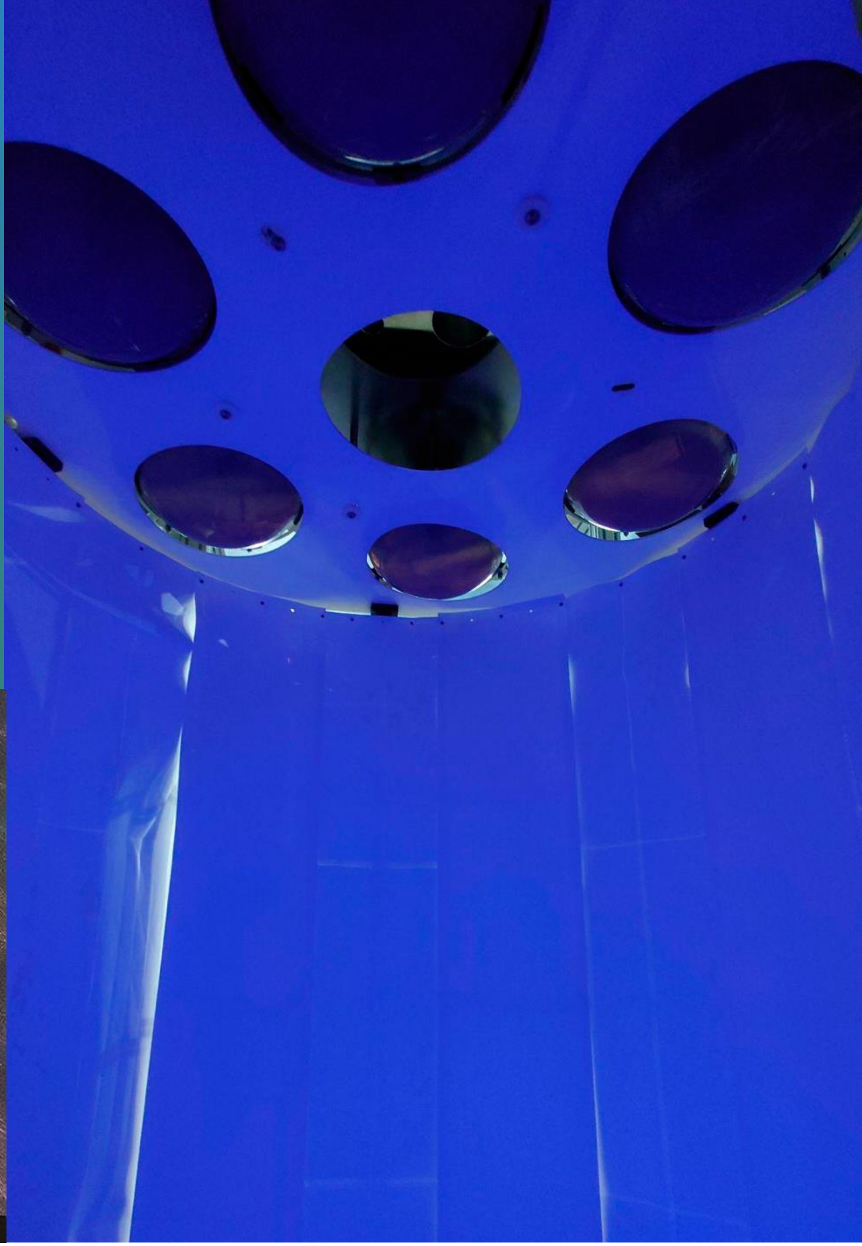
The Underground Argon program of the Global Argon Dark Matter Collaboration

Daniel Díaz Mairena CIEMAT – Madrid

*for the **Global Ar Dark Matter Collaboration***



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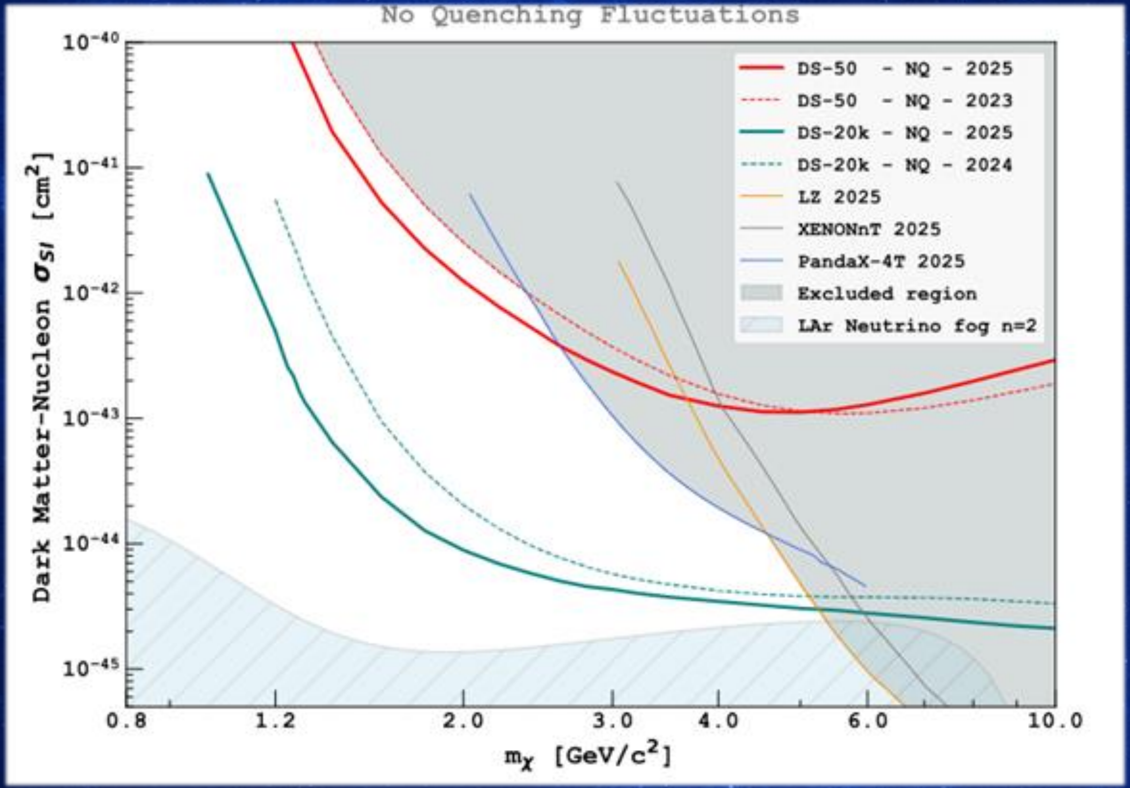
DArT 39

DARKSIDE

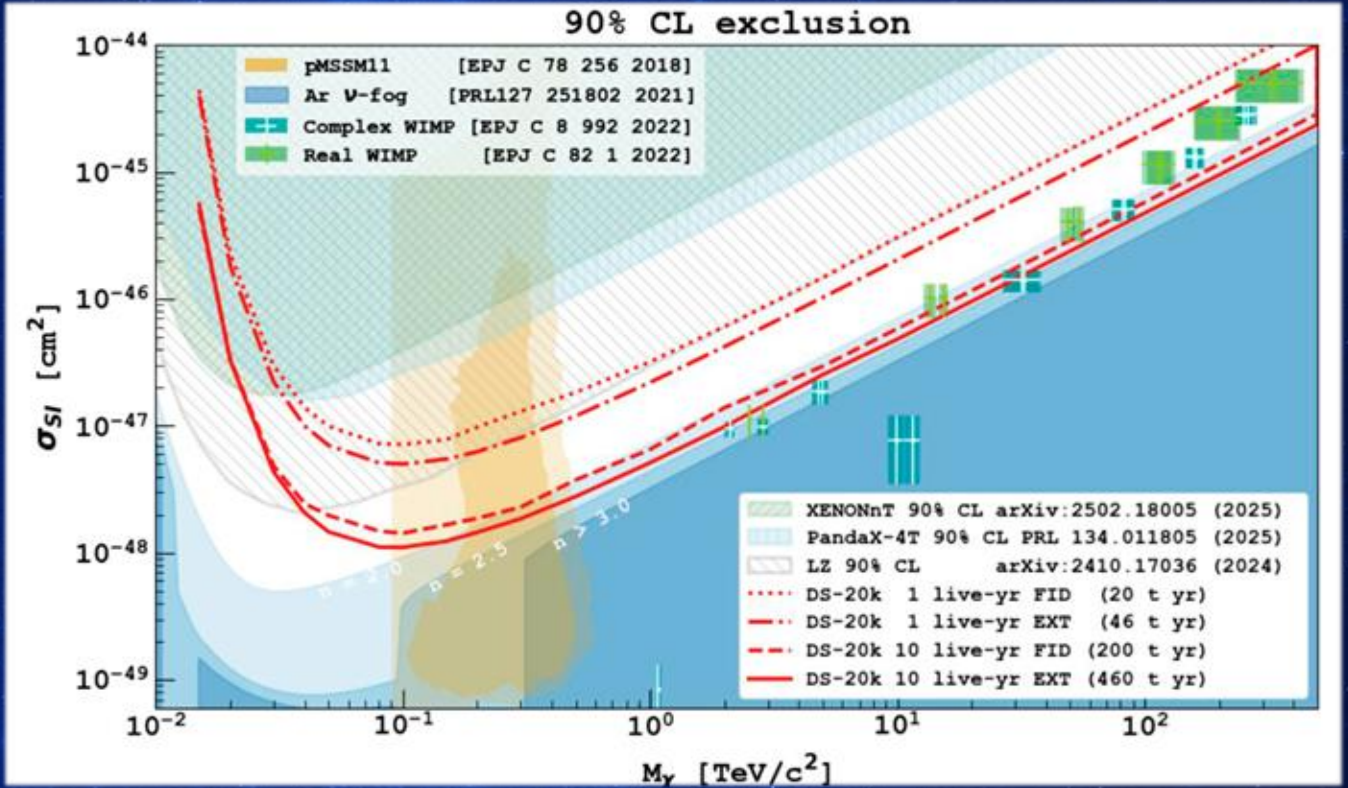
Overall context: DarkSide-20k and the GADMC

The DarkSide-20k experiment is designed to lead WIMP searches in the coming years.

Eur. Phys. J. C 86:220 (2026)



Nucl. Phys. B, vol. 1003 (2024)



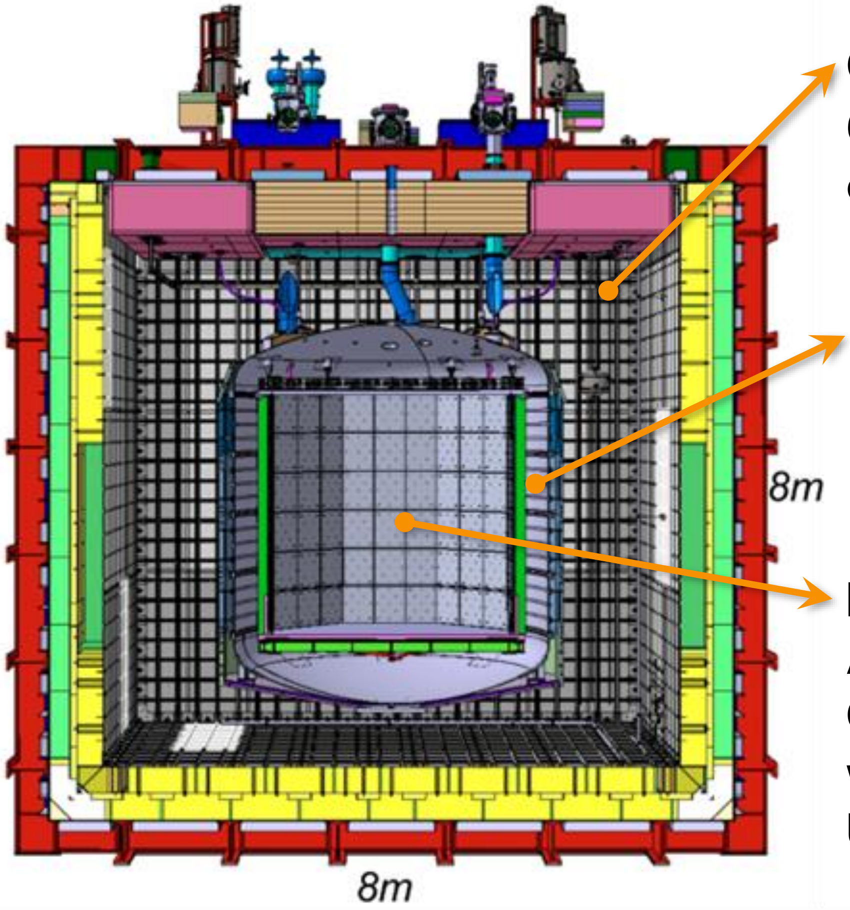
Discussed in detail in Vicente Pesudo Fortes' talk, "Status of DarkSide-20k"

Overall context: DarkSide-20k and the GADMC

Discussed in detail in Vicente Pesudo Fortes' talk, "Status of DarkSide-20k"

@ LNGS, (Italy)

3800 m.w.e



Outer Veto: 650 tonnes of AAr, cosmogenic veto

Inner Veto: 32 tonnes of UAr, neutron veto

Inner Detector: A Time Projection Chamber filled with 49.7 tonnes of UAr

Argon in Dark Matter Direct Detection

An ideal target?

- ✓ Negligible self-absorption of scintillation photons
- ✓ Almost null attachment probability for electrons in pure Ar
- ✓ Pulse Shape Discrimination (PSD) of scintillation signal allows separate nuclear and electron recoils
- ✓ Quite abundant in atmosphere (~ 1%)

Efficient collection of scintillation light

Excellent ionization detector

Excellent background rejection

Affordable large multi-ton detectors

^{39}Ar

Intrinsic activity of ^{39}Ar in atmospheric argon (AAr)

Cosmogenic: $^{40}Ar(n,2n)^{39}Ar$

- β^- decay with $\boldsymbol{Q_\beta = 565\ keV}$
- **Pure** $\boldsymbol{\beta}$ emitter
- $t_{1/2} = 269$ y
- ~1 Bq/kg

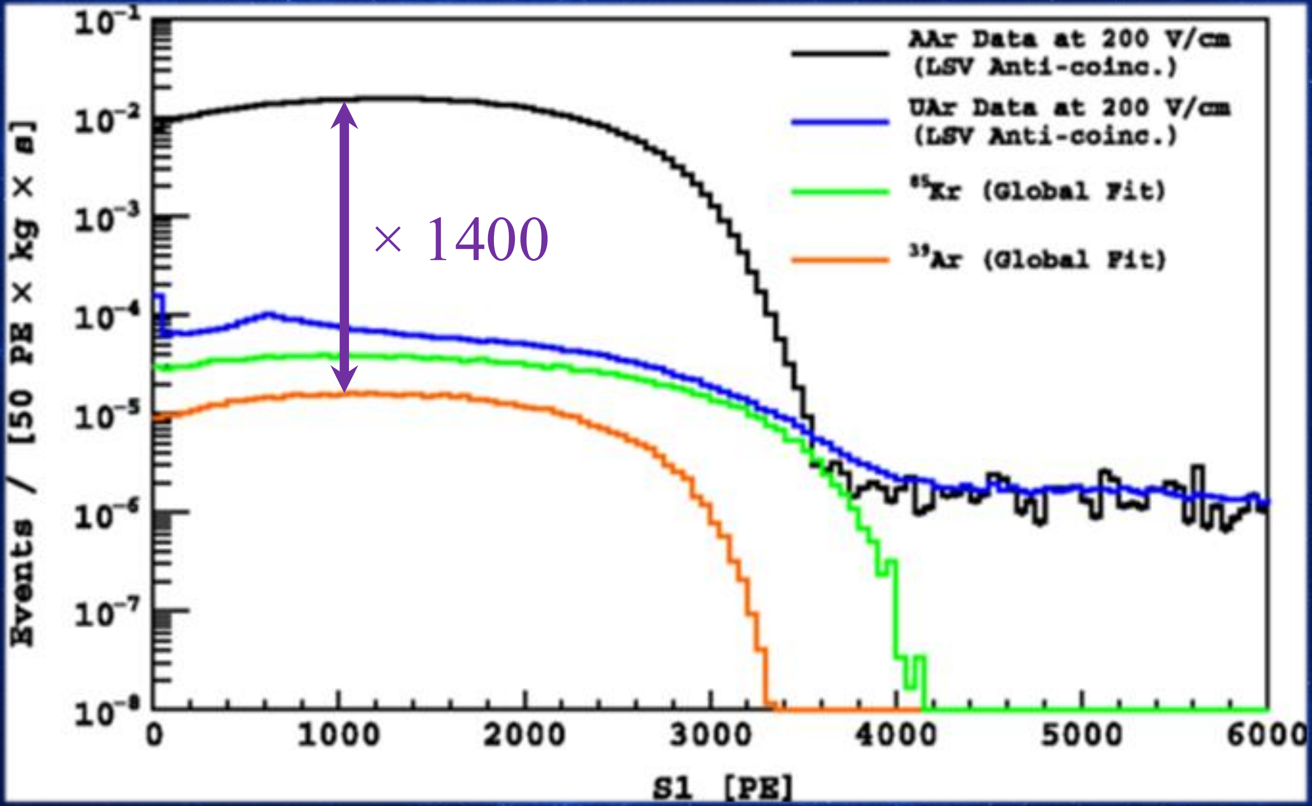
The high trigger rate, in multi-ton TPCs focus on low E, results in pile up problems

Use of underground argon (**UAr**), with significant reduction of **^{39}Ar**

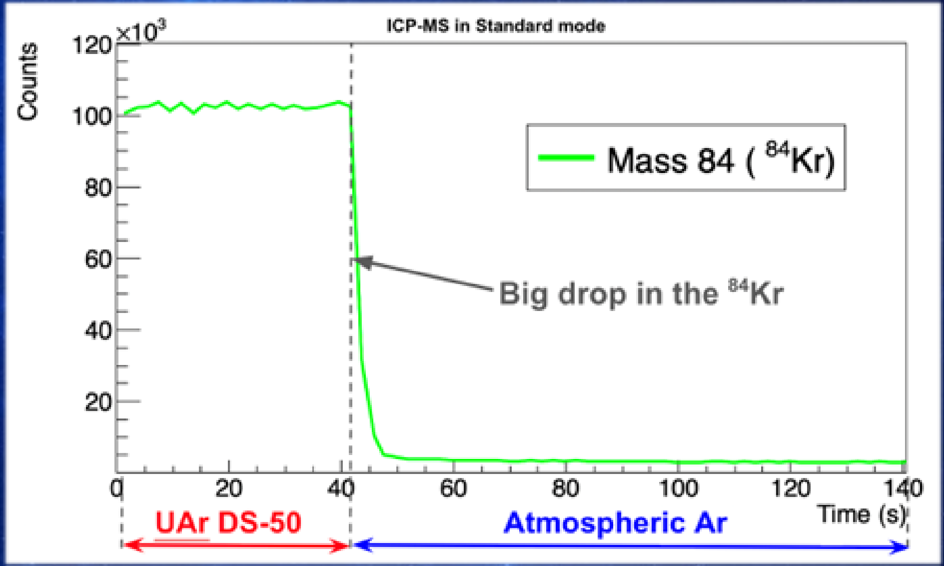
UAr for DarkSide-20k

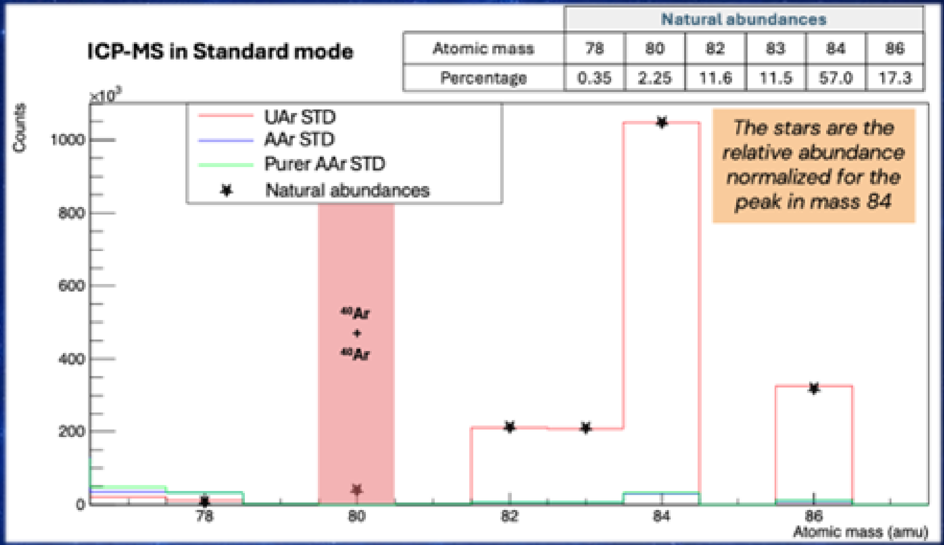
DarkSide-50 measured a **^{39}Ar depletion factor of 1400** in UAr with respect to AAr, i.e. a ^{39}Ar activity of **0.73 ± 0.11 mBq/kg**:

This UAr batch was probably **affected by an air leak** during extraction. *Presence of Kr was confirmed by ICP-MS*



Phys. Rev. D ***93****, 081101 (2016)*





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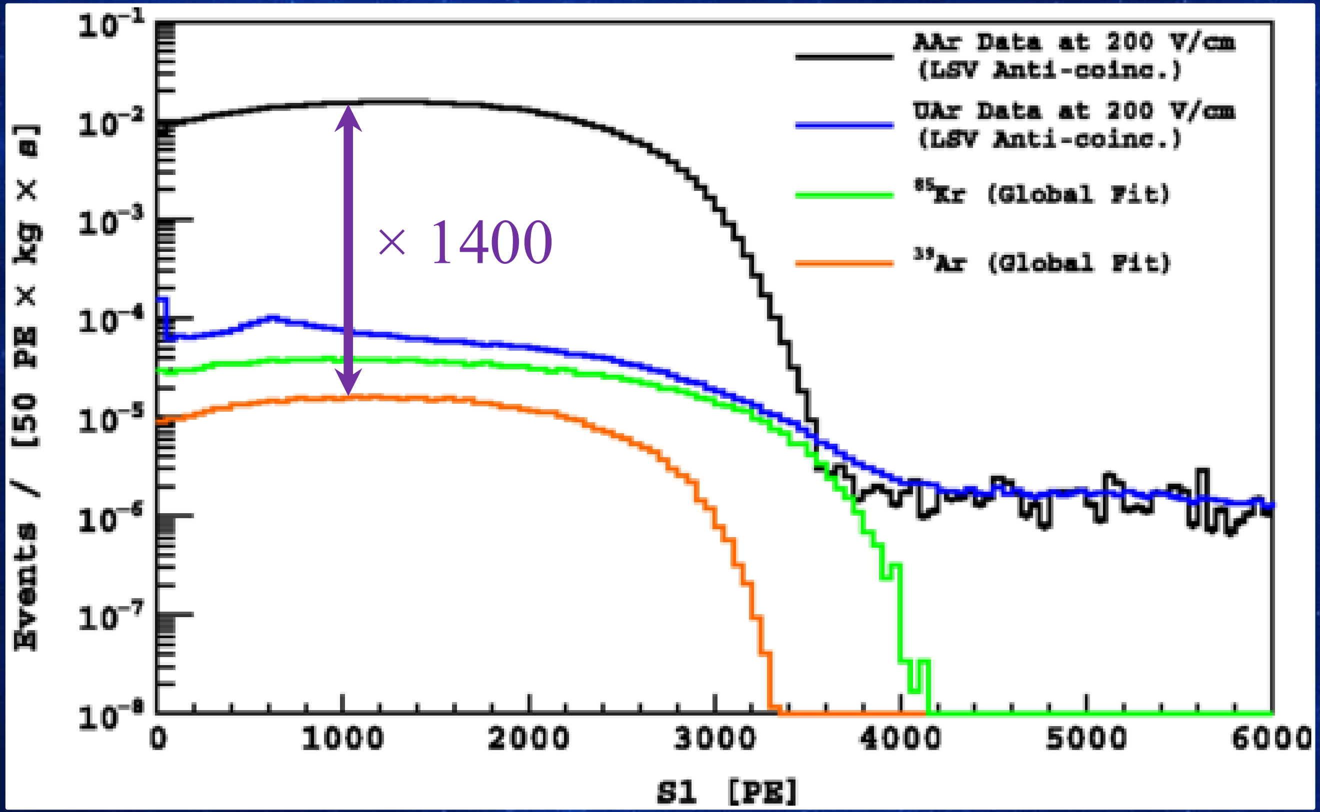


