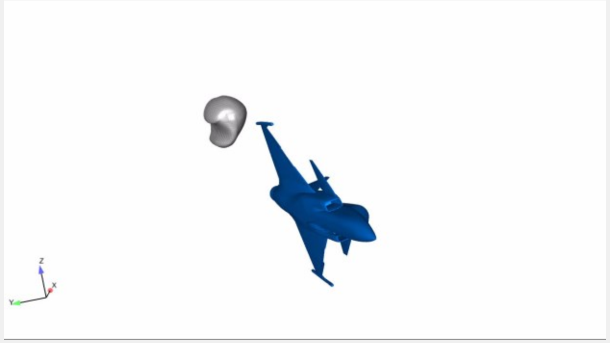
Countermeasures Aerodynamics

Motivation

- CFD can deepen the understanding of the physical process of ejecting countermeasure devices
- Numerical simulations can contribute to develop tactics for use of countermeasure.
- Certification for ejection of flares

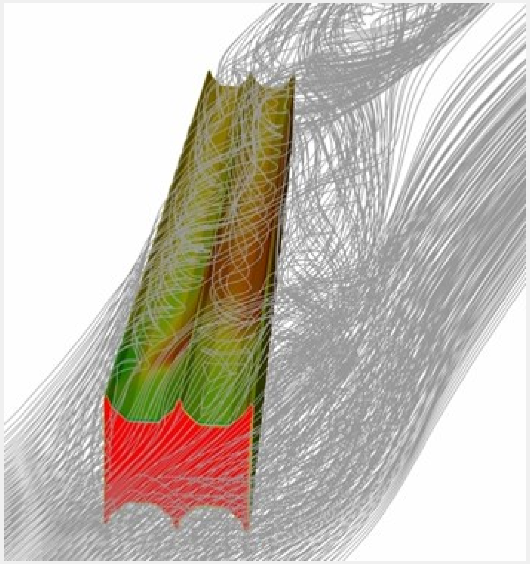


Chaff cloud behind JAS 39 Griffin

Ejection of flares from a F-16 during an airshow in Polen.

Physical modelling

Complex Physics



Assumptions:

- Steady flow
- The countermeasure devices does not effect the flow.
- The size of the flares are small compared to the surrounding vortices

FOI

AD/AG-55: Countermeasures Aerodynamics

GARTEUR GROUP FOR AERONAUTICAL RESEARCH AND TECHNOLOGY IN EUROPE
FRANCE GERMANY ITALY THE NETHERLANDS SPAIN SWEDEN UNITED KINGDOM

http://www.garteur.org

Project duration: June 2015 – June 2018

Action Group Chairman: Torsten Berglind, FOI

Objective:

- Develop/compare modelling methods for chaff
- Study the effects of combustion on the flare trajectory: shape changes, high temperature effects and combustion gases
- Use generic test cases

AG-55 Modelling of chaff

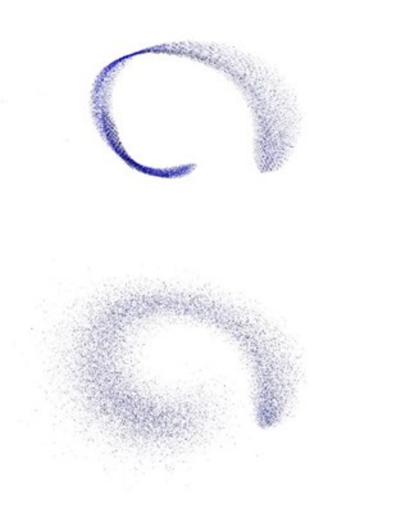
1. Eulerian approach

- Passive scalar transport with simple diffusivity model

2. Lagrangian approach

Step 1:

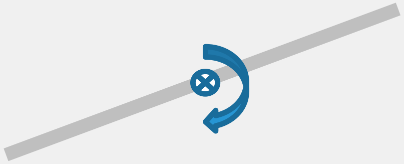
- Chaff is modeled as a point mass, every chaff is tracked,



