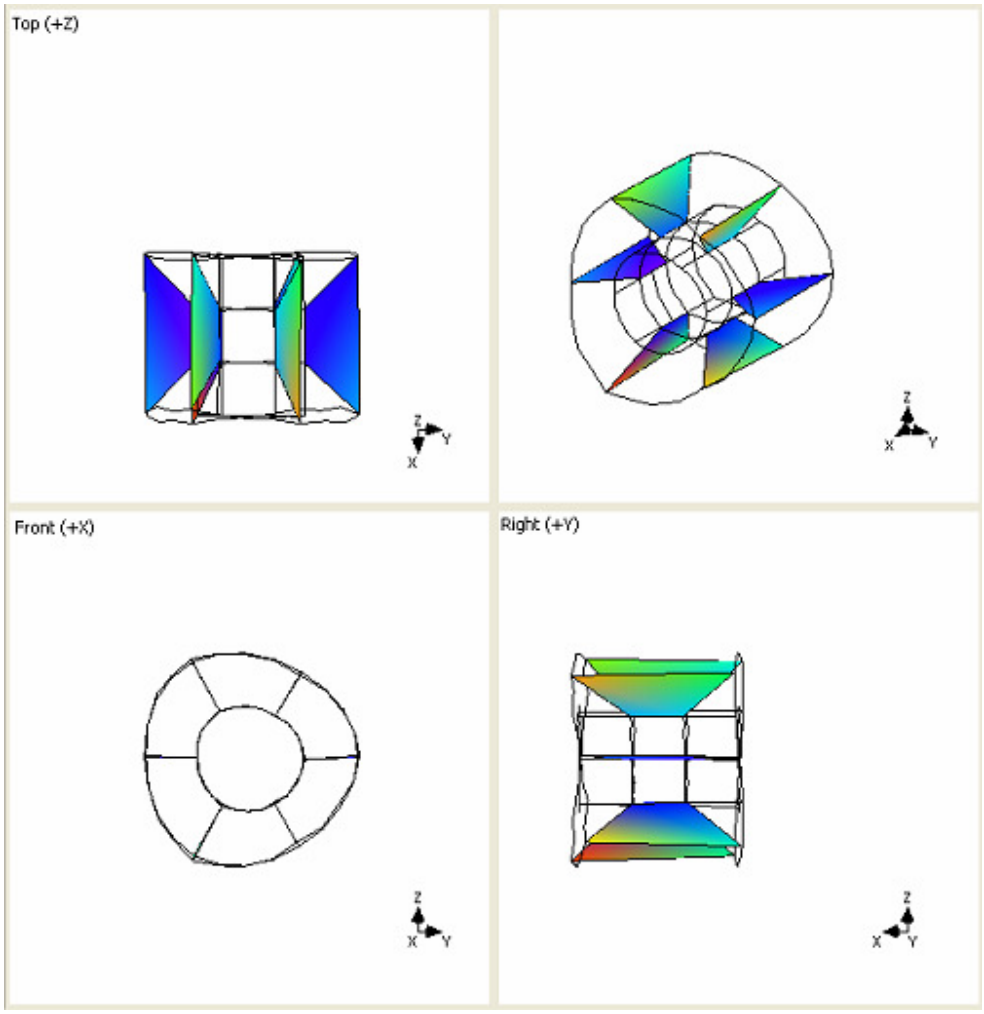
ModalVIEW Application Note

Modal Testing of Magnet Coil Structure



ABSignal

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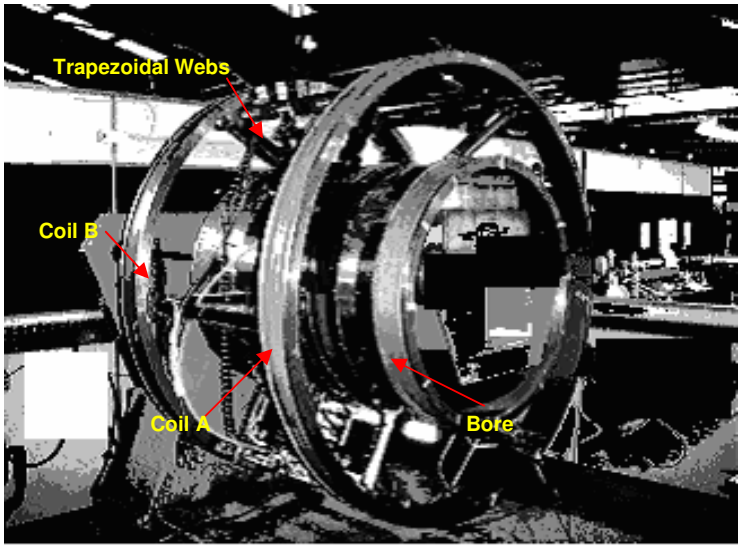
Testing Structure

In this modal testing experiment, the testing object is a magnet coil of steel structure， as following figure shows.



