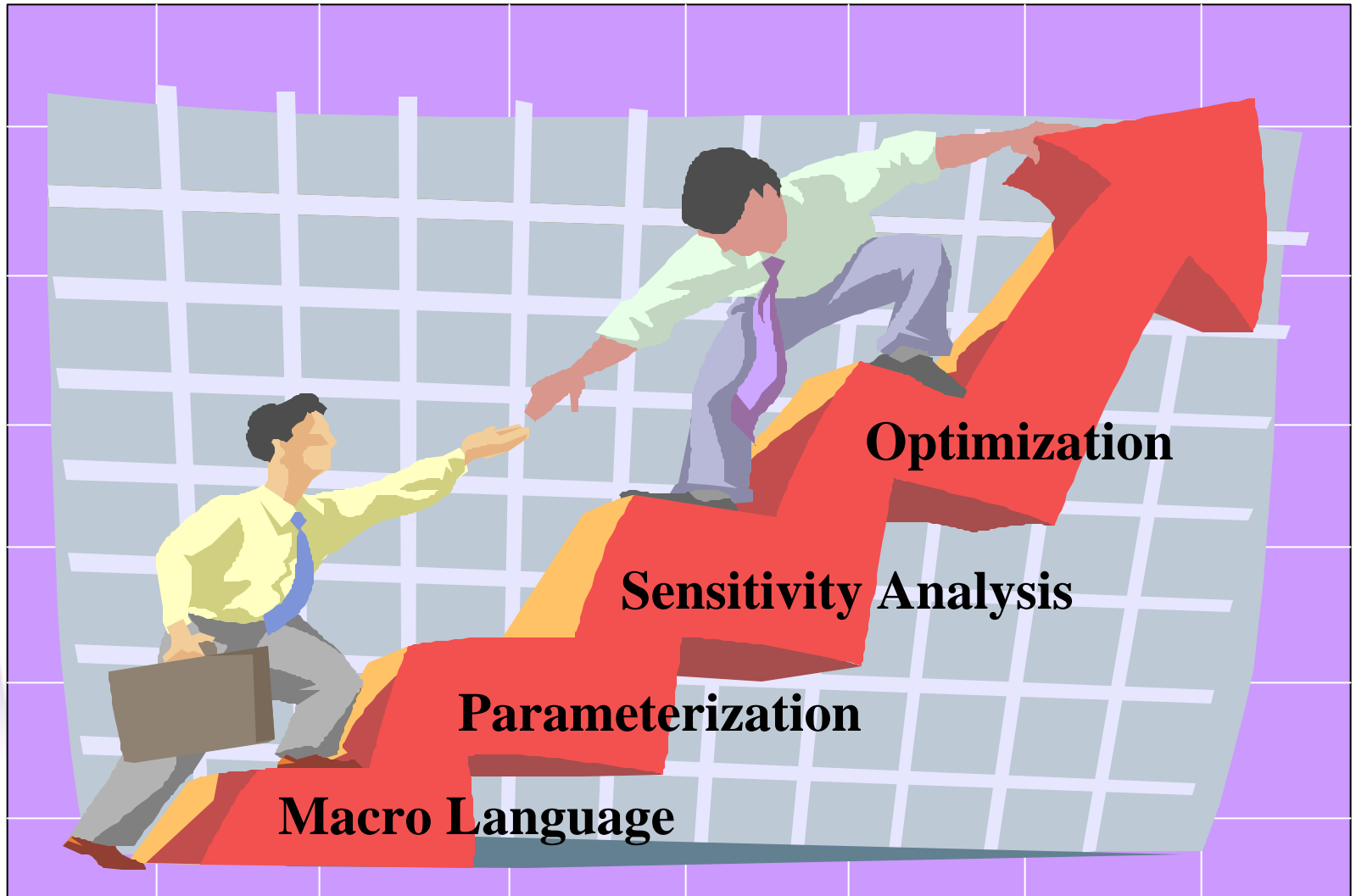


ANSOFT OPTIMETRICS

**Maxwell User's Conference
September, 26-27 2001
PITTSBURGH**

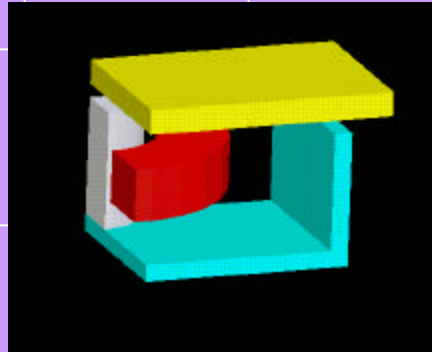


Efficient Electromagnetics Analysis

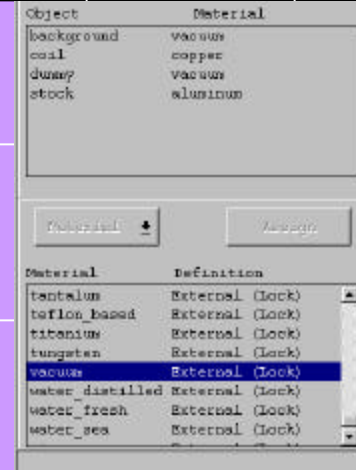


Macro Language

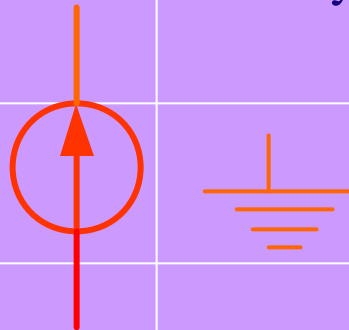
Controls all modeling phases



Geometry Creation



Material assignment



Sources and Boundaries



Post-processing

Macro Debugger

The screenshot shows the Ansoft Macro Debugger window. The main area displays a macro file named 'menu.mac' with the following content:

```
1  
2 # BEGIN: LINES ADDED BY MACRO EDITOR. DO NOT EDIT THE BELOW TEXT  
3 Assign configVar 10.33  
4 Assign PlotStatus 0  
5 Assign temp 76  
6 # END: LINES ADDED BY MACRO EDITOR. DO NOT EDIT THE ABOVE TEXT  
7  
E>8 AddMenuItem ("%Plot" "%Special" "%Automatic") "...does it all."  
9 AddMenuItem ("%Plot" "%Special" "%Reference") "Plot reference"  
10 AddMenuItem ("%Plot" "%Special" "%Comparison" "%Measurements")  
11 AddMenuItem ("%Plot" "%Special" "%Comparison" "%FDTD") "Compar  
12 AddMenuItem ("%Plot" "%Special" "%Comparison" "%MoM") "Compar  
    arison" "%Analytic") "Co
```

