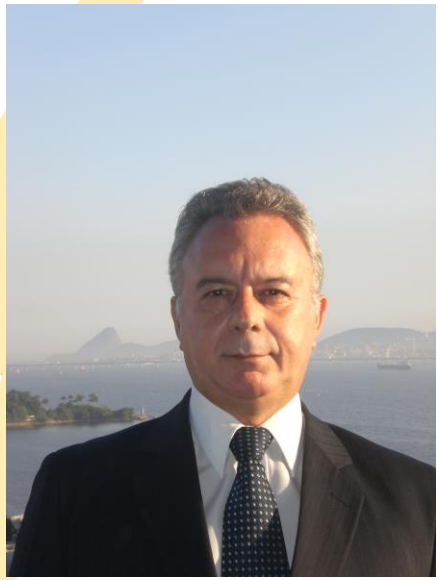
DESIGN CONCEPTS + software SwitchgearDesign

for SWITCHGEAR, SWITCHBOARDS, BUSDUCTS & SUBSTATIONS"



Item 7b1:

Simulations of temperature rise tests with SwitchgearDesign

See also movie in Item 7b2:

Presented by Sergio Feitoza Costa – Cognitor Consultancy & Training sergiofeitoza@cognitor.com.br www.cognitor.com.br

In this video

Step by step description on how to use SwitchgearDesign to design switchgear, switchboards, AIS, GIS, busbar systems and substations

in the aspects related to temperature rise tests

Test cases validated by laboratory test results and more.

The installer of the software is available in item 4a (complete) and 4b (only temperature rise) of the list in http://www.cognitor.com.br/ChaptersEN.htm

Sequence

- Review of the main screens and geometry figures
- Main variables
- How to see and analyze the results

- A movie with the sequence is in Item 7b2

  - Creating a new case based on an existing one sent with the installer
  - Changing the data of an existing case of a medium voltage switchgear to the new desired test case
  - Running the case, analyzing the results and viewing 3D.

- Information about validation and validated cases

Review of the main screens and geometry figures

Project selected

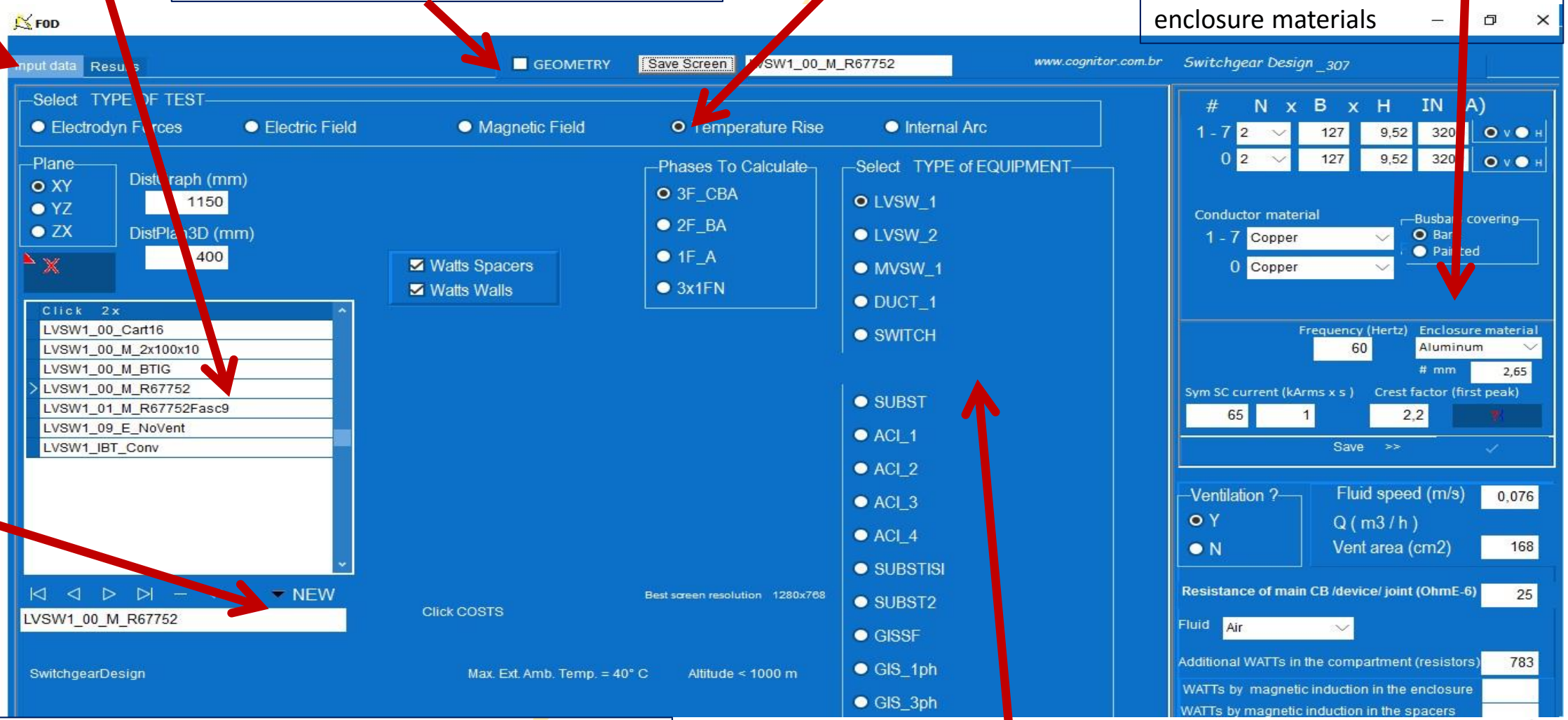
Click here to see the geometry related to the PROJECT TYPE (type of equipment)

Type of test to be simulated

Electric & ventilation data, conductor cross section and enclosure materials

Click INPUT DATA to change the data or click RESULTS to do the calculations and to see the test results

Click the button NEW to create a new project equal to the one which is selected (only the name is different) and them change the data and geometry

