von KARMAN INSTITUTE
FOR FLUID DYNAMICS

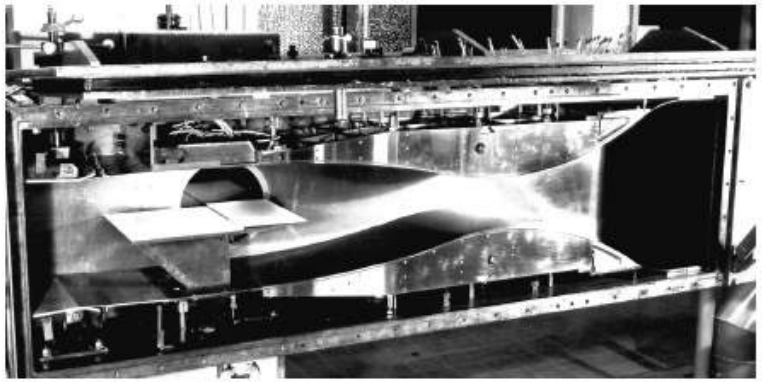
The von Karman Institute for Fluid Dynamics

ir. Peter A. GROGNARD, Managing Director
M.Sc. Aero, Caltech

At the Leading Edge of
Fluid Dynamics Education
& Research

VKI was founded in 1956

THE HORIZONTAL CLOSED TEST SECTION OF THE SUBSONIC WIND TUNNEL



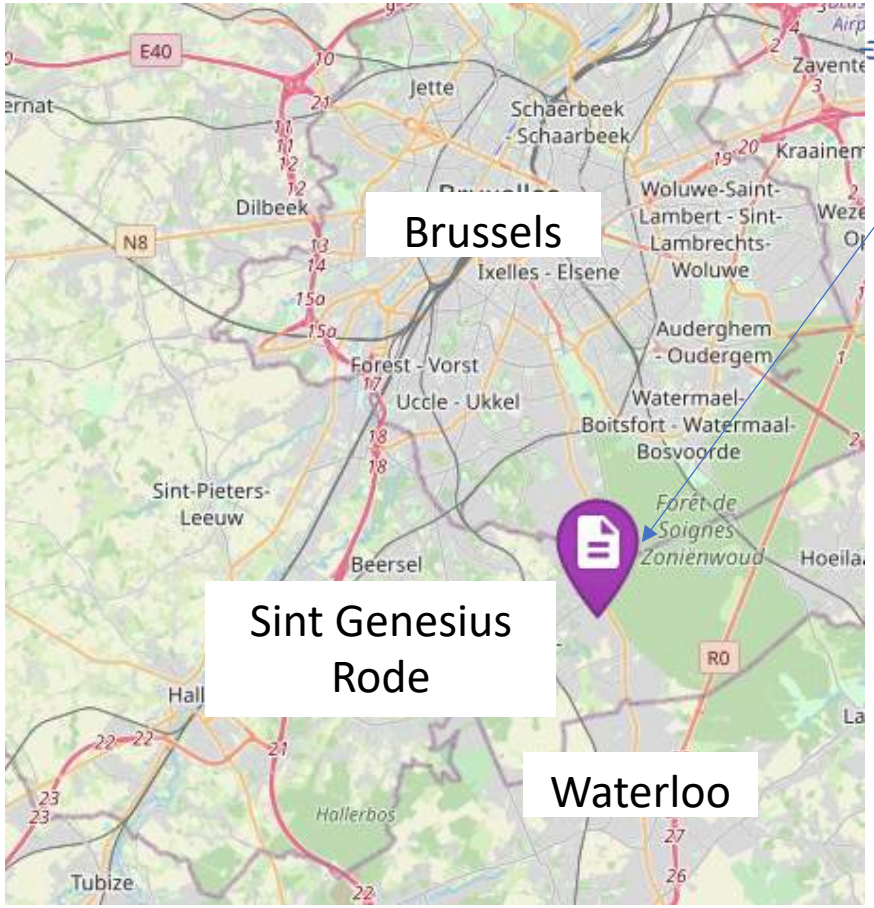
THE NEW SUPERSONIC NOZZLE

"Training in Research through Research"

- Founded in 1956
- as Belgian-American Training Center for Experimental Aerodynamics (TCEA)
- renamed von Karman Institute in 1963

