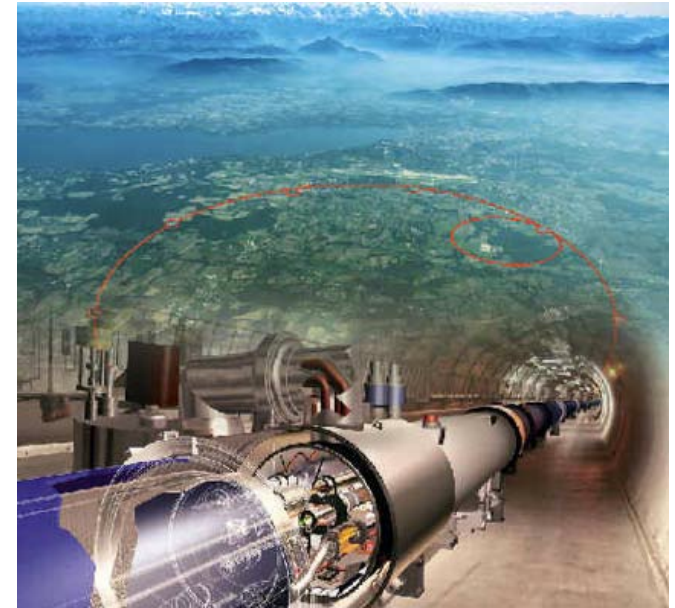




KGW KOPERNIKUS
GYMNASIUM
WALSUM
Tradition und Modernität in Walsum



Der Large-Hadron-Collider am CERN (LHC) und das ATLAS-Experiment

Prof. Dr. Claus Gößling und Silke Altenheiner (TU Dortmund)

6.2.2012, 10:00

Kopernikus-Gymnasium, Duisburg-Walsum

LHC

Large Hadron Collider

Geneva

CERN

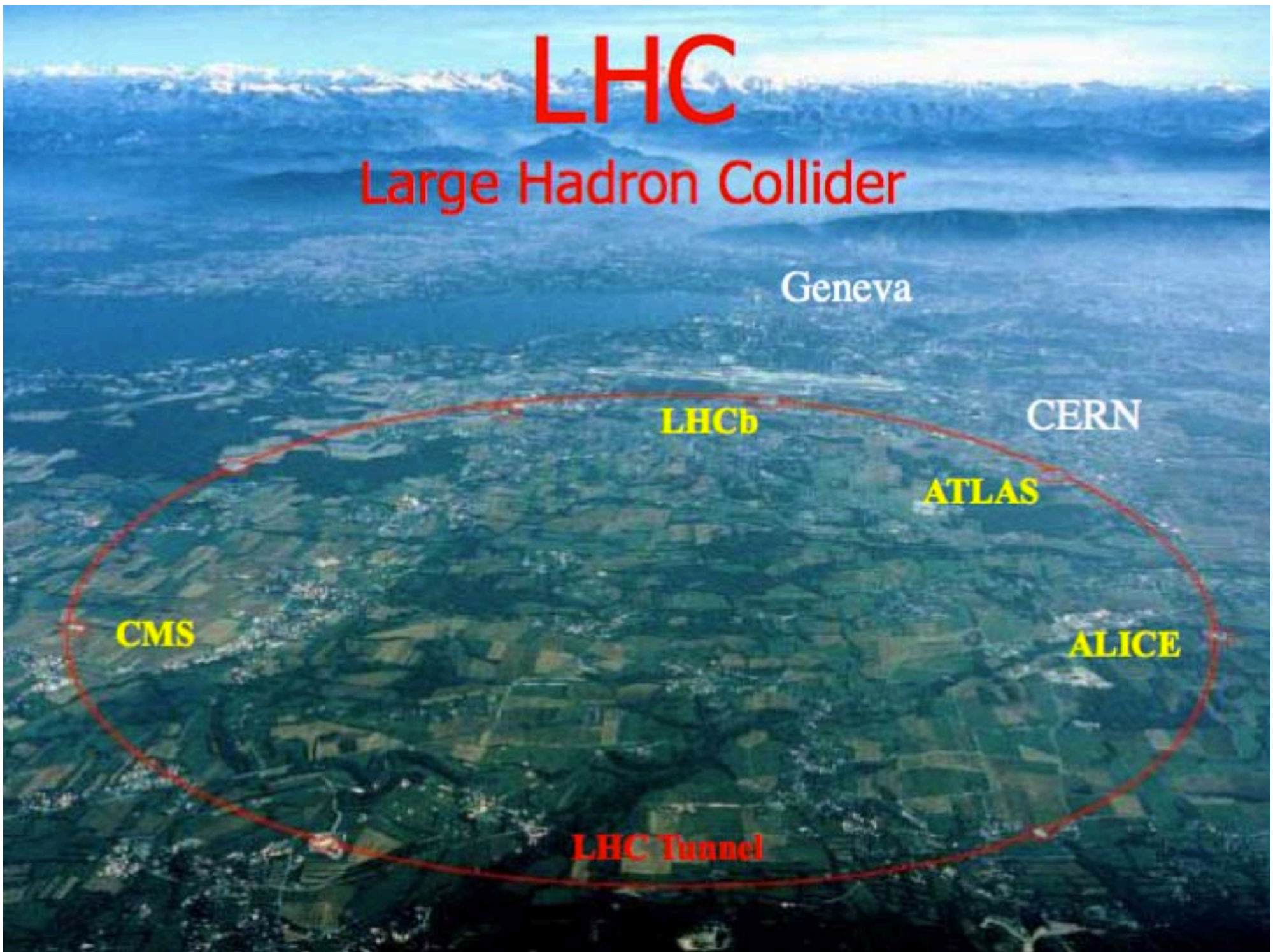
LHCb

ATLAS

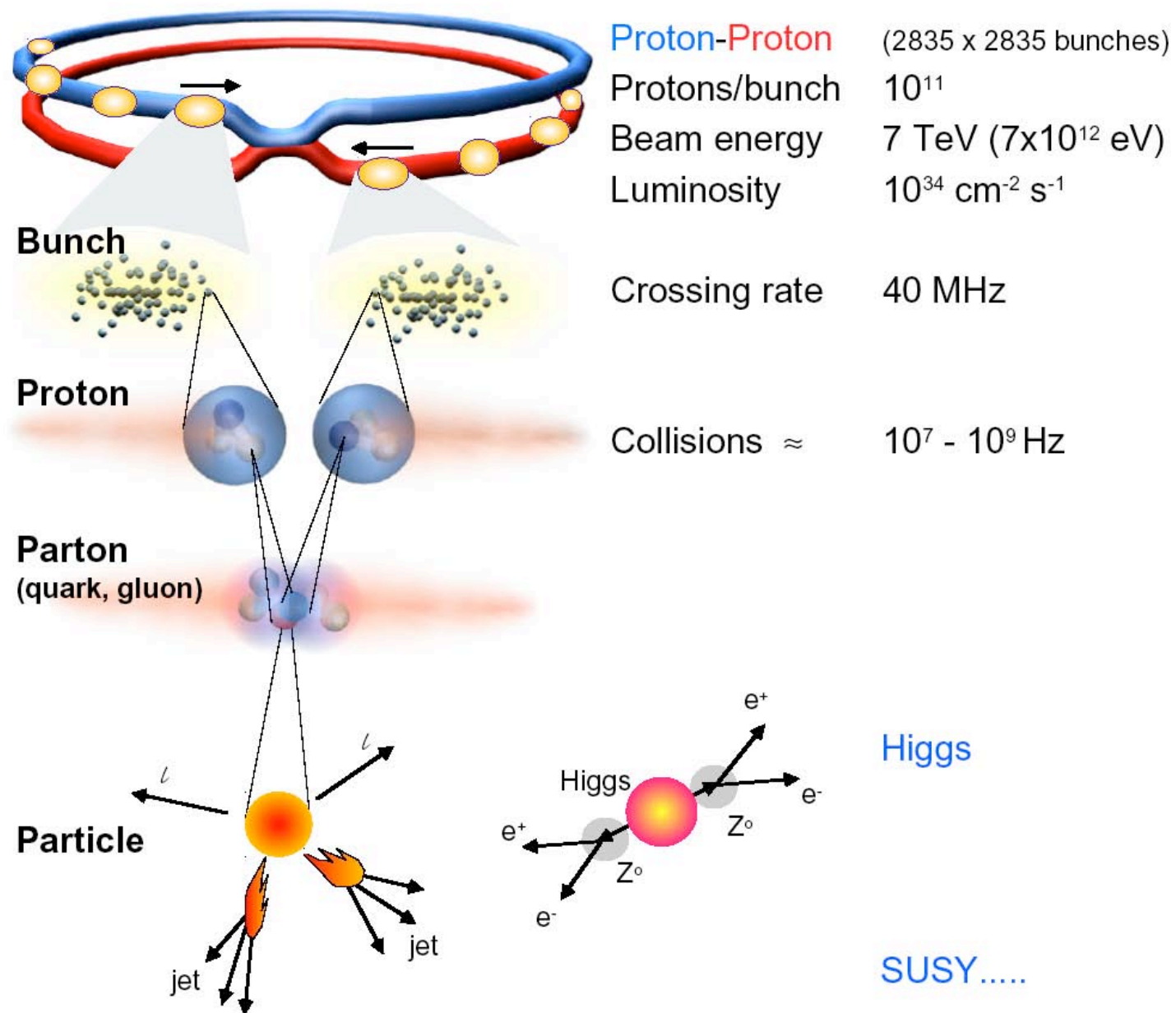
CMS

ALICE

LHC Tunnel



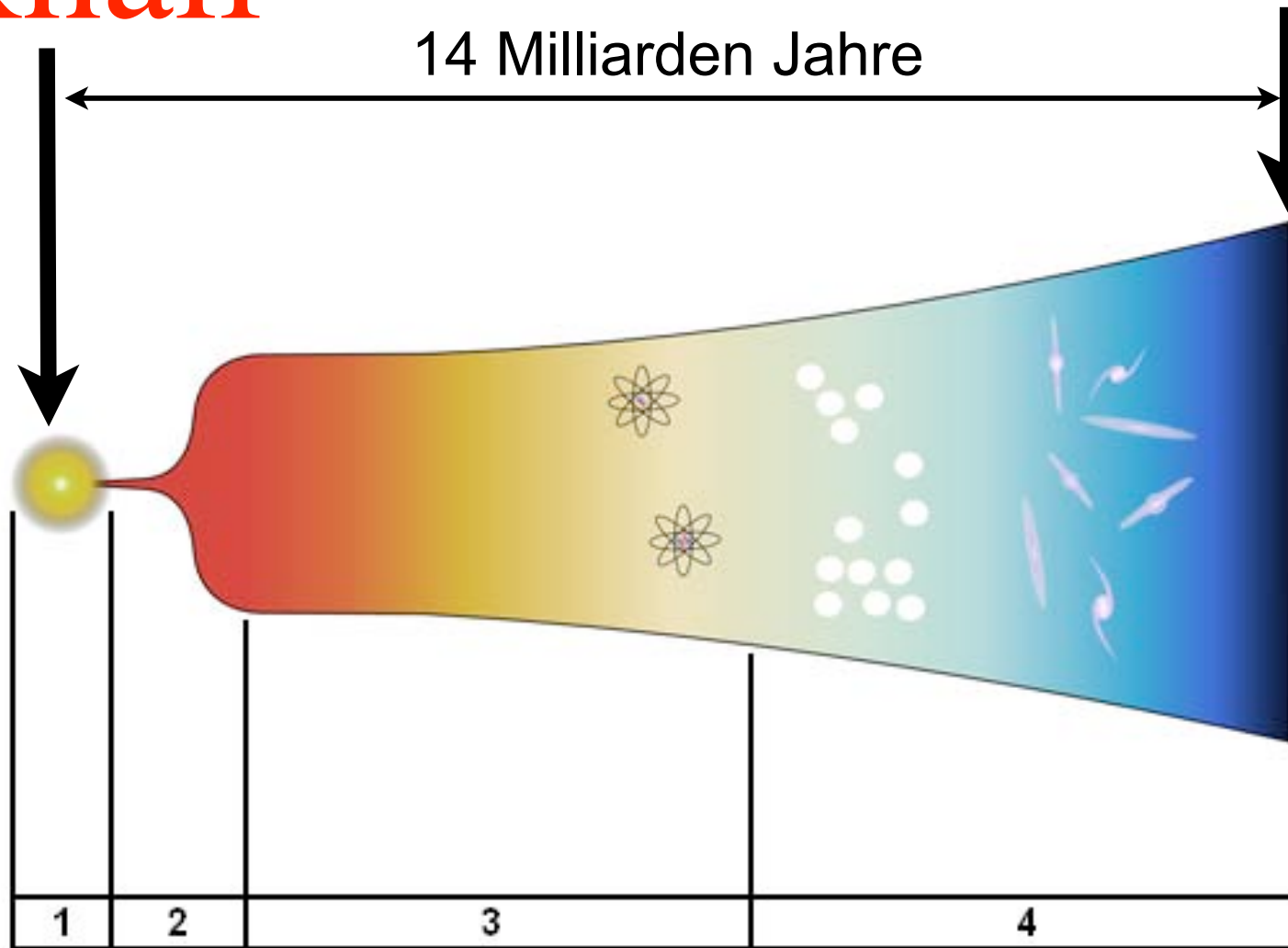
Beschleuniger und Wechselwirkungen :



Urknall

heute

14 Milliarden Jahre

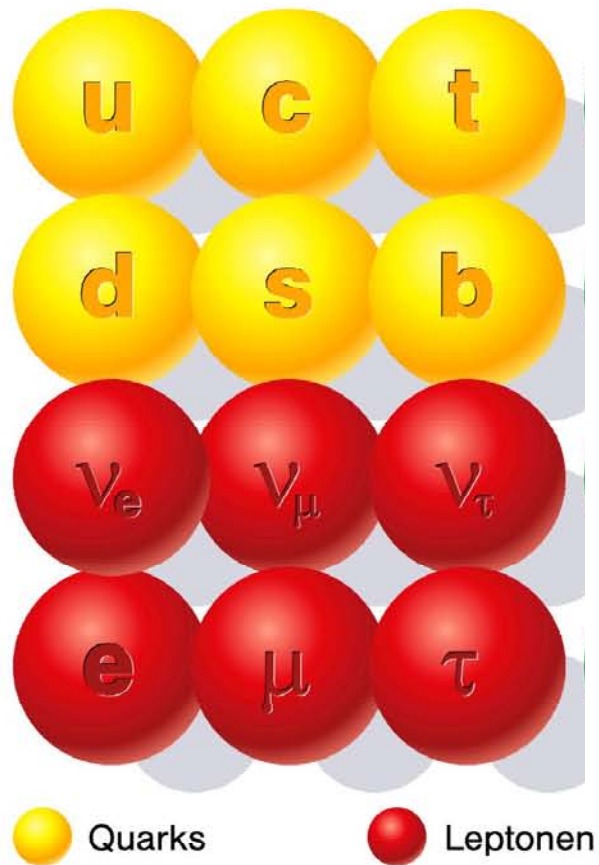


- 1 : Big Bang
- 2 : Inflation
- 3 : Nucléosynthèse
- 4 : Formation des galaxies

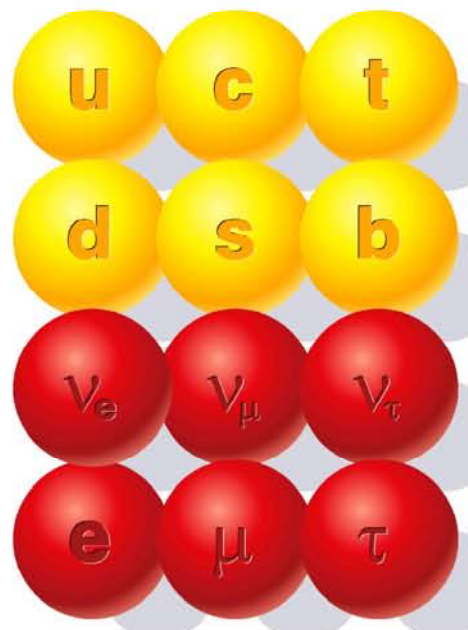
aus: Wikimedia- commons

Baukasten der Elementarteilchen

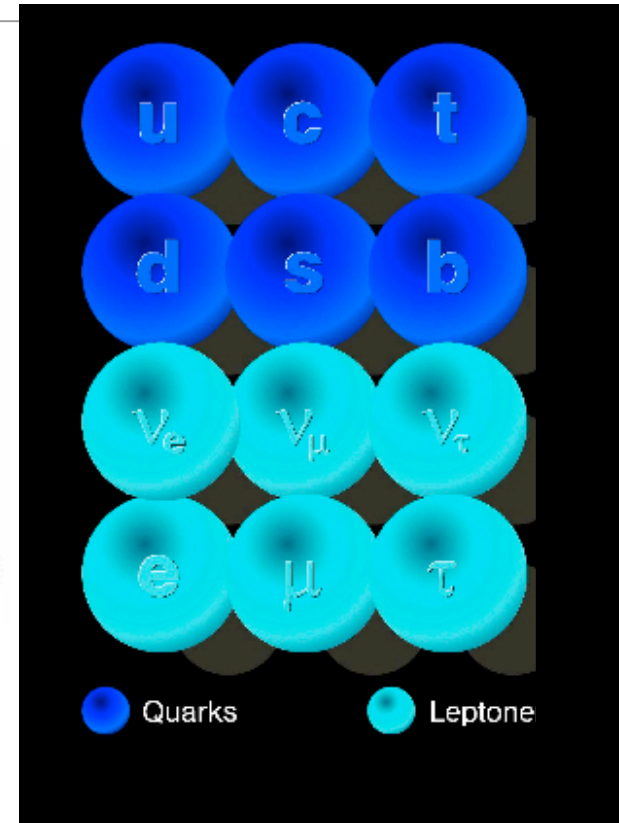
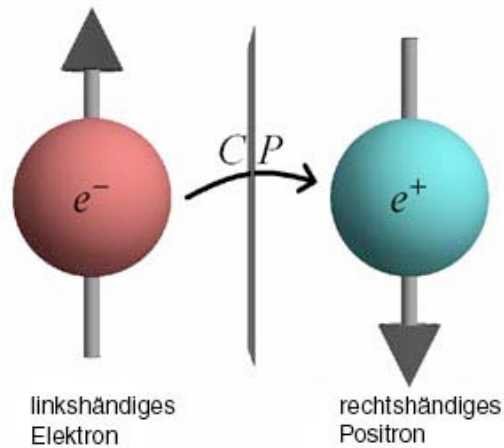
Materie



