DESCRIPTION

MMS-1A-RS is the high-end version of the SENIS 3-axis Magnetic Field Mapping System that allows users to perform a fast, high resolution mapping of magnetic field around permanent magnets, electromagnets and electronic circuit PCBs. The map of the magnetic field can be presented as color coded 1D, 2D or 3D isometric visual displays and as a table of numerical values of the magnetic field and the geometrical coordinates of measured points. The measured data analysis is performed during the mapping of the magnetic field, so that calculated data required for the analysis can be visualized immediately after the mapping.

MMS-ANALYSIS is an additional software module of the MMS-1A-RS magnetic field mapper software that can be used for the on-line (during the mapping) and for the offline analysis of the measured data. It visualizes the measured and calculated 3-axis magnetic field data in various, customized and intuitive color coded displays, and tables.

Due to unique features of the applied fully integrated **3-axis Hall probe**, all three components of the magnetic field are measured simultaneously at virtually same point (field sensitive area is within a 150µm x 150 µm). The Hall probe can be positioned at a very short distance to the magnet surface (<0.3mm). The mapper computer program and its graphical user interface is an extremely easy-to-use-software built on MS Windows platform and NI LabVIEW. Scanning profiles and measured data visualization are fully customizable.

KEY FEATURES

- **On-line and Off-line (historical) visualization and analysis of the 3-axis magnetic field vector measured around permanent magnets of different sizes and geometries (disc, ring, block, segment and rotors)**
- **User-friendly customization of the measured data visualization and analysis**
- **Comparison of multiple measured data sets**
- **Visualization of all three components of the magnetic field, Bx, By and Bz as well as B_{xy} (in-plane field distribution), B_{Total}, B_{max}, B_{min}, B_{rms}, North-South pole**
- **Visualization of the slope (Inclination and Declination), magnetic field homogeneity, angle error**
- **Fourier Analysis (FFT) and visualization of the first 10 harmonics, single and total harmonic distortion**
- **Visualization of the multipole magnetic field – number of poles, min, max, average pole width, pole distribution, pole pitch, pitch error, zero crossing**
- **Visualization of the cracks and inhomogeneity in the magnetized and non-magnetized parts**

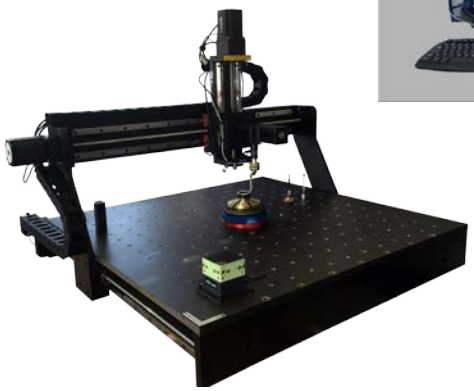

Figure 1: **Magnetic Field Mapper Software with the optional MMS-ANALYSIS Module**

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APPLICATIONS – MAPPING OF PERMANENT AND ELECTRO-MAGNETS & PCBs

Different geometries and sizes of permanent magnets, electromagnets, as well as electronic appliances and PCB's can be easily can be easily positioned and fixed on the mapper table or on the rotary stage to be mapped by an 3-axis Hall probe (magnetic field mapping) or by an eddy-current prob (cracks and inhomogeneity detection) or by a pick-up coil probe (electromagnetic compatibility). The measurement profile, i.e. scanning path, vizualisation and reporting can be setup within minutes using an interactive software graphical user interface and predifined mapping scenarios and commands.

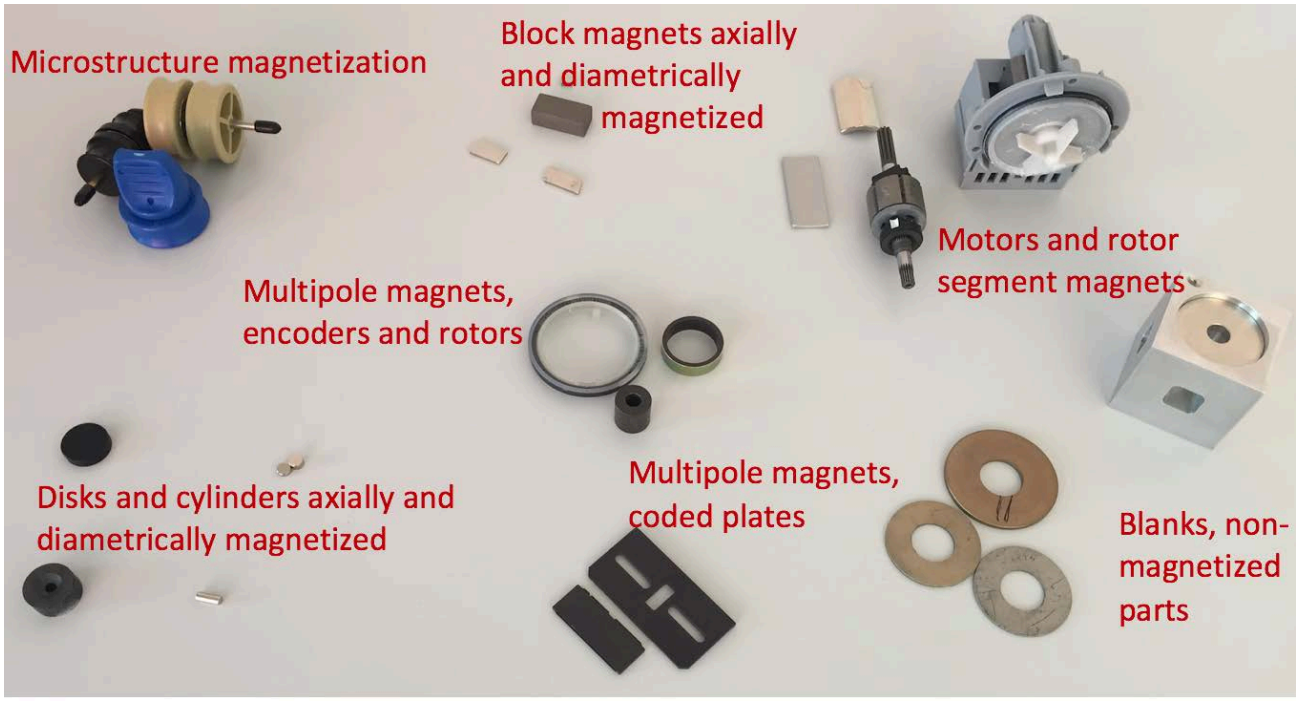

Figure 2: **Some samples of permanent magnets, electromagnets, as well as electronic appliances and PCB's that can be easily mapped on SENIS mappers within minutes**

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MAGNETIC FIELD MAPPER SOFTWARE

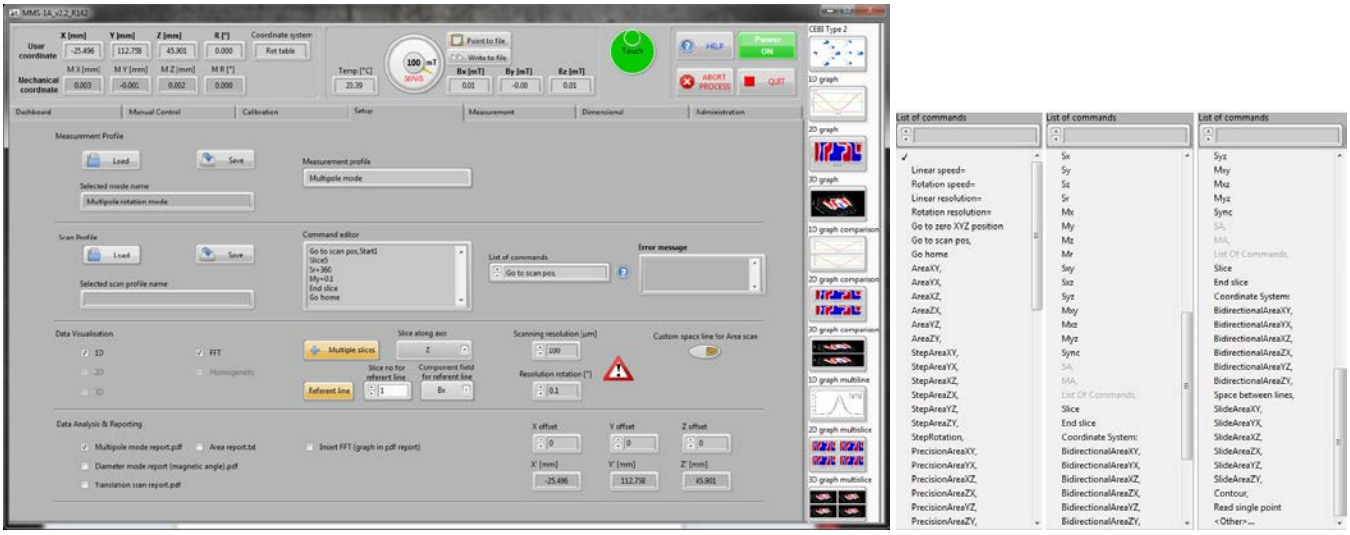

Figure 3: **Flexible setup of measurement profiles and scan paths using the command set**

Figure 4: **Measurement Tab – Header data set-up and data visualization area**

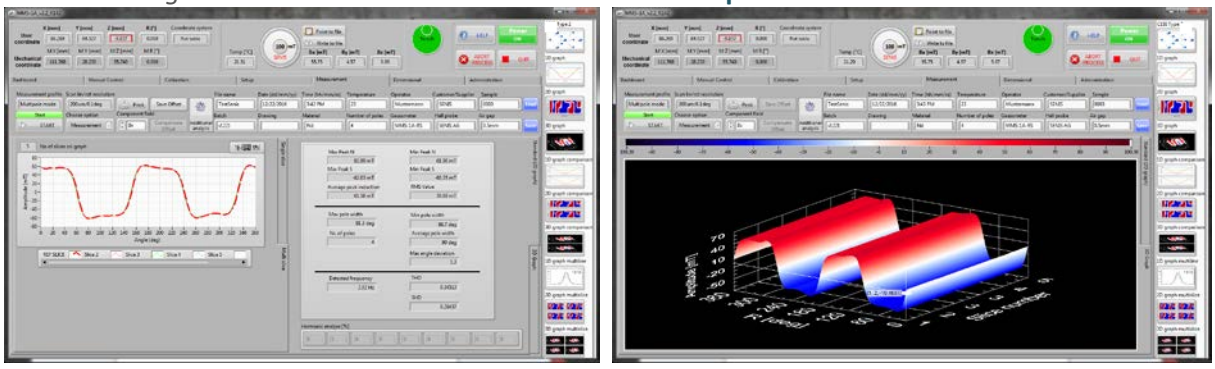

Figure 5: **Header Data set-up; Measured data and analysis visualization in the Mapper software**

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1. DISK AND RING MAGNETS DIAMETRICALLY MAGNETIZED

Applications: Angle and Position Sensors (Automotive, Consumer Industry)
Scanning profile: Hall probe is positioned at the centre of magnet at the defined height (typically 0.3-0.5mm) and the magnet is rotated by 360° on the rotary stage. The probe can be then positioned at different radii and heights.
Pos. resolution: 0.1°
Mapping duration: 5sec
Measured data: Bx, By, Bxy, Btotal, FFT, Homogeneity (angle error), peak values (N and S)

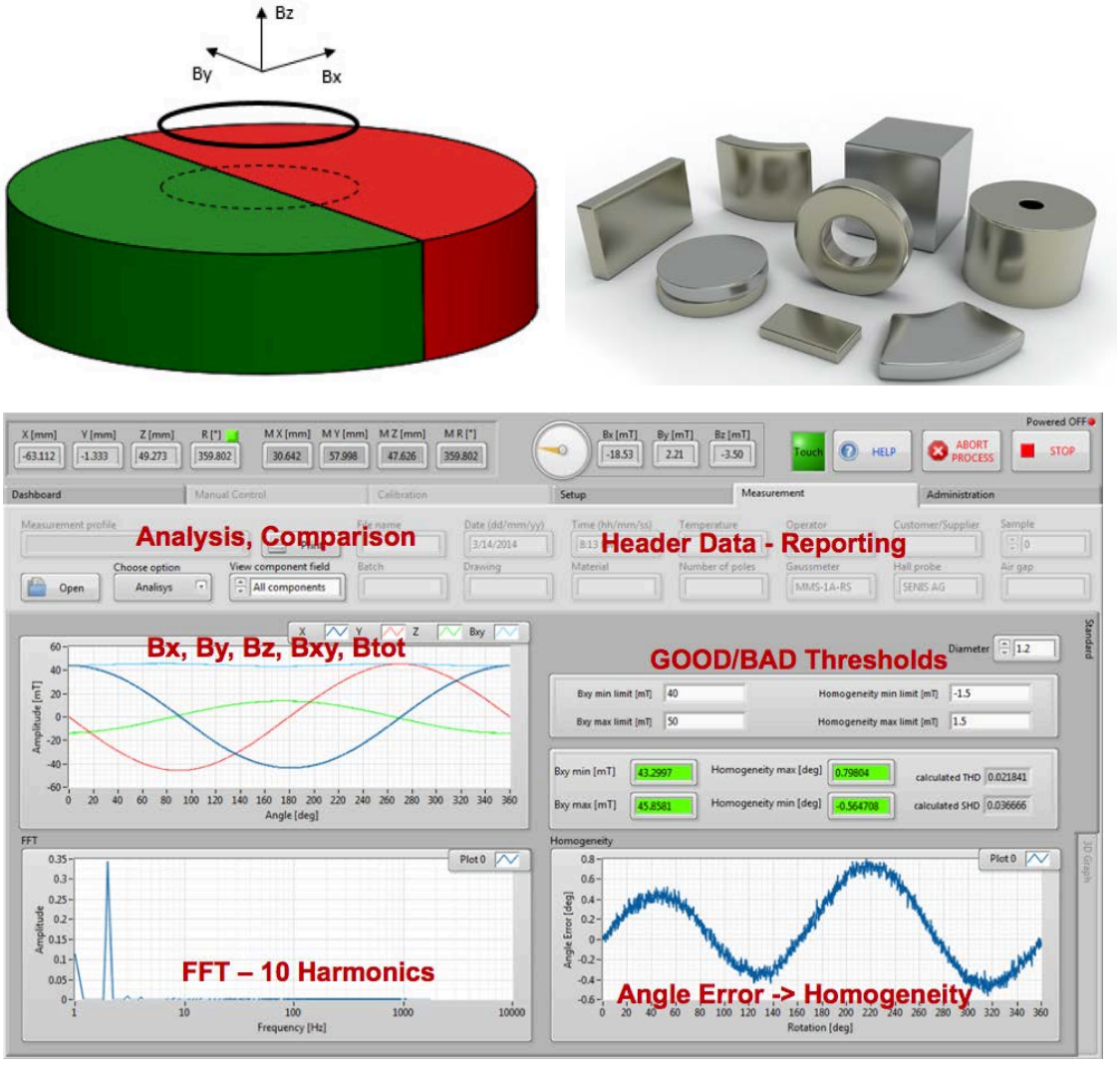

Figure 6: **Mapper Software: Visualization of the map around the diametrically magnetized disk and ring magnets**

