The Stereo Project

The Search for Light Sterile Neutrinos

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The Reactor Anti-neutrino Anomaly

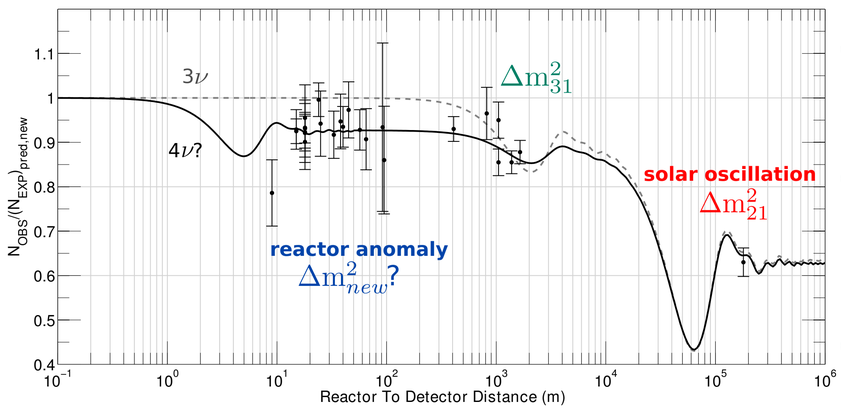
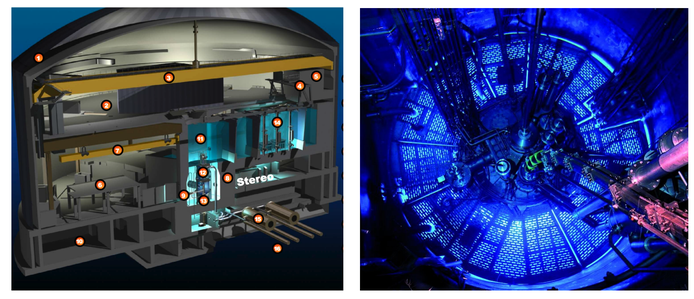


Figure: Ratio of observed to expected $\bar{\nu}_e$ events as a function of the distance to the reactor [1]. The $\bar{\nu}_e$ survival probability is represented in the three neutrino framework and with the assumption of an additional sterile state.

- Re-evaluation of $\bar{\nu}_e$ emitted by nuclear reactors by Th. A. Mueller et al. [2] (later confirmed by P. Huber [3])
- The re-analysis of former short-baseline reactor experiments revealed a $\sim 6\,\%$ deficit in the detected $\bar{\nu}_e$ flux (2.7 σ significance [1]): $R = 0.936 \pm 0.024$
- Additional indications of light sterile neutrinos
- This deficit can be interpreted as an oscillation toward a fourth sterile state, with $\Delta m^2_{new} \sim 1\,eV^2$

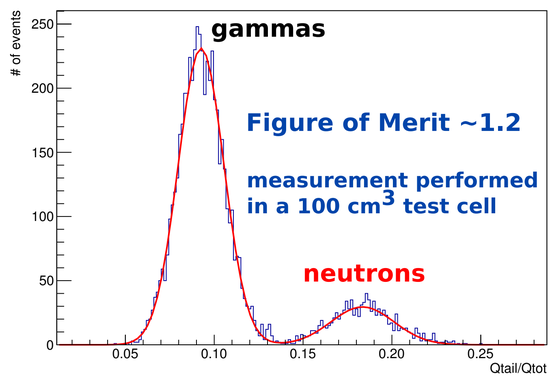
The ILL Reactor



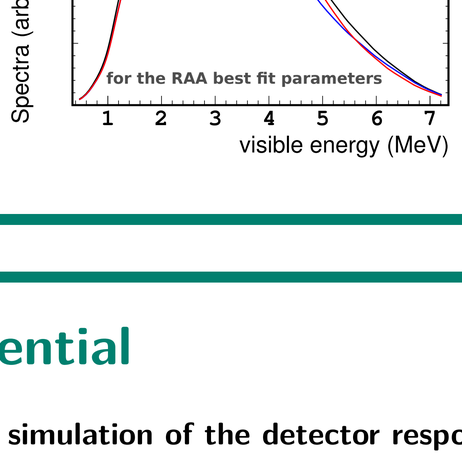
- Located at ILL 57 MW research reactor in Grenoble, France
- Compact core
- Highly enriched ^{235}U nuclear fuel
- 10 meter distance to the reactor core
- Significant overburden but challenging reactor related background: on site measurements performed to characterize background sources

