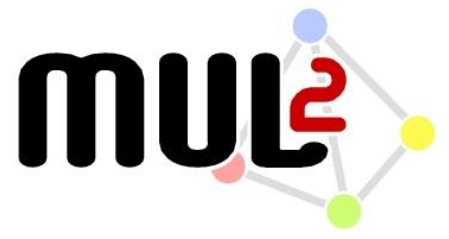


Dynamic Stiffness Analysis of Advanced Beams (DySAAB)

A. Pagani, 2014

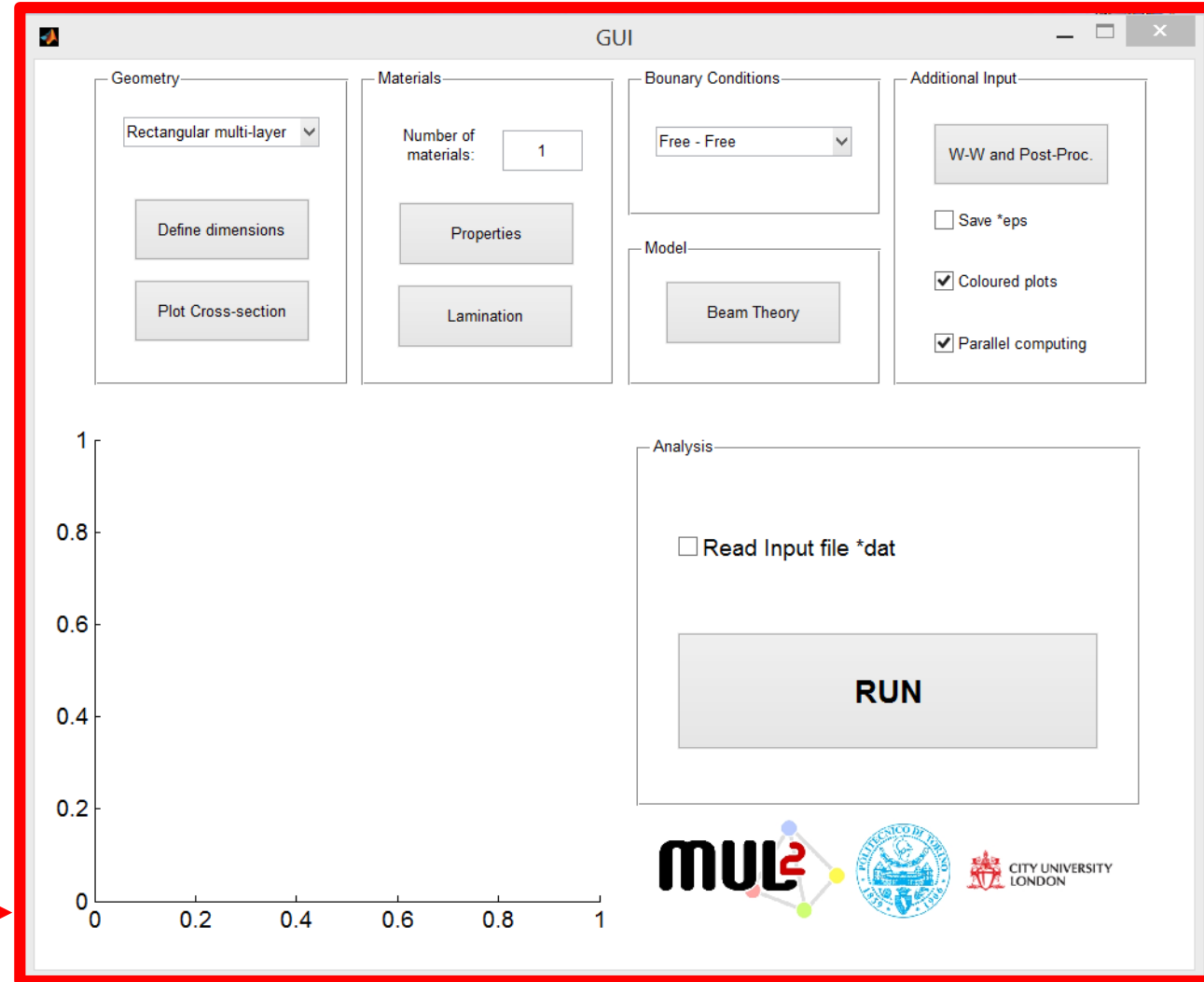


The DySAAB Graphical User Interface (GUI)

DySAAB GUI



Console Application



DySAAB

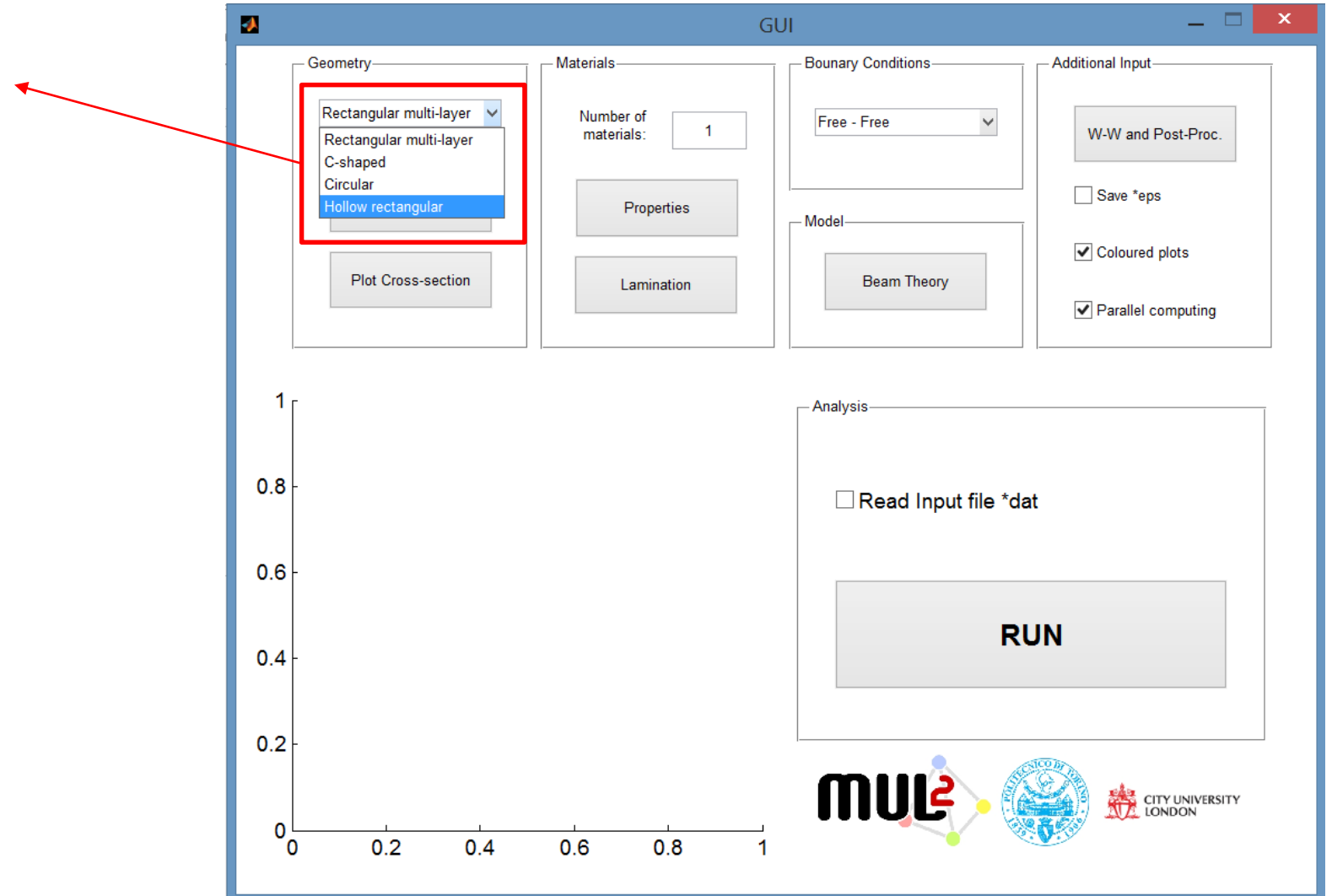
DySAAB GUI

STEP 1 - Geometry

1.1 Define the cross-section

At the moment, only rectangular, C-shaped, circular and box cross-sections can be analysed. Multi-layered orthotropic cross-section can only be used in the case of rectangular section beams.

The possibility to deal with arbitrary geometries will be implemented in the second part of this year.



