

The SoLid sterile neutrino experiment at the BR2 reactor

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On behalf of the SoLid collaboration

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SoLi ∂



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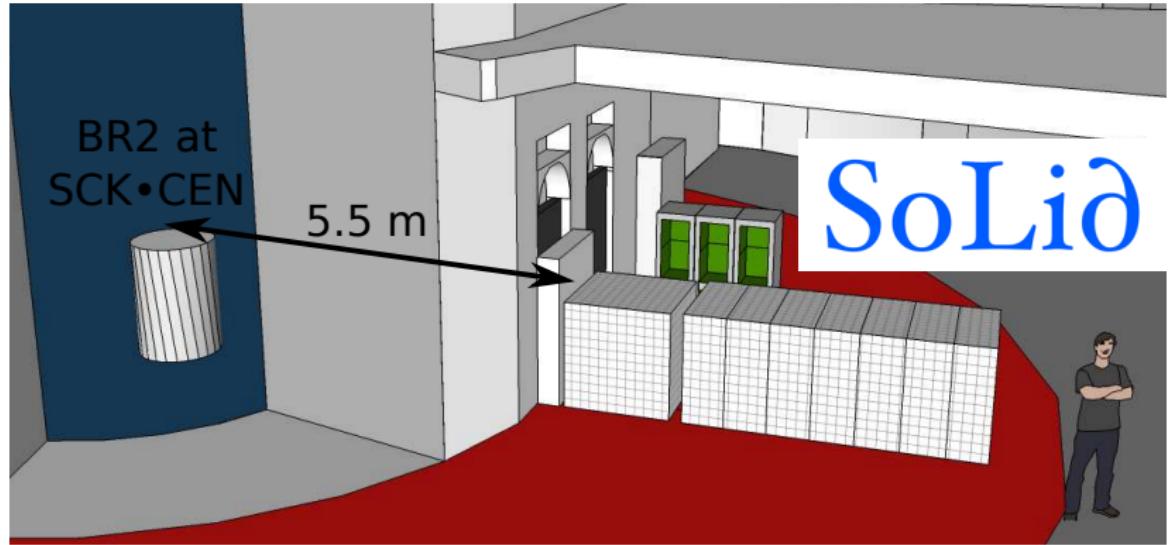
On behalf of the SoLid collaboration



50 collaborators from Belgium, France, UK and US.

Open to new collaborators: contact Antonin.Vacheret@physics.ox.ac.uk

Overview



- The SoLid approach to searching for sterile neutrinos
- Recent 288 kg module deployment
- Future planned deployments

Experimental challenges

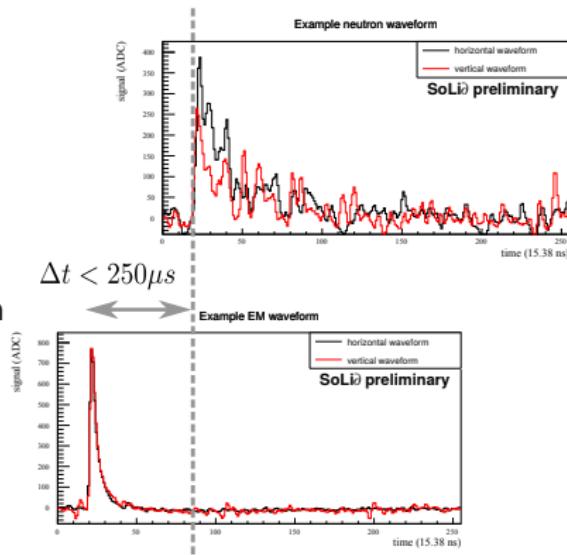
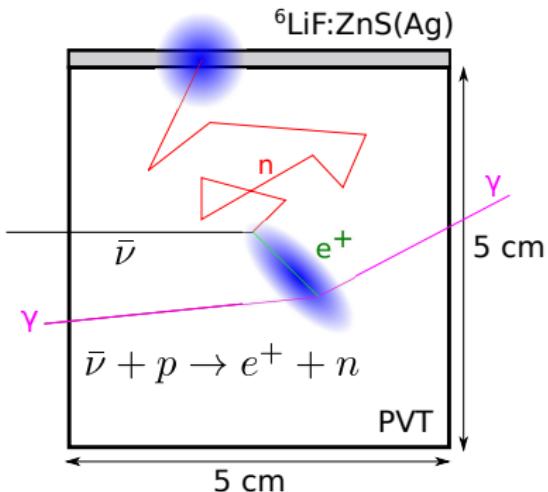
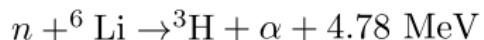
Challenges:

- Within 5-10 m of reactor core
 - Above ground, little overburden
 - High cosmic muon rate / spallation neutron background
 - Additional gamma ray and neutron backgrounds from reactor
- Inside reactor complex
 - Few tonne experiment
 - Restrictions on materials - particularly liquids
 - Access to detector limited

SoLid approach:

- Robust neutron identification
 - Neutron ID must not be sensitive to gamma background
 - ID at trigger level to reduce data from background
- Rich data set for neutrino event selection and background estimations
 - Highly segmented ($5 \times 5 \times 5$ cm voxel) detector
- Detector constructed from solid materials, minimal passive shielding

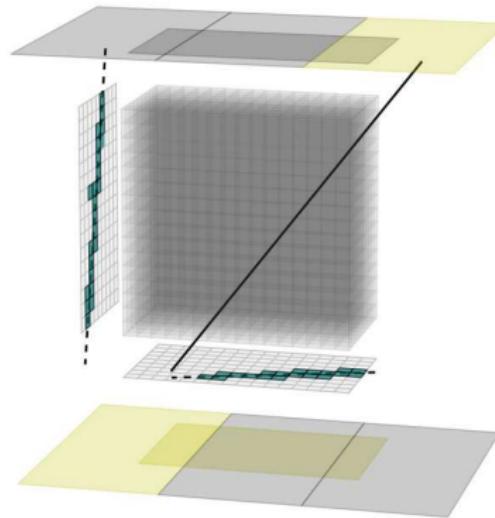
Composite scintillator to detect IBD events



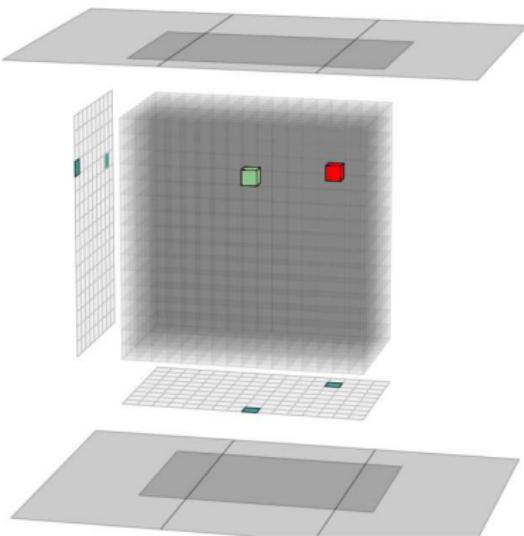
- Both scintillation signals captured in $3 \times 3 \text{ mm}$ square wavelength shifting optical fibres
- Scintillation signal detected by $3 \times 3 \text{ mm}$ silicon photomultipliers

High segmentation to discriminate IBD from backgrounds

Cosmic muon track



Neutron + gamma



SoLid reactor off experimental data

BR2 reactor at SCK•CEN in Mol, Belgium



- Highly enriched uranium
- Up to 70 MW power
- Compact core, $\varnothing_{rms} < 0.5m$
- Closest approach 5.5 m
- Low background rate
- No nearby experiments
- Approx. 50 % duty cycle
- Collaboration with SCK•CEN

