DPC SMF

XXX Reunión Annual de la División de Partículas y Campos de la SMF

The X(750000) and the latest Higgs results from the CMS Detector of the LHC

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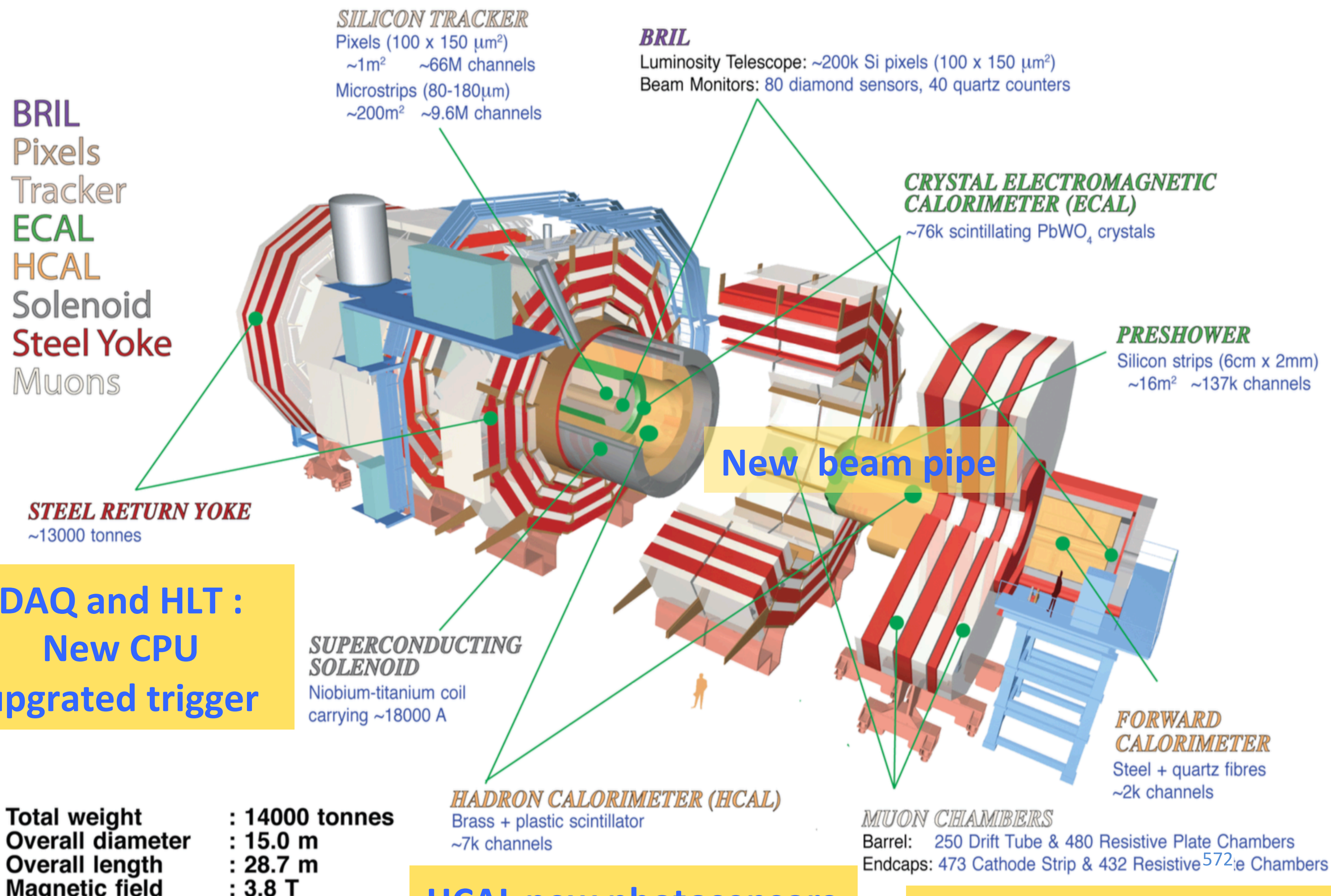
Facultad de Ciencias Físico-Matemáticas
Benemérita Universidad Autónoma de Puebla

May 25, 2016

Compact Muon Solenoid at RUN II

DETAILS GIVEN THIS MORNING BY EDUARD

BRIL
Pixels
Tracker
ECAL
HCAL
Solenoid
Steel Yoke
Muons



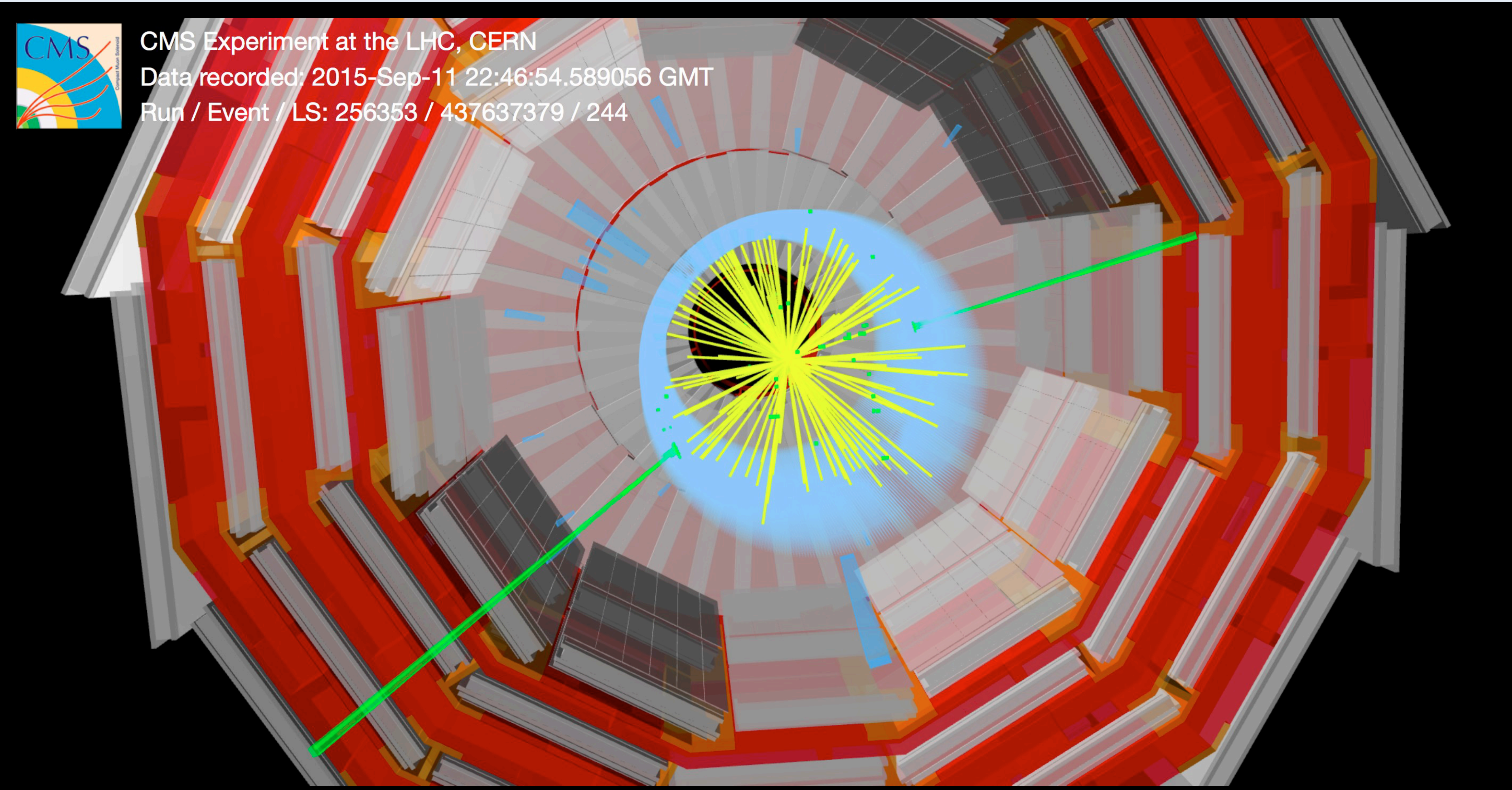
New beam pipe

DAQ and HLT : New CPU upgrated trigger

HCAL new photosensors

4th muon station in the End-cap

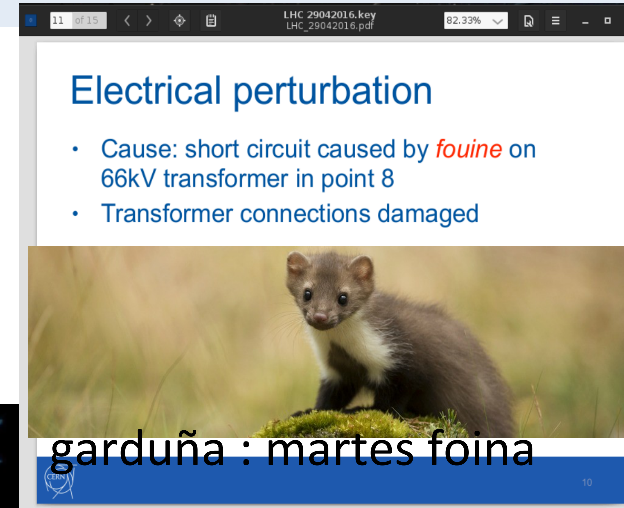
Run II event

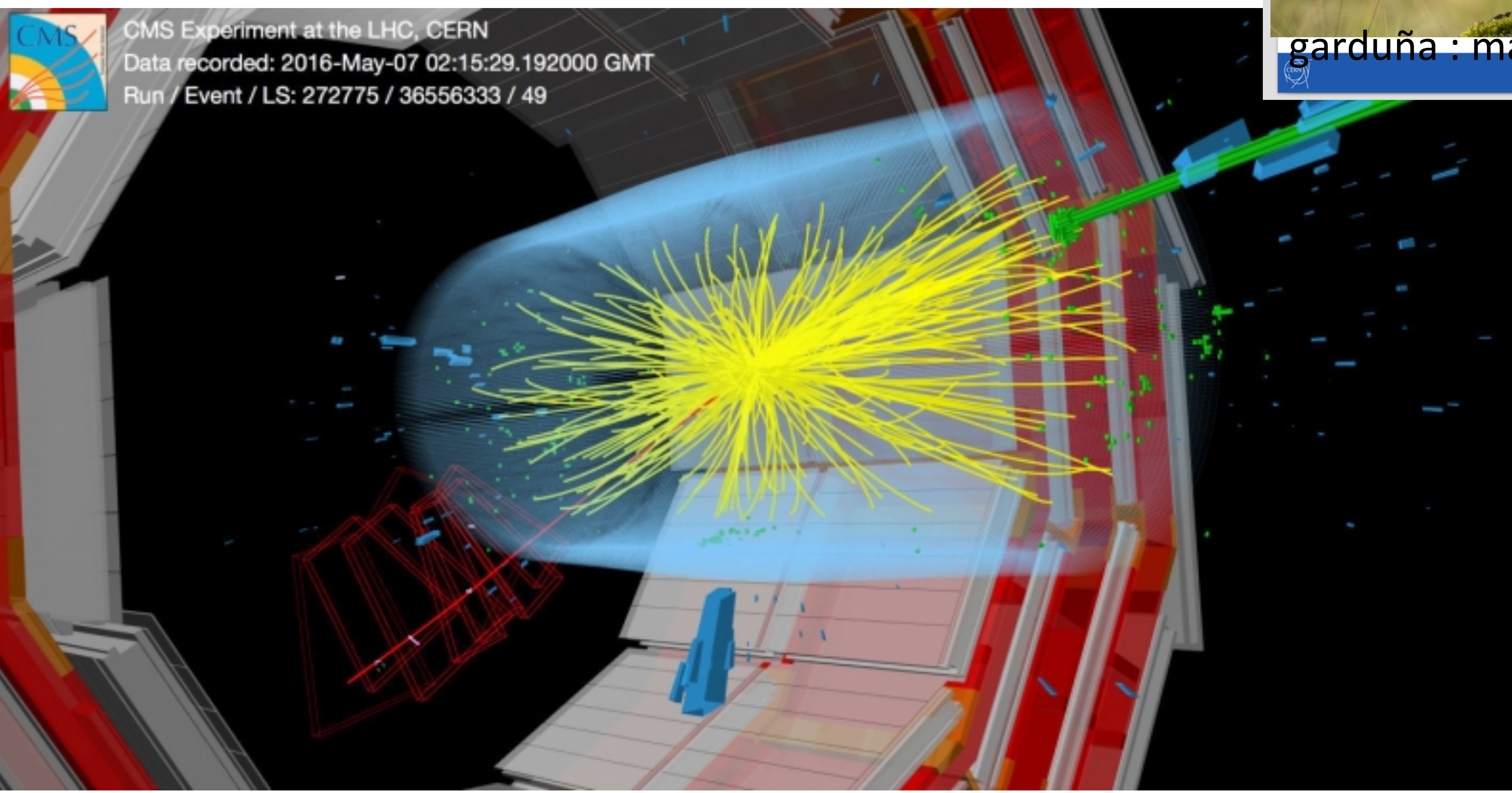

CMS Experiment at the LHC, CERN
Data recorded: 2015-Sep-11 22:46:54.589056 GMT
Run / Event / LS: 256353 / 437637379 / 244

