RFP Assembly of the SNS ion stripping magnet

J Volk

September 6, 2012

Revised November 5, 2012

The Spallation Neutron Source at Oakridge National Laboratory and Fermilab are collaborating on a novel H^- ion stripping scheme. Part of this process will involve a high field hybrid permanent magnet inside a vacuum chamber. This magnet will have two field regions of 1.2 Tesla each with a gap of 29 mm for a length of 30 mm and pole separation of 200 mm. To be considered complete each of the following sections of the RFP must be addressed. The RFP is due in 4 weeks.

1 Magnet material:

To achieve the required field intensity Neodymium Iron Boron magnets of the highest energy density shall be used. The Hci shall be in excess of 30 kOe equivalent to Dexter Magnetics N3820 [1] or Arnold Magnetics N30AHZ [2]. Demagnetization curves for the material shall be provided with the RFP. The total volumes of the various permanent magnets are given in Table 1. The easy axis is the direction of the field. These volumes may be assembled out of smaller pieces, since the magnets will be in vacuum the minimum number of pieces should be used, in addition the use of epoxies for assembly of the magnets is discouraged. Any use of epoxy in assemble shall be stated in the proposal and the type of epoxy specified to determine if the outgassing rate is acceptable. Use of the magnetic field to hold assemblies together is acceptable but must be stated.

All permanent magnet material shall be plated with titanium nitride (Ti-N), alternate coatings can be suggested and will be evaluated. All magnets shall be fully magnetized. All tolerances are according to the magnet manufactures association guidelines given in MMPA 100-00 [1].

All spaces between the magnet materials shall be filled with nonmagnetic material, aluminum or stainless steel are acceptable. The filler blocks shall have the least trapped volume possible. See secton 4 for vacuum requirements.

2 Pole Pieces:

The pole pieces shall be made of high cobalt steel 49% cobalt 49% iron and 2% vanadium (vanadium permendur) or equivalent. The demagnetization curve for the proposed pole material shall be provided with the RFP. Each pole shall be a single piece of material with no stacking or welding permitted. Two of the four poles shall have a 12.7 mm hole drilled on a diagonal through the pole. These will be used on opposite sides of the magnets see the assembly drawing.

These holes shall be aligned through the magnet with a 95% clear aperture. Figure 1 shows the pole piece section. Figure 2 and 5 show various views of the magnet and poles the arrows indicate the direction of the field in each magnet.

3 Flux Returns:

The entire magnet shall be surrounded by 25.4 mm thick steel flux returns with holes for the beam and laser penetrations as indicated on the drawings. The flux returns shall be good quality steel, A36 steel is acceptable. The flux returns shall be plated with a titanium nitride or zinc chromate plating on all sides. Any machine screws used for attaching the sides of the flux returns shall be cap head type screws and counter sunk to be even with the steel. Lubricates or anti seize shall not be used on any screws. In addition to the beam holes and laser hole there shall be a 45 by 10 mm hole in the top and bottom flux return to admit a wire scanner.

4 Vacuum requirements:

Since this magnet will be in vacuum clean assembly procedures shall be employed. All parts of the magnet shall be ultra-sonically cleaned and degreased before assembly. Gloves shall be used in handling all parts so as not to leave finger prints. Trapped gas volumes shall be avoided as much as possible. Vent holes may be used in the non-magnetic spacer material. The use of epoxy for assembly purposes is discouraged. Any use of epoxy for assembly purposes shall be described in the RFP including the type and any outgassing data. A description of the cleaning process shall be provided and evaluated as part of the process. Any prior experience in building magnets used in vacuum systems shall be provided.

5 Testing requirements:

After assembly a hall probe scan at the center line along the longitudinal axis in 5 mm steps shall be performed. The scan shall start 100 mm from the outside of the flux return and go to 100 mm outside of the opposite flux return. A plot of field in Tesla versus position in mm shall be provided. A Group 3 Hall probe or equivalent shall be used. Calibration data of the hall probe shall be provided. In addition a scan of the outside of the magnet shall be performed indicating the 10 Gauss contour line accurate to ± 12.7 mm. This scan shall be done at each end of the magnet near the beam entrance and exit and in the middle region of the magnet.