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2. CYLINDRICAL MAGNETS AXIALLY MAGNETIZED

Applications: Angle and Position Sensors (Automotive, Consumer Industry)
Scanning profile: Hall probe is positioned at the starting position (the corner of the area to be scanned) at the defined height (typically 0.3-0.5mm). Then the probe scans the defined area, XY, XZ or ZY. The probe can be then positioned at different heights to scan several slices.
Pos. resolution: 0.1mm
Mapping duration: 2min with the positioning resolution of 0.1mm
Measured data: 2D and 3D of Bz magnetic field component

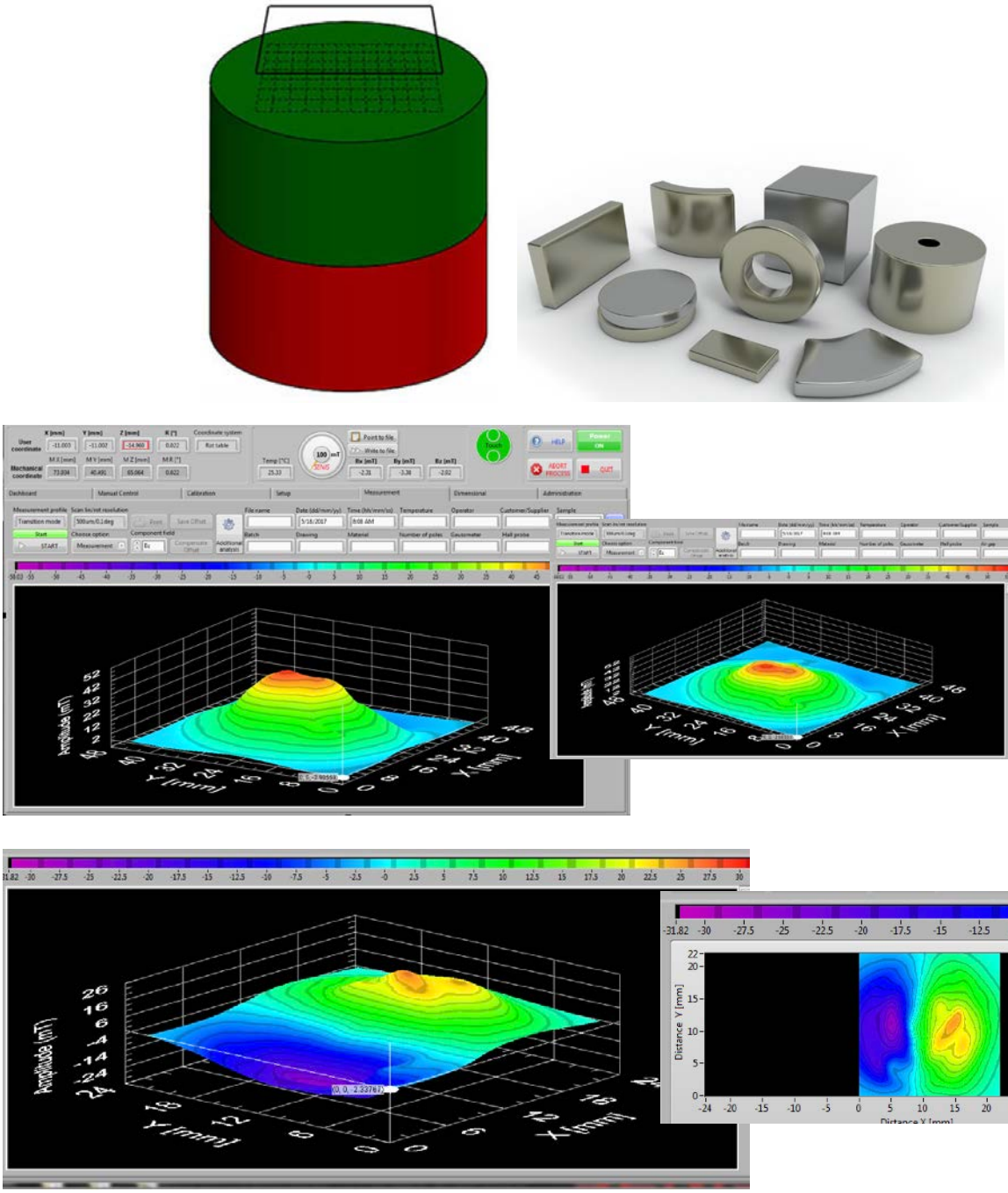

Figure 7: **Mapper Software: Visualization of the map around the axially magnetized cylindrical magnets**

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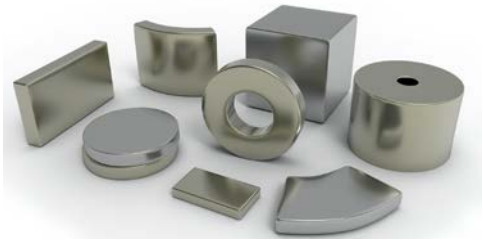
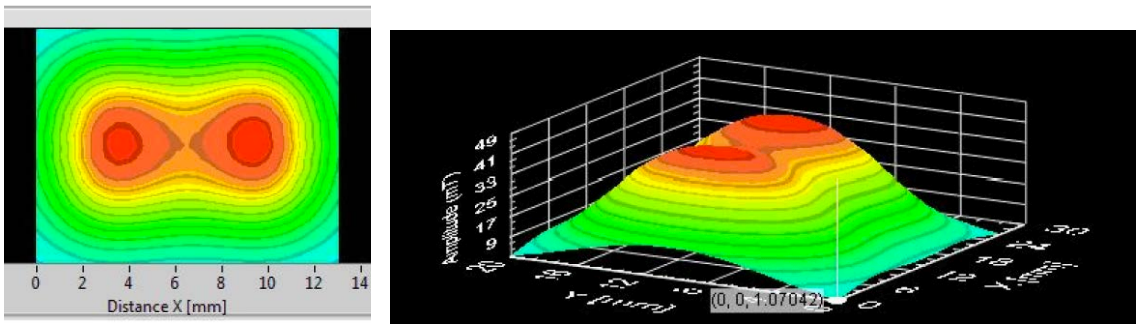
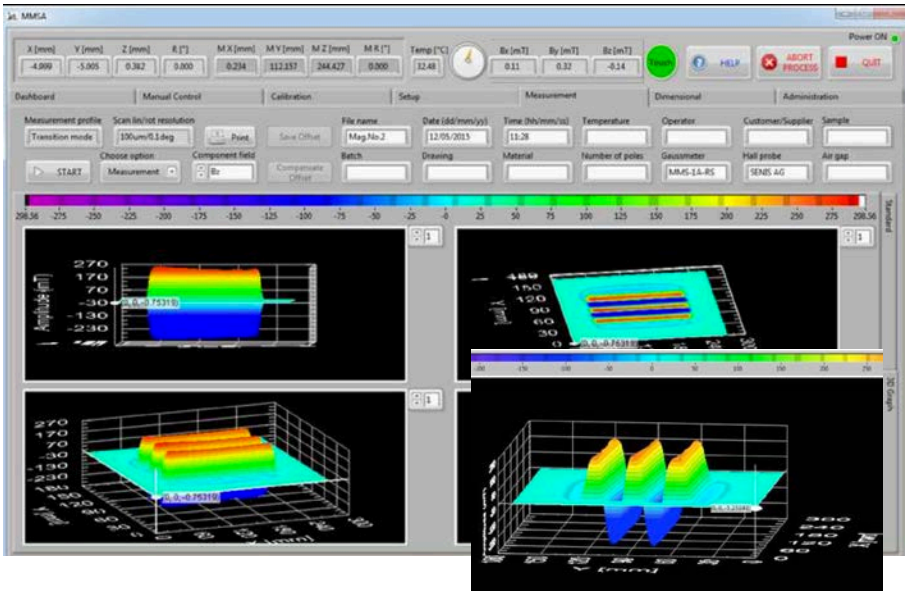
3. BLOCK MAGNETS AXIALLY MAGNETIZED

Applications: Angle and Position Sensors (Automotive, Consumer Industry)
Scanning profile: Hall probe is positioned at the starting position (the corner of the area to be scanned) at the defined height (typically 0.3-0.5mm). Then the probe scans the defined area, XY, XZ or ZY. The probe can be then positioned at different heights to scan several slices.
Pos. resolution: 0.1mm
Mapping duration: 2min with the positioning resolution of 0.1mm
Measured data: 2D and 3D of Bx, By and Bz magnetic field components







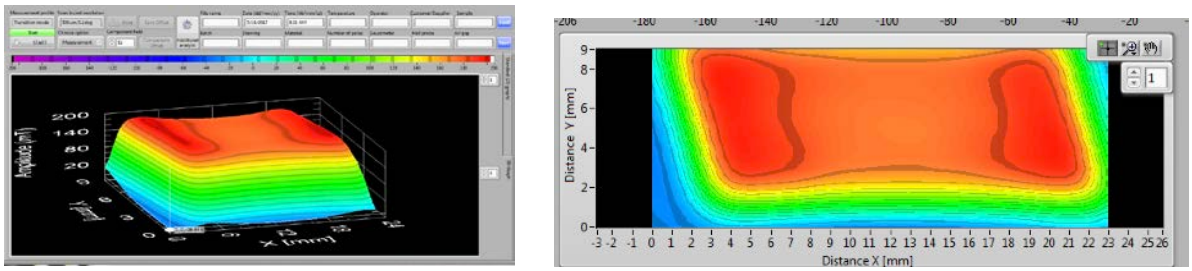


Figure 8: **Mapper Software: Visualization of the map around the axially magnetized block magnets**

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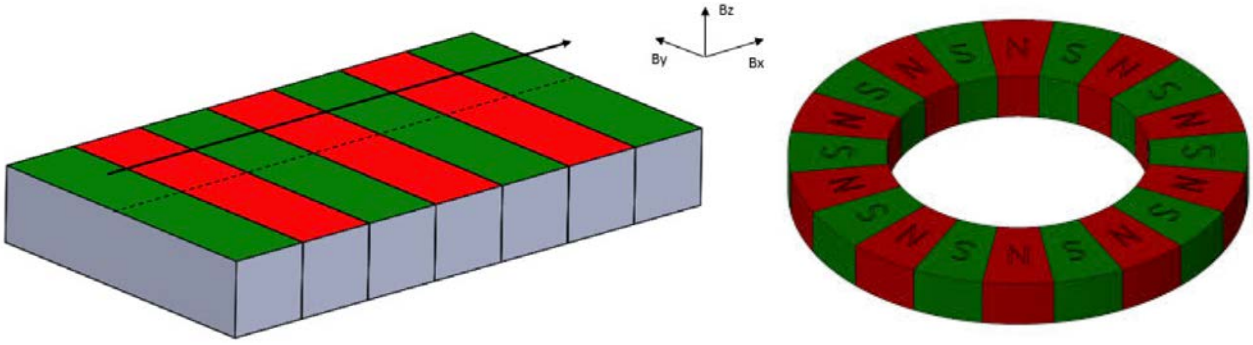
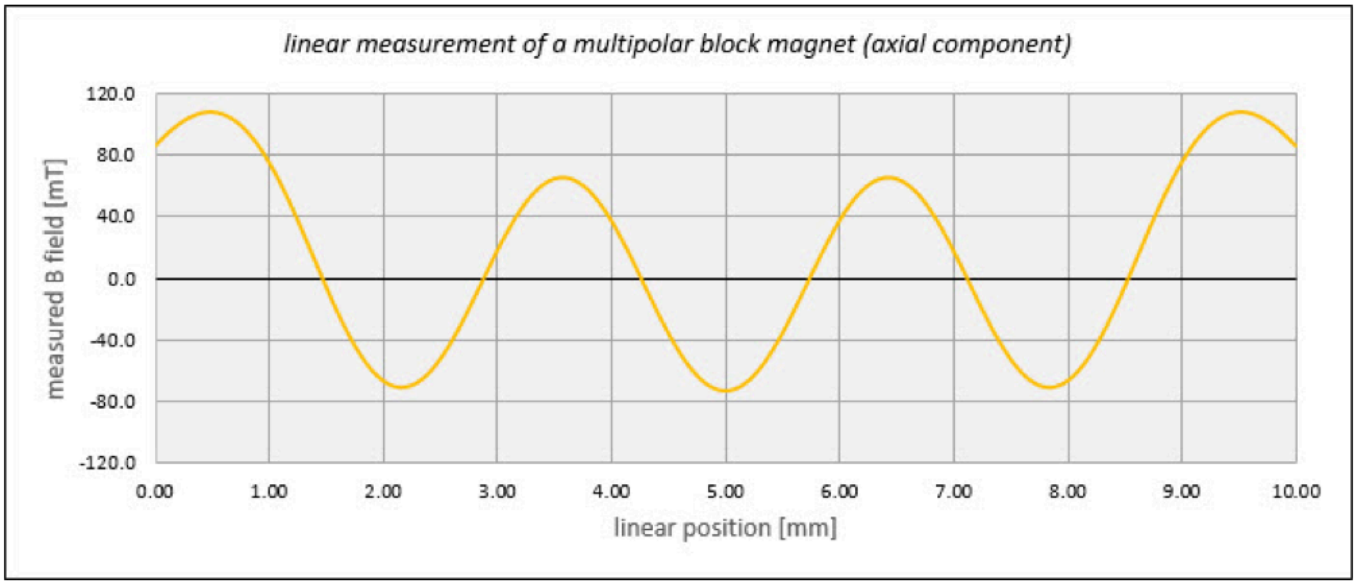
4. LINEAR AND ROTARY ENCODER MAGNETS (SCALES)

