WIN2017

Carsten Rott

Tuesday

Program

Working Group: Astroparticle physics and cosmology - Pacific Ballroom AB (16:30-18:30)

Spencer Klein

time	[id] title	presenter
16:30	[109] Expectations for high energy diffuse galactic neutrinos for different cosmic ray distributions	Dr. VILLANTE, Francesco
16:50	[5] Constraints on the astrophysical flux and the dark matter decay with IceCube HESE data	Prof. SARCEVIC, INA
17:10	[22] Imaging Galactic Dark Matter with IceCube High-Energy Cosmic Neutrinos	KHEIRANDISH, Ali
17:30	[163] Dark Matter Searches with the Fermi-LAT	CAPUTO, Regina
17:50	[145] Dark matter velocity spectroscopy	Dr. LAHA, Ranjan
18:10	[112] Neutrino absorption in the Earth and measurement of the neutrino-nucleon cross-section at multi-TeV energies with IceCube	BINDER, Gary

Wednesday

Program

Working Group: Astroparticle physics and cosmology - Pacific Ballroom AB (11:30-13:00)

Carsten Rott

time	[id] title	presenter
11:30	[151] Searches for Astrophysical Neutrinos using radio-detection	Dr. KLEIN, Spencer
12:00	[207] ANTARES latest results and KM3NeT status and perspectives	Prof. CAPONE, Antonio
12:20	[55] Indirect dark matter searches in IceCube	MEDICI, Morten
12:40	[67] Dark matter searches with the Super-Kamiokande detector	Ms. FRANKIEWICZ, Katarzyna

Working Group: Astroparticle physics and cosmology - Pacific Ballroom AB (14:30-16:00)

Jodi ?

time	[id] title	presenter
14:30	[176] An overview of directional dark matter experiments: current status and future prospects	Prof. LOOMBA, Dinesh
15:00	[36] The XENON1T Dark Matter Experiment	Dr. DIGLIO, Sara
15:20	[110] Dark matter search results from the PandaX-II experiment	Dr. XIAO, Mengjiao
15:40	[51] Recent results from XMASS	Dr. HIRAIDE, Katsuki

Wednesday

Program

Working Group: Astroparticle physics and cosmology - Pacific Ballroom AB (16:30-18:30)

Miura

time	[id] title	presenter
16:30	[54] Astrophysical neutrinos at Super-Kamiokande	Dr. TAKEUCHI, Yasuo
16:50	[93] Supernova neutrinos with the JUNO experiment	Ms. LI, Huiling
17:10	[129] Supernova Neutrinos, Atmospheric Neutrinos and Proton Decay at the DUNE Experiment	REICHENBACHER, Juergen
17:30	[69] An event generator for supernova neutrinos in argon	GARDINER, Steven
17:50	[150] Looking Inward with Neutrinos	Prof. LEARNED, John Gregory
18:10	[28] Results from Borexino on solar and geo-neutrinos	LOMBARDI, Francesco

Supernova
- **Takeuchi (Super-K)**
- **Li (Juno)**
- **Reichenbacher (DUNE)**
- **Gardiner (Event generator)**
- **Lombardi (Borexino)**

Geo-neutrinos
- **Learned (Geo neutrinos)**
- **Lombardi (Borexino)**

Friday

Program

Working Group: Astroparticle physics and cosmology - Pacific Ballroom AB (11:20-12:50)

Dinesh Loomba

time	[id] title	presenter
11:20	[126] DM searches at LHC	Prof. DUTTA, Bhaskar
11:50	[38] Dark Matter Search with the PICO 60 Bubble Chamber	Mr. KRAUSS, Carsten
12:10	[111] Status of the COSINE-100 Experiment	JO, Jay Hyun
12:30	[35] Search for Low Mass Dark Matter with CRESST-III	Dr. WILLERS, Michael

Joint Working Group: Astroparticle and Neutrino Physics - Conference Center (14:20-15:50)

- **Conveners: De Romeri, Valentina**

time	[id] title	presenter
14:20	[19] Fast neutrino flavor conversions near the SN core	Mr. MIRIZZI, Alessandro
14:35	[152] Recent results from the IceCube Neutrino Observatory	Prof. GRANT, Darren
14:50	[64] KM3NeT/ORCA: Measuring neutrino oscillations and the mass hierarchy in the Mediterranean	Mr. BOURRET, Simon
15:05	[125] Neutrino Portal Dark Matter	Dr. MCKEEN, David
15:20	[175] Coherent neutrino-nucleus scattering, dark matter, and Beyond Standard Model physics	DENT, James
15:35	[70] DARWIN: a 50-Ton Liquid Xenon Detector for Dark Matter and Neutrino Physics	Prof. NI, Kaixuan

Topics

DM Direct
- Krauss (PICO)
- Jo (COSINE)
- Willers (CRESST-III)
- Hiraide (XMASS)
- Xiao (PandaX)
- Diglio (Xenon1T)
- Loomba (direction DM)

DM Indirect
- Medici (IceCube)
- Frankiewicz (Super-K)
-

Geo-neutrinos
- Learned (Geo neutrinos)
- Lombardi (Borexino)

Supernova
- Takeuchi (Super-K)
- Li (Juno)
- Reichenbacher (DUNE)
- Gardiner (Event generator)
- Lombardi (Borexino)

DM @ LHC
- Dutta

Astrophysical Neutrinos
- Capone (ANTARES)
- Klein (Radio Detection)
-

My mission

- Summary of the astroparticle physics talks
- In total there were 30 !
- Some of the materials presented in the parallel session have already been highlighted in other plenary talks
- I will focus on those results that have not been shown

Strategy

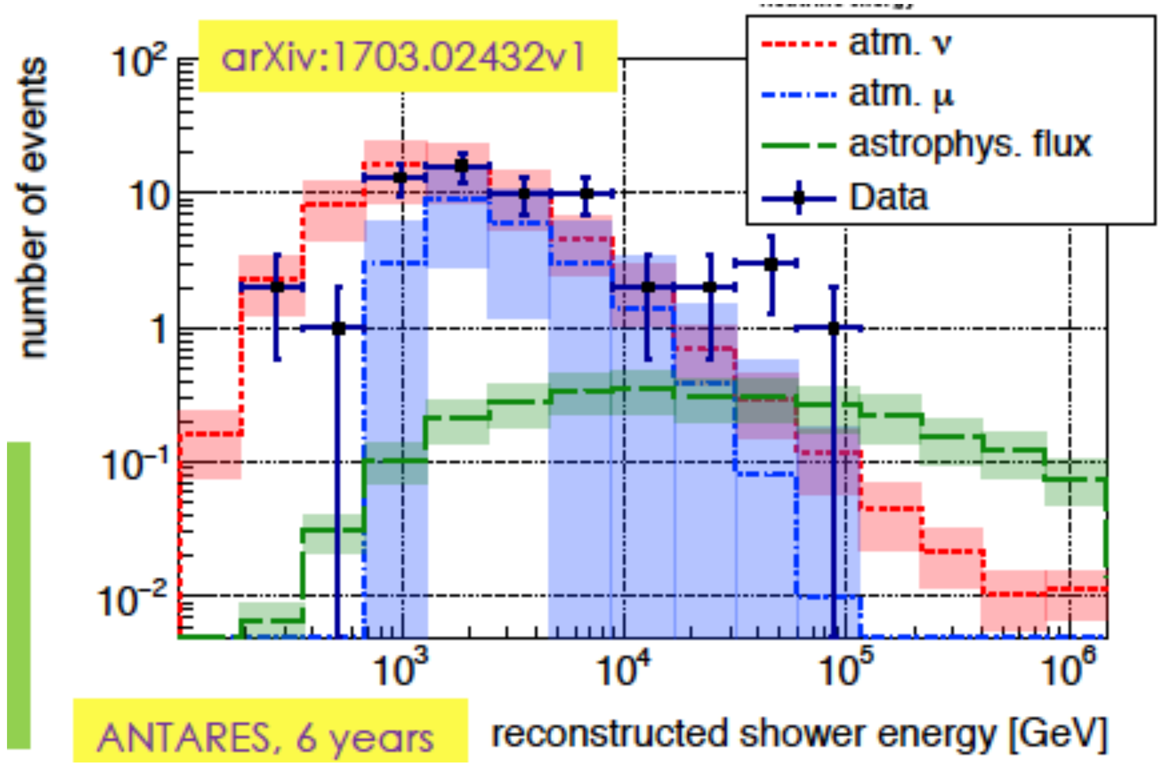
- One slide per talk
  - This serves as reference for future
  - Connect them in consistent story …

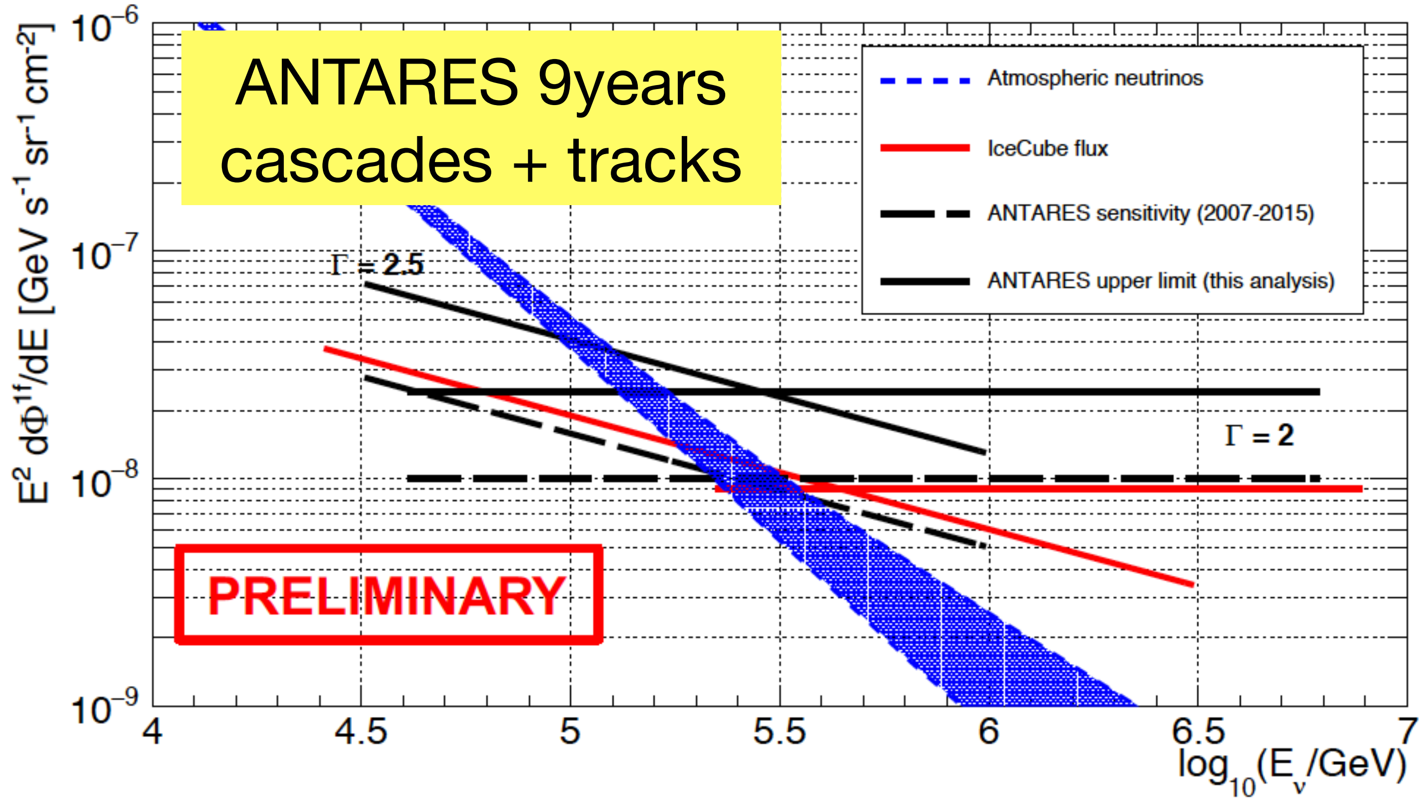
Astrophysical Neutrinos

Recent Results from ANTARES and KM3NeT-ARCA Status report

Antonio Capone

Astrophysical Neutrino Search

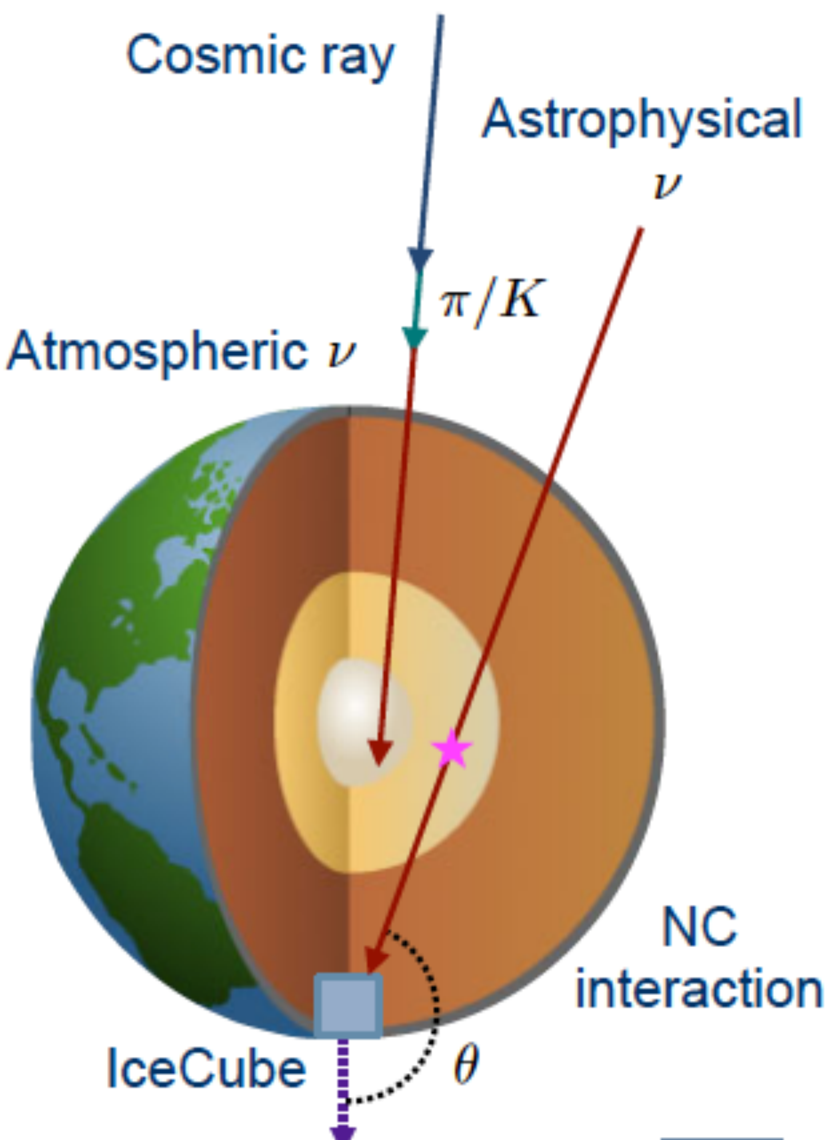


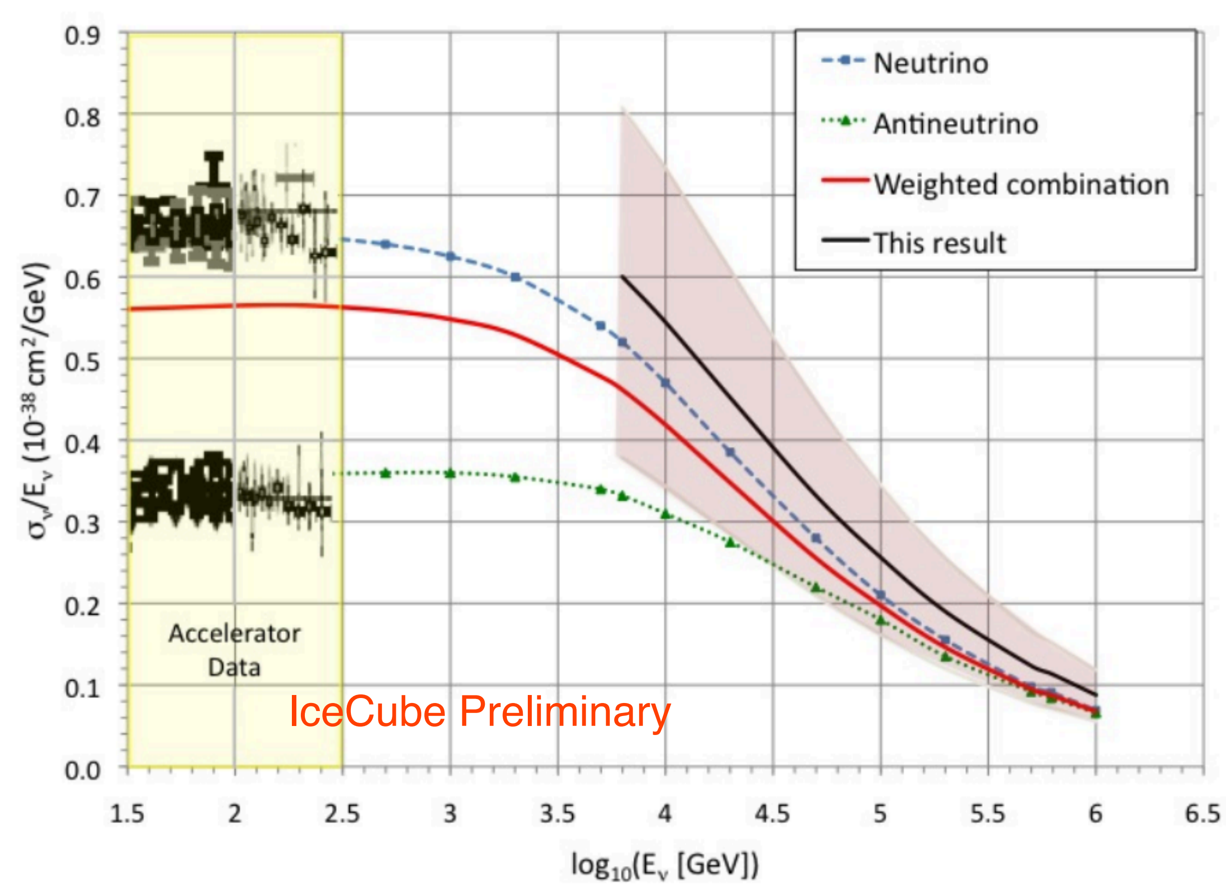


IceCube

Neutrino absorption in the Earth and measurement of the neutrino-nucleon cross-section at multi-TeV energies with IceCube

Gary Binder





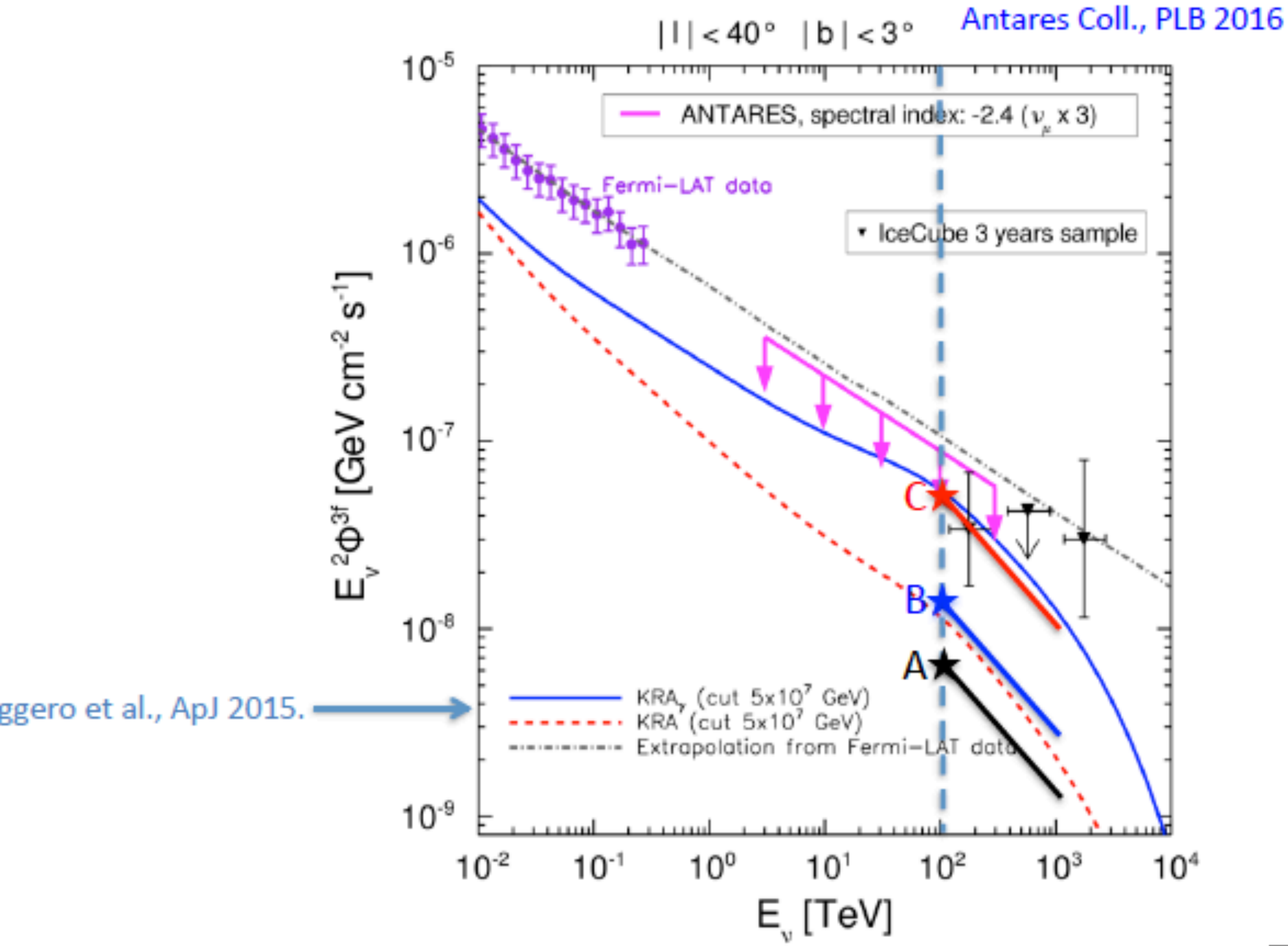
New Result !

High energy diffuse galactic neutrinos for different cosmic ray distributions

F.L.Villante

Consider 3 cases:

- **Case A**: CR flux is homogenous in the Galaxy
- **Case B**: CR flux follows the distribution of Galactic CR sources (SNRs,Pwne)
- **Case C**: CR flux has a spectral index that depends on the galactocentric distance.



The diffuse HE galactic neutrino flux is expected to be subdominant but not necessarily negligible (up to 13% of the total astrophysical signal in our calculations).

