LHC in 2011

A Brief Status Overview

V. Erkcan Özcan
Boğaziçi University

Ankara YEF Günleri, December 29, 2011

Acknowledgement

- This review is based on inputs gathered from a large number of talks and papers, produced by LHC experiments and others presented at various conferences and workshops.
- This presentation provides a personal overview of recents results and did not request, nor obtained official endorsement from any of the LHC.

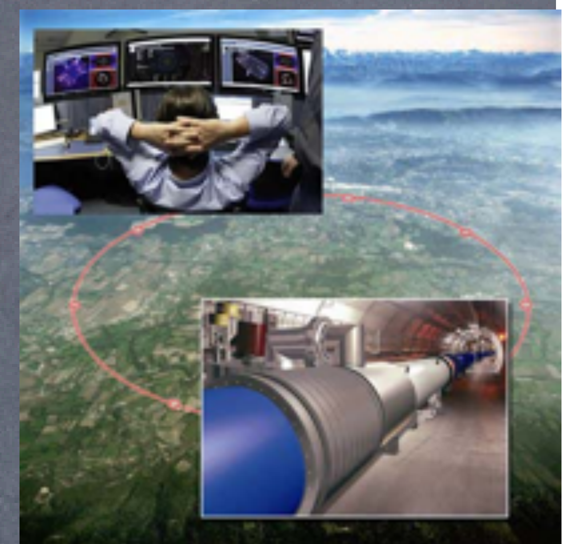
2011 End of Year Summary

- If we had looked at the events of 2011 as seen from CERN, here would be the end of year summary:
  - May - AMS02 in space.
  - June - ALPHA traps antihydrogen atoms for ~1000 secs.
  - July - ASACUSA measures antiproton mass with fractional precision of $O(10^{-9})$
  - August - First publication from CLOUD, showing we still do not understand enough about the formation of clouds.
  - September - OPERA announces superluminal neutrinos.
- What about the news from the LHC?

LHC in News

- Since its start-up, LHC was all over the media. Just two examples:
  - One of the 20 cartoons that brought Mike Keefe of Denver Post his 2011 Pulitzer Prize for editorial cartooning.
  - As featured (at least) three times on Zaytung news satire website...

http://www.zaytung.com/haberdetay.asp?newsid=8101



Kamuoyunun Kıyamet Beklentilerine Cevap Veremeyen CERN'de Olağanüstü Genel Kurul Sesleri

Kısa adıyla CERN olarak bilinen Avrupa Nükleer Araştırma Merkezi'ndeki Büyük Hadron Çarpıştırıcısı'nda yapılan deneylerde bir türlü dünyanın sonunun getirilememesi kamuoyunun tepkisini çekerken, kurum içinde de sert tartışmaların yaşanmasına neden oluyor.

Milyonlarca Euro harcanarak yapılan deneyler sonucu ortaya çıkacak karadelik veya kuramsal bir cisimciğin dünyamızı

Avrupa Nükleer Araştırma Organizasyonu (CERN), Antin Kuntin İşlere Dünyanın Parasını Harcayacaklarına, Dünyada Bir Sürü Fakir İnsan Var, Onları Doyuracaklarını Açıkladı

Avrupa Nükleer Araştırma Organizasyonu (CERN), dün akşam saatlerinde Cenevre'deki merkezlerinde düzenlenen basın toplantısında, kurum bünyesinde halen sürdürülen ve maliyeti 1000 Euro'yu aşan tüm çalışmaları süresiz olarak askıya aldığını duyurdu. Kararın alınmasında, kamuoyunda hakim olan, "Bunun gibi antin kuntin işlere milyarlar harcayacaklarına, dünyada bir sürü aç insan var, onları doyursunlar" yönündeki genel kanaatin etkili olduğu bildirildi. devamı...

Zaytung
dürüst tarafsız ahlaksız haber

http://zaytung.com/haberdetay.asp?newsid=94709

http://www.pulitzer.org/files/works_images/2011/keefe02.jpg

CERN Deneyiyle İlgili de Söyleyecek İki Çift Lafı Olan Rasim Ozan Kütahyalı, Tam Olarak Kimi Şerefsizlikle Suçlayacağını Bulmaya Çalışıyor

Şike yasasından Avrupa Birliği'ne, Kıbrıs sorunundan ABD'deki senato seçimlerine, sualtı hokeyinden ekici tütün piyasasına kadar her konu hakkında fikir üretebilen gazetecilik mesleğinin önde gelen ismi Rasim Ozan Kütahyalı, Avrupa Nükleer Araştırmalar Merkezi (CERN) tarafından Cenevre'de yapılan deneyle ilgili olarak henüz net bir açıklama yapamamış olmanın sıkıntısını yaşıyor. Deneyle ilgili olarak "Şimdi ortada bi şerefsizlik olduğu muhakkak ama tam kim yapıyor o şerefsizliği onu daha bulamadım" diyen Kütahyalı, atomaltı parçacıklar konusunu biraz olsun çözer çözmez bu haysiyetsizlikleri yapanlardan 70 milyonun önünde hesap soracağını ifade etti.

Canlı telefon bağlantısıyla katıldığı bir televizyon programında zaman zaman öfkesine yenik düşen deneyimli gazeteci, şu zamana kadar her konu hakkında en az 5000 vuruşluk yazıları yazabildiğini ve ekranda 2 ila 4 saat arası konuşarak bağıra bağıra hesap sorabildiğini hatırlattı. En son Van depremi ardından "depreme karşı yapısal güçlendirme" ve "şike yasasının TCK'yla çelişen yönleri" hakkında iki haftada altı yazı yazdığını; bu süre zarfında üç ayrı televizyon programında "Fatih Terim'in Milan Baros tecihi" ile "Emre Belözoğlu'nun kadro dışı bırakılması" üzerine yorum yaptığını belirten Kütahyalı, CERN'deki o deneyin sorumlularından da eninde sonunda hesap soracağını, sadece birazcık zamana ihtiyacı olduğunu vurguladı.

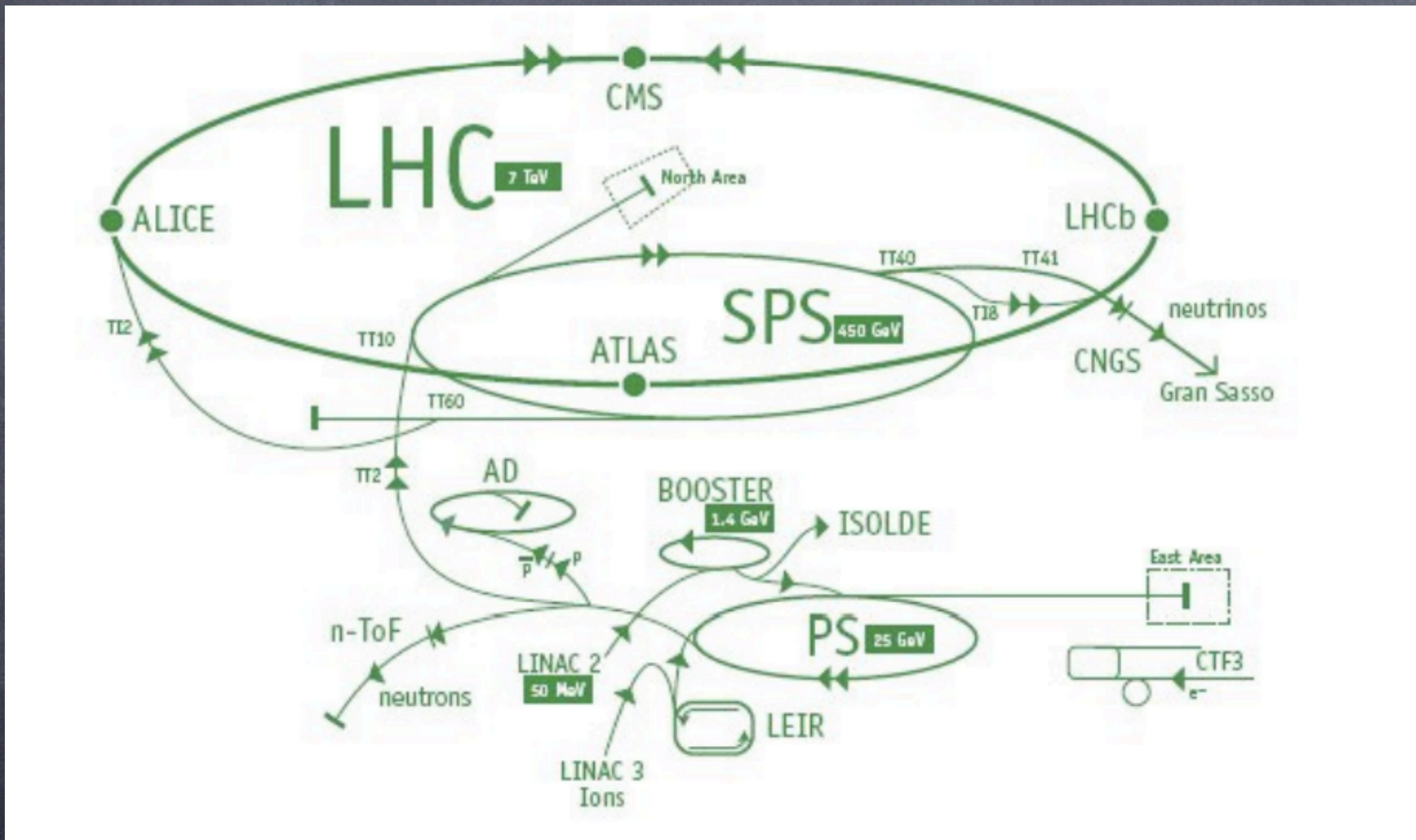
"Elle tutulur, gözle görülür bir şey değil de ondan"

"Allaha şükür şunca zamandır hakkında konuşmayacağım hiçbir konu olmadı. On beş dakikalık bir araştırmayla, iki üç arkadaş sohbetiyle konuya vakıf olabilen bir yapım var" diyen Kütahyalı, şöyle devam etti:

"Yanlış anlaşılmasın, CERN hakkında da bilgim var. Önemli bir kurum olsa gerek. Bilimsel şeyler yapılıyor. Orası net. Fizik, kuantum, zamanın göreceliliği meseleleri ama işte çok elle tutulur bir şeyleri yok. Örneğin şike diyorsun, bir telefon kaydı çıkıyor; Avrupa Birliği diyorsun binlerce sonuç çıkıyor Google'da; kimin şerefsizlik yaptığı üç aşağı beş yukarı belli oluyor lakin CERN'de olup bitenden bir halt anlamadık. Yöneticisi kim bunların? Şenes Erzik'le bir bağları var mı? Eyyamcılık yapılıyor mu? Türkiye olarak biz ne kadar ağırlığımızı koyabiliriz bu meseleye. Bunları değerlendirebilmem için somut bir şeyler olması lâzım. Her şey muğlak..."

http://www.zaytung.com/haberdetay.asp?newsid=154355

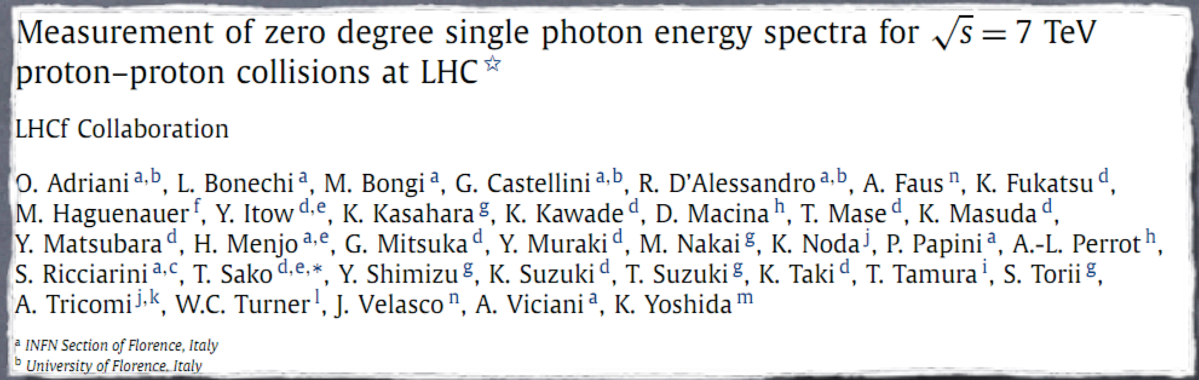
CERN Accelerator Complex



"News from LHC" covers 6 detectors & a large accelerator complex.

LHCf

- Measuring differential x-sections for neutral particle production at "zero"-degrees.
- Calorimeters located 140m away on each side of ATLAS, at the P1 interaction point.
- Essential in understanding the development of the cosmic ray showers in the atmosphere.
- 2011 - first paper published => Photon x-sections.
  - Significant differences between data and all the available MC codes.
  - π^0 x-sections in preparation.
- 2012 plans: Run for ~6 days in 2012 for measurements in Pb-p collisions.

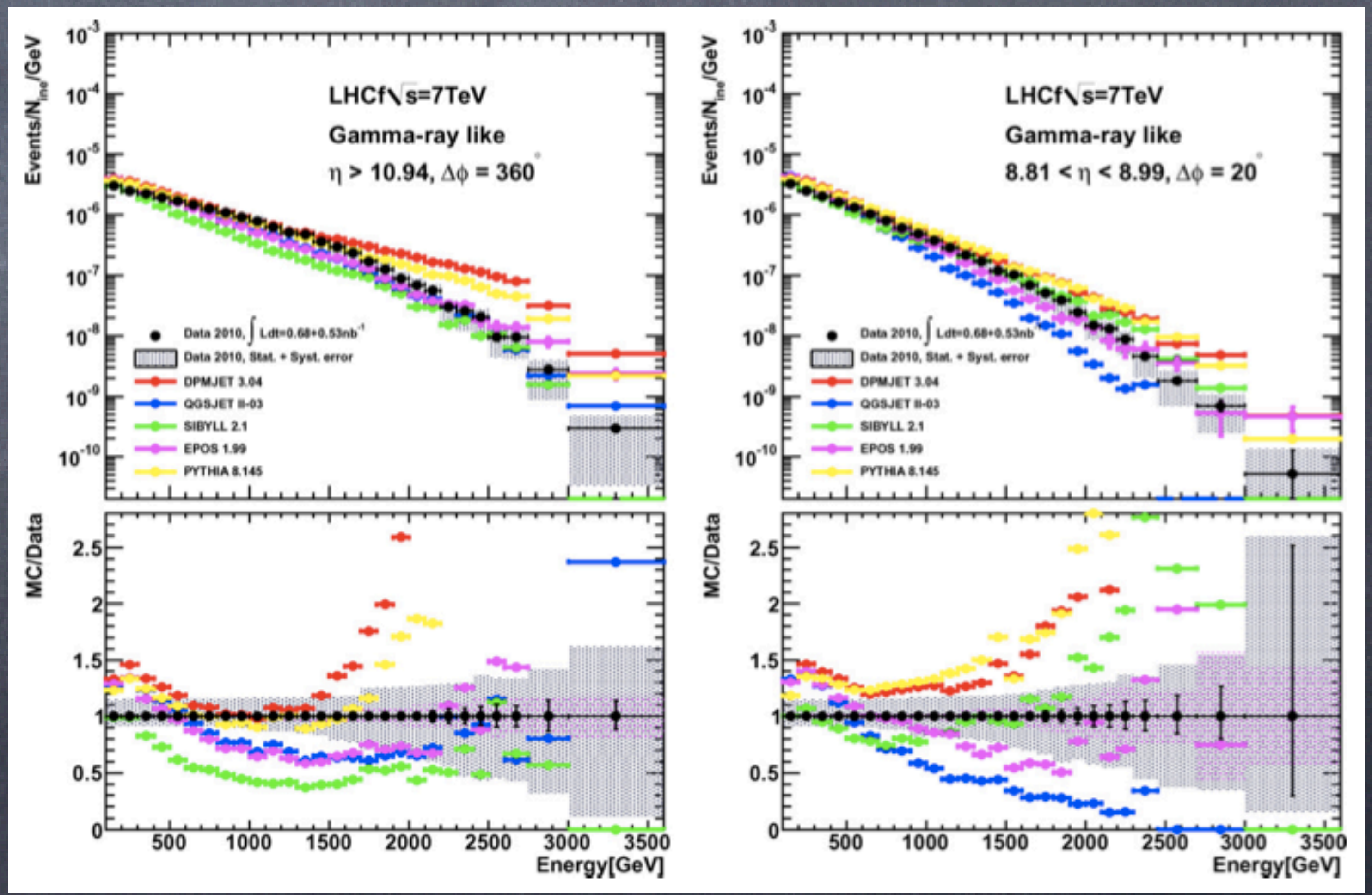

Measurement of zero degree single photon energy spectra for $\sqrt{s} = 7$ TeV proton–proton collisions at LHC ☆

LHCf Collaboration

O. Adriani[a,b], L. Bonechi[a], M. Bongi[a], G. Castellini[a,b], R. D'Alessandro[a,b], A. Faus[n], K. Fukatsu[d], M. Haguenauer[f], Y. Itow[d,e], K. Kasahara[g], K. Kawade[d], D. Macina[h], T. Mase[d], K. Masuda[d], Y. Matsubara[d], H. Menjo[a,e], G. Mitsuka[d], Y. Muraki[d], M. Nakai[g], K. Noda[j], P. Papini[a], A.-L. Perrot[h], S. Ricciarini[a,c], T. Sako[d,e,*], Y. Shimizu[g], K. Suzuki[d], T. Suzuki[g], K. Taki[d], T. Tamura[i], S. Torii[g], A. Tricomi[j,k], W.C. Turner[l], J. Velasco[n], A. Viciani[a], K. Yoshida[m]

[a] INFN Section of Florence, Italy
[b] University of Florence, Italy

Physics Letters B 703 (2011) 128–134



7

For |t| ... GeV², elastic scattering dominated by the exchange of one photon, thus called Coulomb region.
For |t| between 10-3 and 0.4 GeV2, hadronic region, single pomeron exchange.
Between hadronic and Coulomb regions, interference region. See CERN-THESIS-2011-099.

TOTEM

- Measuring p-p x-sections at the LHC, using Roman pots located ~220m away on each side of CMS, at the P5 interaction point.
  - Silicon sensors in moveable beam-pipe insertions. Can approach the beam center to a distance of ~10 times transverse beam size.
- 2011 - first measurement of the total x-section published.
  - Elastic measurement down to |t| $=2\times10^{-2}\text{GeV}^2$ ($\sqrt{t}$ = 4-P-transfer)
  - Extrapolation using optical theorem.
  - Excellent agreement with predictions and with the inelastic x-sections measured by ATLAS & CMS.
- 2012 plans: Up-to twice closer to the beam. Improvements in beam optics could lead to measurements down to $|t|\sim10^{-3}\text{GeV}^2$ => Can start probing ρ itself.

