



Flow Physics Modelling - An Integrated Approach

*) Instability of an axi-symmetric jet; Van Dyke - An album of fluid motion, 1982

The European project FLOMANIA:
Flow physics modelling as an industrial requirement

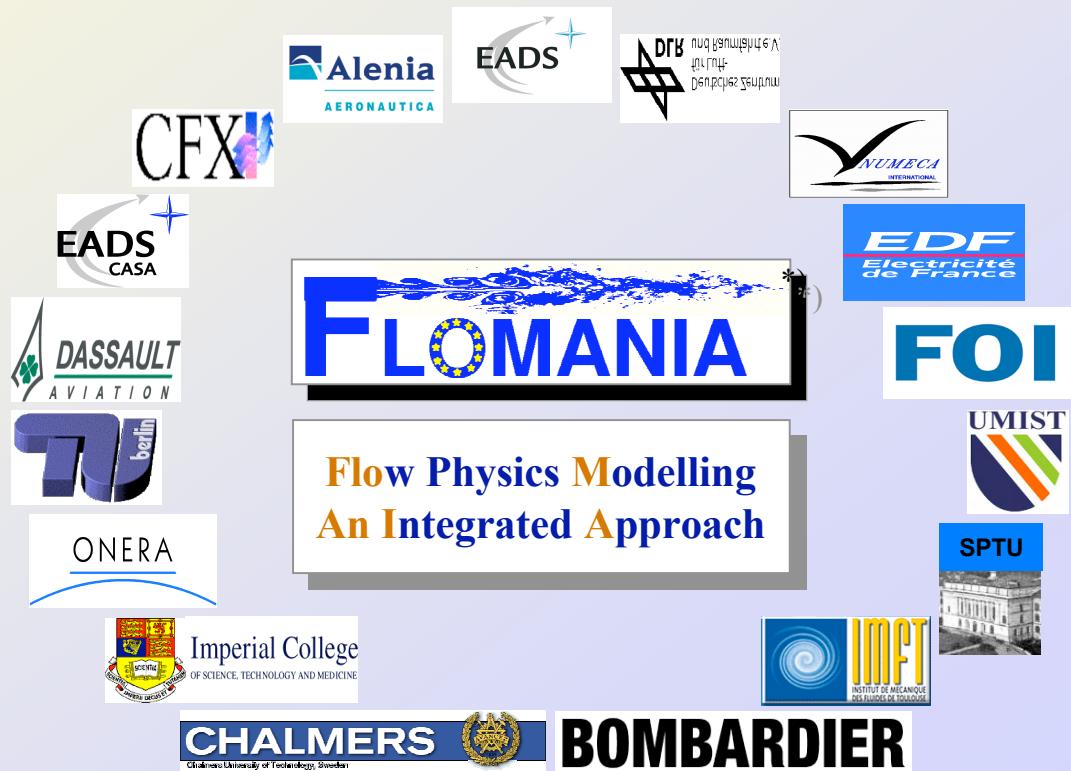
SUMMARY

- Why FLOMANIA ?
- What is FLOMANIA ?
- “Justification” of FLOMANIA
- Some current results around the (industrial) needs
- FLOMANIA and AIAA/DPW-2

What is FLOMANIA ?

The FLOMANIA project is a project funded by the European Union and administrated by the CEC, Research Directorate-General, Growth Programme, under Contract No. G4RD-CT2001-00613

It fosters European collaboration on flow physics modelling between:



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... in order to support industrial needs on :

- Robust, reliable and accurate turbulence models for URANS applications, featuring:
- Complex flows (shock/bl interaction, shock/shock interaction, pressure and shock induced separation, high angle of attack, vortical/vortex flow, vortex-boundary layer interaction, jets, mixing layers, control devices (VGs), Re scaling)
- Complex geometries / full aircraft
- Unsteady - Forced movement / free movements - mesh adaptation/movement
- CFD solutions which also support multi-disciplinary approaches and
- Shape/performance optimisation

Why do we (all) need this support ?

