
CERN

CFD projects at CERN – Detector cooling and beyond

CFD.HU ANSYS User Group Meeting, Budapest – 27th November 2015

Aniko Rakai – CERN EN-CV, CFD team

Overview

- CFD team at CERN
- SHIP experiment target cooling
- Wind and thermal comfort studies on sites

Overview

- CFD team at CERN
- SHIP experiment target cooling
- Wind and thermal comfort studies on sites


LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km

CFD team at CERN

- CFD studies has been carried out at CERN since 1992, the CFD team was created in 2004 in the *Cooling and Ventilation* group of the *Engineering Department*;
- 2-3 persons, fellows or technical students;
- 4-6 projects per year;
- www.cern.ch/cfd.

Computational resources

Two clusters:

- Linux Batch and CFD cluster, 160 cores;
- Windows HPC cluster, ~1000 cores;

10 CFD licences and ~400 HPC licences.

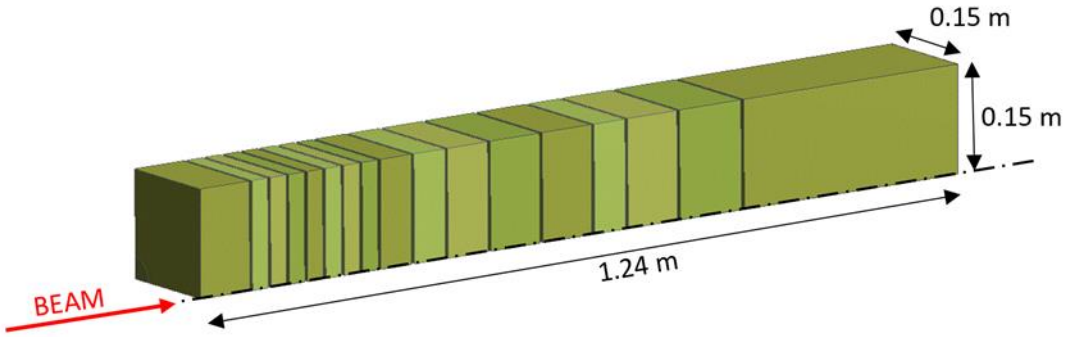
Overview

- CFD team at CERN
- SHIP experiment target cooling
- Wind and thermal comfort studies on sites

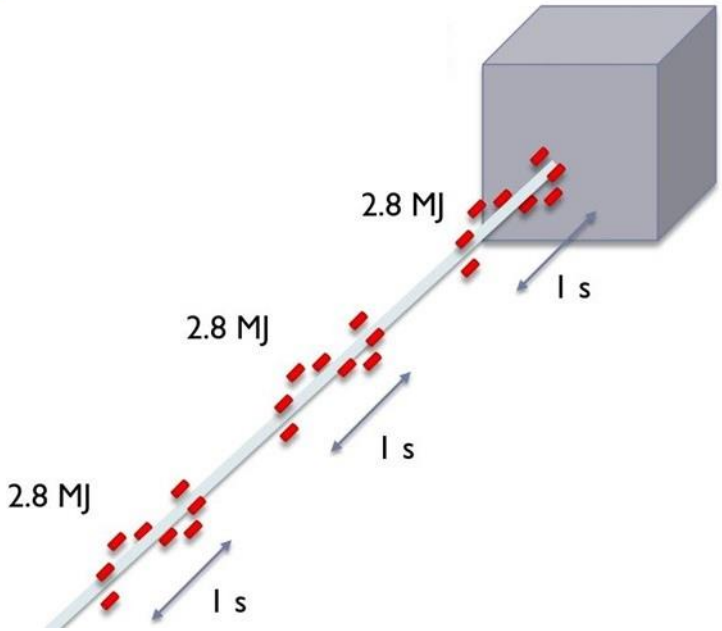
Target of the SHIP experiment

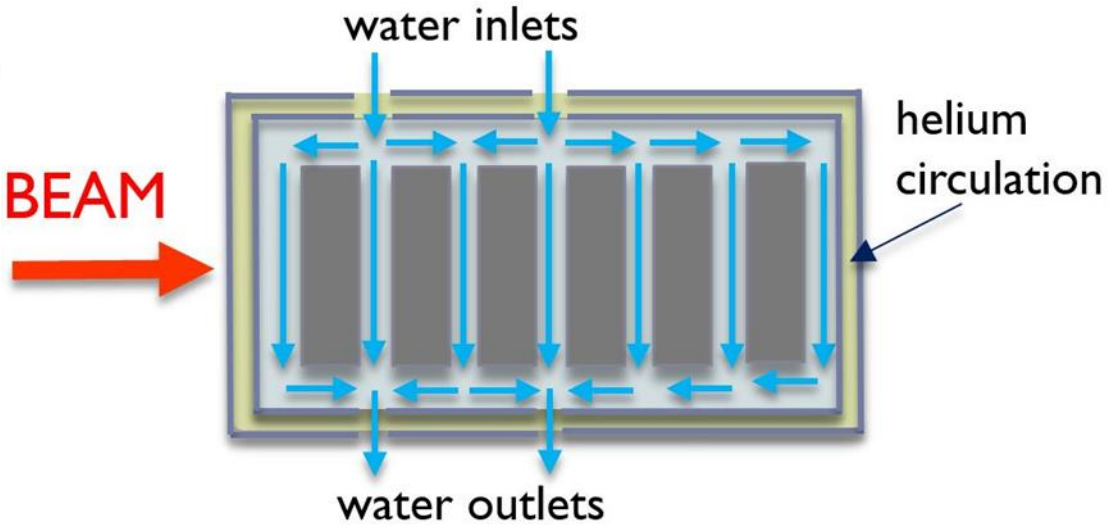
- SHIP: *Search for Hidden Particles*;
- Goal of the experiment: find hidden particles, i.e. Beyond the standard model;
- CFD point of view:
  - Remove ~2MJ energy per beam pulse (20 MW/m3) while the cooling water is far from the boiling point, optimise geometry;
  - 3 million cells; 1 day of computation for each case on 8 cores;
  - Project carried out in cooperation with the SHIP Target Task Force;
- www.cern.ch/ship.