There are some challenges to perform modal testing of this structure:

1. The structure is symmetrical. Vibrations from multiple directions need to be measured to investigate complex mode shapes.
2. Modes are closely spaced, and conjugate modes exist.
3. The structure is large and heavy. The vibration signal of measured points far away from excitation point is weak. The dynamic range of measured signals is large.

Experiment Scenario

In this modal testing experiment, ModalVIEW software and National Instruments dynamic signal acquisition (DSA) hardware are used. To identify closed spaced and conjugate modes of this symmetrical structure, accurate modal analysis method of poly-reference, multiple DOF, global fitting is required. ModalVIEW modal analysis software provides advanced modal analysis method based on mode stabilization diagram to extract modes from poly-reference FRF measurements, which meet testing requirements. National Instruments 24-bit DSA hardware PXI-4498 is used to guarantee the accurate measurement of weak vibration signal of measured points far away from excitation point. The scalability of NI DSA hardware also guarantees the investment of whole modal testing system.

Method and process

In this experiment, roving hammer impact test is used. Tri-axial accelerometer is used to measure structure vibration of X, Y, Z directions. The FRFs from 48 response points are measured with 2 reference excitation points. As following figure shows, blue point is impacted with a hammer and vibration responses of red points are measured with accelerometer. Experiment data with 48*3 FRF measurements are obtained. During the testing, ModalVIEW software can automatically create measurement sets, which define connections between acquisition channels, sensors and measure points on structure under test, to assist measurement operation. The information of roving points or reference points for each measurement set can be highlighted on 3D model, which indicate where to arrange sensors on the structure and where to give excitation. The whole testing time is greatly reduced with testing management from ModalVIEW software.

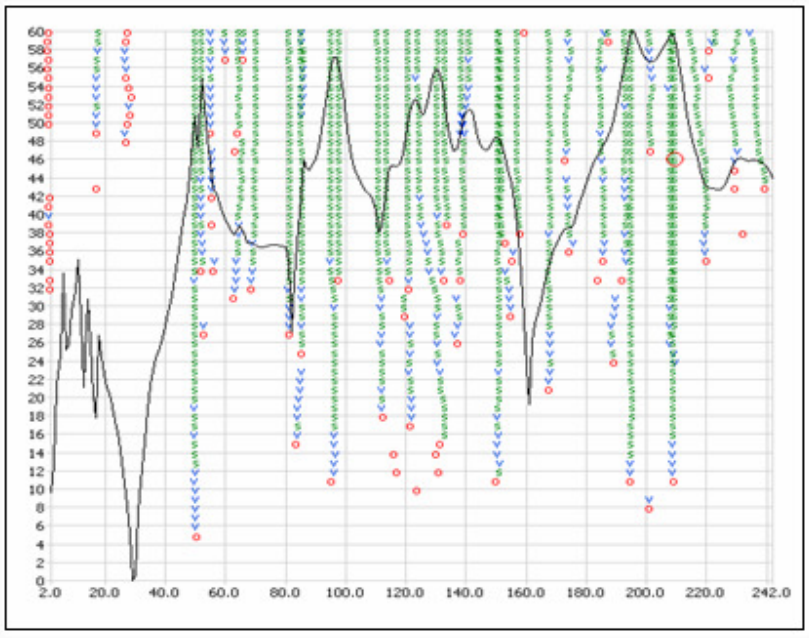
System configuration

In this modal testing experiment, the following software and hardware are used：

1. ModalVIEW1.0 Software
2. NI DSA System (Low noise chassis PXI-1042, Dual-core controller PXI-8106, 16 ch DSA module PXI-4498)
3. Hammer (Lance LC1302) and Charge amplifier (Lance LC0106).
4. Tri-axial accelerometer (Kistler 8690C50).

