Goudsmit Electromagnet.

Note: This magnet weighs 0.8 tonnes!

Transverse or solenoidal magnetic field.

This magnet can generate a magnetic field of 2.0 T with pole gaps of less than 50 mm. The magnetic field strength versus power supplied graph for a pole gap of 90 mm (the maximum possible) is shown overleaf, for both the transverse and solenoidal modes of operation.

The time required for installation is about 2 hours.

Note:

TRANSVERSE MODE

Neutron beam in horizontal plane, perpendicular to horizontal magnetic field.

SOLENOIDAL (OR LONGITUDINAL) MODE

Neutron beam in horizontal plane and along the direction of the magnetic field.

1. Safety

The power supply for this magnet is situated on the balcony above the CRISP Cabin. It is a modified 50kW inverter capable of providing 615 Amps at up to 100 Volts! Though this voltage would not kill a healthy person the stored energy is extremely dangerous! A short circuit would cause violent sparks and severe burns.

A separate safety assessment for installation and operation of the magnet is available (24/11/96, revised 11/12/01), details of which are summarised here. Electrical connections to the magnet are interlocked and covered so that, except inside the magnet coils, there are no exposed live terminals. Under no circumstances should users interfere with the electrical connections; these will be made by an instrument scientist or some other approved person.

A magnetic field of 30mT (= 300 Gauss) is a limit requiring controlled access - being a level at which magnetic materials may move under the influence of a field. RAL HSN9 [2] following [1] states: Where exposure to high magnetic fields in working situations cannot be avoided then the following limits should be observed: Partial body exposure (arms, hands, feet) should be restricted to fields of 2 Tesla for short periods (minutes) and 0.2T for longer periods (hours). Further to this a maximum field of 0.5mT (= 50 Gauss) is a recommended for wearers of heart pacemakers [1].

Access to the magnet for short periods is allowed whilst the magnet is live, since exposure to magnetic fields would be within the limits above, but this should not be necessary in most circumstances. Access may be required, for example, for measurements of the field strength; or to adjust a cryostat if turning off the field would irreversibly destroy the sample alignment or if hysteresis effects are important. If you do need to approach the magnet whilst it is running then remove all loose metal objects from your person - such as keys, watches, steel rulers etc., and *never* attempt to use tools such as spanners or screwdrivers either near to or within the poles of the magnet.

The “MAGNET ON” light remains on, even if the magnet has tripped off. Users must ascertain separately (by visiting the power supply on the balcony if need be) whether the magnet is live before approaching it. If in doubt assume that the magnet is in fact live! The local control (black) box inside the sample enclosure has a red “EMERGENCY OFF” button. This box also has an orange LED which indicates if the interlock circuits are on. If this LED is not lit then the magnet has tripped off. There is also a blue interlock box on the wall of the CRISP Cabin computer room (immediately on the right as you open the door). The key in this box unlocks the case surrounding the electrical connections in the sample enclosure. Removing this key isolates the magnet from the power supply and so can also be used in an emergency.

Close up to the live magnet the stray fields may exceed the 0.5 mT (50 Gauss) limit recommended as safe for pacemakers and so anyone wearing such a device is advised to not to enter the sample enclosure. Stray fields on the footbridge above CRISP sample position are well within this limit.

At present, with a demineralised water flowrate of 20+ Lmin-1, the maximum operating power is around 80%. Above this setting the magnet will ultimately trip off but the magnet

can be safely run to full power for short periods.

[1] Documents of the NRPB 4 (no 5) 1993 (“Board statement on restriction on human exposure to static and time varying electromagnetic fields and radiation”) ISBN 0-85951-366-1

[2] RAL HSN-9 Biological effects of magnetic fields. (see www link from RAL "Safety Handbook" pages.)

2. Installation

Only those persons with valid RAL Lifting Permits are allowed to operate the crane.

Ensure that the separate earth cable is bolted to the casing of the magnet.

Ensure that the trip leads are properly and fully connected to the local control box in the sample enclosure.

Ensure that the demineralised cooling water is connected and turned on. The taps are situated immediately above the connections for the supply. Please watch for water leaks; a flood could be catastrophic and would not make you popular as the demineralised water supply is also used by the ISIS accelerator magnets!

3. Local Control Box

This black box in the sample enclosure (which must be within easy reach) features:

a mains power lead coming in from the power supply on the balcony.

connections for water flow and magnet temperature trips (these are simple switches and so the three connectors are interchangeable).

a mains lead going out to the "MAGNET ON" light.

an orange LED next to a white "RESET" button. The magnet can only be successfully powered up if this LED is lit.

a large red "EMERGENCY OFF" button.

