

14 November 2021

Etude de performances aérodynamiques d'ailes d'A320 par déformation électro-active; bénéfiques d'une approche centrée sur les données

Contribution: Marianna Braza¹, Jean Baptiste Tô¹, César Jimenez- Navarro¹, Clément Rouaix¹, Thierry Louge², Nicolas Renon², Abderahmane Marouf^{1,3}

¹IMFT, ² CALMIP, ³ ICUBE-Univ. Strasbourg

Presentation by: Thierry Louge, Jean-Baptiste Tô, Marianna Braza

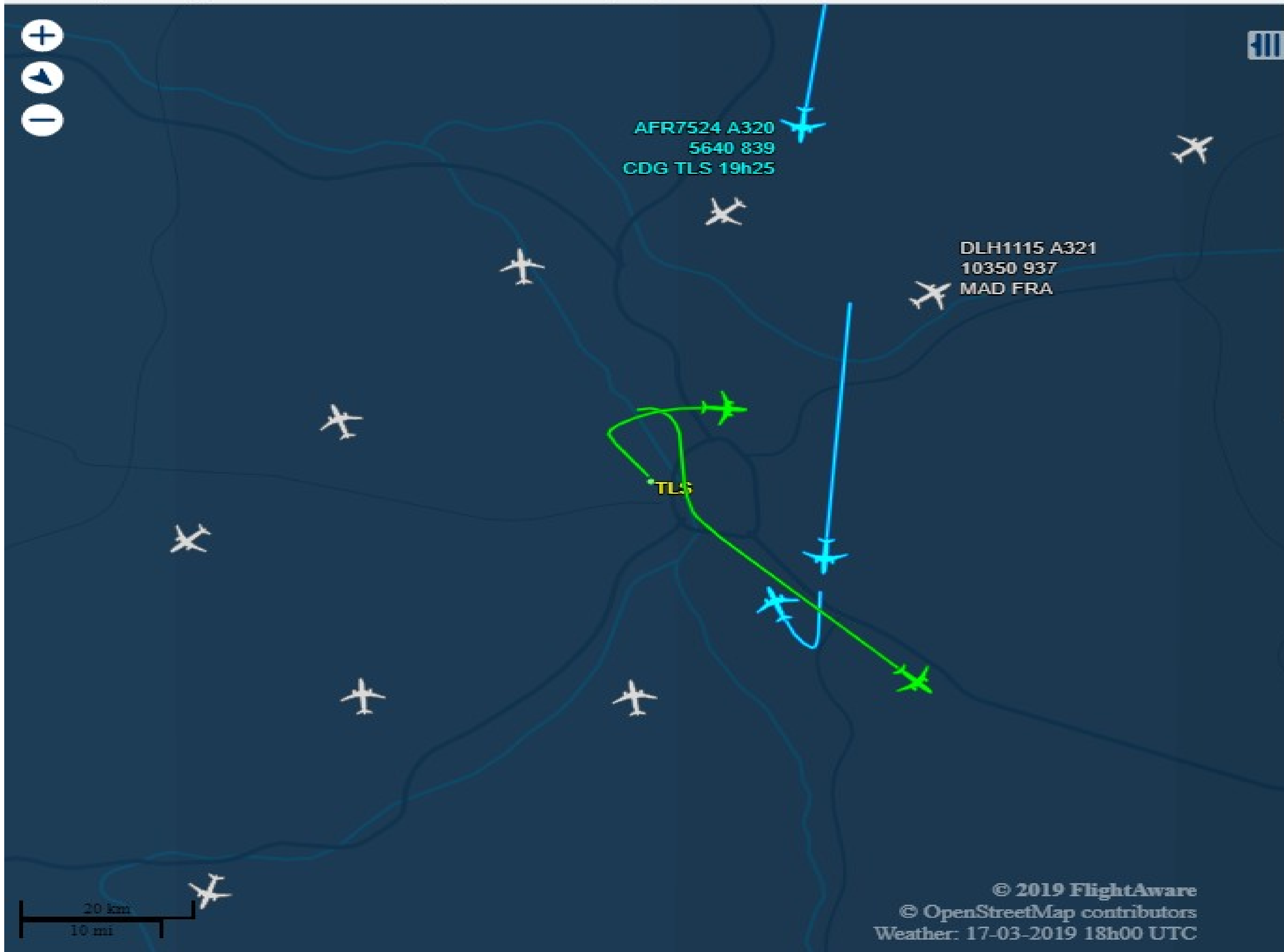
In the context of an aerodynamic use case (UC1) of the DATANOOS platform,

<https://datanoos.univ-toulouse.fr/en/use-case-enhanced-and-intelligent-aerodynamic-modeling>, a concerted effort was made since 2018

to access, exchange, interoperate and reuse under the rules FAIR and towards Open access part of the Data of the H2020 N° 723402