Applications: Angle and Position Sensors (Automotive, Consumer Industry)
Scanning profile: Hall probe is positioned at a starting position (edge of the encoder) very close to the magnet surface (0.3mm). The probe is then linearly moved along the encoder length, or the ring magnet is rotated by 360° on the rotary stage.
Pos. resolution: 0.1mm
Mapping duration: 5sec
Measured data: Bz, number of poles, zero-crossings, peak values (N and S), pole disposition, slope





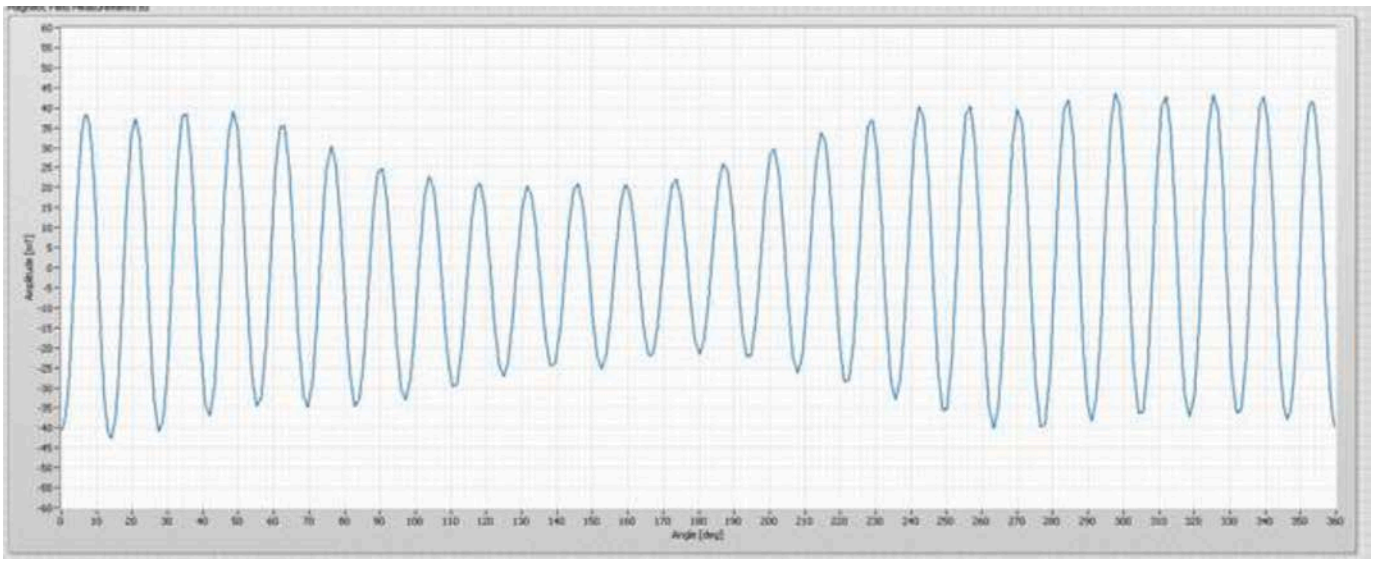


Figure 9: **Mapper Software: Visualization of the map above the linear and rotary encoder magnets**

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5. CODED PLATES

Applications: Position Sensors (Automotive, Consumer Industry)
Scanning profile: Hall probe is positioned at a starting position (edge of the plate) very close to the magnet surface (0.3mm). The probe is then linearly moved along the plate.
Pos. resolution: 0.1mm
Mapping duration: 5sec (for one line); 3min for the area
Measured data: Bz, zero-crossings, peak values

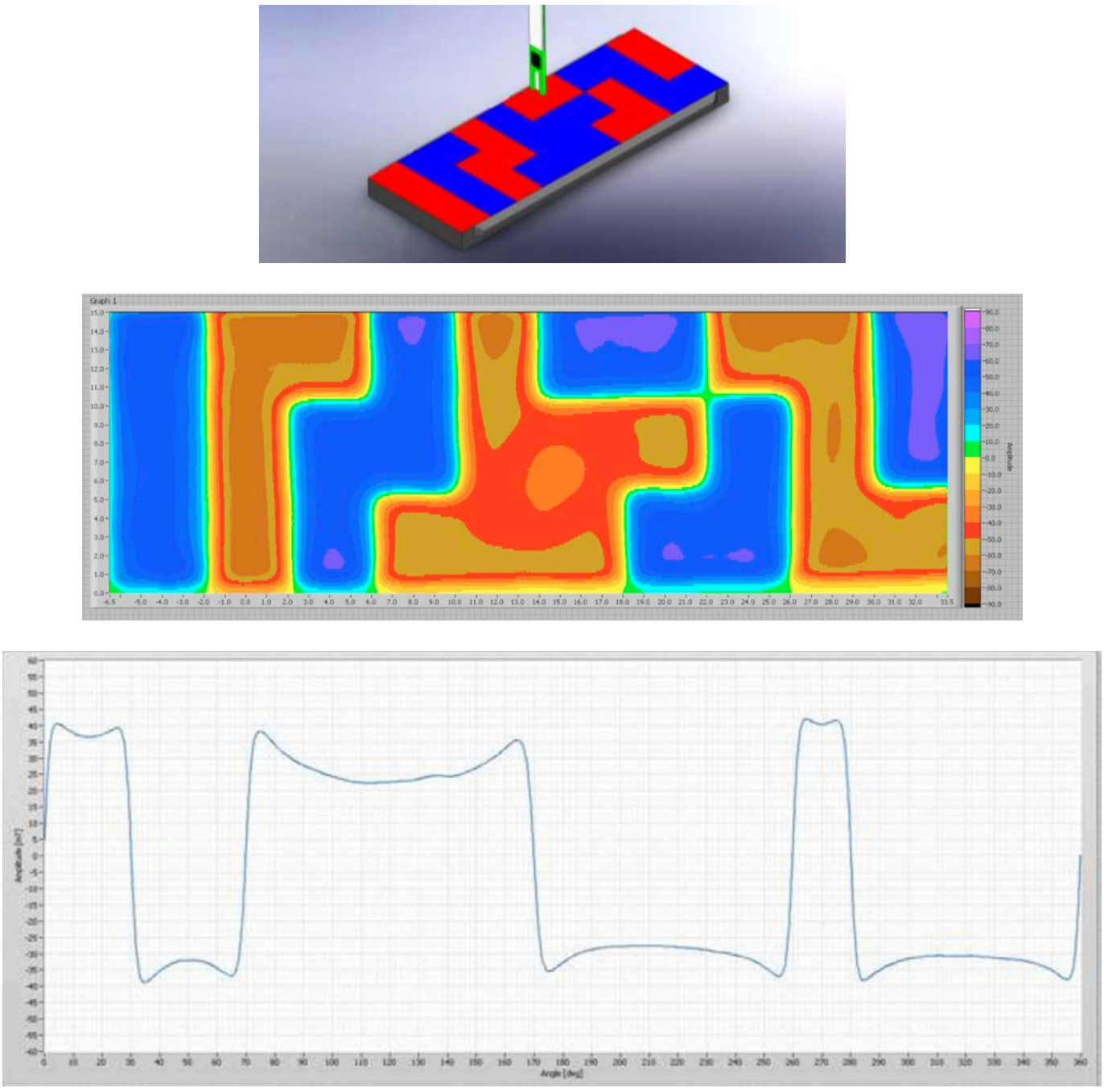

Figure 10: **Mapper Software: Visualization of the map above coded plates**

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6. COMPLEX MAGNETIZATION STRUCTURES – SMART MAGNETS

Applications: Magnets providing spring, latch, align, snap, torque, hold, twist functions for mobile phones, tablets and industry applications

Scanning profile: Hall probe is positioned at the starting position at the defined height (typically 0.3-0.5mm). Then the probe scans the defined XY area in the precision mode. The probe can be then positioned at different heights to scan several slices.

Pos. resolution: high spatial resolution of 10um - 0.1mm (point-by-point and on-the-flight scanning)

Mapping duration: 5min with the positioning resolution of 0.1mm; hours with positioning resolution of 10um

Measured data: 2D and 3D of Bx, By and Bz magnetic field components

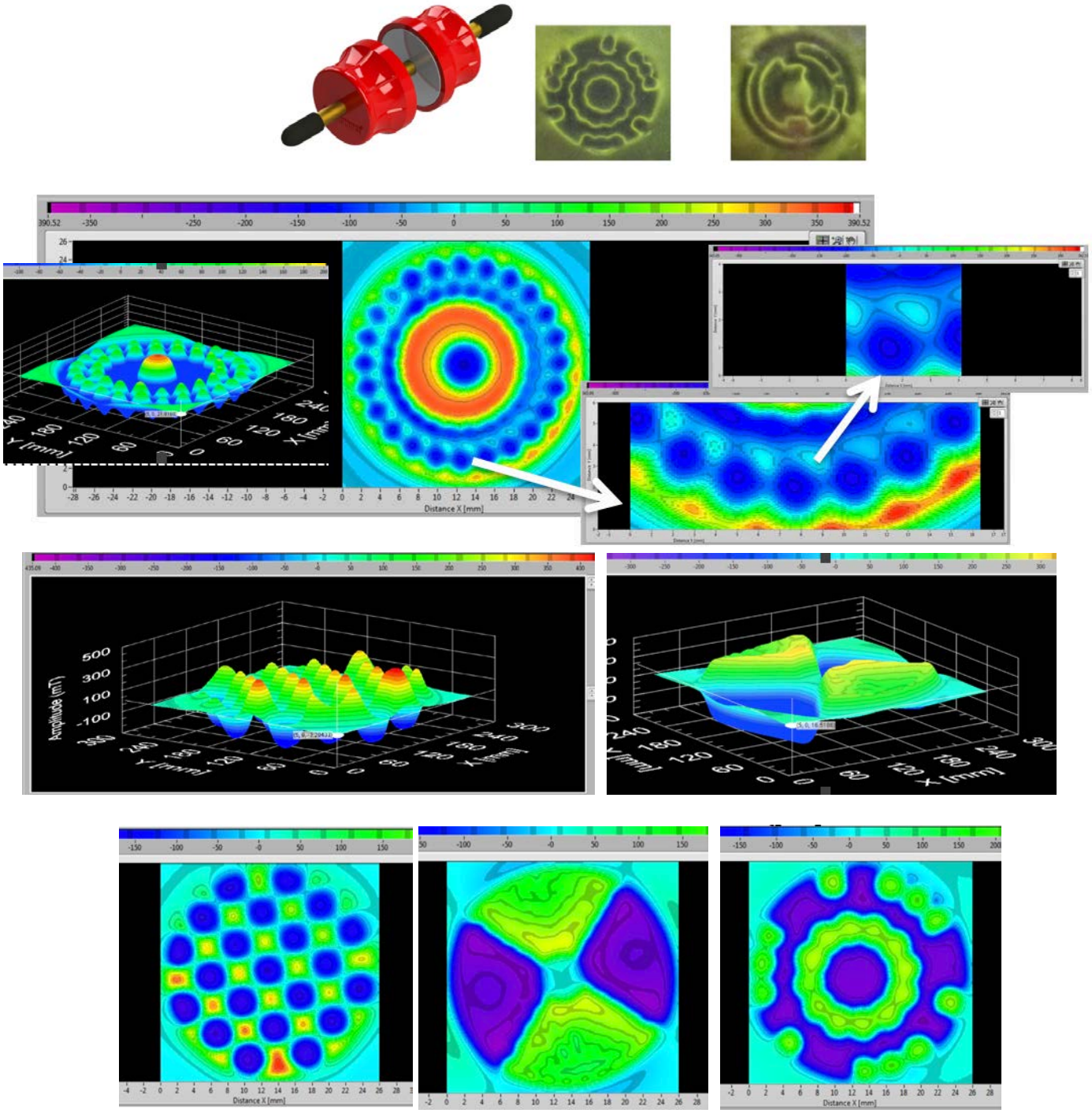

Figure 11: **Mapper Software: Visualization of the map above the complex micro structures**

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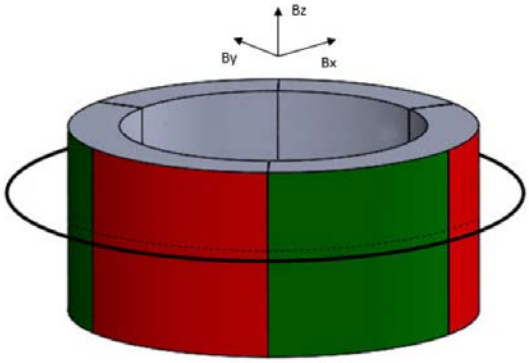
7. ROTOR MAGNETS

