High throughput computing in the service of Big Science at CERN

March 6th 2014

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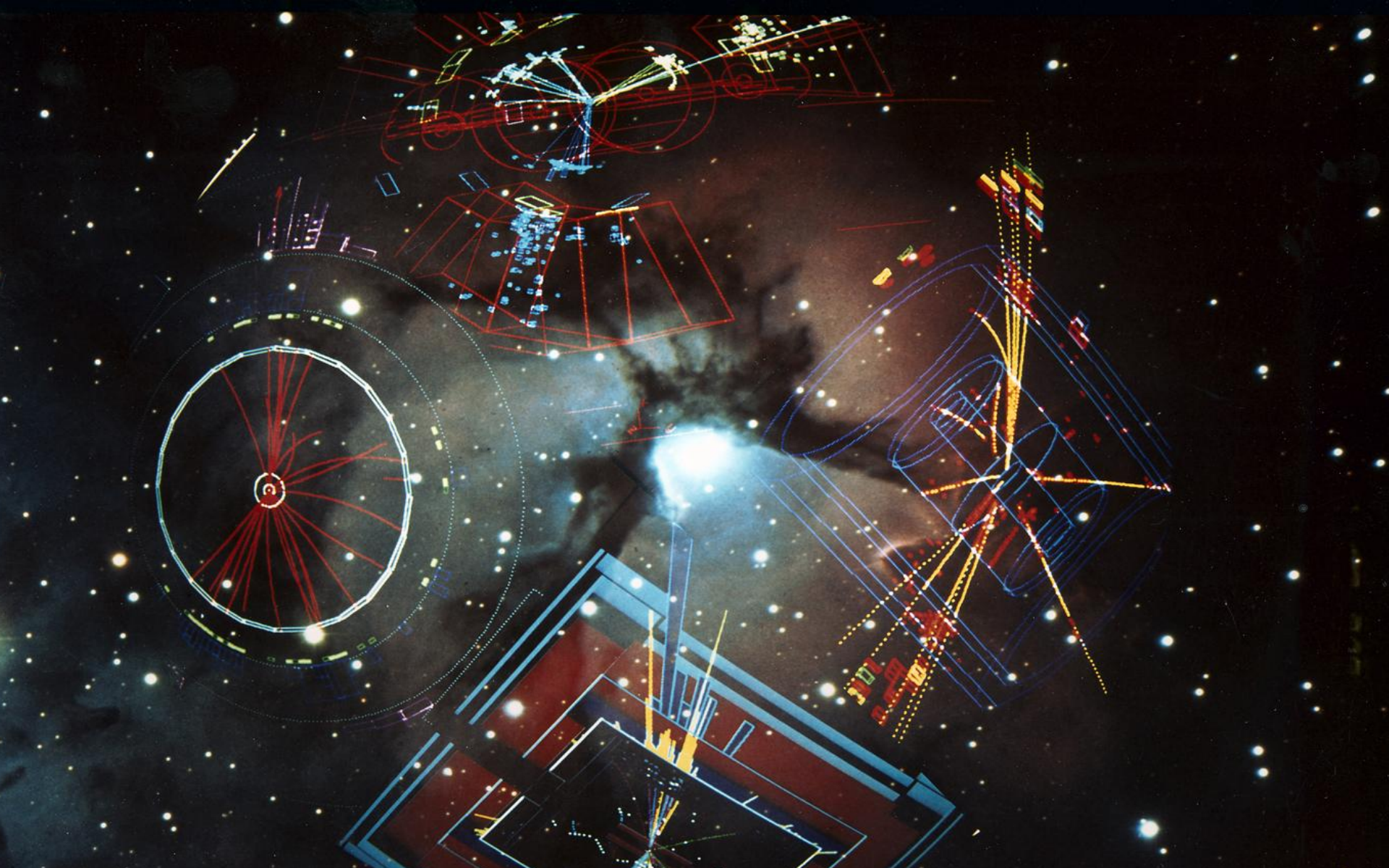
