Aero

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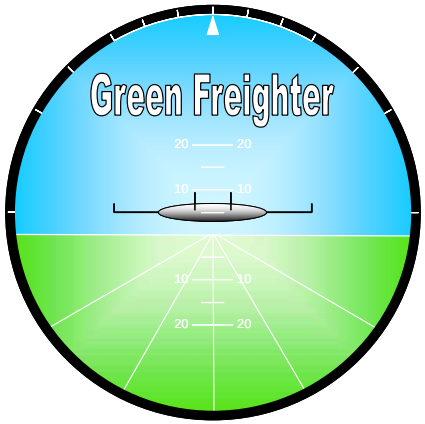

Investigation of the ATR 72 in CEASIOM-50

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Francisco Gómez
Hamburg University of Applied Sciences

SimSac Design Workshop

Simulating aircraft Stability And Control

Liverpool, UK, 27. - 29.04.2009

Content

- Input of aircraft geometry
- Input of flight envelope
- Results
- Findings and comments
- Outlook

Input of aircraft geometry

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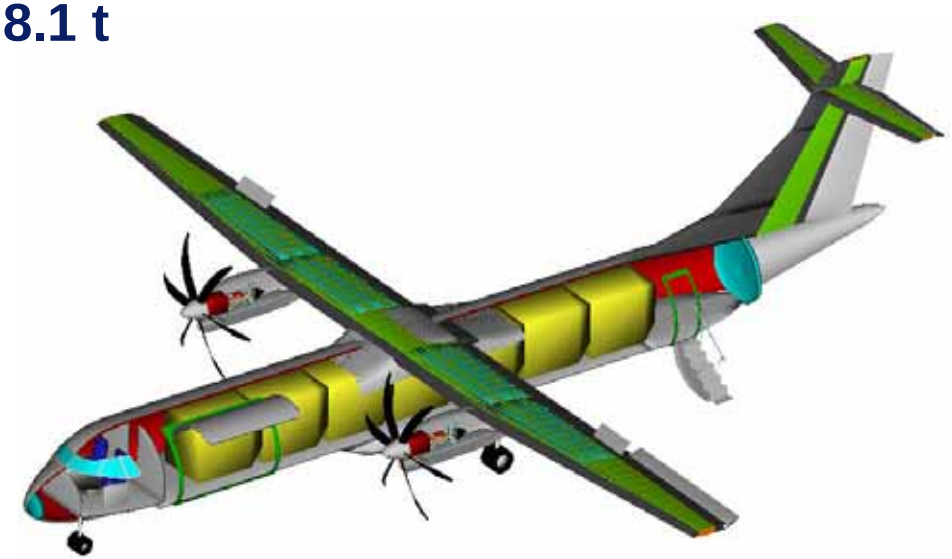
ATR72 aircraft data

- Twin-engine, turboprop
- 27 m x 27 m
- MTOW: 22 t
- Max. payload (freighter): 8.1 t



Input of aircraft geometry

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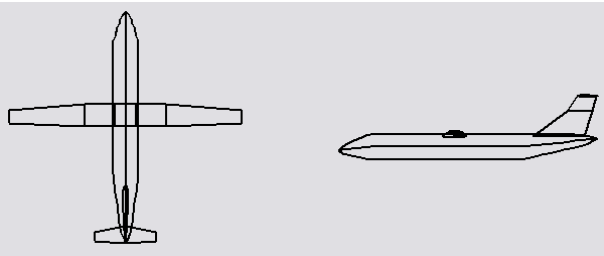
Input directly into xml-file

– **“Edit Geometry”- function for setup of completely new aircraft very slow and complicated**



```
<?xml version="1.0" ?>
<!--  Kolja Seeckt, Hamburg University of Applied Sciences  -->
- <root xml_tb_version="3.2.1" idx="1" type="struct" size="1 1">
    <!--  ok  -->
  - <Fuselage idx="1" type="struct" size="1 1">
      <!--  Fuselage  -->
      <Forefuse_X_sect_vertical_diameter idx="1" type="double" size="1 1">2.64</Forefuse_X_sect_vertical_diameter>
      <!--  ok  -->
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      <omega_nose idx="1" type="double" size="1 1">58</omega_nose>
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      <epsilon_nose idx="1" type="double" size="1 1">1.28</epsilon_nose>
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      <!--  ok  -->
      <phi_tail idx="1" type="double" size="1 1">6</phi_tail>
      <!--  ok  -->
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      <!--  ok  -->
    </Fuselage>
    <!--  ok  -->
```