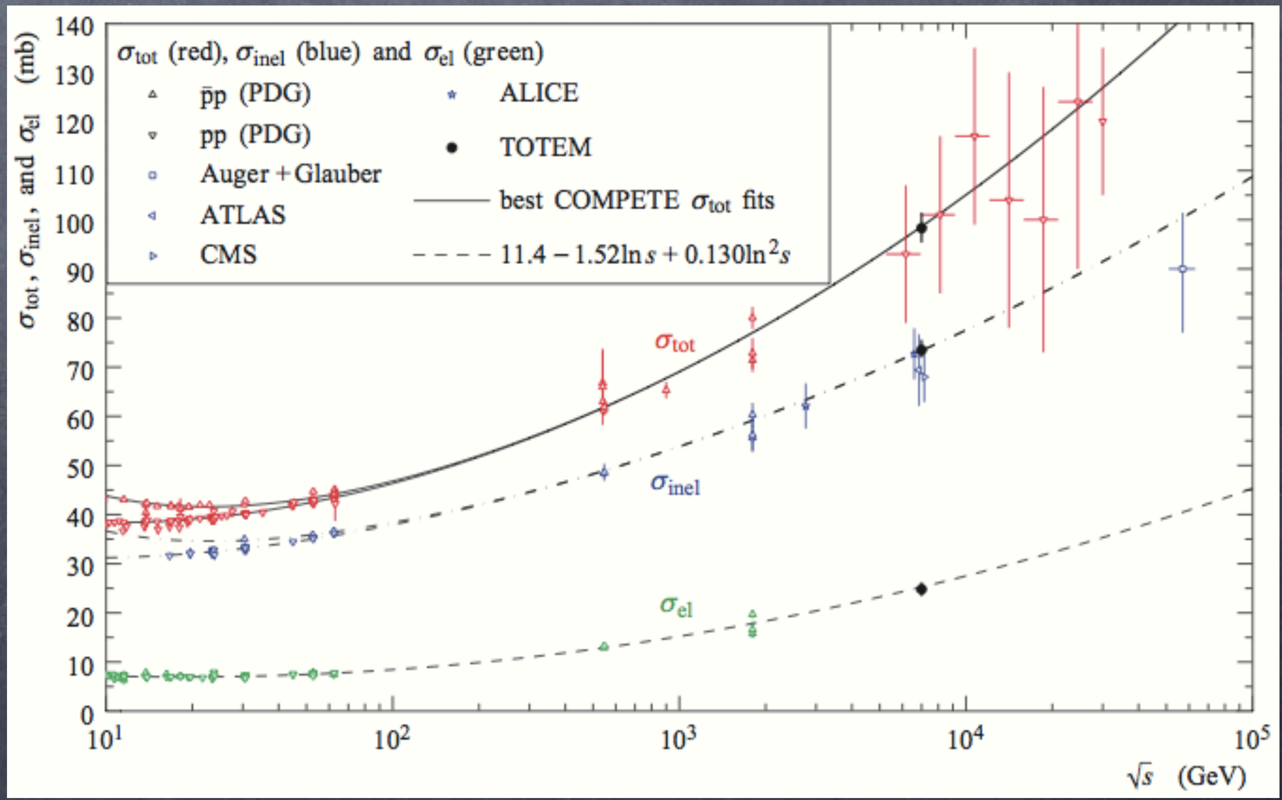
First measurement of the total proton-proton cross-section at the LHC energy of $\sqrt{s} = 7$ TeV

THE TOTEM COLLABORATION
G. Antchev[(a)], P. Aspell[8], I. Atanassov[8(a)], V. Avati[8], J. Baechler[8], V. Berardi[5b,5a], M. Berretti[7b], E. Bossini[7b], M. Bozzo[6b,6a], P. Brogi[7b], E. Brücken[3a,3b], A. Buzzo[6a], F. S. Cafagna[5a], M. Calicchio[5b,5a], M. G. Catanesi[5a], C. Covault[9], T. Csörgő[4], M. Deile[8], K. Eggert[9], V. Eremin[(b)], R. Ferretti[6a,6b], F. Ferro[6a], A. Fiergolski[(c)], F. Garcia[3a], S. Giani[8], V. Greco[7b,8], L. Grzanka[8(d)], J. Heino[3a], T. Hilden[3a,3b], M. R. Intonti[5a], J. Kašpar[1a,7], J. Kopal[1a,8], V. Kundrát[1a], K. Kurvinen[3a], S. Lami[7a], G. Latino[7b], R. Lauhakangas[3a], T. Leszko[(c)], E. Lippmaa[2], M. Lokajíček[1a], M. Lo Vetere[6b,6a], F. Lucas Rodríguez[8], M. Macrí[6a], L. Magaletti[5b,5a], A. Mercadante[5b,5a], S. Minutoli[6a], F. Nemes[4(e)], H. Niewiadomski[8], E. Oliveri[7b], F. Oljemark[3a,3b], R. Orava[3a,3b], M. Oriunno[8(f)], K. Österberg[3a,3b], P. Palazzi[7b], J. Procházka[1a], M. Quinto[5a], E. Radermacher[8], E. Radicioni[5a], F. Ravotti[8], E. Robutti[6a], L. Ropelewski[8], G. Ruggiero[8], H. Saarikko[3a,3b], G. Sanguinetti[7a], A. Santroni[6b,6a], A. Scribano[7b], W. Snoeys[8], J. Sziklai[4], C. Taylor[9], N. Turini[7b], V. Vacek[1b], M. Vitek[1b], J. Welti[3a,3b] and J. Whitmore[10]

[1a] Institute of Physics of the Academy of Sciences of the Czech Republic - Praha, Czech Republic, EU

EPL, 96 (2011) 2100

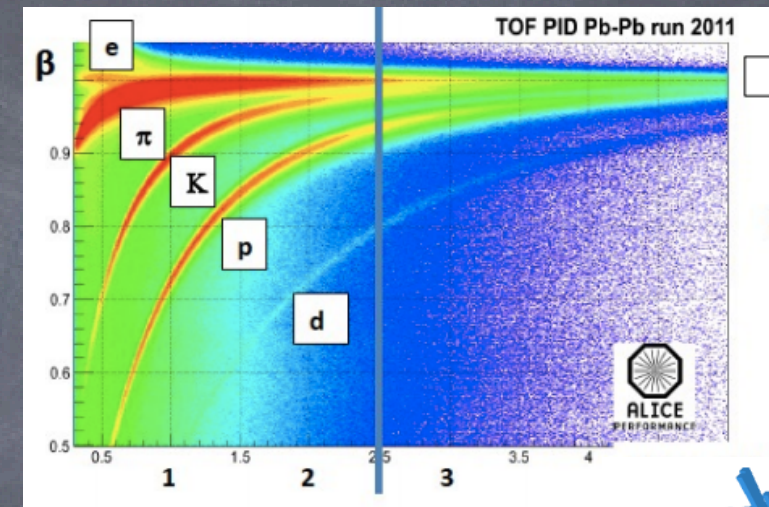
$$\sigma_T = \left(98.3 \pm 0.2^{(\text{stat})} \pm 2.7^{(\text{syst})} \quad \begin{bmatrix} +0.8 \\ -0.2 \end{bmatrix}^{(\text{syst from } \rho)}\right) \text{ mb}$$

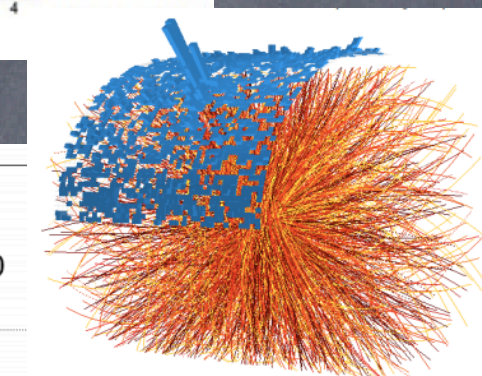


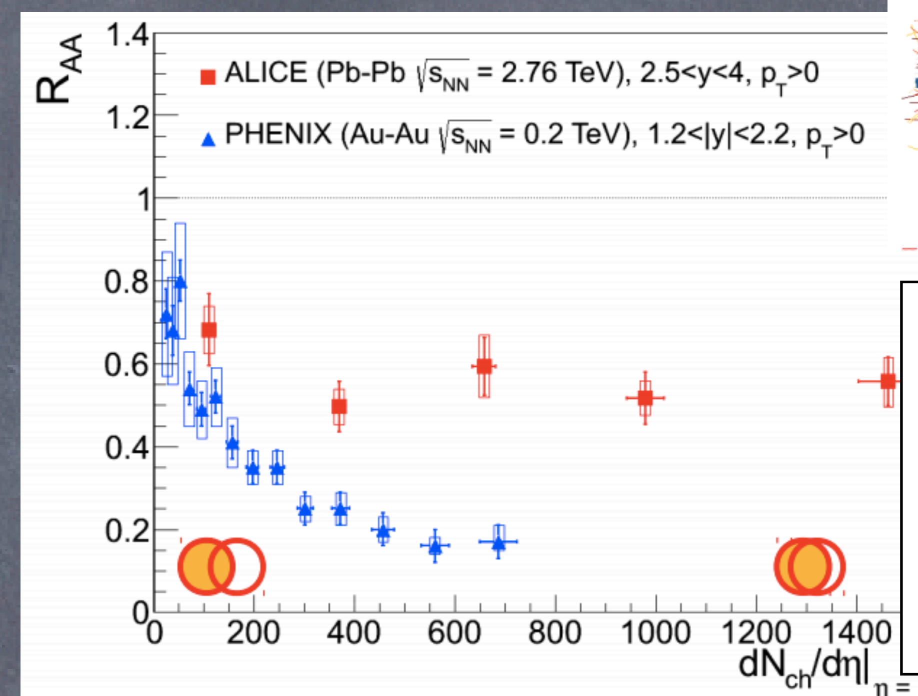
“Similar goals with ALFA detectors at ATLAS”

ALICE

- pp data (few pb^{-1})
  - First inclusive J/ψ production cross section in pp collisions at √s= 2.76 TeV
  - First J/ψ polarization measurement in pp collisions at √s = 7 TeV
  - Final inclusive D meson production cross section in pp at √s = 7 TeV
  - First Λ^+_c signal in pp at √s = 7 TeV
- Pb-Pb data in 2011 (~140ub^{-1})
  - Twice the design luminosity
  - Significantly enhanced rare probe statistics
  - Excellent detector and trigger performances
- Goals for 2012
  - p-Pb (and Pb-p) data taking (30 nb^{-1})
  - Preparations for 2017/18 upgrade



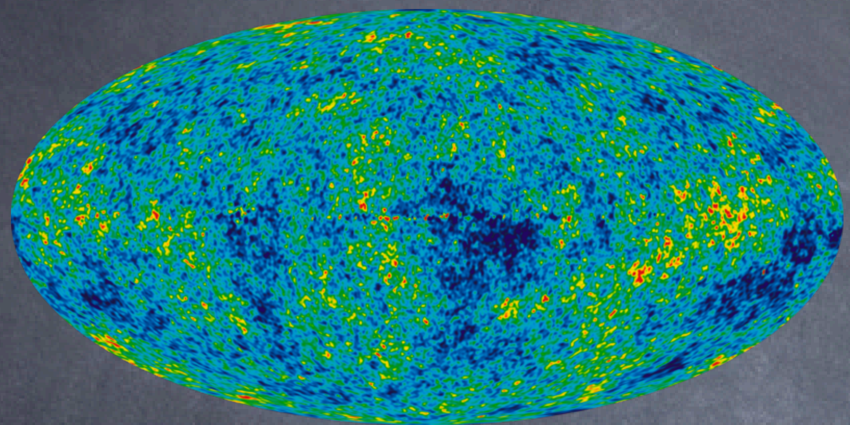




QGP screens all charmonia, but charmonium production takes place at the phase boundary
→ Enhanced production at high energy
→ Signal for deconfinement

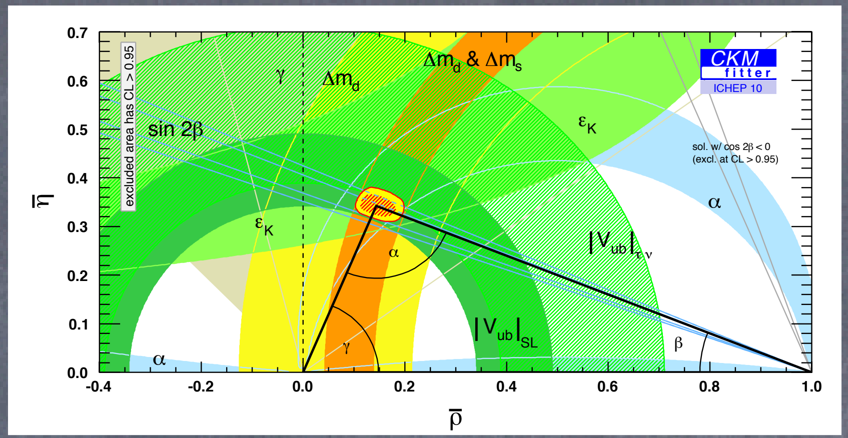
Measurements of charged particle spectra, baryon/meson ratios, nuclear modification factors of light and D mesons & charmonia, etc.
=> Behaviour of QGP at the LHC gives important clues on QCD confinement and chiral symmetry restoration.

Some Big Questions



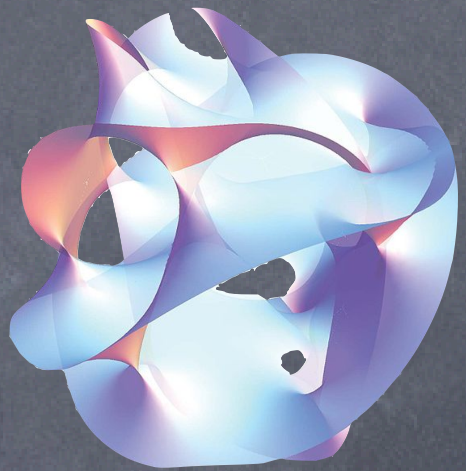
CMB, large-scale-structure,
type-IA supernovae, etc.

- Universe is:
  - 23% dark matter
  - 73% dark energy
  - ~4.5% baryonic matter



β-decays, decays of kaons
and B mesons

- Anti-matter:
  - Where is it all? Why do we have just matter everywhere?



- Gravity:
  - Why so weak?
  - Why is it so difficult to integrate with QM?

What is the mechanism responsible for the mass of matter?

Answers from SM => More Questions...

- Within the SM itself and based on calculations on SM:
  - Naturalness problem: Mass of yet-to-be-discovered Higgs boson diverges.
  - CP violation in SM not enough: Why more matter than antimatter?
- Completely absent from SM:
  - No unification of the 3 forces.
  - Also where is gravity?
  - Why three families?
  - Dark energy?
  - Arbitrary "input" parameters. Why is $m_d > m_u$? Why $m_e < m_n - m_p$?

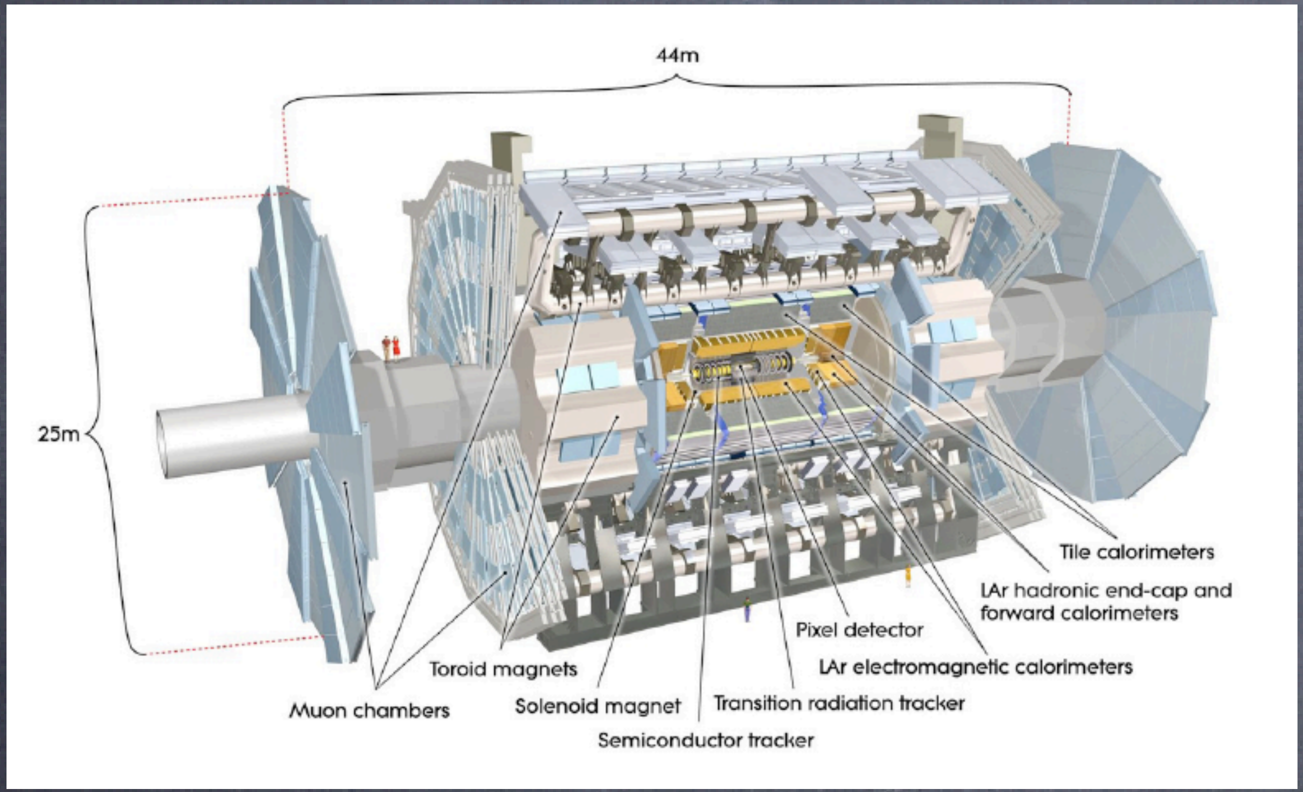
Answers from SM => More Questions...

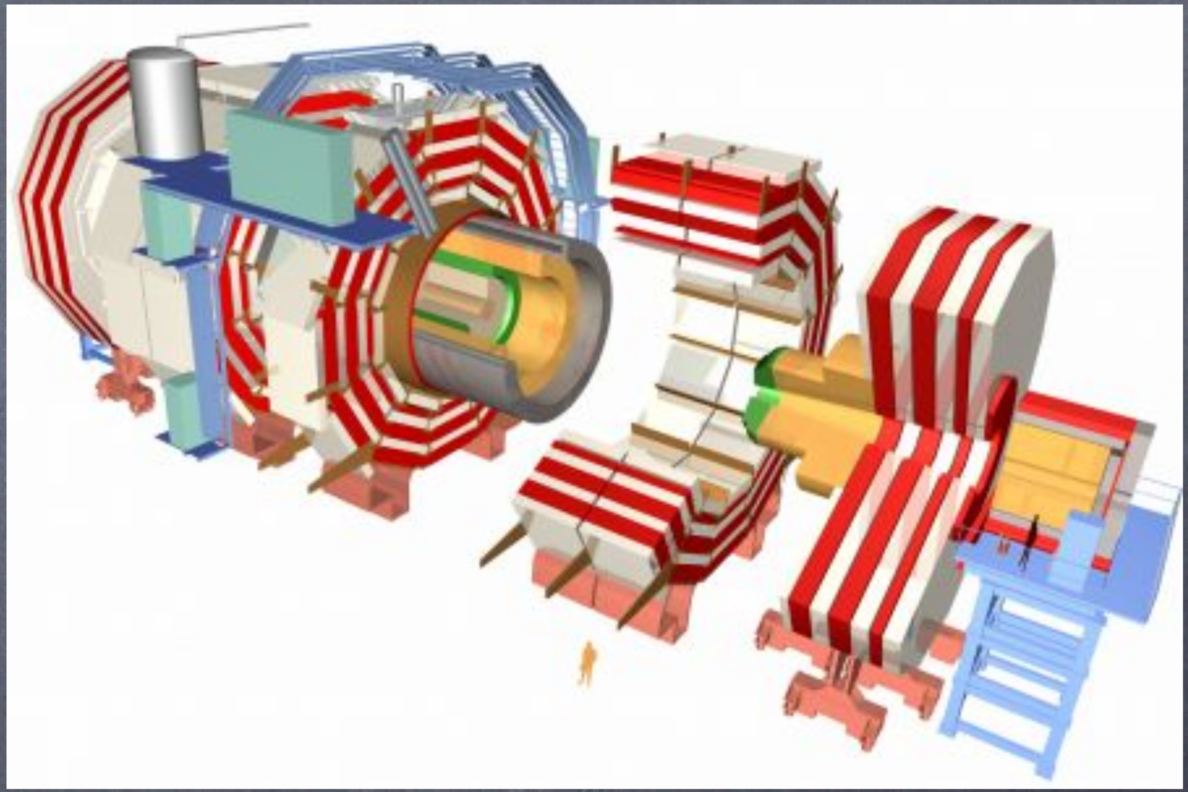
What to look for?