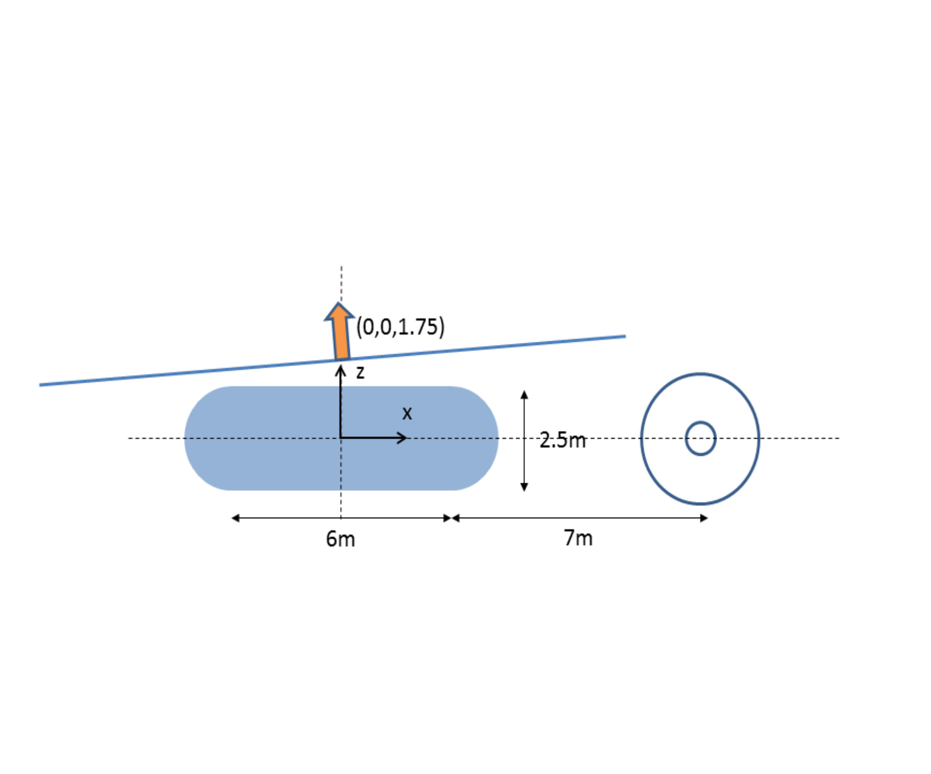
- Apart from the mean flow, chaff is affected by stochastic forces that stems from the turbulent quantities.

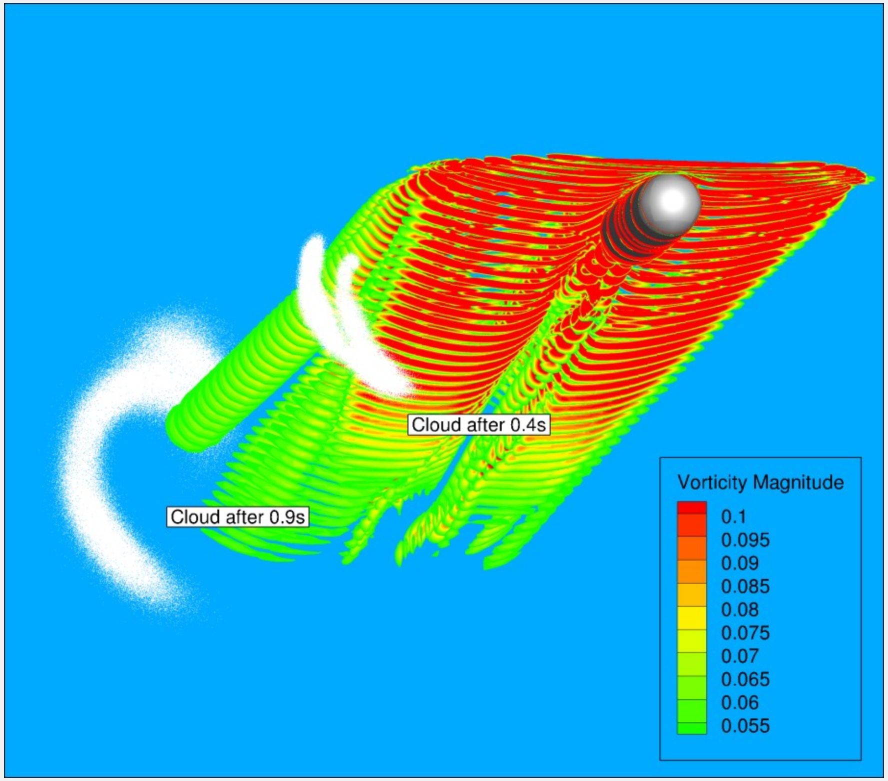
Step 2:

- Chaff is modeled as rigid thin cylinders and the direction is determined by 6DoF mechanics. The computational solution gives both position and direction of each chaff