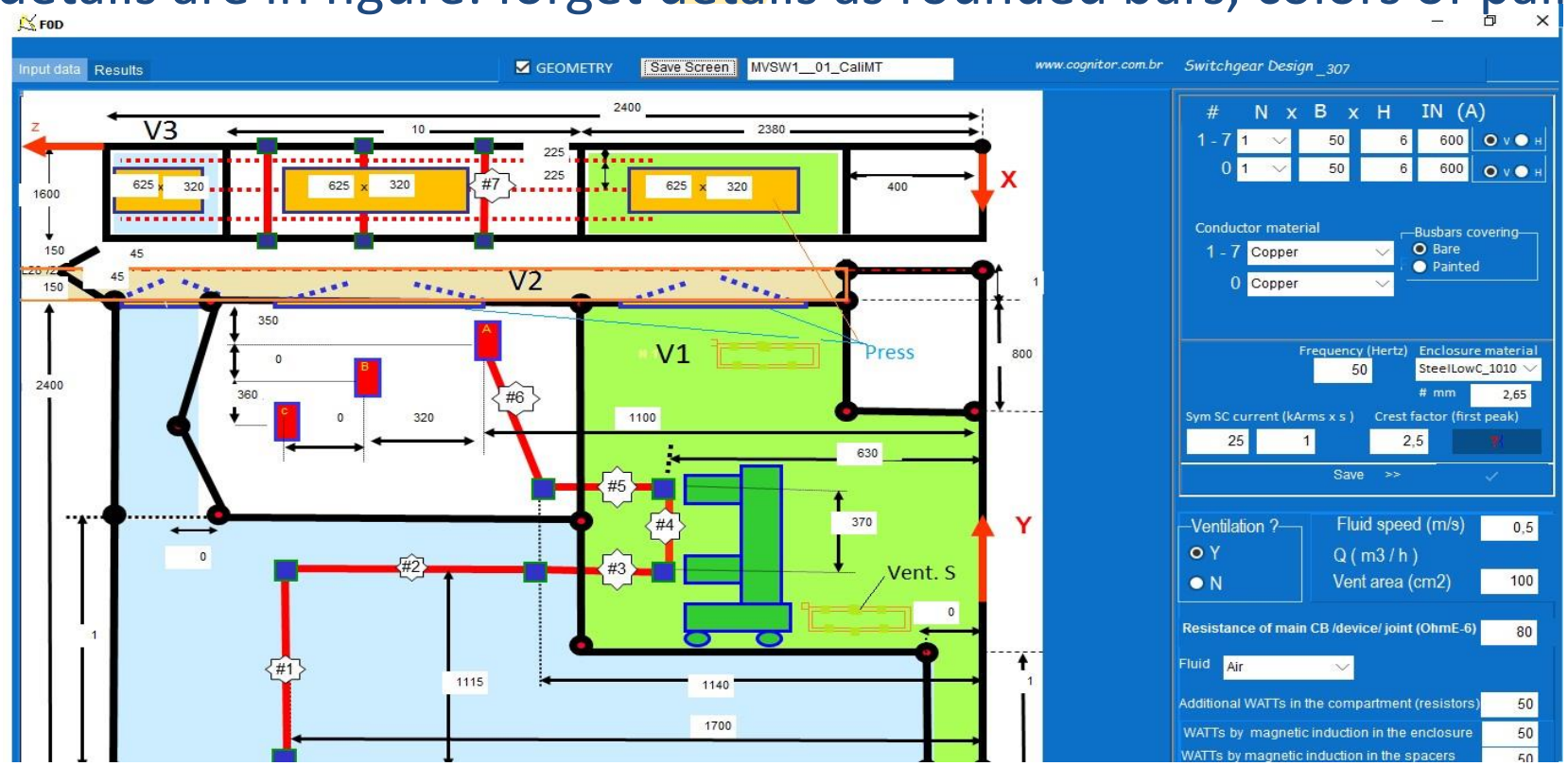


Type of equipment project to be simulated (LVSW 1 &2 = Low Voltage switchgear, MVSW1 – Medium Voltage Switchgear DUCT_1 = bus way … ,)

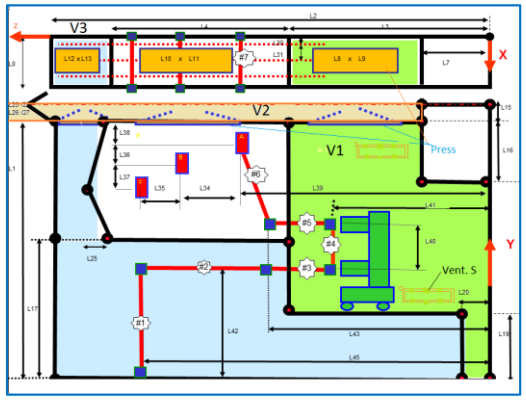
Type of equipment project to be simulated (LVSW 1 &2 = Low Voltage switchgear, MVSW1 – Medium Voltage Switchgear DUCT_1 = bus way …)

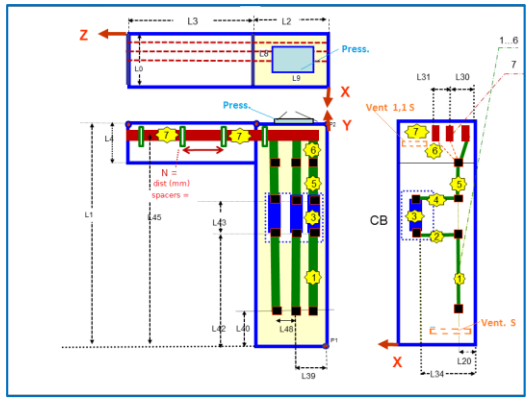
Geometry figures

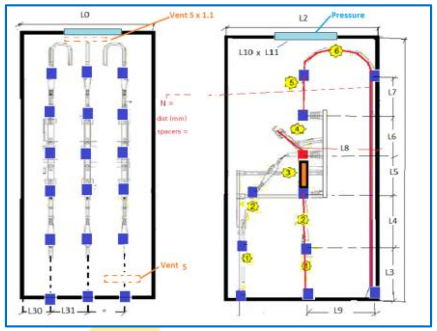
- Think “easy” : all types of equipment can be properly analyzed with these “geometry” figures if you are looking for tolerances between rests and simulation results around 5 to 8 %. If you are looking for lower tolerances ask why !!!
- The relevant details are in figure: forget details as rounded bars, colors of painting, etc..

