

NeoCASS Tutorial

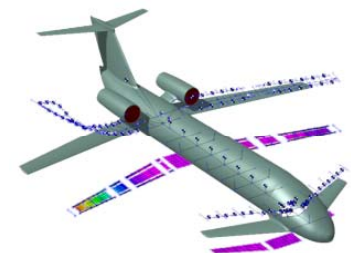
How to run a static aeroelastic analysis
“three maneuver sizing”

Version 2.2(.790)

August 2017

Outline

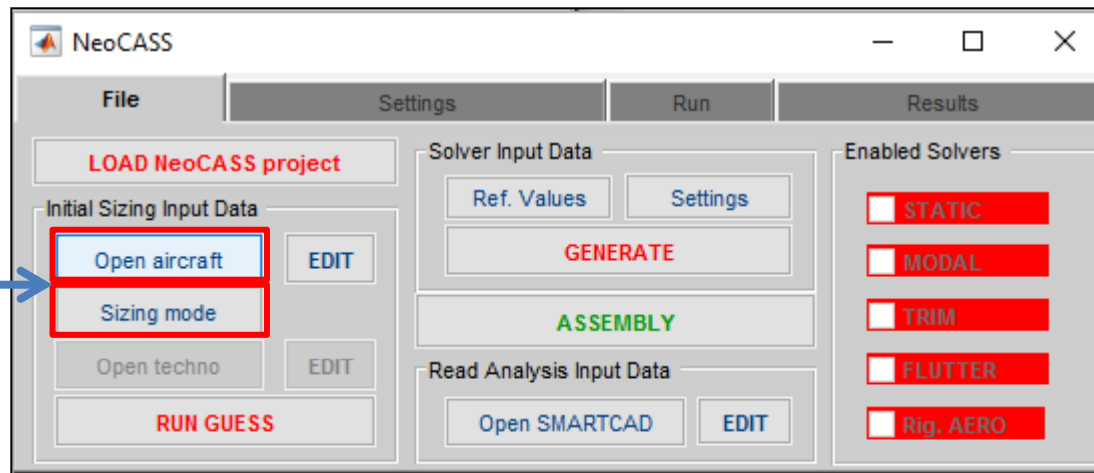
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2. **Dimensioning Maneuvers** pag. [13](#)
3. How to **Run TRIM** analysis pag. [18](#)
4. How to **Run Rigid VLM/DLM** analysis pag. [25](#)
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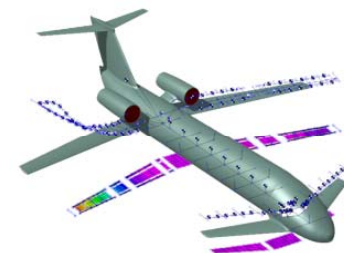
Maneuvers Set Definition



Do not forget to run the script `set_neocass_path` in the installation directory. That allows to include the NeoCASS routines into the current path. Then change directory that you will use for your analysis and start `NeoCASS`, typing it in the command window.



Open the aircraft model ('Open aircraft') and click on 'Sizing mode'. In this tutorial the `B747-400_reference.xml` is used.



Maneuvers Set Definition



GUESS sizing mode

Guess/SMARTCAD trim interface

EASA automatic selection

Pullup Horizontal tail/canard Vertical tail
 Ailerons Static Gust Taildown Landing
 Engine Out High Lift

Cruise altitude (HCRU) [m]:
Min cruise mach number (MCRU) []:
Max ceiling altitude (HMAX) [m]:
Clean max lift coefficient (CLMAX) []:
All flaps down max CL at Take Off (CLMAXTO) []:
All flaps down max CL at Landing (CLMAXLAND) []:
Clean lift curve slope (CLALPHAD) []:
Reference surface (USERSREF) [m²]:
Flap deflection for TO (FLAPTO) [deg]:
Flap deflection for Landing (FLAPLAND) [deg]:
Sink speed at landing (VSINK) [m/s]: 0
Shock absorber stroke at landing (STROKE) [m]: 0
Landing gear efficiency (LNDGEFF) []: 0.8

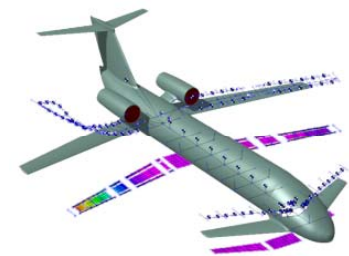
Maneuvers set definition
Number of flight conditions:

Export to file:

Solution Method

Rigid Aircraft Joined wing
 Elastic Aircraft No Strut-braced wing

In Solution Method select 'Rigid Aircraft'.
To impose three user-defined load conditions click on: 'SELECT Values'



Maneuvers Set Definition: *man. ID 1*



Maneuver Definition

1 Mach: 0.5 Altitude [m]: 5000

Symmetric Maneuvers: Cruise/Climb (AoA, pitch control surfaces)

Anti-Symmetric Maneuvers: Sideslip levelled flight

Parameters

Angle of attack (ANGLEA) [deg]:		Sideslip angle (SIDES) [deg]:	0
Roll rate (ROLL) [1/s]:	0	p rate (URDD4) [1/s^2]:	0
Pitch rate (PITCH) [1/s]:	0	q rate (URDD5) [1/s^2]:	0
Yaw rate (YAW) [1/s]:	0	r rate (URDD6) [1/s^2]:	0
Elevator rotation (elev1r) [deg]:		X acc (URDD1) [m/s^2]:	
Canard rotation (elevC1r) [deg]:		Y acc (URDD2) [m/s^2]:	0
Aileron rotation (aileronr) [deg]:	0	Z acc (URDD3) [m/s^2]:	34.3
Rudder rotation (rudder1) [deg]:	0	Vertical speed (VGUST) [EAS m/s]:	0
1st Flap rotation (flap1r) [deg]:	0	Strut efficiency (LNDGEFF) []:	0
2nd Flap rotation (flap2r) [deg]:	0	Sink speed (VSINK) [m/s]:	0
		Shock absorber stroke (STROKE) [m]:	0

Symmetric maneuver

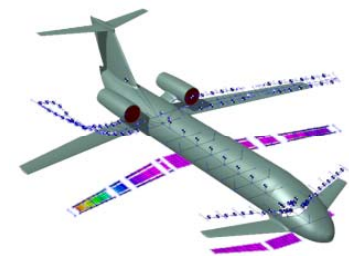
User defined maneuver

Save Discard

For example, define three maneuvers: two symmetric and one anti-symmetric.

Pull Up maneuver:
Z acceleration = $3,5 * g$.

Clicking 'Save' the next maneuver's setting window will appear.



Maneuvers Set Definition: *man. ID 2*



Maneuver Definition

2 Mach: 0.5 Altitude [m]: 5000

Symmetric Maneuvers: Cruise/Climb (AoA, pitch control surfaces)

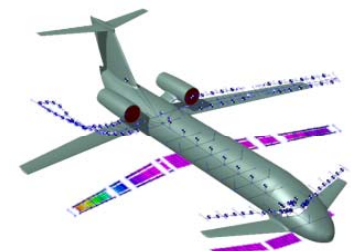
Anti-Symmetric Maneuvers: Sideslip levelled flight

Parameters

Angle of attack (ANGLEA) [deg]:		Sideslip angle (SIDES) [deg]:	0
Roll rate (ROLL) [1/s]:	0	p rate (URDD4) [1/s^2]:	0
Pitch rate (PITCH) [1/s]:	0	q rate (URDD5) [1/s^2]:	0
Yaw rate (YAW) [1/s]:	0	r rate (URDD6) [1/s^2]:	0
Elevator rotation (elev1r) [deg]:		X acc (URDD1) [m/s^2]:	
Canard rotation (elevC1r) [deg]:		Y acc (URDD2) [m/s^2]:	0
Aileron rotation (aileronr) [deg]:	0	Z acc (URDD3) [m/s^2]:	-14.7
Rudder rotation (rudder1) [deg]:	0	Vertical speed (VGUST) [EAS m/s]:	0
1st Flap rotation (flap1r) [deg]:	0	Strut efficiency (LNDGEFF) []:	0
2nd Flap rotation (flap2r) [deg]:	0	Sink speed (VSINK) [m/s]:	0
<input checked="" type="checkbox"/> Symmetric maneuver		Shock absorber stroke (STROKE) [m]:	0
<input type="checkbox"/> User defined maneuver			

Save Discard

Negative g maneuver:
Z acceleration = -1,5*g.



Maneuvers Set Definition: *man. ID 3*



Maneuver Definition

3 Mach: **0.5** Altitude [m]: **5000**

Symmetric Maneuvers **Anti-Symmetric Maneuvers**

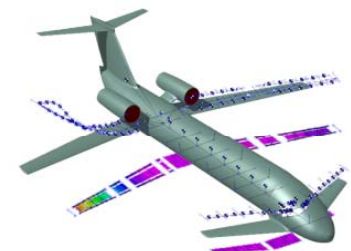
Cruise/Climb (AoA, pitch control surfaces) Sideslip levelled flight

Parameters

Angle of attack (ANGLEA) [deg]:		Sideslip angle (SIDES) [deg]:	20
Roll rate (ROLL) [1/s]:	0	p rate (URDD4) [1/s^2]:	0
Pitch rate (PITCH) [1/s]:	0	q rate (URDD5) [1/s^2]:	0
Yaw rate (YAW) [1/s]:	0	r rate (URDD6) [1/s^2]:	0
Elevator rotation (elev1r) [deg]:		X acc (URDD1) [m/s^2]:	
Canard rotation (elevC1r) [deg]:		Y acc (URDD2) [m/s^2]:	
Aileron rotation (aileronr) [deg]:		Z acc (URDD3) [m/s^2]:	9.81
Rudder rotation (rudder1) [deg]:		Vertical speed (VGUST) [EAS m/s]:	0
1st Flap rotation (flap1r) [deg]:	0	Strut efficiency (LNDGEFF) []:	0
2nd Flap rotation (flap2r) [deg]:	0	Sink speed (VSINK) [m/s]:	0
<input type="checkbox"/> Symmetric maneuver		Shock absorber stroke (STROKE) [m]:	0

