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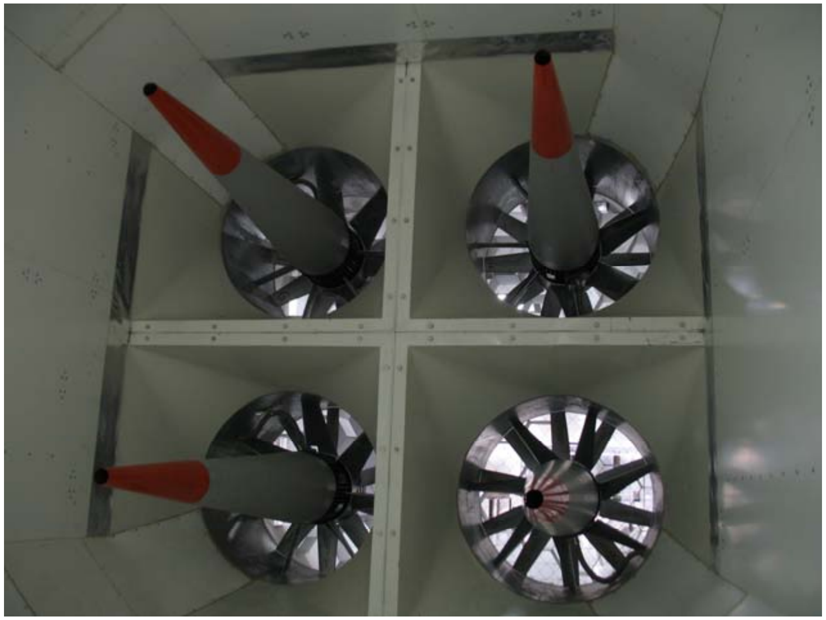
Haute école du paysage, d'ingénierie et d'architecture de Genève

HES - SO

Haute Ecole Spécialisée de Suisse Occidentale

Aeronautics Research & Education

Prof. Flavio Noca



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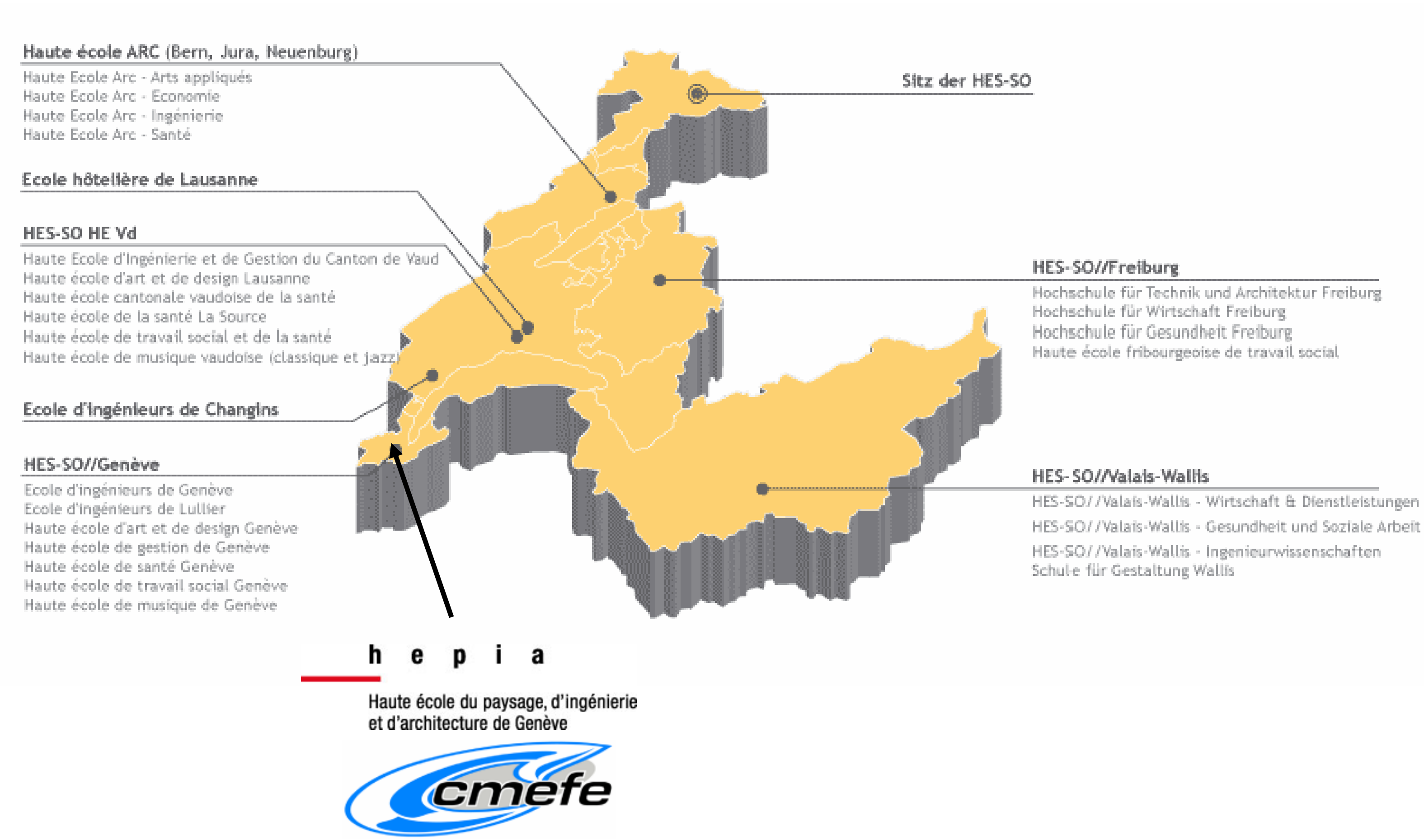

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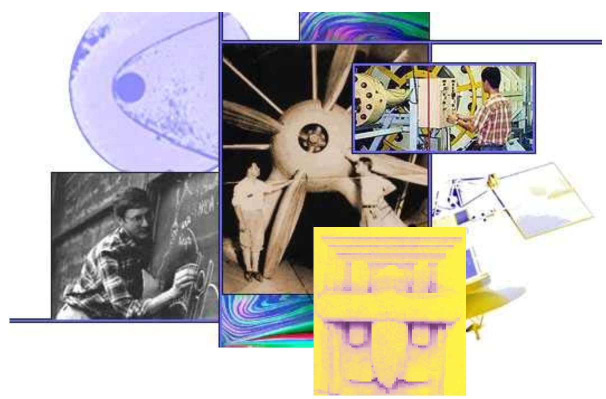
cmefe