Input of aircraft geometry

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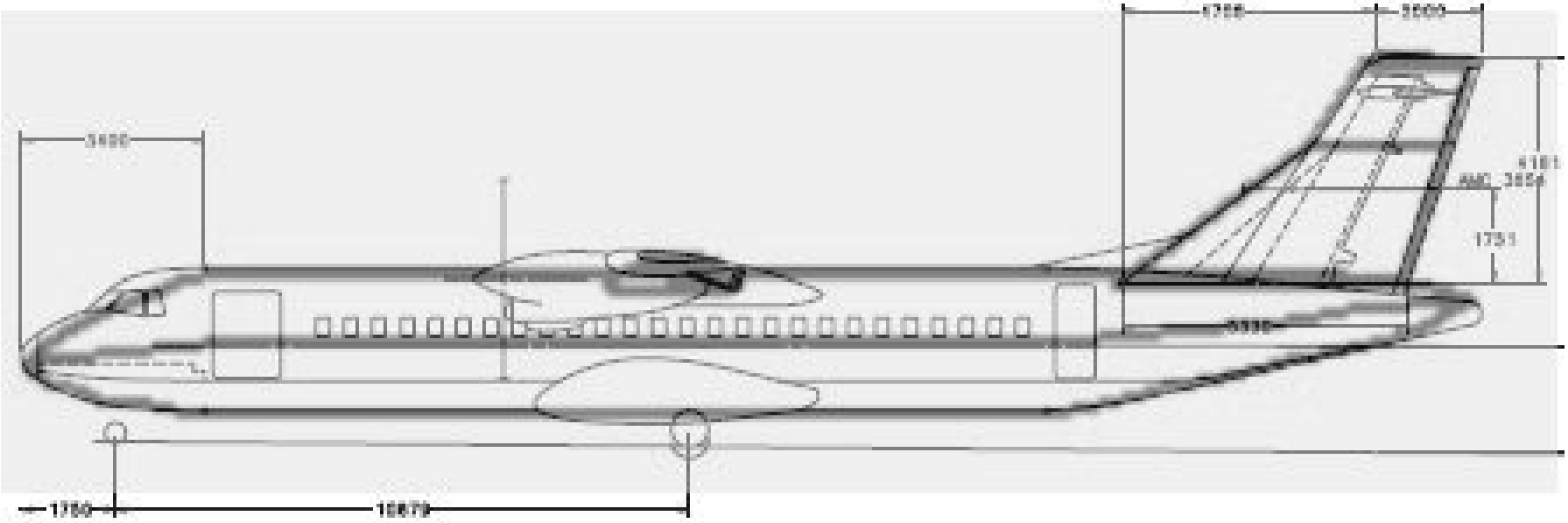
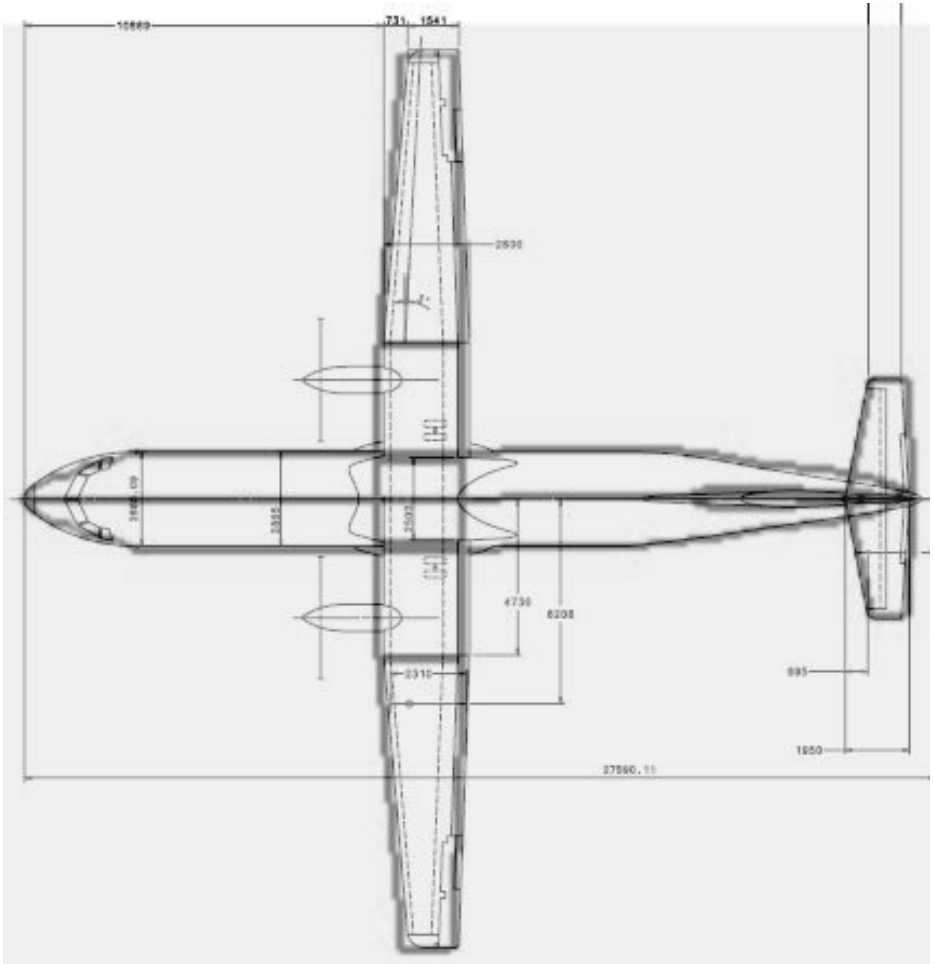
Comparison of original aircraft vs. model



Input of aircraft geometry

Comparison of original aircraft vs. model



Input of flight envelope

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Definition of flight conditions in ‘reasonable’ orders of magnitude (450 conditions in total)

Property Name	Value
Minimum Angle of Attack (Deg)	-5.00
Maximum Angle of Attack (Deg)	15.00
Number of AoA Increments	5.00
Minimum Mach number	0.10
Maximum Mach number	0.60
Number of Mach Increments	6.00
Minimum Side-slip angle (Deg)	-5.00
Maximum Side-slip angle (Deg)	5.00
Number of Beta Increments	2.00
Minimum pitch rate (Deg/s)	-10.00
Maximum pitch rate (Deg/s)	10.00
Number of q Increments	2.00
Minimum roll rate (Deg/s)	-10.00
Maximum roll rate (Deg/s)	10.00

Input of flight envelope

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Definition of flight conditions in ‘reasonable’ orders of magnitude (450 conditions in total)

