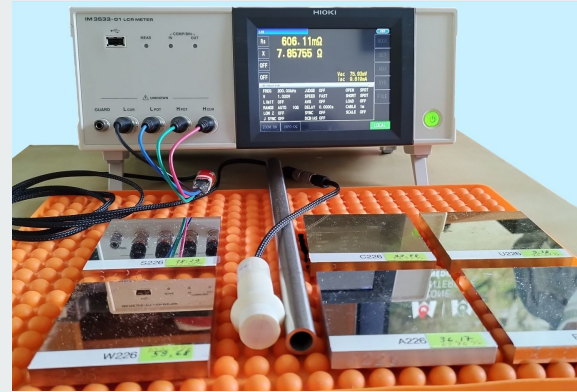


CONDUCESENS™

Eddy Current Non Destructive Testing System

User's guide v.0 - Sciorsoria sarl - <https://www.sciensoria.fr>



Summary

1- Introductionpages 2 to 3

2- Material check up and System setup pages 5 to 11

3- Measurement of probe impedance pages 12 to 18

4- Simulation of probe impedance pages 19 to 23

5- Measurement of material parameters - Conclusion

.....
.....pages 24 to the end

1.1 - What is ConducSens™

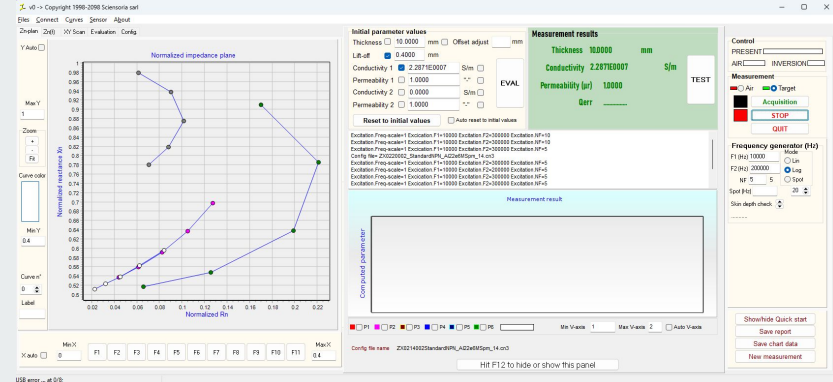
ConducSens™ is a Non Destructive Testing system made by ScienSORIA sarl (<https://www.sciensoria.fr>). It is composed of an impedance meter, an Eddy Current probe, and, the most important, the EddySens™ software made by ScienSORIA. EddySens™ is a multi-function software that allows users to acquire multifrequency material signature, predict impedance signature with supposed material parameters (simulation), and compute material parameters using acquired multifrequency material signature.



Impedance meter



Eddy current probe



EddySens™ software

Applications of ConducSens™



Measurement electrical conductivity of carbon composite materials (CFRP)



Measurement of tube thickness



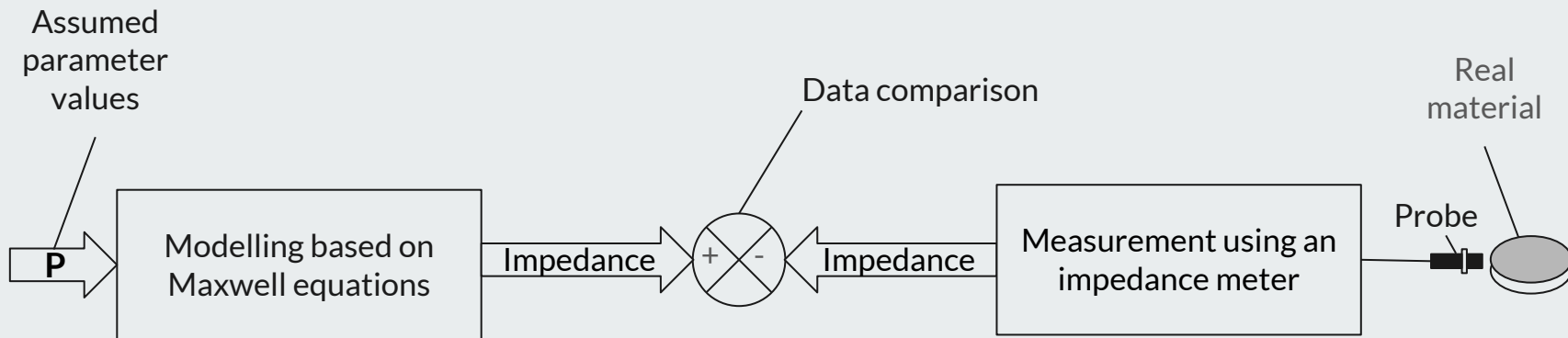
Measurement electrical conductivity of carbon composite materials (CFRP)



Measurement electrical conductivity of graphite

1.2 - Why use an impedance meter?

An impedance meter allows easy correlation between real measurements and physical models. Impedance is the ratio of voltage across the probe coil to the current flowing through it. For linear materials, it depends on the excitation frequency, material, and probe coil properties but not on the magnitude of the excitation voltage or current.



1.3 - Material list

1. Hioki LCR meter (models IM3533-01, IM3536, IM3570) with accessories :
 1. Power cord
 2. USB cable
2. Kelvin cable or Sciensoria's special 4-point to male Binder-712 cable
3. A bare coil or a Sciensoria's eddy current probe, for example
 1. 10 mm-diameter probe (ZX0210002)
 2. 12 mm-diameter probe (ZX0212002)
 3. 14 mm-diameter probe (ZX0214002)
 4. 20 mm-diameter probe (ZX0220002)
 5. 40 mm-diameter probe (ZX0240002)
4. Personal computer running Windows 10 or 11
5. *Optional: IntelliSW™ control USB box for continuous measurement operations*
6. EDDYSENS(L) software
 1. Download link: see delivery email



IntelliSW™ control box

1.4 - Installing the IM3536 Impedance Meter

- Place the IM3536 impedance meter on a flat and stable surface, away from heat and humidity sources.
- If the package was shipped from outside, wait at least 1 hour after unpacking before powering on the device.
- Connect the IM3536 power cord to the mains.
- Connect the USB cable between the IM3536 and the computer.
- Plug the computer's power adapter into the mains.
- Connect an external monitor to the computer's HDMI port.
- Start the computer and check that the keyboard and mouse are functioning properly.
- Connect the Sciensoria's 4xBNC-to-Binder 712 probe cable, ensuring the correct correspondence of the BNC connectors (*Hcur*, *Hpot*, *Lpot*, *Lcur*) with the labels on the cables.
- Connect a probe: push the male and female connectors together until they make contact, then screw the locking caps to secure the cables.
- Connect the IntelliSW™ control box to a USB port
- Power on the IM3536.
- Locate the ConducSens™ folder in the Downloads directory. Open the EXE subdirectory and double-click on EddySens.exe to launch the program.

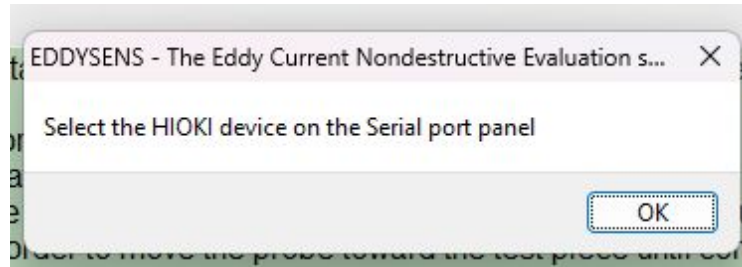
1.5 - Connecting the Measurement Cable



1.6 - Launching EddySens

When launching EddySens, the main window appears (see Figure 1 on the next page). A message prompts you to connect the IM3536 device.

Click OK.



1.7 - Startup screen

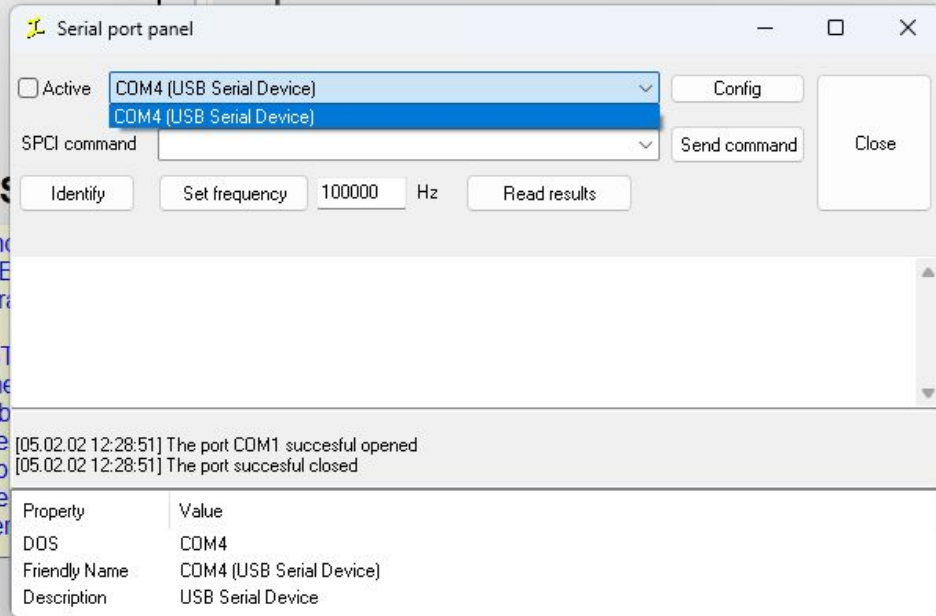
The screenshot shows the EDDYSENS software interface. The main window contains two large plots: "Normalized impedance plane" on the left and "R = f(F)" on the right. The left plot has a vertical axis labeled "Normalized reactance Xn" and a horizontal axis labeled "Normalized Rn". The right plot has a vertical axis labeled "R" and a horizontal axis labeled "F".

A "QUICK START GUIDE" dialog box is open in the center, listing seven steps for starting a measurement. A smaller dialog box titled "EDDYSENS - The Eddy Current Nondestructive Evaluation s..." is also open, with the text "Select the HIOKI device on the Serial port panel" and an "OK" button.

The interface includes a menu bar (Files, Connect, Curves, Sensor, About), a toolbar (Znrplan, Znr(f), XY Scan, Evaluation, Config), and a control panel on the right with sections for "Control", "Measurement", and "Frequency generator (Hz)". The "Frequency generator" section has fields for F1 (10000 Hz), F2 (300000 Hz), NF (5), and Spot (20 Hz), along with a "Mode" selector (Lin, Log, Spot) and a "Skin depth check" dropdown.

At the bottom, there are "Min X" and "Max X" fields (0 and 0.4) and a row of frequency buttons (F1 to F11). The status bar at the bottom left reads "Frequency: logarithmic scale".

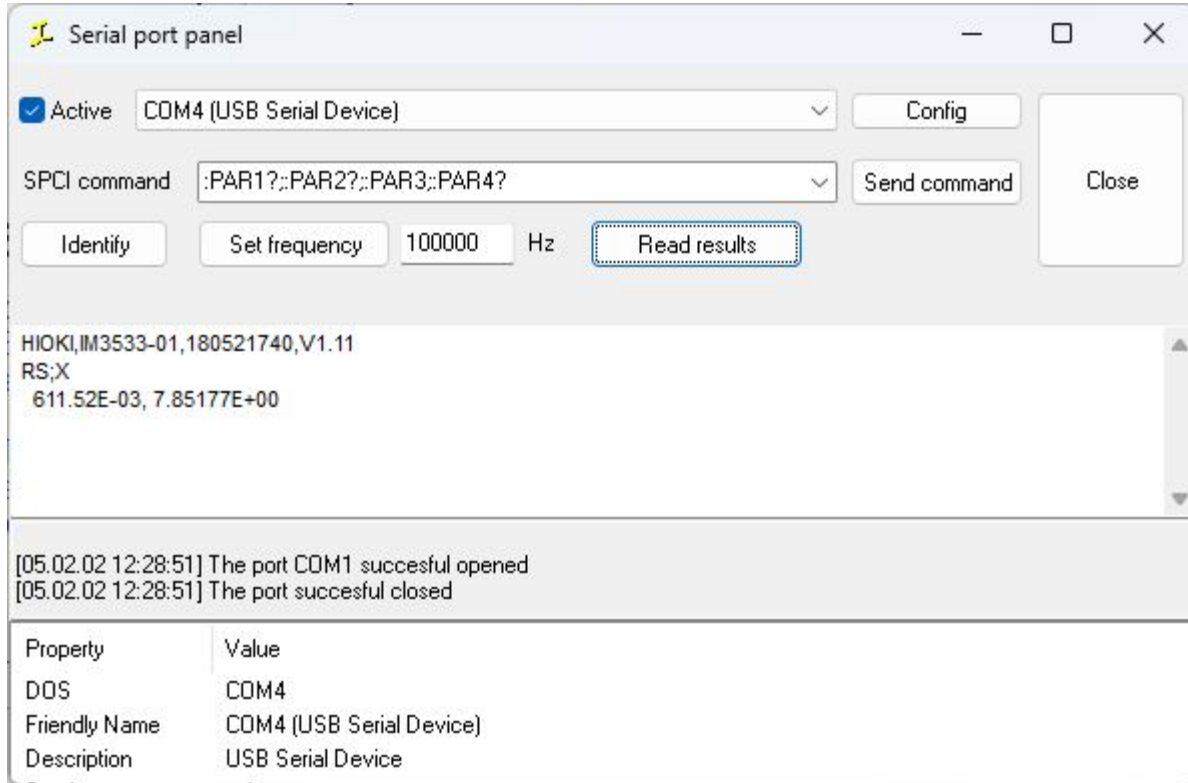
1.8 - LCR Meter Configuration



Configuring the USB Connection to the LCR Meter

1. Select the correct device: Choose (USB Serial Device) on COM5. Do not select (USB Serial Port) on COM8 if an external IntelliSW control box is connected.
2. Check port numbers: The assigned COM ports (e.g., COM5, COM8) may vary depending on the computer.
3. Enable communication: Check the "Active" box to establish the connection between the computer and the impedance meter.
4. Configure the virtual serial port: Click Config and adjust the settings to match the LCR meter's COM port parameters. Refer to the LCR meter user manual for details.
5. Test the connection: Use the following buttons:
 - Identify – Detects the connected LCR meter.
 - Set frequency – Adjusts the measurement frequency.
 - Read results – Retrieves measurement data.
 - Send SCPI command – Manually send SCPI commands (refer to the LCR meter manual).
6. Using the SCPI command box: Type any SCPI command and press Enter or click Send command to execute it over USB.
7. Close the configuration window: Click the Close button when setup is complete.

