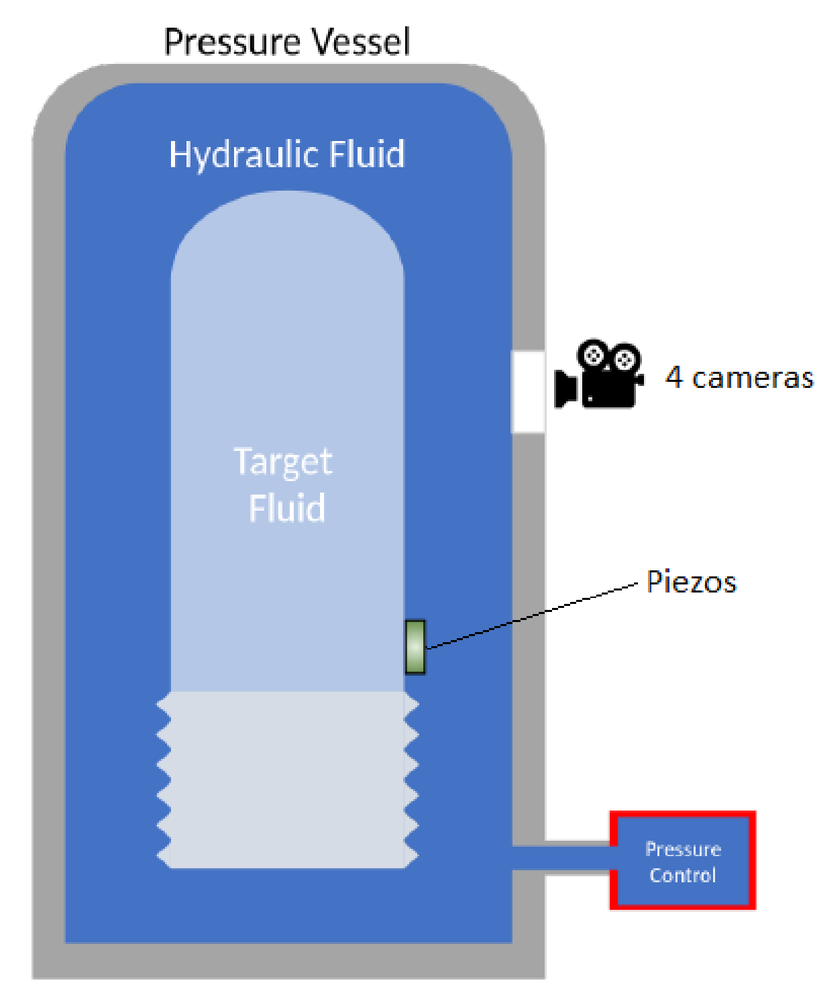
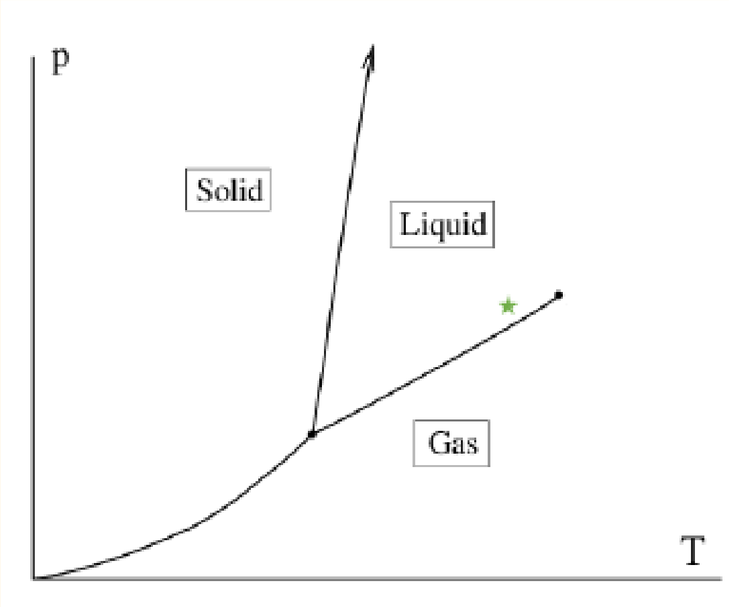
PICO Collaboration: PICO-40L status and PICO-500

