CLOUD: the first reactor antineutrino experiment using the novel LiquidO detection technology

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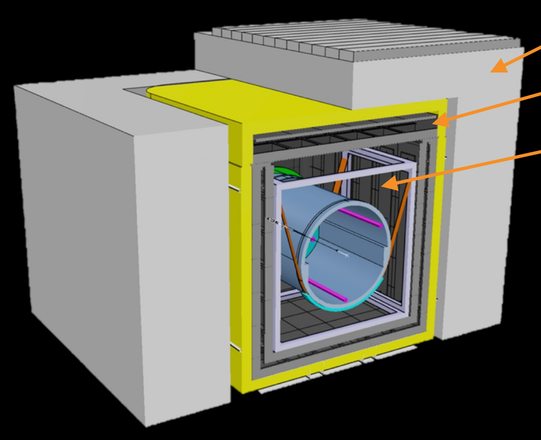
The experimental site

The detector

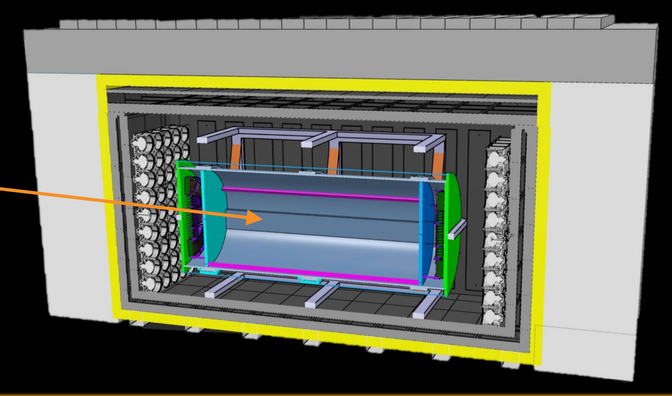


IGLOO: concrete bunker + steel shield

Water Pool: 4π shield, neutron moderator

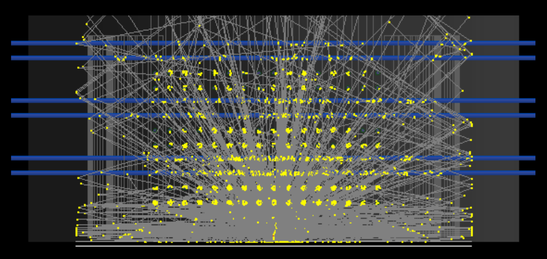
Outer Detector:
Transparent scintillator (LAB + PPO + Bis-MSB)
≤180 20" PMTs & highly reflecting walls
Designed light yield ≥ 400 PE/MeV

5-10 tons Inner Detector (LiquidO)
Filled with opaque scintillator
10,000 wavelength shifting fibres + SiPMs on both ends
1.8 m diameter, > 200 PE/MeV