Analysis Results

Modal analysis for the structure is finished with ModalVIEW's advanced mode estimation method based on mode stabilization diagram。The following figure shows the clear mode stabilization diagram from 48*3 measured FRF data.

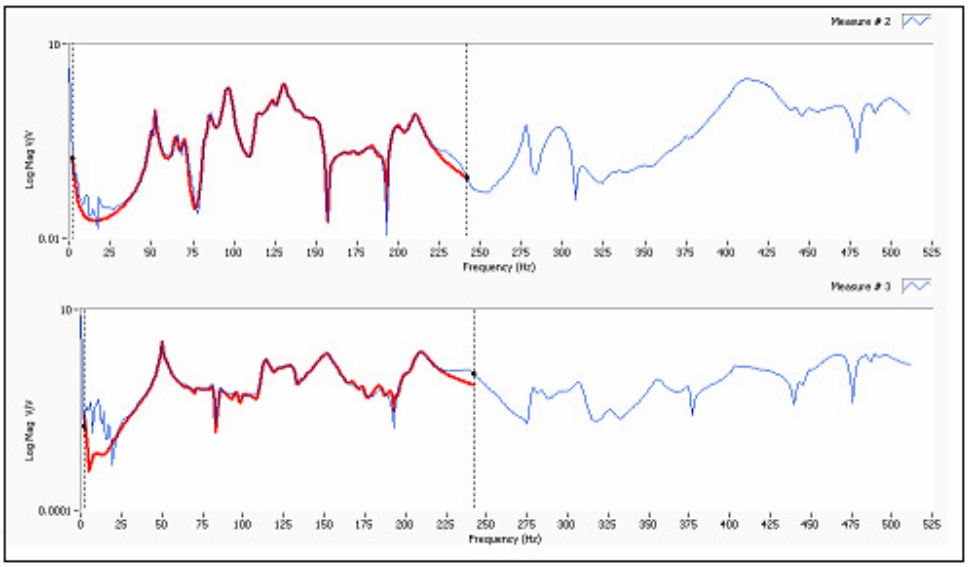


The closely spaced modes can be selected from stabilization diagram. The real modes are kept with mathematical or faked modes being discarded.

Part of the picked meaningful modes are listed in following table

Index	Frequency (Hz)	Damping (%)
1	50.199	0.776
2	52.278	0.756
3	64.991	1.162
4	69.589	1.753
5	81.546	0.884
6	86.970	1.053

