MAGNETIC FIELD MAPPING SYSTEM FOR HORIZONTAL BORE MAGNETS

- **RRI's FMU-MRI system, used for mapping static magnetic fields in Horizontal-bore, MRI magnets**

- **Operates on 1H NMR and a heli-spherical NMR probe actuator.**

- **Digitally synthesized RF with FAST-SWEEP NMR Spectrometer with 10 MHz range**

- **The spectrometer operates from below 5 MHz (0.12 Tesla) to above 1500 MHz (35 Tesla).**

MAGNETIC FIELD MAPPING SYSTEM MAIN OPERATING PROPERTIES

- Operation at proton (H-1)resonance frequency

- Equipped with a heli-spherical path electro-mechanical probe and designed for a single sample operation.

- High resolution stepper motor under computer control with 1600 steps per revolution

- The heli-cylindrical probe actuator was designed for use in bore diameters between 200 and 1200 mm.

- Use of the spherical-path probe is very efficient and result in data suitable for axial and radial component analysis simultaneously.

- System completes a full mapping and analysis cycle in less than 30 minutes.

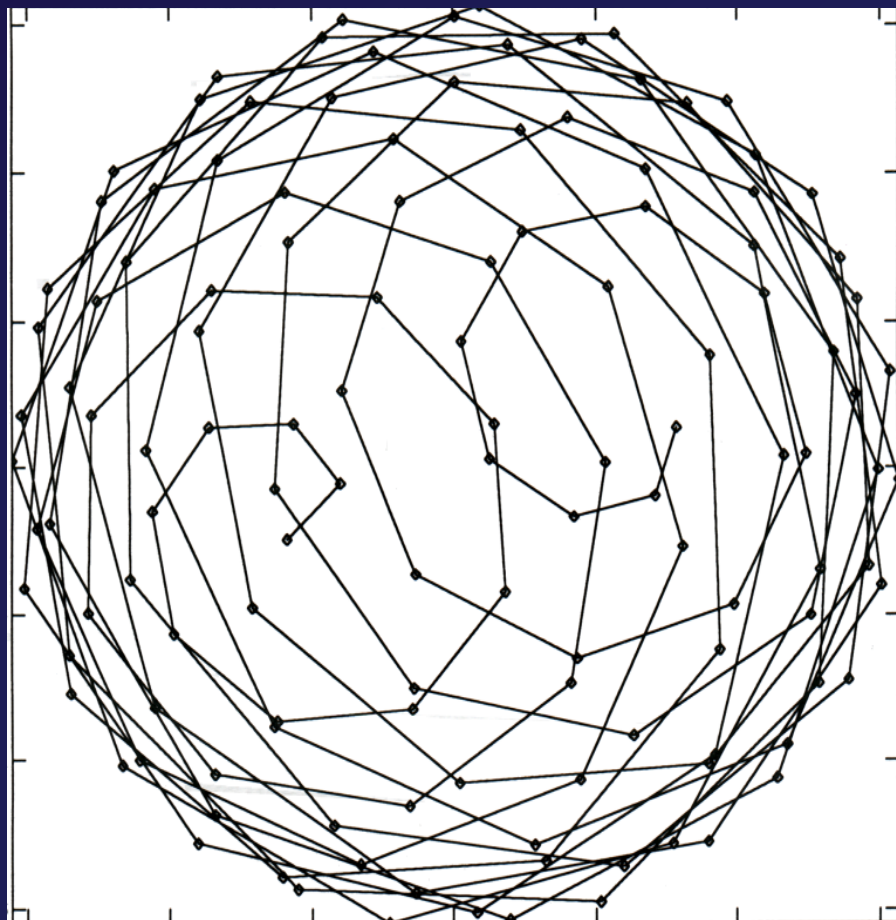# Mapping Probe Parameters
Older version shown