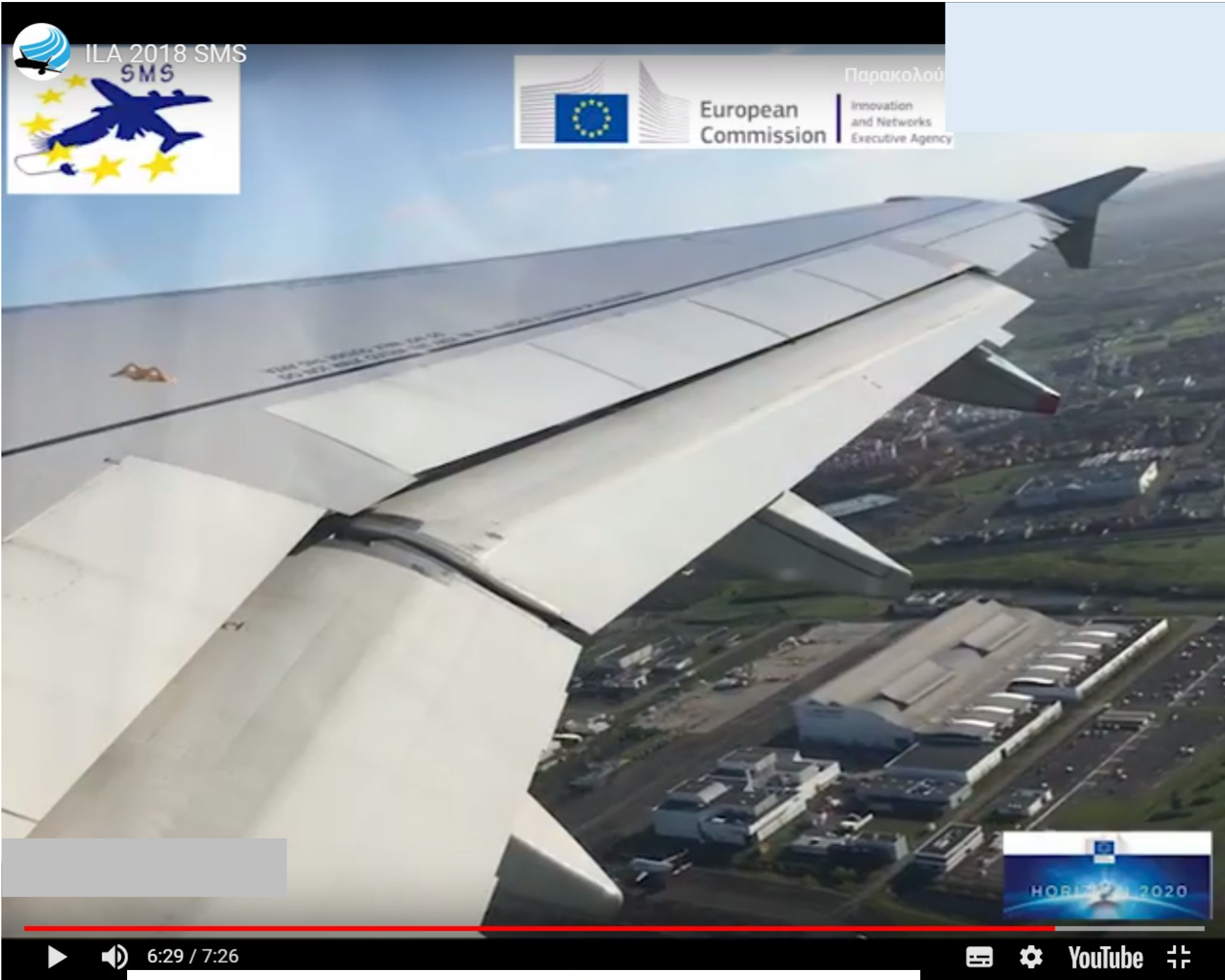
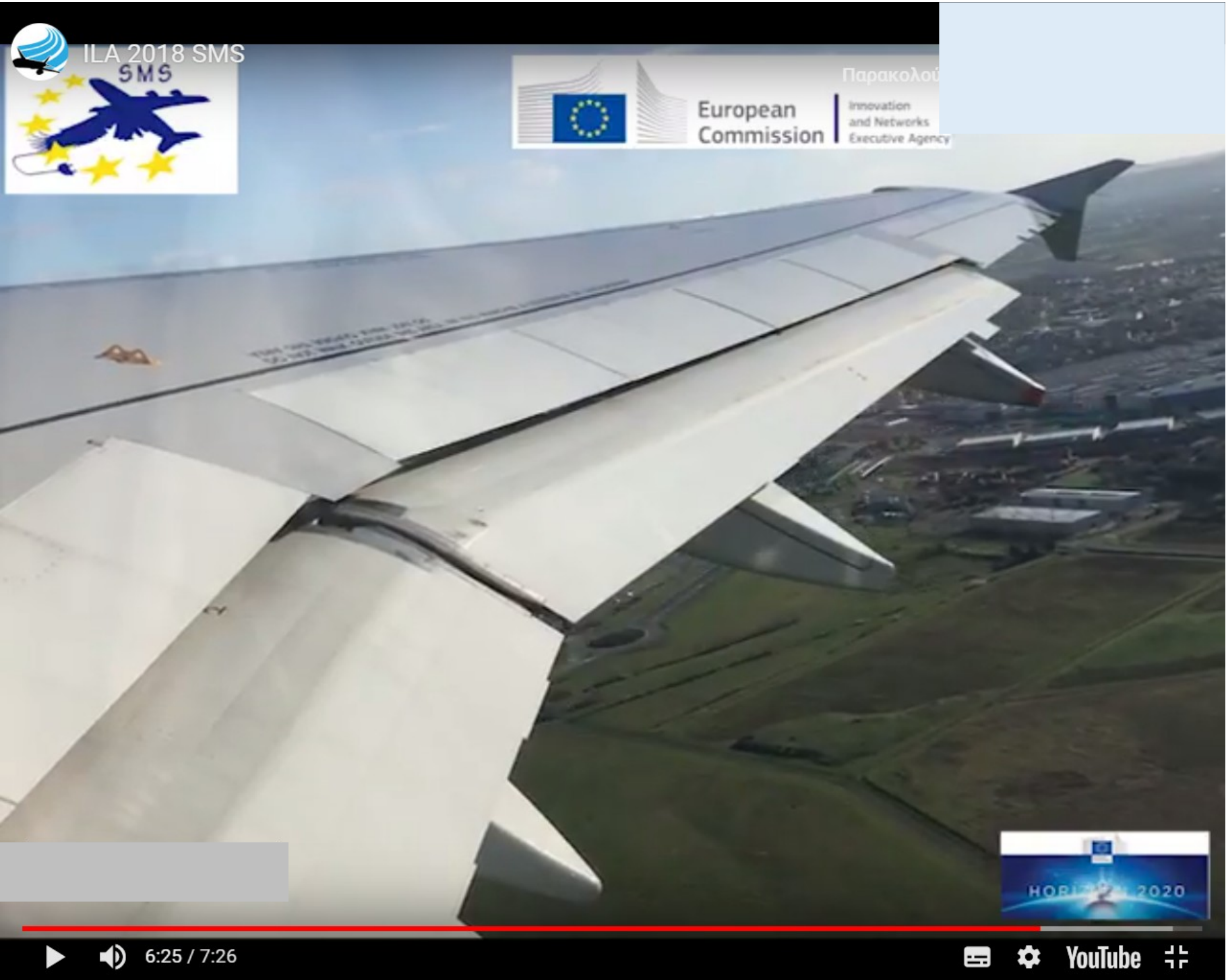
European research project SMS, “**Smart Morphing and Sensing for aeronautical configurations**”, www.smartwing.org/SMS/EU

- Initiation and efficient collaboration between computer scientists from the computing center, CALMIP, (“Calcul en Midi - Pyrénées”) and scientists from the multidisciplinary **SMS** project in aeronautics
- Creation of a platform for data sharing, FAIRness, reprocessing and reusability, conducted under the DataNoos Academic Alliance.
- Efficient multi-disciplinary data sharing among the SMS partners from geographically distant members leading to development of **new services** for the computing center.
- Adoption of FAIR principles and Open Science led creation of the CALLISTO GUI <https://callisto.calmip.univ-toulouse.fr/>. CALLISTO is organized around an **ontological view** of data that are registered in a **Dataverse**



**Flight trajectories A320
Approaching phase of landing
Toulouse - Blagnac Airport**

Data associated to the form of the wing and of the high-lift flap: example - Take-off from Toulouse-Blagnac airport



Take-off A320 Blagnac 2019 (photos of M. Braza)