DySAAB GUI

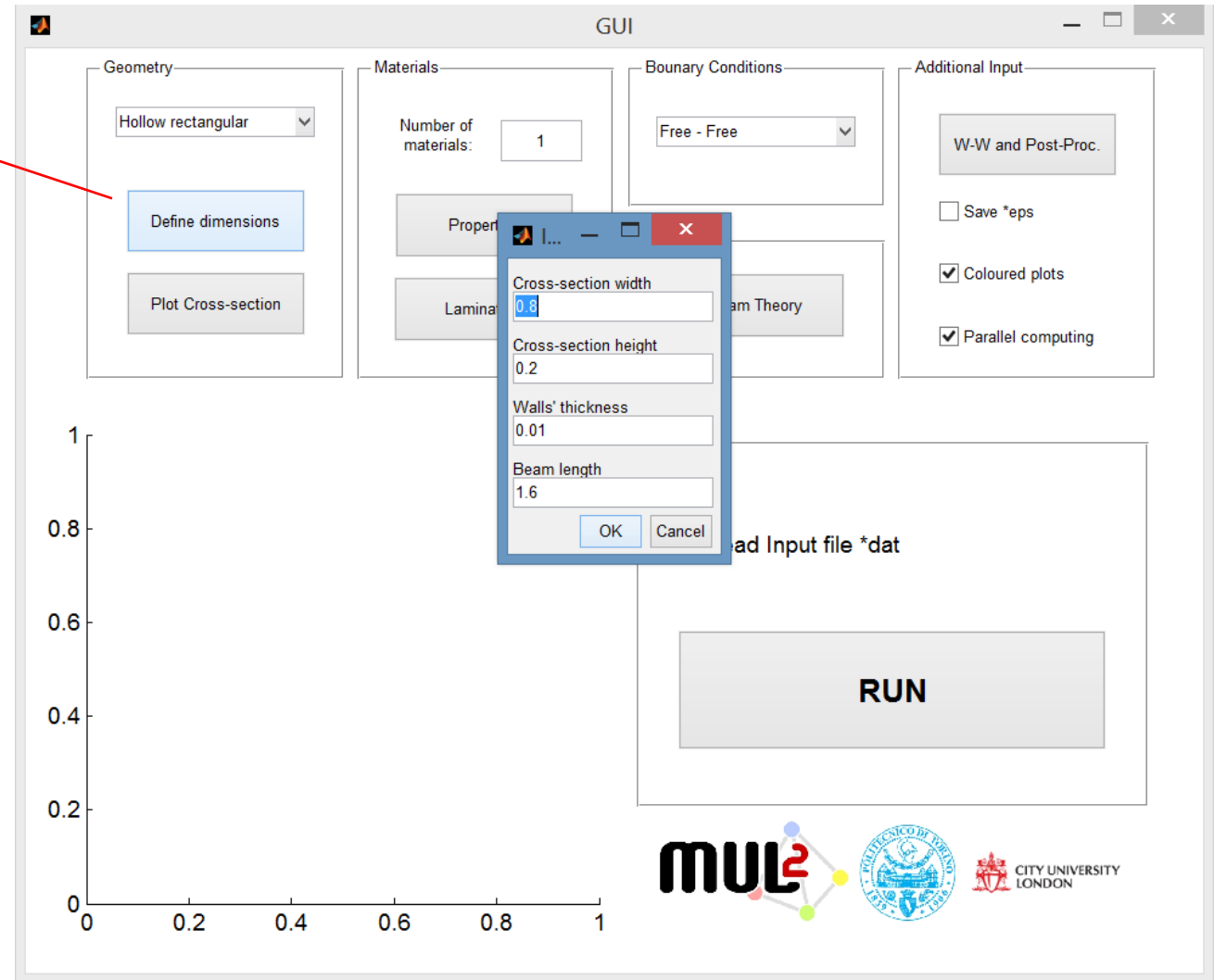
STEP 1 - Geometry

1.2 Push “*Define dimensions*” button

A new window appears. The format of the window depends on the cross-section type. In this example a box beam is selected.

1.3 Enter the geometry properties of the beam

Press OK to confirm.



DySAAB GUI

STEP 1 - Geometry

1.4 Push “*Plot Cross-section*” button

This is necessary to acquire the geometry of the beam. The cross-section is drawn in the window below in order to let the user check the input.



DySAAB GUI

STEP 2 - Material

2.1 Enter the number of different materials

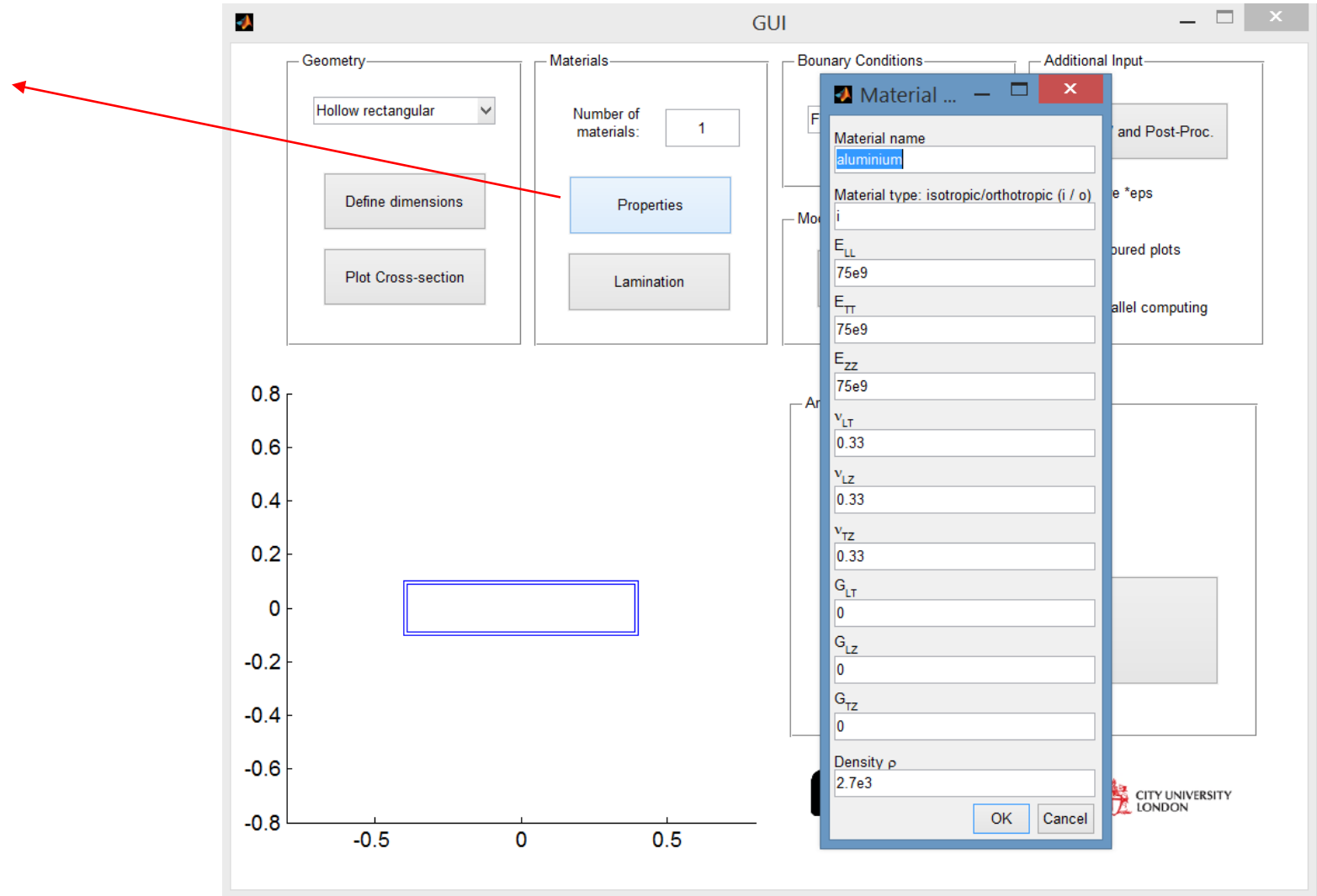
The screenshot displays the DySAAB GUI interface. The 'Materials' section is highlighted with a red box, and a red arrow points from the text '2.1 Enter the number of different materials' to the 'Number of materials' input field, which contains the value '1'. The 'Materials' section includes buttons for 'Properties' and 'Lamination'. Other sections include 'Geometry' (with a dropdown set to 'Hollow rectangular' and buttons for 'Define dimensions' and 'Plot Cross-section'), 'Boundary Conditions' (dropdown set to 'Free - Free'), 'Additional Input' (checkboxes for 'Save *eps', 'Coloured plots', and 'Parallel computing'), 'Model' (button for 'Beam Theory'), and 'Analysis' (checkbox for 'Read Input file *dat' and a large 'RUN' button). A plot at the bottom left shows a hollow rectangular cross-section on a coordinate system. Logos for MUL, Politecnico di Torino, and City University London are visible at the bottom right.

DySAAB GUI

STEP 2 - Material

2.2 Push the “Properties” button

Enter the material name and properties in the new windows. Press OK to confirm.