Applications: Actuators, Motors (Automotive, Consumer Industry)
Scanning profile: Hall probe is positioned next to the rotor at the defined distance (typically 0.3mm) and the magnet is rotated by 360°. The probe can be then positioned at different heights (slices) to cover the whole rotor surface.
Pos. resolution: 0.1°
Mapping duration: 20sec
Measured data: Bx, By, number of poles, pole width, peak values (N and S), pole disposition, slope, skewing…



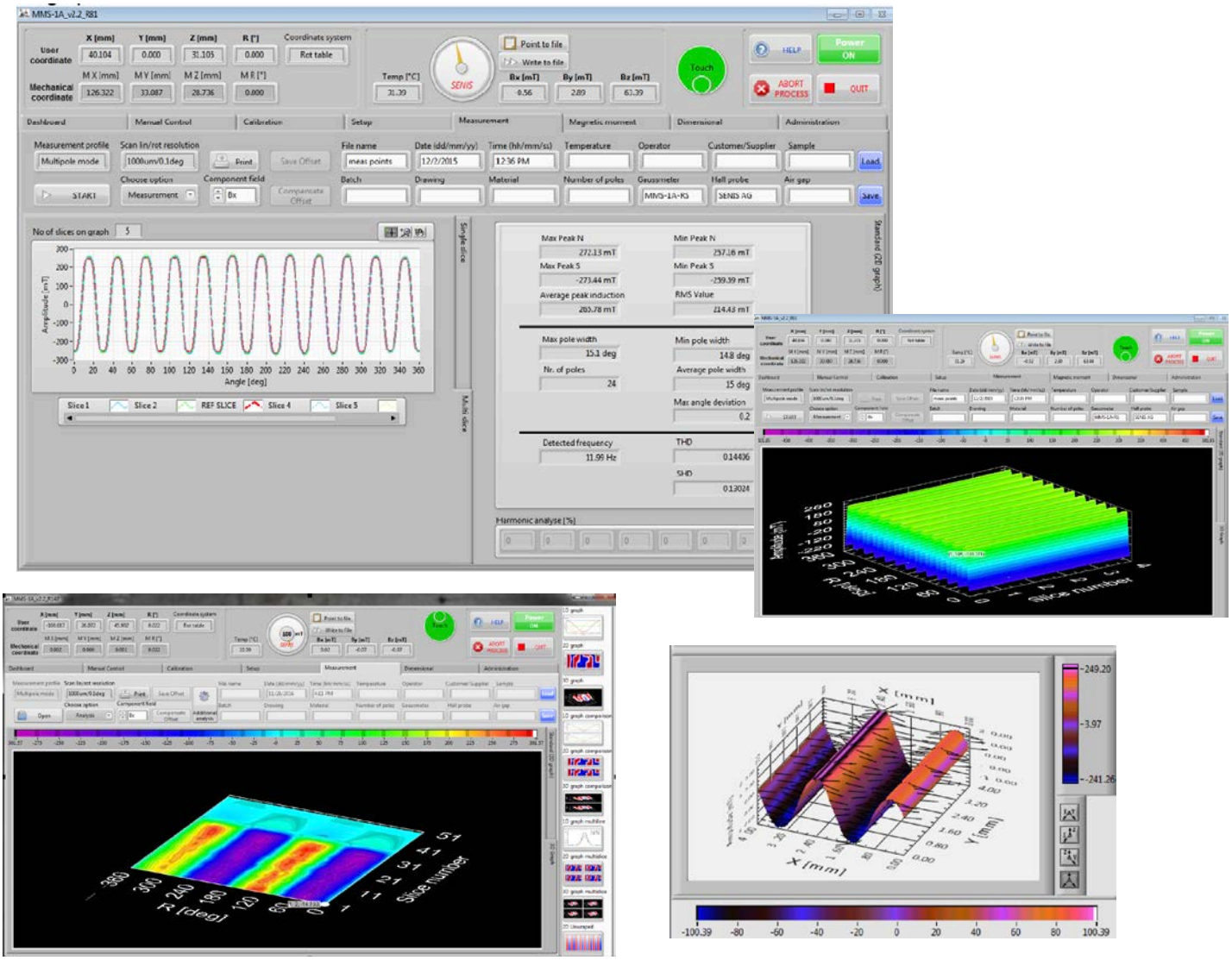


Figure 12: **Mapper Software: Visualization of the map around rotor magnets**

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8. MOTORS

Applications: Actuators, Motors (Automotive, Consumer Industry)

Scanning profile: Hall probe is positioned next to the motor at the defined distance (typically 0.3mm) and the motor is rotated by 360°. The probe can be then positioned at different heights (slices) along the z-axis to cover the whole rotor surface. At the end, the probe can scan the sensor (control) magnet from the top, to calculate the phase shift to the rotor poles.

Pos. resolution: 0.1° - 1°

Mapping duration: 60sec

Measured data: Bx, By, number of poles, pole width, peak values (N and S), pole disposition, slope, skewing…

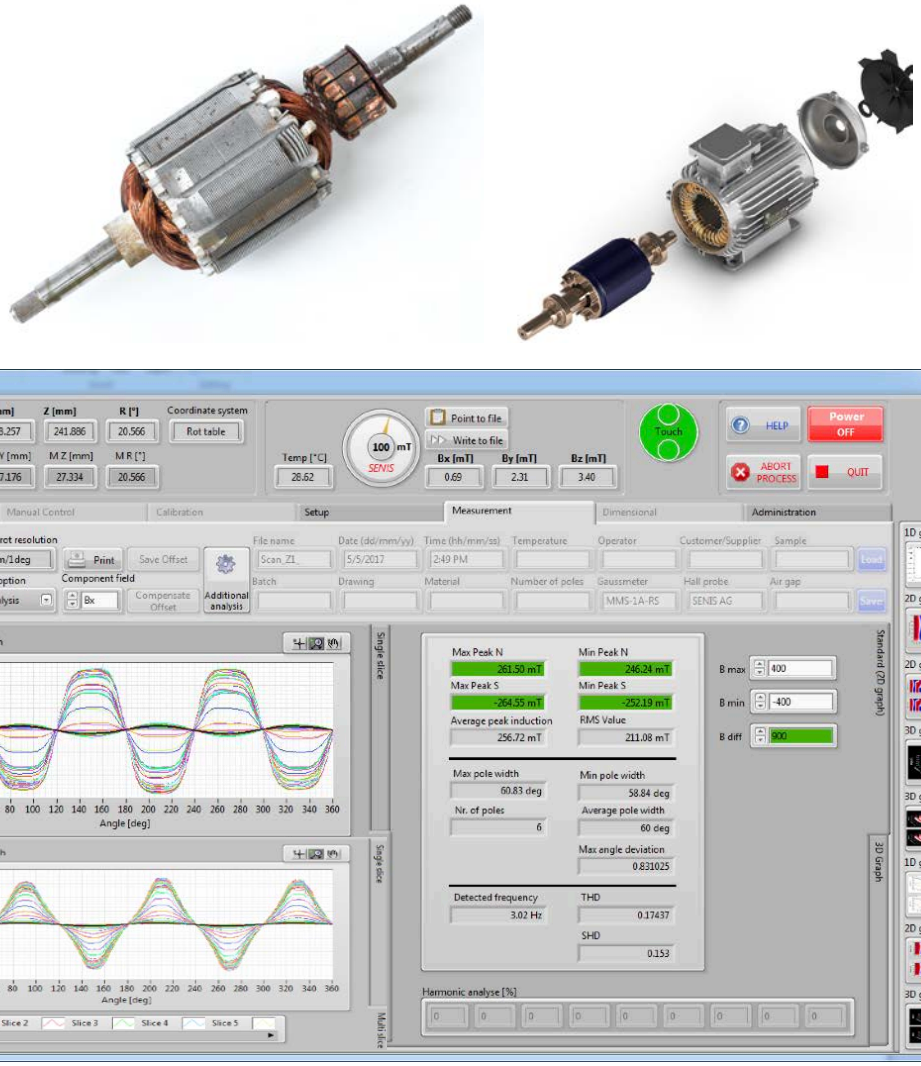

Figure 13: **Mapper Software: Visualization of the map around motors**

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9. MAPPING IN THE MOTOR AIR GAP, BETWEEN ROTOR AND STATOR

Applications: Automotive, Consumer Industry

Scanning profile: The long and thin Hall probe is positioned in the air gap between the stator and the rotor and the motor is rotated by 360°. The probe can be then positioned at different heights (slices) along the z-axis to cover the whole rotor surface. At the end, the probe can scan the sensor (control) magnet from the top, to calculate the phase shift to the rotor poles.

Pos. resolution: 1°

Mapping duration: 5min

Measured data: Bx, By, number of poles, pole width, peak values (N and S), pole disposition, slope, skewing…

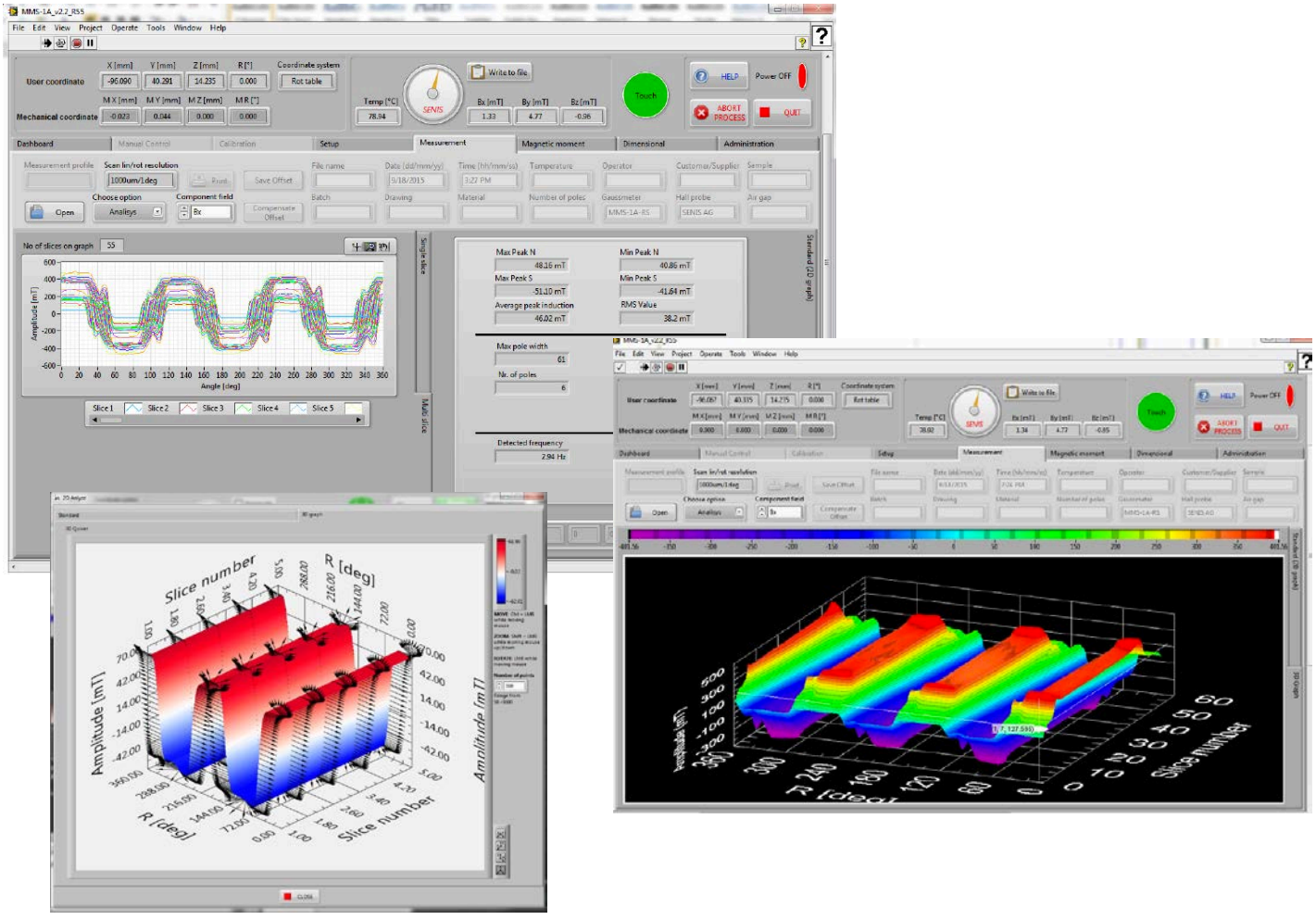

Figure 14: **Mapper Software: Visualization of the map in the air gap**

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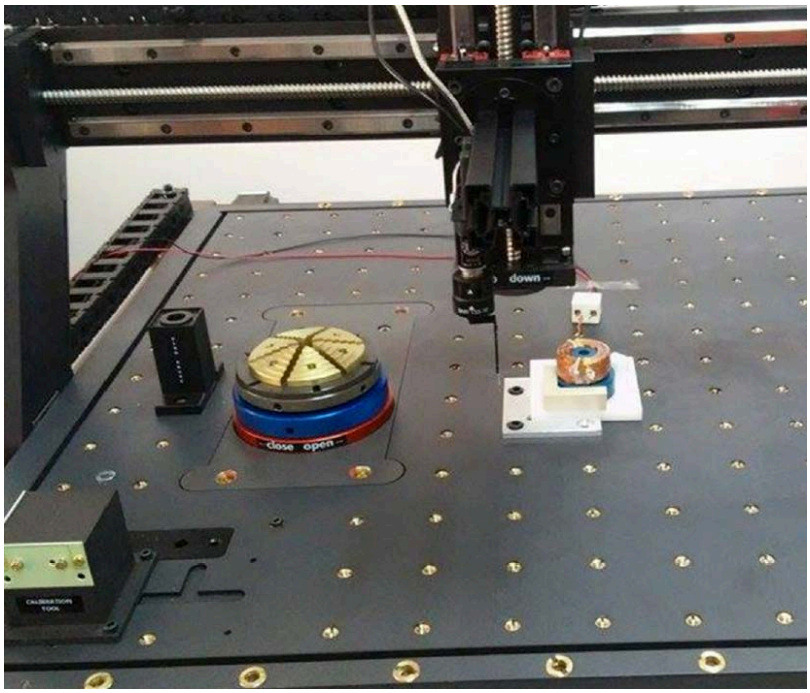
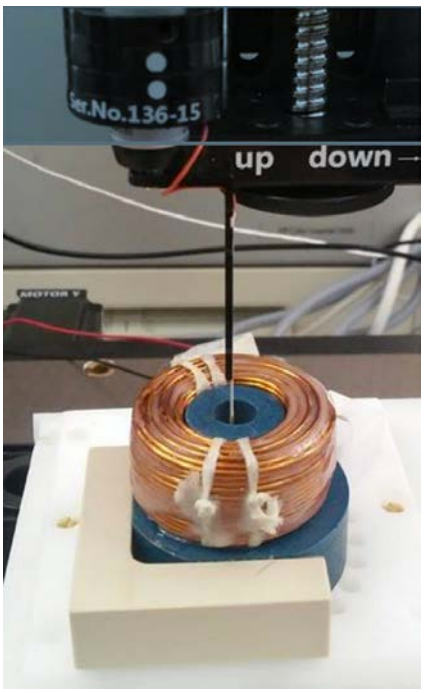
10. AC MAGNETIC FIELD AROUND ELECTROMAGNETS