See also arXiv:1705.00497 for a more stringent (model-dependent) bound from Antares:

- $\phi_{gal} \leq 1.25\ \phi(KRA\gamma)$ [all sky- nine years analysis tuned on Gaggero et al. predictions]

and preliminary IceCube results:

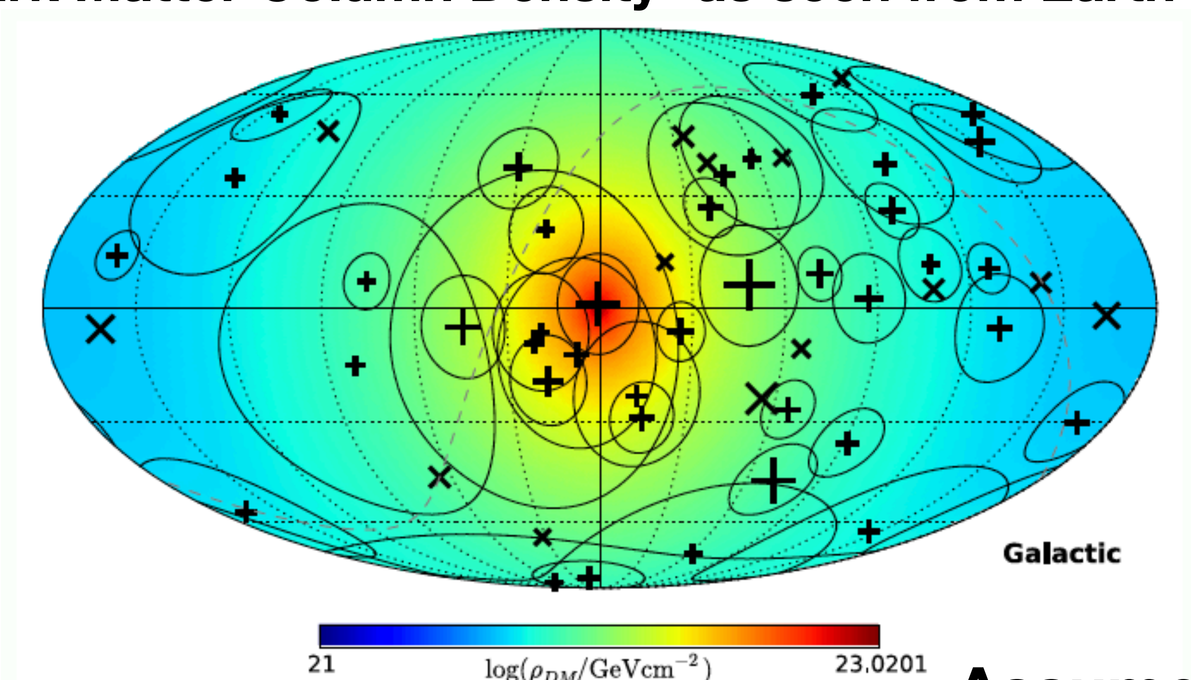
- $\phi_{gal} \leq 1.2\ \phi(KRA\gamma)$ [galactic ν_μ analysis - presented at IPA 2017]

[arXiv:1703.00451]

Ali Kheirandish

Imaging Galactic Dark Matter with IceCube's High-Energy Cosmic Neutrinos

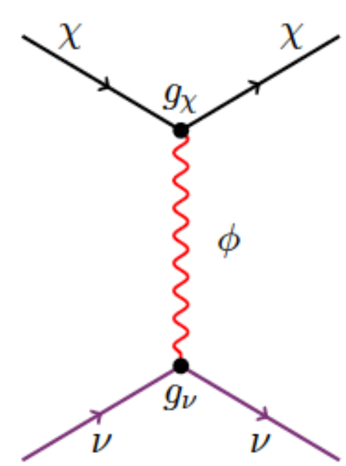
Dark Matter Column Density* as seen from Earth



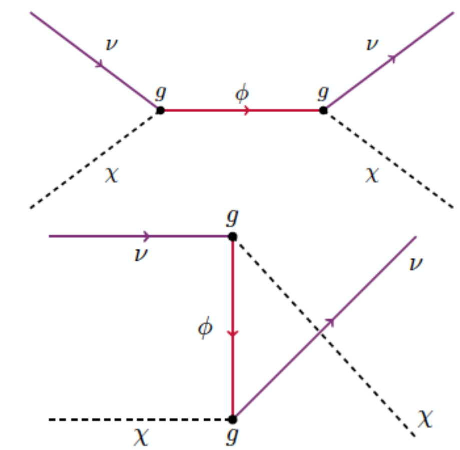
***Einasto Profile**

Dark Matter - Neutrino Interaction

(1) Fermion DM, vector mediator

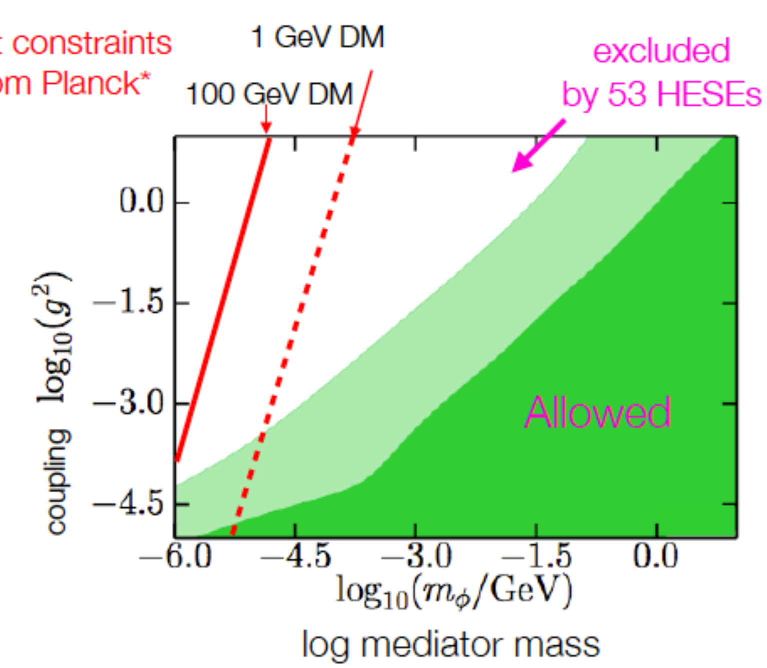


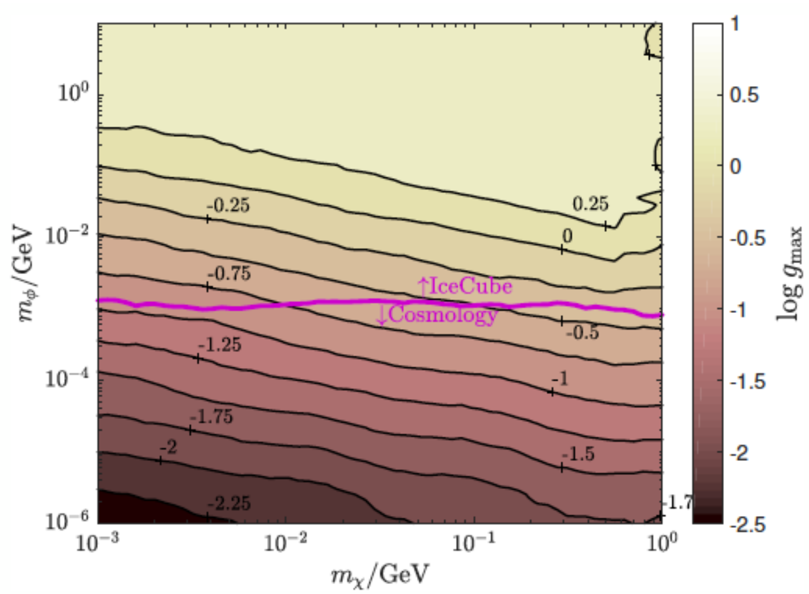
(2) Scale DM, ferminonic mediator

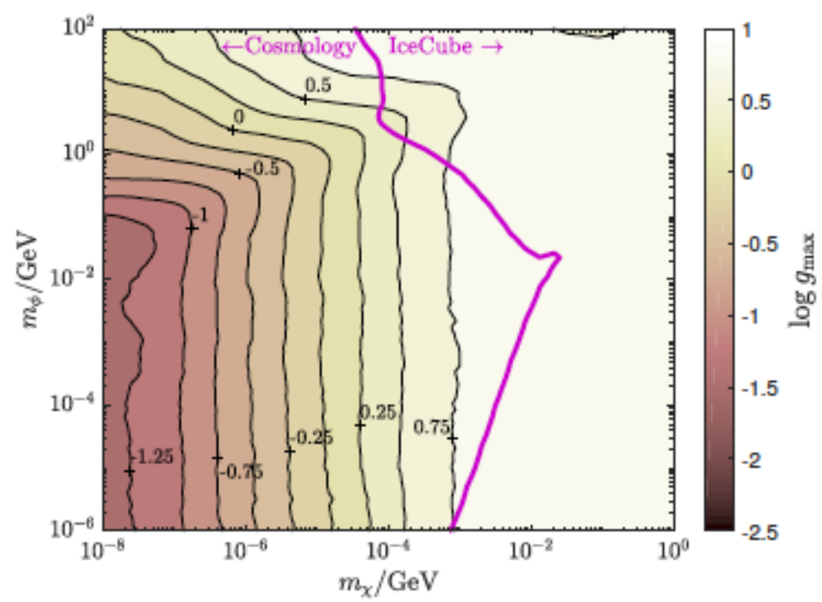


Assume:

$$\sigma_{DM-\nu} \propto E_\nu^2$$







Different techniques for different ν energies

Larger target- antenna separations

Higher $E_{threshold}$

Larger targets

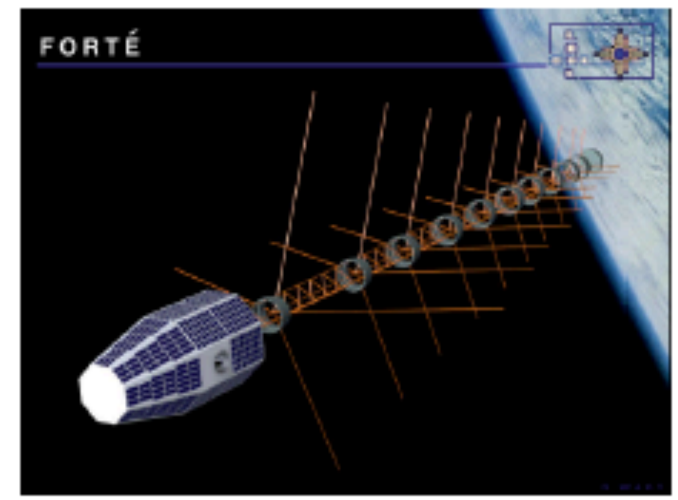
- The Moon -> radiotelescopes
- Greenland -> Satellite
  - FORTE
- Antarctica -> high altitude balloon
  - ANITA
- Antarctica/Greenland-> embedded antennas
  - RICE/ARA/ARIANNA
- Embedded antennas w/ interferometric triggers

New Physics

GZK neutrinos

> PeV ν spectrum

Overall Energy Dynamic range > 10^5

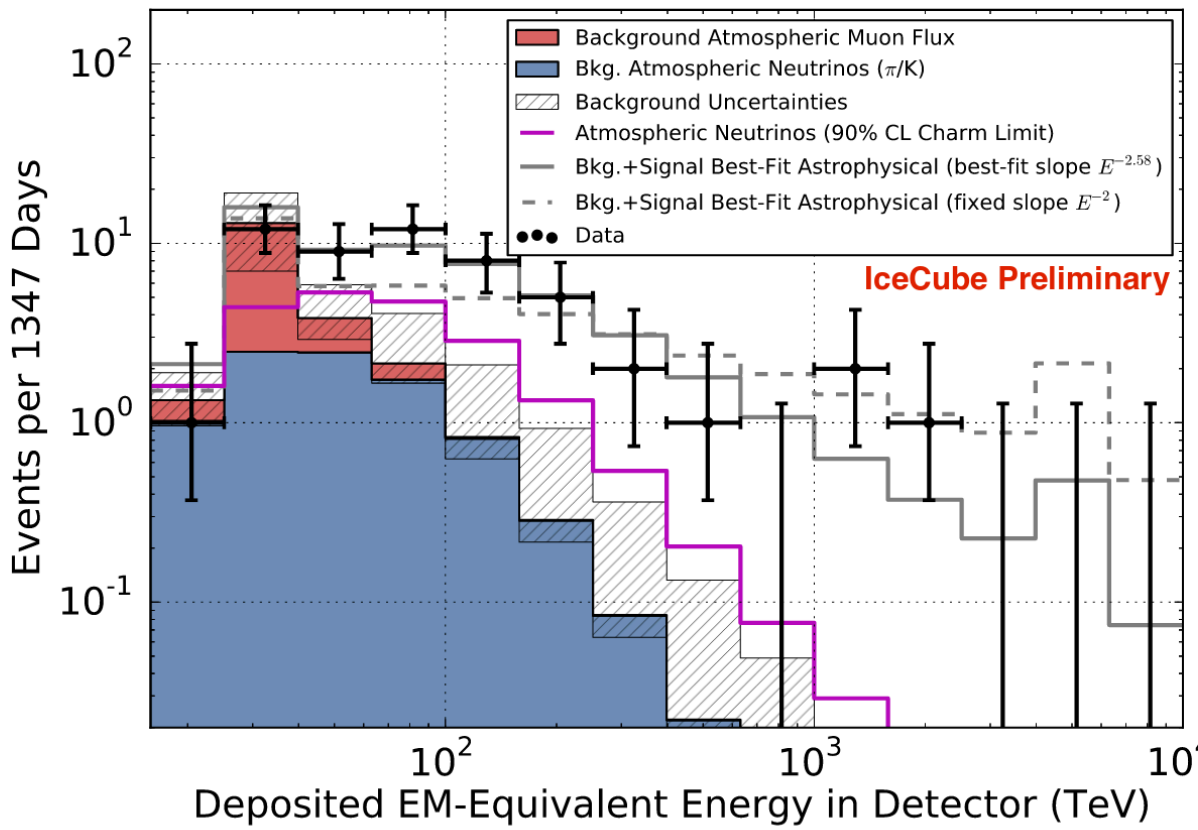


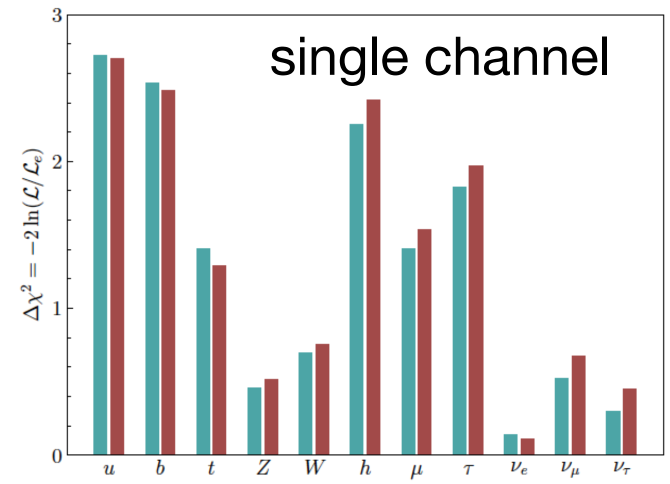
Indirect Dark Matter

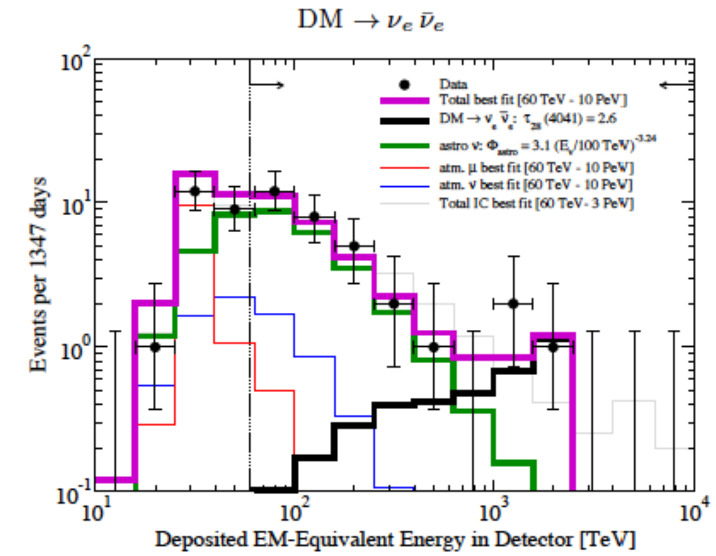
Atri Bhattacharya, Arman Esmaili, Sergio Palomares-Ruiz and Ina Sarcevic, arXiv: 1706.05746

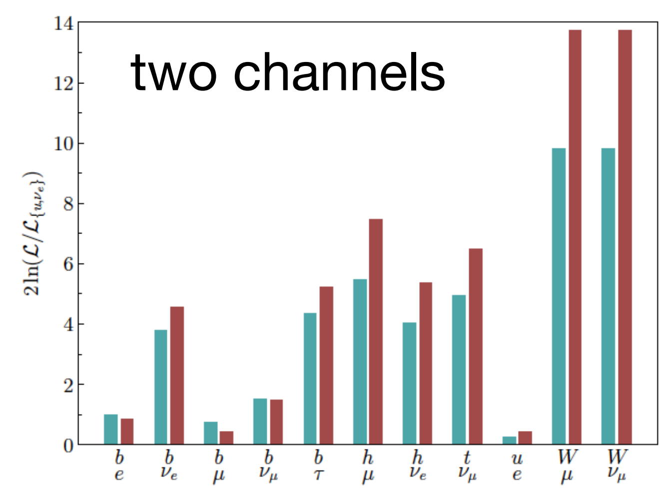
Probing Decaying Heavy Dark Matter with 4-year IceCube HESE data

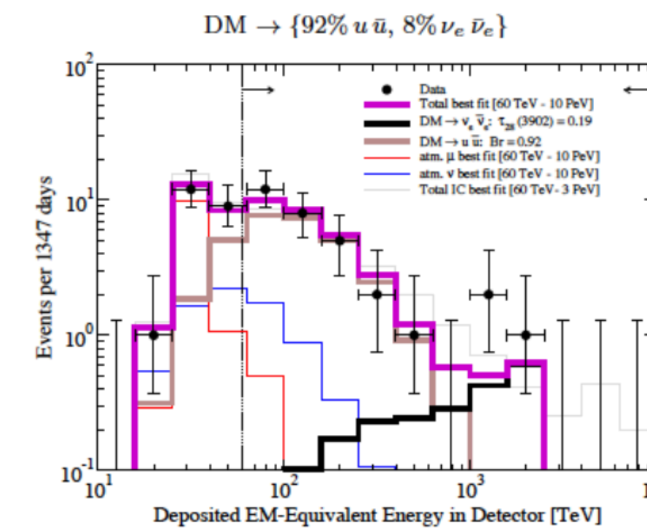
Ina Sarcevic











Could the observed neutrino flux be due to only dark matter decaying into multiple channels?

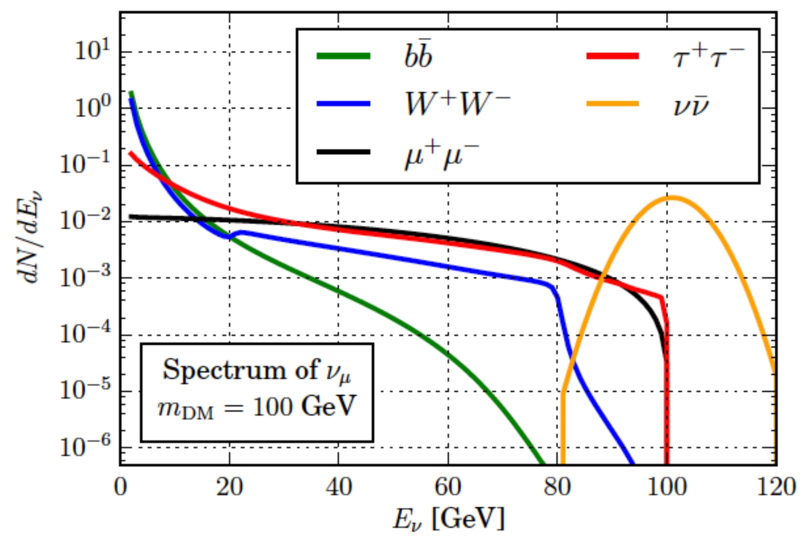
$$\frac{d\Phi_{\mathrm{DM},\nu_\alpha}}{dE_\nu} = \frac{d\Phi_{\mathrm{G},\nu_\alpha}}{dE_\nu} + \frac{d\Phi_{\mathrm{EG},\nu_\alpha}}{dE_\nu}$$

Take Galactic and Extra galactic contributions into account

- Consider DM decay into two channels, one that would describe low energy data and the other high energy (PeV) events
- We find that HESE data can be best described with the combination of the astrophysical neutrino flux and the dark matter decay
- Best fit values for DM mass and lifetime depend on the channel, for DM decay into leptons, DM mass is of the order of several PeV, describing PeV events, while astrophysical flux describes lower energy flux
- DM decay into bb is disfavored

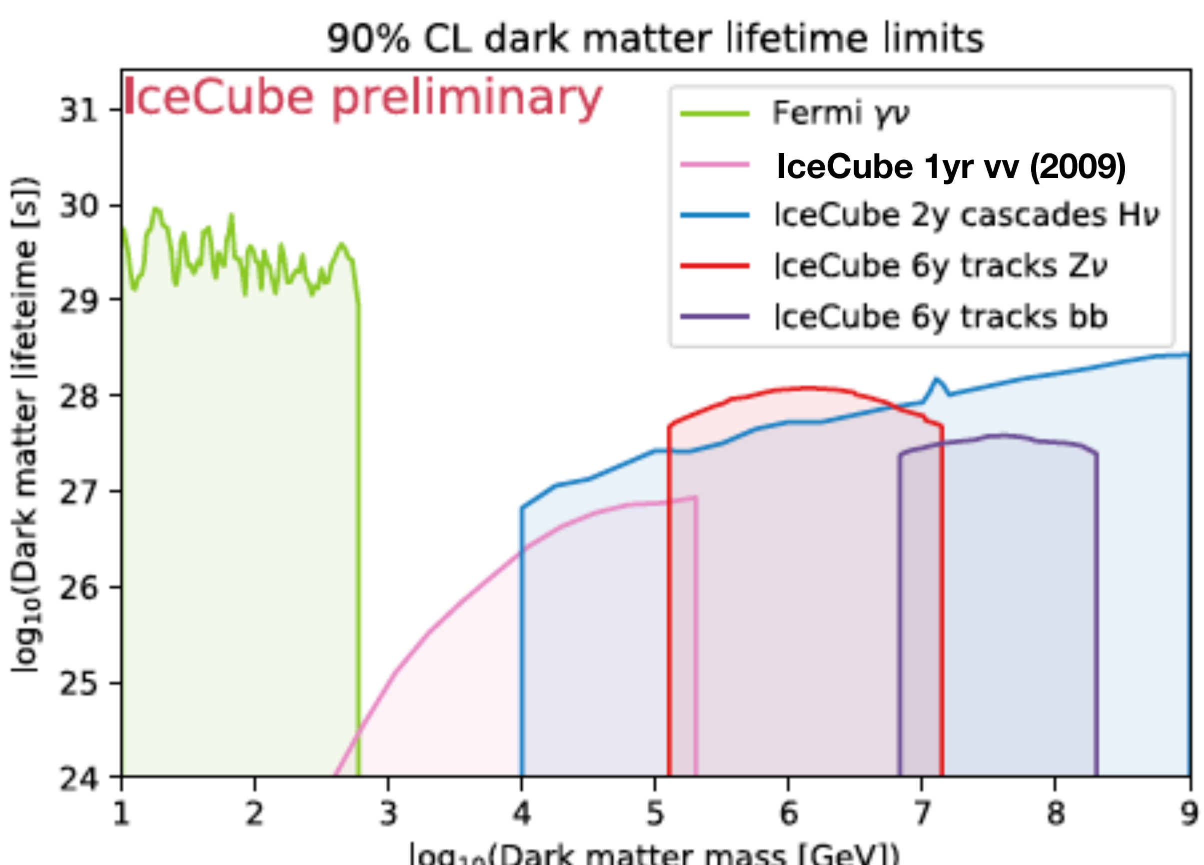
INDIRECT DARK MATTER SEARCHES IN ICECUBE