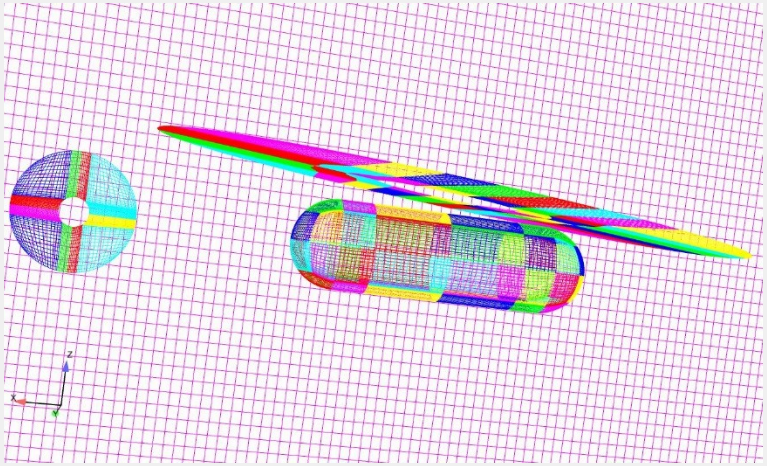


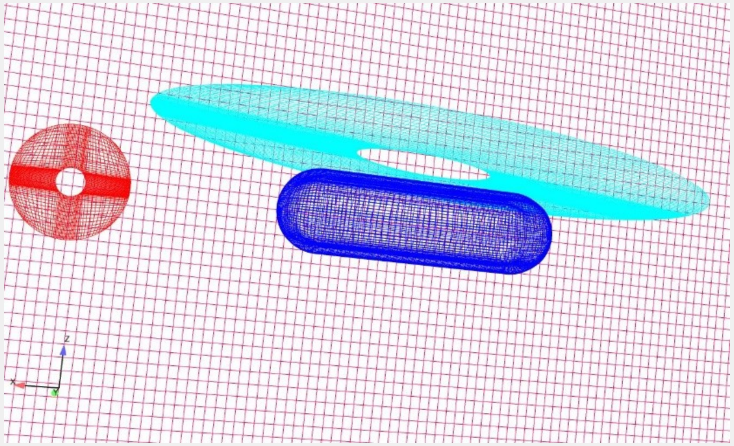
AG-55 Chaff release around a generic helicopter





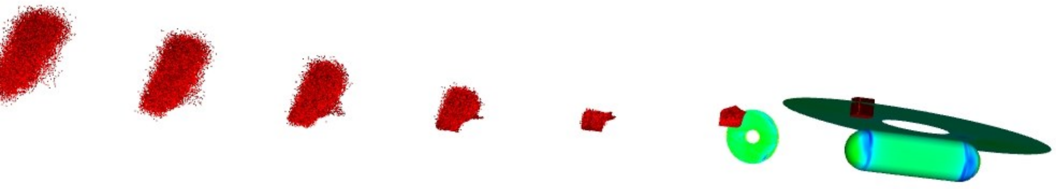
Conversion from a multiblock grid to an unstructured grid



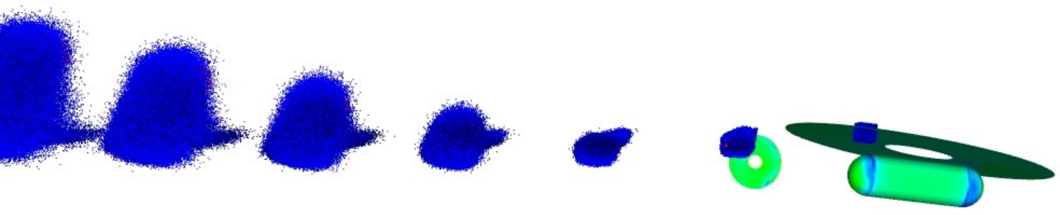


14.4 Miljon nodes

Chaff computations by FOI



Chaff computations by NLR



Flare activity plan

Step 1:

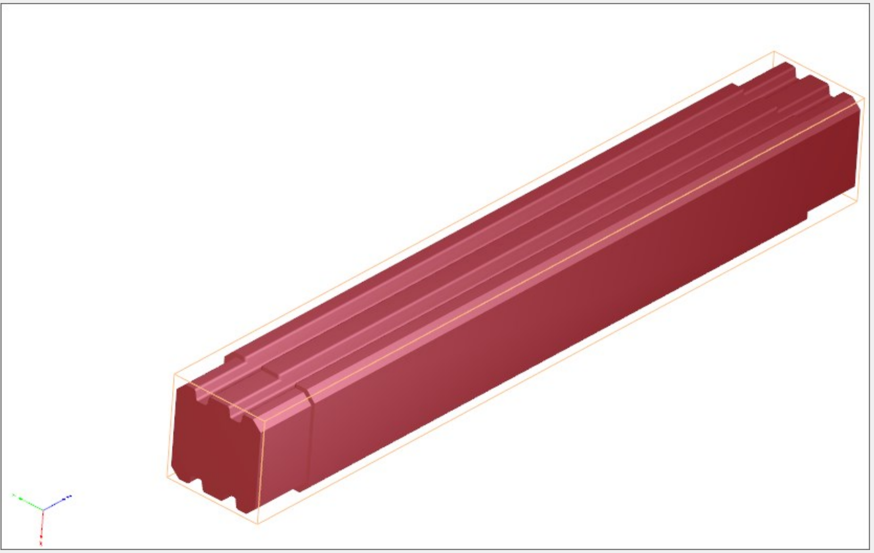
- Shape changes that effects mass, moments of inertia and possibly also mass center