- Within the SM itself and based on calculations on SM:
  - Naturalness problem: Mass of yet-to-be-discovered Higgs boson diverges. Higgs? SUSY?
  - CP violation in SM not enough: Why more matter than antimatter? Does CKM triangle close? New flavor?
- Completely absent from SM:
  - No unification of the 3 forces. Technicolor? E6? SUSY? Test QCD.
  - Also where is gravity? Extra dimensions?
  - Why three families? 4th generation?
  - Dark energy? Related to Higgs vacuum???
  - Arbitrary "input" parameters. Why is $m_d > m_u$? Why $m_e < m_n - m_p$?

Are these particles fundamental?

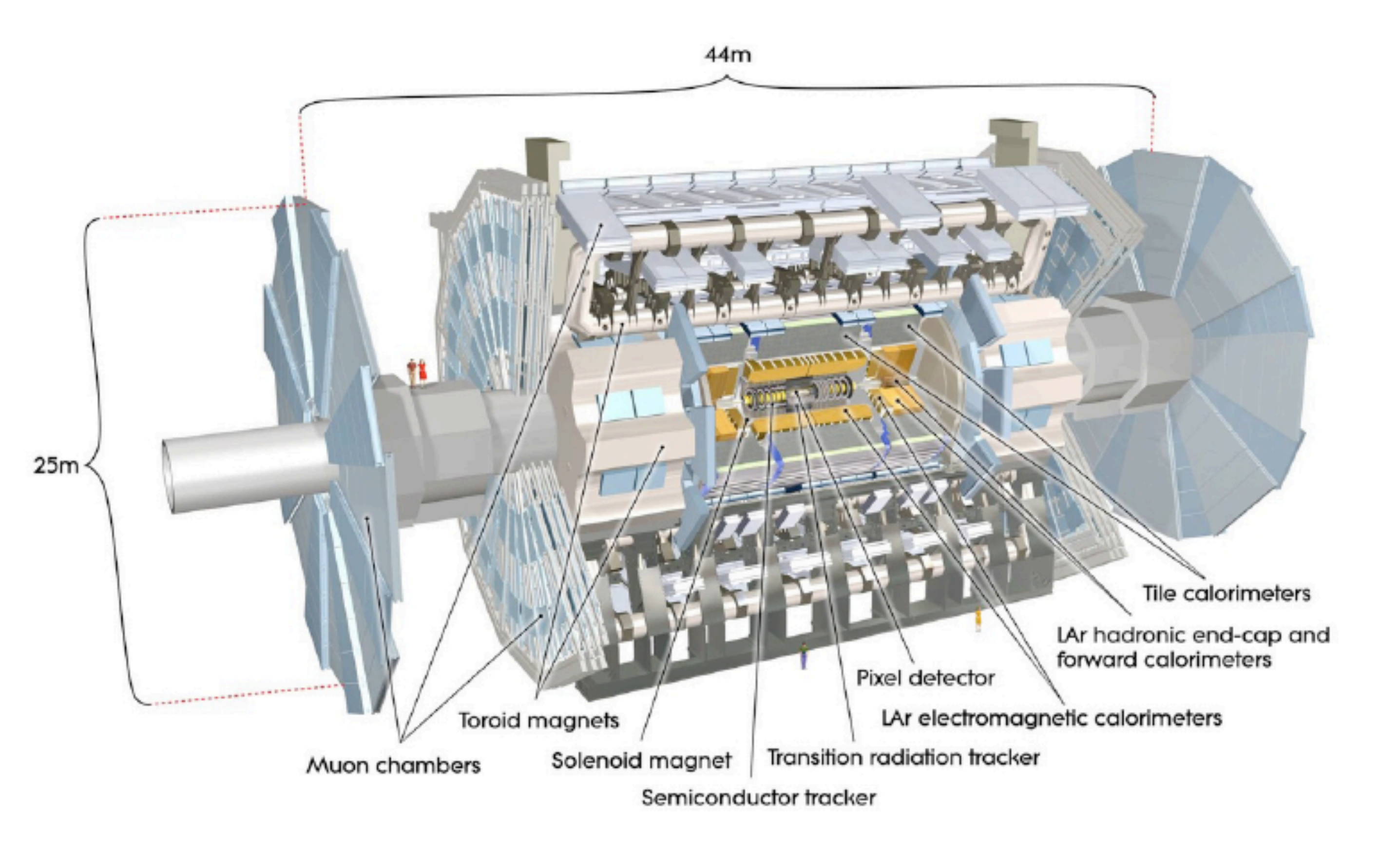
ATLAS and CMS





- The two general-purpose detectors at the LHC. ~3000 collaborators each.

ATLAS Detector



- **Inner Detector:** EPJC 70 (2010) 787

  3 technologies (Pixel detectors, semiconductor tracker & transition radiation tracker)
  2T solenoidal magnetic field up to $|\eta|<2.5$
  resolution ~ 4% for p_T=100 GeV

- **Calorimeters:** EPJC 70 (2010) 723 EPJC 70 (2010) 755 EPJC 70 (2010) 1193

  Good granularity (transverse and longitudinal sampling) and coverage ($|\eta|<4.9$)
  => Good angular resolution
  EM : Pb/Liquid Argon (both in Barrel and Endcap)
  HAD : Fe/scintillation tiles (Barrel) - Cu/Liquid Argon (EC)
  Forward (EM and HAD) : Cu/W - LAr
  Non-compensating

$$\sigma/E \simeq 10-17\%/\sqrt{E} \oplus 0.7\% \text{ (EM)}$$
$$\sigma/E \simeq 50\%/\sqrt{E} \oplus 0.3\% \text{ (HAD)}$$
$$\sigma/E \simeq 100\%/\sqrt{E} \oplus 10\% \text{ (Forward)}$$

- **Muon Spetrometer** EPJC 70 (2010) 875

  4 technologies (MDTs and CSCs as precision chambers, RPCs and TGCs as trigger chambers) in a toroidal magnetic field in air => Resolution ~10% for muon p_T = 1 TeV (standalone measurement)

Detector Status

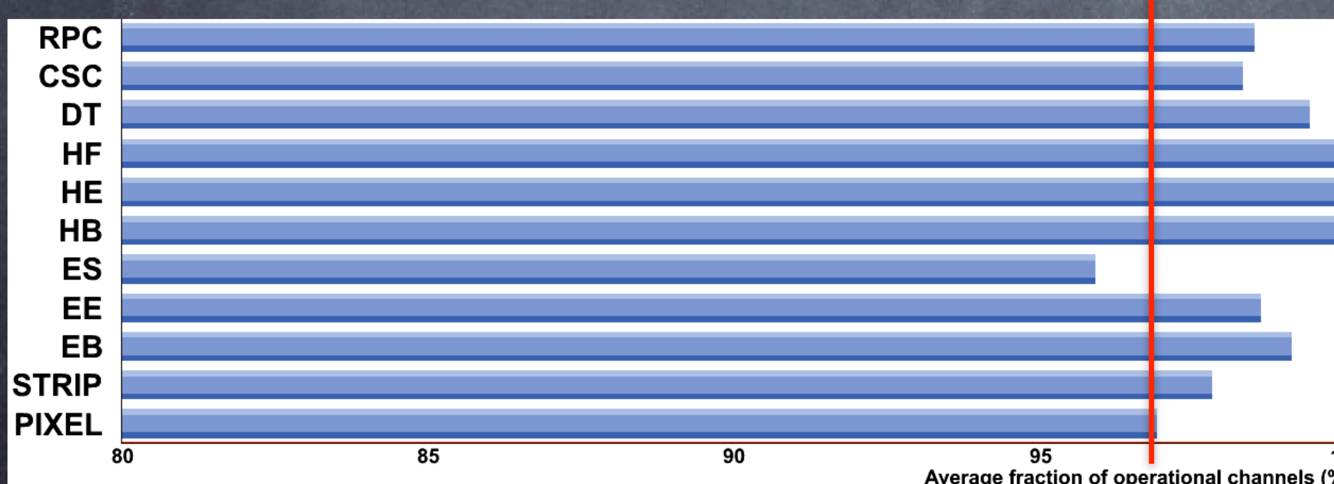
- ATLAS overall data taking eff. : 93.5%
- Overall fraction of data used for offline analyses, better than 90%.

Inner Tracking Detectors			Calorimeters				Muon Detectors				Magnets	
Pixel	SCT	TRT	LAr EM	LAr HAD	LAr FWD	Tile	MDT	RPC	CSC	TGC	Solenoid	Toroid
99.8	99.6	99.2	97.5	99.2	99.5	99.2	99.4	98.8	99.4	99.1	99.8	99.3

Luminosity weighted relative detector uptime and good quality data delivery during 2011 stable beams in pp collisions at √s=7 TeV between March 13th and October 30th (in %), after the summer 2011 reprocessing campaign

Average Live fraction of detector components

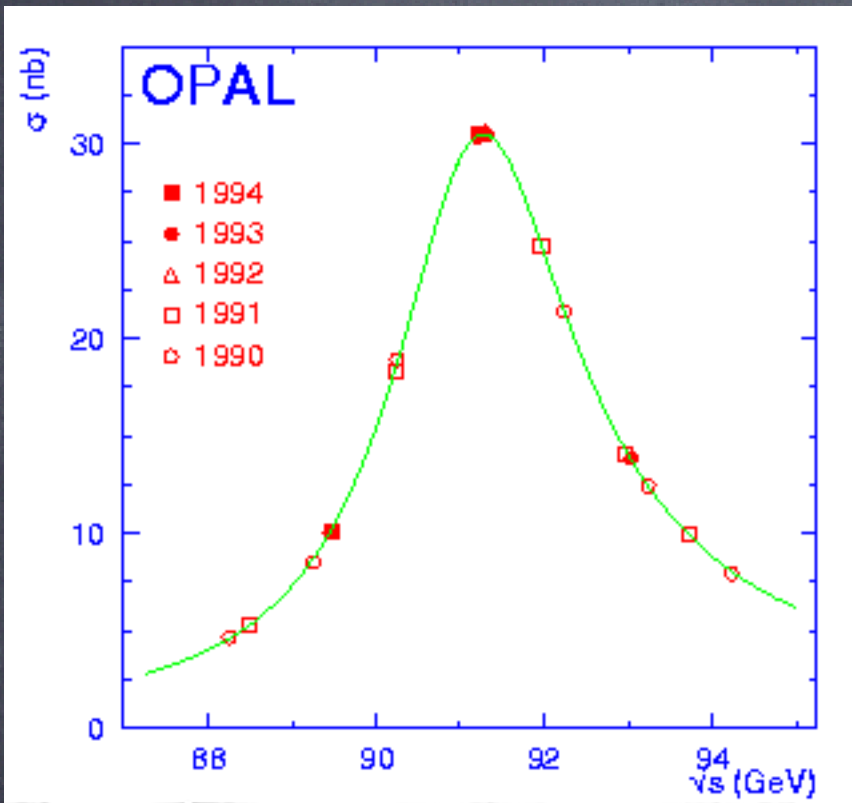
97%



- CMS overall data taking eff. : 92%
- Overall fraction of data used for offline analyses, better than 90%.

Summary: Despite their amazing complexity, excellent performance & >5fb^{-1} of data each!

Step 1: Standard Candles



- Thanks to LEP and Tevatron (and LHC measurements from 2010), precise measurements of gauge bosons and top quarks.
- Z bosons => Candle to calibrate measurements of charged leptons
- W bosons => Candle to calibrate measurements of neutrinos (missing transverse energy)
- top quarks: BR(t->Wb)≈1 => Can be used to understand b-tagging

VALUE (GeV)	EVTS	DOCUMENT ID		TECN	COMMENT
91.1876±0.0021 OUR FIT					
91.1852±0.0030	4.57M	[1] ABBIENDI	01A	OPAL	E^{ee}_{cm} = 88–94 GeV
91.1863±0.0028	4.08M	[2] ABREU	00F	DLPH	E^{ee}_{cm}
91.1898±0.0031	3.96M	[3] ACCIARRI	00C	L3	E^{ee}_{cm}
91.1885±0.0031	4.57M	[4] BARATE	00C	ALEP	E^{ee}_{cm}

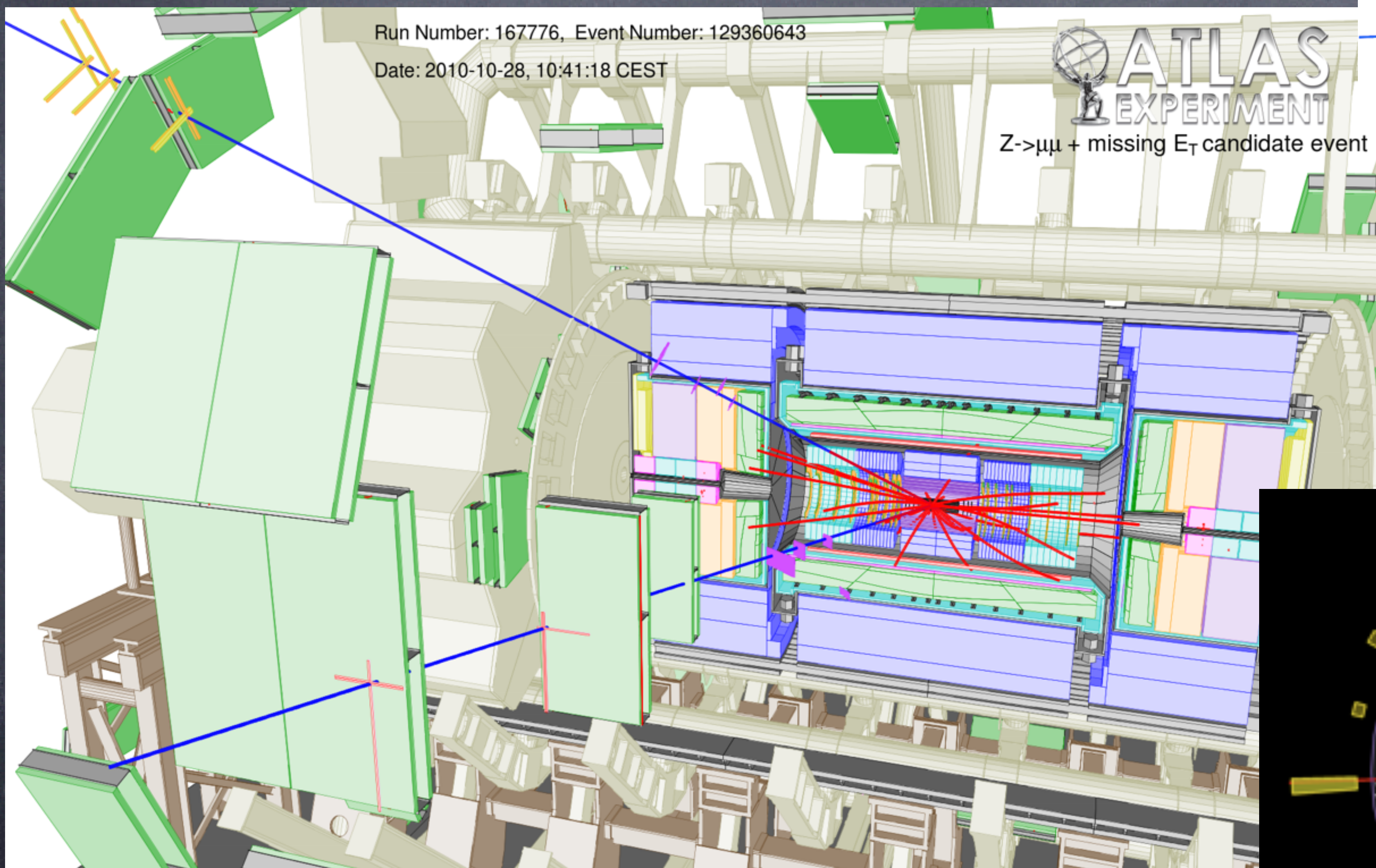
Z mass

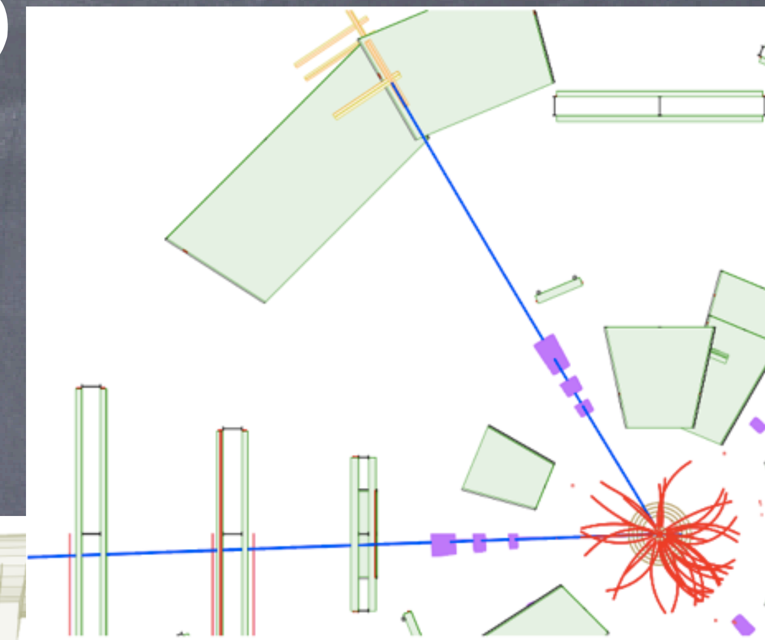
W mass

VALUE (GeV)	EVTS	DOCUMENT ID		TECN	COMMENT
80.399± 0.023 OUR FIT					
80.401± 0.043	500k	[1] ABAZOV	09AB	D0	$E^{p\bar{p}}_{cm}$ = 1.96 TeV
80.336± 0.055±0.039	10.3k	[2] ABDALLAH	08A	DLPH	E^{ee}_{cm} = 161–209 GeV
80.413± 0.034±0.034	115k	[3] AALTONEN	07F	CDF	$E^{p\bar{p}}_{cm}$ = 1.96 TeV
80.415± 0.042±0.031	11830	[4] ABBIENDI	06	OPAL	E^{ee}_{cm} = 170–209 GeV
80.270± 0.046±0.031	9909	[5] ACHARD	06	L3	E^{ee}_{cm} = 161–209 GeV
80.440± 0.043±0.027	8692	[6] SCHAEL	06	ALEP	E^{ee}_{cm} = 161–209 GeV
80.483± 0.084	49247	[7] ABAZOV	02D	D0	$E^{p\bar{p}}_{cm}$ = 1.8 TeV
80.433± 0.079	53841	[8] AFFOLDER	01E	CDF	$E^{p\bar{p}}_{cm}$ = 1.8 TeV