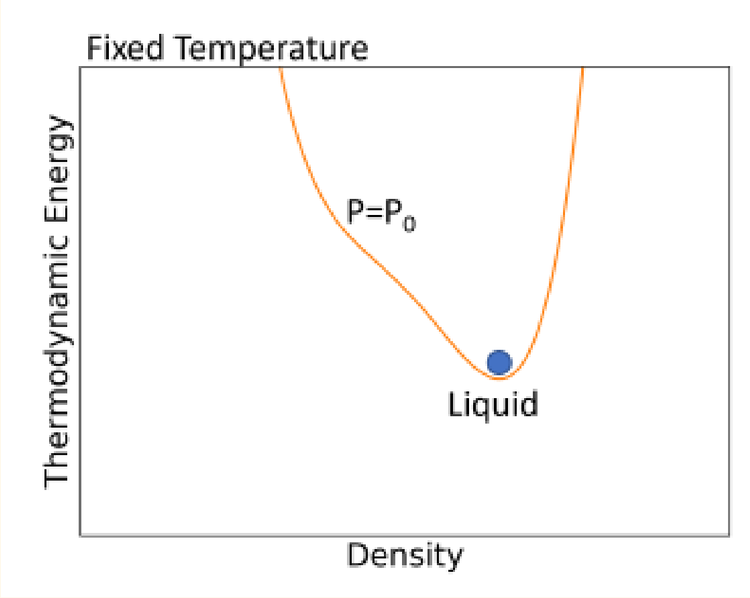
Feb 19th, 2024

Jeremy Savoie
Université de Montréal

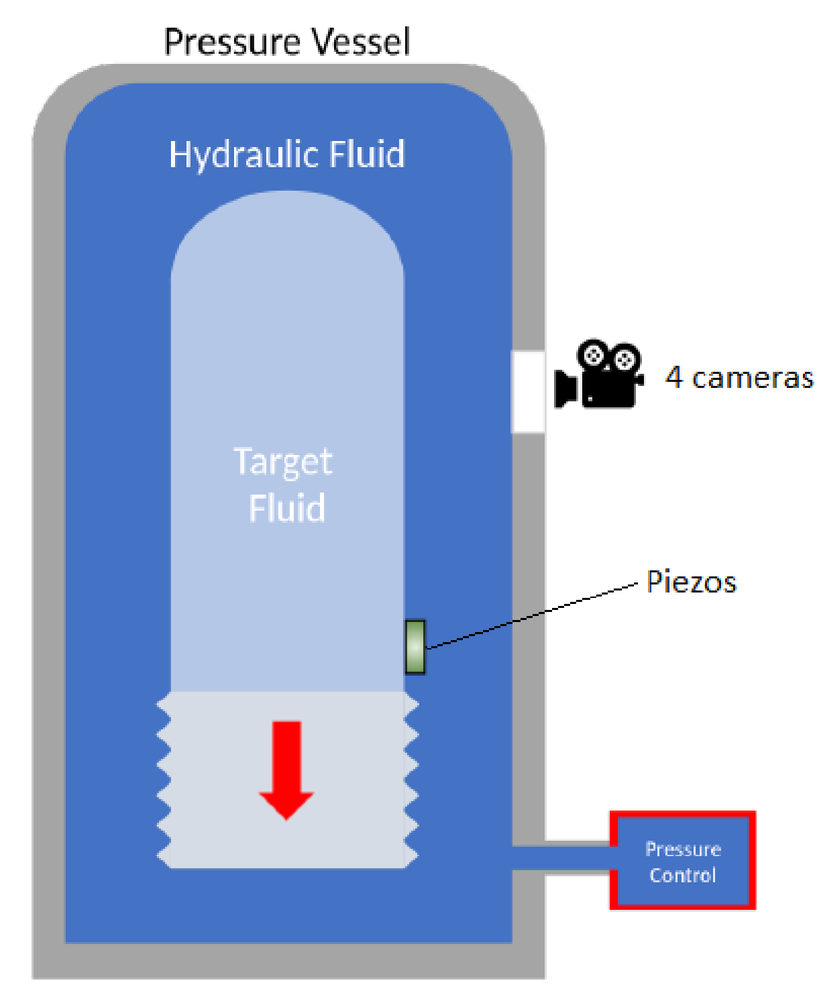
Bubble Chambers as Particle Detectors

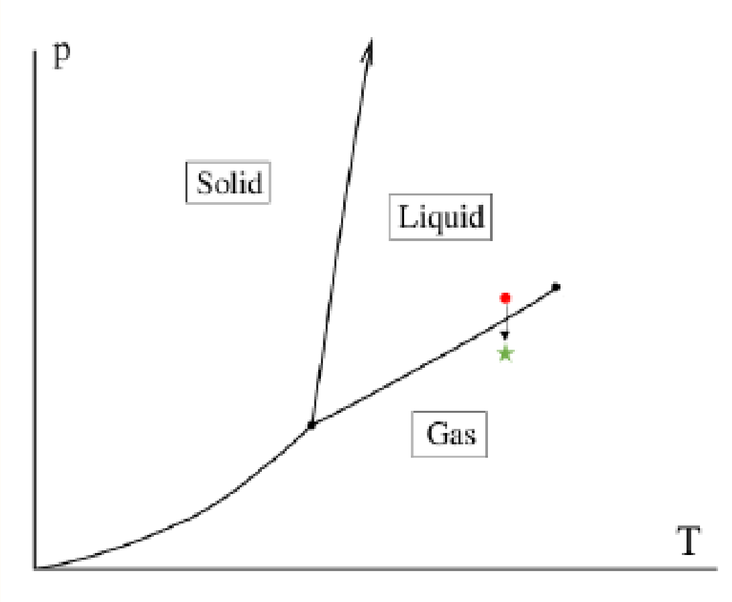


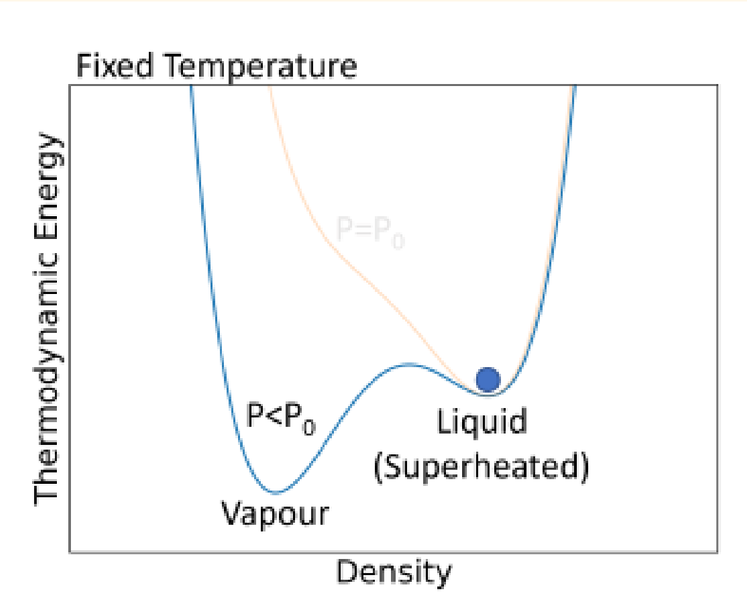




Bubble Chambers as Particle Detectors







Background events

Alphas

Neutrons

Electron recoil

Background events

Alphas

Single bubble

Neutrons

Electron recoil

Background events

Alphas

Single bubble

Neutrons

Multi-bubbles

Electron recoil

Background events

Alphas

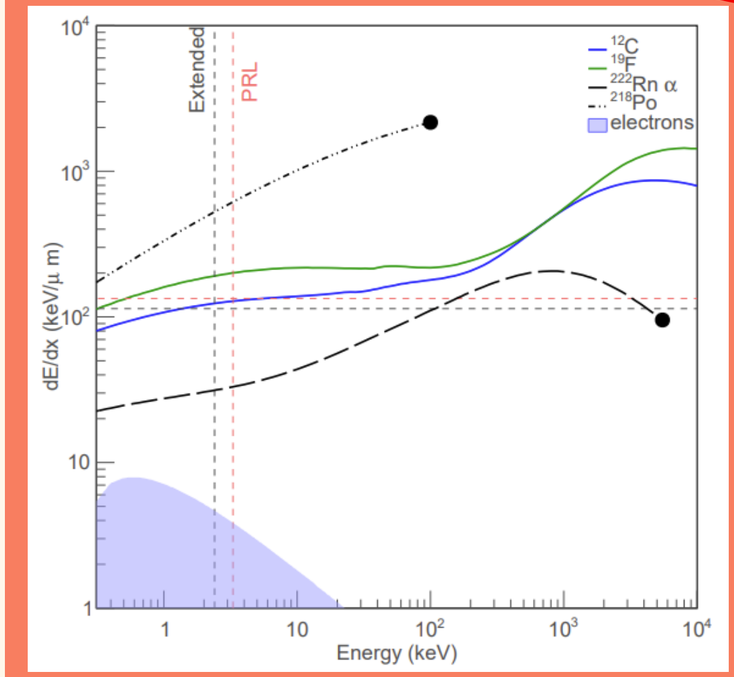
Single bubble

Neutrons

Multi-bubbles

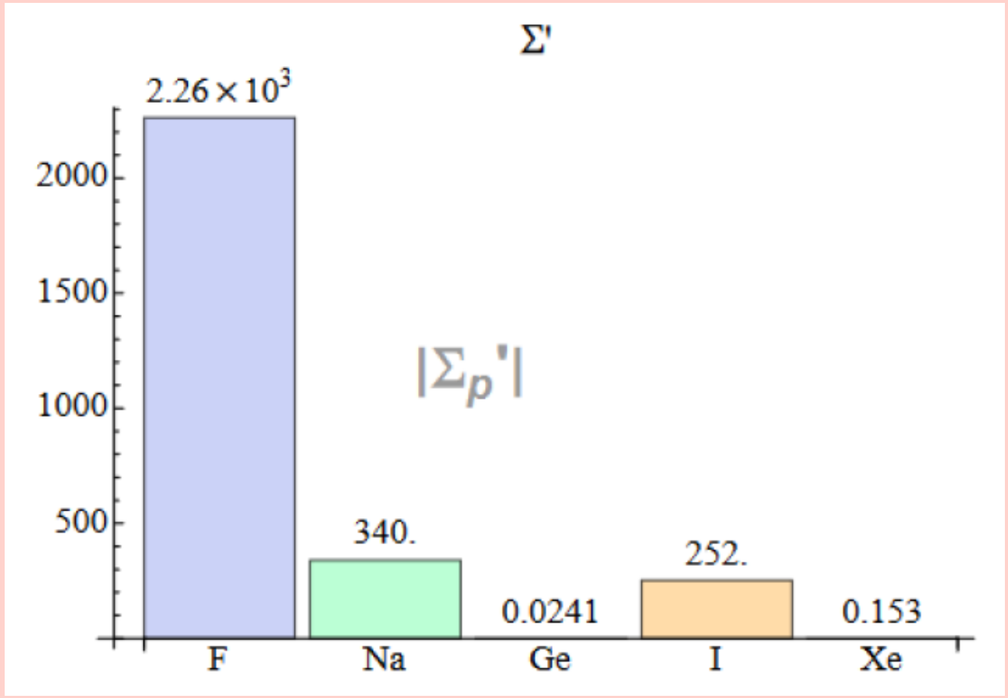
Electron recoil

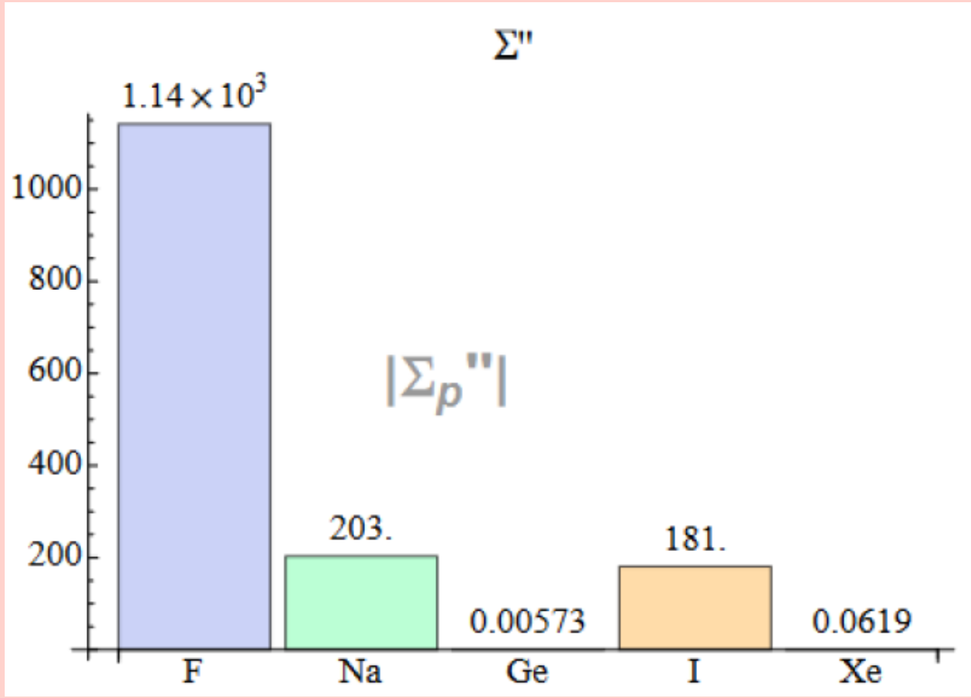
Insensitive



Why Bubble Chambers?

