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INTERSECTING STORAGE ACCELERATOR NOTES

Large Aperture Spectrometer Magnet for the ISA
and the Possible Use of Visual Detectors

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LARGE APERTURE SPECTROMETER MAGNET FOR THE ISA
AND THE POSSIBLE USE OF VISUAL DETECTORS

ABSTRACT

We propose that a large aperture spectrometer magnet be designed as an integral part of the ISA machine to be pulsed with the machine. The design luminosity thus can be optimized in a configuration including the large magnet.

We give some preliminary options concerning magnet types and argue that as a first survey it is likely to be used with visual detectors.

At the ISA, as at lower energies, the strong forces will dominate the $p-p$ interaction. The typical $p-p$ event will be characterized by high track multiplicity and the small transverse momenta of the particles. We feel that the understanding of these events will be essential if we are to achieve an explanation of the strong interaction. We therefore consider it important the ISA be provided with a device which enables one to observe and analyze these events.

The detector we envision is one capable of doing survey experiments in the early days of the ISA, when the luminosity can reasonably be expected to be low, and also be able to do more specific experiments when the outline of the interaction is known and the luminosity is higher.

It is necessary to imagine the kind of measurements which will be needed before we can decide on the device. High multiplicity studies to date have concentrated on measuring charged multiplicities and inclusive spectra. Multiplicity studies require a device with good spatial resolution, high multi-track efficiency $\approx 4\pi$ solid angle and perhaps a moderate magnetic field to spread the particles. Inclusive spectra can be measured with a magnetic spectrometer with only a moderate solid angle.

We contend that these types of experiments alone will be inadequate to understand the nature of the strong interactions. Measurement of momenta and angles and the construction of single and multiparticle invariants will be necessary. To do this will require a device with a "large volume" magnetic field high multi-track efficiency and good (< 1 mm) spatial resolution.

The physics that will come out of such a device cannot be predicted; with $\sim 2/3$ erg or $> 400 m_p c^2$ available in the cofm unexpected things are likely. We will only mention some of the current theoretical musings the device could investigate: the validity of a double or single diffraction model, the differentiation between models of high multiplicity, and the possible existence of yet unknown long lined particles. We would also measure invariant mass and momentum transfer distribution. It is possible to believe that other than bilinear invariants might be significant in the strong interactions and these too could be studied.

With the time available to us for study as well as less than precise ideas of what we will want to measure 6-10 years from now we hesitate to

specify the detailed nature of the instrument. We will however indicate our thoughts on the magnet and the detector.

A large number of particle detection devices exist and more will likely exist before the ISA is ready. At this point we feel it unwise to exclude any detection system including visual devices. We emphasize the visual device because it has often been summarily rejected in favor of newer electronic techniques. We feel that the visual technique has the following advantages that recommend its consideration: good spatial resolution, easy and fast track identification and reconstruction, the ability to easily observe the decay of neutral particles. The mean decay length of a 50 BeV Λ is -3.5 meters! Furthermore, optical devices have no electronic gear that must be located in areas of high radiation.

Detector

At this stage of planning a big detector in one of the straight sections of ISA only very general considerations were taken into account, leading to a very loose concept. This report will only suggest the necessity of having a very general multipurpose detector at ISA to study multiparticle events and sketch two possible solutions for such a detector.

Two solutions for analyzing magnet systems will be considered in the following (all magnets are to be superconducting):

- A) A very big volume single magnet around the interaction region for the measurement of all momenta up to nearly 200 GeV/c.
- B) A smaller magnet around the interaction region, to measure momenta up to about 30 to 50 GeV/c and a system of two forward spectrometers set up on each side at some distance downstream of the interaction region in order to measure high momentum particles.

Solution A: The magnet should have rectangular shape with dimensions about 2 to 4 m high, 3 to 4 m wide and 10 m in the beam direction with a 20 kG field. The particle detection in first generation survey experiments could be done

exclusively by a visual detector such as a big discharge chamber* in the central region of the magnet and optical spark chambers, also placed inside the magnet, along the beam pipes to both sides of the discharge chamber*. Some more spark chambers arranged around the beam pipes at some distance downstream of the magnet could be used to get higher precision on forward produced high momentum particles and to see particles which emerge from the beam pipe after the magnet. The magnet would have swept almost all particles of momentum less than about 70 GeV/c out of the pipe at a distance of 10 m from the end of the magnet.

Solution B: In this case the central magnet should probably be a relatively small vertical field magnet. A magnet about 5 m in diameter, 5 m high and 20 kG field should be sufficient to analyze particles up to 50 GeV/c to a reasonable precision. For the first experiments a streamer chamber would be a suitable detector in this central magnet.

Each of the forward spectrometers would consist of 2 proportional wire chamber arms about 10 m long on each side of a 2 to 3 m long magnet with an aperture about 1 m high and 2 m wide with a field of 20 kG. This would allow a momentum resolution of better than 1% for 150 GeV/c particles. The magnets of the downstream spectrometers could either contain the beam pipe or be set up at one side of the beam pipe, depending on the geometry of the intersection region.

Solution B could in the beginning also be suitable for multiplicity studies of charged particles with crude information on momenta and charge, using only the central magnet.

The central magnets in both solutions A and B should be designed in a way to make it possible to replace the visual detector, when one wants to have

*The streamer chamber or the newer "crystal chamber" of Charpak are possibilities here. (See Charpak, Breskin and Pluz, "Some Properties of Stacks of Discharge Chambers with Infinitely Transparent Electrodes", NUCL. INSTR. & METH. 100 (1972) 157-164.)

selective triggers on specific events, with proportional wire chambers or wire spark chambers. Since we wish to have the possibility of a visual detector the magnet design should have a large opening at the top.

Data Extraction and Processing

Experience derived from bubble chamber and optical spark chamber experiments guarantees reliable extraction of track chamber data. If the data are properly recorded, film readers exist which are functional equivalents of magnetic tape drives. A substantial number of groups have readers that process up to several hundred frames per hour. Accurate data on track geometry, width and density are obtained. Precisions to one micron at the film plane are available.

Film from early survey experiments at ISABELLE would be viewed by physicists and scanning specialists. For this reason the format should be suitable for viewing. Scan table guidance for automated measurement would help reduce the cost of data extraction. Further cost savings can be achieved by optimizing the sampling of well established tracks.

Data processing costs can be minimized by the elimination of most kinematic fitting procedures. Accurate estimates for the cost of data extraction and processing are available because a substantial part of the software exists and because the technology is relatively mature.