JMS 2017

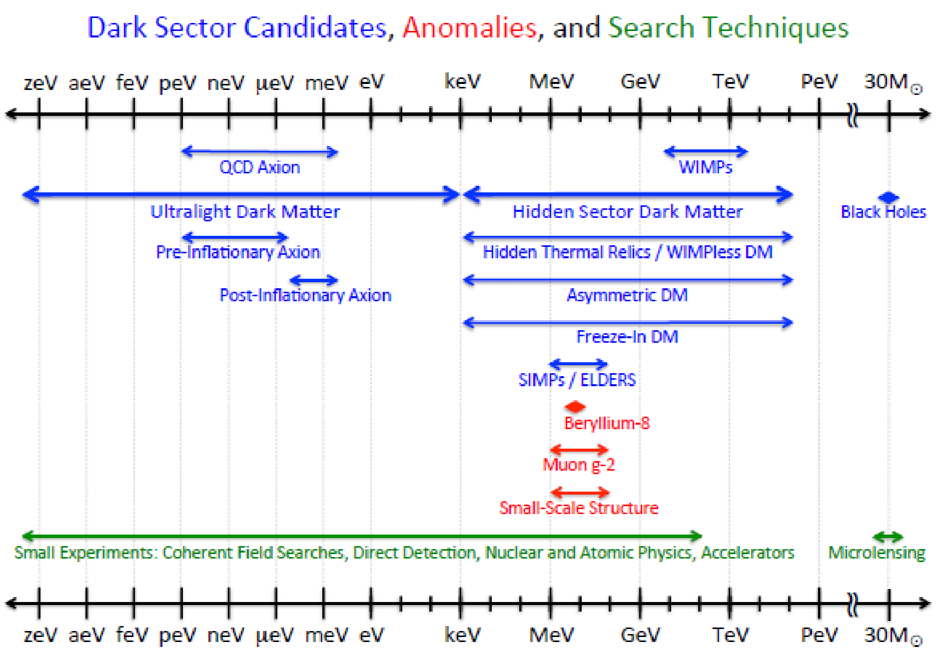
Overview of recent results and perspectives of DDMs experiments

Dominique Thers, SUBATECH

November 30th 2017, LPNHE

2017 DDM

Physics case: stronger than ever



US Cosmic Visions: New Ideas in Dark Matter 2017 arxiv:1707.04591

General overview

1/ New family of Dark Matter particles, compatible with astrophysics and cosmological observations
Reinforced in 2017

2/ DDM experiences not enough sensitive for a first signal
Reinforced in 2017

3/ New experiences, new ideas and new technologies
Reinforced in 2017

- **Detectors and technologies : always better, ultra-high tech experimental research with great potential**

- **France : good positioning with 6 consolidated Astroparticles projects, experiences and R&D**

DDM projects at CNRS

3 types of detector

Gaseous

MIMAC

Directional DDM

LPSC (Grenoble)
IRFU (Saclay)
CCPM (Marseille)
Tsinghua University (Beijing)
XAO (Xinjiang)
IRSN (Cadarache)

NEWS

Very low mass DM

Queen's University Kingston
IRFU/Saclay
CENBG, LPSC, LSM, Subatech
Thessaloniki University
TU Munich
PNN Lab
Associated lab : TRIUMF

Solid

DAMIC

GeV Wimps : nr
Hidden sector : er

- FERMILAB
- U Chicago
- U Michigan
- SNOLAB
- UNAM (Mexico)
- FIUNA (Paraguay)
- UFRJ (Brasil)
- U. Nacional del Sur
- Centro Atomico Bariloche
- U. Zurich
- LPNHE (Paris 6/7)
- 11 institutions
- 8 countries
- 39 collaborators

EDELWEISS

CSNSM CNRS/IN2P3
IPNL CNRS/IN2P3
NEEL CNRS/INP
C2N CNRS
Irfu CEA/IRFU
IRAMIS CEA/IRAMIS
KIT IKP EKP IPE
JINR DUBNA
Univ. OXFORD
Univ. SHEFFIELD

GeV Wimps : nr
Hidden sector : er

Dual-Phase

DARKSIDE

> GeV Wimps : nr
Hidden sector : er

Global Argon Dark Matter coll.
(from ArDM, DarkSide, DEAP3600, and MiniCLEAN)
~350 scientists from 68 institutions in 12 countries
France : APC, IPNO, LPNHE

XENON

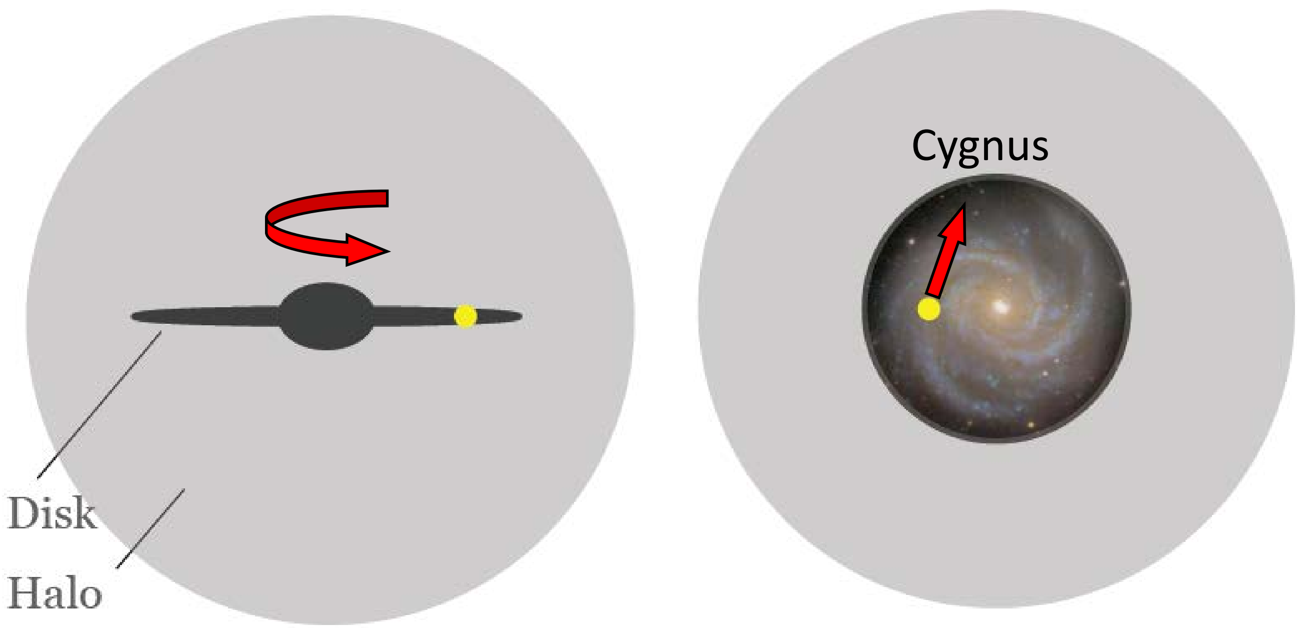
> GeV Wimps : nr
Hidden sector : er

MIMAC

MIcro-tpc MAtrix of Chambers

A Large TPC for Directional Dark Matter detection

Directional detection : principle



$\langle V_{rot} \rangle \sim 220$ km/s

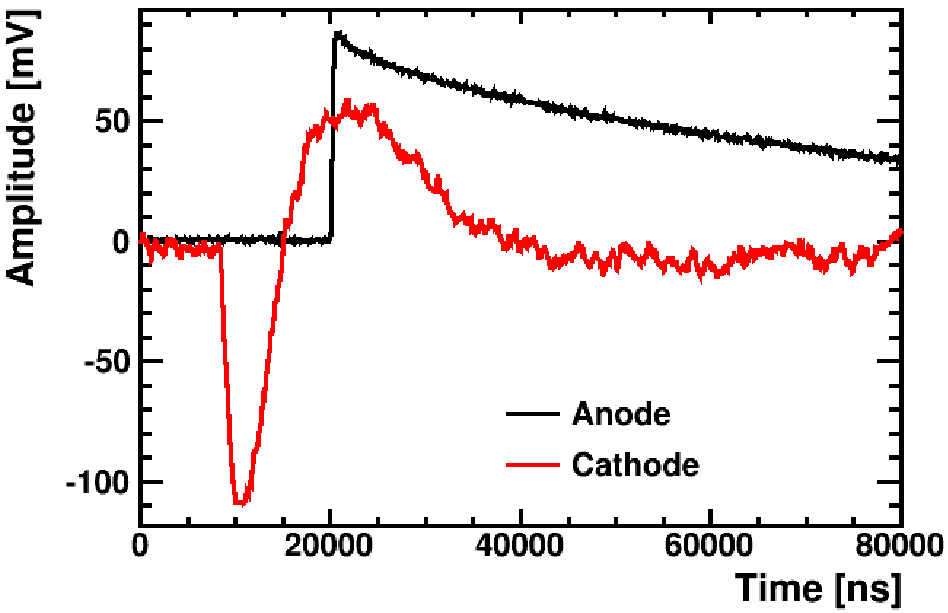
The signature, the only one (!), able to correlate the events in a detector to the galactic halo !!

Cathode Signal to place the 3D-track

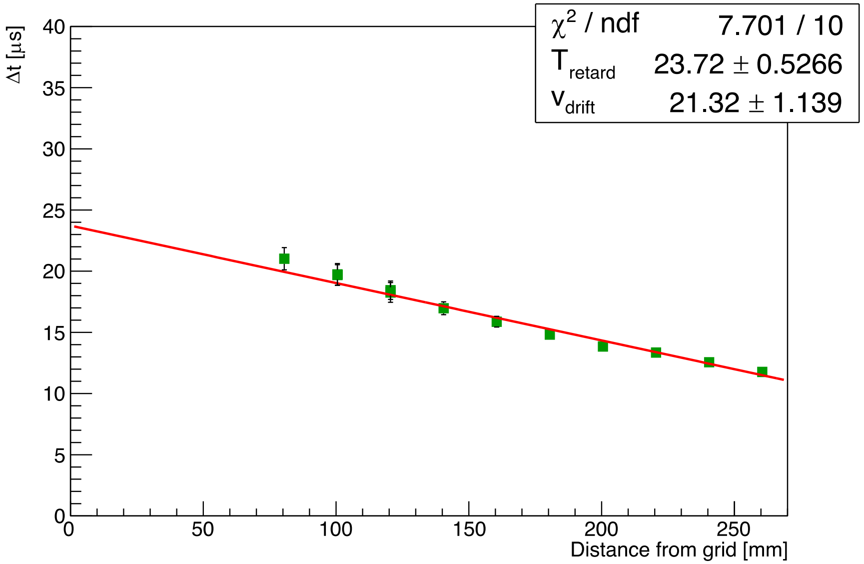
(fiducialization of the active volume)

(C. Couturier, Q. Riffard, N. Sauzet, O.Guillaudin, F. Naraghi, D.Santos
JINST 2017)

- The cathode signal is produced by the primary electrons.



Measurement in a MIMAC chamber of an alpha passing through the active volume parallel to the cathode at 10 cm distance.



Drift velocity measurement with the Cathode signal !!

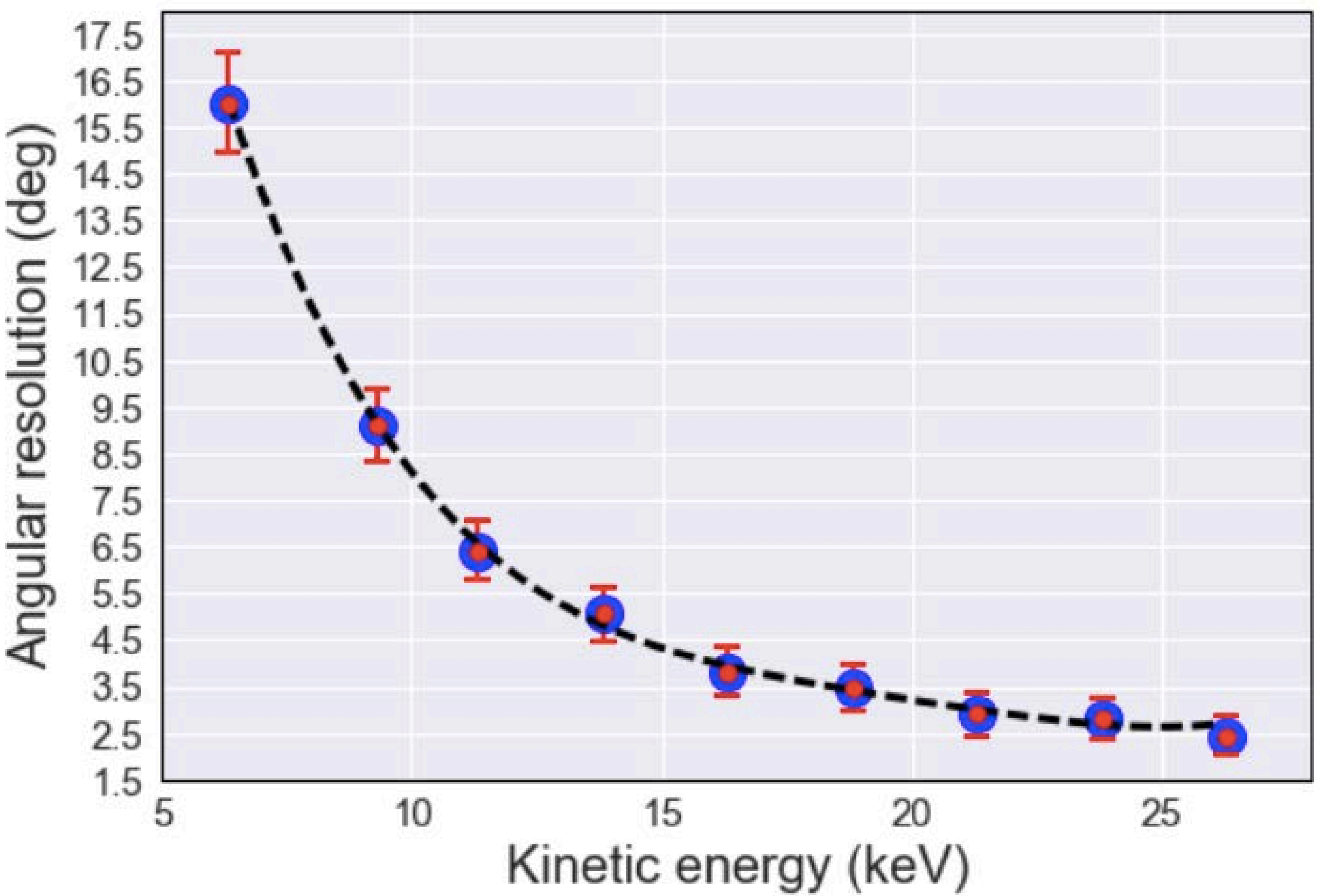
v = 21.32 um/ns

First controlled Fluorine tracks, using COMIMAC

Angular resolution measured with COMIMAC

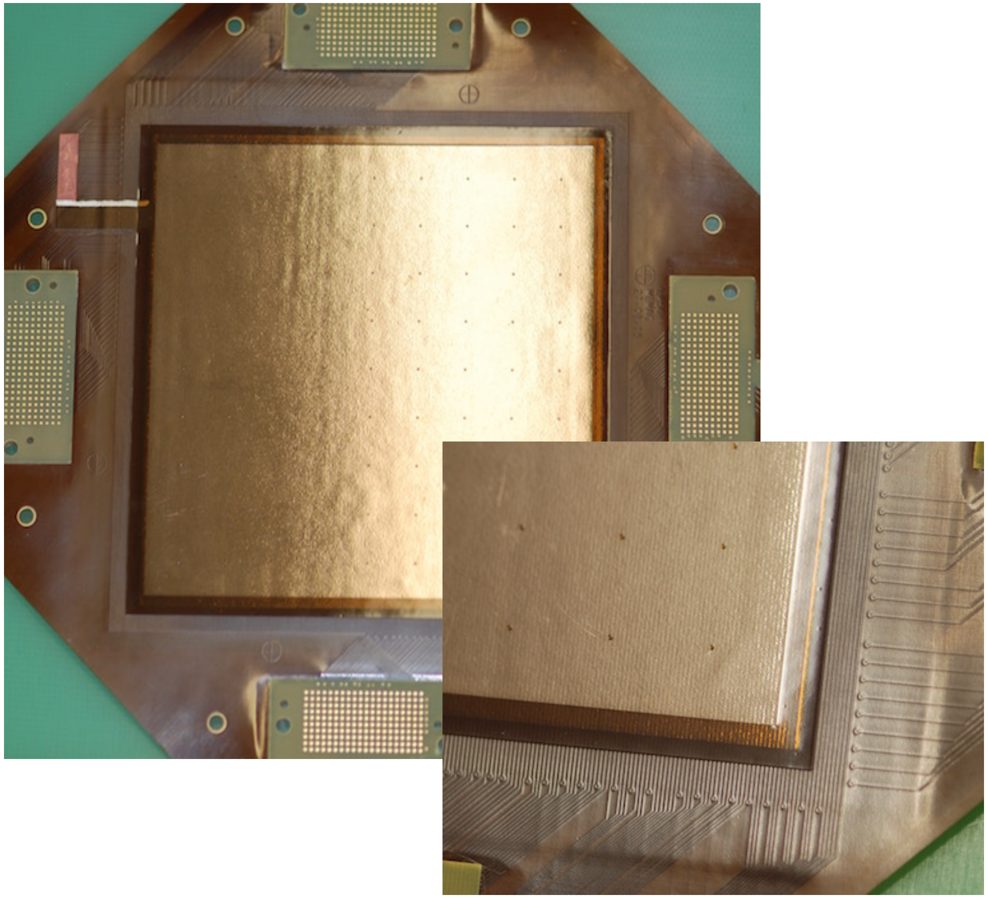
(^{19}F ions at known kinetic energies)

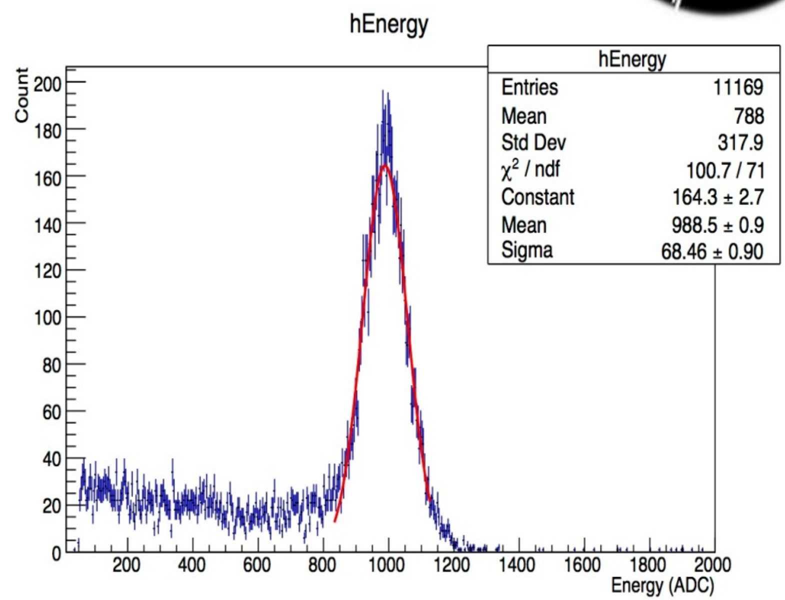
(I. Moric, Y. Tao et al. (2017 data, preliminary))



