SONGS: Site and Core Characteristics

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Motivation

- Excellent relationship and ready access to SONGS

- Very high flux and good background conditions:
  - No reactor correlated background (n or γ)
  - ~30 m.w.e overburden

- 24m baseline limits Δm^2 sensitivity to ~<1eV^2
  - Maybe a useful location for:
    — Detector characterization in "controlled" environment
    — PWR Antineutrino Spectrum measurement – access ^{235}Pu component
    — Rapid measurement in low Δm^2 at baseline quite distinct from closer sites

Current SONGS Status

- Steam Generators (SG) replaced at both units in 2009-2011

- In early 2012 an SG tube ruptured in Unit 3. Unit 2 was refueling at the time

- Inspections found accelerated tube wear in both units
  - Due to tube-to-tube and tube-to-support fretting; CFD models were faulty

- Recovery Plan: Implement changes to Unit 2 and run de-rated at 75% to confirm.
  - Awaiting NRC approval; hope to restart during Q1 of 2013
  - Maybe 5 years until Unit 3 returns to service

The San Onofre Nuclear Generating Station:
## Our laboratory for over a decade
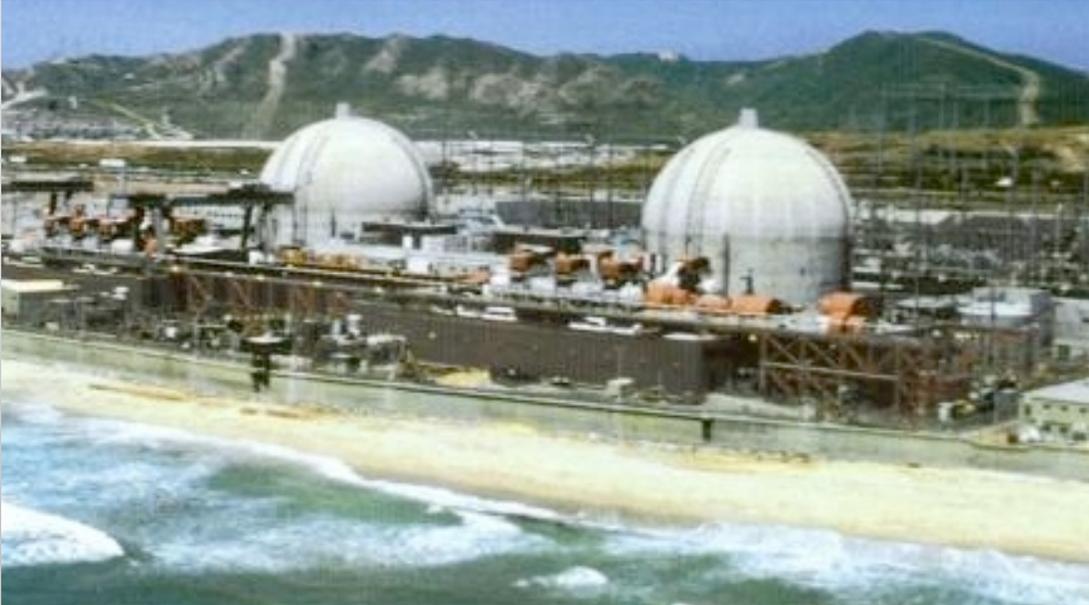
Direct Observation of reactor fuel burnup via antineutrino counting
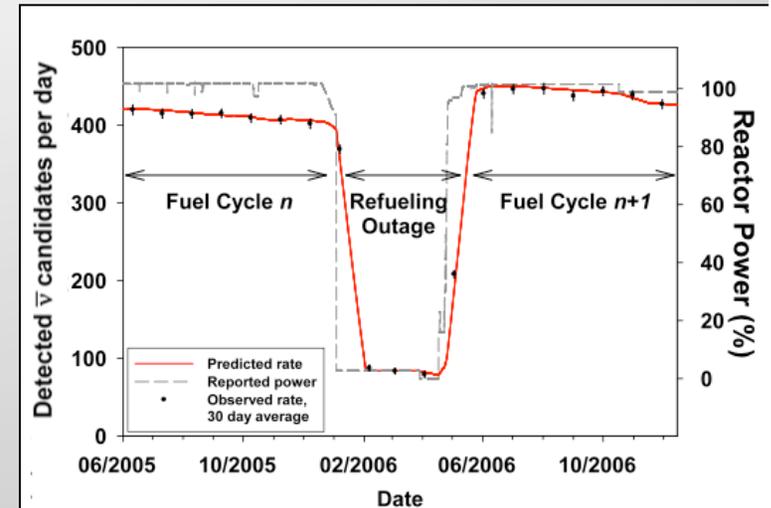
- We have cultivated an exceptionally strong and trusting relationship with SONGS:
  - A multitude of access requests have been readily granted since 1999
  - Provide unescorted reactor access, deployment assistance, commercially sensitive fueling data, introductions to other operators, …..
- We possess extensive operational experience in this industrial environment:
  - **Five** detector deployments since 2003

