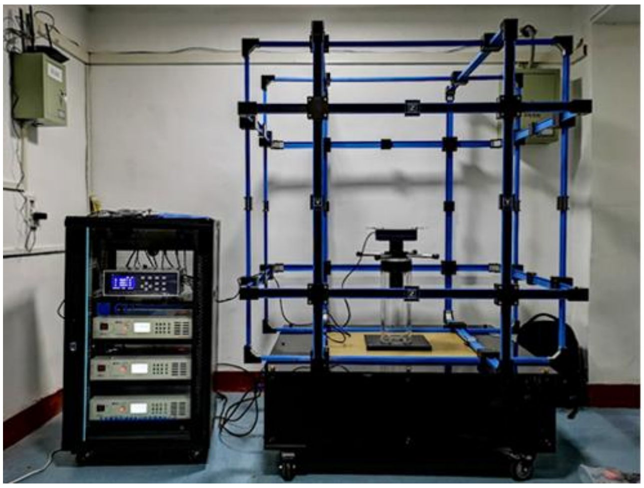
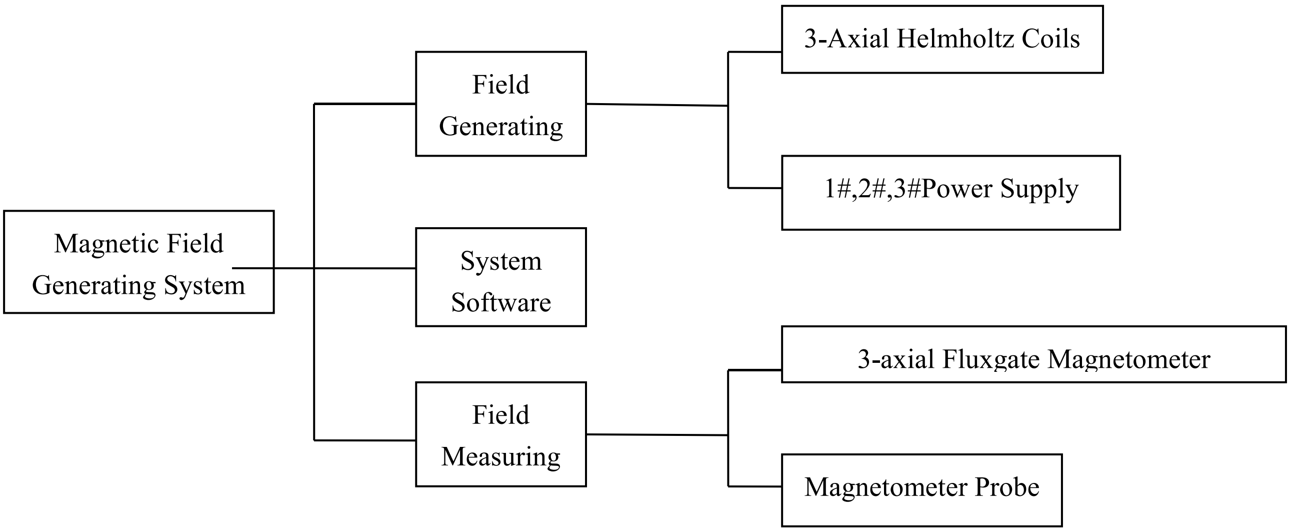
Geomagnetic Compensation & Simulation System



High precision geomagnetic compensation & simulation system is at the international advanced level, the device can produce high precision magnetic field and geomagnetic field direction equivalence of stable and effective instead, and real-time feedback and real-time adjustment using high precision fluxgate, the system of one hundred thousand points in the feedback regulation of state power. The fluctuation of the magnetic field system can real-time offset magnetic field, zero magnetic environment to produce 10nT in geomagnetic environment, such as in the gradient magnetic field shielding room or shielding cylinder can produce 1nT or 0.1nT, the system can randomly generated arbitrary magnetic field in three-dimensional component for scientific experiment and Simulation of geomagnetic variation environment, this system is widely used in the aerospace industry and tertiary institutions, the accuracy and stability of digital level characteristics such as wide acclaim, the dynamic simulation system by magnetic field The magnetic field generating device, the upper computer control software and the magnetic field measuring device are composed, as shown in figure 1.