➢ **Soon to be published**

New MIMAC detector



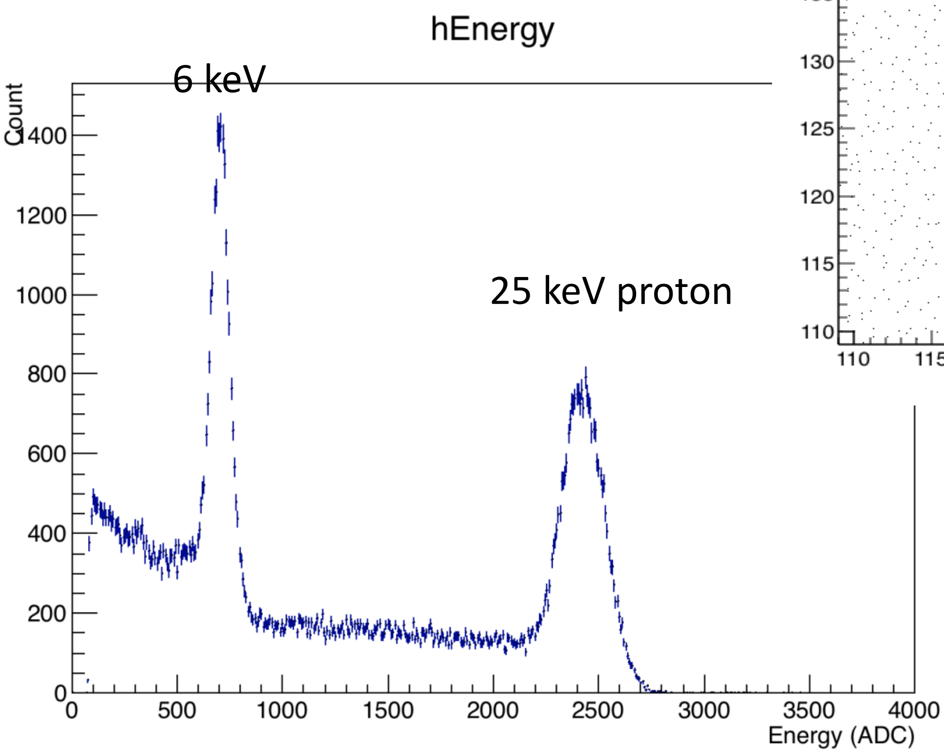


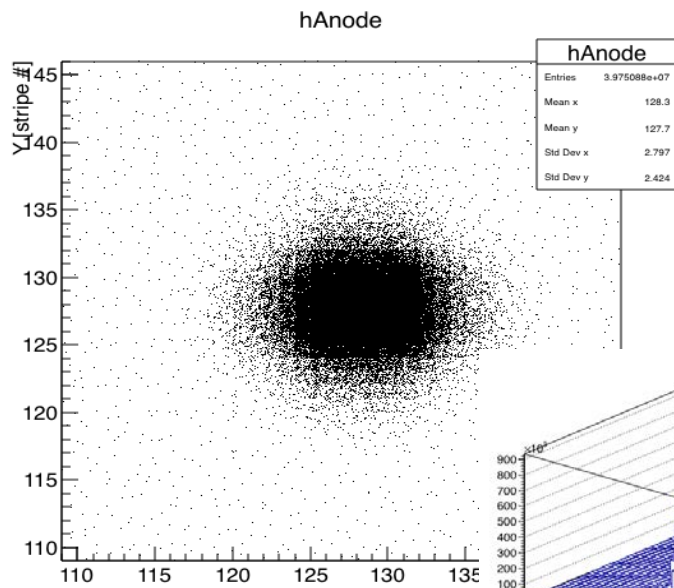
Gaz : MIMAC 50 mbar
HT grille : -560 V
Drift field : -150 V/cm

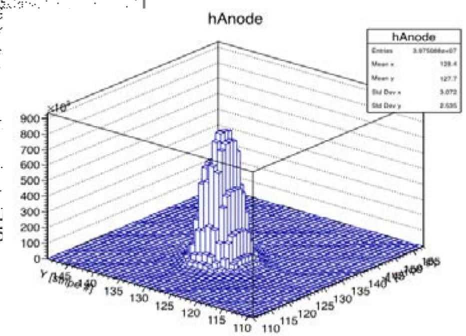
Kapton micromegas readout
Piralux Pilar

16,3 % FWHM (6 keV)
Gain ~25 000
Energy threshold <1 keV

Track measurement with 25 keV Protons





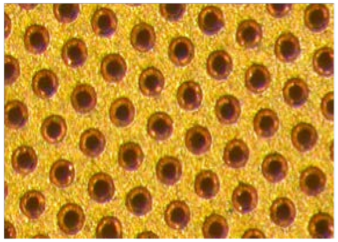


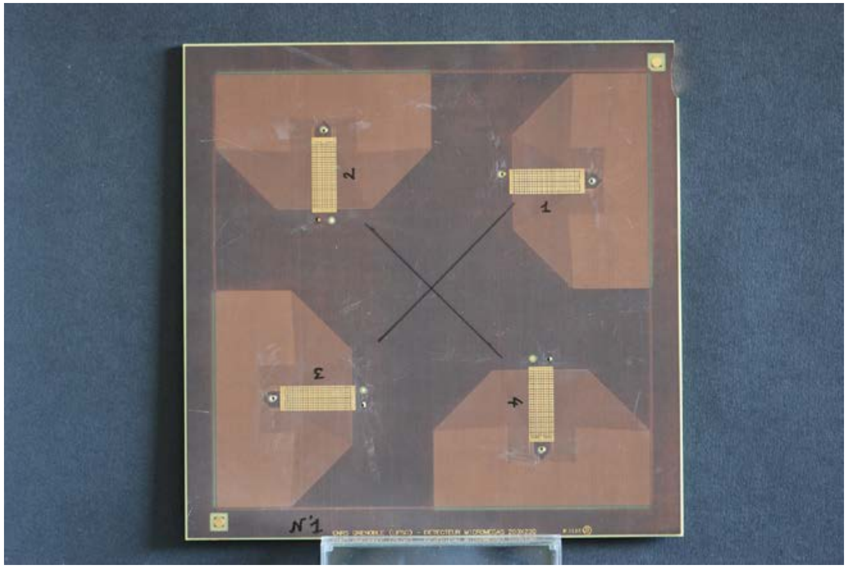
- ~16 000 tracks
- Gain 17 500
- ΔE ~10,6 % FWHM
- Ei ~22 keV

MIMAC – 1m^3

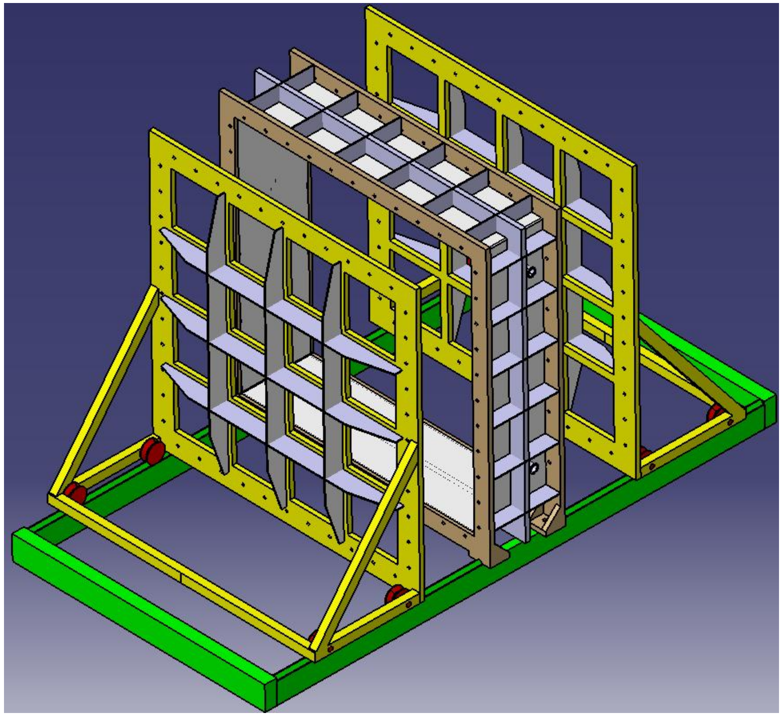
16 bi-chamber modules (2x 35x35x26 cm^3)

i) New technology anode 35cmx35cm
ii) Stretched thin (12 um) grid at 512um.
iii) New electronic board (1792 channels)
iv) Only one big chamber





New 20cmx20cm pixellized anode (1024 channels)



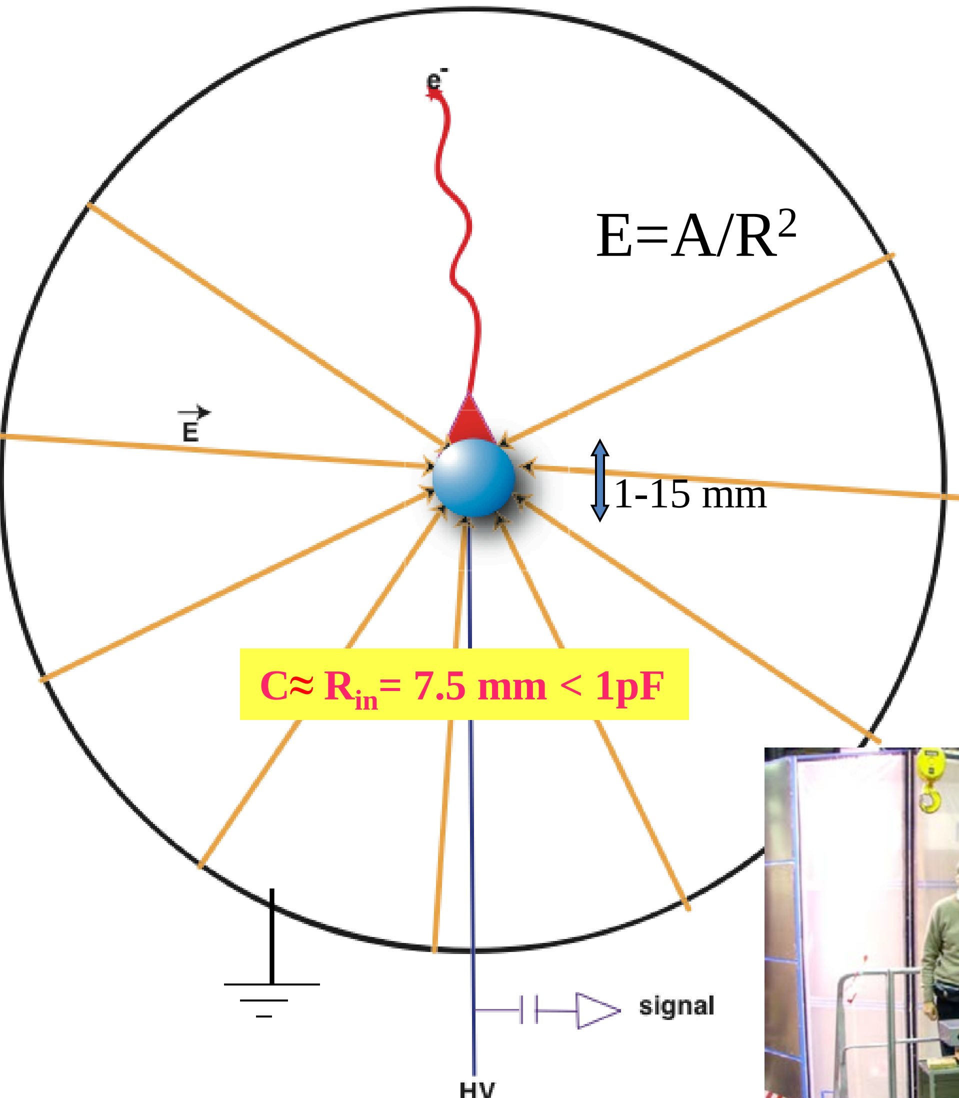
- **Time Schedule:**
  - **First bi-chamber prototype : July 2018**
  - **Commissioning and tests : October 2018**
  - **16 modules for 1 m^3 scale : targeted for end of 2019**

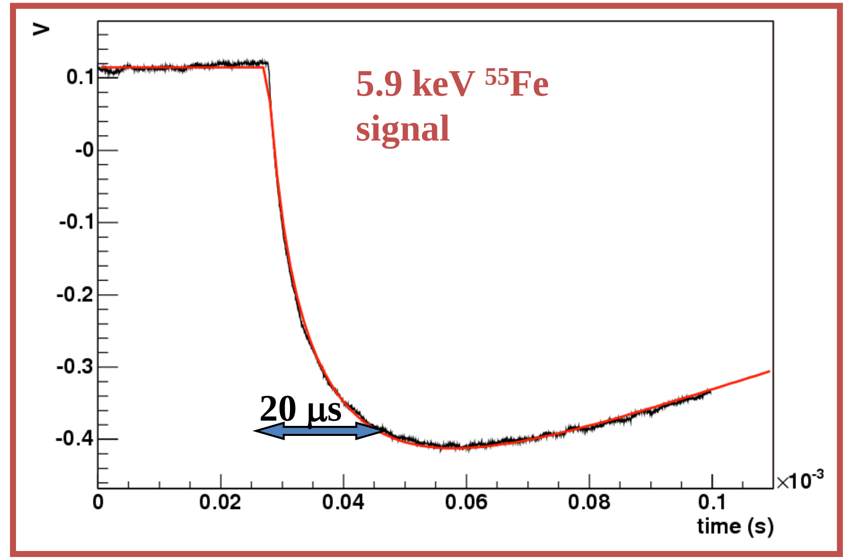
NEWS-G

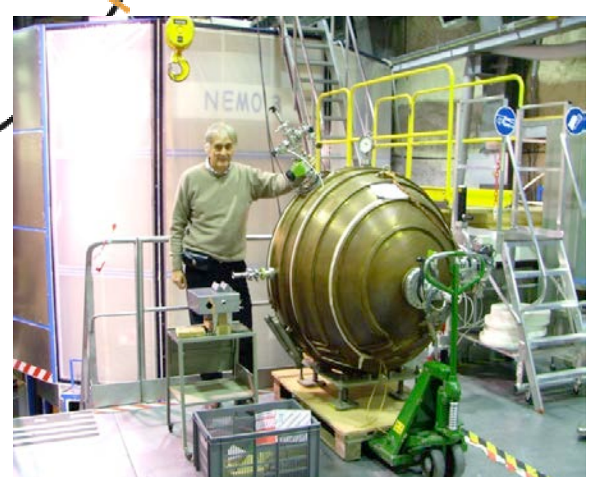
Radial TPC with spherical proportional counter read-out

Saclay-Thessaloniki-Saragoza

A Novel large-volume Spherical Detector with Proportional Amplification read-out, I. Giomataris *et al.*, JINST 3:P09007,2008



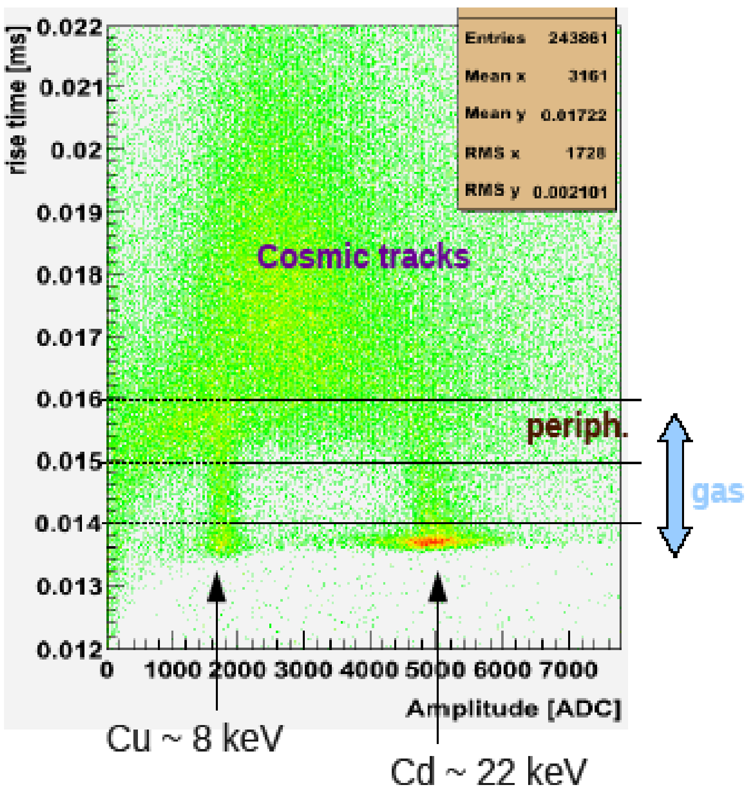


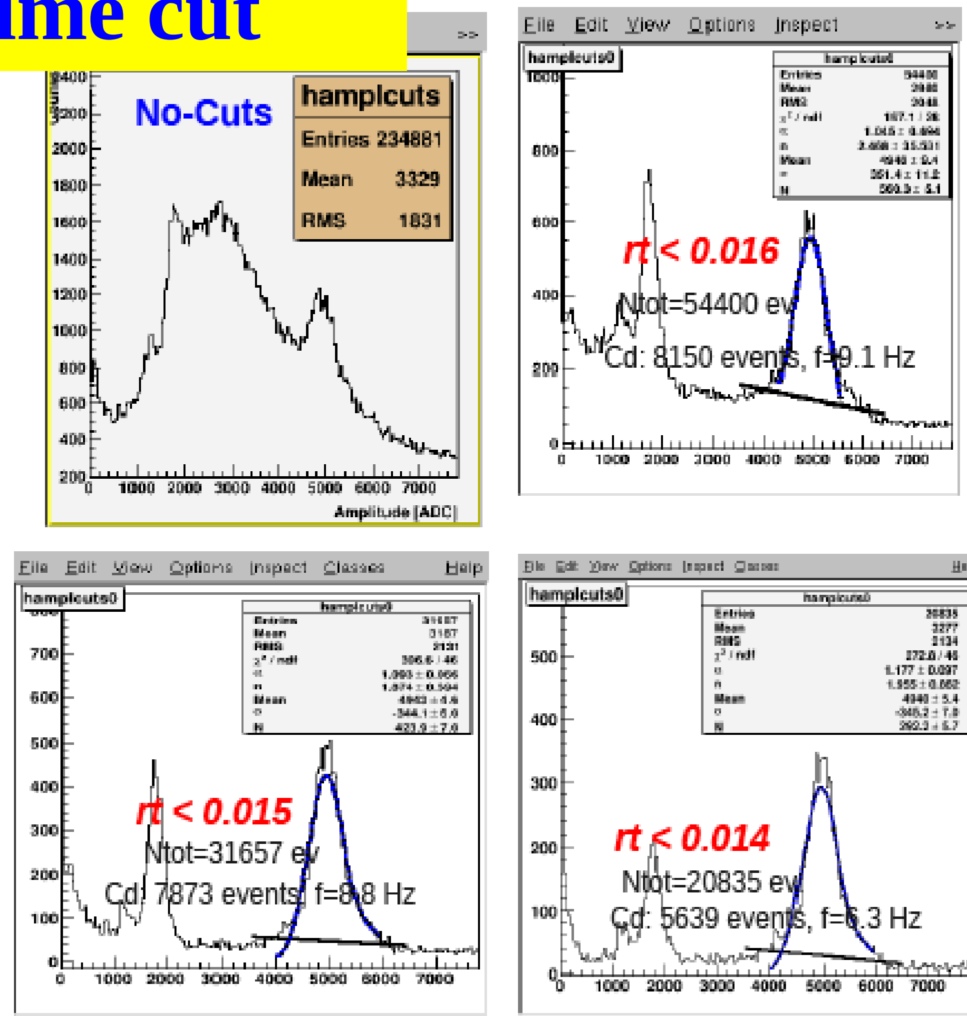


- **Simple and cheap**
- **Large volume**
- **single read-out**
- **Robustness**
- **Good energy resolution**
- **Low energy threshold**
- **Efficient fiducial cut**
- **Low background capability**

Rejection power
Rise time cut

Using Cd-109 source – December 2009
Irradiate gas through 200µm Al window
P = 100 mb, Ar-CH_4 (2%)





If rt ~ 0.0155 ms ==> R = 65 cm
0.014 ms ==> ~70% of signal

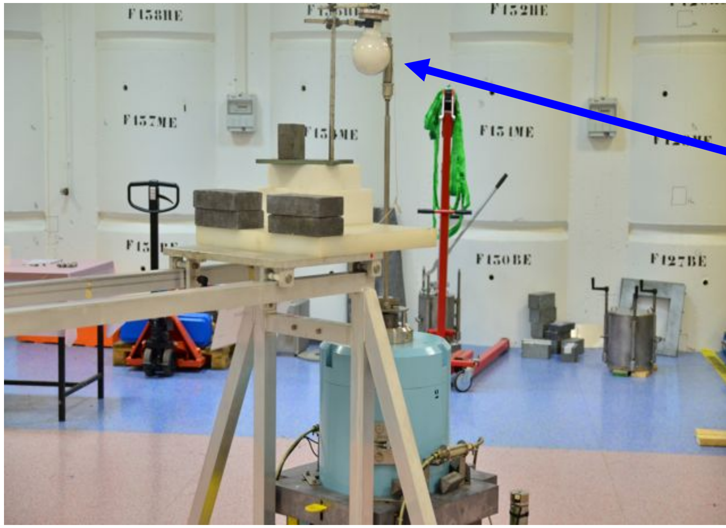
Efficiency of the cut in rt ==> ~ 70% signal (Cd peak)