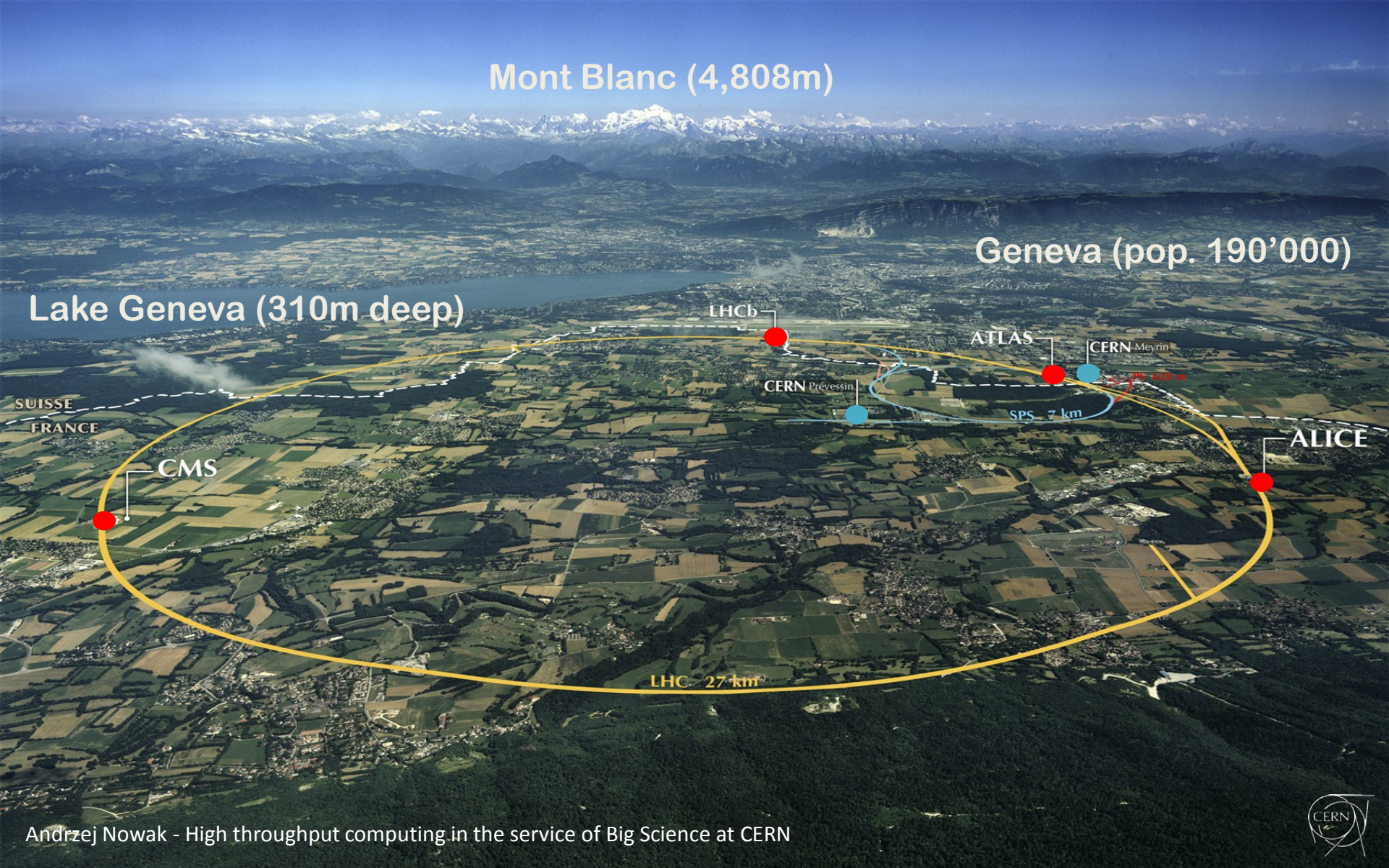
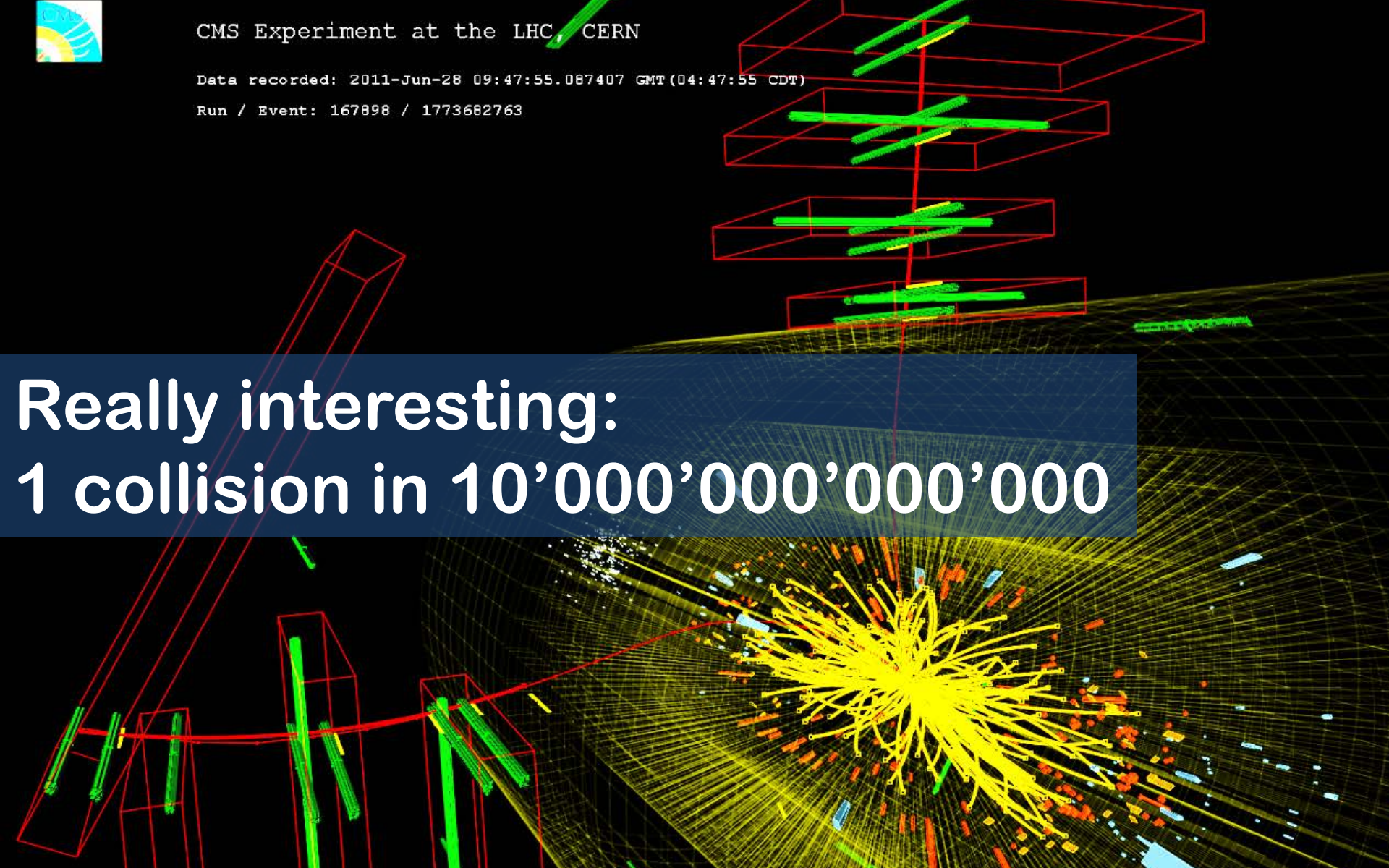
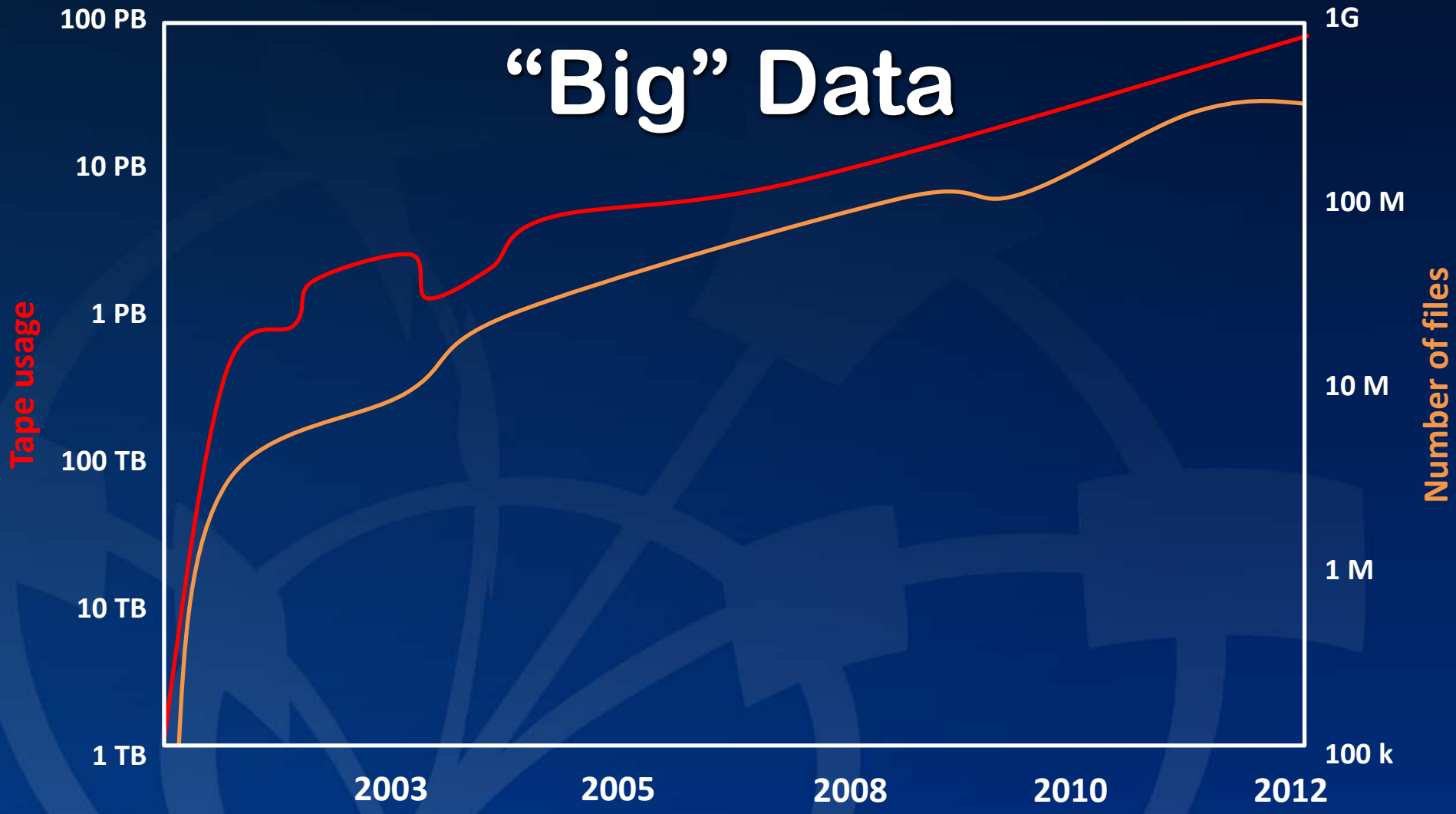
CERN openlab