1.9 - Example of a Successful Connection Window



The screenshot shows the 'Serial port panel' window. It is active and connected to 'COM4 (USB Serial Device)'. The SPCI command is set to ':PAR1?;:PAR2?;:PAR3?;:PAR4?'. The frequency is set to 100000 Hz. The 'Read results' button is highlighted. The output area shows the following text:

```
HIOKI,IM3533-01,180521740,V1.11
RS;X
611.52E-03, 7.85177E+00
```

Below the output area, there are two status messages:

```
[05.02.02 12:28:51] The port COM1 succesful opened
[05.02.02 12:28:51] The port succesful closed
```

At the bottom, there is a table with connection properties:

Property	Value
DOS	COM4
Friendly Name	COM4 (USB Serial Device)
Description	USB Serial Device

The example on the side illustrates a successful connection.

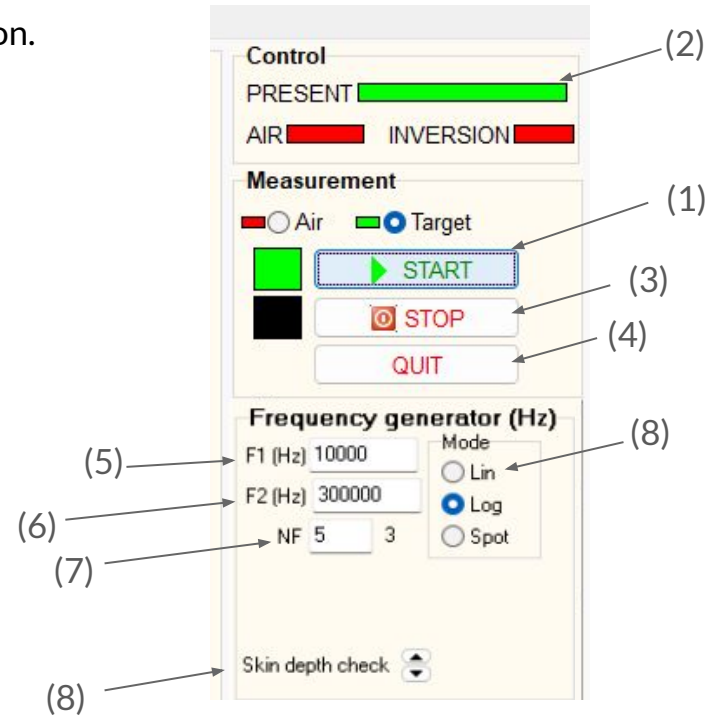
- Connection properties are displayed at the bottom of the window.
- LCR meter responses appear in the middle section of the display.
- When the SCPI composite command `:PAR1?;:PAR2?;:PAR3?;:PAR4?` is sent, the LCR meter responds with "RS;X", indicating that:
 - RS represents the serial resistance of the probe coil.
 - X represents the reactance of the probe coil.

1.10 - Starting Data Acquisition

- Click the START (1) button to begin data acquisition.
- If the IntelliSW™ control box is connected, the PRESENT (2) rectangle will turn green.
- To stop the acquisition, click on STOP (3).
- To exit EddySens™, click on QUIT (4).

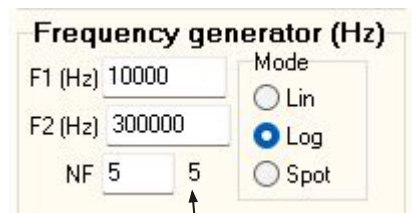
Frequency Sweep:

- Start frequency (F1) (5)
- End frequency (F2) (6)
- Number of frequencies (NF) (7)
- Frequency distribution modes:
 - Linear (Lin)
 - Logarithmic (Log)
 - Single frequency (Spot)
- Skin depth check (8) : test the penetration depth for each used frequency



1.11 - Multi-Frequency Acquisition - Normalized Impedance

- When the START button is pressed, the frequency sweep begins: the frequency sequentially takes the values defined in the frequency generator, and its index changes accordingly.
- If the index does not change, it indicates that an issue has occurred, and the acquisition is not proceeding as expected. This could be due to a problem such as the impedance meter not being properly connected to the computer.



Frequency index

- **Normalization Relative to Air Impedance:**
It is very important to normalize the measured impedance relative to its value in air. This is because the EddySens™ calculations rely on the normalized impedance.
- To do this, lift the probe until it is about 10 cm away from any conductive objects, and press the green button on the IntelliSW™. Keep the probe in this position for 1 second after pressing the button.
- If the IntelliSW™ box is not present, check the Air button (1) to take air measurement. Keep the probe in air for 1 second, then check the Target (2) button.
- Then, bring the probe closer to the metallic object to be measured.



(1)

(2)

1.12 - Graphical Display of Impedance

- As soon as the START button is clicked, the raw impedance $Z(f)$ becomes available. After normalization is performed, the normalized impedance $Z_n(f)$ becomes available.
- The impedance plane Z_{plan} is a polar representation of $Z_n(f)$: the vertical axis represents the values of the imaginary part X_n of $Z_n(f)$, while the horizontal axis represents the values of its real part R_n . Each point corresponds to a pair of (R_n, X_n) at a given frequency

For reference:

$$Z(f) = R(f) + jX(f)$$

and

$$Z_n(f) = R_n(f) + jX_n(f)$$

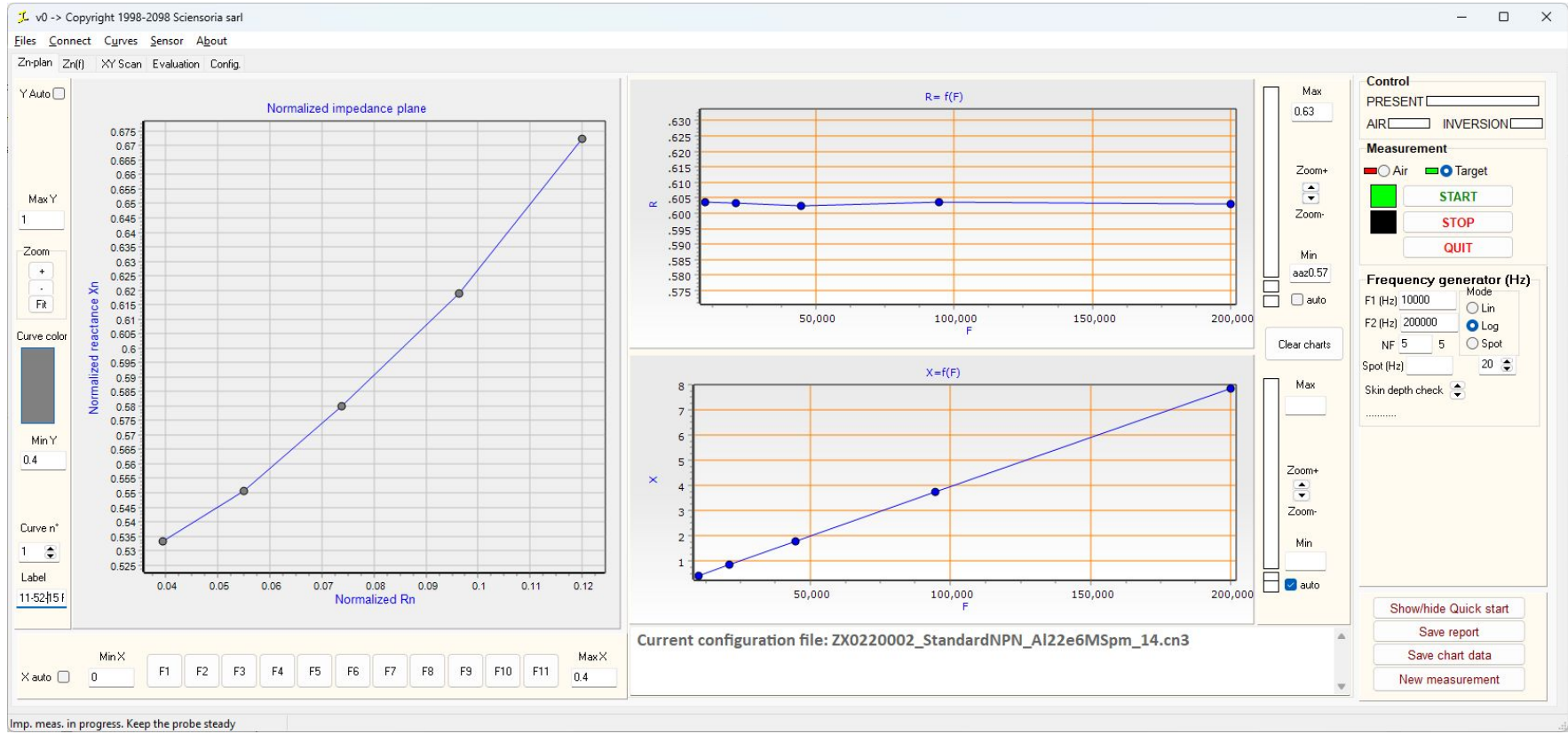
with

$$R_n = \frac{R(f) - R_{air}(f)}{X_{air}(f)}$$

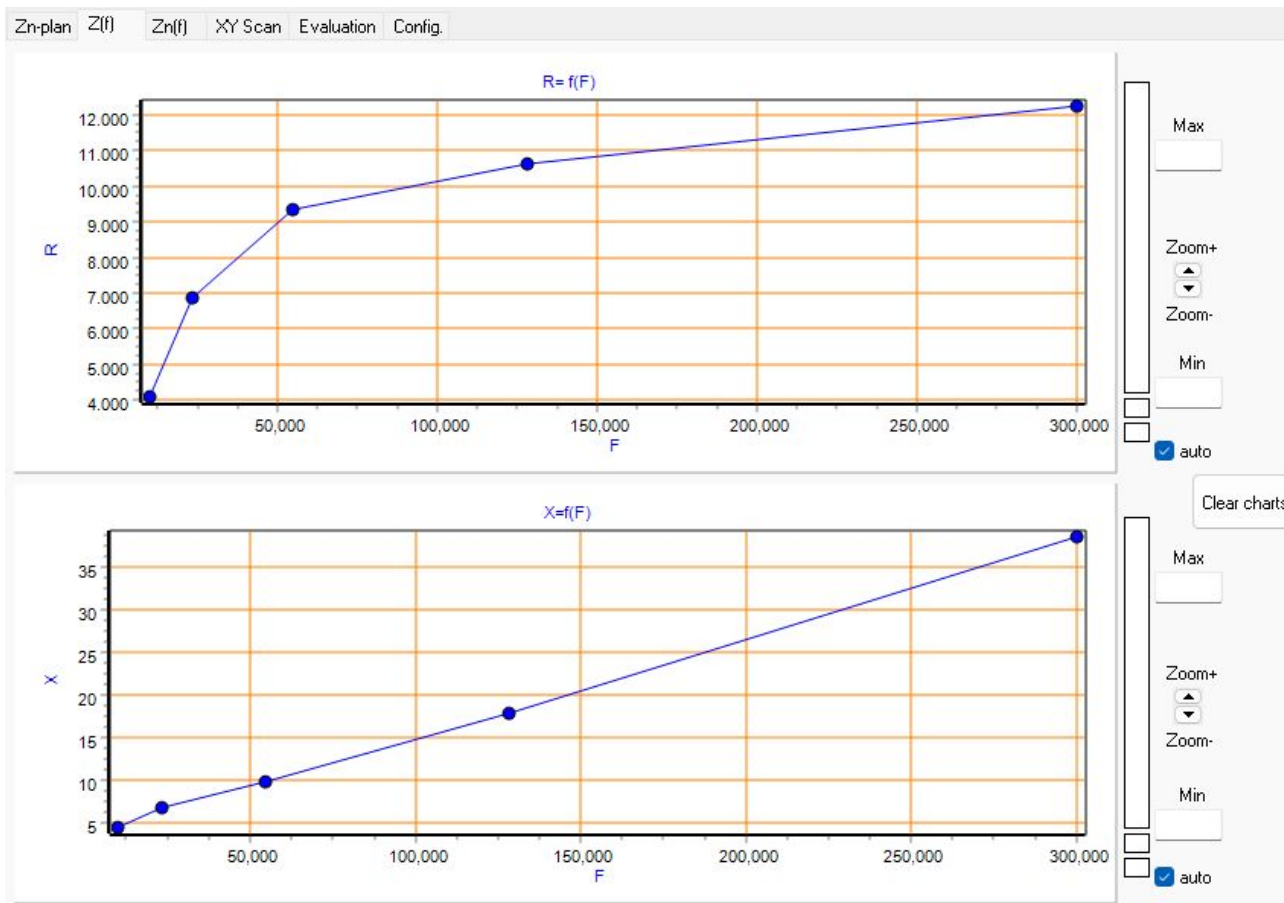
and

$$X_n = \frac{X(f)}{X_{air}(f)}$$

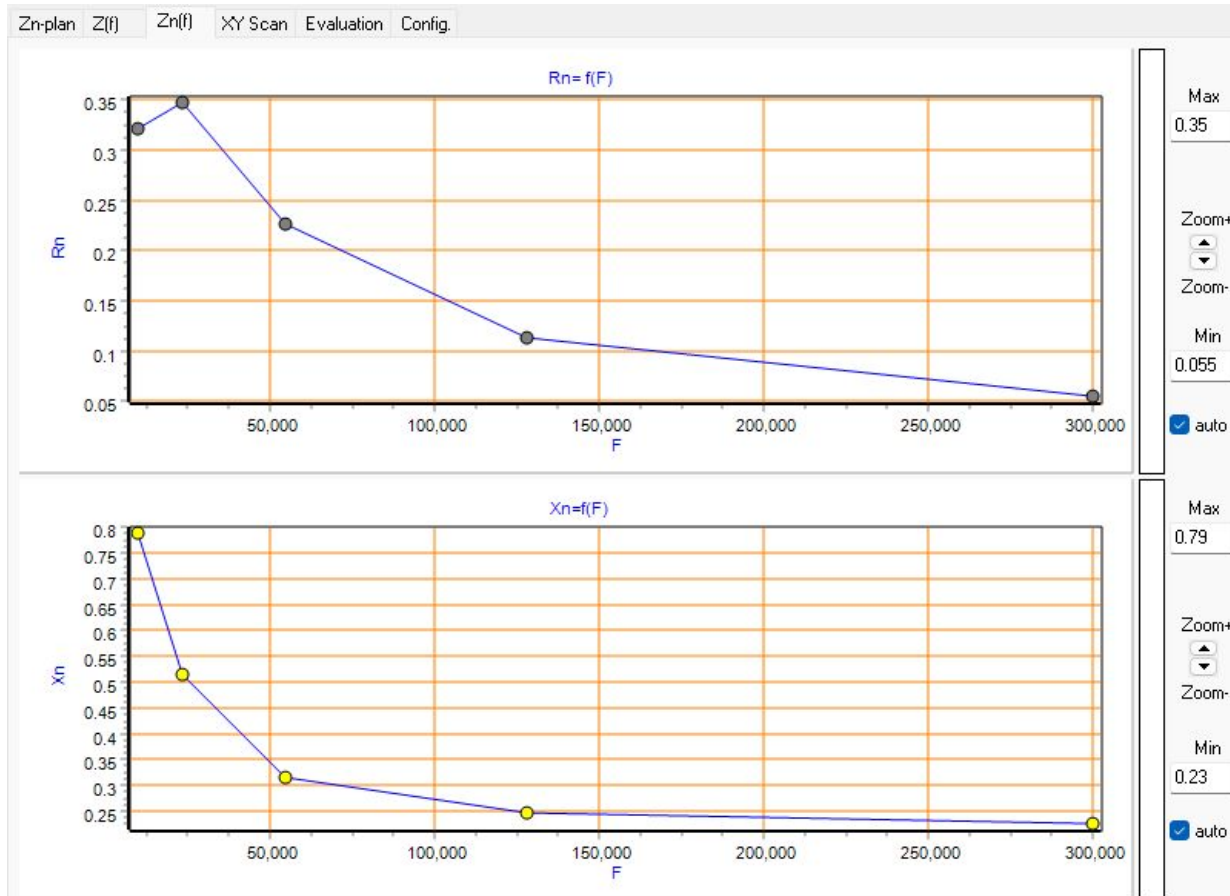
1.13 - Impedance Plots



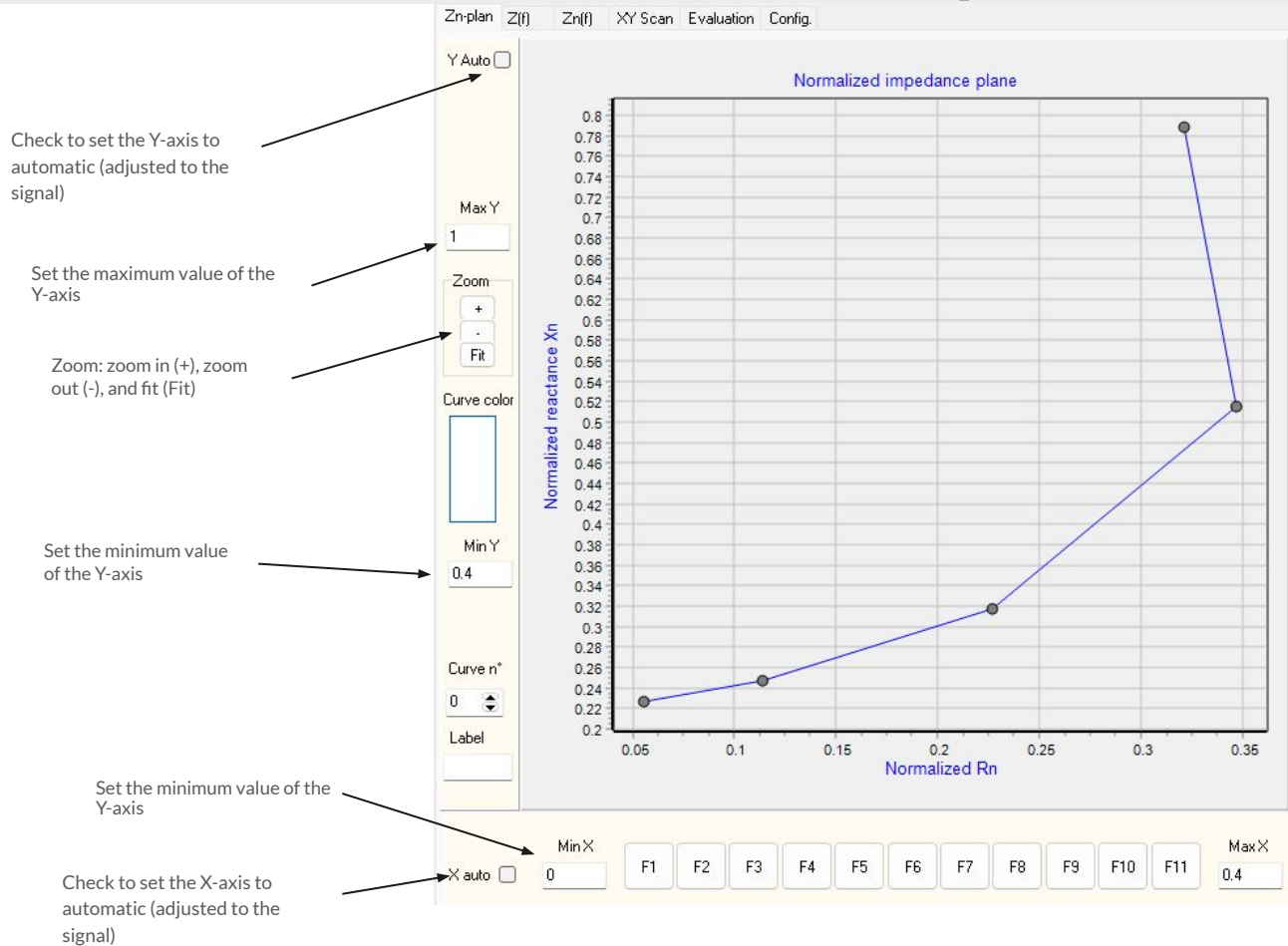
1.14 - Impedance $Z(f)$ vs. frequency



1.15 - Normalized impedance $Z_n(f)$ vs. frequency



1.16 - Normalized Impedance Plane



- Tips:
- Double-click the F1 button: adjust the curves on the screen, then freeze the axes.
 - Press F2: clear all curves.
 - Press F4: zoom in on the display.
 - Press F5: zoom out on the display.

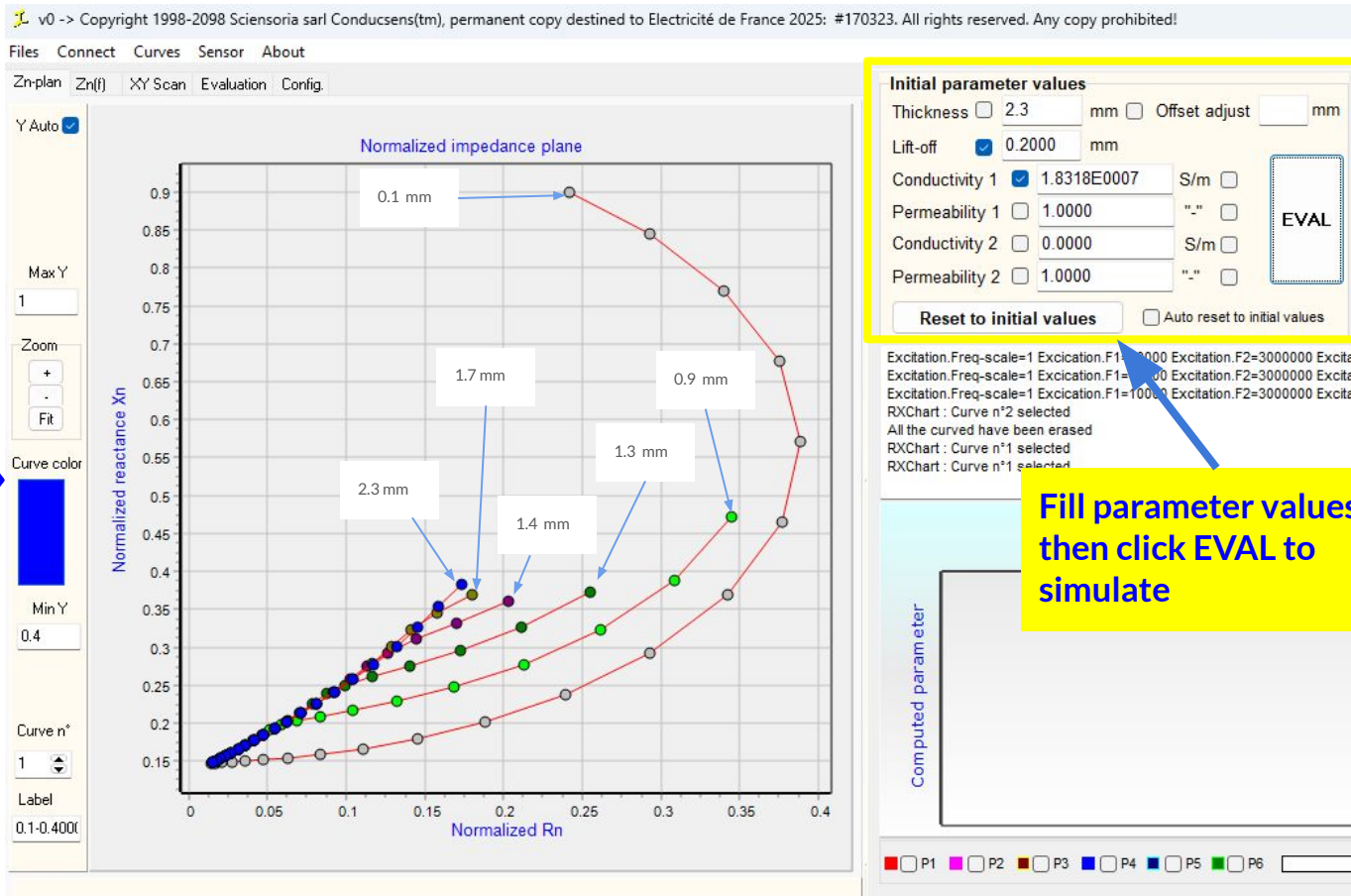
2.1 - Simulation of the Impedance Plane

Important: hit F2 to show the measurement panel.