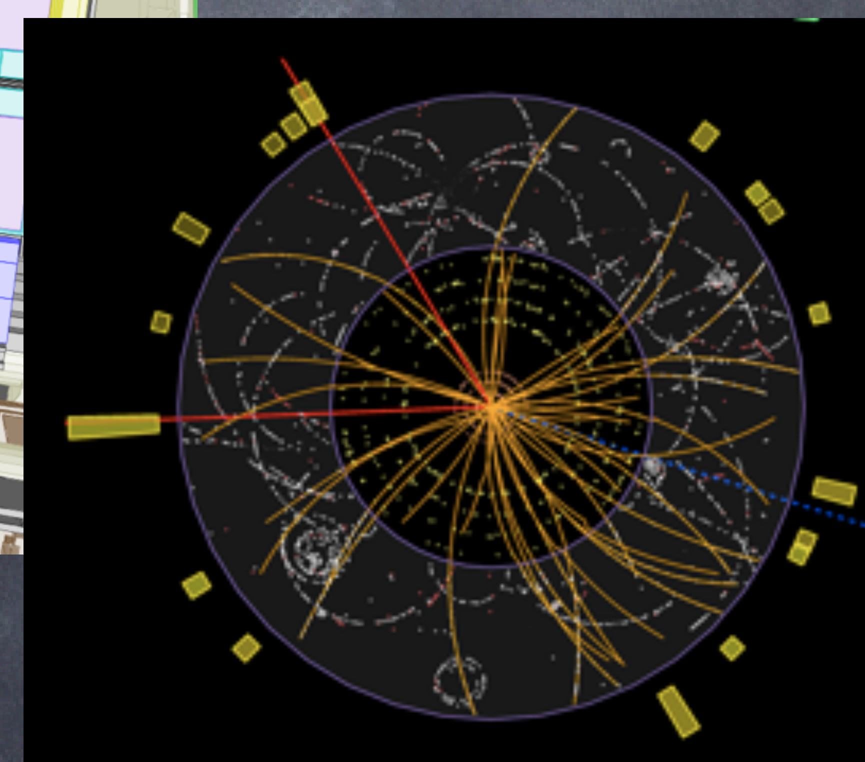
From 2010

$Z_{\mu\mu}$+MET candidate



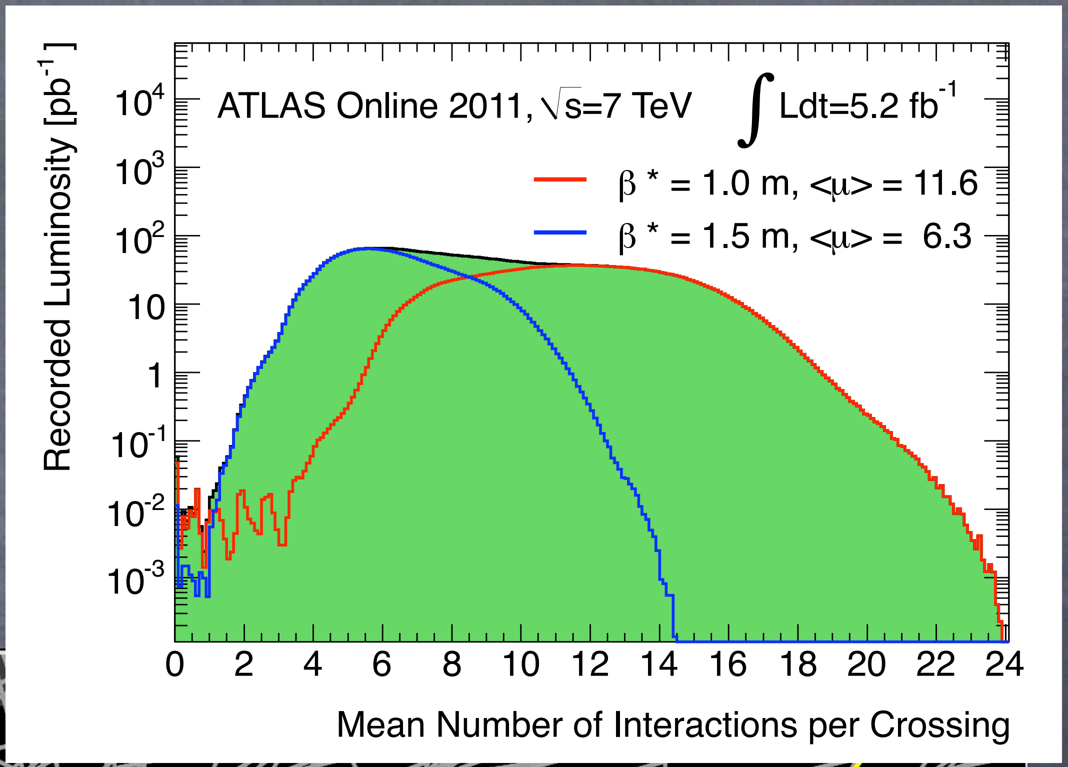


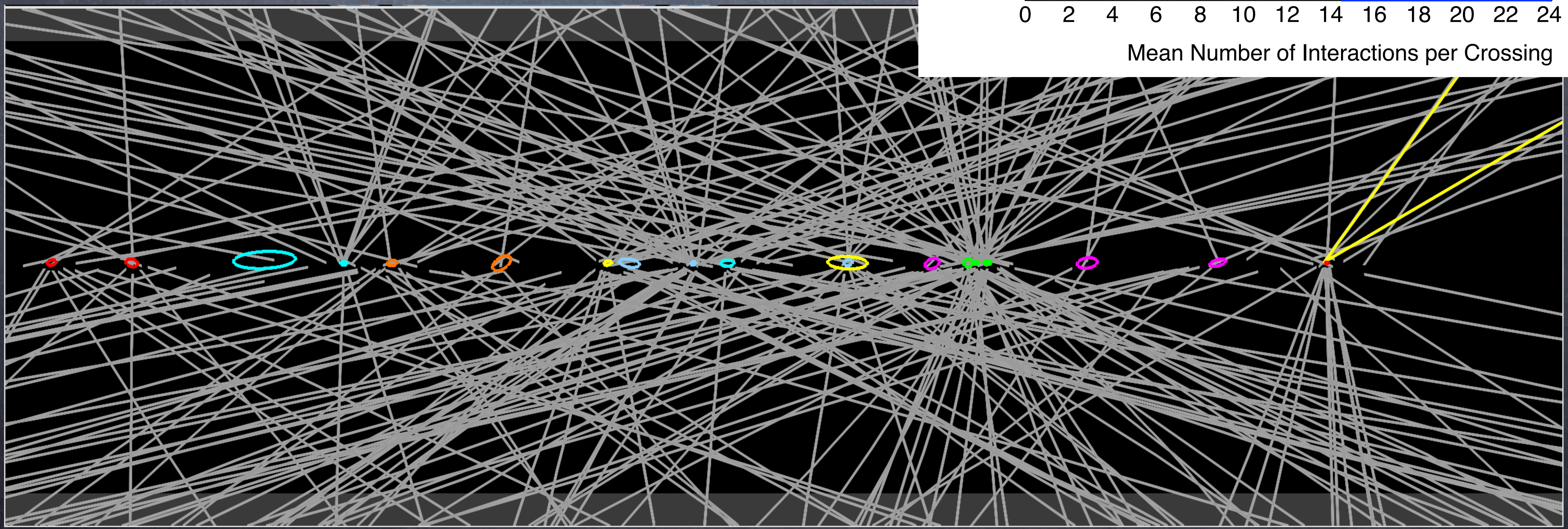
- Invariant mass of muon pair = 94 GeV.
- Missing transverse energy = 161 GeV.



$Z_{\mu\mu}$ candidate with 20 vertices

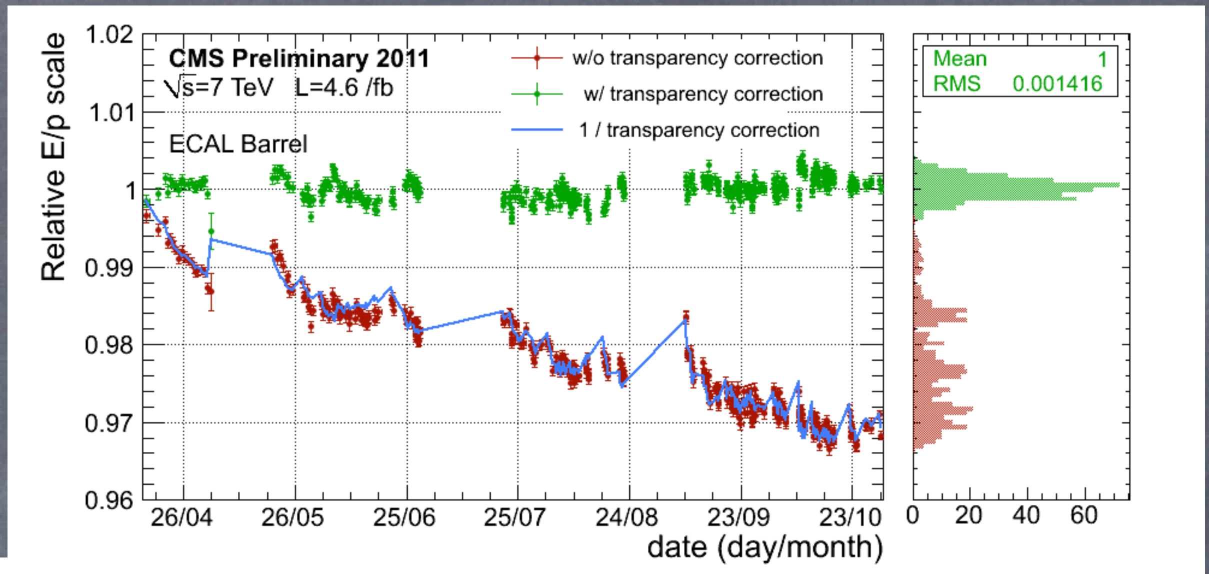
- Standard candles need to be studied consistently, as the detector/machine conditions change.



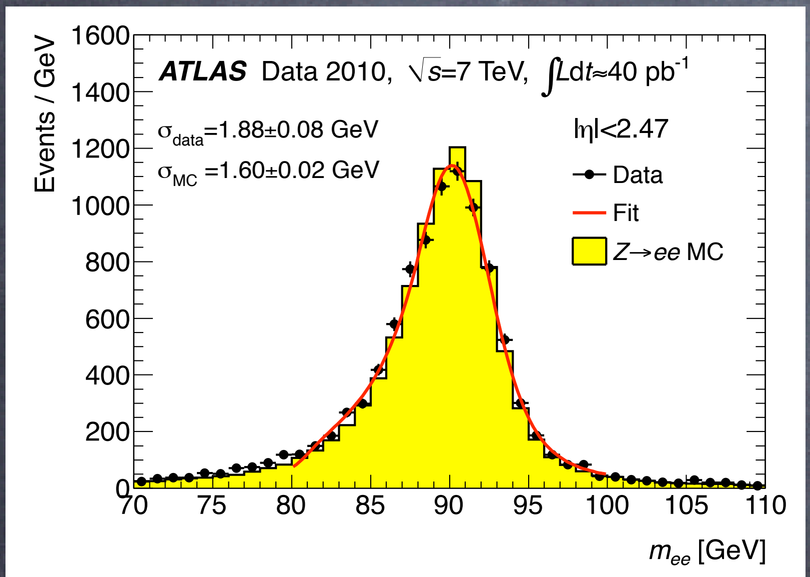


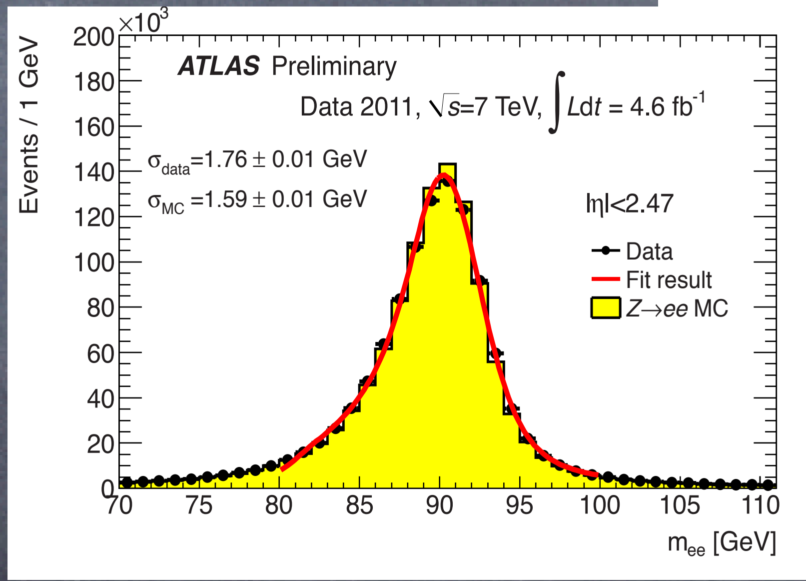
Coping up with high lumi

- In 2011 both ATLAS and CMS have coped well with high pileup.
- Minor degradation in performance (when it exists) is well modeled by simulation.



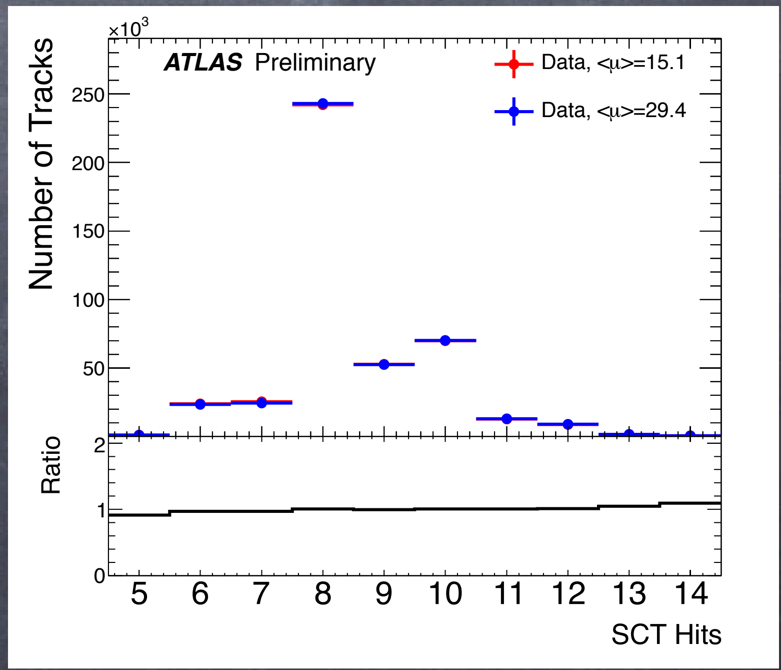
E/p stability in the CMS ECAL using W->eν events





η coverage	2011 resolution (GeV)	2010 resolution (GeV)
$\|\eta\| < 2.47$	1.76 ± 0.01	1.88 ± 0.08
$\|\eta\| < 1.37$	1.60 ± 0.01	1.62 ± 0.09
$2.47 < \|\eta\| < 1.37$	1.99 ± 0.02	1.99 ±0.22

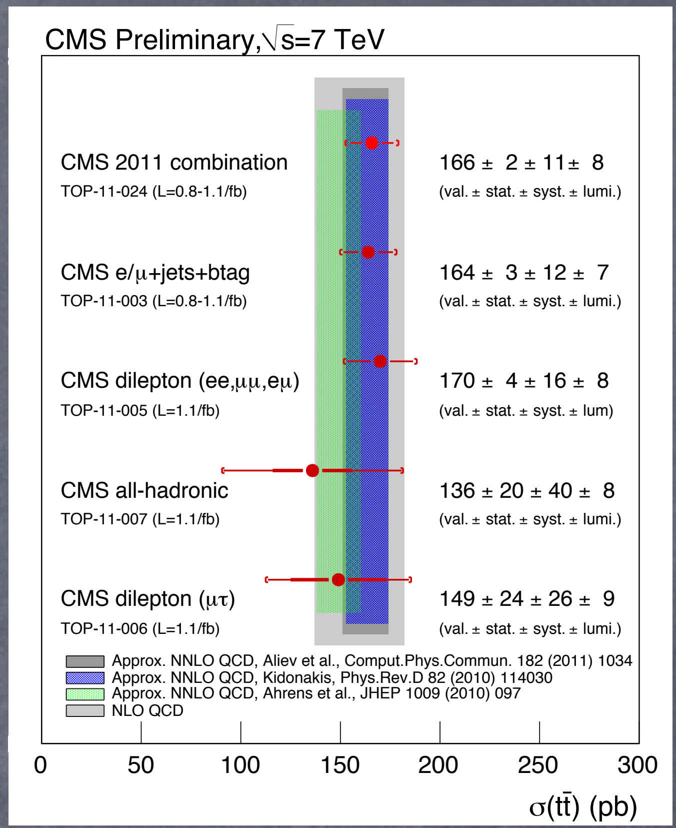
Z->ee mass resolution from ATLAS



number of SCT hits on track for two different pile-up cases from ATLAS.

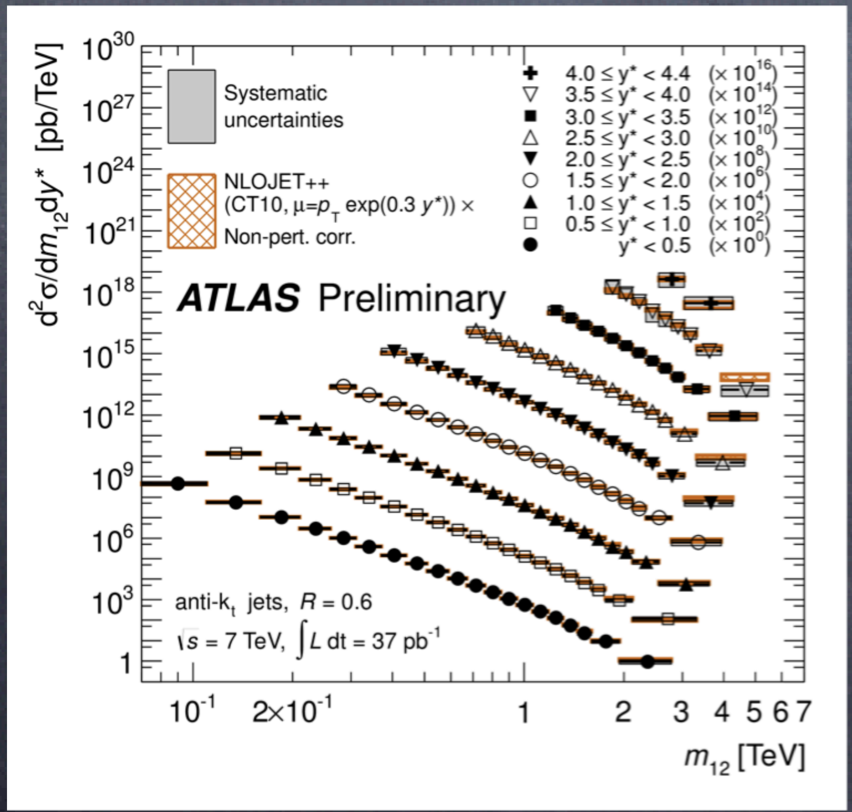
Step 2: Measuring SM

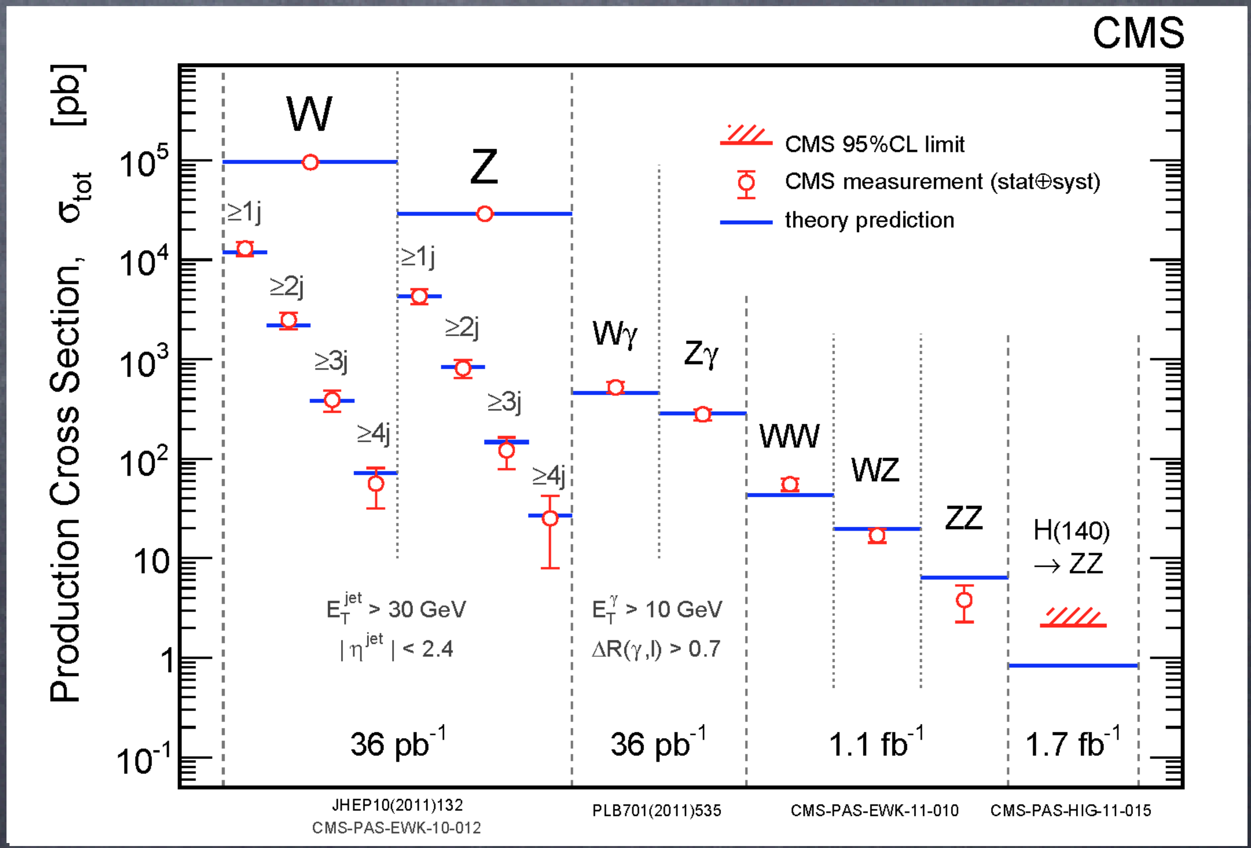
- Important in understanding the level of backgrounds.
  - Most important ones: Weak boson + jets, dibosons, single and pair production of top quarks.
  - Excellent performance. For example, better than 10% uncertainty in tt x-section
- Important in understanding (the implications of) QCD: underlying event, multiple interactions, jet production, etc. Measurements of (b-)jet x-sections, di-jet mass spectra, etc.