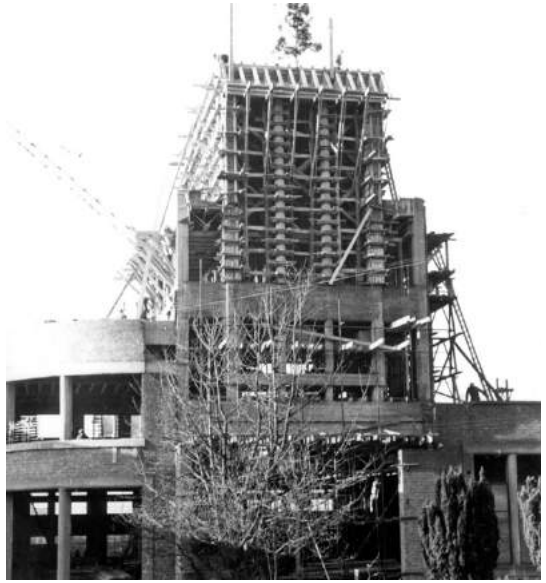
THEODORE VON KÁRMÁN RECEIVING THE NATIONAL MEDAL OF SCIENCE FROM PRESIDENT KENNEDY IN 1963

A century of R&D Activities on VKI's site



von KARMAN INSTITUTE FOR FLUID DYNAMICS

Creation in 1922 of an Aeronautical Institute with a 2m-diameter wind tunnel at Sint-Genesius-Rode



Construction in 1923

Today, 15 NATO countries support VKI


Belgium


Bulgaria


Czech Republic


France


Germany


Greece


Hungary


Iceland


Italy


Luxembourg


Norway


Portugal


Romania


Turkey


United States

VKI funding model

- Voluntary contribution of some NATO Countries
- Funding model open to other voluntary contributions
- NATO oversees this part of the funding of the VKI
- Other NATO Countries warmly invited to (Re)join VKI funding

VKI activities at a glance

Education

- Short Training Program
- Research Master Program
- Doctoral Program

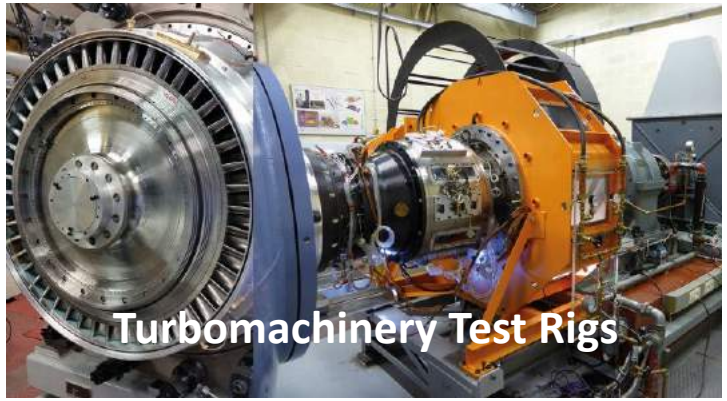
Research & Consulting

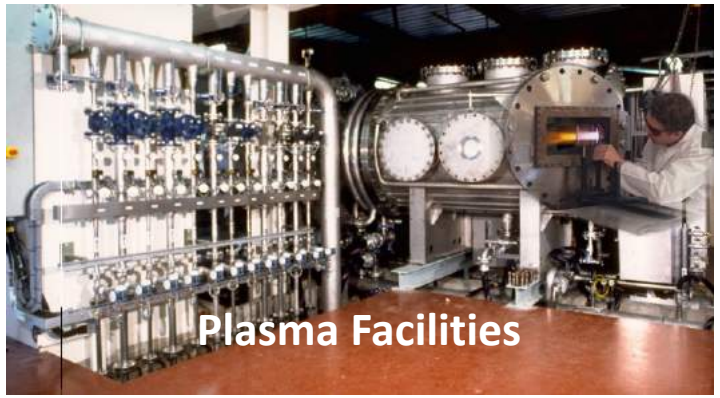
- Aerospace
- Turbomachinery
- Industrial Processes
- Environmental Flows
- Fluid Engineering & Measurements

Lecture Series

- Short courses on special topics
- For industry, academics, military participation
- Invited international lectures

VKI unique research facilities





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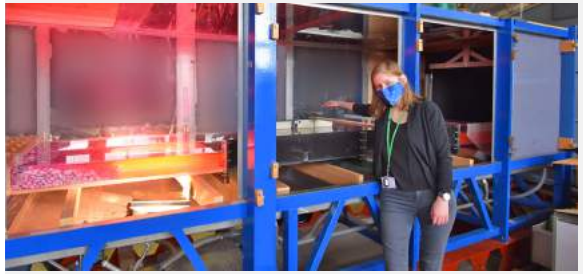


VKI Research Master Program

NVAO accredited master-after-master post-graduate program
Entry with a five-year engineering or science degree (3-year B.S. + 2-year M.S.)

