A partial view on Moriond – colliders

Bernardo Resende

04/04/11

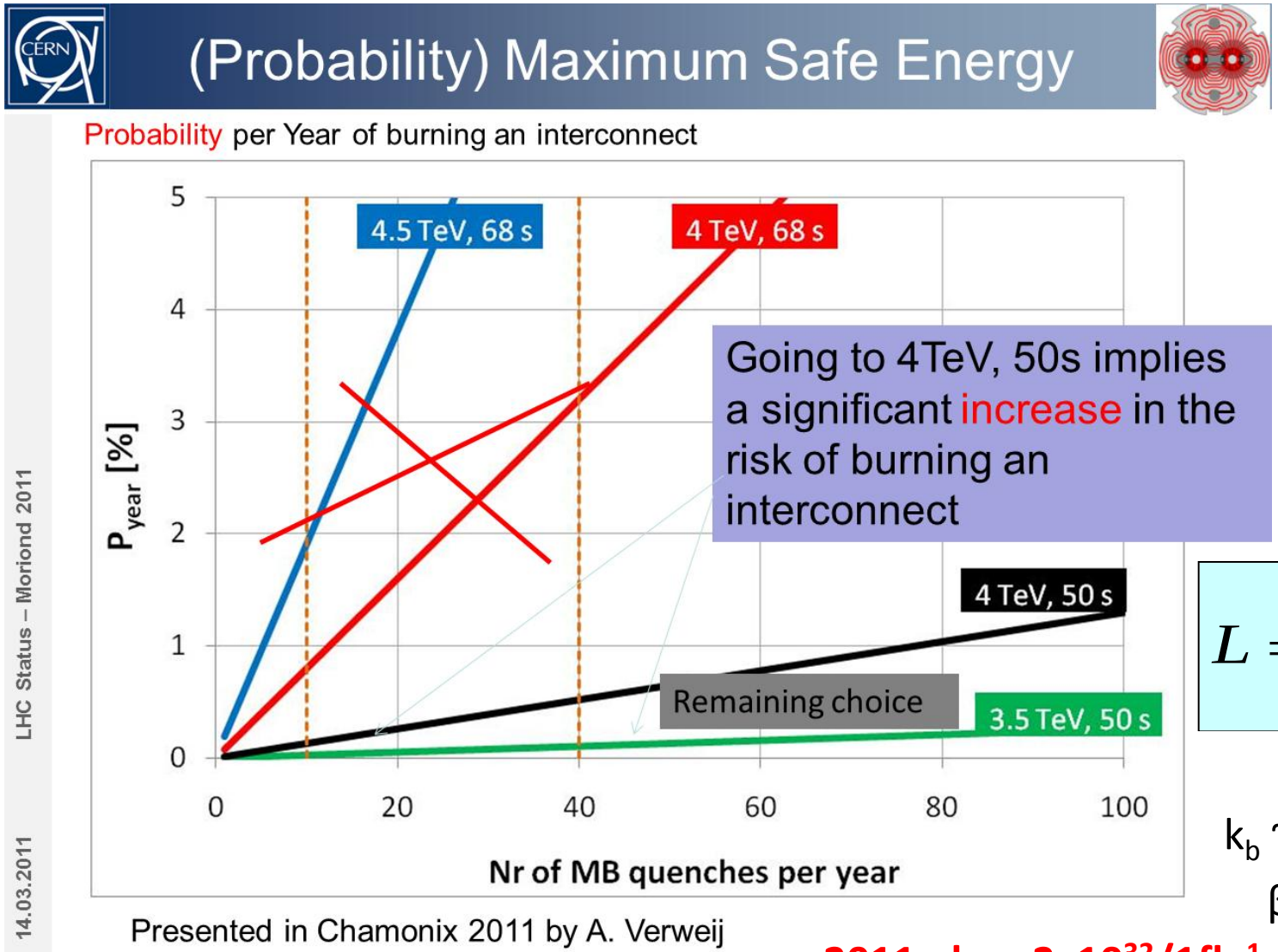
Scope

Presenter's name

- Collider results and updates (Tevatron vs. LHC…)
  - Higgs
  - SM measurements
  - Susy
  - Other BSM/Exotics
  - Top
  - B physics
- Moriond slides plundered and cut apart
  - Some theory considerations mixed in
  - Apologies for any lack of context…

LHC status

Laurette Ponce



Presented in Chamonix 2011 by A. Verweij

→ Staying at 3.5 GeV, based on probability of 2008 incident repeat…

→ Increasing luminosity :

$$L = \frac{N^2 k_b f \gamma}{4\pi\beta^* \varepsilon} F$$

N > nominal !

k_b ~ O(300) vs. 2808

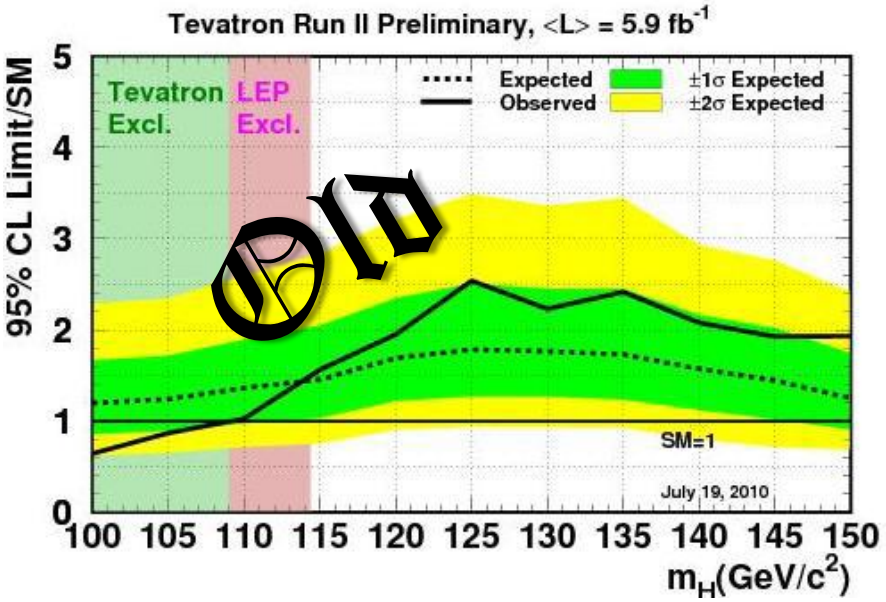
β* 3.5 → 1.5 m

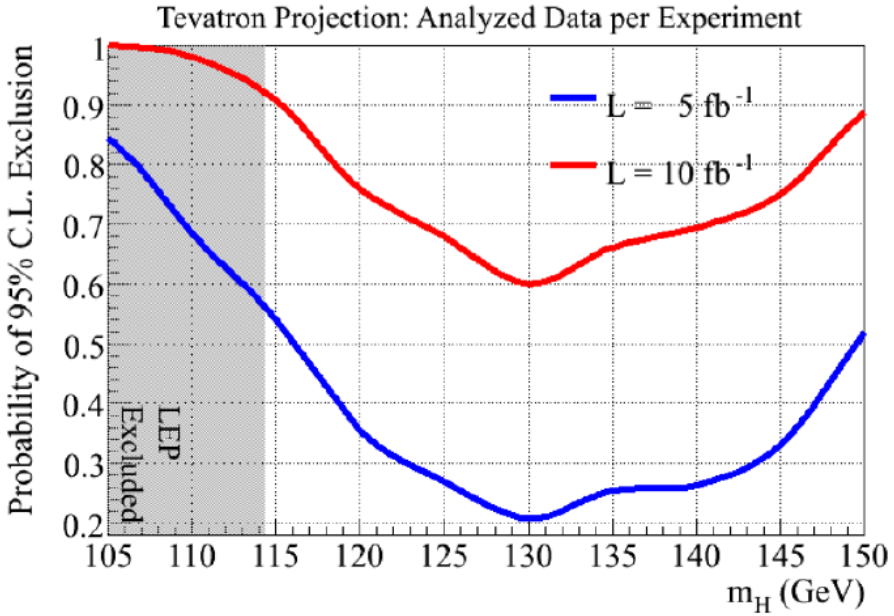
2011 plan: $2\times10^{32}/1fb^{-1}$; hopes: $10^{33}/?fb^{-1}$

Higgs, Tevatron, low mass

Pierluigi Totaro

- 2010 plot not updated, only next summer



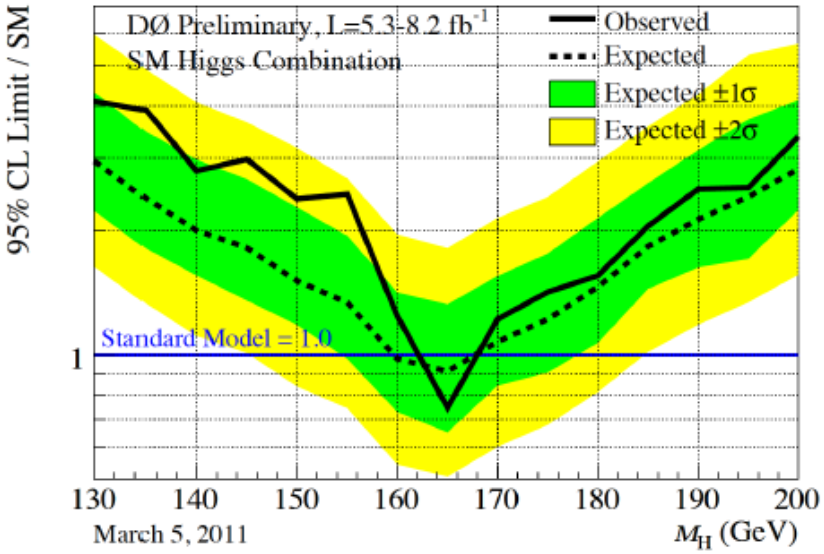


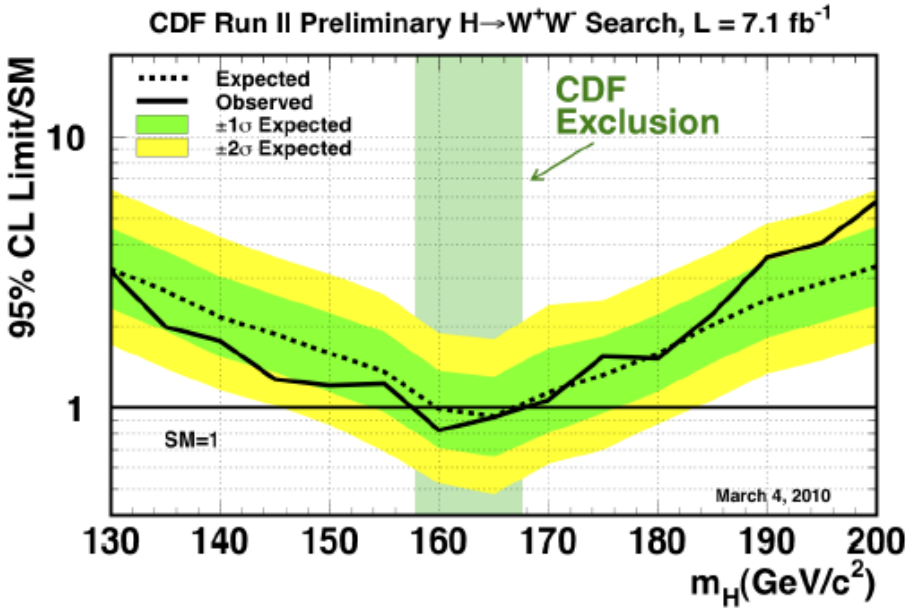
- Stat x 2, but not enough; improvements needed
  - Improve signal acceptance; reduce W/Z+jets: b-tag
  - Include as many channels as possible
  - Multivariate techniques

Higgs, Tevatron, high mass

Konstantinos Petridis

- Exclusion (~165 GeV) in each experiment separately
  - Using all WW final states, split into many channels
  - More data and new channels + multivariate





DØ: Single Experiment Exclusion!!

$163 < M_H < 168$ @95% C.L
$(160 < M_H < 168$ expected)

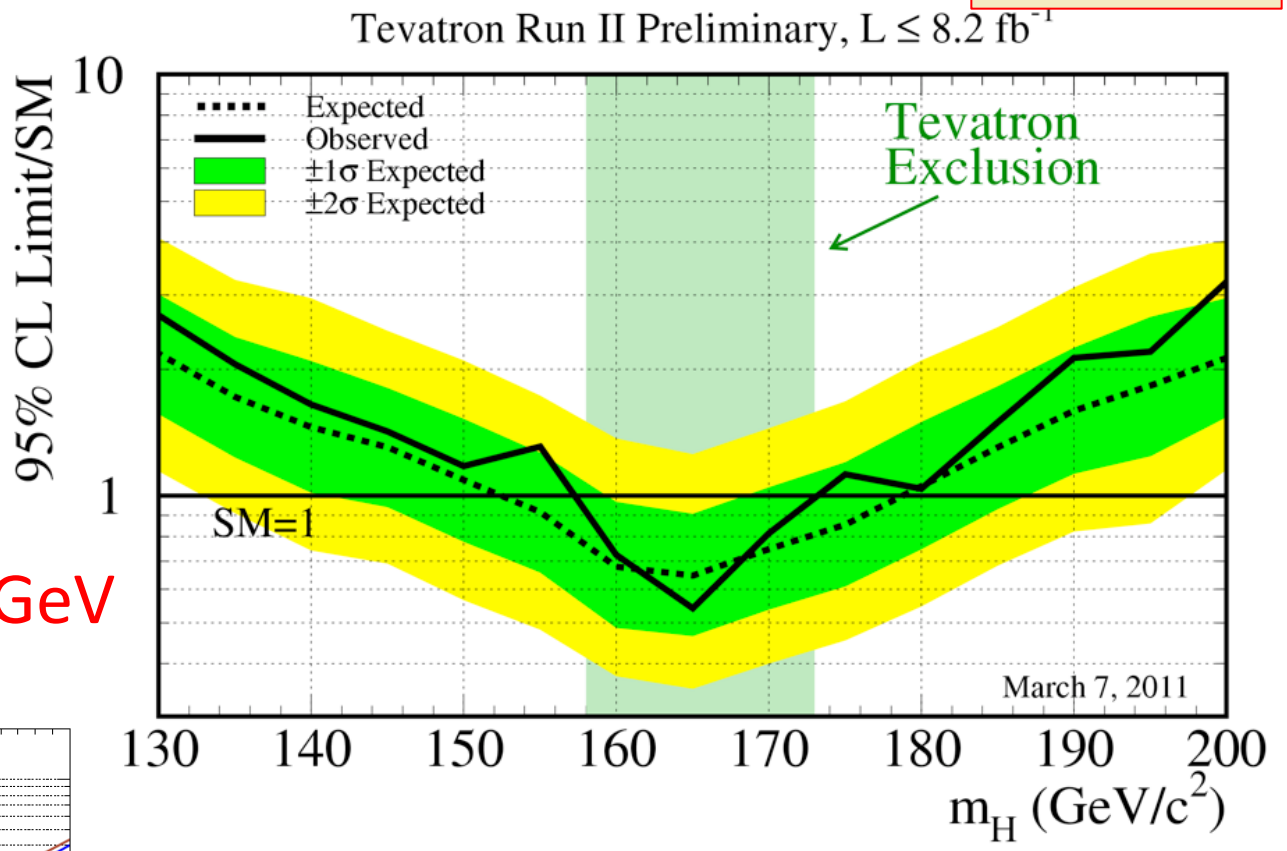
CDF: Single Experiment Exclusion!!