Number of p Increments	2.00
Minimum yaw rate (Deg/s)	-10.00
Maximum yaw rate (Deg/s)	10.00
Number of r Increments	2.00
Minimum Elevator Angle(Deg)	-5.00
Maximum Elevator Angle(Deg)	5.00
Number of Elev. Increments	2.00
Minimum Rudder Angle(Deg)	-5.00
Maximum Rudder Angle(Deg)	5.00
Number of Rud. Increments	2.00
Minimum Aileron Angle(Deg)	-5.00
Maximum Aileron Angle(Deg)	5.00
Number of Ail. Increments	2.00
Minimum Inboard Flap Angle(Deg)	0.00
Maximum Inboard Flap Angle(Deg)	0.00
Number of Flap1. Increments	0.00

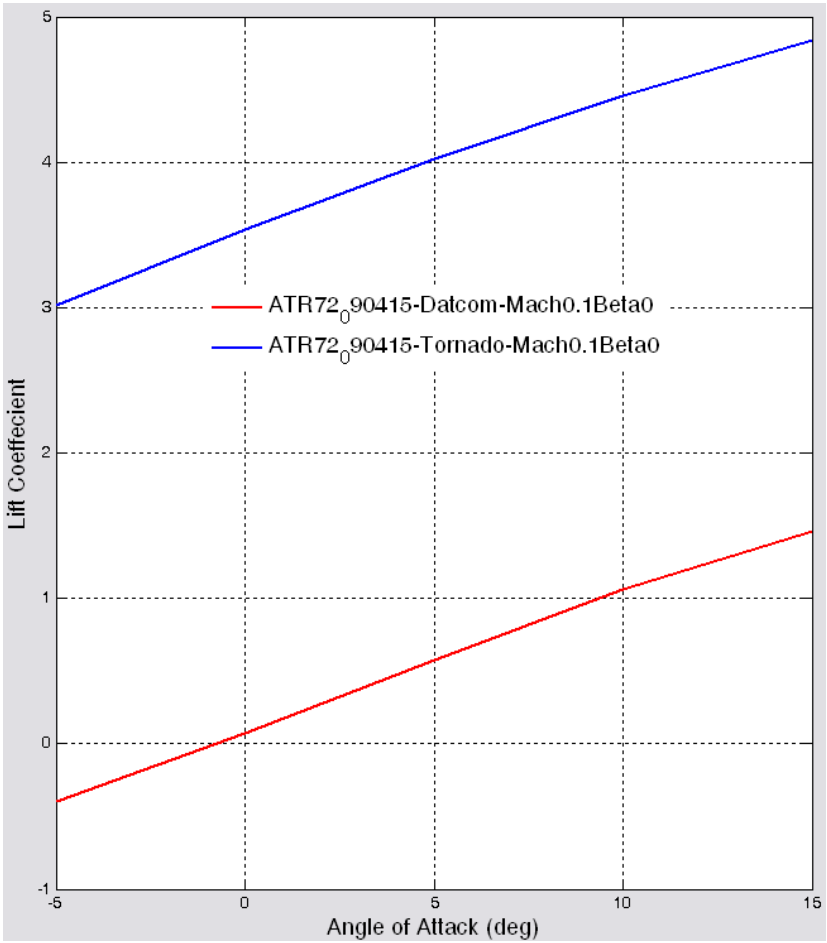
Results

C_L over alpha

⇒ **Tornado delivers unrealistic results**

⇒ **DATCOM delivers results in a realistic order of magnitude**

⇒ **Check: see below**



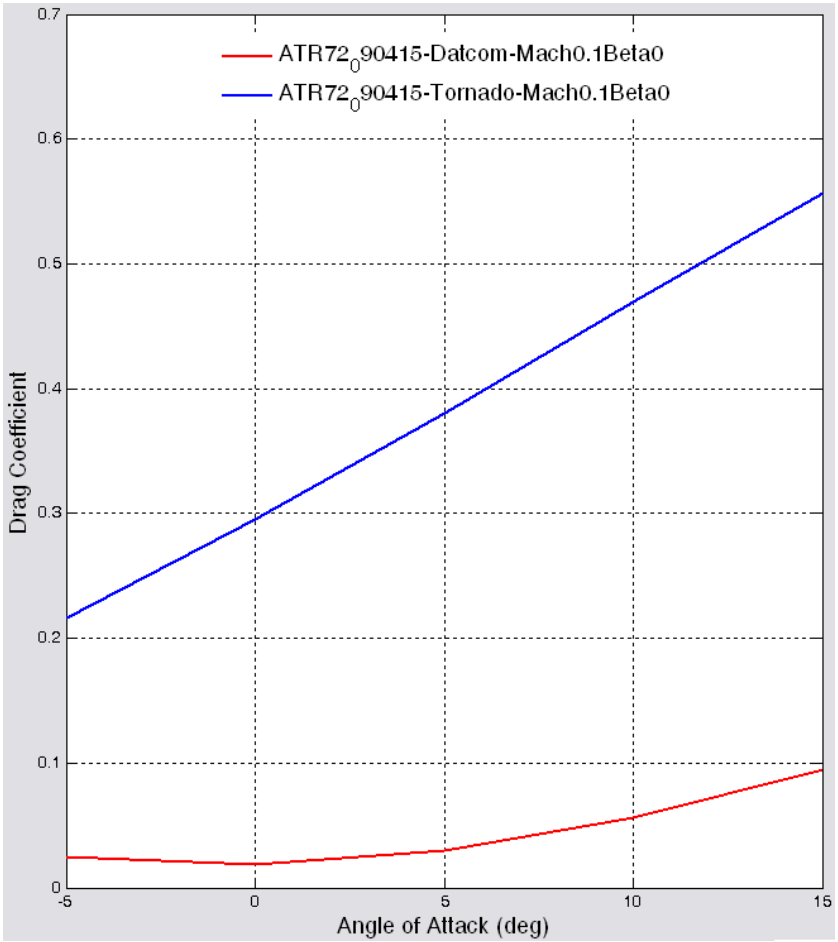
Results

C_D over alpha

⇒ **Tornado delivers unrealistic results**

⇒ **DATCOM delivers results in a realistic order of magnitude**

⇒ **Check: see below**



Results

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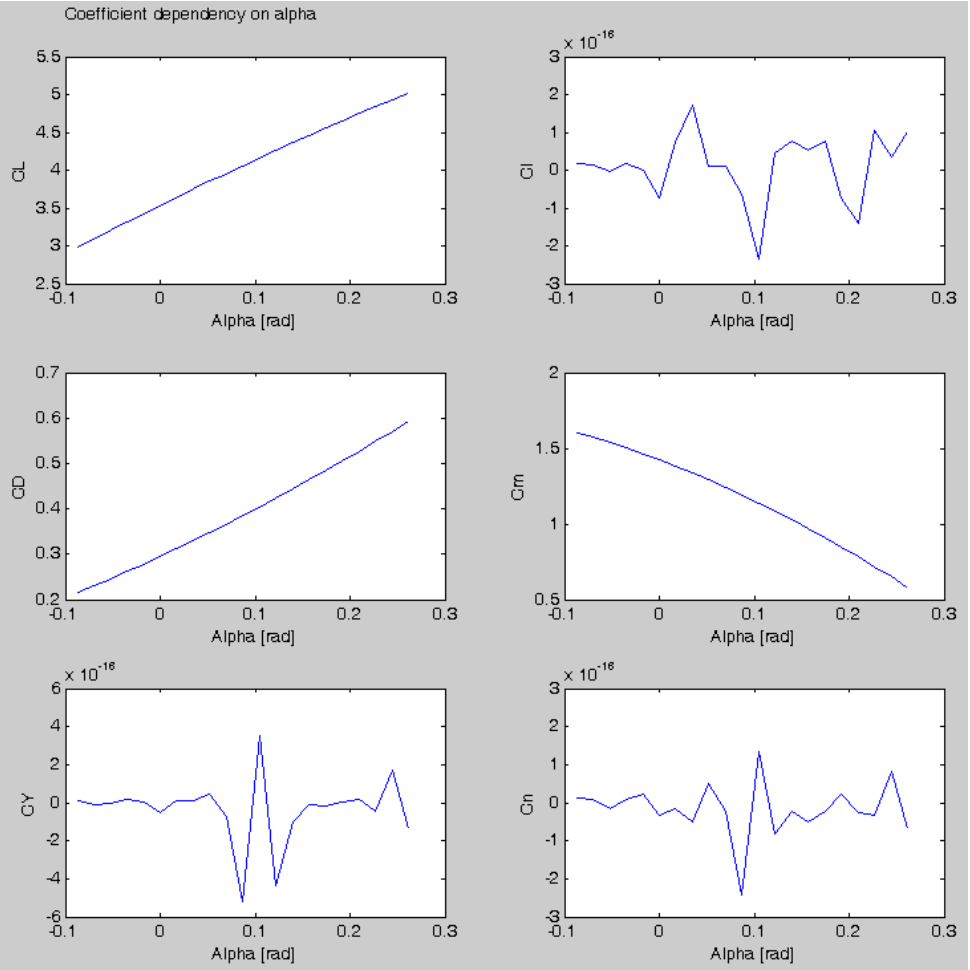
Check: Tornado

⇒ **Same (unrealistic) results as when started from inside CEASIOM**
(see to GAV-presentation)