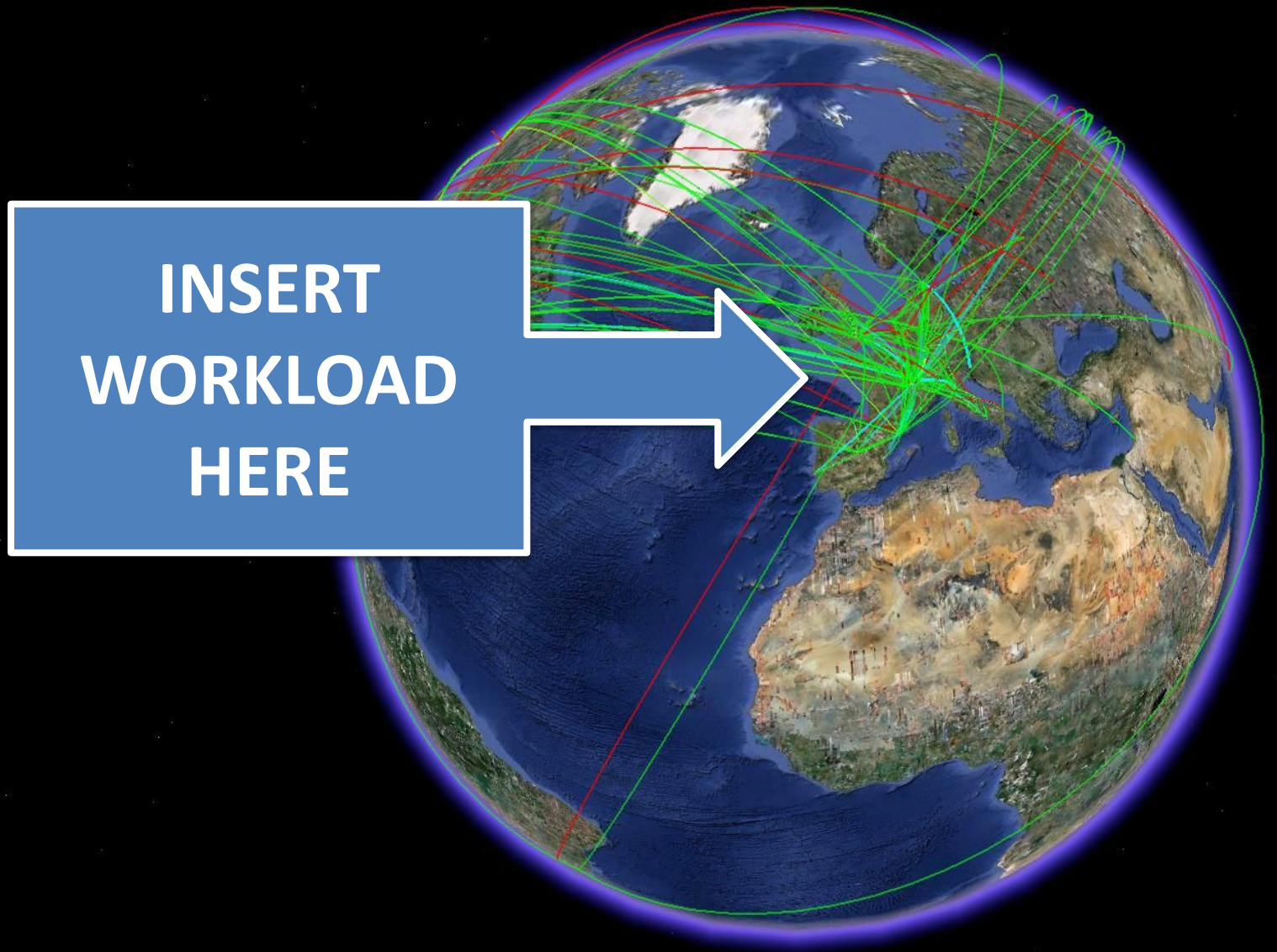



Mont Blanc (4,808m)
Geneva (pop. 190’000)
Lake Geneva (310m deep)
LHCb
ATLAS
CERN Meyrin
CERN Prévessin
SPS 7 km
SUISSE
FRANCE
CMS
ALICE
LHC 27 km



