TO BYPASS OR NOT TO BYPASS; THAT IS THE QUESTION

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The concept of an experimental areas bypass was first discussed at the 1986 Snowmass Summer Study[1] in the context of the SSC (although the general idea dates back to early Fermilab discussions[2]). A more recent discussion was presented by M. Marx in May 1987.[3] Although the case for one or more bypasses in the experimental cluster areas appears compelling, the final detailed ring configuration is still not definite and the bypass question is still open.

The purpose of this note is to reiterate and add to arguments in support of a bypass configuration. An easy conclusion is that it is almost unthinkable that the SSC would not include a bypass. The arguments in favor of bypasses are enumerated below.

1. Down Time Liability. Each of 4 to 6 experiments set up simultaneously in the beam will require periodic maintenance. By combining this with maintenance of the accelerator itself an overall efficiency should be possible. However, it is probable that scheduled operation will be limited to no more than 80 - 90% of full time. More serious are shutdowns for unscheduled breakdowns and repairs. With several detectors operating, at least one such breakdown per year is probable. Then the choice would be to continue operating without that detector or to lose additional running time to shut down and repair it or, alternatively, to move it to its garage. In addition, the major detectors will require periodic upgrading or rebuilding. This will cost added down time to remove the detector from the beam and reduced overall efficiency by leaving it out of the beam while being upgraded.

With a bypass and with experiments in both legs, most of these down time losses could be avoided. If accelerator down time can be held to no more than a couple of weeks per year, the overall operating efficiency can be raised from perhaps 70 - 80% to 90 - 95%.

2. Multiplicity of Experiments. Obviously, the bypass makes possible more experiments, more diversity, more users, and almost certainly more physics. New experiments can be conceived and built following the initial machine turn-on without interruption of the machine operation, even if significant civil construction is needed.

One may raise the issue of whether a very major 4π detector should be run year 'round rather than to share time with another, "lesser" experiment. Although the time share between experiments in the two alternative bypass legs may be different than 50-50 (as determined by the Lab Director), it is nevertheless probable that the greatest physics output would be achieved by spreading operating time between diverse experiments.

3. Eliminate Garages. Many of the current generation of detectors are made in a way which permits them to be removed from the beam into an assembly hall, or "garage". However, the largest of these, L3 at LEP, is being built in situ, with no garage. This detector's weight of 5000 tons is dominated by a magnet roughly 15 m on a side. The cost of a garage and of the provisions to move the assembled detector were judged to be too great. With SSC detectors weighing up to 50 kilotons, it becomes quite impractical to make them moveable. Even for smaller detectors, the cost savings of eliminating the capability of moving the assembled detector and of providing a garage could go a long way toward meeting the added cost of a bypass.

4. Provide Coaxial Assembly. Most large detectors in existence and under construction are assembled coaxially, i.e. a large magnet or muon detector is made in a roughly cylindrical configuration, and other detector components are moved in axially. End plugs are added, as well as up- and down-stream detectors to provide 4π coverage.

Without a bypass, one might construct a detector with the outer, massive components (muon detectors, magnet return yoke) capable of opening along a symmetry plane perpendicular to the beam axis. The central portion of the detector – tracking chamber and electromagnetic calorimeter for example – could then be removed to a smaller garage without the need to move the entire detector mass. However, this operation still requires expensive engineering elaboration of the detector which would be avoided with a bypass and the consequent time and longitudinal space for coaxial assembly.

5. Future Expansion. A most compelling argument for bypasses is the opportunity for future expansion. The history of every major particle accelerator over the past 30 years has been that they were expanded a few years following completion for uses beyond the scope of concepts at the time of their construction and outside of their initial construction budget. Without a bypass, such expansion would necessitate very lengthy time delays and shutdowns of the facility. Thus, with the SSC, the entire far side might be left for future development. This could include accommodation of novel detectors, fixed-target facilities, and expansion in the number of experimental areas. If the bypass tunnels are not constructed initially, at least stubs should be provided to permit later construction with minimal down time.

6. Sociological Issues. The experience of large collaborations and large experiments is that the physicists can maintain aggressive enthusiasm in running an experiment for a few months continuously, but not for a year or more without a break. The difference in productive physics output of an already debugged and operating experiment between

running 6 months and running a year continuously is much less than a factor of two. After months of continuous round-the-clock running, a numbness and exhaustion sets in. This is apparent in cosmic ray and the proton decay experiments as well as with accelerator experiments.

University faculty can often readily arrange to be off campus for a semester (or term) plus the summer, and in some cases to do this year after year. It is more difficult for faculty members to be away continuously for a year and more.

It is absolutely essential that university scientists be major participants in the SSC program, that there be close interactive feedback between the laboratories and the universities, and that graduate students be involved. All of this is more practical with each experiment cycled on and off with a one year (approximately) cycle.

By scheduling each experiment to be down for several months continuously, preventative maintenance and repairs of the detector can be performed Concentrated analysis of the data from the previous run may suggest changes in the detector which would significantly improve it for the next run. A shutdown of several months could also permit a major upgrade of some parts of the detector.

Conclusion. It therefore seems that a bypass scheme providing at least 4 initially developed intersection areas divided (2 and 2 or 3 and 1) between two alternative beam lines is very highly desirable. If the configuration and initially-constructed stubs permit added bypasses and further-developed experimental areas in the future, the utility of the accelerator complex for research would be expanded in a very cost effective manner. If the fully-evolved accelerator complex in the early 21st century had 12 or more intersection regions with 6 taking beam simultaneously, it is this writer's opinion that they would be fully occupied and utilized. History suggests no less.

References

1. D. E. Johnson, "A Possible Beam Bypass for the SSC Clustered IR Region," Proceedings of the 1986 Summer Study on the Physics of the Superconducting Super Collider, p. 515.

2. E. D. Courant, L. W. Jones, B. W. Montague, E. M. Rowe, and A. M. Sessler, "A Bypass - Storage Ring Option for NAL," Nuclear Instruments and Methods, 29, 60, (1968).

3. M. Marx, "Cost (Benefits) of an Experimental Bypass at the SSC," Memo, 5/27/87.