

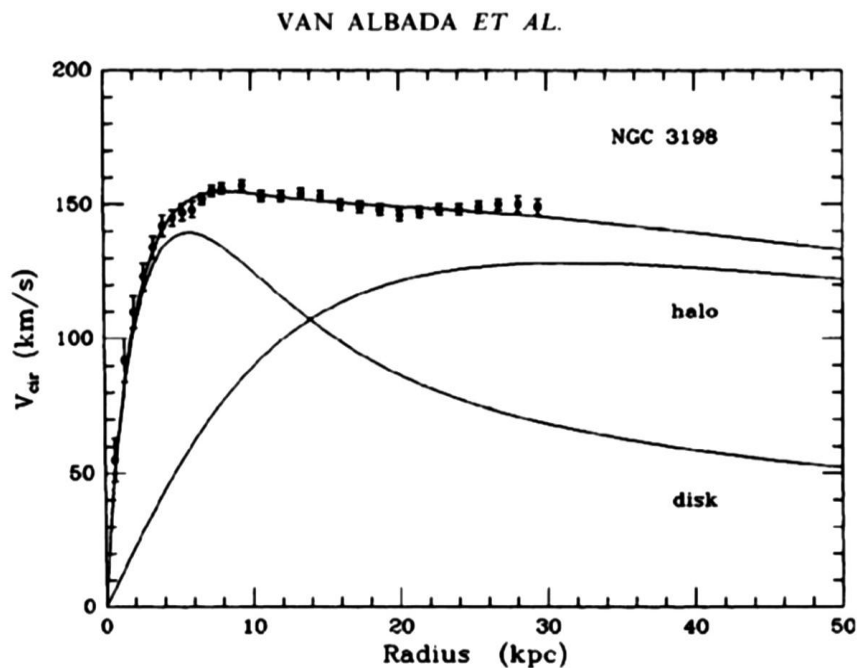
# COUPP-500

Direct Dark Matter Detection  
with a Ton Scale Bubble Chamber

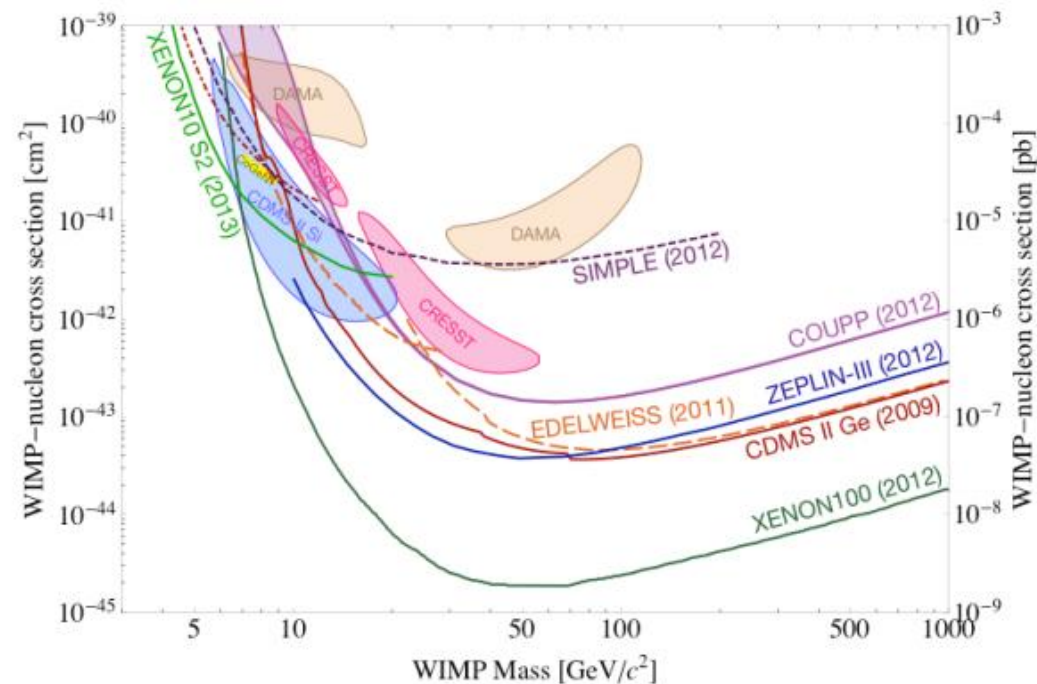
Chicago Underground Observatory for Underground Particle Physics 500kg