Normalized impedance plane evolution for different *aluminum alloy sheet thicknesses*.

Frequency:
20 logarithmically spaced values from 10 kHz to 3 MHz

Probe coil:
 $D_{int} = 2 \text{ mm}$
 $D_{ext} = 10 \text{ mm}$
Height = 0.2 mm

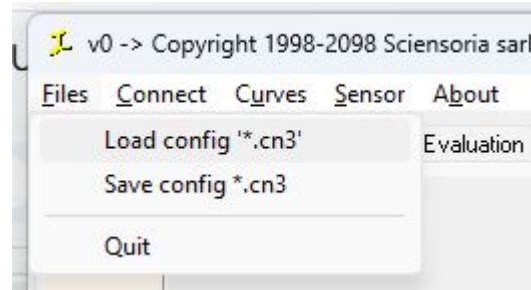


2.2 - Loading a Configuration File

When the program starts, it automatically loads a default configuration file, ZX0220002_StandardNPN_AI22e6MSpm_14.cn3.

Config file name ZX0220002_StandardNPN_AI22e6MSpm_14.cn3

To load a configuration file that matches the probe in use, go to Files → Load config (*.cn3) in the top menu bar.



This allows you to select the probe's characteristics and define the material parameters. These parameters should closely match those of the material being measured.

For example, if the material is a solid aluminum alloy block, you should load a configuration file with:

- Thickness: 10 mm
- Electrical conductivity: 22.643 MS/m
- Relative magnetic permeability: 1

2.3 - Configuration File Parameters (continued)

Probe-Related Parameters:

- Internal radius of the coil (r1)
- External radius of the coil (r2)
- Length of the coil (l)
- Ohmic resistance of the coil (R0)
- Number of turns of the coil (Nturns)

If the probe includes a ferrite disc (Exist = Yes), the following disc parameters must be defined:

- Disc thickness (Thickness)
- Electrical conductivity of the disc (Conductivity)
- Magnetic permeability of the disc (Permeability)
- Thickness between the coil and the disc (Air gap)

Permeabilitv 2 | 1.0000

Configuration of the sensor

Eichier

Coil

r1 1 mm

r2 10.23 mm

l 0.2 mm

R0 0 Ohm

Nturns 100 no unit

Ferrite disc

Exist

No Yes

Thickness 10 mm

Conductivity 0 S/m

Permeability 1 no unit

Air gap 0 mm

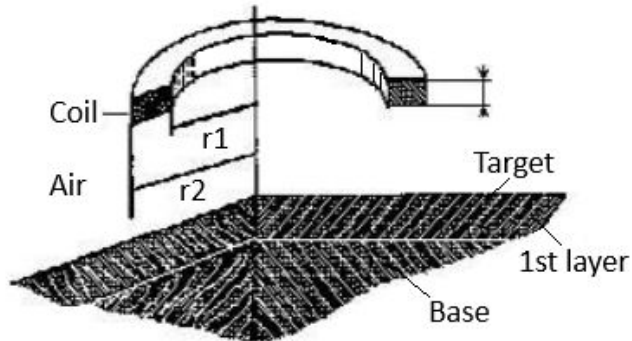
Accept Cancel

2.4 - Configuration File Parameters

Material-Related Parameters:

- Thickness (Épaisseur)
- Coating Electrical Conductivity (Conductivity 1)
- Coating Relative Magnetic Permeability (Permeability 1)
- Base Electrical Conductivity (Conductivity 2)
- Base Relative Magnetic Permeability (Permeability 2)

The base is considered infinitely thick.



Intermediary parameter values

Thickness	<input type="checkbox"/>	10.0000	mm	<input type="checkbox"/>	Offset adjust		mm
Lift-off	<input checked="" type="checkbox"/>	0.4000	mm	<input type="checkbox"/>			
Conductivity 1	<input checked="" type="checkbox"/>	1.8287E0007	S/m	<input type="checkbox"/>			
Permeability 1	<input type="checkbox"/>	1.0000	"."	<input type="checkbox"/>			
Conductivity 2	<input type="checkbox"/>	0.0000	S/m	<input type="checkbox"/>			
Permeability 2	<input type="checkbox"/>	1.0000	"."	<input type="checkbox"/>			

Reset to initial values Auto reset to initial values

EVAL

2.5 - Measurement of material parameters

Once a normalized impedance curve has been obtained, as shown on the screen below, you can proceed with the measurement of parameters. The curve consists of several points, each representing the complex normalized impedance acquired at a frequency during the sweep. Hit F2 to show the measurement panel.

Initial parameter panel

Measured parameter panel

Zplan chart

Survey chart

Initial parameter values

Thickness	<input type="checkbox"/> 10.0000 mm	<input type="checkbox"/> Offset adjust	<input type="checkbox"/> mm
Conductivity 1	<input checked="" type="checkbox"/> 1.0285E0007 S/m	<input checked="" type="checkbox"/> Permeability 1	<input type="checkbox"/> 1.0000
Conductivity 2	<input type="checkbox"/> 0.0000 S/m	<input type="checkbox"/> Permeability 2	<input type="checkbox"/> 1.0000

Measurement results

Thickness	10.0000 mm
Conductivity	1.0285E0007 S/m
Permeability (μ r)	1.0000
Qerr	0.0000033930-

Control

PRESENT

AIR INVERSION

Measurement

Air Target

Frequency generator (Hz)

F1 (Hz) 10000 Mode Lin Log

F2 (Hz) 200000 Log Spot

NF 5 5 Spot

Spot (Hz)

Skin depth check

Measurement result

Computed parameter

Min V-axis 1 Max V-axis 2 Auto V-axis

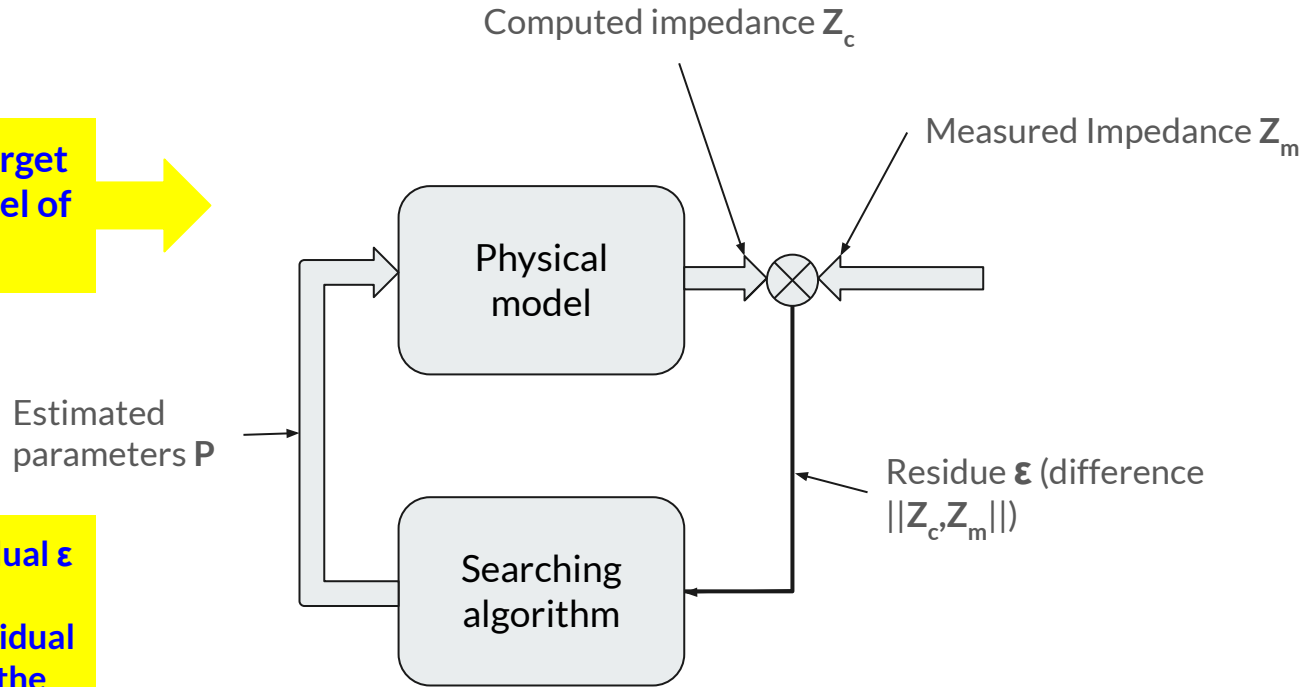
Config file name ZX0214002StandardNPN_AD2e6MSpm_14.cn3

Hit F12 to hide or show this panel

3.1 - Operating principle of Conducsens™

Iterative algorithm for finding target parameters using a physical model of the probe-target system

The search continues until the residual ϵ is sufficiently small or no longer decreases. The amplitude of the residual allows for evaluating the quality of the search.



3.2 - Operating principle of ConducSens™ (continued)

Once the inversion process is started, the software will attempt to match the measured impedance curve to the target curve by adjusting the parameters iteratively. The system uses the defined physical model and the initial parameters to calculate the optimal values for the target material.

During this process, the parameters may be adjusted until the impedance curve from the physical model closely matches the measured impedance curve. Once the curves align sufficiently, the process is considered complete, and the parameters are updated accordingly.

The residue characterizes Q_{err} represents the quality of the search process. It is the difference between the measured impedance and the calculated impedance based on the current parameters. A smaller residue indicates that the current parameter values are closer to the optimal solution, while a larger residue suggests that further iterations or adjustments are needed to improve the accuracy of the model. The goal of the iterative algorithm is to minimize the residue to achieve the best match between the measured and calculated impedance.

3.3 - Providing the initial values

The measurement principle is based on the iterative search for an optimal solution using a physical model of the probe-target system. When the multi-frequency impedance measured is sufficiently close to that calculated by the model, the solution is considered to be found.

To begin, the initial values of the target parameters (measured material) must be entered. The target is represented by 6 parameters:

- Thickness (coating layer thickness) (denoted by P1)
- Lift-off: probe-target distance (denoted by P2)
- Conductivity 1: electrical conductivity of the coating (denoted by P3)
- Permeability 1: relative magnetic permeability of the coating (denoted by P4)
- Conductivity 2: electrical conductivity of the base (denoted by P5)
- Permeability 2: relative magnetic permeability of the base (denoted by P6)

Initial parameter values			
Thickness	<input type="checkbox"/>	10.00	mm
Offset adjust	<input type="checkbox"/>		mm
Lift-off	<input checked="" type="checkbox"/>	0.40	mm
Conductivity 1	<input checked="" type="checkbox"/>	1.8287E07	S/m
Permeability 1	<input type="checkbox"/>	1.00	"-"
Conductivity 2	<input type="checkbox"/>	0.00	S/m
Permeability 2	<input type="checkbox"/>	1.00	"-"

Auto reset to initial values

Important: Check the boxes preceding the parameters to define them as variables. Otherwise, they will be considered constant and will not be included in the calculation. Also check the case following a parameter to include it to the Survey chart underneath.

In the example shown in the image, electrical conductivity and probe-to-target distance are defined as variables.

The "Reset to initial values" button allows you to restore the parameter values to the initial values recorded in the configuration file. The EVAL button calculates the normalized impedance curve corresponding to the specified initial values.

3.4 - The Importance of Initial Values

Important : the initial parameter values must be sufficiently close to the target parameters; otherwise, the search may not converge.

Note:

- Blue parameters are variables.
- Black parameters are constants.

Examples of Initial Values:

① Measuring the conductivity of solid aluminum

- $P1 = 10 \text{ mm}$, $P2 = 0.5 \text{ mm}$, $P3 = 20 \times 10^6 \text{ S/m}$, $P4 = 1$, $P5 = 0$, $P6 = 1$
- Justification: Due to the limited penetration of eddy currents, a thickness of 10 mm is representative of a solid aluminum block.

