



Résumé des conférences d'été

Physique des particules

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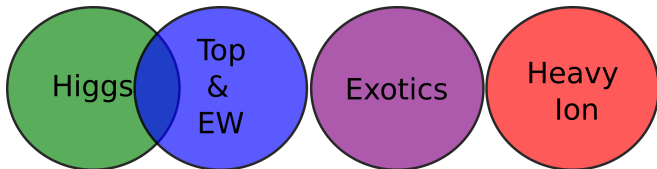
14 Octobre 2013

Outline

Résumé des conférences d'été:

- based on EPS2013 (Jul.) (<http://eps-hep2013.eu/>)
- biased twds (high- p_T , LHC, ATLAS and CMS, pp , physics analysis) experiment;
both due to the overlap with my main field of work and (too) short presentation time (to cover other interesting results)
- apologies for (m)any omissions!

Topics for which I will summarize the new Summer Conferences highlights:



LHC & Detector Performance

Excellent

ATLAS, CMS, 8 TeV run, pp collisions

- LHC Delivered $\mathcal{L}_{\text{int}} = 23.3 \text{ fb}^{-1}$
- Experiments Recorded: 95%
- High-quality: 90% ok for phys.ana

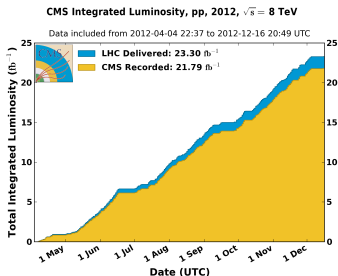
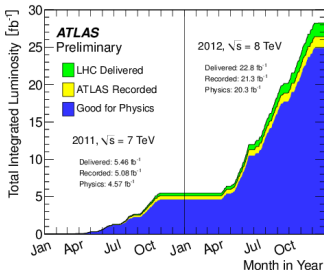
Some numbers:

- number of $t\bar{t}$ pairs in 8 TeV datasets^[1]

$$N = \mathcal{L}_{\text{int}} \sigma(t\bar{t}) = \frac{90\% \cdot 23.3}{10^{-3} \text{ pb}} 245.8 \text{ pb} \sim 5.2\text{M}$$

- LHC 7 TeV : $\mathcal{L}_{\text{int}} \sim 5 \text{ fb}^{-1}$
and smaller σ -s; e.g. $\sim 0.8\text{M}$ $t\bar{t}$ pairs
- Tevatron Run II : $\mathcal{L}_{\text{int}} \sim 12 \text{ fb}^{-1}$
and much smaller σ -s; e.g. $\sim 100\text{k}$ $t\bar{t}$ pairs

[1] using NNLO!(+NNLL) calc. of arXiv:1303.6254 available since Spring 13 and endorsed by experiments for Summer 13 results



F. Cerutti's talk @ EPS

- ATLAS:

<http://twiki.cern.ch/twiki/bin/view/AtlasPublic/HiggsPublicResults>

- Phys. Lett. B 716 (Discovery)

- arXiv:1307.1432 Sub. Phys. Lett. B (Spin)

- arXiv:1307.1427 Sub. Phys. Lett. B (Couplings)

- ATLAS-CONF 2013-040 (Spin)

- ATLAS-CONF 2013-029 ($\gamma\gamma$)

- ATLAS-CONF 2013-031 (WW*)

- ATLAS-CONF 2013-013 (ZZ*)

- ATLAS-CONF-2013-079 (VH \rightarrow bb)

- ATLAS-CONF-2013-072 (H \rightarrow $\gamma\gamma$ diff. σ)

- ATLAS-PHYS-PUB 2012-001/002 (HL-LHC)

- CDF + D0:

<http://tevnpnphwg.fnal.gov/>

- arXiv:1207.6436 – Phys. Rev. Lett 109 (Evidence H \rightarrow bb)

- arXiv:1303.6346 – Subm. Phys. Rev. D (Combination – Couplings)

- D0 note 6387-CONF (Spin 2+ studies)

- CMS:

<http://cms.web.cern.ch/org/cms-papers-and-results>

- Phys. Lett. B 716 (Discovery)

- arXiv:1212.6639 – Phys. Rev. Lett. 110 (ZZ*, Spin)

- CSM-PAS-HIG-13-016 (Properties $\gamma\gamma$)

- CMS-PAS-HIG-13-018 (ZH \rightarrow Z-invisible)

- CMS-PAS-HIG-13-005 (Couplings)