Really interesting:
1 collision in 10’000’000’000’000


"Big" Data
100 PB
10 PB
1 PB
100 TB
10 TB
1 TB
Tape usage
1G
100 M
10 M
1 M
100 k
Number of files
2003
2005
2008
2010
2012

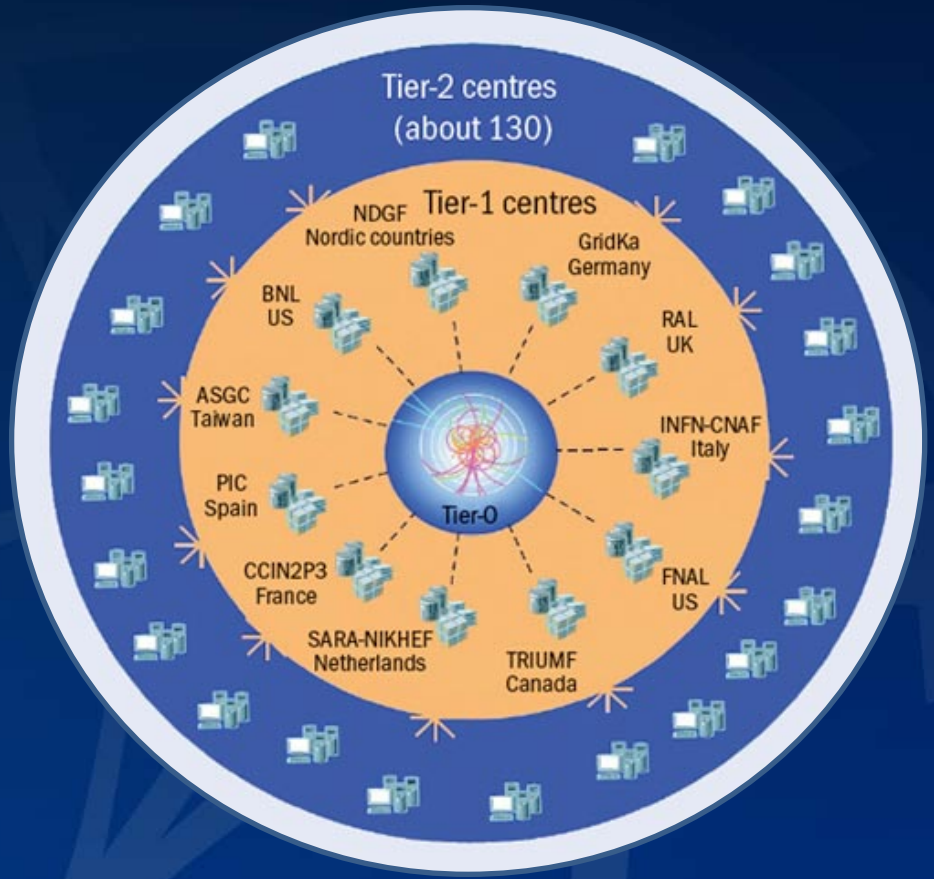

INSERT
WORKLOAD
HERE

Worldwide LHC Computing Grid

Tier-0 (CERN): data recording, reconstruction and distribution

Tier-1: permanent storage, re-processing, analysis

Tier-2: Simulation, end-user analysis

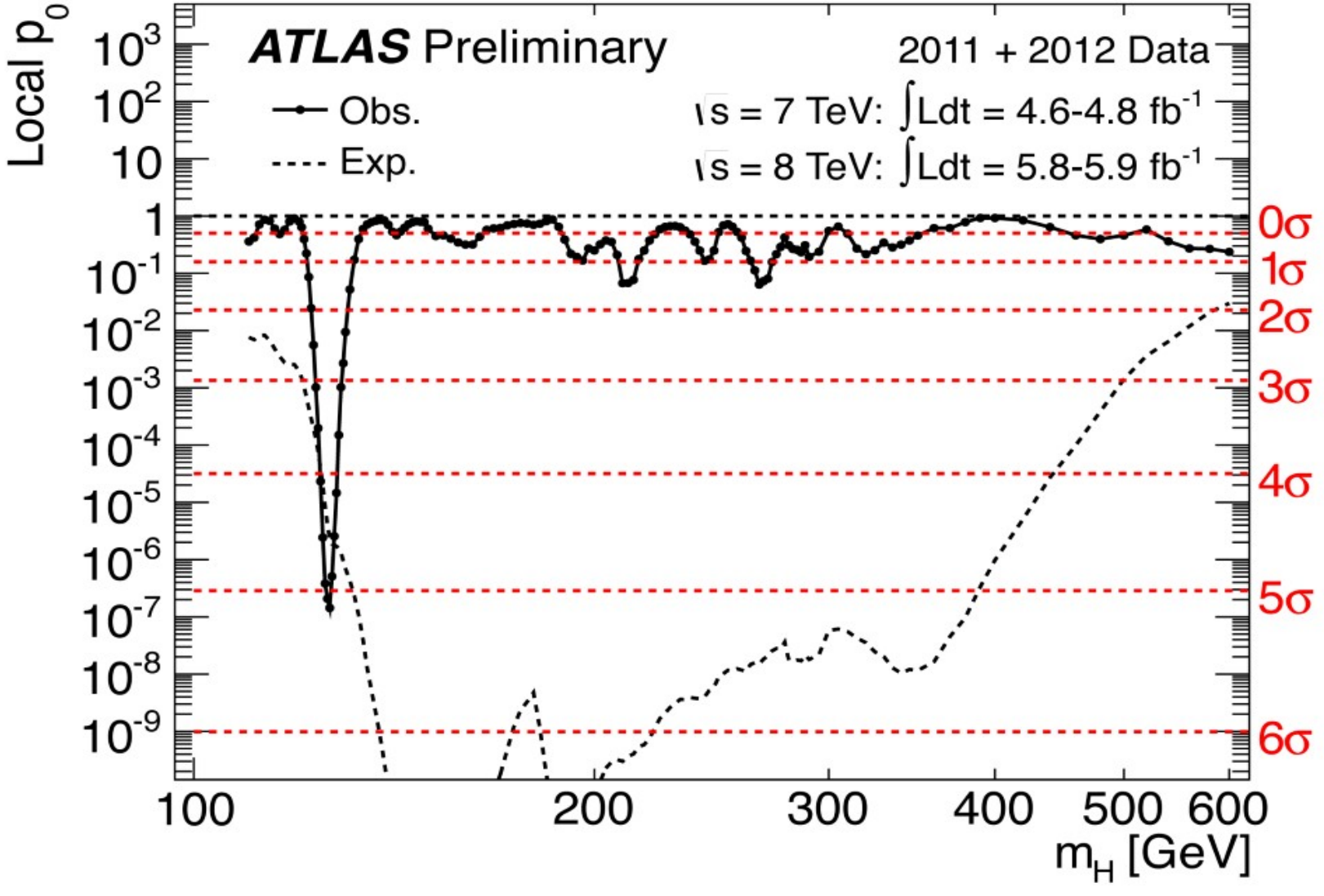


~150 sites

>400'000 cores

>250 PB of storage

> 2 million jobs/day


