



ATLAS physics

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ATLAS physics

Let's start with all the things that this lecture is not about...

For preparation, operation and performance, → see Sergio Gonzalez' talk For detailed accounts → see Fri. and Sat. discussion sessions

In 30 minutes, I can at best hope to deliver a strongly biased summary of 100+ papers

Outline:

A few Standard Model measurements to gain confidence A new kinematic regime: looking for resonances Profumo di SUSY: squark and gluino cascade decays Boosted objects Low energy searches The SM H boson



Note that all public results from ATLAS are available at: https://twiki.cern.ch/twiki/bin/view/AtlasPublic

SM measurements

Fully corrected measurements are a vitally important part of the ATLAS program. The format that ages best.. Early LHC data does not become obsolete...





The top quark

Pair production cross section – no suprises

Inclusive charge asymmetry compatible with SM $A_c = -0.018 \pm 0.028$ (stat.) ± 0.023 (syst.)

 $m_{t} = 174.5 \pm 0.6$ (stat) ± 2.3 (syst) GeV

Spin correlations, W polarization,...



Measurement of the t-channel single top-quark production cross section in pp collisions at $\sqrt{s} = 7$ T



X-sec = 83 ± 4 (stat.) $^{+20}_{-19}$ (syst) pb

Assuming $|V_{tb}| >> |V_{td}|$, $|V_{ts}|$ |V(tb)| = 1.13 + 0.14 - 0.13





Welcome to the TeraScale!

With the LHC we enter a new kinematic regime, even at 7 TeV



Parton luminosity at 1 TeV 2-4 orders of magnitude higher at the 7 TeV LHC than at the Tevatron

Integrated luminosity LHC (5/fb) within a factor 2 of the Tevatron (10/fb) in 2011 For searches, the difference between 0.1 and 1000 events can be discovery!

Much more to come: running with peak L~ $6x10^{33}$ @ 8 TeV \rightarrow 3/fb collected in 2012

In the longer run: 13 TeV, HiLumi LHC, VLHC

Jets!

One of the most spectacular dijet events recorded by ATLAS: $M_{ii} \sim 4 \text{ TeV}$



Search for New Particles in Two-Jet Final States in 7 TeV Proton-Proton Collisions with the ATLAS Detector at the LHC.

One of the first ATLAS papers

Accepted on August 30, 2010. The first 7 TeV paper \rightarrow Phys.Rev.Lett. 105 (2010) 161801

Switch on the machine and hunt for bumps!

With L =315/nb, "These exclude at the 95% CL the q* mass interval 0.30 < mq < 1.26 TeV, extending the reach of previous experiments"

That's what entering a new kinematic regime can do for you!



One word about benchmark models

Most searches end with a negative result

How do we communicate this result most effectively to the model builder? How do we compare searches by different experiments?

The absence of a signal is interpreted in terms of some BSM model \rightarrow limits are derived on the mass or rate of some new particle

Ultimately, a matter of consensus. We don't need the model to be particularly well-motivated physically (i.e. sequential Z', excited quark q*)

Can often recast (reinterpret the result in terms of some other model)

Alternative solutions (each with its own limitations):

- simplified models (we'll see a SUSY example later)
- effective operators (capture global features of BSM family)
- correct the data, report a particle-level cross-section, asymmetry,...

High-lumi follow-up study

And this is what luminosity can do: follow-up with 1/fb and 5/fb has increased the mass reach for excited quark up to 2.99 TeV and 3.35 TeV (was 1.26 TeV with 315/nb)



Now you understand why people involved in "searches" are always asking for higher center-of-mass energy (even if you still don't know what a q^* is)

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Angular distributions



The SM predicts the relative amount of s- and t-channel production. A BSM source of dijet events may upset that mixture.

Particularly relevant for non-resonant production.

Another "angle" to look at the same data: $\chi = e^{(|y_1 - y_2|)} \qquad F_{\chi} = N_{central}/N_{total}$ The SM χ distributions are relatively flat compared to those produced by new phenomena...