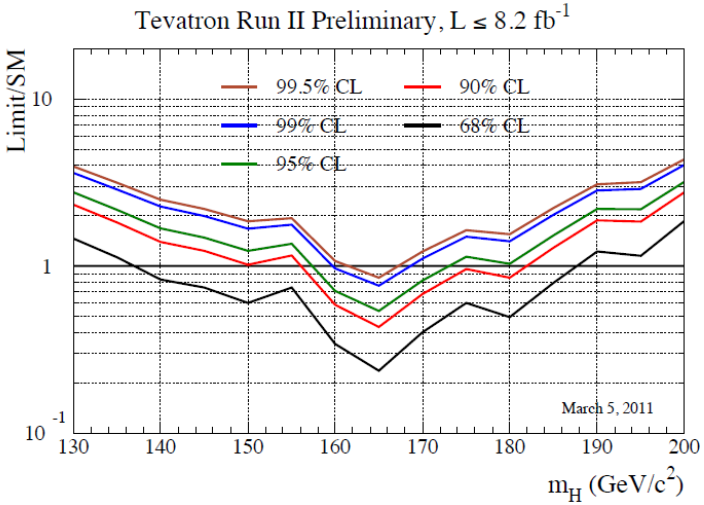
$158 < M_H < 168$ @95% C.L
$(160 < M_H < 167$ expected)

Higgs, Tevatron, high mass combined

Bo Jayatilaka

- Excl. @ 95%CL: 158-173 GeV
  - 153-179 GeV expected
  - Expected last year: 156-173 GeV





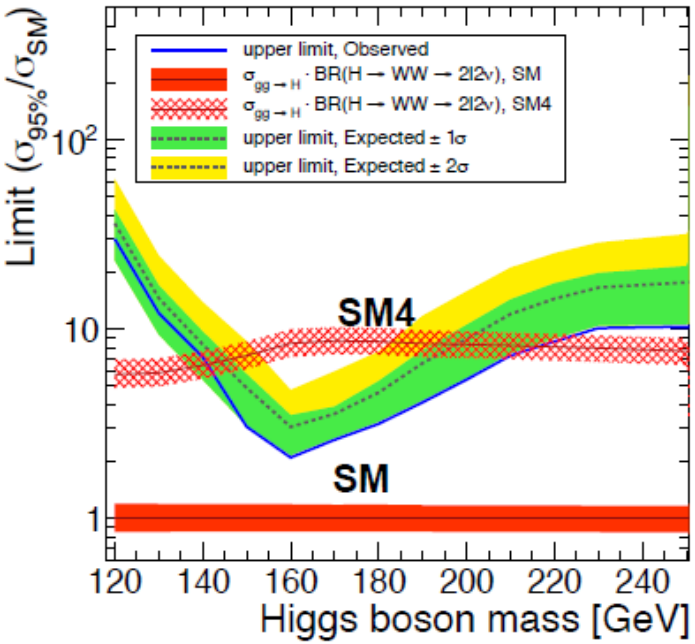
- Exclusion @ other CL:
  - Even at 99.5%CL, 162-166 GeV is out

Higgs, LHC : starting !

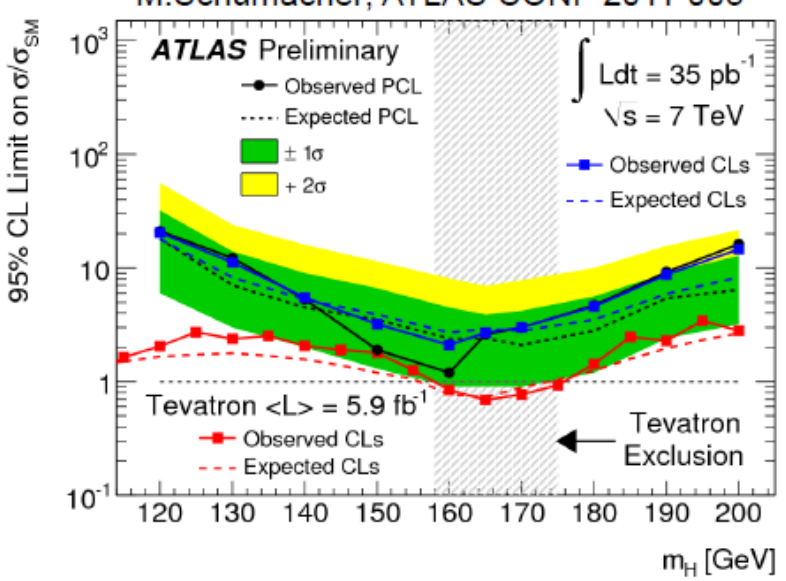
Vivek Sharma

- Single experiment limits: 2-3 x SM in H->WW

ArXiv:1102.5429; submitted to Phys. Lett.



M.Schumacher; ATLAS CONF 2011-005



95 % CL Limit for M_H = 160 GeV	CMS (Bayesian)
Expected	3.0 x SM
Observed	2.1 x SM

95 % CL Limit for M_H = 160GeV	ATLAS (CL_s)
Expected	2.7 x SM
Observed	2.1 x SM

SM-like Higgs in 4-gen models excluded for (144 < M_H< 207) GeV

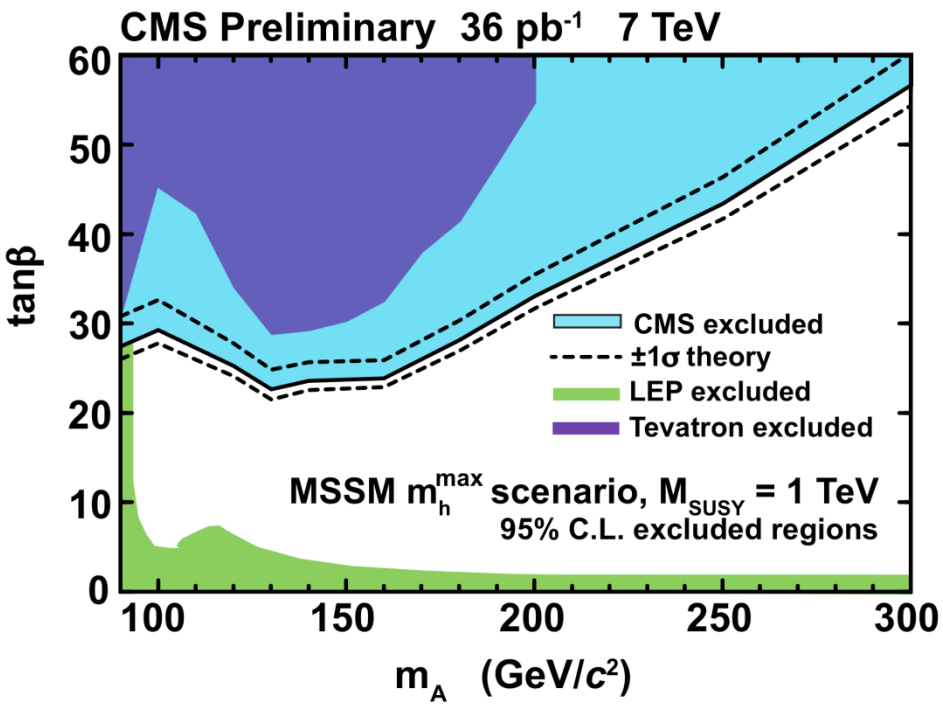
Better limit (already) than CDF+ D0 combined

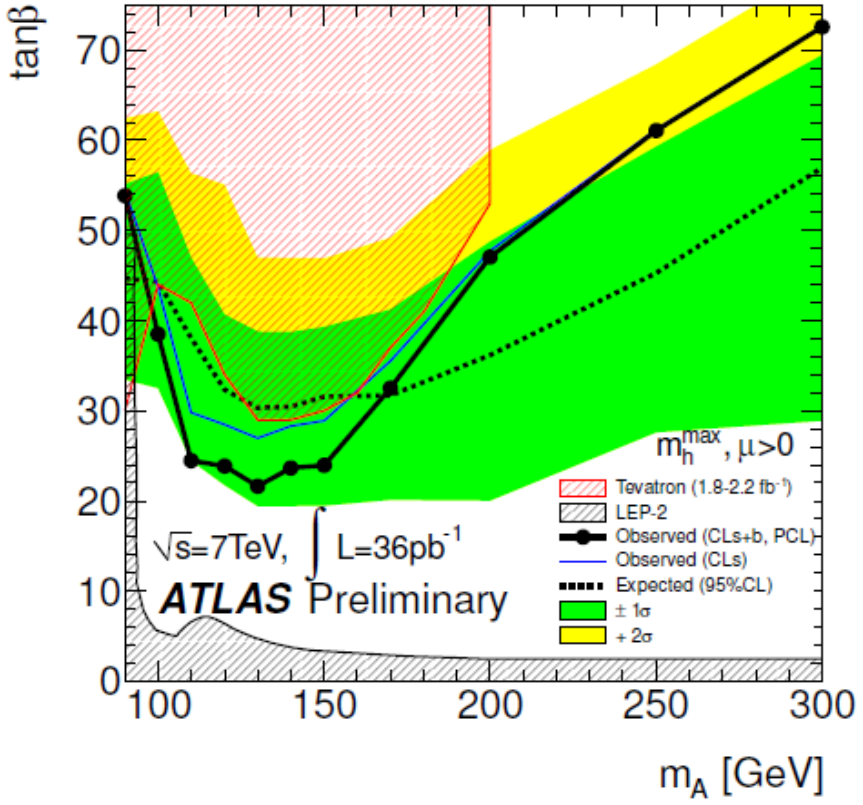
31

BSM Higgs : H→ττ

Christian Veelken
Markus Schumacher

- Challenge: τ id. ; clear Z→ττ peak
- Equivalent exclusion in SUSY parameter space
  - Better than Tevatron over entire range

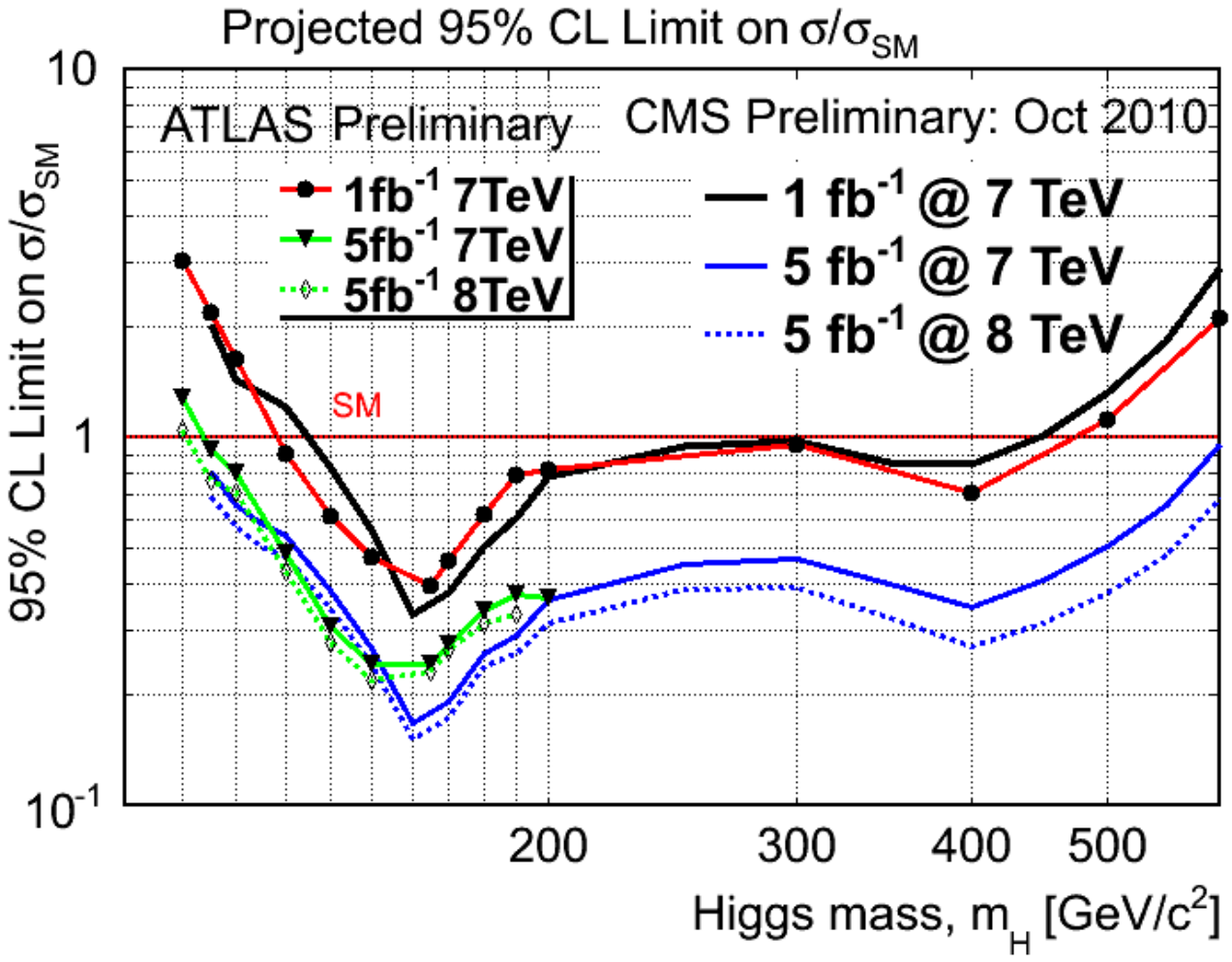




Higgs, LHC : perspectives

Vivek Sharma

- Most of low mass range already covered at 1 fb^{-1}



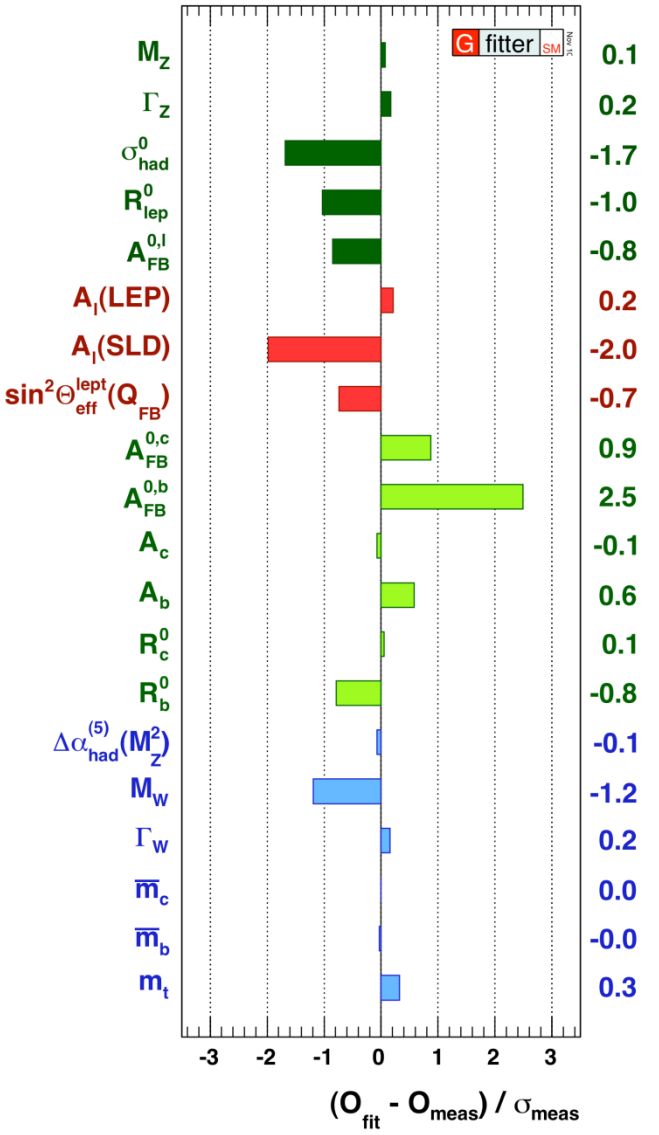
➔ How about discovery?