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System Configuration

The flux generator consists of 1 sets of three dimensional coils and 3 corresponding power supplies. A set of three dimensional coils is used to generate the uniform magnetic field required for the experiment. The three coils are equipped with 3 power supplies to control the coils of the three dimensions respectively. Each dimension has a set of coils for generating a uniform magnetic field. The high-precision fluxgate fluxgate probe is used as the feedback test of magnetic field adjustment, and the feedback signal is adjusted by the host computer to adjust the output current value of high-precision power supply, so as to achieve accurate shielding of the geomagnetic field and the generation of the required magnetic field.
The magnetic field measuring device consists of DX-330F fluxgate magnetometer and fluxgate probe, which is mainly used to measure the magnetic field size and the feedback real magnetic field in the coil center uniform magnetic field.

DX-330F Fluxgate Magnetometer

Model	Descriptions of Goods
DX-330F High Precision Fluxgate Magnetometer	VGA color 6 bit resolution; range 0-100000nT; resolution 0.1 nT; DC precision: reading of the 0.5% + 0.05% range digital RS-232 and USB interface, BNC three analog signal output interface, with fluxgate data communication and graphics software set.

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3-Axial Helmholtz Coils

The 3DXF50-2 square Helmholtz coil is suitable for generating low and weak 3D magnetic field, simulation of geomagnetic field and active shielding of weak magnetic field;
The coil is a square structure with higher structural strength;
The three-dimensional magnetic field components Bx, By and Bz can be controlled independently;
Non conductive and non-magnetic material frame, and the coil is made of oxygen free copper enameled wire;

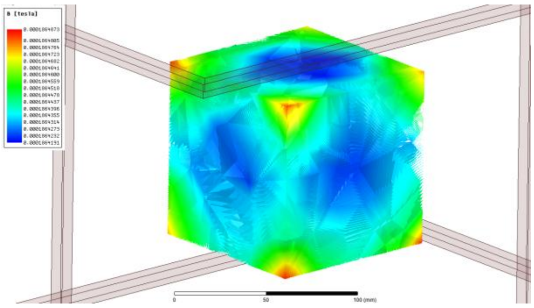
▶Technical Specifications

Data. / Item	X-axis coil	Y-axis coil	Z-axis coil
Magnetic Field		200µT±10µT	
B/I coefficient		200µT±10µt/A	
Field Precision （**F2005 POWER SUPPLY**）		1.1±0.1nT	
Continuous Working Current	1A	1A	1A
Max. Current	2.1A	2.1A	2.1A
Equivalent Side Length	1126mm	1062mm	998mm
Equivalent Spacing	613mm	578mm	543mm
DC Resistance@20℃	18.1Ω±1.3Ω	16.1Ω±1.1Ω	14.2Ω±1Ω
Inductance	≈64mH	≈53mH	≈43mH
Weight		102kg	

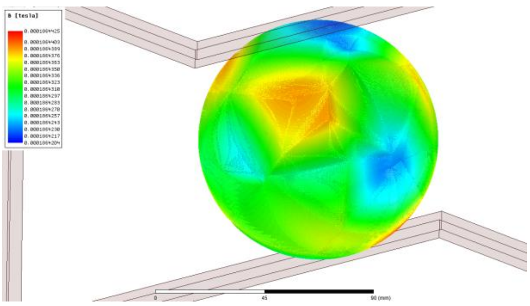
▶ Degree of Uniformity

Dimension of Uniform Field	Degree of Uniformity
100mm*100mm*100mm	**0.07%**
Sϕ100mm	**0.03%**
300mm*300mm*300mm	**3%**
Sϕ300mm	**1%**

