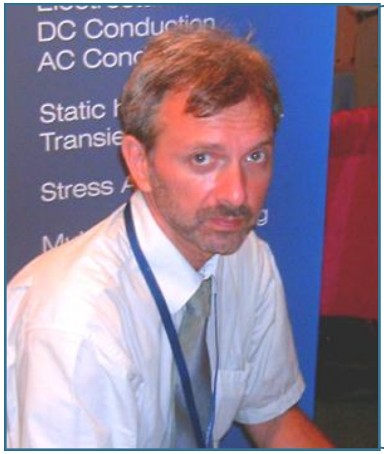
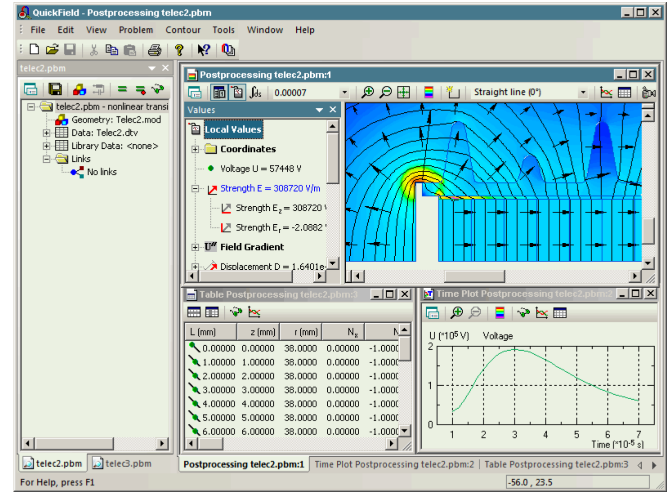
Optimization with QuickField



Vladimir Podnos,
Director of Marketing and Support

Advantages of QuickField
for optimization problems

QuickField Analysis Options



Magnetic Suite

- AC Magnetics
- Transient + DC Magnetics
- DC Magnetics

Electric Suite

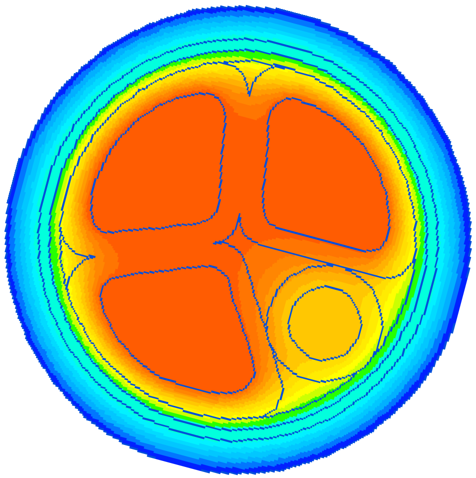
- AC conduction + Electrostatics & DC conduction
- Transient Electric + Electrostatics & DC conduction
- Electrostatics & DC conduction

Thermostructural

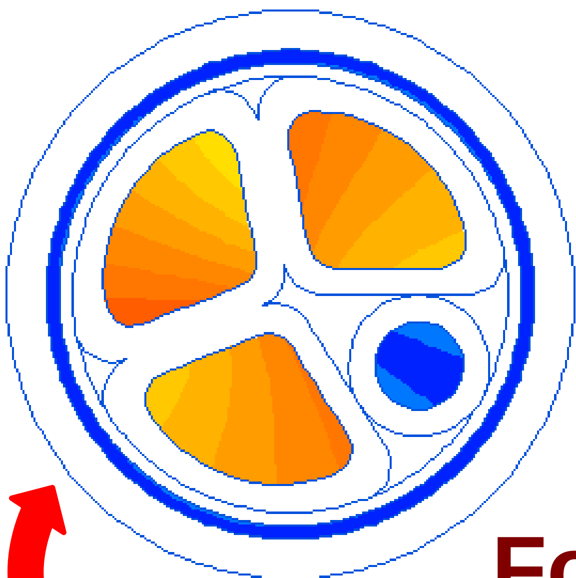
- Stress Analysis
- Transient Heat transfer
- Steady State Heat transfer