- "Combined": mass ranges assuming ATLAS+CMS ~ 2 x CMS

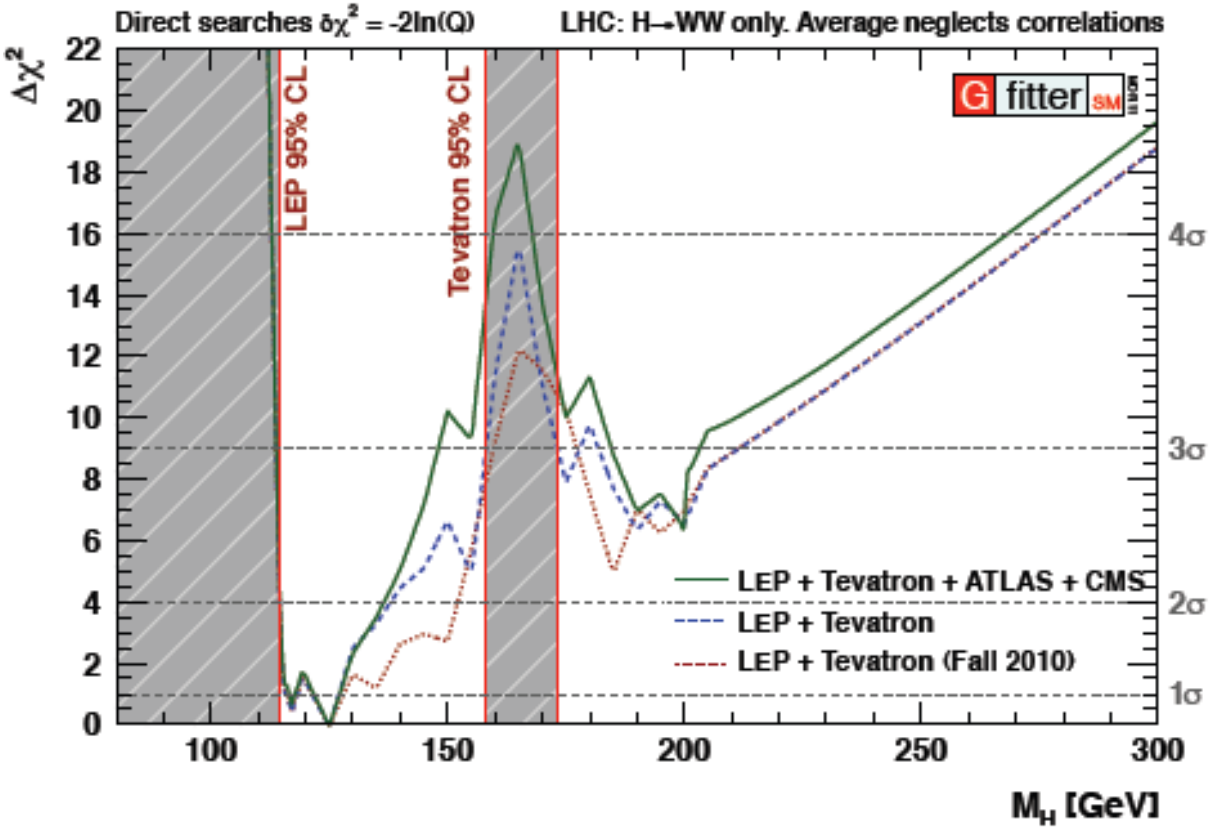
	1 fb^{-1}	5 fb^{-1}
3 σ	**135-475**	**114-600**
5 σ	**152-175**	**128-482**

SM global fits

Max Baak



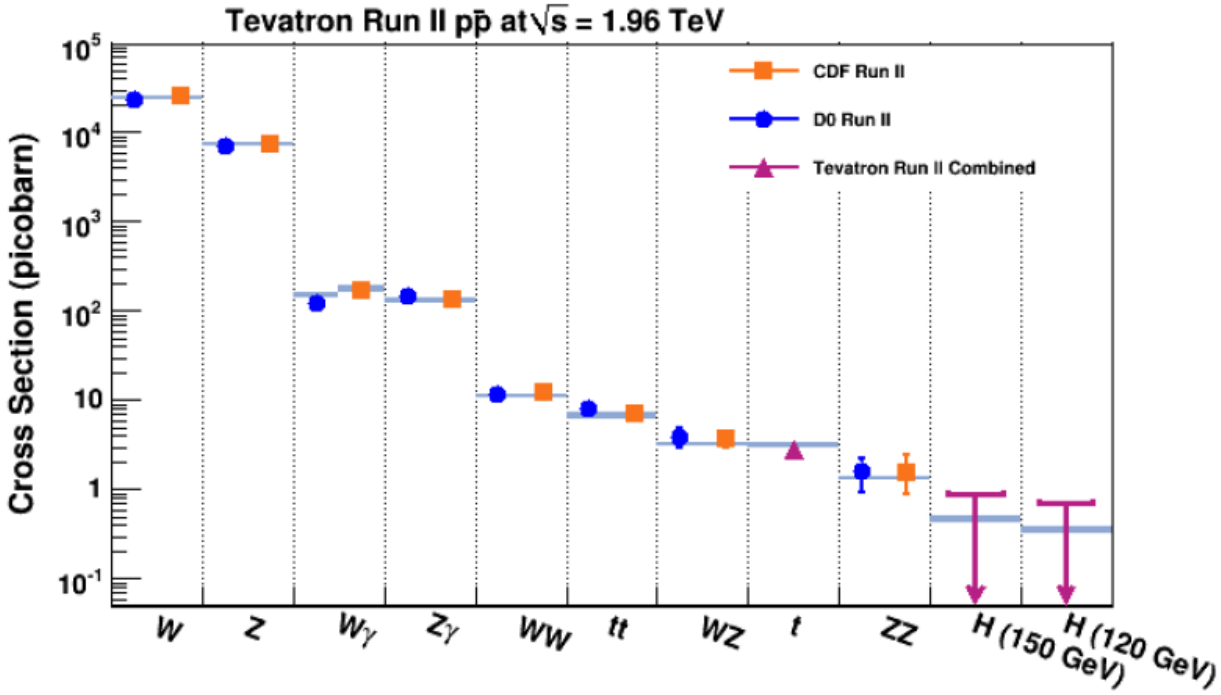
- Gfitter (www.cern.ch/Gfitter)
  - EW fit + Higgs searches : now with LHC data too!



SM measurements, Tevatron

Martina Hurwitz

- Boson, diboson, top, H production σ



Process	D0 measurement [pb]	CDF measurement [pb]	NLO prediction [pb]
WW	11.5 ± 2.2	$12.1^{+1.8}_{-1.7}$	$11.34^{+0.66}_{-0.55}$
WZ	$3.90^{+1.06}_{-0.90}$	4.1 ± 0.7	$3.22^{+0.23}_{-0.19}$
ZZ	$1.35^{+0.52}_{-0.43}$	$1.56^{+0.84}_{-0.68}$	1.4 ± 0.1

(Different measurements use different integrated luminosities, between 1 and 6 fb^{-1})

SM measurements, LHC

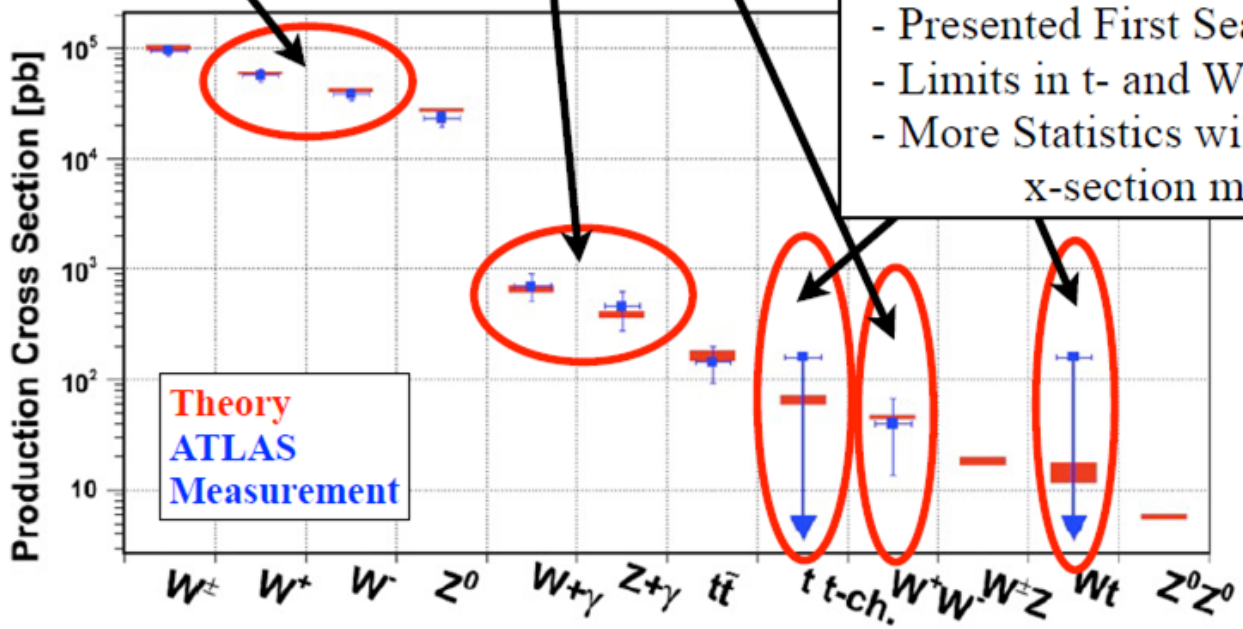
John Alison

- Start probing SM at a higher energy scale

W Asymmetry
- Measured in μ-ch.
- Uncert. Comparable w/ current PDF fits.
- Future measurements Constrain PDFs

Dibosons
- First Wγ / Zγ x-section measurements at 7 TeV
- Measured WW cross section
- Future measurements constrain New Physics aTGCs

Single Top
- Presented First Searches.
- Limits in t- and Wt- channels
- More Statistics will allow x-section measurements

