*Nuclear recoils in CYGNO 10 L prototype

D RECTIONAL DARK MATTER SEARCHES WITH CYGNO

E Baracchini[1,2], L Benussi[3], S Bianco[3], C Capoccia[3], M Caponero[3,4], G Cavoto[5,6], A Cortez[1,2], I A. Costa[7], E Di Marco[5], G D'Imperio[5], G Dho[1,2], F Iacoangeli[5], G Maccarrone[3], M Marafini[5,8], G Mazzitelli[3], A Messina[5,6], R A. Nobrega[7], A Orlandi[3], E Paoletti[3], L Passamonti[3], F Petrucci[9,5], D Piccolo[3], D Pierluigi[3], D Pinci[5], F Renga[5], F Rosatelli[3], A Russo[3], G Saviano[3,10] R Tesauro[3], and S Tomassini[3]

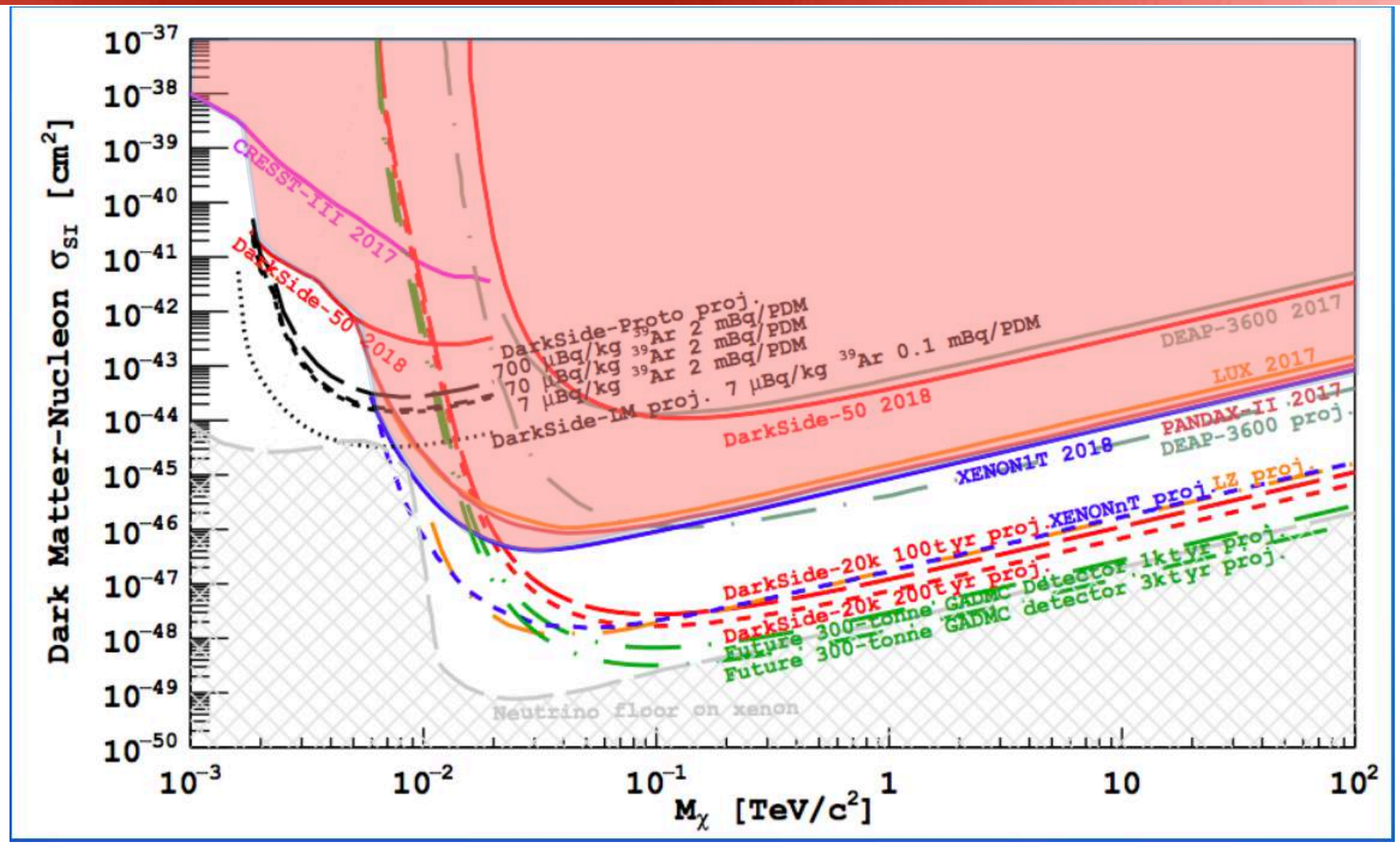
Elisabetta Baracchini

Gran Sasso Science Institute

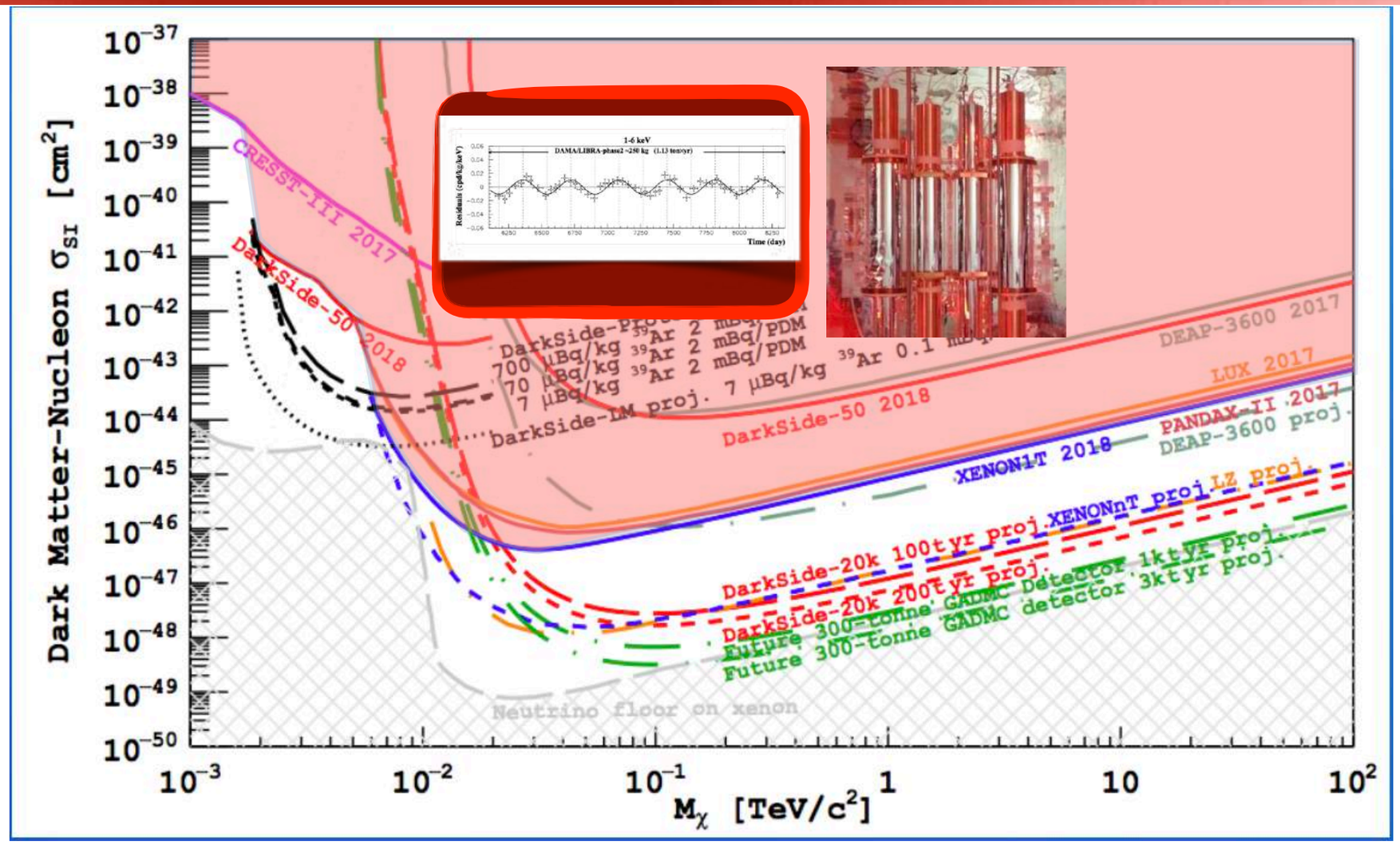
III South American Dark Matter Workshop
ICPT - SAIFR

