

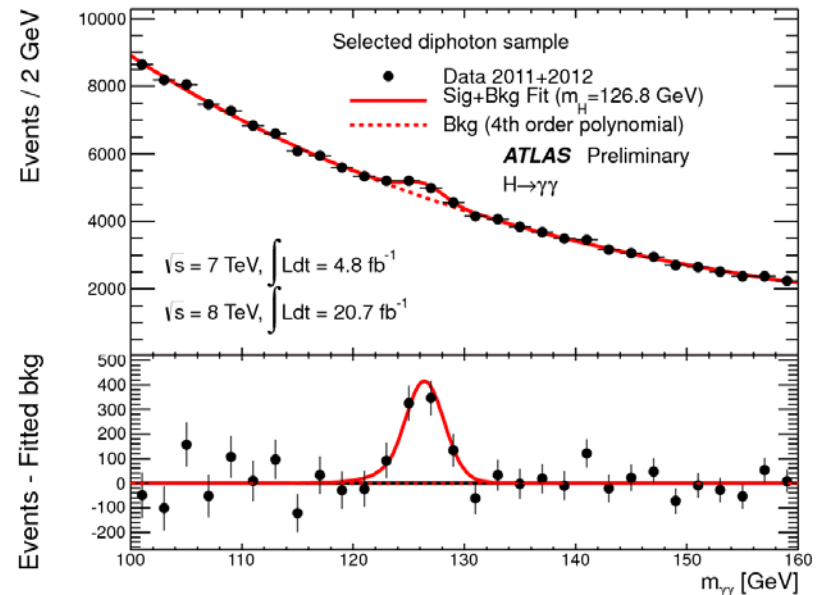
Computing

The Users Perspective

Christian Zeitnitz

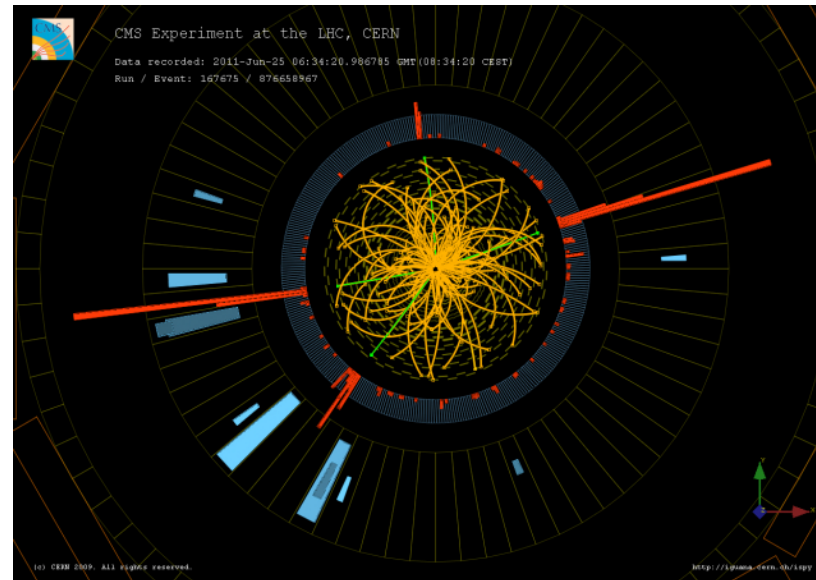
Bergische Universität Wuppertal

- LHC Physics and Computing
- Analysis of Data
- Experiences
- Requirements for the Future
- Summary



Higgs Particle discovery July, 2012

LHC Physics and Computing



- LHC physics goals
 - o Search/discovery of the Higgs particle (2012)
 - o Test of the Standard Model of particle physics
 - o Search for new phenomena
- German groups - ~1000 physicists and students in ~20 institutions - are heavily involved in the 4 big LHC experiments