# Evidence for Dark Matter

- Observational evidence of Dark Matter:
  - rotation curves of galaxies do not match visible matter
  - micro-lensing shows hints of gravitationally interacting matter

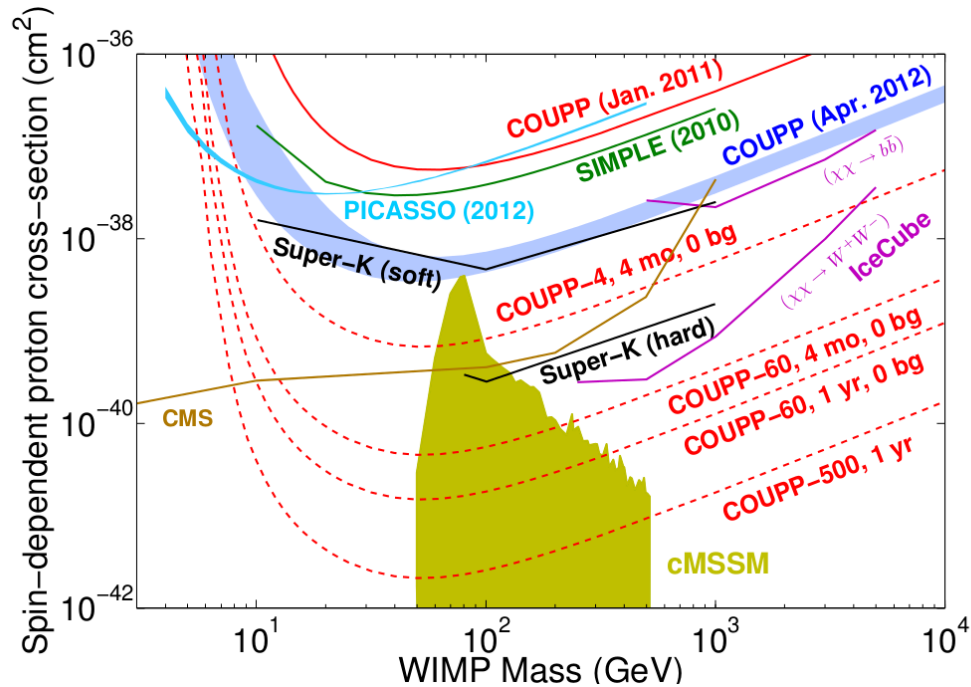


# The state of the art



- **Indirect searches:** DM annihilation (IceCube, H.E.S.S., GLAST,...)
- **Direct searches:** Nuclear recoil of WIMPs (COUPP, CDMS, XENON, CUORE,...)
- **Goal:** Set more stringent limits on DM scattering cross sections
- **Difficulty:** Discriminate true nuclear recoil from electron-, muon-, neutron- recoils and alpha particles