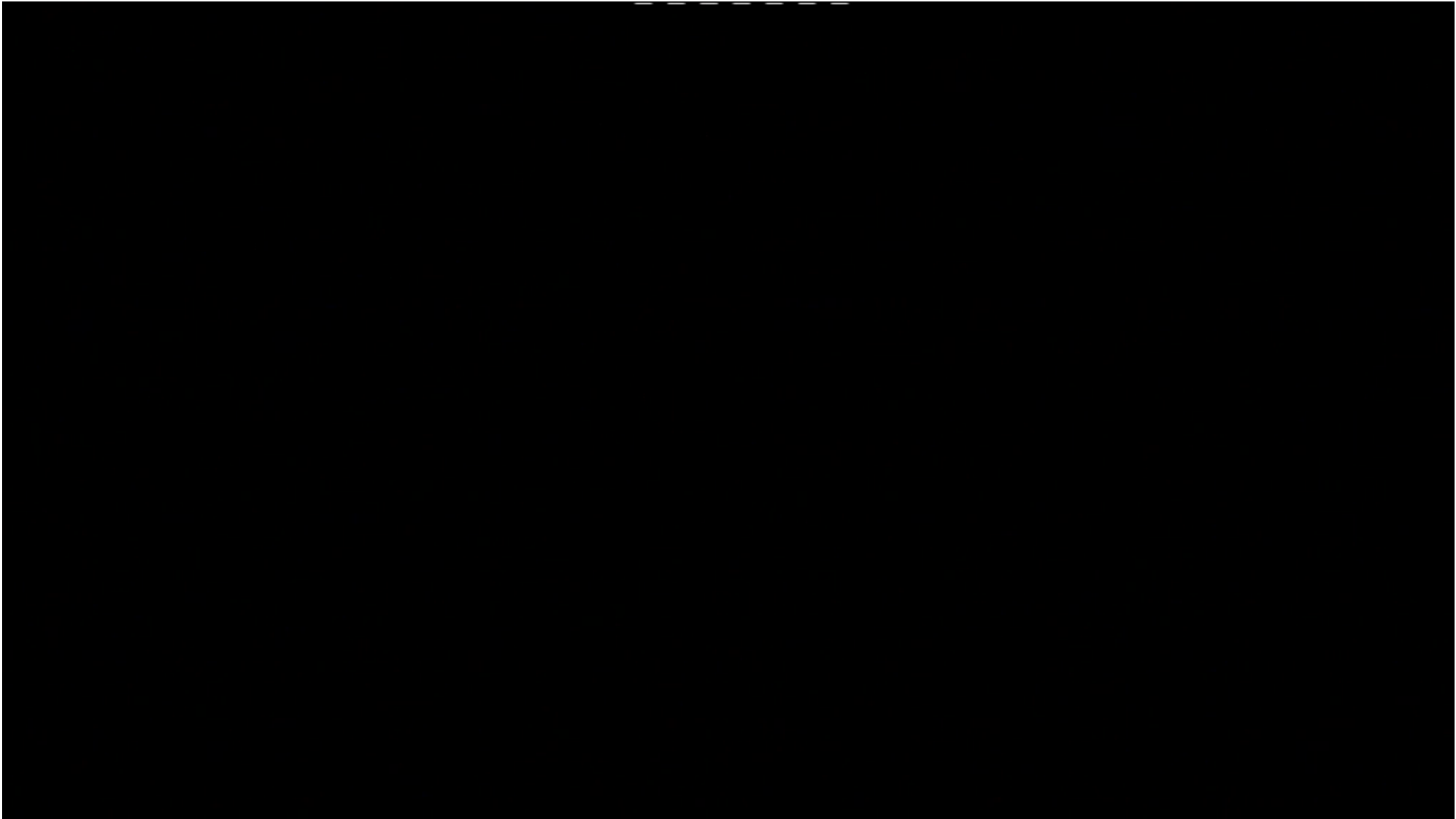
Teilchen und Antiteilchen



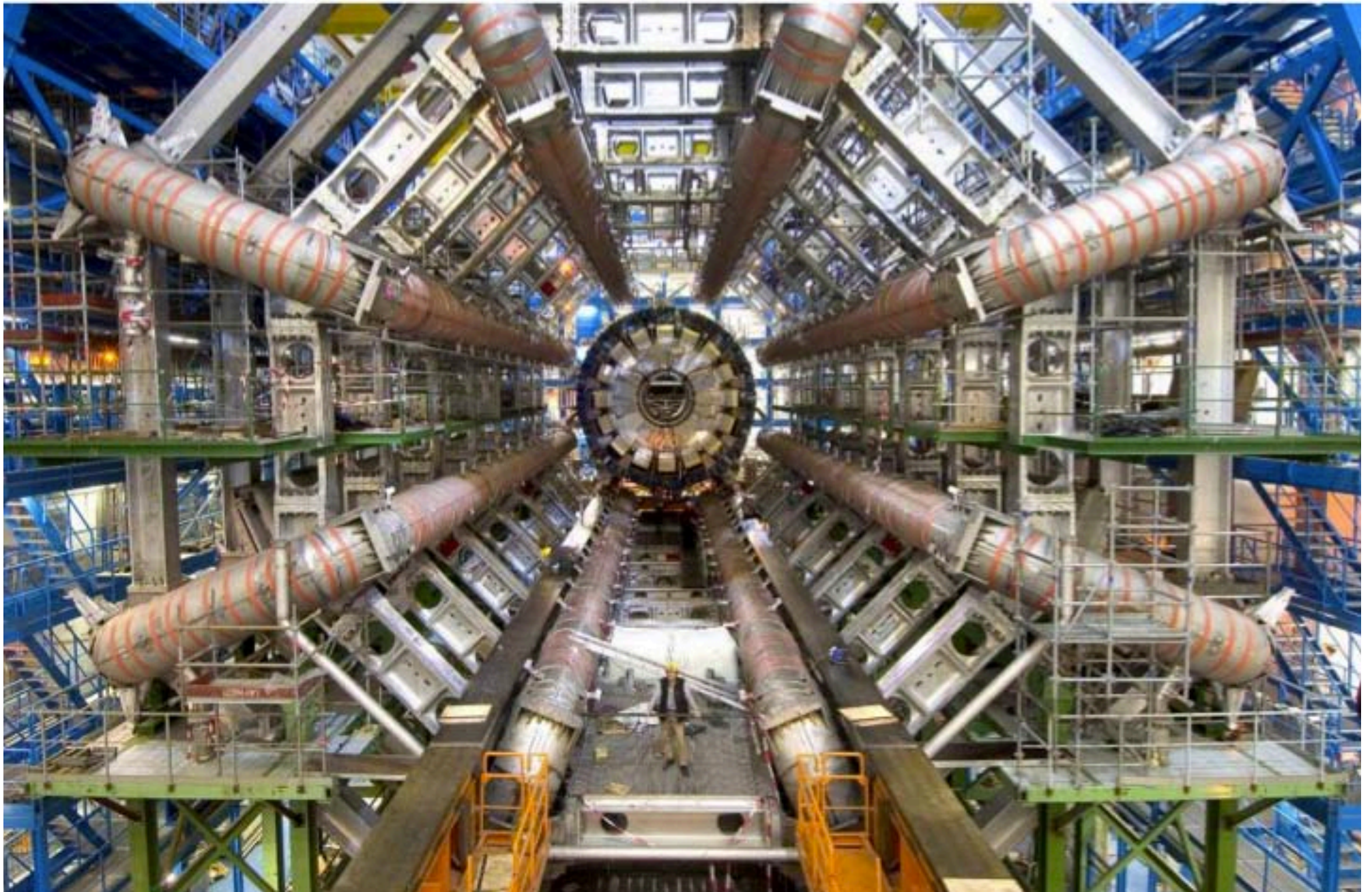
● Quarks ● Leptonen



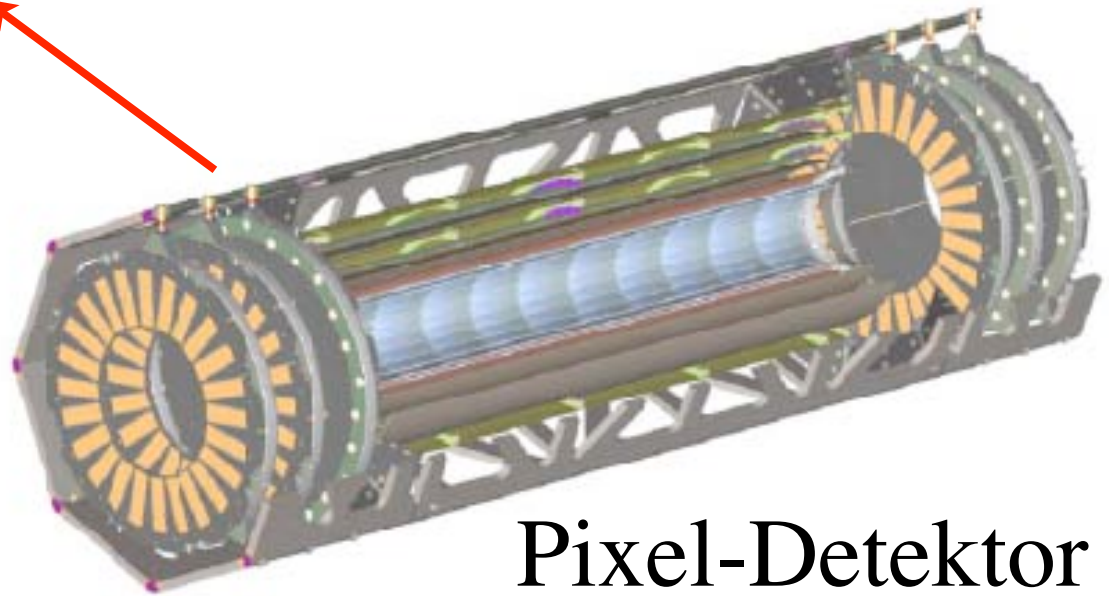
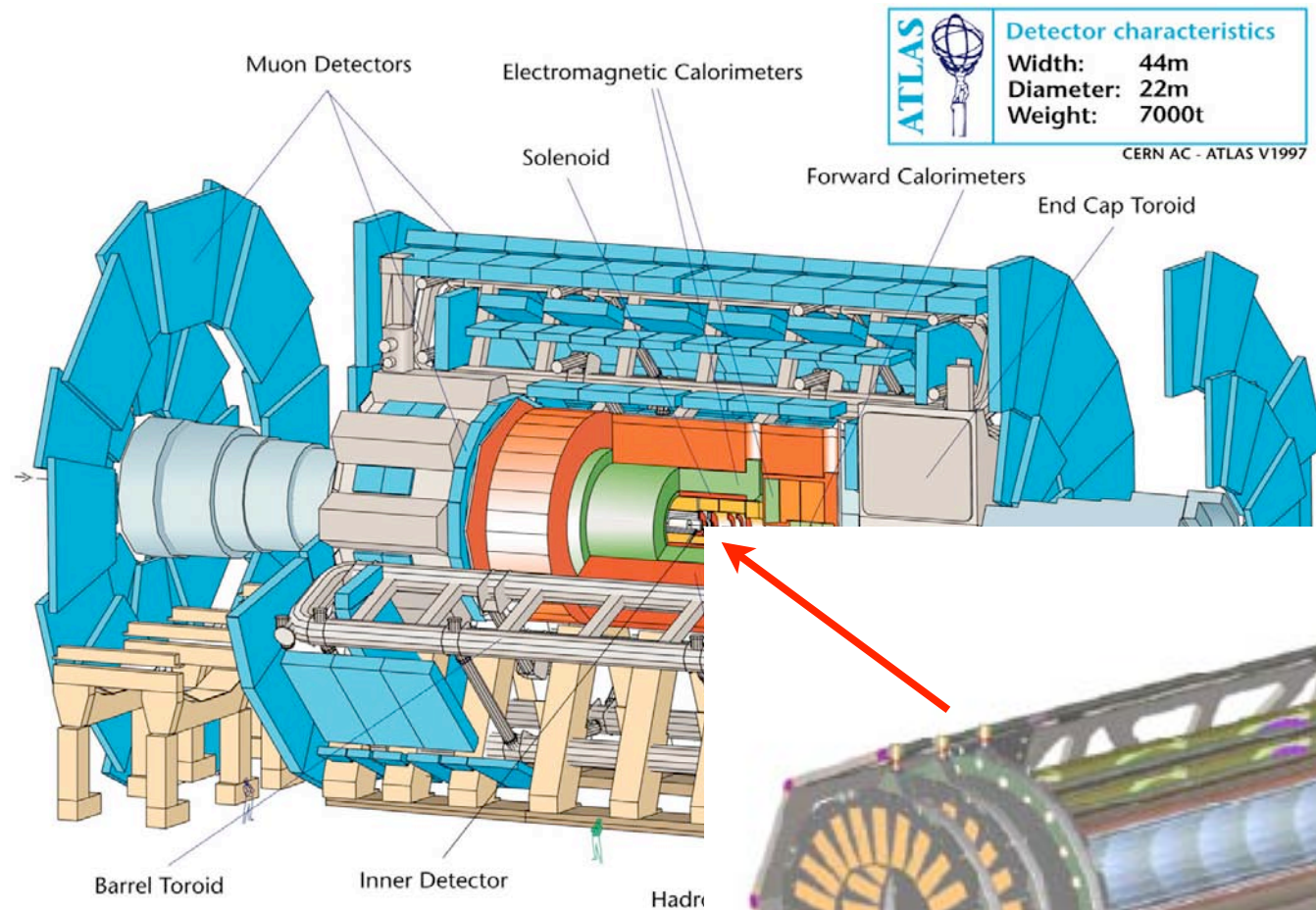
● Quarks ● Leptone



ATLAS



Das ATLAS-Experiment :