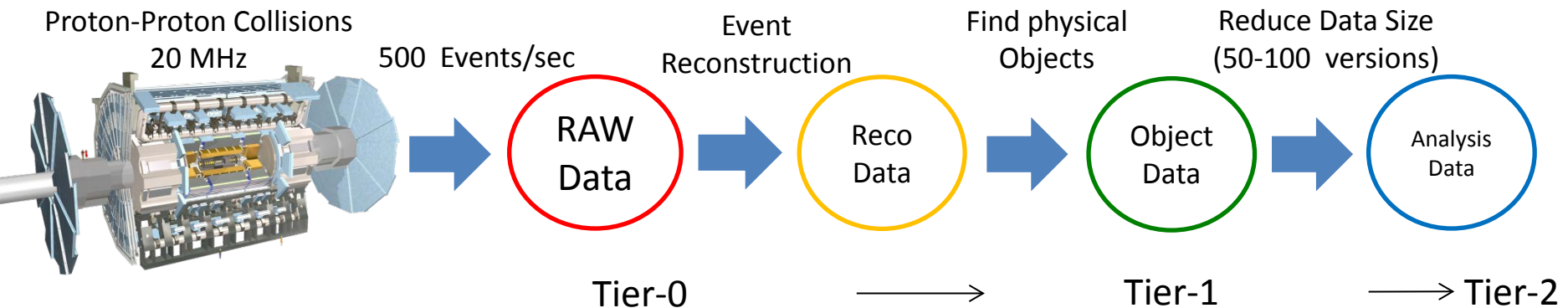
LHC Physics and Computing

■ Challenge

- o Most processes are extremely rare (10^{-6} - 10^{-7})
→ need very high data rate
- o CMS and ATLAS each collected and reconstructed about $3 \cdot 10^{10}$ events + Simulation

■ Data processing

- o Multi steps lead to data collections used for the actual analyses
- o Distribute data over more than 150 sites worldwide



Analysis of Data and Scientific Results

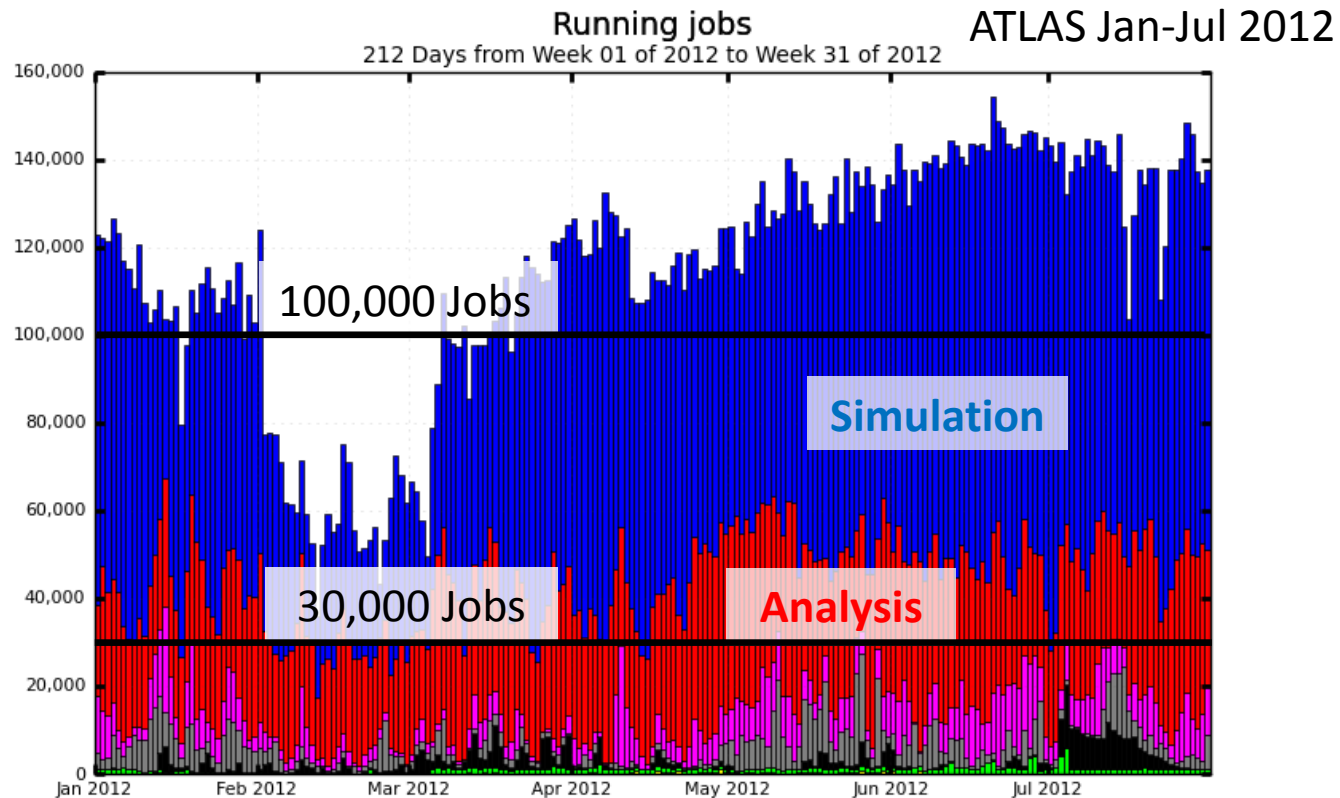
- Physics results (publications) are obtained from data stored at the Tier-2 centers
- Typical time to perform a single analysis and publish: 2-3 years
- What is important for successful analyses?
 - Ease of access to data and resources
 - Short running time of jobs
 - Low failure rate of jobs and good support