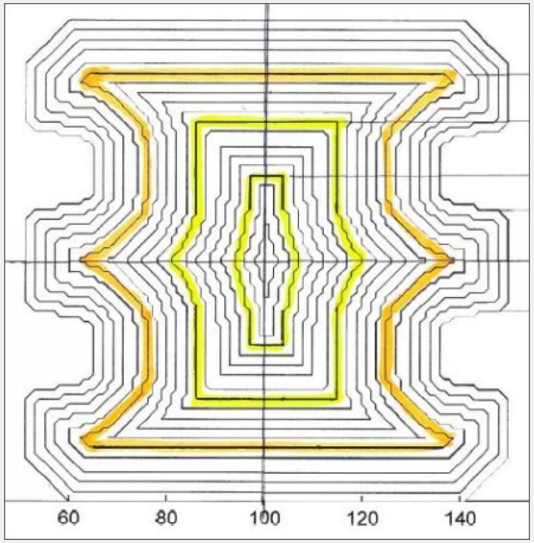
Step 2:

- Surface temperature up to 2000K requiring non-equilibrium gas model
- Outflow of exhaust gases

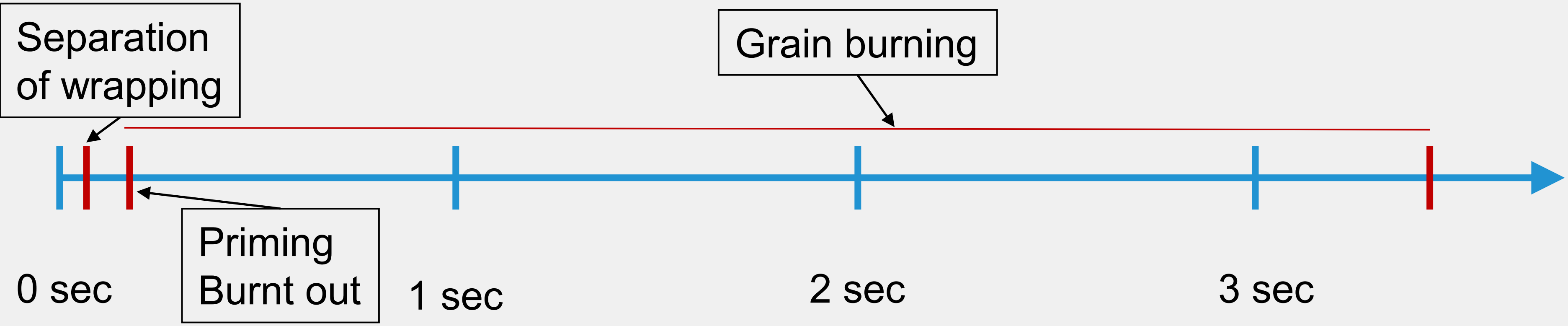
Participants: Airbus Defence and Space, LACROIX, MBDA France, and FOI

