DARKSIDE-50

2014 - 2019

Severino,sm,Simone Sanfilippo 3p/2.0FTE

Computing: (sm,sb)

- computing model
- data transfer LNGS <-> CNAF <-> FermiLab
- data management
- reconstruction

PMT: potting , testing (+studenti)

Analisi: S1/S2 , PSD… (+studenti)

DarkSide program at CNAF

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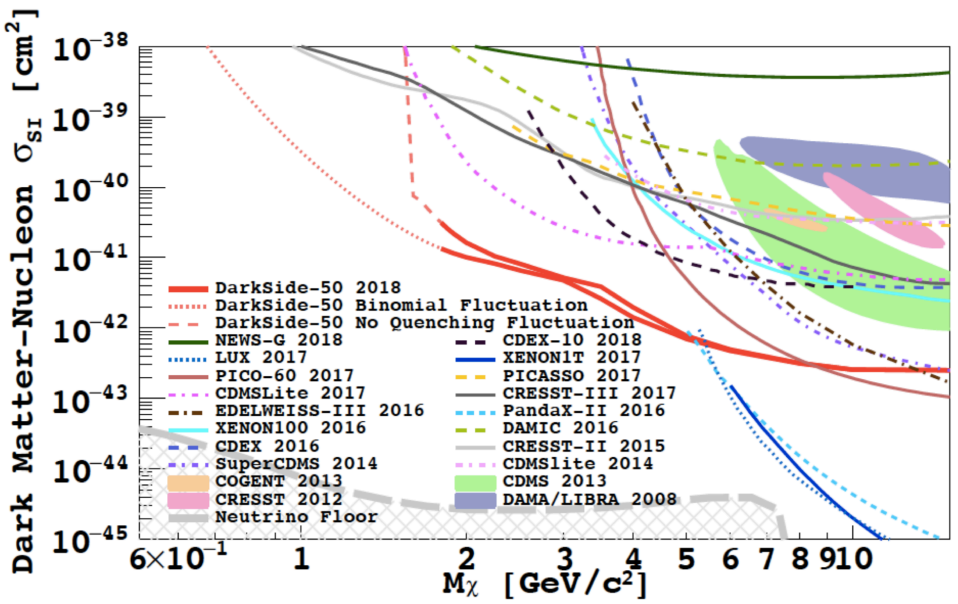
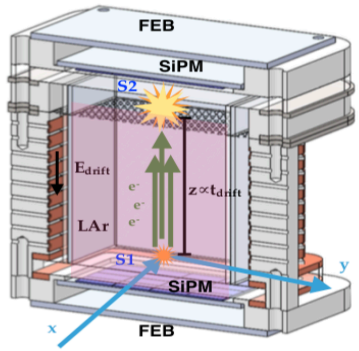
Abstract.
DarkSide is a direct dark matter research program based at the underground Laboratori Nazionali del Gran Sasso (*LNGS*) and it is searching for the rare nuclear recoils (possibly) induced by the so called Weakly Interacting Massive Particles (*WIMPs*). It is based on a dual-phase Time Projection Chamber filled with liquid Argon (*LAr-TPC*) from underground sources. The prototype project is a LAr-TPC with a (46.4±0.7)kg active mass, the DarkSide-50 (*DS-50*) experiment, which is installed inside a 30 t organic liquid scintillator neutron veto, which is in turn installed at the center of a 1kt water Cherenkov veto for the residual flux of cosmic muons. DS-50 has been taking data since November 2013 with Atmospheric Argon (*AAr*) and, since April 2015, has been operated with Underground Argon (*UAr*) highly depleted in radioactive ^{39}Ar. The exposure of 1422 kg d of AAr has demonstrated that the operation of DS-50 for three years in a background free condition is a solid reality, thank to the excellent performance of the pulse shape analysis. The first release of results from an exposure of 2616 kg d of UAr has shown no dark matter candidate events. This is the most sensitive dark matter search performed with an Argon-based detector, corresponding to a 90% CL upper limit on the WIMP-nucleon

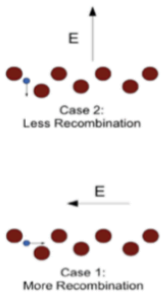


ReD

(sm, simone sanfilippo)