Target of the SHIP experiment



From: «SHiP target feasibility joint WG -**Conceptual design of the SHiP Target and Target Complex** (SHiP-TP-2015-A4)» (public)
https://edms.cern.ch/document/1513294/1.0



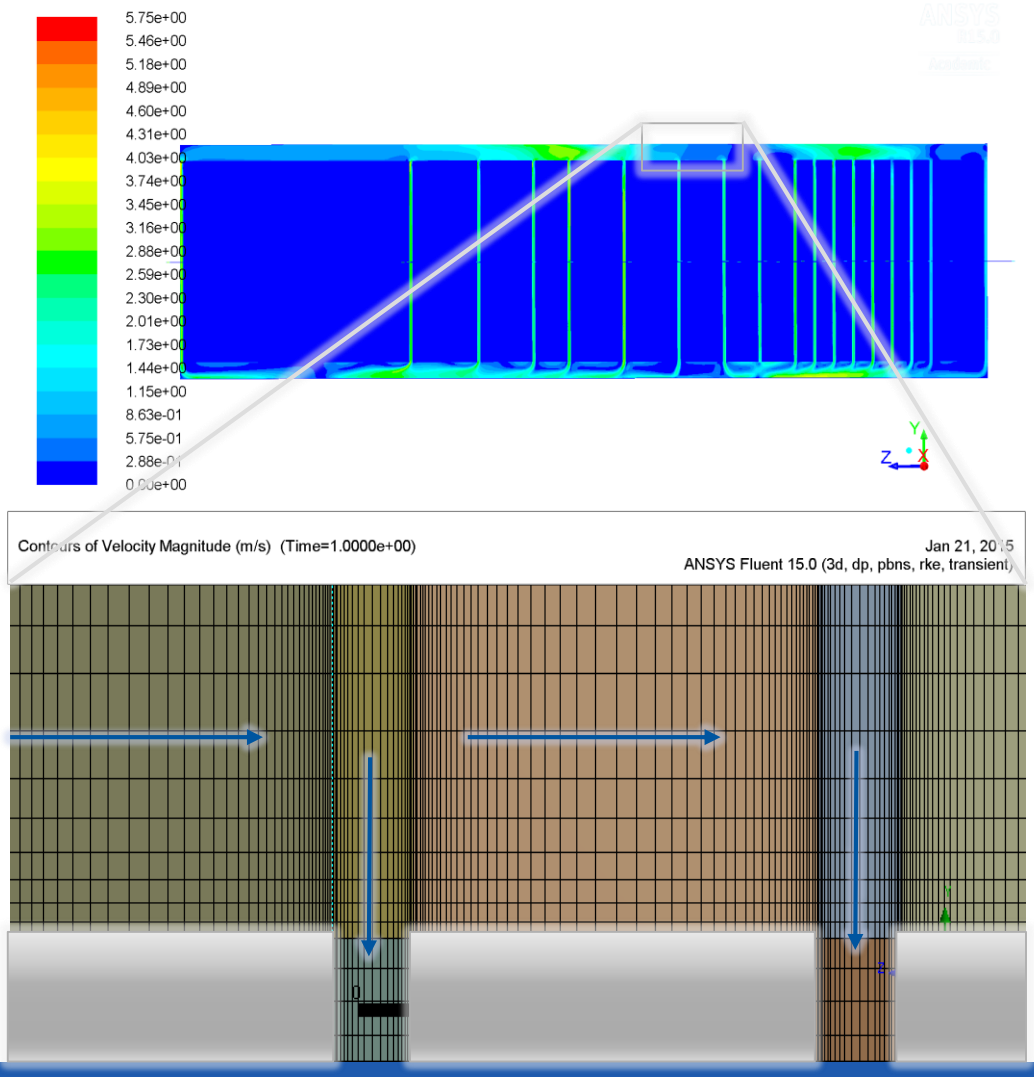


Contribution of the CFD calculation

With analytical calculations it is not possible to predict extreme temperatures and heat transfer coefficient so as to choose optimal conditions and geometry.

- Coolant: water under 10-20 bar pressure to avoid evaporation.
- Particle energy dissipation in the target is modelled by Fluka, an in-house software, and is coupled to Fluent;
- Unsteady simulations are necessary due to beam pulses.