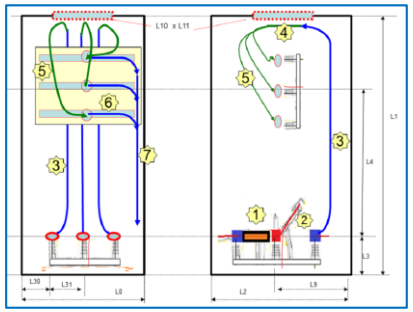


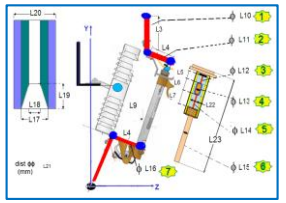
Other geometry figures

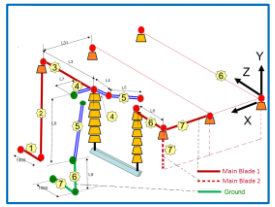


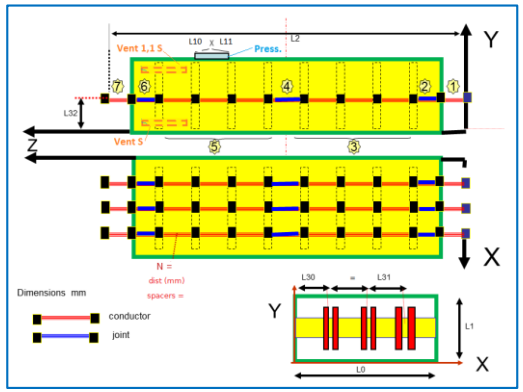


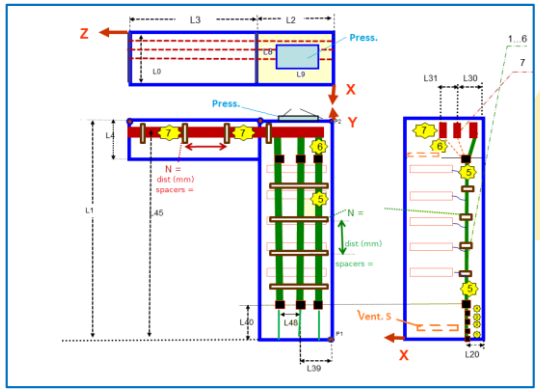


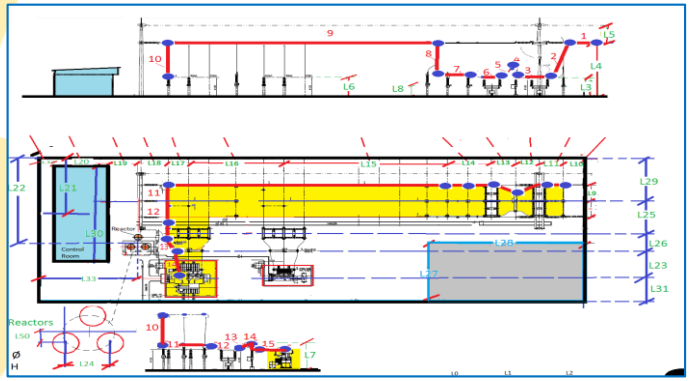


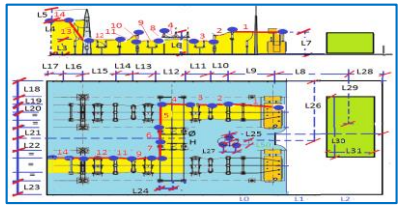


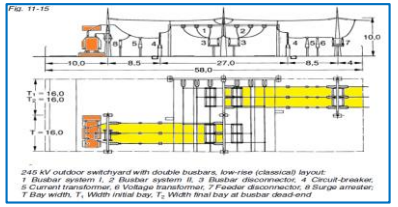


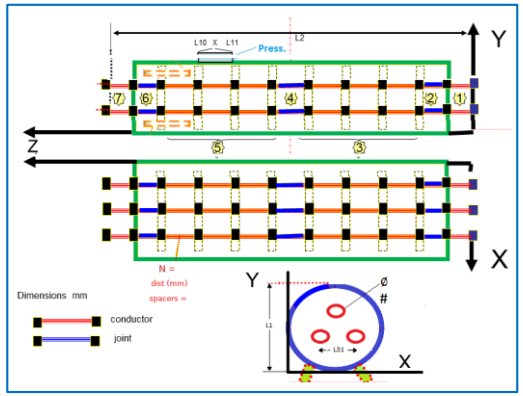


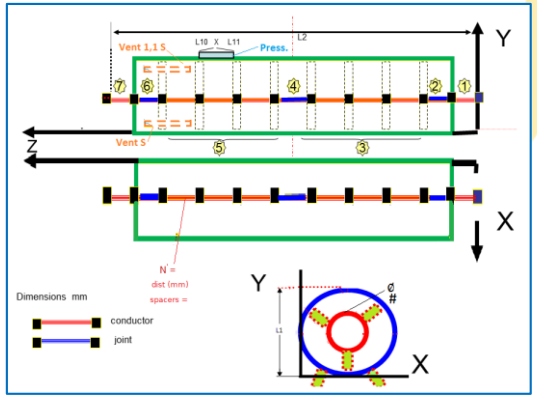


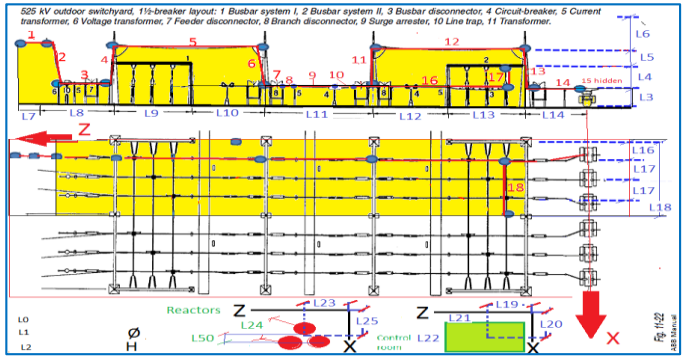


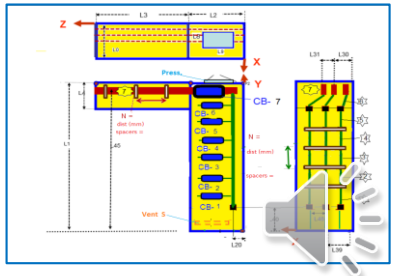












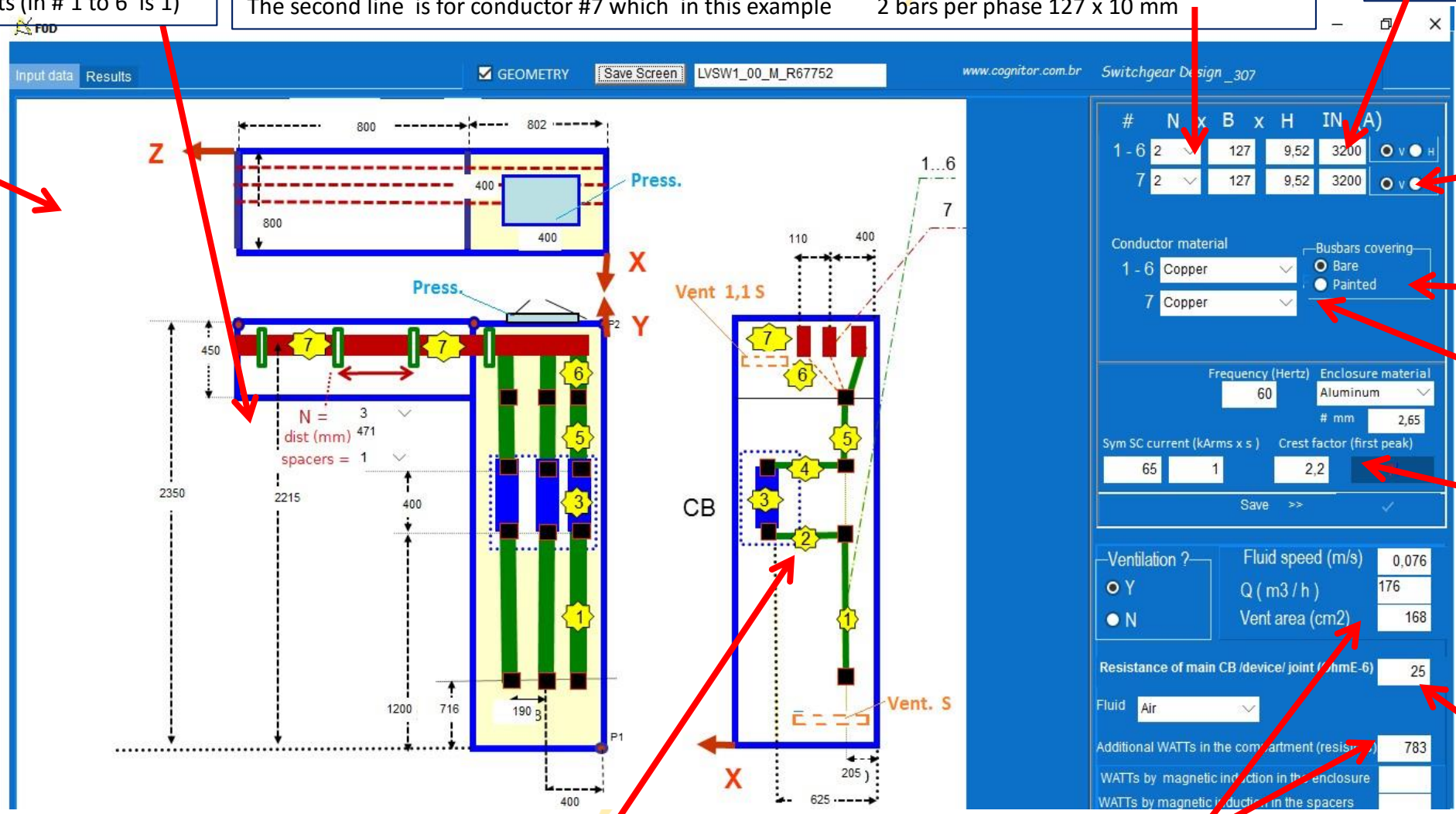
Number of subdivisions in conductor # 7 and corresponding distance between supports (in # 1 to 6 is 1)

The upper line is for conductors # 1 to # 6, in this example 2 bars per phase 127 x 10 mm

The second line is for conductor #7 which in this example 2 bars per phase 127 x 10 mm

Current applied in the temperature rise test (A)

Geometry and dimensions (mm)



Bar in the Horizontal or Vertical position

Bar coating: bare, painted

Material: copper, aluminum

Rated voltage (V)
Enclosure material
Fluid (air, SF6, oil ...)
Frequency
Short circuit current (kA_{rms}), duration (s) and crest factor

Circuit Breaker resistance (μΩ)
Conductors # 2, #3 and #4

Number assigned to each conductor (#1 to # 7) to visualize results

Ventilation area, additional power dissipation (IEC 60890)