From Caltech Aeronautics to Switzerland

Prof. Thomas Rösgen
Institut für Fluiddynamik
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Prof. Petros Koumoutsakos
Computational Science and Engineering Laboratory
ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

CALTECH
GALCIT
Graduate Aeronautical Laboratories
California Institute of Technology



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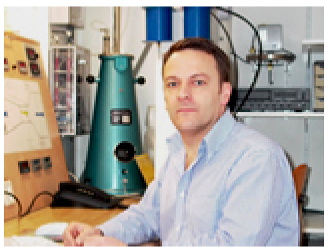
Prof. Flavio Noca
Center for Mechanics of Fluids and Energetics

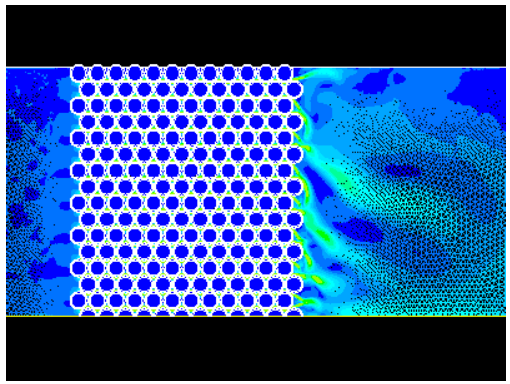
EPFL
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

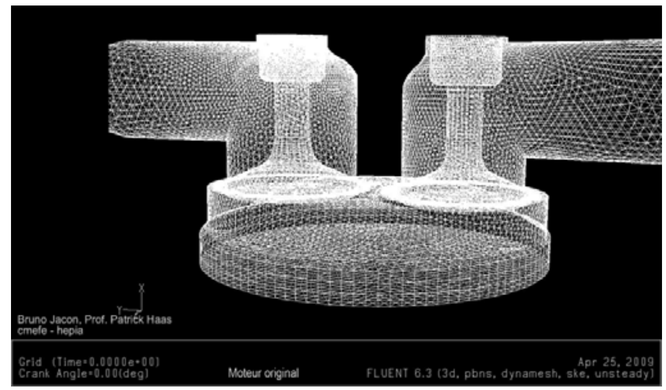
Prof. Jean-François Molinari
Computational Solid Mechanics Laboratory

www.cmefe.ch

Prof. Patrick Haas
Industrial Fluid Mechanics
& CFD

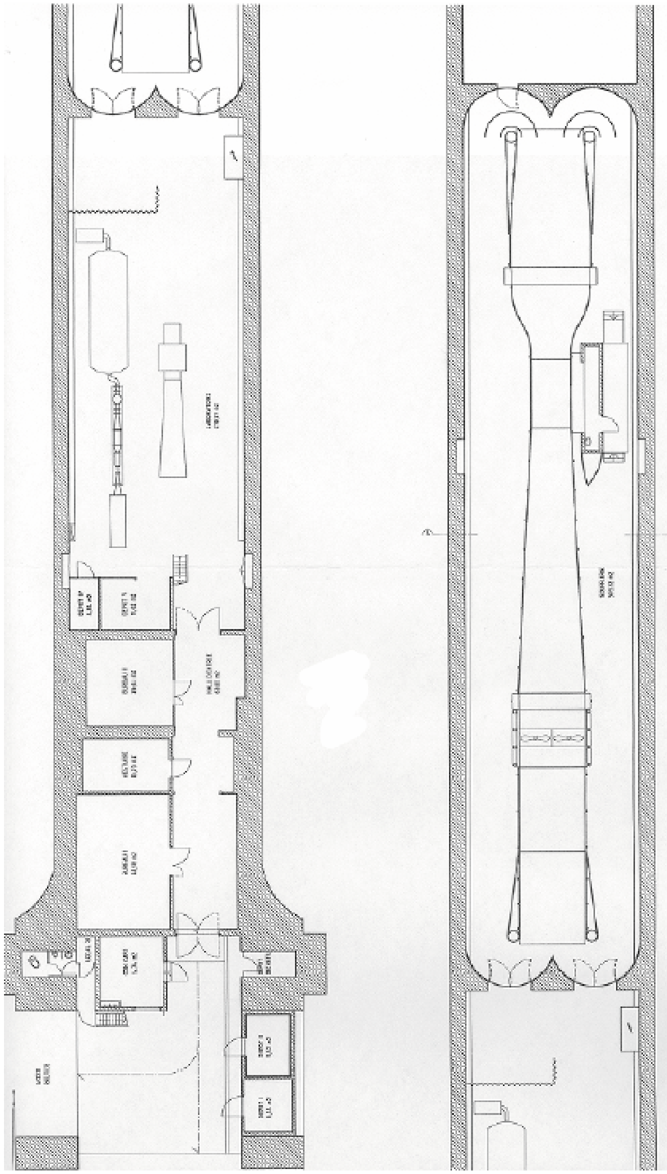






Prof. Flavio Noca
Fundamental Fluid Mechanics
& Measurement Techniques

www.cmefe.ch



Laboratory layout

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cmefe wind tunnels for aeronautical R&D

