CTEQ/MCnet School 2016

QCD and Electroweak Phenomenology

6-16 July 2016

DESY, Hamburg

Program:

- Introductions to QCD and electroweak theory
- Introduction to Monte Carlo generators
- Parton densities: introduction and tutorial
- Monte Carlo tutorials
- Matching and merging higher orders
- W, Z and Higgs production at the LHC
- Heavy quarks
- Jet physics
- BSM searches at the LHC
- Dark matter and Astroparticle physics
- Future colliders

DFG DESY MCnet

Particles, Strings, and the Early Universe
Collaborative Research Center SFB 676

QCD

Local organising committee:
Markus Diehl, Judith Katzy, Katerina Lipka, Sven-Olaf Moch

CTEQ organising committee:
Ed Berger, Joey Huston, Karol Kovarik, Tom LeCompte, Jorge Morfin, Pavel Nadolsky, Fred Olness, Frank Petriello, Zack Sullivan, Dave Soper, Nikos Varelas, Werner Vogelsang

MCnet organising committee:
Stefan Gieseke, David Grellscheid, Stefan Hoeche, Frank Krauss, Peter Richardson, Mike Seymour

http://qcd2016.desy.de

WELCOME

- to 8 exciting days of lectures & tutorials
- to DESY
- to Hamburg

Katerina Lipka for the Organizers

Deutsches Elektronen SYnchrotron

http://www.desy.de

- Founded 18 December 1959
- Research centre of Helmholtz Association,
  Germany's largest organization for basic research with large-scale infrastructures
- Located in Hamburg and Zeuthen (Berlin)
- close connections with local universities:
  Hamburg, Berlin, Potsdam
- 2000 staff (650 scientists),
  100 apprenticeships, 700 students / postdocs
- 3000 guest scientists from 40 countries
- Fundamental Research & Applied Science:
  - accelerator development and operation
  - photon science,
  - particle and astroparticle physics

ACCELERATORS AT DESY

http://m.desy.de

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HERA: Hadron-Electron Ring Accelerator
(1992-2007)
electron (or positron) - proton collider

FLASH: Free Electron Laser in Hamburg
started 2005, the first soft X-ray laser

DESY: Deutsches Elektronen Synchrotron
Quantum Electrodynamics studies
started 1964, until 2012 pre-accelerator

FLASH

European X-ray Free Electron Laser,
34 km long, started 2015,
strongest X-ray laser world-wide

XFEL

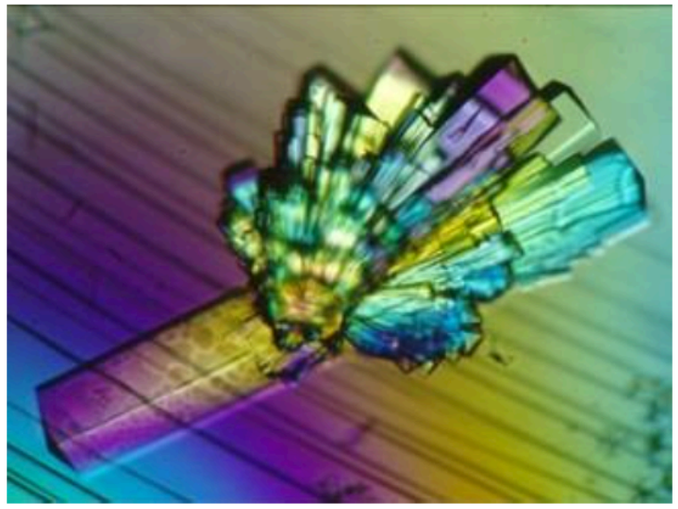
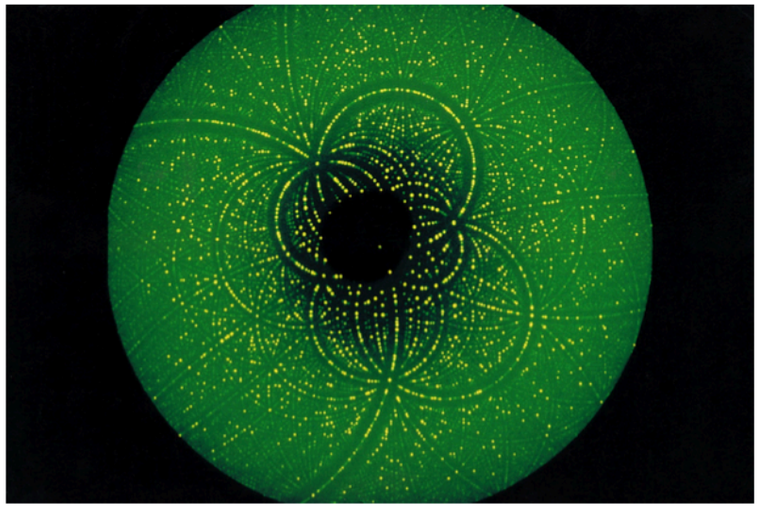
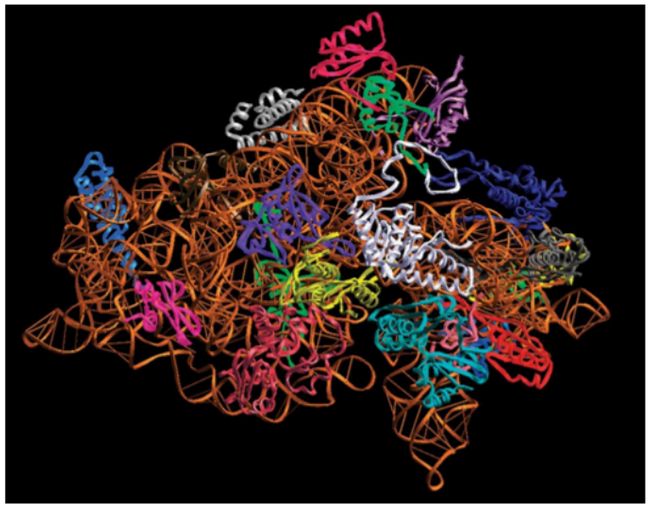
Positron-Electron-Tandem-Ring-Anlage,
started 1978
- > **Gluon Discovery 1979** < -
since 2009 source of synchrotron radiation

PETRA

PHOTON SCIENCE AT DESY

http://photon-science.desy.de

- Structural analysis, e.g. of biomolecules

  - From protein crystals ... via diffraction images ... to the 3D structure of ribosomes

- Structure of ribosomes: Nobel Prize in Chemistry 2009 (*Ada Yonath*)