Applications: Consumer Industry / AC magnetic field
Scanning profile: High-frequency Hall probe is positioned at the starting position at the defined height. Then the probe scans the defined XY area.
Pos. resolution: 0.1mm
Mapping duration: 60min with the positioning resolution of 0.1mm
Measured data: 2D and 3D of Bx, By and Bz magnetic field components





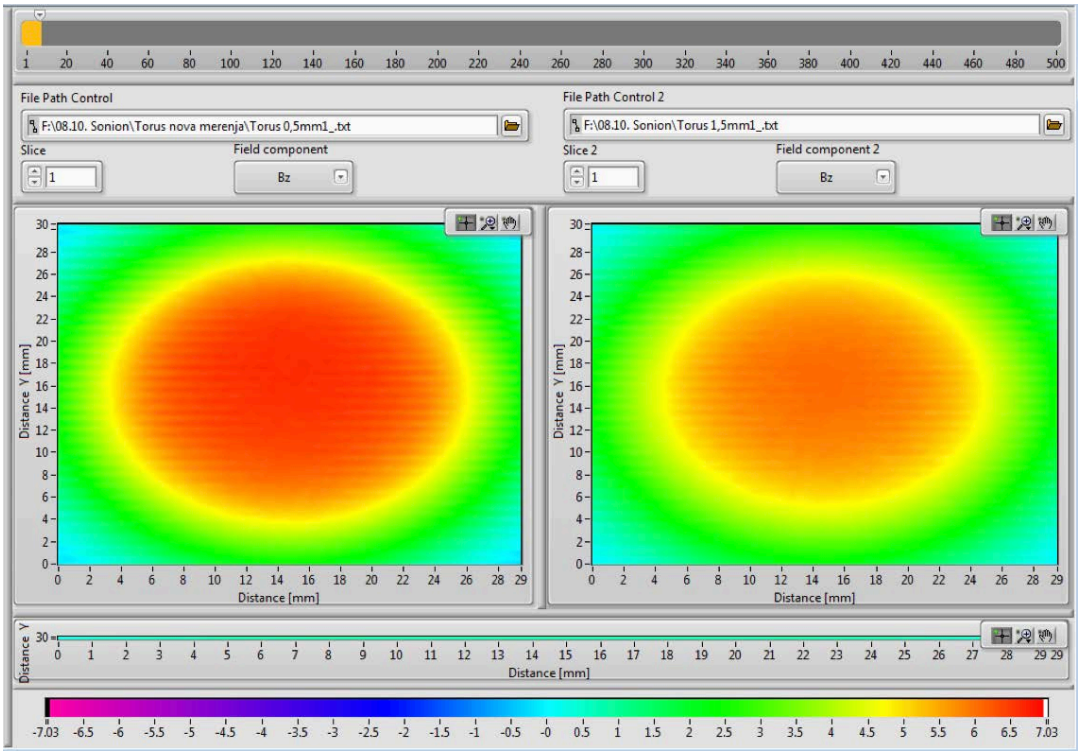


Figure 15: **Mapper Software: Visualization of the AC map around the electromagnet (2 slices)**

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11. HIGH FREQUENCY AC MAGNETIC FIELD MAPPING

Applications: Inductive heaters, cookers for AC magnetic fields of **up to 75kHz**
Scanning profile: High-temperature, High-frequency Hall probe is positioned at the starting position at the defined height. Then the probe scans the defined XY area. The probe has to be cooled during the mapping due to high temperature generated by heater.
Pos. resolution: 1mm
Mapping duration: 15min with the positioning resolution of 1mm
Measured data: 2D and 3D of Bx, By and Bz magnetic field components

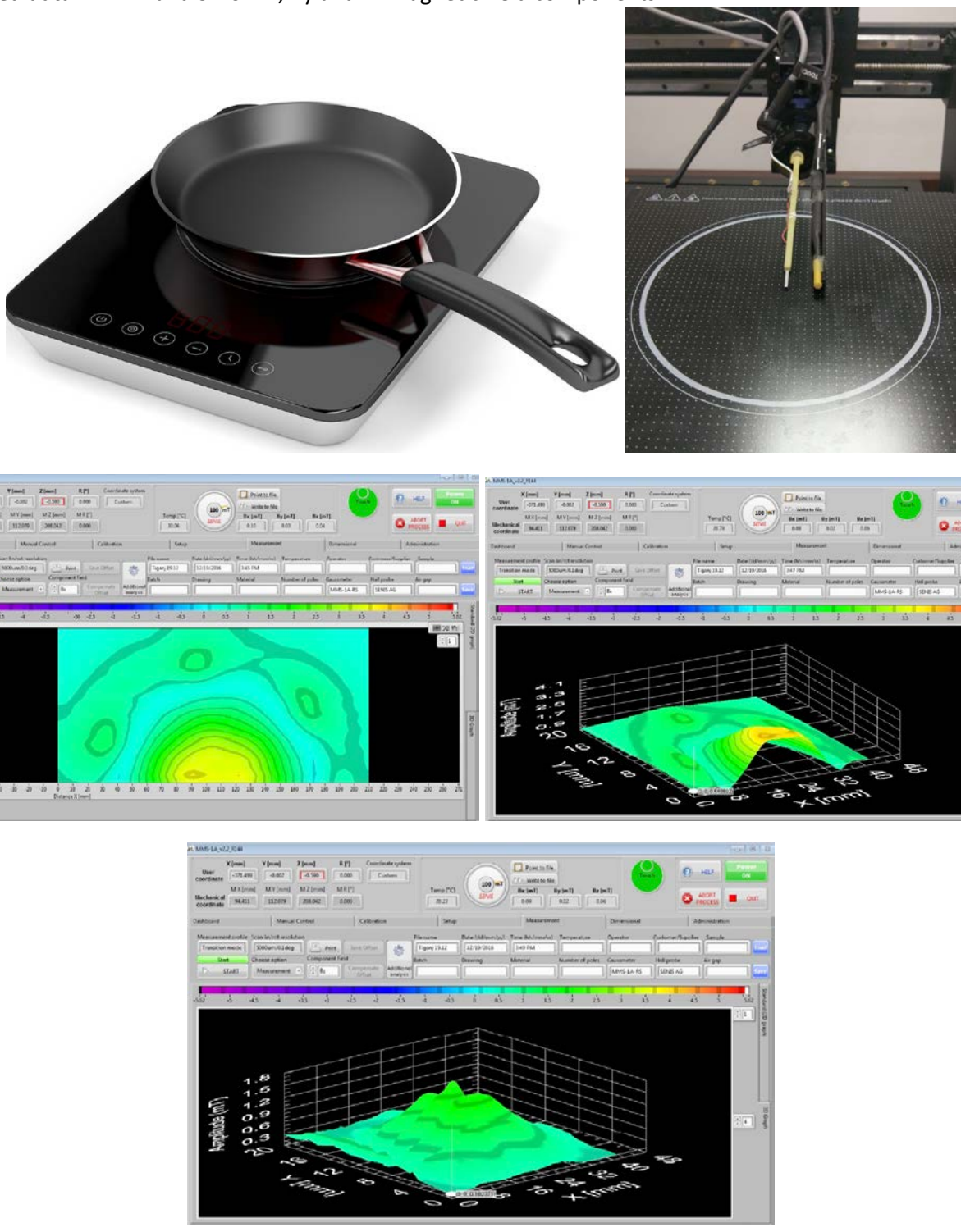

Figure 16: **Mapper Software: Visualization of the map above the heated plate**

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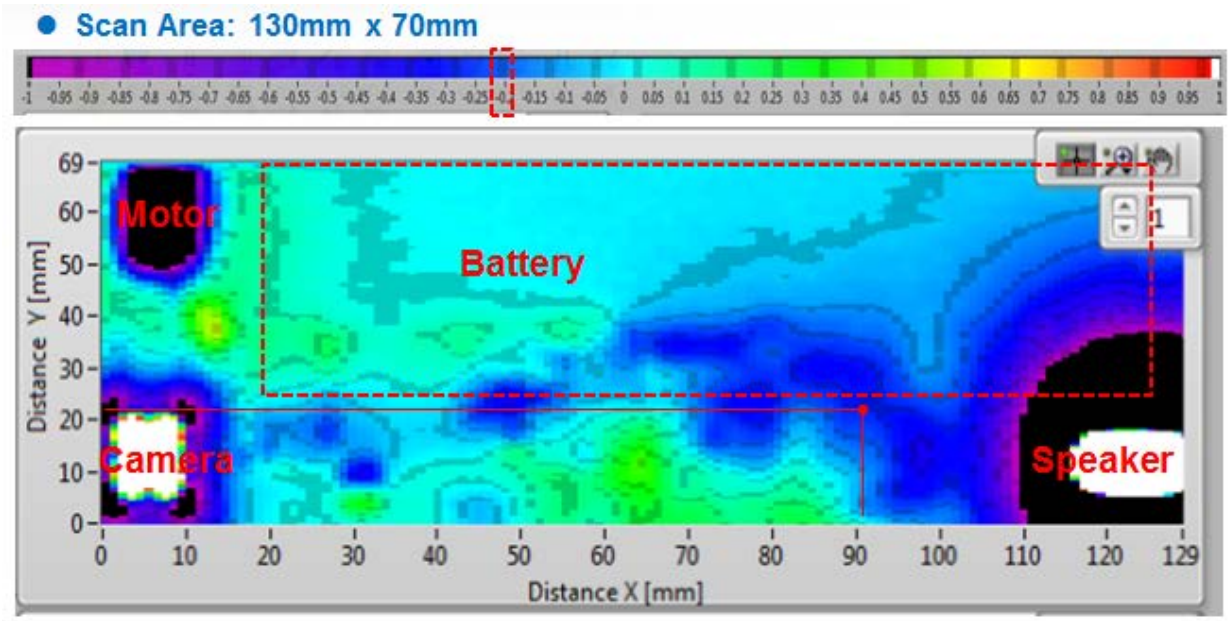
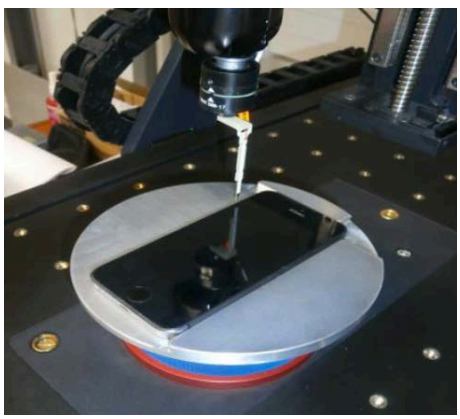
12. SMARTPHONES, TABLETS

Applications: Smart phones, tablets
Scanning profile: Hall probe is positioned at the starting position at the defined height (typically 0.3-0.5mm). Then the probe scans the defined XY area in the precision mode. The probe can be then positioned at different heights to scan several slices.
Pos. resolution: high spatial resolution of 10um - 0.1mm (point-by-point and on-the-flight scanning)
Mapping duration: 5min with the positioning resolution of 0.1mm; hours with positioning resolution of 10um
Measured data: 2D and 3D of Bx, By and Bz magnetic field components





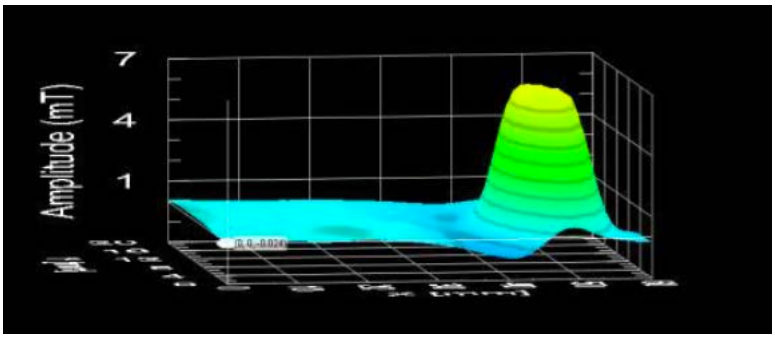


Figure 17: **Mapper Software: Visualization of the map above a smartphone**

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13. LOW-FIELD, HIGH RESOLUTION MAGNETIC FIELD MAPPING

Applications: Credit cards, barcode strips, low-field coded plates
Scanning profile: Hall probe or AMR probeis positioned at the starting position at the defined height (typically 0.3). Then the probe scans the defined area, XY.
Pos. resolution: high spatial resolution of 10um - 0.1mm
Mapping duration: 2min with the positioning resolution of 0.1mm; 60min with positioning resolution of 10um
Measured data: 2D and 3D of Bx, By and Bz magnetic field components

