Product Brochure

Single Axis Helmholtz measurement coils (HH-XXX)

The Hirst standard Helmholtz (HH-XXX range) coils are an easy addition to the Hirst IFM06 integrating fluxmeter for a fast, accurate and a low-cost measuring technique to measure the magnetic field strength of permanent magnets of types and grades.

The Helmholtz configuration consists of a pair of identical wound coaxial coils connected in series at a fixed distance equal to their radius. This configuration permits the sample to be placed in a large uniformity central volume. The standard range is 75mm,150mm, 300mm and 500mm but Hirst has made custom coils up to 3 meters in diameter so please contact us with your requirements. For the greatest sensitivity and resolution in the measurement of the magnet, it is sensible to pick the smallest coil size for the sample to be tested. The HH-XXX range can also be powered to generate a magnetic field.

Above is a HH-150 mounted (left) on its side and vertically (right) with the standard magnet sample table (included). Note the IFM06 fluxmeter is sold separately.

Key benefits

- Easy to use and low-cost measurement technique
- Precise and accurate within 1% if the correct coil is chosen for a given magnet sample.
- Meets international testing standards (IEC 60404-14)
- Non-destructive method of testing magnet samples

Applications

- Laboratory based measurement of magnetic properties of hard magnetic materials -permanent magnets of all kinds including ferrites and all rare earth magnets.
- Production Quality Control (QC) of permeant magnets such as magnetised sensor component, magnets for motor assemblies and loudspeakers using these standard Helmholtz coils and precision sample holders to increase measurement accuracy.

Introduction

Helmholtz coils are named after the German physicist Hermann von Helmholtz. It is comprised of two identical magnetic coils positioned in parallel to each other, and their centres are aligned in the same x-axis. The two coils are separated by a distance equal to the radius (R). When current is passing through the two coils in the same direction, it generates a uniform magnetic field in the region of space within the coils as shown below Helmholtz coils are normally used for scientific experiments, magnetic calibration or powered to cancel the earths background magnetic field.

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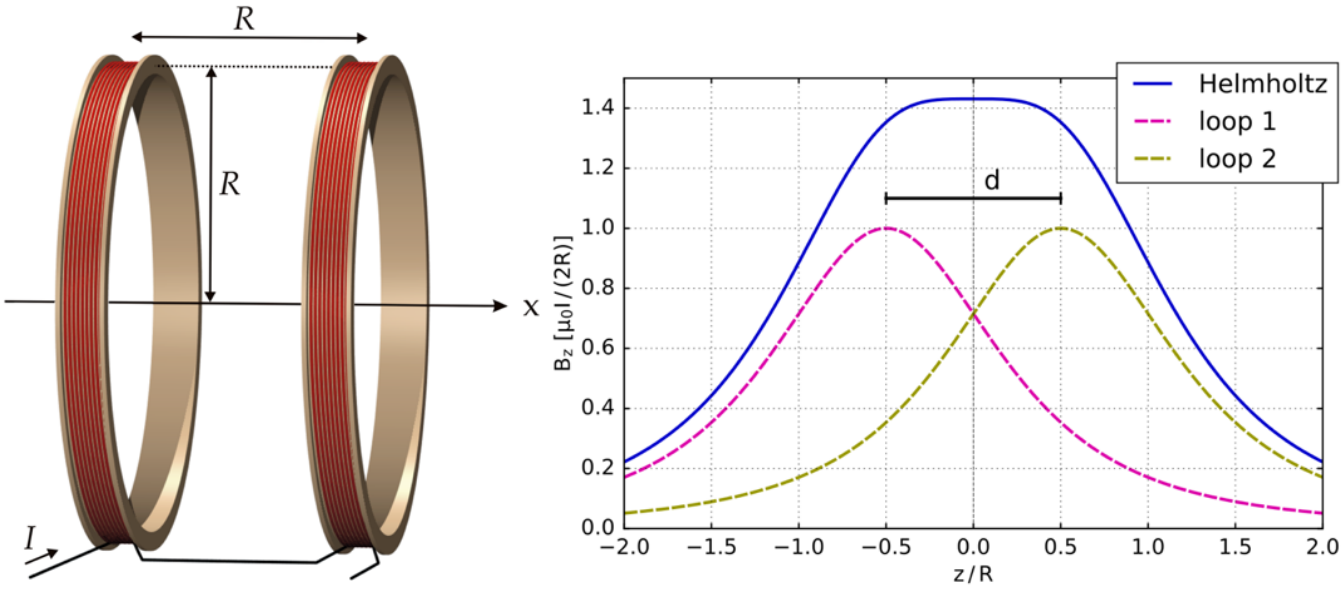