- **Physics:** Material science, plasmas
- **Biology:** proteins,...
- **Chemistry, geology, medicine,...**
- **Arts:** hidden portrait in Van Gogh's painting *Grasgrond*

PARTICLE PHYSICS AT DESY

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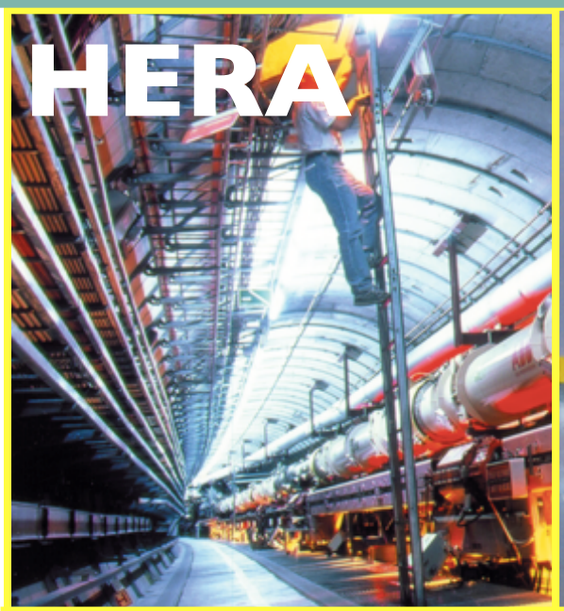
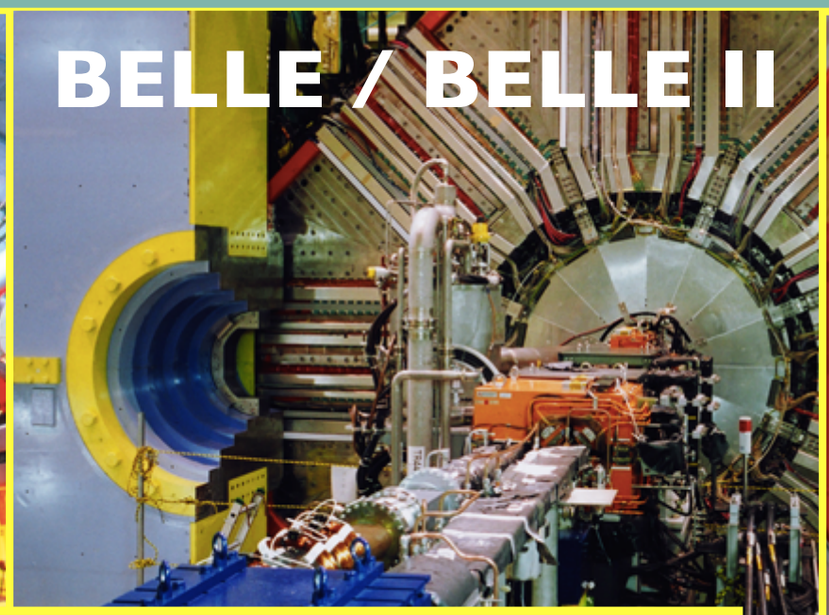
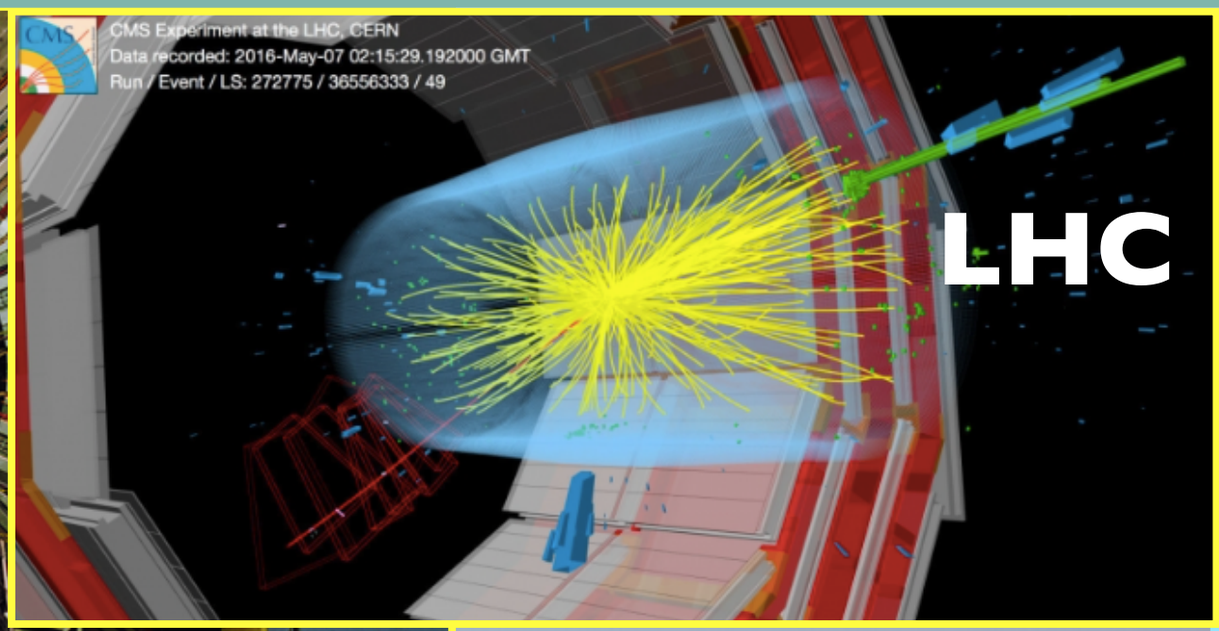
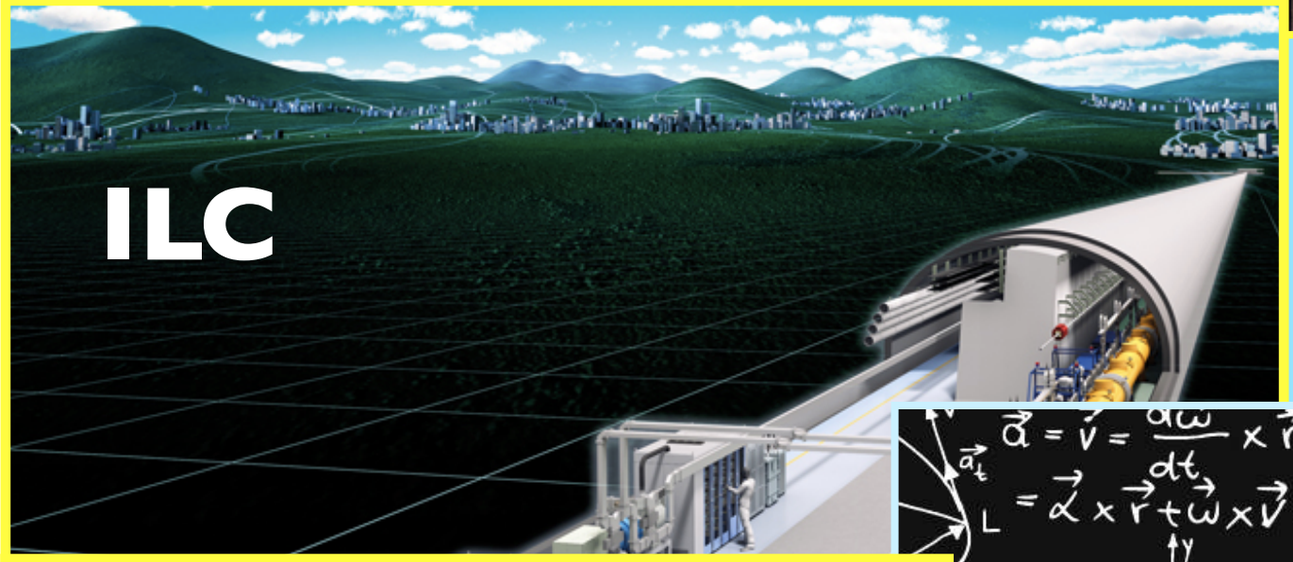
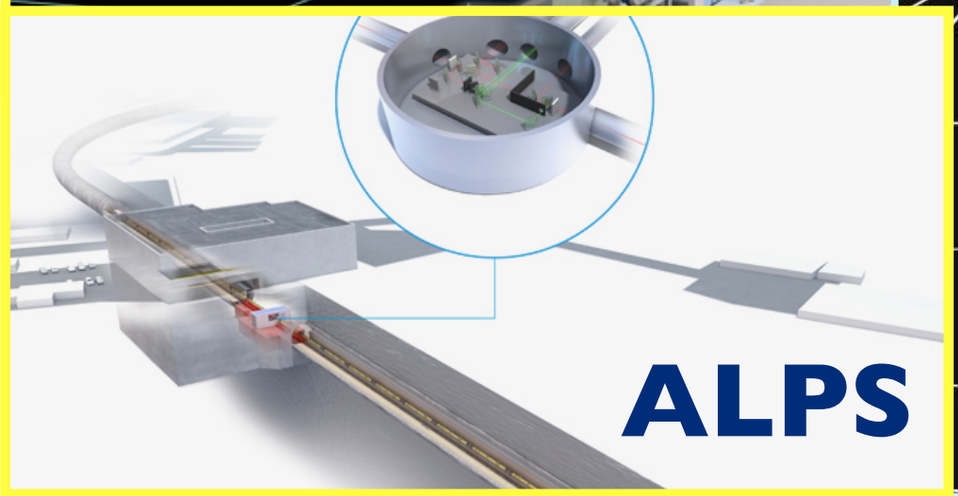
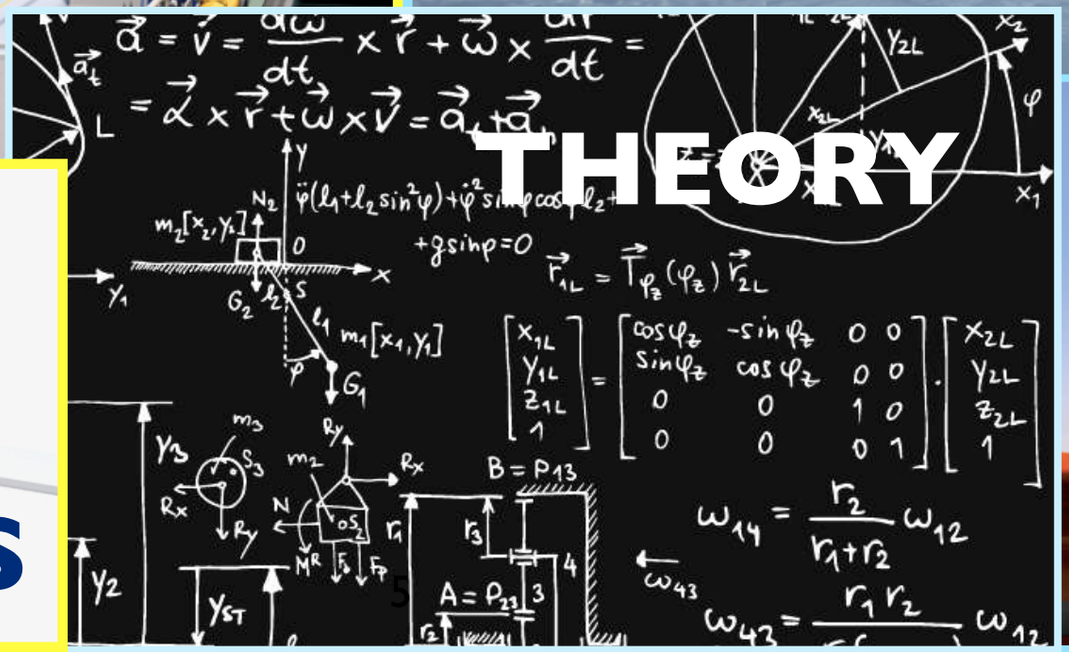


