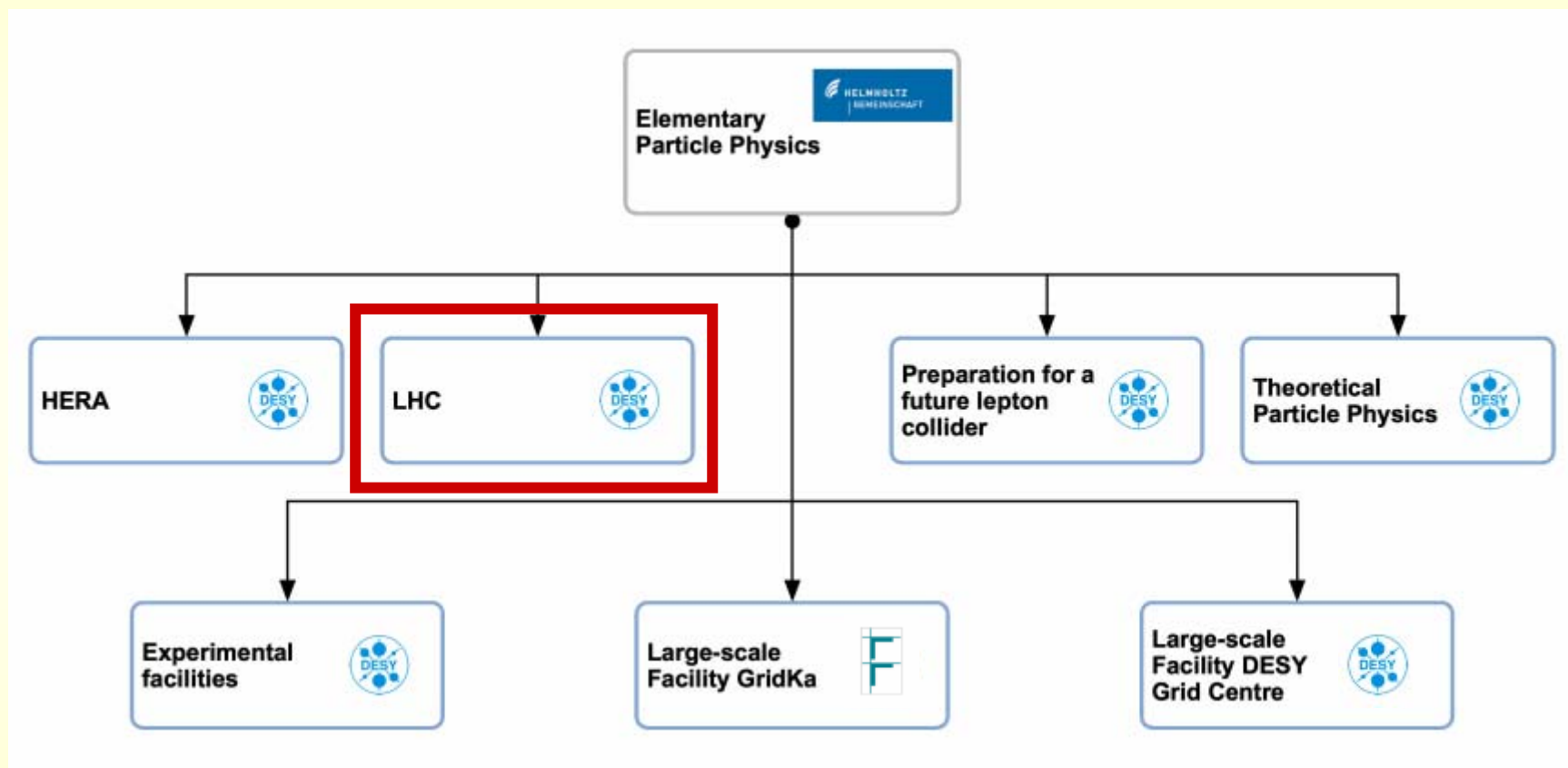
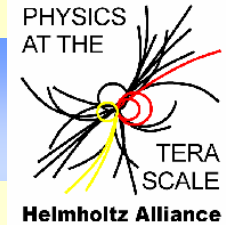


