The SuperChooz project: a LiquidO-based neutrino oscillation experiment

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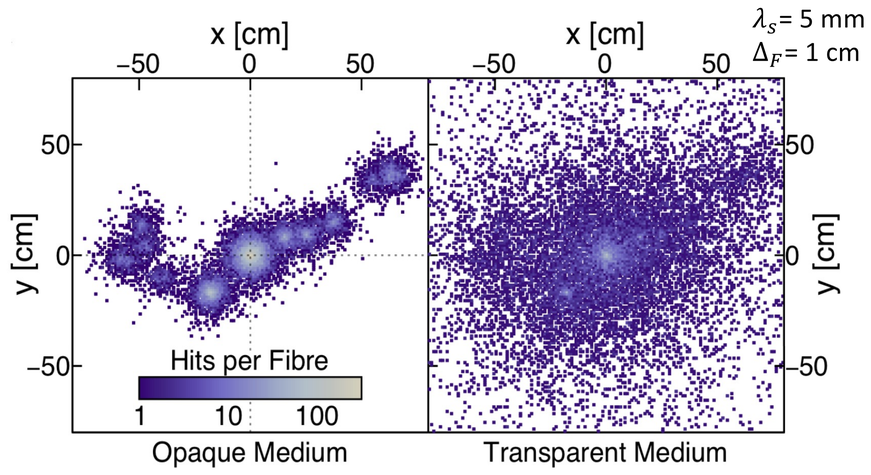
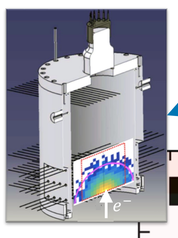
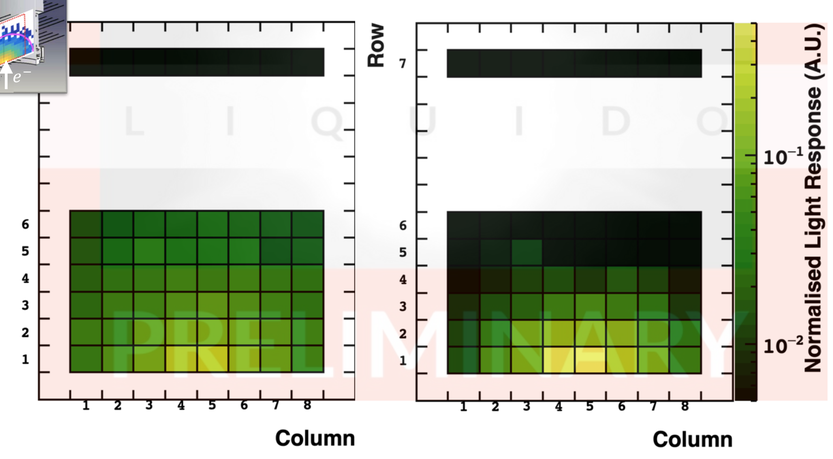
THE LIQUIDO TECHNOLOGY



- Photon confinement via stochastic processes
- Light collected with a dense array of fibers
- Access to mm scale spatial resolution



LiquidO demonstrator: Mini-e^-



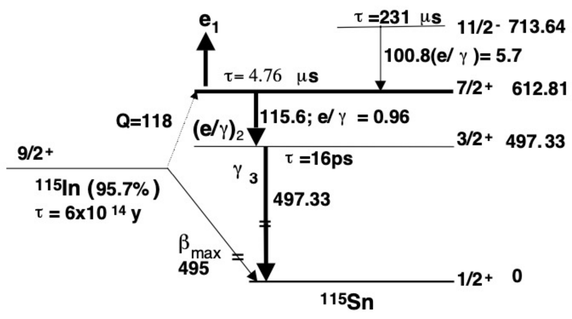
Stochastic light confinement: Demonstrated in the case of a point-like e^- deposition ➔ ≈4 cm for 80 % of collected light

