



European Commission



Wakenet Europe Workshop 2007, 5-7 February 2007, Brussels

FundamentAI Research on Aircraft Wake Phenomena



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Key data

- Project type **Specific Targeted Research Project (STReP)**
- Contract no. **AST4-CT-2005-012238**

- Total budget: **3.75 M€**
- EC grant: **1.98 M€**

- Starting date: **1 February 2005**
- Duration: **3 years**

- Coordinator: **CNRS France (T. Leweke)**
- Participants: **17 organisations in 8 countries**



Participants

Universities (10)



INSTITUTO SUPERIOR TÉCNICO
Universidade Técnica de Lisboa

TU/e
technische universiteit eindhoven

TU Delft

TUM
TECHNISCHE
UNIVERSITÄT
MÜNCHEN

UNIVERSITY OF
BATH

U^{ma}
UNIVERSIDAD
DE MÁLAGA

UNIVERSITE
PAUL
SABATIER
TOULOUSE III



UPM

UNIVERSIDAD POLITÉCNICA DE MADRID

UCL

Université catholique de Louvain

Research centers (6)



CENTRE NATIONAL
DE LA RECHERCHE
SCIENTIFIQUE

cenaero

ONERA



DLR

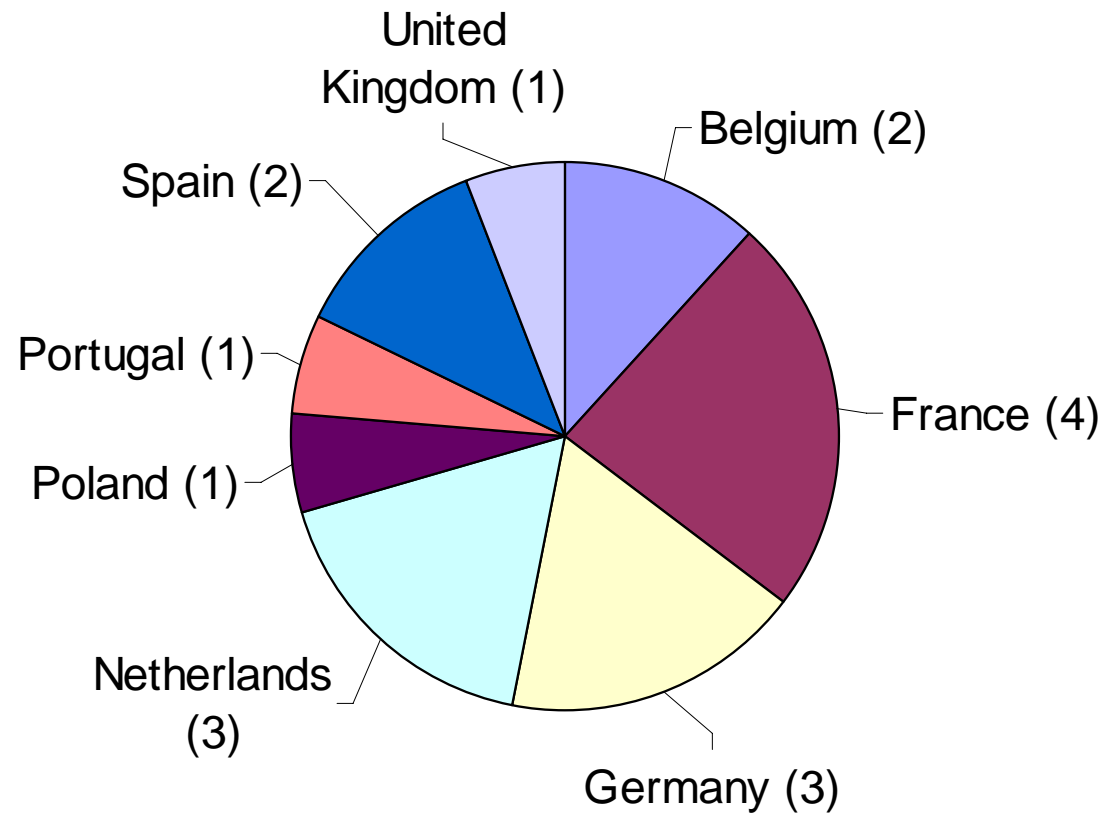


Industry (1)





Participants





Objectives

- gain **new knowledge** about **open issues** of vortex dynamics relevant to aircraft wakes
- improve **physical understanding**



- **short term:**
 - more precise wake **characterization methods** (ground testing, CFD, flight tests)
 - more reliable wake **prediction tools** (ATM context)
- **long term:**
 - knowledge base for strategies of **wake alleviation**