Key features highlighted by red callouts:

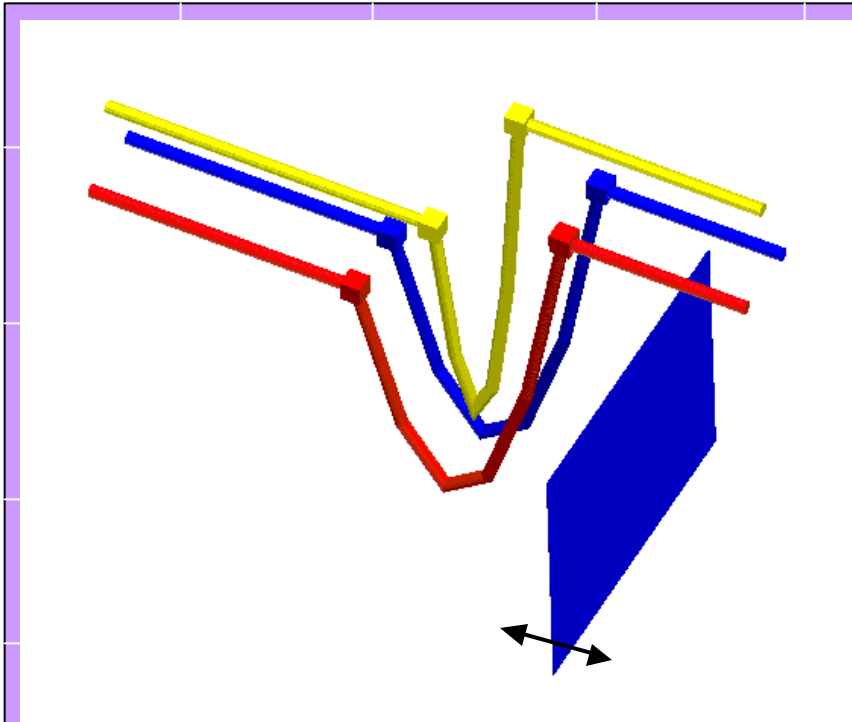
- Set Breakpoints and Step Through Macro:** A callout pointing to the macro code area.
- Inspect or Modify Variables:** A callout pointing to the 'Command variables' panel, which shows:

Variable	Value
PlotStatus	0
configVar	10.33
temp	76

The 'Selected Variable' is 'temp' and its 'Value' is '76'. A 'Set Value' button is also visible.
- Search for Strings:** A callout pointing to the 'Search For:' section, which includes a 'String:' input field and 'Block Start' and 'Block End' buttons.
- Recover from Errors:** A callout pointing to the 'Error Recovery:' section, which includes a 'Retry:' input field containing the macro code snippet: `AddMenuItem ("%Automatic") "...does it all." "AutoPlot.ma`.

At the bottom of the window, there are several control buttons: 'Set Breakpoint', 'Delete Breakpoint', 'Clear Breakpoints', 'Next Breakpoint', 'Previous Breakpoint', 'Current Position', 'Breakpoint Condition:', 'Search For:', 'String:', 'Block Start', 'Block End', 'Continue', 'Step Over', 'Step In', 'Stop Debugger', 'Error Recovery:', 'Retry:', 'Abort File', 'Show Syntax', and 'Help'.