Phys. Rev. D ***93****, 081101 (2016)*

This UAr batch was probably **affected by an air leak** during extraction. *Presence of Kr confirmed with ICP-MS*

Upper limit

A higher depletion factor can be expected in the UAr of DarkSide-20k

An infiltration could happen again

We will measure the ^{39}Ar levels of every batch for DarkSide-20k

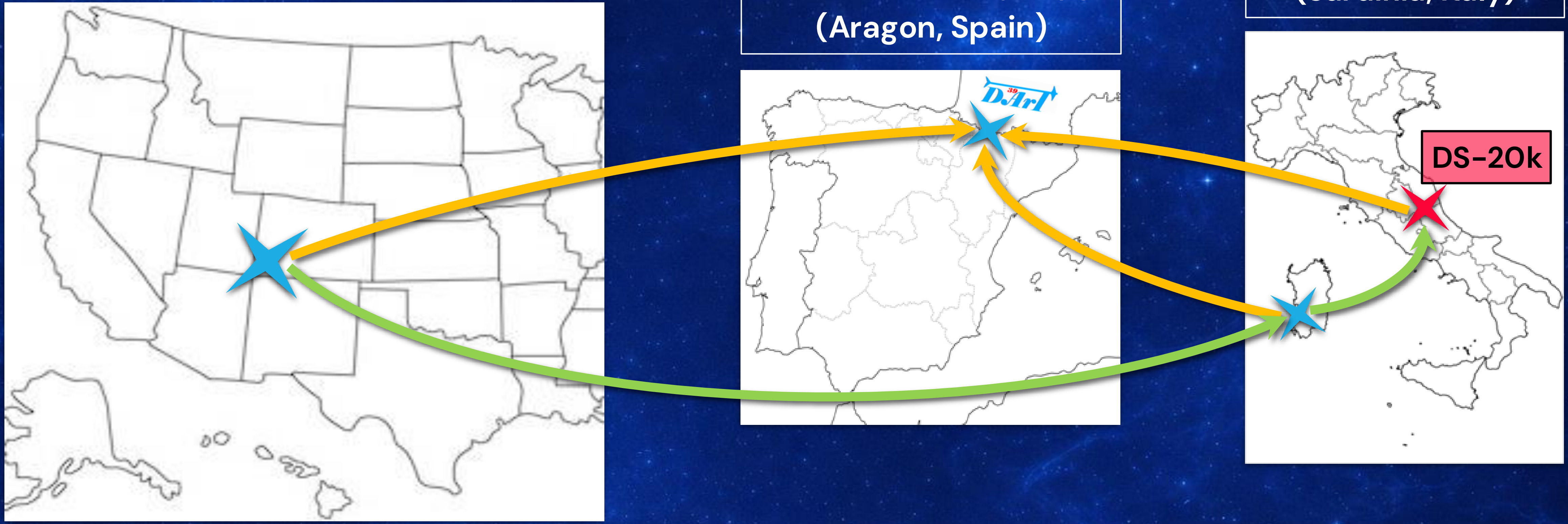
DS-20k: Going to industrial scale to extract and purify the ~120 tonnes of UAr

Production–Purification–Assay

Production: Urania (Colorado, USA)

Characterisation: DArT-in-ArDM at LSC (Aragon, Spain)

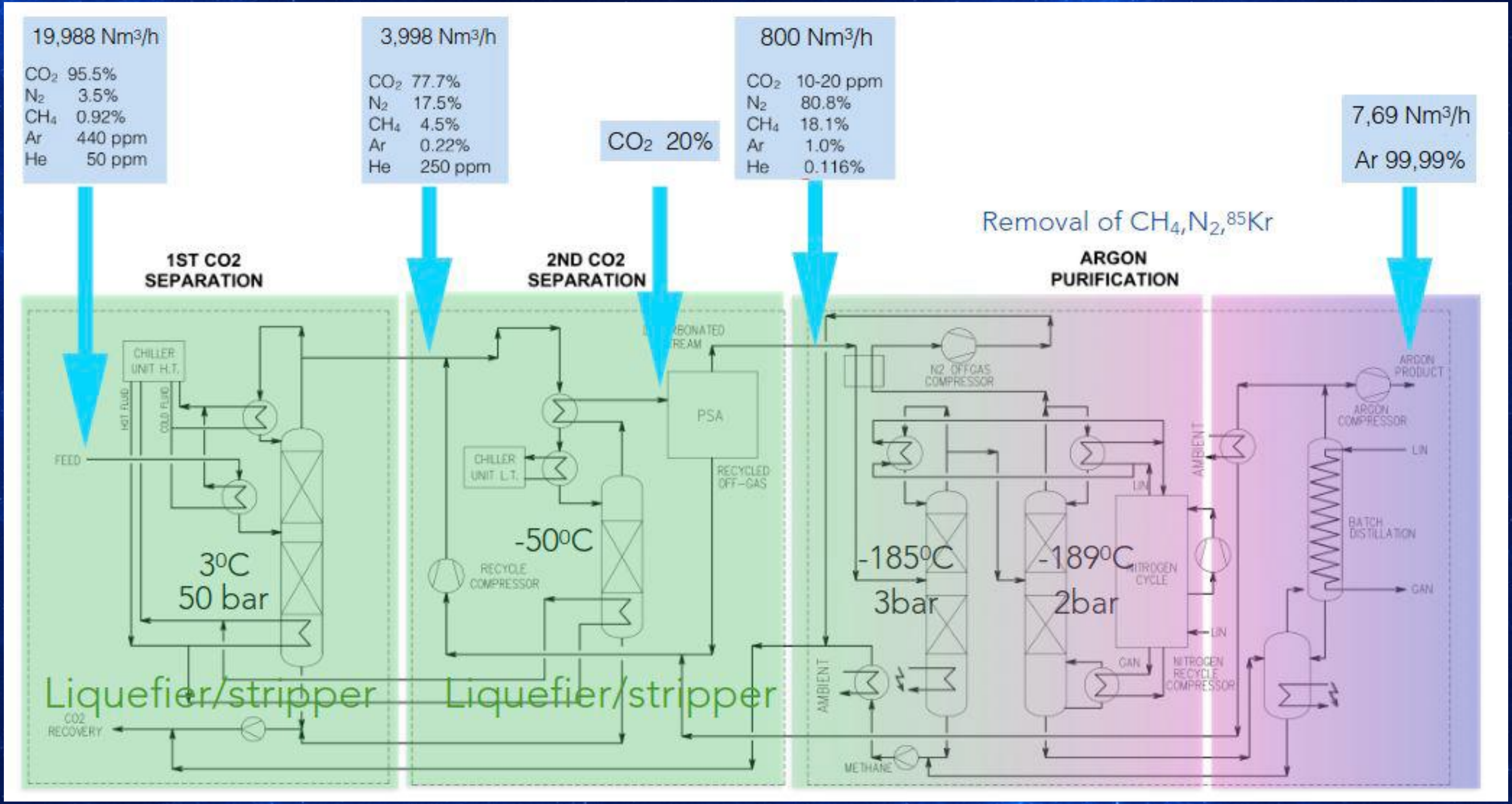
Purification: Aria (Sardinia, Italy)



Cosmogenic activation above ground, during storage and shipping, quantified and subdominant for sea freight (few % of DS-50 reference): *Astroparticle Physics 152, 102878 (2023)*
This program will be valuable for several future low-background experiments, such as LEGEND-1000, ARGO, COHERENT, and others.

Urania ➡ From 440 ppm to 99.99% Ar

@ Cortez, Colorado (US)



➤ Extraction rate: **330 kg/day** ➤ Full amount for Darkside-20k (**120 tonne**) produced in **1.3 y**

Urania :Status

Commissioning run imminent!

Aria ➡ 10^3-fold reduction in chemical impurities

@ Carbosulcis, Sardinia (Italy)

A cryogenic distillation column (height ~350 m) under construction:

- 28 Central modules: 12 m each
- 1 Condenser (top) module: 7 m
- 1 Reboiler (bottom) module: 5m
- Outer Diameter of the column: 32.3 cm
- Outer Diameter of cold box: 71.2 cm

Process is based on the **difference in volatility**

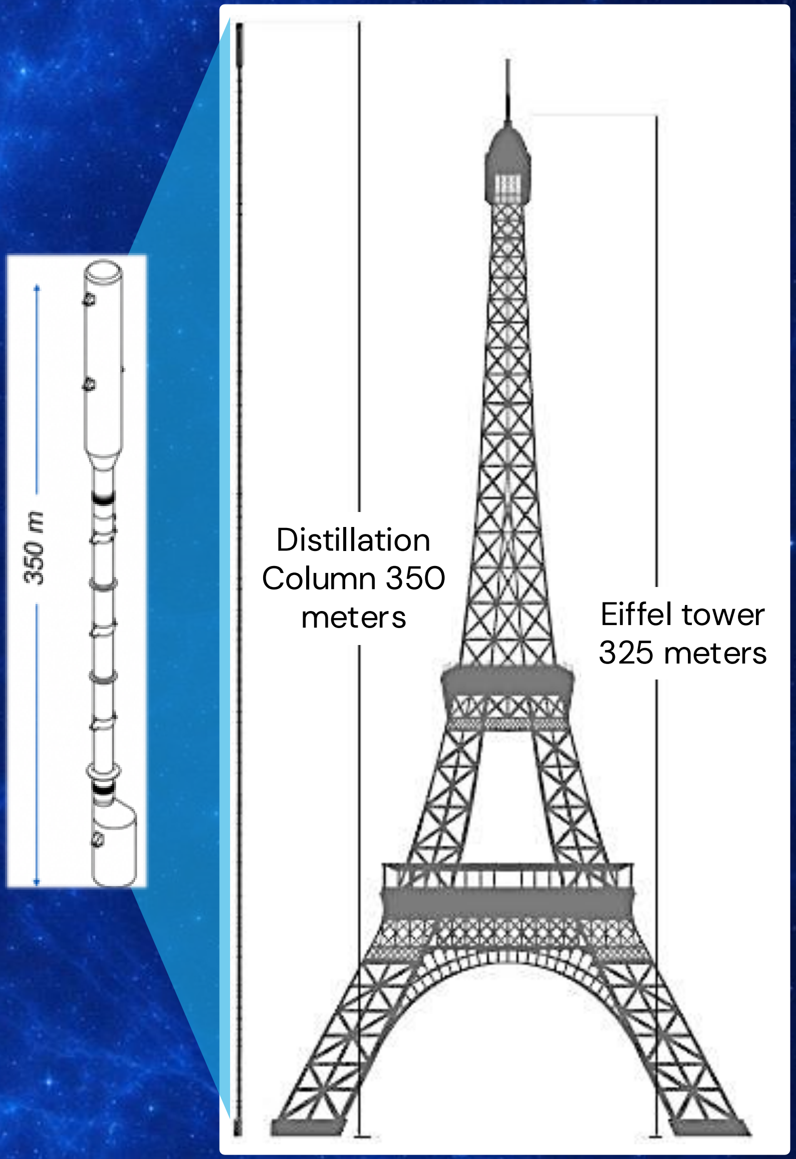
Number of theoretical distillation stages: ~2870

Chemical Purification rate: **1 t/d** (or more)

The process was already tested with a prototype, called **Seruci-0:**

1st operation with N_2: *2019 Eur. Phys. J. C (2021) 81:359*

2nd operation with Ar: *2021 Eur. Phys. J. C (2023) 83:453*

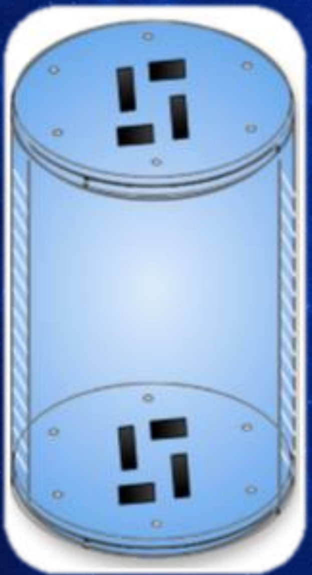


DArT-in-ArDM ➡ Characterization of the UAr

@ Canfranc Underground Lab (LSC), Aragón (Spain)

2400 m.w.e

Depleted Argon Test detector



Single phase detector

- Photosensors: 8 x 1 cm^2 SiPMs
- 1.317 kg LAr active mass
- ESR reflectors
- TPB-coated acrylic

Argon Dark Matter active veto

ArDM Main Vessel

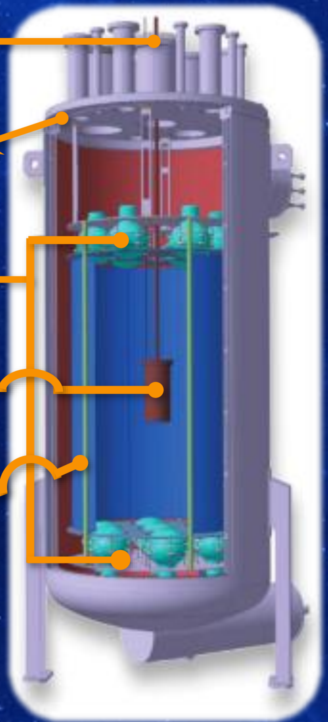
DArT Vessel inlet

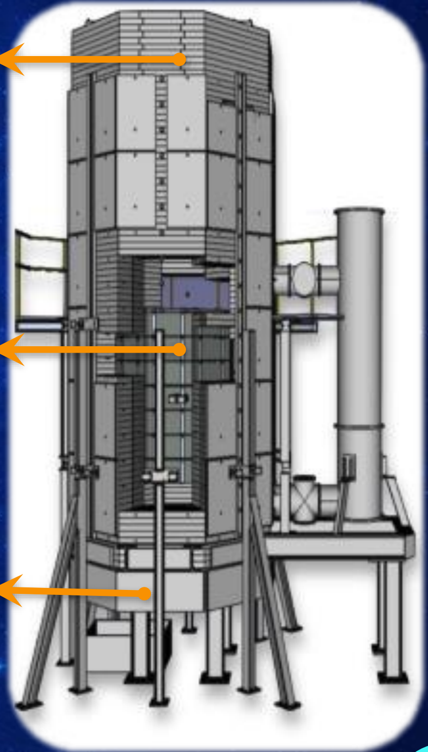
ArDM Top Flange

PMT planes

DArT Vessel

Reflector panels





PE shield

Pb shield

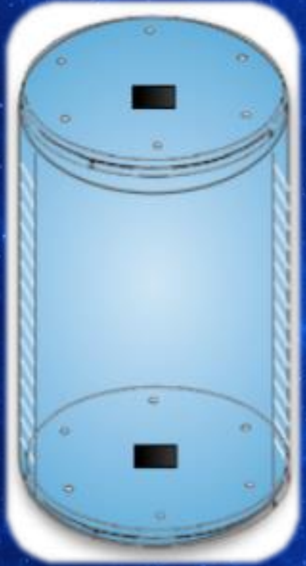
Support plate

Sensitivity < 1 mBq / kg DS-50: ***^{39}Ar Activity = 0.73 ± 0.11 mBq/kg***

DArT-1 (in test cryostat)

DArT-1 (in test cryostat)

Acrylic structure



Inside a **copper vessel**

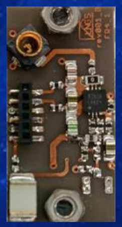
Stainless Steel Cryostat

Filling with LN_2 at overpressure (2.2 bar) keeps the Ar liquid at 85 K.

Pb shield flushed with Rn-free air

DArT SiPMS

- NUV-HD-Cryo SiPM of the DarkSide-20k batch
- **Custom SiPM readout board (1 SiPM/board)**
- **Arlon 55NT substrate**



Goals of the setup

- **Continuous performance** over weeks
- **Operational conditions** for the DAQ and electronics.
- **Measurement of the ^{39}Ar** activity in atmospheric Ar
- Enabling **first , order-0 UAr quality check** before filling of the main detector

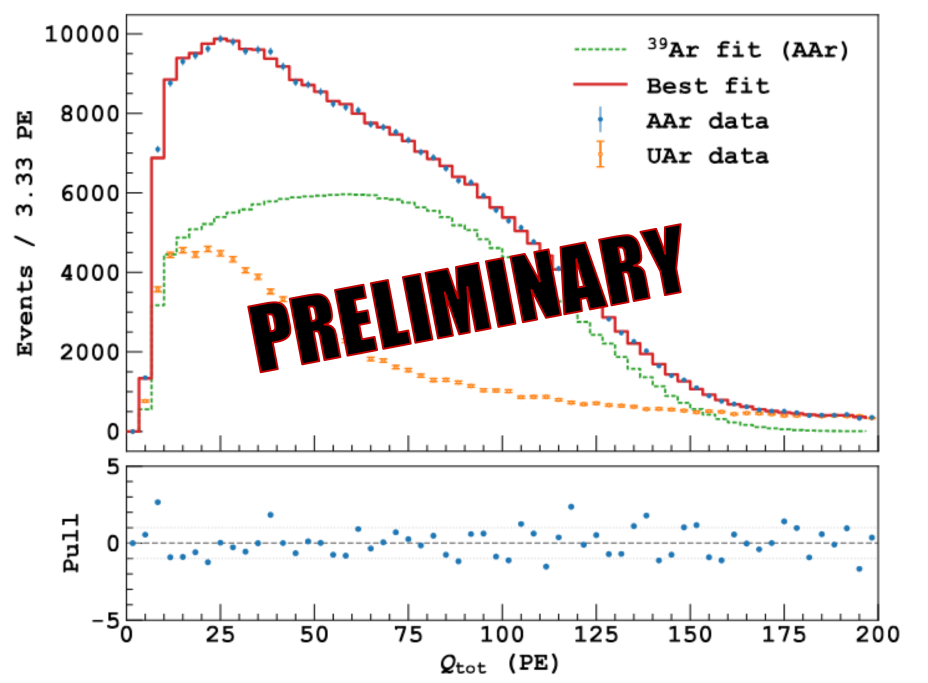
DArT-1: ^{39}Ar activity in atmospheric Ar

Paper under internal review (submission to the journal before the summer)

$$A_{AAr} = \frac{N(AAr_{run}) - N(UAr_{run}) \cdot f_{AAr/UAr}}{\varepsilon_{AAr} \cdot t_{AAr}} + a_{UAr} \cdot M_{LAr}$$

$$a_{AAr} = A_{AAr} / M_{LAr}$$

- $N(AAr_{run})$: Events **after** cuts of the AAr run
- $N(UAr_{run})$: Events **after** cuts of the UAr run
- $f_{AAr/UAr}$: Ratio of AAr and UAr time acquisition
- ε_{AAr} : Total ^{39}Ar efficiency from simulation
- t_{AAr} : AAr run time
- a_{UAr} : UAr specific activity
- M_{LAr} : Liquid Argon Mass in DArT-1 detector



Systematic Uncertainties

	units	value	unc. (%)	unc. on a_{AAr}(%)
$N(AAr)$		xx	0.18	0.18
$N(UAr)$		94721	0.32	0.32
tot stat				0.37
$f_{AAr/UAr}$		1.035		
ε_{AAr}		0.947	0.07	-
t_{AAr}	s	160200		
ρ_{LAr}	g/cm^3	1.409	0.44	0.44
V^{warm}	cm^3	970.02	0.07	0.07
f_{cont}		0.0258	8	0.21
a_{UAr}	mBq/kg	1.71	8	-
tot syst (a)				0.51

type	par. value	par. var.	unc. a_{AAr}(%)
asymm. factor data f_B	0.648	±0.002	-
asymm. factor sim f_B	0.646	±0.002	-
calibration factor S_f	1.034	±0.003	-
thresh. cut in mV	> 5 mV	±2.5mV	-
thresh. cut in $Q_{tot}^{T,B}(PE)$	> 2.5 PE	±0.5	0.14
cut in max $Q_{tot}(PE)$	< 250 PE	±20	-
noise surviving cuts	-	-	0.15
after-pulse, cross-talk	10%, 10%	±10%	0.13
SiPMs QE	45 %	±5%	-
ESR reflectivity	99 %	±0.5%	-
nuclear recoil backg.	-	-	-
β-spectrum shape	-	-	-
tot syst (b)			0.29
tot syst ((a)⊕(b))			0.59

$A_{39Ar^{atm}}$ = *(0.9YY ± 0.0ZZ) Bq/kg*

Other experiments

- ***DEAP – 3600***: A_{39Ar} = 0.96 ± 0.03 Bq/kg — *P. Adhikari et al., Eur. Phys. J. C 83, 642 (2023).*
- ***WARP***: A_{39Ar} = 1.01 ± 0.04 Bq/kg — *P. Benetti et al., Nucl. Instrum. Meth. A 574, 83 620 (2007).*
- ***ArDM***: A_{39Ar} = 0.96 ± 0.05 Bq/kg — *J. Calvo et al., JCAP 12, 011 (2018).*

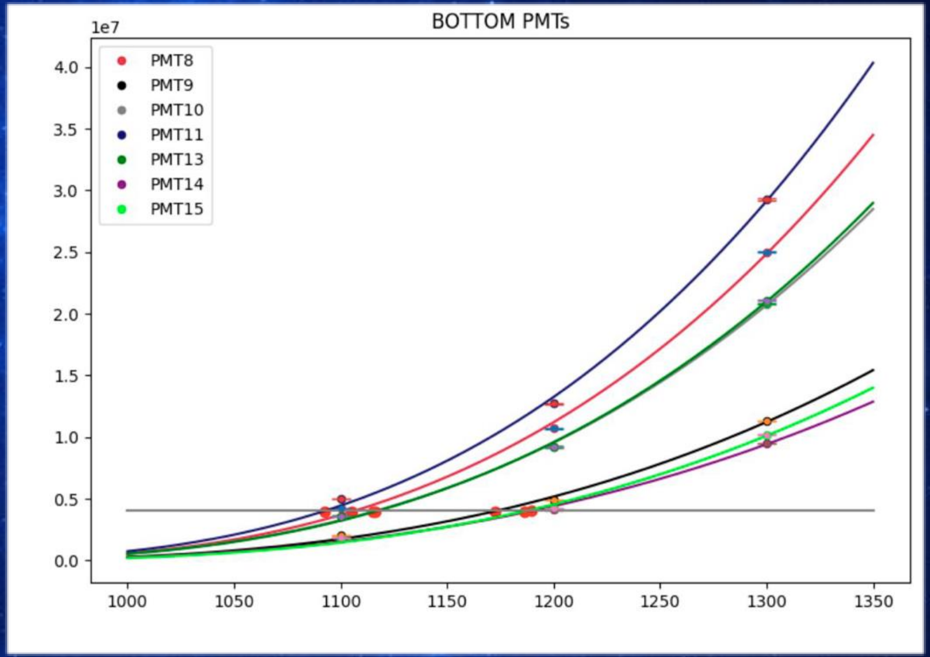
DArT-in-ArDM

Refurbishment of ArDM

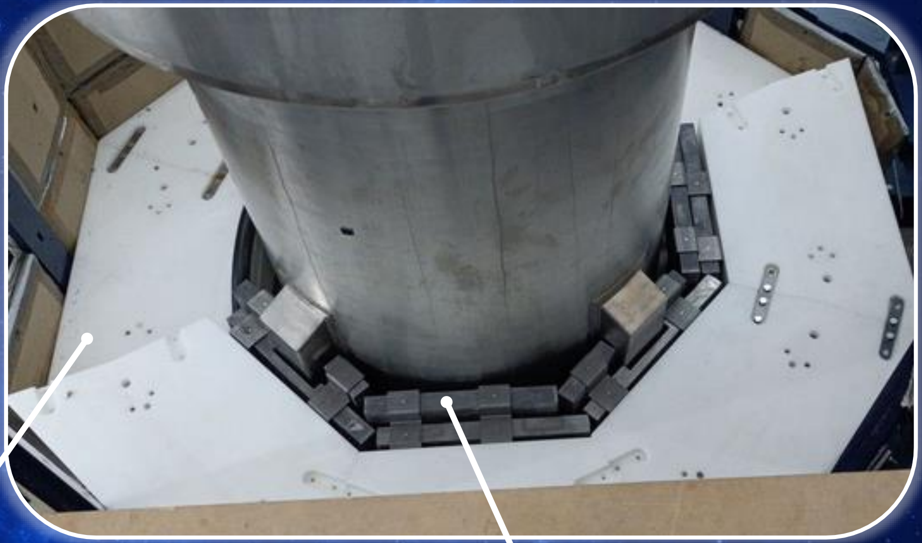
The refurbishment of ArDM was done at LSC:

- 6 tonnes of lead belt attached to the polyethylene shield
- New PMT planes mounted
- Reflectors installed inside

Characterization of the new PMTs:



PMT Plane with reflector coated with TPB



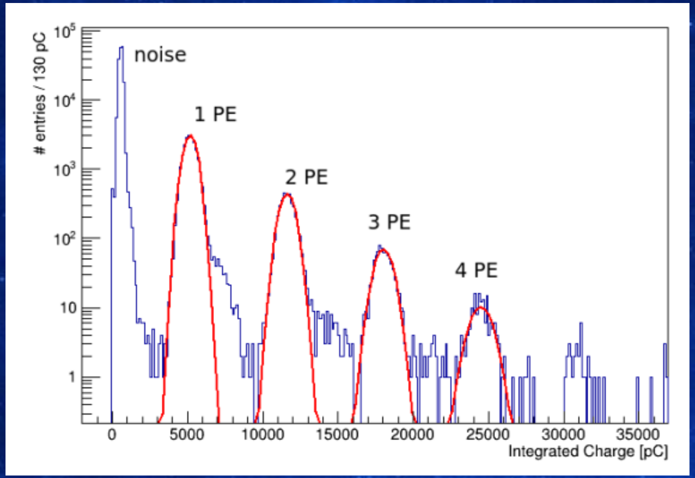
Reflector Coated with TPB

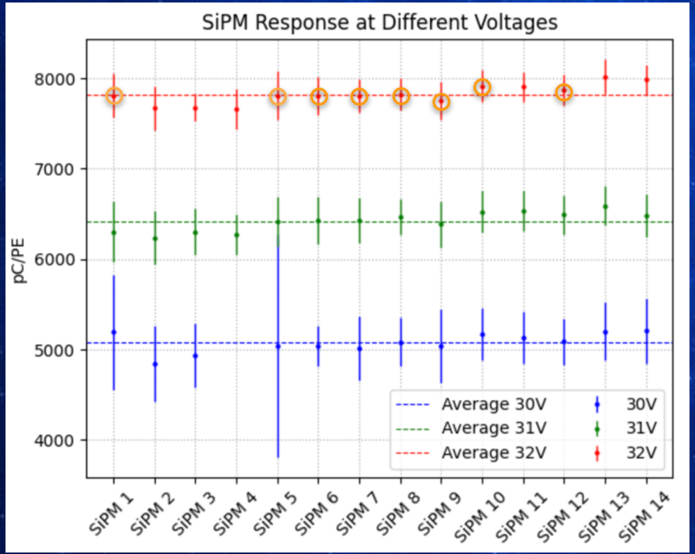
PE Shield

Pb Belt

DArT-2.0: Construction

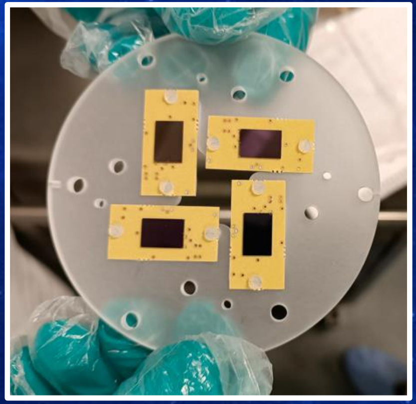
Characterization and selection of SiPMs

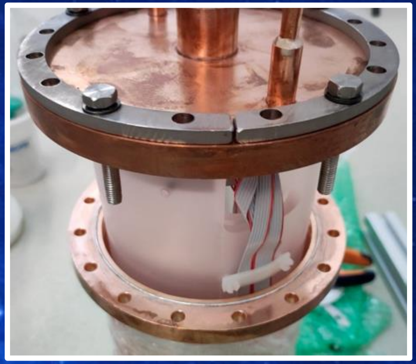




Cleaning

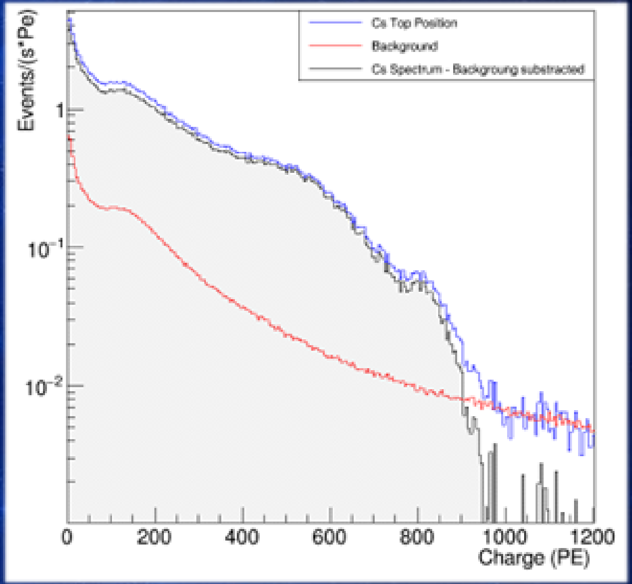
Assembly

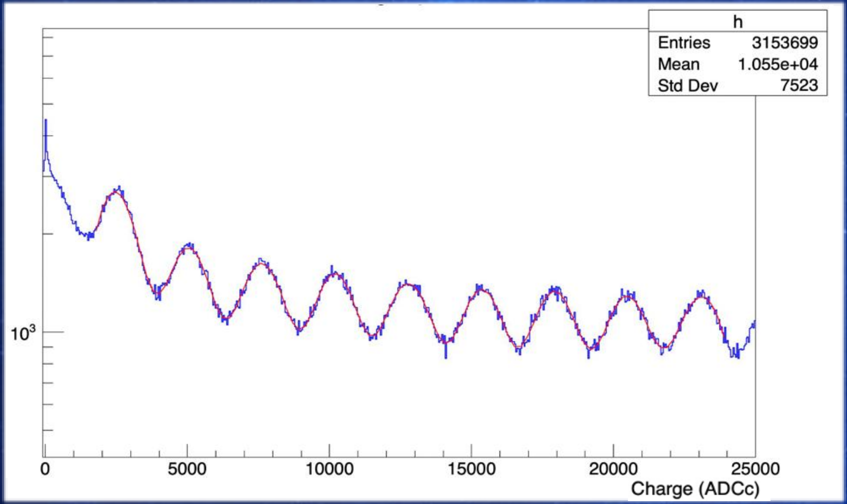


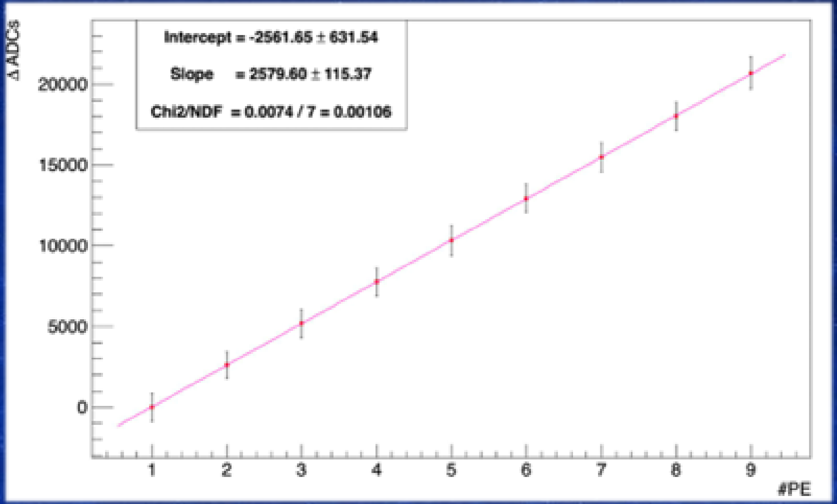


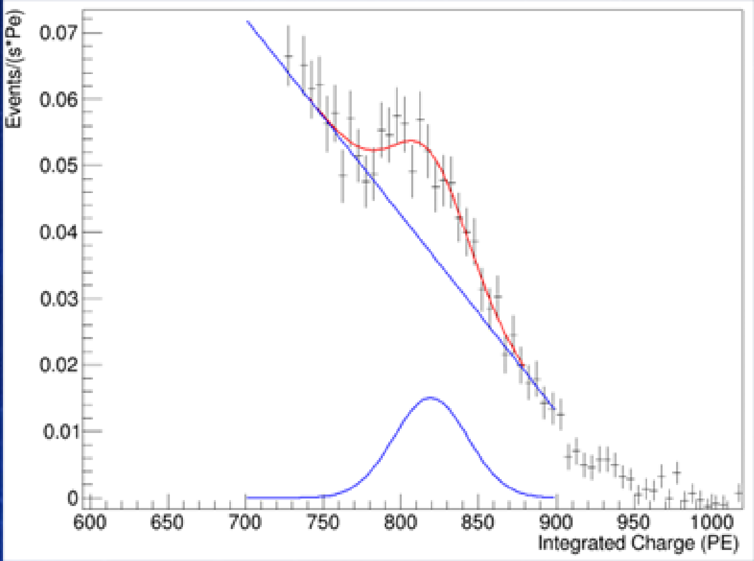
DArT-2.0: First measurement with Liquid AAr

- A **test measurement outside ArDM** was performed to assess the entire system with **DArT-2**.
- From this dataset we obtained the following key results:
  - **Updated characterization of the SiPMs** installed in the detector.
  - **Study of the noise spectrum**.
  - Using a ^{137}Cs , we **measured the improvement in light yield**.





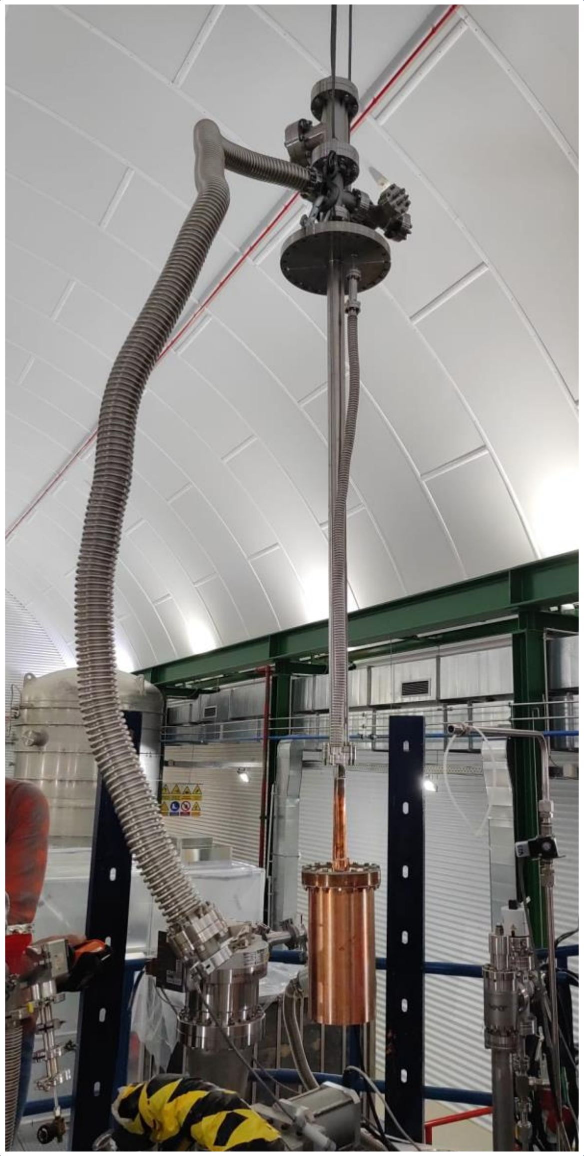




The gain spread among the SiPMs is < 0.04%.
The results are consistent with the previous cold characterization performed outside DArT.

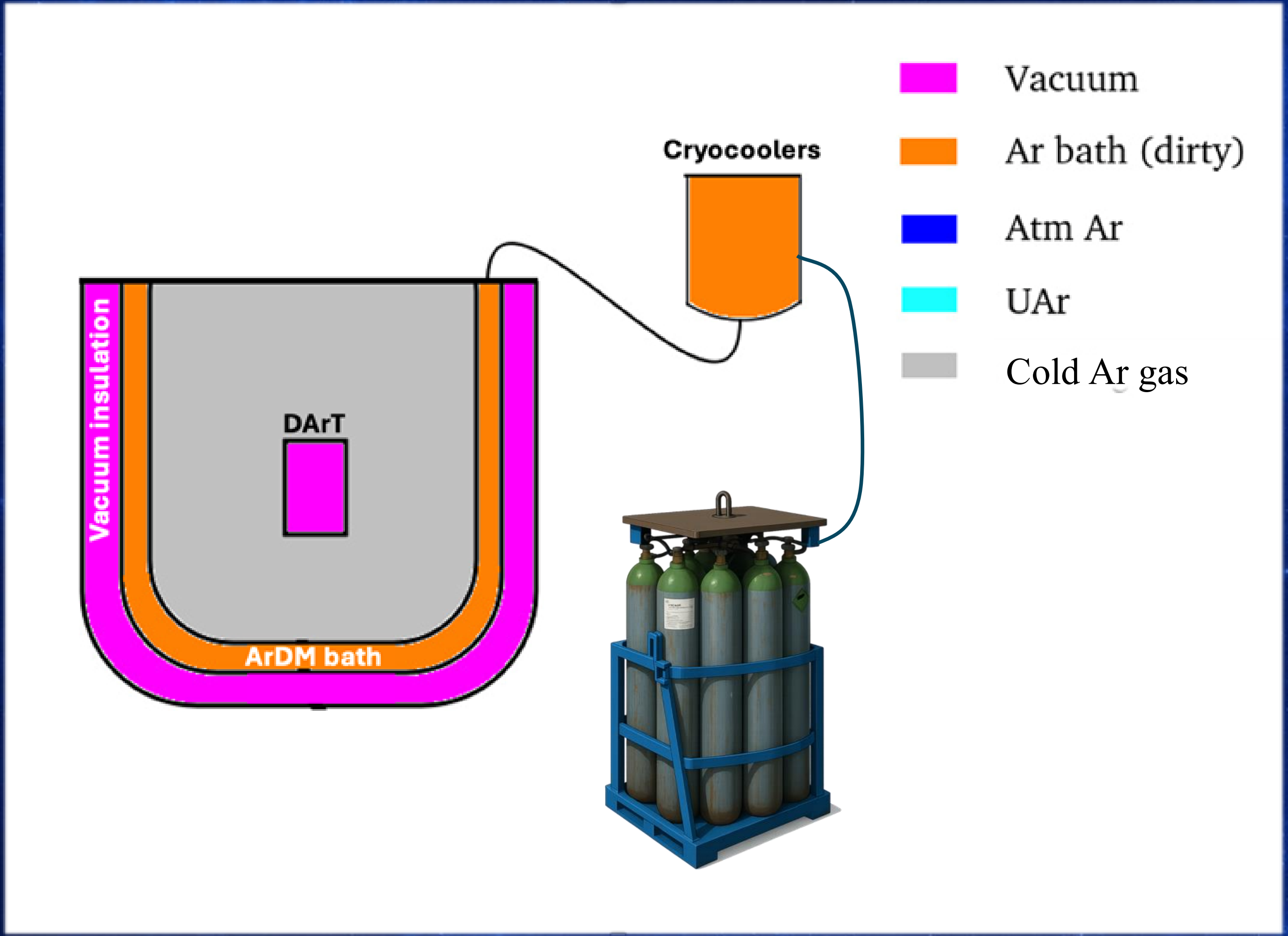
Light yield = 1.23 ± 0.01 PE/keV

DArT-in-ArDM: DArT-2.0 integration in ArDM




DArT-2.0 was integrated into ArDM and was ready to be filled and start data taking

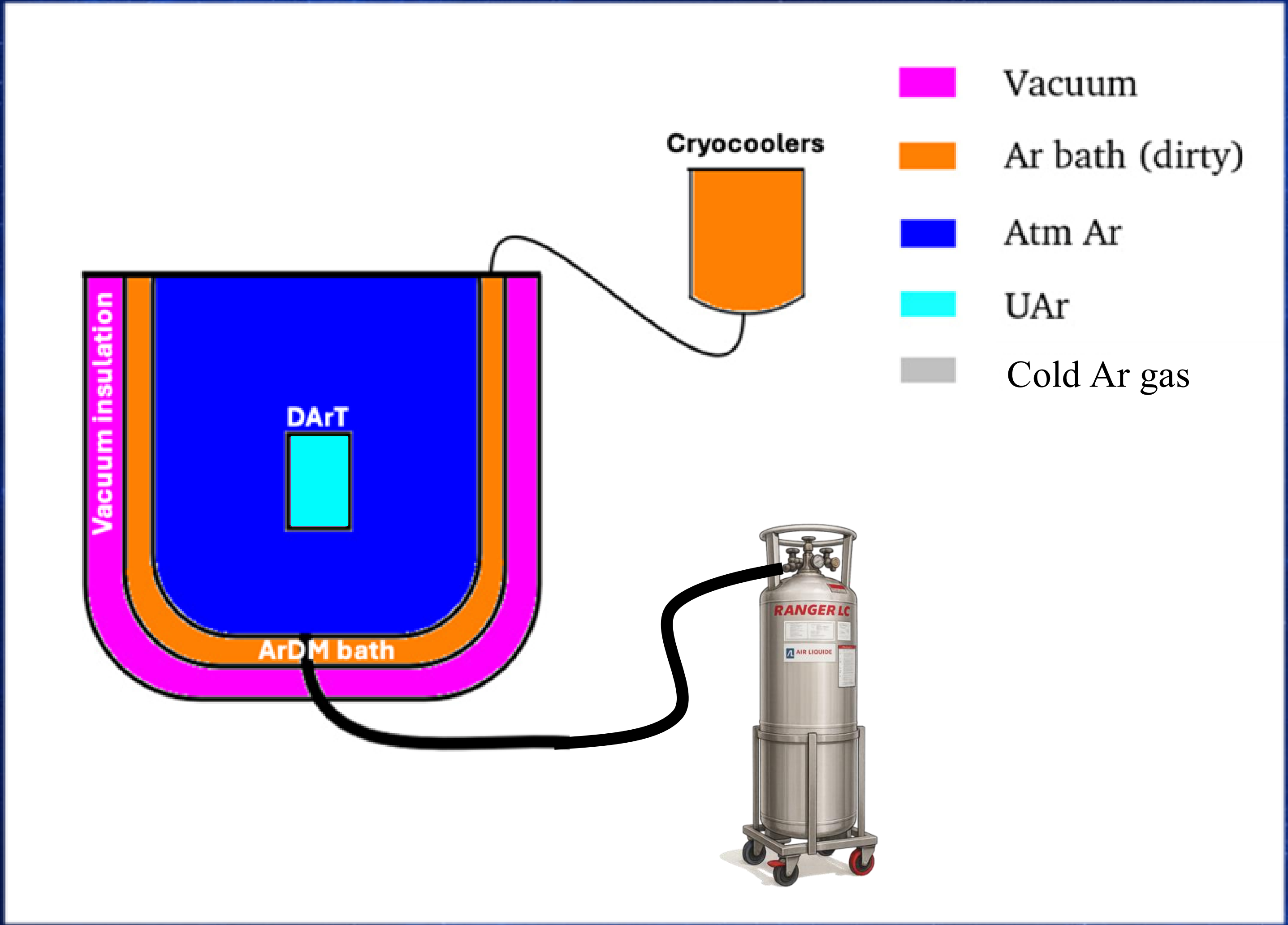

DArT-in-ArDM: Cooling down the detector



Step 1: Fill the bath

- Two cryocoolers cool the detector to the LAr temperature (~87 K).
- During cool-down, the pressure is regulated by solenoid valves: argon is injected when P < 920 mbar, gradually filling the ArDM bath.

DArT-in-ArDM: Filling the main volume of ArDM



Step 2: Filling ArDM and DArT

- **~1 tonne of AAr was transferred** from LAr transport vessels ("rangers") into the main volume of ArDM.
- In mid-December 2025, we filled DArT with AAr and started the first DArT-in-ArDM test measurements.
- In March, we filled DArT with UAr from DarkSide-50, allowing the first estimate of our sensitivity.

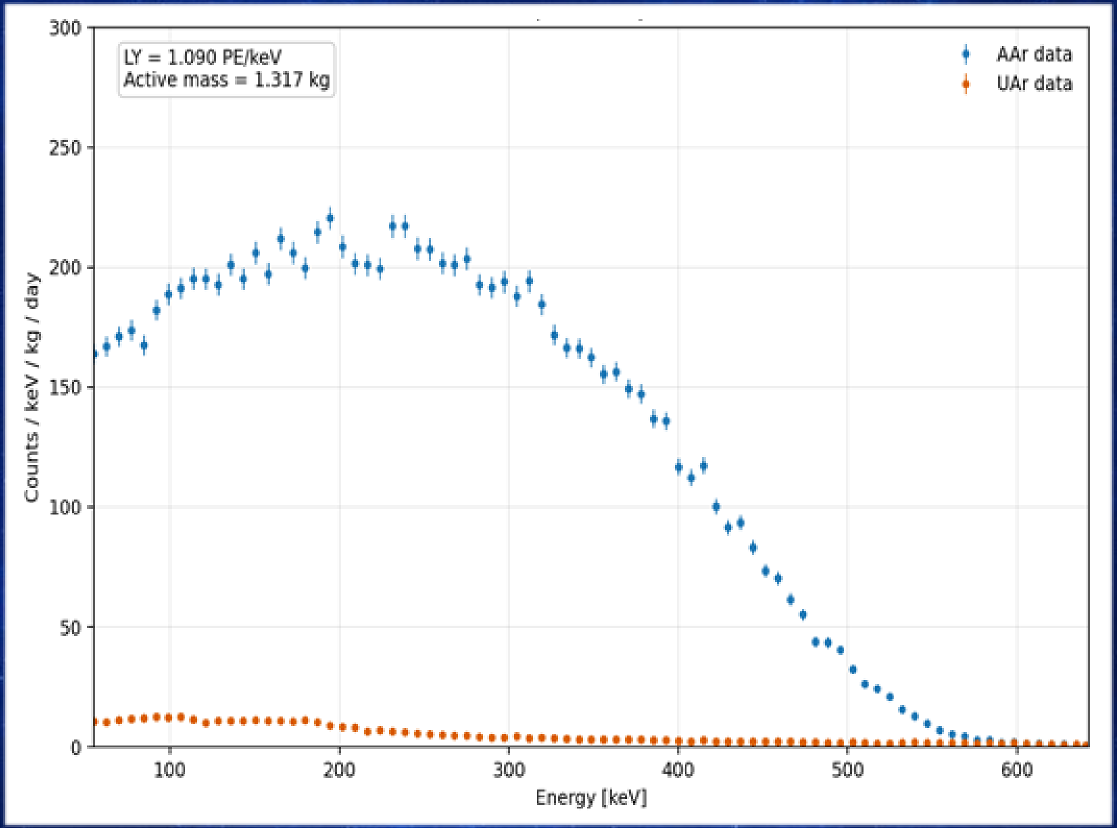
DArT-in-ArDM Current Status

The polyethylene shield was closed in February 2026

We are still **taking commissioning UAr data**:

- to have a final background characterization
- to fine tune the analysis framework