Program Topic: Large Hadron Collider



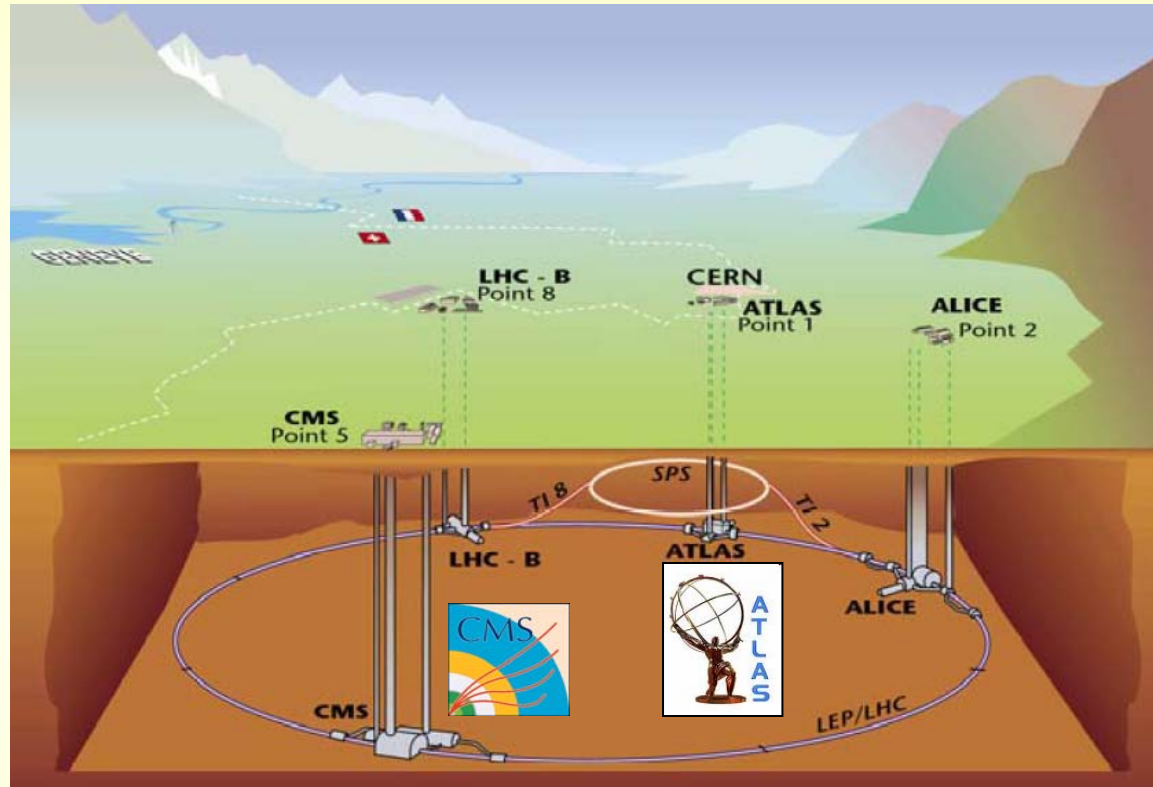
Large Hadron Collider



The LHC is the next step towards the understanding of fundamental laws in physics

→ world-wide effort at the Terascale

→ bundle all forces and resources on international and national level for the discoveries in the next decades

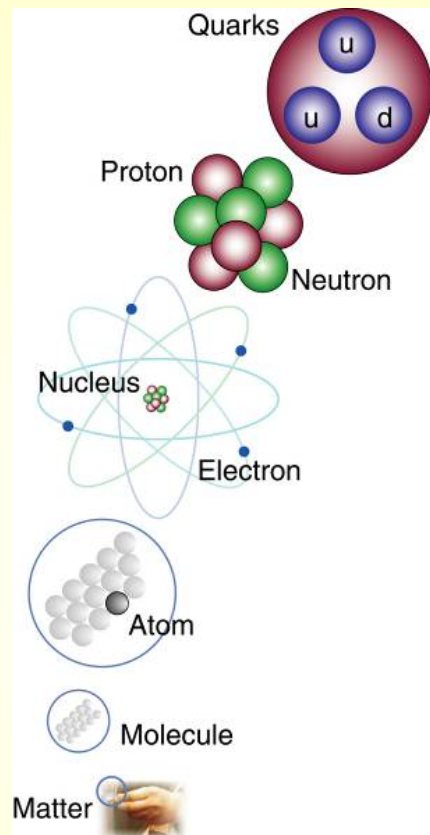


Contents:

- Relevance and Challenges
- Current Status and Proposed Program
- Resources



Scientific Relevance

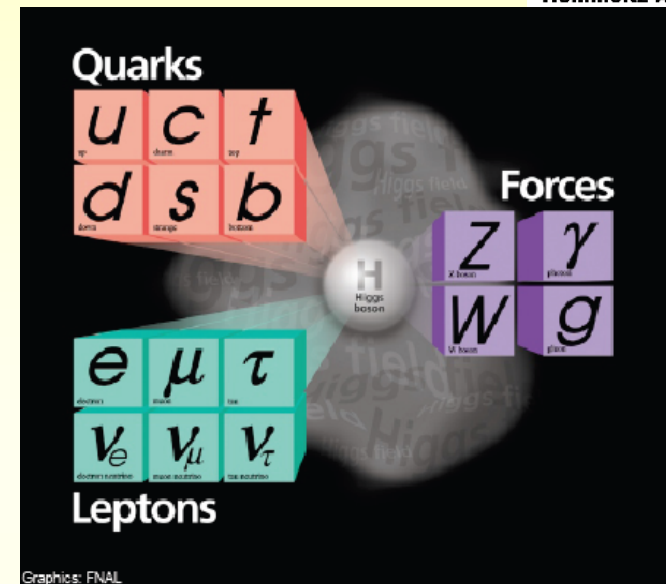


Standard Model of Particle Physics:

- Quarks
- Leptons
- Forces

Very successful


Verified with high precision measurements at LEP, Tevatron and HERA

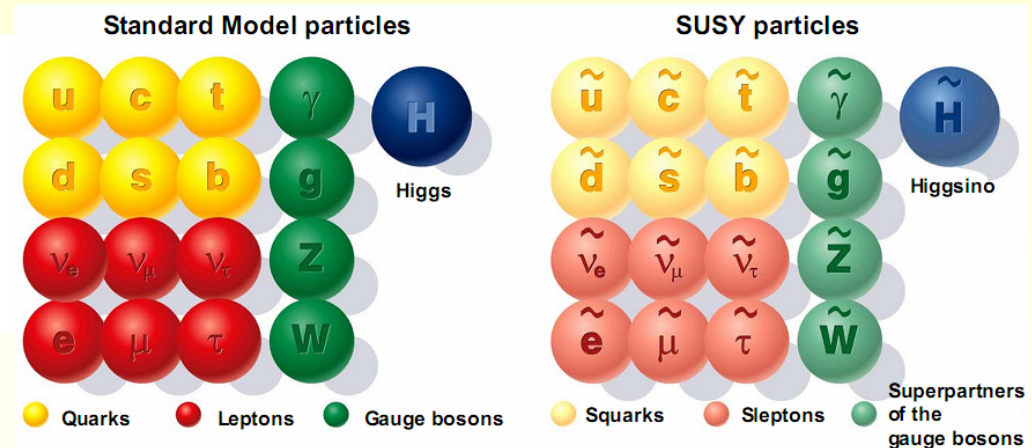
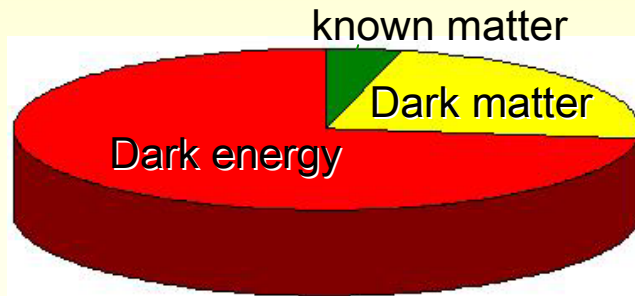


Missing pieces:

- What is the origin of mass for the elementary particles → Higgs?
- How to integrate the fourth fundamental force, the gravity ?
- Where and how do all forces unify in coupling strength ?
- What is dark matter and dark energy ?

