

# Computational Fluid Dynamic at CERN

TS/CV/DC  
CFD Team

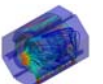
15th April 2005 11h00 AT Auditorium

Michele Battistin, Sara Correia, Moritz Kuhn, Anna Mueller, Antonio Romanazzi, Vaclav Vins, Izabella Wichrowska-Polok



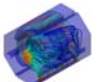
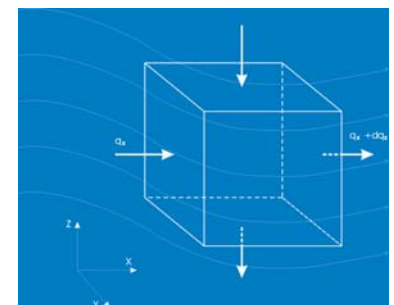
# We want to let you know...

- What is CFD
- Which kind of studies can be done
- Opportunities
- The CFD team at CERN
- How you can access to this service



# Computational Fluid Dynamics

- ✓ Computational Fluid Dynamics (CFD) allows to develop 3D models and find numerical solution of thermal and fluid flow problems in confined spaces
- ✓ The basis of computational fluid dynamics is the reduction of the continuum differential equations governing the dynamics of the fluid into a system of algebraic equations at a finite number of "grid" points, and obtaining the solution to these equations there.



# CFD is useful in many fields at CERN

<b>Natural and forced convection heat transfer</b>	<b>ATLAS muon</b> chambers, ALICE L3 ventilation, ALICE Muon	Some chamber need an additional cooling source: a thermal screen will be implemented
<b>Air cooling</b>	<b>CNGS Horn</b> 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
<b>Water cooling</b>	<b>SPS magnet</b> cooling analysis	Exact definition of the heat power evacuated by cooling water and air
<b>Safety</b>	<b>CNGS tunnel</b> : flow analysis in case of decay tunnel cap rupture. The <i>Globe</i> : 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
<b>Gas distribution</b>	<b>ATLAS Inner Tracker</b> CO <sub>2</sub> and N <sub>2</sub> flow analysis. Flushing time estimation before cooling	Definition of the inlet points position and the time to complete the flush.
<b>Humidity distribution</b>	<b>CMS Tracker</b> flow analysis.	Reduction of inlet points from 8 to 1.



# Opportunities...

- CFD is more and more integrated in the design tools
  - Automatic meshing (boundary layer)
  - Model/surface importation
  - Subroutine facilities
  - CAD integration (Catia - Star C++)
  - 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
- Interface more and more user friendly
- CFD more and more cheap... but:

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

CV group has a CFD team since 1993



# CFD Team



**Anna  
Mueller**



**Izabella  
Wichrowska  
Polok**



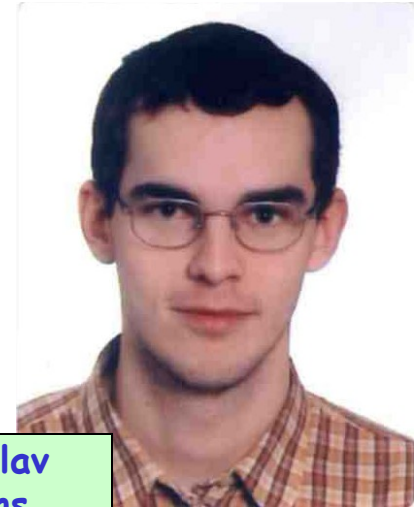
**Antonio  
Romanazzi**



**Moritz  
Kuhn**



**Sara  
Correia**



**Vaclav  
Vins**



# Presentations of

Antonio

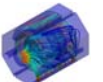
Vaclav

Anna

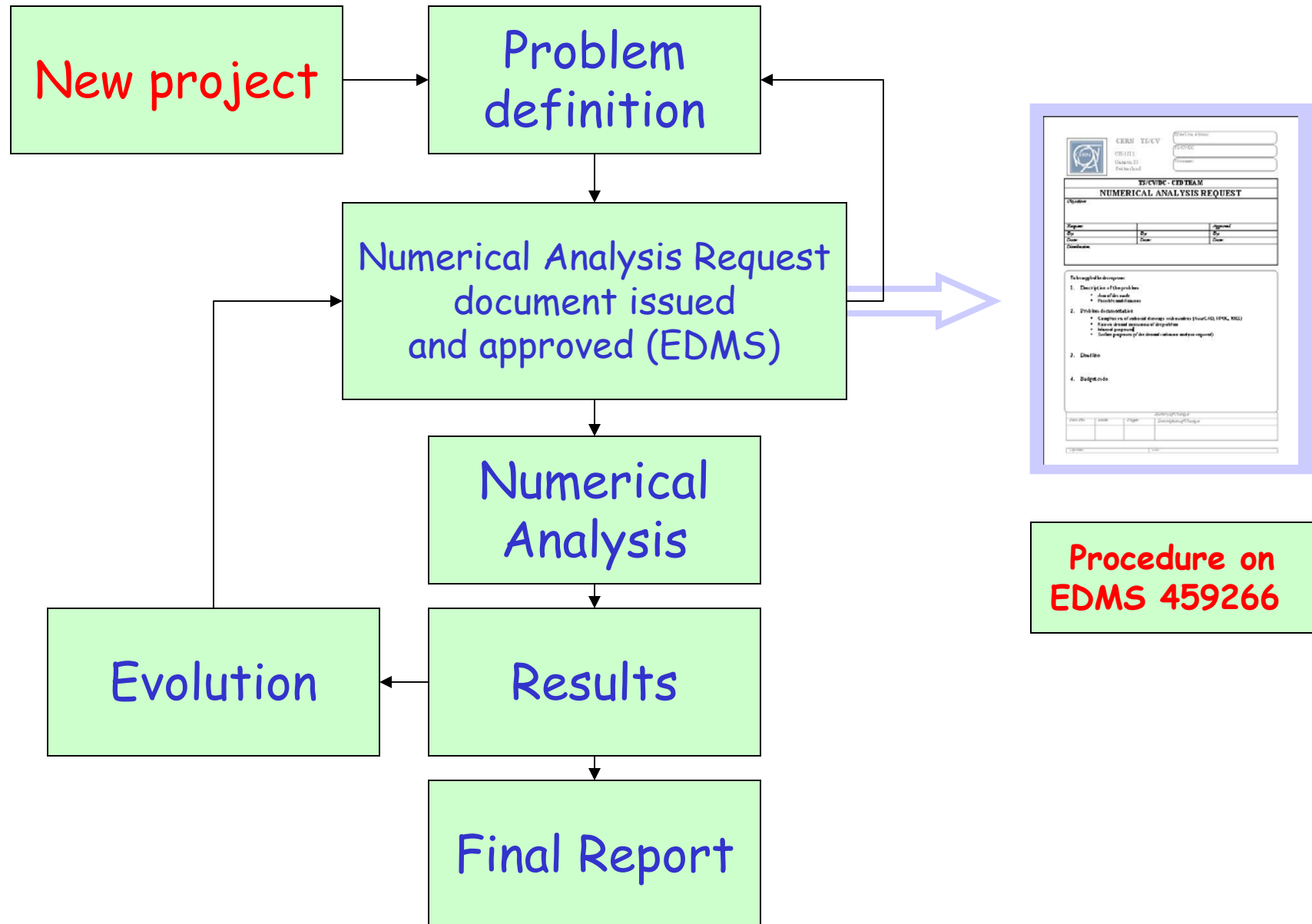
Izabella

Sara

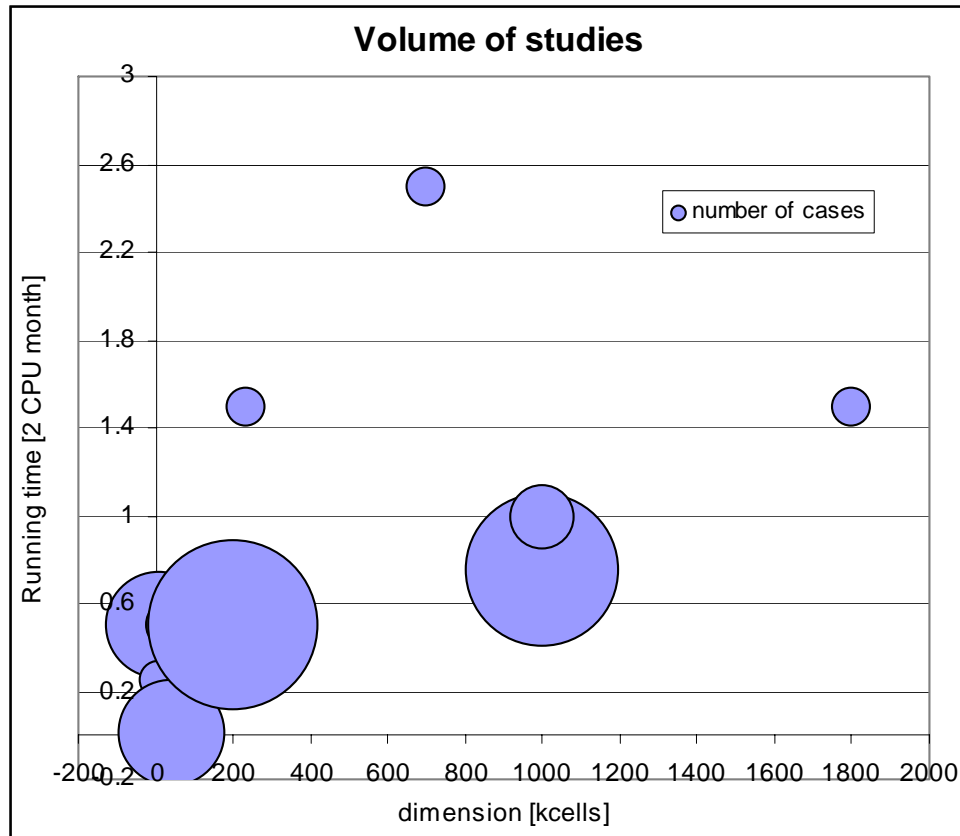
Moritz (Michele)







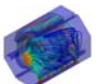
# ...time to result and cost



Experiment	Title of the study	NO. of cells [k-cells]	NO. of cases [N]	Run time per case [months*2CPUmachine* case]	Total CPU time [months*2CPUmachine]
LHCb	MUON DETECTOR	100	3	0.5	1.50
ALICE	Muon Dipole - 3D	40	8	1 hour	0.01
ALICE	Muon Dipole - 2D	40	2	0.5	1.00
ALICE	Muon Detector	700	1	2.5	2.50
ALICE	L3 volume ventilation	1 000	16	0.25~1.0	12.00
ATLAS	Muon Barrel	100	4	0.5	2.00
ATLAS	Muons chambers	230	1	1.5	1.50
ATLAS	N2 inside SCT	10	1	0.1	0.10
ATLAS	C02 inside Inner	1 800	1	1.5	1.50
CMS	Humidity in the Tracker	10	8	0.5	4.00
CNGS	Safety study	200	20	0.5	10.00
CNGS	Horn Cooling - 3D	1 000	3	1	3.00
CNGS	Horn Cooling - 2D	10	1	0.25	0.25
CERN	Bdg 513 ventilation	100	4	0.5	2.00

**Grand total 41.36**

- Model dimension is a compromise between accuracy and time to result
- Most of the projects take about 1 month of calculation time per case
- A project has an average of 6 cases
- CFD team will estimate time and cost in the "Numerical Analysis Request" document.



More information on  
[cfd-studies.web.cern.ch](http://cfd-studies.web.cern.ch)

Questions???