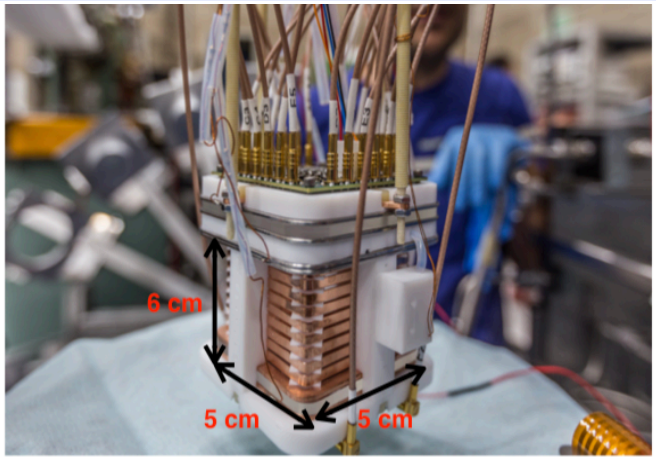
Recoil Directionality in Liquid Argon





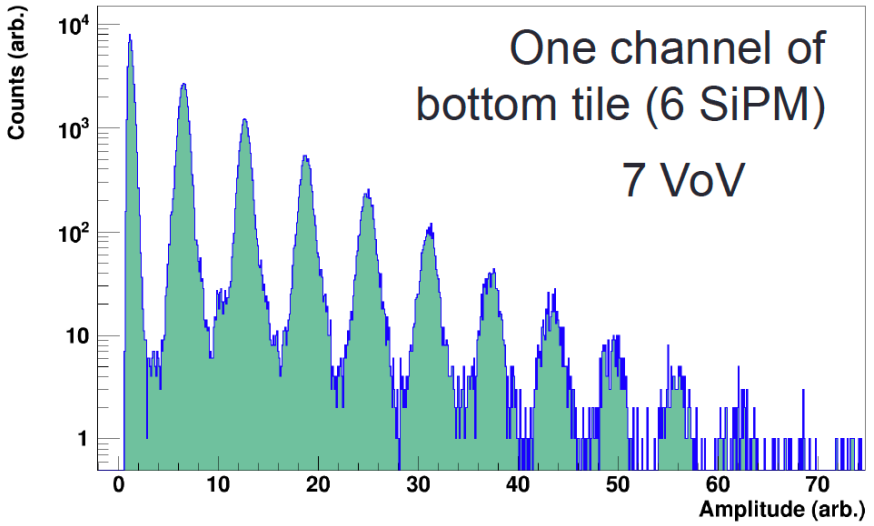
Columnar recombination may display a sensitivity to the angle between nuclear recoil direction θ_R and drift field **E** in a LAr TPC:

- **Scintillation (S1)** and **ionization (S2)** signals expected to depend on **E** and θ_R.

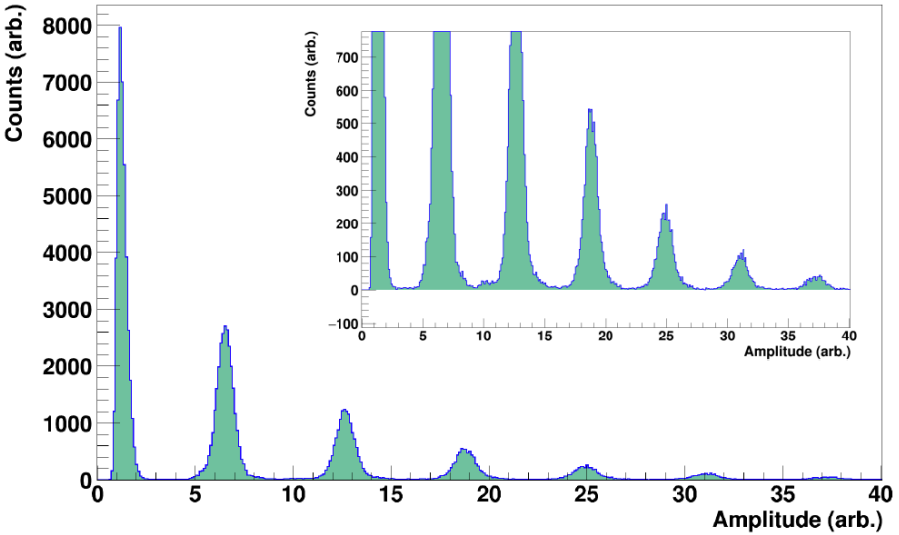


- 24 x 1 cm^2 **FBK** SiPM with **24ch readout** on the **TOP** of the TPC

- **Designed at UCLA** (CA,US);
- **5x5x6 cm dual-phase LAr TPC**:
  - Acrylic with 3M Reflector + TPB coating
- **New SiPMs light readout** at cryogenic temperatures:

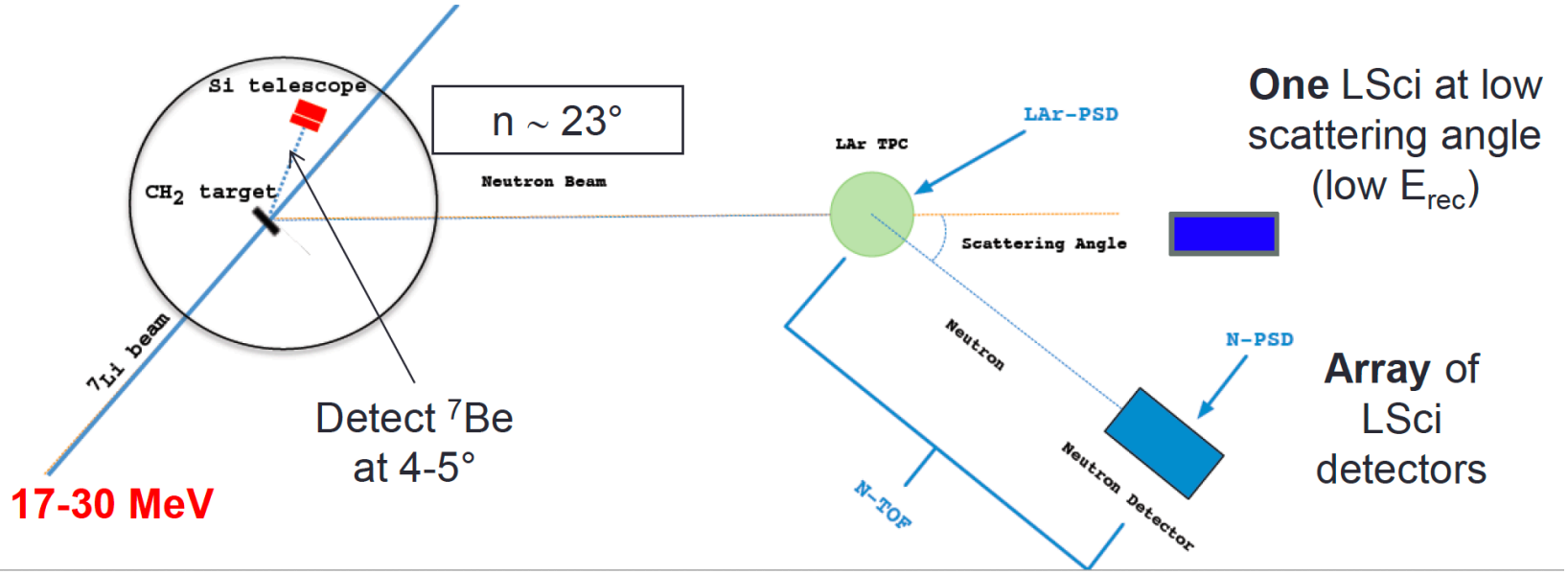


Filtered amplitude Spectrum



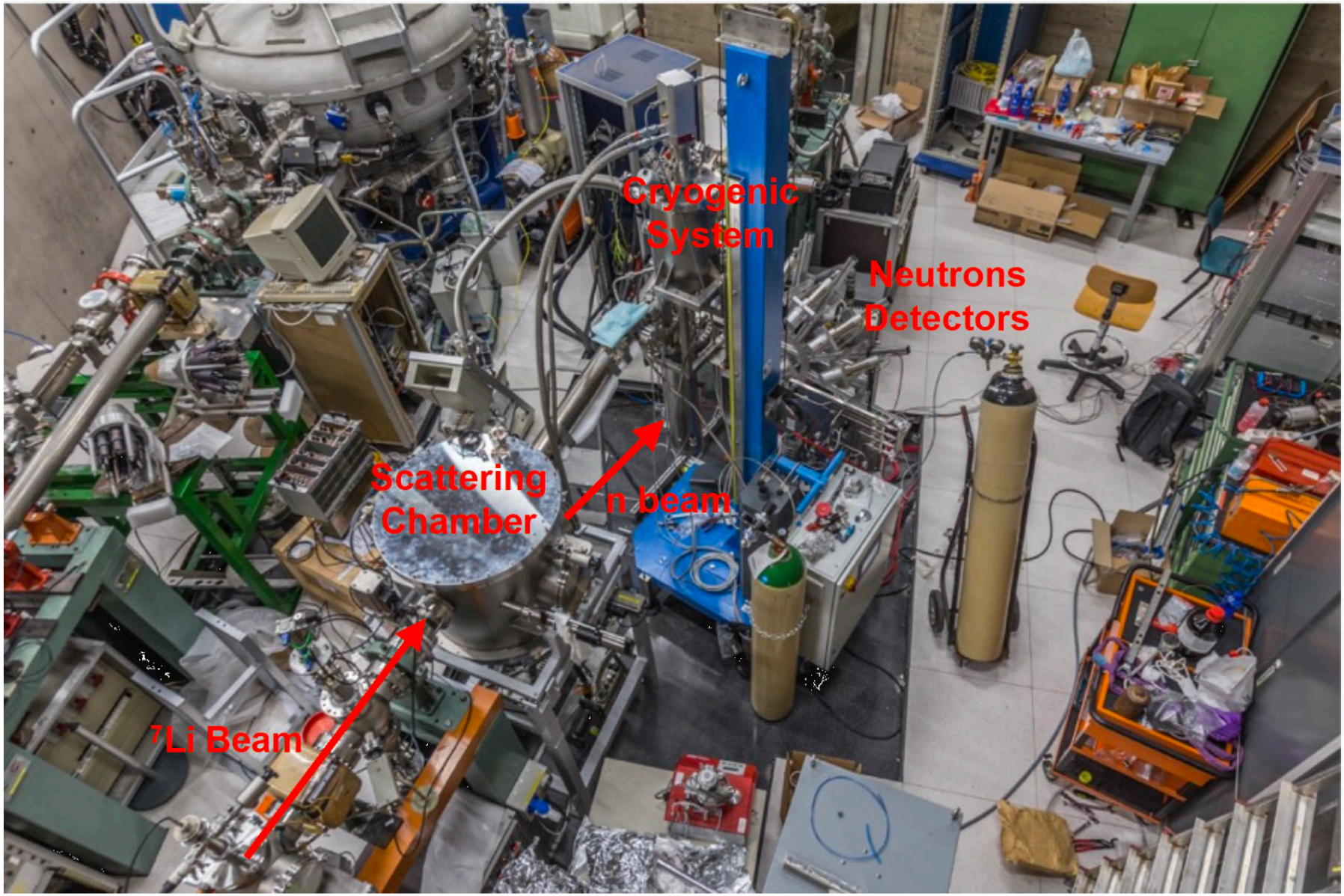
ReD measurement@LNS – recap

- Use a neutron beam produced via **p(^{7}Li,n)**
  - TANDEM accelerator at LNS, Catania
- Detect the associate particle (^{7}Be) and ToF to **tag neutron energy** event by event (fixed by kinematics)