Scientific Relevance of the LHC

Energy Density Budget  Standard Model: only small fraction
→ SuperSYmmetry ?



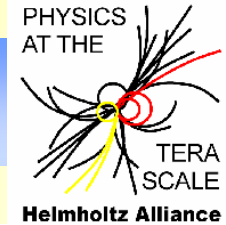
- Searches for New Physics:
 - Higgs → does it exist and is it the clue to the masses of particles ?
 - SUSY → new classes of elementary particles & interactions
- Standard Model Physics:
 - Top-quark: discovery @ Tevatron, precise characterization @ LHC
 - QCD: dominant processes @ LHC (strong HERA input, proton structure...)

Key topics for discoveries in the next decades

Research for the structure of matter at the forefront
with exceptional pre-requisites

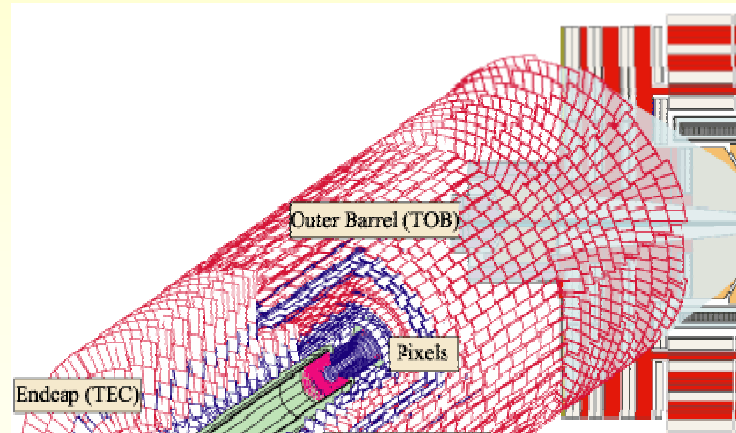
→ pole position for competent input and leadership

Challenges



New generation of Experiments:

- extremely big (height & weight)
- extremely complex
eg. tracker alignment with 50.000 free parameters
- extremely large data volumes



New generation of collaborations:

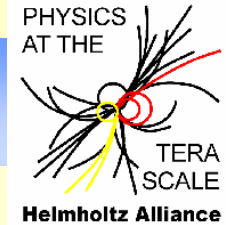
- ~2300 authors, ~180 institutes, ~38 countries
- position of Germany & DESY as national laboratory in the international competitive environment
→ high performance for visibility & leadership

German contributions:

- CERN: Germany main funding contributor (~20%??),
- ATLAS (FSP101): 18 institutes, 11% of funding, 2nd largest group
- CMS (FSP102): 6 institutes, 6% of funding, 4th largest group

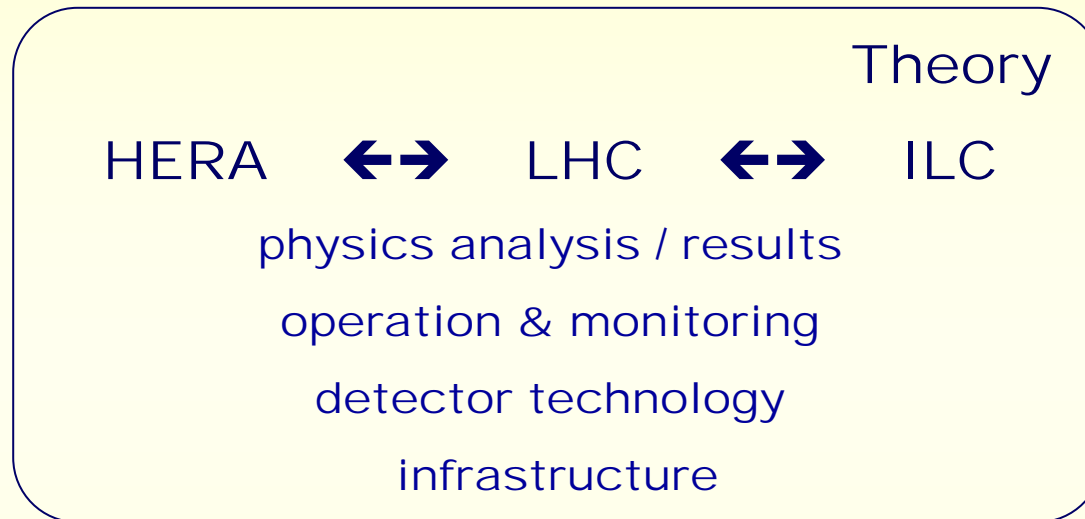


Strategy



Capitalize on distinguished resources and unique competence @ DESY

→ maximize input to the experiment with efficiently dedicated commitments



Close collaboration (even regular daily contacts) with the German Universities, esp. in the framework of the Terascale Alliance

→ mutual benefit for high performance

→ high visibility and leadership in international competition for Germany and DESY as national laboratory



