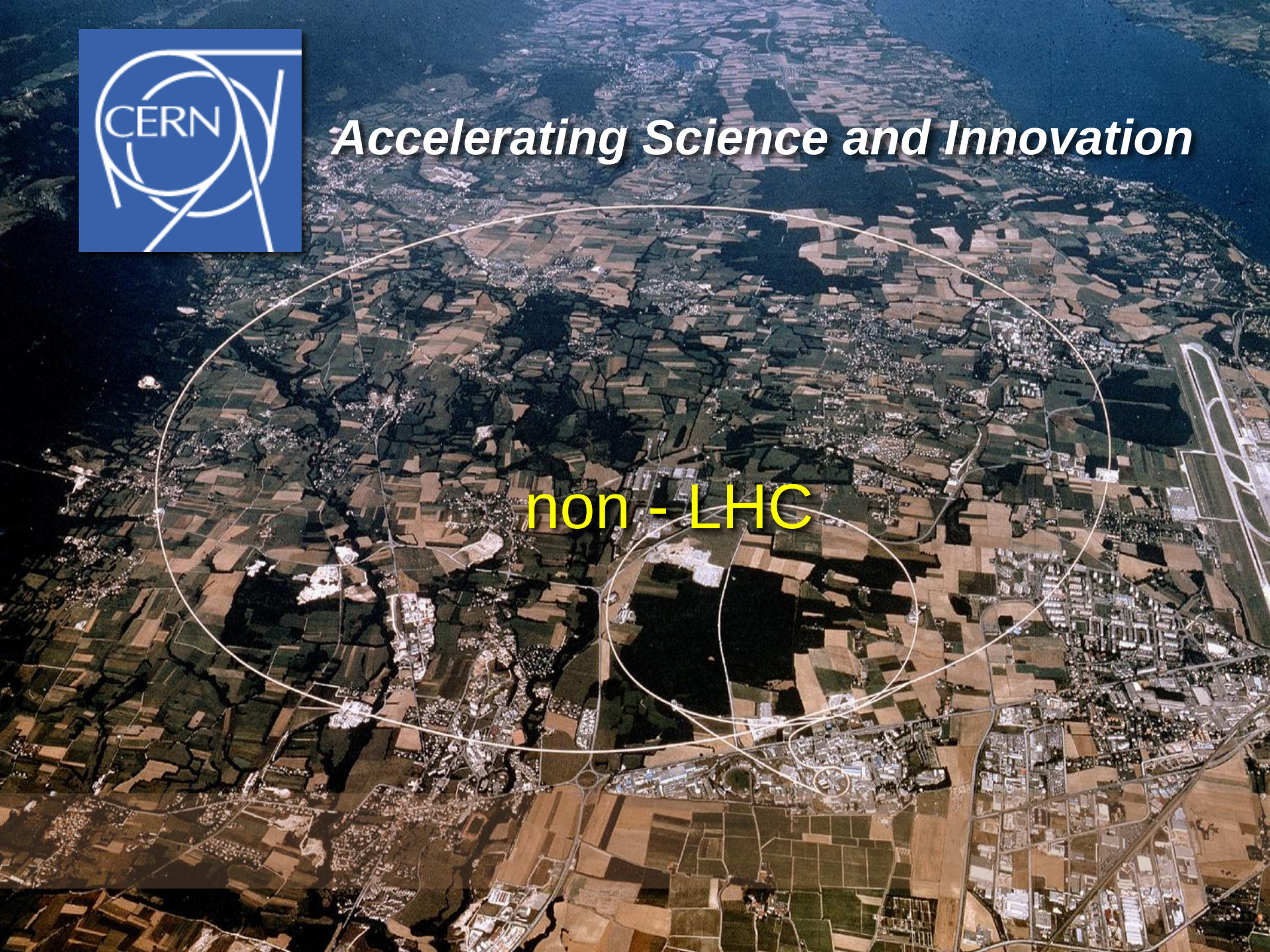
R.-D. Heuer, CERN

ECFA meeting, PSI, July 19, 2012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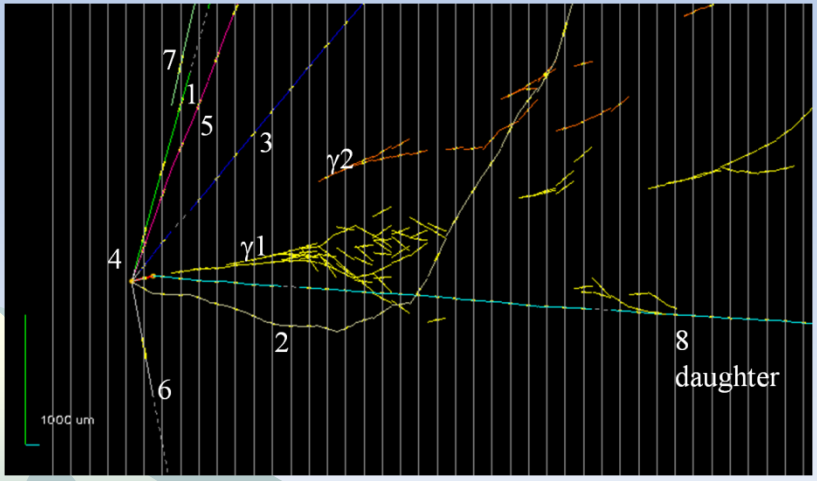
non - LHC

OPERA ν_τ appearance

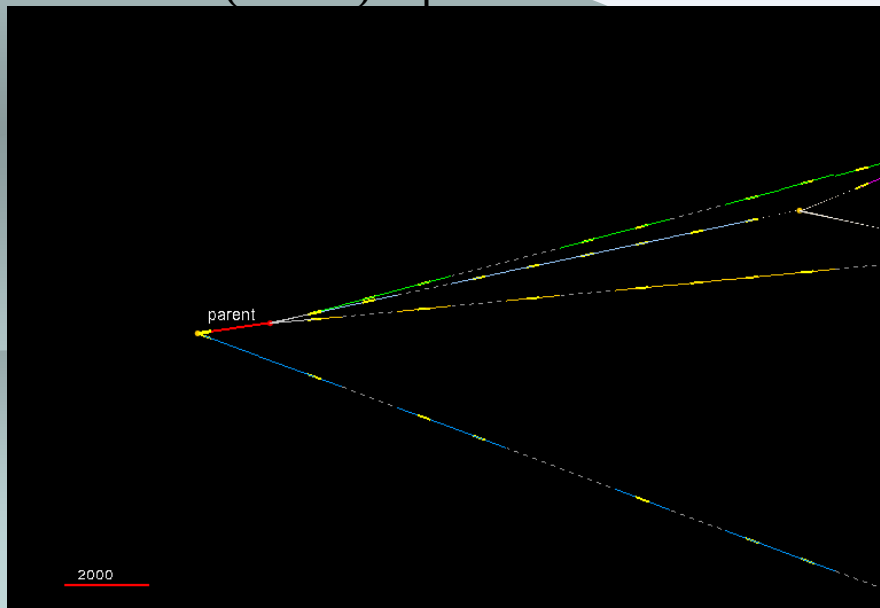
- Status of the analysis
  - 2 candidate events so far (expected 2.1 with 0.2 background events)
  - A few more events are under study.
  - Progress in estimating detection efficiency and BG.

