for the next stages of the Large Hadron Collider (LHC).

The China high-energy physics community, says IHEP director Yifang Wang, is looking for a successor to the 240-m Beijing Electron Positron Collider. For now, he says, "we are focusing on a 50-km ring as the lower limit for creating a Higgs factory." A possible location has been scoped out in Qinhuangdao, some 300 km east of Beijing. Wang lists money, manpower, and technology as the top challenges. Export controls could also put a monkey wrench into importing crucial know-how.

In February IHEP launched the Center for Future High Energy Physics to attract students into the field, garner support among scientists for a future collider in China, and show the Chinese government that the local and global physics communities are behind the idea.

Nima Arkani-Hamed, a theoretical physicist at the Institute for Advanced Study in Princeton, New Jersey, is director of the new center. "I became convinced that they [in China] are serious, and there is a nonzero chance of it happening. This project is something you can be guaranteed to be world leader in if you build it." Proponents hope that the promise of prestige could persuade China to invest new money into the field—and that such a project could move faster and cheaper in China than elsewhere. "It's good for China, and it's good for physics," says Arkani-Hamed.

CERN scientists have their eye on a 100-TeV proton–proton collider that would go under Lake Geneva so as to exploit the existing CERN infrastructure. "What 100-TeV center of mass would give you is lots of high-energy collisions," says John Ellis of King's College London. "If you go much below that, you won't open up as much phase space for new physics." Areas of discovery might include dark matter, supersymmetry, and the origin of the matter–antimatter asymmetry in the universe.

A future circular electron–positron collider would scientifically overlap the design-ready International Linear Collider (ILC), which Japan is considering hosting (see PHYSICS TODAY, March 2013, page 23). High-energy physicists are divided as to whether the two projects would interfere with each other's going forward. Results from the upcoming higher-energy and higher-luminosity stages of the LHC could determine future directions. "But in any circumstance I can imagine," says Arkani-Hamed, "these [high-energy circular] machines are going to be a necessary step."

IHEP

The opening ceremony of the Center for Future High Energy Physics in Beijing attracted many scientists, including (from left) Nima Arkani-Hamed of the Institute for Advanced Study in Princeton, New Jersey, the center's founding director; Hesheng Chen, former director of the Institute of High Energy Physics in Beijing; David Gross, director emeritus of the Kavli Institute for Theoretical Physics at the University of California, Santa Barbara; and IHEP director Yifang Wang.

In China, the plan is to prepare a proposal for R&D funding by the end of this year. In Europe, where money and personnel are currently wrapped up with the LHC, scientists aim to include a circular collider in the next European Strategy for Particle Physics, on which work begins in 2018. The two teams are cooperating and generally concur that at most one 100-km-scale collider would go ahead. The IHEP scientists are taking RMB 20 billion ($3.2 billion) as a preliminary cap for their electron collider. For a 100-TeV hadron machine, says Ellis, "it's premature to estimate. Everyone has in mind 10 billion of your favorite currency unit."

Toni Feder

How much will it cost to destroy stockpiled US plutonium?

Lawmakers reject the Obama administration's plan to suspend construction of a South Carolina plant for fabricating mixed-oxide nuclear fuel.

Mixing plutonium with an inert material—"downblending" it—and entombing it at the Waste Isolation Pilot Plant (WIPP) repository near Carlsbad, New Mexico, is the cheapest way to dispose of the surplus US fissile material. So says a recently released report from the US Department of Energy's National Nuclear Security Administration (NNSA).

The report lists five options for how the US could meet the terms of a 2011 agreement with Russia. Under those terms, the two nations each agreed to permanently get rid of 34 metric tons of plutonium. In its fiscal year 2015 budget request, the Obama administration said that it intends to mothball a half-finished plant being built to transform the US plutonium into mixed-oxide (MOX) fuel for commercial nuclear reactors while it explores potentially less costly routes for disposal over the next 12–18 months (see PHYSICS TODAY, May 2014, page 18). The plant's construction cost, estimated in 2007 at $4.8 billion, has ballooned to $8.7 billion.