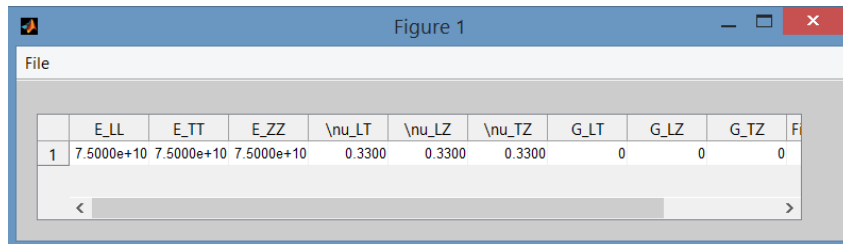
DySAAB GUI

STEP 2 - Material

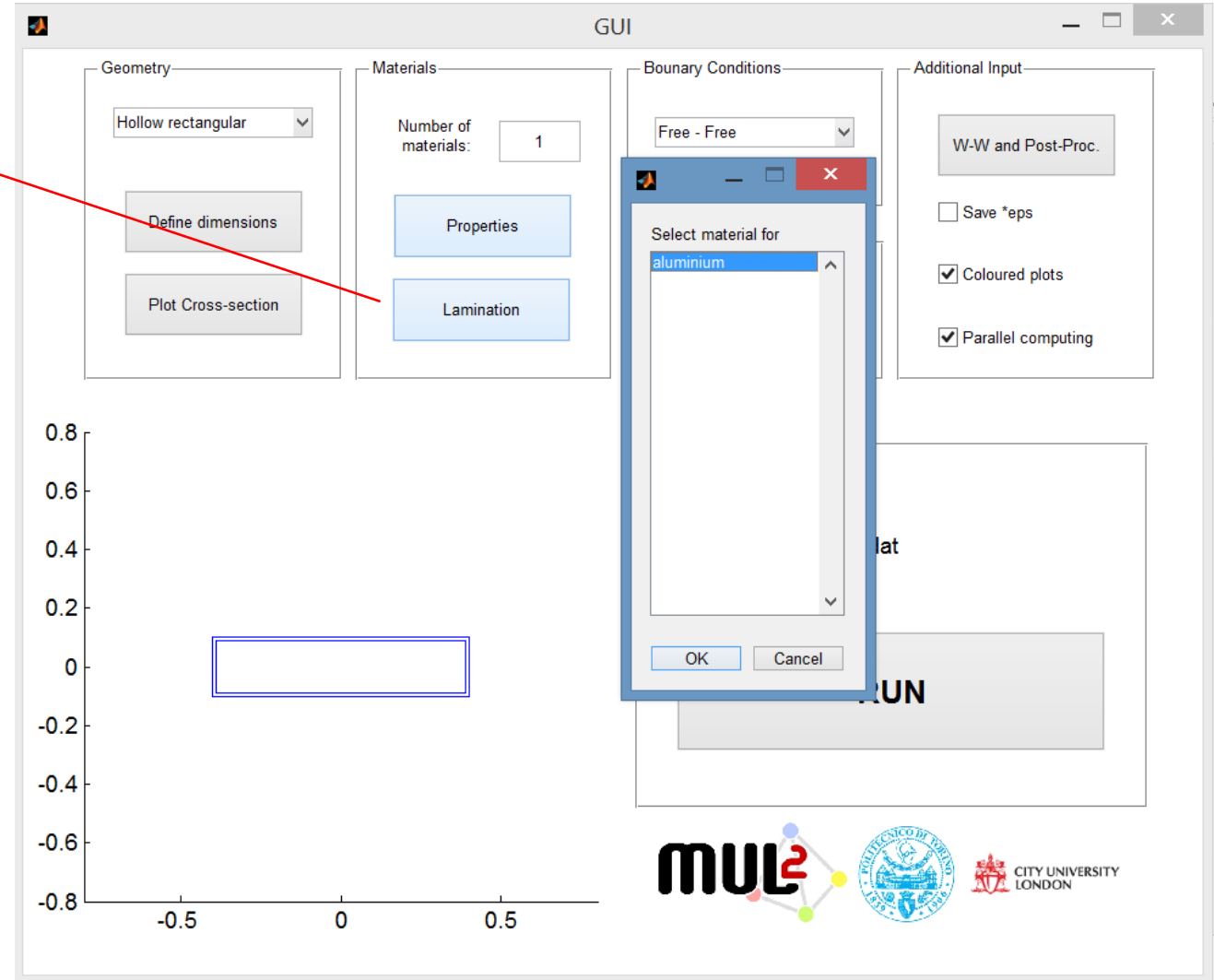
2.3 Push the ‘Lamination’ button

This window is necessary to define the lamination, i.e. stacking sequence and material composition on the cross-section. In this case an isotropic aluminium material is considered. So, select it and press OK.

A new window appears. This window is useful to check the input. You can close the window after checking.



| | E_LL | E_TT | E_ZZ | \nuu_LT | \nuu_LZ | \nuu_TZ | G_LT | G_LZ | G_TZ | F |
|---|------------|------------|------------|---------|---------|---------|------|------|------|---|
| 1 | 7.5000e+10 | 7.5000e+10 | 7.5000e+10 | 0.3300 | 0.3300 | 0.3300 | 0 | 0 | 0 | |



The GUI window is titled 'GUI' and contains several sections:

- Geometry:** A dropdown menu set to 'Hollow rectangular', and buttons for 'Define dimensions' and 'Plot Cross-section'.
- Materials:** A text field for 'Number of materials' set to '1', and buttons for 'Properties' and 'Lamination'.
- Boundary Conditions:** A dropdown menu set to 'Free - Free'.
- Additional Input:** A button for 'W-W and Post-Proc.', and checkboxes for 'Save *.eps', 'Coloured plots', and 'Parallel computing'.
- Plot:** A 2D plot showing a hollow rectangular cross-section with a width of approximately 0.3 and a height of approximately 0.1, centered at the origin of a coordinate system ranging from -0.5 to 0.5 on the x-axis and -0.8 to 0.8 on the y-axis.
- Dialog Box:** A 'Select material for' dialog box is open, showing a list with 'aluminium' selected. It has 'OK' and 'Cancel' buttons.

Logos for MUL², the University of Bristol, and City University London are visible at the bottom right of the GUI window.

DySAAB GUI

STEP 3 – Boundary Conditions

Select the end-to-end boundary conditions you want to use.

The screenshot displays the DySAAB GUI interface. The 'Boundary Conditions' dropdown menu is open, showing options: 'Free - Free', 'Free - Free', 'Clamped - Free' (highlighted), 'Clamped - Clamped', and 'Simply Supported'. A red arrow points from the text 'Select the end-to-end boundary conditions you want to use.' to the 'Clamped - Free' option. The GUI also shows a 'Geometry' section with 'Hollow rectangular' selected, a 'Materials' section with 'Number of materials: 1', and an 'Analysis' section with a 'RUN' button. A plot at the bottom left shows a hollow rectangular cross-section on a coordinate system with x-axis from -0.5 to 0.5 and y-axis from -0.8 to 0.8. Logos for MUL, Politecnico di Torino, and City University London are visible at the bottom right.

DySAAB GUI

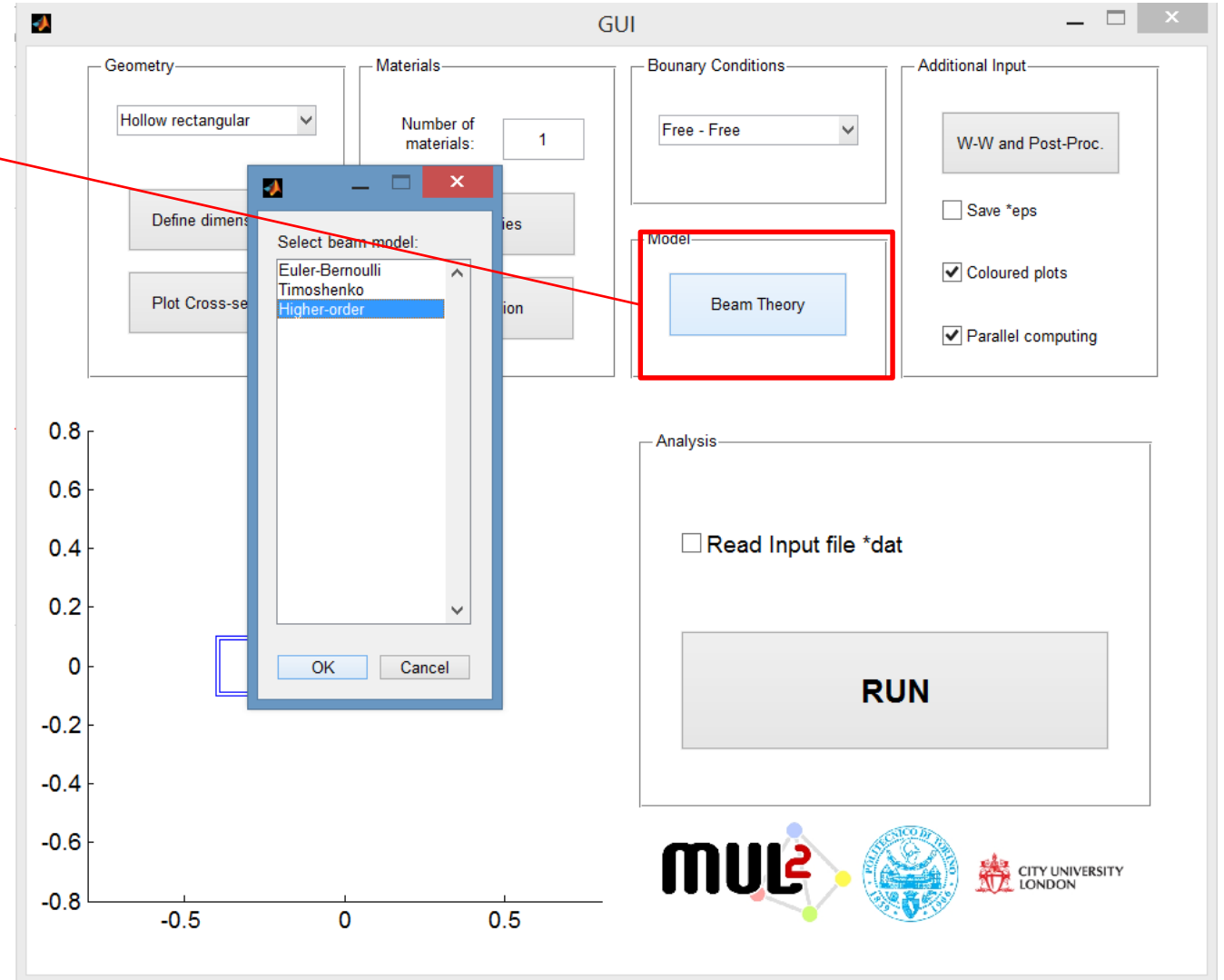
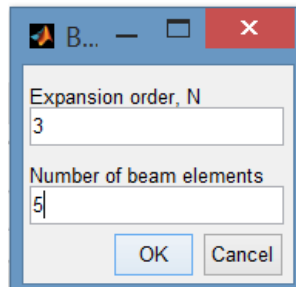
STEP 4 – Model

4.1 Push the “Beam Theory” button

4.2 In the new window, select the beam theory you want to use

User can choose among Euler-Bernoulli and Timoshenko classical beam theories and higher-order TE CUF models.

If “Higher-order” is chosen, the following window opens. Select the theory order N and the number of DS elements.