Because of a change in paradigm for CFD ? (Results from EU Julius project)

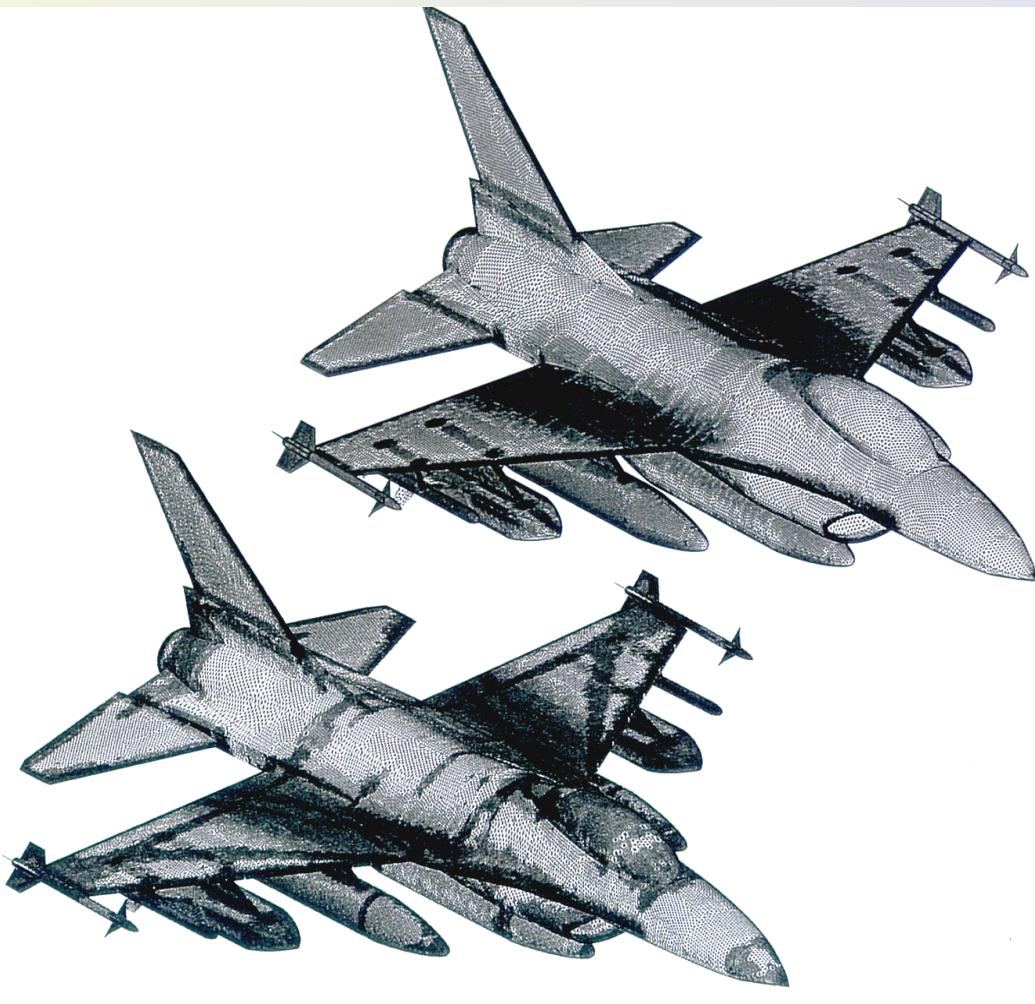
F16:

initial and adapted
unstructured mesh
 $1.2 \rightarrow 3.2$
mio. tets

Do we have experience with ?

- Very fine meshes
- Absolute values' prediction
(no "deltas" anymore)
- Pre- not postdiction ...

We then do need ...



Best Practice Guidelines !

