EXPERIMENTAL BEAMS AND FACILITIES AT THE ARGONNE ZGS *

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The presently existing experimental areas at the Argonne ZGS, and their relationship to the accelerator, are to be seen in Fig. 1. In the center is the Meson Area, about 100 ft by 250 ft, where various secondary-beam systems have been installed, emergent from a single straight section. At the lower left is an auxiliary building, about 100 ft by 80 ft that houses a 30 in hydrogen bubble chamber and the final components of a separated beam that traverses the connecting passage to the Meson Building. Both of these buildings are to be enlarged and construction planning is now in progress. The Meson Building will extend another 80 ft to the left and the Bubble-Chamber Building will also be extended 80 ft; the common walls between the two will be removed.

To the right, in the figure, is the Proton Building, also about 100 ft by 250 ft, where an extracted proton beam travels the full length of the building. It is focused at two target positions where secondary beams can be installed and ends at a beam-stopping cave at the lower right corner of the figure. In the triangular region between this building and the accelerator, a bending magnet diverts the extracted beam toward the neutrino-studies installation.

Returning to the Meson Area, Fig. 2 shows an enlarged layout of the secondary beams which, up to now, have been installed at 7-3/4°, 17-3/4° and 31°. Positive and negative beams may arise from targets located at a field-free location in the straight section, or negative beams can be produced at angles close to 0° by suitable placement of targets inside the magnet octant. The details of targeting and the sharing of pulses of circulating accelerated beam between several targets will be described in another paper at this Conference (1).

At the 7-3/4° location a two-stage separated beam, (2) about 330 ft long, is now in operation providing positive and negative kaons from about 3 to 5.5 BeV/c and antiprotons and pions up to 6 or 7 BeV/c. The beam emerges through a hole cut through the yoke of the next magnet octant of the accelerator and suitable coils provide compensation for the magnetic field therein. Two

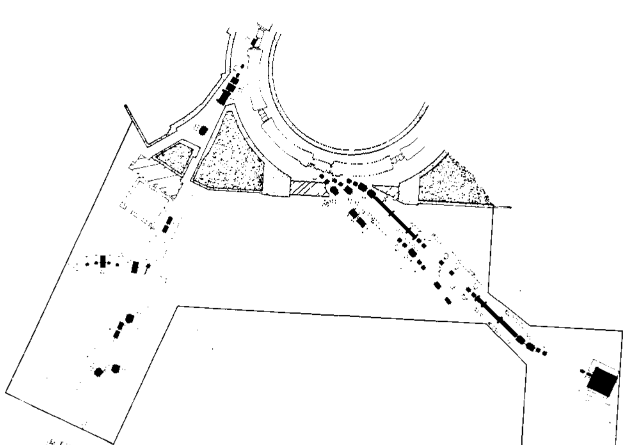

Fig. 1 - Experimental areas at the Argonne ZGS.

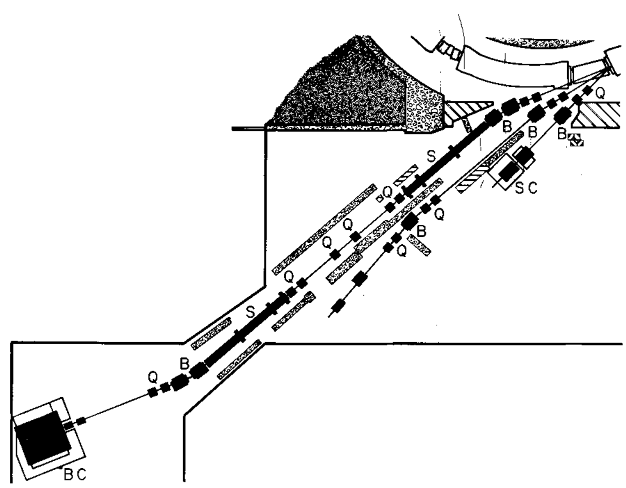

Fig. 2 - Meson area showing secondary-beam installations in Summer of 1965.

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quadrupoles then make the beam parallel in the vertical plane and focus it horizontally at a point just downstream of the second pair of quadrupoles. At this point a sextupole corrects chromatic aberration. Momentum analysis and a total bend of 18-1/2° takes place at the two bending magnets in front of the first separator. A momentum collimator at the horizontal focus determines the resolution, about ± 1 percent. The second doublet focuses the beam vertically at the first mass slit between the fifth and sixth quadrupoles which make the beam horizontally parallel between the first and second sextupoles. The entire beam is completely symmetric about the first mass-slit position. In each stage is a 50 ft length of electromagnetic separator composed of two 20 ft and one 10 ft sections. The electrodes are stainless steel with a 2-1/4-in gap; typical fields are of the order of 70 kV/cm. This gives a π - K separation of about 0.06 in at 5.5 BeV/c. Internal targets are 0.025 in high by 0.25 in wide with an image at the second mass slit that is about 0.04 in high by 0.125 in wide. Between this slit and the bubble chamber are two quadrupoles which shape and deflect the beam for proper entrance into the chamber. Typical yields at the bubble chamber for 10^{11} circulating protons on the target, are:

a) for negative kaons - - 5 at 4 BeV/c and 8 at 5.5 BeV/c, with a purity greater than 95 percent;

b) for antiprotons - - about 4 at 4 BeV/c;

c) for positive kaons - - 4 at 4 BeV/5 and 5 at 2.5 BeV/c.