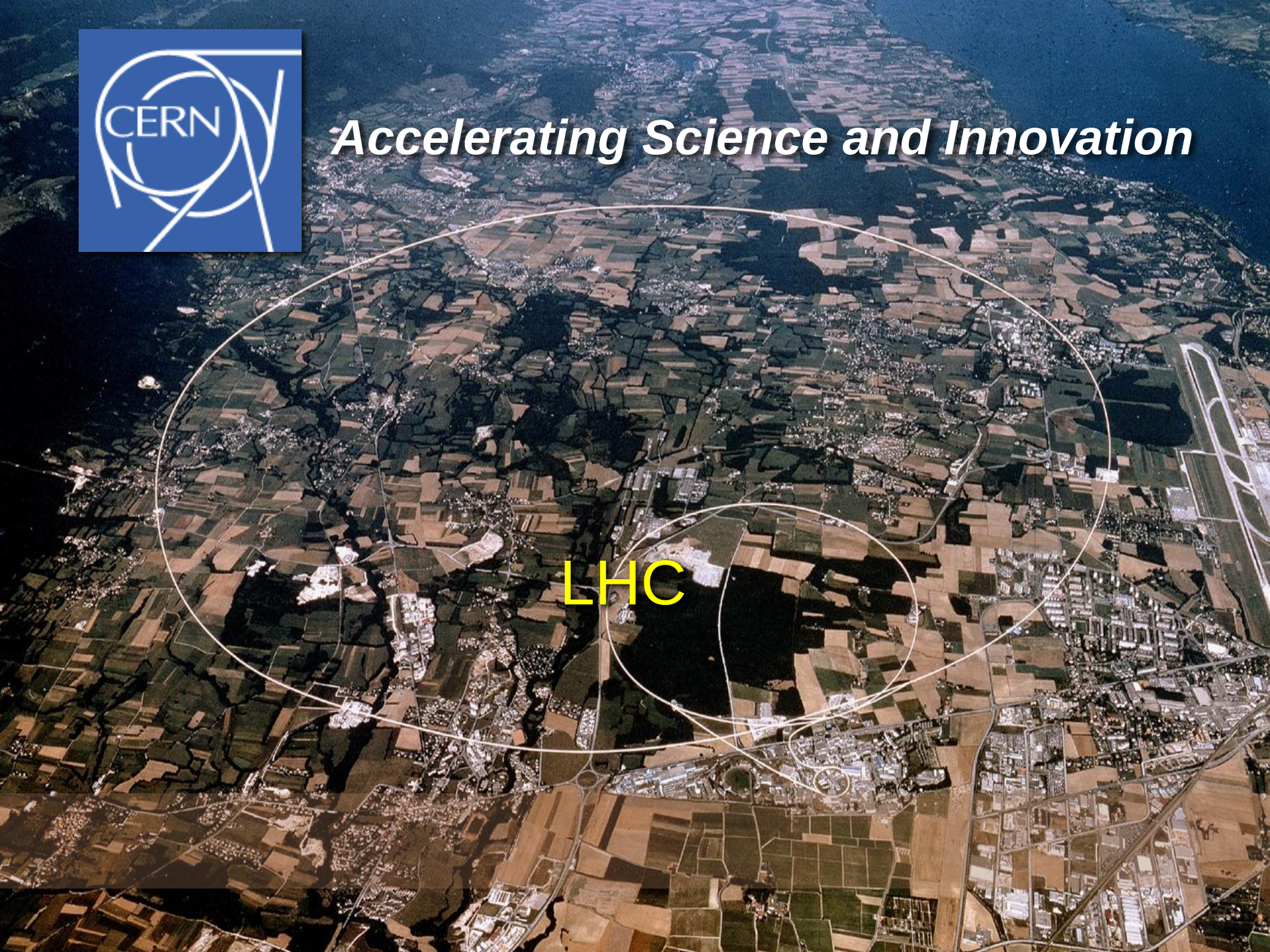
First cand. ($\tau \rightarrow$ 1had kink) reported in 2010



Years	Status	# of events for Decay search	Expected ν_τ (Preliminary)	Observed ν_τ Candidate Events	Expected BG for ν_τ (Preliminary)
2008-2009	Finished	2783		1	
2010-2011	In analysis	1343		1	
2012	Started				
Total		4126	2.1	2	0.2