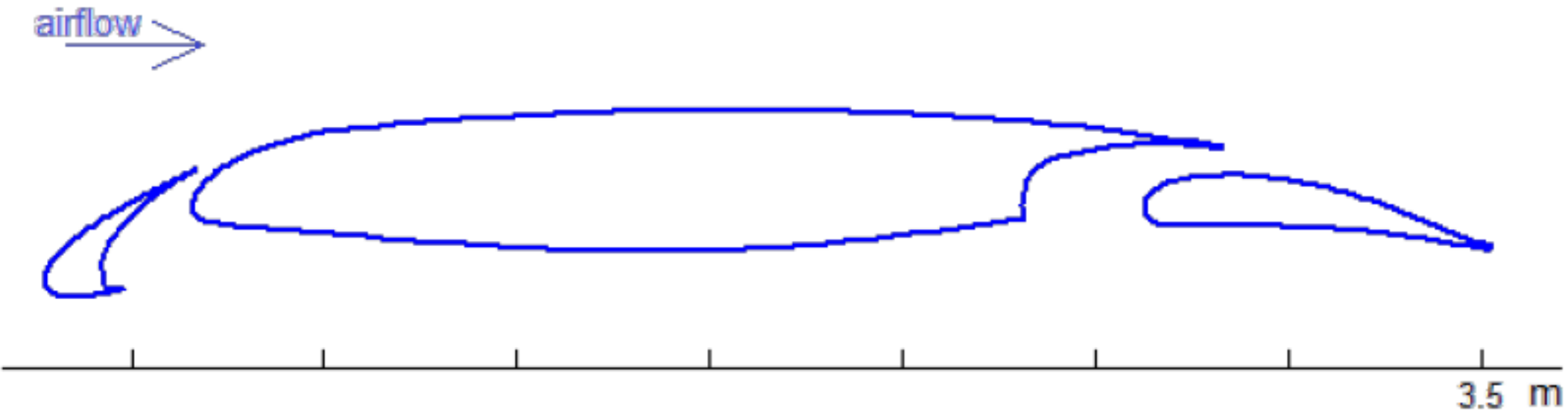
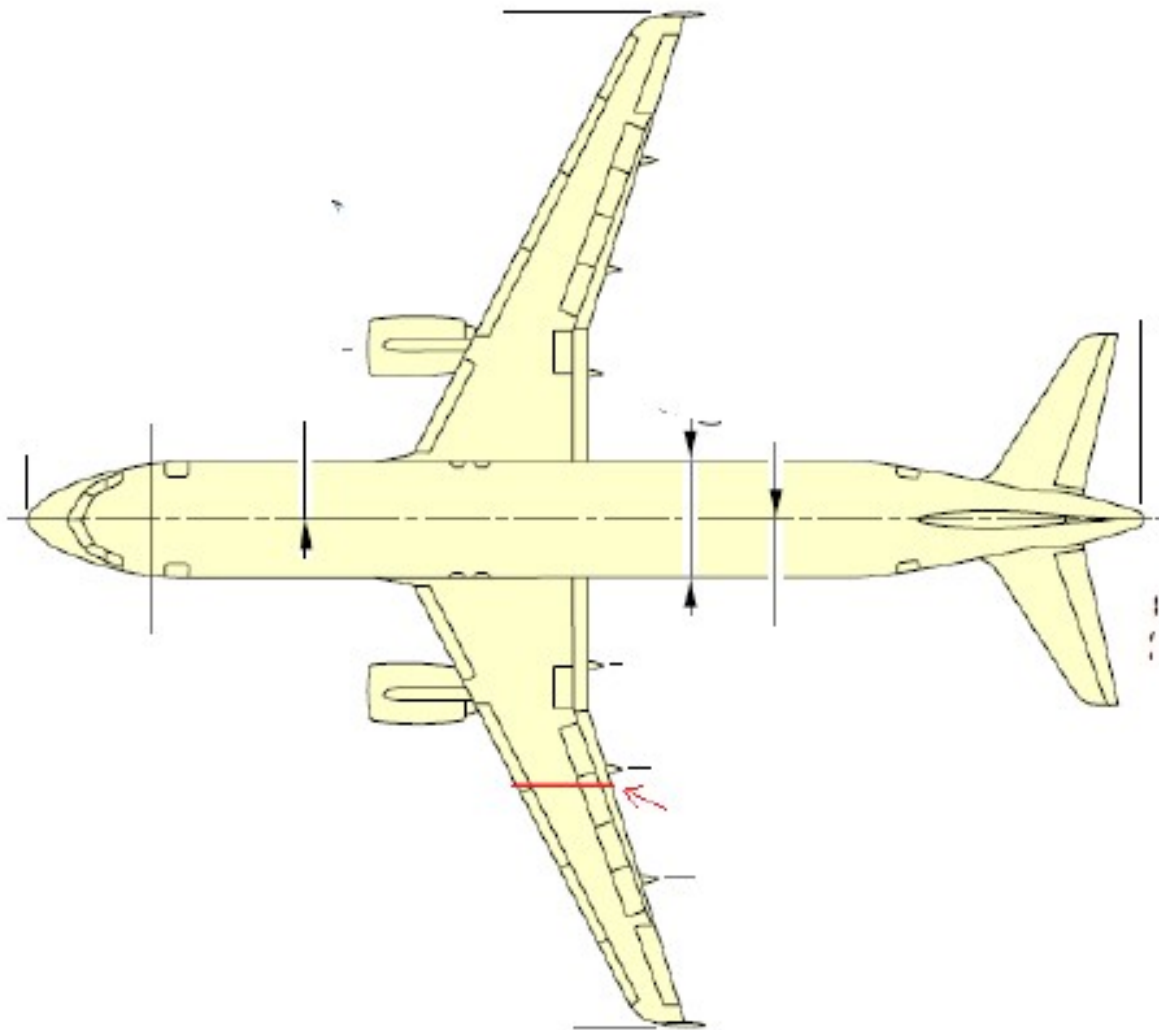


Figure 3: Airfoil cross section of the wing for Take-Of conditions



Platform DATANOOS

UC1 – «Enhanced and intelligent aerodynamic data modelling »

SELECTION OF 4 CONFIGURATIONS ON A TRAJECTOIRY of A320
available by ONERA - Toulouse : Orly - Blagnac : Phases of take-off and cruise

Evaluation of the AERODYNAMIC FORCES : LIFT and DRAG without and with
shape optimisation (MORPHING) through Hi-Fi CFD simulations at IMFT

Optimisation of the flight trajectories by ONERA simulations



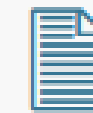
THE SMS DATA IN CALLISTO : INTEROPERABILITY

supercomputer Orlympe. 2D numerical simulation performed with the NSMB code.

Aerodynamic forces; 2D morphing - numerical simulations - incidence 1.8 deg - frequency 350 Hz [Draft](#) [Unpublished](#) 

[Admin](#) [Curator](#)

Oct 19, 2020 - Smart Morphing and Sensing (SMS)



Tô, Jean-Baptiste, 2020, "Aerodynamic forces; 2D morphing - numerical simulations - incidence 1.8 deg - frequency 350 Hz", <https://doi.org/10.5072/FK2/QI7SNP>, Root, DRAFT VERSION

ASCII file containing aerodynamic forces around an A320 wing. From a 2D numerical simulation performed with the NSMB code. The first four columns give the physical time in seconds, the drag coefficient, the lift coefficient and the pitching moment...

Simultaneous_measurement [Draft](#) [Unpublished](#) [Admin](#) 

Jun 26, 2020 - Smart Morphing and Sensing (SMS)

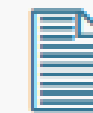


Kitouni, Amaury, 2020, "Simultaneous_measurement", <https://doi.org/10.5072/FK2/KLPMGU>, Root, DRAFT VERSION

Raw data of four measurements from the Cementys sensors. The files contains three rows with wavelength data, each row corresponds to the data of a sensor. Each file correspond to a measurement of ten minutes with a number of Reynolds of 2,2 and a...

POLIMI: 2D PIV snapshots, Take-off 34,1 m/s, AoA=4° [Draft](#) [Unpublished](#) [Admin](#) 

Apr 21, 2020 - Smart Morphing and Sensing (SMS)



Savino, Alberto, 2020, "POLIMI: 2D PIV snapshots, Take-off 34,1 m/s, AoA=4°", <https://doi.org/10.5072/FK2/GWVUIW>, Root, DRAFT VERSION

Attached the snapshots of PIV results computed during the experimental test in MILANO on LS prototype. Please read the 'README' file attached.

POLIMI, 2D PIV (particle image velocimetry) results file, exp. wind tunnel test in MILANO on LS model [Draft](#) 

[Unpublished](#) [Admin](#)

Apr 20, 2020 - Smart Morphing and Sensing (SMS)



Savino, Alberto, 2020, "POLIMI, 2D PIV (particle image velocimetry) results file, exp. wind tunnel test in MILANO on LS model", <https://doi.org/10.5072/FK2/B5TXCP>, Root, DRAFT VERSION

Elaborated results of the PIV measures for all tested cases (N.B. before proceeding with the analysis of the results, please read carefully the 'README' file which contains the instructions to match the windows of the two cameras and to manage the...



CALMIP, CALLISTO : ONTOLOGY, DESCRIPTION AND REPROCESSING

CALLISTO GUI offers a shared data space that can be protected by login/password following user needs, enhanced with a fine-grained data description to ease data reusability.

The level of detail is at the scale of a scientific project, optionally sustained with an ontological description of the scientific context.

➤ **Software provided :**

- Data repository
- Data query interface
- Advanced functionalities such as reprocessing workflows, that require ontological engineering from the projects participants with help from CALMIP ontologists.

