Europe sets strategy for multinational research facilities

The latest road map is intended to sustain the region's leadership in many areas of science.

Landing a spot on the road map of the European Strategy Forum on Research Infrastructures (ESFRI) is no guarantee that a wannabe research facility will be realized, but it is a crucial step. In the latest road map, released on 10 March, 50 pan-European—and in some cases, global—research endeavors got the thumbs up.

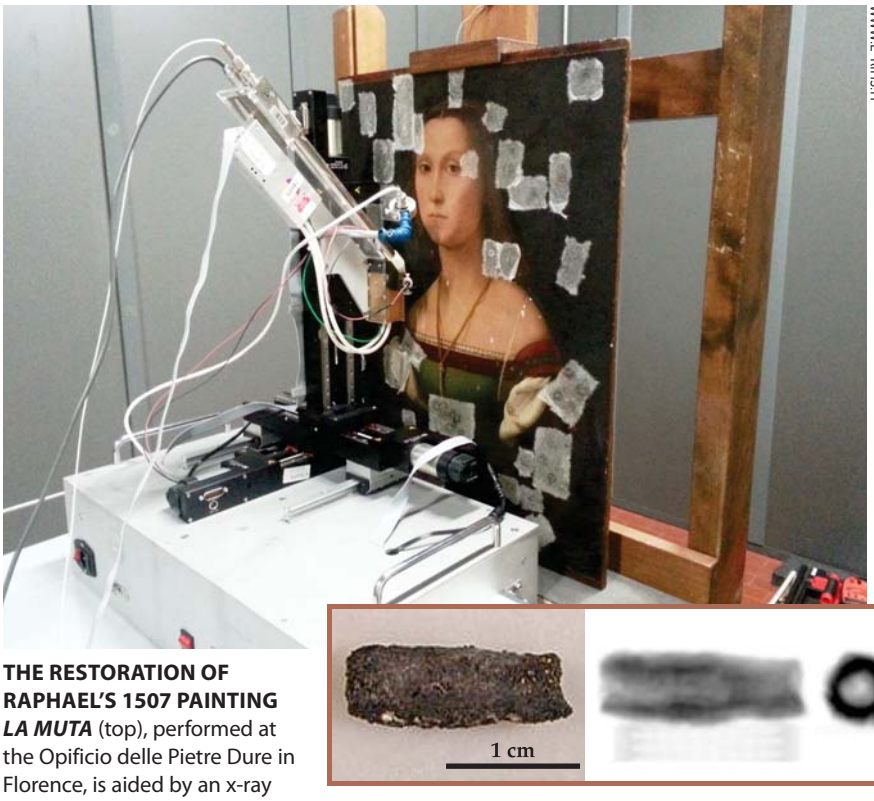
If the European Solar Telescope had not gotten on the new ESFRI list, the project would likely die, says EST project scientist Hector Socas-Navarro of the Institute of Astrophysics of the Canary Islands. "Now I am pretty confident it will happen. Being on the list opens new funding opportunities."

Tough love

The first ESFRI road map, in 2006, was intended to coordinate the prioritization of research projects that are beyond the budget of a single country. At the time, according to current ESFRI chair John Womersley, head of the UK's Science and Technology Facilities Council, there was a realization that countries needed guidance to invest collectively in big science facilities. ESFRI is composed of scientists and government representatives from the European Union's 28 member states and the associated countries Israel, Norway, and Switzerland.

The road map is meant to set the stage for Europe to be competitive across many areas of research. It encompasses humanities and the social, medical, life, and physical sciences, and it includes projects costing from a few million to nearly 2 billion euros. The road map was previously updated in 2008 and 2010.

When ESFRI started, says Péter Lévai, director general of the Wigner Research Centre for Physics in Budapest and the Hungarian scientific delegate to ESFRI, hundreds of ideas for new projects were considered. "This could have been a nightmare. Nobody would have enough money to accomplish all of these plans." The 2006 road map was whittled down to 35 projects.



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THE RESTORATION OF RAPHAEL'S 1507 PAINTING *LA MUTA* (top), performed at the Opificio delle Pietre Dure in Florence, is aided by an x-ray fluorescence scanner designed by the cultural heritage network in Italy's National Institute of Nuclear Physics. Another project involved using neutron radiography (lower center and right) to help prove that 5000-year-old beads (lower left) found in Egypt were made of iron from a meteorite. The radiography was done at the Budapest Neutron Center. Both institutes are part of the distributed European Research Infrastructure for Heritage Science, which is headed by Italy and is a newcomer to the European Strategy Forum on Research Infrastructures road map. (Bead images courtesy of the Budapest Neutron Center, MTA Wigner RCP.)