User defined maneuver **Save** Discard

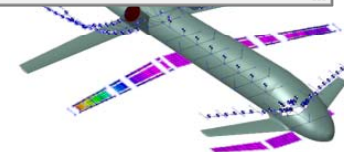
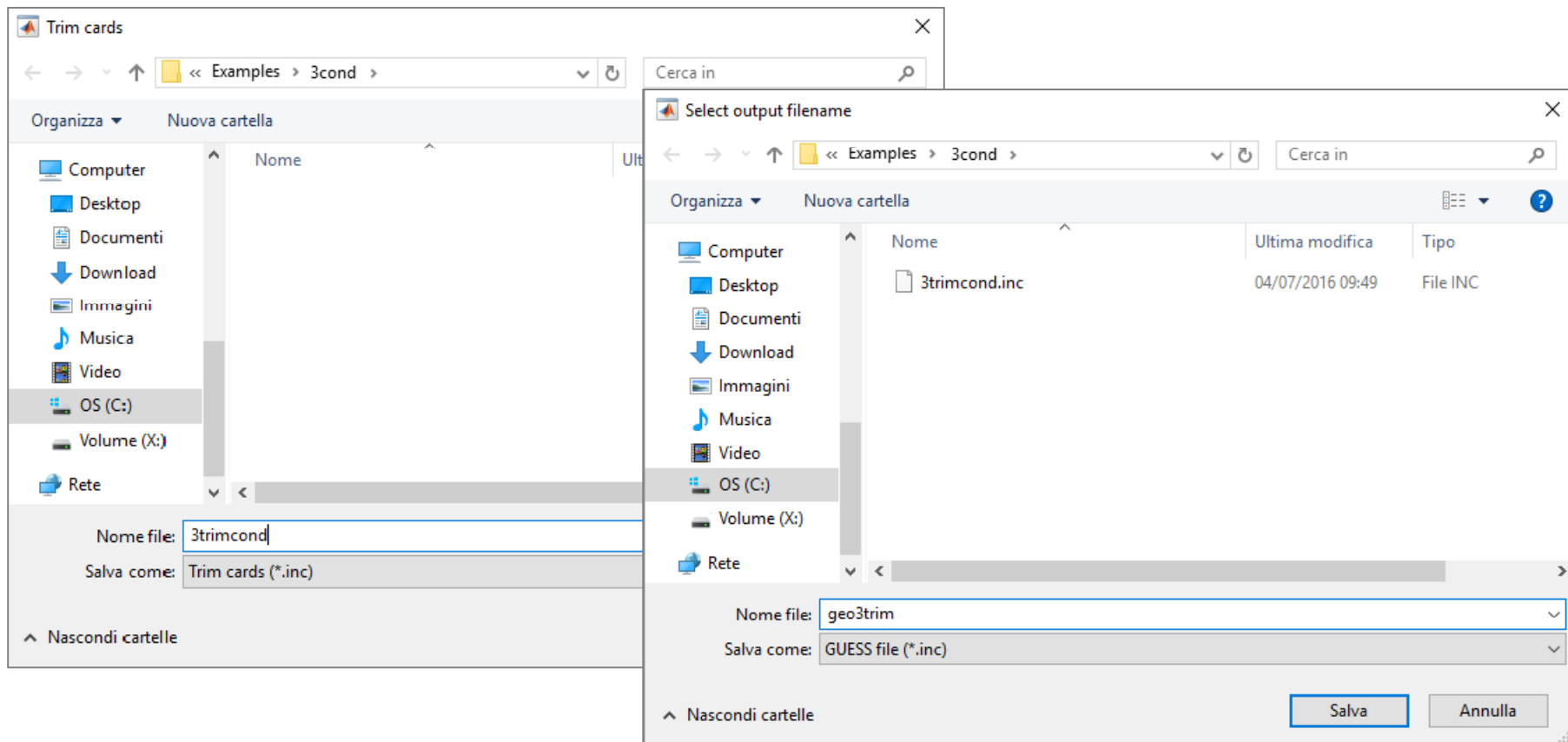
Sideslip maneuver:
sideslip angle = 20°



Running GUESS



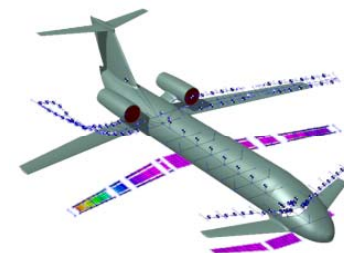
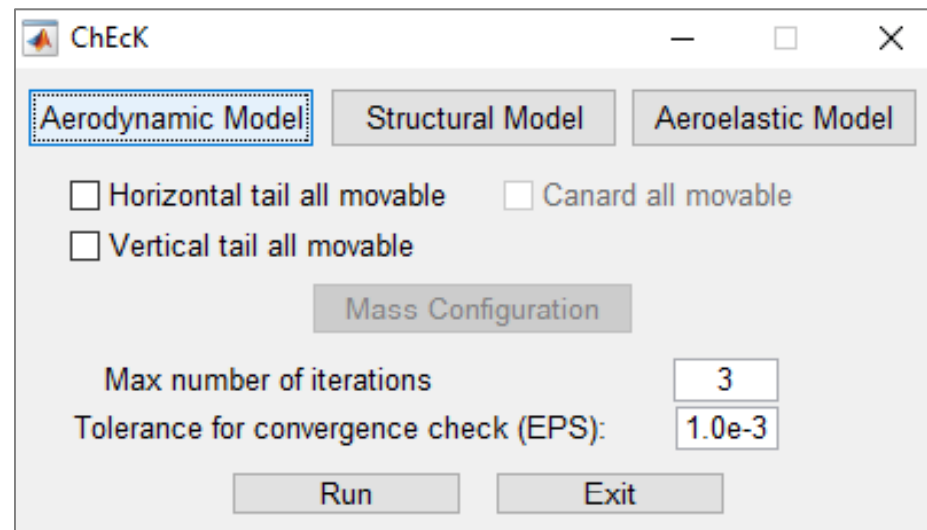
Save the trim condition in a .inc file (*3trimcond.inc*) and run guess creating *geo3trim.inc*



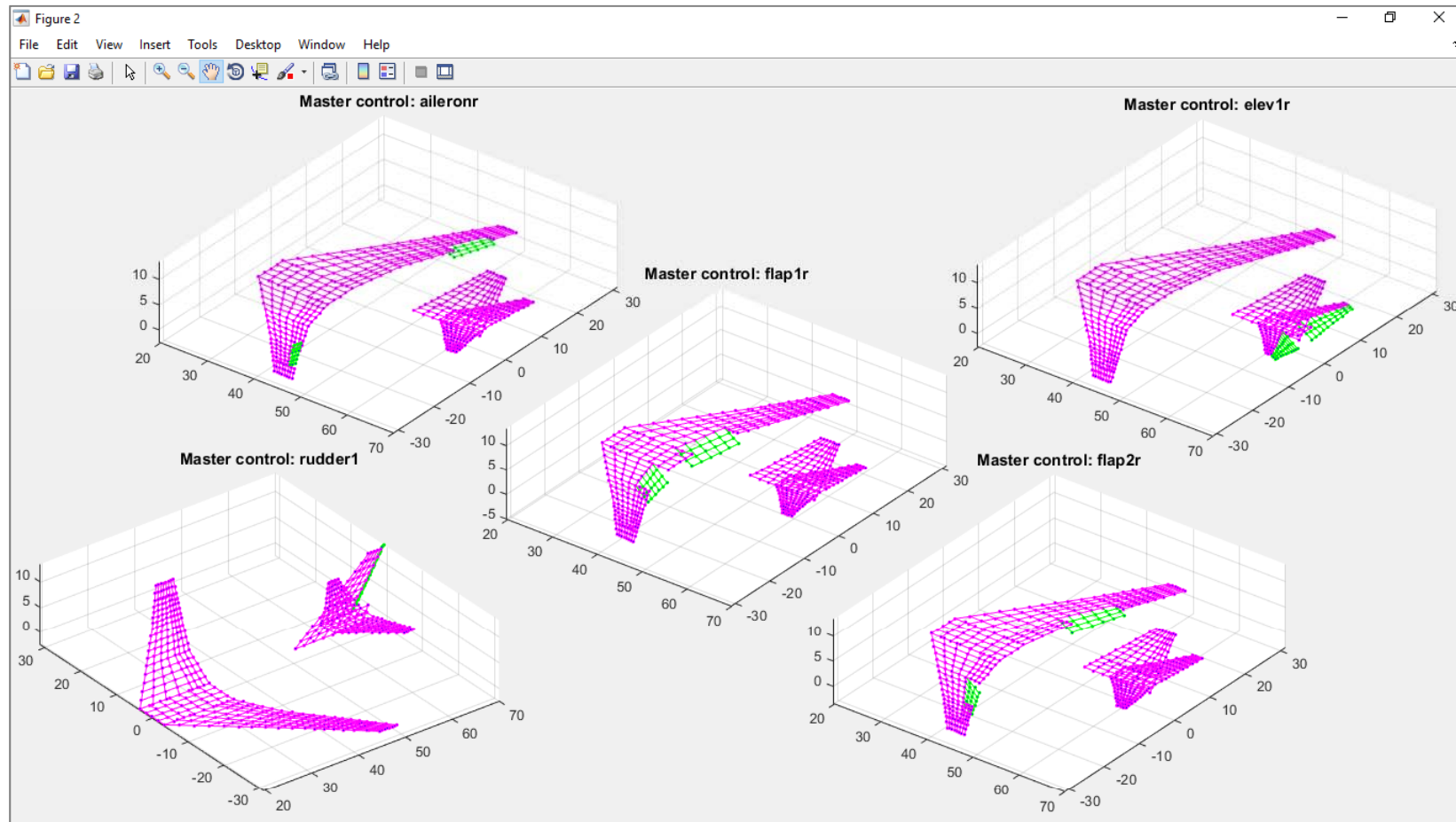
ChEcK phase



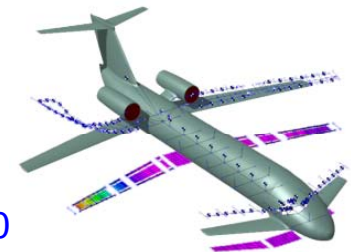
The *ChEcK window* comes up in order to check the way your aircraft is modeled. In the three slide below there is an output example of *Aerodynamic, Structural and Aeroelastic Models of B747-400*.



