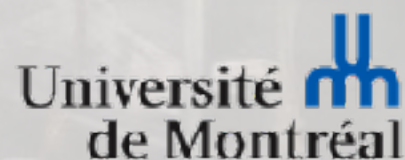


Dark Matter Search with PICO Bubble Chambers

Carsten B. Krauss
for the PICO collaboration



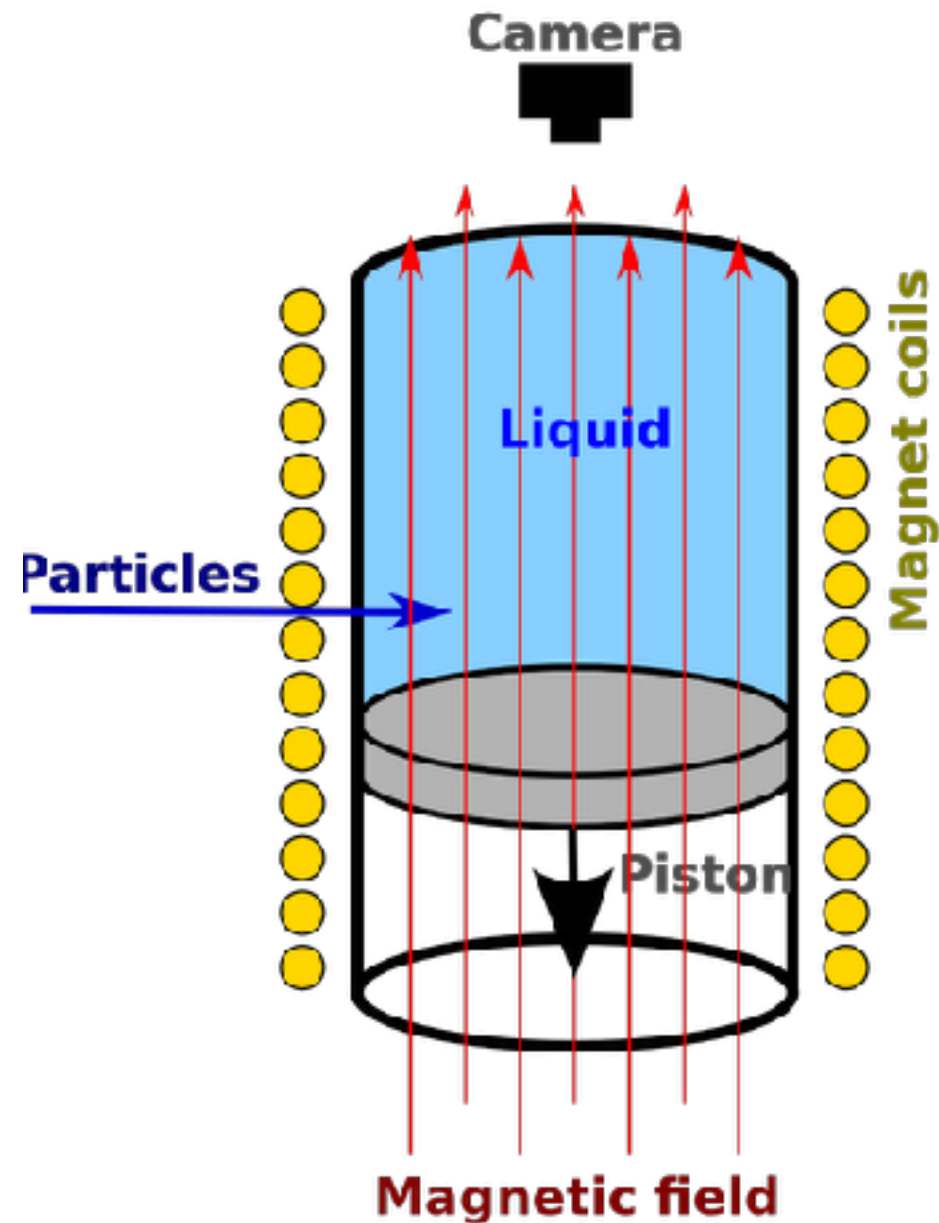