2nd Cand ($\tau \rightarrow$ 3h) reported in June 2012

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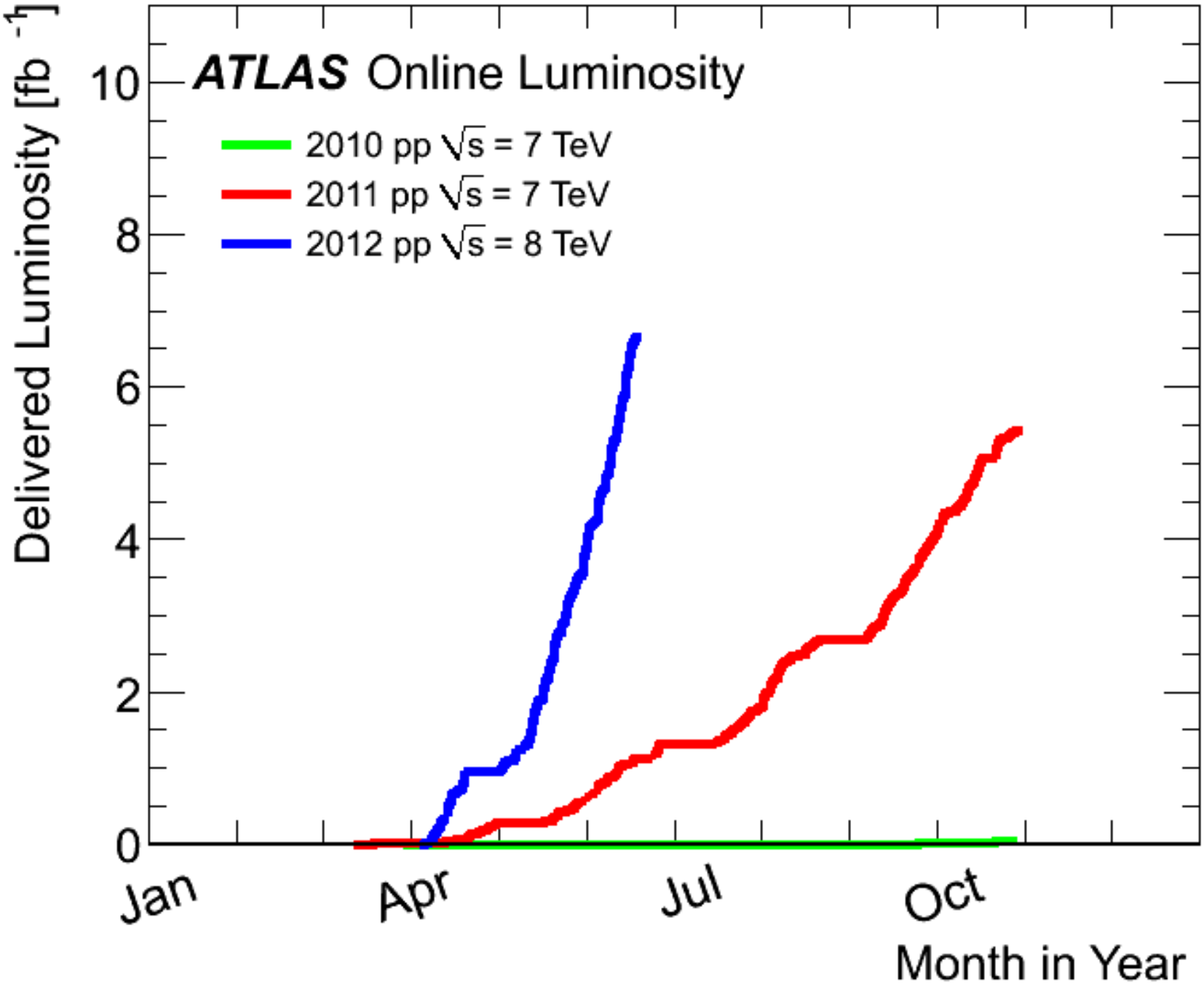
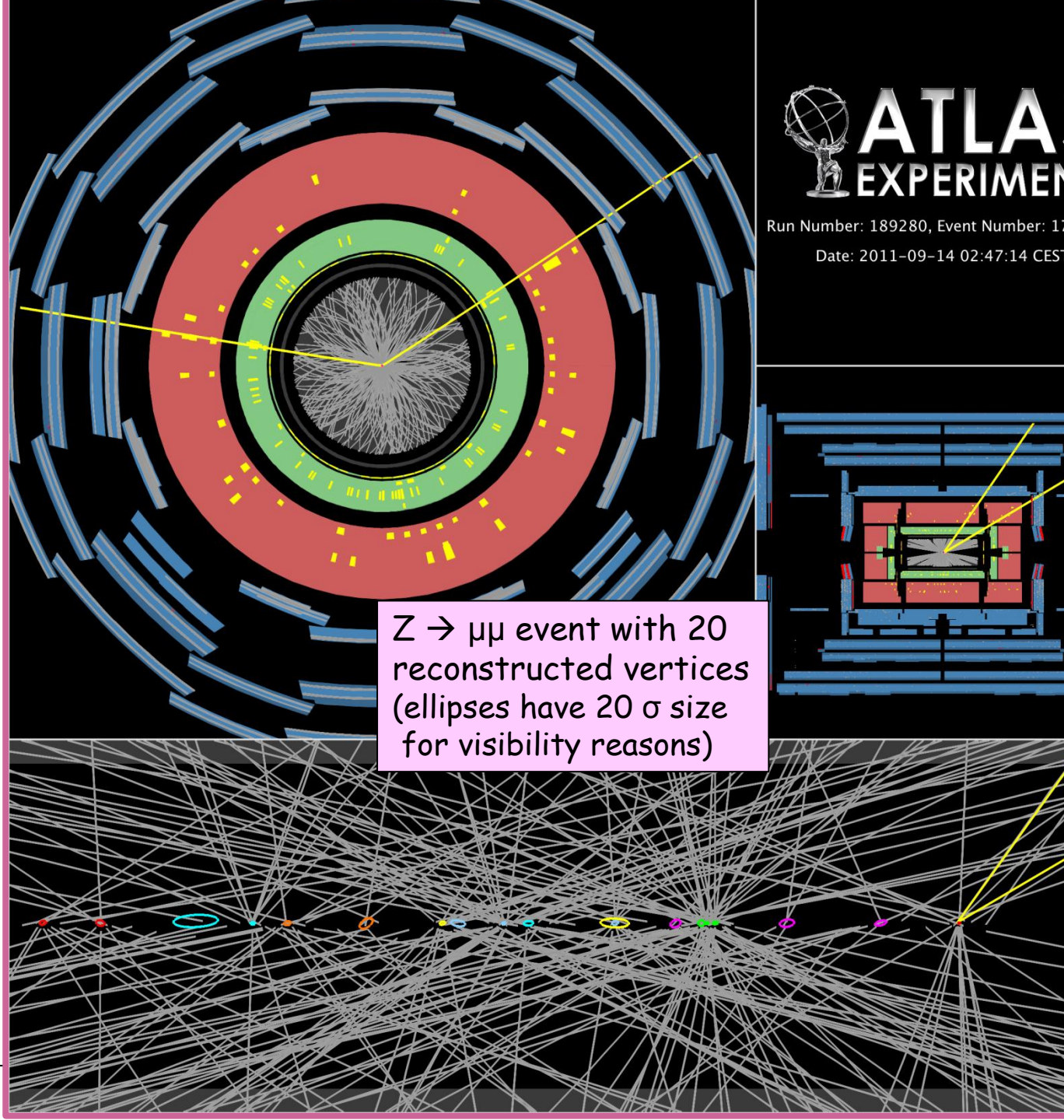

ATLAS Online Luminosity
2010 pp √s = 7 TeV
2011 pp √s = 7 TeV
2012 pp √s = 8 TeV
Delivered Luminosity [fb -1]
0
2
4
6
8
10
Jan
Apr
Jul
Oct
Month in Year

Pile-up

Experiments record data of **high quality** with **high efficiency** at luminosities not expected at such an early stage

