First measurements with the SoLid experiment's prototype anti-neutrino detector

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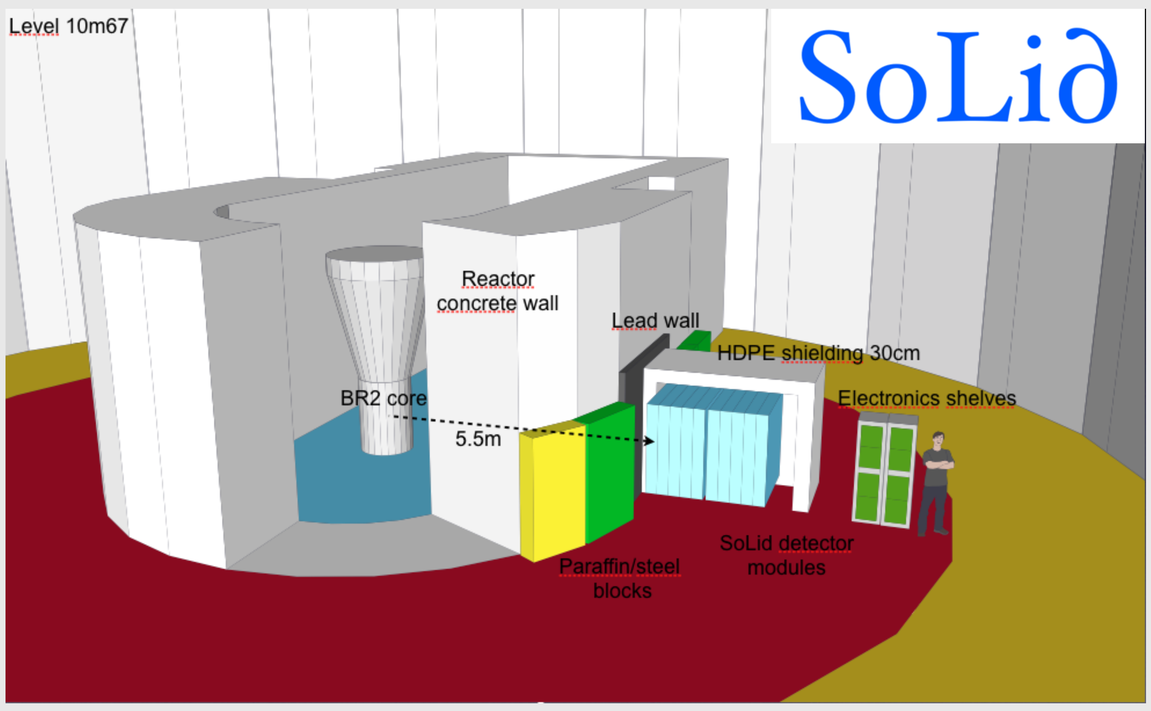
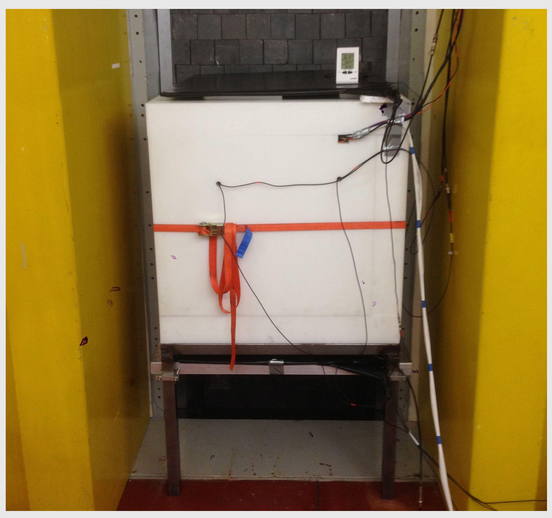
The SoLid experiment

