La bosse di-photon au LHC : nouvelles de la frontière en énergie

(*energy frontier*)

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Journées Scientifiques Equip@Meso, Grenoble, 30-31 janvier 2017

Choix

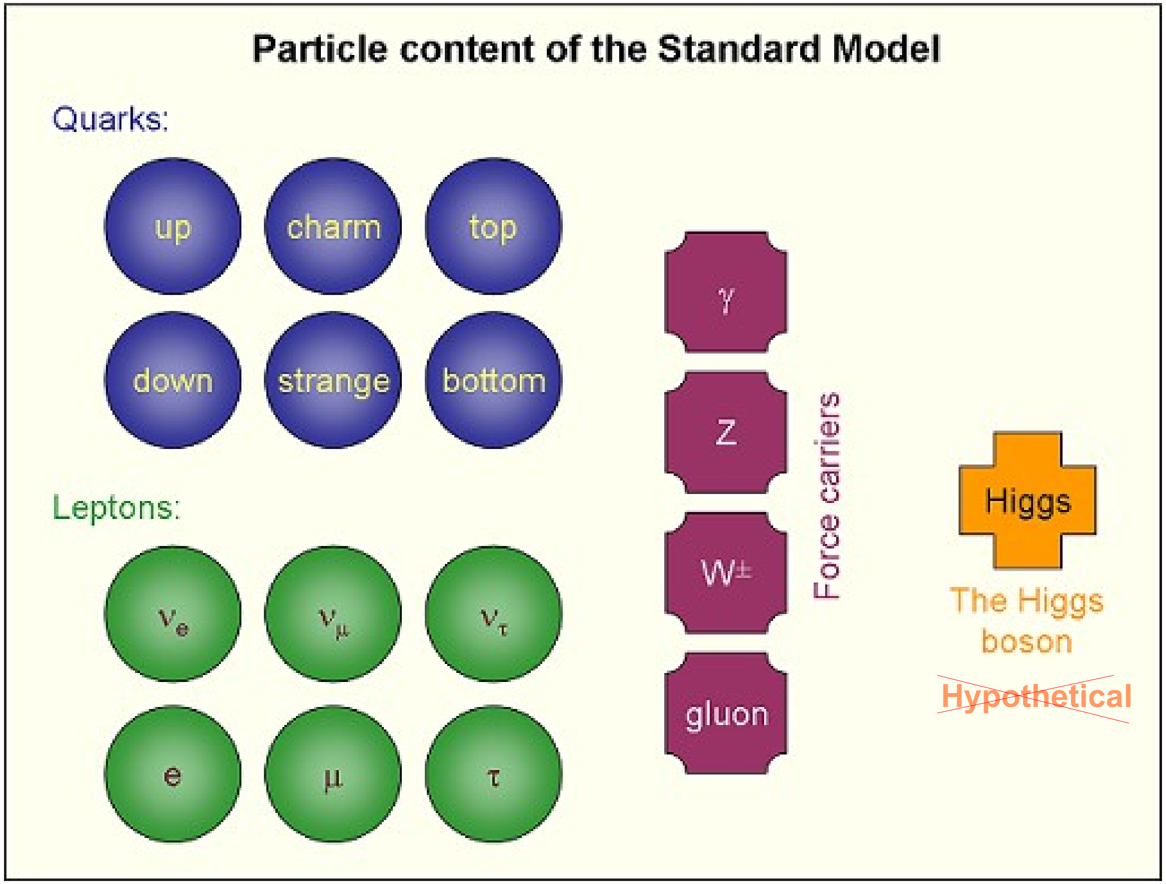
Pendant la préparation de cette présentation, j'étais obligé de faire des choix :

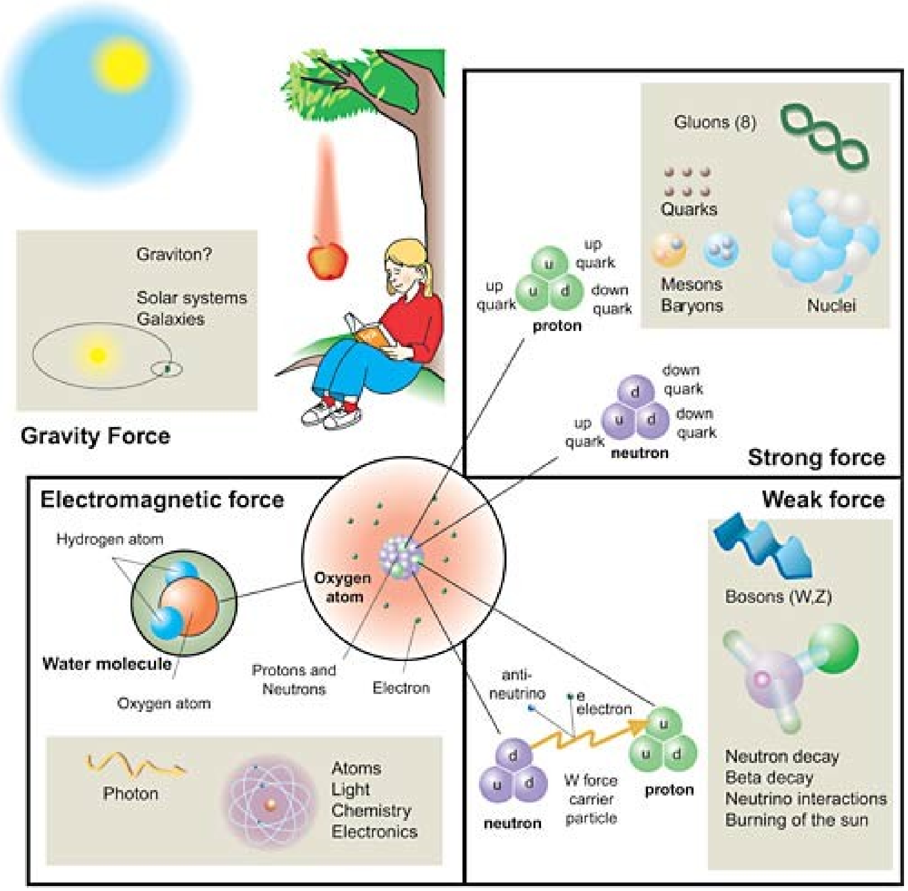
~~Faire un catalogue de résultats du LHC~~

Choisir un seul résultat,
le présenter dans son contexte ✓

Inconvénient de ce choix : je ne pourrai pas rendre justice à toute la richesse des résultats obtenus au LHC. Mes excuses.

Fundamental constituents of matter

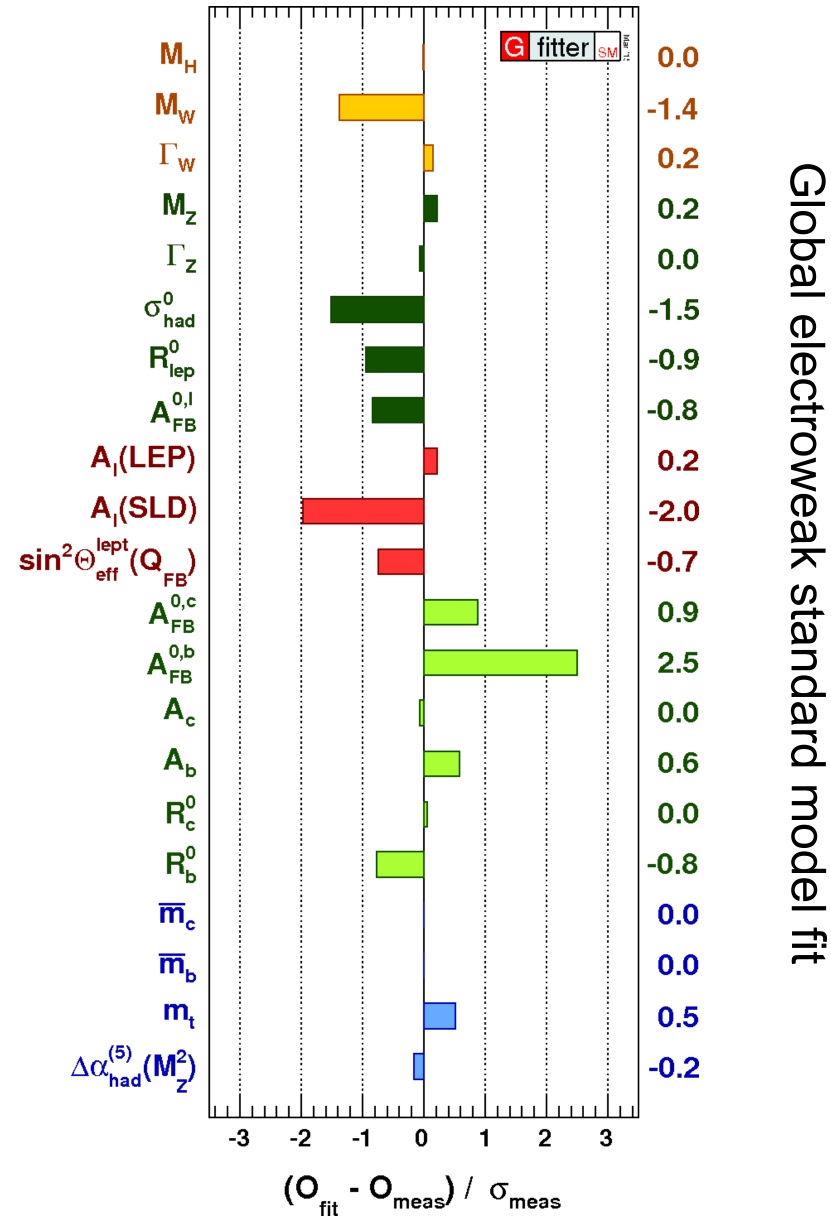




A self-consistent theory !

After the discovery of a Higgs-like boson, the standard model (SM) is a complete (but for an axion) and self-consistent renormalisable theory.

So far, SM in good agreement with data.



Questions ...

But a lot of questions still need answers:

– How to accommodate gravity ?

– Hierarchy problem: $m_{EW}/M_{Pl} \sim 10^{-16}$

– What is dark matter ?

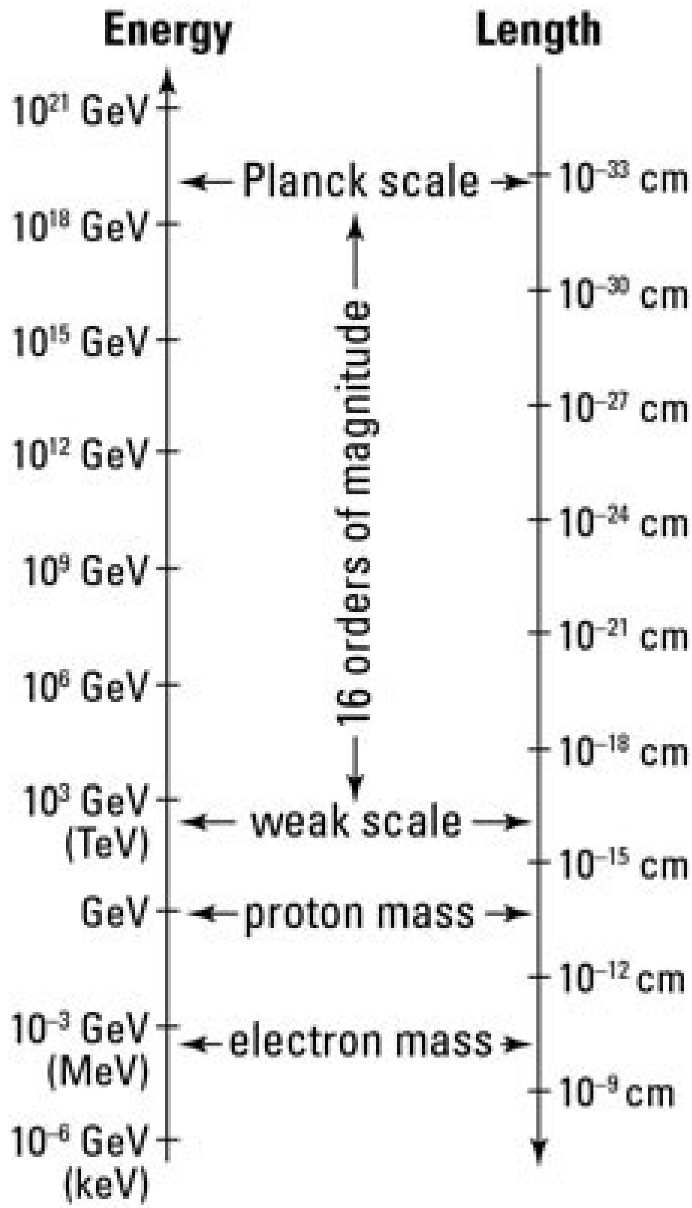
– Matter-antimatter asymmetry

– Origin of generations ?

– ...

Physics beyond the SM is well motivated.

The hierarchy problem

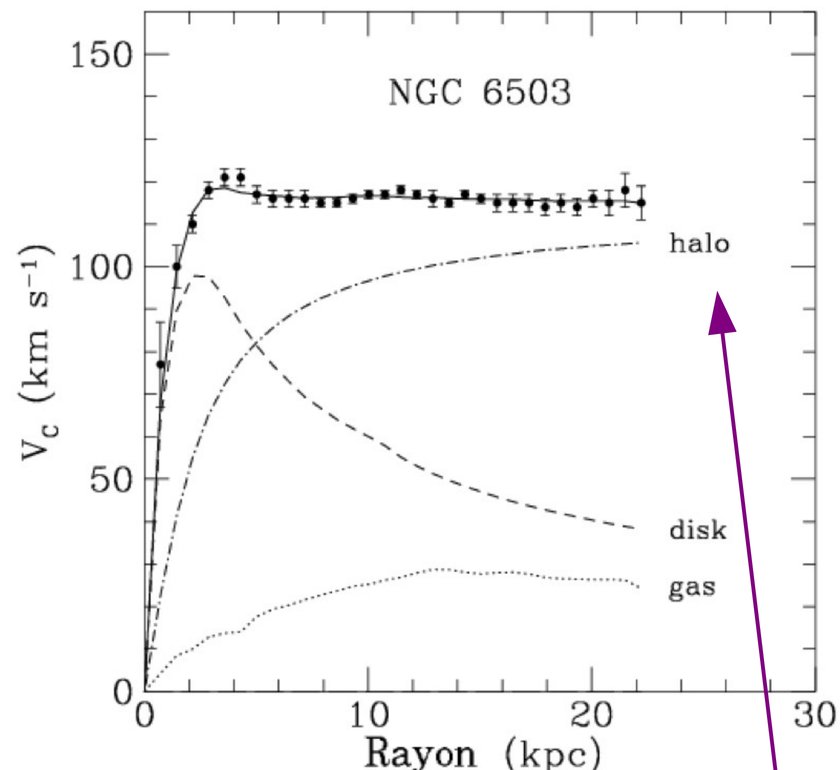


Dark matter

La galaxie NGC 6503

centre de la galaxie

Vitesse de rotation des étoiles dans cette galaxie, en fonction de la distance de l'étoile par rapport au centre de la galaxie



il est fait de quoi, ce halo ?

Les objectifs de l'IN2P3

Rechercher ok

Le CNRS | Annuaires | Mots-Clefs CNRS | Autres sites

dépasser les frontières

Institut national de **physique nucléaire** et de **physique des particules**

Centre national de la recherche scientifique

- Présentation de l'Institut
- Structures de recherche
- Conseil scientifique
- Infos aux laboratoires
- Vie de la recherche
- Carrières et emplois
- Physique subatomique pour tous

English version

Rechercher :
- **une expérience**
- **une personne**
- **une photo**

Rechercher :
une information sur le site de l'IN2P3 ok

Accueil > Présentation de l'Institut > Thématiques scientifiques

Introduction | **Physique des particules** | **Physique nucléaire et hadronique** | **Astroparticules et neutrinos** | **Aval du cycle électronucléaire et énergie nucléaire** | **Recherches interdisciplinaires** | **Recherche et développement en accélérateurs** | **Grille de calcul**

Physique des particules

Le domaine de la physique des particules rassemble les recherches expérimentales visant à faire progresser la connaissance des quarks (les composants des protons et des neutrons), des leptons (tel l'électron gravitant autour du noyau atomique) et des bosons responsables de leurs interactions mutulles. Ces particules sont considérées actuellement comme les constituants les plus élémentaires de la matière.

Le Modèle standard

Les avancées parallèles et couplées des observations expérimentales et des progrès théoriques enregistrés depuis les années 60 ont permis l'élaboration de ce qui est appelé le Modèle standard (voir l'introduction).
Bien que ce modèle donne une description très satisfaisante des phénomènes observés dans les expériences, c'est toutefois une théorie incomplète :

- elle ne peut expliquer le pourquoi de l'existence de trois familles ;
- elle ne permet pas de prédire les valeurs observées des masses des particules ;
- elle ne rend compte que de trois de ces quatre interactions fondamentales à l'œuvre dans l'Univers : la gravitation en est en effet exclue ; en revanche, elle a déjà permis d'unifier les interactions électromagnétique et faible en une interaction unique dite électrofaible.

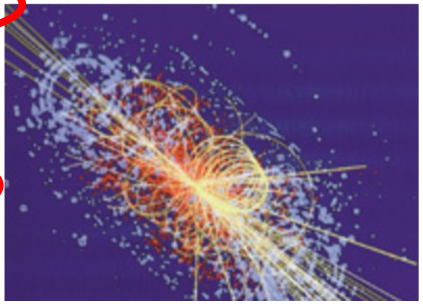
Même s'il n'a jamais été démenti par l'expérience, on sait donc que le Modèle standard n'est pas la théorie ultime. Plusieurs grandes questions se posent, auxquelles il ne peut répondre dans sa forme actuelle :

- **Pourquoi les particules ont-elles une masse et pourquoi ont-elles des masses si différentes ?**

Le boson de Higgs, particule prédite par le Modèle standard et détectée pour la première fois en 2012, devrait expliquer l'origine des masses et permettre de comprendre leurs différences.

- **Comment aller vers une plus grande unification des interactions qui inclurait l'interaction électrofaible et l'interaction forte, et même la gravité ?**

Les physiciens pensent en effet que les quatre interactions fondamentales ne seraient que des aspects différents d'une

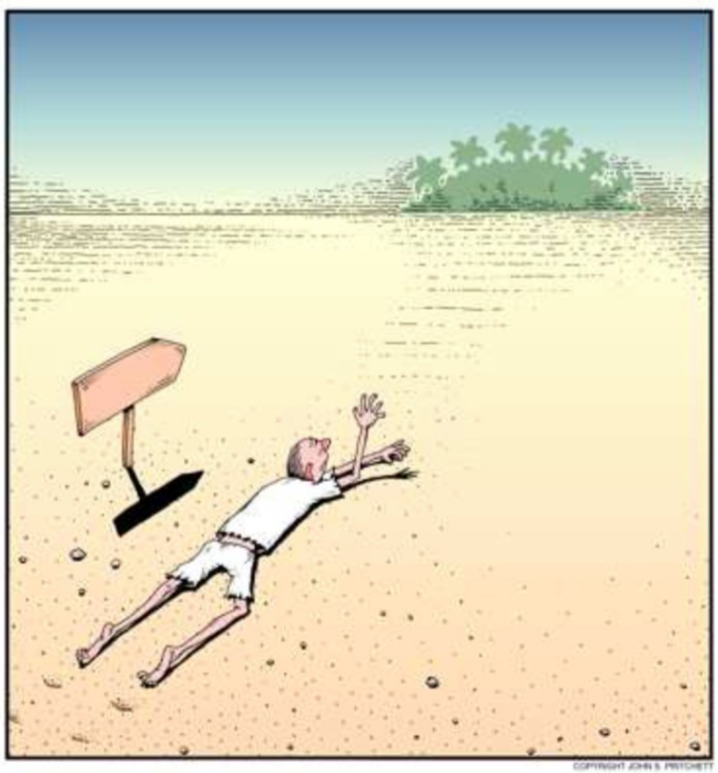


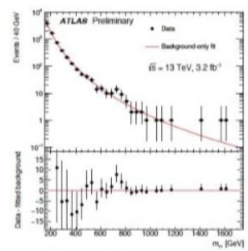
Questions ...

Theorists; state of mind

Poor theorists:

Waiting for new physics for 30 years,
and recently started to get desperate...
and something interesting appears.



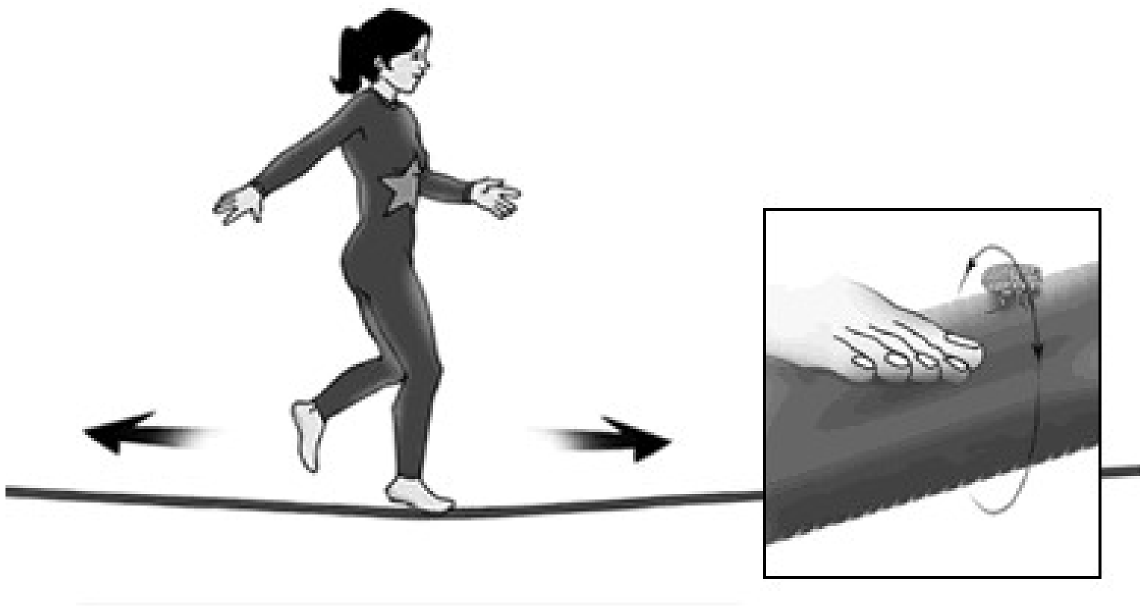


Abdelhak Djouadi (LPT Orsay)
Moriond QCD conference
March 2016

Extra spatial dimensions

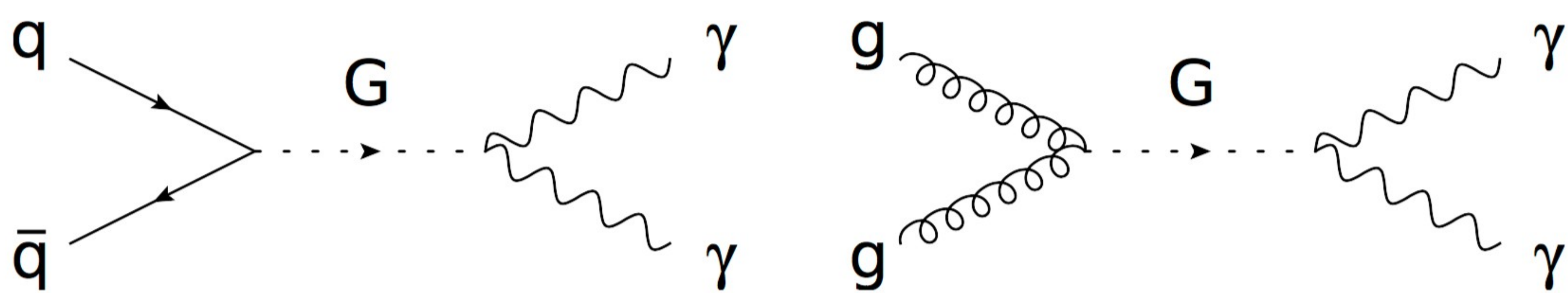
(this hypothesis could explain the hierarchy problem)

- In the Randall-Sundrum model gravity propagates in a warped extra dimension with two fixed points
- The Standard Model fields are constrained to one brane
- The gravity wave function is concentrated near the other brane, falling off exponentially across the extra dimension