High Field Screen Analysis

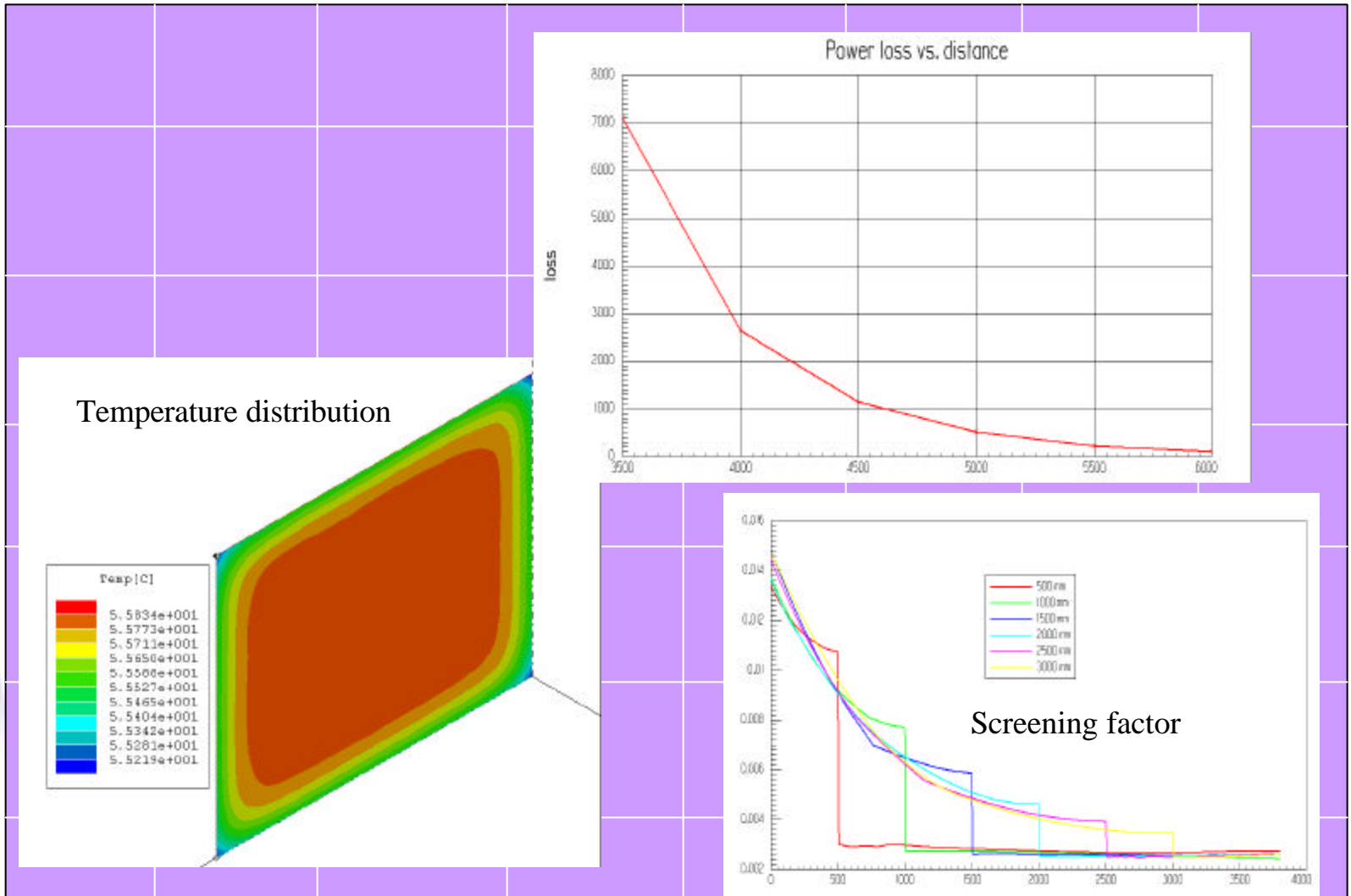


Phase current: 108 kA

Device space: 10x15x8 m³

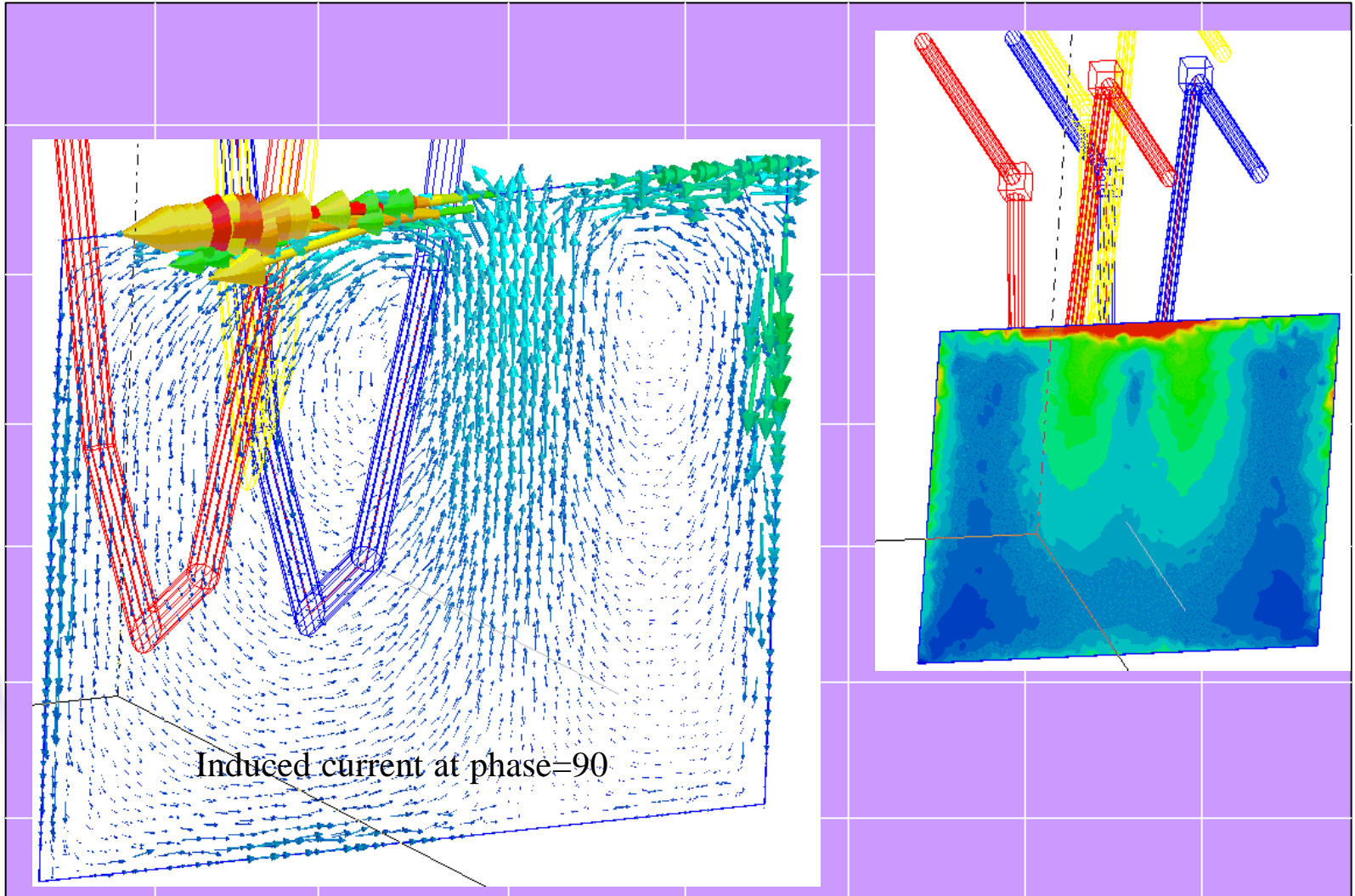
Screen thickness: 6.5 mm

Review of results



Review of results

Induced current magnitude



Sensitivity Analysis

The screenshot shows the 'Setup Sensitivity Analysis' dialog box with the following sections and callouts:

- 1** points to the **Design Point** section, which contains:

```
perm = 10000
theta = 0
```

and a **Set/Edit Design Point** button.
- 2** points to the **Sensitivity Var** table, which lists variables and their ranges:

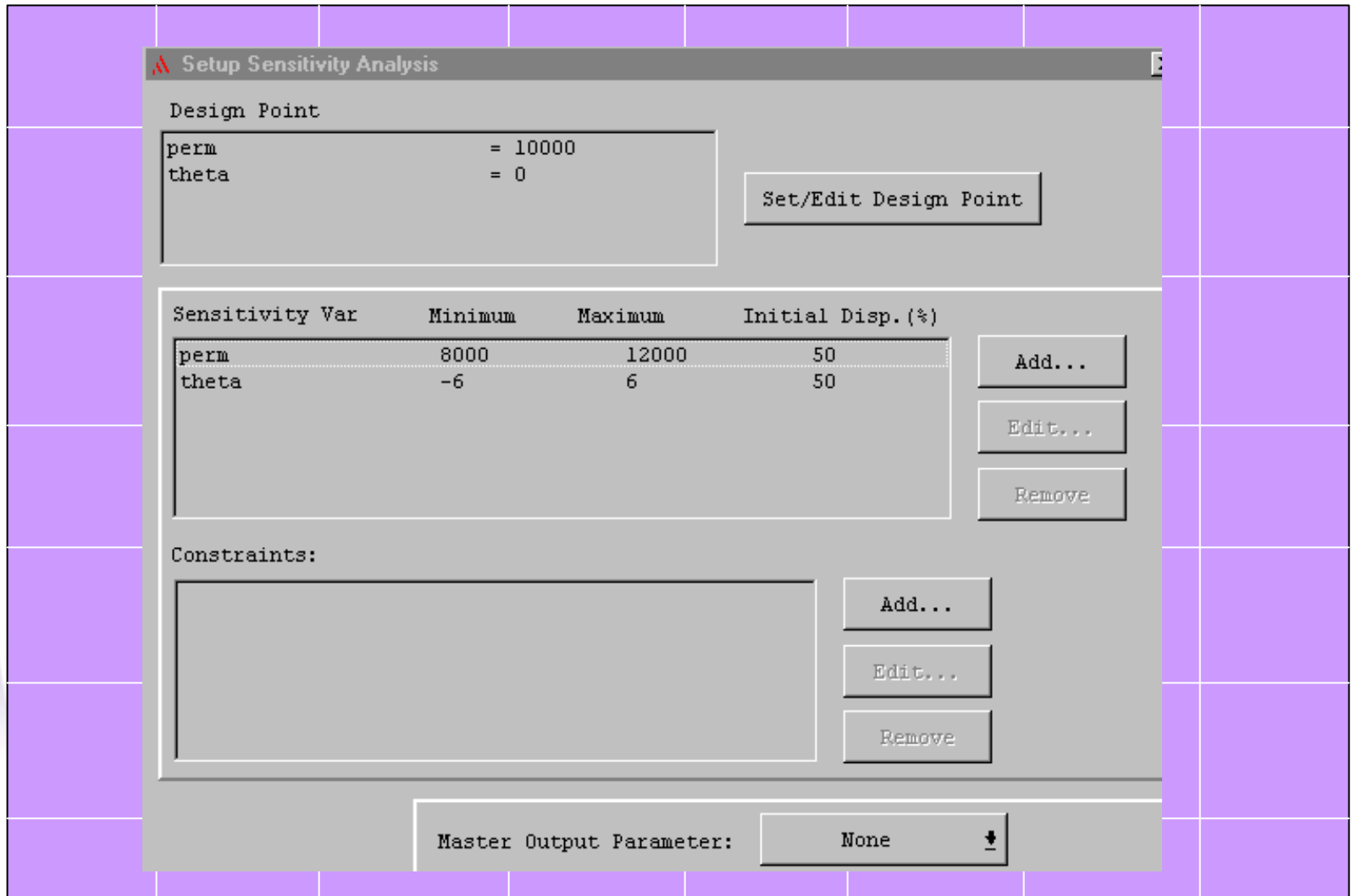
Sensitivity Var	Minimum	Maximum	Initial Disp. (%)
perm	8000	12000	10
theta	-3	3	10

Buttons for **Add...**, **Edit...**, and **Remove** are on the right.
- 3** points to the **Constraints** section, which is currently empty and has **Add...**, **Edit...**, and **Remove** buttons.
- 4** points to the **Analysis Criteria** section, which includes:
 - Master Output Parameter: **b_x**
 - Approx. Error in Master Output Parameter: **1e-007**
 - Max. Iteration/Sensitivity Var: **5**
 - Save FieldsButtons for **OK**, **Cancel**, and **Help** are at the bottom.

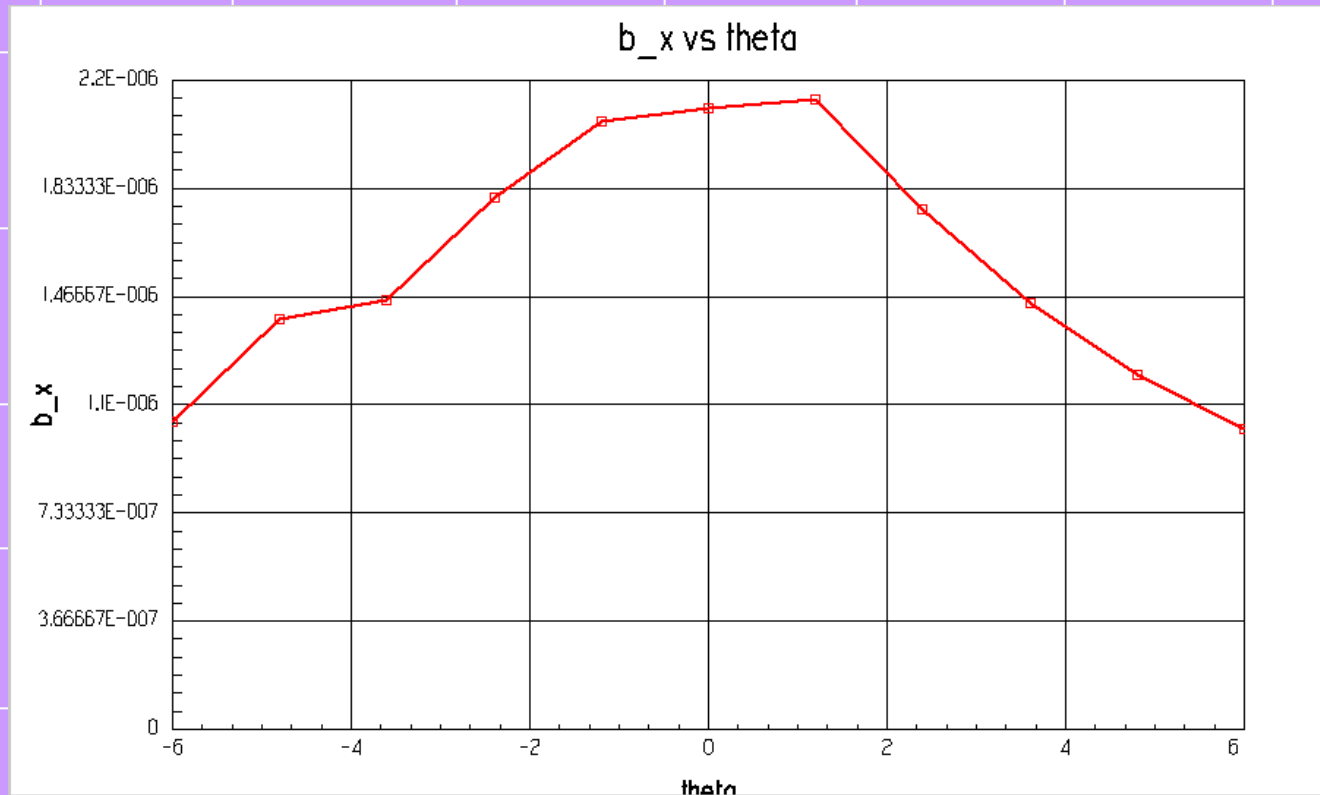
Sensitivity Analysis (how it works)

- ◆ There are two modes of operation
 - ◆ No master output parameter defined
 - ◆ Master output parameter defined

Sensitivity Analysis (no master output parameter)



Sensitivity Analysis (no master output parameter)



Sensitivity Analysis (with master output parameter)

Setup Sensitivity Analysis

Design Point

perm	=	10000
theta	=	0

Set/Edit Design Point

Sensitivity Var	Minimum	Maximum	Initial Disp. (%)	
theta	-6	6	50	Add...
				Edit...
				Remove

Constraints:

Add...