Flare burning scenario

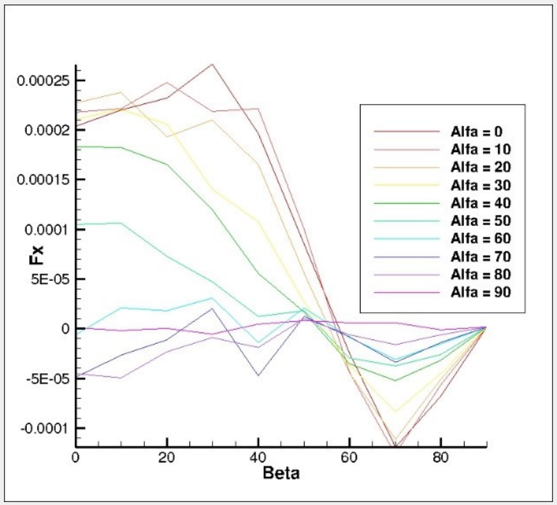


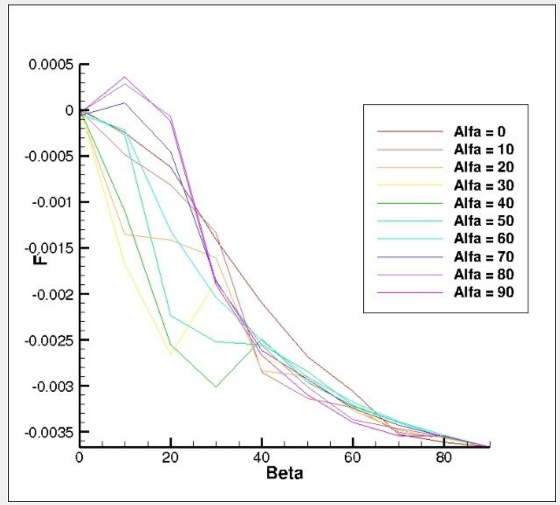


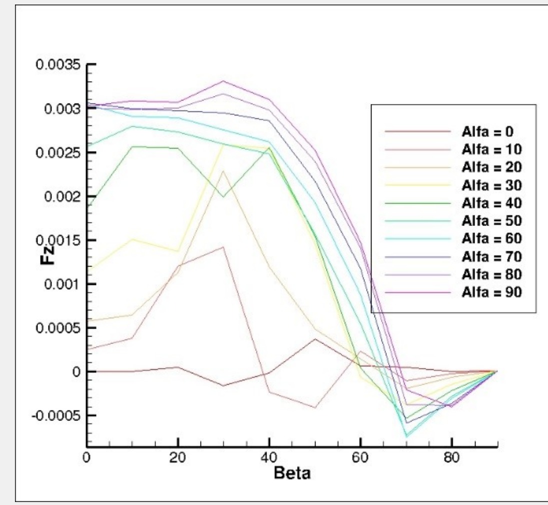
T=0 s Airbus D&S
T=1 s FOI
T=2 s MBDA
T=3 s MBDA