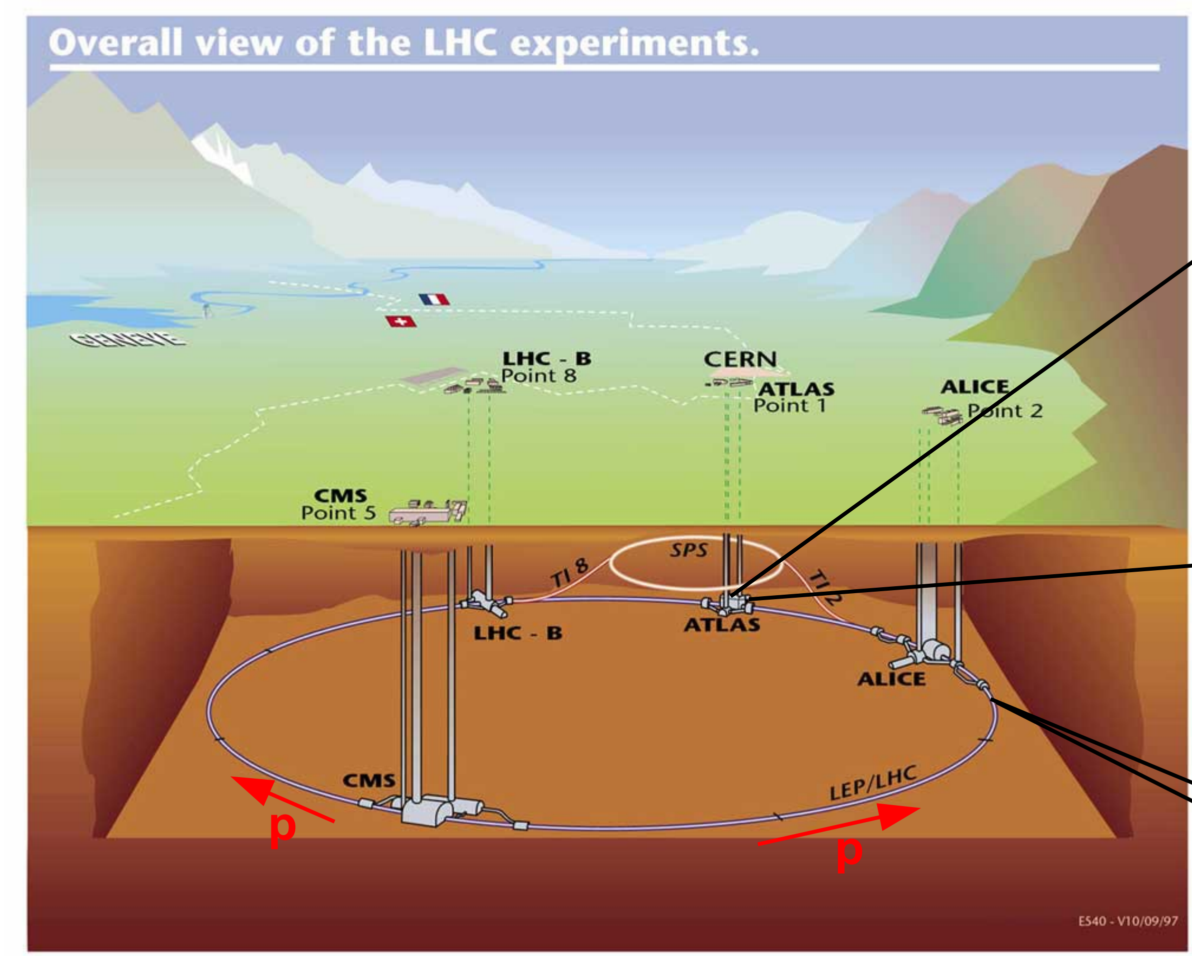


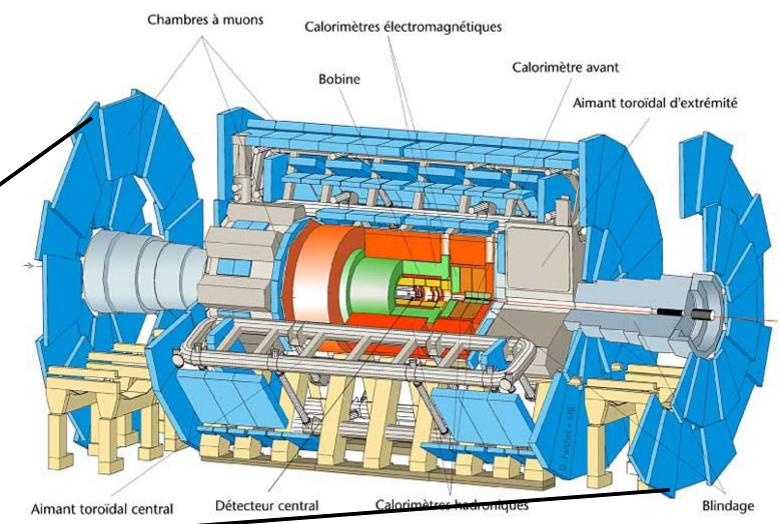
Graviton excitations

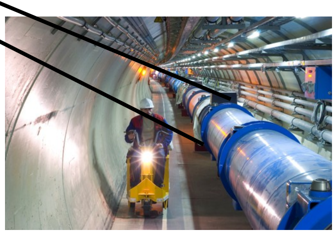
The model predicts a tower of Kaluza-Klein graviton states with TeV scale masses



LHC particle collider and ATLAS detector







« Pourquoi avons-nous besoin de beaucoup de ressources informatiques (et différents types de ressources) ? »

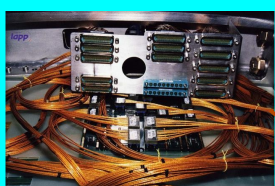
Traitement centralisé

groupe/individu

Reconstruction des données brutes

Identification des objets et sélection d'état final

Analyse finale (n fois / jour)



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101100 010001
110111 001100
111100 100110
110101 110011
001010 001010
100101 000011
010111 010100
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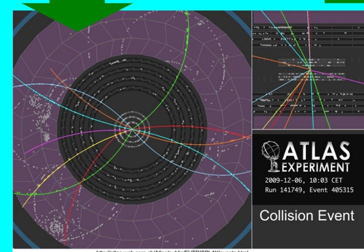
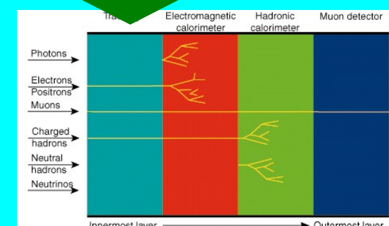
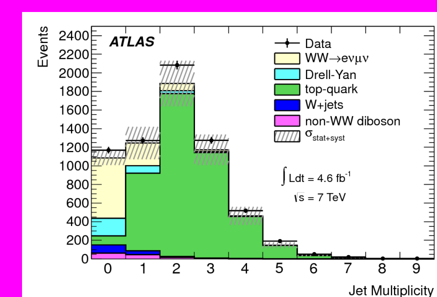
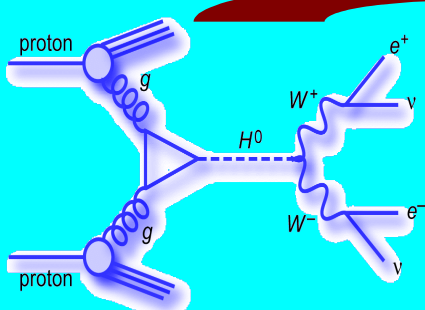
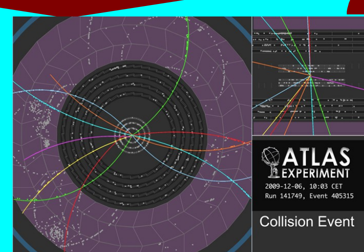


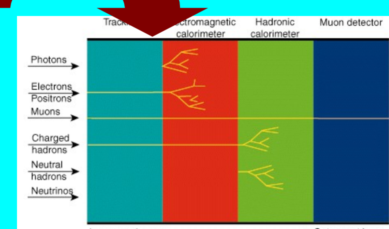




Simulation des événements

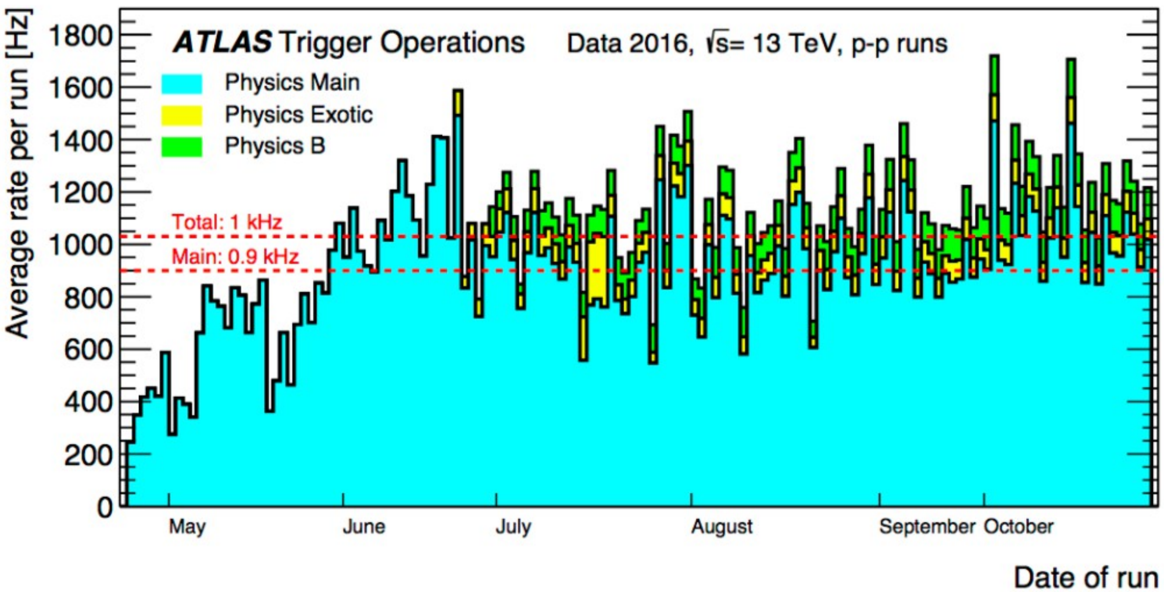


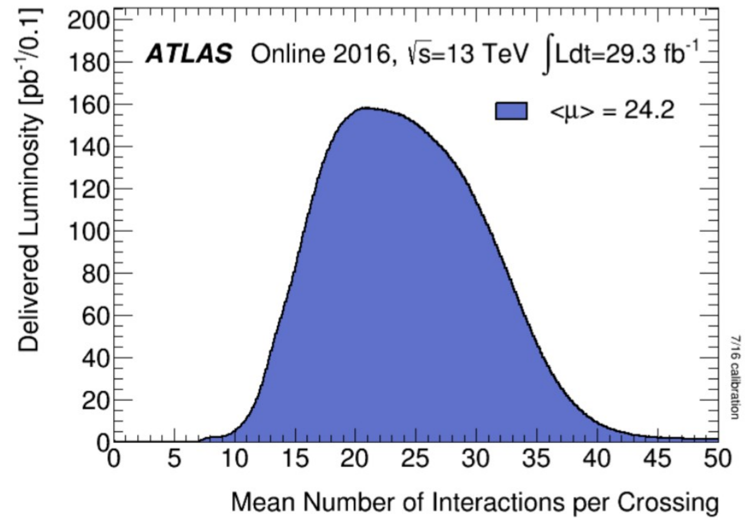


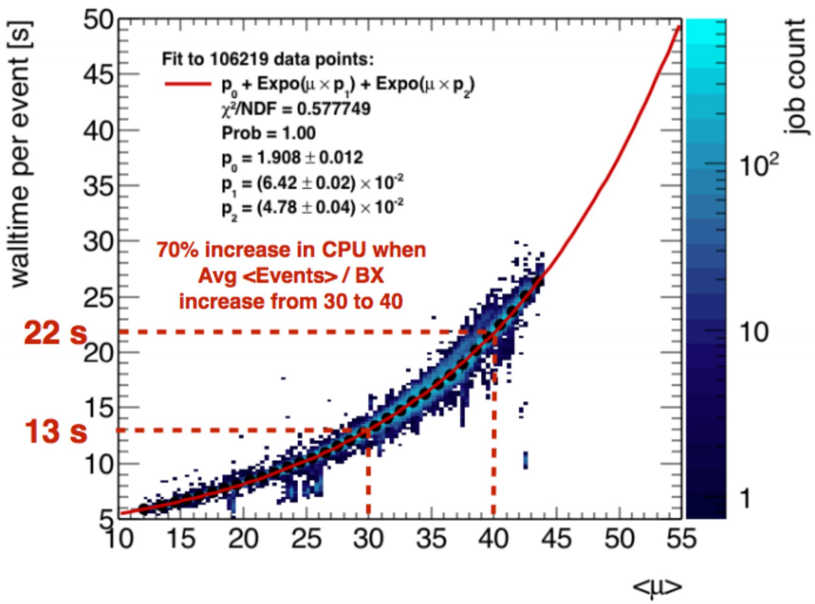


"Petits" calculs théoriques (cf. Diphox dans la suite).

ATLAS computing: orders of magnitude







7.6 billion events in proton-proton collisions

1.4 billion events in proton-lead collisions

ATLAS software and computing worked very well.

Une nouvelle problématique

Une nécessité

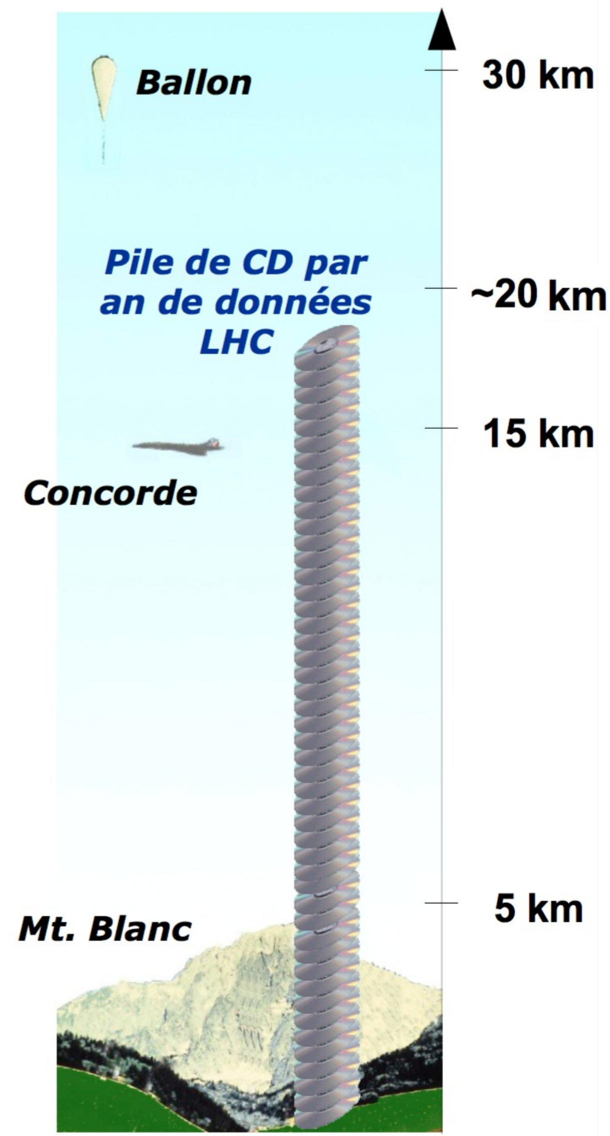
- 23 millions CD produits par un détecteur en un an
- Un site seul n'aurait pas suffit (ressources, infra, €€)
- Utilisateurs distribués partout dans le monde

Or, des sites existaient déjà de part le monde

- Des moyens financiers régionaux
- Souvent partagés entre différentes communautés

Décision de construire une grille de calcul pour le LHC

- Mutualisation de ressources de plusieurs unités pour un but commun
- Correspond bien à notre problématique (collisions indépendantes)

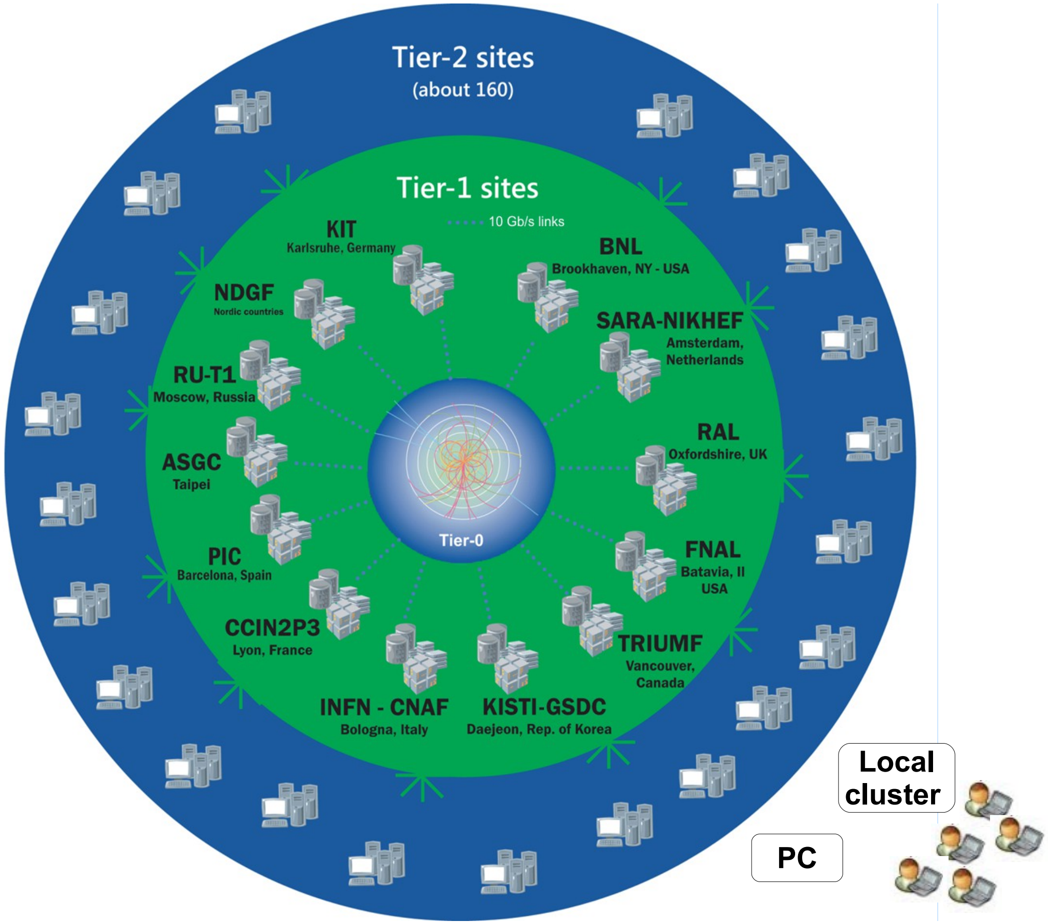


Worldwide LHC computing grid (WLCG)

Hiérarchie des sites / modèle MONARC

Premier modèle pour l'informatique au LHC (1999)

- Modèle en étoile, hiérarchique, distribué
- Focus sur le contrôle du réseau (1Gb/s attendu)



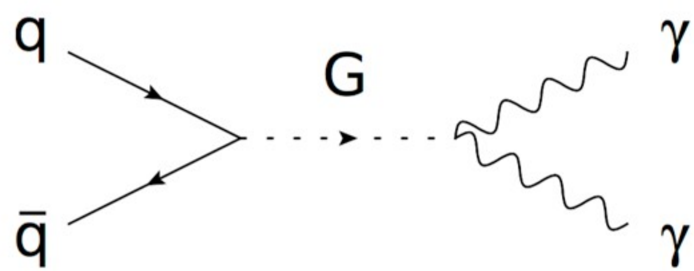
<u>Tier-0 (CERN):</u>
- Raw data storage
- Calibration
- Initial reco
- Data distribution to T1

<u>Tier-1:</u>
- Long term archiving
- Subsequent reco passes
- Large scale organised analysis

<u>Tier-2:</u>
- Simulation
- End user analysis

<u>In addition (end user analysis):</u>
- Tier-3
- Local clusters

Searches for resonances



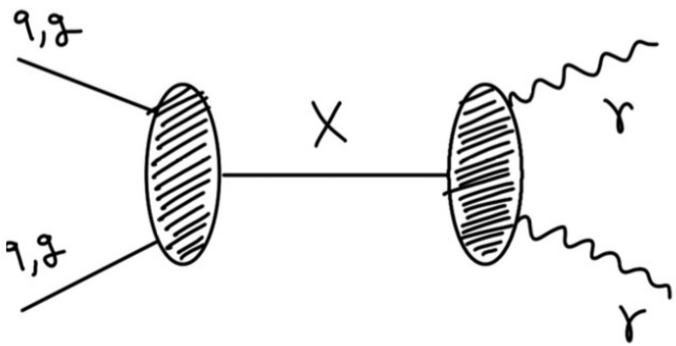
Fully reconstructed resonances: simplest way to discover new particles

Statistically significant peak over a smooth background
- ✓ experimentally robust
- ✓ small systematics
- ✓ difficult for unknown backgrounds to mimic

=> ***simple yet striking signature!***

The most important search method when new energies are explored
- ✓ particularly relevant at LHC Run2 startup
- ✓ model independent probe to new physics

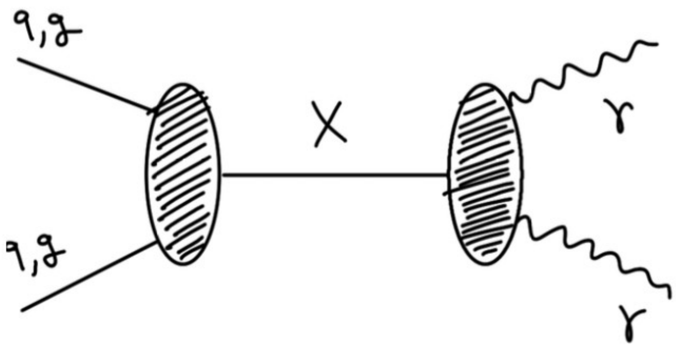
Diphoton bump search



Clean final state at hadron colliders

1) Define the event selection: 2 isolated photons
   - ✓ must be loose and model-independent

Diphoton bump search



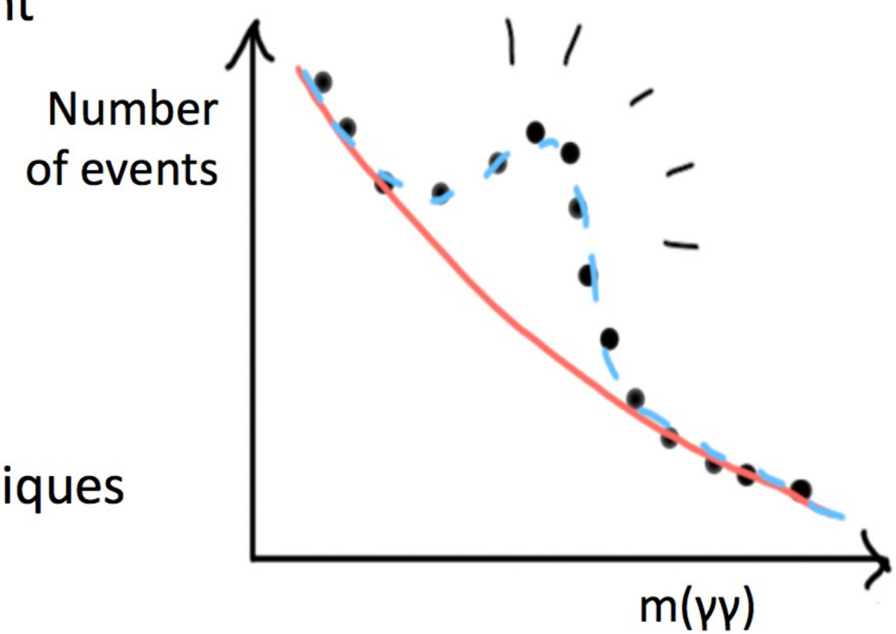
Clean final state at hadron colliders

1) Define the event selection: 2 isolated photons
   - ✓ must be loose and model-independent

2) Reconstruct the γγ invariant mass

$$M = \sqrt{2E_1E_2(1 - cos\theta)}$$

   - ✓ photon reconstruction
   - ✓ detector resolution and scale
   - ✓ dedicated vertex identification techniques



3) Signal extraction

Resonances in past discoveries

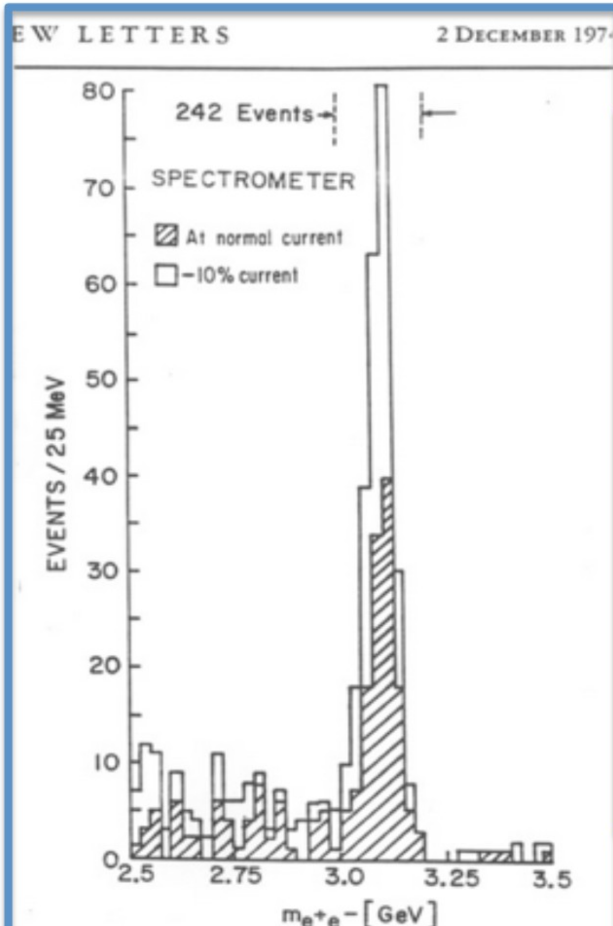
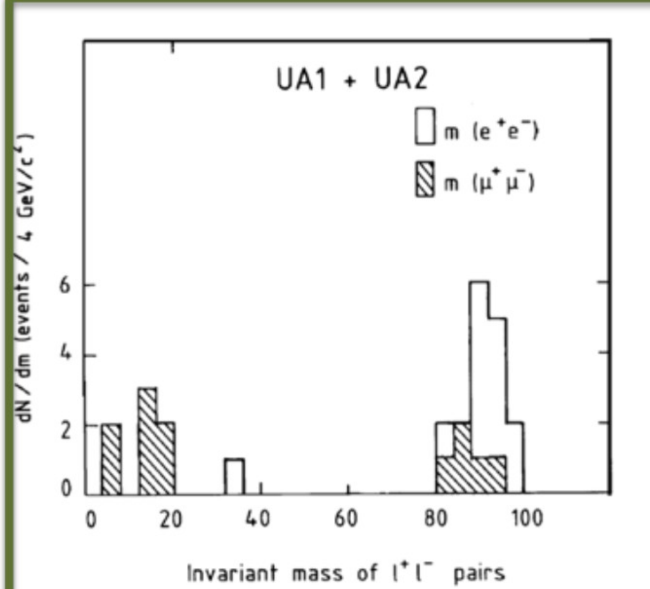
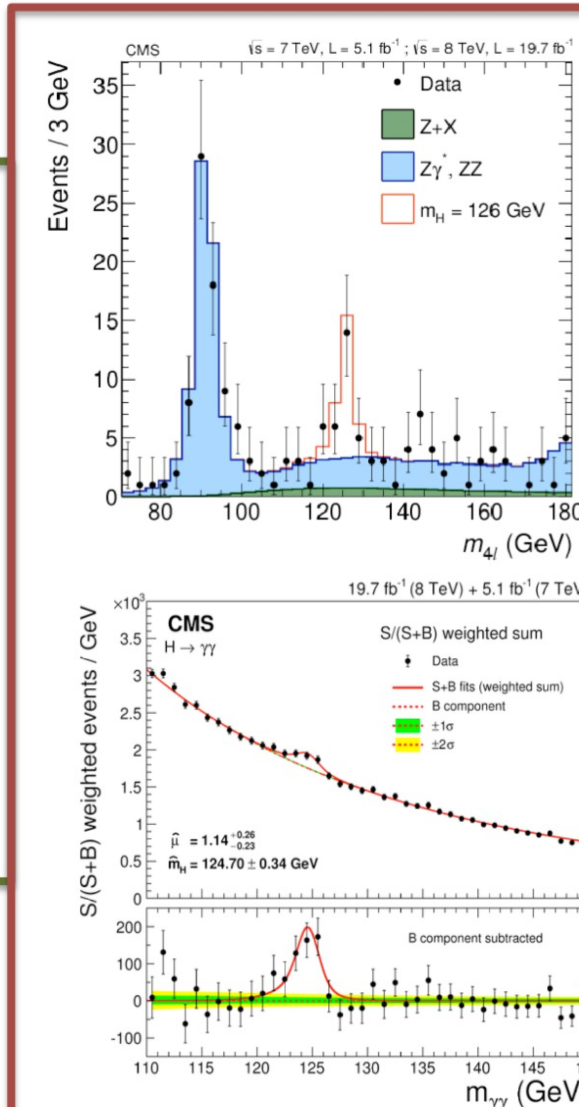


FIG. 2. Mass spectrum showing the existence of J. ...sults from two spectrometer settings are plotted ...wing that the peak is independent of spectrometer ...rents. The run at reduced current was taken two ...nths later than the normal run.