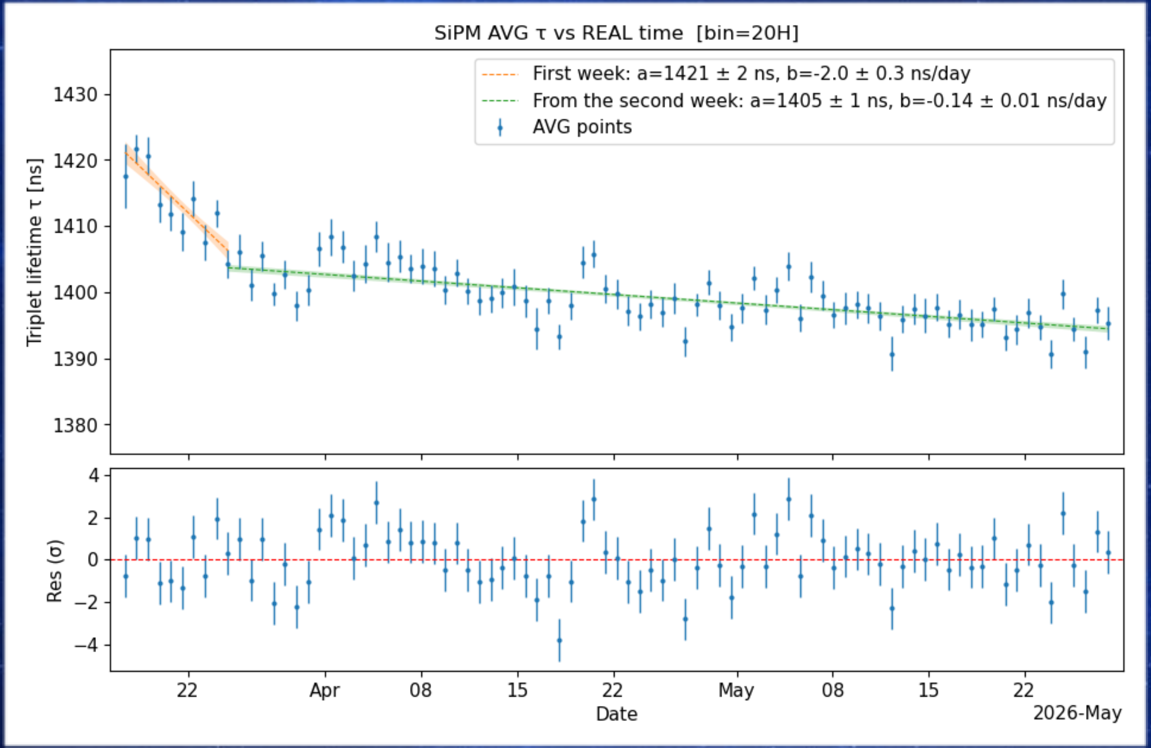
Runs with AAr and UAr



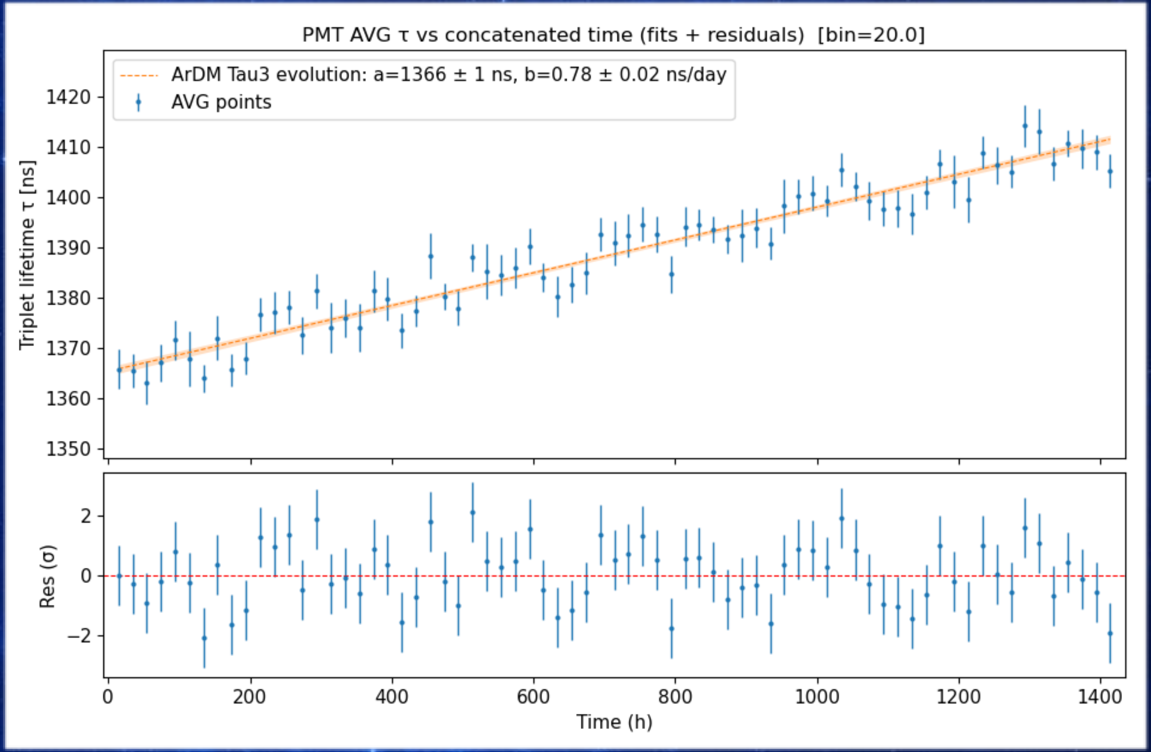
DArT-in-ArDM Current Status and Analysis

The LAr purity is monitored through the triplet lifetime, the slow component of LAr scintillation:

DArT *(~ 3 % variation in more than 2 month)*

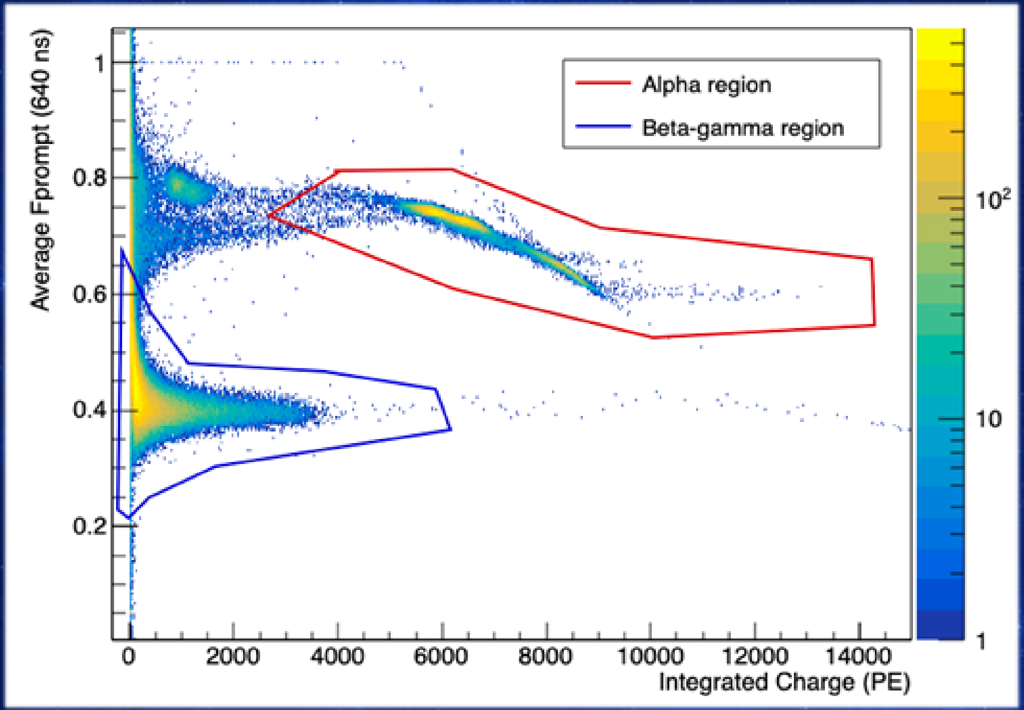


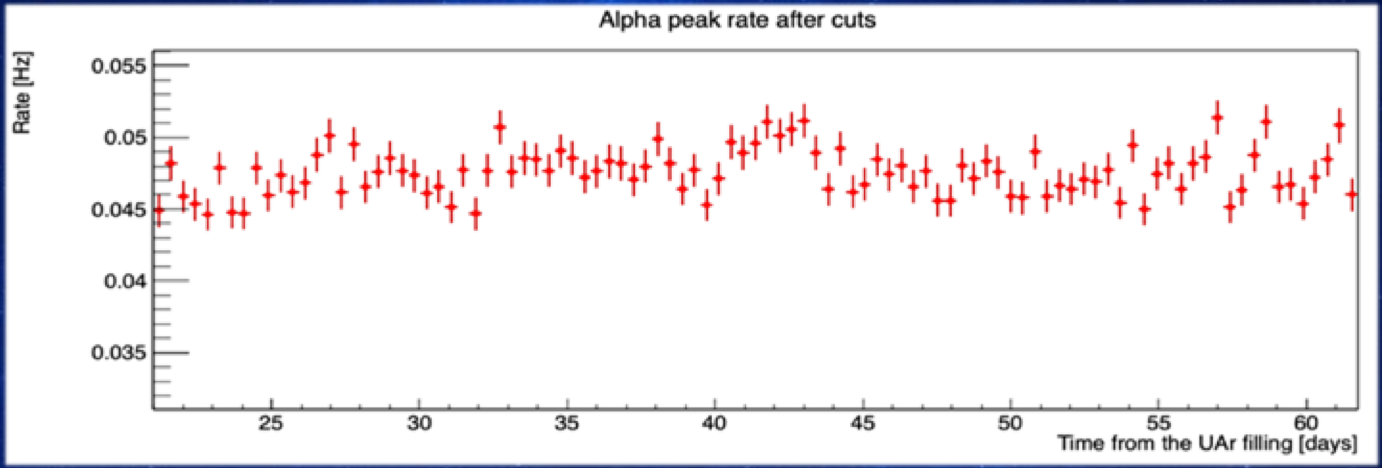
ArDM

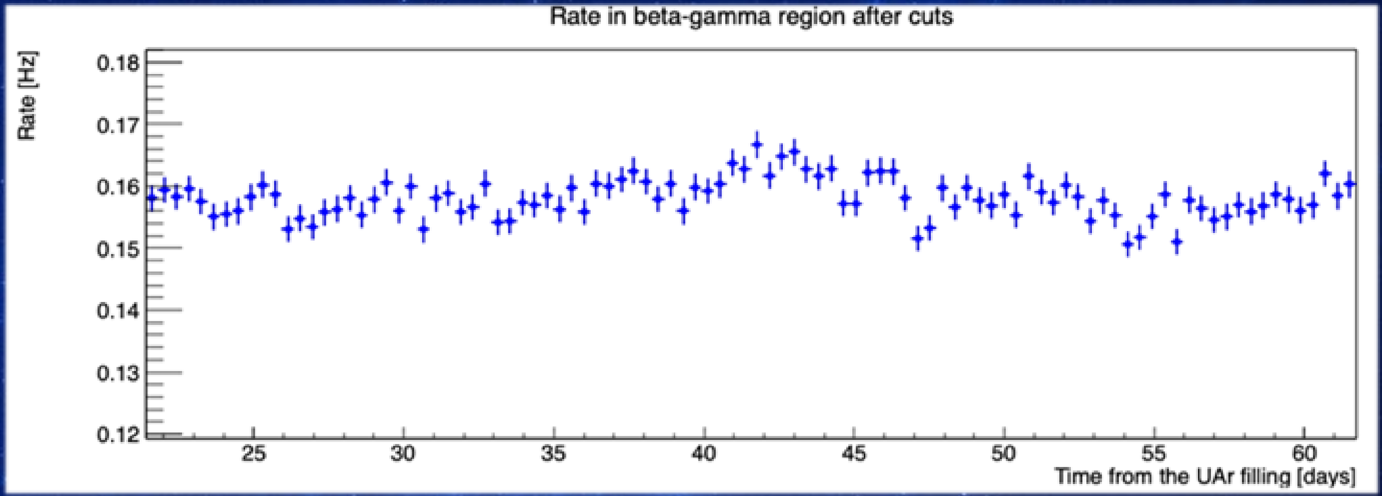


DArT Analysis: rates variation

Event rate stable over more than 40 days!



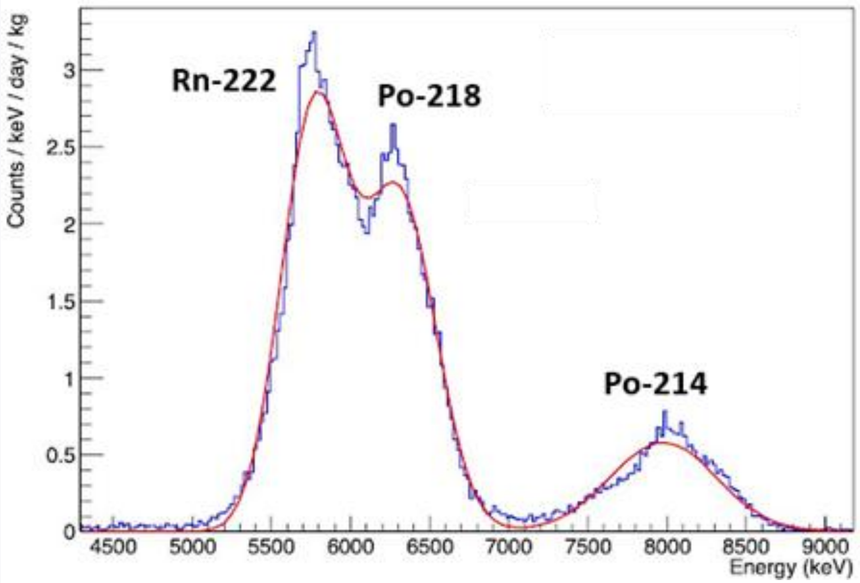




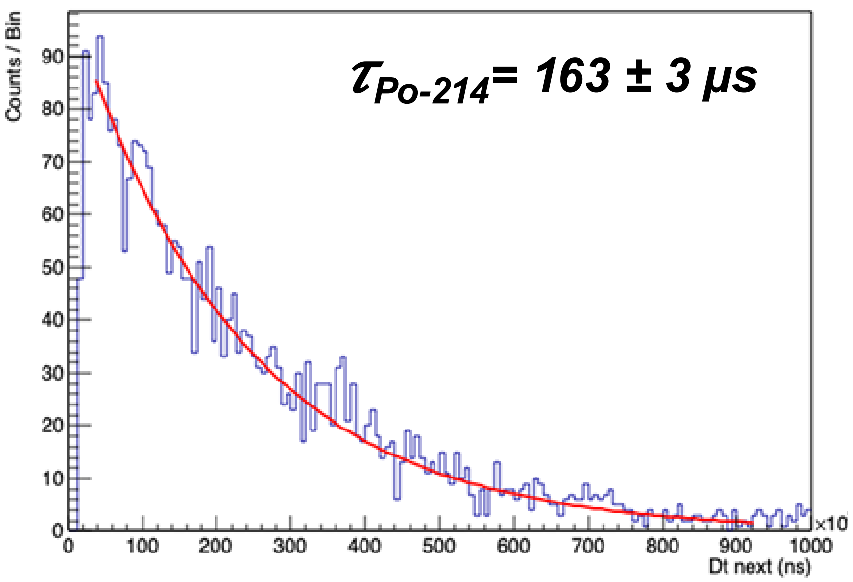
After noise rejection cuts
(Q_{TOT} > 40 pe)

DArT Analysis: alphas

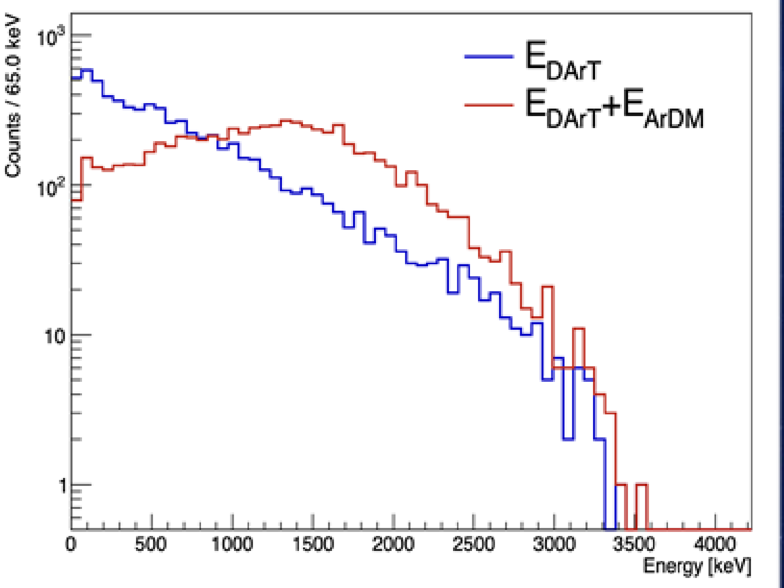
The alpha spectrum shows the ^{222}**Rn**, ^{218}**Po**, and ^{214}**Po** peaks, allowing the **radon contamination** to be **quantified** directly from data



^{214}**Po lifetime** consistent with literature, validating the event timing and radon-chain identification.



^{214}**Bi decay spectrum reconstructed** by $E_{DArT}+E_{ArDM}$

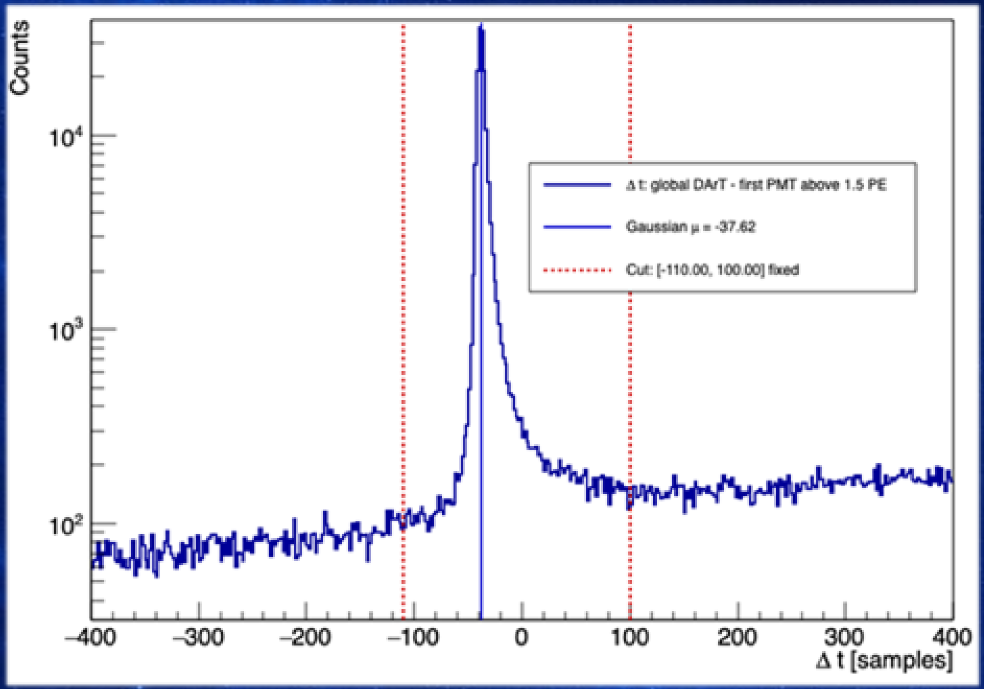


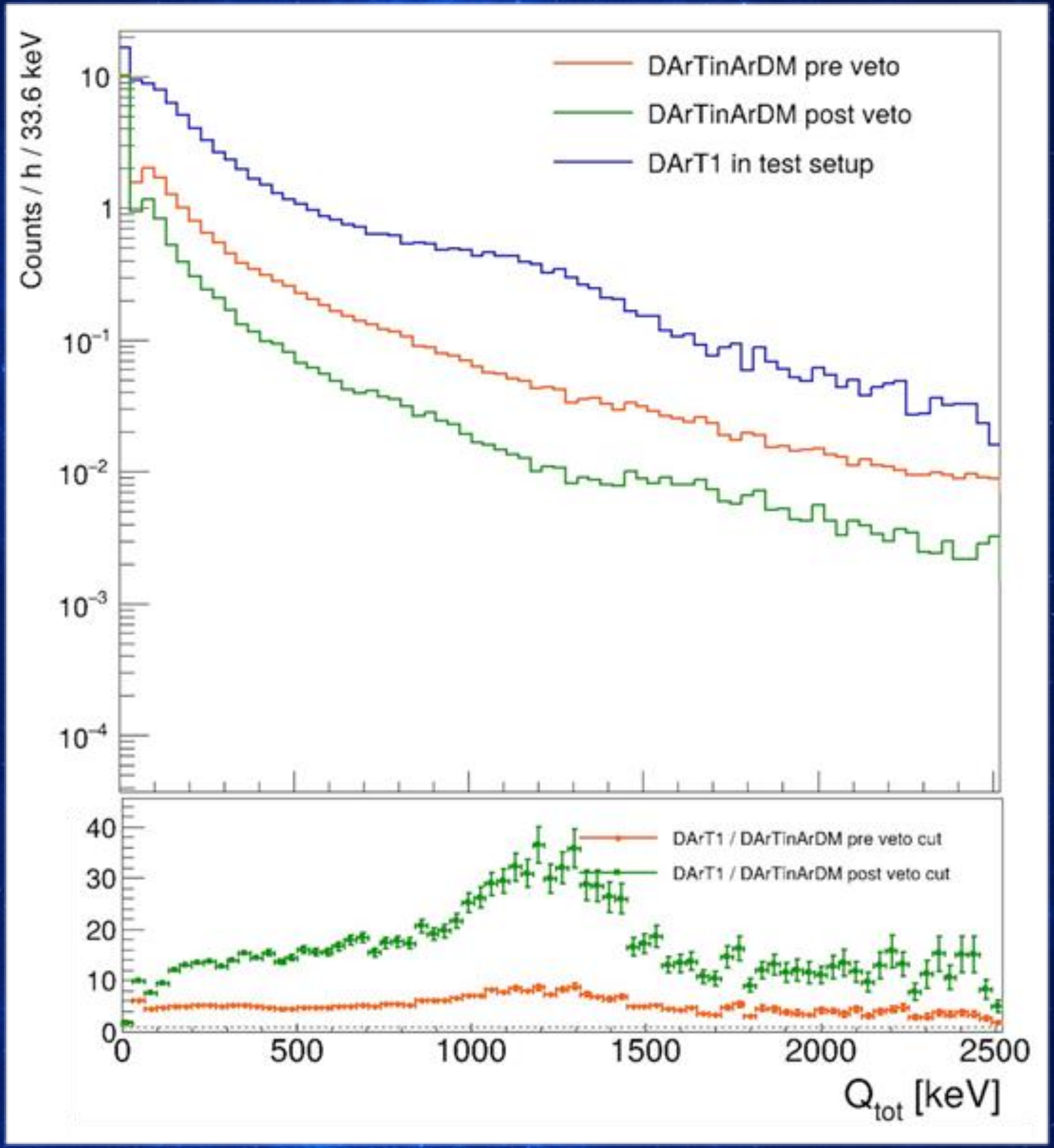
Integral of the peaks	Live time	Rate (Hz)
# ^{222}Rn = 26760 events	397.06 h	0.018
# ^{218}Po = 23698 events	397.06 h	0.016
# ^{214}Po = 9383 events	397.06 h	0.006

Rn emanation :

Alphas are out of the region of interest, but the betas of ^{214}Pb and ^{214}Bi are not

DArT Analysis: ArDM Veto Cut





Veto tagging :

97% from outside (MC)

91% from BiPo (Data)

(Preliminary!)