⇒ **Reason: tail configuration?**



Results

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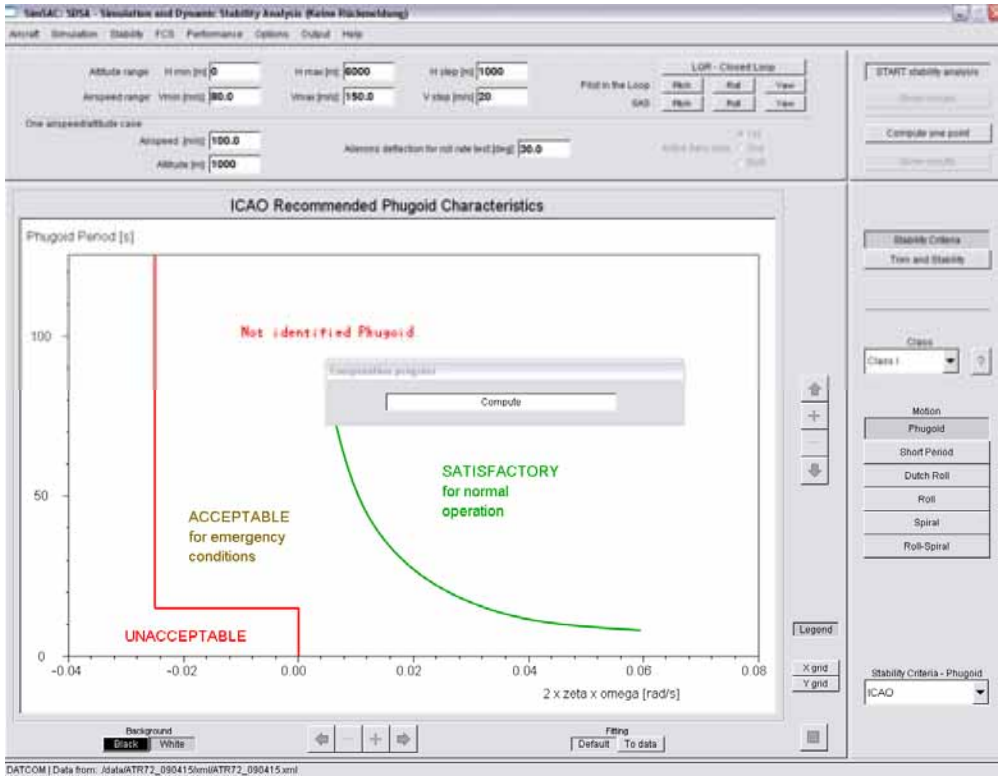
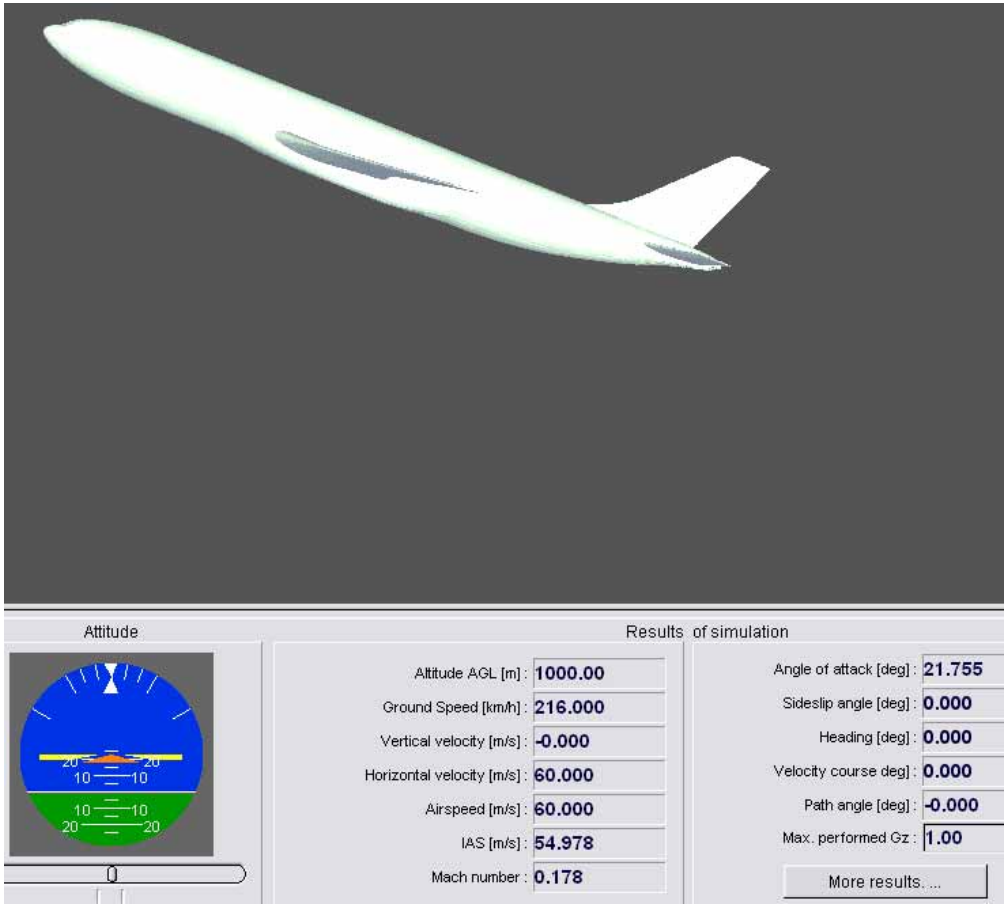
SDSA: Computation of Eigenvalues gets stuck