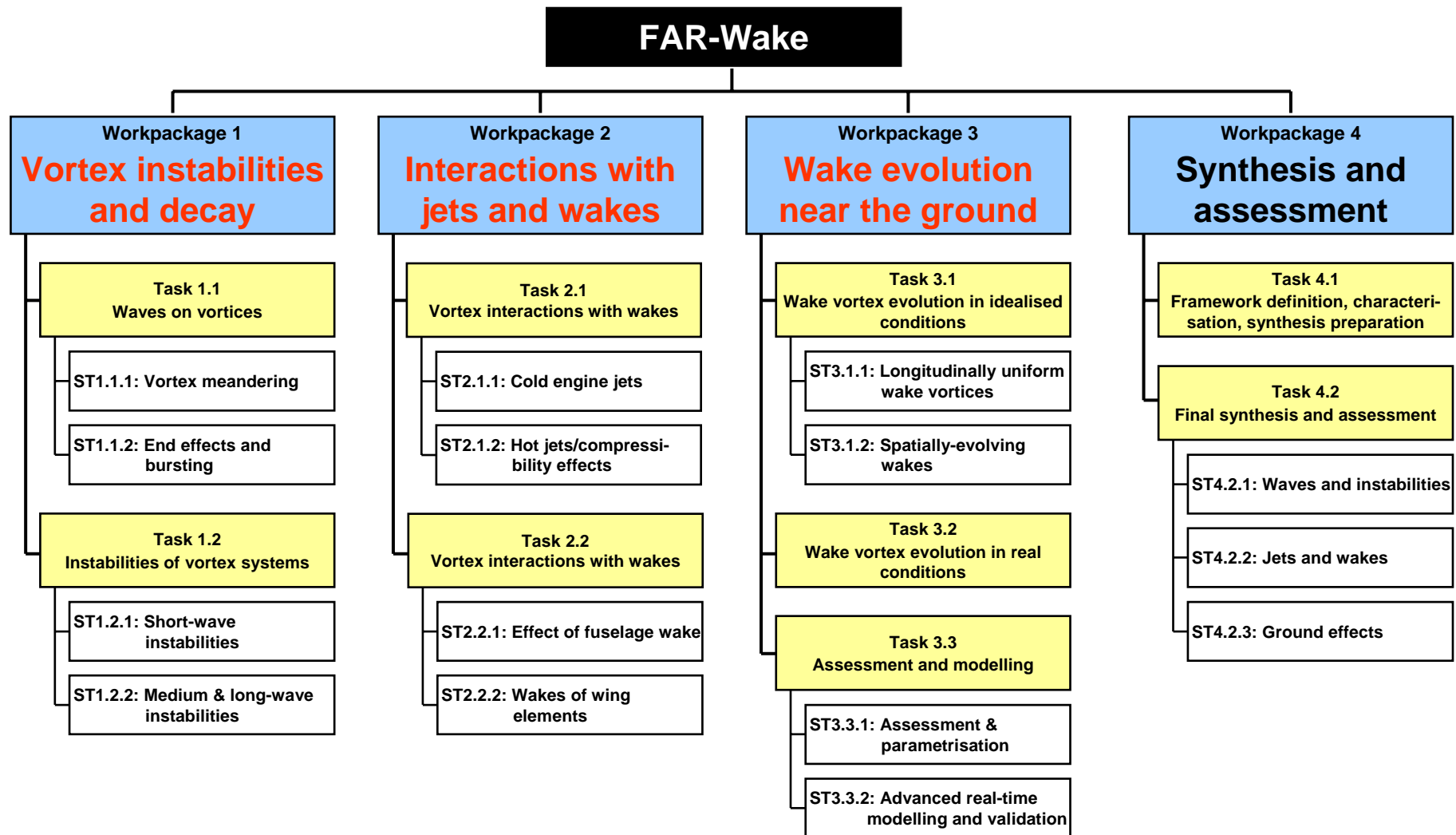


Strategy

- study of **generic / simplified configurations**
- **multiple** complementary **approaches**:
 - **theoretical** analysis
 - **experiments** (mostly small-scale)
 - **CFD**
 - analysis of **existing data**
- emphasis on **physics**



Organization of RTD activity



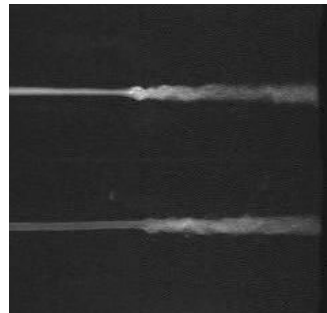


Work Package 1: Vortex instabilities and decay

Task 1.1: Waves on vortices



meandering



end effects

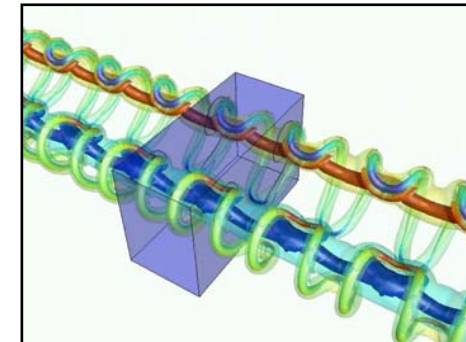
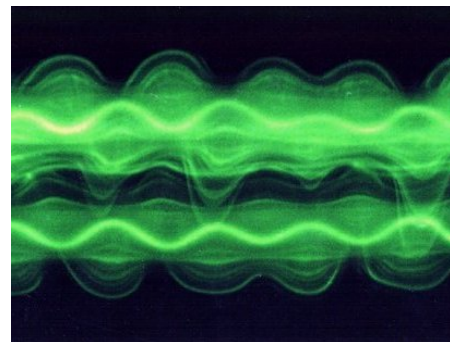


bursting

application to: wind tunnel / catapult studies, relevance for wake decay?

Task 1.2: Instabilities of vortex systems

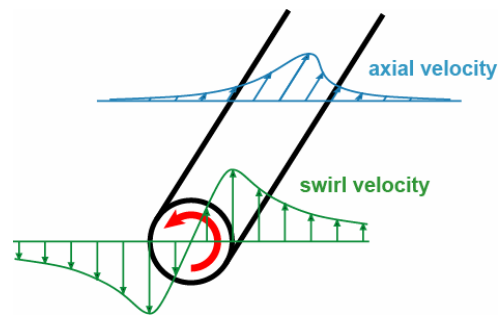
- 2- and 4- vortex systems
- relevance for decay?