European Research Council
Established by the European Commission

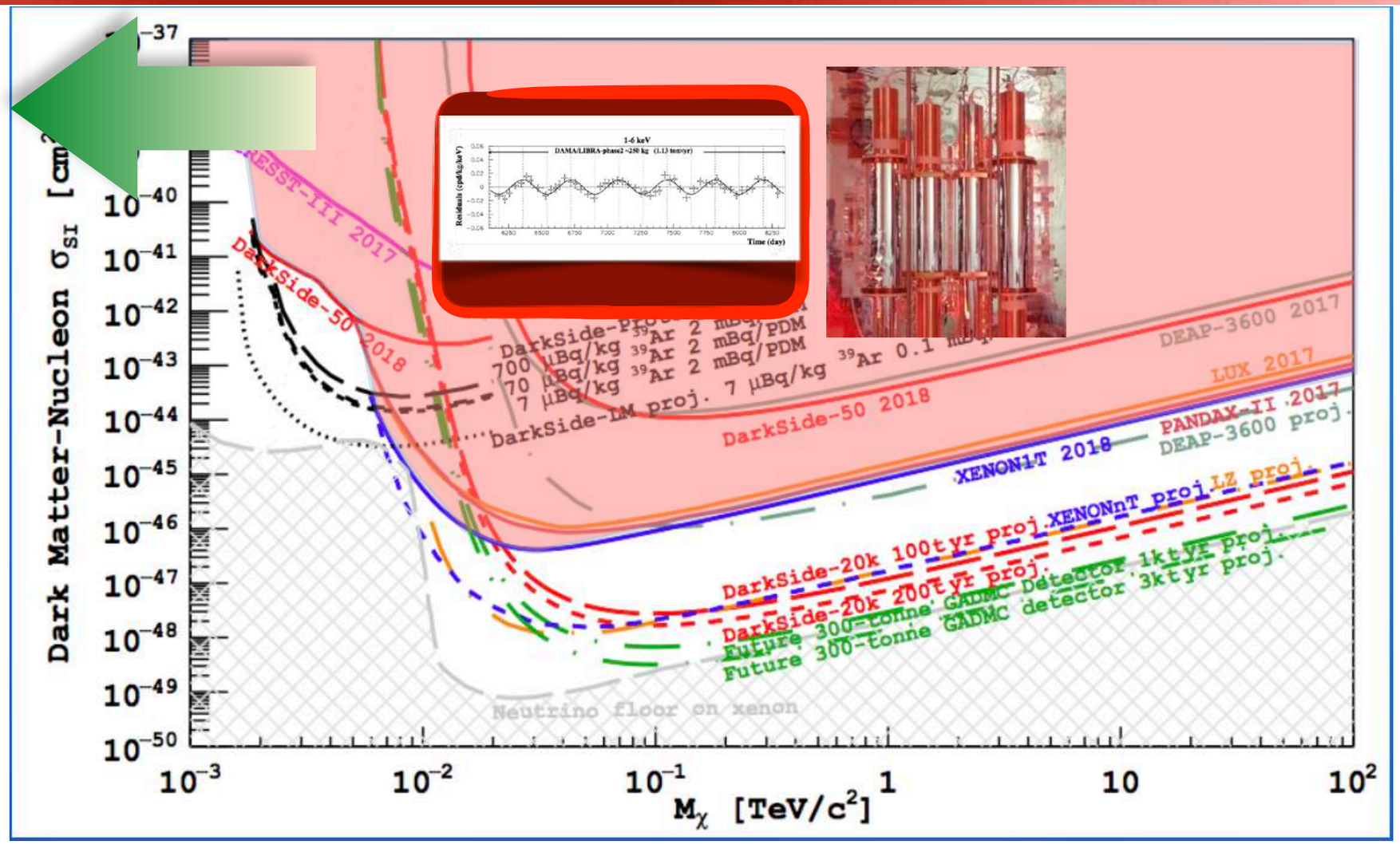
Directional DM searches: context



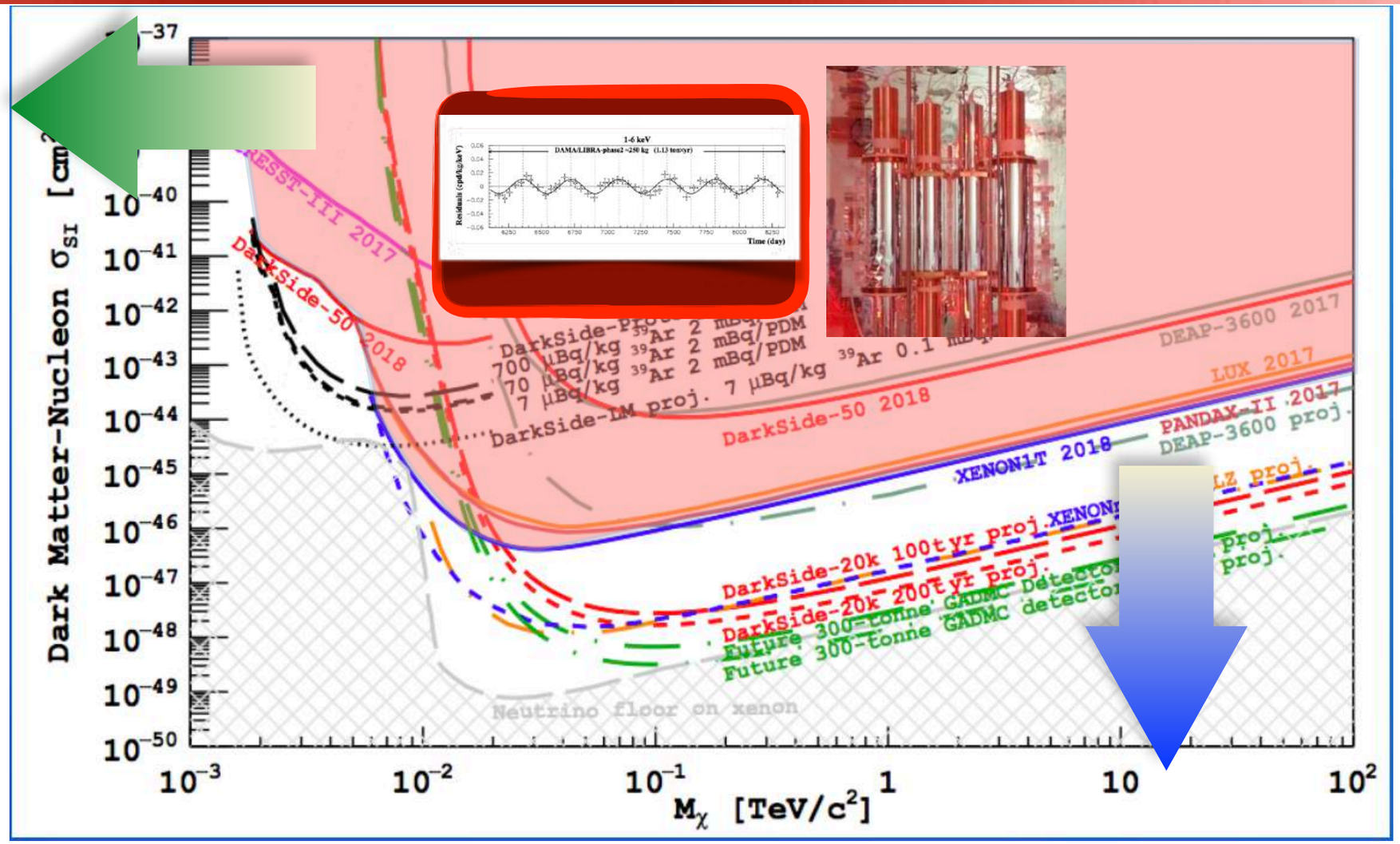
Directional DM searches: context



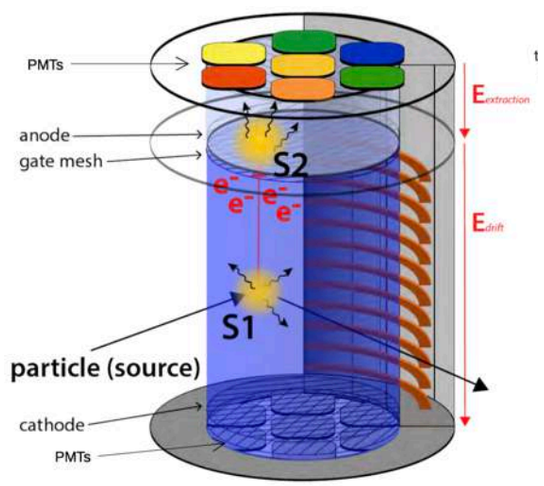
Directional DM searches: context



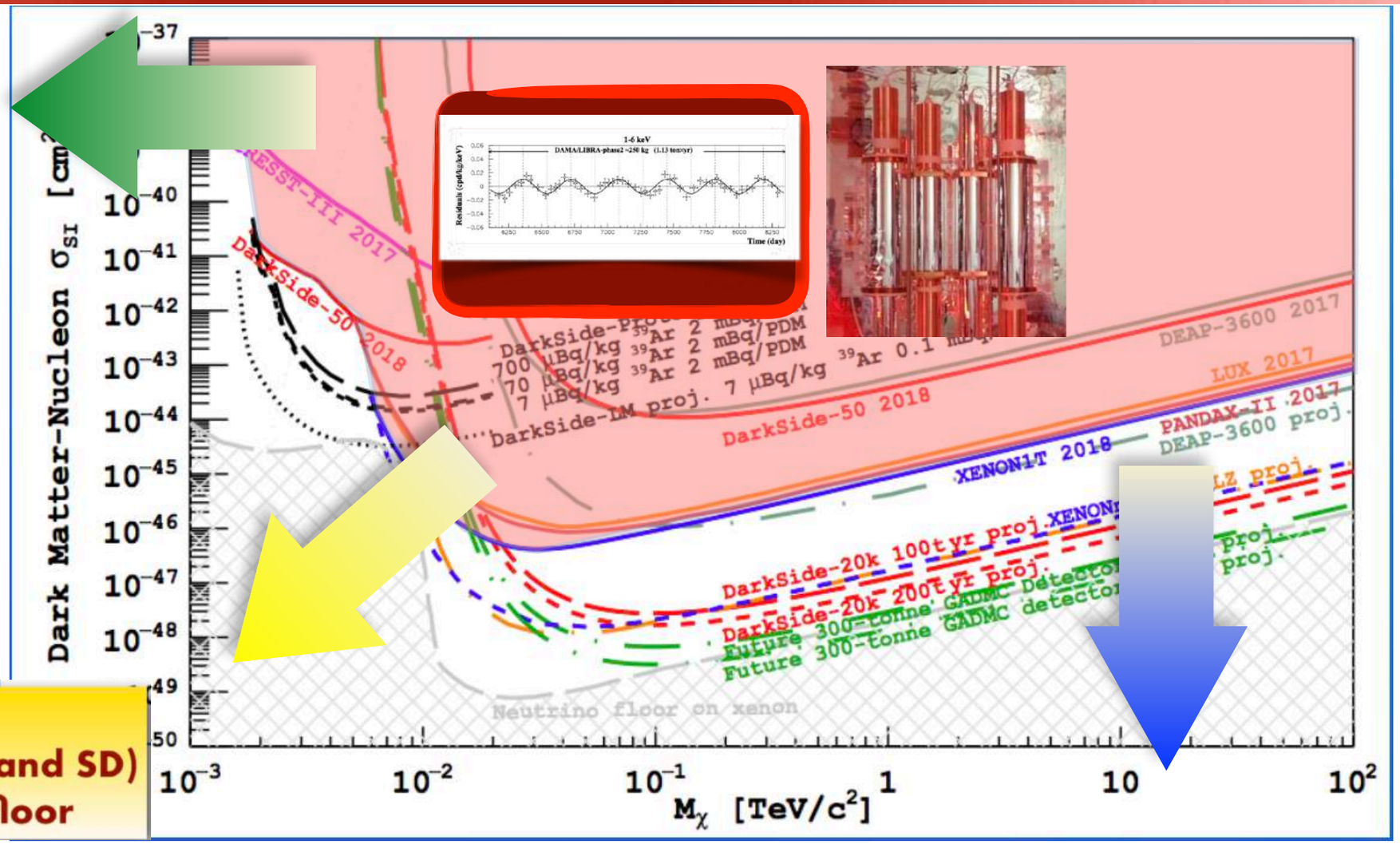
Directional DM searches: context



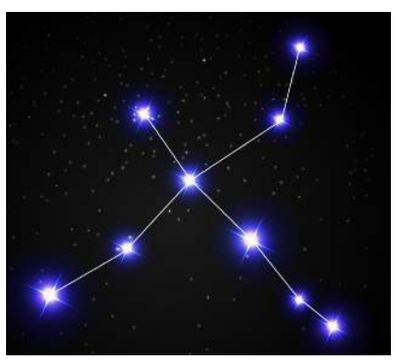
T. Wolf, G. Richbieter & A. Kish talks

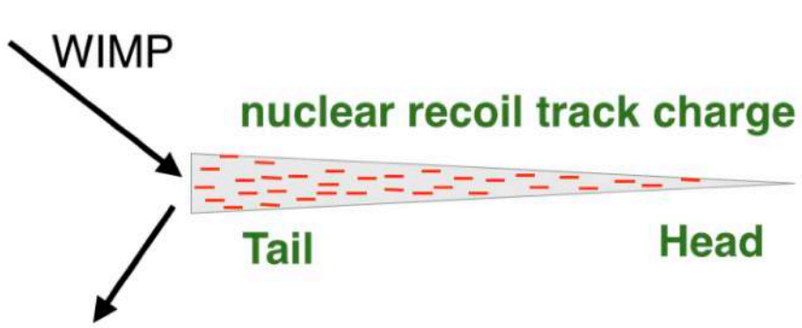


Directional DM searches: context

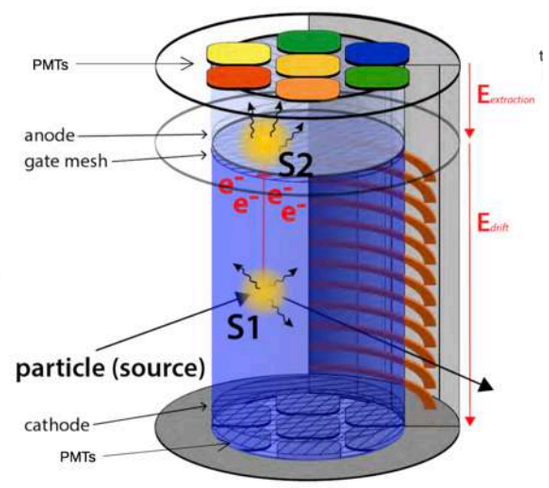


The "third way": directionality (for both SI and SD) through the Neutrino floor

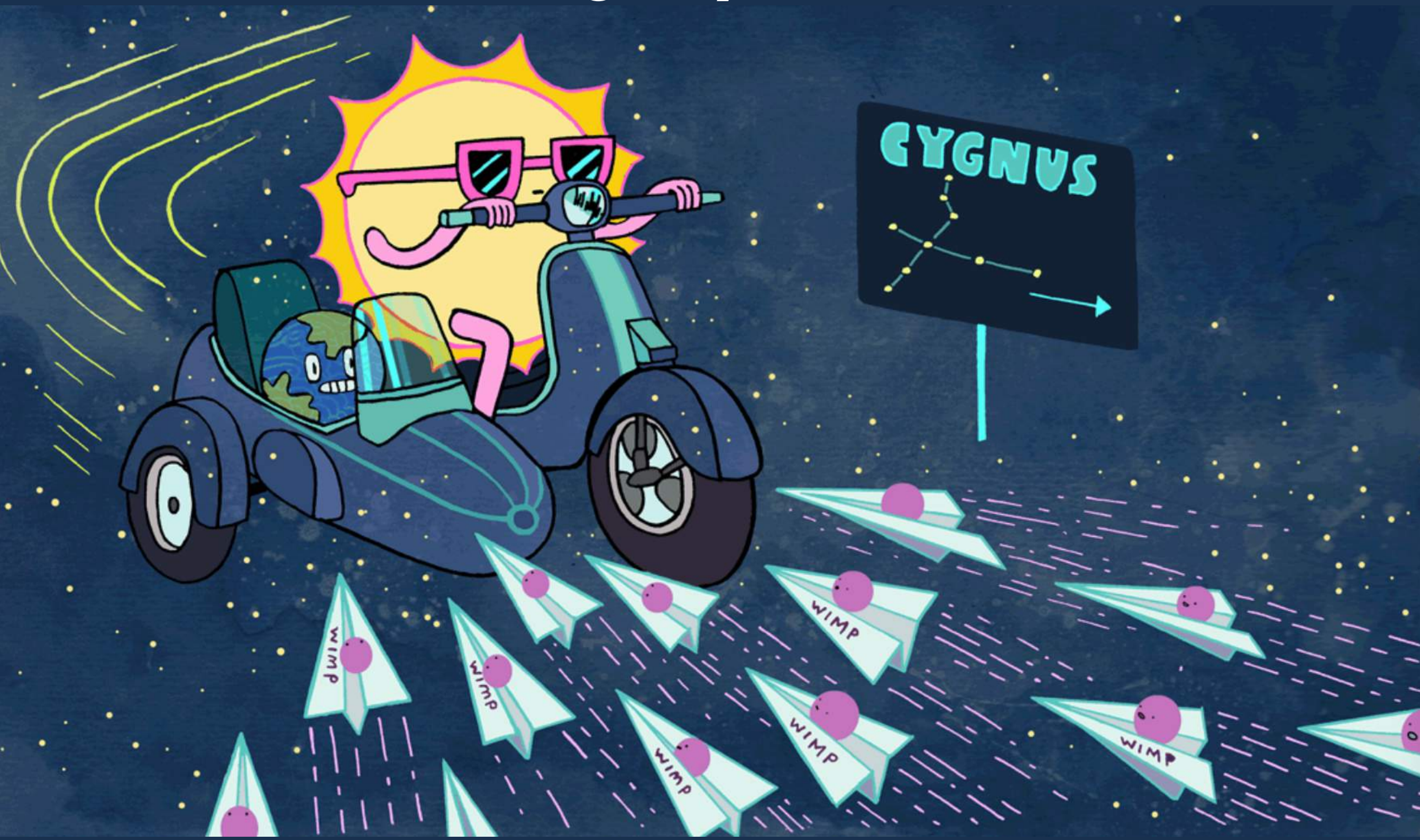




T. Wolf, G. Richbieter & A. Kish talks

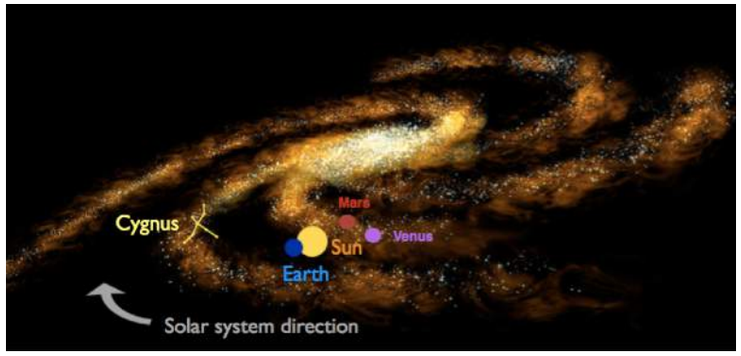


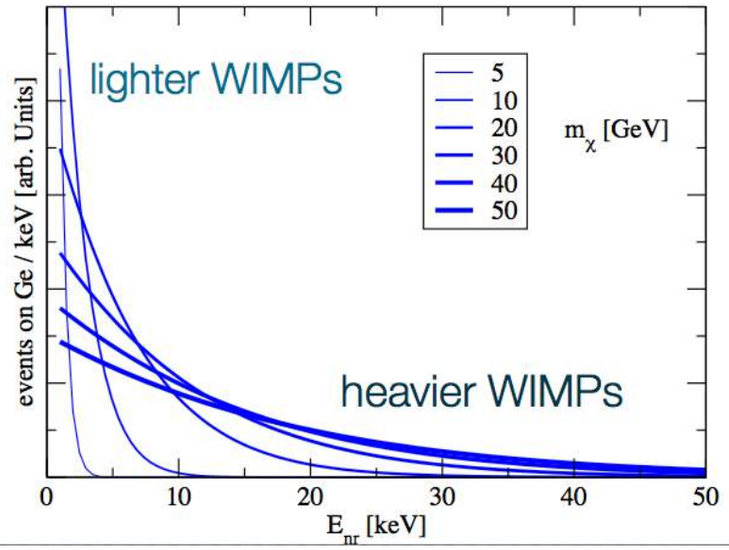
Driving to CYGNUS with a DM wind blowing in your hair...



Directionality as key for unambiguous identification of DM

Increasing reliability of any observed signal, increasing difficulty in the experimental technique

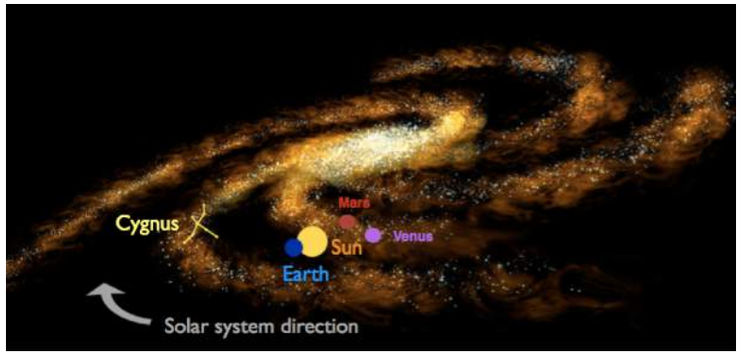


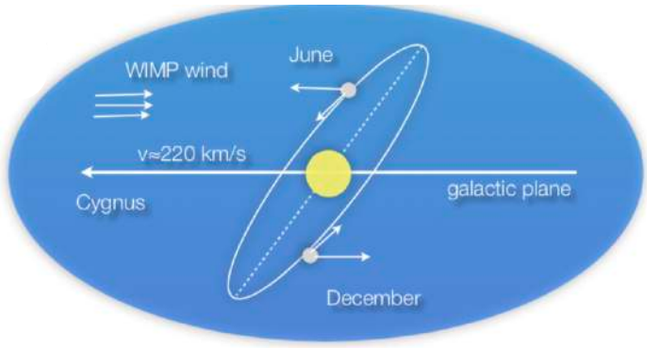


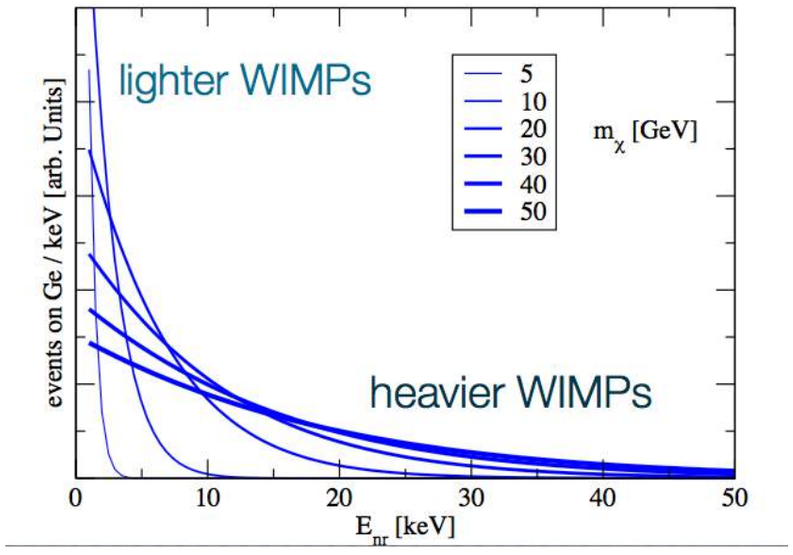
Energy dependence:
a falling exponential with
no peculiar features

Directionality as key for unambiguous identification of DM

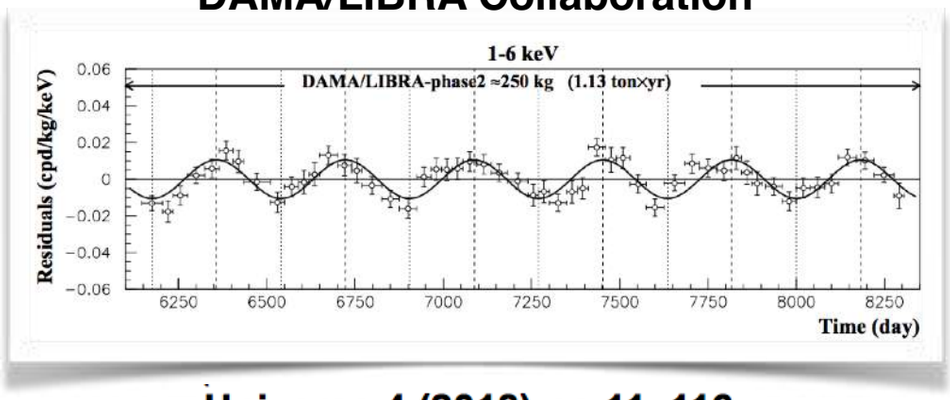
Increasing reliability of any observed signal, increasing difficulty in the experimental technique







DAMA/LIBRA Collaboration



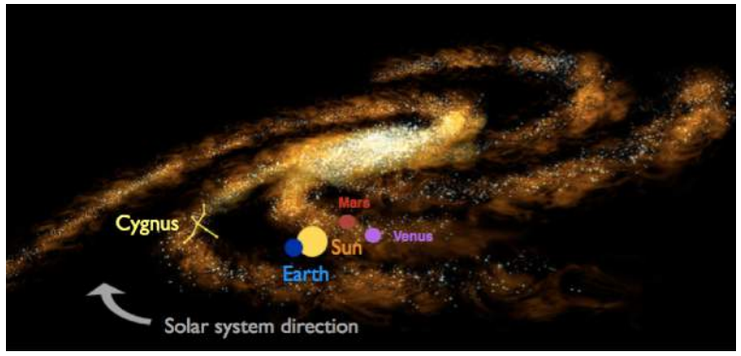
Universe 4 (2018) no.11, 116

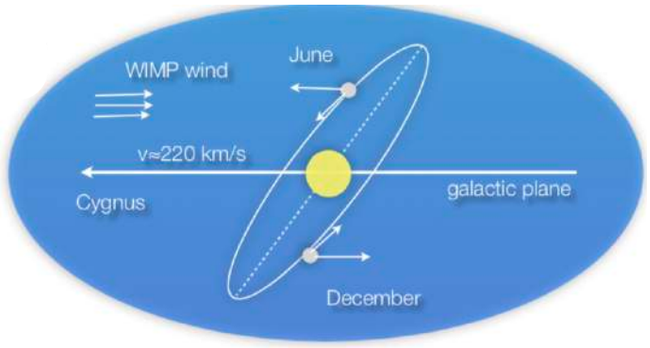
Energy dependence: a falling exponential with no peculiar features

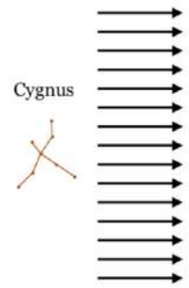
Temporal dependence: a few % annual modulation

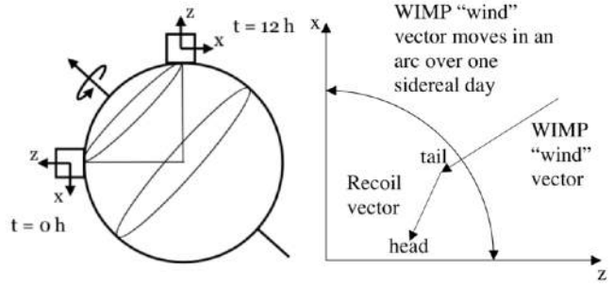
Directionality as key for unambiguous identification of DM

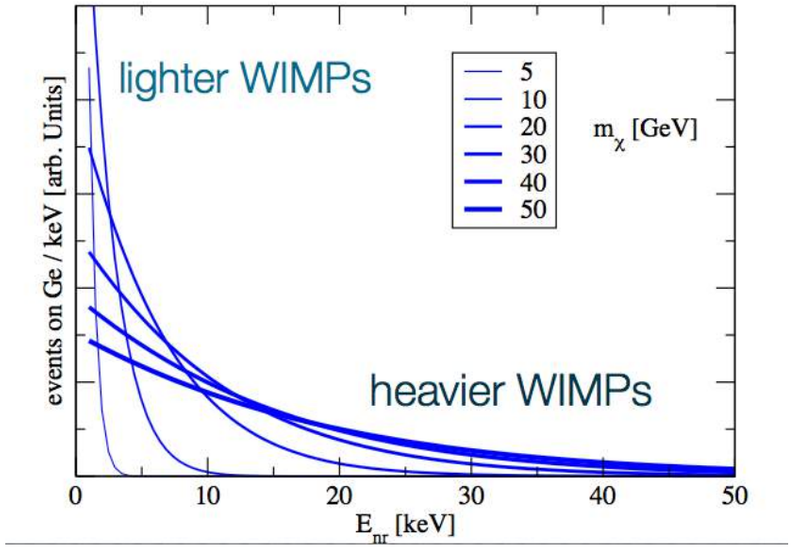
Increasing reliability of any observed signal, increasing difficulty in the experimental technique



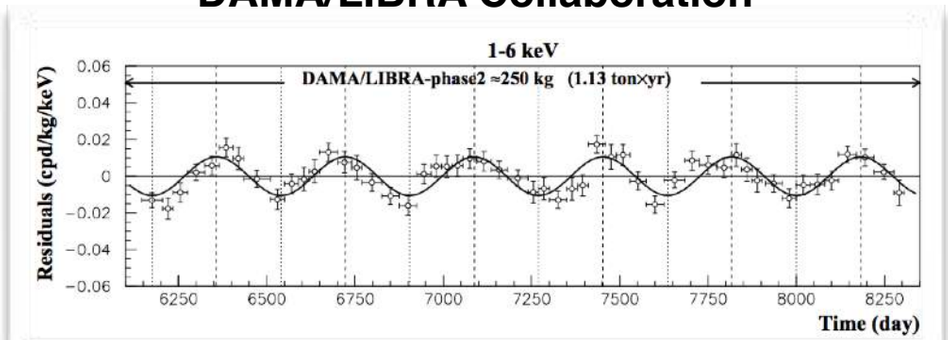




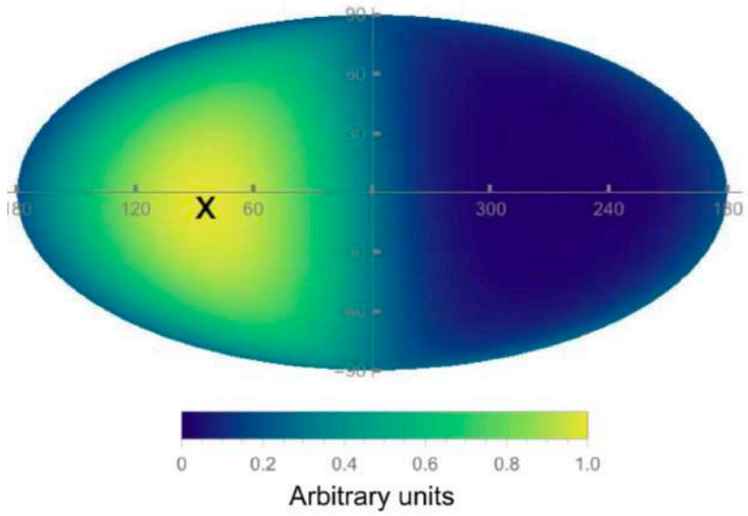




DAMA/LIBRA Collaboration



Universe 4 (2018) no.11, 116



Energy dependence: a falling exponential with no peculiar features

Temporal dependence: a few % annual modulation

Directional dependence: an O(1) effect that no background whatsoever can mimic

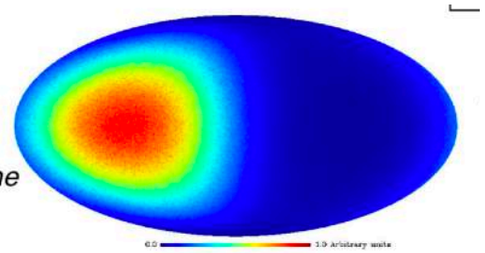
Directional correlation with an astrophysical source is the only available POSITIVE identification of a DM signal

Directionality as tool for background rejection,

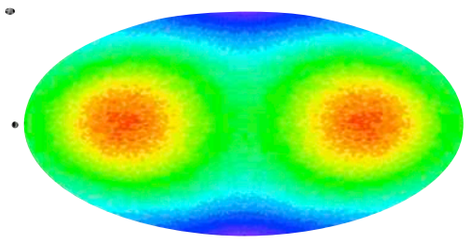
Capability to reject isotropy

A. M. Green et. al, Astropart. Phys. 27 (2007) 142

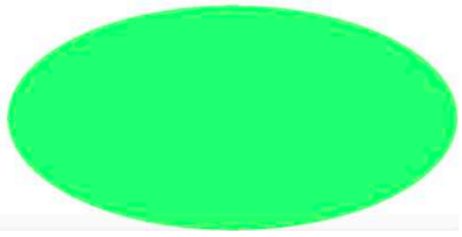
WIMP signal (recoil map) with sense



WIMP signal (recoil map) without sense
(the importance of head-tail)



Background

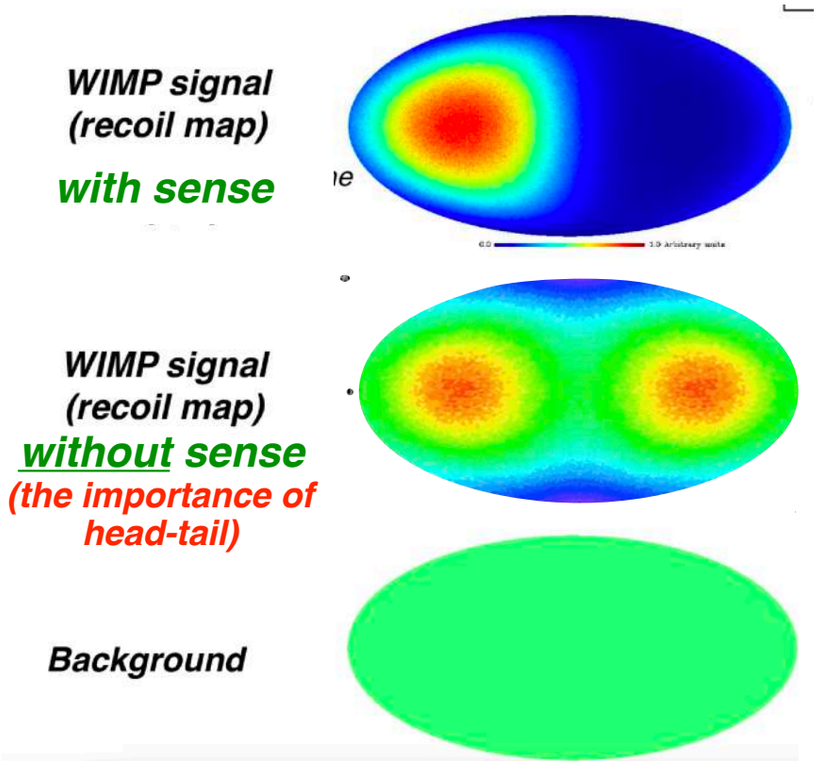


WIMP signal in principle detectable with O(10) 3D events

Directionality as tool for background rejection, neutrino physics

Capability to reject isotropy

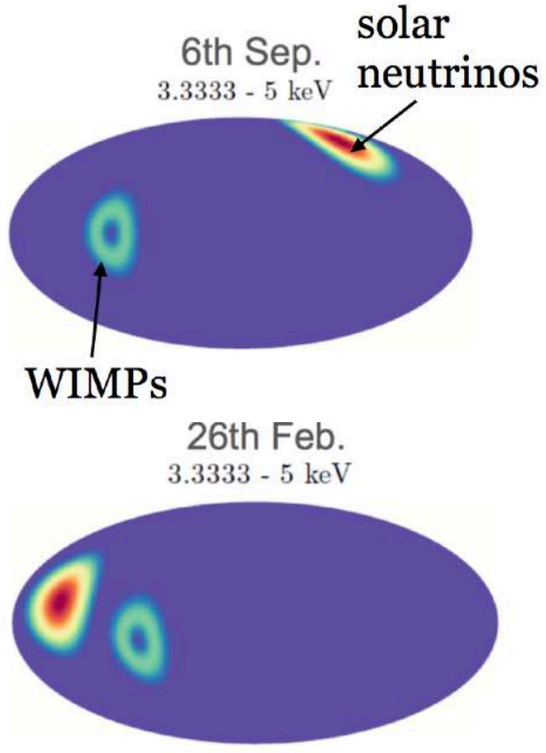
A. M. Green et. al, Astropart. Phys. 27 (2007) 142



WIMP signal in principle detectable with O(10) 3D events

Capability to leap beyond the Neutrino Floor

C. O'Hare et al, Phys. Rev. D 92 063518 (2015)

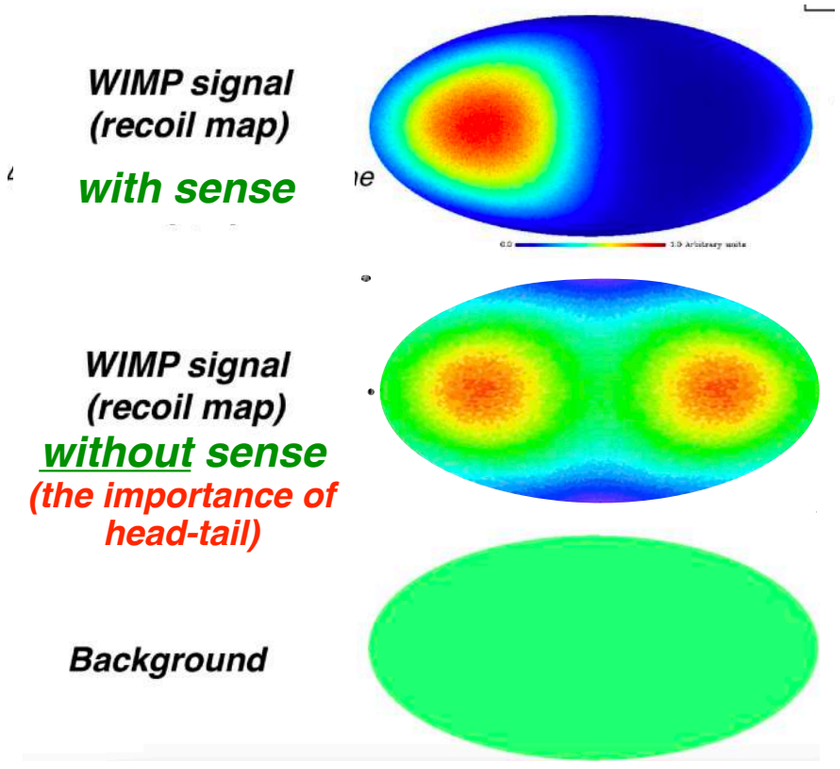


Sun neutrinos physics

Directionality as tool for background rejection, neutrino physics and DM astronomy

Capability to reject isotropy

A. M. Green et. al, Astropart. Phys. 27 (2007) 142



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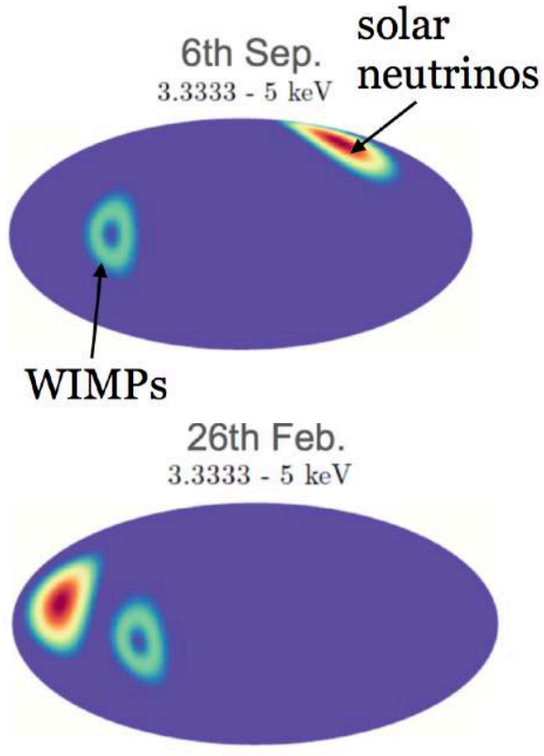
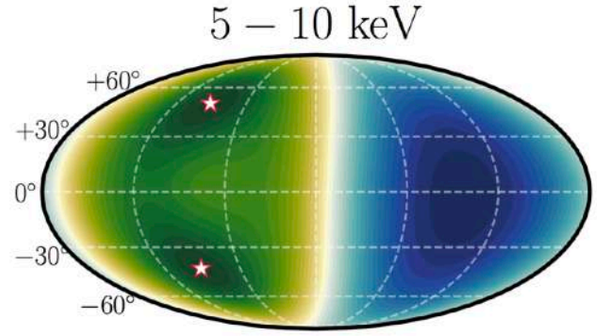