INPUT DATA SCREEN BUSWAY DUCT_1

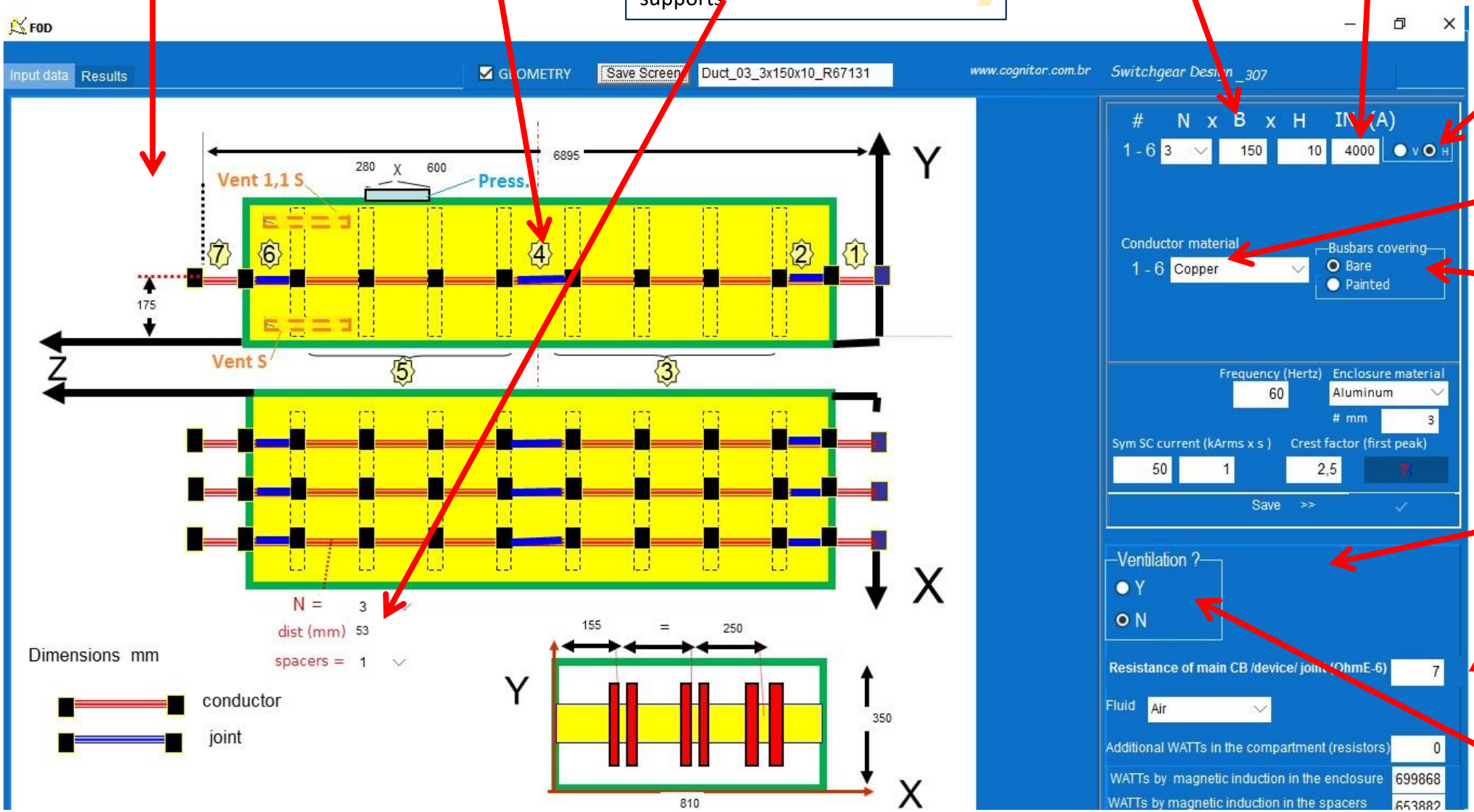
Geometry and dimensions (mm)

Number assigned to each conductor (#1 to # 7) to visualize results

Number of subdivisions in conductors # 3 e 5 and corresponding distance between supports

Conductors # 1 to 7 formed by 3 bars per phase 150x10 mm

Current applied in the temperature rise test (A)



Bar in the Horizontal or Vertical position

Material: copper, aluminum

Bar coating: bare, painted

Rated voltage (V)
Enclosure material
Fluid (air, SF6, óil ...)
Frequency
Short circuit current (kA_{rms}), duration (s) and crest factor

Joints resistance (μΩ) Conductors #2,4 e 6

Ventilation openings area (IEC 60890)

Geometry and dimensions (mm)

Number assigned to each conductor (#1 to # 7) to visualize results

The upper line is for conductors # 1 to # 6, in this example 1 bar per phase 76,2 x 6,35 mm
The second line is for conductor #7 in this example 2 bars per phase 127 x 10 mm

Number of subdivisions in conductor # 5 or 7 & corresponding distance between supports (for others is 1)

Bar in the Horizontal or Vertical position

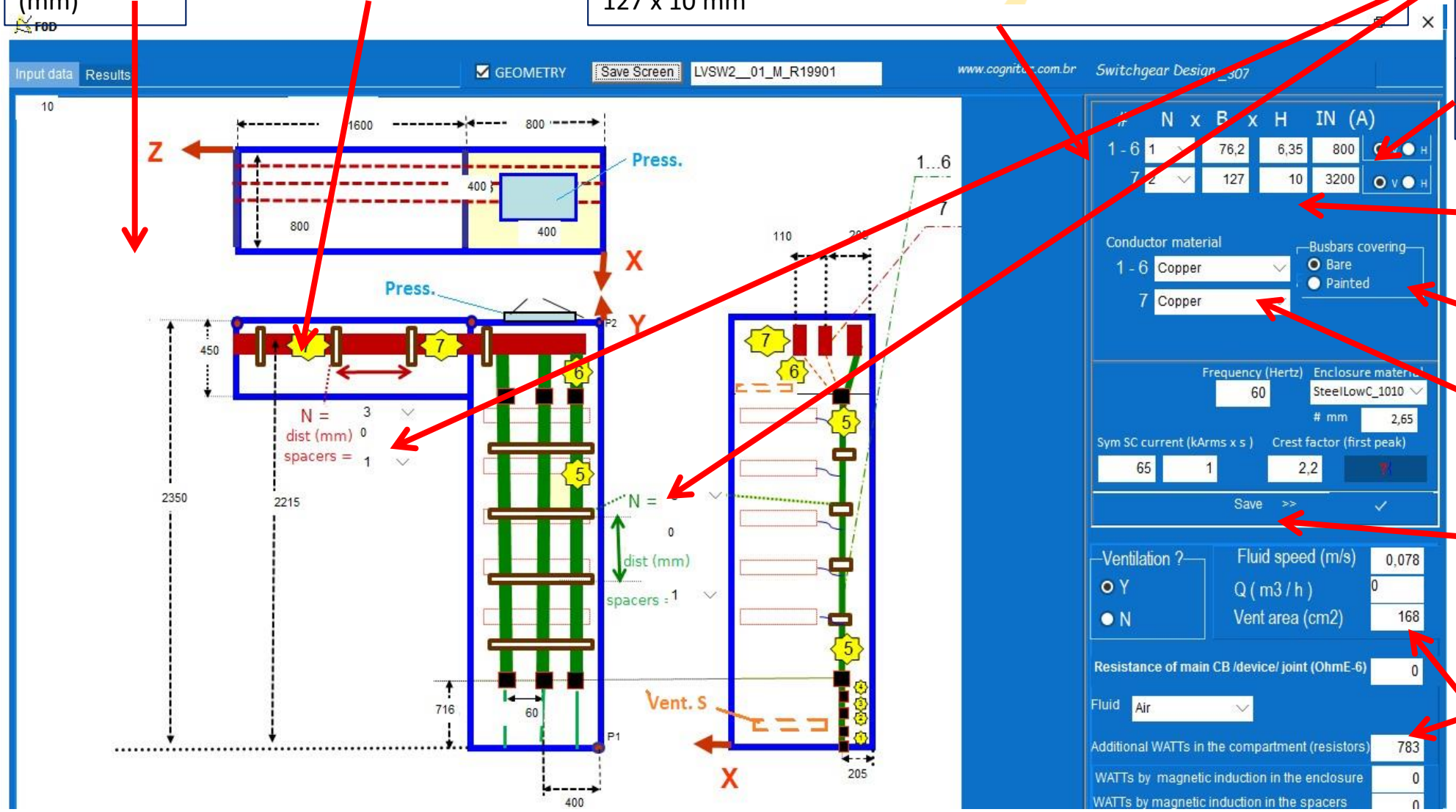
Current applied in the temperature rise test (A)

