

Operation Manual for HC2 Three-Axis Helmholtz Coil



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1. About this Manual

This manual provides the information necessary to help customers install and operate the HC2 Three-axis Helmholtz Coil from Bartington Instruments. It is one component of Bartington Instruments' Helmholtz Coil System. This manual should therefore be read in conjunction with:

- PA1 Control Power Amplifier Manual OM3225
- CU1 Control Unit OM3224
- CU2 Closed-Loop Module (if applicable) OM3999
- Helmholtz Coil Control Software OM3596.

All manuals are available from the Helmholtz Coil System [Operation Manual page](#). The relevant products outline drawings can be found on the Helmholtz Coil System [outline drawing page](#).

This manual should also be read in conjunction with the product brochure [DS2613](#) which can also be found on the product page.

Photographs of key components are included, labelled with numbers. A number in the text in square brackets [] refers to that label.

Bartington Instruments cannot advise on the integration of this equipment with any third party products.

1.1. Symbols Glossary

The following symbols used within this manual call your attention to specific types of information:



WARNING: Indicates a situation in which serious bodily injury or death could result if the warning is ignored.



Caution: Indicates a situation in which bodily injury or damage to your instrument, or both, could result if the caution is ignored.



Identifies items that must be disposed of safely to prevent unnecessary damage to the environment.

Note: Provides useful supporting information on how to make better use of your purchase.

2. Safe Use



WARNING: This product is not qualified for use in explosive atmospheres or life support systems. Consult Bartington Instruments for advice.



WARNING: The electromagnetic field from this product may interfere with the operation of pacemakers and other medical devices. Consult your device's manufacturer before operation.



WARNING: Personal injury may result from lifting the HC2 Helmholtz Coil Assembly. Use more than one person to move this device.

3. Introduction

The HC2 Helmholtz Coil is an assembly of three pairs of ~1m Helmholtz coils. The coils produce a magnetic field when a current is circulated through it. The amplitude of the field generated is proportional to the current applied. Both DC and AC magnetic field can be generated. The coils are typically used for the calibration of magnetic field sensors, or to generate a stable, controlled field.

A complete system will include:

- HC2: an assembly of three Helmholtz coils.
- PA1 Power Amplifier: See OM3225.
- CU1 Control Unit: the control unit for the system which enables it to interface with a PC-based test, measurement and control system. See OM3224.
- Optional CU2 Closed-Loop Module: allows active cancellation of external DC and AC magnetic field disturbances using the CU2 Reference Magnetometer. See OM3999.

The addition of the acquisition card allows the system to be controlled via a Labview™-based software. A system diagram is shown in [“Appendix A: Connecting the Components of the Helmholtz Coil System”](#).

Recommended Accessories:

- Magnetometer and associated mounting jig, which can be supplied in order to check the system at regular intervals.
- Breakout box, enabling access to the signal applied to the coils (Please see [“Appendix C - Helmholtz Coil Breakout Box”](#) for further information). Please contact sales@bartington.com for further information.

As an alternative to the PA1, users with their own power supply can use these with the HC2. Please refer to the product brochure for the maximum current which can be applied to HC2.