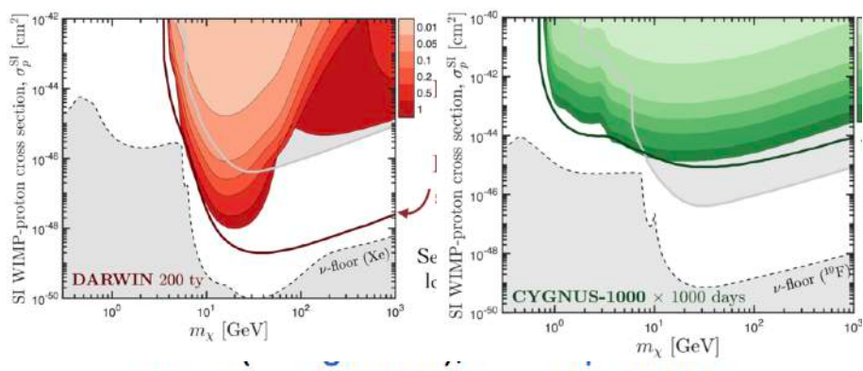
Capability to probe DM nature

The Gaia Sausage gives rise to peaks off center from Cygnus

Phys.Rev. D99 (2019) no.2, 023012



Distribution for 5-10 keVr Fluorine recoils with a 100 GeV WIMP
Halo model = SHM + Sausage



Phys.Rev. D98 (2018) no.10, 103006

WIMP signal in principle detectable with O(10) 3D events

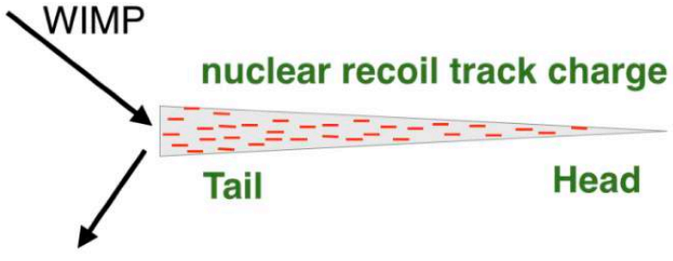
Sun neutrinos physics

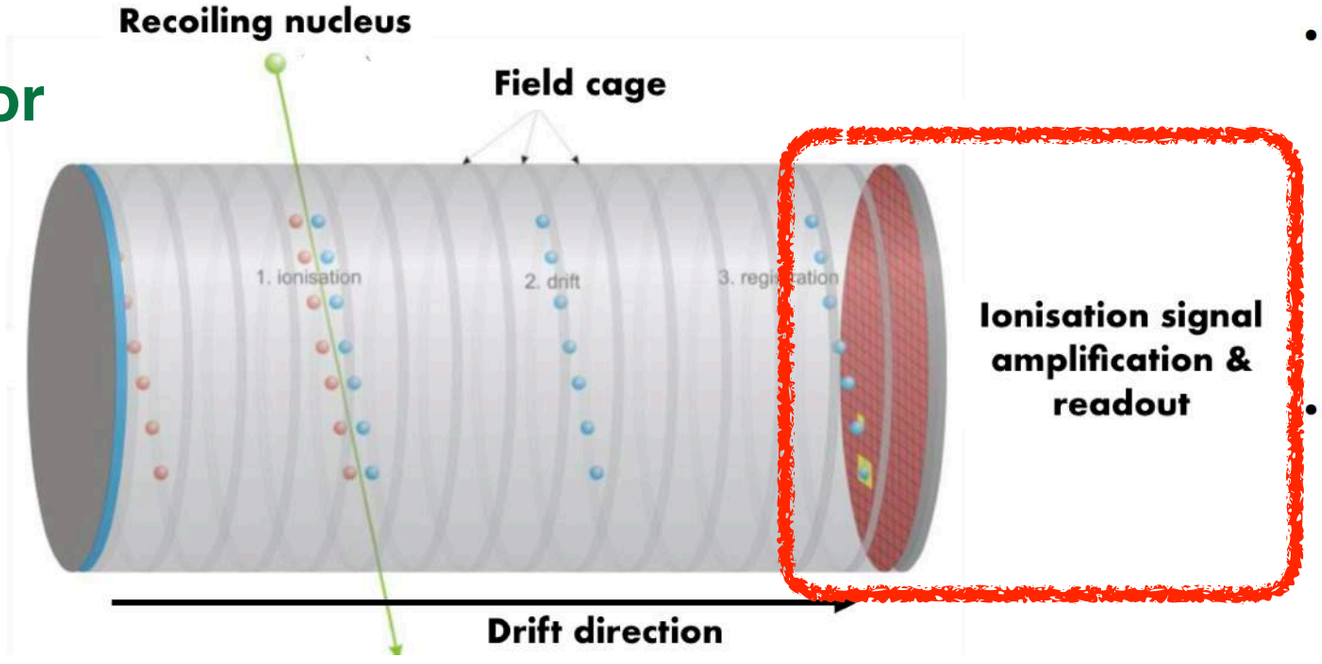
DM astronomy & DM interactions

Gaseous TPC experimental approach to directionality

Inherently a 3D detector

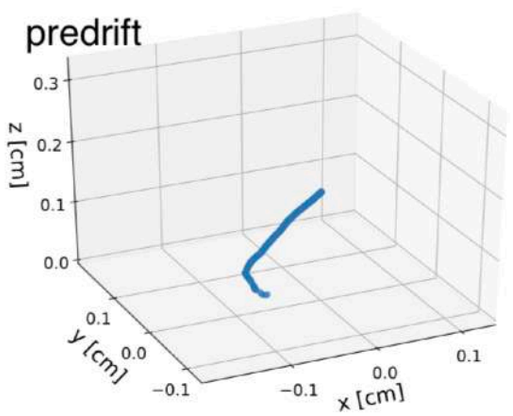
Sensitive to track sense & direction

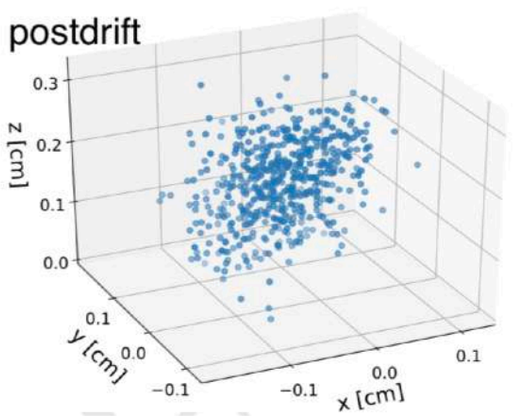


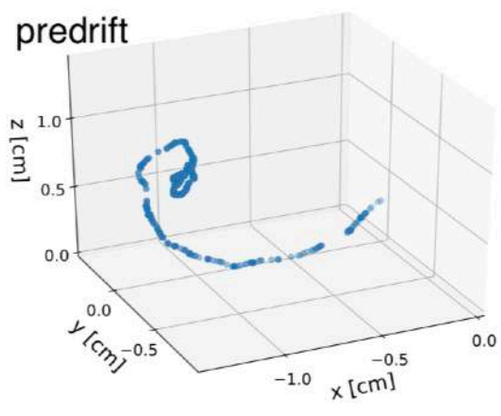


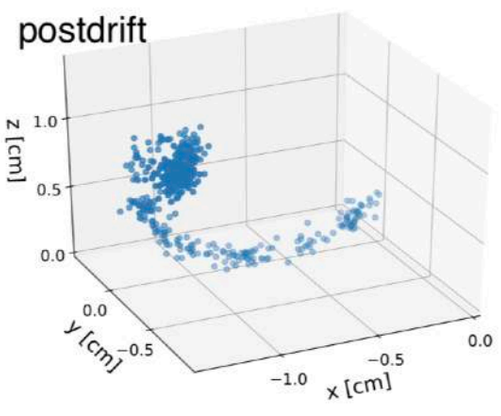
- Advantages:
  - Axial Directionality
  - **Head/tail**
  - Background rejection
  - Particle ID
  - 3D fiducialization
- Technologically challenging, but now achievable via multiple technologies

Energy loss and track topology to efficiently reject background at O(keV) energy threshold







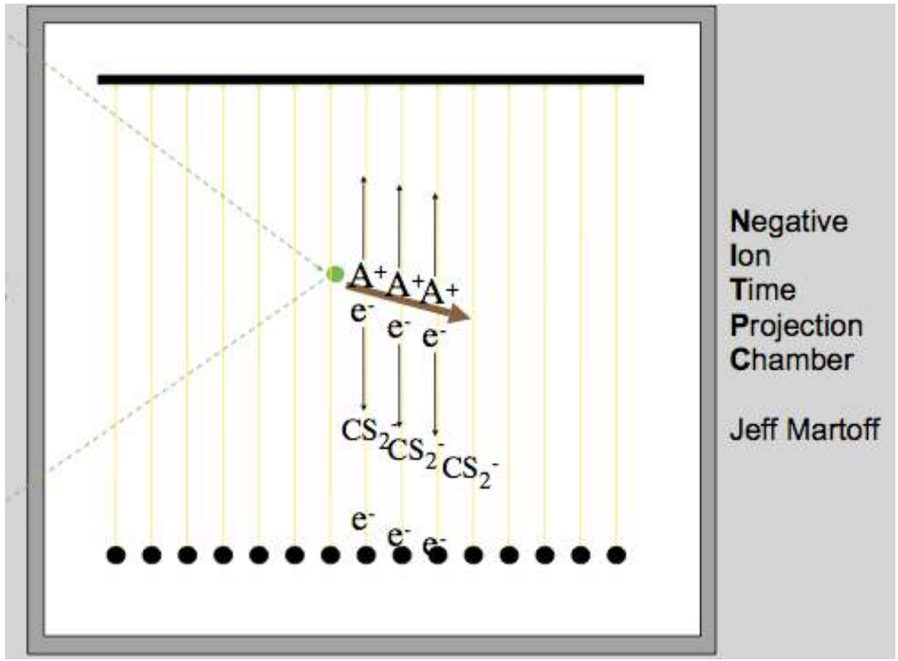


25 keV$_{nr}$ nuclear recoil in He:SF$_6$ 755:5 Torr

20 keV$_{ee}$ electron recoil in He:SF$_6$ 755:5 Torr

arXiv:2008.12587

Negative ion drift (NID): improved tracking



- Electronegative dopant in the gas mixture (CS_2, SF_6, CH_3NO_2, ...)
- Primary ionization electrons captured by electronegative gas molecules at O(100) um
- Anions drift to the anode acting as the effective image carrier instead of the electrons and reducing both longitudinal and transverse diffusion to thermal limit

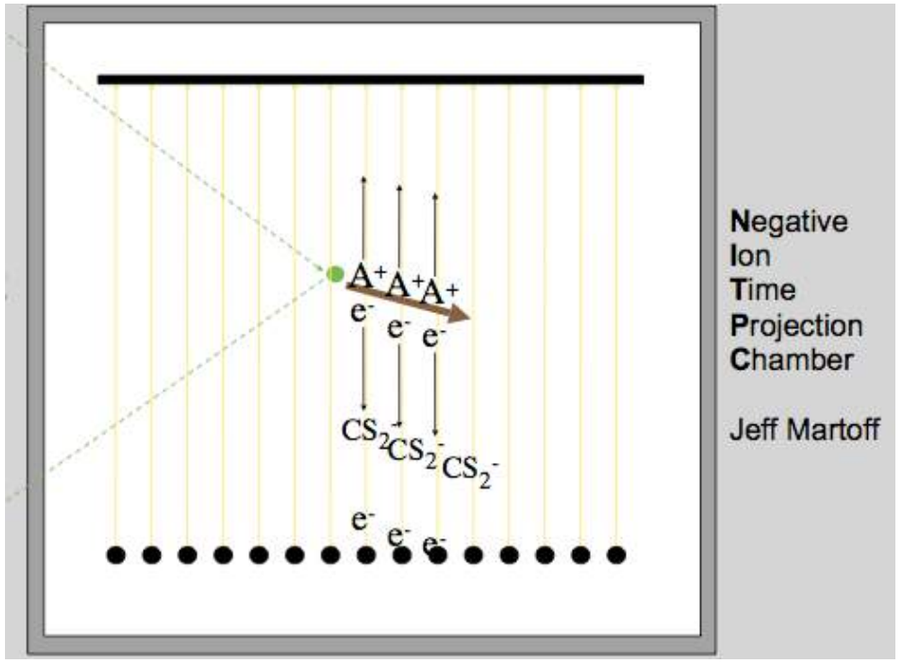
$$\sigma = \sqrt{\frac{2kTL}{eE}} = 0.7\,\mathrm{mm}\left(\frac{T}{300\,\mathrm{K}}\right)^{1/2}\left(\frac{580\,\mathrm{V/cm}}{E}\right)^{1/2}\left(\frac{L}{50\,\mathrm{cm}}\right)^{1/2}$$

low diffusion increases active volume per readout area

T. Ohnuki et al., NIM A 463

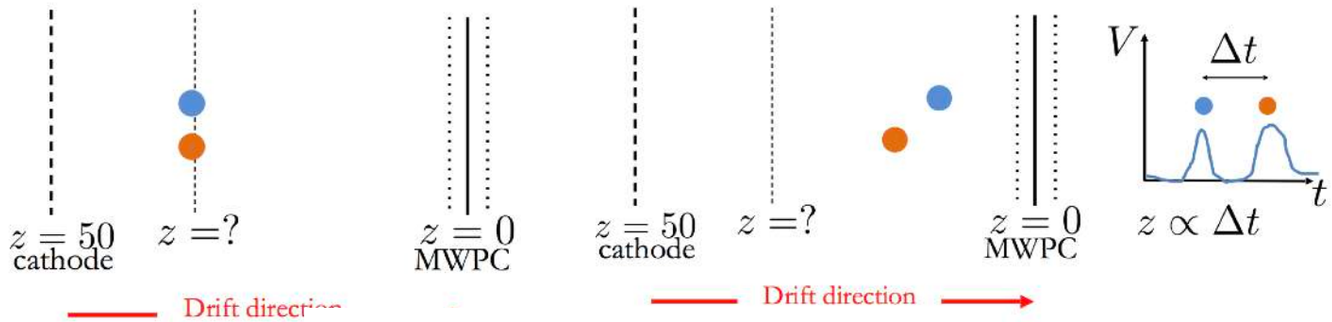
J. Martoff et al., NIM A 440 355

Negative ion drift (NID): improved tracking & full fiducialization



Multiple charge carriers

start together *…but drift at different velocity*



$$z = (t_m - t_p)\frac{v^m_{drift} v^p_{drift}}{v^m_{drift} - v^p_{drift}}$$

- Electronegative dopant in the gas mixture (CS_2, SF_6, CH_3NO_2, …)
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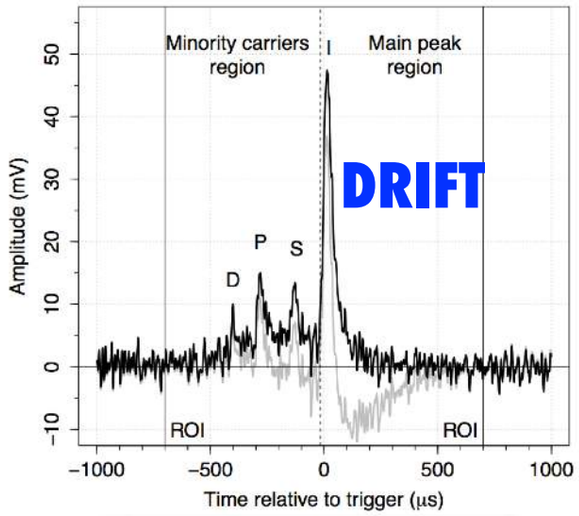
low diffusion increases active volume per readout area

T. Ohnuki et al., NIM A 463

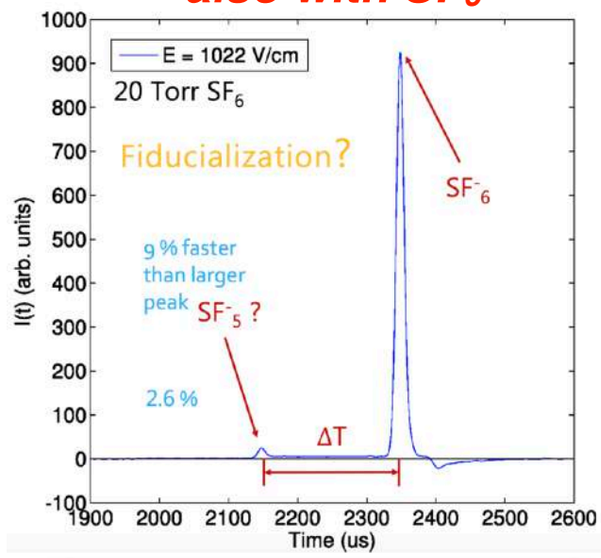
J. Martoff et al., NIM A 440 355

- CS_2:CF_4:O_2 30:10:1 Torr



D. Snowden-Ifft, Rev. Sci. Instrum. 85 (2014) 013303

From 2015 demonstrated also with SF_6

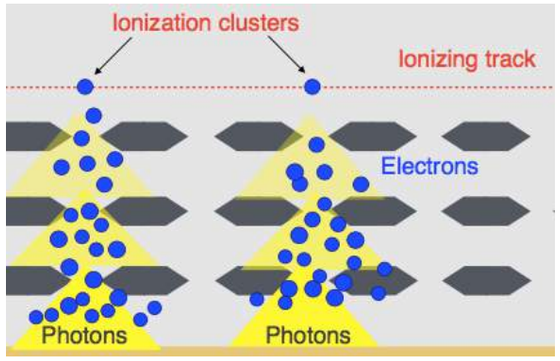


N.S.Phan et al., JINST 12 (2017) no.02, P02012

CYGNO: 3D optical readout with sCMOS & PMT

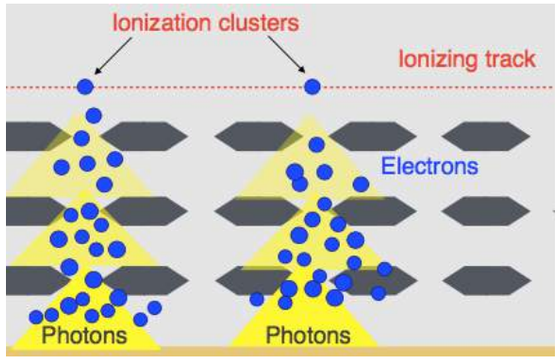
He:CF_4 @ 1 atm

JINST 13 (2018) no.05, P05001



CYGNO: 3D optical readout with sCMOS & PMT

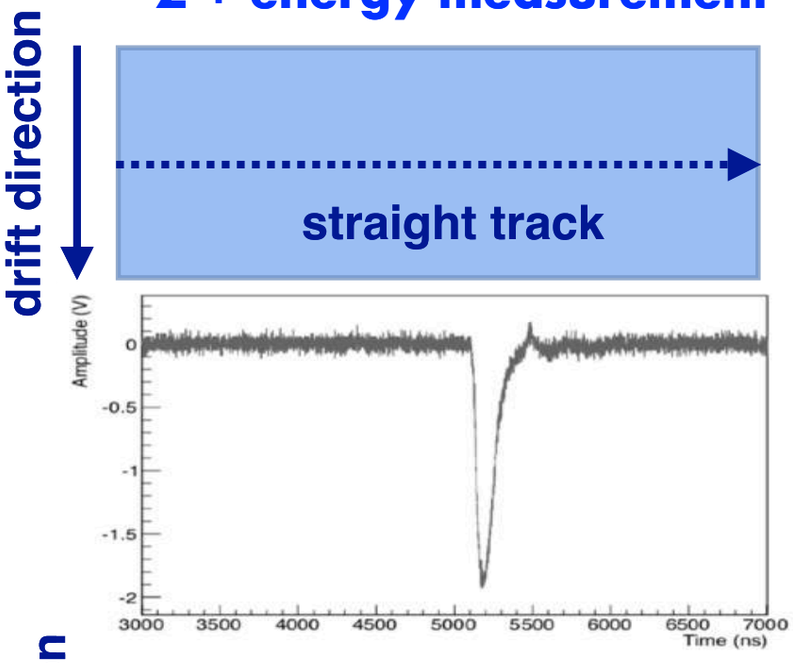
JINST 13 (2018) no.05, P05001

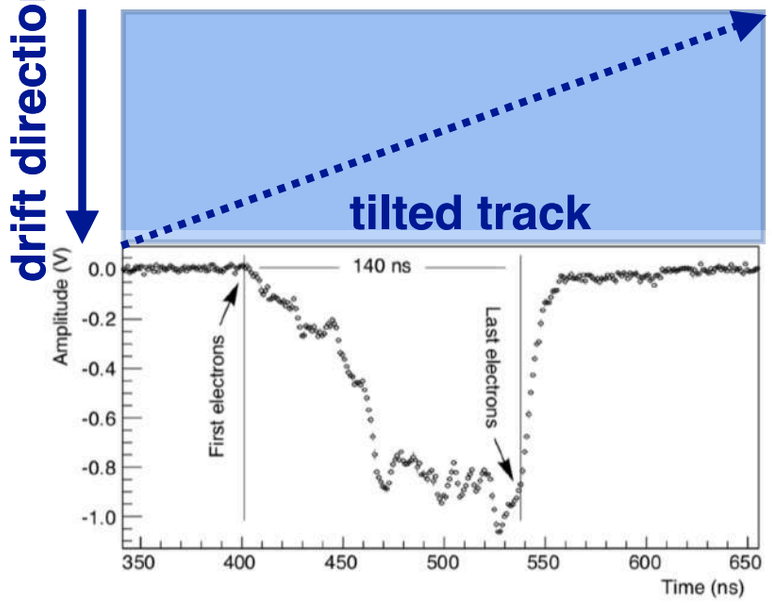


PMT:

integrated

Z + energy measurement





CYGNO: 3D optical readout with sCMOS & PMT

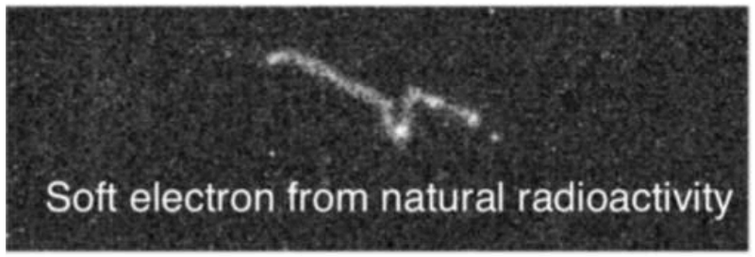
He:CF_4 @ 1 atm

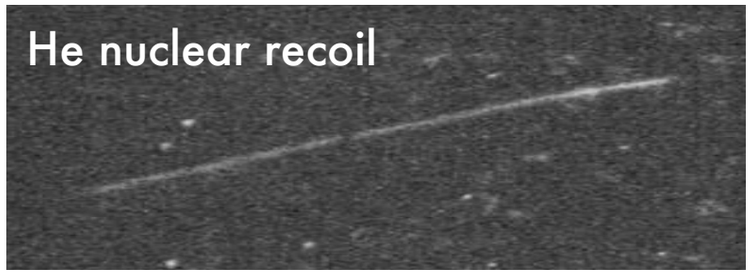
JINST 13 (2018) no.05, P05001

sCMOS:

high granularity

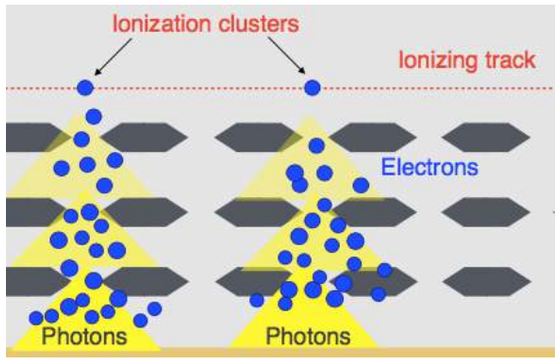
X-Y + energy measurements





- **1/3 noise w.r.t. CCDs**
- **Market pulled**
- **Single photon sensitivity**
- **Decoupled from target**
- **Large areas with proper optics**