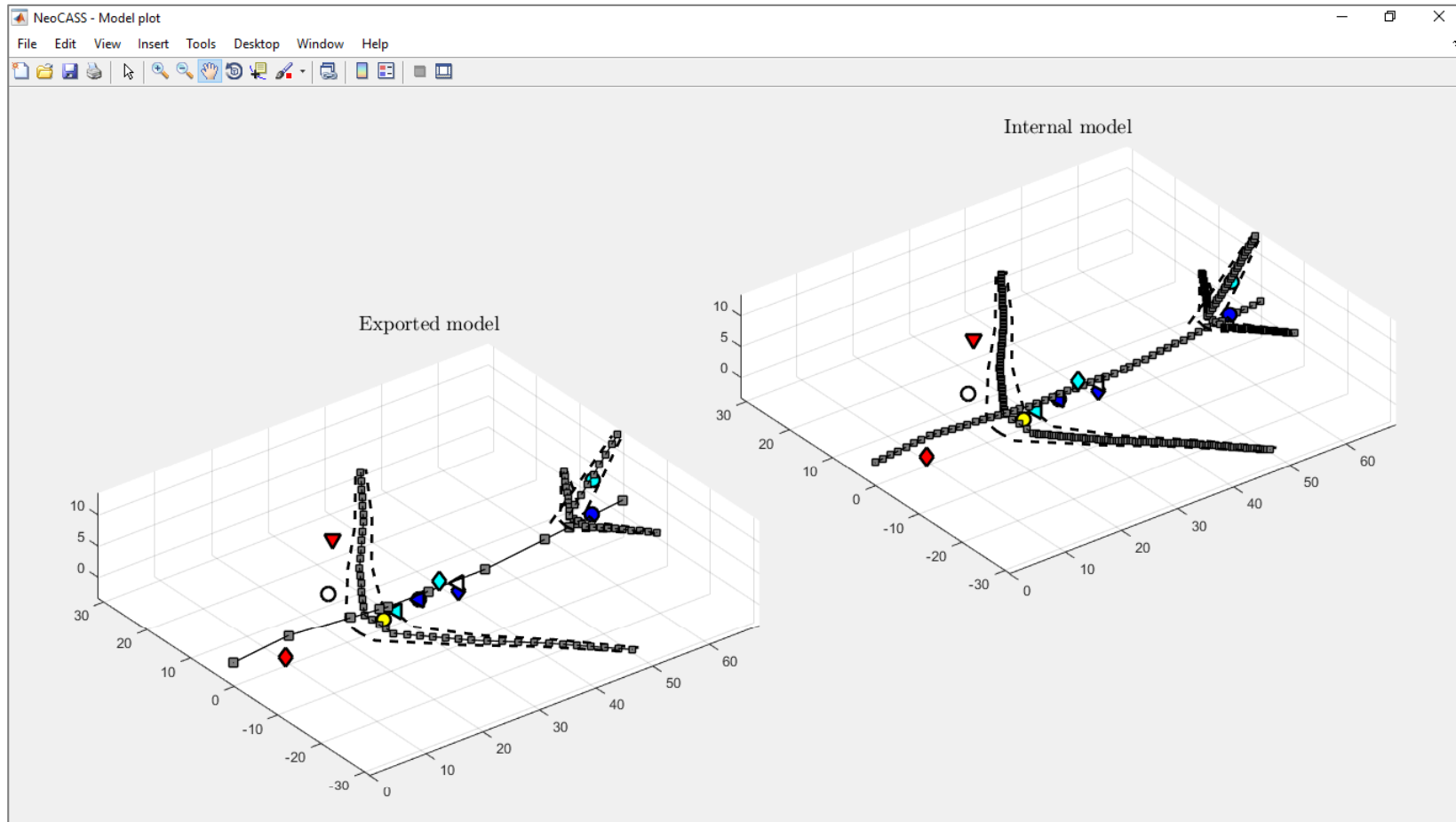
ChEck phase



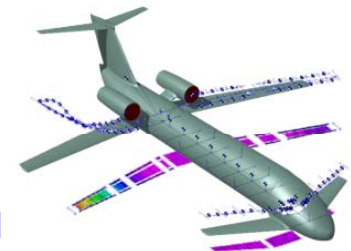
Aerodynamic Model



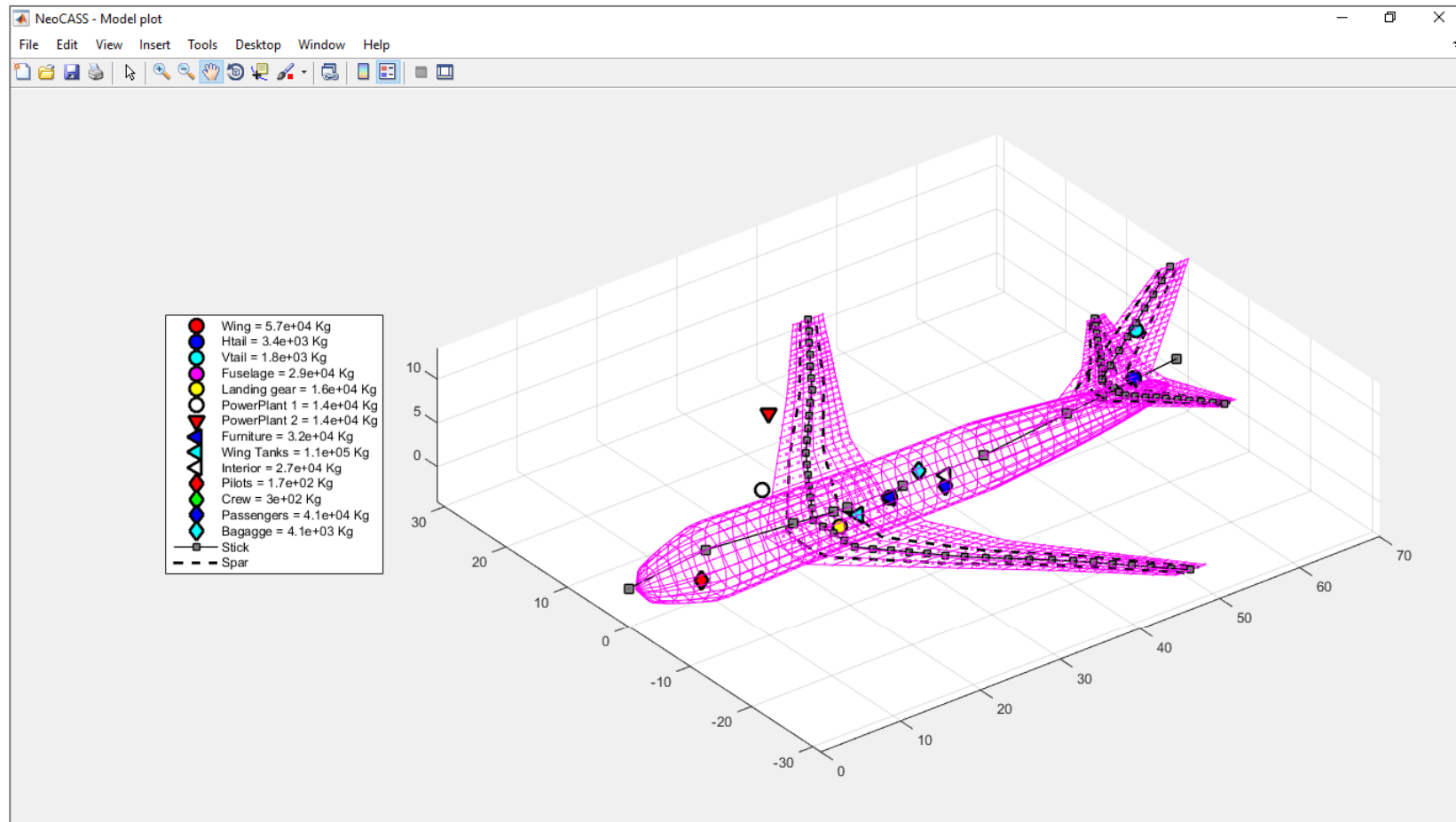
ChEcK phase



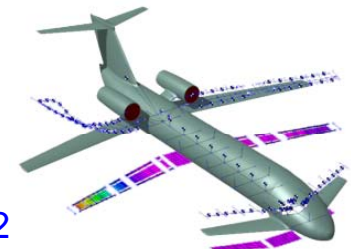
Structural Model



ChEck phase



Aeroelastic Model



Dimensioning Maneuvers

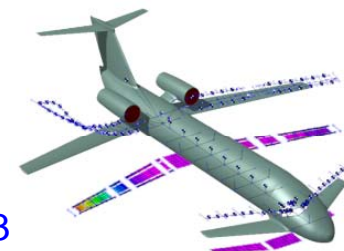


If everything goes well, the output will be similar to this one:

```
----- CONVERGENCE -----  
- Refinement loop history:  
  Iter   1: Total structural mass: 155434 Kg. Tolerance: 1.284e-03.  
  Iter   2: Total structural mass: 152528 Kg. Tolerance: 1.867e-02.  
  
- GUESS model saved in C:\NeoCASS_PG\Examples\PROVA\static_3cond\geo3trim_guess.mat file.  
- GUESS summary saved in C:\NeoCASS_PG\Examples\PROVA\static_3cond\geo3trim_guess.txt file.  
- SMARTCAD main file with OEW configuration saved in C:\NeoCASS_PG\Examples\PROVA\static_3cond\geo3trim.inc.  
- SMARTCAD configuration file saved in C:\NeoCASS_PG\Examples\PROVA\static_3cond\geo3trimCONM_CONF1.inc file.
```

In order to view which maneuver was the most accountable for each a/c part (in terms of bending, shear and torque), one have to load the guess result and process these data through the *'plot_sizing_man'* function.