Reach a compositeness scale of 7.8 TeV



Search for dilepton resonances in pp collisions at sqrt(s) = 7 TeV with the ATLAS detector

Dilepton resonances

Phys.Rev.Lett. 107 (2011) 27200

- :) Mass resolution!
- :/ Production rate @ LHC



m_{uu} [GeV]



tt resonances



Depending on what you're looking for, the differential) cross-section, the charge asymmetry, same-sign top quark search, tt + missing energy, may be more relevant If you're still here on Saturday, come to the BSM new phenomena discussion IMFP2012 12 12 marcel.vos@ific.uv.es

$b'b' \rightarrow W^+tW^-t$



"Boosted objects without substructure" (ATLAS b' search in arXiv:1202.6540) Signal: tt pair + 2 boosted W bosons



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Searches: overview ATLAS Exotics Searches* - 95% CL Lower Limits (Status: March 2012)

	Large ED (ADD) : monojet	L=1.0 fb-1 (2011) [ATLAS-CONF-2011-096]	3.2 TeV M _D (δ=2)	
suo	Large ED (ADD) : diphoton	L=2.1 fb ⁻¹ (2011) [1112.2194]	3.0 TeV M _S (GRW cut-off)	ATLAS
	UED : $\gamma\gamma + E_{T miss}$	L=1.1 fb ⁻¹ (2011) [1111.4116] 1.23	Tev Compact. scale 1/R (SPS8)	Preliminary
	RS with $k/M_{\rm Pl} = 0.1$: diphoton, $m_{\rm Tl}$	L=2.1 fb ⁻¹ (2011) [1112.2194]	1.85 TeV Graviton mass	
ISU	RS with $k/M_{\rm Pl} = 0.1$: dilepton, $m_{\rm e}$	L=4.9-5.0 fb ⁻¹ (2011) [ATLAS-CONF-2012-007]	2.16 TeV Graviton mass	
me	RS with $k/M_{\rm Pl} = 0.1$: ZZ resonance, $m_{\rm IIII/IIII}$	L=1.0 fb ⁻¹ (2011) [1203.0718] 845 GeV	Graviton mass	$\int Ldt = (0.04 - 5.0) \text{ fb}^{-1}$
jo e	RS with $g_{\mu\nu}/g_{\mu}$ =-0.20 : tt \rightarrow I+jets, m_{μ}	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-029] 1.03 TeV	KK gluon mass	s = 7 TeV
xtn	ADD BH $(M_{TH}^{qqr}, M_D^{=}=3)$: multijet, $\Sigma p_{\tau}, N_{iets}^{tt}$	L=35 pb ⁻¹ (2010) [ATLAS-CONF-2011-068] 1.3	7 TeV Μ _D (δ=6)	-
ш	ADD BH ($M_{TH}/M_{D}=3$) : SS dimuon, $N_{ch. part.}$	L=1.3 fb ⁻¹ (2011) [1111.0080] 1.25	TeV M _D (δ=6)	
	ADD BH $(M_{TH}/M_{D}=3)$: leptons + jets, Σp_{T}	L=1.0 fb ⁻¹ (2011) [ATLAS-CONF-2011-147]	1.5 TeV M _D (δ=6)	
	Quantum black hole : dijet, $F_{y}(m_{jj})$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-038]	4.11 TeV M _D (δ=6)	
	qqqq contact interaction : $\hat{\chi}(m)$	L=4.8 fb ⁻¹ (2011) [ATLAS-CONF-2012-038]	7.8 TeV A	
C	qqll Cl : ee, $\mu\mu$ combined, \ddot{m}_{μ}	L=1.1-1.2 fb ⁻¹ (2011) [1112.4462]	10.2 TeV	(constructive int.)
	uutt CI : SS dilepton + jets + $E_{T,miss}$	L=1.0 fb ⁻¹ (2011) [1202.5520]	1.7 TeV Λ	