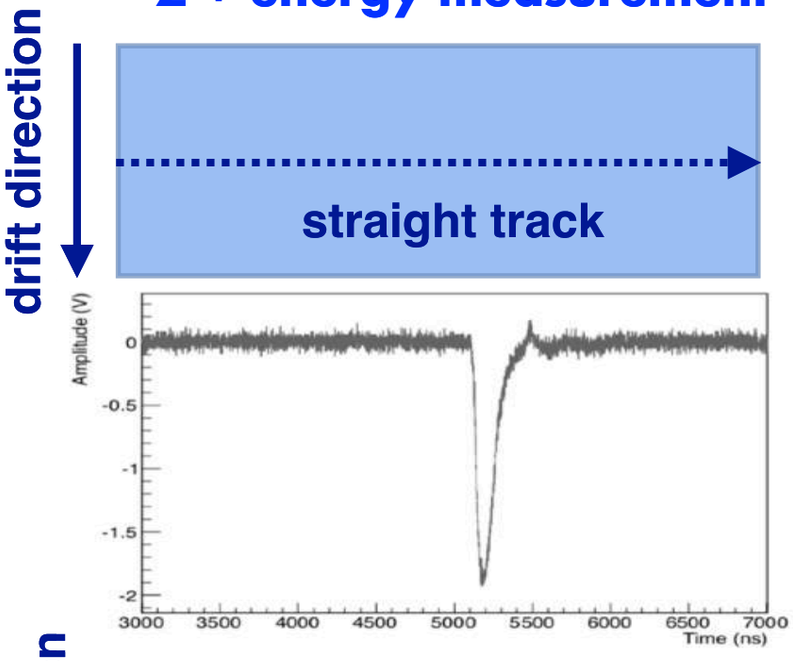
See F. Brunbauer talk on Wed

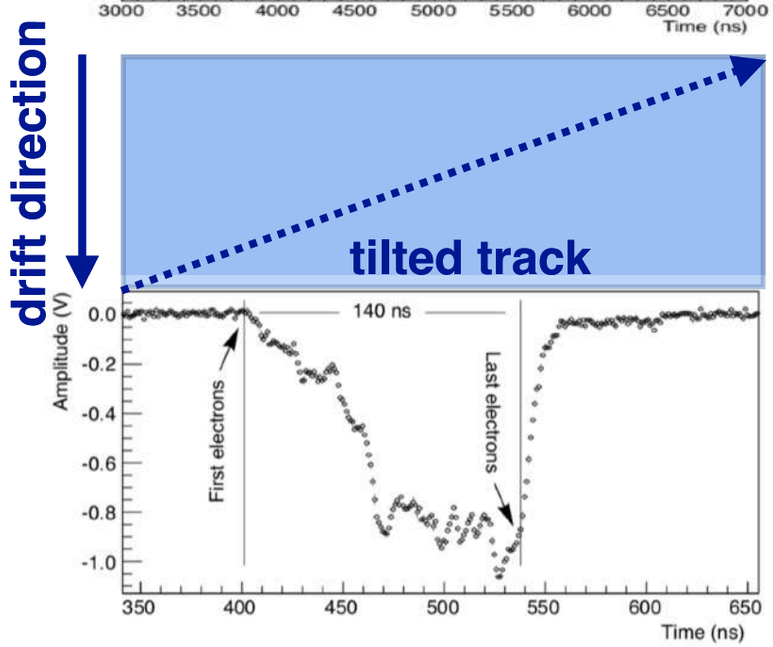


PMT:

integrated

Z + energy measurement





CYGNO: 3D optical readout with sCMOS & PMT

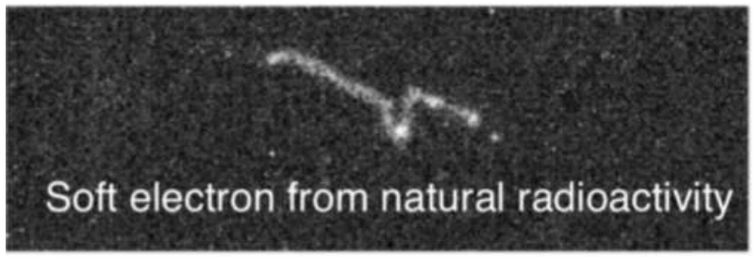
He:CF_4 @ 1 atm

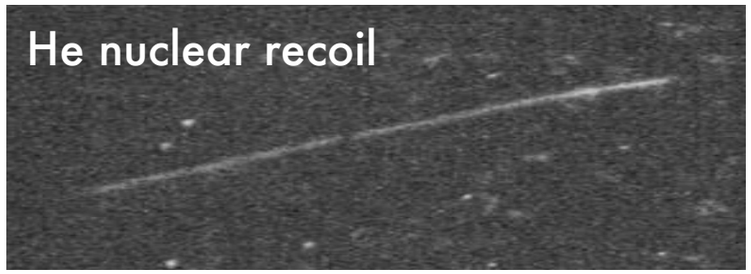
JINST 13 (2018) no.05, P05001

sCMOS:

high granularity

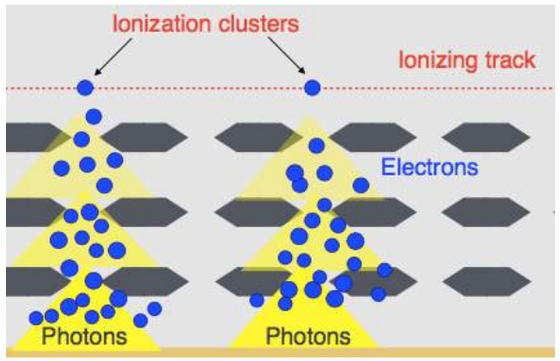
X-Y + energy measurements

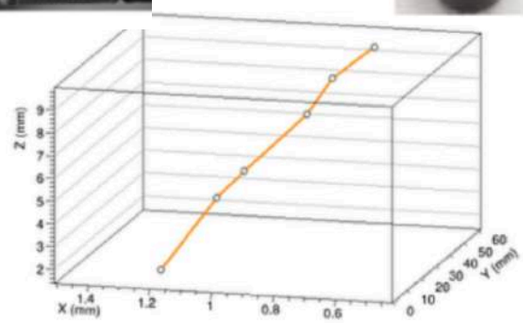




- **1/3 noise w.r.t. CCDs**
- **Market pulled**
- **Single photon sensitivity**
- **Decoupled from target**
- **Large areas with proper optics**

See F. Brunbauer talk on Wed

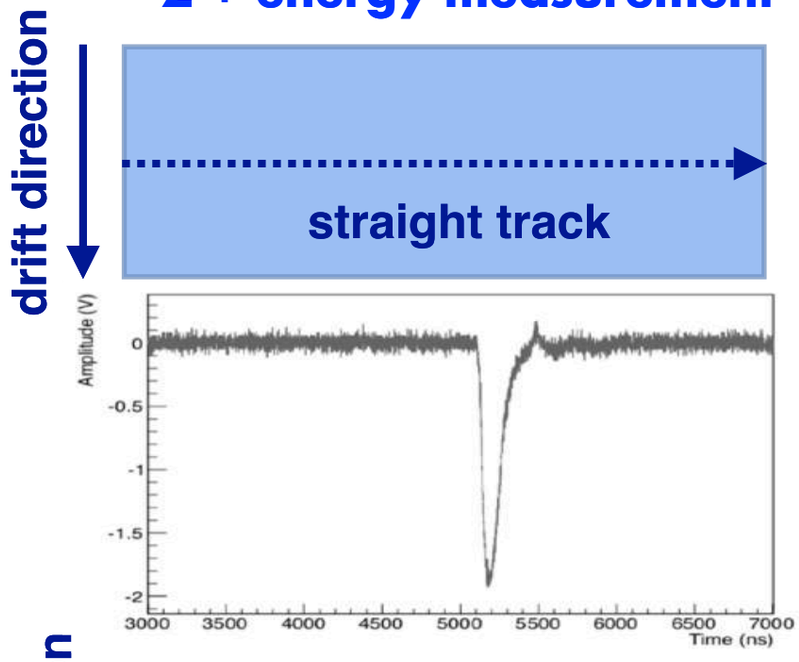


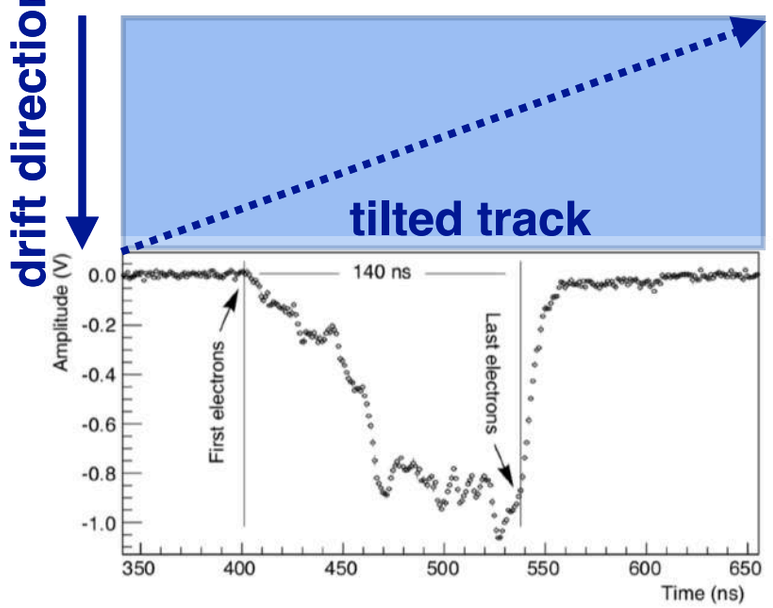


PMT:

integrated

Z + energy measurement





CYGNO: 3D optical readout with sCMOS & PMT

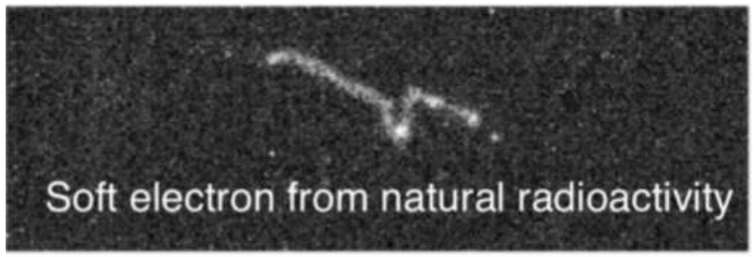
He:CF_4 @ 1 atm

JINST 13 (2018) no.05, P05001

sCMOS:

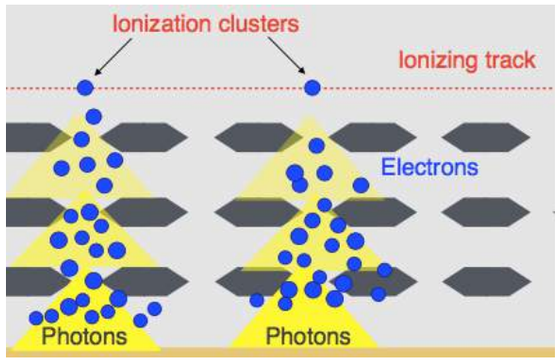
high granularity

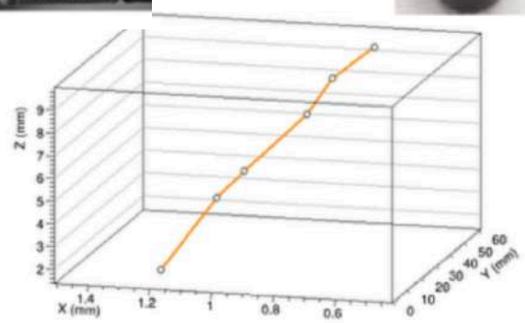
X-Y + energy measurements



- **1/3 noise w.r.t. CCDs**
- **Market pulled**
- **Single photon sensitivity**
- **Decoupled from target**
- **Large areas with proper optics**

See F. Brunbauer talk on Wed



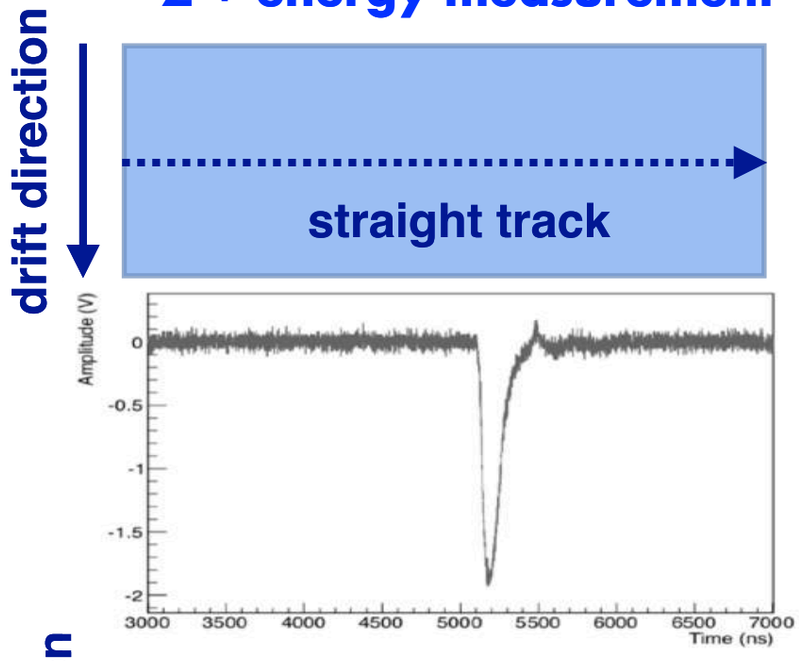


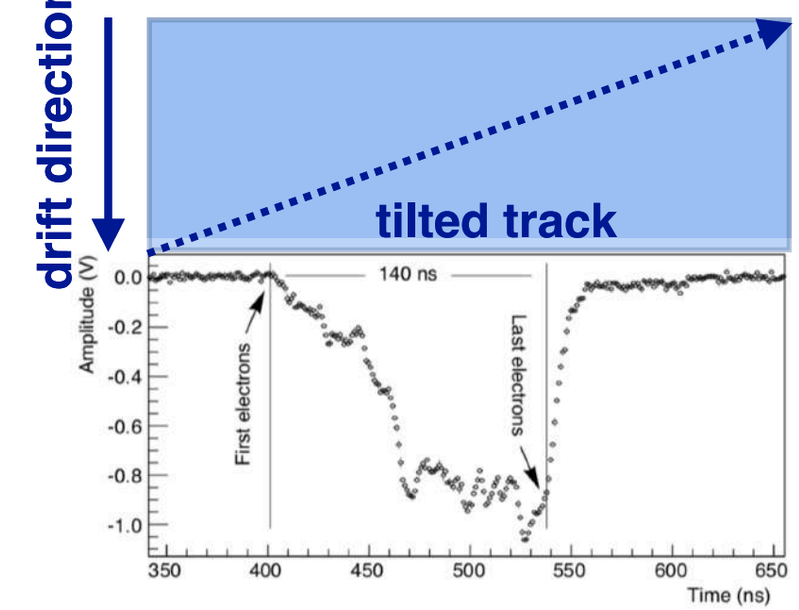
+ SF_6 for negative ion drift

PMT:

integrated

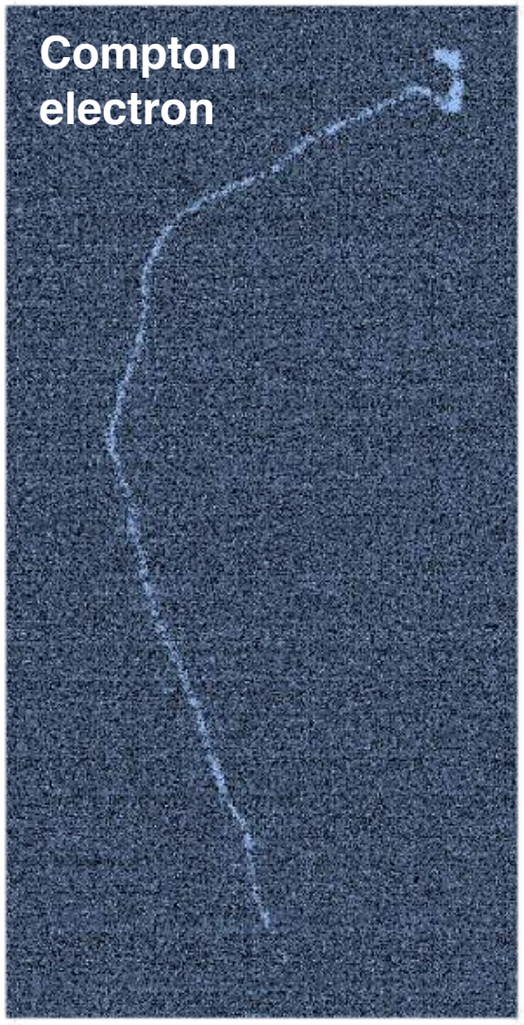
Z + energy measurement

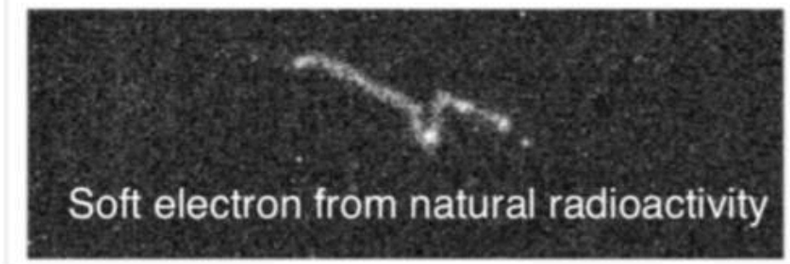


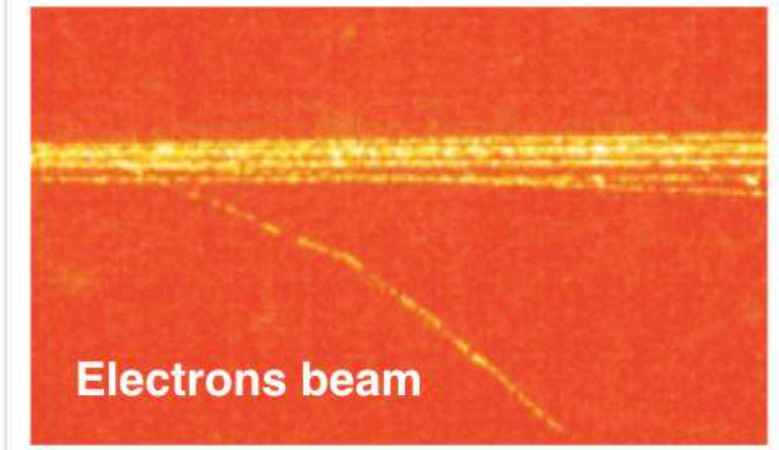


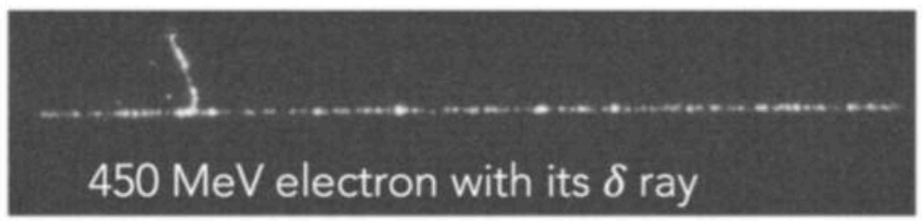
CYGNO : photographing tracks

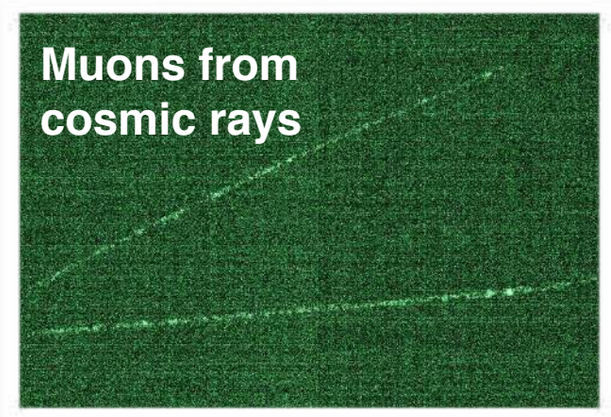
$He:CF_4$ @ 1 atm

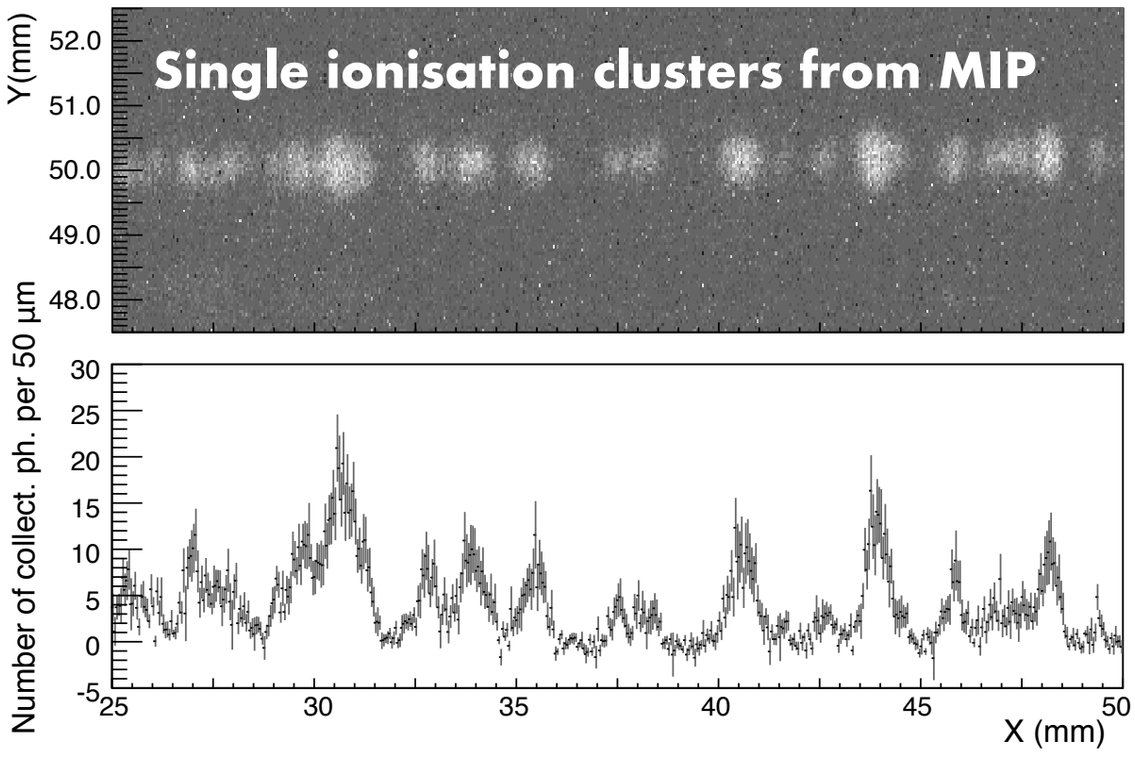


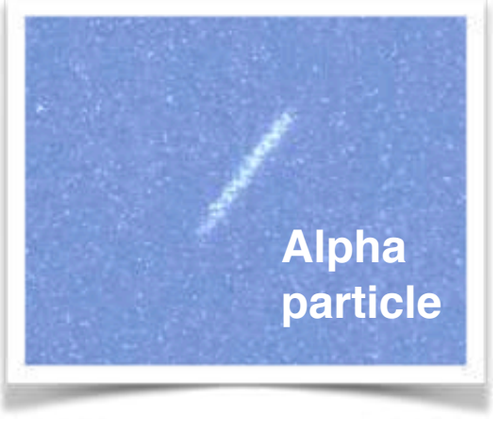


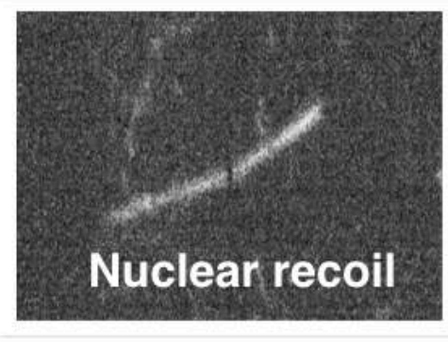












3D optical readout with negative ion drift

CYGNO roadmap & synergy with INITIUM

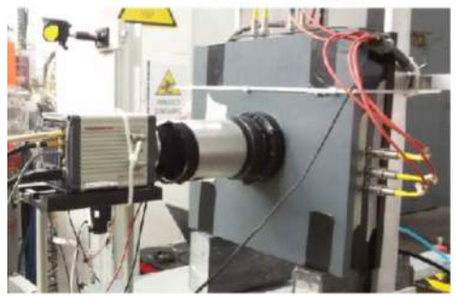
CYGNUS_RD — PHASE_0 — PHASE_1 — PHASE_2

2015 — 201 — 2018 — 2019 — 2020 — 2021 — 2022 — …

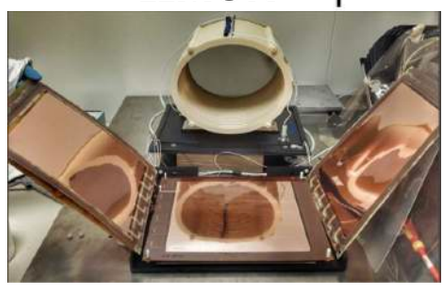
Electron drift

He:CF$_4$
1 atm

100 cm^3 — ORANGE — @ RO… — **0.01 m^3** — LEMON — @ LNF — @ LNF (TDR) — @ LNF (Construction & test) — @ LNGS (Installation & data taking)



