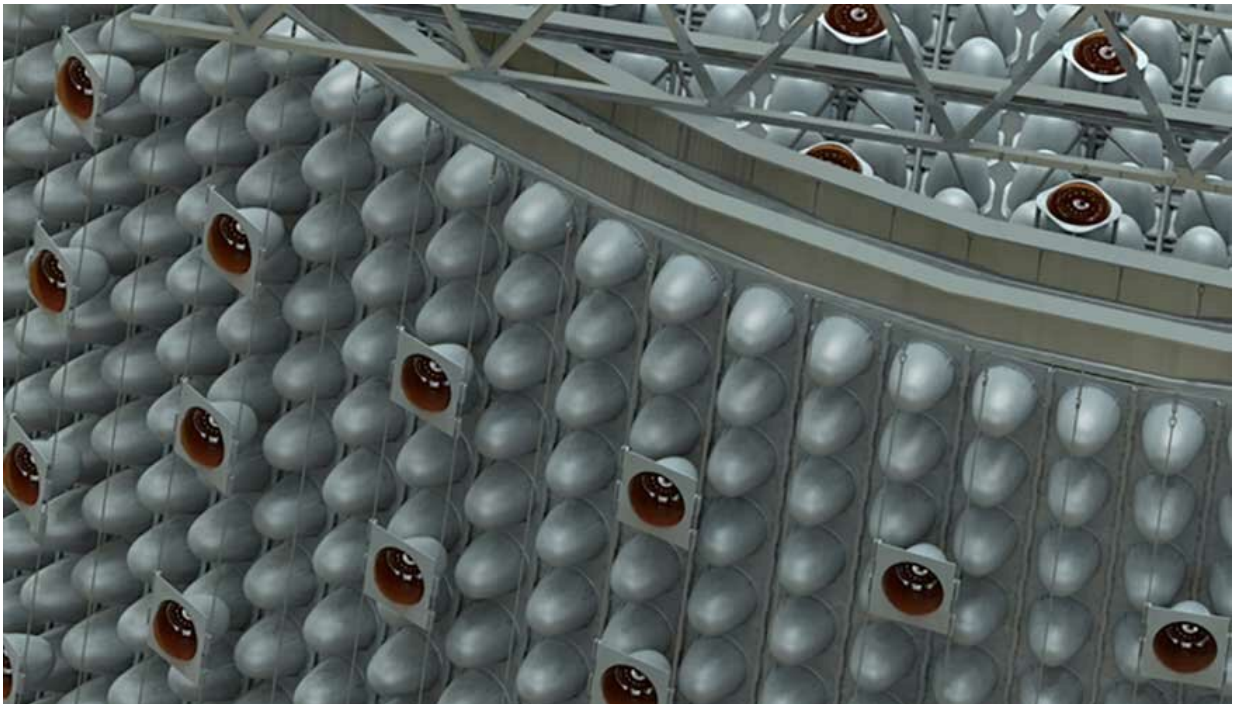


# Study of the universe could help improve global security

January 30 2019

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This graphic shows the detail of a possible configuration of the photomultiplier tube mounting structure for the WATCHMAN antineutrino detector, a key part of the Advanced Instrumentation Testbed. Modules containing sets of photomultiplier tubes are securely bolted to cables, which run the vertical length of the detector – like a giant Christmas decoration that absorbs light rather than emitting it. Credit: University of Sheffield

A major research project between the UK and US to harness existing

particle physics research techniques in order to remotely monitor nuclear reactors has been launched with the help of scientists at the University of Sheffield.

Expected to be operational from 2022 after being awarded new funding of almost £10 million from the UK Research and Innovation's new Fund for International Collaboration, the Advanced Instrumentation Testbed (AIT) project's 6,500 tonne detector will measure the harmless sub-atomic particles called antineutrinos that are emitted by an existing nuclear power plant 25 kilometres away.

The project will test whether the technique could be scaled up in the future for more distant monitoring of nuclear sites. If successful, this could improve global security. Better understanding of neutrinos and antineutrinos would also help solve some of the mysteries around the creation of the universe.

The AIT detector is called WATCHMAN, an acronym for the WATer CHerenkov Monitor of ANTineutrinos.

It will be constructed 1.1 kilometres underground at the ICL Boulby mine in North Yorkshire – the deepest operating mine in Europe. AIT-WATCHMAN will be supported by the Boulby Underground Laboratory, an existing multidisciplinary deep underground science facility operated by the UK's Science and Technology Facilities Council (STFC).

Abundant throughout the universe, and created by our own Sun and other stars, neutrinos are among the most difficult fundamental particles to study, as they carry no electrical charge and rarely interact with ordinary matter. Studying the properties of neutrinos and antineutrinos is an important component of wider physics research into the origins of the universe, especially the apparent imbalance between matter and

antimatter.

Professor Mark Thomson is Executive Chair of the Science and Technology Facilities Council overseeing the UK delivery of the project. He said: "The UK and US have a long history of scientific collaboration, especially in translating the techniques used for basic science to solve real world problems.



Boulby potash, polyhalite and salt mine on the northeast coast of England is Great Britain's deepest mine and the home of the Science and Technology Facilities Council's Boulby Underground Laboratory. The mine, operated by ICL-UK /Cleveland Potash Ltd, is expected to be the site of the Advanced Instrumentation Testbed project. The WATCHMAN detector would be placed in an excavated cavern at the Boulby site and is slated to become operational in approximately 2023. Credit: University of Sheffield

"Not only will this project help improve global security cooperation, it will also provide a boost to joint research efforts into [neutrinos](#) and antineutrinos – research which could help solve some of mysteries around the creation of the universe."

Since 2016, the University of Sheffield has been the UK's leading academic institution on the AIT-WATCHMAN project. Physicists from the University of Sheffield have been working alongside collaborators from the Universities of Edinburgh and Liverpool, as well as national defence and security agencies, including the Atomic Weapons Establishment, on the AIT-WATCHMAN project.

Dr. Matthew Malek of the University of Sheffield is the academic Principal Investigator for the UK. Dr. Malek said: "The beauty of AIT-WATCHMAN is that it enables us to learn more about the universe on so many levels, while also supporting an innovative programme of non-proliferation. We will study one of the fundamental building blocks of nature, the neutrino, and we will use it to search for supernovae in other parts of our galaxy.

"At the same time, we are developing new techniques that will have a positive impact on Britain and the rest of the world."

Dr. Adam Bernstein from the Lawrence Livermore National Laboratory (LLNL) in California is the AIT-WATCHMAN Project Director. He said: "The ICL-Boulby site for AIT, with its proximity to an existing reactor complex, is the ideal location for our experiment.

"WATCHMAN and AIT give the physics and non-proliferation communities a rare opportunity to work together to harness neutrino detection for the practical purpose of non-intrusively monitoring nuclear reactors."

Professor Sean Paling is an Honorary Professor at the University of Sheffield as well as the Director of the existing STFC Underground Science Laboratory at ICL Boulby Mine. Professor Paling added: "It is great to have this world-class research project come to the UK and the North East region. Boulby is a special place for science in the UK and already supports a range of pure and applied science studies from astrophysics to studies of life on Earth and beyond.

"This new project will complement and enhance the existing programme and increase the laboratory's standing in the international science community."

Provided by University of Sheffield

Citation: Study of the universe could help improve global security (2019, January 30) retrieved 9 April 2024 from <https://phys.org/news/2019-01-universe-global.html>

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