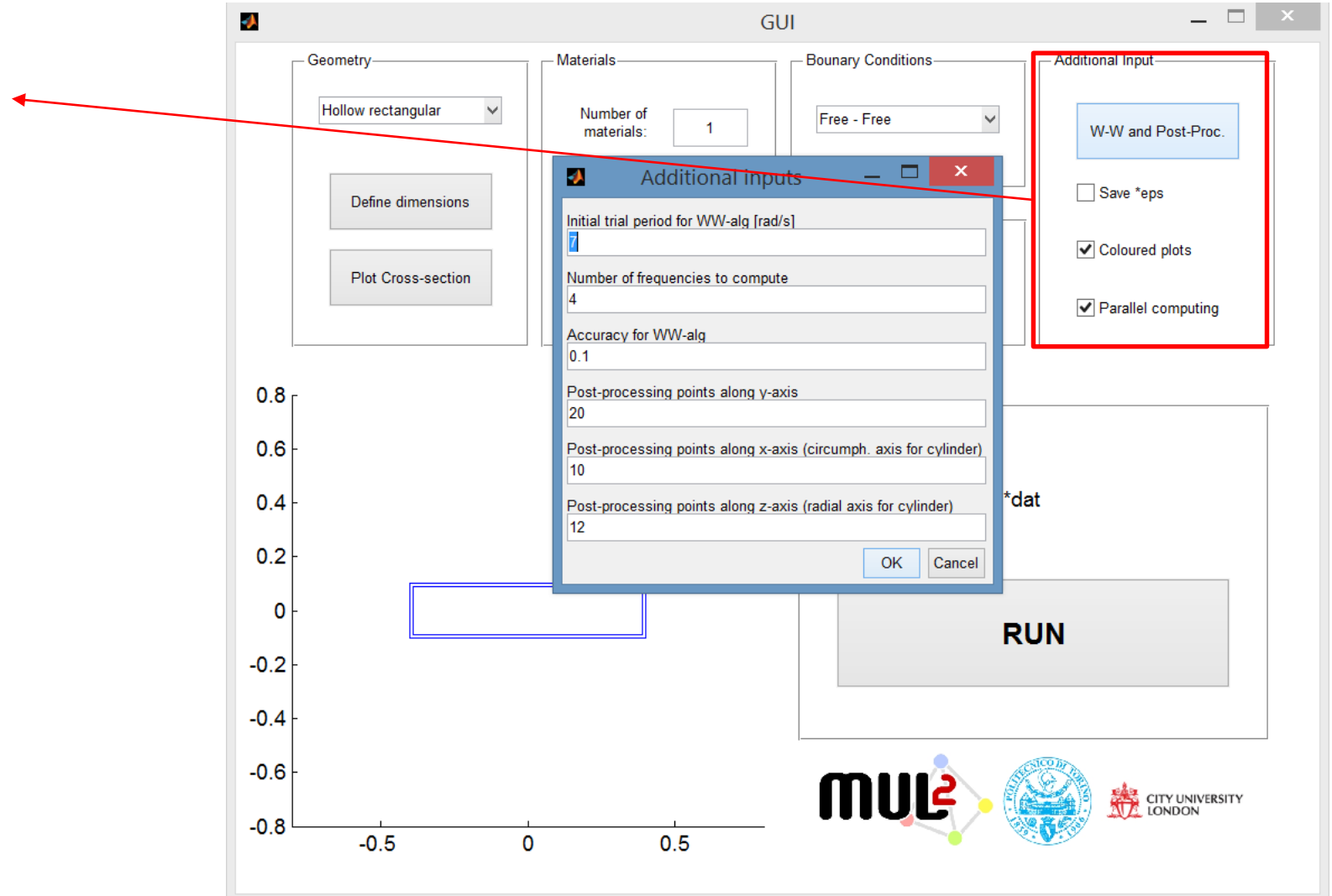


DySAAB GUI

STEP 5 – Additional Input

5.1 Push the “W-W and Post-Proc.” button

In the new window that opens, some input regarding the W-W algorithm and post-processing have to be specified. Press OK to confirm.



DySAAB GUI

STEP 5 – Additional Input

5.2 Tick or un-tick “save *.eps”

If activated, the modes are automatically saved as images in .eps format into the result folder. Anyway, modes are saved in a single .gmsb interactive file.

5.3 Tick or un-tick “Coloured plots”

If activated, the modes are shown and saved in colour. Otherwise, b/w scale is used.

5.4 Tick or un-tick “Parallel computing”

Activate to run in parallel computation mode.



DySAAB GUI

STEP 6 – Run Analysis

Press “RUN” button to run analysis

Analysis progress is shown in the Console Application

```
C:\Users\Alfonso\Desktop\DySAAB\DySAABv6.2_exe\DySAAB.exe - - - - -  
Dynamic Stiffness Analysis of Advanced Beams (DySAAB)  
- Free Vibration Analysis -  
- - - - -  
Starting matlabpool using the 'local' profile ...
```

The screenshot shows the DySAAB GUI with the following settings:

- Geometry:** Hollow rectangular (dropdown), Define dimensions, Plot Cross-section
- Materials:** Number of materials: 1, Properties, Lamination
- Boundary Conditions:** Free - Free (dropdown)
- Model:** Beam Theory (button)
- Additional Input:** W-W and Post-Proc. (button), Save *.eps (checkbox), Coloured plots (checkbox, checked), Parallel computing (checkbox, checked)
- Analysis:** Read Input file *.dat (checkbox), RUN (button)

A plot shows a hollow rectangular cross-section with a blue outline. The x-axis ranges from -0.5 to 0.5, and the y-axis ranges from -0.8 to 0.8. The beam is centered at x=0 and y=0.

Logos for MUL2, Politecnico di Milano, and City University London are visible at the bottom right.

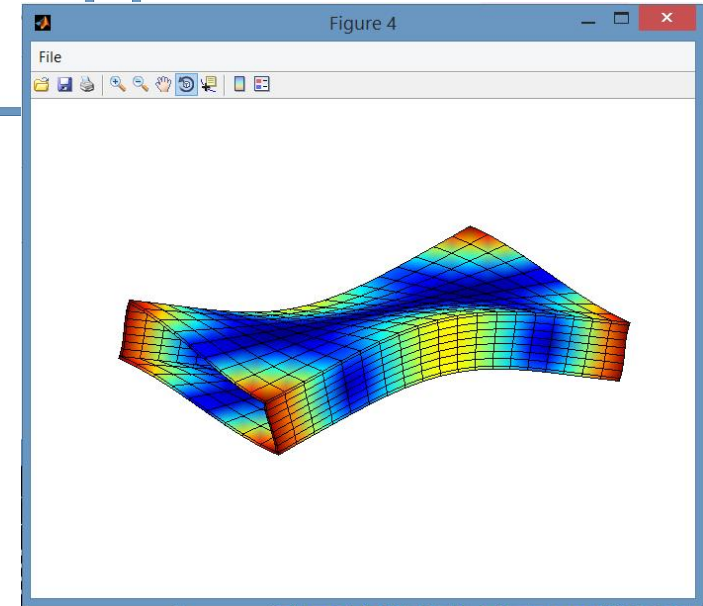
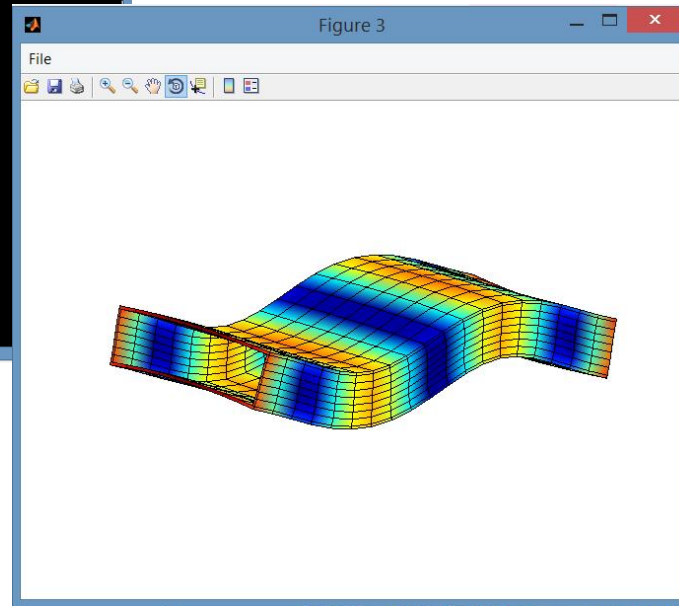
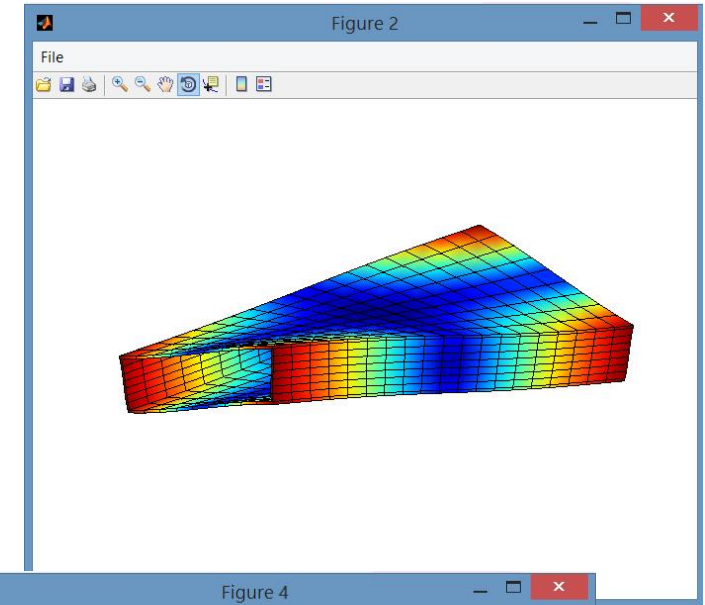
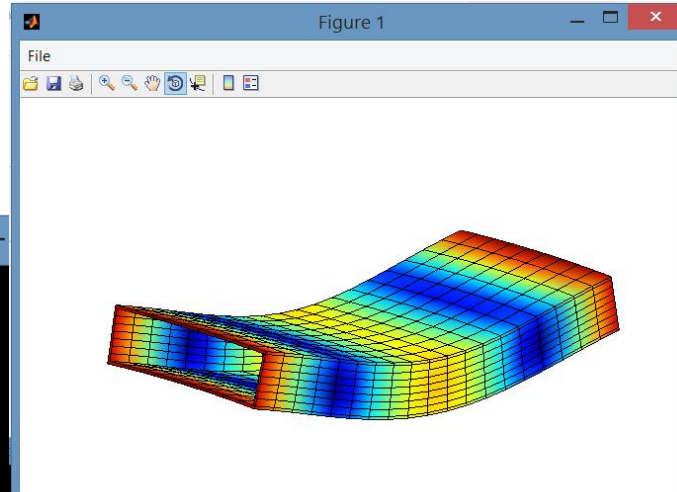
DySAAB GUI

```
C:\Users\Alfonso\Desktop\DySAAB\DySAABv6.2_exe\DySAAB.exe

W-W algorithm parameters:
  initial trial omega: 7
                    accuracy: 0.1
  required frequencies: 4

Post-Processing parameters:
  post-points along y: 20
  post-points along x: 10
  post-points along z: 12

COMPUTING CROSS-SECTION INTEGRALS...
----> OK (2.2592 s)
COMPUTING MATERIAL COEFFICIENTS...
----> OK (0.033915 s)
COMPUTING NATURAL FREQUENCIES...
  Frequency 1 computed: 508.5405 Hz
  Frequency 2 computed: 558.5176 Hz
  Frequency 3 computed: 994.908 Hz
  Frequency 4 computed: 1016.1017 Hz
----> OK (2.8774 s)
COMPUTING MODES AND SAVING RESULTS...
----> OK (6.0667 s)
Sending a stop signal to all the workers ... stopped.
```



DySAAB GUI – Laminated beam

STEP 1 - Geometry

The screenshot shows the DySAAB GUI interface for a laminated beam analysis. The main window is titled "GUI" and contains several panels:

- Geometry:** Includes a dropdown menu set to "Rectangular multi-layer", a "Define dimensions" button, and a "Plot Cross-section" button.
- Materials:** Includes a "Number of materials" input field set to "1". A dialog box is open over this panel, showing input fields for:
 - Cross-section width: 0.2
 - Cross-section height: 0.2
 - Number of layers: 4
 - Beam length: 2and an "OK" button.
- Boundary Conditions:** Includes a dropdown menu set to "Free - Free".
- Additional Input:** Includes a "W-W and Post-Proc." button, a "Save *eps" checkbox, a "Coloured plots" checkbox (checked), and a "Parallel computing" checkbox (checked).
- Model:** Includes a "Beam Theory" button.
- Analysis:** Includes a "Read Input file *dat" checkbox.

