# A TOOL FOR FAST DESIGN OF PRESSURE VESSEL DOMES AND THEIR SIZE AND SHAPE OPTIMIZATION BY USING HYPERSTUDY

*Gerlando Augello ± , Marco Soave © , Lucia Micol Chietera ®*

*The design and analysis of Ultra Light Pressurized Elements requires that high structural performances are achieved by preserving the low weight of their structures. The numerical procedure presented in this paper has been set up in order to give designers a tool which can be suitable for making appropriate choices of the end caps (domes) for pressurized elements and allow for a fast evaluation of their stress field. In fact, the proposed tool allows one to choose among 5 different dome profiles as well as the computation of both hoop and meridian stress. The user can then evaluate the suitability of its choice, change the choice and re-evaluate the stress field automatically. This automatic tool leads to other important information related to the dome characteristics (i.e. closure volume, pressurized elements overall volume, etc.). It is a program written in Visual Basic for Applications and interfacing with Microsoft Software Excel package. It also allows for a direct interface with CAD software; the user, can in fact obtain the IGES file related to the geometry of the domes. As a limitation, the present tool only deals with membrane stress fields; however if the user is interested in considering the local effects (bending and shear ) at the interface of the domes and the cylindrical part of the pressurized element, the present tool allows the use of FE codes ( i.e. RADIOSS, NASTRAN ) for the automatic execution of Finite Element Analysis ( Linear Static, Buckling, Non-Linear Static ). Finally, in order to make a sizing optimization of the wall thicknesses of pressurized elements, a procedure has also been set up, based on the use of the HyperStudy software in conjunction with a solver based program written in Visual Basic for Application (VBA).*

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# INTRODUCTION

- This presentation is related to an automated computational procedure named DOMPRO ( DOMesPROfiles ).
- This procedure is intended to be a simple to use tool for quick design of end closure profiles of pressurized elements ( i.e. tanks, pressurized modules, etc..), which exhibit revolutionary symmetry
- It is based on a program written in Visual Basic for Applications ( VBA )
- It is coupled with a Microsoft Excel worksheet, which acts as a user interface for the input of the program data
- The procedure exploits the batch mode use of HyperMesh and RADIOSS software

# INTRODUCTION ( cont. )

- To give an example of the field of application of the procedure, Figure 1 shows a real application case of two tanks studied, in their first design phase, with this procedure

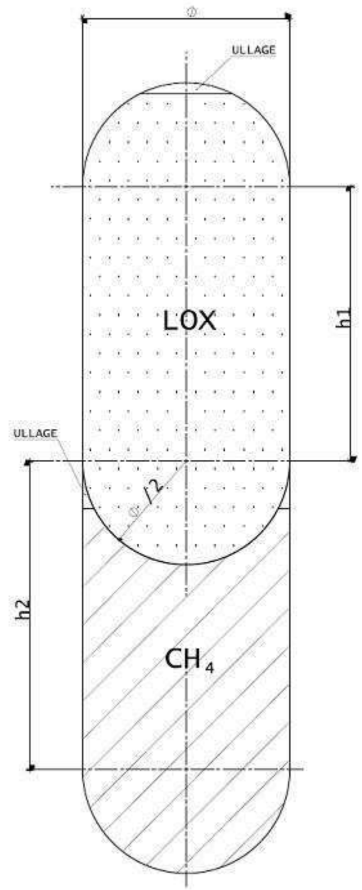



FIG. 1 – Example of real application case

# PROCEDURE PRESENTATION

- For what concern the characteristics of the procedure, its main procedure functionalities are listed below **:**

❑ **data management**
- input data processing
- data summary

❑ **analytical computations**
- profile x ,y coordinates
- profile radii
- profile length
- profile surface
- dome mass
- dome volume
- total volume
- profile meridian stresses
- profile hoop stresses
- profile variable thickness

❑ **CAD & FEM**
- profile IGES file using HyperMesh
- dome FEM analysis using RADIOSS
- dome FD analysis using BOSOR

# PROCEDURE PRESENTATION ( cont. )

- Once the procedure starts the following window appears :

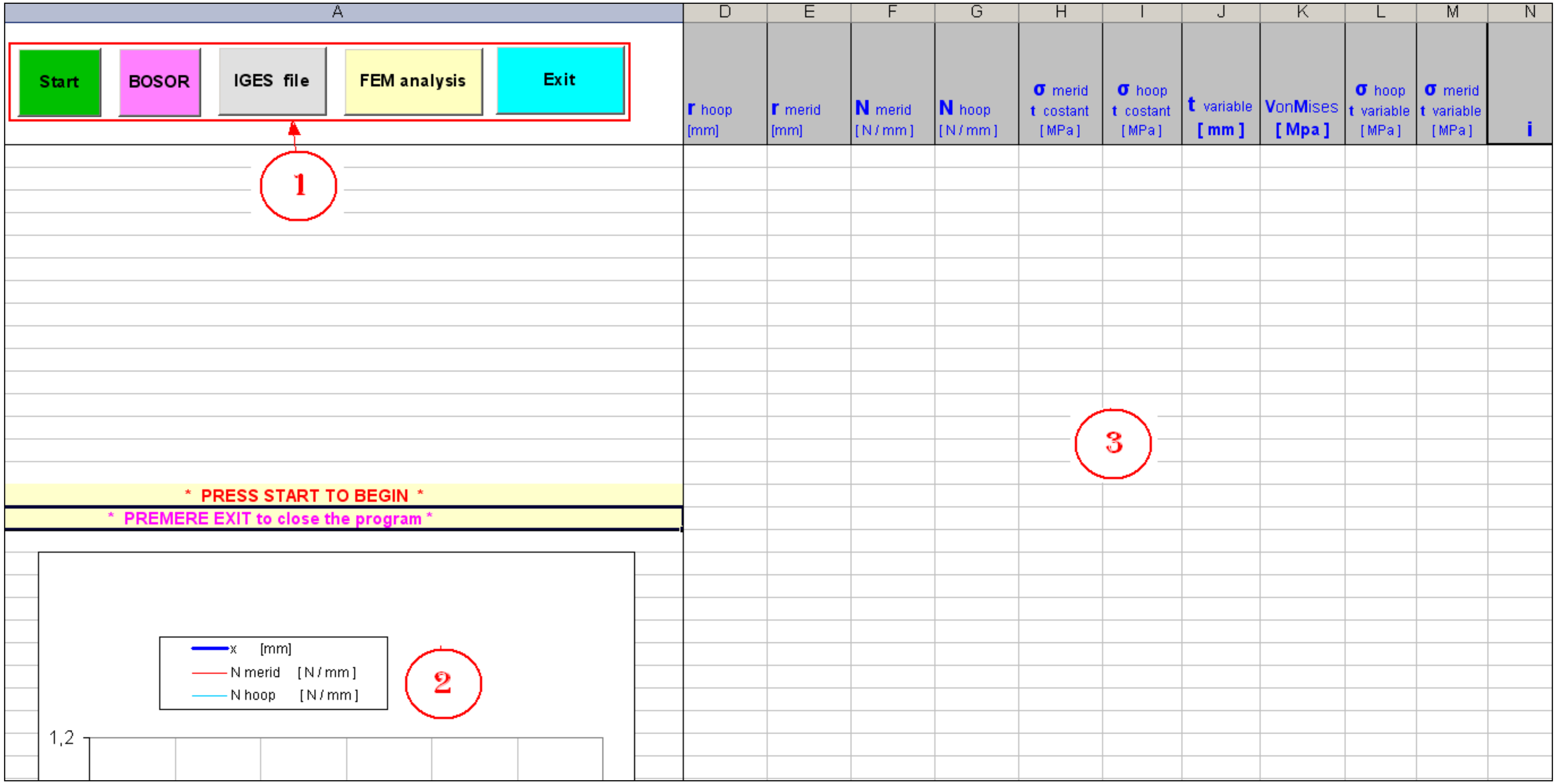



FIG. 2 - 1.Function buttons area; 2.Plots area; 3. Results area.

# PROCEDURE PRESENTATION ( cont. )

- **START button opens the windows of Figure 3, where one can choose the dome profile (among 5 allowed) and input the engineering data.**

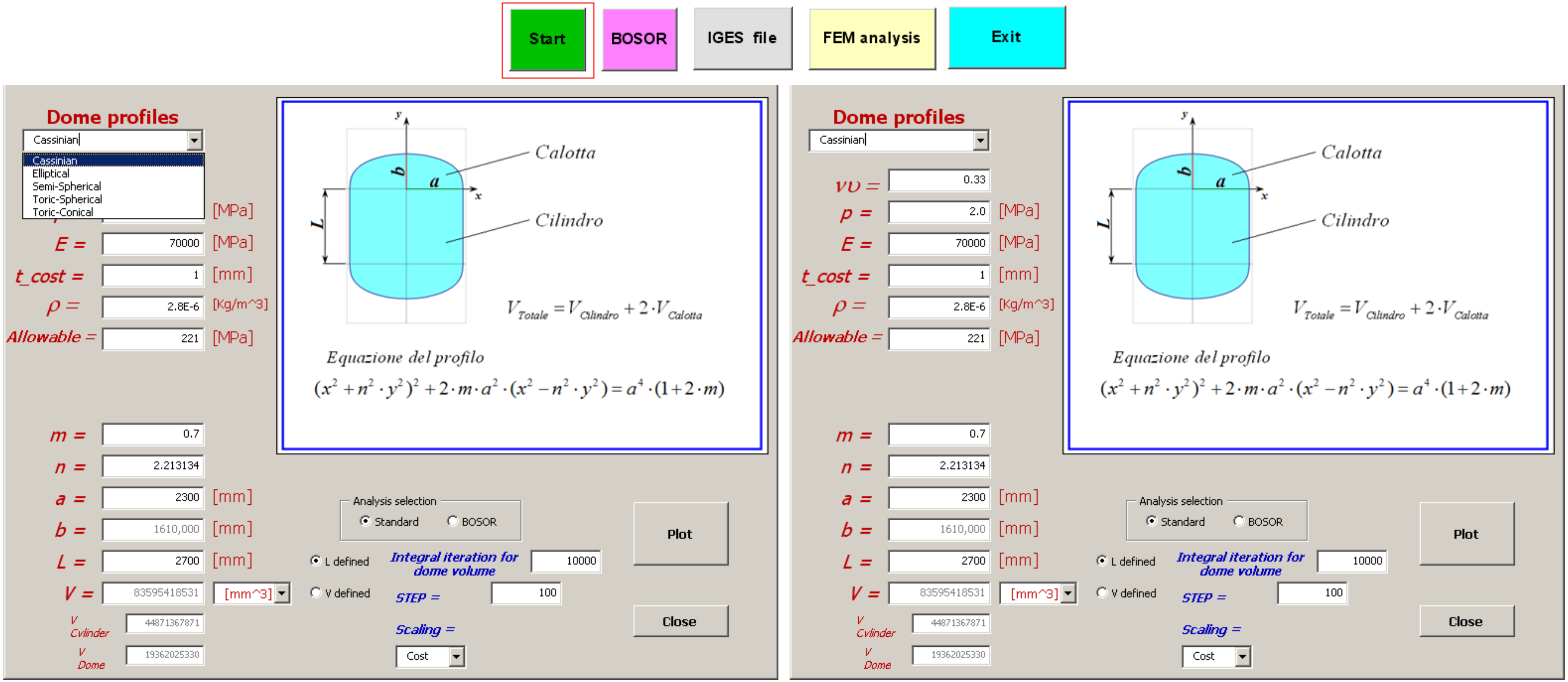



FIG. 3 – Window for Dome profile choice and data input

# PROCEDURE PRESENTATION ( cont. )

- **By applying the Plot and then the Close button, computations are executed and the following window sappears**