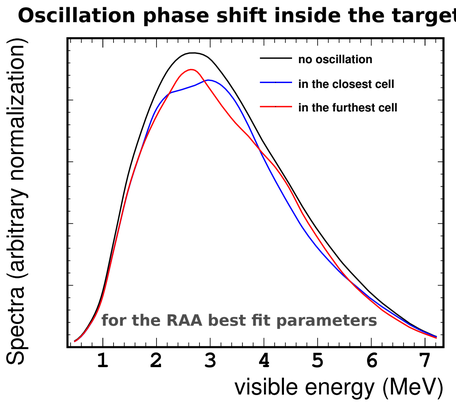
Background Mitigation

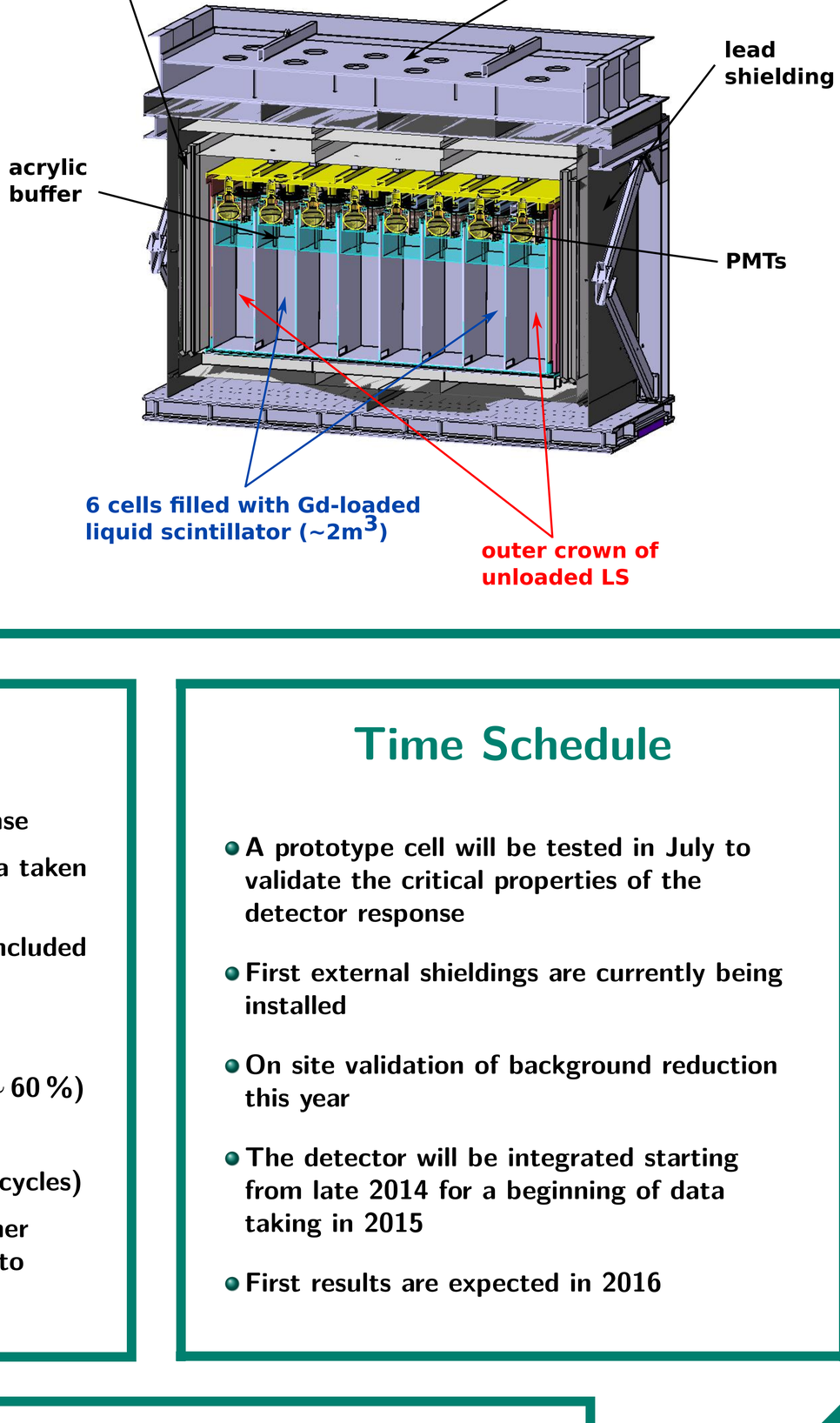
- Thick lead screens and neutron absorbers
- Overburden provided by the transfer channel, active muon veto in addition
- Cosmic background measured during reactor off periods
- Active outer crown tagging external background and reducing energy leaks
- Pulse Shape Discrimination capability



