ICFA MEETING SUMMARY REPORT

PANEL DISCUSSION ON COOPERATION IN ACCELERATOR CONSTRUCTION

I - GENERAL IDEAS

MAY 17, 1984

W. K. H. PANOFSKY - CHAIRMAN

The members of the panel were Lederman, Rubbia, Sandweiss, Schopper, Skrinsky, Thresher, and Nishikawa.

Panofsky opened the meeting by stating that international collaboration on accelerator construction had diverse goals: cost sharing, deepened international commitment and high symbolic significance on international collaboration in science. He stated that today's and tomorrow's panel meetings were to be divided into "what" and "how" sessions. This means that today's session is to provide a frank discussion of the diverse views of the panel members and other ICFA participants on what they perceive to be a logical program for the world's accelerators and colliders over the next decade from the scientific point of view. The "how" panel of tommorrow, to be chaired by Telegdi, would deal with methods of achieving deepened international collaboration.

Panofsky emphasized that decisions on new facilities are made by national authorities unless formal international conventions decree otherwise. ICFA is the only worldwide body now existing charged with promoting cooperation in respect to new facilities. However, ICFA has no authority beyond making its counsel known. In turn, today's panel is not charged with trying to attempt consensus; its purpose is to air a range of views. Panofsky emphasized that this is neither the first nor the last time for discussion of this subject. However there is increasing pressure from national constituencies to consider international cooperation on accelerator construction, and therefore these deliberations are of more than casual interest.

Lederman opened the discussion by showing a chart of his projected time table for construction of international facilities. He presented the various machines in terms of their center-of-mass energy measured in quark-quark collision frame rather than by the more conventional center-of-mass system of the colliding electrons or protons. This method of presentation, of course, presents electron-positron colliders as yielding a higher available energy than in the usual presentations.

Lederman went through a more detailed discussion of the physics reach of a 20 TeV x 20 TeV collider in support of a current planned U.S. program. He made a strong case for making the SSC international and advocated that the HERA model might well be followed as an example.

Skrinsky emphasized that electron-positron colliders and proton-antiproton colliders were complementary. He said the tools for the unexpected should be emphasized and he discussed the advantage of considering collisions among particles ($e\gamma$, $\gamma\gamma$, e p, γp, and $\mu\mu$) which are ordinarily not considered as primary collision tools. He did not make special recommendations for a spectrum of installations on a worldwide basis.

Nishikawa presented a graph indicating the percentage of Gross National Product for Western Europe, the United States and Japan which is dedicated to high energy physics. He showed the distribution of high energy physics personnel in Japan and identified the predominance of theorists. His data indicated that the ratio of experimentalists relative to theorists has been gaining, partially as a result of the TRISTAN project. He said that since TRISTAN is occupying their principal attention,consideration of the future beyond that was "very theoretical." He then enumerated a wide spectrum of alternatives for the Japanese program. He said he will organize a working group of young scientists this year to make suggestions for future plans after TRISTAN has been completed.

Schopper enumerated a number of criteria which he believed to be suitable to guide worldwide decisions for future facilities. These criteria were:

1. At least two regions should have valid programs operating at the frontiers of highest energy.

2. Facilities in different regions should be complementary but should be open to the entire world.

3. Choice of future facilities should be based on their conjectured physics potential.

4. Existing facilities should be used as a basis of new facilities wherever possible. This would avoid attacks on high energy physics from other fields based on the alleged wastefulness of continually beginning new facilities.

5. The time scale for new projects should stretch out over no more than 10 years, although this will be questioned by critics.

Schopper made the following specific proposals: he suggested that there should be a moratorium of a few years before specific decisions are taken. During that time the $\bar{p}p$ colliders, the SLC and detector development could proceed. A future program should use the Tevatron, LEP and HERA as a basis. Schopper presented two models:

I - Europe - 20 TeV pp center-of-mass energy at high luminosity
U.S. 2-4 TeV e^+e^-
USSR - 3 TeV fixed target
Physics use of these machines might start in 12-15 years.

II - Europe - 12 TeV $\bar{p}p$ with a later e-p option
U.S. - A proton-proton collider above 40 TeV center-of-mass energy
USSR - 3 TeV fixed target
U.S./USSR - 2-4 TeV e^+e^-

Schopper said other scenarios could be discussed and he felt the entire matter should be gone over again in two years.

Sandweiss remarked that availability of new frontier facilities is slowing down and this had many adverse consequences. He proposed that the diversity of the program be maximized.