Bar coating: bare, painted

Material: copper, aluminum

Rated voltage (V)
Enclosure material
Fluid (air, SF6, oil ...)
Frequency
Short circuit current (kA_{rms}), duration (s) and crest factor

Ventilation area, additional power dissipation (IEC 60890)



INPUT DATA MEDIUM VOLTAGE SWITCHGEAR **MVSW_1**

Geometry and dimensions (mm)

Number assigned to each conductor (#1 to # 7) to visualize results

The upper line refers to conductors # 1 to # 6 , in this example 2 bars of 63,5 x 10 mm. The second line refers to conductor #7 (here 1x100 x10 mm)

Current applied in the temperature rise test (A)

Bar in the Horizontal position

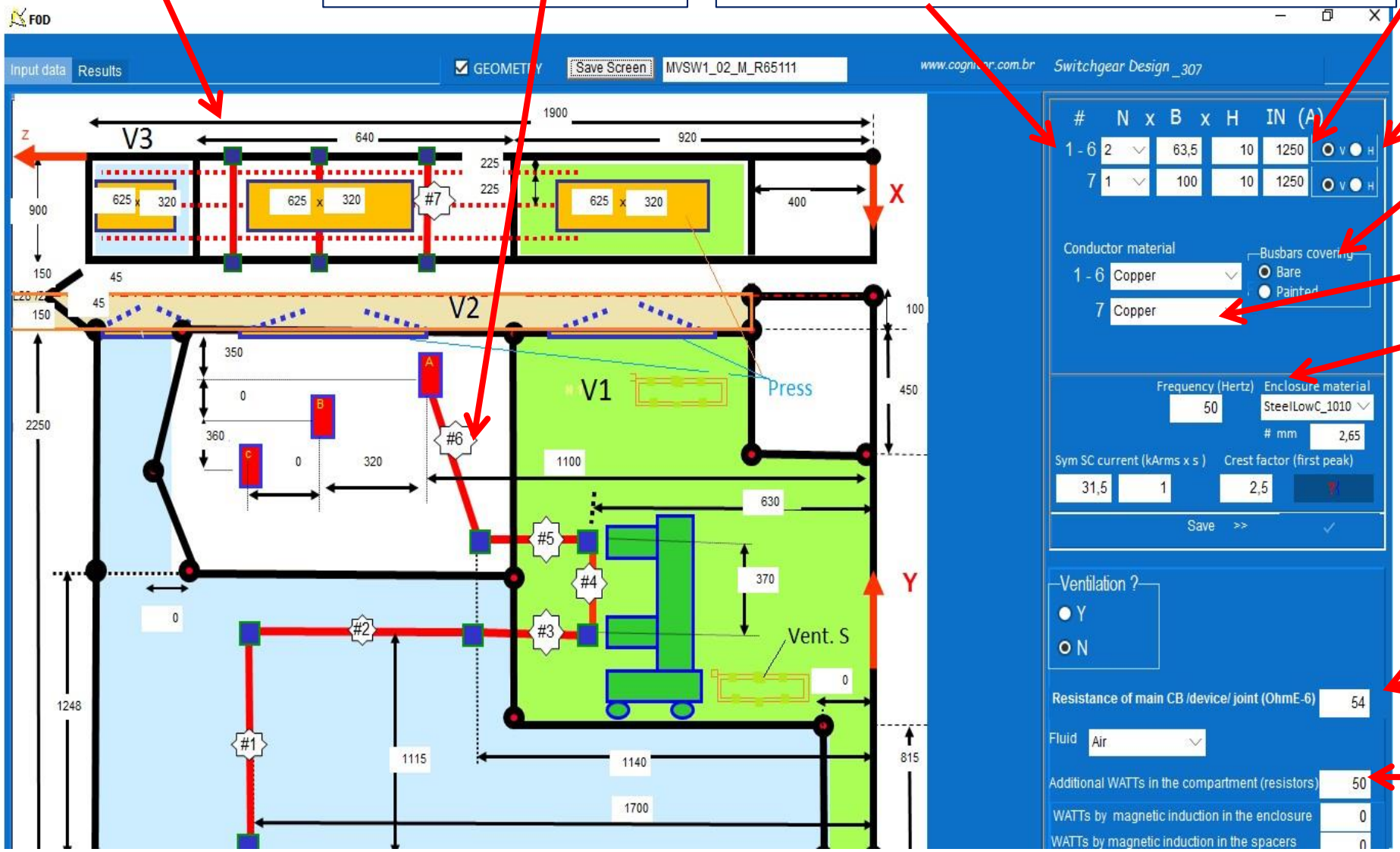
Bar coating: bare, painted

Material: copper, aluminum

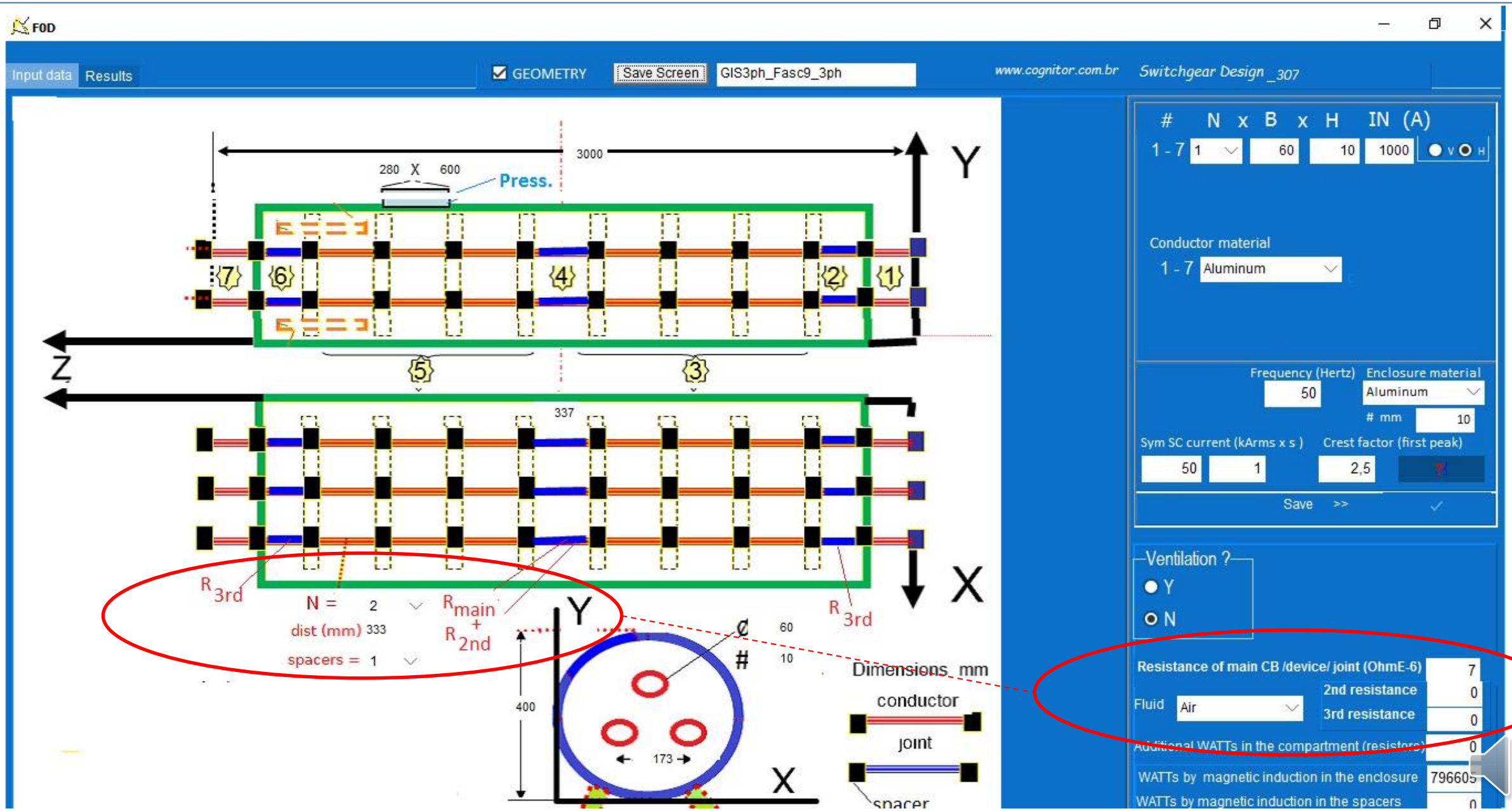
Rated voltage (V)
Enclosure material
Fluid (air, SF6, oil ...)
Frequency
Short circuit current (kA_{rms}), duration (s) and crest factor