6 Drawings and assembly:

A 100% set of drawings is available at;

http://home.fnal.gov/~volk/SNS-electron-stripper/drawings/

Once the project has been awarded the drawings will be frozen. An assembly procedure shall be provided after award of the project and approved by Fermilab before beginning of assembly. Fermilab personnel shall be available to discuss the design as required. An OPERA/TOSCA .opc file is available at;

http://home.fnal.gov/~volk/SNS-electron-stripper/TOSCA/

7 Shipping:

After assembly and testing the magnet shall be wrapped in a clean heavy duty plastic bag and dry nitrogen shall be injected into the bag before sealing. The assembled magnet shall then be packed in a shipping container that will prevent rupture of the bag and exposure to the atmosphere during shipping. Shock indicators shall be attached to the shipping container to indicate excessive force of over 2 g.

Questions should be address to James Volk volk@fnal.gov or 630 840 2412.

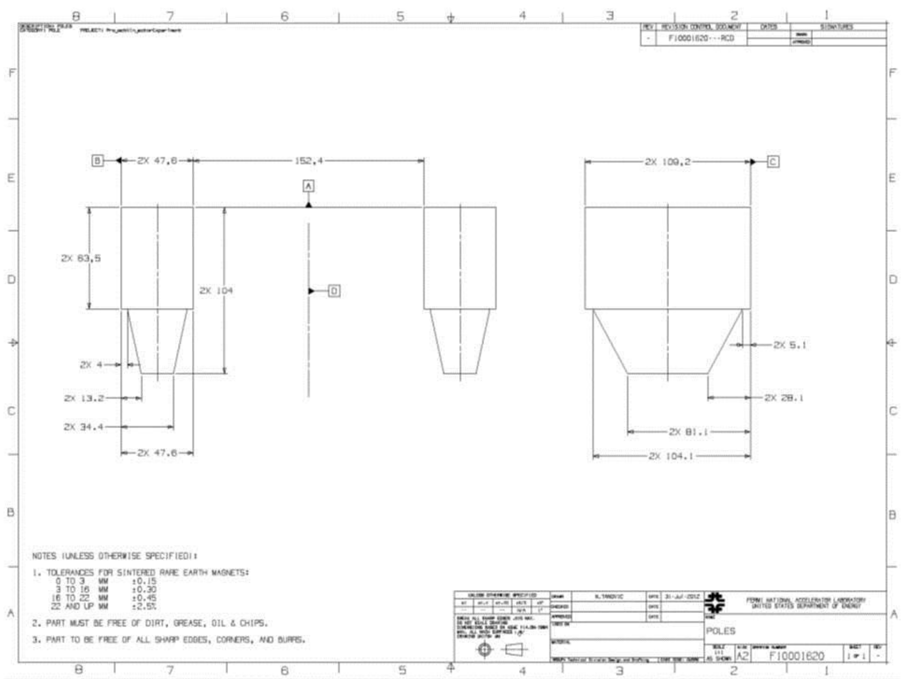

Figure 1 Pole piece detail

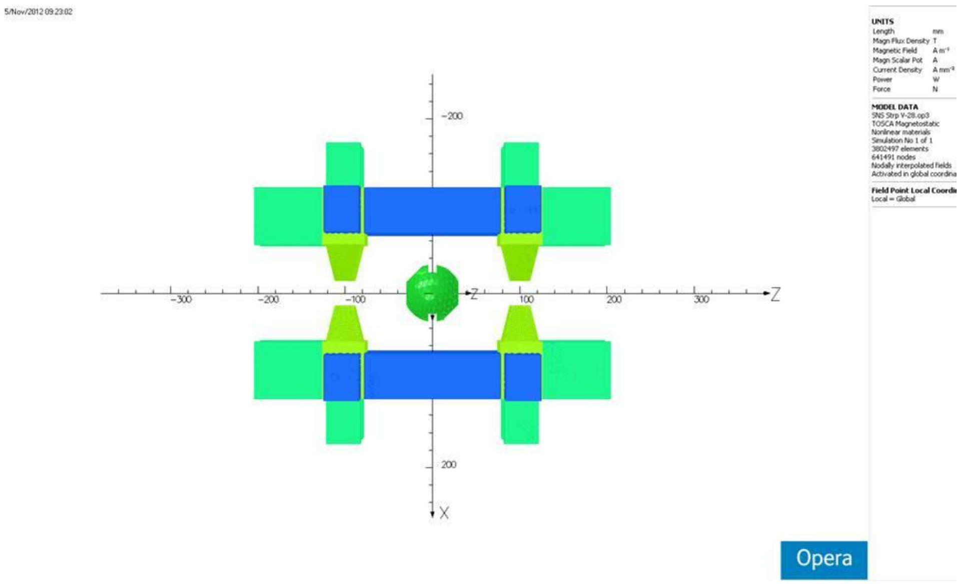

Figure 2 side view of magnet and pole with flux returns removed. The blue and dark green are permanent magnets the light green are the vanadium poles the center sphere is steel.

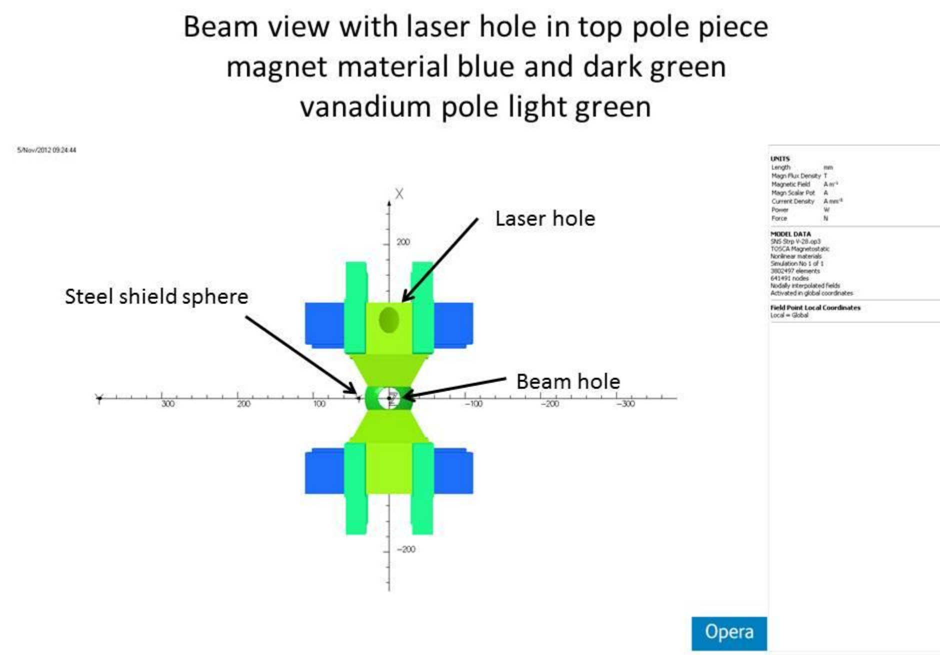

Figure 3 Beam view of magnet showing laser hole in pole and beam hole through steel shield.