4. HC2 Helmholtz Coil Features

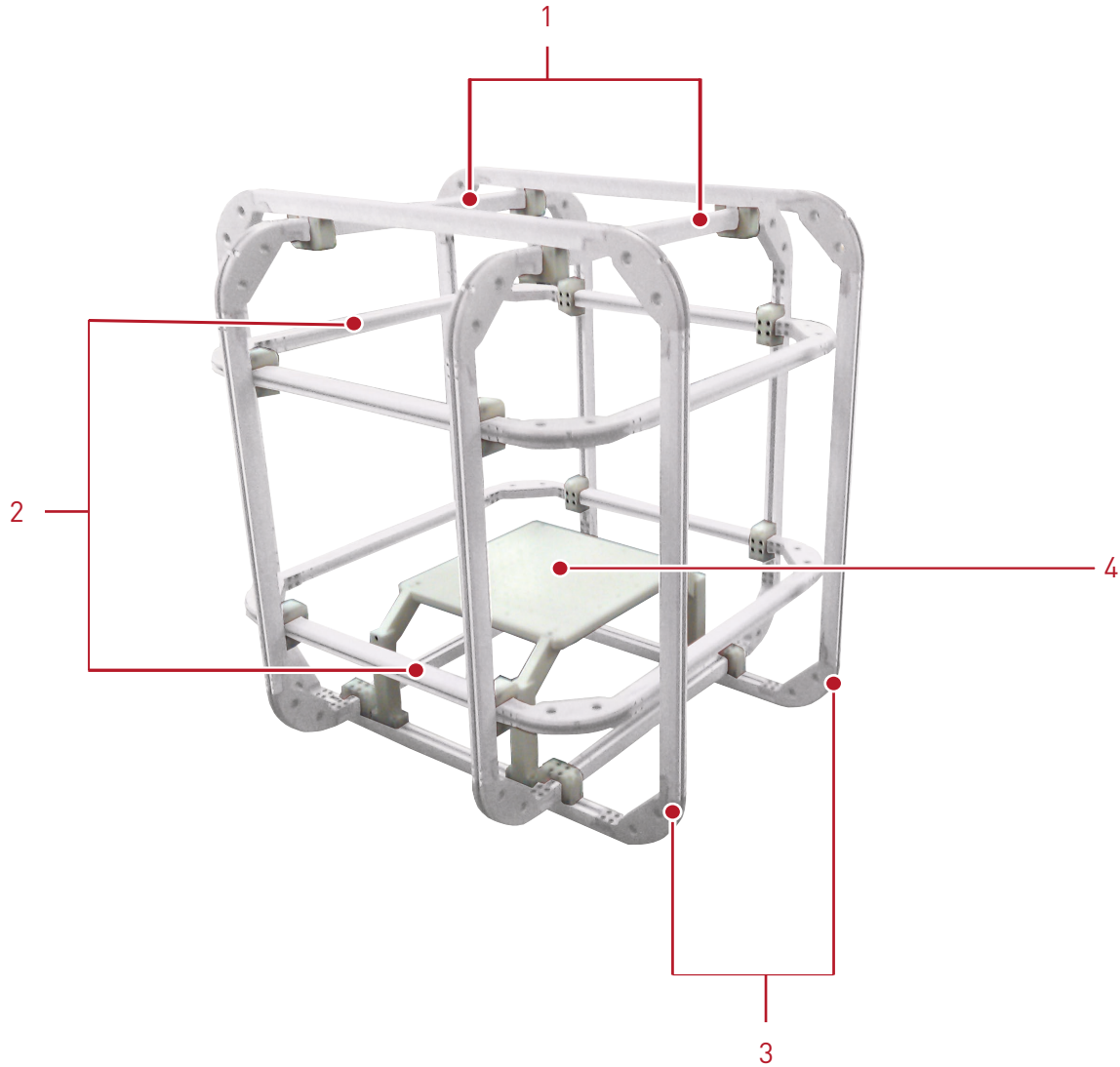


Figure 1. HC2 Helmholtz Coil

- 1. X coil pair
- 2. Y coil pair
- 3. Z coil pair
- 4. Mounting table with mounting holes

5. *Compatibility*

The HC2 is compatible for use with Bartington Instruments PA1-3 Power Amplifier. For a complete system the CU1 Control Unit is also required, and optionally the CU2 Closed-Loop Module.

Mounting accessories for Mag-03MS, Mag-13MS, Mag690, Mag648/649 and Mag678/679 are available as an additional option.

6. *HC2 Helmholtz Coil Operation*

6.1. *Installation*

The HC2 Helmholtz Coil should be installed in a magnetically clean area, that is, an area with small magnetic gradient, and with little magnetic disturbances. See [“Appendix B: Assembling the HC2 Helmholtz Coil”](#) for assembly instructions.

The HC2 should be installed on a non-metallic base and kept away from:

- Large conductive objects which may induce currents, and therefore secondary magnetic fields, when generating AC magnetic fields.
- Sources of magnetic field, either DC (e.g. large objects made of magnetic materials) or AC (e.g. mains powered equipment) as these will distort the magnetic field around them, and may affect the shape and extent of the homogeneous area.

The PA1 includes 3 DC offset controls which are used to compensate for the local DC magnetic field. These will not be able to compensate for large objects which may create a strong localised gradient.

Note: The HC2 should be kept a minimum of 3 metres from any potential magnetic interference.

Ideally a magnetic field survey should be carried out to assess the suitability of the site. This can be carried out using a Mag-03 Three-axis fluxgate magnetometer connected to a Spectramag-6 Data Acquisition Unit. Please contact support@bartington.com for further assistance.

Note: The largest coil of the Helmholtz Coil should be positioned so that the field it generates is in the direction of the lowest ambient field strength. This will reduce the level of DC offset applied, and optimise the maximum field which can be generated in that direction.

Note: Do not place the HC2 on the floor, as there may be unknown elements in or below it that will affect its operation

6.2. *Connecting the HC2*

The HC2 is a passive coil with no controls of its own. When connected to the PA1 (or any other power supply) and current is circulated through the coils, a magnetic field is induced.

A cable is supplied to connect the HC2 to the PA1. The cable is at one end terminated by a multiway connector for connection to the PA1 end. The HC2 side is terminated by 6 connectors, two for the X coils, 2 for the Y coils and 2 for the Z coils. There is no particular polarity to follow with regards to the connection of each X, Y and Z coils.

Note: A diagram showing the interconnection of components of the Helmholtz Coil System is given in [“Appendix A: Connecting the Components of the Helmholtz Coil System”](#).

6.3. *System Checks*

Once the HC2 is connected, no mechanical adjustments are needed. Helmholtz Coil System setup, including DC offset adjustments, are done via the PA1 Power Amplifier, using a reference magnetometer (suited to the range in which the user is working and calibrated by or traceable to a recognised international standards institution) mounted in the homogeneous area of the coil. If using the CU1 and a Bartington Instruments magnetometer, the reference sensor can be directly connected to the CU1.

In addition, because the coils are flat-packed, it is advisable to check and adjust scaling and orthogonality when using the HC2 together with PA1. Electronic adjustment is carried out on the PA1 (see OM3225 for further details). The Mag-13MS together with a suitable open-end mounting jig is recommended to perform these checks.

For further details, please refer to PA1 Power Amplifier OM3225.

7. *Absolute Maximum Power*

When using the PA1, or an alternate power supply, the maximum current that may be applied to the HC2 Helmholtz Coil (shown in the product brochure), should not be exceeded.

8. *Mounting Accessories*

A range of mounting accessories are available to mount some of Bartington Instruments sensors in the middle of the homogeneous area. The Mag-13MS and associated mounting plate is recommended to be used as a reference sensor for periodic checks of the HC2.