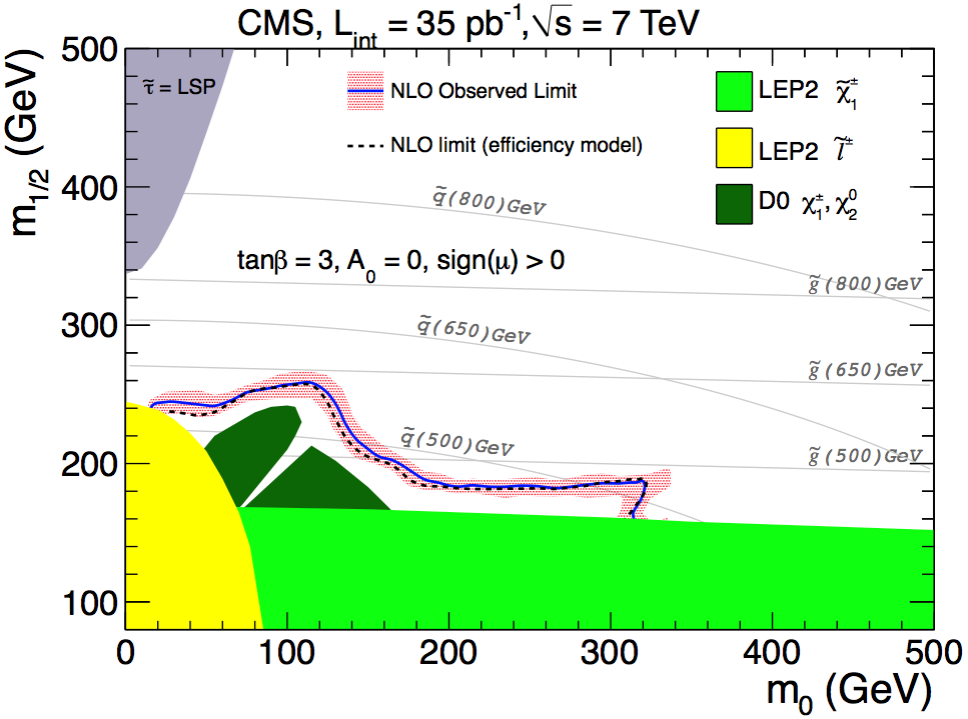


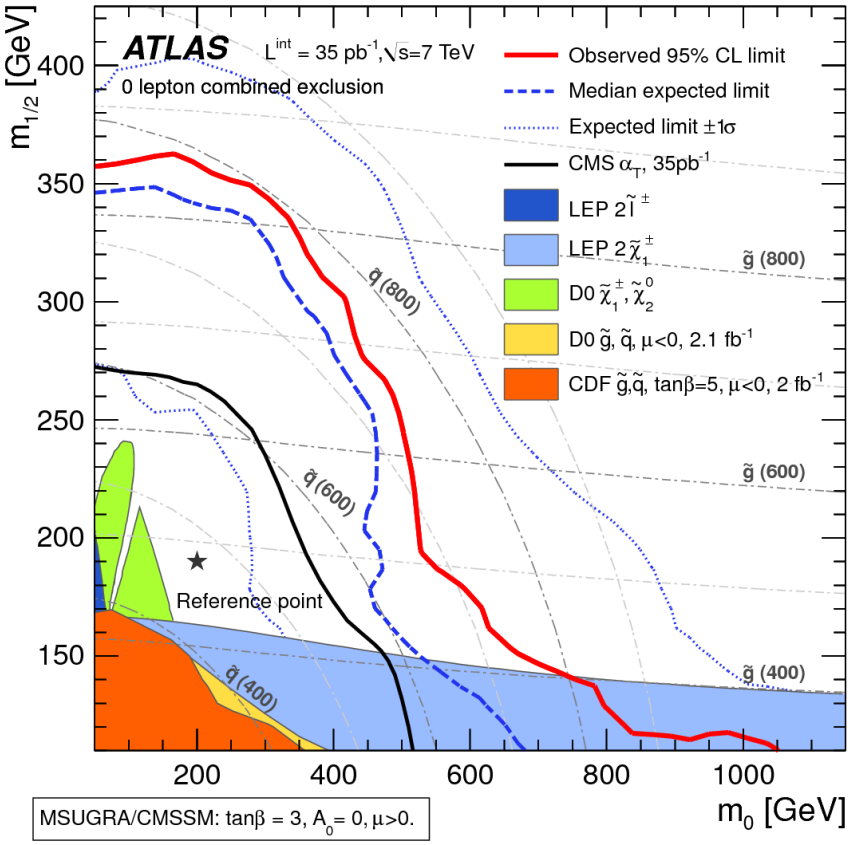
➔ WZ, ZZ coming next…

SUSY : LHC overtaking

Colin Bernet
Sascha Caron

- Significant LHC contribution to exclusion contours

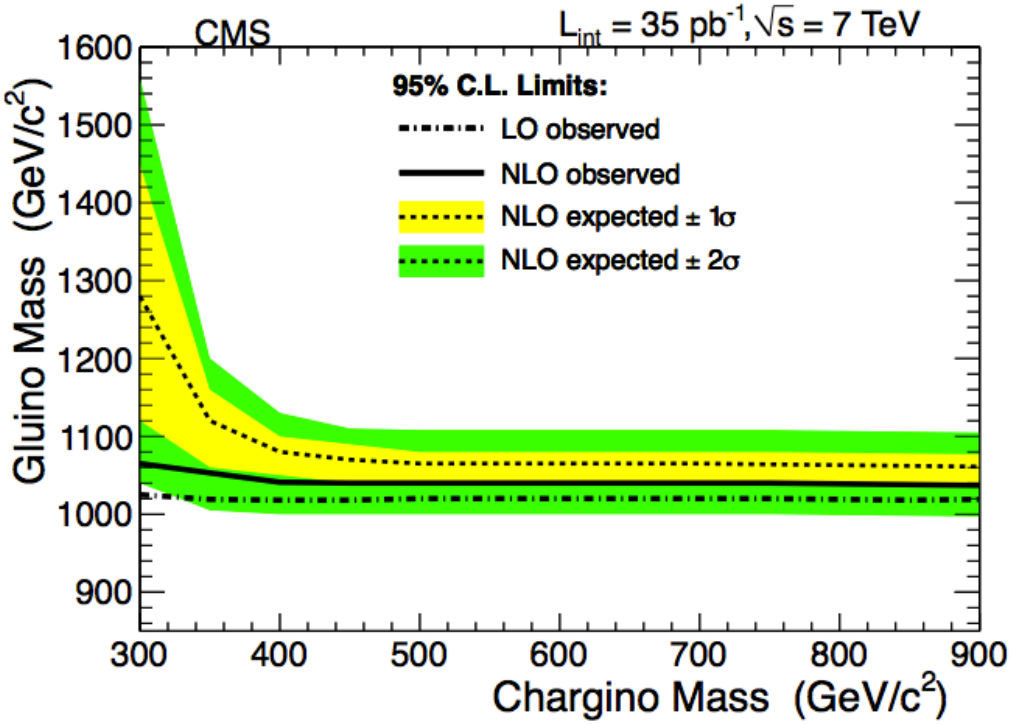




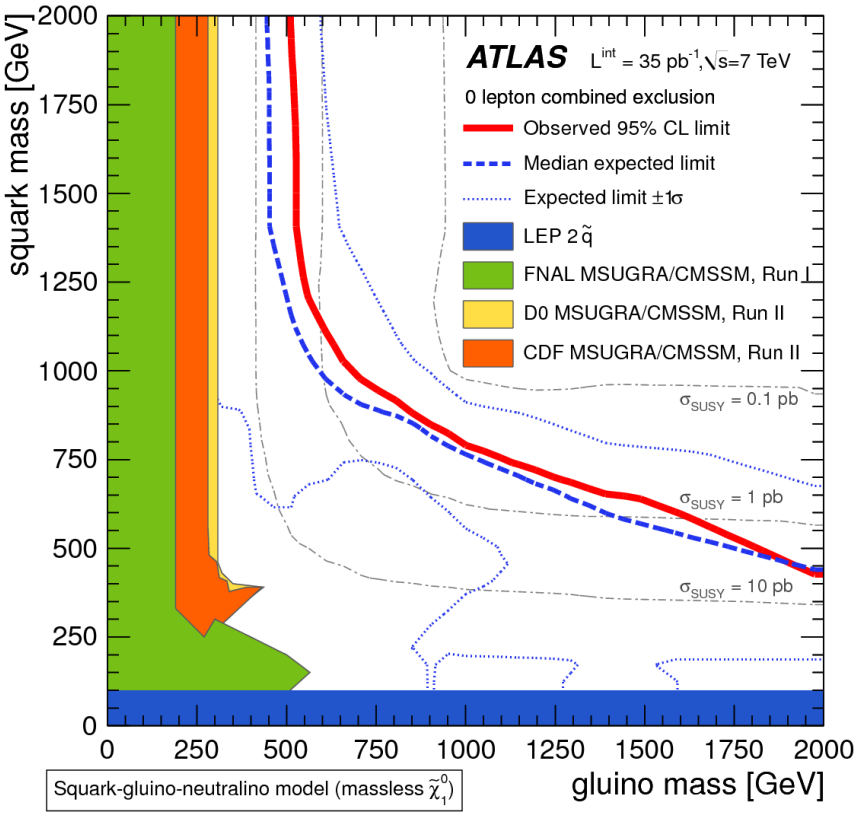
SUSY : LHC overtaking

Colin Bernet
Sascha Caron

- Significant LHC contribution to exclusion contours
  - We were told to look at “real” mass plots…



GMSM: LSP = gravitino

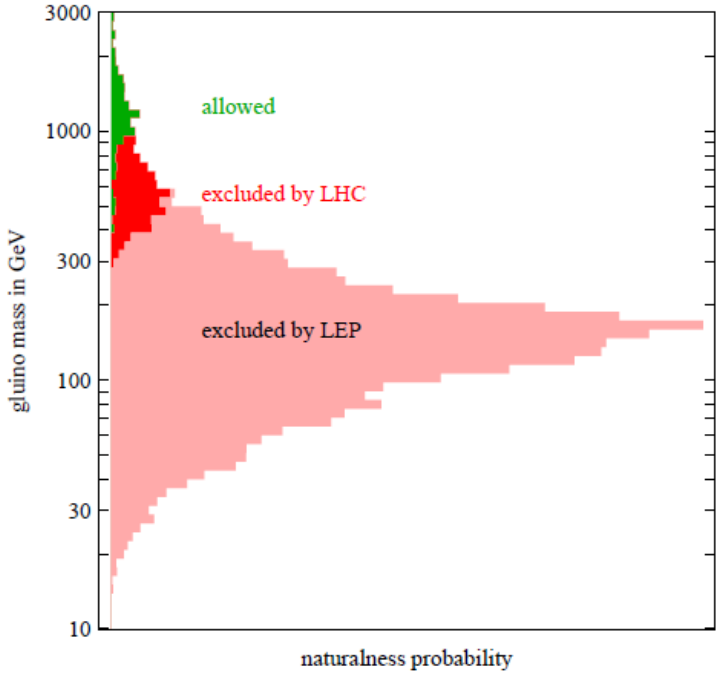


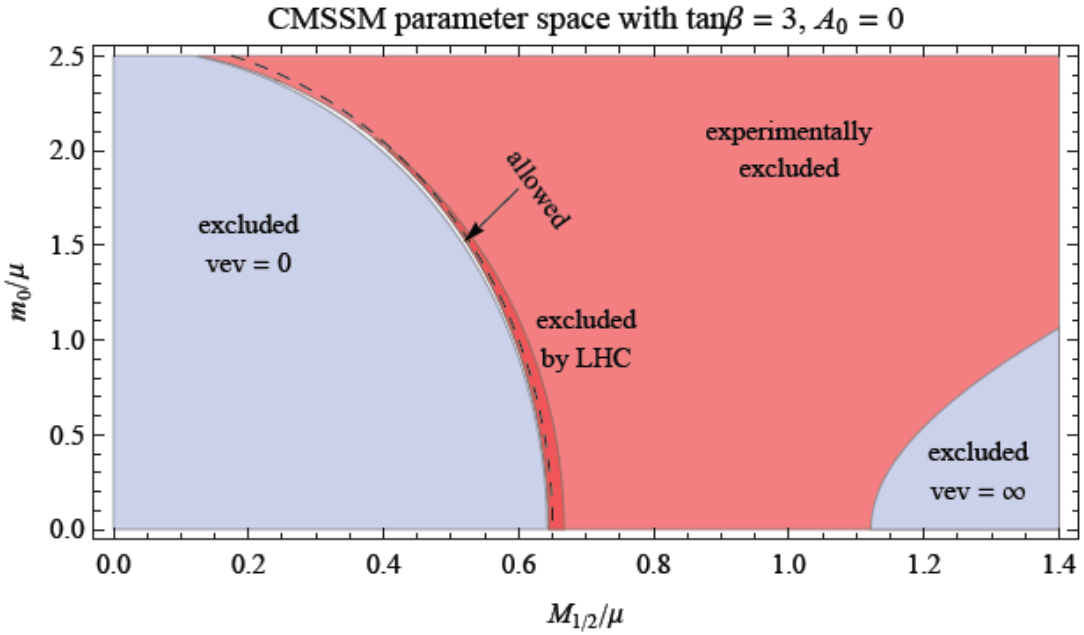
Simple MSSM Model with light 1st and 2nd gen. squarks, gluinos and a massless neutralino

SUSY : believe ?

Alessandro Strumia

- How plausible is supersymmetry after 2010?
  - Natural scale for SUSY is M_Z ; so fine tuning…

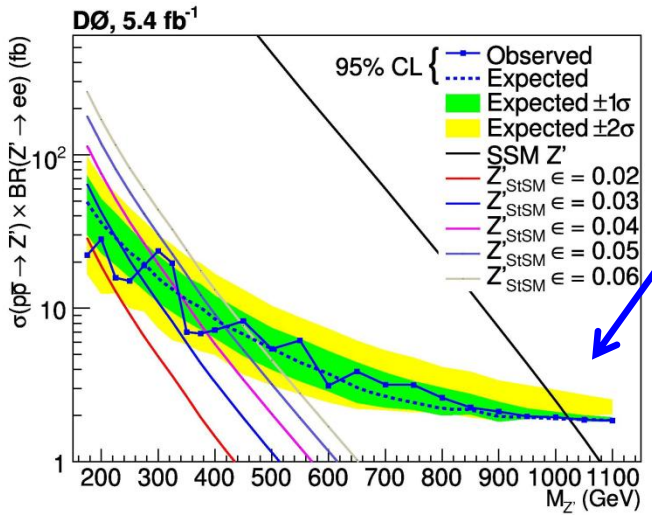




We have significant hints for SUSY.
We have significant hints against SUSY.
At some point somebody will understand what is the logic.

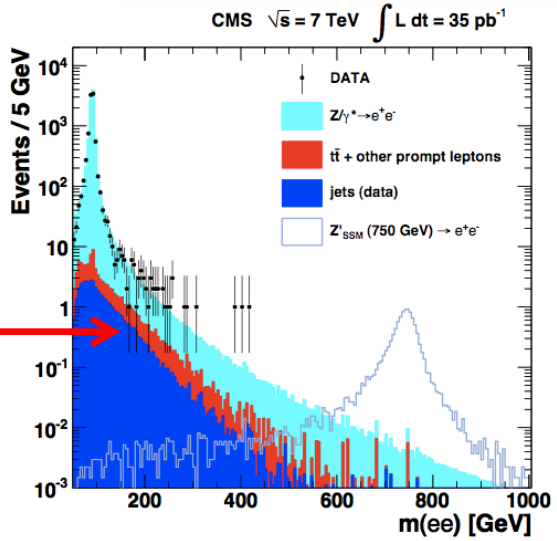
BSM : new bosons

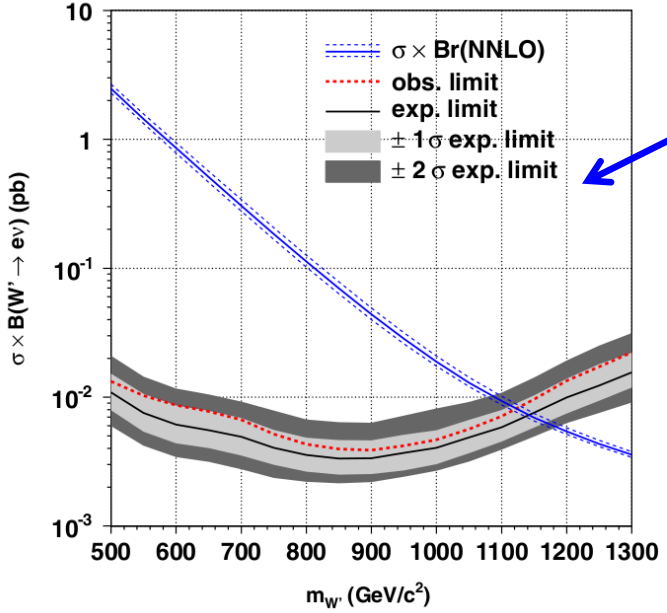
Francesco Santanastasio
Michel Jaffré
Doug Gingrich



Z'→ee, D0:
M>1023 GeV
(all @ 95@CL)