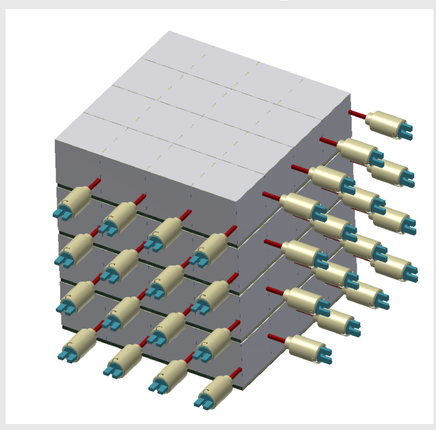


- Probe the reactor neutrino anomaly
- 2.88 tonne PVT sctintillator
- ^{6}LiF:ZnS(Ag) neutron sensitive layers
- 5.5 - 10 m from reactor core
- Segmented into 5 x 5 x 5 cm cubes
- Search for oscillation

Prototype detector

- 8 kg, 20 x 20 x 20 cm
- 4 layers
- 4 x 4 cubes
- 8 wavelength shifting fibres
- Single ended readout with MPPCs
- HDPE shielding



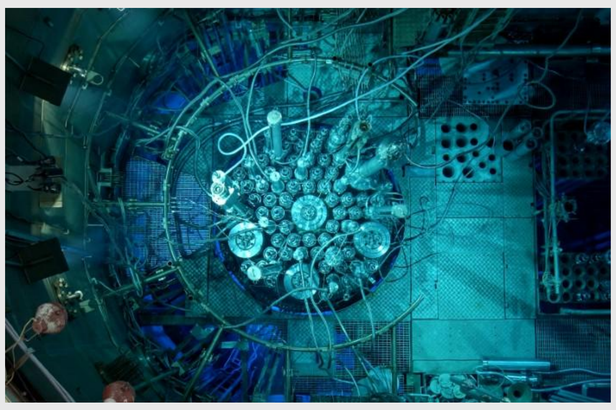


Goals:

- Understand reactor environment
- Develop particle identification
- Optimise design of full scale detector
- Measure backgrounds

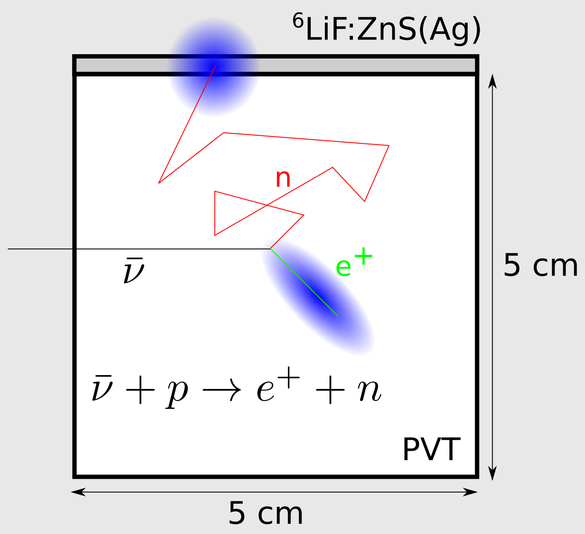
BR2 at SCK•CEN

- Research reactor
- Highly enriched Uranium
- Compact core (40 x 80 cm)
- No neutron portals
- Low, stable backgrounds