MultiPhysics

Temperature Field

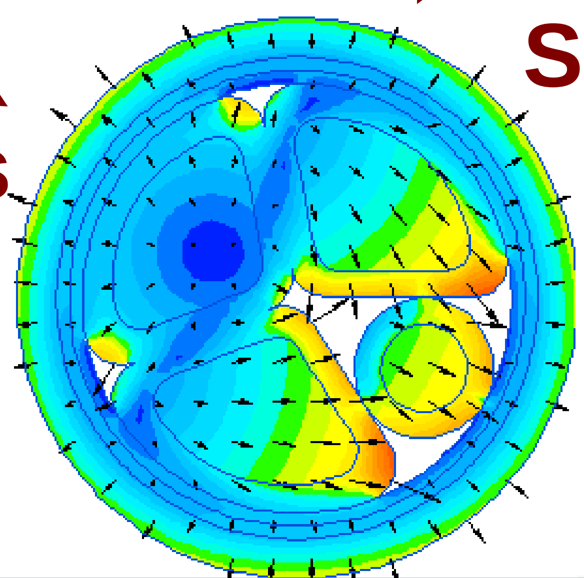


Electromagnetic fields



Thermal Stresses

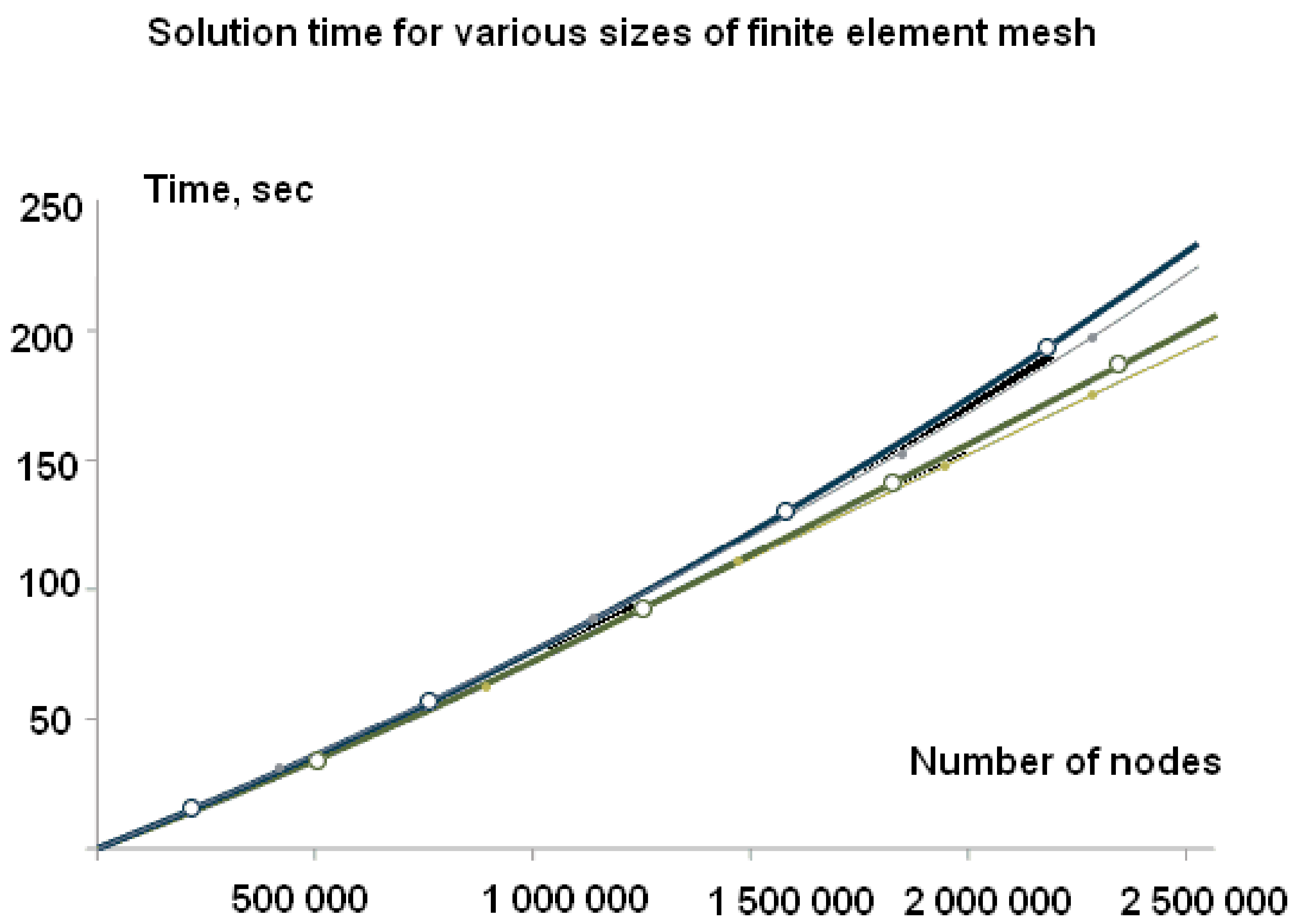
Forces



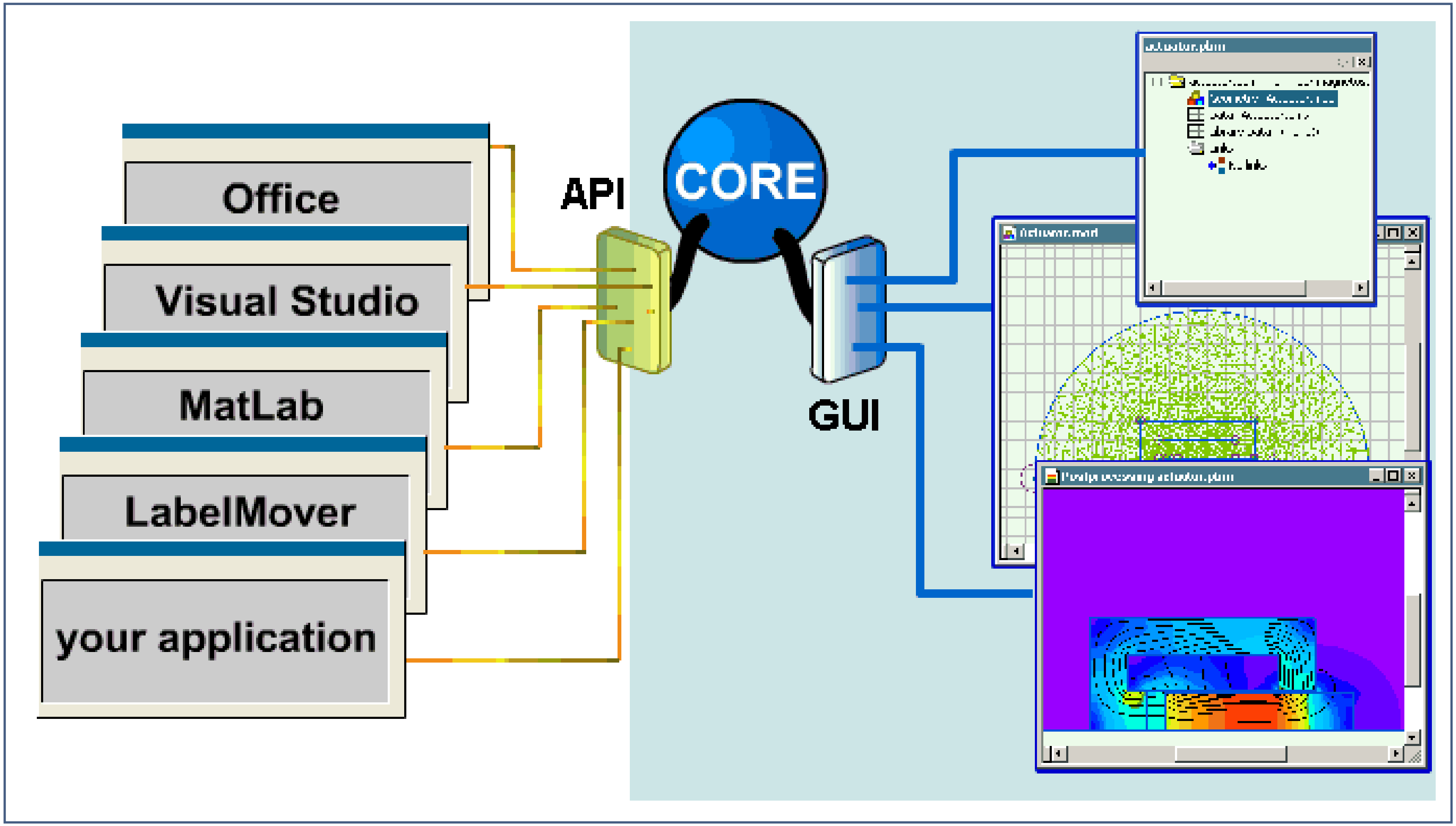
Magnetic state import

Stresses & Deformations

QuickField solvers



Open object interface



ActiveField API object model

ActiveField™ help | Main QuickField Site | Free Downloads | Contacts

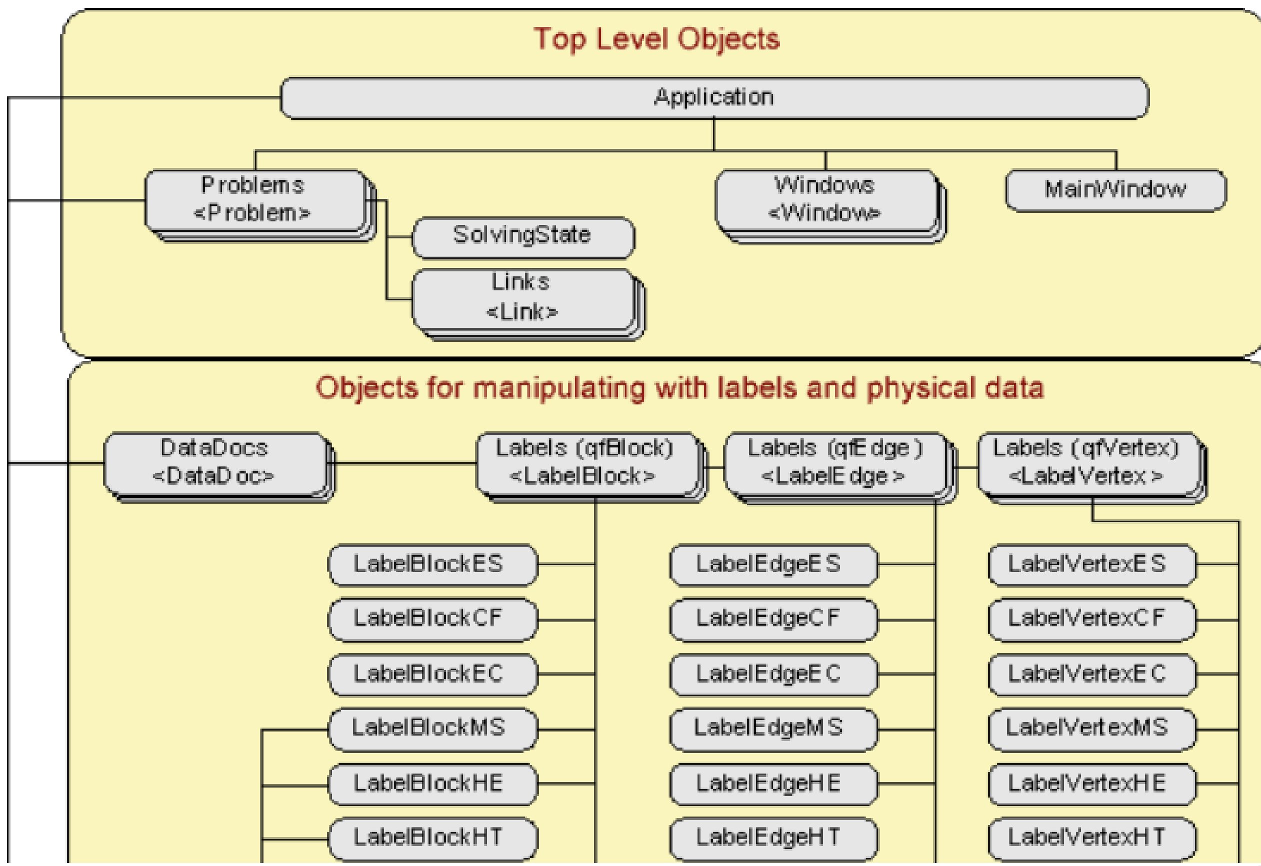
ActiveField Technology
Objects Overview
Hierarchy Chart
How to Start: Application Object
How to work with Problems
How to work with Model
How to work with Data
How to Analyze Results