J/Psi (1974)

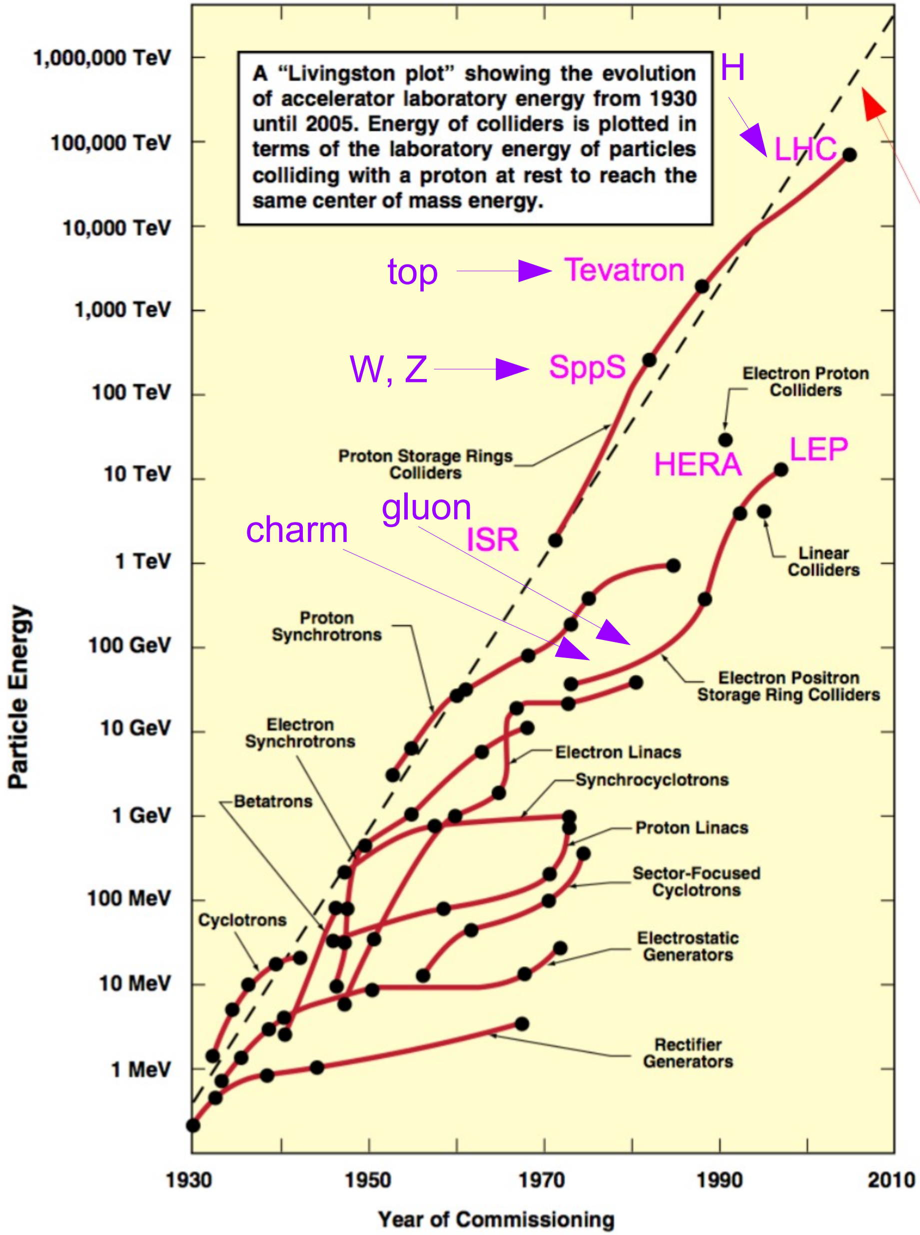


Z (1983)



Higgs (2012)

Livingston plot



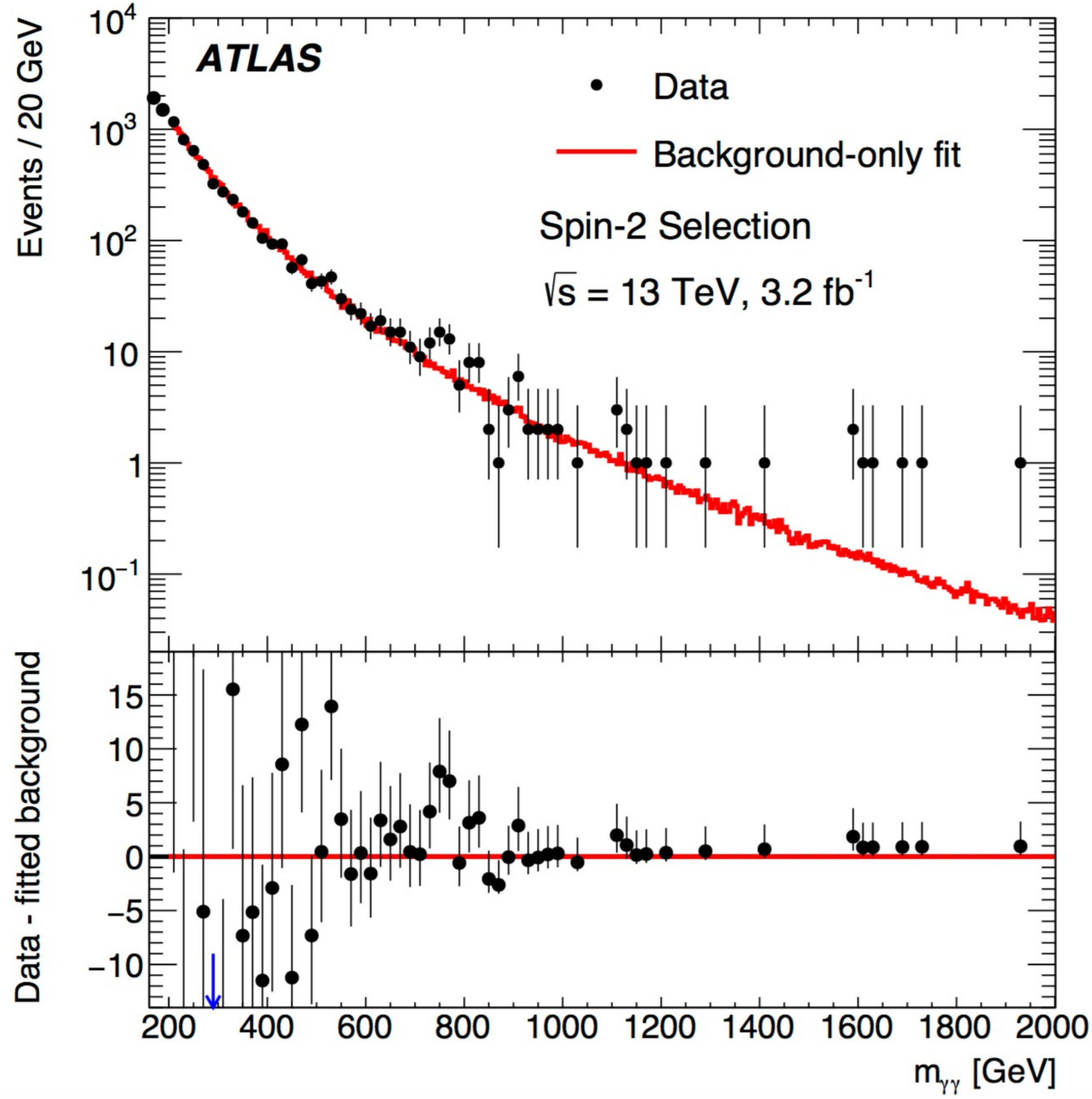
Plot fait pour la première fois par M. Stanley Livingston en 1954.

"Droite de Livingston" : loi de croissance exponentielle.

Pour comparaison : la "loi de Moore" (puissance de calcul des circuits intégrés) a été énoncée pour la première fois en 1965.

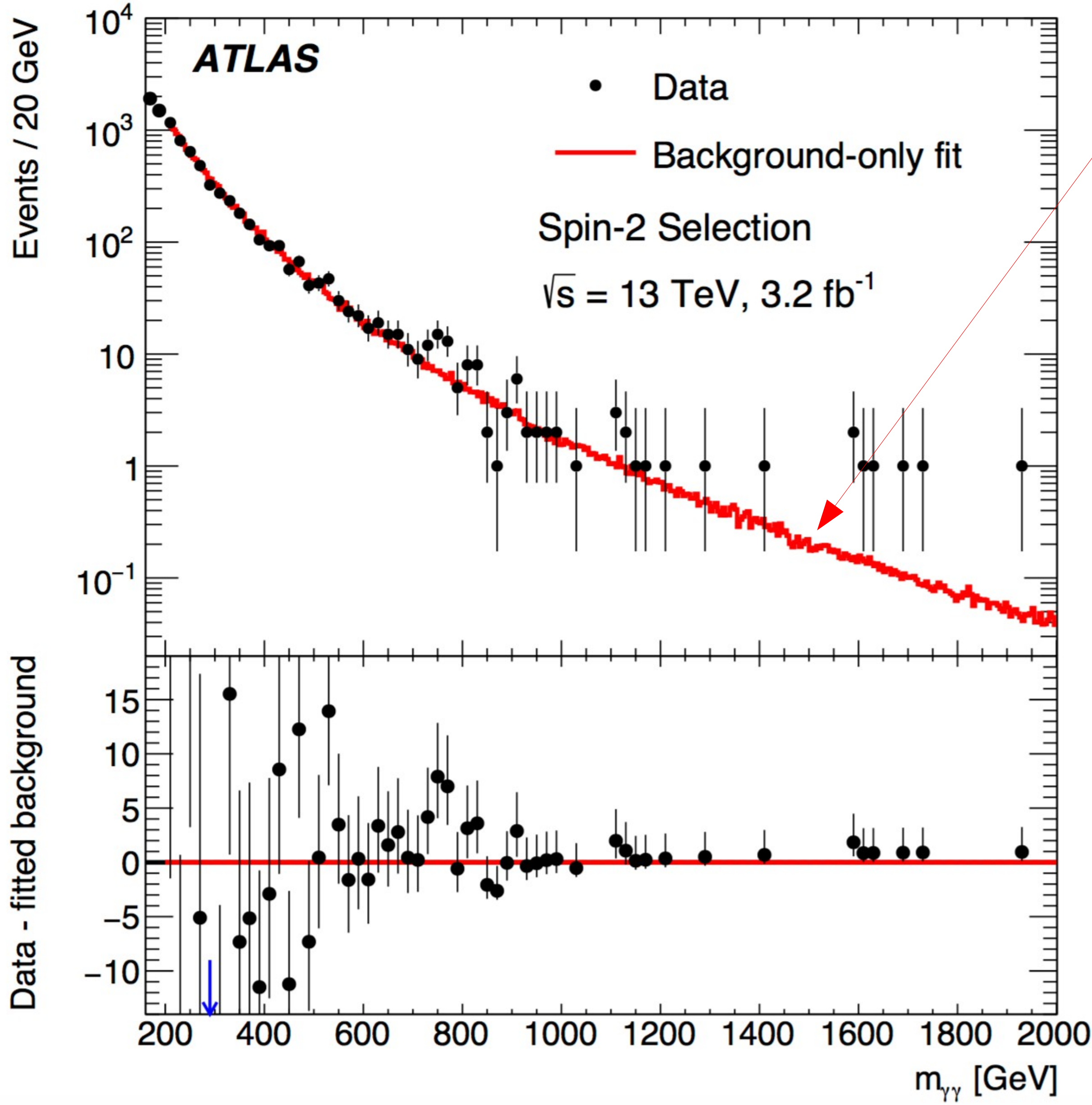
Découvertes récentes

Diphoton mass spectrum



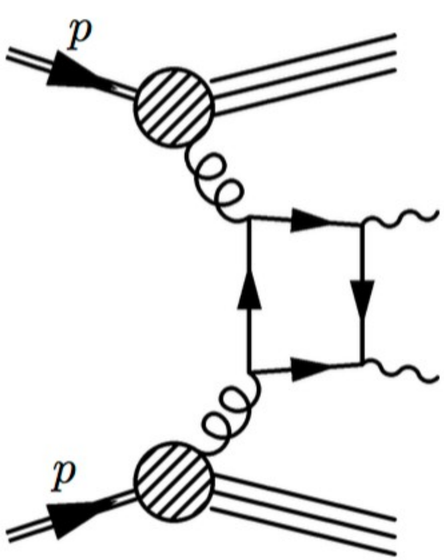
Data collected by the ATLAS experiment in 2015

An aside: Diphox



Standard Model background prediction based on precise first-principles calculation in the Diphox generator.

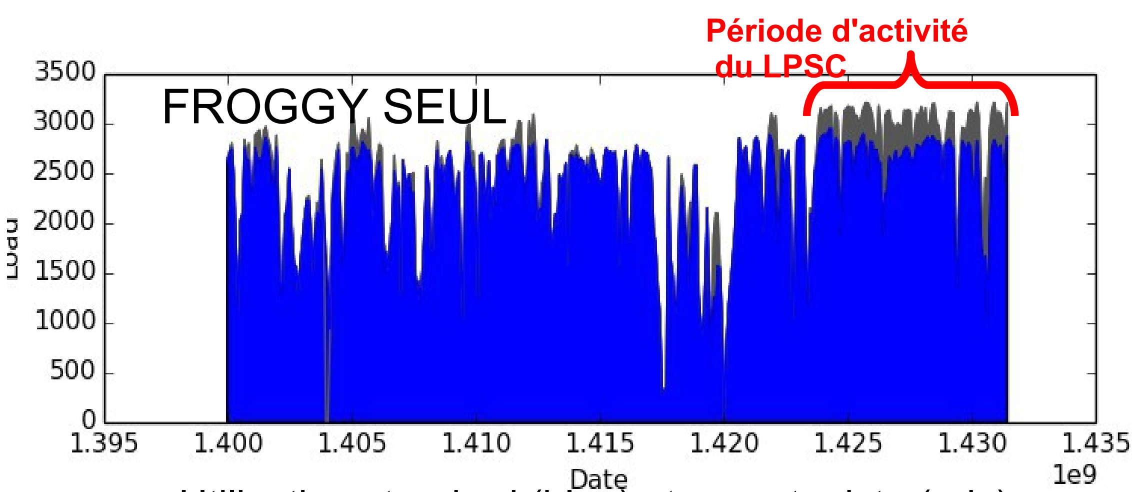
Diphox is computing-intensive; we run it on CIMENT in Grenoble.



Diphox et CIMENT

CIMENT est crucial pour l'analyse di-photon ATLAS (2013-2017) :

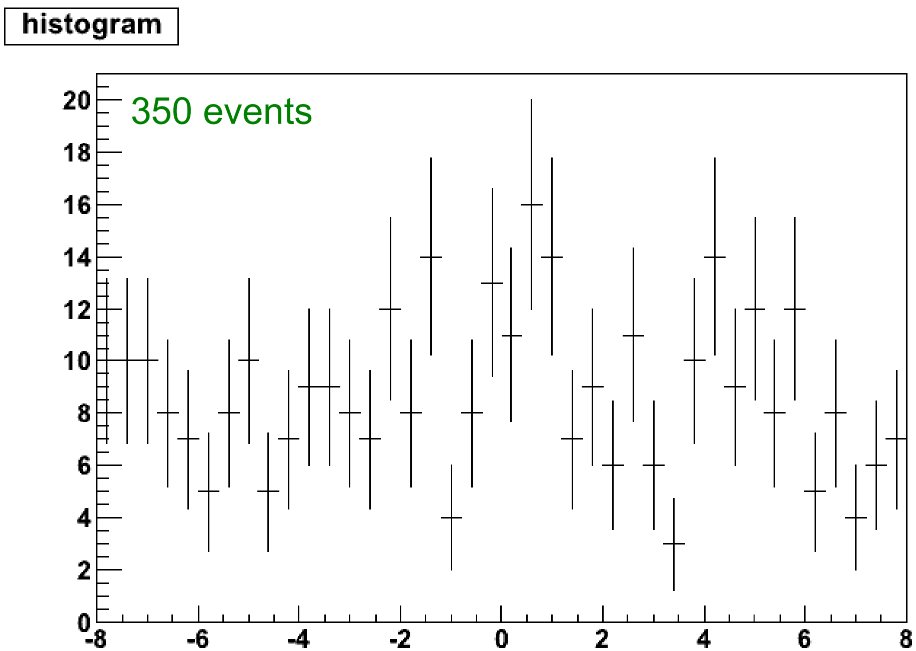
- Seul LPSC-CIMENT produit les échantillons DIPHOX
- Ajout de FROGGY → jusqu'à >1000 cœurs soutenu simultanément (week-end)
- Utilisation de 30 000 jours wall-clock en tout ; avec sur 2 mois Moyenne=430 core[day]/day
- Intérêt des groupes exotics pour ces échantillons
- Le coordinateur de physique de la collaboration ATLAS : « CIMENT is an asset »

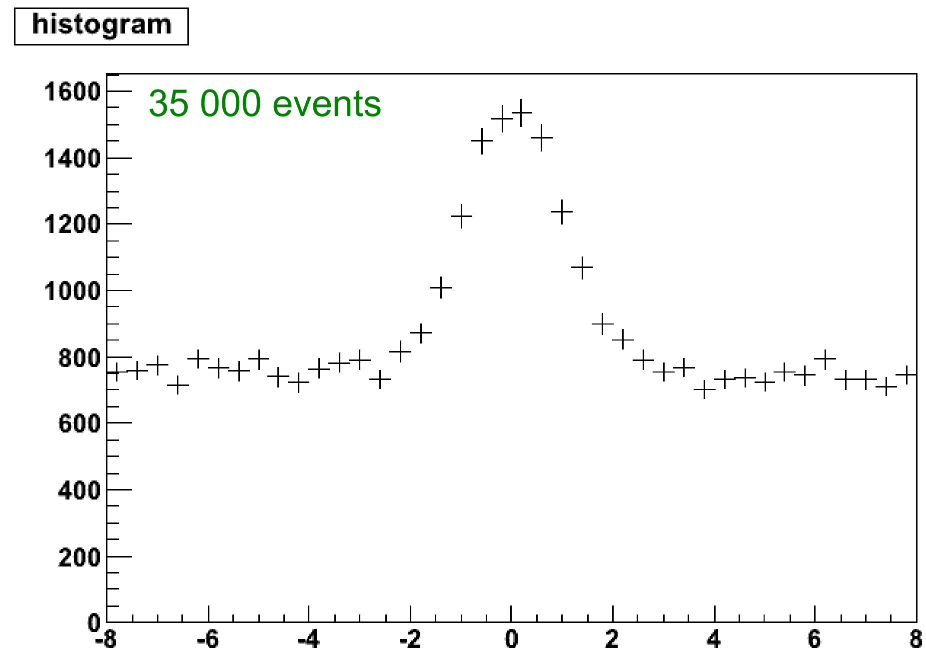


Utilisation standard (bleu) et opportuniste (gris)

Importance of statistics

These two graphs show the same distribution, on the left with little data, and on the right with 100 times more data:

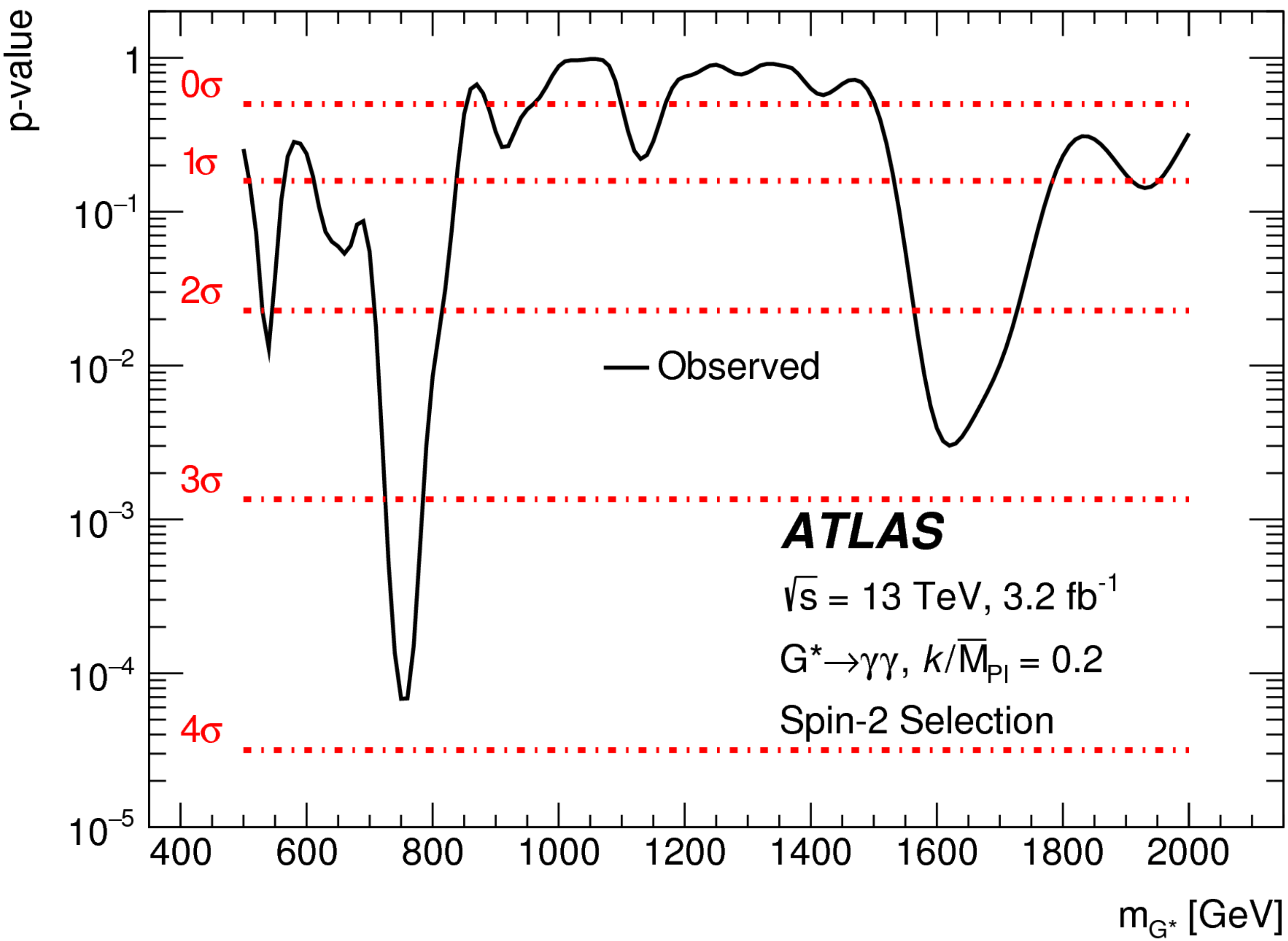




With a lot of data we can clearly see a structure :
a flat spectrum (e.g. due to background),
plus a peak (e.g. due to a new particle).