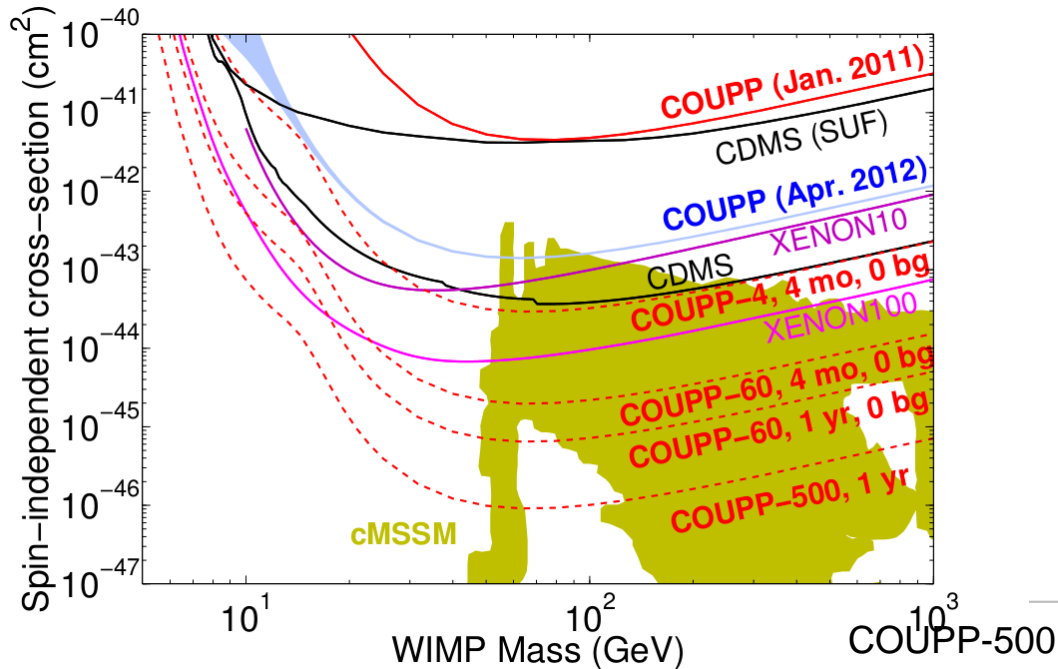
# The state of the art



→ Idea: Upgrade COUPP to 500 kg bubble chamber

→ Advantages:

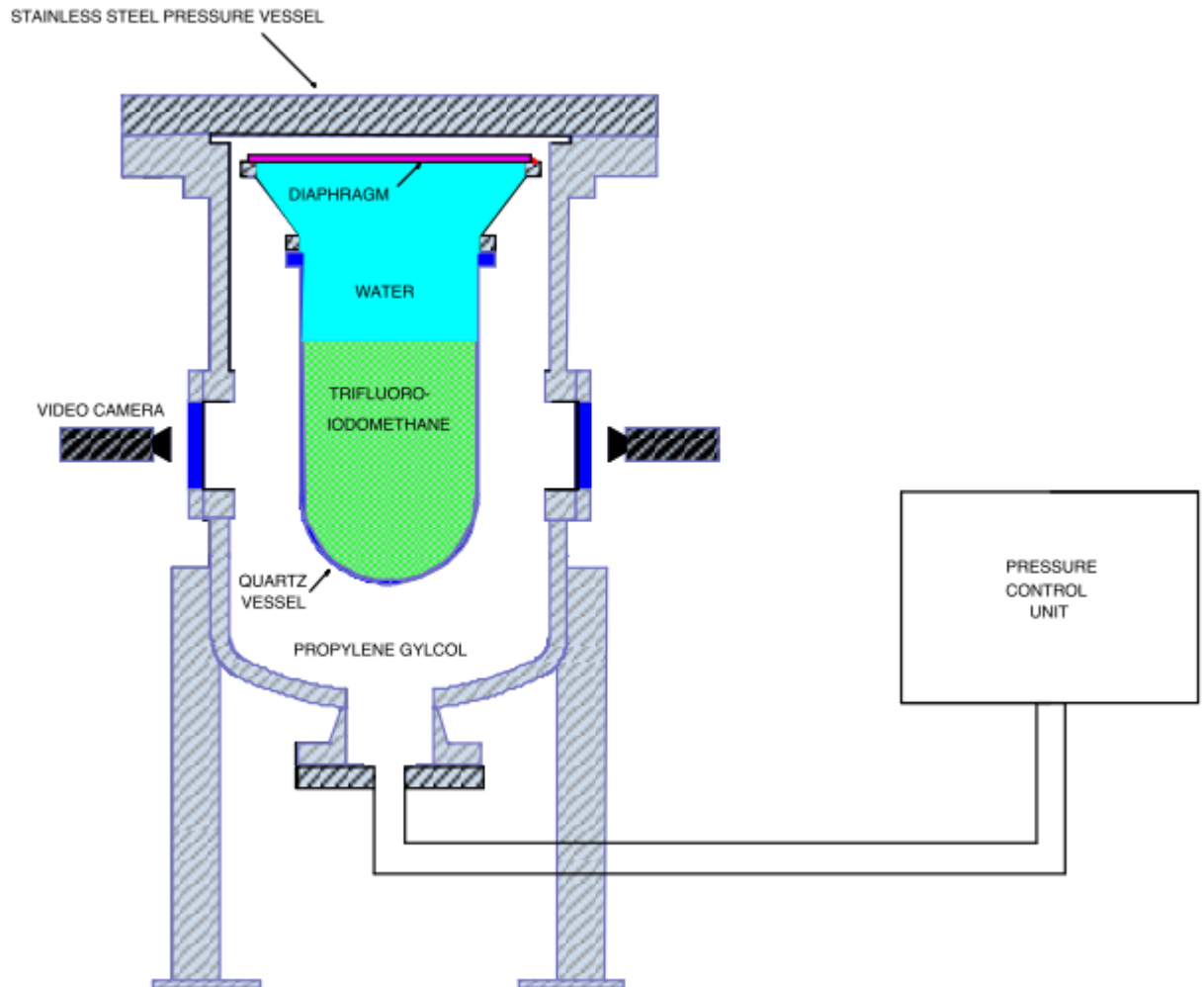
- Most of the R&D already performed
- Necessary know-how present within the collaboration
- High performance/Low cost