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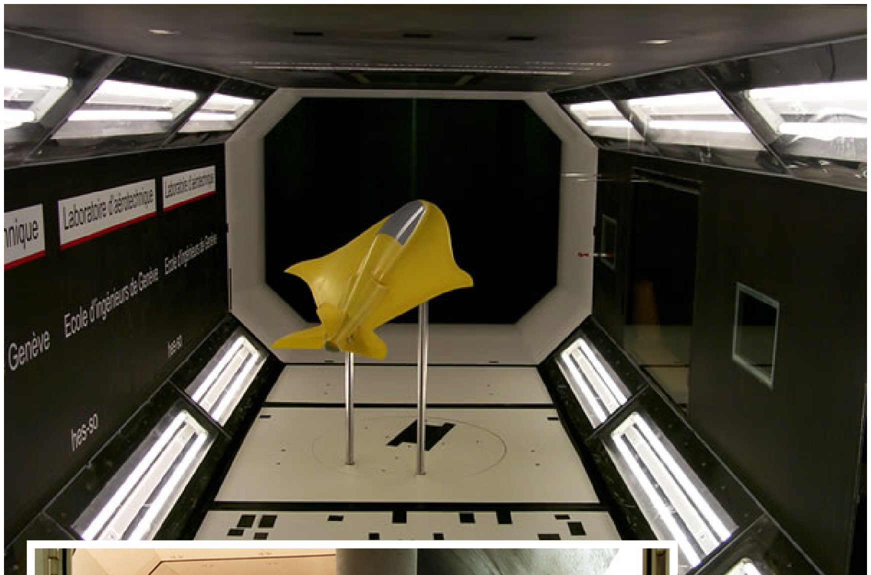
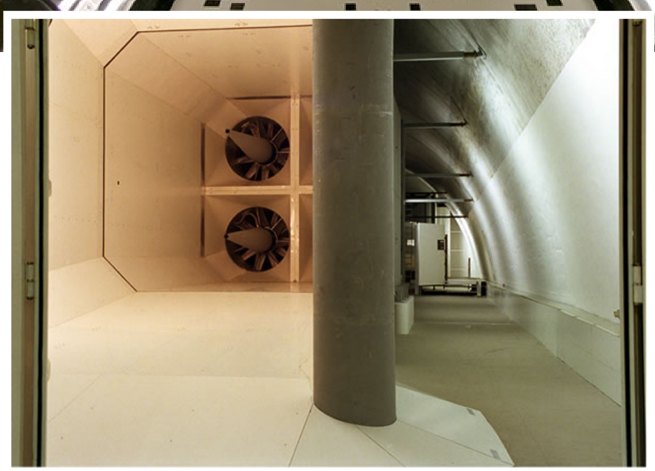
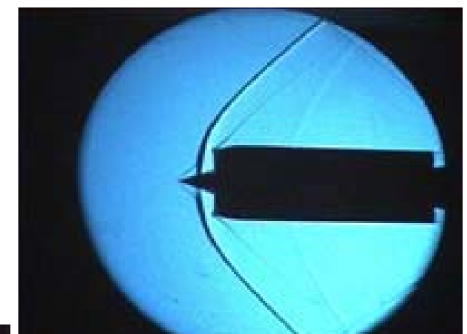
Tunnel	Section	Speed
Large Tunnel	1.5 m x 2.0 m	250 km/h
Eiffel	0.40 m x 0.30 m	250 km/h
Calibration Tunnel	0.20 m x 0.10 m	250 km/h
Supersonic	0.12 m x 0.08 m	Mach 1.4 to 2.4





Wind tunnel

Eiffel tunnel



Supersonic tunnel

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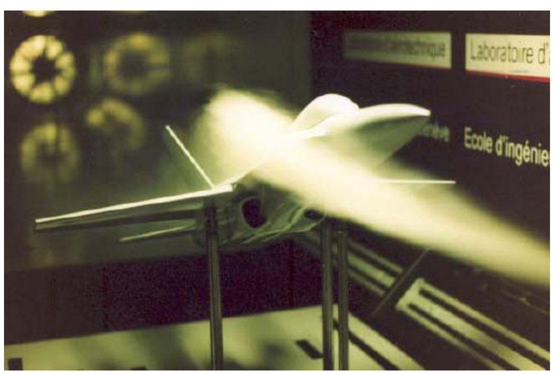
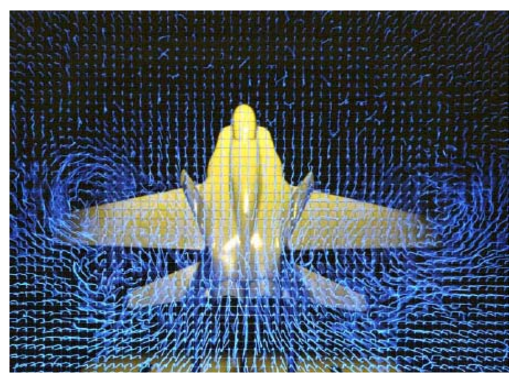
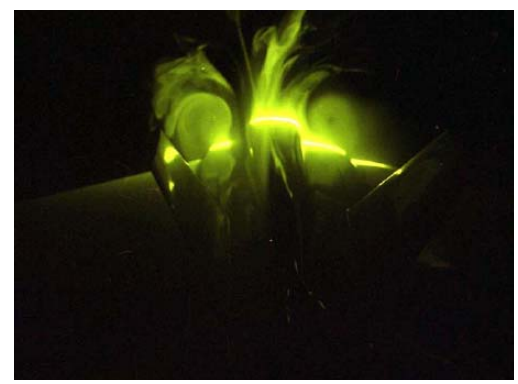
measurement techniques

6-component
force balances

Flow visualization







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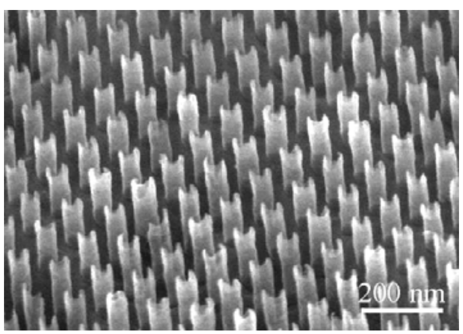
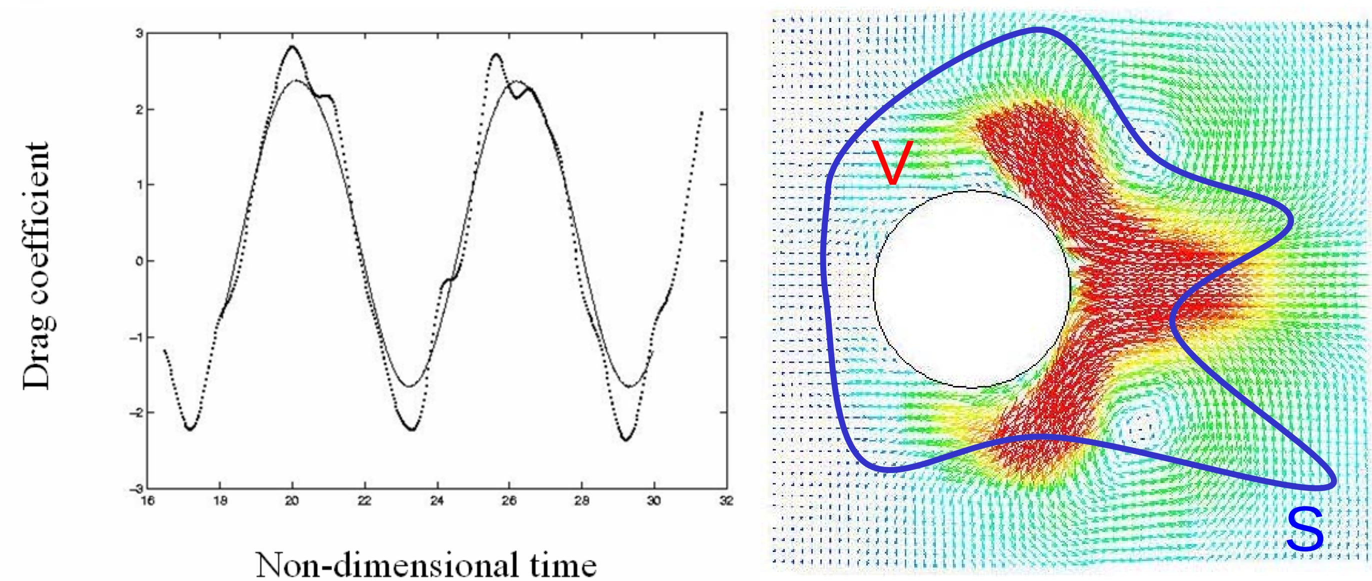
cmefe R&D on novel measurement techniques