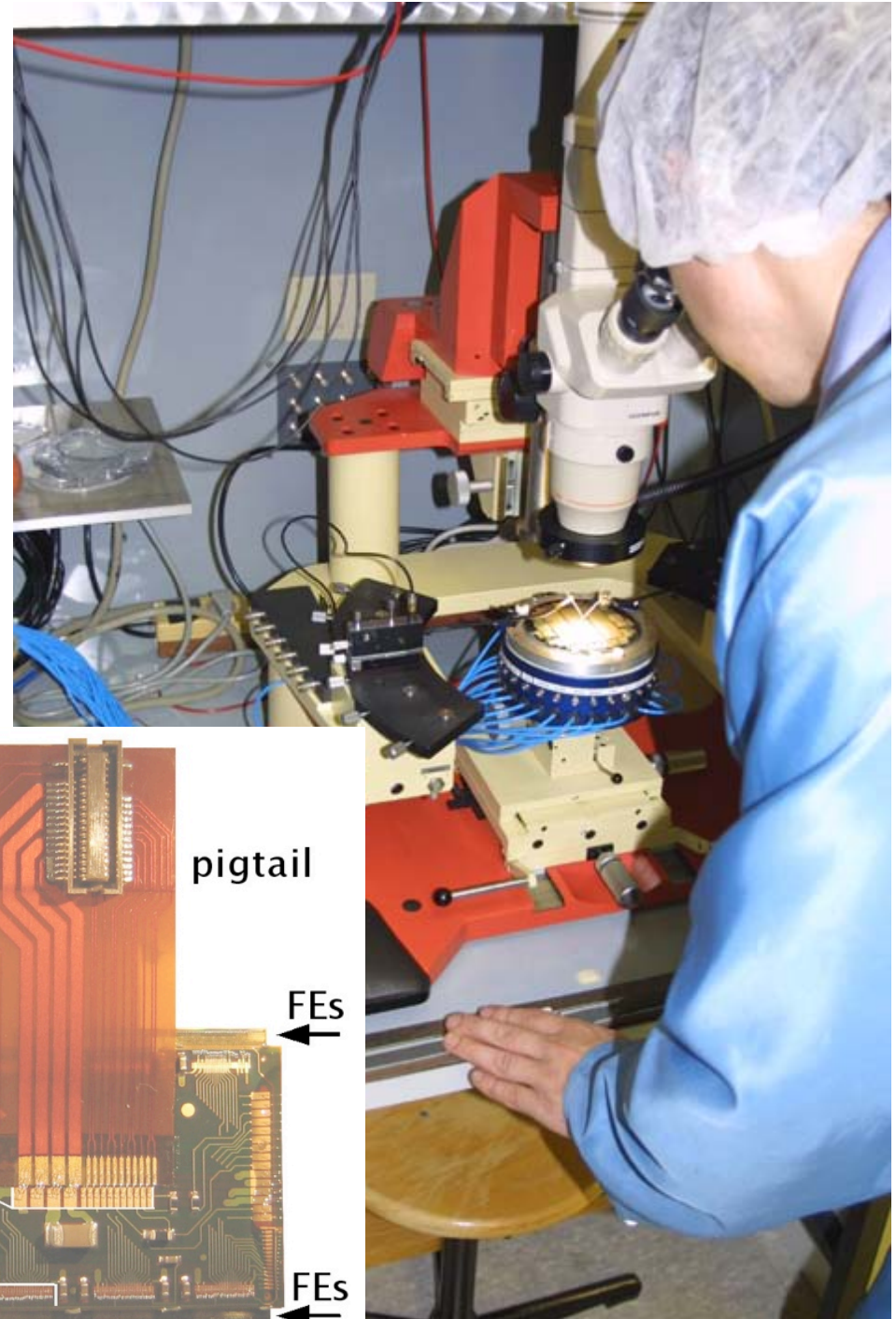


Pixel-Detektor

Der Dortmunder Beitrag zu ATLAS :

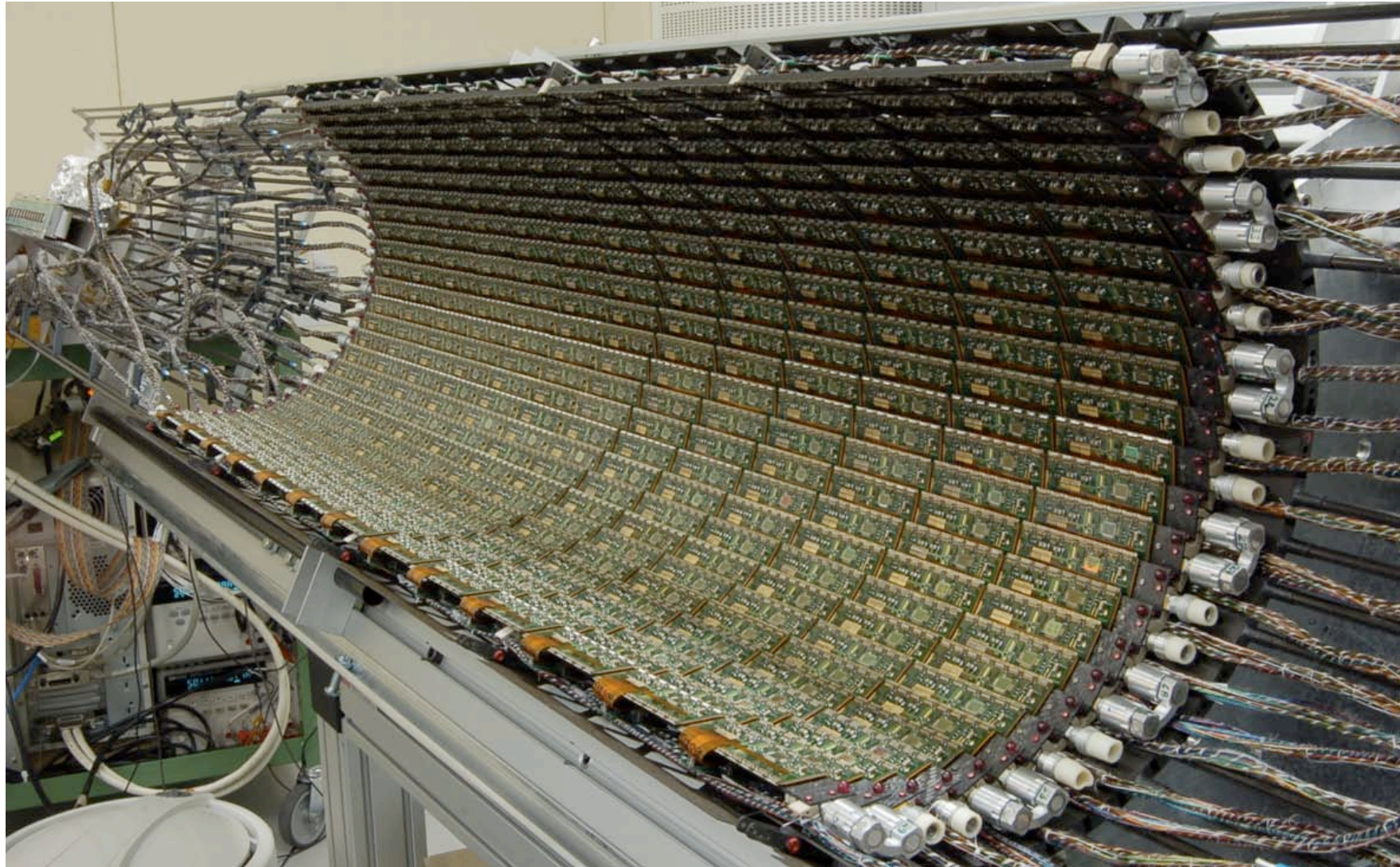
gemeinsam mit 12 anderen Instituten:

Etwa **100 000 000** Pixel
zur präzisen Ortsmessung
von Teilchenspuren
(je $50\text{ }\mu\text{m} * 400\text{ }\mu\text{m}$)



Eine schnelle Kamera
mit 80 Mio. Bildpunkten

**Pixel-Detektor
ATLAS**





LHC Milestones

1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

1994

16 DECEMBER

The CERN Council approves the construction of the LHC. To achieve the project without enlarging CERN's budget, it is decided to build the accelerator in two stages.





LHC Milestones

1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008

2007

NOVEMBER

The interconnections of all the arcs of the LHC are completed.



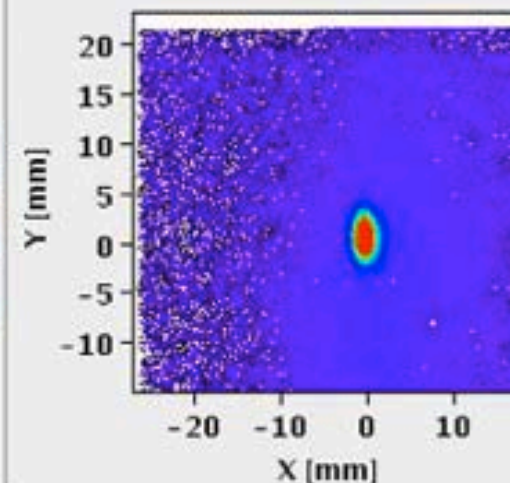
NOVEMBER

For the first time, a beam of lead ions, sent by SPS, is extracted in a transfer line very close to the LHC.

[TT60.BTV.610317/Image](#)

  1  (1 of 1 acquisitions)

Image



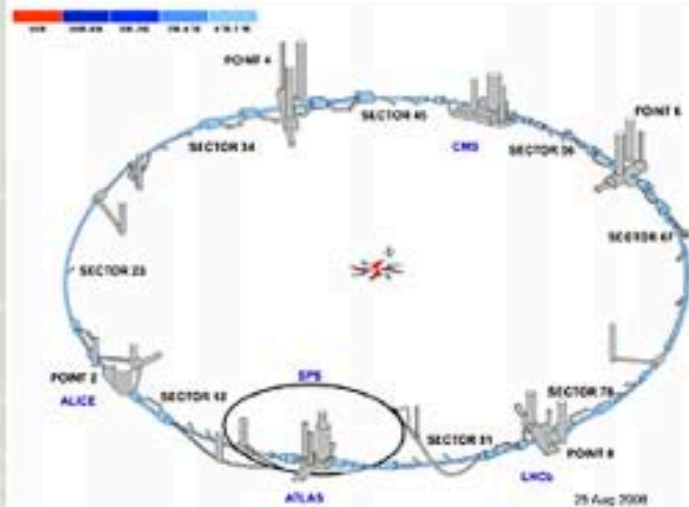
2008

JULY

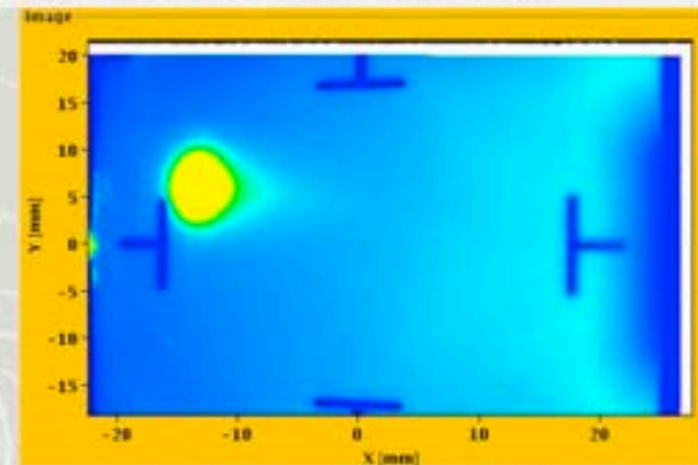
The beampipes, the place where collisions are produced, are now operational. A vacuum, such as exists in the moon's atmosphere, reigns in the 54 kilometres of beampipe.

AUGUST

The 27 kilometres of the LHC have attained the -271°C needed for the experiment. This is just two degrees from absolute zero, the lowest temperature imaginable. The operation needed more than 10,000 tonnes of liquid nitrogen for the first step of the cool down, and 150 tonnes of helium to completely fill the magnets.



Particles have circulated in the LHC for the first time. Two bunches of particles were accelerated by CERN's accelerator chain and then sent in opposite directions around the LHC. The profile of one of these two beams is shown in this image.



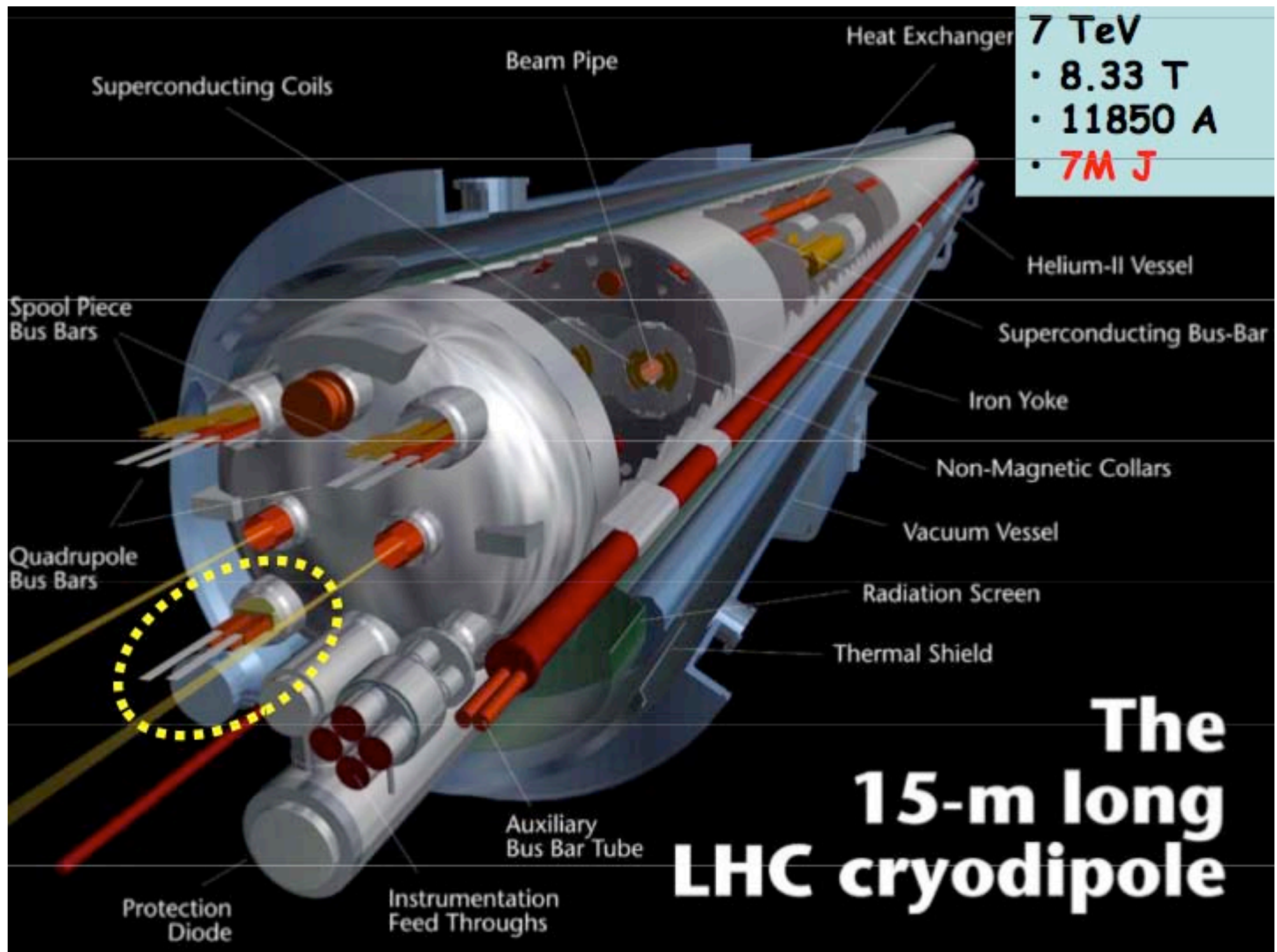
..... und was ist im September 2008 passiert ?

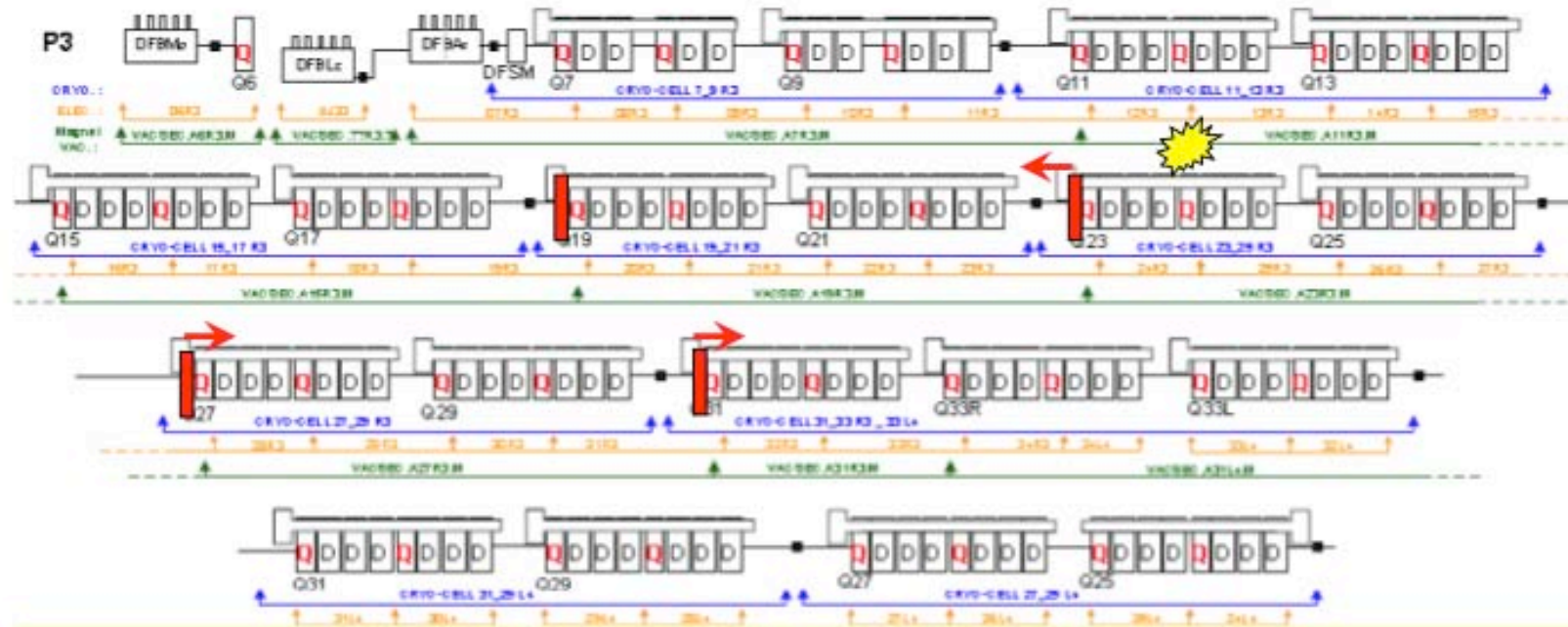
Inbetriebnahme mit großer Aufmerksamkeit durch
die internationale Presse.....