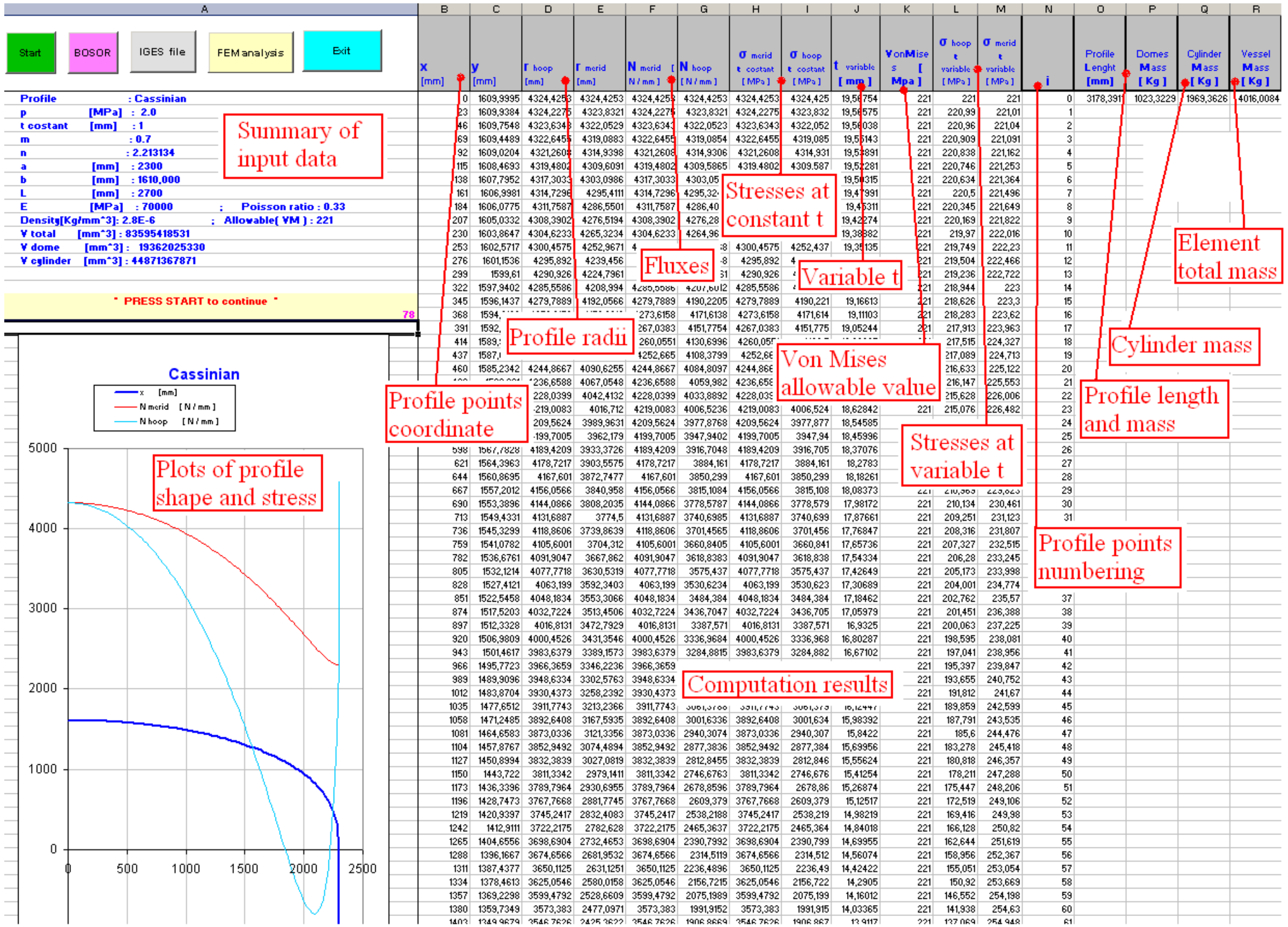
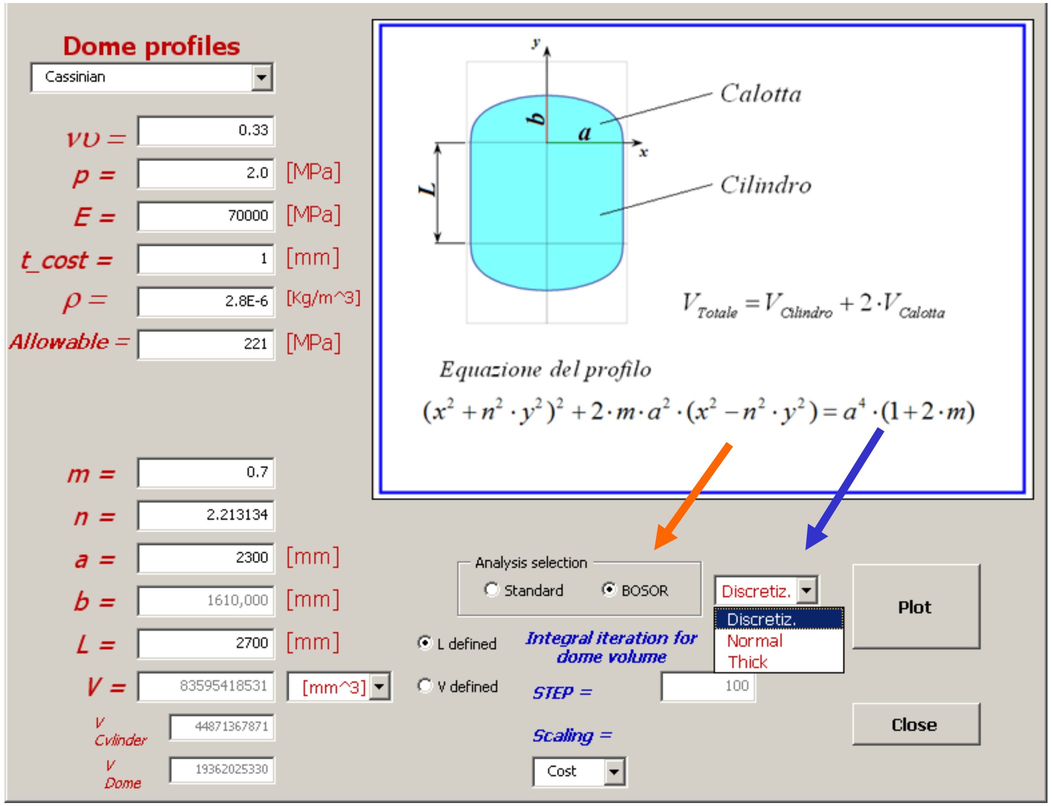


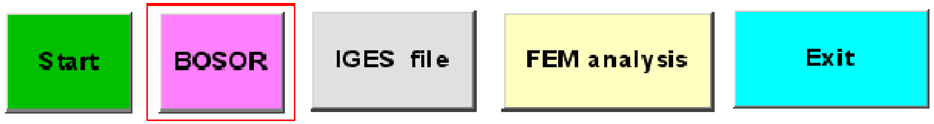

FIG. 4 – Worksheet with computed results

# PROCEDURE PRESENTATION ( cont. )

- **BOSOR button allows the use of a Finite Difference based code ( Buckling Of Shells Of Revolution, by Bushnell ) for a static or non-linear buckling analysis of the profile.**

- **The user must choose the profile discretization and then the analysis type**



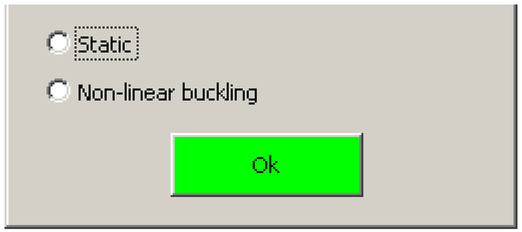




FIG. 5 – BOSOR usage window

# PROCEDURE PRESENTATION ( cont. )

- **IGES file** button performs the generation of a neutral data format file containing the profile geometry
- The generation of the IGES file is done by using the HyperMesh in batch mode
- HyperMesh processes a command file ( *.cmf ) authomatically written by the procedure and based on coordinates of profile points
- IGES file can refers to a constant thickness profile or to a variable thickness one
- In the latter case the user must defined the number and the length of profile subdivisions