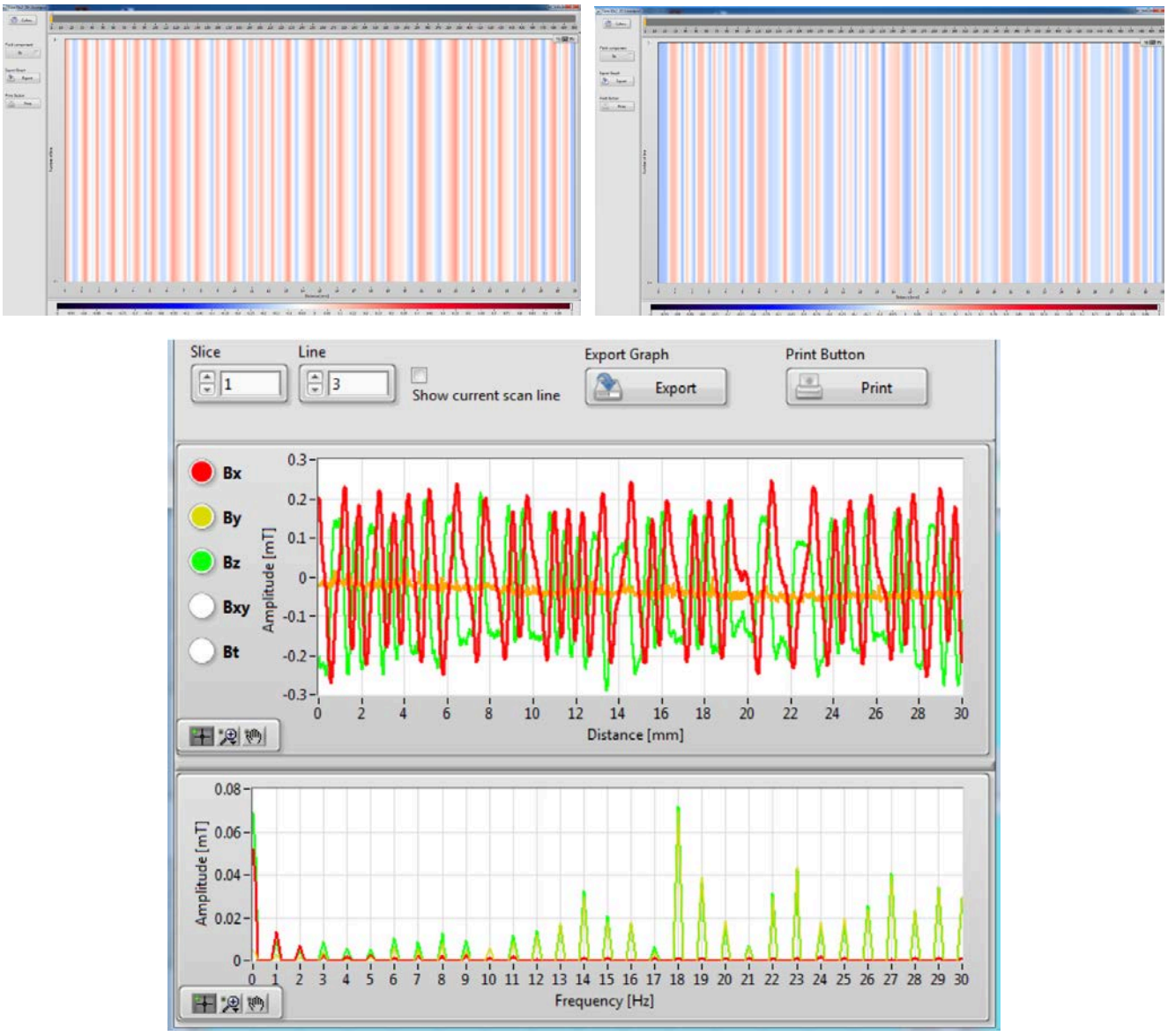

Figure 18: **Mapper Software: Visualization of the map above the credit card stripe**

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14. ENVIRONMENTAL MAGNETIC FIELD MAPPING FOR OFFSET CANCELATION

Applications: Cancelation of the environmental magnetic field
Scanning profile: Hall probe or AMR probe is positioned at the starting position without object under test. The defined scanning profile is run and the map of the environmental magnetic field is obtained. This map can be then subtracted as an offset from the map with the object under tes.t
Pos. resolution: 0.1mm
Mapping duration: several minutes
Measured data: 2D and 3D of Bx, By and Bz magnetic field components

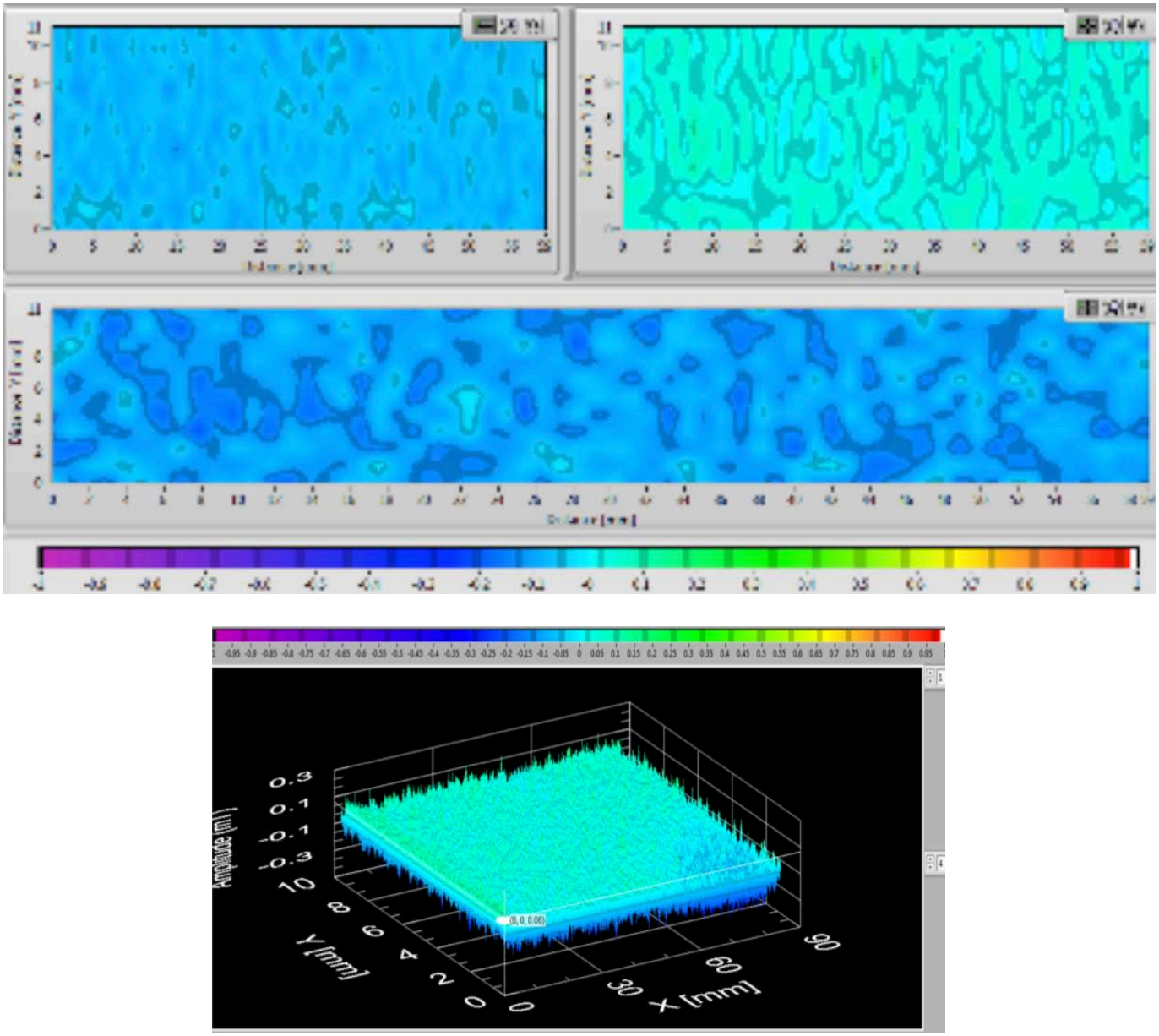

Figure 19: **Mapper Software: Visualization of the map of the environmental magnetic field to be used as the offset cancelation**

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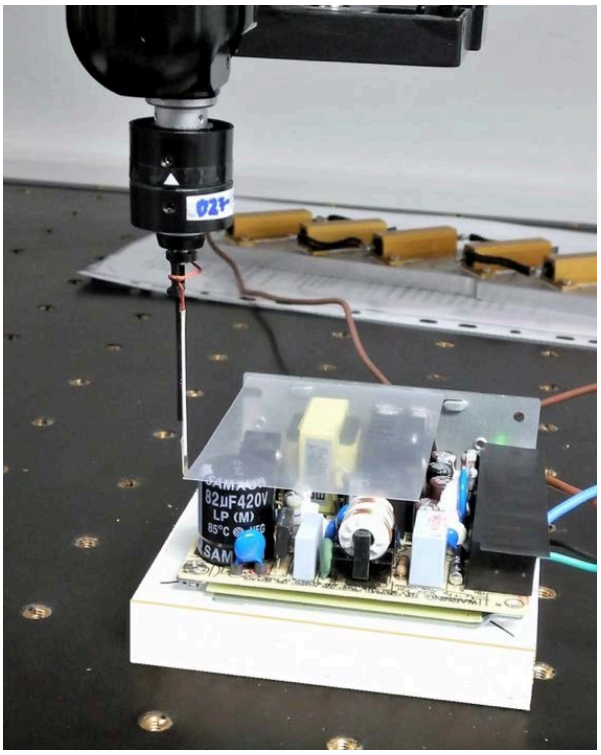
15. AC MAGNETIC FIELD AROUND ELECTRONIC PCBs - EMC

Applications: Consumer Industry / AC magnetic field, EMC
Scanning profile: High-frequency Hall probe or a miniaturized inductive probe (pick-up coil) is positioned at the starting position at the defined height. Then the probe scans the defined XY area.
Pos. resolution: 0.1mm
Mapping duration: 15min with the positioning resolution of 0.1mm
Measured data: 2D and 3D of Bx, By and Bz magnetic field components



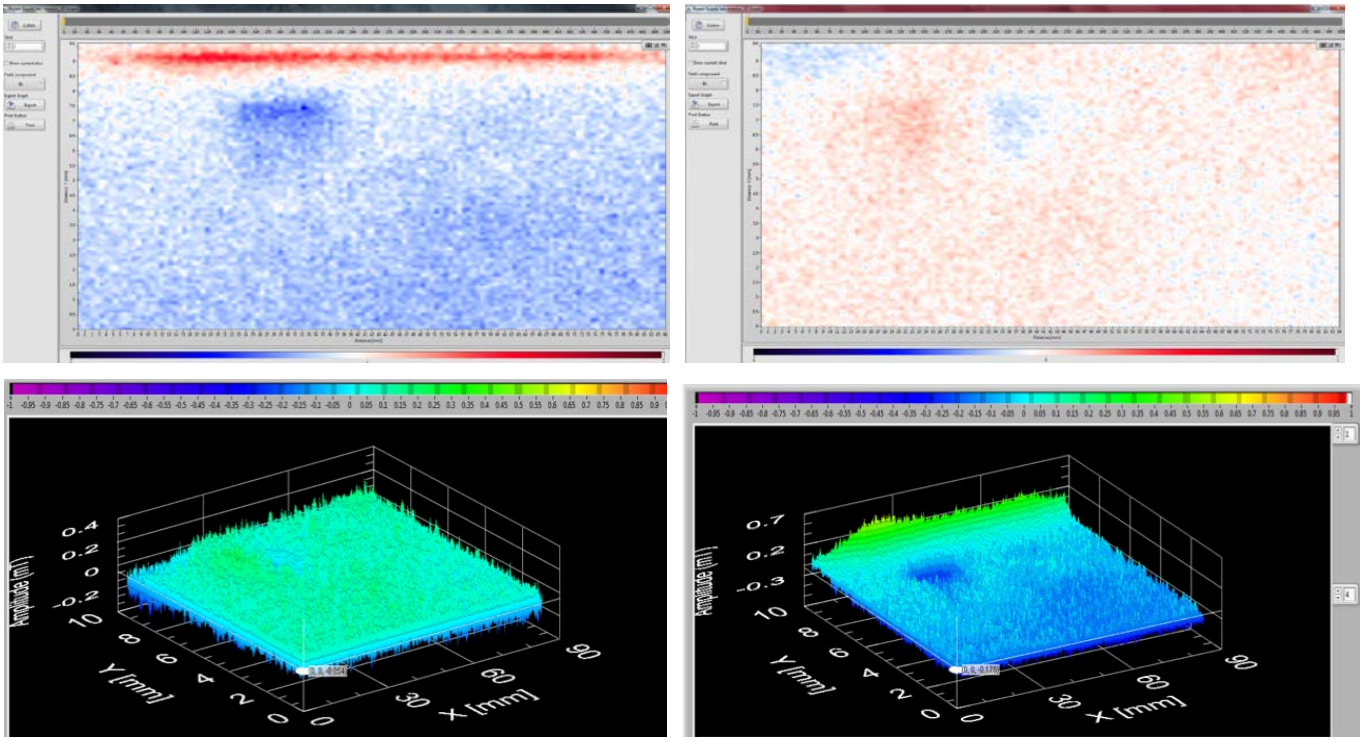


Figure 20: **Mapper Software: Visualization of the AC map around the electronic PCB of a switching power supply**