- Very low sensitivity to electron recoil
- Interchangeable fluid for different
- Large parameter space left to explore

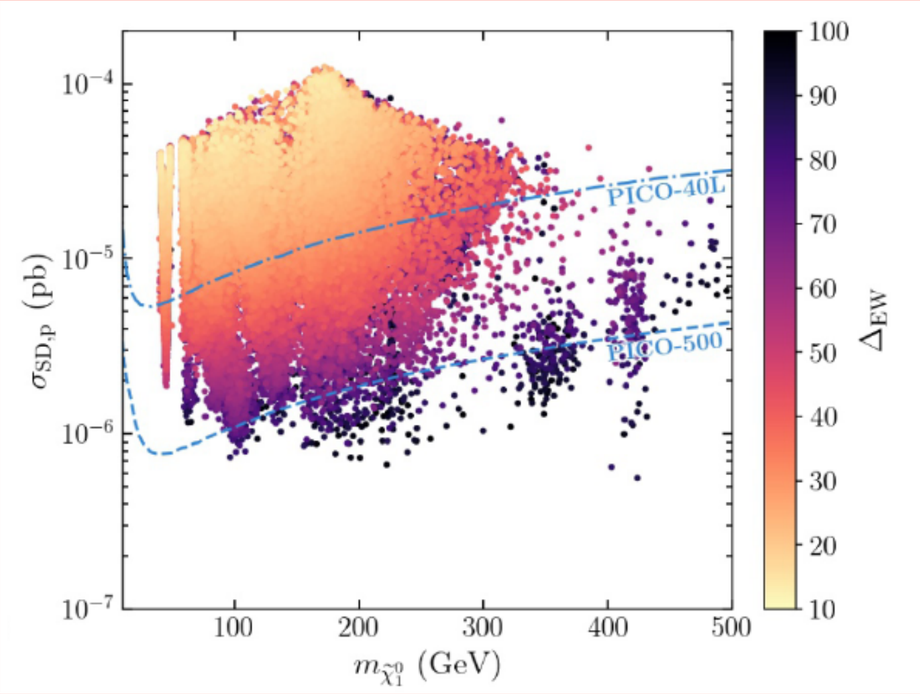


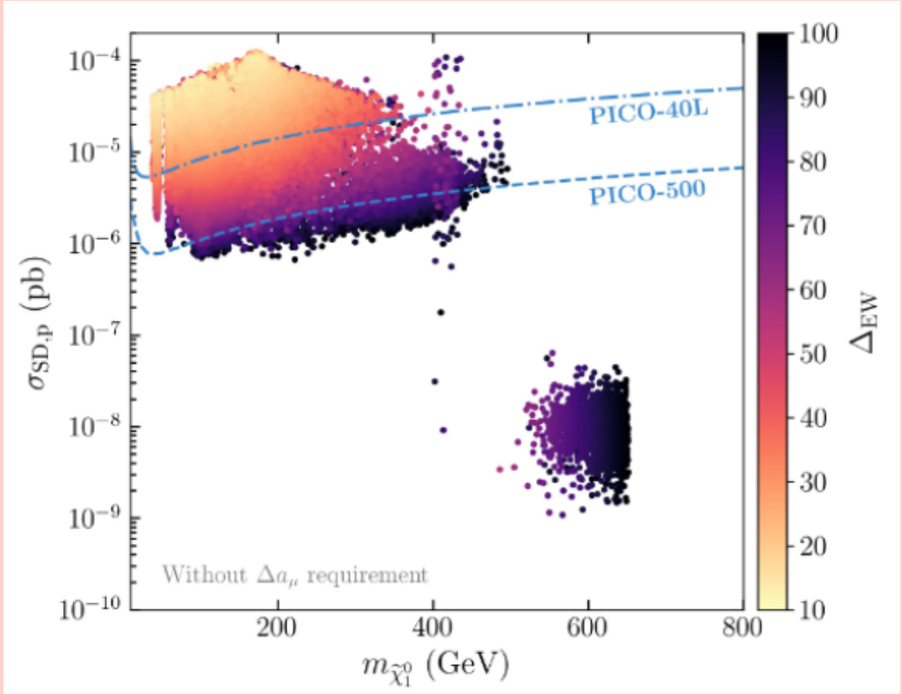


A. Liam Fitzpatrick et al. JCAP02(2013)004

Why Bubble Chambers?

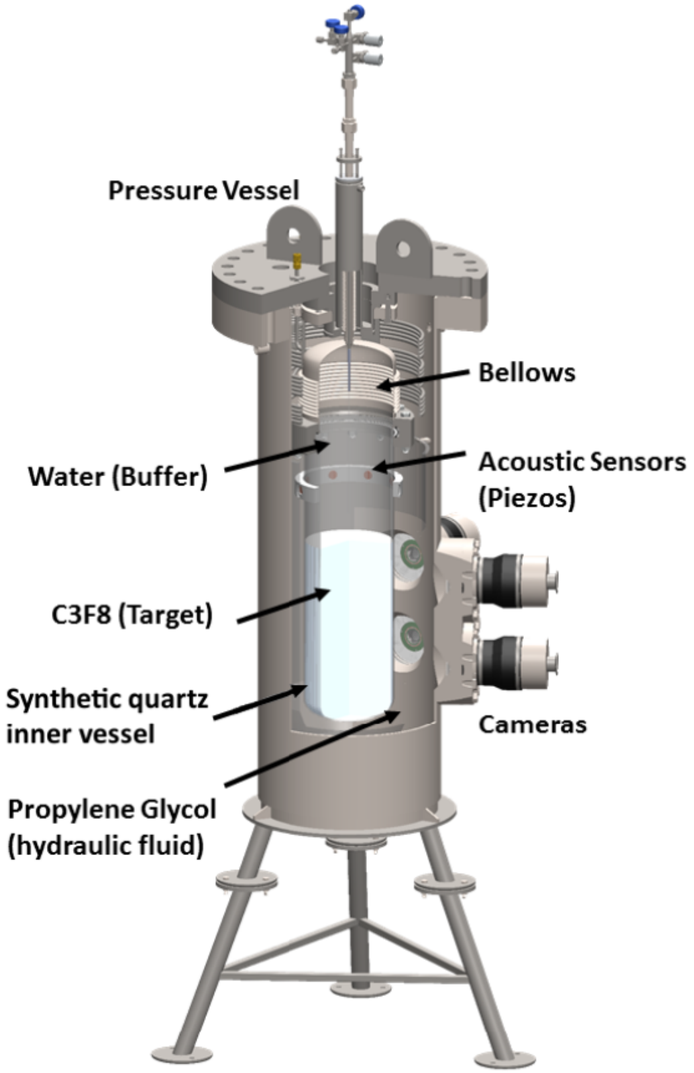
- Very low sensitivity to electron recoil
- Interchangeable fluid for different
- Large parameter space left to explore



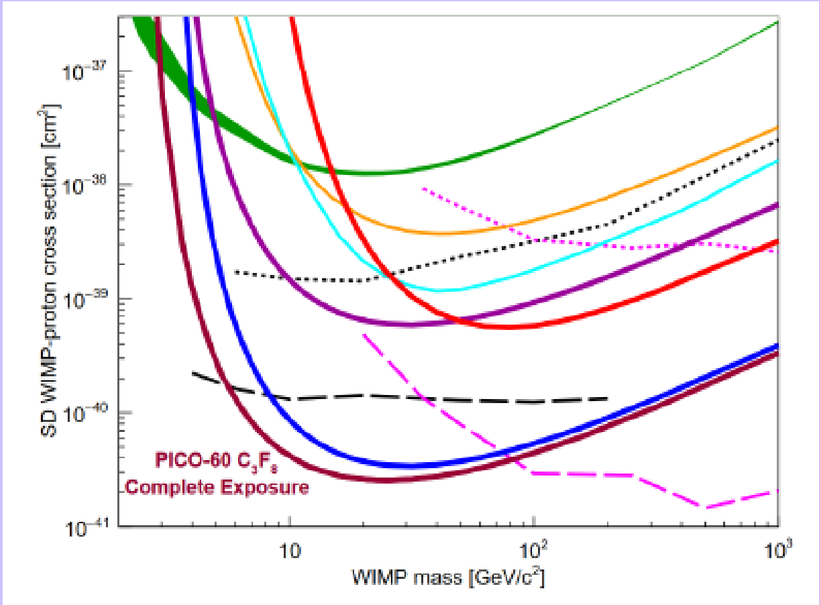


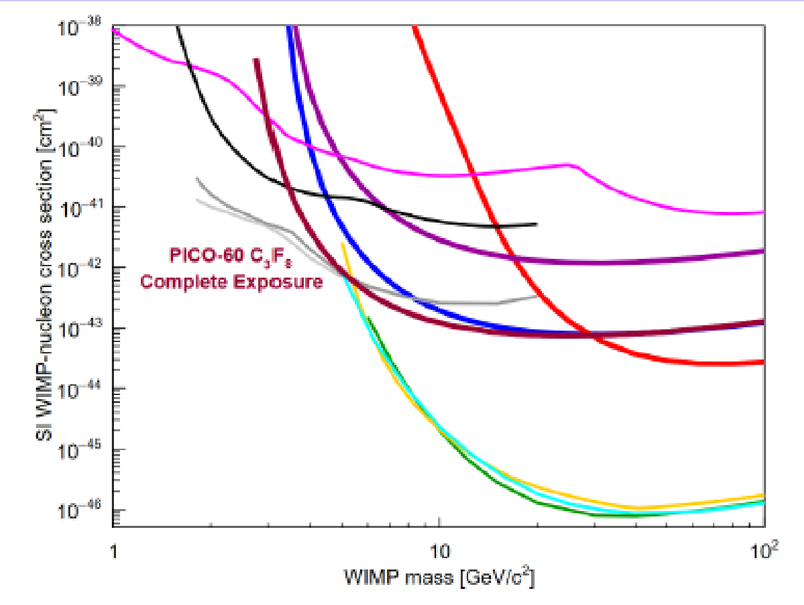
Beekveld et al. SciPost Phys. 11, 049 (2021)