erster Strahl !!!

und wenige Tage danach:







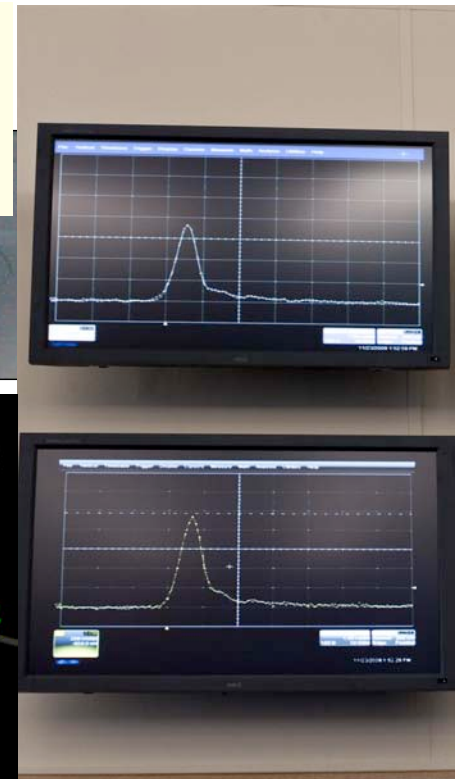
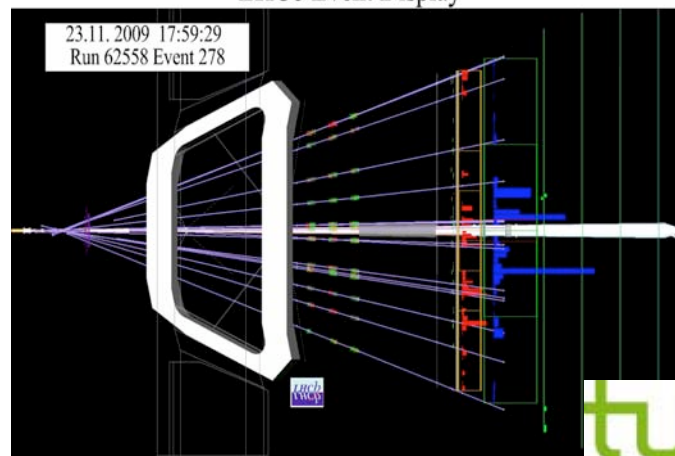
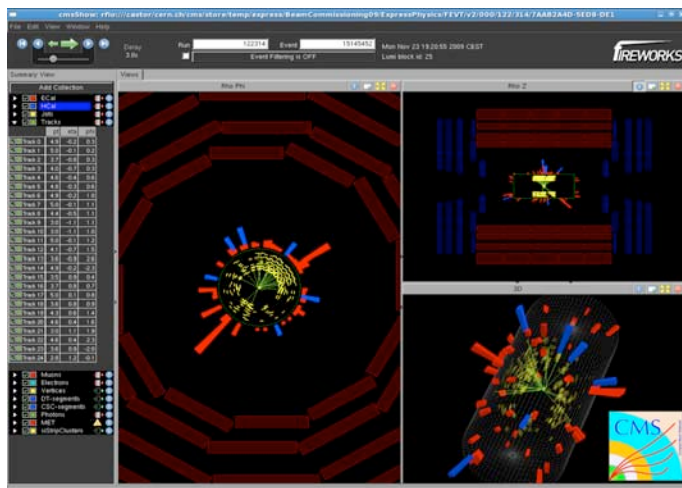
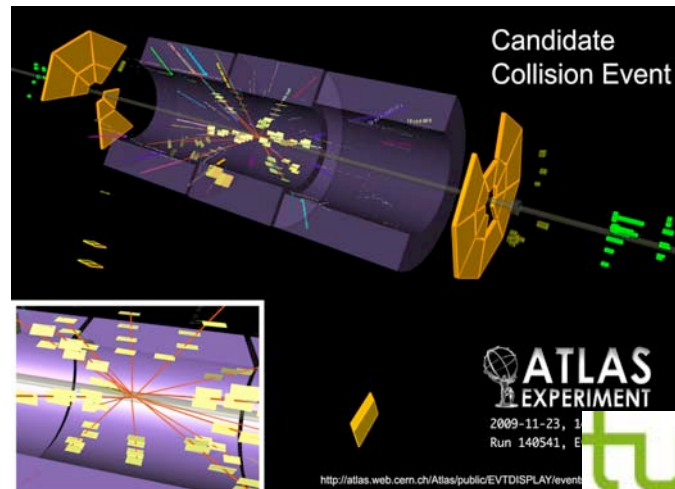
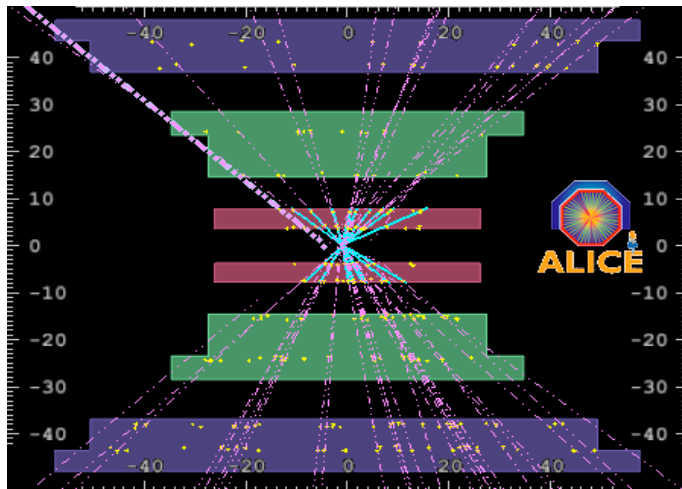
Insulating vacuum barrier every 2 cells in the arc → Some moved

- Considerable collateral damage over few hundred metres
- Contamination by soot of beam pipes
- Damage to super-insulation blankets
- Large release of helium into the tunnel (6 of 15 tons)

etwa ein Jahr Reparatur des LHC
und letzte Aufbauarbeiten bei den
Experimenten

Inbetriebnahme des LHC

!!! BEAM AT ATLAS !!!
20-11-09 20:47



tu technische universität dortmund

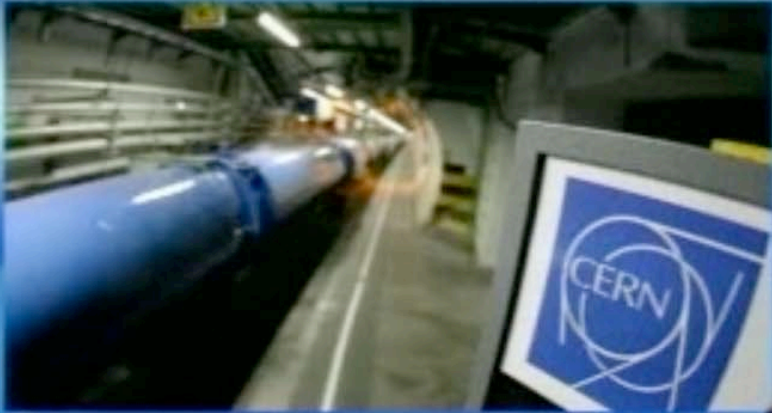
tu technische universität dortmund

Proudly presents ...