Note HH coil schematic by Ansgar Hellwig - created with Povray 3.5, Corel Draw 11 and The Gimp 2.2, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=193184 and HH resulting field graph by https://commons.wikimedia.org/wiki/User:Geek3

How to measure magnet performance

The magnetic moment of a magnet can be determined with the Helmholtz coil. First reset the IFM06 to zero, the magnet is then inserted into the coil with its magnetic axis parallel to the axis of the coil (i.e. North and South parallel to x-axis). The magnetic moment M is then calculated from the output magnetic flux Φ (in Vs) reading of the IFM06 multiplied by the coil constant K (supplied with each Hirst Helmholtz coil). This measurement procedure is described in the International Standard IEC 60404-14. The resistance of the coil can be neglected if it is less than 1 % of the input resistance of the fluxmeter but this is not always the case which results in gain errors which need to be corrected. The IFM06 set up allows the resistance of the attached coil to be entered allowing for automatic correction of any gain errors for the greatest measurement accuracy possible. The standard Hirst Helmholtz coils each come with an individual serial number and a coil constant and coil resistance calibration certificate.

Before measuring with Helmholtz coil it is necessary to ensure that in a radius of 50 cm no external magnetic influences are present (steel, iron etc).

For a permanent magnet sample of volume V (cm^3), intrinsic flux density B_{di} in Tesla can be calculated by dividing the magnetic moment M by the magnet sample volume V.

These measurements, the magnetic moment M and the intrinsic flux density B_{di} are used as the reference criteria for cross-comparison between suppliers and customers for and quality control (QC) purposes.

The IFM06 fluxmeter and Helmholtz coil combination is a quick, accurate and easy to use technique for two pole magnets and can also be used for measuring arc segments with suitable correction.

This method will not work for magnets with multiple pole pairs, or for ring magnets with radial magnetization. It should be noted that the north-south of the magnet sample should be aligned to the x-axis, if the sample axis is not known or the shape of the field is complex then a 3-axis Helmholtz coil and 3 fluxmeters are required for the measurement of the multipole systems / assemblies. An alternative is to use a magnetic field scanner are required see www.hirst-magentics.com website for details.

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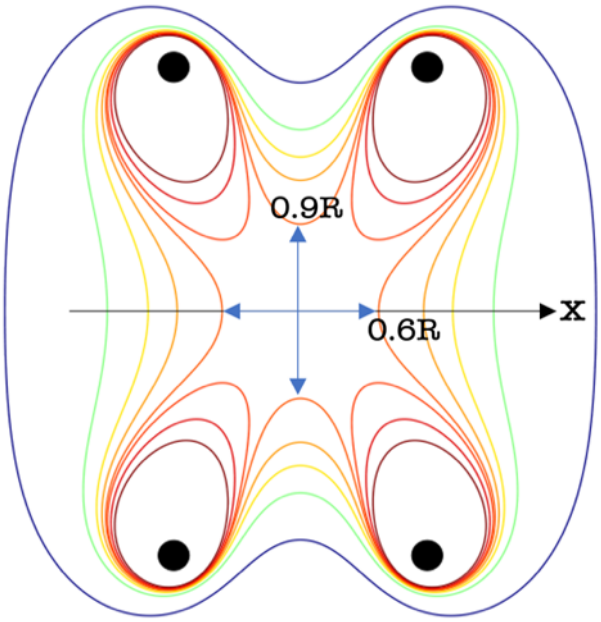
How to choose the right Helmholtz coil

Ideally the Helmholtz coil needs to be as small as possible to increase measurement sensitivity. However, the magnet volume being measured must fit into the most homogeneous section of the HH coils. In the diagram below the contours showing the magnitude of the magnetic field (B_0) near a coil pair (black circles), with one coil on the left and the other on the right. The eight contours are for field magnitudes of 0.5 B_0, 0.8 B_0, 0.9 B_0, 0.95 B_0, 0.99 B_0, 1.01 B_0, 1.05 B_0, and 1.1 B_0.



