National Laboratories, of which Fermilab is one. Furthermore, CERN may find itself hosting several dozen ex-SSC physicists from Japan and Canada, and deals with each country may require lengthy negotiation.

Detector collaborations

Europe's physicists are, however, eager to enlist help from their former SSC competitors—and not just for financial reasons. "LHC will be a very difficult machine," says Pierre Darriulat, CERN's other research director, who points to detector development as a key area of collaboration. Because SSC researchers were already well along with detector development when their machine was canceled, their experience will be especially valuable in building detectors that can spot the signature of the Higgs boson amid a cacophony of other events. The two LHC detectors, dubbed ATLAS and CMS—which will cost about $300 million each and must be paid for largely from outside the CERN budget—have already been selected. CERN has now delayed by more than 6 months, to the end of 1994, the date by which full technical designs must be ready, so that the groups can enroll members of the SSC's experimental teams.

The courtship began last week at a meeting held at CERN to discuss future collaboration between detector groups. The ATLAS and CMS teams, which together already involve almost 1700 scientists, can each accommodate more than 200 additional members. Bill Willis of Columbia University, cospokesman for the SSC's GEM detector, expects a maximum of 400 U.S. physicists to join detector groups.

Detector collaborations have traditionally entailed cost sharing, so a U.S contribution in return for accommodating SSC refugees would be expected. It could also make a big difference to the schedule. "Without the Americans, we were talking about staging the detectors," says CMS spokesman Michel Della Negra—starting with simpler versions requiring only about three-fourths funding, and building up to full capacity only after several years of operation. With a U.S. financial contribution, the complete detectors might be ready in time for the LHC's startup.

Llewellyn Smith will clearly have an interesting first 6 months on the job juggling these issues. He declined to comment in detail last week on the likely reaction of CERN's member states to the new LHC proposal, saying only that the SSC's cancellation makes the LHC "scientifically mandatory." And despite the political uncertainties, the new CERN director-general believes this argument will win through: "Before, I felt very confident we'd get approved. Now, I feel it's certain, somehow." Most of the world's high-energy physicists hope he's right.

–Peter Aldhous

HUBBLE TELESCOPE

Repairs Rekindle 3-Year-Old Dreams

Pictures of 4-billion-year-old galaxies from the Hubble Space Telescope earned astronomers Alan Dressler and Augustus Oemler a bit of scientific limelight and coverage last year by the national media. Where ground telescopes had shown only smudges of light, the space telescope revealed a garden of spiral and elliptical galaxies. "But that was only a tantalizing hint," says Yale's Oemler, of what lies ahead if NASA's recent repair mission succeeded in correcting the telescope's blurry vision. They now hope Hubble will provide an even clearer window on the early history of the universe, revealing evidence of collisions and cannibalism among these ancient galaxies.

To the rescue. Astronauts Kathryn Thornton *(top)* and Thomas Akers install a new solar array panel on the Hubble telescope.

With the astronauts from the Space Shuttle Endeavor safely home after completing five space walks to repair the $1.5-billion Hubble, many astronomers are again dreaming of exploring distant stars, galaxies, supernovae, and quasars and getting a better handle on the size and age of the universe. Although many researchers were able to do notable observations during the 3.5 years since the Hubble was launched, the blur caused by its improperly ground main mirror served as a constant reminder of the instrument's limitations. "A lot of us tried to salvage what we had planned," says Abjihit Saha of the Space Telescope Science Institute in Baltimore. "But everybody suffered."

Over the next 6 to 10 weeks, technicians will adjust the Hubble's newly installed set of corrective mirrors and the mirrors built into the new main camera. Once these tests are finished, astronomers hope the telescope will finally live up to its promise. Among those lining up to find out are Saha and Alan Sandage of the Carnegie Institution, who hope to sharpen estimates of the size and age of the universe by resolving individual stars, known as Cepheid variables, in intermediate-distance galaxies, and then using them to measure the distance to galaxies containing brighter objects—type 1A supernovae. Establishing the brightness of these supernovae (and showing they are approximately all the same) will give astronomers a much longer yardstick with which to measure out to yet more distant galaxies. Their first observations also made headlines last year, but the team's data on only two galaxies didn't convince their colleagues. "We need a larger sample size," Saha says. The repaired Hubble should open up their view to eight or nine more galaxies.

Other astronomers had counted on the Hubble to tell them whether distant galaxies harbored massive black holes. Astronomers Tod Lauer of the Kitt Peak Observatory in Arizona and Sandra Faber of the University of California, Santa Cruz, have collected some compelling pictures of galaxies with very dense centers, but what's missing is a measure of the speeds of stars whirling around the center of the galaxies. They hope the corrective mirrors on the Goddard High Resolution Spectrometer, one of the three instruments on Hubble fixed with the Corrective Optics Space Telescope Axial Replacement (COSTAR), will sharpen the resolution enough to close the case for massive black holes.

Jon Holtzman of Arizona's Lowell Observatory has been using the Hubble to look at oddball galaxies, such as one that appears to be a conglomerate of two merged galaxies, but the flaws in the telescope precluded him from taking such quantitative measure as the brightness and color of its stars. Holtzman also hopes to revive a project to measure the ratio of bright, heavy stars to faint, light ones throughout the Milky Way and nearby galaxies. The flawed mirror made it impossible to measure the brightness of faint stars without contamination from neighbors. His target is a better understanding of two important astronomical puzzles—how stars form and how galaxies evolve with time.

For Holtzman and others, the biggest frustration with a flawed Hubble was using an instrument intended to work so much better. "We were able to do some things," he says, "but it was a far cry from what it should have been." After spending $550 million on this high-stakes mission, NASA has repaired some of the damage to its own reputation—and to the dreams of astronomers like Holtzman.

–Faye Flam