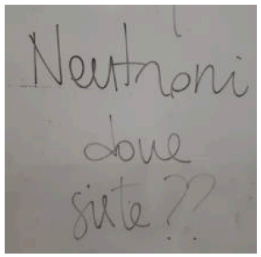
Test beam at LNS

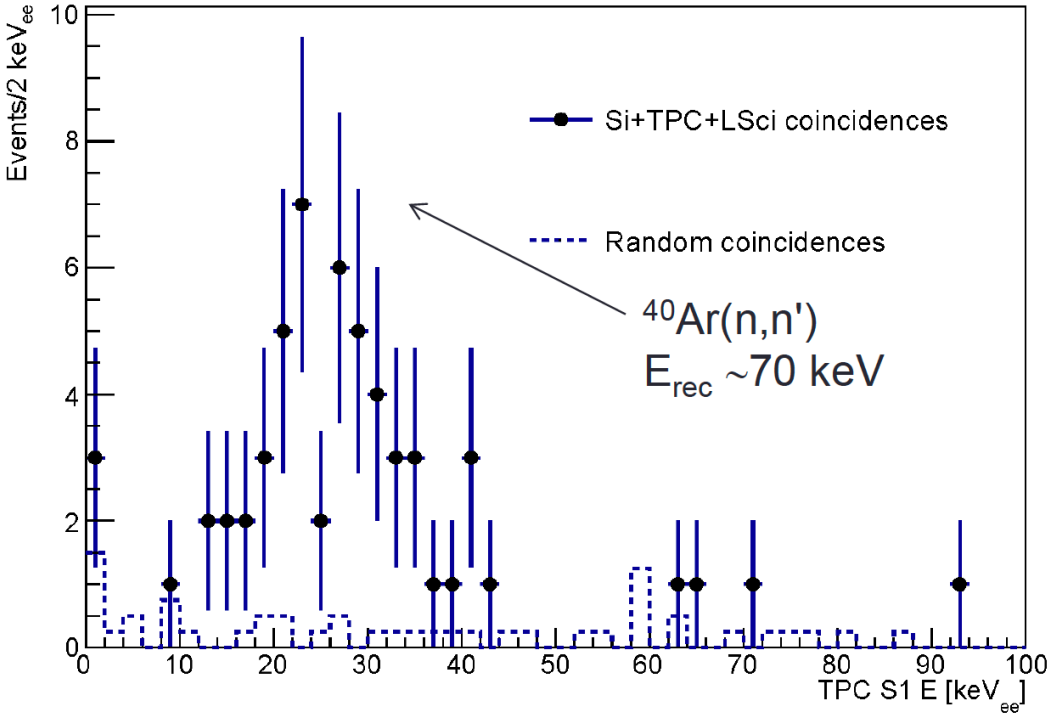
- Performed: May 23rd – 26th, E= 28 MeV
- Goal: Characterize the **neutron beam spot** to demonstrate rate and alignment **(w/o TPC)**
- Problem: **XY movement system** for the Si telescope for the fine-tuning of alignment not delivered yet
  - Order placed March 20th
  - Delivery expected on CW28 (Jul 8th)
  - Trying to get some parts "on loan" to speed up mechanical and software integration
- Use the alignment markers already in place (June 2018) to locate the expected TPC position
- **Test all the rest…**


Cryogenic System
Neutrons Detectors
Scattering Chamber
n beam
^{7}Li Beam

Three-fold coincidences

- Events with the proper signature **seen**
  - Three-fold coincidence, right timing, right PSD in TPC and LSci
- **THE Problem: much smaller rate** than expected
  - factor of ~20 wrt expected 30 cts/(hour nA)





- Possible problems:
  - (Mis)alignment of Si and/or TPC
  - Wrong measurement of current-on-target
  - DAQ/Trigger
  - Detector inefficiencies
  - Collimators

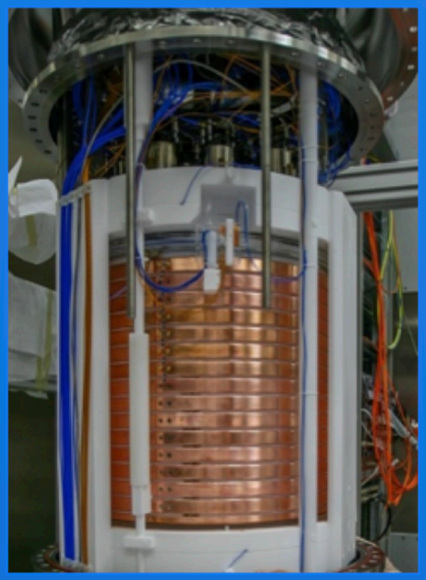
- About 80 runs taken in different trigger and h/w conditions, with neutrons (^{252}Cf) and γ-sources (^{241}Am, ^{137}Cs and ^{22}Na);
- Data are available on Roma3 cluster, both reco and rawdata:
  - /storage/DATA-02/darkside/red/rawdata/lsci (rawdata)
  - /storage/DATA-02/darkside/red/reco/rm3reco/lsci (reco)