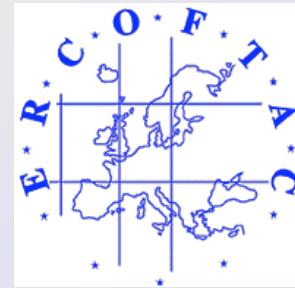
Guide to avoid the most common pitfalls

by providing:

essential information for the novice user,
advice that can also help the experienced expert user.

Guidelines not specific to individual codes, methods or applications

Not exhaustive: 20% of rules to cover 80% of aspects



A.G. Hutton

Email: aughutton@qinetiq.com

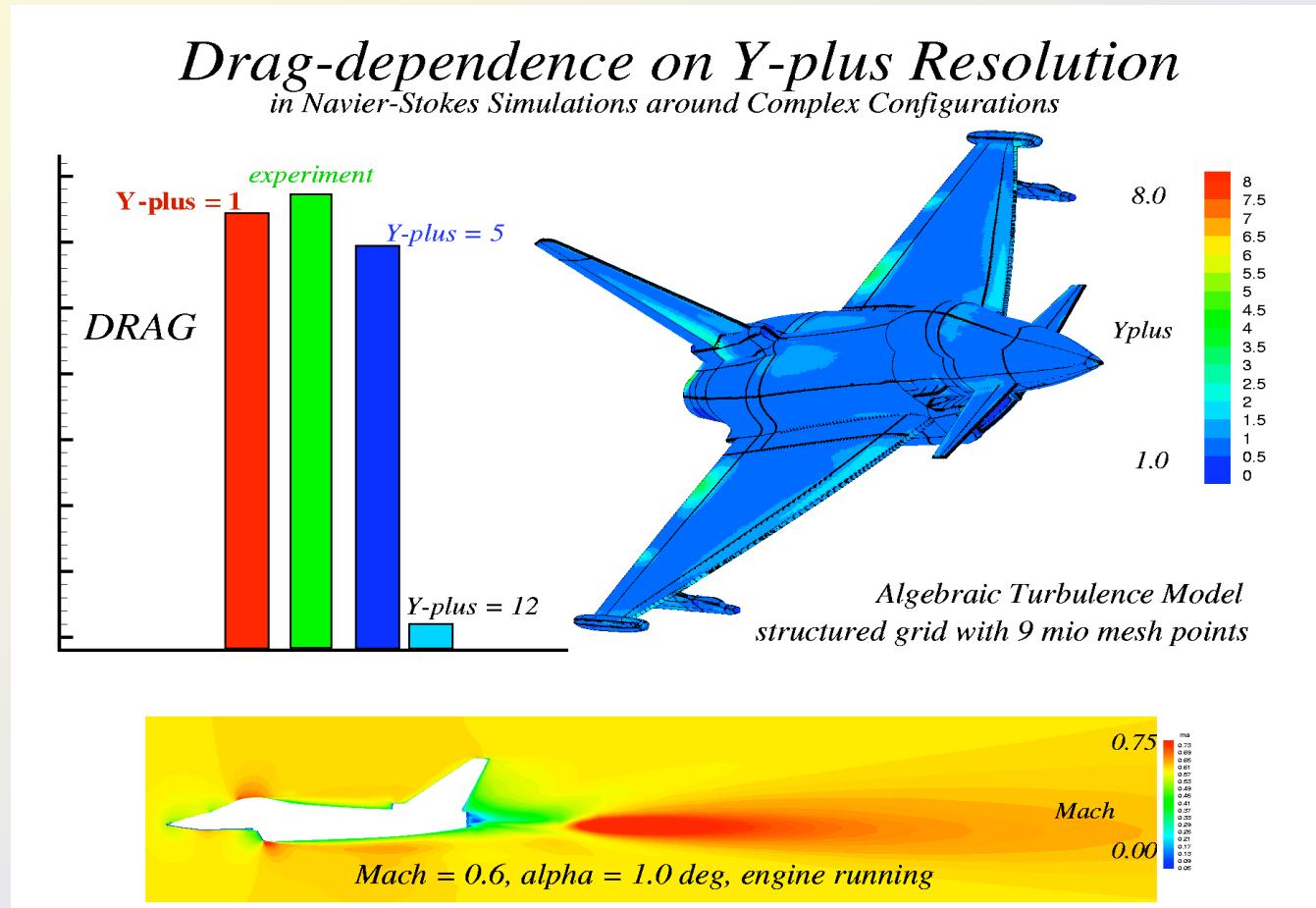
Price per copy:

Non ERCOFTAC Members: 150EUR (Academics 75EUR)

ERCOFTAC Members: 100EUR (Academics 50EUR)

Special Prices for Students (via institutes/professors)

An examples for applying BPGs (complex/full A/C)



iff taking care of BPGs, then we can be sure that ...

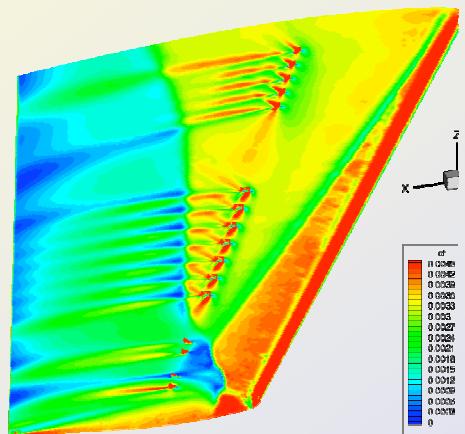
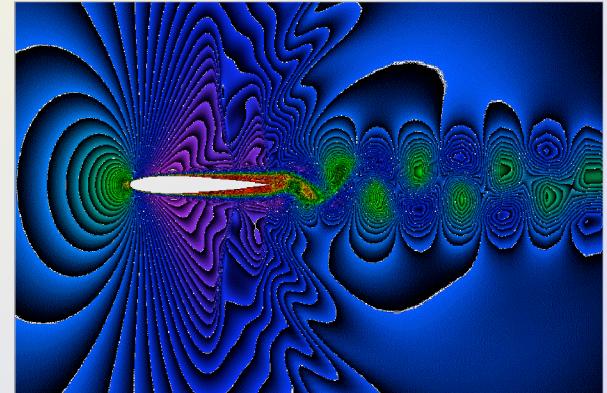
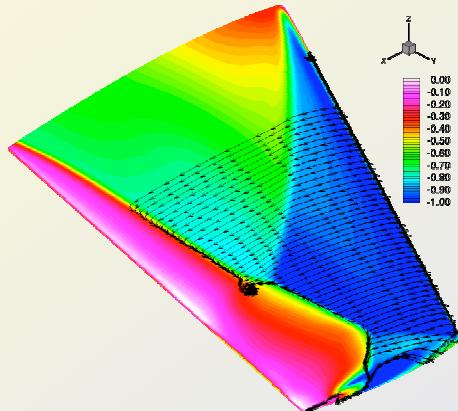
Multi-disciplinary applications are mature ! (EU Julius project)



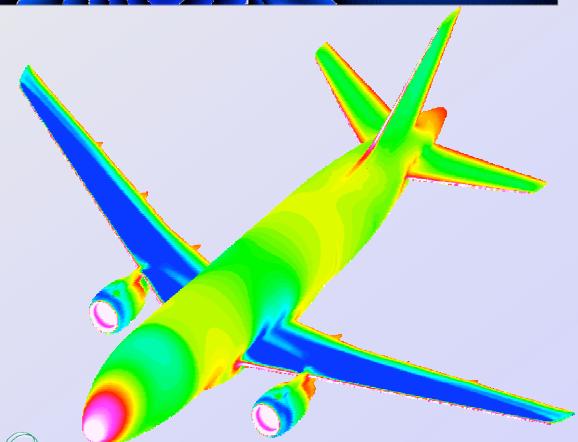
X31 5g pull-up manoeuvre



*Algebraic Turbulence
structured grid with 9 mio n*



*Can one model
handle all this?*



Main FLOMANIA objectives

- **Short-term goal**

Robust, reliable and accurate turbulence models for RANS (URANS) applications
(with effort on both structured/unstructured/hybrid meshes and methods)