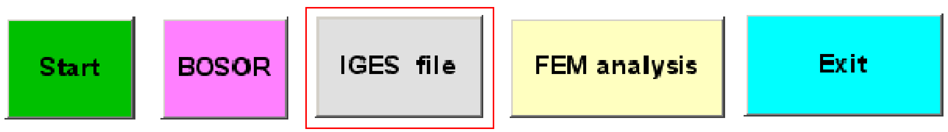



FIG. 6 – IGES file button

# PROCEDURE PRESENTATION ( cont. )

| | J | K | L | M | N | O | P | Q | R |
|---|---|---|---|---|---|---|---|---|---|
| op ant ] | t variable [ mm ] | VonMises [ Mpa ] | σ hoop t variable [MPa] | σ merid t variable [MPa] | i | Profile Lenght [mm] | Domes Mass [ Kg ] | Cylinder Mass [ Kg ] | Vessel Mass [ Kg ] |
| 43 | 19,5675 | 221 | 221 | 221 | 0 | 3178,39 | 1023,32 | 1969,36 | 4016,01 |
| 83 | 19,5657 | 221 | 220,99 | 221,01 | 1 | | | | |
| 05 | 19,5604 | 221 | 220,96 | 221,04 | 2 | | | | |
| 09 | 19,5514 | 221 | 220,91 | 221,09 | 3 | | | | |
| 93 | 19,5389 | 221 | 220,84 | 221,16 | 4 | | | | |
| 59 | 19,5228 | 221 | 220,75 | 221,25 | 5 | | | | |
| 05 | 19,5031 | 221 | 220,63 | 221,36 | 6 | | | | |
| 32 | 19,4799 | 221 | 220,5 | 221,5 | 7 | | | | |
| ,4 | 19,4531 | 221 | 220,35 | 221,65 | 8 | | | | |
| 28 | 19,4227 | 221 | 220,17 | 221,82 | 9 | | | | |
| 96 | 19,3888 | 221 | 219,97 | 222,02 | 10 | | | | |
| 44 | 19,3514 | 221 | 219,75 | 222,23 | 11 | | | | |
| ,7 | 19,3103 | 221 | 219,5 | 222,47 | 12 | | | | |
| 76 | 19,2658 | 221 | 219,24 | 222,72 | 13 | | | | |
| ,6 | 19,2177 | 221 | 218,94 | 223 | 14 | | | | |
| 22 | 19,1661 | 221 | 218,63 | 223,3 | 15 | | | | |
| 61 | 19,111 | 221 | 218,28 | 223,62 | 16 | | | | |
| 78 | 19,0524 | 221 | 217,91 | 223,96 | 17 | | | | |
| ,7 | 18,9904 | 221 | 217,52 | 224,33 | 18 | | | | |
| 38 | 18,9248 | 221 | 217,09 | 224,71 | 19 | | | | |
| 81 | 18,8559 | 221 | 216,63 | 225,12 | **20** | | | | |
| 98 | 18,7834 | 221 | 216,15 | 225,55 | 21 | | | | |
| 89 | 18,7076 | 221 | 215,63 | 226,01 | 22 | | | | |
| 52 | 18,6284 | 221 | 215,08 | 226,48 | 23 | | | | |
| 88 | 18,5459 | 221 | 214,49 | 226,98 | 24 | | | | |
| 94 | 18,46 | 221 | 213,87 | 227,5 | 25 | | | | |
| ,7 | 18,3708 | 221 | 213,2 | 228,05 | 26 | | | | |
| 16 | 18,2783 | 221 | 212,5 | 228,62 | 27 | | | | |
| ,3 | 18,1826 | 221 | 211,76 | 229,21 | 28 | | | | |
| 11 | 18,0837 | 221 | 210,97 | 229,82 | 29 | | | | |
| 58 | 17,9817 | 221 | 210,13 | 230,46 | 30 | | | | |
| ,7 | 17,8766 | 221 | 209,25 | 231,12 | 31 | | | | |
| 46 | 17,7685 | 221 | 208,32 | 231,81 | 32 | | | | |
| 84 | 17,6574 | 221 | 207,33 | 232,51 | 33 | | | | |
| 84 | 17,5433 | 221 | 206,28 | 233,25 | 34 | | | | |
| 44 | 17,4265 | 221 | 205,17 | 234 | **35** | | | | |
| 62 | 17,3069 | 221 | 204 | 234,77 | 36 | | | | |
| 38 | 17,1846 | 221 | 202,76 | 235,57 | 37 | | | | |
| ,7 | 17,0598 | 221 | 201,45 | 236,39 | 38 | | | | |
| 57 | 16,9325 | 221 | 200,06 | 237,23 | 39 | | | | |
| 97 | 16,8029 | 221 | 198,6 | 238,08 | 40 | | | | |
| 88 | 16,671 | 221 | 197,04 | 238,96 | 41 | | | | |
| ,3 | 16,5371 | 221 | 195,4 | 239,85 | 42 | | | | |
| 19 | 16,4013 | 221 | 193,66 | 240,75 | 43 | | | | |
| 56 | 16,2637 | 221 | 191,81 | 241,67 | 44 | | | | |
| 38 | 16,1245 | 221 | 189,86 | 242,6 | 45 | | | | |
| 63 | 15,9839 | 221 | 187,79 | 243,53 | 46 | | | | |
| 31 | 15,8422 | 221 | 185,6 | 244,48 | 47 | | | | |
| 38 | 15,6996 | 221 | 183,28 | 245,42 | 48 | | | | |
| 85 | 15,5562 | 221 | 180,82 | 246,36 | 49 | | | | |
| 68 | 15,4125 | 221 | 178,21 | 247,29 | **50** | | | | |