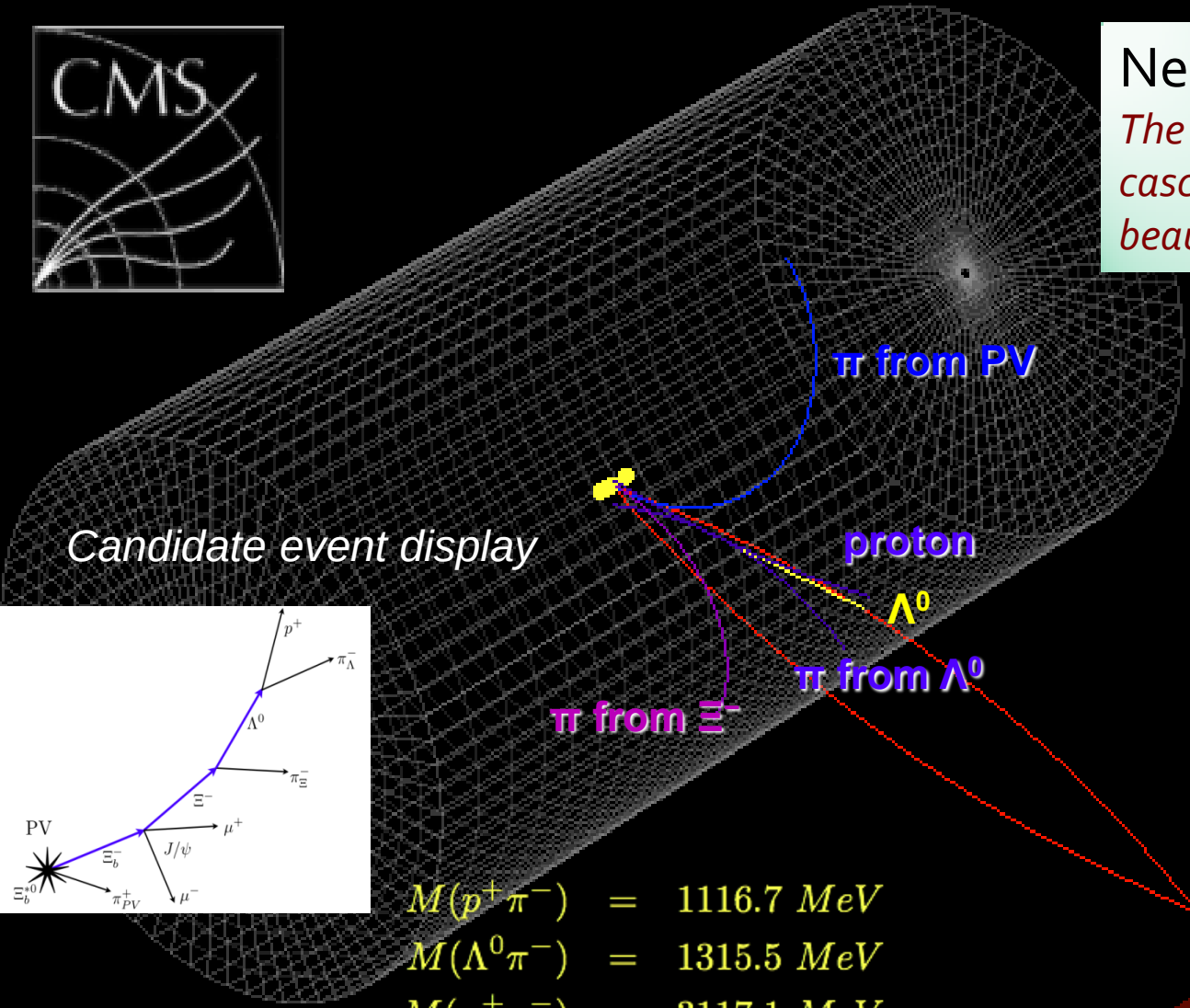


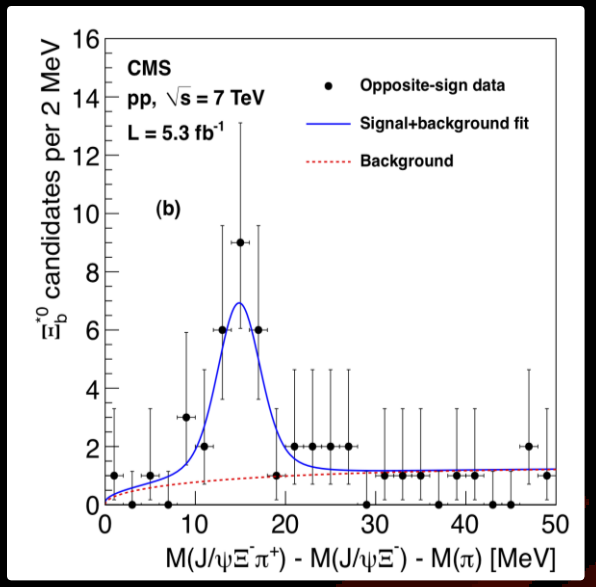
Z → μμ event with 20 reconstructed vertices (ellipses have 20 σ size for visibility reasons)

New ParticleDiscovery

The Ξ_b^{*o} involves elegant cascade that CMS tracker handles beautifully.

Candidate event display





$$M(p^+\pi^-) = 1116.7\ MeV$$
$$M(\Lambda^0\pi^-) = 1315.5\ MeV$$
$$M(\mu^+\mu^-) = 3117.1\ MeV$$
$$M(J/\psi\Xi^-) = 5787.8\ MeV$$
$$Q(J/\psi\Xi^-\pi^+) = 15.7\ MeV$$

$$\Xi_b^{*0} \rightarrow \Xi_b^- \pi^+ \rightarrow \Xi^- J/\psi\, \pi^+ \rightarrow \Lambda \pi^- \mu^+ \mu^- \pi^+ \rightarrow p^+ \pi^- \pi^- \mu^+ \mu^- \pi^+$$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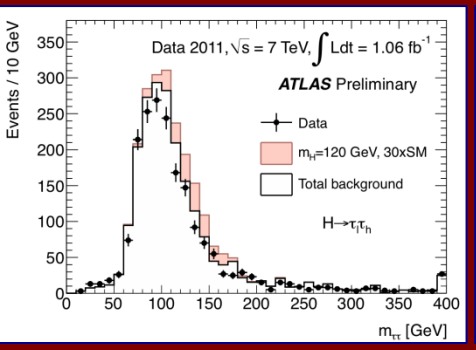
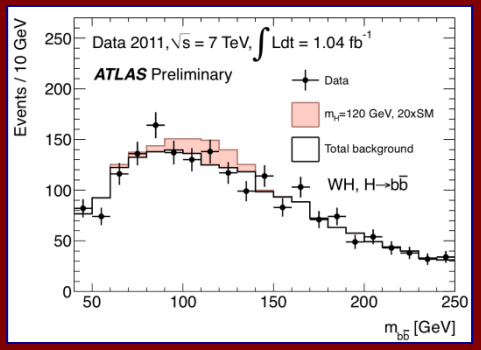
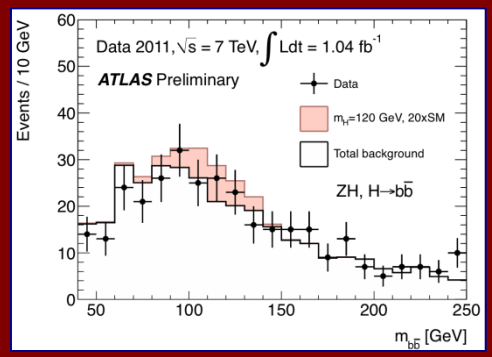
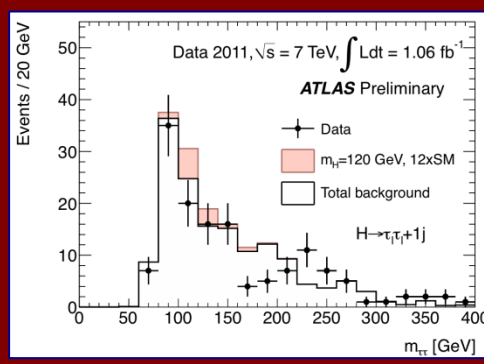
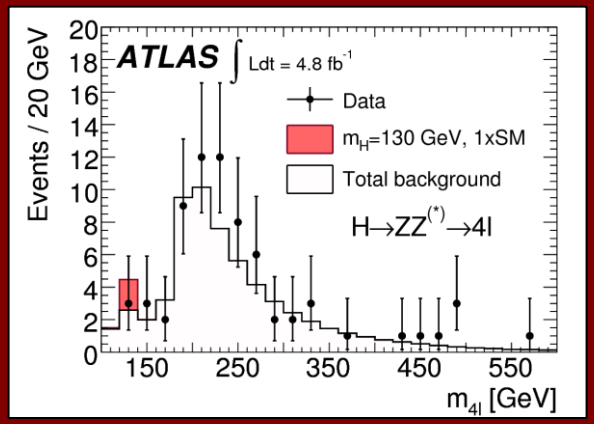
Search for the Higgs Boson