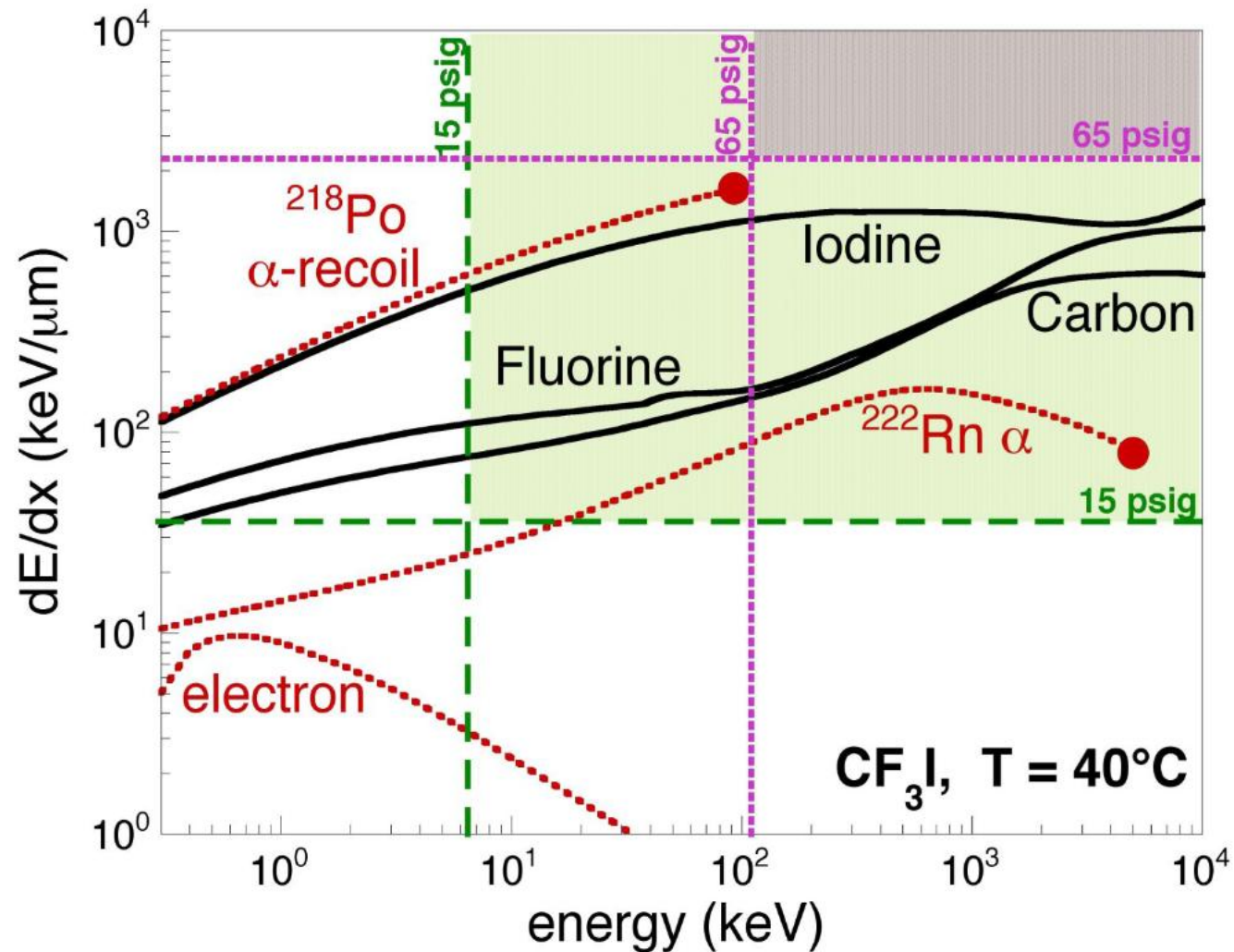


# Experimental Setup

- COUPP-500: Bubble Chamber (fluid:  $\text{CF}_3\text{I}$ )
  - Bubble nucleation ~ temperature and pressure
- Setup based on previous COUPP experiments (upgrade)
- Signal: single bubble  
produced through  
DM recoil
- Background:
  - EM recoil ( $\beta$  and  $\gamma$ )
  - Neutrons