IPP Town Hall Meeting July 15 2020



Overview

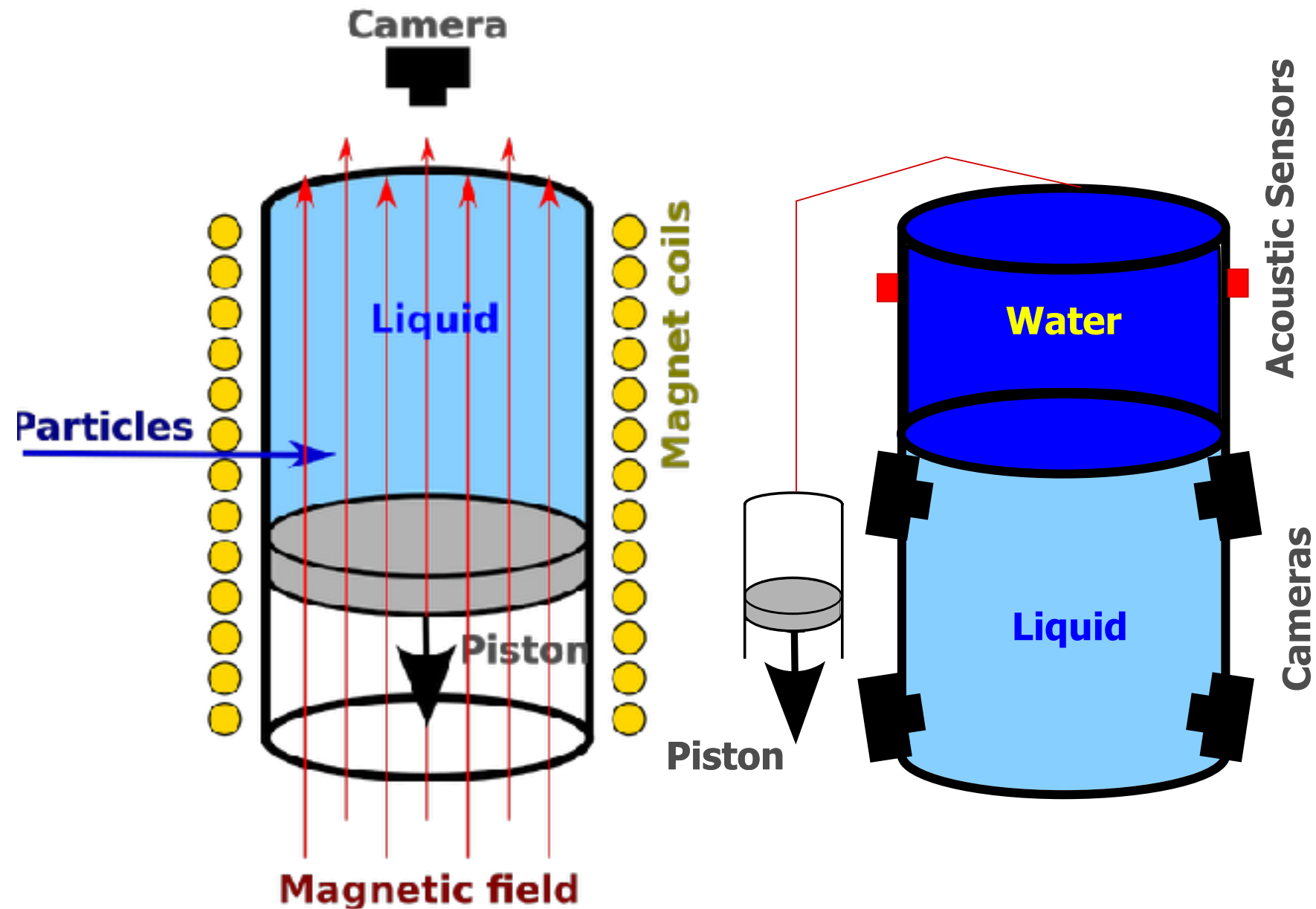
- Status
- Plans
- Challenges
- Opportunities
- Summary