Objects

Properties

Methods

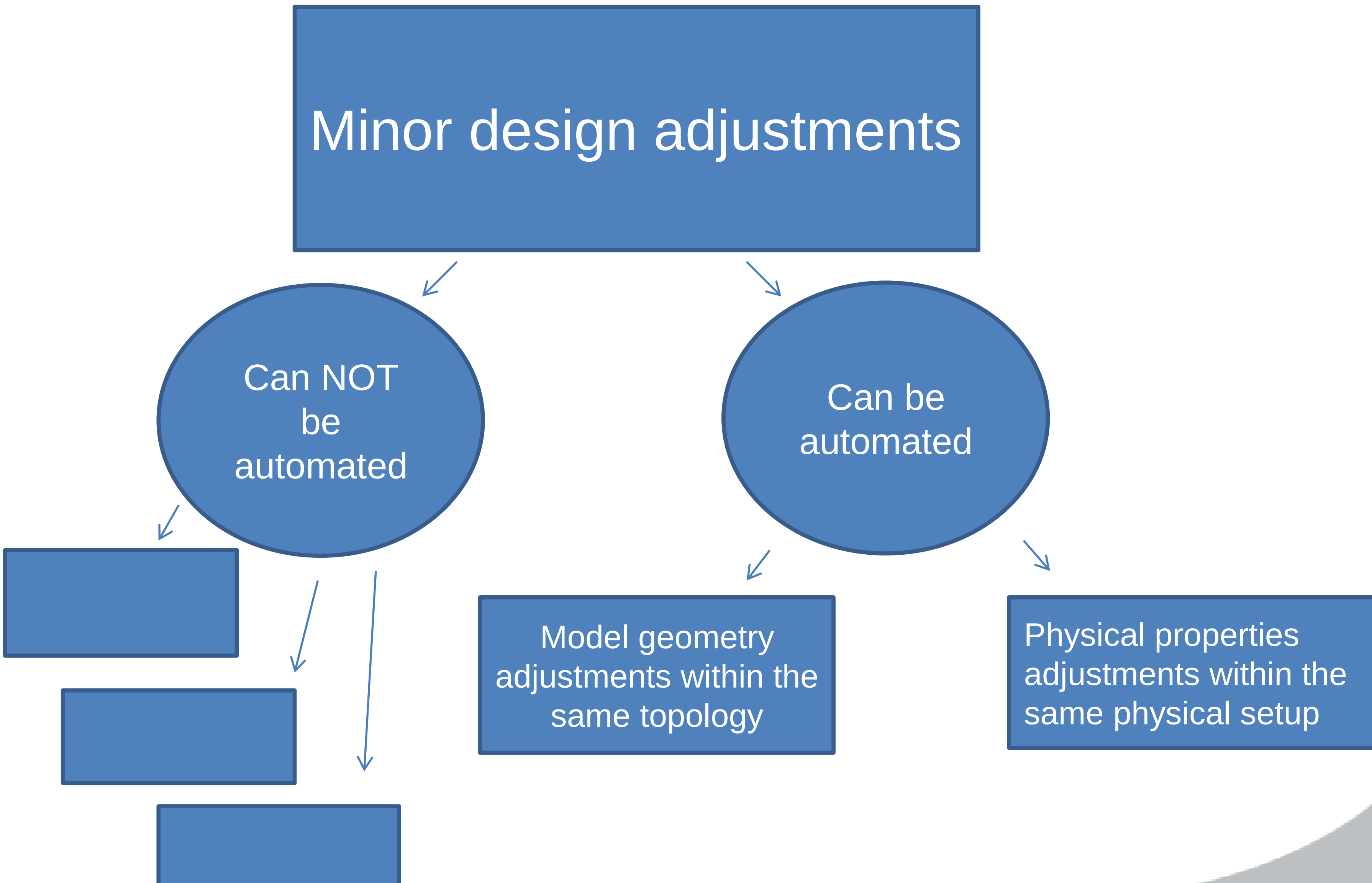
QuickField Object Model



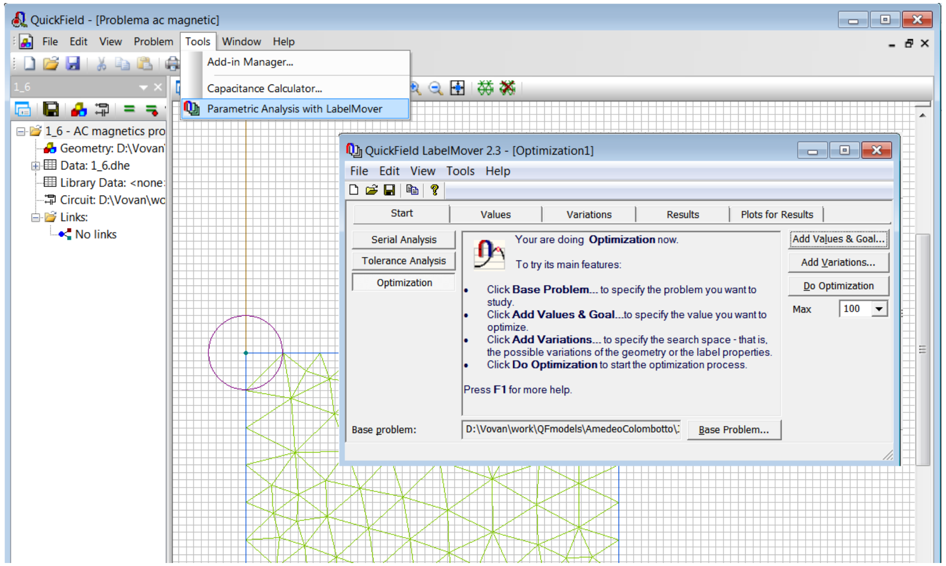
Engineering design optimization

- Major design modifications performed by experienced engineer or
- Minor design adjustments due to slightly different operating conditions, material change, technological limitations, adjusted design specifications etc.

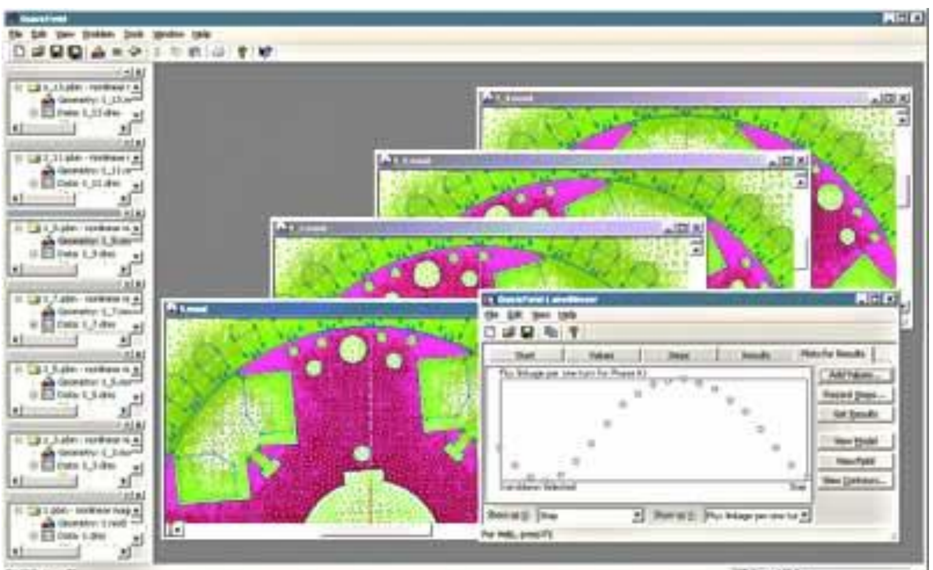
Engineering design optimization



Parametric analysis with LabelMover



- Serial analysis
- Tolerance analysis
- Optimization
  - Built-in algorithms
  - Externally connected algorithms



LabelMover optimization benchmarks

http://www.quickfield.com/advanced/optimization-benchmarks.htm

QuickField | A new approach to field modelling

Language: | Search

PRODUCT | APPLICATIONS | SUPPORT | DOWNLOAD | NEWS | CONTACTS

Main > Application > Sample problems

LabelMover optimization benchmark

Here are LabelMover optimization benchmarks.