Tendon Galleries are Ideal Deployment Locations

30mwe

24m
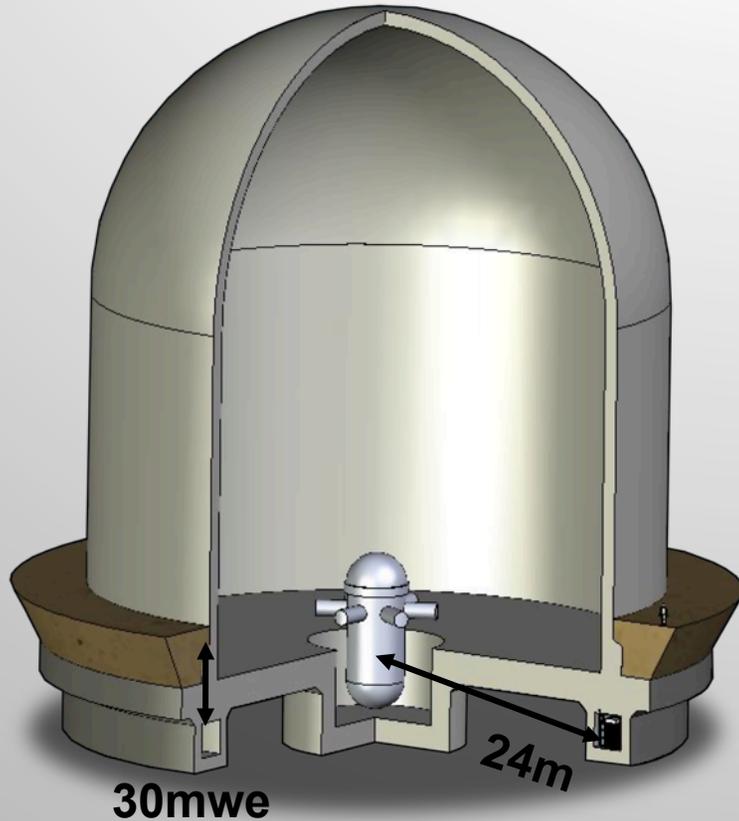
- High Flux: $\sim 10^{17}$ $\nu/m^2/s$
- 130-180m to other reactor
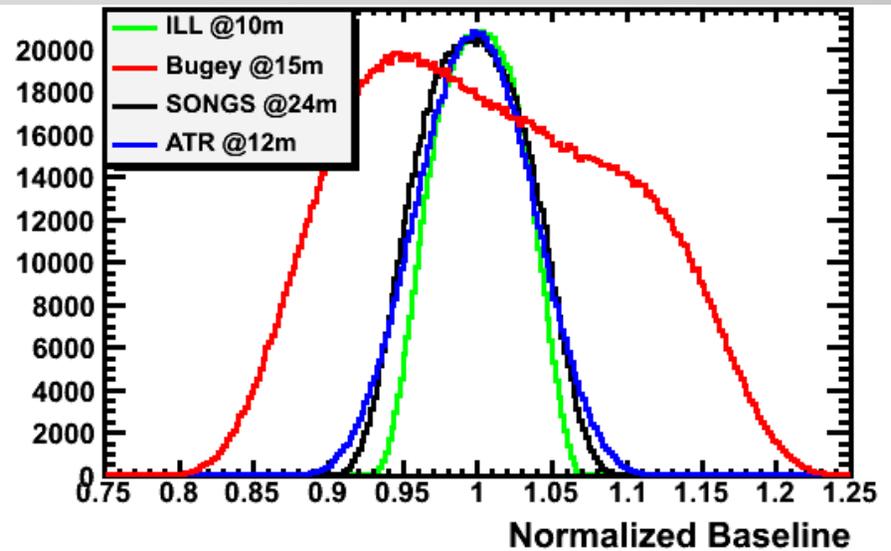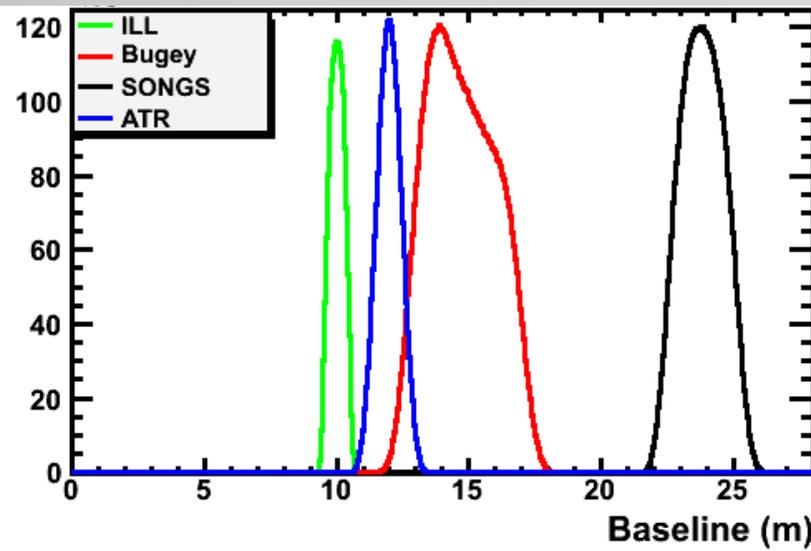- Exception: Gallery is annular – no possibility to vary baseline