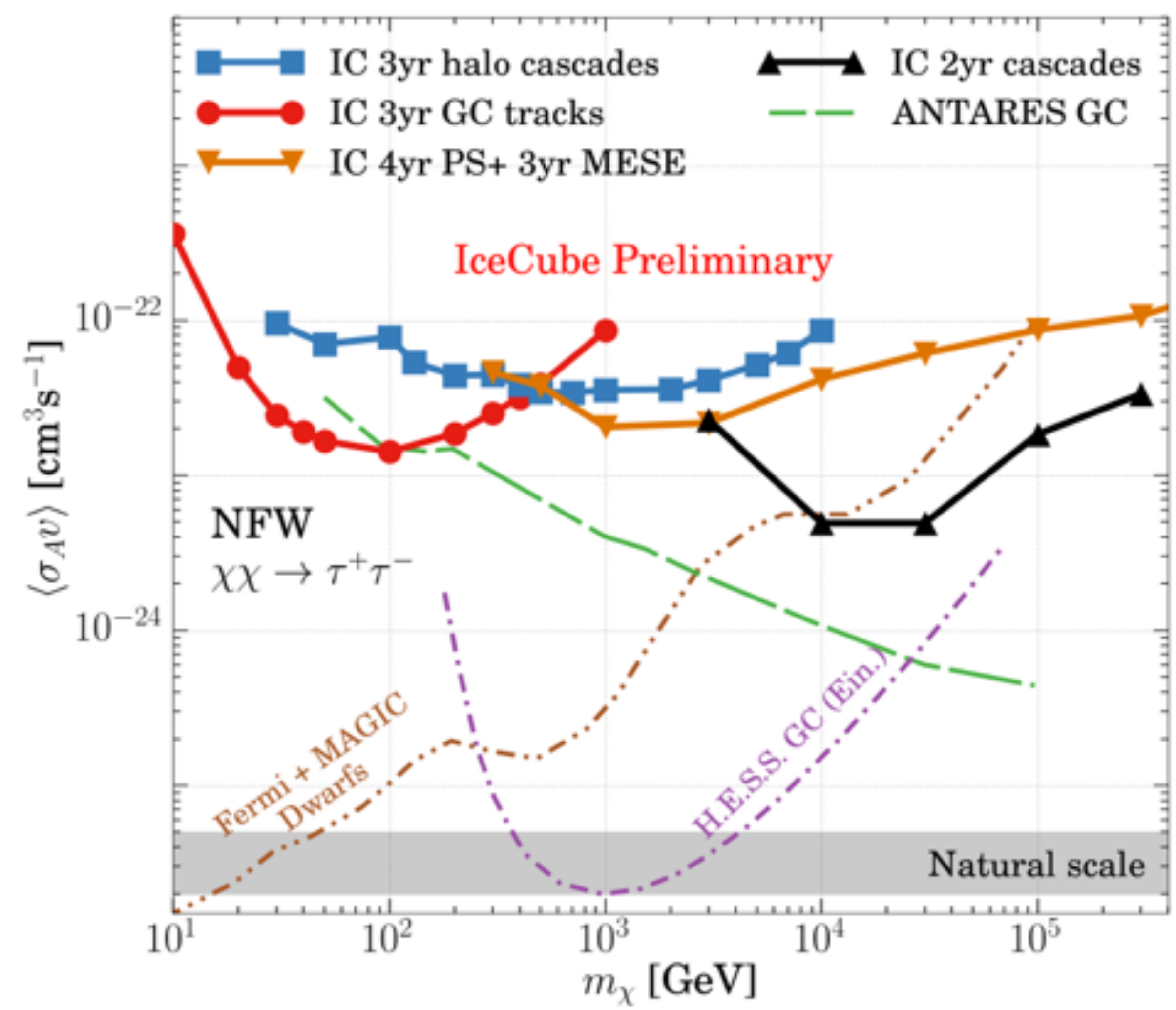
Morten Medici



Galactic Halo DM annihilation searches cover 10 GeV - 300 TeV Dark Matter masses with 3 analyses:

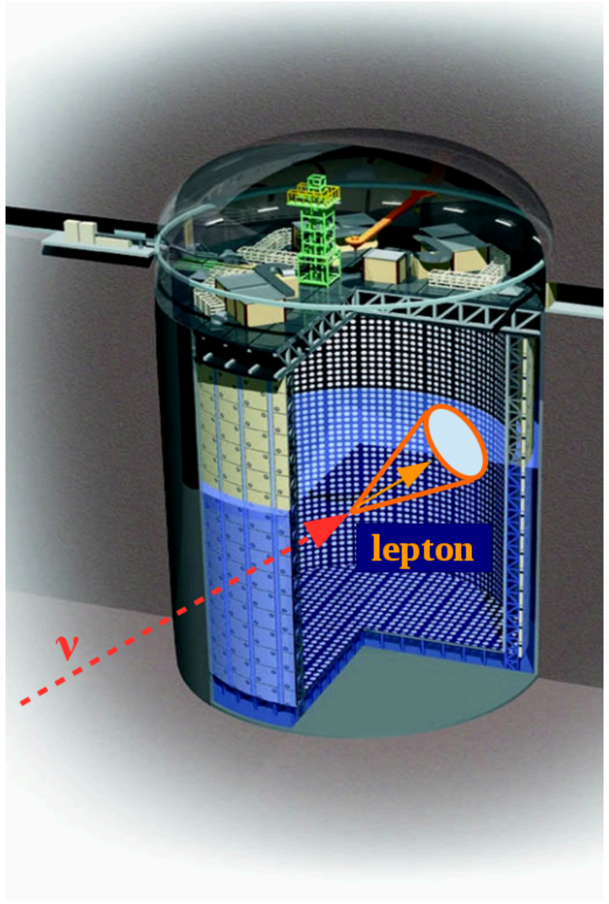
- Galactic Halo Cascades 2yrs
- Galactic Center Tracks 7yrs (NEW)
- Galactic Center Track 3yrs (low-energy)
  - IceCube [arXiv:1705.08103]

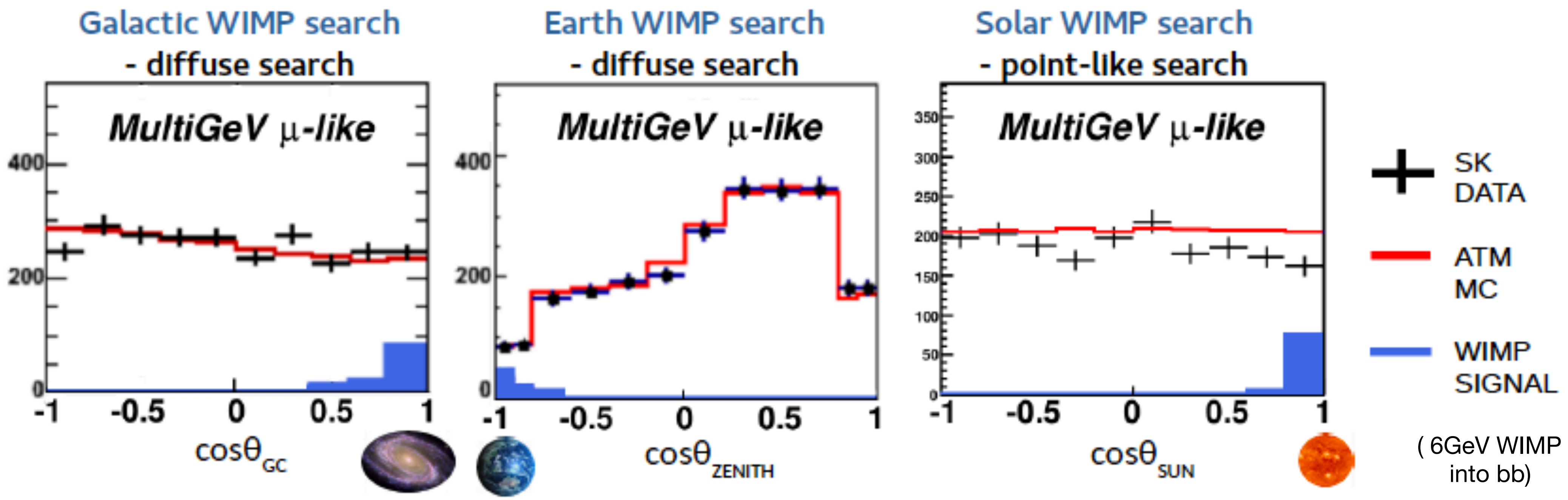


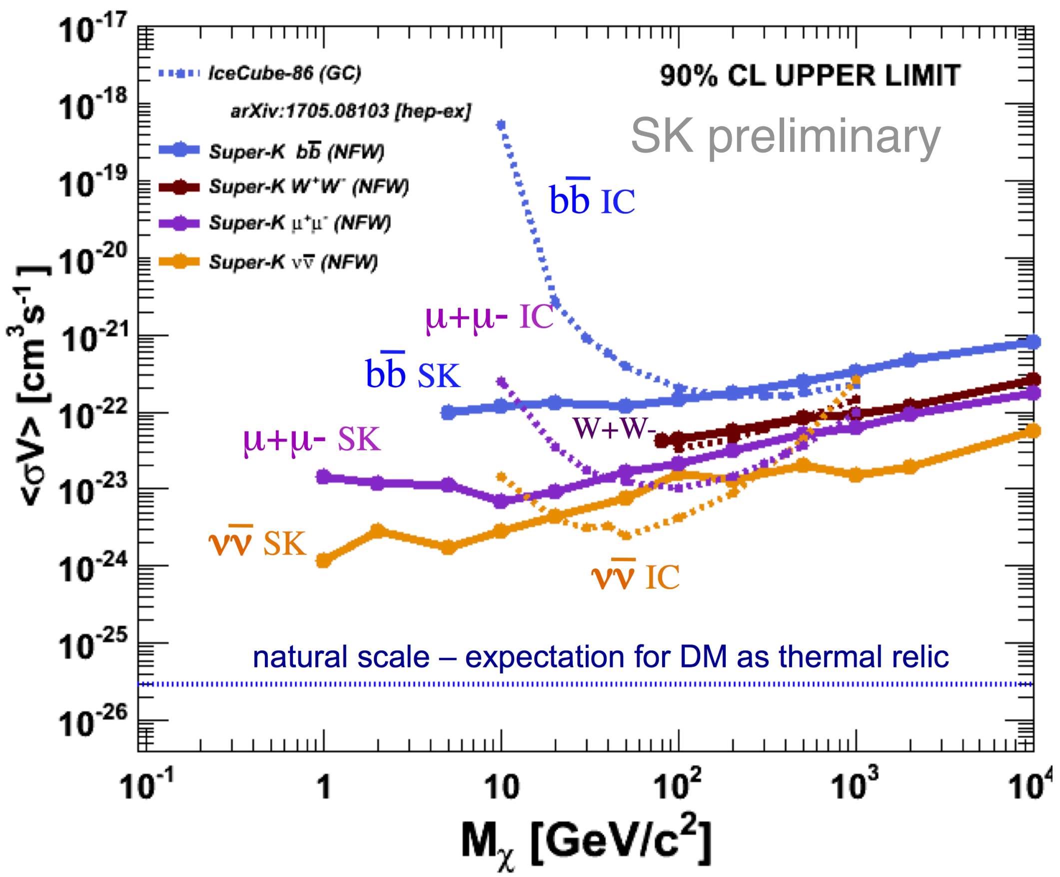


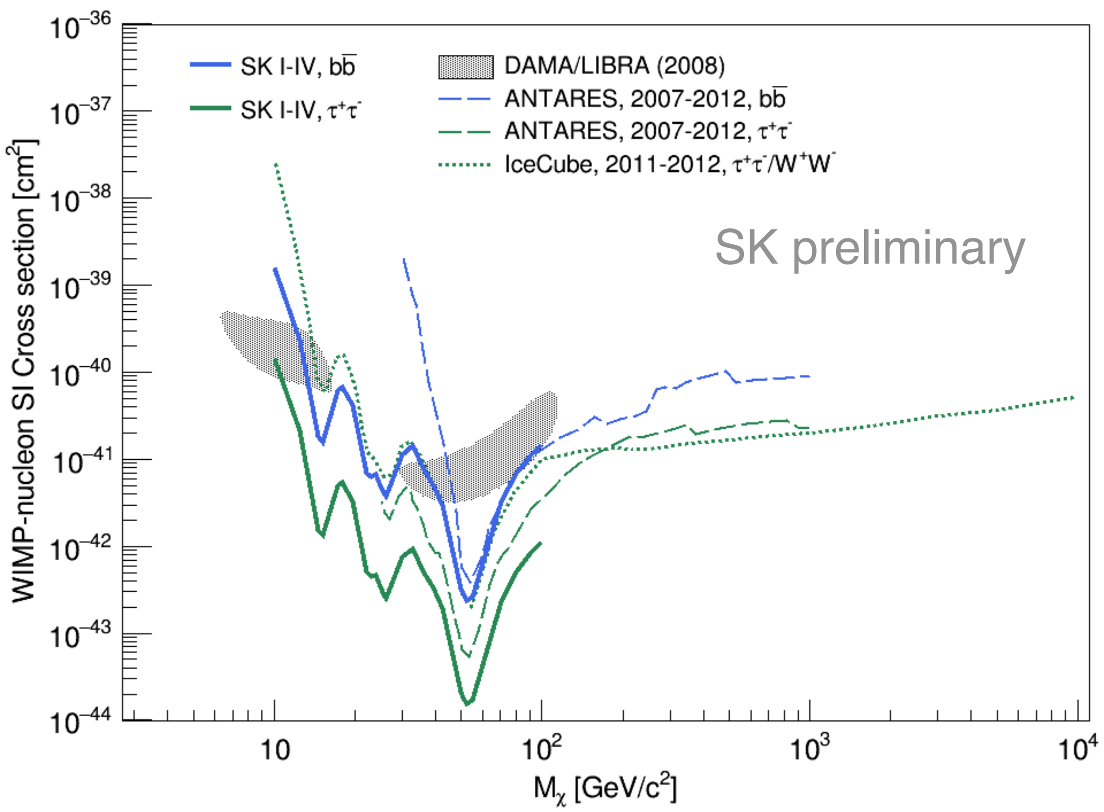
Dark matter searches with the Super-Kamiokande detector

K. Frankiewicz





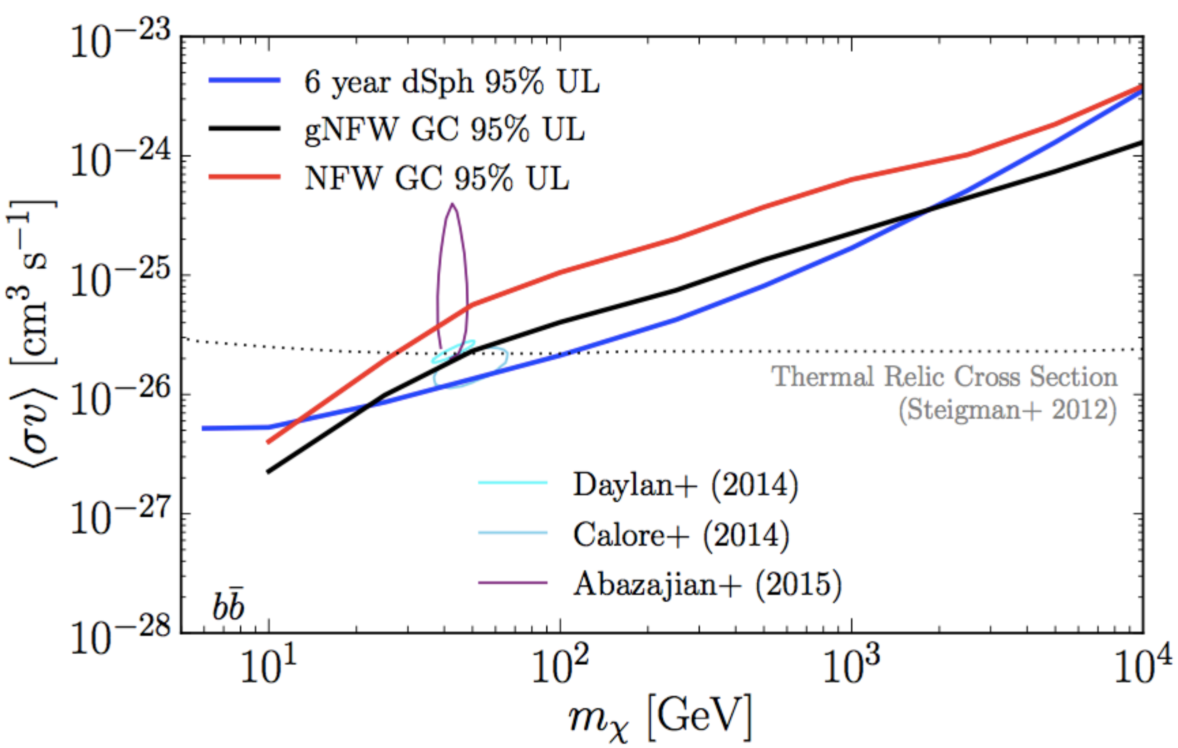


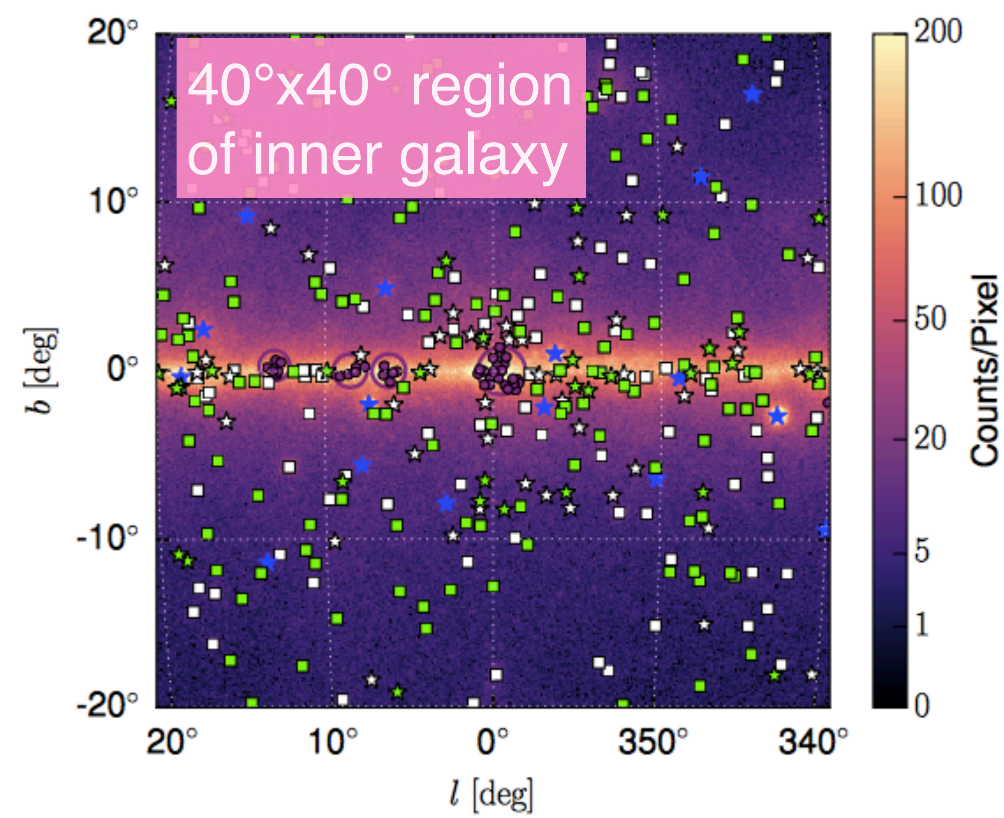


Dark Matter Searches with Fermi-LAT

R. Caputo

What's going on in the Galactic Center?

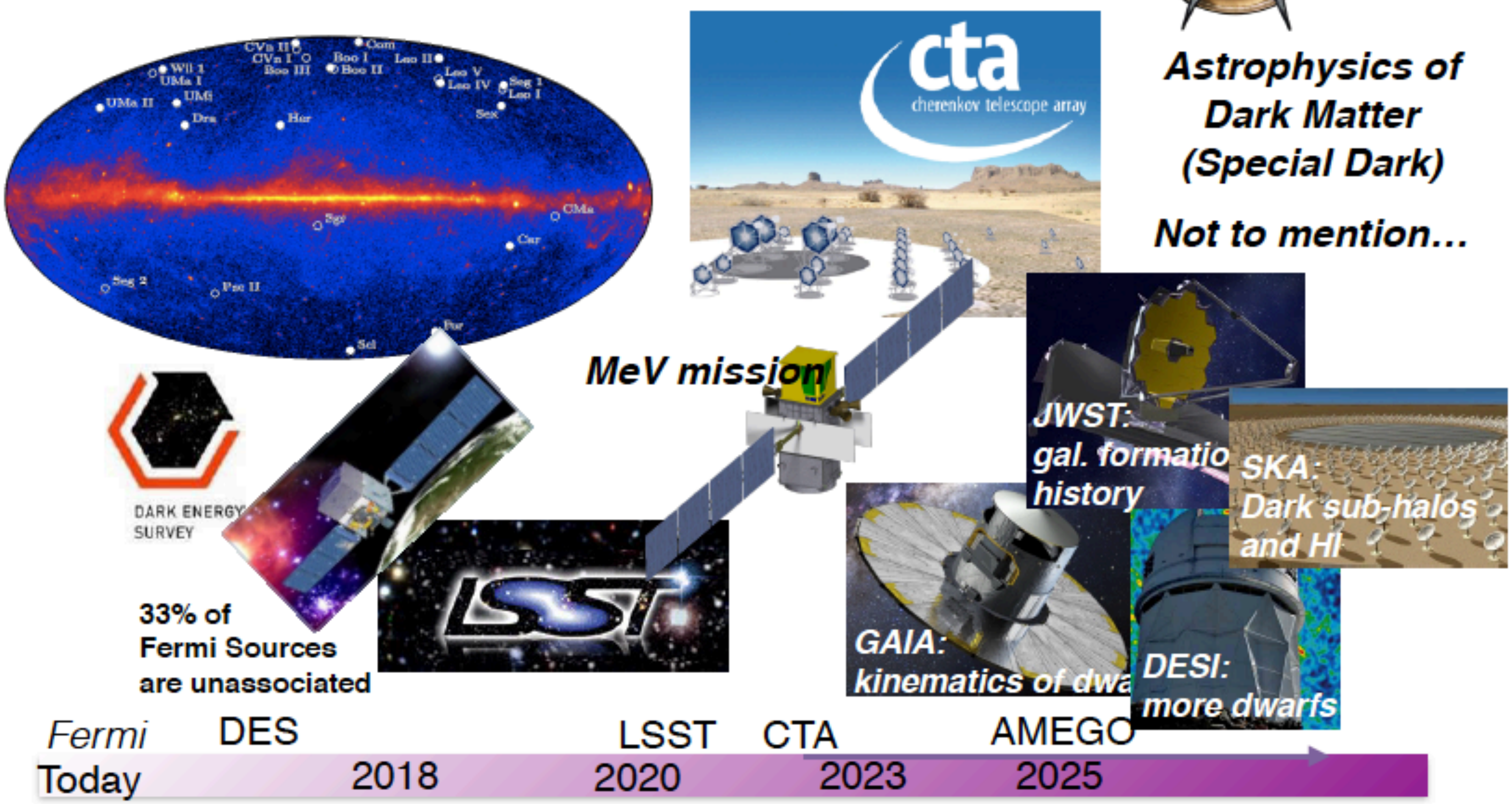




Current campaigns to identify pulsars near the Galactic Center

R. Caputo

The Next Generation...