Probe trajectory
HELISPHERICAL

Radius	**75-250mm**
Pitch	**9.8 deg**
Length	**1600 mm**
Sample size	**1 mm^3**

HELISPHERICAL SAMPLE TRAJECTORY

Mapper Principles of Operation

- **Magnet center and probe orientation by difference plot, typically ZX**

- **Shim calibration by difference plot and spherical harmonic analysis**

- **Results stored in .STR files**

- **Shim convergence by matrix inversion using the .STR files**

- **Option for remote shim power supply operation**

- **Residual gradient calculation with SD error**
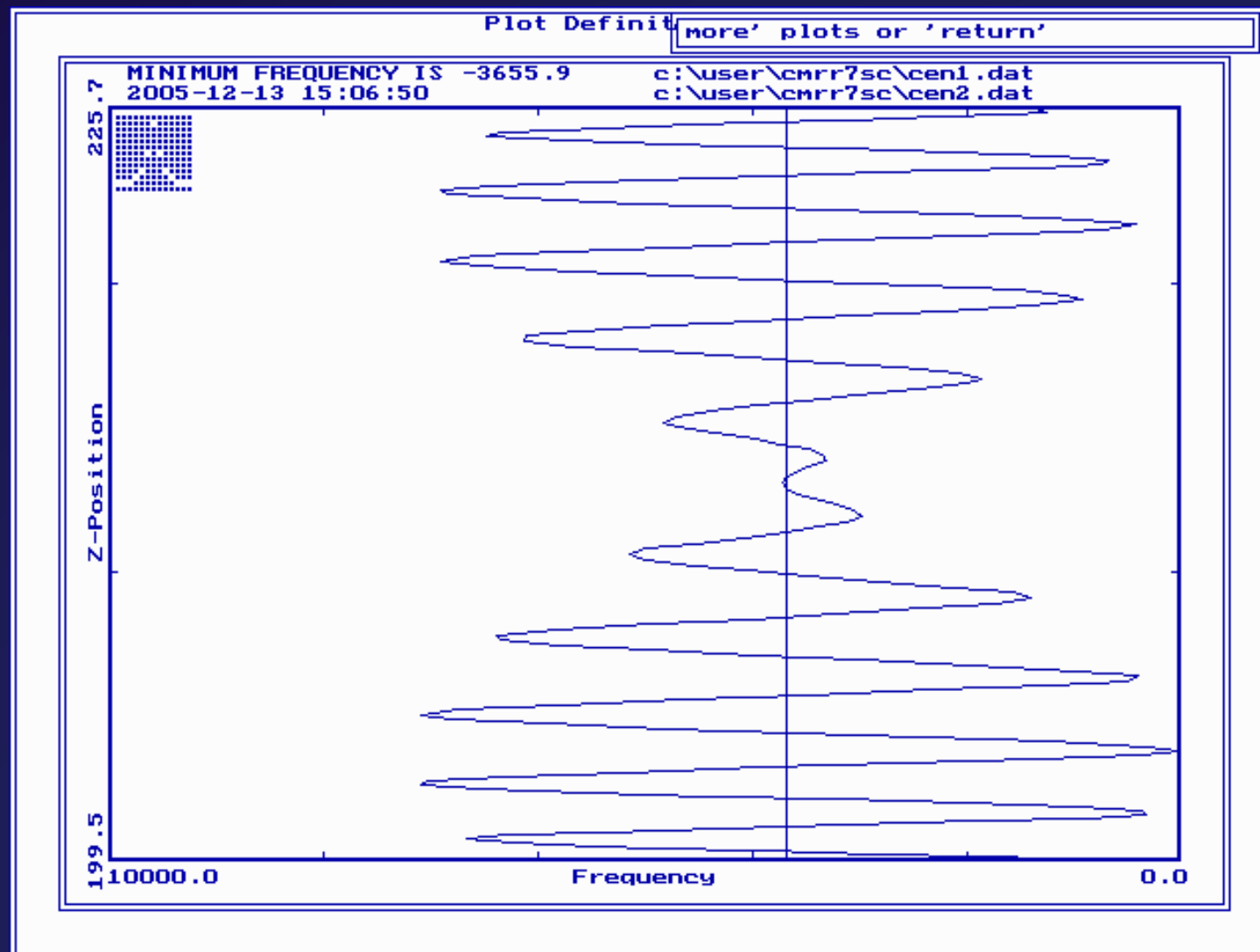
Shim Calibration by Difference plot