CMS PAS TOP-11-024

Double differential di-jet cross sections measured over a very large range of m12 and rapidity (y)



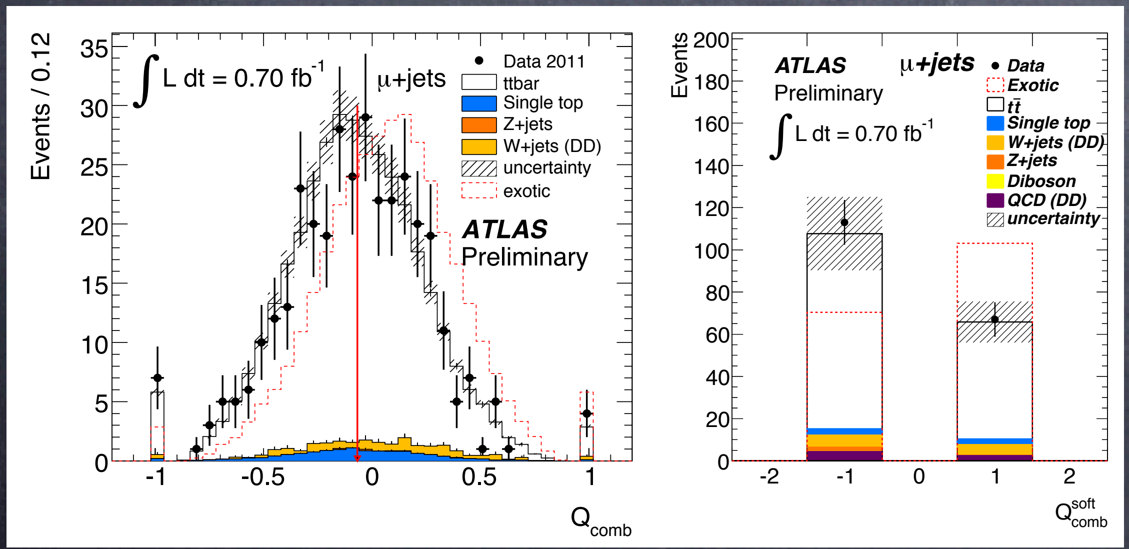


Revisiting Old Friends

- While measuring the SM particles, we also check for unexpected surprises:
  - Best measurement of the top-antitop mass difference. (CMS TOP-11-019).

$$\Delta m_t^{\text{measured}} = -1.20 \pm 1.21\ (\text{stat}) \pm 0.47\ (\text{syst})\ \text{GeV}$$

  - Could the top quark be a quark with exotic charge? Q=-4/3 hypothesis excluded at more than 5σ.



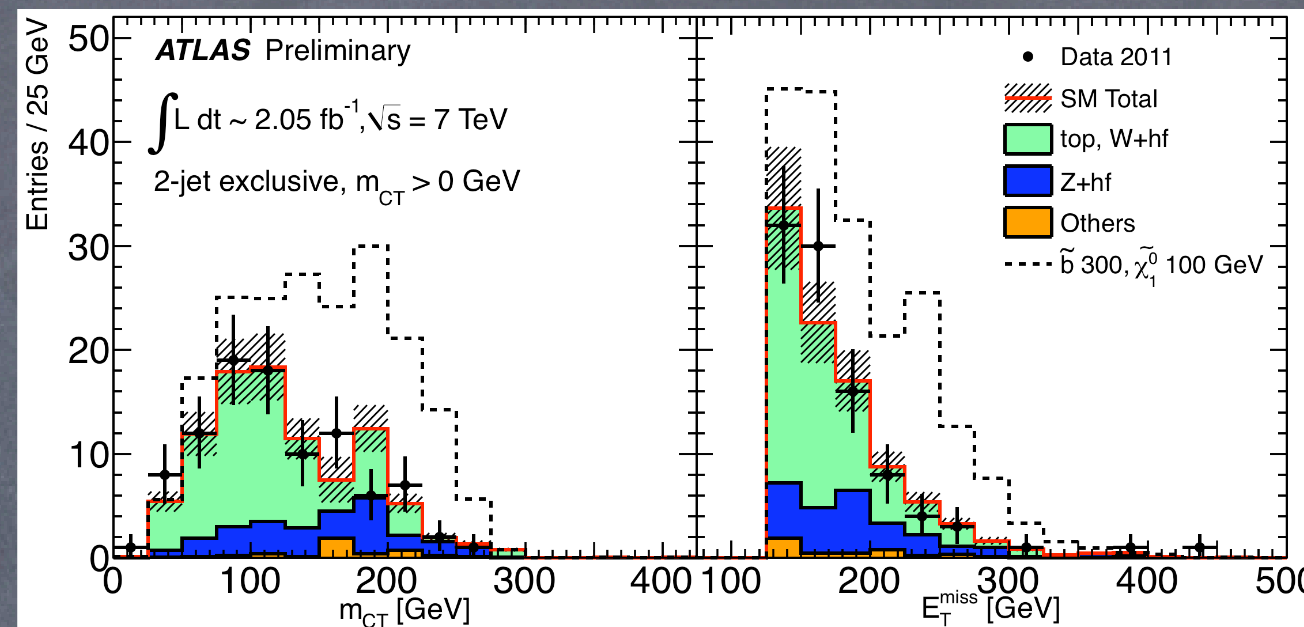
	$\langle Q_{comb}^{soft} \rangle$
SM	-0.234 ± 0.011
Exotic	$+0.209 \pm 0.011$
Measured	-0.31 ± 0.07

ATLAS-CONF-2011-141

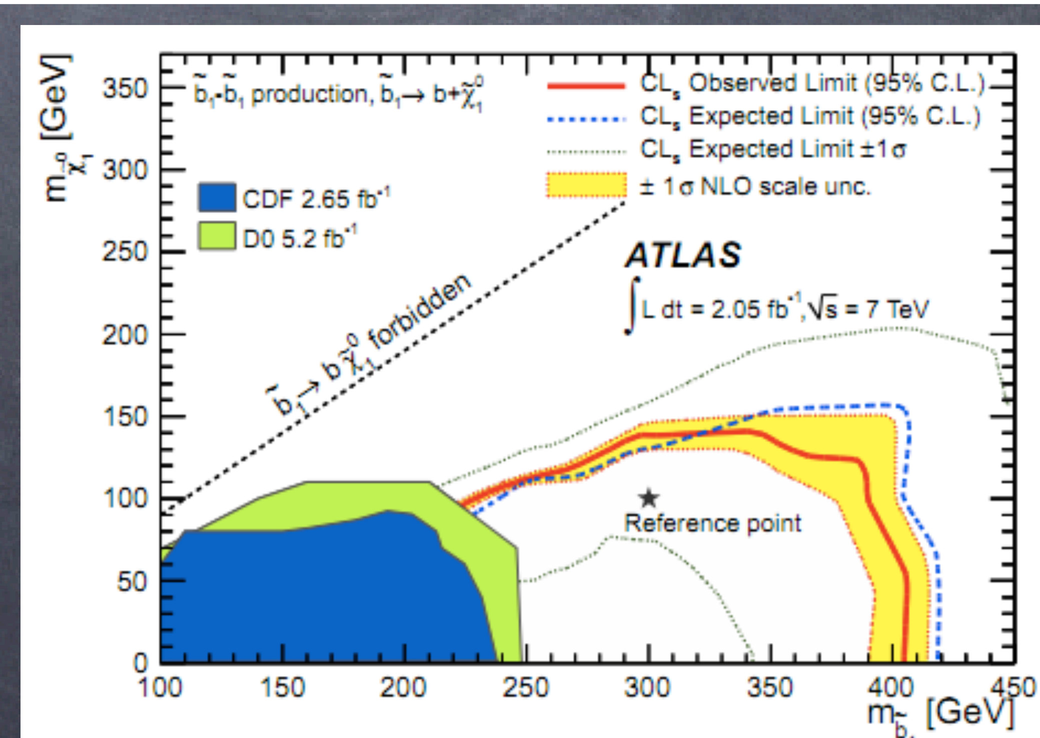
	$\langle Q_{comb} \rangle$
SM	-0.082 ± 0.020
Exotic	$+0.083 \pm 0.020$
Measured	-0.082 ± 0.015

Step 3: Look for New Stuff

- Outline of example analysis: search for sbottoms.
- Pair production, then each decays to a b-quark and the LSP.
- Signature: 2 b-tagged jets + large missing E_T.
- Require $P_T(j1)>130$ GeV, ET>130 GeV, $P_T(j2)>50$ GeV. Veto events with additional high P_T objects.
- Construct a discriminating variable, most commonly some sort of mass variable that relates to the objects being search for.
- Obtain background estimates in data control samples. For example events with high PT leptons considered in this analysis.
- Compare background estimate with data.
- Done with $2fb^{-1}$ of early 2011 data.

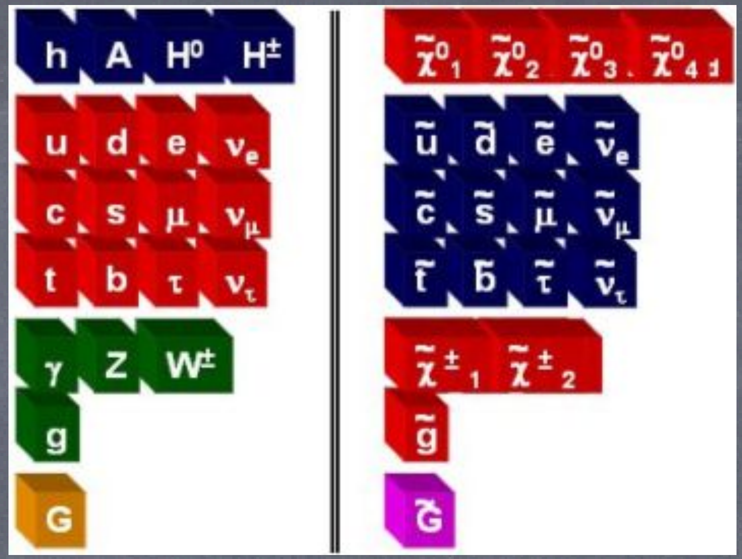


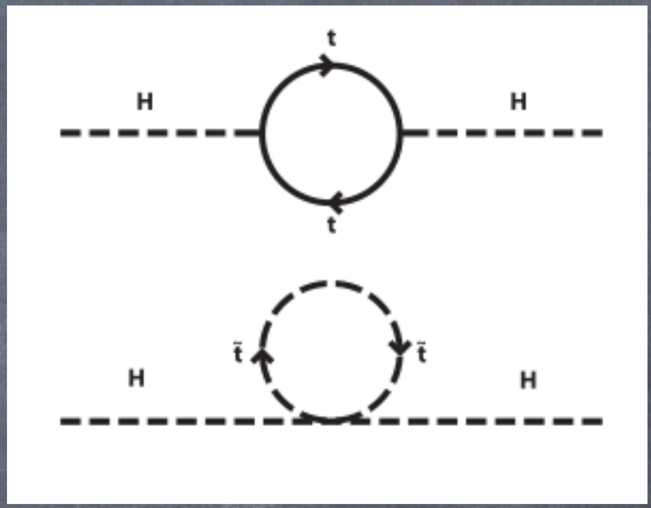
$$m_{CT}(v_1,v_2) = \left([E_\mathrm{T}(v_1)+E_\mathrm{T}(v_2)]^2 - [\mathbf{p_T}(v_1)-\mathbf{p_T}(v_2)]^2\right)^{1/2}$$

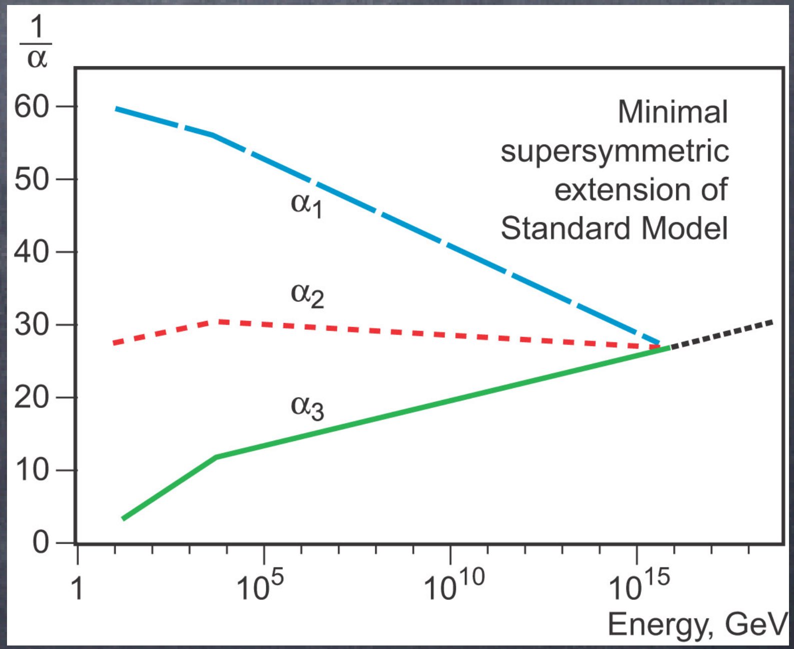


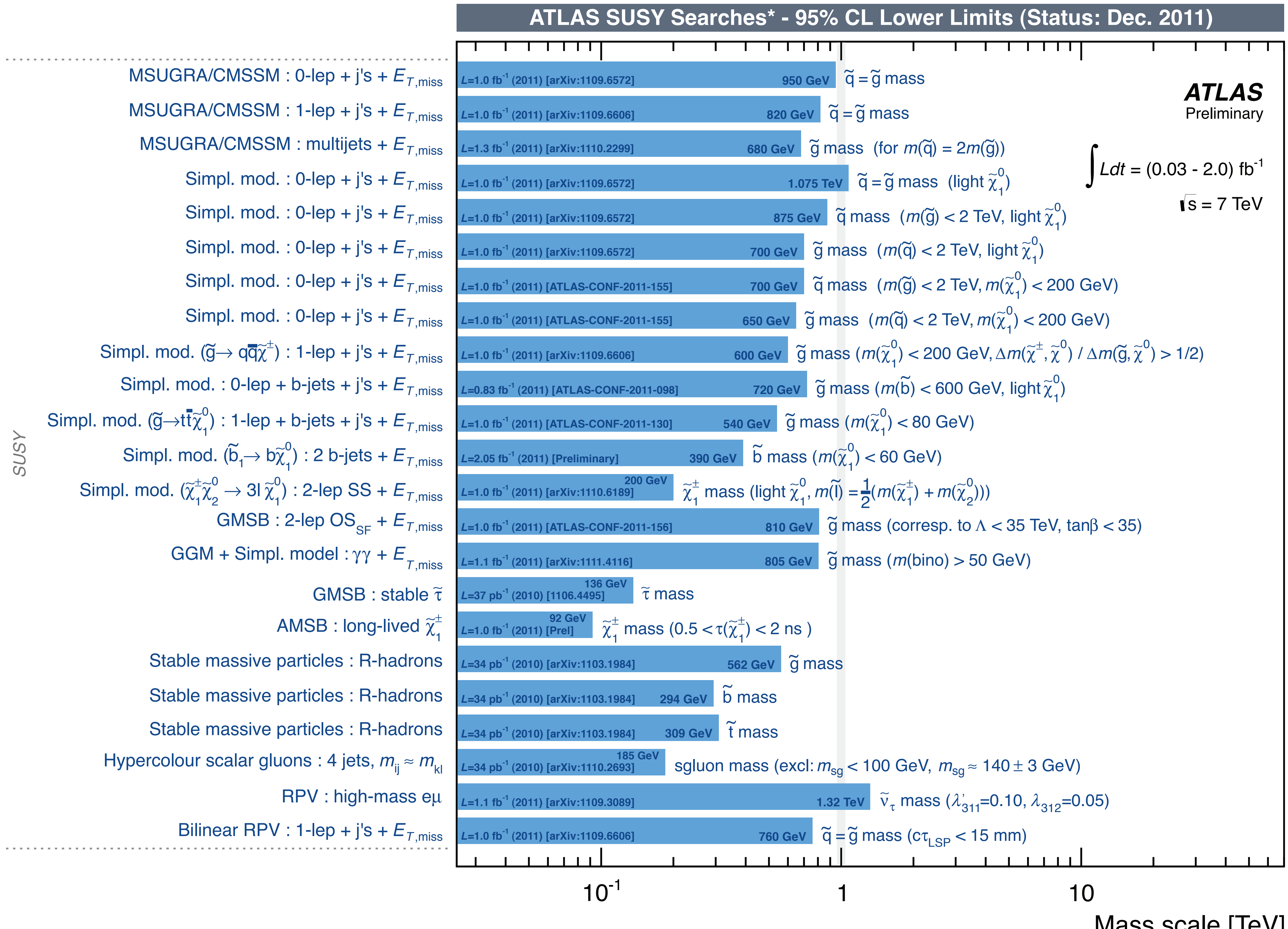
Supersymmetry

- Naturalness / Hierarchy problem: Radiative corrections to the Higgs mass are divergent.
    - New supersymmetric partners of known particles to cancel contributions from known particles.
    - A new fermion for each boson, a new boson for each fermion.
- Gauge coupling unification (at percent level)!
- Excellent dark matter candidate if R parity is conserved: Lightest supersymmetric particle will be stable & weakly interacting.