Ultra high-speed imaging

Force measurement from Particle Image Velocimetry (PIV)



Development of novel low shear sensors



Dotted line: DPIV (Noca et. al 1998)
Solid line: Computations (Shiels 1998)

PIV velocity data for evaluating hydrodynamic forces on cylinder

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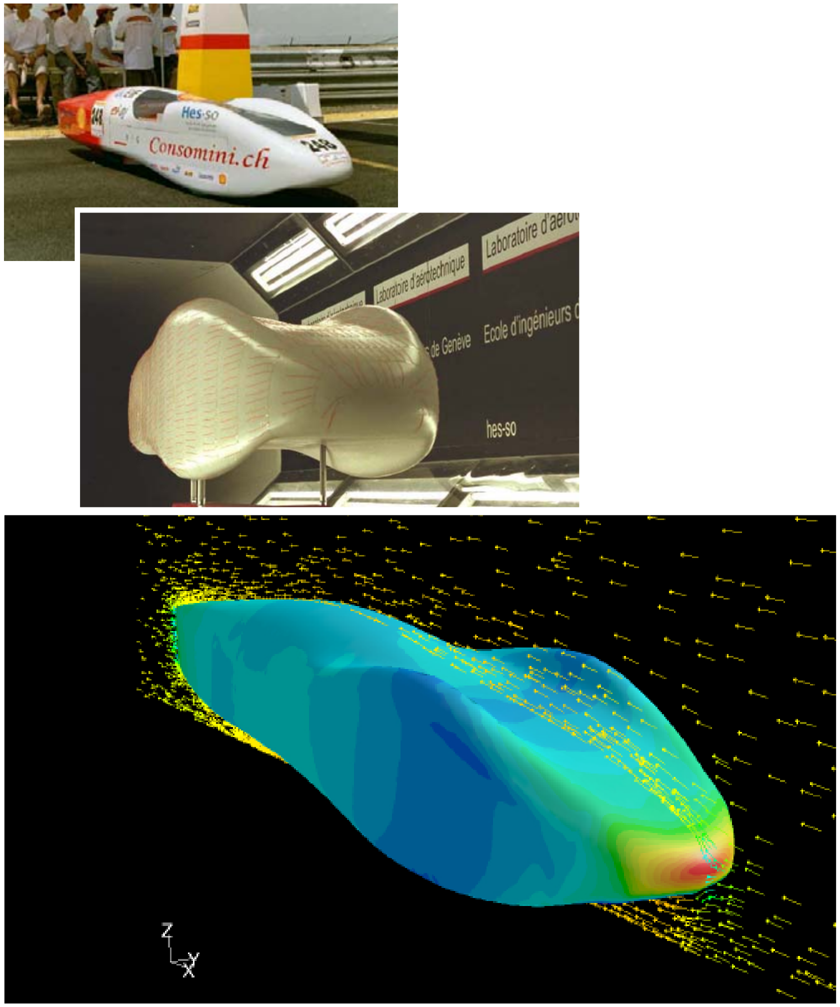
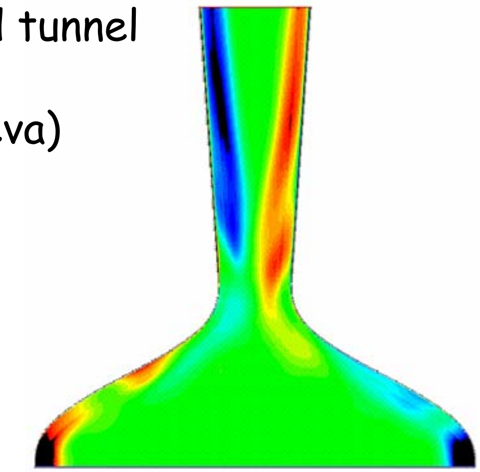
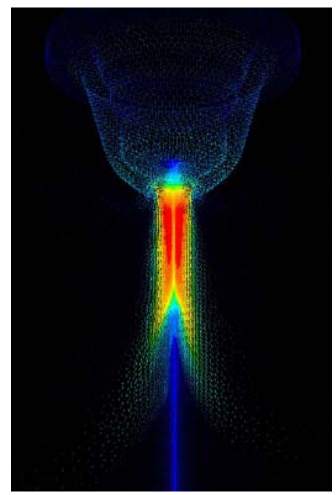
computational aerodynamics



Design of a vertical wind tunnel
for volcanology studies
(with University of Geneva)





Dielectric jet

Experimental and computational aerodynamics
of HES-SO Ecomarathon vehicle

Examples of cmefe aeronautics R&D projects

- fauX - DufauX 1910 – 2010
- Safe Aircraft Fuel (SAiF)
- Aircraft Humidity Sensors

Examples of cmefe aeronautics R&D projects

- **fauX - DufauX 1910 – 2010**
- Safe Aircraft Fuel (SAiF)
- Aircraft Humidity Sensors

fauX - DufauX 1910 – 2010

In 1910, the Swiss Dufaux brothers crossed the Leman Lake
in 56 minutes and won the Perrot-Duval Prize…

The Dufaux aircraft in Luzern (Verkehrshaus)