ATLAS Preliminary
2011 + 2012 Data
Obs.
Exp.
√s = 7 TeV: ∫Ldt = 4.6-4.8 fb-1
√s = 8 TeV: ∫Ldt = 5.8-5.9 fb-1
Local p0
10^3
10^2
10
1
10^-1
10^-2
10^-3
10^-4
10^-5
10^-6
10^-7
10^-8
10^-9
0σ
1σ
2σ
3σ
4σ
5σ
6σ
100
200
300
400
500
600
mH [GeV]

Reviewed hardware

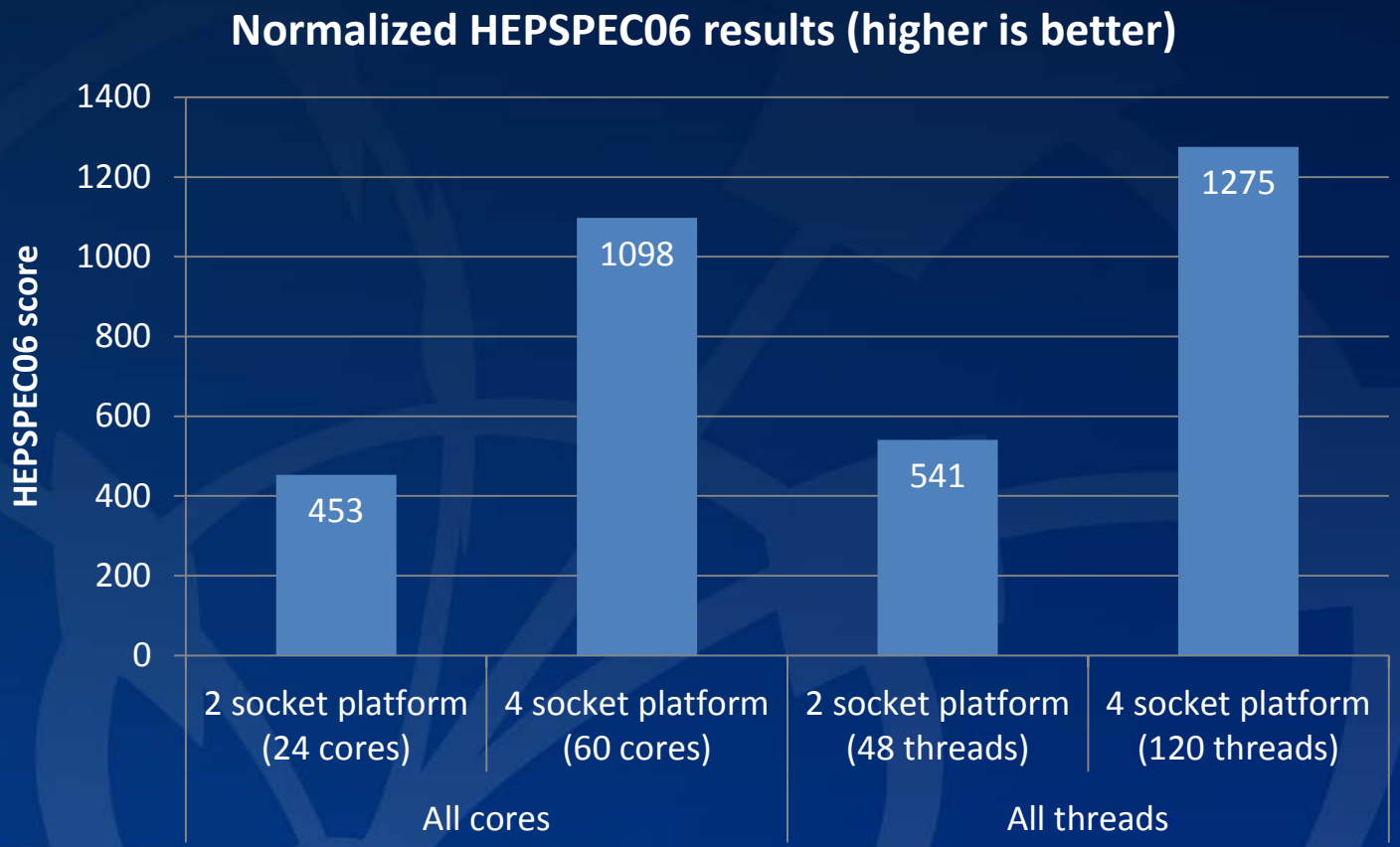
- “Ivy Bridge-EP”
- Production version
- 2x Intel Xeon E5-2695 v2 (2.4 GHz)
- 24 cores x 2 threads
- 2x 1600W PSU (per 4 systems)

- “Ivy Bridge-EX”
- Pre-production
- 4x Intel Xeon E7-4890 v2 (2.8 GHz)
- 60 cores x 2 threads
- 2x 1200W PSU

