# CSCS – CERN videoconference CFD applications

TS/CV/Detector Cooling - CFD Team

CERN June 13th 2006

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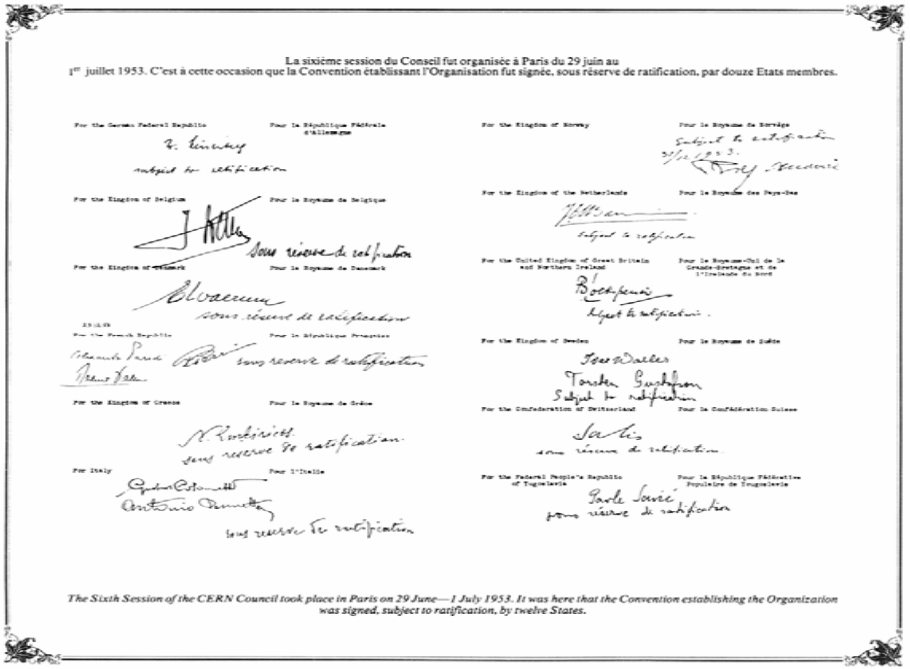
# TOPICS

- Some feedback about already existing collaboration between CERN and CSCS
- Activities of the CERN CFD Studies (computation, visualization), needs in terms of computation, visualization resources
- Activities of the CSCS Engineering group, experience in HPC for CFD, services proposed
- Identification of potential fields for scientific collaboration and exchange of knowledge between CSCS and CERN



# CERN European Organization for Nuclear Research

- Founded in 1954 by 12 countries
- Today: 20 member states
- More than 7000 users from all over the world
- ~1000 MCHF / Year budget



La sixième session du Conseil fut organisée à Paris du 29 juin au 1er juillet 1953. C'est à cette occasion que la Convention établissant l'Organisation fut signée, sous réserve de ratification, par douze Etats membres.

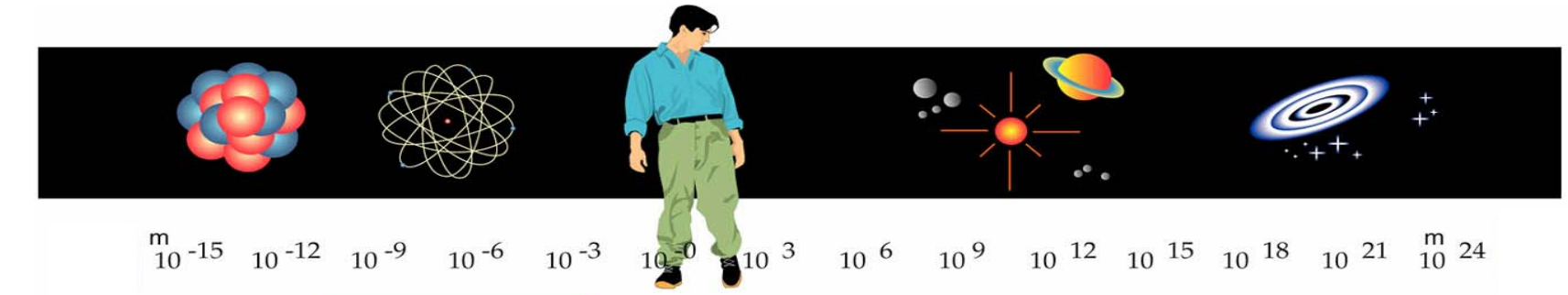
*The Sixth Session of the CERN Council took place in Paris on 29 June—1 July 1953. It was here that the Convention establishing the Organization was signed, subject to ratification, by twelve States.*

1954: Convention establishing the Organization - original signatures

2004: The 20 member states

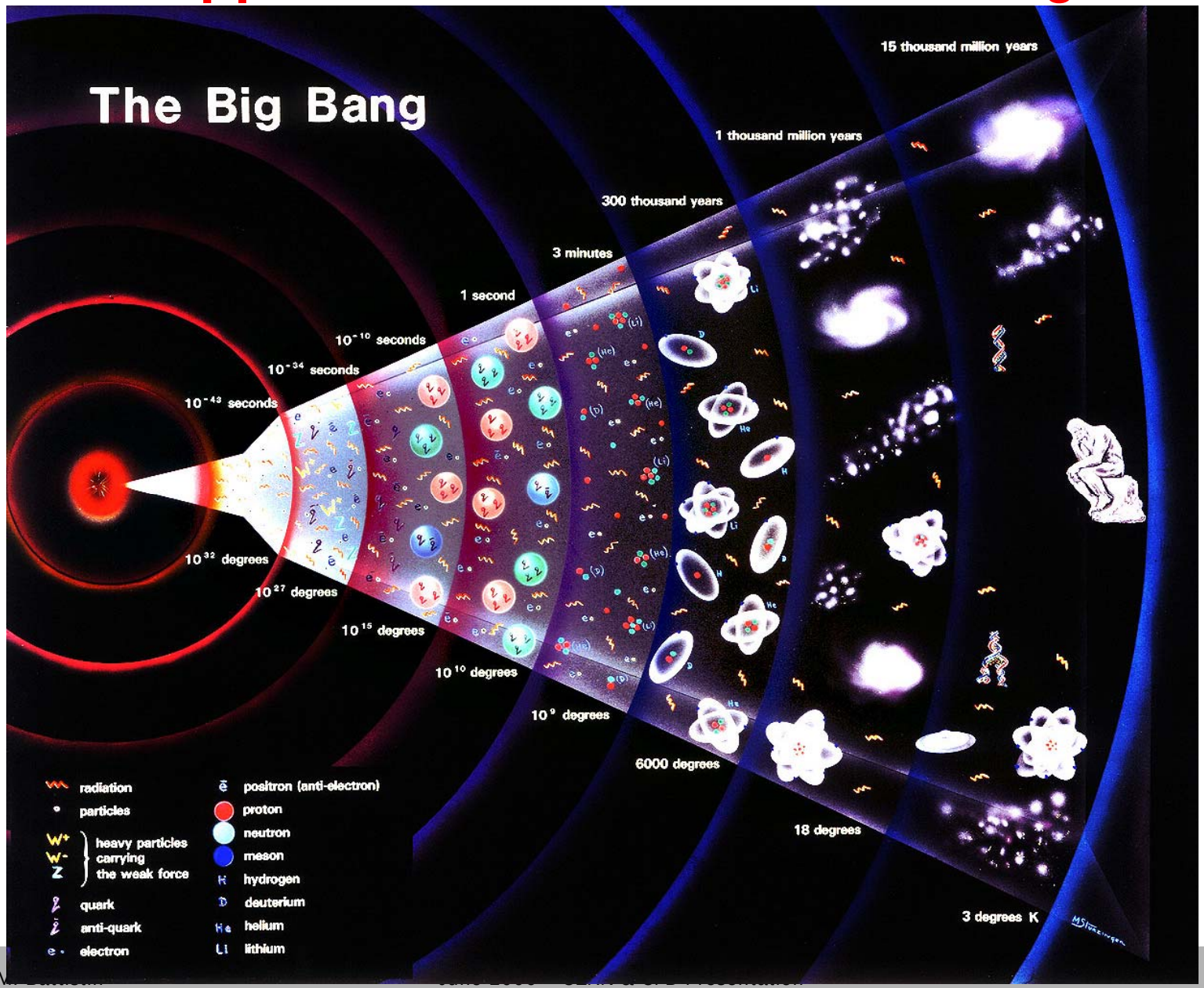
# Why accelerators? To investigate Particle Physics