1 sCMOS
10 x 10 cm^2 area



1 sCMOS
20 x 24 cm^2 area

CYGNO 30-100 m^3

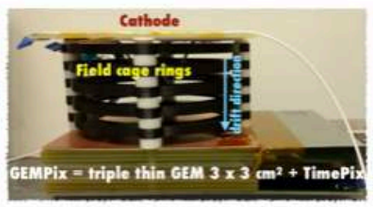
He:CF$_4$:SF$_6$
0.8-1 atm

4 Timepix chips
3 x 3 cm^2 area

NITEC

Negative ion drift

MARIE CURIE ACTIONS



50 cm^3 — 2015 — 2016 — 2017 — 2018 — @ LNF

Part of this project has received fundings under the European Union's Horizon 2020 research and innovation programme from the Marie Sklodowska-Curie grant agreement No 657751 and from the European Research Council (ERC) grant agreement No 818744

3D optical readout with negative ion drift

CYGNO roadmap & synergy with INITIUM

CYGNUS_RD

PHASE_0

PHASE_1

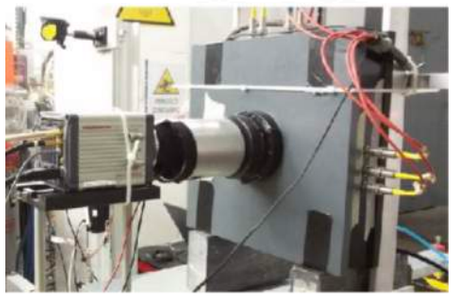
PHASE_2

2015 — 201 — 2018 — 2019 — 2020 — 2021 — 2022 — …

Electron drift

He:CF$_4$
1 atm

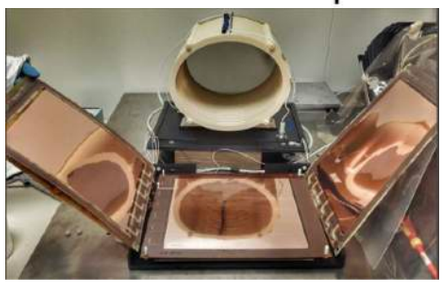
100 cm^3
ORANGE



1 sCMOS
10 x 10 cm^2 area

@ RO… @ LN…

0.01 m^3
LEMON



1 sCMOS
20 x 24 cm^2 area

Published results in the following from LEMOn with He:CF$_4$ 60:40

@ LNF — TDR

@ LNF — Construction & test

@ LNGS — Installation & data taking

CYGNO 30-100 m^3

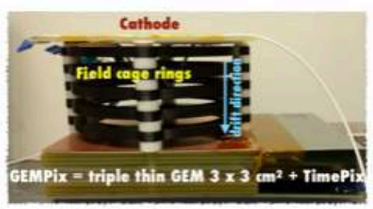
He:CF$_4$:SF$_6$
0.8-1 atm

4 Timepix chips
3 x 3 cm^2 area

NITEC

Negative ion drift

MARIE CURIE ACTIONS



50 cm^3

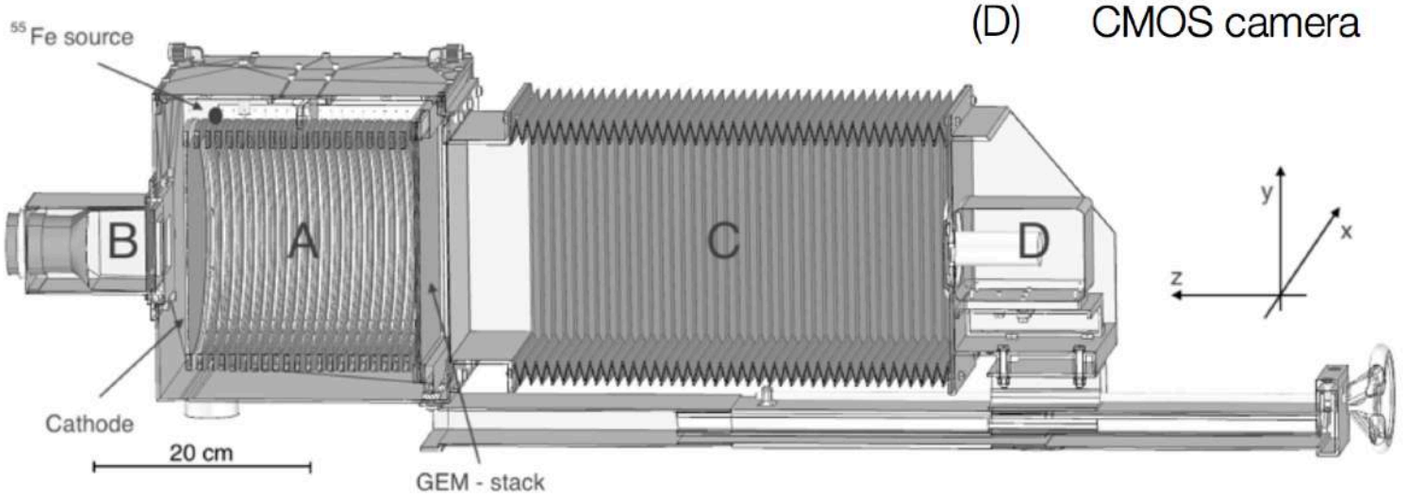
2015 — 2016 — 2017 — 2018 — @ LNF

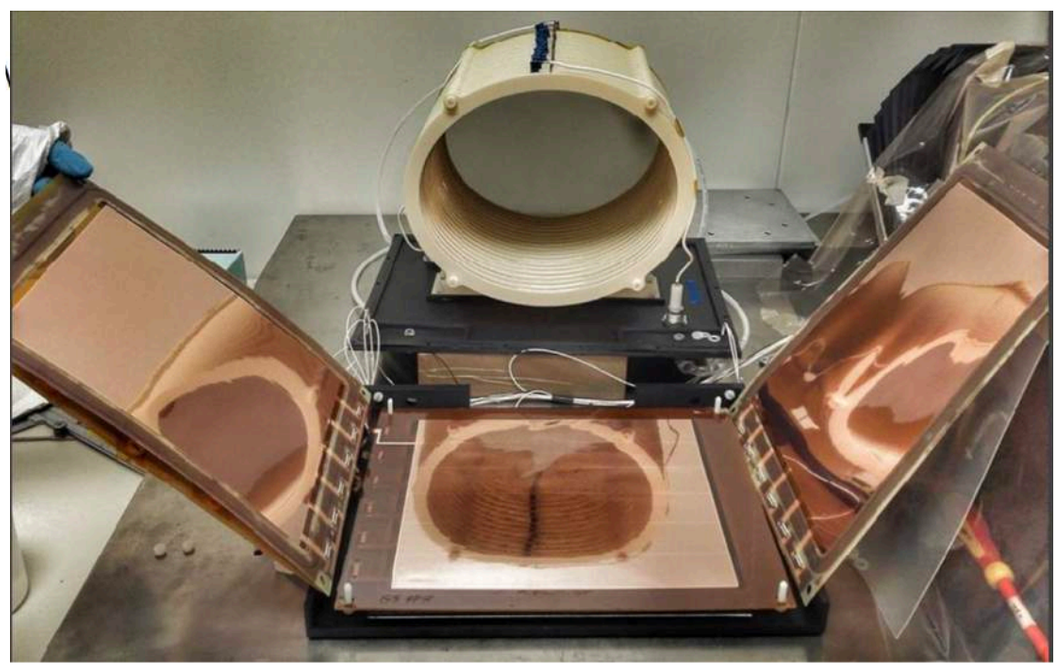
Part of this project has received fundings under the European Union's Horizon 2020 research and innovation programme from the Marie Sklodowska-Curie grant agreement No 657751 and from the European Research Council (ERC) grant agreement No 818744

LEMOn prototype

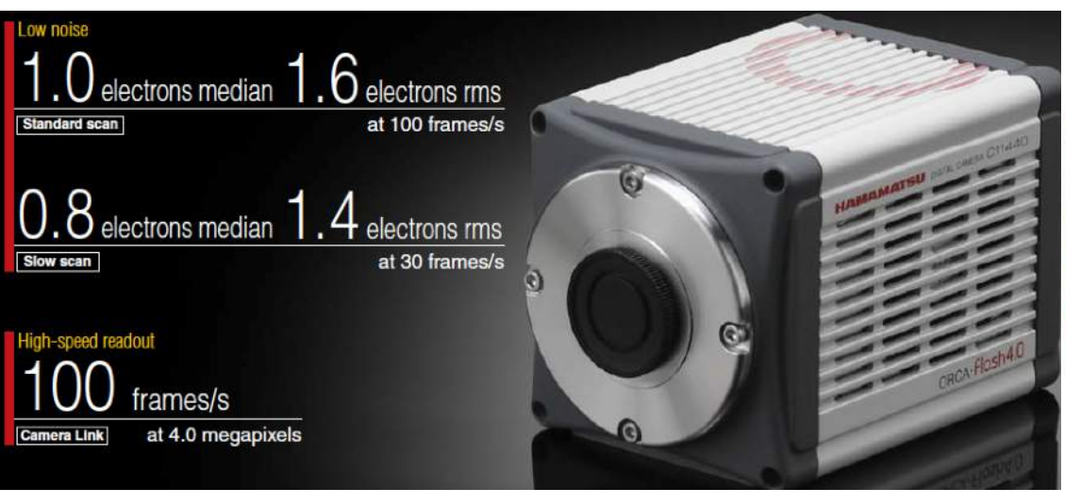
1 sCMOS + 1 PMT
20 x 24 cm² readout area
20 cm drift
7 L active volume

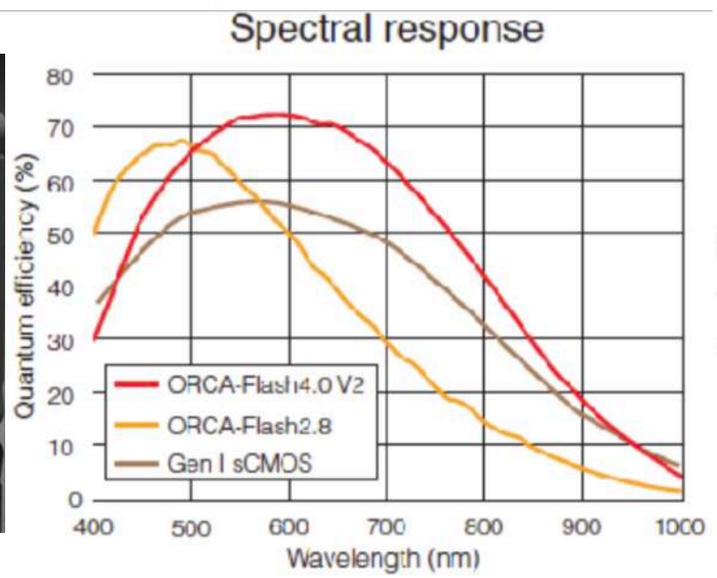
(A) Field Cage
(B) PMT
(C) Adaptable bellow
(D) CMOS camera



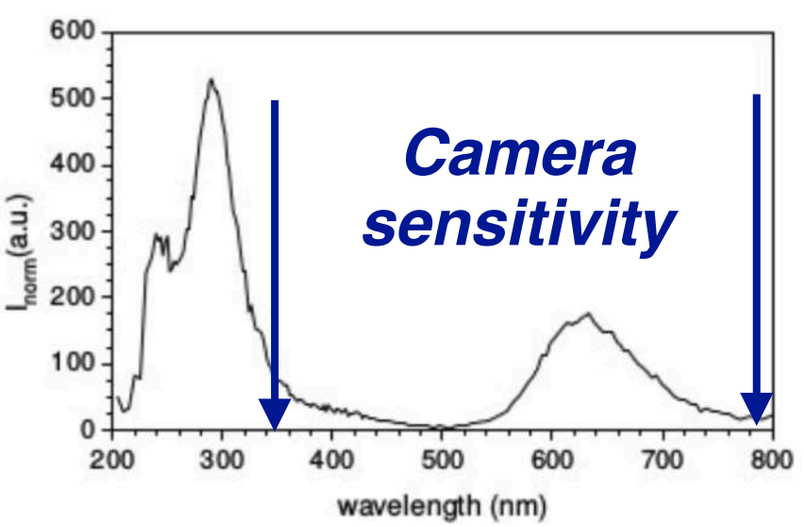


ORCA-Flash4.0





He:CF_4 spectrum

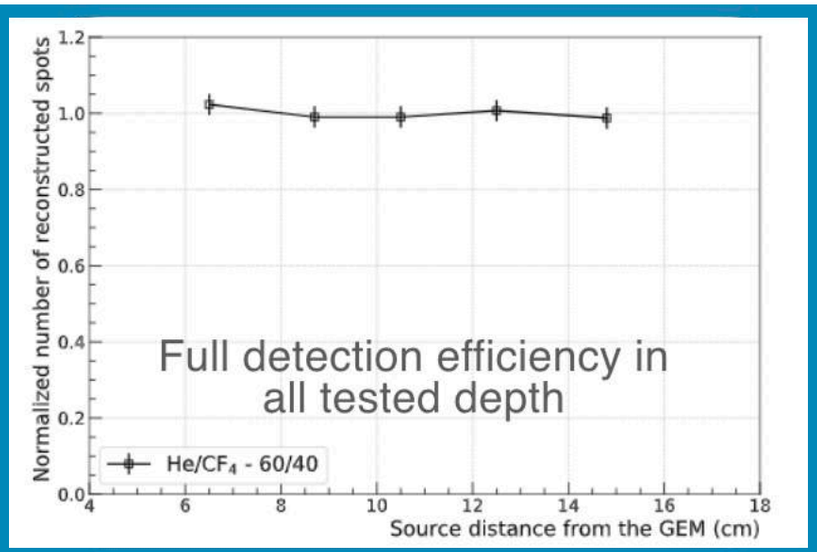


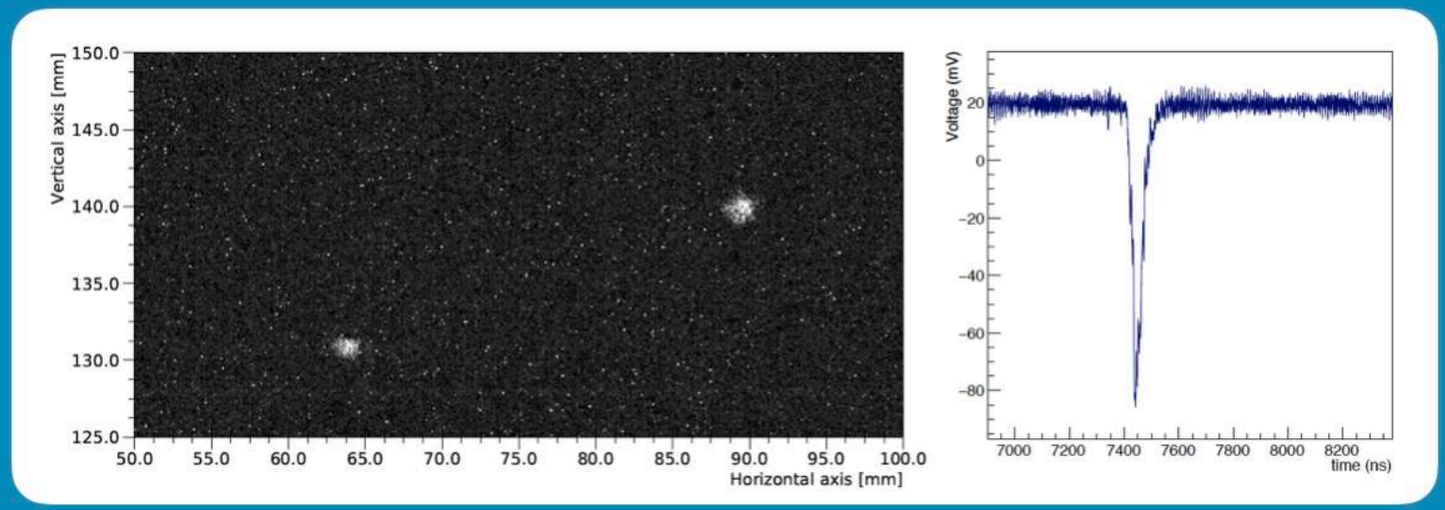
Response to X-rays: energy threshold

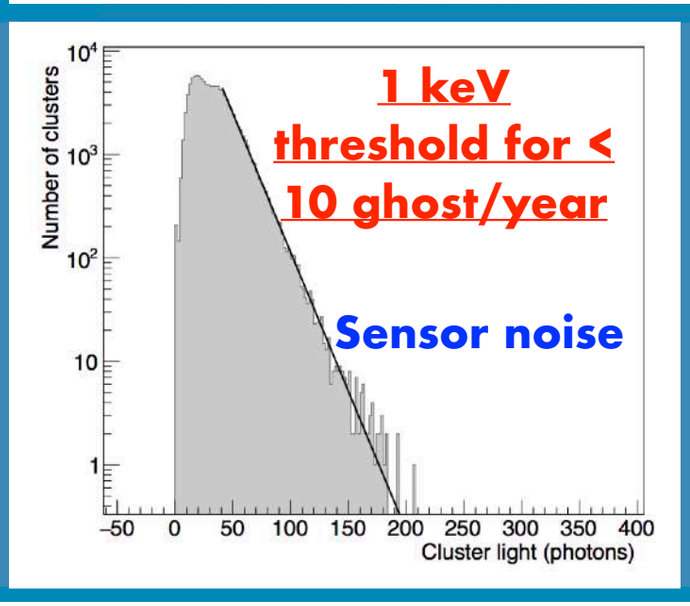
JINST 15 (2020) P10001

JINST 14 (2019) P07011

Performance on 5.9 keV_{ee} electron recoils from ^{55}Fe x-ray source

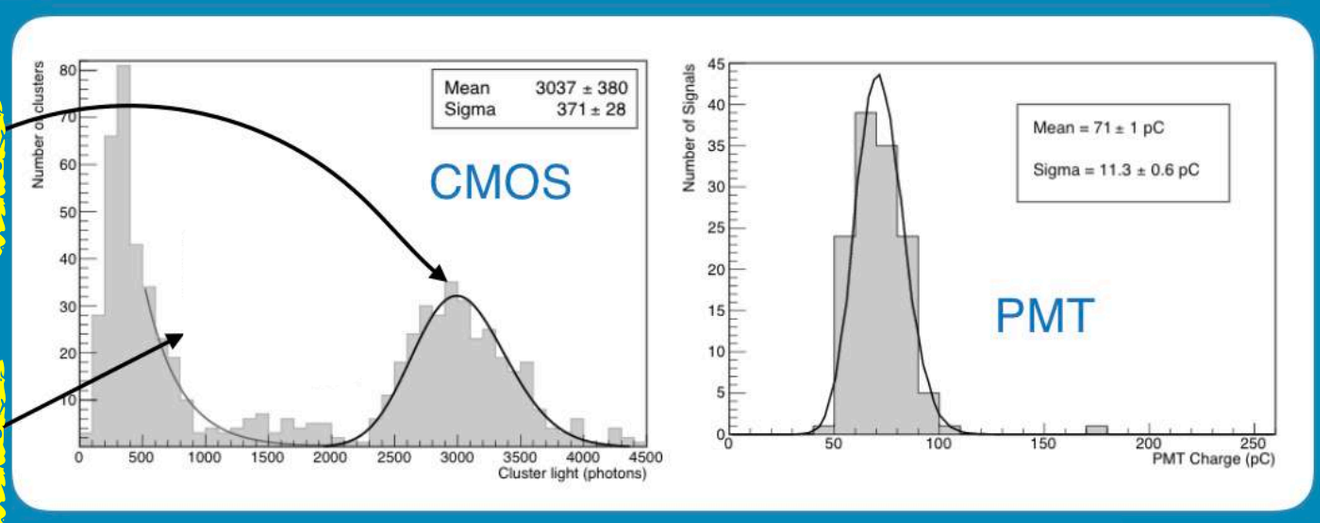






500 photons collected per keV

Sensor noise below 200 photons (i.e. 400 eV)



4

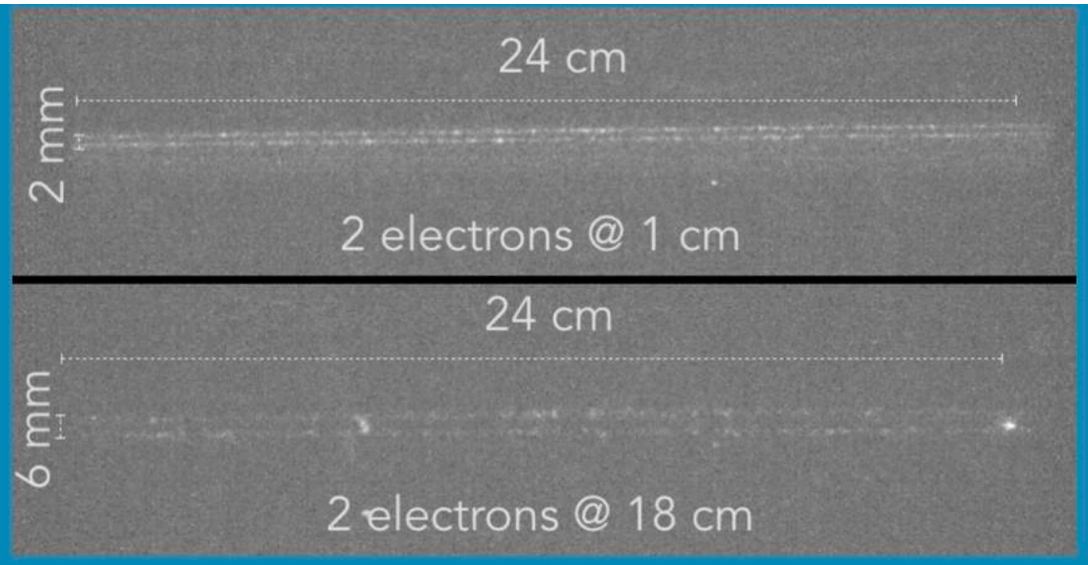
Energy resolution at 15% at 5.9 keV_{ee} from both sCMOS & PMT

Response to high energy electrons: tracking & fiducialization

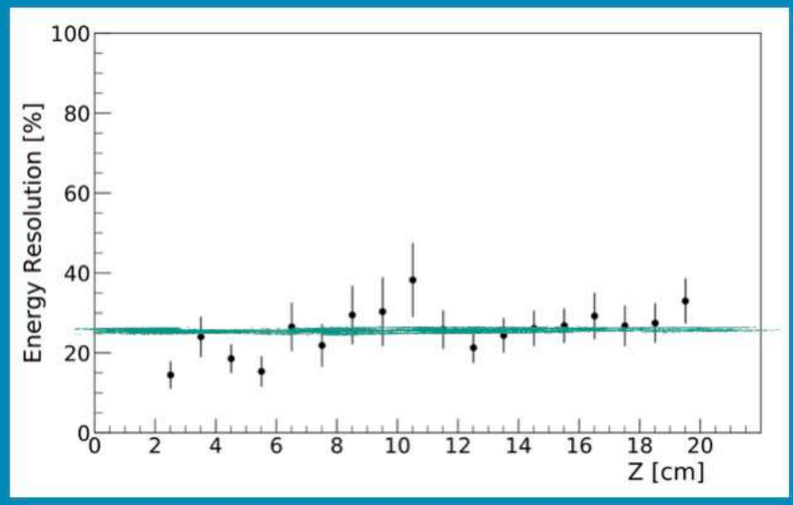
NIM A 936 (2019) 453-455

arXiv: 2005.12272

450 MeV electrons from Frascati BTF

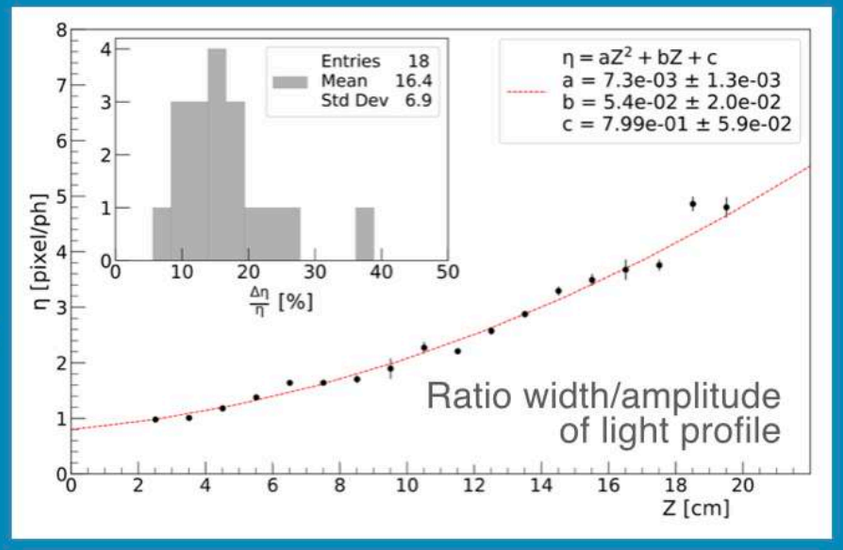


Analysis was performed by splitting tracks in 36 slices 7 mm long (i.e. 1.6 keV)