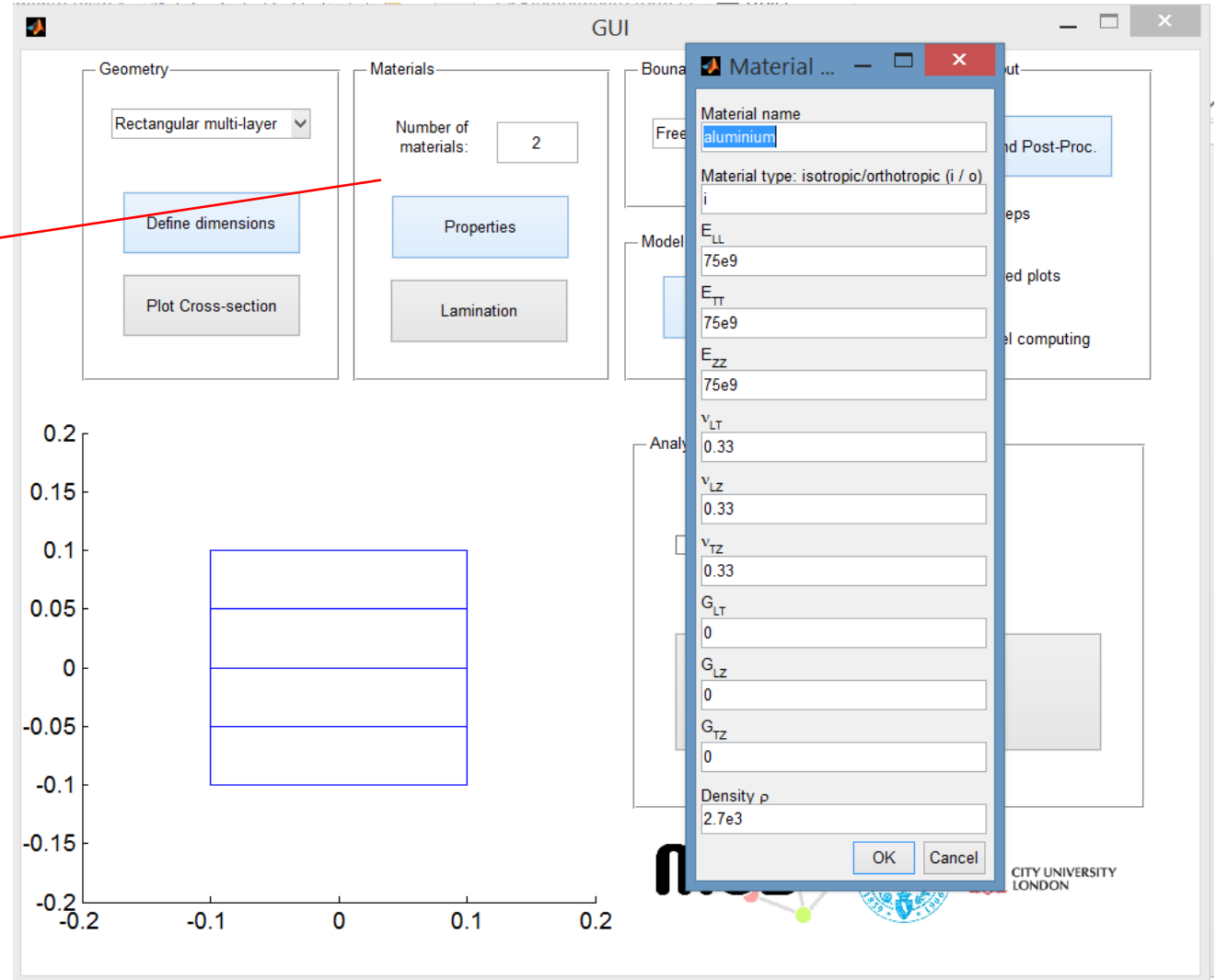
A red arrow points from the text "STEP 1 - Geometry" to the "Define dimensions" button in the Geometry panel. Below the panels is a plot showing the cross-section of the beam, which is a rectangle with a width of 0.2 and a height of 0.2, divided into four horizontal layers. The plot axes range from -0.2 to 0.2 on both the x and y axes.

At the bottom right of the GUI, there are logos for MUL2, the University of Derby, and City University London.

