



The
University
Of
Sheffield.



Neutrinos for Non-Proliferation

Advanced Instrumentation Testbed & WATER Cherenkov Monitor for ANTineutrinos (AIT & WATCHMAN)

Poster E3

<https://commons.wikimedia.org/w/index.php?curid=27024528>

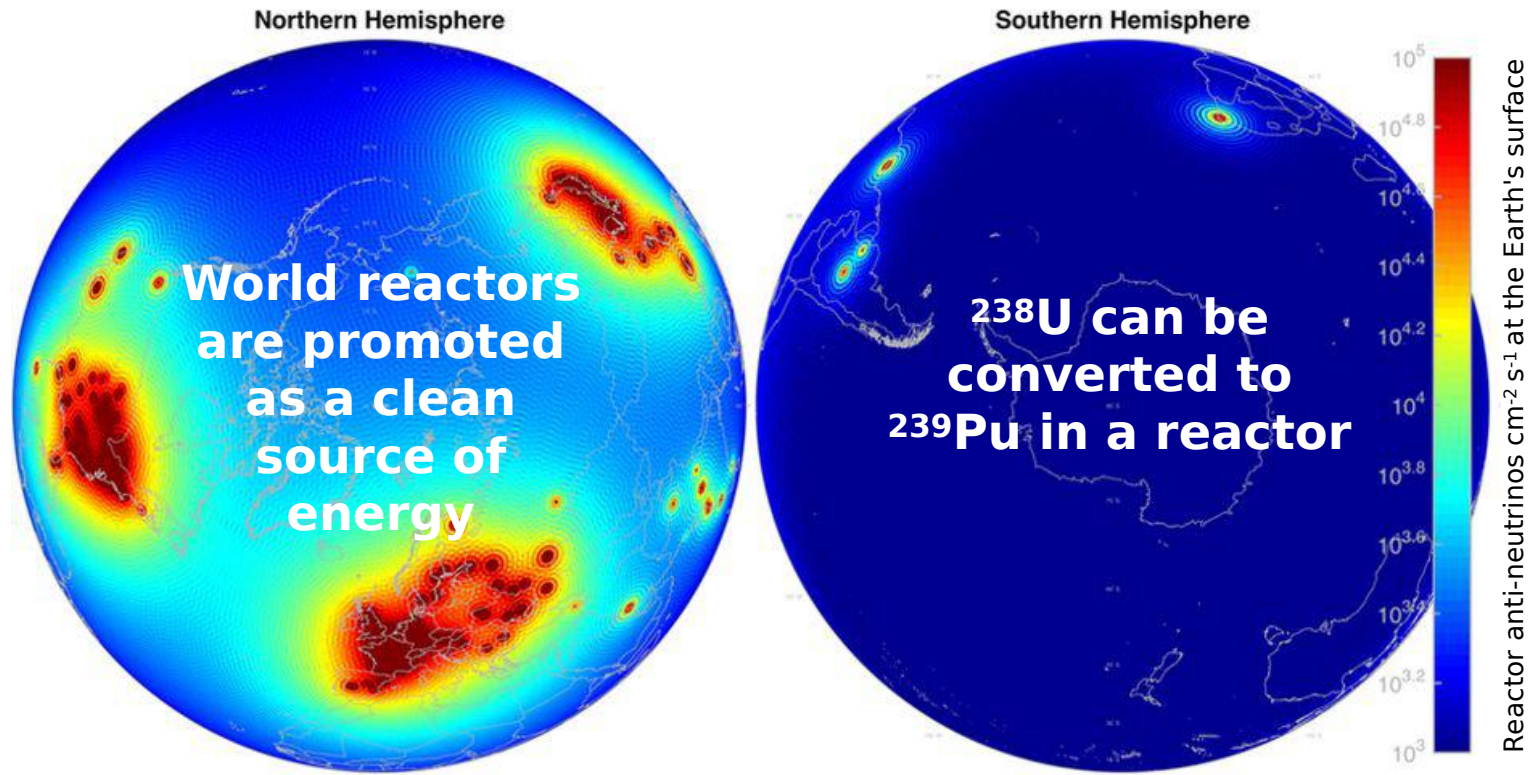


NuPhys, December 2019

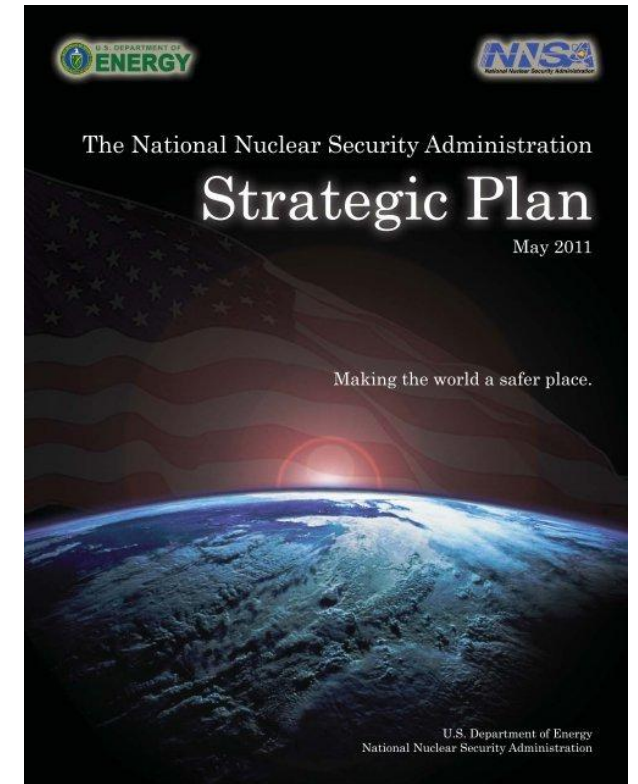
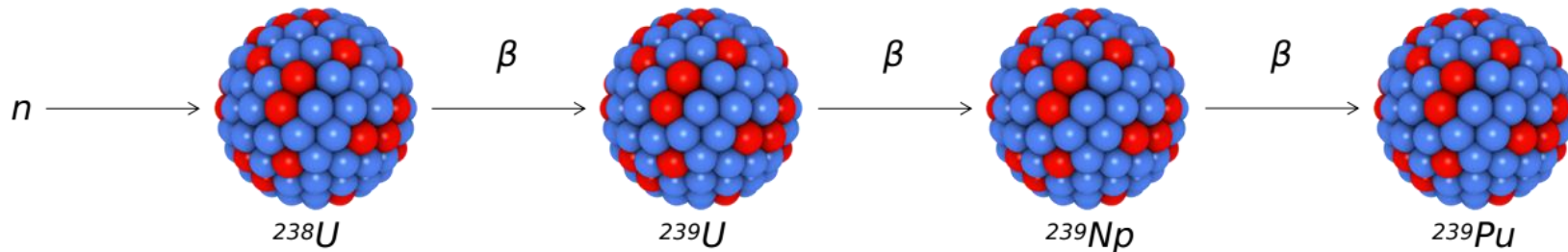
Liz Kneale, on behalf of the WATCHMAN collaboration
University of Sheffield & AWE