From May 9th, 2016

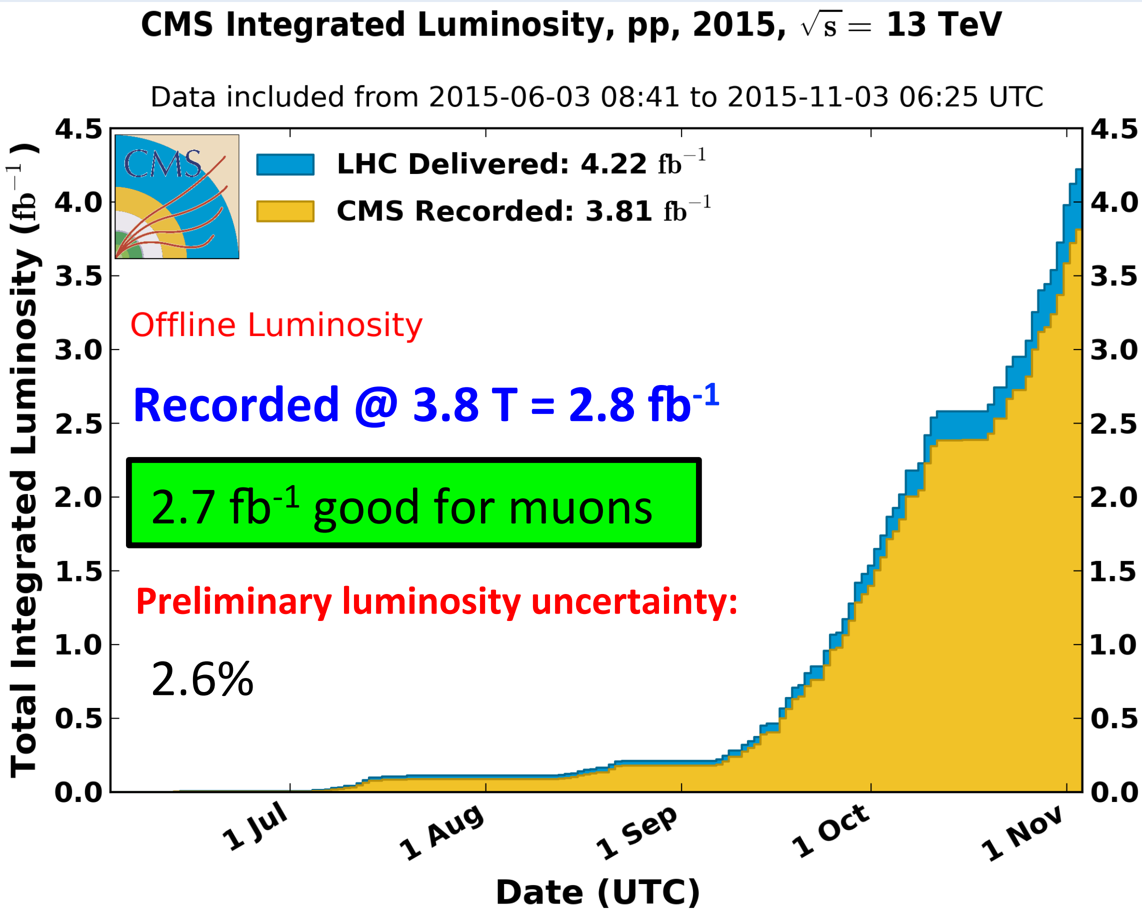
CMS is taking data with magnet ON

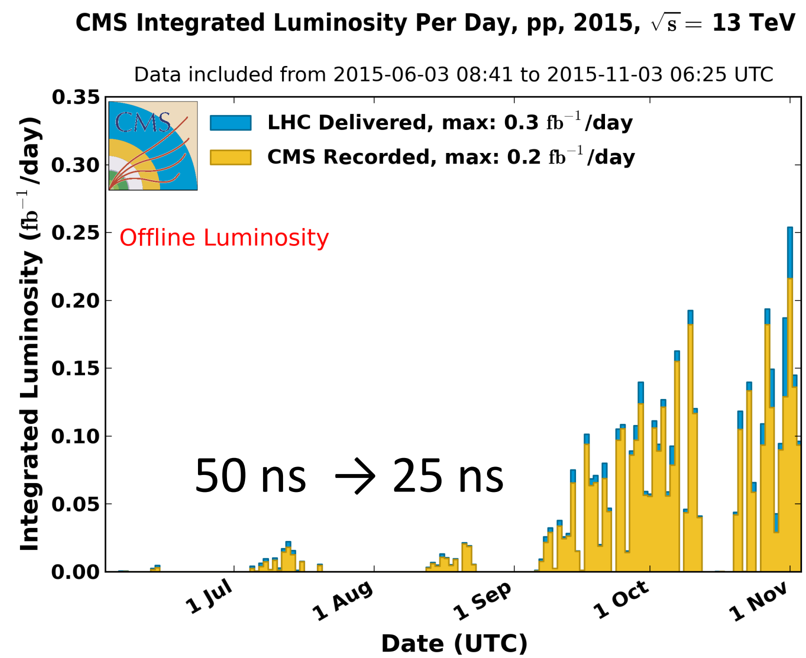
Magnet ON on May 1st . It was the only one that stay ON when the weasel took down most of CERN





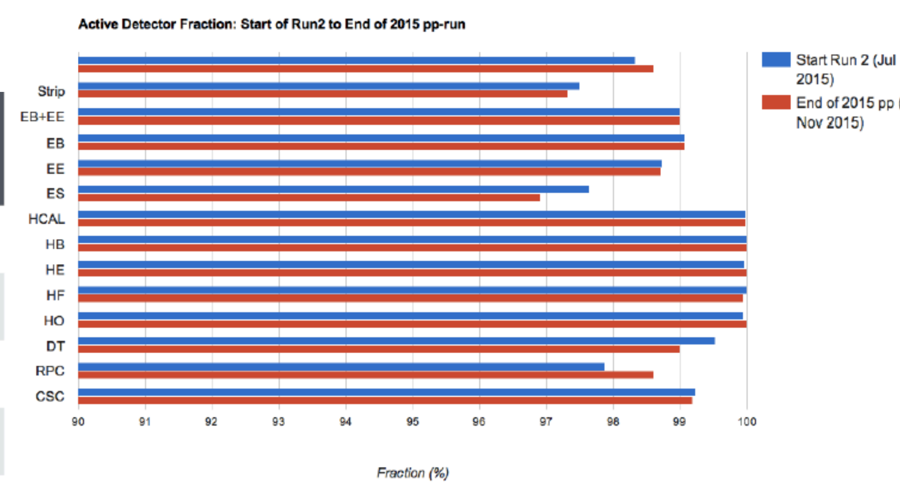
Run Data Set 2015



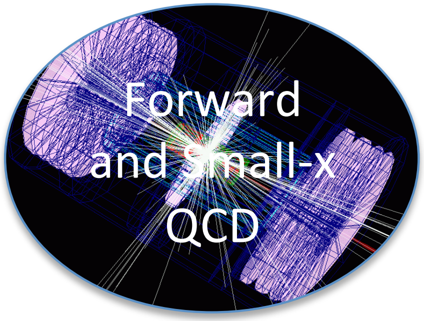


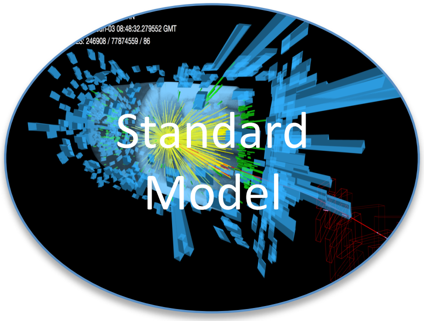
	energy [TeV]	peak lumi E34 $cm^{-2}s^{-1}$	approx. int lumi [fb^{-1}]
2010	7	0.02	0.04
2011	7	0.4	5
2012	8	0.8	23
2015	13	0.5	4