Bubble Chamber Design



Classic Bubble Chamber

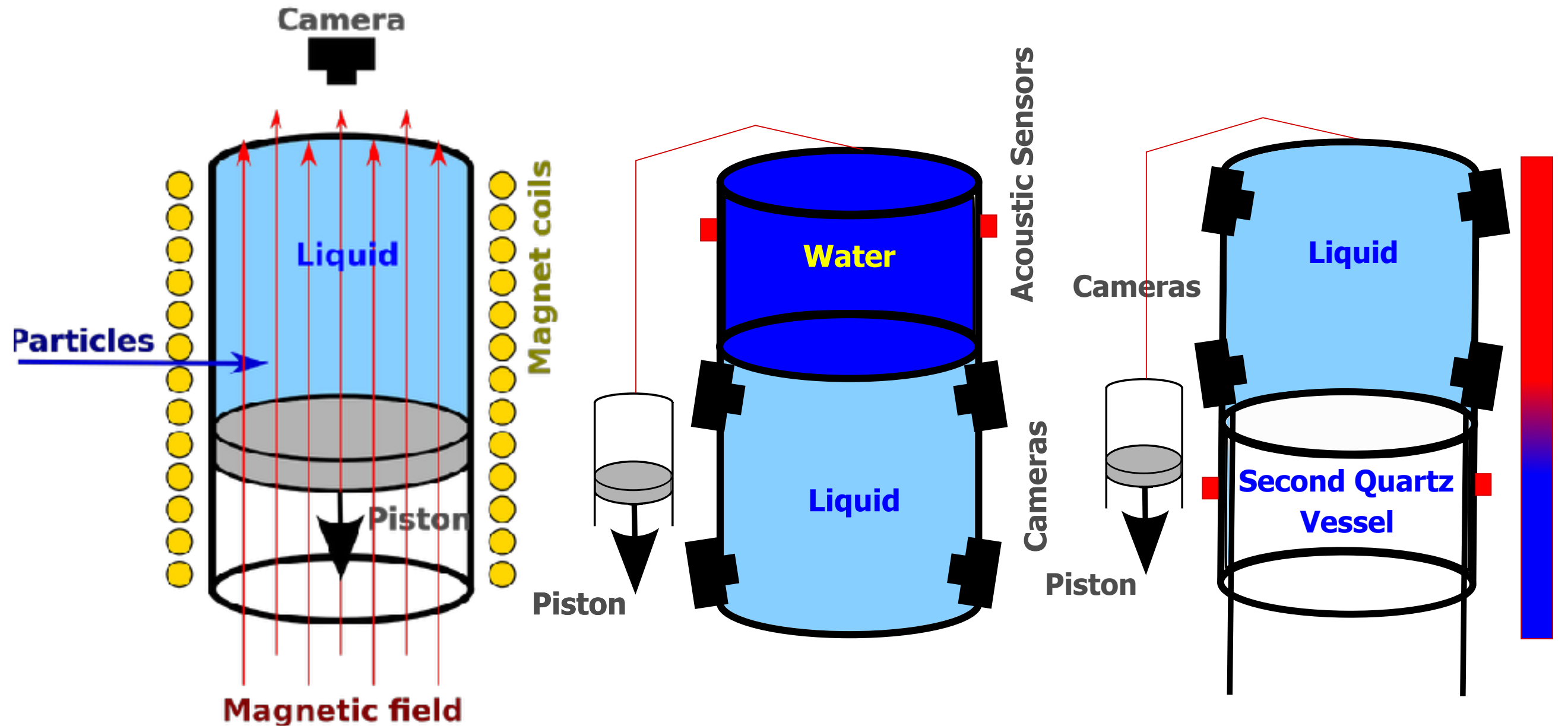
Bubble Chamber Design



Classic Bubble Chamber

PICO-60

Bubble Chamber Design



Classic Bubble Chamber

PICO-60

PICO "right-side-up" chamber

Status: PICO-40L

- PICO-40L is the first bubble chamber of a new type, without buffer liquid and with a new thermal design called “right-side-up” chamber
- The system is fully assembled and operation has started in fall 2019. Final commissioning steps will be completed after the annual SNOLAB summer shutdown in August 2020
- More than 1800 bubbles have been recorded, albeit not yet with physics quality thermal stability