Particle physics looks at matter in its smallest dimensions

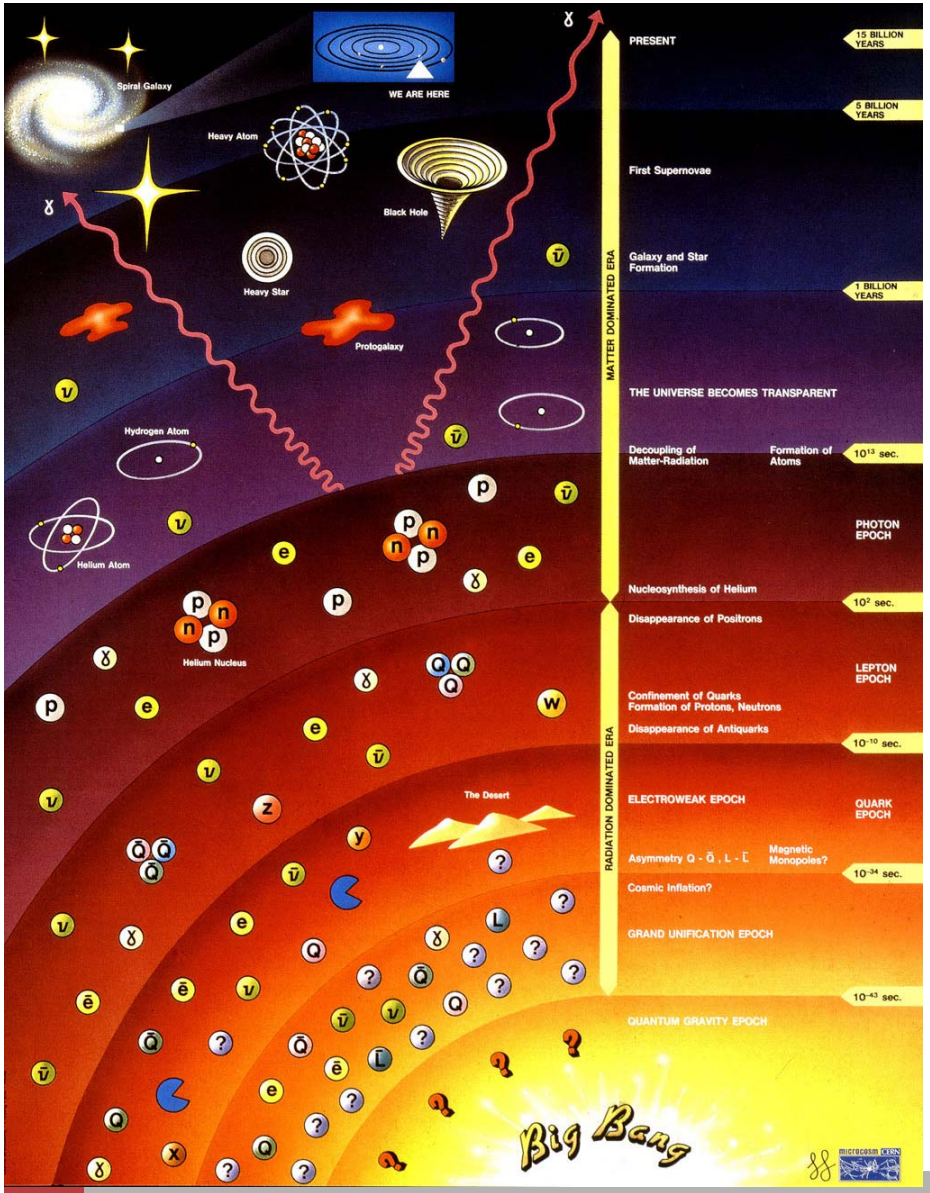



Accelerators | Microscopes | Binoculars | Optical and radio telescopes

# What happened an instant after the Big Bang?



# How can we go back the time?




15 Billions of years

5 Billions of years

1 Billion of years

330.000 years

100 seconds

0.1 Nanoseconds ($10^{-10}$)

$10^{-34}$ seconds

$10^{-43}$ seconds

ACCELERATOR ENERGY

PS ('59)

LEP ('89)

LHC ('07)

# The "bricks" of the matter

# We don't know everything!

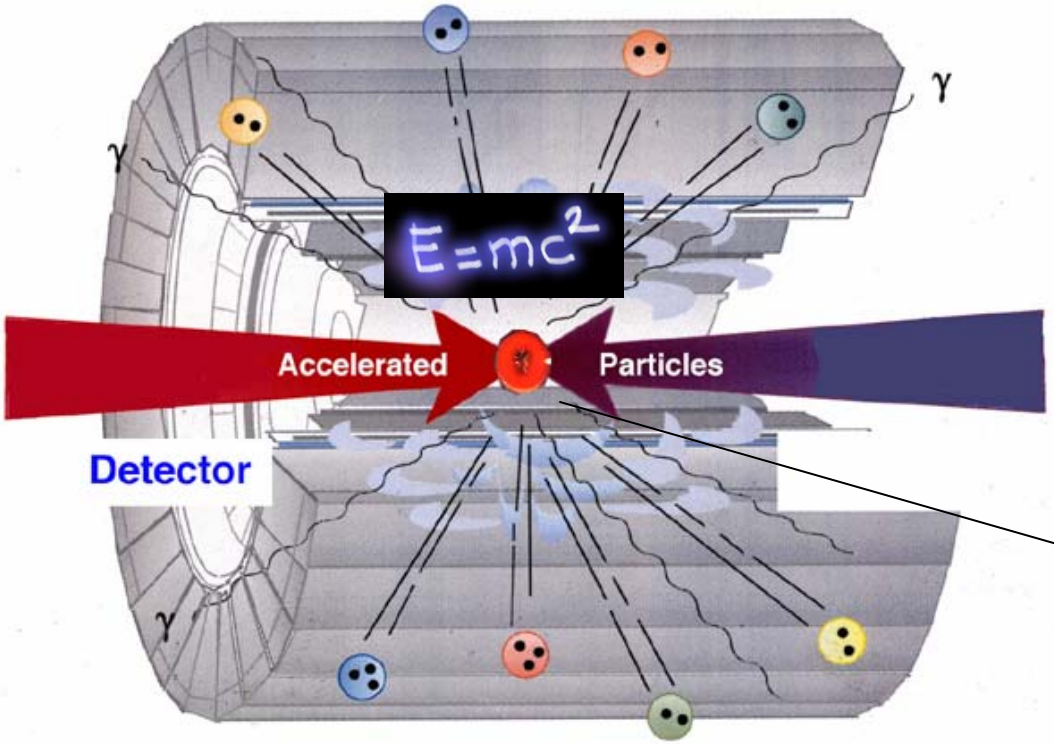

Why three generations?


Supersymmetry?


Higgs boson?

The LHC will help solving all these unsolved mysteries

# Methods of particle physics

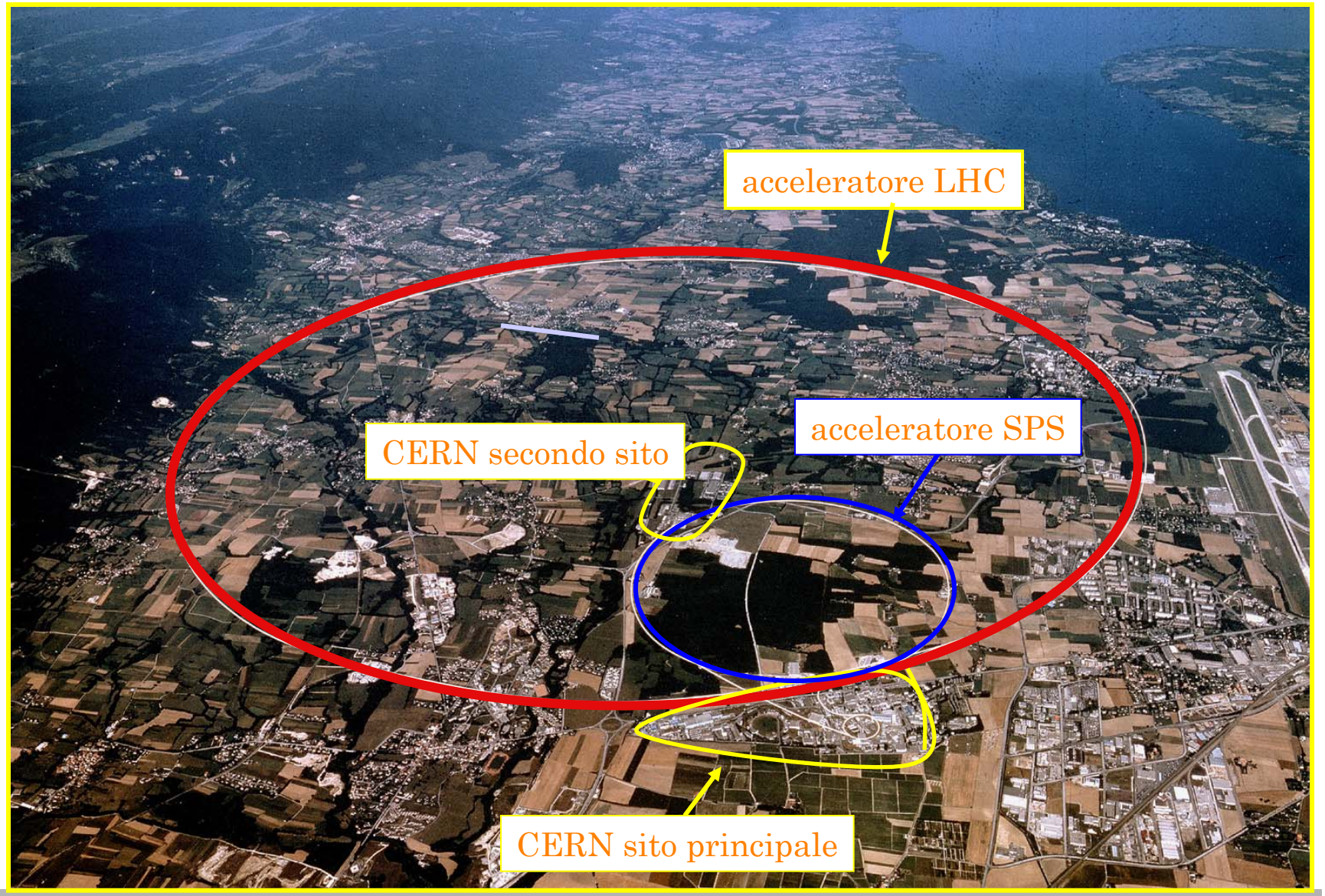



1) Concentrate energy on particles (**accelerator**)