PICO-60



Full Exposure

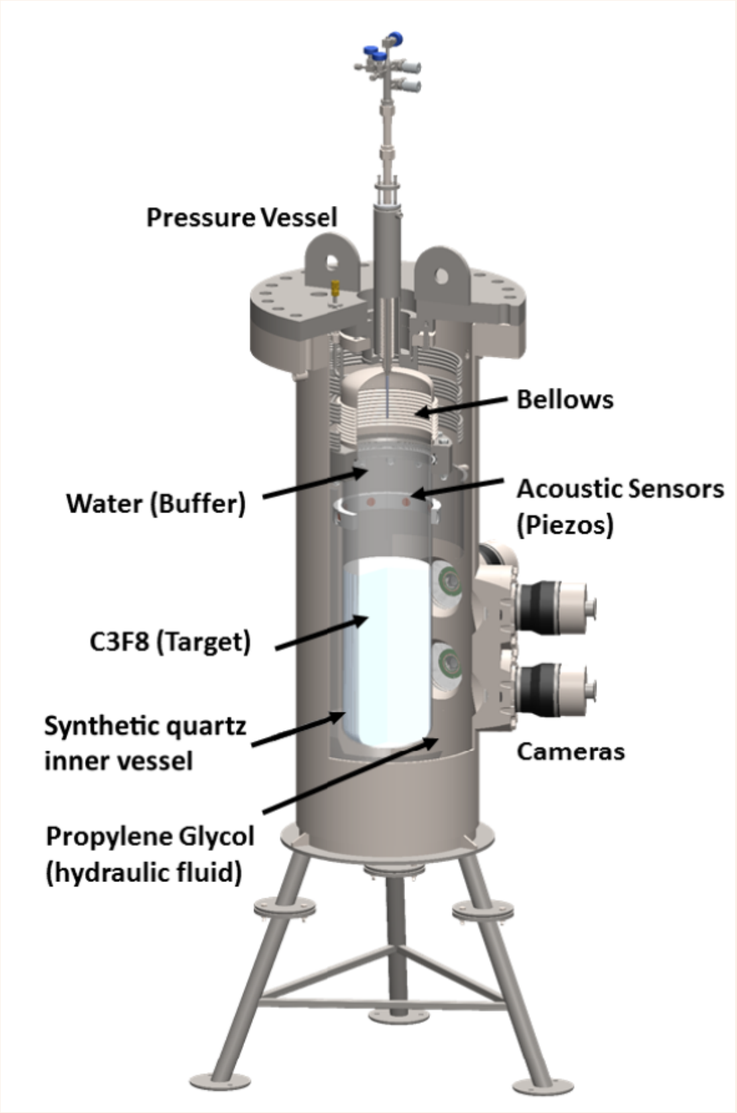




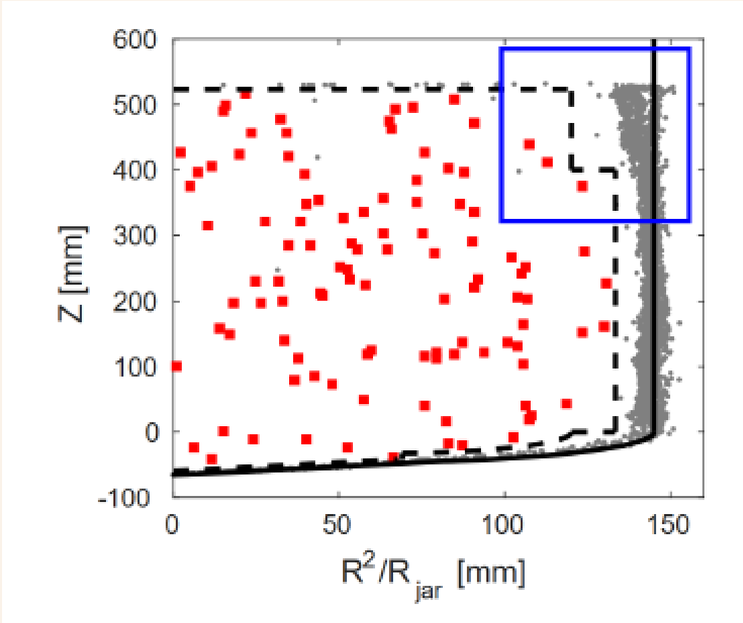
C. Amole et al. (PICO Collaboration) Phys. Rev. D 100, 022001 (2019)

World-leading in WIMP-proton in 2016-2017

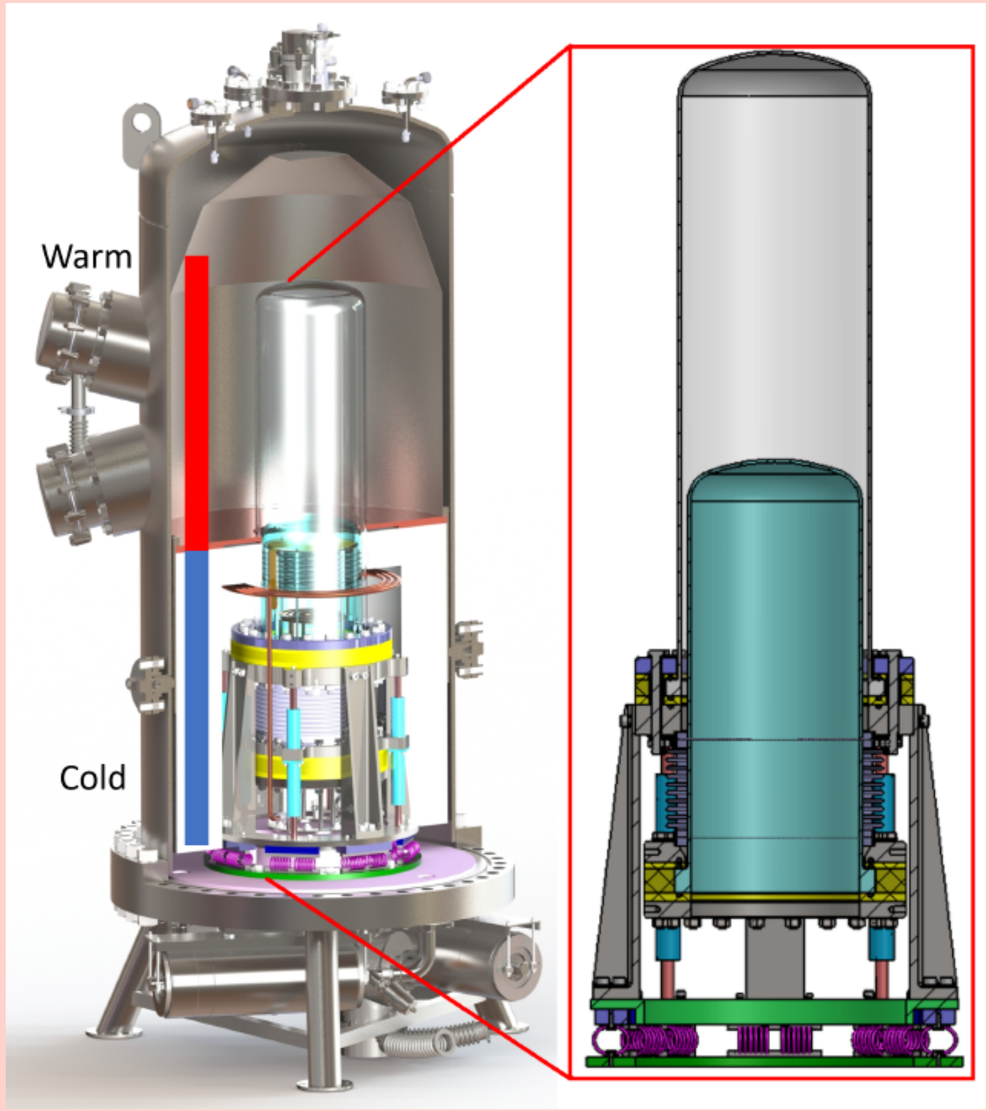
PICO-60 Limitations



- Freon-water-jar interface has a higher rate
- Debris accumulation at the bottom of the jar