**Requires huge amount of computing resources
and committed people**

Analysis Procedure

- Run pre-selection on the GRID (data and MC)
 - o 10000-20000 CPU hours (turnaround ~1 week)
- Optimize analysis on NAF or local institute resources
- Iterate 3-4 times a year with all data
- For 2000 people (4 experiments) this sums up to
~160 Mio CPU hours/year or 25000 CPU cores (~30%)
of the Tier-2 resources

Snapshot of CPU Utilization



- Simulation dominates CPU usage on Tier-1/2 centers (~60%)
- Analysis ~20-30%
- Utilization varies substantially
- Not included: NAF and Tier-3 usage

Experiences

- Since 2009 the Tier-centers and NAFs in Germany performed extremely well
 - This made the strong impact by German groups possible
- Reliability and accessibility was very good
- Additional resources like the National Analysis Facilities and Tier-3 have been heavily used
 - NAF at DESY/GSI especially important for smaller groups with little local resources
- Visible result: ~1000 papers published since 2011 by the four LHC experiments

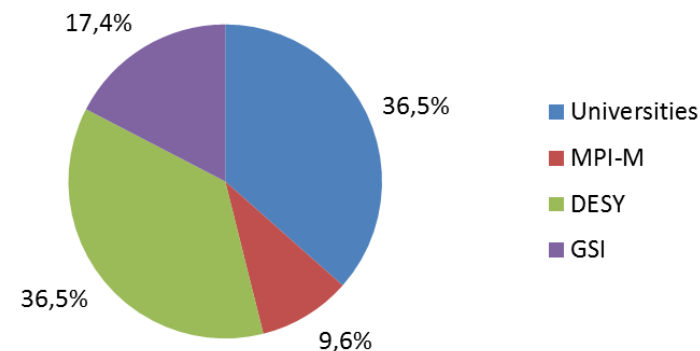
Experiences – Expert View

- Tier-1 GridKa
 - Very reliable partner of the computing experts of the experiments
 - Close cooperation between center and experiments was essential for success
- Tier-2/NAF in Germany
 - Distributed over DESY, GSI, MPI and 5 Universities
 - Experts at multiple sites helped to support the “users”
 - Reliability is at very high level
- Hierarchical structure of the computing models is dissolving at least for the analysis

Utilized resources in Germany (11/2012-11/2013)