Mounting points on the test table are shown in [Figure 1](#) and DR3342.

9. Troubleshooting, Care and Maintenance

In the event of any apparent malfunction, please email: service@bartington.com or telephone the Bartington Instruments service team on: +44 (0)1993 706565.

10. Storage and Transport



WARNING: Lift the complete assembly only by the large Z coils. A minimum of two people are needed to move the complete assembly.

The HC2 is a precision electronic instrument and should be treated as such.

Bartington Instruments has supplied this product in appropriate packaging for transportation. It is recommended that this packaging is used for any future transport.

Refer to the product brochure for this product's maximum environmental, electrical and mechanical ratings.



Caution: Exceeding the maximum environmental ratings may cause irreparable damage to the equipment.

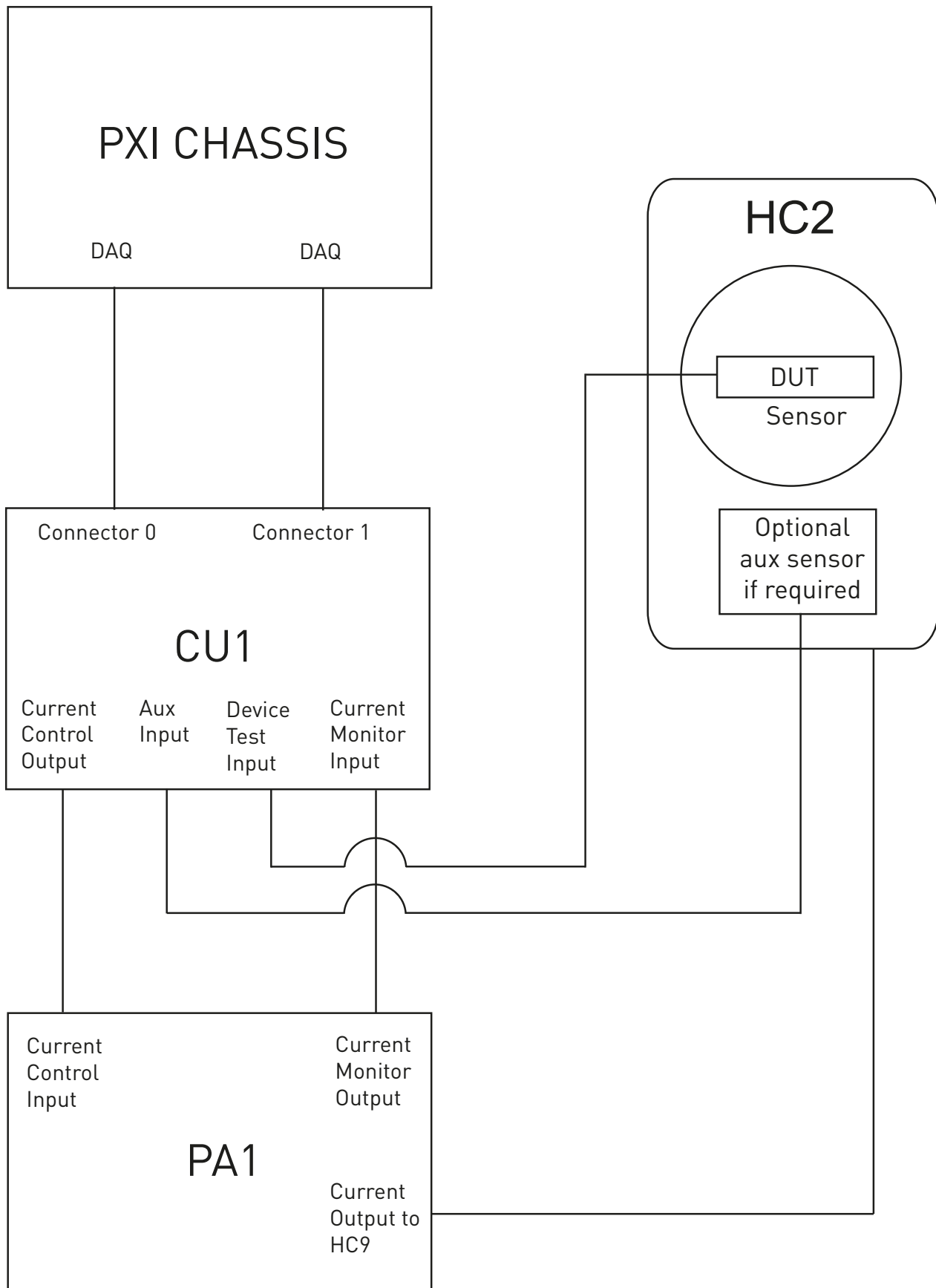
11. Disposal

This product should not be disposed of in domestic or municipal waste. For information about disposing of this product safely, check local regulations for disposal of electrical / electronic products.

11.1. Waste Electrical and Electronic Equipment (WEEE) Regulations



This product complies fully with Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) and WEEE Regulations current at the time of printing.

Appendix A: Connecting the Components of the Helmholtz Coil System

Appendix B: Assembling the HC2 Helmholtz Coil



WARNING: The HC2 three-axis Helmholtz coil is heavy and can be difficult to handle. It should be put together by no less than two people.



Caution: Do not exceed 1.8 Nm torque on the M8 x 40 non-magnetic nylon socket head bolts, so as not to overtighten or break the heads.