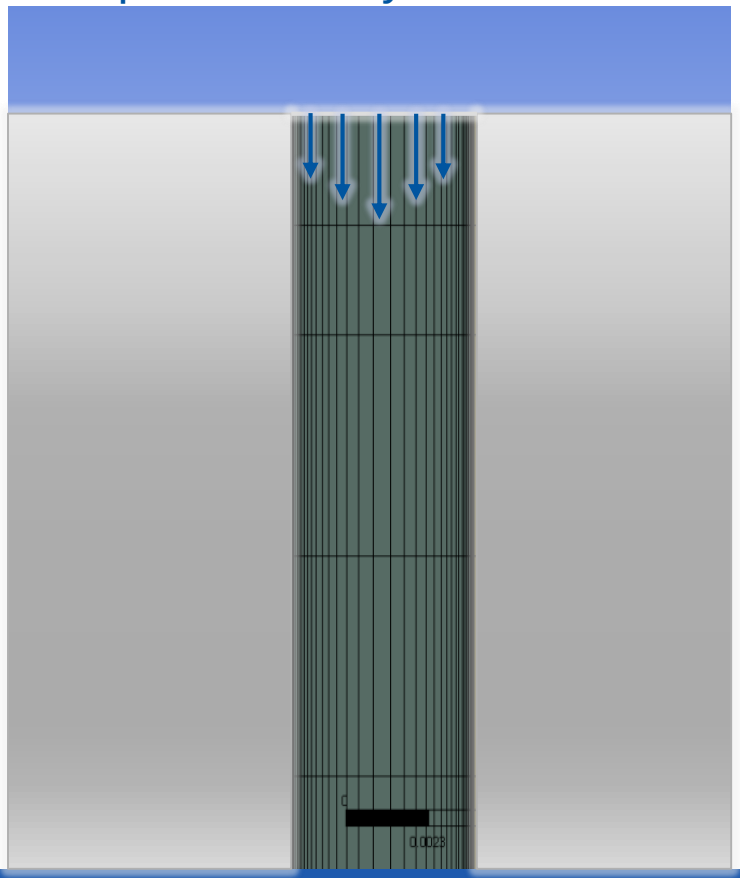
Target of the SHIP experiment

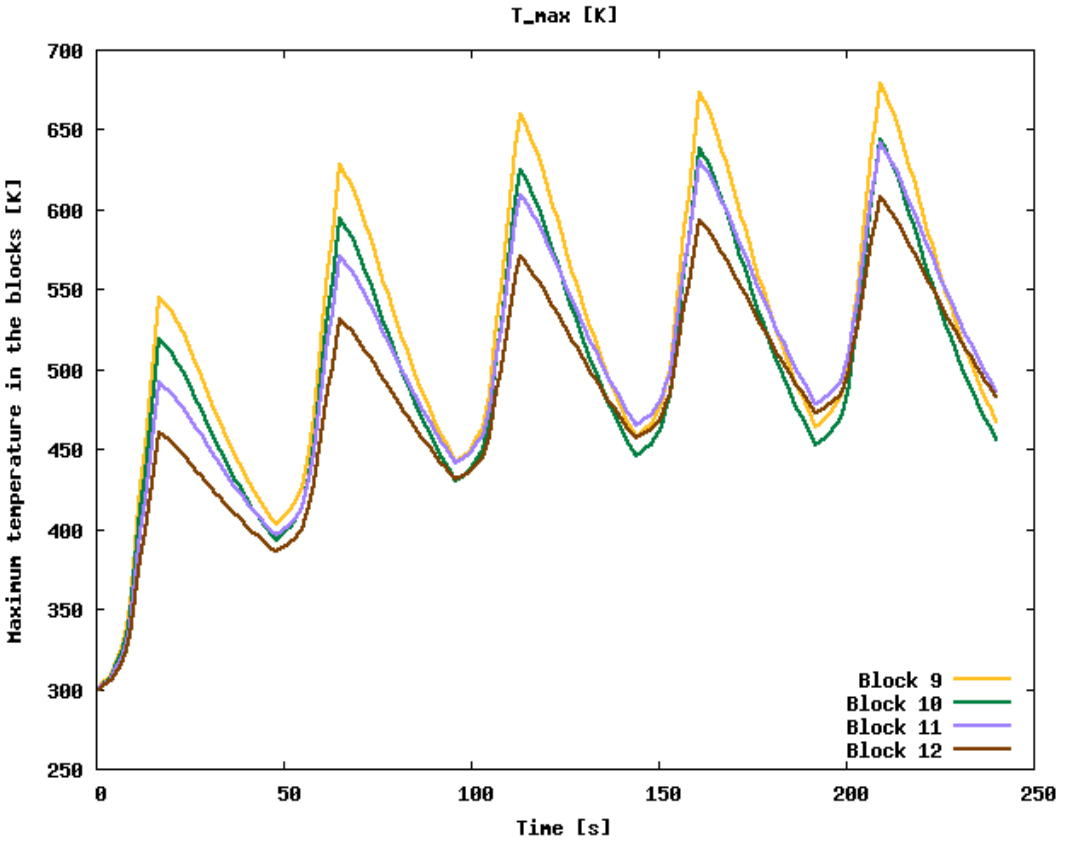


1st step:
Steady state calculations of the whole system to obtain velocity profile at the inlet of vertical passages.

Target of the SHIP experiment

2nd step:
Unsteady calculations on a part of the system to be able to reach $y^+<1$ to compute correctly the heat transfer in the boundary layer.