Task	Theory	QuickField	%
linear1. Move square's right edge to the right in order to get the maximal cross-section area. The movement range is 0..1 The optimized value is linearly dependent upon the optimization parameter.	2	1.9981	0.1%
linear2. Move square's right and top edges right and up correspondingly in order to get the maximal cross-section area. The movement range for each edge is 0..1. The optimized value is linearly dependent upon two optimization parameters.	4	3.9836	0.41%
linear3. Move square's 3 edges (right, left and top) in order to get the maximal cross-section area. The movement range for each edge is 0..1. The optimized value is linearly dependent upon three optimization parameters.	6	5.9674	0.54%

- Industrial
- Educational
- Scientific
- Sample problems
- Examples gallery
- Step-by-step tutorials
- Verification examples
- Programming examples
- Distributive examples
- Success stories
- Customers

QuickField Difference

Optimization with QuickField

Sergey Ionin,

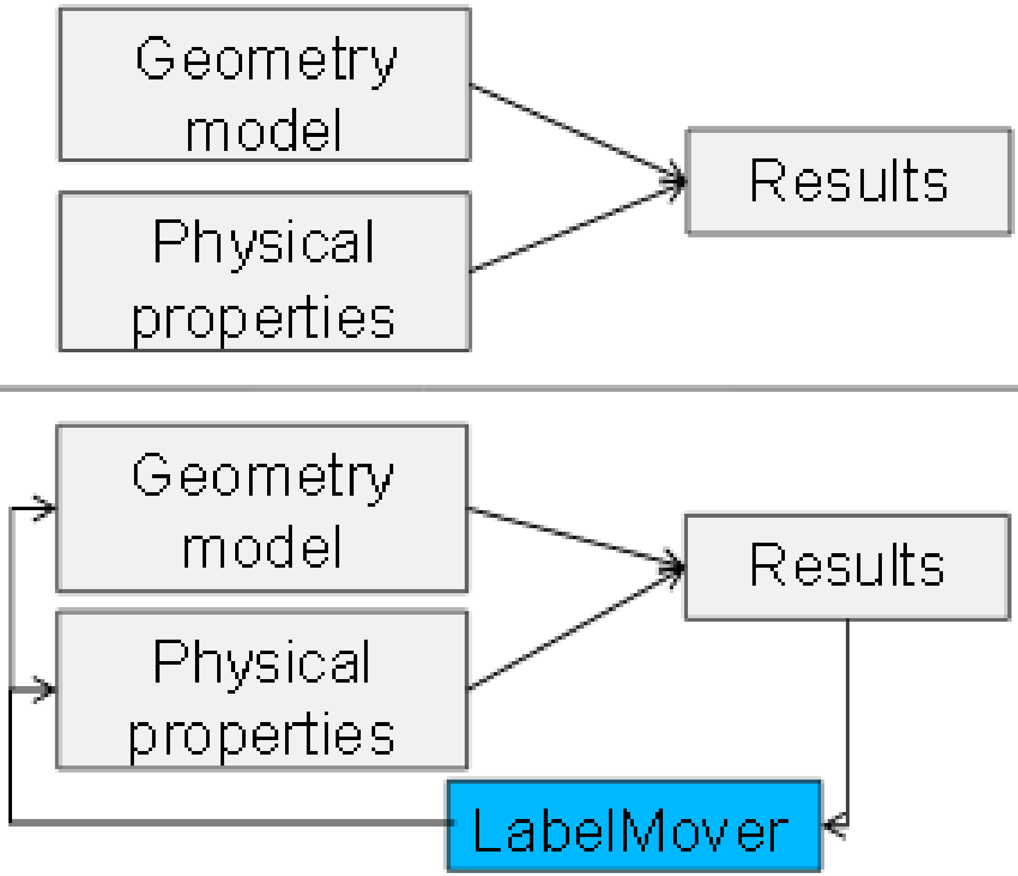
Support engineer

Optimization in QuickField

Problems in QuickField

Direct problem

Inverse problem (optimization or identification)