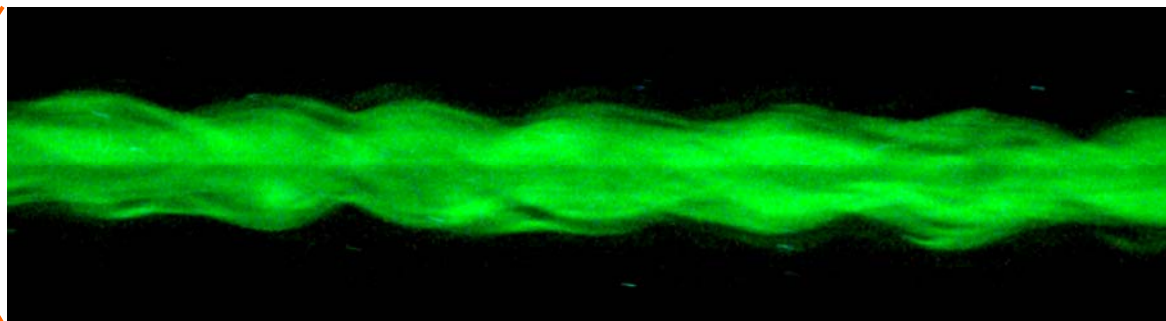
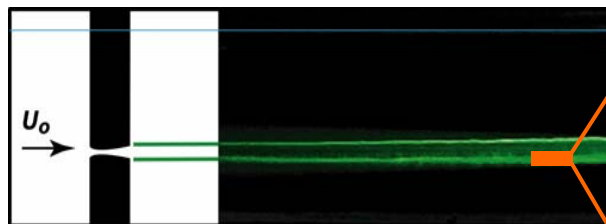
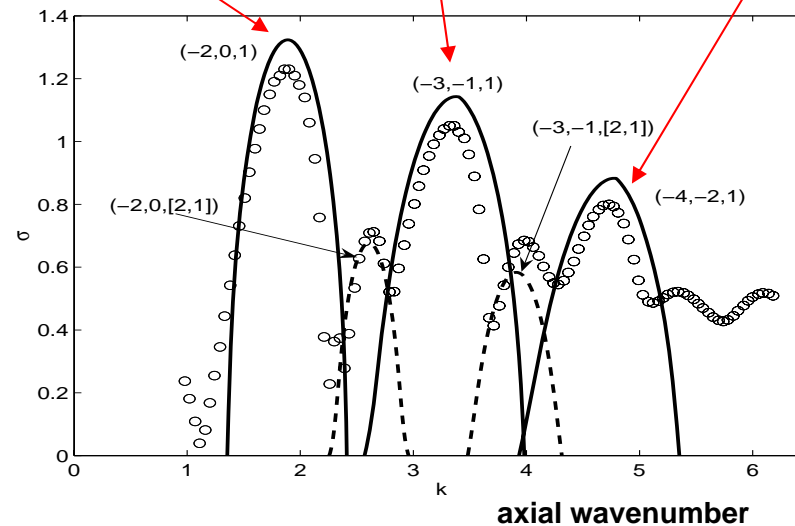


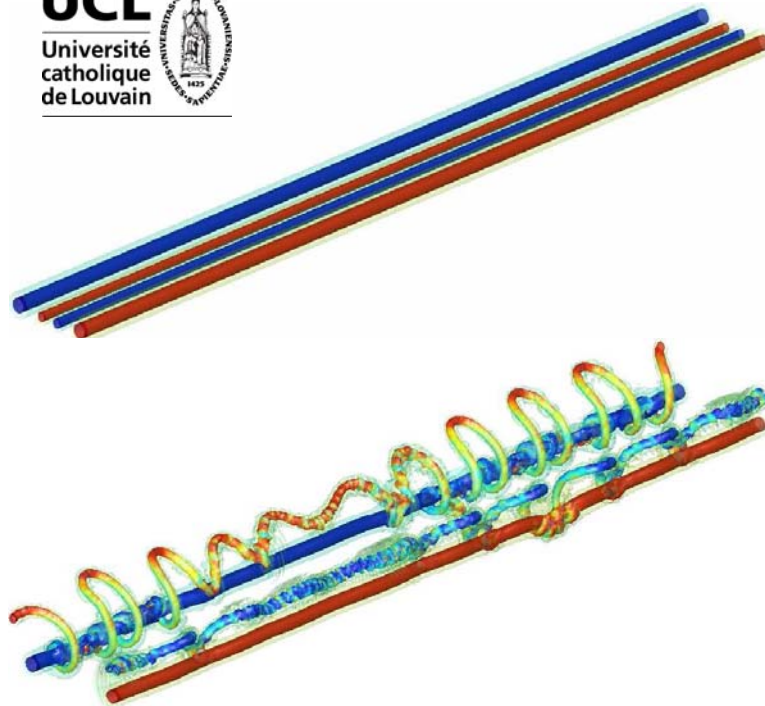
Subtask 1.2.1

instability of vortices with axial flow



instability
growth
rate





Subtask 1.2.2

instability of counter-rotating 4-vortex systems

Large-Eddy Simulations
of **temporally-** and
spatially-developing wakes

Planned:

towing-tank experiments with generic wing model
generating a “promising” 4-vortex system.





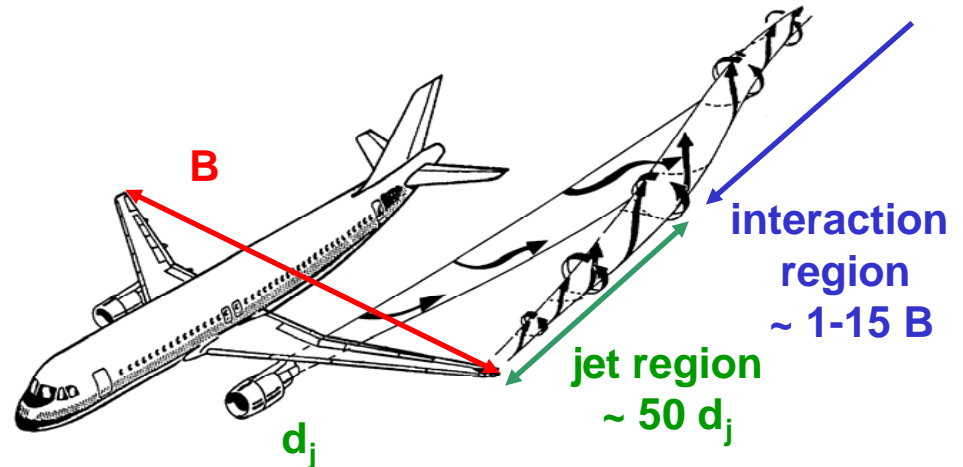
Work Package 2: Vortex interactions with jets and wakes

Task 2.1: Vortex interactions with jets

- “cold” engine jets
- hot engine jets

relevance for:

- stability of vortex system
- wake decay?