1 Research Project
(30 ECTS)

- Individual research project
- Guided by VKI Faculty & Research Engineers

5 Common Courses
(14 ECTS)

- Presenting, Reporting & Research Management
- Scientific Modeling of Fluid Flows
- Experimental Fluid Dynamics, CFD, Signal Processing

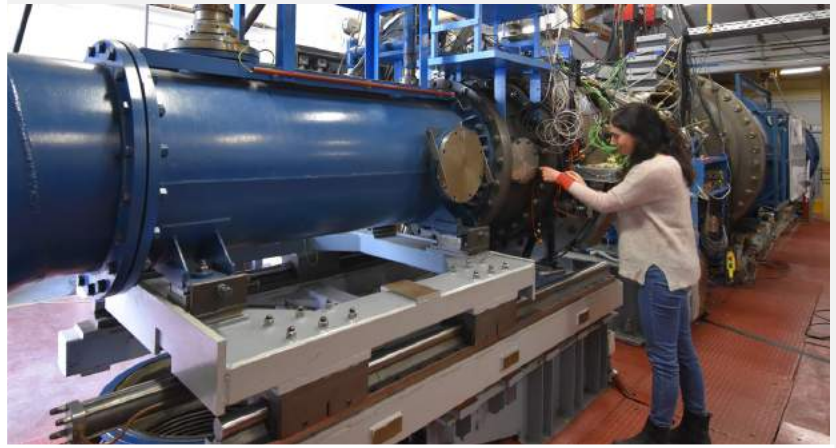
20 Specialized Courses
(16 ECTS)

Examples:

- Hypersonics, Aeroacoustics,
- Turbomachinery, Introduction to Turbulence
- Machine Learning for Fluid Dynamics

No tuition fees for citizens of funding nations - fellowships available

VKI Doctoral Program



Collaboration with Universities

International Environment

Center of Excellence

- Entering usually after completing VKI Research Master
- PhD thesis is presented at a university
- 300 Doctoral programs complete, currently 67 PhD candidates enrolled

VKI Short Training Program

- 3 to 6 months training for **university students in engineering, physics or mathematics**, involving active participation in a guided research project
- Often used to prepare the **MS graduation thesis** at the home university
- Also open to **visiting PhD candidates**, as part of their PhD program

fellowships available

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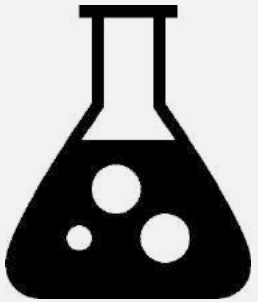
VKI research focus in fluid dynamics

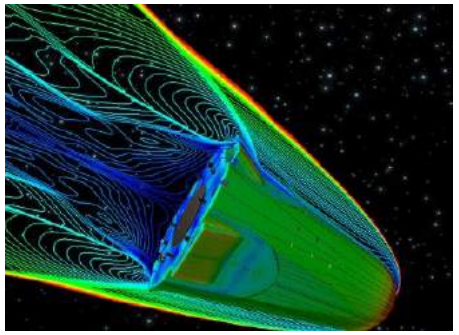


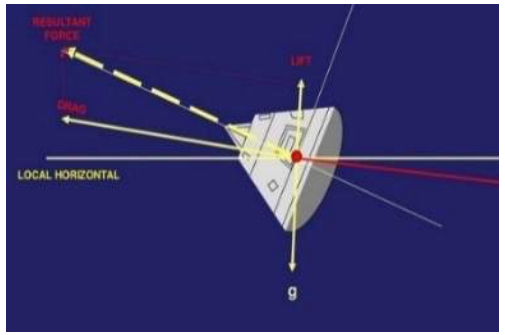




AEROSPACE	TURBOMACHINERY	INDUSTRIAL PROCESSES	ENVIRONMENTAL FLOWS	FLUID ENGINEERING & MEASUREMENT
1. Hypersonics	1. Propulsion	1. Liquid metal flows	1. Wind energy	1. Instrumentation
2. Space exploration	2. Turbines	2. Hydrogen	2. Atmospheric flows	2. Artificial Intelligence
3. Re-entry/debris	3. Compressors	3. Multiphase flows	3. Pollution dispersion	3. Calibration
4. Aeronautics	4. Energy Systems	4. Cryogenic flows	4. Explosion impact	

