SWEEPER MAGNET STATUS

A. F. Zeller, D. Bazin, M. Bird[a], J. C. DeKamp, Y. Eyssa[a], P. G. Hansen, K. W. Kemper[b], L. Morris, S. Prestemon[a], B. M. Sherrill, M. Thoennessen, and S. W. Van Sciver[a]

A superconducting dipole, designed for use as a sweeper magnet, is being constructed jointly at the NSCL and NHMFL. The completed magnet will be installed at the NSCL and used in nuclear physics experiments. The magnet operates at a peak field of 4 T in the 140 mm gap. Since it is necessary that the area that corresponds to the outgoing beam direction be open to allow the exit of the neutrons, the magnet is built as a modified "C"-magnet. The actual coil shape is in the form of a "D", which keeps the magnet compact and removes the need for a negative curvature side. Resistive trim coils on the side of the iron yoke reduce the external fringe field to levels which allow operation of photo-tubes as close as 300 mm from the iron. The main instrument for detection of charged particles will be the S800 Spectrograph, although the instrument will be capable of stand alone operation. The sweeper in position in front of the S800 is shown in Figure 1.

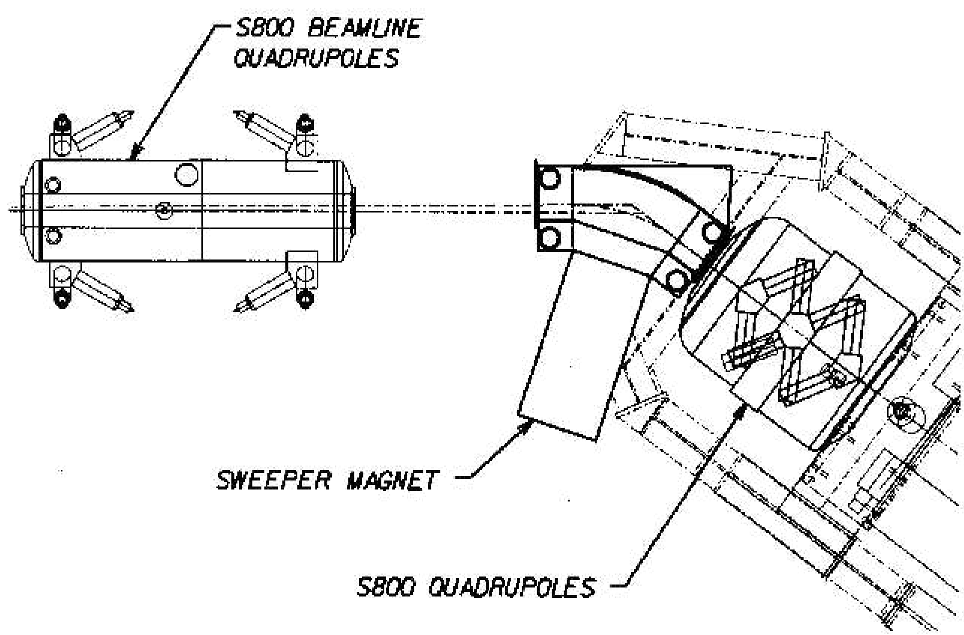

Figure 1. The sweeper magnet in place in front of the S800.

To accommodate a large set of different requirements the magnet has to be compact, have a large gap, and be portable. The large gap is needed to allow the neutrons to reach a large detector (2000 mm by 2000 mm) placed sufficiently far away to provide adequate angular resolution. The geometry of the S800 is fixed, so the magnet has to fit into place and have a high enough field to bend the fragments 40^0 into the first quadrupole of the S800. The pieces of the magnet must be small enough to be moved around with a small crane in a restricted space when the magnet is moved from one location to the other.

The large gap requirement and the beam rigidity dictate the superconducting requirements for the magnet. A bend angle of approximately 40 degrees and the relatively small radius of one meter means the central field is 4 T. Because the saturation magnetization of low carbon iron is approximately

2.2 T, the remaining field must be generated directly by the coil. The iron then serves mainly as a clamp to reduce stray field. The large gap and compact shape means the coils must be relatively small and the current density high. Another problem with high field operation is the high fringe field levels. Since one of the operational modes is having gamma detectors close to the beam direction, the fringe fields must be kept below 10 mT, otherwise the photo-tube pre-amps will not work. Moving the detectors farther away from the magnet increases the cost because more tube would be needed to cover the same solid angle. To help reduce the external field, the mass of iron is larger than would normally be needed and an external, resistive coil is used to buck the fringe field.