Inside the central "octopus", the field is within 1% of its central value B_0 giving the best accuracy of measurement possible of 1%. Practically speaking the magnet length along the north-south magnet sample axis and the x-axis should be 0.6 times the radius of the HH coil (0.6R) but can be as much as 0.9R perpendicular to the north-south magnet axis and the x-axis. If it is slightly larger than this, then the accuracy is reduced as the whole sample no longer lies in the homogeneous region of the Helmholtz coils.

"Octopus" diagram by https://commons.wikimedia.org/wiki/User:Morn

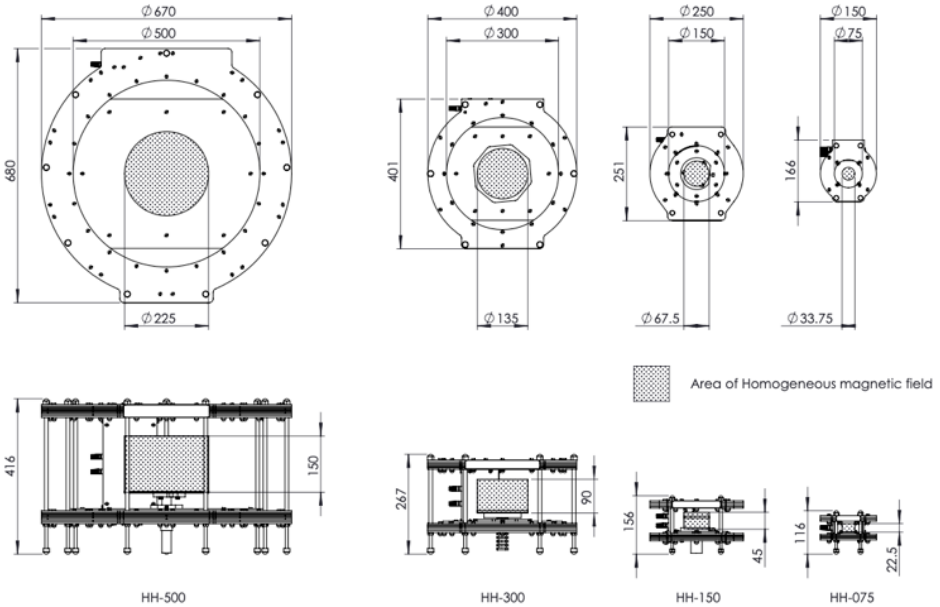
Technical Data and coil picker

The standard Helmholtz coil pairs Hirst offers are given in the table below.

Model Number	Coil diameter (mm)	Coil radius (mm)	Max Sample -length / x-axis (cm)	Max Sample -width (cm)
HH-075	75	37	22	33
HH-150	150	75	45	67.5
HH-300	300	150	90	135
HH-500	500	250	150	225

For the greatest sensitivity and resolution in the measurement, it is sensible to pick the smallest coil size for the sample to be tested.

Custom models are also available on request. Note Hirst provides custom sample holders upon request or a generic mounting table as standard with its Helmholtz coils. Helmholtz coil measurement can be used as part of magnet quality control.



