Proposal for a HELMHOLTZ GEMEINSCHAFT Alliance

Physics at the Terascale

Network
of complementary excellence
between

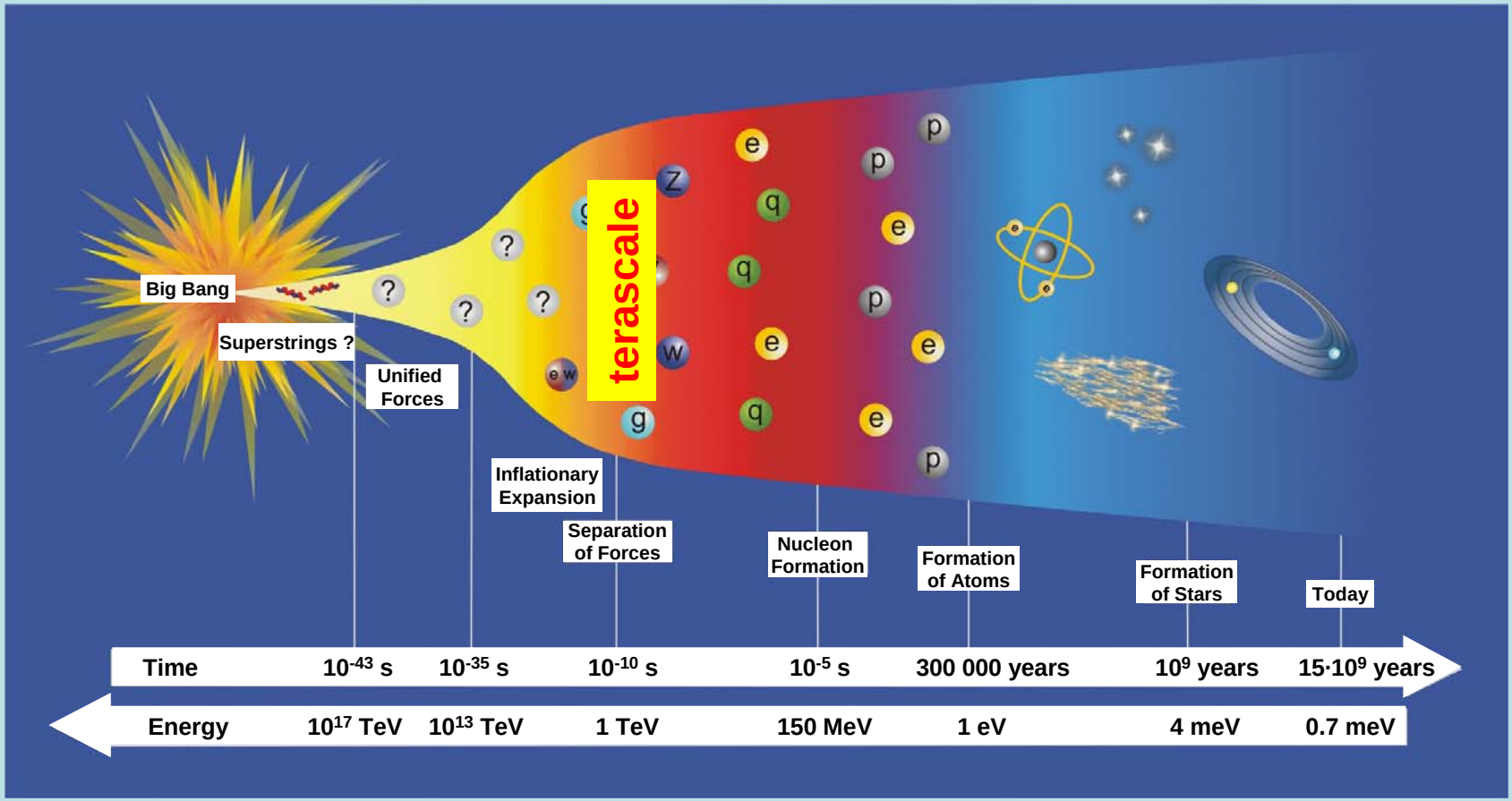
2 Helmholtz Centres
17 Universities
1 Max Planck Institute

Present today:

Univ	Desch, Herten, Krämer, Mättig, Meier, Quadt, Zeppenfeld
DESY	Behnke, Heuer, Mnich, Wagner
FZK	Heiss

Vision

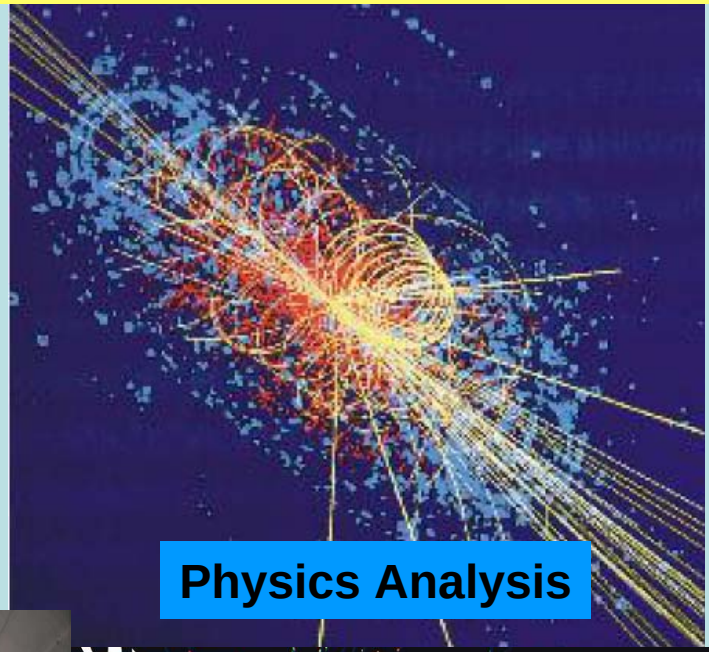
- **Revolutionary advances in understanding the microcosm**
- **Connect microcosm with early Universe**



Particle Physics at the Energy Frontier with highest collision energies ever will change our view of the universe