DySAAB GUI – Laminated beam

STEP 2 – Material

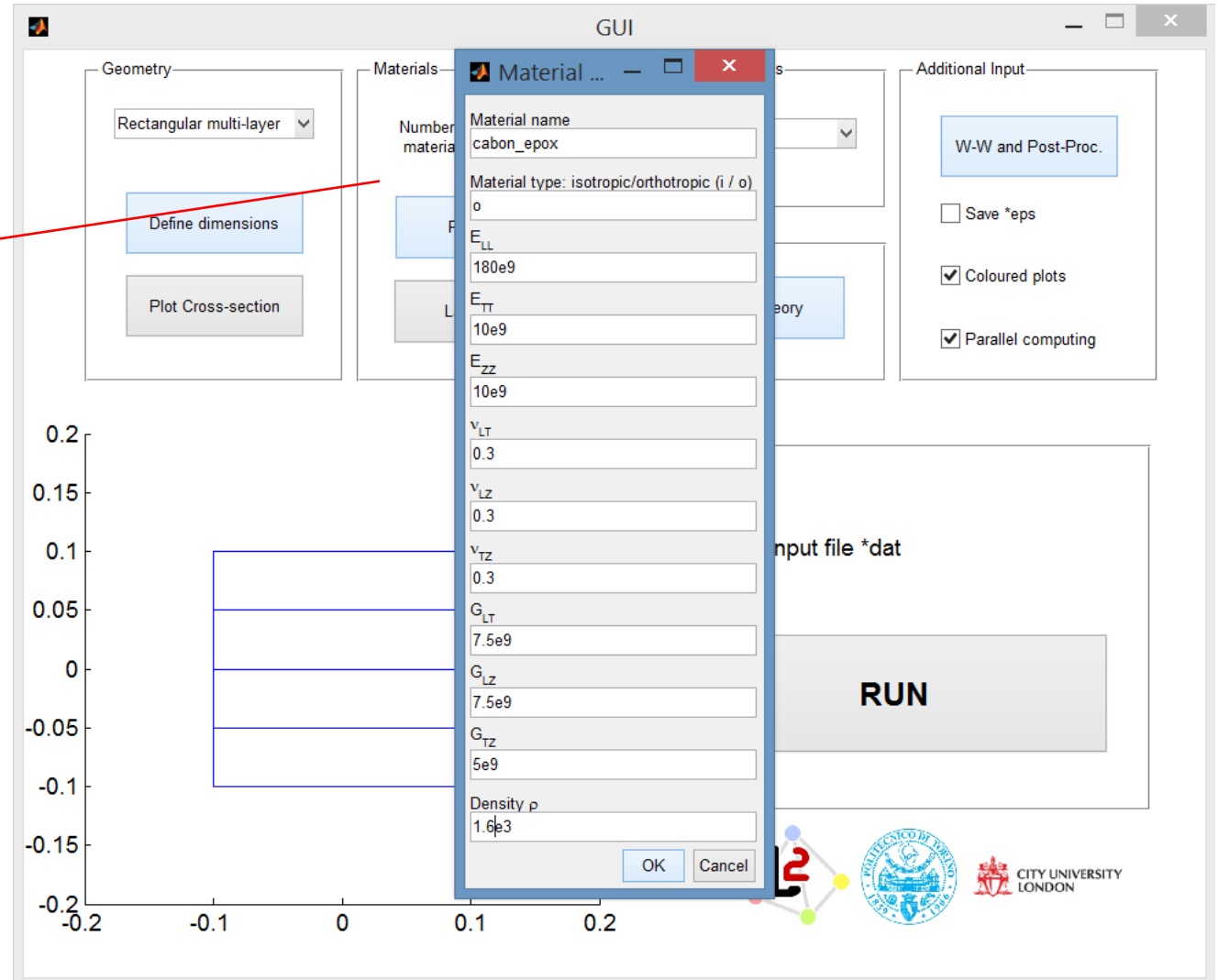
Define material 1, aluminium



DySAAB GUI – Laminated beam

STEP 2 – Material

Define material 2, carbon_epox

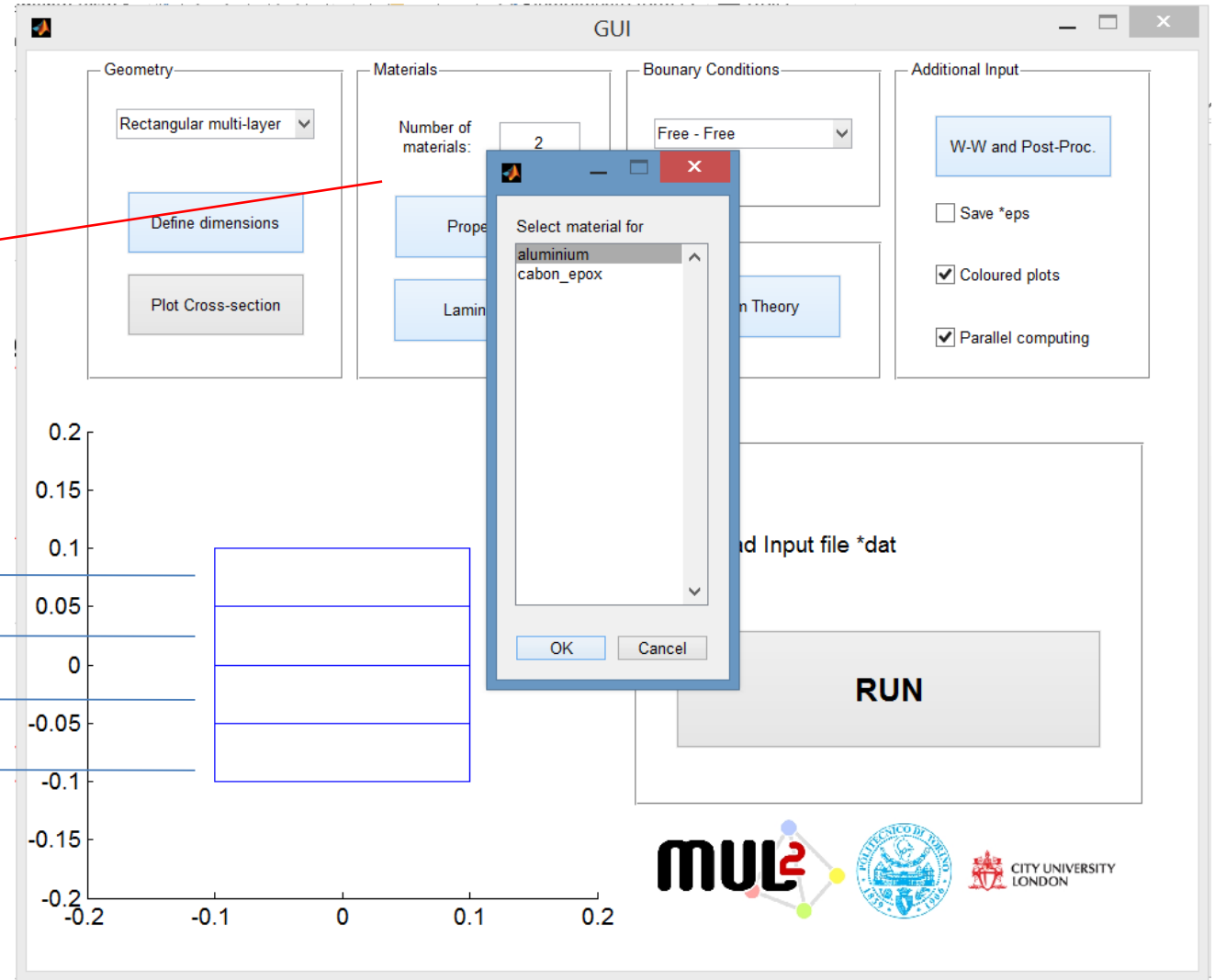


DySAAB GUI – Laminated beam

STEP 2 – Material

Lamination: define the material for layer 1

aluminium
carbon_epox (-45°)
carbon_epox (45°)
aluminium

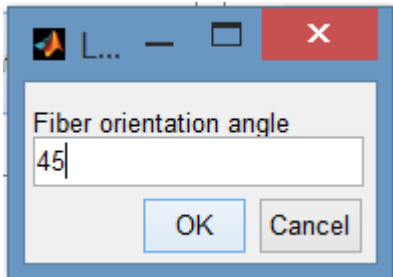


DySAAB GUI – Laminated beam

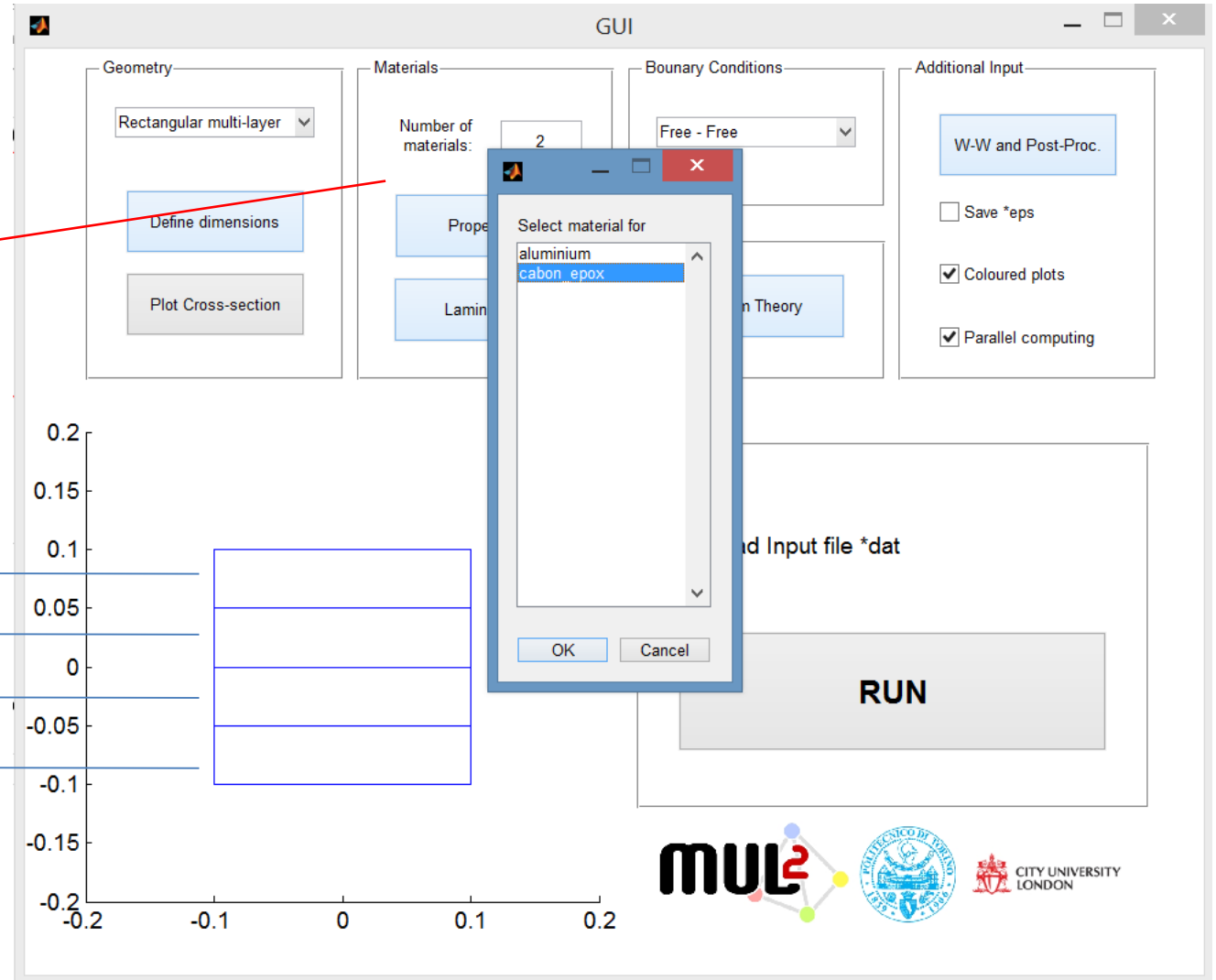
STEP 2 – Material

Lamination: define the material for layer 2

When you select an orthotropic material, a new window opens.



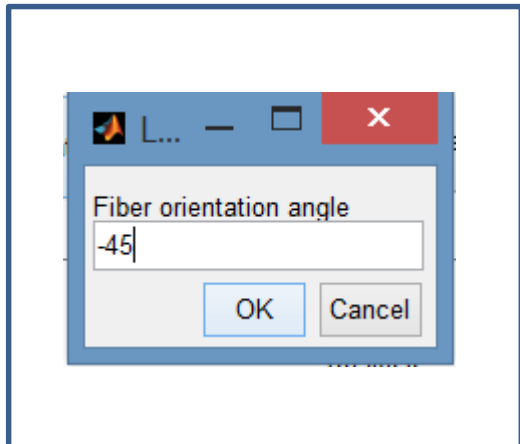
aluminium
carbon_epox (-45°)
carbon_epox (45°)
aluminium



DySAAB GUI – Laminated beam

STEP 2 – Material

Lamination: define the material for layer 3



aluminium
carbon_epox (-45°)
carbon_epox (45°)
aluminium

The screenshot shows the DySAAB GUI with several panels: 'Geometry' (Rectangular multi-layer, Define dimensions, Plot Cross-section), 'Materials' (Number of materials: 2, Properties, Lamination Theory), 'Boundary Conditions' (Free - Free), and 'Additional Input' (W-W and Post-Proc, Save *eps, Coloured plots, Parallel computing). A 'Select material for' dialog box is open, showing a list with 'aluminium' and 'carbon_epox' selected. A red arrow points from the 'Define dimensions' button to the 'STEP 2 – Material' text. A blue box highlights the 'Lamination Theory' section, which includes a cross-section plot of a beam with four layers. The plot has a vertical axis from -0.2 to 0.2 and a horizontal axis from -0.2 to 0.2. Blue arrows point from the layer labels to the corresponding layers in the plot: aluminium (top), carbon_epox (-45°), carbon_epox (45°), and aluminium (bottom). A 'RUN' button is visible at the bottom right of the GUI. Logos for MUL2, Politecnico di Torino, and City University London are at the bottom right.

DySAAB GUI – Laminated beam

STEP 2 – Material

Lamination: define the material for layer 4

aluminium
carbon_epox (-45°)
carbon_epox (45°)
aluminium

The screenshot shows the DySAAB GUI interface. The 'Materials' section is active, and a dialog box titled 'Select material for' is open, displaying a list of materials: 'aluminium' (selected) and 'carbon_epox'. The background GUI shows the 'Lamination' button highlighted. A cross-section plot of the beam is visible at the bottom left, with arrows pointing to the layers: aluminium, carbon_epox (-45°), carbon_epox (45°), and aluminium. The plot shows a rectangular cross-section with a height of 0.2 and a width of 0.2. The layers are stacked vertically, with the top layer being aluminium (0.1 to 0.2), the second layer being carbon_epox (-45°) (0.05 to 0.1), the third layer being carbon_epox (45°) (0 to 0.05), and the bottom layer being aluminium (-0.05 to 0).



DySAAB GUI – Laminated beam

STEPS 3 to 6

As in the previous analysis case.

