WATCHMAN: Reactor Monitoring and Neutrino Physics with a Gadolinium Doped Water Detector

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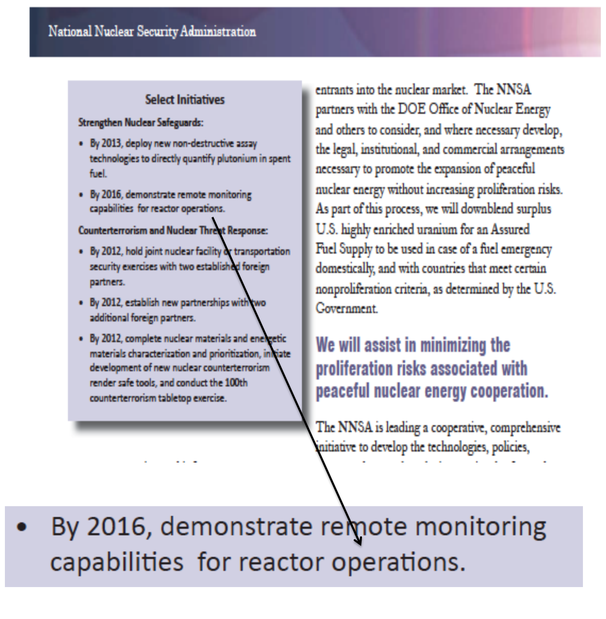
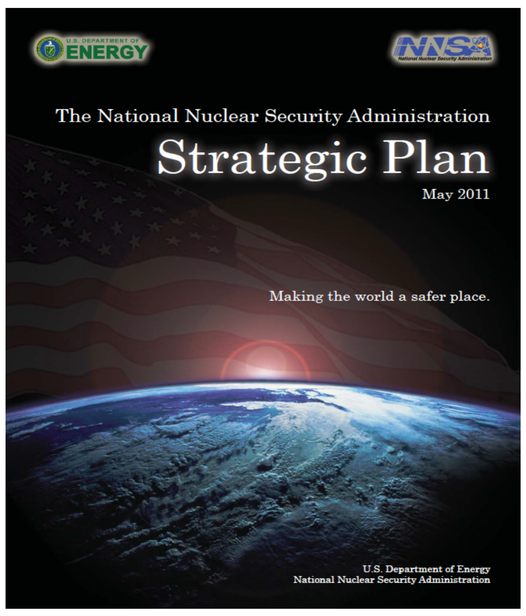
For The WATCHMAN Collaboration

- ✓ Kiloton-scale water+gadolinium antineutrino detector at old IMB location (Fairport mine, Ohio)
- ✓ Enabling Long Distance Reactor Discovery/Monitoring for non-proliferation and basic neutrino research

Introduction



- By 2016, demonstrate remote monitoring capabilities for reactor operations.



A Remote Reactor Monitoring Demonstration is in the NNSA Strategic Plan

AIM: To demonstrate the capability to monitor the nuclear fission by remote means

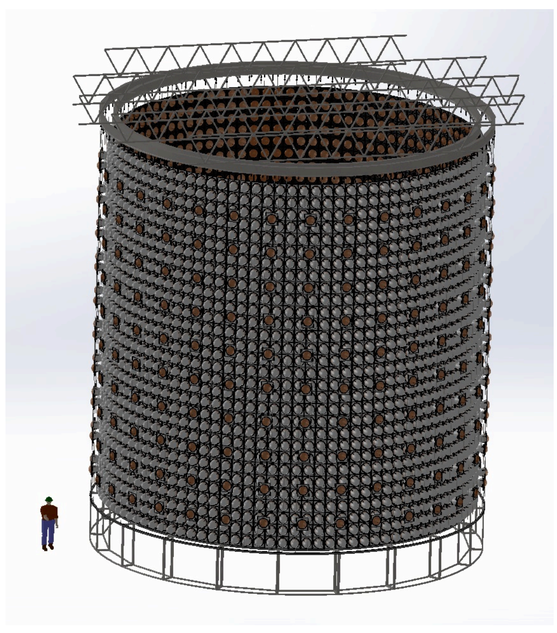
Advantages of Antineutrino-based monitoring