288 kg module

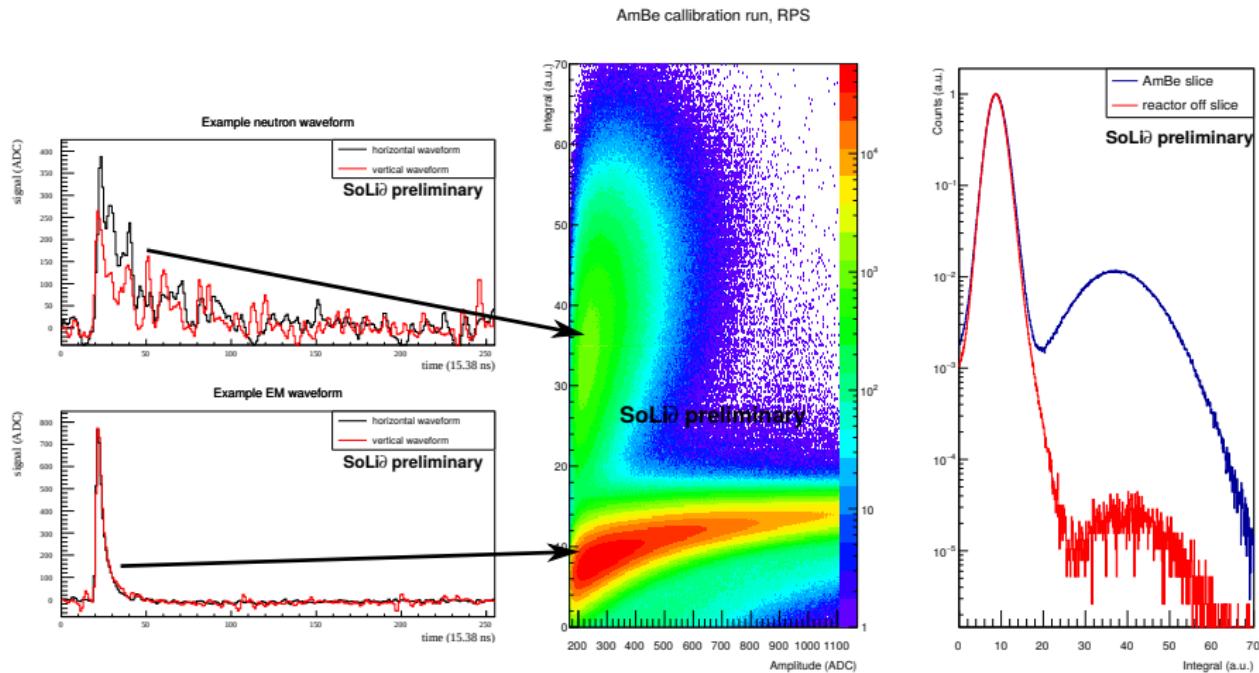
- $0.8 \times 0.8 \times 0.45$ m
- $16 \times 16 \times 9$ cubes
- Top/bottom muon veto panels
- 288 + 16 channels
- Deployed Dec 2014
- 1 week reactor on (Feb)
- 2 months reactor off (Mar/Apr)
- Neutron sources: ongoing
- Poster #171: Céline Moortgat



Goals:

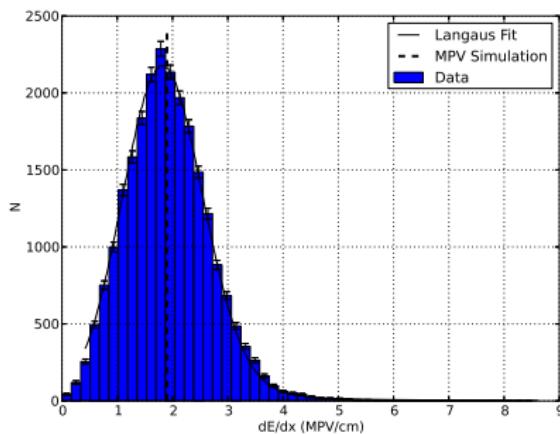
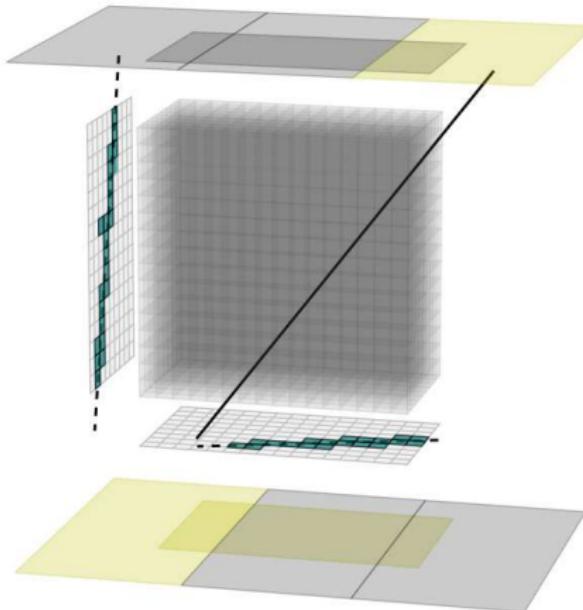
- Demonstrate power of high segmentation detector
- Develop analysis and calibration techniques for novel detector
- Detect reactor anti-neutrinos