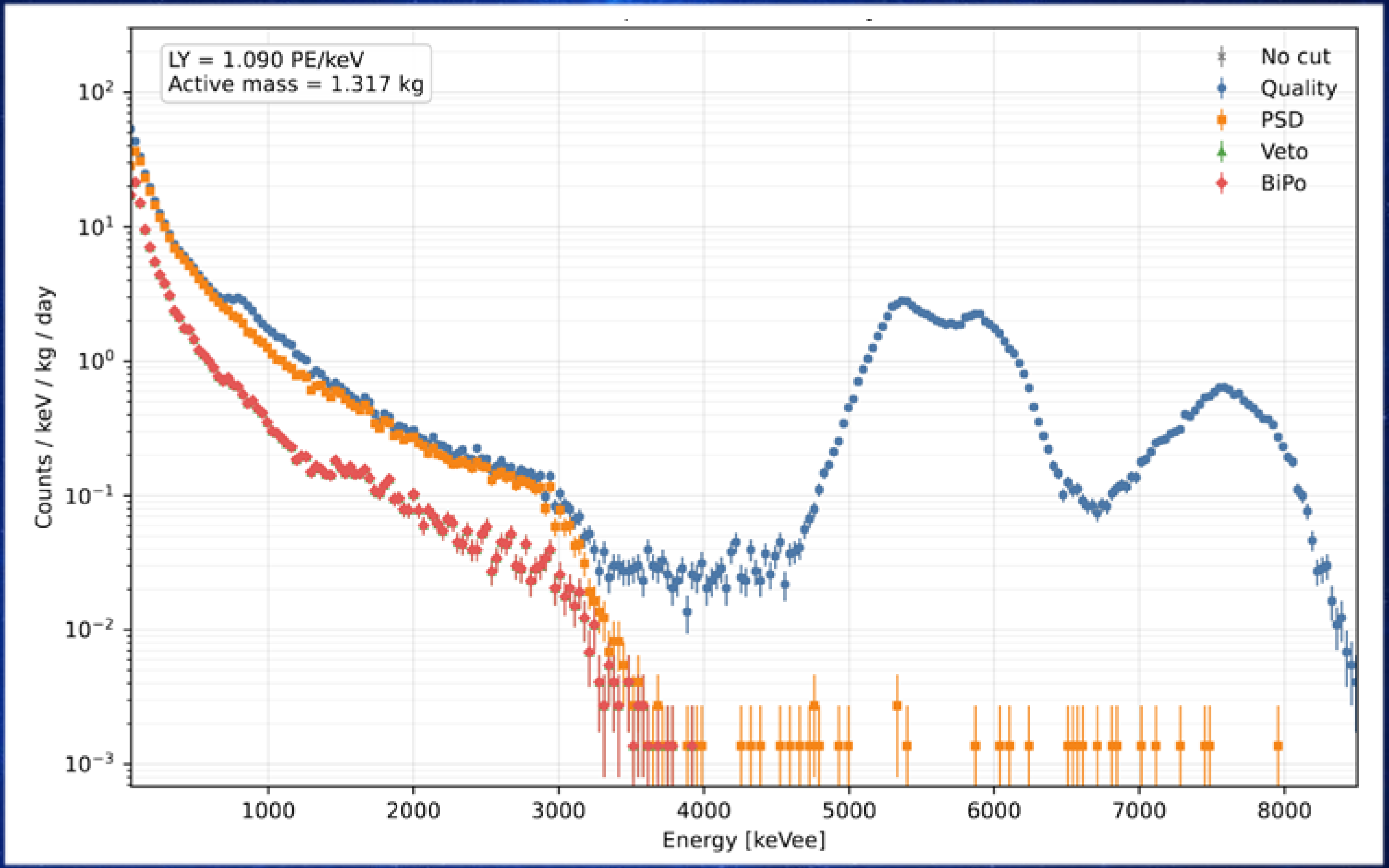
DArT Analysis: Analysis Cuts

Analysis cuts:

- **ArDM** (int./ext γ)
- **PSD** (α rejection)
- **BiPo** (Bi-214 rejection)

Rate after analysis cuts:

~40 mBq



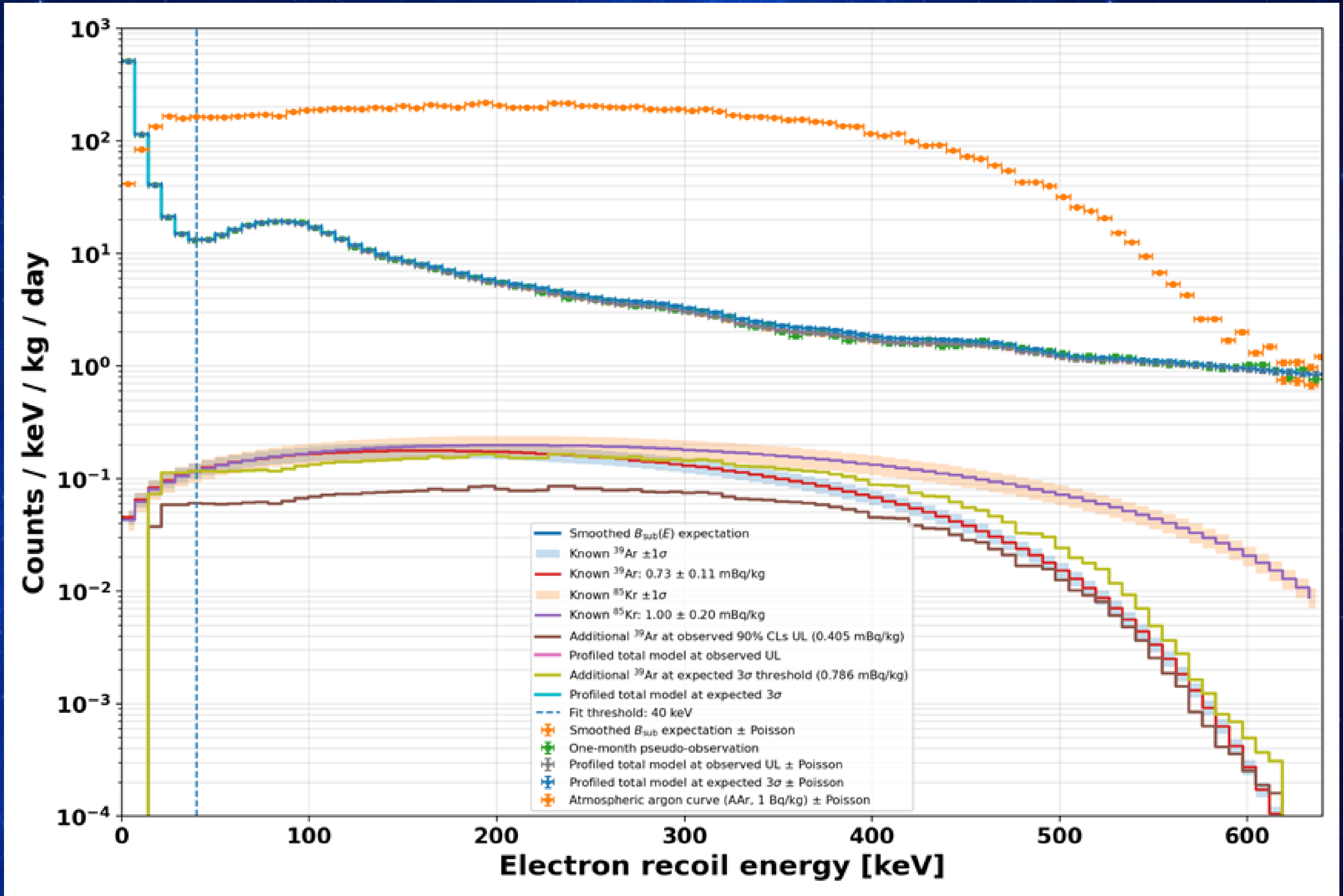
DArT Analysis: Sensitivity

We assess the sensitivity using the **asymptotic CLs method**, based on the **profile-likelihood ratio**.

We use AAr spectra and DarkSide-50 UAr data as reference distributions. The latter contains about 1 mBq/kg of ^{85}Kr and 0.7 mBq/kg of ^{39}Ar, known to about 20%.

Assuming one month of data taking, the expected 90% C.L. average upper limit (100 toys):

0.42mBq/kg at 90% C.L.



Conclusions

- The **pulse shape discrimination (PSD)** capabilities of Argon make it an ideal choice for the next generation of low-background experiments.
- **Atmospheric argon (AAr)** is unsuitable for the next generation of rare events searches due to its intrinsic **^{39}Ar** activity.
- **Underground Argon (UAr), strongly depleted in ^{39}Ar,** addresses this limitation.
- An ambitious program is underway **to extract, purify and characterize ~120 tonnes of UAr**.
- This year, fresh UAr will be extracted using the **URANIA** plant.
- The **ARIA** facility will chemically purify UAr at a rate of **1 tonne/day**.
- **DArT-in-ArDM**, commissioned with **AAr** and now with **UAr (Ds-50)** for more than two months, is **ready to assay the intrinsic activity of the full UAr production for DarkSide-20k.**
- **UAr** will have a pivotal role **DM searches, 0νbb, CEνNS** and more. Stay tuned!

Backup

ICP-MS Analysis With the UAr of Ds-50

Experimental Setup

There are some masses, corresponding to the most abundant elements in the gas and its interferences, that the ICP-MS doesn't measure → **Forbidden Masses**

The ICP-MS has two different working modes:

- **Standard mode** (STD).
- **With collision cell**: to reduce the spurious signal given by polyatomic ions: collision with a non-reactive gas (He). This process is called kinetic energy discrimination (KED).

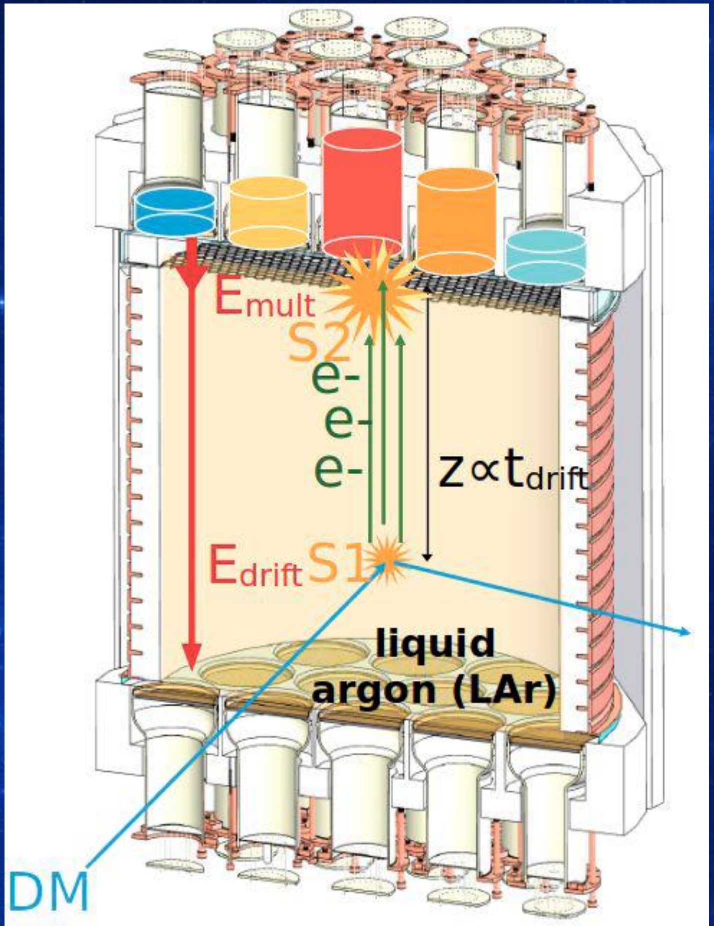
In KED mode some masses forbidden in STD mode can be measured.

Dual-phase TPCs

Massive targets

Scintillation detected promptly (S1)

Uniform E field to measure ionization: prevents recombination + drifts e- to anode



e- extracted to gas phase in stronger field to induce electroluminescence (S2

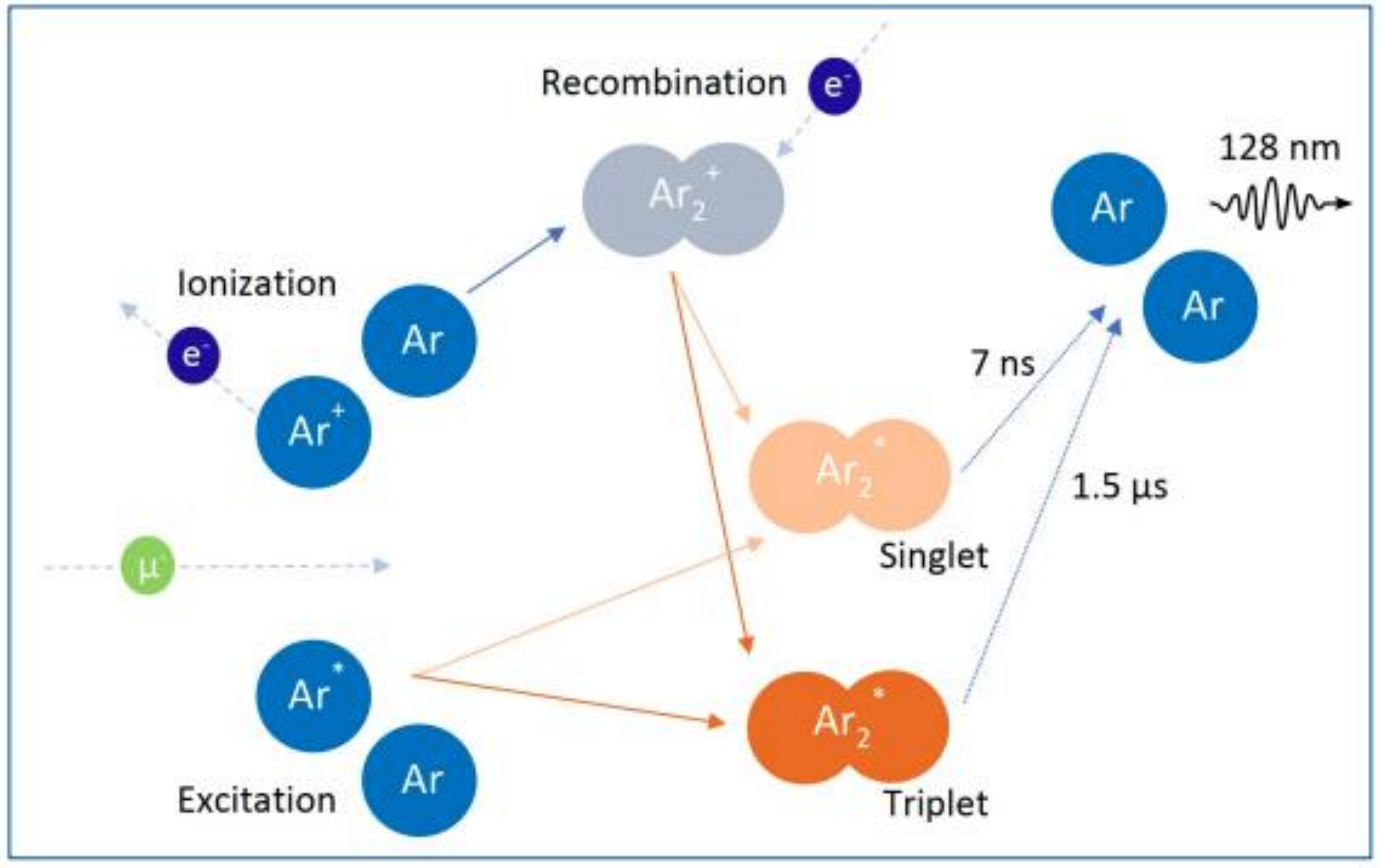
light pattern in detection plane provides XY information

Time difference between S1 and S2 provides Z info (mm resolution)

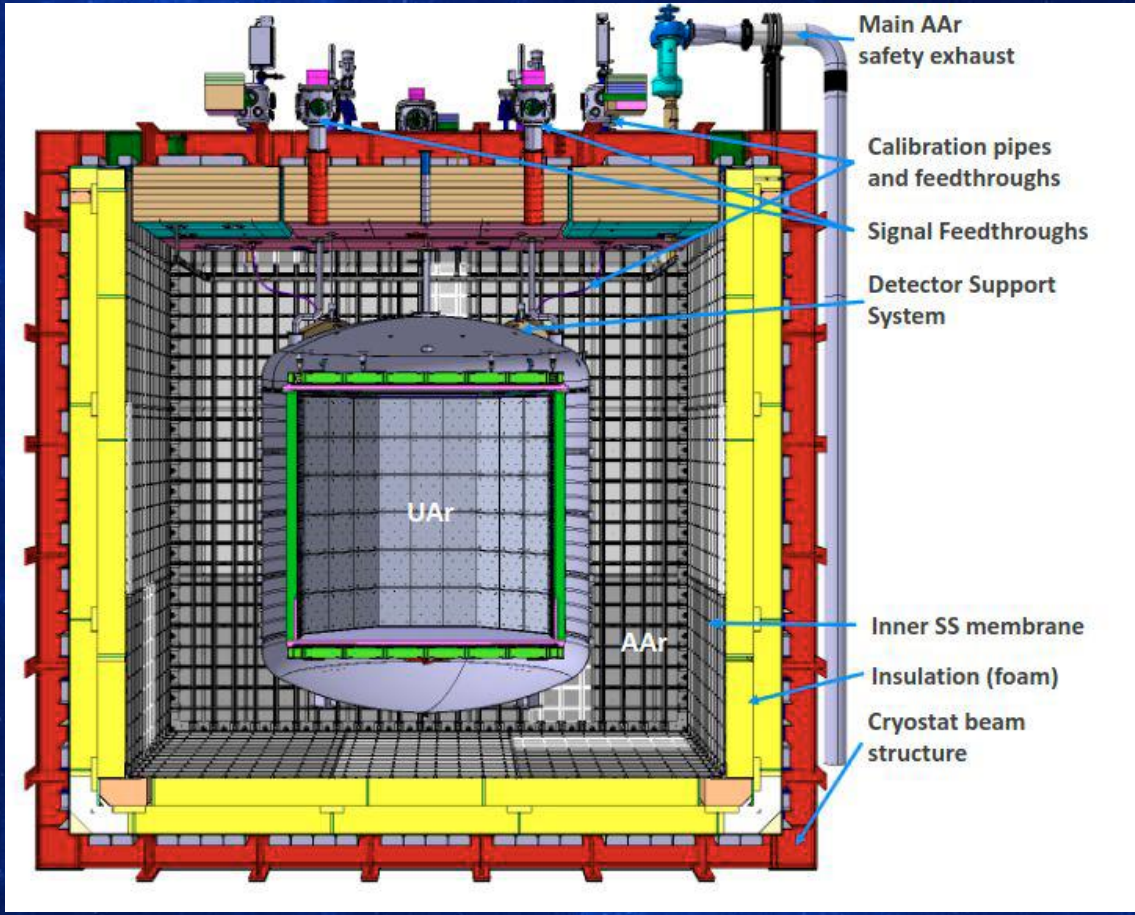
S2/S1 provides particle discrimination

At low E, S1 and S2 almost featureless:
Unambiguous identification of S1-S2 necessary

Ar Excitation and ionization process



DarkSide-20k



90 tonnes of UAr

50 TPC (20 fiducial) + 40 Veto

650 tonnes of AAr as buffer and muon veto

ProtoDune-like cryostat

21 m^2 of cryogenic & high QE & radiopure SiPM + electronics

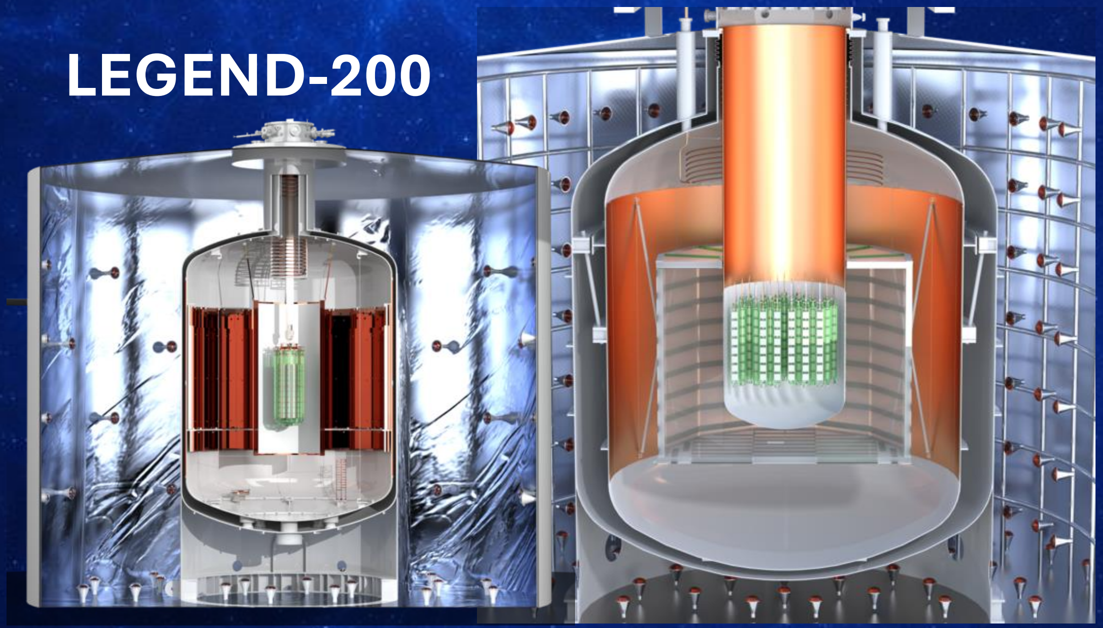
First detector of the Global Argon Dark Matter Collaboration

UAr in other experiments: Legend-1000

- **LEGEND-200**: Initial phase deploying ~200 kg of enriched germanium detectors (^{76}Ge) in liquid argon (LAr) at LNGS. Taking data with ~140 kg.
- **LEGEND-1000**: Planned to employ 1000 kg of ^{76}Ge in UAr.

LEGEND-1000

LEGEND-200



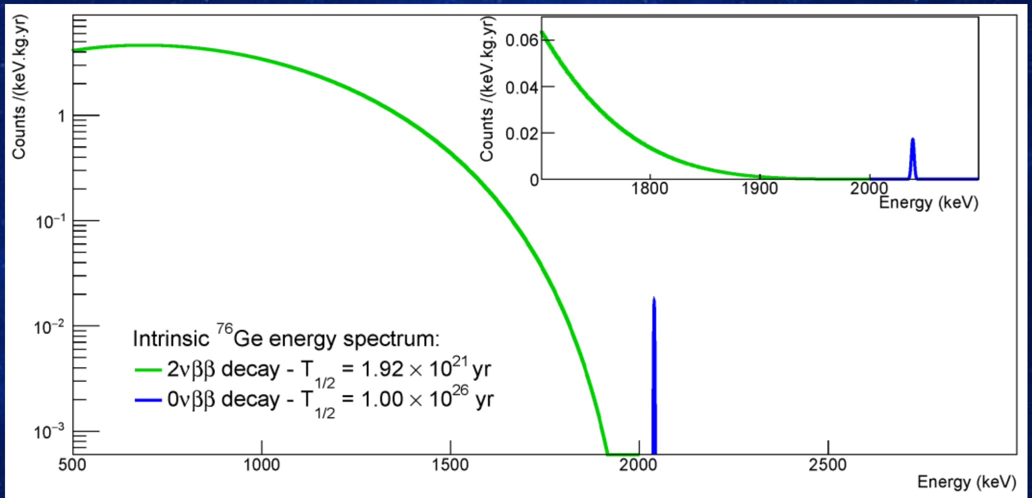
^{42}Ar

Intrinsic activity of ^{42}Ar in AAr

Cosmogenic: $^{40}Ar(\alpha, 2p)^{42}Ar$

- β^- decay to **^{42}K** with **Q_β = 599 keV**
- $t_{1/2}$ = 32.9 y
- 40.4 ± 5.9 μBq/kg
  - **^{42}K** is a β^- with a $t_{1/2}$ = 12.4 h
  - β^- decay to **^{42}Ca** with **Q_β = 3.5 MeV**

Same ROI of the $\beta\beta$ decay of ^{76}Ge: $Q_{\beta\beta}$ = 2.04 MeV



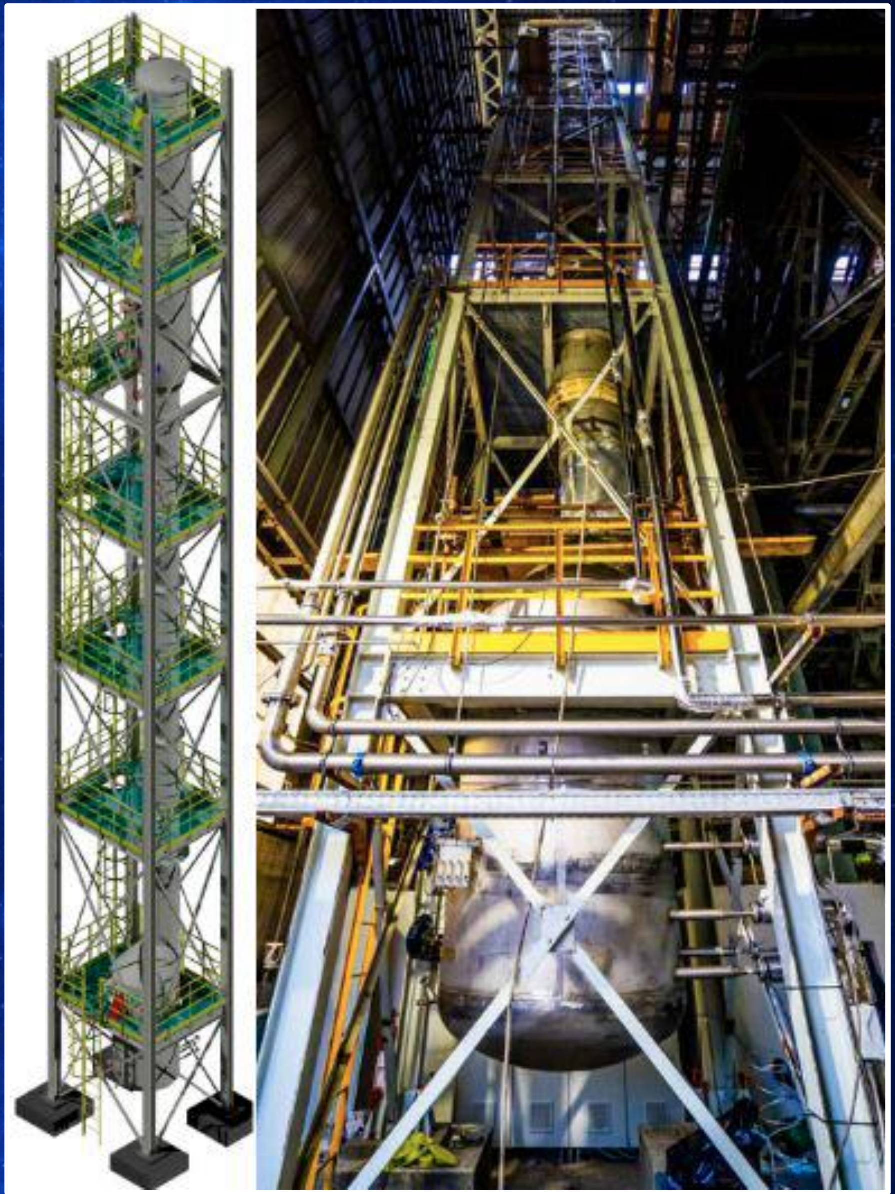
Aria ➡ Seruci-0

Reduced scale cryogenic distillation column (total ~26 m)