IGES file with constant thickness

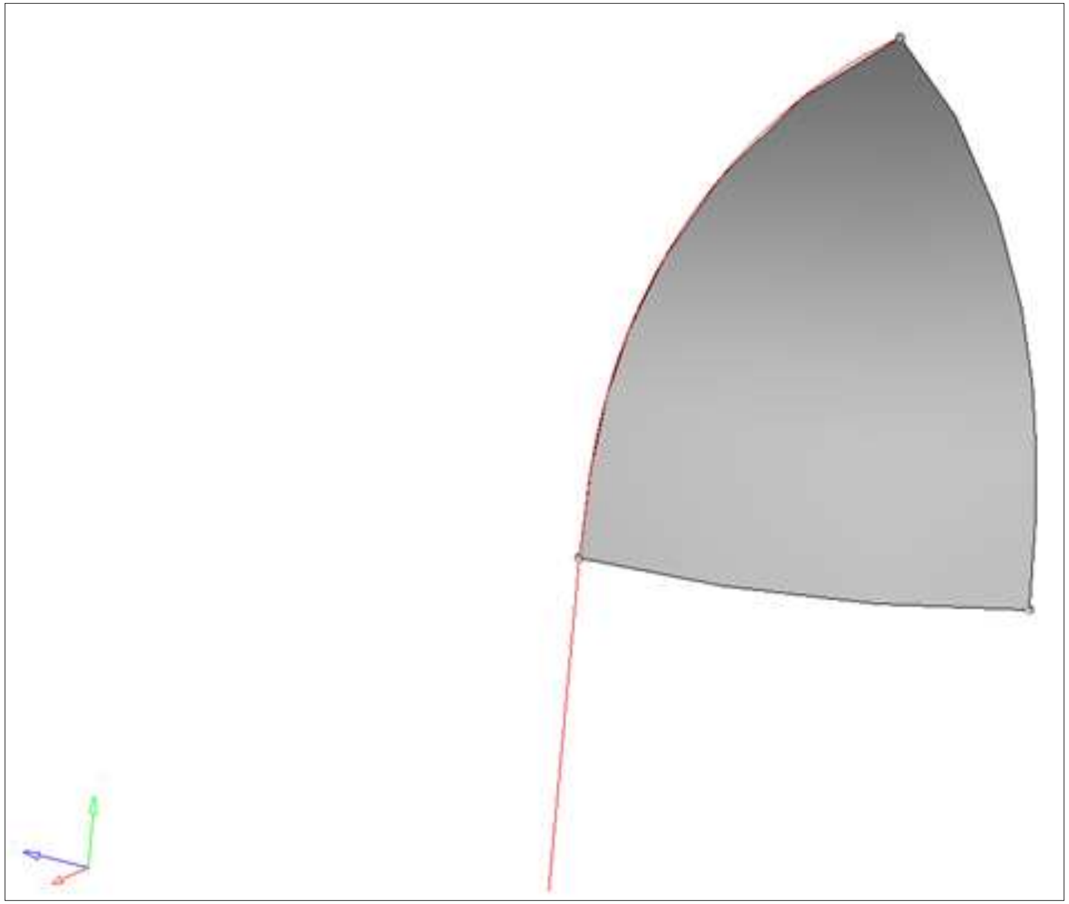
IGES file with variable thickness

| J | K | L | M | N | O | P | Q | R | S | T | U |
|---|---|---|---|---|---|---|---|---|---|---|---|
| t variable [ mm ] | VonMises [ Mpa ] | σ hoop t variable [MPa] | σ merid t variable [MPa] | i | Profile Lenght [mm] | Domes Mass [ Kg ] | Cylinder Mass [ Kg ] | Vessel Mass [ Kg ] | | | |
| 19,5675 | 221 | 221 | 221 | 0 | 3178,39 | 1023,32 | 1969,36 | 4016,01 | | 19,5675 | |
| 19,5657 | 221 | 220,99 | 221,01 | 1 | | | | | | 19,5675 | |
| 19,5604 | 221 | 220,96 | 221,04 | 2 | | | | | | 19,5675 | |
| 19,5514 | 221 | 220,91 | 221,09 | 3 | | | | | | 19,5675 | |
| 19,5389 | 221 | 220,84 | 221,16 | 4 | | | | | | 19,5675 | |
| 19,5228 | 221 | 220,75 | 221,25 | 5 | | | | | | 19,5675 | |
| 19,5031 | 221 | 220,63 | 221,36 | 6 | | | | | | 19,5675 | |
| 19,4799 | 221 | 220,5 | 221,5 | 7 | | | | | | 19,5675 | |
| 19,4531 | 221 | 220,35 | 221,65 | 8 | | | | | | 19,5675 | |
| 19,4227 | 221 | 220,17 | 221,82 | 9 | | | | | | 19,5675 | |
| 19,3888 | 221 | 219,97 | 222,02 | 10 | | | | | | 19,5675 | |
| 19,3514 | 221 | 219,75 | 222,23 | 11 | | | | | | 19,5675 | |
| 19,3103 | 221 | 219,5 | 222,47 | 12 | | | | | | 19,5675 | |
| 19,2658 | 221 | 219,24 | 222,72 | 13 | | | | | | 19,5675 | |
| 19,2177 | 221 | 218,94 | 223 | 14 | | | | | | 19,5675 | |
| 19,1661 | 221 | 218,63 | 223,3 | 15 | | | | | | 19,5675 | |
| 19,111 | 221 | 218,28 | 223,62 | 16 | | | | | | 19,5675 | |
| 19,0524 | 221 | 217,91 | 223,96 | 17 | | | | | | 19,5675 | |
| 18,9904 | 221 | 217,52 | 224,33 | 18 | | | | | | 19,5675 | |
| 18,9248 | 221 | 217,09 | 224,71 | 19 | | | | | | 19,5675 | |
| 18,8559 | 221 | 216,63 | 225,12 | 20 | | | | | | 19,5675 | 20 |
| 18,7834 | 221 | 216,15 | 225,55 | 21 | | | | | | 18,7834 | |
| 18,7076 | 221 | 215,63 | 226,01 | 22 | | | | | | 18,7834 | |
| 18,6284 | 221 | 215,08 | 226,48 | 23 | | | | | | 18,7834 | |
| 18,5459 | 221 | 214,49 | 226,98 | 24 | | | | | | 18,7834 | |
| 18,46 | 221 | 213,87 | 227,5 | 25 | | | | | | 18,7834 | |
| 18,3708 | 221 | 213,2 | 228,05 | 26 | | | | | | 18,7834 | |
| 18,2783 | 221 | 212,5 | 228,62 | 27 | | | | | | 18,7834 | |
| 18,1826 | 221 | 211,76 | 229,21 | 28 | | | | | | 18,7834 | |
| 18,0837 | 221 | 210,97 | 229,82 | 29 | | | | | | 18,7834 | |
| 17,9817 | 221 | 210,13 | 230,46 | 30 | | | | | | 18,7834 | |
| 17,8766 | 221 | 209,25 | 231,12 | 31 | | | | | | 18,7834 | |
| 17,7685 | 221 | 208,32 | 231,81 | 32 | | | | | | 18,7834 | |
| 17,6574 | 221 | 207,33 | 232,51 | 33 | | | | | | 18,7834 | |
| 17,5433 | 221 | 206,28 | 233,25 | 34 | | | | | | 18,7834 | |
| 17,4265 | 221 | 205,17 | 234 | 35 | | | | | | 18,7834 | 35 |
| 17,3069 | 221 | 204 | 234,77 | 36 | | | | | | 17,3069 | |
| 17,1846 | 221 | 202,76 | 235,57 | 37 | | | | | | 17,3069 | |
| 17,0598 | 221 | 201,45 | 236,39 | 38 | | | | | | 17,3069 | |
| 16,9325 | 221 | 200,06 | 237,23 | 39 | | | | | | 17,3069 | |
| 16,8029 | 221 | 198,6 | 238,08 | 40 | | | | | | 17,3069 | |
| 16,671 | 221 | 197,04 | 238,96 | 41 | | | | | | 17,3069 | |
| 16,5371 | 221 | 195,4 | 239,85 | 42 | | | | | | 17,3069 | |
| 16,4013 | 221 | 193,66 | 240,75 | 43 | | | | | | 17,3069 | |
| 16,2637 | 221 | 191,81 | 241,67 | 44 | | | | | | 17,3069 | |
| 16,1245 | 221 | 189,86 | 242,6 | 45 | | | | | | 17,3069 | |
| 15,9839 | 221 | 187,79 | 243,53 | 46 | | | | | | 17,3069 | |
| 15,8422 | 221 | 185,6 | 244,48 | 47 | | | | | | 17,3069 | |
| 15,6996 | 221 | 183,28 | 245,42 | 48 | | | | | | 17,3069 | |
| 15,5562 | 221 | 180,82 | 246,36 | 49 | | | | | | 17,3069 | |
| 15,4125 | 221 | 178,21 | 247,29 | 50 | | | | | | 17,3069 | 50 |

FIG. 7 – IGES file creation

# PROCEDURE PRESENTATION ( cont. )

- **Figure 7 shows constant thickness and segmented profile**



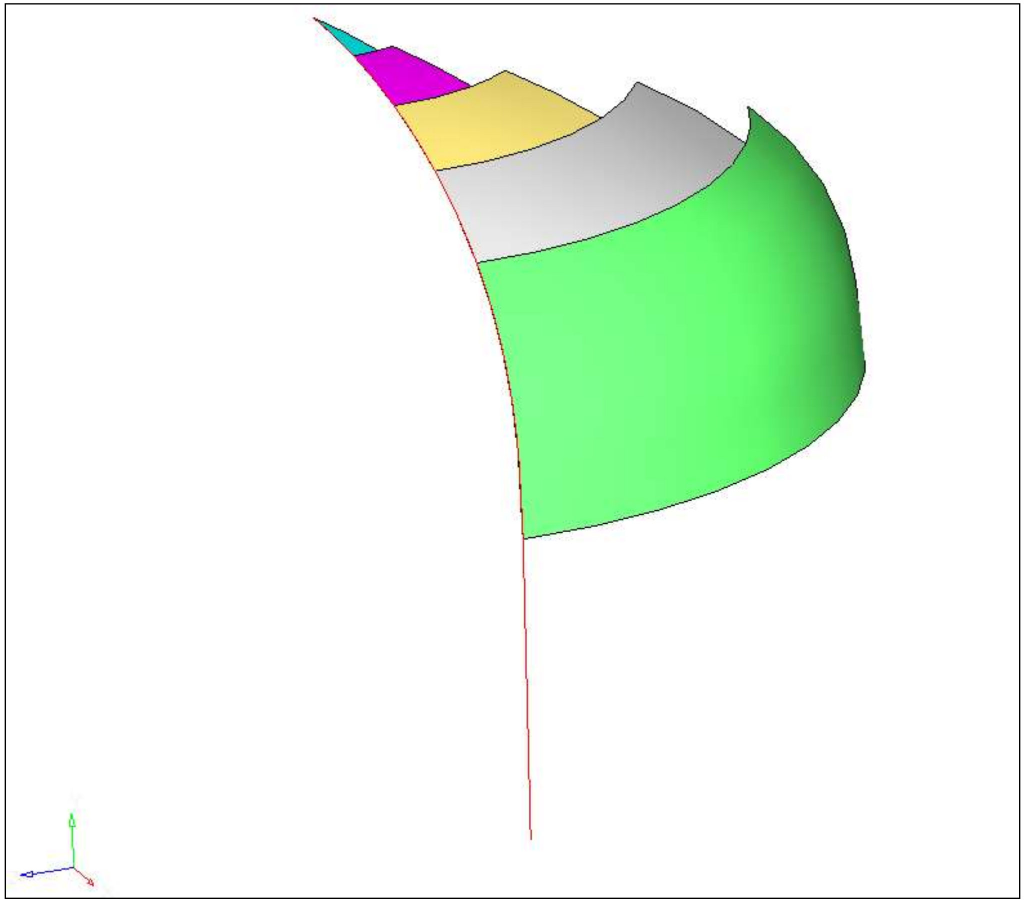


FIG. 8 – IGES profile examples

# PROCEDURE PRESENTATION ( cont. )

- **FEM analysis button allows the automatic execution of Finite Element Analyses**

- **FEM analysis is done by using Hypermesh and RADIOSS in batch mode**

- **Suitable command files are automatically written by the procedure and processed for the following operations:**

- **importing of IGES file containing the profile geometry**
- **generation of a revolving surface (right now based on fixed parameters )**
- **generation of Finite Element Model**
- **application of boundary conditions ( simmetry constraints and internal pressure )**
- **generation of input file suitable for Linear Static, Non-Linear Static or Buckling analyses**
- **run FE analysis**

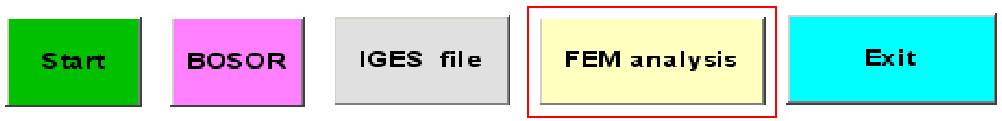



FIG. 9 – FEM analysis button

# PROCEDURE PRESENTATION ( cont. )

- **In order to perform Finite Element Analyses the user can choose among three different analysis types**

