Beam Facilities Planned for the ORIC

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I think if we assume that we know how to design these types of cyclotrons there is still one controversial subject left. That is, the external optics and facilities. It was pointed out this morning that the shielding requirements for a typical machine of this type, say, 75-Mev protons, amounts to the order of 7 to 8 ft of concrete, and it is fairly clear that once you get your shielding poured even minor changes are going to be very expensive.

Unfortunately, you have a machine that appeals to a very large number of different types of scientists, all of whom have extremely conflicting desires as to what they want and will insist on for research facilities.

The present plans of the ORIC machine are shown in Figure 267. In order that particularly large pieces of apparatus can be installed or removed large openings, filled with stacked concrete block, are left in the walls of the two larger areas. The cyclotron and part of the ion optics are placed in the same shielded area. The actual experimental work will be done in either of two separate shielded rooms. One of these rooms can be split into two regions by adding a wall of loaded concrete and a door, if there is sufficient demand for cyclotron time. With this arrangement, it is possible to do an experiment in one room while people can safely work in the other two rooms. Since many experiments require a long and painstaking effort to prepare, the accelerator can be used efficiently if the time to change ion or energy is short and the beam can be easily shifted from one room to another.

The emergent beam from the cyclotron is focused by a quadrupole lens and is bent by a switching magnet to one of several locations in the target room shown at the left. There will be a slit in the separating wall with several 3-in. pipes to carry the beam. The slit will be filled with blocks and water. It may be necessary to slide

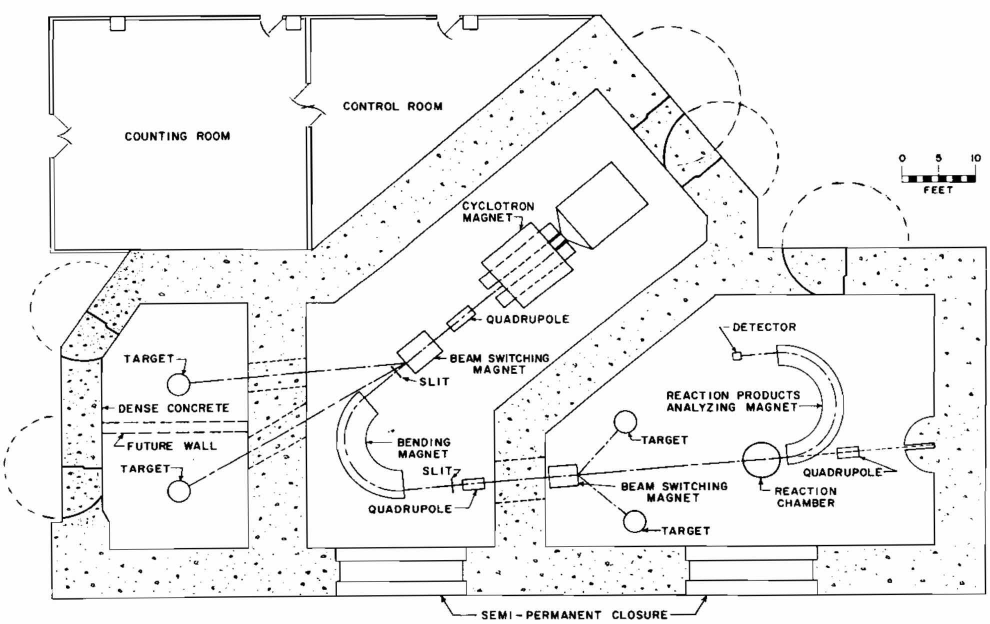

Fig. 267. Proposed research facilities for ORIC

shielding into some of these pipes or around the end of the pipes to reduce the radiation level; an effort is made to keep the beam pipes from looking at a high source of radiation. The quadrupole lens is adjusted to achieve the best beam on the target.

If high precision measurements are required, the quadrupole lens is used to focus the beam on the entrance slit to a large double-focusing $n = 1/2$ analyzing magnet with a 6-ft. radius of curvature. The range of a 75-Mev proton is the order of 1 cm in heavy material. If, for high resolution, the slit opening is 1 mm, then scattering from the slit edges is serious. In addition the beam intercepted by the slits causes a high radiation background. For these reasons, the exit slit is placed in the cyclotron room and a quadrupole lens focuses the beam onto a target in the room at the right. Ions which are scattered in angle or degraded in energy have less chance of hitting the target. If the demand for experimental facilities is sufficiently high, a beam switching magnet in the larger room allows a further choice of target location.

Another 180°, $n = 1/2$, double-focusing magnet is used to analyze the charged particles leaving the target. It is designed so that it can be rotated about the target and deflect the ions either horizontally or vertically. In the vertical position, the deflector remains stationary above the target as the magnet is rotated in the horizontal plane. Background corrections are simpler under these conditions. A major problem in precision comes from the fact that for a given reaction the energy of the outgoing ion depends on the angle of scattering. In the case of elastic scattering of nitrogen by nitrogen, for example, the energy for zero angle scattering is 100 Mev; at 45° in the lab, the energy has dropped to zero. The best ratio of precision to solid angle is obtained when the bending of the beam lies in the horizontal plane. The dispersive power of the analyzing magnets is 20 kev/mm for 75-Mev protons. One can calibrate the energy of the beam used by passing it through the first analyzing magnet in the cyclotron enclosure.

To decrease background in the large target room, it may be advisable to install an additional quadrupole to focus the beam which passes through a thin target into a shielded hole in the wall as shown in the drawing. The room has been made sufficiently large that time-of-flight studies, double-scattering, and other types of elaborate studies may be performed.

PARKINSON: Your beam analyzer is arranged in such a way that the dispersions do not add, is that correct? The way your picture showed it, the two magnets and the analyzer bend the beam in opposite directions. You compress the energy?

BENDER: Yes.