Computational Fluid Dynamics at CERN

TS/CV/Detector Cooling - CFD Team
AT Seminar
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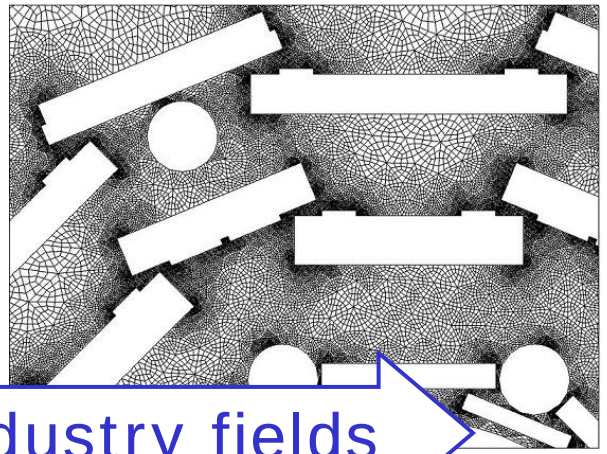
A CFD service team exists at CERN

- What is CFD
- Industrial and CERN applications
- Introduction to CFD – S. Eicher
- Project examples – CFD team
- LHC MQY Quadrupole simulation – A. Mueller
- Team resources and benefits
- How you can access to this service

Computational Fluid Dynamics

- ✓ Computational Fluid Dynamics (CFD) is an analysis of fluid flow, heat transfer and associated phenomena in physical systems using numerical methods.

- ✓ The basis of computational fluid dynamics is the reduction of the continuum differential equations describing the dynamics of the fluid (Navier-Stokes + mass and energy conservation equations) into a system of algebraic equations at a finite number of "grid" points, and the s number of points only.