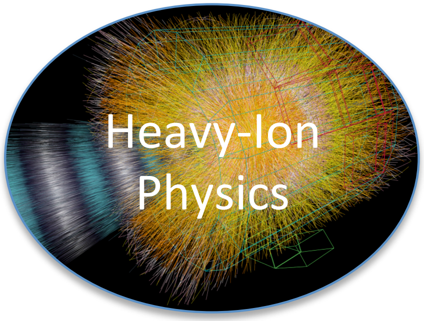
Fraction of active channels >97%

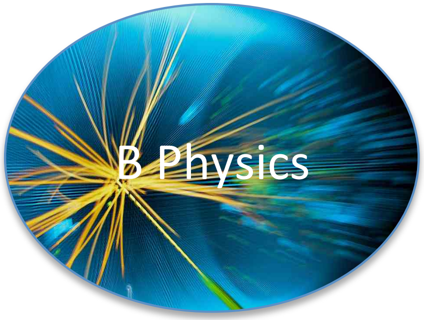


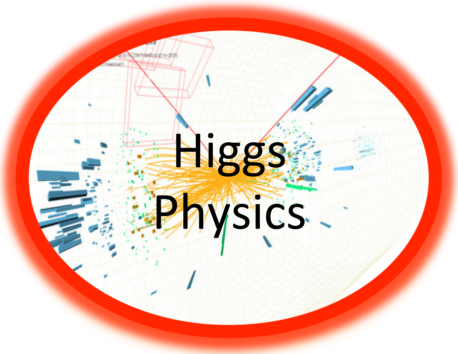
Physics Analysis at CMS

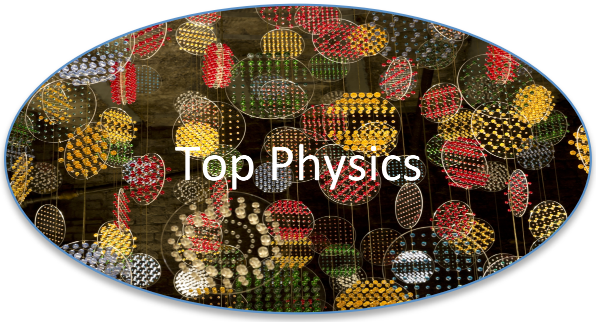


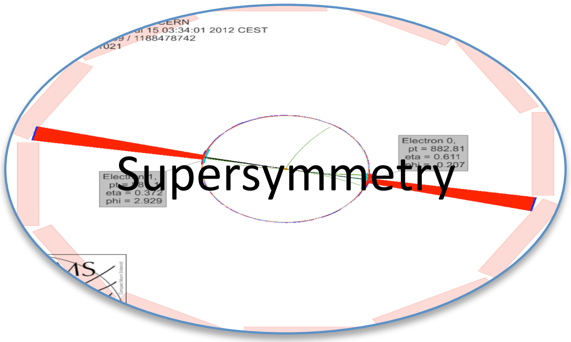




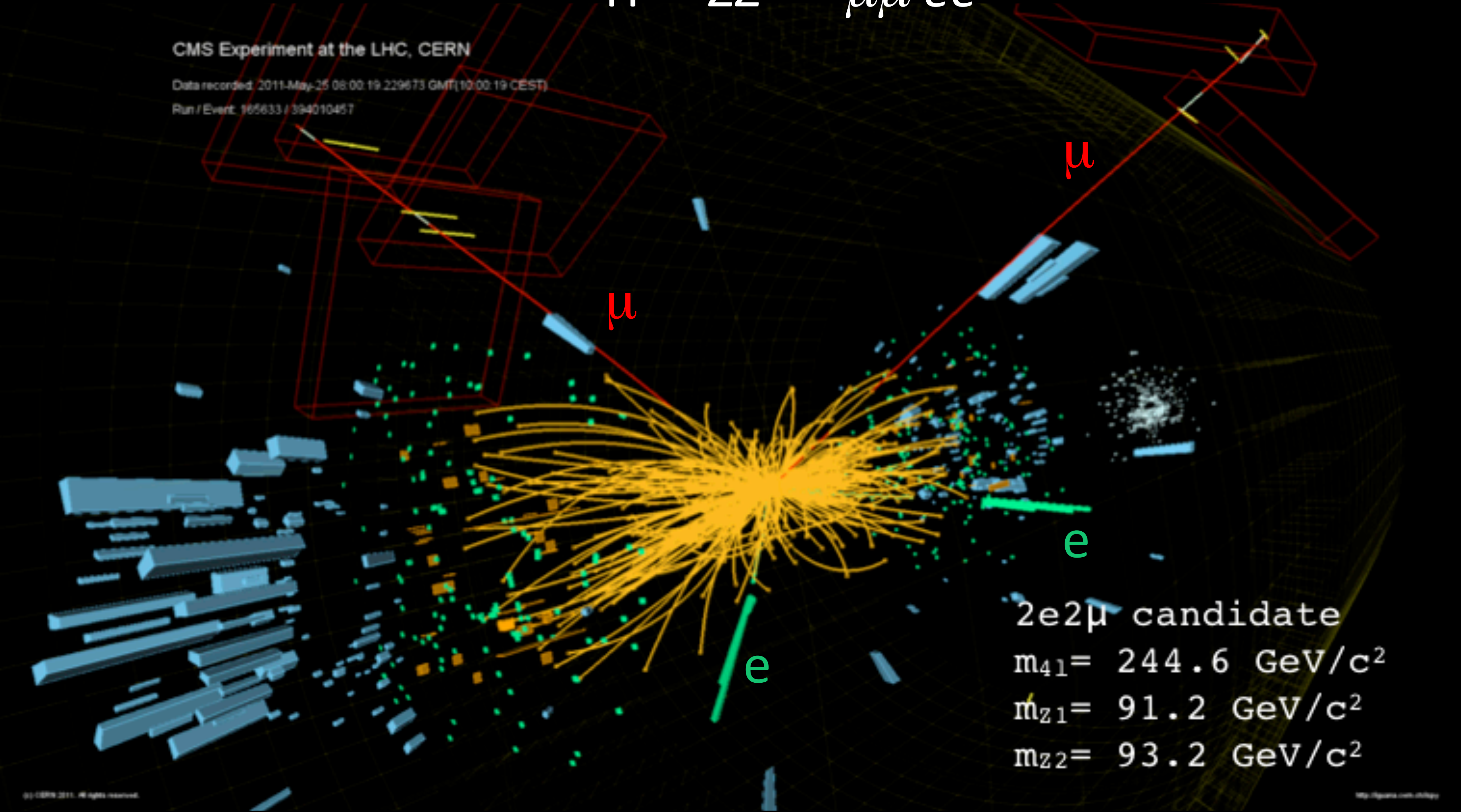








$H \rightarrow ZZ \rightarrow \mu\mu\, ee$

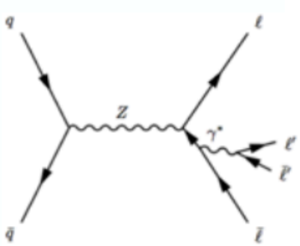


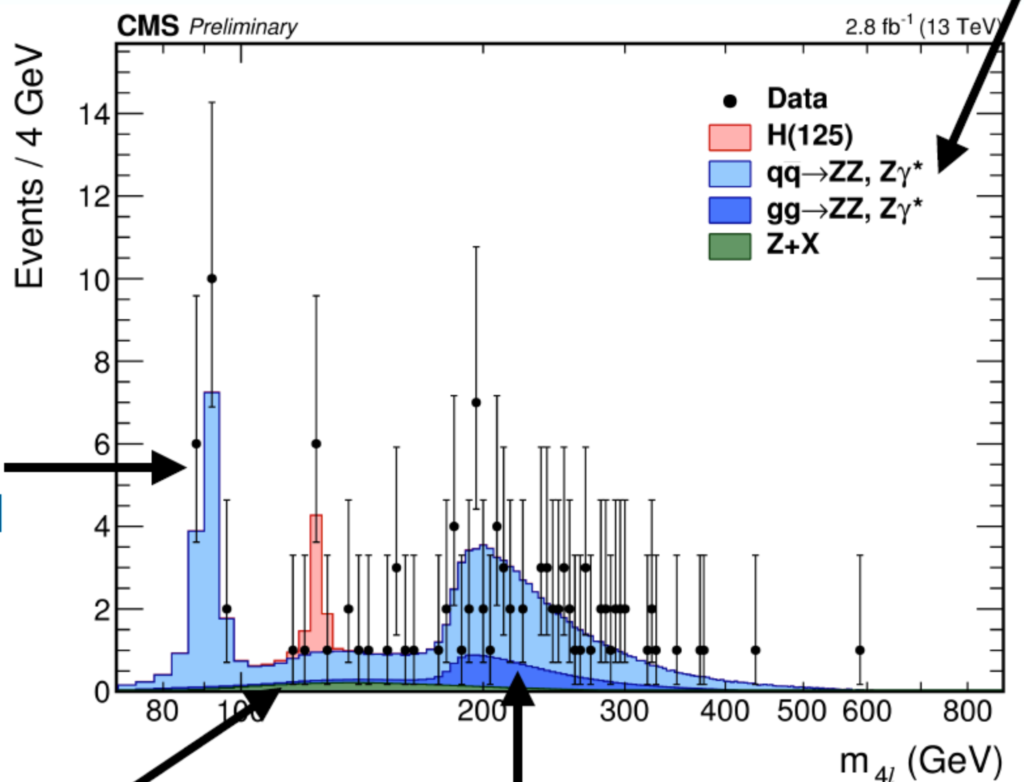
$H \rightarrow ZZ^{(*)} \rightarrow 4l$ at 13 TeV

Signature: 4e, 2e2μ, 4μ

- Need **momentum** as **low** as pT>7 GeV (electrons) and pT>5 GeV (muons) to not loose too much efficiency missing the 4th lepton

Main backgrounds: ZZ continuum, Z+jets, ttbar





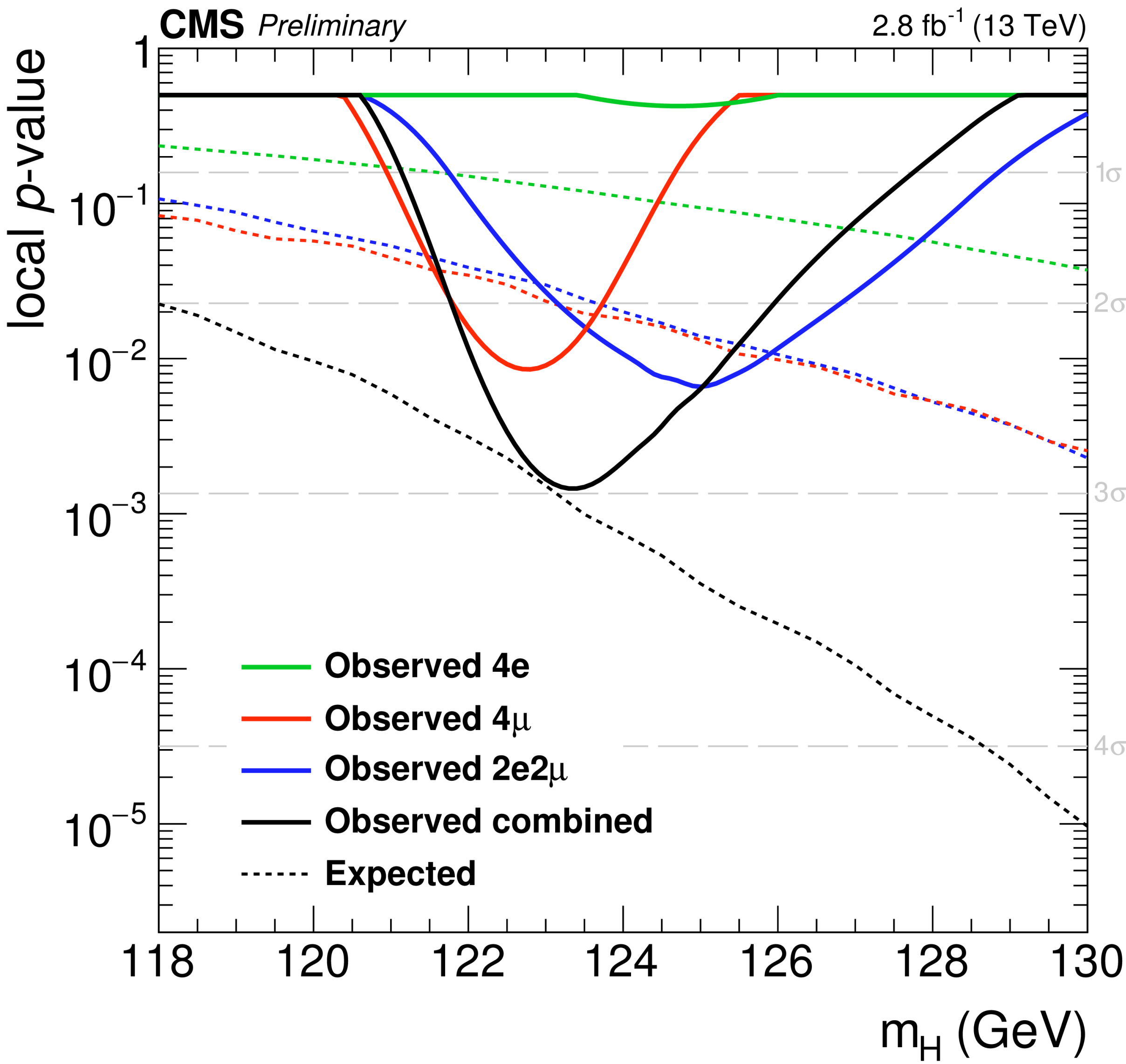
Z→4l: control region

H→ZZ*→4l:
- **Very good s/b~2**
- **2D analysis**

ZZ→4l region: was used to indirectly constrain Higgs boson width (Run I)

HIG-15-004

$H \rightarrow ZZ^{(*)} \rightarrow 4l$ at 13 TeV



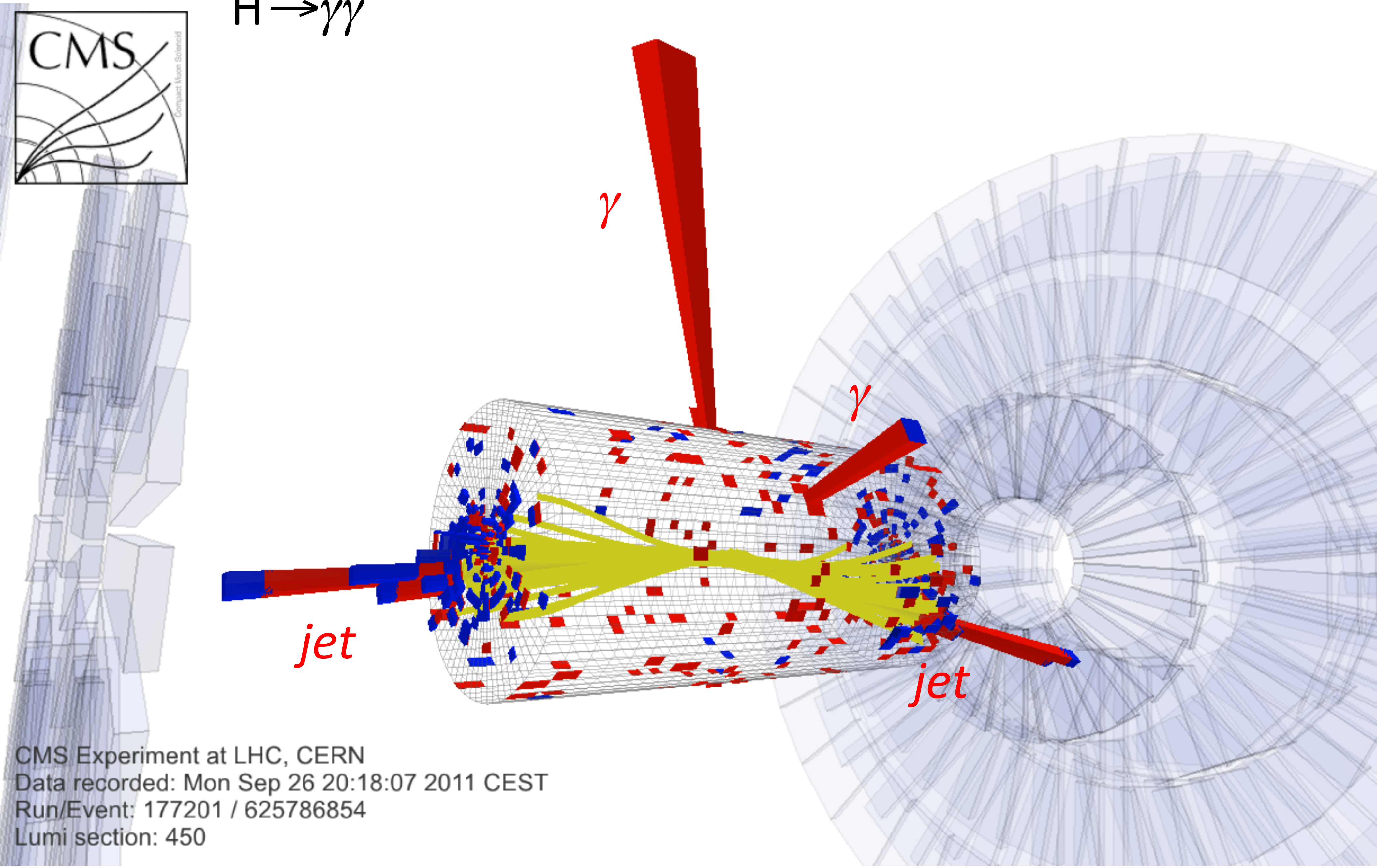
$\mu = 0.82^{+0.57}_{-0.43}$ at 125.09 GeV

2.5σ obs (3.4σ expected)