Edit...

Remove

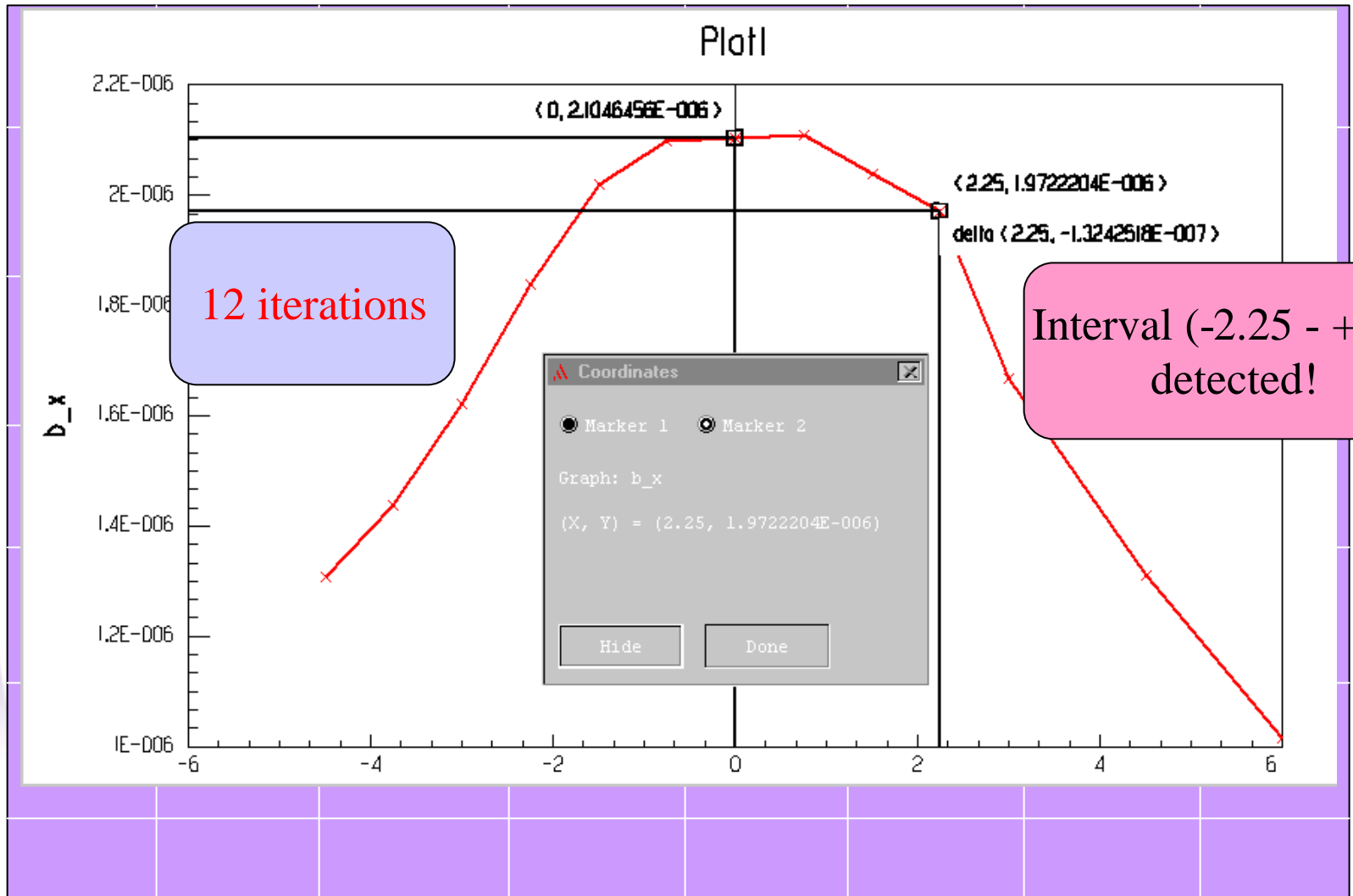
Master Output Parameter: b_x

Approx. Error in Master Output Parameter: 1e-007

Max. Iteration/Sensitivity Var: 12

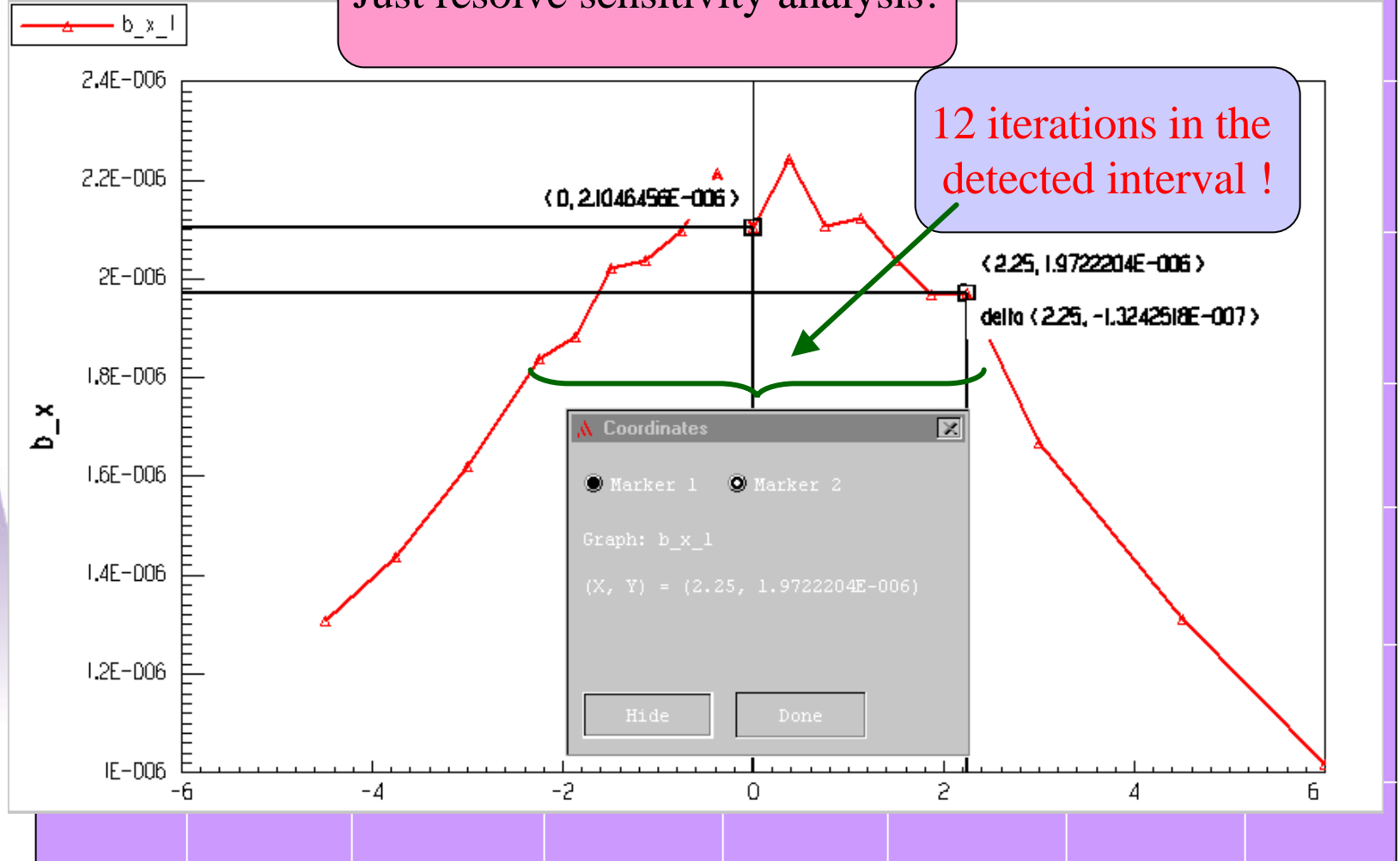
Save Fields

Sensitivity Analysis (with master output parameter)




Sensitivity Analysis (with master output parameter)


Just resolve sensitivity analysis!



Sensitivity Analysis

Table Model Solutions  Convergence Profile

Sensitivity Analysis with respect to input variable

theta 

Design Point Characteristics