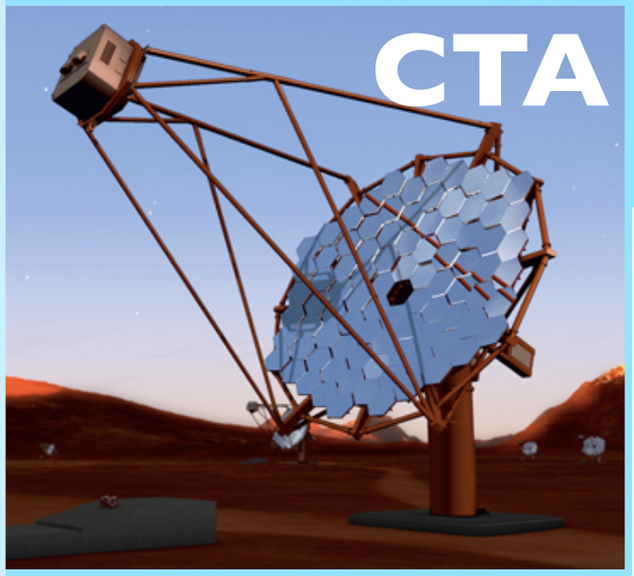






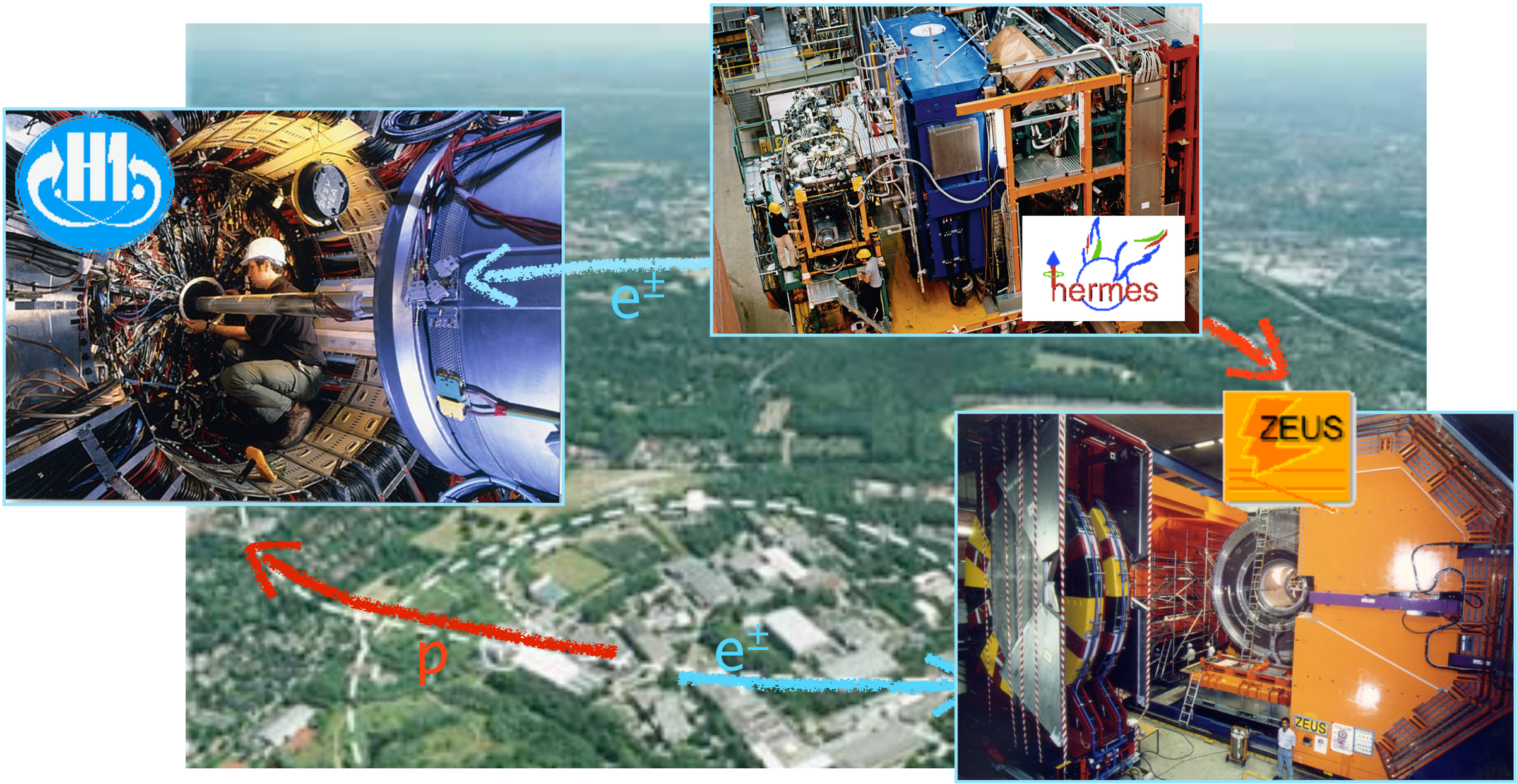






HERA: world's-only *ep* collider

ran 1992 - 2007 with **electrons** (27.6 GeV) and **protons** (460-920 GeV)