PICO-40L



- Right-side up detector
- Remove the buffer fluid and add a second jar
- Cold region to avoid bubble nucleation in the bellows

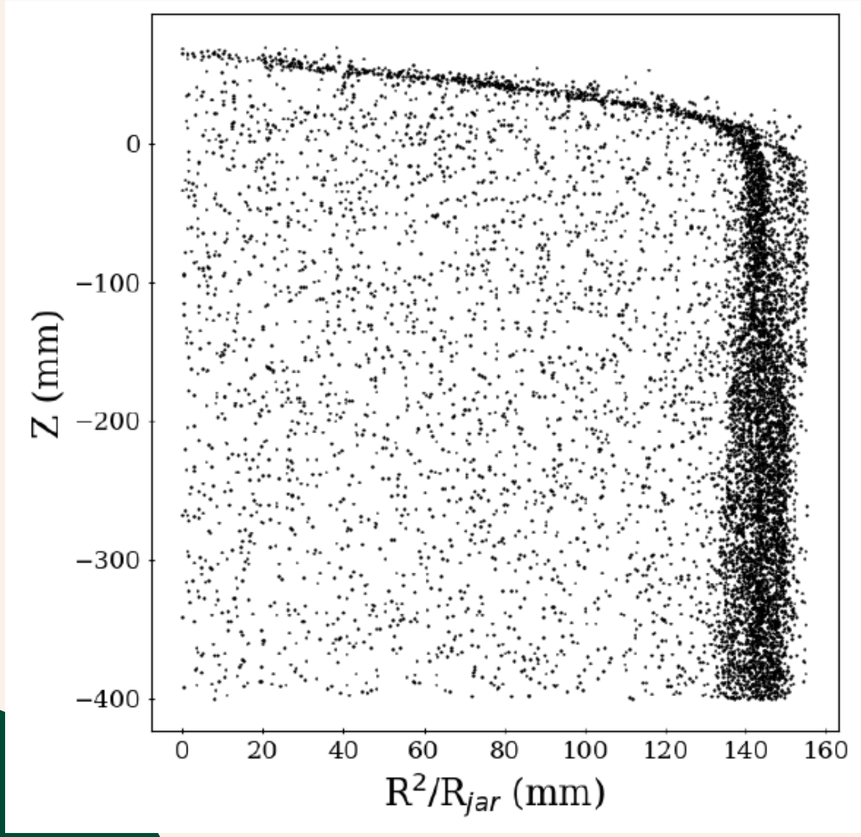
PICO-40L Timeline

2019: Assembly and system tests
May 2020: Commissioning begins with all systems active
September 2020: Commissioning halted due to chiller issues
May 2021: Leak appears internal to detector; disassembly begins
2021-2022: Fix leak, upgrades to address shortcomings of thermal system
2022: Reassembly
2023: Recommissioning and Calibrations
Imminent: Start of physics run

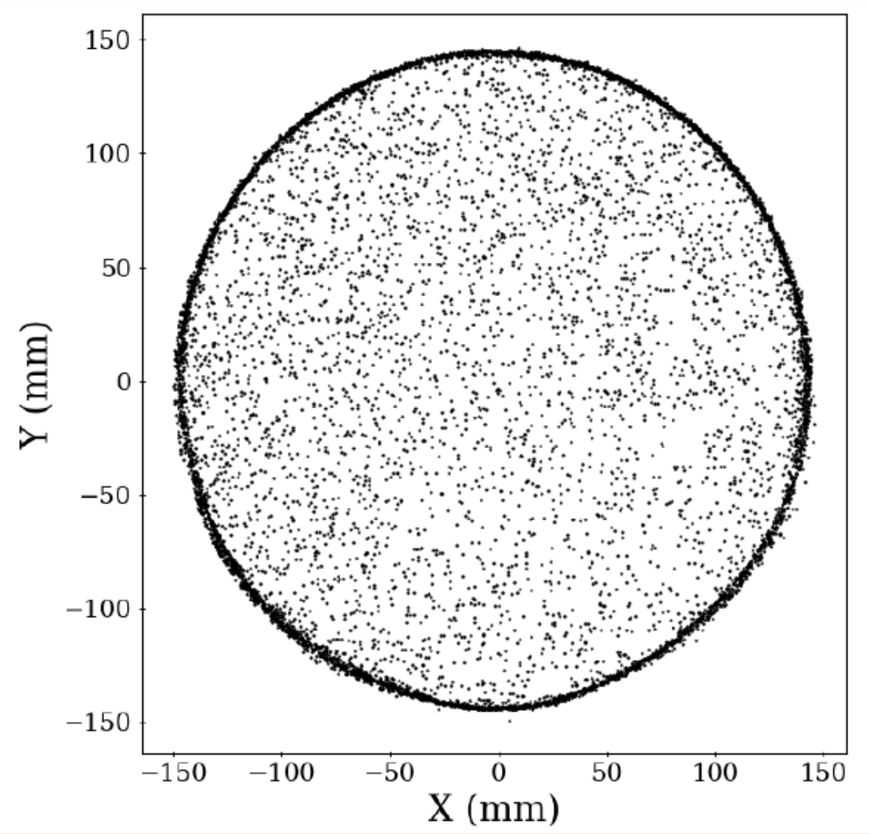
PICO-40L: Position reconstruction

- Stereoscopic images allows 3D reconstruction
- Spatial resolution of around 2 mm with more improvement on the way