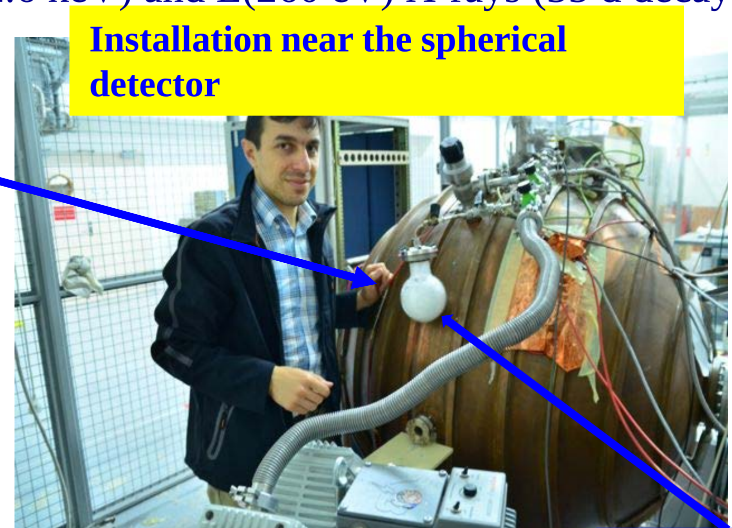
Severe background reduction

Energy resolution ~ 6 % and 9 % for Cu and Cd

Low-energy calibration source *Argon-37*

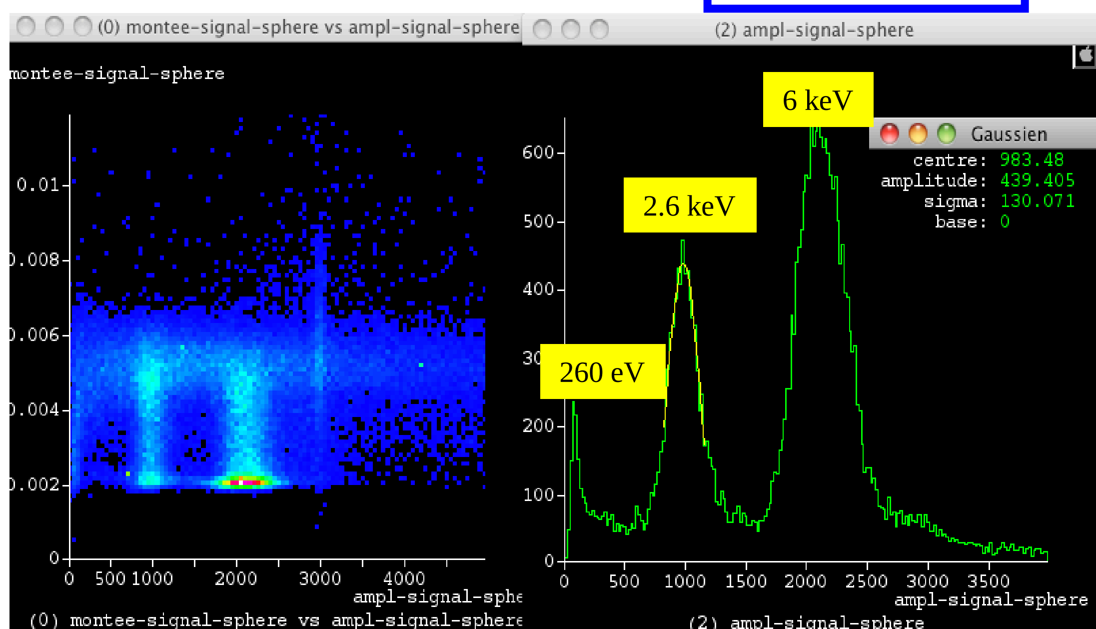
Home made Ar-37 source: irradiating Ca-40 powder with fast neutrons $7\text{x}10^{6}$neutrons/s
Irradiation time 14 days. Ar-37 emits K(2.6 keV) and L(260 eV) X-rays (35 d decay time)





Argon 37 bulb

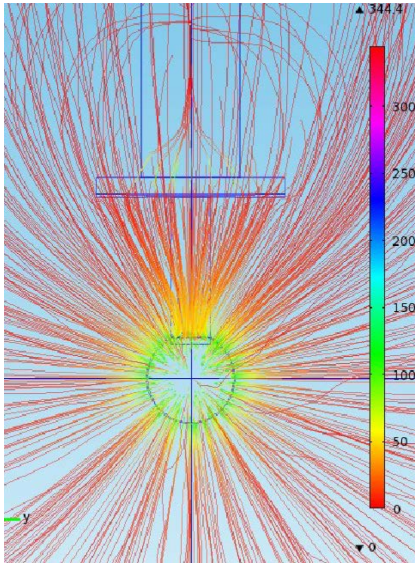
First measurement with Ar-37 source
Total rate 40 hz
in 250 mbar gas, 8 mm ball
260 eV peak clearly seen
A key result for light dark matter search
Treshold ~ 30 eV

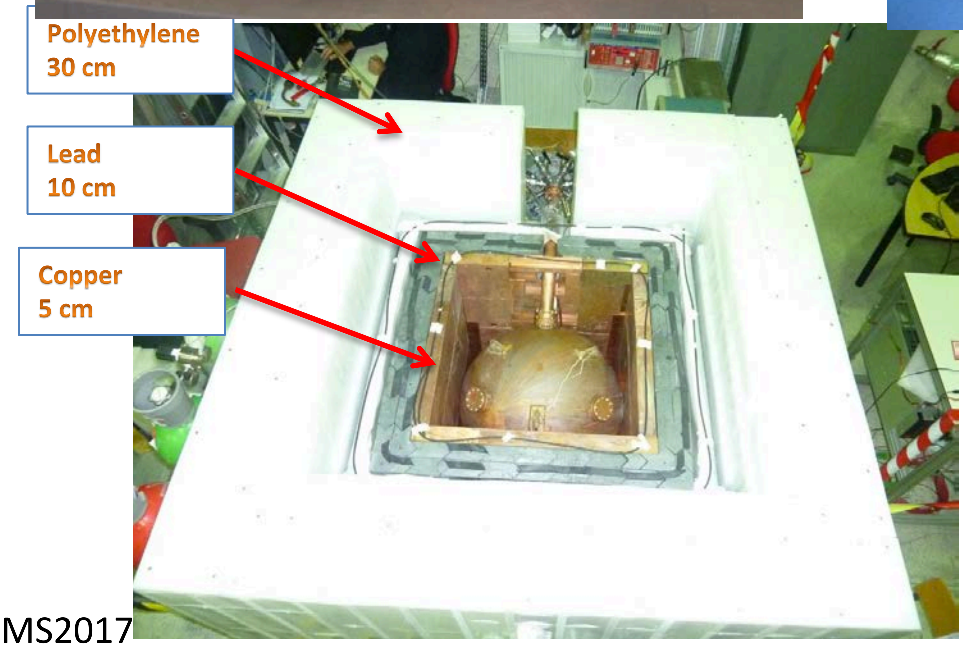


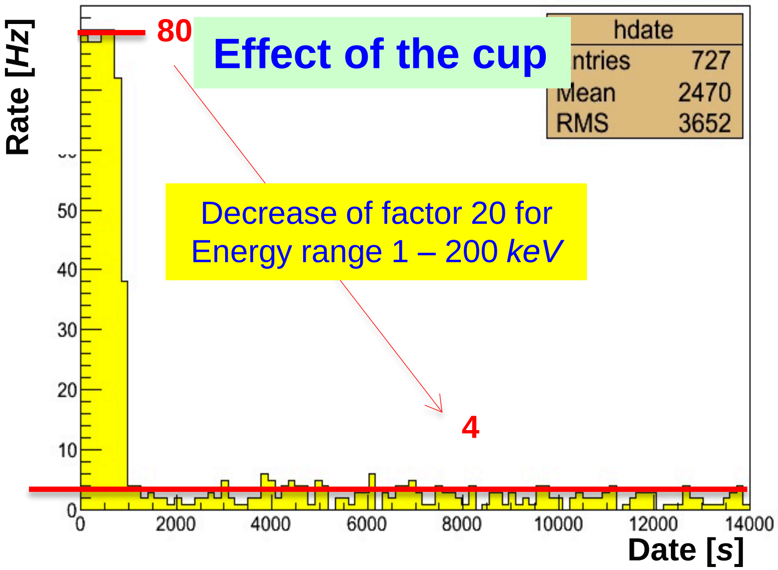
NEWS-LSM: Exploration of light dark matter search at LSM

Detector installed at LSM end 2012: 60 cm, Pressure = up to 10 bar

Gas targets: Ne, He, CH4

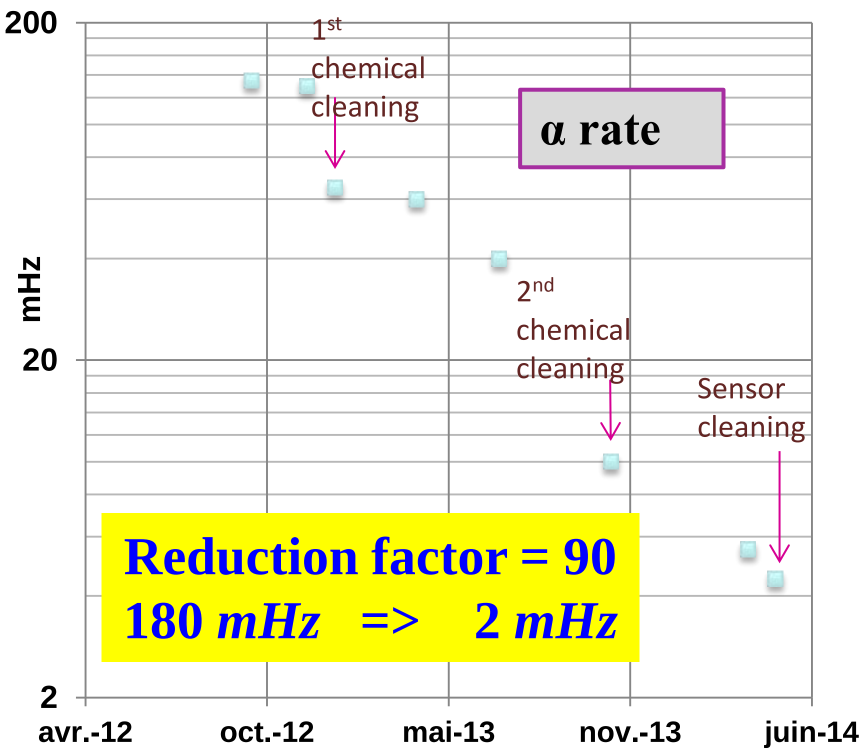




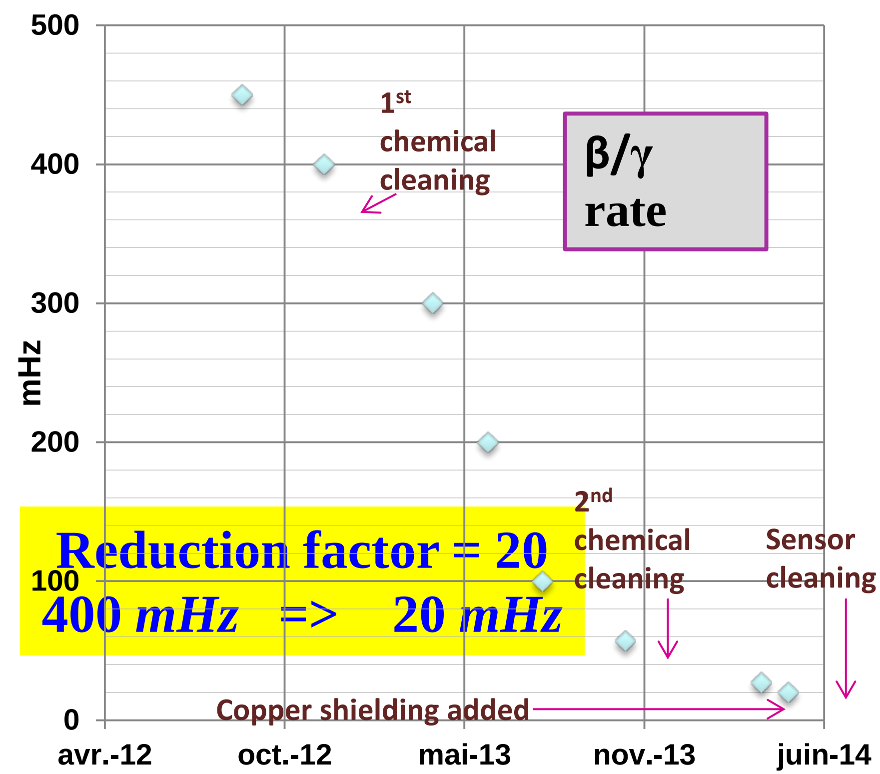


NEWS-LSM
Backround evolution of the detector

Alpha rate evolution



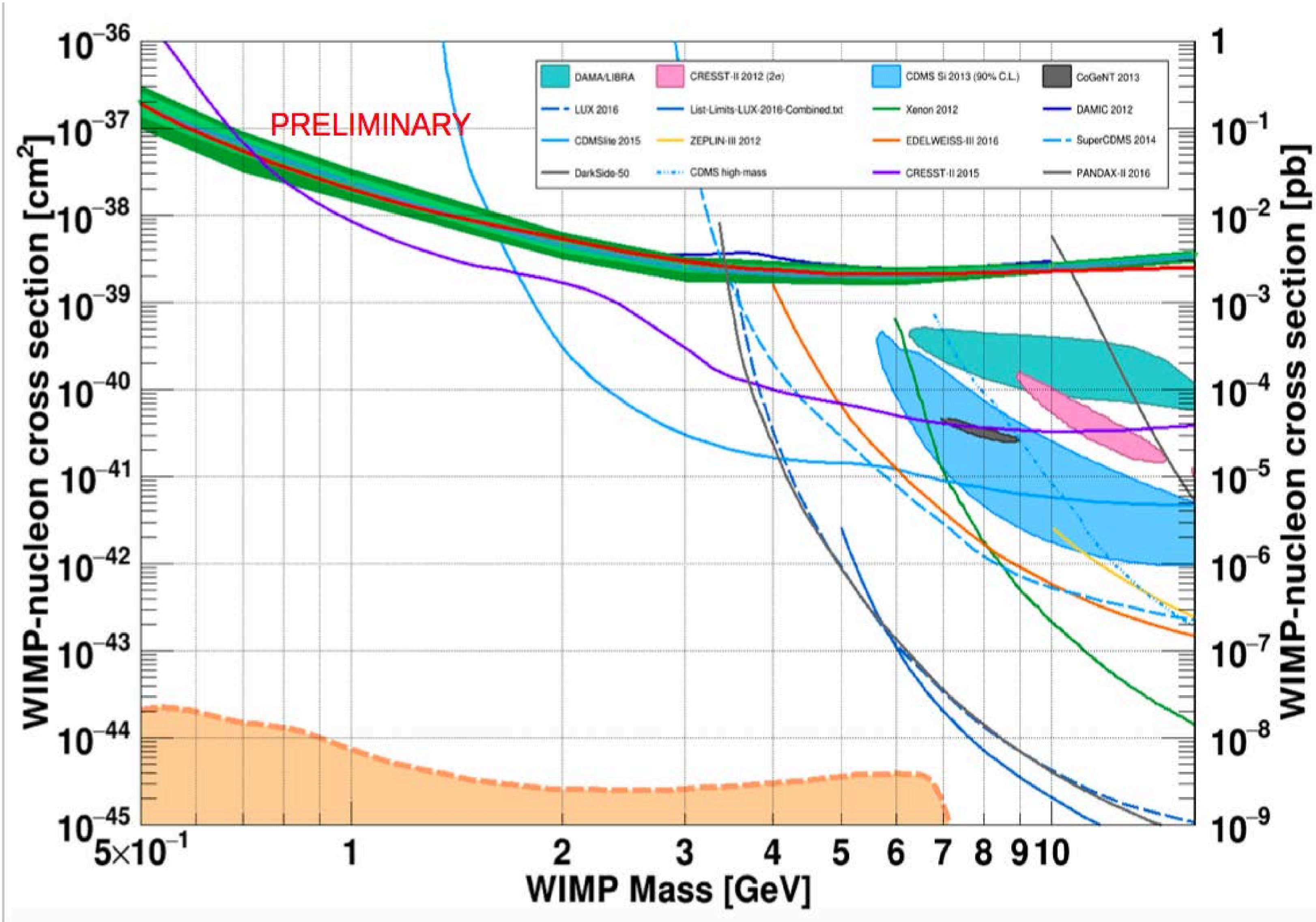
β/γ rate evolution



New development
Removal of about 10mm copper using a high pressure jet is under study with a french compagny

NEWS-LSM
First SI results

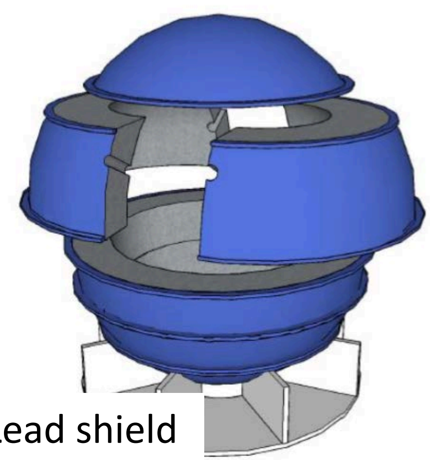
Current sensitivity with Neon at 3 bar
Data 40.5 days, threshold 30 eV



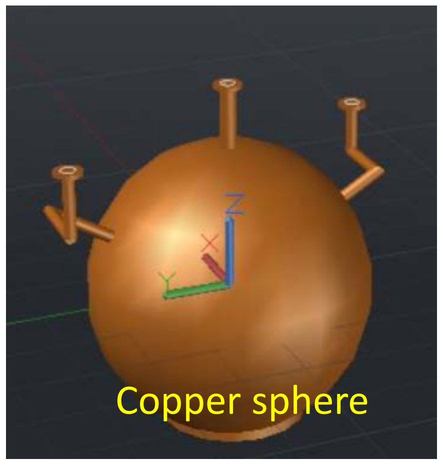
- ➢ **Best worldwide limits at very low mass!**
- ➢ **Next run with He-CH_4 for new observations projected down to 0.1 GeV**

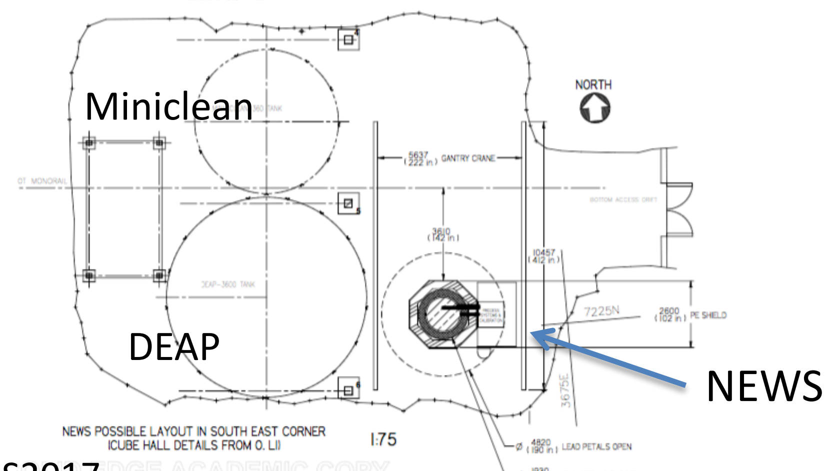
NEWS-SNO with compact shield : implementation at SNOLAB by fall 2017
Funded mainly by Canadian grant of excellence and ANR-France