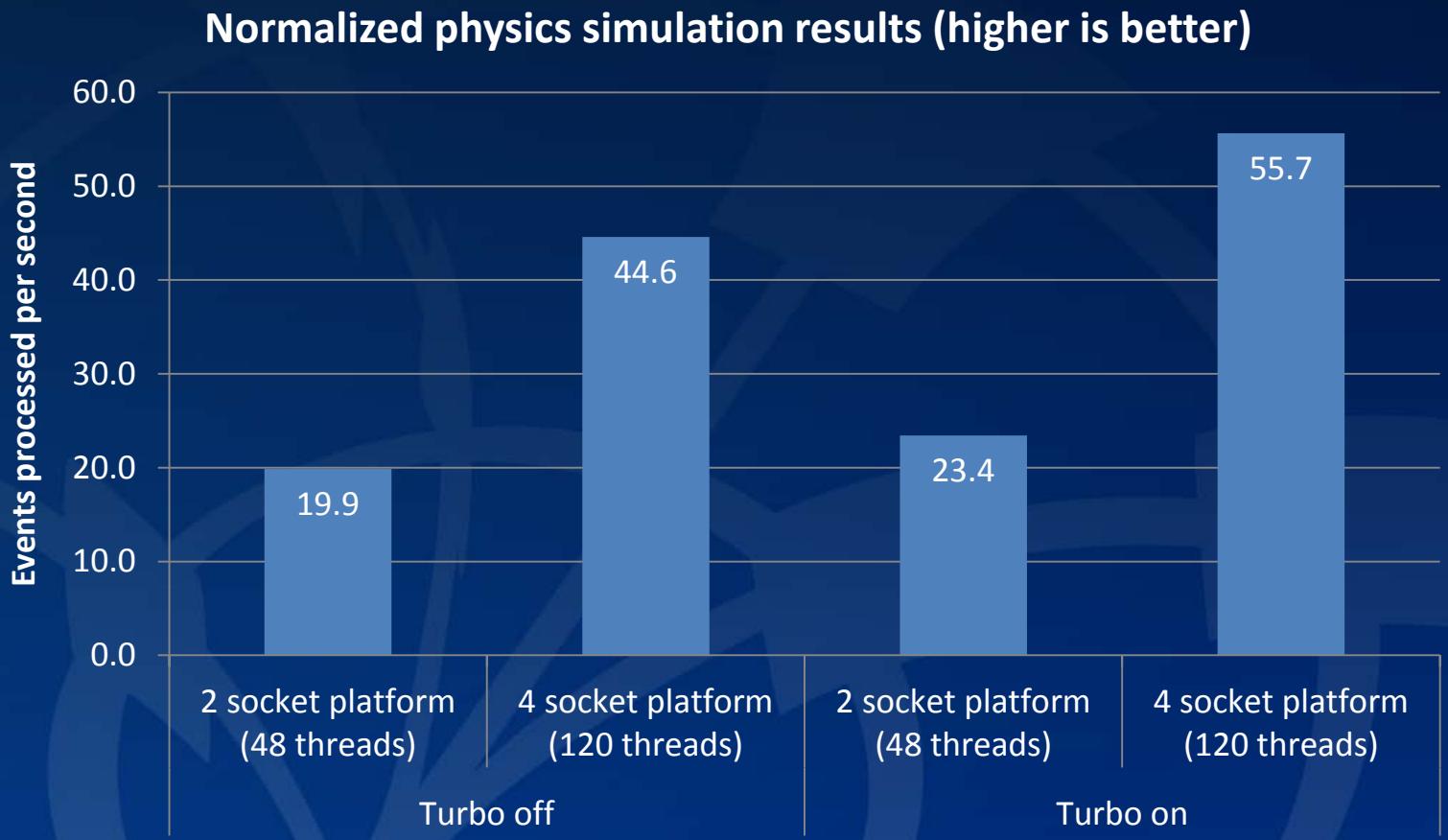
Results are frequency scaled

All measurements performed by the openlab Platform Competence Center team at CERN

