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RECOMMENDATIONS FOR LARGE-APERTURE, GENERAL-PURPOSE MAGNETS AT NAL

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ABSTRACT

The magnet requirements of the first 79 proposals have been studied. As a result, recommendations are made for the acquisition of magnets of three different designs.

We have examined nearly all of the proposals up through 79 to determine their magnet requirements. There was a discussion of these requirements in a meeting of summer-study participants held July 10. The requested magnets are tabulated in Table II and Fig. 1. The scatter diagram in Fig. 1 plots aperture width vs height in inches and also gives the field integral for the individual requests. The diagram does not include unusual configurations (i. e., "C" magnets, septum magnets, cyclotron magnets). Wherever an experiment called for a number of similar magnets in series, we have lumped their field integrals together. There were a number of requests for rather small aperture magnets (usually to be used as sweeping magnets). We assume that main-ring magnets would suffice for these and have omitted them from what follows.

Upon examining the scatter diagram, a definite pattern emerges. There are two very large magnets requested (Proposals 33 and 51). There is one with an unusual aspect ratio (Proposal 70). These, along with the unusual configurations, will have to be considered individually and, if they are built, will clearly not be stock items. We are here more concerned with experimental magnets that will be required in some quantity.

The most commonly requested magnet is one with an aperture about 8 in. high and a width of 12 in. to 30 in. The requested length ranges from 30 to about 100 kilo-gauss-meters. The authors of proposals frequently mention existing BNL or ANL beam-transport magnet designs as satisfying their needs (the BNL 18D72 or ANL BM-109, for example). In these proposals these magnets are usually used as forward spectrometer analyzing magnets. It was the consensus of the meeting that a single existing design should be adopted to fill this requirement and that it should be large enough to include most all of the requests for this type of magnet. Specifically, an 8-in. × 24-in. aperture was mentioned. It was noted that decreasing the horizontal aperture saves practically nothing in power. The length should be dictated primarily by rigging considerations. A 72-in. length is fairly standard and seems reasonable.

The second commonly requested class of magnets is a large window-frame type. The ANL SCM-105 is frequently mentioned in this application. This type is usually used in the recoil arm of a spectrometer system or to analyze K^o decays in neutral-beam experiments. It was felt that two standard sizes should be adopted here. Both would have adjustable gap widths, this being accomplished by inserting shims in the flux return yoke. The recommendations coming from the meeting are summarized in Table I.

One might criticize the above conclusions on the grounds that they were based on experiments designed, for the most part, for 200-GeV beams. We did not feel that 500-GeV experiments would require greatly different magnets, however. A crude argument can be made as follows: If one doubles the energy, the lab-angle for a given momentum transfer to the beam particle decreases by a factor of two. This means the magnet for the forward spectrometer arm can be placed twice as far downstream. The increased lever arm on the entrance angle measurement for this magnet implies that the same length magnet can be used to obtain the same momentum resolution even though the particle has higher momentum. In the recoil arm, the kinematics are nearly independent of incident momentum and so, for a given t range, the spectrometer will appear identical. A more convincing argument, perhaps, is to point out that the magnets required for 20-GeV experiments are not very different from what is required at 200 GeV and, so, another factor of two should not change things much more.

The magnet design should influence the choice of beam height. In the target area the beam should be high enough to be at the midplane of the large magnets mentioned above when they are opened to a one-meter gap.

When choosing magnet and power-supply parameters, such as the temperature rise of the magnets and the method of cooling, the influence on the entire experimental-hall environment should be considered. Such things as air temperature in the building and noise level are important.

R. Wilson has suggested the use of a dual-crane system in Area 2. Each crane would have a capacity of, say, 25 tons and could be arranged to operate in tandem to lift 50-ton loads. He points out that this sort of installation exists in commercial plants. Rigging tends to be a bottleneck at most accelerators. A dual-crane system would help alleviate the problem. The cranes should be equipped with a fast hook for small jobs. A coverage of 75 ft (in the beam direction) is recommended.

The advice and suggestions of many summer-study participants is gratefully acknowledged.

Table I. Recommended Magnet Designs.