With less data the situation is much less clear :
- is this simply a flat spectrum ?
- or is there a peak somewhere ??

p-value



At 750 GeV:

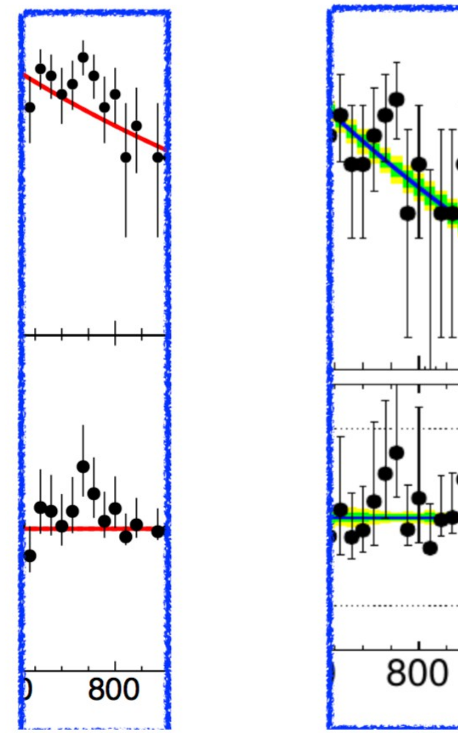
3.8σ local
2.1σ global
for $\Gamma \approx 50$ GeV

Excitement

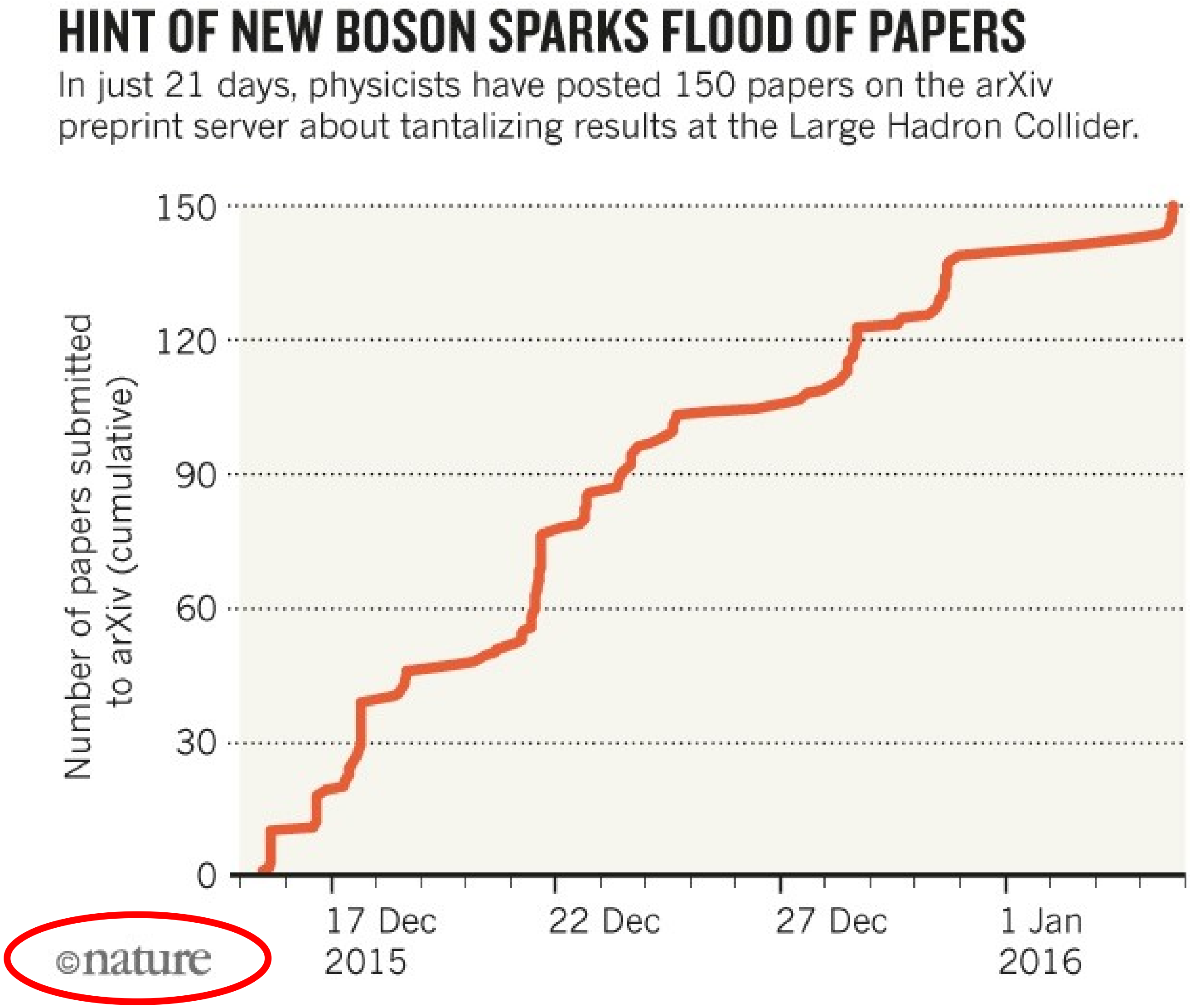
Abdelhak Djouadi (LPT Orsay)
Moriond QCD conference
March 2016

**If true then the future is bright!
a new continent is ahead and
needs decades of exploration...**

Alessandro Strumia
Moriond conferences
March 2016



Excitement

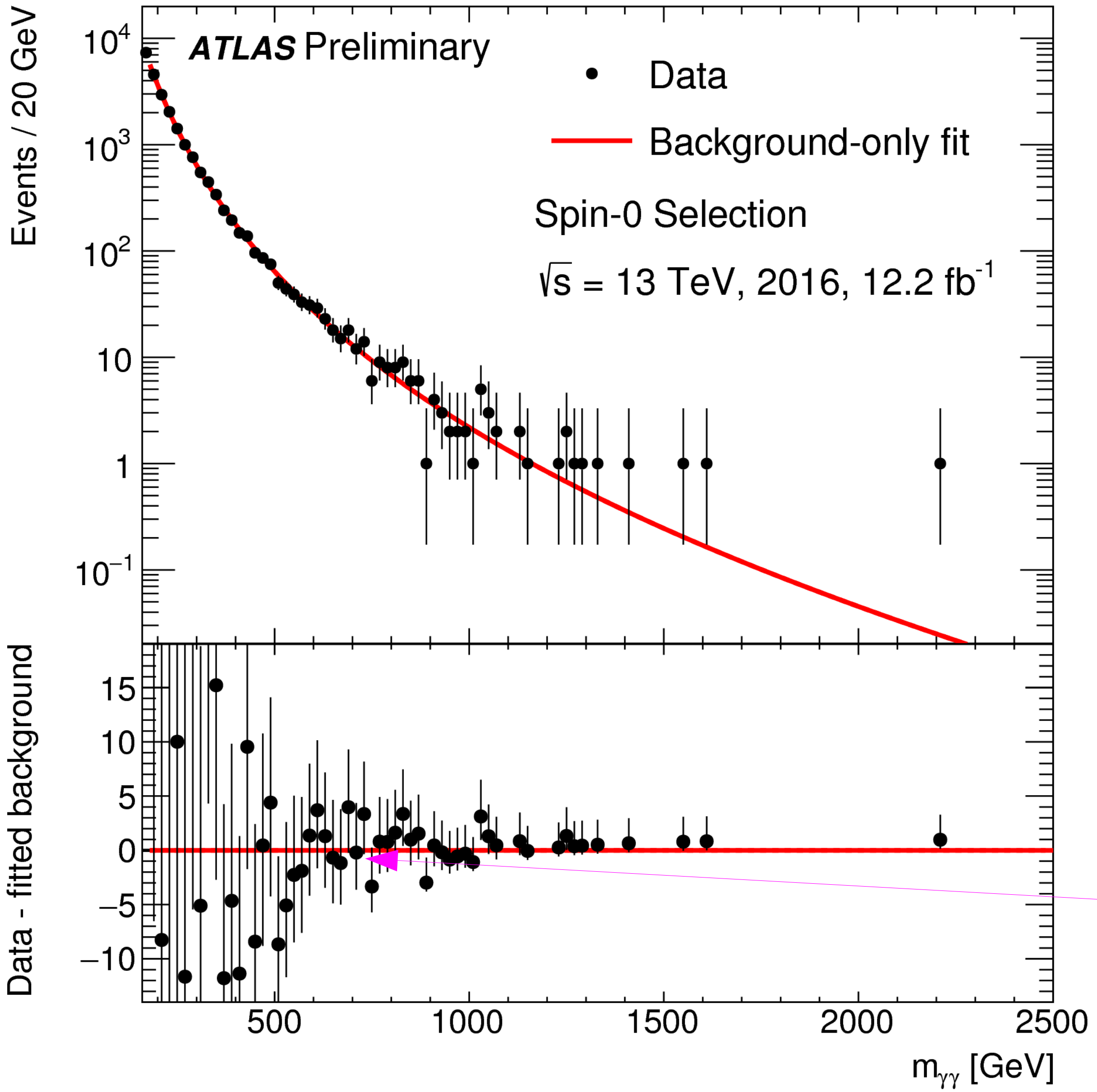


More than 456 papers as of June 16th.

Excitement

Mai 2016

So what about the 2016 data ?



Results based on the first third of the 2016 data (full dataset to be published).

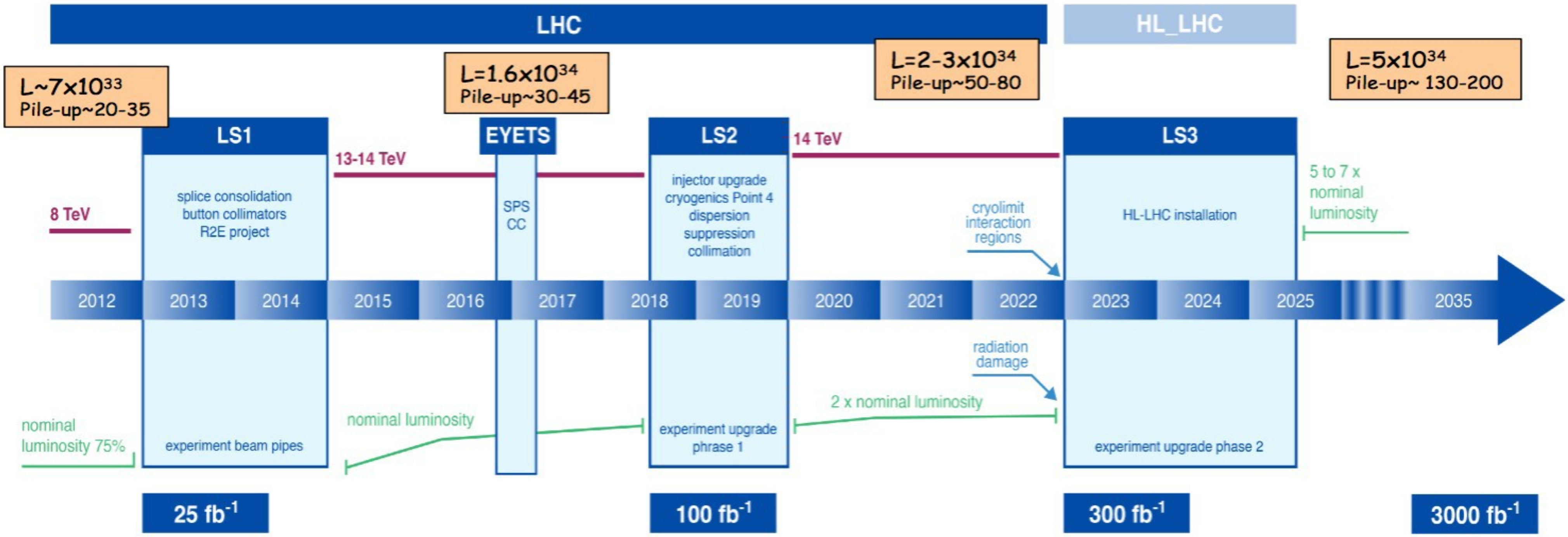
No peak at 750 GeV.
Looks like bump in 2015 was a statistical fluctuation.

A plus long terme : HL-LHC

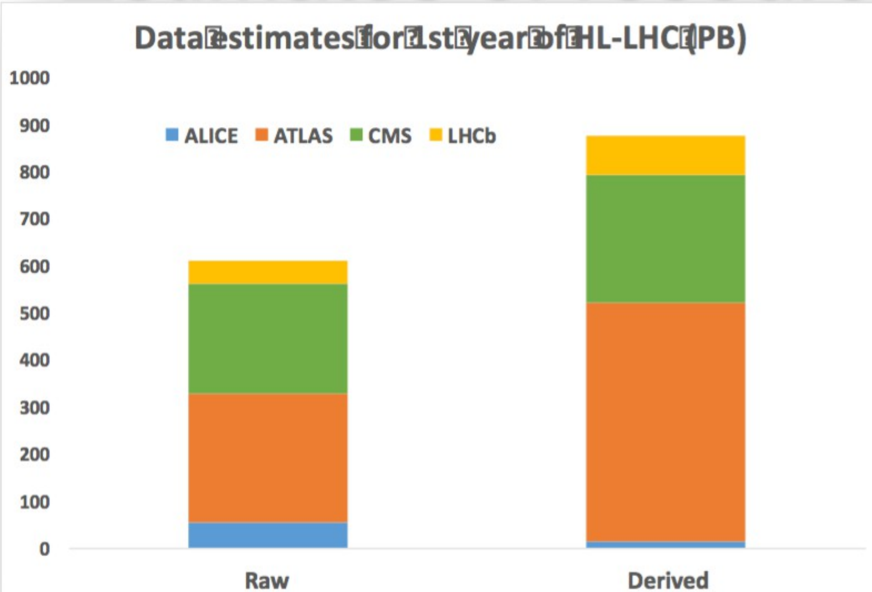
Mais ce n'était que le début de nos explorations.

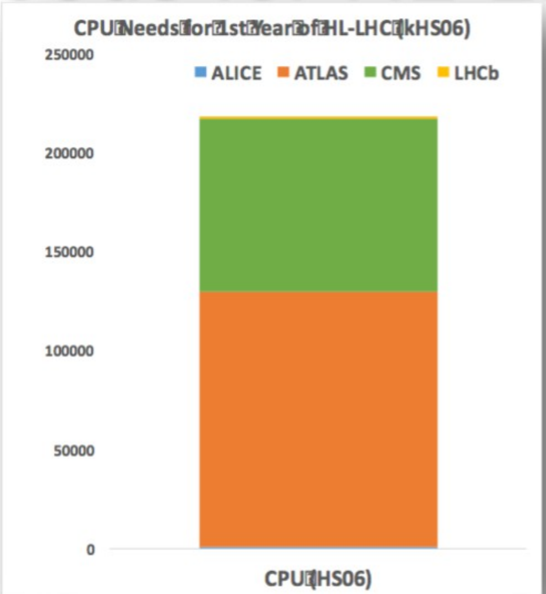
La prise de données et la chasse continuent !

L.Rossi



Estimated resource needs for HL-LHC





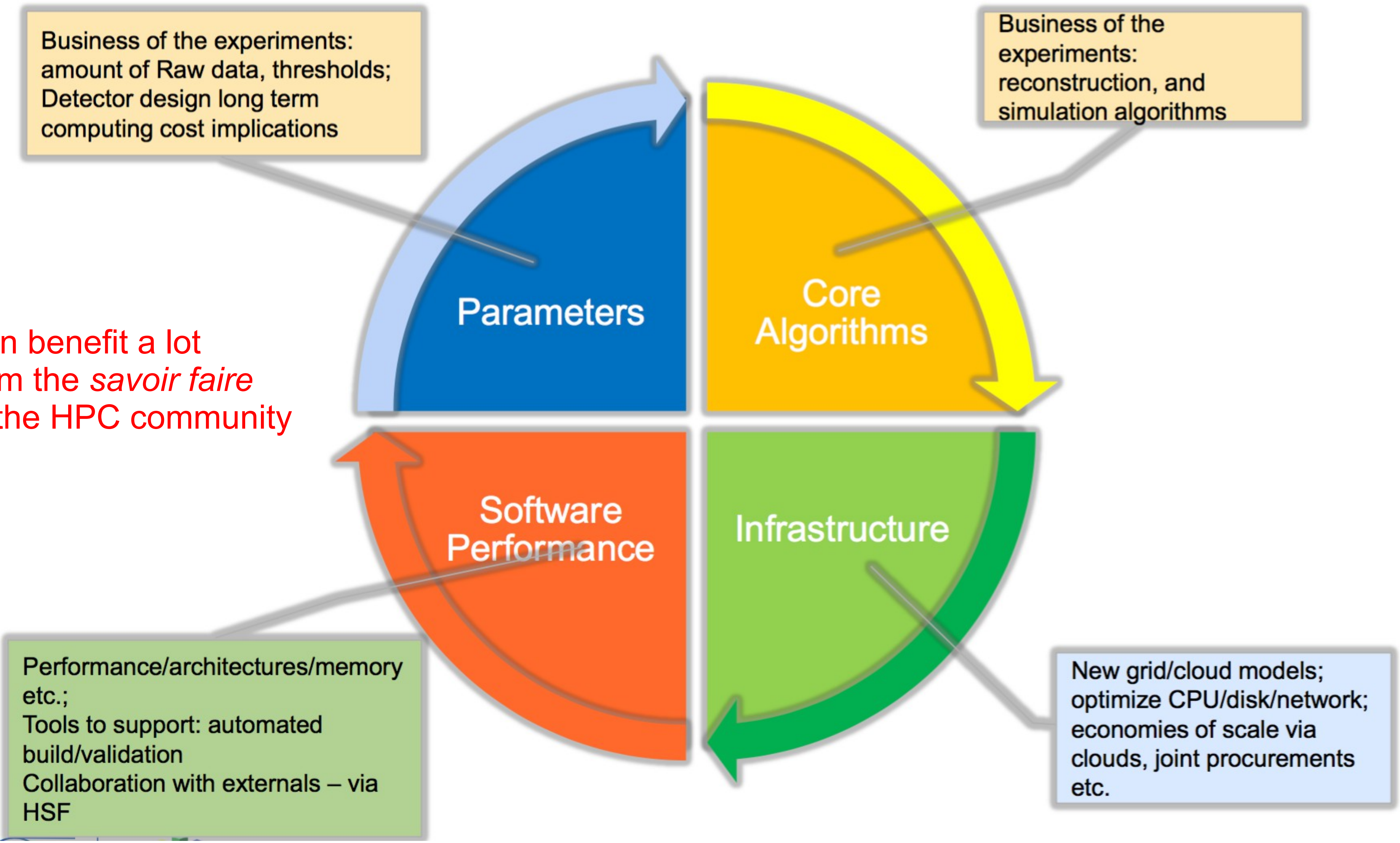
Data:
- Raw 2016: 50 PB → 2027: 600 PB
- Derived (1 copy): 2016: 80 PB → 2027: 900 PB

CPU:
- x60 from 2016

Technology at ~20%/year will bring x6-10 in 10-11 years

- ❑ Simple model based on today's computing models, but with expected HL-LHC operating parameters (pile-up, trigger rates, etc.)
- ❑ At least x10 above what is realistic to expect from technology with reasonably constant cost

HL-LHC cost parameters



Can benefit a lot from the *savoir faire* of the HPC community

Conclusions

Standard model (SM) of particle physics (including the Higgs mechanism):
consistent renormalisable theory that "works" all the way up to the Planck scale.

But is it really a complete description of Nature up to these extreme energies (Planck scale) ?

Various "aesthetic" issues (like e.g. the hierarchy problem) lead us to suspect that the answer is "no" and that the SM is a low-energy approximation of a more complete theory.

The direct search for physics beyond the SM is on at the LHC.

First data in a new energy regime (13 TeV) collected in 2015 and 2016.

An intriguing excess of events in the diphoton final state has lead to some excitement In 2015 and early 2016. Looks like the excess in 2015 data was a statistical fluctuation.

This was just the beginning. We are looking at hundreds of other final states (not just diphotons); and we have collected very little data so far.

Our computing paradigms have worked extremely well and have allowed us to deliver Results (discovery of the Higgs boson, first searches for new phenomena).
They will not work without evolutions in the medium-term future. HCP-like concepts will be part of the solution to this problem.

Acknowledgements

In the preparation of this set of slides, I have made ample use of two seminars that have been given by

C. Rovelli

and

M. Vanadia

at INFN (Italy).

I have also incorporated individual slides from talks given by the following authors:

C. Biscarat

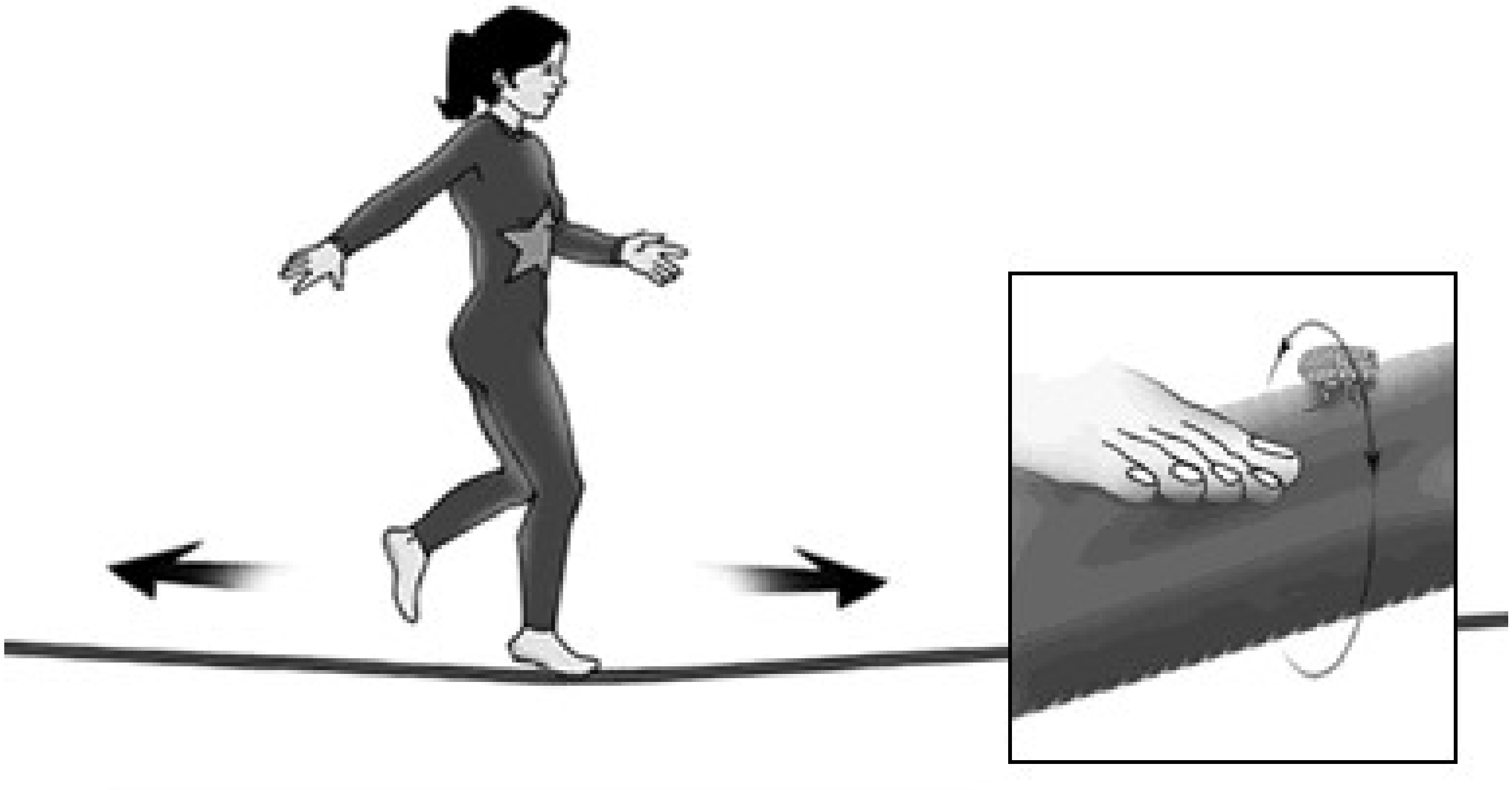
S. Campana

I. Bird

I am a researcher in experimental particle physics; not an expert in computing. Many thanks to the LCG-France Technical Coordinator (Catherine Biscarat) for explaining me a number of things.

