BEAM LINE DEVELOPMENT FOR THE MEG EXPERIMENT

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2003, marked a milestone in the development of the beam transport system for the MEG experiment. The goal of which is to produce and stop a high intensity surface muon beam in a 37 mg/cm^2 thick target, placed at the centre of the COBRA superconducting, gradient field magnet, with only a minimum of contaminant particles entering the detector. The promising measurements, undertaken in the so-called 'U'- and 'Z'-branches of the πE5 beam line, during the previous year [1], were concluded with a final run in April/May of this year. This allowed a final design of the transport system to be made, which will be comprised of a 'two-stage' arrangement of separation and momentum degradation, as shown schematically in Figure 1.

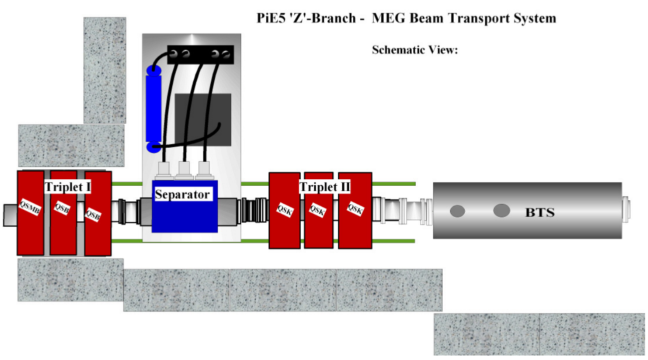

Figure 1: Schematic of the MEG beam line layout up to the injection into the COBRA spectrometer .

The four main components are: (i)The extraction element, Triplet I, a quadrupole triplet which couples to the present 'Z'-branch of the πE5 channel. (ii) The WIEN-filter, an (E$\wedge$B) crossed-field, vertically deflecting separator, necessary for good beam positron suppression. (iii) Triplet II, necessary for good optical focusing at the collimator system placed behind this triplet. (iv) BTS or beam transport solenoid, which is used as a coupling element to the final COBRA spectrometer, as well as housing the momentum degrader/ collimator system.

The test beam setup used this Spring is shown in Figure 2. Of the 1.3$\cdot 10^8 \mu^+ s^{-1}$ that entered the separator at 1.8mA of proton beam current and for a 4 cm long target E, approximately (71$\pm$5)% were transmitted through the separator, while a further 10% were cut by the collimator between triplet II and the solenoid. The beam positron contamination measured upstream of the collimator, with the separator off, amounted to a factor 9.5$\pm$0.5 times more than the surface muon rate. Nevertheless, a good separation quality was achieved, as shown in Figure 3. This was measured using a pill scintillation counter placed behind the collimator. A vertical spot-separation between the muons and positrons of approximately 12 cm was achieved, corresponding to a 7.2σ separation.

Finally, the PSC solenoid was used to simulate the injection optics into the COBRA magnet as well as to test the stopping distribution in a target of the final thickness. Due

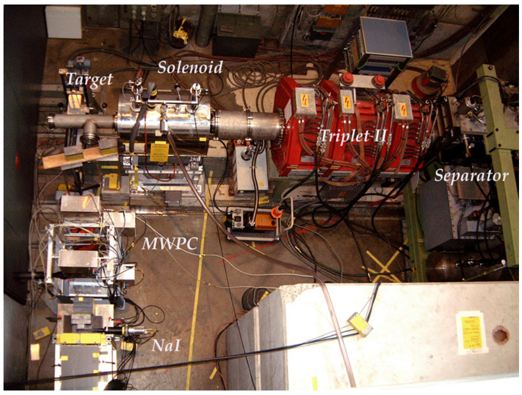

Figure 2: Spring 2003 test beam setup, showing the beam line between the separator and the target vacuum chamber, post PSC solenoid. Also shown are the tracking MWPCs as well as the NaI detector used to detect the decay positrons from the stopped muons in the target.

to the small bore of the PSC, compared to the proposed final beam transport solenoid BTS a transmission factor

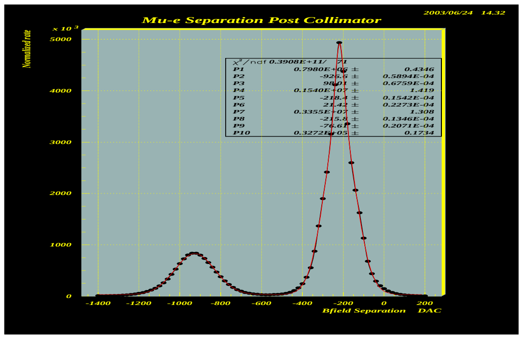

Figure 3: Measured μ-e separation at the collimator, placed between triplet II and the solenoid. The horizontal scale represents the separator magnet current, while the vertical scale is a measure of the rate. The peak on the right is due to beam positrons originating from Target E, while that on the left originates from muons and their associated decay positrons.

of only 71% could be achieved. Despite this, more than 6$\cdot 10^7 \mu^+ s^{-1}$ could be focussed to a spot of between 5-6 mm in sigma, at a beam current of 1.8 mA and a 4 cm long Target E. Of these muons 88% could be stopped in a 37 mg/cm^2 thick polyethylene target. This clearly demonstrated that as a lower limit, a stop rate of close to 1$\cdot 10^8 \mu^+ s^{-1}$ at 1.8 mA, when scaled to a 6 cm long Target E (as in the proposal) could be achieved even with a small bore solenoid.

The design of the BTS solenoid is currently underway, as is the procurement of the other elements.

REFERENCES

[1] PSI-Scientific Report 2002/Volume 1.