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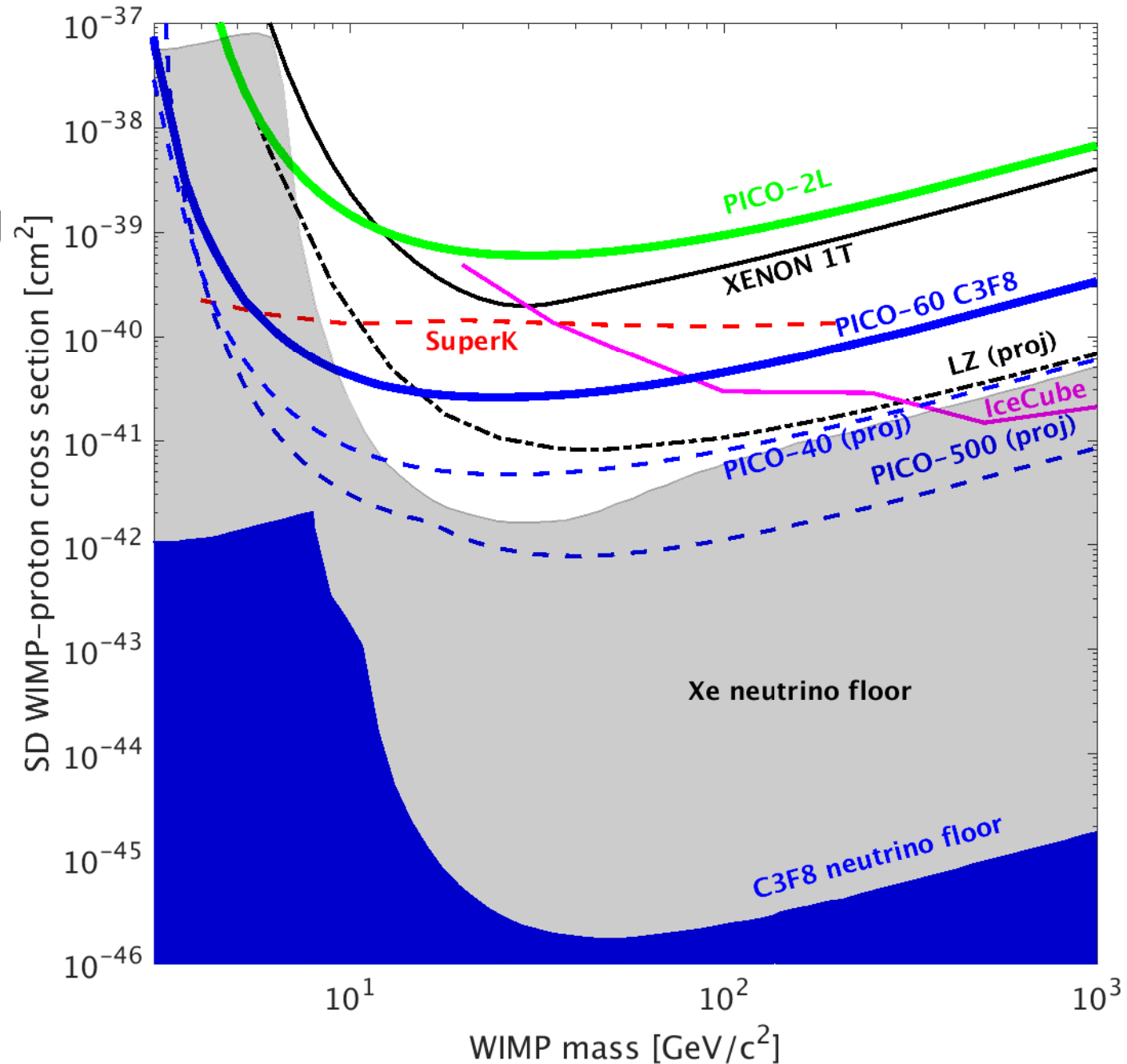
Status PICO-500

- Design status: most major systems are designed and many important parts are being procured right now
- Sensitivity: we expect to be impacted by coherently scattered solar neutrinos, requiring higher threshold operation
- Limitations: PICO-500 uses the largest commercially available synthetic quartz vessel



