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The beam dump in the slow external proton beam (SEB) experimental area at the AGS

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No. 9

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THE BEAM DUMP IN THE SLOW EXTERNAL PROTON BEAM (SEB) EXPERIMENTAL AREA AT THE AGS

I. Shielding Considerations

The beam dump for the residual protons in the SEB experimental area at the AGS is designed for 30 GeV/c protons at an intensity of 10^{12} protons per pulse against the possibility of the full beam being deposited in the beam dump. Such a shield providing reasonable experimental access to targets becomes rather massive and inflexible. Since the problem of shielding the nuclear cascade and that of shielding against muons are rather different the beam stop has been designed as a massive steel basic shield to stop the nuclear cascade. Concrete and/or steel are to be added around this basic shield to cut down the muon and neutron fluxes as required by the various experiments. This note is concerned with the massive steel basic shield for the nuclear cascade.

A reasonable attenuation factor for an incident flux of 10^{12} protons is the order of 10^{-12}, or about 28 attenuation lengths beyond the transition region for the nuclear cascade ($F_{att} \approx 7 \times 10^{-13}$). The available experimental data for the nuclear cascade in steel[1] gives for the length of the transition region along the axis of the cascade 120 gm/cm^2, equal to the attenuation

1 A. Citron, et al., CERN MPS/Int. MU/EP67-1.

2 J. Ranft, CERN MPS/Int. MU/EP67-1.

length, λ_{att}, for axial attenuation. The thickness of a shield extending 28 λ_{att} beyond the transition region is 3480 gm/cm^2 or 14.6 ft. For the attenuation of the integrated flux over the cross section of the cascade the transition length is 620 gm/cm^2 and λ_{att} = 185 gm/cm^2 for a total length of shield in the forward direction of 5800 gm/cm^2 or 24.4 ft. The relevant shield thickness lies somewhere between these two values. Ranft[2], using a Monte Carlo technique, calculates a thickness of 15.6 ft. for the steel shielding required for a dose rate outside the shield of 1 mrem/hr from 10^{12} particles/pulse incident at 20 GeV/c. Gourain[3] arrives at a thickness of 5.5 m or 18 ft. for 10^{12} protons/pulse incident at 28 GeV/c from a calculation similar to what I have done above. The thickness of 20 ft. in the forward direction from the beam catcher re-entrant cavity in Fig. 1 should be, then, a conservative estimate of the shielding required to stop the nuclear cascade.

The width of the shield as shown in Fig. 1 is determined by requiring a minimum of 6 ft. of steel transverse to the beam at the maximum excursion points of the beam in the beam catcher. This is based on Ranft's calculations[2].

II. Experimental Considerations

Probably the most attractive feature of the SEB from an experimental viewpoint is that it makes accessible high momentum secondary particle production at 0^o. The configuration of the beam dump as shown in Fig. 1 is determined primarily by the 0^o production facility. Charged secondary particles produced at 0^o at the primary target are directed by the steering magnets as shown in Fig. 1 into the -5.9^o beam port. The whole range of secondary particle momenta up to 25 GeV/c and of both signs of charge can be steered down the -5.9^o port by suitable tuning of the steering magnets.

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3 R. Gourain, CERN MPS/Int. MU/EP64-12.

The residual proton beam is dumped at a point in the beam catcher dependent on the field strengths tuned in the bending magnets. When the steering magnets are tuned for 25 BeV/c positive particles in the -5.9° port, the 30 BeV/c residual proton beam is incident on the beam dump at -4.9°. This determines the wall of the re-entrant cavity on the negative side of the beam. With 25 BeV/c negative particles in the -5.9° port, the 30 BeV/c residual proton beam is incident on the beam dump at $+4.9^{\circ}$, determining the wall of the re-entrant cavity on the positive side. The maximum field strengths in the magnets from which the position and angle of the beam port and beam catcher wall were determined are given in Fig. 1.

Neutral beam experiments and experiments utilizing the primary proton beam directly can be set up so as to be compatible with the -5.9° port facility and simultaneously with one another as indicated in Fig. 1. The steering magnets act as sweepers for the neutral beam experiments which make use of the axial beam port as shown in Fig. 1. Proton beam experiments utilizing the shield wall as a filter would be targeted at a point symmetric with the edge of the beam catcher re-entrant cavity. The scheme shown on Fig. 1 for carrying out the two experiments of this type which have been proposed is based on the desirability of maximizing physics output by intelligent use of available resources. In this case it is desirable to maximize the compatibility of the various categories of experiment by minimizing their interference with one another. As projected that portion of the backstop down to line AA which contains the two beam ports, would be left intact once built. This leaves the -5.9° charged particle and neutral beam facility as available facilities without massive re-arrangement of iron shielding and ports. Experiment #388 (Adair) would be targeted with steel modules I (18D72 backleg), II, III, IV in place. When this experiment is finished, modules I and II would be removed. Experiment #420 would then be targeted at the position shown. In this way the upper part of the backstop as far as line AA including the neutral beam facility is left intact, even though for the period of running of Experiment #420 the neutral port is masked by the detectors used in that experiment. Figure 2 indicates the layout of Experiment #420. The first block of steel in Fig. 2 would be the last 12 ft. of the backstop, module III.