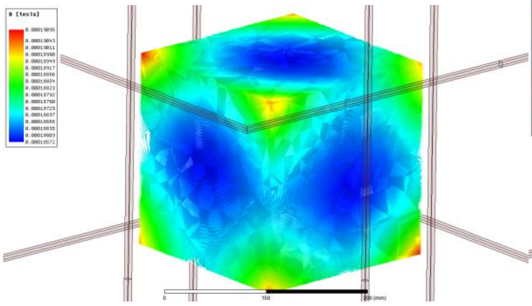
▶ **Simulation Data.**



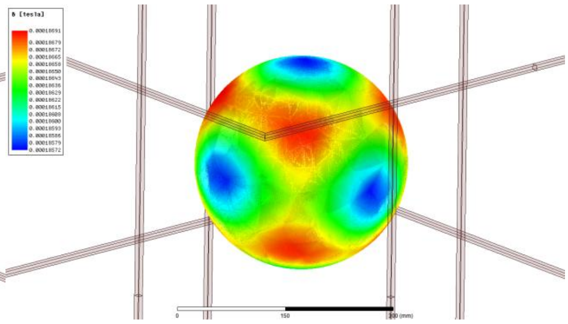
100*100*100mm Field Distribution



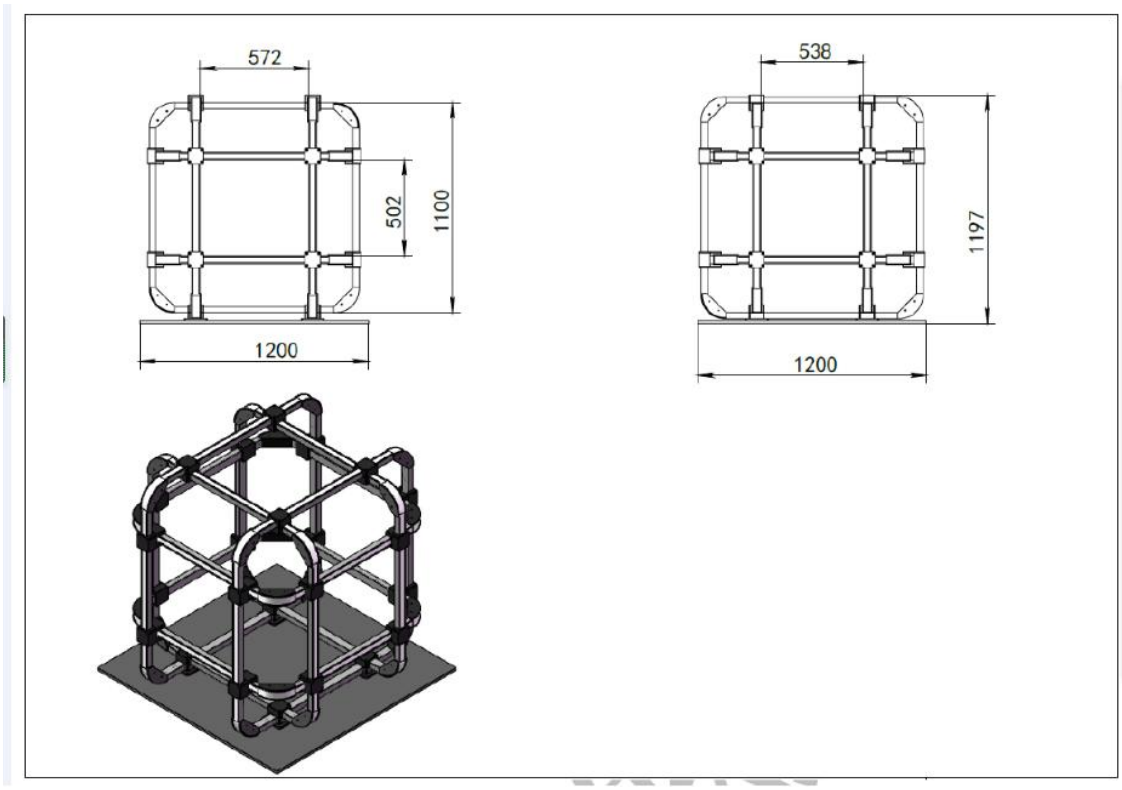
Sϕ100mm Field Distribution



300*300*300mm Field Distribution



Sϕ300mm Field Distribution



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DEXINMAG®

Xiamen Dexing Magnet Tech. Co., Ltd

▶ **Test Data.**

Test Time	Name	Test Add.	Instrument
2020.12.15	Wang Stone	XIAMEN DEXING	DX-330F

X-Axis Magnetic Field Distribution

Coordinate	Environmental Field	Folded Field	Coil Field
(0，0，0)	-31	67401.8	67432.8
（0,0,37.5)	-129.6	67305	67434.6
（0,0,-37.5）	87	67513.5	67426.5
（0，37.5，0）	-310.1	67118.4	67428.5
（0，-37.5，0）	270.5	67699.2	67428.7
（37.5,0,0）	2.9	67419.1	67416.2
（-37.5,0,0）	-55.3	67386.3	67441.6
	Degree of Uniformity		0.0246%