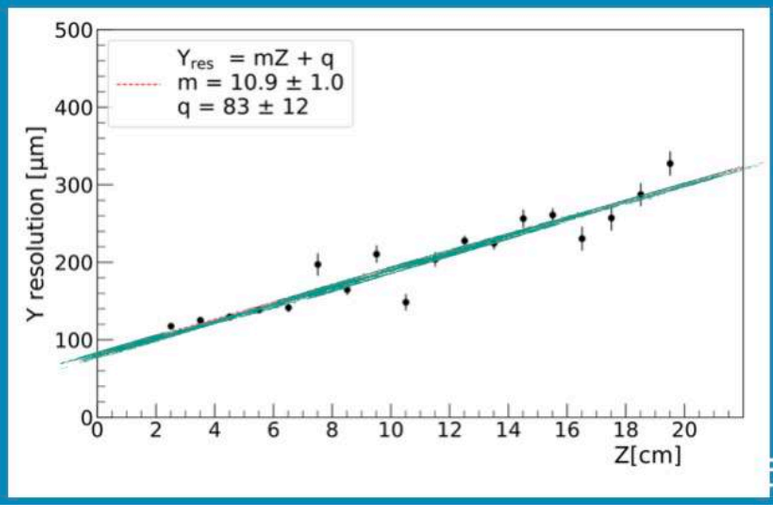


Average Energy resolution of 25% (i.e. 400 eV)

Diffusion can be exploited to evaluate absolute Z position with an average resolution of 15%



Relative position evaluated with a resolution between 100 µm and 300 µm

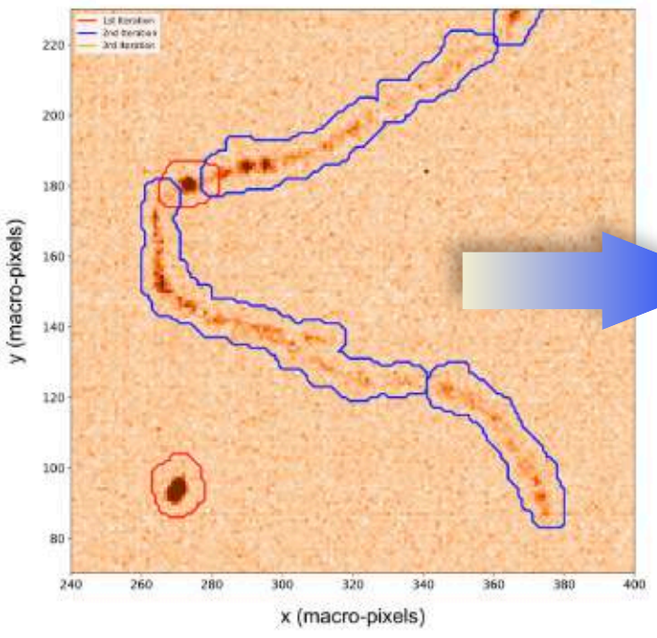


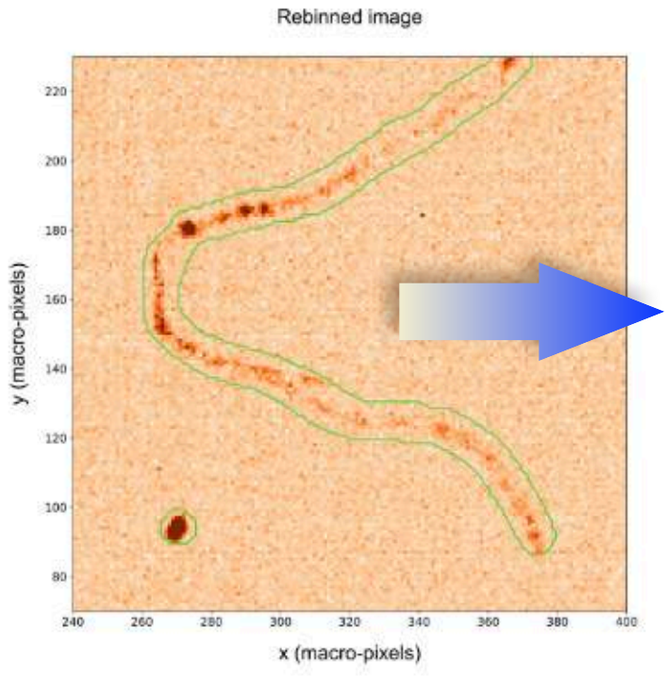
Tracking in X-Y with O(100) um resolution
Fiducialization along Z with 15% average position resolution

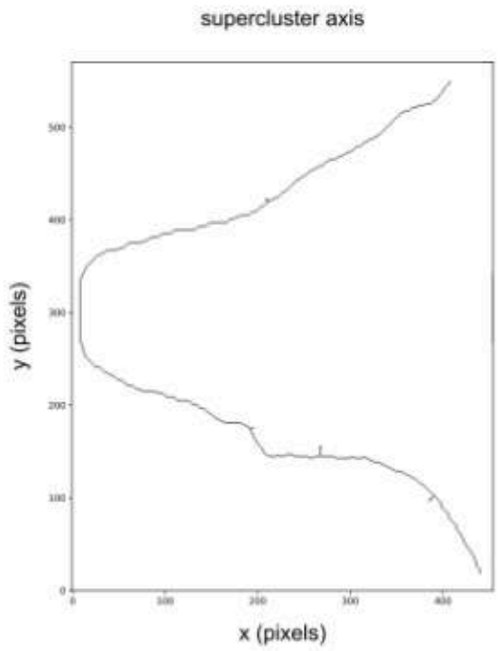
Response to neutrons & gammas: low energy nuclear recoil & discrimination from ^{55}Fe

AmBe source, Pb shield

arXiv: 2007.01763



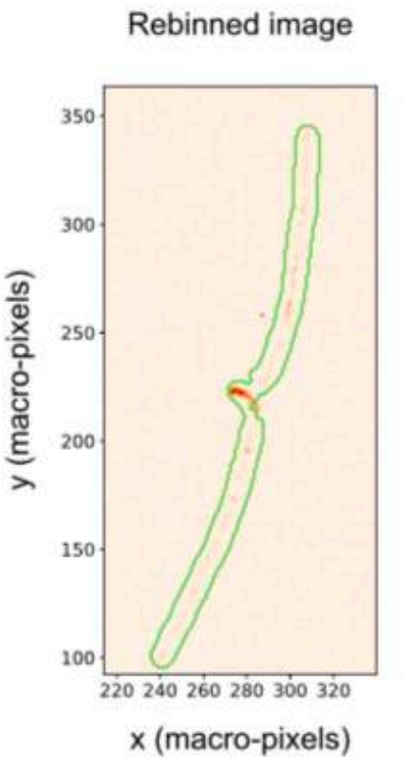


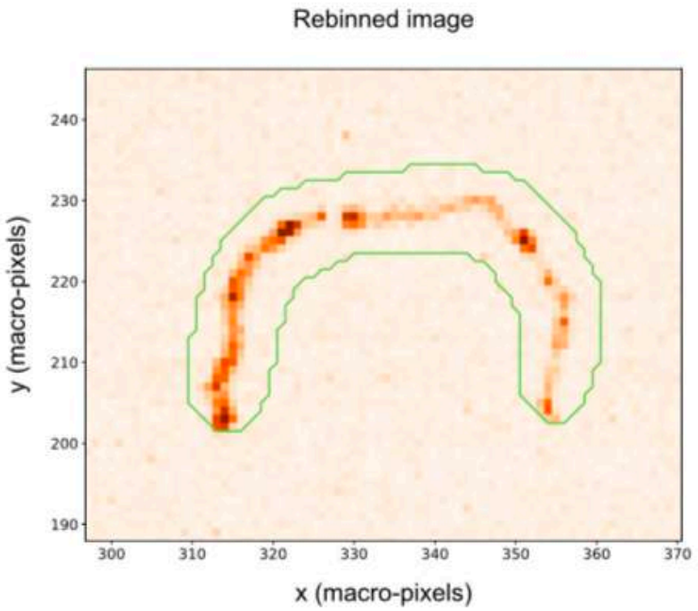


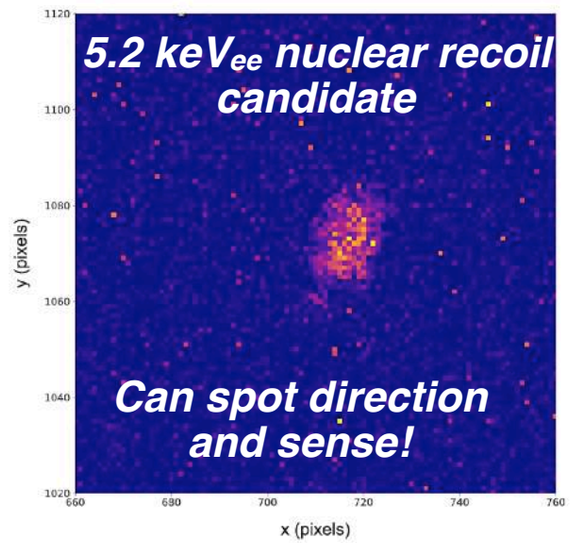
Multiple DBSCAN iteration to select different ionisation patters

Morphological geodesic active contours (GAC) to connect long tracks

Iterative morphological thinning for actual track length

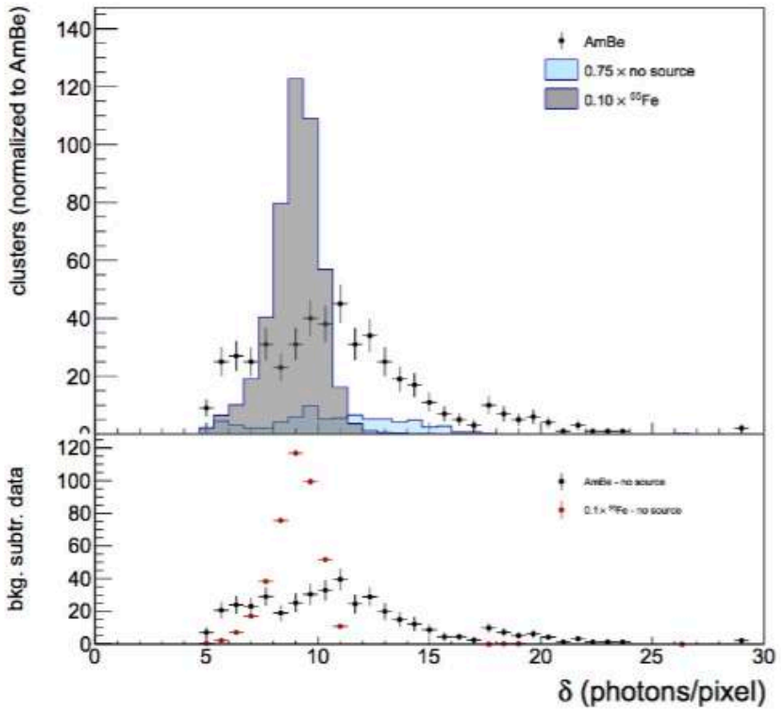




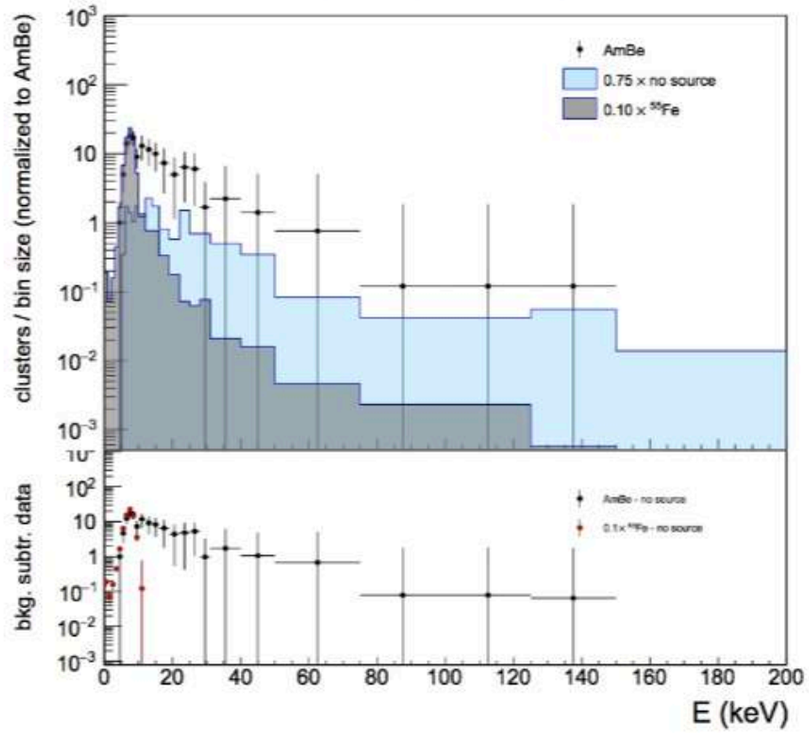


Response to neutrons & gammas: low energy nuclear recoil & discrimination from ^{55}Fe

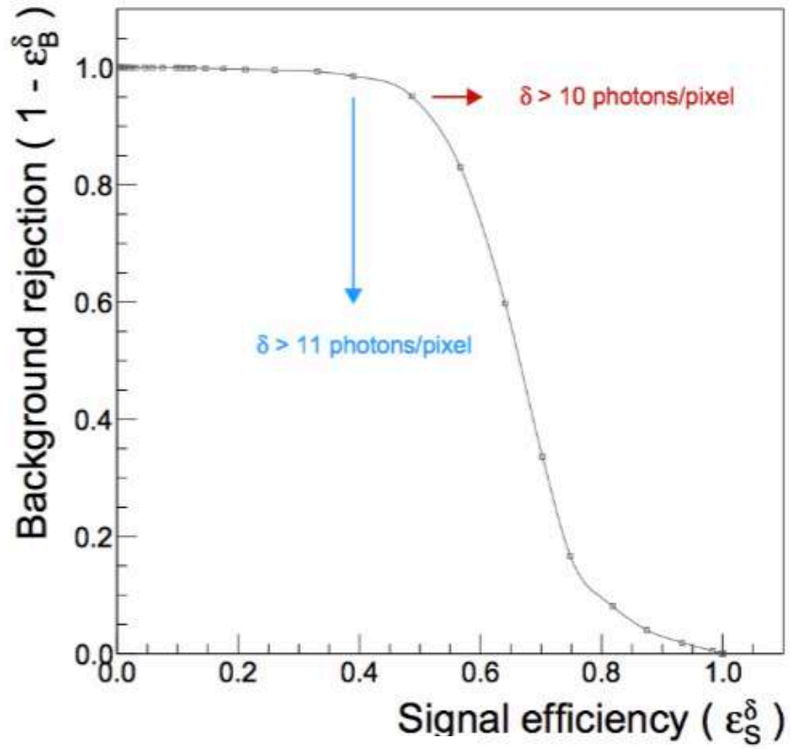
Light density δ



Calibrated energy for δ >10



ROC curve



working point	Signal efficiency			Background efficiency		
	ε_S^{presel}	ε_S^{δ}	ε_S^{total}	ε_B^{presel}	ε_B^{δ}	ε_B^{total}
WP_{50}	0.98	0.51	0.50	0.70	0.050	0.035
WP_{40}	0.98	0.41	0.40	0.70	0.012	0.008

Meas. Sci. and Tech. 2020 • e-Print: 2007.12508

40% nuclear recoil efficiency for energies < 20 keV$_{ee}$, with 99% ^{55}Fe events rejected

3D optical readout with negative ion drift

CYGNO roadmap & synergy with INTIUM

CYGNUS_RD

PHASE_0

PHASE_1

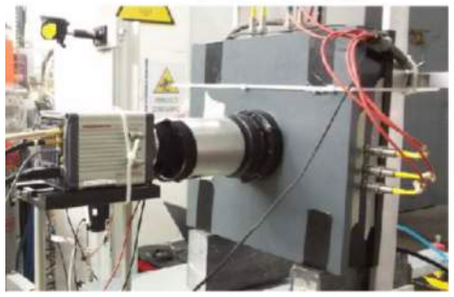
PHASE_2

Electron drift

$He:CF_4$
1 atm

2015 — 201 — 2018 — 2019 — 2020 — 2021 — 2022 — …

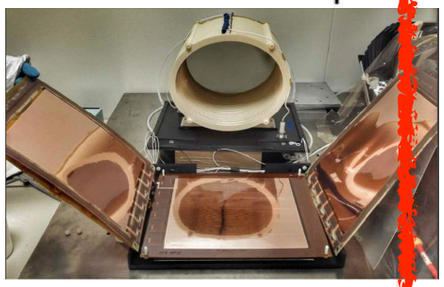
100 cm^3
ORANGE



1 sCMOS
10 x 10 cm^2 area

@ RO…

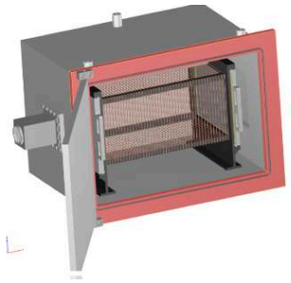
0.01 m^3
LEMON



1 sCMOS
20 x 24 cm^2 area

@ LNF

0.05 m^3
LIME



1 sCMOS
33 x 33 cm^2 area

@ LNF
Construction & test

@ LNGS
Installation & data taking

CYGNO 30-100 m^3

$He:CF_4:SF_6$
0.8-1 atm

Negative ion drift

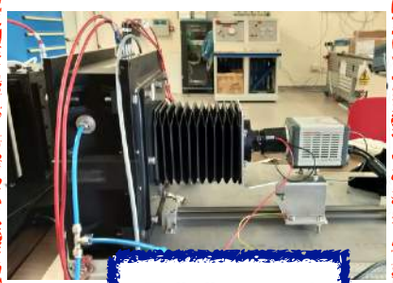
4 Timepix chips
3 x 3 cm^2 area
NITEC

MARIE CURIE ACTIONS

2015 — 2016 — 2017 — 2018

50 cm^3

1 sCMOS
10 x 10 cm^2 area
MANGO

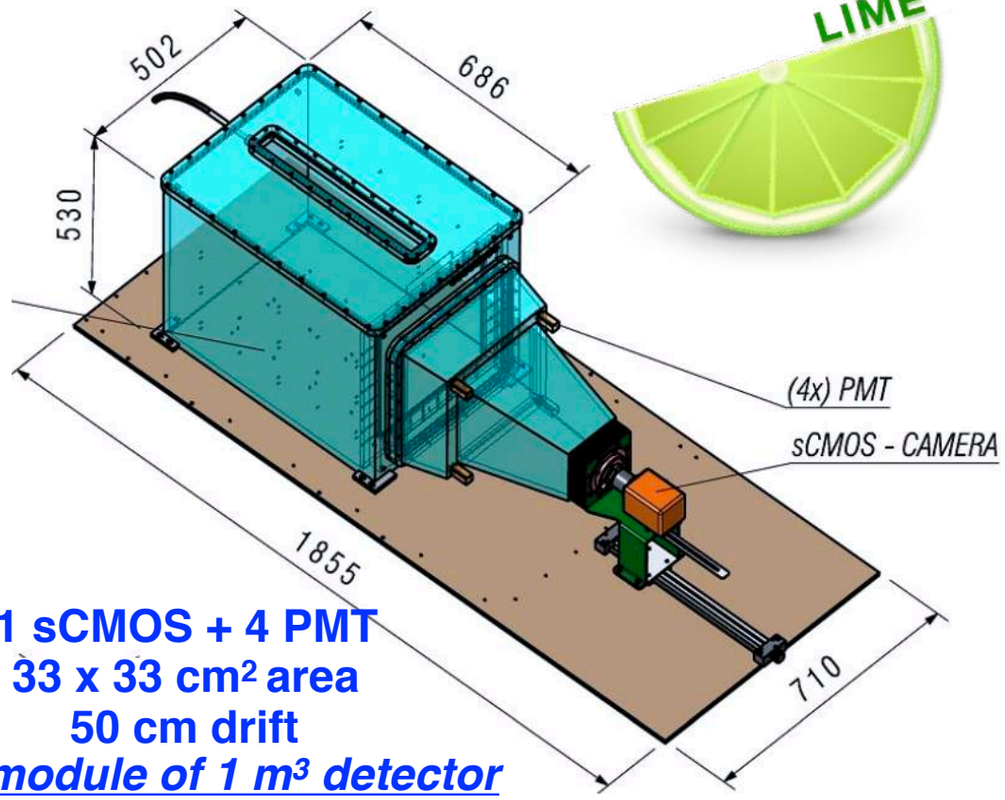


500 cm^3

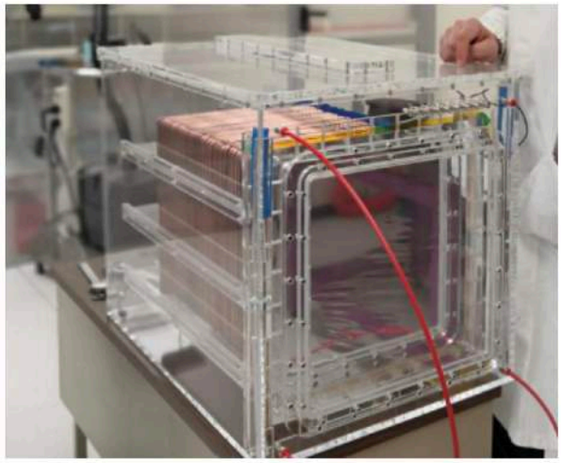
@ LN…

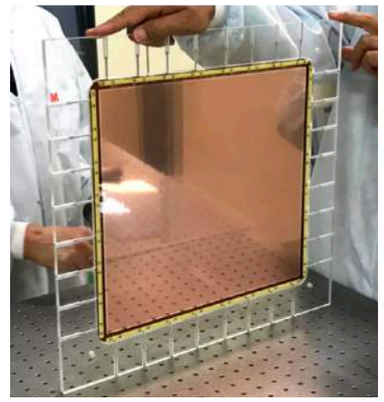
Part of this project has received fundings under the European Union's Horizon 2020 research and innovation programme from the Marie Sklodowska-Curie grant agreement No 657751 and from the European Research Council (ERC) grant agreement No 818744

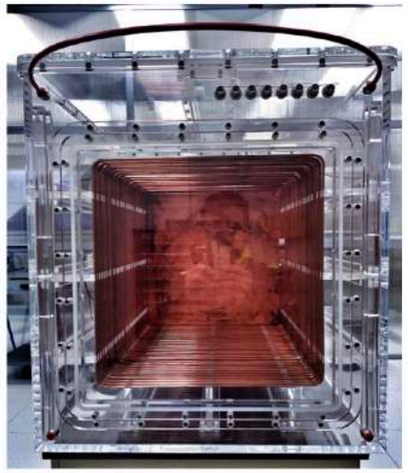
LIME: a 1 m³ module prototype for 50 L active volume