CFD is developing fast in many industry fields

A wide range of application fields

Aerospace

Automotive

Biomedical

Buildings

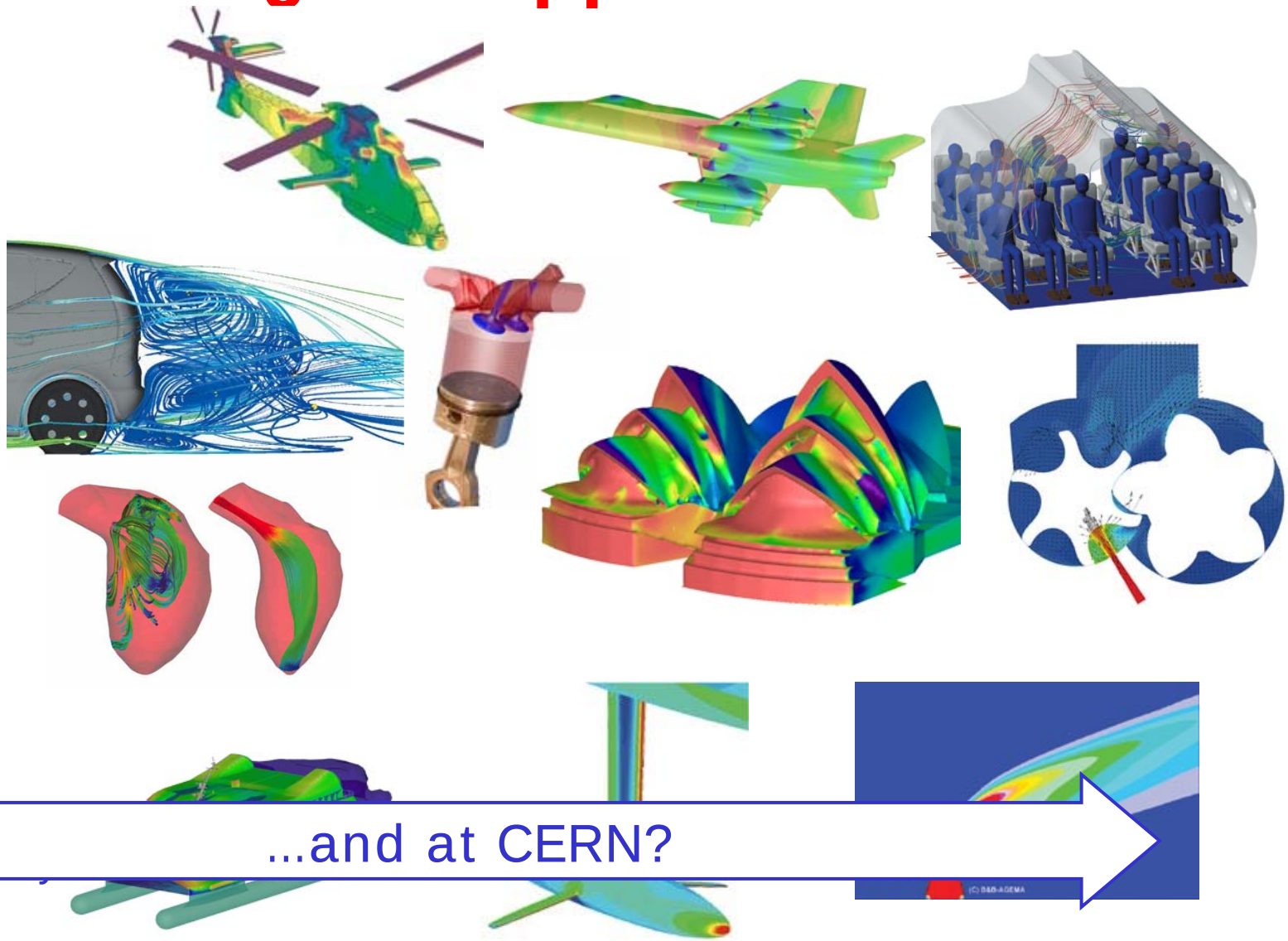
Chemical

Environment

Marine

Power gen.

Turbo



...and at CERN?

CFD is useful in many fields at CERN

Natural and forced convection heat transfer	**ATLAS Muons** chambers, ALICE L3 ventilation, **ALICE Muons**	Some chamber need an additional cooling source: a thermal screen will be implemented
Air cooling	**CNGS Horn** and Reflector air cooling analysis, **LHCb electronics** cooling. Bdg 513 ventilation of the grid computer room.	Additional gaps in the shielding walls, trenches on the target chamber floor
Water cooling	**SPS magnet** cooling analysis	Exact definition of the heat power evacuated by cooling water and air
Safety	**CNGS tunnel**: flow analysis in case of decay tunnel cap rupture. **The Globe**: fire effect simulation, transient temperature distribution.	Special duct installation to resist to high pressure and move the high speed point in a safe zone of ECA4 cavern
Gas distribution	**ATLAS Inner Tracker** CO_2 and N_2 flow analysis. Flushing time estimation before cooling	Definition of the inlet points position and the time to complete the flush.
Humidity distribution	**CMS Tracker** flow analysis.	Reduction of inlet points from 8 to 1.
Thermal conduction	**LHC** MQY Quadrupole quench study	Running

CFD Team

Anna Mueller

Izabella Wichrowska Polok

Antonio Romanazzi

Moritz Kuhn

Sara Correia

Vaclav Vins

Presentations of

Sara
Izabella
Vaclav
Antonio
Anna
Moritz (Michele)

...to sum up

- What is CFD
- Industrial and CERN applications
- CERN examples of CFD Studies
- Team resources and benefits
- How you can access to this service

The team resources…

- 6 young engineers (PJAS, FELL, TechStud)
- 6 engineering PCs for pre-post processing
- Access to a 20 Itanium dual CPU 64 bit cluster form **Openlab** for parallel calculation (8 times faster since May 05).
- Access to more **Openlab** machines in case of peak and depending on cluster availability
- 10 development licenses
- 40 calculation licenses - 60 more in case of peak

CERN openlab
for DataGrid applications

Opportunities…

- CFD is more and more **integrated** in the design tools
  - Automatic meshing (boundary layer)
  - Model/surface importation
  - Subroutine facilities
  - CAD integration (**CATIA**)
  - New polyhedra meshing technique
- **Meshing** time (and cost) has dramatically decreased
- PC **speed** and parallel calculation have reduced the numerical solution time (and cost)
- LHC **Grid**
- Graphical User Interface more and more user friendly
- CFD is less and less expensive

The tool has an easy access and gives always a result…

...specific knowledge is required

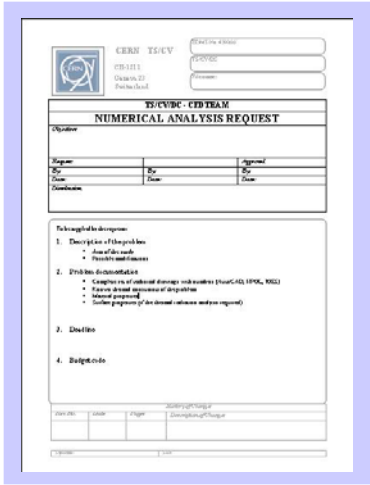
- Efficiency to build the right model
- Selection of the right numerical solver
- Sensibility to result interpretation
- ...training
- ...experience
- ...knowledge and problem sharing

How can you access this service...

New project

Problem definition

Numerical Analysis Request document issued and approved (EDMS)



Procedure on EDMS 459266

Numerical Analysis

Results

Final Report

Evolution

More information on cfd-studies.web.cern.ch

Questions???

You will find all the slides in EDMS document **624664**