Proposed LHC Program

- Physics
input with special expertise from HERA well placed & received
→ enhance performance in Germany with common efforts:
Analysis Center → excellent input to analyses & strategies
- Coordination tasks:
extraordinary high share → high visibility → try to keep level
- Trigger, data acquisition, monitoring
exploit & maintain special DESY experience from HERA → adapt to
growing demands with incoming data, take fair share of duties
- Computing and software
input with special expertise and infrastructure well placed &
received → develop & contribute key tools for effective computing
- Commissioning & detectors
presently in specialized areas on limited level → additional
participation in sLHC upgrade projects with German groups

Goal:

Sustain the accomplished position in the new role from remote
Master the transition from preparation to operation and streaming
→ need to deepen and enlarge effort in the activity areas



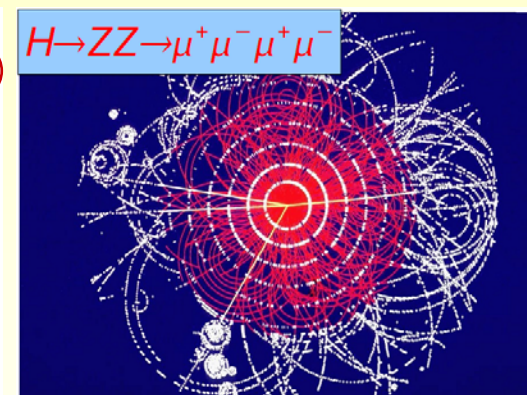
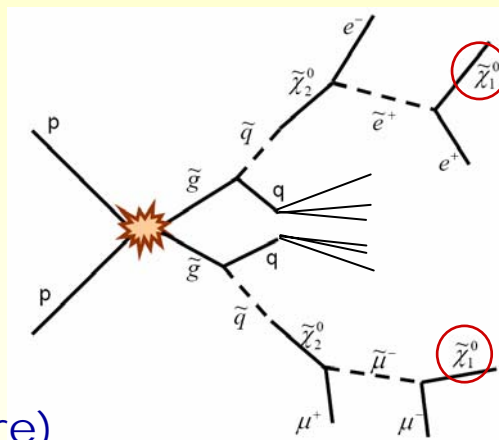
Physics

Searches for new physics:

- SUSY
- Higgs

Standard Model Physics:

- top-quark properties
- QCD (HERA: proton structure)



Basic ingredient for the education & training for tomorrow's physicists.
Experienced seniors in close collaboration with German Universities
→ achieve efficiently strong input within international working groups.
Specially interesting and covered by Young Investigator Groups (5 groups)

Goal:

- Rigorously pursue data analyses on intensified and distinguished level
→ timely publication of results / discoveries
- Special time for mutual stimulation between experiment and theory
→ crucial contributions to the gain of knowledge possible
- Strong cornerstone for educating students



Trigger

Incredible high collision rate → filter is crucial

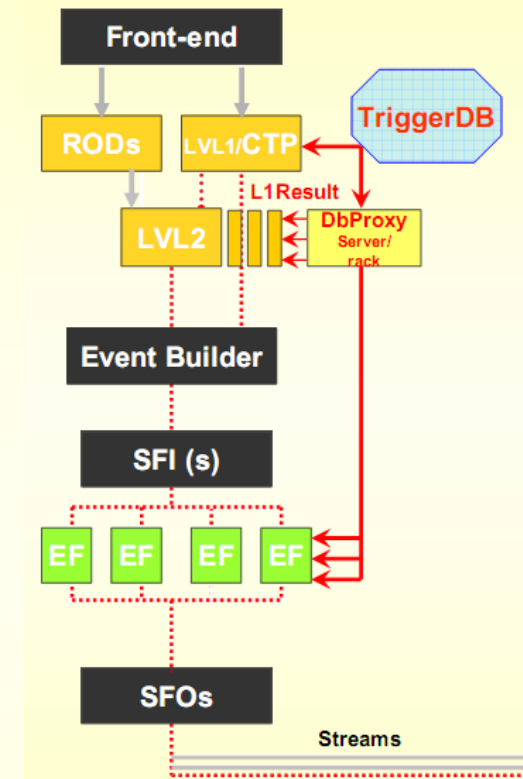
40 MHz beam bunch crossing rate with up to 20 interactions → down to ~100 Hz logging rate
→ different filter levels

Responsibilities & contributions in various areas:

- trigger configuration and steering, archiving
- monitoring on Tier-0 and CERN Analysis Facility
- supervisor for event filter farm (~2000 PC's)
- clever trigger algorithms

Goals:

- Adapt to changing boundary conditions: LHC machine parameters, rapidly increasing data rate, evolution of physics program
- Operation and maintenance in parallel to improvement and partially new development
- Development of new & efficient trigger algorithms
- Develop direct connection of trigger to hardware (eg. track trigger)



Monitoring

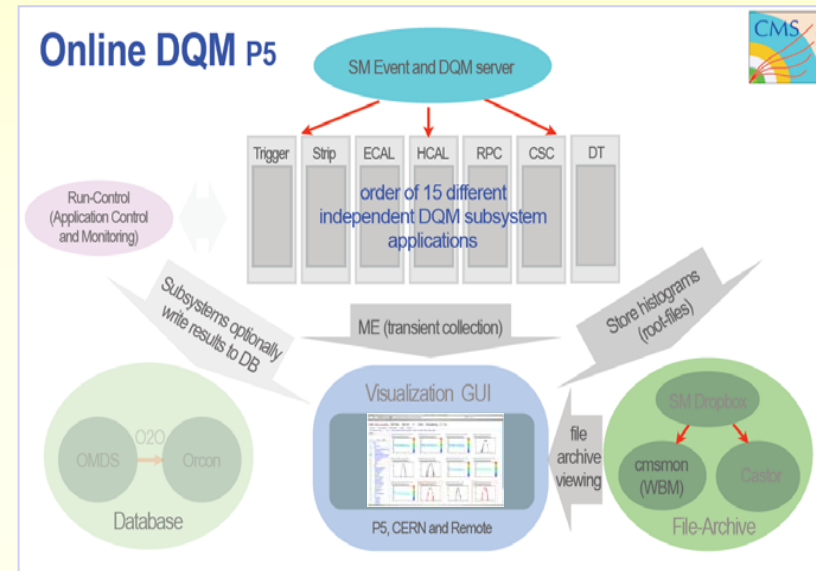
Activities highly visible in daily operation of the experiment

Data Quality Monitoring:

- crucial to ensure excellent data
- framework developed & successful

Goal: further expansion from

- online to offline and archive,
- Tier-0 → Tier-1 & Tier-2,
- data to MC samples,
- detector to physics quantities



Calibration & alignment:

- precise calibration and alignment of tracker on micron-level pivotal for prime analysis results
- algorithms & framework proven to work within short time constrain

Goal:

- develop new strategies & algorithms for large data samples
- in parallel: phase transition from preparation to streaming with high reliability



Computing

Essential contributions to the realization of the complicated computing models.