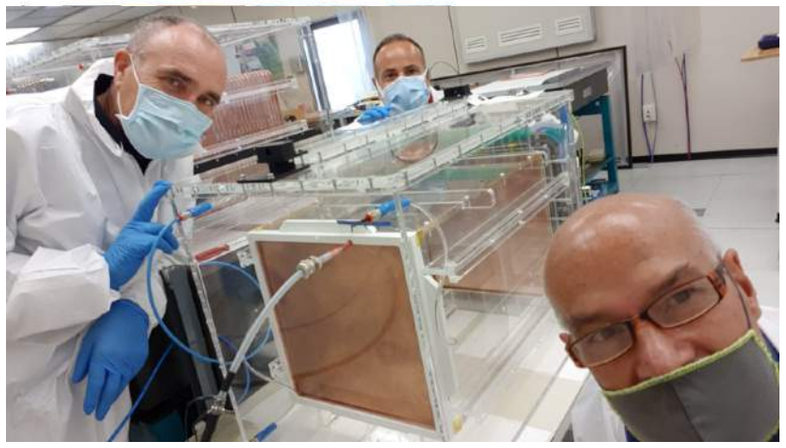


1 sCMOS + 4 PMT
33 x 33 cm² area
50 cm drift
1/18 module of 1 m³ detector



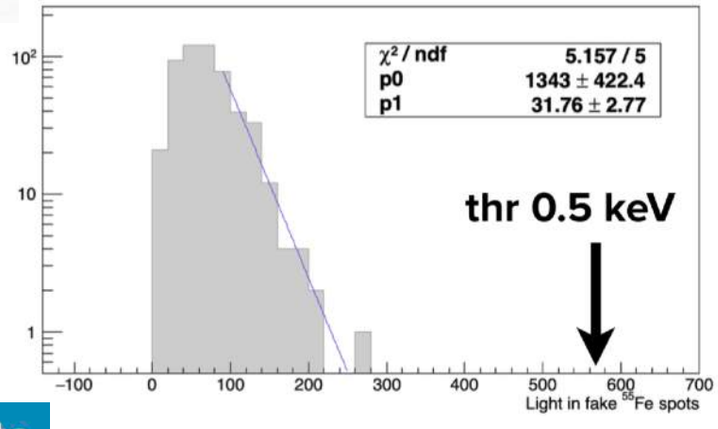






ORCA-Fusion

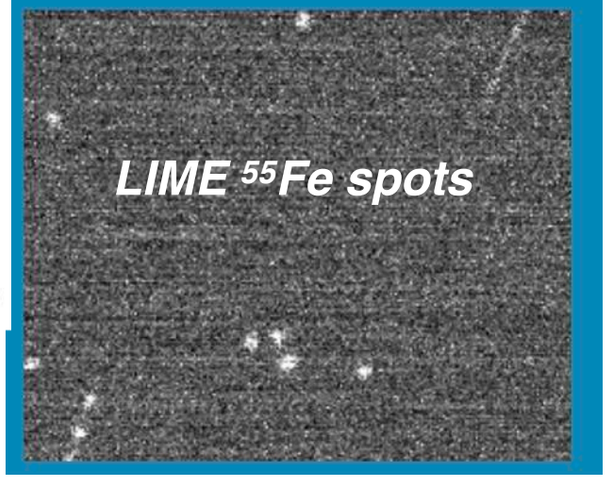
Sensor noise

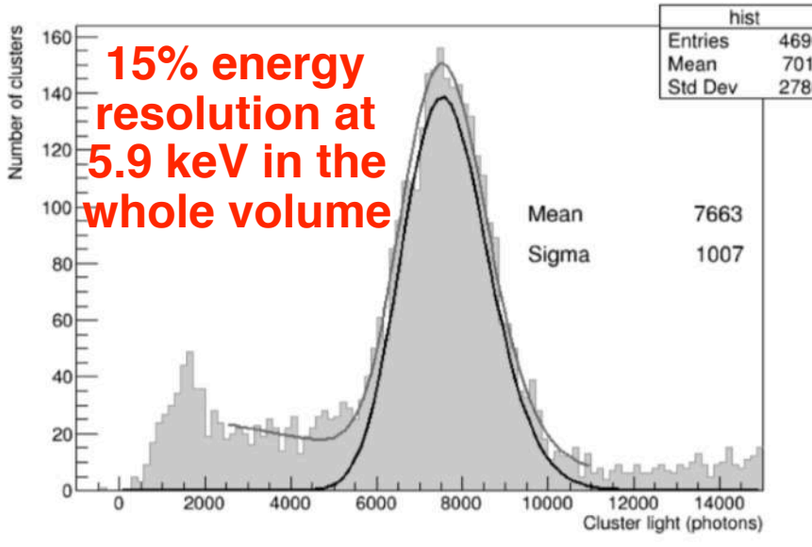


1 keV = 1180 counts
Larger sensitivity;
Lower noise;

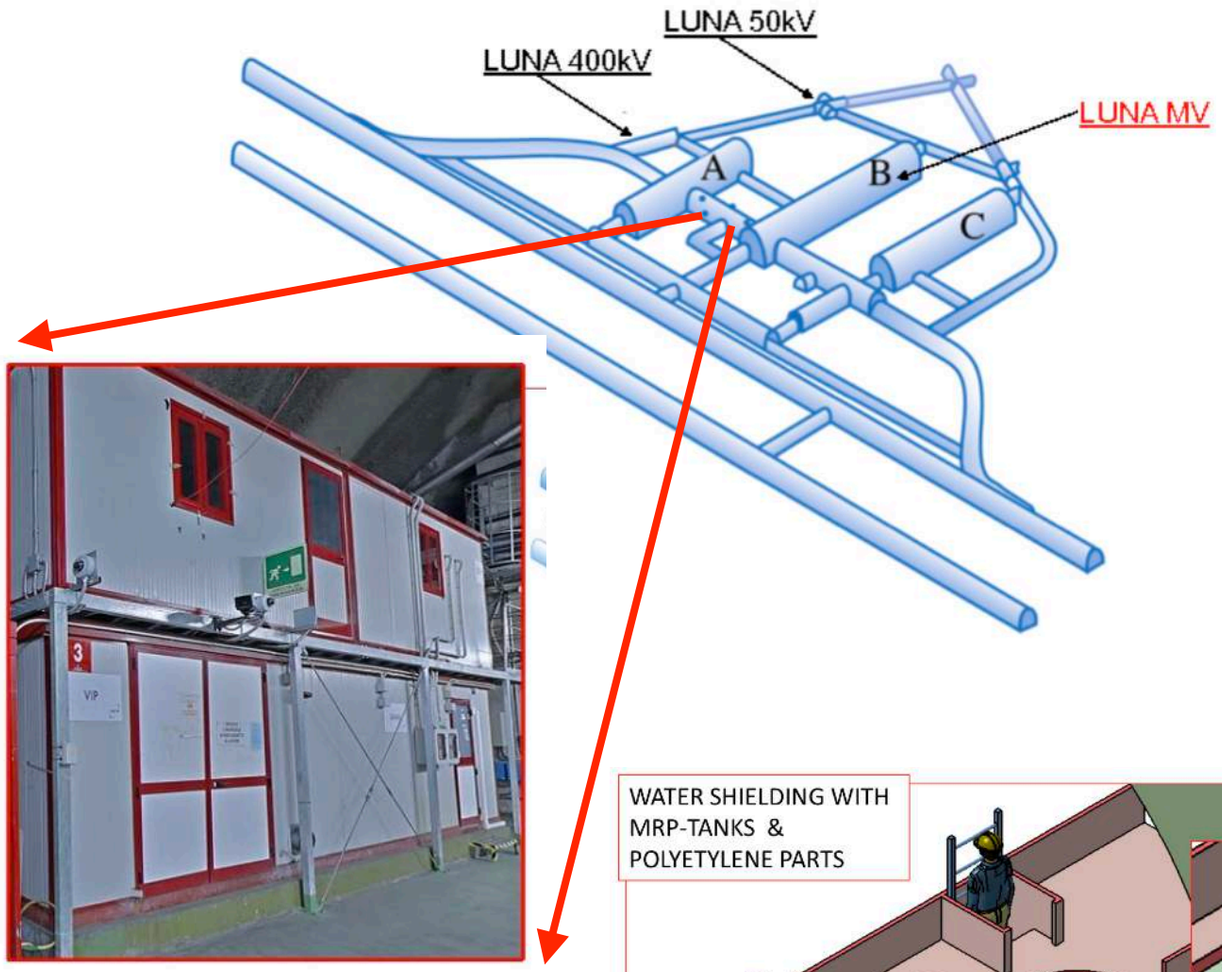
Detection threshold could be lowered to 0.5 keV_{ee}

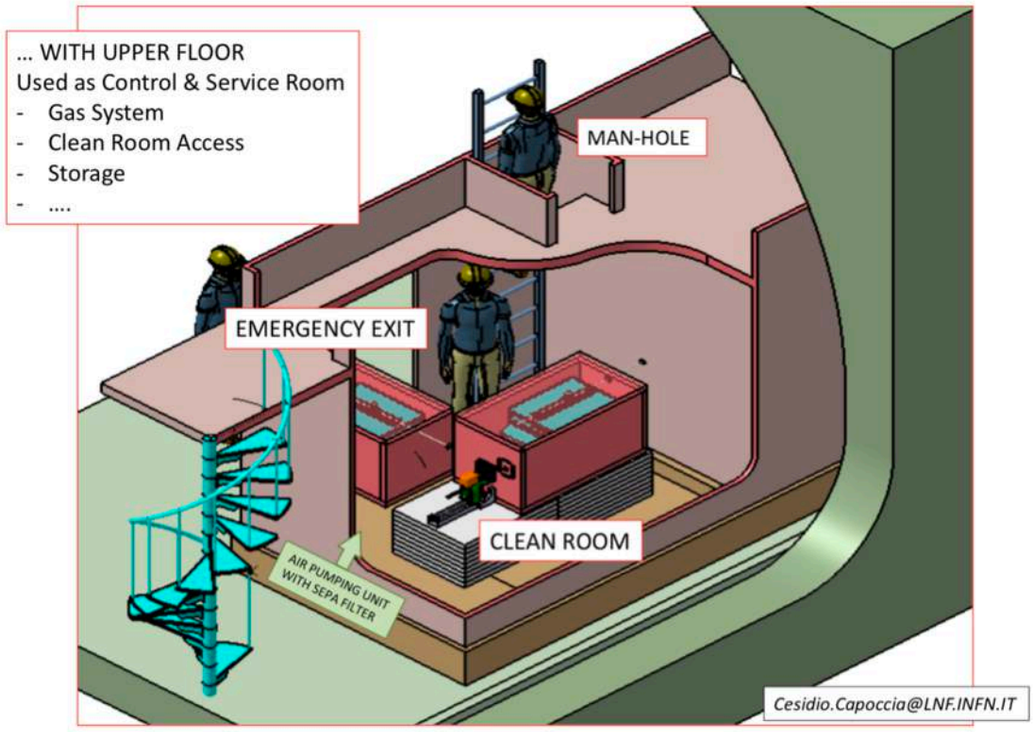
- 45 cm from GEMs



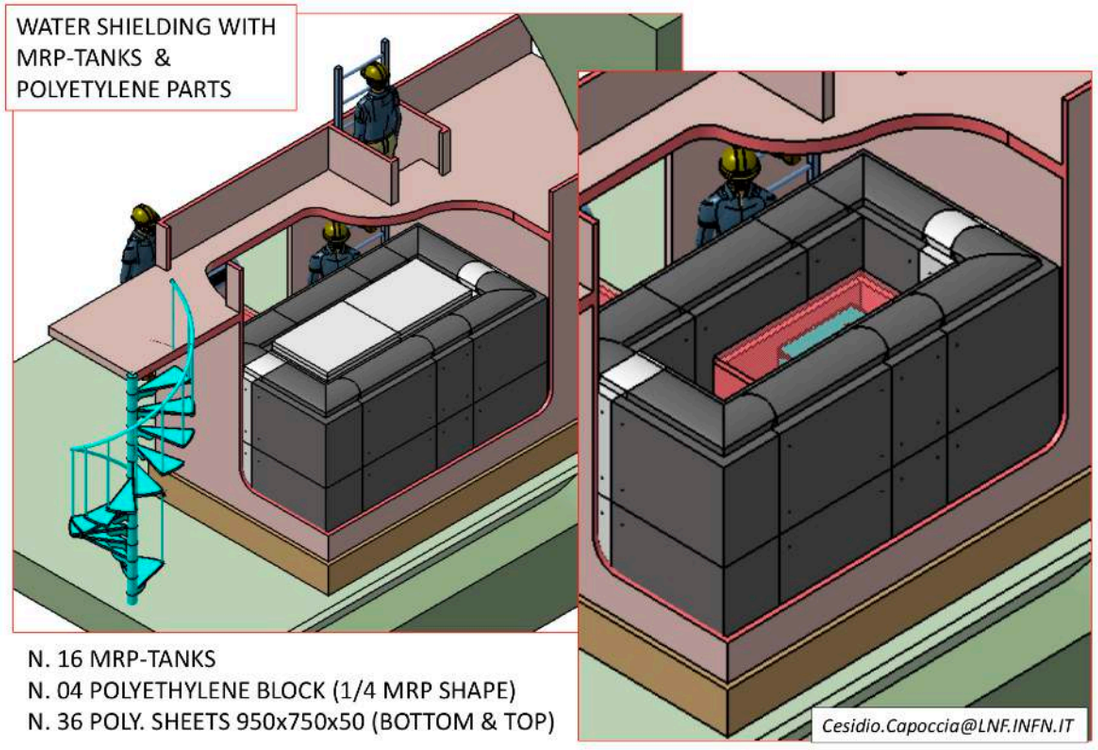


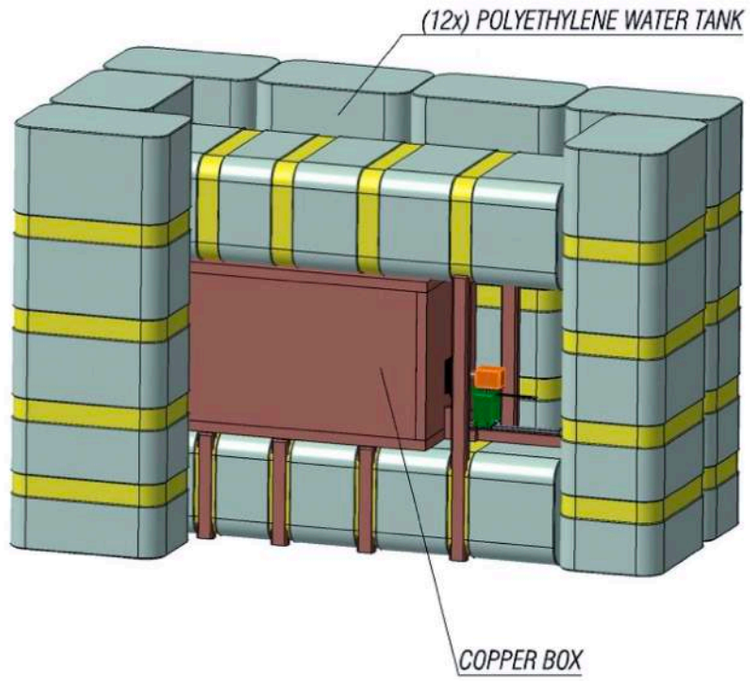
CYGNO LIME prototype @ underground LNGS



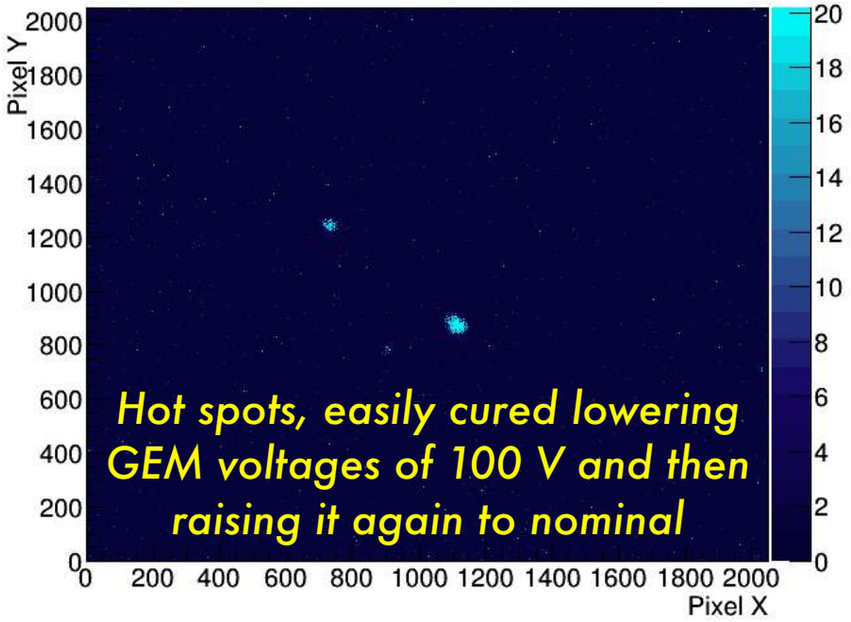


Slowed by COVID19, expected completion by first semester 2021



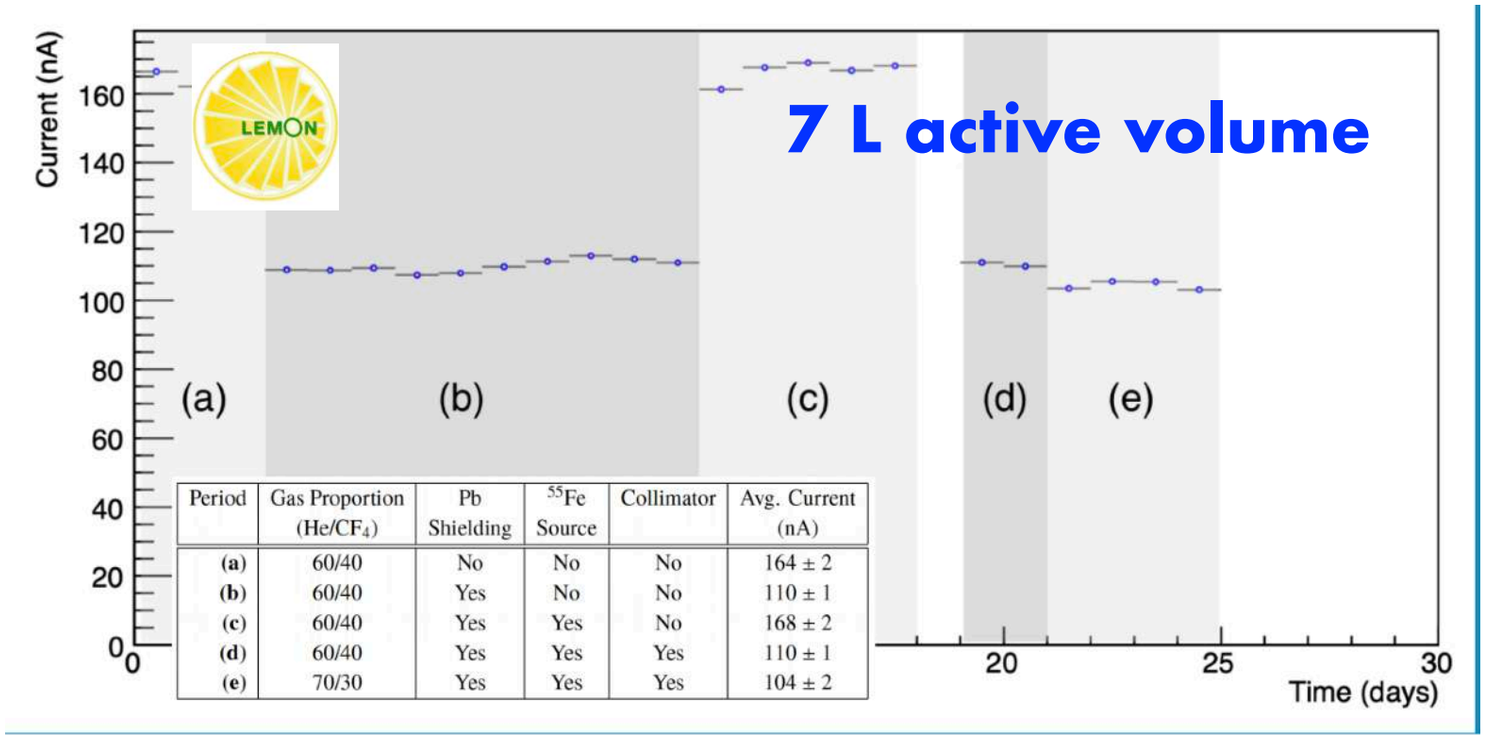


Large prototypes stability test

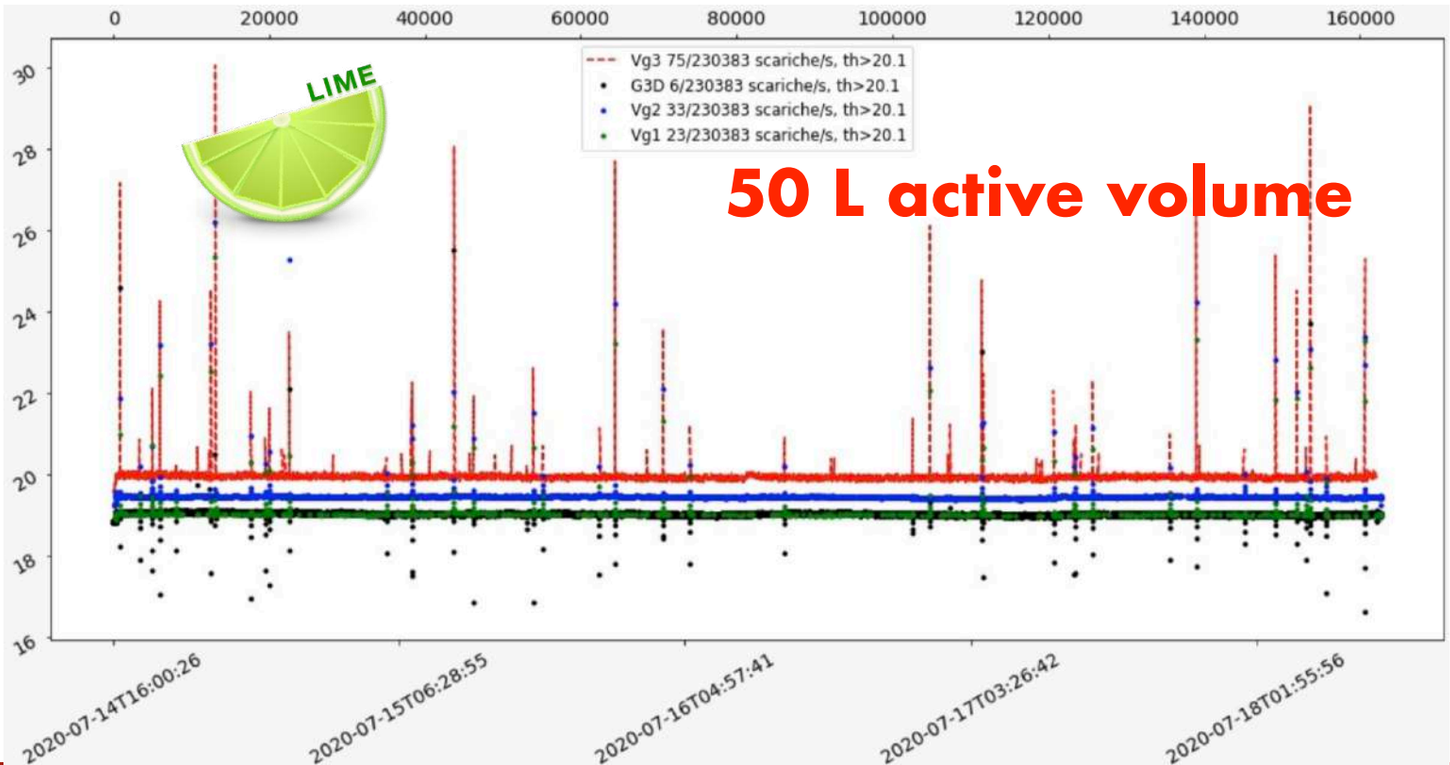


LEMOn successfully operated for 25 consecutive days, with automatic GEM hot spots + trips recovery

JINST 15 (2020) P10001



Period	Gas Proportion (He/CF_4)	Pb Shielding	^{55}Fe Source	Collimator	Avg. Current (nA)
(a)	60/40	No	No	No	164 ± 2
(b)	60/40	Yes	No	No	110 ± 1
(c)	60/40	Yes	Yes	No	168 ± 2
(d)	60/40	Yes	Yes	Yes	110 ± 1
(e)	70/30	Yes	Yes	Yes	104 ± 2



Similar stability observed with LIME over 1 week (i.e. < 1 event/ hour), in agreement with a factor 2 larger GEMs

3D optical readout with negative ion drift

CYGNO roadmap & synergy with INTIUM

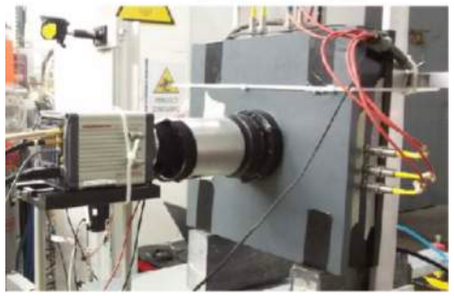
CYGNUS_RD — PHASE_0 — PHASE_1 — PHASE_2

Electron drift

He:CF$_4$
1 atm

2015 — 201 — 2018 — 2019 — 2020 — 2021 — 2022 — …

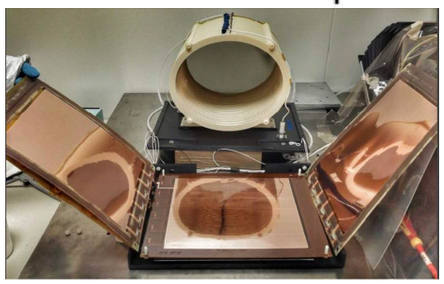
100 cm³ — ORANGE



1 sCMOS
10 x 10 cm² area

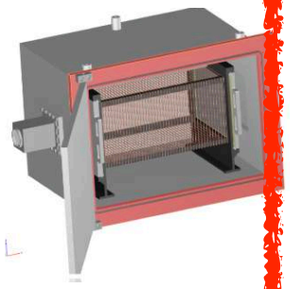
@ RO… — @ LNF

0.01 m³ — LEMON



1 sCMOS
20 x 24 cm² area

0.05 m³ — LIME

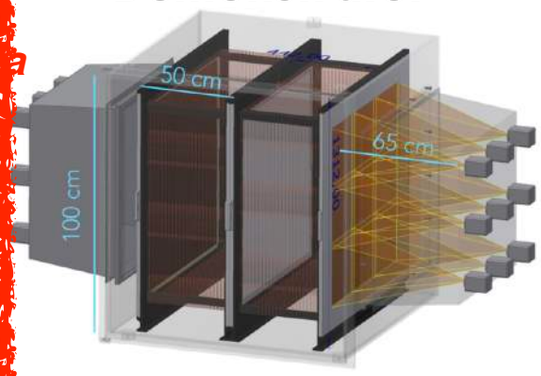


1 sCMOS
33 x 33 cm² area

@ LNF — Construction & test

@ LNGS — Installation & data taking

CYGNO Demonstrator



IN TIUM

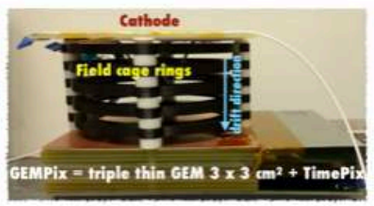
CYGNO 30-100 m³

He:CF$_4$:SF$_6$
0.8-1 atm

Negative ion drift

4 Timepix chips
3 x 3 cm² area

NITEC



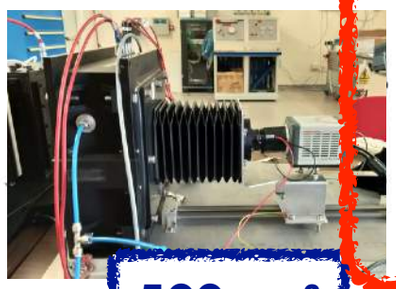
MARIE CURIE ACTIONS

50 cm³

2015 — 2016 — 2017 — 2018

1 sCMOS
10 x 10 cm² area

MANGO



@ LN… — **500 cm³**

erc

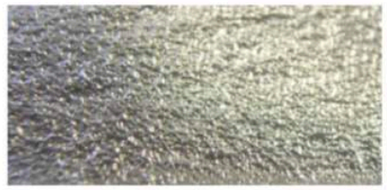
Part of this project has received fundings under the European Union's Horizon 2020 research and innovation programme from the Marie Sklodowska-Curie grant agreement No 657751 and from the European Research Council (ERC) grant agreement No 818744

CYGNO INTIUM 1 m³ detector concept

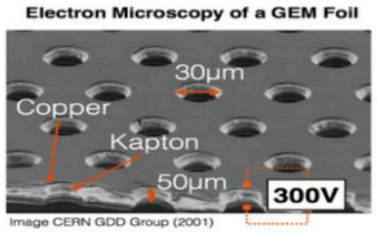
FUNDED!