Research Expertise Groups in Space Research





Facilities for Experimental Testing in Aerospace

Subsonic

L1 – *Large Scale Low Speed Wind Tunnel*

Transonic

S1 –*Transonic/Supersonic Wind Tunnel*

Supersonic

H3 – *Mach 6 Hypersonic Wind Tunnel*

Hypersonic

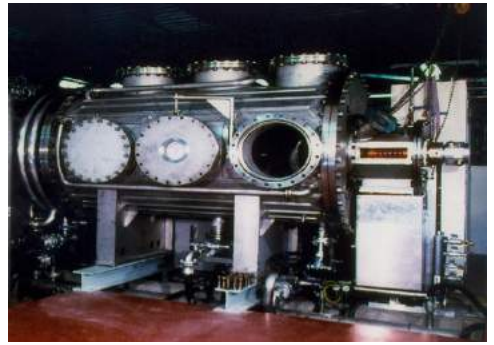
LongShot – *Mach 14 Hypersonic Wind Tunnel*

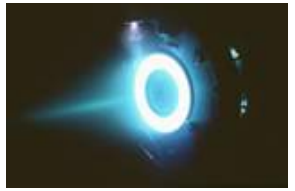
Plasma

Plasmatron – *Induced Coupled Plasma Facility*

rarefied **LDF** – *Low Density Facility (under construction)*