5	SSM Z' : m _{ee/µµ}	L=4.9-5.0 fb ⁻¹ (2011) [ATLAS-CONF-2012-007]	2.21 TeV Z' mass	
	SSM W': <i>m</i> _{T,e/µ}	L=1.0 fb ⁻¹ (2011) [1108.1316]	2.15 TeV W' mass	
a	Scalar LQ pairs (β =1) : kin. vars. in eejj, evjj	L=1.0 fb ⁻¹ (2011) [1112.4828] 660 GeV 1 St g	en. LQ mass	
L	Scalar LQ pairs (β=1) : kin. vars. in μμjj, μνjj	L=1.0 fb ⁻¹ (2011) [Preliminary] 685 GeV 2 nd	gen. LQ mass	
3	4^{th} generation : $Q_{4}\overline{Q}_{4} \rightarrow WqWq$	L=1.0 fb ⁻¹ (2011) [1202.3389] 350 GeV Q ₄ mass		
iarl	4^{in} generation : $\vec{u}_{4} \overline{u}_{4} \rightarrow WbWb$	L=1.0 fb ⁻¹ (2011) [1202.3076] 404 GeV U ₄ mass		
, dr	4^{th} generation : $d_{\lambda} \overline{d}_{4} \rightarrow WtWt$	L=1.0 fb ⁻¹ (2011) [Preliminary] 480 GeV d ₄ mass	5	
Vew	New quark b' : b'b'→ Zb+X, m _{zb}	L=2.0 fb ⁻¹ (2011) [Preliminary] 400 GeV b' mass		
<	$T\overline{T}_{exo, 4th, gen} \rightarrow t\overline{t} + A_0A_0$: 1-lep + jets + $E_{T, miss}$	L=1.0 fb ⁻¹ (2011) [1109.4725] 420 GeV T mass (n	n(A ₀) < 140 GeV)	
ш.	Excited quarks : y-jet resonance, m	L=2.1 fb ⁻¹ (2011) [1112.3580]	2.46 TeV q* mass	
fe	Excited quarks : dijet resonance, m	L=4.8 fb ⁻¹ (2011) [ATLAS-CONF-2012-038]	3.35 TeV q* mass	
xcit	Excited electron : e-y resonance, m	L=4.9 fb ⁻¹ (2011) [ATLAS-CONF-2012-023]	2.0 TeV e* mass (Λ = m(e*))	
Щ	Excited muon : µ-y resonance, m	L=4.8 fb ⁻¹ (2011) [ATLAS-CONF-2012-023]	1.9 TeV μ* mass (Λ = m(μ*))	
	Techni-hadrons : dilepton, m _{ee/µµ}	L=1.1-1.2 fb ⁻¹ (2011) [ATLAS-CONF-2011-125] 470 GeV ρ_T / ω_T ma	ass $(m(\rho_{T}/\omega_{T}) - m(\pi_{T}) = 100 \text{ GeV})$	
	Techni-hadrons : VVZ resonance (VIII), m	L=1.0 fb ⁻¹ (2011) [Preliminary] 483 GeV ρ _T mass	$m(m(\rho_{T}) = m(\pi_{T}) + m_{W}, m(a_{T}) = 1.1r$	n(ρ ₁))
	Major. neutr. (LRSM, no mixing) : 2-lep + jets	L=2.1 fb ⁻¹ (2011) [Preliminary]	1.5 TeV N mass $(m(W_R) = 2 \text{ TeV})$	
hei	W_R (LRSM, no mixing) : 2-lep + jets	L=2.1 fb ⁻¹ (2011) [Preliminary]	2.4 теv W _R mass (m(N) < 1.4	4 GeV)
0	H_{L}^{++} (DY prod., BR($H^{++} \rightarrow \mu\mu$)=1): SS dimuon, $m_{\mu\mu}$	L=1.6 fb ⁻¹ (2011) [1201.1091] 355 GeV H ^{LL} mass		
	Color octet scalar : dijet resonance, m	L=4.8 fb ⁻¹ (2011) [ATLAS-CONF-2012-038]	1.94 TeV Scalar resonance mass	
	Vector-like quark : CC, mivq	L=1.0 fb ⁻¹ (2011) [1112.5755] 900 GeV	Q mass (coupling κ _{qQ} = v/m _Q)	
	Vector-like quark : NC, m _{ilq}	L=1.0 fb ⁻¹ (2011) [1112.5755] 760 GeV Q	mass (coupling $\kappa_{qQ} = v/m_Q$)	
		10-'	1 TeV ¹⁰	10'
			± 10V	Mass scale [TeV]