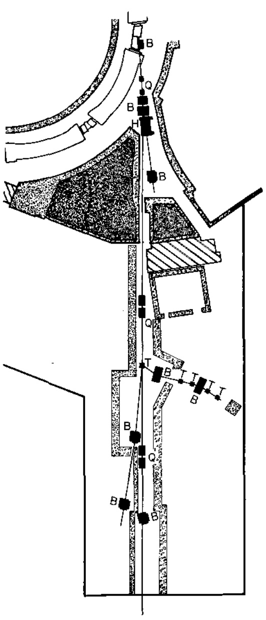
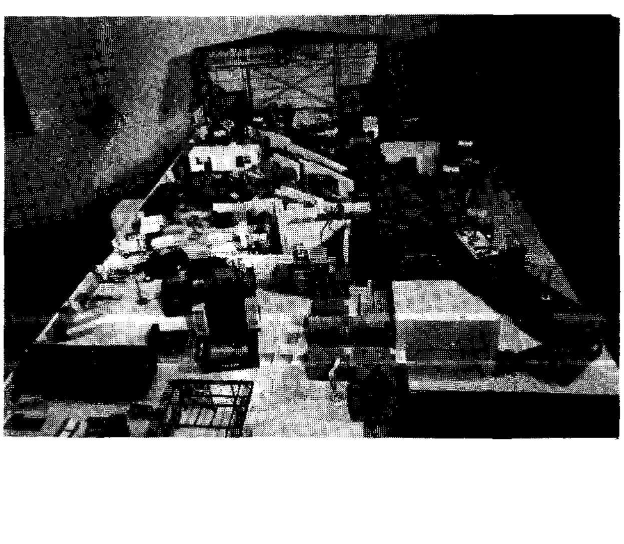


Fig. 3 - Proton area with neutrino-studies installation and beams at first focus of external proton beam.

Fig. 4 - Protograph of scaled model of meson area showing installations planned for Winter 1965-66.



The bubble chamber itself has a diameter of 30 in and a capacity of about 250 liters; the associated magnetic field has a maximum value of 32 kG.

The beam at 17 - 3/4° provides pions from about 1 BeV/c to somewhat over 6 BeV/c with momentum resolution of about ± 0.75 percent. With an angular acceptance of about 3.5×10^{-4} sr, typical yields for 10^{11} circulating protons on target have been about 10^5 negative pions of 1 to 2 BeV/c at 0° production angle. The beam at 31° has been recently used as a neutral beam for studies with K°_2 mesons. There is also a hole in the main shield wall at 75° but, up to the present, this has been used solely for monitoring and testing.

An enlargement of the external proton beam installation is shown in Fig. 3. The extraction method uses an energy-loss target and three permanently placed extraction magnets. Preliminary studies have shown that some 30-35 percent of the circulating beam can be extracted. However, up to the present, most of the studies with extracted protons have used a parasitic proton beam that is obtained by having the extraction magnets turned on to eject those protons which have lost energy in passing through the secondary-beam targets. This results in an extraction of about 1/2 to 1 percent of the circulating beam.

The extracted beam can be brought out quickly, in about 1/2 to 2 msec, by means of a beam-bumping magnet, or long spills of more than 200 msec duration can be extracted using the flat top of the accelerator's magnetic field. After traversing a pair of quadrupoles and various monitoring devices, the beam can be bent by a switching magnet toward the neutrino area or can pass through the channel in the main shield wall into the Proton Building. This channel is filled with water when beam is used in the neutrino area. The beam to the neutrino area contains a pion-focusing magnetic horn which being described at this Conference (3) and another bending magnet for beam-survey studies. In front of the spark-chamber detectors, there is an absorbing wall of concrete and steel (density - 5) that is 28 ft thick followed by a 20 - ft thick steel wall.

In the Proton Building, the external beam can be focused at two locations by two pairs of quadrupoles of 10-in diameter and 72 in long, and then passes outside the building into a beam-stopping cave. Up to now, an experiment has been installed only at the first focus where two sets of bending magnets on either side of the proton beam are being used to study p-p interactions in a liquid-hydrogen target. The beam size at this focus is about 2 cm high and 1 cm wide but may be somewhat smaller than this after further studies have been made on extraction parameters and focusing It is planned that the second focus will be used for heavy targets, but further radiation measurements are needed before final beam designs with adequate shielding can be drawn up.

At the present time, the ZGS is shut down for the istallation of two new secondary beams that can be seen in Fig. 4. This is a photograph of a three-dimensional scale model which has proved to be very useful for planning new beams or rearrangements necessary for proposed experiments. At the 7-3/4° location, modifications of the second bending magnet of the separated beam will provide neutral beams or charged beams up to momenta of the order of 10 BeV/c. The latter, of course, can only be used on an alternate basis with the separated beam.

The 31° neutral beam is being removed and a low-momentum separated beam is being set up at 28° to provide kaons and antiprotons up to somewhat over 800 MeV/c. This beam will also have two stages of separation using two 10 ft long electromagnetic separators of the same design as those in the 7° beam. With a momentum resolution of about ± 1 percent and an acceptance of about 1/2 msr, about 80 K-mesons can be expected to reach the second mass slit for each 10^{11} protons hitting a target with 0° production.

The first pictures in this beam will probably be taken in a 10-in helium bubble chamber with a superconducting magnet capable of providing fields of the order of 40 kG (4). This system and its auxiliary equipment can be seen in the enclosure at the end of the beam. Following this experiment the helium chamber will be replaced by a 40-in heavy-liquid bubble chamber that can be seen at the side of the beam; its magnet is also expected to produce fields of the order of 40 kG. The chamber itself is operational but the magnet is not yet complete; its assembly will take place during the coming winter.

And added feature of this separated beam is a branch beam arising at the second bending magnet which, with further quadrupoles and bending magnets, can be used for counter or spark-chamber experiments. A typical installation is shown in the figure.

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