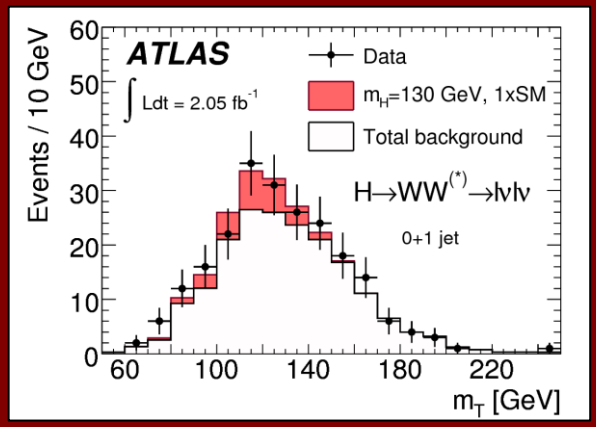

Data 2011, √s = 7 TeV, ∫ Ldt = 1.06 fb-1
ATLAS Preliminary
Data
mH=120 GeV, 30xSM
Total background
H→τlτh
Events / 10 GeV
mττ [GeV]

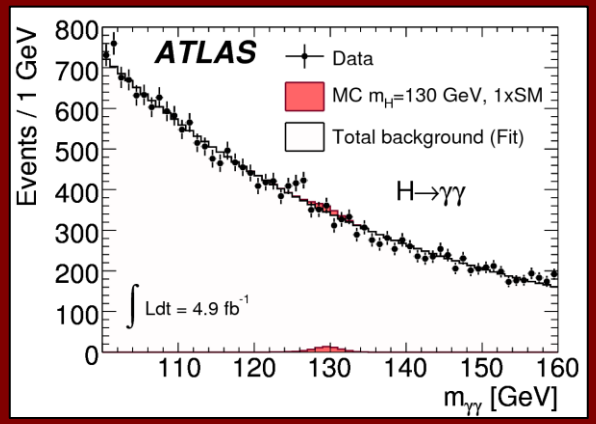

Data 2011, √s = 7 TeV, ∫ Ldt = 1.04 fb-1
ATLAS Preliminary
Data
mH=120 GeV, 20xSM
Total background
WH, H→bb̄
Events / 10 GeV
mbb̄ [GeV]


Data 2011, √s = 7 TeV, ∫ Ldt = 1.04 fb-1
ATLAS Preliminary
Data
mH=120 GeV, 20xSM
Total background
ZH, H→bb̄
Events / 10 GeV
mbb̄ [GeV]

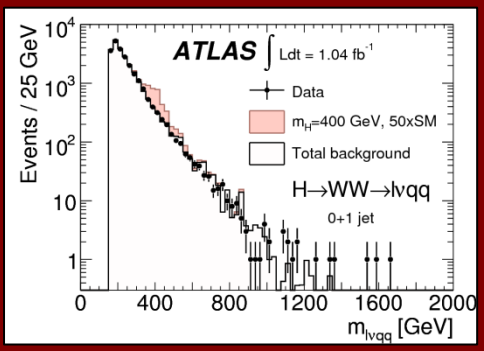

Data 2011, √s = 7 TeV, ∫ Ldt = 1.06 fb-1
ATLAS Preliminary
Data
mH=120 GeV, 12xSM
Total background
H→τlτl+1j
Events / 20 GeV
mττ [GeV]

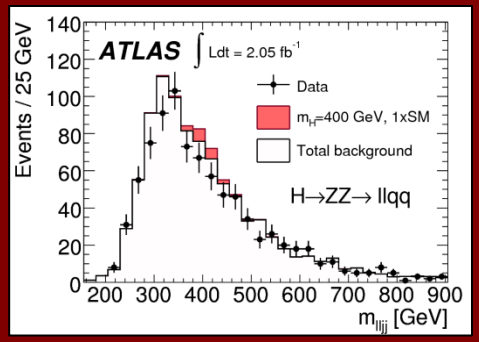

ATLAS ∫ Ldt = 4.8 fb-1
Data
mH=130 GeV, 1xSM
Total background
H→ZZ(*)→4l
Events / 20 GeV
m4l [GeV]

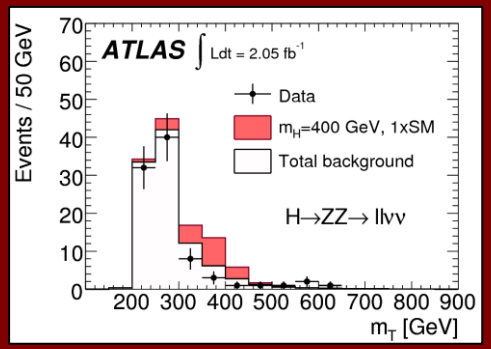

ATLAS
∫ Ldt = 2.05 fb-1
Data
mH=130 GeV, 1xSM
Total background
H→WW(*)→lνlν
0+1 jet
Events / 10 GeV
mT [GeV]

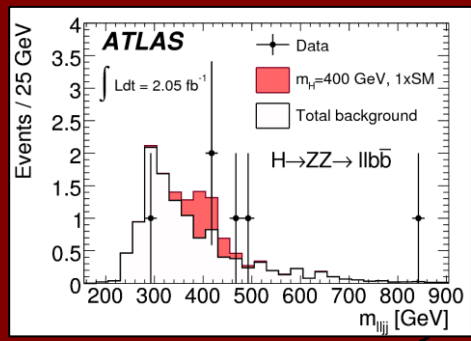

ATLAS
Data
MC mH=130 GeV, 1xSM
Total background (Fit)
H→γγ
∫ Ldt = 4.9 fb-1
Events / 1 GeV
mγγ [GeV]