insight into polarized and unpolarized proton structure

BELLE / BELLE II

https://belle2.desy.de

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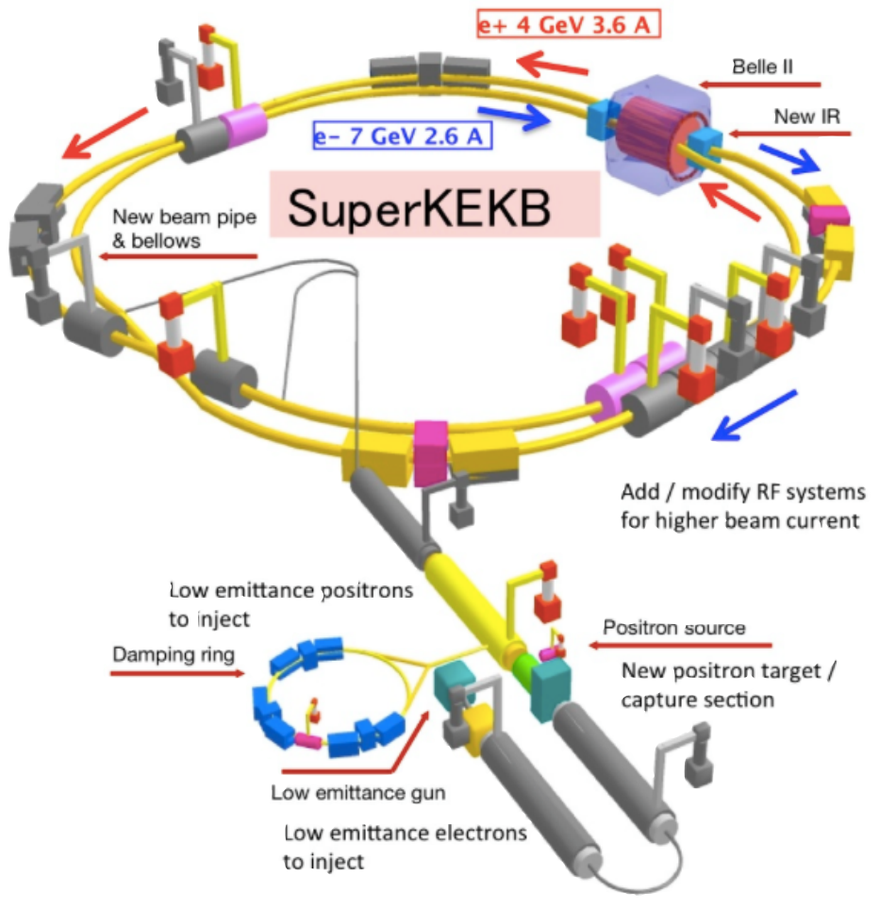
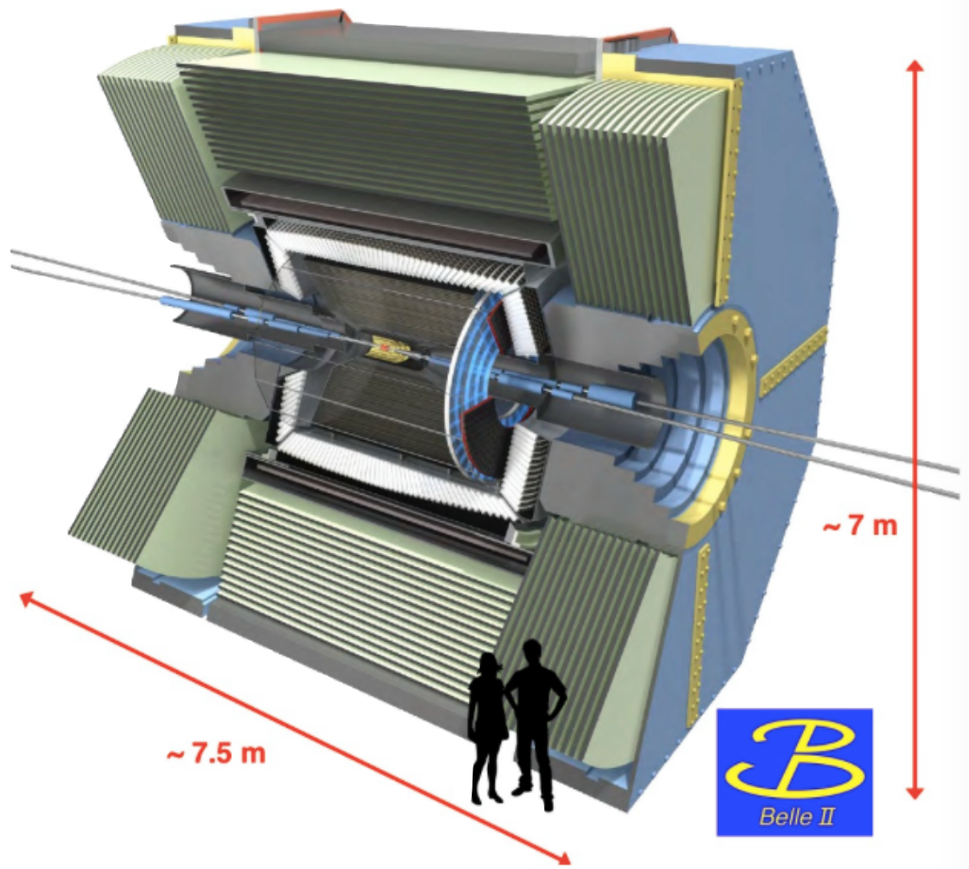
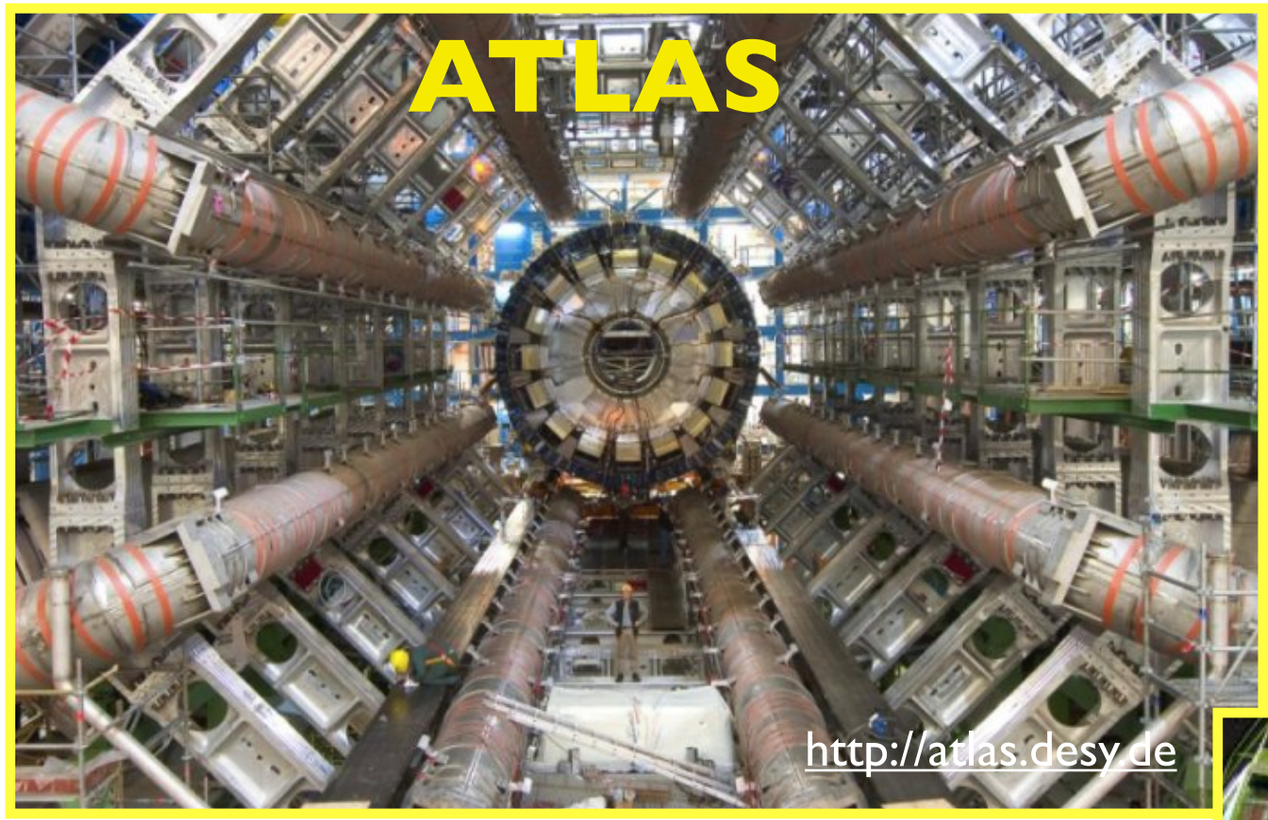
Understanding CP violation and search for New Physics at B-factory