Armand Dufaux (1910)

fauX - DufauX 1910 – 2010

… and in 2010,

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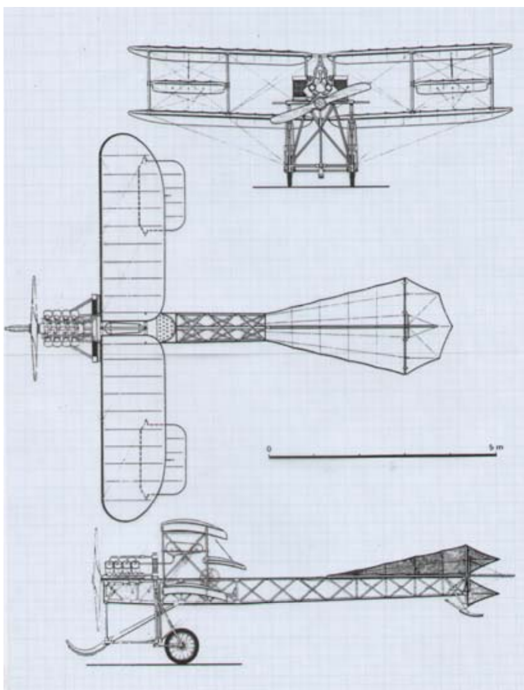
histoire et pionniers de la technologie aéronautique

www.hepta.aero President: Anibal Jaimes



is building a replica of the Dufaux aircraft
(the FauX – DufauX)
with students and technical personnel from all over Switzerland
to celebrate the centenary.

fauX - DufauX 1910 – 2010

Manufacturing of the fauX-DufauX wing for testing in the cmefe wind tunnel

Ecole de Couture de Fribourg
wrapped the airfoil
(Veronika Khojman, Basile Charmillot)

Ecole Technique
des Métiers de Lausanne
built the wooden skeleton
(Prof. Chabloz)

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fauX - DufauX 1910 – 2010

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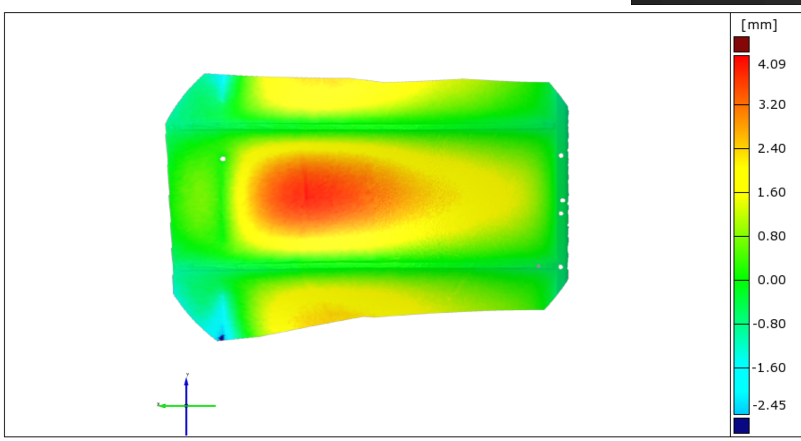
Testing of the fauX - Dufaux wing in the cmefe wind tunnel

Measurement with a 3D camera of the wing surface deformation induced by aerodynamic forces



Pierre Munier
Bachelor Student
Diploma Project
(2009)

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Future collaboration on another aeronautical project led by

hepta.aero

histoire et pionniers de la technologie aéronautique

SEARCH

SEmirigid Advanced ResearCH

Airship, 3000 m^3, 25 m long with storage facilities and associated systems

Examples of cmefe aeronautics R&D projects

- fauX - DufauX 1910 – 2010
- **Safe Aircraft Fuel (SAiF)**
- Aircraft Humidity Sensors

Safe Aircraft Fuel (SAiF)

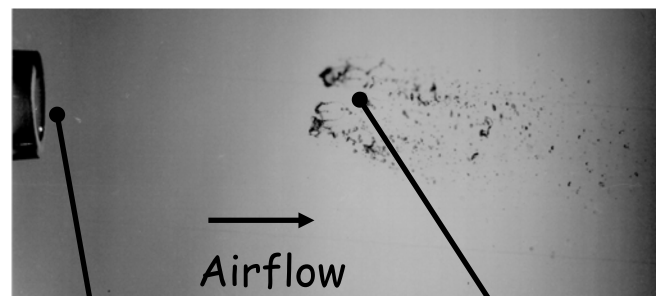
Safe aircraft fuel
would burn inside an engine …

… but would NOT catch fire
if released accidentally

Safe Aircraft Fuel (SAiF)

Regular aircraft fuel
(kerosene, Jet-A, JP-8, etc.)
does NOT burn easily.

Kerosene needs to be "atomized"
(droplets of a few microns)
in order to burn.



Safe Aircraft Fuel (SAiF)

Fuel Release (spill, splash)

Jet A fuel (Kerosene)

Shear/ Impact

Mist of fine droplets with large surface/volume and high vaporization when heated

Lots of vapor

Easily ignitable

There will always be ignition sources and, thus, a large, self-supporting, "hot" fire ball, which will easily trigger pool fires

Pool fire

Modified Kerosene

Shear/ Impact

Cloud of large drops (blobs) with small surface/volume and limited vaporization when heated

Less vapor

NOT easily ignitable

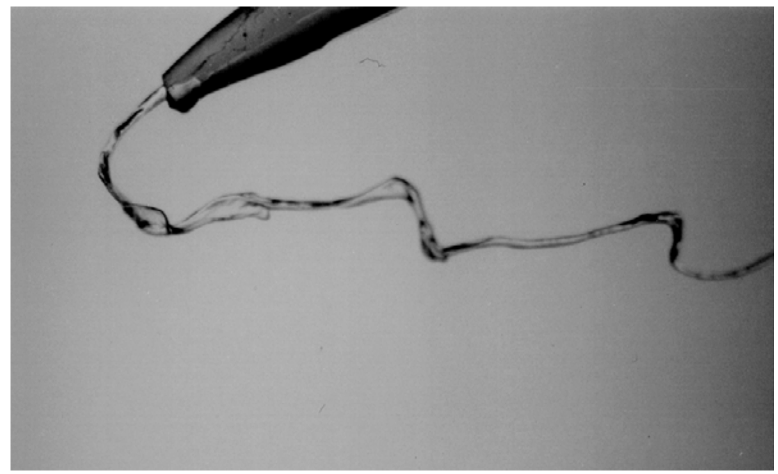
Even if ignition occurs, there will be a small, self-quenching, "cold" fire, which eliminates or delays pool fires

Little or No Pool fire

Safe Aircraft Fuel (SAiF)

JP-8

JP-8 + 0.3% FM-9



Air flow →

Freestream velocity = 27 m/s, jet exit velocity = 3.2 m/s, jet exit diameter = 0.88 mm

Safe Aircraft Fuel (SAiF)