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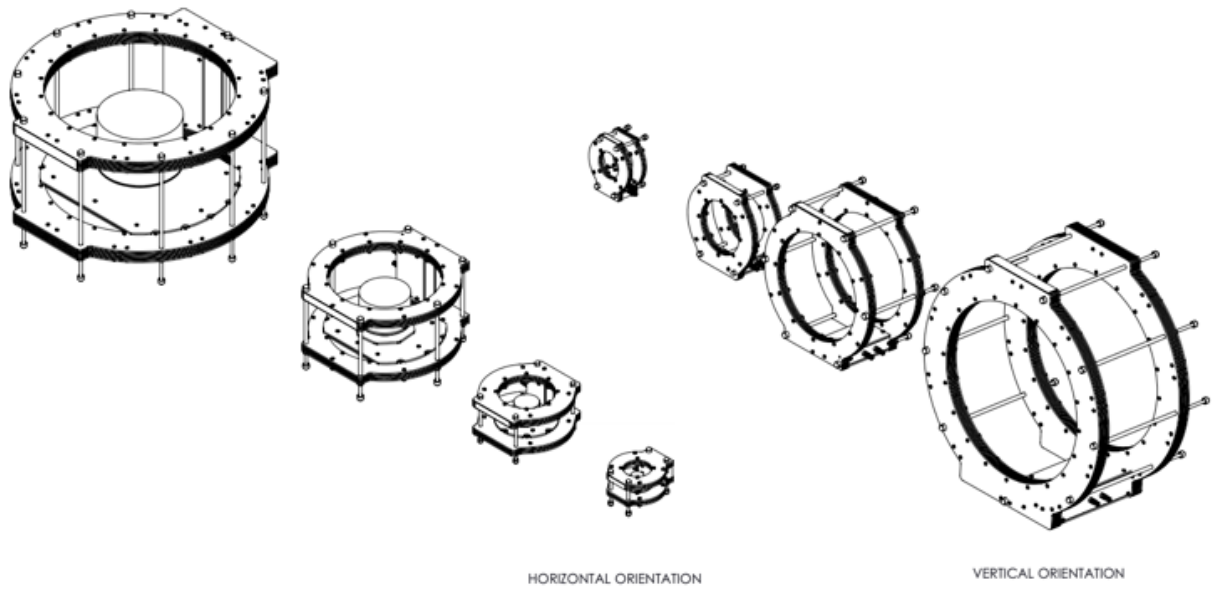
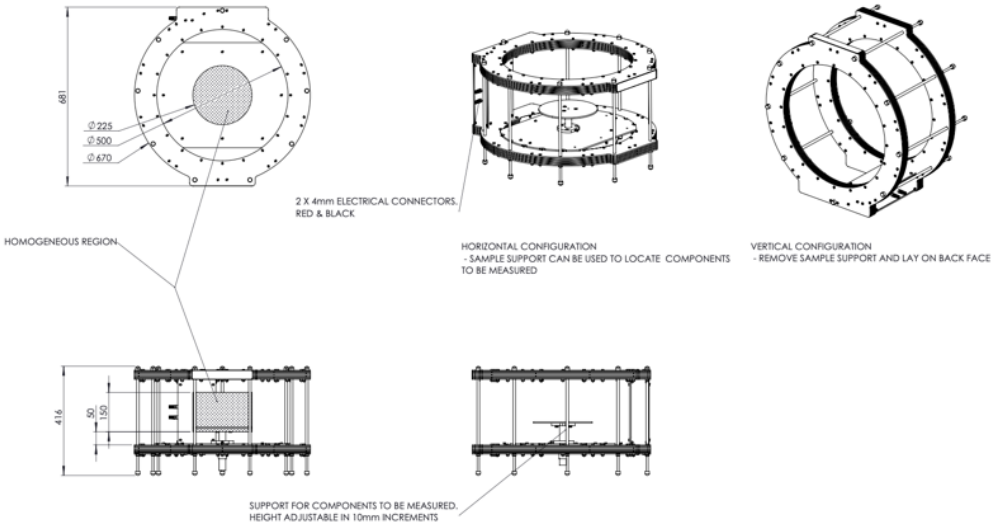
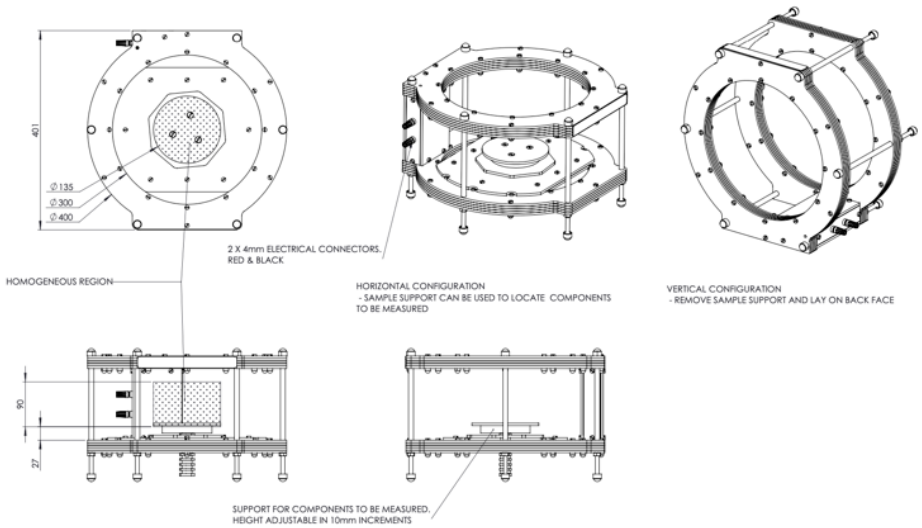