➤ **Associated technical support :**

- GUI hands-on support
- Close collaboration for ontological engineering

CALLISTO is in continuous development, it grows with its users. What has been done so far is the result of the collaboration of CALMIP and calculus projects participants.

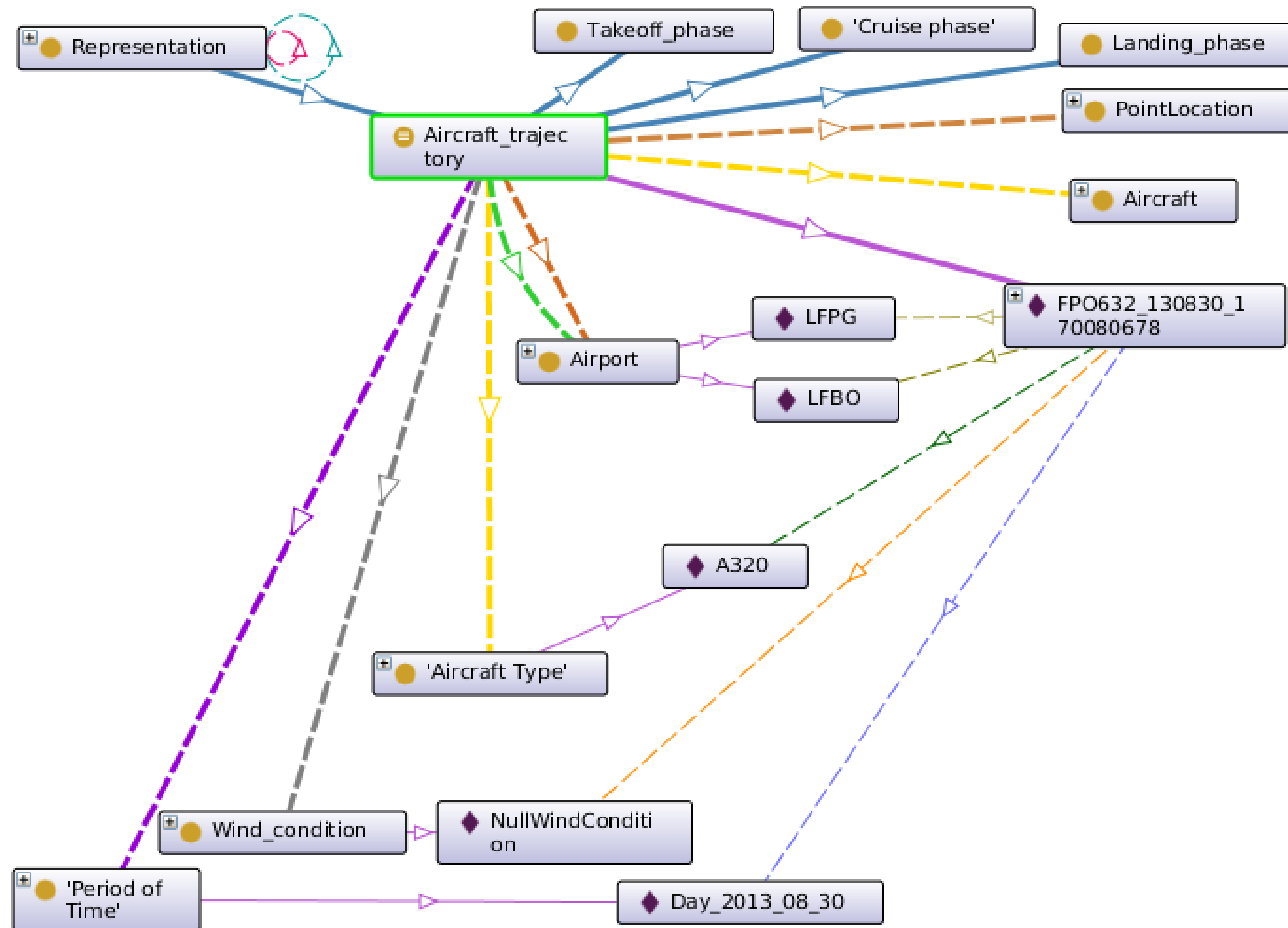
An ontology for easy trajectory finding

A320 trajectory from Toulouse-Blagnac LFBO to Paris-CDG LFPG. Flight date is 08/30/2013. Wind is considered zero.

Ontology concepts inherited from NASA ATMONTO ontology

<https://data.nasa.gov/Aerospace/The-NASA-Air-Traffic-Management-Ontology-atmonto-/2fu8-vt82/data>

Computer view:

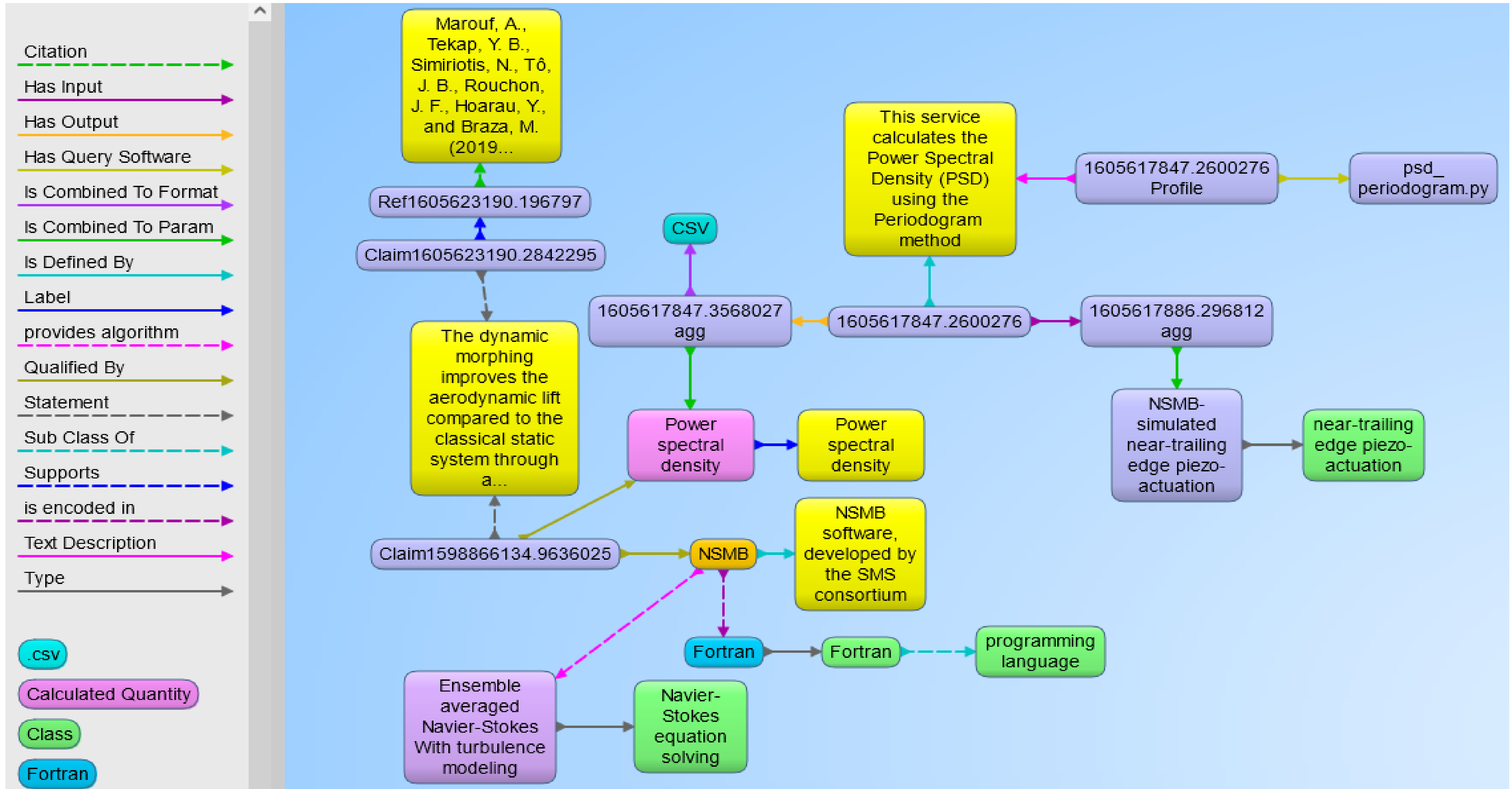


Arc Types

type filter text

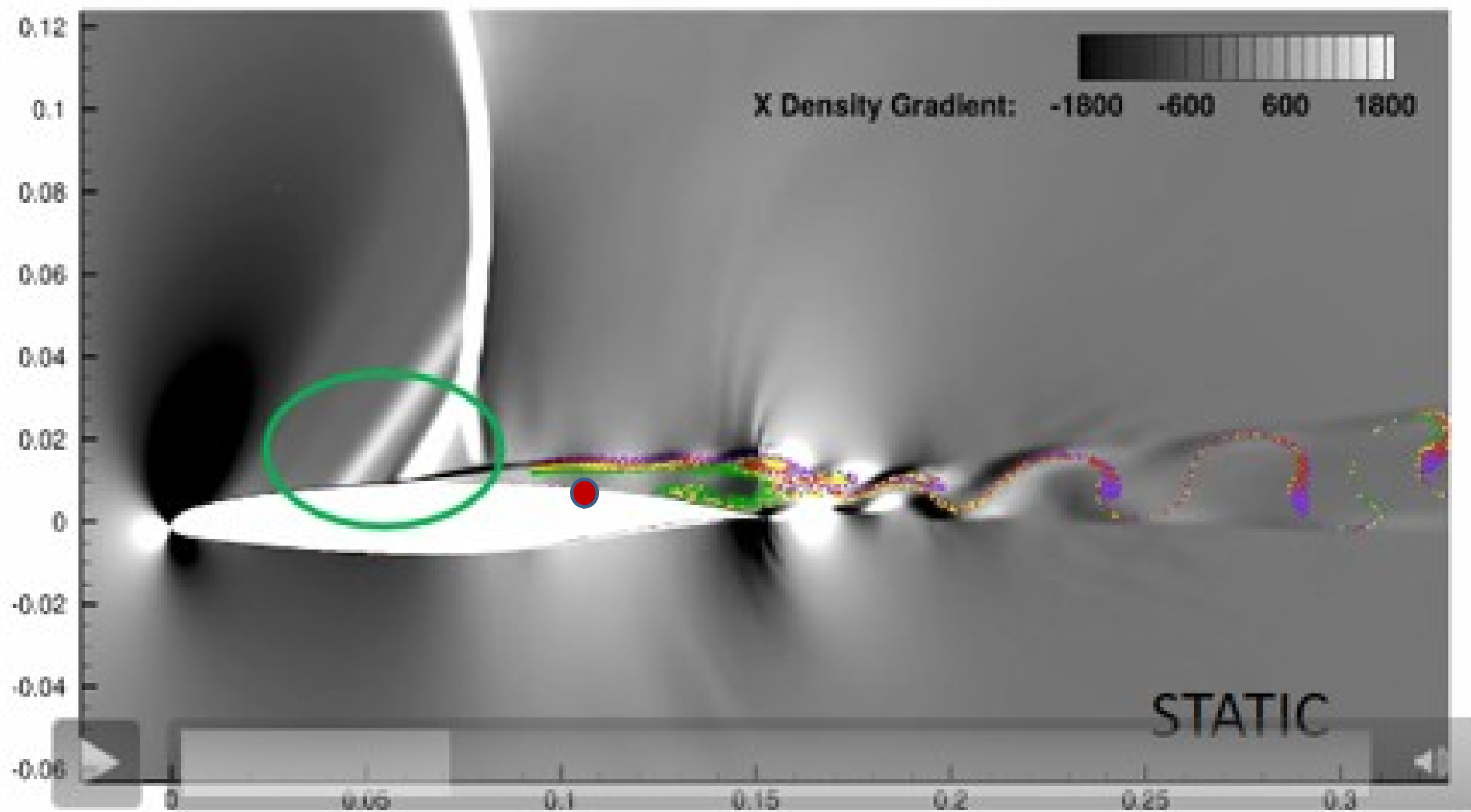
- 'is composed of' (Domain>Range)
- challengedBy (Domain>Range)
- has individual
- has subclass
- has_arrival_airport
- has_arrival_airport (Domain>Range)
- has_departure_airport
- has_departure_airport (Domain>Range)
- has_wind_condition
- has_wind_condition (Domain>Range)
- is_flown_by
- is_flown_by (Domain>Range)
- is_in_period_of_time
- is_in_period_of_time (Domain>Range)
- supportedBy (Domain>Range)

ONTOLOGY publically available : <https://allegro.callisto.calmip.univ-toulouse.fr/#/repositories/sms/overview>
 and browse with graphical interface : <https://allegro.callisto.calmip.univ-toulouse.fr/#/repositories/sms/gruff>