② Measuring the conductivity of solid 316L stainless steel

- $P1 = 10 \text{ mm}$, $P2 = 0.5 \text{ mm}$, $P3 = 1 \times 10^6 \text{ S/m}$, $P4 = 1$, $P5 = 0$, $P6 = 1$

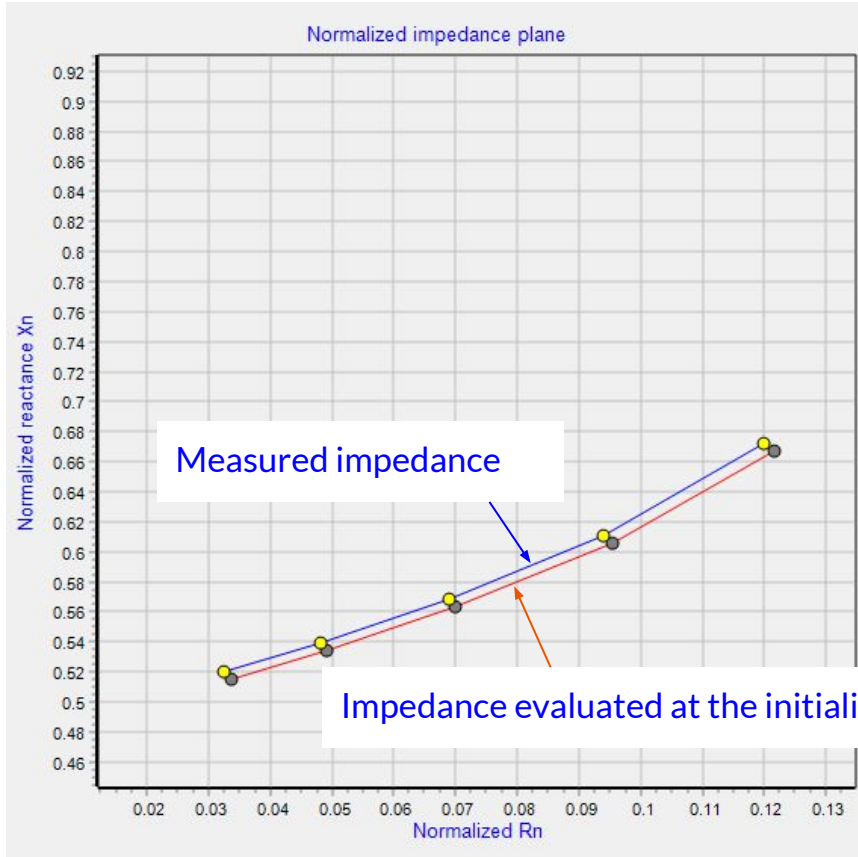
③ Measuring the conductivity and permeability of solid 316L stainless steel

- $P1 = 200 \text{ mm}$, $P2 = 0.5 \text{ mm}$, $P3 = 1 \times 10^6 \text{ S/m}$, $P4 = 1$, $P5 = 0$, $P6 = 1$
- Justification: Since 316L stainless steel is less conductive than aluminum, a 200 mm thickness represents a solid block.

④ Measuring the thickness and conductivity of a 316L stainless steel tube with a nominal thickness of 1.8 mm

- $P1 = 1.8 \text{ mm}$, $P2 = 0.5 \text{ mm}$, $P3 = 1 \times 10^6 \text{ S/m}$, $P4 = 1$, $P5 = 0$, $P6 = 1$
- Justification: The thickness is initially set to the nominal tube value to determine the actual thickness after wear or corrosion. The real thickness will always be smaller. Setting $P1$ to 10 mm (as in the solid block case) would mislead the algorithm, as eddy current signals have low sensitivity to thickness variations at that depth.

3.5 - Testing the Initial Values



Initial parameter values

Thickness 10.0000 mm Offset adjust mm

Lift-off 0.4000 mm

Conductivity 1 1.8287E0007 S/m

Permeability 1 1.0000 "-"

Conductivity 2 0.0000 S/m

Permeability 2 1.0000 "-"

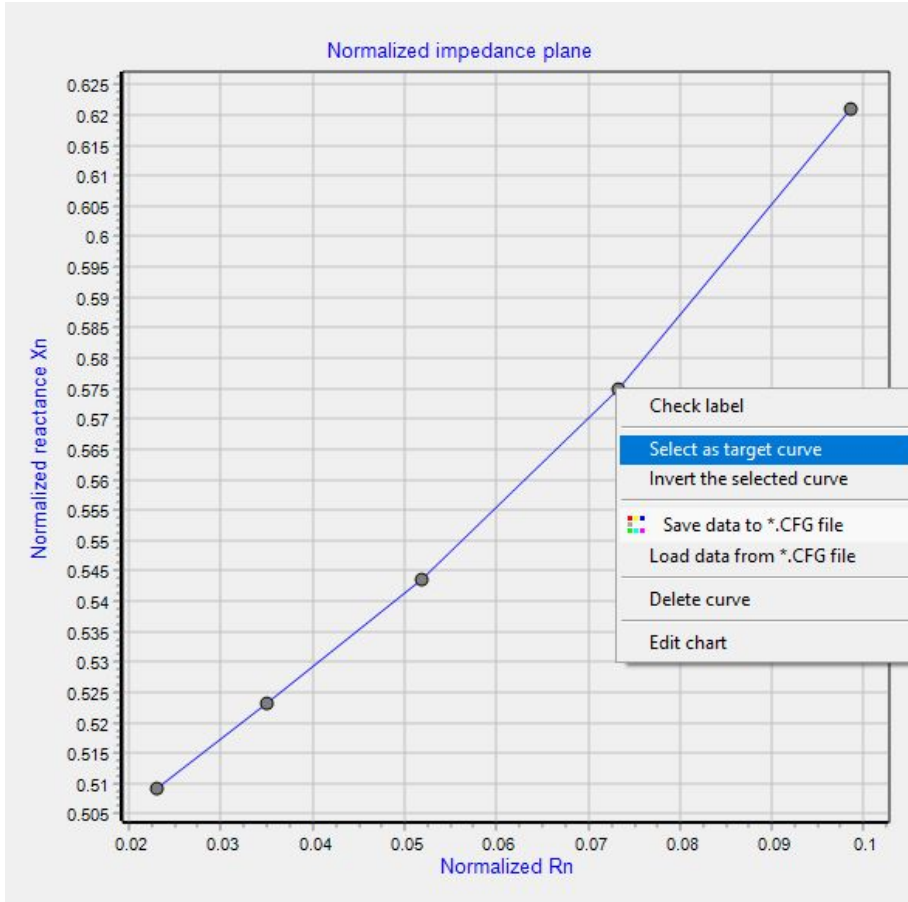
EVAL

Reset to initial values Auto reset to initial values

After entering the initial values of the target parameters, press the EVAL button to compute the impedance corresponding to this initialization point.

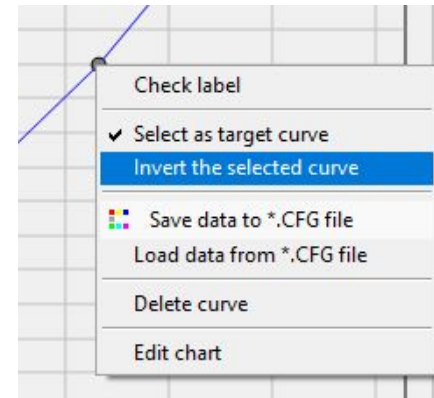
In the example shown in the image on the left, the initialization appears to be very close to reality, making it favorable.

3.6 - Inversion of measured impedance - Manual inversion

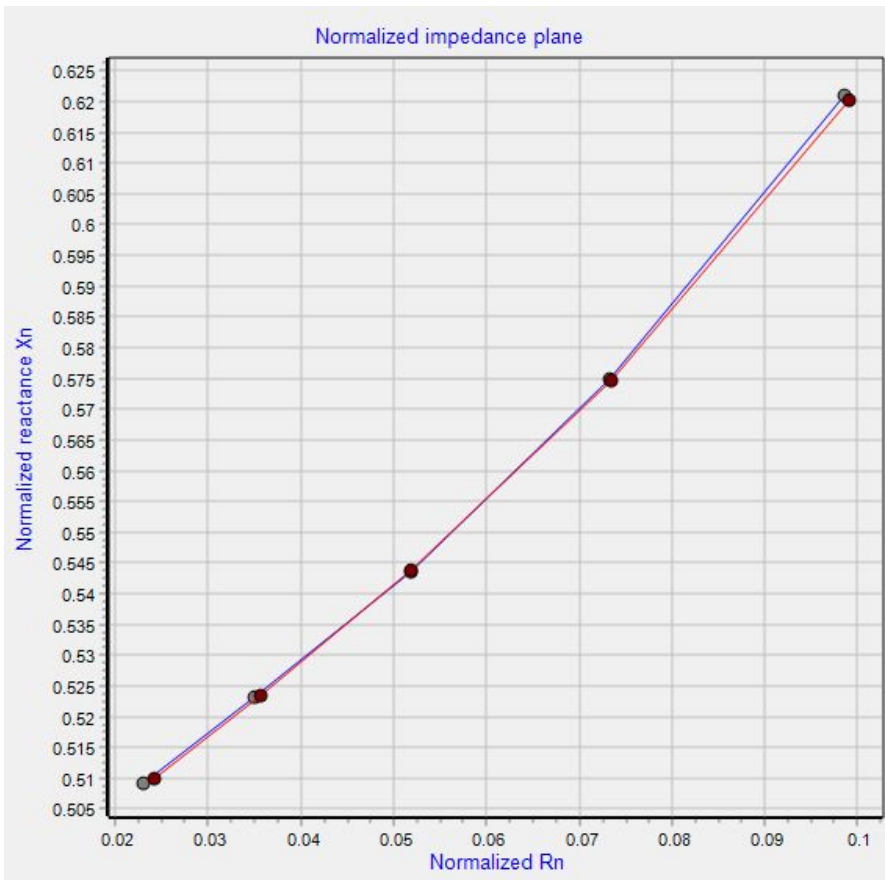


Manual inversion:

1. Stop the acquisition to freeze the curve by clicking the STOP button or pressing the Esc key on the keyboard.
2. Right-click on the frozen impedance curve displayed on the screen, then select the "Select as target curve" option.
3. Right-click again and choose the "Invert the selected curve" command as shown below. The inversion process will begin.



3.7 - Manual inversion (continued)



Measurement results

Thickness 10.0000 mm
Conductivity 3.5814E0007 S/m TEST
Permeability (μ r)

Note: do not forget to configure beforehand (as shown below).

Thickness 10.0000 mm Offset adjust mm

Lift-off 0.4000 mm

Conductivity 1 3.5814E0007 S/m

Permeability 1 1.0000 "-"

Conductivity 2 0.0000 S/m

Permeability 2 1.0000 "-"

Reset to initial values Auto reset to initial values

EVAL

3.8 - Continuous Inversion with IntelliSW™



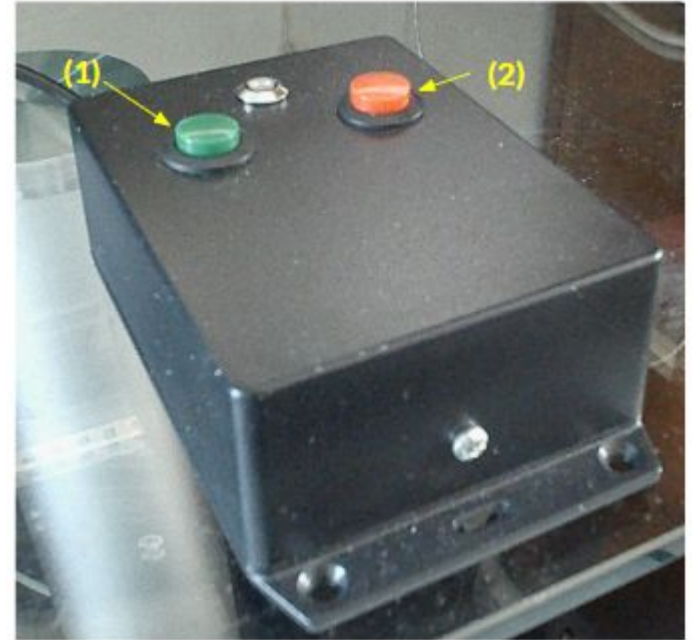
Manual inversion requires stopping the acquisition, selecting the impedance curve, and then initiating the inversion with the mouse.



Continuous inversion allows for the continuous calculation of the target parameters by pressing the red button (2) on the IntelliSW™ box. This enables the inspection of different points on the target continuously, making it easier to observe variations.