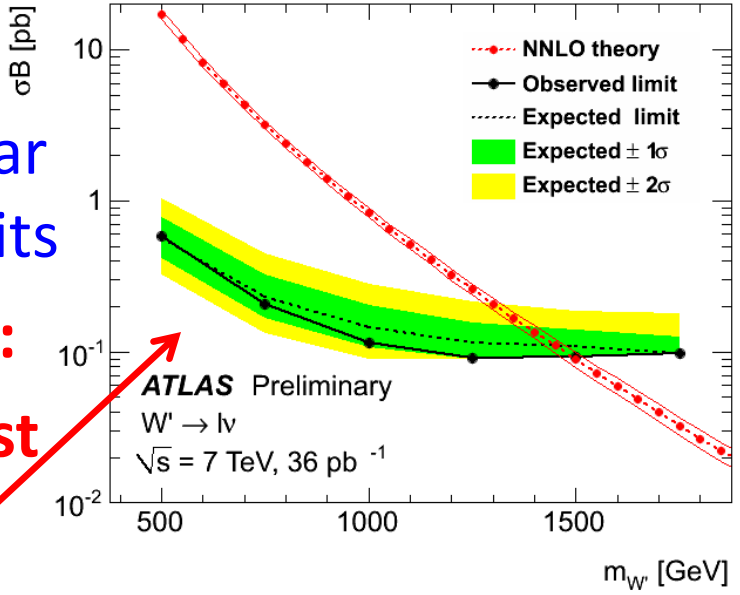
Z'→ee, CMS:
M>958 GeV





W', CDF:
M>1.12 TeV, near phase space limits

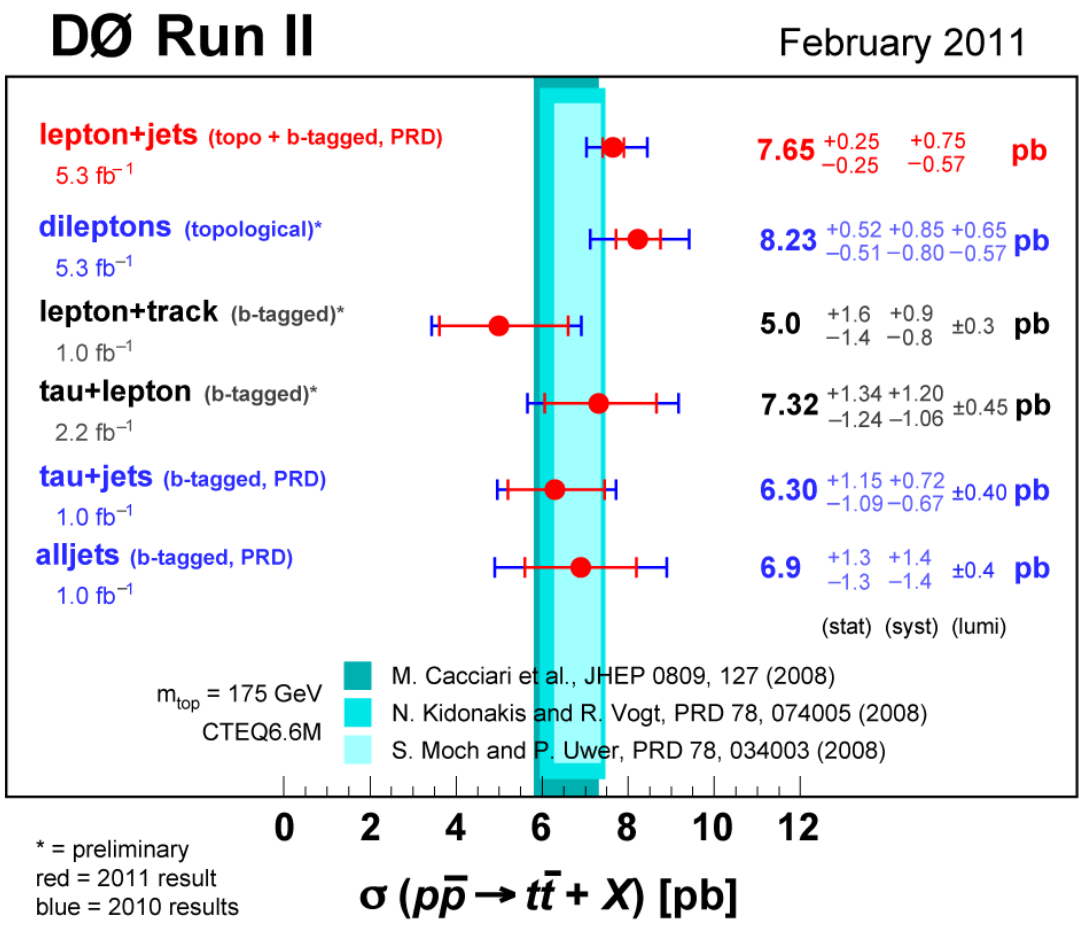
W'→lν, ATLAS:
M>1.46 TeV, just beginning

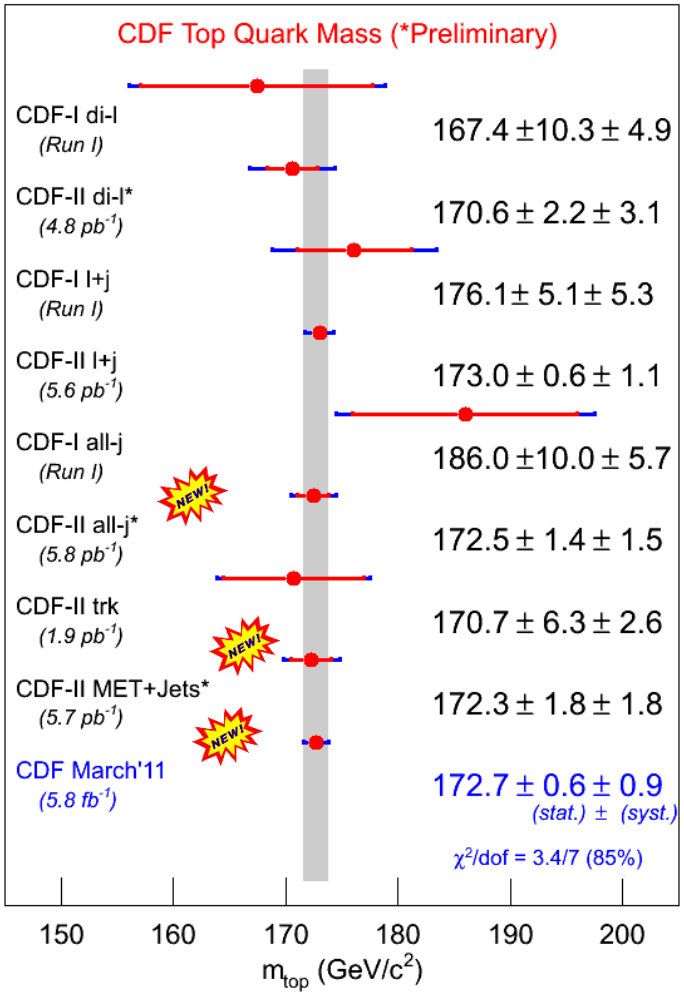


Top : precisely

Liang Li
Fabrizio Margaroli

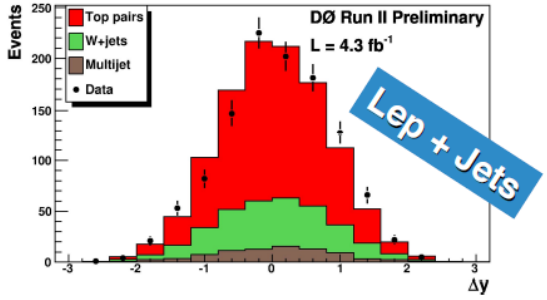
- Tevatron still main top physics source !





Top : getting outside SM

Fabrizio Margaroli



$A_{FB}^{SM} = 1 \pm 1.5\ \%$

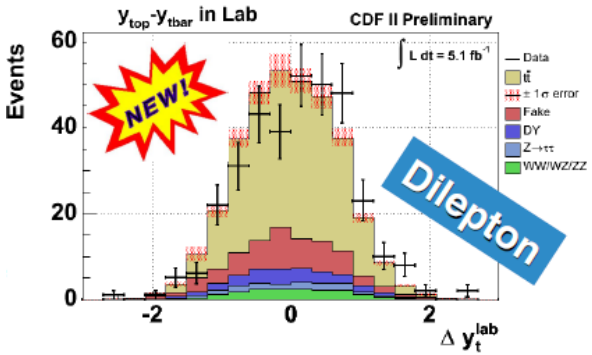
vs

$A_{FB}^{D0} = 8.0 \pm 4\ \%$

*background subtracted

2σ

D0



$A_{FB}^{SM} = 5.0 \pm 1.5\ \%$

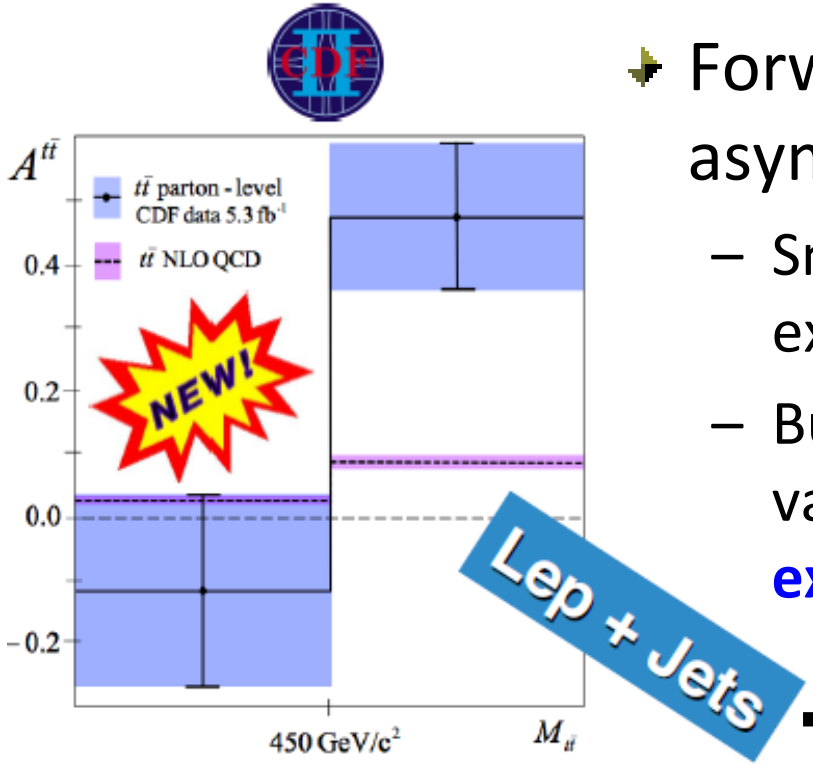
vs

$A_{FB}^{CDF} = 42 \pm 16\%$

*parton level

2.3σ

CDF



$A_{FB}^{SM} = 8.8 \pm 1.3\ \%$

vs

$A_{FB}^{CDF} = 48 \pm 11\ \%$

hep-ex/1101.0034

*parton level

>3σ

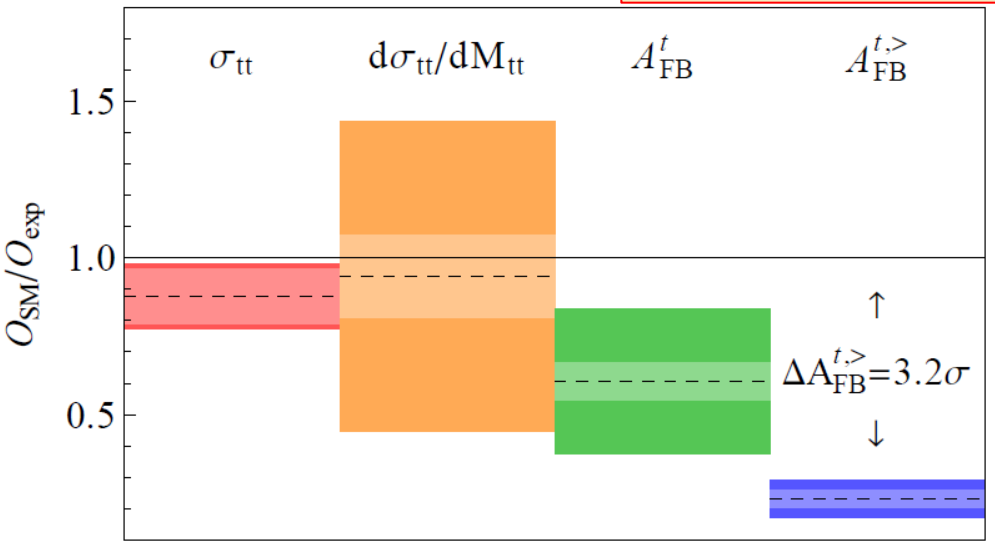
- Forward-backward asymmetry in ttbar
  - Small contribution expected from QCD
  - But observed values not so small: **excess > 3 σ…**

➔Still include 2 x data, 2 decay modes, D0 + CDF… More to come !

Top : non-SM A_{FB} ?

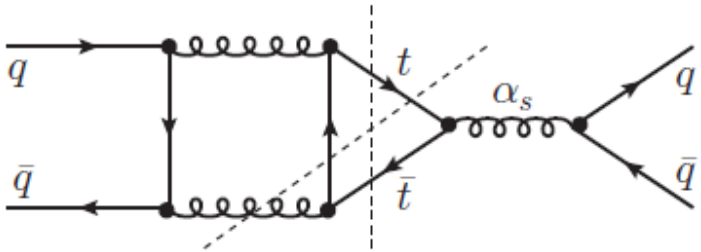
Susanne Westhoff

- New physics ?
  - No hint in other top measurements
  - A_{FB} may be explained by Randall-Sundrum extra dimensions models