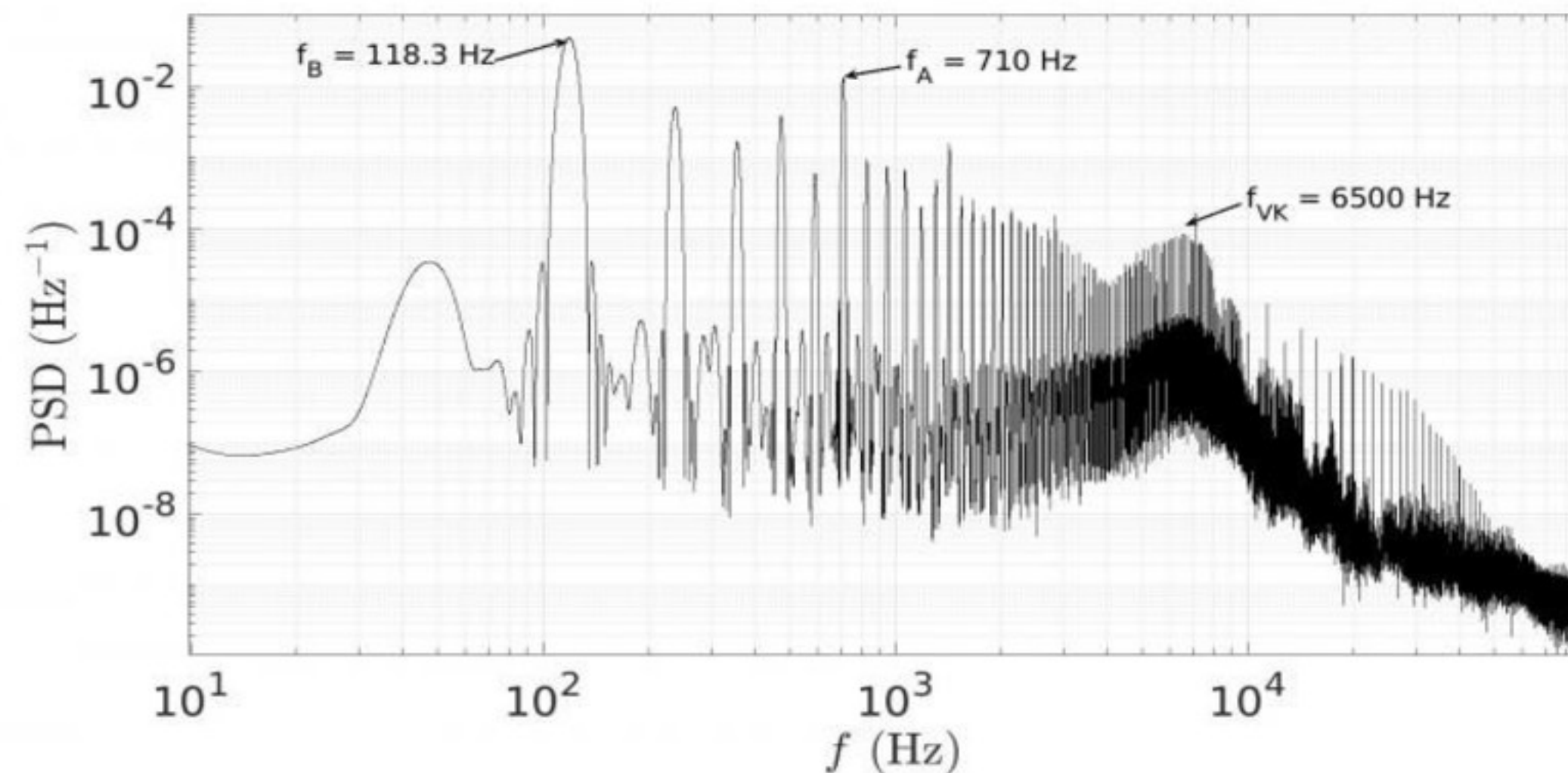


Workflows available:

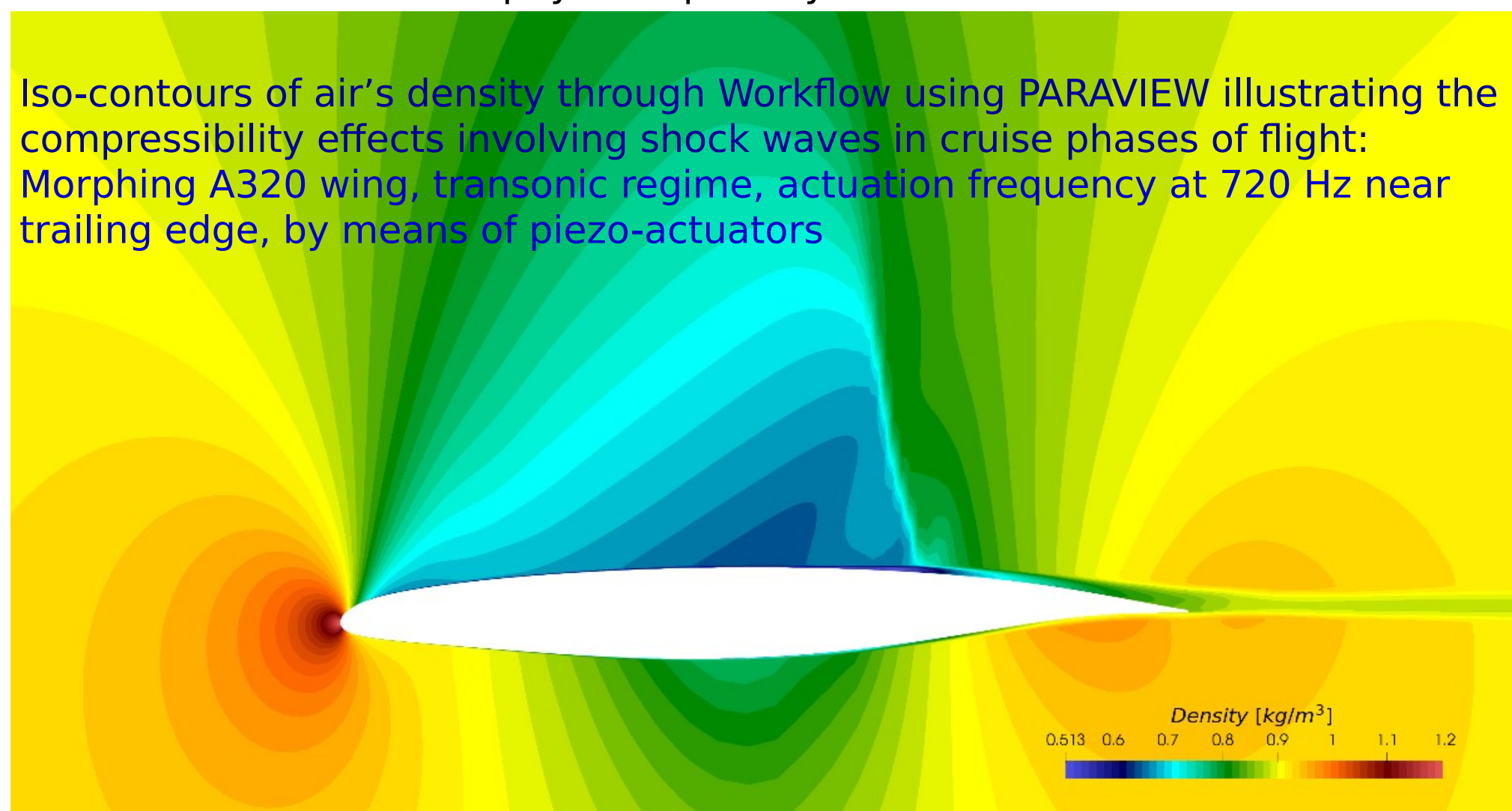
- Evaluation of (| Power Spectral densities) through Fast Fourier Transform of pressure/aerodynamic forces/velocity signals with **optimised parameters**
- Calculation and visualisation of physical quantity contours (velocities,) using on line PARAVIEW (open access software) on CALMIP Computing Centre



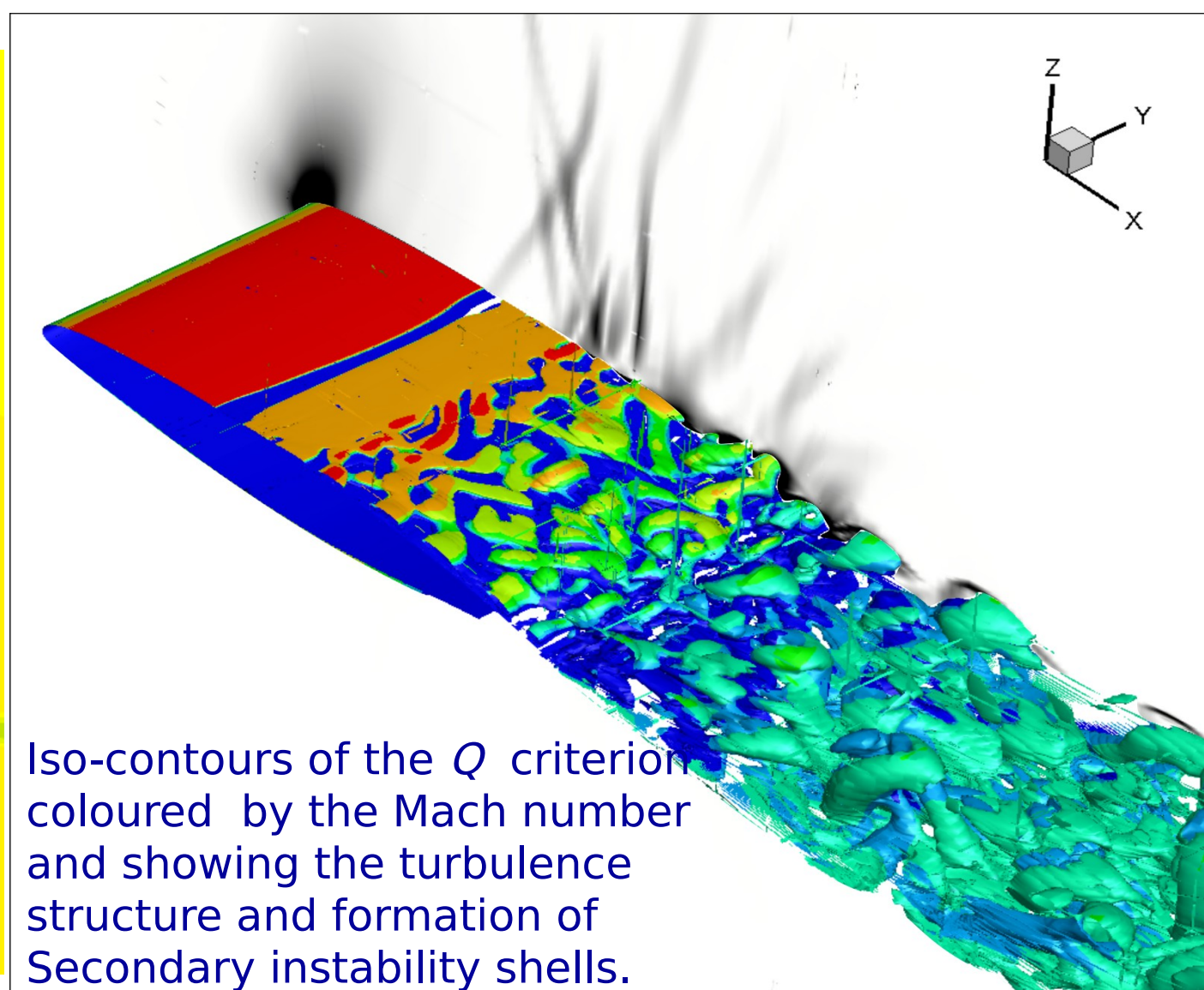
- Monitor points to extract signals : evolution of a physical quantity versus time