The NNSA report estimates that combining the plutonium with materials to inhibit reuse and storing the mixture permanently underground would come to $8.8 billion over the lifetime of the operation. By comparison, the projected lifetime expenditures for converting the plutonium to MOX fuel would be $25.2 billion. The estimates include both capital and operational expenses, plus costs for preparing the plutonium metal. They do not include funds already spent. The downblending option was based on the assumption that the geological repository

would be WIPP, the sole US facility licensed for permanent disposal of transuranic wastes. Building an alternate disposal facility would obviously cause the option's cost to mushroom, the report acknowledges.

Senator Lindsey Graham (R-SC) has led congressional opposition to halting construction of the MOX facility, located at the Savannah River Site in South Carolina. Graham insists that there is no cheaper alternative to MOX that will allow the US to meet the 2018 timetable of its agreement with Russia. And he and other lawmakers have noted that changing the disposal method would require renegotiation of the terms of that agreement.

In May the House passed a FY 2015 defense authorization bill that would require the MOX plant construction to continue. The same requirement was included in the version of the bill approved by the Senate Armed Services Committee later that month. The Senate measure also added $145 million to the $196 million the administration had requested to put the half-completed project in standby condition. The House version of the appropriations bill that funds DOE also would require that construction continue.

"Now is not the time to change course on the MOX program and try to renegotiate anything with the Russians," Graham said in a statement issued after committee approval of the bill. He has promised to work with project contractors to bring costs down.

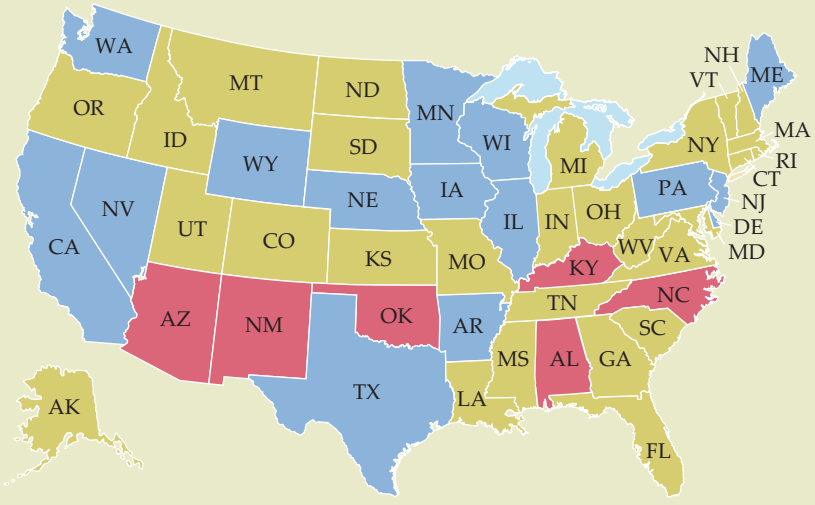
Rose Gottemoeller, the State Department's undersecretary for arms control and international security, said that despite the heightened tensions with Moscow, she believes Russia would agree to negotiate a change in the method of disposal if the US requested it. "The Russians have an interest in seeing those 34 tons of US plutonium gone, so my view is that they will work with us," she said in remarks on 13 May.

The three other plutonium-disposal options considered in the NNSA report are irradiation in fast reactors, estimated to cost $50.4 billion; mixing with nuclear waste and glassification, estimated to cost $28.6 billion; and deep borehole disposal, for which no estimate was prepared. Russia has chosen the fast-reactor route for disposing of its plutonium.

A DOE inspector general's audit released on 22 May blames the project's escalating costs and schedule slippages on a combination of an "immature design," understating the difficulty of installing "various construction commodity items," and high personnel turnover. When approved for construction in 2007, the MOX plant was expected to be finished in 2016. According to the inspector general's report, if construction isn't halted as the administration wants, the plant won't be completed until 2019.

David Kramer

Availability of physics in US high schools



Over the past three decades, the percentage of US high school students who take physics has steadily climbed—from 20% in 1986 to 33% in 1997 to 39% in 2013. In that same period, the proportion of high school seniors attending a school where physics was taught at least every other year has hovered around 95%. In the map above, states in yellow hold closely to that national average in availability, while states in blue exceed the average and those in red fall significantly below it; Hawaii opted out of the nationwide survey. More details from the survey can be found in *High School Physics Availability* by the American Institute of Physics's Statistical Research Center; the report can be downloaded at http://www.aip.org/statistics/highschool. **Toni Feder** ■