Anti-Misting Kerosene (AMK) Program
NASA & FAA, 1960's – 1986

- Kerosene with additive was NOT supposed to burn upon impact
- Controlled Impact Demonstration (CID, 1986) was viewed as a failure

Controlled Impact Demonstration (CID, 1986)

Safe Aircraft Fuel (SAiF)

Mist Control Kerosene (MCK) Program
NASA, 2001 – present

- Renewed concern with the events of September 11, 2001
- High Speed Impact (800 km/h) tests at China Lake Warfare Center (2003)
- Kerosene (Jet-A) modified with PolyIsoButylene (PIB)

Canon

Target against which the projectile is fired

Projectile loaded with 15 liters of kerosene

Safe Aircraft Fuel (SAiF)

NASA

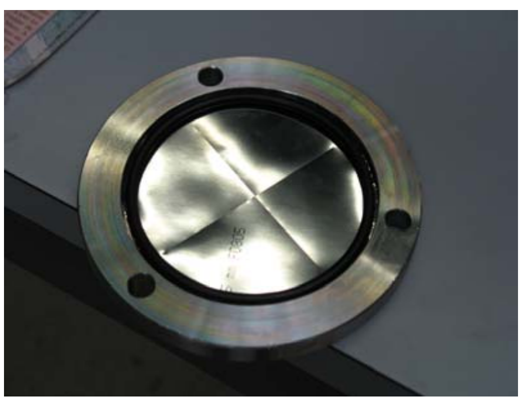
Jet-A
Fireball

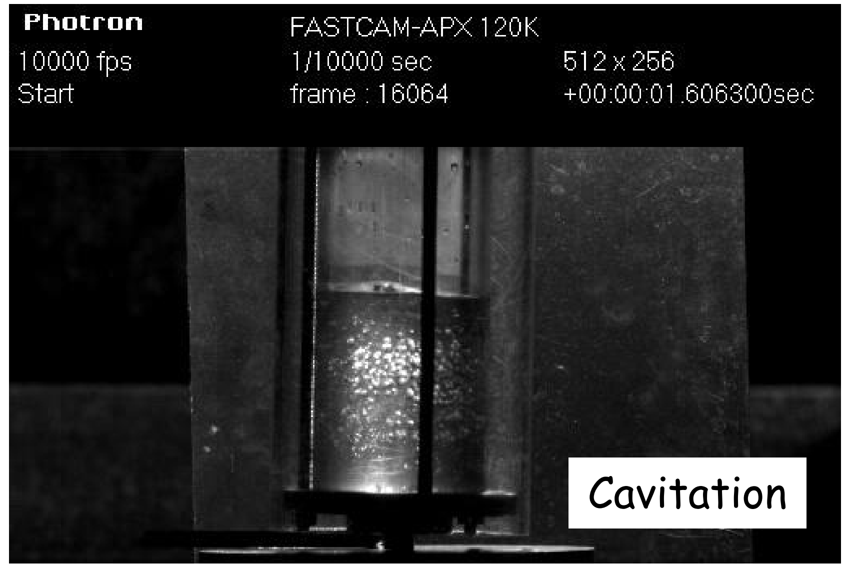
Impacting kerosene
at 800 km/h

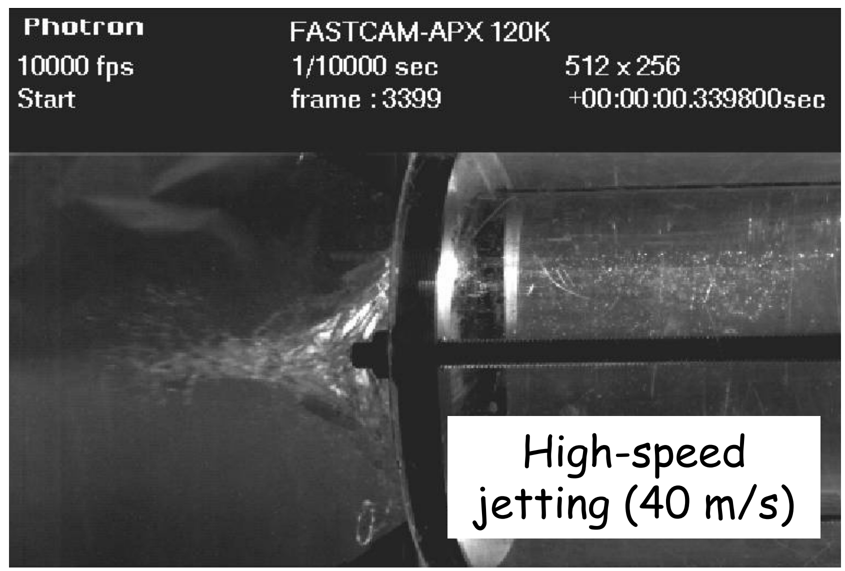
MCK (Jet-A with 1% PIB)
No fire

Safe Aircraft Fuel (SAiF)

Effects of liquid impact at 5 m/s







Examples of cmefe aeronautics R&D projects

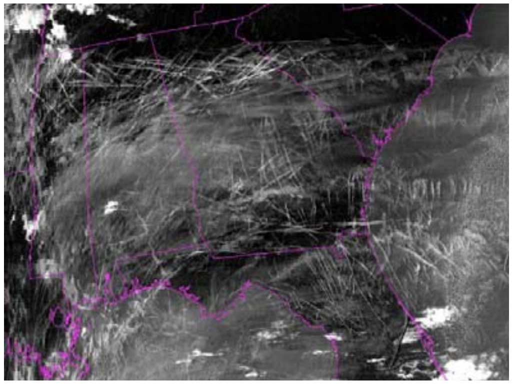
- fauX - DufauX 1910 – 2010
- Safe Aircraft Fuel (SAiF)
- ***Aircraft Humidity Sensors***

Aircraft Humidity Sensors

Why humidity sensors (hygrometers) on aircraft?

