



The
University
Of
Sheffield.

The BOLEYN* Testbed

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*Placeholder name. Naming competition still in progress

Motivation

- This is a continuation of the WATCHMAN/AIT project which aimed to put a ~few kilotonne detector in Boulby mine for detecting neutrinos from nuclear reactors.
- The prospect of a large WATCHMAN was recently ended as EDF announced all the AGR fleet will be decommissioning by 2028.
- We are now looking towards creating a technology testbed at Boulby for future neutrino detector R&D.

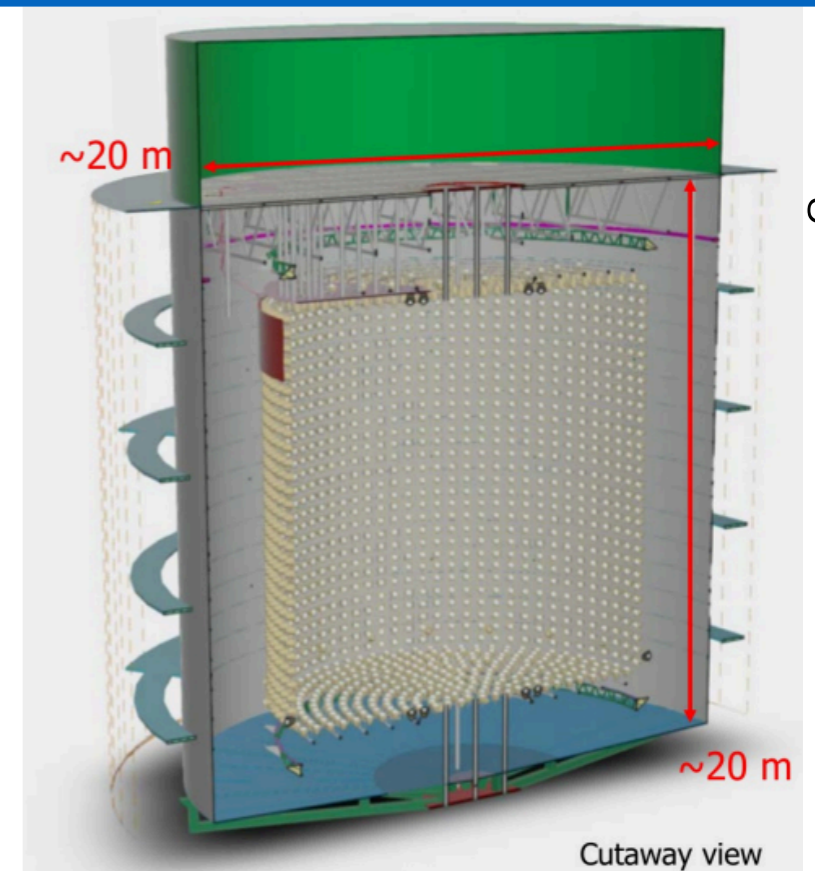
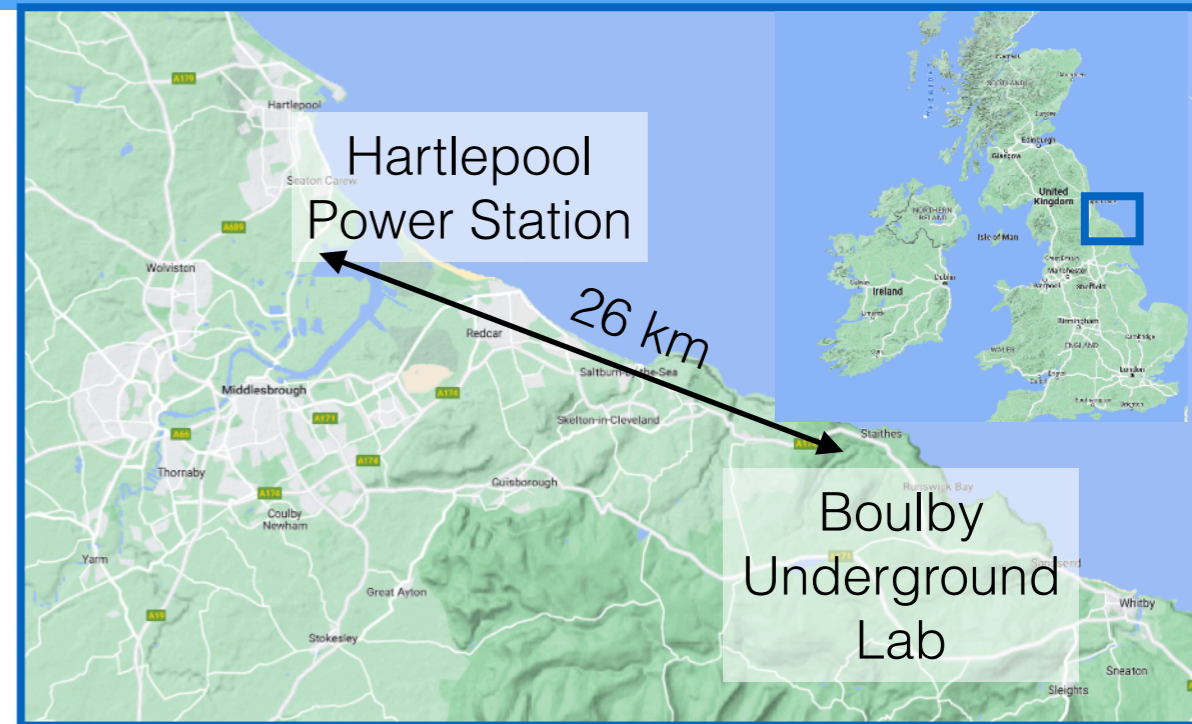