- CMS-PAS-HIG-13-012 (H \rightarrow bb)

- CMS-PAS-HIG-13-001 ($\gamma\gamma$)

- CMS-PAS-HIG-13-002 (ZZ*, Spin)

- CMS-PAS-HIG-13-003 (WW*)

- CMS-PAS-HIG-13-004 ($\tau\tau$)

- CMS-NOTE-2012-006 (HL-LHC)

- LHC-XS Higgs wg:

<http://twiki.cern.ch/twiki/bin/view/LHCPhysics/CrossSections>

- arXiv:1307.1347 (Yellow Report 3: σ , BR and coupling and spin/CP-fit models)

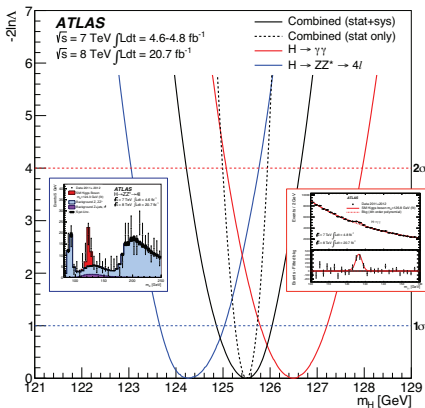
+ New CMS ttH CMS-PAS-HIG-13-015 (H $\rightarrow \gamma\gamma$), CMS-PAS-HIG-13-019 (H $\rightarrow b\bar{b}, \tau\tau$)

+ New ATLAS ttH , ATLAS-CONF-2013-080 (H $\rightarrow \gamma\gamma$)

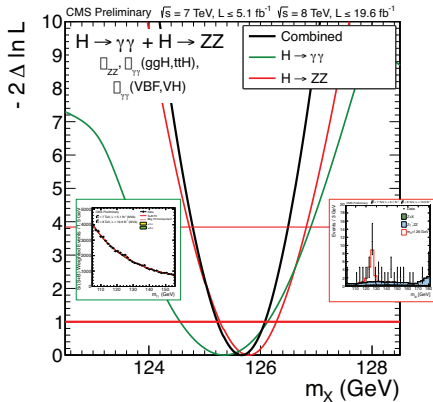
Higgs Mass

F. Cerutti's talk @ EPS

Measured from $\gamma\gamma$ and $ZZ^*(4\ell)$ mass spectra: needed to predict $\sigma \times BR$



ATLAS: $M_H = 125.5 \pm 0.2_{\text{stat}} \pm 0.6_{\text{sys}} \text{ GeV}$



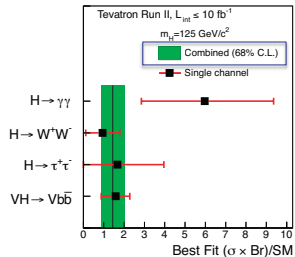
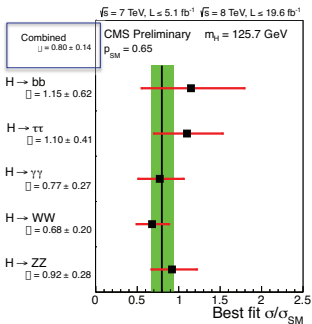
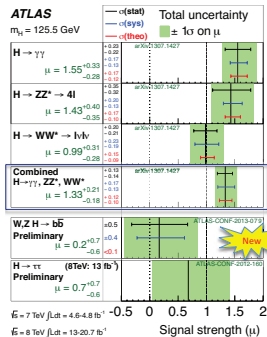
CMS: $M_H = 125.7 \pm 0.3_{\text{stat}} \pm 0.3_{\text{sys}} \text{ GeV}$



From $\gamma\gamma$: $\Gamma_H < 6.9 \text{ GeV}$ at 95% CL (direct)

Higgs Signal Strength

F. Cerutti's talk @ EPS $\mu = (\sigma \cdot BR)/(\sigma \cdot BR)_{SM}$

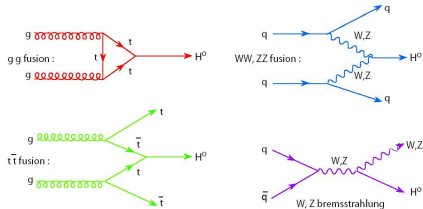


• Combined $\square \rightarrow$ Best accuracy but no strong physics motivation:

- ATLAS ($\gamma\gamma, WW^*$ and ZZ^*) $\square = (1.33 \pm 0.20)$ (1.23 ± 0.18 including bb and $\tau\tau$)
- CMS ($\gamma\gamma, \tau\tau, bb, WW^*$ and ZZ^*) $\square = (0.80 \pm 0.14)$
- TEVATRON ($bb, \gamma\gamma, \tau\tau, WW^*$) $\square = (1.44 \pm 0.60)$

Compatible with SM Higgs boson expectation: Accuracy $\sim 15\%$

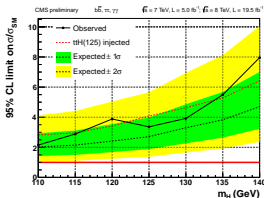
Higgs : associated ttH production



ttH @ CMS, 7 and 8 TeV comb.

$H \rightarrow \gamma\gamma, H \rightarrow b\bar{b}, \tau\tau$

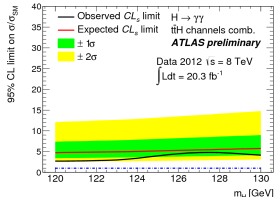
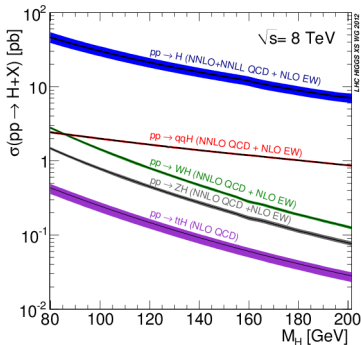
$\mu < 3.4$ (2.7 expected)



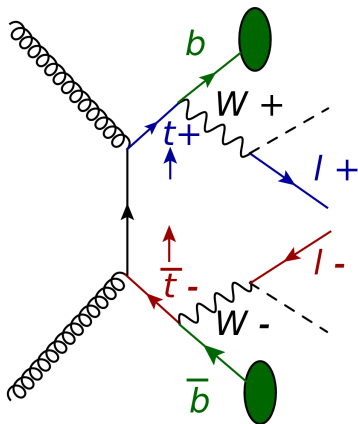
ttH @ ATLAS, 7 and 8 TeV comb.

$H \rightarrow \gamma\gamma$

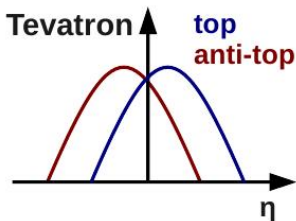
$\mu < 5.3$ (6.4 expected)



Top : Asymmetries



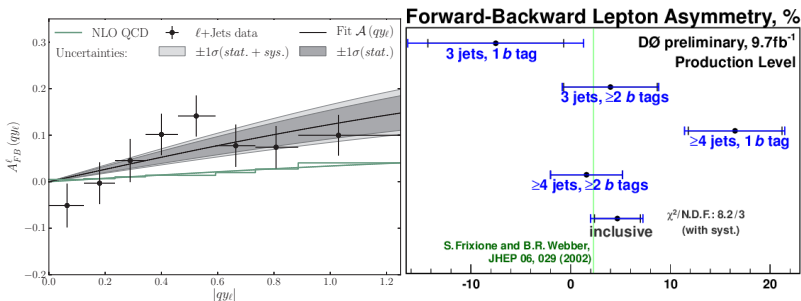
- top (t) and antitop (\bar{t}) have different electric charges
- **forward-backward asymmetry** : we can measure if **top** is produced more forward than **antitop** in our detector
- **forward-backward asymmetry** is predicted to be small in SM



- we can also measure **forward-backward asymmetry** using the leptons
- **till this summer** : CDF, D0 reported both $t\bar{t}$ and lepton A_{FB} notably larger than SM ...