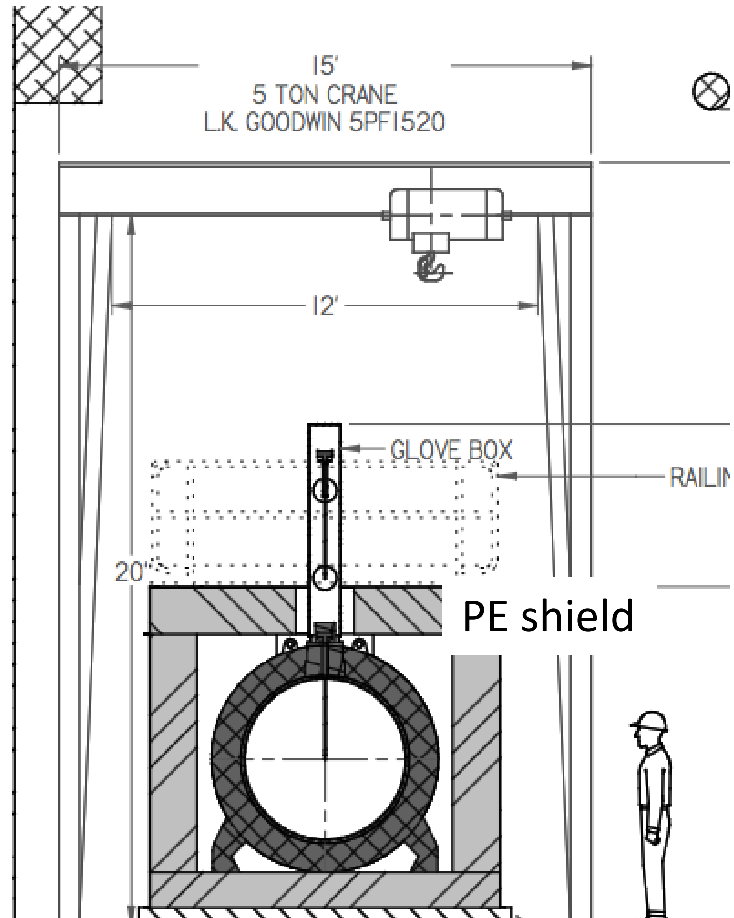
140 cm Ø detector, 10 bars, Ne, He, CH_4
Copper 1 mBq/kg
Compact lead –ancient- & PE shield solution



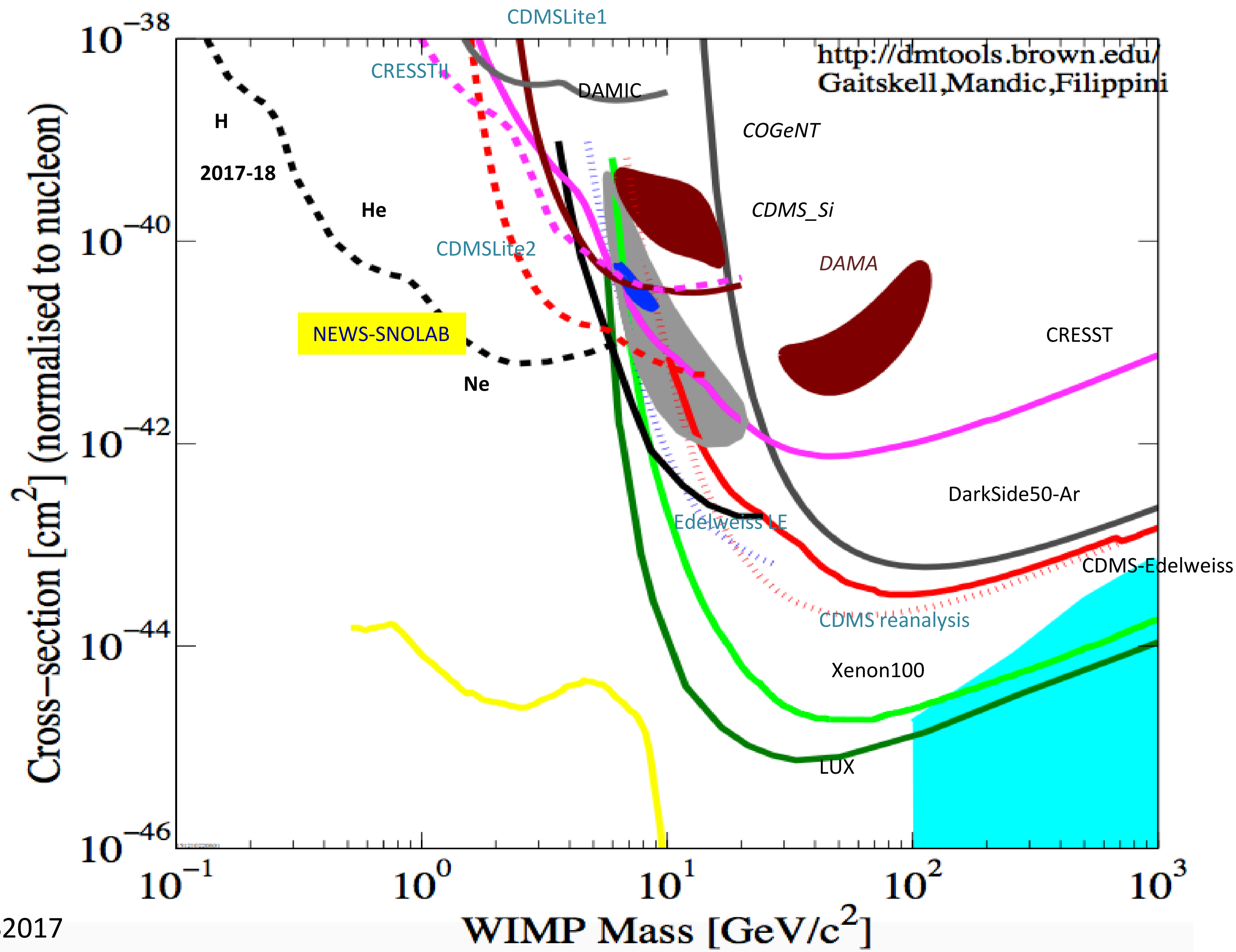
Lead shield



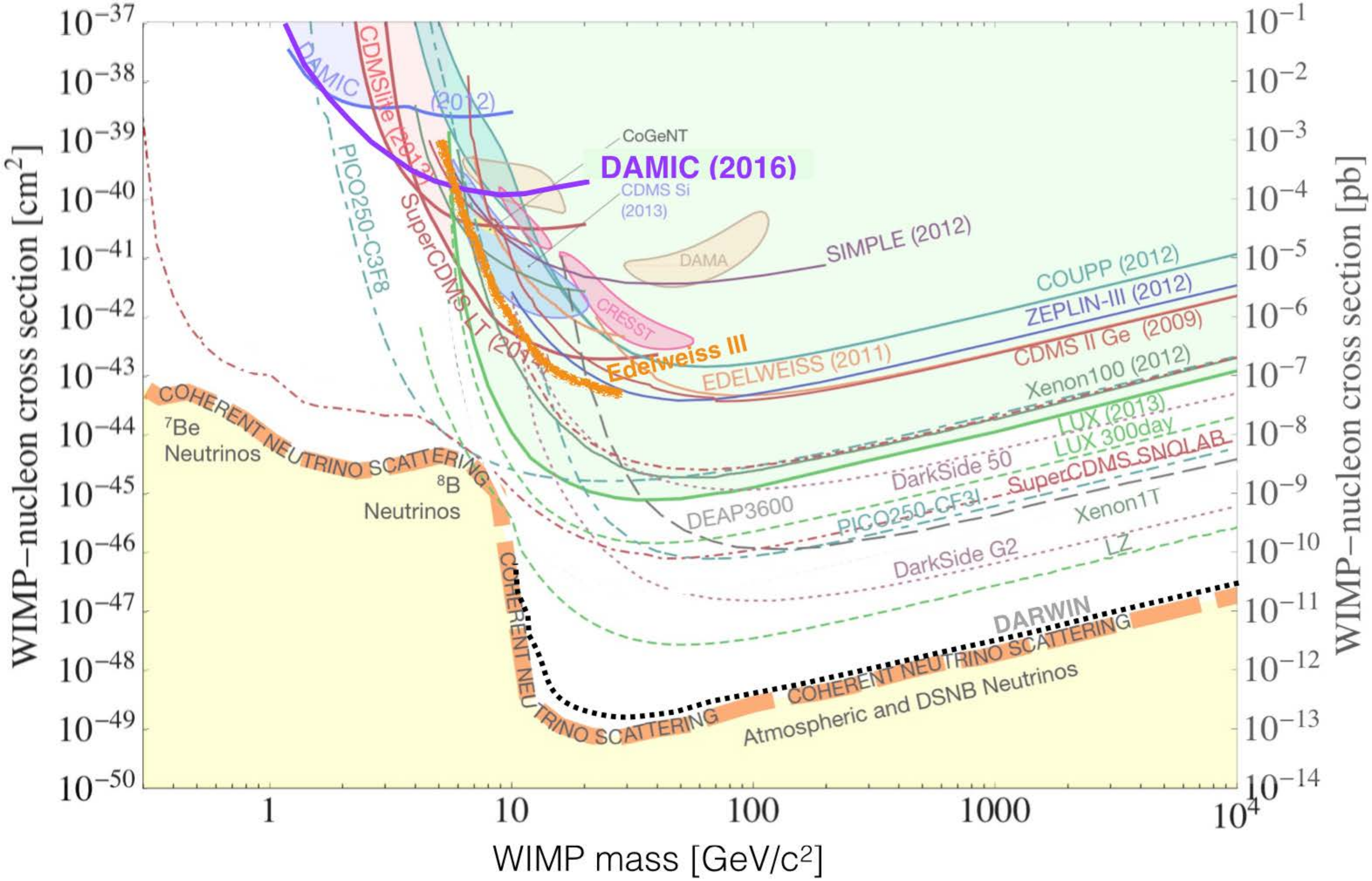




NEWS-SNOLAB project sensitivity

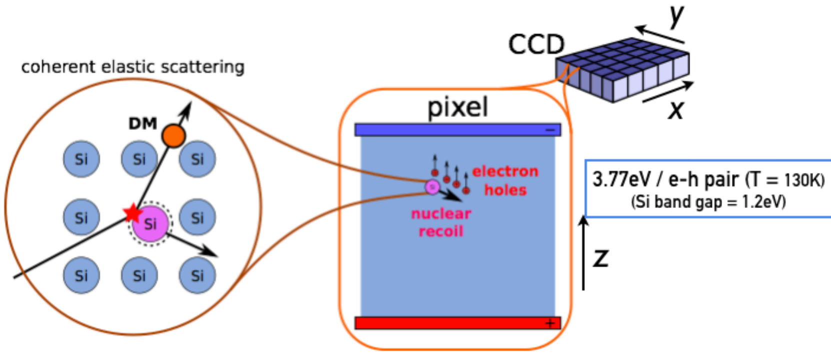


DAMIC



- Low masses matter too ! (~GeV WIMP, ADM)
- low energy threshold (10-100 eV) obtained with solid (e.g. semiconductor band gap)

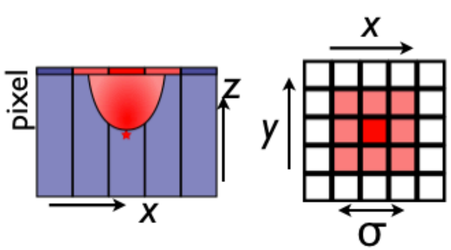
DAMIC: DETECTION PRINCIPLE



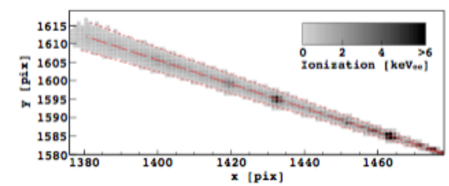
- low noise ~2e- (= 7.5 eV) —> E_{th} = 50-60 eVee
- ~light mass target (kinetic matching)

3D RECONSTRUCTION

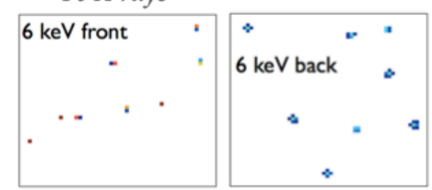
charge diffusion σ along z axis



muon track



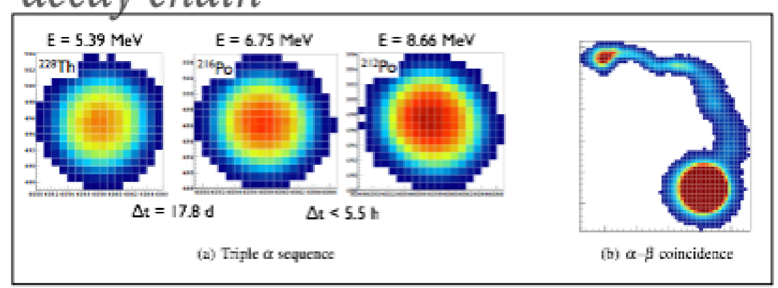
^{55}Fe X rays

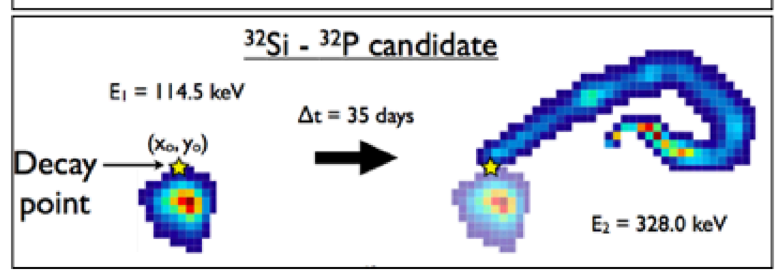


- 3D reconstruction
- surface event tagging

- unique spatial and energy resolution
  - observe decay chain from a single isotope*
  - ^{238}U and ^{232}Th chain
  - ^{32}Si, ^{210}Pb chains
  - ^{3}H ?

decay chain



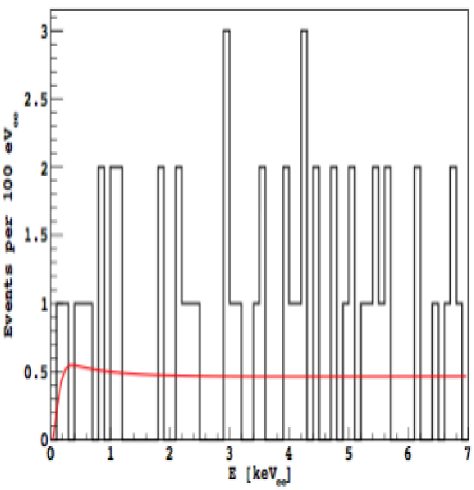


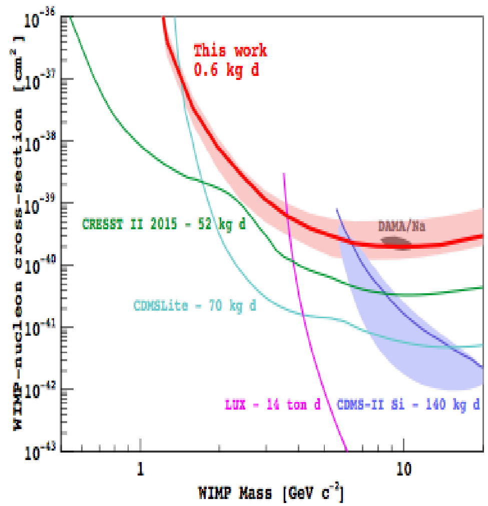
x

(JINST 10 (2016) no.08, P08014 arXiv:1506.02562 [astro-ph.IM])

DAMIC RESULTS IN 2016

WIMP SEARCH: RESULTS

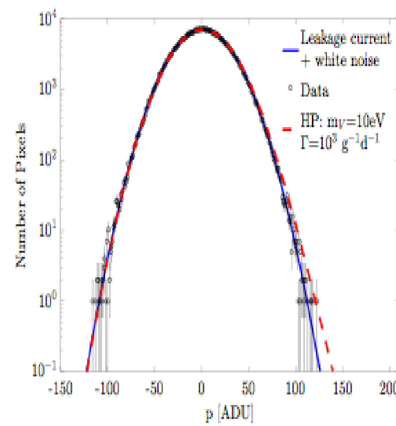


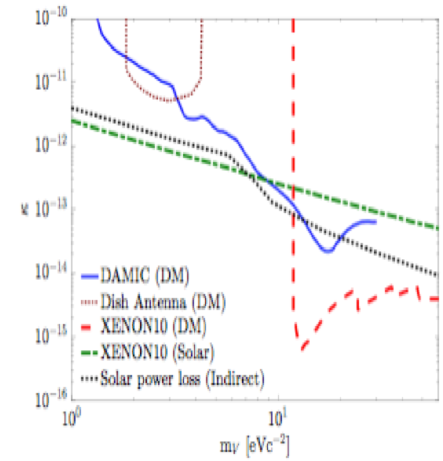


- compatible background hypothesis (Compton scatt.)
- sensitivity at low mass WIMP (m_X< 10 GeV/c^2)
- Limits with 0.6kg.day
- exclusion of a part of CDMSII signal with same target (Si)

HIDDEN PHOTON SEARCH

(arXiv:1611.03066, Phys.Rev.Lett. 118 (2017) no.14, 141803)



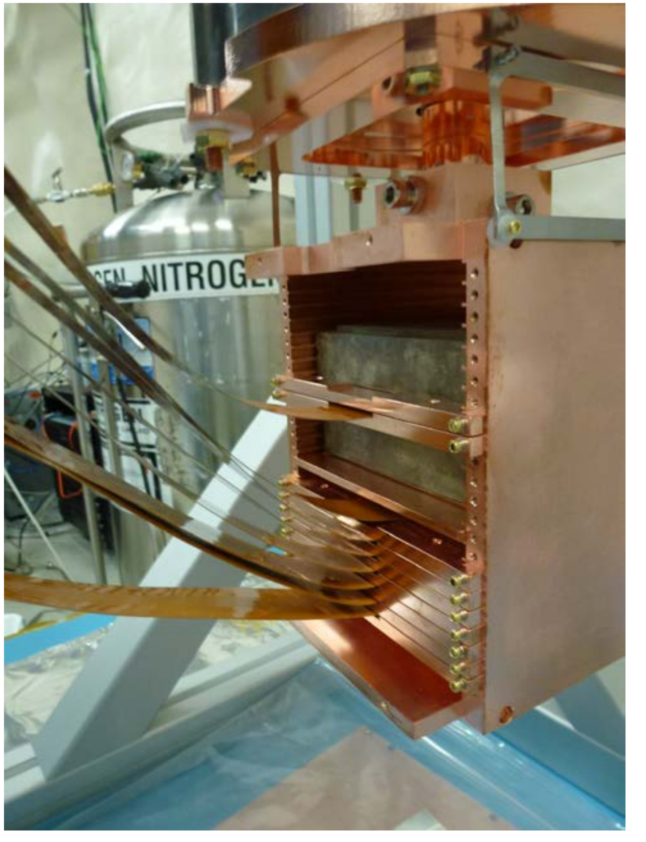


- hidden photon (m = [1-30 eV]) absorbed by electron → ionisation
- search for additional contribution in the leakage current

