Septum Magnet and SBS Power Supply for PREX/CREX

Supplement to the OSP with the same name

The PREX septum, has been used by several Hall A approved experiments. It was commissioned to 800A under TOSP PHY-10-001-TOSP (Physics Division) and PHY-10008.100-T (ESH&Q). The purpose of this document is to describe the hazards and safety procedures for operating this magnet. This is a room temperature coil septum magnet used to deflect charged particles into the Hall A HRS's. The SBS power supply will be used to energize this magnet. The power supply has previously been tested and was successfully used during the APEX experiment in the Spring 2019 run.

The septum magnet will be used in the 3-coil configuration, similar to the g2p configuration. This configuration will be used for both the PREX-II experiment and the CREX experiment. Table I lists the expected parameters for operating the septum for each measurement. Also as for g2p, shims will be used to reduce the vertical bore dimension by 2", and so reduce the coil current and thermal power relative to the required field integral. The available acceptance with these shims has been considered in calculating the experimental figure of merit. The alignment tolerance is ± 2 mm in the horizontal, and $\pm 1/4$" in the vertical. The required excitation will be well less than the maximum that was used during the g2p experiment, so the configuration parameters for this magnet are well known.

The septum alignment is allowed a vertical tolerance of 1/4". A horizontal alignment tolerance of 2mm is required, to avoid interfering with acceptance on the front end and to align the beam pipe with the primary beam on the back end.

Fenced Area Around the PREX Septum

The region around the center of Hall A, where the Septum magnet and the Target are located, will be restricted to personnel by fence enclosure with an approximately 20 foot radius. The fence will create a barrier around the pivot and entrance will be controlled by RADCON. This is a radiation ALARA requirement due to the radiation in this region. The fence also serves as a safety barrier for electrical and magnetic safety, which is the subject of this OSP. (This is the same fence used in the past two years by the Tritium family of experiments and by the APEX experiments.)

Testing the PREX septum After Installation

Once the PREX septum has been installed and connected to the SBS power supply, which should have been locked out during the connection, i.e. an administrative lock was placed on the power supply disconnect switch, it should be tested to ensure that it is working properly.

- At least two qualified persons must be working on the task together.
- Fenced off the area around the magnet. See the section above about the fenced area.
- Install protective covers as needed over the target windows and the spectrometer sieve slit. Check with the HallA work coordinator to ensure proper covers are used.
- Sweep the area inside the fencing for magnetic material. Make sure that the area is clean, and that no foreign objects are in or near the aperture of the magnet or the inside of the stay-clear zone. All such materials must be removed and placed outside of the fence.
- Make sure all protective barricades, signs and beacons are in place to warn of possible exposure to magnetic and electrical hazards.
- Verify all covers on energized conductors on the magnet are securely in place.
- Verify that water flow is present. The flow switches on the supply and return lines must be open and the supply pressure must be verified to be 50psi greater than the return pressure.

Parameter	PREX	CREX
Beam energy (GeV)	1.068	2.2
$\int B \cdot dl$ (T·m)	0.49	1.08
Current (A)	377	820 (nominal), 900 (peak)
Power (kW)	75	315
Water flow (gpm)	15	60
Water temperature (°C)	20	20
Differential pressure (psi)	100	100

TABLE I: Parameters for septum magnet operation. The 5 degree configuration for CREX would bring the current into a regime already proven by the g2p experiment.

- Turn on the flashing beacons.
- Remove the administrative lock on the power supply disconnect switch. Make sure the Jefferson Lab's Lockout/Tagout procedures, as described in Chapter 6110 of the Jefferson Lab ESH&Q manual are followed. Make sure your Lockout/Tagout training is up-to-date, you have been trained on the operation of the power supply and magnet and that you have been authorized by Jack Segal.
- Enable main power on the power supply and ramp output current at the rate of approximately 10A per second to 50A. Check that all controls and safety features are operational then continue to ramp at the rate of 10A per second to the maximum current and verify that the magnet exit water temperature is $< 90°$C.
- Restore the administrative lock on the power supply disconnect switch.
- Enter record of the successful test into a Hall A electronic log book.