SM Higgs

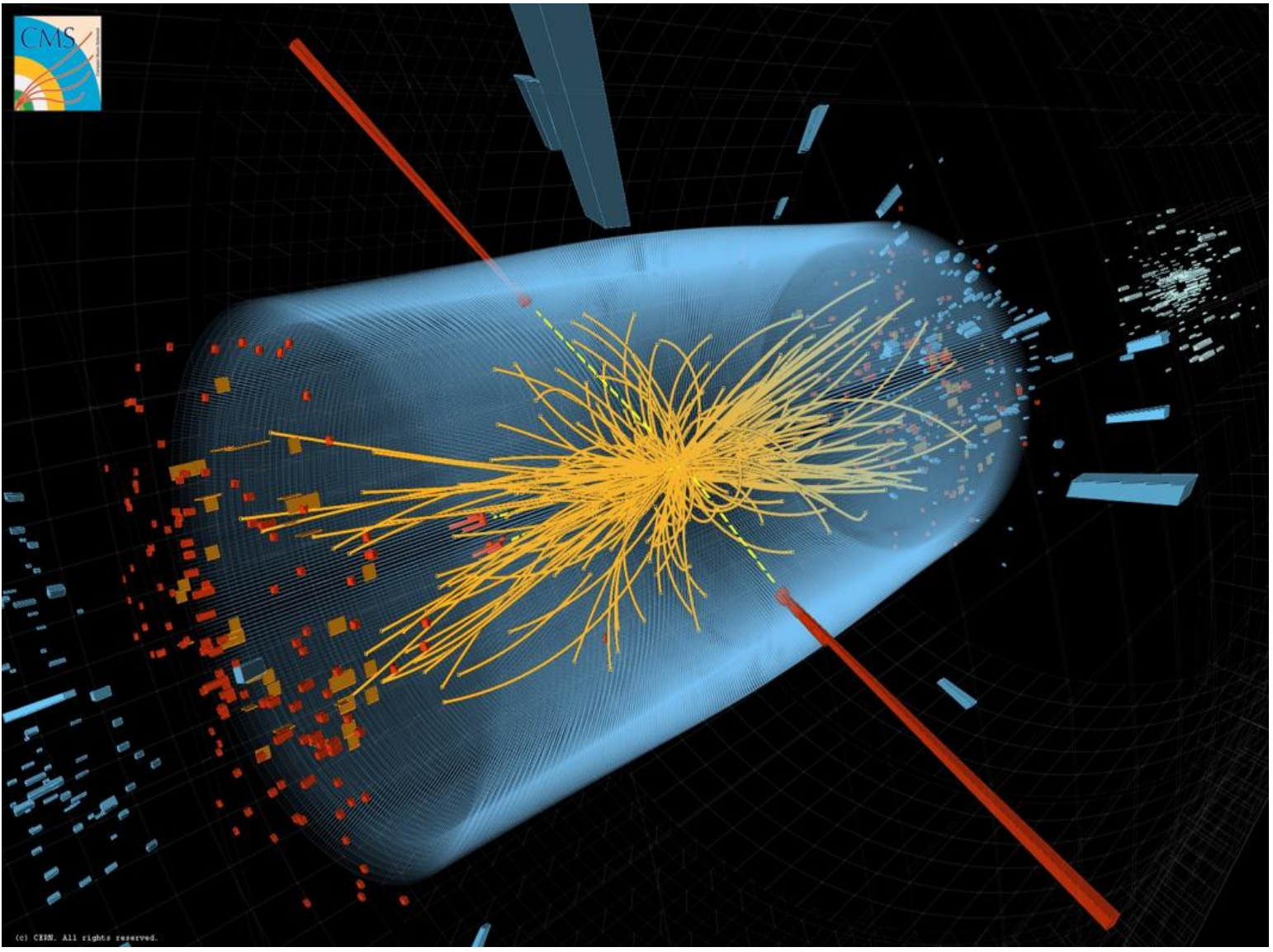

ATLAS ∫ Ldt = 1.04 fb-1
Data
mH=400 GeV, 50xSM
Total background
H→WW→lνqq
0+1 jet
Events / 25 GeV
mlνqq [GeV]

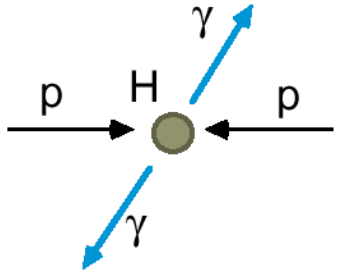

ATLAS ∫ Ldt = 2.05 fb-1
Data
mH=400 GeV, 1xSM
Total background
H→ZZ→ llqq
Events / 25 GeV
mlljj [GeV]


ATLAS ∫ Ldt = 2.05 fb-1
Data
mH=400 GeV, 1xSM
Total background
H→ZZ→ llνν
Events / 50 GeV
mT [GeV]


ATLAS
∫ Ldt = 2.05 fb-1
Data
mH=400 GeV, 1xSM
Total background
H→ZZ→ llbb̄
Events / 25 GeV
mlljj [GeV]

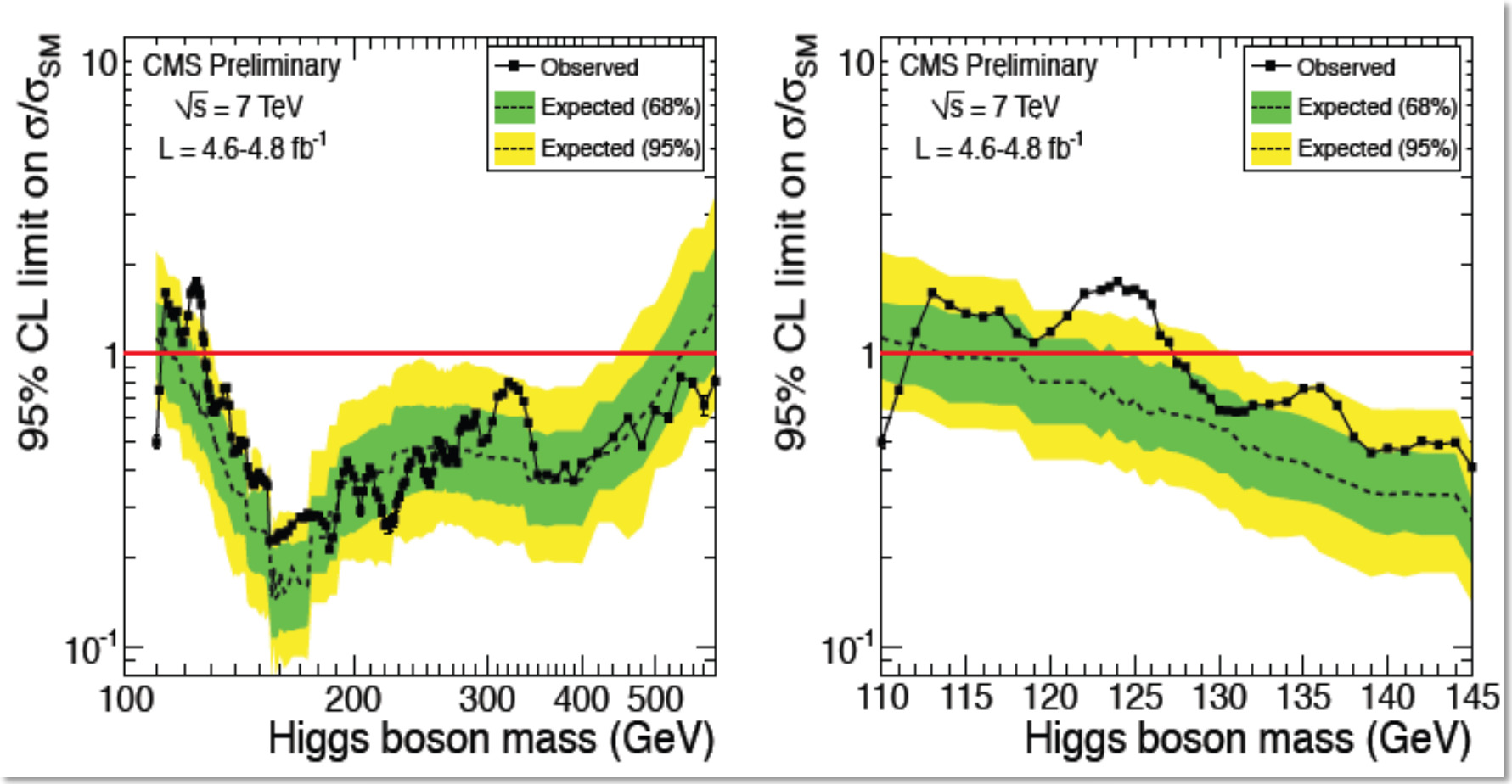
A Collision with two Photons





A Higgs or
a ‘background’
process without
a Higgs?