b_x

Solved Value	2.1046E-006
Interpolated Value	2.1614E-006
1st Derivative	2.3558E-008
2nd Derivative	-1.1322E-007

Displaced by unit from design point value

b_x

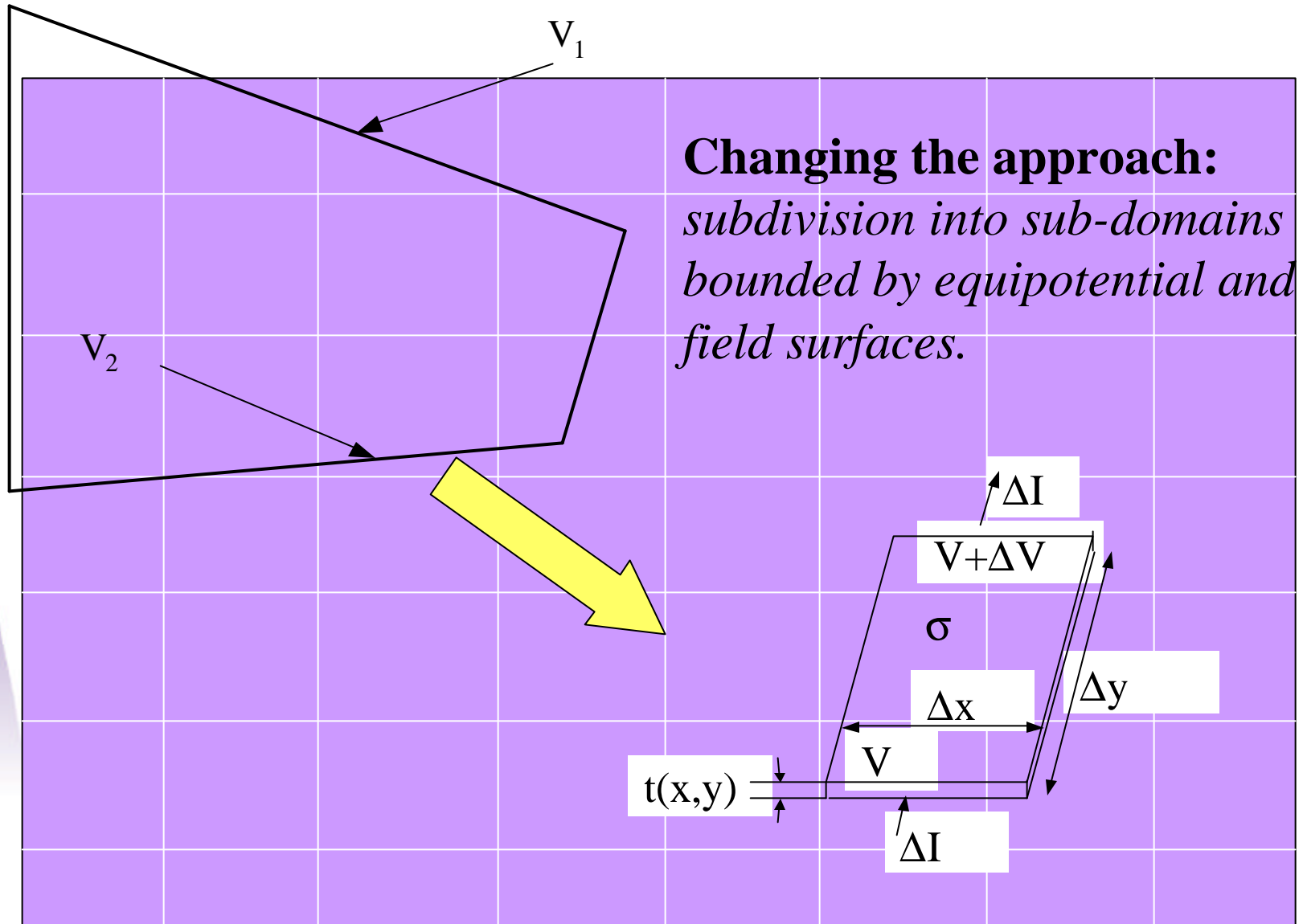
Interpolated Value	2.1614E-006
Delta	0

Interpolator 

Sensitivity Analysis (click on solution tab!)

- ◆ No master output parameter defined
 - ◆ Use it for “global” evaluation !
- ◆ Master output parameter defined
 - ◆ Use it for “local” evaluation !
 - ◆ Outside the local interval extrapolation may be wrong !