- Detection of icing conditions
- Worldwide measurement of water vapor (green house gas) in the atmosphere
- Avoidance of humid regions, which lead to the formation of contrails (whitish vapor trails in the wake of engines) and may contribute to the modification of the Earth albedo

Aircraft contrails may modify Earth albedo



Satellite image of NASA Terra Modis showing contrails over the United States

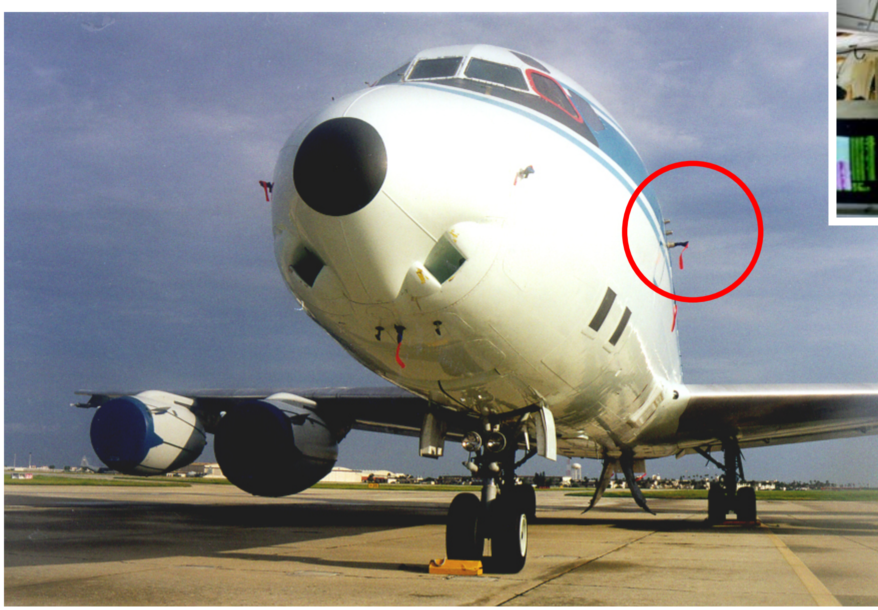
Current humidity sensors:

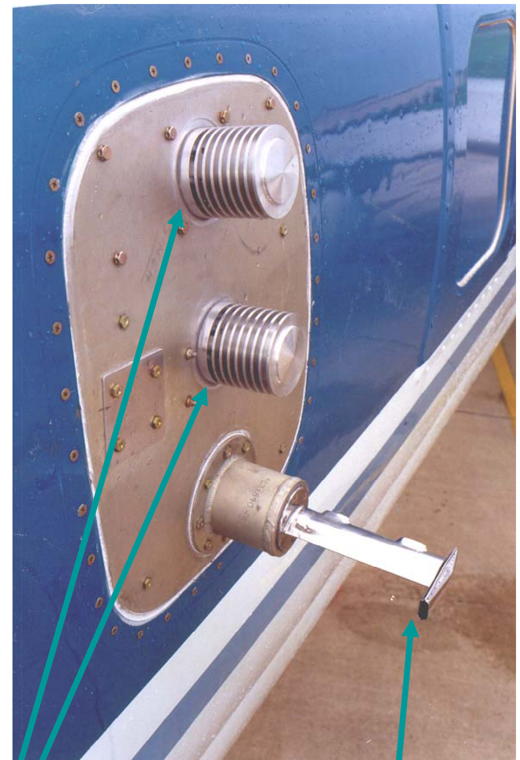
- Are not reliable
- Have a very slow response

New hygrometer technology needs to be developed for future implementation on aircrafts

Aircraft Humidity Sensors

NASA DC-8 Aircraft
Instrumented with Hygrometer



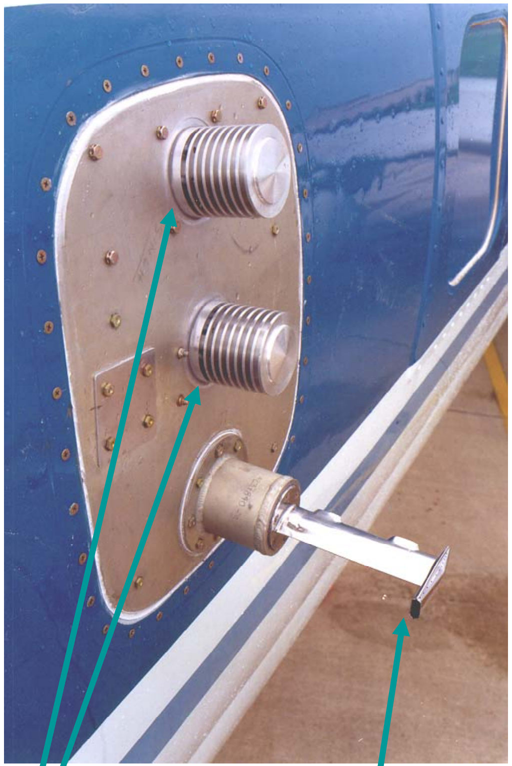


Air-cooled housings containing each one hygrometer

Air-sampling (Rosemount probe)

Aircraft Humidity Sensors

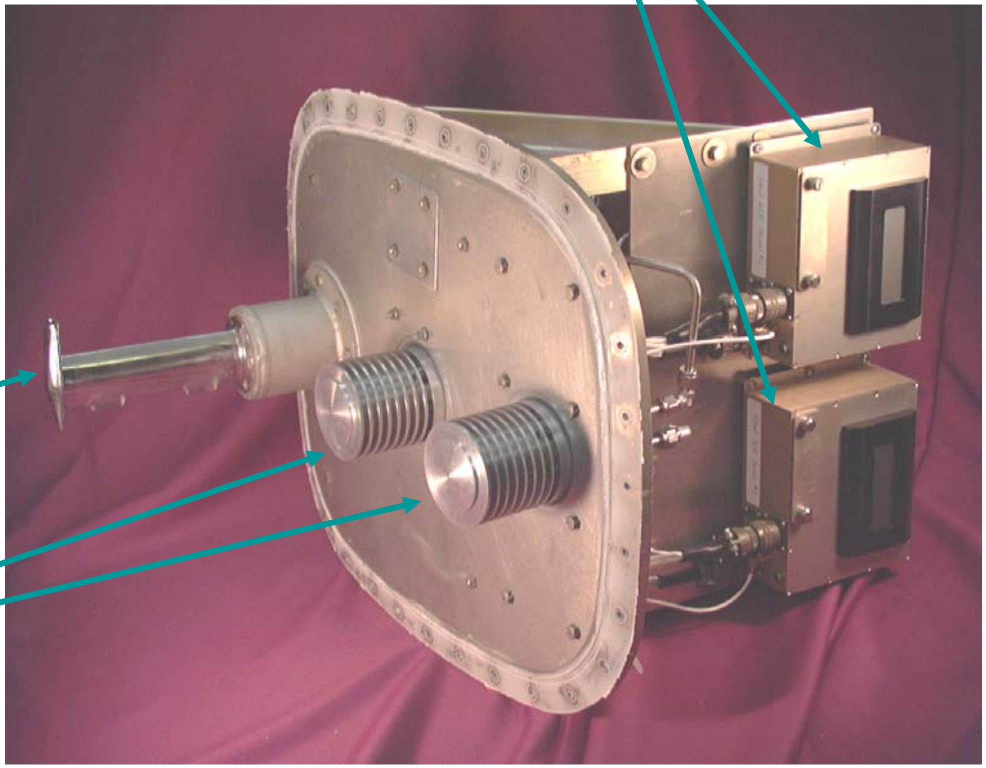
DC-8 window assembly



Microhygrometer, NASA (Hoenk, Noca *et al.*)