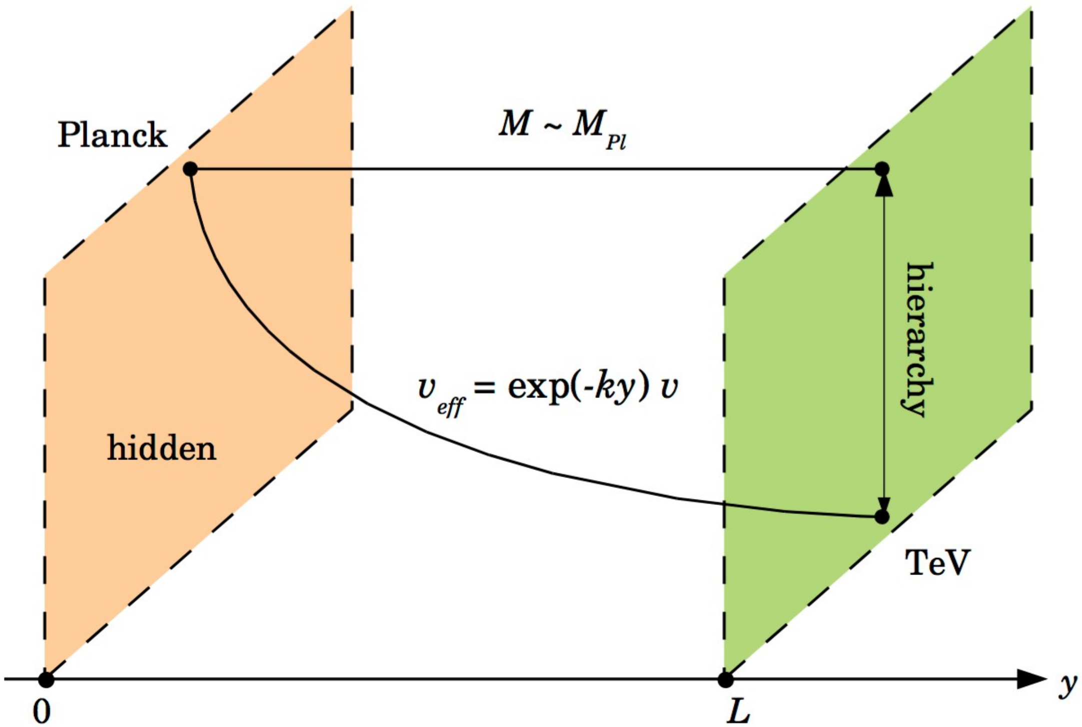
Backup slides

Extra spatial dimensions



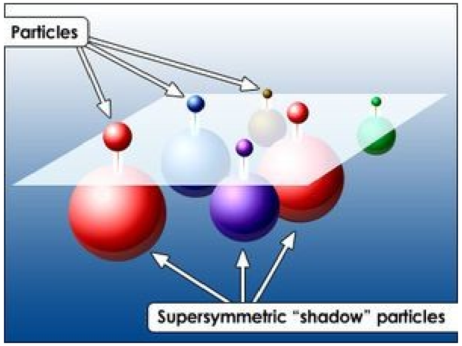
Extra spatial dimensions

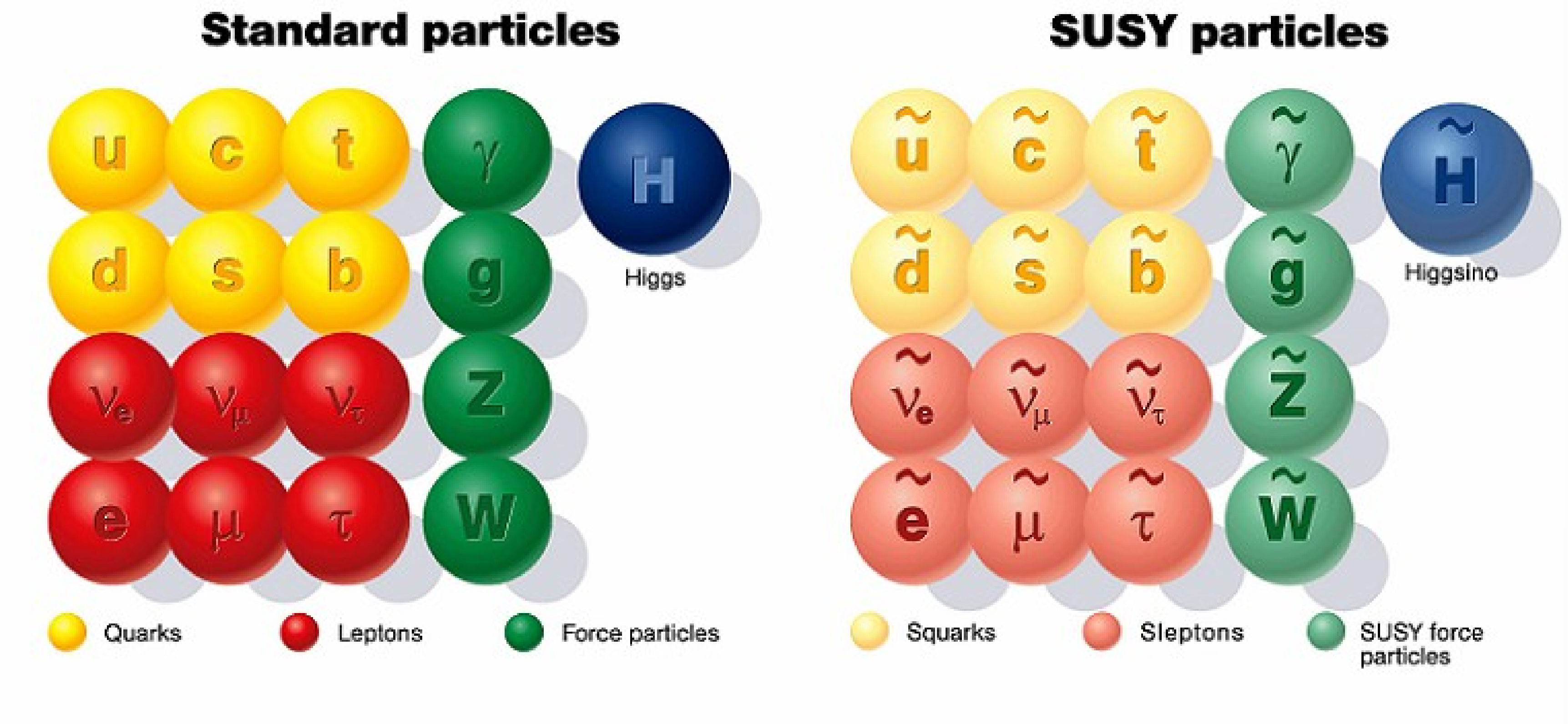
- In the Randall-Sundrum model gravity propagates in a warped extra dimension with two fixed points
- The Standard Model fields are constrained to one brane
- The gravity wave function is concentrated near the other brane, falling off exponentially across the extra dimension



$$ds^2 = e^{-2k|y|}\eta_{\mu\nu}dx^\mu dx^\nu + dy^2$$

Two times more particles ??

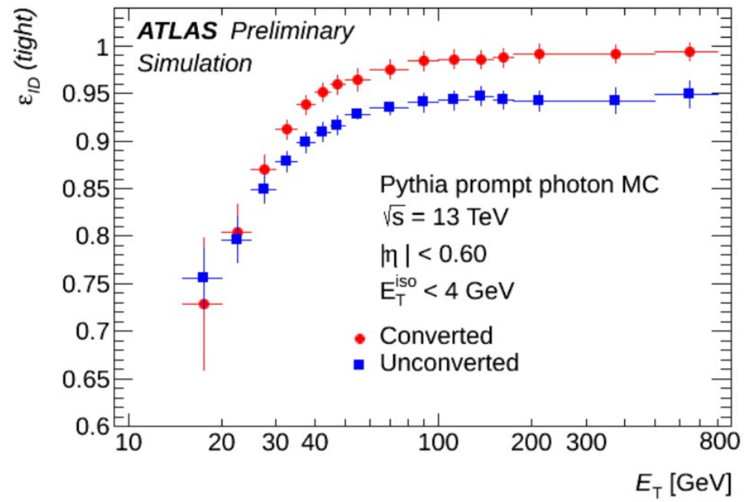




Event selection

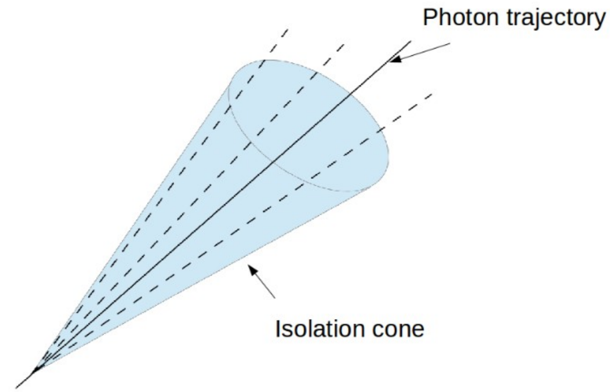
- Trigger: two γ, with $E_T^{\gamma 1} > 35$ GeV, $E_T^{\gamma 2} > 25$ GeV ($>99\%$ signal efficiency)
- Pre-selection:
  - γ quality criteria: shower shape, leakage in the hadronic calorimeter
  - $E_T^{\gamma 1} > 40$ GeV, $E_T^{\gamma 2} > 30$ GeV
  - $|\eta^{1,2}| < 2.37$, excluded $1.37 \leq |\eta| < 1.52$
- $\epsilon_{identification} = 85\%$ (90%) for unconverted (converted) γ for $E_T = 25$ GeV
- It asymptotically reaches 95% (98%) for $E_T > 200$ GeV
- γ are required to be **isolated**, i.e. to have little activity in the Inner Detector/calorimeters in a ΔR^1 cone around them

Central photon efficiency @ 13 TeV (simulation)^2



Isolation

- Calorimeter: $E_T^{iso} < 2.45 + 0.022 \cdot E_T^{\gamma}$ in $\Delta R < 0.4$
- Inner detector: $p_T^{iso} < 0.05 \cdot E_T^{\gamma}$ in $\Delta R < 0.2$



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[1] $\Delta R = \sqrt{(\Delta\eta)^2 + (\Delta\phi)^2}$

[2] EGAM-2015-002

From the ATLAS publication

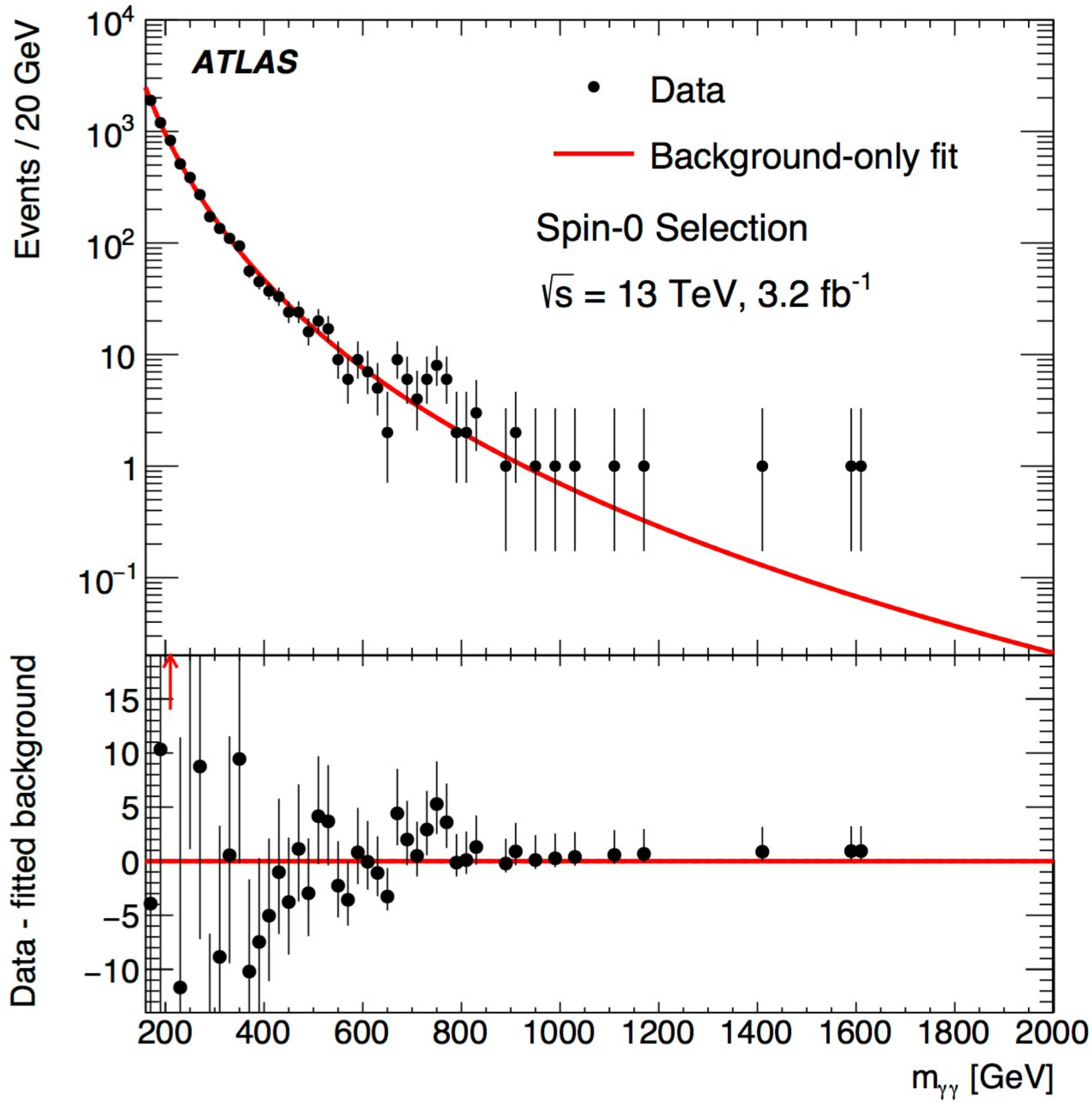
http://arxiv.org/abs/1606.03833

10 Conclusion

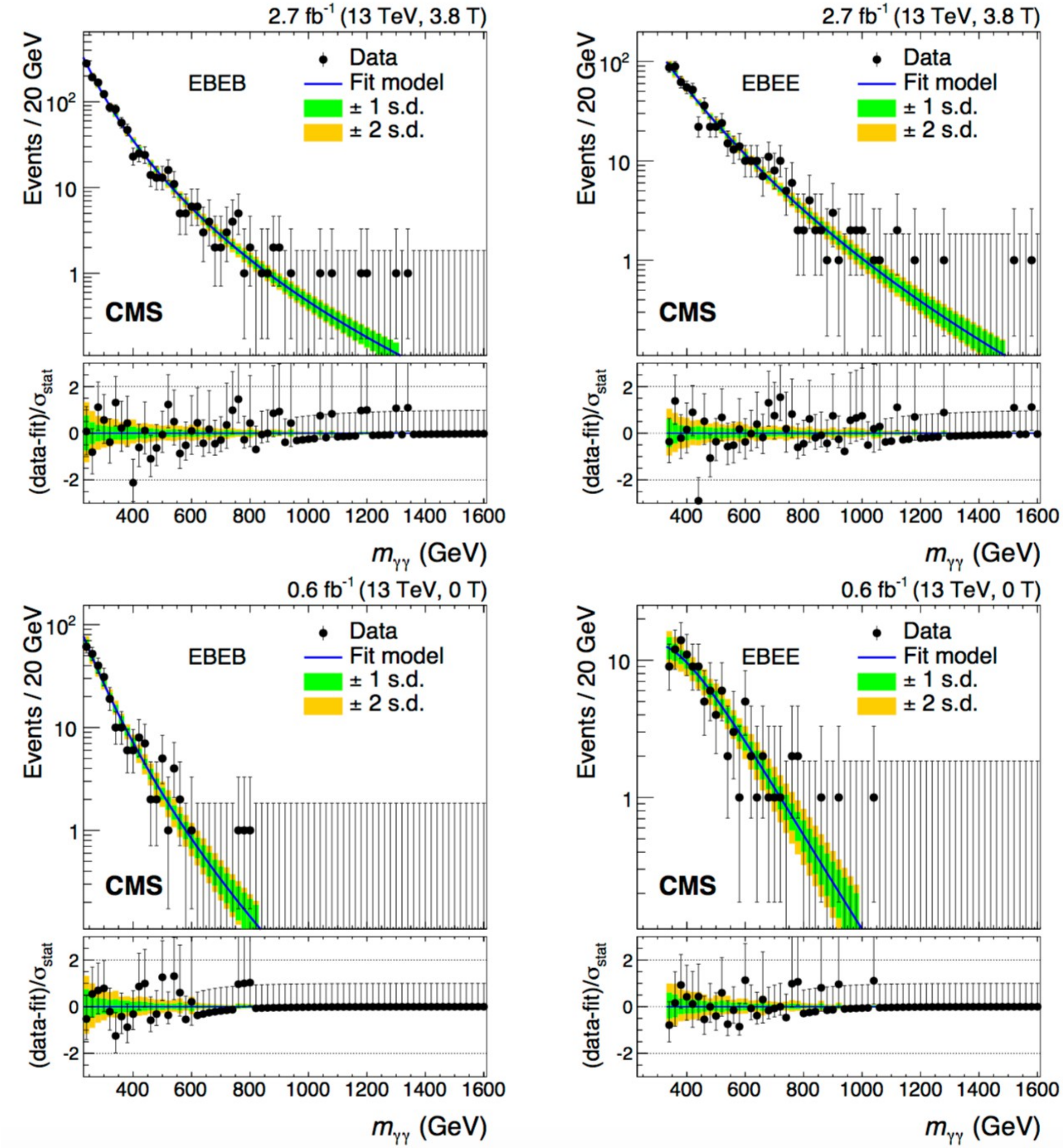
Searches for new resonances decaying into two photons in the ATLAS experiment at the LHC are presented. The *pp* collision data corresponding to an integrated luminosity of 3.2 fb^{-1} were recorded in 2015 at a centre-of-mass energy of $\sqrt{s} = 13$ TeV. Analyses optimized for the search for spin-2 Randall–Sundrum graviton resonances with mass above 500 GeV and for spin-0 resonances with mass above 200 GeV are performed. The events selected in the second analysis are a subset of the events selected for the spin-2 search.

Over most of the diphoton mass range, the data are consistent with the background-only hypothesis and 95% CL limits are derived on the cross section for the production of the two benchmark resonances as a function of their masses and widths. Varying both the mass and the decay width of the hypothesised resonance, the largest deviation from the background-only hypothesis is observed in a broad region near a mass of 750 GeV and with a width of about 50 GeV, with local significances of 3.8 and 3.9 standard deviations in the searches optimized for the spin-2 and spin-0 resonances, respectively. The global significances are estimated to be 2.1 standard deviations for both searches. When considering narrow-width signal hypotheses, the largest local significances for the two searches are observed near a mass of 770 GeV and 750 GeV with local significances corresponding to 3.3 and 2.9 standard deviations, respectively. No significant difference is observed in the properties of the events with a diphoton mass near 750 GeV compared to those at higher or lower masses. Assuming a scaling of the production cross section for an *s*-channel resonance produced by gluon fusion (light quark–antiquark annihilation), the consistency between the 13 TeV data and the data collected at 8 TeV is found to be at the level of 2.7 (3.3) standard deviations using results from the searches optimized for a spin-2 particle and at the level of 1.2 (2.1) standard deviations using results from the searches optimized for a spin-0 particle.

From the ATLAS publication



CMS



http://arxiv.org/abs/1606.04093

CMS

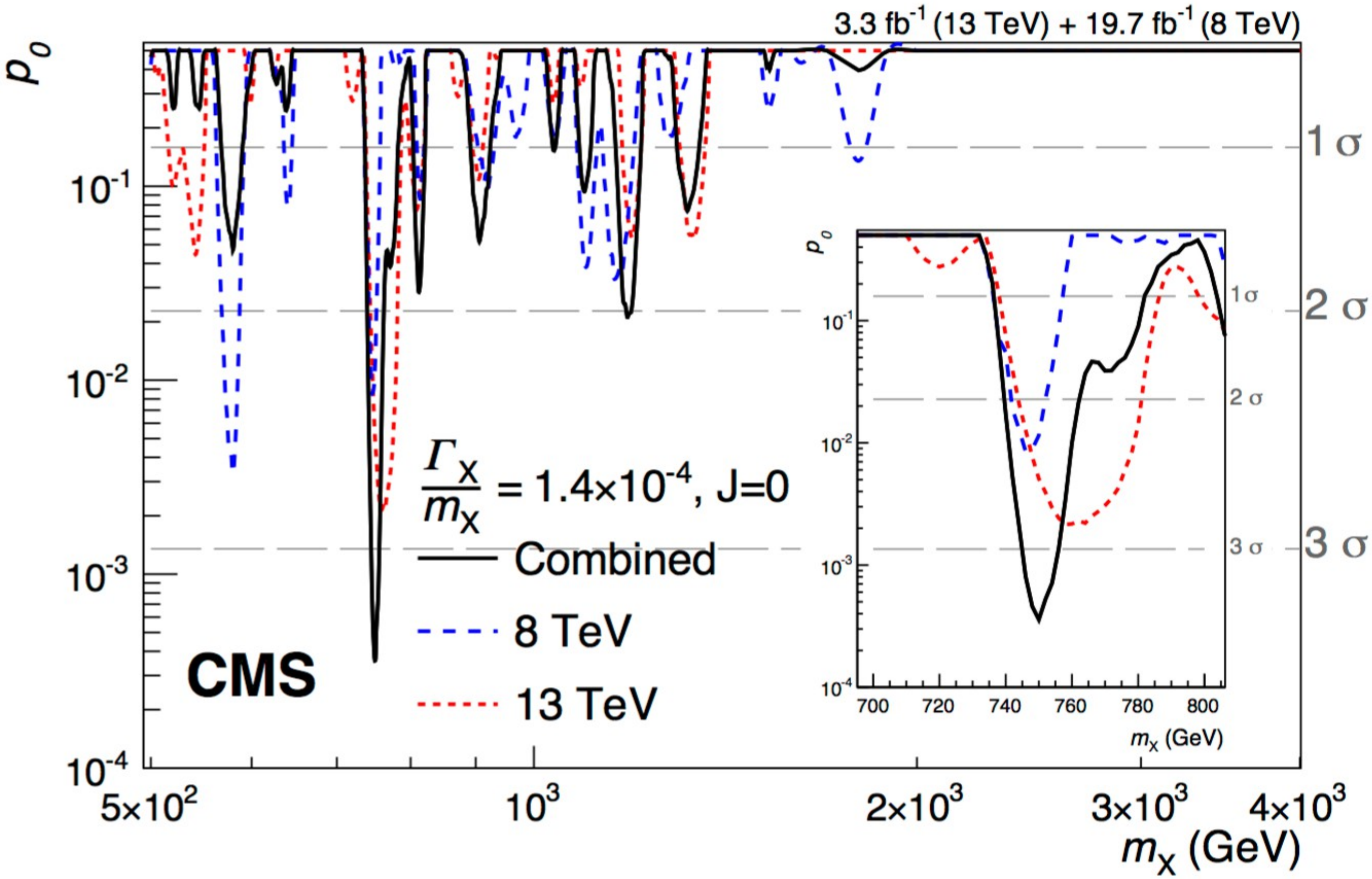
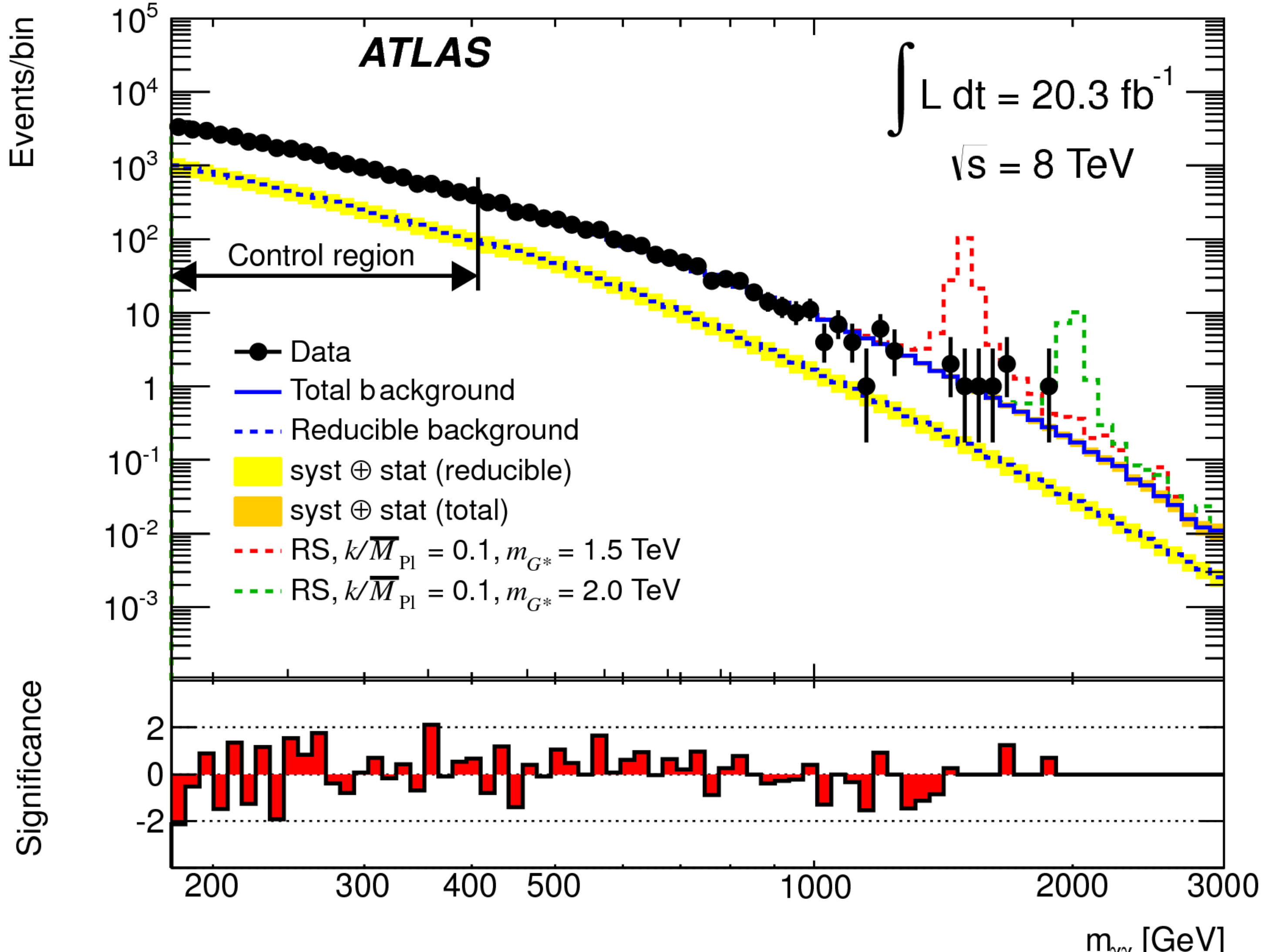
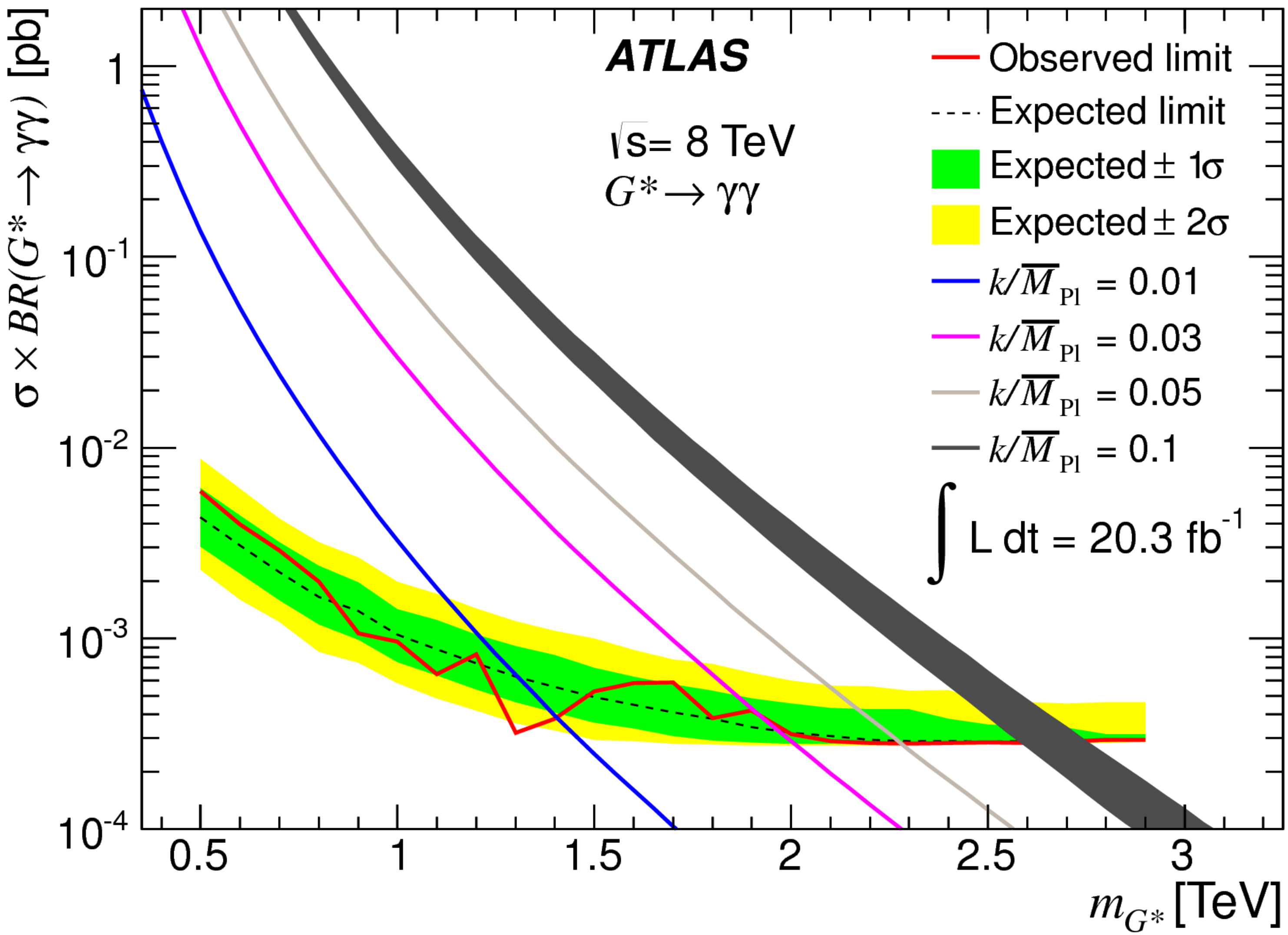