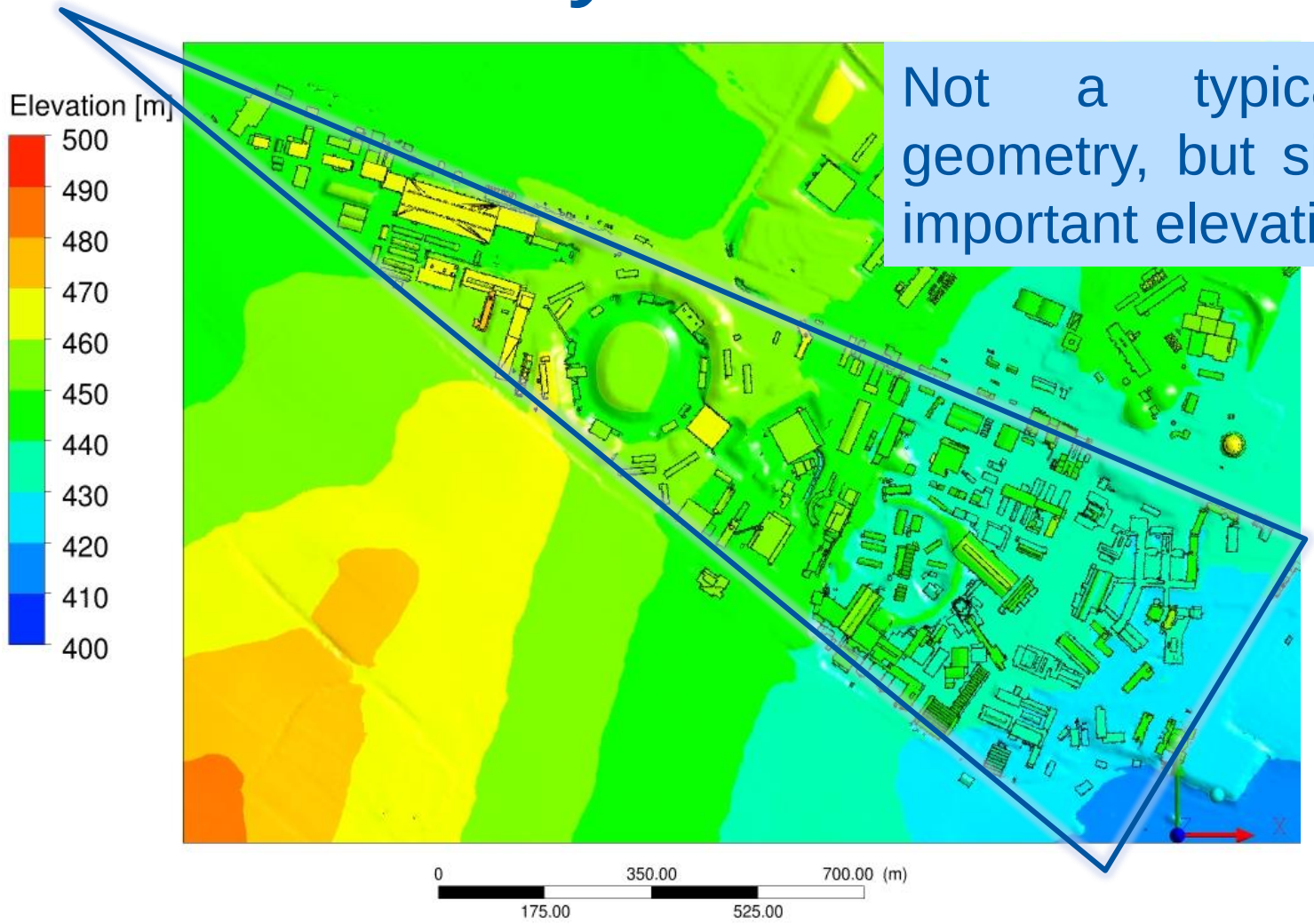
Overview

- CFD team at CERN
- SHIP experiment target cooling
- Wind and thermal comfort studies on sites

Wind and thermal comfort

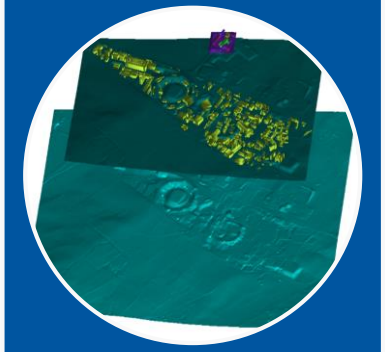
- Investigate the possibility to use CFD modelling at CERN sites;
- Develop a modelling strategy;
- Challenges:
  - Around 200 building for the Meyrin site;
  - 1.5km x 2km domain;
  - Complex topography.

CERN Meyrin site



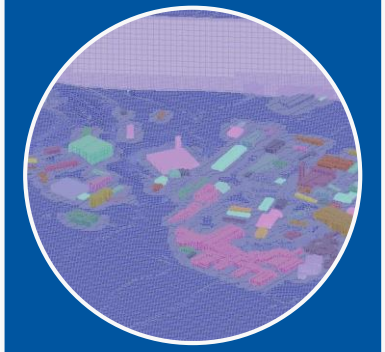
Not a typical urban geometry, but similar, with important elevation change

Modelling strategy



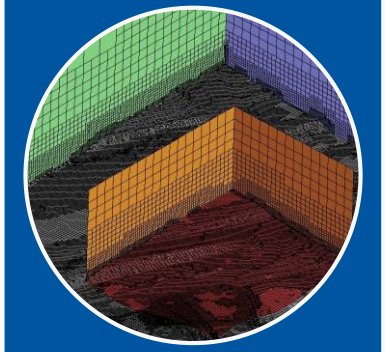
Two domain

- nested
- non-conformal interface



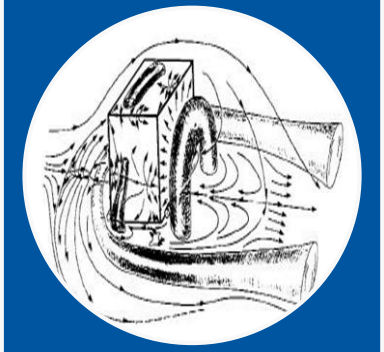
RANS on large domain

- ABL inlet
- wall functions
- turbulence model
- potential flow initialization
- increasing order of convection schemes
- write interface to data file