Inbetriebnahme des LHC

Teilchenbeschleuniger
wieder in Betrieb



tagesschau 21.11.2009



seit November 2009
0.45 TeV + 0.45 TeV

seit März 2010
3.5 TeV + 3.5 TeV

Forschung zum Urknall



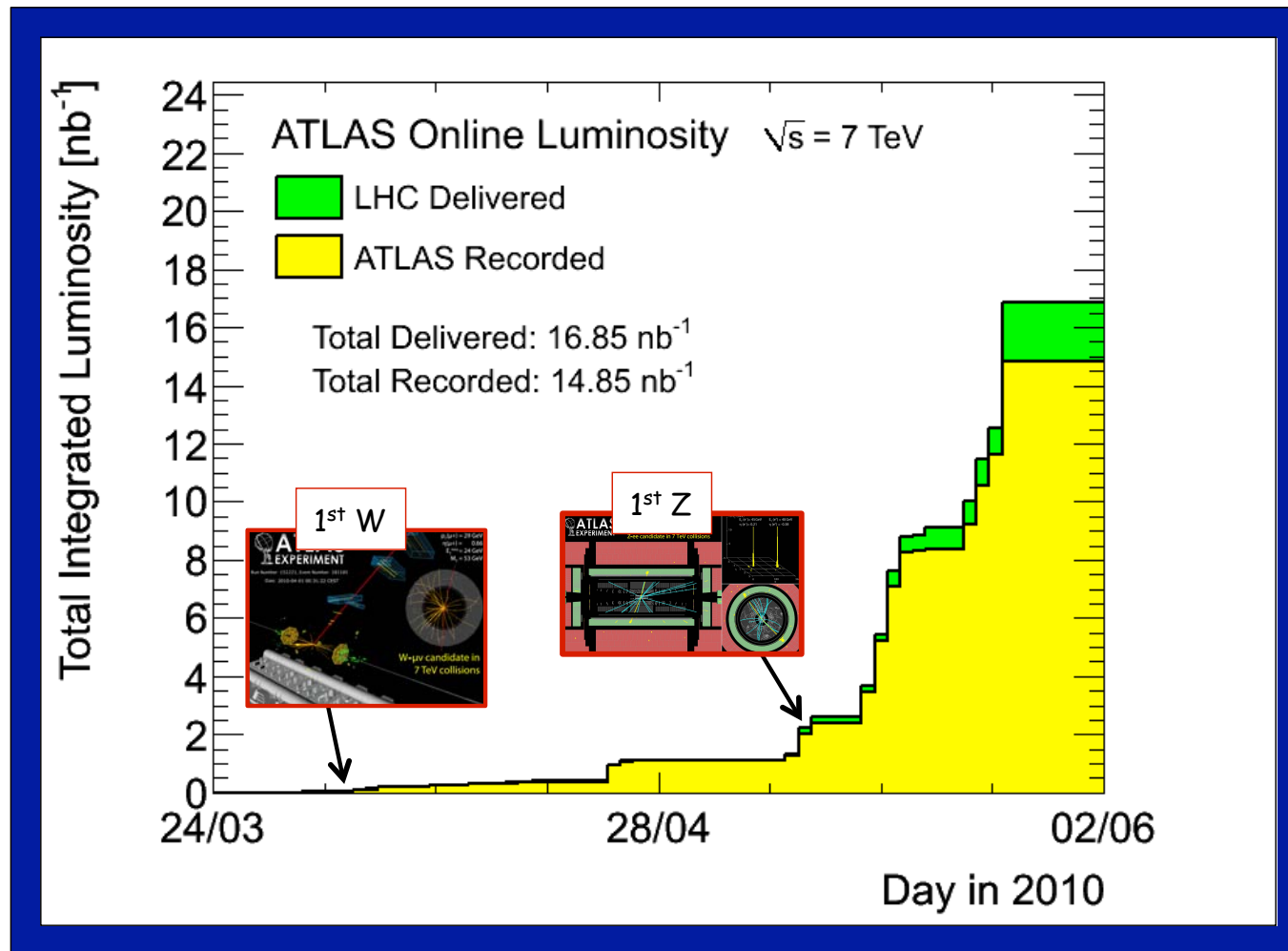
Genf

tagesschau 30.03.2010



Inbetriebnahme des LHC

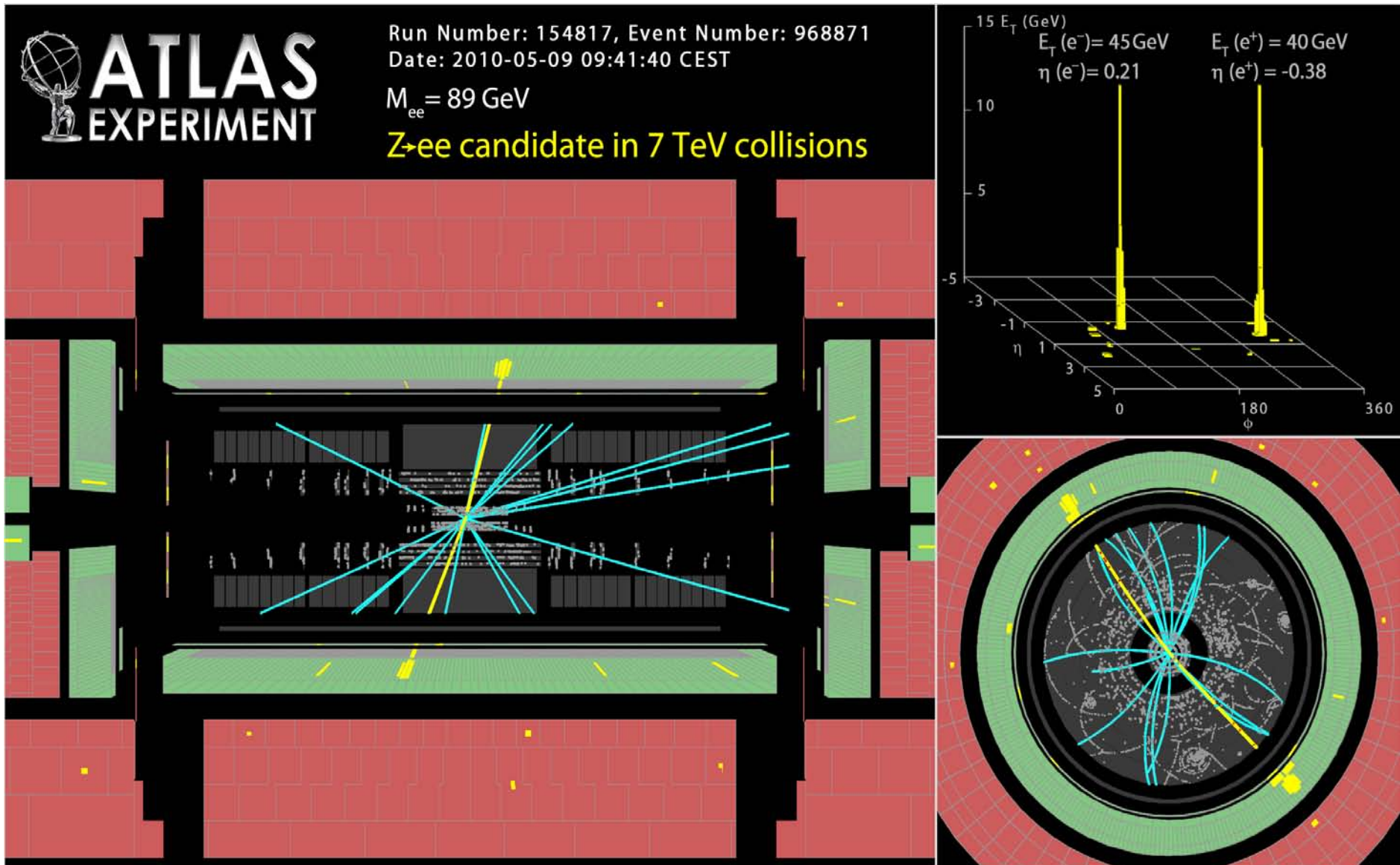
ansteigende Luminosität



Wiederentdeckung einzelner
Teilchen des Teilchenszoos

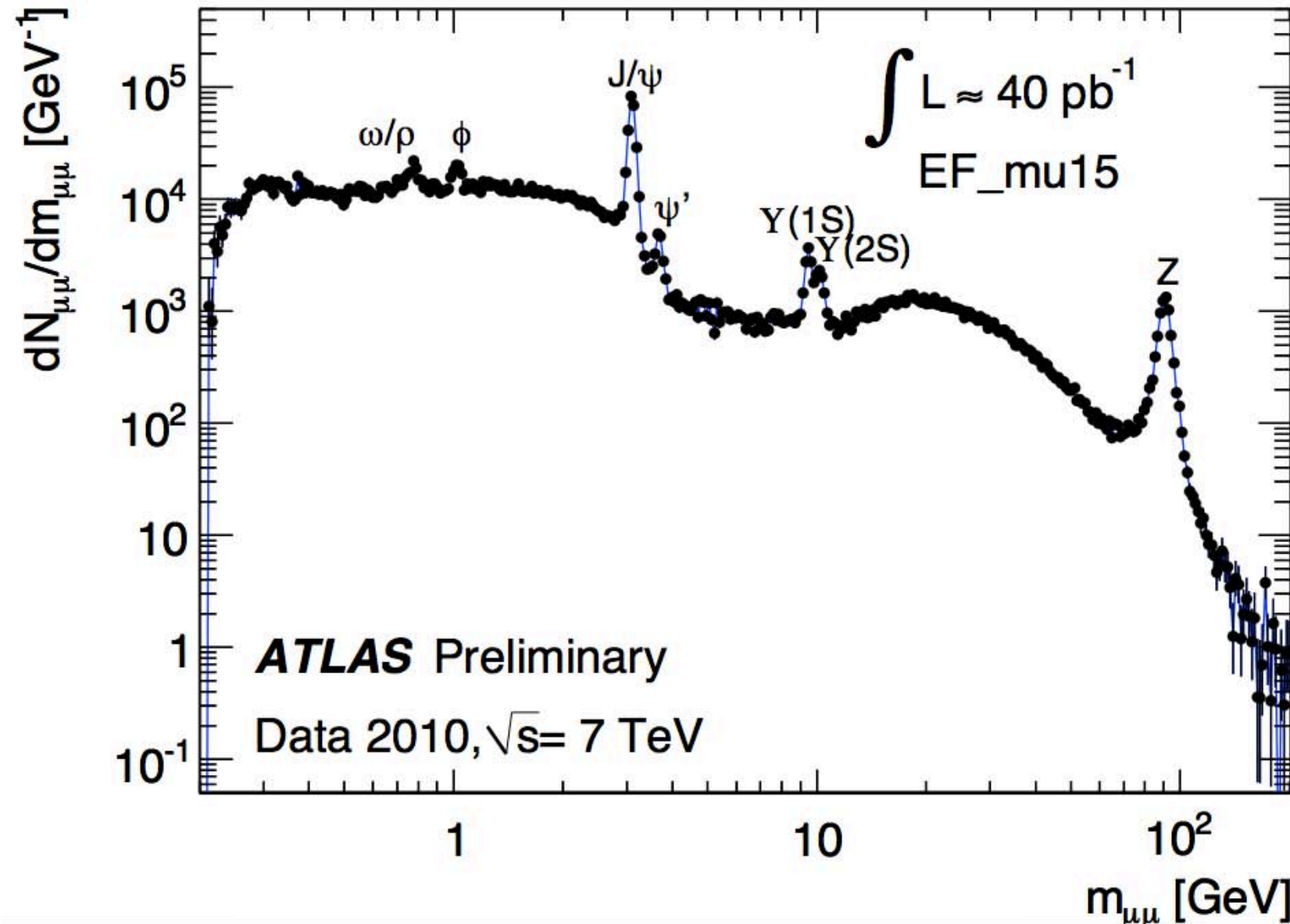
Inbetriebnahme des LHC

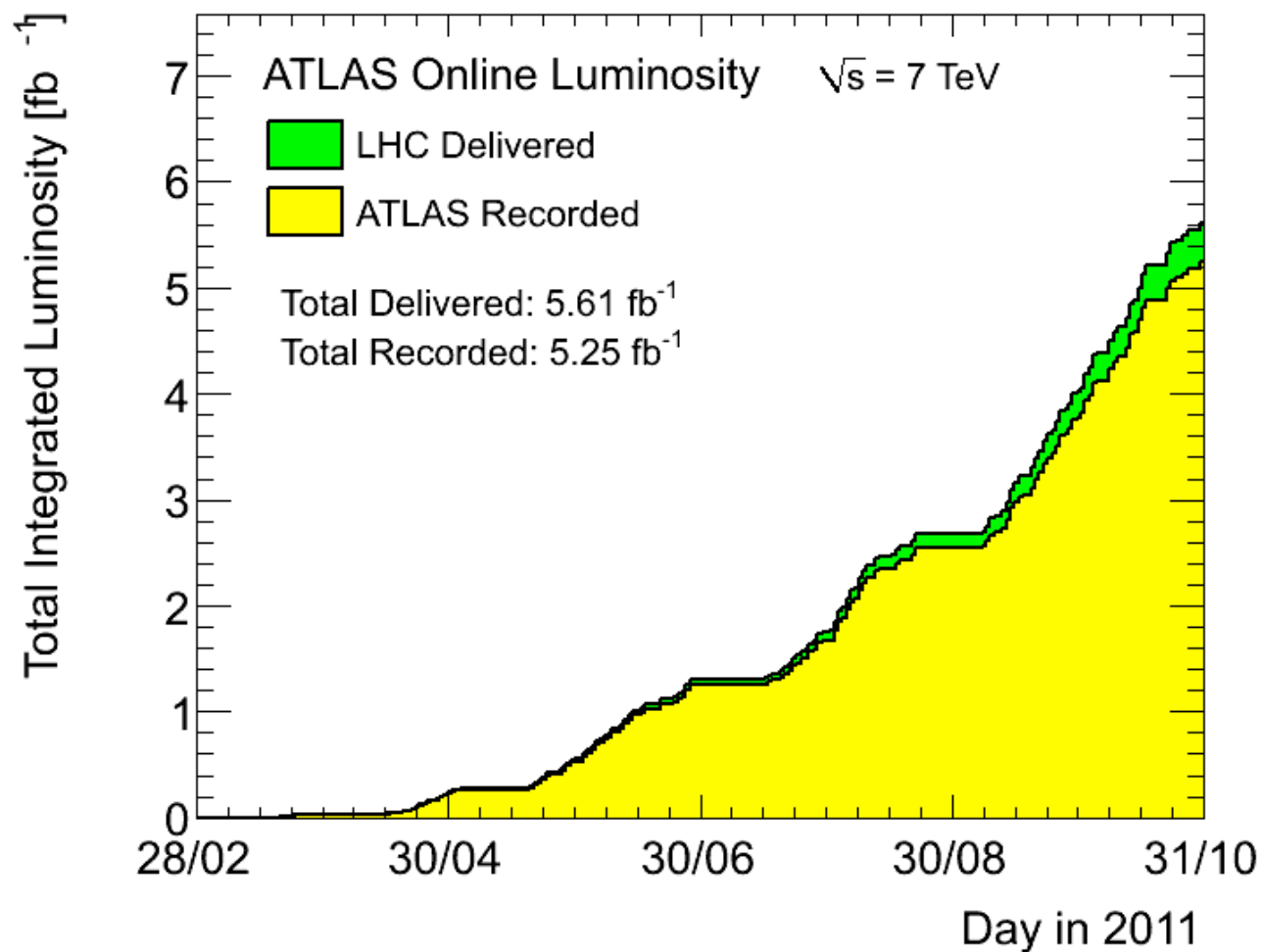
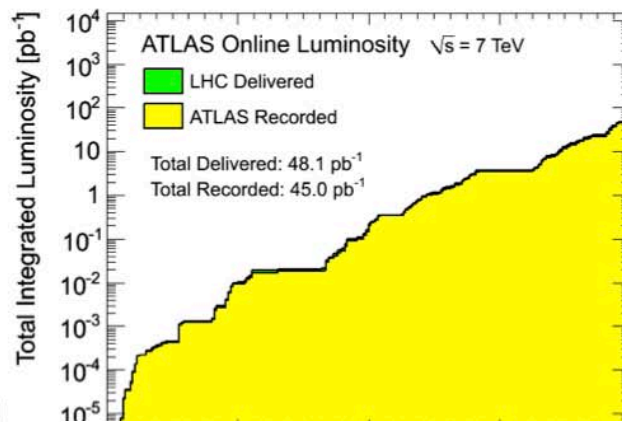
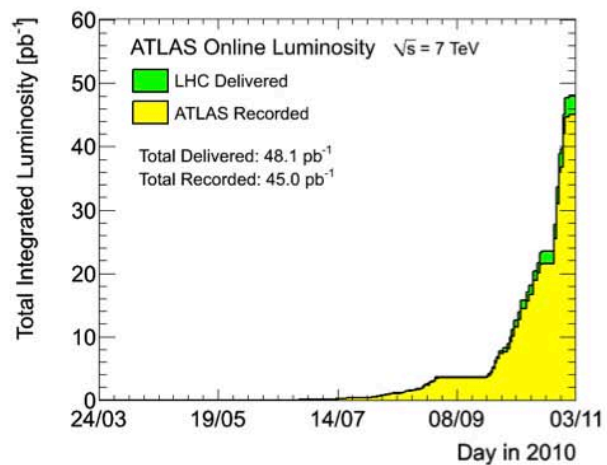
Rekonstruktion eines Z-Teilchens, rund 90 GeV



Inbetriebnahme des LHC

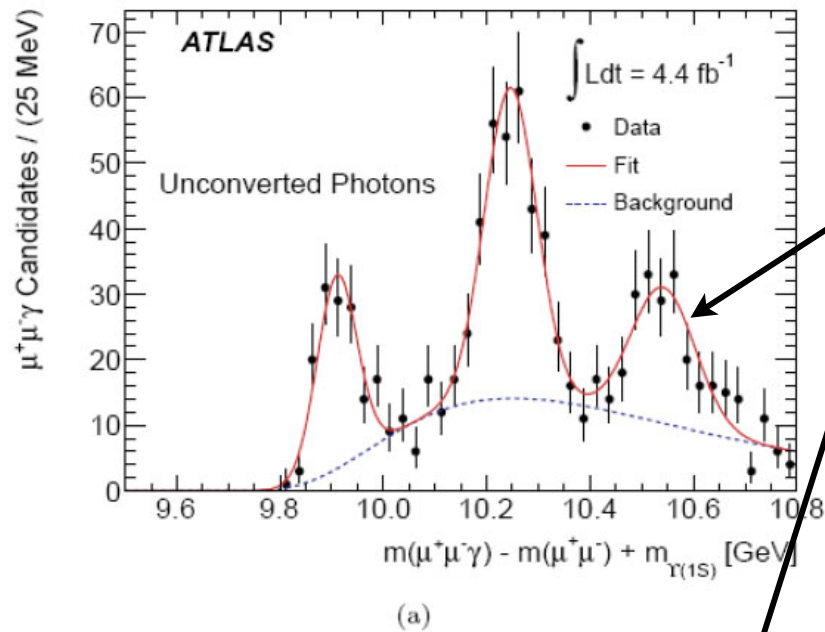
“Wiederentdeckung”
bekannter Teilchen





Entdeckung neuer Teilchen?

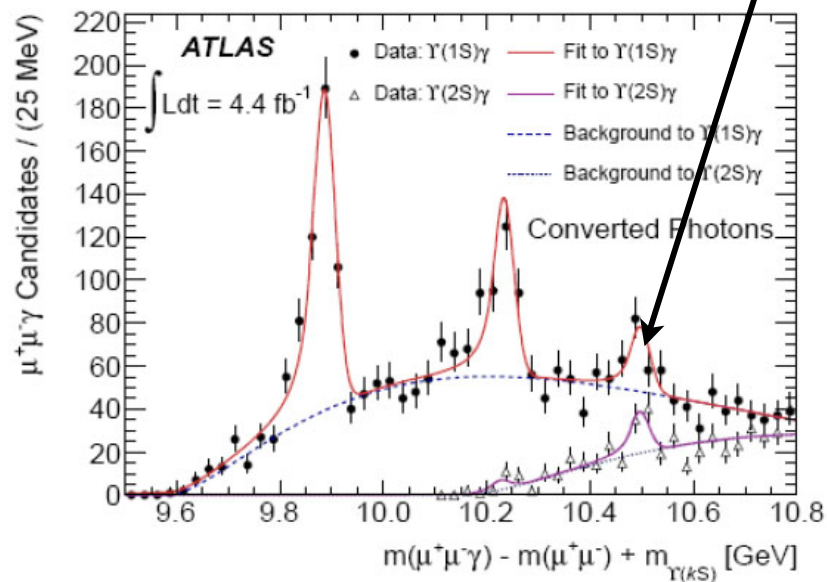
Higgs-Teilchen?



$\chi_{b(3P)}$

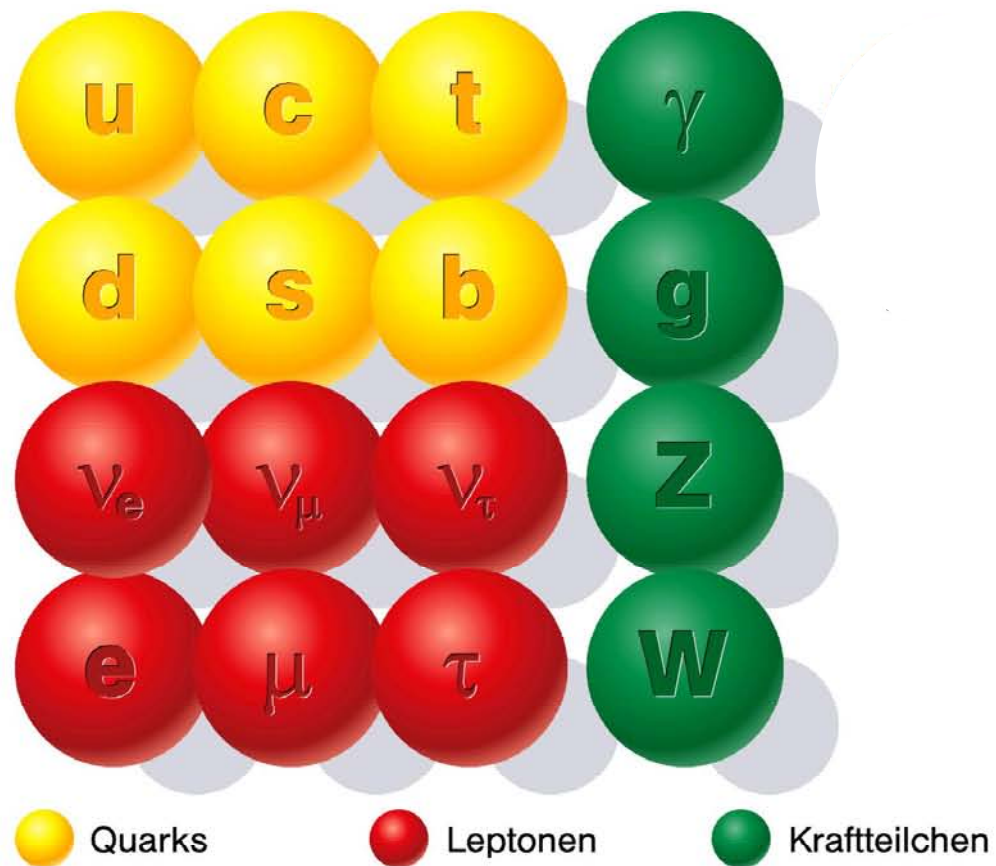
$= b + \text{anti-}b$

?