- 1 Central modules 12 m
- 1 Condenser top module: 7 m
- 1 Reboiler bottom module: 5 m

First operation with nitrogen in:
2019 Eur. Phys. J. C (2021) 81:359

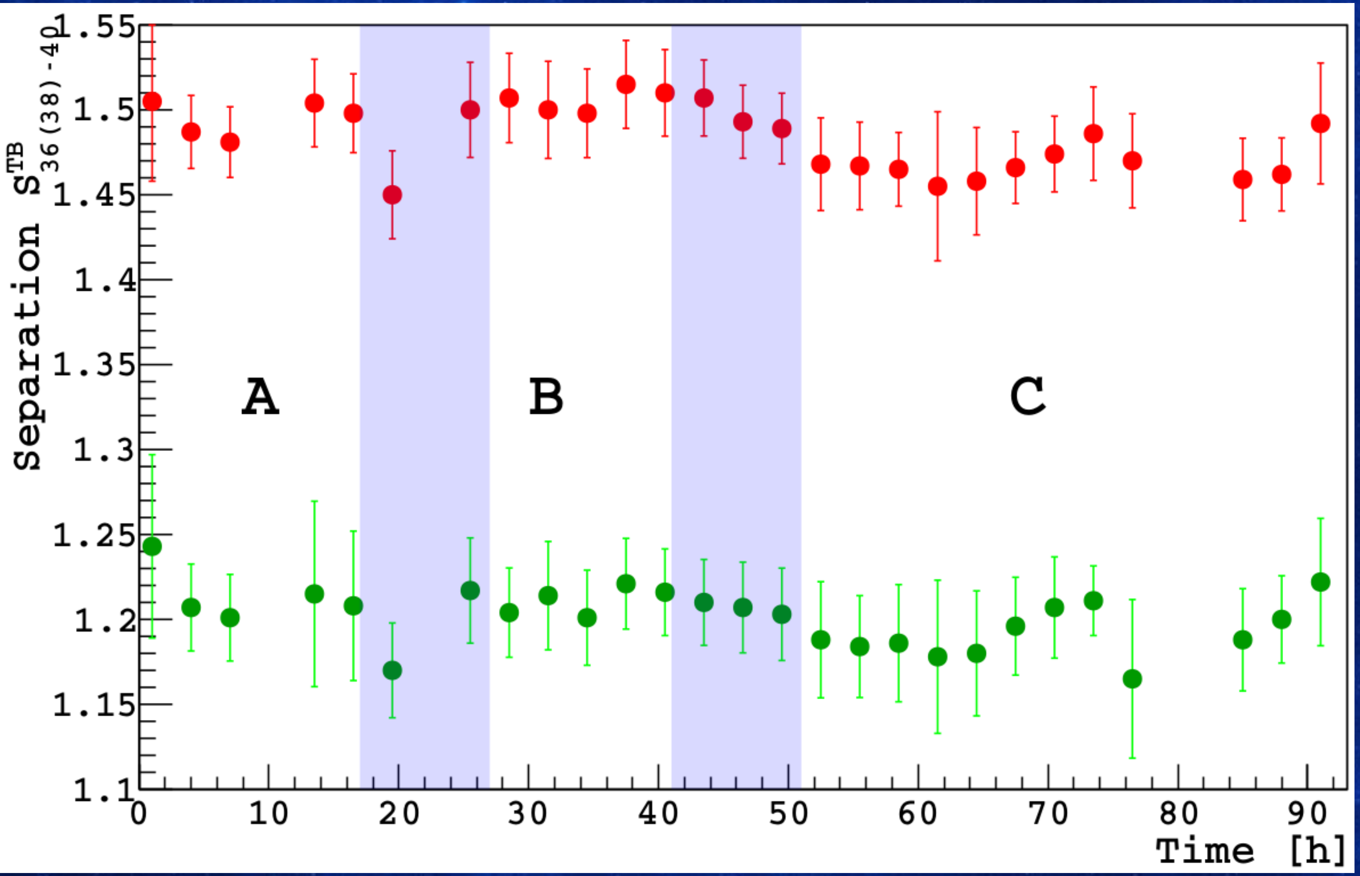
Second operation with argon in:
2021 Eur. Phys. J. C (2023) 83:453



Aria ➡ Seruci-0

Measurement of isotopic separation of argon with the prototype of the cryogenic distillation plant Aria for dark matter searches

Eur. Phys. J. C (2023) 83:453



$$S_{36-40} = S_{T-B} = \frac{\left(\frac{x_{36}}{x_{40}}\right)_T}{\left(\frac{x_{36}}{x_{40}}\right)_B}$$

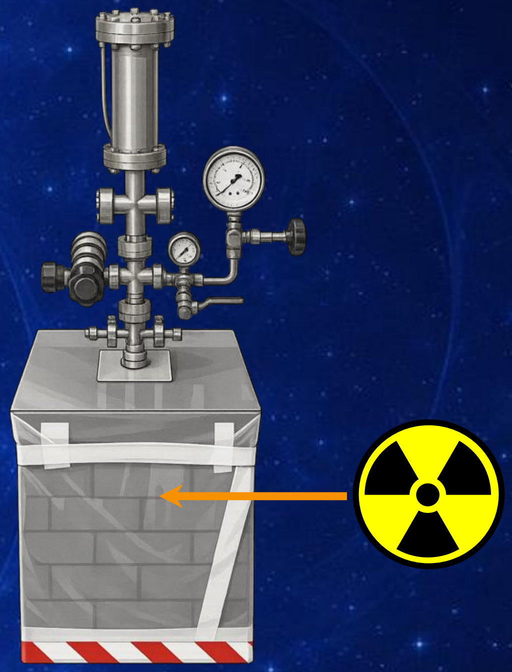
$$S_{38-40} = S_{T-B} = \frac{\left(\frac{x_{38}}{x_{40}}\right)_T}{\left(\frac{x_{38}}{x_{40}}\right)_B}$$

Radiogenic Characterization

DArT-1 (in test cryostat): Run Overview

Data Taking

- **Atmospheric Argon runs**: With **Argon 6.0**, 1 ppm impurity level
- **Underground Argon runs**: With **UAr** from **DarkSide-50**
- **^{137}Cs runs**: Adding a ^{137}Cs source (27 kBq) outside the cryostat inside the lead shield

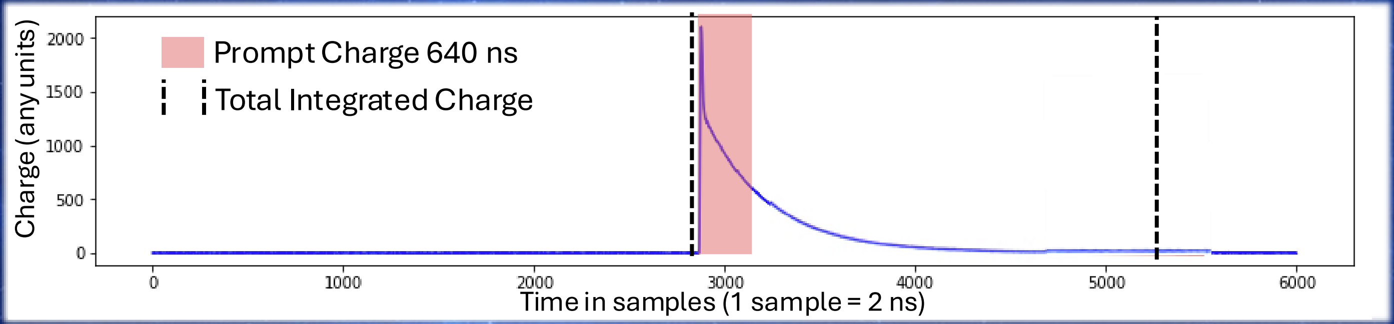


Prospect

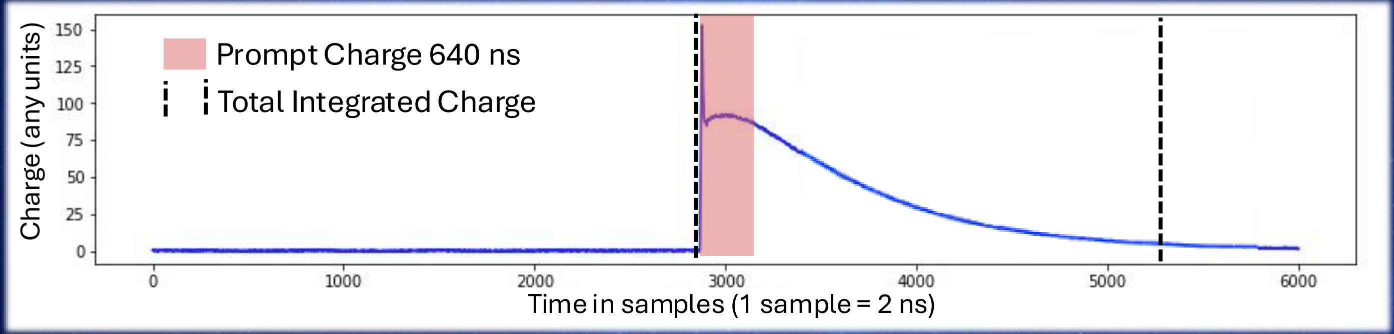
- **DArT-1 (in test cryostat) will operate in parallel to DArT-in-ArDM**
- Enabling **first , order-0 UAr quality check** before filling of the main detector

Demonstration of the Pulse shape discrimination with DS-20k SiPMs

α decay



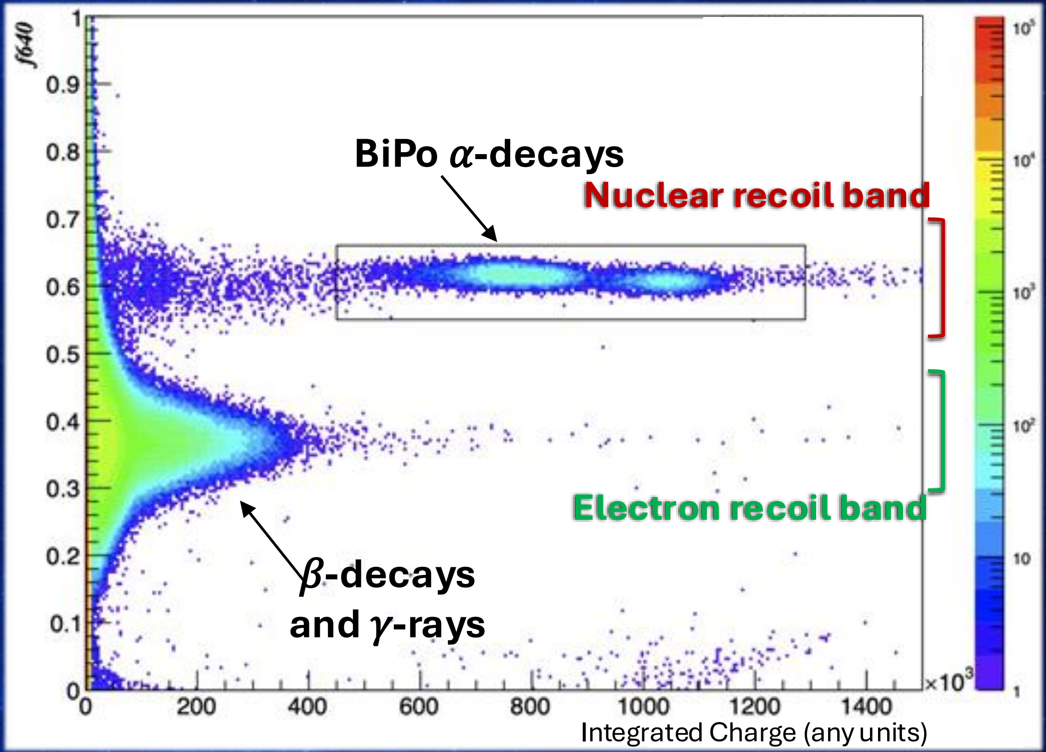
β or γ particle



To use this PSD tool of the Ar we define the following variable:

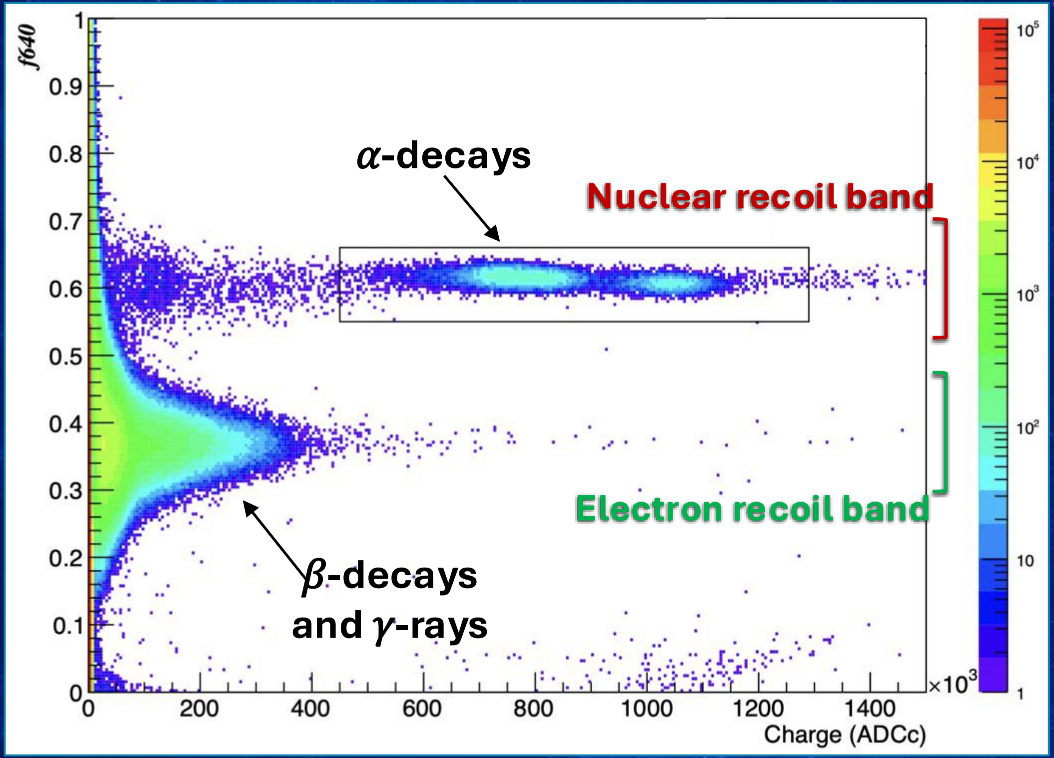
$$f_{640} = \frac{q_p}{q_T},$$

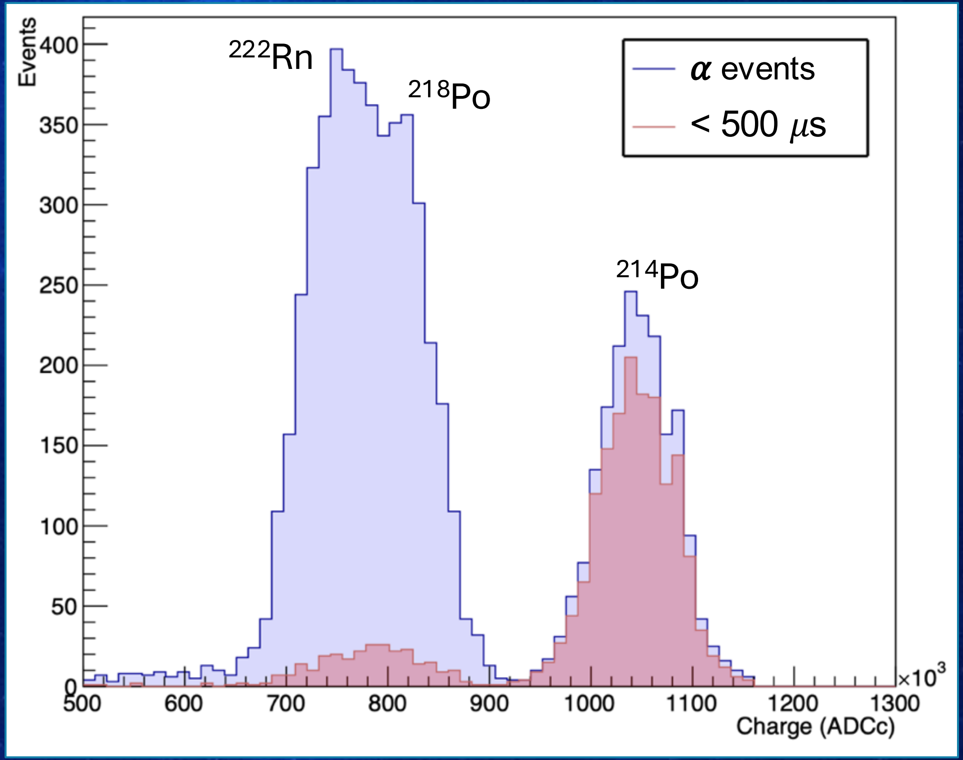
where q_p is the integrated charge in the first 640 ns and q_T is the total integrated charge.



Characterization of events in LAr

Pulse shape discrimination (PSD)



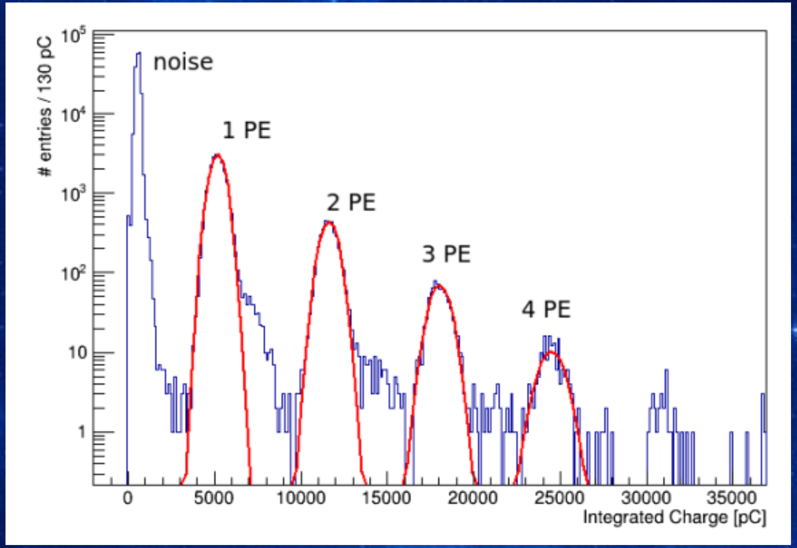


Measured $t_{1/2}(^{214}\text{Po}) = 166.6 \pm 2.6\ \mu s$

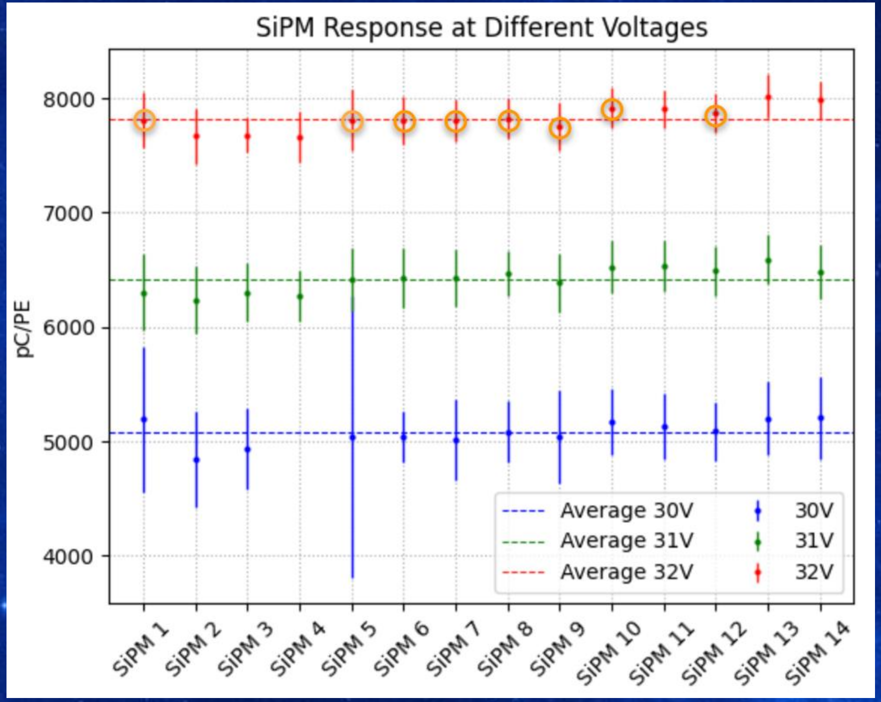
PSD + BiPo coincidence →

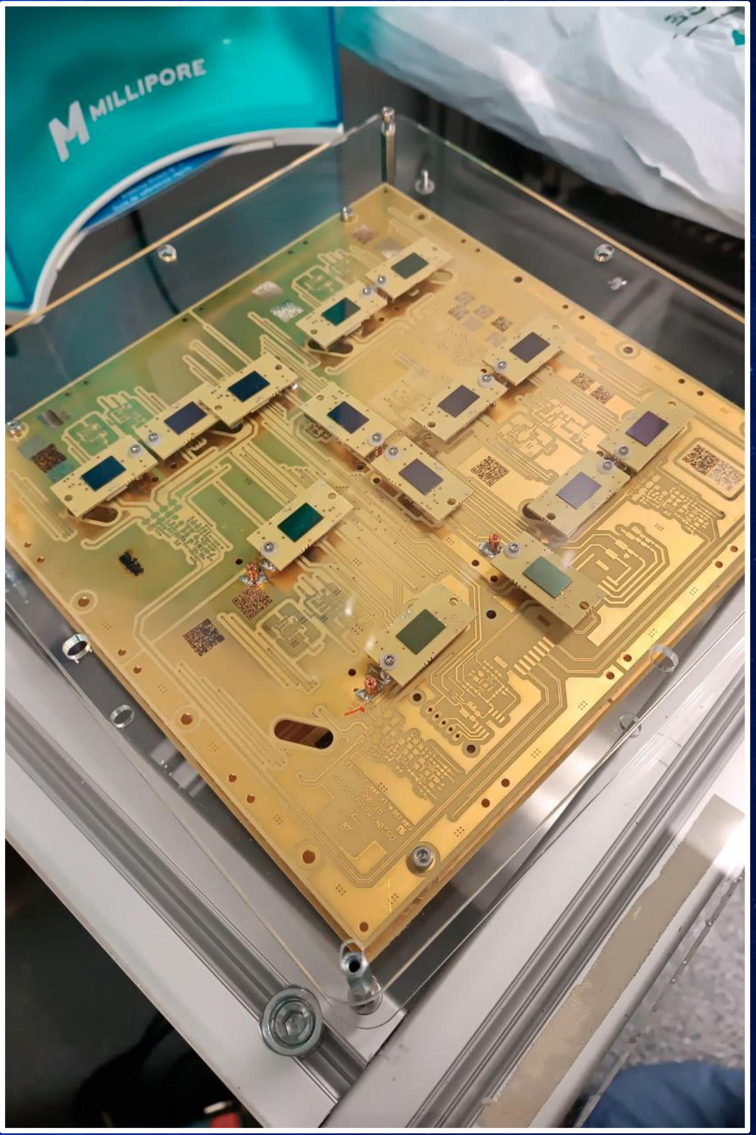
Compatible with the value measured with more precise experiments: $t_{1/2}(^{214}\text{Po}) = 164.3\ \mu s$

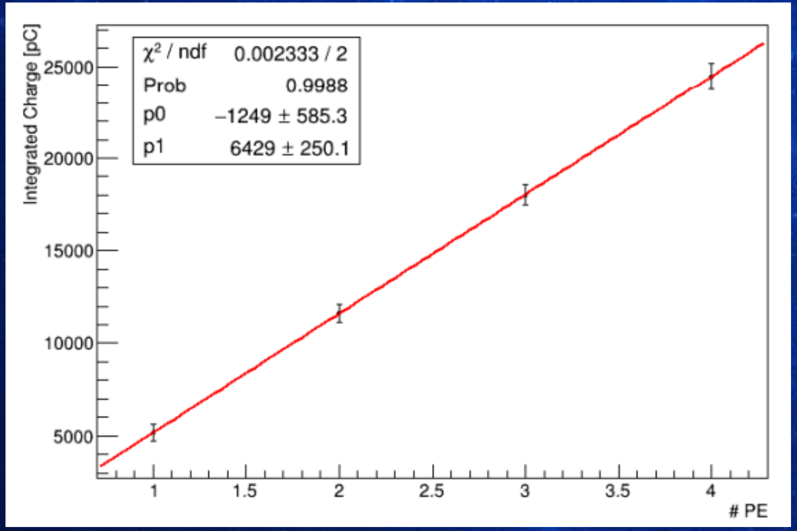
DArT-2.0: Characterization of the SiPM



SiPMs with similar response were selected based on their performance in cold.