RANS on small domain

- with interface data as boundary condition
- calculate raw turbulence

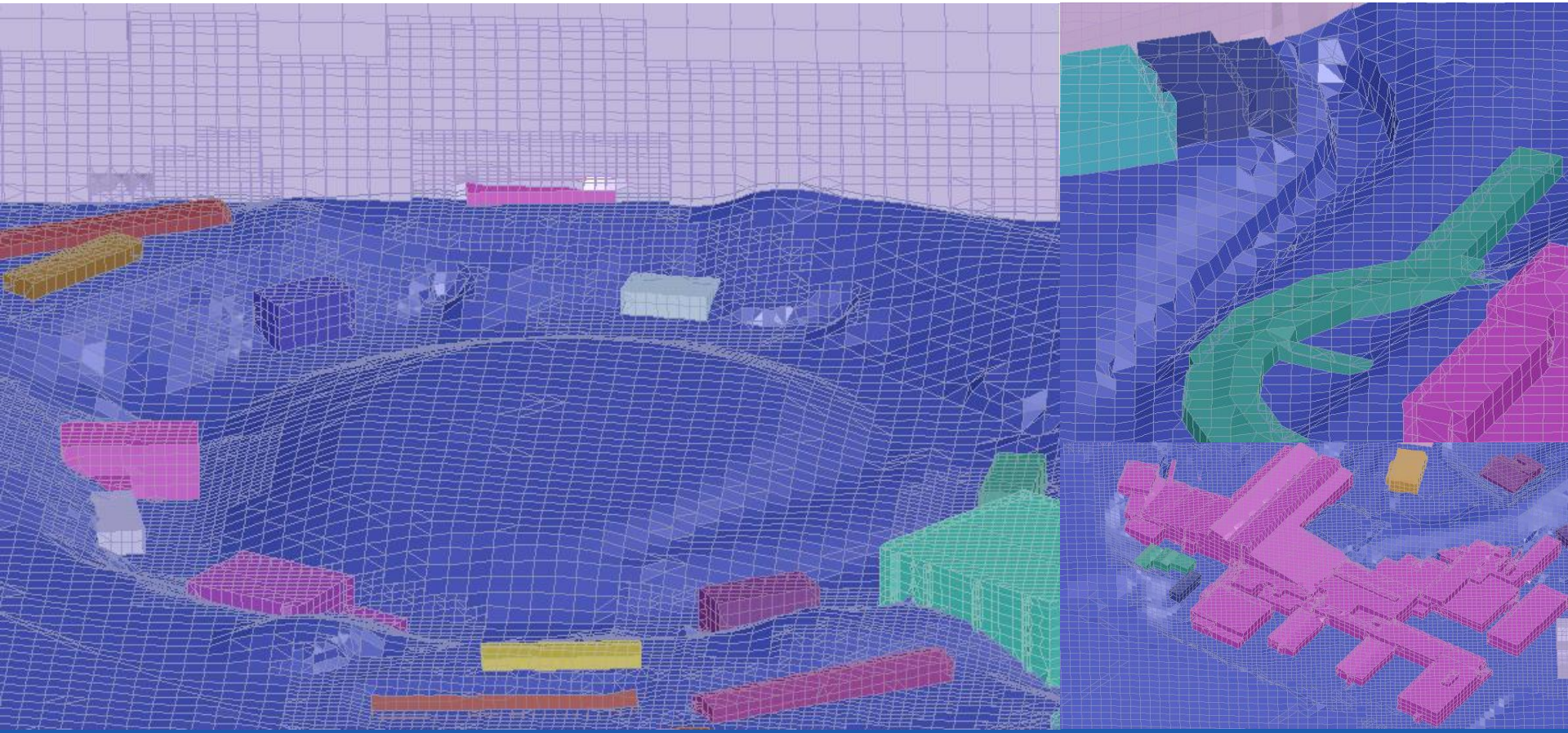


SAS on small domain

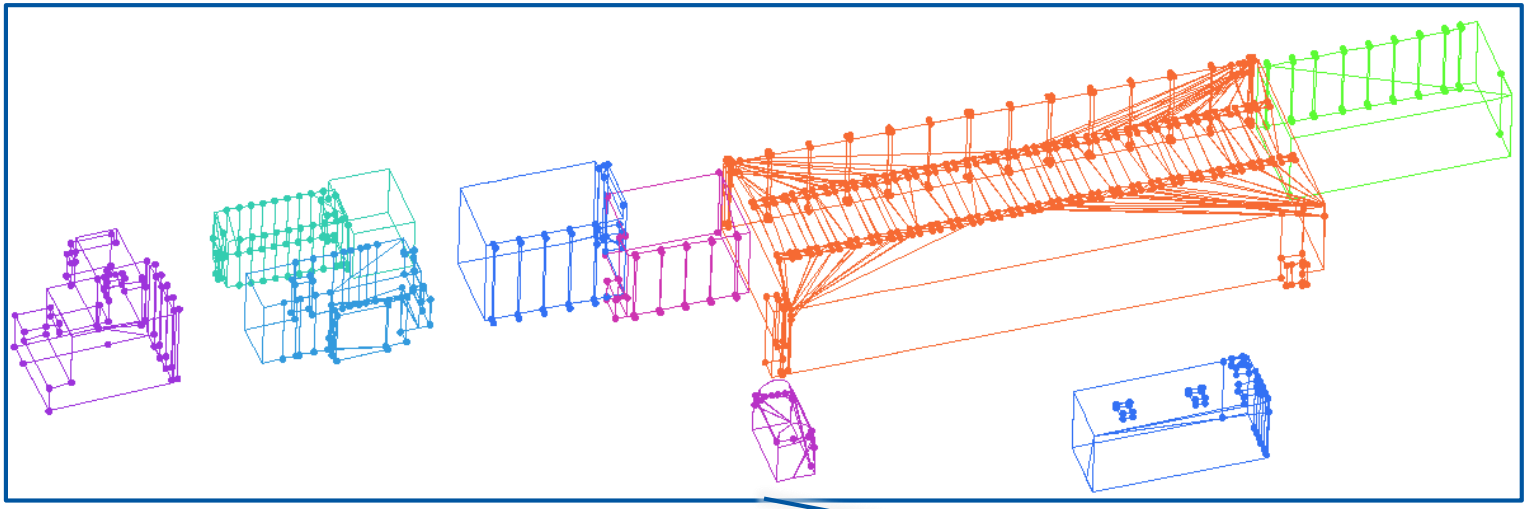
- averaging process

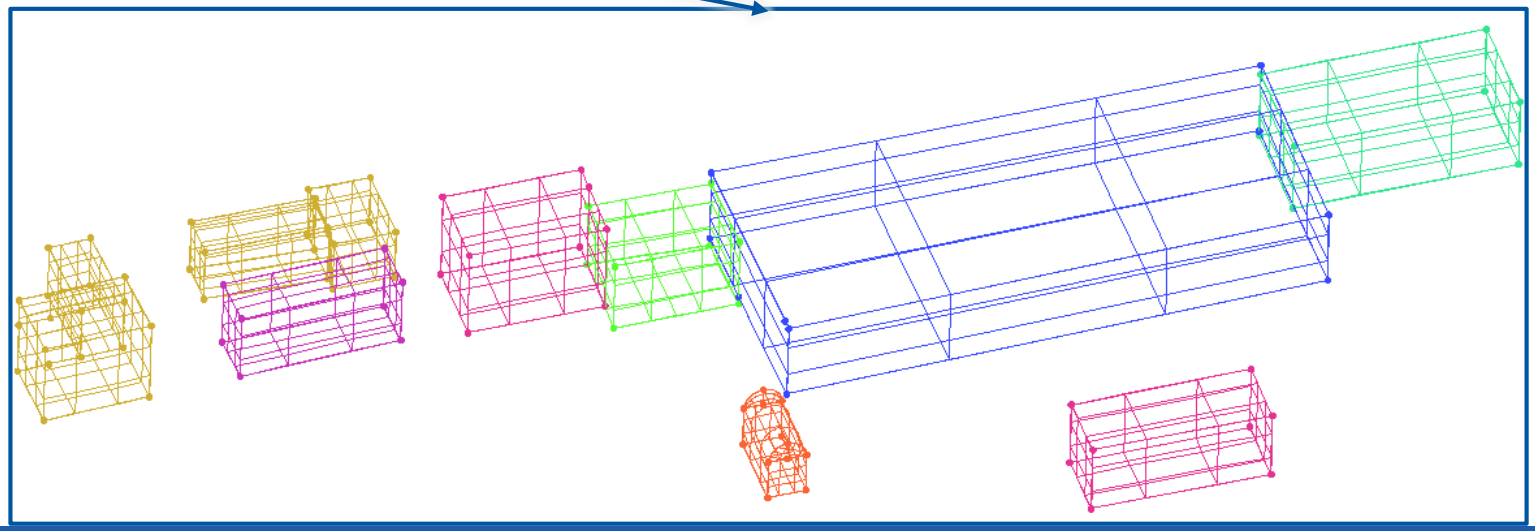
Current status