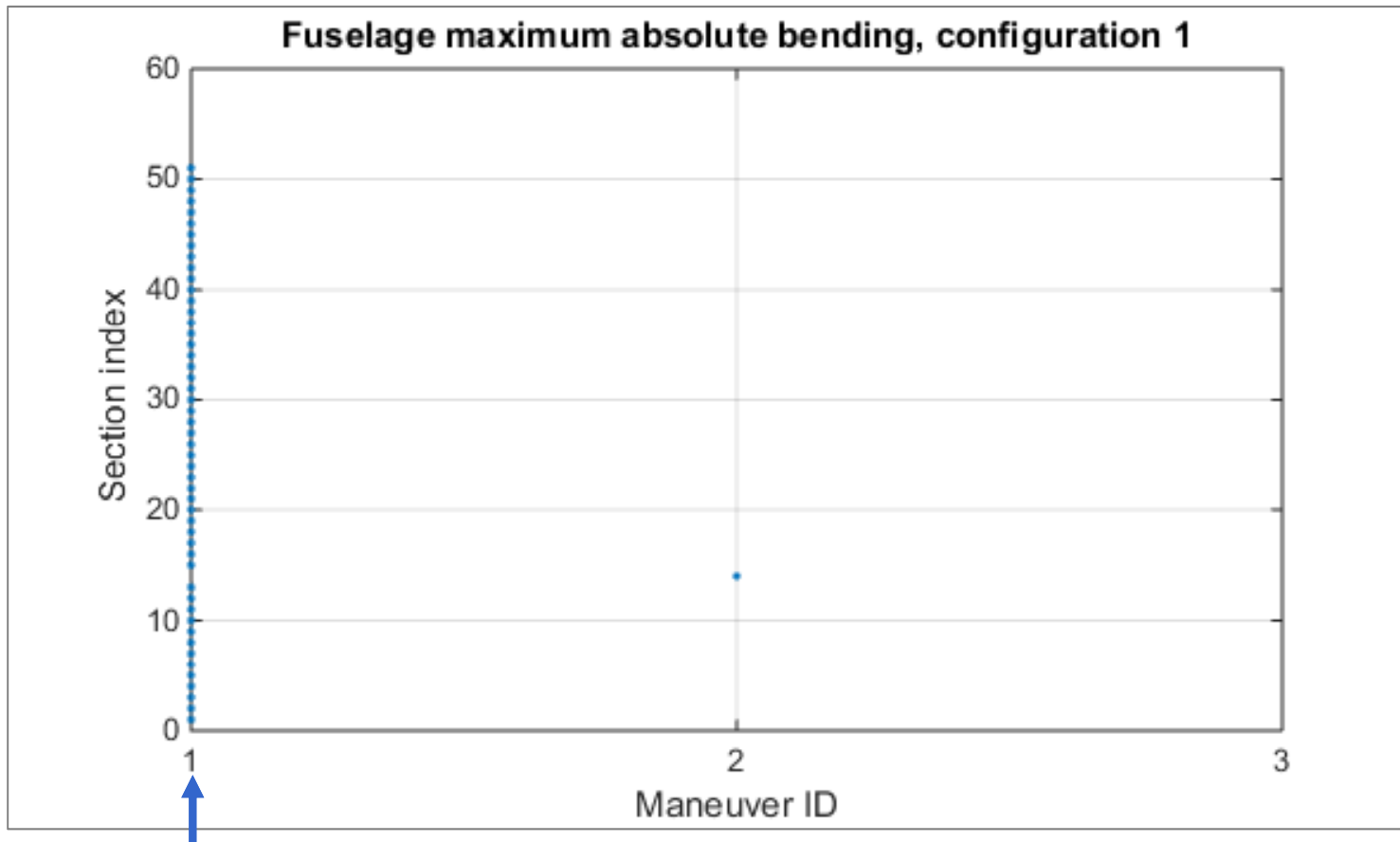
```
>> load('geo3trim_guess.mat')  
>> plot_sizing_man(guess_model.loads, guess_model, p1, [0.1:0.1:0.9], 1)
```



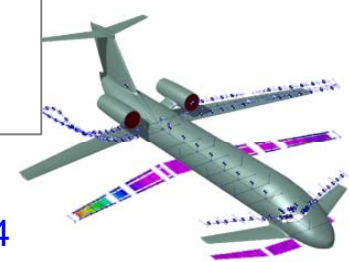
Dimensioning Maneuvers



For instance, the sizing maneuver of the fuselage in bending loading is predictably the pull-up m. (ID 1)



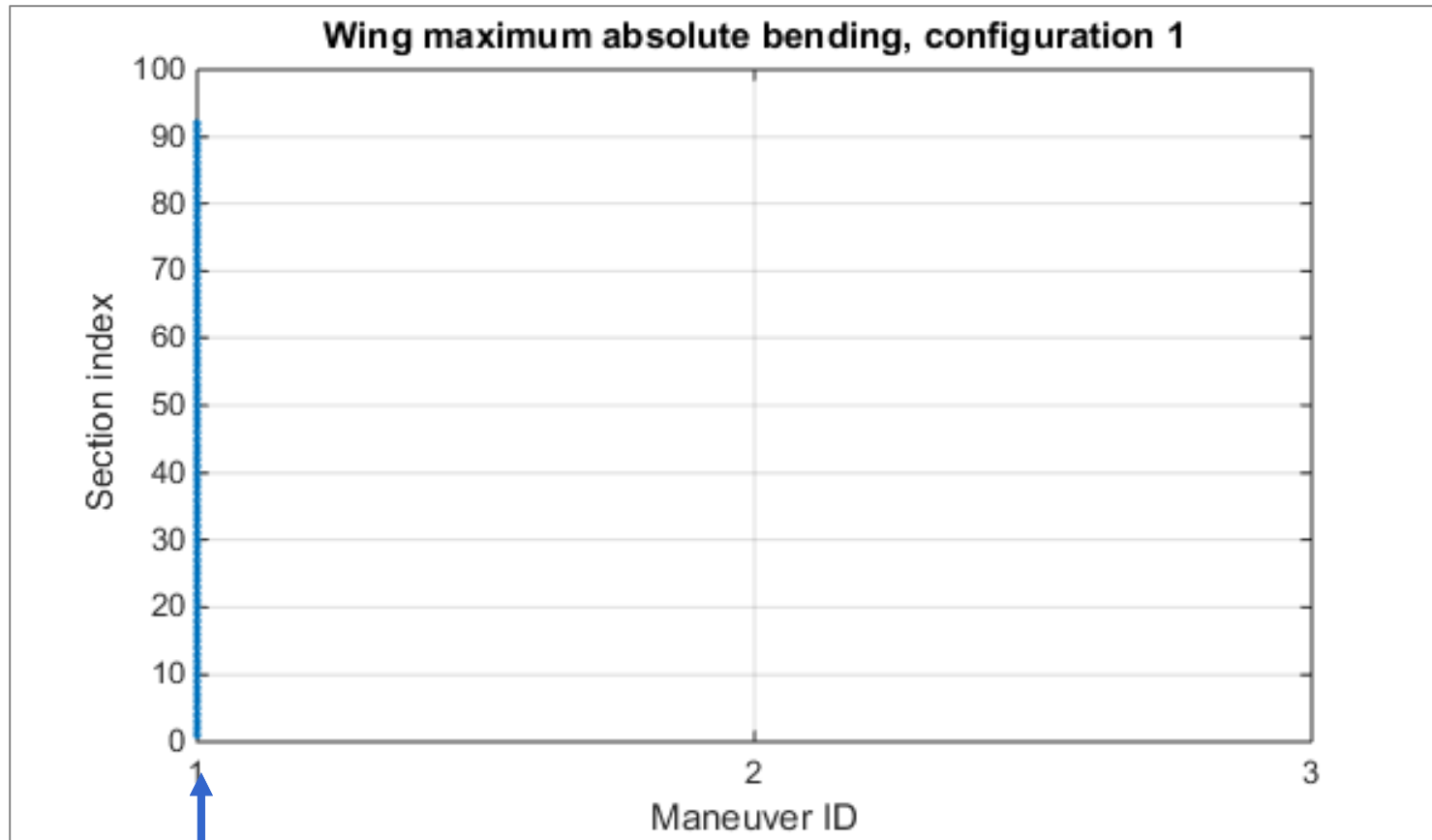
*p = 1 :
fuselage*



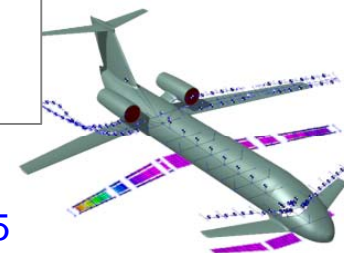
Dimensioning Maneuvers



The same will be for bend, torque and shear of wings.