Top : Tevatron asymmetries in l+jets

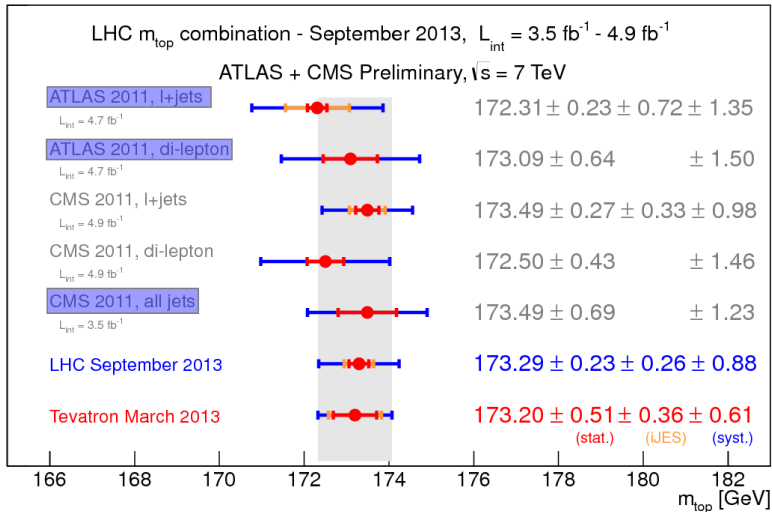
- **new this summer :**
D0 (conf. note 6381, 9.7 fb⁻¹) reports lepton A_{FB} consistent with SM (RHS)
- **CDF (arXiv:1308.1120, 9.4 fb⁻¹) : lepton A_{FB} > SM (LHS)**
- **ttbar A_{FB} still reported to be larger than SM by both D0 and CDF**



- **CDF:** $A_{FB} = 0.094^{+0.032}_{-0.029}$
- **D0:** $A_{FB} = 0.047 \pm 0.023^{+0.011}_{-0.014}$ [was (5.4 fb⁻¹): $A_{FB} = 0.152 \pm 0.038^{+0.010}_{-0.013}$]
- **SM:** $A_{FB} = 0.023$ (MC@NLO, D0)

Top : mass

ATLAS-CONF-2013-102



Global Electroweak Fit

global test of state-of-the-art theo vs exp.

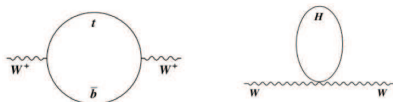
Gfitter (May2013) updates:^[1]

- including (SM) Higgs
- update to latest Tevatron m_t , m_W
- theo calc. updates, ...

Good consistency with SM:

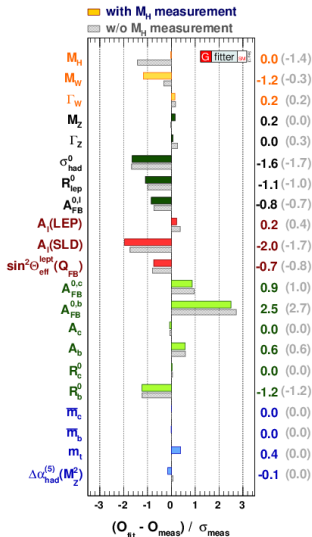
- $\chi^2 = 18.1/14$ DOF
- $\chi^2 = 16.7/13$ DOF w/o H

Prospective improvements incl. LHC m_W
 m_W, m_t also interesting in comb. w m_H



$$m_W = \sqrt{\frac{\pi\alpha}{\sqrt{2}G_F} \frac{1}{\sin\theta_w \sqrt{(1-\Delta r)}}}$$

$\Delta r =$ radiative corrections, $\propto m_t^2, \log m_H$



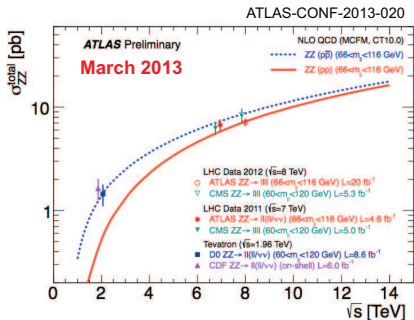
Plot inspired by Eberhardt et al. [arXiv:1209.1101]

[1] Results and Fig. correspond to Sept2013 update, <http://project-gfitter.web.cern.ch>

Diboson cross-section

LHC : 8 TeV full-dataset + Tevatron Run II updates.

E.g. ZZ production



Three updates since this plot.

CMS prel. (8 TeV, 19.6 fb $^{-1}$):
CMS PAS SMP-13-005

$$\sigma(pp \rightarrow ZZ) = 7.7^{+0.5}_{-0.5}(\text{stat.})^{+0.5}_{-0.4}(\text{syst.}) \pm 0.4(\text{theo.}) \pm 0.3(\text{lum.}) \text{ pb}$$

in agreement with prediction (MCFM):
 7.7 ± 0.6 pb

CDF prel. (9.7 fb $^{-1}$): $\sigma(p\bar{p} \rightarrow ZZ) = 1.04^{+0.20}_{-0.24}(\text{stat.})^{+0.15}_{-0.08}(\text{syst.}) = 1.04^{+0.32}_{-0.25} \text{ pb}$