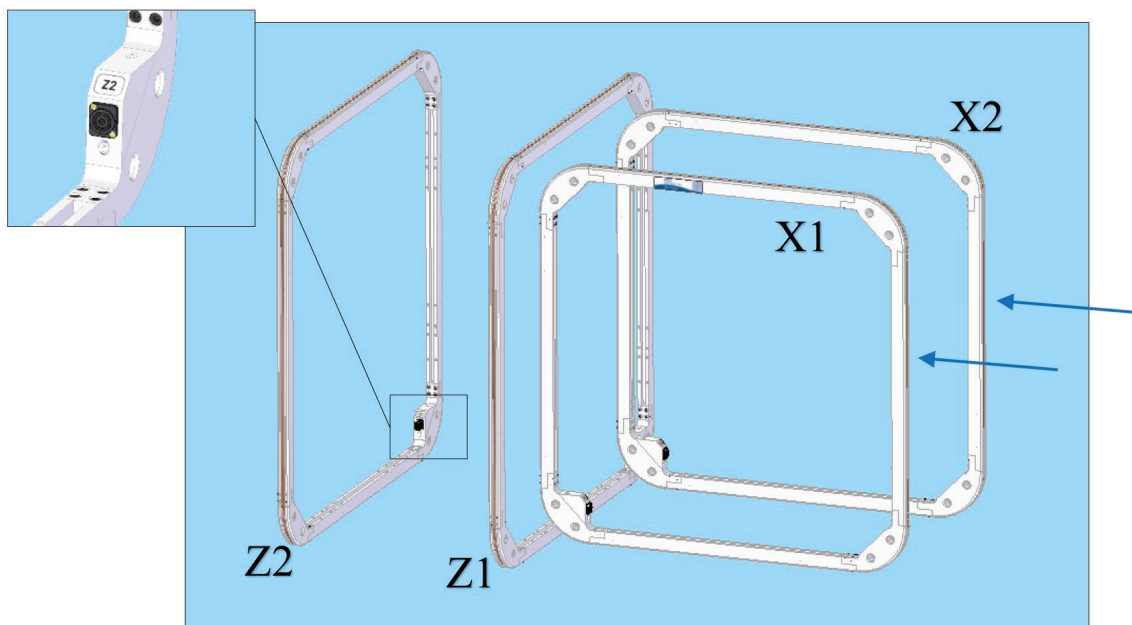
Note: For speed and ease of assembly an electric screwdriver with appropriate torque settings is recommended. An M8 electric screwdriver head is provided.

Note: More recent coils are marked X Y or Z with the direction of the winding marked on the label (rather than X1 and X2)

Note: The HC2 coils should be assembled from largest to smallest.

1: Attach large coils (Z) to medium coils (X)

Place the two large coils (Z) parallel to each other about 620mm apart, with the labels at the bottom, facing up. Ensure that the arrows on the coil label denoting the winding direction face the same direction. Hold the coils in that position and insert the two medium coils (X), also with the labels at the bottom and facing up, in the order shown in the image.

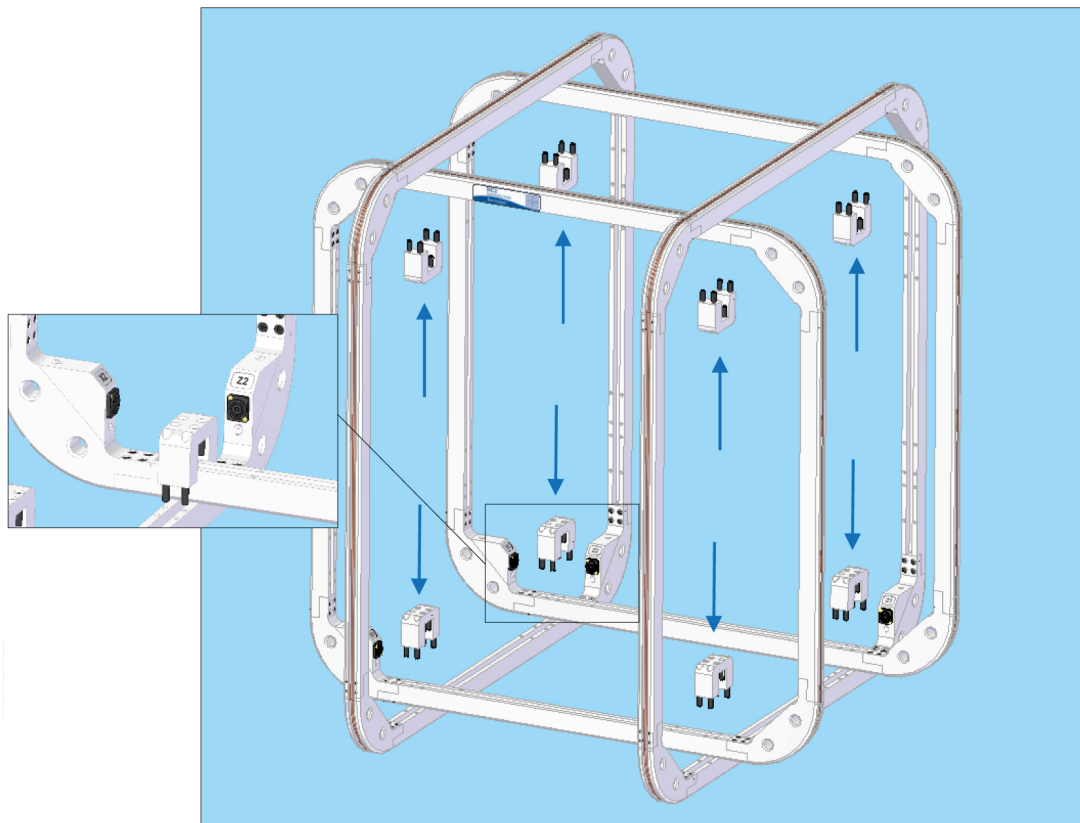


Note: The X coil should rest between the set of four holes and the set of two holes in the Z coil.