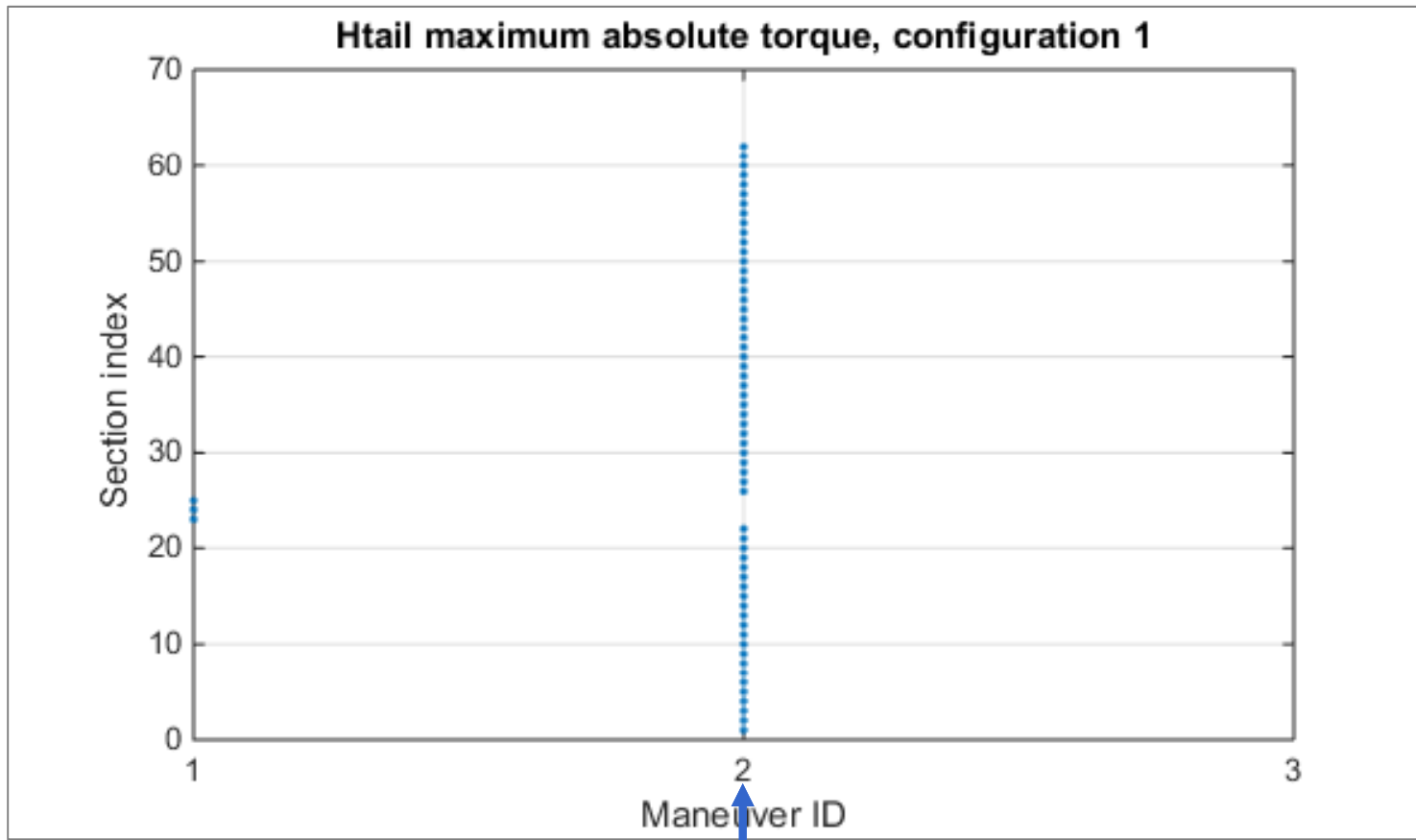
*p = 2 :
wings*



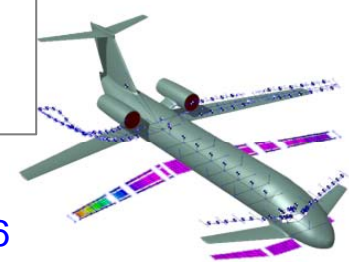
Dimensioning Maneuvers



The negative g maneuver (ID 2) is the dimensioning one for horizontal tail as far as the torque loading is considered.



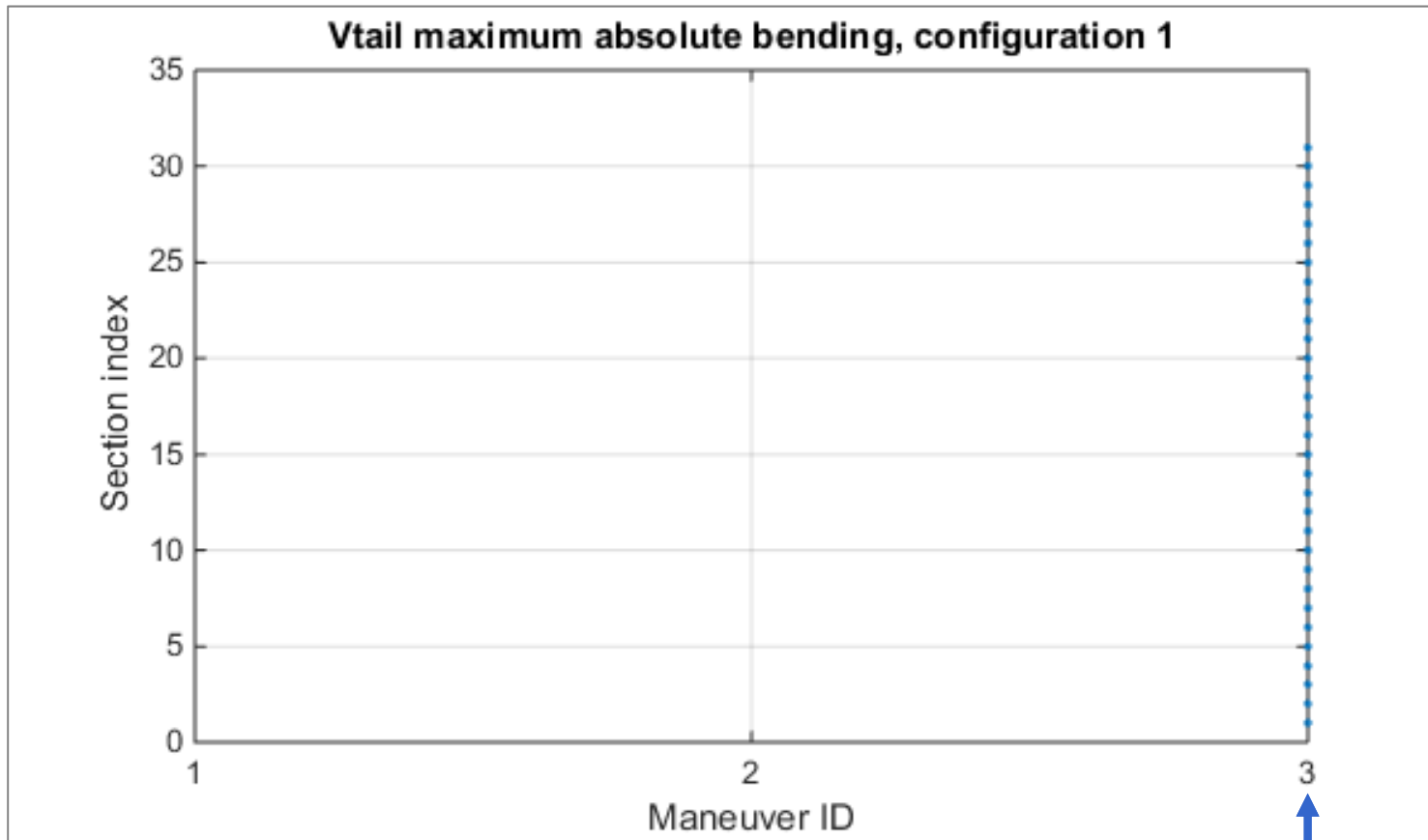
*p = 3 :
horizontal
tail*



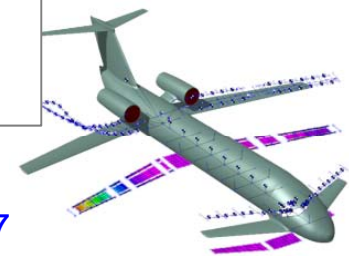
Dimensioning Maneuvers



Finally, the side slip m. (ID 3) is the most significant for the vertical tail sizing.



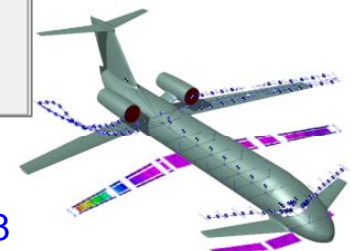
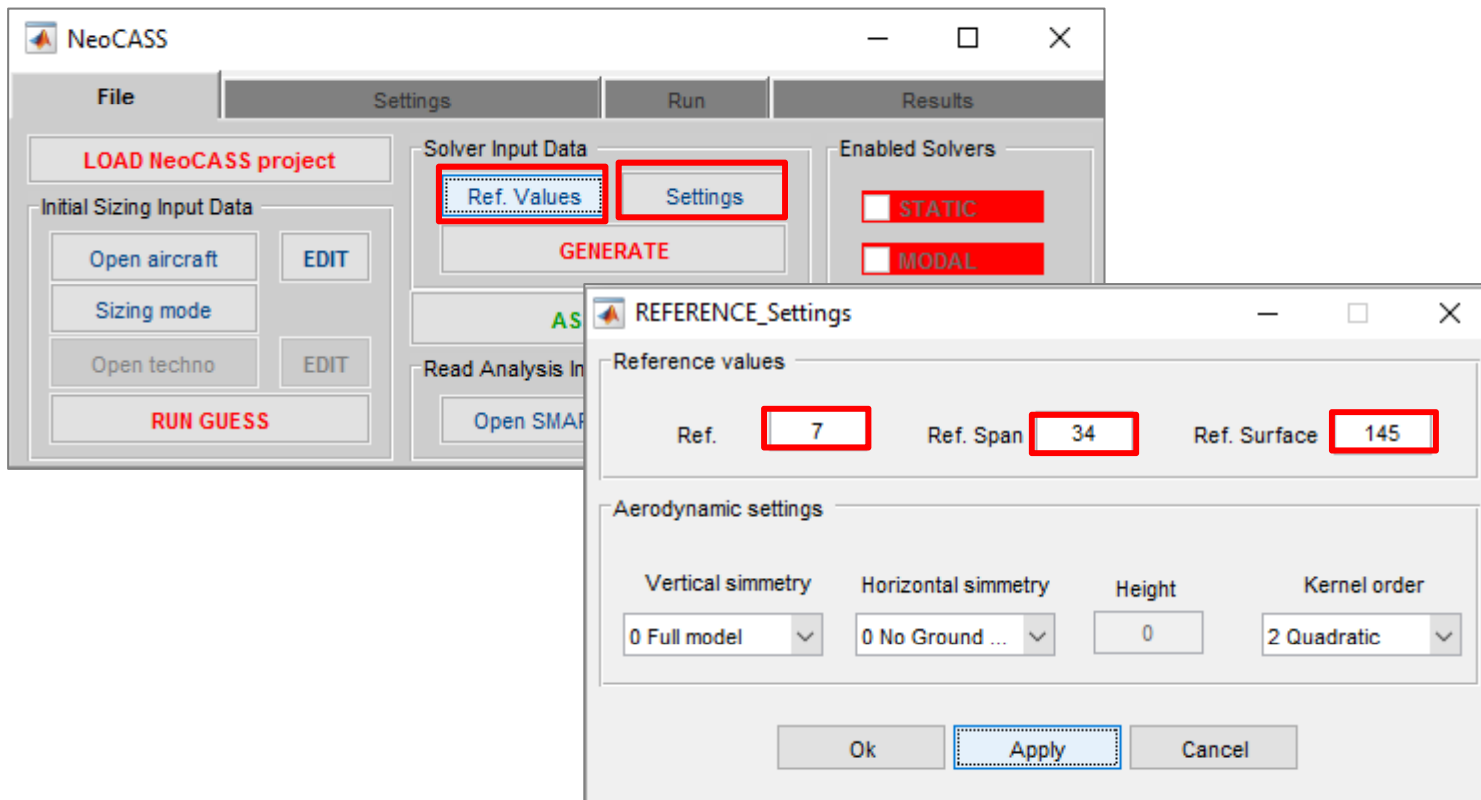
*p = 4 :
vertical tail*