Proliferation of nuclear energy, non-proliferation of weapons



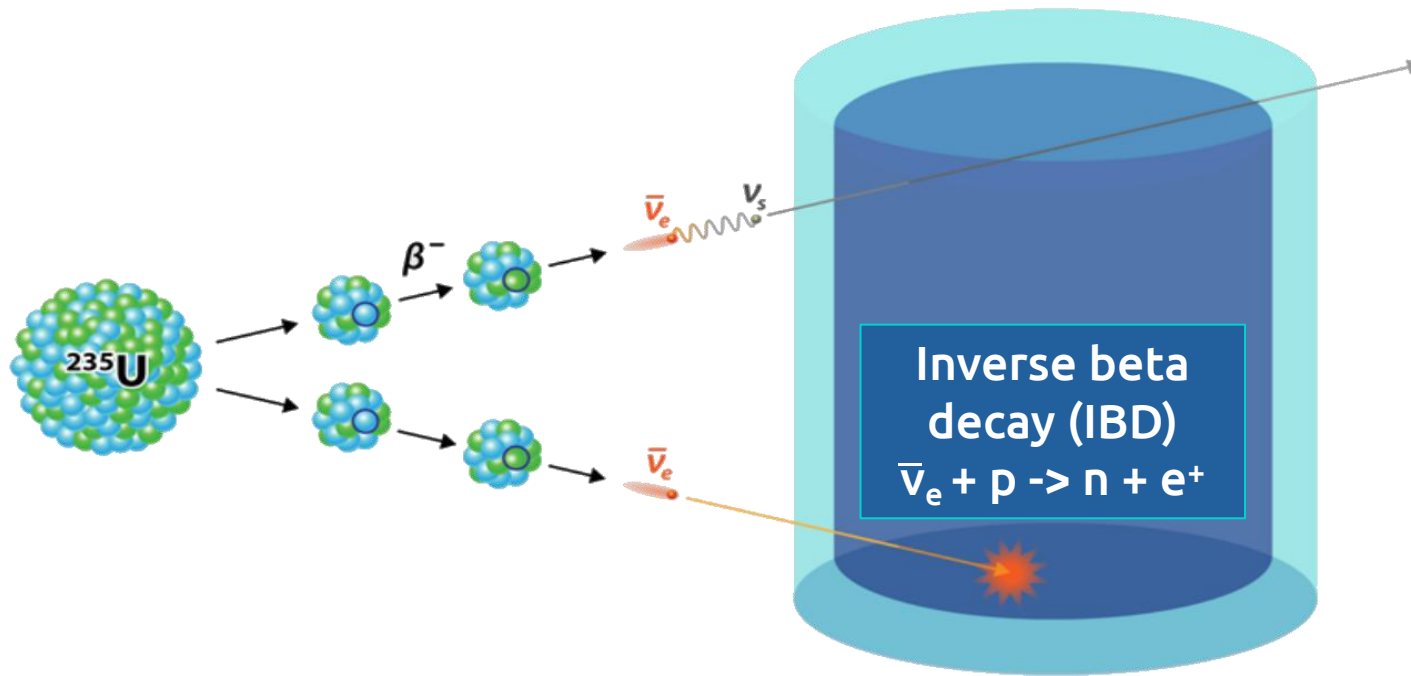
AGM2015



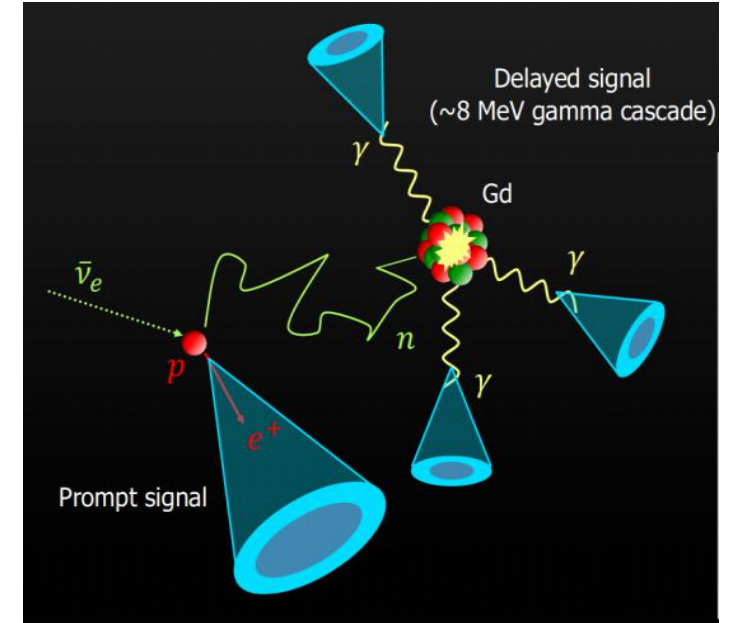
“Demonstrate remote monitoring capabilities for reactor operations”

Big problem, small solution

Reactor anti-neutrino flux carries information about the power, location and composition of a core.