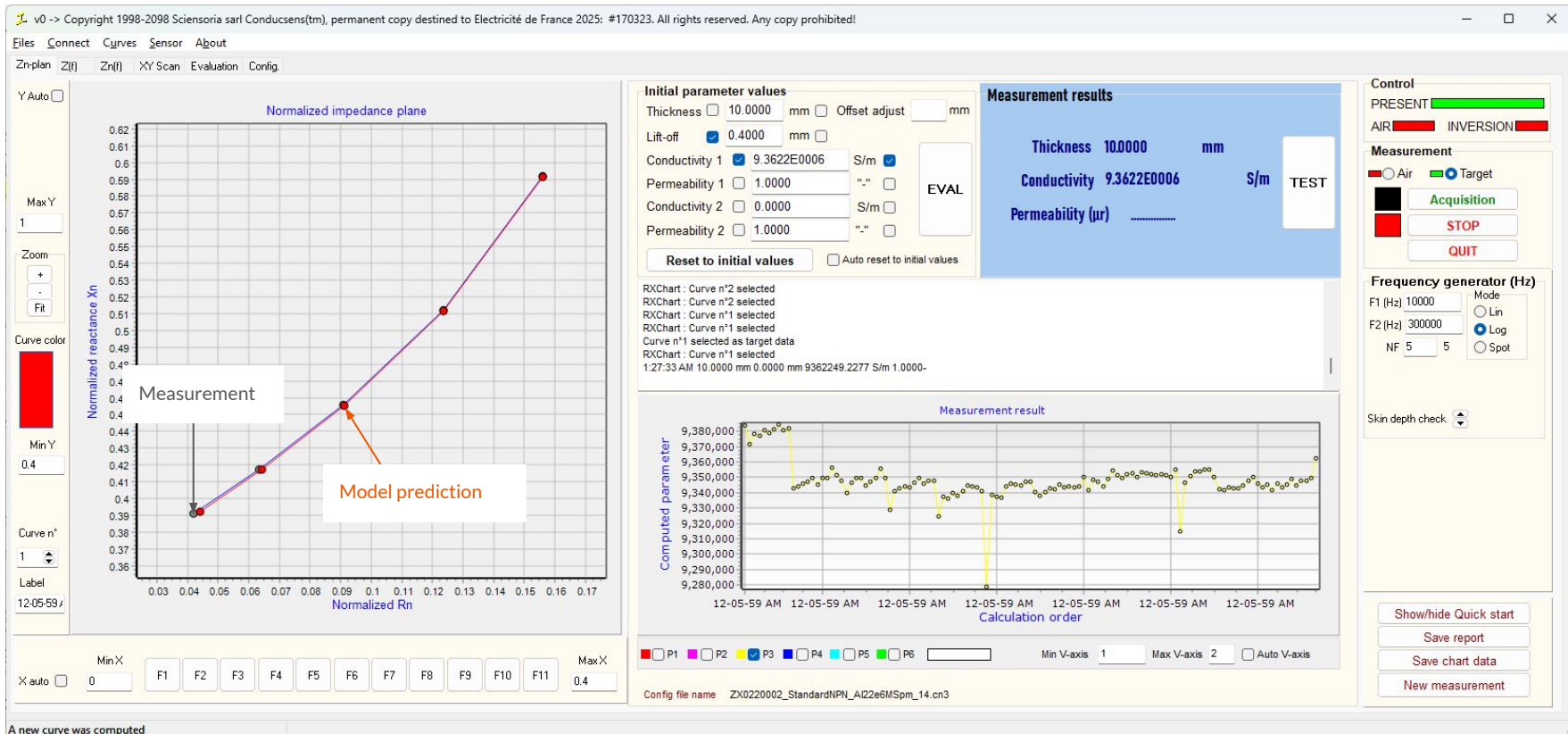
To perform continuous inversion, press the "Inversion" button (red button) on the IntelliSW™ box while the probe is positioned in front of the target.

Note: It is recommended to lift the probe into the air and press the "Air" button (green button) (1) on the IntelliSW™ box beforehand to eliminate any low-frequency drift from the impedance meter.

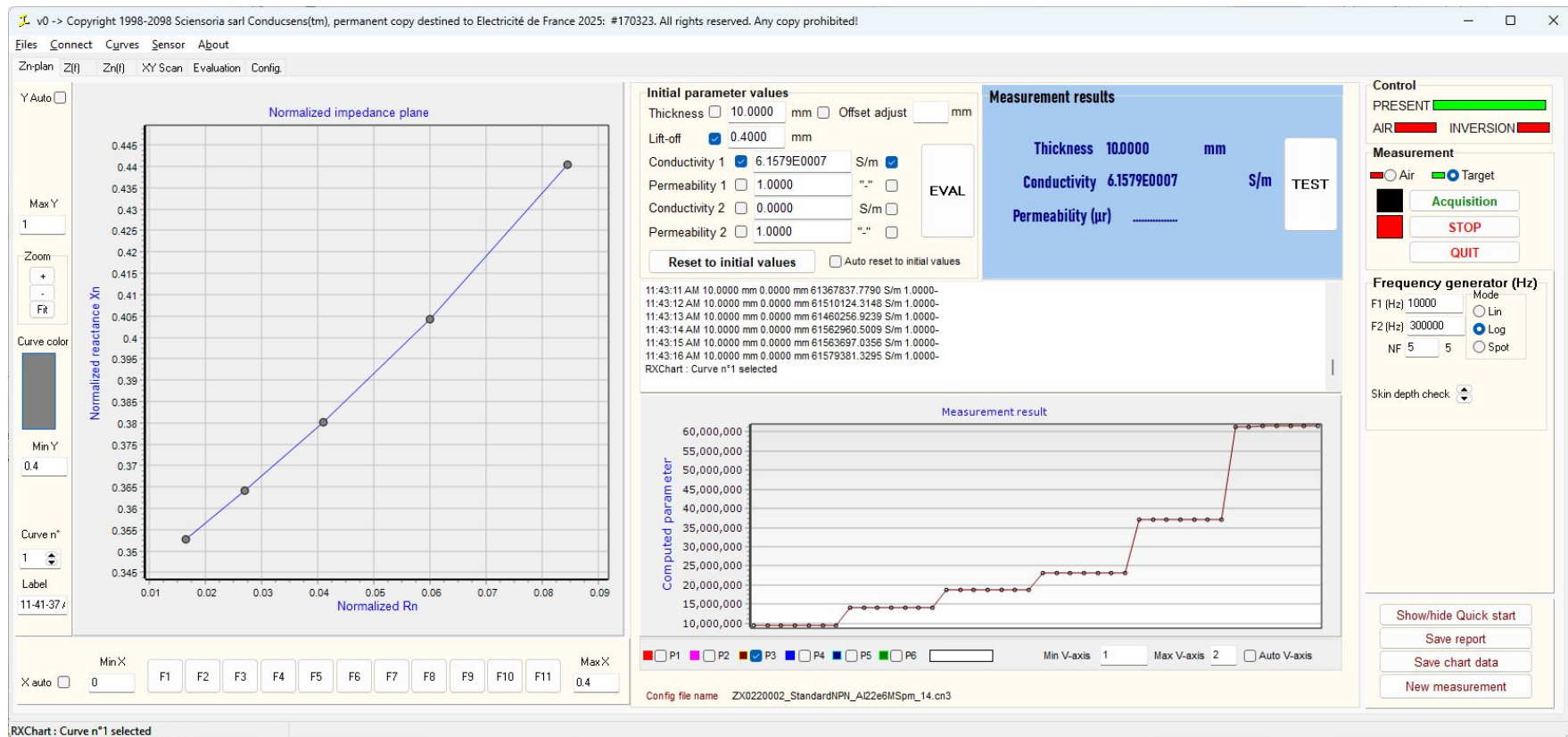


IntelliSW™ control box

3.9 - Measurement on a NPL's standard (16.17% IACS 9.38 MS/m)

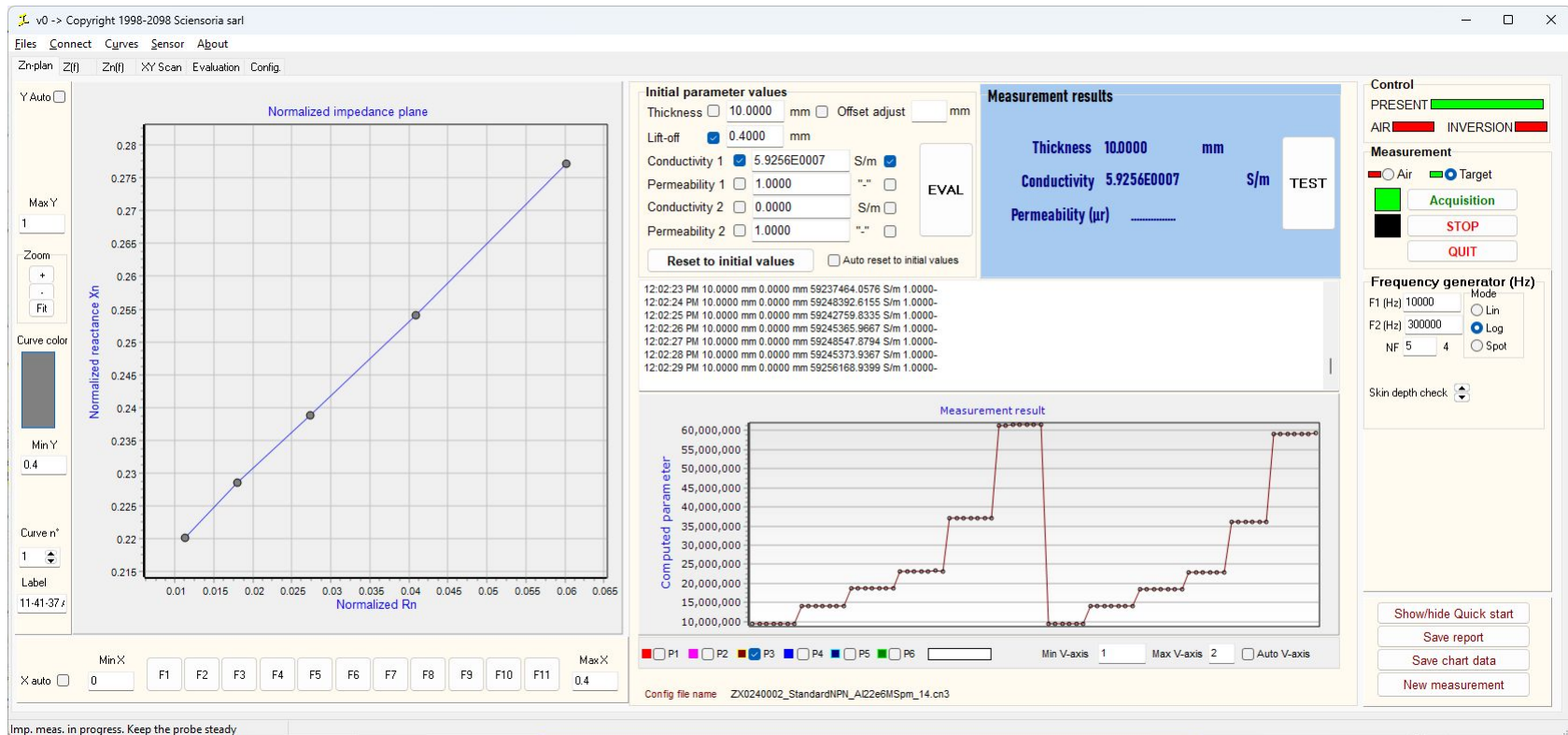


3.10 - Measurement of electrical conductivity on NPL's standards



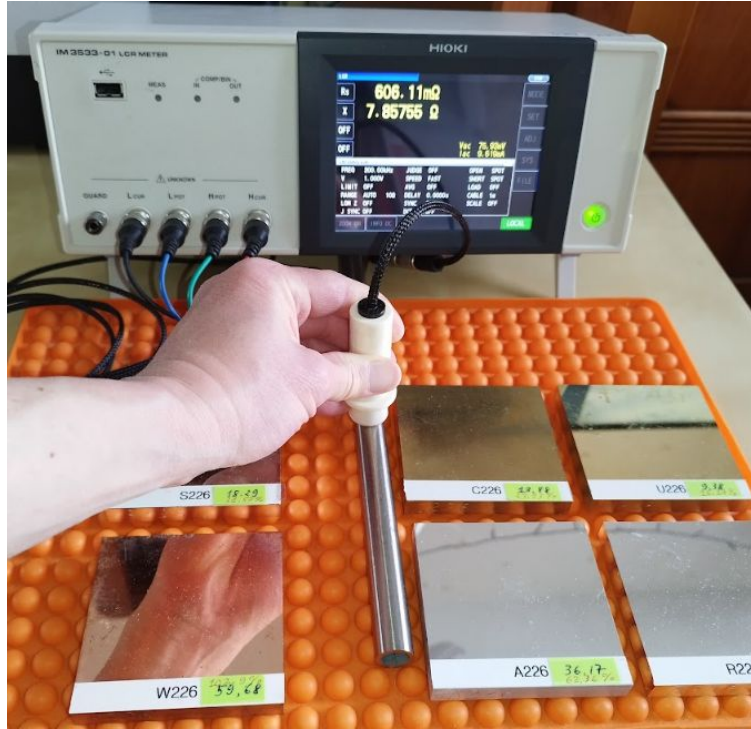
Probe ZX0220002-EDF2024-1

3.11 - Measurement of electrical conductivity on NPL's standards using two different probes



Probes ZX0220002-EDF2024-1 and ZX0240002-EDF2024-1

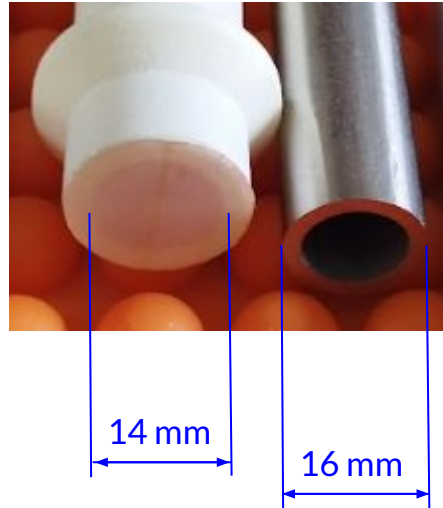
Measuring thickness of tubes and other curved surfaces



Example n°1: Measuring Thickness and Conductivity of an Unknown Non-Magnetic Stainless Steel Tube (Nominal ID = 14 mm, OD = 2 mm)

- The tube's surface is curved rather than flat, which can introduce measurement errors. Additionally, the outer radius (8 mm) is relatively small compared to the probe diameter (14 mm), further complicating the measurement process.
- Since the probe position is not stable, the lift-off is always considered a variable.
- Simultaneous measurement of thickness and conductivity is challenging because these parameters are strongly correlated at certain frequency ranges. Due to convergence difficulties, a partial 2-parameter inversion is used instead of a full 3-parameter inversion to improve stability and accuracy.