Image from Jan Boissevain.

- Liz Kneale's talk - Sensitivity to distant reactors - ~2 hours ago
- Yan-Jie Schnellbach's talk - Supernova sensitivity - Weds, 12pm
- Steve Wilson's poster - Reactor ranging

BOLEYN*

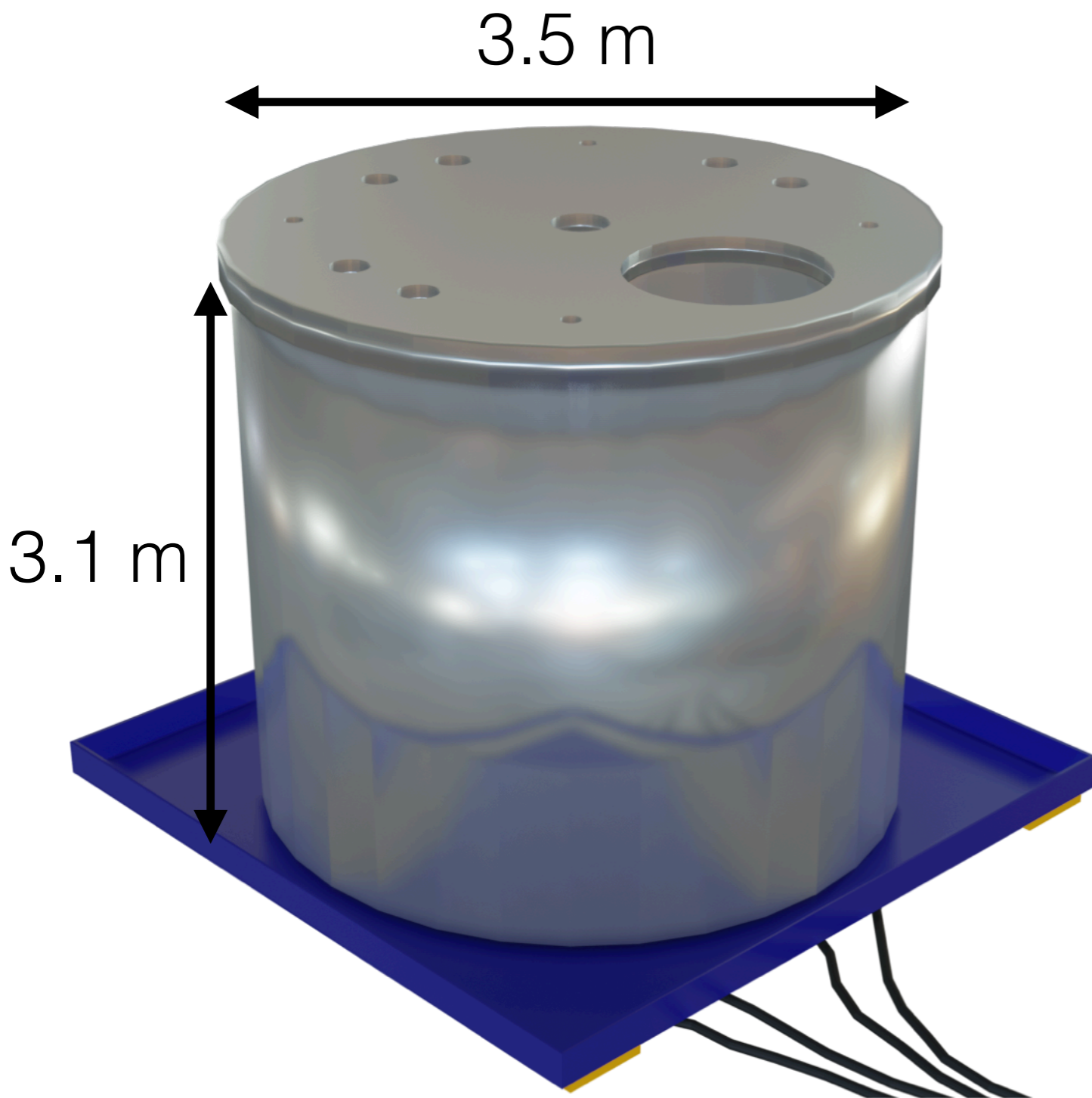


Image from Yan-Jie Schnellbach (Liverpool)

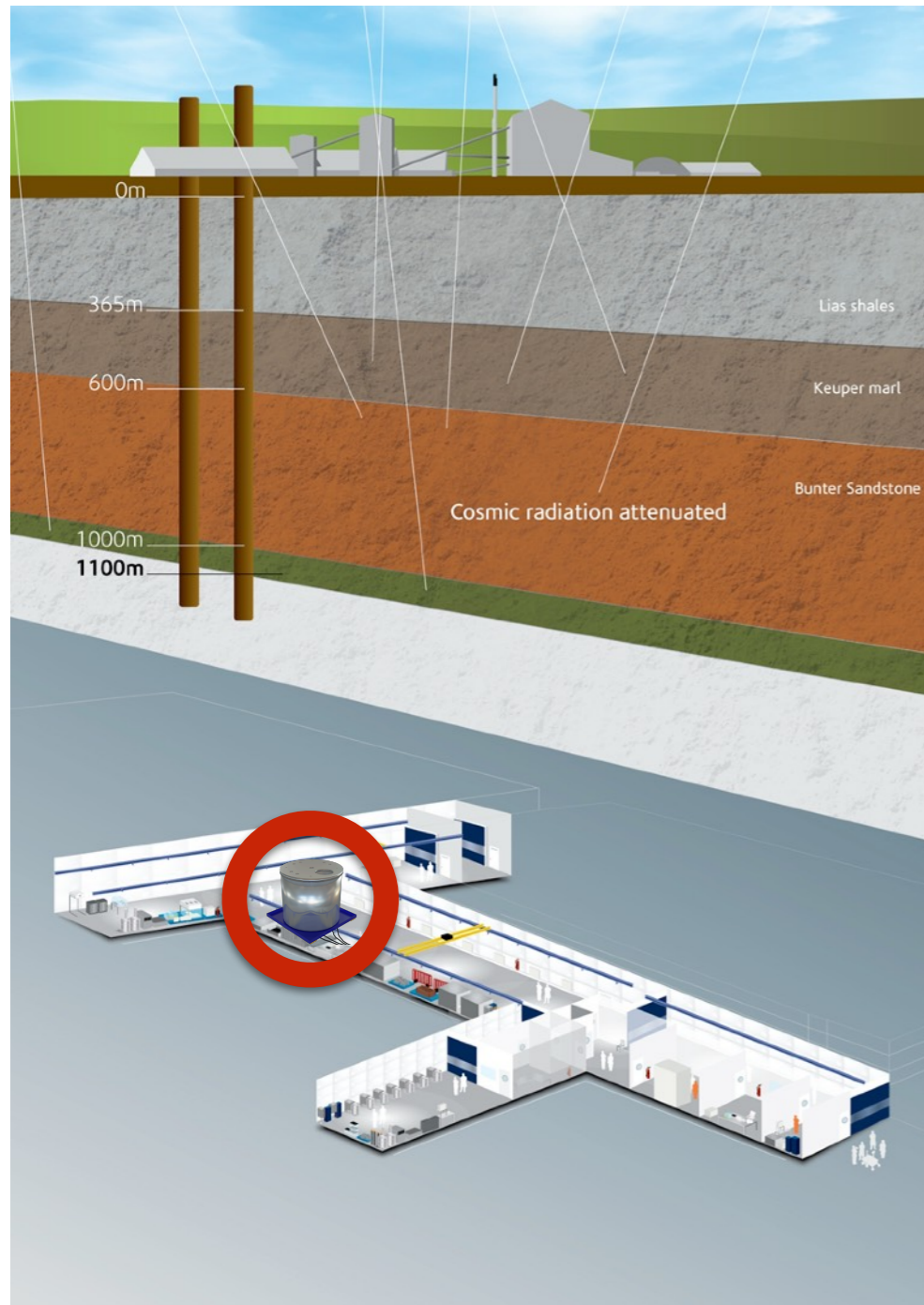
- * Temp name. Naming competition in progress.
- A low background testbed for neutrino detector hardware and media. Focussing on photosensors and liquid fill materials.
- Overview:
 - ~30 tonne volume
 - ~90 Hamamatsu R7081 10" PMTs
 - Advanced photodetectors
 - Compatible with various fill materials
 - Will be ready for deploying various calibration sources.