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

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Supersymmetry

Conserve R-parity (SUSY particles produced in pairs, Lightest Stable Particle escapes detection) Inclusive search, primarily sensitive to abundant squark and gluino production:

- cascade decays to SM particles + LSP

- simple model pp \rightarrow gg \rightarrow tt χ tt χ

Derive a data-driven SM prediction based on data in a (signal-free) control region

Compare the template to data in regions with some distinct signature (missing energy, large multiplicity)





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Supersymmetry

Specific analyses for the third generation (recent ATLAS papers use bottom, τ -lepton and top quark signatures)

Much more distinctive signature: same-sign lepton + 4 jets



SuperSymmetry

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Inclusive searches	MSUGRA/CMSSM : 0-lep + j's + E _{T.miss}	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-033]	1.40 TeV q̃= g̃mass	
	MSUGRA/CMSSM : 1-lep + j's + <i>E</i> _{T,miss}	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-041]	1.20 TeV q̃ = g̃ mass	$\int Ldt = (0.03 - 4.7) \text{fb}^{-1}$
	MSUGRA/CMSSM : multijets + E _{T.miss}	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-037]	850 GeV ∯ mass (large m ₀)	is = 7 TeV
	Pheno model : 0-lep + j's + $E_{T,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-033]	1.38 τ εν q̃ mass (<i>m</i> (g̃) < 2 TeV,	light $\overline{\chi}_1^0$) ATLAS
	Pheno model : 0-lep + j's + $E_{T,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-033]	940 GeV g̃ mass (m(q̃) < 2 TeV, light	x ⁰ ₁) Preliminary
	Gluino med. $\tilde{\chi}^{\pm}$ ($\tilde{g} \rightarrow q \overline{q} \tilde{\chi}^{\pm}$) : 1-lep + j's + $E_{\tau,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-041]	900 GeV \tilde{g} mass $(m(\tilde{\chi}_1^0) < 200 \text{ GeV}, m$	$(\tilde{\chi}^{\pm}) = \frac{1}{2}(m(\tilde{\chi}^0) + m(\tilde{g}))$
	GMSB : 2-lep OS _{SF} + $E_{T,miss}$	L=1.0 fb ⁻¹ (2011) [ATLAS-CONF-2011-156]	810 GeV g̃ mass (tanβ < 35)	2
	GMSB : $1-\tau + j's + E_{\tau,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-005]	920 GeV \tilde{g} mass (tan β > 20)	
	GMSB: $2-\tau + j's + E_{\tau,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-002]	990 GeV \tilde{g} mass (tan β > 20)	
	GGM : γγ + E _{τ.miss}	L=1.1 fb ⁻¹ (2011) [1111.4116]	805 GeV \tilde{g} mass $(m(\tilde{\chi}_1^0) > 50 \text{ GeV})$	
Third generation	Gluino med. \tilde{b} ($\tilde{g} \rightarrow b \overline{b} \tilde{\chi}_{1}^{0}$) : 0-lep + b-j's + $E_{T,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-003]	900 GeV \tilde{g} mass $(m(\tilde{\chi}_1^0) < 300 \text{ GeV})$	
	Gluino med. \tilde{t} ($\tilde{g} \rightarrow t \bar{\chi}_1^0$) : 1-lep + b-j's + $E_{T,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-003]	710 GeV \tilde{g} mass $(m(\tilde{\chi}_1^0) < 150 \text{ GeV})$	
	Gluino med. \tilde{t} ($\tilde{g} \rightarrow t t \tilde{\chi}_1^0$) : 2-lep (SS) + j's + $E_{T,miss}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-004]	650 GeV \tilde{g} mass $(m(\tilde{\chi}_1^0) < 210 \text{ GeV})$	
	Gluino med. \tilde{t} ($\tilde{g} \rightarrow t \bar{t} \tilde{\chi}_1^0$) : multi-j's + $E_{T,miss}$	L=4.7 fb ⁻¹ (2011) [ATLAS-CONF-2012-037]	830 GeV ĝ̃ mass (<i>m</i> (χ̃ ₁ ⁰) < 200 GeV)	
	Direct $\widetilde{b}\widetilde{b}$ ($\widetilde{b}_1 \rightarrow b \widetilde{\chi}_1^0$) : 2 b-jets + $E_{T,miss}$	L=2.1 fb ⁻¹ (2011) [1112.3832] 390 GeV	\tilde{b} mass ($m(\tilde{\chi}_1^0) < 60$ GeV)	
	Direct $\tilde{t}t$ (GMSB) : Z(\rightarrow II) + b-jet + E	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-036] 310 GeV t	mass (115 < $m(\tilde{\chi}_1^0)$ < 230 GeV)	
G	Direct gaugino $(\tilde{\chi}_1^{\pm} \tilde{\chi}_2^0 \rightarrow 3 I \tilde{\chi}_1^0)$: 2-lep SS + $E_{T,miss}$	L=1.0 fb ⁻¹ (2011) [1110.6189] 170 GeV $\tilde{\chi}_1^{\pm}$ mass	$((m(\tilde{\chi}_1^0) < 40 \text{ GeV}, \tilde{\chi}_1^0, m(\tilde{\chi}_1^{\pm}) = m(\tilde{\chi}_2^0), m(\tilde{l}, \tilde{v}_1)$	$=\frac{1}{2}(m(\tilde{\chi}_{1}^{0}) + m(\tilde{\chi}_{2}^{0})))$
D	Direct gaugino $(\tilde{\chi}_1^{\pm} \tilde{\chi}_2^0 \rightarrow 3I \tilde{\chi}_1^0)$: 3-lep + $E_{T,\text{miss}}$	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-023] 250 GeV $\tilde{\chi}_1^{\pm}$ r	nass ($m(\tilde{\chi}_1^0)$ < 170 GeV, and as above)	
les	AMSB : long-lived $\tilde{\chi}_1^{\pm}$	L=4.7 fb ⁻¹ (2011) [CF-2012-034] $\tilde{\chi}_1^{\pm}$ mass (1 <	$\tau(\bar{\chi}_1^{\pm}) < 2 \text{ ns}, 90 \text{ GeV limit in } [0.2,90] \text{ ns})$	
inticl	Stable massive particles (SMP) : R-hadrons	L=34 pb ⁻¹ (2010) [1103.1984] 56	<mark>z gev</mark> ĝ mass	
id þ	SMP : R-hadrons	L=34 pb ⁻¹ (2010) [1103.1984] 294 GeV b	mass	
-live	SMP : R-hadrons	L=34 pb ⁻¹ (2010) [1103.1984] 309 GeV t	mass	
RPV Long.	SMP : R-hadrons (Pixel det. only)	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-022]	810 GeV ĝ mass	
	GMSB : stable τ	L=37 pb ⁻¹ (2010) [1106.4495] 136 GeV $\overline{ au} { m Mass}$		
	RPV : high-mass eµ	L=1.1 fb ⁻¹ (2011) [1109.3089]	1.32 TeV $\tilde{\mathbf{v}}_{\tau}$ mass $(\lambda_{311}^{\cdot}=0.10, \lambda_{31})$	₂ =0.05)
	Bilinear RPV : 1-lep + j's + $E_{T,miss}$	L=1.0 fb ⁻¹ (2011) [1109.6606]	760 Gev q̃ = g̃ mass (cτ _{LSP} < 15 mm)	
	MSUGRA/CMSSM - BC1 RPV : 4-lepton + E _{T,miss}	L=2.1 fb ⁻¹ (2011) [ATLAS-CONF-2012-035]	1.77 TeV ĝ mass	
	Hypercolour scalar gluons : 4 jets, $m_{ij} \approx m_{kl}$	L=34 pb ⁻¹ (2010) [1110.2693] 185 GeV Sgluon	mass (excl: $m_{sg} < 100 \text{ GeV}, m_{sg} \approx 140 \pm 3$	GeV)
		40-1		40
		10	1 TeV	
*~		to an an a training of the second s		Mass scale [TeV]