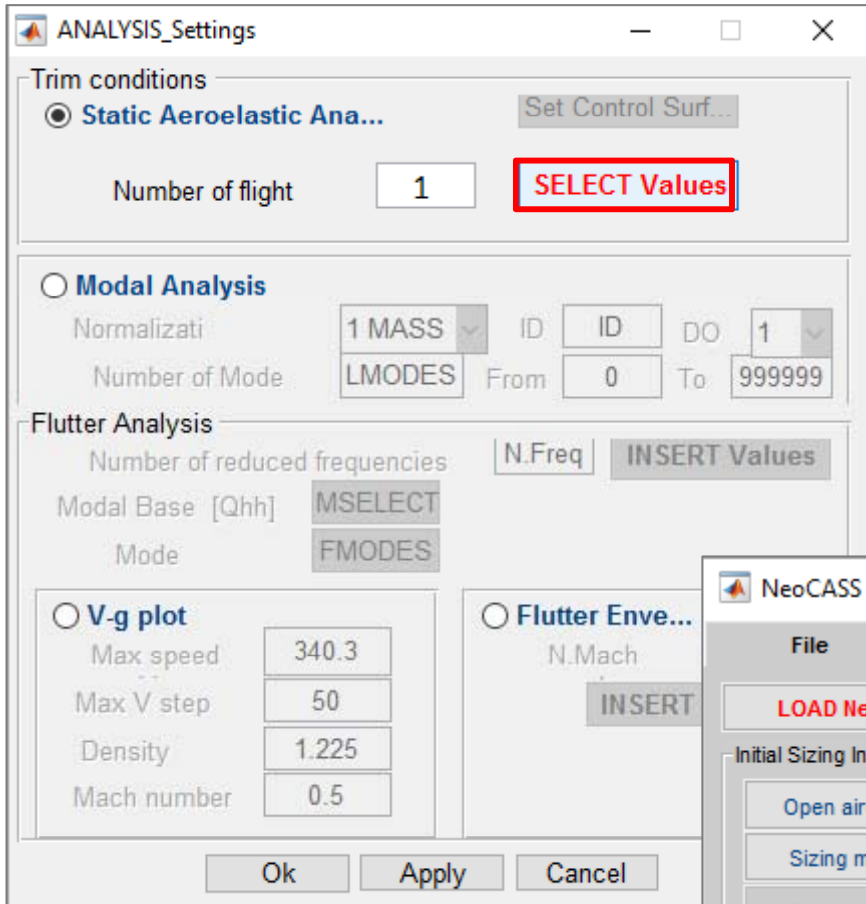
Running a 'TRIM' analysis



Set *Reference Values* and then press *Settings* for assigning loading details for further analysis.

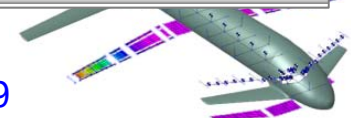
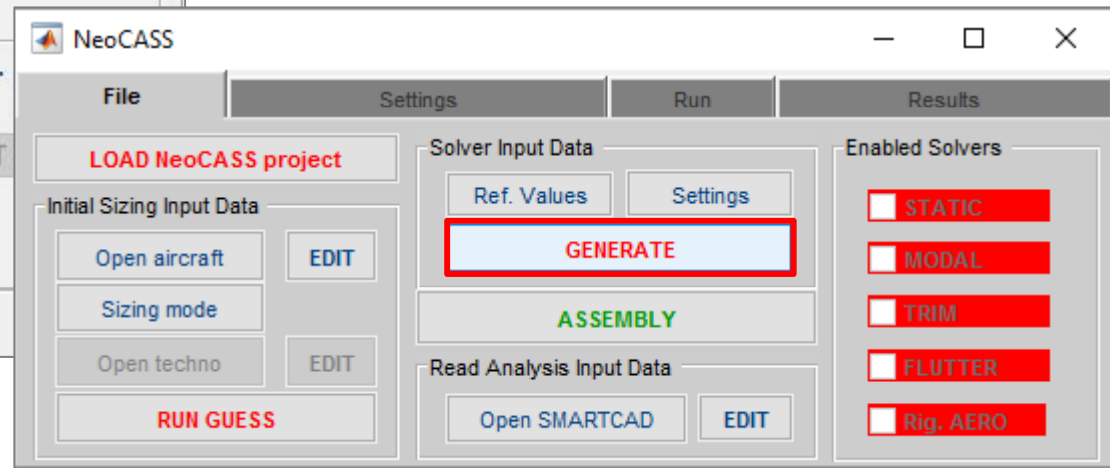


Running a 'TRIM' analysis

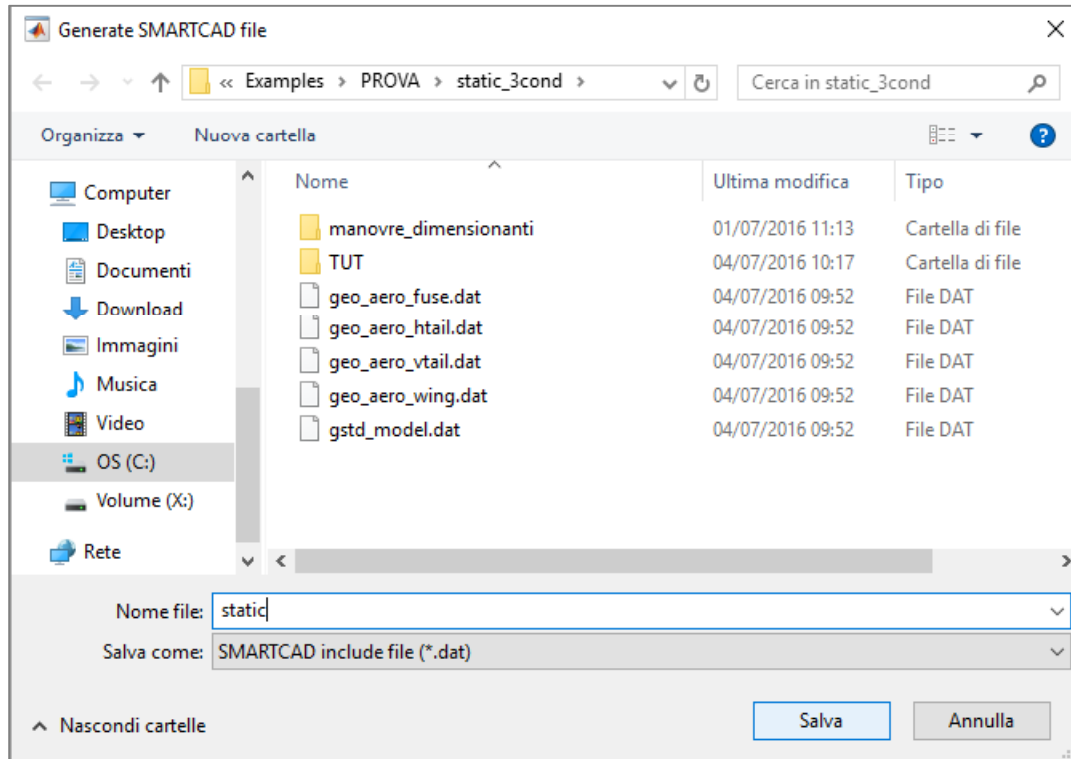


Select 'Static Aeroelastic Analysis' and *SELECT* the *Values* for one out the three flight condition analyzed before during GUESS module, for instance 'pull-up'.

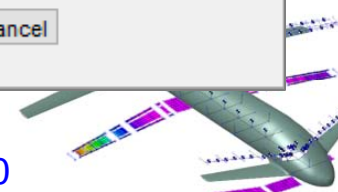
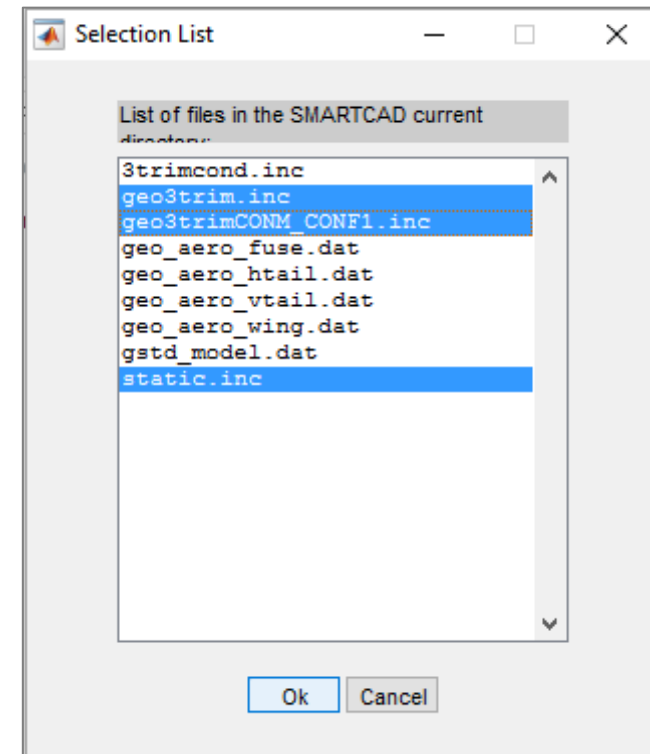
Then *GENERATE* the *static.inc* file that contains these information.