Task 2.2: Vortex interactions with wakes

- fuselage wake
- wakes of wing elements (nacelle, pylon, landing gear, devices, etc.)

relevance for:

- formation of vortex system
- excitation of instabilities
- wake decay?

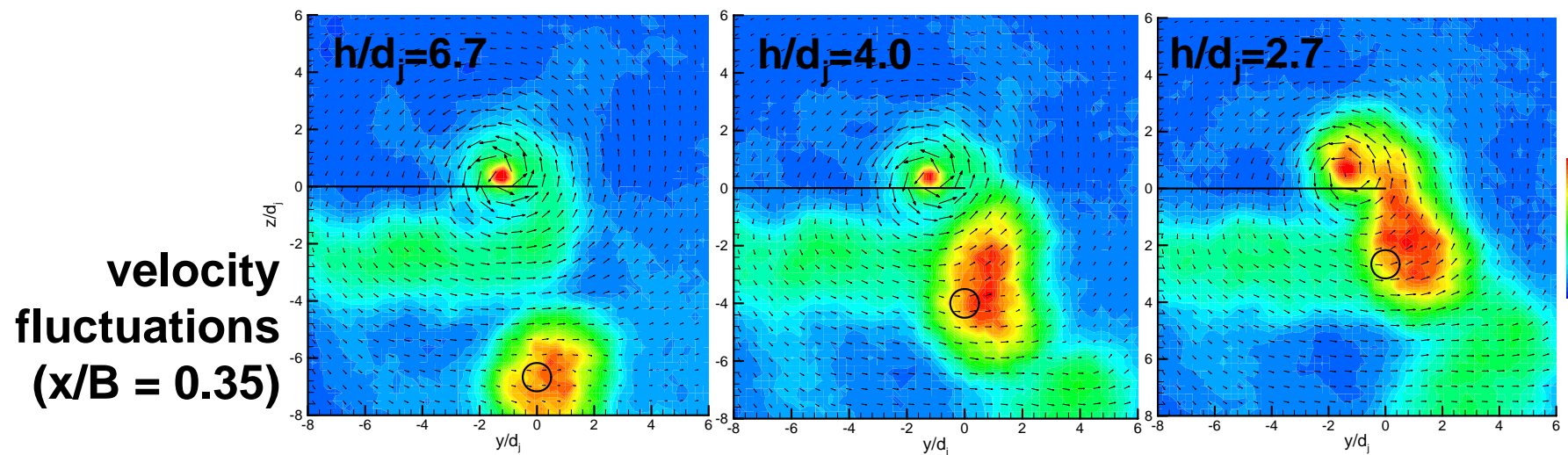
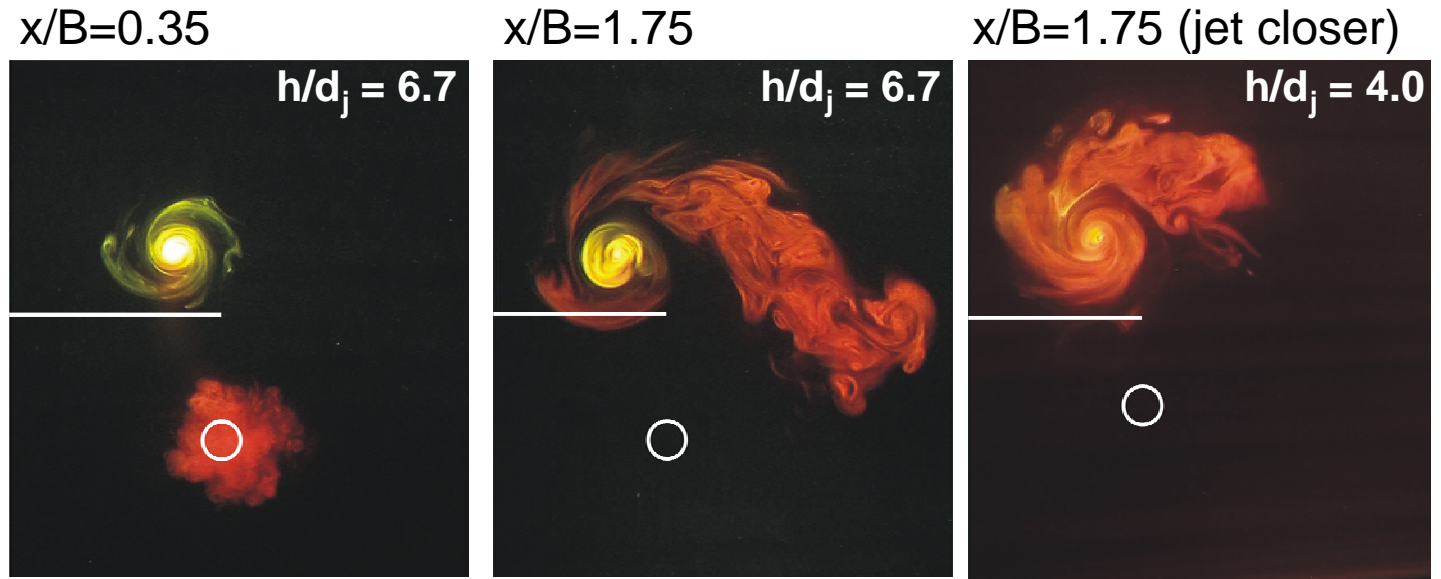


Subtask 2.1.1

water channel
experiments



jet turbulence
ingestion

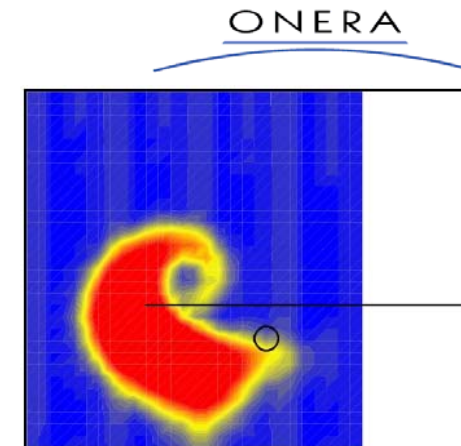




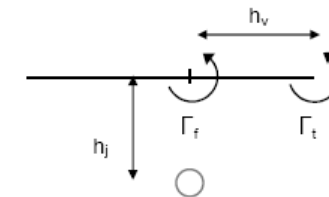
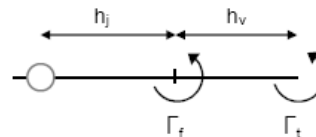
Task 2.1

other jet / vortex studies include:

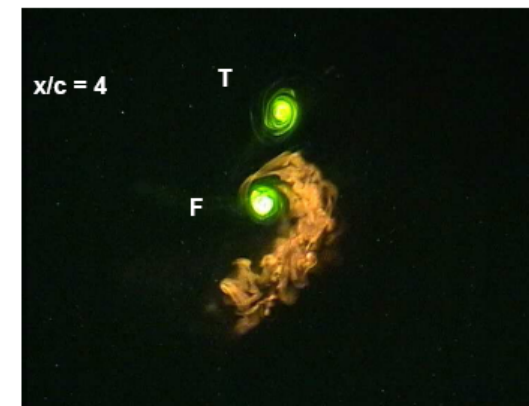
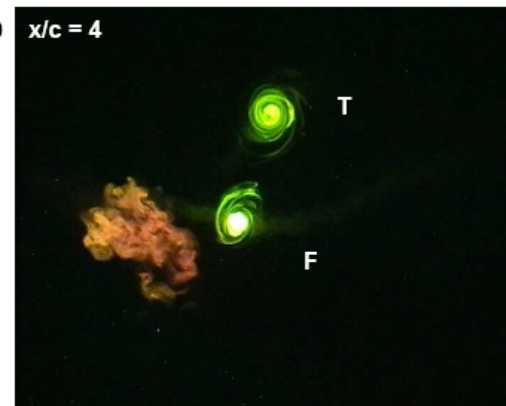
- hot jet vortex interaction



- dynamics and stability of hot jets



- vortex pairs and jet





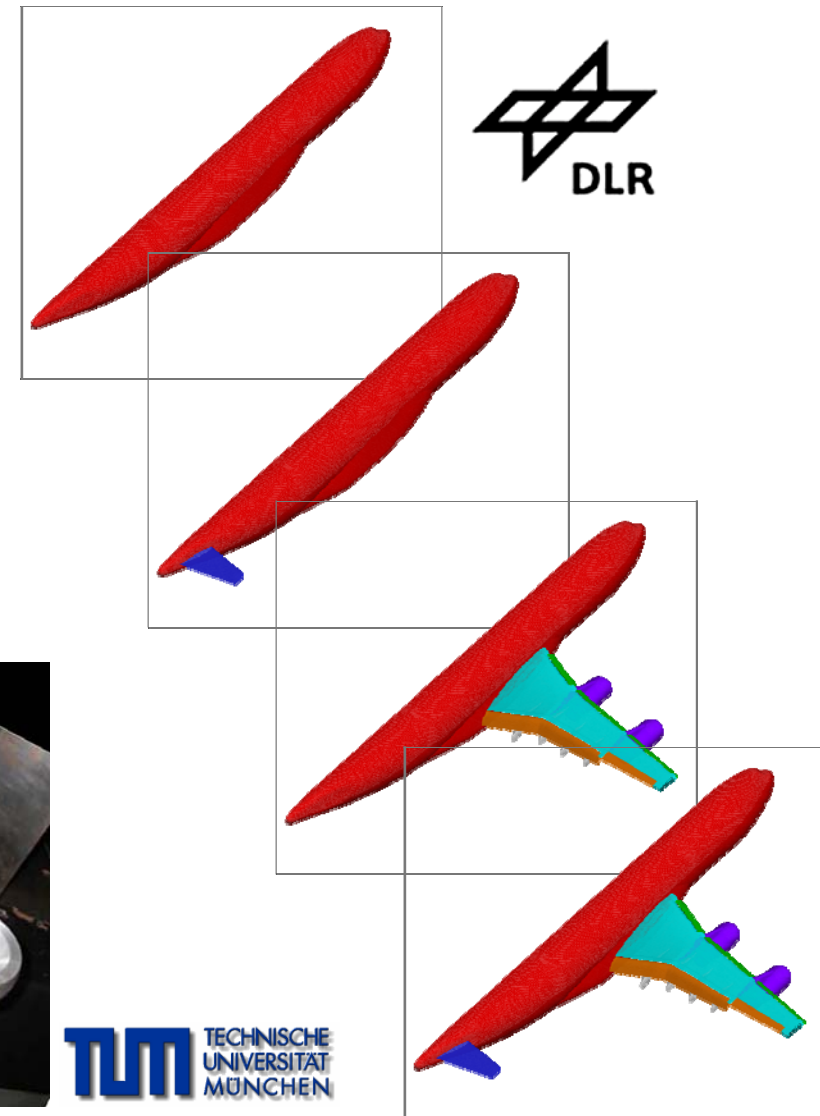
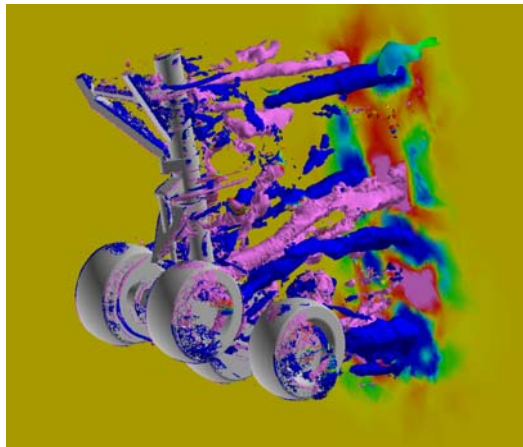
Task 2.2

fuselage wake

- RANS / LES simulations
- wind tunnel measurements
- same A/C geometry

landing gear wake

- same approach





Work Package 3: Wake evolution near the ground

Task 3.1: Dynamics and decay in idealised conditions

- uniform wakes NGE and IGE
- spatially evolving wakes

relevance for:

- wake roll-up
- instabilities / decay?