ATLAS SUSY Searches* - 95% CL Lower Limits (Status: March 2012)

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

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Boosted objects: A Probe of beyond the Standard Model physics.

Boosting BSM sensitivity

Let's define "boosted object" by comparing the standard approach (reconstruct components and combine) to Mike Seymour's alternative (find composite object and decompose).

Rules of thumb for maximum jet radius parameter for 2-body decay:

 $R < 2m/p_{T}$ (always resolve two jets)

 $R > 3m/p_{T}$ (capture full decay in a single jet 75% of cases)



W boson at rest \rightarrow use resolved approach

 $p_{\tau} \sim 240 \text{ GeV} \rightarrow \text{coexisting algorithms},$

can resolve with R=0.4, or contain in R=1

 \rightarrow boosted regime

cannot always resolve with R=0.4

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p_T ~ 400 GeV

Boosted top quarks

2010 data: the first five events of what will become an excellent control sample

When reclustered with R = 1.0 three jets merge into a single "fat" jet with:

 $\begin{array}{ll} m_{j} = 197 \; \text{GeV} & (\text{expected: } m_{t}) \\ \text{sqrt}(d_{12}) = 110 \; \text{GeV} \; (\text{expected } \sim m_{w}) \\ \text{sqrt}(d_{23}) = 40 \; \text{GeV} \; \; (\text{expected } \ldots) \end{array}$

Matching small and large jets we can transfer the small uncertainties of the well-known jets to less well-know ones

Measurement of Jet Mass and Substructure for Inclusive Jets in $\sqrt{s} = 7$ TeV pp Collisions with the ATLAS Experiment, ATLAS-CONF-2011-073



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Jet substructure

arXiv:1203.4606 [hep-ex]

- Agreement SM data
- Parton Shower model is adequate
- Detector response is under control
- Underlying event OK



2010: few events/crossing
(20% has a single primary vertex)
2011: average 12 events/crossing
(50 ns operation; machine beyond design)
2012: average up to ~25 events/crossing
(8 TeV, squeezed beams: β*=0.6m)

Jet grooming increases pile-up resilience



Come to Valencia this summer marcel.vos@ific.uv.es

Observation of a new chi_b state in radiative transitions to Upsilon(1S) and Upsilon(2S) at ATLAS New particles at the LHC!

