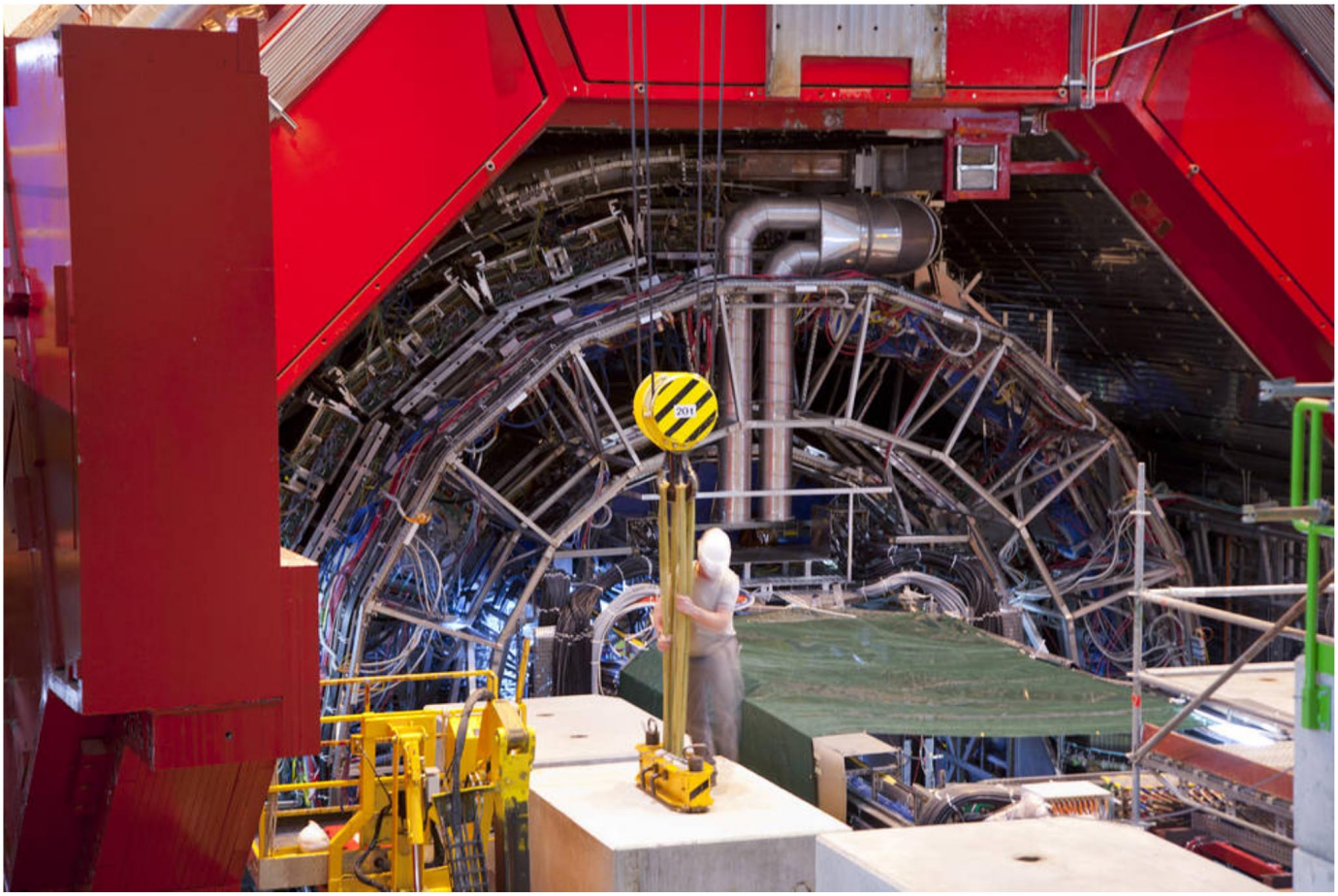
China’s Great Scientific Leap Forward

Completion of a planned ‘Great Collider’ would transform particle physics.



Atlas, one of two general-purpose detectors at CERN’s Large Hadron Collider below the France-Switzerland border near Geneva. *PHOTO:GETTY IMAGES*

By DAVID J. GROSS and EDWARD WITTEN
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Chinese President Xi Jinping's visit to Washington is an excellent opportunity to recognize China’s scientific contributions to the global community, and to foster more cooperation between the U.S. and China in many areas of science, especially particle physics.

The discovery of the Higgs particle at Europe’s Large Hadron Collider in 2012 began a new era. It confirmed an essential feature of the 40-year-old Standard Model of particle physics, a missing ingredient that was needed to make the whole structure work. But the discovery also left many questions unanswered. These include the mass of the Higgs particle, the unification of all subatomic forces, and the incorporation of quantum gravity—issues that must be addressed if scientists wish to understand the origin of the universe.

The Large Hadron Collider, which is funded and operated by the European Organization for Nuclear Research, known as CERN, will provide important clues. But some big questions may require an even more powerful tool. Where might the next discovery take place? Physicists in the traditional centers of particle physics—the U.S., Europe and Japan—have exciting projects and proposals. But there is a new player in the game: China.

Most people know that after Mao Zedong's death in 1976, Deng Xiaoping began to liberalize China's economy, putting the country on a far more productive path. Less known is another of Deng's initiatives. He greatly extended the particle physics effort in China, authorizing in 1983 the construction of the Beijing Electron-Positron Collider, which began operation in 1988.

For most of the past 30 years, particle physics advanced in China at a steady pace. But lately Chinese particle physics took a "great leap forward." In March 2012 an important property of neutrinos—enigmatic neutral particles whose study has yielded numerous surprises—was measured for the first time by a Chinese-American collaboration at the Daya Bay nuclear reactor in southern China.

Now, a group of Chinese physicists headed by Wang Yifang, the leader of the Daya Bay experiment, has proposed an ambitious long-term plan for particle physics in China. The plan involves building what some have dubbed the "Great Collider.'' Starting in the 2020s, this accelerator will create very high-energy electron-positron collisions, revealing properties of the Higgs particle in much more detail than will be possible at CERN's Large Hadron Collider. Starting in the 2030s, the goal is to collide protons at energies, again, far beyond the reach of the LHC to challenge our understanding and probe the unknown.

Will China embark on this project? It is impossible to know. Crucial early decisions may be made soon.

The total cost of this 30-year project will be great—billions of dollars. But the benefits will also be great. In one fell swoop, China would leap to a leadership position in an important frontier area of basic science. More practically, to build such a massive collider, China would need to develop frontier technology in many fields, from superconducting magnets to high-speed electronic detectors, attracting many of the world's top scientists and technologists.

There are also great potential benefits for U.S. science in collaborating on this project. Currently, the U.S. high-energy physics program is concentrated on exploring the properties of the mysterious neutrino, with no plan for a large collider. But many of our high-energy experimenters, currently working at CERN, and a phenomenal amount of U.S. accelerator physics talent could contribute to and benefit from collaboration with the Chinese.

There is another enormous benefit of a Great Collider in China that attracts U.S. and international scientists. Competition and conflict between China and the U.S. could easily spiral into a new Cold War where distrust becomes the norm. Finding ways to cooperate and collaborate are essential. International facilities are marvelous settings for such collaborations.

CERN, which was founded in 1954, attracted scientists from around the globe and played an important role in establishing harmony in Europe after World War II. Scientific contacts between physicists in the U.S. and the U.S.S.R. helped dampen the dangerous tensions between the two superpowers. With China emerging as a superpower in its own right, U.S.-Chinese collaboration on the Great Collider could play a similar role.

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