The screenshot displays the DySAAB GUI interface for a laminated beam analysis. The window is titled "GUI" and contains several panels for configuring the analysis:

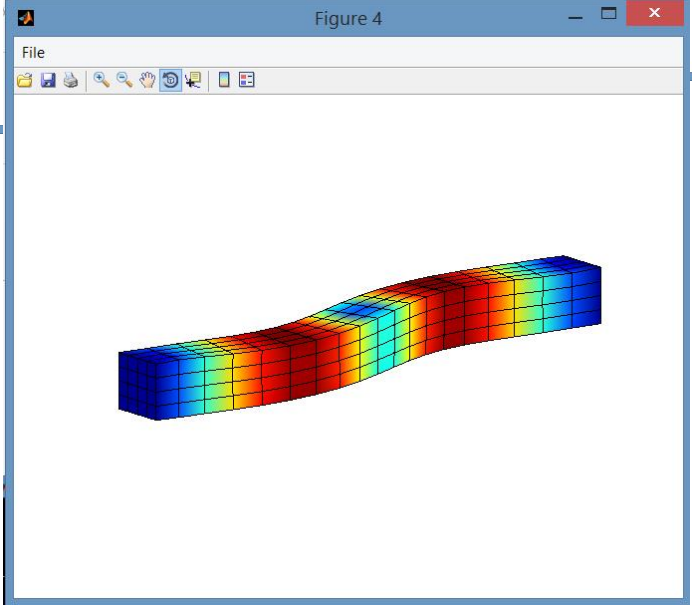
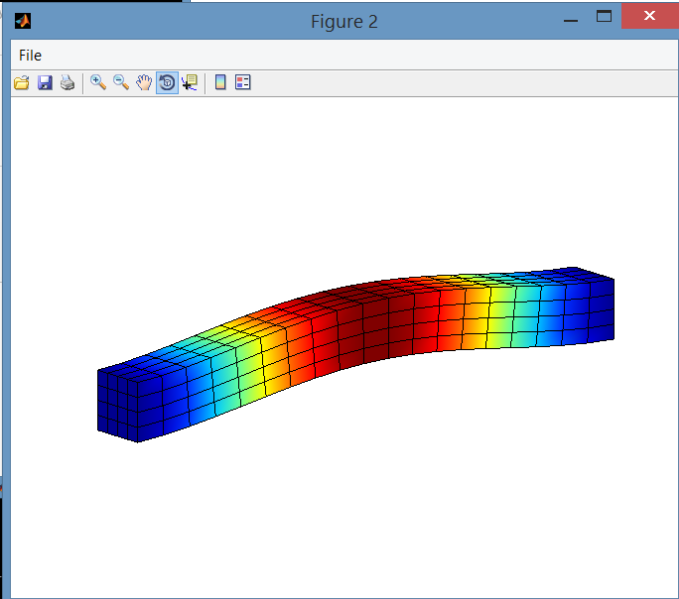
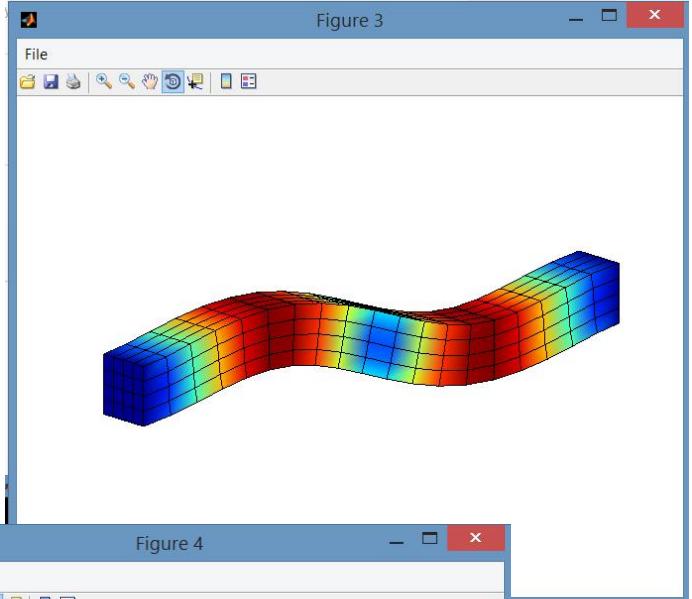
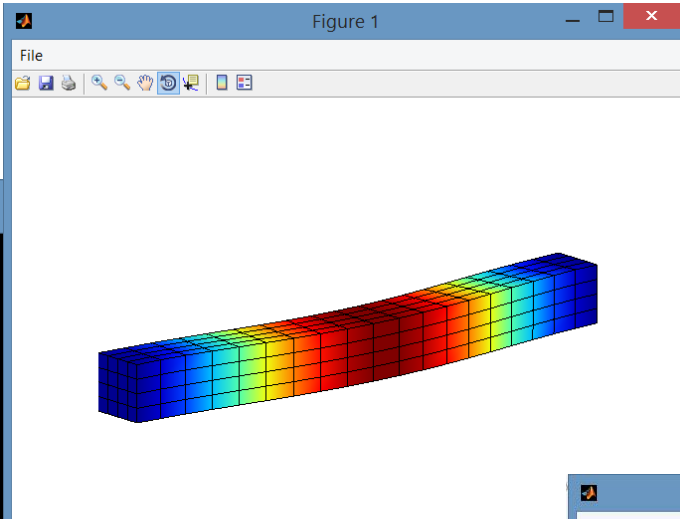
- Geometry:** A dropdown menu is set to "Rectangular multi-layer". Below it are buttons for "Define dimensions" and "Plot Cross-section".
- Materials:** A text input field shows "Number of materials: 2". Below it are buttons for "Properties" and "Lamination".
- Boundary Conditions:** A dropdown menu is set to "Clamped - Clamped".
- Additional Input:** A button labeled "W-W and Post-Proc." is highlighted. Below it are checkboxes for "Save *.eps" (unchecked), "Coloured plots" (checked), and "Parallel computing" (checked).
- Model:** A button labeled "Beam Theory" is present.
- Analysis:** A checkbox for "Read Input file *.dat" is unchecked. A large "RUN" button is prominently displayed.

A plot in the bottom-left corner shows the cross-section of the laminated beam. The plot has a vertical axis ranging from -0.2 to 0.2 and a horizontal axis ranging from -0.2 to 0.2. The cross-section is a rectangle centered at the origin, with a total height of 0.2 units and a total width of 0.2 units. The cross-section is divided into four horizontal layers, each 0.05 units thick, with a central layer at the origin.

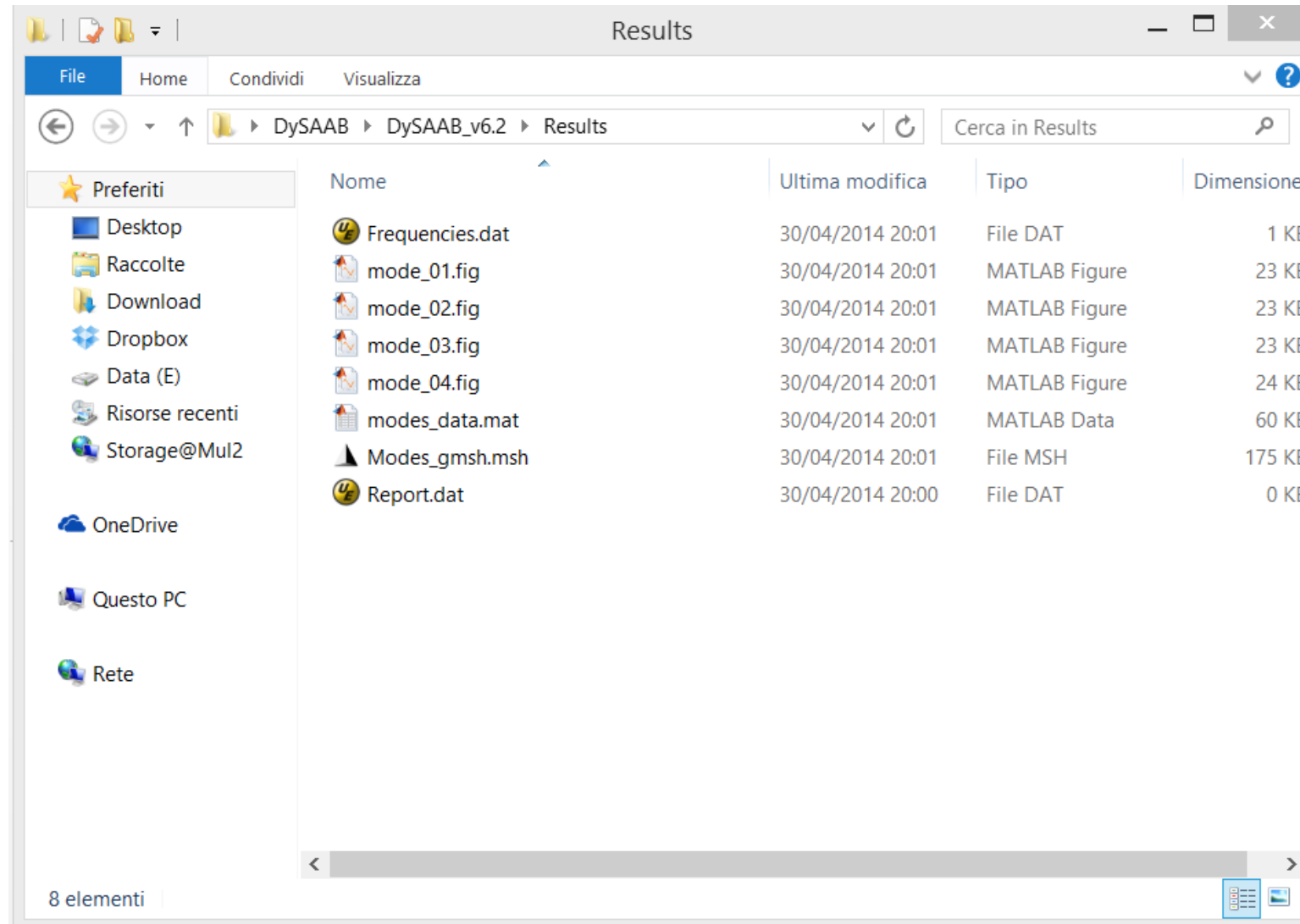
Logos for MUL², City University London, and City University London are visible in the bottom-right corner of the GUI window.