Z vs R^2



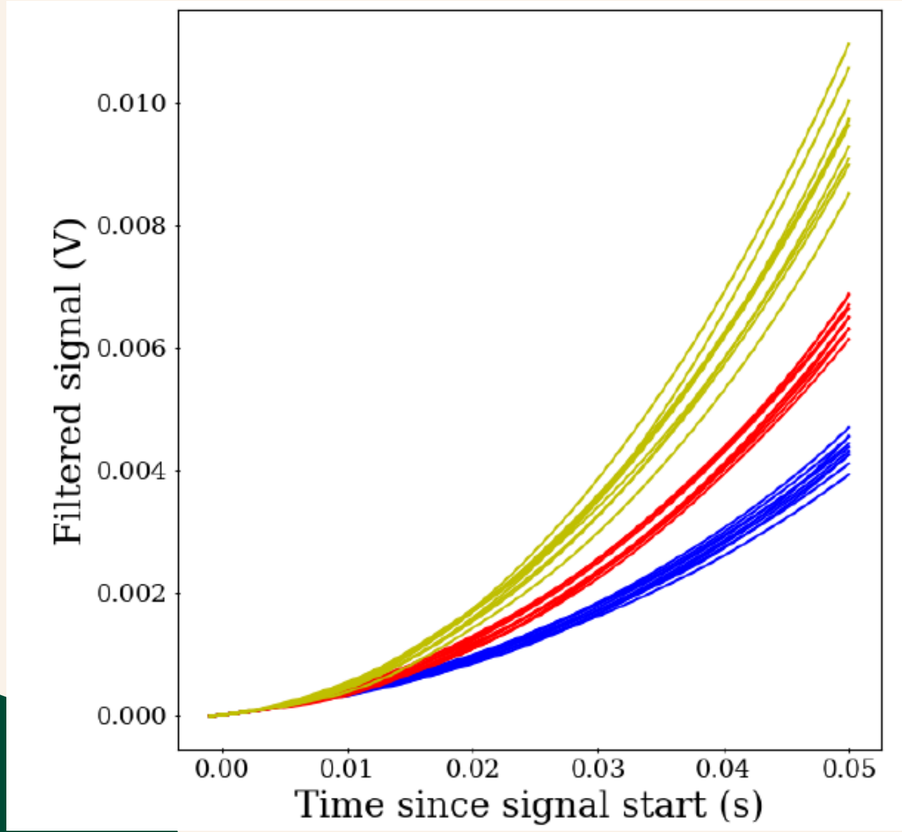
X vs Y



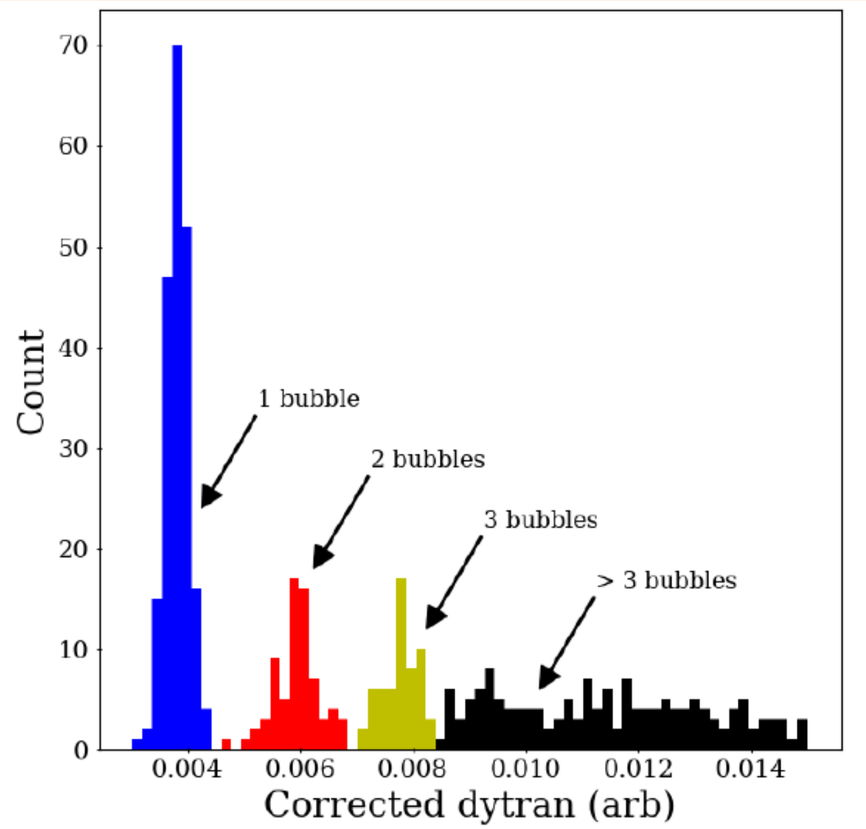
PICO-40L: Bubble counting with Dytran

- Dytran: Fast pressure transducer. Measures change in pressure
- Dytran signal allows for precise bubble counting

Filtered Dytran



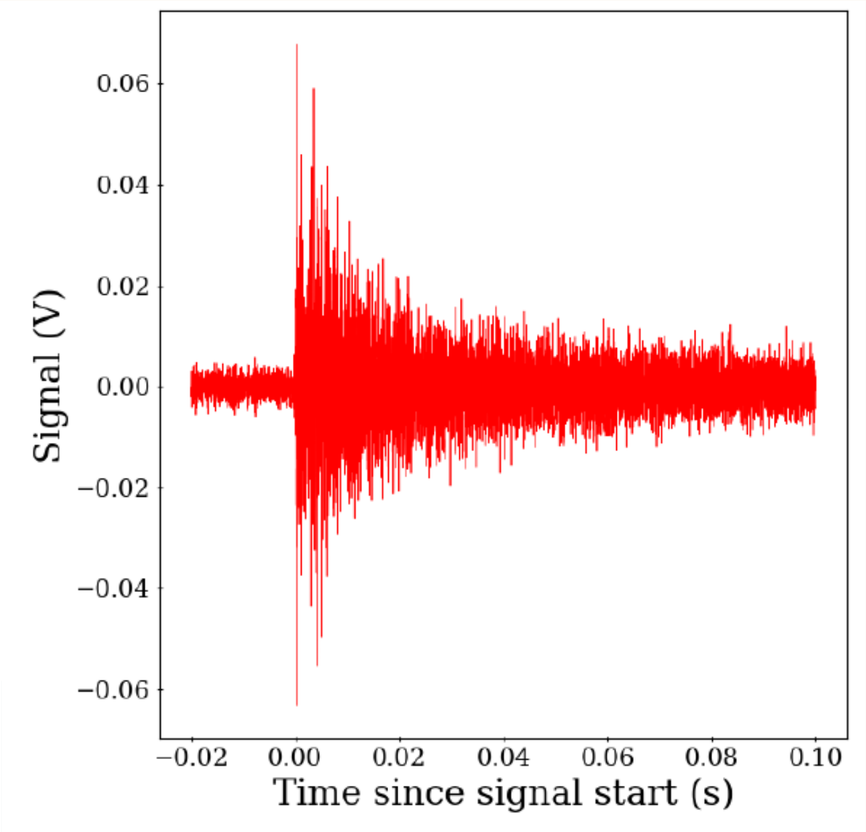
Corrected Dytran



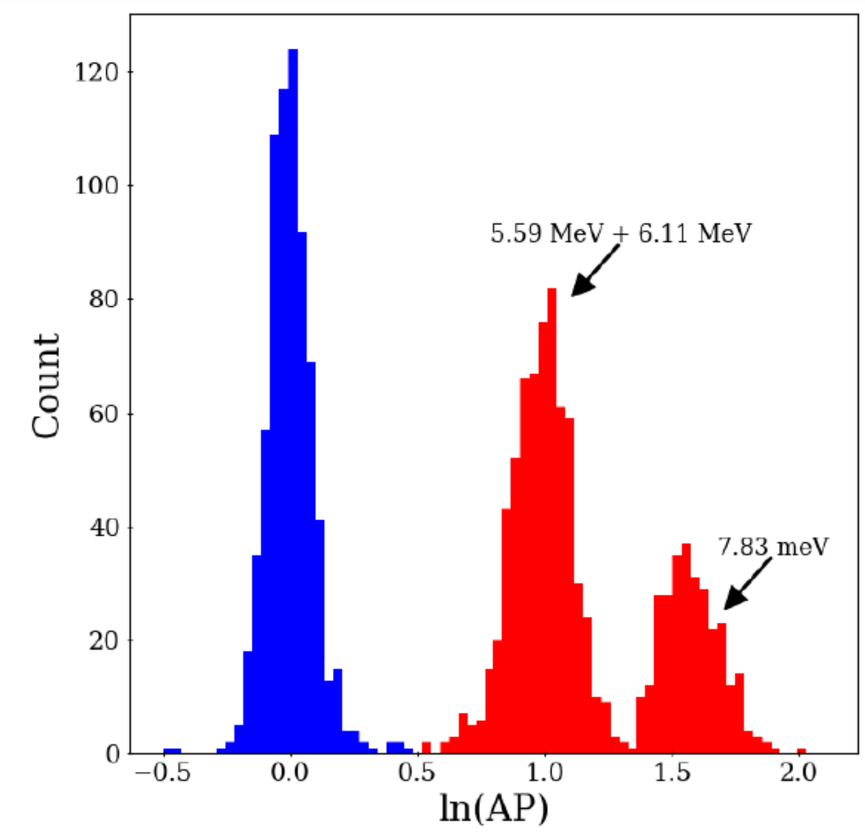
PICO-40L: Particle ID with Acoustics

- 12 Piezos sensors at the bottom of the jar measure acoustic signals
- Magnitude of acoustic signal allows for particle discrimination