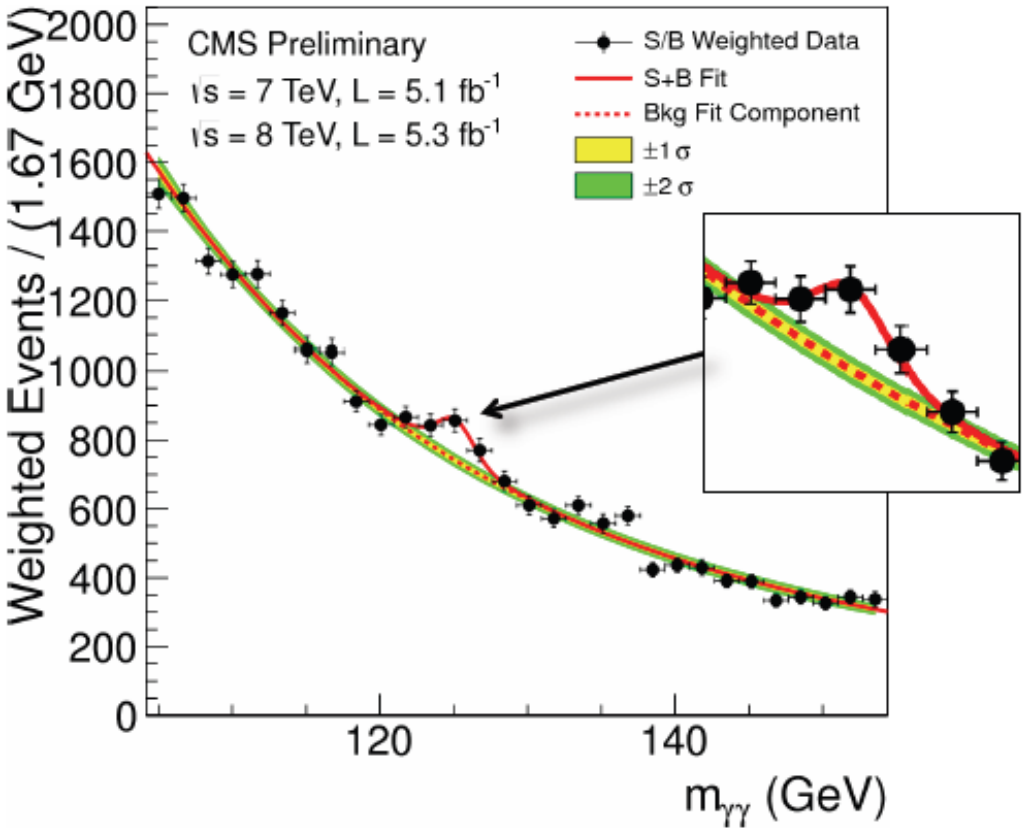
Status beginning of July 2012



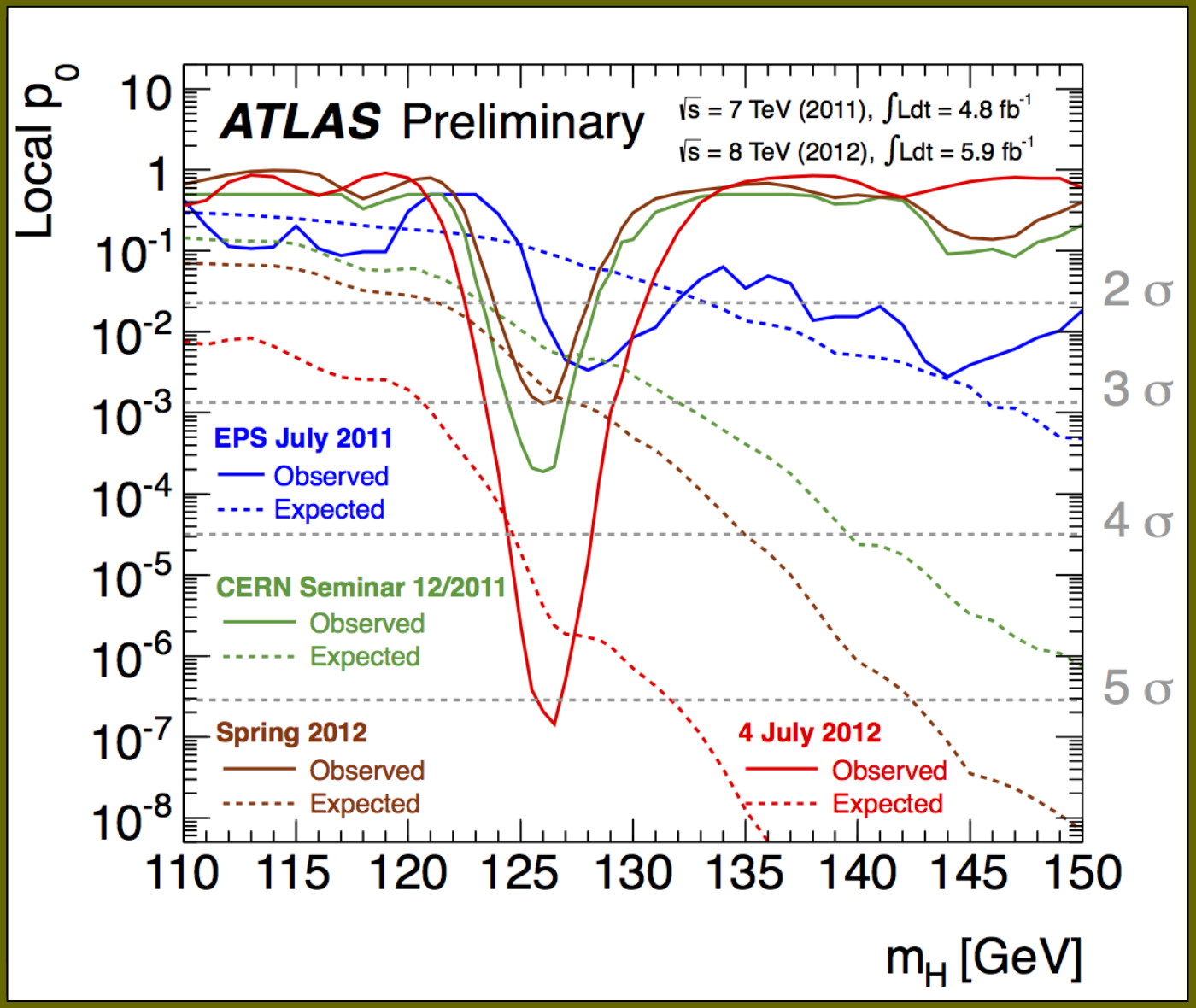
It took ~30 years to experimentally restrict the SM Higgs mass to be above 114 GeV
CMS and ATLAS independently eliminated another ~475 GeV of the range in 2011

S/B Weighted Mass Distribution

- Sum of mass distributions for each event class, weighted by S/B
  - B is integral of background model over a constant signal fraction interval