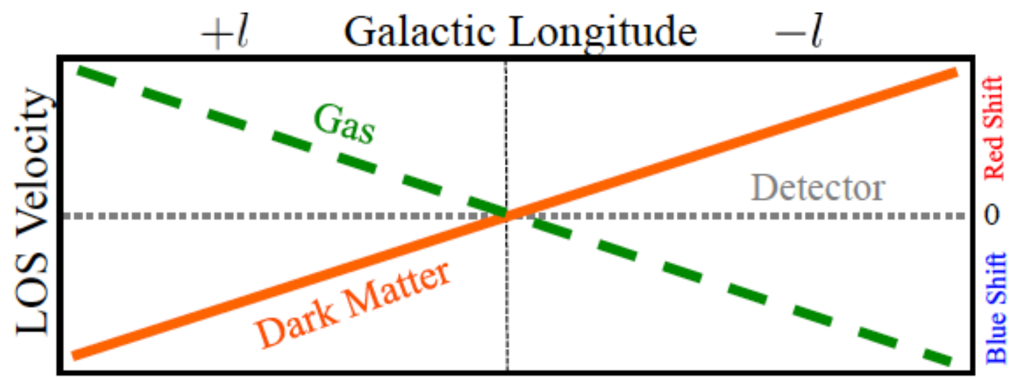


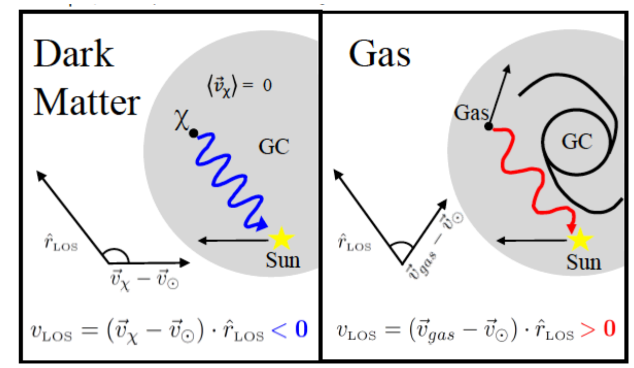
Dark matter velocity spectroscopy

Ranjan Laha

- Dark matter halo has little angular momentum

Bett, Eke, etal., "The angular momentum of cold dark matter haloes with and without baryons"; Kimm etal., "The angular momentum of baryons and dark matter revisited"





- Sun moves at ~220 km/s

Instruments with $\sim \mathcal{O}(0.1)\%$ energy resolution

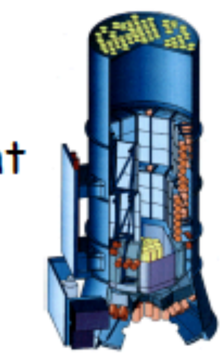
- Distinct longitudinal dependence of signal

Past

Hitomi/ Astro-H

$$\frac{\sigma_E}{E} \approx \frac{1.7\,\mathrm{eV}}{3.5\,\mathrm{keV}}$$

Present



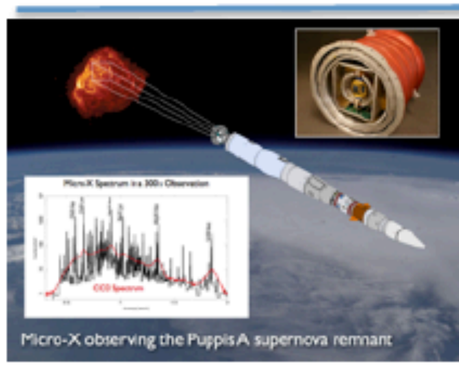
INTEGRAL/ SPI

2.2 keV (FWHM) at 1.33 MeV

http://www.cosmos.esa.int/web/integral/instruments-spi

Future

- Doppler effect



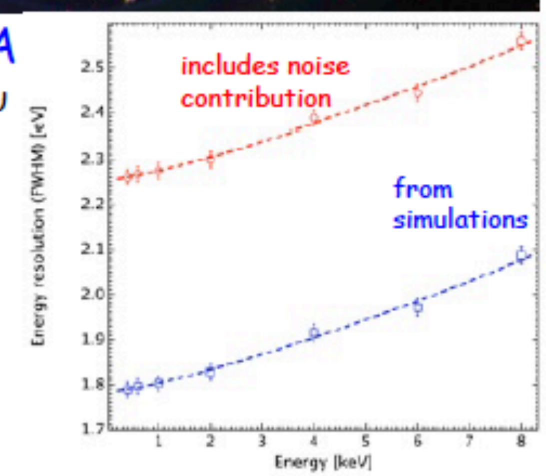
Micro-X

FWHM of 3 eV at 3.5 keV

Figueroa-Feliciano etal. 2015

ATHENA

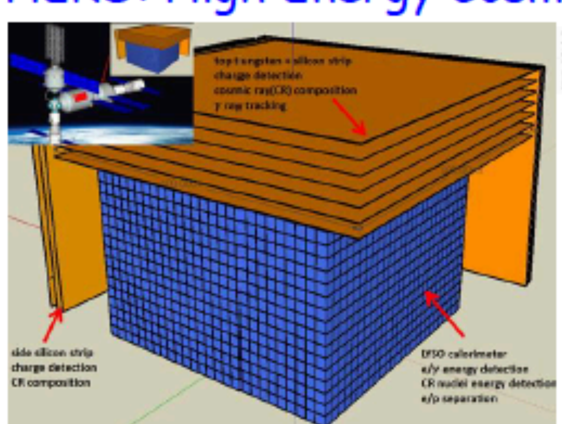
ATHENA X-IFU 1608.08105

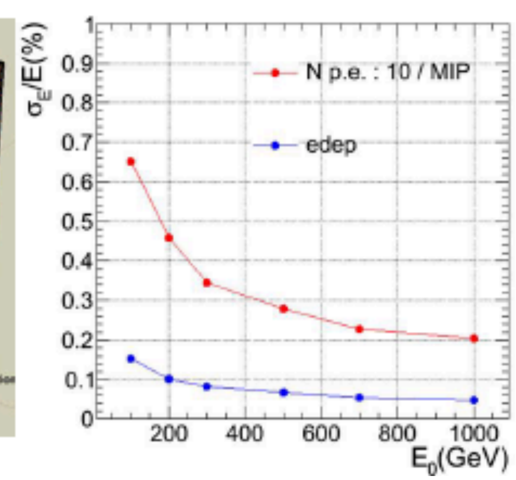


Dark matter velocity spectroscopy is a promising tool to distinguish signal and background in dark matter indirect detection

- We see smoking gun in motion
- Immediate application to the 3.5 keV line
- Future improvements in the energy resolution of telescopes at various energies will result in this technique being widely adopted

HERD: High Energy Cosmic Radiation Detection





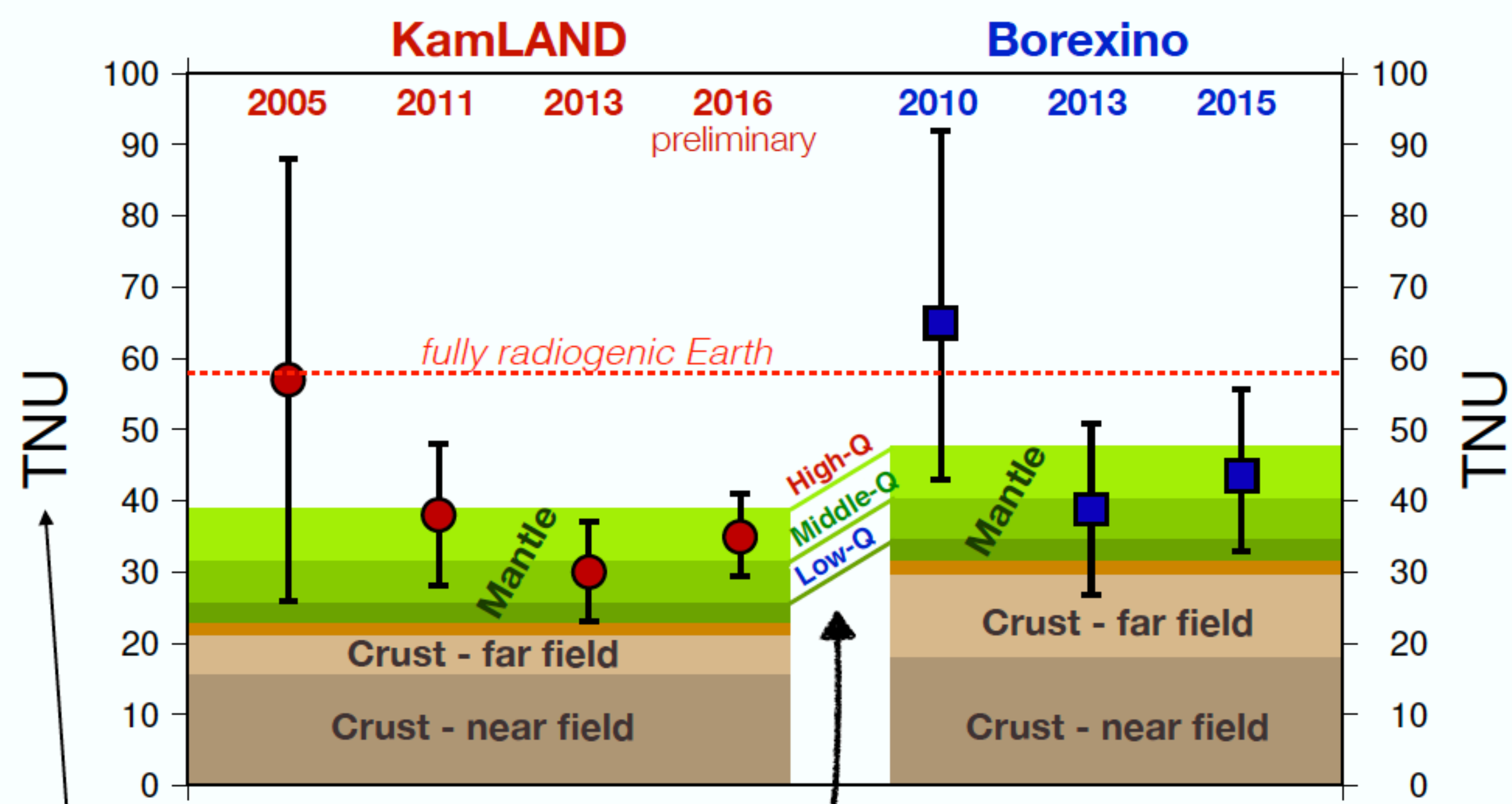
Energy resolution for electrons and gamma will be < 1% at 200 GeV

Wang & Xu Progress of the HERD detector

Geo and Solar Neutrinos

Looking Inward with Neutrinos

John Learned

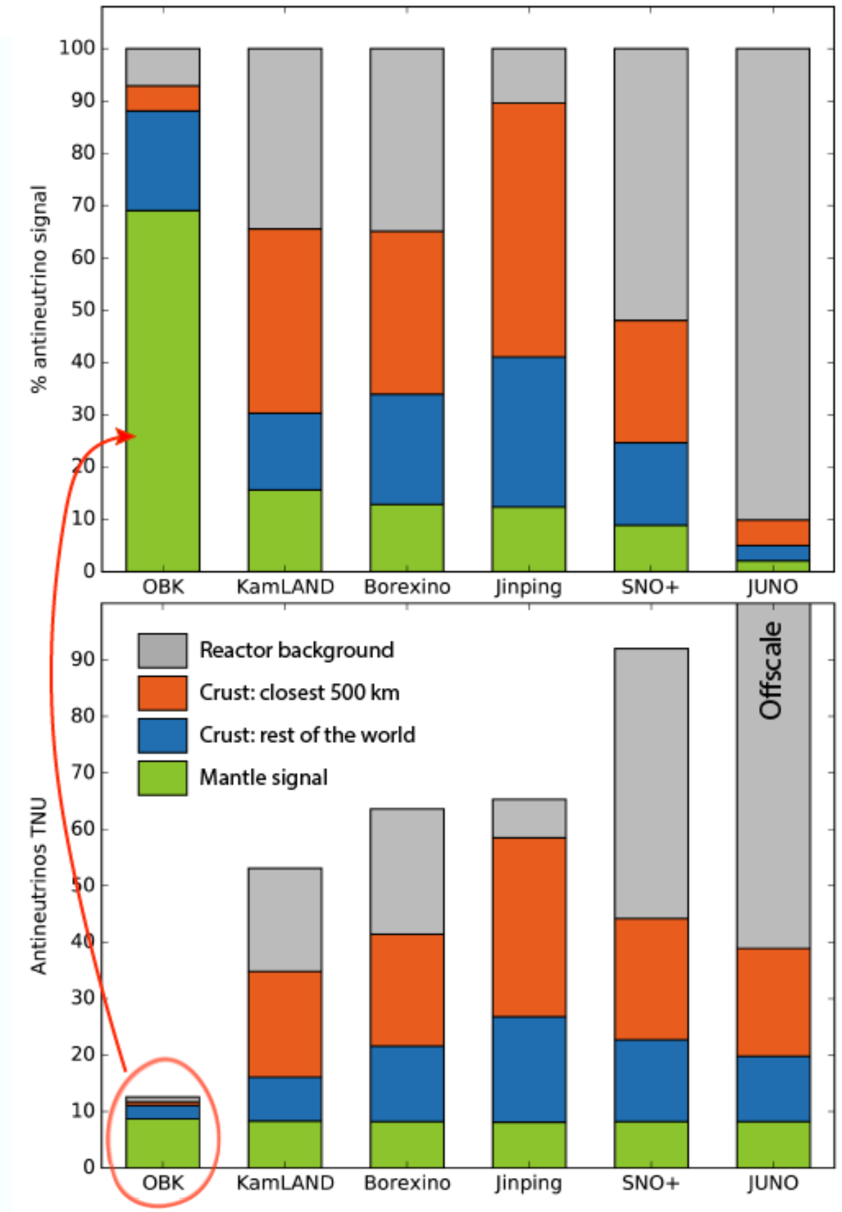


1 TNU (Terrestrial Neutrino Unit) = 1 event over a year-long exposure of 10^{32} protons

Silicate Earth models:

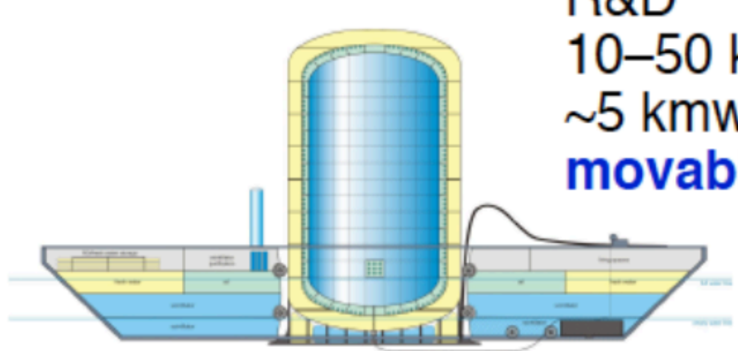
- High-Q: ~30 TW radiogenic power
- Middle-Q: ~20 TW
- Low-Q: ~10 TW

modified from McDonough & Šrámek 2014
doi:10.1007/s12665-014-3133-9



Ocean Bottom KamLAND

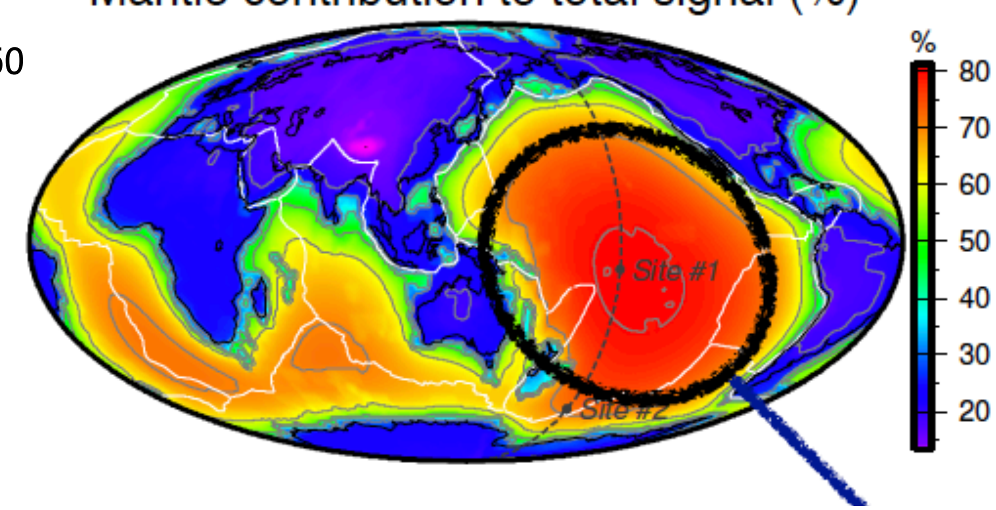
R&D
10–50 kt
~5 kmwe
movable



OBK Requirements*

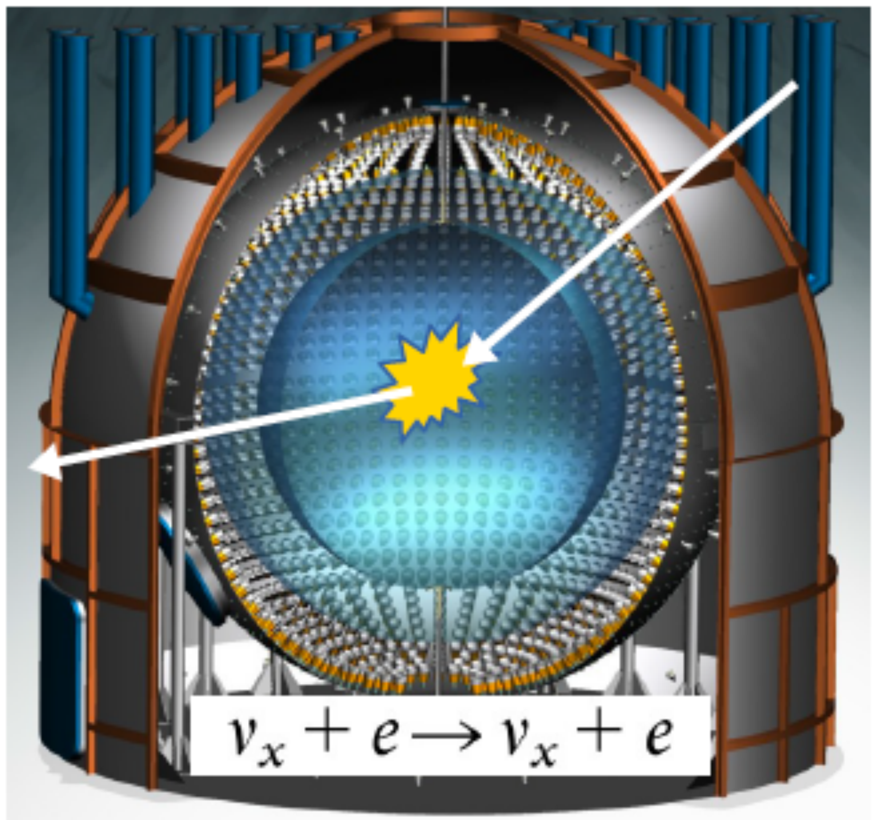
- Deep ocean neutrino detector 10-50 kT
- Filled with ultra pure liquid scintillator
- Viewed by many photodetectors (~10,0000)
- Moveable to various ~5km deep locations
- Service-able
- Shore cable for power & communications

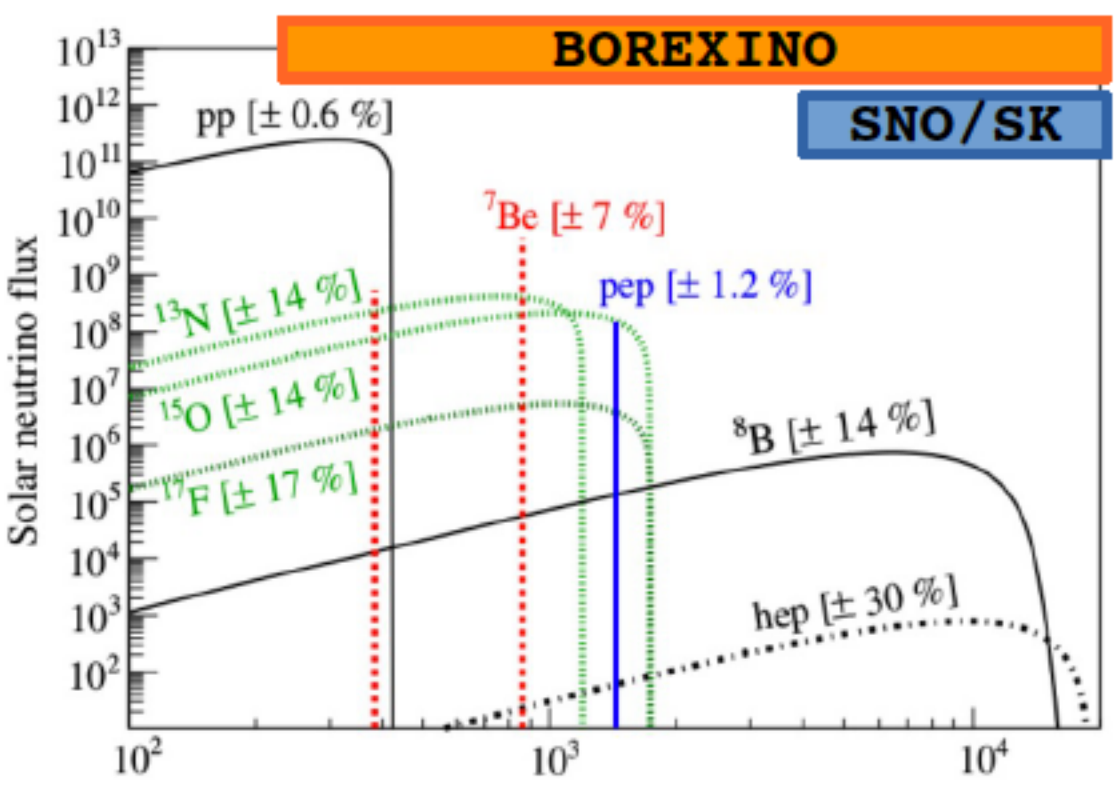
Mantle contribution to total signal (%)