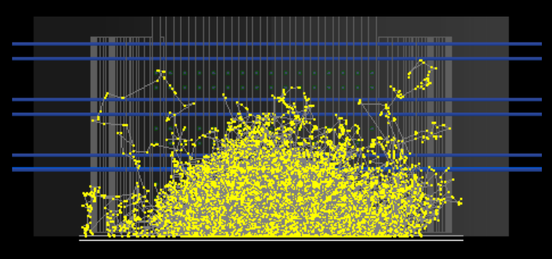


LiquidO detection technology

Stochastic light confinement near its creation point by using opaque medium

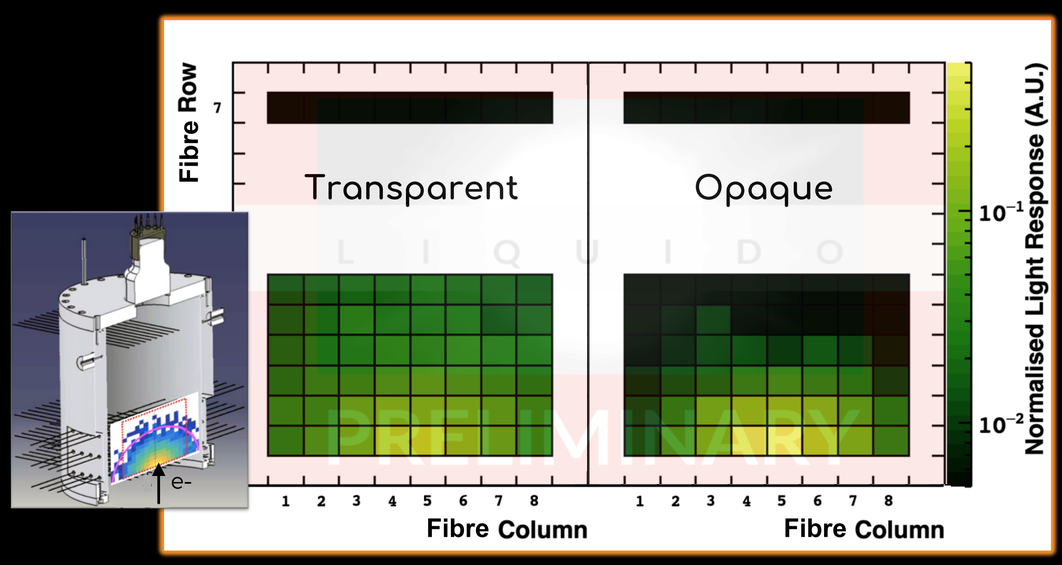


Transparent: Today's technology
Topology information washed-out



Opaque: LiquidO technology
Light clustering. Scattering length (~mm)

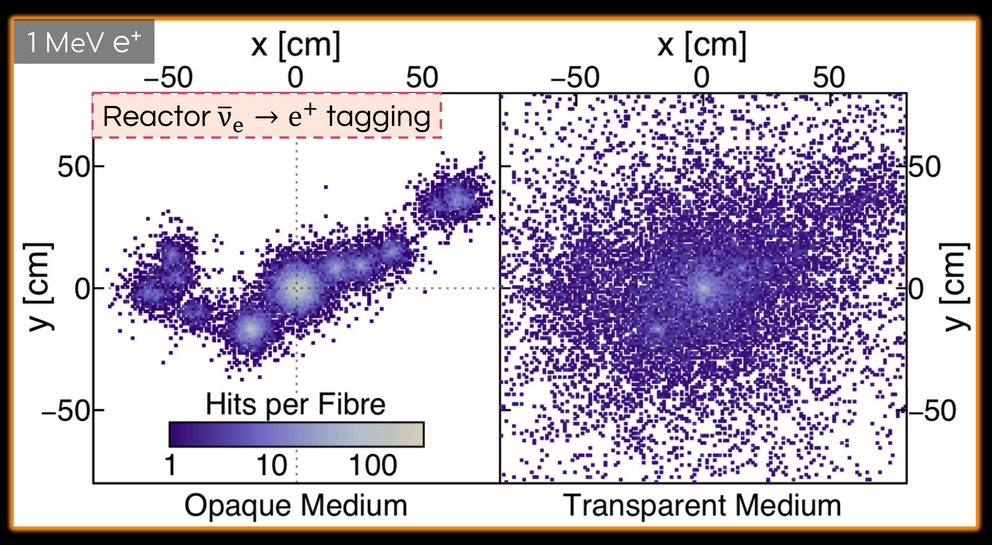
- Maximal light collection by a dense array of fibers connected to SiPMs
- Fast time resolution (< 0.1 ns)
- Excellent spatial resolution (mm scale)



Experimental demonstration of point-like energy depositions of electrons with a 10-litre LiquidO prototype

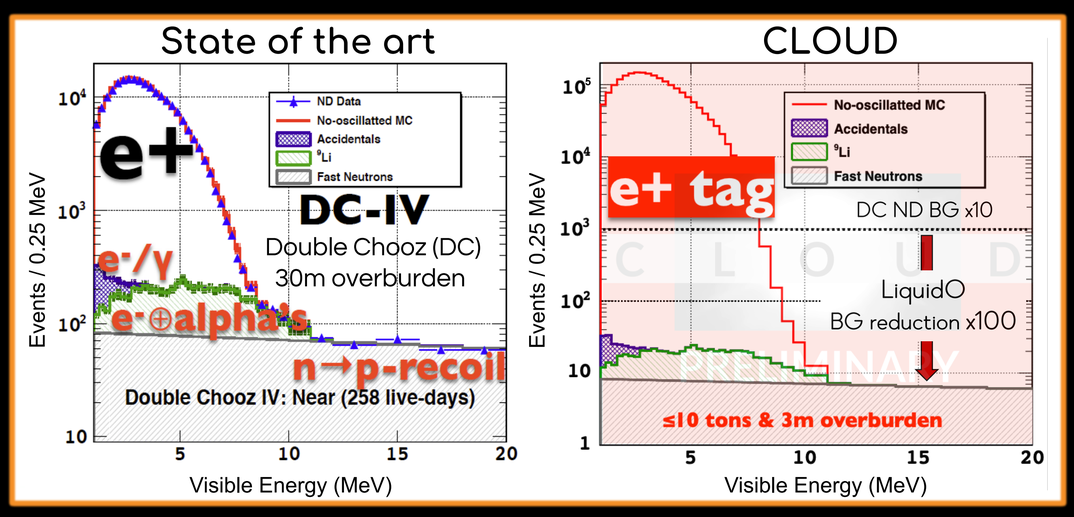
Reactor antineutrino physics

- Detection channel - Inverse Beta Decay: $\bar{\nu}_e + p \rightarrow e^+ + n$



- Confinement of light into sphere around each ionization point
- Discrimination of individual e^+, e^- and γ events @1MeV
- Self-segmented detector (no need to introduce dead material)

