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PROPOSAL TO SEARCH FOR FRACTIONAL CHARGE PARTICLES FROM A MAGNETIZED BEAM DUMP

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ABSTRACT

We propose to use a counter telescope of 15 to 25 elements measuring pulse height (dE/dx) to search for fractional charge particles emerging from the E361 Hyperon beam dump and the E613 ν beam dump in the MESON LAB (M2). Angular and momentum selection by the telescope-magnetized dump combination bias the acceptance to favor particles from heavy parent particle decay (ψ, T, etc). The life time of accepted particles would be $\geq 10^{-9}$ sec. and the absorbtion cross section $\leq$ ½ mb.

We ask for 100 hours of M2 beam control time (hyperon channel plugged) and some PREP electronics.

SEARCH FOR FRACTIONAL CHARGE PARTICLES FROM A MAGNETIZED BEAM DUMP

We propose to search for fractional charge particles (eg quarks,lepto-quarks,leptons,...) amoungst the muons emerging from a magnetized beam dump with incident 400 or 450 GeV protons. Such a dump exists in the MESON LAB for E361 using intensities up to about 10^{10}/pulse; a more powerful source will be available with the dump to be constructed for E613. Such particles could be produced by decay of heavy mesons (ψ, T, etc),by the Drell-Yan process for heavy photons,or by some unknown process. They might thus escape the apparent quark confining processes that seem to be present in strong processes. To traverse the dump (about 5m of iron) requires a small absorbtion cross section, $\simeq$ ½mb or less. Such a cross section is at least quasi-plausible for some hadronic quarks, eg one can assume the charmed quark cross section is

$$\sigma^{tot}_{qc} \simeq \tfrac{1}{2}\sigma^{tot}_{\psi p} \simeq \tfrac{1}{2} \text{ mb}$$

as measured in photoproduction; the absorbtion crossection is likely of order ½ or less the total cross section. A real detector can be as close as about 22 feet downstream from the production target. This implies sensitivity for γ = 15 to 30 for lifetimes greater than about 10^{-9} sec.

Our proposed detector consists of 15 or more scintillation counters in a dE/dx telescope pointed at the dump target through 5m of magnetized iron at an angle of 50 mr. The P_t kick of the magnet is about 3.7 GeV/c. The defining counters will be about 5" x 10" in size and be about 12" below the hyperon decay pipe 22 feet from the target. (See fig. 1) Six of the counters will be used to define a trigger with a veto for minimum ionizing particles. All counter pulse heights will be digitized. Adjacent times to the gate will be digitized in several counters. Discriminator and gate times will be digitized. Several counters which mask phototubes and others in strategic places will also be digitized (pulse height). We plan to have the trigger counters sensitive to about 1/20 ionizing minimum, thus clearly including the 1/9 ionizing pulses expected from conventional charge 1/3 quarks.

We believe the detector can work with a flux of 10^4 real muons traversing the telescope per 1 second pulse. This would give about 40 events in 12 hours at the $1/10^6$ muon rate neglecting the difference in the kinematic phase space accepted. ($1/10^6$ muon is about the level of present long beam line-life time fractional charge particle searches.)

Most muons come from low mass pairs produced at low P_t. We plan to put our detector in the region shown in fig. 2, requiring a large angle (50 mr) relative to the beam direction, and requiring small bend angle (high momentum or small

charge). Muons and fractional charge particles from heavy parent decay fairly easily satisfy these requirements while the low mass pairs cannot except by large P_t in the original production.

The apparatus can be installed ,tested, and to some extent run during experiment E361; there is complete spatial compatibility with the E361 apparatus. It is possible to run at some level with the hyperon channel open. We request 100 hours to run with control of the intensity,the hyperon channel plugged, and the beam steered off the hyperon channel a small amount. We believe it is possible to change the plug in a period of minutes. The runs should be for periods of 12 or 24 hours.

The detector and cabling will be furnished by the experimenters; it partly exists and is presently in place. The computer system and software will be furnished by the experimenters and also exists operationally in place. We plan to use a small part of the E613 portacamp (we are part of E613) and some of the existing support equipment (beam line controls, TV's,scopes,etc). The plug for the hyperon magnet exists. No new support is required of the MESON LAB.

FERMILAB is asked to supply PREP electronic equipment at the level of about $40k. These are all common modules requiring no new purchases: 3 NIMBINS, powered,with logic units, discriminators, fanin/fanouts; CAMAC crate,powersupply, controller,3 ADC's, 2 TDC's, scalers, scaler display system; 2 high voltage PS, NIMFANS, etc. A complete list is append-

ed. No other support requirements have been identified.

We feel this effort will explore an important physical possibility, and are optimistic of a positive result. A test run was made in late August-September of 1978 with about 12 counters; we believe we understand the experimental problems and are anxious to proceed.

