# China Joins Hunt for Cosmic Rays

By XIN Ling

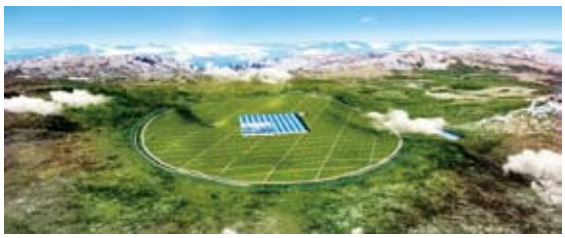
On the beautiful Haizi Mountain 4,410 m above sea level in southwest China's Sichuan Province, construction work has begun on one of the world's biggest and most sensitive cosmic ray detection facilities. Upon completion in 2020, the 1.2 billion yuan (180 million dollar) Large High Altitude Air Shower Observatory (LHAASO) will not only search for the sources of different types of high energy cosmic rays, but try to answer open questions like the nature and evolution of these mysterious rays.

Cosmic rays are all kinds of nuclei and very tiny fraction of electrons, photons and neutrinos that rain down onto the Earth from outside of our solar system. Composed primarily of high-energy protons and atomic nuclei, they travel nearly the speed of light and carry energies millions of times greater than those produced in the most powerful accelerators on Earth. Since the particles are extremely rare and hard to detect, now a hundred years after they were first discovered, a large part of such rays remain a mystery, including the very basic yet unanswered question of where they are actually coming from – although their origin is suspected to be related to the end-points of stellar evolution like supernova explosions and their remanences.

And LHAASO was born for this quest. According to CAO Zhen, LHAASO's chief scientist and researcher from the Institute of High Energy Physics, Chinese Academy of Sciences, the new facility will consist of four types of detectors: (1) a close-packed, surface water Cherenkov detector with a total area of 80k $m^2$ to catch air showers induced by high energy photons, (2) a 1.3 $km^2$ array made up by 6k scintillation detectors for the detection of electrons and photons in the showers, (3) an overlapping 1.3 $km^2$ array of 1.2K underground water Cherenkov tanks aimed for muon detection, and (4) 12 wide field-of-view air Cherenkov telescopes to observe shower electron-induced Cherenkov photons in the air.

With such a large instrumented area, especially an unprecedented detection area for muons and low energy photons, CAO was pretty optimistic about the scientific outcome of LHAASO.

Compared with other leading projects of its scale, such as the IceCube deployed under the South Pole ice to observe high energy neutrinos, and the Pierre Auger array in Argentina exploring the extreme high energy branch of the cosmic ray spectrum starting from $10^{18}$ eV, LHAASO allows the detection of cosmic rays over a wide range of



energies from $10^{11}$ to $10^{18}$ eV.

"Once completed, LHAASO will play a complementary role with existing detectors to offer a more comprehensive picture of the cosmic ray sky," said WANG Yifang, director general of the Institute.

The construction of LHAASO would not be easy though, CAO confessed, probably with the huge water Cherenkov detector in the middle of the facility being the toughest part.

"The deployment, debugging, and operations management of many thousands of detectors of different types is very challenging at a level never faced before", said Benedetto D'Ettorre Piazzoli, former Vice President of the National Institute of Nuclear Physics (INFN) in Italy who has been strongly involved in Sino-Italian collaboration in cosmic ray research.

Haizi Mountain was selected as the site for LHAASO because of its high elevation and good accessibility – only 10 km away from (the world's highest) Yading Airport and about 50 km from Daocheng County, where the on-site LHAASO team will be based later. The project kicked off pre-study in 2008, and got approved by the National Development and Reform Commission of China in December 2015.

As an international collaboration endeavor, LHAASO has already attracted scientists and contributions from Italy, Switzerland, France, Russia and Thailand, said Cao.

"In all these years, China's investment in 'pure science' has increased a lot, and China has become one of the main actors on the fundamental research landscape," Giuseppe Di Sciascio, an INFN particle physicist and leader of the Italian LHASSO team, commented. "Successful experiments like Daya Bay, BESIII and new ambitious projects such as JUNO, LHAASO and DAMPE make China one of the favorite destinations of the international scientific community to make advanced studies and research."