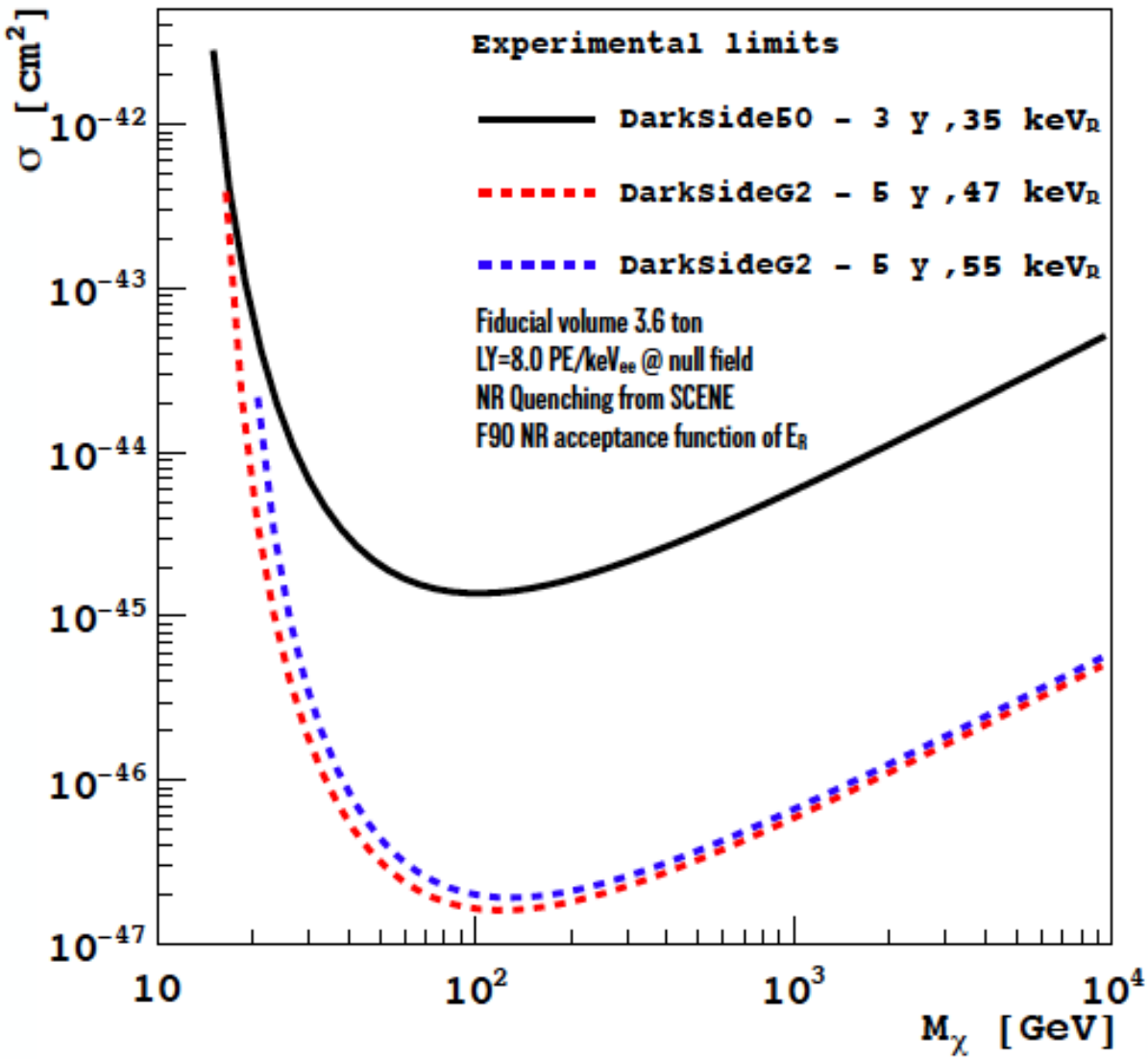
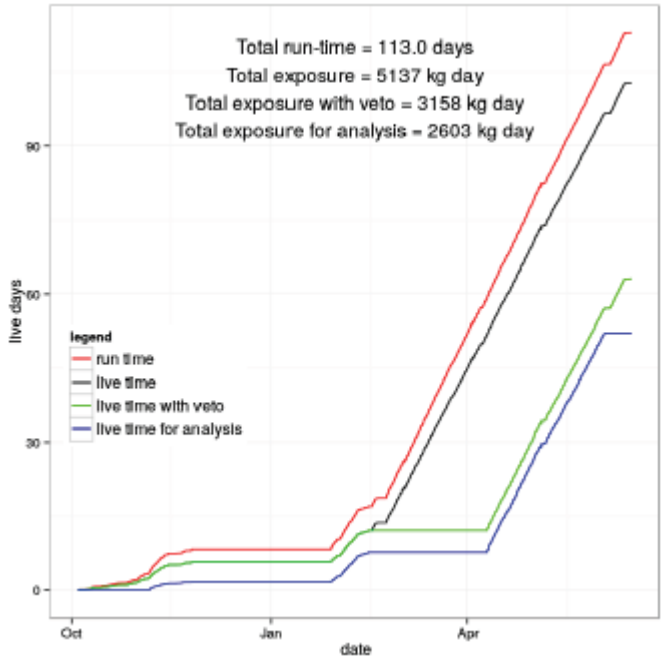
Backup: DS-G2 expected sensitivity



Backup: DS-50 run time