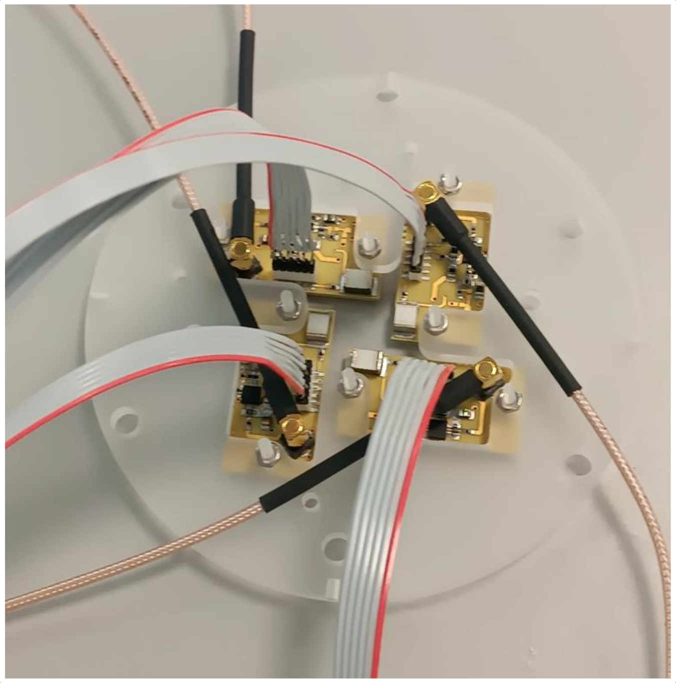


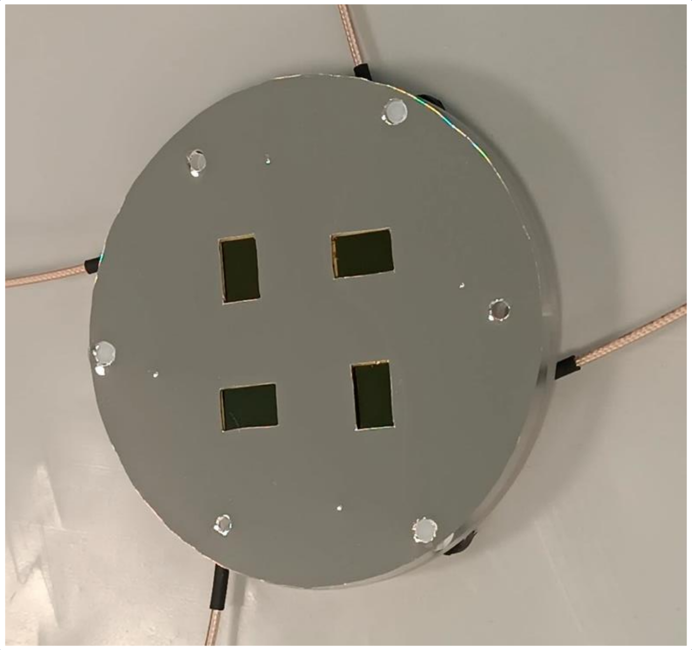
DArT-2.0: Cleaning and assembly

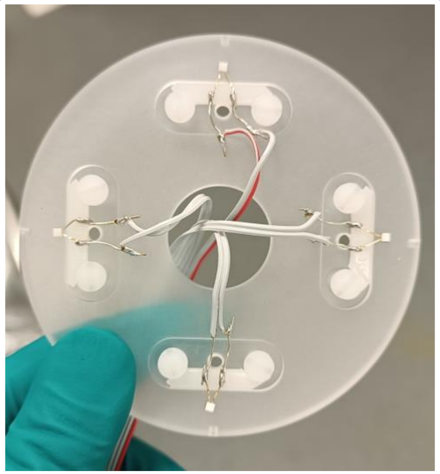
All the manipulations on DArT-2 performed in clean rooms/clean tents of LSC.

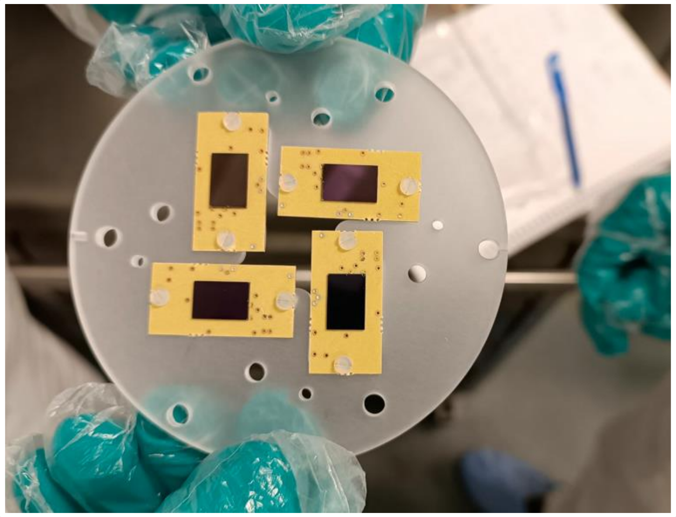
Exhaustive cleaning, specially of the metal parts: degreasing and rinsing in ultra sonic bath, etching and passivation.

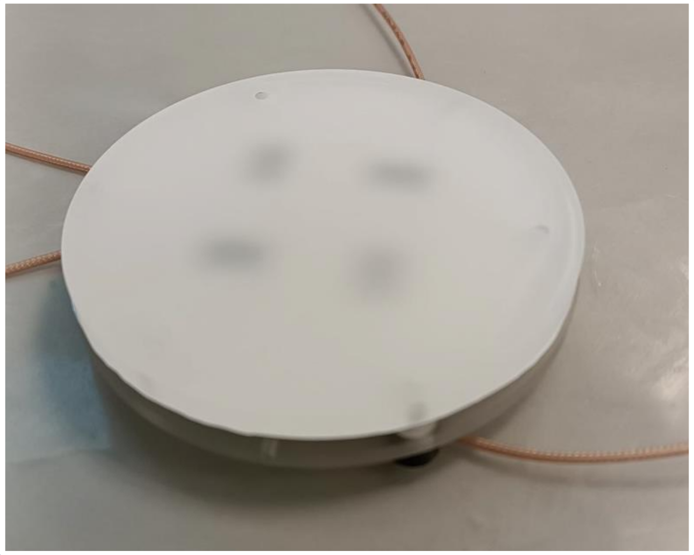
DArT-2.0: Assembly SiPM planes and reflector

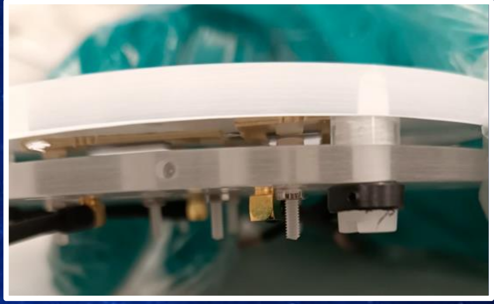






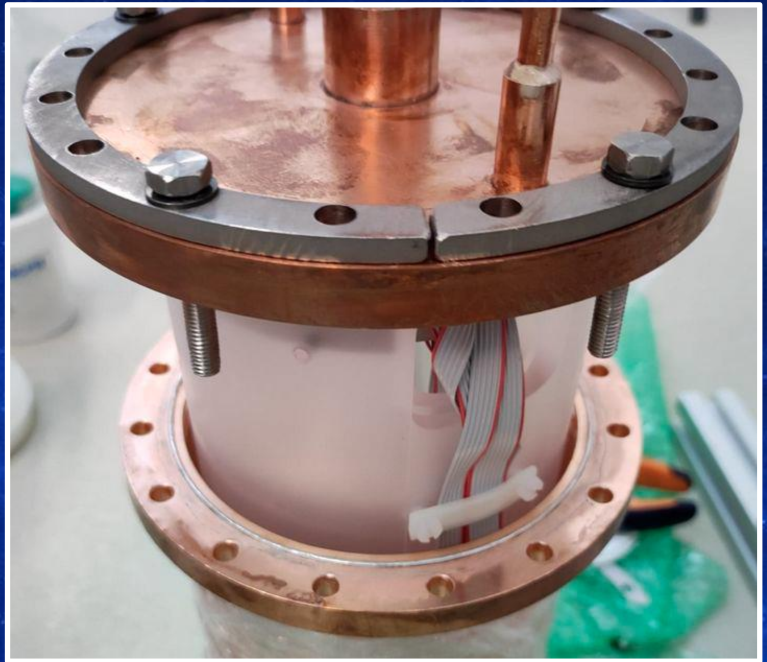


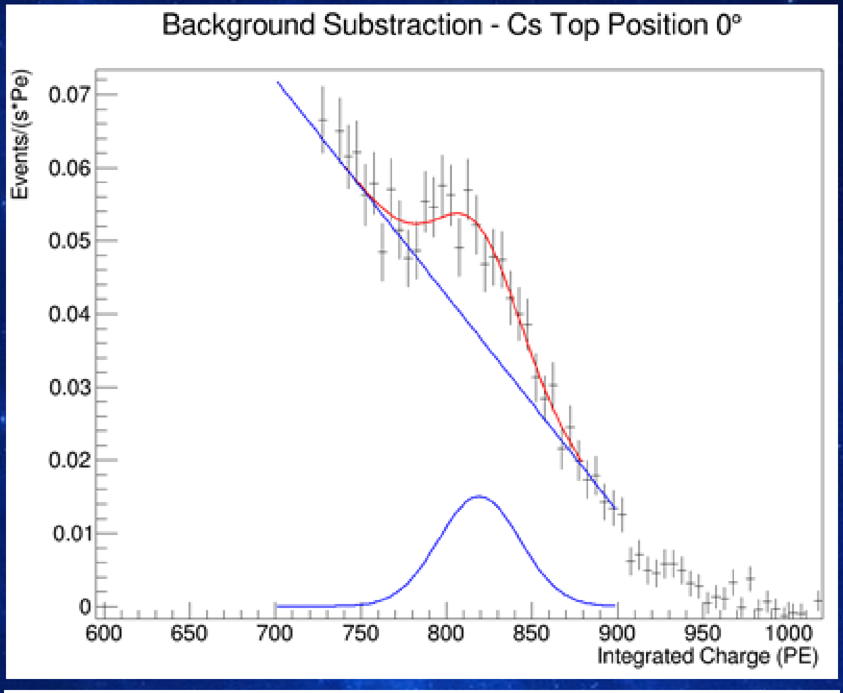




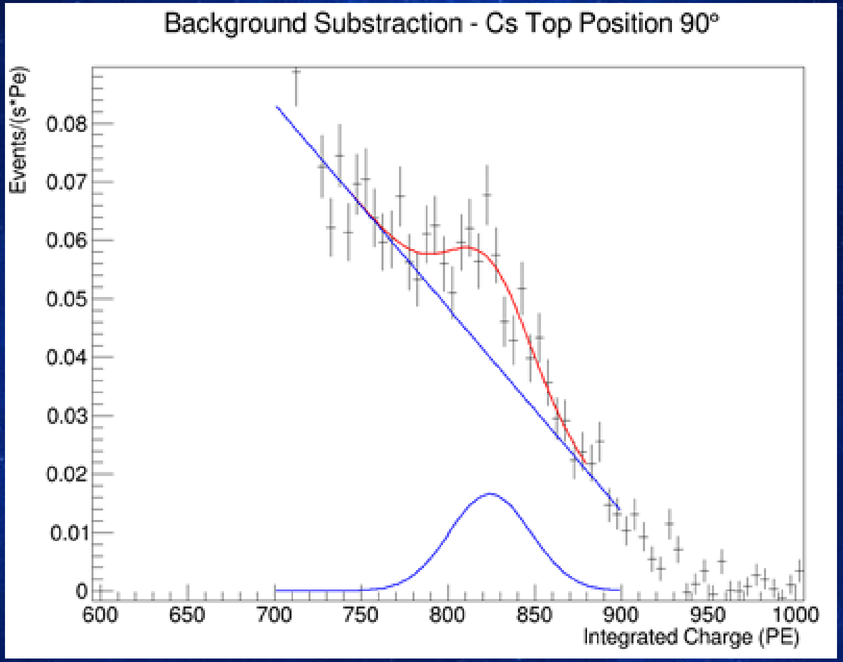
DArT-2.0: Closing the detector

Indium closure done:
Tight at 10^{-9} mbar l / s

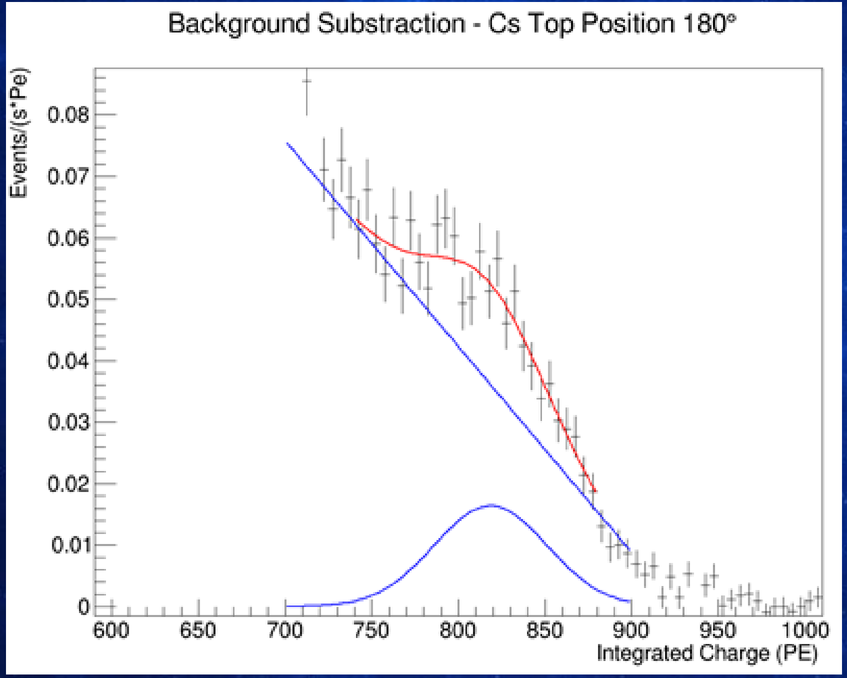




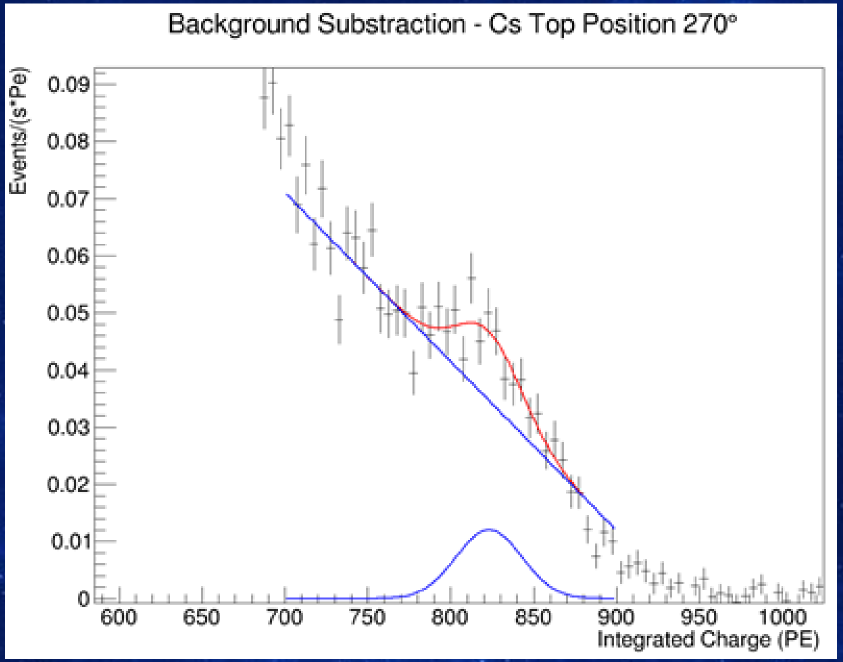
μ= 819 ± 4
σ= 24 ± 4
χ^2 = 16.0
NDf= 23



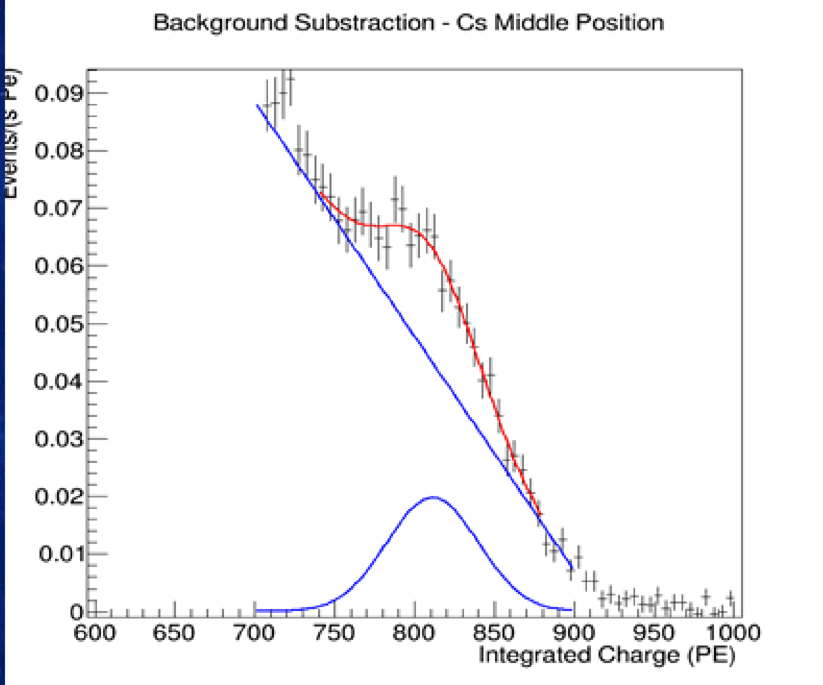
μ= 824 ± 4
σ= 23 ± 7
χ^2 = 26.5
NDf= 23



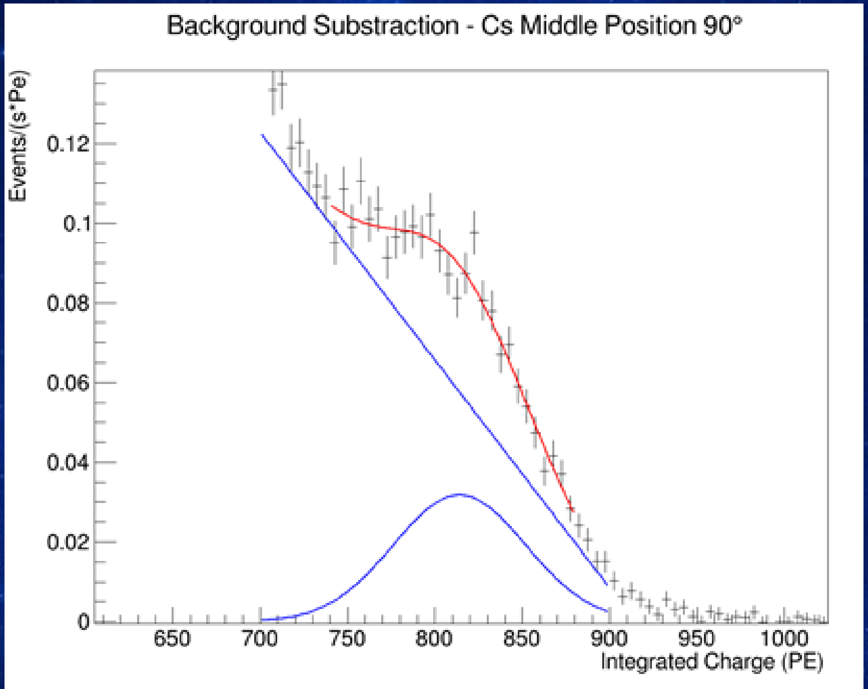
μ= 818 ± 7
σ= 32 ± 11
χ^2 = 22.3
NDf= 23



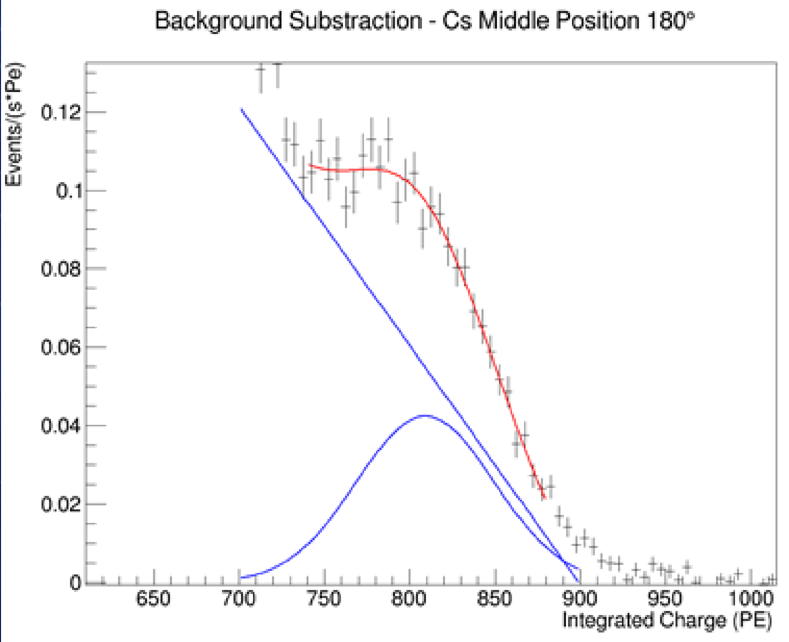
μ= 823 ± 4
σ= 20 ± 5
χ^2 = 25.0
NDf= 23



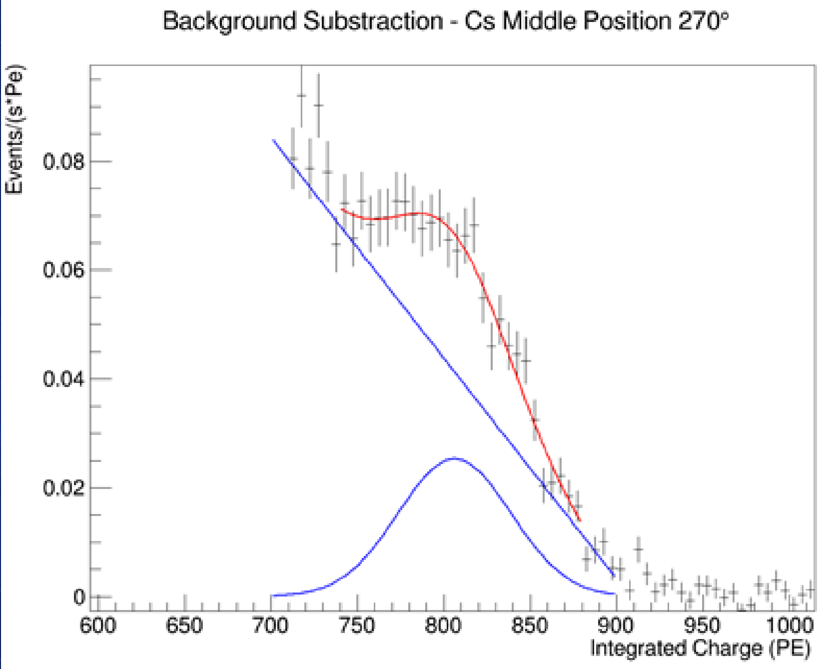
$\mu = 811 \pm 3$
$\sigma = 29 \pm 5$
$\chi^2 = 10.6$
NDf= 23