- **Acquire magnet Map 1 with shim setting to Value 1**

- **Acquire magnet Map 2 with shim setting to Value 2**

- **Automated difference map plot**

- **Spherical harmonic coefficient calculation**

- **Store data**

Difference Plot of ZX Shim

Typical Spherical Harmonic Coefficient Analysis of a Map (shown 750 MHz vertical bore)

```
                      Results of Analysis
                             2007-12-24 14:59:04
                             c:\user\mit75sc\map16.dat


     Gradient    z0 =      -1478.71    +/-     3.55     Hz/cm^n
     Gradient     z =       -147.46    +/-     3.11     Hz/cm^n
     Gradient    z2 =        151.04    +/-     4.17     Hz/cm^n
     Gradient    z3 =        -21.79    +/-     4.91     Hz/cm^n
     Gradient    z4 =         -3.02    +/-     6.64     Hz/cm^n
     Gradient    z5 =        0.0000
     Gradient    z6 =        0.0000
     Gradient    z7 =        0.0000
     Gradient    z8 =        0.0000
     Gradient    z9 =        0.0000
     Gradient   z10 =        0.0000
     Gradient   z11 =        0.0000
     Gradient     x =        -45.99    +/-     5.36     Hz/cm^n
     Gradient     y =         93.22    +/-     5.38     Hz/cm^n
     Gradient    zx =        878.85    +/-     8.01     Hz/cm^n
