SUMMARY OF TOTAL CROSS-SECTION PROPOSALS

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ABSTRACT

A summary of the hadron total cross-section proposals is presented, and a few additional comments are made.

Total cross-section experiments are extremely simple in concept if not in execution. It is not surprising that the three proposals which have been submitted to measure charged hadron total cross sections are very similar, and that they discuss in detail one or more of the major sources of possible systematic error. We have considered only the proposals to measure total cross sections for neutrons and for $\pi^{\pm}$, $K^{\pm}$, p, and $\bar{p}$. The targets planned are always liquid hydrogen and deuterium and sometimes heavier elements.

A prime goal of these experiments is to determine the energy dependence of the cross section over a wide range of energies. Thus, one concern of the neutron experiment is the problem of determining the energy of the incident neutrons. The plan is to use a total absorption spectrometer with an expected energy resolution of ~±5% at 200 GeV (and worse at lower energies). The energy resolution is not expected to cause difficulty since the cross section is expected to vary slowly with energy.

Statistical precision is not a problem in any of the experiments; even for K^+ and $\bar{p}$ the time per point is expected to be only a few hours. Estimates of accuracy, running time, and other information extracted from the proposals are given in Table I. Since the data are presented without the qualifications included in the texts, the numbers should be taken only as a guide.

Particle identification is of crucial importance in the charged hadron experiments. All experiments plan to measure the μ contamination with a thick absorber. They plan to use appropriate Cerenkov counters to identify incident particles. Some savings in running time can be achieved by identifying π, K, and p simultaneously at each momentum. More attention needs to be given to the details of the Cerenkov counter system for the beam to select a combination of threshold and DISC-type counters which will provide redundancy and yet not be overly complicated.

Two other obvious sources of possible systematic error besides particle misidentification are the extrapolation to zero solid angle and the determination of target density. These are old problems in total cross-section work and have received much attention.

The constraints on the liquid hydrogen and liquid deuterium target system place severe restrictions on its design. It should be rather long to optimize counting statistics, yet the target flask should be surrounded by a second jacket (except for the ends) to keep the target liquid quiescent. It is also desirable to make identical vacuum, hydrogen and deuterium flasks which can be rapidly cycled into the beam. These considerations make it unlikely that such a target system will be useful for other types of experiments. On the other hand, it may be wise to use the same well-built target system for both charged and neutral hadrons (and even hyperons).

The extrapolation to zero solid angle is dependent on the design of the detector. It is here that the greatest differences between the proposals appear. The neutron experiment must convert the neutrons in an Fe plate and rely on the charged particles to preserve the direction of the neutron. Then the energy deposited in the thick total absorption spectrometer is used to determine the energy of the incident neutron.

Of the charged particle proposals, one experiment plans to use a standard set of transmission counters. This technique places greater demands on the beam design as to divergence and stability. Another experiment plans to use proportional wire chambers to sample the very small $|t|$ region. Since these chambers can count only a few hundred events per pulse, they will be used to determine the slope, and a standard scintillation counter arrangement will be used to collect high statistics. The third experiment plans to use crossed counter hodoscopes both before and after the target to determine the trajectory of each particle. This technique is least dependent on beam divergence and collects high statistics at all $|t|$ values it covers.

One proposal discusses putting the data for each pulse into a buffer and making detailed checks on the spill quality, magnet parameters, etc. before recording the data for that pulse on magnetic tape. This seems to be an excellent way to make maximum use of the beam-time, especially if these experiments are scheduled before the machine operation becomes very stable.

Table I. Parameters of Total Cross-Section Proposals.

Proposal No.	4	10	56	57
Particles	n	←	$\pi^{\pm}$, $K^{\pm}$, p, $\bar{p}$	→
Quoted Precision				
systematic	?	1%	0.1%	0.3%
statistical	?	0.1-0.2%	0.05%	0.1%
Flux/pulse	10^6	10^6	1.5×10^5	10^6
Time requested				
test	100 hrs	50 hrs	-	50 hrs
run	200 hrs	400 hrs	1000 hrs	400 hrs
No. of points	?	?	96	?
Target				
type	←	←	LH_2, LD_2	→
	← heavy elements →			
length	~1.3 m	~2 m	5 m	~3 m
Detector				
distance	250 m	~23-83 m	5-40 m	?, ~100 m
type	← transmission counters →			crossed scintillation hodoscopes
	plus total absorption spectrometer		plus proportional wire chambers for $(t) < 0.1 (GeV/c)^2$	