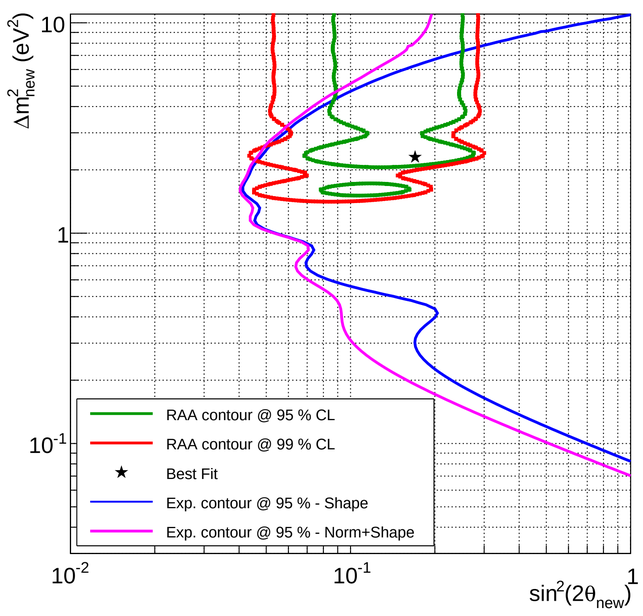
The Stereo Detector







Discovery Potential



- Complete simulation of the detector response
- Systematics of the emitted neutrino spectra taken into account
- Detection and reconstruction systematics included
- Signal / background = 1.5
- Prompt signal cut: Evisible > 2 MeV
- Delayed cut: Evisible > 5 MeV (efficiency $\sim 60\,\%$)
- Expected detection rate: $\sim$ 410 $\bar{\nu}_e$ / day
- Statistics: 300 days data taking (6 reactor cycles)
- Possibility to move the detector 1.2 m further from the reactor to increase the sensibility to low Δm^2

Time Schedule

- A prototype cell will be tested in July to validate the critical properties of the detector response
- First external shieldings are currently being installed
- On site validation of background reduction this year
- The detector will be integrated starting from late 2014 for a beginning of data taking in 2015
- First results are expected in 2016

- T. Lasserre, "Evidence for Sterile Neutrinos and Implications for Physics–Astrophysics." Talk at the TAUP conference, 2013.
- Th. A. Mueller *et al.*, "Improved Predictions of Reactor Antineutrino Spectra," *Phys.Rev.*, vol. C83, p. 054615, 2011.
- P. Huber, "On the determination of anti-neutrino spectra from nuclear reactors," *Phys.Rev.*, vol. C84, p. 024617, 2011.

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