Circuit breaker (CB) resistance (μΩ) CB represented by conductors #4, 5 and 6

Ventilation area, additional Watts (IEC 60890)



GIS3ph


FOD
Input data
Results
GEOMETRY
Save Screen
GIS3ph_Fasc9_3ph
www.cognitor.com.br
Switchgear Design _307
N x B x H IN (A)
1 - 7 1 60 10 1000
Conductor material
1 - 7 Aluminum
Frequency (Hertz) 50
Enclosure material Aluminum
mm 10
Sym SC current (kArms x s) 50 1
Crest factor (first peak) 2,5
Save >>
Ventilation ?
Y
N
Resistance of main CB /device/ joint (OhmE-6) 7
Fluid Air
2nd resistance 0
3rd resistance 0
Additional WATTs in the compartment (resistors) 0
WATTs by magnetic induction in the enclosure 796605
WATTs by magnetic induction in the spacers 0
3000
280 X 600
Press.
337
R 3rd
N = 2
dist (mm) 333
spacers = 1
R main + R 2nd
R 3rd
Ø 60
10
400
173
Dimensions, mm
conductor
joint
spacer

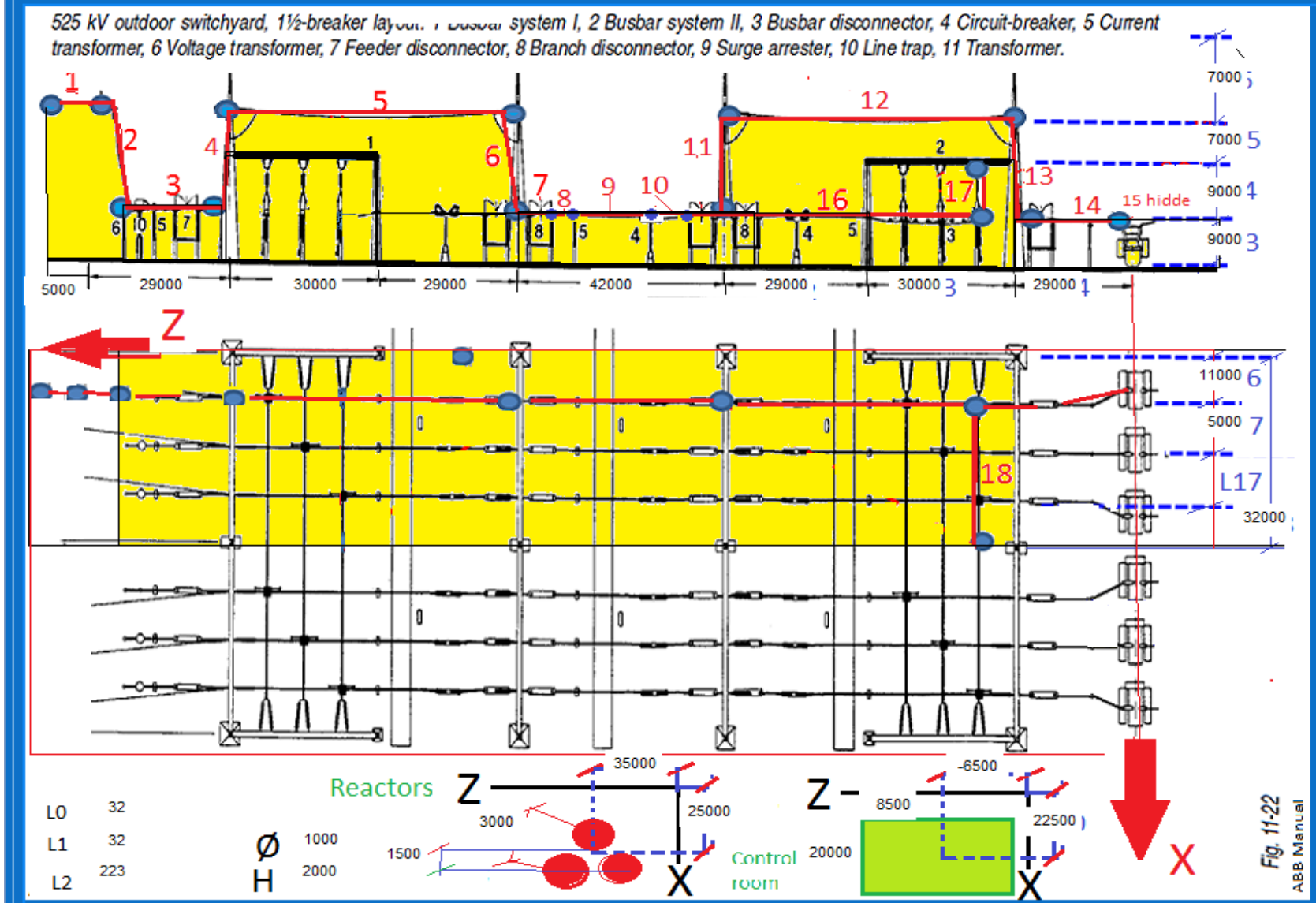
INPUT DATA

SUBST

COGNITOR

FOD

Input data | Results | GEOMETRY | Save Screen | subST_01_OneHalfCB | www.cognitor.com.br | Switchgear Design _307