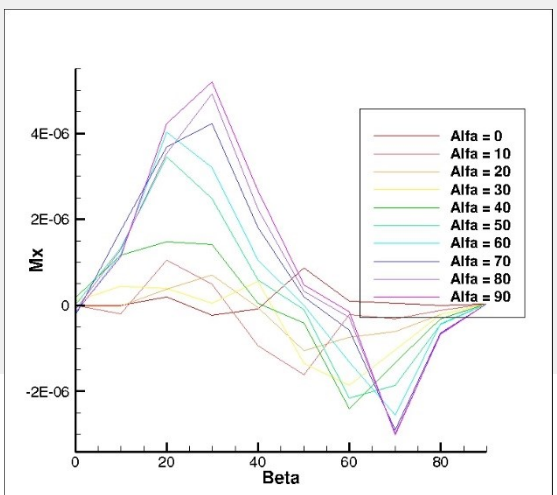


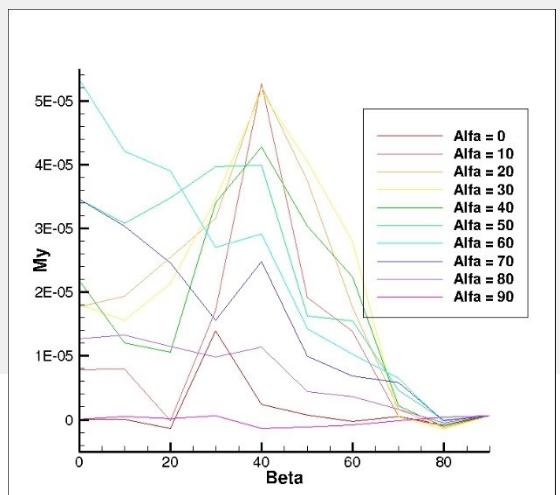
Aerodynamic database t= 1.0 sec

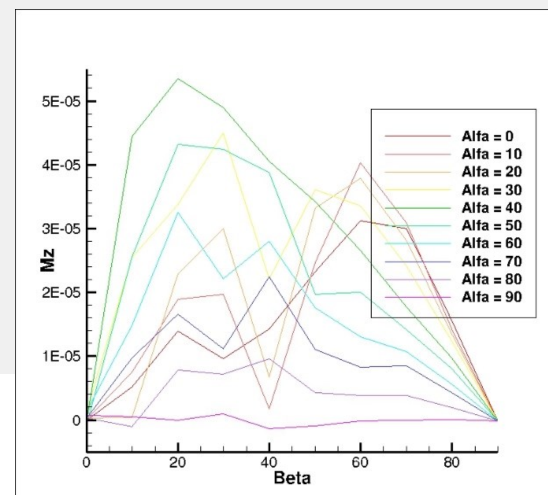




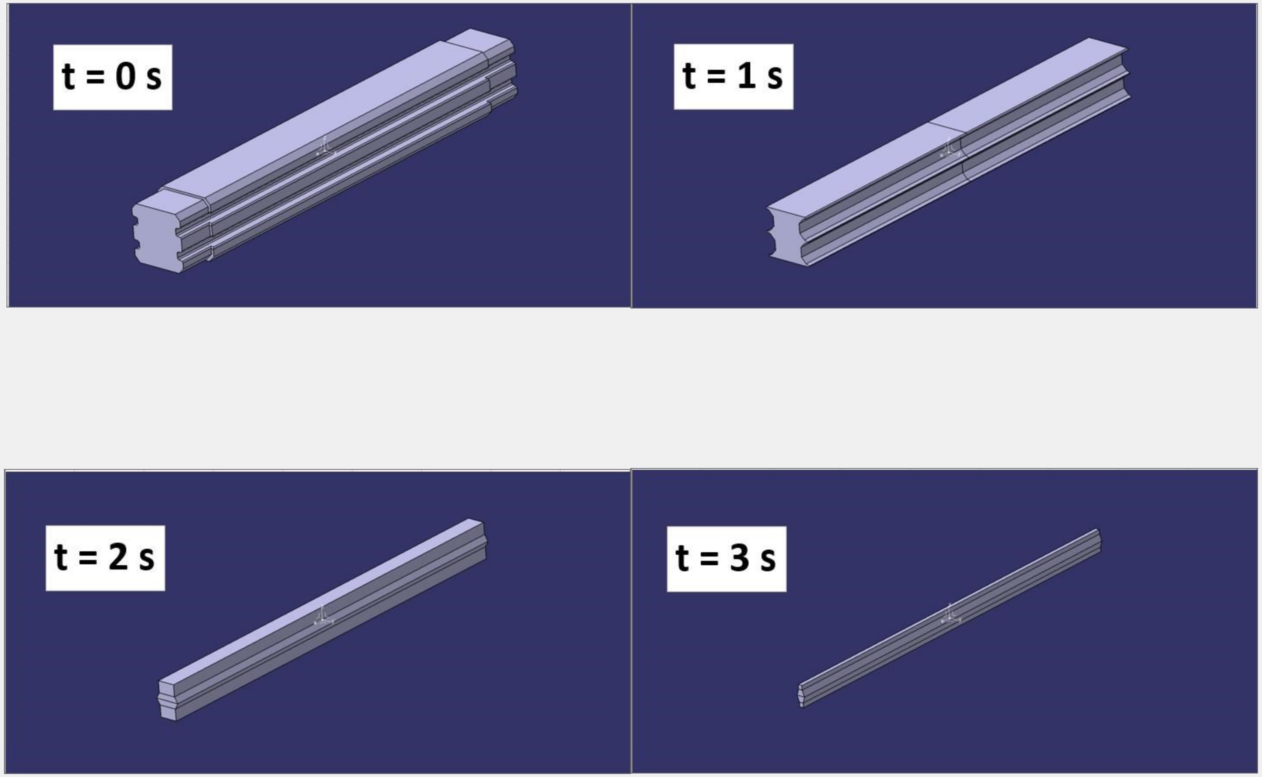