HH-500



Mass 41kg

HH-300



Mass 8kg

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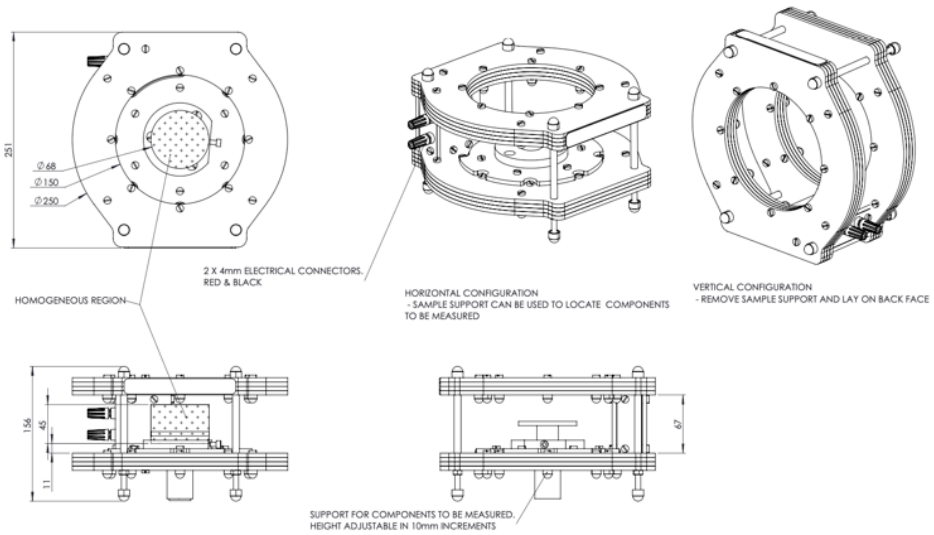
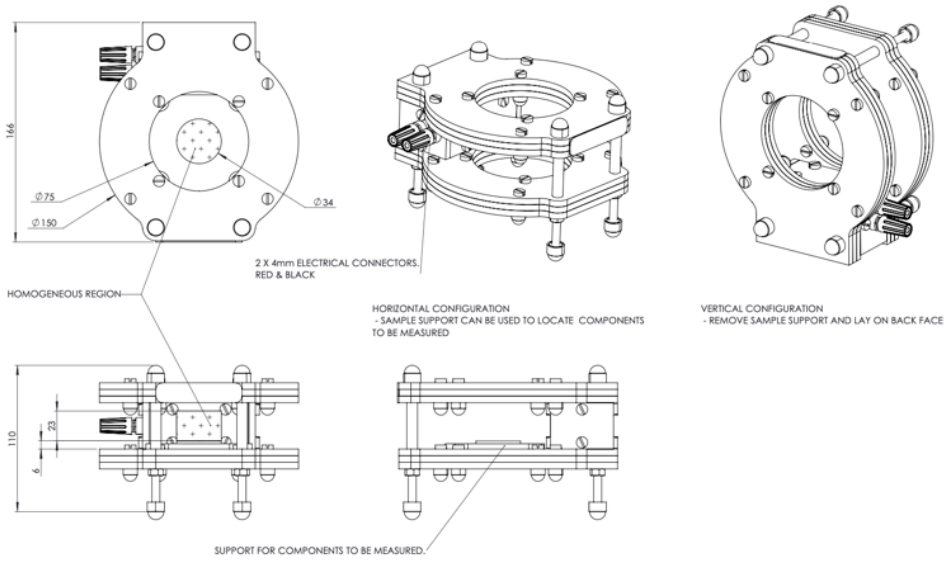
HH-150