- **Medium-term goal**

Overcome still existing weaknesses in turbulence modelling by closing the gap
between currently available RSM and industrially used 2-equ. models
(using expertise from FLOMANIA “technology providers” - for common and
comparable implementation of model(s))

- **Long-term goal**

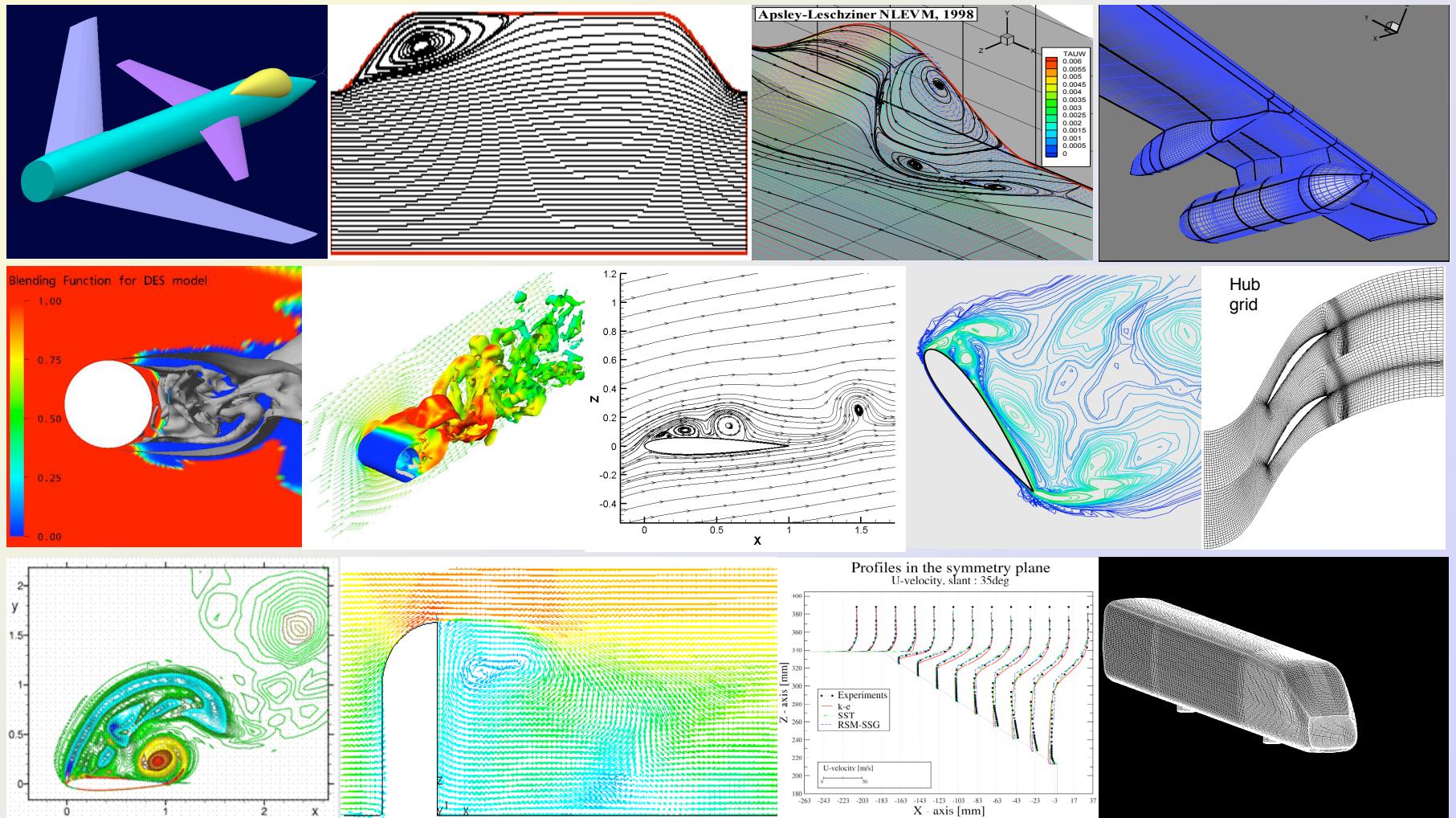
Upstream research taking into account DES method(s) for validation and for
evaluating range of validity of RANS methods
A set of generic DES test cases will be carried out - also providing models for DES
approaches