Y-Axis Magnetic Field Distribution

Coordinate	Environmental Field	Folded Field	Coil Field
(0，0，0)	-63.4	67371.7	67435.1
（0,0,37.5)	-164.9	67275.4	67440.3
（0,0,-37.5）	50.7	67481.3	67430.6
（0，37.5，0）	-346.7	67086.5	67433.2
（0，-37.5，0）	233.8	67666.9	67433.1
（37.5,0,0）	-37.8	67392.5	67430.3
（-37.5,0,0）	-97.6	67346.8	67444.4
	Degree of Uniformity		0.0138%

Z-Axis Magnetic Field Distribution

Coordinate	Environmental Field	Folded Field	Coil Field
(0，0，0)	-30	-66904.3	-66874.3
（0,0,37.5)	229.3	-66633.8	-66863.1
（0,0,-37.5）	-329	-67216.2	-66887.2
（0，37.5，0）	-1	-66880.4	-66879.4
（0，-37.5，0）	-36.8	-66912.5	-66875.7
（37.5,0,0）	355.8	-66523.5	-66879.3
（-37.5,0,0）	-395.4	-67273.2	-66877.8
	Degree of Uniformity		0.0193%

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High Precision Programming Control Power Supply

Model	Current	Resolution	Output Voltage	Power	Loading	Perfect Load
F2005	±1.2A	10μA	±40V	48W	0—40Ω	>20Ω

Software Control Principle

The main interface of the software is shown in the diagram below, the control of the geomagnetic shielding coil set is used to eliminate the influence of geomagnetism; the control of the coil set in the magnetic field is used to generate the magnetic field of the specified size in the uniform area. External input options can be selected by external signal control magnetic field settings.

When choosing by the external magnetic field control signal set, its working process is: receiving the external control signal to control the geomagnetic shielding coil group, the three dimensions of the set value is set to 0nT, to zero; the geomagnetic shielding coil group three dimensions of the magnetic field value is adjusted to the specified range (+ 50nT), software to send "ready" signal to the control computer, and stop zero; the control computer receives the "ready" signal, the user can set the specified dimension values of the magnetic field, such as setting Bx to 1000nT; the received external control signal "Bx:1000nT" after the power generation coil group X dimension control software of magnetic field. The PID closed loop control Bx control in 1000nT, the user can control precision in the software "sensitivity adjustment of a set; completed the specified dimension magnetic field After adjustment, the software sends the "adjustment completion" signal to the control computer to prompt the user to set the next magnetic field value.

The PID parameter setting interface is shown in the following diagram, which is mainly used to adjust the PID parameters, so that the system performance can be optimized in terms of adjusting time, overshoot, oscillation, steady-state error and other indicators.

The Kp addition will reduce the steady-state error and improve the dynamic response speed of the system, but the oscillation frequency will increase when too large. Ki can be used to eliminate the steady-state

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error of the system. When the Ki is suitable, the system characteristics are ideal. However, the oscillation of Ki is larger than that of Ki, and the integral control has little effect on the system performance, so that the steady-state error of the system can not be effectively eliminated. The Kd control can reduce the overshoot of the system, overcome the oscillation and shorten the adjustment time. When Kd is partial, the overshoot changes greatly and the regulation time becomes longer.

PID correction combines the characteristics of lead and lag correction, uses the advance correction to increase the phase margin of the system, improves its dynamic performance, and uses the lag part to improve the static performance of the system, thus improving the stability and rapidity of the system. The PID correction adopts the method of trial and error, and the test principle is based on the principle of first proportion, post integral and re differentiation, that is, according to the order of P, PI and PID, the satisfactory control parameters are obtained.

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