4. Switching the Magnet ON

The telephone on the balcony next to the power supply is extension 5199.

Warning: do not interfere with any of the other power supplies on the balcony and if in doubt about any aspect of the operation of the power supply please consult an instrument scientist or the ISIS MCR crew.

Locate Power Supply R67 T5/11. Turn on the *Main Isolator* by swinging the long-handled rotary switch on the front of the power supply (this is stiff to operate).

The Control Panel display will say "INITIALISE" for some time before the %Power Indicator appears as "SET 000000 ADC 00000"

Press the "REM" button so that the yellow “LOCAL / REMOTE” LED above it goes out. Select CRISP with the “POLARITY” button (check the lights under the *T-switch* on the shelf in the walkway between the LOQ and CRISP cabins). If the lights under the T-switch fail to change contact an instrument scientist. Manual application of a 24 Volt signal is required to cause the polarity switch to move.

Check to see if any of the four red LED's under “INTERLOCK STATUS”, indicating trips, are lit. If “MAG”, for magnet trip, is lit, pushing the appropriate button will cause the identities of the active trips to be displayed on the display.

Have someone press the white button on the *Local Control Box* by the magnet, so that the orange LED on the Local Control Box lights up. This will clear any trips. Then press the “OFF / RESET” button on the Control Panel. The amber LED by this button should not be lit now.

Press the "MAIN POWER" button firmly. There will be a noise as contactors operate. (It is likely that the contact may bounce and so several attempts may have to be made for the power remains on)

Check again that no trip lights have appeared as it is not unknown for the contactors to “bounce” off setting an “MPS” trip light! If this happens, press the “OFF / RESET” button to clear the trip and try again.

Press the "COARSE" button next to the *Current Adjustment Knob* and then rotate the knob clockwise to increase the current to the magnet.

The left display on the Control Panel shows the requested power setting as 10000 times the % of the maximum (615 Amps), whilst the right display shows the actual power setting (ie; for 10% power, about 60 A, set the readout to 100000 and for 80% power, about 490 A, set the readout to 800000). A green "READY" LED shows when the requested setting has been achieved. Analogue meters on the front of the power supply indicate the actual current and voltage.

5. Clearing a Magnet Trip

If the magnet trips off during operation, press “OFF / RESET” button on the balcony Control Panel to clear the trips and then the “MAIN POWER” button. Ramp the power back up.

6. Switching the Magnet OFF

The magnet should switched off as follows in order to avoid damaging induction effects.

Rotate the *Current Adjustment Knob* anticlockwise until the requested power setting reduces to zero.

Press the “OFF / RESET” button to release the main power contactors.

Turn off the *Main Isolator* rotary switch on the front of the power supply.

7. Computer Control of the Magnet

Please contact an instrument scientist for tuition before attempting computer control of the magnet.

(a) Ensure that the Amplicon 485Fi Interface is connected to serial port on the back of the Ray of Light PC via its optical isolation connection and that both the power supplies for the connectors are switched on.

(b) Ensure that the 4-way RS422 signal cable is connected to the Amplicon interface.

(c) Ensure that the *T-switch* on the shelf in the walkway between the LOQ and CRISP cabins is switched to CRISP.

(d) Follow the instructions in Part 4 above for turning the magnet on but do not set a power level with the *Current Adjustment Knob*.

(e) Press the “REM” button so that the yellow “LOCAL / REMOTE” LED is illuminated.

8. The Ray of Light Interface

Click on the Goudsmit tap within Ray of Light to display the Labview control for the Danyfisk controller on the Magnet power supply.

When started the control initiates communication and establishes the current state of the magnet and its interlocks. Any interlock faults show as illuminated lights on the control panel.

The magnet current may be adjusted changing the value in of the "magnet set point". Once requested the "magnet current" value will change.

The magnet may also be turned off from the control this results in a gradual power down of the supply as described in section six above.

NOTE: The magnet power supply cannot be turned **ON** from the Ray of Light control.

Control from the VMS command is achieved using commands similar to those used to control the instrument. To change the magnet current enter the command

se goudsmitamps xxxx

where xxxx is the required value.

se goudsmitamps

without a value returns the value of the current value of the current.

se goudsmitoff

turns the magnet off.

These commands may be incorporated within a command file in the same way as instrument control commands prefixed with sl (e.g. sl theta 0.5)

9. Data Logging.

There is currently no data logging of the current in the magnet. However, the field may be logged using the Hirst Gaussmeter.