Boulby Underground Laboratory

See Sean Paling's talk - Weds, 3:50pm

- The testbed will be built in Boulby Underground Lab, based in the North East of England.
- Boulby is the UK's deep underground lab hosting an array of multi-disciplinary science projects, from particle physics to astrobiology.
- Reduction in muon flux of $\sim 10^6$ compared to the surface (2800 m.w.e.).
- Lowest natural radon levels of any underground lab ($\sim 3 \text{ Bq/m}^3$).



Tank

- The tank will be a roughly cylindrical design.
- Made of stainless steel 316 - compatible with most liquid fills, no liner needed.
- Removable lid for easy access and modifications.

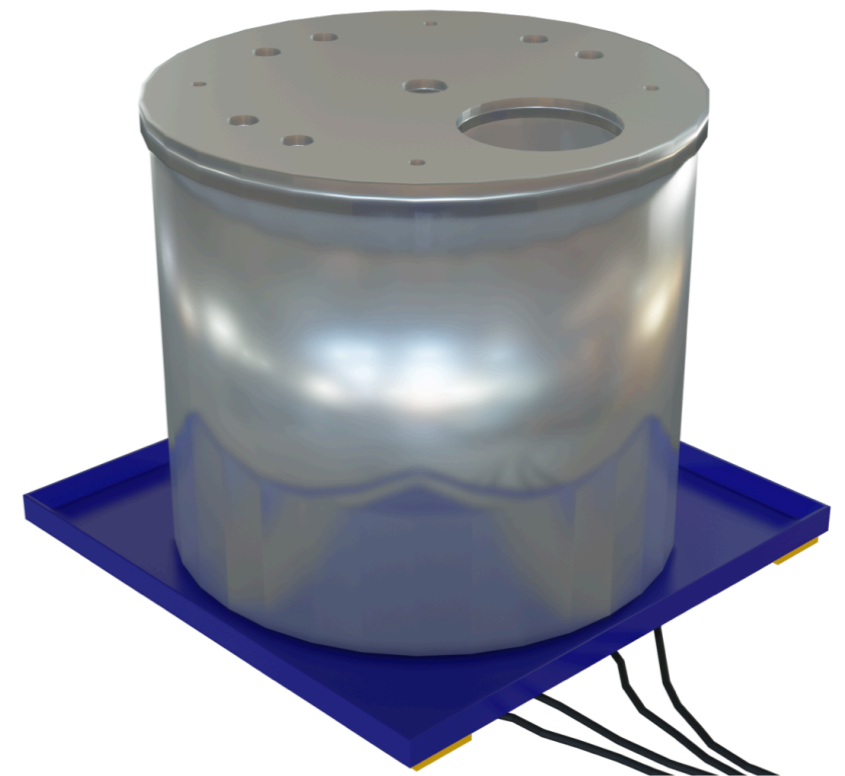
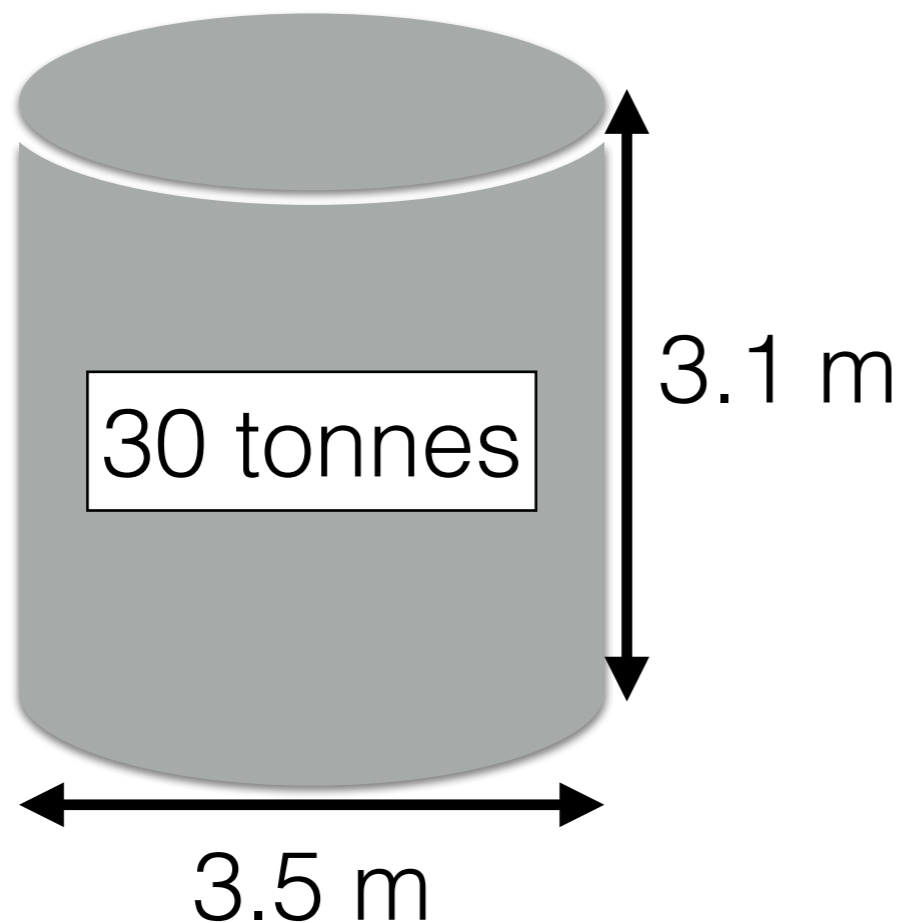
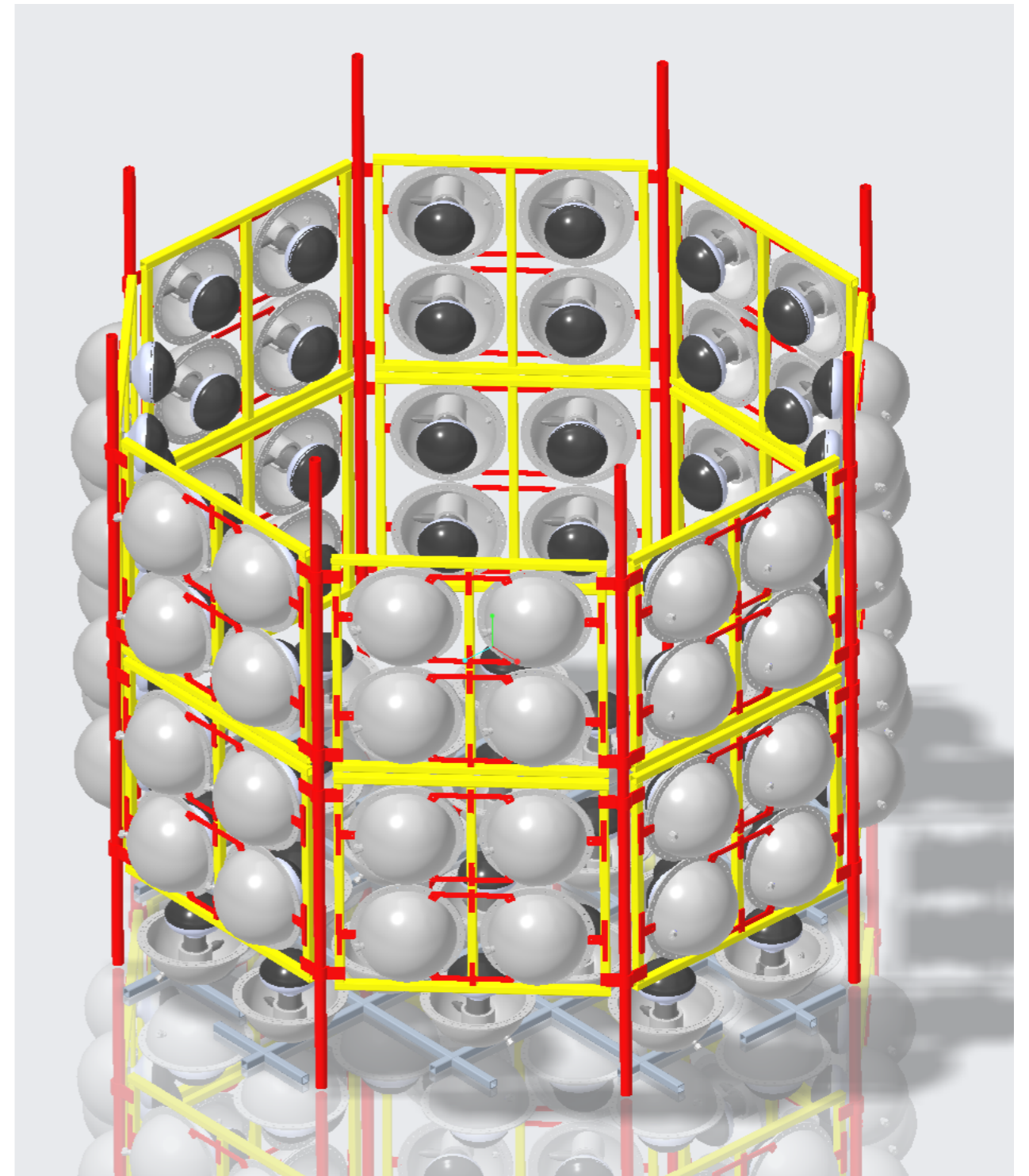