Mass 3kg

HH-075



Mass 1kg

Warranty and Calibration

Supplied calibrated with 1 year warranty, to maintain measurement accuracy, calibration of the IFM06 fluxmeter is required every year to maintain the highest performance – service contracts available, see website for details.

Accessories and options

All Hirst Helmholtz coils are supplied with a simple sample holder table, but for increased precision of sample location (and repeatability of measurement) custom magnet sample holders are also available. In most cases the standard sample table will be suffice. However, if in doubt please contact us with your specific requirements.

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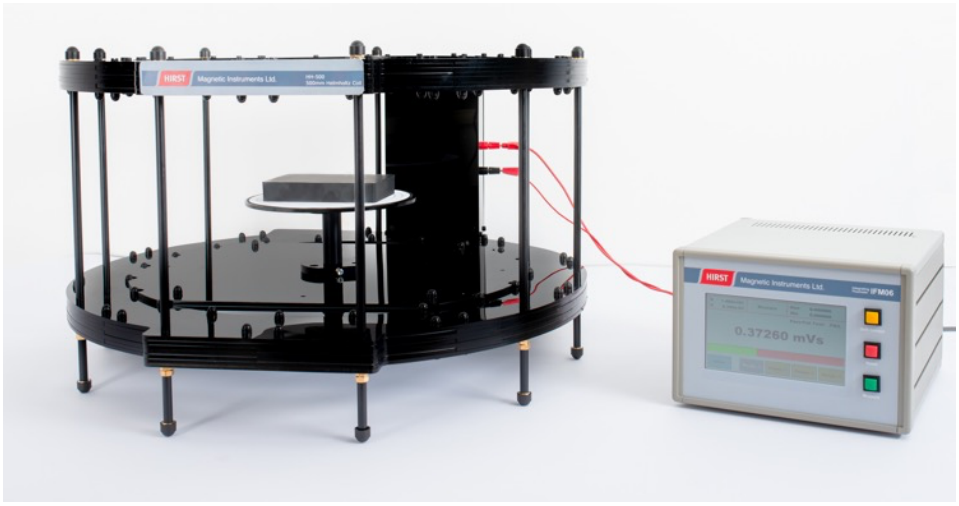

Above an IFM06 with a Hirst 500mm (HH-500) Helmholtz coil pair used for permanent magnet measurement and quality control applications. Note IFM06 is not included and needs to be purchased separately.

Above an IFM06 with a Hirst 150mm (HH-150) Helmholtz coil pair used for permanent magnet measurement and quality control applications. Note IFM06 is not included and needs to be purchased separately.

The Hirst Helmholtz coils are also capable of being powered to provide regions of fixed magnetic fields – please contact us for further details.

Hirst Magnetic Instruments has been active in providing solutions for 60 years in magnetics and magnetic measurement. Hirst manufacture precision hand-held gaussmeters, Fluxmeters, de-magnetisers, bench top & workstation industrial magnetisers, industrial production-line magnetisers, pulse field magnetometers (PFMs) for developing and characterising magnetic materials.

Hirst Magnetic Instruments Ltd reserves the right to make changes to any specifications or performance implied in this product brochure without notice – please refer to www.hirst-magnetics.com for the latest version.

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