Fluent Meshing with cutCell method from .stl

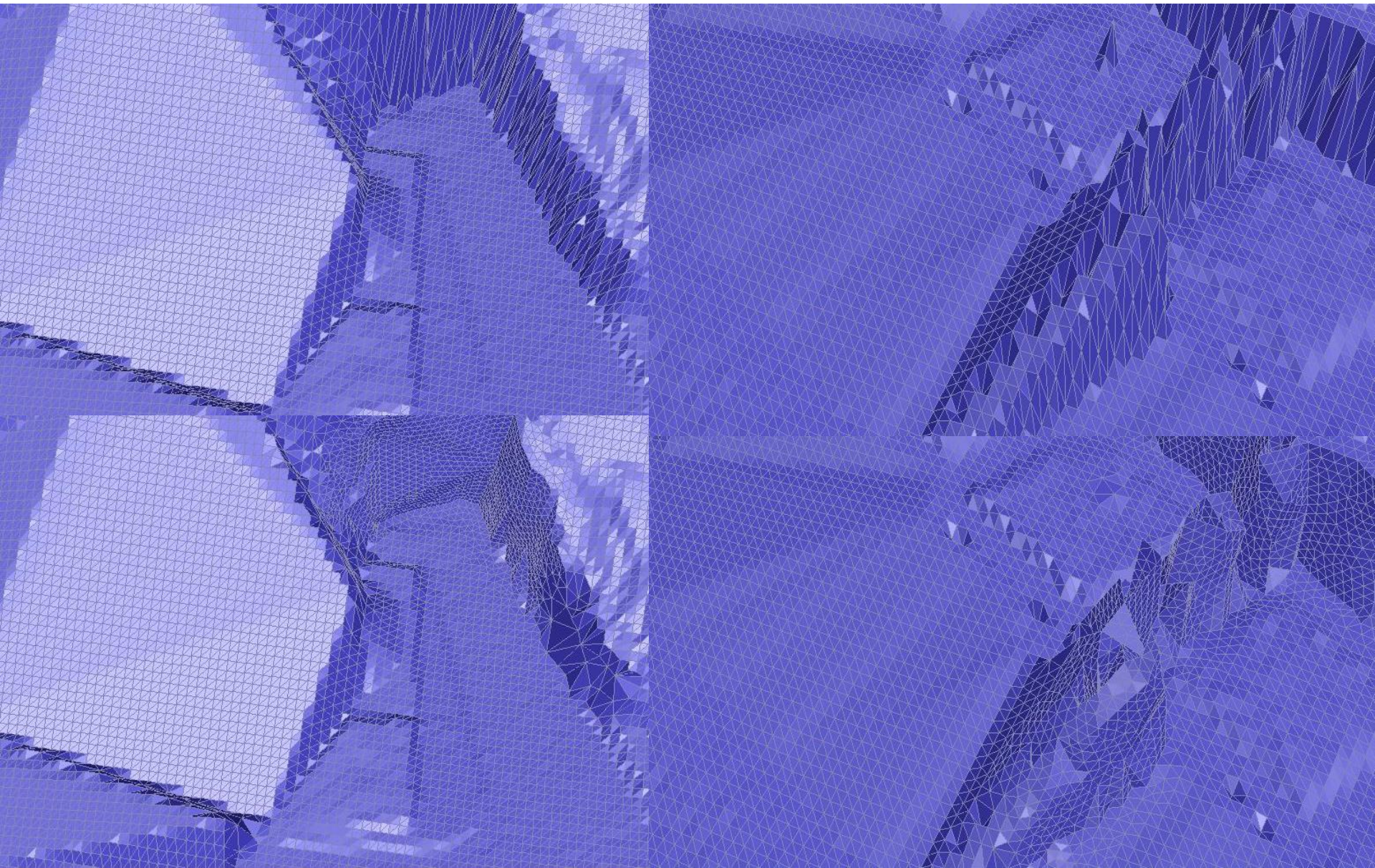


Current status: buildings





Current status: topography



Overview

- CFD team at CERN
- SHIP experiment target cooling
- Wind and thermal comfort studies on sites

Conclusions