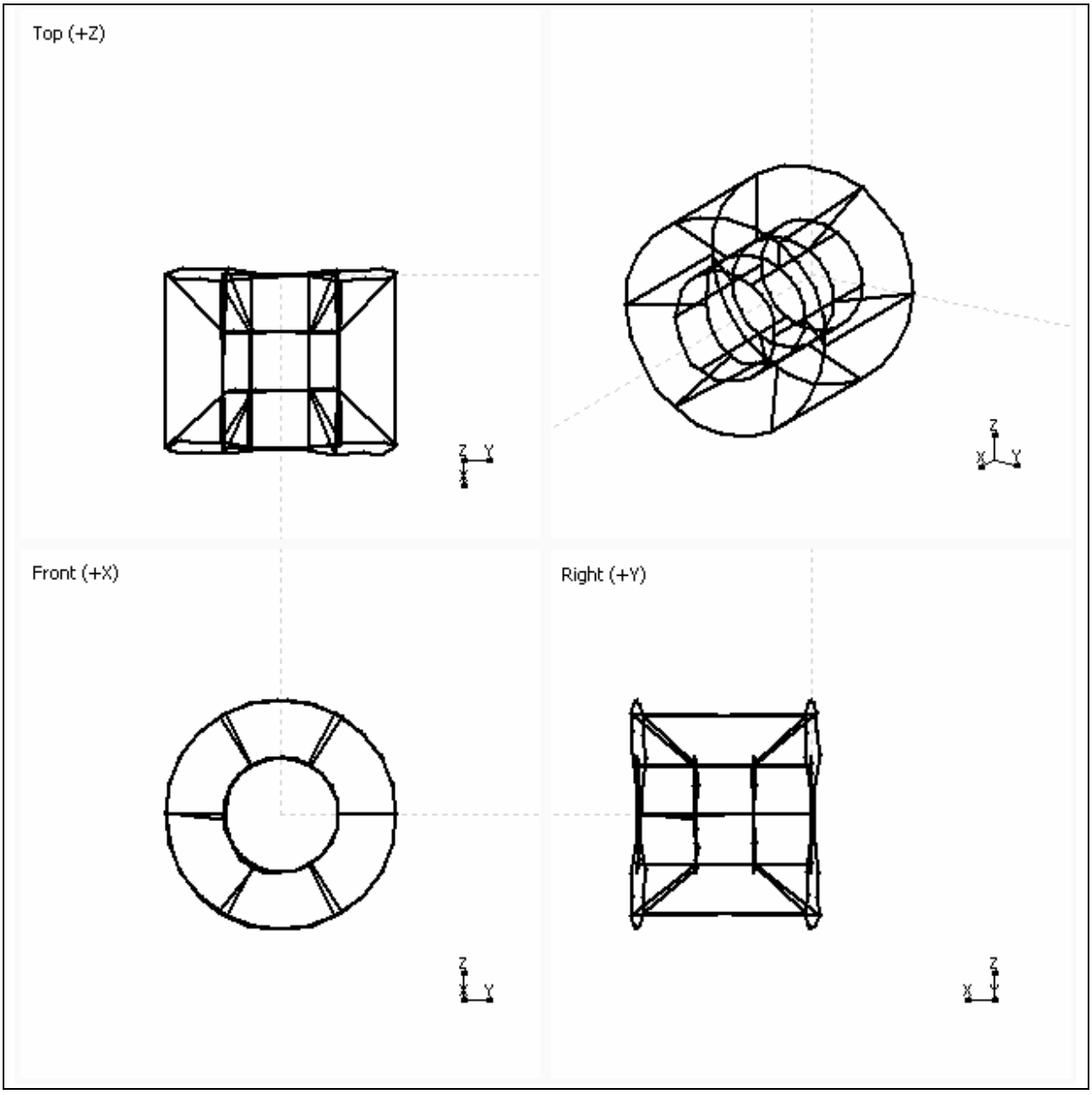
The following figure displays the plot of synthesized FRFs from estimated modes (red line) and measured original FRFs. The synthesized FRFs should match original FRFs well, which indicates that estimated modes are accurate enough.



Part of mode shapes obtained in this modal testing are displayed in the following list:

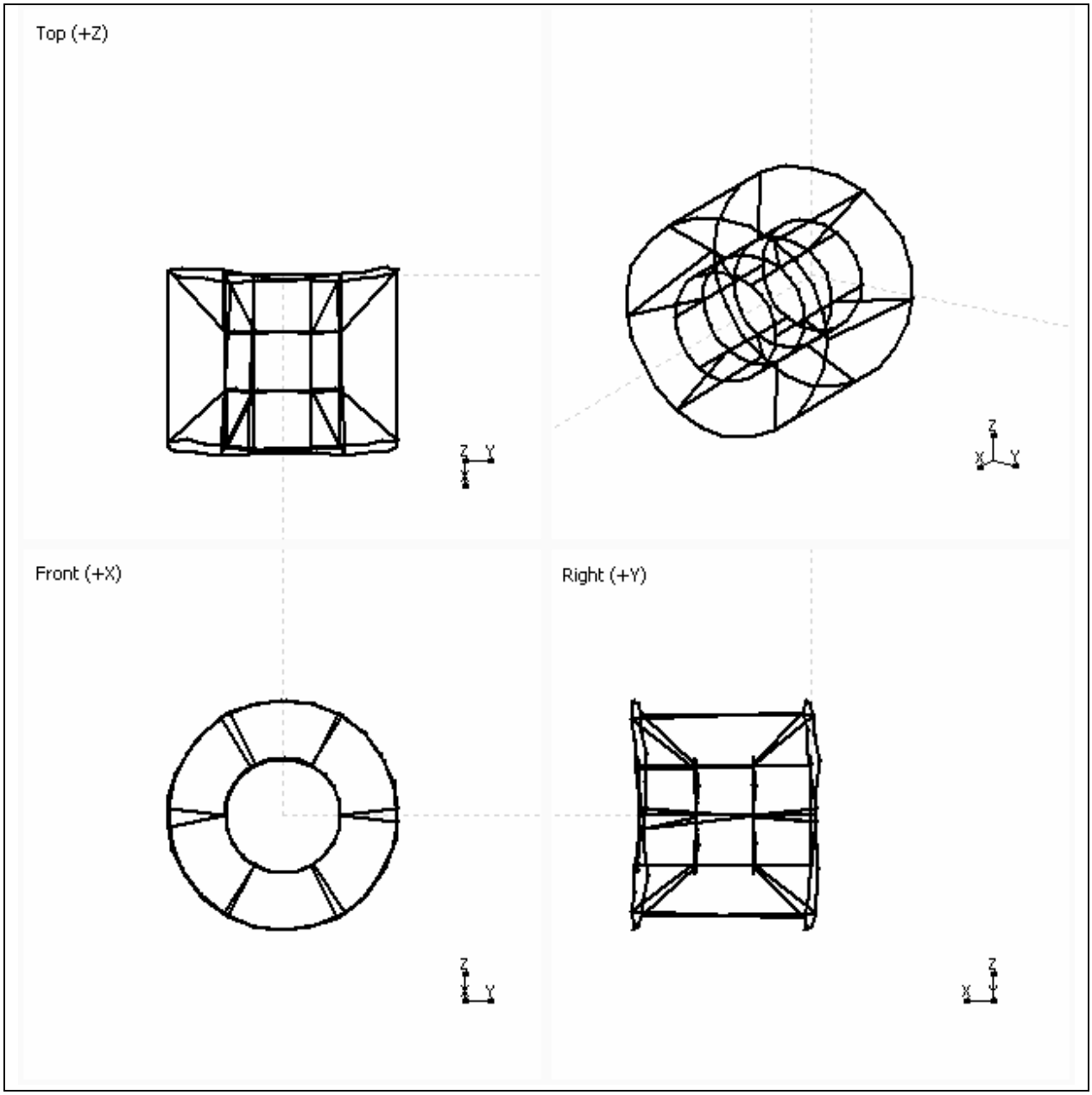
Mode 50.199Hz

1. Coil a and coil b rotate around X axis
2. Coil a and coil b twist



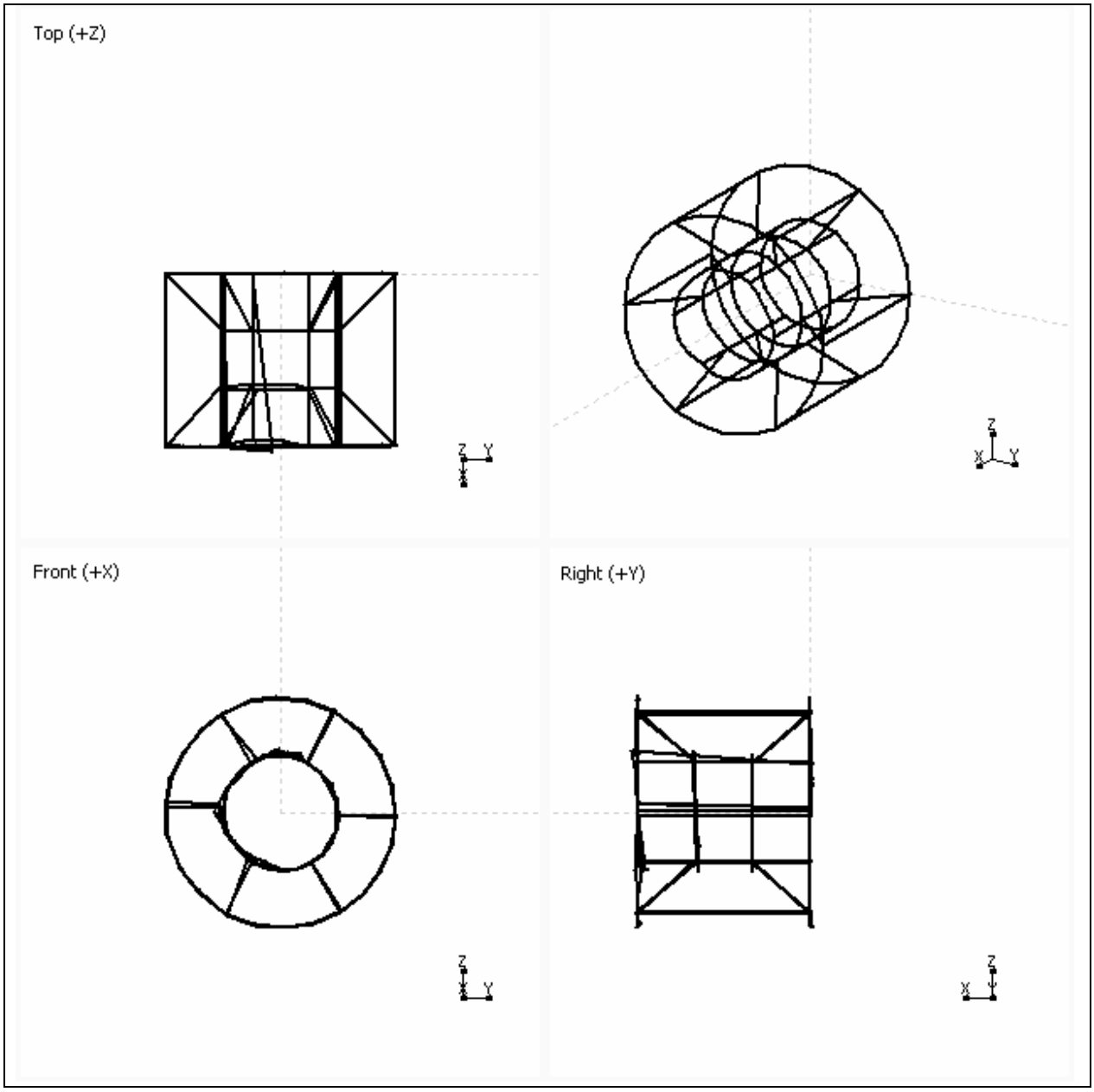
Mode 52.278Hz

1. Coil a and coil b rotate around X axis
2. Coil a and coil b bend



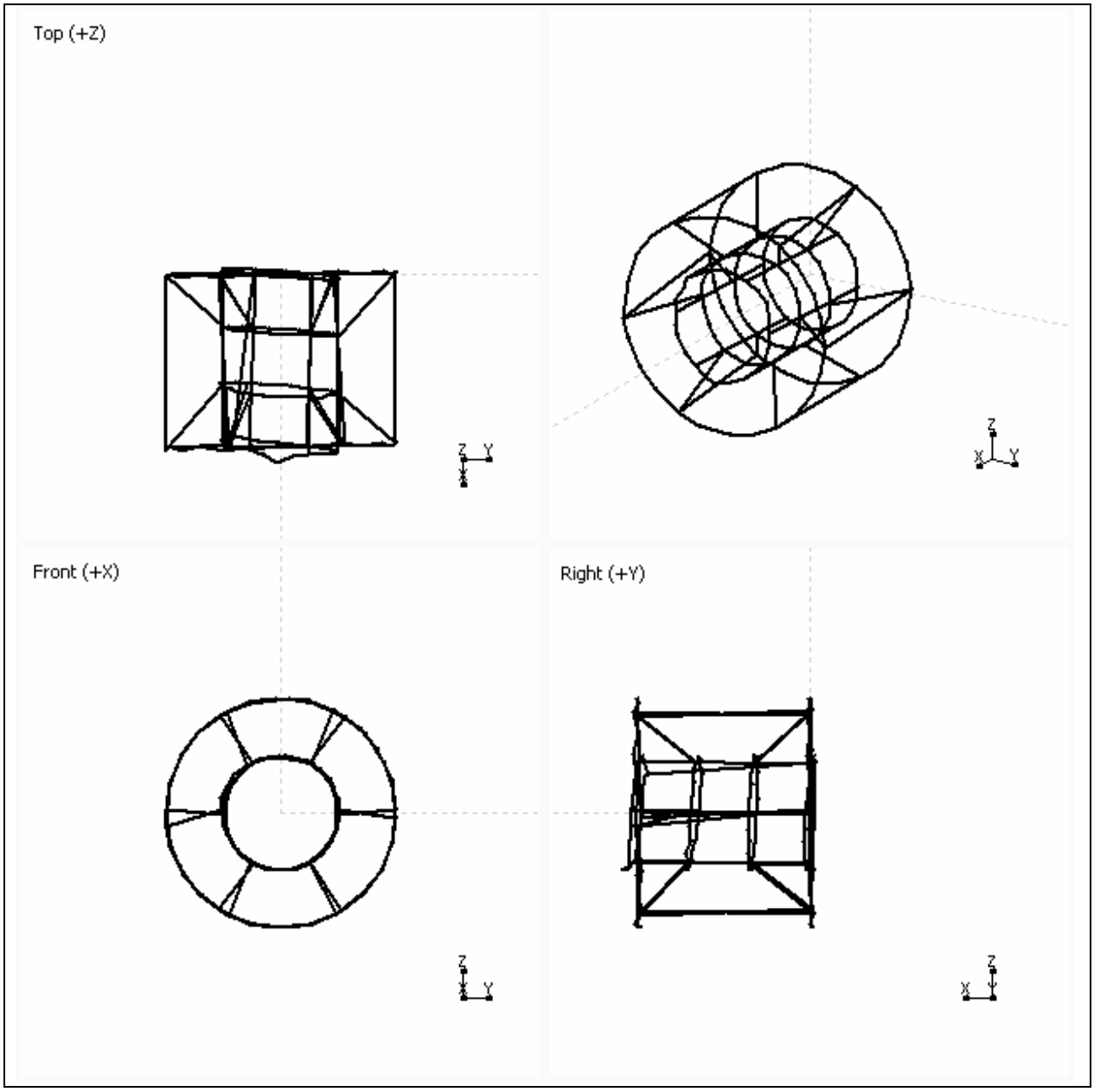
Mode 64.991Hz, 69.589Hz

1. Trapezoidal webs translates



Mode 81.546Hz, 86.97Hz

1. Bore twists



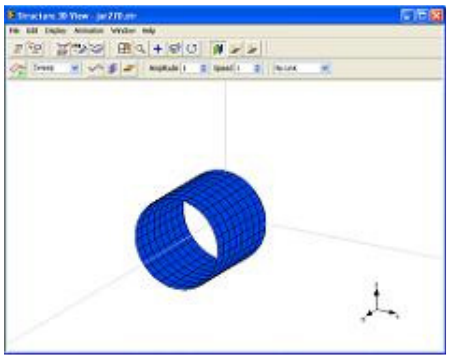
Conclusion

The modal testing experiment of magnet coil structure is successfully finished with ModalVIEW software and National Instruments DSA System. The seamless