A PROPOSAL FOR THE USE OF THE 10-BeV BOOSTER ACCELERATOR AS A SOURCE OF LOW ENERGY $K^{\pm}$ MESONS

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Experiments with low energy K mesons have provided a great deal of information about the weak interaction. This is so for the trivial reason that many more decay channels are available in K decay than in, for example, π decay. Almost all experiments other than bubble-chamber experiments on charged K decay have been severely limited by insufficient K fluxes. A flux of 2000/second K^+ is typical.

I would like to propose that the beam of the booster accelerator at Weston, when it is not being injected into the 200-BeV ring, be used to produce K mesons. With the high flux of K mesons that it would produce, it would be possible to make significant advances in a variety of experiments. The following are examples.

Experiments With K^-

1. K^- capture x rays; studies of the nuclear surface
2. Σ^- capture x rays; precision determination of the Σ^- magnetic moment by measurement of the spin-orbit splitting of capture x rays
3. Studies of excited hyperfragments: Λ-nucleon force
4. C-violating effects--comparison of $K^+ \rightarrow \pi^+\pi^o\gamma$ with $K^- \rightarrow \pi^-\pi^o\gamma$ or $K^+ \rightarrow \mu^+ + \nu + \gamma$ with $K^- \rightarrow \mu^- + \nu + \gamma$

Experiments With K^+

1. Precise studies of the form factors in $K^+ \rightarrow \pi l \nu$ and $K^+ \rightarrow \pi\pi l \nu$ -- tests of weak interaction selection rules
2. Search for forbidden decays--$K^+ \rightarrow \pi^+ + \nu + \bar{\nu}$
3. Search for time reversal invariance violations--$\sigma_\mu \times (p_\mu \times p_\gamma)$ in $K^+ \rightarrow \mu^+ + \nu + \gamma$ and in other 3-body decays such as $K^+ \rightarrow \pi^o + \mu^+ + \nu$
4. Tests of muon-electron universality

   $$\frac{\Gamma(K^+ \rightarrow \pi^o \mu^+ \nu)}{\Gamma(K^+ \rightarrow \pi^o e^+ \nu)} , \quad \frac{\Gamma(K^+ \rightarrow \mu + \nu)}{\Gamma(K^+ \rightarrow e + \nu)} , \text{ etc.}$$

5. Investigation of $\Delta I = 3/2$ transitions--$K^+ \rightarrow \pi^+ + \pi^o$ studied by $\gamma\gamma$ spectrum in $K^+ \rightarrow \pi^+ + \gamma + \gamma$, etc.

Experiments With K^o

One could make a "monoenergetic" K^o beam by K^- charge exchange on hydrogen.

These are only a few examples of experiments that can be greatly improved, or made possible, if an intense source of K mesons is available. I would like to point out that, although it is doubtful whether or not the so-called π factories will be useful for elementary particle physics (present cyclotrons produce more π's than can be used in most experiments), the source of K's I am considering here is less intense than a cyclotron π beam. For this reason, no yet undeveloped experimental technique will be essential to the utilization of the facility.

Description of the Proposed Facility

Because the extraction from the booster occurs in a single revolution of the circulating proton beam, this extracted beam does not have an adequate duty factor for counter experiments. As the beam intensity is very high (3.8×10^{12} protons/pulse, 15 pulses/second), and as the booster magnets are excited in resonance, it does not appear to be reasonable to make a separate slow extraction system for the booster. Rather, the fast extracted booster beam can be switched from the main-ring injector into a 20 kG, 55 foot radius beam stretcher ring and extracted in an almost continuous manner for K-meson production. In this manner the K facility will not interfere with the operation of the 200-BeV machine.

In Fig. 1 a possible location for the K facility is shown. The booster beam, instead of being injected in the 200-BeV ring, is transported down the 200-BeV external proton beam channel to the point shown on the figure. The transport system needed for this purpose is not very expensive.

A detailed view of the proposed K facility is shown in Fig. 2. The 10-BeV beam is injected into a conventional 20 kG dc iron magnet ring 55 feet in radius. (It has been suggested that such a ring might be constructed as a clashing-beam storage-ring prototype. A 27 foot radius, 20-kG ring would do as the booster extraction could be at 5 rather than 10 BeV. The facility, however, would then not be useful as a K^- source.)

The circulating beam is extracted from the ring in a continuous manner and strikes a thick K production target. K mesons are then analyzed in a conventional magnet system with two stages of electrostatic separation. Two stages of separation are needed to purify the beam to the point where the high flux of particles can be used for spark-chamber experiments. A single experimental hall 30 ft × 50 ft is proposed. As the particle flux is high, it should not be necessary to design monster (large solid angle) experiments. Experiments would be constructed on a rigid frame and would be moved into the hall in one piece. I would propose an average occupancy limit of 3 months/experiment. In this manner, the K facility should yield four experiments/year.