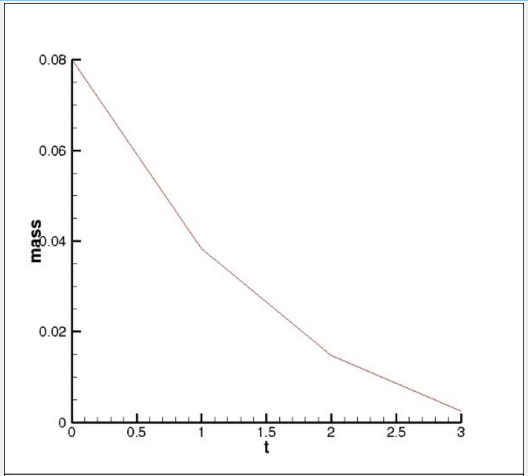


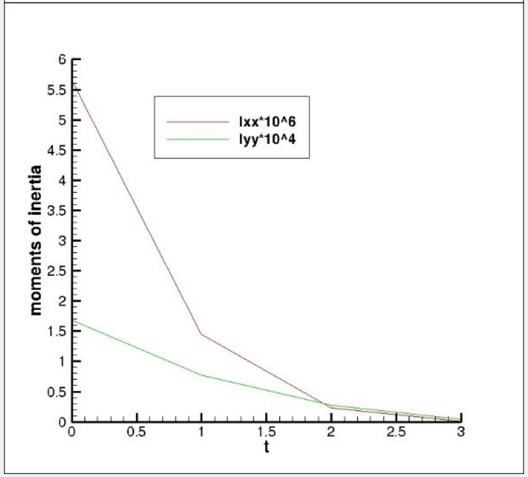




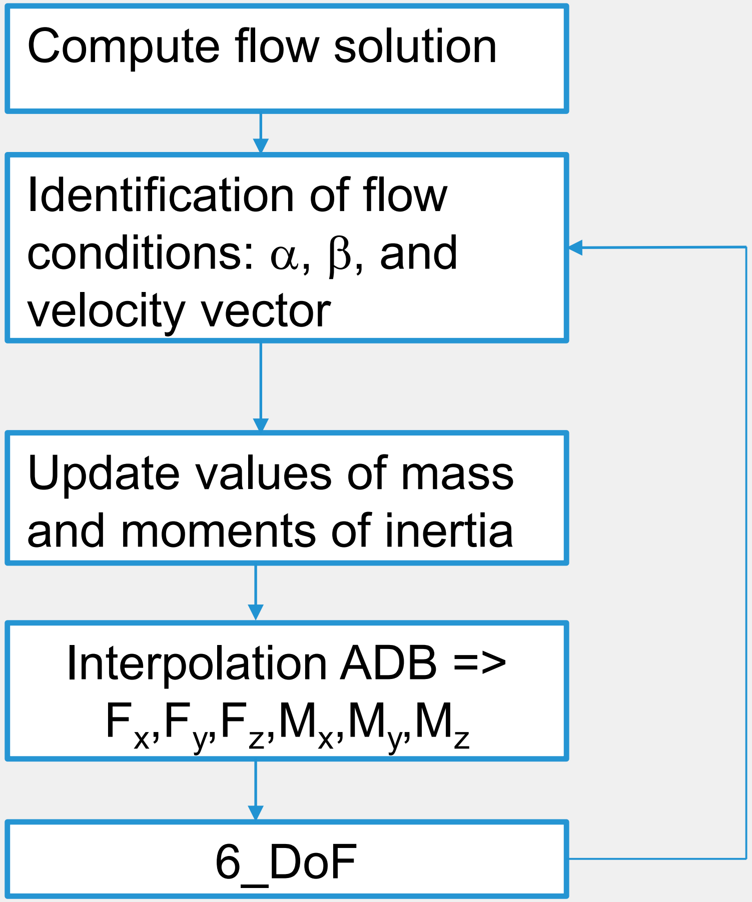
Time dependency for mass and moments of inertia