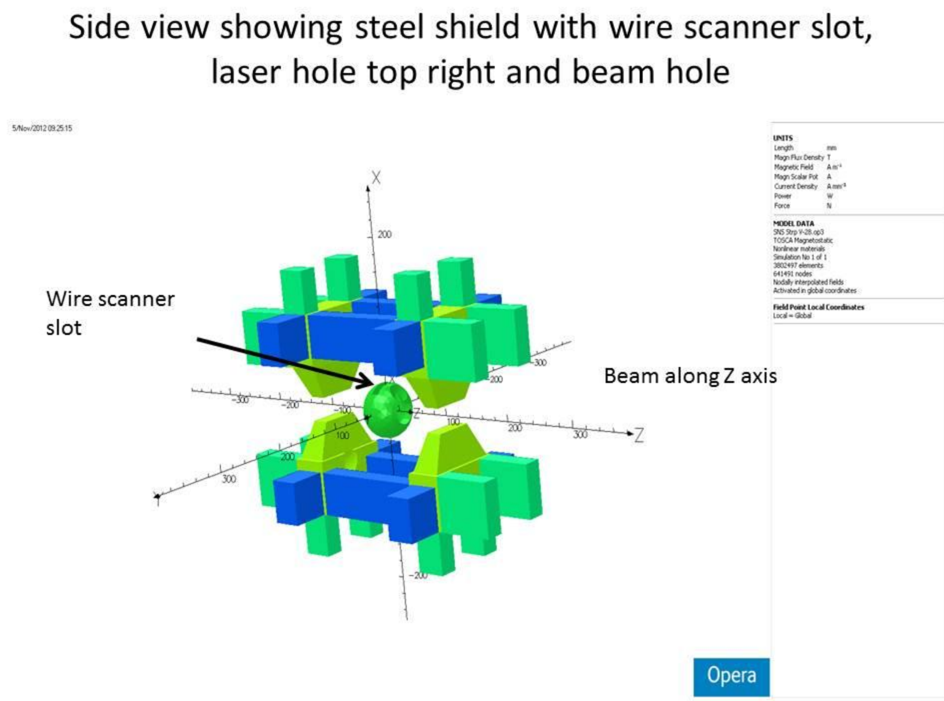

Figure 4 side views showing steel shield with wire scanner slot.

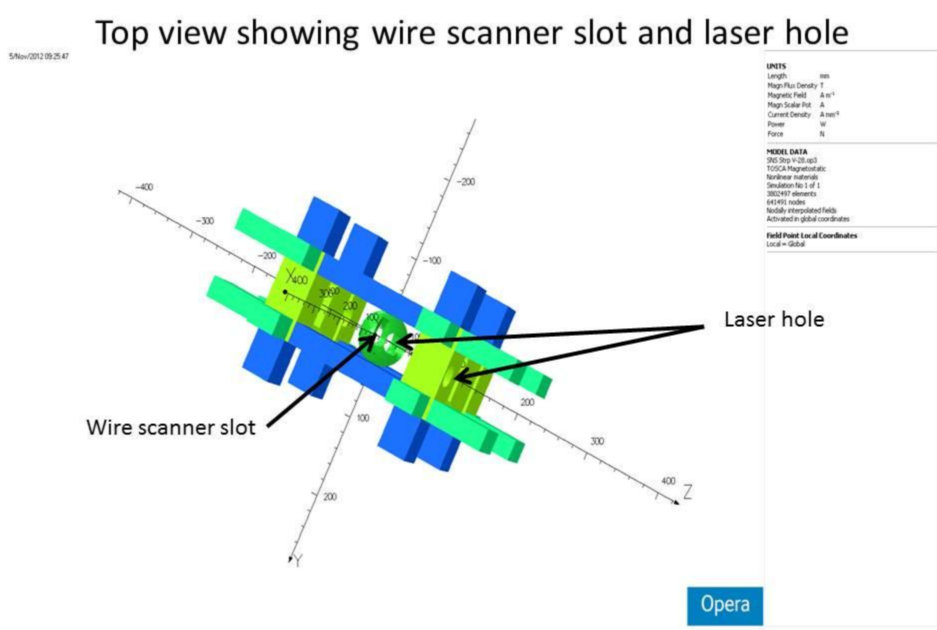

Figure 5 oblique view showing wire scanner slot and laser holes through shield and pole.

Table 1 dimensions of the magnet material the easy axis is the direction of the magnet field.

Name	Quantity	X inches	Y inches	Z inches easy axis	Total volume cubic inches
End magnets	8	2.5	1	3	60
Center magnets	8	2	1	3	48
Top magnets	8	1	1.5	2	24
Side magnets	8	2	1.5	2	24

References

[1] Dexter magnetics http://www.dextermag.com/N3830

[2]Arnold Magnetics http://www.arnoldmagnetics.com/Neodymium_Literature.aspx

[3] Magnet Manufactures web page http://www.intl-magnetics.org/pdfs/0100-00.pdf