2) **Collide** particles (recreate conditions after Big Bang)

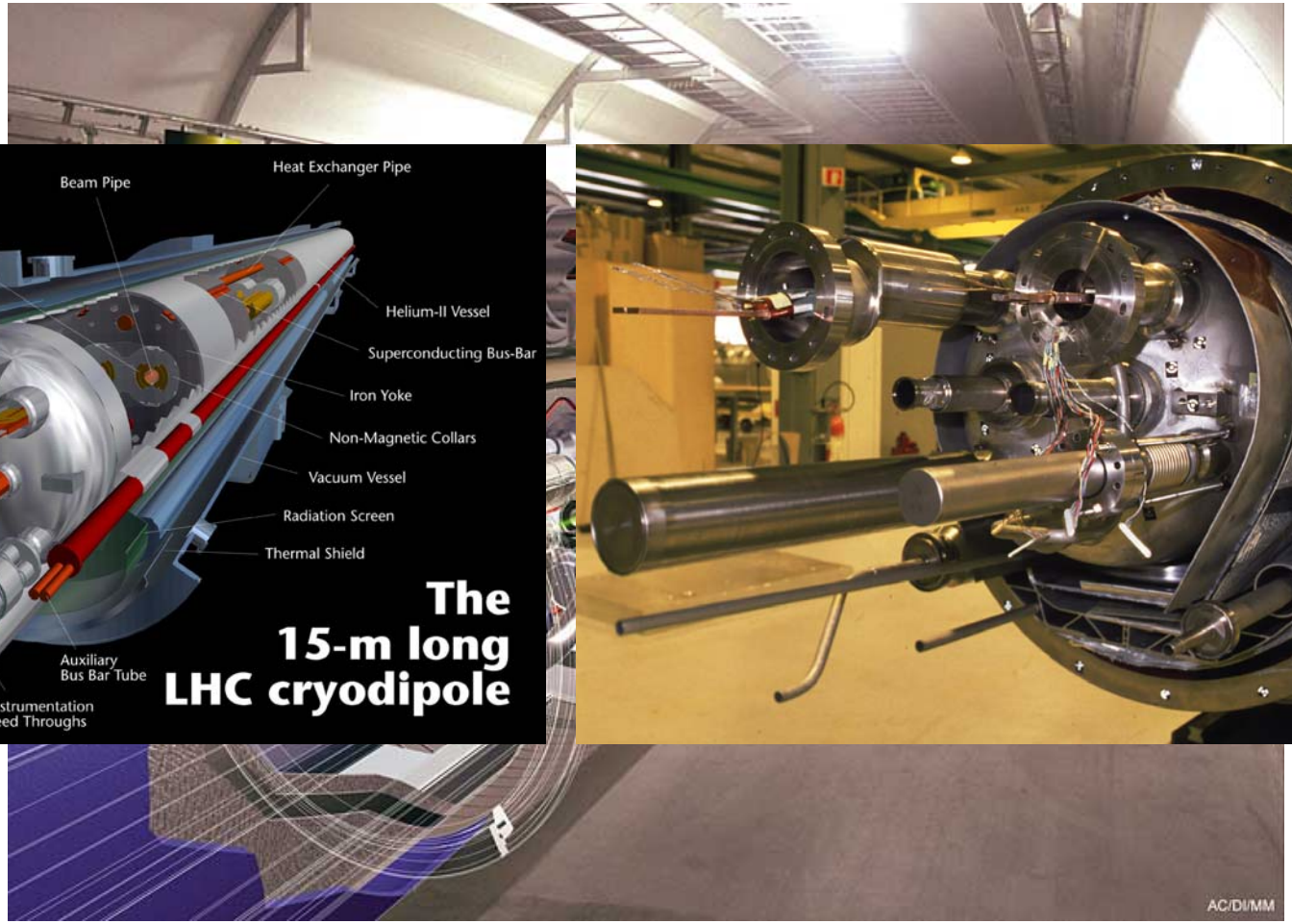
3) Identify created particles in **Detector** (search for new clues)