APS/Alan Stonebraker



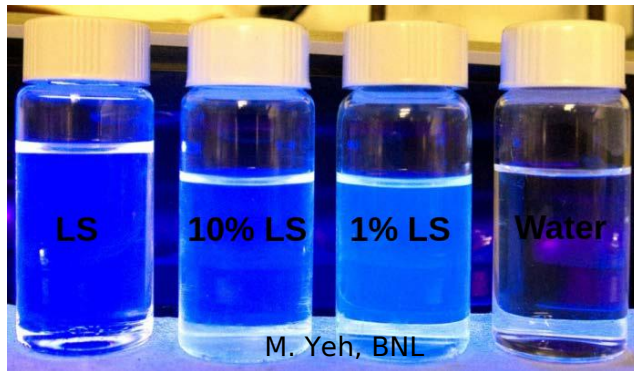
Gadolinium (Gd) loading:
IBD heartbeat

Anti-neutrinos from a 1GW_{th} reactor: 10^{20} per second

Each fission in a reactor releases on average 6 anti-neutrinos

Scalable prototype for low-energy antineutrino detection

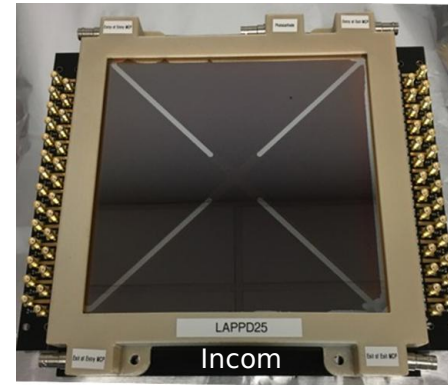
First or future phase



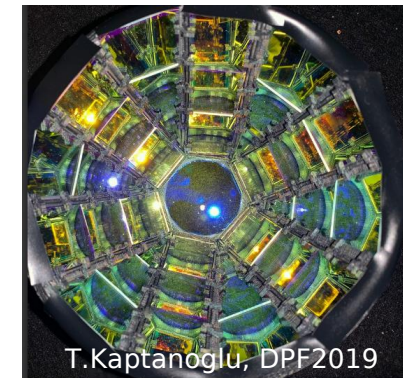
Water-based liquid scintillator (WbLS): added bonus of scintillation light.

Augmented solutions

+



Picosecond photosensors: fast timing



Dichroicons: light concentration and separation

= the 'Holy Grail' of Cherenkov and scintillation separation

Advanced Instrumentation Testbed (AIT) site

Hartlepool Power Station 26 km from AIT.

Twin-core,
 $2 \times 1.5 \text{GW}_{\text{th}}$
Advanced Gas-cooled Reactors (AGR).

Dual core mimics complexity of situations we expect in the field.



Boulby Mine: A quiet place in the Universe.

1.1km underground
(factor 10^6 muon reduction).

Cavern and laboratory to be built close to existing STFC Boulby Underground Laboratory.

One of the world's largest precision neutrino detectors to be built in the UK

Remote monitoring... and beyond

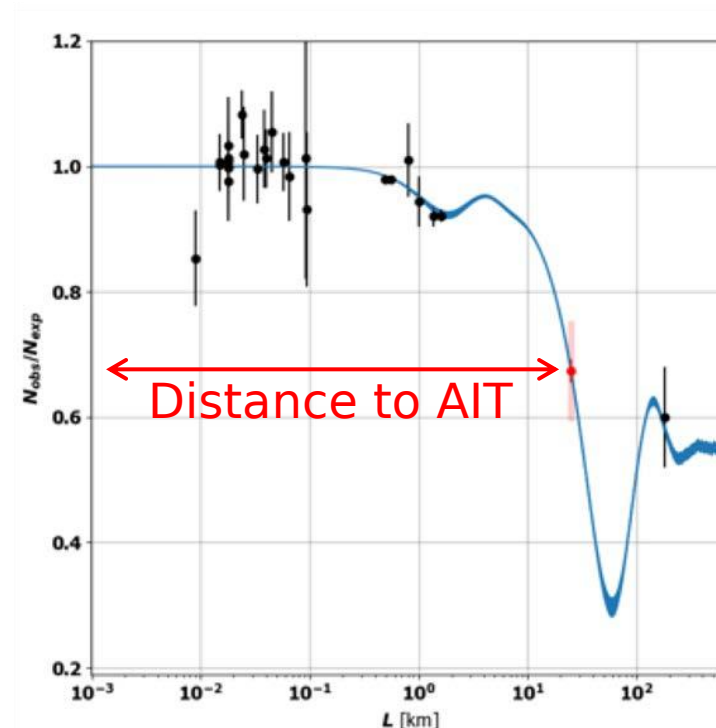
First phase

→ Future

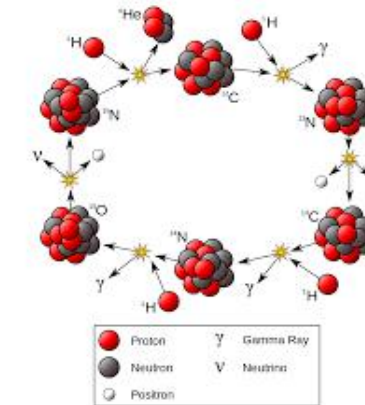


SN 1994D, NASA/ESA

Supernova neutrino detection and input into Supernova NEutrino Warning System (SNEWS)