To estimate the expected particle flux, I have assumed that the booster will deliver an average of 3.8×10^{12} protons/pulse 15 times each second and that the booster beam will be available for the K facility 3/4 of the time. Thus the average proton beam delivered to the K production target will be 4.3×10^{13}/second if there are no losses. For the production of K mesons, I assume that there will be 2×10^{13} effective interactions/second in the production target. The 500 MeV/c secondary beam will have an acceptance of 2×10^{-3} sr and a $\Delta p/p$ of ± 0.02. As it is 80 feet long, the decay in flight loss at 500 MeV/c will be 0.022. I assume that the K^+ and K^- production cross sections at 10 BeV are the same and are 10^{-8} $K^{\pm}$/interacting proton-MeV/c-sr at a secondary momentum of 500 MeV/c. We can therefore expect a $K^{\pm}$

flux at the final focus in the experimental hall of 175,000/sec. The background of particles other than K's might equal the rate. The effective duty factor would be 0.5.

This flux is a factor of 87 greater than that available at present machines.

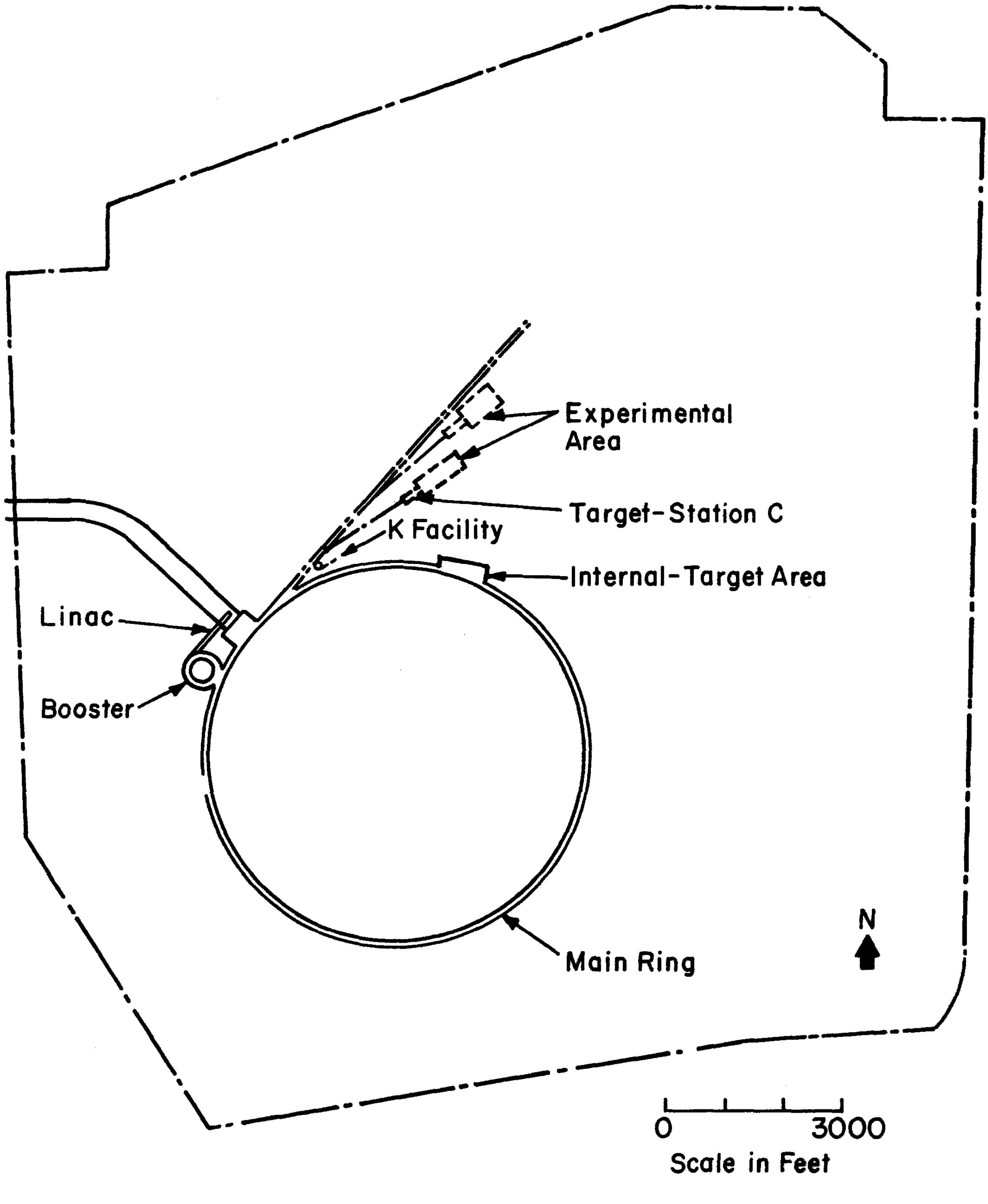

Fig. 1. Layout showing location of proposed K facility relative to accelerator and experimental areas.