Electronics include
- Instrument controller
- Flash card data logger

Monitoring
- LCD display shows current measurements and status



Air-sampling probe

Air-cooled housings containing each one SAW device

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Aircraft Humidity Sensors

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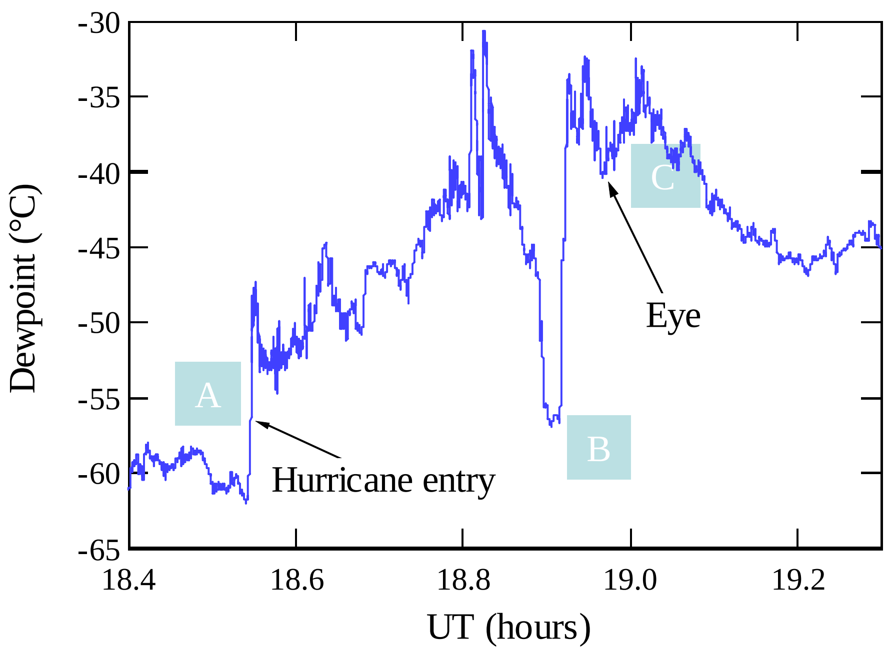
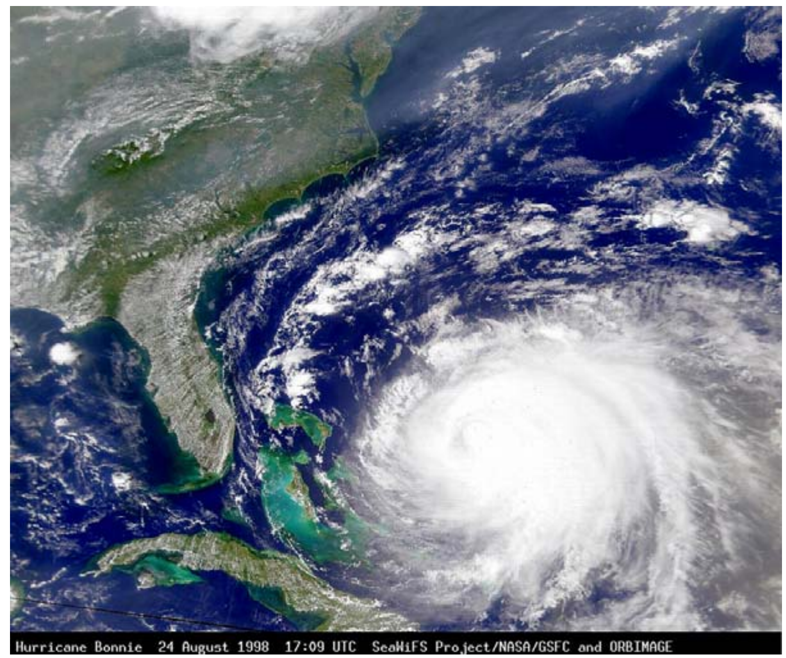
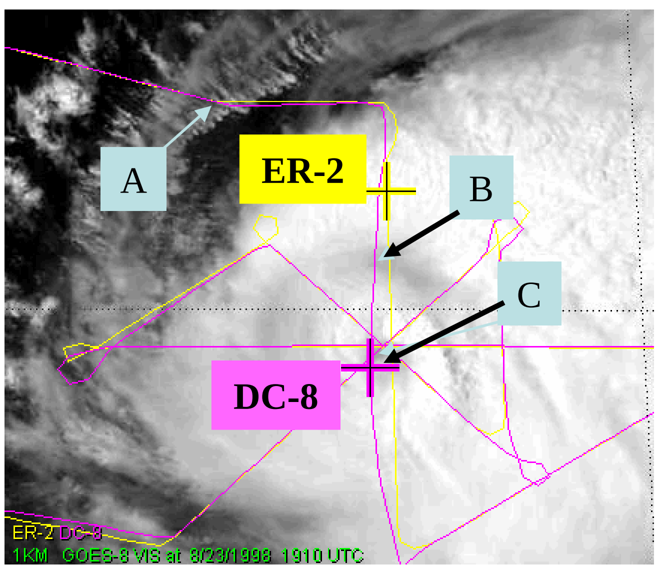
Hurricane Bonnie In Situ Humidity Measurement (DC-8, 08-23-98)





Satellite image of Hurricane Bonnie with flight tracks
Markers indicate aircrafts position at 19:00 UT August 23, 1998.



1. Noca F., Hoenk M., Cardell G., Price D., Watson R. K. 1998 "SAW Dewpoint Microhygrometer", *NASA CAMEX-3 Science Symposium,* Cocoa Beach, Florida.
2. Noca F., Hoenk M. 1999 "Dewpoint measurements in hurricanes", *1998 Hurricane Data Workshop, 79th American Meteorological Society Annual meeting ,* Dallas, Texas.

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Aircraft Humidity Sensors

Micro-hygrometer mounted on solar aircraft, Centurion