Image from Yan-Jie Schnellbach (Liverpool)

Support Structure

- Will have a modular support structure.
- Will be clamped into the tank so easy to remove if we want to make future changes.
- Connections will be set to take all detector modules interchangeably for easy swapping/moving with PMTs and advanced detectors.
- Needs to be designed to take both the dry load of the PMTs as well as the buoyant load when the liquid is inside.



Advanced Photodetectors

- The first advanced photodetectors we plan to deploy are:
 - LAPPDs (Large Area Picosecond PhotoDetectors).
 - WLS (WaveLength Shifting) plates with SiPM readout.
- Deployment in the tank will allow direct comparisons with the well understood PMTs in a low background environment.

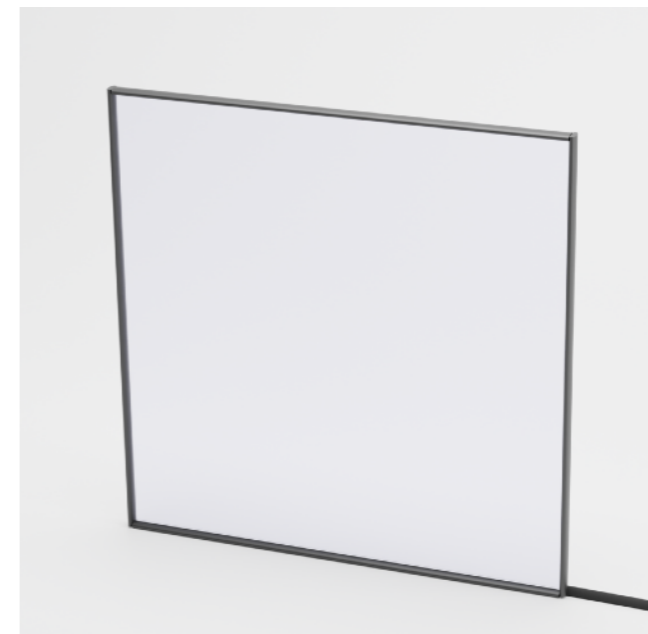


Image from Frank Thomson (Glasgow)

LAPPDs

- Produced by US company Incom.
- 20 cm square tile
- QE: ~25%
- Gain: $>10^6$
- Time resolution: <80 ps (TTS)
- Position resolution: ~mm
- Gen 1 strip readout
- Gen 2 pixel readout
- Current bench top R&D at Sheffield, Edinburgh and (shortly) Glasgow.