Power Loss Distribution Optimization



In A Sub-Domain

$$\begin{aligned} p(x, y) &= \Delta V(x, y) \cdot \Delta I(x, y) \\ &= E(x, y) \cdot \Delta y \cdot J(x, y) \cdot \Delta x \cdot t(x, y) \end{aligned}$$

$$p(x, y) = E^2(x, y) \cdot \mathbf{S} \cdot t(x, y) \cdot \Delta x \cdot \Delta y \quad J(x, y) = \mathbf{S} E(x, y)$$

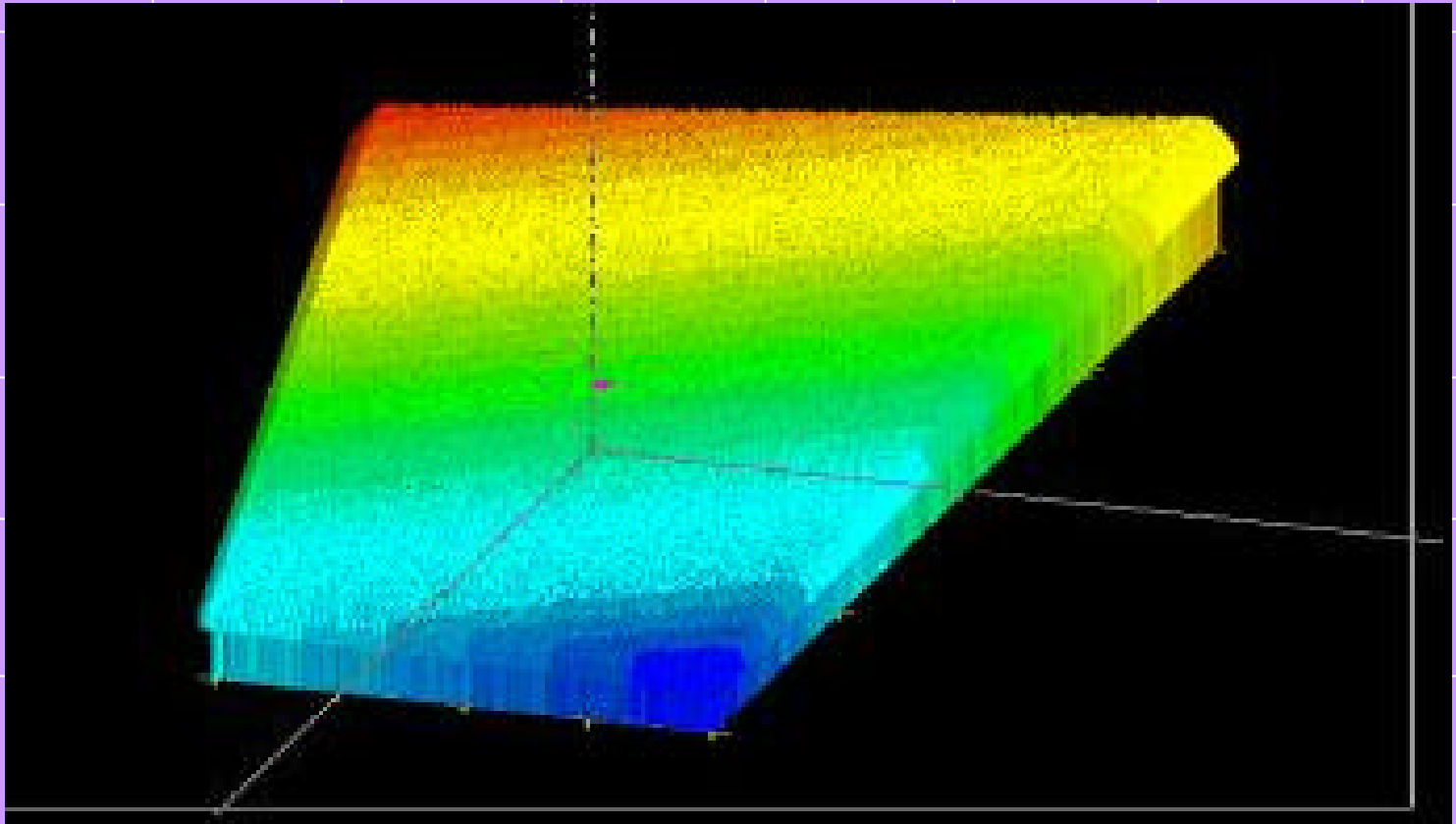
$$t(x, y) = K \cdot 10^{-N} \cdot f^*(x, y)$$

$$\begin{aligned} p(x, y) &= E^2(x, y) \cdot K \cdot \mathbf{S} \cdot 10^{-N} f^*(x, y) \cdot \Delta x \cdot \Delta y \\ &= E^2(x, y) \cdot K \cdot \mathbf{S}^*(x, y) \cdot \Delta x \cdot \Delta y \end{aligned}$$

$$F = \sum_1^q [p_k(x_k, y_k) - const]^2$$

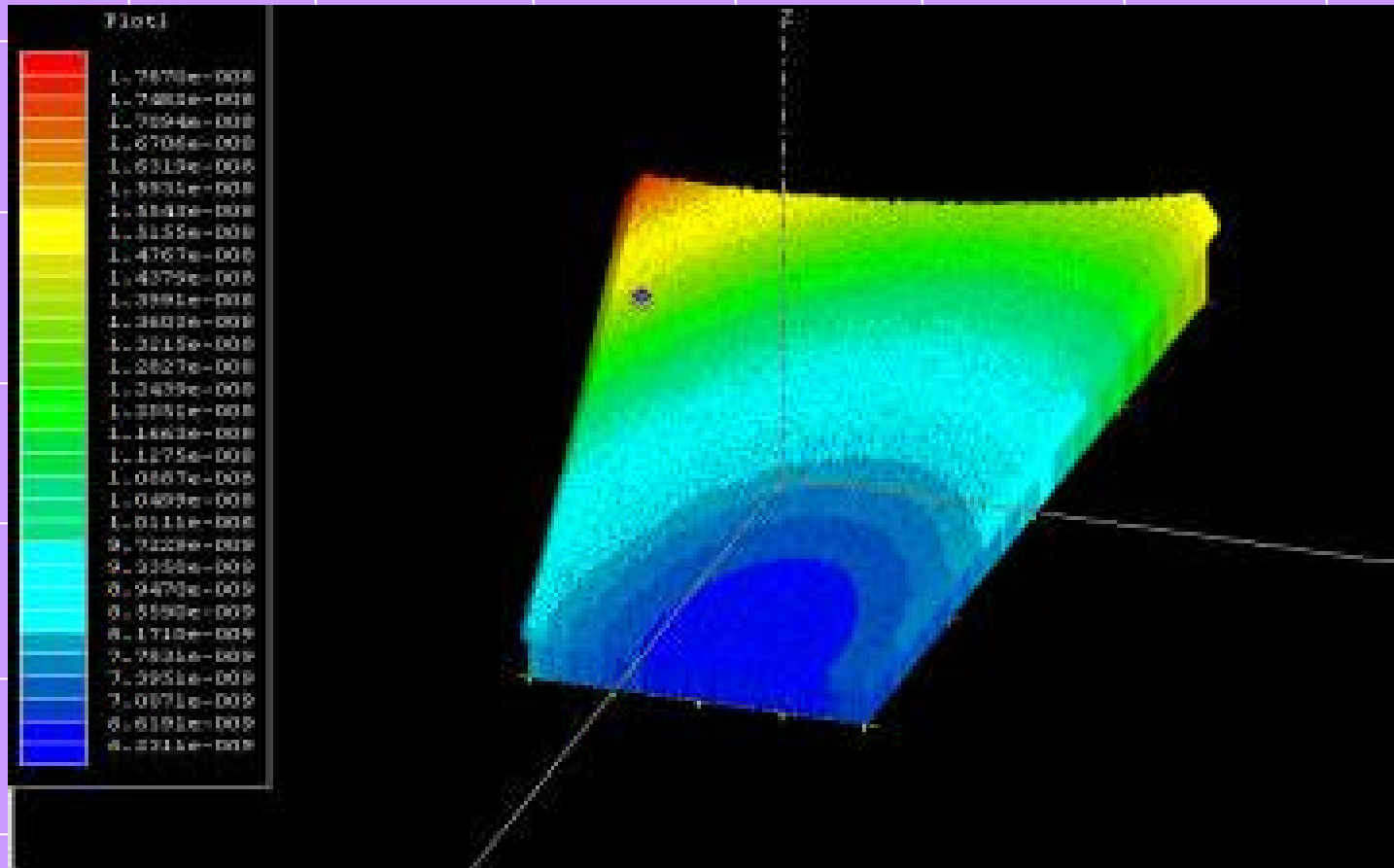
Distribution of Thickness using Linear Approximation