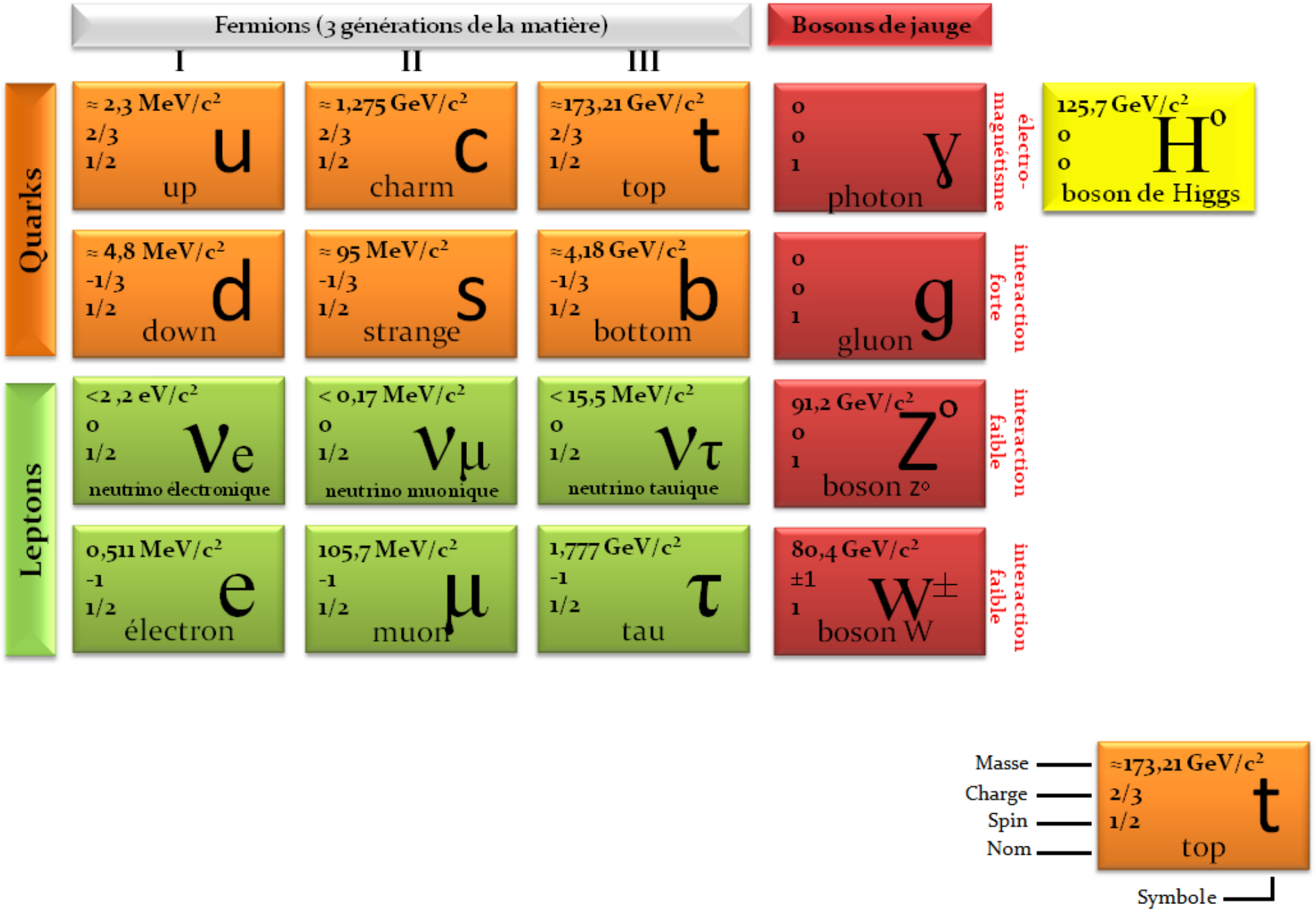
- CFD has been an important tool at CERN since 1992;
- It is used in several domains (particle detector cooling, data centre cooling, environmental protection);
- CERN is open to cooperate with universities and research institution in the CFD domain.