Results from Borexino on Solar and Geo-Neutrino

Francesco Lombardi



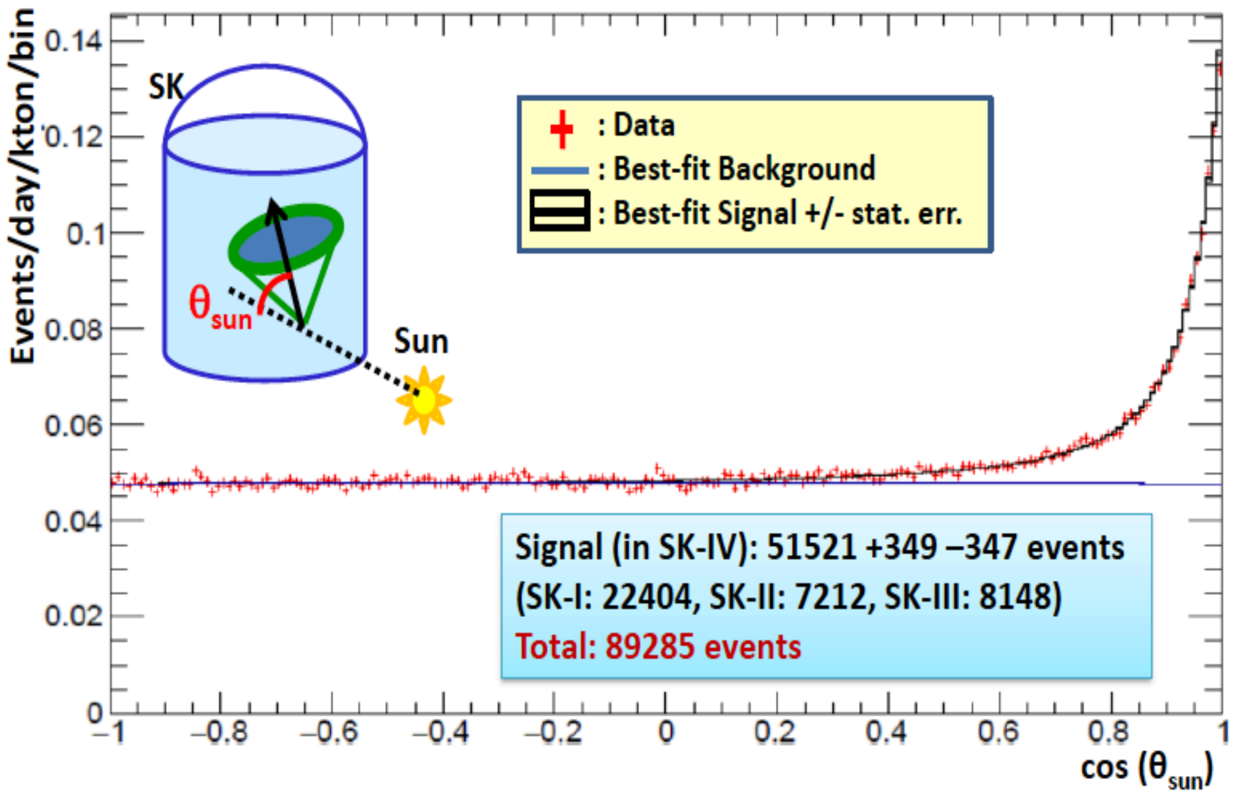


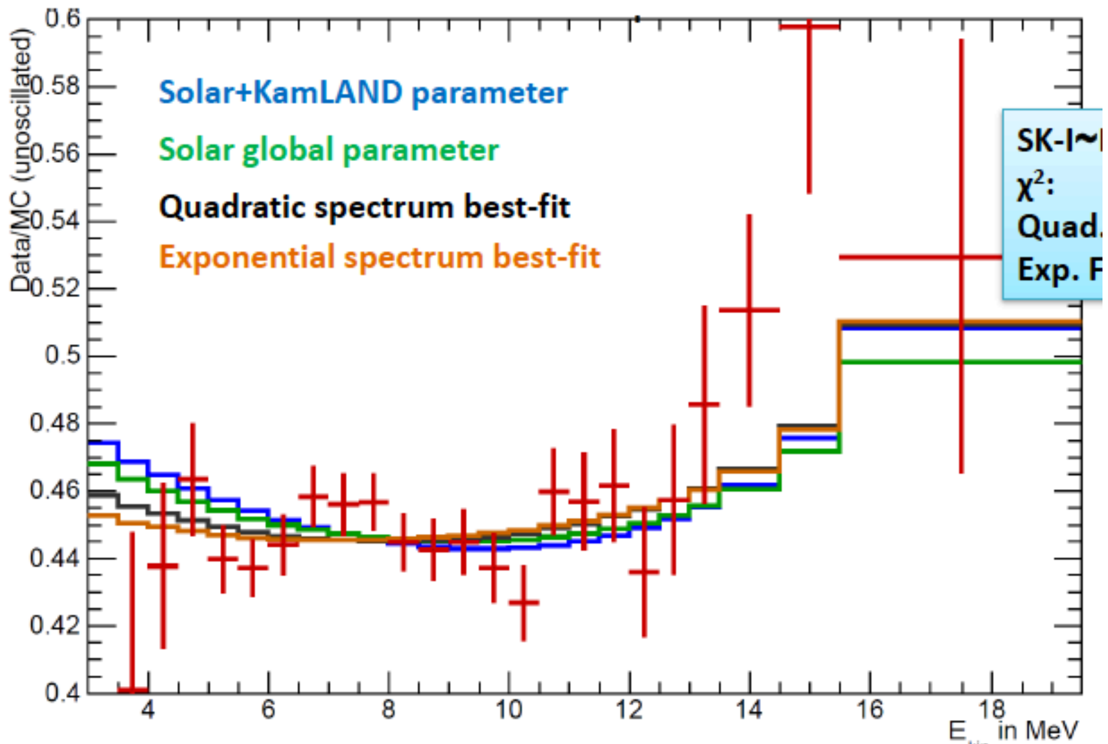
Neutrinos	$R(\nu)$ [cpd/100 ton]	
^7Be	46.0	±1.5 (stat) $^{+1.5}_{-1.6}$(sys)
^8B(3 -16 MeV)	0.22	±0.04(stat)±0.01(sys)
pep	3.1	±0.6(stat)±0.3(sys)
$CNO(limit)$	< 7.9	–
pp	144	±13(stat)±10(sys)

Neutrinos	$\Phi(\nu)$ $[cm^{-2}s^{-1}]$	
^7Be $(\times10^9)$	2.79	±0.13
^8B $(\times10^6)$	2.4	±0.4(stat)±0.1(sys)
pep $(\times10^8)$	1.6	±0.3
CNO $(\times10^8)$	< 7.7	95% C.L.
pp $(\times10^{10})$	6.6	±0.7

Astrophysical Neutrinos at Super-Kamiokande

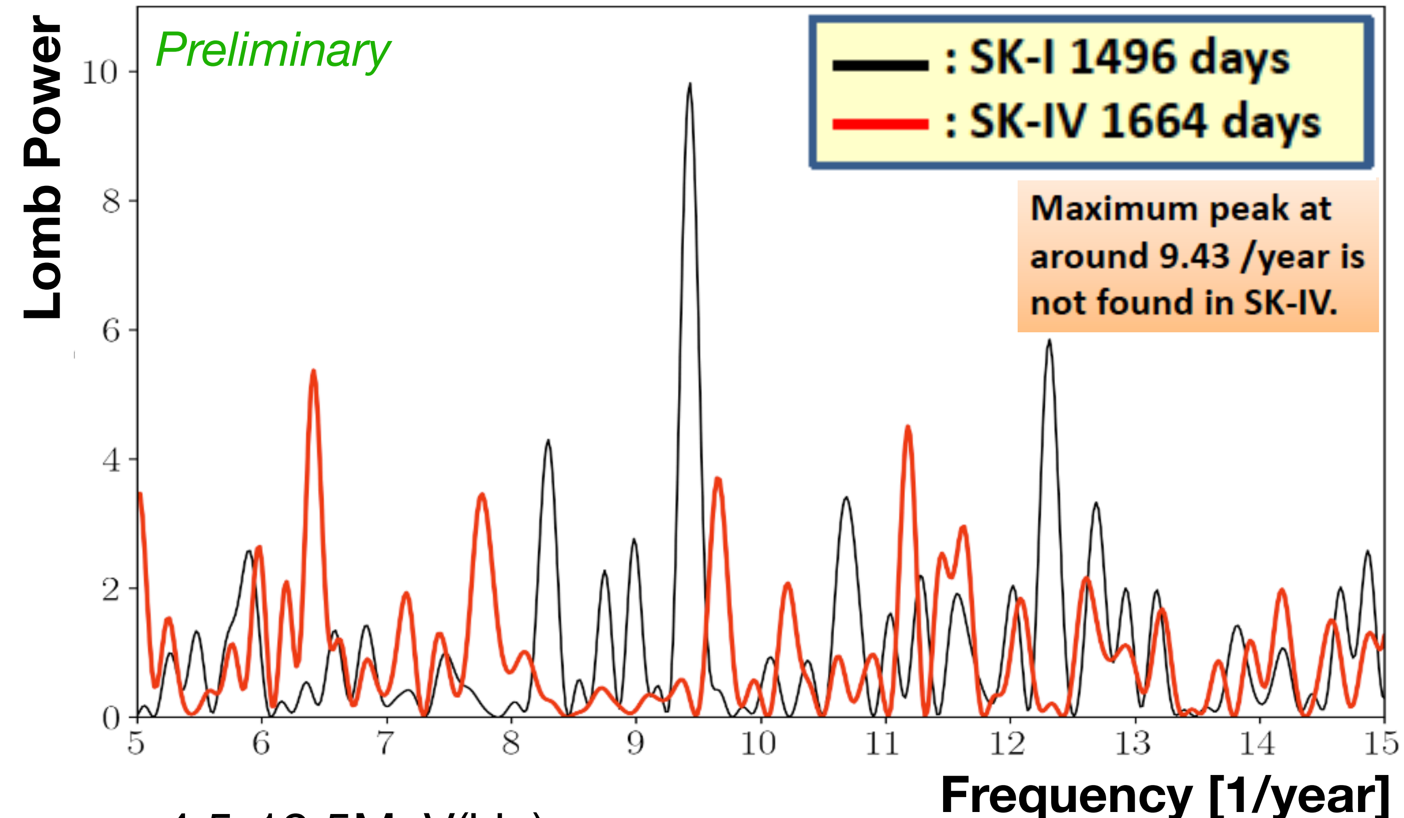
Yasuo Takeuchi



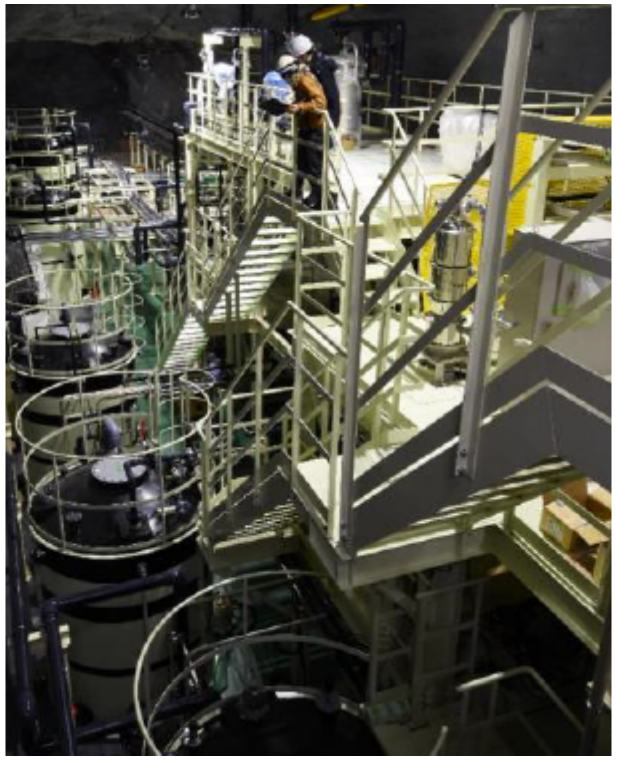


SK spectrum is consistent within ~1 sigma with the MSW upturn for the solar best fit parameters, and marginally consistent within ~2 sigma with the MSW upturn for the solar+KamLAND best fit parameters.

Periodic Modulation Analysis in SK-IV



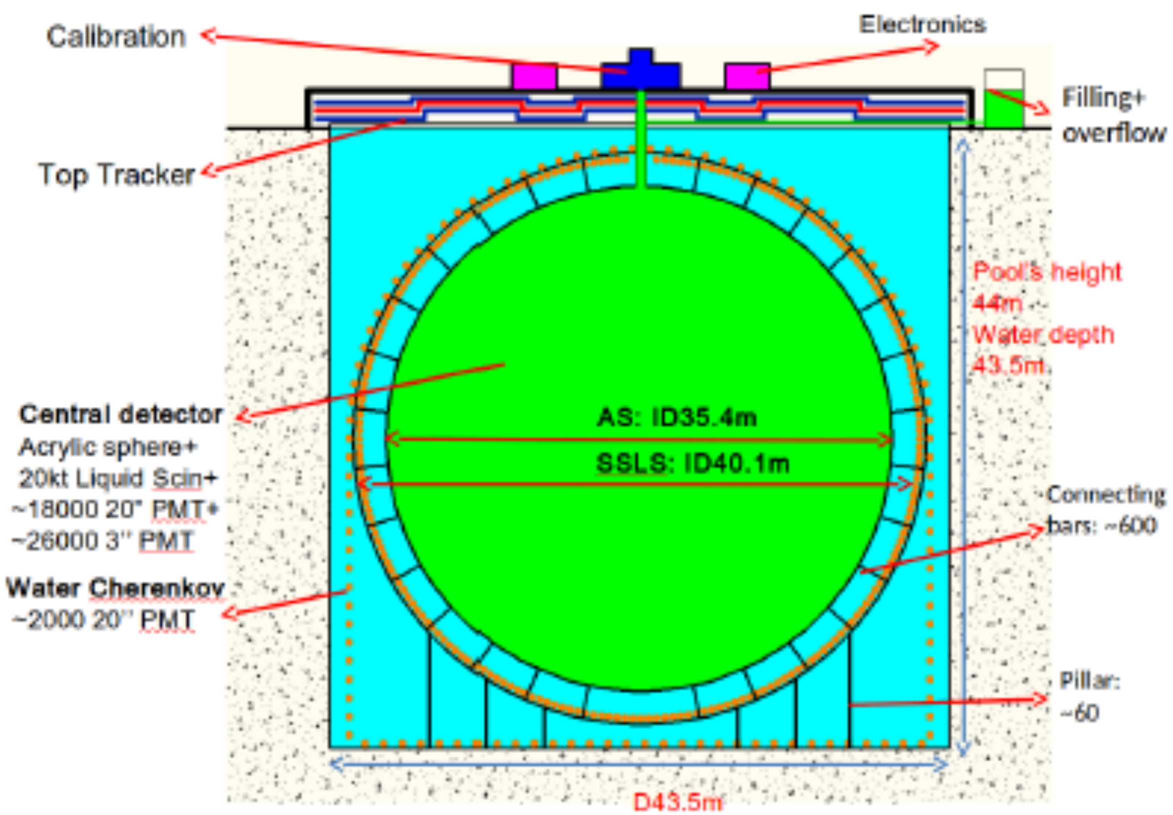
- 4.5-19.5MeV(kin)
- 5-day long samples

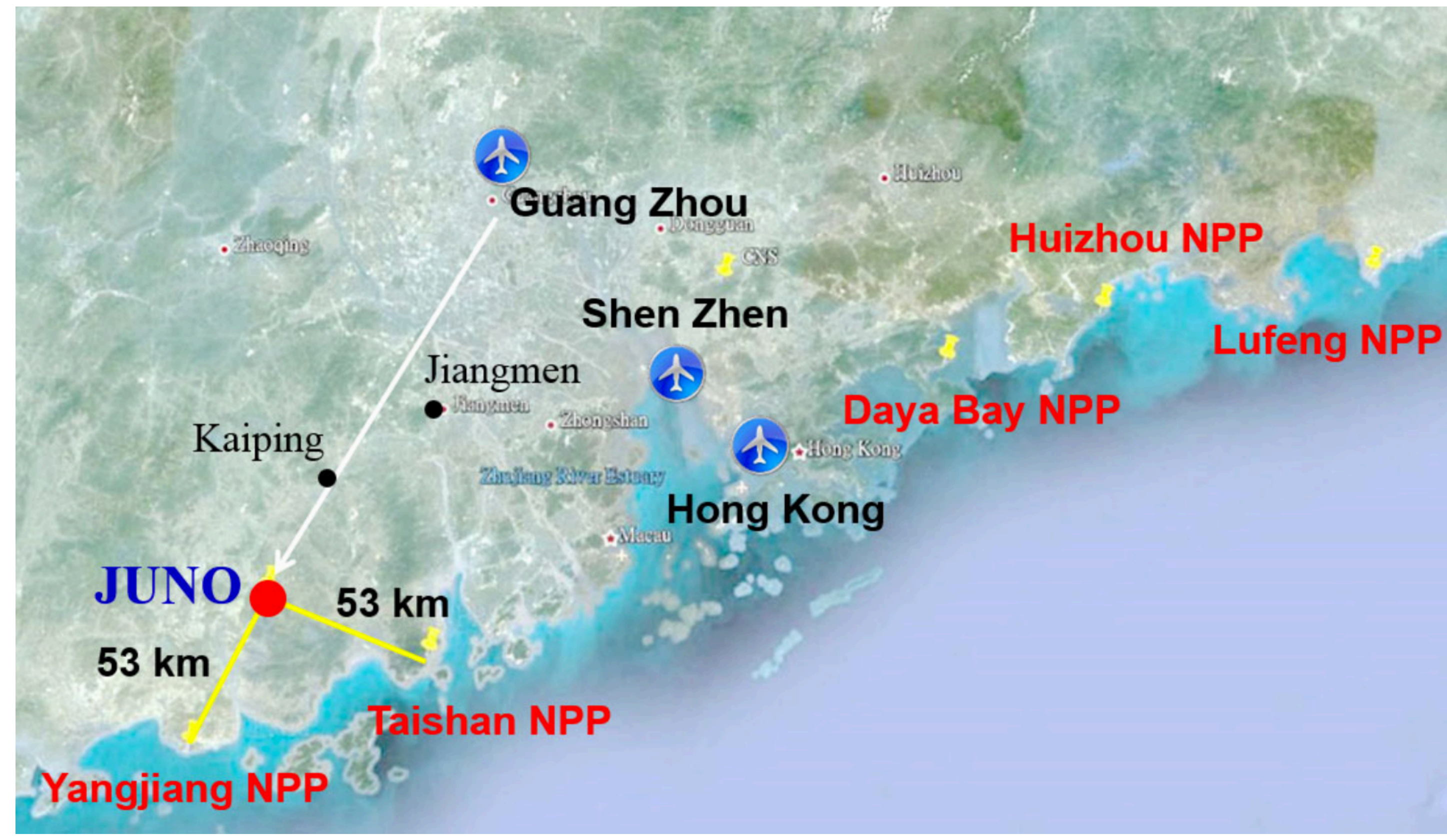


- Next detector upgrade for SK-Gd is expected to start in 2018

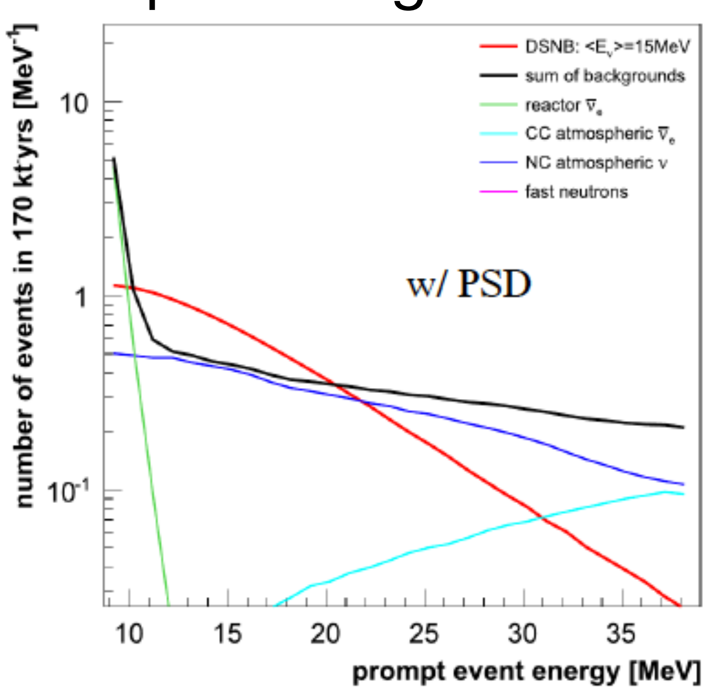
Supernova Neutrinos with the JUNO Experiment

Huiling Li

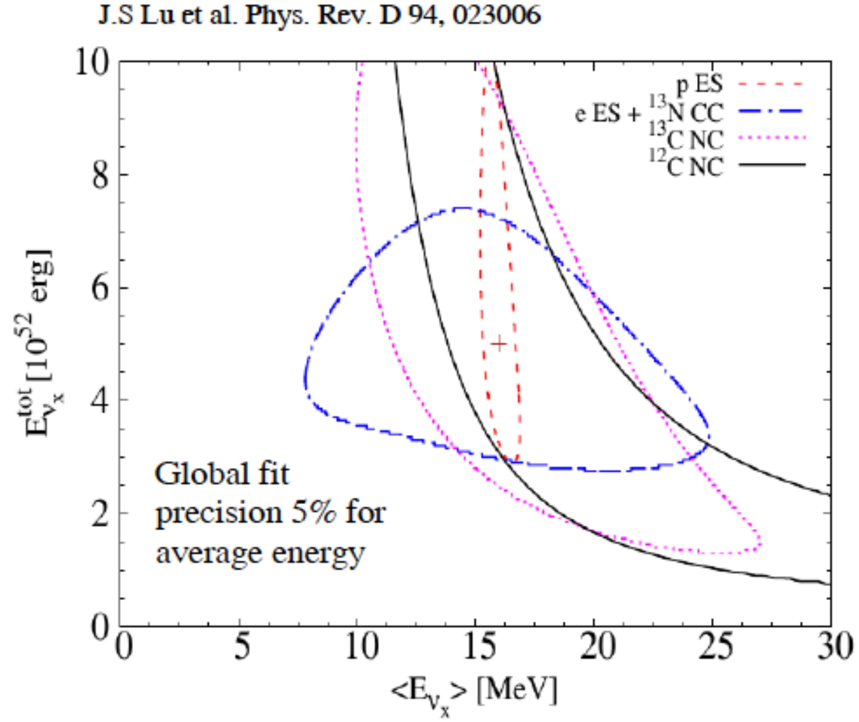




Also promising for DSNB



J.S Lu et al. Phys. Rev. D 94, 023006

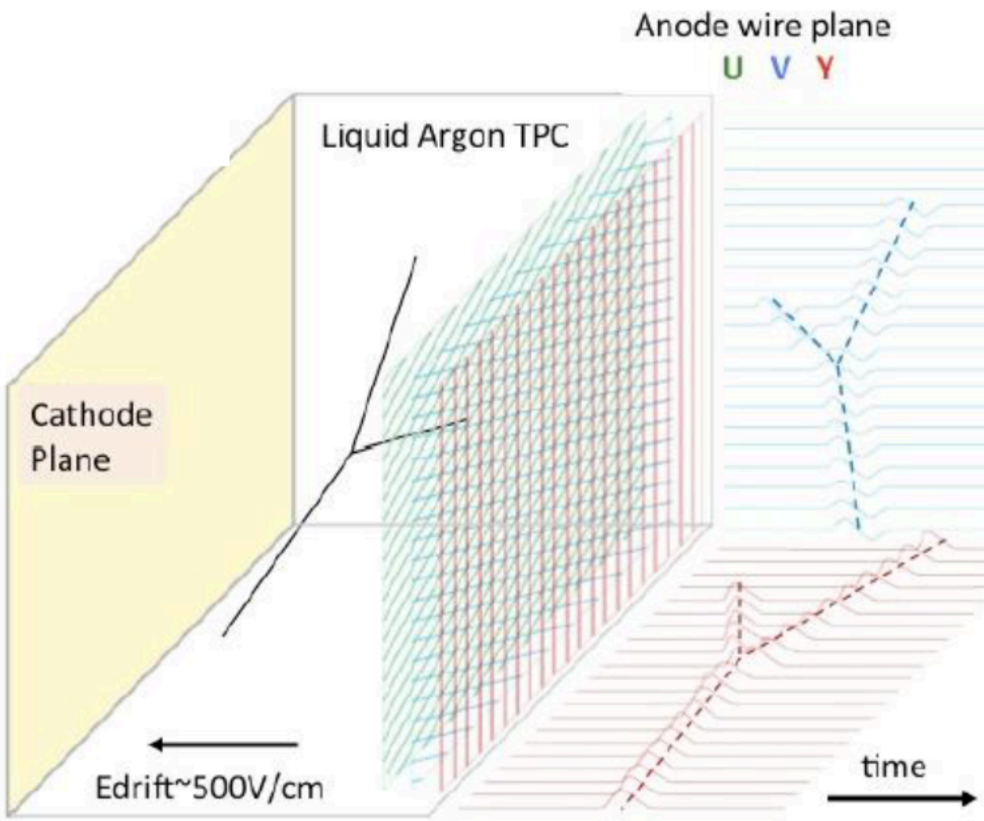


- 700m underground
- 20kt LS
- plan to start data taking in 2020
- Sensitivity to $\bar{\nu}_e$, ν_e, ν_x