  - Alpha particles



# Background

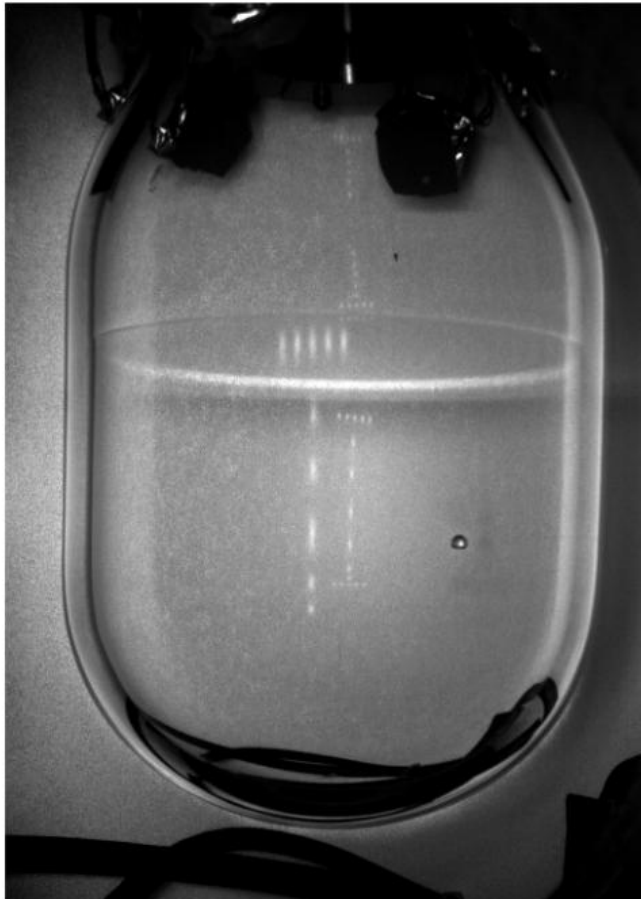


Tune operation parameters ~ sensitive to nuclear recoils & blind to minimum ionization ( $\beta$  and  $\gamma$ )

→ Full EM background rejection

# Background

- Neutrons: mean-free-path 15 cm ( $\sim 10^{12}$  cm for WIMPs) with multiple scattering
  - More bubbles!