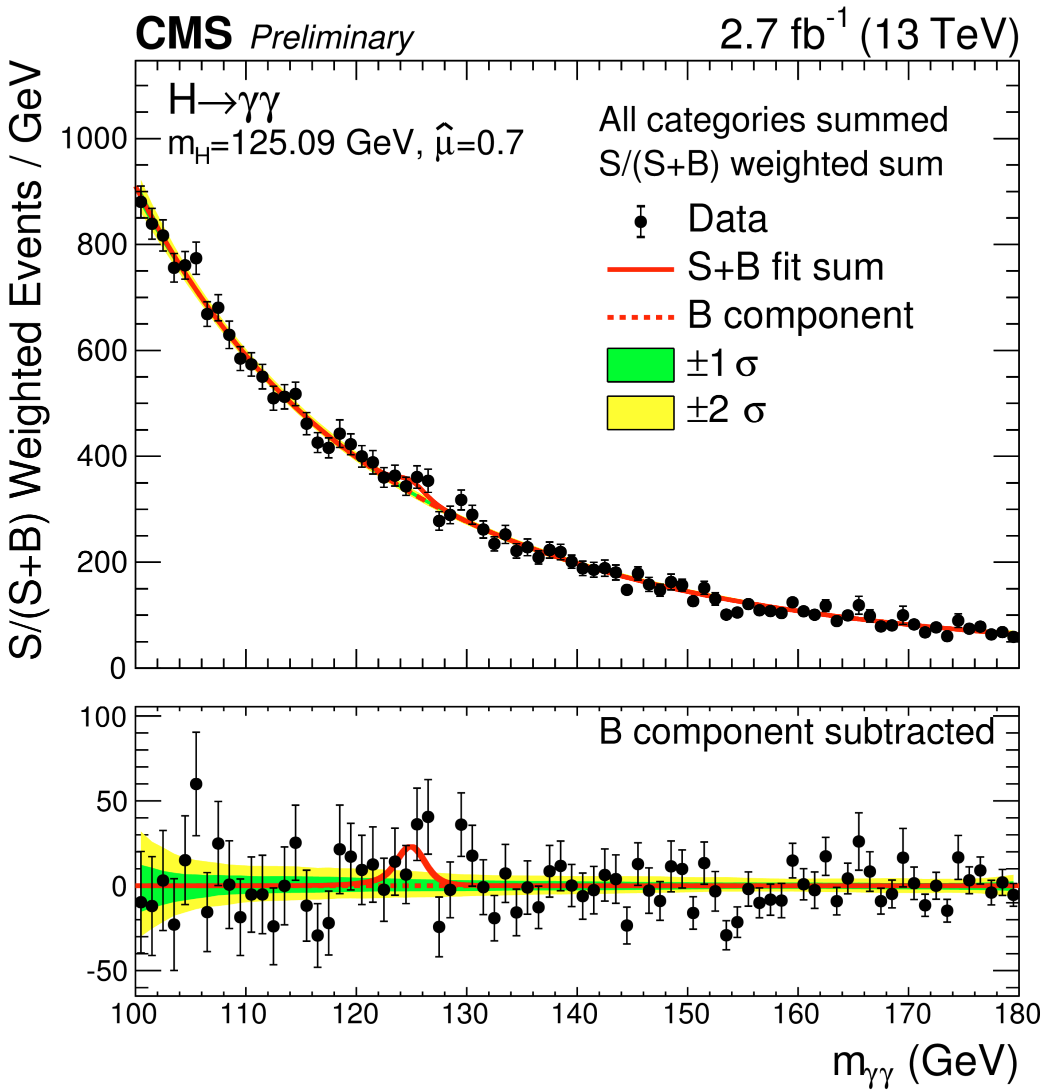
Best fit mass $123.4^{+0.8}_{-0.7}$ GeV: agreement within 1.6σ with Run I LHC measurement

HIG-15-004

H $\rightarrow \gamma\gamma$

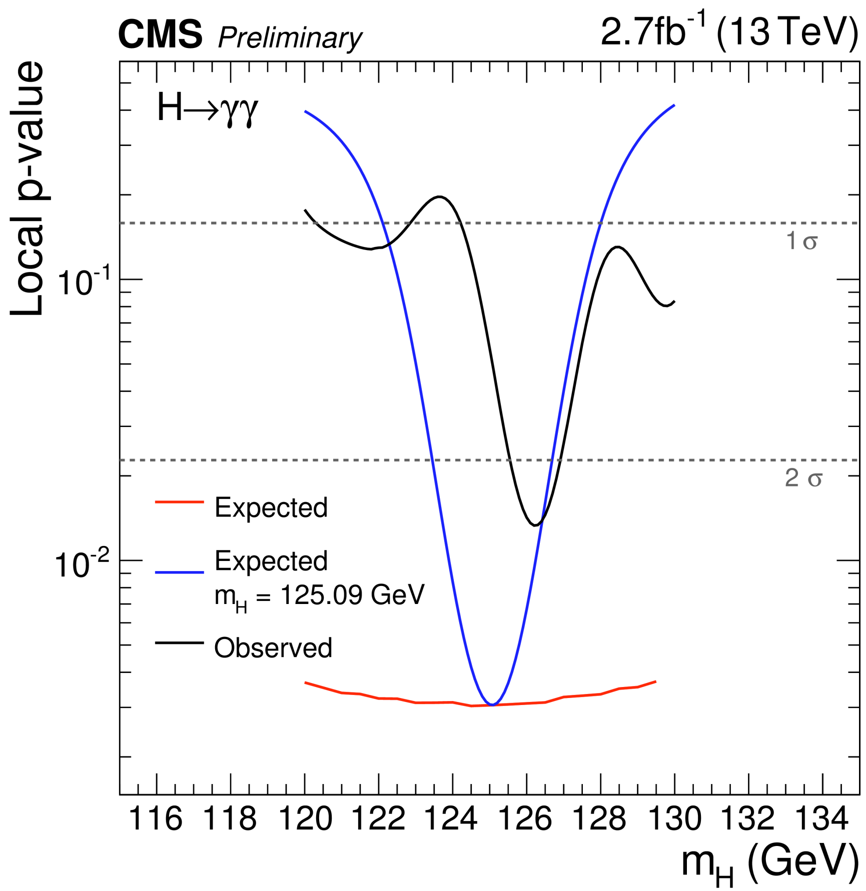


H→γγ at 13 TeV



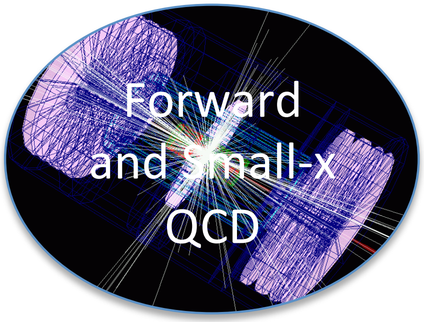
Sensitivity from mass fit

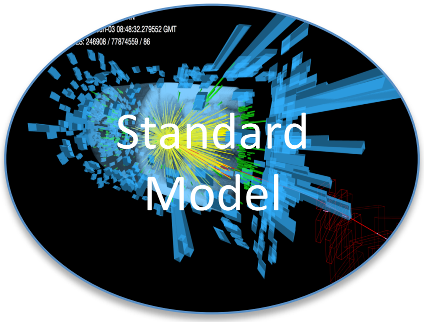
- Untagged, VBF, ttH categories
- **μ=0.7$^{+0.47}_{-0.42}$** at **125.09 GeV**
- **1.7σ obs** (2.7σ expected)