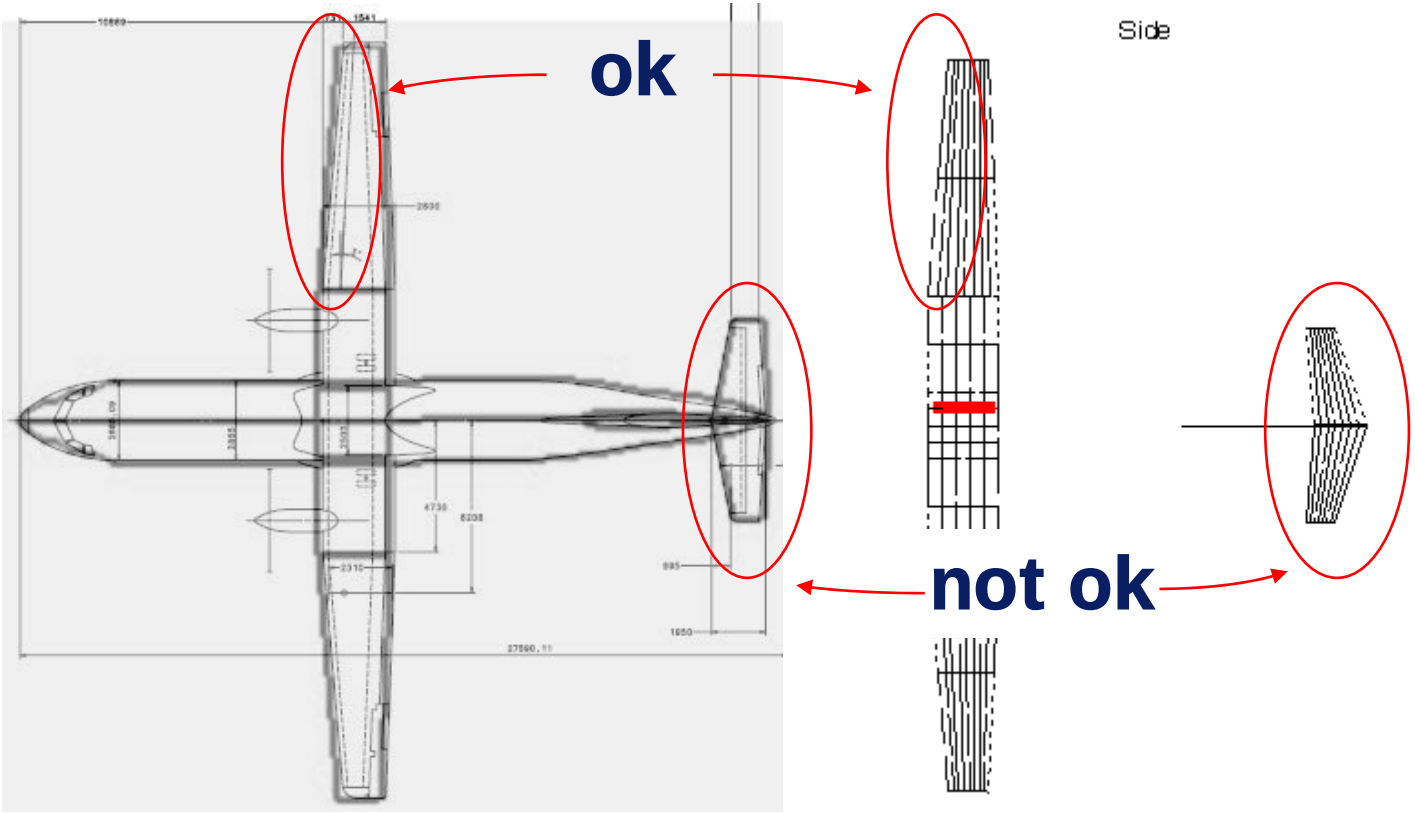


Results

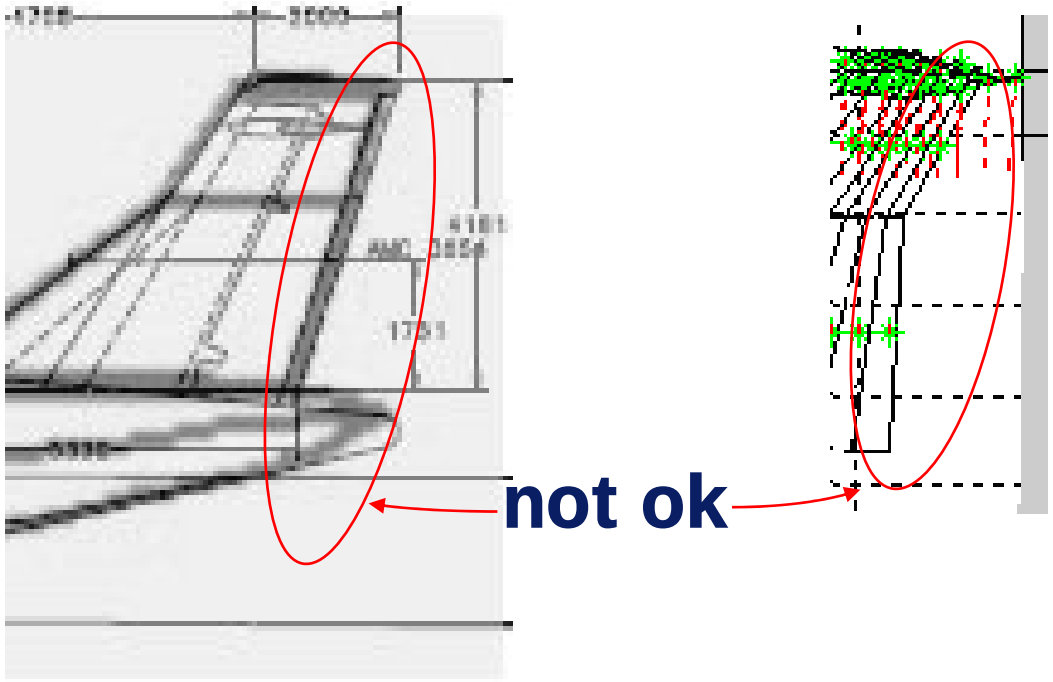
SDSA: Simulation is running (principally)



Tornado: Inverted sweep angle definition? (1)



Tornado: Inverted sweep angle definition? (2)