Enabling the PREX/CREX Septum for Physics

- At least two persons must be working on the task together.
- Fenced off the area around the magnet. See the section above about the fenced area.
- Sweep the area inside the fence for magnetic material. Make sure that the area is clean, and that no foreign objects are in or near the aperture of the magnet or the inside of the stay-clear zone. All such materials must be removed and placed outside of the fence.
- Make sure all protective barricades, signs and beacons are in place to warn of possible exposure to magnetic and electrical hazards.
- Verify all covers on energized conductors on the magnet are securely in place.
- Verify all power supply doors and cabinets are closed and locked.
- Check that the cooling water is turned on. Valves on the magnet and on individual cooling paths must all be open.
- Verify that water flow is present — checking that the differential pressure is greater than 50 psi and look at flow switches (inlet pressure should be greater than 100psi).
- Turn on the flashing beacons.
- Remove the administrative lock on the power supply disconnect switch. Make sure the Jefferson Lab's Lockout/Tagout procedures, as described in Chapter 6110 of the Jefferson Lab ES&H manual are followed. Make sure your Lockout/Tagout training is up-to-date, you have been trained on the operation of the power supply and magnet and that you have been authorized by Jack Segal.
- Enable main power on the power supply and check the current by ramping the magnet to 50A.

- Set the magnet to 0A and submit a electronic log entry that magnet is ready and that HallA shift workers now can control the magnet.

Energizing the PREX septum

Once the SBS power supply has been enabled, the PREX septum can either be controlled locally or with the SBS GUI. Shift workers will only be allowed to control the magnet via the SBS GUI and only after they have read and signed the COO of the experiment for which they are taking shift. One shall immediately turn off the magnet via the SBS GUI or locally at the SBS supply if someone unauthorized and/or unknown is seen entering the magnet area or any hazard, e.g. leaking low conductivity water, is identified.

Magnetic Field Exposure

All work in the vicinity of the magnet must conform to the practice described in Chapter 6440 of the Jefferson Lab ES&H manual. In particular all workers must respect the limits shown in the table exposure limits for static magnetic fields of that chapter. The limit is 5G for people wearing a medical implant. Other workers may not be exposed to 20,000G or higher at any time. Note, in the septum magnet the maximum field is about 10,000 G over a distance of about 1 meter.

Magnetic Field Measurements

With the HallA work coordinator's written authorization, a map of the magnet's fringe field can be made. During magnetic field measurements, the covers should be on the scattering chamber. Workers must conform to the safety limits on magnetic field exposure, see the previous section entitled Magnetic Field Exposure. The first field measurements should be made around the 1meter perimeter to make sure the fringe is less than 5G at this location. Measurements closer to the magnet and in the gap of the magnet can be made as long as the exposure limits are adhered to.

Turning off the SBS Power Supply

The magnet power supply should always be locked out when the magnet is not going to be used for any extended period. The magnet should be turned off, verified by MCC, during routine access to the hall. Energizing the magnet can be allowed while personnel are in the hall with authorization of the Work Coordinator Jessie Butler.

Training Requirements

Shift workers must have standard Hall A/ JLab user required safety training and have read and signed the COO for the experiment for which they are taking shifts. In order to energize the power supply once its in a safe operational state, shift workers must have first read and understood this document.

People authorized to energize the power supply for testing and diagnostic purposes must

- Read and understand this document.
- Read and understand Chapter 6440 of the Jefferson Lab ESH&Q Manual on Static Magnet Fields.
- Complete JLab Lock and Tag Training (SAF104)
- Complete NFPA-70E Electrical Safety Training (SAF603)
- Complete training on power supply operation by authorized Hall A technical staff.

People authorized to energize the power supply once its in a safe operational state must have first read and understood this document.