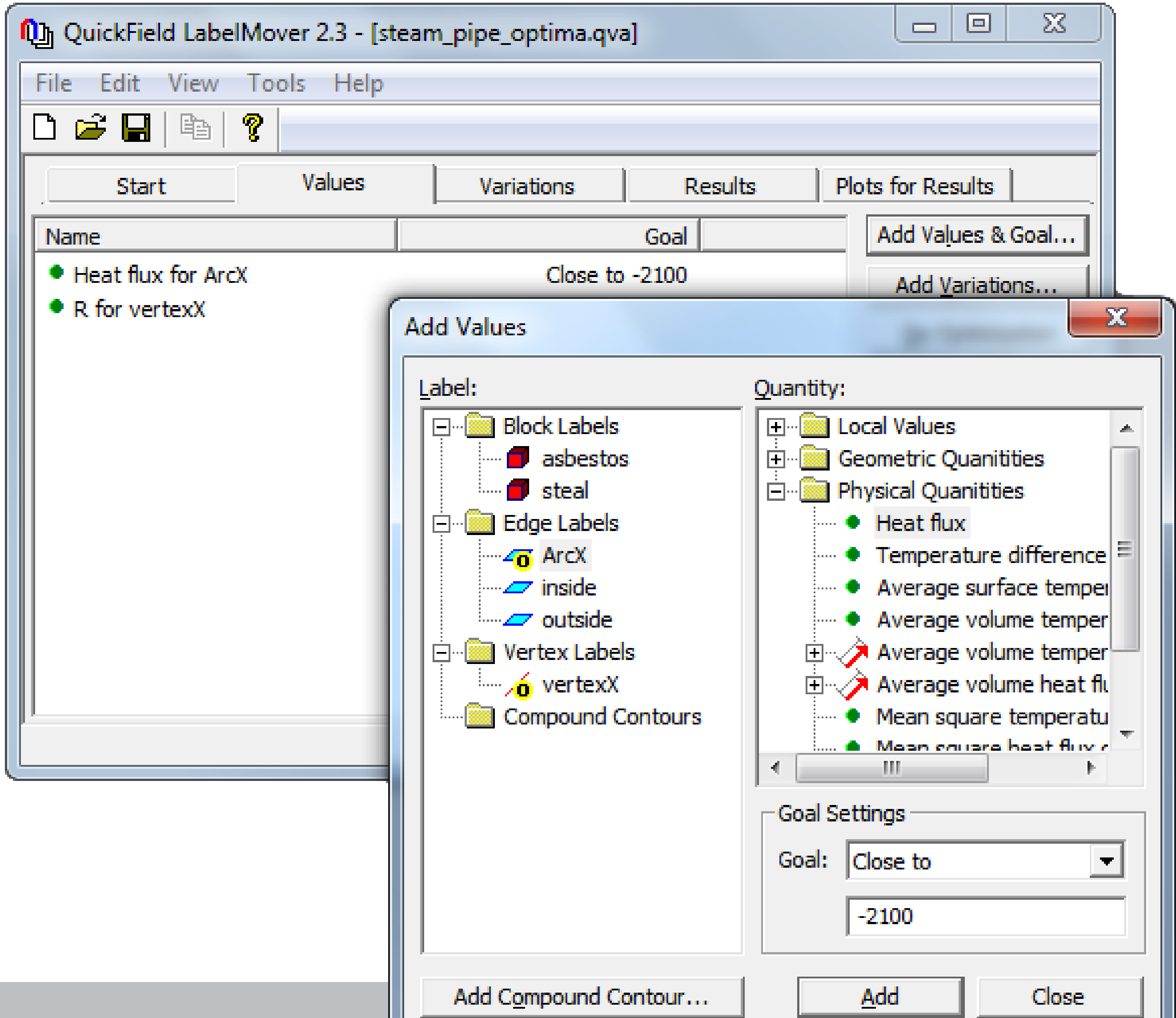
Inverse problems

- Design
- Identification
- Diagnostics

…

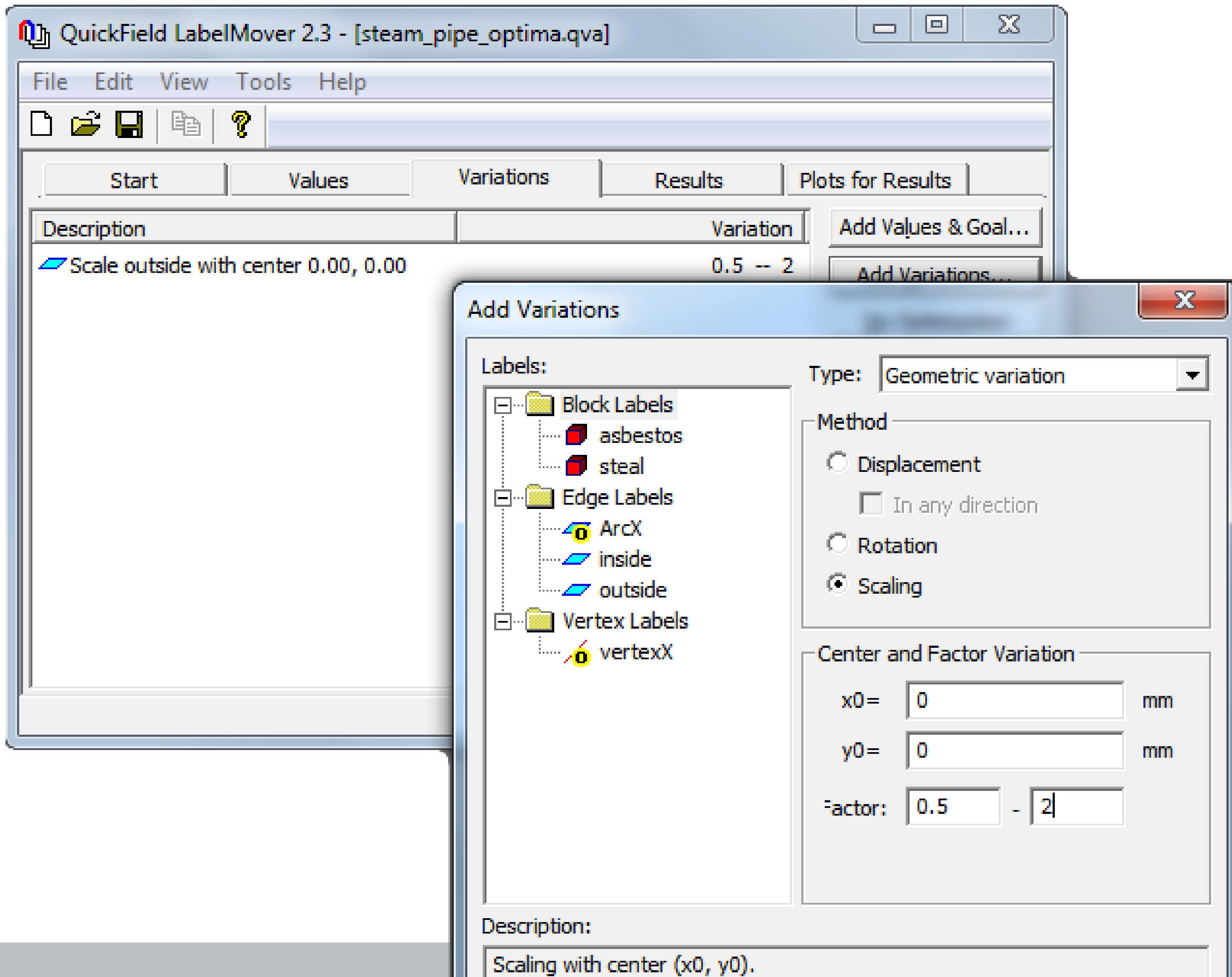
Optimization in LabelMover

1.Set values and goal



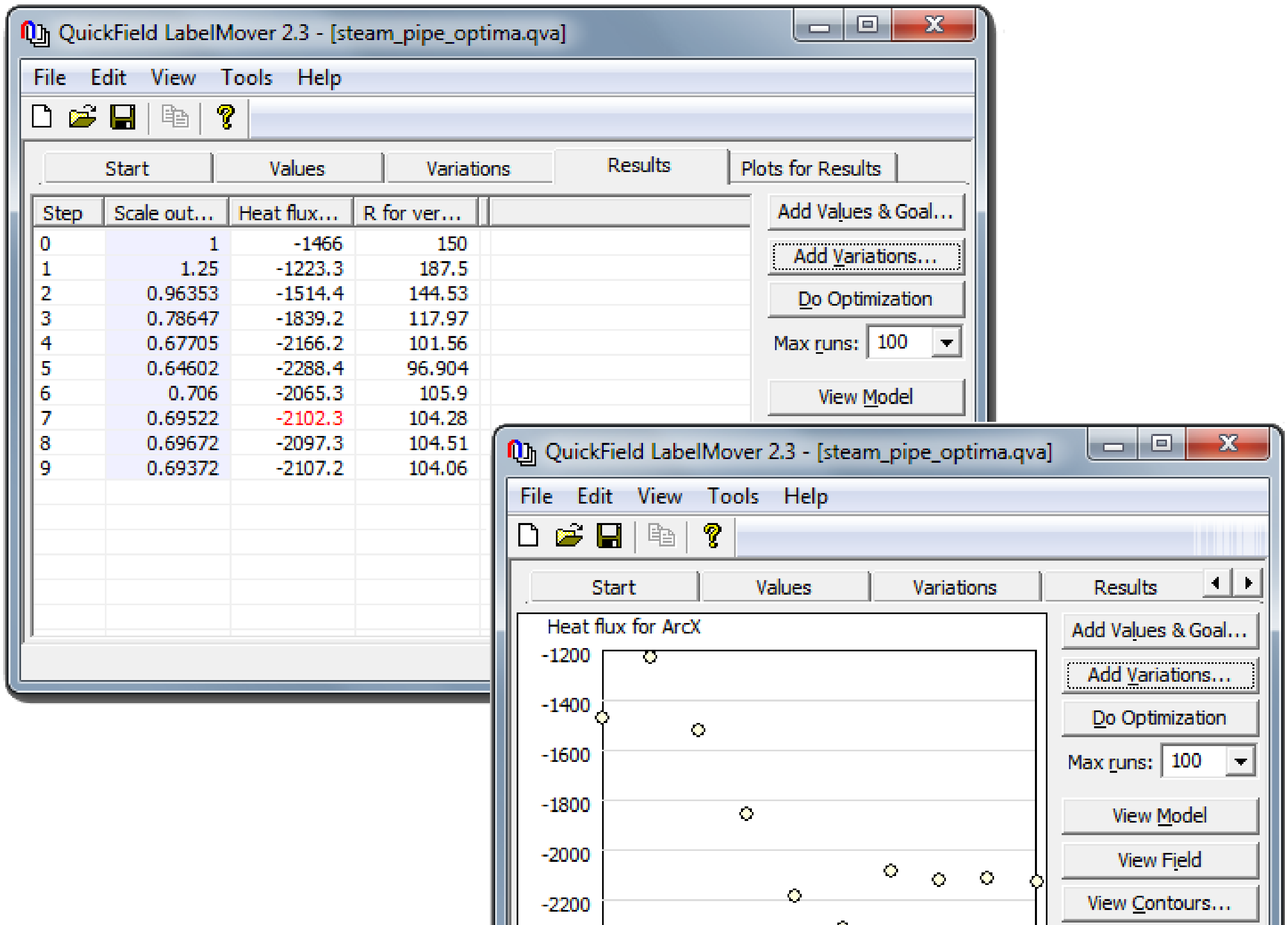
Optimization in LabelMover

2.Set variations



Optimization in LabelMover

3.Get results



Optimization using external Monte-Carlo algorithm

VBA (Visual Basic for Applications) script will do random variations controlling solving of problems in QuickField

Optimization using external Monte-Carlo algorithm

Variation of parameter will be calculated by the formula:

$$V = V\_down + (V\_up - V\_down) \cdot Rnd(1)$$

V_down – lower limit for variation
V_up - upper limit for variation
Rnd(1) – random value in range of (0-1)

VBA code for Monte-Carlo

```
Sub Optimize()

' Declaration of values
Dim my_qlm As QLM.SimpleInterface
Set my_qlm = CreateObject("qlm.SimpleInterface")
Dim variation_0 As Double 'variation
Dim result As Double ' result
Dim result_intermediate As Double ' intermediate result
Dim N As Double 'number of iterations
Dim N_better_res As Double 'number of another better result
Dim limit_0_down As Double ' lower limit of variation
Dim limit_0_up As Double ' upper limit of variation
Dim goal As Double ' optimization aim
Dim count As Integer ' counter
```

Declaration of values

```
'Reading of values from the spreadsheet
limit_0_down = Worksheets("UI").Cells(7, 2).Value
limit_0_up = Worksheets("UI").Cells(8, 2).Value
N = Worksheets("UI").Cells(9, 2).Value
goal = Worksheets("UI").Cells(10, 2).Value
```

Reading of values from the spreadsheet

```
' Initialization of values
    variation_0 = limit_0_down + (limit_0_up - limit_0_down) * Rnd(1)
    my_qlm.SetVariation 0, variation_0
    my_qlm.Solve
    result = my_qlm.GetResult(0)
    N_better_res = 1
    Worksheets("UI").Cells(6, 4).Value = 1
    Worksheets("UI").Cells(6, 5).Value = result
```

