

International collaboration

In the wake of the demise of the US Superconducting Supercollider (SSC) project last year which impoverished both US and world science, some rapid scene shifting is going on. The SSC may be dead, but the underlying physics quest lives on.

In the US, the 'future vision' subpanel of the High Energy Physics Advisory Board (HEPAB), chaired by Sid Drell, is at work formulating its recommendations (March, page 7). On the international front, the International Committee for Future Accelerators (ICFA) at a special meeting in Vancouver in January drafted a statement.

In canvassing input for his subpanel, Drell cited an eloquent article by Energy Secretary Hazel O'Leary and Chairman of the House Committee on Science, Space and Technology George E. Brown recently published in the Los Angeles Times which said 'unless we are intent on stopping the pursuit of the knowledge that (the SSC) would have delivered, we must find a way to achieve a truly international framework for large scientific and technological projects'.

A recent statement by the International Committee for Future Accelerators (ICFA) said - 'Following the cancellation of the SSC, the Large Hadron Collider (LHC) at CERN now offers the only realistic opportunity to study multi-TeV hadron collisions' (the full ICFA statement is published on page 4).

To nurture the natural enthusiasm to continue this physics, contacts have been developing at several levels. In December, informal exploratory talks were held at CERN between spokesmen of the LHC experiments and their counterparts from the major SDC and GEM projects which were being readied for the SSC, and with CERN manage-

ment. The object was to establish the common interest in multi-TeV physics at the LHC, and, once this is in place, to exploit valuable research and development work already accomplished and the high level of expertise achieved in the SSC framework.

A substantial number of US physicists involved in SDC and GEM could be interested in joining LHC experiments, together with a significant fraction of the 100 or so Japanese researchers involved in SDC. Many of the SDC Canadian contingent could also turn their sights towards Geneva.

Initial contacts late last year were followed up by a meeting at UCLA looking at possibilities around the LHC CMS experiment for additional collaborators, particularly from the US, while at CERN, the ATLAS experiment's collaboration meeting attracted many additional visitors.

The initial LHC/ex-SSC contacts led to a two-day Large Hadron Collider Workshop at Fermilab on 15-16 February, attended by several hundred US physicists. This meeting confirmed the strong interest in the US and elsewhere in LHC physics and sowed the seeds of a future US LHC User Group, seen as a necessary element in substantial US involvement in the experimental programme.

At this meeting, the Department of Energy's Director of Energy Research Martha Krebs pointed at the possibilities of the LHC route to international collaboration, and challenged the community to produce the 'compelling arguments' needed to convince Washington that this was the way to go. The Drell subpanel and its advisory bodies have an important role to play in this respect.

At this meeting, CERN Research Director Walter Hoogland reiterated the message which had been spelled

US Energy Secretary Hazel O'Leary - looking for a way to achieve a truly international framework for large scientific and technological projects.



out by CERN's governing body, Council, in December (January/February, page 3). With CERN's increasing role as a world, rather than a European, Laboratory, compounded with the tight financing of the LHC project, contributions from non-Member States would facilitate LHC construction. (Under a CERN fallback plan, LHC could still be built without non-Member State aid, but this would be more difficult.) CERN is now definitely a major world focus - there are as many physicists working at CERN from the US as from the UK, for example, the latter contributing some 15% of CERN's annual budget. Thus Council had concluded that it 'is conscious of, and welcomes, the world interest in the LHC project and encourages CERN to report back on the modes of involvement of non-Member States.....such involvement should be on the understanding that usage on a significant scale must involve the provision of resources to suit both CERN and the non-member States concerned.' These possibilities are being studied.

Hoogland emphasized the importance of confirmation of US interest in the LHC programme, through involvement in the LHC experimental

collaborations (where an orderly integration in preparation work is better than a proliferation of scattered activity), through open meetings, and through official advisory bodies.

With integration signs already visible on the experimental front, it was a propitious time to begin dialogue on other common interests such as accelerator matters and computing. Around the Computing for High Energy Physics (CHEP) meeting in San Francisco will be a useful opportunity to air LHC computing issues. There is interest in the US on collaboration in research and development work on the design and construction of the LHC accelerator as well as its detectors.

Speaking at the Fermilab meeting on behalf of the Drell subpanel, Joel Butler recommended that US researchers take this opportunity to learn how to work in an international environment. 'If there is no vision, then retrenchment is your future,' he warned. Peter Lyman of Fermilab enumerated possible areas of CERN-US accelerator cooperation for further discussion.

However some US voices advocated a full exploitation of US national resources before migrating in mass to Europe.

Meanwhile the Executive Committee of the Division of Particles and Fields (DPF) of the American Physical Society has set up a number of working groups to examine various research opportunities in particle physics. This long term planning effort by the community itself will go on in parallel with the work of the 'Future Vision' subpanel chaired by Sid Drell, which has now had several meetings.

Roberto Peccei, Chairman of the Executive Committee in 1993 when the study was established, chairs the

overall long range planning effort. The current chairman of the DPF Executive Committee is Michael Zeller of Yale.

These working groups are charged with formulating the broad range of physics questions in their respective areas, to discuss the means by which these questions might be best addressed, and relate these means to the exploitation of existing and future facilities, both in the US and elsewhere. Each group should arrive at a set of priorities, and the perceived priority of their area in the overall programme.

After preliminary contacts, the groups will convene at Johns Hopkins University at the beginning of May to present their preliminary assessments. A fuller assessment would follow at the DPF meeting at Albuquerque in August. A final written report is scheduled for January 1995.

The DPF working groups and their chairpersons are: Tests of electroweak theory (Frank Merritt, Chicago), Flavour Spectroscopy (John Cumulat, Colorado), QCD (Alfred Mueller, Columbia), CP violation and flavour issues (Helen Quinn, SLAC), Neutrinos (Paul Langacker, Pennsylvania), Electroweak symmetry breaking (Sarah Dawson, Brookhaven), Astroparticle physics (Michael Turner, Chicago/Fermilab), Structural issues (Ray Brook, Michigan State), and New accelerator techniques (Steve Holmes, Fermilab).

To monitor sentiment, 'town meetings' are being organized. The agenda of these meetings will be set by the individual hosts, however identifiable issues for debate include:

- In terms of clearly defined scientific goals, and in the context of what is already planned and in progress worldwide, what should the US high

CERN Research Director Walter Hoogland - emphasizing the importance of confirming US interest in the LHC programme.



energy physics programme be doing five and ten years from now?

- What opportunities are scientifically compelling for proton machines, for electron-positron machines, and for non-accelerator based research?
- How should the US divide its high energy physics resources between its domestic programme and foreign collaboration? How might it best pursue international collaboration in advancing our field and in construction of new facilities?
- What are the appropriate roles of universities and domestic laboratories in the future of high energy physics?
- In her report to Congress in July, the Secretary of Energy must "include recommendations as to whether high energy physics and other large research projects and programmes should continue to be pursued by the United States and, if so, for what purpose should they be pursued and how should they be funded and financed". What should the Secretary include in her report?

Away from the Laboratories, on January 26 the House of Repre-

sentatives Subcommittee on Science held a three-hour hearing on the future of high energy physics research in the United States. After last year's termination of the SSC, there was general agreement among most hearing witnesses that the United States should participate with CERN in the construction of the Large Hadron Collider (LHC) or its detectors.

The LHC is now acknowledged (see the ICFA statement on page 4) as the only route open to the multi-TeV hadron collisions required to open up the symmetry breaking effects at the heart of Standard Model physics.

Among those testifying at the House meeting were HEPAP chairman Stanley Wojcicki, former chairman of the American Physical Society's Division of Particle and Fields Roberto Peccei, Fermilab Director John Peoples, Frank S. Merritt of Chicago's Enrico Fermi Institute, the Department of Energy's Director of Energy Research Martha Krebs, and Director of the Office of Science and Technology Policy John Gibbons.

Subcommittee chairman Rick Boucher (D-Virginia) acknowledged that the SSC's termination "is a watershed in this nation's commitment to supporting big science, and has thrown the field of high energy physics into turmoil." He continued, "we must assume that in future years, the high energy physics budget will have level funding, adjusted, if at all, for inflation only," perhaps leading to consolidation of existing facilities to free up money for new construction. Sharing the podium with Boucher was Sherwood Boehlert (R-New York), a former major SSC foe, who gave assurances that "we are united, I am sure, in our determination to maintain a vital US effort in particle physics." Boehlert had kind words about US

participation with CERN in constructing the LHC. Much less enthusiastic about the LHC was Joe Barton (R-Texas), a strong SSC proponent.

First to testify was John Gibbons who stated, "The most logical and current steps for the US programme in high energy physics are:

- to complete in timely fashion the Fermilab Main Injector Upgrade and the Stanford B-Factor;
- to provide full operational funding for these facilities once they are completed, in order to achieve the most and best physics research; and
- to plan for US participation in an international consortium to build and operate 21st century accelerator facilities needed to push forward the high energy physics frontier." Gibbons did not cite CERN in his written testimony.

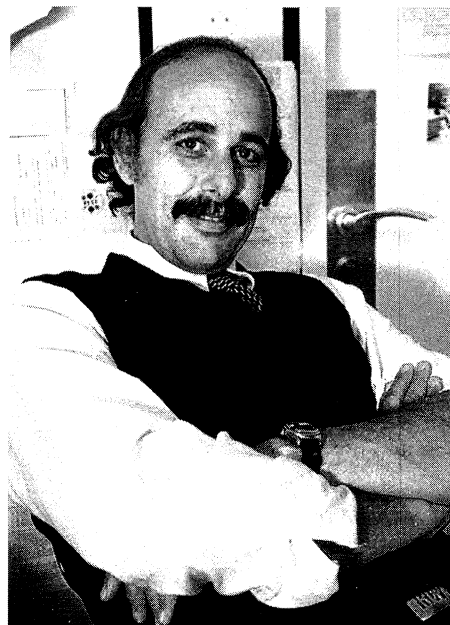
Martha Krebs spoke of a "vision for the future" which could include the LHC or the High Energy Linear Collider (also known as the Next Linear Collider).

The physicists were in general agreement that the US should explore participation in the LHC. All indicated that this would benefit both CERN and US high energy physics.

Of more immediate concern is assuring that US base programme funding to operate existing and planned facilities will be sufficient during the remainder of this decade. This funding, and a \$500 million CERN contribution, would require a 10 percent increase in the high energy physics budget. While this is small compared to the SSC, it is nevertheless significant under current federal budget constraints.

At the recent meeting of the American Association for the Advancement of Science (AAAS) in San Francisco, House Science, Space and Technology Committee Chairman George

Roberto Peccei, last year's Chairman of the Executive Committee of the Division of Particles and Fields of the American Physical Society, chairs the overall long range planning effort by the US particle physics community.



Brown proposed three initiatives in a 'white paper' on 'Big Science and International Cooperation':

- 1 - in the short term, all research projects in excess of \$50 million should be required to have Congressional support (unlike the ill-fated SSC);
- 2 - in the medium term, an official forecast of big science projects until 2010; and
- 3 - in the long-term, a G7-nation panel to establish big science priorities.

Also speaking at the AAAS, Director of the Office of Science and Technology Policy Gibbons said that a decision of US participation in the LHC is likely following the publication of the report of the Drell 'future visions' subpanel.

CMS in the US

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To inform potential US collaborators about the design and status of the Compact Muon Solenoid (CMS) experiment at CERN's LHC proton collider, the CMS group organized a collaboration meeting at UCLA from 2 - 4 February. Only two weeks after the devastating earthquake in Los Angeles, more than 150 people from 12 European and 37 US institutions participated.



experiment at the LHC, the CMS group organized (through Th. Muller) a collaboration meeting at UCLA from 2 - 4 February.

It is a remarkable sign of the vitality and enthusiasm of high energy physicists that only two weeks after the devastating earthquake in Los Angeles more than 150 people from 12 European and 37 US institutions participated. After a welcome by Roberto Peccei, now Dean at UCLA, and introductory presentations including a status report of the LHC by W. Hoogland and of CMS by M. Della Negra, the meeting was organized into five sessions covering major CMS detector components.

Presentations were given on details of CMS as well as on experience with relevant SSC detector design. In four fields major US participation would be welcome: the endcap muon system (where presently four US groups - UC Davis, UCLA, UC Riverside and UT Dallas - are involved together with a group from Dubna) the trigger, the hadron calorimeter, and the central tracking system.

The CMS collaborators recognized the valuable experience of the

groups formerly involved in the SSC, who were typically two years more advanced in technical design than their LHC colleagues, and warmly welcomed new participants.

Electron-positron route

While the proton-proton collider option is foremost in most people's minds, a TeV-scale electron-positron collider is acknowledged as a complementary route to new physics horizons, but with a longer lead time. Research and development work is underway at electron Laboratories all over the world, and continued international collaboration on this front is strongly endorsed by the International Committee for Future Accelerators (ICFA - see next article).

Future accelerators

Future accelerators is what ICFA (the International Committee for Future Accelerators) is all about. Following an emergency ICFA meeting at CERN early in December, the following statement was drafted for a subsequent meeting of ICFA Members and Laboratory Directors at the TRIUMF Laboratory, Vancouver, on 16 January.

High energy physics seeks to discover basic principles that underlie the workings of the physical universe through the exploration of the building blocks of matter and forces among them. World-wide effort over the past half-century has produced a remarkably successful theoretical picture describing all matter and energy as built of certain constituents, interacting through specific forces according to general principles of symmetry, relativity and quantum mechanics.

Yet the picture contains gaps - profound questions that can only be answered with new facilities. The answers to these questions hold the promise of yielding a historic unification of ideas and principles, as significant as those that have marked past revolutionary advances in scientific understanding.

Particle accelerators and detectors have served as experiments' most successful tools for this exploration of the subatomic world, and will do so for the foreseeable future. To probe matter and energy at the point where revolutionary discoveries are expected, particle accelerators of energies higher than are now available must be built. Drawn by the importance and the scientific challenge of such discoveries, high energy physics experimenters have traditionally pooled their resources to build detectors, across international boundaries, forming large regional