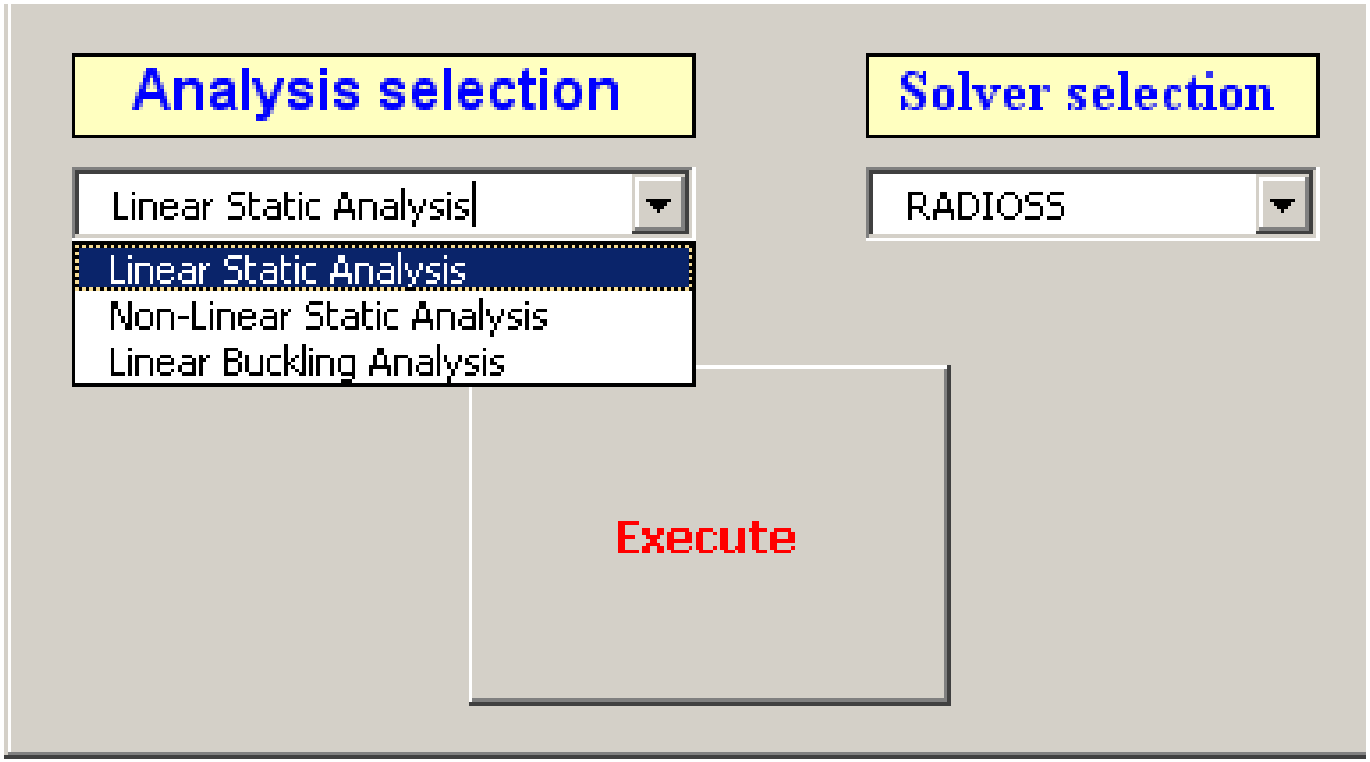



FIG. 10 – Windows for the choice of Finite Element Analysis

# PROCEDURE PRESENTATION ( cont.)

- Once FEM analysis is executed, the procedure allows results visualization for a quick evaluation. Examples of Buckling and Static analyses results are shown below.

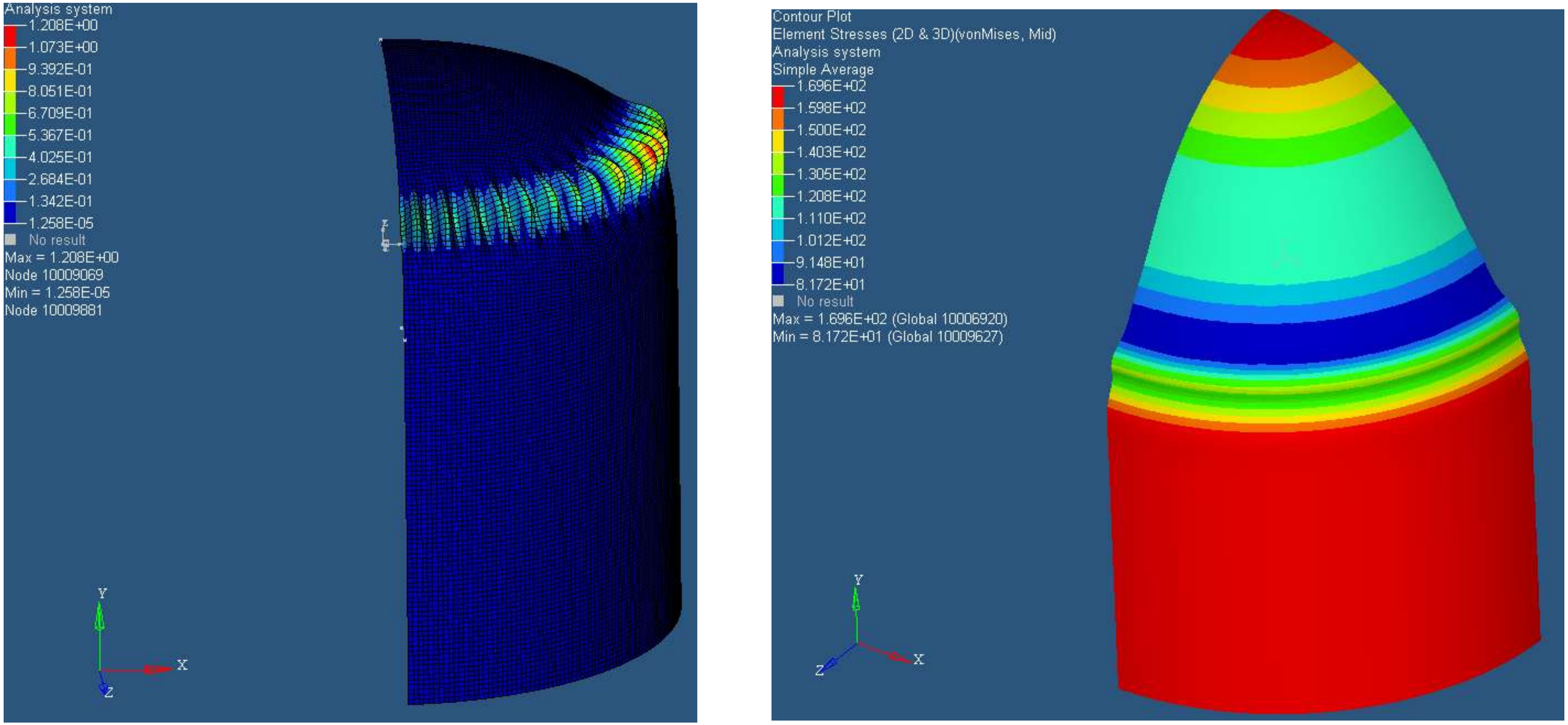



FIG. 11 – FEM Analyses results

# PROCEDURE PRESENTATION ( cont. )

- **Exit button allows to end the procedure**

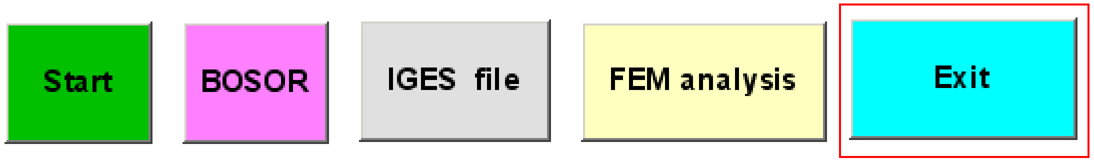



FIG. 12 – Exit command button

# PROCEDURE VALIDATION

- Validation of the procedure has been made by comparing analytical with numerical results obtained from a dedicatedFEM analysis
- In order to do this, a strip FEM model has been used

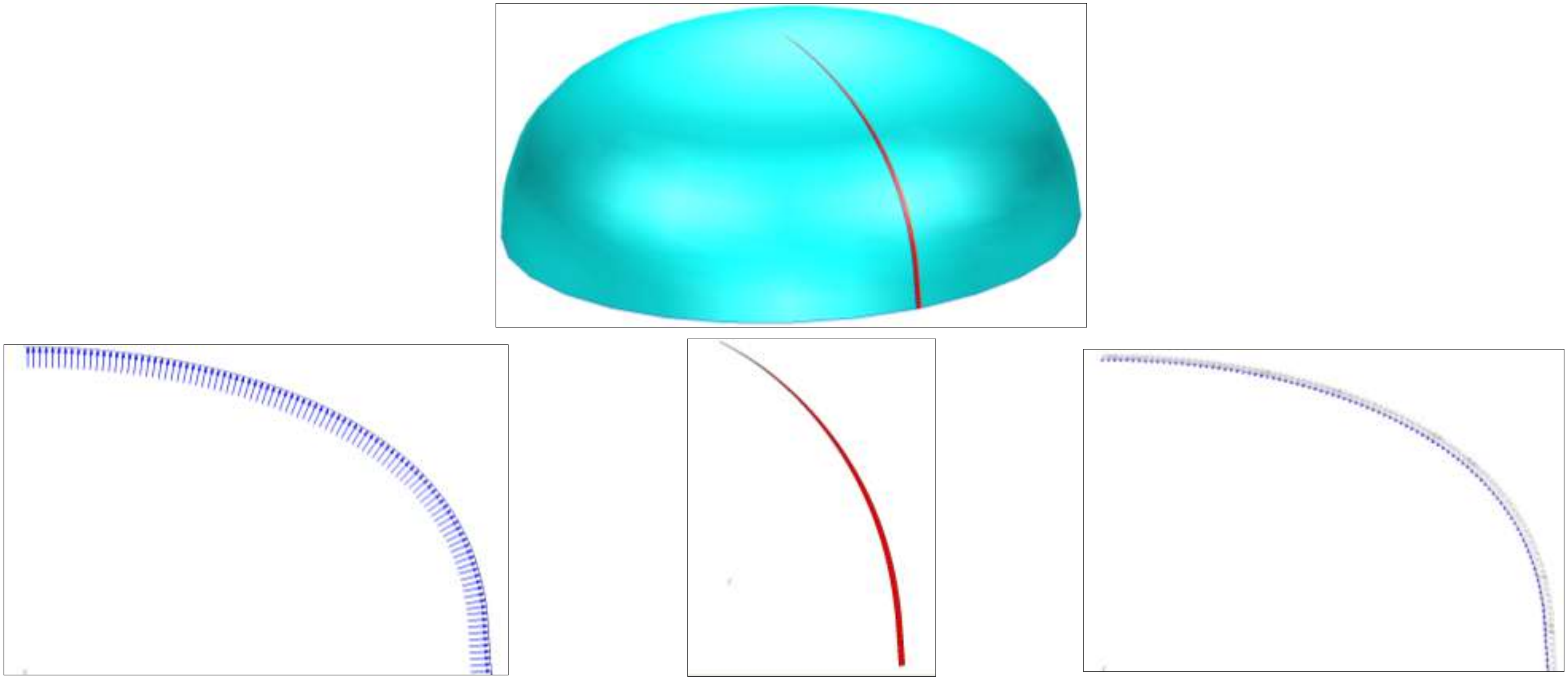
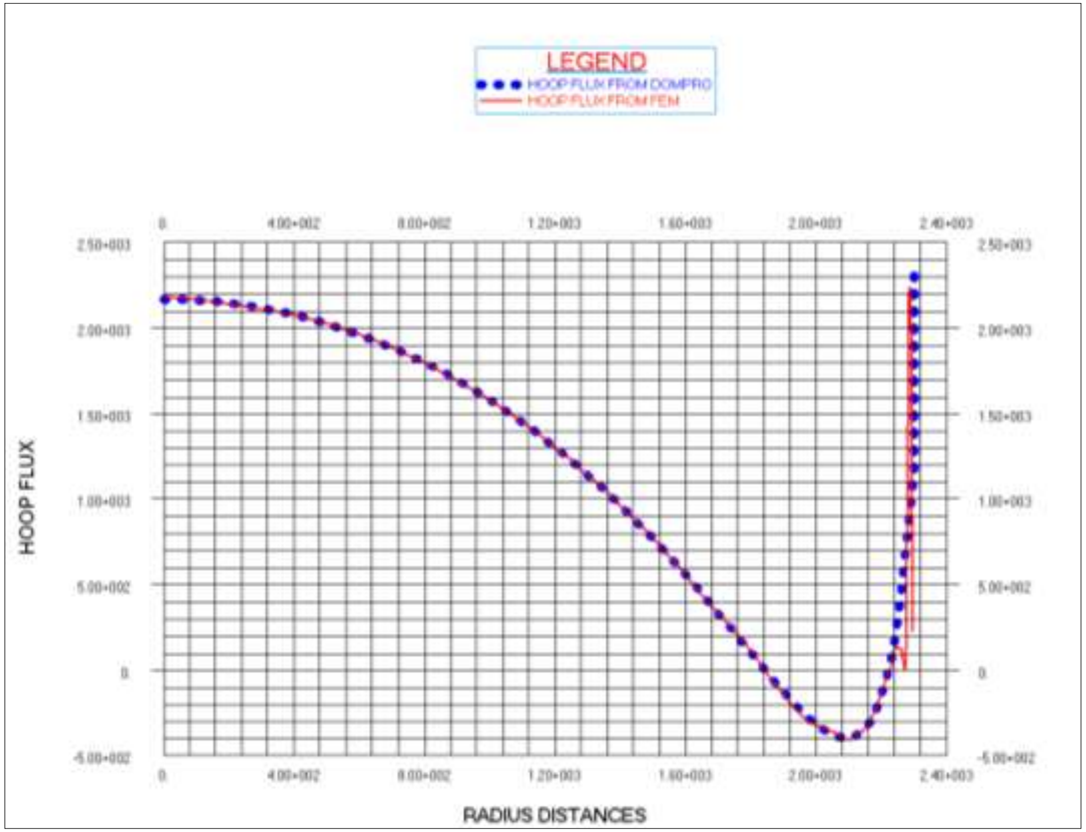