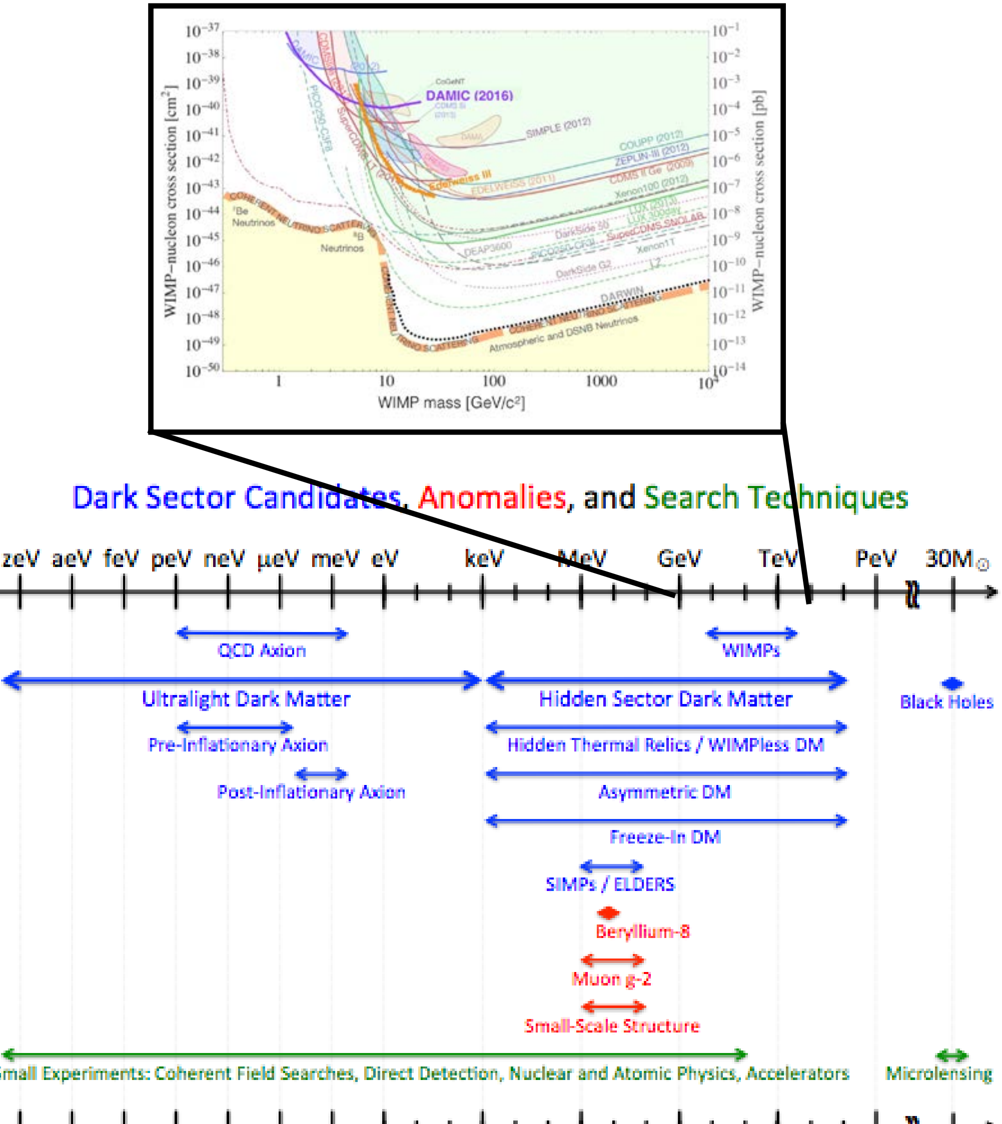
- most stringent direct detection limits in 3-12 eV mass region

STATUS: DAMIC 2017

- DAMIC40: Intermediate step to confirm progress in background, improvement of operations.
- April 2016 - January 2017: **Installation of 6-7 working CCDs (4k x 4k => ~40g of mass)**
  - replaced copper box and modules
  - replaced of parts of the shielding with ancient lead (Roman lead from Modane)
  - cleaning and etching
- Already **6 kg.day with 5-15 d.r.u.**



DAMIC FUTURE



US Cosmic Visions: New Ideas in Dark Matter 2017

Physics goals

- ➢ **~GeV WIMPs nuclear recoil**:
- ➢ **Hidden sector DM: electronic recoil**

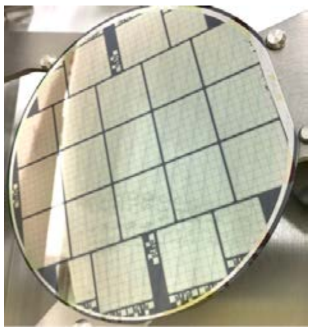
Experimental parameter to improve

- ➢ <u>target mass</u> to **kg scale**
- ➢ <u>background</u> ~ **0.1 d.r.u.**
- ➢ <u>detector threshold</u> down to ~**2e⁻ threshold** (resolution and E threshold)

DAMIC TARGET MASS & BACKGROUND REDUCTION

Mass: ~ 1kg

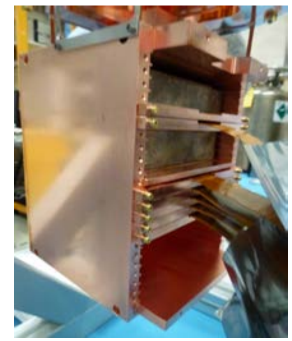
(current ~ 40 g)



- current mass: 5.8g /CCD
- goal: increase CCD mass 3X (1kg=>~50CCDs)
  - ~1mm with same fabrication process
    ~ *few mm thickness might be possible*
  - larger format :4k x 4x —> 6k x 6k

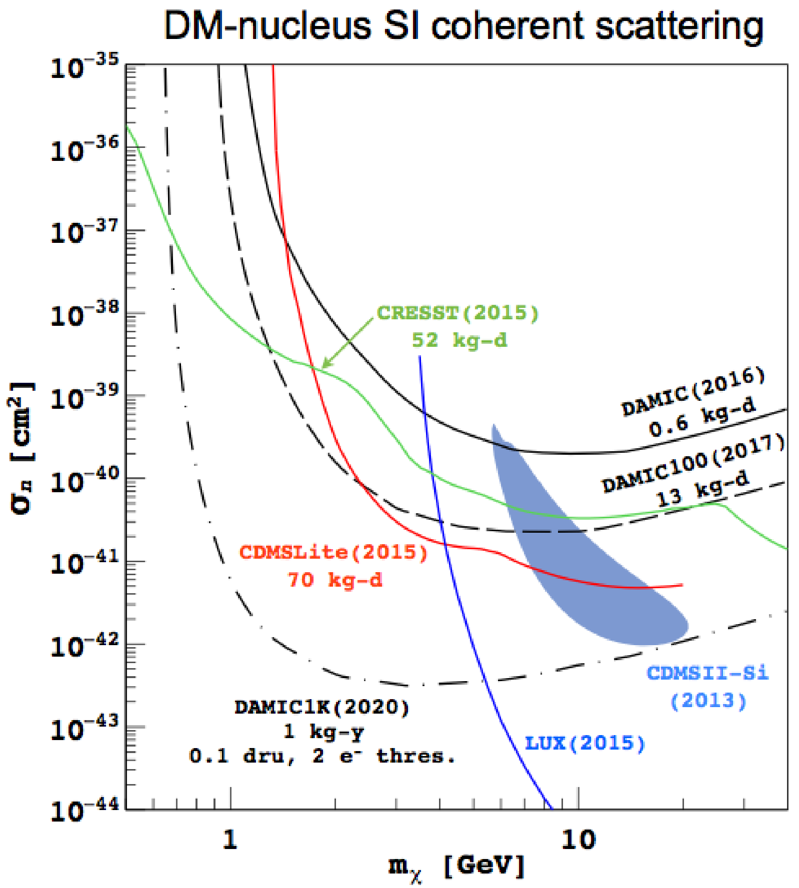
background: ~0.1 d.r.u

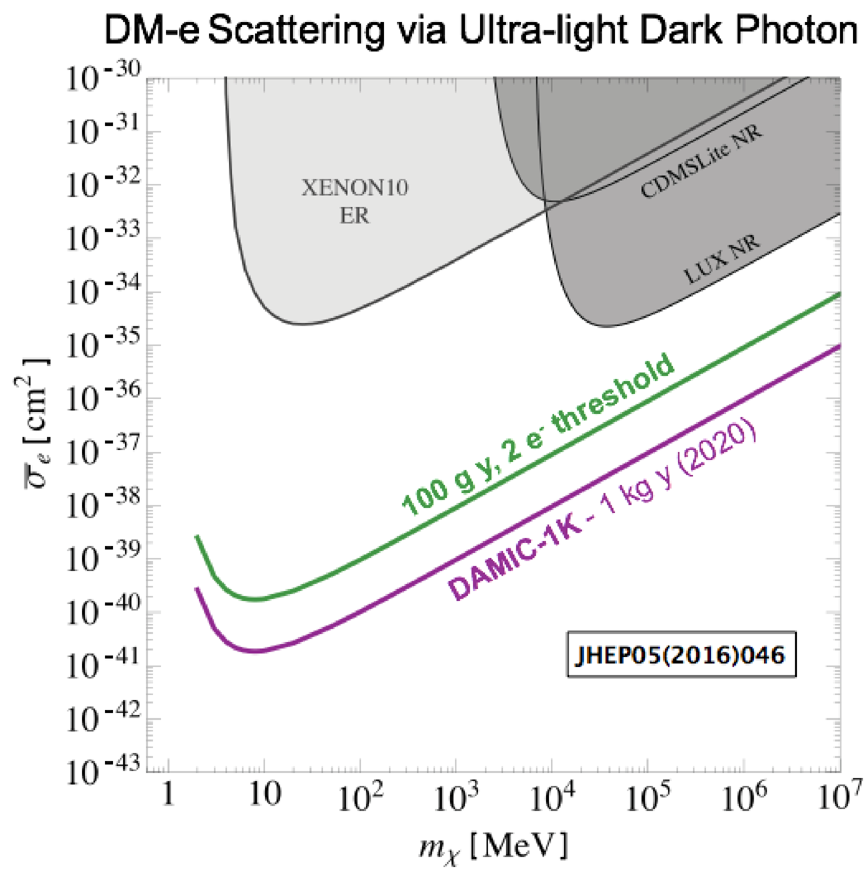
(current ~ 5 d.r.u. / EDELWEISS < 1)



- Lots of effort and experience gained
- keep activation low (Cu / Si)
  - track the Si and Cu
  - electroformed Cu
- Chain identification
  (a plus w.r.t. other exp.)

DAMIC POTENTIAL SENSITIVITY





- Competitive limits on ~GeV WIMP interaction
- Can exploit e- recoil as well and explore hidden sector

Low-mass WIMP searches with EDELWEISS

EDELWEISS-III:

2014-2015 results

EDELWEISS-LT:

With low thresholds, for ~GeV scale masses

EDELWEISS-DMB8:

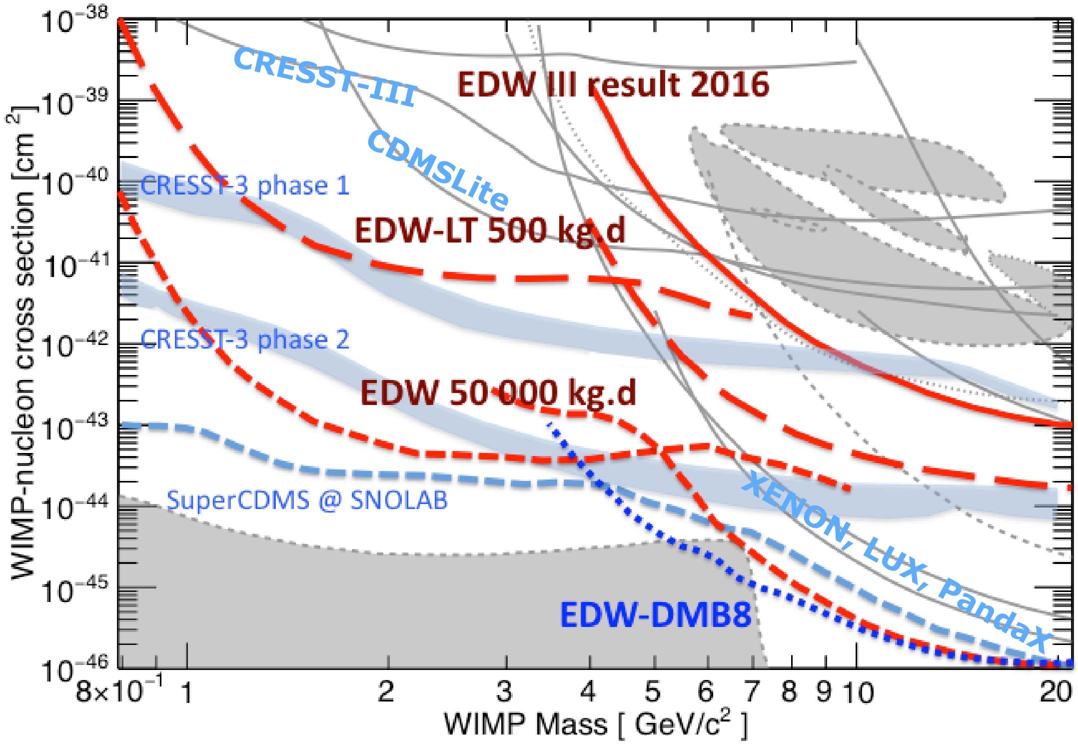
With discrimination to investigate the ^{8}B region

Jules Gascon
(IPNLyon, Université Lyon 1 + CNRS/IN2P3)

Context: Direct detection of 1-10 GeV WIMPs

- Cryogenic (bolometer) experiments should have the energy resolution needed for achieving the energy thresholds needed to cover the 1-10 GeV range for WIMPs

- **CDMSLite**: Best between 2-5 GeV, but no new data taking until ~2020 move to SNOLAB
- **CRESST-III**: Best between 0.1-2 GeV, recently moved to small 25g units, but no improvement limited by background

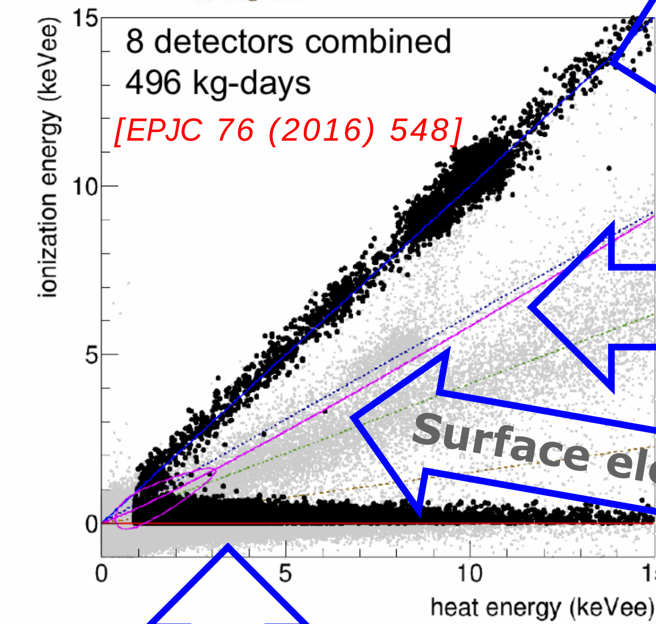


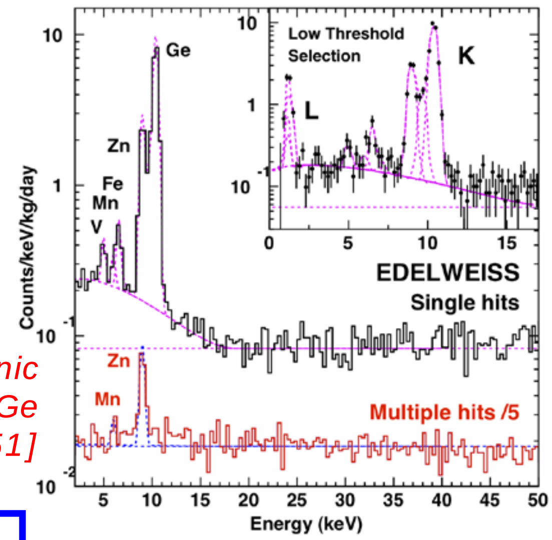
EDELWEISS-III: *[arXiv:1706.01070]*

- 20 kg Ge total (Ion+Heat), 870g units with simple & robust design (important for scalability to large arrays) + best background before rejection in cryogenic DM expt.
- Phase III initially designed for >20 GeV WIMPs and ~3000 kgd, extended down to 5 GeV in 2014-2015 given achieved resolutions
- Now preparing LT (low-thresholds: 1-5 GeV) and DMB8 (4-10 GeV) phases

Ge: electron/recoil + bulk/surface ID

Ionization+Heat Ge detectors:
- → *Resolution*
- → *Discrimination*
- → *Fiducialisation*



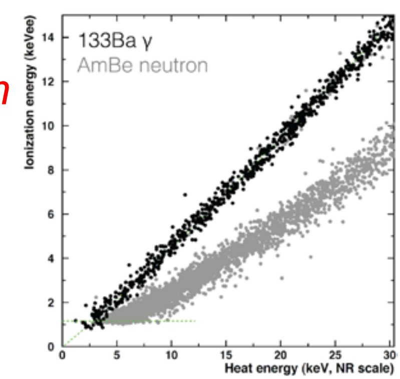


Bulk electron recoils

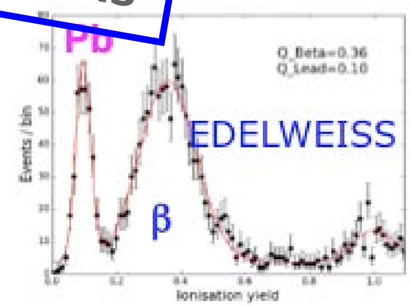
First measurement of cosmogenic production of ^3H in Ge [AstroPart. 91 (2017) 51]

Bulk nuclear recoil

Clearly separated ($<4x10^{-5}$) from



Surface electron/Pb recoils



Heat-Only events

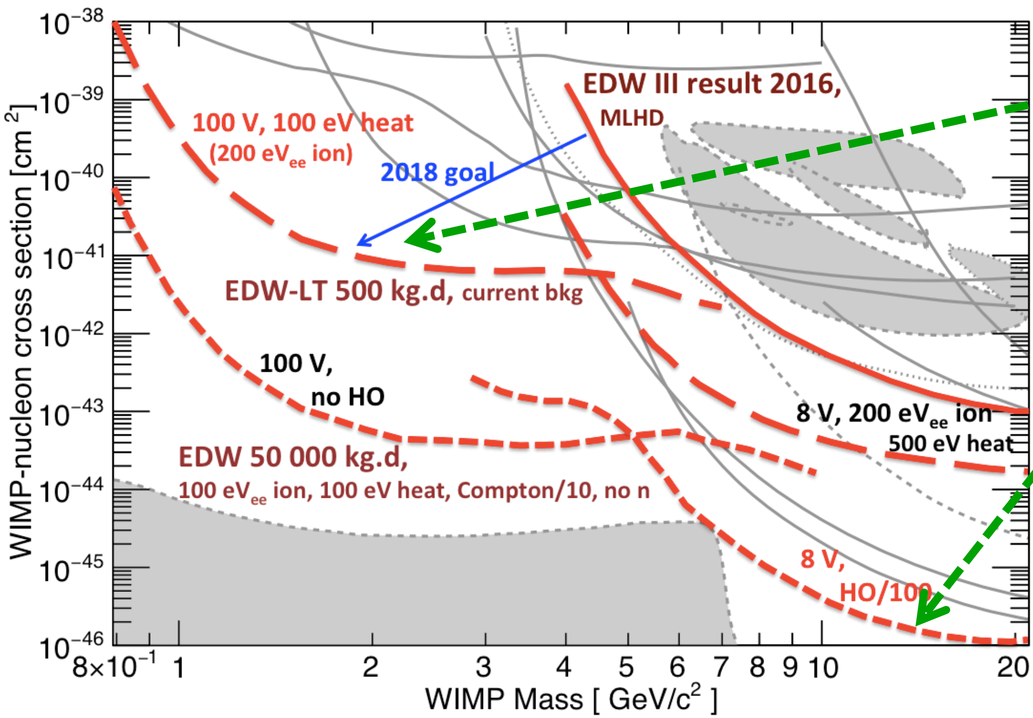
Under investigation,
Not limiting so far

Prospects for GeV-range masses

- [ArXiv:1707.04308] Complete study based on present measured backgrounds and resolutions *vs* possible improvements
- ***Ionization resolution is the key to improve bkg rejection***
- ***Heat resolution is the key to lower E thresholds***

"4x100" goals

Lower thresholds



1. Use of Luke-Neganov boost to lower thresholds (up to 100V bias)
2. Improve heat resolution
   σ_{heat} = 500 eV → **100 eV**
   (x5 gain in sensitivity already achieved on 200 g detectors)
3. Reduction x100 of heat-only background
4. Improve ionization resolution
   σ_{ion} = 200 eV_{ee} → **100 / 50 eV_{ee}**

Discrimination

Also: effect of improved n/γ background (+ increased mass) in the environment planned for SuperCDMS at SNOLAB