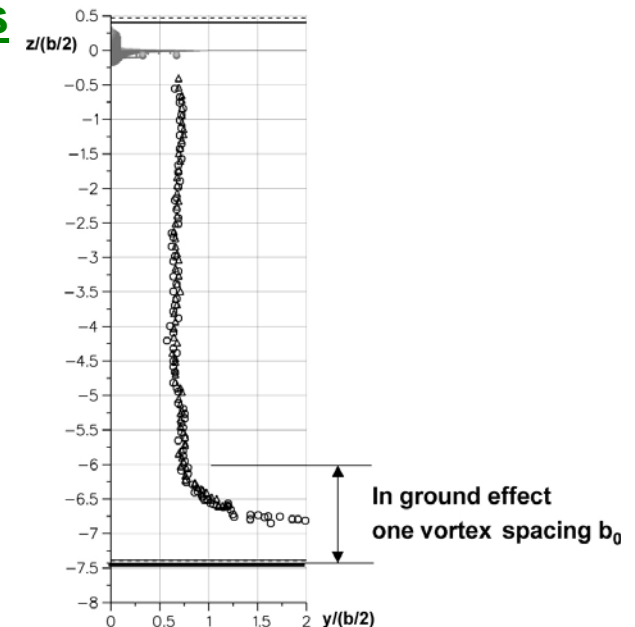
Task 3.2: Dynamics and decay in real conditions

- data base analysis
- identification of weather and ground effects

Task 3.3: Assessment and advanced real-time modelling

- comparison of 3.1 & 3.2
- improvement & validation of P2P and P-VFS wake prediction tools

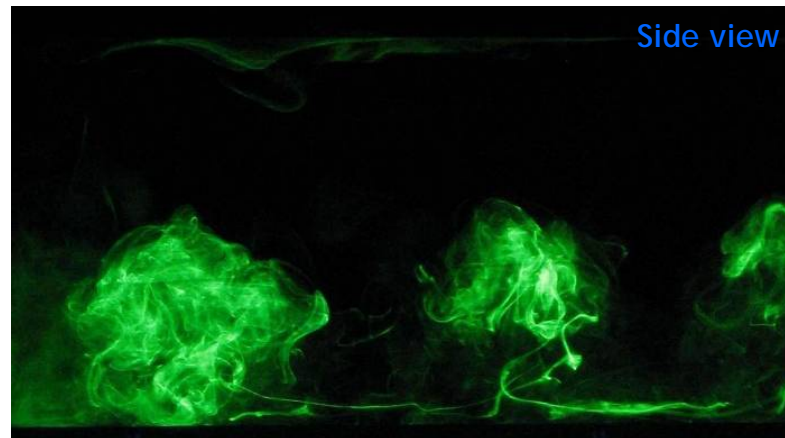
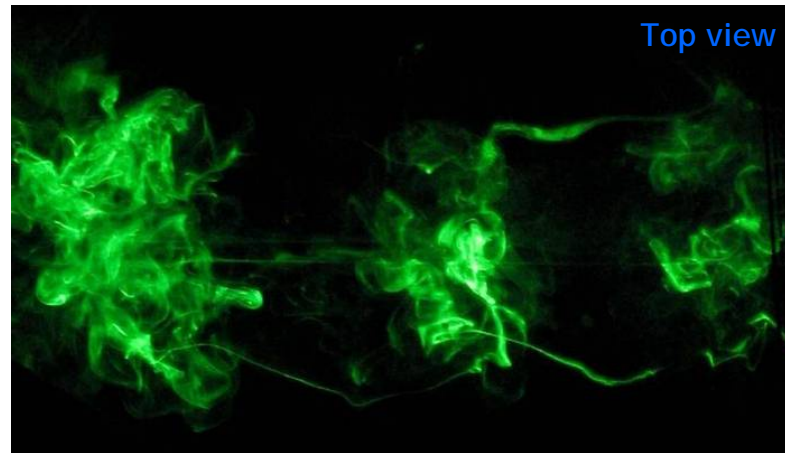
relevance for ATM applications



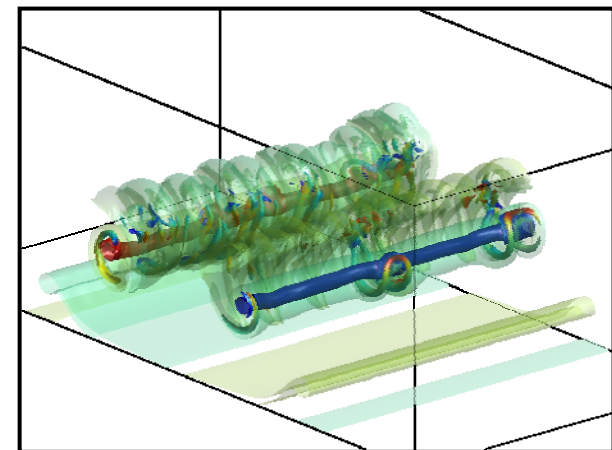
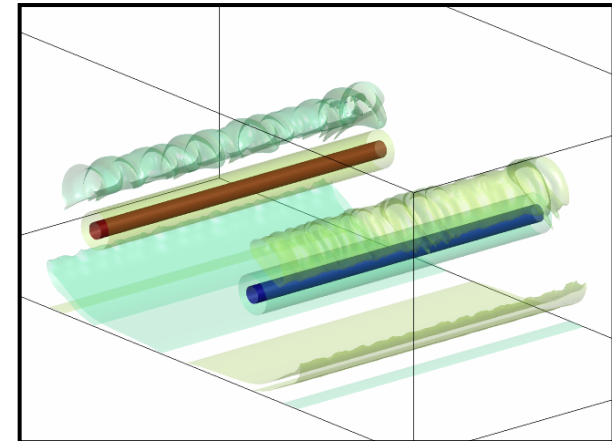