DySAAB GUI – Laminated beam

```
C:\Users\Alfonso\Desktop\DySAAB\DySAAB_v6.2\DySAAB.exe  
  
W-W algorithm parameters:  
  initial trial omega: 7  
    accuracy: 0.1  
  required frequencies: 4  
  
Post-Processing parameters:  
  post-points along y: 20  
  post-points along x: 5  
  post-points along z: 5  
  
COMPUTING CROSS-SECTION INTEGRALS...  
----> OK (1.7364 s)  
COMPUTING MATERIAL COEFFICIENTS...  
----> OK (0.036497 s)  
COMPUTING NATURAL FREQUENCIES...  
  Frequency 2 computed: 255.3038 Hz  
  Frequency 1 computed: 248.4974 Hz  
  Frequency 4 computed: 651.2303 Hz  
  Frequency 3 computed: 616.3891 Hz  
----> OK (2.0622 s)  
COMPUTING MODES AND SAVING RESULTS...  
----> OK (2.7156 s)  
Sending a stop signal to all the workers ... stopped.
```

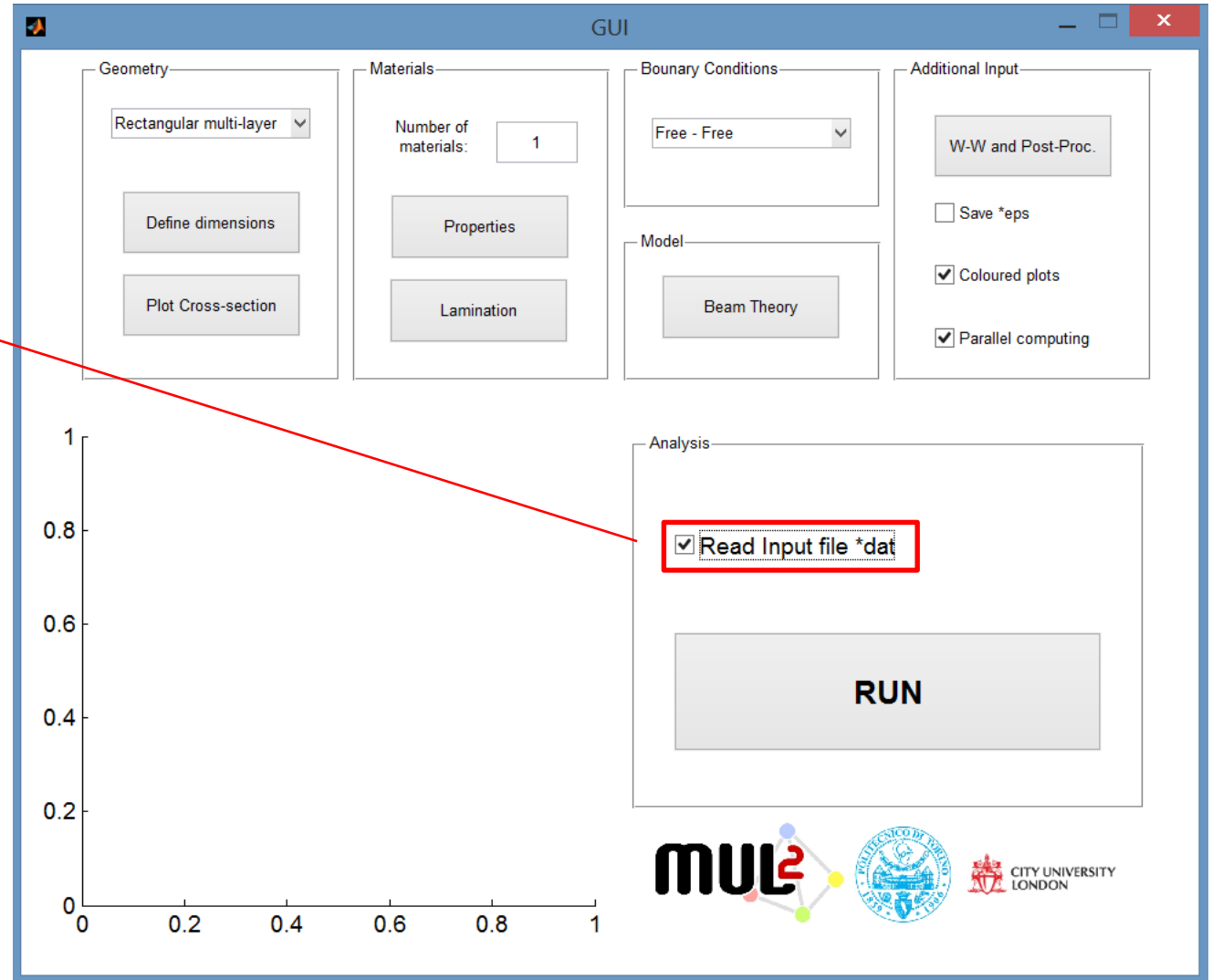


DySAAB GUI – Laminated beam



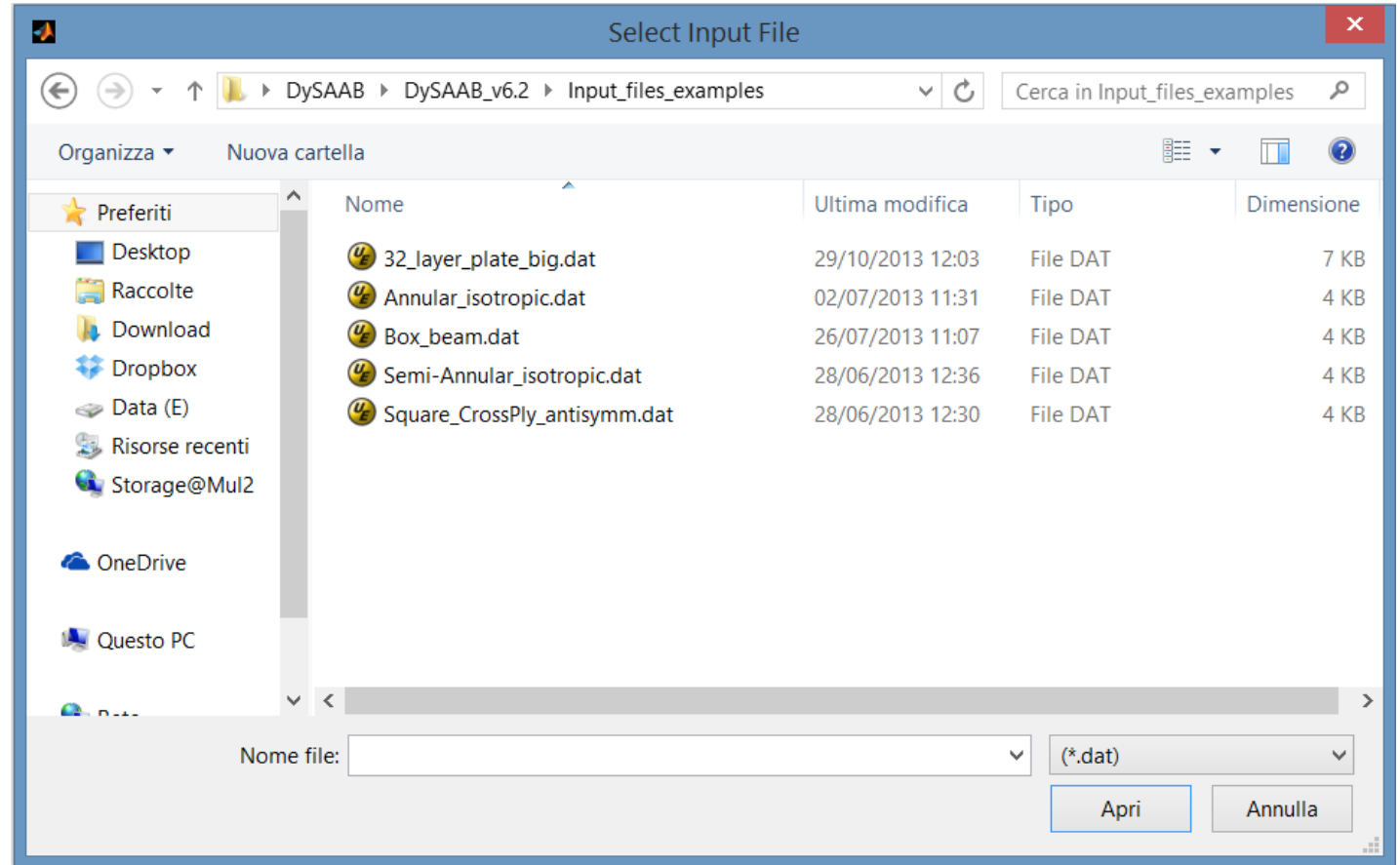
DySAAB GUI – Text data file input

If the user tick this box before pushing “RUN” button, an input file can be read and used to running analysis.



DySAAB GUI – Text data file input

A new window opens to let the user chose the input data file.



DySAAB GUI – Text data file input

Example of input data file

```
##### INPUT #####
#### Theory order
## Format: N
% -> 'N': 1.1 Euler-Bernoulli beam model;
% ..... 1.2 Timoshenko beam model;
% ..... 1,2,3... Higher-order beam models

8

#### Number of DS beam elements

10

#### Shape of the cross-section
## Format: CS_type CS_geometry
% -> 'CS_type': 1 for Rectangular multi-layered, 2 for Isotropic C shape, 3 for Isotropic multi-layered cylinder, 4 for Isotropic rectangular box;
% -> 'CS_geometry':
% --- Rectangular multi-layered -----> width z1_bottom z1_top ... zk_bottom zk_top
% --- Isotropic C shape -----> thickness bottom_flange top_flange vertical_left_web
% ..... (Note: bottom, top and left side are measured on the mean line of the cross-section)
% --- Isotropic multi-layered cylinder --> theta_initial theta_final ri_inner ri_outer ... rk_inner rk_outer
% ..... (Note: ri_int,ri_out are the radii of the i_th layer; theta_in is the angle where the cylinder starts (in d
% --- Isotropic Rectangular Box -----> width height thickness

1 296.5 -3.083328 -2.89062 -2.89062 -2.697912 -2.697912 -2.505204 -2.505204 -2.312496 -2.312496 -2.119788 -2.119788 -1.92708 -1.92708 -1.734372 -1.73

#### Length of the beam

559

#### Boundary Conditions
## Format: bcs
% -> 'bcs': FF for Free-Free boundary conditions;
% ..... CF for Clamped-Free boundary conditions;
% ..... SS for Simply supported boundary conditions. Etc.

FF
```