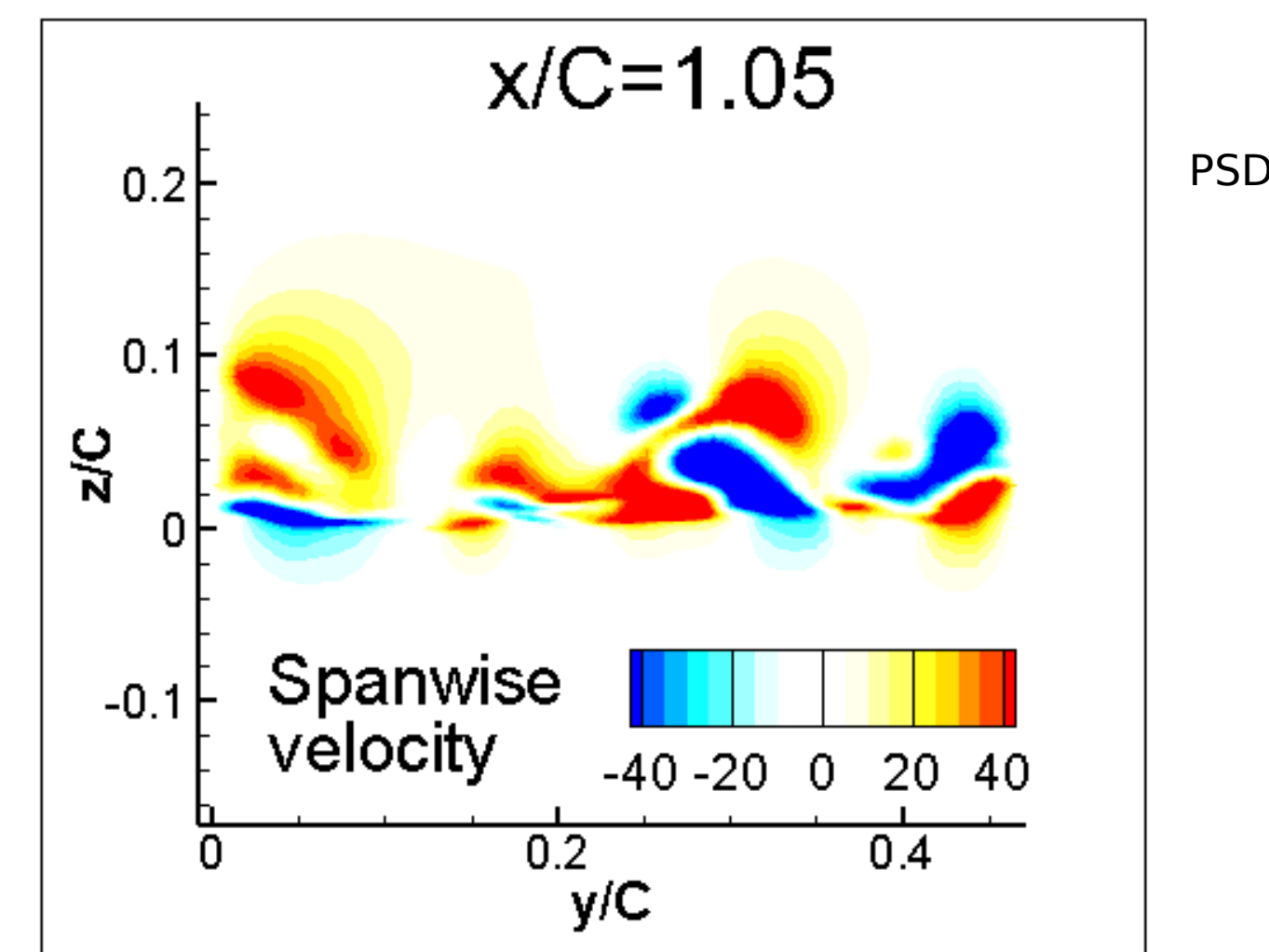
- Spectral Density PSD of pressure signal at monitor point
Illustrating the frequencies of the turbulence vortices (see image on left)



Iso-contours of air's density through Workflow using PARAVIEW illustrating the compressibility effects involving shock waves in cruise phases of flight: Morphing A320 wing, transonic regime, actuation frequency at 720 Hz near trailing edge, by means of piezo-actuators



Iso-contours of the Q criterion coloured by the Mach number and showing the turbulence structure and formation of Secondary instability shells.



SADA (Semi-automatic data analysis)

This semi-automatic data analysis interface allows you to identify datasets in a specified repository that match the text entered in the search field. For each of these datasets, you can then examine what operations are possible and what potential results you can obtain (automatic processing flows).

Step 1: Select a repository

Smart Morphing and Sensing (SMS) ▼

Step 2: Search by keywords

pressure

Search

measured by inclinometer) , WindSpeed_[m/s]: (free-stream velocity measured at test-section inlet)'''

FDV_53

IMP PAN - transonic - pressure measurements on profile'''

FDV_614

This dataset is to be used with the Paraview workflow, which extracts the relevant fields and surface values from it. Two files can be used by the workflow: a plt file containing 2D data bound to the computational domain, and another plt file (named YYY_sfc.tec) containing surface data.'''

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Step 1: Select a repository

Smart Morphing and Sensing (SMS) ▾

Step 2: Search by keywords

pressure

Search

Workflow



< Go back

Get results 

S1's Information

↑ SAPD1 ↓ Paraview_Display

"Service displaying pressure distribution data Using Paraview"

SADA (Semi-automatic data analysis)

This semi-automatic data analysis interface allows you to identify datasets in a specified repository that match the text entered in the search field. For each of these datasets, you can then examine what operations are possible and what potential results you can obtain (automatic processing flows).

Step 1: Select a repository

Smart Morphing and Sensing (SMS) ▾

Step 2: Search by keywords

pressure

Search

Workflow



[Go back](#)

[Get results](#) 

S0's Information

↑ [void](#) ↓ [SAPD1](#)

"This dataset is to be used with the Paraview workflow, which extracts the relevant fields and surface values from it.\nTwo files can be used by the workflow: a plt file containing 2D data bound to the computational domain, and another plt file (named `YYY_sfc.tec`) containing surface data."