EDELWEISS-LT: Luke-Neganov boost

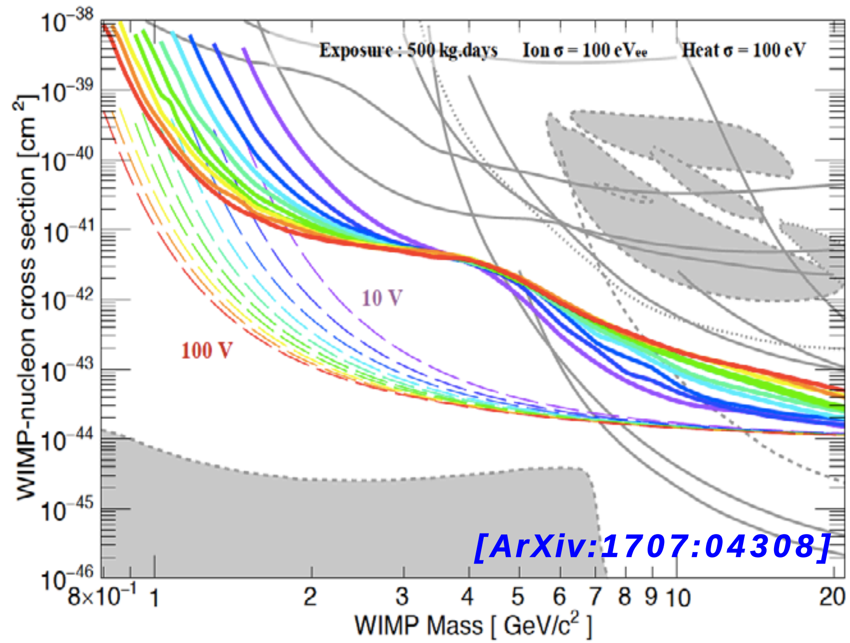
Heat thresholds can be improved by applying larger bias voltages

- Heat signal boosted by Neganov-Luke effect (~Joule heating, factor $[1+V_{bias}/3]$)
- Loss of ionization-based bkg discrimination: method benefits low-mass searches only
  → *10^{-41} cm² with 500 kgd and current bkgs*

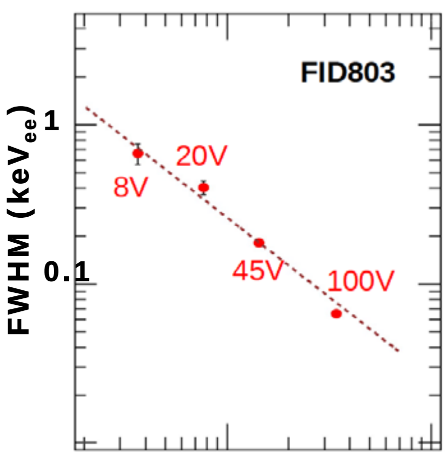
✔ **100V bias already achieved**

✔ **nucl. recoils down to ~0.1 keV_{ee}**

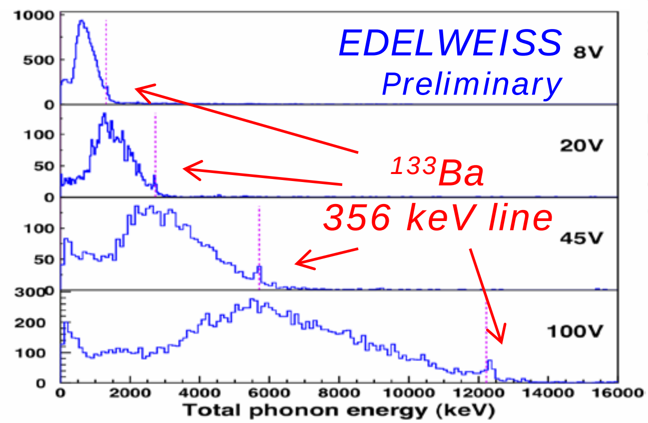
✔ **First WIMP Data@100V analysis underway**

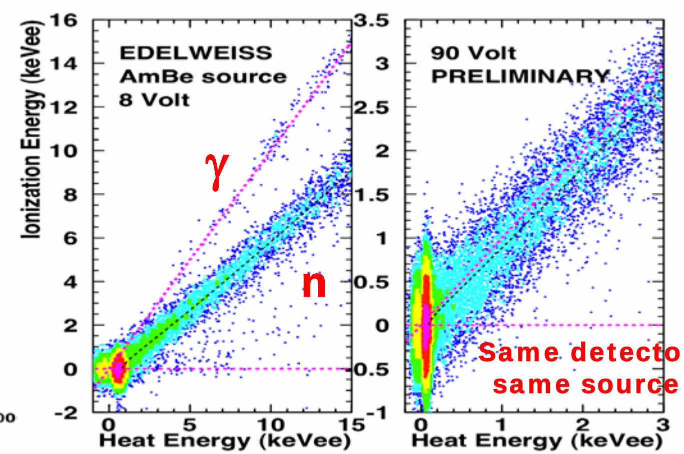


[ArXiv:1707:04308]



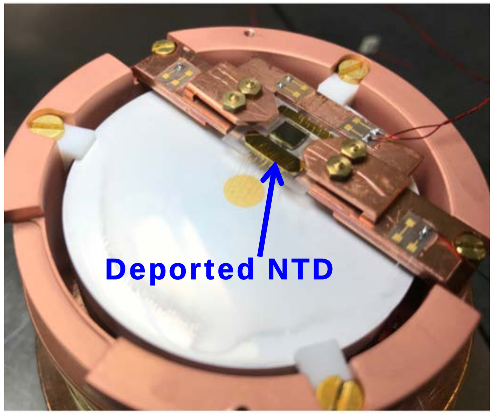
Luke boost = 1 + V/3

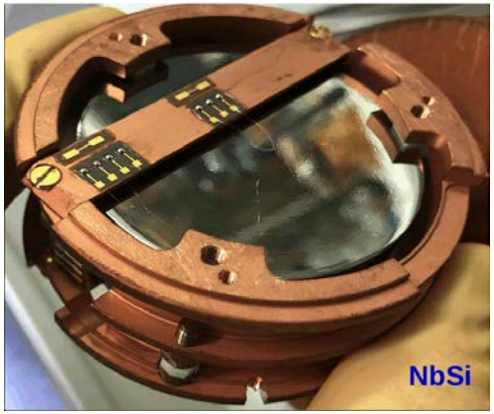


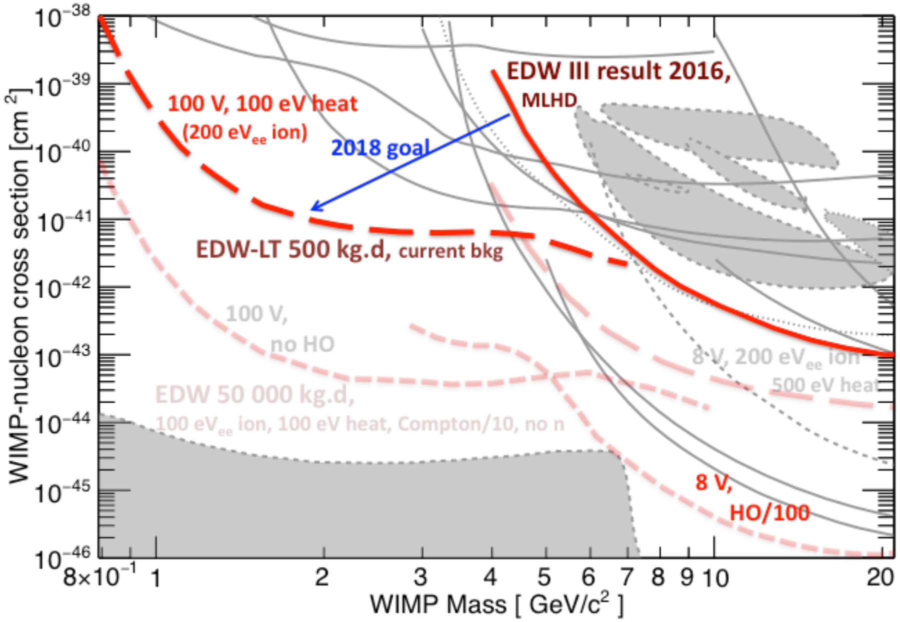


EDELWEISS-LT: Heat-only background

- Standard signals on both NTDs but none on any electrodes
- Many studied hypotheses, none conclusive so far
  - Noise, cryogenics, stress from detector suspension or from glueing, natural radioactivity…
- New detector configurations being tested to study these hypotheses
  - Deported NTD glued on separate sapphire wafer
  - Photolithographed high-impedance NbSi TES sensitive to athermal phonons
- **Dominant at low energy, but sufficiently reproducible for analysis of present 100V data** **& for EDELWEISS-LT: operation of 4x870g at 100V for 150 days in current LSM backgrounds**



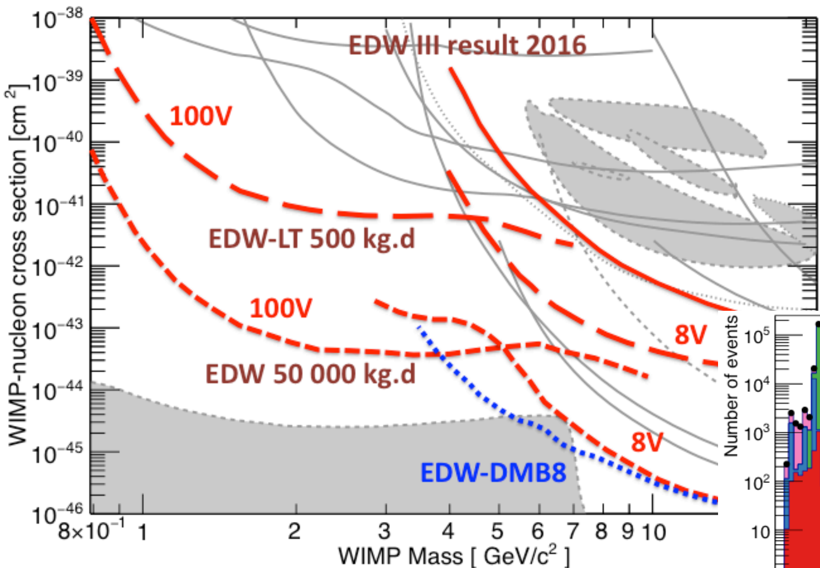




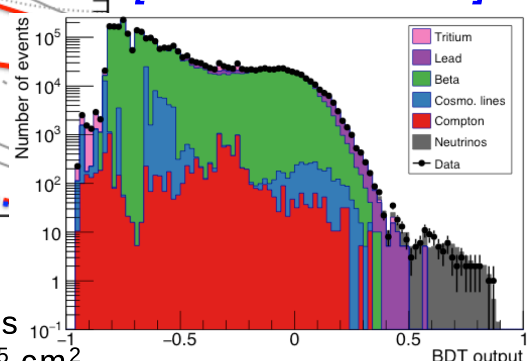
Ionization improvements

- Cold front-end: replace JFET @100K with HEMT (High Electron Mobility Transistor) @4K
- Can be operated at 4K: shorter cabling -> reduced capacitance -> better signal/noise
- Successful HEMT amplifier with sub-100 eV resolution operated on a CDMS-II detector *[A. Phipps et al., arXiv:1611.09712]*
- EDELWEISS electrode design with lower capacitance: 2 → 4 mm spacing already achieved. Goal: reach 50 eV_{ee}.

2 mm spacing → 4 mm spacing



[arXiv:1707.04308]



EDELWEISS-DMB8:
Operation of a 200 kg array @8V (with nuclear recoil discrimination) in the improved background environment of SuperCDMS @ SNOLAB

Probing the region of ^{8}B solar ν's coherent scattering with resolution and discrimination

Coherent nuclear scattering of solar ^{8}B ν's mimic a ~6 GeV WIMP with σ ~ 4.4×10^{-45} cm^2
Probe with discrimination and resolution (~10%) a bkg that will soon become relevant for WIMP searches near 6 GeV/c^2.

Conclusions

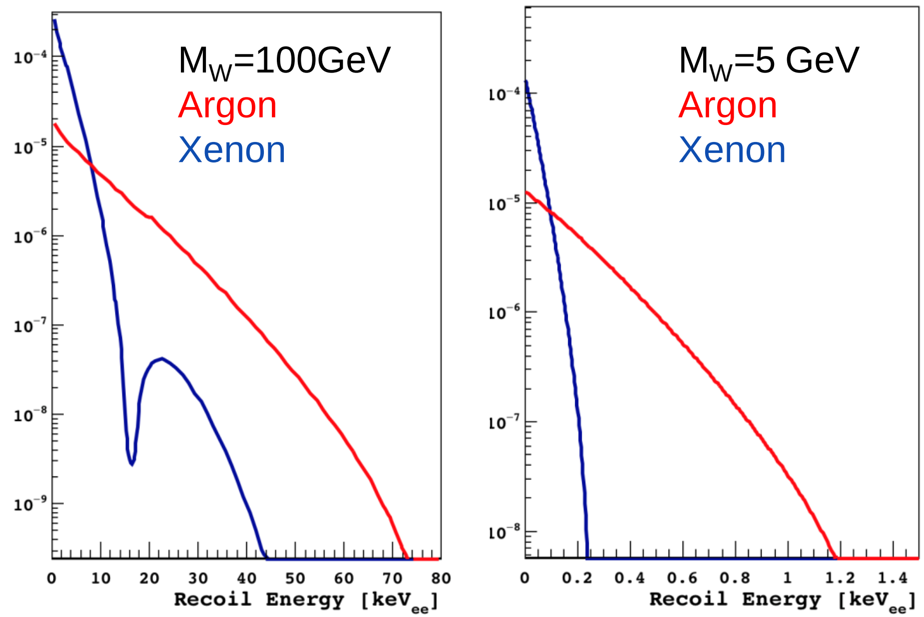
- EDELWEISS-III
  - Robust design, good reproducibility of performances *[arXiv:1706.01070]* *[JINST 11 (2016) P10008]*
  - Detailed description of backgrounds *[AstroPart. 91 (2017) 51]*
  - Improved ionization resolution & thresholds lead to x40 improvement of WIMP sensitivity at ~5-10 GeV wrt EDELWEISS-II. *[JCAP05 (2016) 019]* *[EPJC 76 (2016) 548]*
- Prospects in the GeV-WIMP range: EDELWEISS-LT *[arXiv:1707.04308]*
  - Improve thresholds x10 using boost from 8 to 100V (achieved)
  - 10^{-41} cm^2 achievable at LSM with 4 detectors with present levels of backgrounds
- Prospects for WIMPs in the ^{8}B region: EDELWEISS-DMB8
  - 50 eV ionization resolution to obtain pure nuclear recoil sample + 10% resolution on recoil energy: clear spectral identification of ^{8}B ν *[arXiv:1707.04309]*
  - Use HEMT preamplifier + reduce electrode capacitance (reduction by a factor of 2 of number of electrodes achieved)
  - ~200 kg FIDs at SNOLAB to complement nicely the SuperCDMS-SNOLAB reach

DarkSide: the Argon Target

Argon is a light nucleus:

- Smaller cross section but easily scalable in target mass
- Higher recoil energy
- Lower quenching effect
- Very low background rate in underground argon mode:
    - <1.5 Hz trigger rate with 50 kg
    - signal rate in the 0.1-10 keVee range at <1 ev/kg/keVee/day
- DS-50 S1 LY: 7.1 pe/keV at 200 V/cm (S1+S2 analysis threshold at ~8 keVee)
- DS-50 S2 LY: ~26 pe/e- (S2 only analysis threshold at ~3-4 electrons with W_e=23.5 eV)

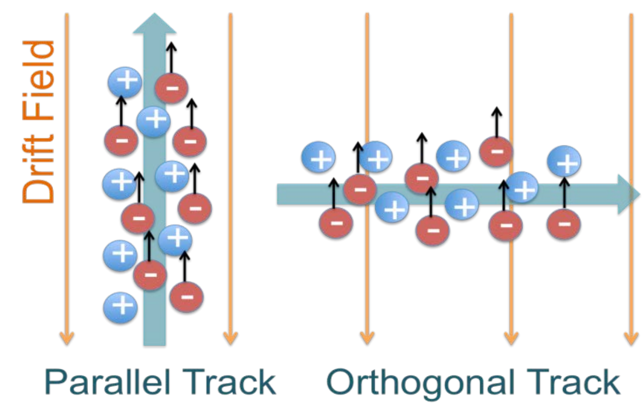
Recoil Spectra



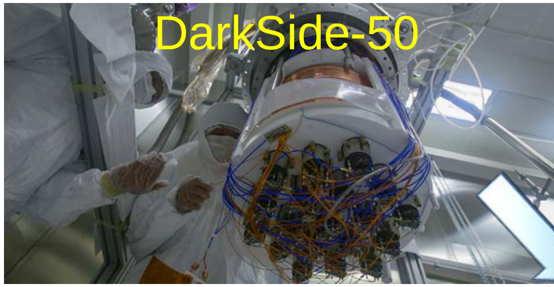
Visible energy (including quenching)

Large potential at high (>50 GeV) and very low WIMP masses (<10 GeV), by operating at "relatively" high thresholds

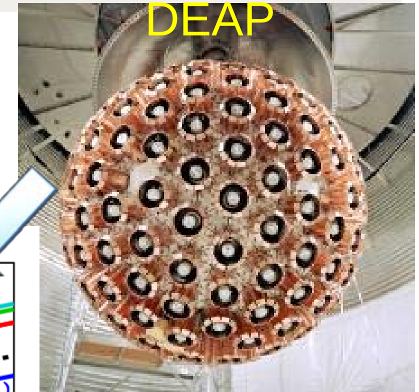
Directional signature by looking at recombination effect variation as function of the track orientation with respect to the direction of the field (to be proved!! → ANR AXIS submitted)



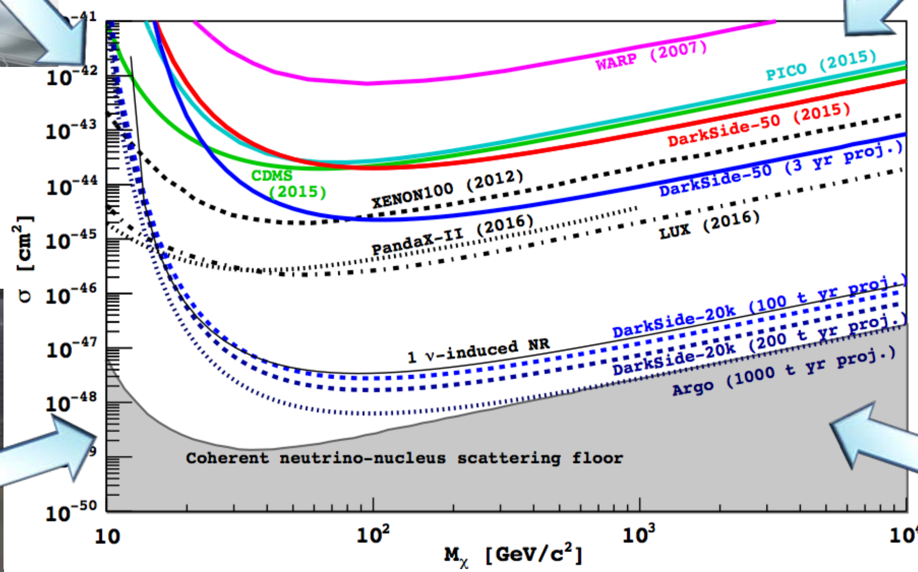
DarkSide-20k (~2021)

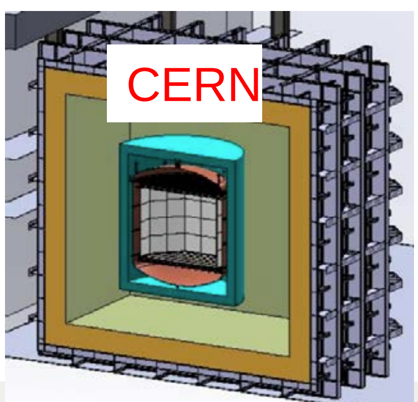


Global effort from all liquid argon experiments looking for dark matter



Access to current DEAP-3600 data

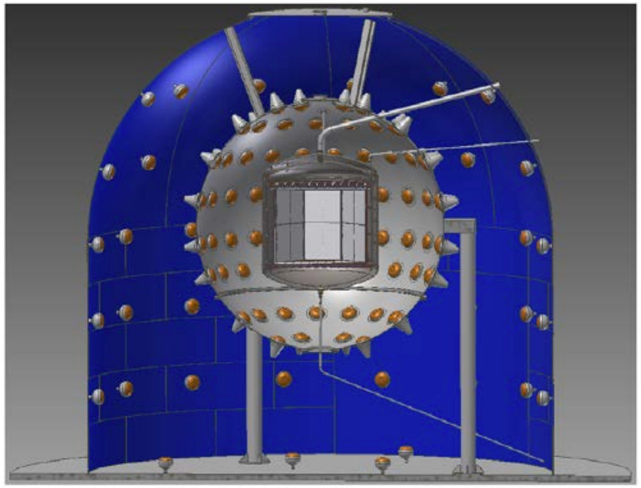




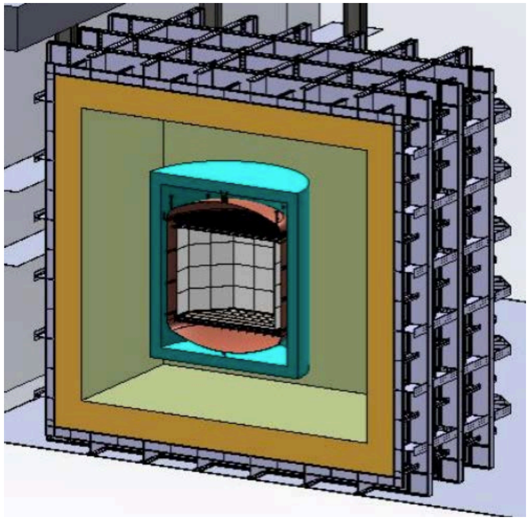
Discussion with CERN on going: interest in participating with the DUNE cryostat technology

DarkSide-20k, **a 20 t** fiducial mass detector.
Design goal: **a background free exposure of 100 t yr**
Background free condition: **< 0.1 ev / 100 t yr** in WIMP ROI

New design of TPC in a liquid argon bath, to further reduce the neutron background. Replacement of the largest sources of (alpha,n) neutrons: copper vessel instead of the steel cryostat and acrylic instead of teflon.
Involvement of the CERN neutrino platform.