Standard Model: A_{FB}^{t} at NLO

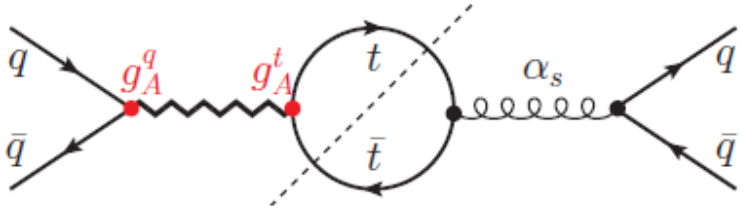
$$\sigma_a \sim \alpha_s^3$$



+ 10% electroweak corrections

New physics: A_{FB}^{t} at tree level

$$\sigma_a \sim -\alpha_s\, g_A^q g_A^t$$

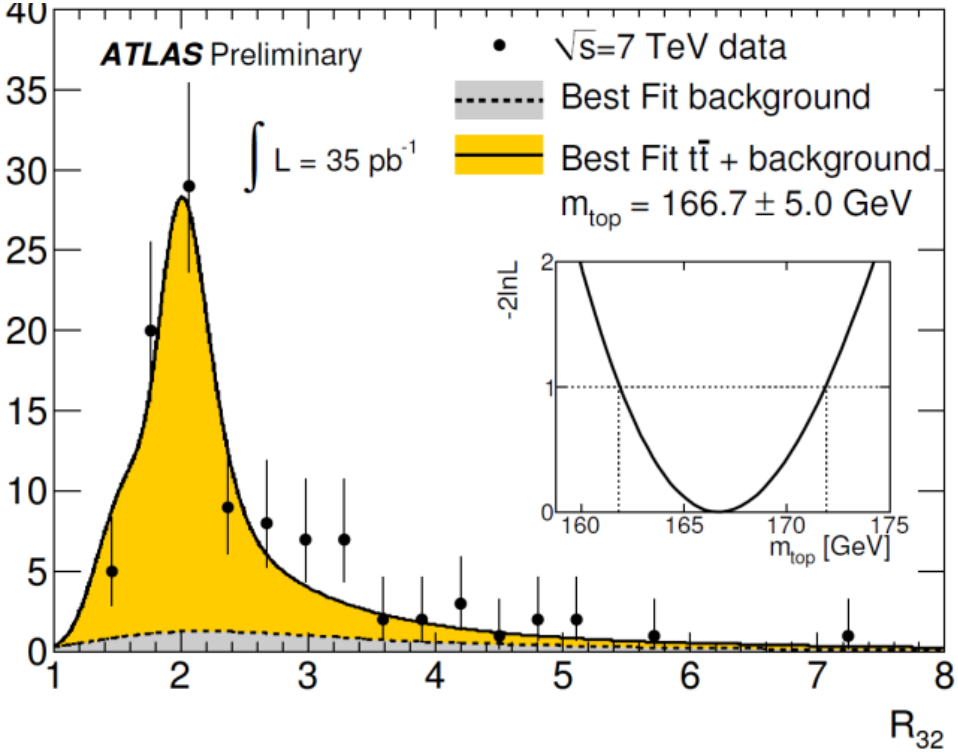


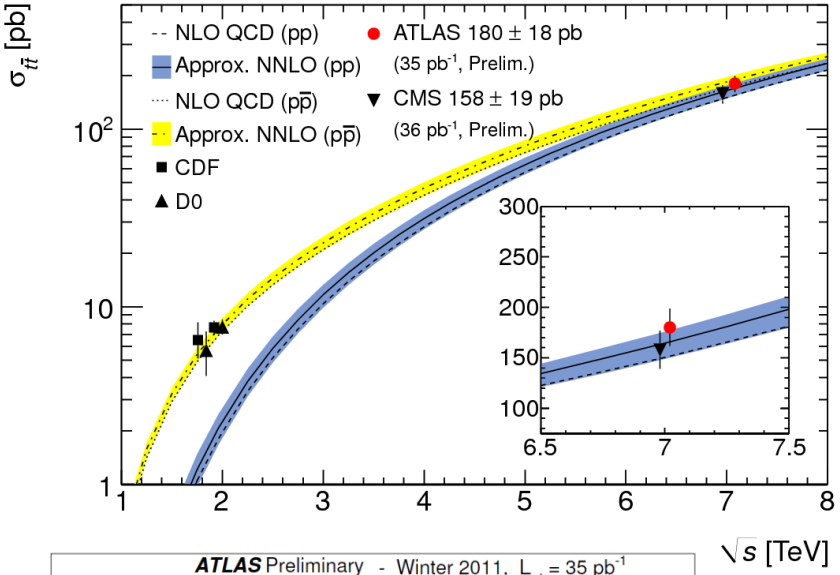
+ t- and u-channel new physics

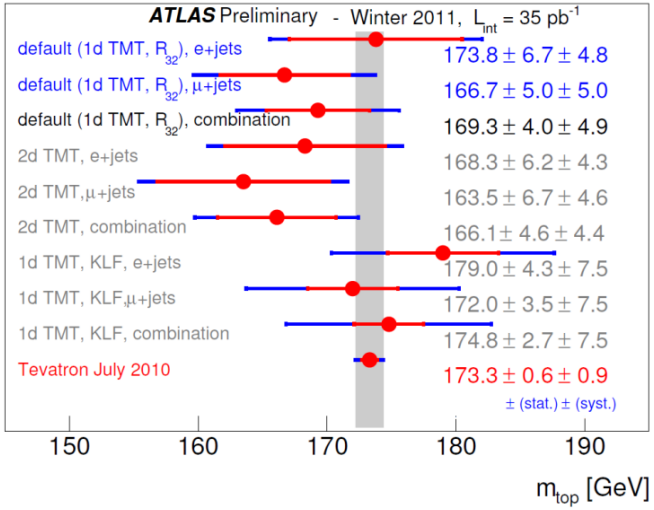
Top : LHC, too

Markus Cristinziani

- Soon more tops than Tevatron…
  - σ already at 10% level, in pp collisions
  - First mass measurements







B physics : another > 3 σ…

Julia Thom-Levy

- D0 6.1 fb^{-1}analysis yields:

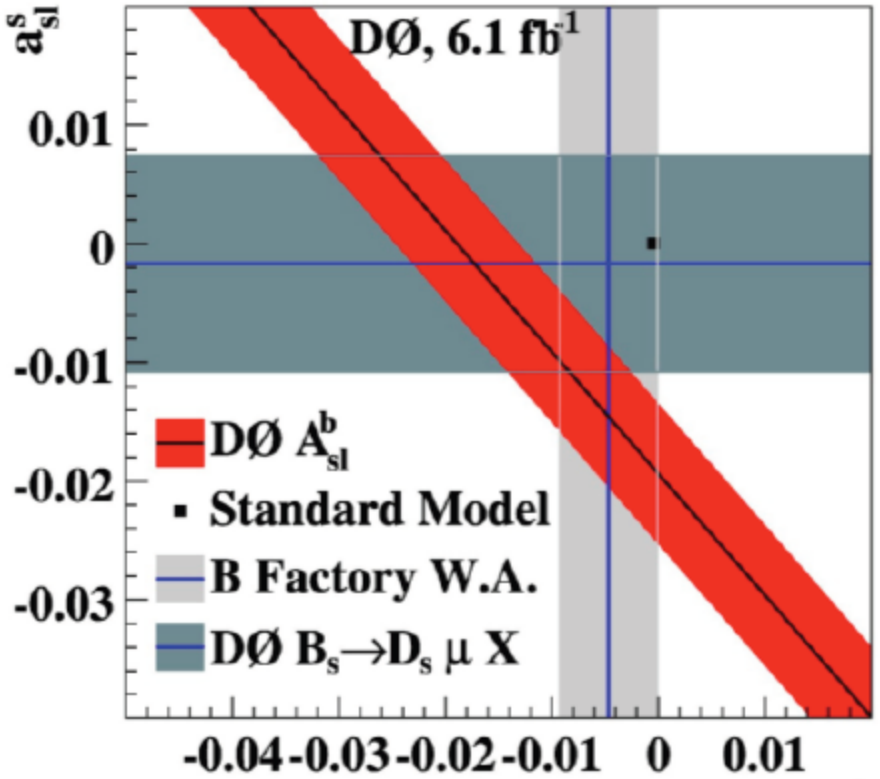
$$A_{sl}^{b} = (-0.957 \pm 0.251(stat) \pm 0.146(syst))\%$$

- SM prediction:

$$A_{sl}^{b}(SM) = (-0.023^{+0.005}_{-0.006})\%$$

using prediction of a_d and a_s from *A. Lenz, U. Nierste, hep-ph/0612167*

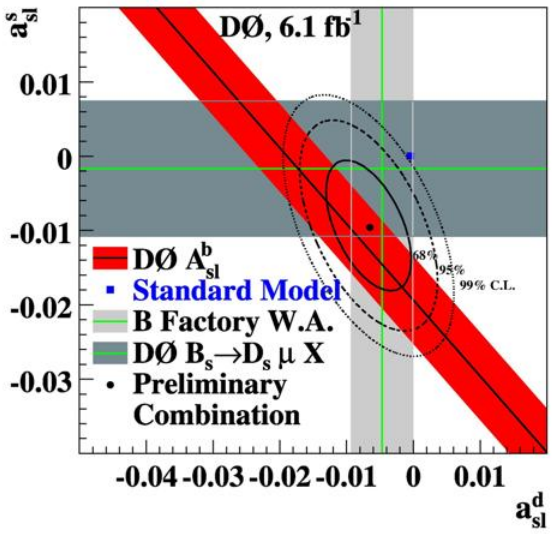
- Differs from SM by ~3.2σ
  - Indication of an anomalously large B_s mixing phase?

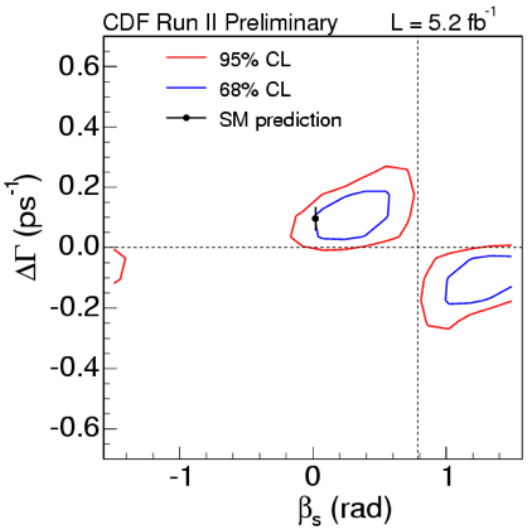


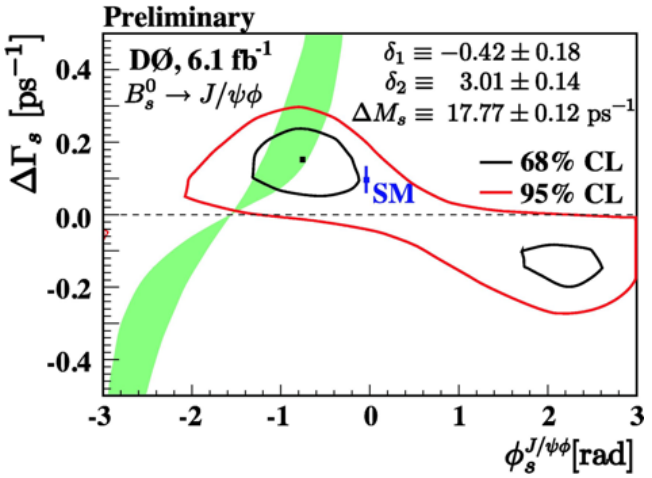
$$A_{\rm sl}^{b} = (0.506 \pm 0.043)a_{\rm sl}^{d} + (0.494 \pm 0.043)a_{\rm sl}^{s}.$$

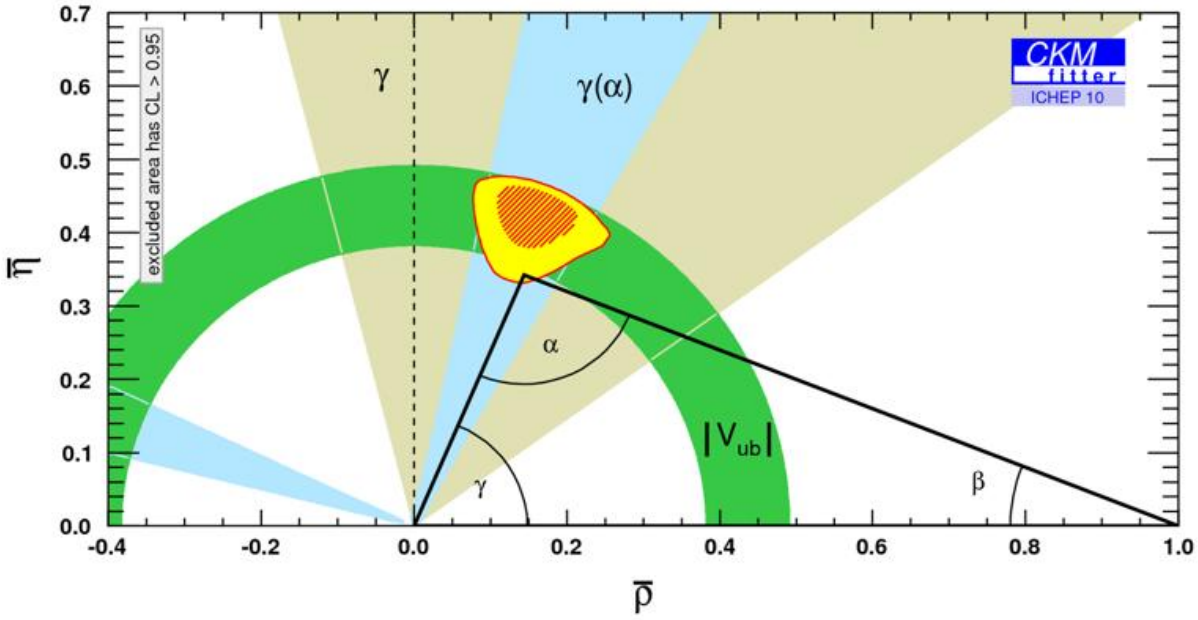
B physics : something new?

Michele Papucci









- Discrepancies in this sector, no clear hint
- NP : minimal flavor violation possible

Summary

- **Great news from LHC**
  - Excellent 2010, optimism for 2011
  - No discovery but better limits in many cases
- **No surprises from Higgs**
  - Both colliders claim large spectrum probing soon !
- **An indirect hint of… what ?**
  - A_{FB}, di-μ charge asym… Something hiding in there ?
- **I'm a bit lost in theory phase space**
  - Personal taste for extra dim (wouldn't that be cool ?)

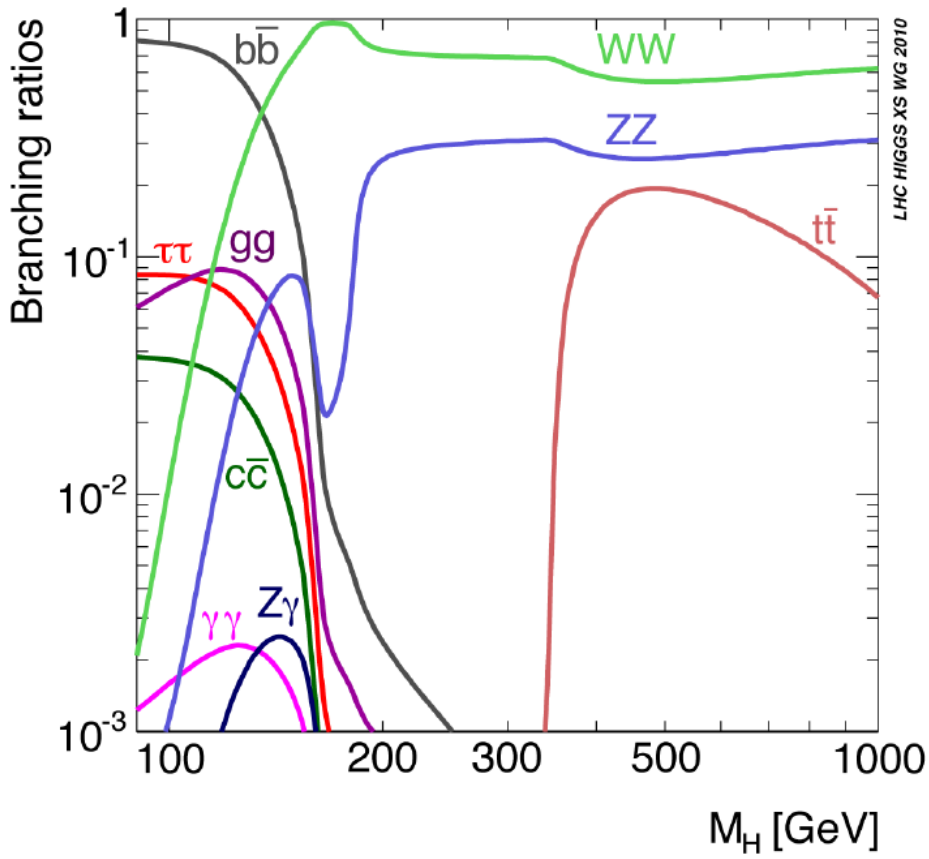
Backup

Higgs : no surprise, many hopes

- TeVatron : now separating two search ranges
  - Combination covers m_H=100 GeV/c^2 to 200 GeV/c^2
    - "Low mass": all channels, $m_H < 150$ GeV/c^2
      - Last updated summer 2010
    - "High mass": primarily $H \rightarrow WW$, m_H>130 GeV/c^2
      - **New** for this conference
- LHC : first results coming !
  - SM Higgs : many studies started, limited sensitivity
  - BSM Higgs : already competitive
  - Interesting expectations for 2011