Raw Signal

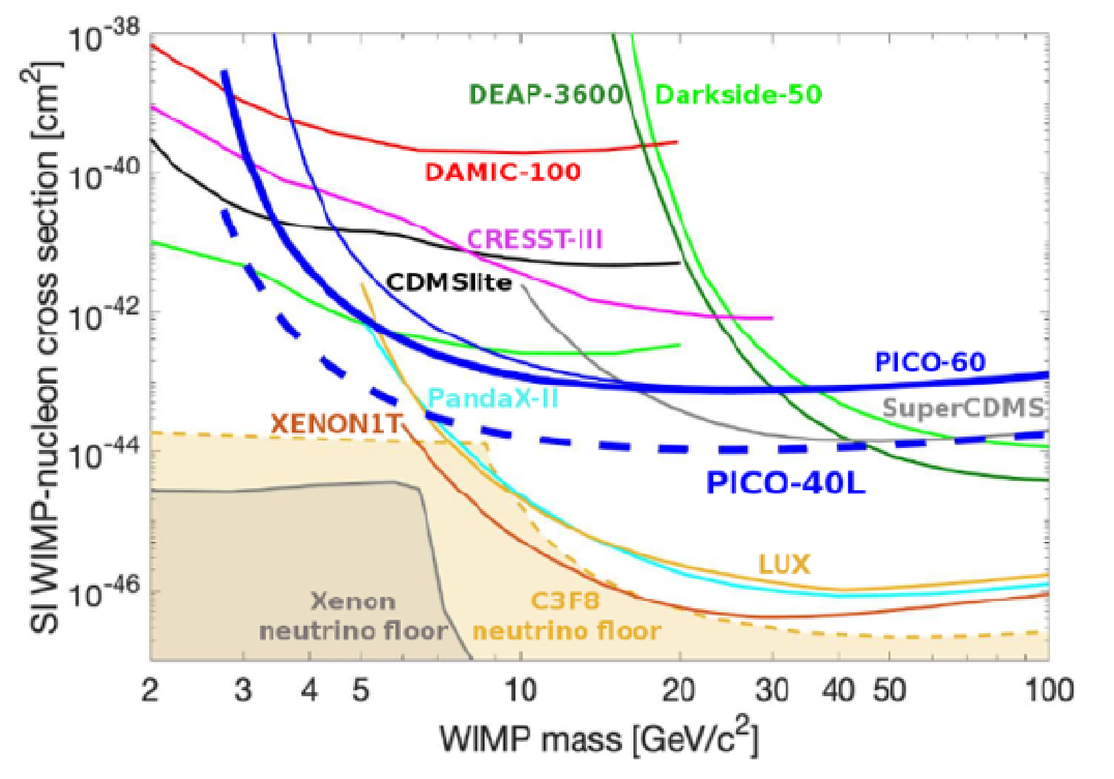


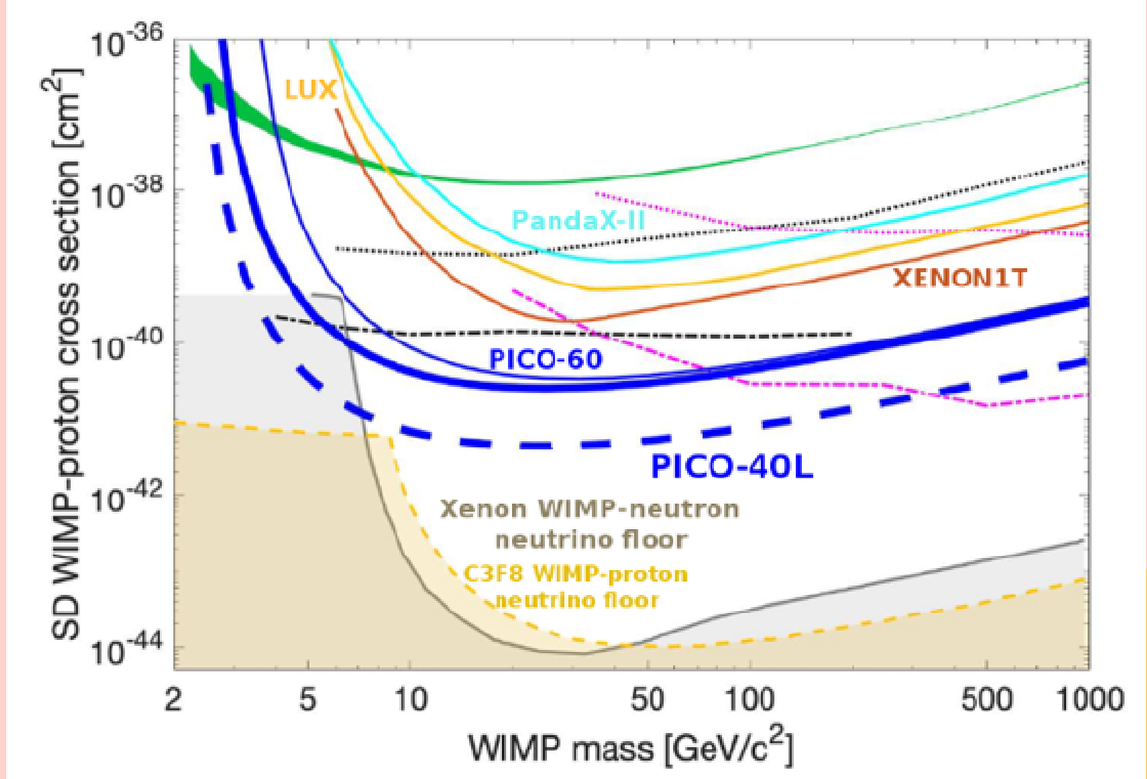
Acoustic Power



PICO-40L Projected limits

After approx. 1 year of livetime at 2.8 keV with 2 background events

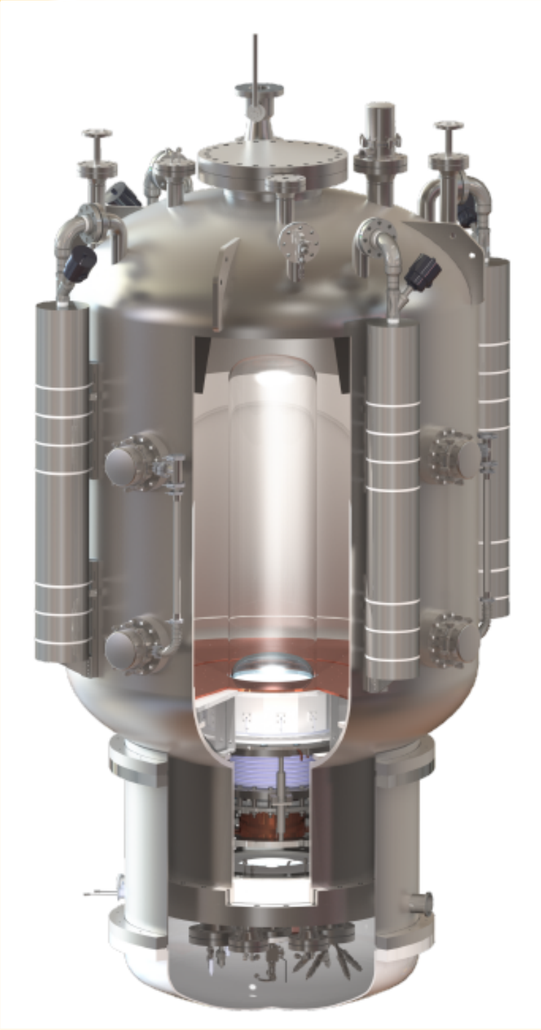


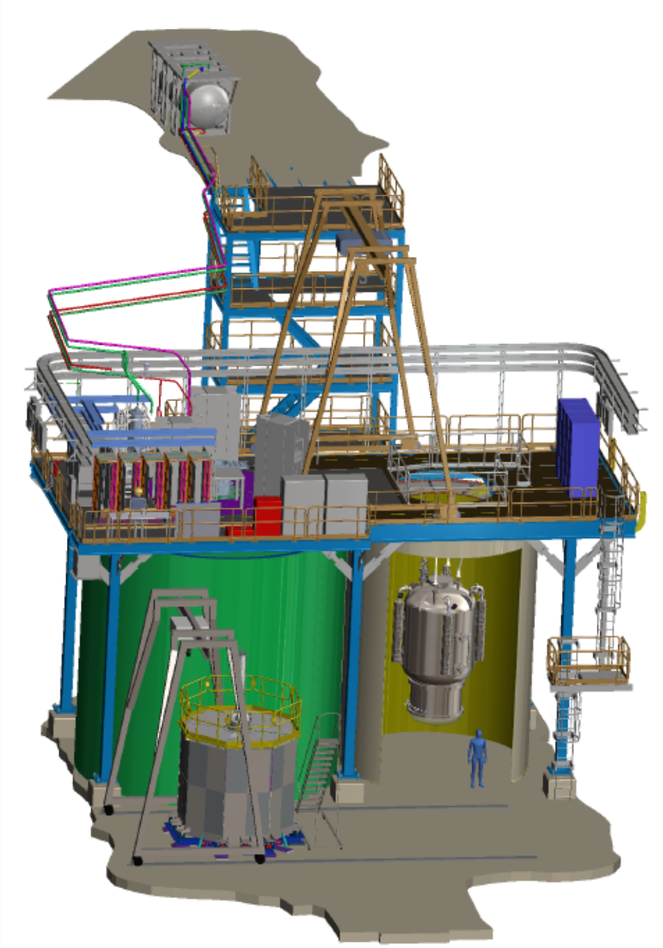


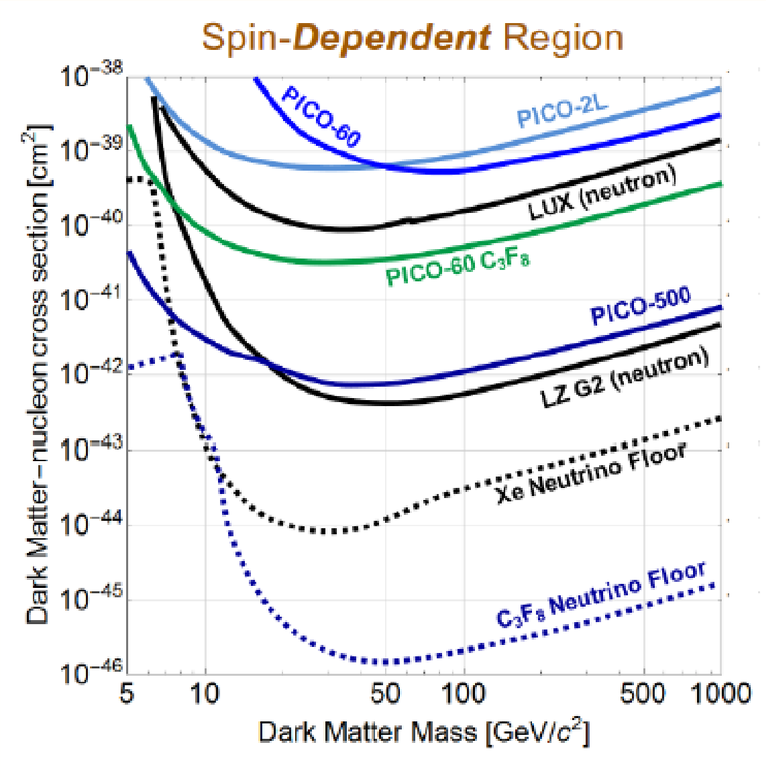
C. Amole et al. (PICO Collaboration), Phys. Rev. D 100, 082006 (2019)