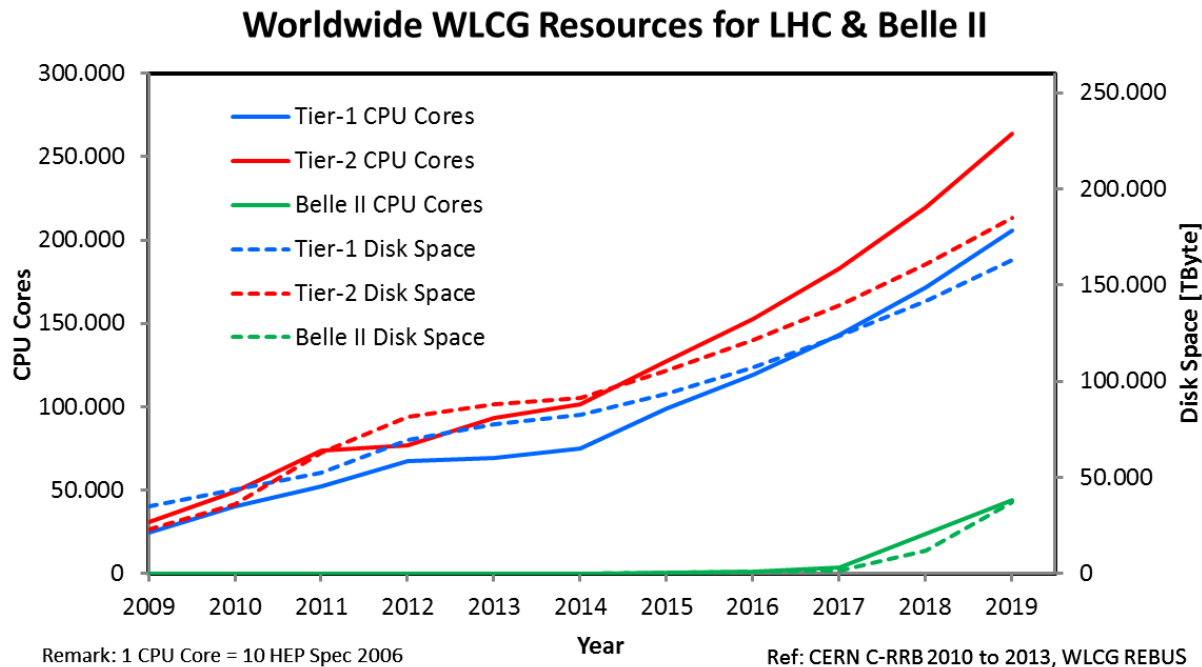
- Total 200 Mio. CPU hours
- **Tier-1: 42%, Tier-2: 58%**

CPU shares of German Tier-2



Future Requirements

- Increase of data from 2015-18 by factor 5-10
- At best constant budget for computing resources
 - Increase of available resources by factor 2-3 (C-RRB Oct 2013)
- Substantial optimization of experiment software and resource utilization required (task for the experiments)



Future Requirements (2)

- Will need 20-30% increase of resources in 2015!
 - Currently not really clear how to achieve this
- German groups are already now and will in the future contribute heavily to the upgrade of the LHC detectors (~10% of total cost)
- Long term commitment required (next 10-15 years)
- Development of the computing not predictable, but need long term funding as well

Summary

- The engagement of KIT, DESY, GSI and University partners made the strong contribution of the German community to the scientific results possible
- Very good performance of the German Tier-1, Tier-2 centers and NAFs
- Helmholtz Alliances extremely important for the current success
- The next LHC run (2015-18) will require a resource increase by at least a factor 2-3
- Worried about the funding situation in Germany
- Long term planning for the LHC (next 15 years) requires a long term solution for the computing as well

The LHC community is relying in the future on the computing expertise and resources provided by KIT, DESY and GSI and strongly supports the current proposals

BACKUP

Tier-2 Funding Options

- Current locations
 - o DESY, GSI, MPI M and 5 Universities
- Funding of HGF centers – hopefully – secured
- MPI promised, at least for the next years, to maintain the Tier-2 in Munich
- University funding unclear
 - o Helmholtz Alliance at the Terascale provided funding from 2007-2012
 - o Transfer of funds/hardware from HGF?

Funding in the Past

- Tier-1
 - BMBF (Hardware) and HGF PoF1 and 2 (personnel and operation cost)
- Tier-2 and NAF
 - Hardware - very heterogeneous funding sources
 - Personnel and operation: Covered by institutions - DESY, GSI, MPI M, Universities
- Experiment specific personnel supported by BMBF