     Gradient    zy =       -113.18    +/-     8.11     Hz/cm^n
     Gradient    c2 =          4.64    +/-     6.61     Hz/cm^n
     Gradient    s2 =          9.18    +/-     6.60     Hz/cm^n
     Gradient   z2x =          3.55    +/-     6.08     Hz/cm^n
     Gradient   z2y =         -5.07    +/-     6.29     Hz/cm^n
     Gradient   zc2 =         -5.68    +/-     5.58     Hz/cm^n
     Gradient   zs2 =         -3.81    +/-     5.56     Hz/cm^n
     Gradient    c3 =         -1.90    +/-     5.66     Hz/cm^n
     Gradient    s3 =          5.52    +/-     5.64     Hz/cm^n
     Gradient   z3x =         -6.89    +/-     8.04     Hz/cm^n
     Gradient   z3y =          4.97    +/-     8.58     Hz/cm^n
     Gradient  z2c2 =        -27.59    +/-     7.30     Hz/cm^n
     Gradient  z2s2 =        -11.60    +/-     7.27     Hz/cm^n
     Gradient   zc3 =          2.31    +/-     6.58     Hz/cm^n
     Gradient   zs3 =          5.50    +/-     6.50     Hz/cm^n

     Sum of squared residuals is 44306.7
     Correlation coefficient is 0.999517
     RMS uncertainty is 6.307




                   PRESS <Enter> TO CONTINUE
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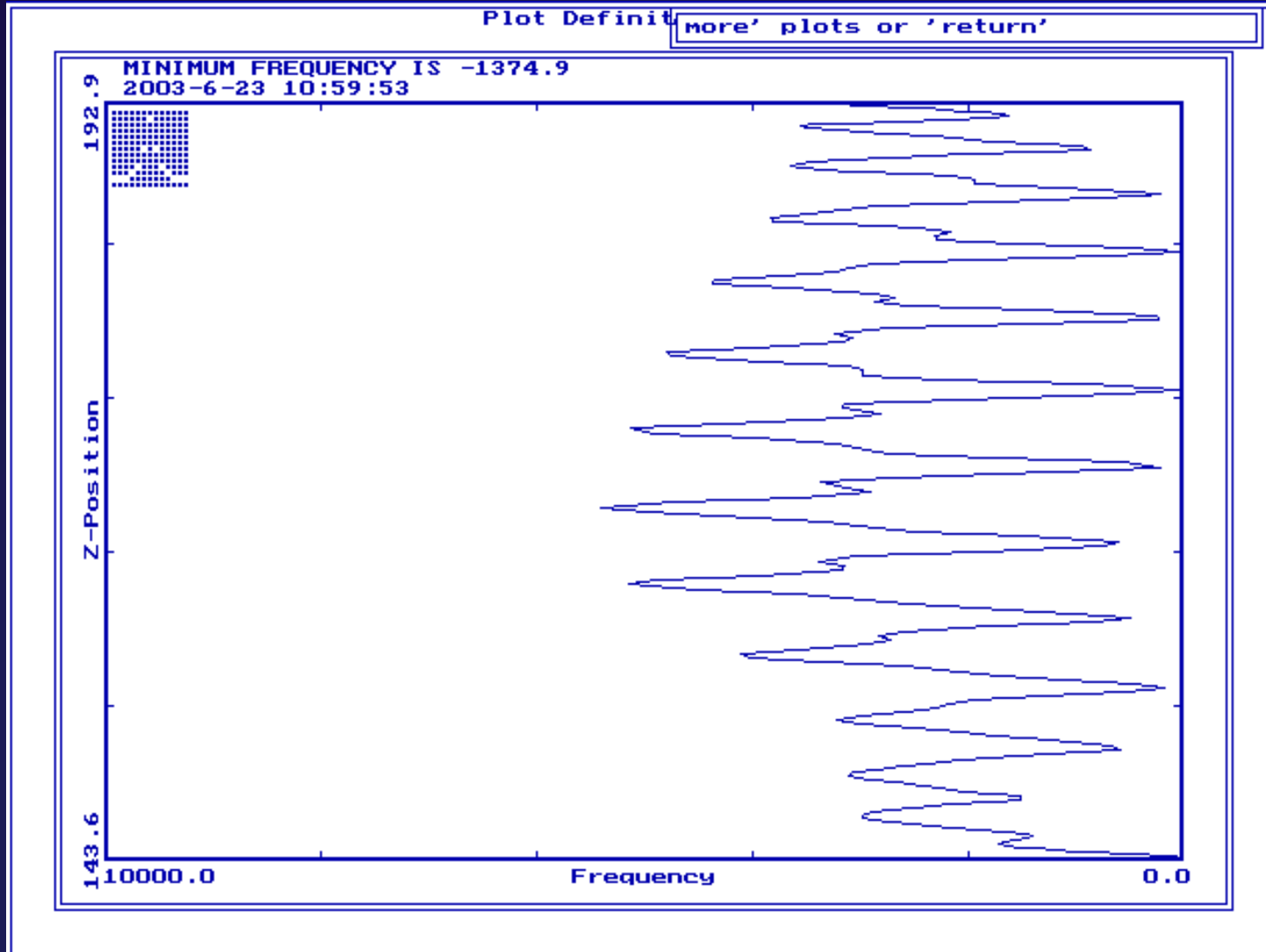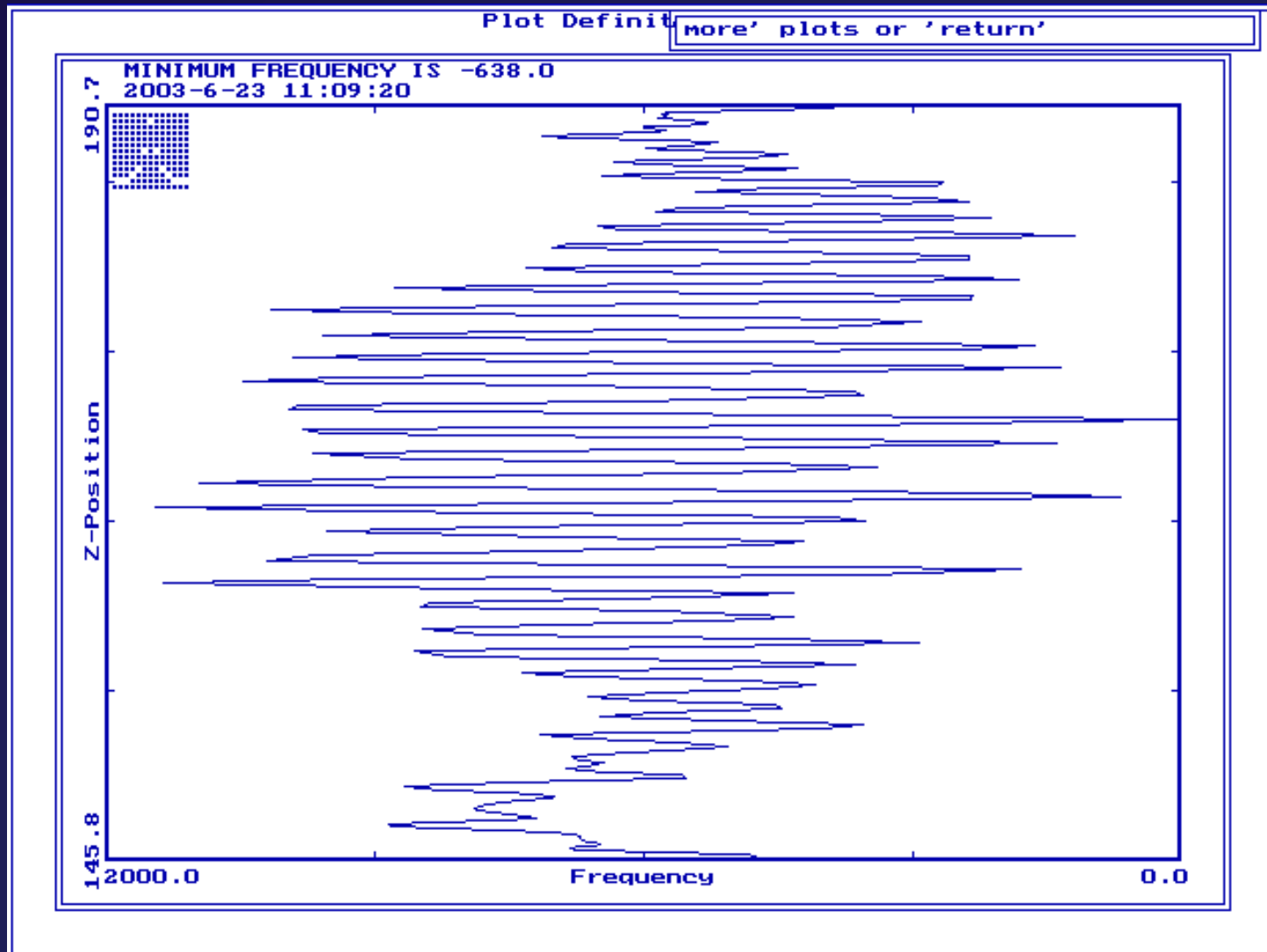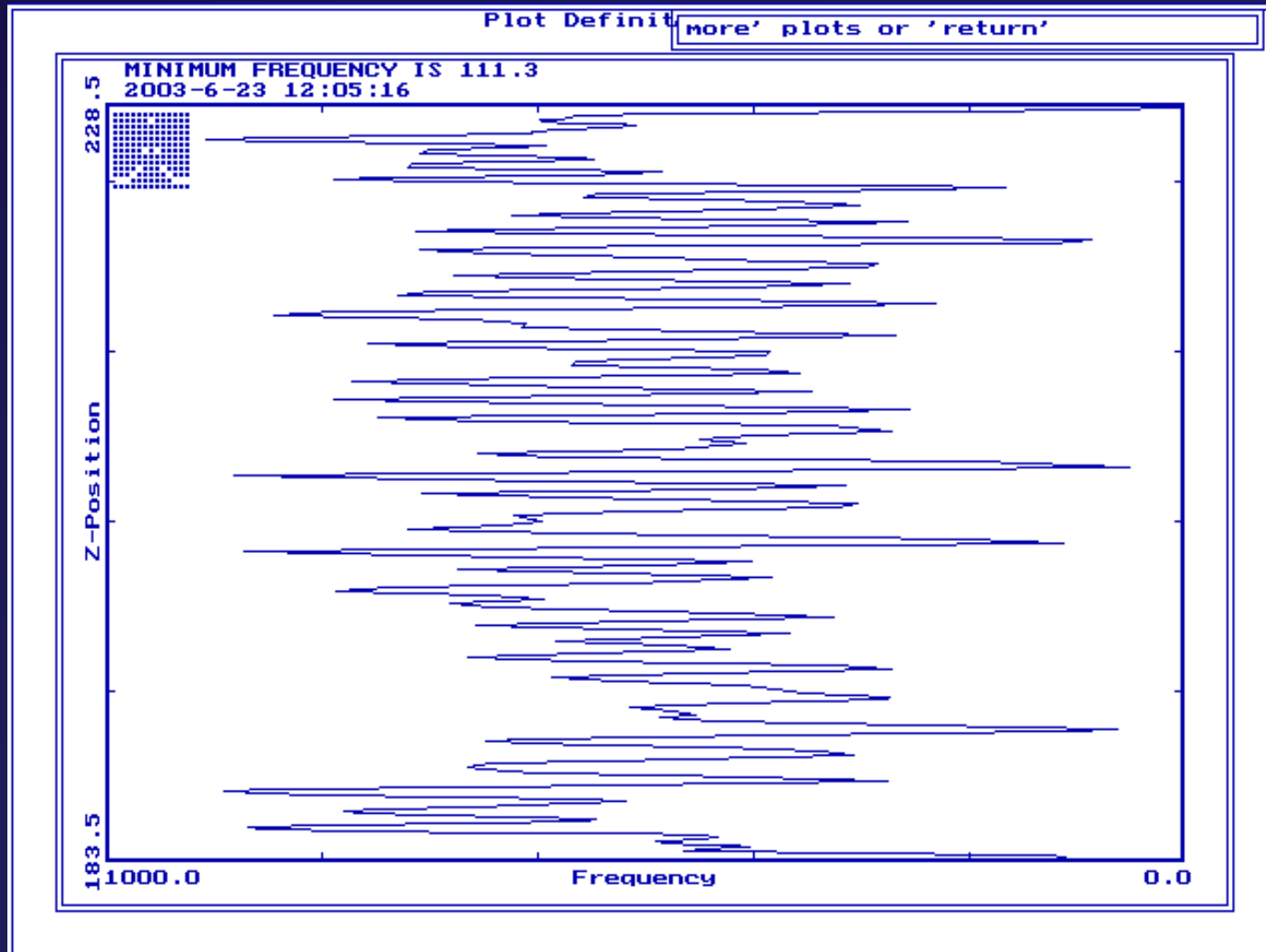
7 T 900 mm Bore Magnet – raw field