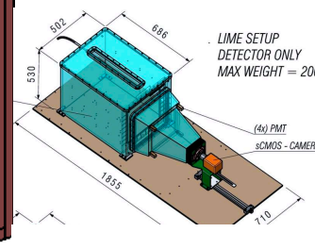
Atmospheric pressure & room temperature:

Transparent texturised mylar cathode a'la DRIFT



Gas Electron Multipliers (GEMs) amplification





9 LIMEs per 1 m²

Isometric view
Scale: 1:15

9 cameras/m²

A total of 72 10^6 readout
165 x 165 μm² pixels

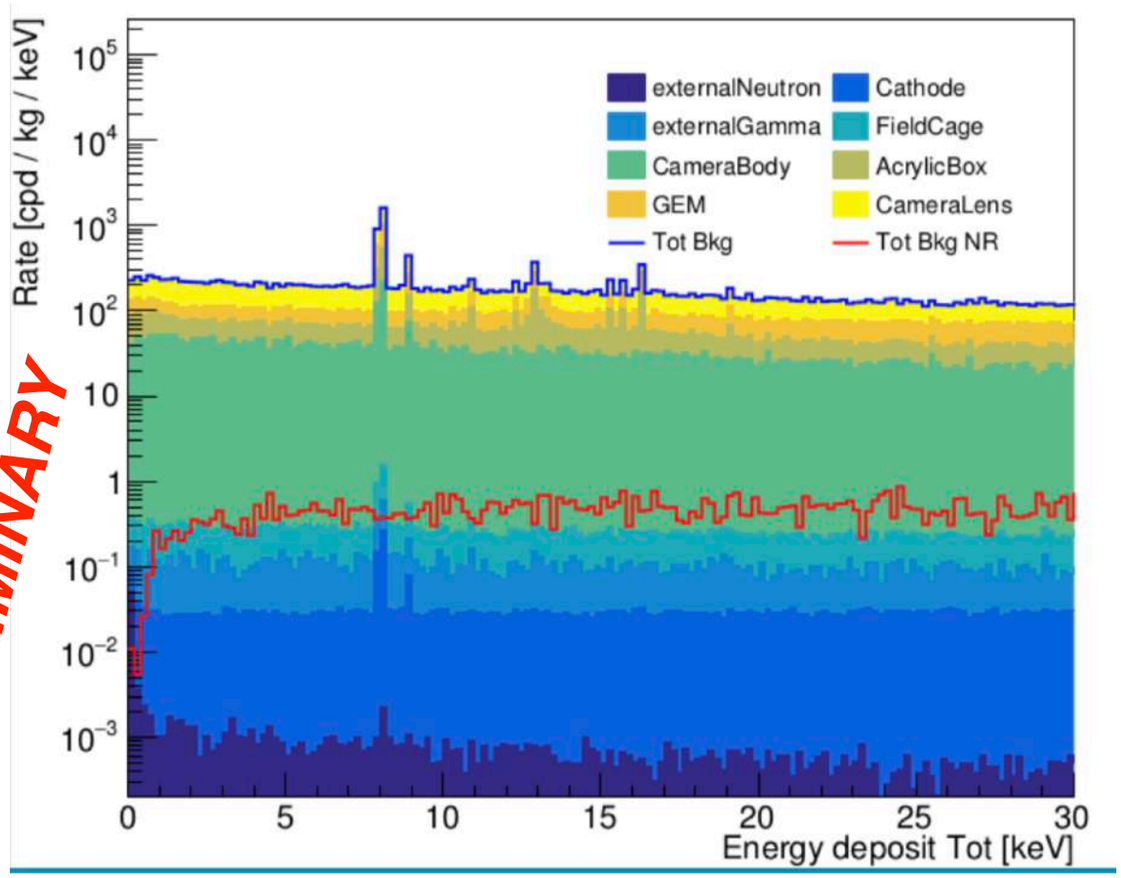
PMT + sCMOS optical readout decoupled from target volume

He:CF_4(:SF_6) 1.5 kg mass, 1 m³ volume

18 cameras monitoring
330*330 mm each
with **160 μm** resolution

1 m³ preliminary background

(Ambitious) goal: < 10^4 ɣ/year between 0-20 keV interacting in the active volume for zero background after ER rejection with 10^5 discriminating power

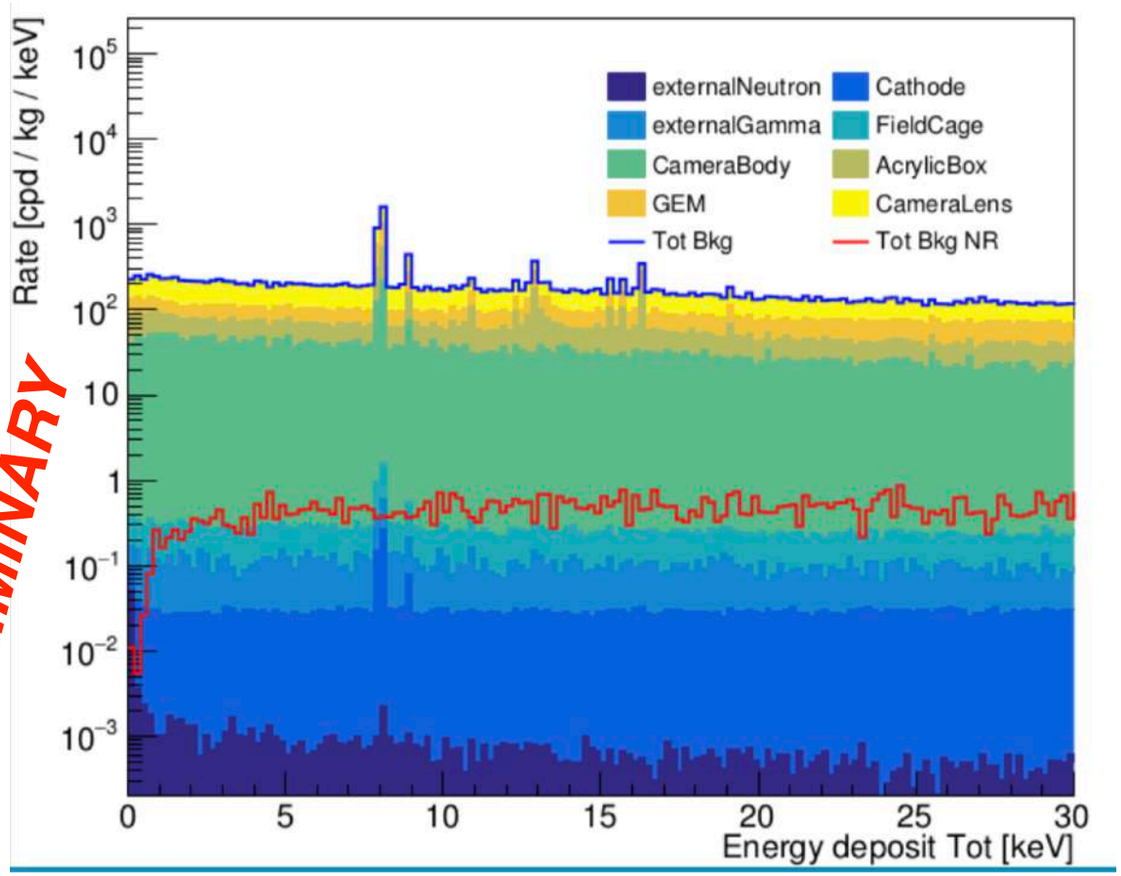


Shield: 200 cm water + 5 cm copper;
Detector: current GEM, acrylic, copper, camera and lens

Main internal contribution from sCMOS & GEMs O(10^5) /year in [1-20] keV

CYGNO INTIUM 1 m³ preliminary background

(Ambitious) goal: < 10^4 ɣ/year between 0-20 keV interacting in the active volume for zero background after ER rejection with 10^5 discriminating power

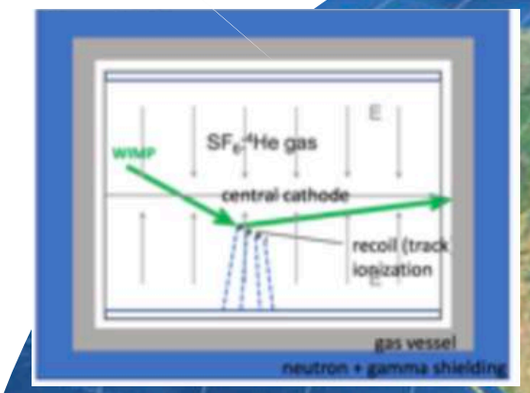


Camera	Sensitivity (eV/count)	Resolution (%)	Noise (eV)	^{228}Ra (Bq)	^{228}Th (Bq)	^{226}Ra (Bq)	^{234}Pa (Bq)	^{40}K (Bq)	Total activity
Hamamatsu ORCA FLASH 4.0	2.96	15.2	4.6	2.1	2.1	1.9	7.0	1.9	15.0
ORCA FLASH sensor	2.6	15.2	8	1.0	1.0	1.1	1.1	4.3	8.5
Photometrics Prime BSI Mode 1	3.3	19.0	9.7	-	-	-	-	-	tbm
Photometrics Prime BSI Mode 2	1.12	16.4	4.5	-	-	-	-	-	tbm
Photometrics BSI Express Mode 2	0.84	13.4	3.0	1.3	1.8	1.0	6.0	3.6	13.7
Hamamatsu Fusion Closer (LEMON)	0.65	17.5	1.58	-	-	-	-	-	tbm
Hamamatsu Fusion Farther (LIME)	0.85	16.4	2.06	-	-	-	-	-	tbm
Thorlab Quantalux	tbm	tbm	tbm	0.3	0.6	0.2	3.0	1.2	5.3

Shield: 200 cm water + 5 cm copper;
Detector: current GEM, acrylic, copper, camera and lens

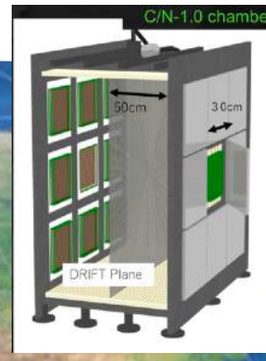
Main internal contribution from sCMOS & GEMs O(10^5) /year in [1-20] keV

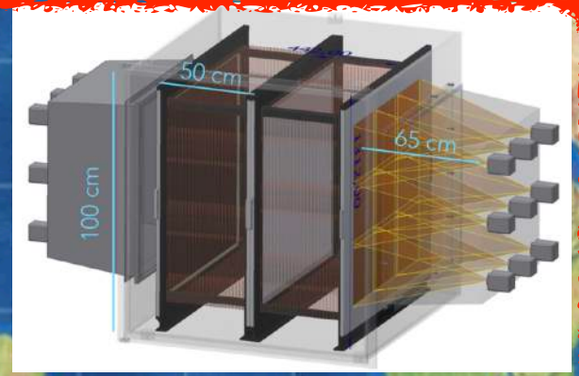
CYGNO IN TIUM in the CYGNUS picture



CYGNUS-HD10
GEMs + 2D strips
$He:CF_4:C_4H_{10}$
1 m³ under construction
towards 10 m³
experiment

CYGNUS-10
10 m³, GEMs + wires
$He:SF_6$
Boulby, UK
R&D ongoing on 1 m³





CYGNO/INITIUM
GEMs + sCMOS + PMT
$He:CF_4$ (:SF_6)
LNGS, Italy
1 m³ demonstrator
funded towards 30 m³
experiment

CYGNUS-KM
1 m³, GEMs + 2D strips
SF_6/CF_4
Kamioka, Japan
R&D ongoing on 1 m³

CYGNUS-OZ
Stawell, Australia
GEMs + CCDs for gas studies
Plans for 1 m³
demonstrator

Since fall 2016

CYGNUS proto-collaboration

- About 70 members
- Steering group:
  - Elisabetta Baracchini (GSSI/INFN, Italy)
  - Greg Lane (Canberra, Australia)
  - Kentaro Miuchi (Kobe, Japan)
  - Neil Spooner (Sheffield, UK)
  - Sven Vahsen (Hawaii, USA)





A multi-site, multi-target Galactic Recoil Observatory at the ton-scale to probe Dark Matter below the Neutrino Floor and measure solar Neutrinos with directionality

- **Helium/Fluorine gas mixtures at 1 bar**
  - **Sensitivity to O(GeV) WIMP for both SI & SD couplings**
  - **Possibility of switching between higher (search mode) and lower gas densities (improved directionality) for signal confirmation**
- **Reduced diffusion**
  - **Through negative ion drift or “cold” gases**
- **3D fiducialization**
  - **Through minority carriers or fit to diffusion**
- **Directional threshold at O(keV)**
- **Full background rejection at O(keV)**

CYGNUS: Feasibility of a nuclear recoil observatory with directional sensitivity to dark matter and neutrinos

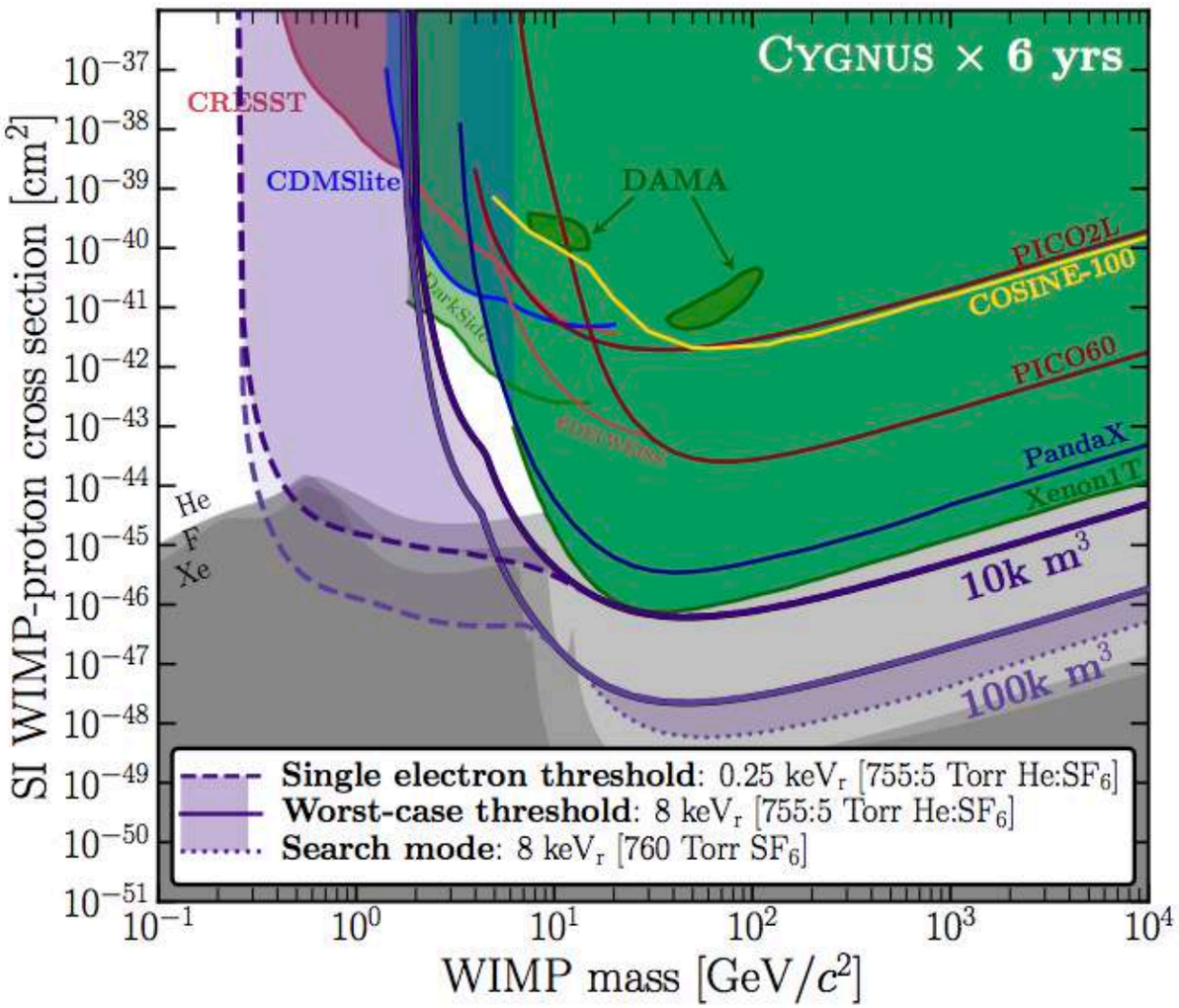
S. E. Vahsen,[1] C. A. J. O'Hare,[2] W. A. Lynch,[3] N. J. C. Spooner,[3] E. Baracchini,[4,5,6] P. Barbeau,[7] J. B. R. Battat,[8] B. Crow,[1] C. Deaconu,[9] C. Eldridge,[3] A. C. Ezeribe,[3] M. Ghrear,[1] D. Loomba,[10] K. J. Mack,[11] K. Miuchi,[12] F. M. Mouton,[3] N. S. Phan,[13] K. Scholberg,[7] and T. N. Thorpe[1,6]

arXiv:2008.12587

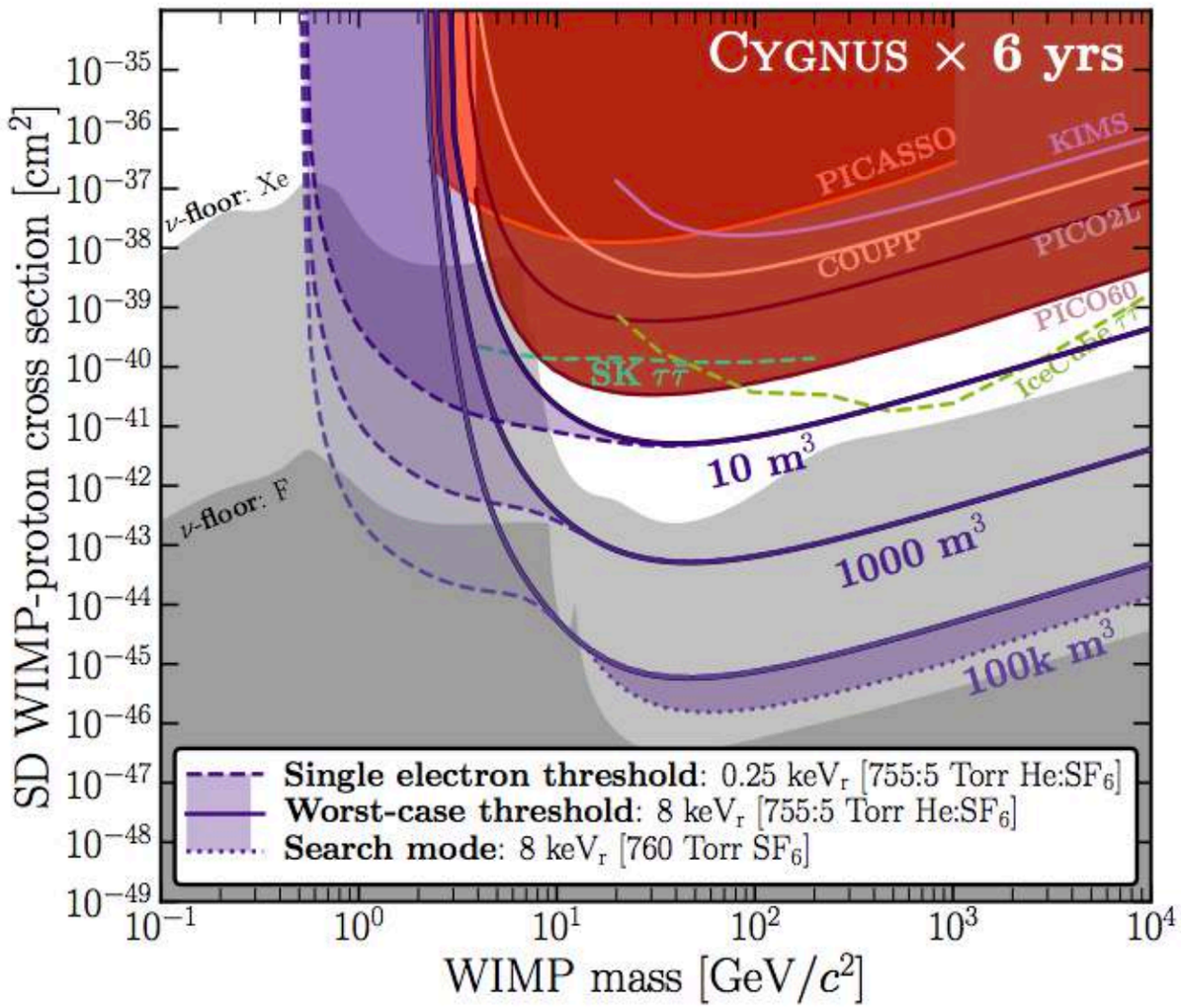
Final message of the paper:

need to demonstrate on actual O(m³) detector rejection performances

He:SF_6 755:5



Significant improvement in SI in the low WIMP mass region, expect 10-50 IDENTIFIED neutrino nuclear recoil events



Significant improvement in SD reach over existing experiments for all WIMP masses, a 10 m³ detector can already breach the Xe neutrino floor

Stay tuned for (a flock of) CYGNUS birth!

https://web.infn.it/cygnus/

Backup slides