Tier-2:

- major hardware investment
- operation
- responsibility for the distribution of software and data for more than 50 centers within < 24h.
- federated Tier-2 center from RWTH Aachen & DESY

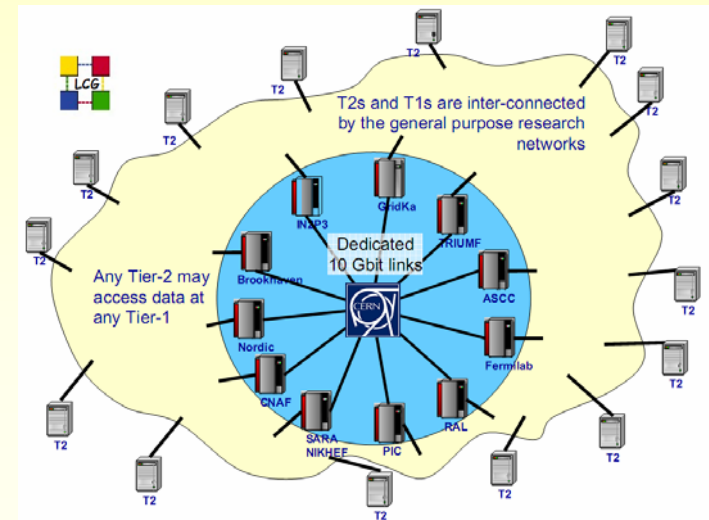
Further: define data formats, MC event generators, fast shower simulation

National Analysis Facility:

- important tool to speed up data analysis for German groups
- installation of latest software, user support, accounting ...

Goals:

- Evolving Tier-2 centers, processing & re-processing in parallel
 - extensive usage of NAF → strong user support
 - development of special tools for effective computing
- significant manpower commitment for computing



Remote Center @ DESY

One cornerstone in the strategy of DESY to play a key role from remote

Operations room :
~ 30 m²

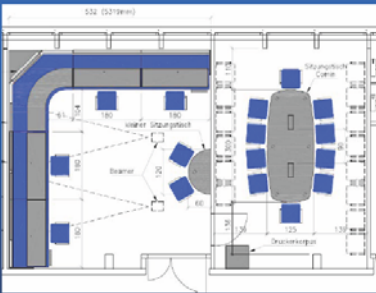
4 workplaces with
2 PCs
4 Screens

audio/video system

2 beamer

Room was ready for installation on September 29
Oct. 8 – 10 installation of furniture, network infrastructure, PCs, Screens
Since Oct. 13 shift operation in new CMS Center (1b/343)

10/29/2008
G. Eckerlin



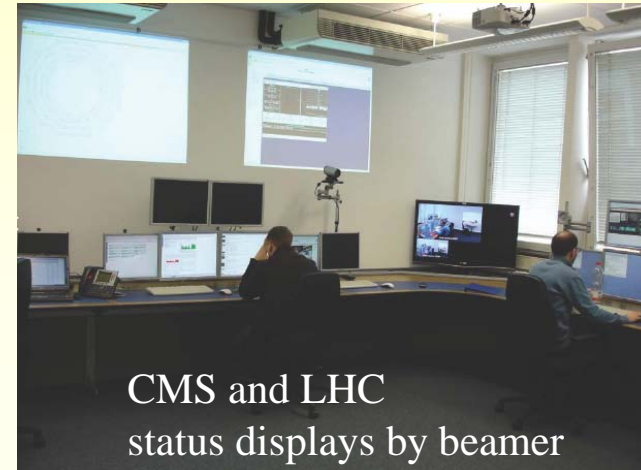
Meeting room :
~ 23 m²

10/12 seats

audio/video

1 beamer

1 printer (not yet)




CMS Centres Worldwide

Major Sites are fully operational for monitoring, operations, shifts ...

- CMS Centre @ CERN
- LHC @ FNAL
- CMS Centre @ DESY

Modest Centres at CMS institutes for monitoring, analysis, students, outreach, video-conferencing ...

- CMS Centre @ Adana
- CMS Centre @ Dubna
- CMS Centre @ Mumbai
- CMS Centre @ New Zealand
- CMS Centre @ Pisa
- CMS Centre @ Rio
- CMS Centre @ Sao Paulo ...



DESY is one of the three major site worldwide fully operational !

