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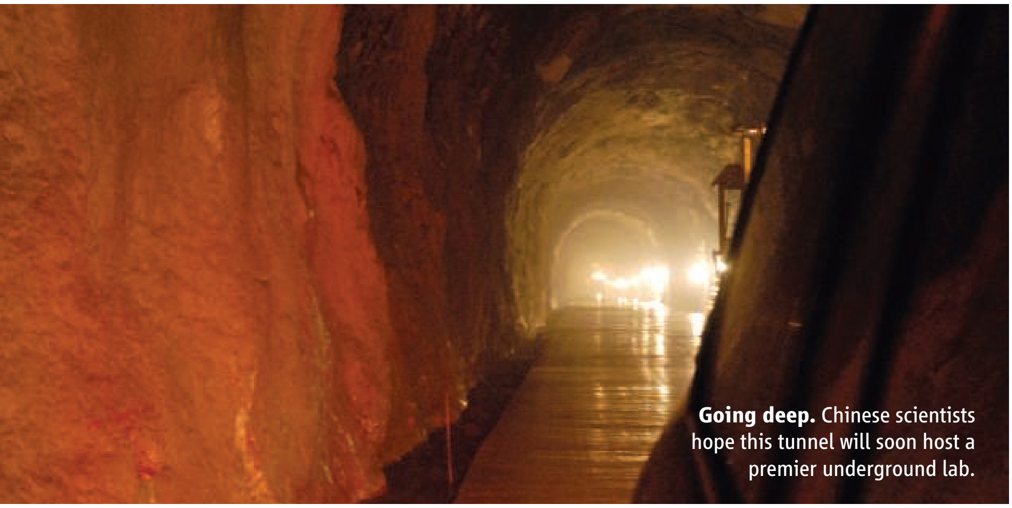

Going deep. Chinese scientists hope this tunnel will soon host a premier underground lab.

PARTICLE PHYSICS

Chinese Scientists Hope to Make Deepest, Darkest Dreams Come True

Particle physicist Yue Qian had his eureka moment in front of the TV set. For over a decade, Chinese scientists have longed for an underground laboratory that would enable them to join efforts across the globe to detect dark matter, observe neutrinos, and watch for exotic particle physics phenomena. Searches for suitable sites repeatedly came up empty-handed. But last August, after Yue caught a news report on the completion of two tunnels piercing Jinping Mountain in Sichuan Province, he felt that the long quest for such a lab might finally be over.

After months of negotiations, on 8 May Tsinghua University in Beijing, where Yue is an associate professor, signed an agreement with the tunnels' owner, Ertan Hydropower Development Co., to hollow out an experimental chamber. The Jinping lab would be the deepest underground science facility in the world, edging out—by 100 meters or so—the Deep Underground Science and Engineering Laboratory that the U.S. National Science Foundation may build in an abandoned mine in Lead, South Dakota. By placing sensors deep in the earth, physicists hope to reduce spurious signals from cosmic rays. China's subterranean aspirations have been circulating in Asia for months; the international community will get its first glimpse of the project at a dark-matter workshop in Shanghai on 15 June and at an astroparticle and underground physics conference in Rome next month.

An underground lab has been a dream for several generations of Chinese scientists, says Wang Yifang, a particle physicist at the Institute of High Energy Physics of the Chinese Academy of Sciences in Beijing. Past candidate sites, including an underground aviation museum near Beijing and coal and gold mines around the country, all were judged too shallow or impractical.

Short cut. Tunnels between the Jinping dams on the Yalong River offer a serendipitous lab site.

Jinping, on the other hand, "looks ideal," Wang says. The lab would have approximately 2500 meters of marble and sandstone above it: more shielding than any similar site in the world. Researchers will be able to make a 1-hour drive from a regional airport to the lab's front door. And the tunnels are sized for construction equipment, promising smooth delivery of instruments and supplies.

Wang cautions that the lab is not a done deal. "It's really at a very early stage," he says. To start with, Yue's group must verify that the rock overburden really does screen out unwanted cosmic rays and that there is no unexpected radiation emanating from nearby rock or groundwater. To provide space for instruments, by the end of the year the team plans to have hollowed out a 5-meter-high, 5-meter-wide, 30-meter-long chamber. They will then measure cosmic ray flux and background radiation for about 6 months. And they will begin at least one experiment. Yue is forming a collaboration to install a germanium detector to search for a postulated component of dark matter known as WIMPs, or weakly interacting massive particles. Chinese physicists are also talking about observations of atmospheric and solar neutrinos as well as experiments to watch for neutrinoless double-beta decay, an extremely rare phenomenon that might help refine estimates of neutrino mass.

Yue doesn't yet know what the first phase will cost, as design efforts are just starting. "But [Tsinghua] university has promised strong support," he says, and they are seeking funds from the science ministry. If the project develops as hoped, says Yue, "we would want to get more universities and institutions from China and around the world to join us and push this project ahead."