Supernova Neutrinos, Proton Decay and Atmospheric Neutrinos at DUNE

Juergen Reichenbacher

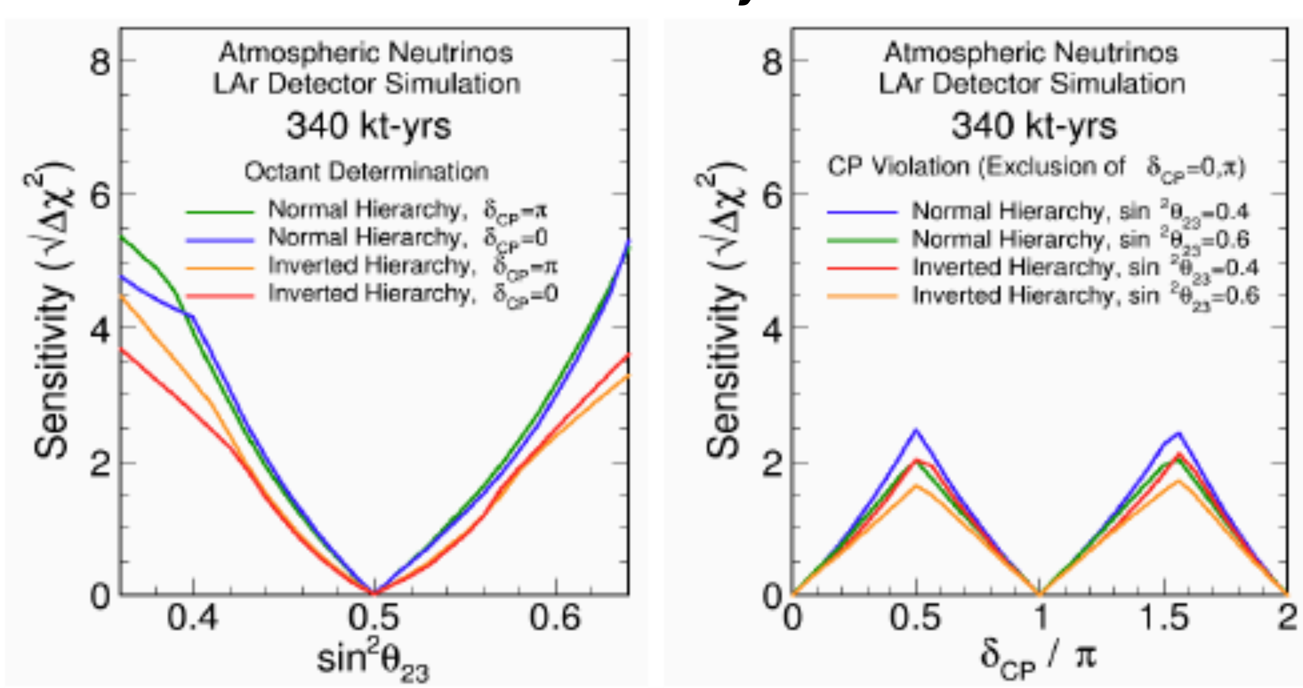
DEEP UNDERGROUND NEUTRINO EXPERIMENT



July 21, 2017: groundbreaking @ SURF

DUNE
(USA)
40 kton

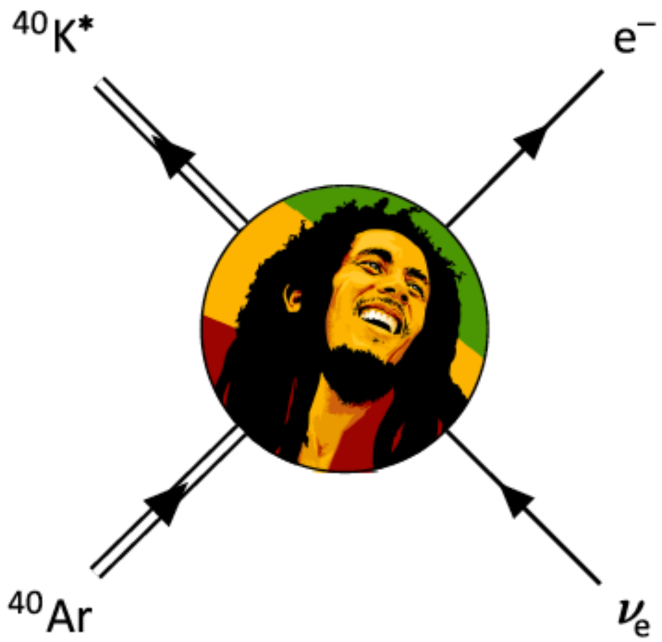
Moderate sensitivity to octant and dCP



Sample	Events / 340 kt-yr
FC ν_e-like	13,651
FC ν_μ-like	20,257
PC ν_μ-like	6,675

An event generator for supernova neutrinos in argon

Steven Gardiner



Model of Argon Reaction Low Energy Yields

Bob Marley illustration by Zero Anixter

Reconstructing true neutrino energy:

Q is determined by measuring de-excitation gammas and nucleons

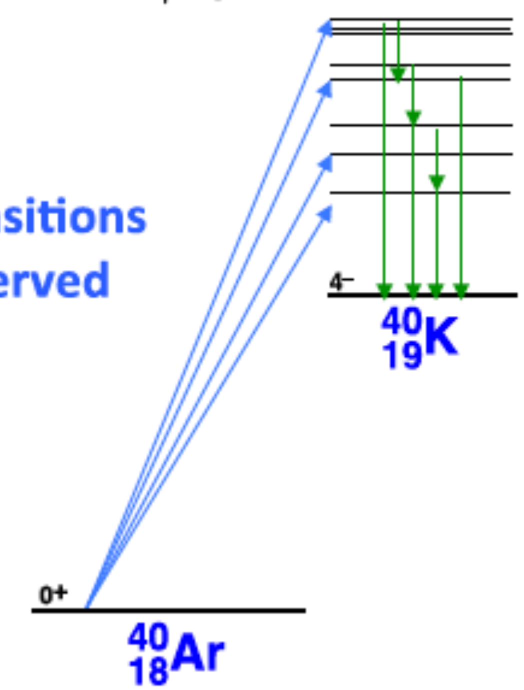
Outgoing e⁻ Energy | Energy donated to transition | Recoil Energy of Nucleus (negligible)

$$E_\nu = E_e + Q + K_{\text{recoil}}$$

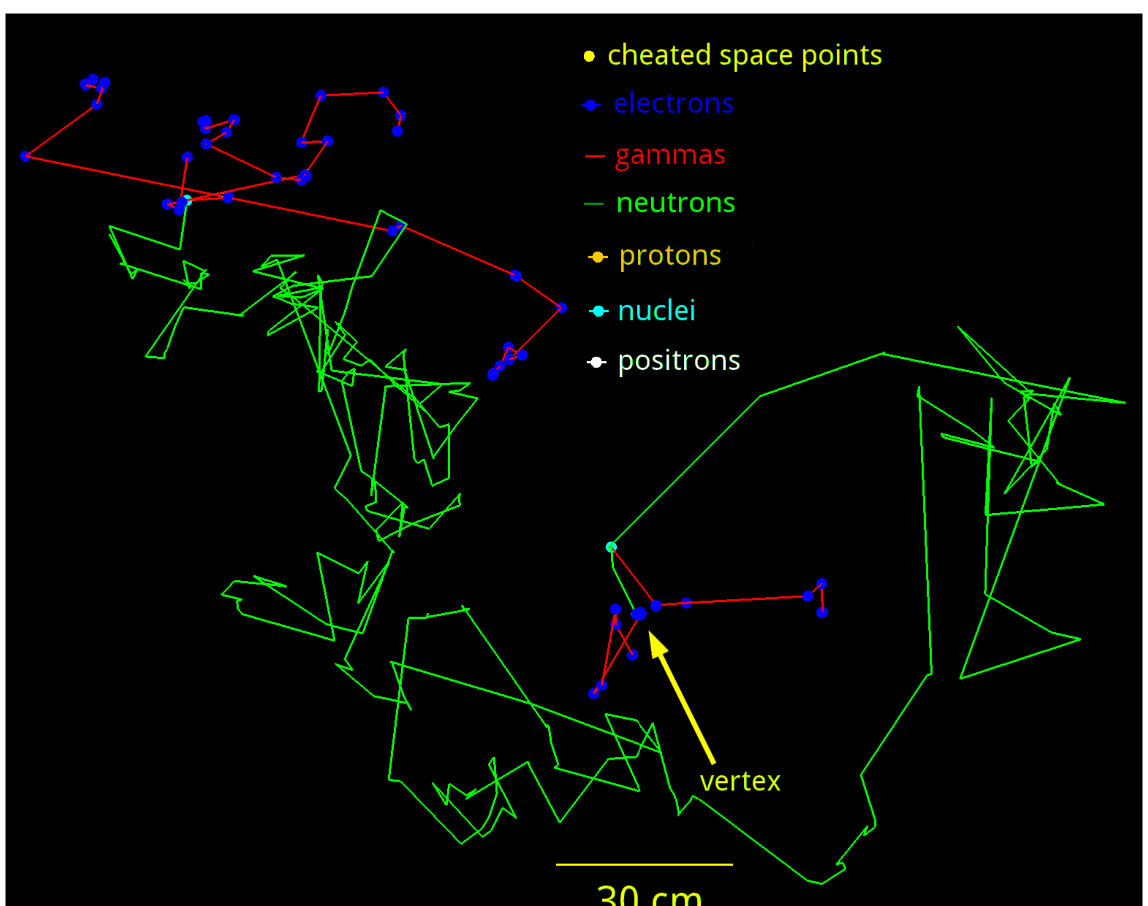
Charged-current absorption:

$$\nu_e + {}^{40}\text{Ar} \rightarrow {}^{40}\text{K}^* + e^-$$

At least 25 transitions have been observed indirectly



Transition levels are determined by observing de-excitations (γ's and nucleons)

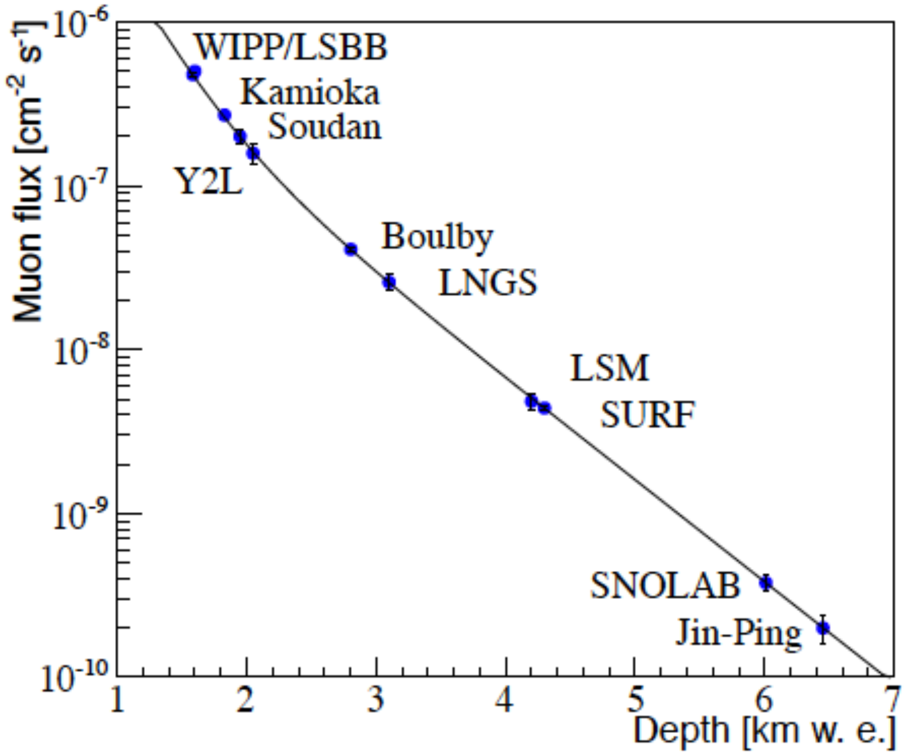


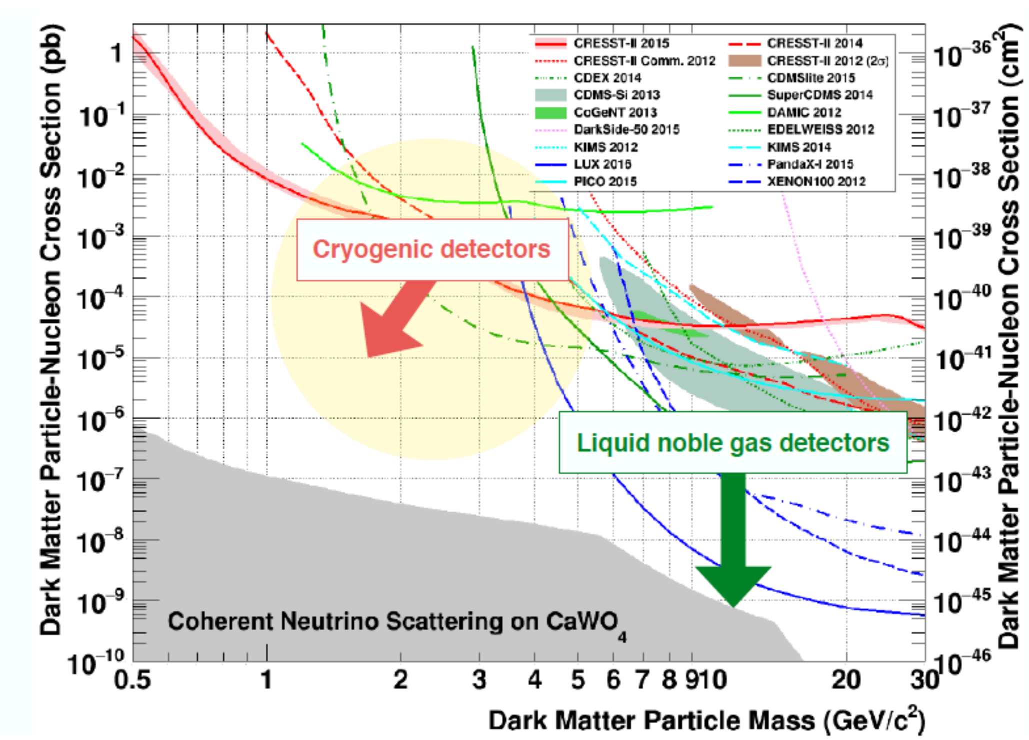
Nuclear effects greatly complicate supernova neutrino event reconstruction in argon

- MARLEY is a new generator specifically targeting supernova neutrinos in ^{40}Ar
- Studies are underway to learn how to reconstruct these events in DUNE

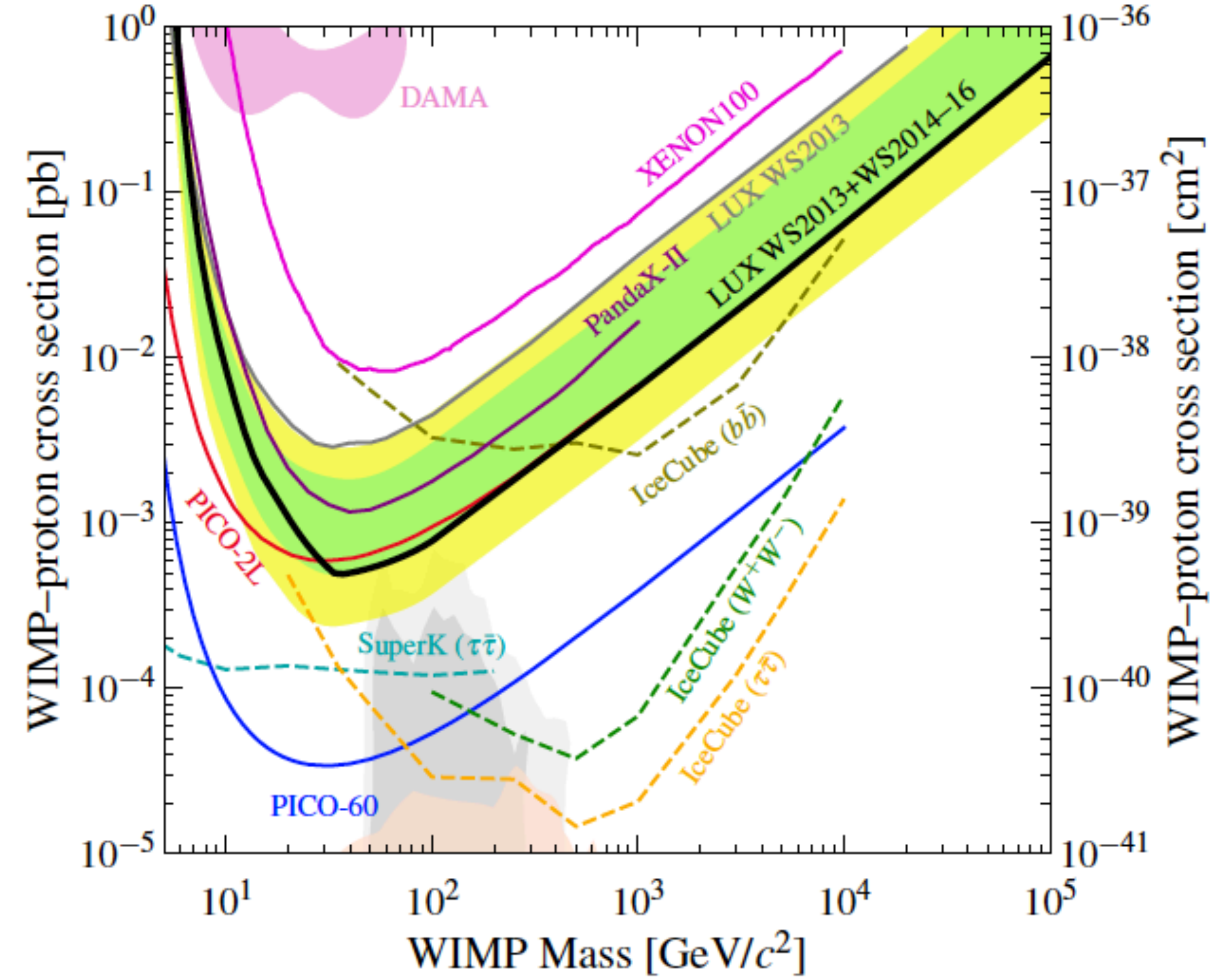
Dark Matter Direct

Underground Labs



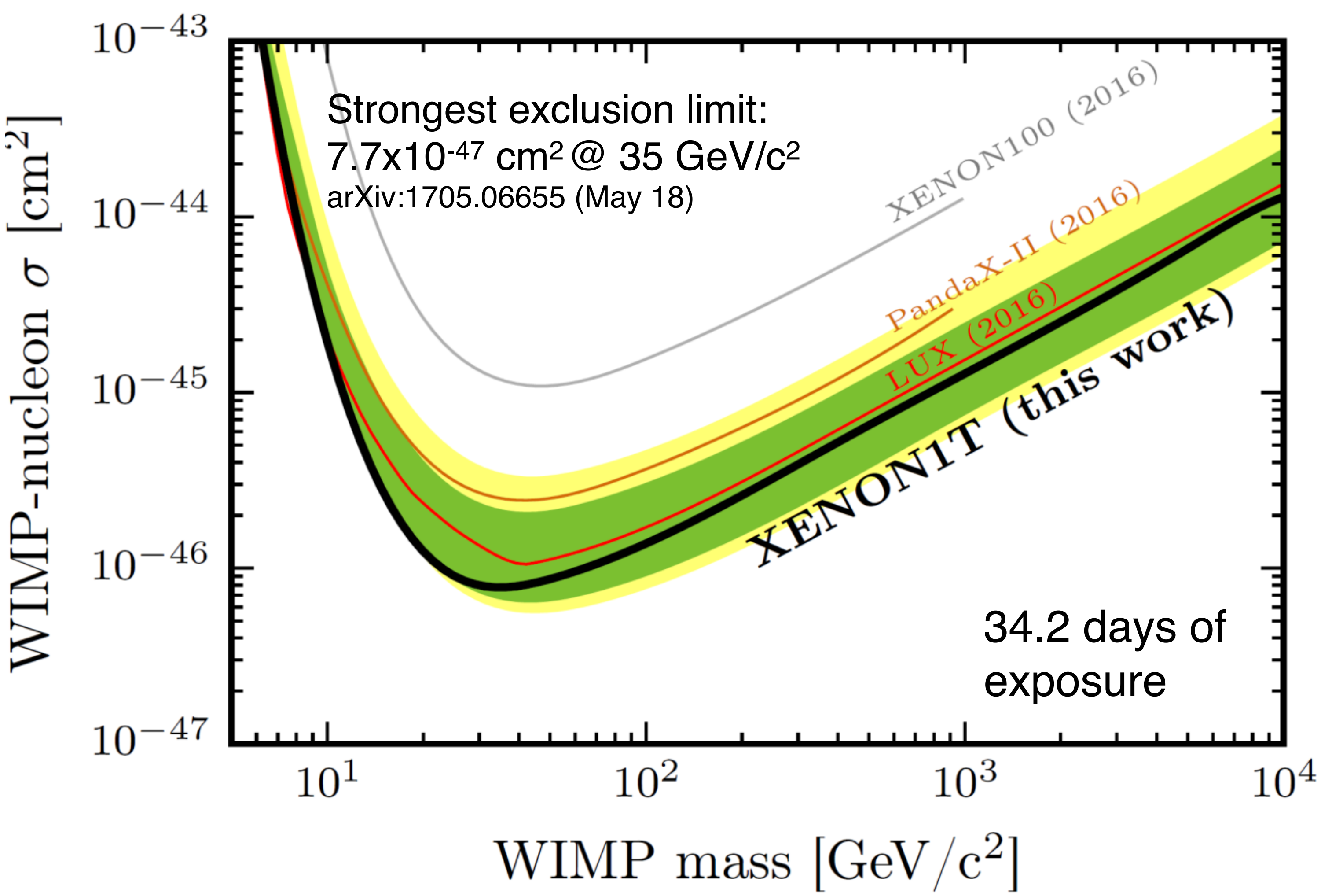


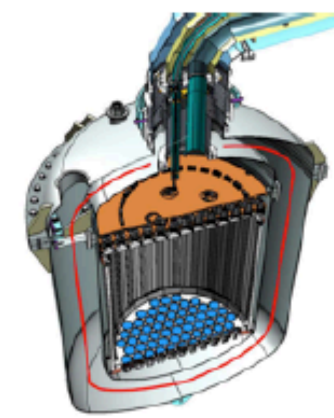
LUX Collaboration 1705.03380



FIRST RESULTS FROM THE XENON1T EXPERIMENT

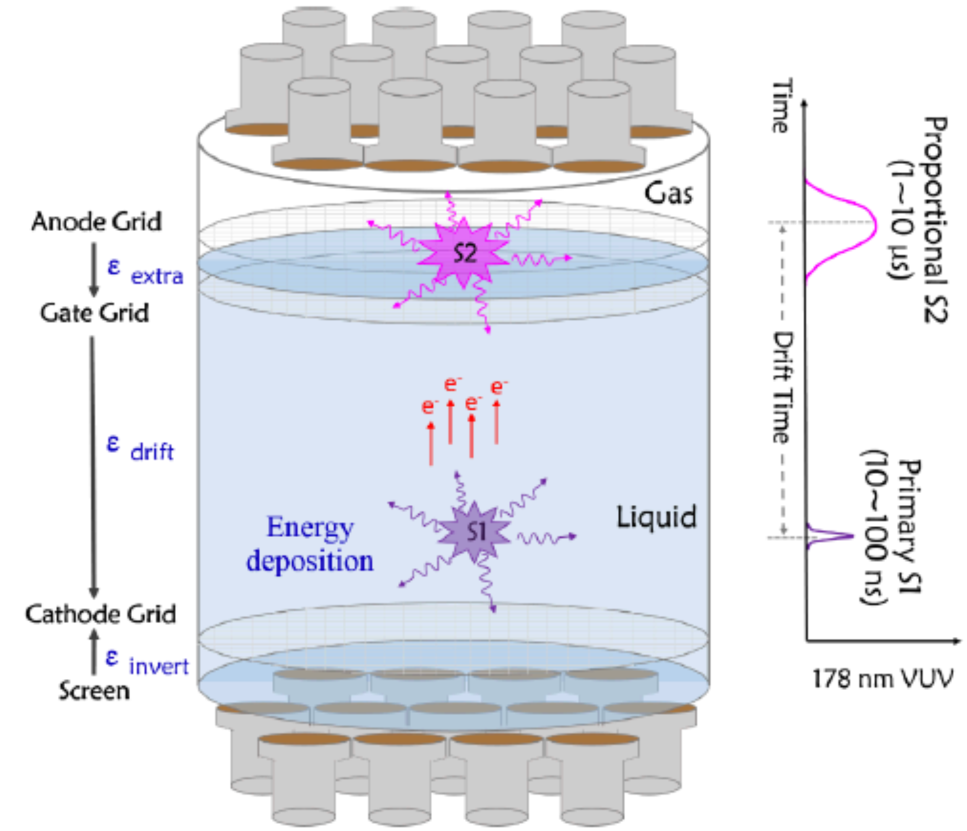
Sara Diglio

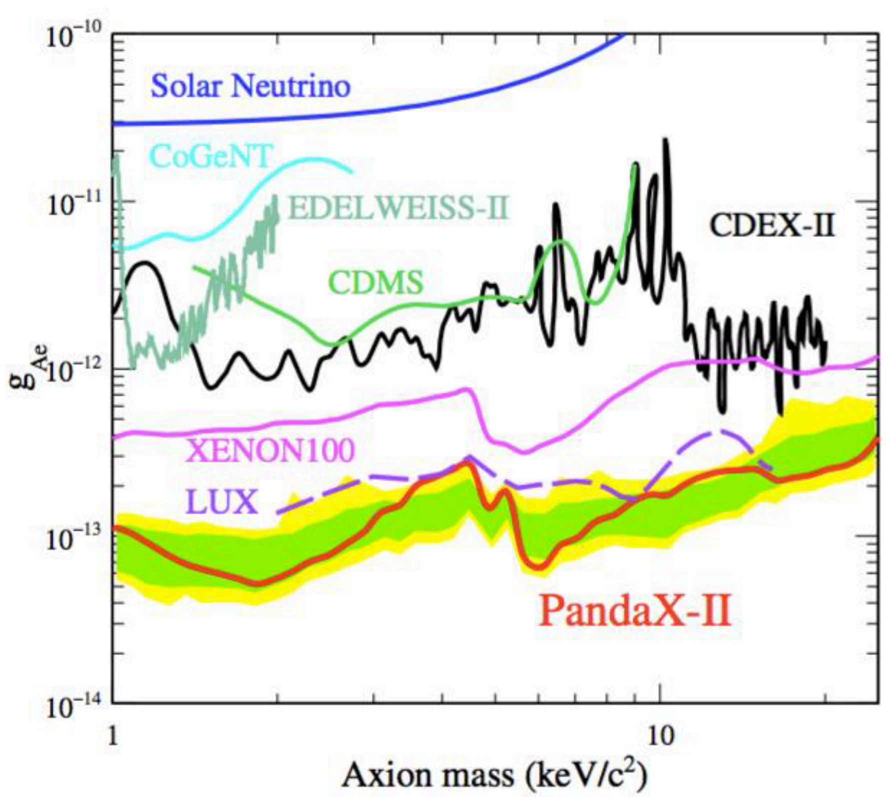


XENON1T 2012 – 2019	XENONnT 2017 – 2023	DARWIN ~2023 –
		
Total mass : 3.2 t	Total mass : ~8 t	Total mass : ~50 t
Target mass: 2 t	Target mass: ~6 t	Target mass: ~40 t
Drift TPC: 96 cm	Drift TPC: 144 cm	Drift TPC: 260 cm
Sensitivity ~ 10^{-47}cm^2	Sensitivity ~ 10^{-48}cm^2	Sensitivity ~ 10^{-49}cm^2