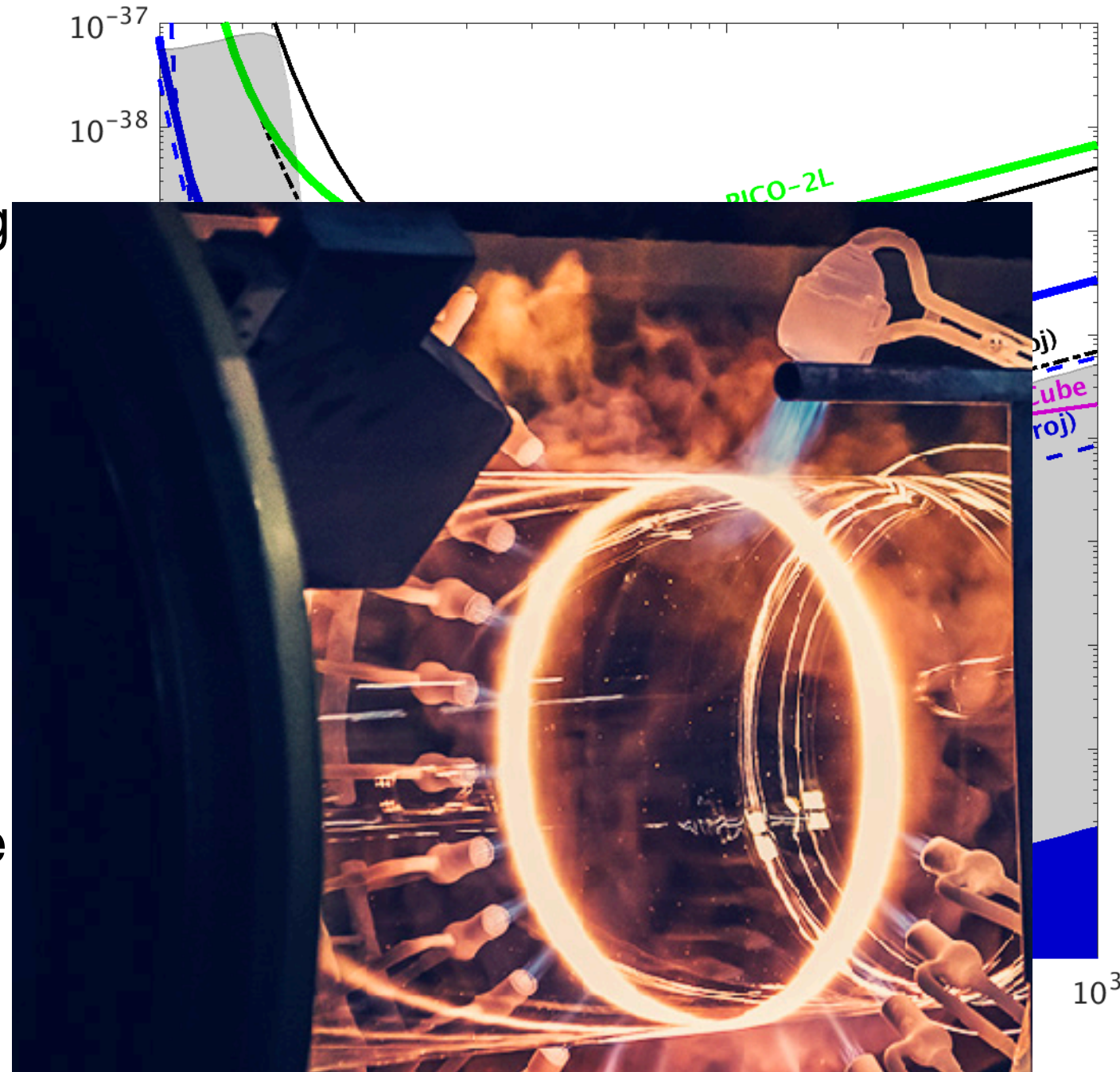
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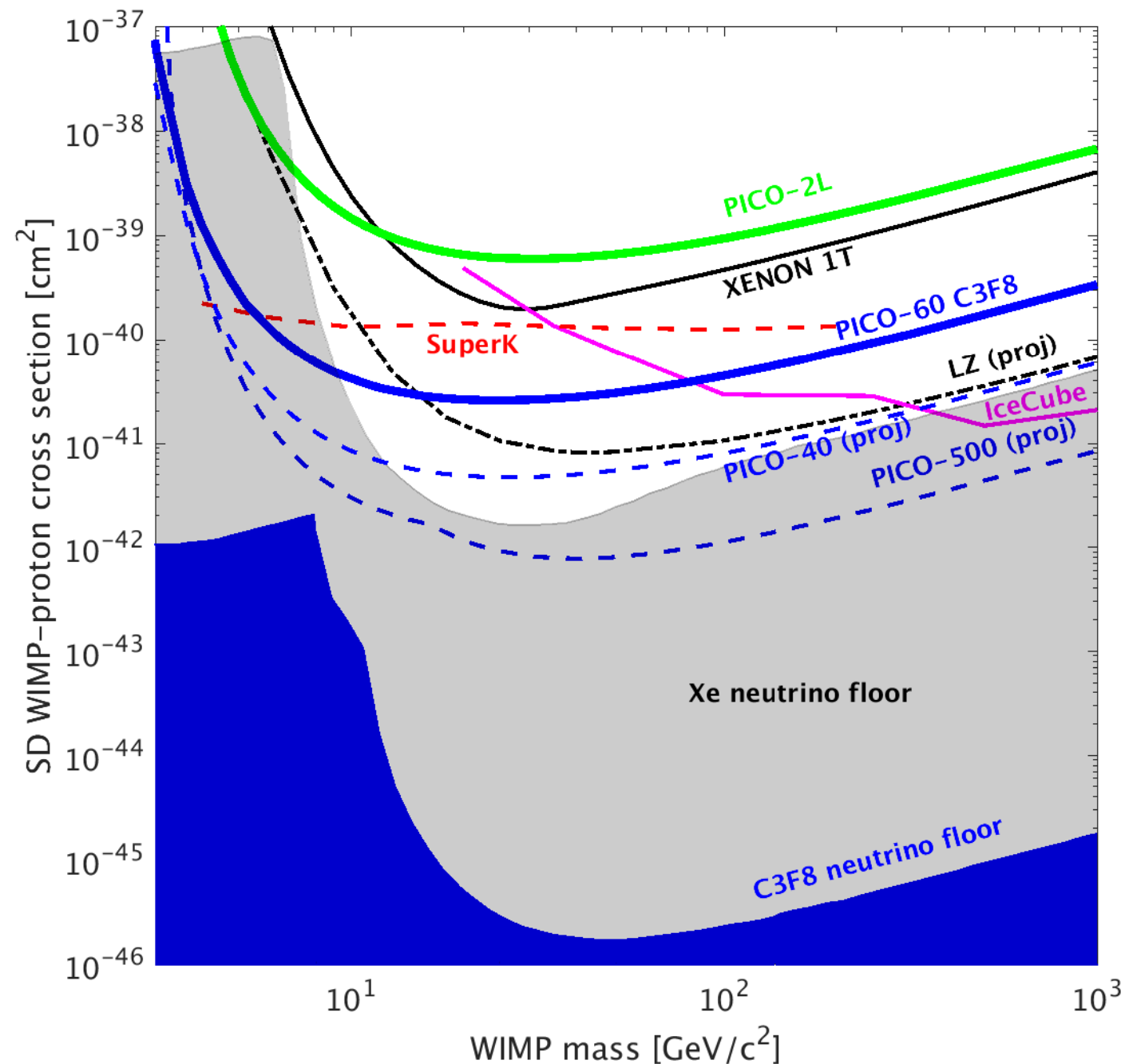