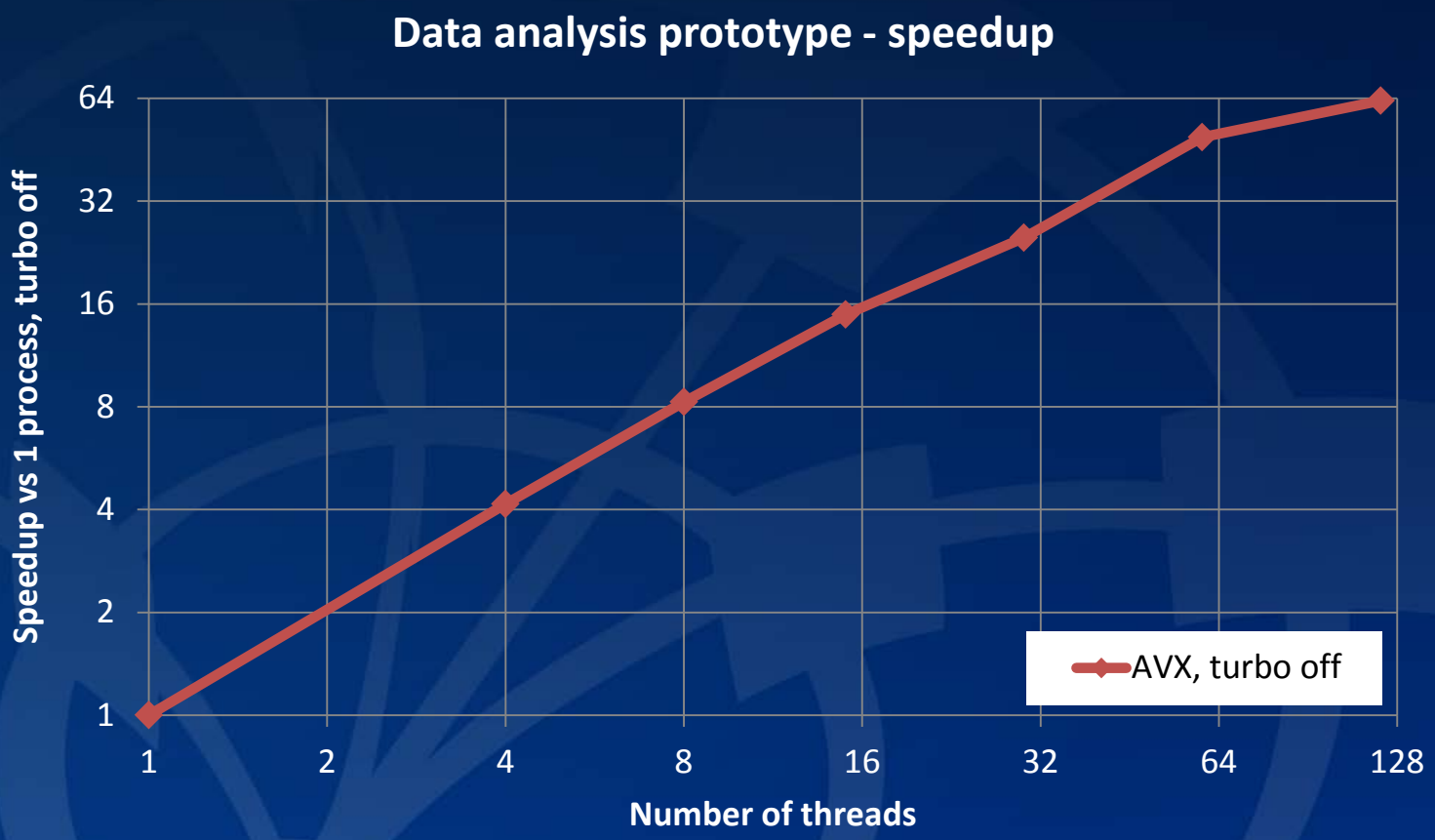
HEPSPEC06


Normalized HEPSPEC06 results (higher is better)
HEPSPEC06 score
1400
1200
1000
800
600
400
200
0
453
1098
541
1275
2 socket platform (24 cores)
4 socket platform (60 cores)
2 socket platform (48 threads)
4 socket platform (120 threads)
All cores
All threads

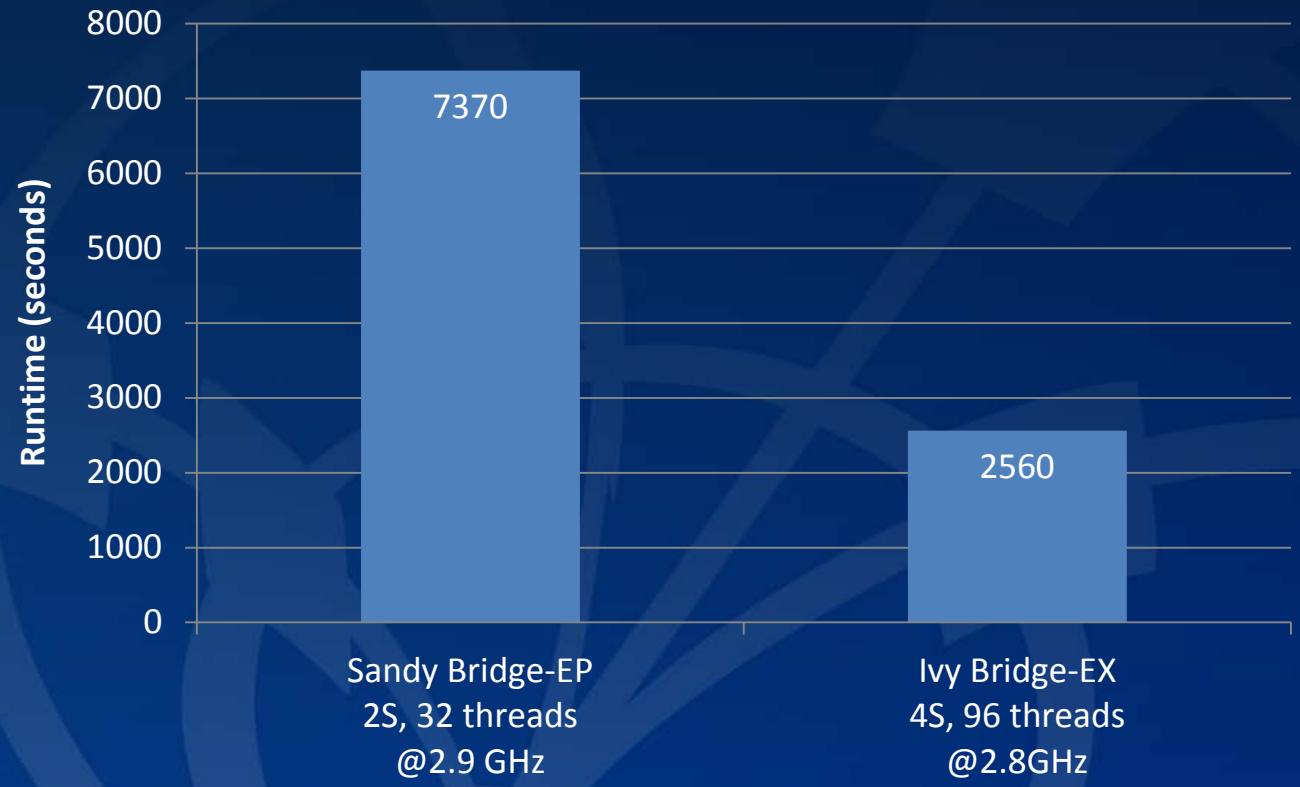
Multi-threaded particle simulation prototype