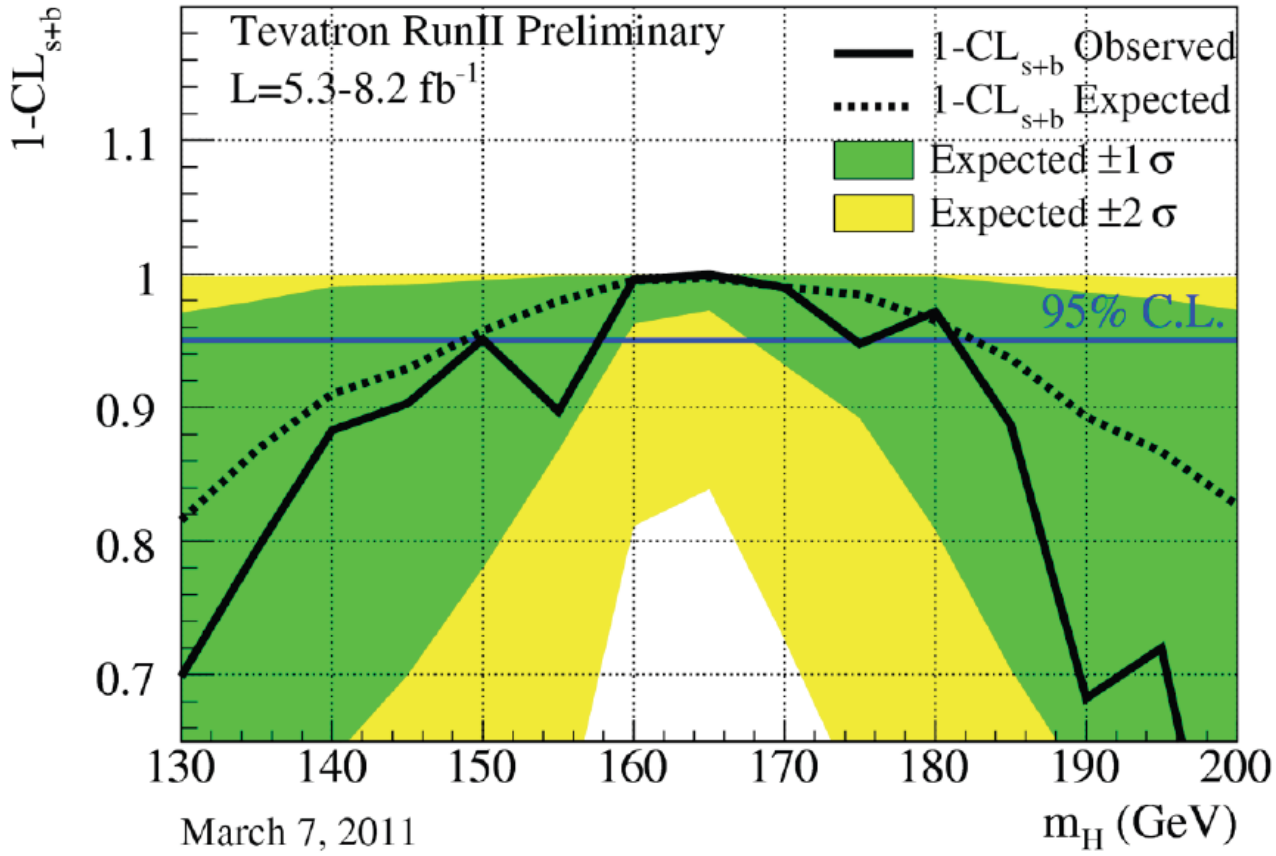
Higgs decays

Higgs Decay Modes Vs Its Mass



Higgs, Tevatron, high mass, alt.

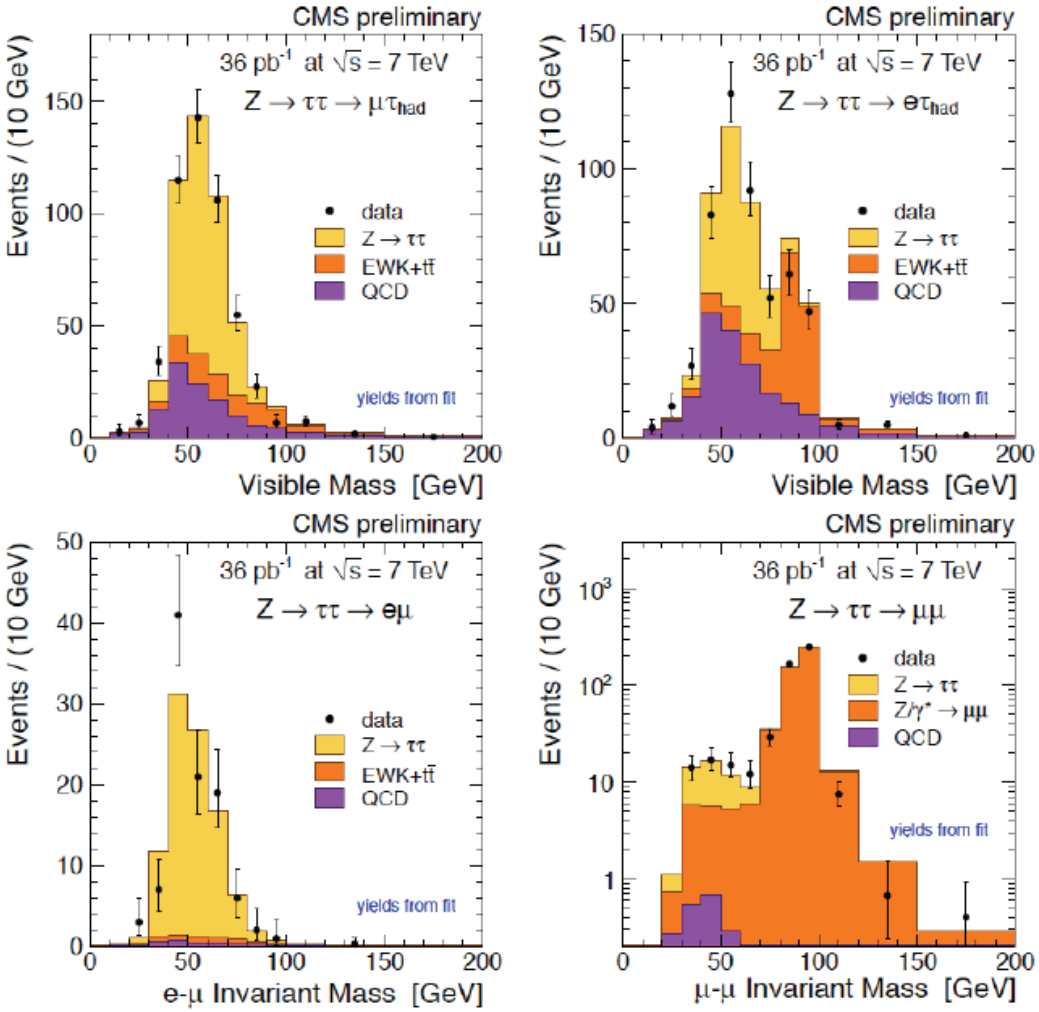
Another approach: CL_{s+b}



- Roughly comparable to Power constrained CL_{s+b} approach used by ATLAS

Z→ττ peak in CMS

Visible Mass Spectra

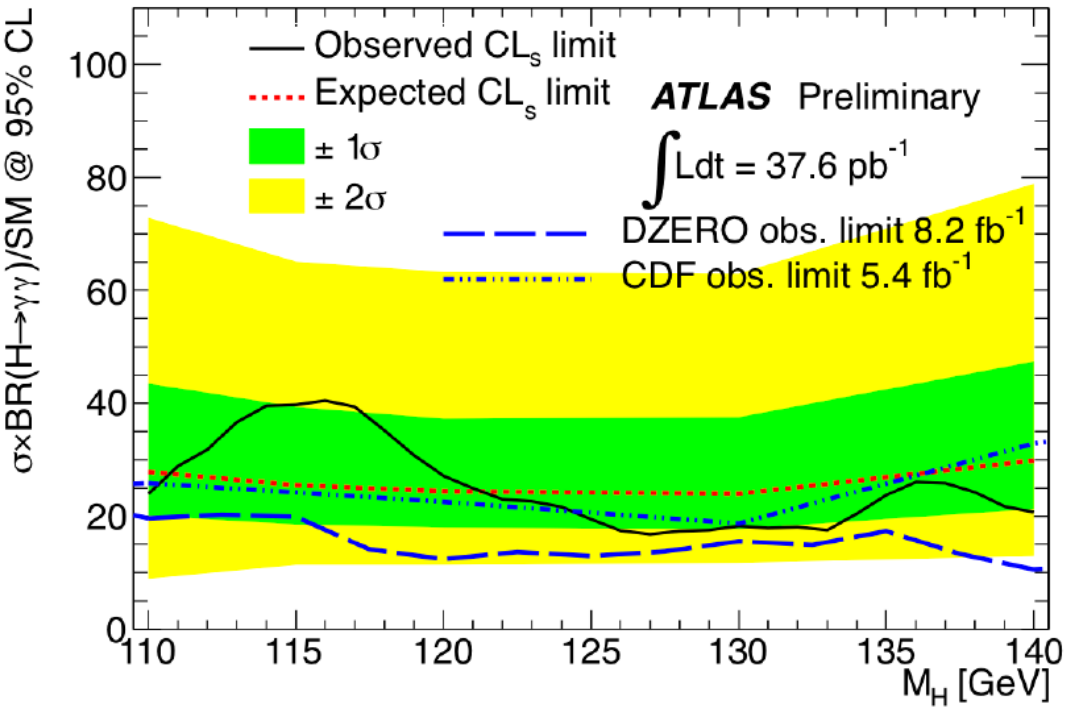


➔ Clear Z → $\tau^+\tau^-$ Signal established in all Channels

H→γγ, ATLAS : already competitive

H → γγ : ATLAS & D0 Limits Overlaid

M.Schumacher; ATLAS CONF-2011-025 P. Totaro; D0 Note 6177-CONF



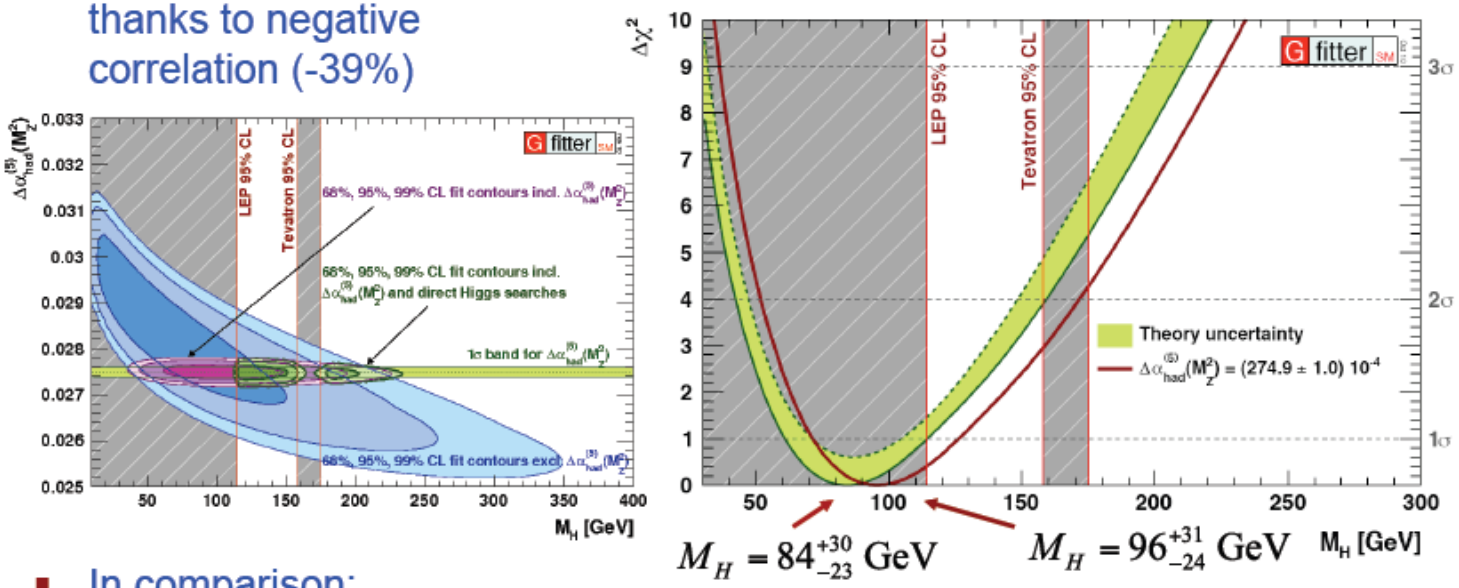
LHC already competitive with Tevatron

29

Higgs, without Higgs searches

Electroweak fit – Impact of new $\Delta\alpha_{had}^{(5)}(M_Z^2)$

- We use latest value: $\Delta\alpha_{had}^{(5)}(M_Z) = (274.9 \pm 1.0)\cdot 10^{-4}$ [Davier et al., arXiv:1010.4180]
  - Includes (among others) new $\pi^+\pi^-$ and multi-hadron x-sections from BABAR
  - Value decreased compared with previous value: $\Delta\alpha_{had}^{(5)}(M_Z) = (276.8 \pm 2.2)\cdot 10^{-4}$ [Hagiwara et al., PLB B649, 173 (2007)]
- Increase of M_H by 12 GeV thanks to negative correlation (-39%)

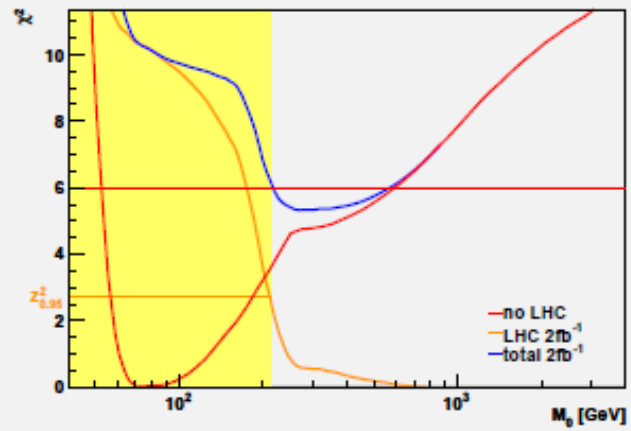


- In comparison:
  - Preliminary value $(275.9\pm1.5)\cdot10^{-4}$ (Teubner at Tau2010): $M_H = 90^{+30}_{-24}$ GeV
  - LEP EW wg: $(275.8\pm3.5)\cdot10^{-4}$ (Burghardt & Pietrzyk, 2005): $M_H = 89^{+36}_{-26}$ GeV

SUSY plausibility

Is there a Tension Building Up?