$$s^*(x, y) = A + B \cdot x + C \cdot y$$

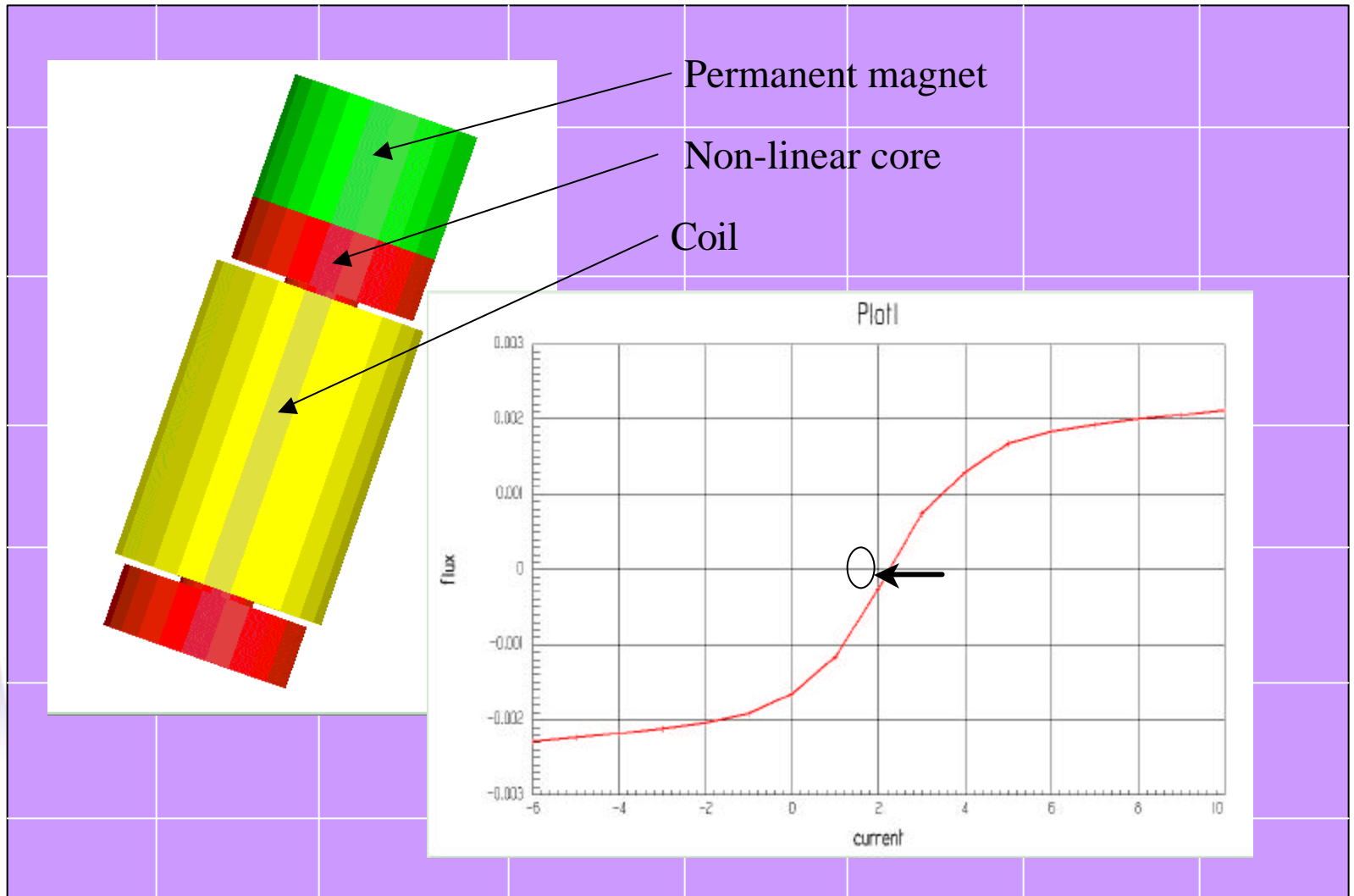


Distribution of Thickness using Quadratic Approximation

$$s^*(x, y) = A + B \cdot x + C \cdot x^2 + D \cdot y + E \cdot y^2$$



Coil with non-linear characteristic



Optimization Setup

Setup Optimization

Quasi Newton Optimizer Cost Function: objective

Cost Function Noise: 1e-005

Design Variables: Add... Edit... Remove

Variable	Minimum	Maximum	Min. Step	Max. Step
current	1.495	1.505	0.001	0.005
mag_height	2	10.1	0.1	1

Constraints: Add... Edit... Remove

Stopping Criteria:

Acceptable Cost: 0

Max Iterations: 62

Save Fields

Plot1

mag_height	flux
4	0.0002
5	0
6	-0.00015
7	-0.00035
8	-0.0005
9	-0.00065
10	-0.00075