Data Analysis prototype

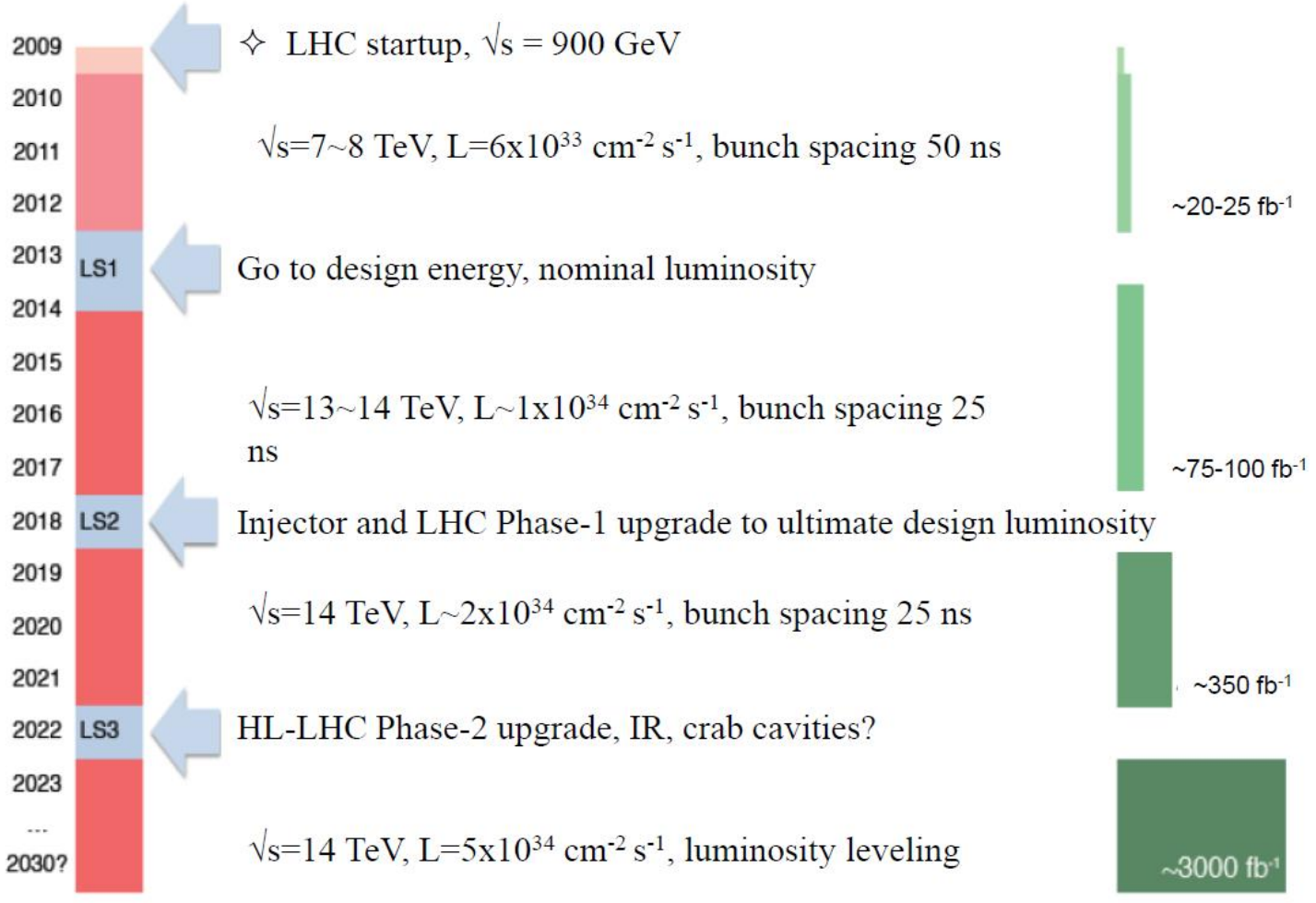


Scientific HPC - QCD



This test is a physics workload which usually runs on clusters and supercomputers composed of many nodes

The LHC Timeline



Tentative plan, subject to change

Challenges of the future

Raw data rates at the LHC could increase by 100x
What would happen then?

"Sustainable computing"

The CERN openlab

A unique research partnership of CERN and the industry
Objective: The advancement of cutting-edge computing solutions to be used by the worldwide LHC community

- Partners work with dedicated competence centers
- openlab delivers published research and evaluations based on partners' solutions – in a very challenging setting
- Created robust hands-on training program in various computing topics, including international computing schools; Summer Student program
- Past involvement: Enterasys Networks, HP, IBM, Voltaire, F-secure, Stonesoft, EDS
- Now planning phase V: 2015-2017

http://cern.ch/openlab

PARTNERS

HUAWEI

intel

ORACLE

SIEMENS

CONTRIBUTOR

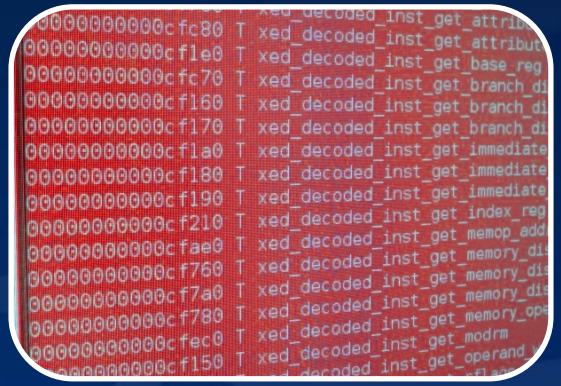
rackspace

ASSOCIATE

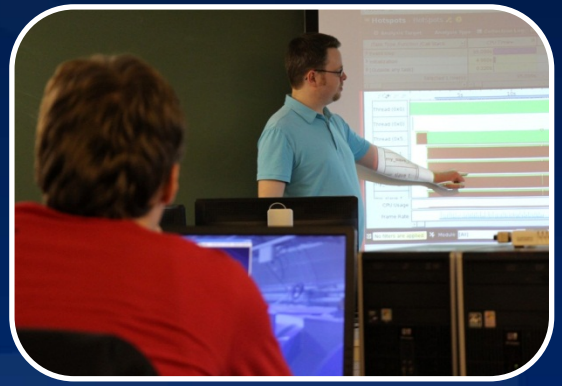
Yandex

The openlab-Intel collaboration

Hardware: processors, accelerators, networking



Software: optimization studies and tuning, co-development



Education: thematic classes and workshops

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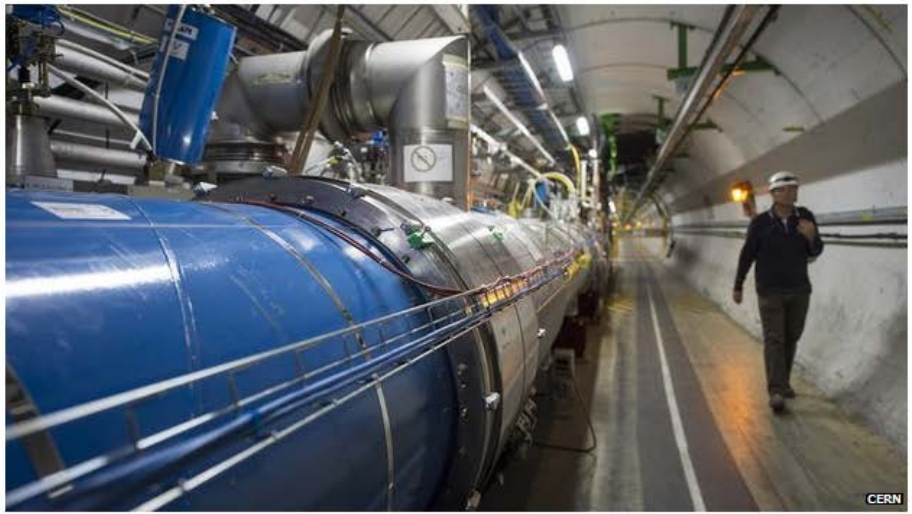
Cern considers building huge physics machine

By Roland Pease
Science writer



The current tunnel housing the Large Hadron Collider is some 27km long

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Questions? Andrzej.Nowak@cern.ch