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16. CRACK AND MATERIAL INHOMOGENEITY DETECTION

Applications: Cracks and material inhomogeneity detection in magnetized and non-magnetized blanks
Scanning profile: **Eddy-Current probe** is positioned at a starting position very close to the magnet surface (0.2mm). The probe is then linearly moved along the object, or the object is rotated by 360° on the rotary stage.
Pos. resolution: 0.1mm
Mapping duration: 5sec
Measured data: Eddy-current distribution in the measured object that provides the information on cracks or inhomogeneity presence

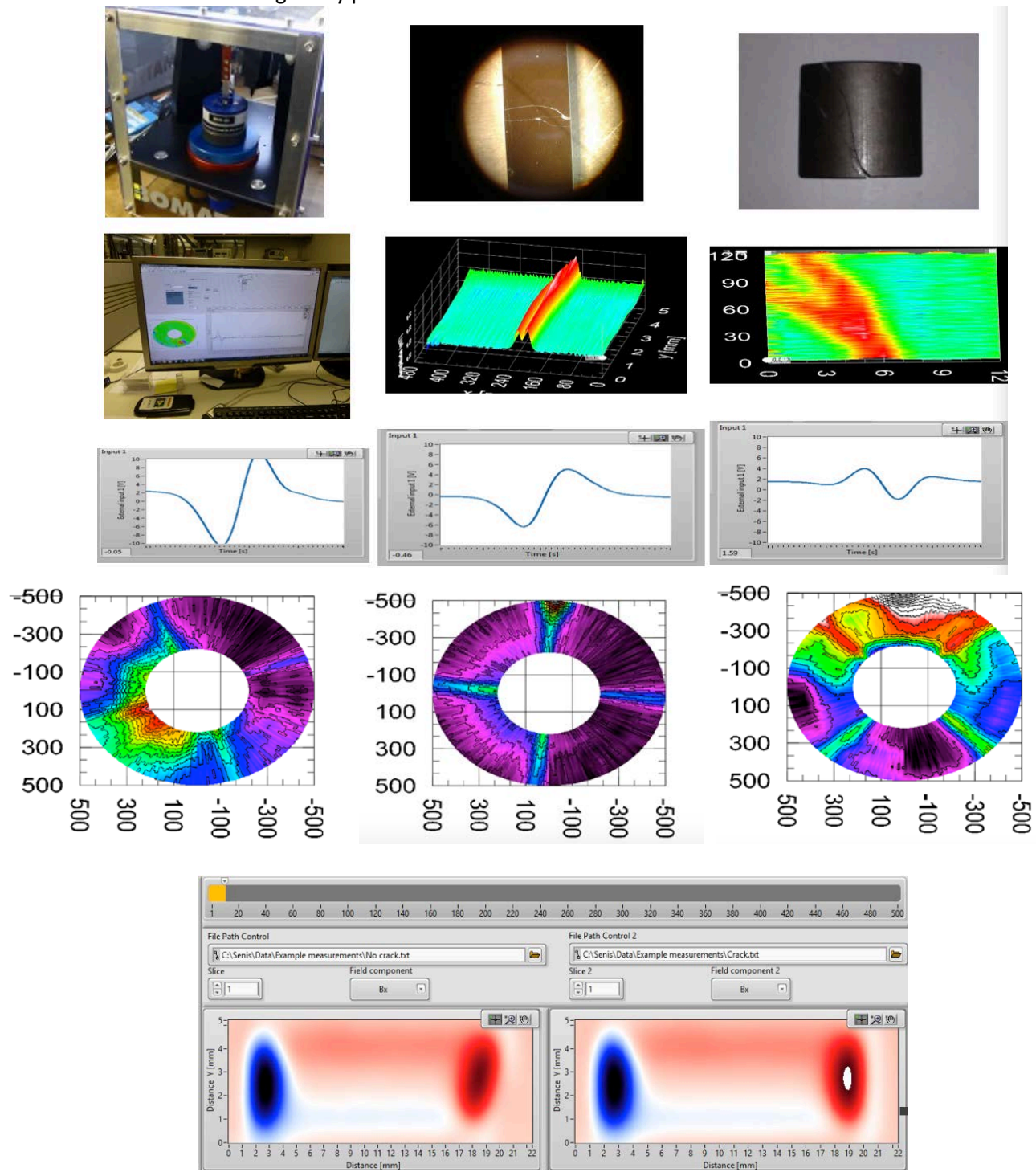

Figure 21: **Crack Analysis: Detection and location of cracks and material inhomogeneity in the magnetized and non-magnetized parts by comparing to the eddy-current probe measured data of a reference (GOOD) part**

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17. MAP ANALYSIS, COMPARISSON

MMS-1A-RS Magnetic Field Mapper Software includes an ANALYSIS module that allows customized on-line (during the mapping) and the offline visualization and analysis of the measured data. It visualizes the measured and calculated 3-axis magnetic field data in various, customized and intuitive color coded displays, and tables. This software module allows a measured data comparison of several magnetic field maps.

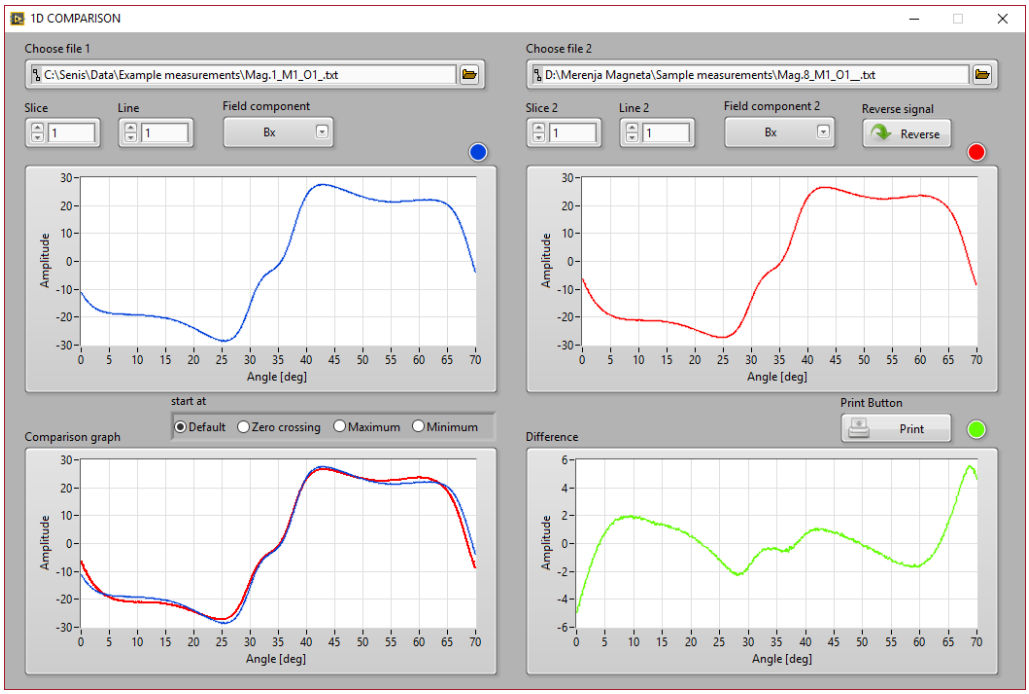

Figure 22: **1D Graph Comparison - App: Two or more measurement data-sets are compared, by showing each data separately, then both measured data consolidated on the same graph and the difference between them**

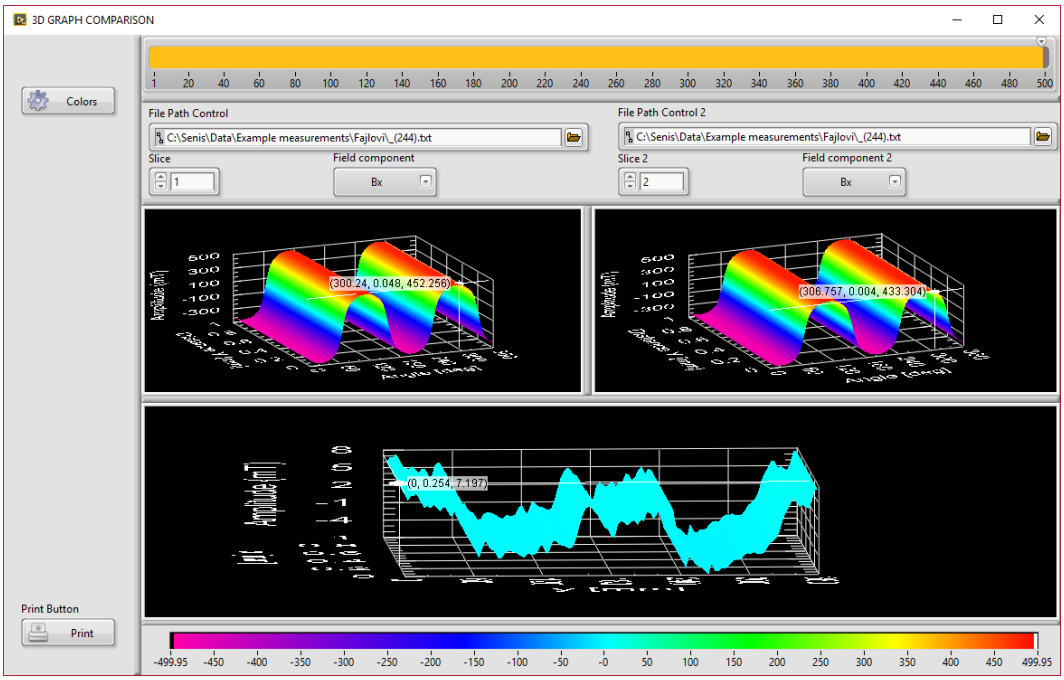

Figure 23: **2D and 3D Graph Comparison - App: Two measurement data-sets are compared, by showing each data separately and by showing the difference between two measurements**

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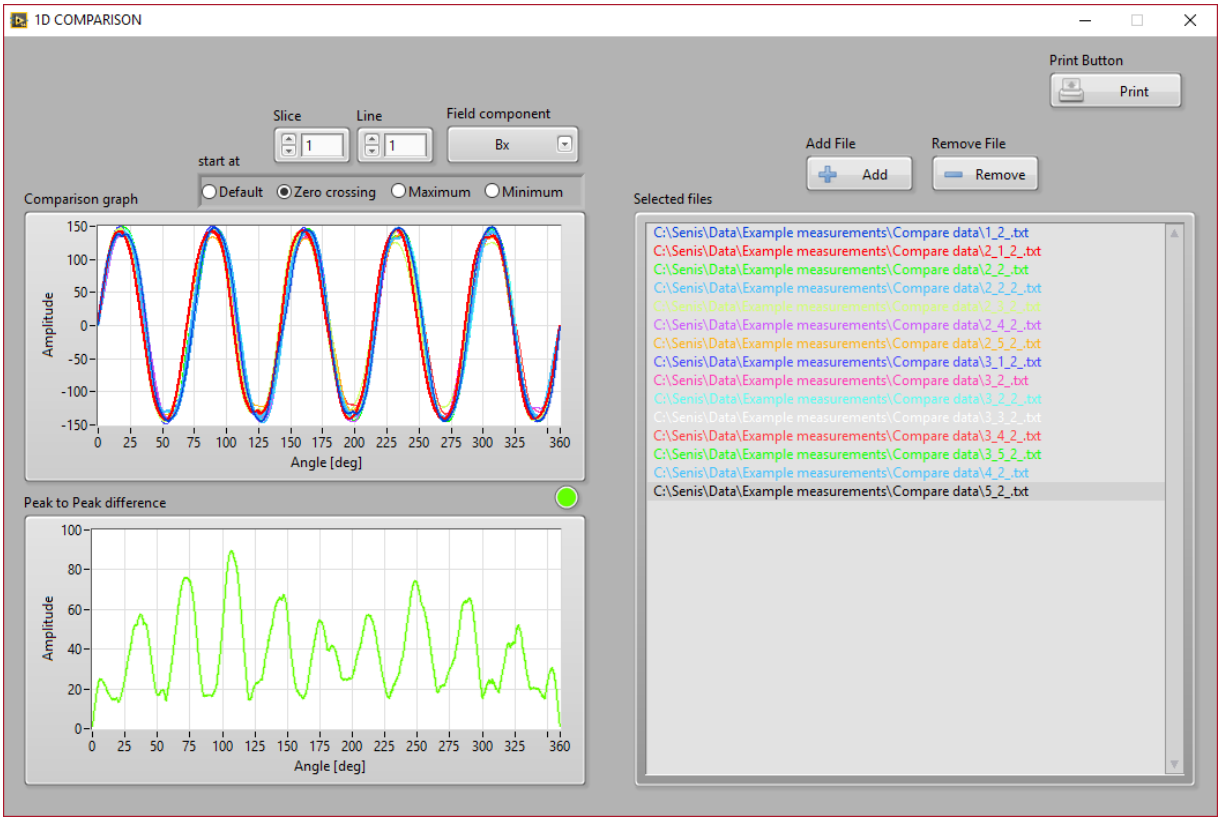

Figure 24: **Multi-Graph Comparison - App: Multi-measurement data-sets are compared, by showing each data-set in different colors on the common graph and by showing the largest peak-to-peak difference**