Original design:
+ Water Cerenkov (muons)
+ Liquid Scintillator + ^{10}B (n)

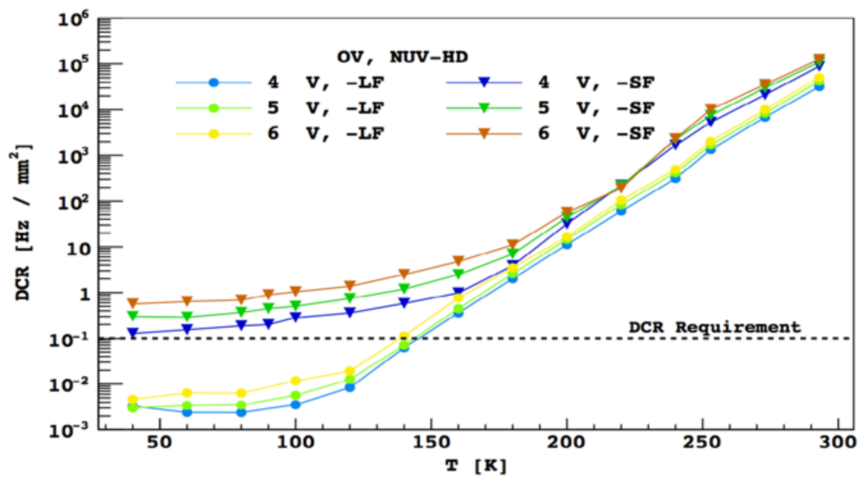


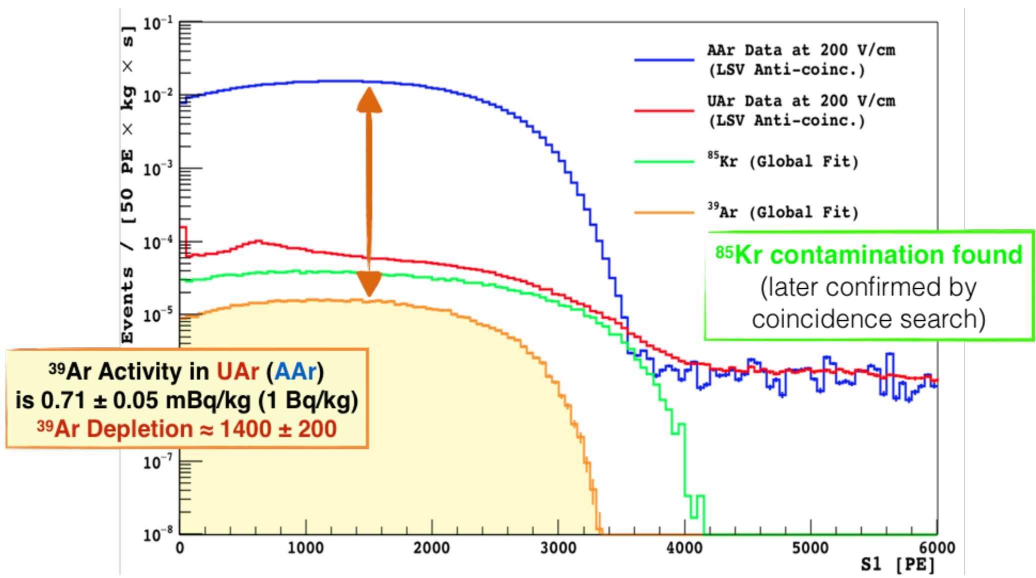
Alternative design (**DUNE cryostat**):
+ Lar veto (muons)
+ Plastic Scintillator + ^{10}B (n)

More details at https://indico.cern.ch/event/670834/

Main features

- PSD removes ER contamination (rejection power ~10^8)
- Cleaner materials, mostly due SiPM instead of PMTs (14 m^2 required).
- SiPM development concluded: all the requirements are matched (DCR at 10^{-1} Hz/mm^2, PDE at >40%)
- ^{39}Ar in underground argon: DS-50 measured a depletion factor of ~1400 (might be better: leak found in the distillation process!)
- URANIA: large underground argon extraction plant in Colorado
- ARIA: ~350 m distillation column in Sardinia for 39Ar/40Ar separation

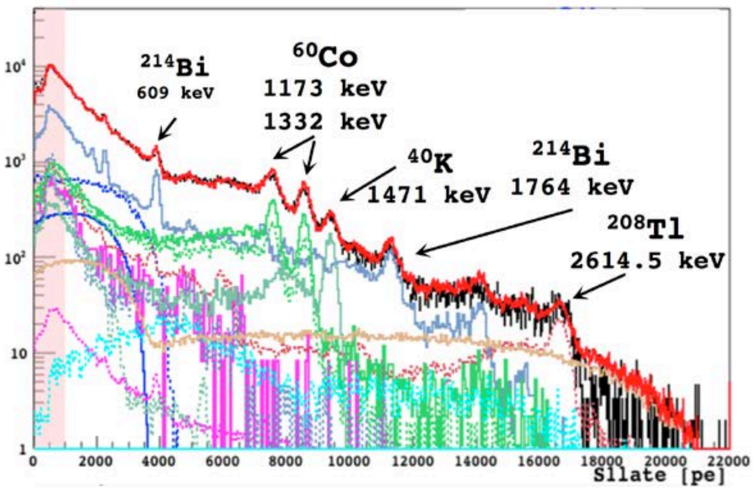




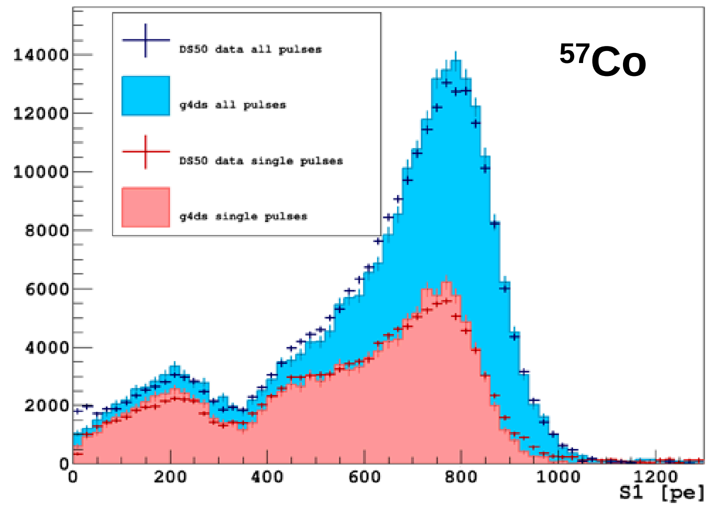
Status of DarkSide-50

- DarkSide-50 is currently taking data (500 days of UAr).
- Blind analysis ongoing, to be released at UCLA DM (February 2018)
- Preliminary analysis of S2-only events, currently ongoing: very promising (stay tuned)

- << **Simulation of argon response and light detection in the DarkSide-50 dual phase TPC** >>, mainly developed by French groups (JINST12P10015). It features an effective model for recombination of e^-/ion pairs for electron recoils in the [2.6, 565] keV energy range.



Fit of the full DS50 spectrum with MC spectra and measurement of the depletion factor of ^{39}Ar



Cross check of energy scale calibration with external calibration sources

Toward DarkSide-20k

DarkSide-20k milestones

- **Yellow Book** (preliminary TDR) submitted: arXiv:1707.08145

. TPC design is ready and the baseline requirements for SiPMs are matched.
. A 1 t prototype will be run at CERN during 2018 (TPC, cryogenics and SiPMs)

- **DarkSide-20k approved by INFN and NSF**
- Canada (DEAP groups) asking for funding
- New groups from Germany, UK and Spain

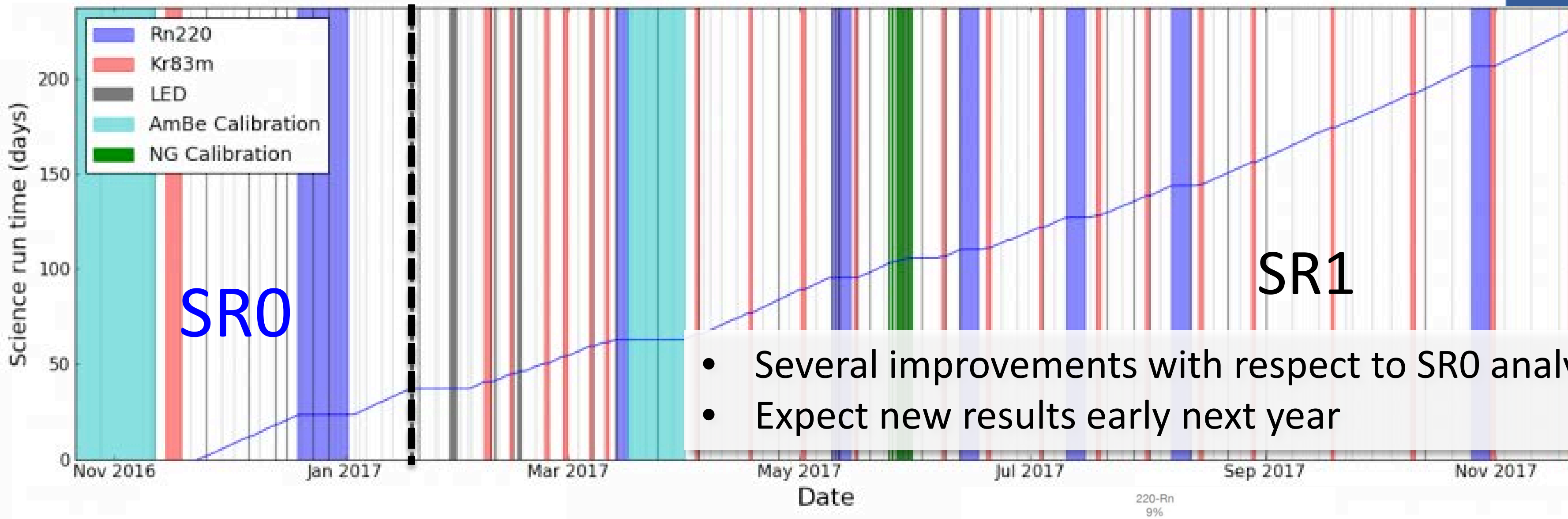
- Discussion about the **involvement of CERN Neutrino Platform**

. Extensive simulation campaign led by French groups to determine the performance of the new veto design.

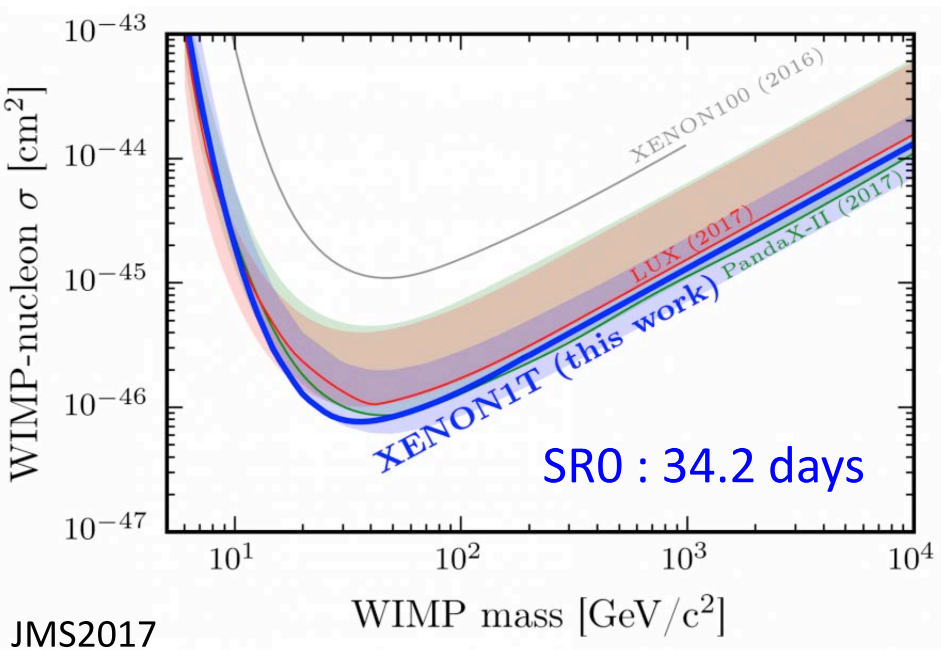
- **External calibrations**: **ARIS** successfully performed at IPNO, analysis just completed (see Anyssa's talk)

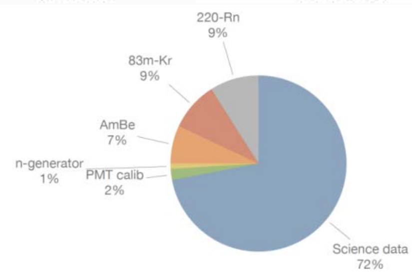
. IPNO guarantees 2 weeks/year of beam for LAr external calibrations

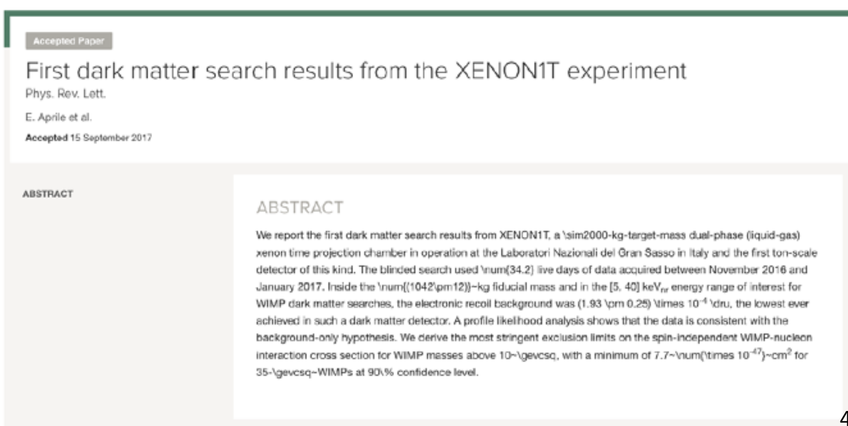
XENON1T : Exposition and SR0 results



- Several improvements with respect to SR0 analysis
- Expect new results early next year






Accepted Paper

First dark matter search results from the XENON1T experiment

Phys. Rev. Lett.

E. Aprile et al.

Accepted 15 September 2017

ABSTRACT

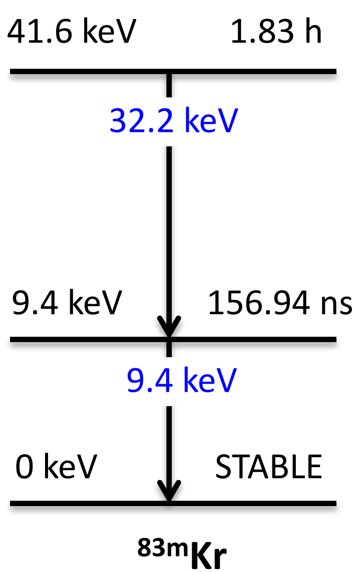
ABSTRACT

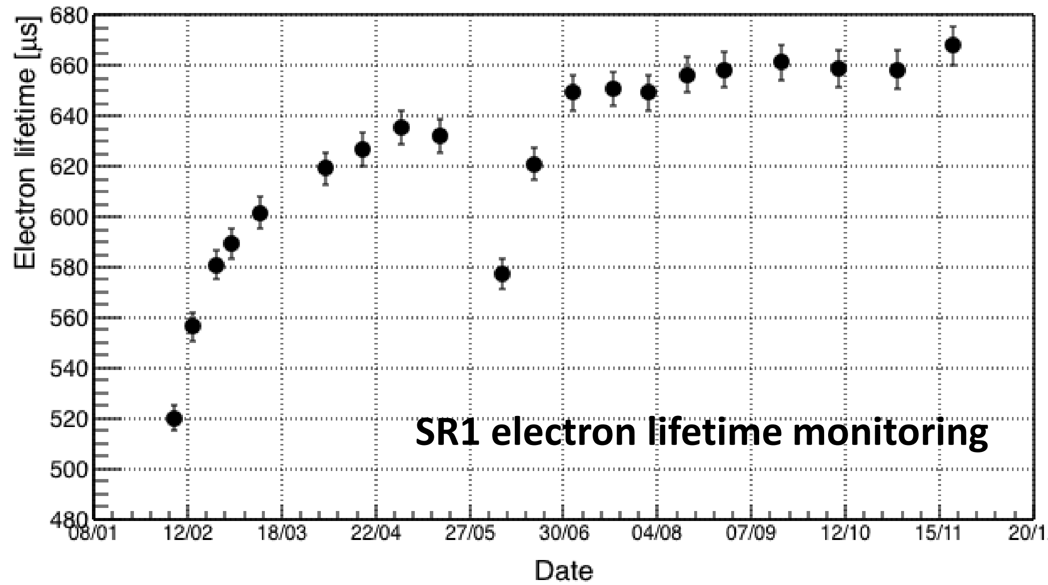
We report the first dark matter search results from XENON1T, a \sim2000-kg-target-mass dual-phase (liquid-gas) xenon time projection chamber in operation at the Laboratori Nazionali del Gran Sasso in Italy and the first ton-scale detector of this kind. The blinded search used \num{34.2} live days of data acquired between November 2016 and January 2017. Inside the \num{(1042\pm12)}~kg fiducial mass and in the [5, 40] keV$_{nr}$ energy range of interest for WIMP dark matter searches, the electronic recoil background was (1.93 \pm 0.25) \times 10^{-4} \dru, the lowest ever achieved in such a dark matter detector. A profile likelihood analysis shows that the data is consistent with the background-only hypothesis. We derive the most stringent exclusion limits on the spin-independent WIMP-nucleon interaction cross section for WIMP masses above 10~\gevcsq, with a minimum of 7.7~\num{\times 10^{-47}}~cm^2 for 35-\gevcsq~WIMPs at 90\% confidence level.