# CERN accelerators structure

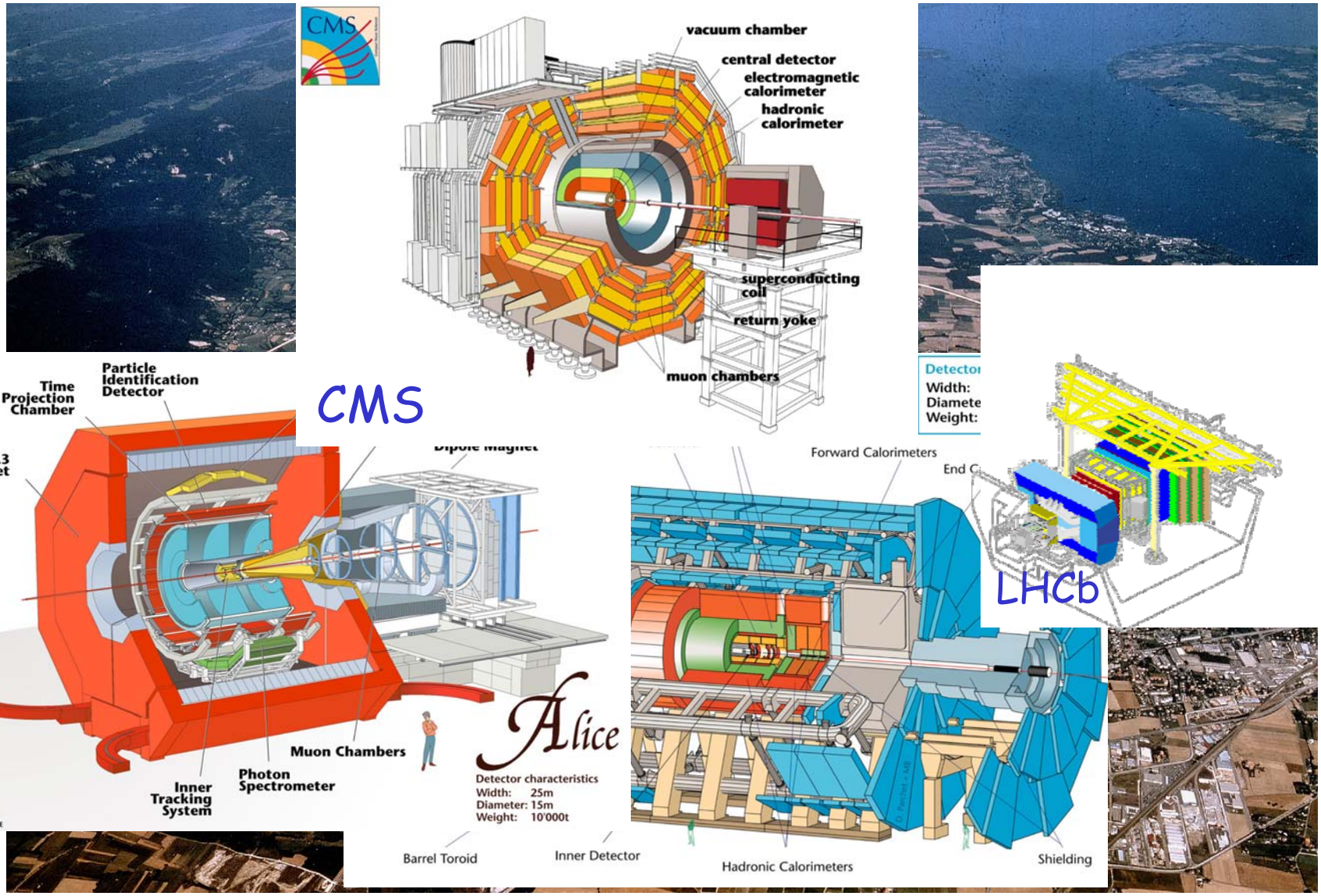


# LHC Large Hadron Collider

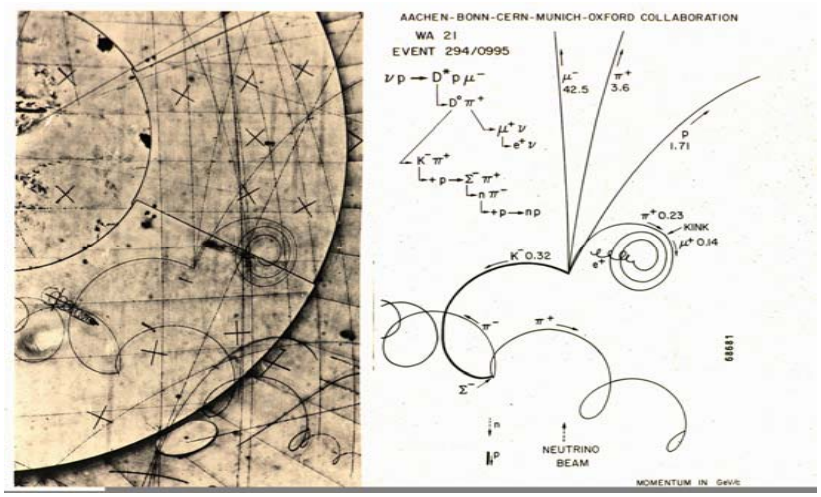
1230 magnets will be installed in the
27 km long tunnel - They will run at -271˚C

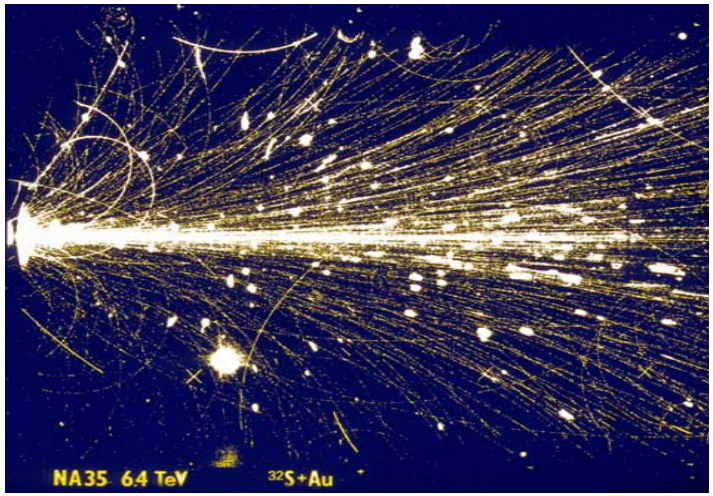


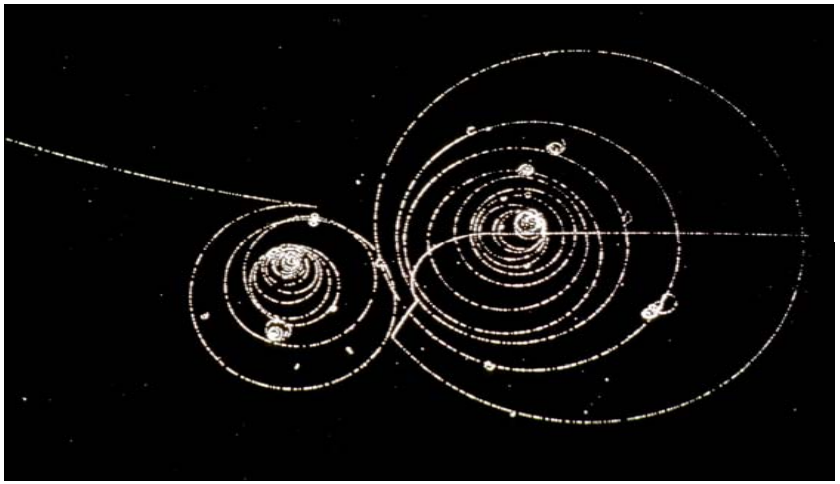
# At 4 points the particles are forced to collide