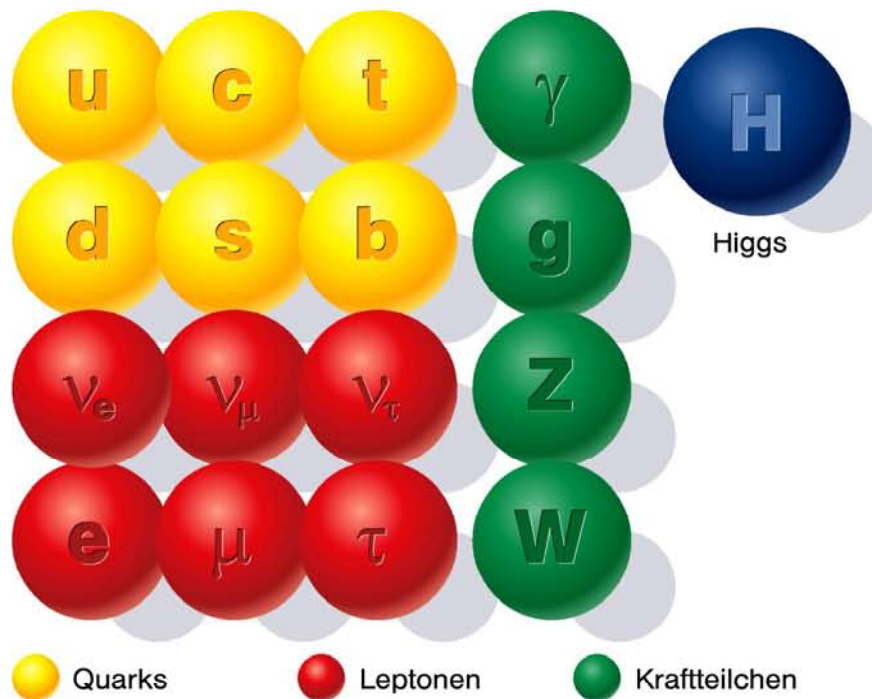
Baukasten der Elementarteilchen

Materie und Kräfte



Erweiterung des Elementarteilchen-Baukastens

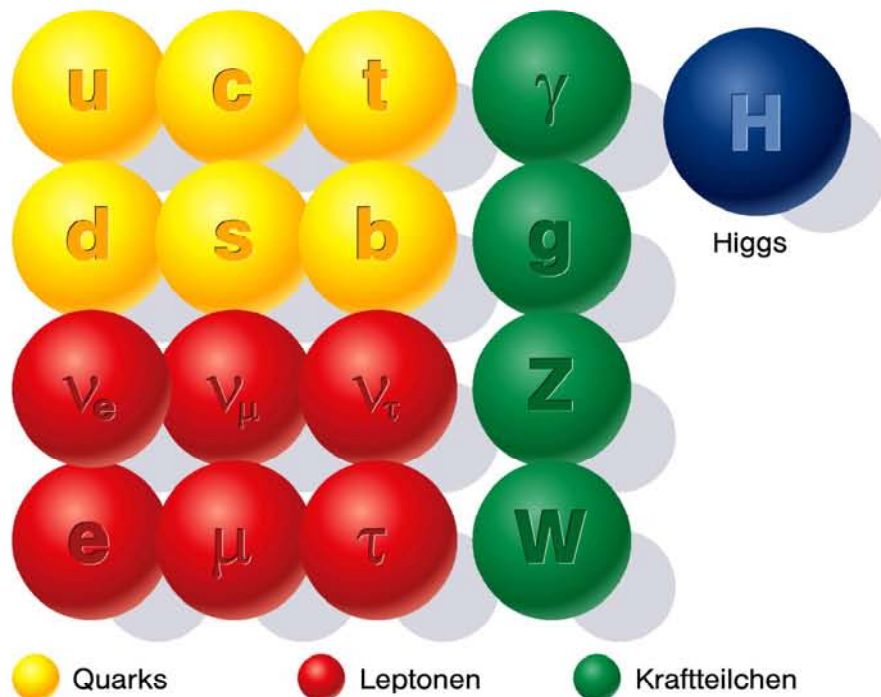
Standard-Teilchen



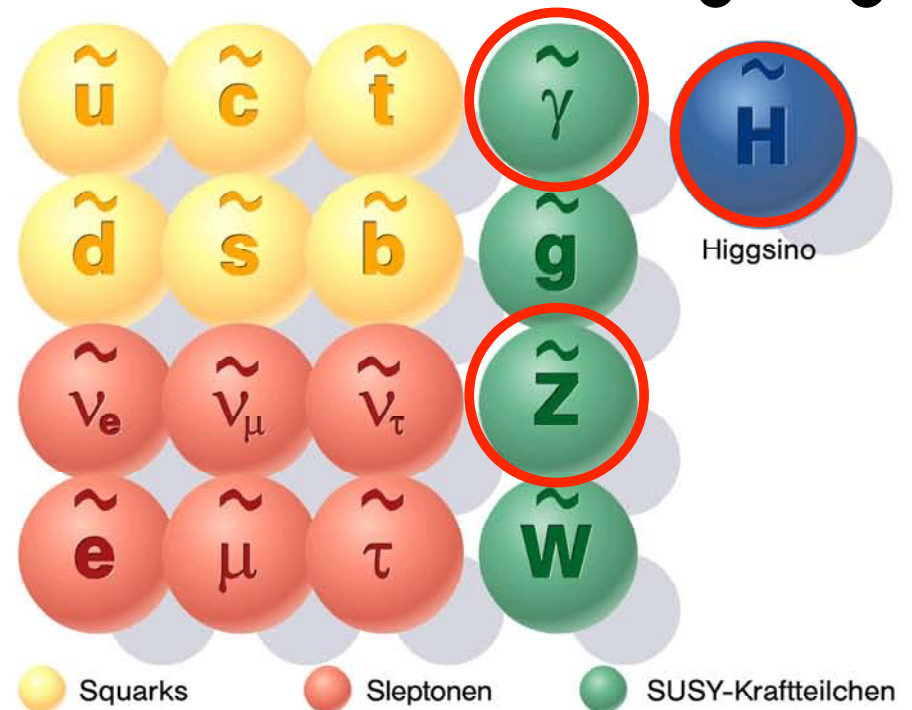
Erweiterung des Elementarteilchen-Baukastens

??

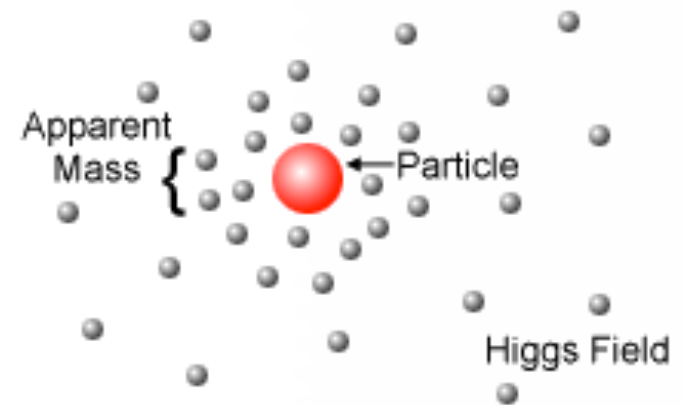
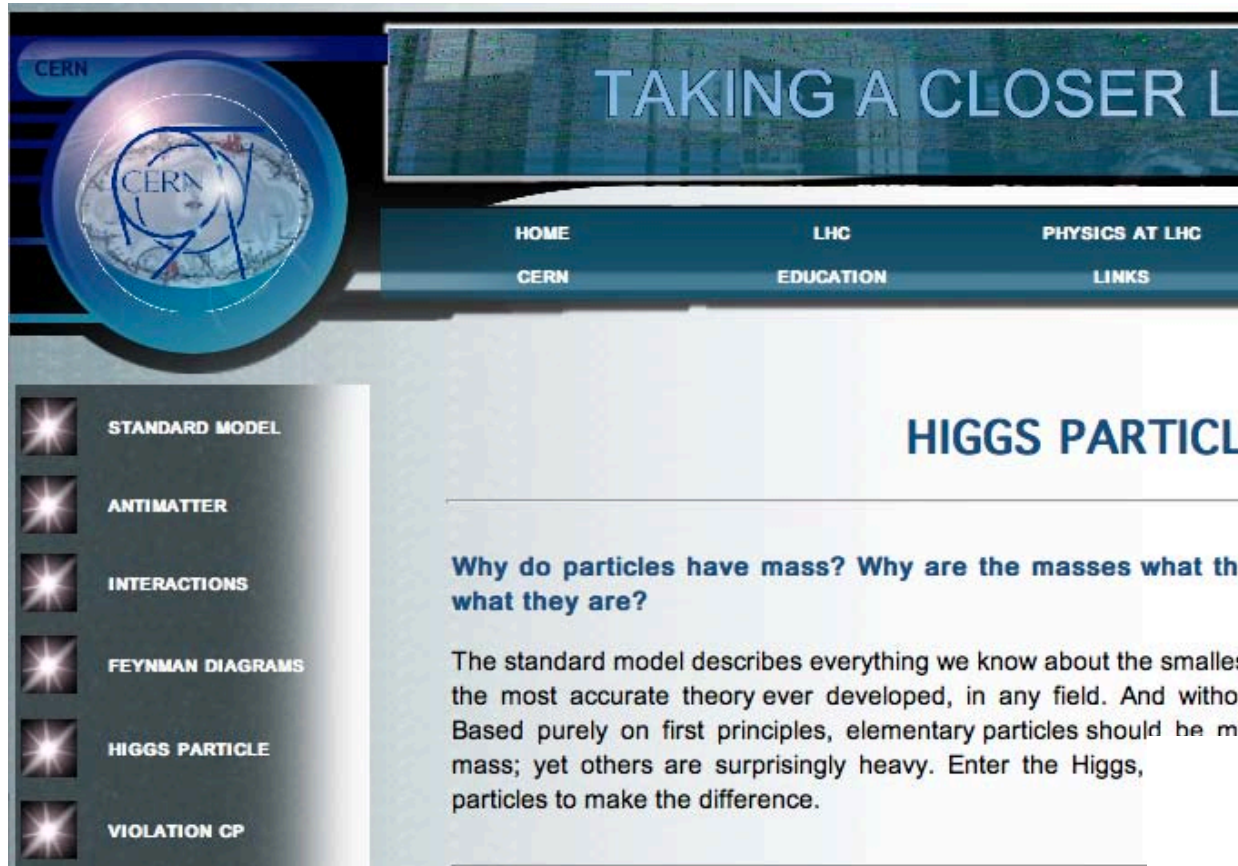
Standard-Teilchen



SUSY-Teilchen

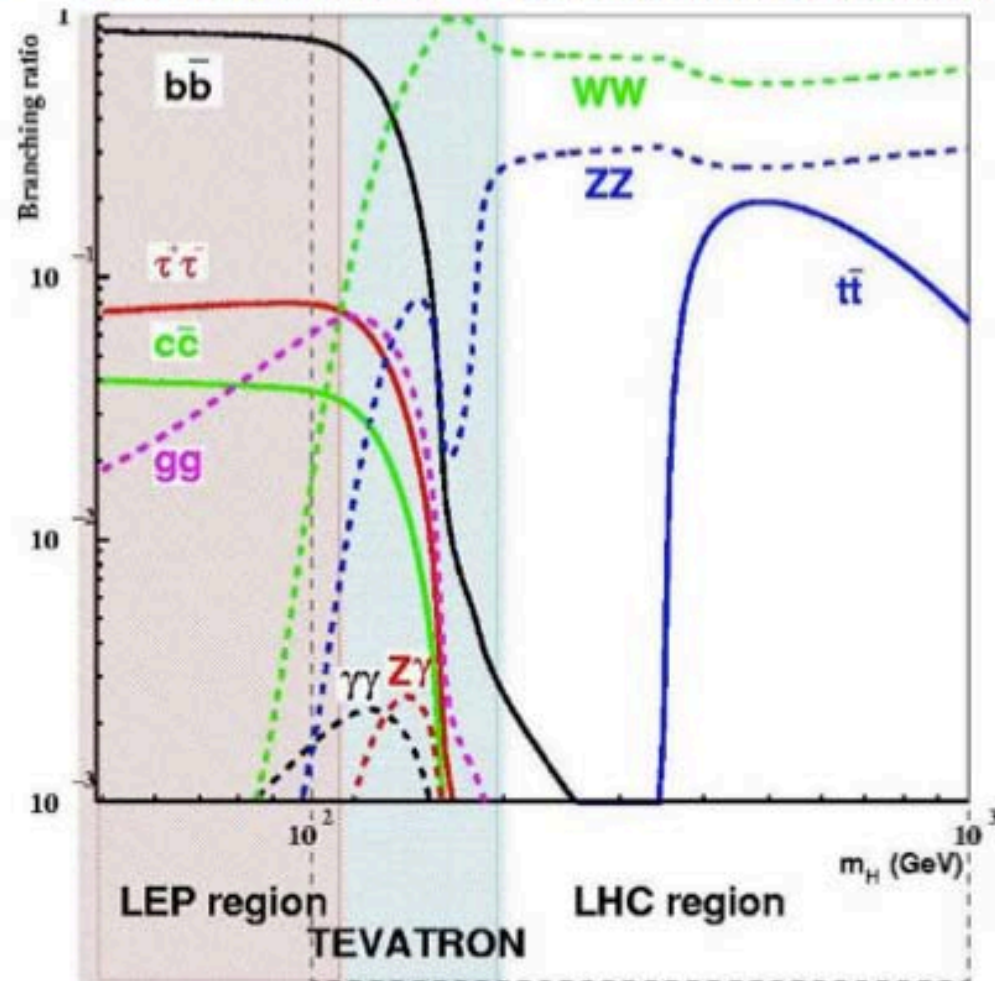


Neutralino als Kandidat
für Dunkle Materie



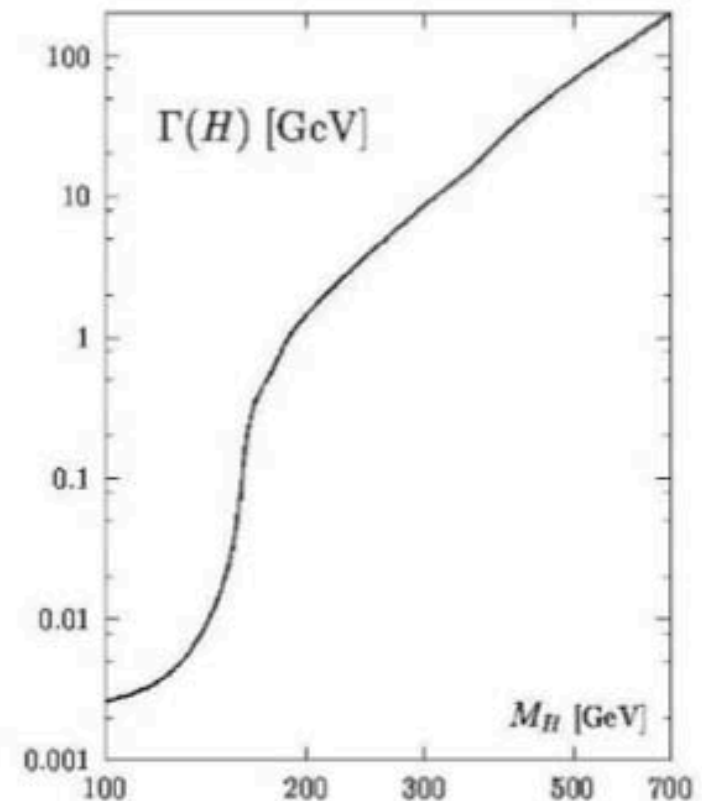
Higgs Zerfälle

- Zerfalls BRs eindeutig vorhersagbar für das Standard Model Higgs:
 - Oberhalb Schwelle μm_f^2 für Fermionen, μm_H^2 für Bosonen (W,Z)
- Produktionsprozess vom abhängig vom Experiment



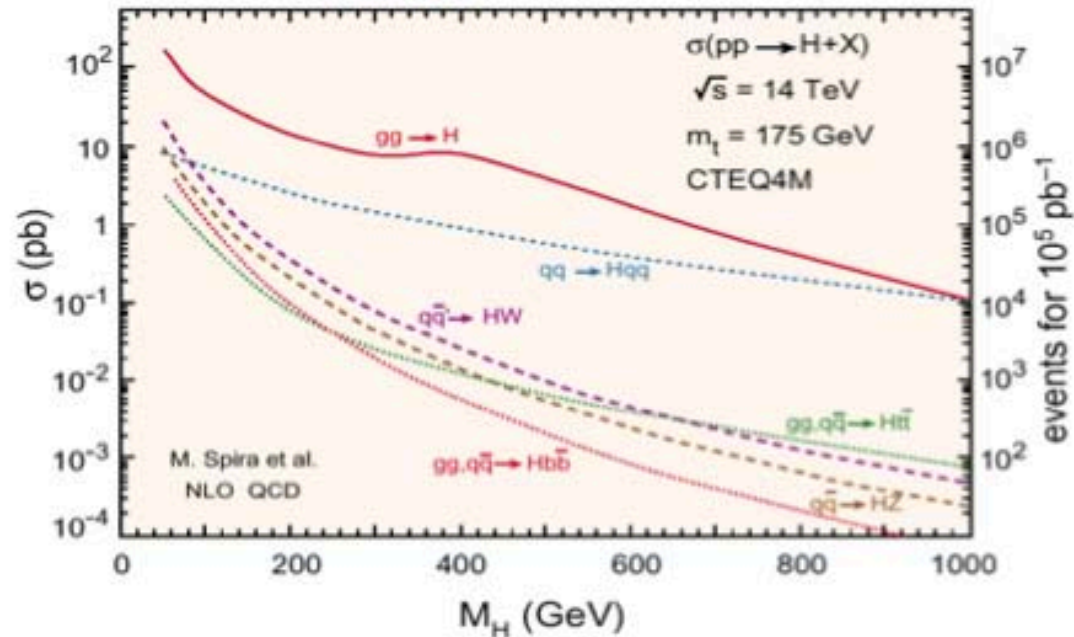
$$\Gamma(M_H = 130 \text{ GeV}) \approx 10 \text{ MeV}$$

$$\Gamma(M_H \approx 1 \text{ TeV}) \approx \frac{1}{2} M_H^3 (\text{TeV}) \approx \frac{1}{3} \text{ TeV}$$



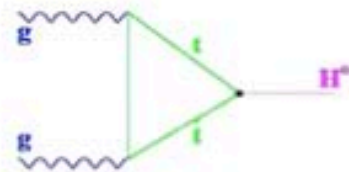
30

Higgs @ LHC



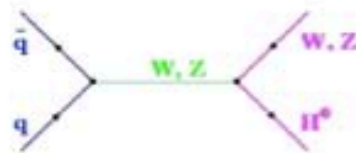
- Andere dominierende Produktionsprozesse als bei Tevatron:

Gluon Fusion



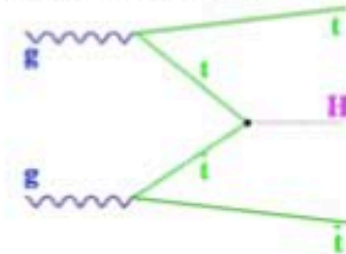
nicht triggerbar
für $H \rightarrow b\bar{b}, t\bar{t}$

Associate Production



zu kleiner
Wirkungsquerschnitt

Yukawa Process



wichtig für $BR_{b\bar{b}}, BR_{t\bar{t}}$ Entdeckungskanal

Weak Boson Fusion



http://atlas.ch/ Google

privat ▾ OpenMap GoogleMap allg. Nützl. ▾ E4 ▾ FAK Physik ▾ TU Dortmund ▾ CERN ▾ ATLAS ▾ Pixel ▾ COBRA ▾ Physik-sonst. ▾ BMBF A