QARMAN – *flight facility for Reentry flows*

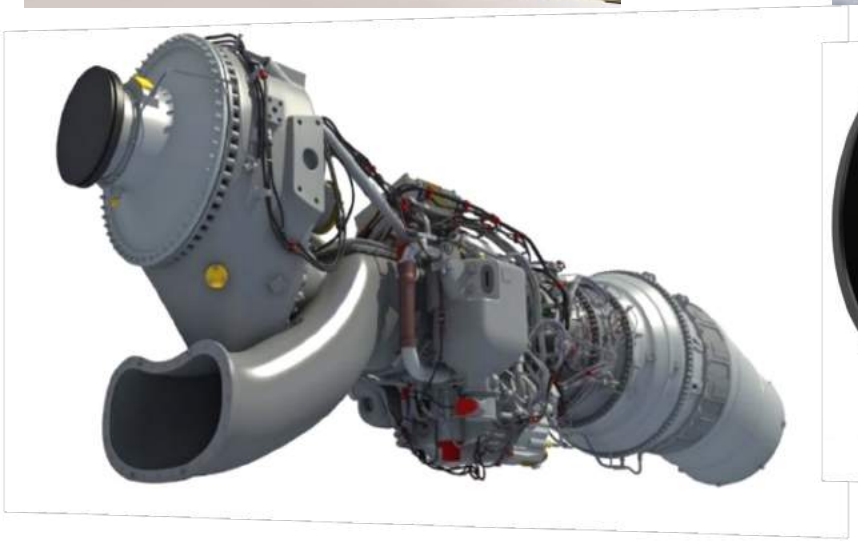




MOU with NASA Ames on Entry Systems Modelling signed June 8, 2022

2. Turbomachinery: Research on Aero Engines

Research & Consulting



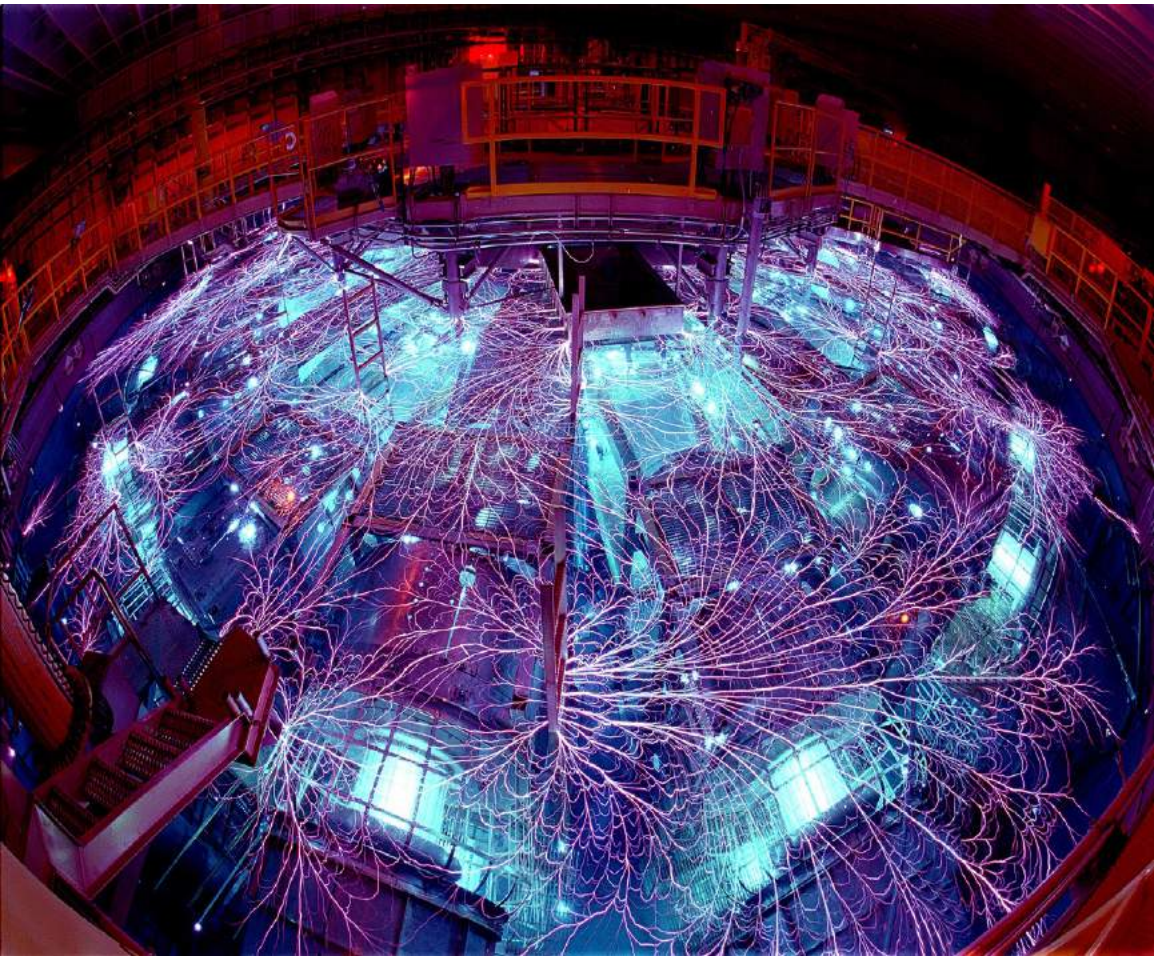
TP400 Engine
Airbus A 400 M

M88 engine – SAFRAN
RAFALE - Dassault

Sustainable and Green
Engine Cleansky (EU)

3. Industrial Fluid Dynamics – Liquid Metals

Research & Consulting



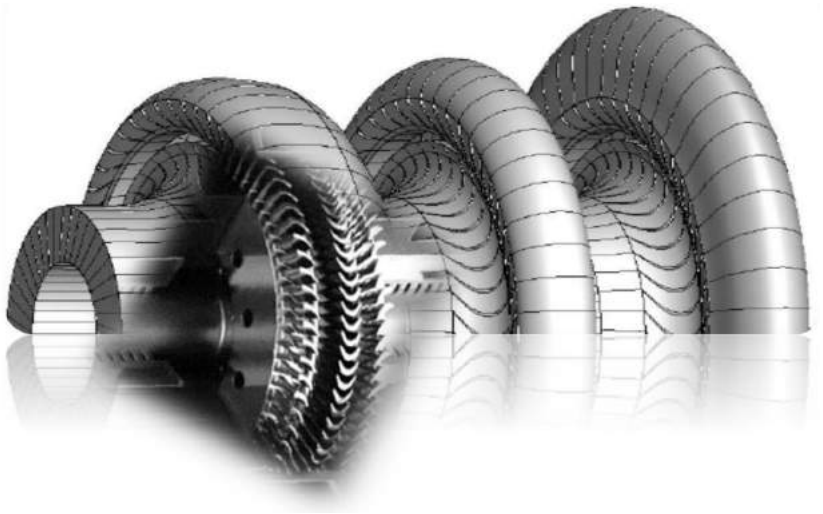
Cooling system of MYRRHA Research Reactor