Dark matter search results from the PandaX-II experiment

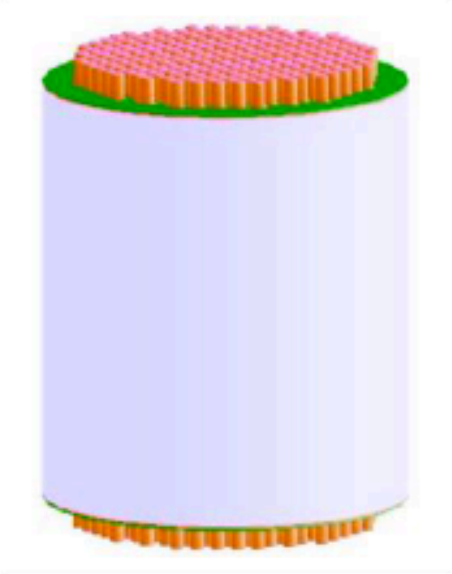
Mengjiao Xiao



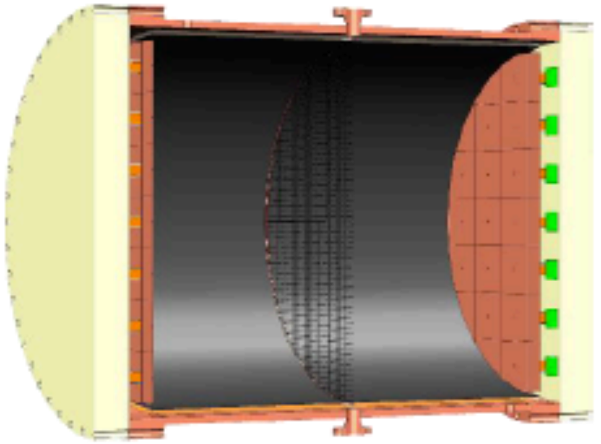


upper limits are set to Solar and Galactic ALP, paper is coming soon

PandaX-II: 500 kg DM experiment 2014-2018



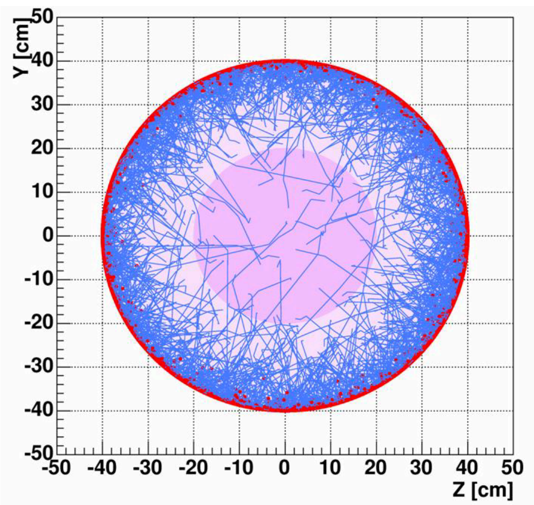
PandaX-xT: multi-ton (~4-T) DM experiment future



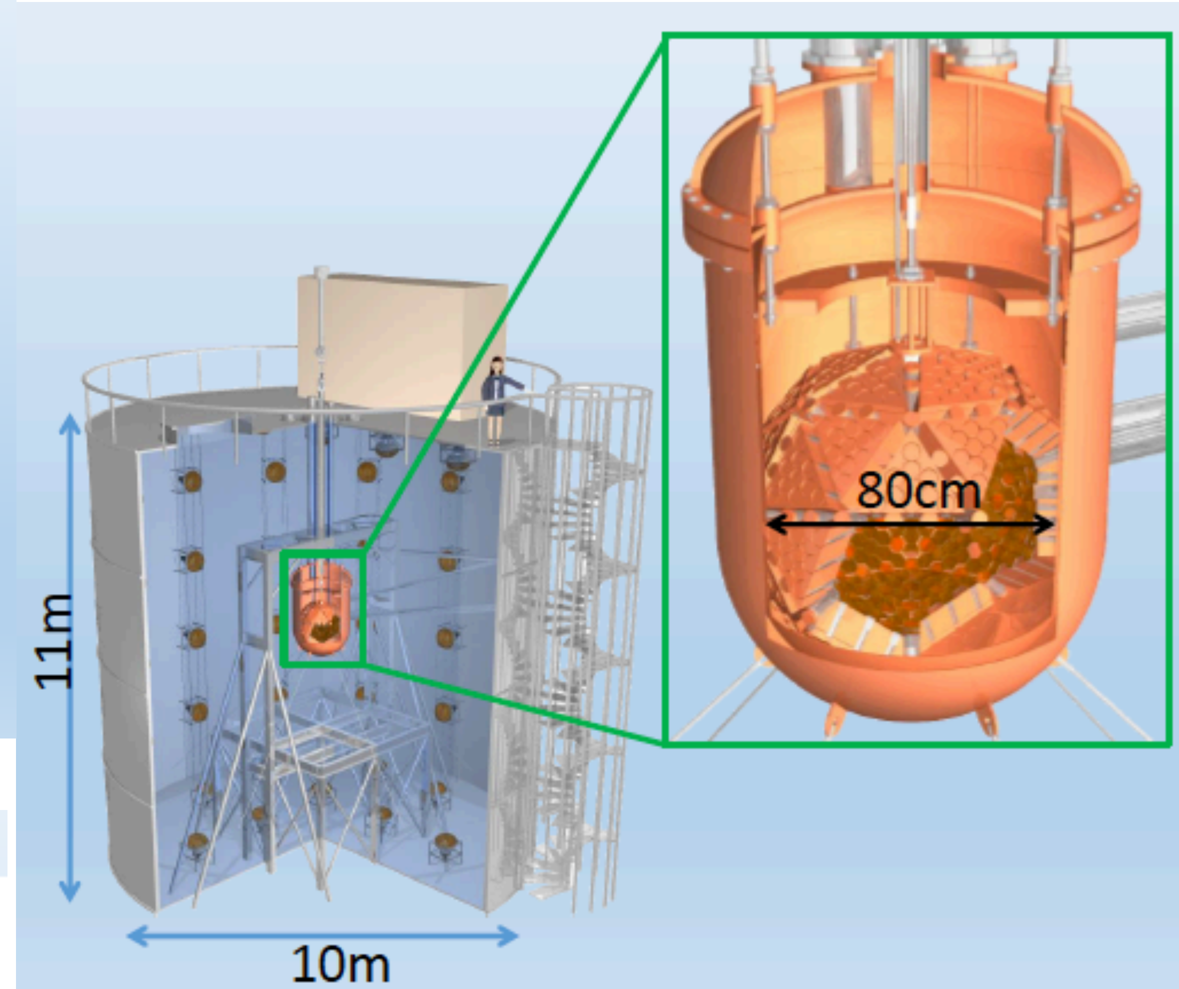
PandaX-III: 200 kg to 1 ton HP gas ^{136}Xe 0vDBD experiment future

Recent results from XMASS

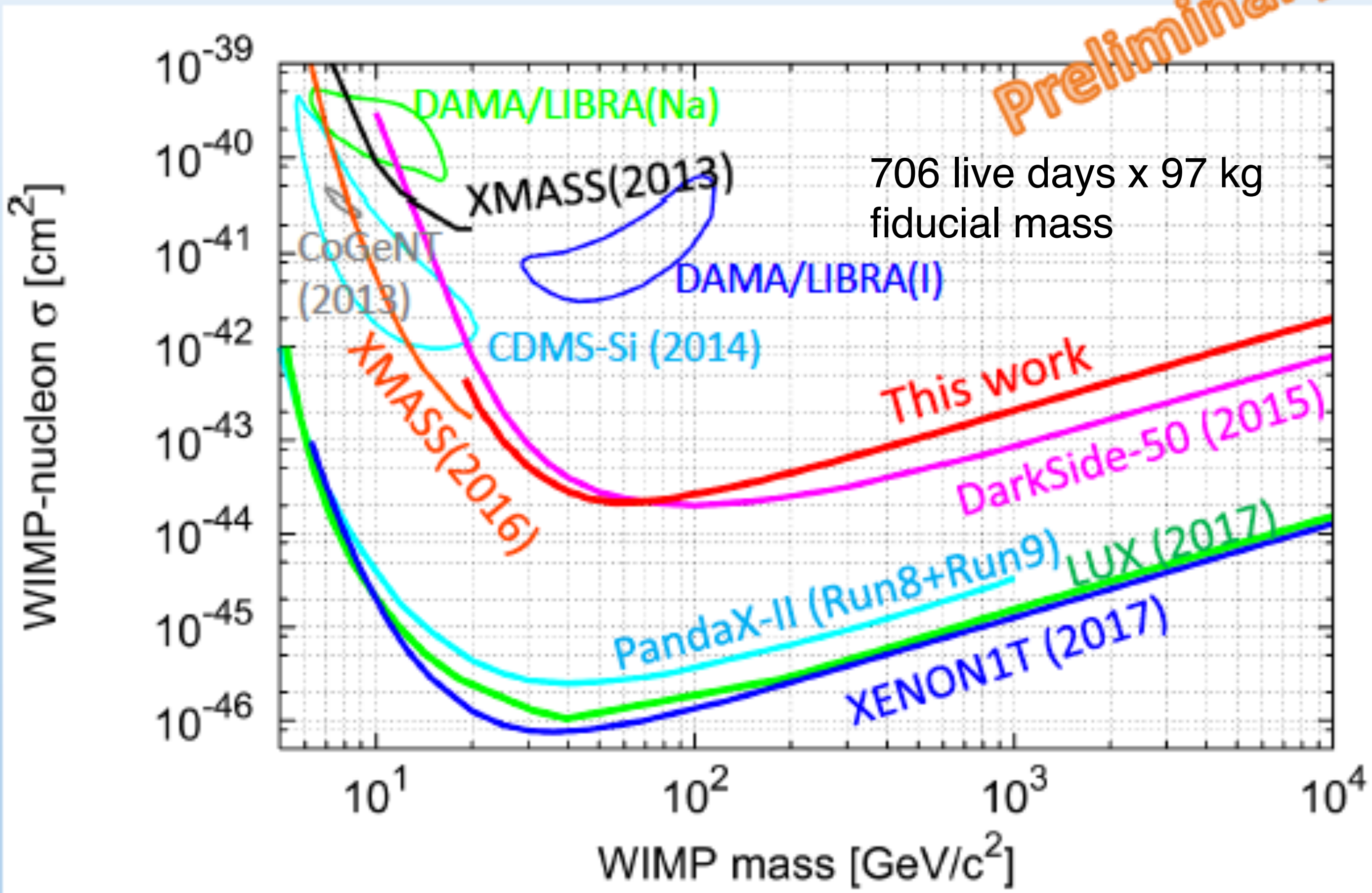
Katsuki Hiraide



- Liquid xenon detector
  - 832 kg of liquid xenon (-100 ºC)
  - 642 2-inch PMTs (Photocathode coverage >62%)
  - Each PMT signal is recorded by 10-bit 1GS/s waveform digitizers
- Water Cherenkov detector
  - 10m diameter, 11m high
  - 72 20-inch PMTs
  - Active shield for cosmic-ray muons
  - Passive shield for *n*/*γ*

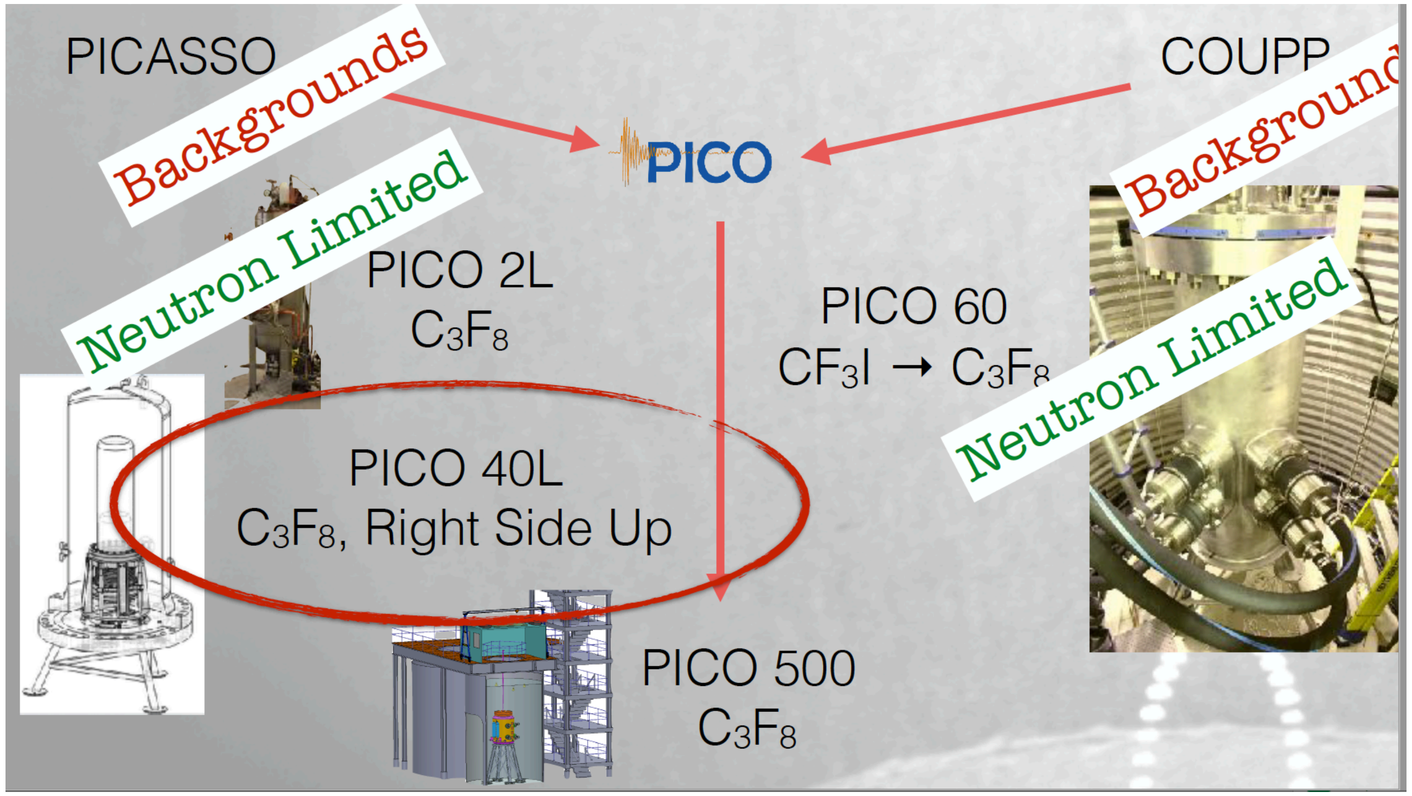


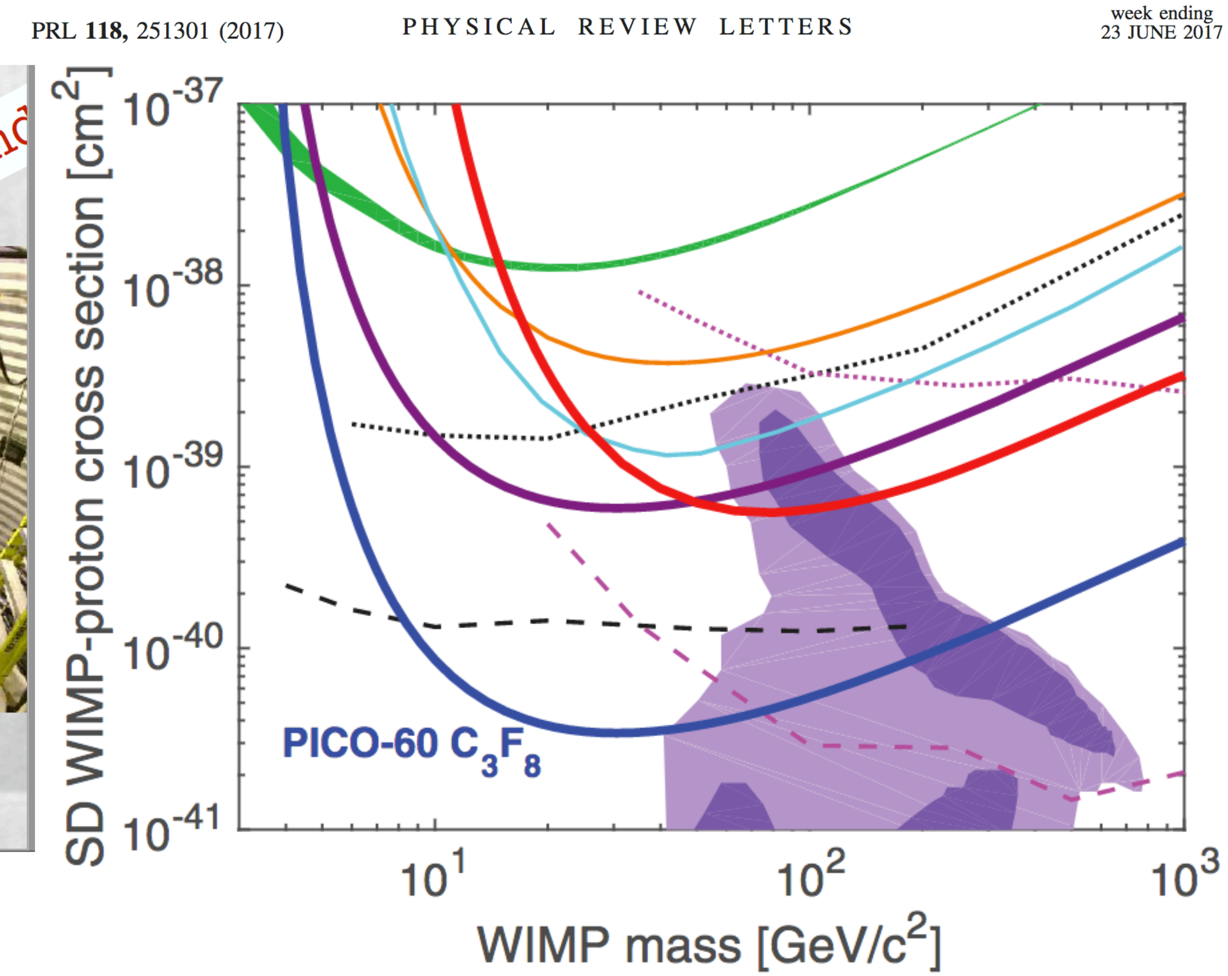
NEW fiducialization Result



Bubble Chambers for Dark Matter Searches and Recent PICO 60 Results

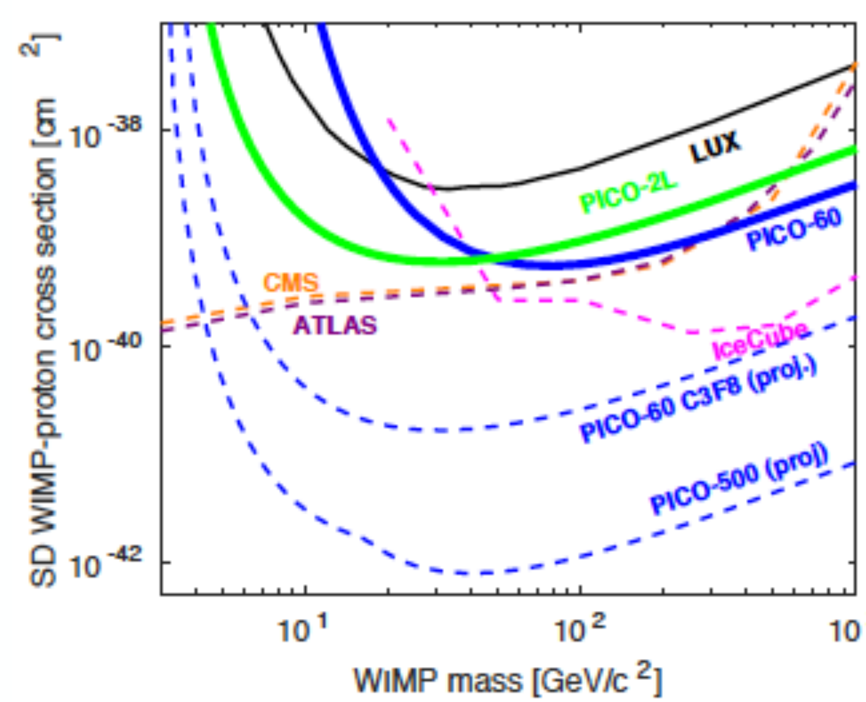
Carsten Krauss





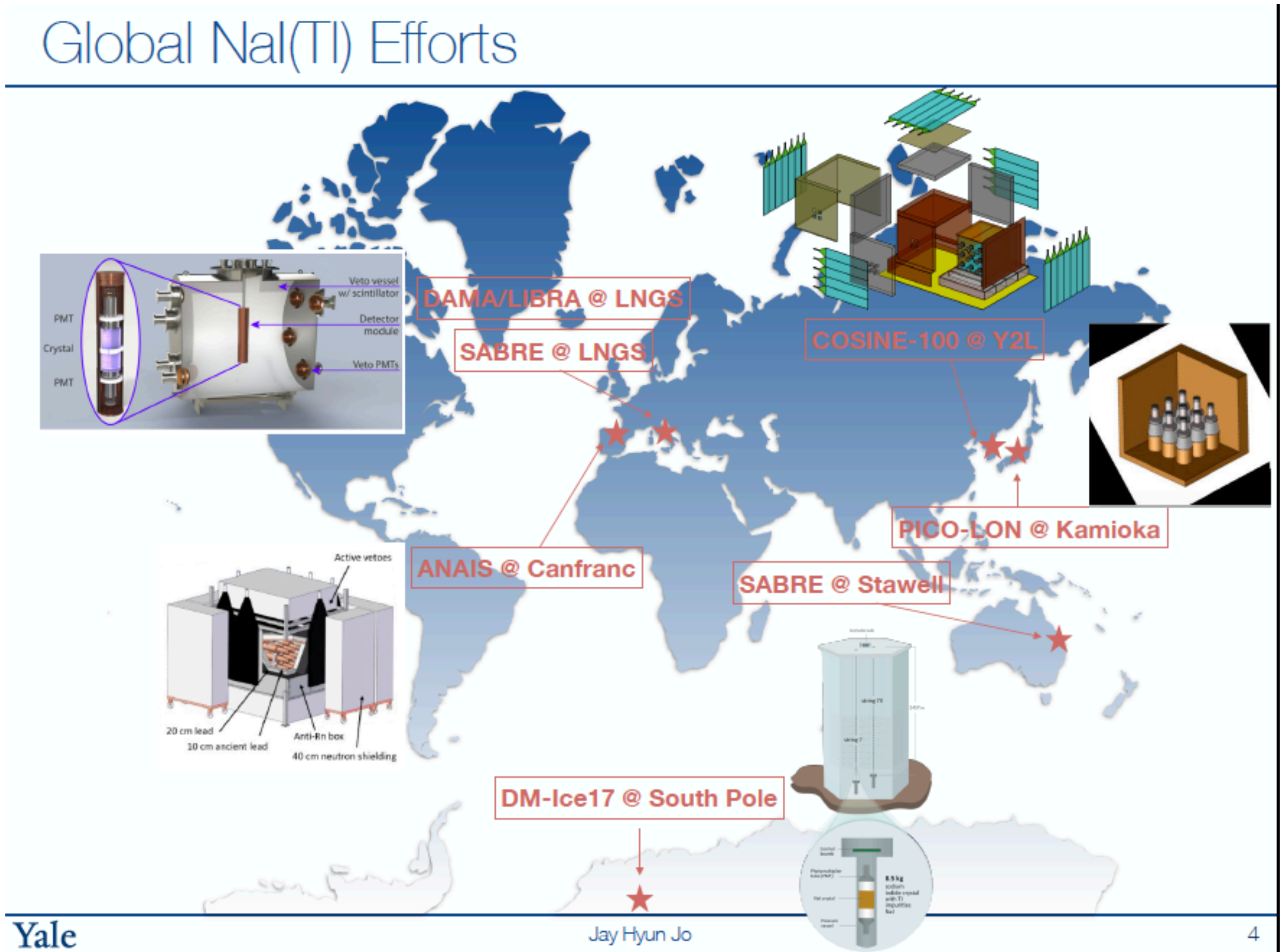
PICO 40L is expected to be operational by the end of the year 2017