Fulfill service duties with shifts for:

- Data Quality Monitoring
- Calibration & Alignment Monitoring
- Data Acquisition
- Computing (Tier-1, Tier-2, MC production)

Daily meeting point for run organization

Goals:

- enlarge to LHC center
- use by outside institutes



Contributions to Detectors

Presently only limited commitment in dedicated areas

ATLAS Participations:

- construct, commission & analyze data from the ALFA detectors
→ luminosity measurement → will last throughout the funding period
- Pixel: participation in commissioning & simulation, trigger
→ experience for future contribution for pixel upgrade for sLHC

CMS Participations:

- CASTOR calorimeter project (funded with HRJRG*)
→ determination of underlying event and multiple interaction, strong overlap with HERA for small-x (for low luminosity only)
- Beam Condition Monitor: employ diamond sensors from ILC-FCAL
→ protect tracker against too high beam background,
in future improve performance and R&D for radiation hard sensors

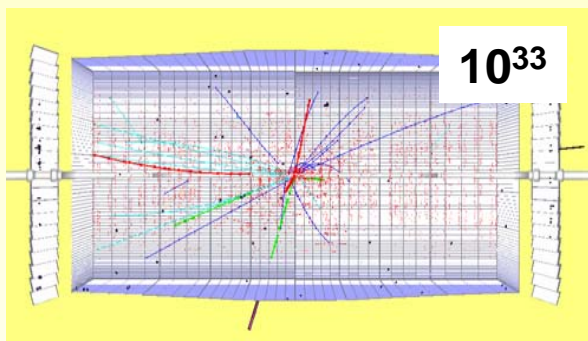
Plans:

- Strong contribution to the upgrade of ATLAS Pixel & CMS Tracker
- Otherwise only limited projects: realization of ATLAS-ALFA, improvement of CMS-BCM, CMS-MTT: combine ILC-HCAL technology with muon track tag & CMS-HCAL upgrade



* Helmholtz-Russia-Joint-Research Group

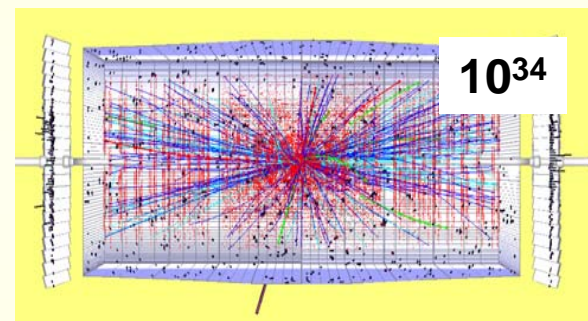
Tracker @ sLHC



Already clear: some important aspects of new physics cannot be addressed with the present LHC (too rare processes ...)

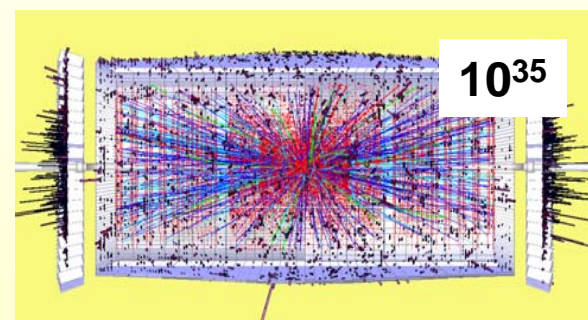
→ Upgrade in luminosity (~interactions) and possibly also in energy planned.

German groups made major contributions to the present trackers and plan for a strong participation in the tracker upgrade.



DESY plans to join and give strong support:

- Reduction of non-detector material
→ system integration aspects in powering schemes, cooling, optical data transmission, mechanical support → special engineering
- Sensor material and design (radiation hardness, occupancy)
- Simulation studies for design optimization in respect of physics, occupancy, alignment, tracking algorithm improvement



With special expertise in engineering and common developments
DESY is well suited to tackle these aspects in close collaboration
with and giving support to the German institutes



Milestones

With these assumptions the expected results and milestones can be summarised as:

- By 2010 stable operation of the LHC and the detectors at luminosities of a few times $10^{33} \text{ cm}^{-2}\text{s}^{-1}$. This will allow for detector calibration and alignment using Standard Model processes and to obtain first estimates of multi-parton interactions and the underlying event. Also, it is expected to have first indications on answers to fundamental questions.
- By 2011 more precise measurements of Standard Model and new physics processes may start. After proof of principle of detector technologies projects for LHC detector upgrades will be determined.
- In 2012 the nominal LHC luminosity $10^{34} \text{ cm}^{-2}\text{s}^{-1}$ should be reached. It is expected to obtain an initial picture of the Terascale physics (Higgs, SUSY) allowing to consolidate the global particle physics strategy and to decide on the future direction and projects concerning the upgrade of the LHC and a future electron positron collider.
- In the second half of the funding period, 2012-2014, LHC physics analyses will be continued and improved. In addition, production of detector replacements will take place and R&D for detector upgrades will be ongoing, with construction starting towards the end of the funding period.