The good fortune befell physicists thanks to a mammoth hydroelectric project about 350 kilometers southwest of Chengdu, the capital of Sichuan Province, where the Yalong River makes a 150-kilometer-long U-turn around Jinping Mountain. Ertan Hydropower is building two dams: Jinping 1 at the start of the U-turn and Jinping 2 at the end. To move workers and materials between the construction sites, Ertan blasted a pair of 17-kilometer-

CREDITS (TOP TO BOTTOM): YUE QIAN; INTERNATIONAL WATER POWER & DAM CONSTRUCTION

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long access tunnels through the mountain. One will host the lab.

The hydropower project is controversial because some geologists think the weight of the impounded water could destabilize faults in the earthquake-prone region (*Science*, 8 May, p. 714). The prospect of an underground lab, though, is warmly welcomed by physicists throughout Asia. "It certainly is good news," says Henry Wong, a physicist at Academia Sinica in Taiwan, who will collaborate with Yue on the dark-matter experiment. Wong says he expects the lab to strengthen scientific ties between Taiwan and mainland China. Kim Sun Kee, a particle physicist at Seoul National University, is also enthusiastic. "Compared to other regions, in Asia, we don't have many underground labs," he says. Kim spearheads a collaboration hunting for dark matter in a lab in South Korea's Jeombong Mountain (*Science*, 6 July 2007, p. 32). But the Korean lab is only 700 meters beneath the surface, and more sensitive detectors now being contemplated by the community would need better shielding. Jinping, says Kim, "will be a great place for next-generation experiments."

–DENNIS NORMILE

RESEARCH FACILITIES

European Neutron Source Finally Finds a Home

After a frustrating decade watching their preeminence in neutron-beam science ebb away to newer facilities in the United States and Japan, European researchers got some good news last week: Their €1.4 billion dream machine, the European Spallation Source (ESS), which has been on the drawing board for more than 15 years, overcame a major hurdle when the countries interested in funding the project picked a site on which to build it in Lund, Sweden. "This is the real thing, something we can focus on and move forward," says Robert Cywinski of the University of Huddersfield in the United Kingdom, spokesperson for the ESS preparatory phase project.

Research fields. An artist's impression of ESS at Lund, with the doughnut-shaped MAX IV synchrotron.

CREDIT: ESS SCANDINAVIA

Government ministers are not getting out their checkbooks yet, as there is still much to sort out, including a final site-specific design and an environmental impact assessment, as well as obtaining planning permission and figuring out exactly which countries want to join. But as with other major European research facilities, choosing a site—Lund won out over rivals Debrecen in Hungary and Bilbao in Spain—is always a tense and deeply political part of the process. ESS will be "the first European experimental facility in Sweden and the first outside the big five E.U. nations," says Colin Carlile of Lund University, who headed the effort to bring ESS there.

ESS will surpass current U.S. and Japanese neutron sources in power, unless they upgrade in the meantime. Neutron beams are used by a wide variety of researchers to probe how atoms are arranged within materials and how they interact. Beams of the particles can be produced using a nuclear reactor or by smashing a proton beam into a metallic target, a process known as spallation.

In the 1990s, Europe had the top two neutron sources: a reactor in France and a spallation source in the United Kingdom. U.S. researchers at the time were facing a neutron drought after a planned reactor was canceled in 1995. But the Spallation Neutron Source in Oak Ridge, Tennessee, got the green light in 1998 and opened for business in 2007 with a 1.5-megawatt beam. J-PARC, a multi-accelerator facility in Tokai-mura, Japan, is in the process of commissioning its 1-MW neutron beamline.

Although Europe drew up plans for a 10-MW spallation source in 1995, no European government seemed to want to pick up the ball and run with it. By 2003, ESS seemed all but dead, despite a cost reduction by downgrading to 5 MW. Cywinski blames this impasse on the fact that Europe "doesn't have one doorstep on which to put a proposal." Instead, researchers have to find a government to champion their idea and build a group of collaborators, a process known in E.U. circles as "variable geometry." Says Cywinski: "Variable geometry doesn't work, or we would have had ESS years ago."

ESS finally got a shot in the arm from the European Strategy Forum on Research Infrastructures, an E.U. body that in 2006 drew up a list of facilities that would benefit European research, describing ESS as a mature project. That stamp of approval led to E.U. money for preparatory work and several countries stepping up to offer possible sites. The Swedish government, for example, offered to pay 50% of ESS's construction cost and 20% of operating expenses. The site at Lund will also be home to a new Swedish-built synchrotron, an intense source of x-rays for research, and ESS will aim to be carbon-neutral through a joint project with a wind-energy company.

Sweden worked hard to get neighboring countries in Scandinavia and the Baltic on board before the vote. The final decision was made on 28 May after a group of research ministers from 12 countries interested in participating met to discuss the bids and then the non-bidding countries voted. Seven declared they would join the Lund effort—Germany, France, Poland, Denmark, Norway, Estonia, and Latvia—and two others, Italy and Switzerland, backed the Lund site. Portugal voted for Bilbao.

Sweden must cement the collaboration over the next few months with a memorandum of understanding signed by the partners and attempt to bring Italy and Switzerland as well as defeated rivals Spain and Hungary into the collaboration. Construction is penciled in to start in 2012.

–DANIEL CLERY

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Dennis Normile (June 4, 2009)

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