Neutron ID



- Poster #177: Simon Vercaemer

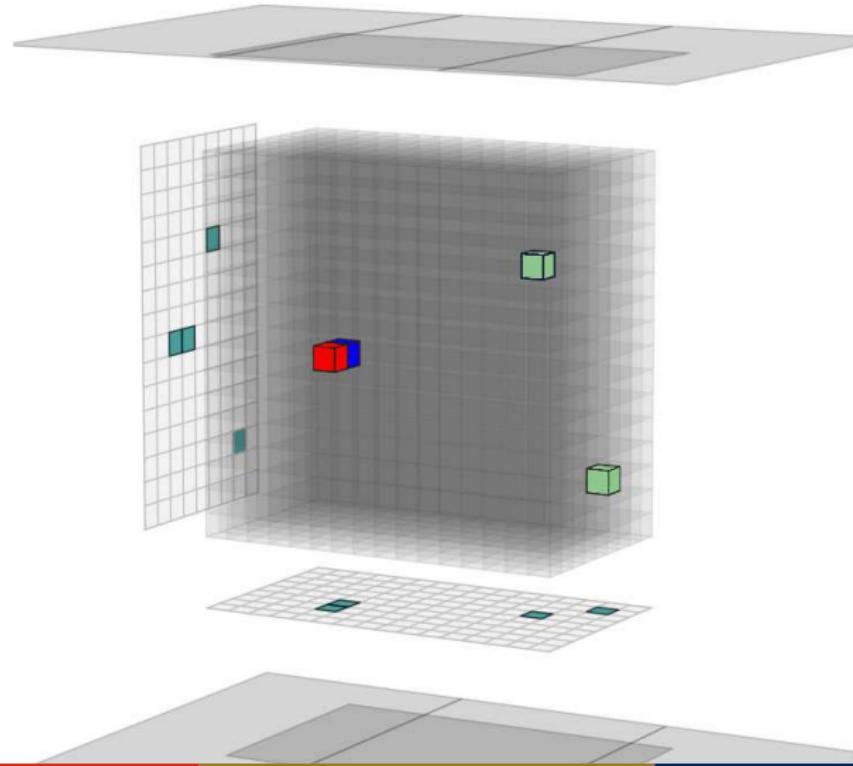
Muon tracking for in-situ MeV range energy calibration



• Poster #173: Dan Saunders

IBD candidates

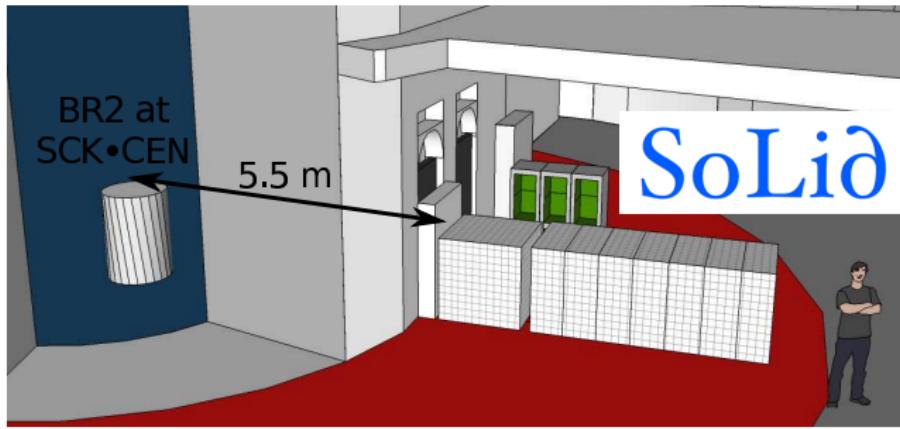
IBD candidate: positron + neutron
(+ accidental gammas)