Gap	Width	∫Bdl kG-m	Approx. Weight	Approx. Power	Quantity	Approx. Cost(each)
20 cm	60 cm	30	50 tons	280 kW	2 per beam line	$60 K
adjustable to 1 meter	200 cm	12 (at 70-cm gap)	110 tons	510 kW	2 per experimental area	$95 K
adjustable to 1 meter	200 cm	24 (at 70-cm gap)	200 tons	680 kW	1 or 2 per experimental area	

Table II. Magnet Requests.

Proposal	Experiment	Gap (in.)	Width (in.)	B×L (kG-m)	Remarks
2	BC hybrid	30	84	13	
4	np scattering	6	48	20	
5	μp scattering	30	60	20	
6	pp scattering	6	12	55	
		2	20	48	septum magnets
		5	8	12	septum magnets
		1	4	64	septum magnets
		2	2	16	septum magnets
7	πp, pp scattering	26	84	12	
		8	24	68	
8	neut. beam	8	30	45	
12	np chex	10	24	65	
15	K^o regen.	22	96	12	
23	πp incl.	8	24	25	
25	$\gamma\sigma_T$	4	18	54	
		4	18	100	
26	μ scattering	6	18	31	
27	neut. beam	24	72	20	
29	μ scattering	30	60	27	
33	μ scattering	79	118	90	
35	$\pi p \rightarrow Xp$	16	32	15	
47	πp, pp scattering	6	15	130	
49	πe scattering	8	13	54	
50	πp, Kp scattering	8	18	94	
51	πp, $Kp \rightarrow XN$	79	79	60	
52	beam survey	6	13	~9	"C" magnet
54	πp, Kp, pp	24	79	~9	"C" magnet
		20	40	36	

Table II. Magnet Requests. (con't)

Proposal	Experiment	Gap (in.)	Width (in.)	B×L (kG-m)	Remarks
60	K_L^o	48	48	12	
61	pol. tgt	~14	84	24	
		8	24	66	
68	πp	12 ?	170	< 65 ?	cyclotron magnet
70	dilepton	30	8	60	
71	πe	10	48	100	
79	K^o regen.	24	30	20	

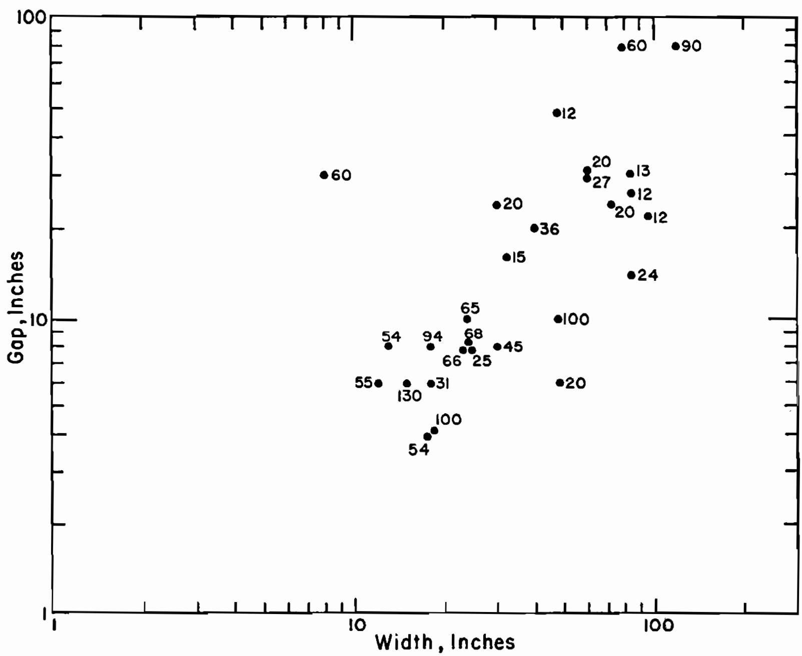

Fig. 1. Scatter diagram showing aperture dimensions of magnets requested in Proposals 1 through 79. The number associated with each point is the length in kG-m. Unusual configurations are not plotted.