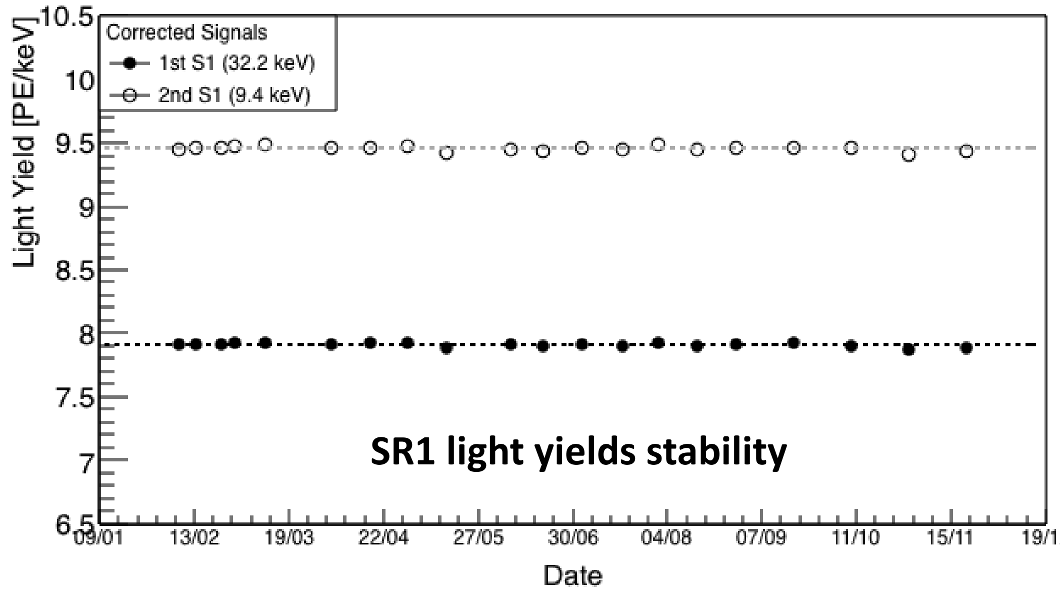
SR1 : Kr83m Calibration

Electron absorption along the 1m drift : controlled thanks to Kr^{83m} calibration

- Electron lifetime monitoring
- Light/charge yields stability
- Signal corrections

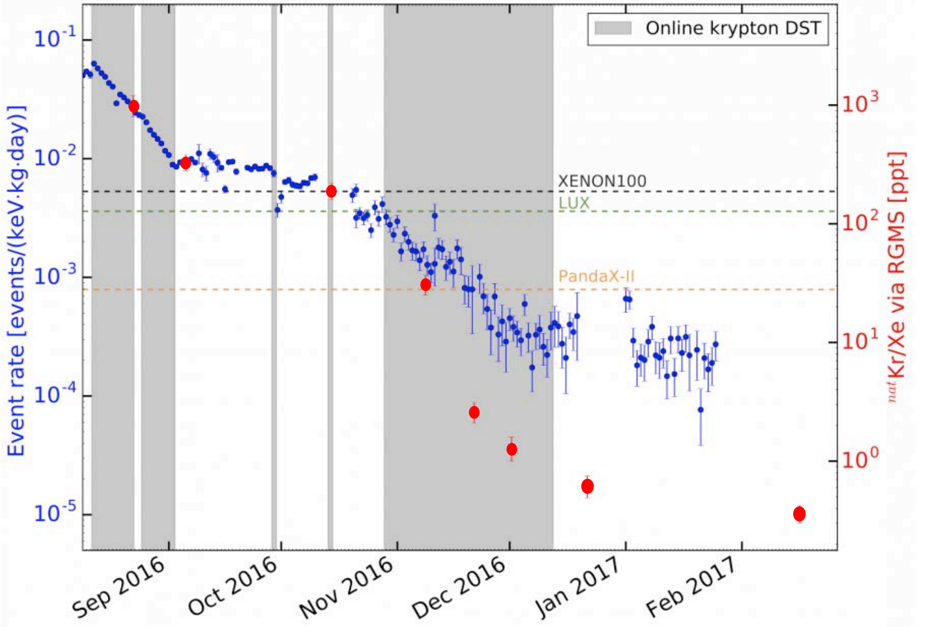






XENON 2017 photo
XENON100 - XENON1T - XENONnT

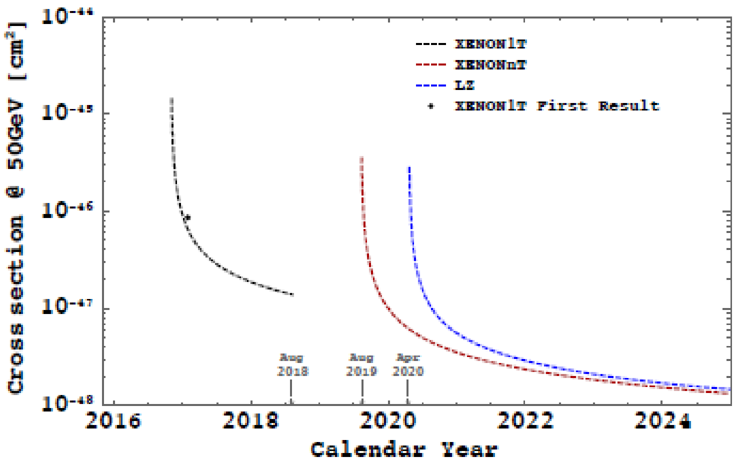
Search for Bosonic Super-WIMP Interactions with the XENON100 Experiment (submitted to PRD, arXiv:1709.02222)
First Dark Matter Search Results from the XENON1T Experiment (accepted in PRL)
The XENON1T Dark Matter Experiment (submitted to EPJC, arXiv:1708.07051)
Intrinsic backgrounds from Rn and Kr in the XENON100 experiment (submitted to EPJC, arXiv:1708.03617)
Search for magnetic inelastic dark matter with XENON100 (accepted in JCAP, arXiv:1704.05804)
Effective field theory search for high-energy nuclear recoils using the XENON100 dark matter detector (published in PRD 96, 042004, 2017)
Material radio-assay and selection for the XENON1T dark matter experiment (submitted to EPJC, 1705.01828)
Search for WIMP Inelastic Scattering off Xenon Nuclei with XENON100 (published in PRD 96, 022008, 2017)
Online 222Rn removal by cryogenic distillation in the XENON100 experiment (published in Eur. Phys. J. C, 2017, 77
Search for Electronic Recoil Event Rate Modulation with 4 Years of XENON100 Data (published in PRL 118, 101101, 2017)
Removing krypton from xenon by cryogenic distillation to the ppq level (published in Eur. Phys. J. C (2017) 77: 275)
Results from a Calibration of XENON100 Using a Source of Dissolved Radon-220 (published in Phys. Rev. D 95, 072008)
XENON100 Dark Matter Results from a Combination of 477 Live Days (published in Phys.Rev. D94 no.12, 122001)



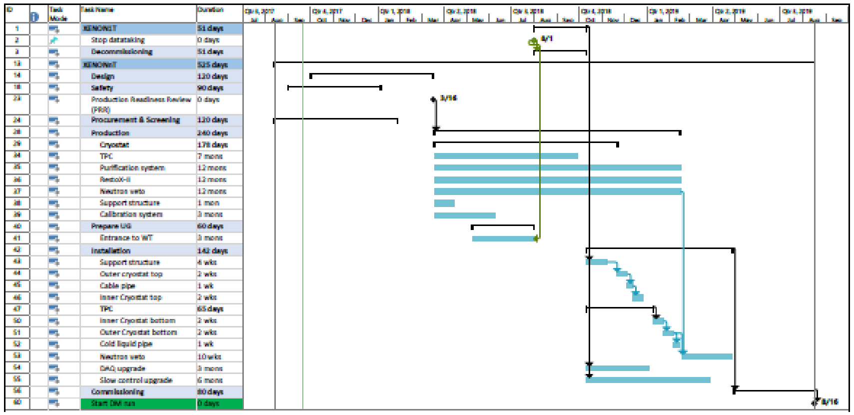
➢ **XENONnT upgrade for 2018**

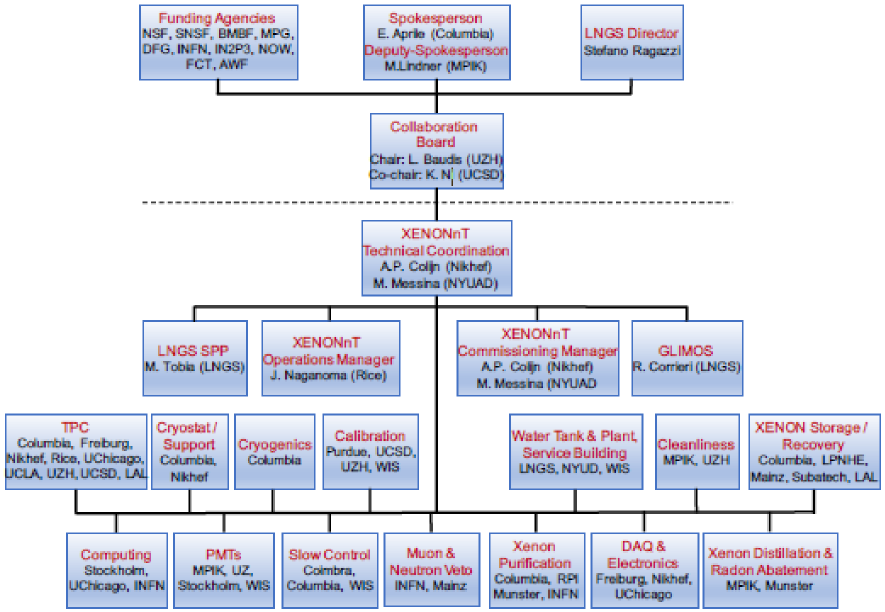
new internal cryostat
new TPC
improving the purification system,
reducing the residual radon contamination
increasing the capacity of the data acquisition system
increasing the xenon storage and recovery capacities

Fast upgrade XENONnT



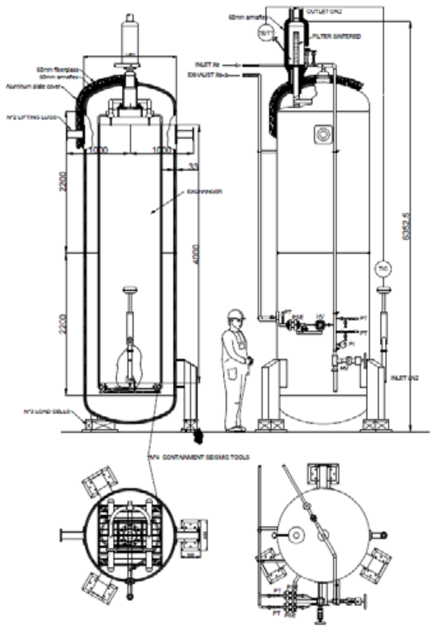
+ PandaX 4t in commisionning until summer 2018





- Installation for Summer 2018
- Science run for 2019

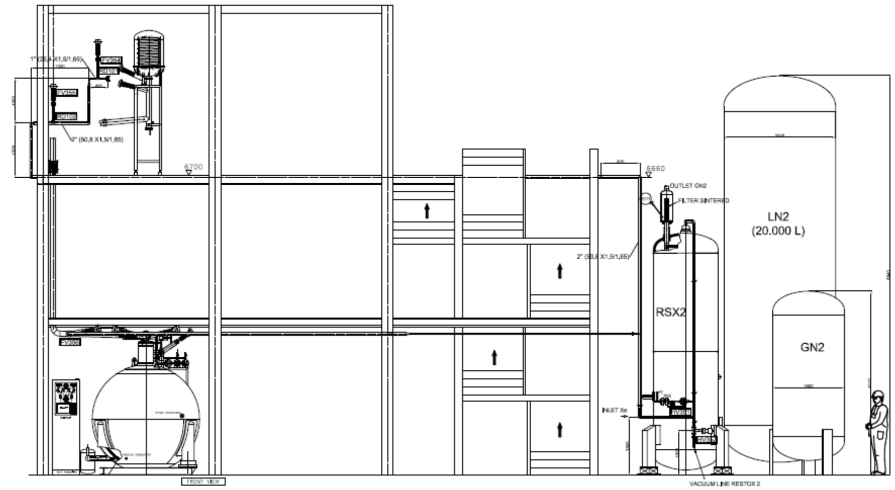
ReStoX2 @ CNRS



- ReStoX2 equipment is entirely funded by CNRS and French labs : LAL, LPNHE, SUBATECH

- Technical teams will be deployed :

to follow the construction
for the installation
for the qualification
for the commissioning
for the operation of ReStoX2



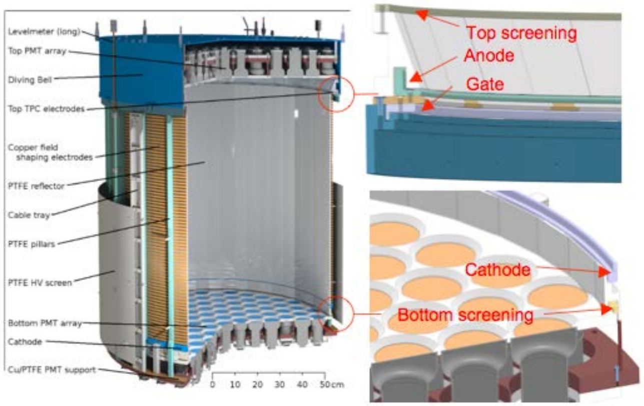
Main caracteristics for users :

- Connected to both ReStoX1 and TPC
- Maximum xenon charge 10 tons
- Cooled by LN2
- High pressure storage vessel
- Fast recovering with xenon cristalization, 1 ton/hour expected

Tight planning

- **November 17 : official orders**
- **December 17: details studies ready, beginning of the construction**
- **April 18: exchanger insertion inside the vessel**
- **May 18: passive isolation installation at LNGS**
- **July 18: connection and start of the qualification**

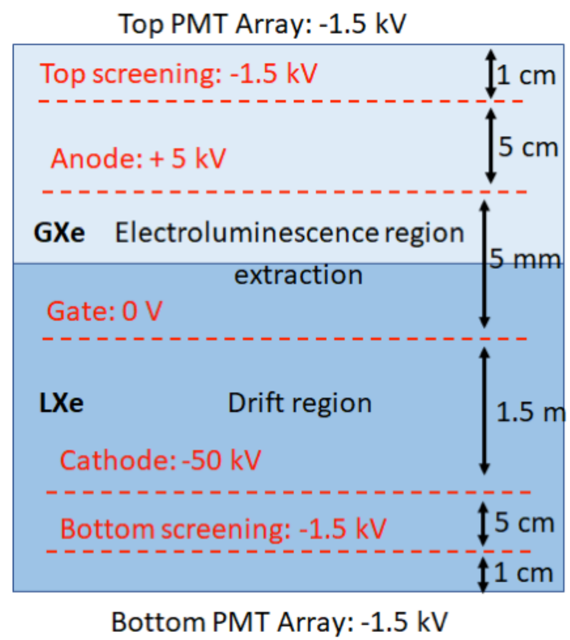
Electrodes TPC



- Essential part of the core of the experiment
- 5 electrodes in total
- Challenging goal to obtain optimal design that minimize material (low radioactivity and transparency) and assures enough mechanical rigidity
- LAL responsibility in collaboration with Rice University (USA)
- Design needed end of 2017
- Installation end of 2018

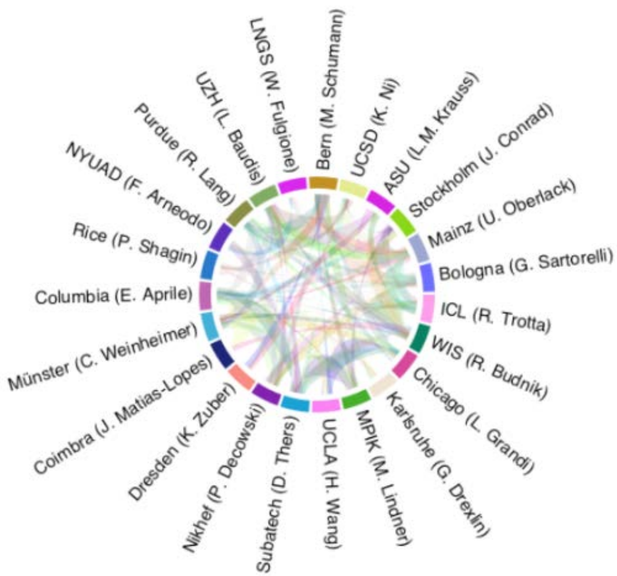
- 5 grids with different purposes, requirements
- Light must go through grids for the detection by PMTs (*)
- Electric fields in drift and extraction/electroluminescence regions are separated by gate grid
- E-field of drift region is defined by cathode and gate voltages, and field shaping rings
- E-fields of extraction / electroluminescence regions are defined by gate and anode voltages.
- Top and bottom screening meshes are placed to avoid high E-field on PMTs.

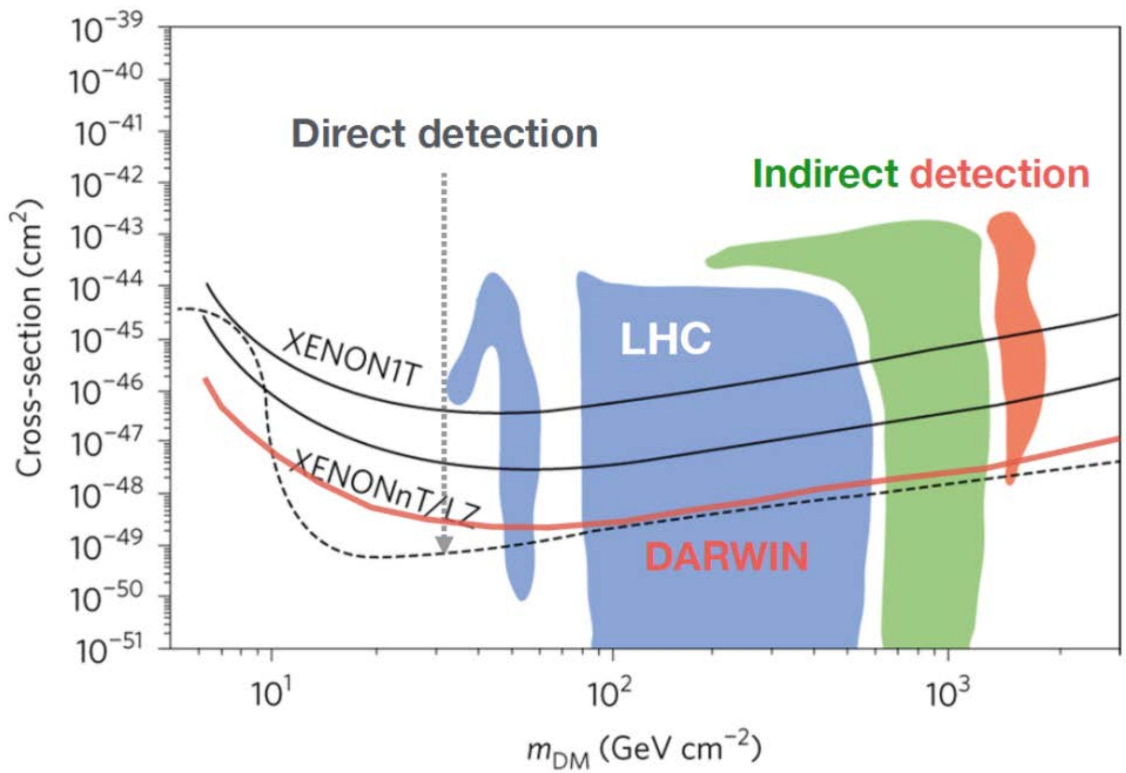
➢ **ANR JC ASIX**



DARWIN

DARWIN : in Europe, after XENONnT, 50T of xenon





- **Large community in Europe, strong program on ν physics and leptophysics also (solar, pp-n, 0νββ, solar axions, ALPs, …)**

- **Horizon 2024**

JMS 2017 Conclusion

2017: Very active year for DDM

Experimental French projects covered a large domain of research

Good strategy until discovery

French teams are at the edges of key detectors

Very active developments, very positive

Other very nice results this year from PICO60, DEAP3600 and PandaX2

World research

➢ **Logic of international collaborations**