III. Final Form of the Beam Dump

On completion of Experiment #420 modules III, IV of Fig. 1 would be pulled out and that side of the backstop made symmetric with the existing -5.9^{o} hole as shown in Fig. 3 by the construction of a $+5.9^{o}$ port. In this final form of the beam dump charged particles of opposite sign produced at 0^{o} at a given momentum would be simultaneously tuned in the symmetric charged particle channels. This would seem highly desirable in view of the fact that this doubles the facility for 0^{o} production of charged particles, which is perhaps the prime physics reason for building the SEB.

By proceeding in this modular fashion towards the final form of the beam dump we do maximize the physics output by preserving compatibility as far as possible. This makes most effective use of our resources by eliminating unnecessary building, tearing down and rebuilding of these massive iron shields.

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BY TET DATE 11-17-67 SUBJECT SEB Beam Dump: Rev. SHEET No. ______ OF ______

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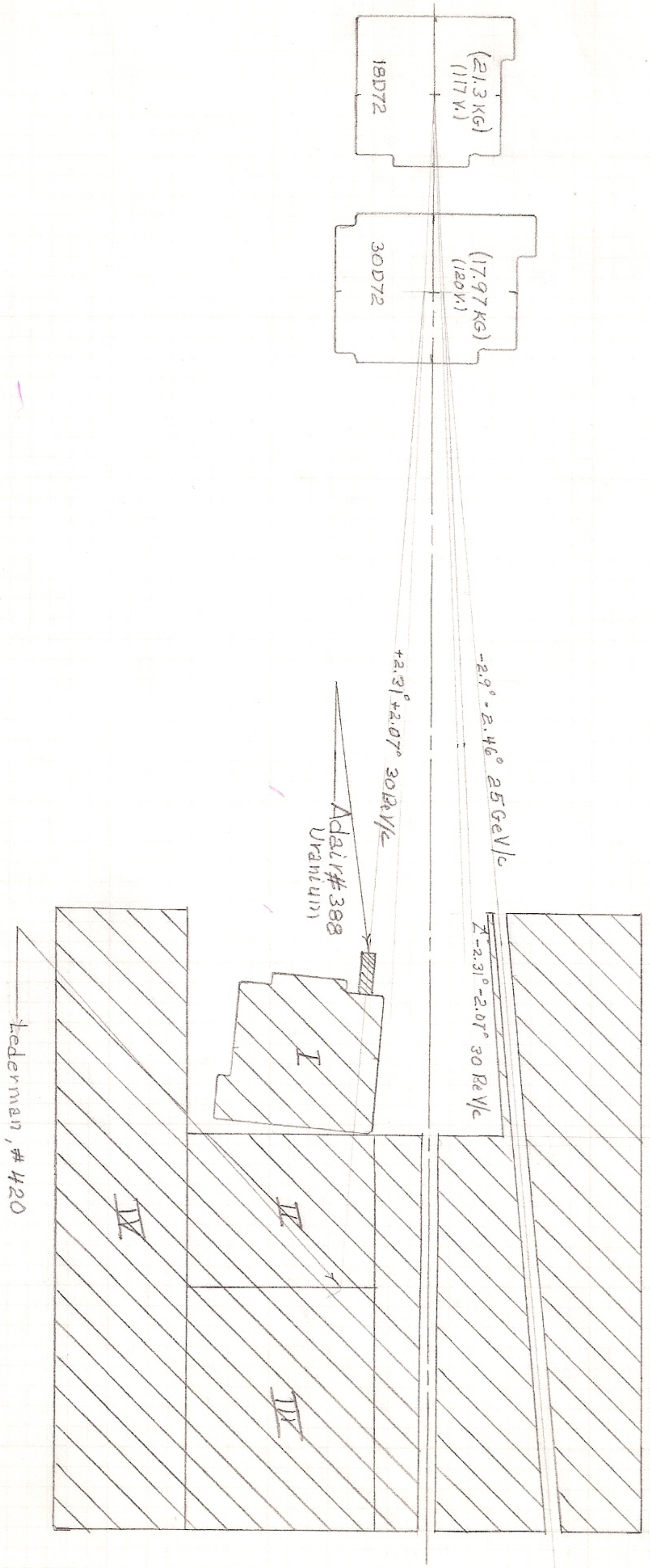