Tendon Gallery Access

Relative Baseline Spread Acceptable; Absolute Baseline limits sensitivity to ~<1eV^2

| Reactor	Baseline	Core Size (m)	Detector	ΔL/L (FWHM)	Power	Flux $\nu/m^2/s$
ATR	11m	~Ø1 x 1 (HEU)	1mx1m	~11%	130 MW$_{th}$	~2x10^{16}
Bugey3	15m	Ø2.5 x 2.5	1mx1m	~30%	2800 MW$_{th}$	~2x10^{17}
SONGS	24m	Ø3 x 4	Ø1mx2m	~10%	3400 MW$_{th}$	~1x10^{17}

Reactor Simulation Framework and access to Fueling Data

- Core evolution must be tracked

- Through our nonproliferation efforts we have detailed simulation expertise and access to the required operator fueling and reactor data
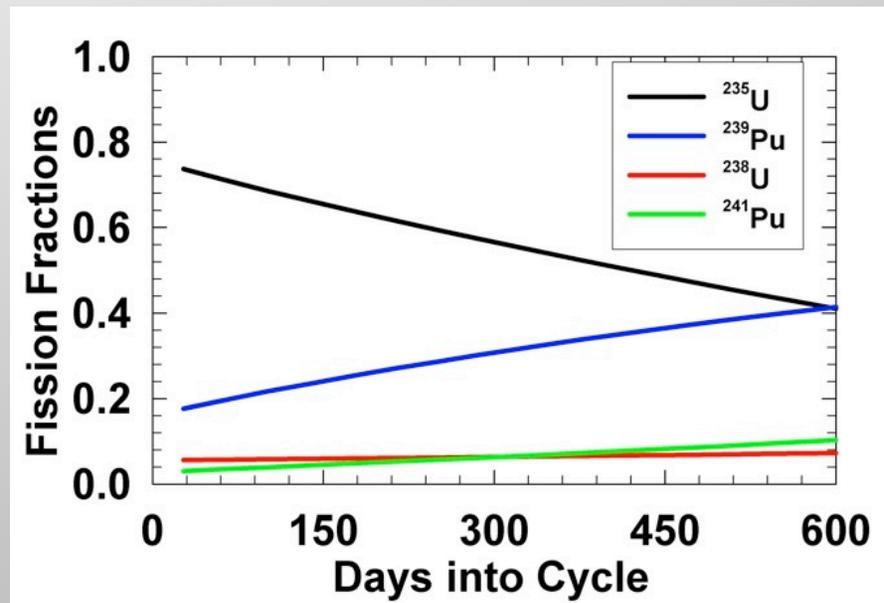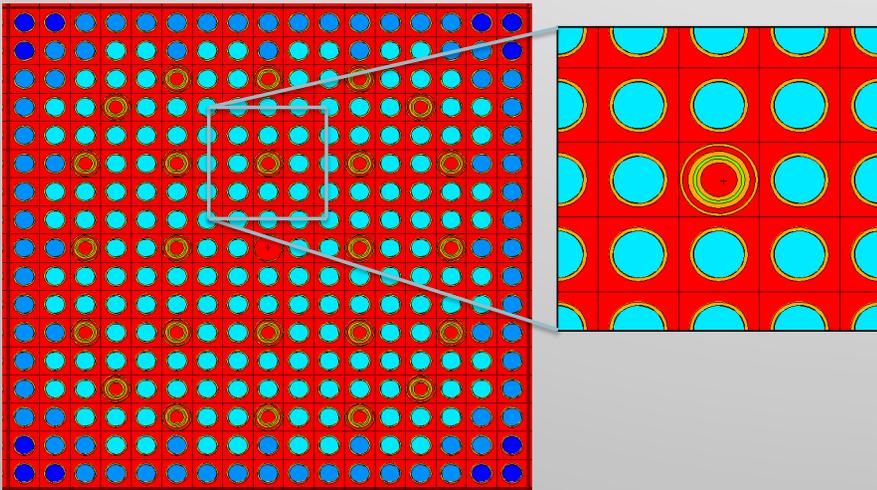
Measured Background