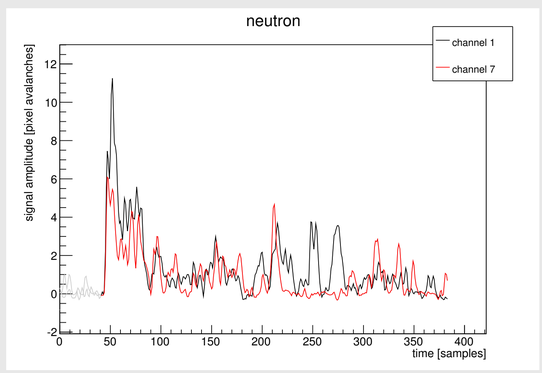


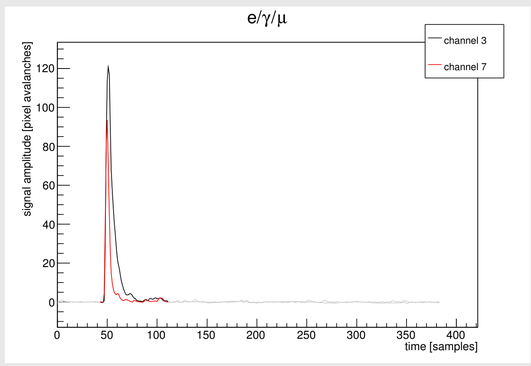
Anti-neutrino detection principle

$$n + {}^{6}\mathrm{Li} \rightarrow {}^{3}\mathrm{He} + \alpha + 4.78\ \mathrm{MeV}$$



- Inverse beta decay
- Positron scintillates in PVT
- Fast scintillation signal
- Prompt signal with E~E_ν
- Neutron thermalises
- Neutron captured by ^{6}Li
- Decay into ^{3}He + α
- He and α scintillate in ZnS(Ag)
- Slow scintillation signal
- Find puses in MPPC pairs
- Identify as neutron or e/γ/μ
- Combine multiple pairs for μ



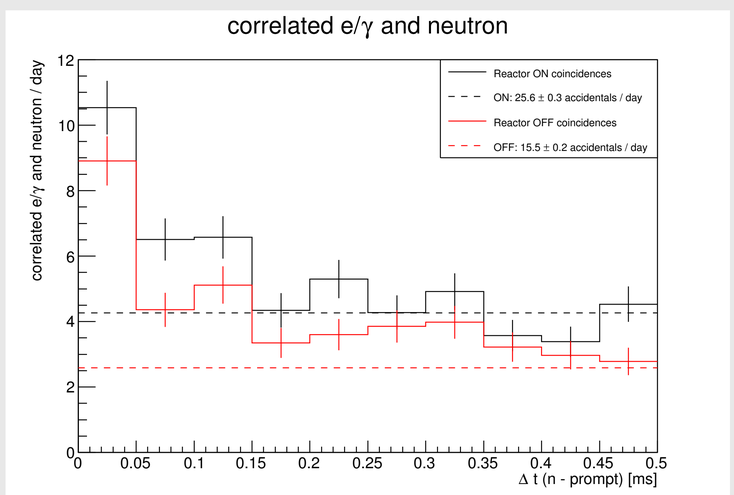


Mar 2014 upgrade

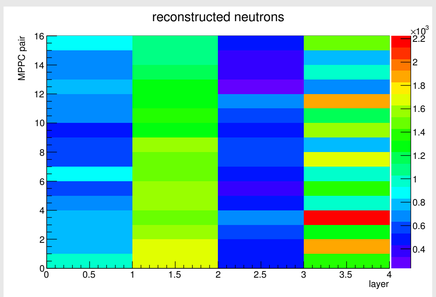
- Replaced Caen desktop digitiser
- 32 channel 12-bit ADC @ 62.5 MS/s
- → 5 x Caen V1724
- 8 channel 14-bit ADC @ 100 MS/s
- Increased stored event rate
- < 1 Hz increased to > 200 Hz
- Addition of 4 muon veto panels

Correlated e/γ - neutron events

- Correlated events detected
- ~15 / day from backgrounds
- ~10 extra reactor on accidentals / day
- 8 kg prototype expects ~ 1 IBD / day
- Aim to extract significant IBD excess



Reconstructed particles



neutrons:

- Layer 0 and 2:
  - ELJEN, 325 µm thick
  - 6LiF : ZnS(Ag) = 1 : 3
- Layer 1 and 3
  - AST, 250 µm thick
  - 6LiF : ZnS(Ag) = 1 : 2
  - Higher n efficiency