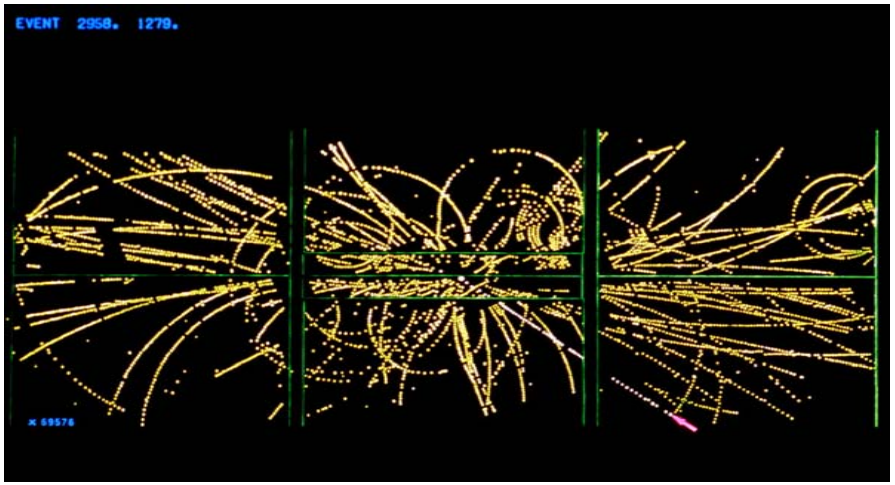


# Detectors are used to “take a picture” to the particles



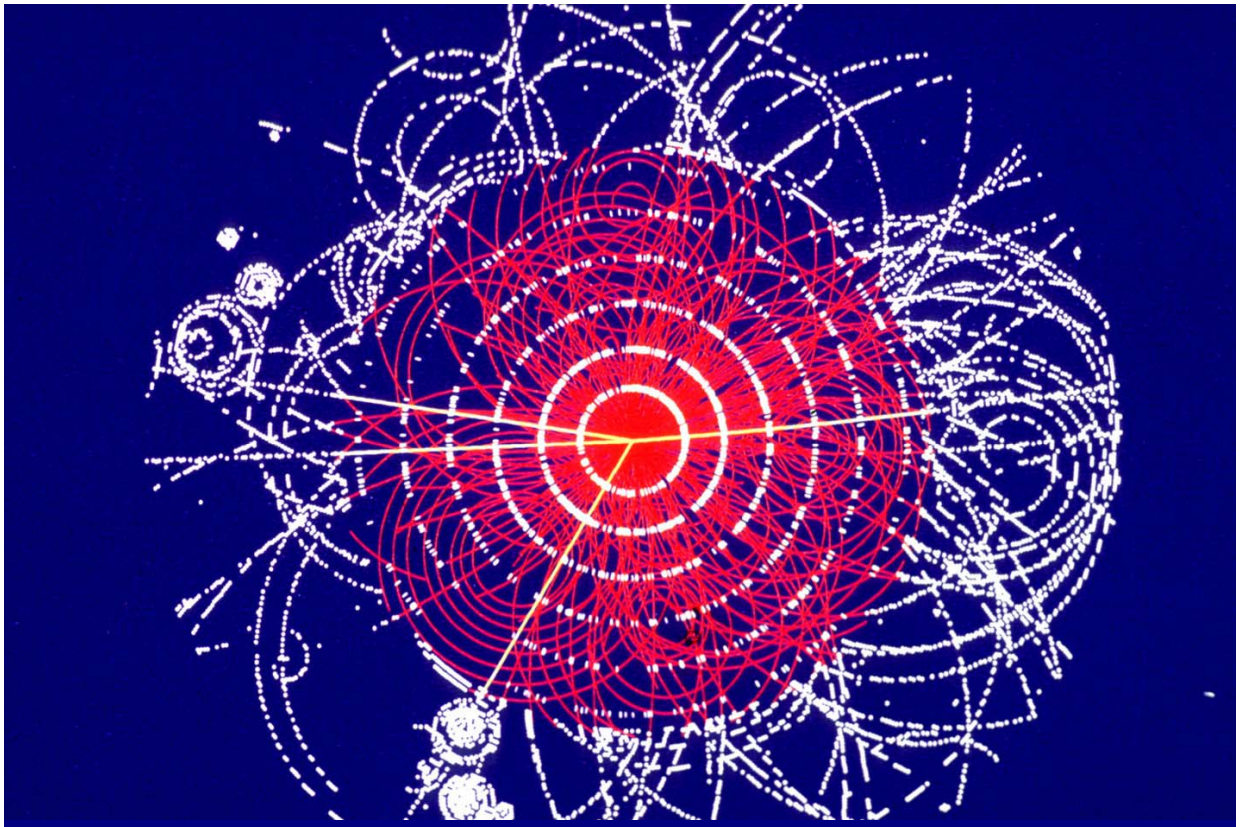





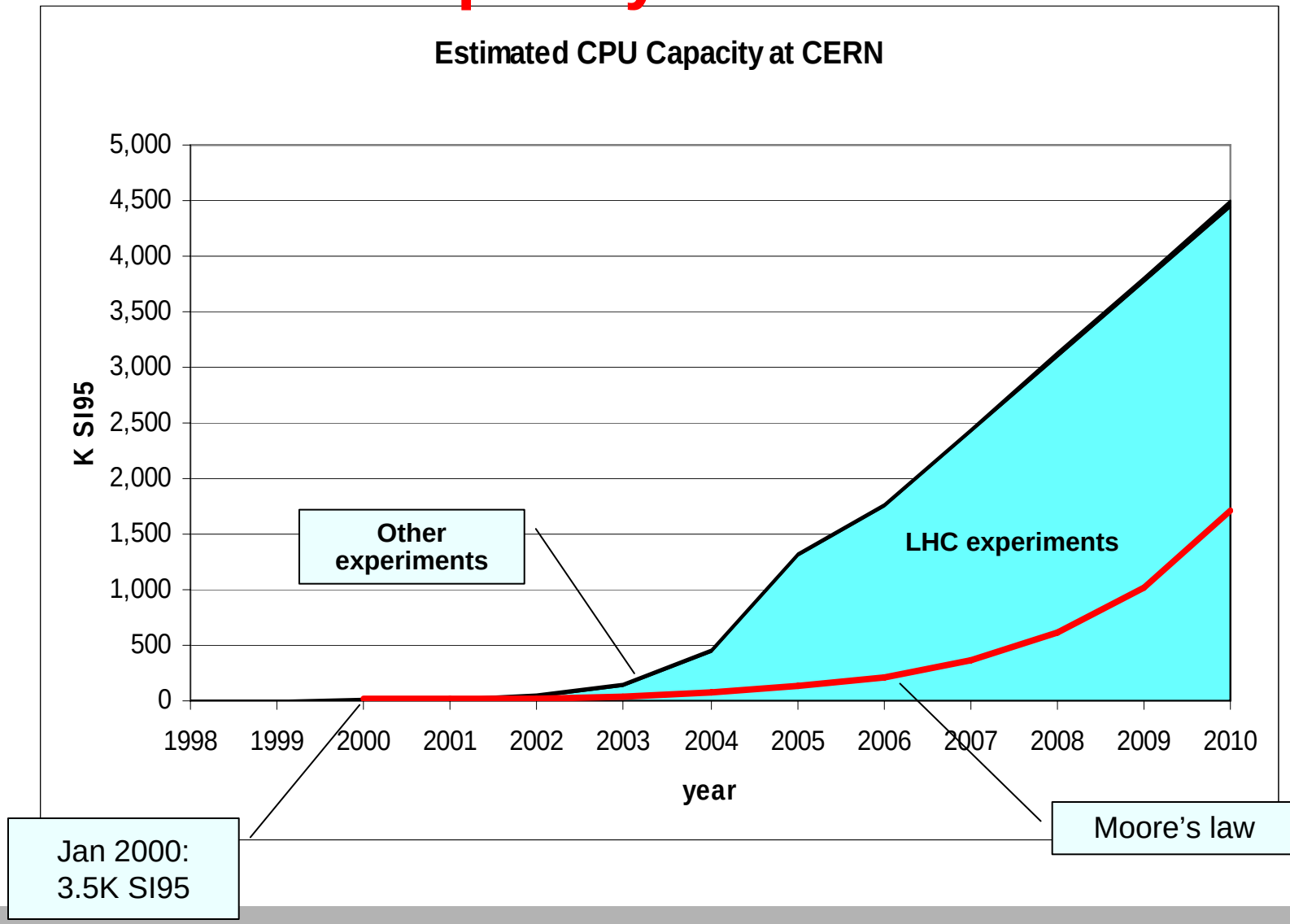
# Higgs signature at the LHC

The two proton beams at the LHC will collide head-on 800 million times per second



WE EXPECT ONLY 1 HIGGS IN 1,000,000,000,000 EVENTS

# Evolution of CERN computing needs
# CPU capacity 1998-2010

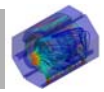


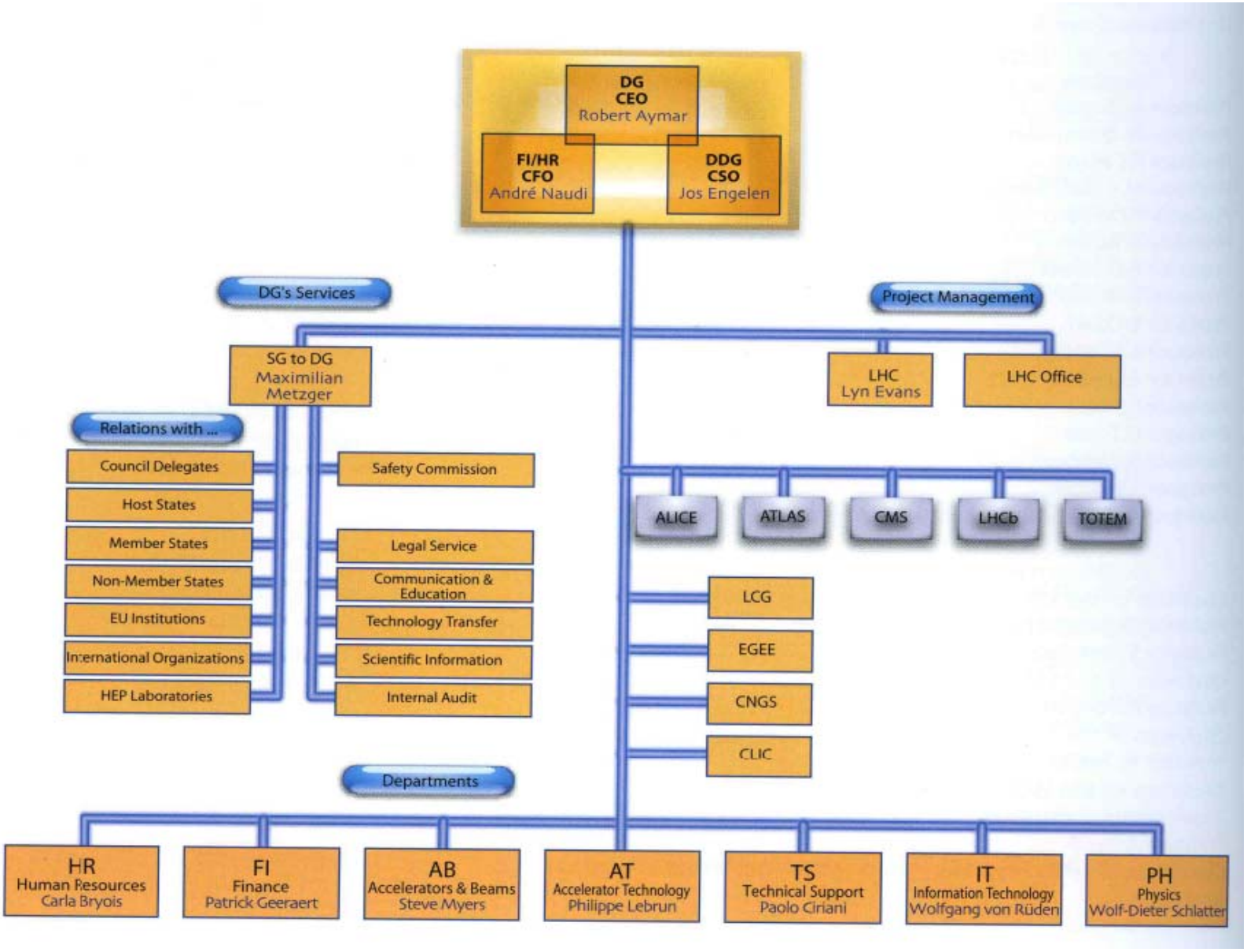
# The GRID: a possible solution to CERN computing needs

The LHC computing GRID is a project funded by the European Union. The objective is to build the next generation computing infrastructure providing intensive computation and analysis

# Computational Fluid Dynamic Team at CERN






DG
CEO
Robert Aymar
FI/HR
CFO
André Naudi
DDG
CSO
Jos Engelen
DG's Services
SG to DG
Maximilian
Metzger
Relations with ...
Council Delegates
Host States
Member States
Non-Member States
EU Institutions
International Organizations
HEP Laboratories
Safety Commission
Legal Service
Communication &
Education
Technology Transfer
Scientific Information
Internal Audit
Project Management
LHC
Lyn Evans
LHC Office
ALICE
ATLAS
CMS
LHCb
TOTEM
LCG
EGEE
CNGS
CLIC
Departments
HR
Human Resources
Carla Bryois
FI
Finance
Patrick Geeraert
AB
Accelerators & Beams
Steve Myers
AT
Accelerator Technology
Philippe Lebrun
TS
Technical Support
Paolo Ciriani
IT
Information Technology
Wolfgang von Rüden
PH
Physics
Wolf-Dieter Schlatter

# CFD team mission

The mandate of this team is to provide assistance to the LHC experiments in the design and prototype phase and support all other CERN units too.