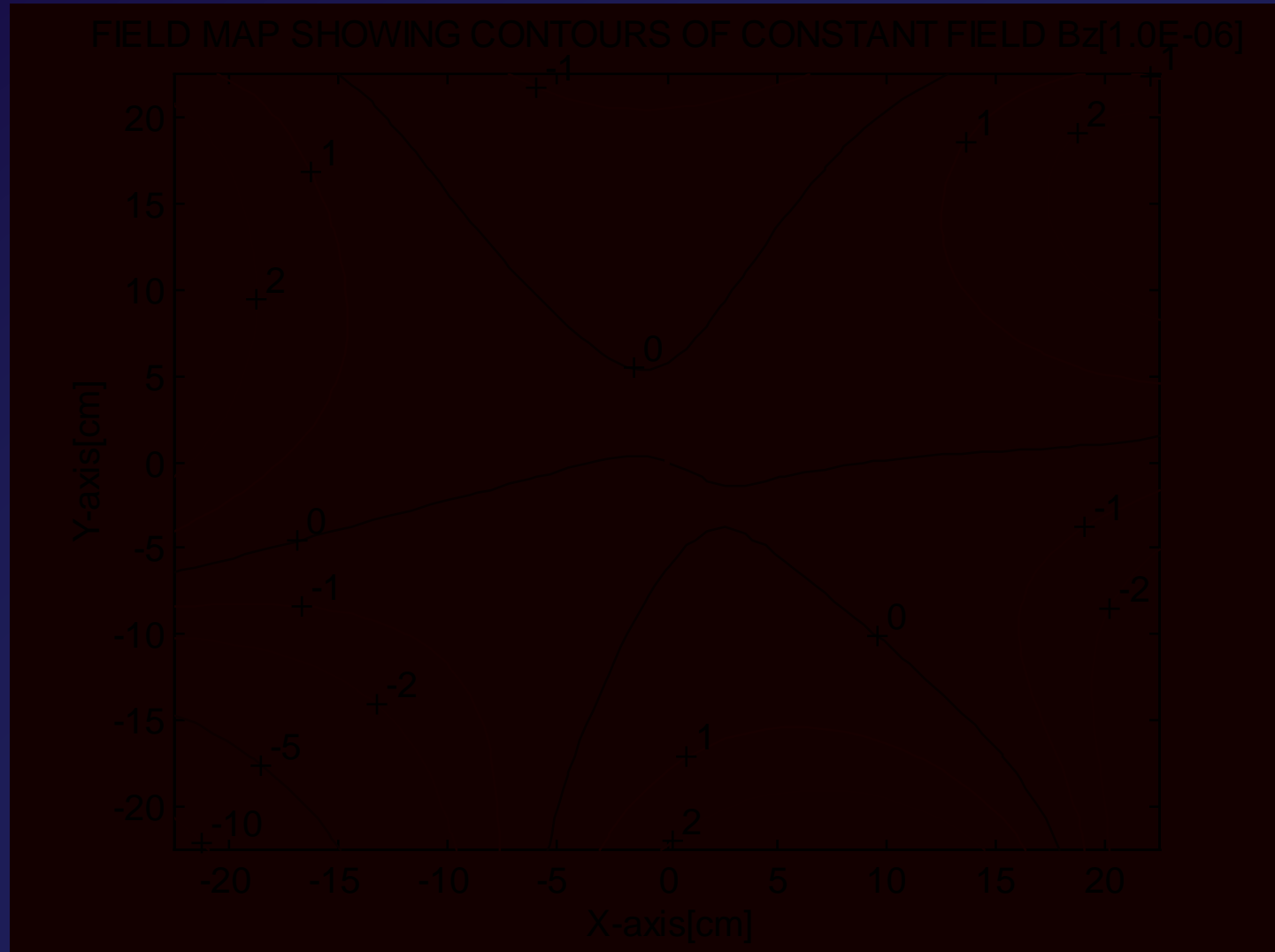**Couresy of Dr. Alan Koretsky NIH**
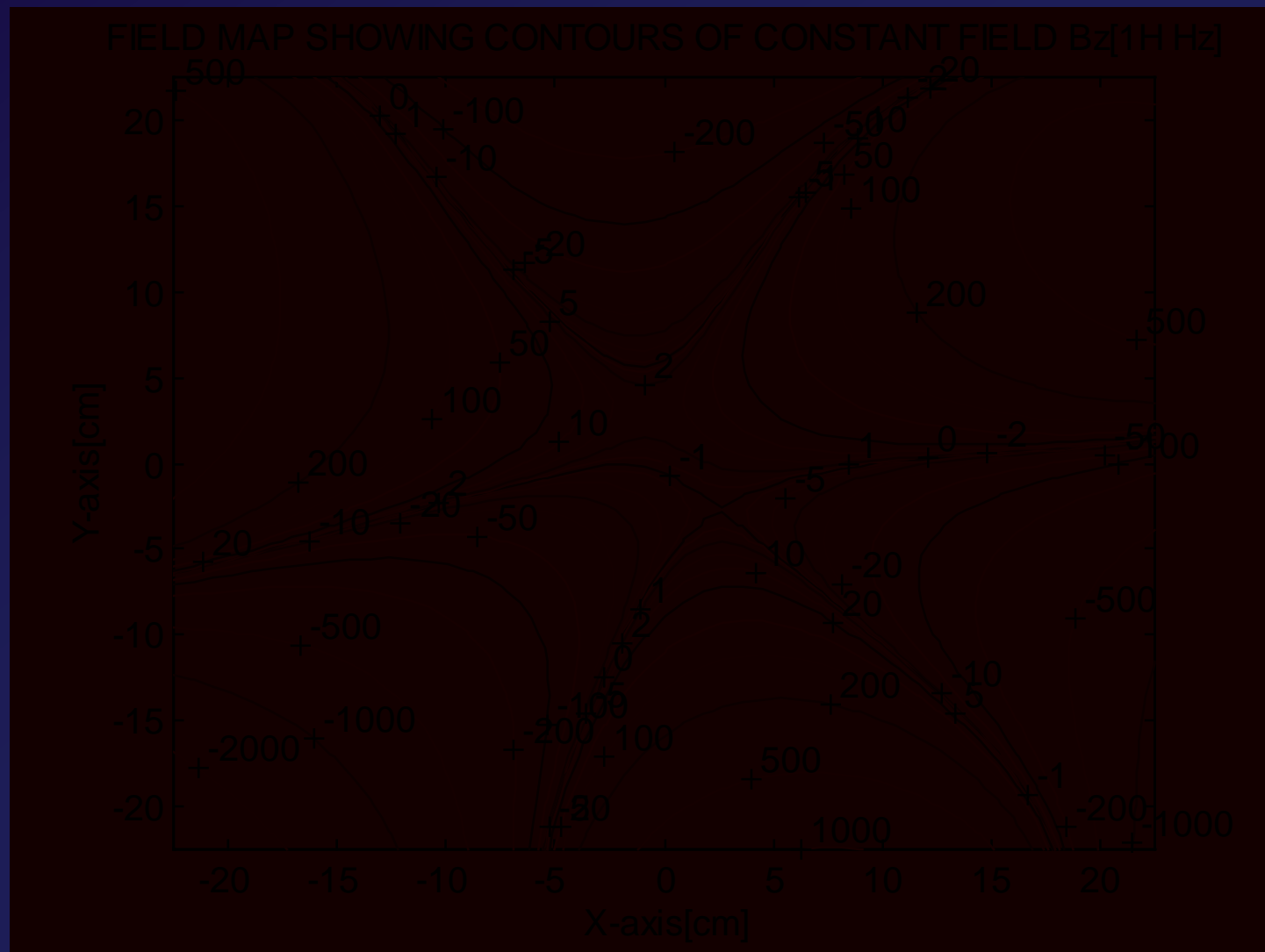
Plot of Final SC Convergence on 45 cm DSV
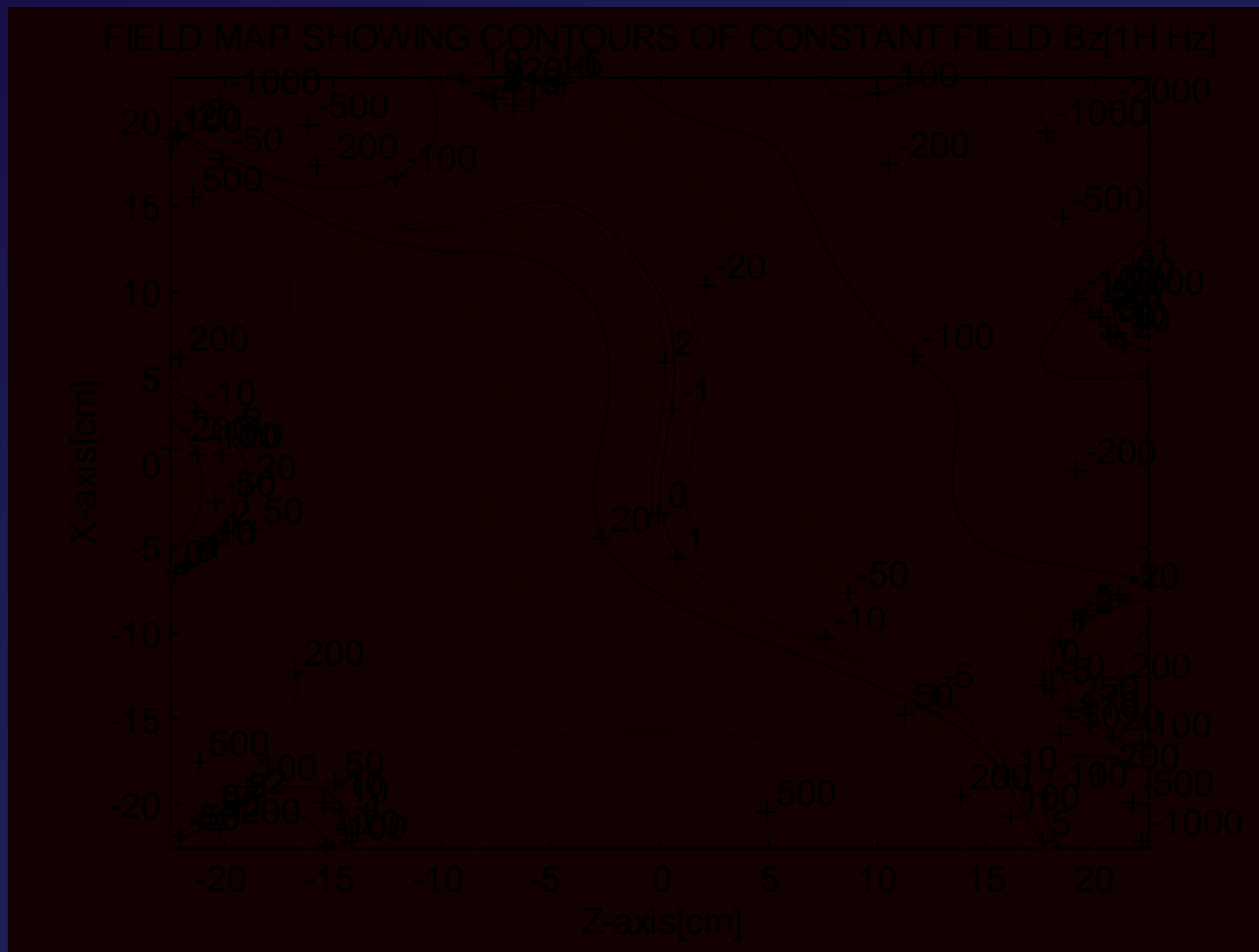
Final RT Convergence with 17 channel shims on 45 cm DSV

Final RT Convergence ppm contour plot
(MathLab post-processing)

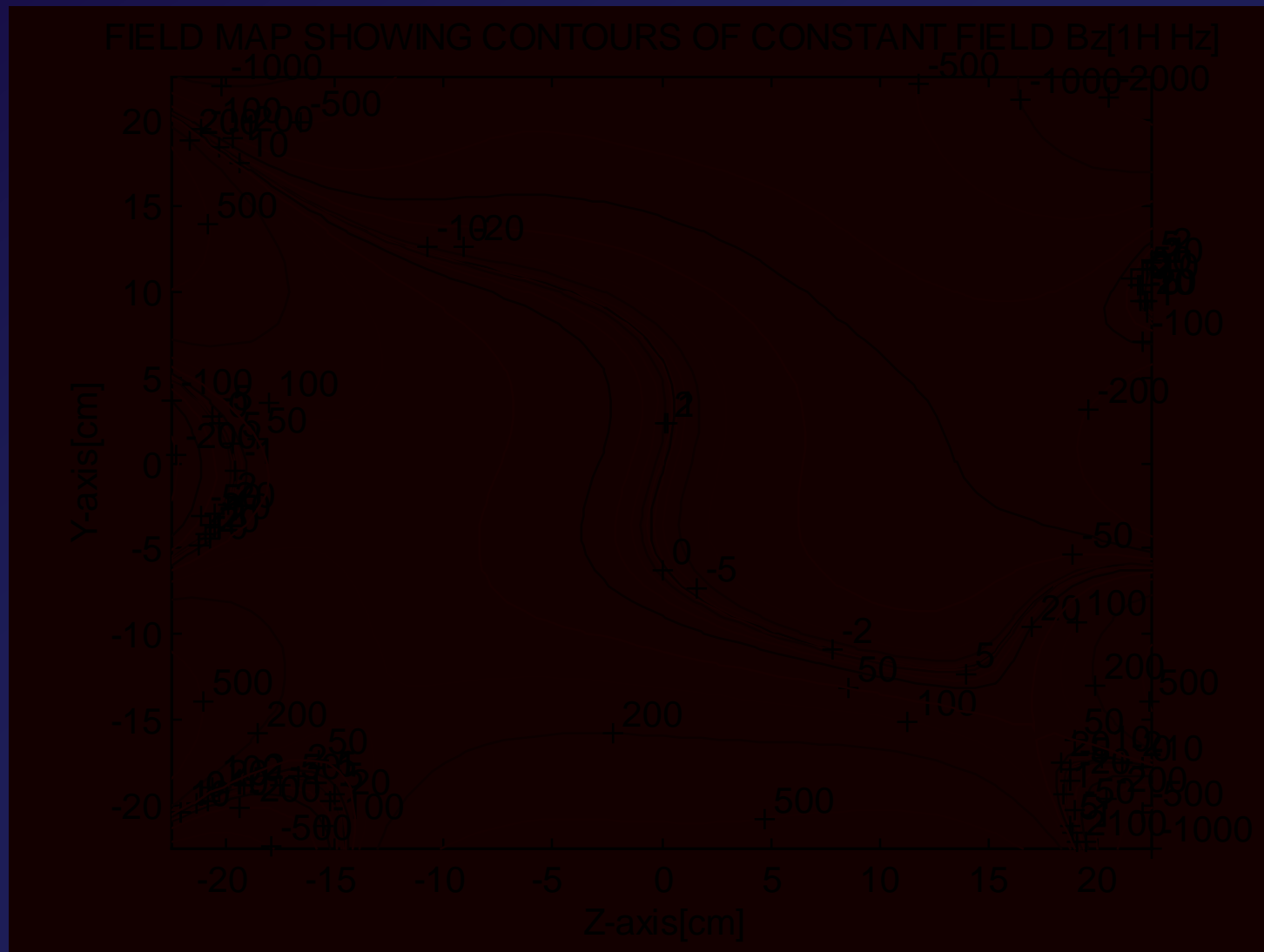FIELD MAP SHOWING CONTOURS OF CONSTANT FIELD Bz[1.0E-06]

Final RT Convergence 1H Hz contour plot in X-Y plane

Final RT Convergence 1H Hz contour plot in Z-X plane

Final RT Convergence 1H Hz contour plot in Z-Y plane

FIELD MAP SHOWING CONTOURS OF CONSTANT FIELD Bz[1H Hz]

Other Functions

- **Drift measurement**
  - **Single point frequency plotted against time**

- **Multiple map repeat and analysis**
- **Probe tuning**

- **Extended analysis and map editing options**
- **Shim simulations**
- **Shim power calculations**
- **Passive shimming as service by RRI**

Magnet Ramp Power Supply

MXR-800

- **Output: 880A @ 12V**
- **Programmable ramp sequences**
- **Ramp rates adjustable up to 120A/min in 1A increments**
- **20mA current resolution**
- **Quench detection circuit**
- **Programmable switch heater current up to 1A**
- **Reinforced shippable enclosure**

Thank you for your attention