PICO-500

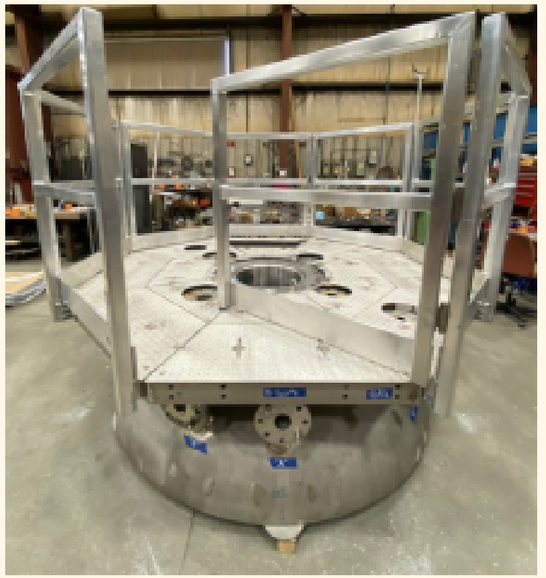
- 250 L of Freon
- Will be located at Cube Hall
- Assembly should start later this year







PICO-500



Thanks for listening!

PICO

ČESKÉ VYSOKÉ UČENÍ TECHNICKÉ V PRAZE
R. Filgas, D. Mamedov, E. Rukhadze, I. Stekl

PennState
D. Priya, S. Priya, Y. Yan

NORTHWESTERN UNIVERSITY
C.E. Dahl

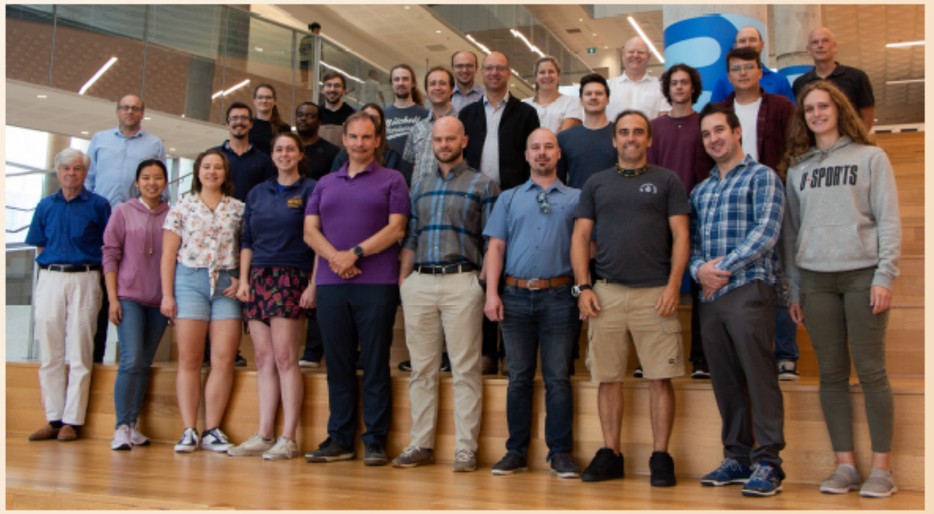
SNOLAB
P. Grylls, A. Mathewson, I. Lawson, S. Sekula

Northeastern ILLINOIS UNIVERSITY
O. Harris

Fermilab
P.S. Cooper, M. Crisler, A. Sonnenschein

Drexel UNIVERSITY
R. Neilson

A. Acevedo-Rentería, A. García-Viltres, E. Vázquez-Jáuregui



KICP
Kavli Institute for Cosmological Physics at The University of Chicago
J.I. Collar

SAHA INSTITUTE OF NUCLEAR PHYSICS CALCUTTA
J. Basu, M. Das, V. Kumar

UNIVERSITY OF ALBERTA
M. Baker, S. Fallows, C. Krauss, Q. Malin, S. Miller, M. Rangen, C. Rethmeier, P. Welingampola

INDIANA UNIVERSITY SOUTH BEND
E. Behnke, C. Cripe, I. Levine,

Pacific Northwest NATIONAL LABORATORY
I. Arnquist, C.M. Jackson, B. Loer

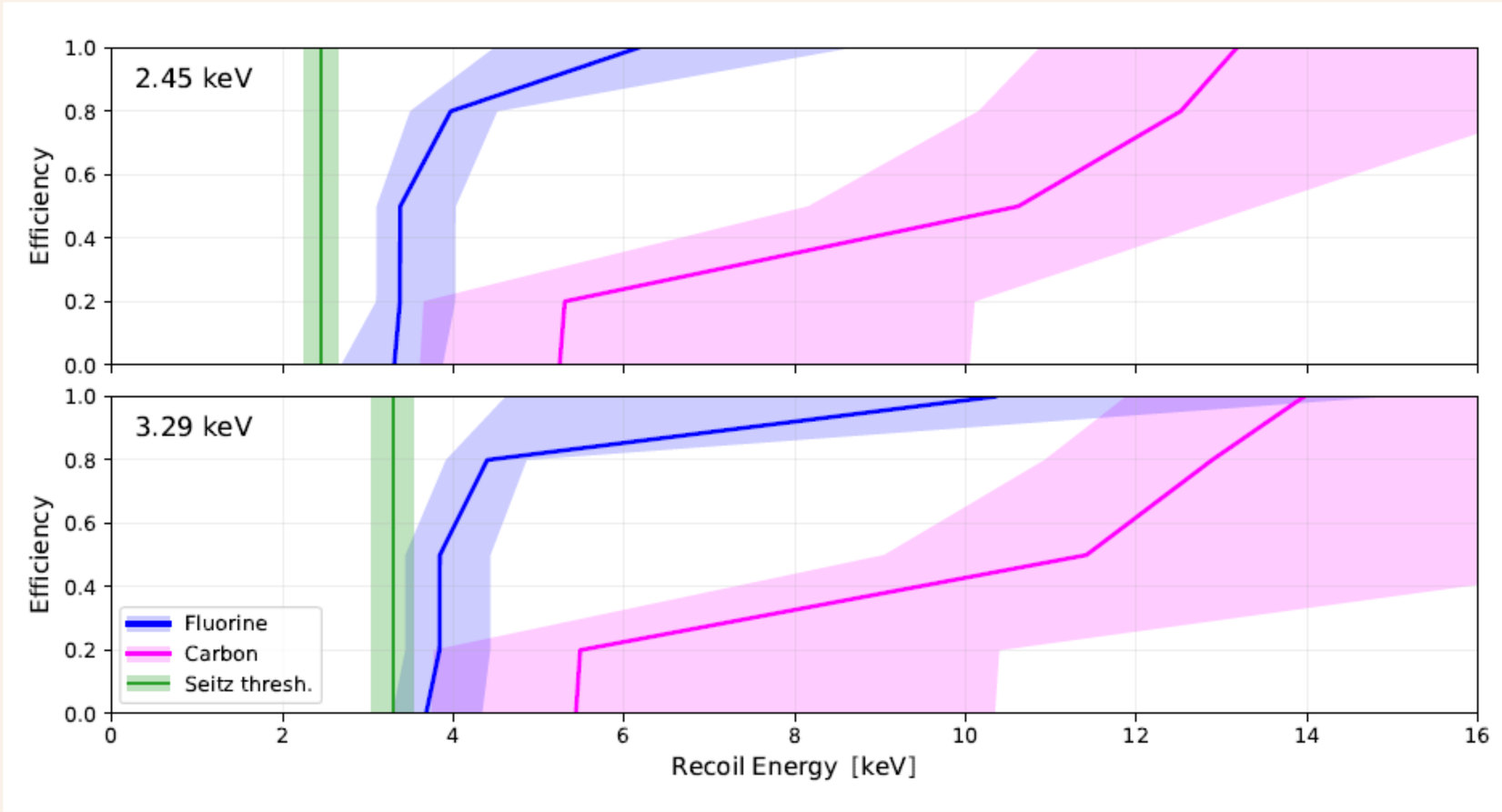
Queen's UNIVERSITY
E. Adams, M. Bai, K. Clark, D. Cranshaw, K. Dering, G. Giroux, H. Herrera, C. Moore, A. Noble, M. Robert

Université de Montréal
I. Brooklyn Varela, L. Desmmarais, P. Frédérick, M. Laurin, V. Monette, H. Nozard, A. Robinson, J. Savoie, N. Starinski, V Zacek, C. Wen Chao

LaurentianUniversity UniversitéLaurentienne
J. Farine, A. Le Blanc, C. Licciardi, U. Wichoski

Efficiency curves

Extras



arXiv: 1902.04031