FIG. 13 – Pressurized Element strip FEM mode

# PROCEDURE VALIDATION ( cont. )

- **The comparison has been made bewtween the membrane fluxes ( meridian and hoop )**



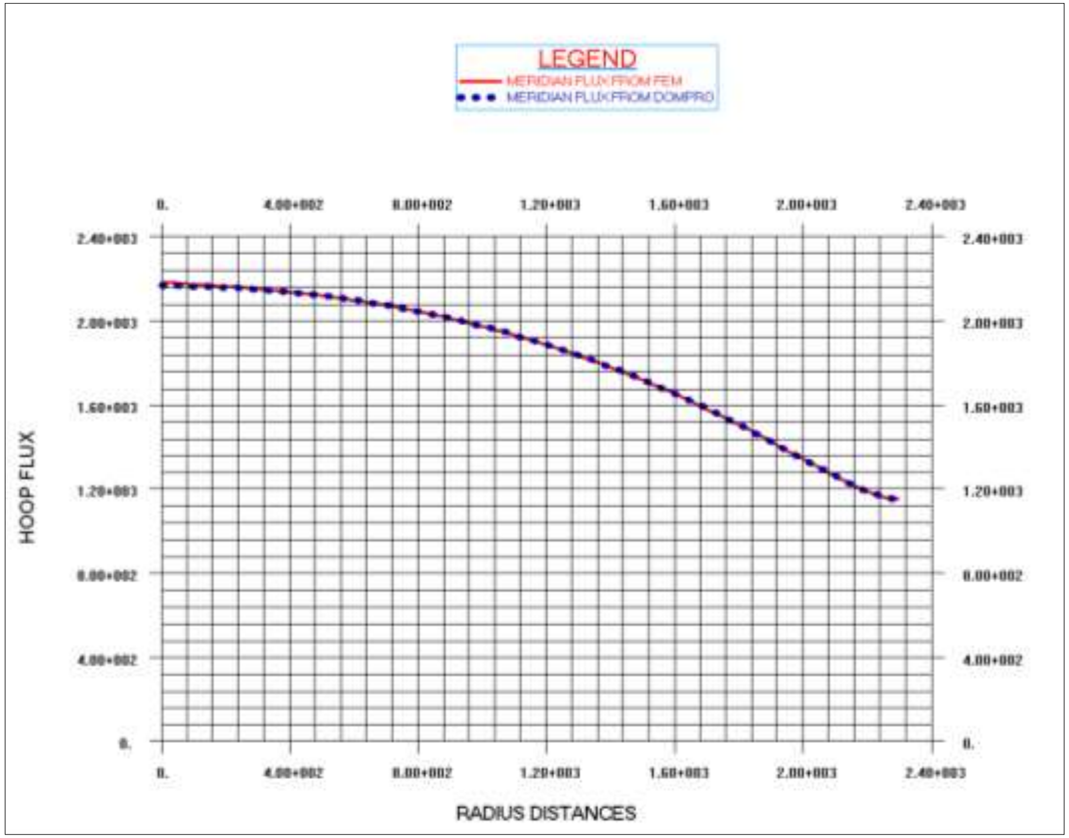




FIG. 14 – Membrane Meridian and Hoop fluxes comparison

# OPTIMIZATION WITH HYPERSTUDY

- The optimization relates the Cassinian family of dome profiles
- Coupling of HyperStudy with DOMPRO has been made to optimize equation parameters
- The equation which describes the Cassinian profiles is :

$$(x^2 + n^2 \cdot y^2)^2 + 2 \cdot m \cdot a^2 \cdot (x^2 - n^2 \cdot y^2) = a^4 \cdot (1 + 2 \cdot m)$$

- where :
  - a ➔ radius of pressurized element
  - m, n ➔ equation parameters

- The shape of the dome profile depends on the parameters value

- Usually, for some practical design assumptions, the ratio of " b/a " ( dome height to dome radius ratio ) is fixed or varying inside a range
- This ratio depends on the values of the equation parameters "m" and "n"
- Optimization is made to obtain the parameters value which corresponds to a minimum mass dome design, while respecting an imposed b/a ratio

# OPTIMIZATION WITH HYPERSTUDY ( cont. )

- **For this purpose DOMPRO procedure has been adapted to become suitable for its use inside HyperStudy**
- **Once HyperStudy is started  the following window appears**
- **In this window the user can then define the optimization variables**

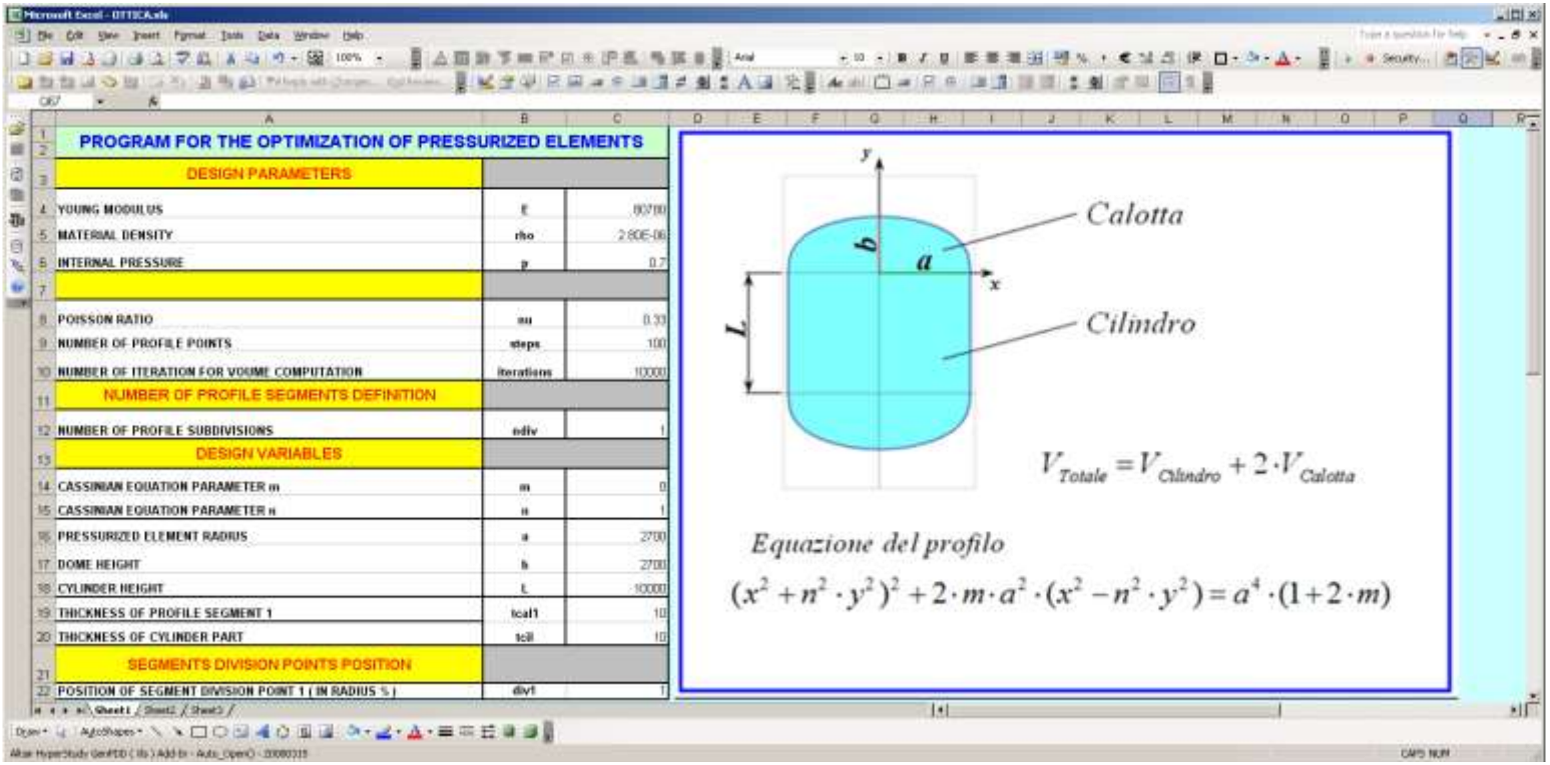



FIG. 15 –  Windows for Optimization

# OPTIMIZATION WITH HYPERSTUDY ( cont. )

- **The responses, the constraints and the optimization objective are defined in HyperStudy**
- **All computations are made by a VBA program named PROFILO which is defined into HyperStudy as the computational code**
- **This Optimization study has been made for the real case application shown in Figure 1**
- **The study and optimization set up are explained in next slides**