CERN mandate is also to give training opportunity to students and young professionals (especially i the physics, engineering and computer science fields) coming form the member states to spread then, this knowledge in the origin states. The Team has formed tens of engineers to CFD in since last 12 years.



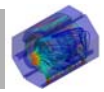
# CFD team resources

- ✓3-6 young engineers coming form the member states for short medium periods (6 months – 3 years)
- ✓Engineering PC Pentium 4 - 2 GRam - 2,8 GHz for development
- ✓A cluster of 20 Intel Itanium 64 bit, double CPU machines for calculation
- ✓Limited access to a larger Itanium cluster (OpenLab)
- ✓ADAPCO® StarCD software licenses

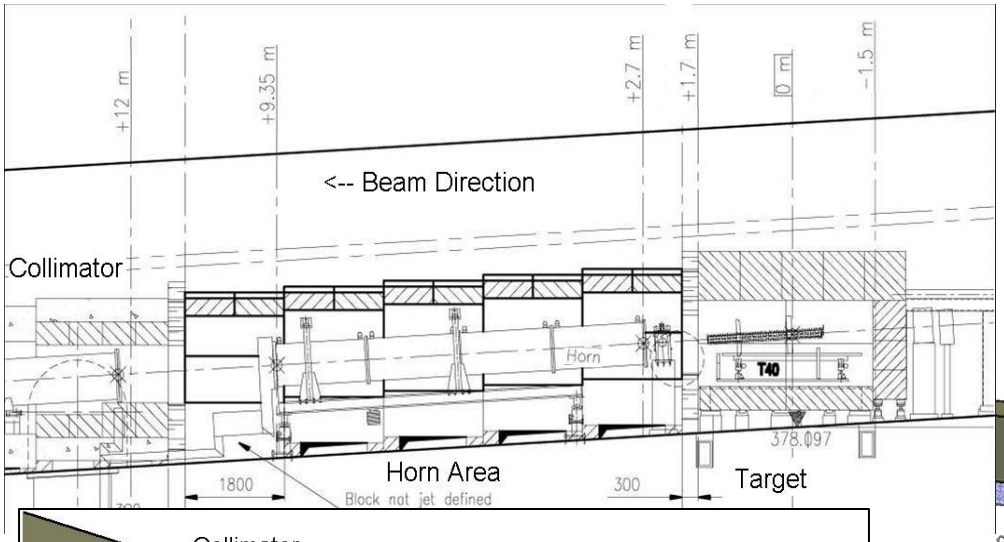


# Some example of simulation

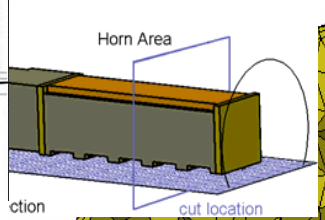