Dark matter



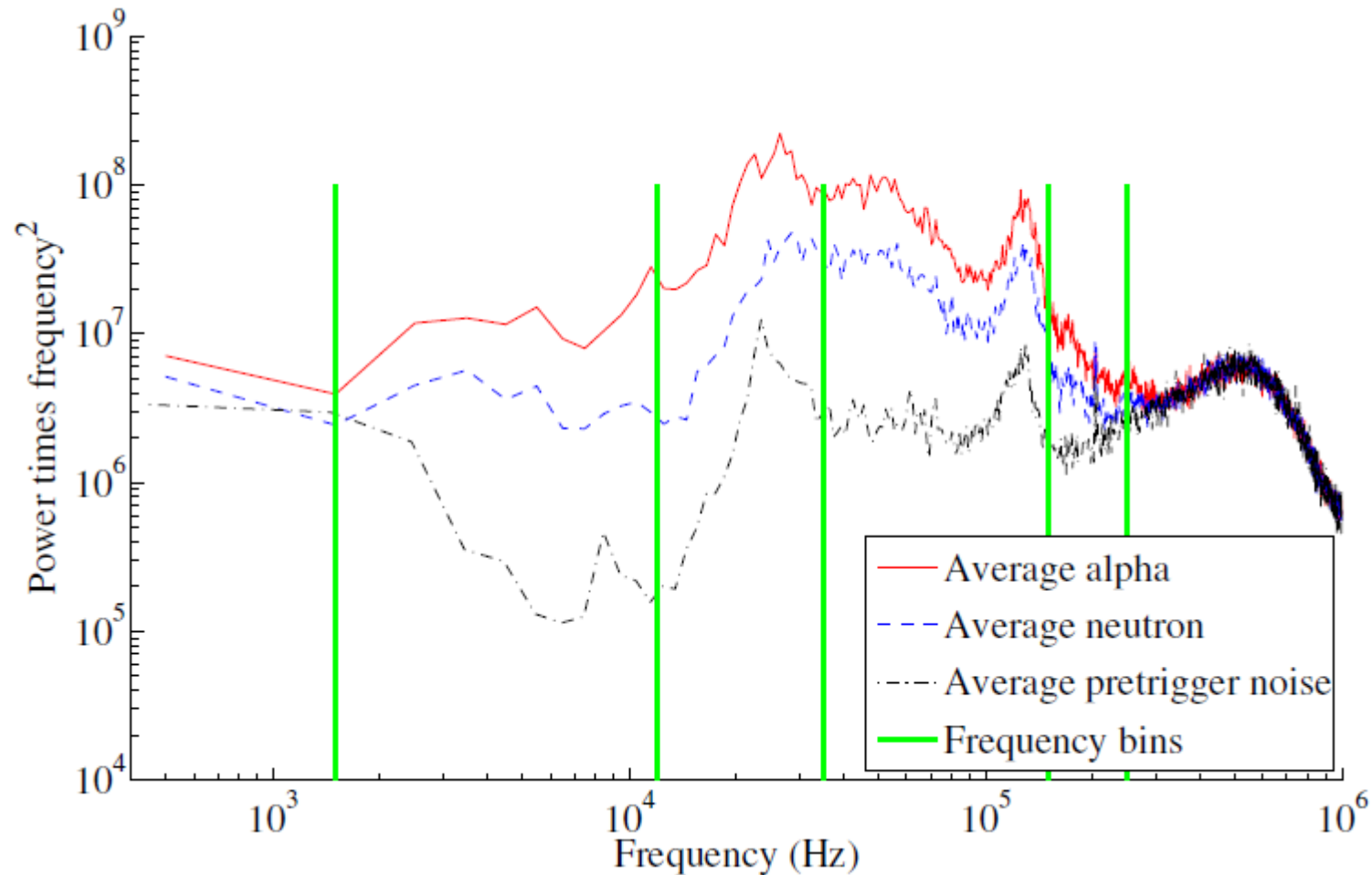
Neutron

→ Full neutron background rejection

COUPP-500

# Background

- Alphas: Louder acoustics than nuclear recoil (4-5 X louder)





# R&D

- Most of the R&D has been established in previous COUPP experiments
- Planned R&D:
  - Chemical studies of the active fluid
  - Bubble acoustics and acoustic sensors
- Ongoing/future calibrations:
  - Low energy nuclear recoil response
  - Acoustic alpha/recoil separation

# Conclusion

- Direct detection of DM nuclear recoil
- Based on know-how from previous COUPP experiments
- Simple experimental setup
- Relatively cheap compared to other experiments
- Full EM and neutron rejection possible
- Excellent alpha rejection ( $> 98.9\%$ )
- Competitive limits