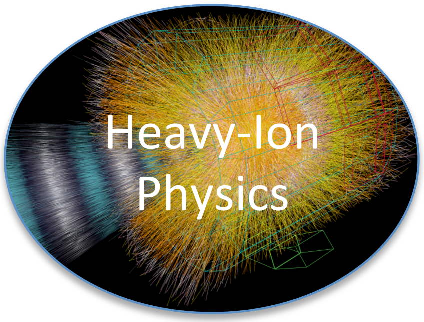


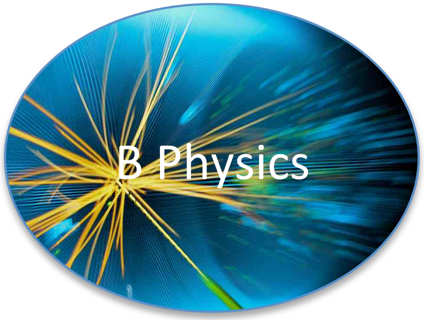
HIG-15-005

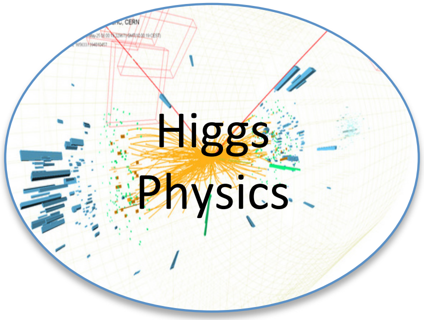
Physics Analysis at CMS

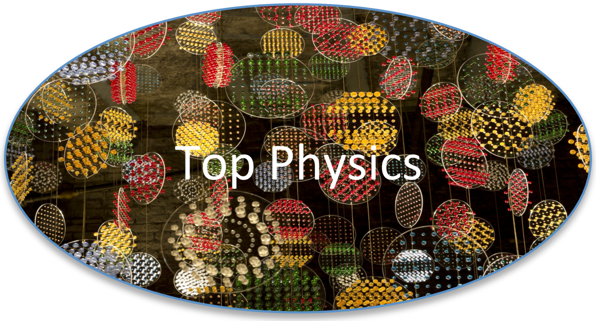


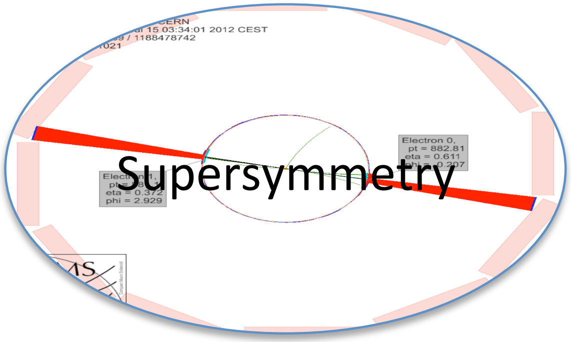




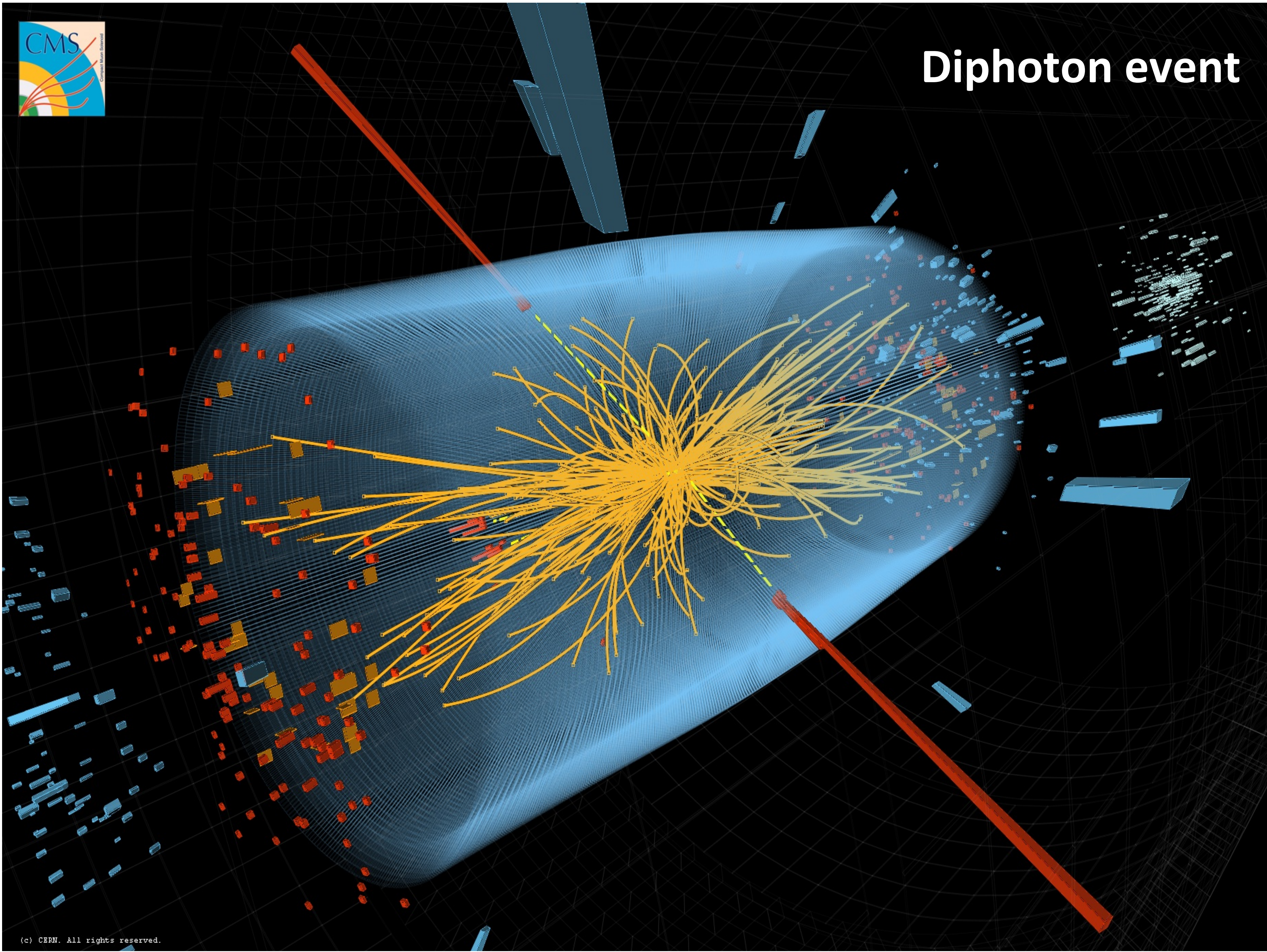








Diphoton event



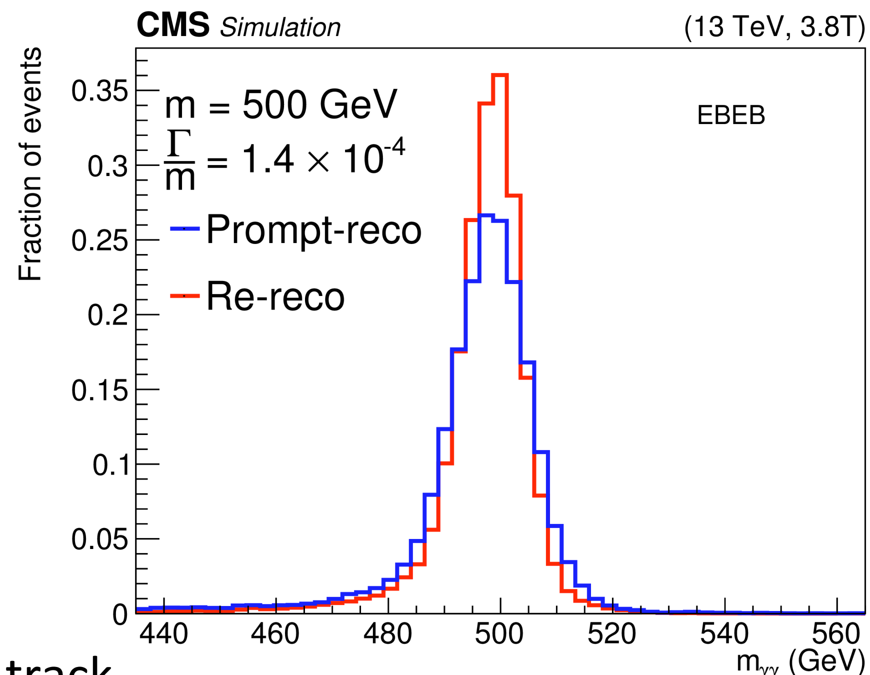
High Mass Searches with Diphotons

EXO-16-018

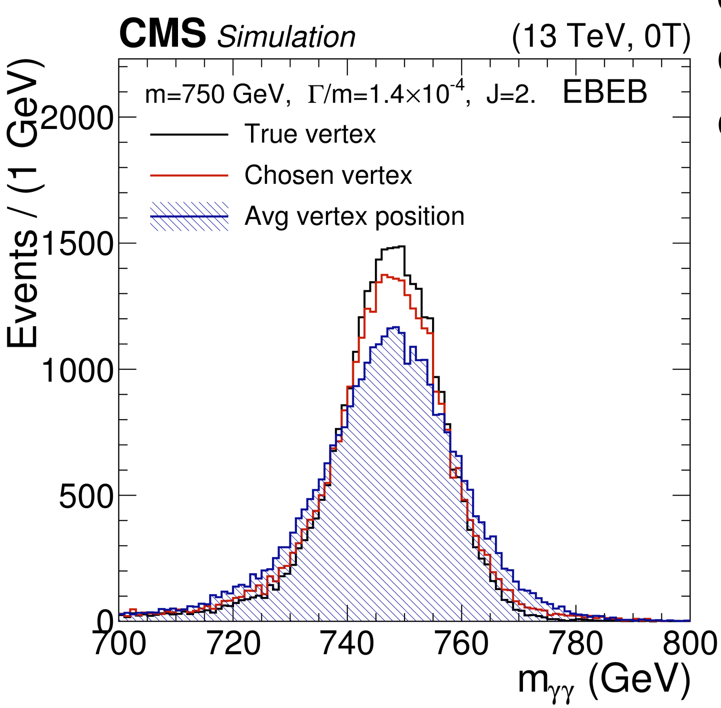
Analysis updated since December

- **New ECAL calibration**:
  - **resolution improved by ~30%** (10% better analysis sensitivity)
- Includes **data with no magnetic field: 0.6 fb-1**

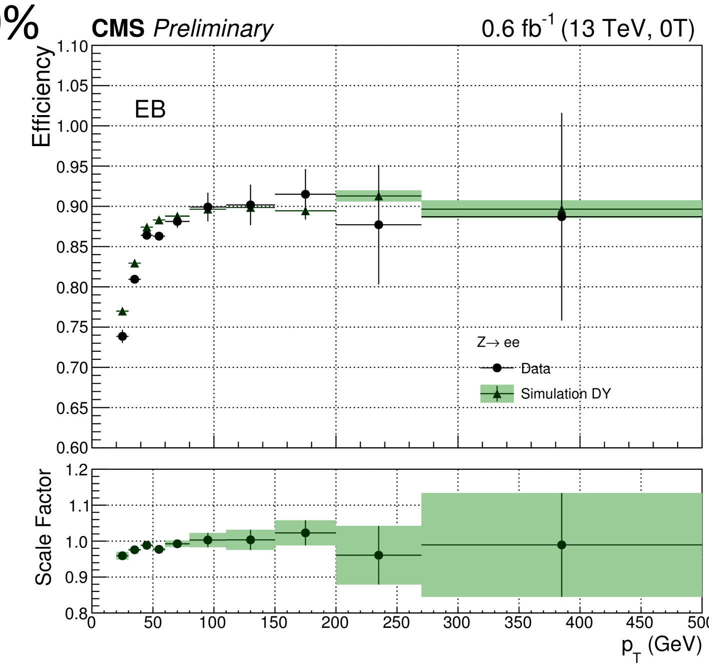
  => **0T improves** also sensitivity by 10%
  - **Updated calibration:** 1% difference in energy scale correction relative to 3.8T



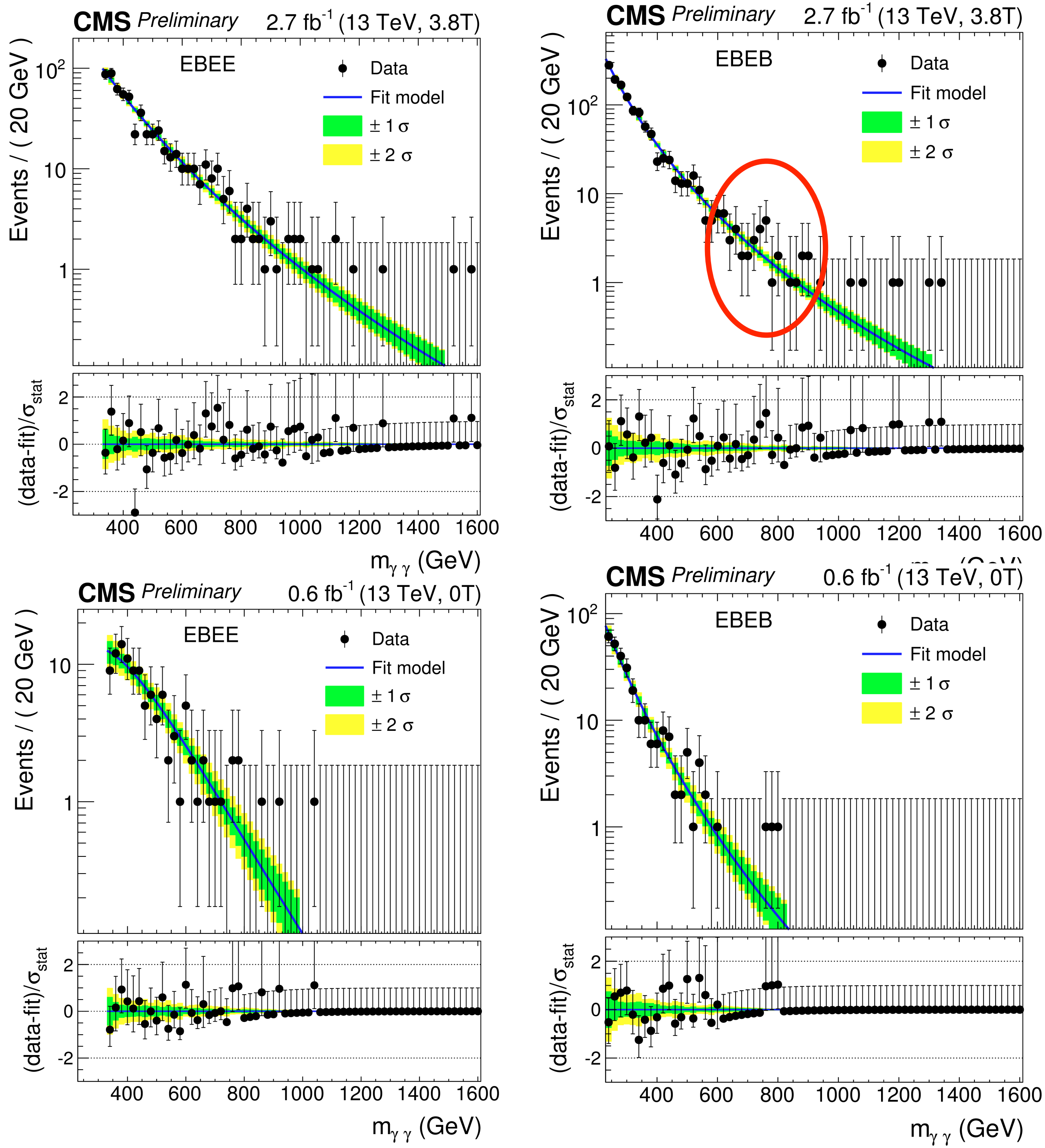
0T Vertexing: simple track counting, 60% efficient (90% efficient at 3.8T)



0T photon identification: efficiency similar at high photon pT



High Mass Searches with Diphotons



Excess driven by category with **two photons in the barrel**, at 3.8 T

Mass fit with

$$f(m_{\gamma\gamma}) = m_{\gamma\gamma}^{a+b\cdot\log(m_{\gamma\gamma})}$$

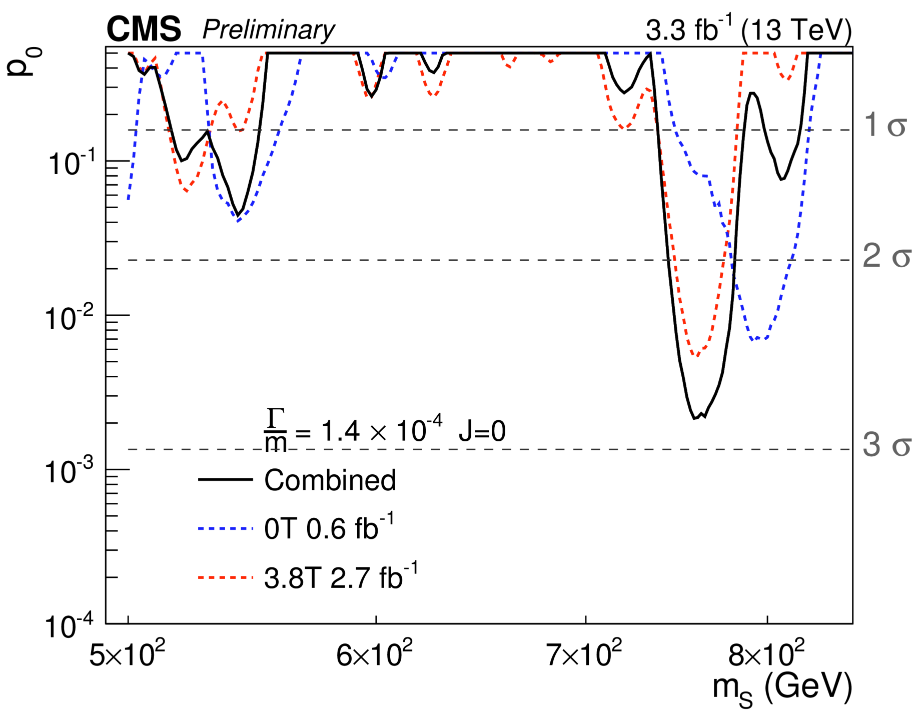
- Possible mismodeling accounted in the systematic uncertainties

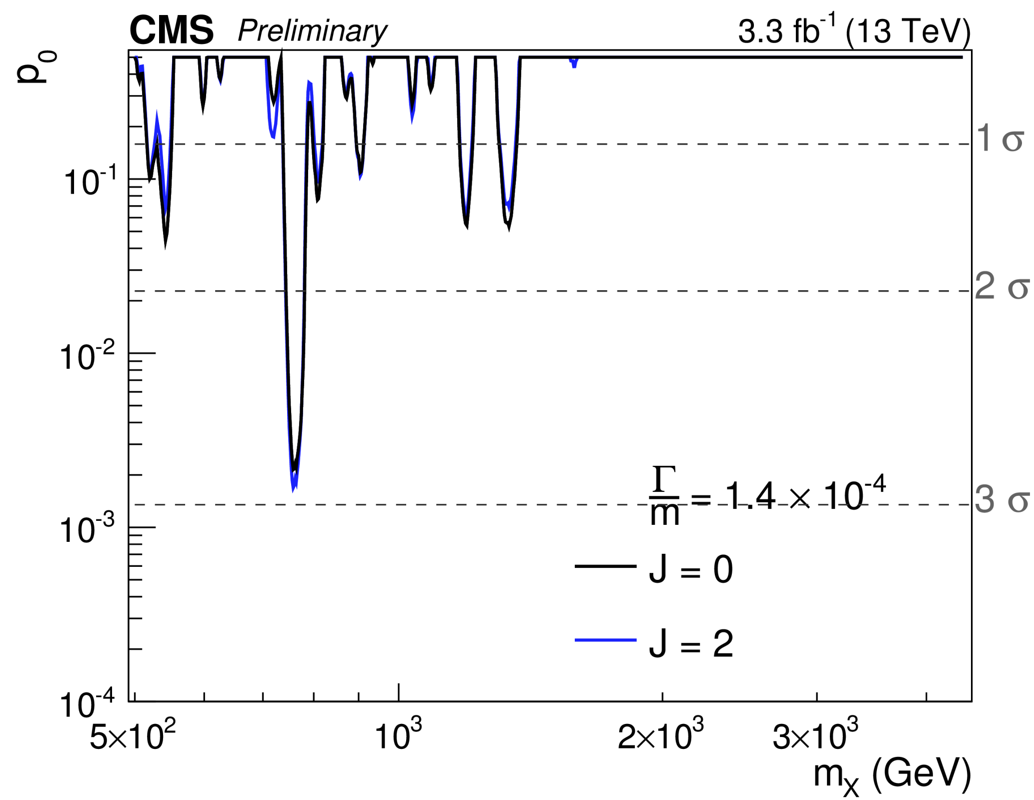
EXO-16-018

High Mass Searches with Diphotons

Largest excess: mX=760 GeV and Γ/m=1.4x10-4

- Compatibility between 0T and 3.8T datasets



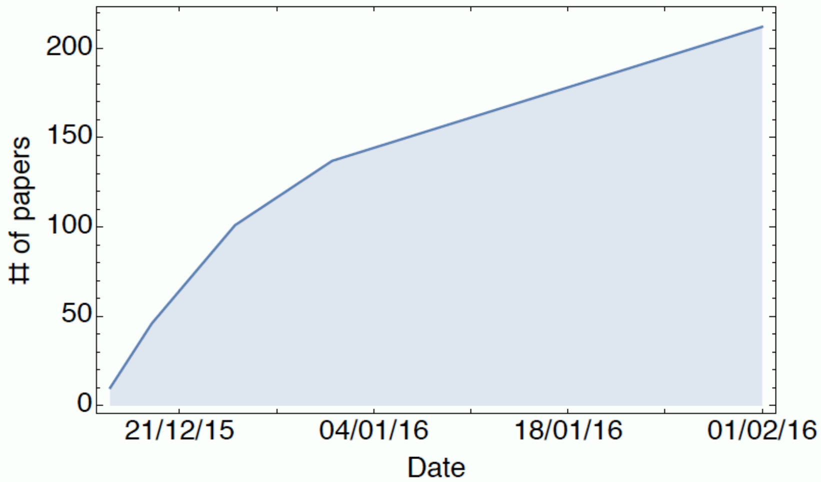


Results **interpreted** in terms of **spin-0** and **spin-2** resonances.