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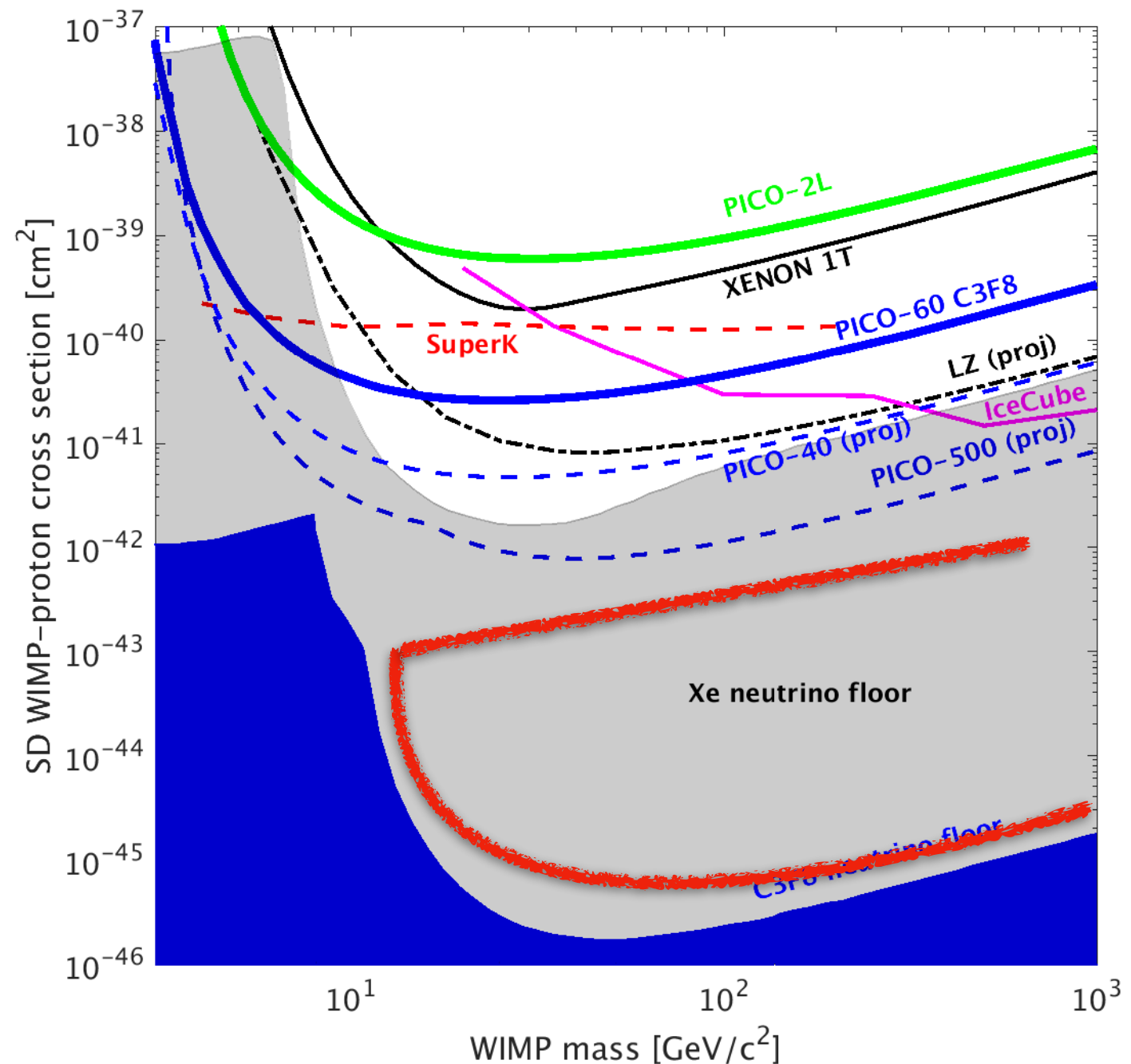
The Future: PICO