	74		168k	252Cf	t_start: 23:43 t_stop: 09:54	channelmapping_lsci swapped	PMT1 (near) **in coincidence with** (PMT0 or PMT2)
23/02/19 Simone	75		3.8M	252Cf	t_start: 10:10 t_stop: 10:59	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode **changed FILE_MAX_EVENTS from 10000 to 50000**
	76		3.9M	252Cf	t_start: 11:02 t_stop: 11:53	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode **changed FILE_MAX_EVENTS from 10000 to 50000**
	77		3.9M	252Cf	t_start: 11:56 t_stop: 13:04	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode **changed FILE_MAX_EVENTS from 10000 to 50000**
	78		3.9M	252Cf	t_start: 16:14 t_stop: 17:03	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode **changed FILE_MAX_EVENTS from 10000 to 50000**
	79		3.8M	252Cf	t_start: 17:08 t_stop: 17:57	channelmapping_lsci swapped	trigger on PMT1 in single mode only PMT0 and PMT2 on board1 acquired in slave mode **changed FILE_MAX_EVENTS from 10000 to 50000**

BKG	t_start: 11:57 t_stop:	channelmapping_lsci	trigger on PMT1
241Am	t_start: 12:09 t_stop: 12:14	channelmapping_lsci	trigger on PMT1
137Cs	t_start: 12:16 t_stop: 12:20	channelmapping_lsci	trigger on PMT1
22Na	t_start: 12:23 t_stop: 12:27	channelmapping_lsci	trigger on PMT1
BKG	t_start: 12:31 t_stop: 12:39	channelmapping_lsci	trigger on PMT2
241Am	t_start: 12:46 t_stop: 12:49	channelmapping_lsci	trigger on PMT2
137Cs	t_start: 12:52 t_stop: 12:55	channelmapping_lsci	trigger on PMT2
22Na	t_start: 12:59 t_stop: 13:02	channelmapping_lsci	trigger on PMT2
BKG	t_start: 13:05 t_stop: 13:14	channelmapping_lsci	trigger on PMT3
241Am	t_start: 15:24 t_stop: 15:29	channelmapping_lsci	trigger on PMT3
137Cs	t_start: 15:31 t_stop: 15:36	channelmapping_lsci	trigger on PMT3

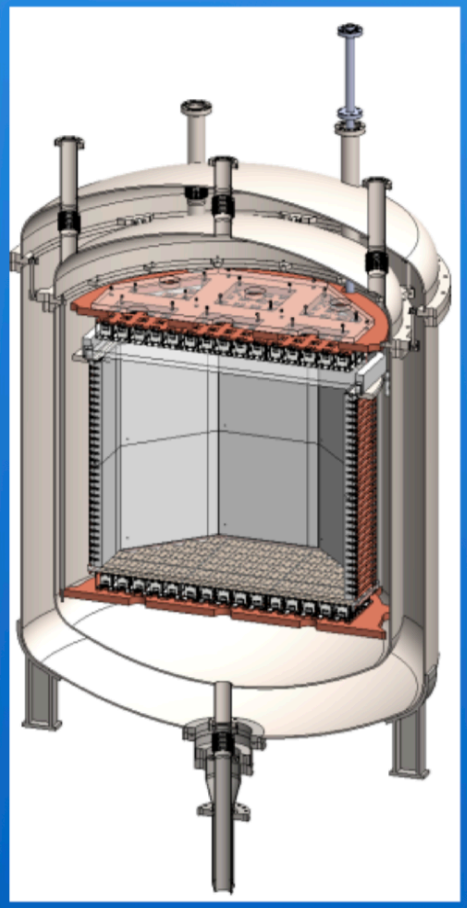
	19		100k	22Na
	20		100k	BKG
	21		100k	241Am
	22		200k	137Cs

DarkSide-50



50 kg fiducial

DarkSide-prototype



1 ton fiducial

DarkSide-20k

32 ton fiducial

GADMC

300 ton fiducial

2019:

DS-50: in chiusura….
ReD: completare analisi dati LNS (in chiusura)

2020:

DS-proto: computing + SW