Future plans

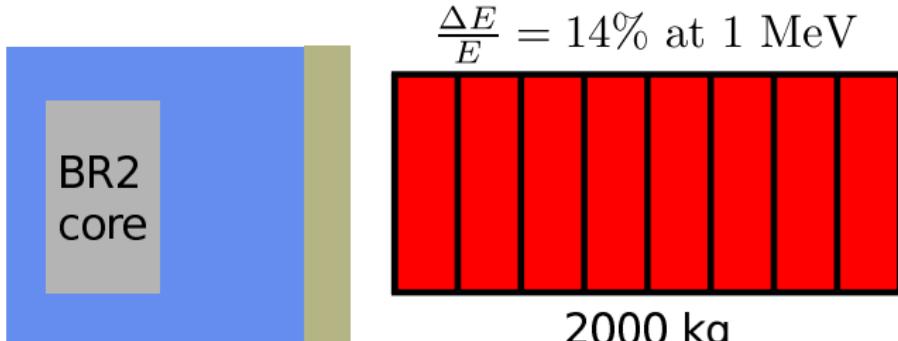
Goal: Resolve reactor anomaly by 2020

- 2013 - 2015: 8 kg prototype detector
- 2014 - 2015: 288 kg detector module
- 2016 - 2017: Initial oscillation search
 - 2 tonne SoLid detector
- 2017 - 2020: Precision oscillation search
 - Add additional tonne with better energy resolution

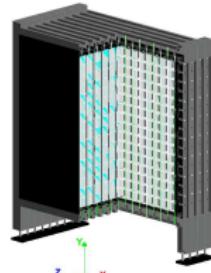
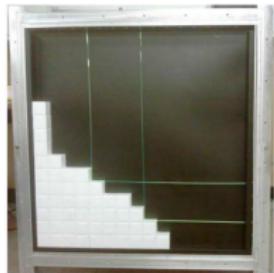