**Although FLOMANIA is NOT a validation program,
it features a quite big list of test cases ...**

Test Cases, Coordinators and Mandatory Meshes

| <u>Test case</u> | <u>Co-ordinator</u> | <u>Mand. Mesh</u> |
|--------------------------------------|---------------------|-------------------|
| Rotor 37 | NUMECA | NUMECA |
| <i>Asym. plane diffuser</i> | <i>ICSTM</i> | <i>ICSTM</i> |
| ONERA M6 | DLR (B) | (EADS) |
| OAT15A | Alenia | Alenia |
| NACA0012 beyond stall | DLR (G) | SPTU |
| MRTT | EADS-CASA | EADS-CASA |
| Generic train model | Bombardier | Bombardier |
| Generic car mirror | Bombardier | Bombardier |
| Forward swept wing A/C | EADS-M | EADS-M |
| TUM delta wing | Dassault | EADS-M |
| 3D circular cylinder | IMFT | SPTU |
| AS28 w/b | ONERA | ONERA |
| Generic air intake | ONERA | ONERA |
| Ahmed car body | AEA | UMIST |
| <i>3D low hill with complex sep.</i> | <i>Chalmers</i> | <i>ICSTM</i> |
| Separation behind 2D hills | UMIST | UMIST |
| Aerospatiale A-airfoil | EADS-M | EADS-M |
| NACA0012 - DNS | IMFT | IMFT |
| DLR-F6 | DLR | DPW |
| NACA64A010 pitch (SSC) | DLR | DLR |

An “impression” of results



FLOMANIA and AIAA/DPW-2

Why?

- DLR-F6 has been adopted as an additional test case because of participation of at least three FLOMANIA partners in the DPW-2
- Offers a possibility for (FLOMANIA and DPW-2 people) to provide new and/or advanced results (continuously) until mid of 2004
=> “prolongation of DPW-2”
- Utilisation of DPW-2 results for validation work in FLOMANIA
- Thus: Cross-fertilisation between AIAA/DPW-2 and FLOMANIA
=> “linking US and European effort”

FLOMANIA and AIAA/DPW-2

How?

- • Web link FLOMANIA / AIAA-DPW-2
- • Presentation of FLOMANIA at AIAA-DPW-2 workshop
- • Access of DPW-2 participants to DLR-F6 data base as part of FLOMANIA Web
cfd.me.umist.ac.uk/flomania and direct link to test case - password-protected
- • **DLR** is taking over FLOMANIA co-ordination for DLR-F6
 - Attendance of (interested) DPW-2 participants at FLOMANIA “Open Workshop”
=> Final FLOMANIA meeting - Likely to take place in the second half of June 2004

FLOMANIA and AIAA/DPW-2

Whom to contact ?

- **DLR** has taken over FLOMANIA co-ordination for DLR-F6 test case
(Dieter.Schwamborn@dlr.de)
- **EADS-M**, FLOMANIA co-ordinator
(Werner.Haase@m.eads.net)

FLOMANIA and AIAA/DPW-2

Interested ?

How to proceed ?

- Visit FLOMANIA Web site for extended information
- Get password for DLR-F6 test case from FLOMANIA co-ordinator
(send an email with your co-ordinates)
- Check FLOMANIA site for new results and/or provide your own new results
- Final Meeting will have separate session on DLR-F6
... thus you can bring new results

The FLOMANIA partners are welcoming you