Key Elements

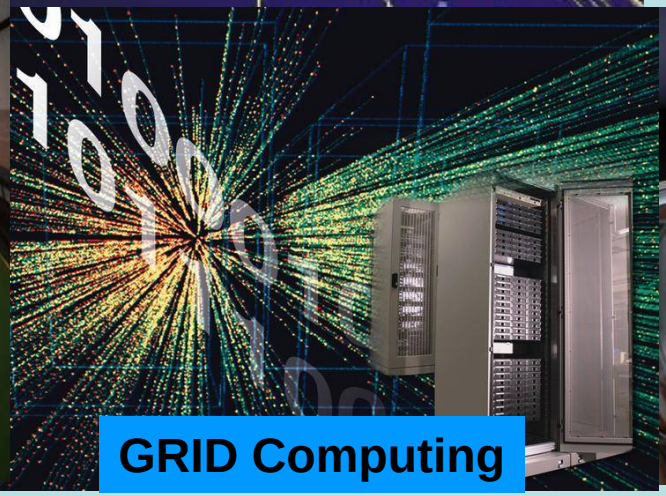
Particle Physics at the Energy Frontier



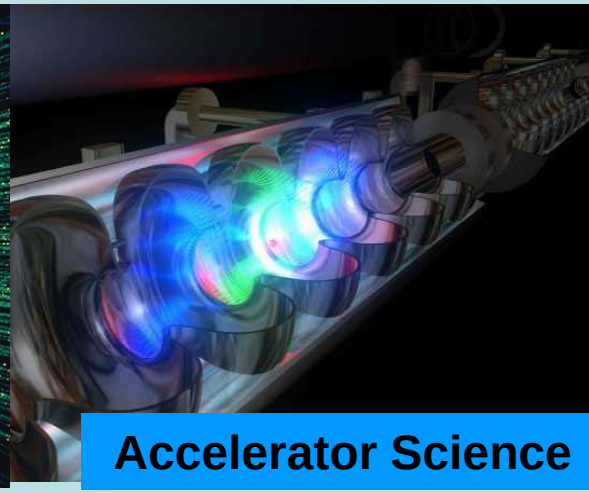
Physics Analysis

Instrumentation at the Technology Frontier

Detector Development



GRID Computing



Accelerator Science

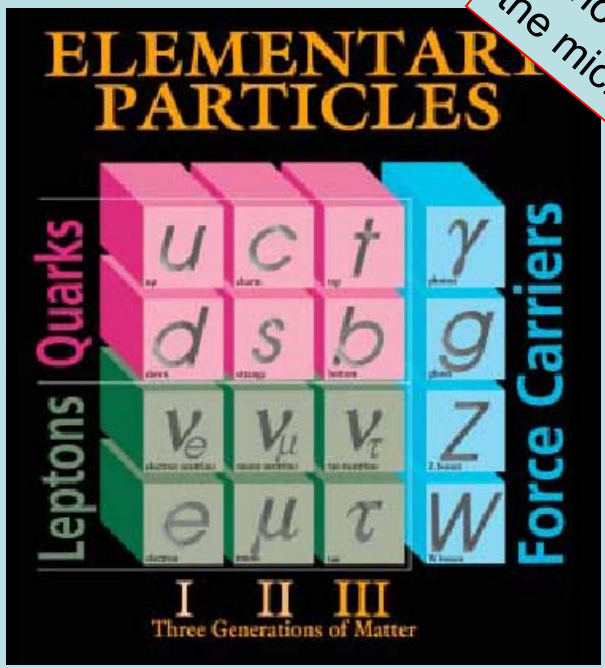
Particle Physics at the Energy Frontier

Progress in theory and experiment over the past decades

Standard Model of Particle Physics

- Matter particles: Quarks and Leptons
- Force carriers: Gauge Bosons

Excellent theory tested down to 10^{-18} m at (sub) per mille level



Periodic system of the microcosm

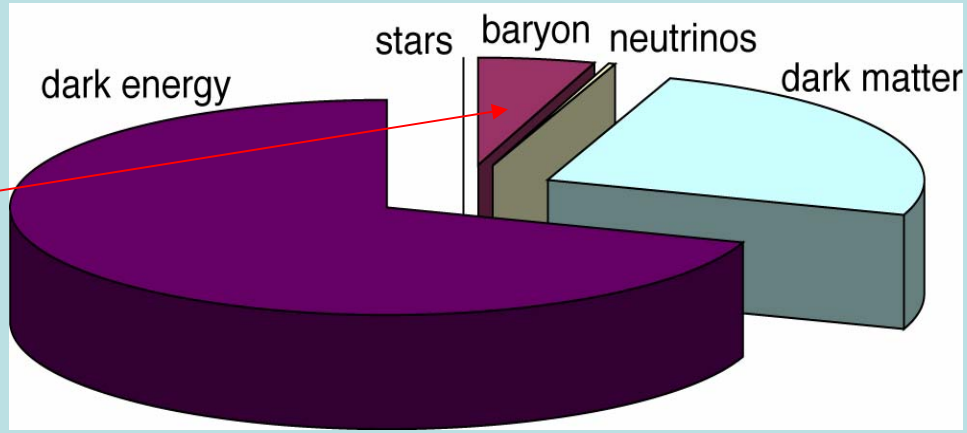
However:

- Missing corner stone: Higgs-Boson
- Many open questions

→ to be addressed at the Terascale
close collaboration particle physics ↔ astro(particle) physics

Particle Physics at the Energy Frontier

Standard Model valid only for
about 5% of the universe



Experimental and theoretical evidence for new physics at scale of one TeV

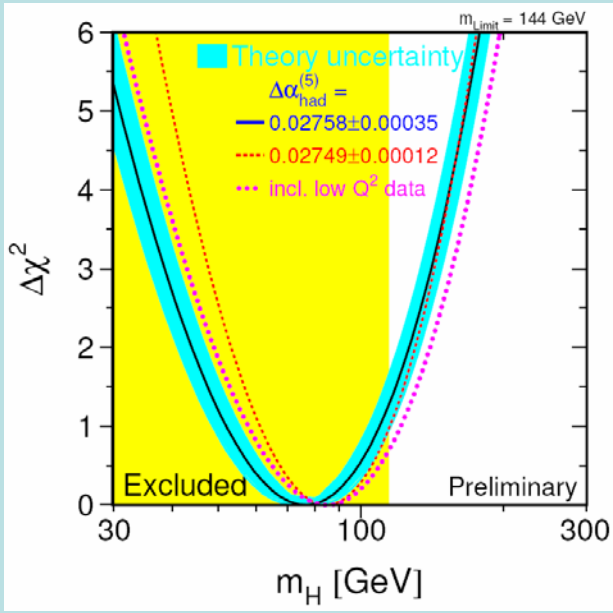
Mystery of Dark Matter

- What is the universe made of?
- Particles produced copiously at the big bang?
- Supersymmetry provides a candidate
  for Dark Matter to be discovered at the Terascale

Origin of Mass and Supersymmetry

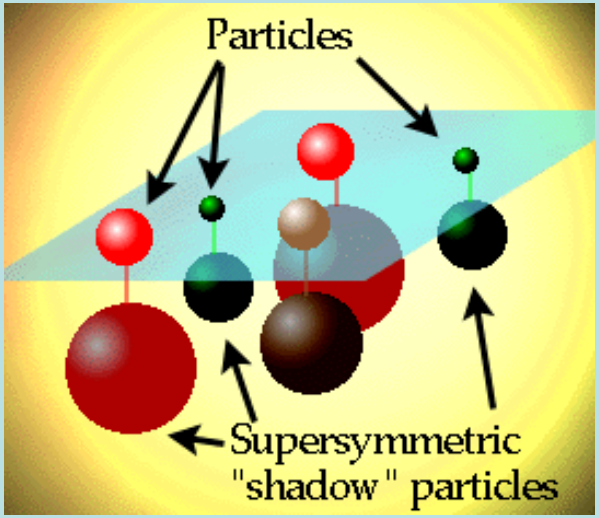
Higgs particle:
- What is the origin of mass?
- Do fundamental particles acquire their mass through the Higgs mechanism?
- Is space filled with an omnipresent energy field?