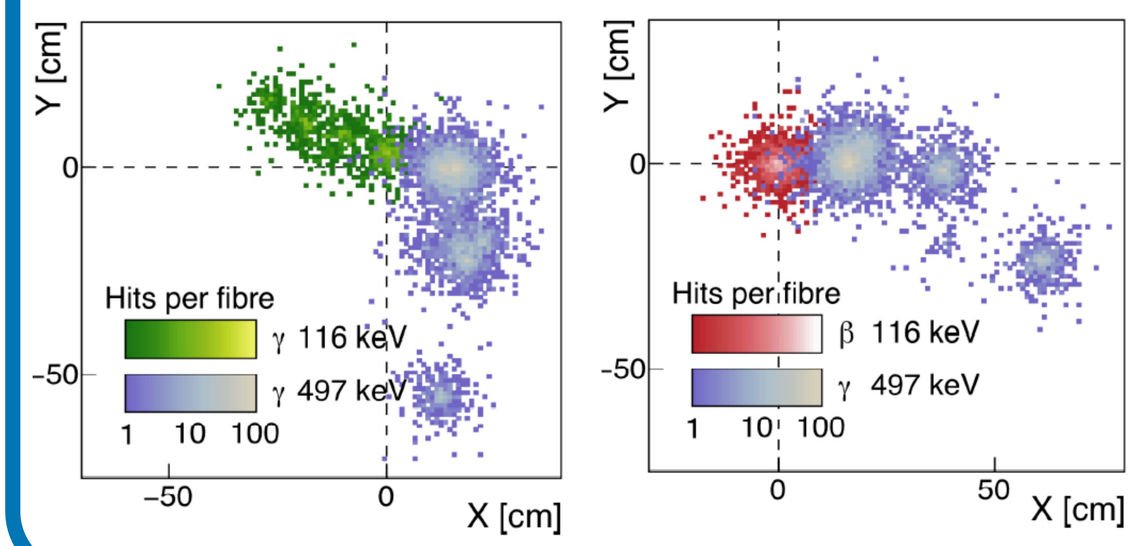
$\nu_e - {}^{115}In$ REACTION

- Proposed by Raghavan in 1976
- Low Q value ➔ probe the low energy solar ν_e spectrum
- e^- prompt, two delayed emissions

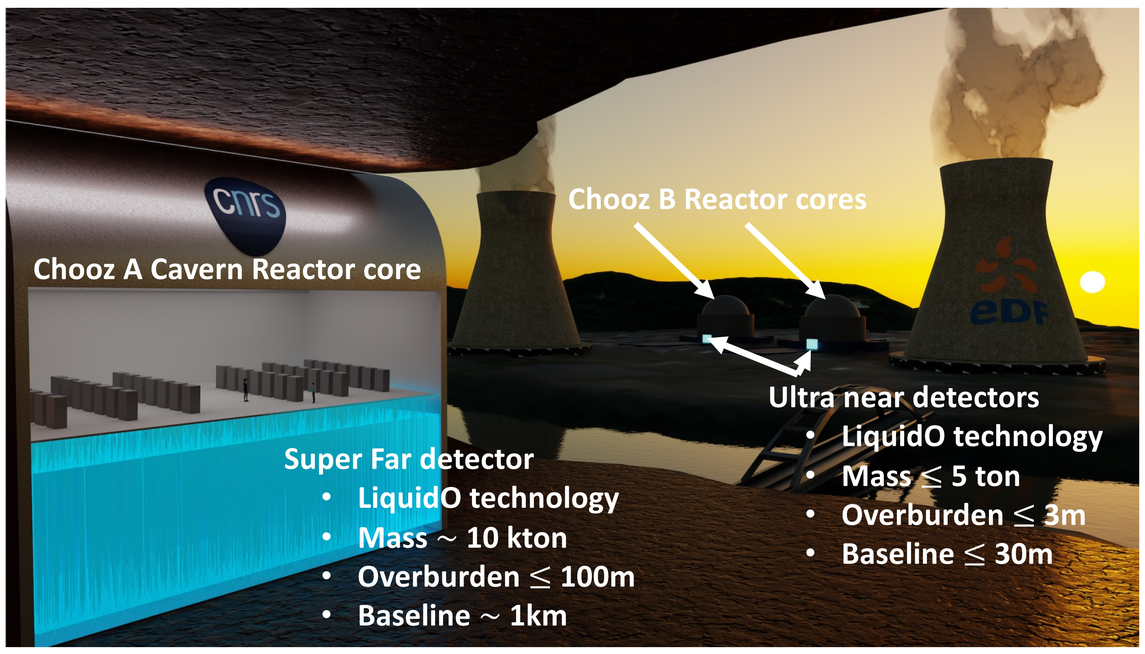
- In-doped media is the source of its own background (In β^--decay)
- Requires high background rejection capabilities