- J=0: assumed gluon-fusion produciton, J=2: RS-graviton
- **Three widths** ($\Gamma/m=1.4x10^{-4}$, $1.4x10^{-2}$, $5.6x10^{-2}$)

Theorist reaction

Even with this little information, the theory community could speculate a lot



We even have a Mexican team in the race

Has a Higgs-flavon with a 750 GeV mass been detected at the LHC13?

A. Bolaños, J.L. Diaz-Cruz, G. Hernández-Tomé, G. Tavares-Velasco

(Submitted on 17 Apr 2016)

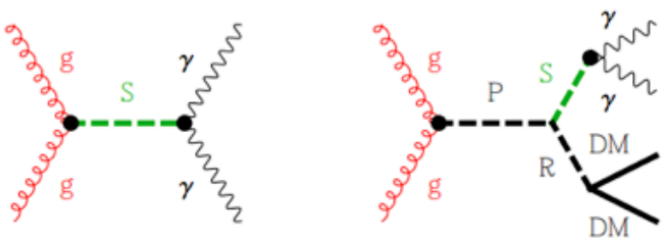
Higgs-flavon fields appear as part of the Froggart-Nielsen (FN) mechanism, which attempts to explain the hierarchy of Yukawa couplings. We explore the possibility that the 750 GeV diphoton resonance recently reported at the LHC13, could be identified with a low-scale Higgs-flavon field H_F. We work within an extension of the standard model (SM) that contains two Higgs doublets (a standard one and an inert one) and one complex FN singlet. The inert doublet includes a stable neutral boson, which provides a viable dark matter candidate, while the mixing of the standard doublet and the FN singlet induces flavor violation in the Higgs sector at the tree-level. Constraints on the parameters of the model are derived from the LHC Higgs data, which include the search for the lepton flavor violating decay of the SM Higgs boson $h \to \bar{\mu}\tau$. We also identify the viable parameter space that can reproduce the profile of the 750 GeV diphoton signal; in particular, the heavy fermions from the ultraviolet completion of the FN mechanism must play an important role to reproduce the large width of the signal. In addition, we find that the model predicts a large branching ratio for the $H_F \to hh$ decay, of the order of 0.1, which should be searched for at the LHC13 to test this model.

Comments: 15 pages, 4 Figures
Subjects: **High Energy Physics - Phenomenology (hep-ph)**
Cite as: arXiv:1604.04822 [hep-ph]
(or arXiv:1604.04822v1 [hep-ph] for this version)

Submission history

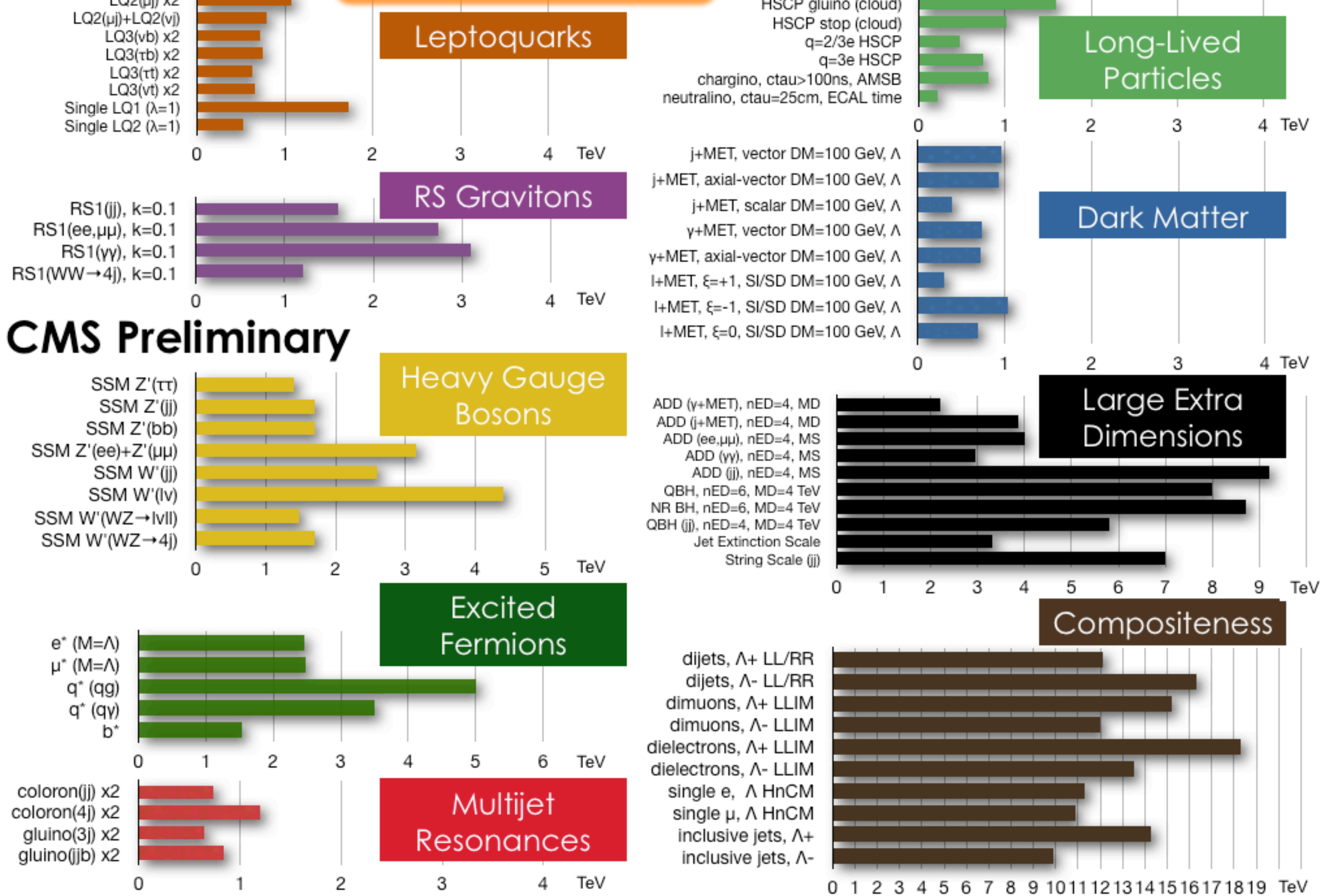
From: Gilberto Tavares-Velasco [view email]
[v1] Sun, 17 Apr 2016 03:25:51 GMT (282kb)

Many different explanations



- Spin 0 or 2 due to Landau-Yang
- For narrow resonance very simple (trivial) theory explanations
- For large width harder to explain (non-perturbative couplings, nearby resonances, etc.)

67 Analysis on Exotics



Conclusions

Higgs boson physics

- First measurements available (diphoton, ZZ), more data needed for a rediscovery at 13 TeV

Beyond standard model searches

- A large number of BSMP analyses pushing limits in strong production are available

Results interpreted in terms of scalar resonances and RS gravitons production of different widths.

- Observation generally consistent with SM expectations.
- **Modest excess** of events observed at $\mathbf{m_X}$ **= 750(760)GeV** for the 8+13TeV(13TeV) dataset.
- **Local** significance is **3.4(2.9)**σ, **reduced to 1.6(<1)**σ after accounting for look-elsewhere-effect.

References

- The X(750000), Ridado Torres, CERN, February CMS Week.
- Recent Higgs Results from CMS, David Sperka, Moriond QCD 2016.
- Overview of the latest results from BSM Higgs Boson Searches, Xifeng RUAN, Moriond 2016.
- Extended scalar searches at ATLAS & CMS, Allison McCarn, Moriond EW 2016.
- LHC Run1 Higgs Results, Quentin Buat, Moriond 2016.
- Search for high mass diphoton resonances at CMS, Pasquale Musella, Moriond EW 2016.
- Highlights of CMS 13 TeV results, Nicolas Chanon, FCPPL 2016.

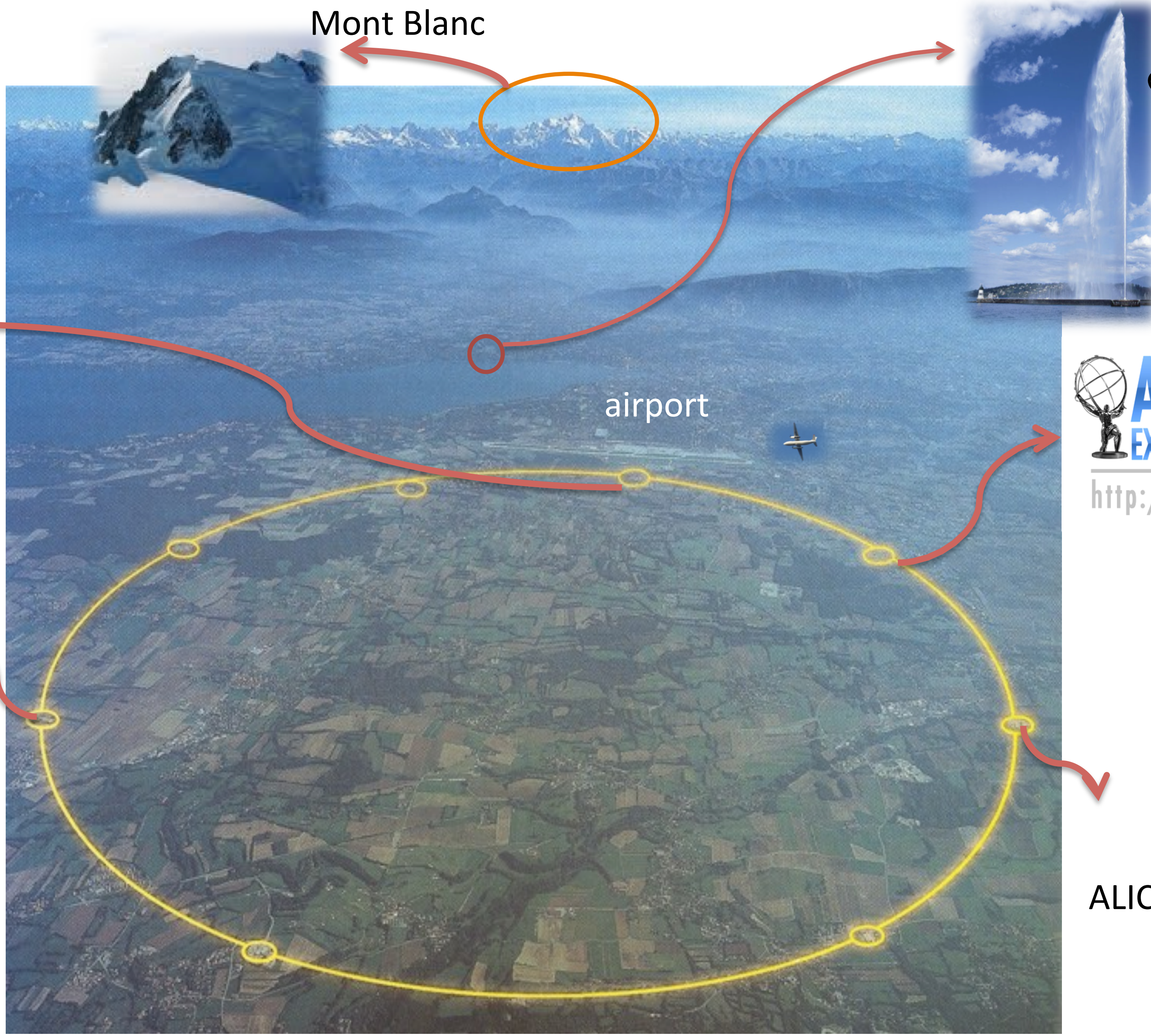
EXTRA MATERIAL

The Large Hadron Collider

- 27km circumference, 50-150m below ground, across French-Swiss border
- pp collisions @ √s = 7 TeV in 2010-2011, 8 TeV in 2012, and 13 TeV in 2015.
- Each beam ~ 1400 proton bunches, each bunch ~ 1.5×10^{11} protons
- On average, ~ 20 pp collisions per bunch crossing