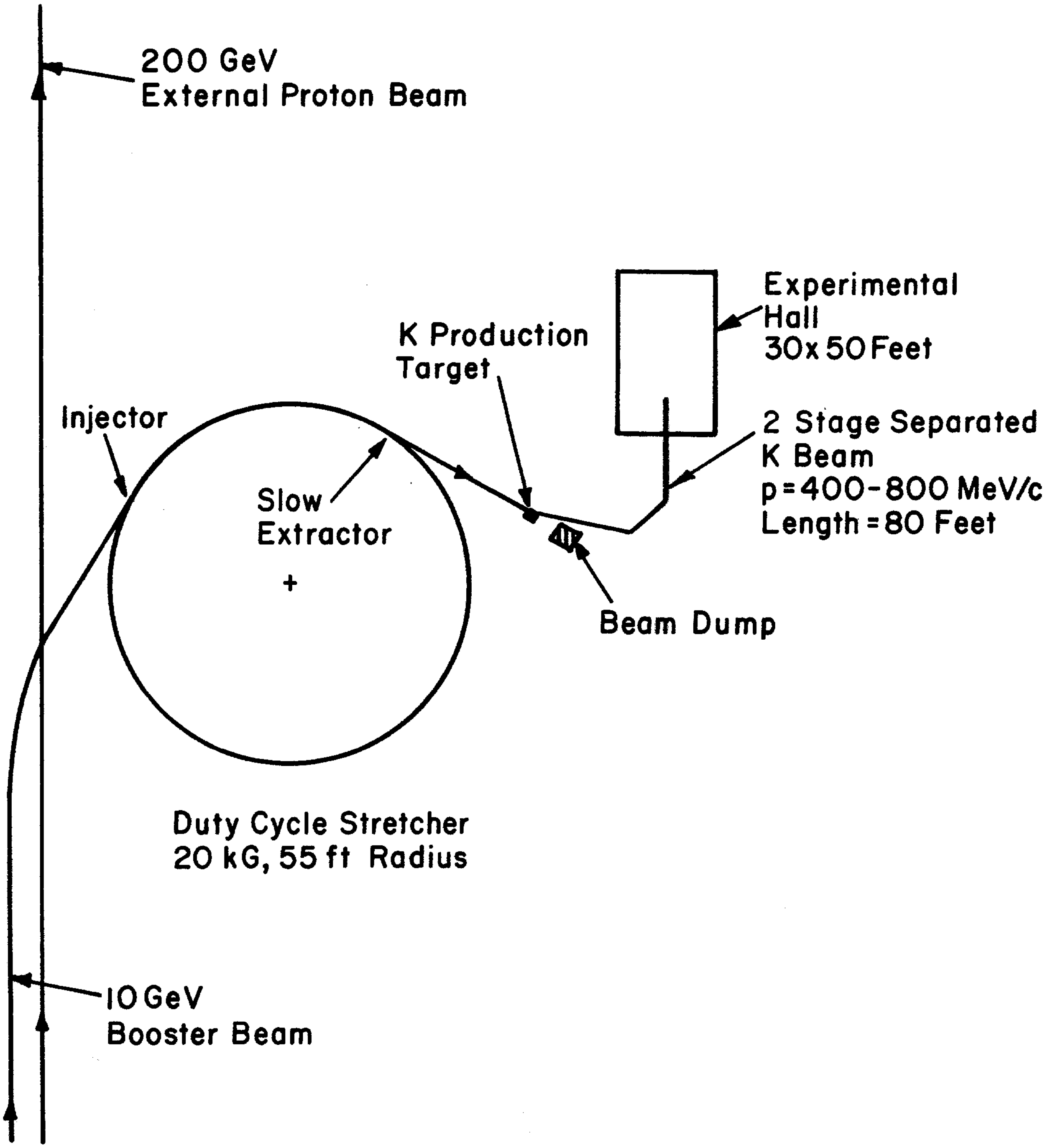

Fig. 2. Detailed sketch of extracted booster beam, 10-GeV storage ring, and K-production and utilization facilities.