# OPTIMIZATION WITH HYPERSTUDY ( cont. )

- **Design variables : m, n, L ( equation parameters, total tank Length )**

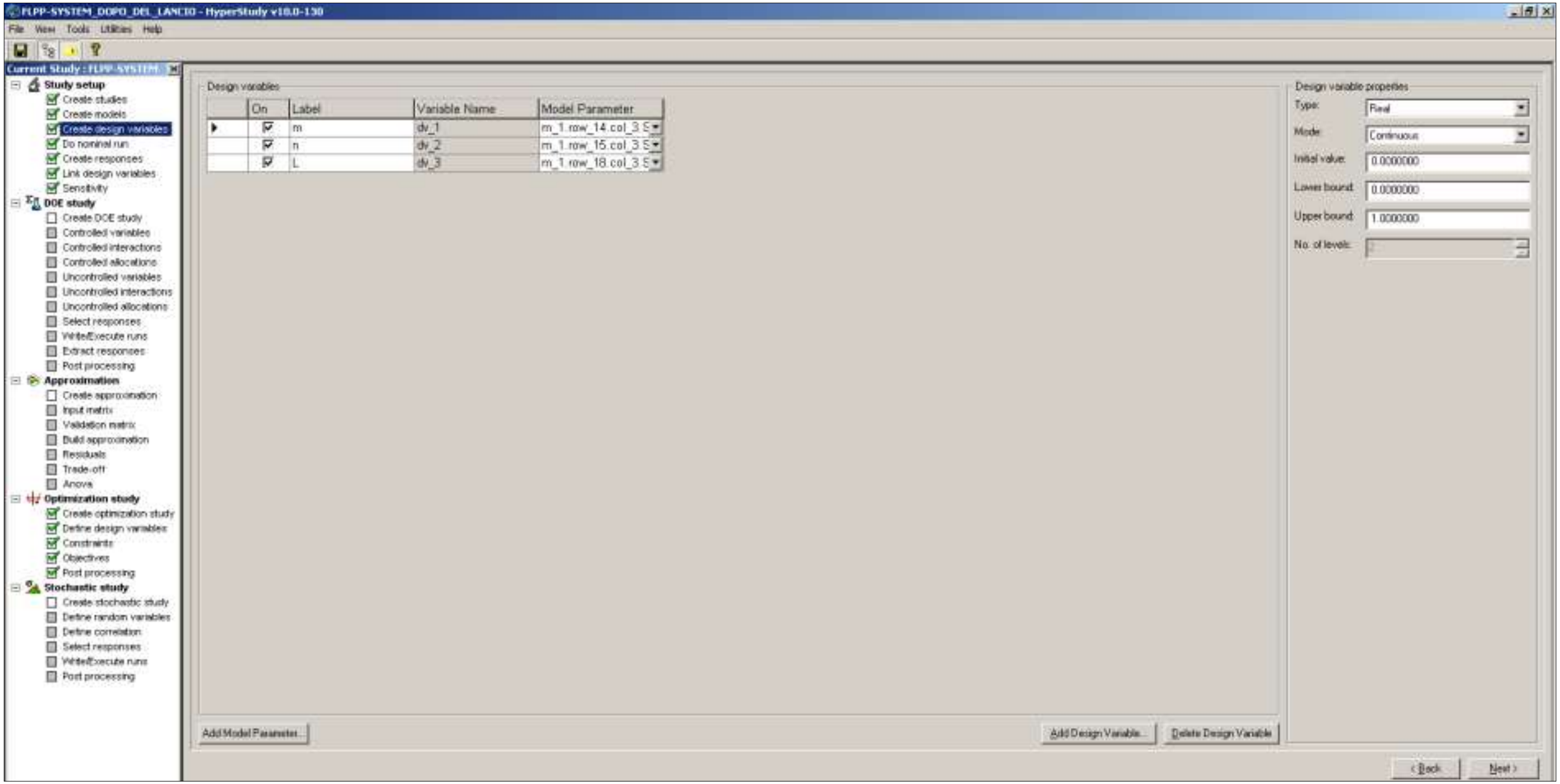



FIG. 16 – Design variables definition

# OPTIMIZATION WITH HYPERSTUDY ( cont. )

- **Responses : b/a, total tank Volume, total tank Mass**

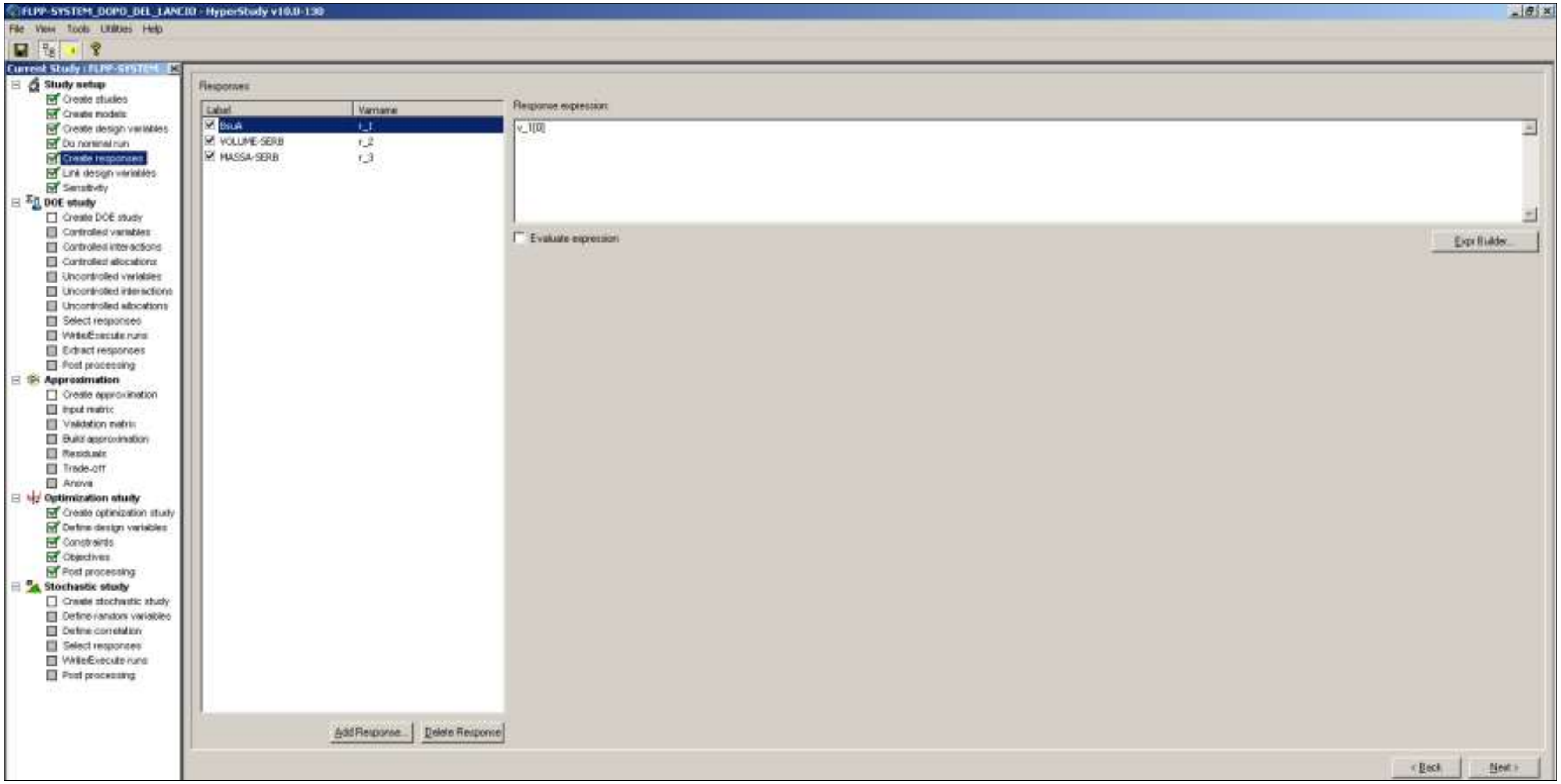



FIG. 17 – Design responses definition

# OPTIMIZATION WITH HYPERSTUDY ( cont. )

➢ **Design constraints: b/a, total tank Volume**

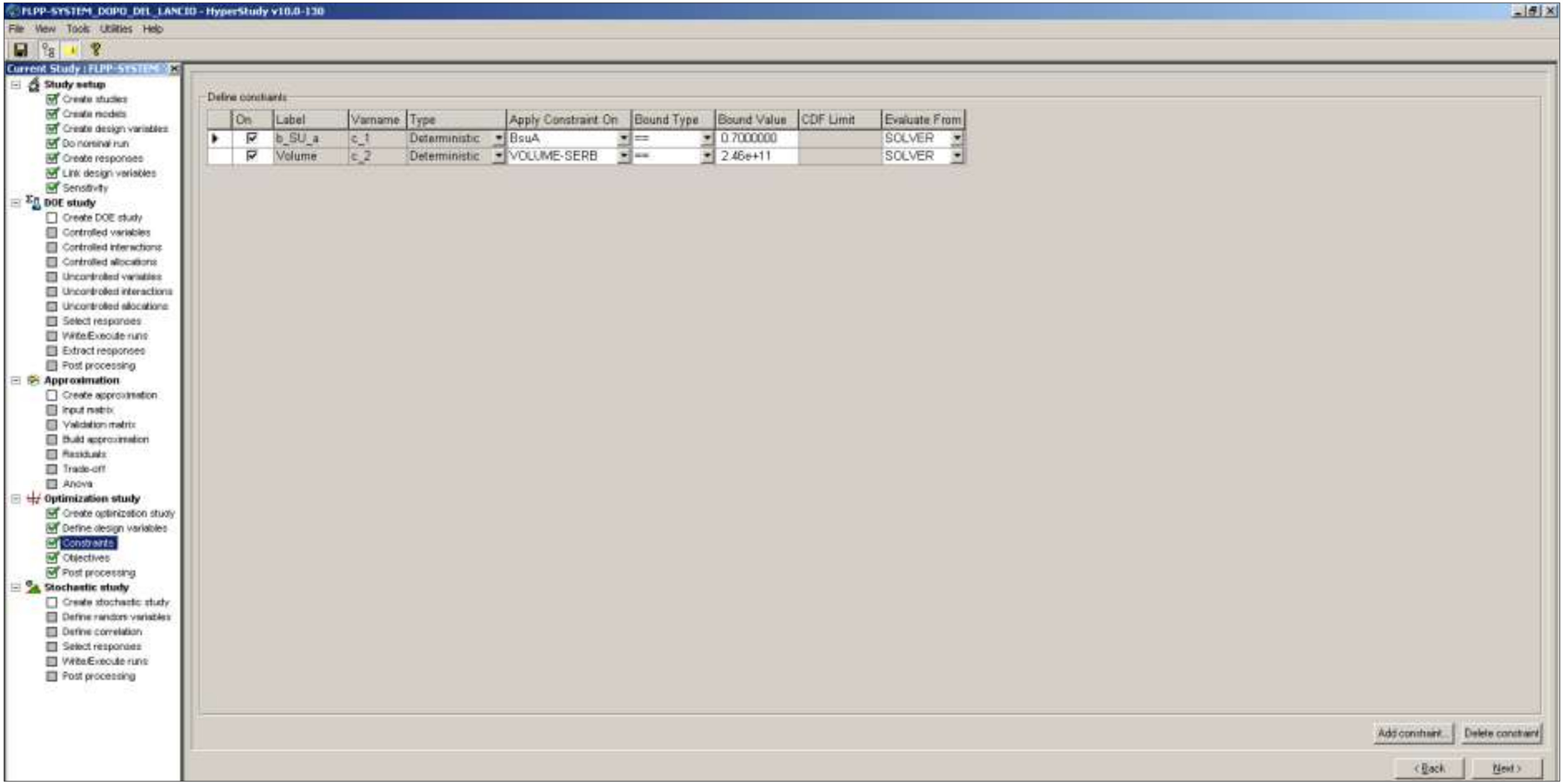



FIG. 18 – Design constraints definition

# OPTIMIZATION WITH HYPERSTUDY ( cont. )

➢ **Design objective: total tank Mass**

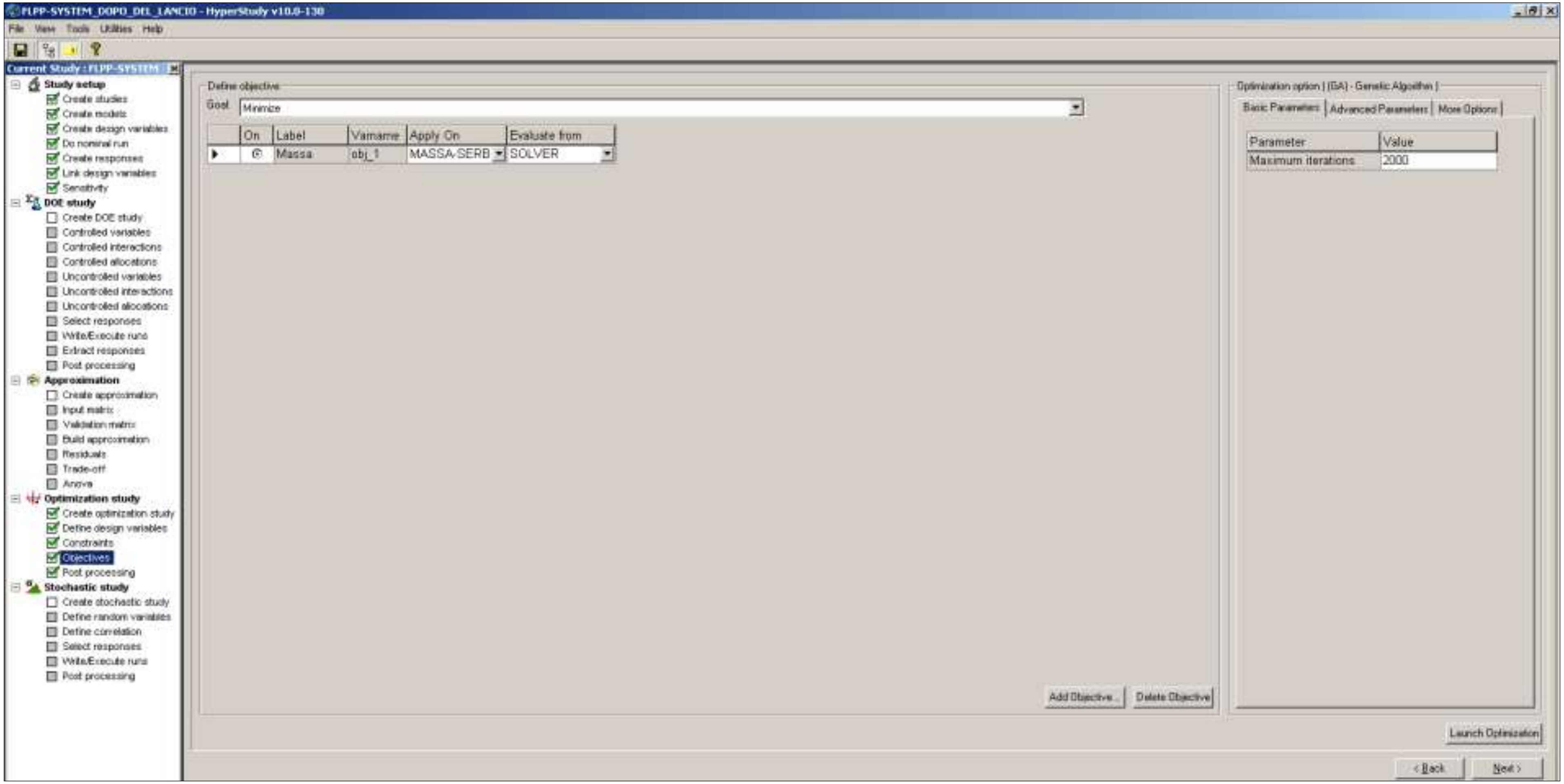



FIG. 19 – Design objective definition

# OPTIMIZATION WITH HYPERSTUDY ( cont. )

➢ **Optimization results : a converged solution has been obtained**

rent Study : FLPP-SYSTEM

- **Study setup**
  - ☑ Create studies
  - ☑ Create models
  - ☑ Create design variables
  - ☑ Do nominal run
  - ☑ Create responses
  - ☑ Link design variables
  - ☑ Sensitivity
- **DOE study**
  - ☐ Create DOE study
  - Controlled variables
  - Controlled interactions
  - Controlled allocations
  - Uncontrolled variables
  - Uncontrolled interactions
  - Uncontrolled allocations
  - Select responses
  - Write/Execute runs
  - Extract responses
  - Post processing
- **Approximation**
  - ☐ Create approximation
  - Input matrix

Optimization Iteration History Plot | Optimization Iteration History Table

| Iteration | Massa | b_SU_a | Volume | m | n | L | BsuA | VOLUME-SERB | MASSA-SERB |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 4614.8674 | 1.0000000 | 3.11e+11 | 0.0000000 | 1.0000000 | 10000.000 | 1.0000000 | 3.11e+11 | 4614.8674 |
| 2 | 3863.5088 | 0.7091900 | 2.47e+11 | 0.3753666 | 1.8657185 | 8156.8915 | 0.7091900 | 2.47e+11 | 3863.5088 |
| 3 | 4089.1919 | 0.6999300 | 2.43e+11 | 0.9413490 | 2.4257478 | 7753.1769 | 0.6999300 | 2.43e+11 | 4089.1919 |
| 4 | 4097.9635 | 0.6980300 | 2.44e+11 | 0.9257087 | 2.4191202 | 7814.7605 | 0.6980300 | 2.44e+11 | 4097.9635 |
| 5 | 4097.9635 | 0.6980300 | 2.44e+11 | 0.9257087 | 2.4191202 | 7814.7605 | 0.6980300 | 2.44e+11 | 4097.9635 |