- Research Reactor developed by SCK.CEN
- Aimed at production of medical radio-isotopes and destruction of highly radioactive nuclear waste
- VKI responsible for cooling system
  - Coolant: Lead-Bismuth-Eutectic (liquid metal) liquid metal
  - Design of the reactor **primary pump.**
  - Thermal-hydraulic analysis of a **pool type reactor** by water modelling and by simulating a liquid metal pool facility.
  - Development of **numerical tools** for the analysis of different scenarios in support to the licensing of MYRRHA

3. Industrial Fluid Dynamics – Decarbonization of Industry

Research & Consulting

- Contribute to CO2 emission reduction by electrifying the steam cracking of ethylene
- Heating of the naphta and steam by adding mechanical energy with a rotor-stator (turbo) machine, driven by green electricity
- VKI: shape optimalisation of the rotor-stator turbo machine



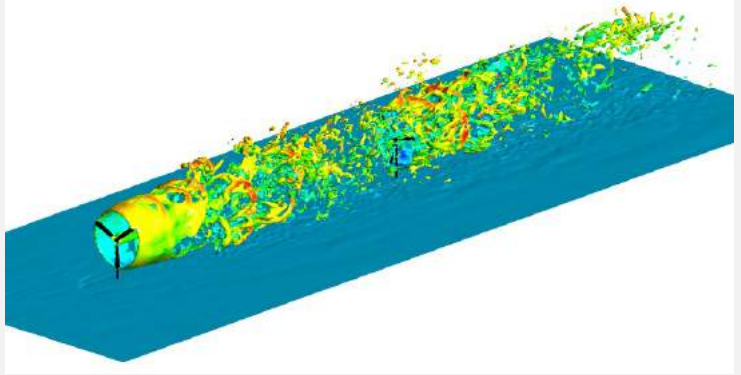
4. Environmental Fluid Dynamics: Wind Park Optimization

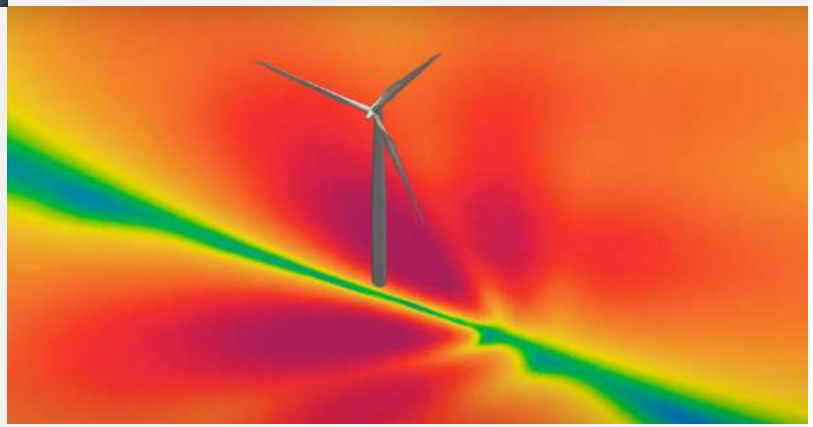
Research & Consulting

Noise Generation by Nacelle and Blades

Realistic Weather Conditions

Noise Propagation





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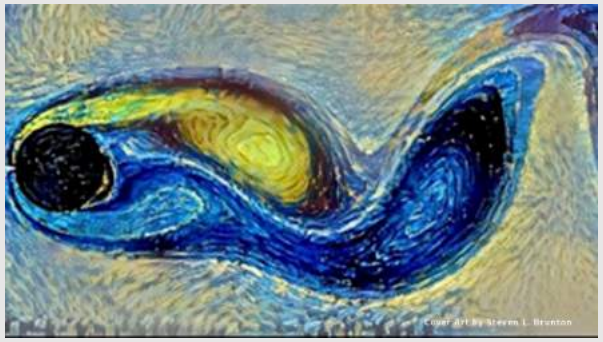
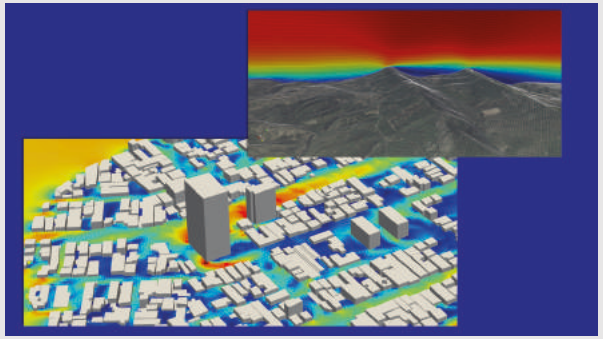
VKI Lecture Series Program