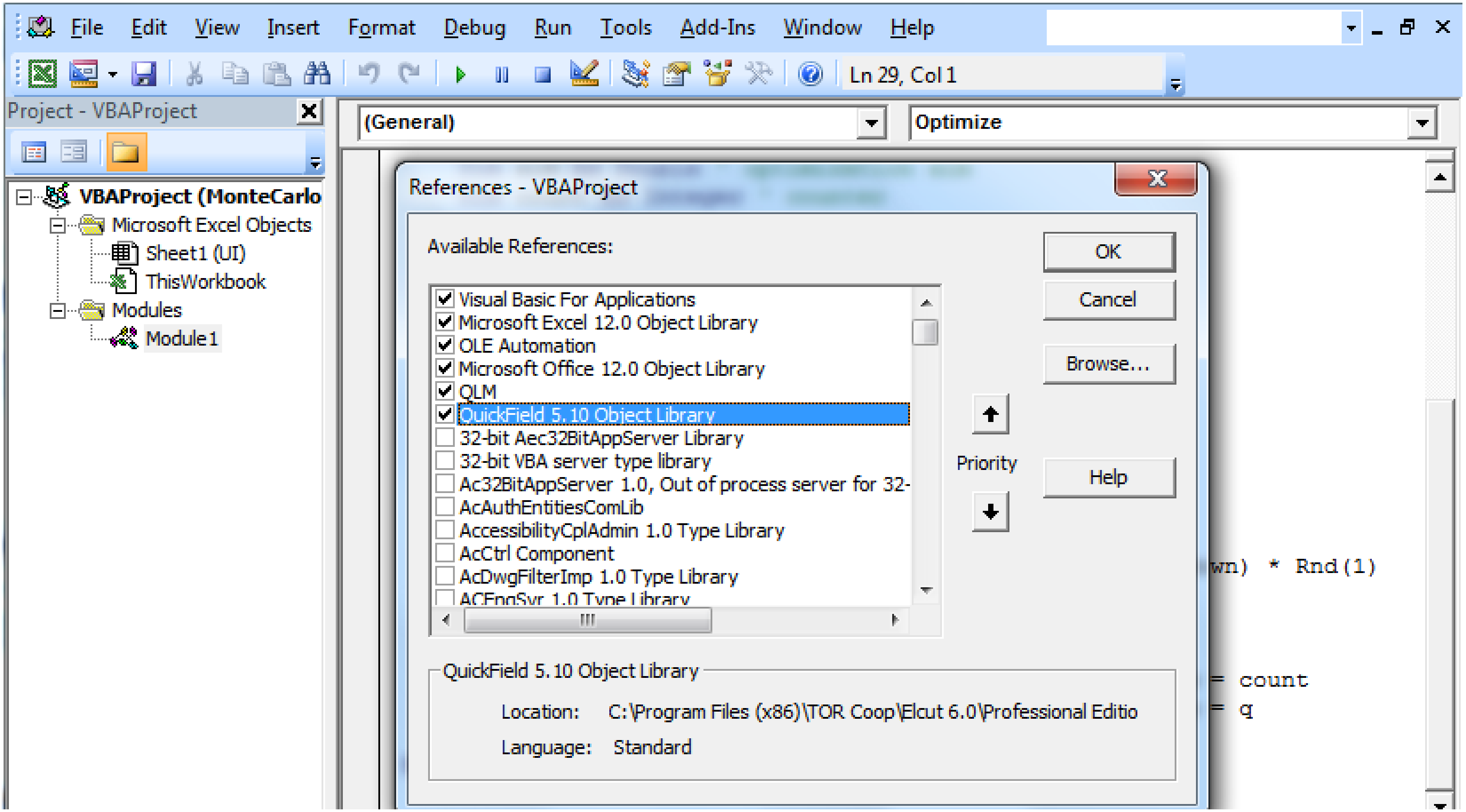
Initialization of values

```
' Cycle
For count = 2 To N
variation_0 = limit_0_down + (limit_0_up - limit_0_down) * Rnd(1)
    my_qlm.SetVariation 0, variation_0
    my_qlm.Solve
    result_intermediate = my_qlm.GetResult(0)
            If Abs(result_intermediate - goal) < Abs(result - goal) Then
            result = result_intermediate
            N_better_res = N_better_res + 1
            Worksheets("UI").Cells(6 + (N_better_res - 1), 4).Value = count
            Worksheets("UI").Cells(6 + (N_better_res - 1), 5).Value = result
            End If
Next count
End Sub
```

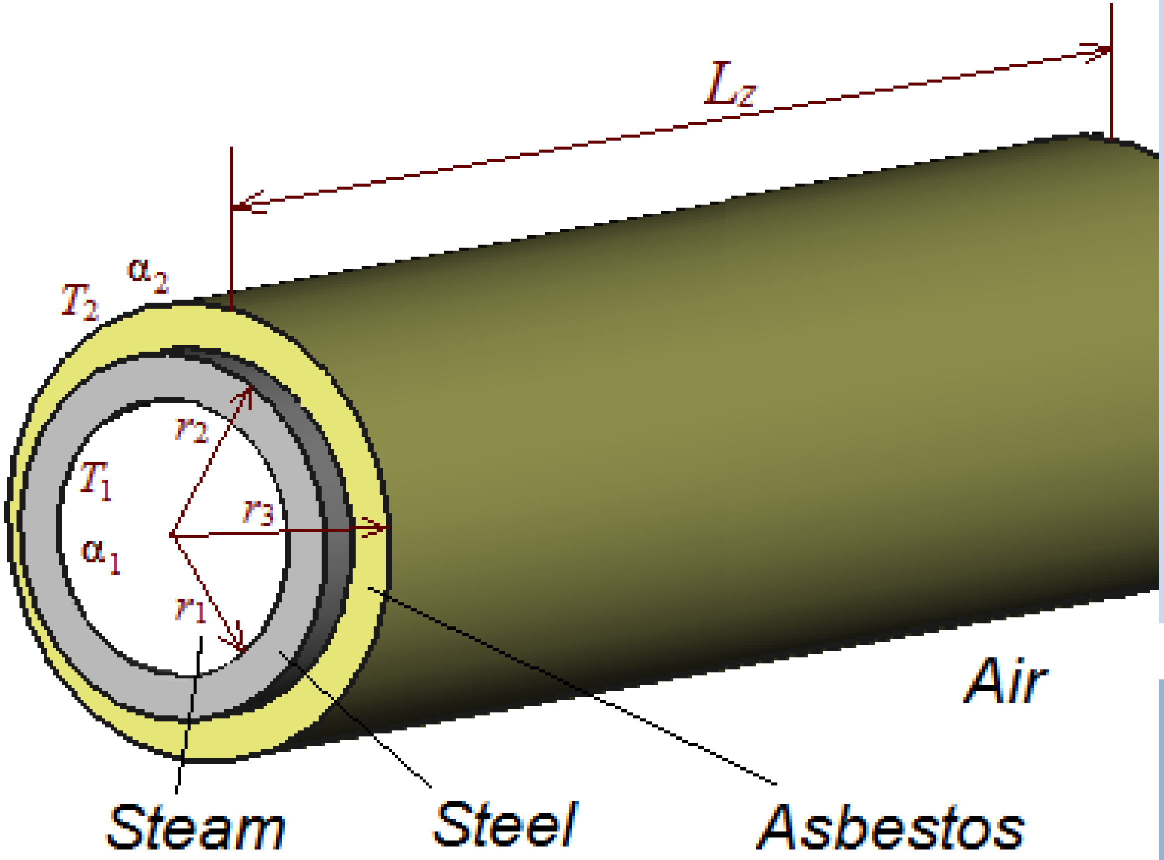
Cycle

Preparations in VBA

Tools > References



Heat Transfer problem: calculation of required insulation thickness



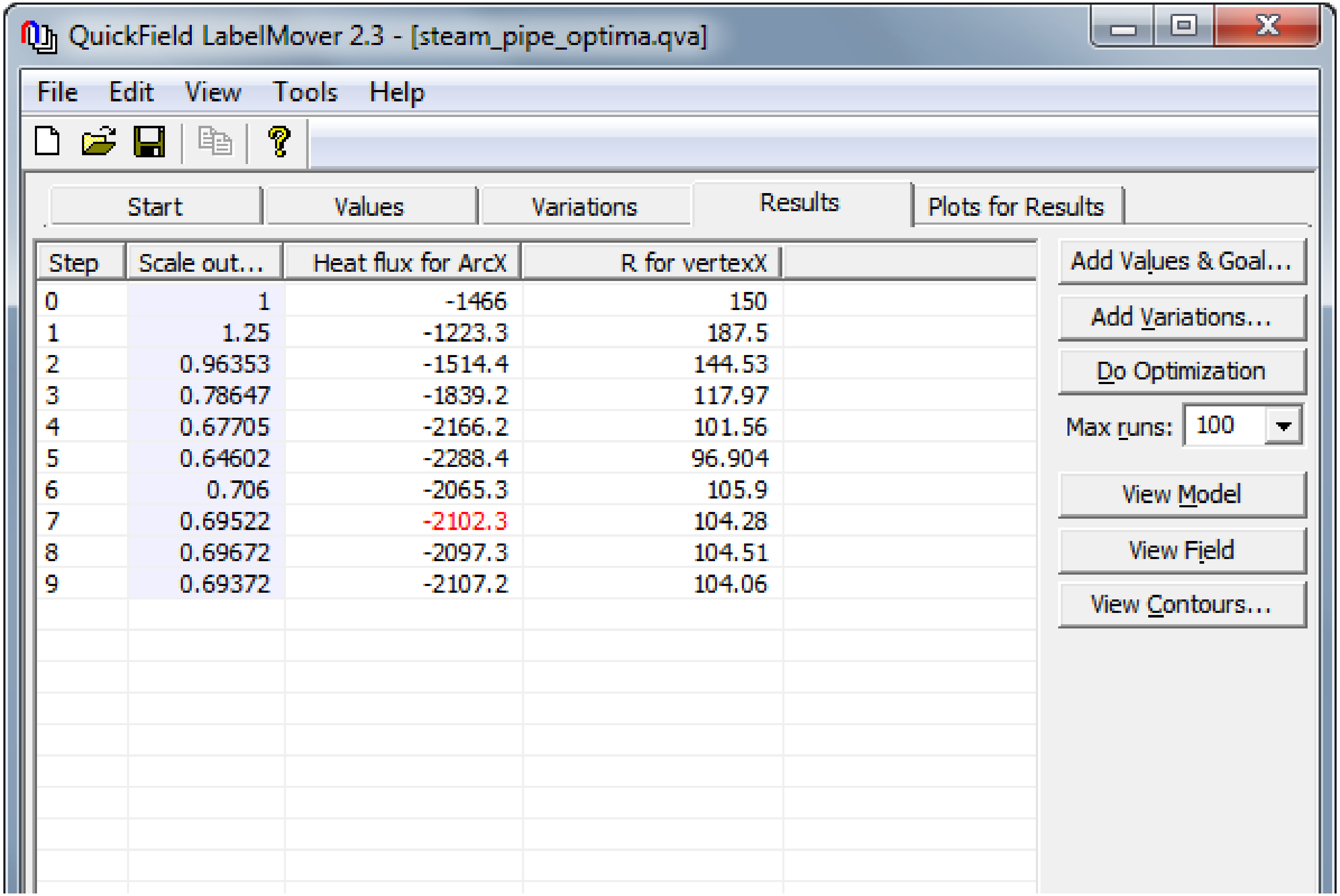
Task:

Calculate thickness of the steam pipe insulation to provide prescribed value of heat flux of 2100 W

Exact solution:

r3 - *r2* = 25 mm

Solving using LabelMover



Solving using VBA

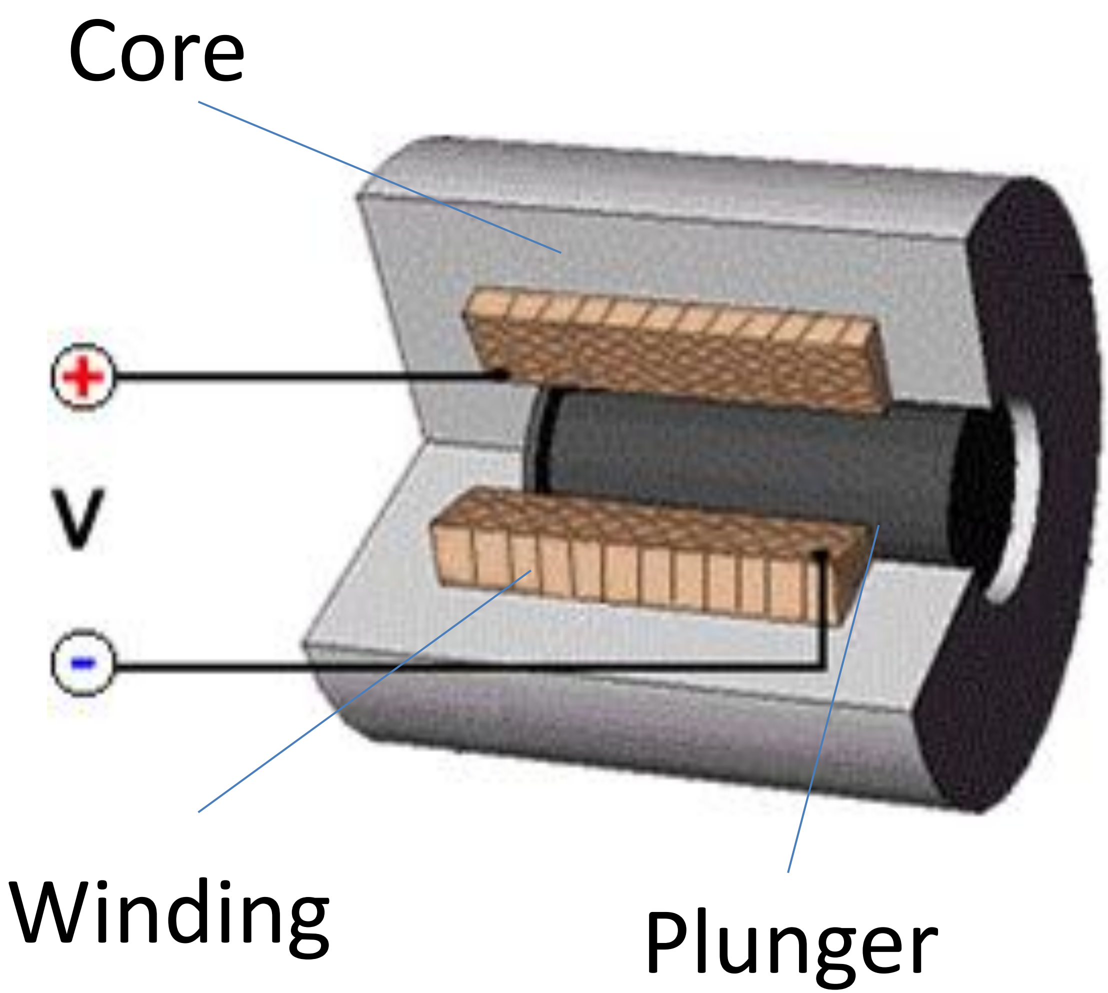
Monte-Carlo approach in Optimization

This script will work with opened QuickField problem and LabelMover optimization file

Limits for variation of the value	
Lower limit	5,00E-01
Upper limit	2,00E+00
Number of iterations	1,00E+01
Goal	-2,10E+03

Results		
№ of iteration	function value	parameter value
1	-971,905	1,744702429
2	-974,577	1,736903191
3	-1134,69	1,383744508
4	-1134,69	1,383744508
5	-1134,69	1,383744508
6	-1720,71	0,84029901
7	-1720,71	0,84029901
8	-1720,71	0,84029901
9	-1720,71	0,84029901
10	-1720,71	0,84029901

Magnetic problem: calculation of required core cross-section of the drive



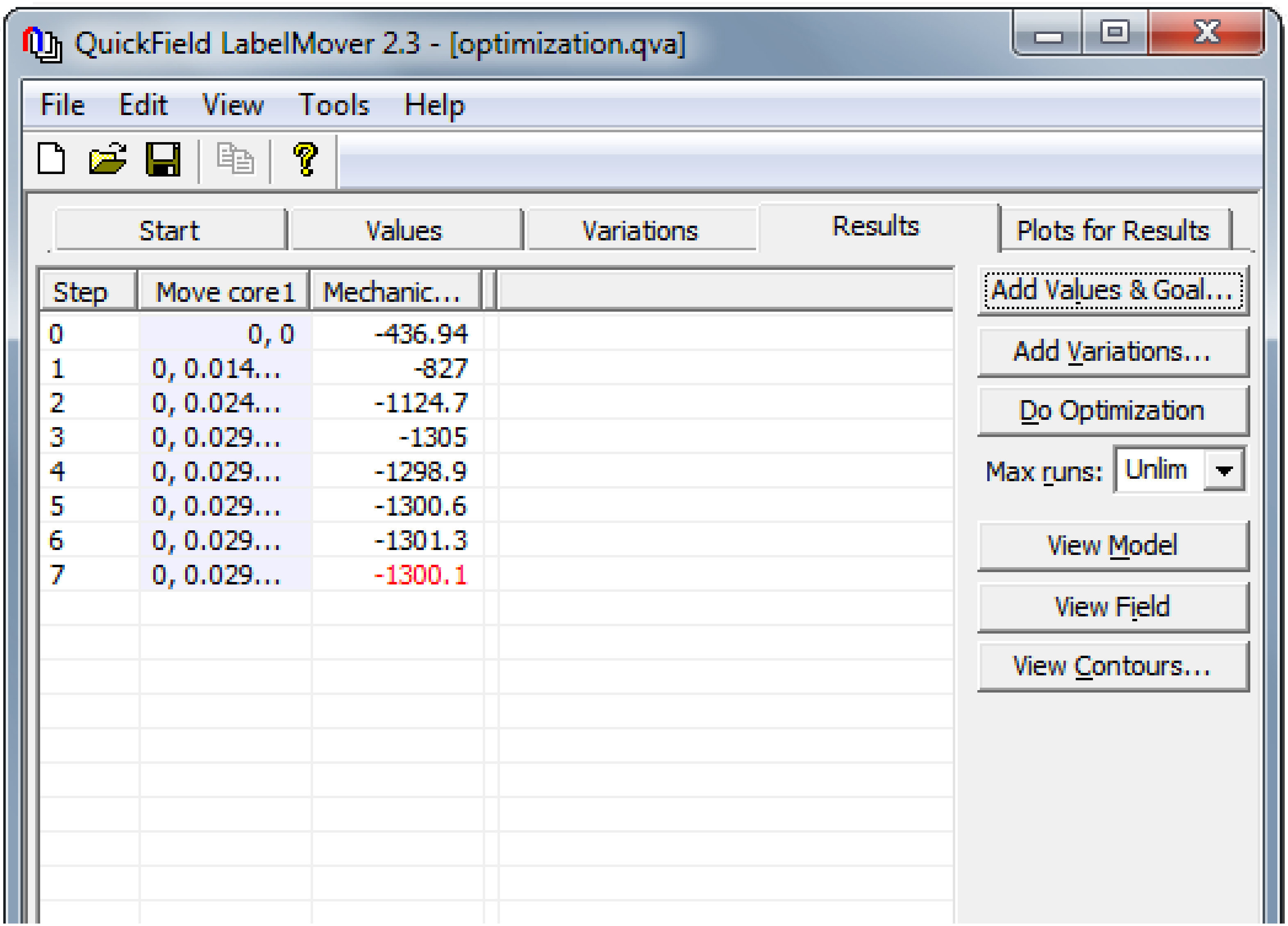
Task:

Calculate required thickness of the core to provide force on the plunger of 1300 N.