The requirement for open space in the beam direction results in having to build a C-magnet. The requirement for compactness and minimum mass would require a sector magnet, with a negative curvature side. To avoid this major complication, the negative curvature side is replaced with a straight section, resulting in a “D” shaped coil (Similar to the A1900 dipoles). The magnet and iron parameters are given in Table 1.

Table 1. Parameters of the sweeper magnet.

Parameter	
Nominal bend angle	40 degrees
Gap	140 mm
Maximum gap field	4 T
Radius	1000 mm
Iron mass	14 850 kg
Total height	2400 mm
Iron length	1570 mm
Stored energy	790 kJ

The rather small space available for the coils means the current density must be about 20 kA/cm^2 at a peak conductor field of 5.5 T. To achieve the maximum packing factor an ordered winding with rectangular conductor is used. Because of a desire to keep the liquid helium consumption low, the desired maximum current is less than 500 A, consistent with safety during a quench. Since the coils are potted, no active quench protection is used so the coils are self-protected. The wire and coil parameters are listed in Table 2. The calculated quench voltages and hot spot temperatures are low and acceptable.

Table 2. Parameters of the sweeper magnet coil.

Parameter	
Bare wire size	1.898 X 0.898 mm^2
Cu:SC	1.8:1
Operating current	387 A
Critical current at 5.5 T and 4.2 K	1100
Number of turns per layer	35
Number of layers	62
Current density	22.7 kA/cm^2

The majority of the magnet system will be constructed by the NHMFL. The magnet will be assembled and tested there, before being shipped to the NSCL for installation. The NSCL is in the midst of a two year shut down for upgrading the facility. At the end of that time, the magnet will be installed and operated attached to the S800 Spectrograph. Provision has been made to install it for independent operation. This is shown in figure 2.

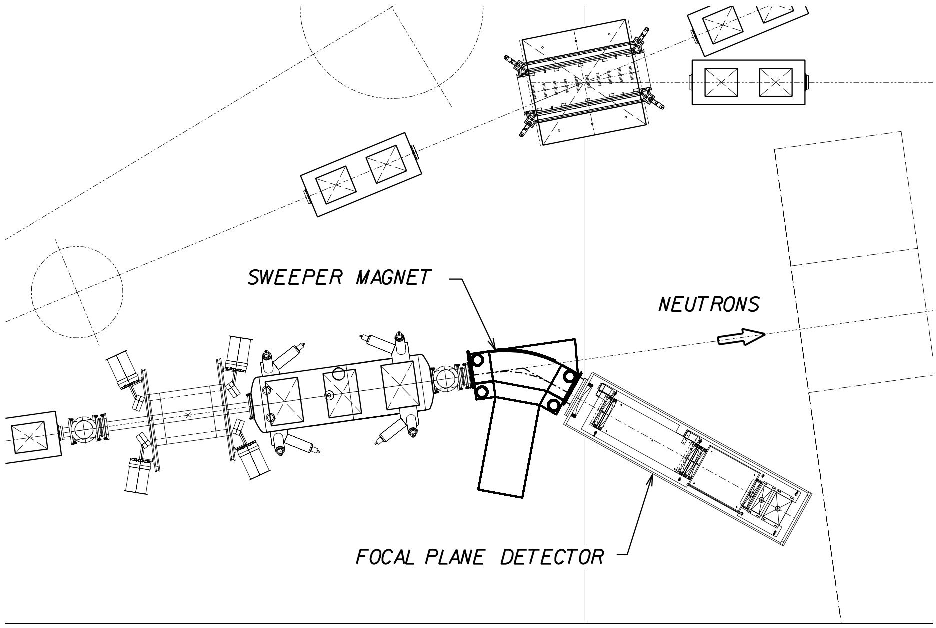

Figure 2. The sweeper in N4.

a. National High Magnetic Field Lab, Florida State University
b. Department of Physics, Florida State University