PICO 500 will explore the ultimate sensitivity of a low background bubble chamber

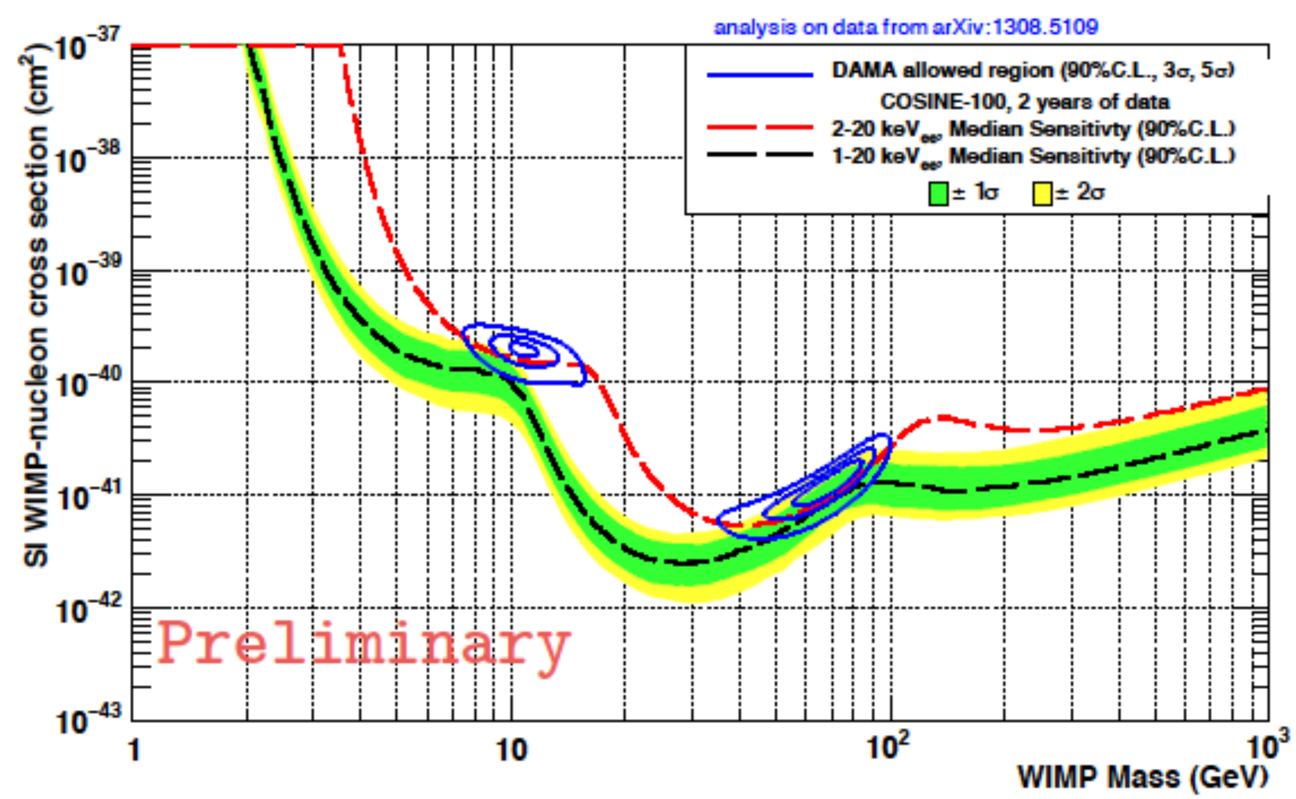


COSINE-100

Jay Hyun Jo



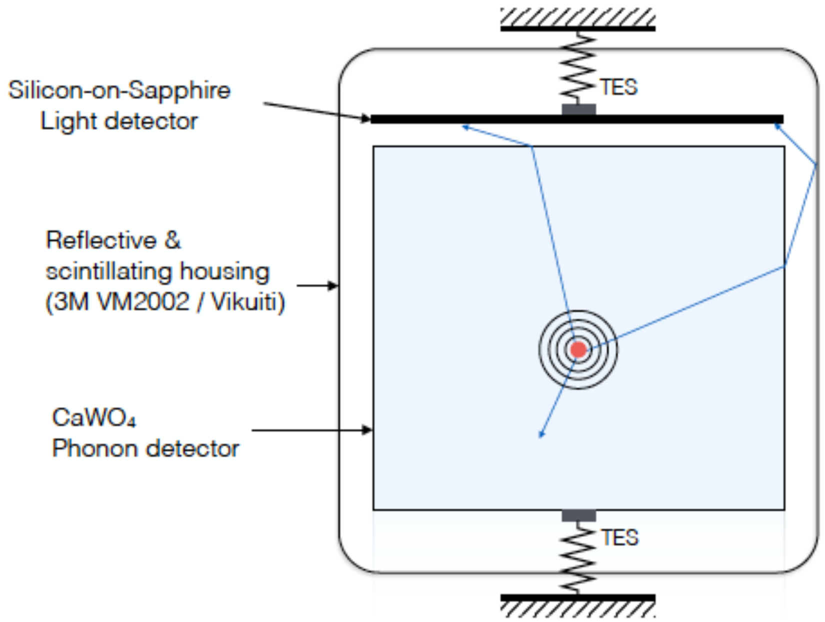
- Detector construction started Dec 2016
- Data taking since Sep 2016
- Expect first results ~1year
- ~2 years of data with 1 keV analysis threshold will give comparable sensitivity to DAMA's 90% C.L. allowed region

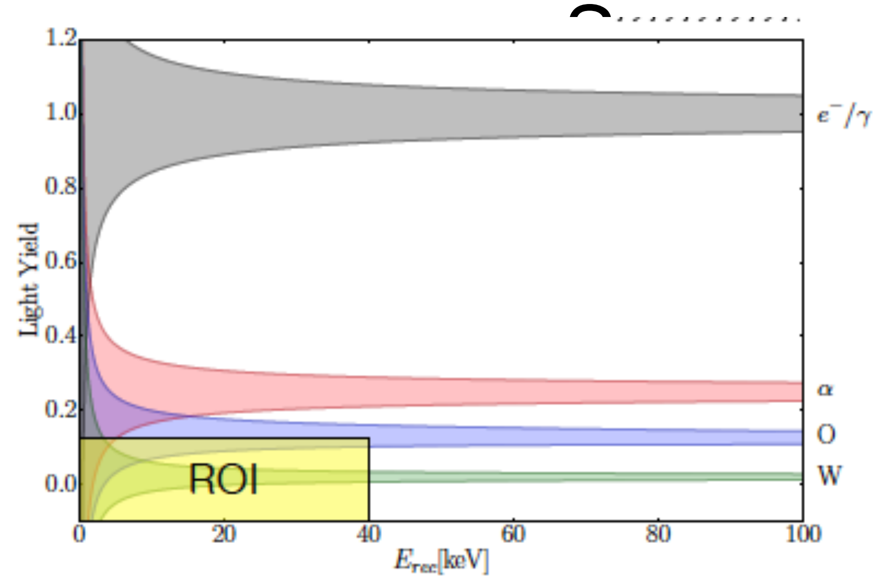


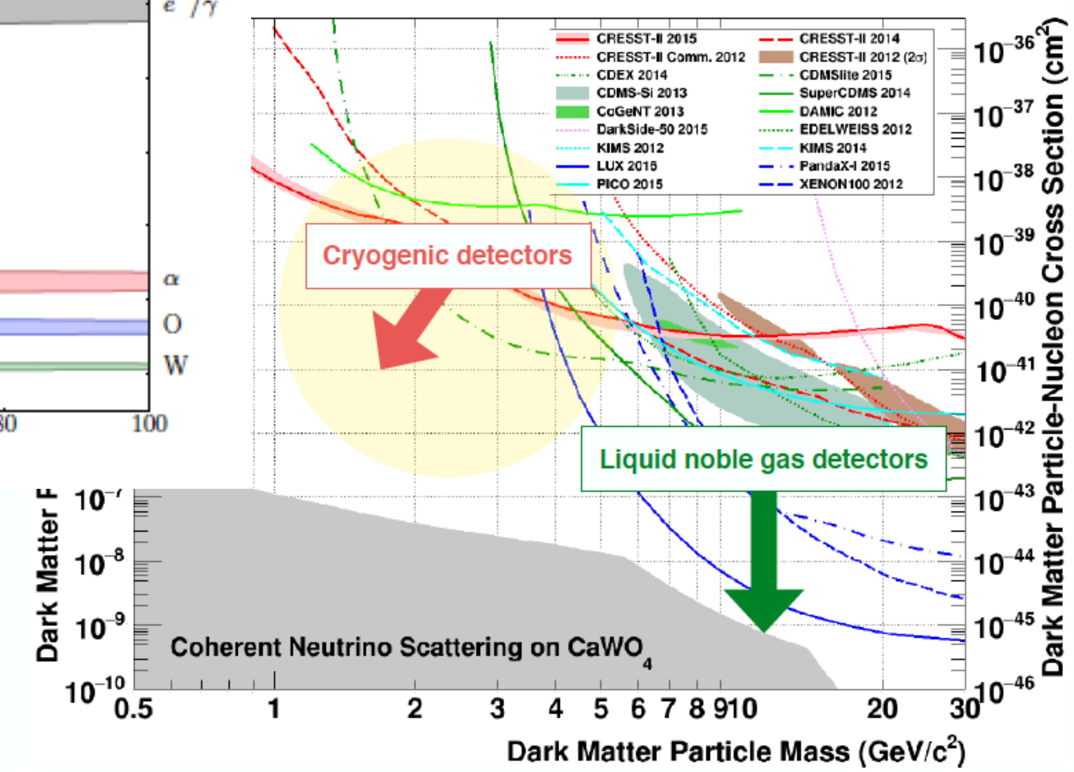
Search for low-mass Dark Matter with CRESST-III

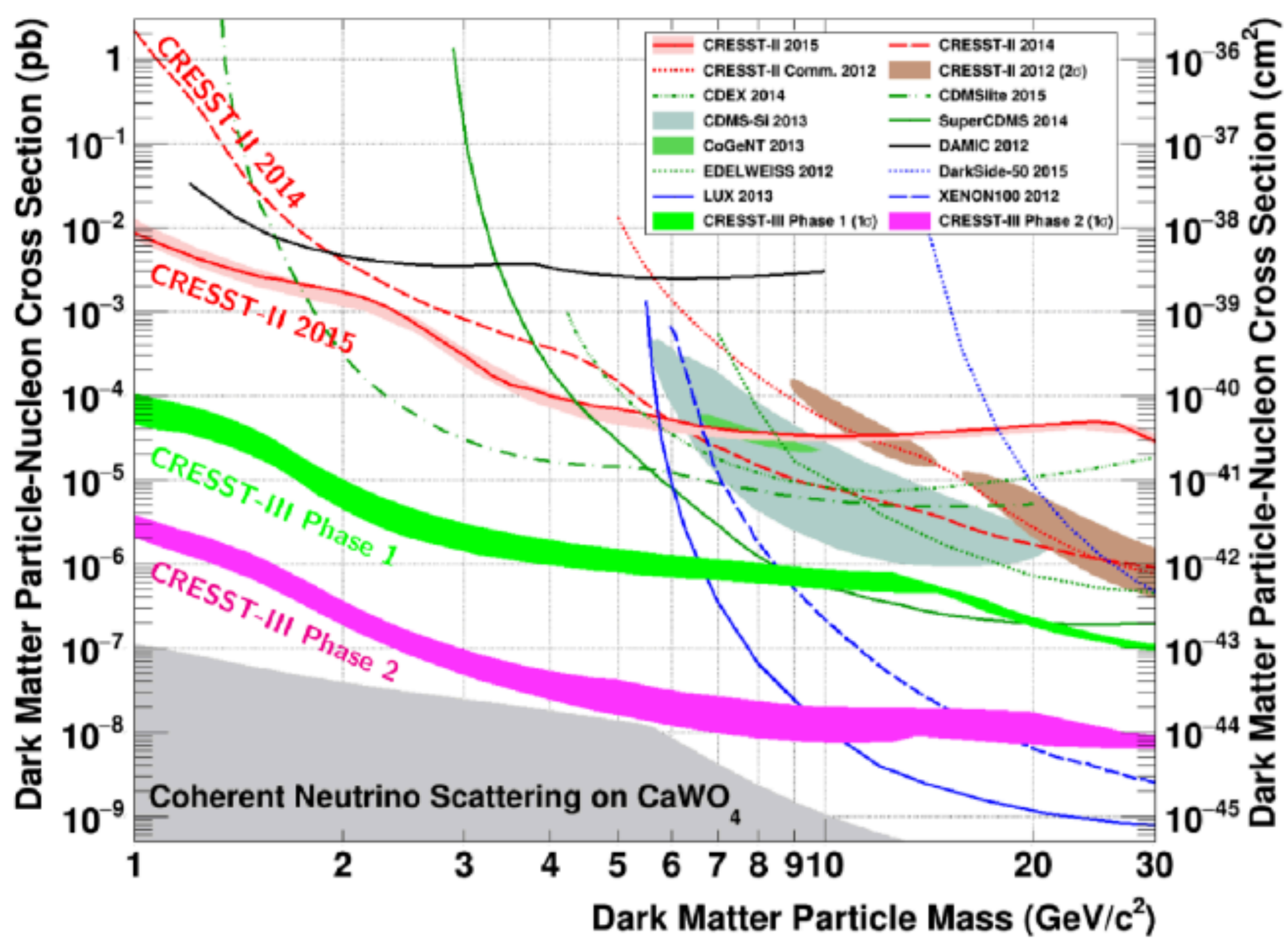
Michael Willers

Cryogenic Rare Event Search with S… ducting Thermometers









CRESST → World leading DM limit below ~ 1.7 GeV / c²

CRESST-III detector technology:

- Precise measurement of low-energetic nuclear recoils
- Very low threshold: E_{thr} < 100 eV
- Fully scintillating detector housing & rejection of holding structure related backgrounds
- TUM-grown crystals provide improved radiopurity

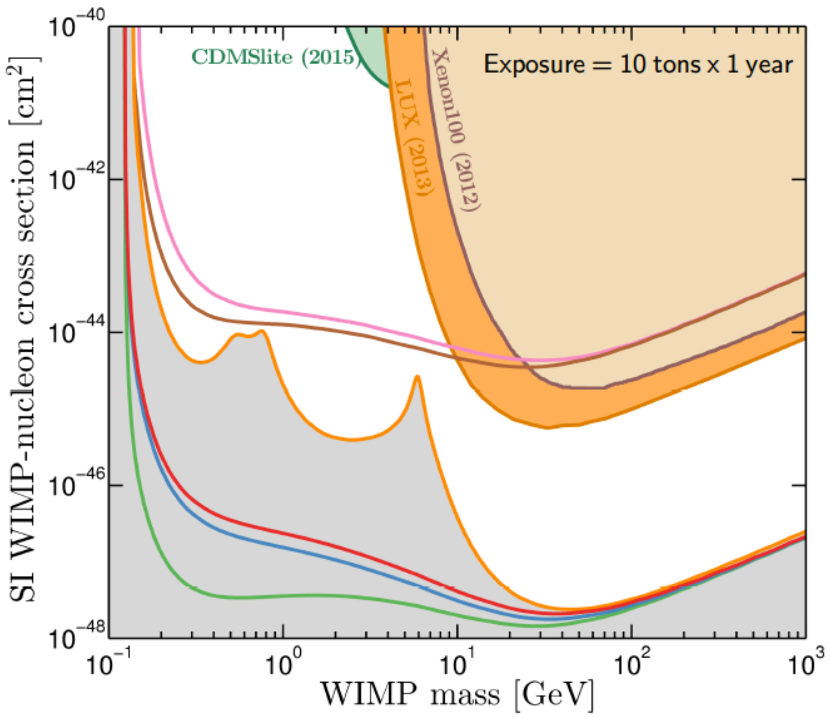
→ CRESST III has high potential to explore low-mass dark matter parameter space below ~ 3 GeV / c²

arXiv:1503.08065 & Journal of Physics: Conference Series **718** (2016) 042048

An Overview of Directional Dark Matter Experiments: Current Status and Future Prospects

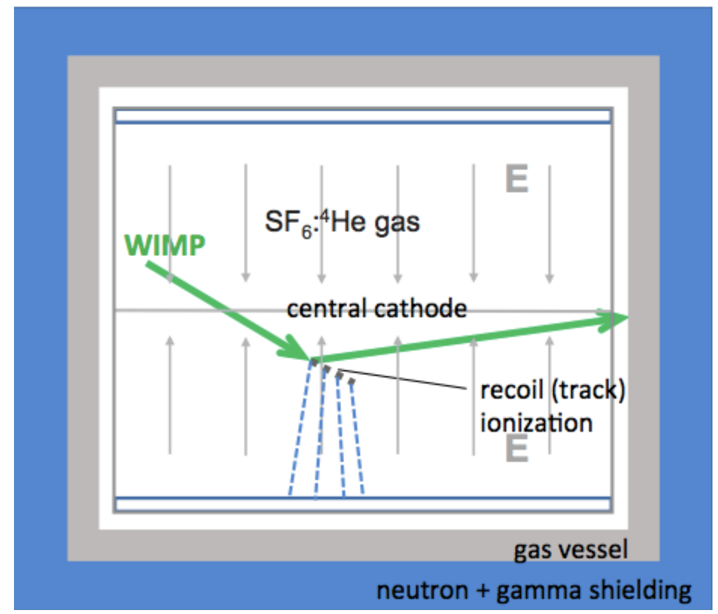
Dinesh Loomba

…directional experiments critical for going below the neutrino floor:



Adapted from C. O'Hare, et al., PRD 92 (2015) by S. Vahsen

CYGNUS HD10*

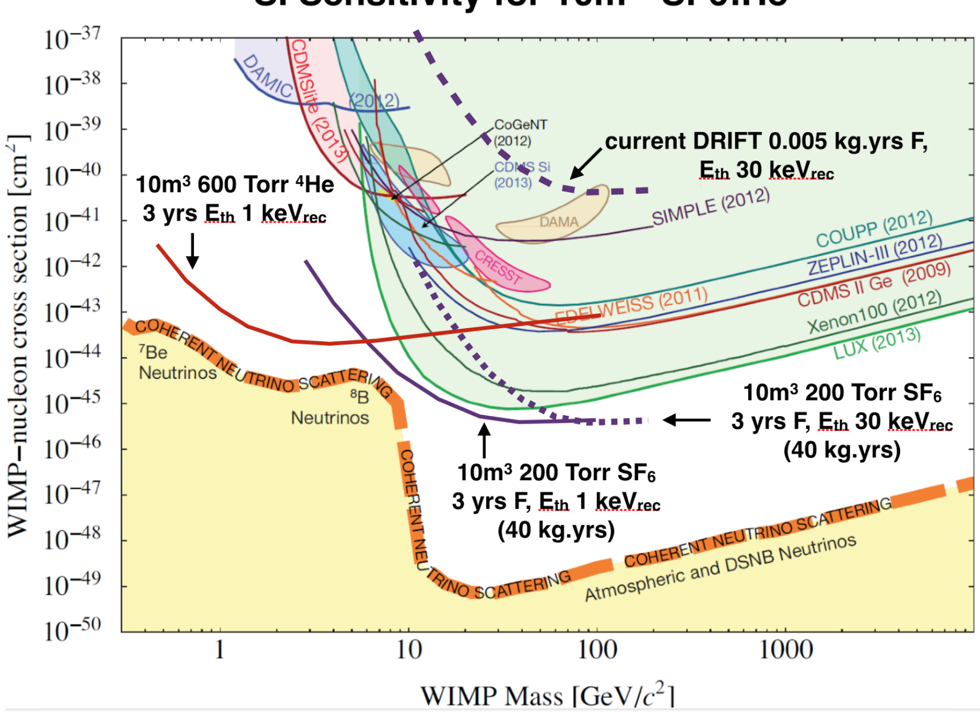


Presented by S. Vahsen at the "U.S. Cosmic Visions: New Ideas in Dark Matter" workshop as a strawman proposal to the DoE

On-going efforts

- DRIFT
  - operating for >10years
- NEWAGE
- Cygnus Newage 1m^3
  - Funded, ready by 2018
- DMTPC
- MIMAC

SI Sensitivity for 10m^3 SF6:He



- Experimental effort have demonstrated and improved their directionality. We are approaching the simulated predictions on strength of signature.
- Discrimination with range vs energy is excellent. But good signal-to-noise and resolution will be needed as we push to lower thresholds.
- Demonstrated ZERO background operation: the RPR problem has a solutions that work.
- Flexibility of technology enables numerous approaches for probing a wide range of WIMP parameters, e.g. low mass WIMPs
- Experiments are all getting larger, but we are volume limited and need to scale up.
- Many new groups entering field, some with novel ideas in solids-state and high pressure gas

Direct Detection Summary

- Liquid Nobel Gases approaching
  - Neutrino Floor in reach
  - Moving towards multi ton scales
- PICO SD
- Light DM (CDMSLite, CRESST-III)
- DAMA Anomaly to be resolved in near future
- Directional DM

DM at the LHC

BhaskarDutta

Larger/ smaller <σv> : Non thermal dark matter, e.g., due to moduli decay
Prior to BBN
Non standard cosmology: Expansion rate is different
[Dark Matter is thermal]

Search for non-colored particle, smaller mass gaps are crucial to tie DM explanations with models at the LHC. However, the reach is not very good

Conclusions

- …