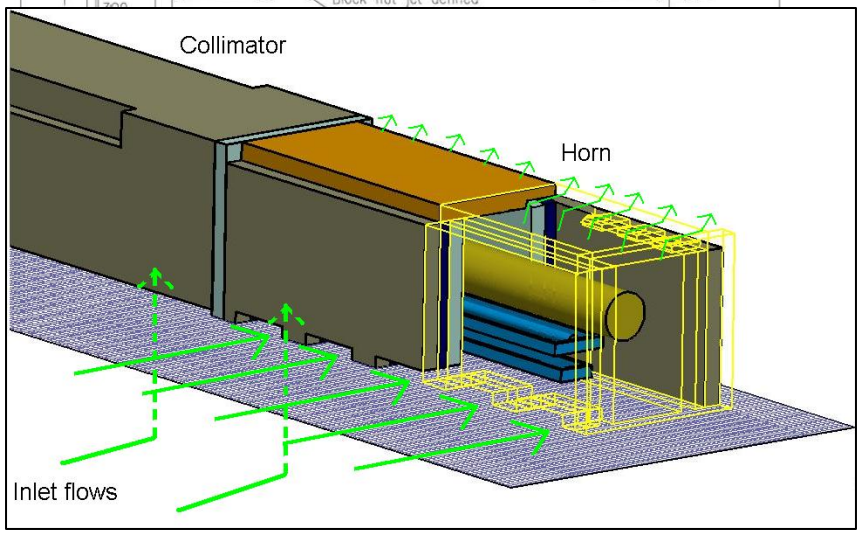


# CNGS Horn Air Cooling




Particle energy deposition heats up the horn and its shielding structure



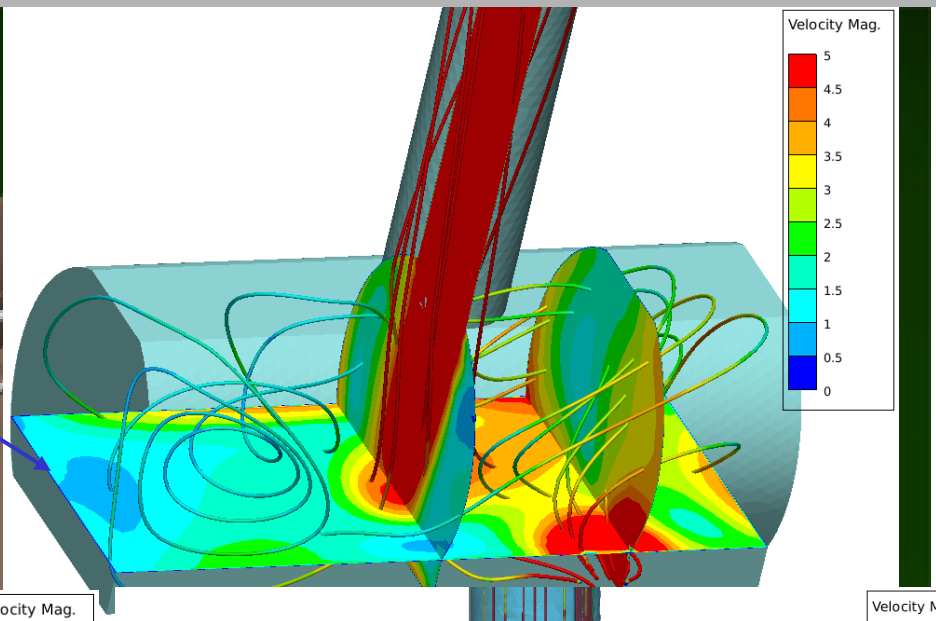





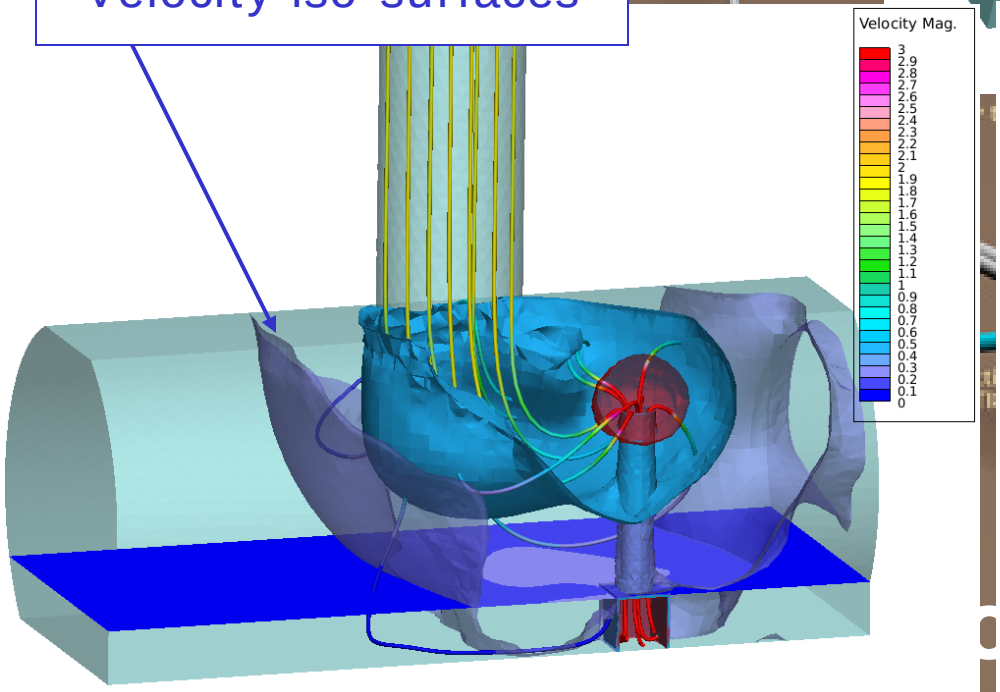


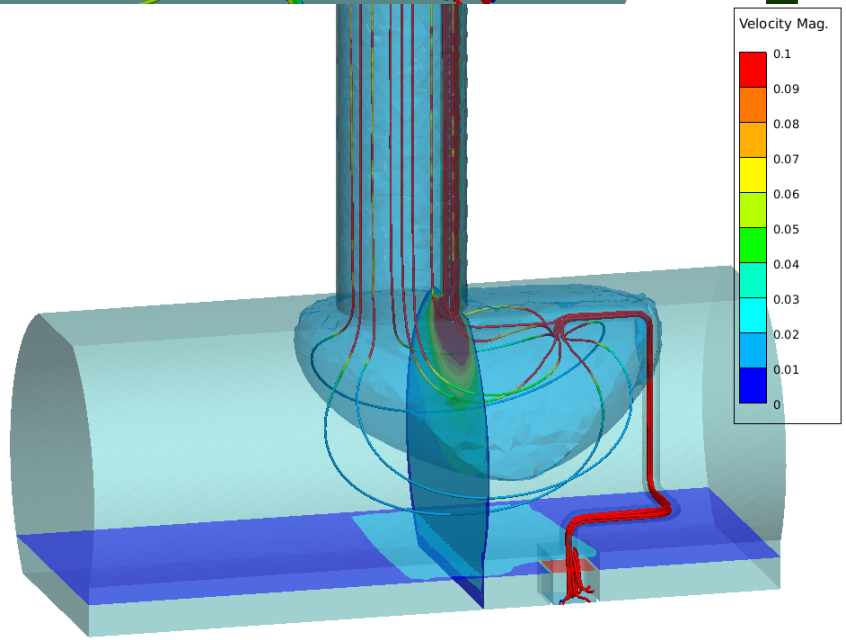
CFD simulations helped to decide modifications even during the construction phase


Cavern floor: where some person could be present

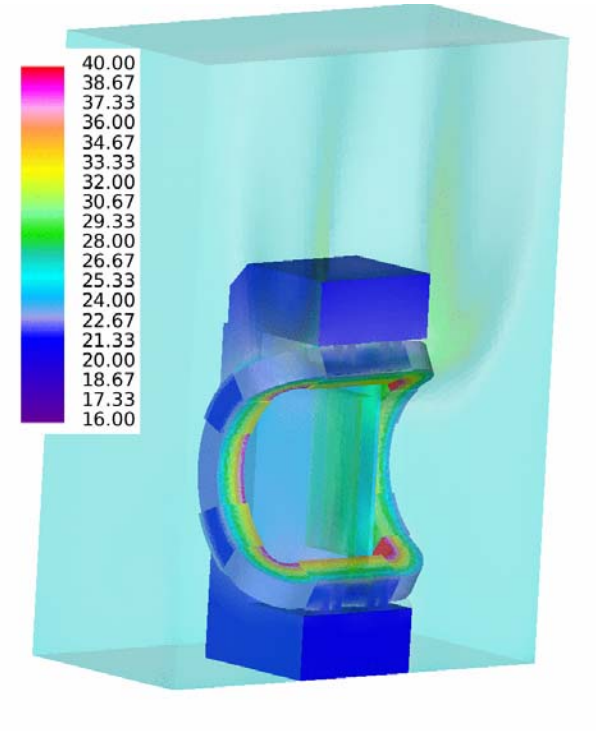


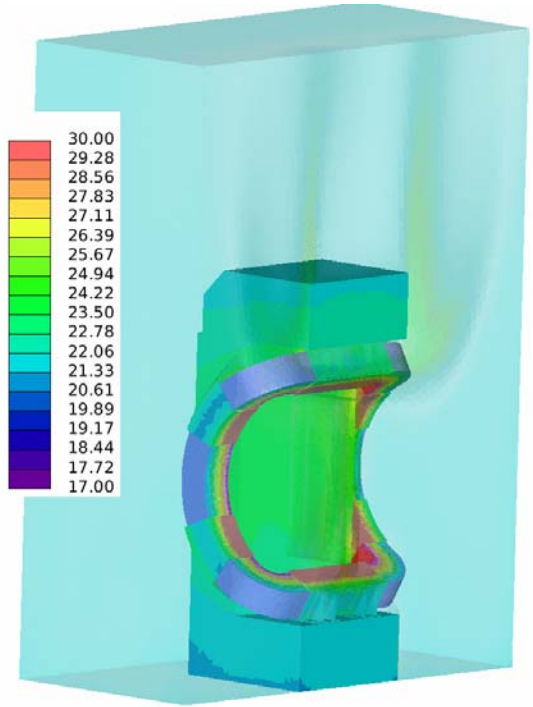

Velocity iso-surfaces



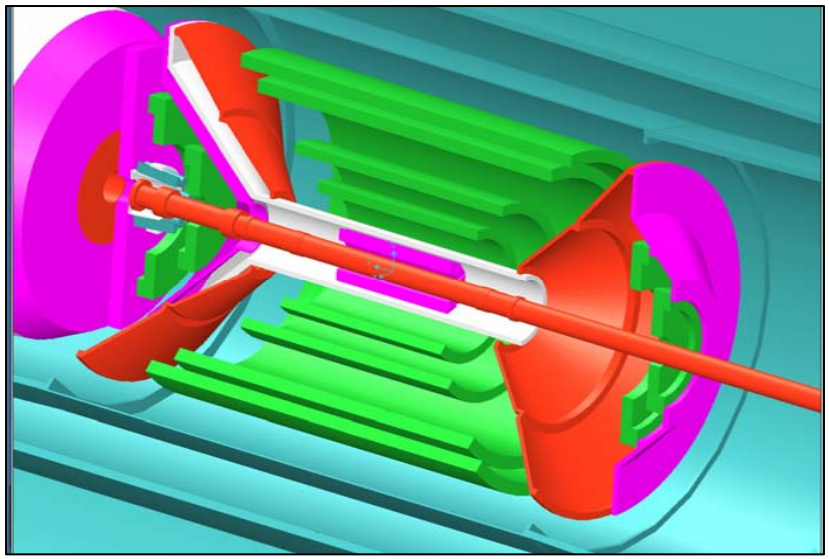



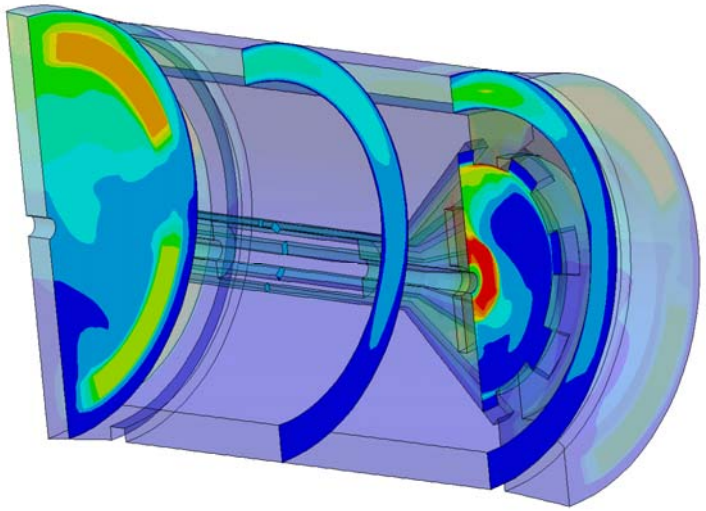
# Alice Muons Detector heat transfer

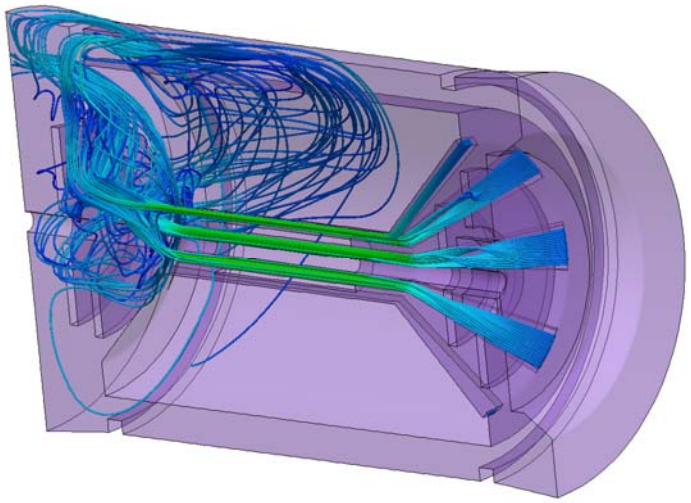



# Inner Trackers: no time for prototypes



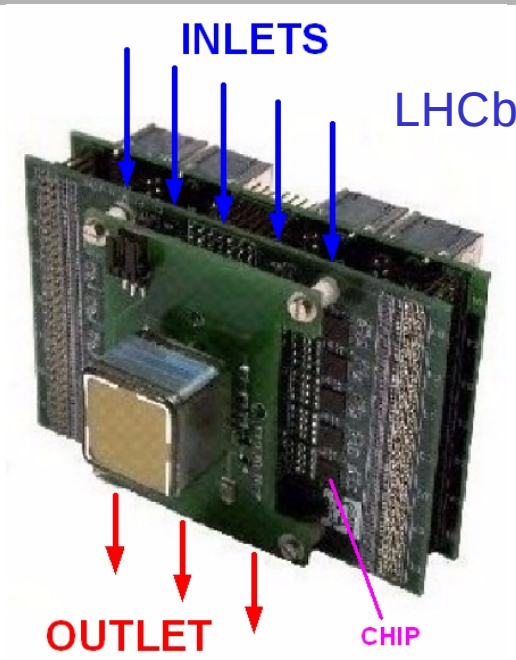




At CERN, most of the times, the final system is the prototype.