Thank you for your attention!

Aniko Rakai, CFD Team, CERN, www.cern.ch/cfd

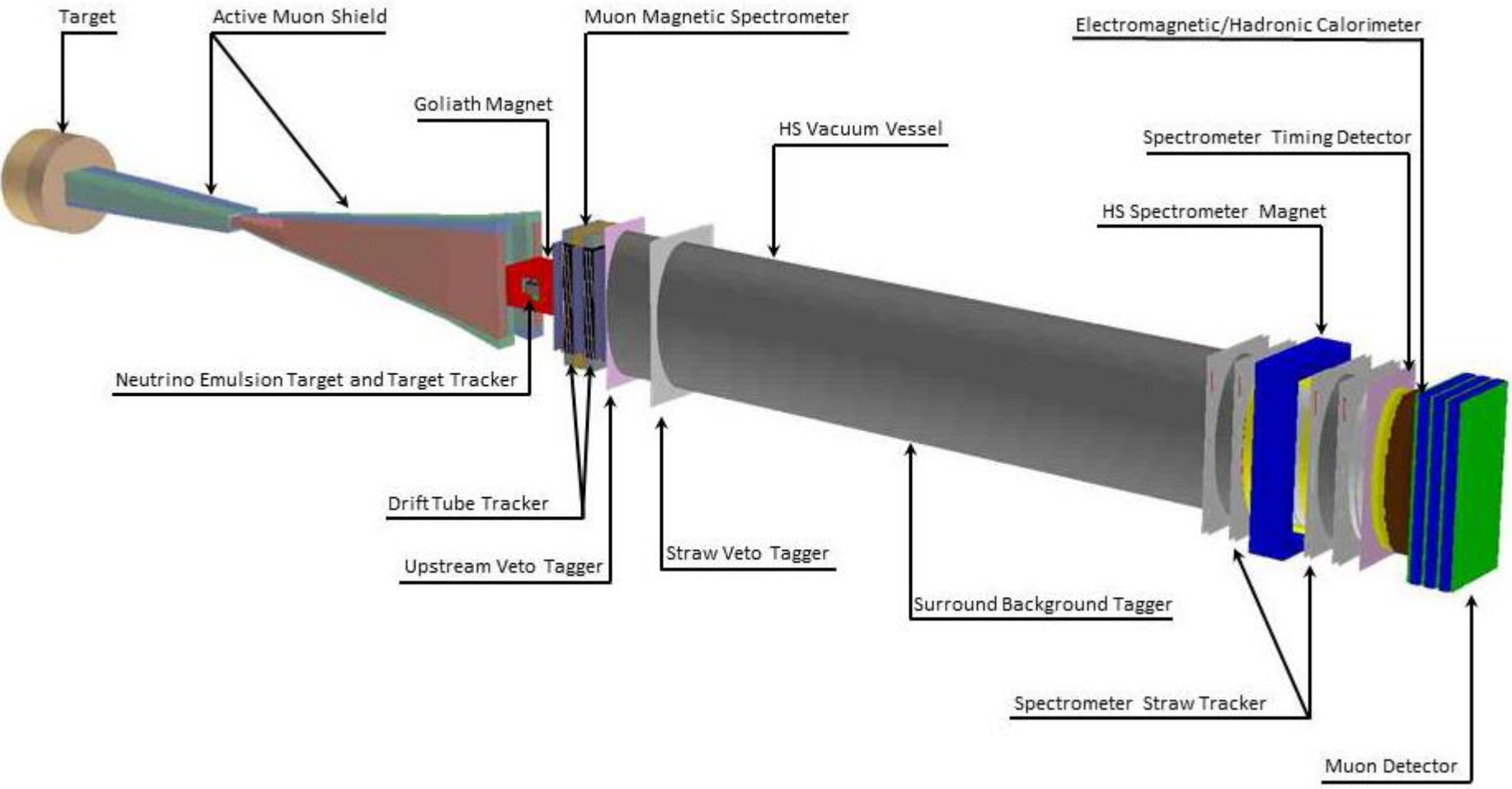
www.cern.ch

Tableau des particules élémentaires du Modèle standard



Backup

SHIP:


Target
Active Muon Shield
Muon Magnetic Spectrometer
Electromagnetic/Hadronic Calorimeter
Goliath Magnet
HS Vacuum Vessel
Spectrometer Timing Detector
HS Spectrometer Magnet
Neutrino Emulsion Target and Target Tracker
Drift Tube Tracker
Upstream Veto Tagger
Straw Veto Tagger
Surround Background Tagger
Spectrometer Straw Tracker
Muon Detector