SADA (Semi-automatic data analysis)

This semi-automatic data analysis interface allows you to identify datasets in a specified repository that match the text entered in the search field. For each of these datasets, you can then examine what operations are possible and what potential results you can obtain (automatic processing flows).

Step 1: Select a repository

Smart Morphing and Sensing (SMS) ▾

Step 2: Search by keywords

pressure

Search

Workflow



Go back

Analyze and get files

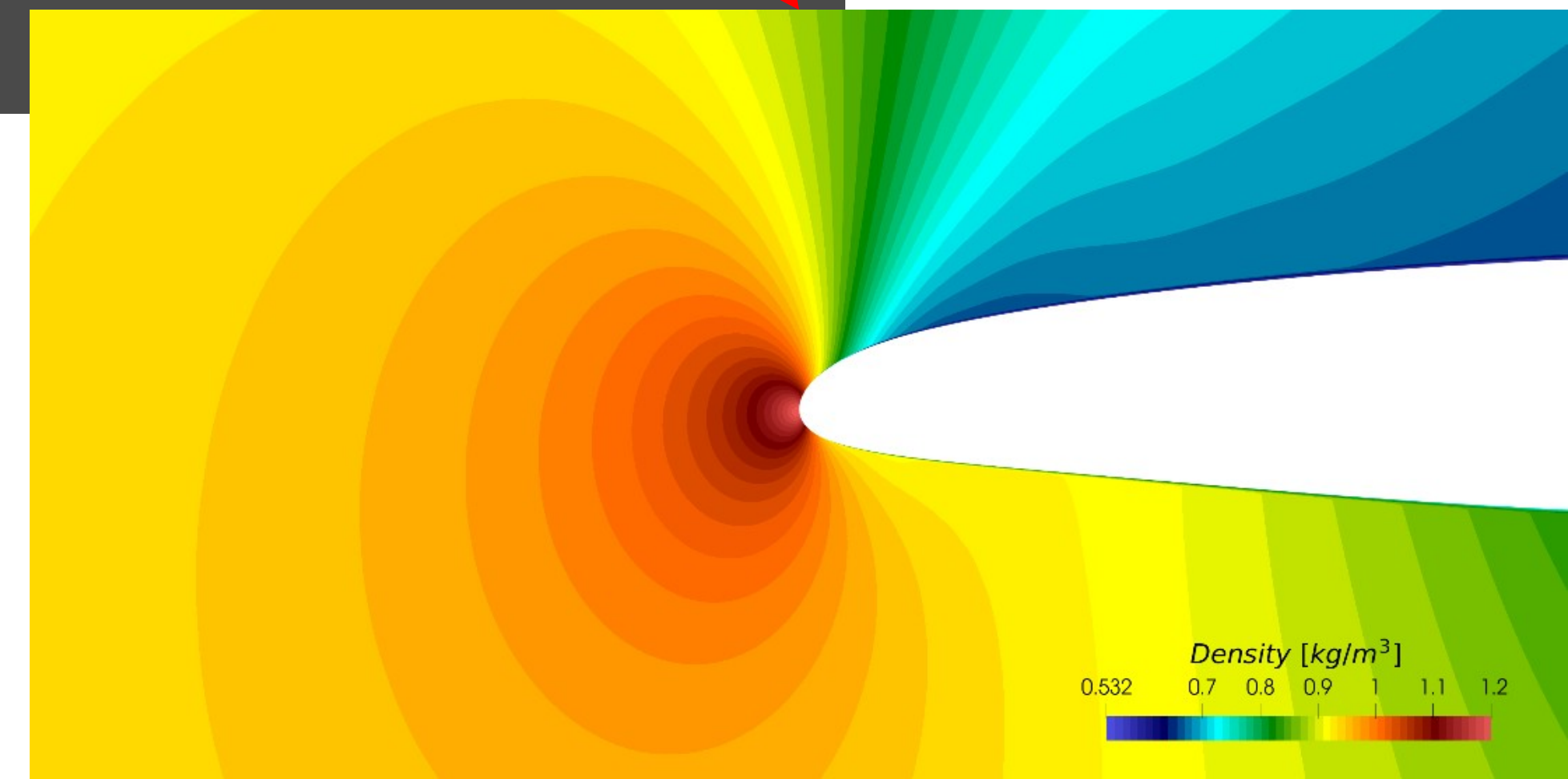
Go

Downloadable files:  

S0's Information

↑ [void](#) ↓ [SAPD1](#)

"This dataset is to be used with the Paraview workflow, which extracts the relevant fields and surface values from it. Two files can be used by the workflow: a plt file containing 2D data bound to the computational domain, and another plt file (named YYY_sfc.tec) containing surface data."



WRITING OPEN-ACCESS DATAPAPER USING CALLISTO PLATFORM

Aerodynamic performance in transonic regime around an A320 airfoil by means of electroactive morphing through vibration and slight deformation of the near-trailing edge region at high Reynolds number

By

Jean-Baptiste Tô¹, Thierry Louge², Clément Rouaix¹, César Jimenez Navarro¹, Abderahamane Marouf¹, Marianna Braza¹

¹IMFT- Institut de Mécanique des Fluides de Toulouse, UMR 5502 CNRS-INPT-UT3

²CALMIP Supercomputing Meso - Centre, UMS3667 CNRS-INPT-UT3

³ICUBE Laboratoire des sciences de l'ingénieur, de l'informatique et de l'imagerieUMR 7357 CNRS

Data Paper prepared with the contribution of CALMIP

On CALLISTO platform: <https://callisto.calmip.univ-toulouse.fr/>

<https://doi.org/10.48531/JBRU.CALMIP/19XGRY>

CALLISTO also allows register DOIs for datasets, which has been done for the datasets presented in this paper. These DOIs are the following:

[Aerodynamic forces; 2D morphing - numerical simulations - incidence 1.8 deg - static case:](https://doi.org/10.48531/jbru.calmip/buabfj)

<https://doi.org/10.48531/jbru.calmip/buabfj>

[Aerodynamic forces; 2D morphing - numerical simulations - incidence 1.8 deg - frequency](https://doi.org/10.48531/jbru.calmip/robira)

[710 Hz: https://doi.org/10.48531/jbru.calmip/robira](https://doi.org/10.48531/jbru.calmip/robira)

[Aerodynamic forces; 2D morphing - numerical simulations - incidence 1.8 deg - frequency](https://doi.org/10.48531/jbru.calmip/echixn)

[720 Hz : https://doi.org/10.48531/jbru.calmip/echixn](https://doi.org/10.48531/jbru.calmip/echixn)

[Aerodynamic forces; 2D morphing - numerical simulations - incidence 1.8 deg - frequency](https://doi.org/10.48531/jbru.calmip/jx2o55)

[730 Hz: https://doi.org/10.48531/jbru.calmip/jx2o55](https://doi.org/10.48531/jbru.calmip/jx2o55)

[Aerodynamic forces; 2D morphing - numerical simulations - incidence 1.8 deg - frequency](https://doi.org/10.48531/jbru.calmip/x5unj4)

[750 Hz : https://doi.org/10.48531/jbru.calmip/x5unj4](https://doi.org/10.48531/jbru.calmip/x5unj4)

[plt dataset for Paraview visualization - 730 Hz morphing actuation :](https://doi.org/10.48531/jbru.calmip/p76fwg)

<https://doi.org/10.48531/jbru.calmip/p76fwg>

CONCLUSION

- Dataverse and Ontology operational on CALMIP/CALLISTO able to handle a DMP of a project
- Interoperability and Reuse of the data sets
- Example of Datapaper elaboration in open access on CALMIP CALLISTO
- Development of services (workflows) in open, useful for the data Reuse
- High interest for the scientific advancing - improvement of the approaches among partners

