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1.5 GeV/c FEB extraction and transport

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DISCLAIMER

Date 5/9-10/77 Time 0800 5/9 → 0800 5/10 Experimenters Blumberg, Gabusi, Gill, LoSecco, Soukas, Sulak, Weng, Witkover

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OBSERVATIONS AND CONCLUSION

Objectives: (1) Increase extraction efficiency by reducing losses at E13. (2) Measure emittance with U167 SEM, and (3) transport beam to production target for Expt. 704 background run.

Procedure: (1) Extraction. To avoid a calculated outside aperture at E13, the E10 magnet was positioned as far to the inside as possible with existing injection bumps--3 A in a 3/2 λ bump using injection dipoles D10, E4, E18 and F12. In addition the low field backleg windings at above magnets were pulsed to give additional inward deformation after injection. The E10 magnet was moved in to $\sim$ 1.3" and the high field E10 $\lambda/2$ backleg bump (magnets E2, E3, E16, E17) were off. With the above conditions extraction efficiency (U15 CT)/CBM was $\gtrsim$ 70%, which approaches the theoretical $\sim$ 77% when vertical losses of $\sim$ 20% are included. We used the J19 target to shave the beam vertically--the CBM was read before the J19 target was fully up. With subsequent tuning the maximum CBM of $\sim 4\ 10^{12}$ indicated that E10 was a horizontal aperture. The maximum extracted beam was $\sim 3 \times 10^{12}$ p/p and the spill duration $\sim$ 10-12 μsec. The C15 and E15 current waveform was $\sim$ 40 μsec base-to-base. Tune was measured as 8.69 horizontal, 8.76 vertical.

(2) Emittance at U167 SEM. Again, the calculated values for Q_1, Q_2 and Q_{3-7} gave a sharp ($\sim$ several mm) minimum at U165 flag. However, the signal from the SEM .002" W wire varied by about a factor of 2 from pulse to pulse when the wire was positioned near the beam center, and the resulting profile showed large fluctuations from step-to-step (.5 mm steps). The problem is not understood.

(3) Transport and Background Run. With optics near the calculated lens strengths (J. LoSecco, 3/31/77 memo) based on the theoretical emittances (Weng, Blumberg, 3/29/77 memo), the beam "spot" at the U165 flag appeared too large and the losses on loss monitors #6 and #9 (near U165 instrument box and downstream of Q_8--both upstream of 8^o magnet) were large. We do not have a quantitative estimate of beam through the 8^o but beam was visible on flags at U618 and U667. Beam was seen on the U772 flag and the last current transformer (U799) indicated $\sim$ 5% of the extracted beam. The loss monitors downstream of the 8^o (#13 at Q_9 and #17 at the U618 box) also showed losses. Several instabilities were noted: A pulse-to-pulse intensity variation on the U303 flag and Expt. 704 counter in the U-line tunnel, variation in Q_2 power supply, a drift of $\sim$ 3% in the Gauss clock (100 counts out of 2900) and thus momentum of extracted beam, and a slow variation of $\sim$ 10 sec period. Also, we ran without the ±1A sextupole current suggested by G. Danby for the 8^o magnet.

The 613 detector was turned on and four hours of tape written. The timing of the on-gate was set by a counter in the decay tube which showed a 3½ turn, 70 ns FWHM rf structure. During the first two hours, conditions remained as described above; vis. transmission to the target with $\sim$ uniform 95% loss all along the U line. These were ideal conditions for assessing background in the detector. One thousand triggers were recorded in time with the beam and 900 triggers in an equal period between beam spills ($\sim$ 80% of which are accidentals and 70% are cosmic rays). Thus a beam associated background was observed. However, the on-line analysis showed that although 15% of the events were totally contained--a requirement for neutrino induction--none of them fired more than one cylinder of the detector ($\geq$ 3 cylinders are the signature for a valid ν_e event). This beam associated background is consistent with the signal from very low energy neutrons.

A detailed analysis of the data is underway to verify this result of essentially negligible background for a 2×10^{12} proton loss in the transport line.

Recommendations.

(1) Injection study of E10 position at $\sim 9 \times 10^{12}$ p/p.
(2) Calculations of effect of tune ν_H on E13 loss and spill duration and emittance.
(3) Longer C15 and E15 kicker pulses ($\gtrsim 60\ \mu$sec ?).
(4) Ability to vary Q_{3-7} independently. More quads.
(5) Study of stability of both extraction and transport power supplies.
(6) Gauss clock shift should be fixed.
(7) Fix Q_2 power supply.