Exact solution:

10.4 mm

Solving using LabelMover



Solving using VBA

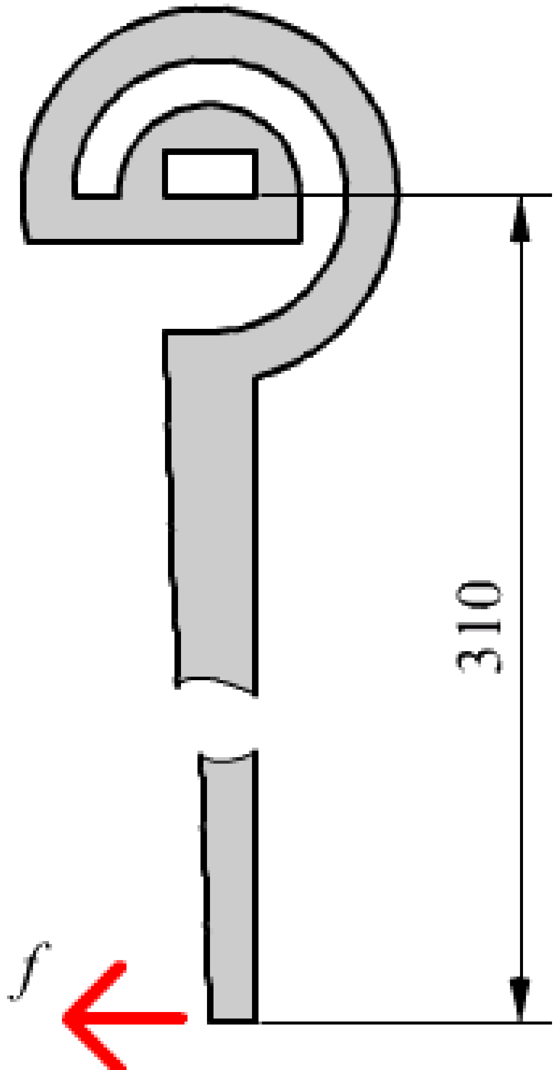
Monte-Carlo approach in Optimization

This script will work with opened QuickField problem and LabelMover optimization file

Limits for variation of the value	
Lower limit	0,00E+00
Upper limit	3,90E-02
Number of iterations	1,00E+01
Goal	-1,30E+03

Results		
№ of iteration	function value	parameter value
1	-1237,57	0,027516353
2	-1237,57	0,027516353
3	-1237,57	0,027516353
4	-1237,57	0,027516353
5	-1237,57	0,027516353
6	-1314,09	0,030214864
7	-1314,09	0,030214864
8	-1302,73	0,02966822
9	-1302,73	0,02966822
10	-1302,73	0,02966822

Mechanical problem: calculation of allowable force for dynamo wrench



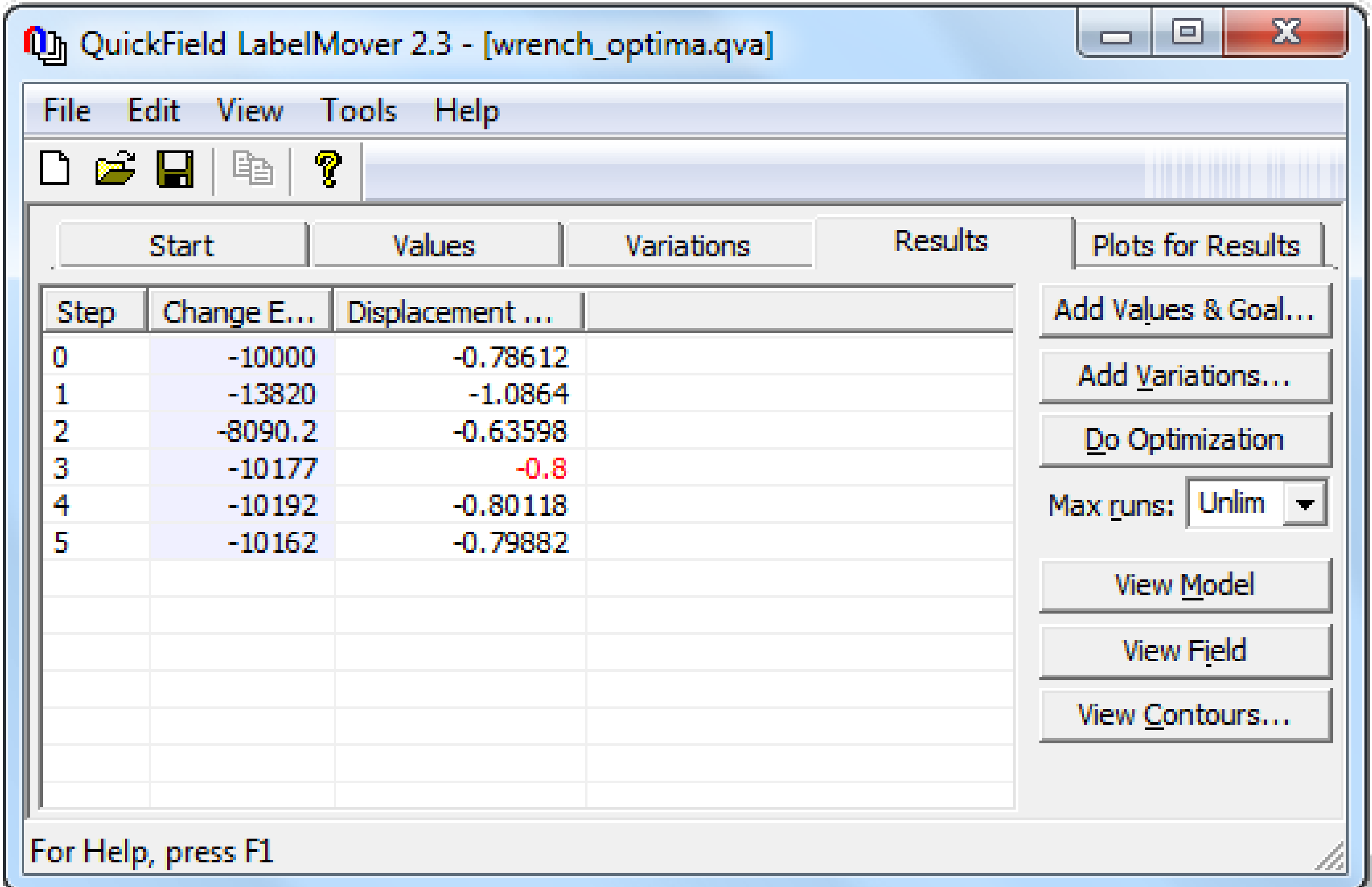
Task:

Determine maximal force which will not cause unallowable deformations

Exact solution:

$f = 10177\ N$

Solving using LabelMover



Step	Change E...	Displacement ...
0	-10000	-0.78612
1	-13820	-1.0864
2	-8090.2	-0.63598
3	-10177	-0.8
4	-10192	-0.80118
5	-10162	-0.79882

Solving using VBA

Monte-Carlo approach in Optimization

This script will work with opened QuickField problem and LabelMover optimization file

Limits for variation of the value	
Lower limit	-2,00E+04
Upper limit	-5,00E+03
Number of iterations	1,00E+01
Goal	-8,00E-01

Results		
№ of iteration	function value	parameter value
1	-0,95332	-12126,9736
2	-0,66768	-8493,32511
3	-0,66768	-8493,32511
4	-0,87362	-11113,1263
5	-0,87362	-11113,1263
6	-0,87362	-11113,1263
7	-0,83797	-10659,5495
8	-0,80834	-10282,6822
9	-0,80834	-10282,6822
10	-0,80834	-10282,6822