Findings and comments

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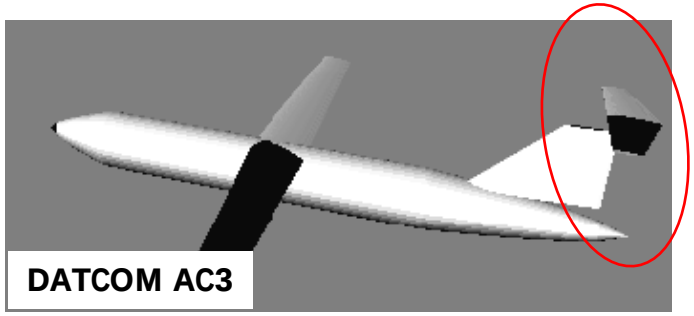
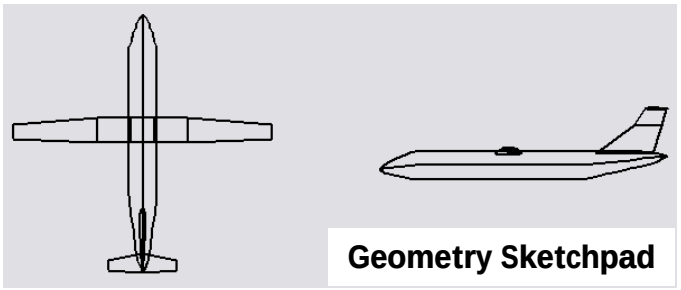
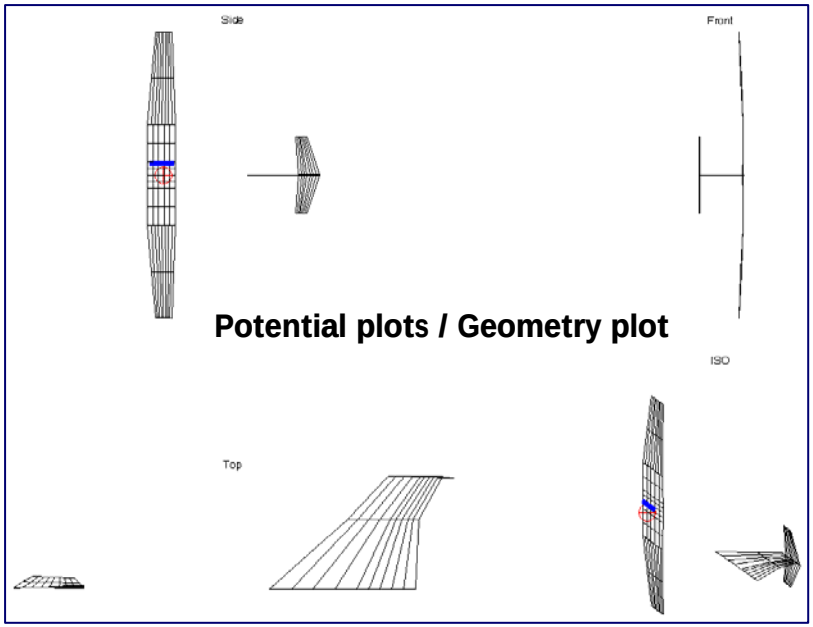
Is “IsoViewer” “AircraftBuilder”?