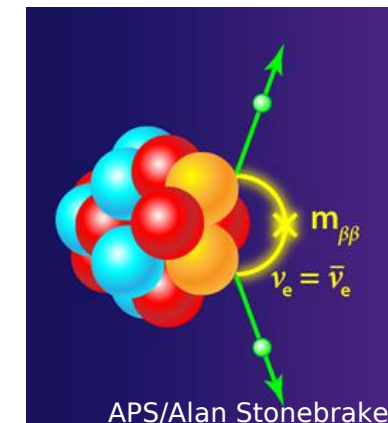


Neutrino oscillations



© Borb

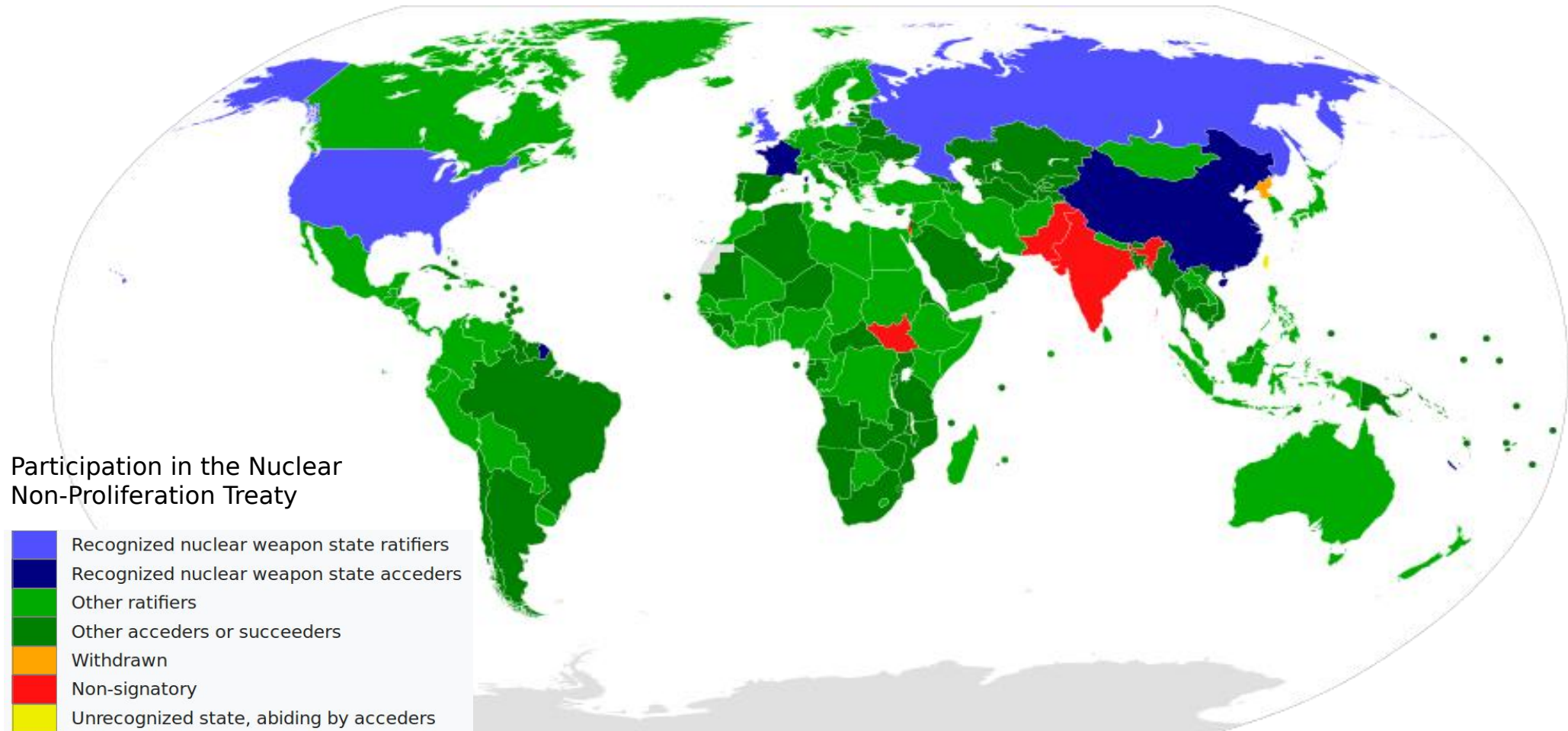
CNO solar neutrinos



APS/Alan Stonebraker

Neutrinoless- $\beta\beta$ decay

Remote monitoring supports non proliferation agreements



Non-intrusive monitoring with a megatonne-scale detector