#	N	x	B	x	H	IN (A)	
1 - 18	1		16		16	3150	V / H

Conductor material

1 - 18 Aluminum

Busbars covering
- Bare
- Painted

Frequency (Hertz): 60

Enclosure material: Aluminum

mm: 2,65

Sym SC current (kArms x s): 50 | 1

Crest factor (first peak): 2,5

Save >>

Ventilation ?
- Y
- N

Resistance of main CB /device/ joint (OhmE-6): 50

Fluid: Air

Additional WATTs in the compartment (resistors): 0

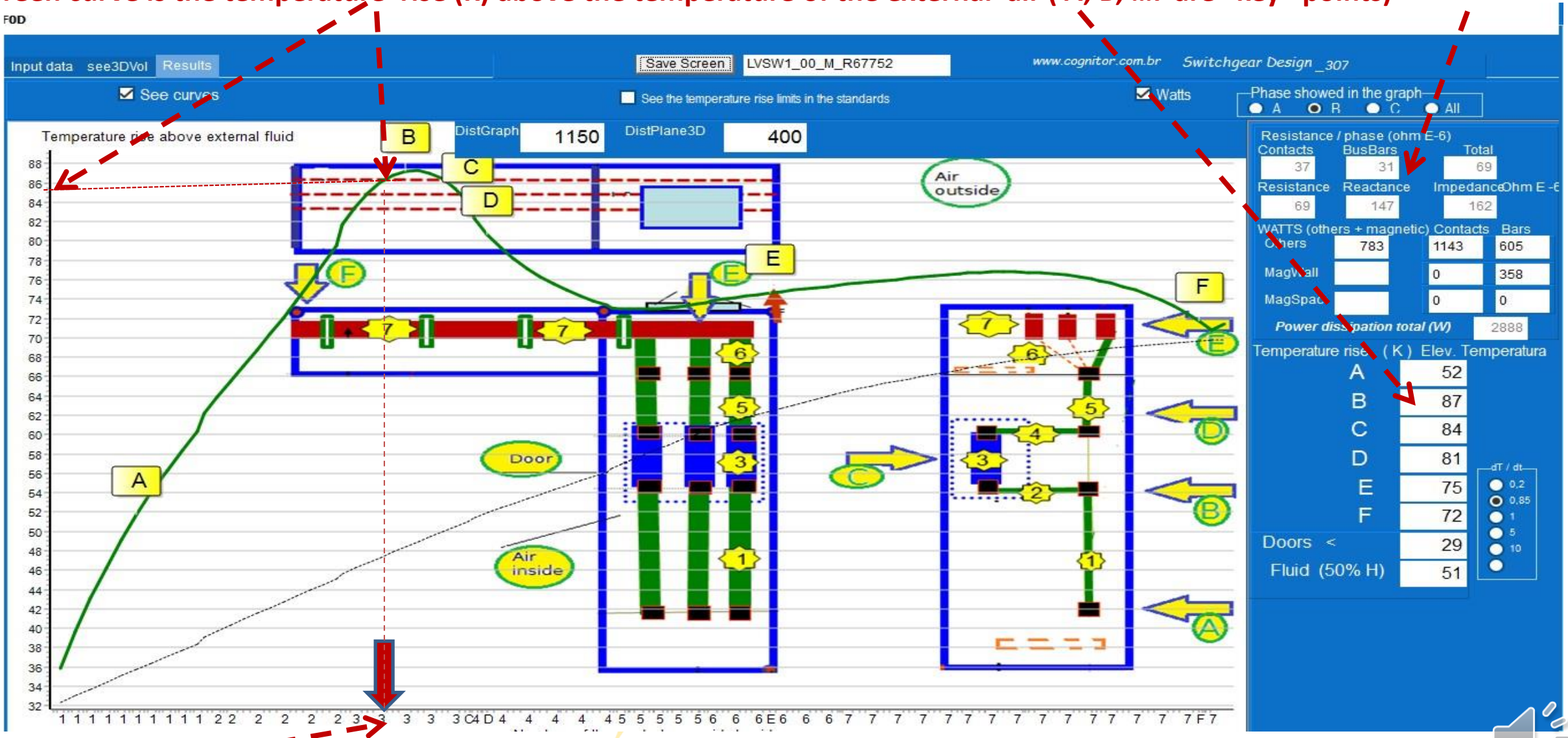
WATTs by magnetic induction in the enclosure: 574095

WATTs by magnetic induction in the spacers: 0

How to see and to analyze the results

Green curve is the temperature rise (K) above the temperature of the external air (A, B, …F are “key” points)

Other results

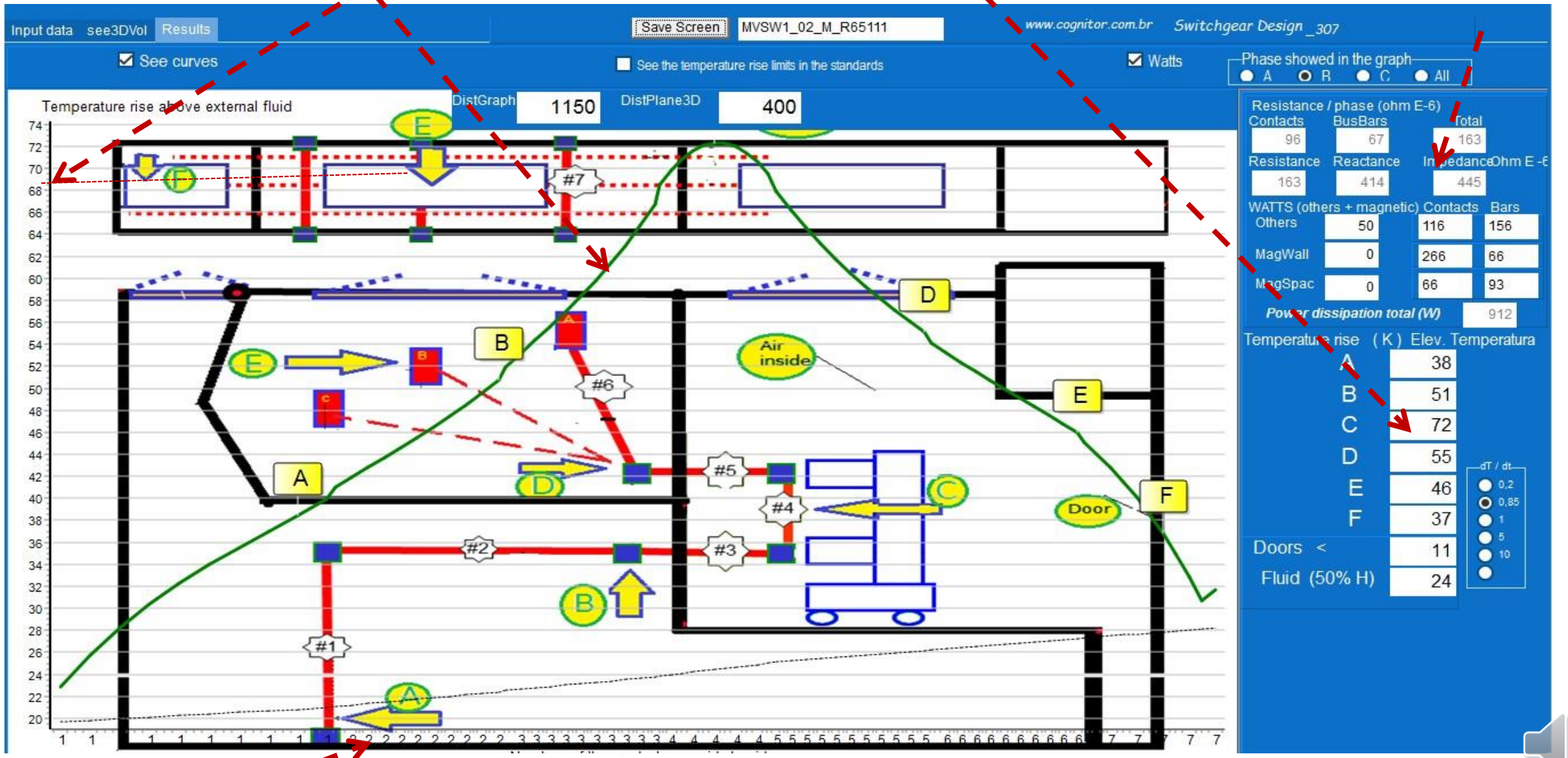


Position of conductors 1 to 7 as they were side by side in a straight line

How to see and to analyze the results

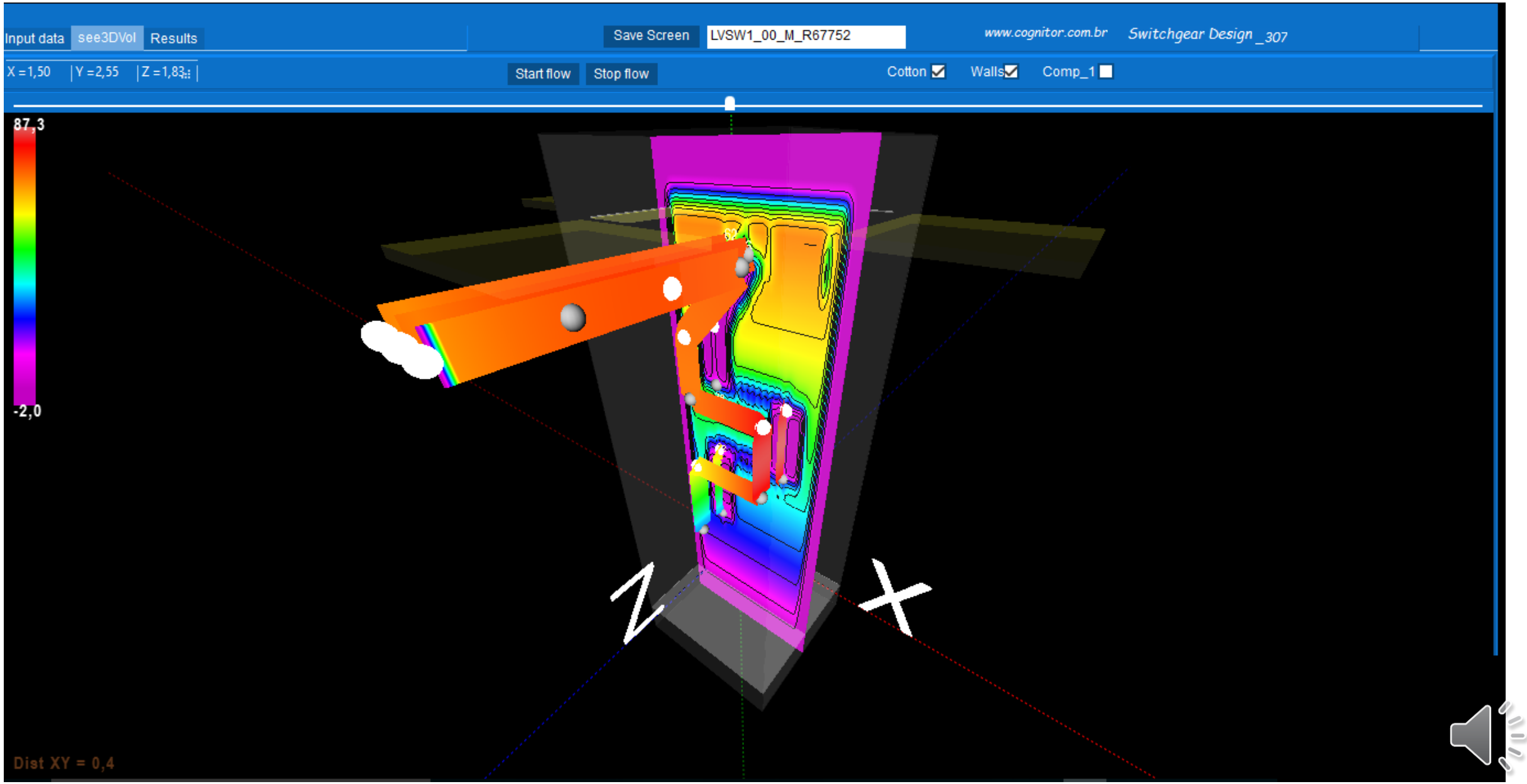
Green curve is the temperature rise (K) above the temperature of the external air (A, B, …F are “key” points)