integration between ModalVIEW and NI DSA hardware reduces the time to perform modal testing experiment. The analysis result from powerful modal analysis functions in ModalVIEW provides instructive guidance on the design of the products.

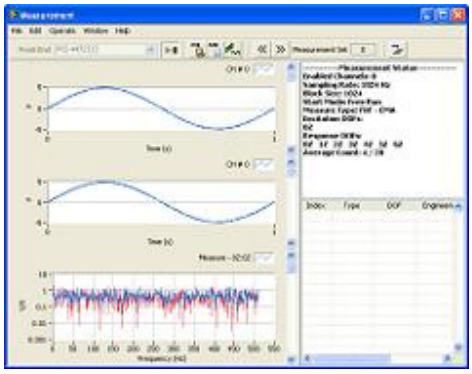
About ModalVIEW

ModalVIEW software is a modal testing and analysis tool. It helps you to extract and visualize useful modal parameters information from acquired time- and frequency-domain experimental data. ModalVIEW software is developed under National Instruments' LabVIEW, an open environment designed to make interfacing with any measurement hardware rapidly and simple. ModalVIEW software is compatible with any dynamic signal acquisition (DSA) hardware of National Instruments including plug-in boards, USB devices, and PXI systems and speed your time to perform experimental measurement. With ModalVIEW software, you can also leverage your structural testing capabilities by utilizing existing investment in NI DSA hardware.

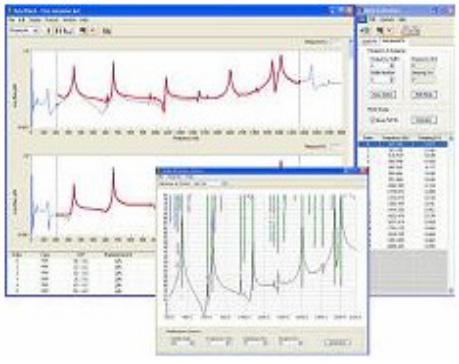
Data Management



3D modeling and animation



Data acquisition



Modal analysis

Note：LabVIEW is the trademark of National Instruments Corp.