Fasten coils together with assembly brackets and bolts provided. Fasten one side at a time.

Note: When fitting the bracket it may be easier to use two bolts at a time, holding the coils together loosely so that the other holes can be aligned.

Note: One person should hold the coils upright while the second tightens the bolts.

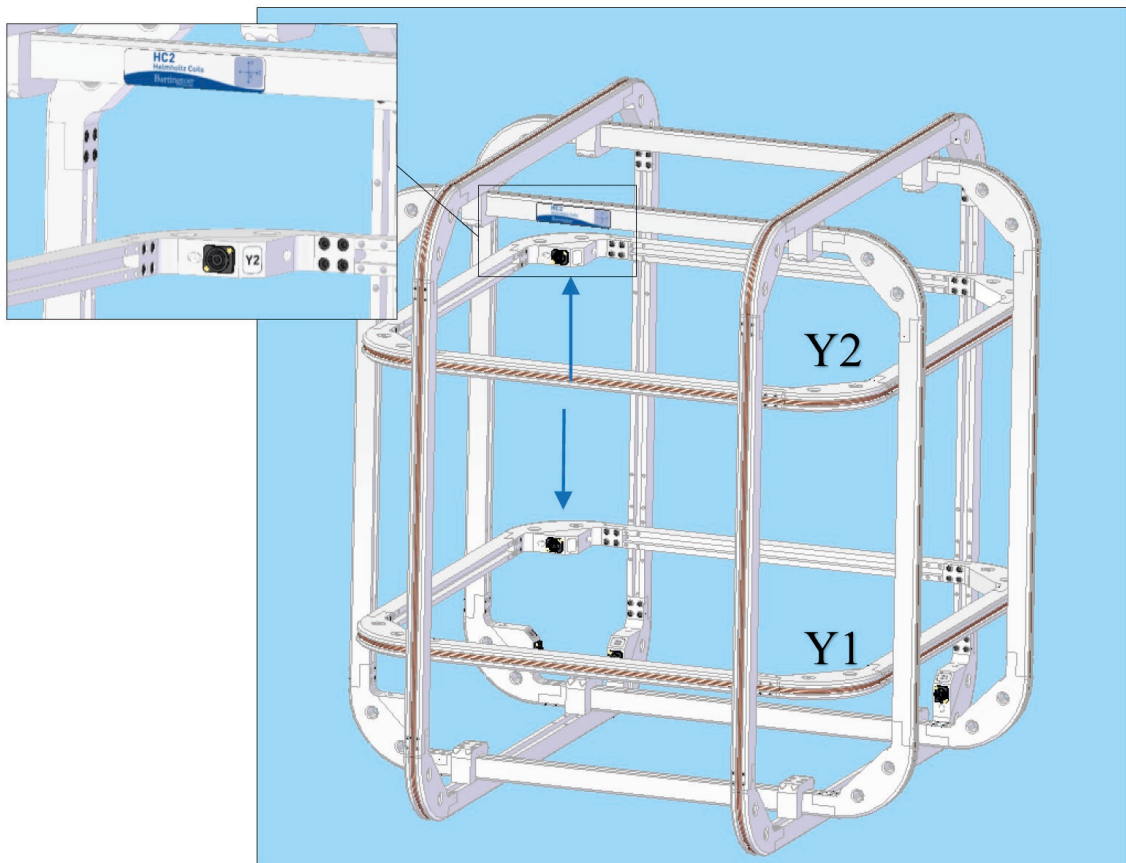


2: Insert small coils (Y)

Carefully lift the two small coils (Y) and lower over the top of the assembly into the centre, parallel to the Z coils. Once inside the assembly, turn them parallel to the floor with the labels facing up.