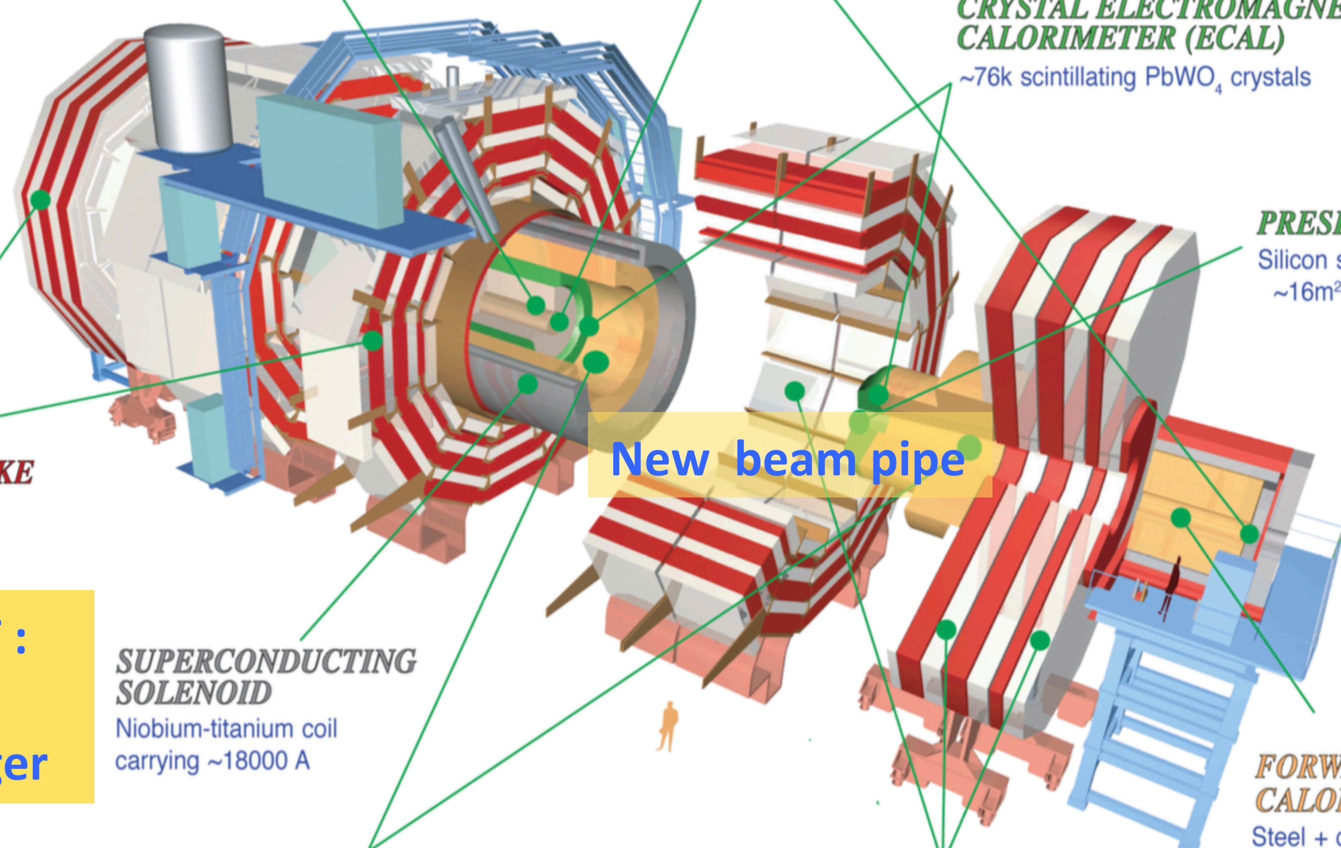
  … times 20 MHz bunch crossing rate = 400 M pp collisions per second
- Reduced by trigger systems to ~500 events/sec.
- 2132 magnetic dipoles of 15 m.
- 392 Quadrupoles of 5-7 m.

LHC


Mont Blanc
Geneva
LHCb
airport
ATLAS EXPERIMENT
http://atlas.ch
CMS
ALICE

Compact Muon Solenoid at RUN II

BRIL
Pixels
Tracker
ECAL
HCAL
Solenoid
Steel Yoke
Muons



DAQ and HLT : New CPU upgrated trigger

Total weight	: 14000 tonnes
Overall diameter	: 15.0 m
Overall length	: 28.7 m
Magnetic field	: 3.8 T

HCAL new photosensors

4th muon station in the End-cap

Compact Muon Solenoid

Higgs seen by CMS detector

Total weight : 14000 tonnes
Overall diameter : 15.0 m
Overall length : 28.7 m
Magnetic field : 3.8 T

Higgs

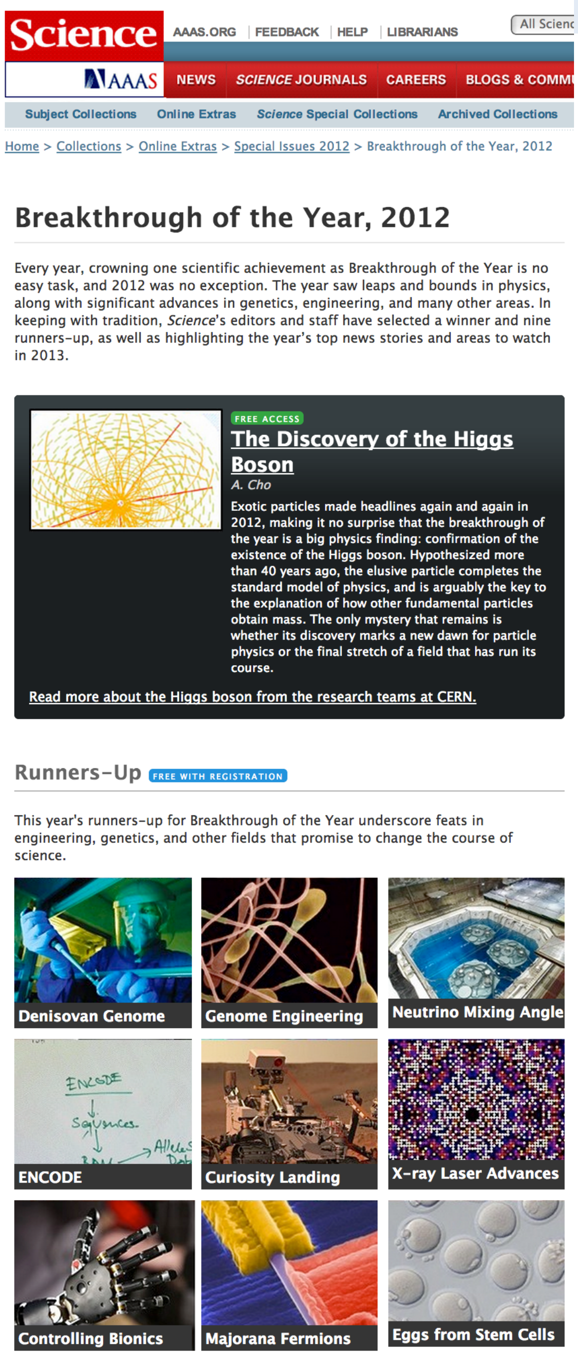
July 4th, 2012. Almost two years ago

The Nobel Prize in Physics 2013

Photo: A. Mahmoud
François Englert

Photo: A. Mahmoud
Peter W. Higgs

The Nobel Prize in Physics 2013 was awarded jointly to François Englert and Peter W. Higgs *"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"*



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Home > Collections > Online Extras > Special Issues 2012 > Breakthrough of the Year, 2012

Breakthrough of the Year, 2012

Every year, crowning one scientific achievement as Breakthrough of the Year is no easy task, and 2012 was no exception. The year saw leaps and bounds in physics, along with significant advances in genetics, engineering, and many other areas. In keeping with tradition, *Science*'s editors and staff have selected a winner and nine runners-up, as well as highlighting the year's top news stories and areas to watch in 2013.

FREE ACCESS

The Discovery of the Higgs Boson

A. Cho

Exotic particles made headlines again and again in 2012, making it no surprise that the breakthrough of the year is a big physics finding: confirmation of the existence of the Higgs boson. Hypothesized more than 40 years ago, the elusive particle completes the standard model of physics, and is arguably the key to the explanation of how other fundamental particles obtain mass. The only mystery that remains is whether its discovery marks a new dawn for particle physics or the final stretch of a field that has run its course.

Read more about the Higgs boson from the research teams at CERN.

Runners-Up

FREE WITH REGISTRATION

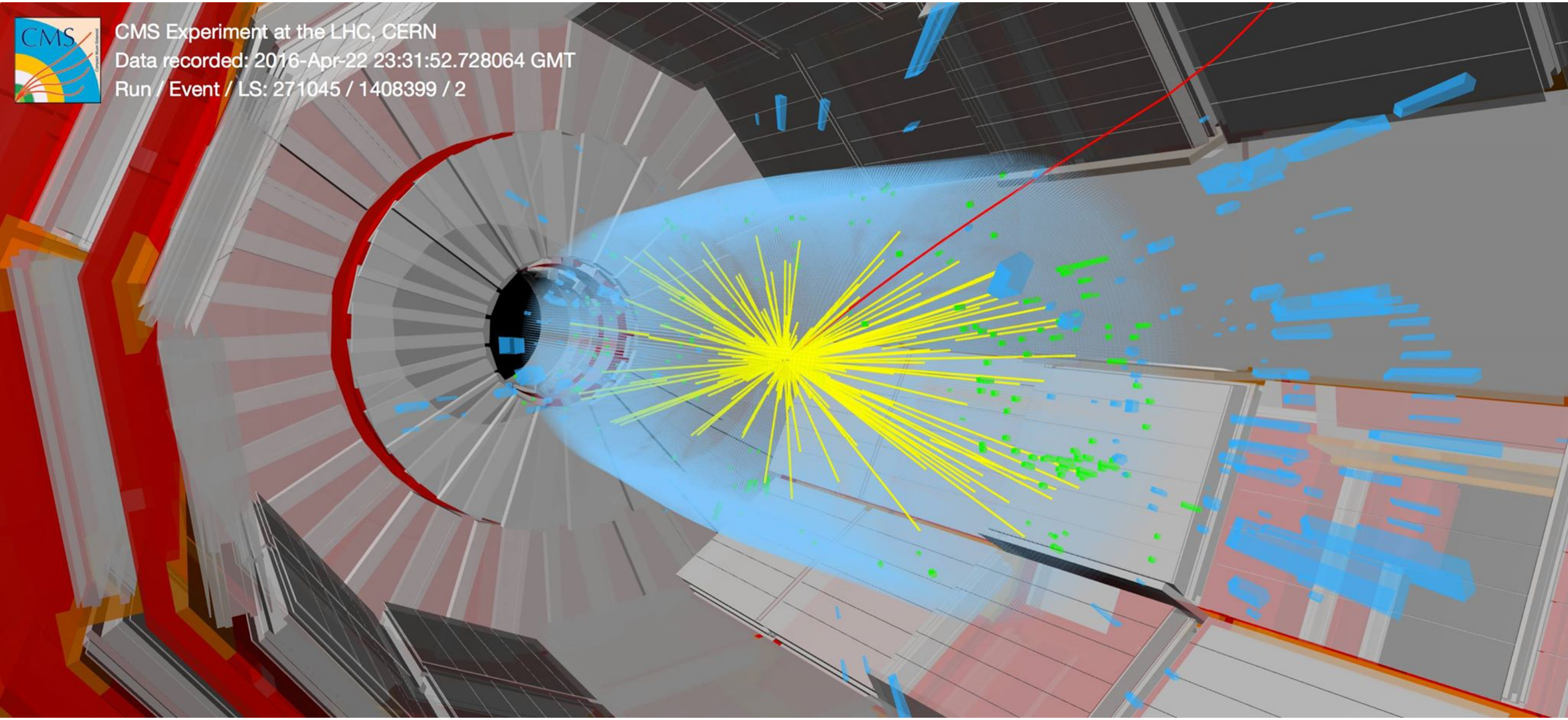
This year's runners-up for Breakthrough of the Year underscore feats in engineering, genetics, and other fields that promise to change the course of science.