- SONGS1 detector had ~0.5m of water shielding and 95% veto coverage

- Signal/Correlated background ~ 4/1
  - Further scope for rejection of multiple neutrons in analysis
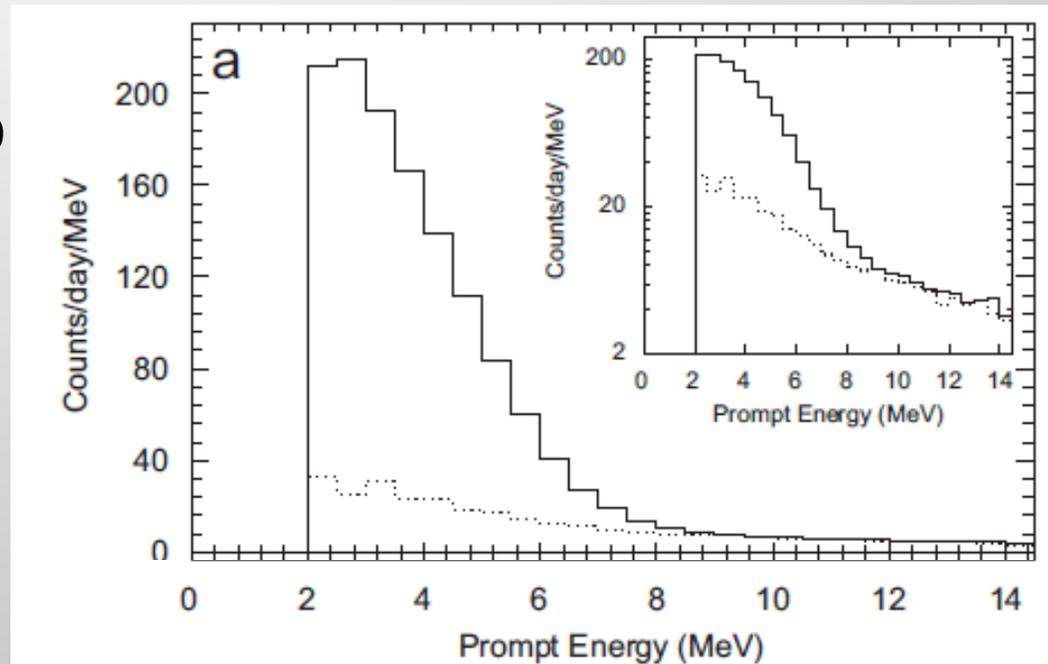
Conclusion

- SONGS, by itself, is not the best option for an anomaly measurement

  - Limited sensitivity above $\Delta m^2 \sim{<}1eV^2$

  - Infrequent reactor outages

  - Evolving fuel composition

- High flux and good background conditions would make it suitable for:

  — Detector characterization in "controlled" environment

  — PWR Antineutrino Spectrum measurement – access ^{235}Pu component

  — Rapid measurement in low Δm^2 region at baseline quite distinct from closer sites

- Pursuit of these options has some risk due to operational problems