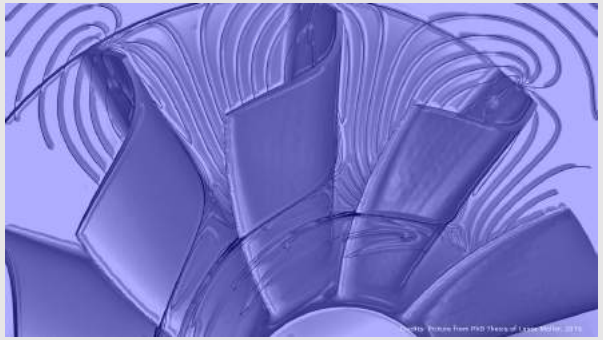
Lecture Series



Machine Learning for Fluid Mechanics



CFD for Atmospheric Flows

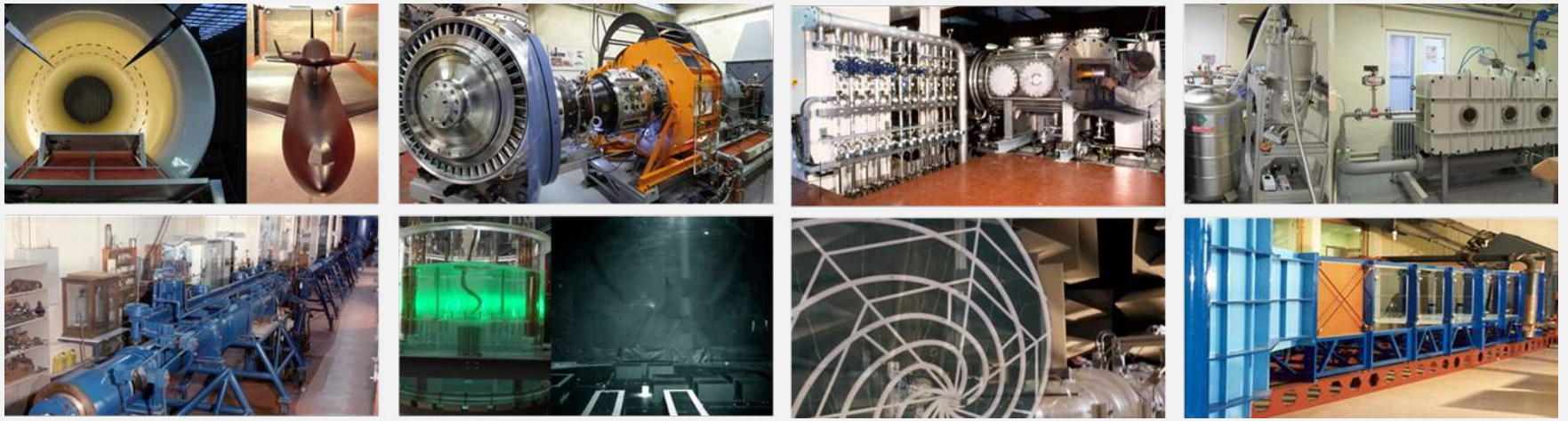


Optimization for CFD

Store Separation and Trajectory Prediction

- VKI organizes yearly 8 to 12 one-week Lecture Series on specialized topics
- For an academic, industrial and military audience

VKI summary



- VKI is a globally renowned center of excellence in fluid dynamics:
  - Space and Defence
  - Aeronautics and Propulsion
  - Clean energy systems
- VKI is a Unique Training Framework for young engineers and scientists in these critical technologies, with proven experience in international collaboration
- Almost 2000 highly skilled VKI alumni occupy top functions in member states industries, governmental agencies, research institutions and universities

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Thank you for your attention!