- If so it can be studied at the Terascale
- If not new phenomena must appear



Supersymmetry:
- Symmetry between forces and matter?
- Mirror world of new supersymmetric particles? New shadow world like antimatter?
- Supersymmetry as key to resolve clash between Einstein's general relativity and quantum mechanics, i.e. the worlds of large and small scales?

- Experiments at the Terascale will provide answers

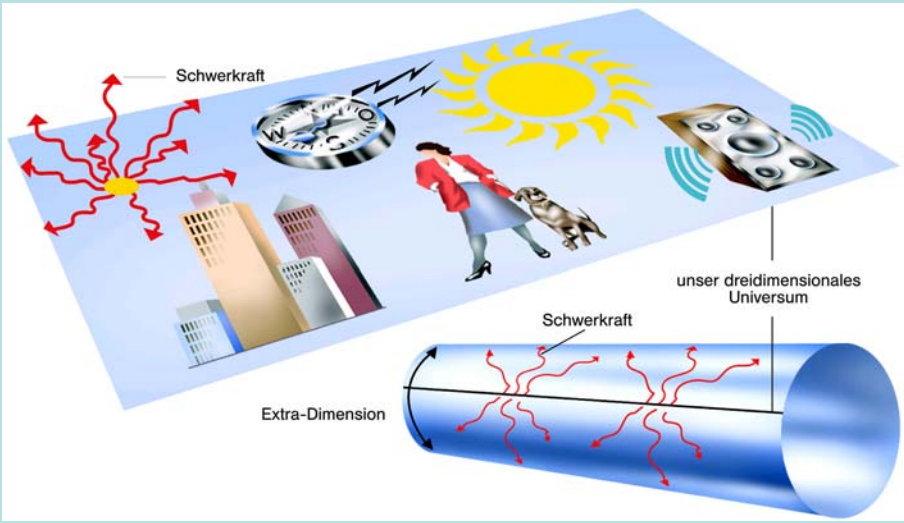


Extra Dimensions and Grand Unification

Extra Space Dimensions:

- Mystery of vastly different scales of electroweak force (0.1 TeV) and gravity (10^{16} TeV)
- Gravity scale lowered through extra spatial dimensions to 1 TeV? Curled up on small distances?

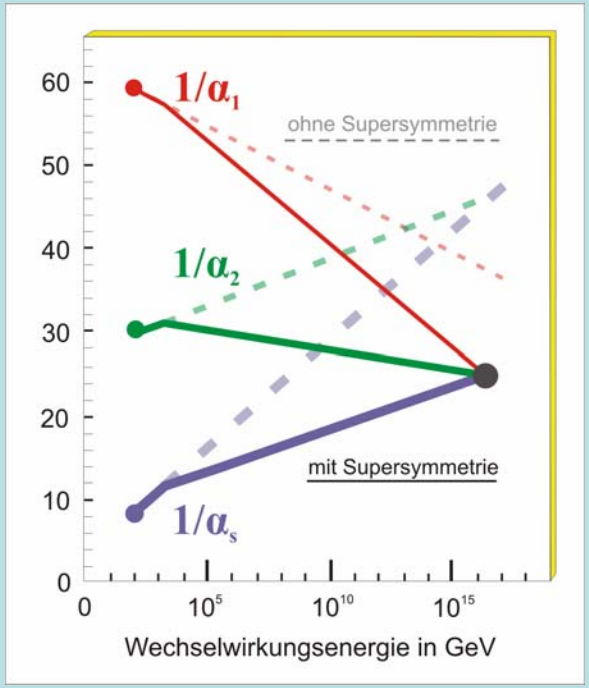
- Particles living in extra dimensions could be detected at the Terascale



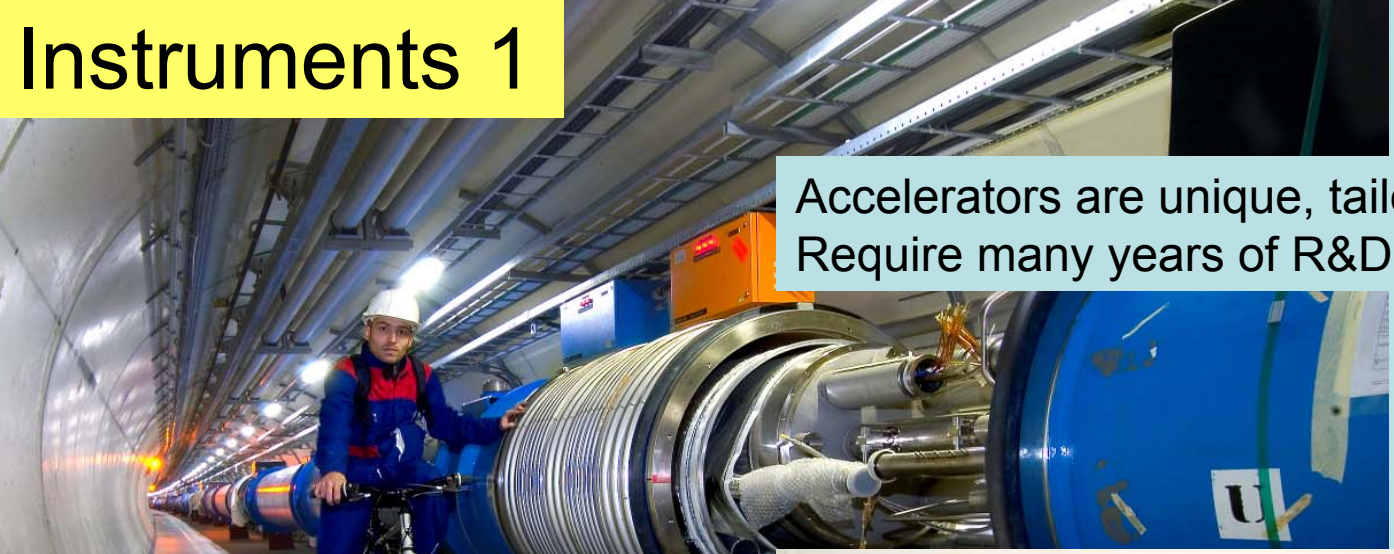
Grand Unification:

- Why are there three different fundamental interactions?
- one truly fundamental interaction of universal strength?