Measuring tube thickness - Example n°1



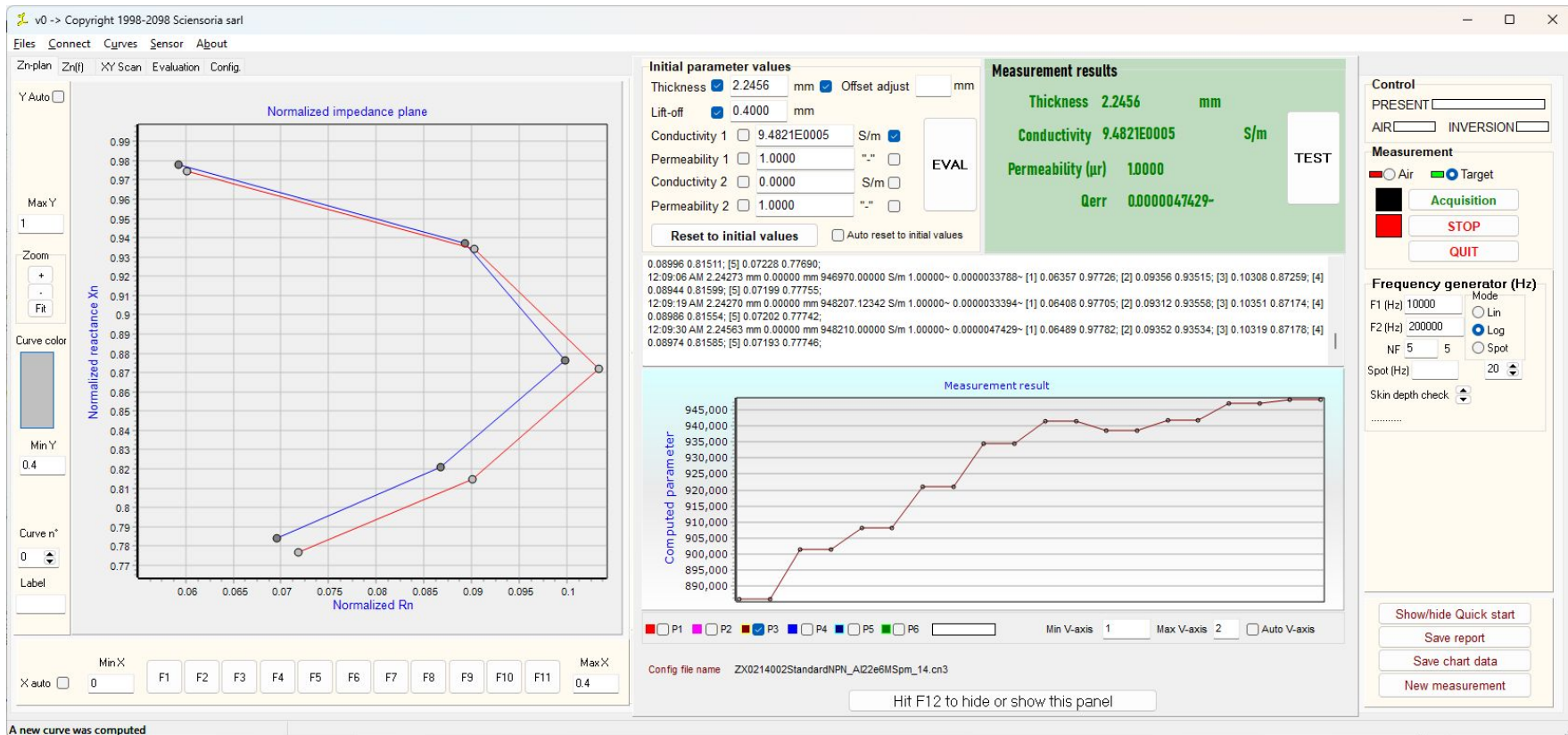
Probe diameter vs tube diameter

Example n°1 - Inversion strategies

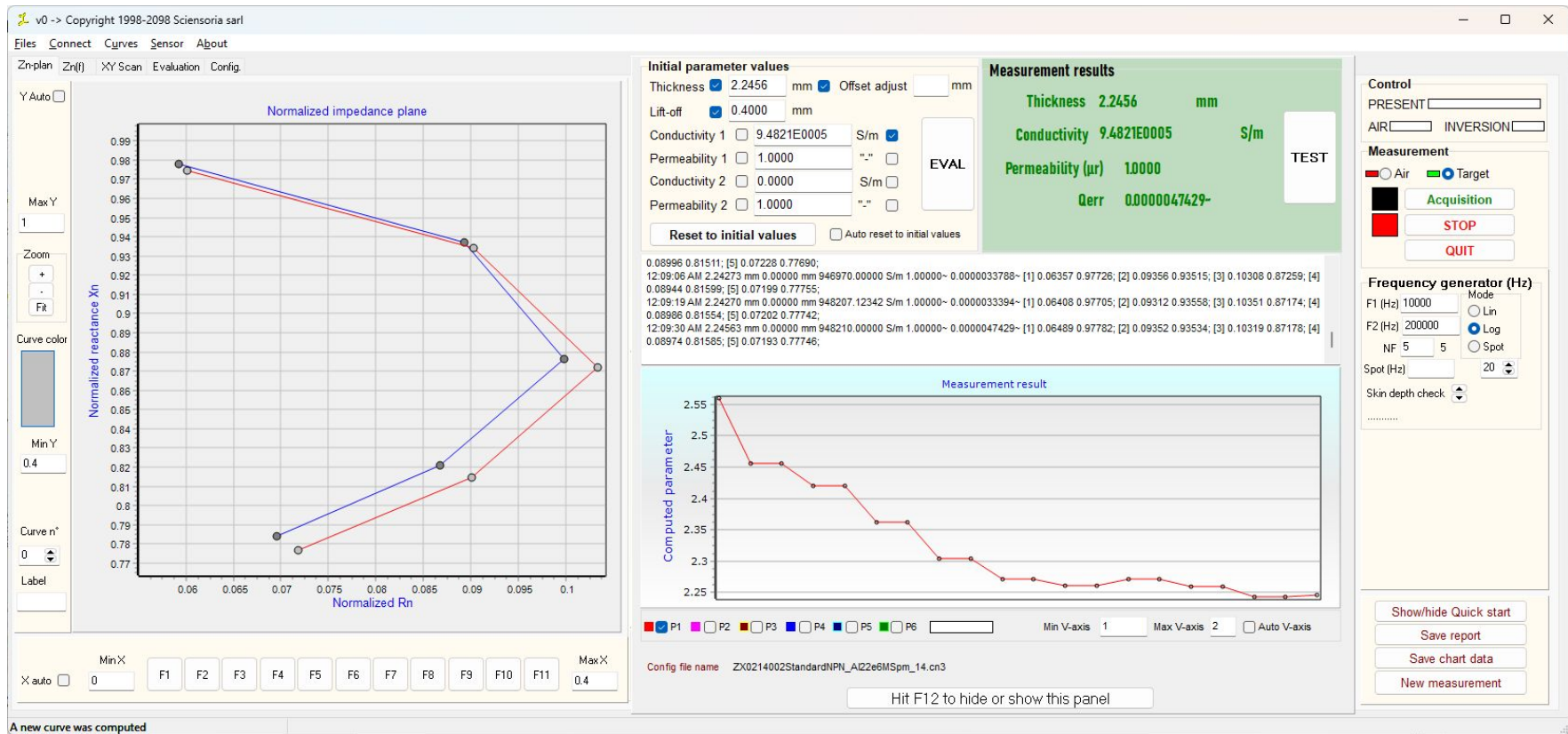
To avoid divergence, a sequential inversion strategy is utilized. This approach, referred to as *Alternating Parameter Inversion* (or *Cyclic Partial Inversion*), involves solving the inverse problem by varying only two out of the three unknown parameters at each step while keeping the third fixed.

The process iterates cyclically, updating different parameter subsets until global convergence is achieved for all three parameters.