[Home](#) [Info](#) [Multimedia](#) [Store](#) [Blogs](#) [Links](#) [Tour of ATLAS](#) [Contact](#) [Collaboration Site](#) [Press](#) [Student/Teachers](#)

[Facebook](#) [Twitter](#) [YouTube](#)

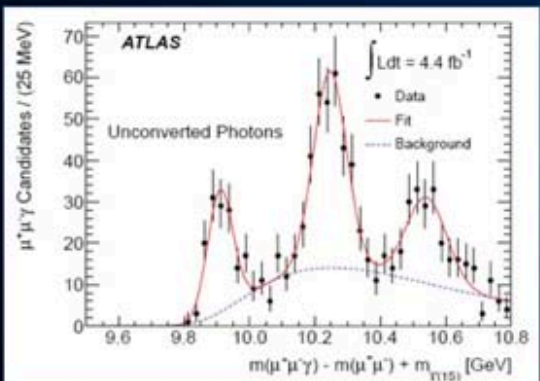
LA Times: The quest for the 'God particle': Tiny matter, big cliffhanger_ Like 1k Send

ATLAS discovers its first new particle

The ATLAS collaboration has announced the discovery of the $\chi_b(3P)$, which is a bound state of a bottom quark and bottom antiquark ($b\bar{b}$). [More...](#)

ATLAS Experiment presents latest Higgs search status

The latest update of the ATLAS searches for the Standard Model Higgs boson was presented at a CERN seminar on December 13, 2011. [More...](#)



ATLAS
Unconverted Photons
 $\int L dt = 4.4 \text{ fb}^{-1}$
• Data
— Fit
--- Background
 $\mu^+\mu^-\gamma \text{ Candidates} / (25 \text{ MeV})$
 $m(\mu^+\mu^-\gamma) - m(\mu^+\mu^-) + m_{\gamma(1S)} [\text{GeV}]$

The spectrum of the χ_b states: the leftmost peak is [More...](#)

ATLAS RUN STATUS

PROTON RUN HEAVY ION RUN

Winter shutdown through March 2012

LIVE EVENTS

LATEST LHC RUNS

STATUS PLANS

IMAGES VIDEOS MURAL

ATLAS Science

[Discovery Quest](#)

[ATLAS eTours](#)

ATLAS Store

[Brochures](#) [DVD](#) [Music CD](#) [Popup Book](#) [Photo Book](#) [3D Viewer](#) [More](#)

About ATLAS

Mapping the Secrets of the Universe

ATLAS is a particle physics experiment at the Large Hadron Collider at CERN. The ATLAS detector is searching for new discoveries in the head-on collisions of protons of extraordinarily

[Images](#) [Videos](#) [YouTube](#)

AS Image 3-1: Sascha Mehlhase's detailed model of the ATLAS detector created entirely of LEGO blocks!

[Full size version of photo...](#)



ATLAS News

 Tweet Like Send 424 likes. [Sign Up](#) to see what your friends like.

ATLAS experiment presents latest Higgs search status

December 13, 2011

The statement below is also available in:

Chinese | Dutch | French | German | Italian | Japanese | Brazilian Portuguese | Portuguese

The latest update of the ATLAS searches for the Standard Model Higgs boson was presented at a CERN seminar on December 13, 2011. As stated in the CERN press release, the new ATLAS and CMS results are "sufficient to make significant progress in the search for the Higgs boson, but not enough to make any conclusive statement on the existence or non-existence of the elusive Higgs. Tantalising hints have been seen by both experiments in the same mass region, but these are not yet strong enough to claim a discovery."

"We have restricted the most likely mass region for the Higgs boson to 115-130 GeV, and over the last few weeks we have started to see an intriguing excess of events in the mass range around 125 GeV," explained ATLAS experiment spokesperson Fabiola Gianotti. "This excess may be due to a fluctuation, but it could also be something more interesting. We cannot conclude anything at this stage. We need more study and more data. Given the outstanding performance of the LHC this year, we will not need to wait long for enough data and can look forward to resolving this puzzle in 2012."

The CMS experiment also has updated their results in this same low mass region.

The Higgs boson is predicted by the Standard Model. Via the Higgs field, it gives mass to the fundamental particles. It is so short-lived that it decays almost instantly, and the experiment can only observe the particles that it decays into. The Higgs boson is expected to decay in several distinct combinations of particles, and what is most intriguing about these results is that small excesses of events are seen in more than one such decay mode and in more than one experiment.

Links

CERN Press Release: [English](#) / [French](#)

[Interview with Fabiola Gianotti](#)

Background on the Higgs

Animation of event, 4 muons

Animation of event, 2 electrons & 2 muons

Animation of event, 2 photons

Event Displays

Higgs limit plot for masses between 110-150 GeV

Higgs limit plot for masses between 110-600 GeV

Important terms in discussing the search for the Higgs boson

CMS Experiment latest Higgs results

Phil Owen's "ATLAS Multimedia Contest" winning film about the Higgs

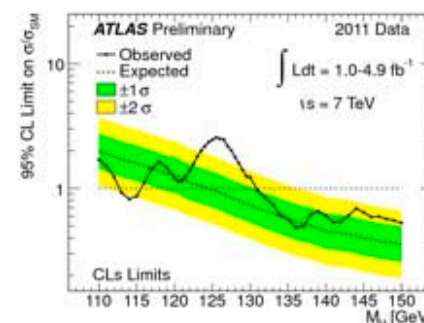
ATLAS Notes about the latest results

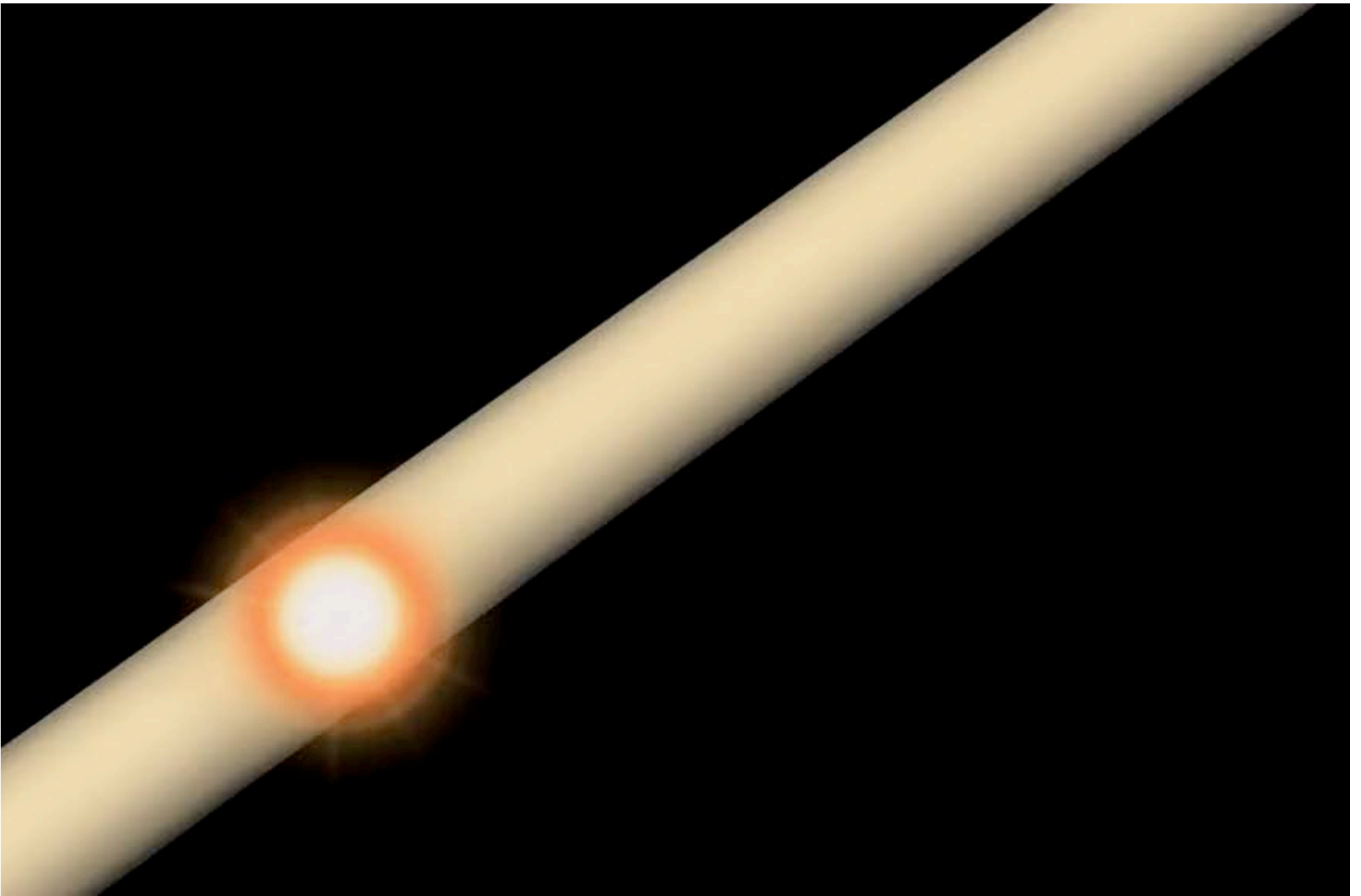
Combination of Higgs Boson Searches...

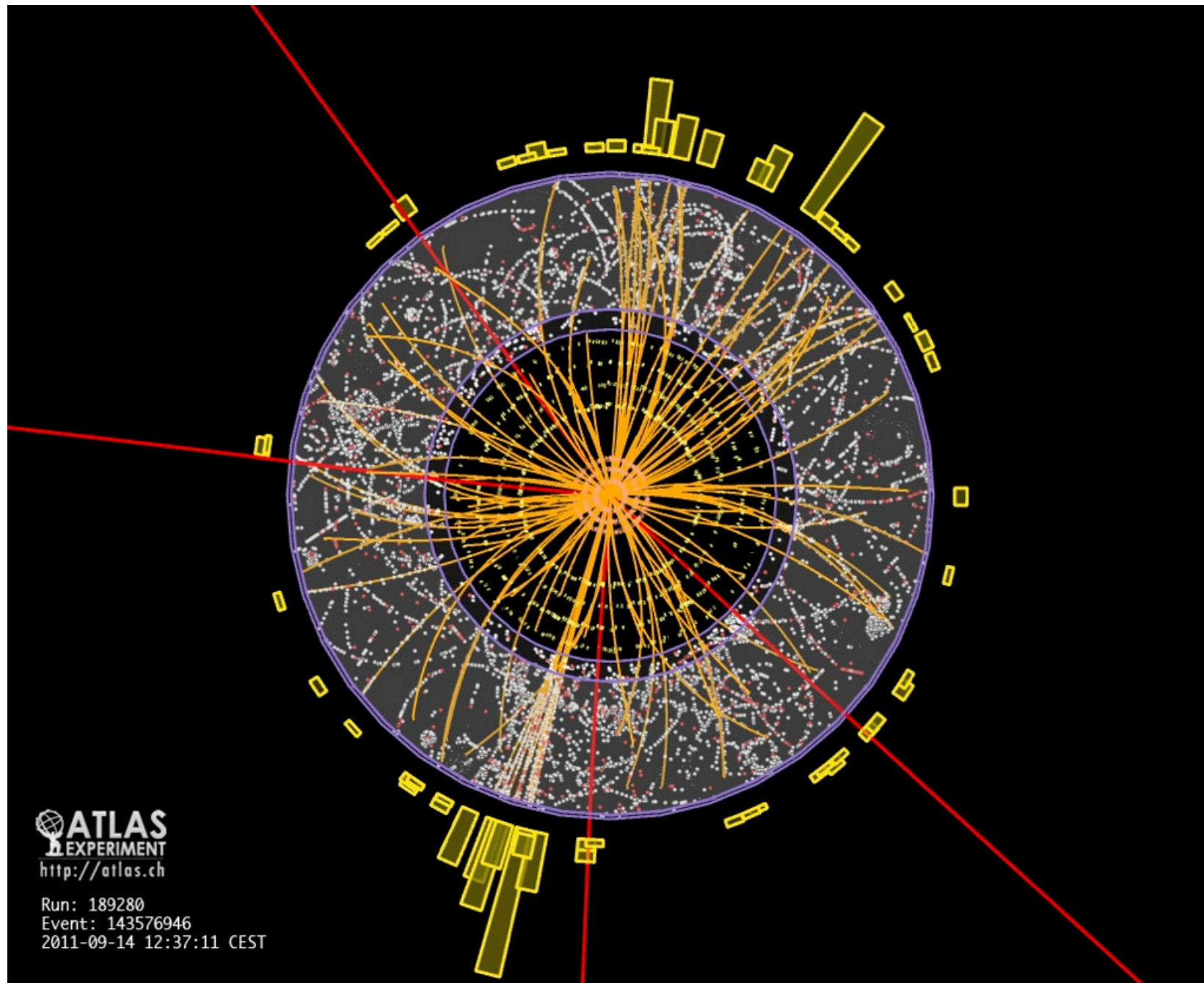
Search for the Standard Model Higgs boson in the decay channel $H \rightarrow ZZ(\gamma) \rightarrow 4 \text{ leptons}$...

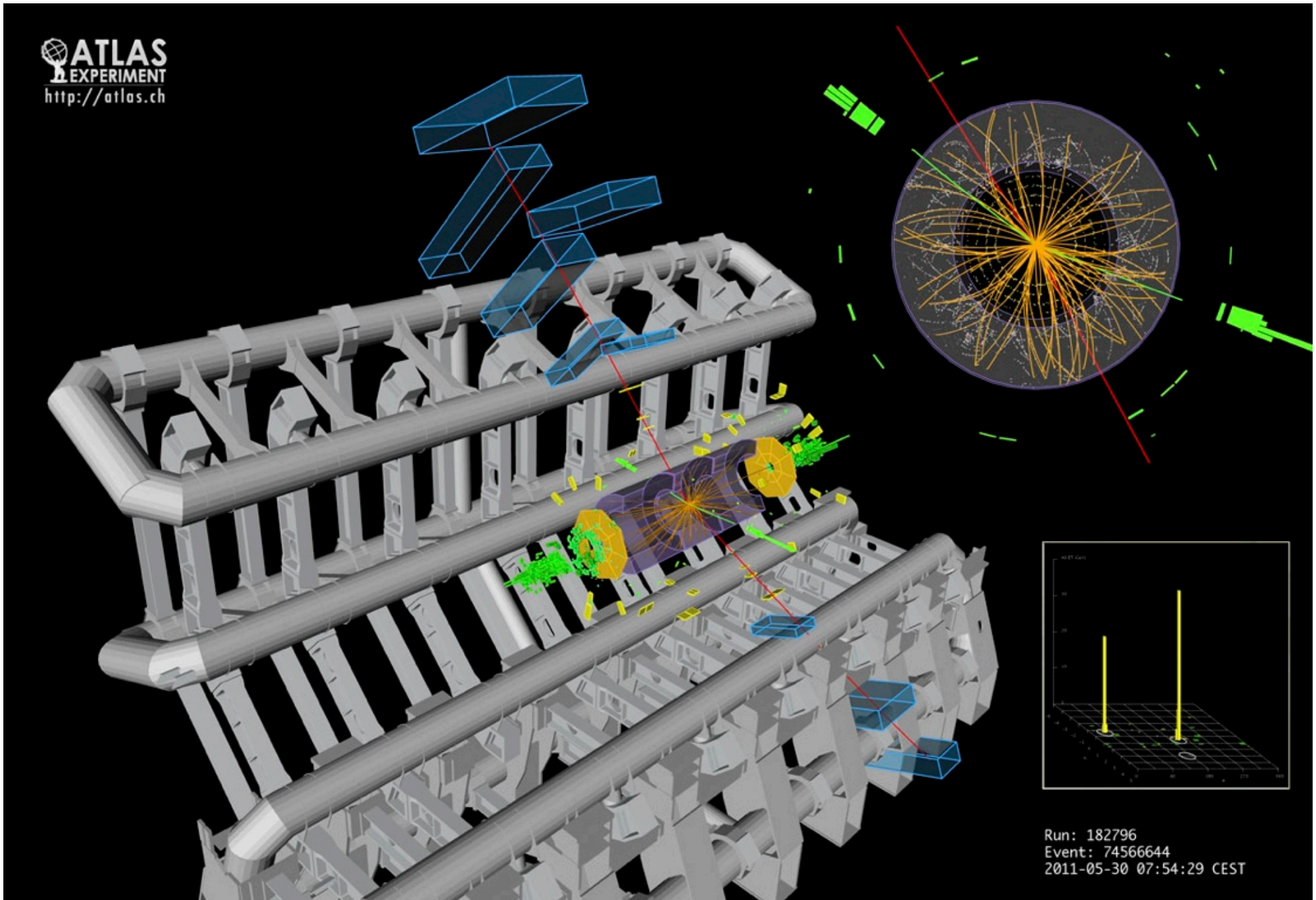
Search for the Standard Model Higgs boson in the diphoton decay...