- vertex detector construction
- computing and reconstruction software
- physics analysis: search for flavour-changing neutral current in $B \to K^* ll$
  search for dark photon and understanding fragmentation

LHC EXPERIMENTS



Detector upgrade

for the high-luminosity LHC (2020):
radiation-hard fine-grained sensors

- chip manufacturing technology
- research with new materials
- test beam at DESY

Analysis of LHC data

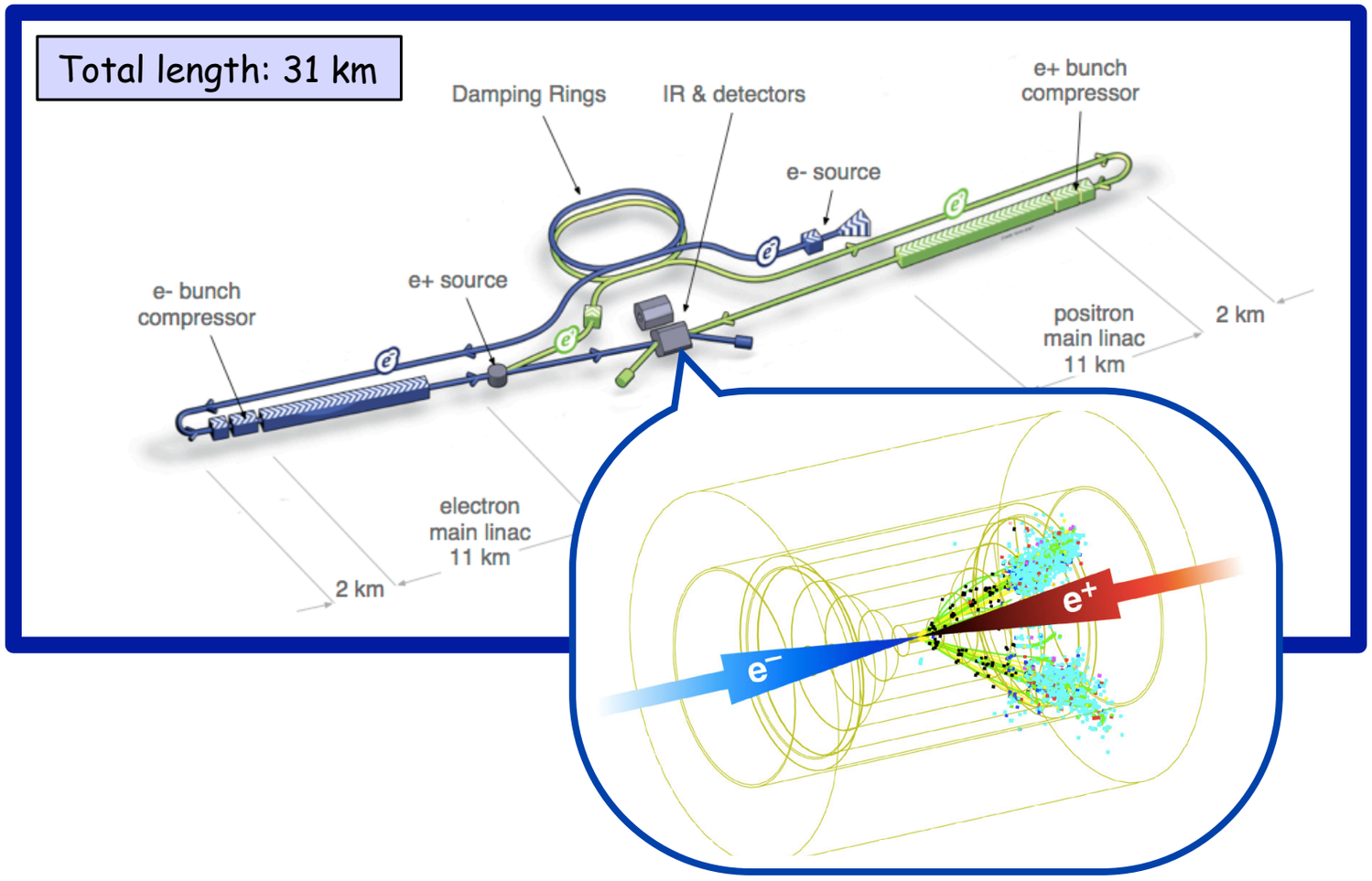
- properties of hadronic jets and electroweak bosons;
- top-quark and Higgs physics;
- searches for Supersymmetry and dark matter;
- ...

Grid Computing: Tier-2 center

International Linear Collider

Future electron-positron linear accelerator

to complement and extend the findings of the LHC



energies

500, 350, 250 GeV

2 detectors (push/pull)

- development of superconducting accelerator technology
- development of components for the ILC accelerator
- design and development of the high-precision ILC detectors
- computing and preparation for data analysis