Other results



Position of conductors 1 to 7 as they were side by side in a straight line

Visualization in 3D (good to see if a wrong dimension was typed)



Using SwitchgearDesign to simulate a temperature rise test

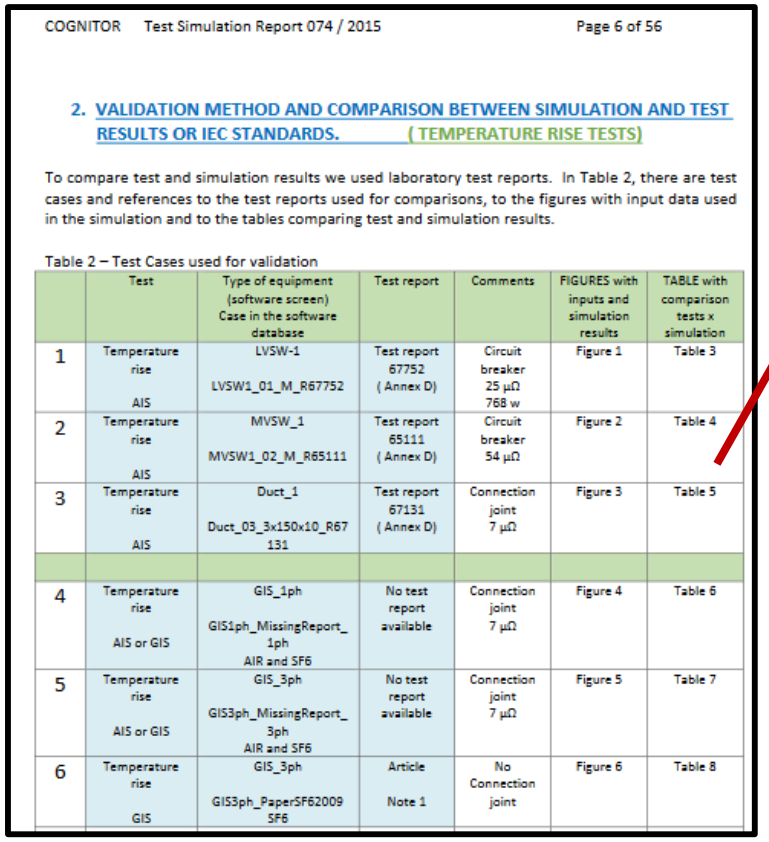
- Install SwitchgearDesign
- Click the icon in the desktop
- Select " temperature rise" if using the all "**TYPE OF TEST**" version.
- Click the "**TYPE OF EQUIPMENT**" you need, for example MVSW1
- Select an existing desired case, for example MVSW1_02_M_R65111
- Click **GEOMETRY** to see dimensions
- Click the tab "**Results**" (top – left) for calculating and seeing results
- Click **See3Dvol** to see the geometry in 3D (use the mouse to enlarge or to educe size)
- Click the tab **InputData**.
- Increase rated current changing the value 1250 (top – right) to 2000.
- Confirm with the button "**Save >> V** "
- Click **Results** (temperature rises are higher now that when it was 1250 A)
- Click "**InputData**"
- To create a new test case based on an existing one, select the case to duplicate clicking twice in the table (left side) . The line becomes blue. Click the button " **NEW**" and see that a new line was created . The name of the new is equal to the one before but with an added _ bis MVSW1_02_M_R65111 _bis.
- Change the name as you wish , for example "MVSW1_03"
- Change the desired data as dimensions and others, confirm change with "**Save >> V** " and click **Results**

See movie in Item 7b2

Information about validation and validated cases

Report 074/2014: VALIDATION OF MAGNETIC & ELECTRIC FIELDS MAPPING & TEMPERATURE RISE TESTS SIMULATIONS.

http://www.cognitor.com.br/TR074ENGValidationTempRise.pdf



COGNITOR Test Simulation Report 074 / 2015 Page 6 of 56

2. VALIDATION METHOD AND COMPARISON BETWEEN SIMULATION AND TEST RESULTS OR IEC STANDARDS. (TEMPERATURE RISE TESTS)

To compare test and simulation results we used laboratory test reports. In Table 2, there are test cases and references to the test reports used for comparisons, to the figures with input data used in the simulation and to the tables comparing test and simulation results.

Table 2 – Test Cases used for validation

	Test	Type of equipment (software screen) Case in the software database	Test report	Comments	FIGURES with inputs and simulation results	TABLE with comparison tests x simulation
1	Temperature rise AIS	LVSW-1 LVSW1_01_M_R67752	Test report 67752 (Annex D)	Circuit breaker 25 µΩ 768 w	Figure 1	Table 3
2	Temperature rise AIS	MVSW_1 MVSW1_02_M_R65111	Test report 65111 (Annex D)	Circuit breaker 54 µΩ	Figure 2	Table 4
3	Temperature rise AIS	Duct_1 Duct_03_3x150x10_R67131	Test report 67131 (Annex D)	Connection joint 7 µΩ	Figure 3	Table 5
4	Temperature rise AIS or GIS	GIS_1ph GIS1ph_MissingReport_1ph AIR and SF6	No test report available	Connection joint 7 µΩ	Figure 4	Table 6
5	Temperature rise AIS or GIS	GIS_3ph GIS3ph_MissingReport_3ph AIR and SF6	No test report available	Connection joint 7 µΩ	Figure 5	Table 7
6	Temperature rise GIS	GIS_3ph GIS3ph_PaperSF62009 SF6	Article Note 1	No Connection joint	Figure 6	Table 8

Table 4 – MVSW1 – Temperature rise test MVSW1_02_M_R65111
Bare bus bar Without ventilation openings
Circuit breaker resistance as seen from the terminals – 54 µΩ per phase

Measuring point	Test temperature rise (K)	Simulation (K)	Difference
A - Terminals for the connection to external conductors	39	38	< 5 %
B – C – D – connection between bars and circuit breaker (**)	56 al-72	55 a 72	< 5 %
E – Connection between the horizontal and vertical bars	44	46	< 5 %
F – Short circuit point	34	37	< 9 %
Door	12 (*)	11	< 15 %
Internal air	Not measured	18 to 26	(***)

E N D