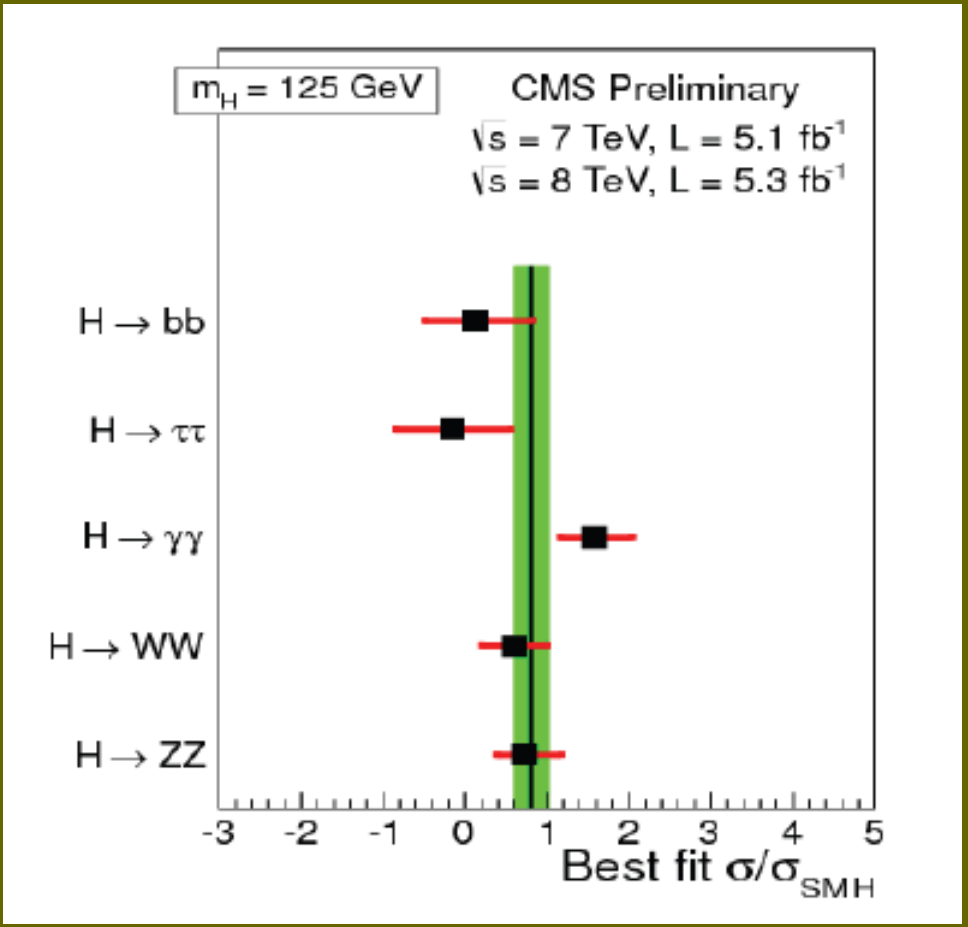


Evolution of the excess with time



Energy-scale systematics not included

… but that's only the beginning !
What's next ?



Measure the properties of the new particle with high precision

… is it a scalar particle ?

… is it *the* Higgs Boson?
or one of several?

… its properties could give information
on Dark Matter

… its properties could give first hints
on Dark Energy

Present run extended by seven weeks before going into a 20 months shutdown

… a few words about LHC and Higgs

at Melbourne

at ESOF2012 in Dublin

The predictable future: LHC Time-line

2009 — Start of LHC

Run 1: 7 and 8 TeV centre of mass energy, luminosity ramping up to few 10^{33} cm^{-2} s^{-1}, few fb^{-1} delivered

2013/14 — LHC shut-down to prepare machine for design energy and nominal luminosity

Run 2: Ramp up luminosity to nominal (10^{34} cm^{-2} s^{-1}), ~50 to 100 fb^{-1}

2018 — Injector and LHC Phase-I upgrades to go to ultimate luminosity

Run 3: Ramp up luminosity to 2.2 x nominal, reaching ~100 fb^{-1} / year accumulate few hundred fb^{-1}

~2022 — Phase-II: High-luminosity LHC. New focussing magnets and CRAB cavities for very high luminosity with levelling

Run 4: Collect data until > 3000 fb^{-1}

2030

The predictable future: Strategy

1) Continuously throughout the years (mainly during shutdowns):

Performance-Improving Consolidation

i.e. replace (aging) components by better performing ones

2) Depending on Physics Requirements:

High Luminosity LHC (~2022)

i.e. upgrade to deliver a total of some 3/ab

LHC

Key message

There is a program at the energy frontier with the LHC for at least 20 years:

8 TeV
14 TeV design luminosity
14 TeV high luminosity (HL-LHC)

Key Messages to June Council

- Logical succession/continuation of previous MTP(s)
- Physics (and other) Goals unchanged
- All options (R&D and studies) for the future kept open (within a global scenario) until outcome of European Strategy update known, i.e. until next year's MTP when priorities might need to be adjusted
- In addition a ten years outlook ("LTP") is presented

- This MTP assumes
  - no increase of contributions from Member States
  - 60 MSfr/yr contribution to stabilize pension fund
  - balancing the deficit by 2020

→ Not all projects/options are (fully) funded


beyond LHC ?

R&D Projects and Studies (examples)

- LC (CLIC, ILC)
- HE-LHC
- LHeC

all continuing as planned

- Neutrino beam line

SPS area more promising than reconstruction of the PS beam line

- Study of “LEP3” initiated

Key message

All projects need continuing accelerator and detector R&D;

All projects need continuing at
concerning a convincing
close collaboratio ndatory

so th ecision can be made when the tim to identify the next energy frontier acce erator (collider).

Today, we need to keep our choices open.

Update of the European Strategy
→ setting priorities

→ Need to present and discuss all these projects in an international context before making choices

→ Need to present physics case(s) always taking into account latest results at existing facilities

→ Need to present (additional) benefits to society from the very beginning of the project

→ Need to have excellent communication and outreach accompanying all projects

(Editorial)

. . . The laws of physics, though, are eternal and universal. Elucidating them is one of the triumphs of mankind. And this week has seen just such a triumphant elucidation.

For non-physicists, the importance of finding the Higgs belongs to the realm of understanding rather than utility. It adds to the sum of human knowledge–

(10bn) That is still a relatively small amount, though, to pay for knowing how things really work, and no form of science reaches deeper into reality than particle physics. As J.B.S. Haldane, a polymathic British scientist, once put it, the universe may be not only queerer than we suppose, but queerer than we can suppose. Yet given the chance, particle physicists will give it a run for its money. ■

Fixed Target Program (examples)

- HIE-Isolde as approved and ongoing
- AD and ELENA as approved; extension for GBAR and addition of a storage ring under consideration
- n-TOF (with EAR2) as approved

- Dirac at PS will terminate end 2012
- Continuation of CNGS beyond 2012 unlikely but not decided yet

Miscellaneous

- **AMS**

One year at ISS, all Astronauts from that flight at CERN 25 July

- **Open Days 2013: 27-29 September**
- **CERN 60th anniversary 2014**

Propose CERN events in member states

- **Summer Students 2012**

269 students from 71 countries

CERN Membership

- **Membership**

Serbia: ratified agreement March 2012

Cyprus: signature expected October 2012

Slovenia and Turkey: process ongoing

- **Associate Membership**

Ukraine: Task Force report due September Council

Brazil: Application File received

Russia: official application, File in preparation