Any Light Particle Search

http://alps.desy.de

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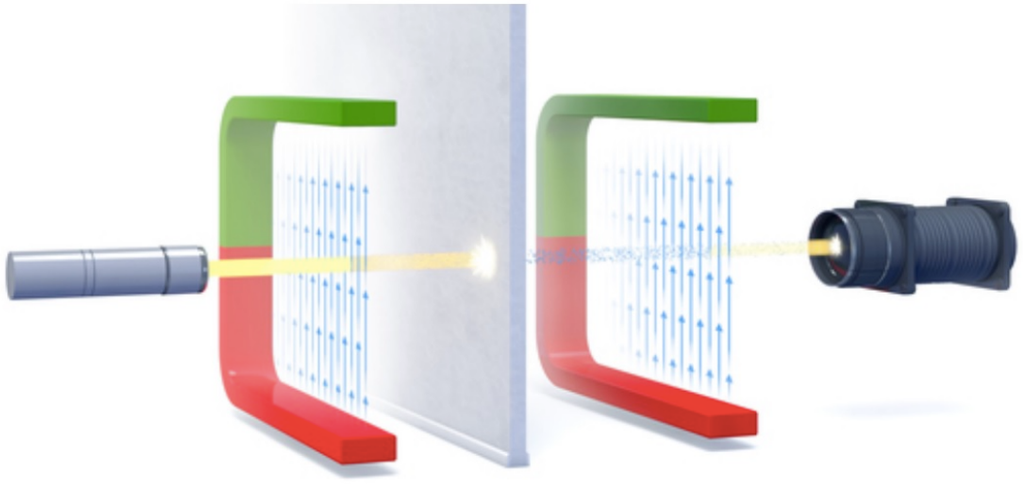
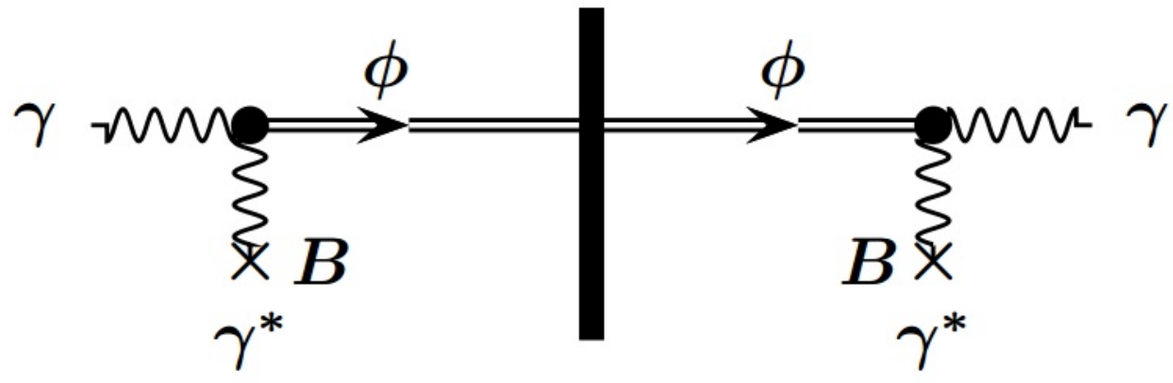
Axions are candidates for **Weakly Interacting Sub-eV Particle (WISP)** predicted by extensions of the Standard Model:

- could explain smallness of CP violation in QCD
- are candidate for constituent of the dark matter in the universe.

Search for axions in a "light through the wall" experiment





Laser light is shone into a magnetic field. Laser photons can be converted into a WISP in front of a light-blocking barrier (production region) and reconverted into photons behind that barrier (regeneration region).

ASTROPARTICLE PHYSICS

http://astro.desy.de

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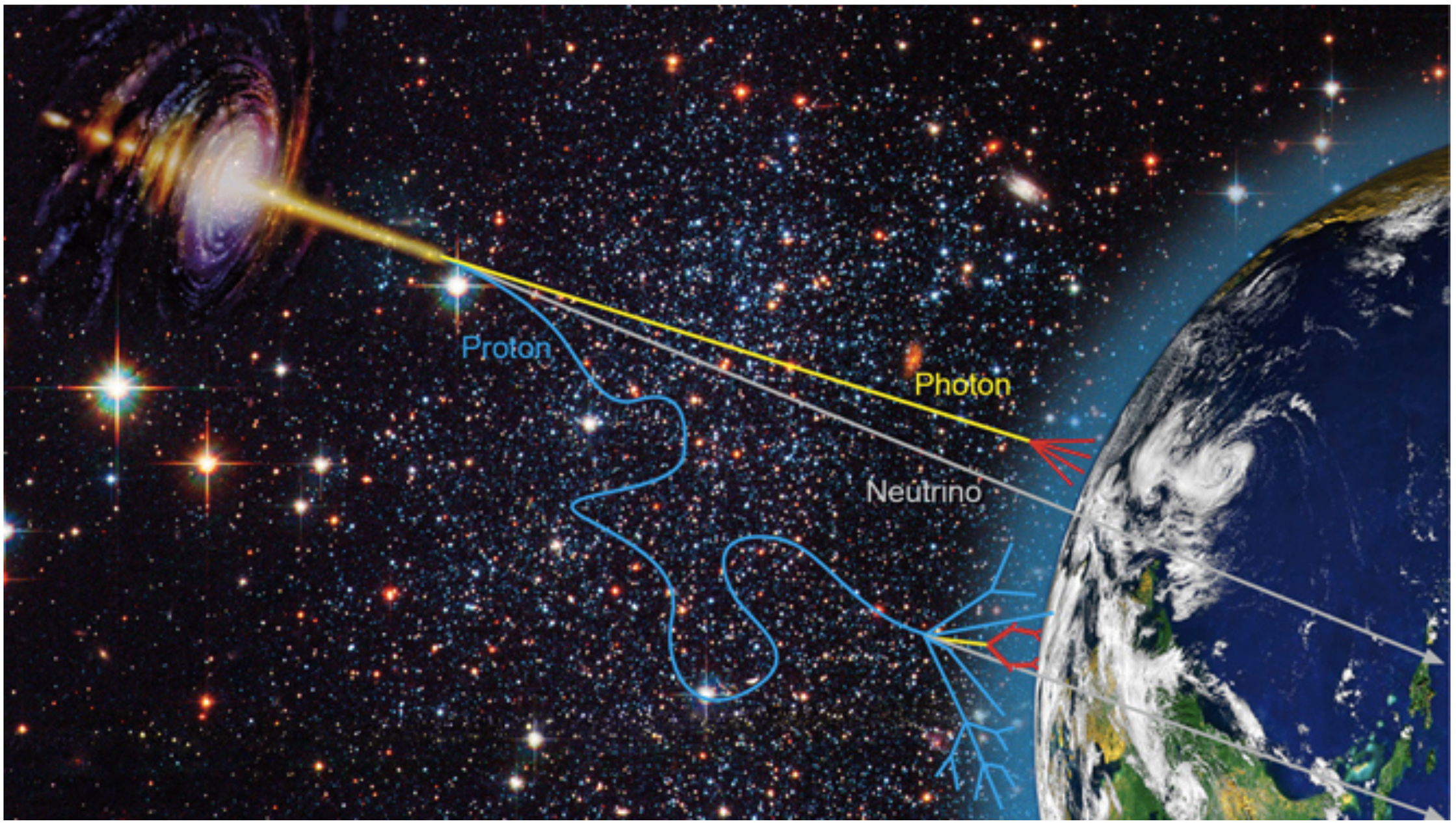
Cosmic particles constantly reach the Earth – particles that can provide insights into events happening in the depths of the universe. DESY studies two of the cosmic messengers: neutrinos and high-energy gamma rays.