DØ (9.6-9.8 fb $^{-1}$):
arXiv:1304.5422

$$1.32^{+0.29}_{-0.25}(\text{stat.}) \pm 0.12(\text{syst.}) \pm 0.04(\text{lumi}) \text{ pb}$$

in agreement with
prediction (MCFM):
 1.4 ± 0.1 pb

(SUSY and) Exotics : BSM Resonance Searches

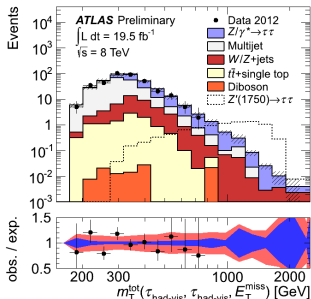
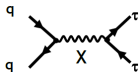
Name of the game:

- BSM models (GUT, Extra-Dim, TechniColor, Compositeness, SUSY ...) predict existence of new resonances
- 1) model independent searches (e.g. peak in invariant mass spectrum of decay products)
- 2) interpretation for benchmark model(s)

ATLAS-CONF-2013-066, 8 TeV

$\tau\tau$ (\rightarrow had.) Final State

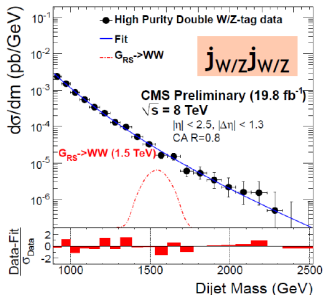
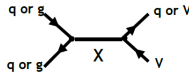
exclude (SSM) Z' : [0.5-1.9 TeV]



CMS-EXO-12-024, 8 TeV

$qV(\rightarrow q\bar{q})$ and $V(\rightarrow q\bar{q})V(\rightarrow q\bar{q})$ FS

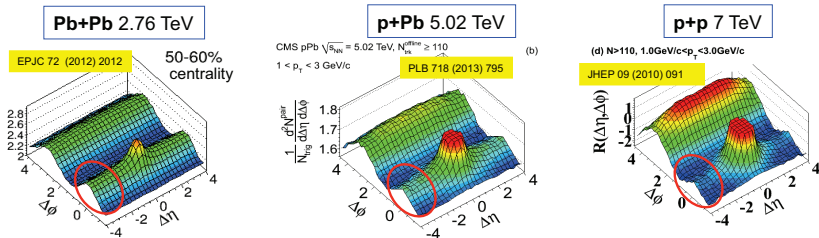
exclude (SSM) $W' \rightarrow WZ$: [1.0-1.73 TeV]



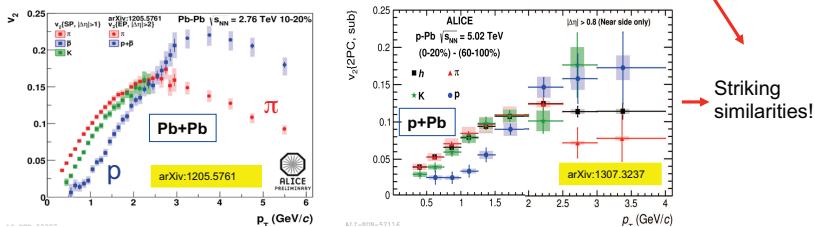
No BSM hints found in searches; using all available data and also challenging FS-s

Heavy Ion

From S. Bertolucci's *Highlights from EPS HEP 2013*



Mass ordering of second Fourier-coefficient (v_2):



Summary

Higgs

- precision properties measurements: consistent with SM H
- improved searches for other H -like particles: nothing found so far
- trying out challenging production/decay modes (e.g. ttH)
- more experiments (BaBar, Belle, LHCb) also contributing

Top & EW

- big progress in precision of m_t , σ_{tt} measurements
- $> 6\sigma$ evidence for s-top Wt -production (CMS)
- asymmetries : interesting updates, overall still tension at Tevatron
- improvements in V/VV measurements, incl. very forward region (LHCb)

SUSY & Exotics

- no hints of BSM in LHC searches yet
- using full dataset, extending searches to very challenging channels
- ditto for SUSY
- BTW: $W(l\nu) + jj$ anomaly (m_{jj}) reported by CDF gone in Spring13 (JES, QCD)! CDF Pub. Note 10973

Heavy Ion

- very interesting to compare ALICE, STAR and PHENIX vs ATLAS, CMS results and Pb-Pb, Pb-p, pp
- the latter e.g. exhibits (unexpected?) similarities for long-range correlations