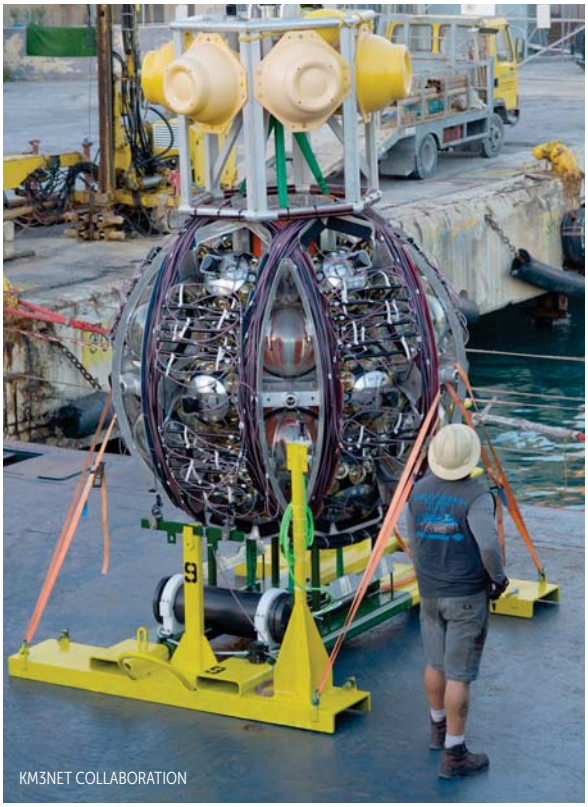
"We were much tougher this time," says Womersley. Earlier, if the science was good, "we put you on the list—as encouragement to move forward. This time, if you have not thought through the governance and funding, we didn't put you on the list—as an encouragement to think about it."

New projects

For the first time, the ESFRI road map divides projects into categories based on how advanced they are. After 10 years, projects should reach the more established "landmark" status, be dropped from the list, or be reconfigured and reapply.

The road map has 21 projects that still need money and final design, site, and governance plans. In addition to the EST, the new projects this go-round are in heritage science (see photos above); food security; river–sea systems; and aerosols, clouds, and trace gases. The underwater neutrino telescope KM3NeT (see photo, next page) won a second chance in a reconfigured, less costly form; the initial version, on the original road map, didn't progress as planned largely due to Greece's financial difficulties and the 2008 economic collapse. Those 6 projects join 15 that entered in the last two road map updates.

The other 29 items on the road map are more mature landmarks, which are either under construction or already producing science. "It's important that we remind our member governments to continue to support these projects," says Womersley. "Investment is not just about building new things, but about operations and continuing to upgrade. It's a balance."



A STRING OF 18 OPTICAL MODULES, wound on a sphere, is on its way to be deployed deep underwater as part of the KM3NeT neutrino telescope. The telescope will have a total of 345 such strings at two sites, off the shores of France and Italy. It will also offer ports for Earth and sea science studies. The KM3NeT project is back on the road map of the European Strategy Forum on Research Infrastructures after having been reconfigured and halving its cost.

Most of the landmarks are projects from the original 2006 road map that have graduated to the implementation stage. Among them are projects on health, ageing, and retirement; mouse disease models; and biodiversity. The list also includes such major facilities as the European Spallation Source, the Facility for Antiproton and Ion Research, and the Extreme Light Infrastructure (ELI). (See PHYSICS TODAY, March 2010, page 24; November 2015, page 22; and June 2010, page 20.)

But two landmarks are new to the road map: the High-Luminosity Large Hadron Collider (HL-LHC), an upgrade to the particle accelerator at CERN, and the Extremely Brilliant Source addition to the European Synchrotron Radiation Facility (ESRF) in Grenoble, France. They were deemed too mature for the projects category. Mostly funded, they would likely proceed regardless of appearing on the ESFRI road map. But ESRF director general Francesco Sette notes two advantages of being listed: It gives some assurance that member states will pay in even if they face financial hardship, and it could make finding additional partners easier.