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- A multi ton scale low background bubble chamber could exploit the low background, low cost and Canadian expertise to reach the high energy atmospheric neutrino coherent scattering floor



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Challenges

- We don't know how to build a low background bubble chamber larger than PICO-500, yet
- Backgrounds in bubble chambers are simpler to control than in other types of dark matter search experiments, due to the nature of the liquid target — still, achieving the level of background control needed for a multi ton scale detector remains hard
- Some aspects of the low background bubble chamber have not been verified at large scale, such as acoustic signal attenuation. PICO-500 will help to fill these gaps

Opportunities

- Bubble chambers are fascinating, visually captivating and allow for excellent public engagement
- Bubble chambers are one of the cheapest way to search for dark matter recoil events known - with a fluorine based target PICO remains the leader in the spin-dependent dark matter search
- With recent progress in R&D it seems feasible to use materials other than quartz for future bubble chambers. If this can be confirmed at larger scale, ton scale chambers become possible which would allow for a next generation PICO detector
- With SBC, an opportunity to use a liquid noble gas for such a multi ton scale detector in a bubble chamber could be developed. This will be informed by the direction dark matter searches take in the coming years. (see K. Clark's talk in the next session)

Summary

- PICO is an exciting, Canadian led direct dark matter search experiment with world leading sensitivity
- PICO-500 aims to retain and enhance this leadership position
- In order to make an next generation bubble chamber experiment for dark matter possible, new technical solutions will have to be found
- With the current PICO-40L and PICO-500 experiments successful, we aim to keep building international momentum to develop the next phase of PICO