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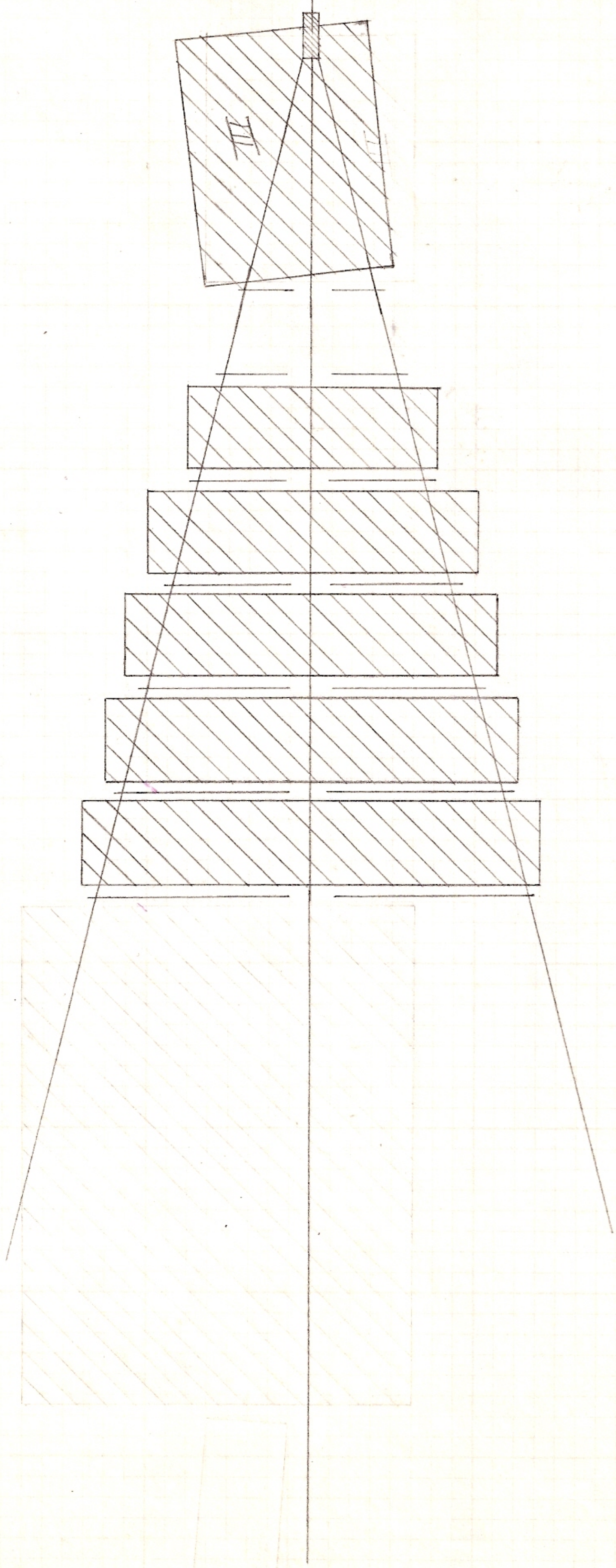

#420 CHRISTENSON

Figure 2

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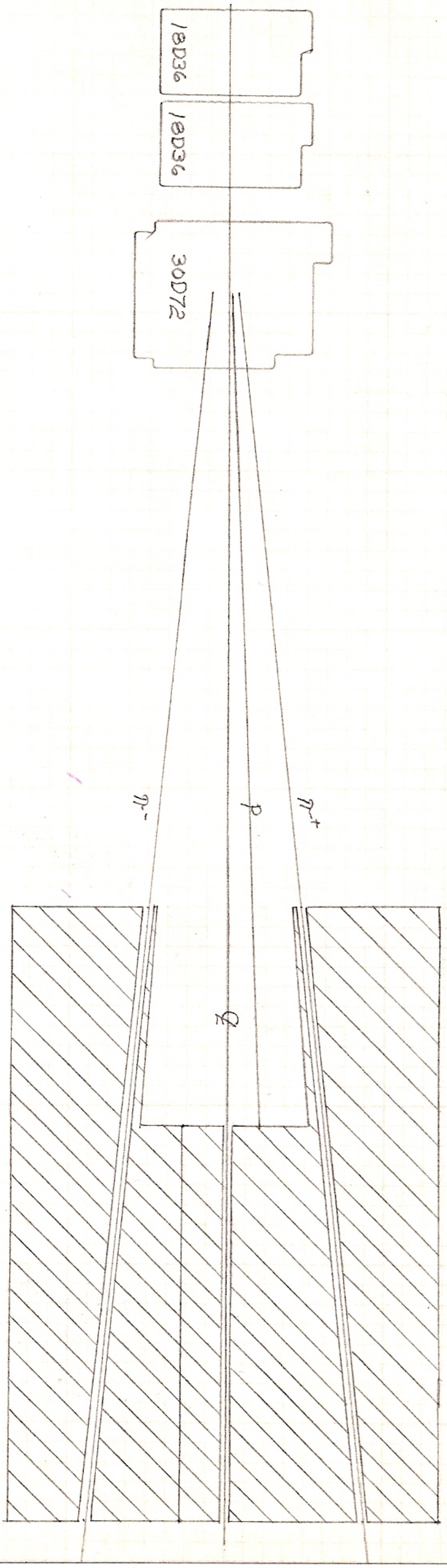

Figure 3