Figure 4: Observed background-only p-values for narrow-width scalar resonances as a function of the resonance mass m_X, from the combined analysis of the 8 and 13 TeV data. The results for the separate 8 and 13 TeV data sets are also shown. The inset shows an expanded region around $m_X = 750$ GeV.

ATLAS at $\sqrt{s}$ = 8 TeV



ATLAS at $\sqrt{s}$ = 8 TeV



ATLAS Exotics Searches* - 95% CL Exclusion

Status: March 2016

ATLAS Preliminary

$\int \mathcal{L}\, dt = (3.2 - 20.3)\ \mathrm{fb}^{-1}$ $\sqrt{s} = 8, 13$ TeV

	Model	ℓ, γ	Jets†	E_T^{miss}	$\int \mathcal{L}\, dt[\mathrm{fb}^{-1}]$	Limit		Reference
Extra dimensions	ADD $G_{KK} + g/q$	–	≥ 1 j	Yes	3.2	M_D 6.86 TeV	$n = 2$	Preliminary
	ADD non-resonant $\ell\ell$	2 e, μ	–	–	20.3	M_S 4.7 TeV	$n = 3$ HLZ	1407.2410
	ADD QBH $\to \ell q$	1 e, μ	1 j	–	20.3	M_{th} 5.2 TeV	$n = 6$	1311.2006
	ADD QBH	–	2 j	–	3.6	M_{th} 8.3 TeV	$n = 6$	1512.01530
	ADD BH high $\sum p_T$	≥ 1 e, μ	≥ 2 j	–	3.2	M_{th} 8.2 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	ATLAS-CONF-2016-006
	ADD BH multijet	–	≥ 3 j	–	3.6	M_{th} 9.55 TeV	$n = 6$, $M_D = 3$ TeV, rot BH	1512.02586
	RS1 $G_{KK} \to \ell\ell$	2 e, μ	–	–	20.3	G_{KK} mass 2.68 TeV	$k/\overline{M}_{Pl} = 0.1$	1405.4123
	RS1 $G_{KK} \to \gamma\gamma$	2 γ	–	–	20.3	G_{KK} mass 2.66 TeV	$k/\overline{M}_{Pl} = 0.1$	1504.05511
	Bulk RS $G_{KK} \to WW \to qq\ell\nu$	1 e, μ	1 J	Yes	3.2	G_{KK} mass 1.06 TeV	$k/\overline{M}_{Pl} = 1.0$	ATLAS-CONF-2015-075
	Bulk RS $G_{KK} \to HH \to bbbb$	–	4 b	–	3.2	G_{KK} mass 475-785 GeV	$k/\overline{M}_{Pl} = 1.0$	ATLAS-CONF-2016-017
	Bulk RS $g_{KK} \to tt$	1 e, μ	≥ 1 b, ≥ 1J/2j	Yes	20.3	g_{KK} mass 2.2 TeV	BR = 0.925	1505.07018
	2UED / RPP	1 e, μ	≥ 2 b, ≥ 4 j	Yes	3.2	KK mass 1.46 TeV	Tier (1,1), BR($A^{(1,1)} \to tt$) = 1	ATLAS-CONF-2016-013
Gauge bosons	SSM $Z' \to \ell\ell$	2 e, μ	–	–	3.2	Z' mass 3.4 TeV		ATLAS-CONF-2015-070
	SSM $Z' \to \tau\tau$	2 τ	–	–	19.5	Z' mass 2.02 TeV		1502.07177
	Leptophobic $Z' \to bb$	–	2 b	–	3.2	Z' mass 1.5 TeV		Preliminary
	SSM $W' \to \ell\nu$	1 e, μ	–	Yes	3.2	W' mass 4.07 TeV		ATLAS-CONF-2015-063
	HVT $W' \to WZ \to qq\nu\nu$ model A	0 e, μ	1 J	Yes	3.2	W' mass 1.6 TeV	$g_V = 1$	ATLAS-CONF-2015-068
	HVT $W' \to WZ \to qqqq$ model A	–	2 J	–	3.2	W' mass 1.38-1.6 TeV	$g_V = 1$	ATLAS-CONF-2015-073
	HVT $W' \to WH \to \ell\nu bb$ model B	1 e, μ	1-2 b, 1-0 j	Yes	3.2	W' mass 1.62 TeV	$g_V = 3$	ATLAS-CONF-2015-074
	HVT $Z' \to ZH \to \nu\nu bb$ model B	0 e, μ	1-2 b, 1-0 j	Yes	3.2	Z' mass 1.76 TeV	$g_V = 3$	ATLAS-CONF-2015-074
	LRSM $W'_R \to tb$	1 e, μ	2 b, 0-1 j	Yes	20.3	W' mass 1.92 TeV		1410.4103
	LRSM $W'_R \to tb$	0 e, μ	≥ 1 b, 1 J	–	20.3	W' mass 1.76 TeV		1408.0886
CI	CI $qqqq$	–	2 j	–	3.6	Λ 17.5 TeV	$\eta_{LL} = -1$	1512.01530
	CI $qq\ell\ell$	2 e, μ	–	–	3.2	Λ 23.1 TeV	$\eta_{LL} = -1$	ATLAS-CONF-2015-070
	CI $uutt$	2 e, μ (SS)	≥ 1 b, 1-4 j	Yes	20.3	Λ 4.3 TeV	$\lvert C_{LL}\rvert = 1$	1504.04605
DM	Axial-vector mediator (Dirac DM)	0 e, μ	≥ 1 j	Yes	3.2	m_A 1.0 TeV	g_q=0.25, g_χ=1.0, $m(\chi) < 140$ GeV	Preliminary
	Axial-vector mediator (Dirac DM)	0 e, μ, 1 γ	1 j	Yes	3.2	m_A 650 GeV	g_q=0.25, g_χ=1.0, $m(\chi) < 10$ GeV	Preliminary
	$ZZ\chi\chi$ EFT (Dirac DM)	0 e, μ	1 J, ≤ 1 j	Yes	3.2	M_* 550 GeV	$m(\chi) < 150$ GeV	ATLAS-CONF-2015-080
LQ	Scalar LQ 1st gen	2 e	≥ 2 j	–	3.2	LQ mass 1.07 TeV	$\beta = 1$	Preliminary
	Scalar LQ 2nd gen	2 μ	≥ 2 j	–	3.2	LQ mass 1.03 TeV	$\beta = 1$	Preliminary
	Scalar LQ 3rd gen	1 e, μ	≥ 1 b, ≥ 3 j	Yes	20.3	LQ mass 640 GeV	$\beta = 0$	1508.04735
Heavy quarks	VLQ $TT \to Ht + X$	1 e, μ	≥ 2 b, ≥ 3 j	Yes	20.3	T mass 855 GeV	T in (T,B) doublet	1505.04306
	VLQ $YY \to Wb + X$	1 e, μ	≥ 1 b, ≥ 3 j	Yes	20.3	Y mass 770 GeV	Y in (B,Y) doublet	1505.04306
	VLQ $BB \to Hb + X$	1 e, μ	≥ 2 b, ≥ 3 j	Yes	20.3	B mass 735 GeV	isospin singlet	1505.04306
	VLQ $BB \to Zb + X$	2/$\geq$3 e, μ	$\geq$2/$\geq$1 b	–	20.3	B mass 755 GeV	B in (B,Y) doublet	1409.5500
	VLQ $QQ \to WqWq$	1 e, μ	≥ 4 j	Yes	20.3	Q mass 690 GeV		1509.04261
	$T_{5/3} \to Wt$	1 e, μ	≥ 1 b, ≥ 5 j	Yes	20.3	$T_{5/3}$ mass 840 GeV		1503.05425
Excited fermions	Excited quark $q^* \to q\gamma$	1 γ	1 j	–	3.2	q^* mass 4.4 TeV	only u^* and d^*, $\Lambda = m(q^*)$	1512.05910
	Excited quark $q^* \to qg$	–	2 j	–	3.6	q^* mass 5.2 TeV	only u^* and d^*, $\Lambda = m(q^*)$	1512.01530
	Excited quark $b^* \to bg$	–	1 b, 1 j	–	3.2	b^* mass 2.1 TeV		Preliminary
	Excited quark $b^* \to Wt$	1 or 2 e, μ	1 b, 2-0 j	Yes	20.3	b^* mass 1.5 TeV	$f_g = f_L = f_R = 1$	1510.02664
	Excited lepton ℓ^*	3 e, μ	–	–	20.3	ℓ^* mass 3.0 TeV	$\Lambda = 3.0$ TeV	1411.2921
	Excited lepton ν^*	3 e, μ, τ	–	–	20.3	ν^* mass 1.6 TeV	$\Lambda = 1.6$ TeV	1411.2921
Other	LSTC $a_T \to W\gamma$	1 e, μ, 1 γ	–	Yes	20.3	a_T mass 960 GeV		1407.8150
	LRSM Majorana ν	2 e, μ	2 j	–	20.3	N^0 mass 2.0 TeV	$m(W_R) = 2.4$ TeV, no mixing	1506.06020
	Higgs triplet $H^{\pm\pm} \to \ell\ell$	2 e, μ (SS)	–	–	20.3	$H^{\pm\pm}$ mass 551 GeV	DY production, BR($H_L^{\pm\pm} \to \ell\ell$)=1	1412.0237
	Higgs triplet $H^{\pm\pm} \to \ell\tau$	3 e, μ, τ	–	–	20.3	$H^{\pm\pm}$ mass 400 GeV	DY production, BR($H_L^{\pm\pm} \to \ell\tau$)=1	1411.2921
	Monotop (non-res prod)	1 e, μ	1 b	Yes	20.3	spin-1 invisible particle mass 657 GeV	$a_{non-res} = 0.2$	1410.5404
	Multi-charged particles	–	–	–	20.3	multi-charged particle mass 785 GeV	DY production, $\lvert q\rvert = 5e$	1504.04188
	Magnetic monopoles	–	–	–	7.0	monopole mass 1.34 TeV	DY production, $\lvert g\rvert = 1 g_D$, spin 1/2	1509.08059

$\sqrt{s}$ = 8 TeV $\sqrt{s}$ = 13 TeV

10^{-1} 1   10   **Mass scale [TeV]**

*Only a selection of the available mass limits on new states or phenomena is shown. Lower bounds are specified only when explicitly not excluded.

†Small-radius (large-radius) jets are denoted by the letter j (J).

ATLAS SUSY Searches* - 95% CL Lower Limits

Status: March 2016

ATLAS Preliminary

$\sqrt{s}$ = 7, 8, 13 TeV

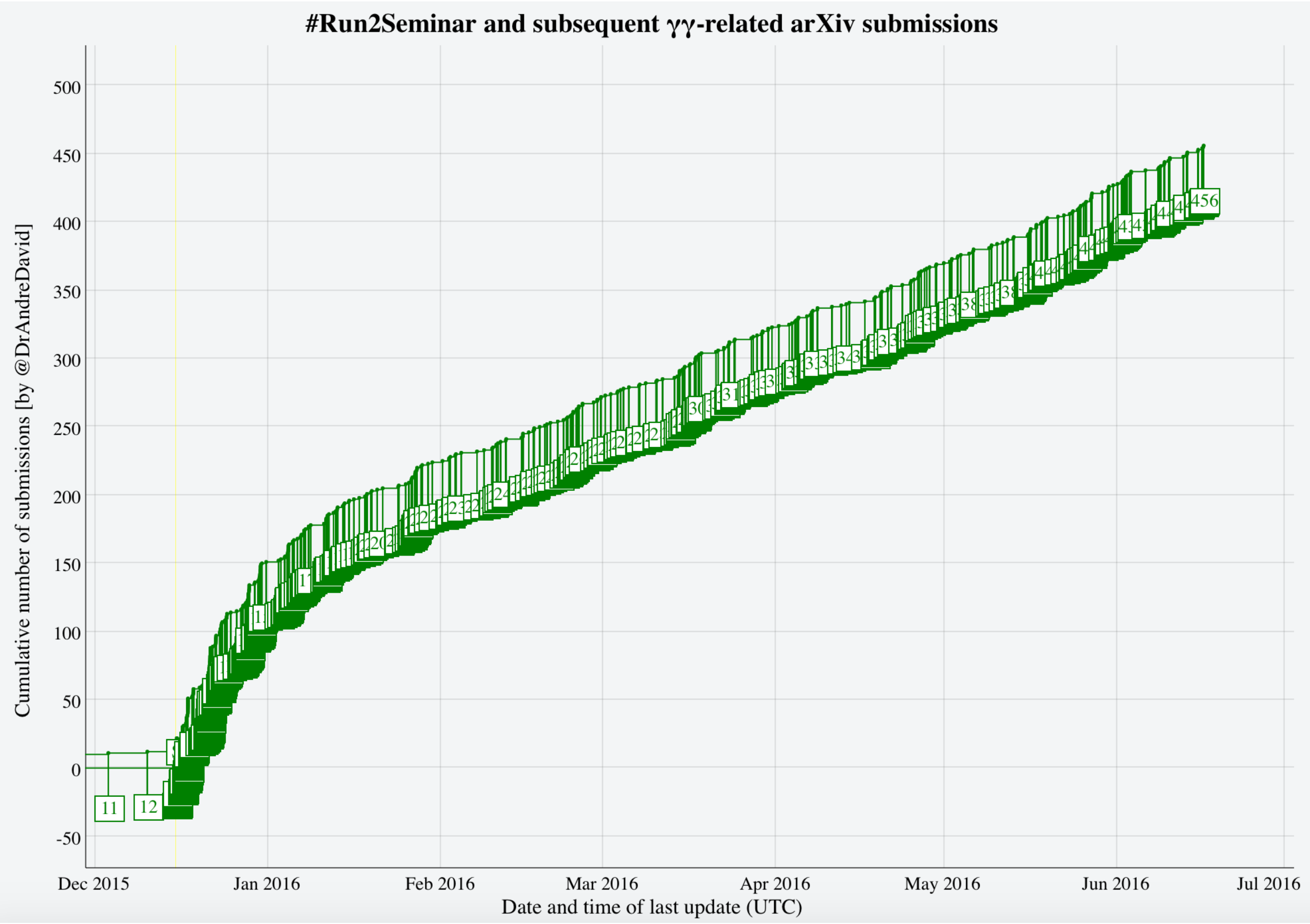
$\sqrt{s}$ = 7, 8 TeV | $\sqrt{s}$ = 13 TeV