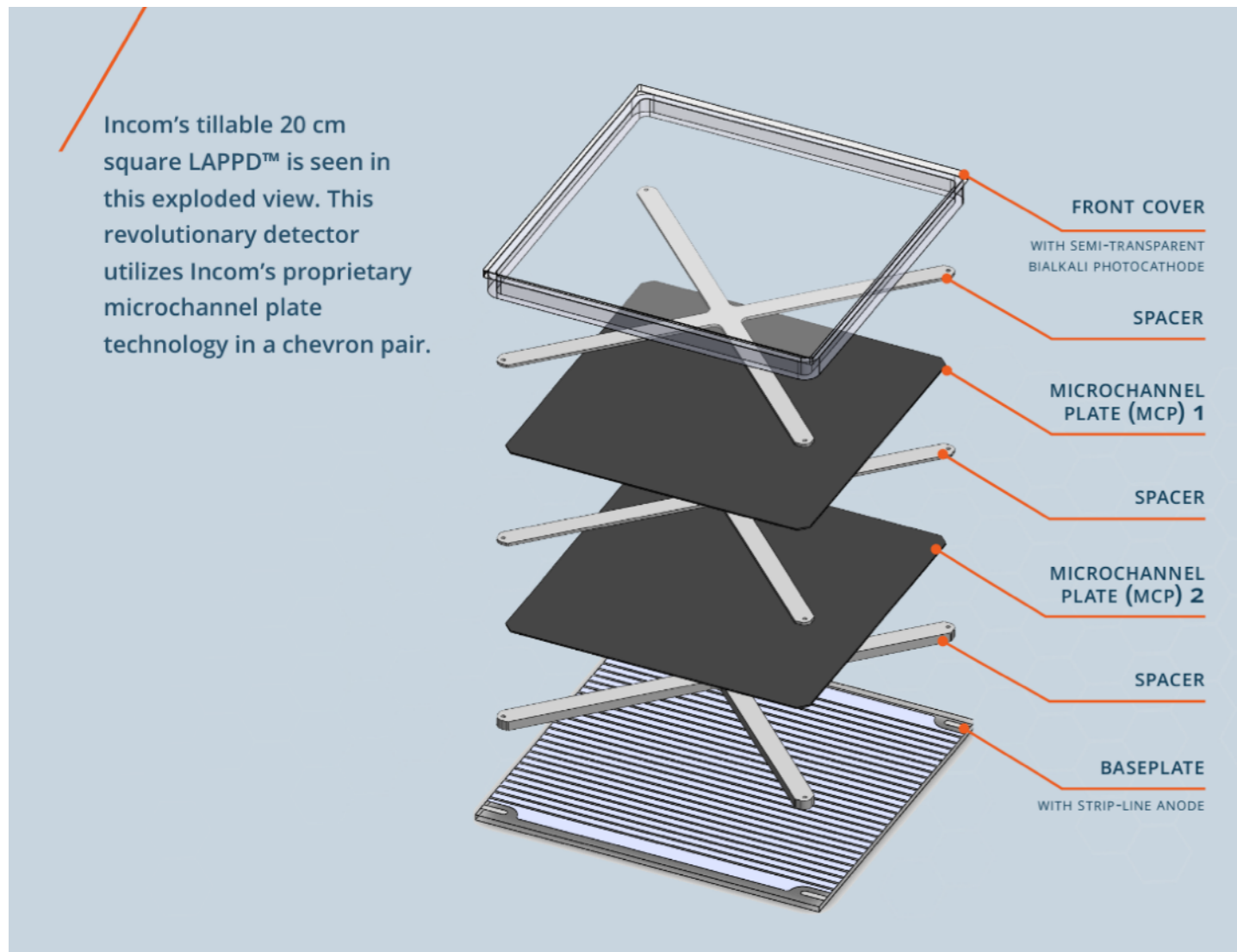


Image from Incom.

See Rob Foster's talk - Weds, 1:30pm

WLS Plates + SiPMs

- WLS + SiPM R&D ongoing at Glasgow.
- FRANCIS (Fast Research Anti Neutrino Counter In Scintillators).
- Combination of 4 Hamamatsu SiPMs with a 50 x 50 x 3 mm Eljen WLS plate.
- Test setup in Glasgow will check the uniformity and plans to test with a 'Cherenkov source'.
- As with LAPPDs, lots of R&D underway, and should be ready for deployment next year.