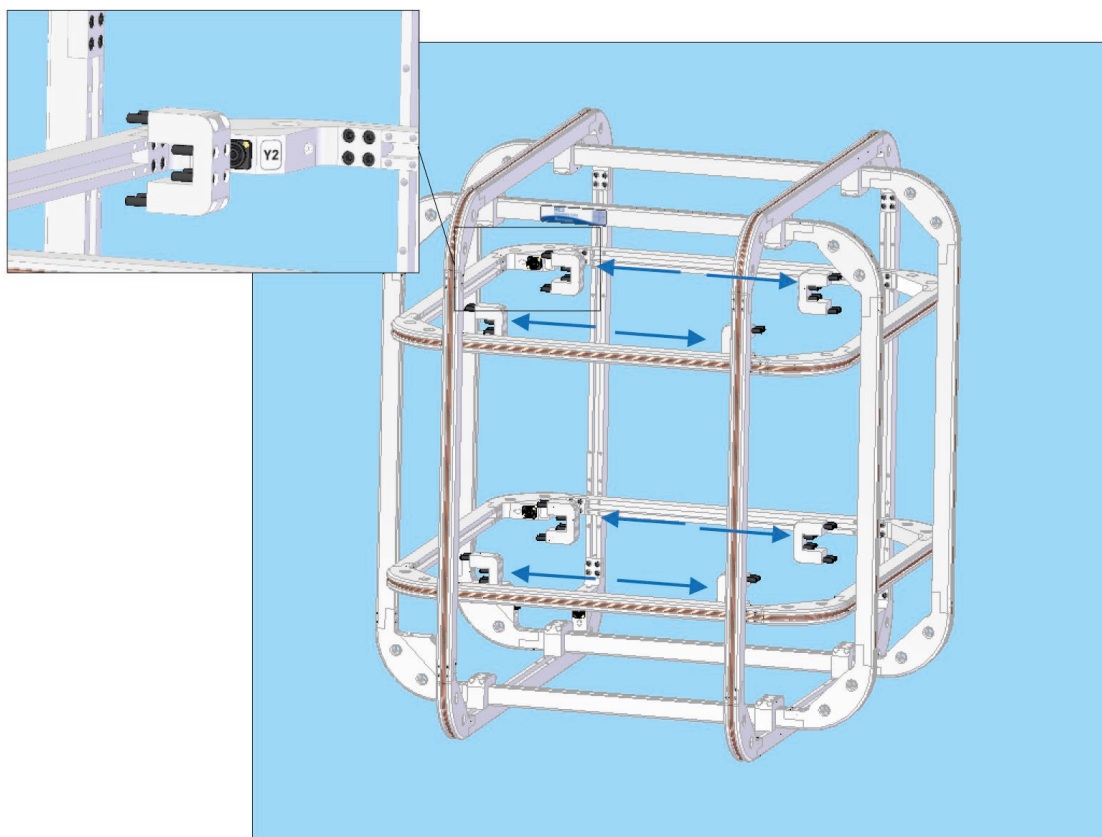
Note: Both Y coils need to be put in at the same time as this will not be possible at a later stage.

The two Y coils should be arranged inside the medium X coil, each one between the set of 4 holes and the set of two holes on the X coils. Ensure that the wind direction of both coils is the same, and that the labels on the bottom are facing in the same direction.



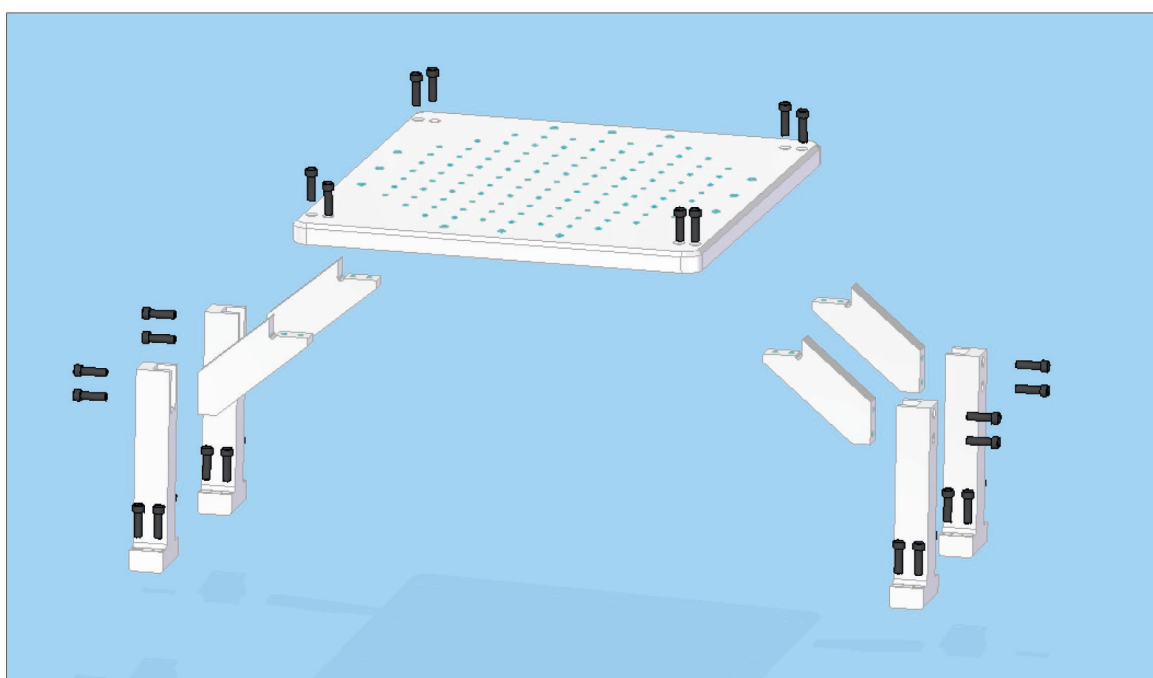
Fix these two coils with the assembly brackets as shown.

Note: Fasten the mounting brackets to the small Y coil first and then secure to the medium X coil.