Resources

Graph with LHC topic **costs**

Graph with LHC topic **FTE**

Graph with LHC topic **investment**

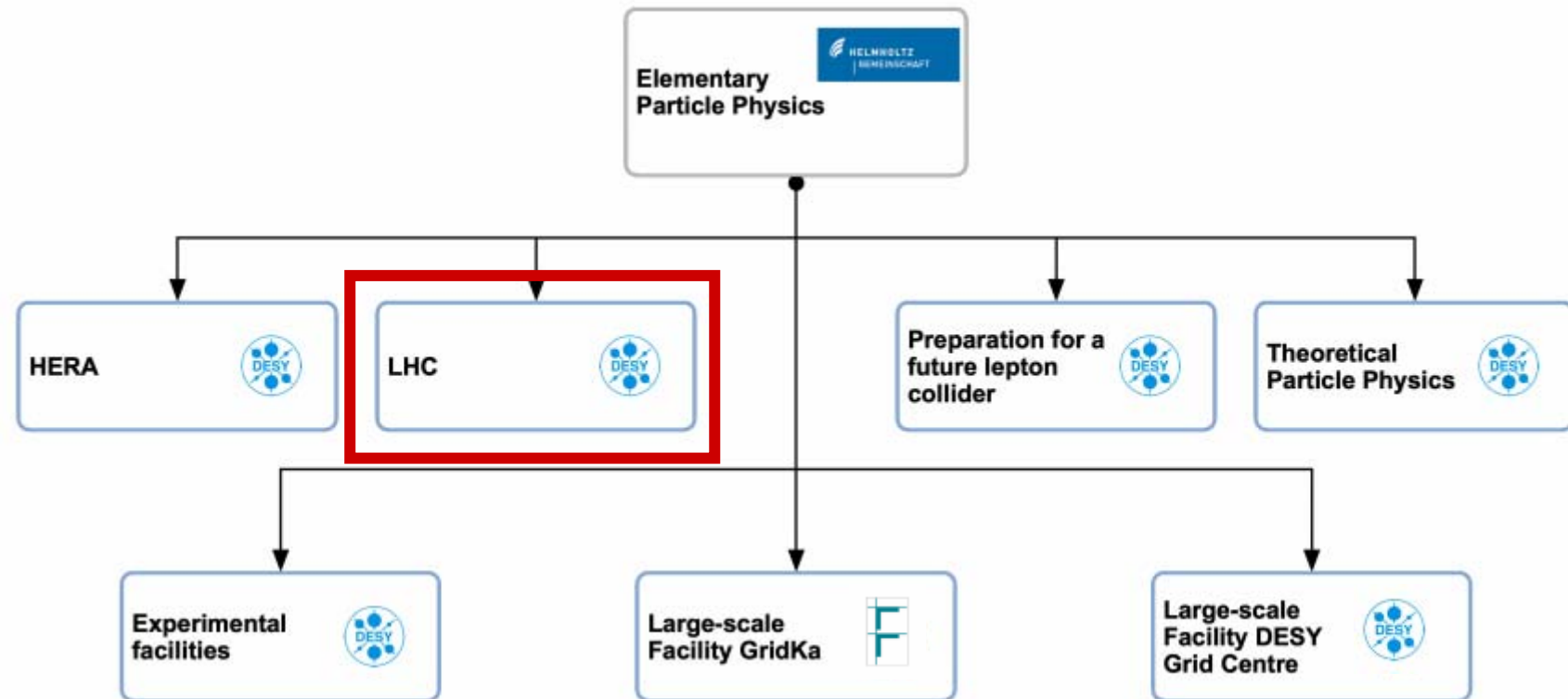
Within this program moderate increase compared to the rapid growing demands due to start of data taking and evolving analyses

Strive for the bonus award → R&D for sLHC tracking

Capital investment project planned: participation in the construction of sLHC tracking devices: ATLAS pixel, CMS tracker (strixel)



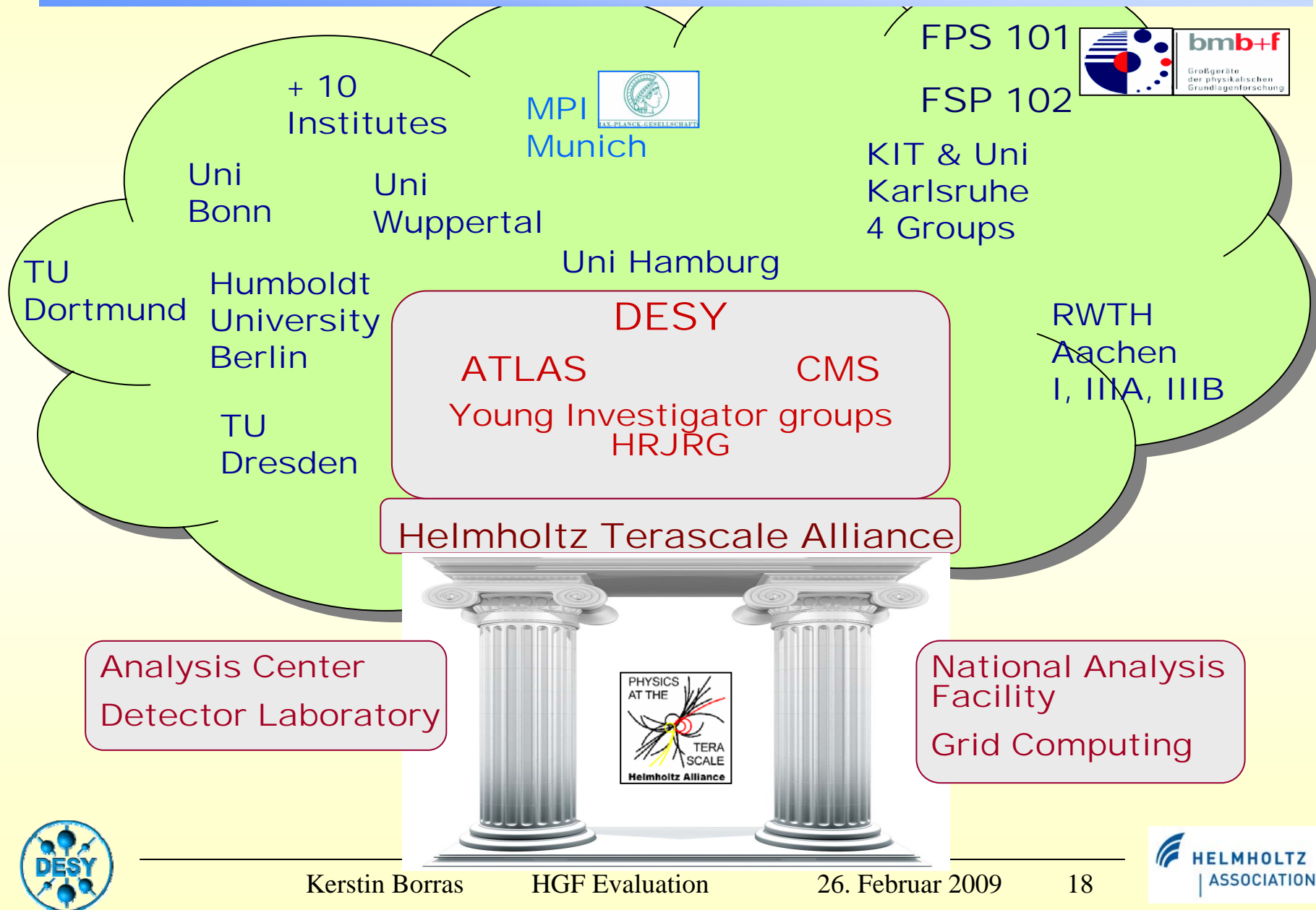
Networking within the program



- ➔ Vivid communication between the program topics
- ➔ Efficient use of resources and
- ➔ maximum exploitation of experience for immediate transfer to the other projects.