- ≥10,000 $\bar{\nu}_e$ interactions per day for 10tons [≥3M interactions per year]
- LiquidO technology can improve today's BG control (PID + vertex precision)
- S/BG >100 with Reactor-ON & S/BG >1 with Reactor-OFF (unprecedented)
- Most precise reactor neutrino flux (<1%) and unique information (reactor ON-OFF transition) for reactor prediction model validation

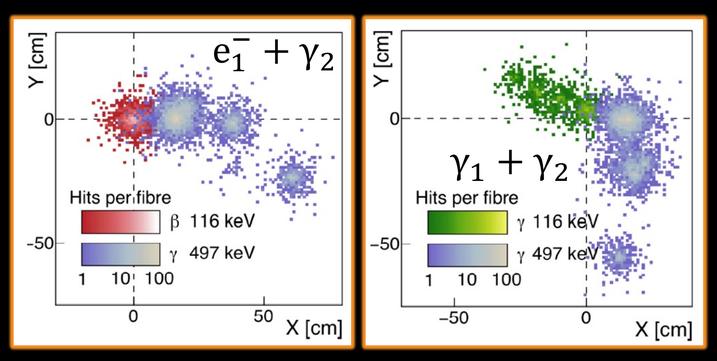


Solar neutrino detection

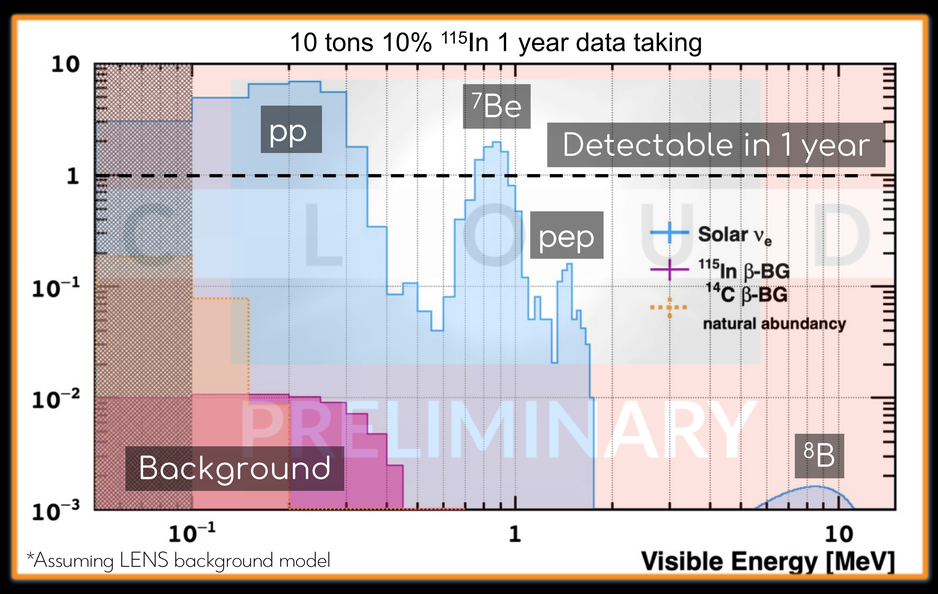
Indium loading could allow to perform precise solar ν physics

$\nu_e + {}^{115}\mathrm{In} \rightarrow {}^{115}\mathrm{Sn}^* + e^-$ Three-fold coincidence

τ = 4,76 μs → e_1^-/γ_1 (E = 116 keV) + γ_2 (E = 497 keV)



- E_{th} = 114 keV
  95.5% of pp ν_e
- High background rejection
- S/BG > 100



- Demonstrator for pp-solar neutrino detection with ^{115}In-tagging
- Solar-pp ~25 ν_e/year
- Solar-^{7}Be ~9 ν_e/year
- ^{115}In + ^{14}C intrinsic background ~negligible (w/LiquidO)

The CLOUD experiment is a fundamental physics extension of the AntiMatter-Otech innovation project

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