Example n°1 - Partial Inversion - Convergence of electrical conductivity



Example n°1 - Partial Inversion - Convergence of thickness

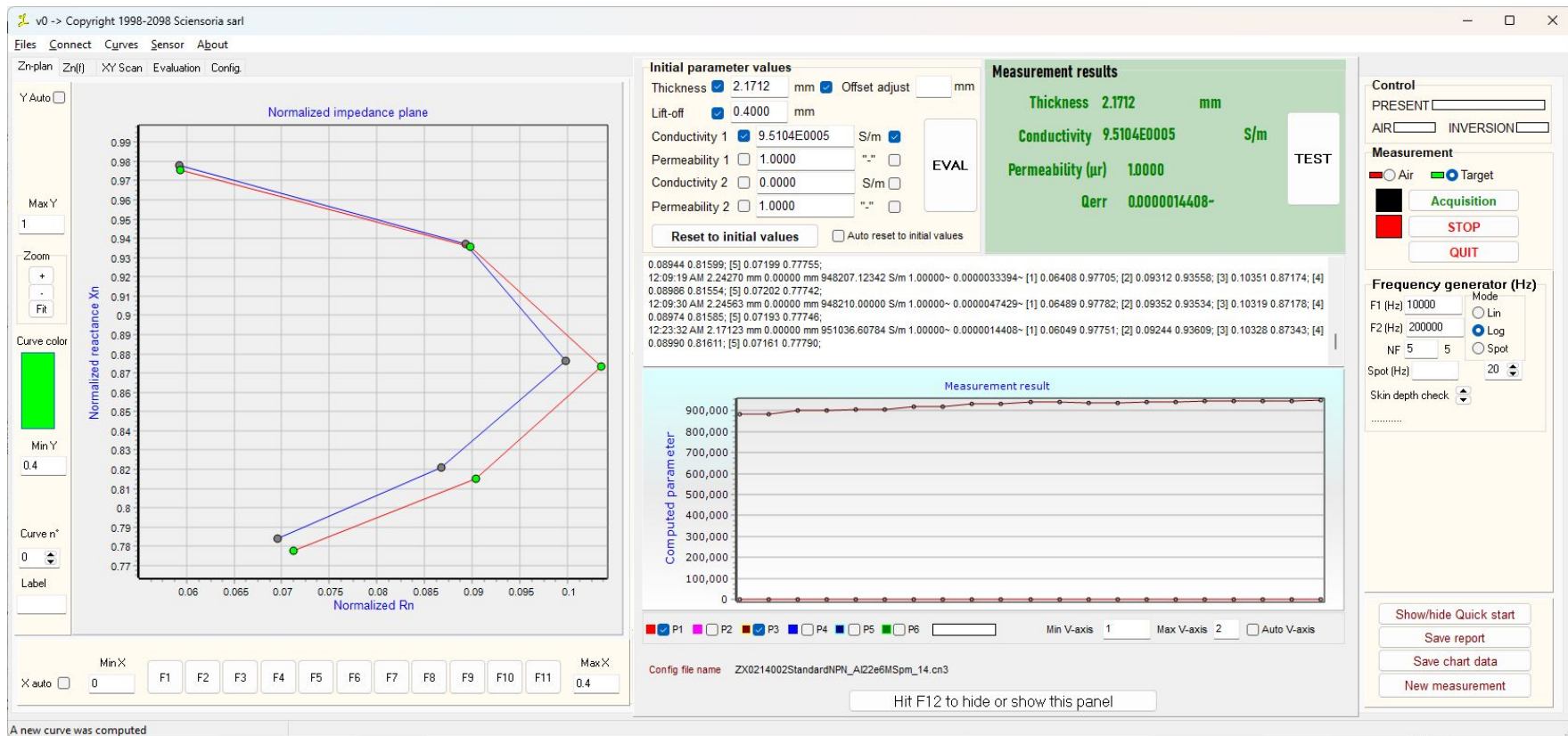


Example n°1 - Global Inversion

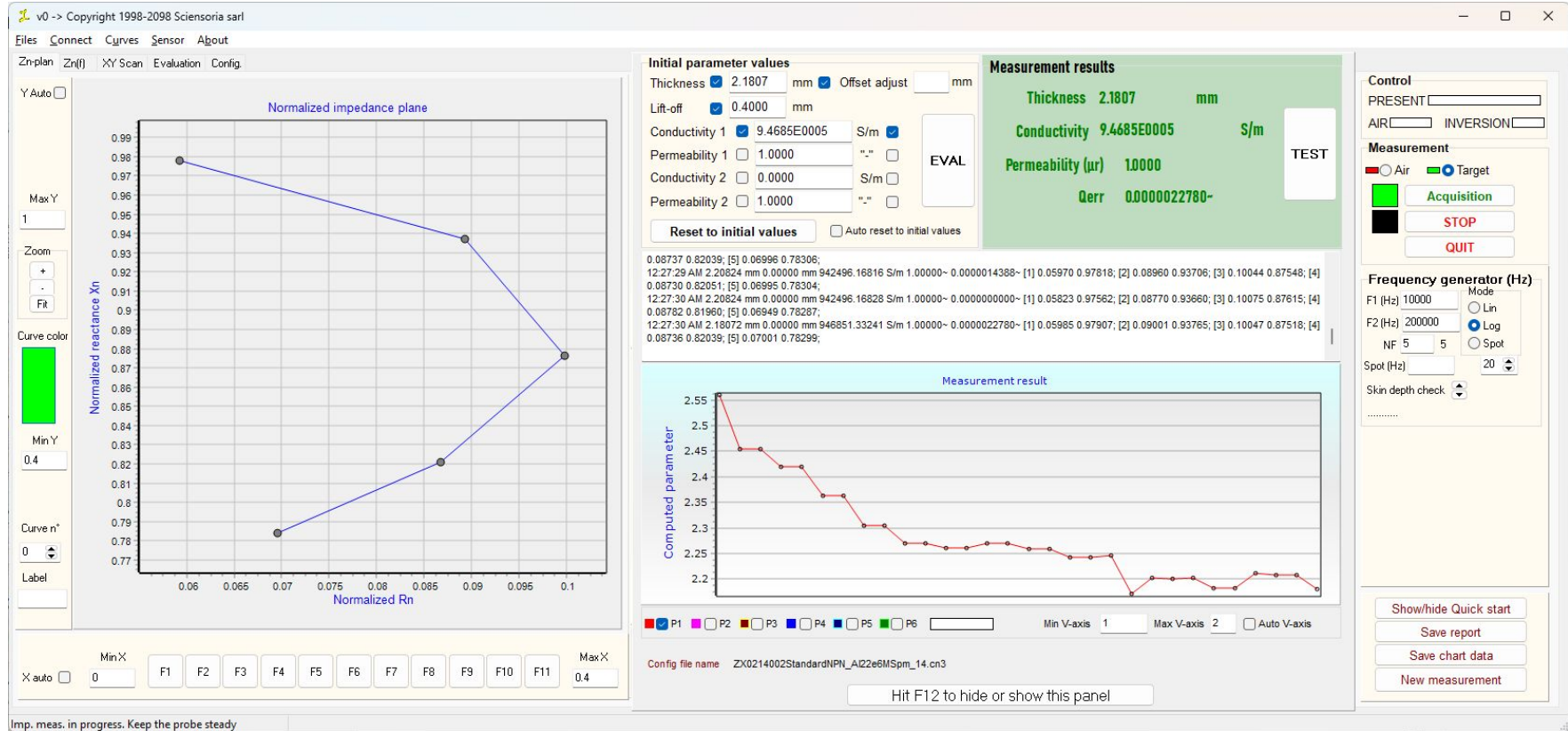
In contrast with sequential partial inversion, global inversion attempts to solve for all three parameters simultaneously, which can be more challenging and prone to divergence if initial values are poorly selected.

When the convergence of thickness and conductivity is slow, it may indicate that the estimated values are close to the true solution. In such cases, one can attempt global inversion to obtain a quicker result.

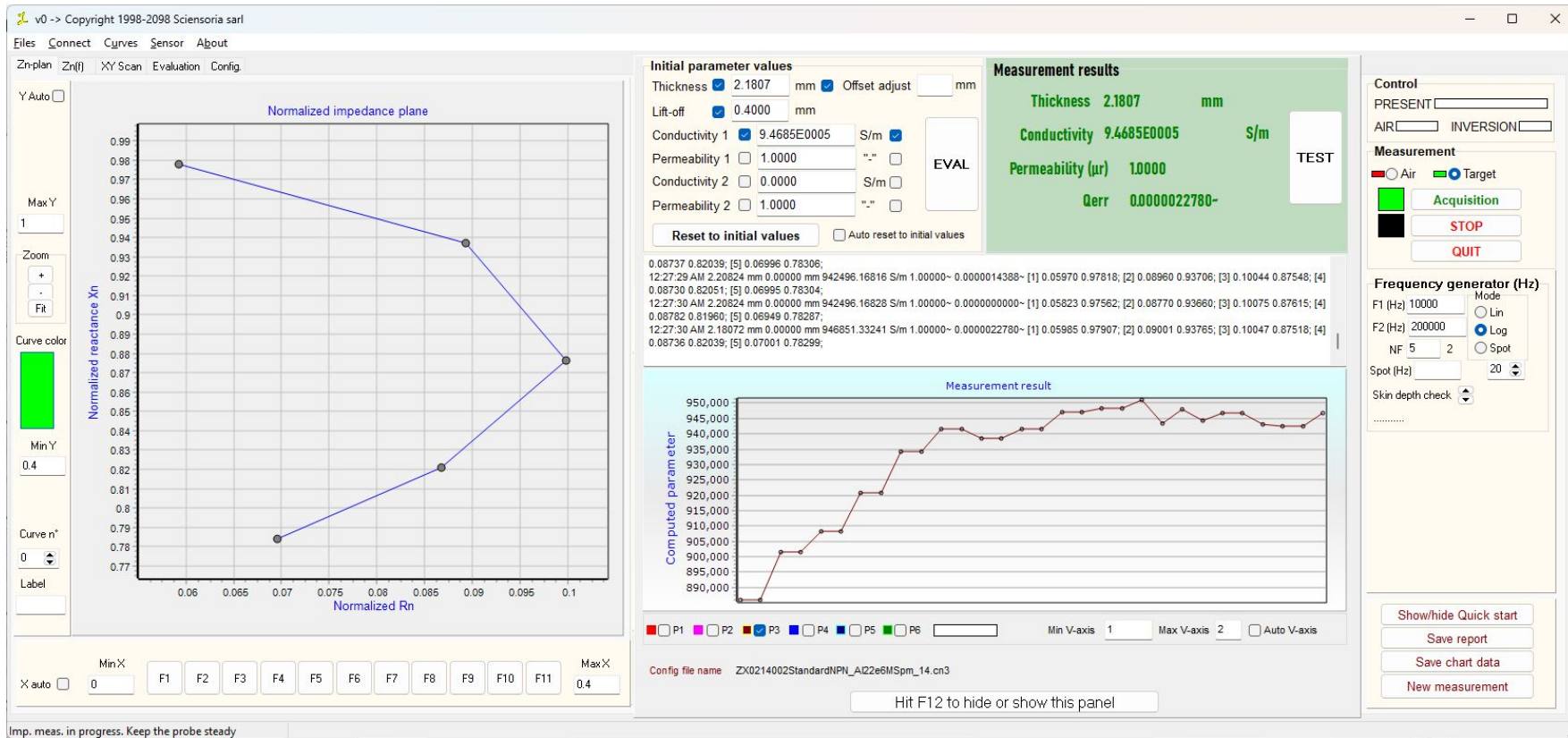
Example n°1 - Global Inversion When Close to Target



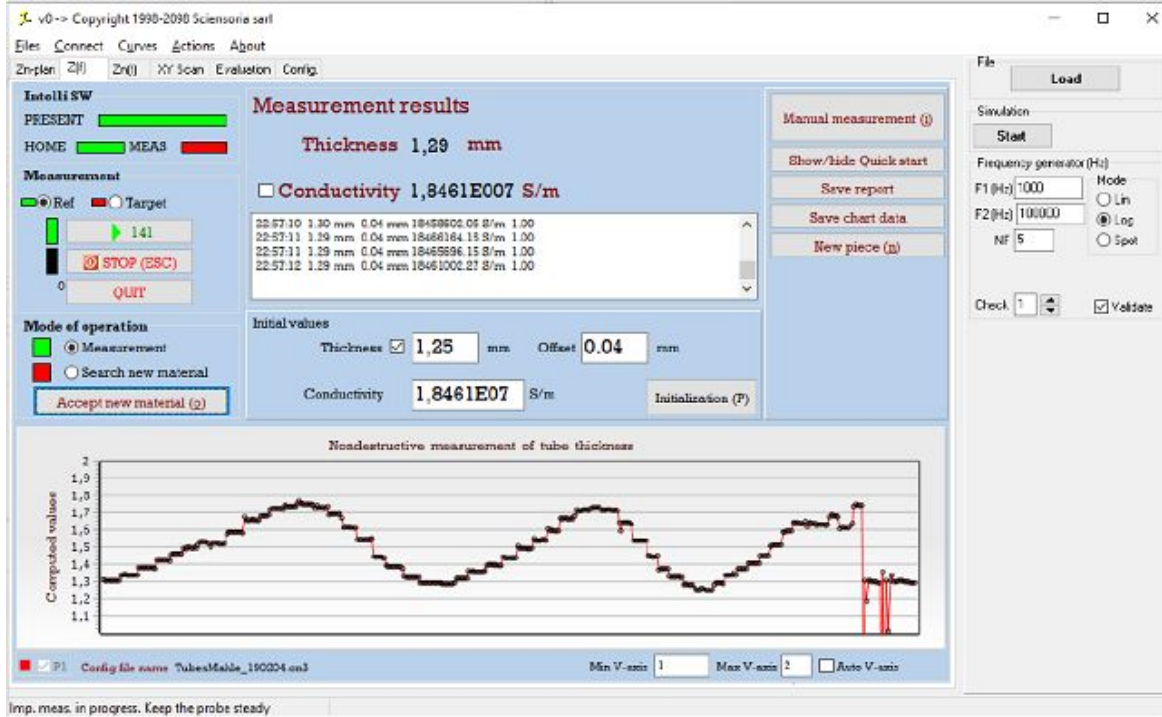
Global Inversion - Convergence of Thickness



Global Inversion - Convergence of Electrical Conductivity



Example n°2 - Measurement of aluminum tube wall thickness



ConducSens™ has been used to assess the uniformity of the thickness of aluminum pistons.

Example n°2 - EddySens™ screen

v0 -> Copyright 1998-2008 Sciensoria s.r.l.

Files Connect Curves Sensor About
Zn-plan Zn(f) XY Scan Evaluation Config.

Y Auto

Max Y 1

Zoom + - Fit

Curve color

Min Y 0.4

Curve n° 3

Label 1.64920.1

Min X 0 Max X 0.4

F1 F2 F3 F4 F5 F6 F7 F8 F9 F10 F11

X auto 0

A new curve was computed

Initial parameter values

Thickness 1.6492 mm Offset adjust mm

Lift-off 1.3 mm

Conductivity 1 1.7161E0007 S/m EVAL

Permeability 1 1.0000 "-"

Conductivity 2 0.0000 S/m

Permeability 2 1.0000 "-"

Auto reset to initial values

Measurement results

Thickness 1.6492 mm

Conductivity 1.7161E0007 S/m

Permeability (μr) 1.0000

Qerr 0.0000000000-

[4] 0.03803 0.68247; [5] 0.02697 0.66827;
11:57:51 PM 1.61683 mm 0.00000 mm 16907634.99991 S/m 1.00000~ 0.0000002487~ [1] 0.08712 0.76085; [2] 0.06561 0.72914; [3] 0.05130 0.70530;
[4] 0.03776 0.68442; [5] 0.02665 0.67154;
11:57:57 PM 1.60415 mm 0.00000 mm 17238434.98954 S/m 1.00000~ 0.0000003780~ [1] 0.09167 0.74869; [2] 0.06915 0.71566; [3] 0.05367 0.68958;
[4] 0.03979 0.66795; [5] 0.02812 0.65569;
11:57:58 PM 1.56235 mm 0.00000 mm 17223453.21624 S/m 1.00000~ 0.0000003014~ [1] 0.09134 0.75144; [2] 0.06802 0.71890; [3] 0.05299 0.69295;
[4] 0.03924 0.67294; [5] 0.02764 0.66003;
11:57:59 PM 1.64923 mm 0.00000 mm 17161377.66433 S/m 1.00000~ 0.0000001274~ [1] 0.08999 0.75174; [2] 0.06756 0.72004; [3] 0.05262 0.69342;

Control

PRESENT

AIR INVERSION

Measurement

Air Target

Frequency generator (Hz)

F1 (Hz) 10000 Mode Lin Log

F2 (Hz) 200000 Log Spot

NF 5 5 Spot

Spot (Hz) 20

Skin depth check

.....

Measurement result

Computed parameter

P1 P2 P3 P4 P5 P6 Min V-axis 1 Max V-axis 2 Auto V-axis

Config file name ZX0214002StandardNPN_AI22e6MSpm_14.cn3