⇒ **IsoViewer is best (only) possibility to visually check control surface positions and sizes**

Findings and comments

Aircraft Builder doesn't work

```
??? Error using ==> acbuilder
Too many output arguments.

Error in ==> acbuilder at 17
   ACB=AcBuilder;

Error in ==> AMB>open_viewer_Callback at 2786
     acbuilder(viewergeo)

Error in ==> gui_mainfcn at 96
        feval(varargin{:});

Error in ==> AMB at 138
    gui_mainfcn(gui_State, varargin{:});

Error in ==>
guidemfile>@(hObject,eventdata)AMB('open_viewer_Callback',hObject,eventdata,guidata(hObject))


??? Error while evaluating uimenu Callback
```

Findings and comments

How are the geometry parameters defined?

Examples:

- F12 template has negative root and positive tip incidence angle (irritating)
- Definition of dorsal and ventral fin,
- Aerofoil technology, fractional_change_vortex_induced_drag_factor,
- ...

⇒ **Documentation**

Findings and comments

Sweep angles and kink positions of zero degree / zero percent not possible

Template files of some airfoils (e.g. NACA0012.DAT) contain too many sections for use inside DATCOM

Findings and comments

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Adaptation of aircraft (fuel) mass very concealed

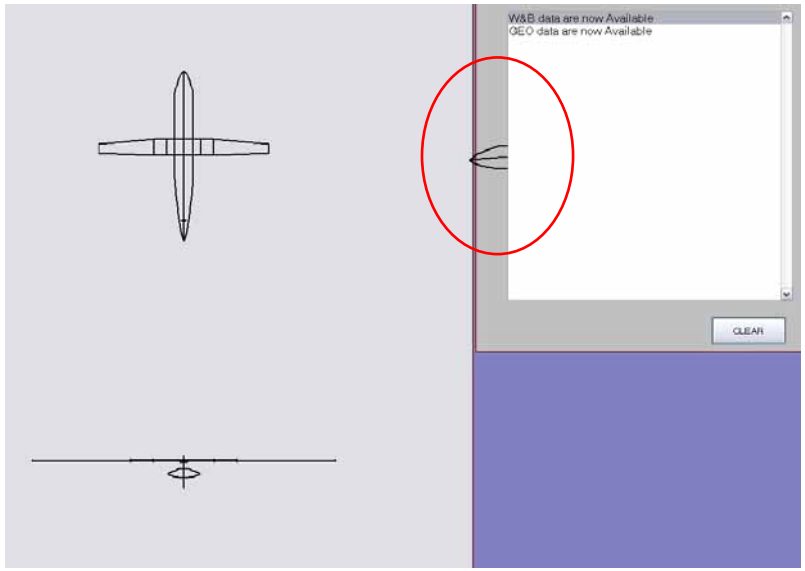
...\CEASIOM\W&B\wb_struct_init.m

```
40      %-------------------------------------------------------------------------
41      % PARAMETERS INPUT ONLY MODIFIED BY THE USER / NEVER MODIFIED BY WB
42      %-------------------------------------------------------------------------
43 -    aircraft.weight_balance.Fuel.Maximum_fuel_in_wings          = 2500;
44 -    aircraft.weight_balance.Fuel.Maximum_fuel_in_auxiliary      = 0;
45 -    aircraft.weight_balance.Fuel.Maximum_fuel_in_central_wingbox = 0;
46
47      %-------------------------------------------------------------------------
```

Findings and comments

CEASIOM-48 + Matlab V7 (R14)

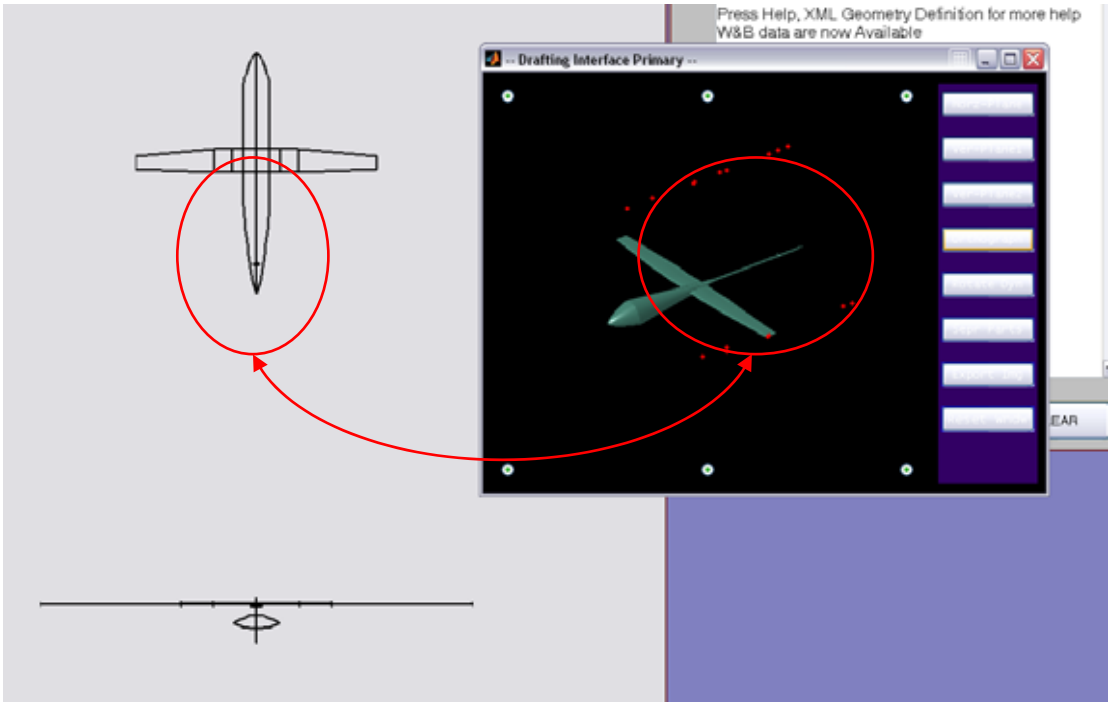
Wrong geometry display (behind message box)



Findings and comments

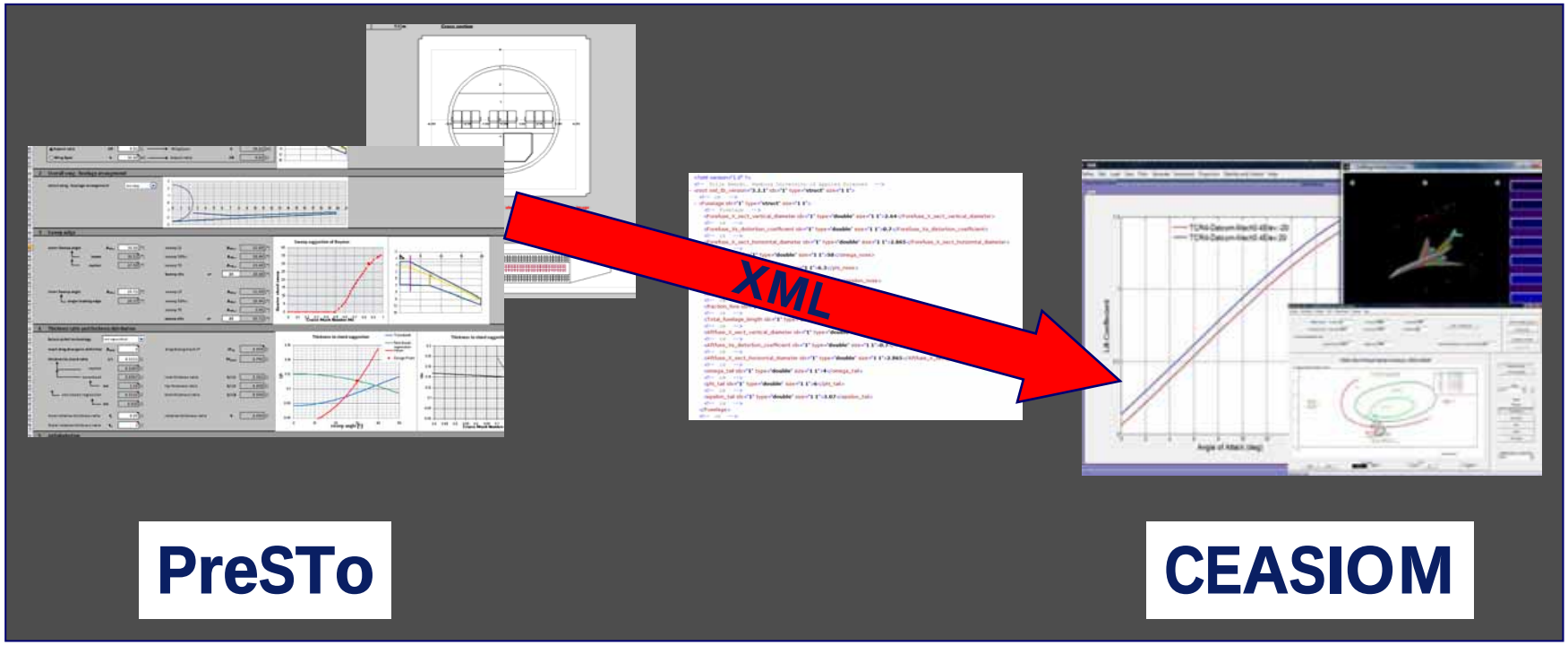
CEASIOM-48 + Matlab V7 (R14)

Iso-Viewer loads old data (even after restart of Matlab and AMB)



Outlook

Combination of PreSTo (HAW's Aircraft Preliminary Sizing Tool) and CEASIOM



Thank you for your attention!

For further information please contact:

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