Running a 'TRIM' analysis



Finally, as usual, collect the geometric and analysis settings in one *static.dat* file.

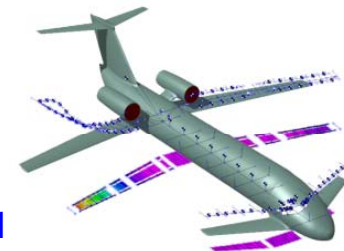
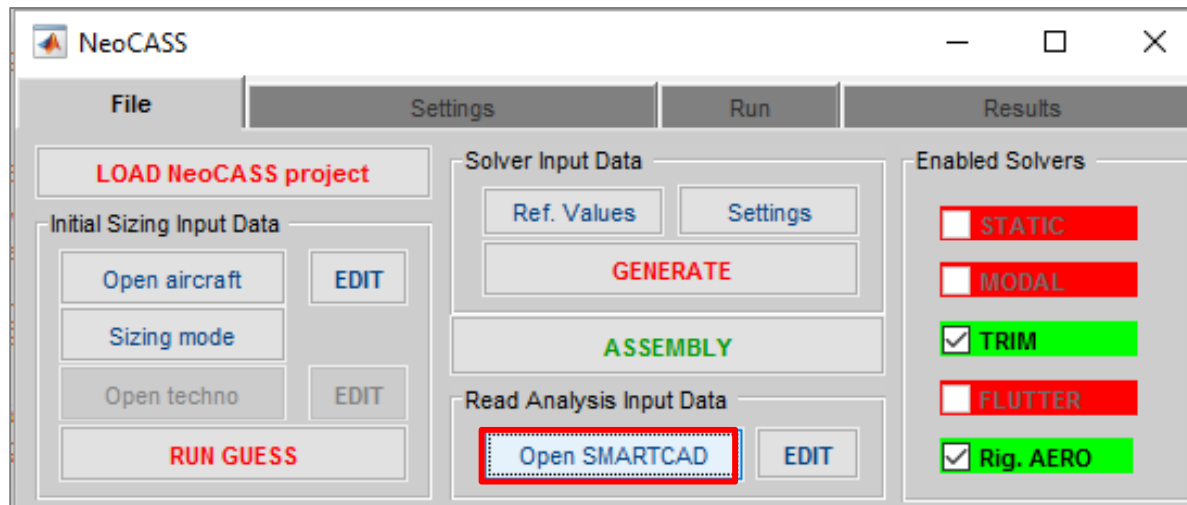


Running a 'TRIM' analysis

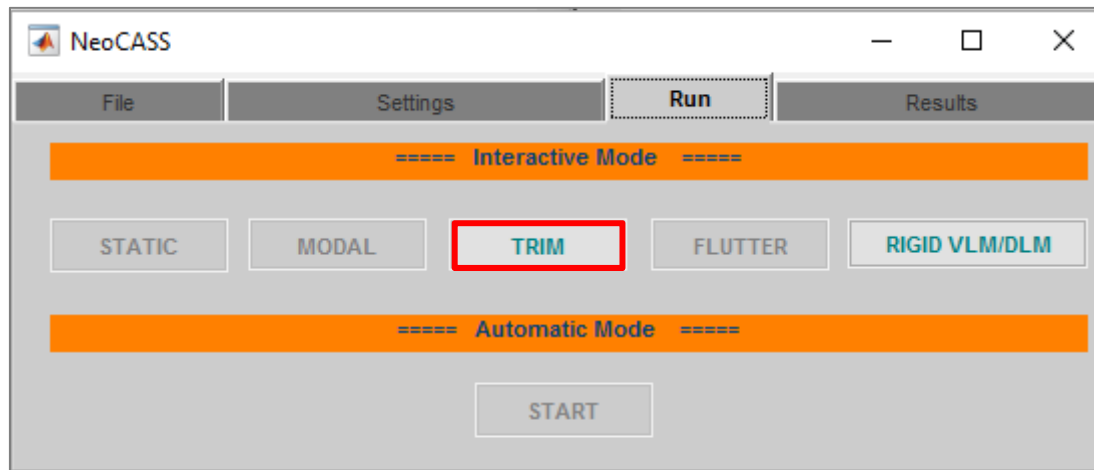


```
- Solver input data file: C:\NeoCASS_PG\Examples\PROVA\static_3cond\static.inc.  
- Exporting parameters for steady VLM solver...done.  
- SMARTCAD file: C:\NeoCASS_PG\Examples\PROVA\static_3cond\static.dat.
```

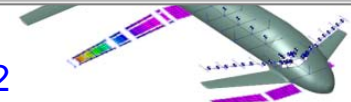
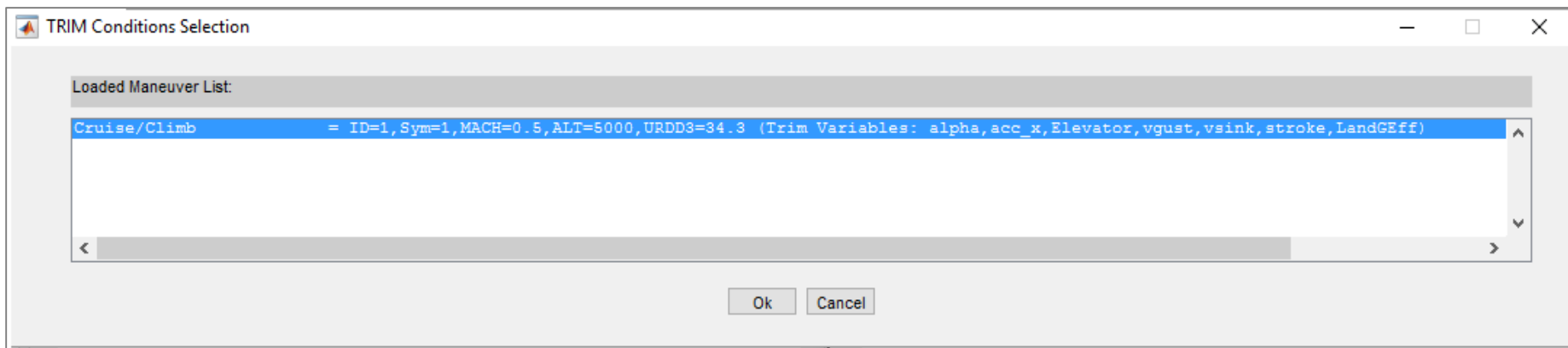
Loading the SMARTCAD file *static.dat* enables the TRIM and Rigid AERO analysis.



Running a 'TRIM' analysis



Start running the TRIM process that equilibrate the ac in the selected flight condition.

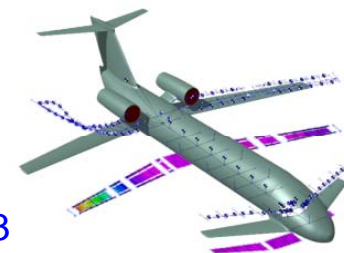


Running a 'TRIM' analysis



In the command window the solver tells you about the actual process.

```
Solving linear static unrestrained trim (ID 1)...\n\n- Setting internal database...done.\n- Building aero-structural interpolation matrices...\n  - Method: 1.\n  - Assembling collocation points interpolation matrix...done.\n  - Assembling nodes interpolation matrix...done.\n  - Assembling vorticities interpolation matrix...done.\n  - Assembling vortices midpoint interpolation matrix...done.\n  - Assembling body collocation points interpolation matrix...done.\ndone.\n\n- Assembling stiffness matrix...done.\n- Assembling mass matrix...done.\netc...
```



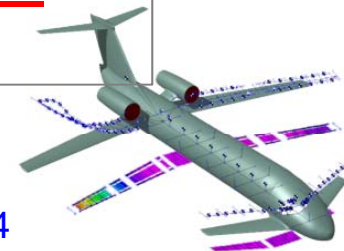
Running a 'TRIM' analysis



The trim condition is solved.

```
Solving deformable aircraft trim condition...
- X acc:      -6.88209e-12 [m/s^2].
- Y acc:      0 [m/s^2].
- Z acc:      34.3 [m/s^2].
- P-DOT:     0 [rad/s^2].
- Q-DOT:     0 [rad/s^2].
- R-DOT:     0 [rad/s^2].

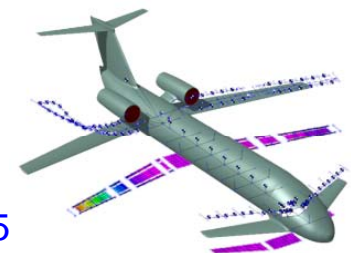
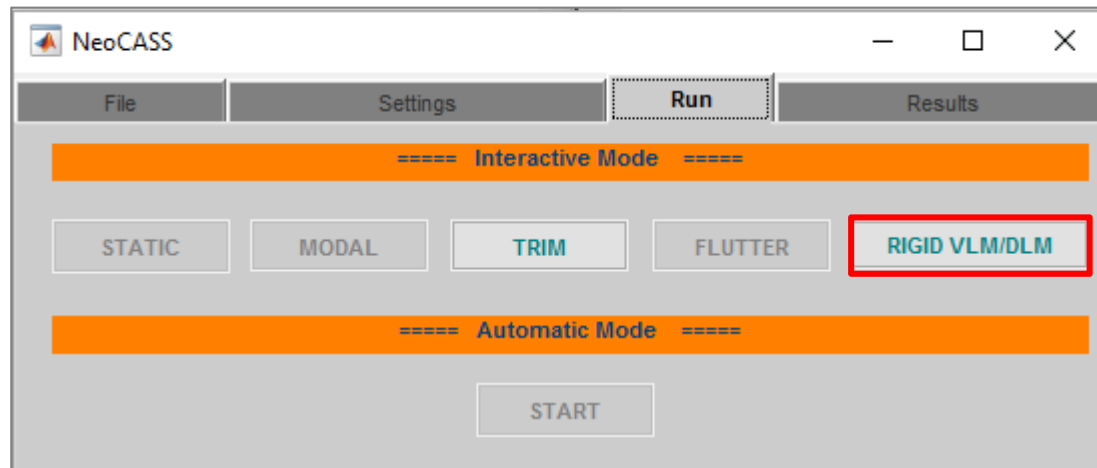
- Alpha:     38.1965 [deg].
- Sideslip:  0 [deg].
- Roll rate:  0 [-] (p*BREF/(2VREF)).
- Pitch rate: 0 [-] (q*CREF/(2VREF)).
- Yaw rate:  0 [-] (r*BREF/(2VREF)).
- Control flap1r: 0 [deg].
- Control flap2r: 0 [deg].
- Control aileronr: 0 [deg].
- Control elev1r: -6.25167 [deg].
- Control rudder1: 0 [deg].
done.
- Updating vlm model in Aero.lattice_defo...done.
- Solution summary exported to C:\NeoCASS_PG\Examples\PROVA\static_3cond\static man 1.txt file.
completed.
```