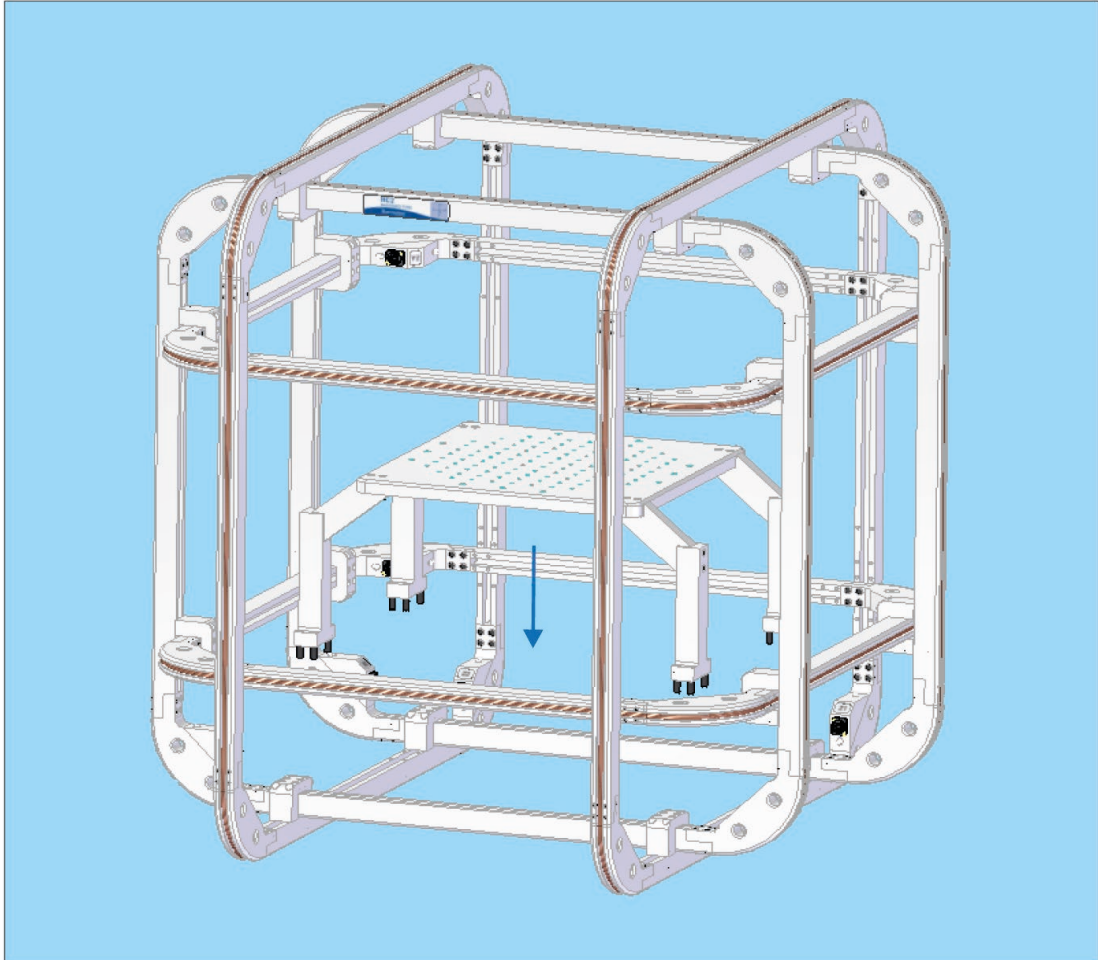
3: Assemble table

The sample table consists of four legs and a flat surface. Assemble the table as shown in the picture.



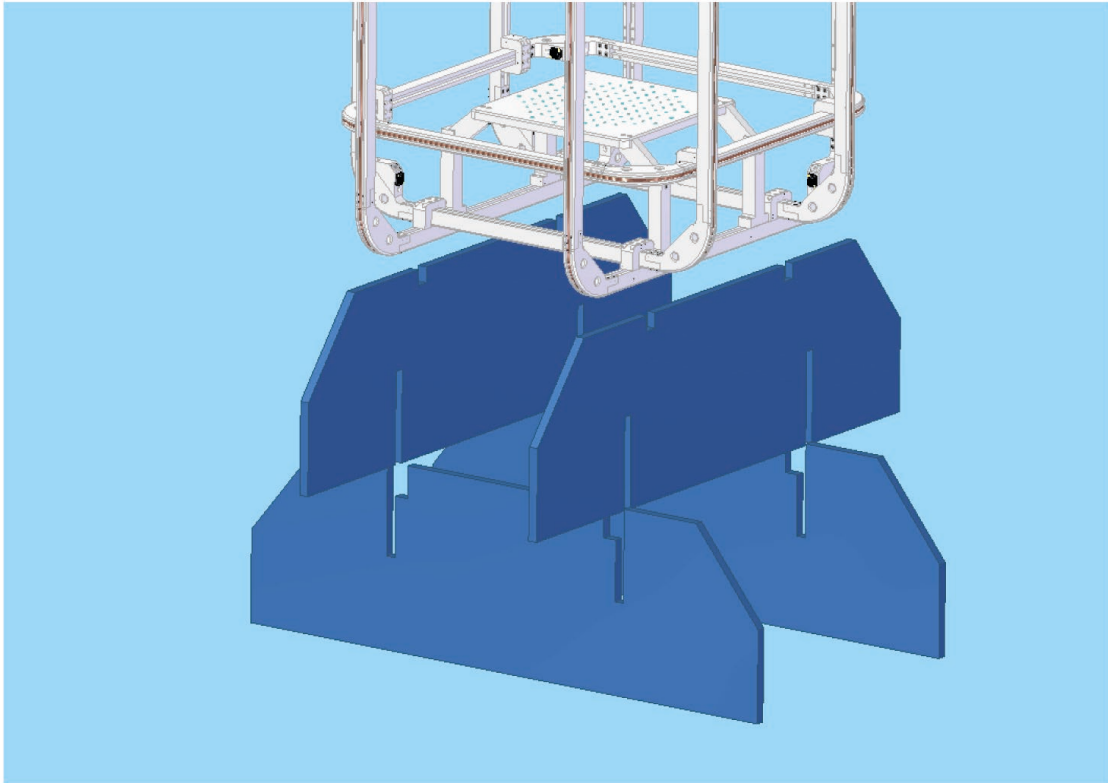
4: Place table in coil assembly

Place the mounted table inside the HC2 and screw the legs to the large Z coils, as shown in the picture



5: The base

Drawings for a suitable base are available. Mount the HC2 as shown in the image, placing the large and medium coils carefully in the base.