$$\nu_e + {}^{115}In \rightarrow {}^{115}Sn^* + e^-$$



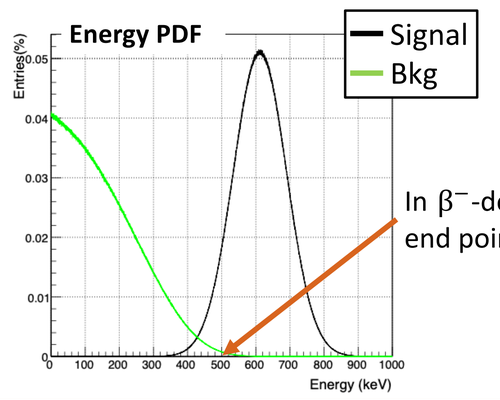


THE SUPERCHOOZ EXPERIMENT

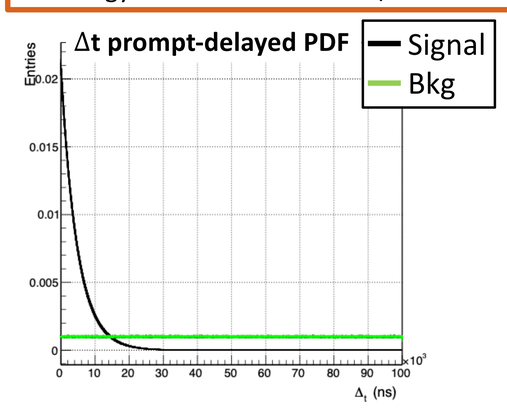


- Study of reactor and solar neutrinos thanks to an In-doped scintillator
- Using LiquidO technology ➔ background rejection can be vastly improved
- Background rejection estimations via coincidences simulation
- Goal of coincidences simulation: feasability study of SuperChooz
- Experiment running for 10 years to reach <1% precision on θ_{12}, θ_{23} and $|\Delta m^2|$

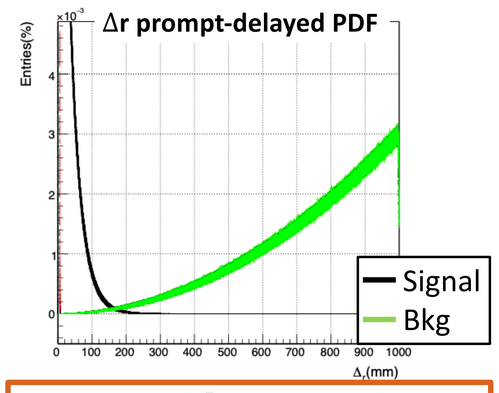
COINCIDENCES SIMULATIONS



- Background ➔ In β^--decay spectrum
- Signal ➔ Sum of the two delayed emissions
- Energy resolution for 100 PE/MeV



- Background ➔ Uncorrelated
- Signal ➔ Excited state decay exponential τ = 4.76 μs

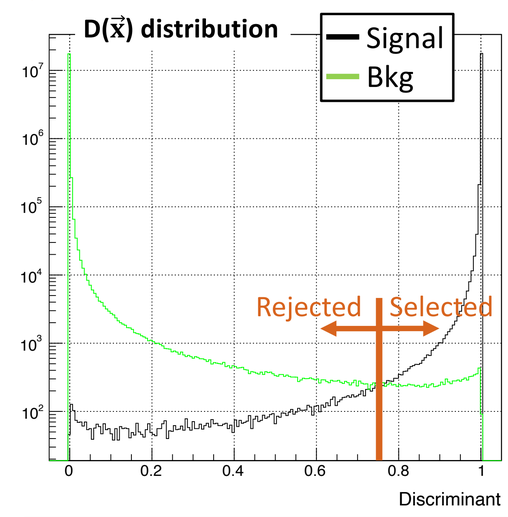


- Background ➔ Uncorrelated
- Signal ➔ Main influence is mean free path of the delayed γ
- Resolution 1mm in x,y,z (optimistic)

Discriminant:

$$D(\vec{x}) = \frac{p(\vec{x}|sig)}{p(\vec{x}|sig) + p(\vec{x}|bkg)}$$

With $$p(\vec{x}|sig) = \prod_i p(x_i|sig)$$



- Using a $D(\vec{x})$ value as a threshold
- Compute signal efficiency by integrating right of the cut
- Compute background rejection efficiency by integrating to the left
- Example at $D(\vec{x}) = 0.75$
  ε_{sig} = 0.9993 ; ε_{bkg} = 0.9993

- The method can be adapted by changing the resolution parameters (Energy, Δt, Δr)
- Exploration of SuperChooz' feasability ➔ putting constraints on resolution parameters
- For example for Δr simulations:
  - x,y resolution: 1-5-10 mm
  - z resolution > x,y resolutions because of the geometry of the fiber array (grid in x,y but not z)

The SuperChooz pathfinder project explores the feasability of SuperChooz for the study of neutrino fundamental physics.