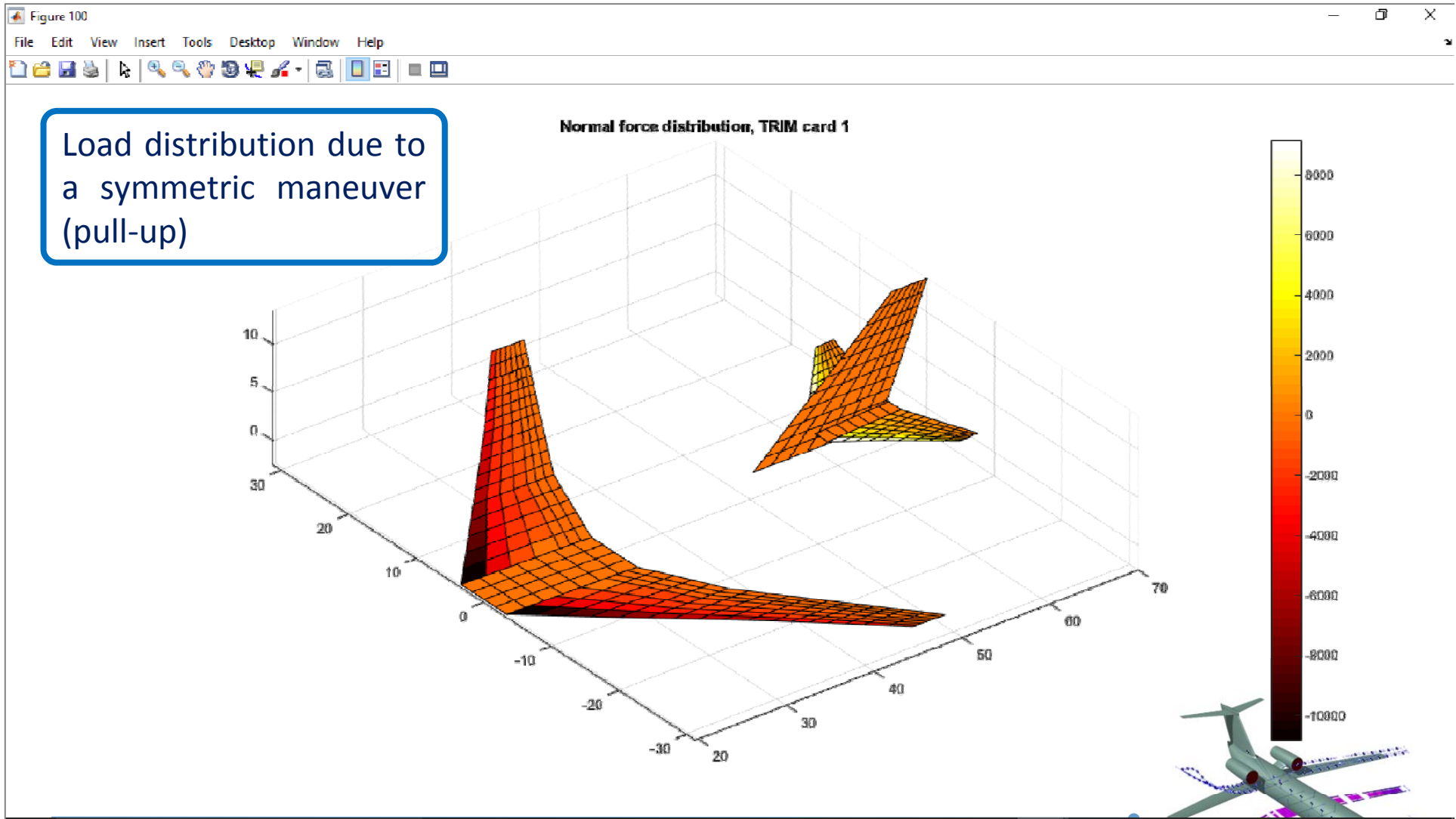
Running a 'Rigid VLM/DLM' analysis



Now one could also run the 'Rigid VLM/DLM analysis'. By clicking it the analysis will start automatically.



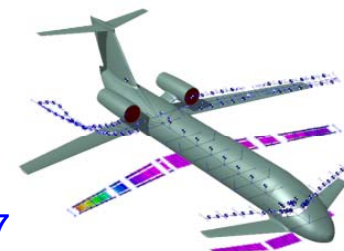
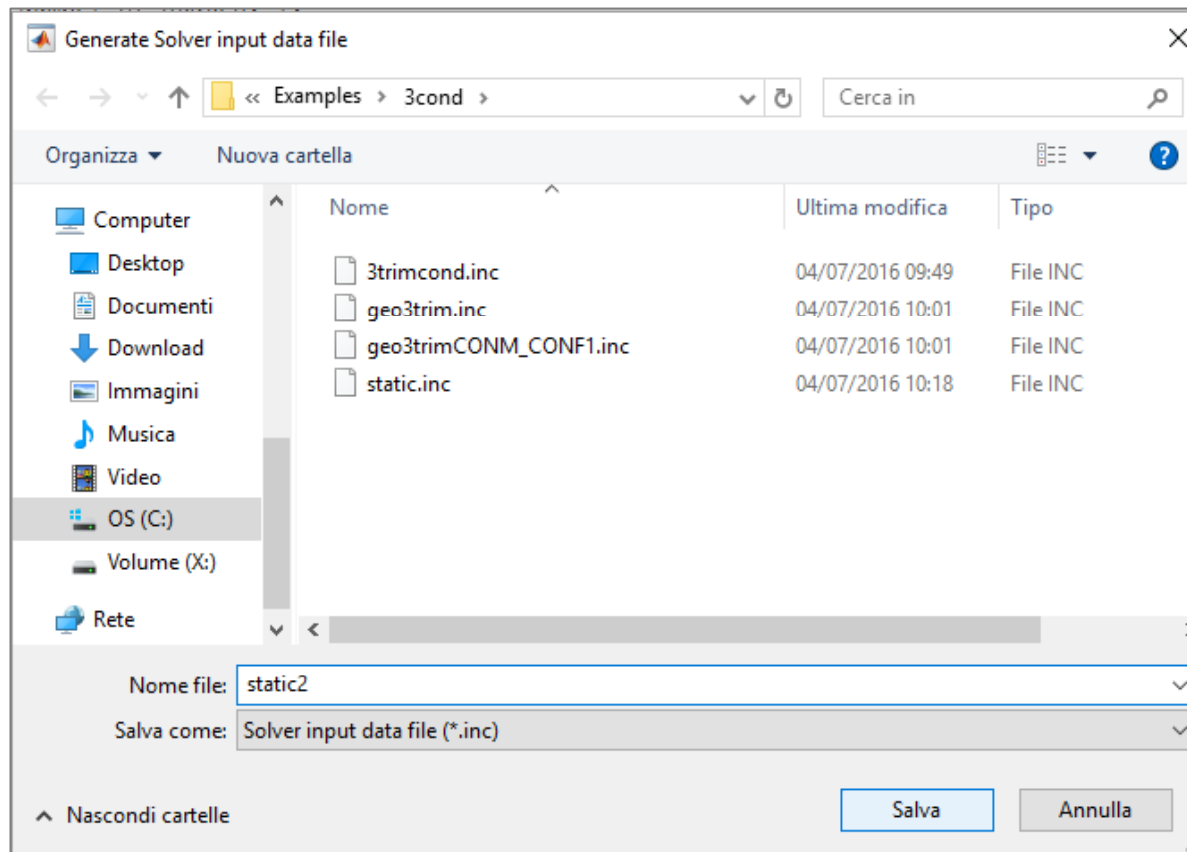
Running a 'Rigid VLM/DLM' analysis



Running another 'TRIM' and 'Rigid VLM/DLM' analysis



In order to analyze another loading condition, return to the [18th](#) slide and repeat the procedure for 'sideslip'.



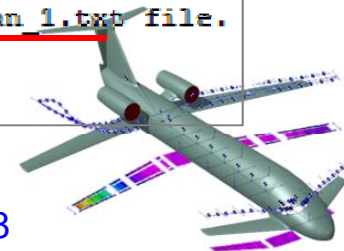
Running another 'TRIM' and 'Rigid VLM/DLM' analysis



The new trim condition is solved:

```
Solving deformable aircraft trim condition...
- X acc:      -3.36379e-12 [m/s^2].
- Y acc:      1.04461 [m/s^2].
- Z acc:      9.81 [m/s^2].
- P-DOT:      0 [rad/s^2].
- Q-DOT:      0 [rad/s^2].
- R-DOT:      0 [rad/s^2].

- Alpha:      10.2084 [deg].
- Sideslip:   20 [deg].
- Roll rate:  0 [-] (p*BREF/(2VREF)).
- Pitch rate: 0 [-] (q*CREF/(2VREF)).
- Yaw rate:   0 [-] (r*BREF/(2VREF)).
- Control flap1r: 0 [deg].
- Control flap2r: 0 [deg].
- Control aileronr: 18.9543 [deg].
- Control elev1r: 4.89144 [deg].
- Control rudder1: 19.3475 [deg].
done.
- Updating vlm model in Aero.lattice_defo...done.
- Solution summary exported to C:\NeoCASS_PG\Examples\PROVA\static_3cond\static2_man_1.txt file.
completed.
```



Running another 'TRIM' and 'Rigid VLM/DLM' analysis