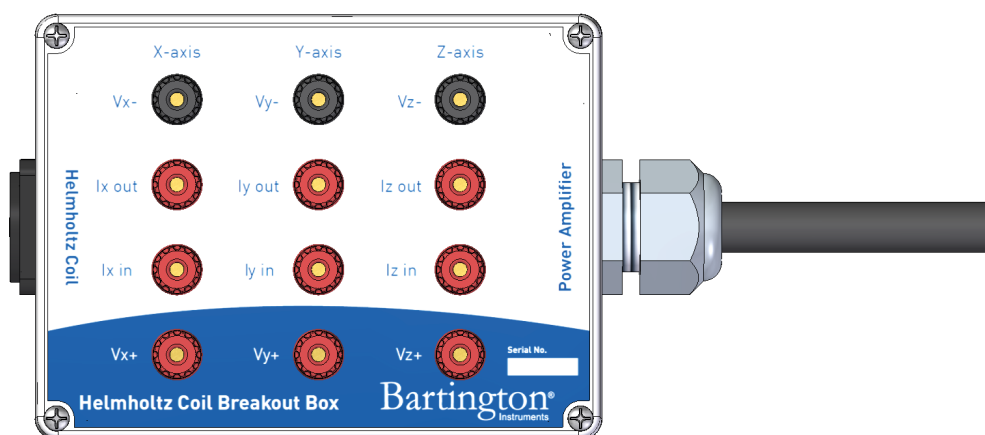
6: Cables

The final step is to connect the coils to the PA1 Power Amplifier. The cable from the PA1 splits into six plugs labelled 'X1', 'Y1' etc. Connect each X, Y and Z plugs the appropriate socket on each coil. Connect the other end of the cable to the coil drive output socket on the PA1.

Appendix C - Helmholtz Coil Breakout Box

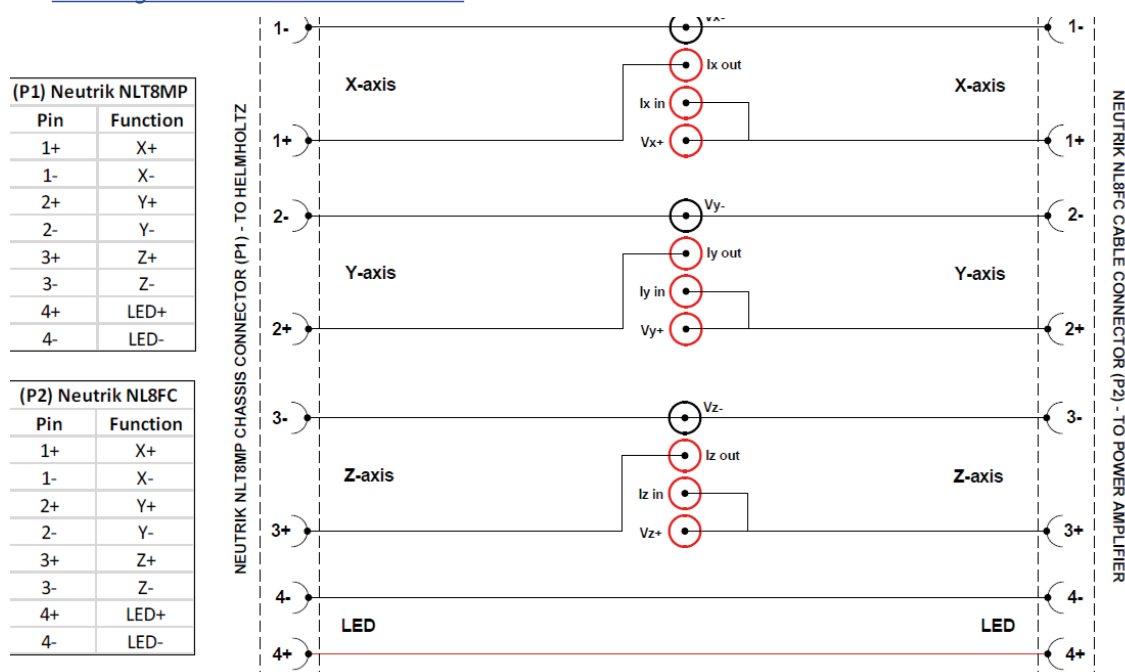
The Helmholtz Coil Breakout Box can be purchased separately for use between the HC2 Helmholtz Coil and the PA1 Power Amplifier. It is used to monitor the current and voltage from each axis. This can be done separately or in conjunction with the other axes.

The box consists of 12 terminals; positive and negative voltage terminals, and current in and out terminals, for each axis. Connections can be made using 4mm banana plugs.



The voltage can be measured across the **Vx+** and **Vx-** terminals on each axis. During normal operation the **I in** and **I out** terminals will be connected together by a short wire link. To measure the current, the appropriate link should be removed and replaced with an ammeter.

The connection diagram for the breakout box can be found below. See also the outline drawing on the [Bartington Instruments website](http://www.bartingtoninstruments.com).



Caution: Do not interconnect the negative return signals.

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