- Antineutrino emission cannot be shielded. There is no known way to hide your own reactor-based antineutrino production.
- Detection is clear indication that nuclear fission is occurring

The WATCHMAN Detector

Location at former IMB site

- Standoff from Perry Reactor 13km
- Reactor Power 3800 MWt
- Detector overburden 1500 mwe



Detector Design

- 1 kiloton fiducial volume
- DI water + gadolinium
- 6000 high QE PMTs
- 40% photo coverage

Design work

- Geant4 based simulations based on Super-K and LBNE Simulations (WCSim)
- Engineering underway now (LLNL and Sandia)

Ultimate Aim of WATCHMAN

To prove the feasibility of long distance reactor Monitoring

Predicted Distance scales and Detector sizes

Long Term Goals	Detector mass (Fiducial)	standoff
16 events in 1 year (power measured at ±25%) **from a 10 MWt reactor** (3 kg of Pu)	10 kiloton	~40 km
	1 Megaton	~400 km

Physics Research at WATCHMAN

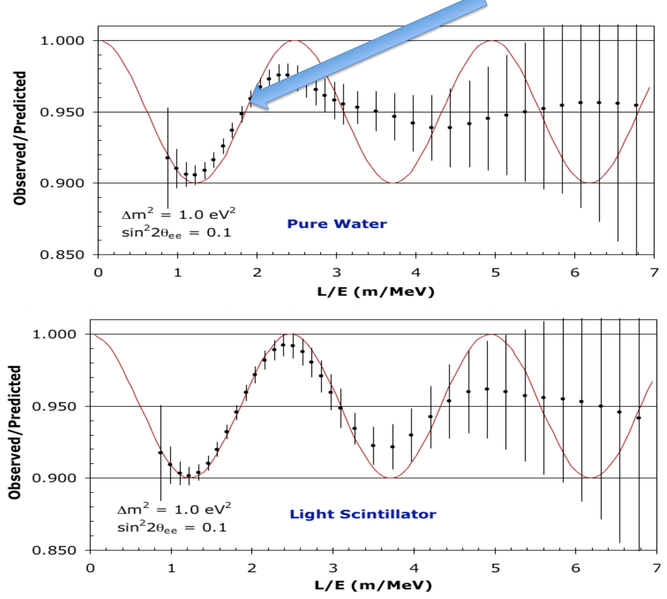
Physics Opportunities at WATCHMAN

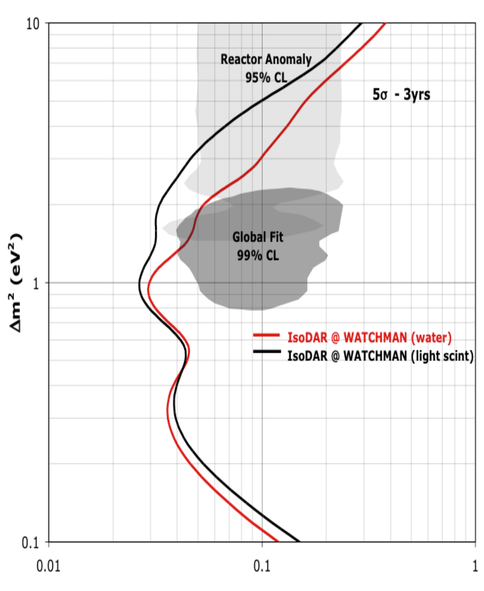
- **Supernova detector** – Only supernova detector capable of background free supernova antineutrino detection. Also background free electron scattering (fast pointing to galactic supernovae)
- **Sterile neutrino oscillation search** – Requires IsoDAR deployment at WATCHMAN
- **Non standard neutrino interactions** – Also Requires IsoDAR deployment at WATCHMAN

Upgrade to liquid scintillator

- **Mass hierarchy** – using antineutrinos from the Perry reactor
- **Sterile neutrino oscillation search** – Requires IsoDAR deployment at WATCHMAN
- **Non standard neutrino interactions** – Also Requires IsoDAR deployment at WATCHMAN

Example: Sterile neutrino oscillations can be observed with IsoDAR + water-based WATCHMAN (assuming $\Delta m^2 \sim 1\ eV^2$)





Acknowledgments

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