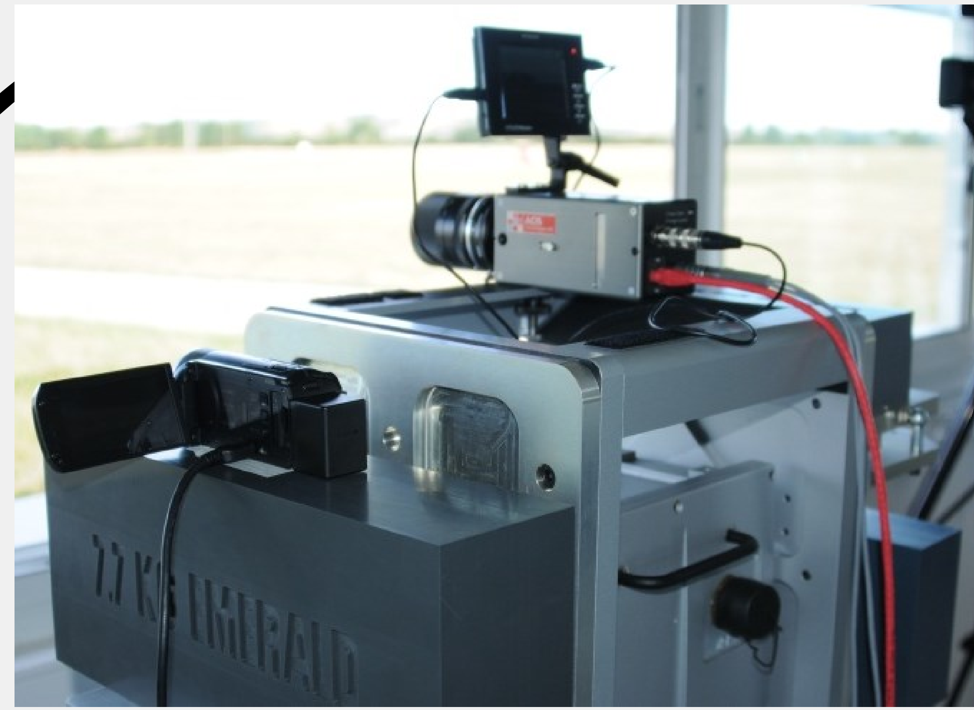


Trajectory simulations



Flare Ground Test

Lacroix High Speed Track



Trajectory measurement

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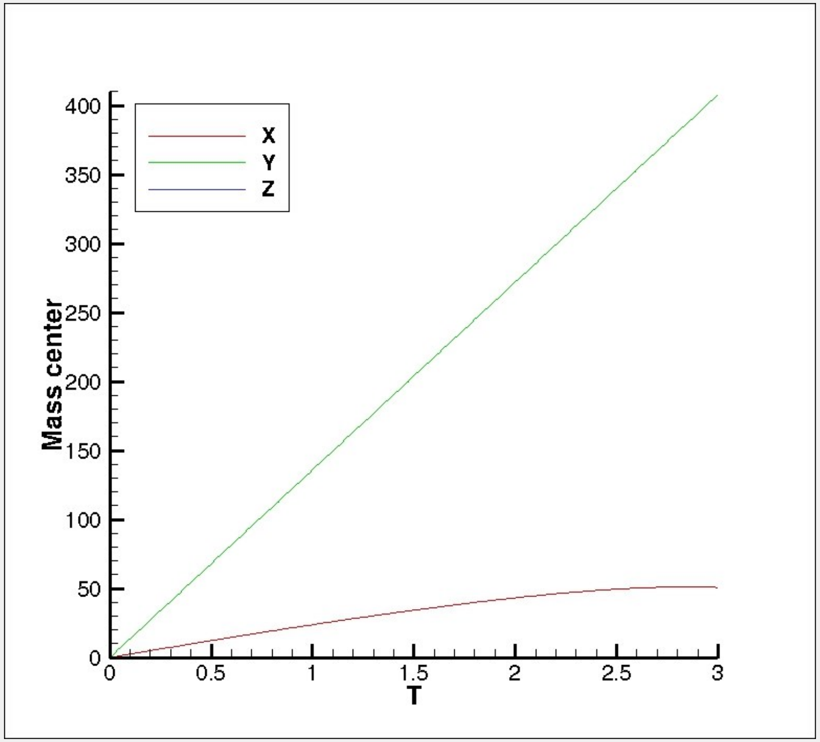
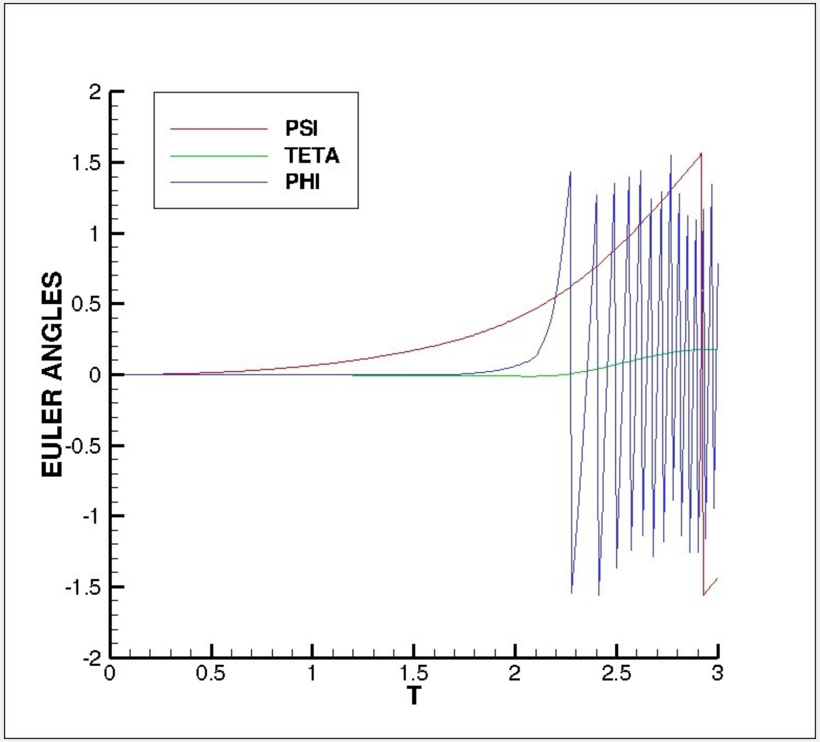
Test computations





Test computations

Flare track

Concluding remarks

- Numerical simulations of chaff cloud propagation is a good complement to flight tests.
- Analysis of chaff cloud computations can be coupled to CEM to compute effects on radar signals.
- CFD is already in use to certify ejection of flares. AG-55 will contribute to best practice guide for computations of flare trajectories.
- It is a large investment to compute an aerodynamic database for a flare but once it's done each trajectory computation is cheap.
- The weakness using an aerodynamic database based on steady solutions is that the solution will fluctuate for high incidence angles, which in general will not give correct mean values.

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