$X_{b}(3P) \rightarrow Y(1s,2s) \gamma m [\chi_{b}(3P)] = 10.530 \pm 0.005 (stat) \pm 0.009 (syst) GeV$



Observed bottomonium radiative decays in ATLAS, L = 4.4 ft

The H boson

A word of caution

In particle physics, the Higgs mechanism is the process that gives mass to elementary particles. The simplest implementation of the mechanism adds an extra Higgs field to the gauge theory.

In the Standard Model, the phrase "Higgs mechanism" refers specifically to the generation of masses for the W[±], and Z weak gauge bosons through electroweak symmetry breaking. The SM yields definite predictions for everything but the mass of the H boson.

Observation of a resonance with Higgs-like properties

≠

discovery of the SM Higgs boson

Many BSM proposals have their "Higgs sector", which may be experimentally distinguishable from the SM Higgs with more data at the LHC (or with a Higgs factory)

The mother of all searches: the H boson



Many production processes, even more decay channels SM H boson production cross sections times observable deca branching ratios at 7 TeV



Higgs!







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High resolution channels: $H \rightarrow \gamma \gamma$ and $H \rightarrow ZZ(*) \rightarrow IIII$



H → 4I: in the region mH < 141 GeV (not excluded at 99% CL by ATLAS+CMS combination) 3 events are observed: two 2e2µ events (m=123.6 GeV, m=124.3 GeV) and one 4µ event (m=124.6 GeV)

 $H \rightarrow \gamma\gamma$: for m_H ~ 125 GeV, ~70 signal events expected after all cuts, and ~ 3000 background events in signal mass window: S/B ~ 0.02



An update to the combined search for the Standard Model Higgs boson All channels, all (2011) data, ATLAS-CONF-2012-019



The **ratio of the limit on the rate and the SM cross-section times branching fraction** is plotted (where the line falls below 1 the SM H boson is excluded)

Expected limits: Estimate the sensitivity of the analysis, from MC without H boson

(if expected limit >> 1, poor sensitivity for SM H boson)

(if observed limit ~ expected limit, data are compatible with no H boson)

Observed limits: the 95% CL limit on the rate from data

(an excess of events causes the the observed limit to be weaker than the expected limit) (channels with good mass resolution yield sharp localized deviation) ("counting" channels yield a mismatch over a broad mass range) IMFP2012

An update to the combined search for the Standard Model Higgs boson 12 channels, full 2011 data, ATLAS-CONF-2012-019



These figures come with a manual

Expected 95% CL region if no signal: 120 – 555 GeV

Excluded at 95% CL $- 110 < m_{H} < 117.5 \text{ GeV}$ $- 118.5 < m_{H} < 122.5 \text{ GeV}$ $- 129 < m_{H} < 539 \text{ GeV}$

An update to the combined search for the Standard Model Higgs boson Interpretation of the excess at 125 GeV

P-value

 P_0 -value = local probability for a background-only experiment to be more signal-like than the observation.

Solid = observed p_0

Dashed = median expected value for the hypothesis of a SM Higgs boson signal at that mass.

The global probability for the background to produce such a fluctuation anywhere in the explored Higgs boson mass range 110-600 GeV is estimated to be $\sim 1.4\%$ or, equivalently 2.2 sigma.

Signal strength

 μ = best-fit signal strength as a function of the m_H hypothesis.



Summary

ATLAS has published well over 100 physics papers.

Standard Model measurements confirm the SM works for 7 TeV pp collisions

ATLAS has explored an enormous range of potential BSM signatures. Negative result so far extend the constraints on proposed extensions of the Standard Model to a previously uncharged region.

Stay tuned; new results on the Standard Model Higgs boson search soon

8 TeV run well underway. Over 2/fb collected. Adding 100/pb/day on good days. 5/fb by ICHEP, 15/fb in 2012. Cross-sections increase by 25-30% for Higgs production, more for massive objects