Subtask 3.1.1

3D instabilities in ground effect



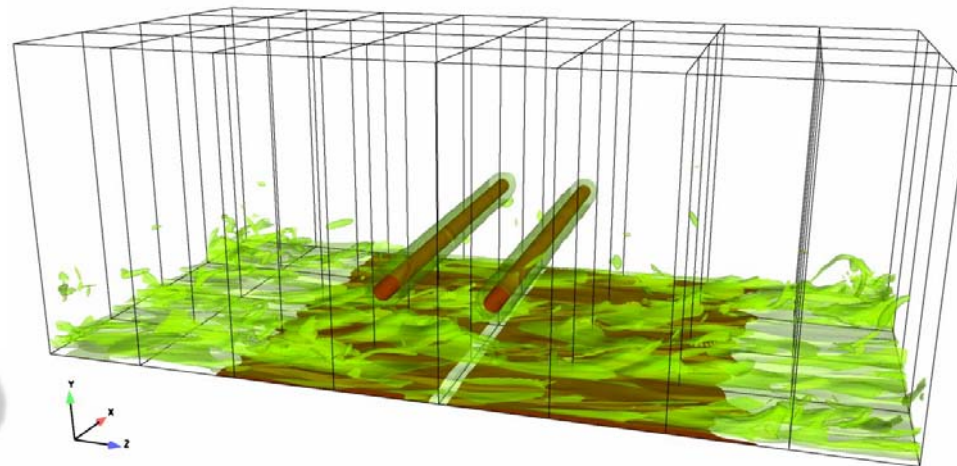
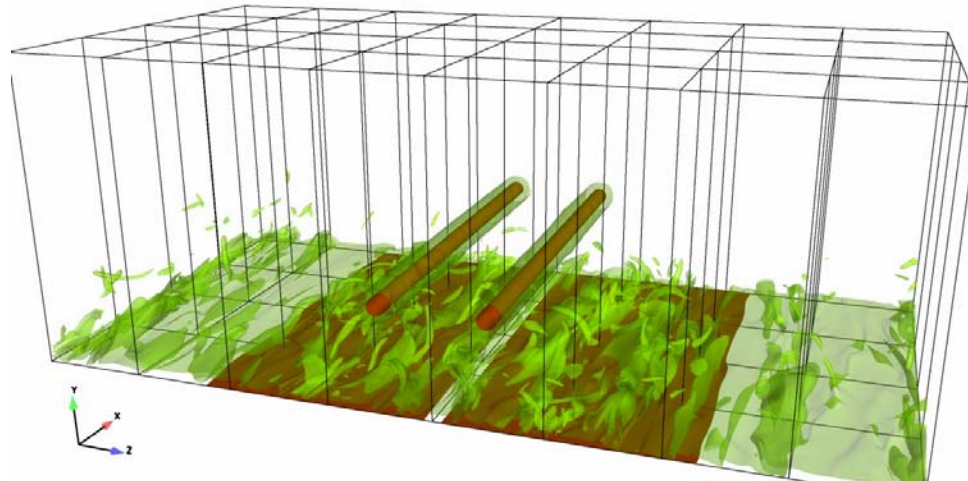
Crow instability
(visualisation in water tank)



short-wave instability
(DNS)



LES of a longitudinally uniform 2-vortex system in ground effect at $Re = 20,000$ (with and without wind)

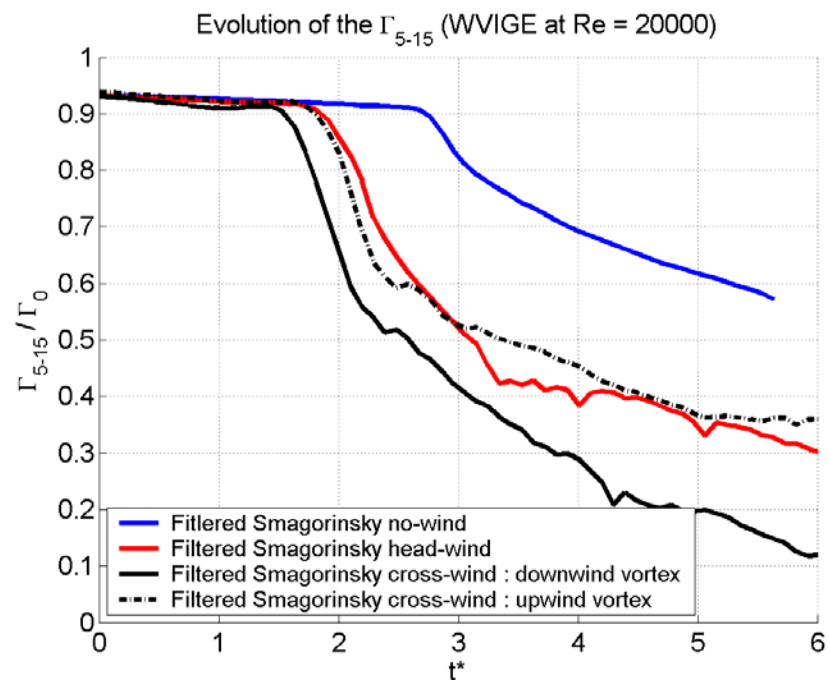
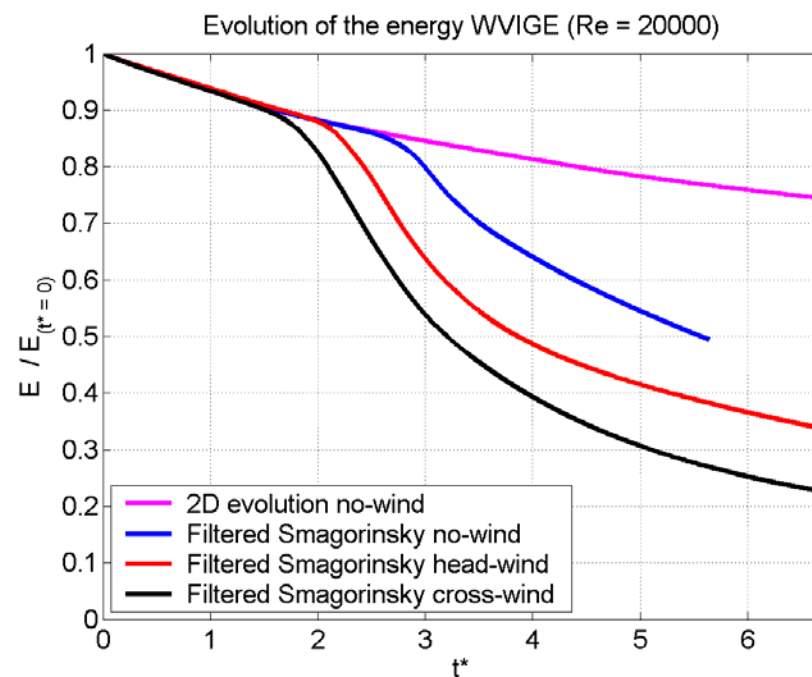