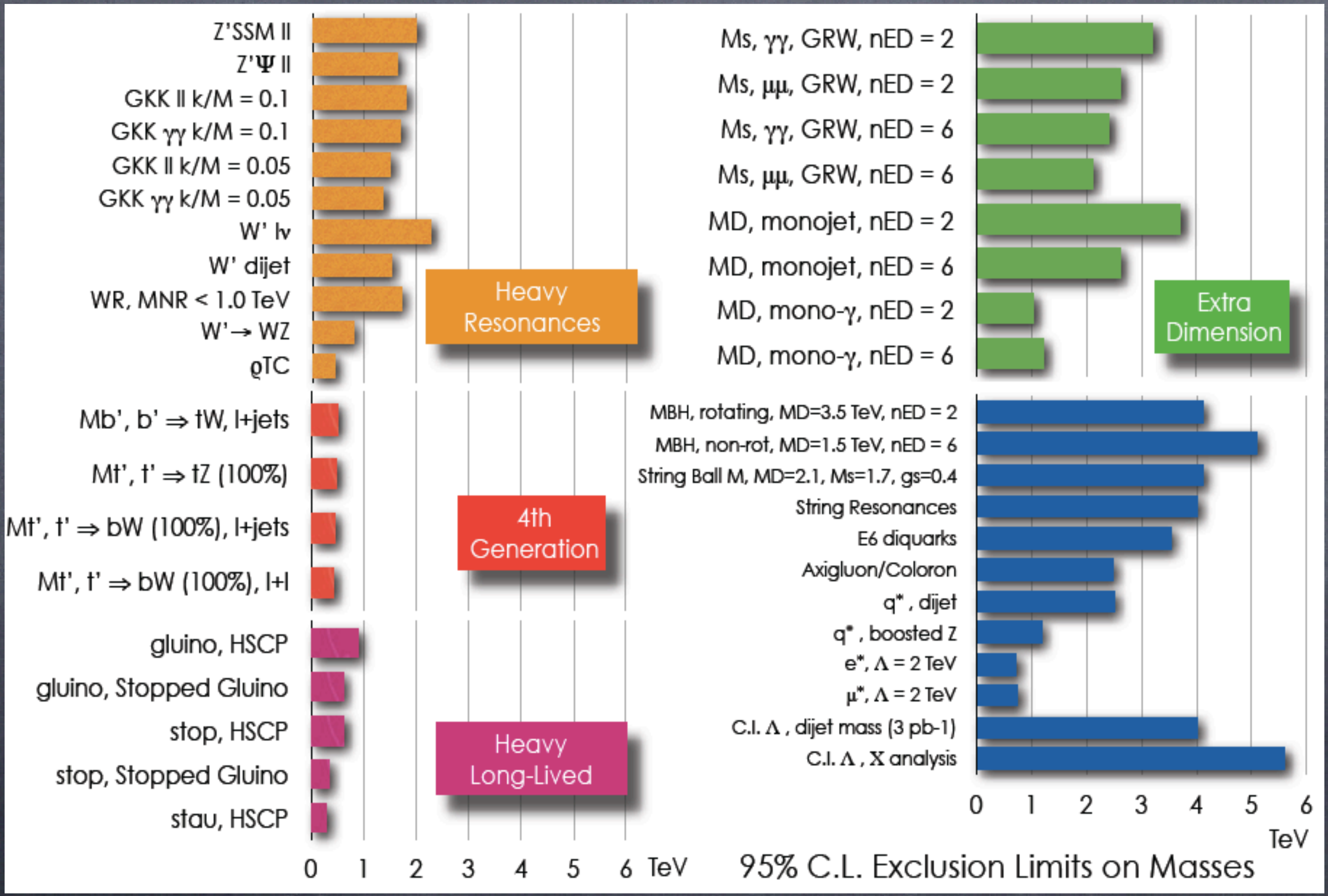




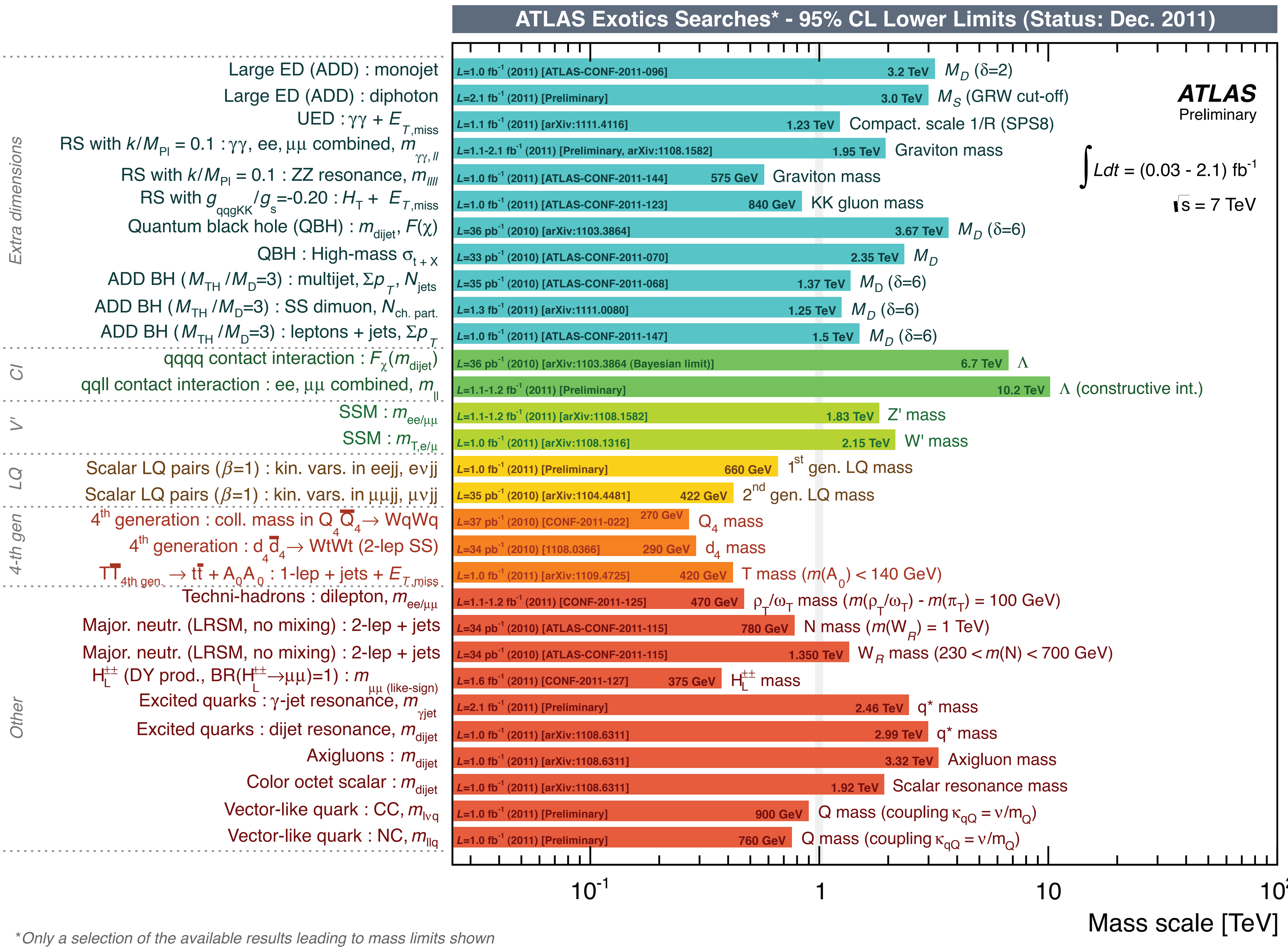


*Only a selection of the available results leading to mass limits shown

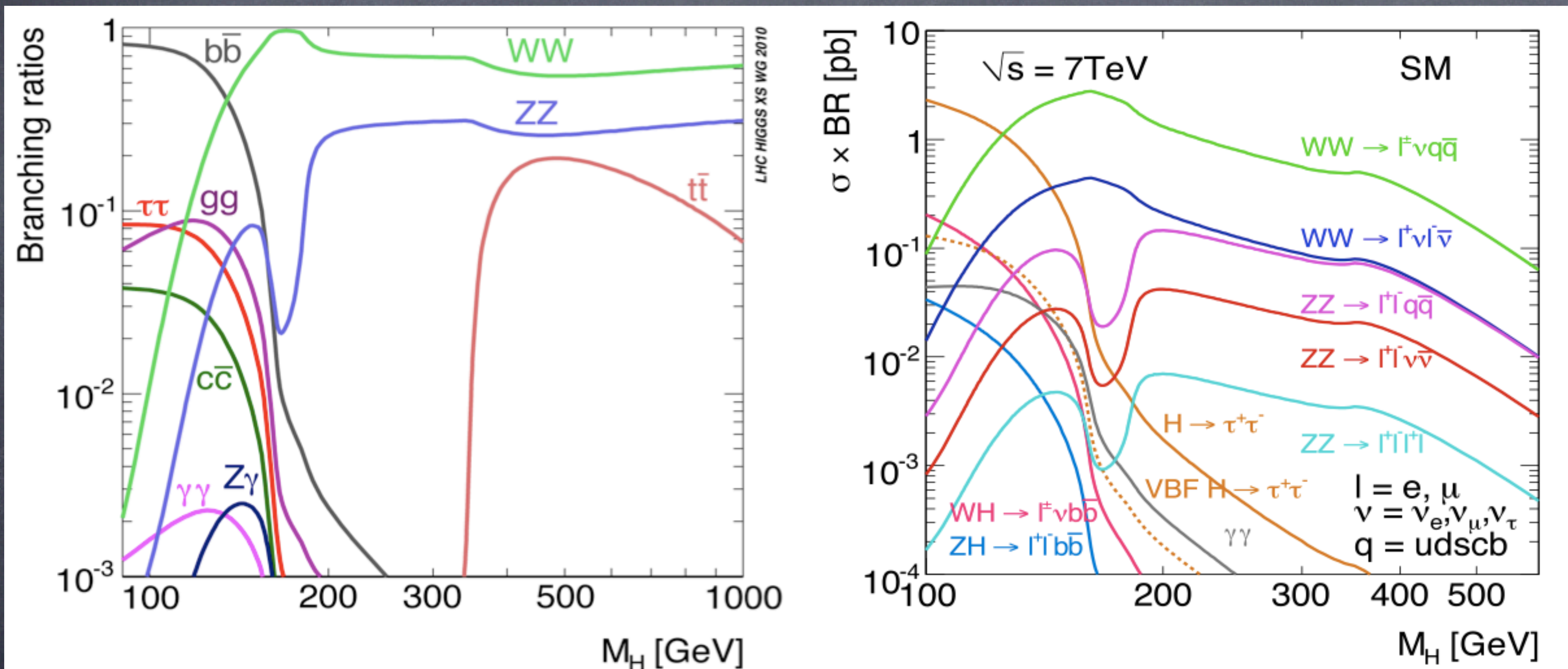
More exotic stuff



Grand unification, new bosons, new quarks, extra dimensions, micro-black holes, ...

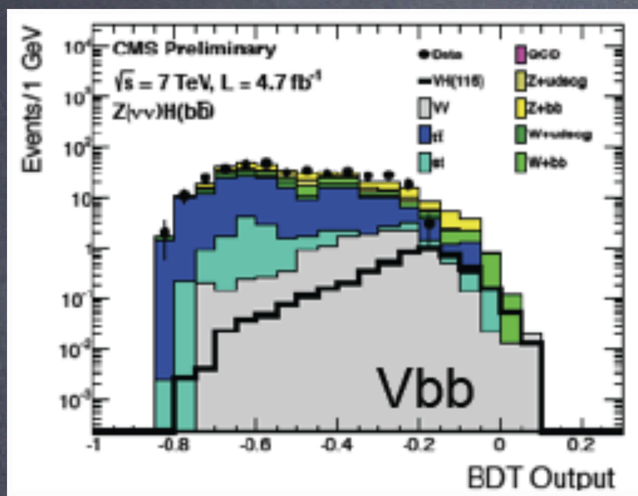

ATLAS Exotics Searches* - 95% CL Lower Limits (Status: Dec. 2011)
ATLAS
Preliminary
∫Ldt = (0.03 - 2.1) fb-1
√s = 7 TeV
Extra dimensions
CI
V'
LQ
4-th gen
Other
Large ED (ADD) : monojet
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-096]
3.2 TeV
MD (δ=2)
Large ED (ADD) : diphoton
L=2.1 fb-1 (2011) [Preliminary]
3.0 TeV
MS (GRW cut-off)
UED : γγ + ET,miss
L=1.1 fb-1 (2011) [arXiv:1111.4116]
1.23 TeV
Compact. scale 1/R (SPS8)
RS with k/MPl = 0.1 : γγ, ee, μμ combined, mγγ,ll
L=1.1-2.1 fb-1 (2011) [Preliminary, arXiv:1108.1582]
1.95 TeV
Graviton mass
RS with k/MPl = 0.1 : ZZ resonance, mllll
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-144]
575 GeV
Graviton mass
RS with gqqgKK/gs=-0.20 : HT + ET,miss
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-123]
840 GeV
KK gluon mass
Quantum black hole (QBH) : mdijet, F(χ)
L=36 pb-1 (2010) [arXiv:1103.3864]
3.67 TeV
MD (δ=6)
QBH : High-mass σt + X
L=33 pb-1 (2010) [ATLAS-CONF-2011-070]
2.35 TeV
MD
ADD BH (MTH /MD=3) : multijet, ΣpT, Njets
L=35 pb-1 (2010) [ATLAS-CONF-2011-068]
1.37 TeV
MD (δ=6)
ADD BH (MTH /MD=3) : SS dimuon, Nch. part.
L=1.3 fb-1 (2011) [arXiv:1111.0080]
1.25 TeV
MD (δ=6)
ADD BH (MTH /MD=3) : leptons + jets, ΣpT
L=1.0 fb-1 (2011) [ATLAS-CONF-2011-147]
1.5 TeV
MD (δ=6)
qqqq contact interaction : Fχ(mdijet)
L=36 pb-1 (2010) [arXiv:1103.3864 (Bayesian limit)]
6.7 TeV
Λ
qqll contact interaction : ee, μμ combined, mll
L=1.1-1.2 fb-1 (2011) [Preliminary]
10.2 TeV
Λ (constructive int.)
SSM : mee/μμ
L=1.1-1.2 fb-1 (2011) [arXiv:1108.1582]
1.83 TeV
Z' mass
SSM : mT,e/μ
L=1.0 fb-1 (2011) [arXiv:1108.1316]
2.15 TeV
W' mass
Scalar LQ pairs (β=1) : kin. vars. in eejj, eνjj
L=1.0 fb-1 (2011) [Preliminary]
660 GeV
1st gen. LQ mass
Scalar LQ pairs (β=1) : kin. vars. in μμjj, μνjj
L=35 pb-1 (2010) [arXiv:1104.4481]
422 GeV
2nd gen. LQ mass
4th generation : coll. mass in Q4Q̄4→ WqWq
L=37 pb-1 (2010) [CONF-2011-022]
270 GeV
Q4 mass
4th generation : d4d̄4→ WtWt (2-lep SS)
L=34 pb-1 (2010) [1108.0366]
290 GeV
d4 mass
TT̄4th gen. → tt̄ + A0A0 : 1-lep + jets + ET,miss
L=1.0 fb-1 (2011) [arXiv:1109.4725]
420 GeV
T mass (m(A0) < 140 GeV)
Techni-hadrons : dilepton, mee/μμ
L=1.1-1.2 fb-1 (2011) [CONF-2011-125]
470 GeV
ρT/ωT mass (m(ρT/ωT) - m(πT) = 100 GeV)
Major. neutr. (LRSM, no mixing) : 2-lep + jets
L=34 pb-1 (2010) [ATLAS-CONF-2011-115]
780 GeV
N mass (m(WR) = 1 TeV)
Major. neutr. (LRSM, no mixing) : 2-lep + jets
L=34 pb-1 (2010) [ATLAS-CONF-2011-115]
1.350 TeV
WR mass (230 < m(N) < 700 GeV)
H±±L (DY prod., BR(H±±L→μμ)=1) : mμμ (like-sign)
L=1.6 fb-1 (2011) [CONF-2011-127]
375 GeV
H±±L mass
Excited quarks : γ-jet resonance, mγjet
L=2.1 fb-1 (2011) [Preliminary]
2.46 TeV
q* mass
Excited quarks : dijet resonance, mdijet
L=1.0 fb-1 (2011) [arXiv:1108.6311]
2.99 TeV
q* mass
Axigluons : mdijet
L=1.0 fb-1 (2011) [arXiv:1108.6311]
3.32 TeV
Axigluon mass
Color octet scalar : mdijet
L=1.0 fb-1 (2011) [arXiv:1108.6311]
1.92 TeV
Scalar resonance mass
Vector-like quark : CC, mlνq
L=1.0 fb-1 (2011) [Preliminary]
900 GeV
Q mass (coupling κqQ = ν/mQ)
Vector-like quark : NC, mllq
L=1.0 fb-1 (2011) [Preliminary]
760 GeV
Q mass (coupling κqQ = ν/mQ)
10-1
1
10
102
Mass scale [TeV]
*Only a selection of the available results leading to mass limits shown

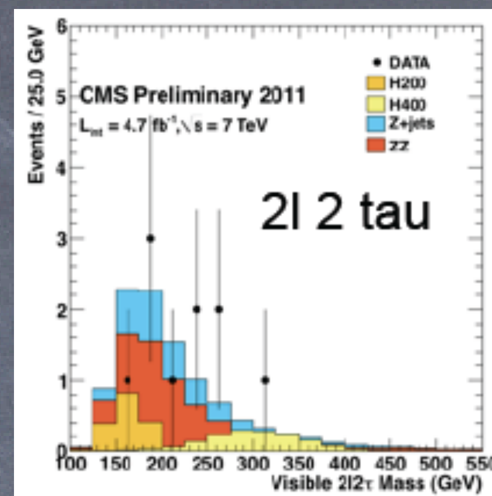
Step 4: Look for Something Familiar

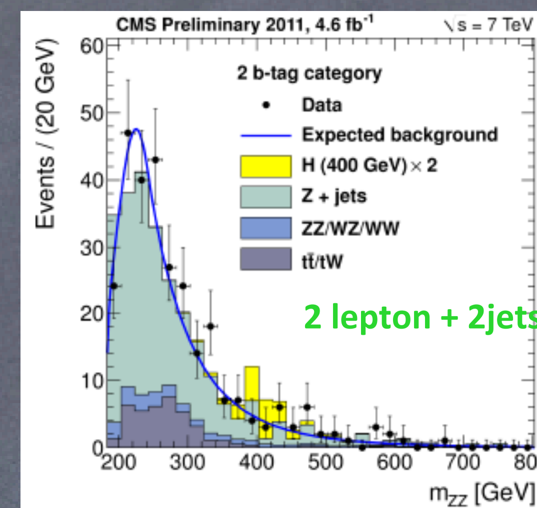


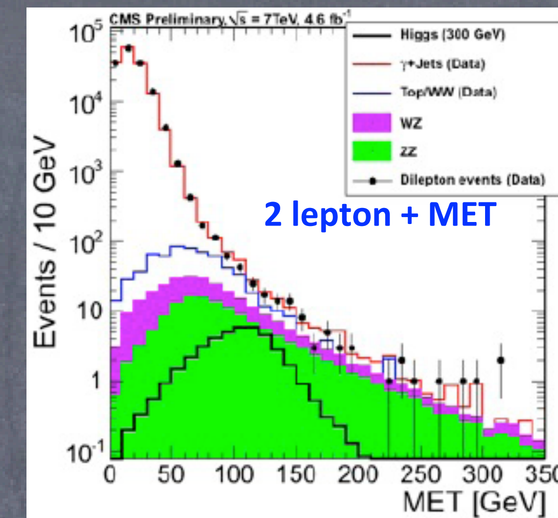
- Last piece of the SM: Higgs - need analyses in many channels as the branching ratio to various final states depends on the Higgs mass.