$\mu = 814 \pm 5$
$\sigma = 38 \pm 12$
$\chi^2 = 28.3$
NDf= 23



$\mu = 809 \pm 5$
$\sigma = 40 \pm 9$
$\chi^2 = 20.5$
NDf= 23



$\mu = 806 \pm 5$
$\sigma = 32 \pm 7$
$\chi^2 = 19.8$
NDf= 23

Calibration Measurements

Cs Position	Calibration (PE/keV)
Top Position 0º	1.24 ± 0.01
Top Position 90º	1.25 ± 0.01
Top Position 180º	1.24 ± 0.01
Top Position 270º	1.24 ± 0.01
Middle Position 0º	1.23 ± 0.01
Middle Position 90º	1.22 ± 0.01
Middle Position 180º	1.22 ± 0.01
Middle Position 270º	1.21 ± 0.01

- Coincidence in all runs
- Systematic errors

Mean calibration = 1.23 ± 0.01 PE/keV

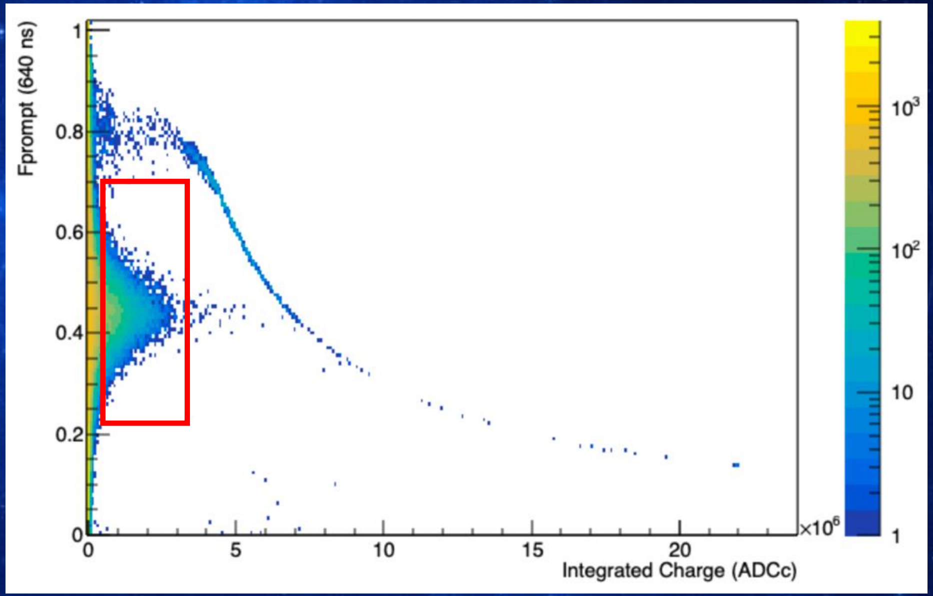
UAR activation

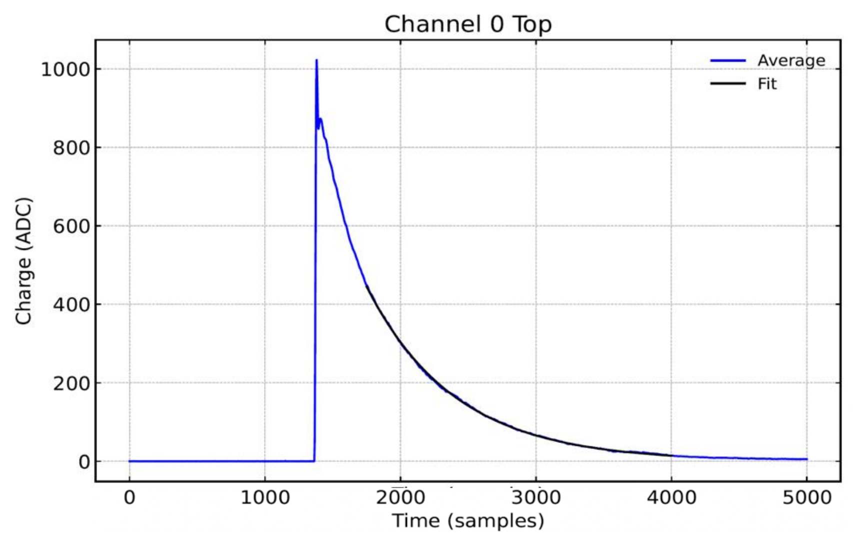
Calculations done by Susana Cebrián (UNIZAR), to be compare with **0.7 mBq/kg**, the activity of the UAR.

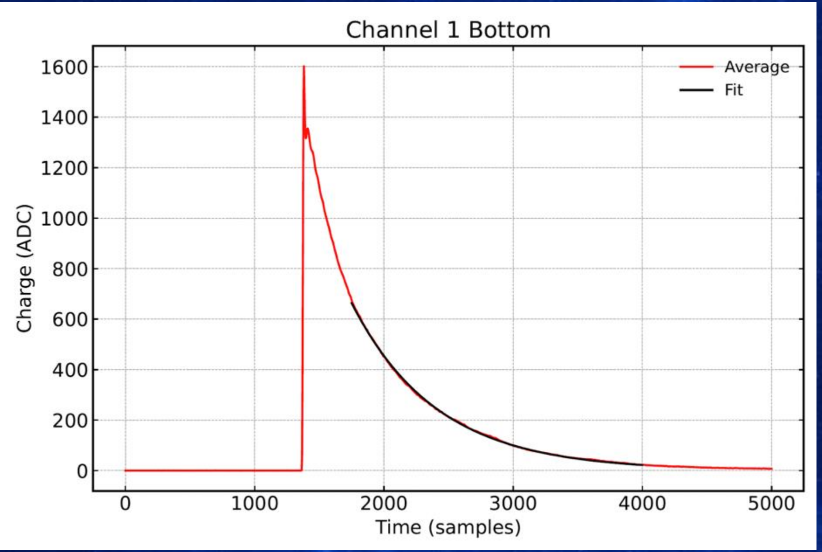
					Flight 8 h		Flight 12 h		Sea level 15 d		Sea level 30 d		Sea level 45 d	
Isotope		R	err	f flight	A	err	A	err	A	err	A	err	A	err
		(kg-1 d-1)			(microBq/kg)		(microBq/kg)		(microBq/kg)		(microBq/kg)		(microBq/kg)	
39Ar	n	759	128	257.5	5.324	0.898	7.985	1.347	0.930	0.157	1.860	0.314	2.790	0.471
	mu	172	26	18.0	0.085	0.013	0.127	0.019	0.211	0.032	0.422	0.064	0.632	0.096
	p	3.6	2.2	956.4	0.094	0.057	0.141	0.086	0.004	0.003	0.009	0.005	0.013	0.008
	g	113	21	169.2	0.520	0.096	0.780	0.144	0.138	0.026	0.276	0.051	0.415	0.077
	total	1048	133		**6.02**	**0.90**	**9.03**	**1.36**	**1.28**	**0.16**	**2.57**	**0.32**	**3.85**	**0.49**
		(from R. Saldanha et al, PRC 100, 024608 (2019)												
3H	n	168	53	257.5	**25.7**	**8.1**	**38.6**	**12.2**	**4.5**	**1.4**	**9.0**	**2.8**	**13.4**	**4.2**
		(DS estimate)												
					Flight 8 h		Flight 12 h		Sea level 15 d		Sea level 30 d		Sea level 45 d	
Isotope		R	err	f flight	A	err	A	err	A	err	A	err	A	err
		(kg-1 d-1)			(mBq/kg)		(mBq/kg)		(mBq/kg)		(mBq/kg)		(mBq/kg)	
37Ar	n	51	7.4	257.5	1.000	1.000	1.497	0.217	0.152	0.022	0.264	0.038	0.348	0.051
	p	1.3	0.4	956.4	0.095	0.029	0.142	0.044	0.004	0.001	0.007	0.002	0.009	0.003
	g	3.5	0.7	169.2	0.045	0.009	0.067	0.013	0.010	0.002	0.018	0.004	0.024	0.005
	th n	0.9	0.3	257.5	0.018	0.006	0.026	0.009	0.003	0.001	0.005	0.002	0.006	0.002
	total	56.7	7.5		**1.16**	**1.00**	**1.73**	**0.22**	**0.17**	**0.02**	**0.29**	**0.04**	**0.39**	**0.05**
		(from R. Saldanha et al, PRC 100, 024608 (2019)												

Triplet lifetime study

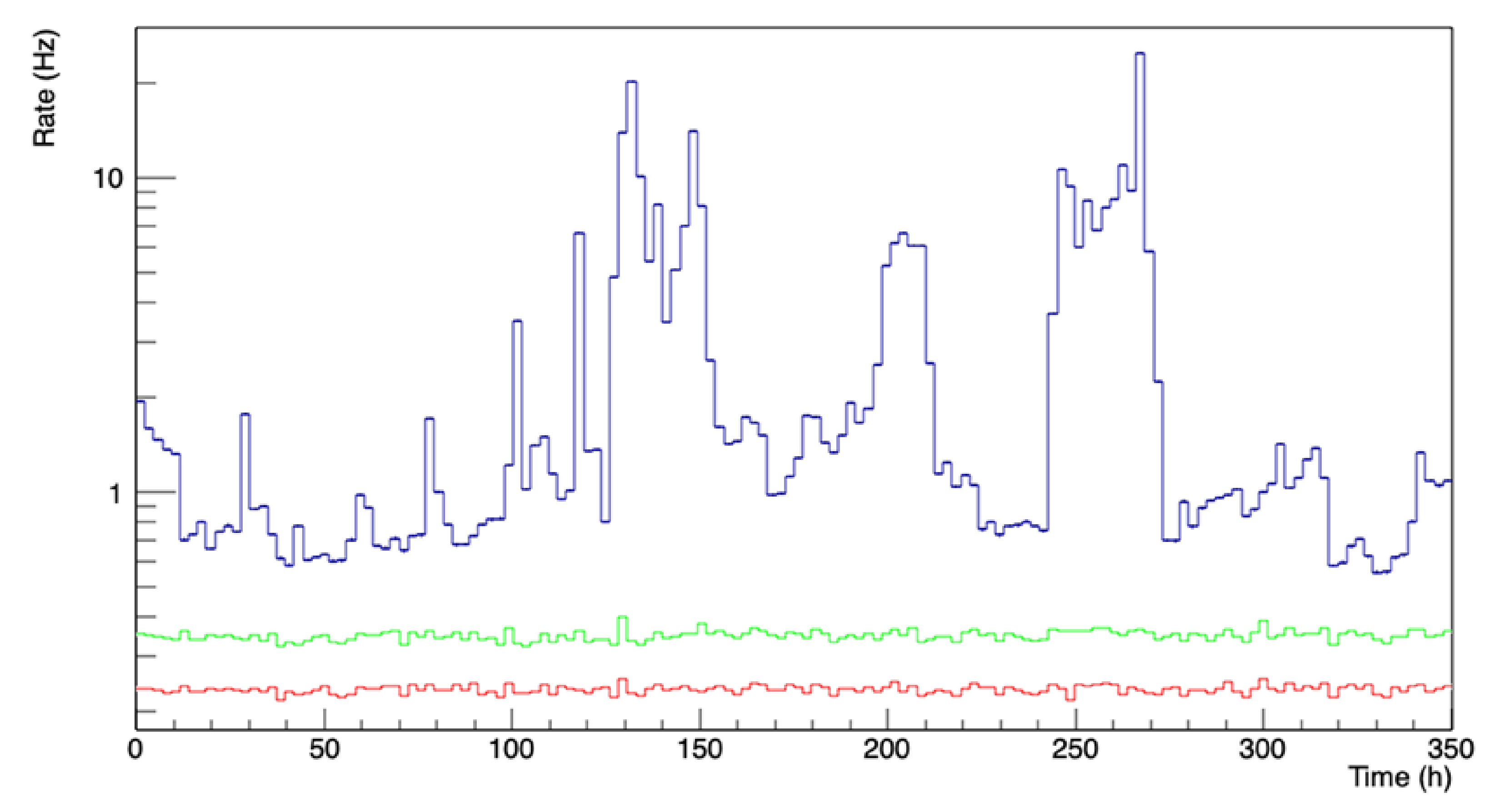
Selecting events in the beta region, averaging them, and then fitting the results with an exponential function allows us to track the evolution of the triplet lifetime (τ_3).







DArT Analysis: alphas



Event rate during the UAr run before and after the basic noise-rejection selection.

Stable residual rate of ~240 mHz

(Q_{TOT} > 40 pe)

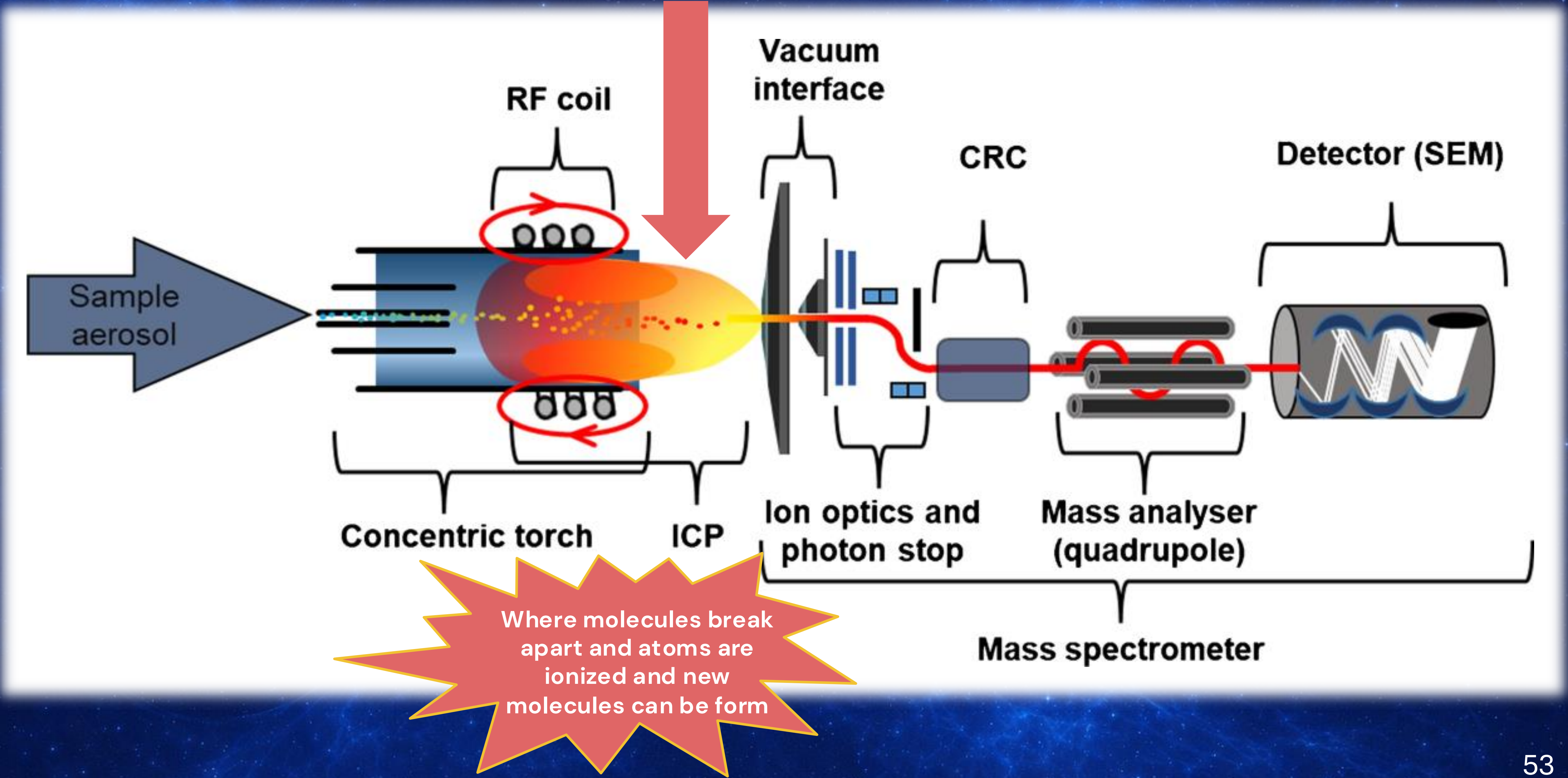
51

ICP-MS

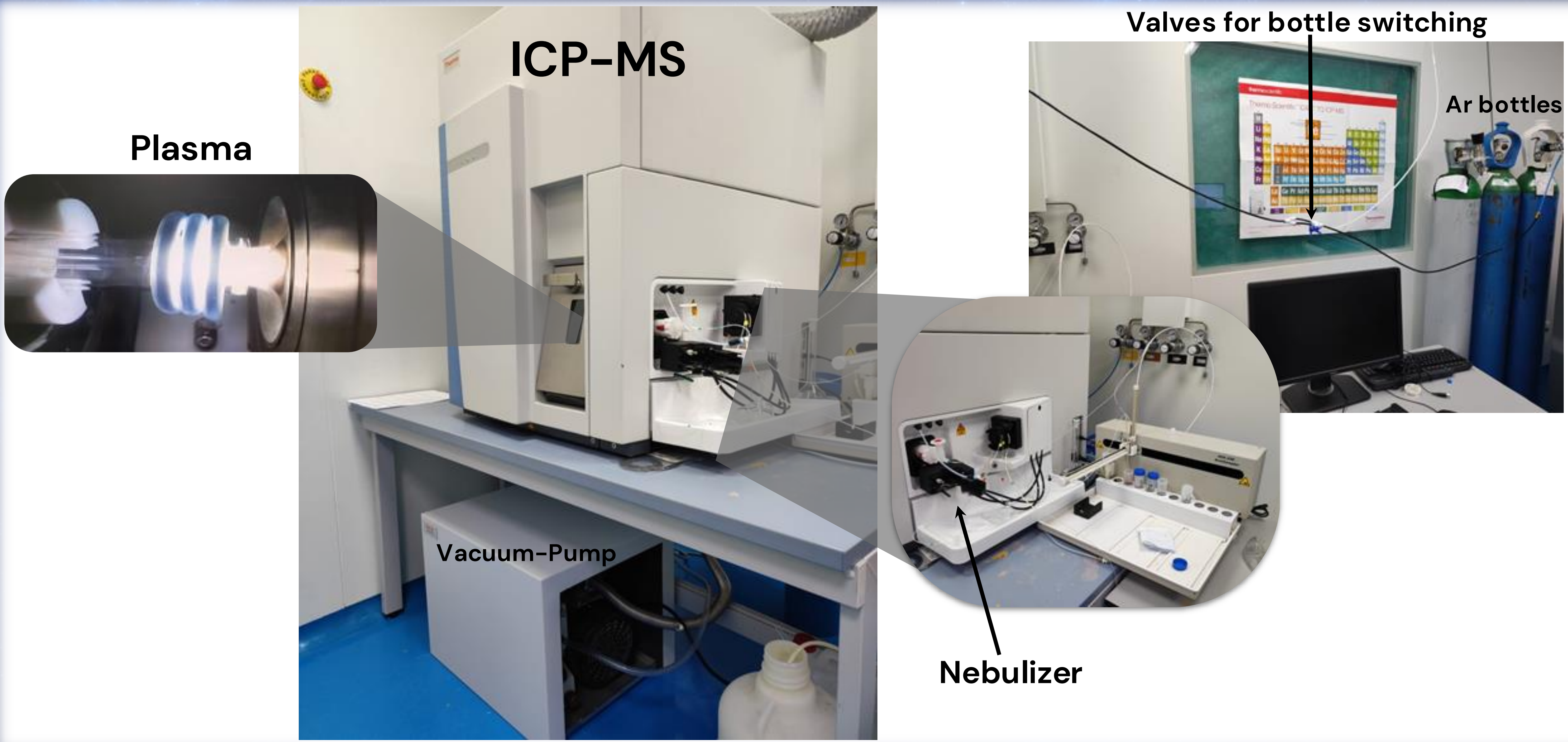
Chemical Characterization

ICP-MS scheme

Plasma generated using Ar gas



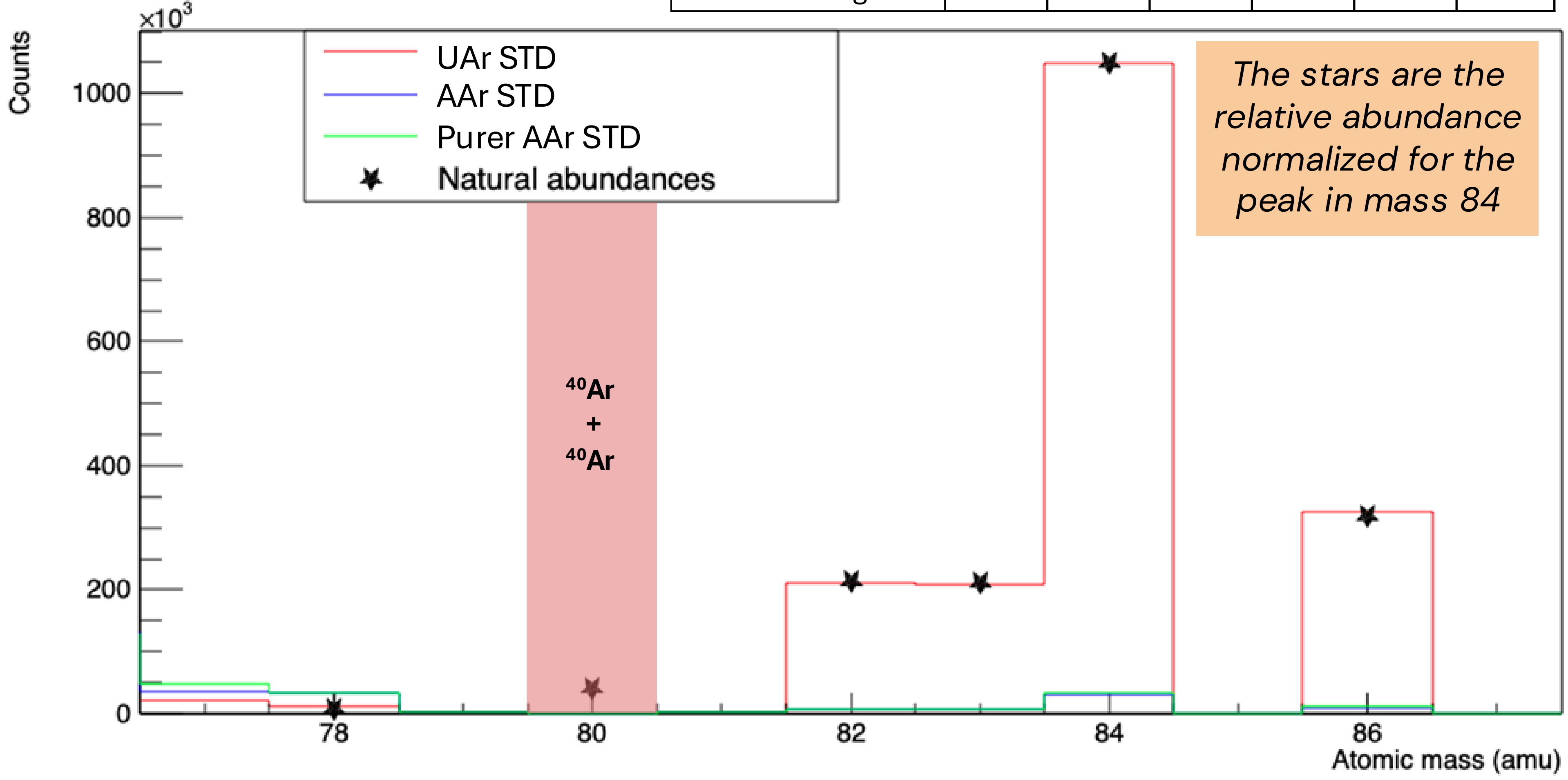
Our experimental setup



Measurement of DarkSide-50 UAr

ICP-MS in Standard mode

	Natural abundances					
Atomic mass	78	80	82	83	84	86
Percentage	0.35	2.25	11.6	11.5	57.0	17.3



The presence of Kr in the UAr of DarkSide-50 is confirmed.

Monitoring mass 84 with ICP-MS