- LES without and with head or cross 3D turbulent winds
- 33,000,000 node mesh using fourth-order finite differences
- Mean velocity of the wind at the initial vortex location is equal to the initial descent velocity of the vortex pair



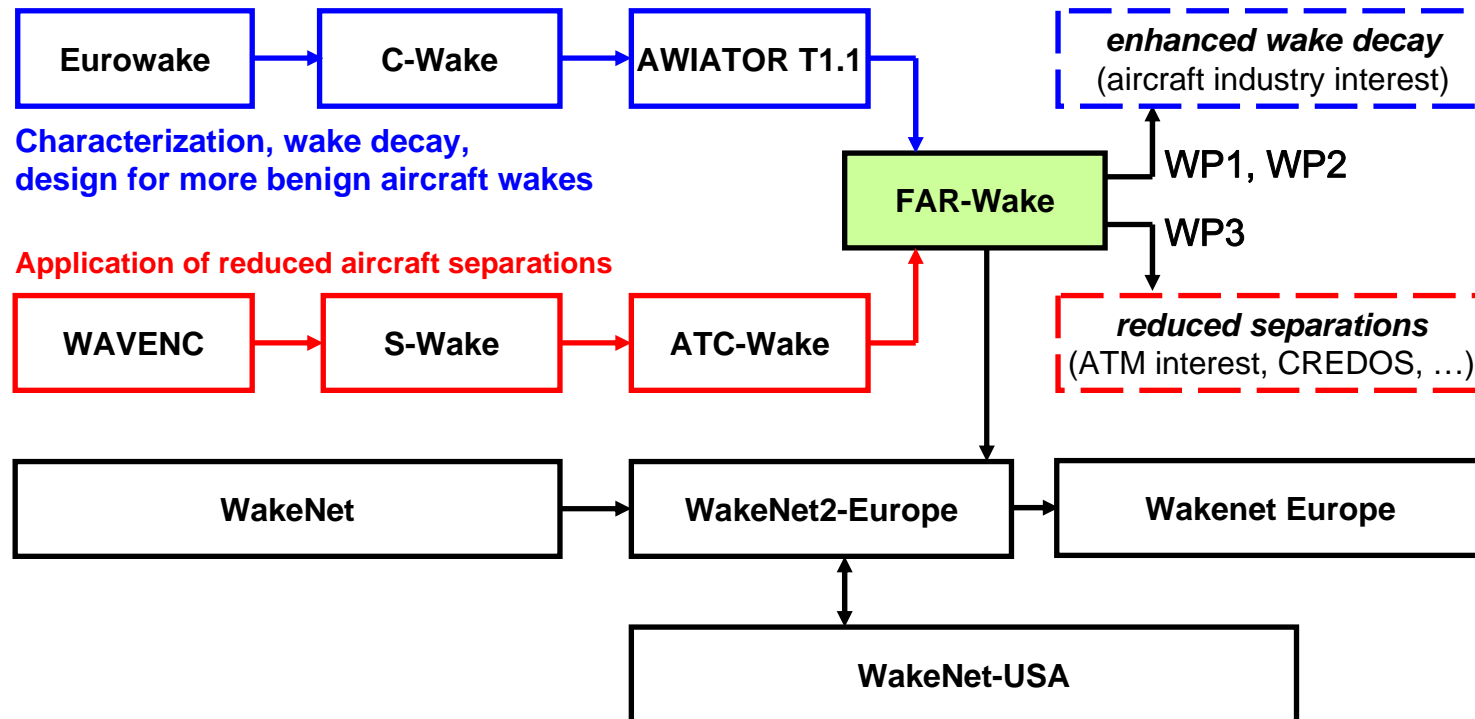


LES of a longitudinally uniform 2-vortex system in ground effect at $Re = 20,000$ (with and without wind)





Relation to other projects



Other possible **input** (if available) from:

MFLAME, I-Wake, WVWS, Memphis & St. Louis data bases, etc.

Output to:

aircraft industry, ATM community (Eurocontrol, DFS, etc.),
research community on vortex dynamics



The project is open to exchanges with third parties and welcomes feedback from outside the consortium:

- participation in **project meetings**
- www.FAR-Wake.org
 - description of work
 - contact points
 - publications & deliverables
 - meeting announcements



Partner login

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European Union
6th Framework Programme for Research and Technological Development
Priority 4: Aeronautics and Space

Specific Targeted Research Project

FAR-Wake
Fundamental Research on Aircraft Wake Phenomena
2005-2008

Latest news

- ♦ 22 December 2006: The EC launches the first FP7 [Call for Proposals](#) in Aeronautics and Air Transport. The deadline for submission is 3 May 2007.
- ♦ The **2nd Annual Review Meeting**, including Technical Sessions on all project activities, will be held in **Toulouse** on **8-9 February 2007**. Participants from third parties are welcome. Details are available from the [Coordinator](#) upon request.

FAR-Wake leaflet available [here](#) (PDF).

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