The HL-LHC upgrade entails not just increasing the beam luminosity, but also upgrading the detectors. "We are in the process of securing those funds," says Eckhard Elsen, CERN's director of research and computing. For many national funding agencies, a project's being on the ESFRI road map is a reaffirmation of the European strategy in particle physics, he says. More broadly, the ESFRI road map shows Europe's overall strength and strategy in research, says Elsen. "Particle physics should, of course, be represented."

On the road map, 3 projects and 11 landmarks are categorized as "physical sciences and engineering." But many of the other items on the list—in the categories of energy, environment, health and food, and social and cultural innovation—are physics-related.

Aligning strategies

To be considered for the road map this time, a proposal had to have letters of support from three countries, one leading the project and committing funding and two offering political support. "We want to stimulate interactions between scientists and funders much earlier," Womersley says. The stricter requirements mean that all projects making it onto the road map have a good chance of succeeding, he adds.

Although the road map as a whole specifies European research priorities, projects are not ranked. The breadth of topics would make that tough. But beyond that, says Womersley, "different

countries have different priorities." So the Square Kilometre Array, for example, is a priority for the UK and the Netherlands, which have strong radio astronomy communities. ELI is a top priority for the Czech Republic, Hungary, and Romania because they each host a branch of that project. And a landlocked country in central Europe won't find Arctic research as urgent as the Nordic countries.

The European Commission "would like the national strategies for research infrastructure to align with ESFRI. We try to push in that direction," says Octavi Quintana Trias, the commission's representative in ESFRI. Construction funding comes from the member states, whereas the EC grants money for project preparation. In the case of poorer countries, the EC distributes so-called structural funds, which can be used to build research facilities. About 95% of ELI's construction comes from such funds.

ESFRI tries "to fulfill an incubation role by providing continued feedback, monitoring, and guidance," says Womersley. Balance among fields emerged naturally, he says. For the arts and humanities, "it's a new trend to do large projects. Mostly they involve large data sets." The ESFRI process weeds out overlap among projects, and its stamp of approval helps scientists and countries choose which projects to sign on to.

On a day-to-day level, the road map can also help researchers. Says Lévai, "If a group at my center wants to start a new activity, I can ask, What is the future of this activity? How can you connect it to the ESFRI list?" The ESFRI road map suggests where to focus effort, because it reflects the common European priorities and portends new facilities. "This serves the Hungarian interest," he says. "It gives us, our young people in research, security."

The next road map updates will be in 2018 and 2020, to assess projects first listed a decade earlier. New projects will also be eligible for consideration.

Toni Feder

Mapping the hazard from induced earthquakes

Much of Oklahoma and the vicinity of Dallas, Texas, face the same earthquake risk this year as the fault-ridden areas of California, according to a 28 March study by the US Geological Survey. It is the first time the USGS has mapped the hazard from both natural and induced earthquakes. Past forecasts have included only natural earthquakes.

The main cause of induced earthquakes is wastewater injection associated with gas and oil extraction—not, as commonly assumed, hydraulic fracturing, or fracking. When wastewater from the extraction process is disposed of underground—typically at least 1 km deep—it increases the pressure and can cause slippage along faults. In fracking, fluid is injected for the purpose of creating cracks, but it tends to involve less fluid for shorter times, so it causes fewer and smaller earthquakes than wastewater injection, according to Justin Rubinstein, the deputy chief of the USGS induced seismicity project and one of the study's authors. (See also the article "Super fracking," by Donald Turcotte, Eldridge Moores, and John Rundle, PHYSICS TODAY, August 2014, page 34.)

Since 2009 the number of induced quakes has jumped immensely, particularly in Oklahoma. Until then, the state saw two or so earthquakes each year; last year alone, some 907 earthquakes of magnitude 3.0 or greater were recorded. Arkansas, Colorado, Kansas, New Mexico, and Texas also have areas with increased hazard levels due to induced earthquakes. In the highest-risk regions, the chance of earthquake damage this year is 10–12% (see the figure). The study's authors define damage as cracking or worse occurring in buildings or other structures.

Because changes in industrial injection activity can affect the incidence of induced earthquakes on a short time scale, the USGS scientists limited their predictions to 2016; they focused on the eastern and central US because induced earthquakes in the West are not a significant contributor to the earthquake-damage hazard in that part of the country.

There is no known seismological difference between natural and induced