PREP List for Beam Dump Particle Search

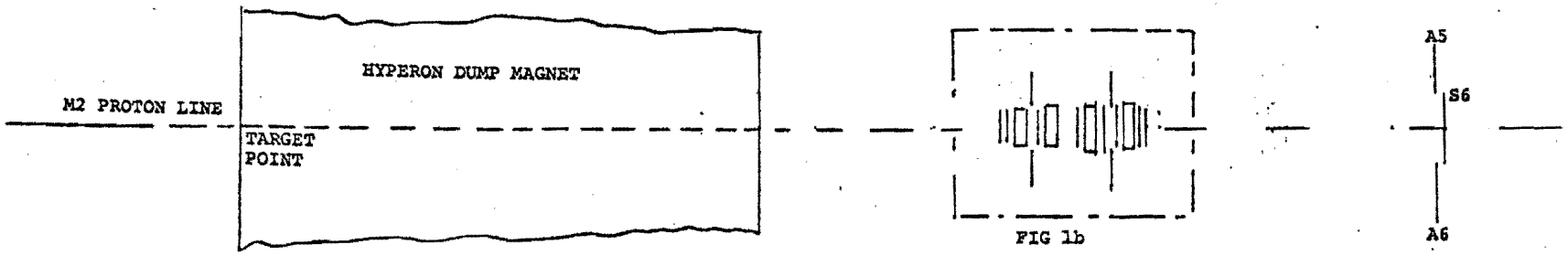
NIM Type Electronics

3	NIM Bins
3	NIM Power Supplies
6	365 Logic Units
2	222 Gate Generators
2	Dual Visual Scalers
1	688 Level Converter
2	934 Ortec Discriminators
3	621 Discriminators
3	620 Discriminators
5	428 Linear Fanin/Fanouts
1	612 Amplifier
1	Predet Scaler

CAMAC Type Electronics

1	CAMAC Crate
1	CAMAC Power Supply
1	Al Controller
6	Quad Scalers
3	2249 ADC's
2	2228 TDC's
2	CAMAC Branch Cables (6', 8')
1	72A Visual Display Unit
1	MRDS
1	TV Monitor

2	415 HV Power Supplies
2	NIMFANs



PLAN VIEW

FIG 1b

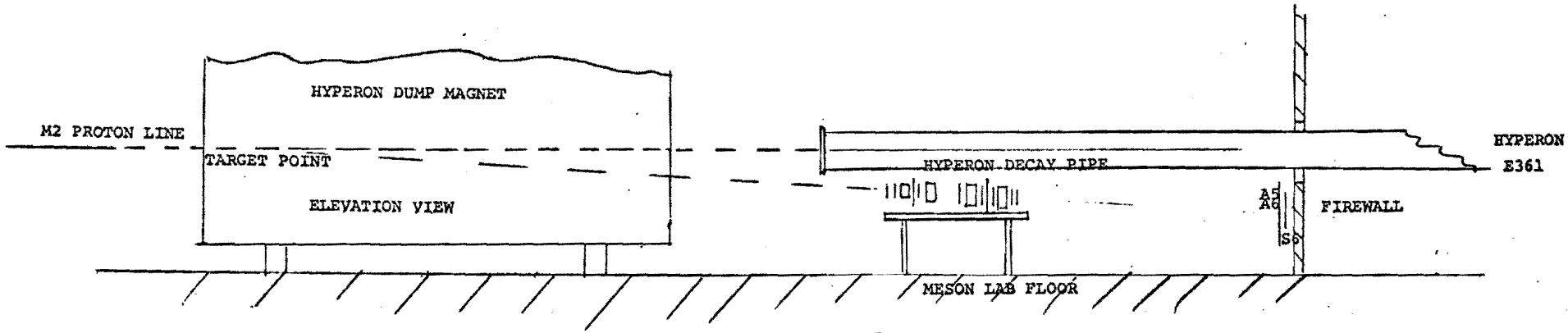


FIG 1a

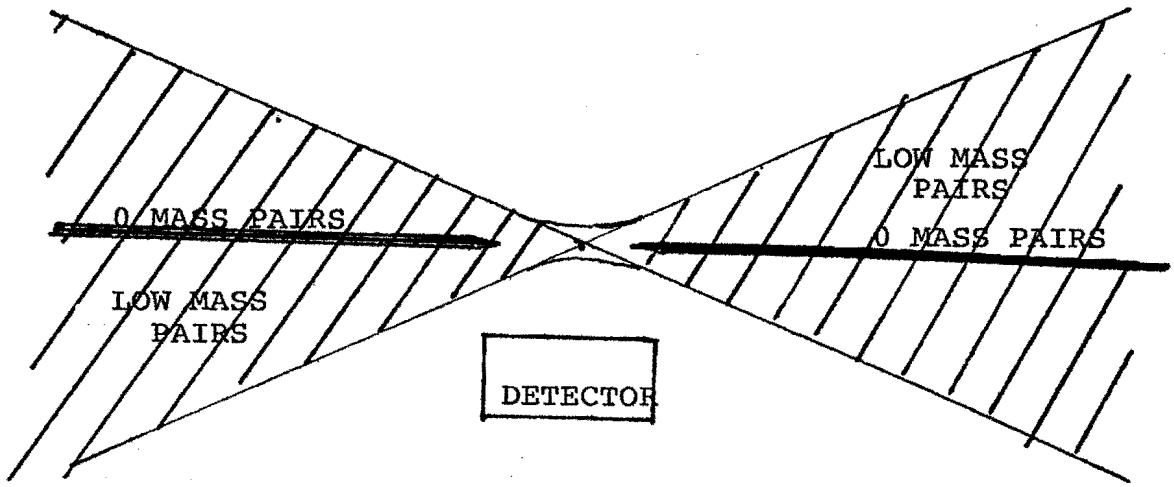


FIG 2 BEAMS EYE VIEW OF ACCEPTANCE

FOR MUONS FROM LOW MASS PAIRS AT SMALL P_t

The vertical dump field deflects particles horizontally $\propto 1/P$. The vertical distance is limited by $P_v \leq M/2$.

FIGURE 2