| 6 | 4097.9635 | 0.6980300 | 2.44e+11 | 0.9257087 | 2.4191202 | 7814.7605 | 0.6980300 | 2.44e+11 | 4097.9635 |
| 7 | 3877.4763 | 0.6964100 | 2.47e+11 | 0.3440860 | 1.8657185 | 8197.9472 | 0.6964100 | 2.47e+11 | 3877.4763 |
| 8 | 3877.4763 | 0.6964100 | 2.47e+11 | 0.3440860 | 1.8657185 | 8197.9472 | 0.6964100 | 2.47e+11 | 3877.4763 |
| 9 | 3877.4763 | 0.6964100 | 2.47e+11 | 0.3440860 | 1.8657185 | 8197.9472 | 0.6964100 | 2.47e+11 | 3877.4763 |
| 10 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528751 | 1.8657185 | 8146.6376 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 11 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528751 | 1.8657185 | 8146.6376 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 12 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 13 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 14 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 15 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 16 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 17 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 18 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 19 | 3859.2909 | 0.7000200 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000200 | 2.46e+11 | 3859.2909 |
| 20 | 3859.2874 | 0.7000300 | 2.46e+11 | 0.3528837 | 1.8657185 | 8146.6276 | 0.7000300 | 2.46e+11 | 3859.2874 |

FIG. 20 – Optimization history table

# CONCLUSION

- DOMPRO procedure presented in this work shows the possibility of analyzing pressurized elements in a simple and rapid way
- Benefits derive from coupling different software (Hypermesh, RADIOSS, BOSOR) and from their use in batch mode
- Coupling DOMPRO with Hyperstudy seems to be very promising for the optimization of pressurized elements
- Future developments of DOMPRO are foreseen, as :
  - differentiate solvers for FEM non linear analyses (i.e. Abaqus)
  - complete automatic output reporting
  - Insert the procedure in a more complete Automated Analytical Tool for the Conceptual phase of the pressurized elements design

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