Net-working with German Groups



DESY's Role and Mission

With the outlined scientific activities and goals DESY's role as the central laboratory for particle physics in Germany will be ensured. Even without an accelerator installation on site a research laboratory has an important role to play. Due to the long years of HERA operation the DESY staff is especially experienced in detector operation, data processing and physics analysis. As compared to universities research laboratories like DESY are characterised by their large fraction of permanent staff without teaching duties, being available for long-term service tasks, coordination and project management. Such tasks are difficult to fulfil for university groups. DESY offers special infrastructure and knowledge that was built up during HERA running in areas like computing or test beams.

In closely cooperating with the German universities and institutes DESY will take a fair share in the service tasks and upgrade activities, providing infrastructure and engineering, usually not easily available outside research laboratories and profound competence in physics data analysis. Education and training for young scientists starting with the level of diploma students up to young investigator groups is a pronounced goal embedded in all activity areas with hands-on thesis work and specialised topical workshop meetings.

This proposed program is going along with the national and international strategy for particle physics.

It ensures high visibility of German groups in reward of the high German investments & opens the possibility to participate and even take up leading roles for discoveries in the next decade.

The LHC program is the key element to maintain an attractive in-house particle physics program for the next funding period and beyond



BACKUP



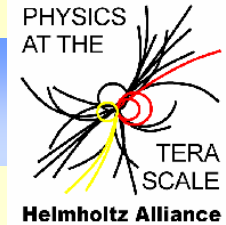
Coordination Responsibilities

CMS

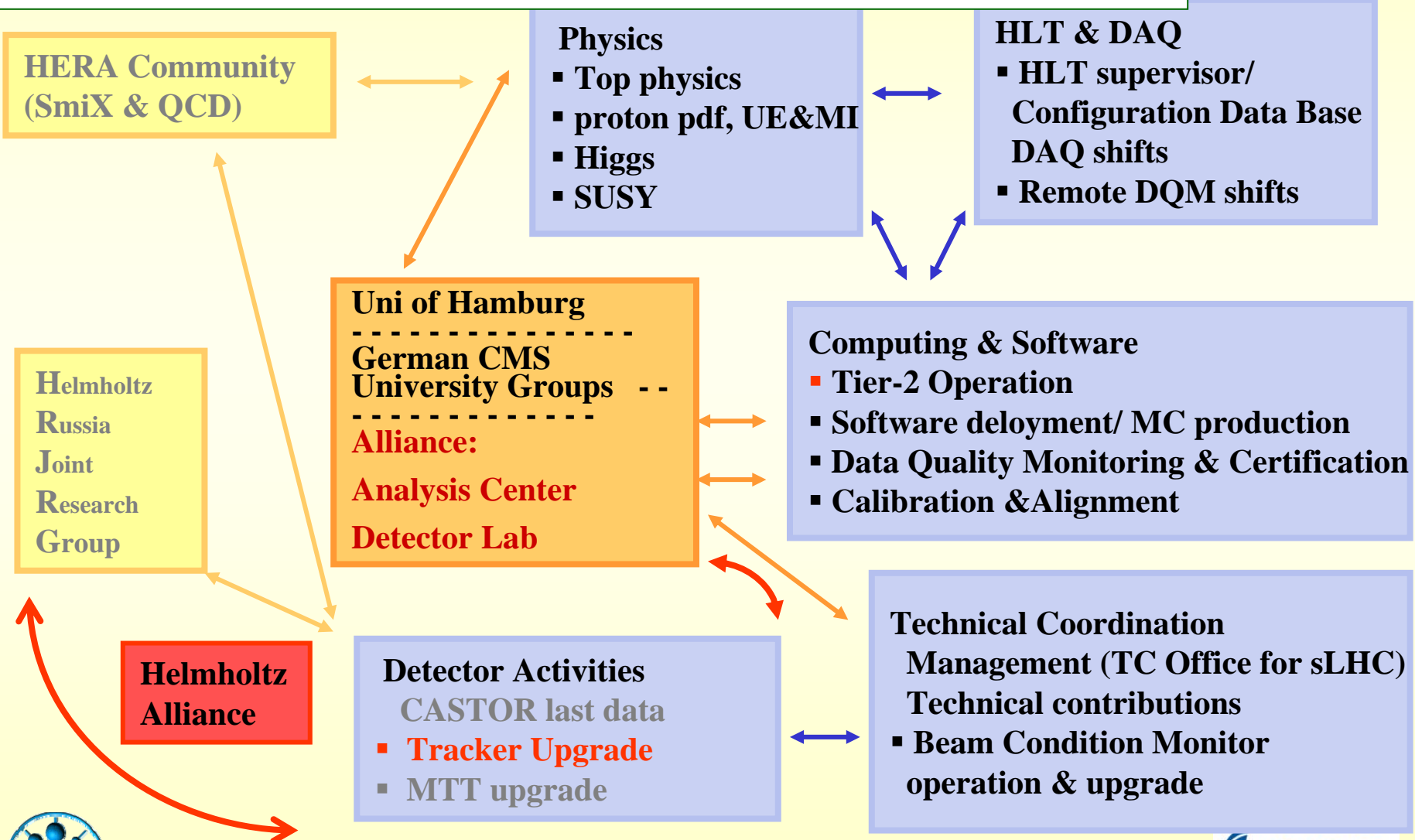
ATLAS



Net-working with German Groups



So ähnlich, muss noch angepasst werden, Theorie, ILC ...



Net-working with German Groups