Denisovan Genome | Genome Engineering | Neutrino Mixing Angle

ENCODE | Curiosity Landing | X-ray Laser Advances

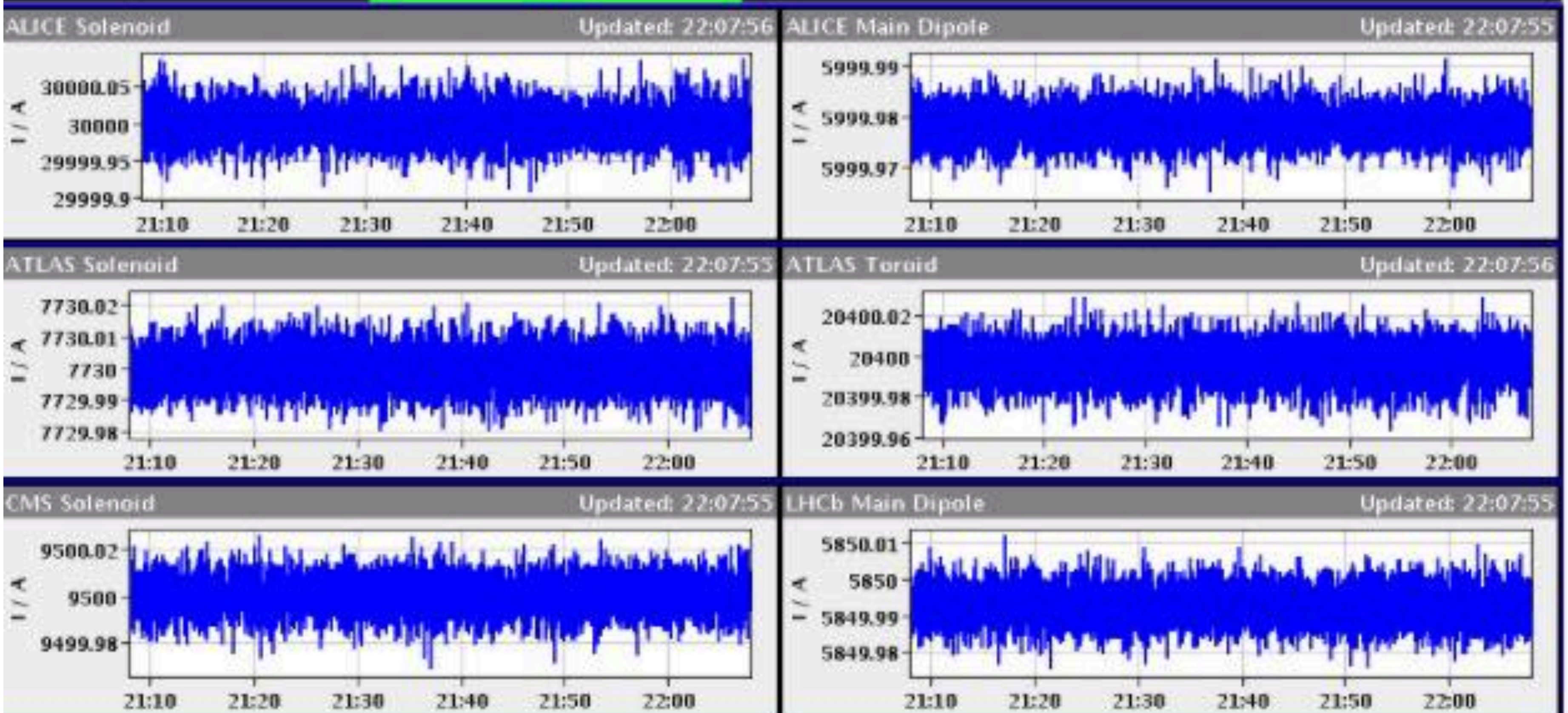
Controlling Bionics | Majorana Fermions | Eggs from Stem Cells

April 23rd low-intensity stable beams declared, CMS captures the first 2016 collisions

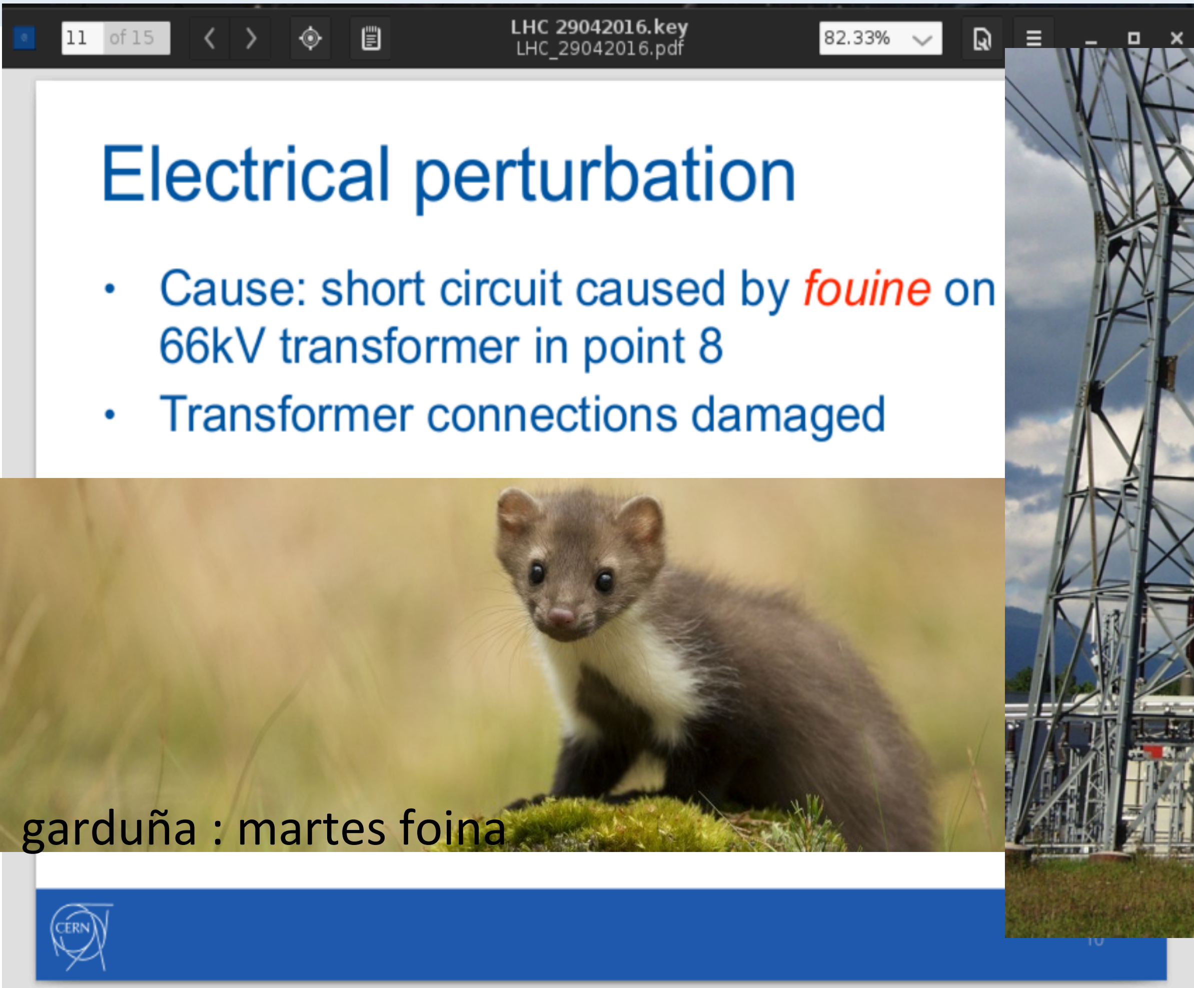


April 27th CMS Magnet ON

Magnet	State	I / A	Polarity	27-04-16 22:07:56
ALICE solenoid	IDLE	30000.01	negative	
ALICE dipole	IDLE	5999.98	negative	
ATLAS solenoid	IDLE	7730.00	no polarity switch	
ATLAS toroid	IDLE	20400.00	no polarity switch	
CMS solenoid	IDLE	9500.01	no polarity switch	
LHCb dipole	IDLE	5850.00	positive	



April 29th

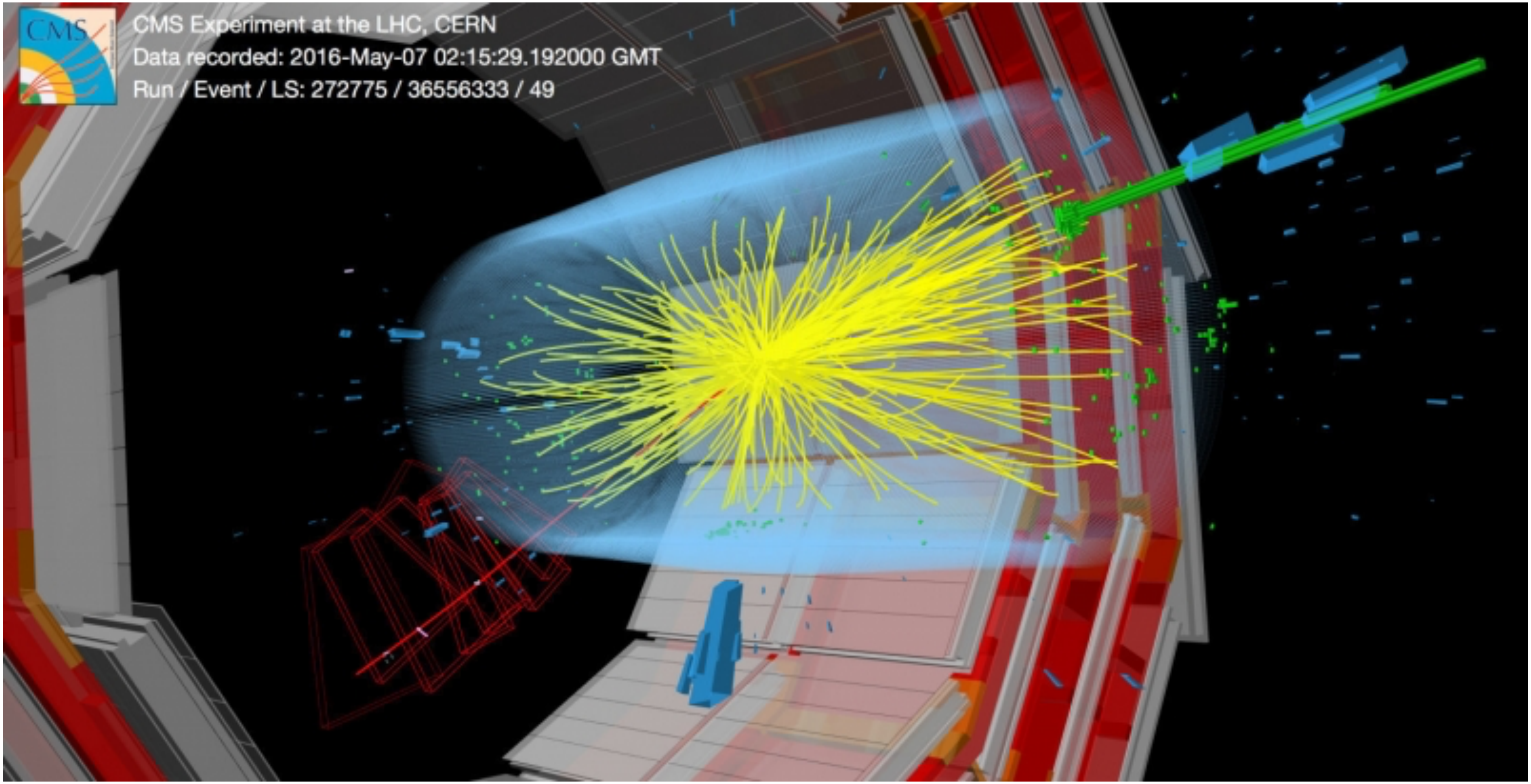


garduña : martes foina

A team assessed the situation over the following weekend and found no indication of damage inside the transformer. Repairs to the connections were done and the LHC continues the 2016 physics run.

From May 9th, 2016

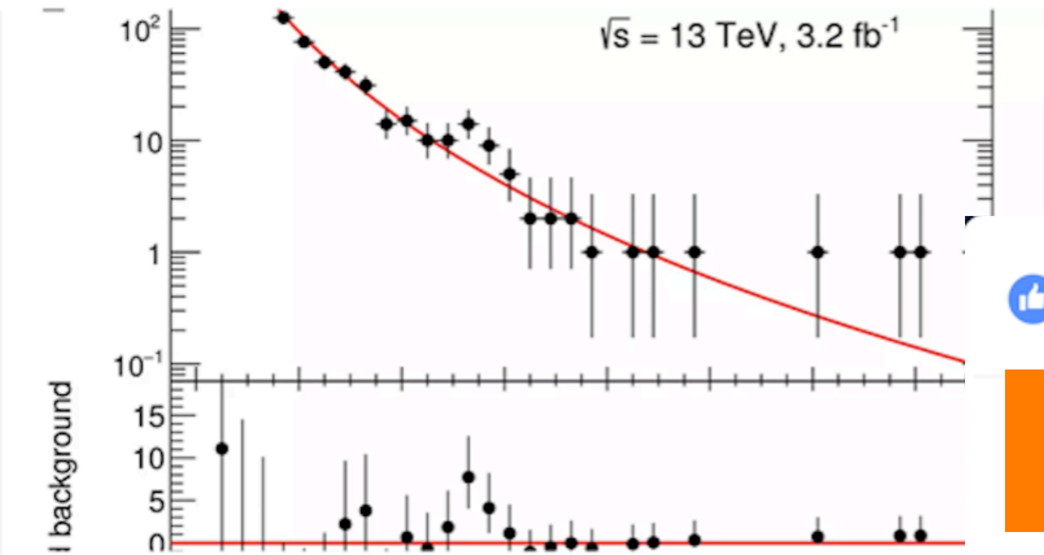
CMS is taking data with magnet ON



At 99.5% confidence!

18 mars à 9:06am • Geneva, Switzerland •

New particle or statistical fluctuation?



atlas.web.cern.ch

atlas.web.cern.ch

18 · 12 comment

J'aime · Commenter · Partag

Wang Haichen et 17 autres personnes

why, yes..... i believe it is!

18 mars à 9:07 AM • J'aime • Répondre

I can say with 99.5% confidence that we've discovered a vast amount of work for graduate students and postdocs.

18 mars à 9:25 AM • Je n'aime plus • 14 • Répondre

CMS Magnet

- Before Run II starts it was realised that the performance of the **cryogenic system feeding Liquide He** to the magnet was severely impaired by a **contamination of the Cold box**
- Thanks to efforts from CERN cryogenic and technical departments working with CMS technical coordination, the impact was limited, allowing to **collect ~3/4 of the 2015 delivered luminosity with full magnetic field**

Magnet / cryogenic system revision during YETS 2015-2016:

- **Cold box cleaning** with special solvent was successful
- **370g of compressor oil removed**. All evidence consistent with this being the source of instabilities in 2015.
- Oil filters (surface of compressor hall), old oil removal system and coalescers dismounted
  - All **new components delivered**
  - **Reconnection and testing** procedure is lengthy and must be done rigorously before connecting to new He transfer line leading underground the cold box
  - Estimate **"magnet ready" in week of 25 April**