Thresher commented that one should look at the program with a critical eye from the point of view of an outsider to direct participants. From such external critics the USSR program was too slow, in particular UNK should go faster, and he would like to see immediate use of UNK as a $\bar{p}p$ collider rather than as a fixed target machine. The critic would feel that CERN should consider LEP as its highest priority, reaching highest e^+e^- energy in the early '90's. Alternate use of the LEP tunnel for e-p, $\bar{p}p$ and pp should follow on afterward. A critic would be very excited by the potential of an electron-positron linear collider but would fully understand that the USA's first logical step was the SSC. Thresher emphasized that the picture until the end of the century looked reasonable but that a totally new approach was needed beyond that.

Rubbia made comments on the LEP Hadron Collider (LHC). He pointed out that the reach of a hadron collider into new mass regions increased only roughly with the square root of the energy and that the LHC had considerably higher reach in those terms than HERA. Rubbia felt that the LHC and LEP could operate simultaneously without trouble by the use of "modest" bypasses. Rubbia felt that cost estimates for the LHC operating at 6.5 T could be made reliably scaling from the HERA experiments. He felt the total cost of the LHC was less than $400 million and therefore very much less than the SSC.

Discussions from the floor followed. Numerous questions were asked. Telegdi asked whether techniques are available to handle the expected high data rates from the SSC or the LHC as far as that goes. Lederman replied that a luminosity of $10^{33}cm^{-2}sec^{-1}$ could be handled only at great cost, while $10^{32}cm^{-2}sec^{-1}$ would not require major development. Koshiba felt that the SSC was a "brute force" approach and he had hoped for more creative ideas. Mulvey remarked that the widest diversity of tools should be made available decades from now and he questioned whether the SSC cost of six times the LHC was justified. Lederman doubted the quoted LHC/SSC cost ratio based on scaling from Fermilab experience. Schopper pointed out that LEP cost less than the SPS. Panofsky pointed out the steeply decreasing costs measured in dollar per MeV in the center-of-mass, and pointed out that the SSC is following that decreasing cost curve. Telegdi drew attention to the high cost of equipment needed to exploit the new generation of high luminosity colliders. Ellis expressed doubt that the SSC could be built along the HERA model with international participation from Europe, since European finances would not permit this. He felt that the cost ratio from the SSC to the LHC was too large to justify the SSC, and recommended construction of a large electron-positron linear collider. Panofsky said that although he did not disagree with Ellis' physics, a linear electron-positron collider could not be built "by purchase order" until the technology was ready. Everyone hopes that the SLC will work, but as a practical matter no decision on large electron-positron linear colliders can be contemplated before that event.

Richter pointed to his past record as a reliable cost estimator and said he felt that the cost ratio between the SSC and the LHC was in reality closer to 3 than to 6. He agreed that this would extend the "reach into unknown masses" by a factor of $\sqrt{3}$ but felt this was well worth it. This remark was followed by further cost discussions involving Richter, Rubbia and Brianti.

There followed a general discussion about the SSC. Tollestrup remarked that it was not clear whether the SSC should also be the "VBA" (Very Big Accelerator). His feeling was that the VBA should read the highest energy that is considered practical and he was not sure whether the SSC met that criterion. McDaniel said the SSC represents the most ambitious project which could now be built within the state of the art. He did not believe that the promise of other technologies would become clear in less than four years. Schopper said that there was no known physics argument which defined what energy to choose. Sandweiss said this was true but there are thresholds; the problem is that we do not know what they are. Rubbia agreed that the energy was quite important but that there were legitimate arguments about the optimal number of steps to get to the highest point.

Telegdi asked Skrinsky how long it would take to build an electron-positron collider at Novosibirsk, ignoring for a moment political constraints. Skrinsky said that such a question would be difficult to answer; the technology is growing. He is not prepared to give a complete design since technology had to be developed. He would prefer a "creeping"approach to reach 100 GeV. Once that is attained he would suggest a new proposal to get to, perhaps, 3 TeV energy.

Lederman felt that details of what is to be built were not critical but the drive and the "scientific imperative" were essential. Jackson asked Schopper for the planned schedule for the LHC, but Schopper said no such schedule had been proposed, let alone established. A question was asked whether the plans for the Novosibirsk linear collider were authorized and Skrinsky said the project was not approved beyond the R&D stage. Voss emphasized that the economics of technical solutions for an e^+e^- linear collider were far from established and looked very unfavorable if one simply extrapolated

existing designs. Williams questioned why the European speakers were eemphasizing the longevity of LEP I and II; he felt these machines would support creative physics for a long time.

Rubbia concluded the session by saying that he considered the physics of e^+e^- collisions to have been a great success. He agreed that everyone would be happy if this history would repeat itself for LEP I and II, and of course even more so at higher energies.