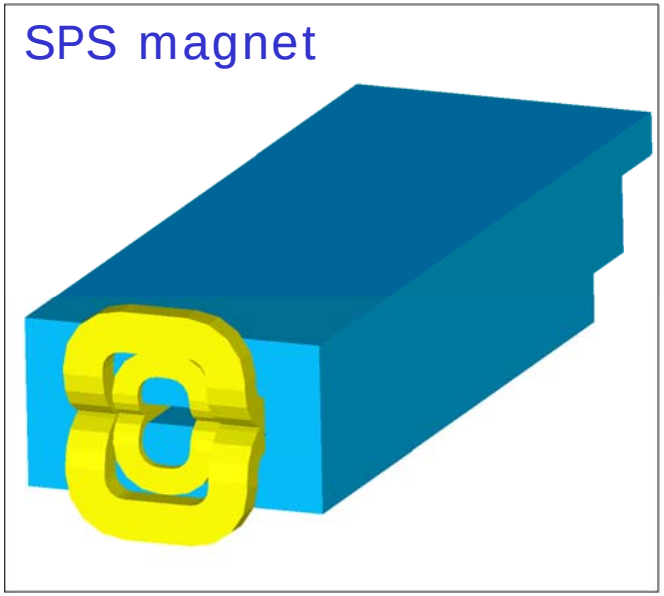
CFD can provide insight into fluid flow problems when experimental techniques are too expensive or physically impossible.

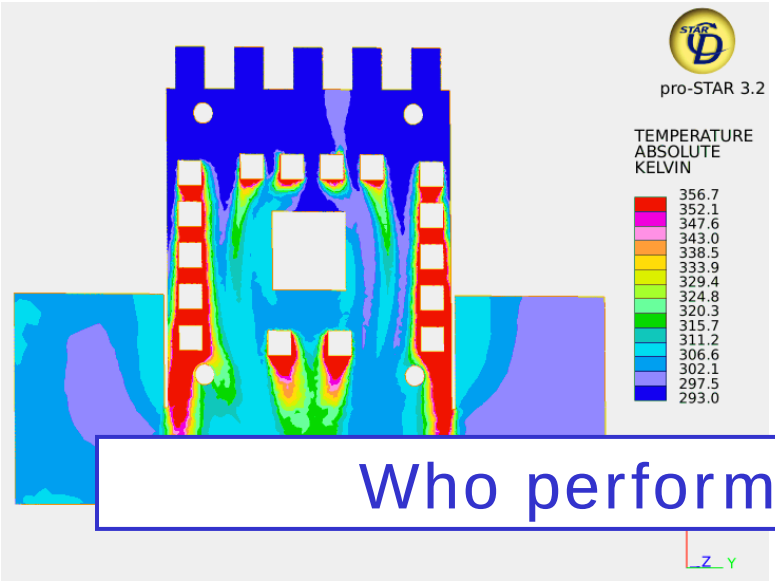
The Alice, ATLAS and CMS Inner Trackers are good examples.

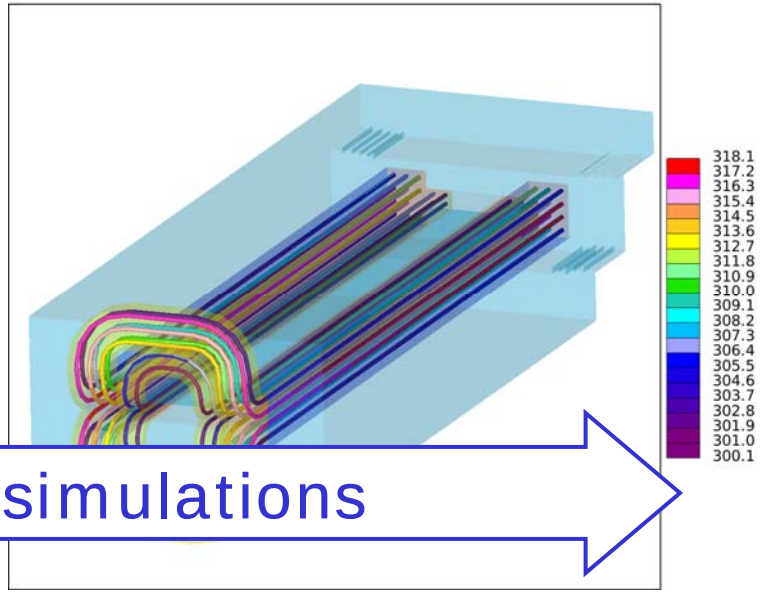



LHCb PS/SPD

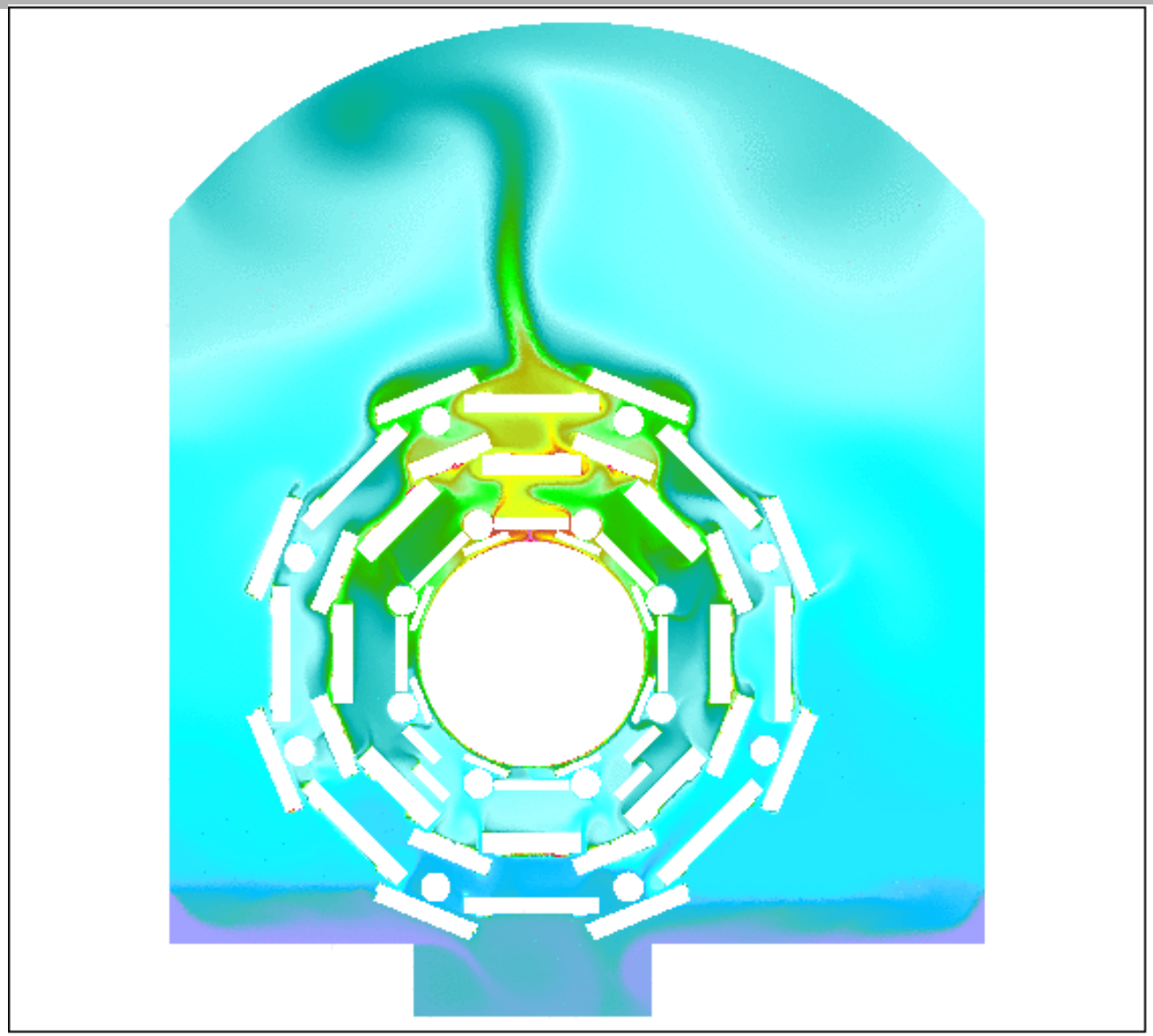
SPS magnet






Who performs these simulations


pro-STAR 3.2
TIME = 320.000
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