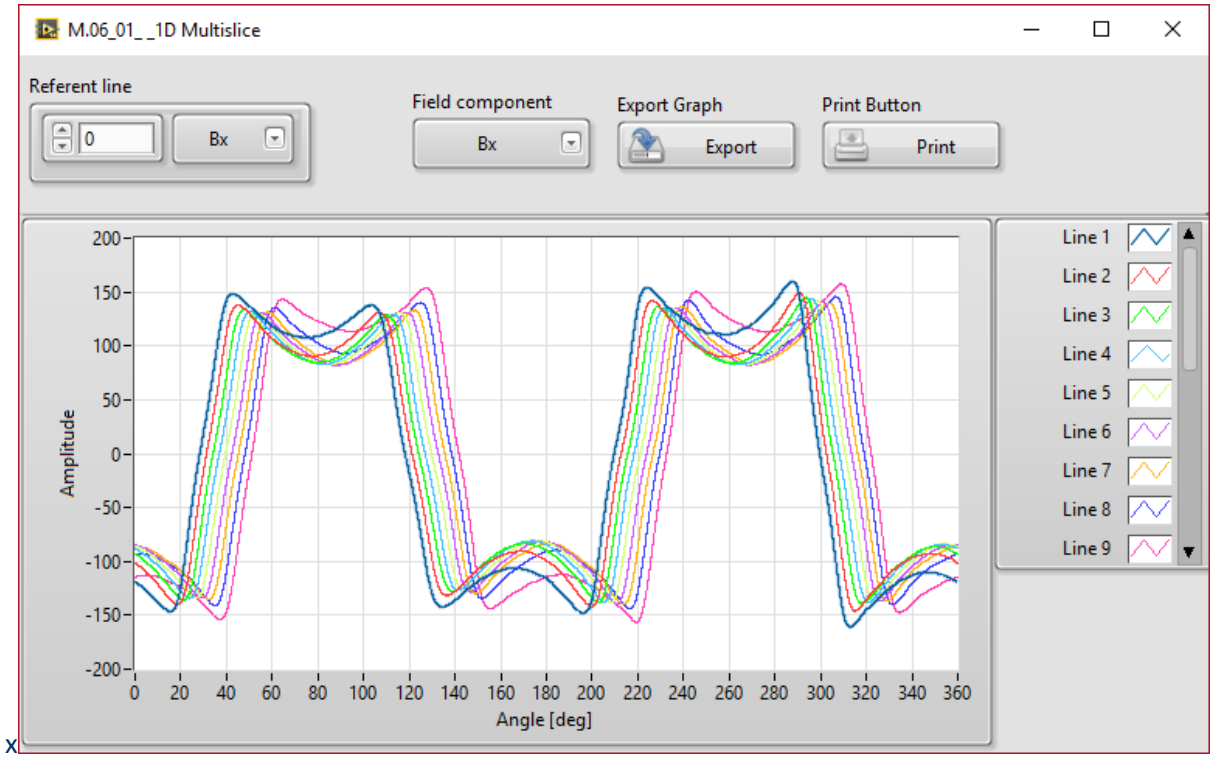

Figure 25: **Multislice Analysis - App: Analysis of the magnetic field distribution (selectable magnetic field components) along selected number of scanned lines**

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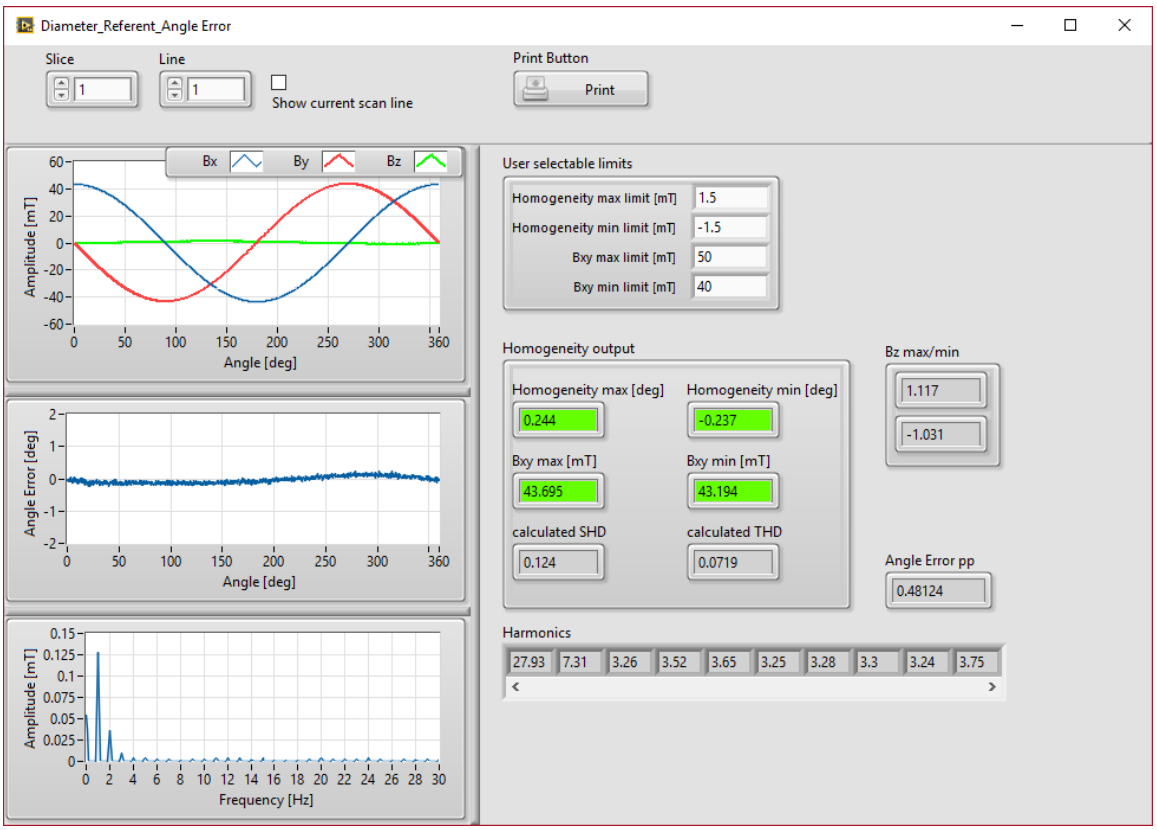

Figure 26: **Dipole Magnet Analysis - App: GOOD/BAD Analysis based on the thresholds of Angle Error (Homogeneity), Min/Max values of the magnetic field components and Fourier Analysis**

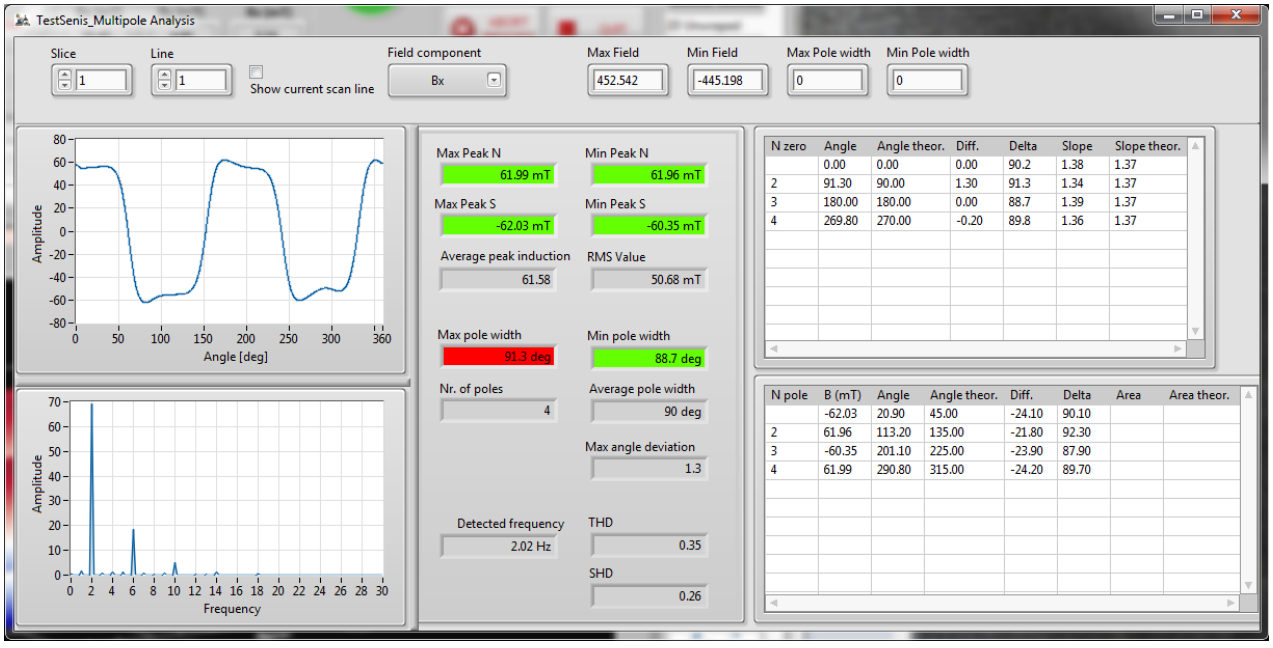

Figure 27: **Rotor and Multipole Magnet Analysis - App: GOOD/BAD Analysis based on the magnetic poles distribution and Min/Max values in North/South pole**

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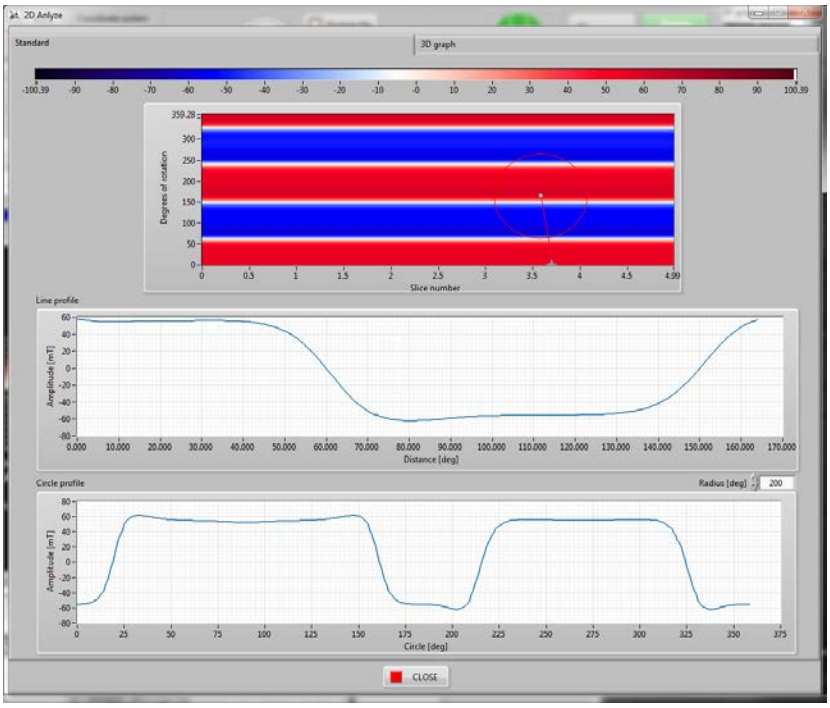

Figure 28: **Magnetic Field Analysis - App: Analysis of the magnetic field distribution along a customer-defined line or circle in the unwrapped map**

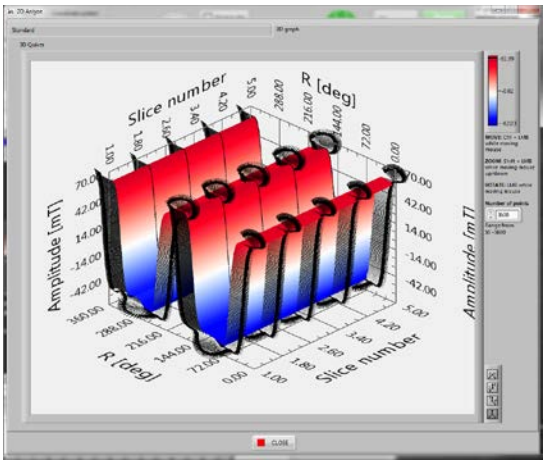

Figure 29: **Magnetic Field Lines - App: Analysis of the magnetic field lines along scanned lines**

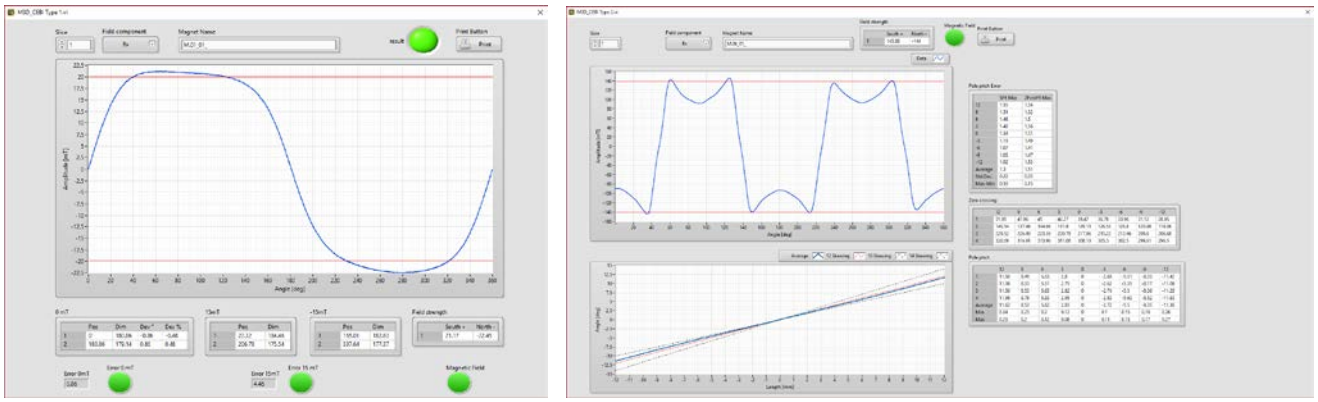

Figure 30: **Customized Analysis - App: Analysis of the magnetic field in set points, pole pitch and pitch angle, zero crossing and more**

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