News & Analysis

Neutrino search heads under water

Construction of a new €25m telescope designed to detect high-energy neutrinos from astrophysical sources has begun at the bottom of the world's deepest lake. The Gigaton Volume Detector (GVD) is being built at Lake Baikal in Siberia – the world's second largest lake – by the Russian Institute for Nuclear Research in Moscow. Once complete in 2018, the GVD will be one of the biggest neutrino telescopes in the world.

Neutrinos are very difficult to detect as they are electrically neutral and almost massless, meaning they can travel great distances through space without interacting with matter or being deflected from their course. However, when passing through water or ice, neutrinos can interact with water molecules to produce charged particles known as muons. These give off Cerenkov radiation when they travel through water faster than light does in it. The Cerenkov radiation can then be picked up by photomultiplier tubes, with the chance of spotting a neutrino increasing with the volume of water.

The new telescope will replace the current prototype NT-200 telescope, which has been running at Lake Baikal since 1998 and consists of 230 modules operating across an effective volume of 10 000 m^3. The GVD, in contrast, will be made up of around 2500 optical modules spread across nearly 1 km^3 of water. Project leader Grigory Domogatsky says that the Baikal facility will look primarily for muon neutrinos, but may give insights into other phenomena too. "Large-scale neutrino telescopes offer remarkable opportunities in the search for dark matter, magnetic monopoles and other hypothetical particles," Domogatsky told *Physics World*.

G V Domogatsky, Institute for Nuclear Research

Extreme physics
The Gigaton Volume Detector under construction at Lake Baikal in Siberia will have around 2500 optical modules spread across nearly 1 km^3 of water.

Plans for the GVD come hard on the heels of the $271m IceCube facility, which opened at the South Pole in January. It has more than 5000 optical modules, is 30% larger than the Baikal telescope and can detect particles at a much broader range of energies. However, according to particle astrophysicist Susan Cartwright at the University of Sheffield, the GVD has an advantage over IceCube by being based in the northern hemisphere. "Baikal will see the galactic centre, which is in the southern sky and therefore not well placed for IceCube," she says. "This is significant because this galactic centre is a promising location for nearby neutrino sources."

However, this advantage may not last long because a consortium of 10 European countries is drawing up plans to build KM3NeT – a gigatonne-scale detector in the Mediterranean Sea that is designed to replace the current ANTARES facility. If KM3NeT gets the go-ahead following completion of a detailed design study in March, it could be operational in 2016, and with more than 10 000 optical modules would exceed the GVD in both size and angular resolution. "If KM3NeT gets built, it would be difficult for Baikal to maintain its standing," says ANTARES spokesperson Paschal Coyle from the Centre for Particle Physics in Marseille. "But we have a great deal of respect for their efforts. They pioneered the way."

Simon Perks

Facilities

Japanese earthquake-hit labs seek quick restart

The $1.5bn Japan Proton Accelerator Research Complex (J-PARC) will not be fully open until the end of the year, according to a schedule released last month by the lab. Although experiments were largely unscathed after the 9.0 magnitude earthquake that struck Tohoku, Japan, in March, some roads and buildings were badly damaged at J-PARC, which lies on the east coast of the country around 200 km from the worst hit area.

Under the recovery plan, repairs at J-PARC will be carried out until early October, when the facility will begin several months of power tests. The beams themselves will be tested early next year, with experiments set to continue after March 2012.

Meanwhile, the KEK particle-physics lab, which lies in Tsukuba, some 50 km north-east of Tokyo, will resume operations later this year as it was less affected by the earthquake than J-PARC. KEK director-general Atsuto Suzuki says that beams at the centre's 8 GeV linac, which suffered magnet damage during the earthquake, will begin to be tested this month, with experiments set to start by early October. That month will also see the lab's two photon factories fire up again.

"Our highest priority is the restoration of [KEK and J-PARC] so that they can resume scientific activities," says Suzuki, who also insists that the construction of the new SuperKEKB facility to study B-mesons is still on track. This will involve upgrading KEK's 3 km-circumference electron–positron collider, which produces streams of B-mesons that are studied by the Belle detector. When built, SuperKEKB will be able to produce B-mesons 40 times faster than the current collider.

J-PARC

Feeling the impact
It will take until next year for J-PARC to come back online after the earthquake that struck Tohoku, Japan, in March.

"We are making concerted efforts to ensure construction remains on schedule," says Suzuki. "The fact that there is only minor damage to KEKB gives us some confidence that this should be fulfilled."

Michael Banks