Mini-Experiments

MINI-BEAMS AND MODULAR EXPERIMENTS

(Mini-Beam Discussions as Summarized by R. Carrigan,
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This section discusses possible new ways to provide flexibility and speed in implementing new experiments. It is followed by various selected information on Tevatron II beams, yields, etc., all taken from workshop talks by Fermilab area heads.

The Mini-Beam, Modular Experiment Concept

L. Lederman has recently suggested the mini-beam, modular experiment concept as a path to a more lively program. The concept consists of two ingredients, one "hardware" and the other "software". The "hardware" component is a modest beam with detector modules available that could be easily configured into experiments. The "software" is a "fast track" program planning algorithm that approves only one experiment at a time for a limited run of several months on an "in-and-then-out" basis. This concept could allow new ideas a quick path into the program.

Variants

Beam Alone

The most important feature of such a beam is its energy be competitive with the Tevatron program--that is above present Fermilab-SPS energies. Intensity is less important in that hot beams tend to focus on more specialized detector approaches. The more flexible the beam is, the better. It should include tagging and upstream trajectory information. Facilities for making electrons should be present. Other possibilities such as neutrals including photons would be interesting. Possibilities that have been suggested for a beam have included M4, PC, M3, M6E using an active slow spill split, the new beam in PE, and the Booster. Each of these has advantages and disadvantages. For example, M4 has distinct access problems and the intensity is low.

Even with no further support such a beam would have some interest. However, the less support in the way of existing equipment, the longer will be the dwell time of the experiment in the beam and the waiting time to get in the beam while equipment is rounded up.

Beam Plus Simple Detection Modules

Modularity for such a system could and probably should extend beyond detectors as such to include electronics, smart triggers, computer elements, and software. Some magnet should be available with a well-measured and reproducible field. A minimum magnet is probably a BM109 but many people felt something substantially larger would be needed (see below). Detector sizes might be somewhat reduced if new high resolution technologies were incorporated.

It did not seem possible to rig in and rig out an experiment much larger than a target system and a magnet with fore and aft chambers for a run of several months.

An inventory of existing detectors around the country was suggested as a corollary to this approach. This would give experimenters a ready means to locate possible detector components. This idea has merit beyond the mini-beam, modular experiments concept. Past experience, particularly with surplus lists, indicates that there are lots of pitfalls in trying to establish and operate such inventories.

Downstream Spectrometer With "Bring-Your-Own" Target Modules

Many experimenters felt that an important "module" was a downstream, open geometry, multi-particle spectrometer. Facilities and experiments such as the MPS, TPL, CCM, or E-537, and E-401 all have somewhat similar configurations. The MPS magnet (48D48, p_T = 0.67 GeV/c, 16 kG for 4.5 ft) was cited as a minimum size, with the requirement being that the magnet be able to reach y = 0. Cherenkov identification and gamma-ray calorimetry were considered essential, hadron calorimetry and muon identification desirable.

There are existence proofs that such detectors can operate at 100 triggers per second. Such a rate would permit a wide range of experiments.

Since this is quite similar to the present operation of several existing multiparticle spetrometers, it is possible to understand the impact of such an operation. It is possible to do 500 hour, two-to-three month experiments with an MPS system where target modules and triggering philosophies change. Failure of experiments are sometimes catastrophic because of neglect of some hardware aspect of an MPS. This possibility means that it is desirable for an incipient user to train for several prior cycles.

That, in turn, implies a longer waiting queue. The rule is obvious--the more sophisticated the existing system, the longer the wait.

This approach, a large downstream spectrometer module, coupled to flexible target and trigger modules, was favored by many. The sample might have been biased because MPS users tend to identify with this philosophy.

Some Examples of Experiments

Pocket experiments that could have utilized a readily accessible beam in the past include the MIT multiplicity studies, A-dependence studies, Rockefeller active target that was used in M6 for coherent dissociation, searches for long-lived bottom, quark searches, the Yale apparatus to detect short-lived particles, and the crystal-channeling experiment. Developments in short-track technology experiments may possibly lead to a significant increase in such mini-experiments. As an aside, it was suggested that the development of such technologies should occur at universities since the scale is right for a university operation.

Possibilities using a downstream spectrometer included the detection of V events. Several millibarns of interesting cross section could be studied looking at neutron, V, and N* recoils.

Support

Flexible handling facilities (a crane, rails) would obviously be needed. Some manpower support would be necessary. Physicist involvement, can be an important element in the success of an operation. On the other hand, too much support could be a bad thing since it would tend to codify and perpetuate a particular operation. Software support is particularly important. In this regard, the software should be very straightforward so that non-experts can penetrate it.

Related Aspects

The "fast track" part of this concept has possibilities that extend beyond mini-beams and modular experiments. Flexible downstream spectrometers already exist in several beams at the Laboratory. Indeed the Tevatron era will start with an array of very sophisticated facilities in nearly every beam at the Laboratory. Most of these systems, though, are really only available to the groups that built them. Perhaps more consideration should be given to permit independent or semi-independent groups using these facilities and to let such requests compete on a physics basis rather than on the basis of an existing schedule. No "shoot-outs" but they might thereby respond more rapidly to changing physics opportunities. It may be useful to discuss such possibilities at future experimenters' meetings.

In this regard, some felt the Director should continually emphasize the needs to share and cooperate in the use of existing resources.

Even with this "fast-track" concept, it will still be difficult to rip out good experiments. At the same time, the pressure to complete experiments should not be lessened on the normal program.

There was mixed reaction on the significance of mini-experiments for graduate student training. Some felt it was a good opportunity to learn about hardware, while others believed that they would learn about the wrong devices.

The "mini beam" relates to the test beam needs for the Tevatron. Many felt we will be short of test beams and suggested that a second test beam may be required soon. In particular, the Colliding Detector Facility may be a heavy user of test beams resources in the next few years and long periods of colliding detector operation will shut off operation of any test beams.

Present M5 operation is 100% committed. If the Colliding Detector Facility needs the equivalent of an entire beam, then the instantaneous demand will increase a factor of four in these years of half-time running.

The possibility of operation of the Booster for tests and mini-experiment opportunities, along the lines of Rae Stiening's 1968 summer study, could exist at Booster energies.

The beam that is discussed here should not be considered as a test beam except insofar as initial operation of a detector such as the Yale Streamer Chamber is regarded as a test. Stated differently, necessary testing facilities must continue to exist independently of such a beam if the concept is to work.

How to Proceed

One way to approach the modest experiment concept would be to designate a particular beam as a modest beam reservation some time in the future. For example, M4 could be reserved beginning in the spring of 1981. The PAC would then entertain proposals in November 1980, and approve one experiment. Any unused time could be filled with test beam activities. Experience over the next several years would give a feeling for viability at the Tevatron.

If a more comprehensive facility is envisaged, a different path may be needed. A small working group consisting of Laboratory staff and a few users should devise a plan. This plan would then be reviewed by the Laboratory, the PAC, and the Users' Executive Committee this fall.

Summary

(1) The concept is interesting, some experiments will be able to exploit it, and several month turn-around is possible.

(2) The "fast track" program planning algorithm may have applicability elsewhere in the Laboratory.

(3) The beam should be competitive in energy. Rate is not so important.

(4) The modular concept should include detectors, triggers, and software.

(5) Some felt an important module was a downstream spectrometer.