Future plans: initial oscillation search

2016/17, reactor on: 150 days

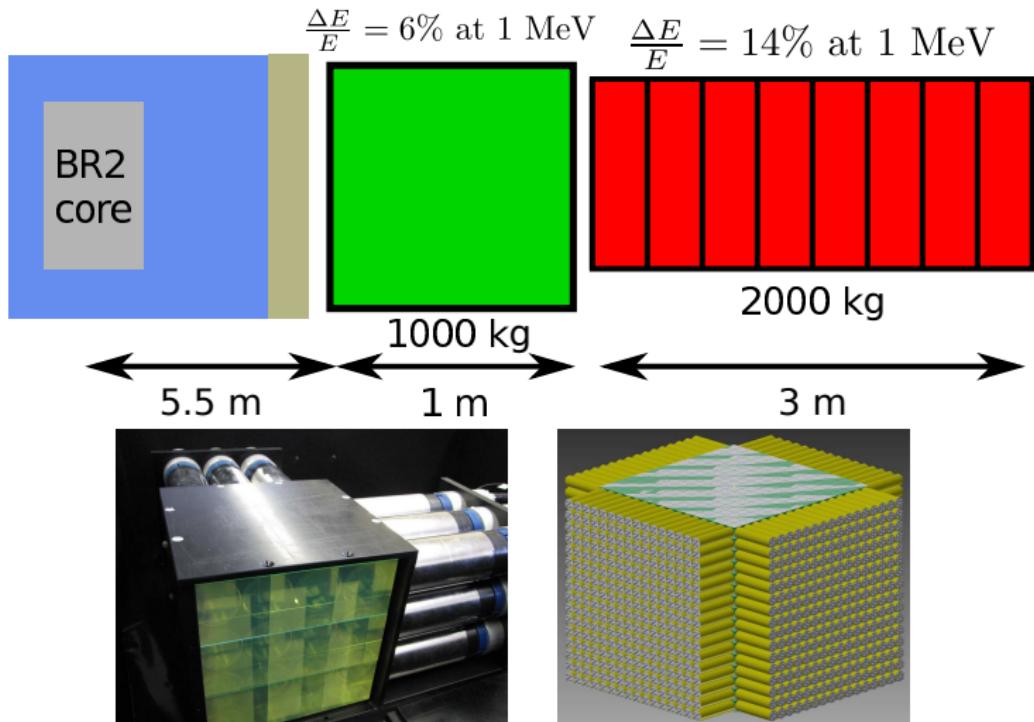


← 5.5 m ← 3 m →

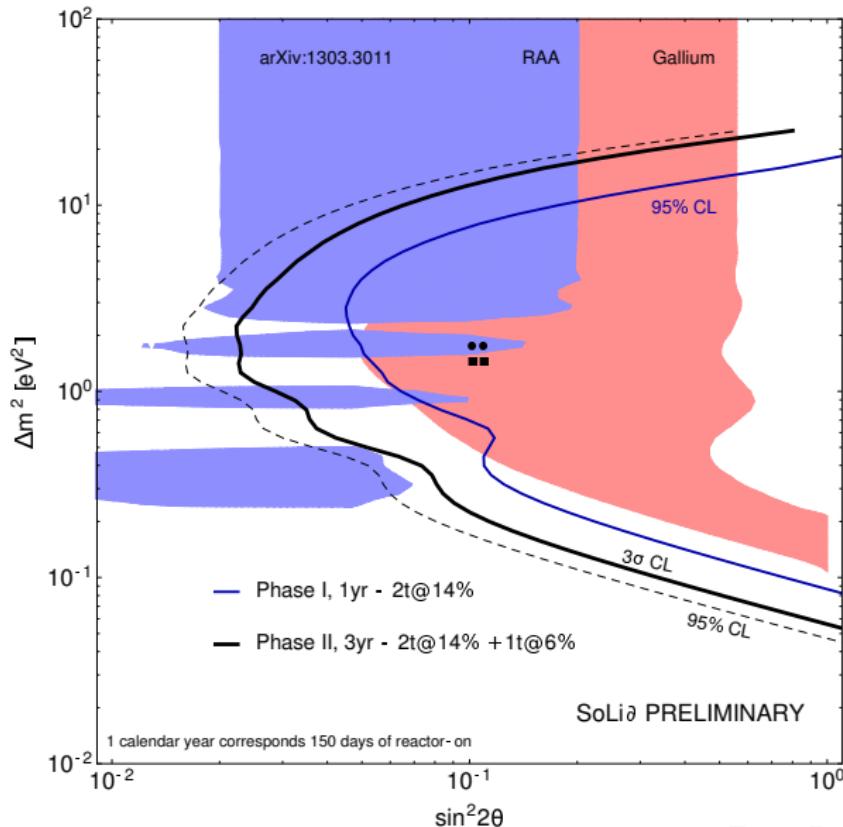


Future plans: precision oscillation search

2017 - 20, reactor on: 450 days



Sensitivity to 3 + 1 sterile neutrino oscillations



Summary



- Deployed 288 kg first module at BR2 reactor
- Collected reactor on/off data, calibration campaign ongoing
- Initial analysis to understand novel detector
- Full scale, sensitive experiment deploying next year
- Reactor anomaly solved by 2020

Sensitivity parameters

- 1 or 3 years data taking, 40 % up time
- 60 MW reactor power
- Closest approach 5.5 m
- Furthest distance 9.6 m
- BR2 core model used
- 40 % IBD efficiency
- Signal:background = 3
- Background equal combination of $1/E_\nu^2$ and flat

Sensitivity comparisons