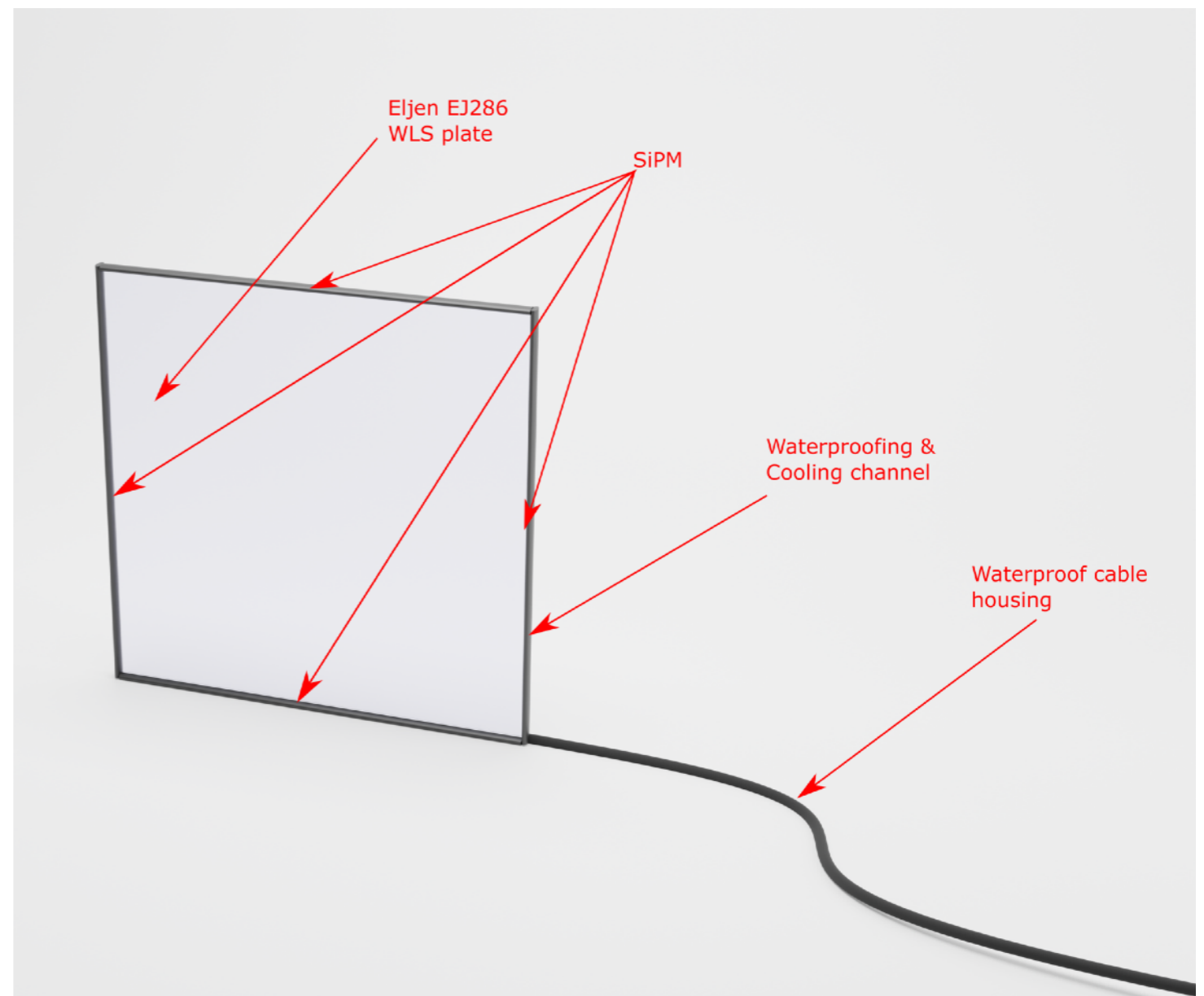


Image from Frank Thomson (Glasgow)

Material Compatibility

- Initially will be filled with pure water.
- Will have the capability to hold many other media in the future for comparison testing, including:
 - Gadolinium-doped water (Gd-H₂O)
 - Water-based liquid scintillator (+Gd)
 - Liquid scintillator (+Gd)
 - Slow-fluor scintillator
 - Opaque liquid scintillator (Liquid-O)
- All detectors will be housed in modules to separate them from the liquid fill.

See Chris Toth's poster - Gd-H₂O compatibility of PMTs



UVT acrylic PMT module. Image from Edinburgh group. Modules developed by Edinburgh and ICL Tech.

Other R&D

- Will have ports ready for deployment of calibration sources for detector testing and testing of calibration sources themselves.
- DAQ being developed by Warwick and Liverpool groups.
- Can be used to prototype other electronics systems (e.g. wireless optical modules).
- Simulations being led by Liverpool and Sheffield.

Status and Involvement

- Pushing forward nicely with the design, construction to be completed next year (2023).
- Main involvement: AWE + Boulby + 5 UK universities.
- International collaborators from the US and interest from elsewhere (including Germany + Greece).
- We're very open to new collaborators! If you're interested or have technologies/ideas you would like to test then please get in touch!

Summary

- New BOLEYN* testbed to be housed at Boulby.
- ~30 tonne system for testing photosensors and liquid fills.
- Initial deployment expected next year with PMTs, LAPPDs and WLS plates + SiPMs in pure water.
- Open to new collaborators and new ideas, please let us know!

*Temp name. Permanent name coming soon.

Thanks for listening