- LE prefers low mass scales (for non-coloured sector),
  LHC prefers high mass scales (for coloured sector)



$\mathcal{L}^{int}/\mathrm{fb}^{-1}$	χ^2/ndf	$\mathcal{P}-Value$
0	18.9/20	53.1 %
0.035	20.4/21	49.8 %
1	23.7/21	30.9 %
2	24.2/21	28.3 %
7	25.0/21	24.6 %

- Using the present systematic uncertainties on the background estimation (and ignoring fine-tuning), even mSUGRA will survive the 2011/2012 run.
  You may not find the model too attractive anymore, but that's an entirely different question

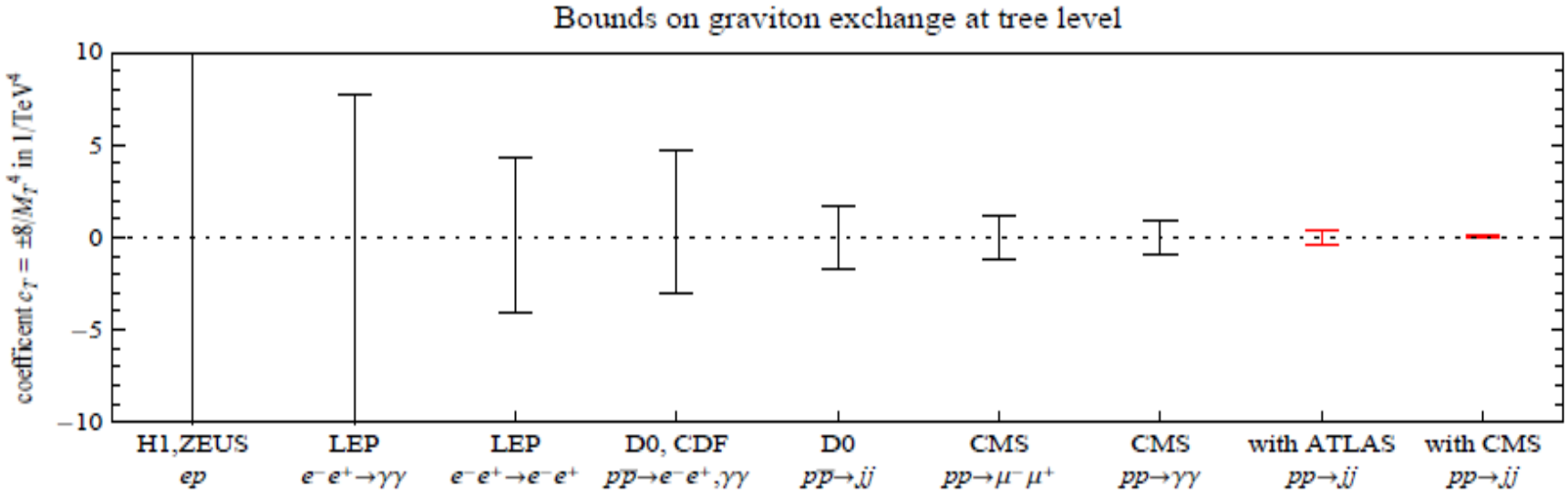
Exotics : LHC take-over

Alessandro Strumia

- Graviton: very energy-dependent

  → LHC ahead, even with few data

We derived the new dominant bound $M_T > 3.4\,\text{TeV}$ from first LHC data:



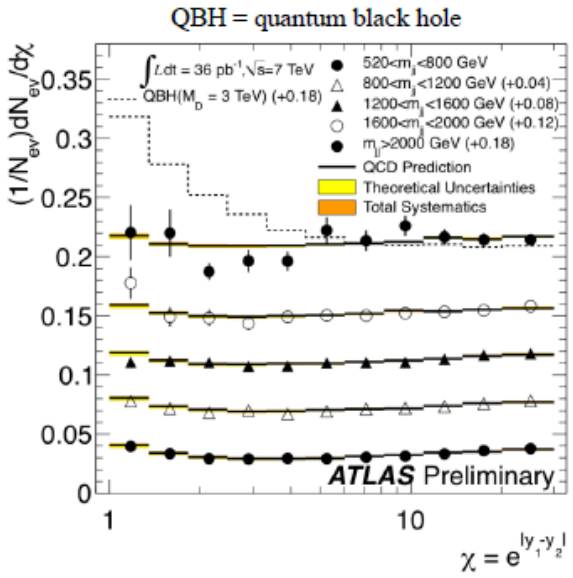
No black holes yet

Angular Distributions

- $p_T^{J1} > 60$ GeV, $p_T^{J2} > 30$ GeV.
- $y_B = 0.5\,(y_1 + y_2) < 1.10$
- $y^* = 0.5\,(y_1 - y_2) < 1.70$
- Data consistent with QCD.

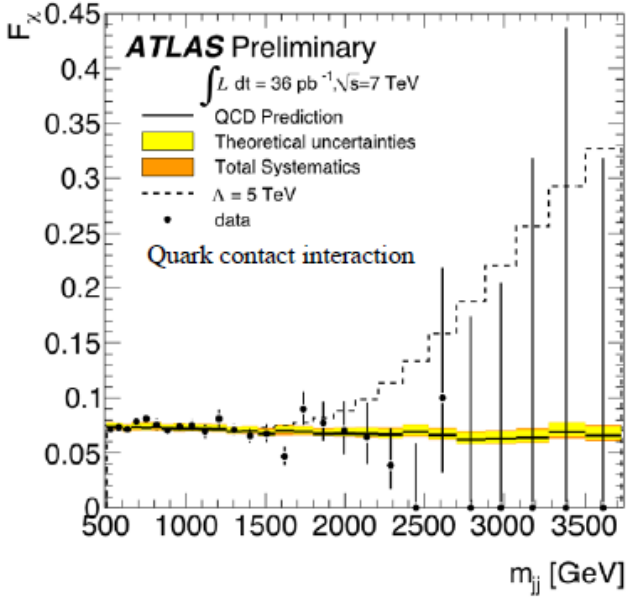
$$\chi = \exp(|y_1 - y_2|) = \exp(2\,|y^*|)$$

QBH = quantum black hole

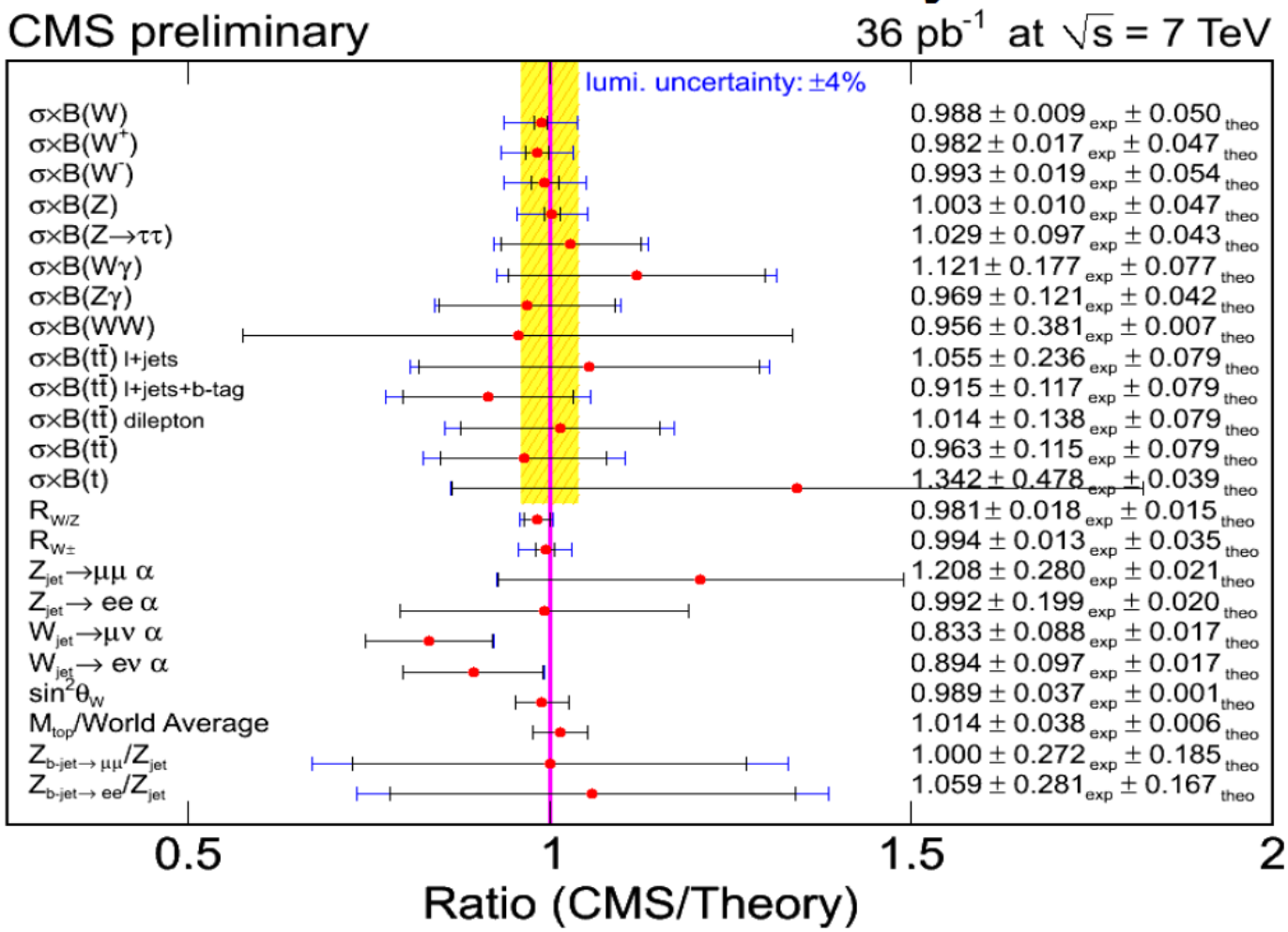


Dijet centrality

$$F_\chi(m_{jj}) = \frac{N_{events}(|y^*| < 0.6)}{N_{events}(|y^*| < 1.7)}$$

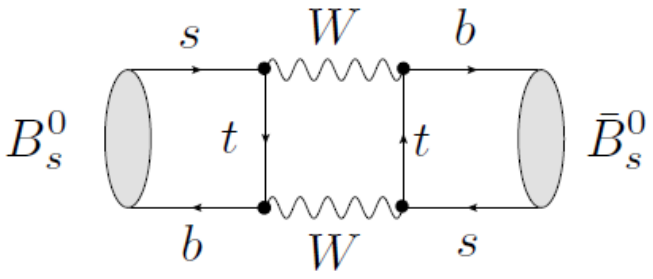


SM/Top : many measurements at CMS

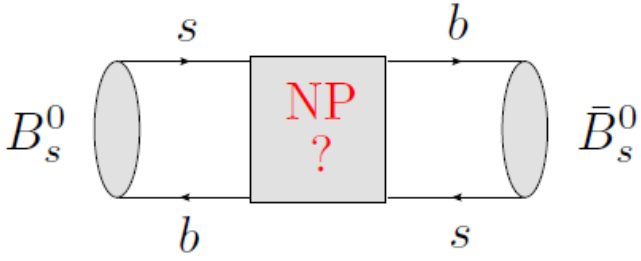


B physics : where NP appears

⋆ Search for NP in B_s^0–$\bar{B}_s^0$ mixing:



Standard Model



New Physics (e.g. SUSY, Z' models)

◇ FCNC process: ⇒ strongly suppressed in the SM ("box" diagrams)

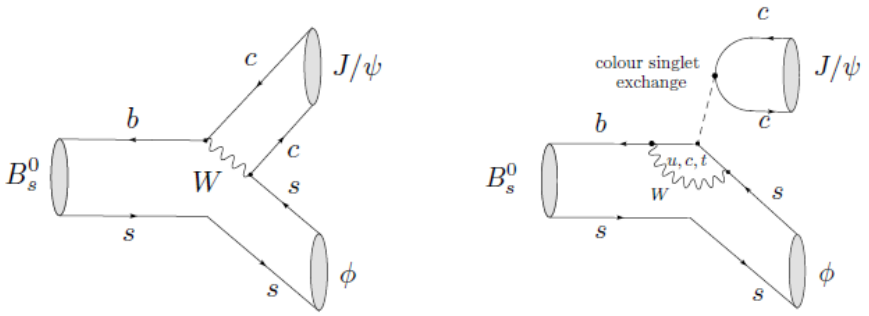
⋆ involves a CP-violating phase $\phi_s = \phi_s^{\rm SM} + \phi_s^{\rm NP}$

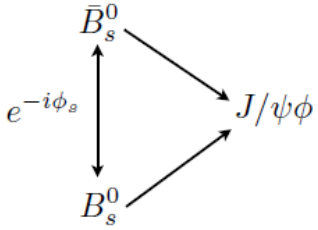
→ SM piece is *tiny*: $\phi_s^{\rm SM} \approx -2^\circ$

⇒ sensitive probe for NP

B physics : where NP appears (2)

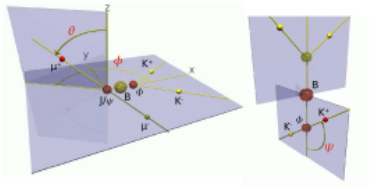
CP Violation in $B_s^0 \to J/\psi\phi$





- Interference effects through B_s^0–$\bar{B}_s^0$ mixing:
  - *Mixing-induced* CP violation in time-dependent rates.
  - Hadronic parameters cancel to good approximation:

$$\Rightarrow \boxed{\text{CP asymmetries} \sim \sin\phi_s}$$



- Final state is mixture of CP-odd and -even eigenstates:

  $\to$ disentangle through $J/\psi[\to \mu^+\mu^-]\phi[\to\ K^+K^-]$ angular distribution.

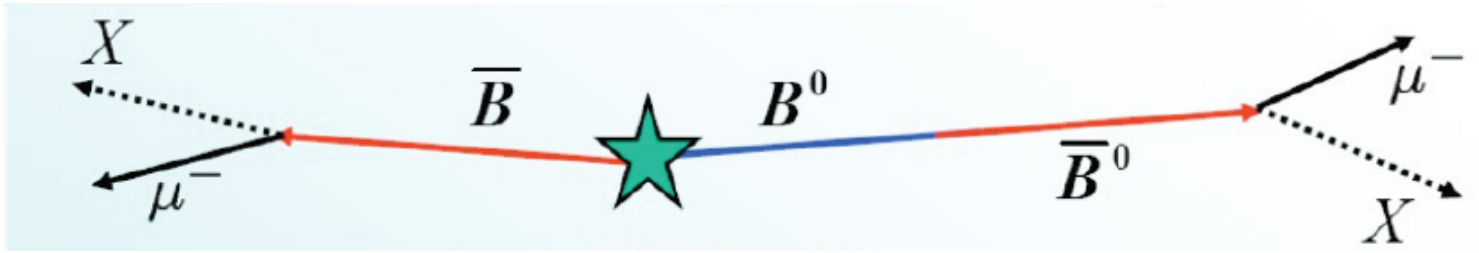
- *Smallish* CPV in the SM: $\Rightarrow$ sensitive probe for NP in B_s^0–$\bar{B}_s^0$ mixing

[Dighe, Dunietz & R.F. ('99); Dunietz, R.F. & Nierste ('01); Faller, R.F. & Mannel ('08)]

What is A_{sl}^{B} ?

Di-muon charge asymmetry

V. A. Abazov et al, Phys. Rev. Lett. ***105****, 081801 (2010)*



Decay of B tags its flavor

- Measure:

$$A_{sl}^{b} = \frac{N_b^{++} - N_b^{--}}{N_b^{++} + N_b^{--}}$$

N^{++}: Number of events with 2 b hadrons decaying semileptonically to produce same sign muon pair: one muon from b->μX, 2nd muon from decay after mixing.

- If the rate of $B \rightarrow \overline{B}$ is the same as $\overline{B} \rightarrow B$, this quantity will be zero. The SM expectation is ~few 10^{-4}.
- A_{sl} is derived from dimuon and inclusive muon asymmetries:

$$A \equiv \frac{N^{++} - N^{--}}{N^{++} + N^{--}} \quad \text{and} \quad a \equiv \frac{n^{+} - n^{-}}{n^{+} + n^{-}}$$