	Model	e, μ, τ, γ	Jets	E_T^{miss}	$\int \mathcal{L}\, dt [fb^{-1}]$	Mass limit			Reference
Inclusive Searches	MSUGRA/CMSSM	0-3 e,μ/1-2 τ	2-10 jets/3 b	Yes	20.3	$\tilde{q}, \tilde{g}$	1.85 TeV	$m(\tilde{q})$=$m(\tilde{g})$	1507.05525
	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}^0_1$	0	2-6 jets	Yes	3.2	$\tilde{q}$	980 GeV	$m(\tilde{\chi}^0_1)$=0 GeV, m(1st gen. $\tilde{q}$)=m(2nd gen. $\tilde{q}$)	ATLAS-CONF-2015-062
	$\tilde{q}\tilde{q}, \tilde{q}\to q\tilde{\chi}^0_1$ (compressed)	mono-jet	1-3 jets	Yes	3.2	$\tilde{q}$	610 GeV	$m(\tilde{q})$-$m(\tilde{\chi}^0_1)$<5 GeV	*To appear*
	$\tilde{q}\tilde{q}, \tilde{q}\to q(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}^0_1$	2 e,μ (off-Z)	2 jets	Yes	20.3	$\tilde{q}$	820 GeV	$m(\tilde{\chi}^0_1)$=0 GeV	1503.03290
	$\tilde{g}\tilde{g}, \tilde{g}\to q\bar{q}\tilde{\chi}^0_1$	0	2-6 jets	Yes	3.2	$\tilde{g}$	1.52 TeV	$m(\tilde{\chi}^0_1)$=0 GeV	ATLAS-CONF-2015-062
	$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}^{\pm}_1\to qqW^{\pm}\tilde{\chi}^0_1$	1 e,μ	2-6 jets	Yes	3.3	$\tilde{g}$	1.6 TeV	$m(\tilde{\chi}^0_1)$<350 GeV, $m(\tilde{\chi}^{\pm})$=0.5($m(\tilde{\chi}^0_1)$+$m(\tilde{g})$)	ATLAS-CONF-2015-076
	$\tilde{g}\tilde{g}, \tilde{g}\to qq(\ell\ell/\ell\nu/\nu\nu)\tilde{\chi}^0_1$	2 e,μ	0-3 jets	-	20	$\tilde{g}$	1.38 TeV	$m(\tilde{\chi}^0_1)$=0 GeV	1501.03555
	$\tilde{g}\tilde{g}, \tilde{g}\to qqWZ\tilde{\chi}^0_1$	0	7-10 jets	Yes	3.2	$\tilde{g}$	1.4 TeV	$m(\tilde{\chi}^0_1)$ =100 GeV	1602.06194
	GMSB ($\tilde{\ell}$ NLSP)	1-2 τ + 0-1 ℓ	0-2 jets	Yes	20.3	$\tilde{g}$	1.63 TeV	tanβ >20	1407.0603
	GGM (bino NLSP)	2 γ	-	Yes	20.3	$\tilde{g}$	1.34 TeV	$c\tau$(NLSP)<0.1 mm	1507.05493
	GGM (higgsino-bino NLSP)	γ	1 b	Yes	20.3	$\tilde{g}$	1.37 TeV	$m(\tilde{\chi}^0_1)$<950 GeV, $c\tau$(NLSP)<0.1 mm, μ<0	1507.05493
	GGM (higgsino-bino NLSP)	γ	2 jets	Yes	20.3	$\tilde{g}$	1.3 TeV	$m(\tilde{\chi}^0_1)$<850 GeV, $c\tau$(NLSP)<0.1 mm, μ>0	1507.05493
	GGM (higgsino NLSP)	2 e,μ (Z)	2 jets	Yes	20.3	$\tilde{g}$	900 GeV	m(NLSP)>430 GeV	1503.03290
	Gravitino LSP	0	mono-jet	Yes	20.3	$F^{1/2}$ scale	865 GeV	$m(\tilde{G})$>1.8 × 10^{-4} eV, $m(\tilde{g})$=$m(\tilde{q})$=1.5 TeV	1502.01518
3rd gen. $\tilde{g}$ med.	$\tilde{g}\tilde{g}, \tilde{g}\to b\bar{b}\tilde{\chi}^0_1$	0	3 b	Yes	3.3	$\tilde{g}$	1.78 TeV	$m(\tilde{\chi}^0_1)$<800 GeV	ATLAS-CONF-2015-067
	$\tilde{g}\tilde{g}, \tilde{g}\to t\bar{t}\tilde{\chi}^0_1$	0-1 e,μ	3 b	Yes	3.3	$\tilde{g}$	1.76 TeV	$m(\tilde{\chi}^0_1)$=0 GeV	*To appear*
	$\tilde{g}\tilde{g}, \tilde{g}\to b\bar{t}\tilde{\chi}^+_1$	0-1 e,μ	3 b	Yes	20.1	$\tilde{g}$	1.37 TeV	$m(\tilde{\chi}^0_1)$<300 GeV	1407.0600
3rd gen. squarks direct production	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to b\tilde{\chi}^0_1$	0	2 b	Yes	3.2	$\tilde{b}_1$	840 GeV	$m(\tilde{\chi}^0_1)$<100 GeV	ATLAS-CONF-2015-066
	$\tilde{b}_1\tilde{b}_1, \tilde{b}_1\to t\tilde{\chi}^{\pm}_1$	2 e,μ (SS)	0-3 b	Yes	3.2	$\tilde{b}_1$	325-540 GeV	$m(\tilde{\chi}^0_1)$=50 GeV, $m(\tilde{\chi}^{\pm}_1)$= $m(\tilde{\chi}^0_1)$+100 GeV	1602.09058
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to b\tilde{\chi}^{\pm}_1$	1-2 e,μ	1-2 b	Yes	4.7/20.3	$\tilde{t}_1$	117-170 GeV; 200-500 GeV	$m(\tilde{\chi}^{\pm}_1)$ = 2$m(\tilde{\chi}^0_1)$, $m(\tilde{\chi}^0_1)$=55 GeV	1209.2102, 1407.0583
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to Wb\tilde{\chi}^0_1$ or $t\tilde{\chi}^0_1$	0-2 e,μ	0-2 jets/1-2 b	Yes	20.3	$\tilde{t}_1$	90-198 GeV; 205-715 GeV; 745-785 GeV	$m(\tilde{\chi}^0_1)$=1 GeV	1506.08616, ATLAS-CONF-2016-007
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to c\tilde{\chi}^0_1$	0	mono-jet/c-tag	Yes	20.3	$\tilde{t}_1$	90-245 GeV	$m(\tilde{t}_1)$-$m(\tilde{\chi}^0_1)$<85 GeV	1407.0608
	$\tilde{t}_1\tilde{t}_1$(natural GMSB)	2 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_1$	150-600 GeV	$m(\tilde{\chi}^0_1)$>150 GeV	1403.5222
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1 + Z$	3 e,μ (Z)	1 b	Yes	20.3	$\tilde{t}_2$	290-610 GeV	$m(\tilde{\chi}^0_1)$<200 GeV	1403.5222
	$\tilde{t}_2\tilde{t}_2, \tilde{t}_2\to\tilde{t}_1 + h$	1 e,μ	6 jets + 2 b	Yes	20.3	$\tilde{t}_2$	320-620 GeV	$m(\tilde{\chi}^0_1)$=0 GeV	1506.08616
EW direct	$\tilde{\ell}_{L,R}\tilde{\ell}_{L,R}, \tilde{\ell}\to\ell\tilde{\chi}^0_1$	2 e,μ	0	Yes	20.3	$\tilde{\ell}$	90-335 GeV	$m(\tilde{\chi}^0_1)$=0 GeV	1403.5294
	$\tilde{\chi}^+_1\tilde{\chi}^-_1, \tilde{\chi}^+_1\to\tilde{\ell}\nu(\ell\tilde{\nu})$	2 e,μ	0	Yes	20.3	$\tilde{\chi}^{\pm}_1$	140-475 GeV	$m(\tilde{\chi}^0_1)$=0 GeV, $m(\tilde{\ell},\tilde{\nu})$=0.5($m(\tilde{\chi}^{\pm}_1)$+$m(\tilde{\chi}^0_1)$)	1403.5294
	$\tilde{\chi}^+_1\tilde{\chi}^-_1, \tilde{\chi}^+_1\to\tilde{\tau}\nu(\tau\tilde{\nu})$	2 τ	-	Yes	20.3	$\tilde{\chi}^{\pm}_1$	355 GeV	$m(\tilde{\chi}^0_1)$=0 GeV, $m(\tilde{\tau},\tilde{\nu})$=0.5($m(\tilde{\chi}^{\pm}_1)$+$m(\tilde{\chi}^0_1)$)	1407.0350
	$\tilde{\chi}^{\pm}_1\tilde{\chi}^0_2\to\tilde{\ell}_L\nu\tilde{\ell}_L\ell(\tilde{\nu}\nu), \ell\tilde{\nu}\tilde{\ell}_L\ell(\tilde{\nu}\nu)$	3 e,μ	0	Yes	20.3	$\tilde{\chi}^{\pm}_1, \tilde{\chi}^0_2$	715 GeV	$m(\tilde{\chi}^{\pm}_1)$=$m(\tilde{\chi}^0_2)$, $m(\tilde{\chi}^0_1)$=0, $m(\tilde{\ell},\tilde{\nu})$=0.5($m(\tilde{\chi}^{\pm}_1)$+$m(\tilde{\chi}^0_1)$)	1402.7029
	$\tilde{\chi}^{\pm}_1\tilde{\chi}^0_2\to W\tilde{\chi}^0_1 Z\tilde{\chi}^0_1$	2-3 e,μ	0-2 jets	Yes	20.3	$\tilde{\chi}^{\pm}_1, \tilde{\chi}^0_2$	425 GeV	$m(\tilde{\chi}^{\pm}_1)$=$m(\tilde{\chi}^0_2)$, $m(\tilde{\chi}^0_1)$=0, sleptons decoupled	1403.5294, 1402.7029
	$\tilde{\chi}^{\pm}_1\tilde{\chi}^0_2\to W\tilde{\chi}^0_1 h\tilde{\chi}^0_1, h\to b\bar{b}/WW/\tau\tau/\gamma\gamma$	e,μ,γ	0-2 b	Yes	20.3	$\tilde{\chi}^{\pm}_1, \tilde{\chi}^0_2$	270 GeV	$m(\tilde{\chi}^{\pm}_1)$=$m(\tilde{\chi}^0_2)$, $m(\tilde{\chi}^0_1)$=0, sleptons decoupled	1501.07110
	$\tilde{\chi}^0_2\tilde{\chi}^0_3, \tilde{\chi}^0_{2,3}\to\tilde{\ell}_R\ell$	4 e,μ	0	Yes	20.3	$\tilde{\chi}^0_{2,3}$	635 GeV	$m(\tilde{\chi}^0_2)$=$m(\tilde{\chi}^0_3)$, $m(\tilde{\chi}^0_1)$=0, $m(\tilde{\ell},\tilde{\nu})$=0.5($m(\tilde{\chi}^0_2)$+$m(\tilde{\chi}^0_1)$)	1405.5086
	GGM (wino NLSP) weak prod.	1 e,μ + γ	-	Yes	20.3	$\tilde{W}$	115-370 GeV	$c\tau$<1 mm	1507.05493
Long-lived particles	Direct $\tilde{\chi}^+_1\tilde{\chi}^-_1$ prod., long-lived $\tilde{\chi}^{\pm}_1$	Disapp. trk	1 jet	Yes	20.3	$\tilde{\chi}^{\pm}_1$	270 GeV	$m(\tilde{\chi}^{\pm}_1)$-$m(\tilde{\chi}^0_1)$~160 MeV, $\tau(\tilde{\chi}^{\pm}_1)$=0.2 ns	1310.3675
	Direct $\tilde{\chi}^+_1\tilde{\chi}^-_1$ prod., long-lived $\tilde{\chi}^{\pm}_1$	dE/dx trk	-	Yes	18.4	$\tilde{\chi}^{\pm}_1$	495 GeV	$m(\tilde{\chi}^{\pm}_1)$-$m(\tilde{\chi}^0_1)$~160 MeV, $\tau(\tilde{\chi}^{\pm}_1)$<15 ns	1506.05332
	Stable, stopped $\tilde{g}$ R-hadron	0	1-5 jets	Yes	27.9	$\tilde{g}$	850 GeV	$m(\tilde{\chi}^0_1)$=100 GeV, 10 μs<$\tau(\tilde{g})$<1000 s	1310.6584
	Metastable $\tilde{g}$ R-hadron	dE/dx trk	-	-	3.2	$\tilde{g}$	1.54 TeV	$m(\tilde{\chi}^0_1)$=100 GeV, τ>10 ns	*To appear*
	GMSB, stable $\tilde{\tau}, \tilde{\chi}^0_1\to\tilde{\tau}(\tilde{e},\tilde{\mu})+\tau(e,\mu)$	1-2 μ	-	-	19.1	$\tilde{\chi}^0_1$	537 GeV	10<tanβ<50	1411.6795
	GMSB, $\tilde{\chi}^0_1\to\gamma\tilde{G}$, long-lived $\tilde{\chi}^0_1$	2 γ	-	Yes	20.3	$\tilde{\chi}^0_1$	440 GeV	1<$\tau(\tilde{\chi}^0_1)$<3 ns, SPS8 model	1409.5542
	$\tilde{g}\tilde{g}, \tilde{\chi}^0_1\to ee\nu/e\mu\nu/\mu\mu\nu$	displ. $ee/e\mu/\mu\mu$	-	-	20.3	$\tilde{\chi}^0_1$	1.0 TeV	7 <$c\tau(\tilde{\chi}^0_1)$< 740 mm, $m(\tilde{g})$=1.3 TeV	1504.05162
	GGM $\tilde{g}\tilde{g}, \tilde{\chi}^0_1\to Z\tilde{G}$	displ. vtx + jets	-	-	20.3	$\tilde{\chi}^0_1$	1.0 TeV	6 <$c\tau(\tilde{\chi}^0_1)$< 480 mm, $m(\tilde{g})$=1.1 TeV	1504.05162
RPV	LFV $pp\to\tilde{\nu}_\tau + X, \tilde{\nu}_\tau\to e\mu/e\tau/\mu\tau$	$e\mu,e\tau,\mu\tau$	-	-	20.3	$\tilde{\nu}_\tau$	1.7 TeV	λ'_{311}=0.11, $\lambda_{132/133/233}$=0.07	1503.04430
	Bilinear RPV CMSSM	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{q}, \tilde{g}$	1.45 TeV	$m(\tilde{q})$=$m(\tilde{g})$, $c\tau_{LSP}$<1 mm	1404.2500
	$\tilde{\chi}^+_1\tilde{\chi}^-_1, \tilde{\chi}^+_1\to W\tilde{\chi}^0_1, \tilde{\chi}^0_1\to ee\tilde{\nu}_\mu, e\mu\tilde{\nu}_e$	4 e,μ	-	Yes	20.3	$\tilde{\chi}^{\pm}_1$	760 GeV	$m(\tilde{\chi}^0_1)$>0.2×$m(\tilde{\chi}^{\pm}_1)$, $\lambda_{121}\neq0$	1405.5086
	$\tilde{\chi}^+_1\tilde{\chi}^-_1, \tilde{\chi}^+_1\to W\tilde{\chi}^0_1, \tilde{\chi}^0_1\to\tau\tau\tilde{\nu}_e, e\tau\tilde{\nu}_\tau$	3 e,μ + τ	-	Yes	20.3	$\tilde{\chi}^{\pm}_1$	450 GeV	$m(\tilde{\chi}^0_1)$>0.2×$m(\tilde{\chi}^{\pm}_1)$, $\lambda_{133}\neq0$	1405.5086
	$\tilde{g}\tilde{g}, \tilde{g}\to qqq$	0	6-7 jets	-	20.3	$\tilde{g}$	917 GeV	BR(t)=BR(b)=BR(c)=0%	1502.05686
	$\tilde{g}\tilde{g}, \tilde{g}\to qq\tilde{\chi}^0_1, \tilde{\chi}^0_1\to qqq$	0	6-7 jets	-	20.3	$\tilde{g}$	980 GeV	$m(\tilde{\chi}^0_1)$=600 GeV	1502.05686
	$\tilde{g}\tilde{g}, \tilde{g}\to\tilde{t}_1 t, \tilde{t}_1\to bs$	2 e,μ (SS)	0-3 b	Yes	20.3	$\tilde{g}$	880 GeV		1404.2500
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to bs$	0	2 jets + 2 b	-	20.3	$\tilde{t}_1$	320 GeV		1601.07453
	$\tilde{t}_1\tilde{t}_1, \tilde{t}_1\to b\ell$	2 e,μ	2 b	-	20.3	$\tilde{t}_1$	0.4-1.0 TeV	BR($\tilde{t}_1\to be/\mu$)>20%	ATLAS-CONF-2015-015
Other	Scalar charm, $\tilde{c}\to c\tilde{\chi}^0_1$	0	2 c	Yes	20.3	$\tilde{c}$	510 GeV	$m(\tilde{\chi}^0_1)$<200 GeV	1501.01325

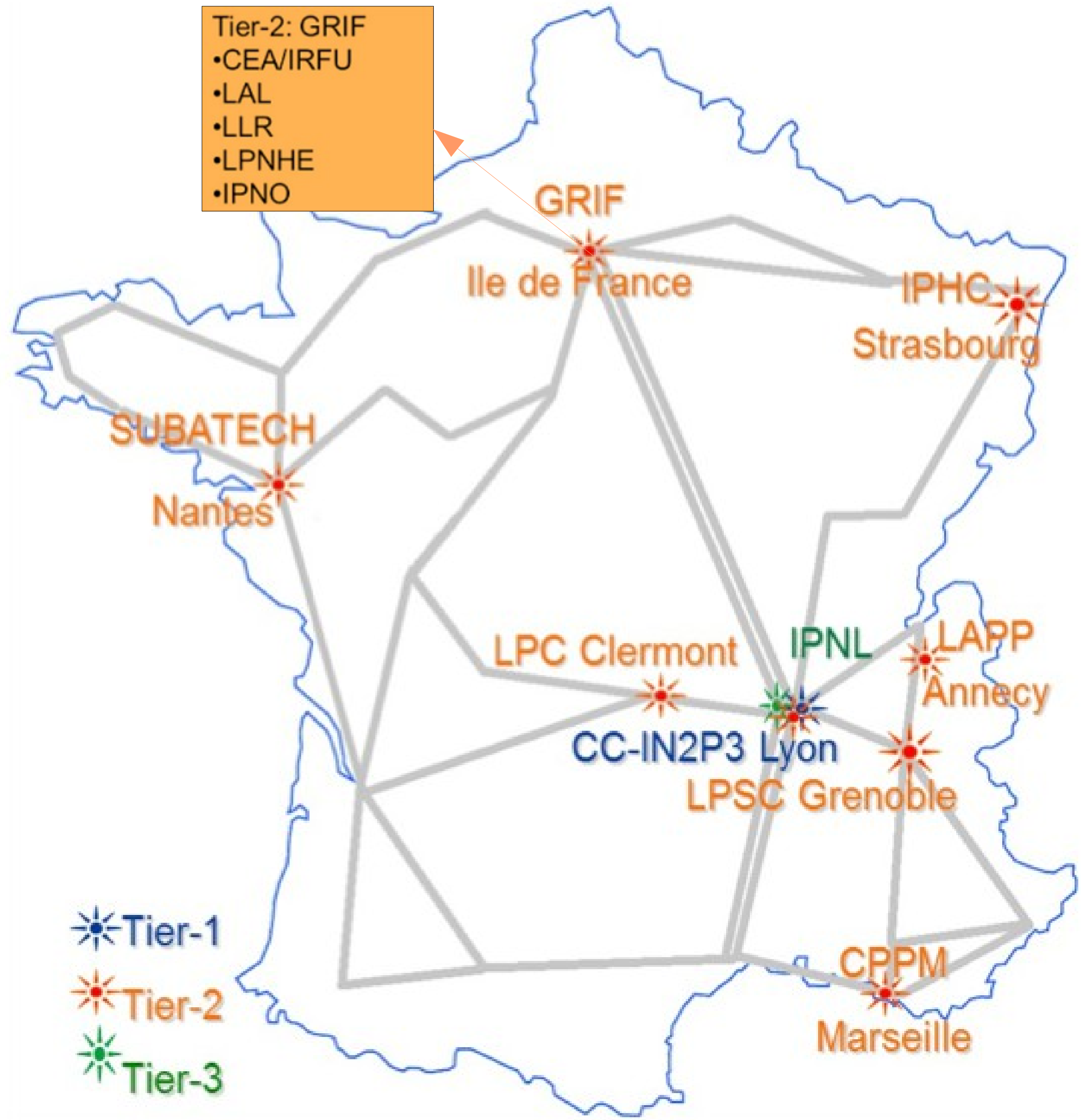
10^{-1} — 1 — Mass scale [TeV]

*Only a selection of the available mass limits on new states or phenomena is shown.

Excitement


#Run2Seminar and subsequent γγ-related arXiv submissions
Cumulative number of submissions [by @DrAndreDavid]
500
450
400
350
300
250
200
150
100
50
0
-50
Dec 2015
Jan 2016
Feb 2016
Mar 2016
Apr 2016
May 2016
Jun 2016
Jul 2016
Date and time of last update (UTC)
11
12
456

Sites WLCG en France

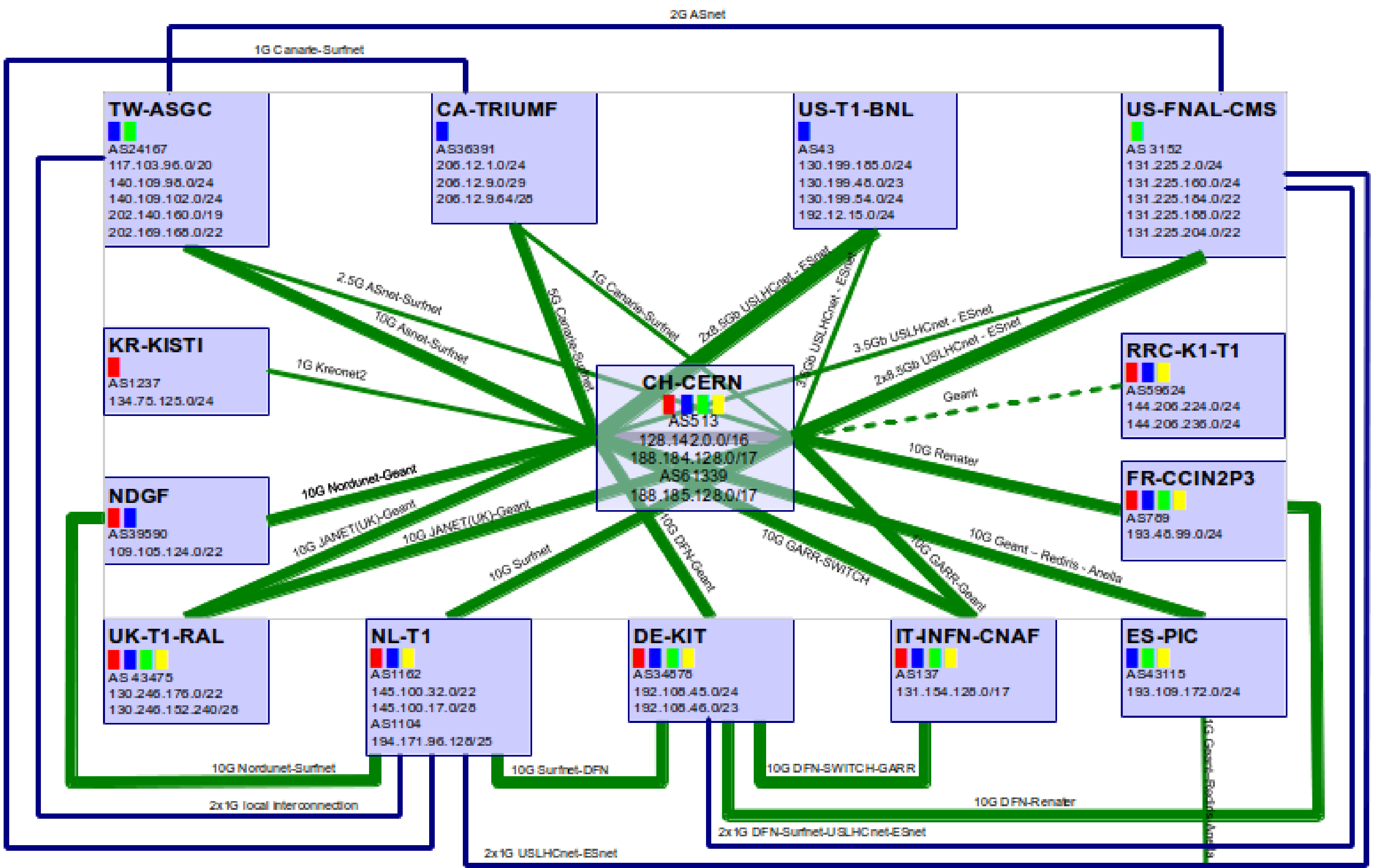


Role	Site	ALICE	ATLAS	CMS	LHCb
Tier-1	IN2P3-CC	✓	✓	✓	✓
Tier-2	IN2P3-CC-T2 (AF)			✓	
	IN2P3-CPPM		✓		✓
	GRIF	✓	✓	✓	✓
	IN2P3-LPC	✓	✓		✓
	IN2P3-IPHC	✓		✓	
	IN2P3-LAPP		✓		✓
	IN2P3-LPSC	✓	✓		
	IN2P3-SUBATECH	✓			
Tier-3	IN2P3-IPNL	✓		✓	

Accords sites/CERN pour une haute disponibilité (>98% pour le T1, 7/24)

LHC Optical Private Network (T0-T1)

Agreements to provide back-up links between T1s



T0-T1 and T1-T1 traffic
T1-T1 traffic only
Not deployed yet
(thick) >=10Gbps
(thin) <10Gbps

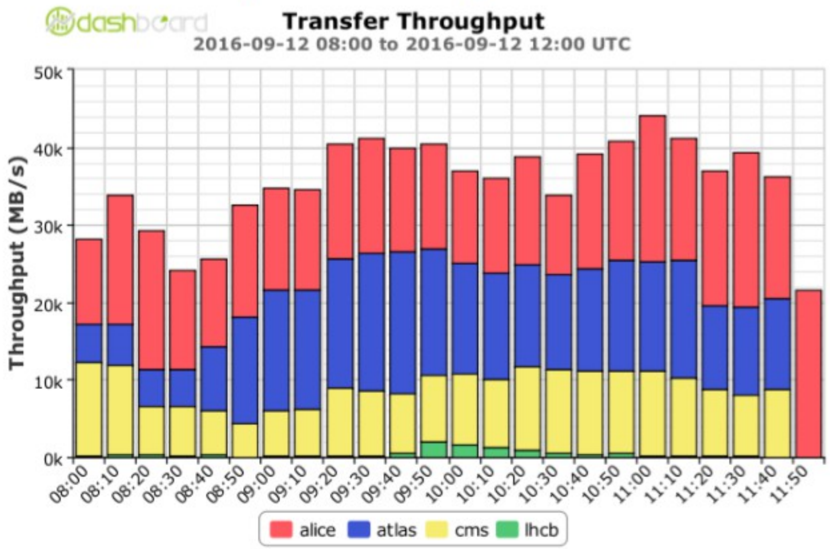
■ = Alice ■ = Atlas
■ = CMS ■ = LHCb

p2p prefix: 192.16.166.0/24
edoardo.martelli@cern.ch 20131113

- Dedicated and redundant links
- T0->FR_T1: nominal ~225 MB/s

Data distribution

- Global transfer rates increased to > 40 GB/s (=2 x Run1)



Monthly traffic growth on LHCONE

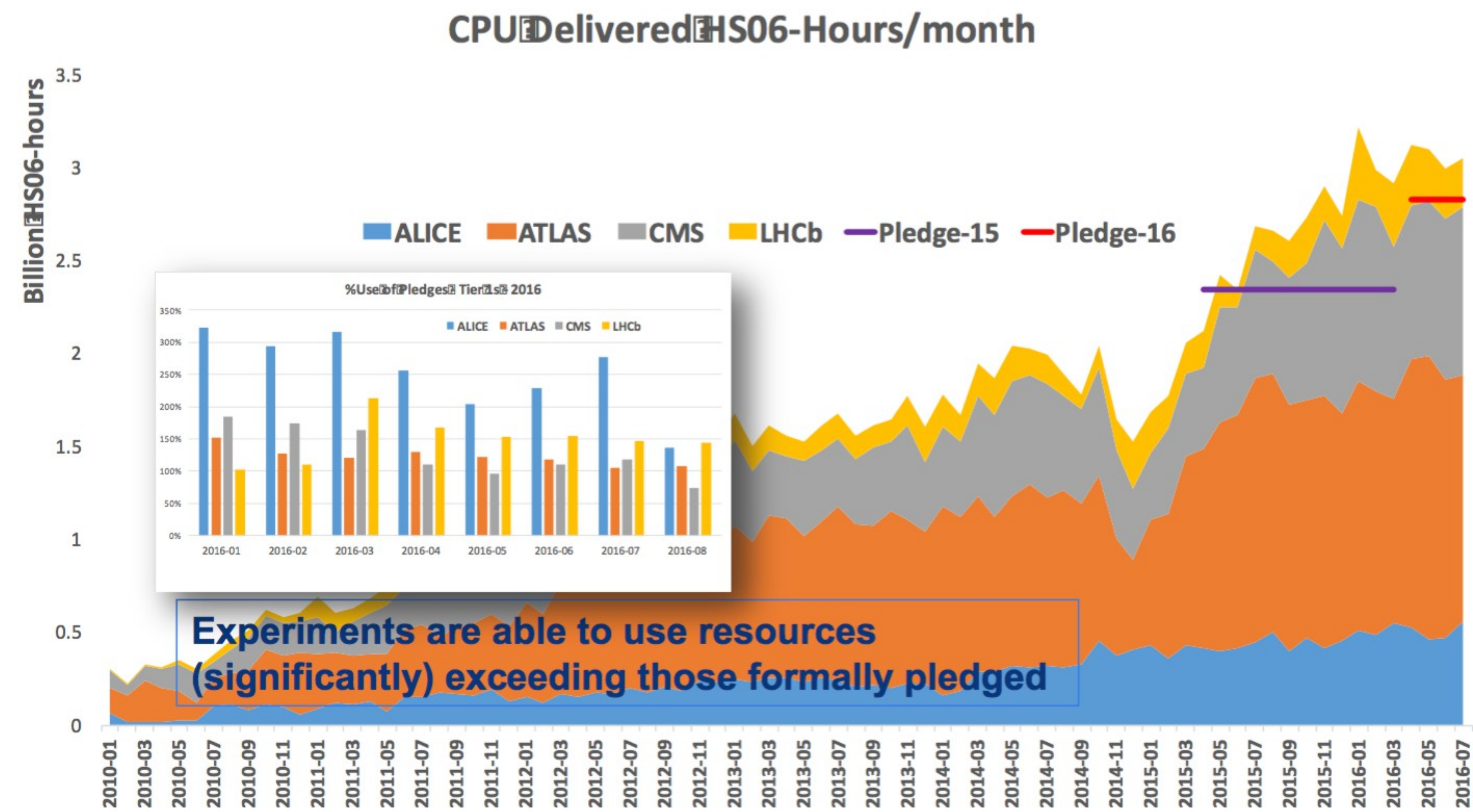
Increased performance everywhere:

- Data acquisition >10PB / month
- Data transfer rates > 40 GB/s globally

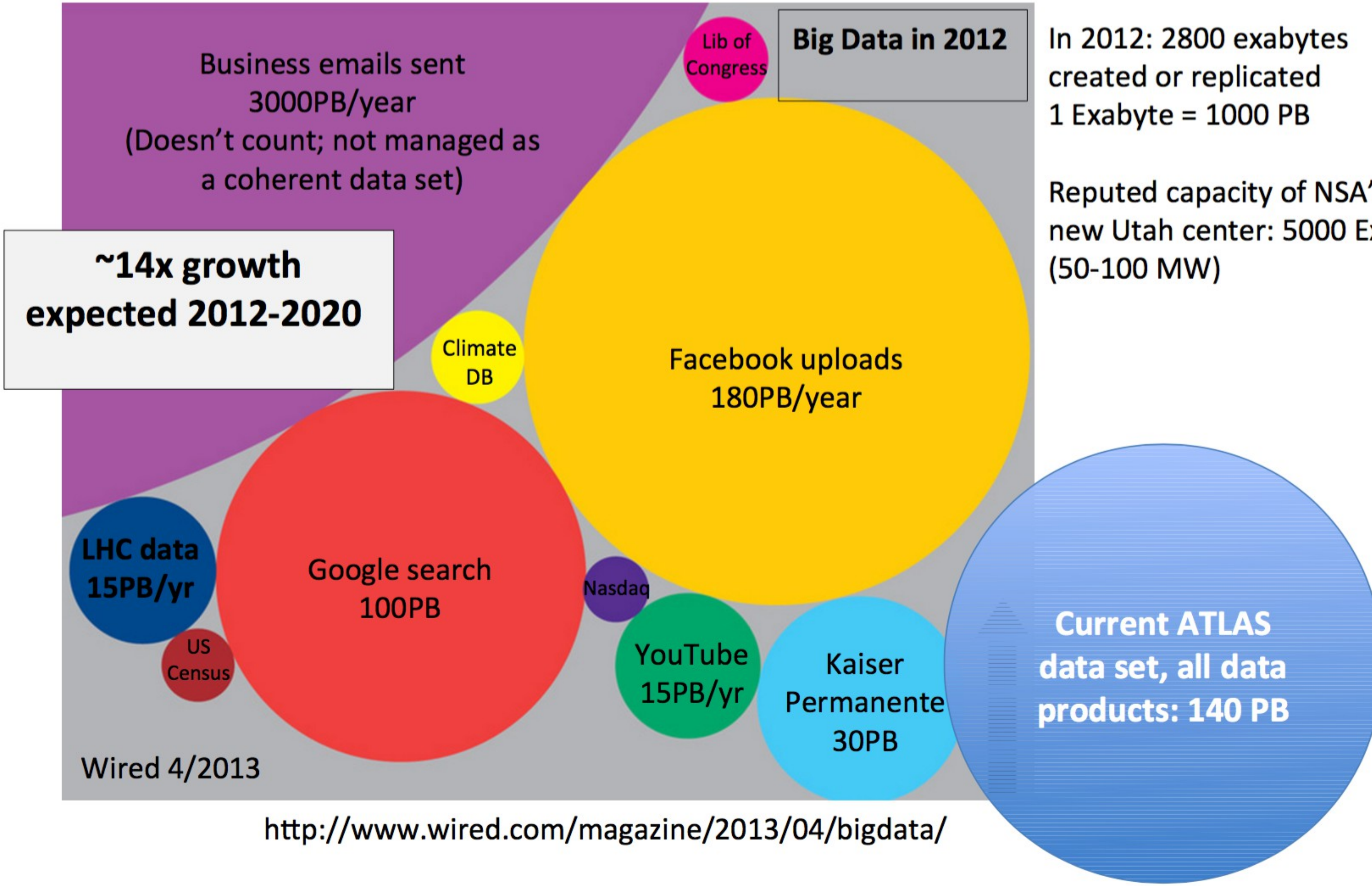
Several Tier 1s have increased network bandwidth to CERN to manage new data rates;
GEANT has deployed additional capacity for LHC

Regular transfers of 80 PB/month with 100 PB/month during July-Aug (many billions of files)

CPU delivered to the experiments



Data set sizes in perspective

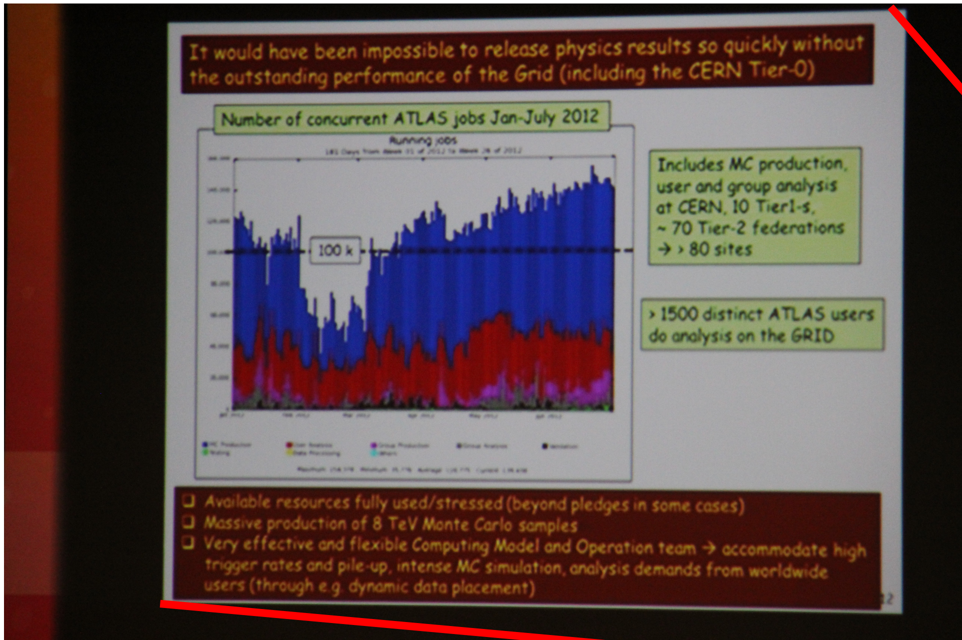


In 2012: 2800 exabytes created or replicated
1 Exabyte = 1000 PB

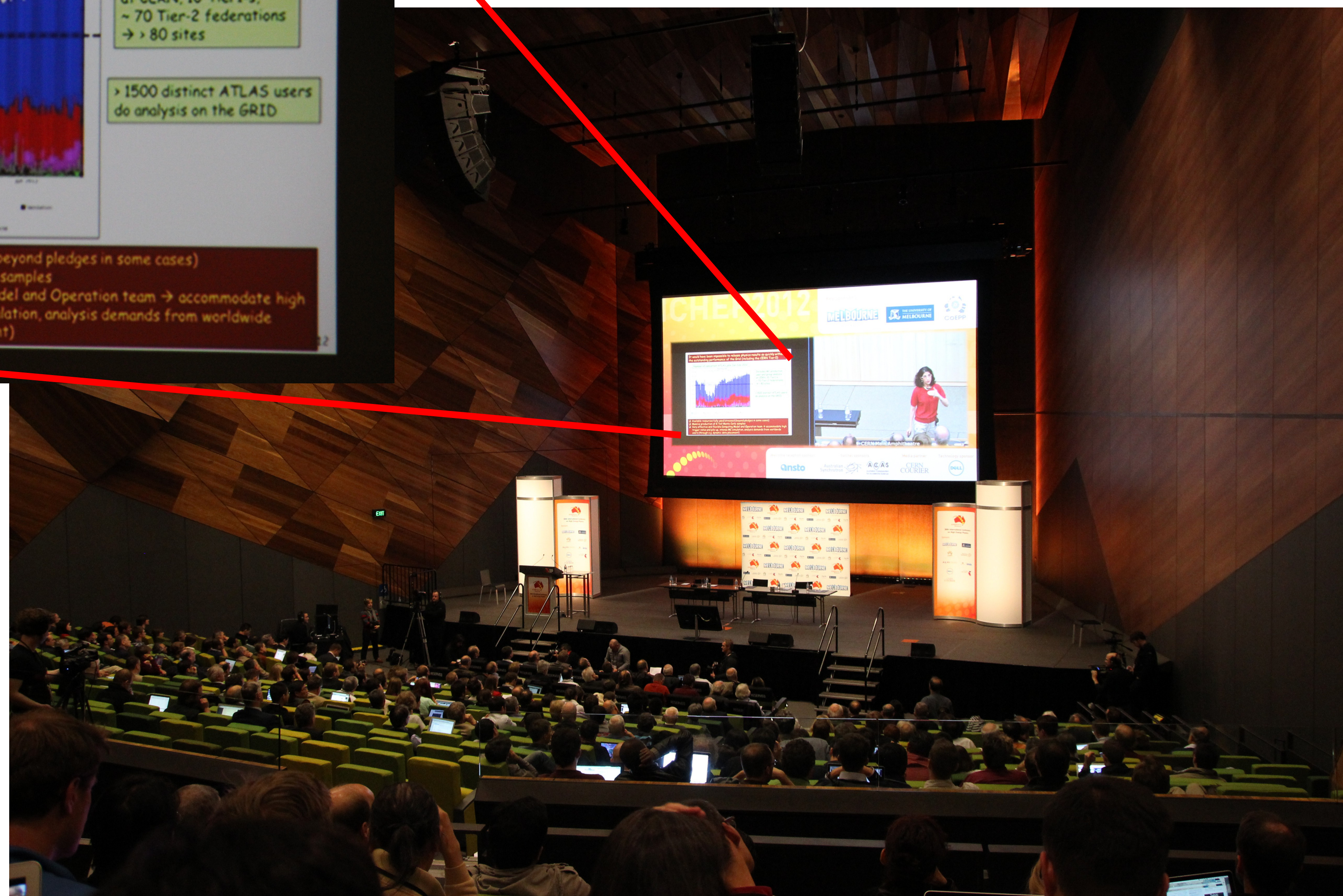
Reputed capacity of NSA's new Utah center: 5000 ExaB (50-100 MW)

http://www.wired.com/magazine/2013/04/bigdata/

« Computing enables physics »



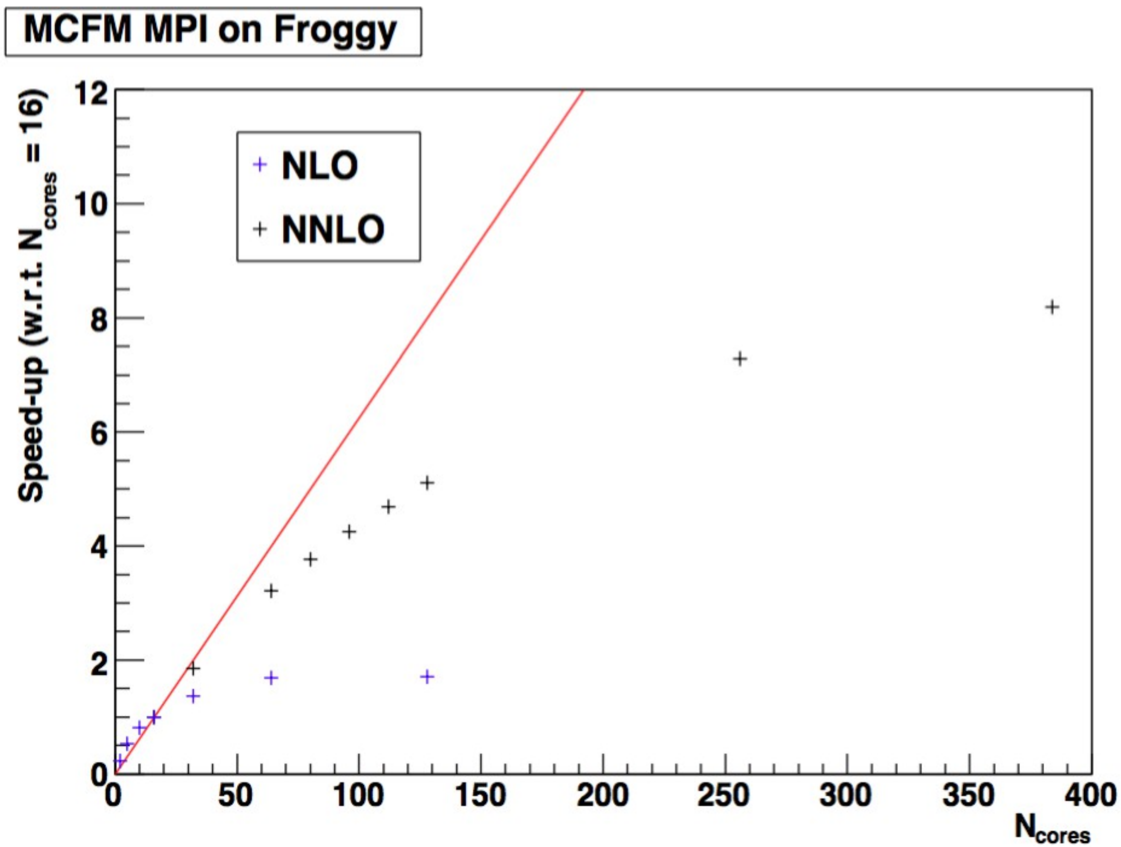
Photography: C. Biscarat



CERN seminar, July 4th 2012, (announcement of the discovery of the Higgs boson) retransmitted at ICHEP (Melbourne)

Plus récemment : ATLAS et CIMENT en mode « HPC »

- Nouveaux générateurs de processus proton-proton naturellement parallèles (multi-cœur)
- MCFM, l'un de ces générateurs, « scale » très bien pour une utilisation de FROGGY



Utilisation de CIMENT par le LPSC avant l'expérience ATLAS : DØ

L'analyse « di-photons » dans l'expérience ATLAS ne représente pas la première utilisation des ressources du mésocentre grenoblois CIMENT par les équipes d'analyse du LPSC.

En effet, nous avons déjà travaillé sur CIMENT pour une analyse des données de l'expérience DØ (« Dzero », auprès du collisionneur Tevatron à Chicago ; la génération de collisionneur juste avant le LHC).

Les deux transparents suivants montrent l'une de nos publications clé sur les données de DØ.

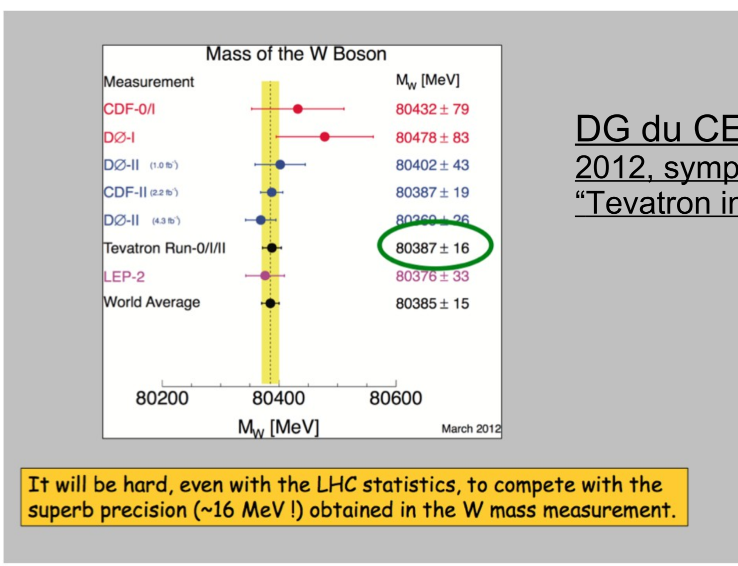
Portage d'applications – DØ

Expérience internationale Dzero (Fermilab - USA)

Recherche indirecte du boson de Higgs (mesure de M_W) initiative du LPSC

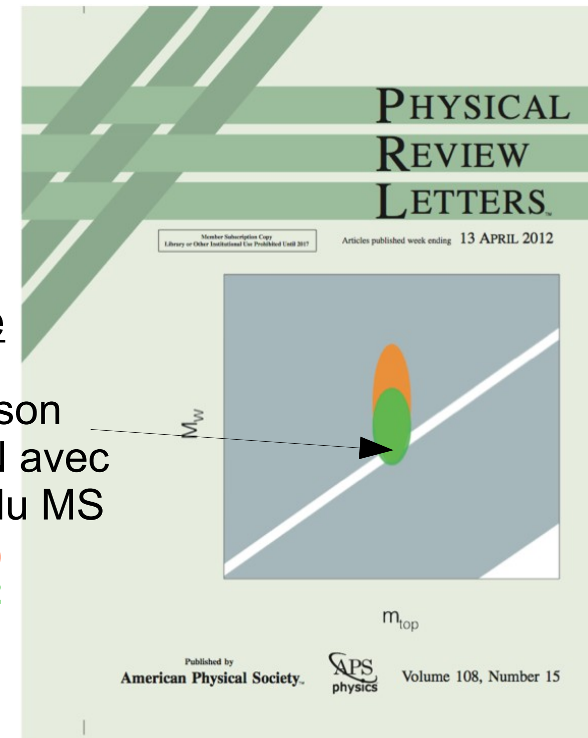
- Simulation paramétrée du détecteur
  - des milliers de tâches < 1 heure

Résultat scientifique publié :
- crucial pour notre discipline
- pérenne pour les années à venir



DG du CERN, 2012, symposium "Tevatron impact"

Couverture d'une revue prestigieuse



Compatibilité du boson découvert au CERN avec le boson de Higgs du MS

LEP+FNAL 2009

LEP+FNAL 2012

Reconnaissances :
- médaille de bronze du CNRS (2006)
- prix Joliot-Curie de la SFP (2009)

Measurement of the *W* Boson Mass with the D0 Detector

V. M. Abazov,[32] B. Abbott,[70] B. S. Acharya,[26] M. Adams,[46] T. Adams,[44] G. D. Alexeev,[32] G. Alkhazov,[36] A. Alton,[58,†] G. Alverson,[57] M. Aoki,[45] A. Askew,[44] B. Åsman,[38] S. Atkins,[55] O. Atramentov,[62] K. Augsten,[7] C. Avila,[5] F. Badaud,[10] L. Bagby,[45] B. Baldin,[45] D. V. Bandurin,[44] S. Banerjee,[26] E. Barberis,[57] P. Baringer,[53] J. Barreto,[2] J. F. Bartlett,[45] U. Bassler,[15] V. Bazterra,[46] A. Bean,[53] M. Begalli,[2] C. Belanger-Champagne,[38] L. Bellantoni,[45] S. B. Beri,[24] G. Bernardi,[14] R. Bernhard,[19] I. Bertram,[39] M. Besançon,[15] R. Beuselinck,[40] V. A. Bezzubov,[35] P. C. Bhat,[45] S. Bhatia,[60] V. Bhatnagar,[24] G. Blazey,[47] S. Blessing,[44] K. Bloom,[61] A. Boehnlein,[45] D. Boline,[67] E. E. Boos,[34] G. Borissov,[39] T. Bose,[56] A. Brandt,[73] O. Brandt,[20] R. Brock,[59] G. Brooijmans,[65] A. Bross,[45] D. Brown,[14] J. Brown,[14] X. B. Bu,[45] M. Buehler,[45] V. Buescher,[21] V. Bunichev,[34] S. Burdin,[39,‡] C. P. Buszello,[38] E. Camacho-Pérez,[29] B. C. K. Casey,[45] H. Castilla-Valdez,[29] S. Caughron,[59] S. Chakrabarti,[67] D. Chakraborty,[47] K. M. Chan,[51] A. Chandra,[75] E. Chapon,[15] G. Chen,[53] S. Chevalier-Théry,[15] D. K. Cho,[72] S. W. Cho,[28] S. Choi,[28] B. Choudhary,[25] S. Cihangir,[45] D. Claes,[61] J. Clutter,[53] M. Cooke,[45] W. E. Cooper,[45] M. Corcoran,[75] F. Couderc,[15] M.-C. Cousinou,[12] A. Croc,[15] D. Cutts,[72] A. Das,[42] G. Davies,[40] S. J. de Jong,[30,31] E. De La Cruz-Burelo,[29] F. Déliot,[15] R. Demina,[66] D. Denisov,[45] S. P. Denisov,[35] S. Desai,[45] C. Deterre,[15] K. DeVaughan,[61] H. T. Diehl,[45] M. Diesburg,[45] P. F. Ding,[41] A. Dominguez,[61] T. Dorland,[77] A. Dubey,[25] L. V. Dudko,[34] D. Duggan,[62] A. Duperrin,[12] S. Dutt,[24] A. Dyshkant,[47] M. Eads,[61] D. Edmunds,[59] J. Ellison,[43] V. D. Elvira,[45] Y. Enari,[14] H. Evans,[49] A. Evdokimov,[68] V. N. Evdokimov,[35] G. Facini,[57] L. Feng,[47] T. Ferbel,[66] F. Fiedler,[21] F. Filthaut,[30,31] W. Fisher,[59] H. E. Fisk,[45] M. Fortner,[47] H. Fox,[39] S. Fuess,[45] A. Garcia-Bellido,[66] G. A. García-Guerra,[29,§] V. Gavrilov,[33] P. Gay,[10] W. Geng,[12,59] D. Gerbaudo,[63] C. E. Gerber,[46] Y. Gershtein,[62] G. Ginther,[45,66] G. Golovanov,[32] A. Goussiou,[77] P. D. Grannis,[67] S. Greder,[16] H. Greenlee,[45] G. Grenier,[17] Ph. Gris,[10] J.-F. Grivaz,[13] A. Grohsjean,[15,‖] S. Grünendahl,[45] M. W. Grünewald,[27] T. Guillemin,[13] G. Gutierrez,[45] P. Gutierrez,[70] A. Haas,[65,¶] S. Hagopian,[44] J. Haley,[57] L. Han,[4] K. Harder,[41] A. Harel,[66] J. M. Hauptman,[52] J. Hays,[40] T. Head,[41] T. Hebbeker,[18] D. Hedin,[47] H. Hegab,[71] A. P. Heinson,[43] U. Heintz,[72] C. Hensel,[20] I. Heredia-De La Cruz,[29] K. Herner,[58] G. Hesketh,[41,**] M. D. Hildreth,[51] R. Hirosky,[76] T. Hoang,[44] J. D. Hobbs,[67] B. Hoeneisen,[9] M. Hohlfeld,[21] I. Howley,[73] Z. Hubacek,[7,15] V. Hynek,[7] I. Iashvili,[64] Y. Ilchenko,[74] R. Illingworth,[45] A. S. Ito,[45] S. Jabeen,[72] M. Jaffré,[13] A. Jayasinghe,[70] R. Jesik,[40] K. Johns,[42] E. Johnson,[59] M. Johnson,[45] A. Jonckheere,[45] P. Jonsson,[40] J. Joshi,[24] A. W. Jung,[45] A. Juste,[37] K. Kaadze,[54] E. Kajfasz,[12] D. Karmanov,[34] P. A. Kasper,[45] I. Katsanos,[61] R. Kehoe,[74] S. Kermiche,[12] N. Khalatyan,[45] A. Khanov,[71] A. Kharchilava,[64] Y. N. Kharzheev,[32] J. M. Kohli,[24] A. V. Kozelov,[35] J. Kraus,[59] S. Kulikov,[35] A. Kumar,[64] A. Kupco,[8] T. Kurča,[17] V. A. Kuzmin,[34] S. Lammers,[49] G. Landsberg,[72] P. Lebrun,[17] H. S. Lee,[28] S. W. Lee,[52] W. M. Lee,[45] J. Lellouch,[14] H. Li,[11] L. Li,[43] Q. Z. Li,[45] J. K. Lim,[28] D. Lincoln,[45] J. Linnemann,[59] V. V. Lipaev,[35] R. Lipton,[45] H. Liu,[74] Y. Liu,[4] A. Lobodenko,[36] M. Lokajicek,[8] R. Lopes de Sa,[67] H. J. Lubatti,[77] R. Luna-Garcia,[29,††] A. L. Lyon,[45] A. K. A. Maciel,[1] R. Madar,[15] R. Magaña-Villalba,[29] S. Malik,[61] V. L. Malyshev,[32] Y. Maravin,[54] J. Martínez-Ortega,[29] R. McCarthy,[67] C. L. McGivern,[53] M. M. Meijer,[30,31] A. Melnitchouk,[60] D. Menezes,[47] P. G. Mercadante,[3] M. Merkin,[34] A. Meyer,[18] J. Meyer,[20] F. Miconi,[16] N. K. Mondal,[26] H. E. Montgomery,[45,‡‡] M. Mulhearn,[76] E. Nagy,[12] M. Naimuddin,[25] M. Narain,[72] R. Nayyar,[42] H. A. Neal,[58] J. P. Negret,[5] P. Neustroev,[36] T. Nunnemann,[22] G. Obrant,[36,*] J. Orduna,[75] N. Osman,[12] J. Osta,[51] M. Padilla,[43] A. Pal,[73] N. Parashar,[50] V. Parihar,[72] S. K. Park,[28] R. Partridge,[72,¶] N. Parua,[49] A. Patwa,[68] B. Penning,[45] M. Perfilov,[34] Y. Peters,[41] K. Petridis,[41] G. Petrillo,[66] P. Pétroff,[13] M.-A. Pleier,[68] P. L. M. Podesta-Lerma,[29,§§] V. M. Podstavkov,[45] P. Polozov,[33] A. V. Popov,[35] M. Prewitt,[75] D. Price,[49] N. Prokopenko,[35] J. Qian,[58] A. Quadt,[20] B. Quinn,[60] M. S. Rangel,[1] K. Ranjan,[25] P. N. Ratoff,[39] I. Razumov,[35] P. Renkel,[74] I. Ripp-Baudot,[16] F. Rizatdinova,[71] M. 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M. van Leeuwen,[30] N. Varelas,[46] E. W. Varnes,[42] I. A. Vasilyev,[35] P. Verdier,[17] A. Y. Verkheev,[32] L. S. Vertogradov,[32] M. Verzocchi,[45] M. Vesterinen,[41] D. Vilanova,[15] P. Vokac,[7] H. D. Wahl,[44] M. H. L. S. Wang,[45] J. Warchol,[51] G. Watts,[77] M. Wayne,[51] J. Weichert,[21] L. Welty-Rieger,[48] A. White,[73] D. Wicke,[23] M. R. J. Williams,[39] G. W. Wilson,[53] M. Wobisch,[55] D. R. Wood,[57]

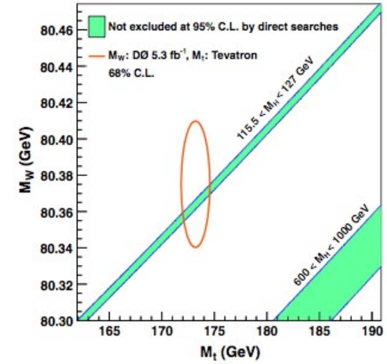

FIG. 3 (color online). Contour curves of 68% probability in the (M_t, M_W) plane. The ellipse represents the measurement of M_t from Ref. [11] and the measurement of $M_W = 80.375 \pm 0.023$ GeV reported in this Letter. The bands show the SM prediction for different Higgs boson mass hypotheses that are not yet ruled out by direct searches [30] for the Higgs boson.

LHC. Our new measurement of M_W is in good agreement with one of the regions allowed by direct searches for the Higgs boson.

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