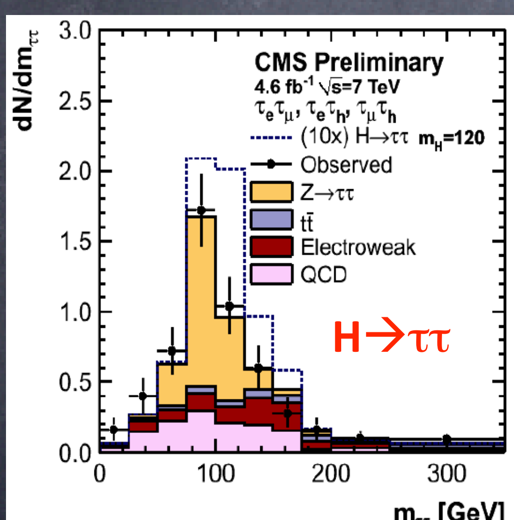
Hunt for the Higgs



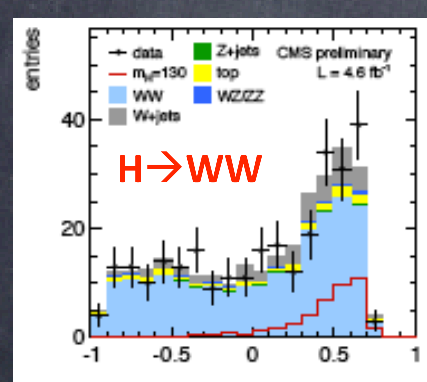


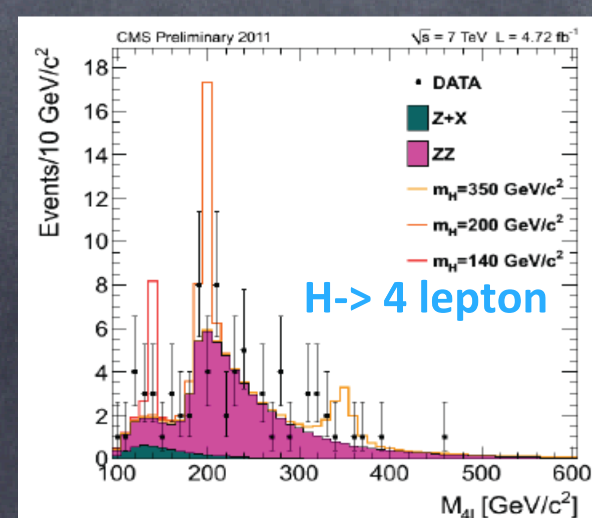


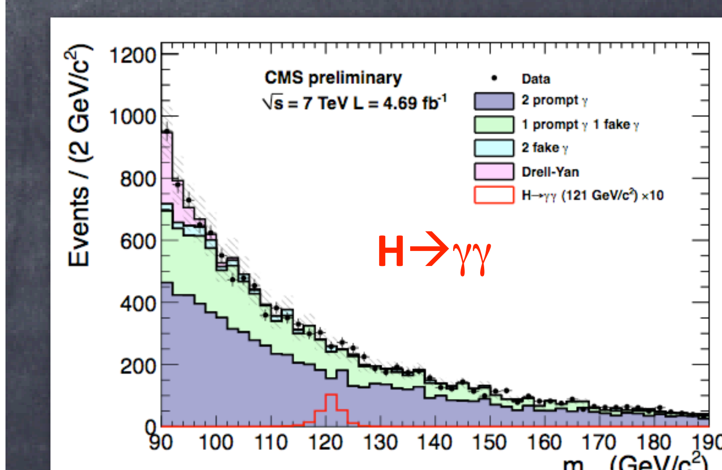




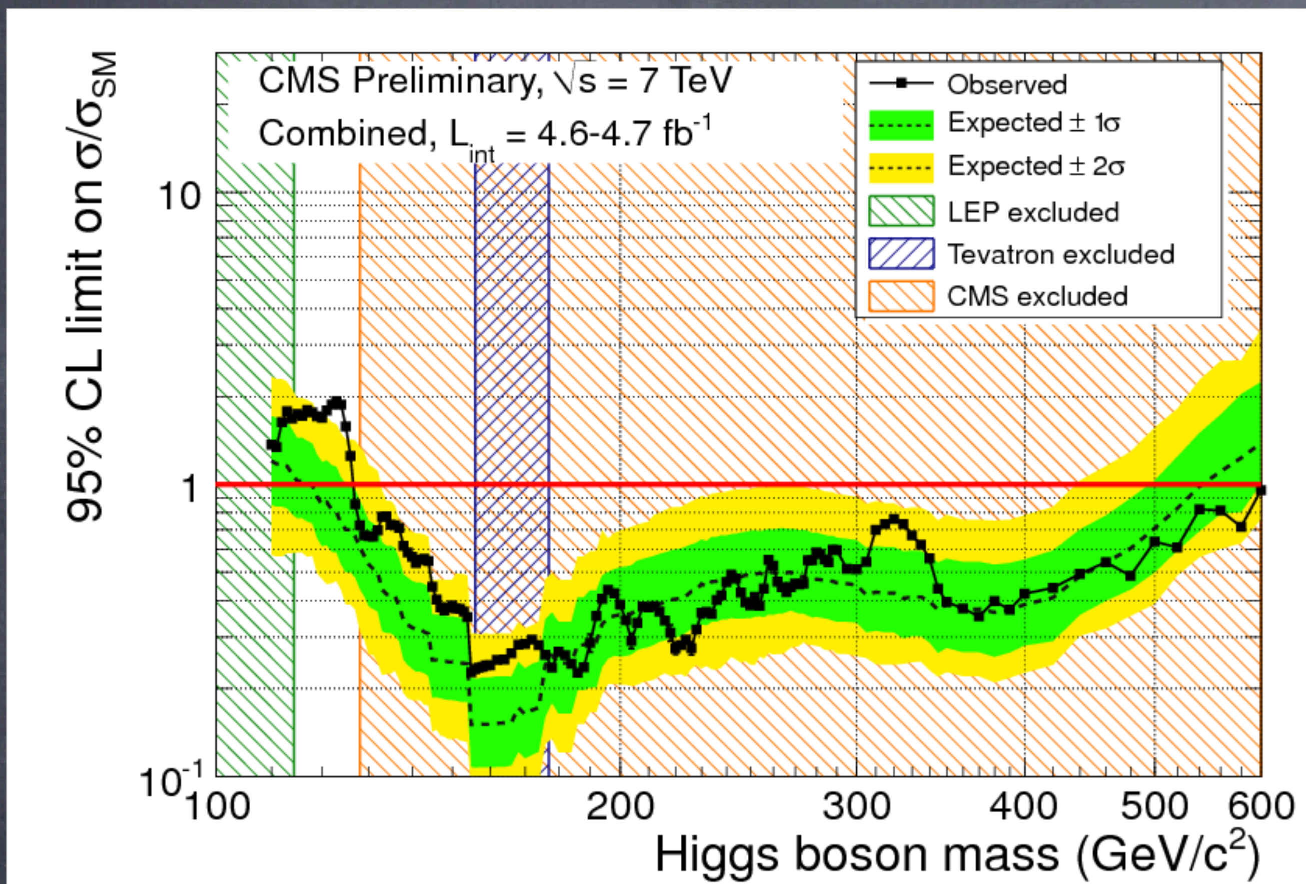
- Many channels - each with different backgrounds, different systematics, etc.

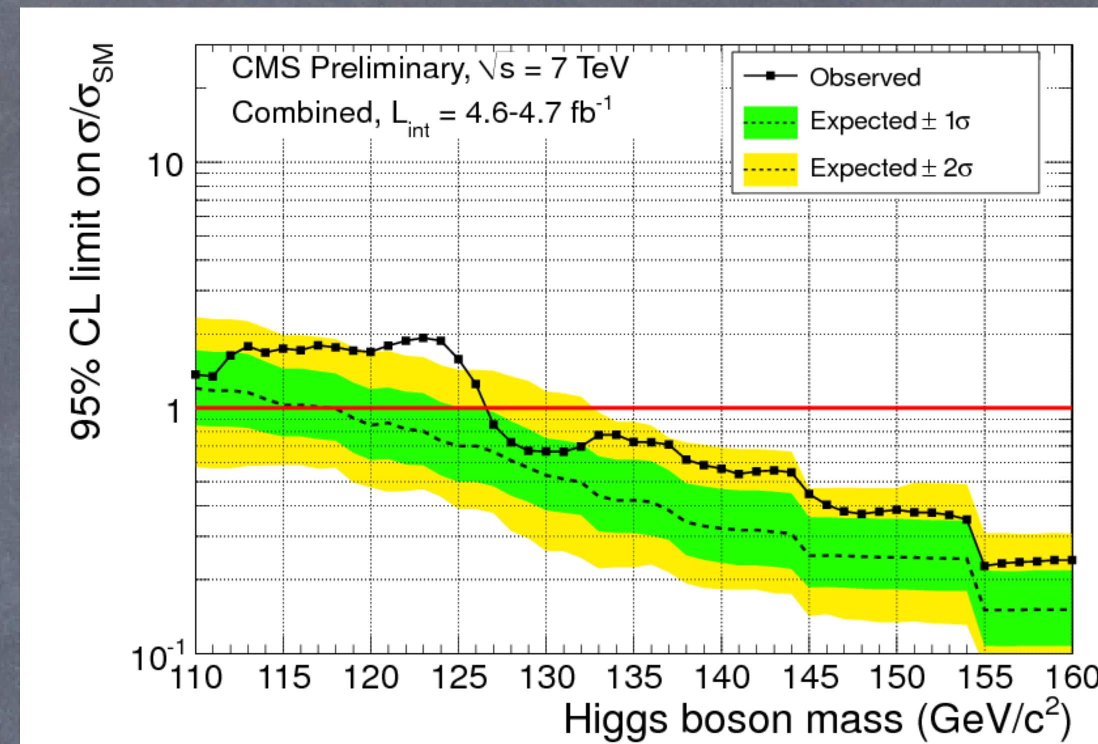


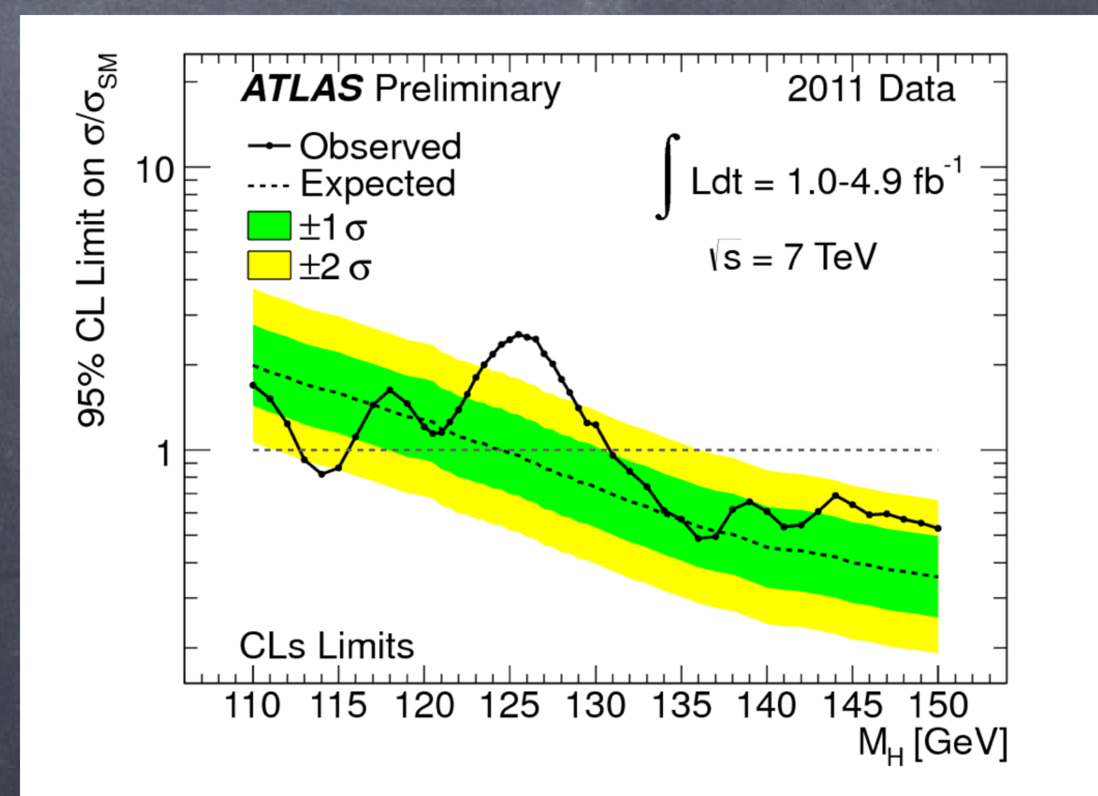




So have we found it yet?

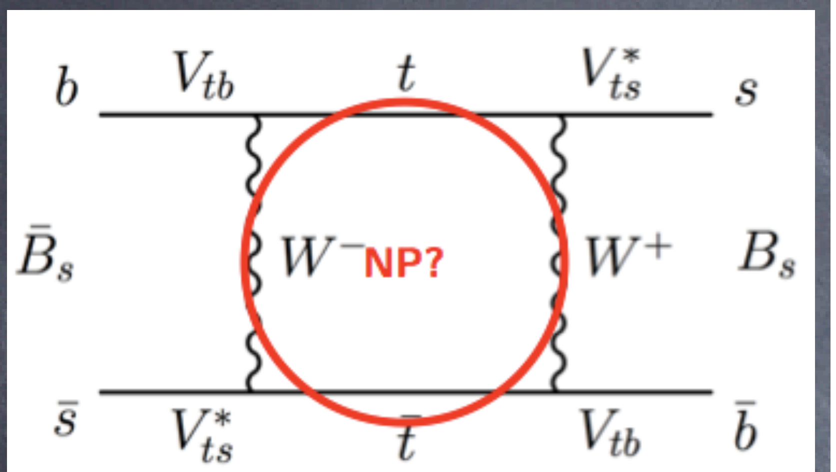


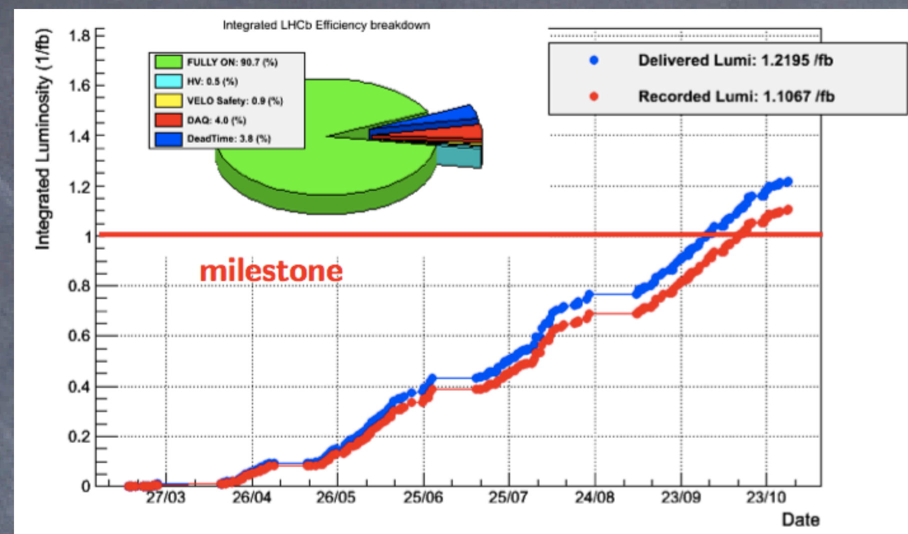


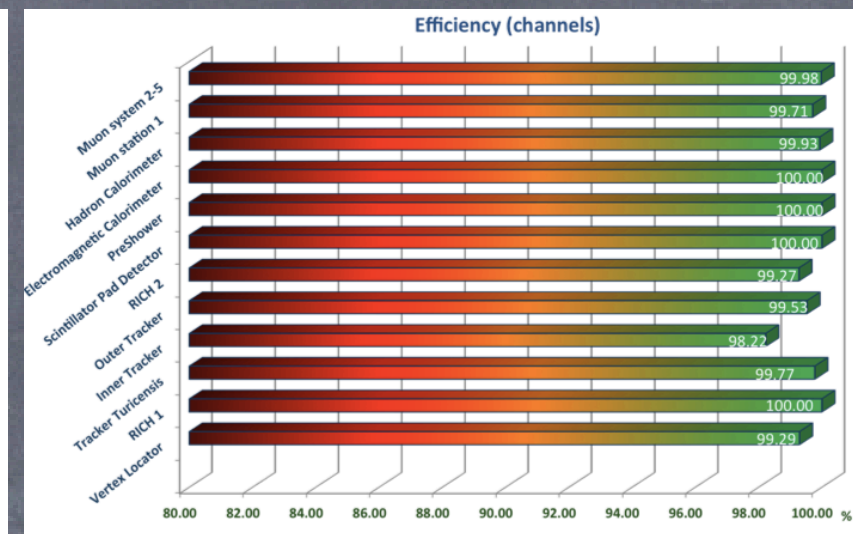


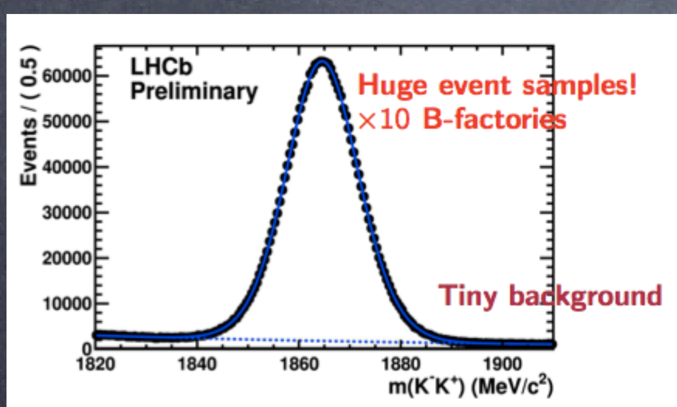
- No, but both experiments see a strange excess.
- Maximum local excess at the level of 2.6σ and 3.6σ for CMS and ATLAS, around 124 - 126 GeV.
- Correcting for LEE, significance goes down to 1.9σ and 2.3σ.
- So we are unable to say there is no Higgs.

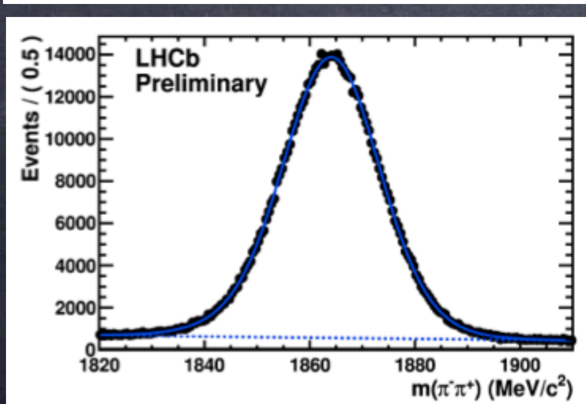
LHCb (LHCcharm) to Rescue?












BBC NEWS SCIENCE & ENVIRONMENT

15 November 2011 Last updated at 12:18 GMT

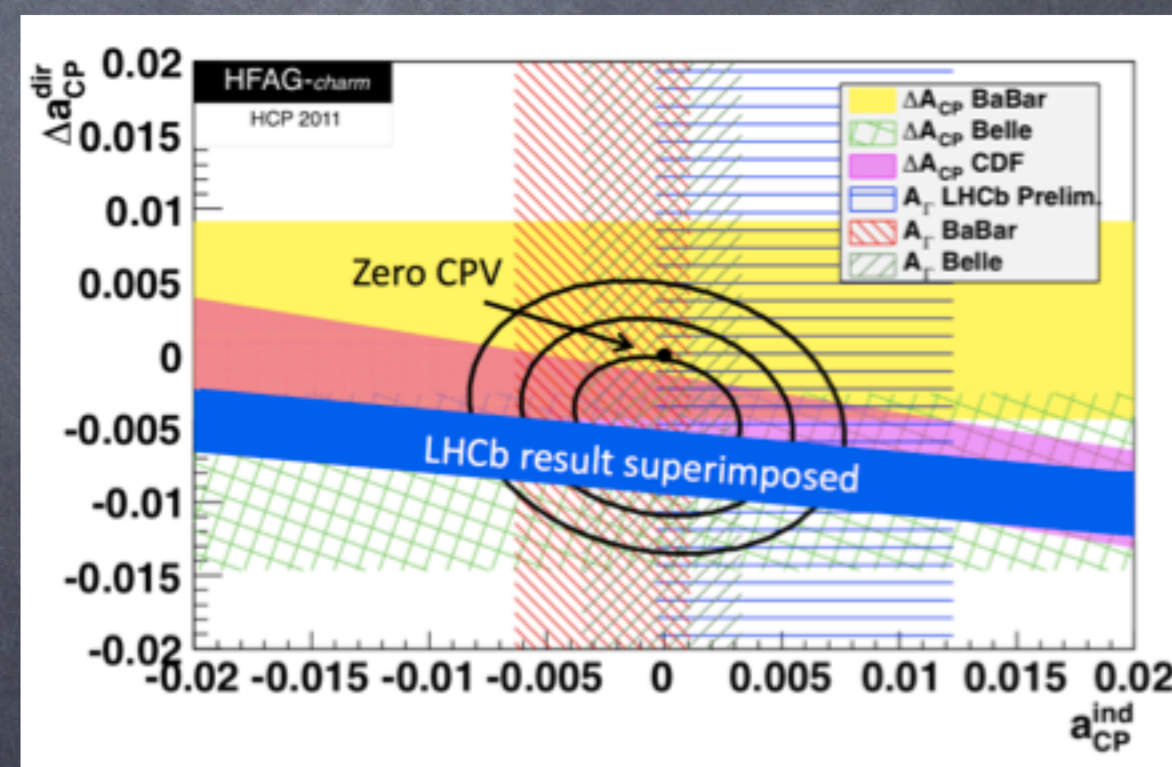
LHC reveals hints of 'new physics' in particle decays

By Jason Palmer
Science and technology reporter, BBC News

LHC-beauty, or LHCb, is an enormous detector designed to examine CP violation

Large Hadron Collider researchers have shown off what may be the facility's first "new physics" outside our current understanding of the Universe.

Particles called D-mesons seem to decay slightly differently from their antiparticles, LHCb physicist Matthew Charles told the HCP 2011 meeting on Monday.



- 3.5σ effect!

$$\mathcal{A}_{CP}(D \to K^+K^-) - \mathcal{A}_{CP}(D \to \pi^+\pi^-) = (-0.82 \pm 0.21 \pm 0.11)\%$$

Sorry, says Brod et al.

On the size of direct CP violation in singly Cabibbo-suppressed D decays

Joachim Brod,[1,*] Alexander L. Kagan,[1,†] and Jure Zupan[1,‡]

[1] *Department of Physics, University of Cincinnati, Cincinnati, Ohio 45221, USA*

The first experimental evidence for direct CP violation in charm-quark decays has recently been presented by the LHCb collaboration in the difference between the $D \to K^+K^-$ and $D \to \pi^+\pi^-$ time-integrated CP asymmetries. We estimate the size of the effects that can be expected within the Standard Model and find that at leading order in $1/m_c$ they are an order of magnitude smaller. However, tree-level annihilation type amplitudes are known to be large experimentally. This implies that certain formally $1/m_c$ suppressed penguin amplitudes could plausibly account for the LHCb measurement.

http://arxiv.org/pdf/1111.5000v2

LHC Luminosity

- So we have to keep on looking... => More data!

$$\mathcal{L} \propto \frac{N_1 N_2 n_b}{\sigma^2}$$

N_i = bunch intensity
n_b = number of bunches
σ = colliding beam size

$$\sigma^2 = \frac{\varepsilon \cdot \beta^*}{\gamma}$$

ε = normalized emittance – beam property
β^* = beta star - accelerator property

Nominal values:

ε = 3.5 μm

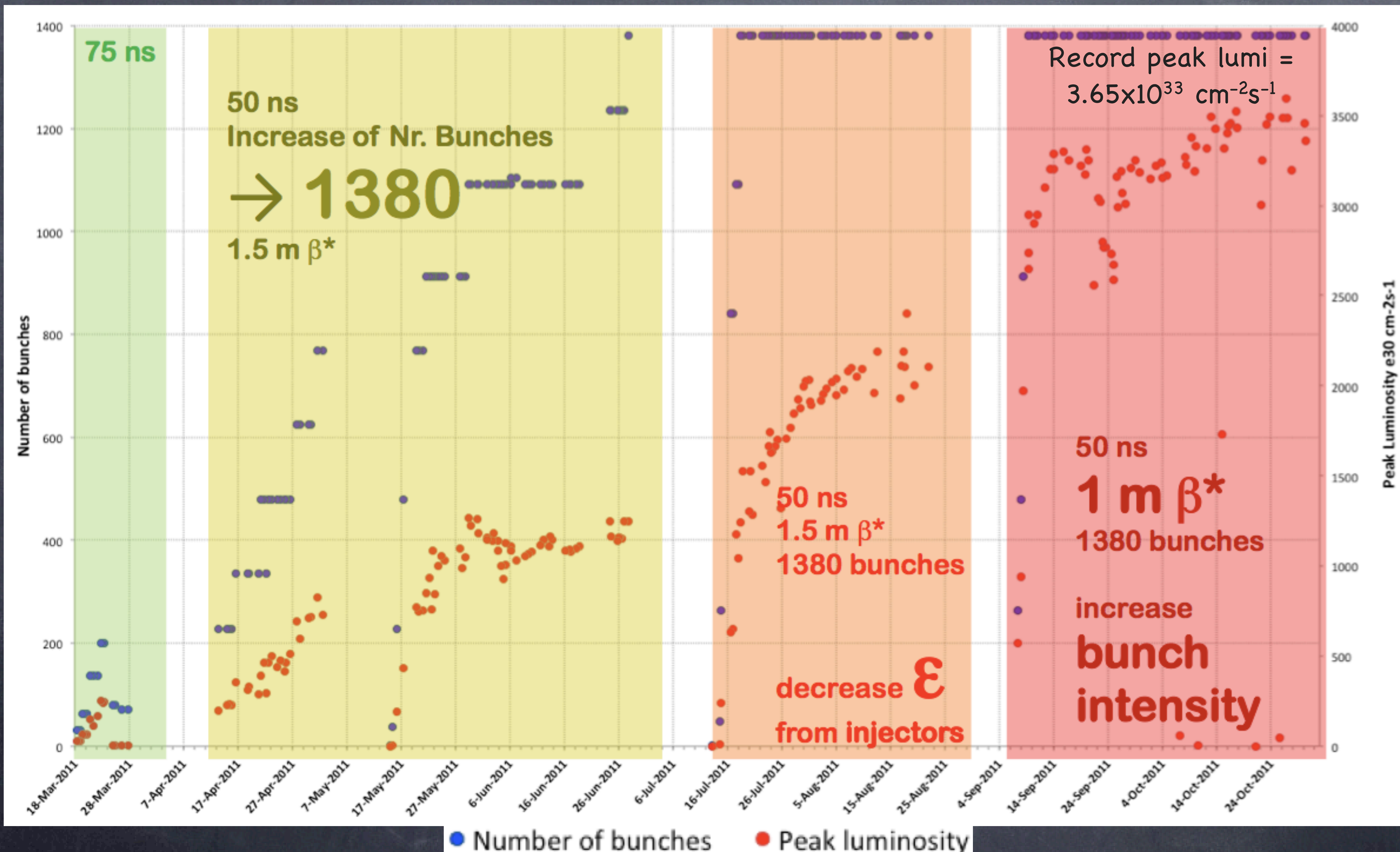
β^* = 0.55 m

γ ~ 7000 for energy of 7 TeV

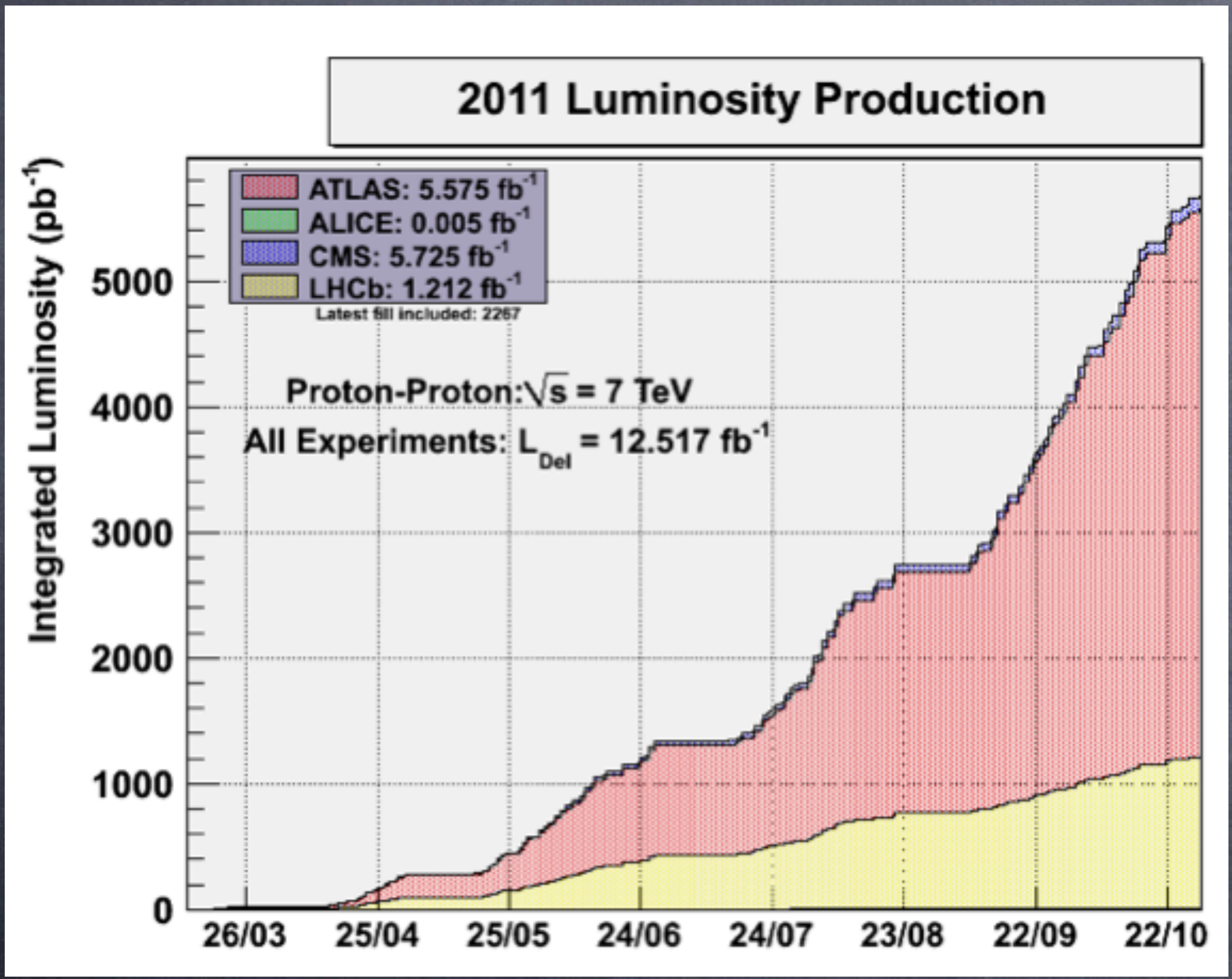
$N_i = 1.15 \times 10^{11}$

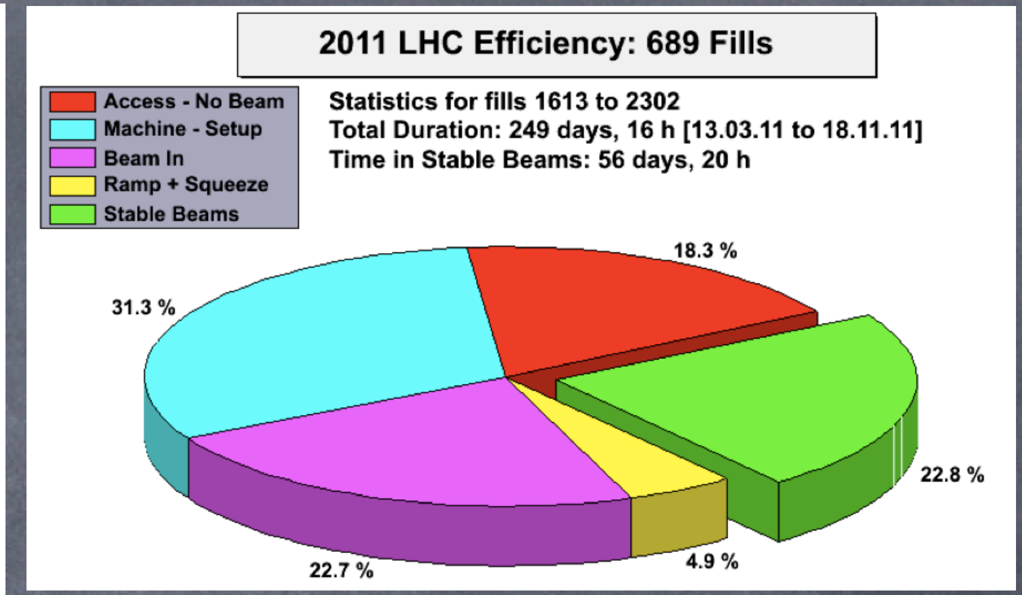
n_b = 2808

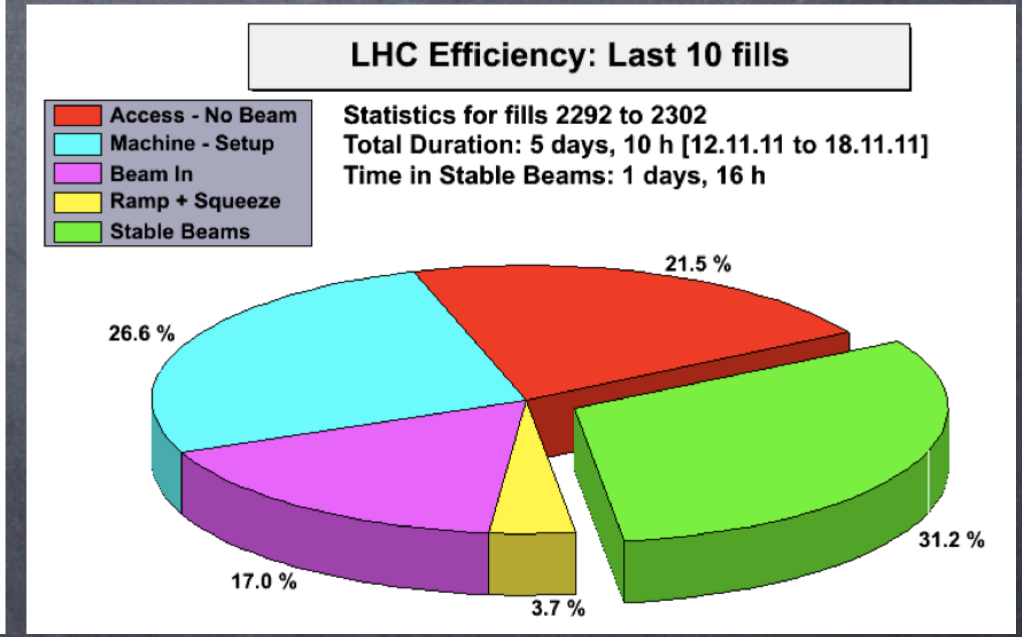
Luminosity throughout 2011



Learning to work at high intensity







- UFOs are getting less frequent. Single event upsets being mitigated by shielding and relocation.

pileup:
μ=9 for 25ns, ~10fb-1 scenario
μ=27 for 50ns, 16fb-1 scenario

2012 Expectations

- Bunch spacing: Keep 50ns
  - 25ns seem would be preferred to reduce pileup. However limits due to the brightness from the injectors => Lower integrated luminosity.
- Predictions for total integrated lumi per experiment, running through ~April to October 2012:
  - 9 fb^{-1}, assuming performance in October 2011.
  - 12 fb^{-1}, with increased bunch intensity and smaller β* (0.8-0.9m).
  - 16 fb^{-1}, with increased bunch intensity and smaller β* (0.7-0.8m), thanks to beam energy increased to 4GeV. Decision to be taken early in 2012.

Conclusions

- LHC ran well above expectations in 2011.
- A plethora of results:
  - No new physics beyond SM.
  - Too early to say we found Higgs either.
  - Like a bad TV series, we are left with a cliffhanger at the end of the season.
- Excellent understanding of the machine suggests that we will get up to 3 times more data in 2012, possibly at higher E_{CM}.
- Keep on watching us, as 2012 will be the year of "Higgs or no Higgs" for sure.

http://www.hurriyet.com.tr/planet/19526138.asp

A.A. 23 Aralık 2011

Avrupa Nükleer Araştırma Merkezi (CERN) bilimadamları, atomların çekirdeğinin oluşmasına yardımcı olan yeni bir parçacık keşfettiklerini açıkladı.

Hürriyet PLANET

Keşif, Cenevre yakınlarındaki Büyük Hadron Çarpıştırıcısı'nda (BHÇ) yürütülen ATLAS deneyinden elde edilen veriler kullanılarak yapıldı.
13 Aralık'ta Cern bilimadamları, parçacıklara kütlelerini verdiği düşünülen ve "Higgs Boson" adlı atomaltı parçacığının izini bulduklarını ancak elde edilen verilerin keşif olarak nitelenemeyeceğini açıklamıştı.

Chi_b (3P) olarak adlandırılan yeni parçacık, Higgs Boson'dan farklı olarak iki kısımdan oluşuyor. "Alt tanecik" diye bilinen temel parçacık ve bu parçacığın karşıt taneciği. Bu iki tanecik bir araya geldiğinde atom çekirdeklerini bir arada tutan gücü oluşturuyor.

Bilimadamları, yeni parçacığın atomların içindeki çekirdekleri bir arada tutan gücü anlamalarına olanak tanıyacağını bildirdi.
Parçacığın varlığını öngören bilimadamları, daha önce parçacığı gözleme şansı bulamamıştı. Chi_b (3P), BHÇ'nin bulduğu ilk parçacık oldu.

Henüz resmi olarak yayımlanmayan keşfin, bilimadamlarının elde ettikleri verileri yorumlamalarına yardımcı olarak Higgs Boson'u bulmalarını kolaylaştırması bekleniyor.

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"Teselli Ikramiyesi"