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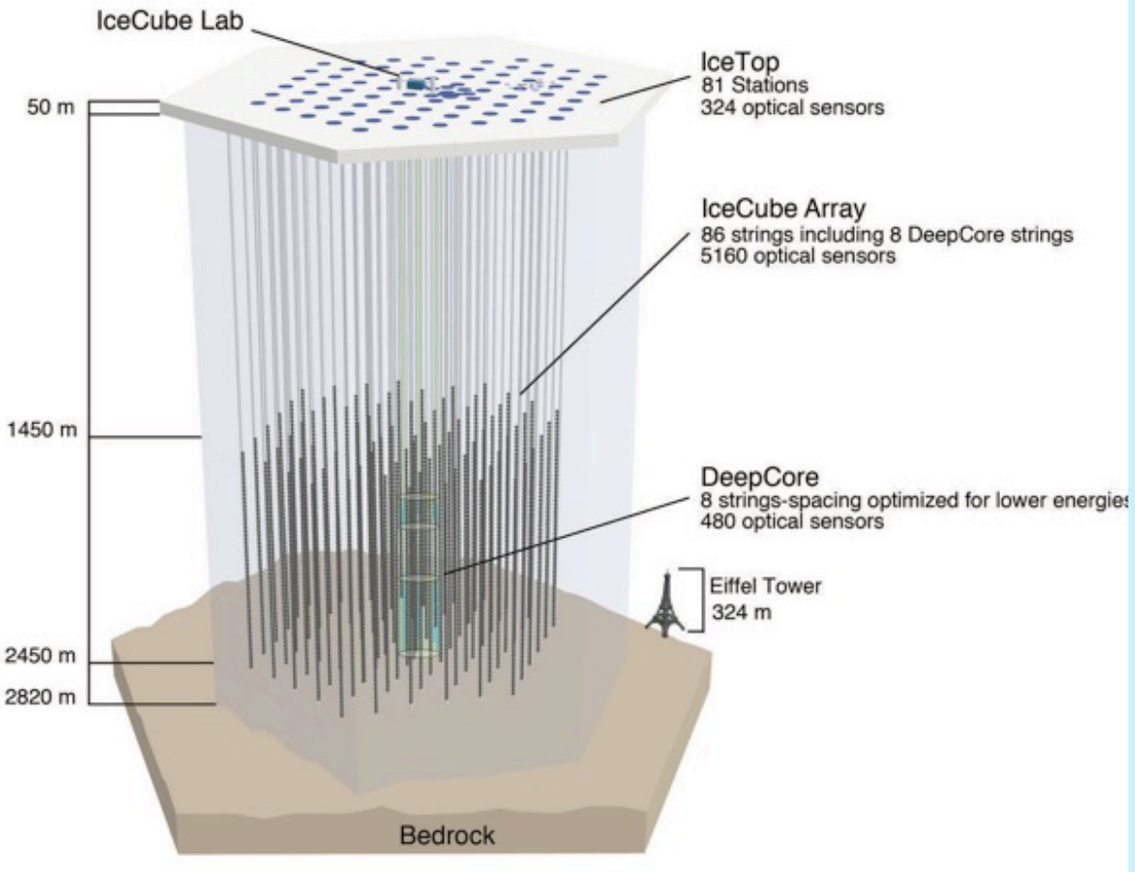
ICE CUBE



1 km^3 of ice at the South Pole
instrumented with 5160 photomultipliers

CTA

About 100 Cherenkov telescopes planned on two sites in the northern & southern hemisphere

12 m prototype
in tests in Berlin

THEORY

https://theory-hamburg.desy.de

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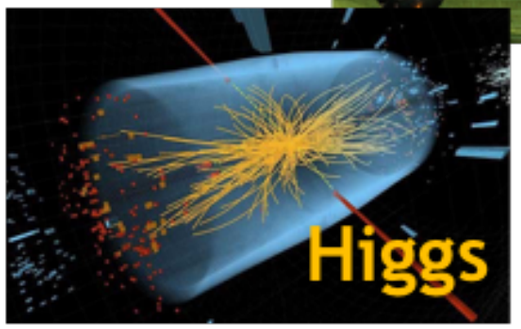
Collider phenomenology

electroweak symmetry breaking
physics beyond Standard Model
precision calculations
QCD



Particle cosmology

dark matter
baryogenesis
cosmic inflation
axions and WISPS

String theory

dualities
strings on curved spacetimes
integrable systems
conformal field theory

Lattice QCD

strong coupling, quark masses
flavour physics
hadron structure, muon g-2
algorithms

CLOSE CONNECTION TO UNIVERSITY OF HAMBURG

- several institutes situated at DESY campus in Hamburg
- common research activities in accelerator, laser and X-ray, (astro)particle physics
- the II. Institute for Theoretical Physics together with the DESY Theory Group comprises one of the largest theoretical high-energy physics groups in the world
- many topics addressed in collaboration via collaborative research projects, e.g. research programme at the interface of Particle Physics, String Theory and Cosmology:

Particles, Strings, and the Early Universe
Collaborative Research Center SFB 676

- such collaboration offers unique opportunities for training of doctoral students

YOUR NEXT DAYS AT DESY

INFORMATION YOU NEED IS ON INDICO

http://qcd2016.desy.de

AGENDA

PRACTICAL INFORMATION

HELP DESK:
building 01b
room O2.202

Search

Europe/Berlin timezone

- **Overview**
- School Poster
- Week Schedule
- Detailed Timetable
- List of registrants
- Visa Information
- Travel and Accommodation
- Useful Information and Directions inside DESY
- Tutorials: Instructions and Material for Download
- Social Programme

The CTEQ - MCnet School 2016
on QCD & Electroweak Phenomenology and Monte Carlo Generators
will be hosted by DESY in Hamburg, Germany.

The school is organised by DESY together with the Coordinated Theoretical-Experimental Project on QCD CTEQ and the Monte Carlo Network MCnet.

This is 23rd CTEQ School. Previous Schools have been held in USA, Mexico, Peru, China, Italy, Hungary, Greece, Spain and Scotland.

Participation Fee
The regular registration fee of 650 Euro includes accomodation and meals.

School Programme
The program includes lectures as well as the hand-on tutorials on the topics of high relevance for modern high-energy physics. In 2016, the main focus of the school will be the physics program of the LHC in Run II:

- Introduction to QCD and electroweak theory
- Introduction to Monte Carlo generators
- Parton Densities: introduction and tutorial
- Monte Carlo tutorials

YOUR NEXT DAYS AT DESY

TUTORIAL INSTRUCTIONS AND MATERIAL

http://qcd2016.desy.de

WIFi INFO in your maps

Virtual Machine on USB