- Insight to be gained at the Terascale



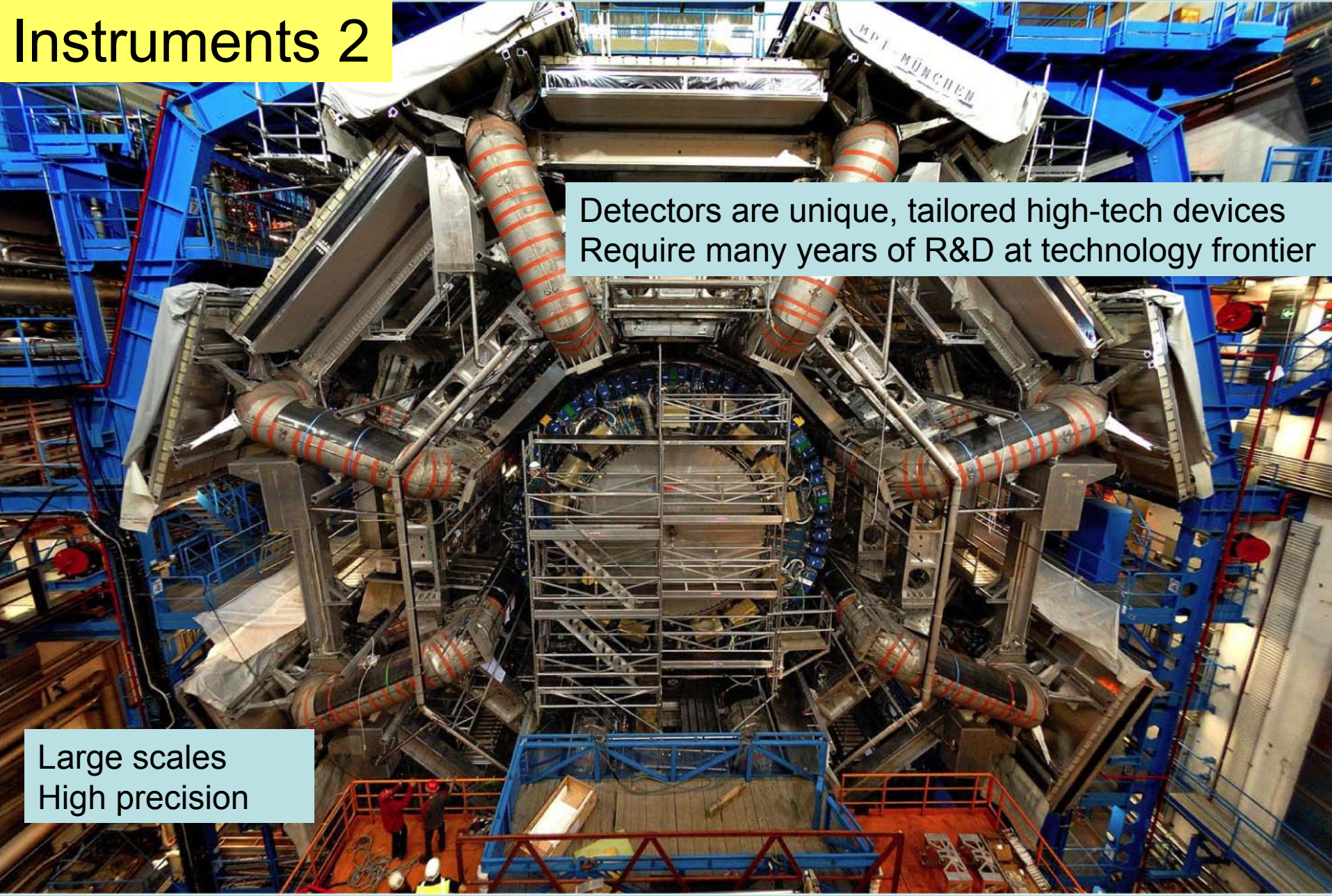
Instruments 1



Accelerators are unique, tailored high-tech devices
Require many years of R&D at technology frontier

High energies
High collision rates

Instruments 2



Detectors are unique, tailored high-tech devices
Require many years of R&D at technology frontier

Large scales
High precision

HEP in Germany - past and present

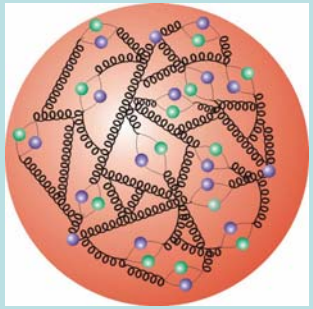
Particle Physics: international with national contributions in large collaborations
Particle Physics projects: long-term (~ 20 years)

Strong contributions from German Universities, MPG and DESY
to forefront experiments and physics at CERN and DESY

Examples from colliders at DESY:

Evidence for Matter-Antimatter transformation at DORIS
Discovery of the gluon (carrier of the strong force) at PETRA
Detailed Structure of the Proton at HERA

Excellent expertise in
accelerator science at DESY

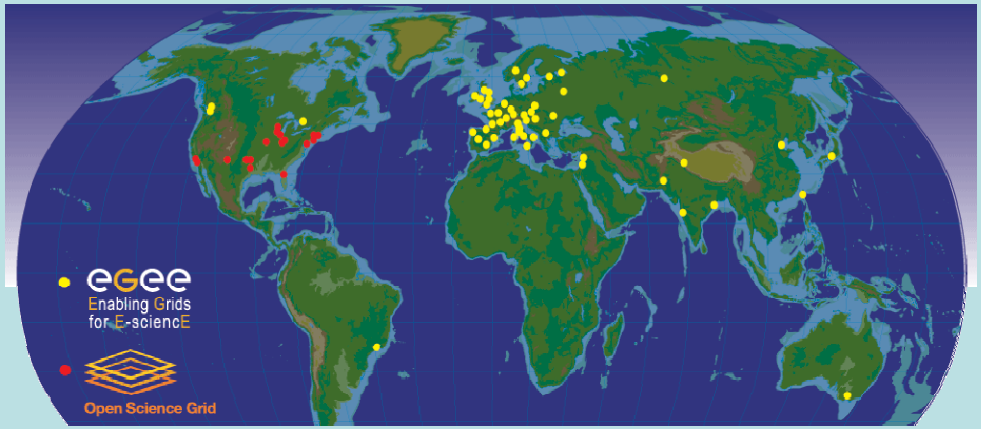


Excellent expertise in computing at DESY, FZK, Universities

HEP in Germany – future challenges

- end of HERA:
  turning point for HEP in Germany

- particle physics at the energy frontier
  is becoming global in all its areas



stay competitive with high impact
→ restructuring demands for HEP in D:
Join all forces of complementary excellence in all areas (analysis, computing, detector, accelerator) in a long-lasting structure and strong sustained infrastructures to improve on

- support physics analysis (tools and techniques)
- coordination of infrastructures with long term sustainability
- coordination of manpower in particular for young physicists
- coordination of novel R&D projects
- focussed support for GRID developments
- support of accelerator science at the universities

The Alliance: nationwide coherence in HEP

Universities:

- special infrastructure
- specialised expertise
- scientific diversity
- young blood

Helmholtz Centres:

- large infrastructure
- general engineering
- strategic research
- longterm support

Combine complementary strengths: share infrastructure + expertise

Establish sustainable network of 17 universities, DESY, FZK

German Particle Physics @ Terascale:

a coherent nationwide organisation of research

UNIQUE CHANCE TO RE-STRUCTURE GERMAN PARTICLE PHYSICS FOR TOMORROW'S CHALLENGES

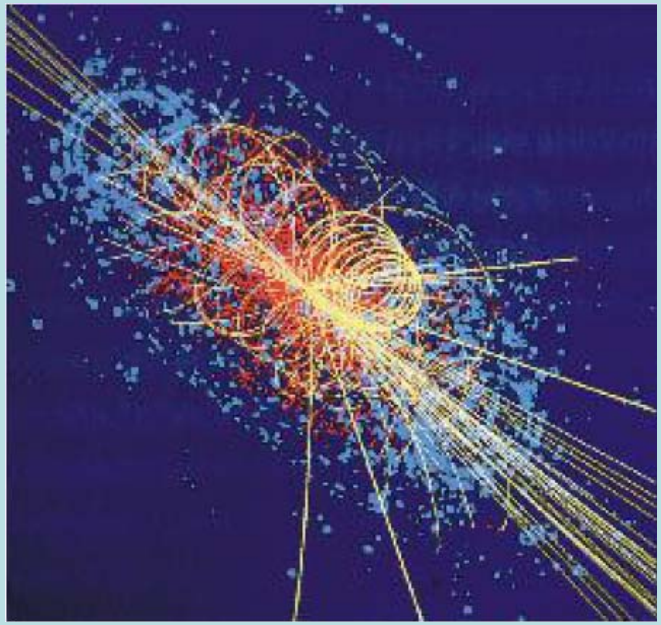
Physics at the Terascale

	Physics Analysis	Grid Computing	Detector Science	Accelerator Science
Scientific Goals	**Data Analysis** • Understanding LHC Detectors • Physics at the LHC • The path to the ILC	**Improved Grid** • Virtualization • Application-driven monitoring • Development of NAF tools	**ILC Detectors** • Vertex Detector • Tracking • Calorimetry • Forward Detectors	**Optimizing the ILC** • Acceleration Technology • Sources • Beam Dynamics
	Analysis Tools • Algorithms and Techniques • Simulation Tools	**Data Storage + Retrieval** • Mass storage • Data Access	**(s)LHC Detectors** • Vertex Detectors • Tracking • Trigger • Luminosity Monitor	
	Theory/Phenomenology • Monte Carlo Generators • Precise Predictions • New Models			
Work Packages	**Analysis Network** • Alliance Working Groups • Monte Carlo Group • Virtual Theory Institute	**Virtual Computing Centre** • Tier 2 • National Analysis Facility • High performance network	**Virtual Detector Lab** • VLSI & Electronics • Support Sensor Design & Characterization • Detectors Systems Support	**Advancing Accelerator Science**
	Analysis Centre at DESY	**R&D on Grid Tools:** • Mass storage • Collaborative & Interactive tools • User friendliness	**R&D Projects**	**R&D Projects**
	Training and Exchange	**Grid Training**		

Backbone Activities

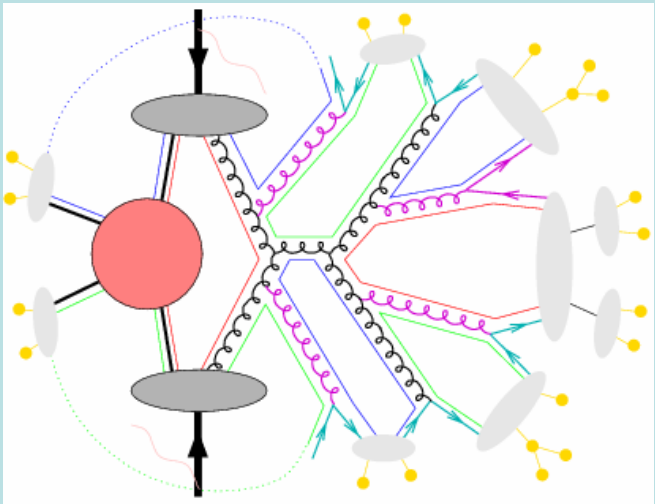
Management – Young Investigator Groups - Fellowships – Equal Opportunities – Outreach – Interim Professorships

Physics Analysis 1



Preparation for future challenges :

- huge international collaborations
  LHC: 2000 scientists from 150 institutes
- higher data rates
- new physics
- more complex signatures
  identify 1 event in 10^9
- extreme precision (ILC)

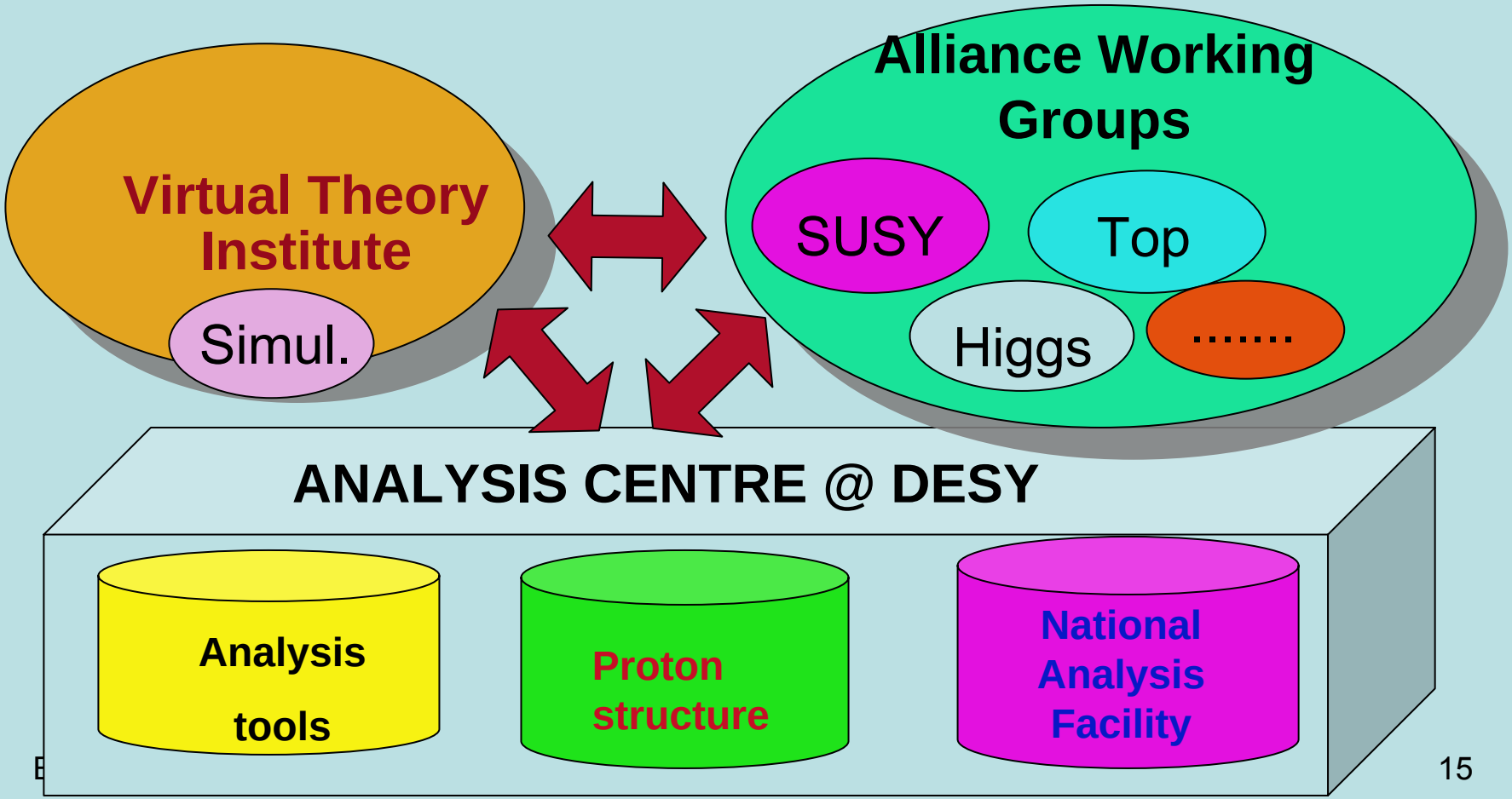


Examples for analysis tools:

- complex pattern recognition
- novel statistical methods
- complicated algebraic methods for theory
- Monte Carlo simulation

Physics Analysis 2

- Lasting new collaborative structures for visible German impact on LHC and ILC physics
- Cooperation theorists - experimentalists

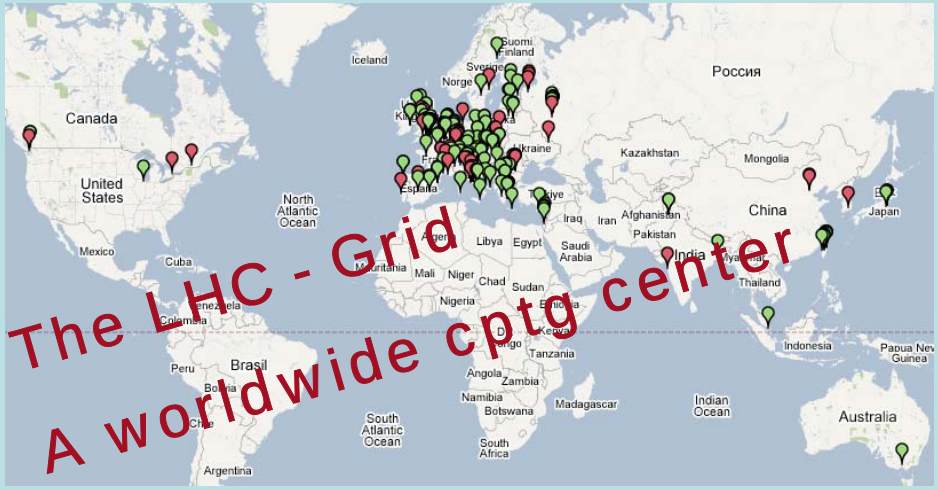


Grid Computing 1

A New Computing Paradigm

The LHC data challenge:

- **7 Petabyte of data /year**
- **100000s of jobs/day**
- **40000 CPUs**
- **6000 users**
- **all continents**



Start-up of LHC:

endurance test of unprecedented dimensions

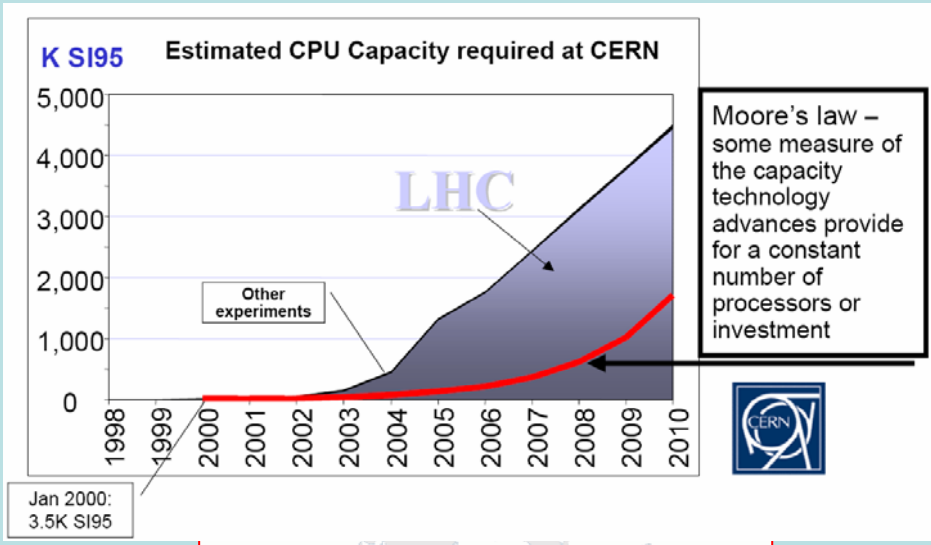
Universities + FZ Karlsruhe + DESY:
Build a network of competence in Germany

Strengthen & expand IT expertise by Grid R&D

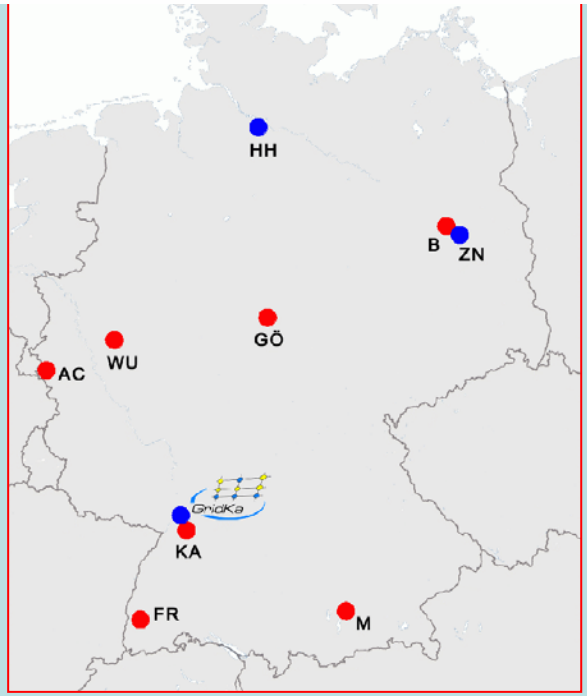
Grid Computing 2

Computing for the Terascale

Fast and easy data access
+ CPU resources
==> precondition for
competitive data analysis

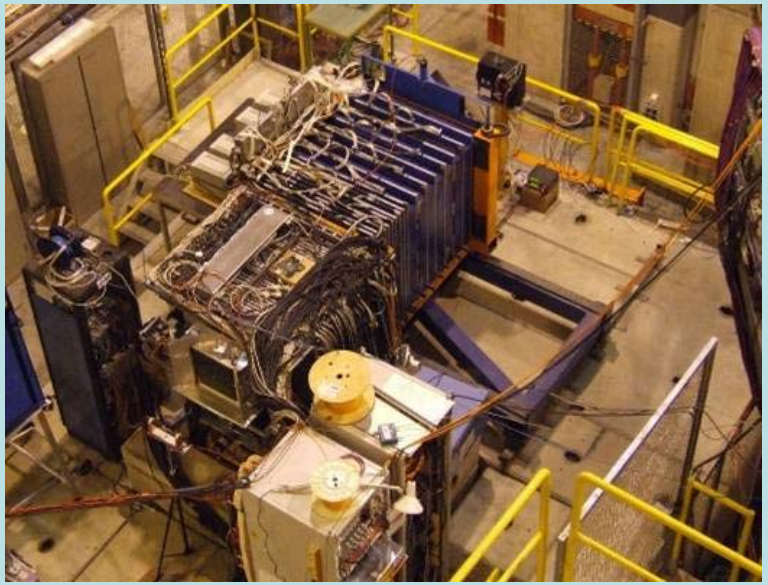


- **Develop a distributed National Analysis Facility**
- **High bandwidth connection between all Alliance partners**
- **Distributed resources to be part of the World - Wide Grid**



Detector Development 1

Detectors are unique, tailored high-tech devices
Require many years of R&D at the technology frontier
many years of continuous high performance operation



Challenges:

Excellent precision, granularity,
radiation resistance
for large detector sizes

Alliance

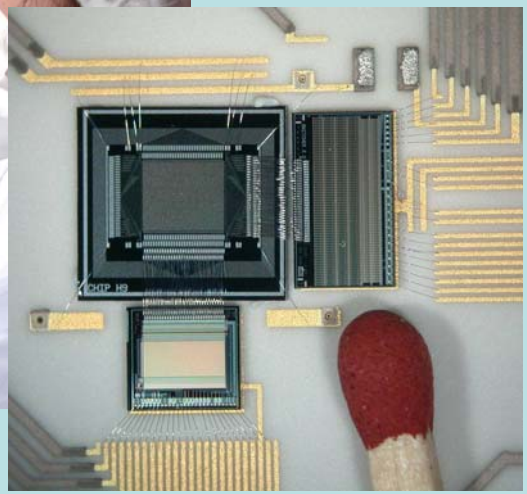
- invest in common key infrastructures ("virtual lab", expand existing laboratories in BN, HD + facilities at DESY, HH, KA)
- open these key infrastructures to all partners of the Alliance
- training in key technologies for graduate students, engineers and scientists
- coordinate future large scale R&D efforts (sLHC and ILC)

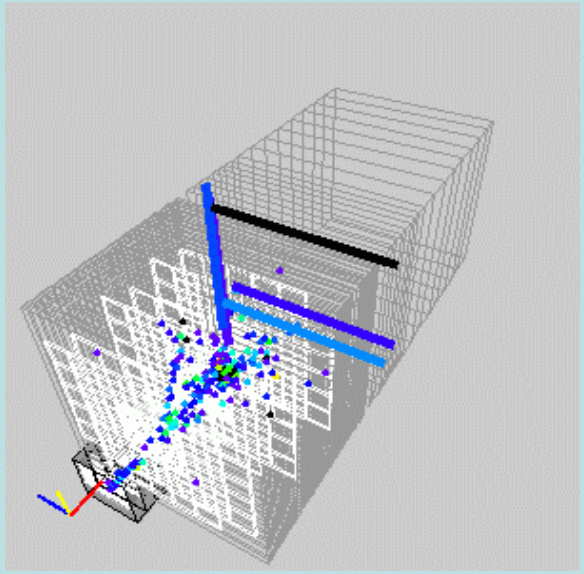
Detector Development 2

Major Infrastructures:

- VLSI chip design + microelectronics system development (BN, HD)
- Semiconductor sensor materials, design, characterization (HH, KA)
- Large scale detector systems, engineering, development, testbeams (DESY,AA,BN,FR)

  -- will be used for novel R&D projects (mainly 3rd party funded) towards LHC upgrade and towards ILC
  -- provide excellent training ground for students





Accelerator Science

DESY: Centre of excellence

- broaden scope of the accelerator science at the universities
- increase links between universities and DESY
- increase education in accelerator science at universities (model: UK)
  e.g. through support of lectures from DESY
- trigger a number of small R&D projects which open up novel directions,
  are interesting for students, and motivate more involvement in accelerator science
  (example: novel accelerator technologies, accelerator applications at the ILC)

Instruments

Emphasis: Sustainability

-Structural Elements:
National Analysis Facility, Theory network, virtual institutes, infrastructures

-Promotion of Young Researchers:
- Young Investigator Groups (tenure track)
- Fellowships (many tenure track)
  -- model UK, fairly large degree of freedom,
  build-in mobility important, high profile projects)
- Technical Physicist / Engineer (tenure)
- close cooperation with Graduate Schools
- training, special lectures

-Equal opportunity (new measures)

-Teaching buy-out

-Outreach

Promises for Tenure

example
Univ. Siegen

Die Universität Siegen wird für die Beteiligung an der Helmholtz-Allianz 2,0 FTEs für Wissenschaftler zur Verfügung stellen, wobei 2 halbe FTEs aus den Berufungszusagen von den Professoren Schumacher und Kilian eingebracht werden. Zusätzlich wird zunächst für die Dauer der Helmholtz Allianz eine FTE von der Universität Siegen zur Verfügung gestellt.

Es wird erwartet, dass aus der Helmholtz-Allianz Mittel in mindestens äquivalenter Höhe bereitgestellt werden.

Für den Fall, dass eine vollständig ausgestattete Nachwuchsgruppe aus Mitteln der Allianz
ät Siegen
Stelle aus
entisieren,
ewünschte

in total

21 promises for tenure positions
(from technicians to professorships)
more are coming

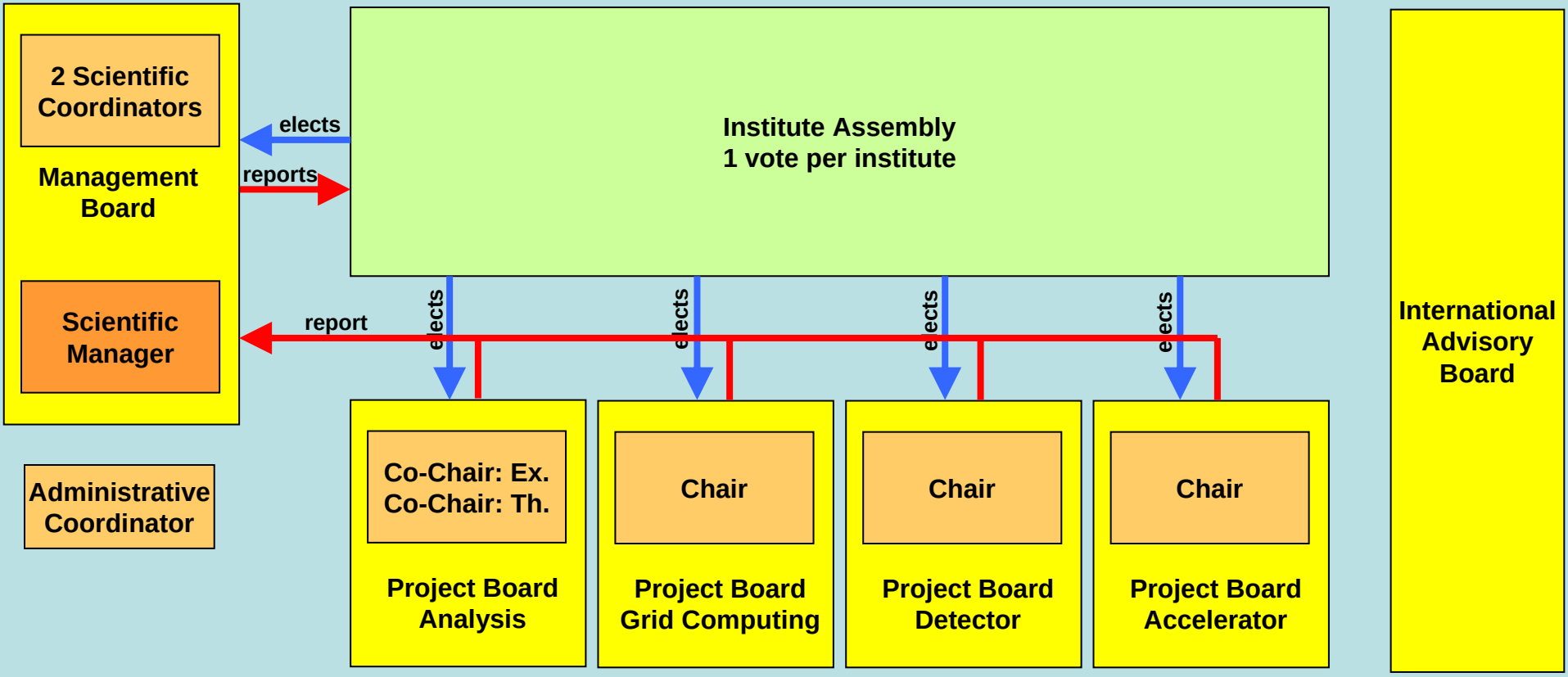
Alliance personnel: Helmholtz request 54 FTE
Institute contribution: 131 FTE
(average per year)

Die TU Dr
permanen
finanzierur
sichert die
maximal (1
Außerdem
Verfügung

Die Junior [illegible] gesetz nach erfolgreicher Zwischenevaluation auf 2 x 3 Jahre angelegt, und soll für 5 Jahre von der Helmholtz Allianz finanziert werden. Das 6.Jahr würde von der TU Dresden übernommen. Die Umsetzung der Tenure Track Option setzt eine erfolgreiche Abschlussevaluation voraus und besteht mindestens aus einer permanenten Wissenschaftlerstelle (W1 als Beamter oder E 13 TV-L Niveau). Bewerbungen auf ausgeschriebene Professuren innerhalb der TU Dresden sind nach der erfolgreichen Zwischenevaluation möglich, vorausgesetzt, der Bewerber hat nicht an der TU Dresden promoviert oder war vor seiner Einstellung mindestens 2 Jahre außerhalb der einstellenden Hochschule hauptberuflich wissenschaftlich tätig.

Univ. Dresden

Management



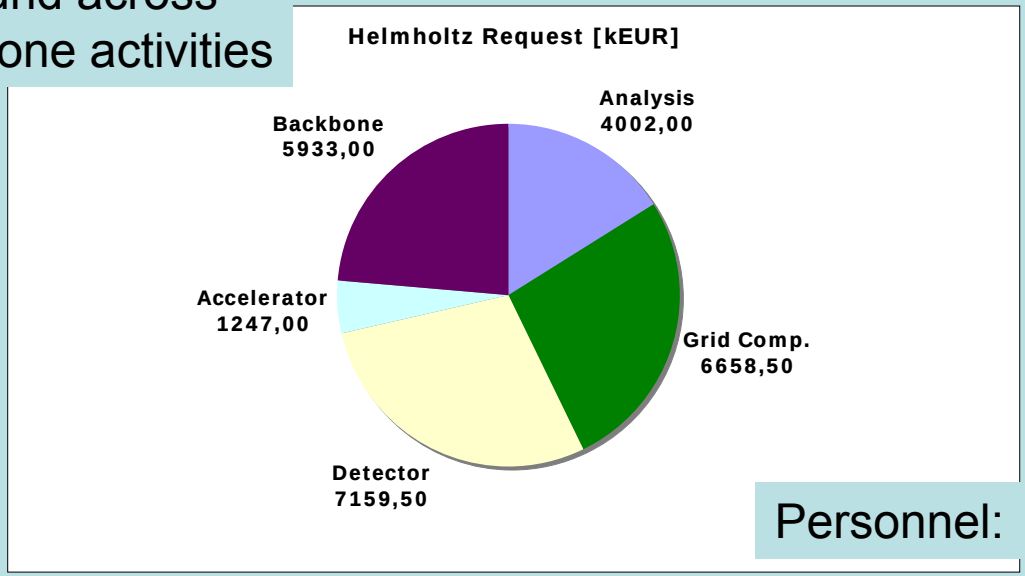
- structure modelled after large HEP collaborations and EU projects
- light, but with clear personal responsibilities

Funding

Total Budget: 73 M Euro

HGF Request: 25 M Euro

Distribution of requested fund across research topics and backbone activities



Personnel: 15 M Euro

HGF funds mainly for
- young researchers (theory and experiment) and collaborative efforts assuring long-term coverage
- creation of shared infrastructures for computing and detector R&D
- develop accelerator science

Summary

The Alliance will

-establish a new structure for particle physics in Germany
-create novel network of excellence between all Helmholtz-, University- and MPG-institutes working at the energy frontier across the whole of Germany
-provide excellent training grounds for young researchers
-create sustainable infrastructures at the technology frontier

with the vision

to play an internationally leading role in forefront research with the expectation of revolutionary scientific results today and tomorrow