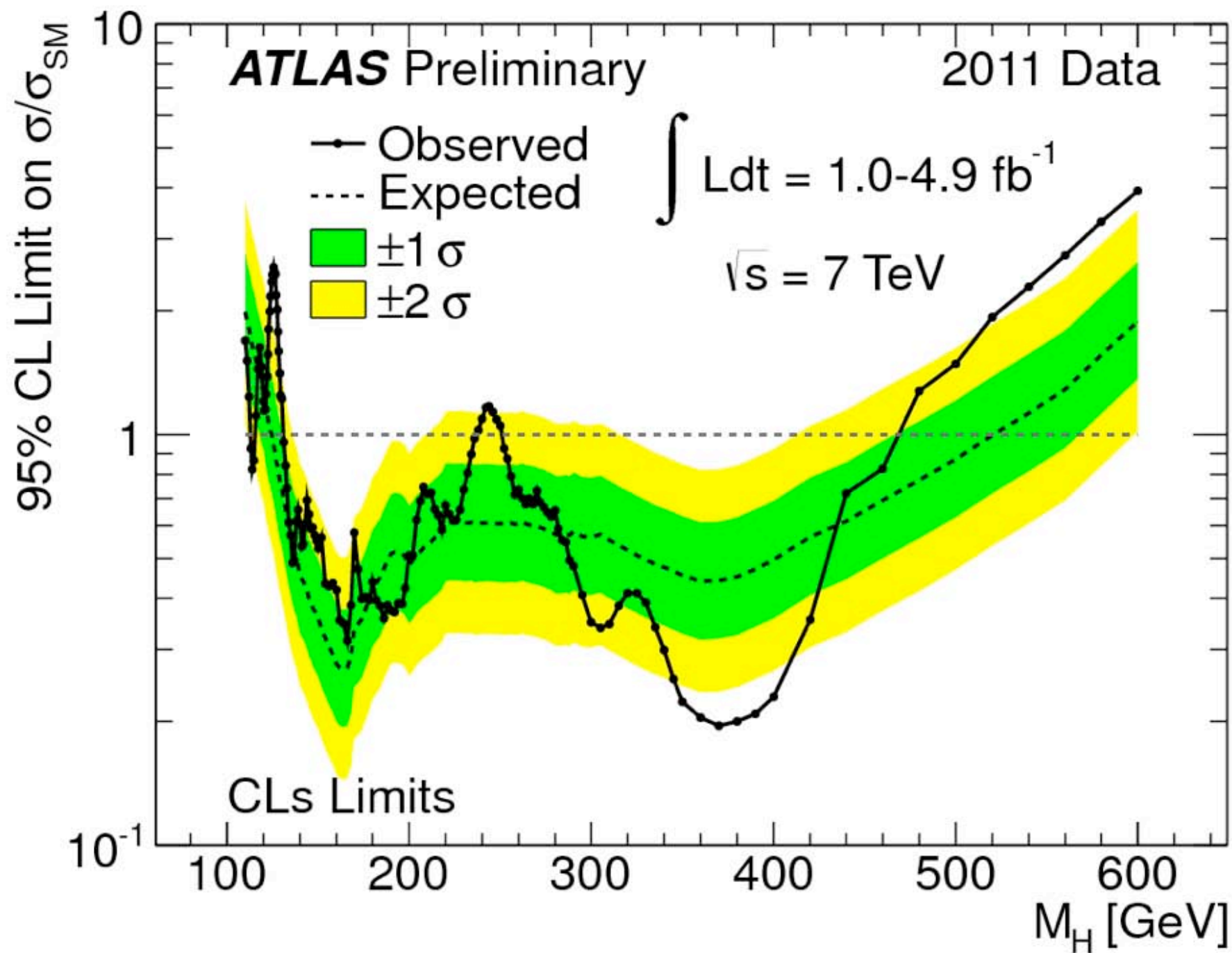
Search for the Higgs boson in the $H \rightarrow WW(\gamma) \rightarrow l\nu l\nu$ decay channel...



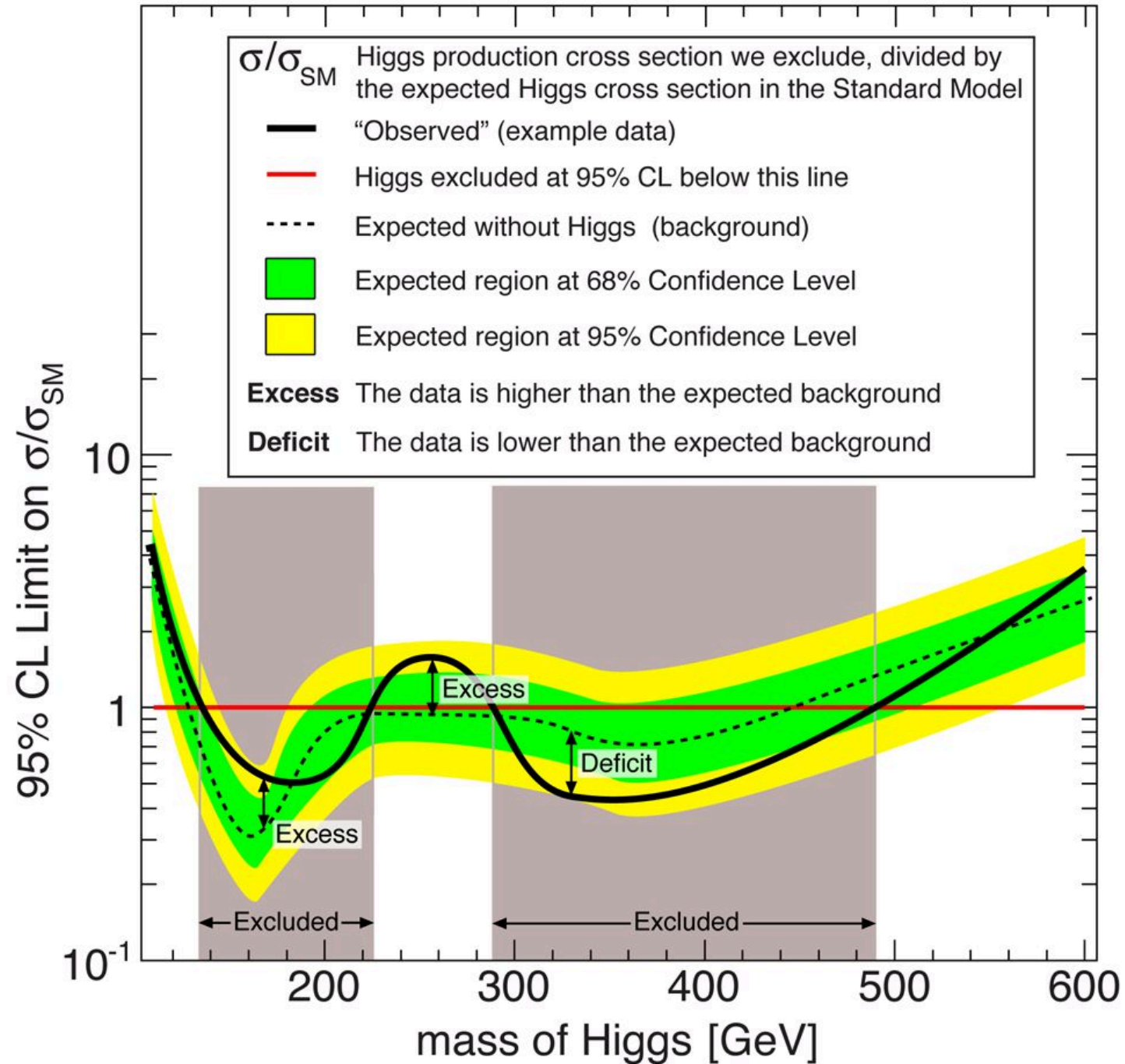








Explanatory figure (not actual data)



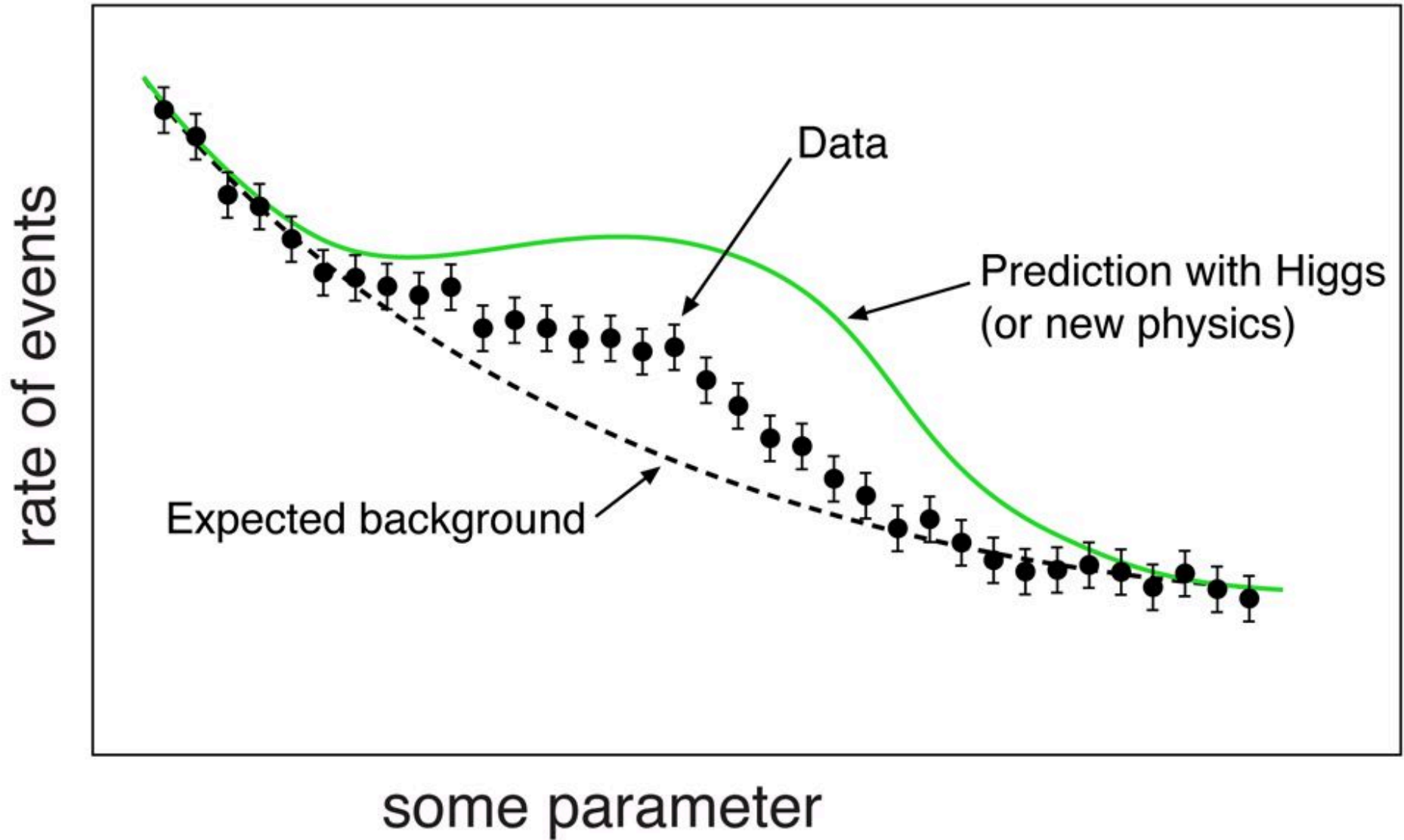
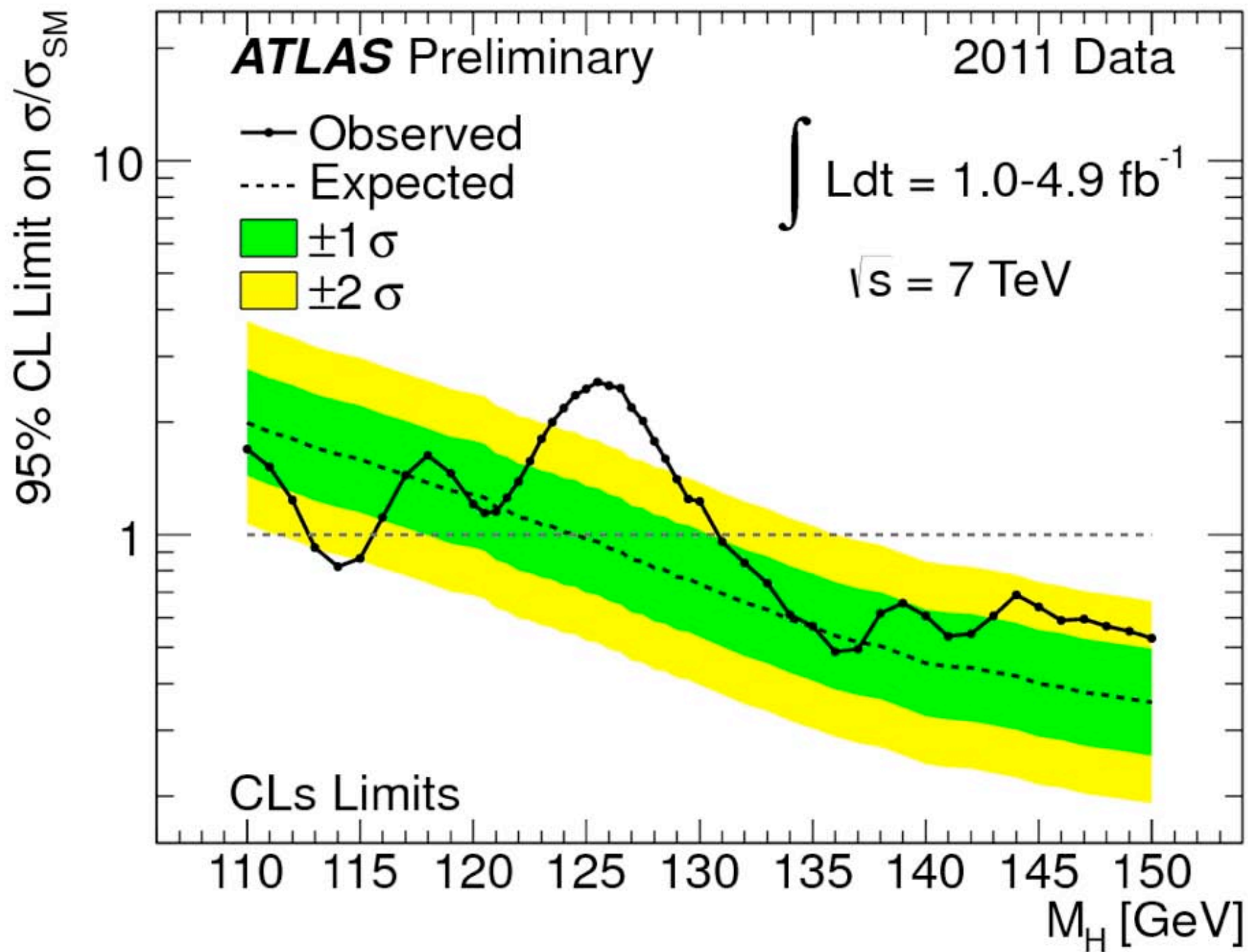


Figure B





Das ATLAS Experiment präsentiert den aktuellen Status in der Suche nach dem Higgs-Teilchen

Das ATLAS Experiment hat den aktuellen Status seiner Suche nach dem Higgs-Teilchen am 13. Dezember 2011 in einem Seminar am CERN vorgestellt. Wie in der

Pressemitteilung des CERN bekannt gemacht wurde, sind die neuen Resultate der ATLAS und CMS Experimente „ausreichend, die Suche nach dem Higgs Boson signifikant voranzutreiben, aber noch nicht hinreichend um eine definitive Schlussfolgerung über die mögliche Existenz oder Nicht-Existenz des nur schwer nachzuweisenden Teilchens zu treffen. Hinweise, die auf eine Existenz hindeuten, haben beide Experimente im selben Massenbereich gemeldet, diese sind aber noch nicht eindeutig genug um eine Entdeckung zu proklamieren.“

„Wir haben den noch möglichen Massenbereich des Higgs Bosons auf 115-130 GeV eingeschränkt. Ausserdem haben wir in den letzten Wochen einen interessanten Überschuss charakteristischer Ereignisse im Massenbereich um 125 GeV gesehen.“ so die Sprecherin des ATLAS Experiments Fabiola Gianotti. *„Dieser Überschuss könnte durch eine statistische Fluktuation hervorgerufen sein, oder aber auf etwas wirklich Interessantes hindeuten. Wir müssen dies weiter überprüfen und wir brauchen dazu weitere Daten. Mit der hervorragenden Leistung des LHC in diesem Jahr werden wir nicht allzu lange warten müssen, um im nächsten Jahr genügend Daten zu haben dieses Rätsel zu lösen.“*

Das CMS Experiment hat auch über neue Resultate im selben Massenbereich berichtet.

Das Higgs Boson ist im Standard Modell der Teilchenphysik vorhergesagt. Erst durch das Higgs Feld erhalten Elementarteilchen ihre Masse. Das Higgs Boson ist

statt einer Zusammenfassung:

