Electroweak Physics
&
Beyond the SM

Jadranka Sekaric (EXP)
On behalf of WG3

DIS 2011, April 15, Newport News, Virginia

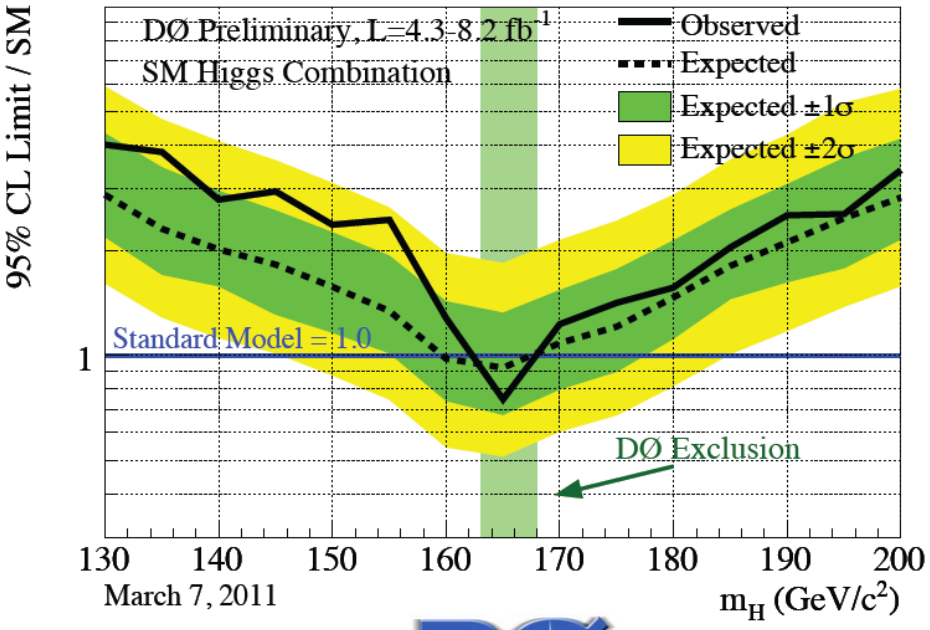
Contributions

- **10 parallel Sessions**
  - **7 EW+BSM**
    - **21 Experimental Talks**
    - 10 Theory Talks
  - 2 Joint with Structure Functions and Parton Densities (WG1)
    - 8 Experimental Talks
    - 2 Theory Talks
  - 1 Joint with Heavy Flavors (WG5)
    - 5 experimental Talks
    - 1 Theory Talk
- **Analyzed integrated luminosity:**
  - **LHC: 35 - 40 /pb**
  - **TEVATRON: up to 8 /fb**
  - **HERA: 0.255 - 0.5 /fb**

SM Higgs Boson Searches

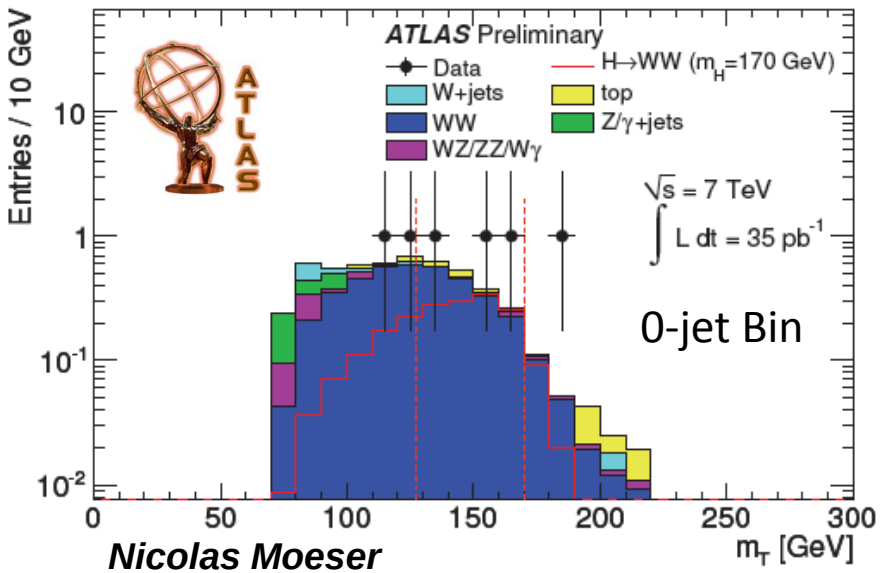
$gg \rightarrow H \rightarrow WW \rightarrow l\nu l\nu$

DØ high mass combination winter 2011

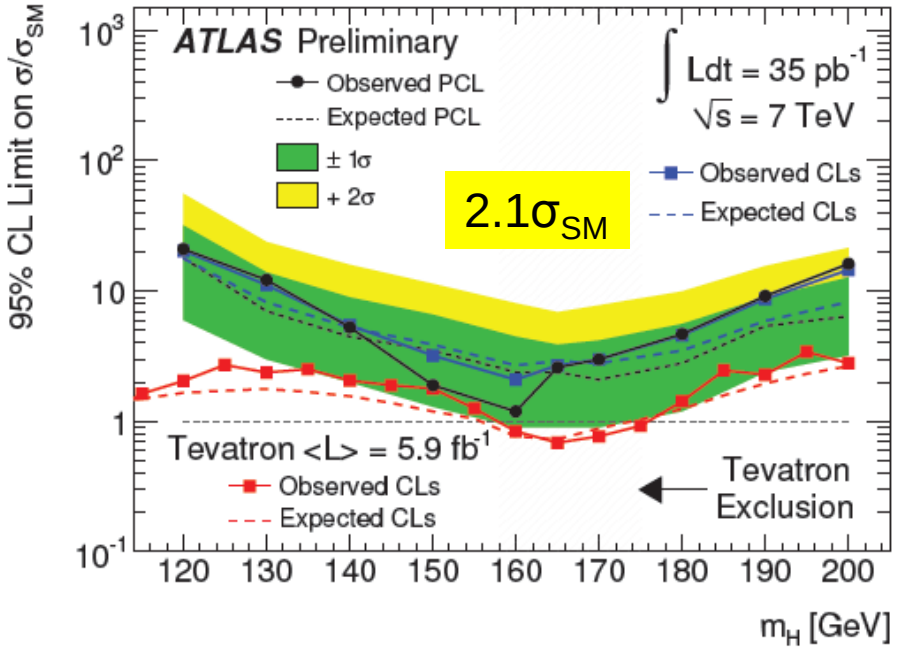


Maiko Takahashi

DØ: 163 - 168 GeV
Single experiment exclusion
by CDF and DØ



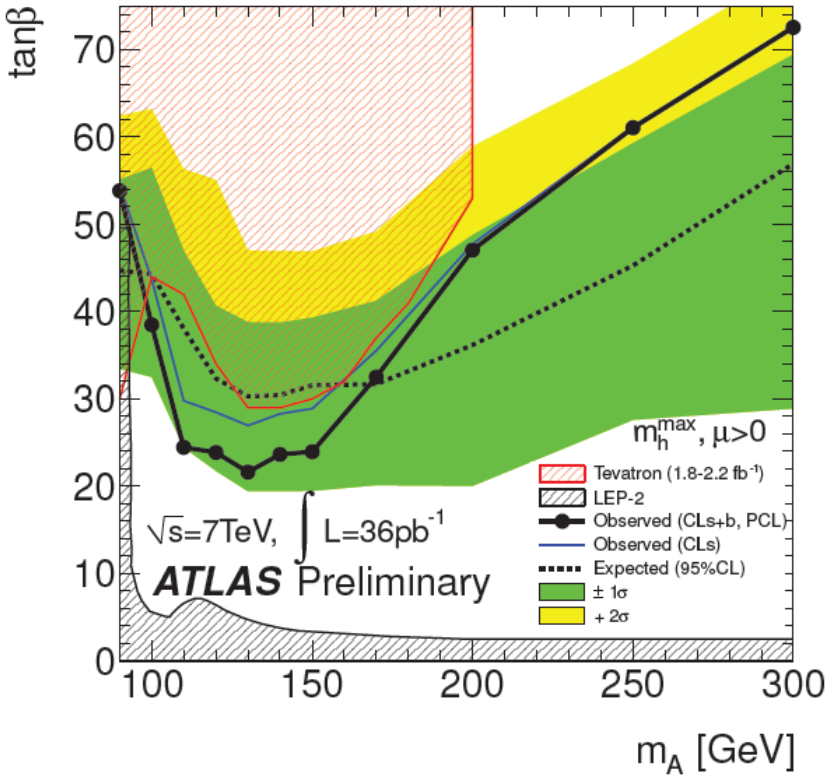
Nicolas Moeser



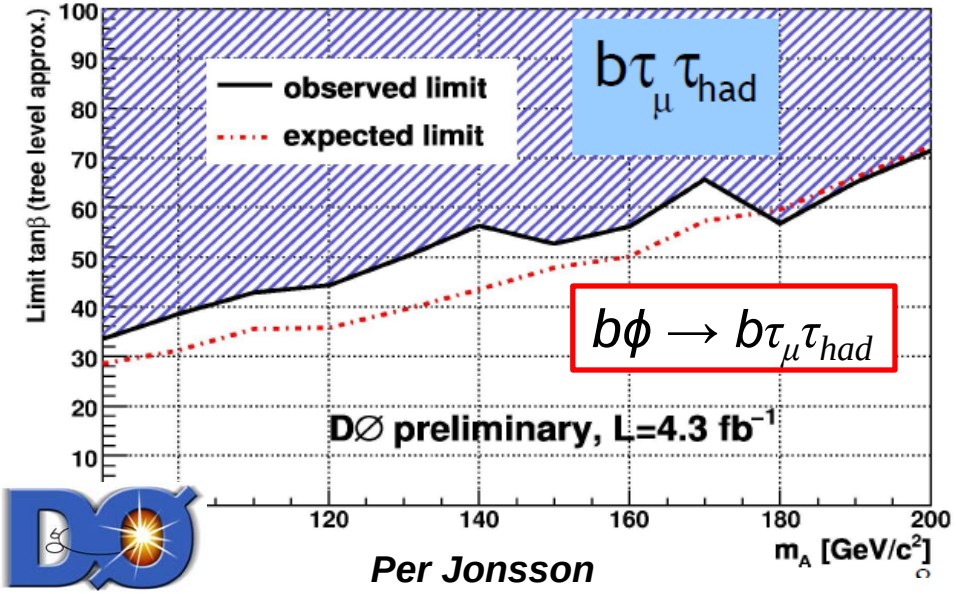
BSM Higgs Boson Searches

Nicolas Moeser

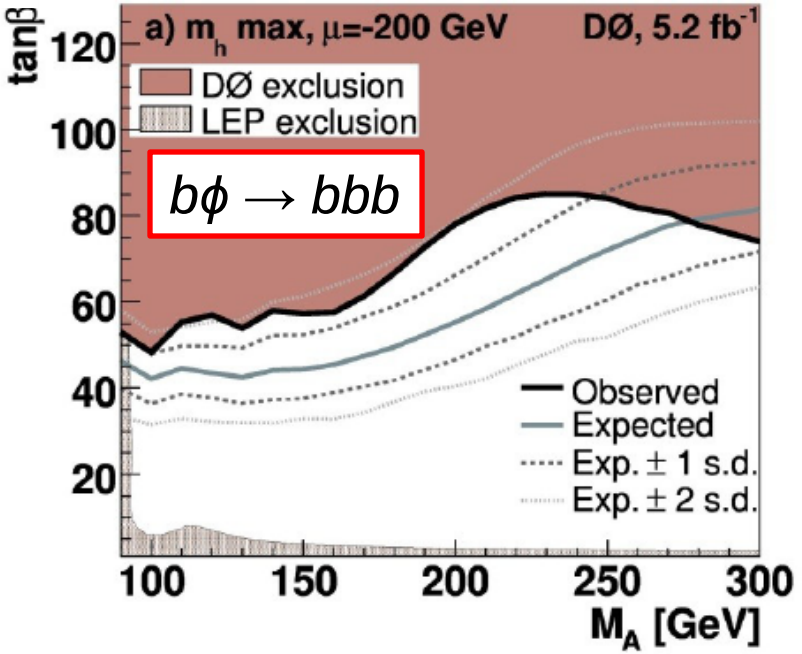
$\phi \rightarrow \tau_l \tau_{had}$



Expands Tevatron exclusion area for these two channels

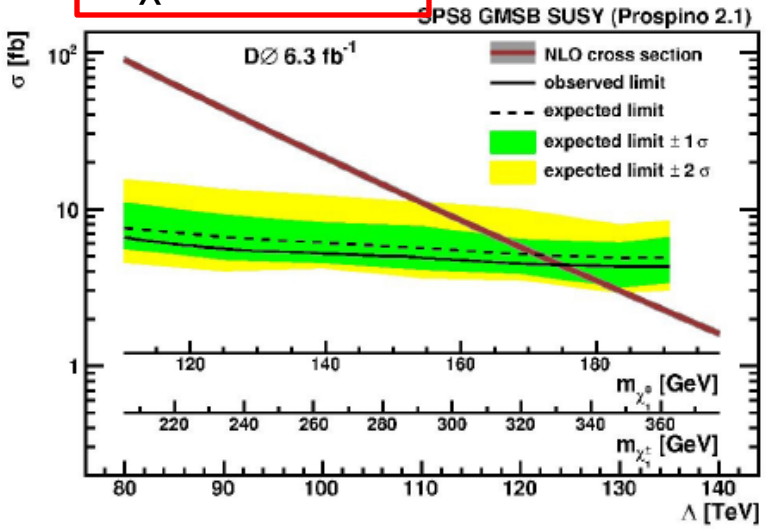


Per Jonsson

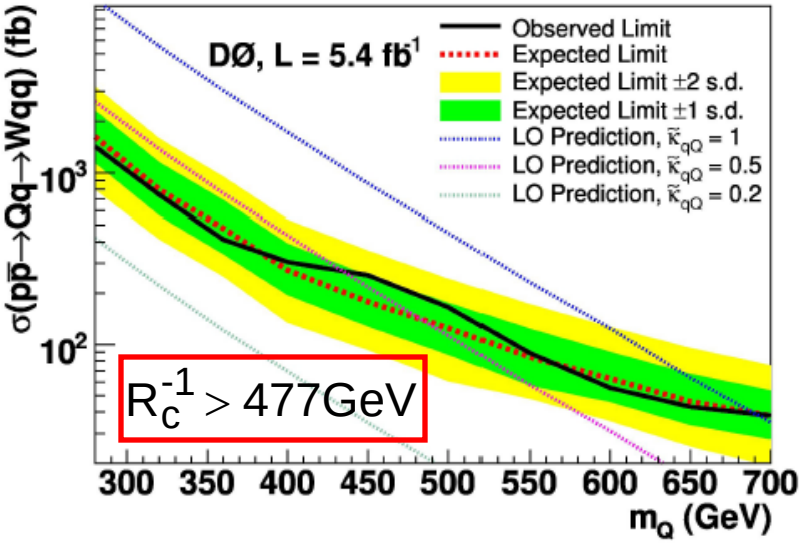


BSM Searches

On SPS8 GMSB: $\Lambda > 124$ TeV, $m_{\tilde{\chi}^0} > 175$ GeV



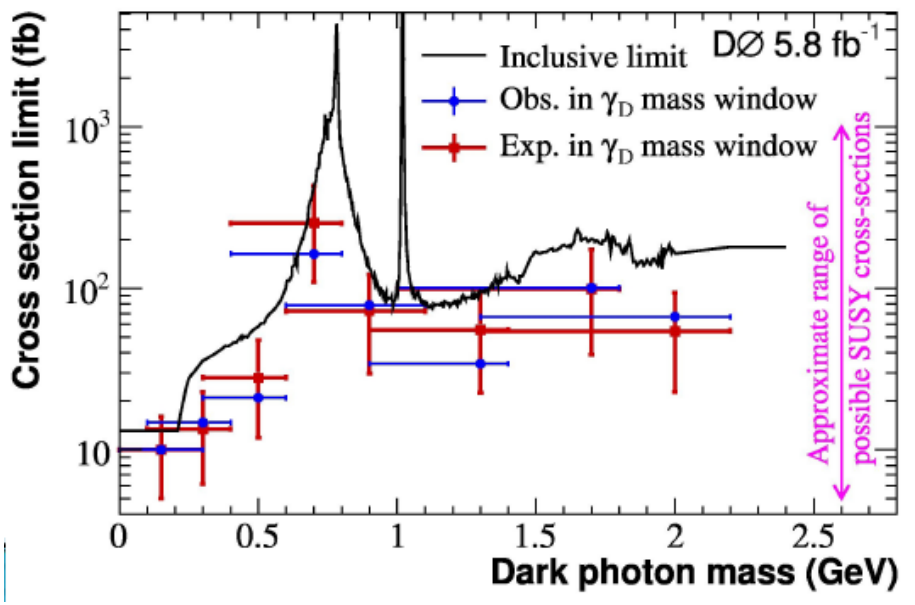
On UED with N=6, $M_D = 5$ TeV:



$R_c^{-1} > 477$GeV

- Many new limits from DØ GMSB SUSY Models, Universal Extra Dimensions, Hidden Valleys

James Kraus



Hidden Valley dark photon decaying to leptonic jets

(SUSY) Dark photon produced via GSMB for SPS8

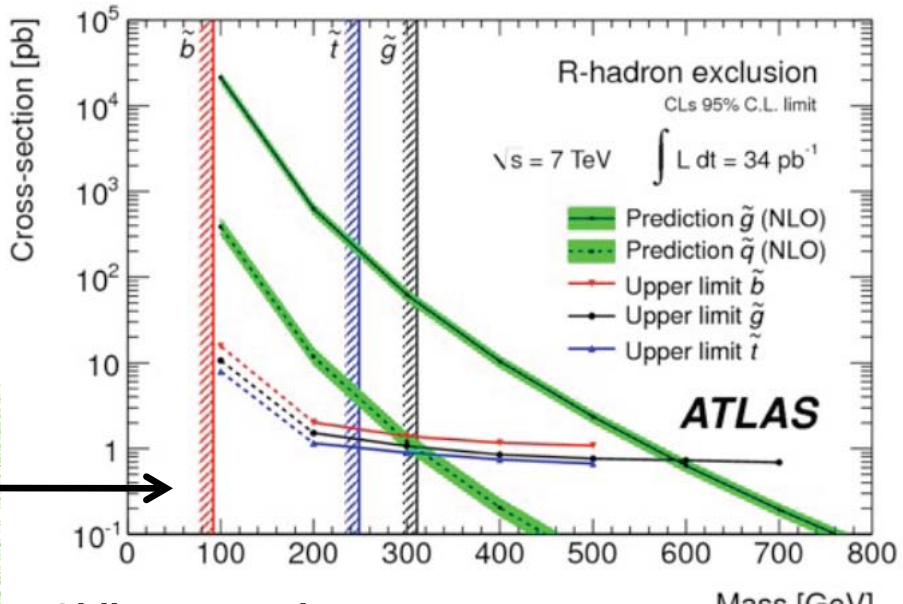
$\sigma \times B < 13 - 20$ fb @95% CL

BSM Searches

- Limits on the masses of SUSY particles (different scenarios)
- Most of them most stringent to date

HSMPs (95%CL)
(squarks, gluinos)

$$m_{\tilde{b}-Rhad} > 294GeV$$
$$m_{\tilde{t}-Rhad} > 309GeV$$
$$m_{\tilde{g}-Rhad} > 586GeV$$



Shikma Bressler

Lepton + jets + pT

$$\tilde{q}_L \to q\tilde{\chi}^{\pm} \to q\tilde{\chi}^0 l^{\pm}$$
$$\tilde{g} \to q\bar{q}'\tilde{\chi}^{\pm} \to q\bar{q}'\tilde{\chi}^0 l^{\pm}$$

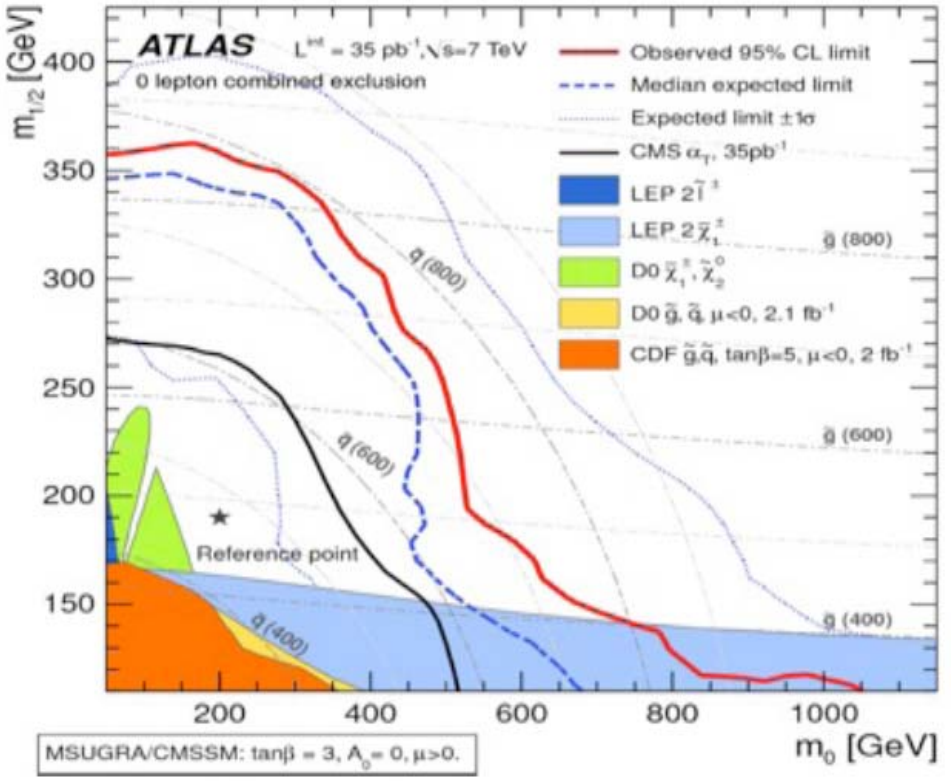
$$m_{\tilde{g}} = m_{\tilde{q}} > 700GeV$$

Missing pT + jets

$$\tilde{q} \to q\tilde{\chi}_1^0$$
$$\tilde{g} \to qq\tilde{\chi}_1^0$$

- $m_{\tilde{g}} = m_{\tilde{q}} > 775GeV$

(tanβ=3 A_0=0GeV sign(μ)=1)



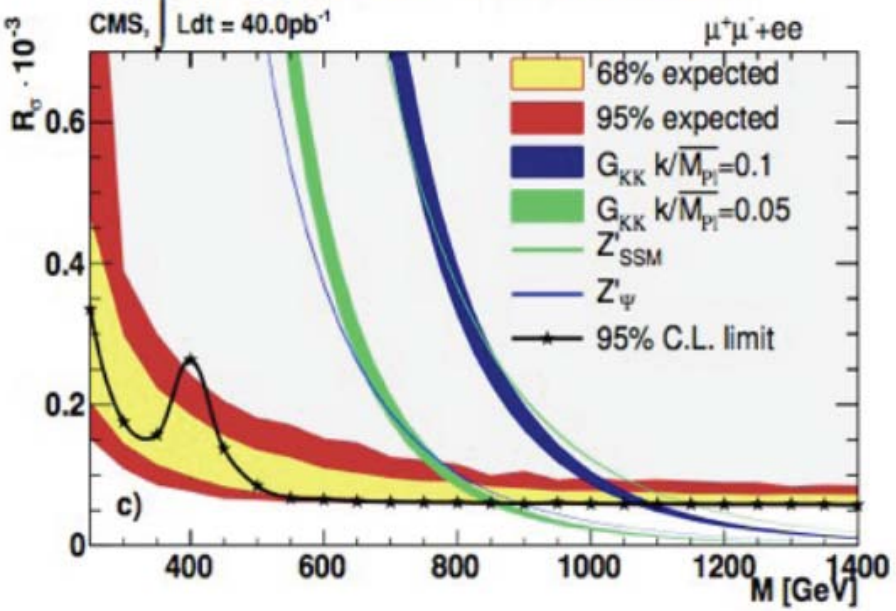
BSM Searches

- **Searches for Z', W' and LQ pairs with high pT e/μ**
  Good understanding of the detector and backgrounds
  New exclusion limits for Z', W' and LQ pair

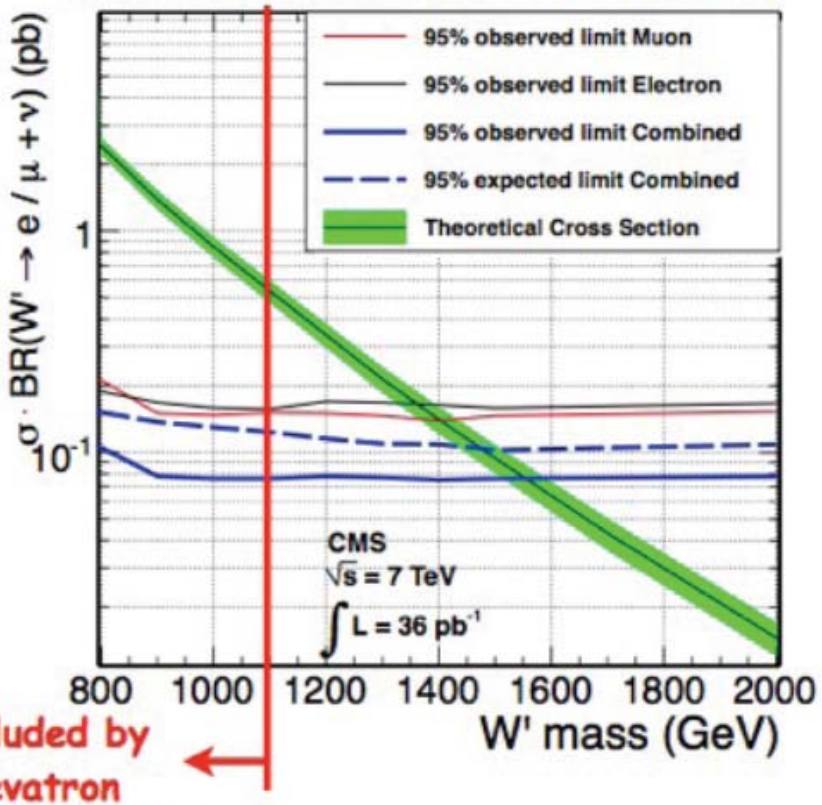
Federico De Guio

New exclusion limit for Z' and RS graviton

Z_{SSM}	1140 GeV
Z_ψ	887 GeV
G_{kk} k/M_{Pl} = 0.05	855 GeV
G_{kk} k/M_{Pl} = 0.10	1079 GeV



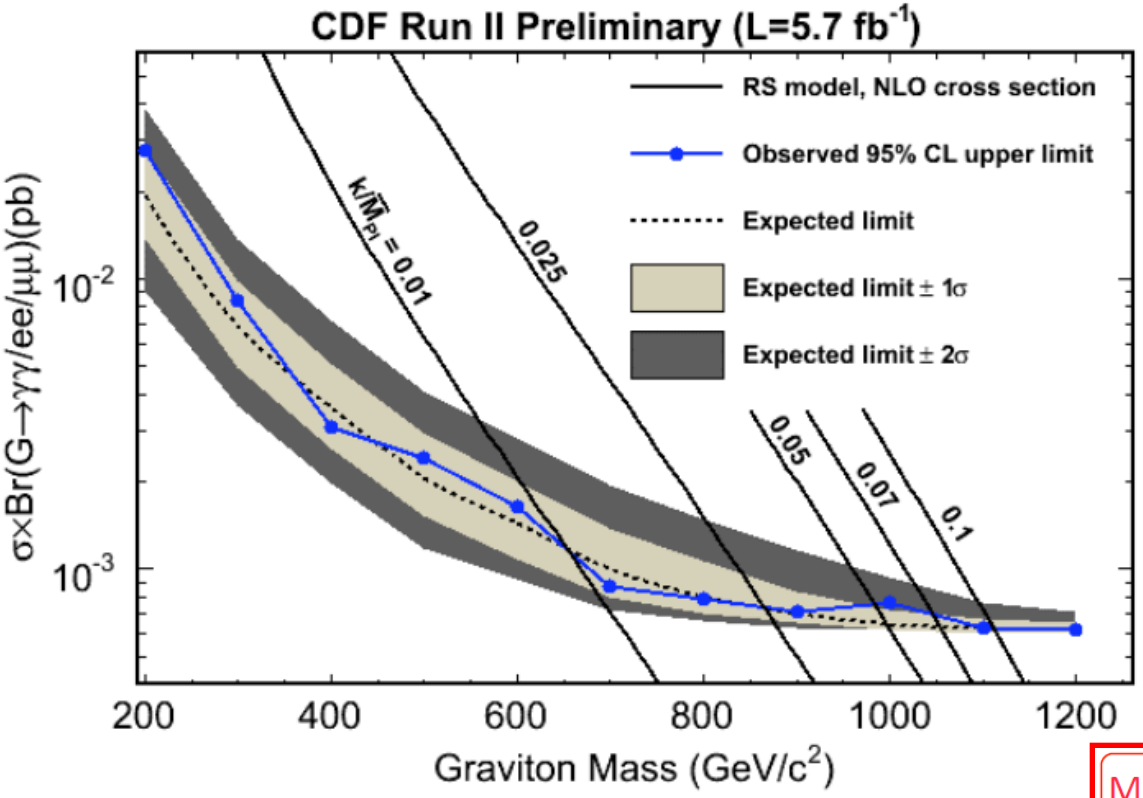
new exclusion limit for W' < 1.58 TeV



Excluded by Tevatron below 1.1 TeV

BSM Searches

RS Graviton



John Strologas

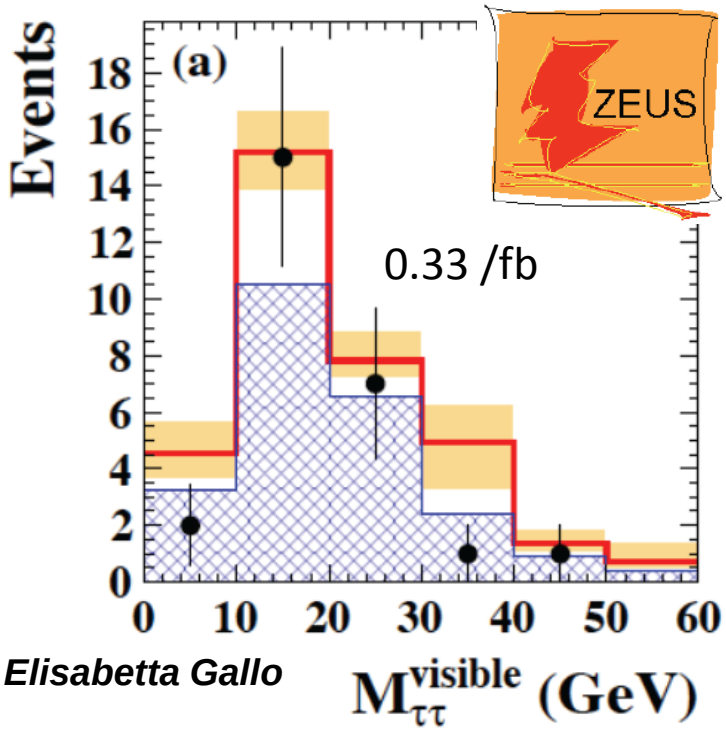
CDF Run II Preliminary

$k/\overline{M}_{PL}$	Graviton Mass (GeV/c^2)
0.01	642
0.025	865
0.05	984
0.07	1046
0.1	1111

M_G>1111 GeV/c^2 at 95% CL, for k/M_{PL} =0.1

Searches at HERA II

Search for New Physics at di-tau events



Elisabetta Gallo

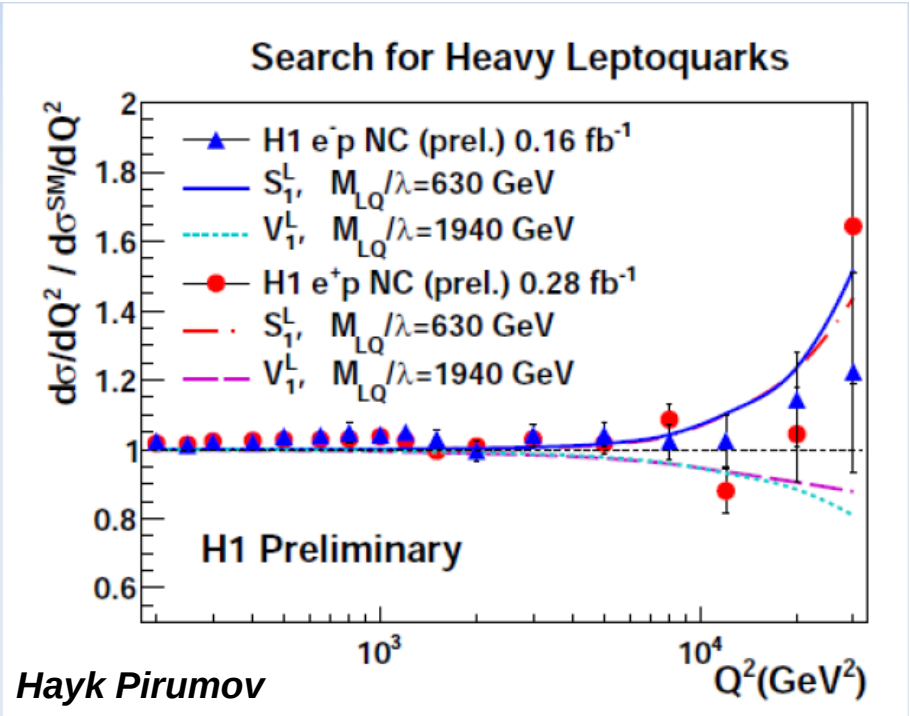
$\tau\tau \rightarrow$ e-μ, e-jet, μ-jet, jet-jet

- No surprises at high mass and high total pT
- Measured x-section agrees with the SM

Contact Interactions

- NC data in a good agreement with the SM
  $\Rightarrow$ constrains on various CI models
- Limits on deviations from the SM set in:

Compositeness (> 3.2 - 7.2 TeV)
Leptoquarks (> 0.4 - 1.9 TeV)
Large Extra Dimensions (> 0.9 - 0.91 TeV)
Quark Radius (< $0.65 \cdot 10^{-18}$m)



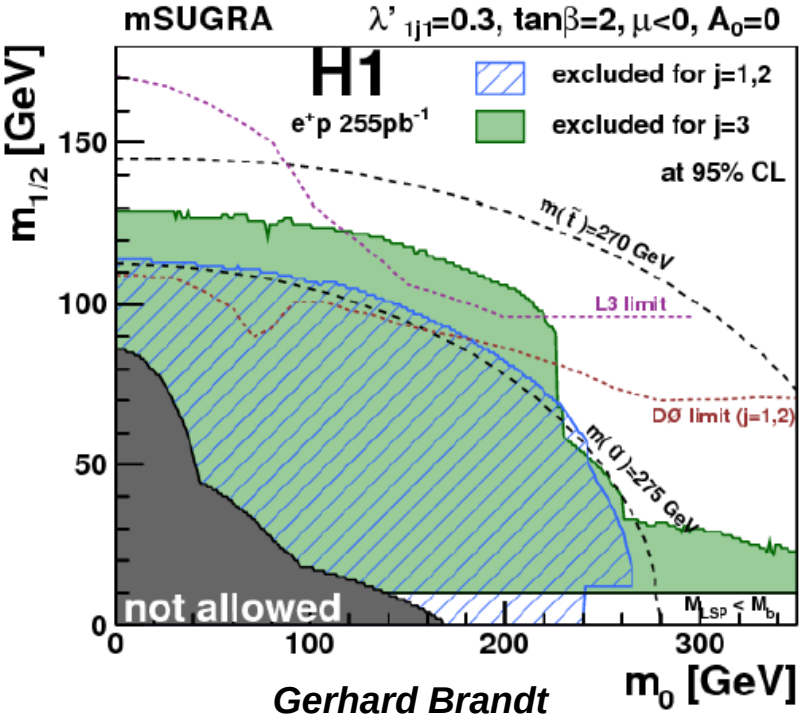
Hayk Pirumov

Searches at HERA II

R-Parity Violation

• ep collisions best environment for searches for RPV SUSY via λ' coupling, constrain MSSM model to mSUGRA
• For λ'_{1j1}, $\lambda_{11k}' \cong 0.3$

u-,c-,t- squark 275 GeV @ 95% CL
d-,s-,b- squark 290 GeV @95% CL



Gerhard Brandt

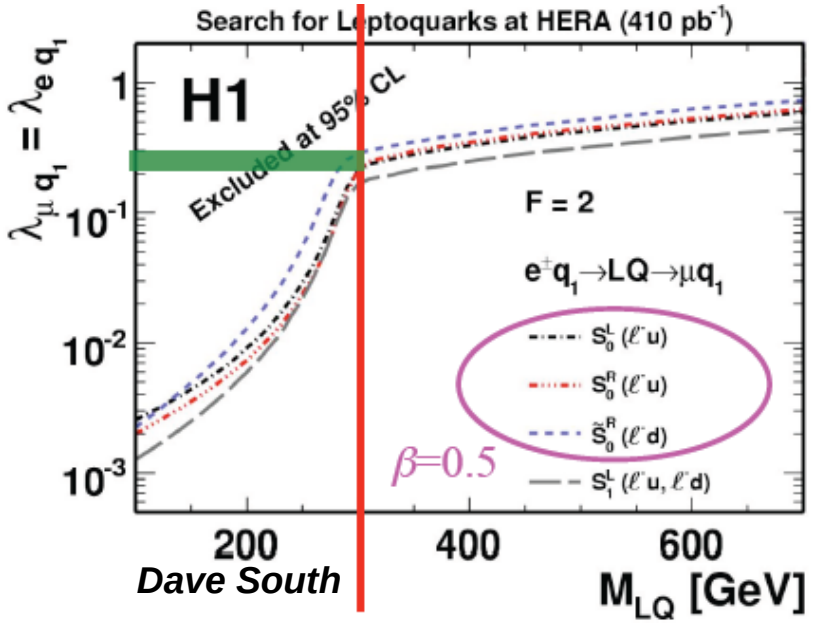
Lepton Flavor Violation

Search for leptoquarks

• First generations mostly superseded by limits from hadron colliders
Still best for large λ / high mass region
• Second and third generation searches, for a coupling of electromagnetic strength $\lambda = 0.3$:

eq→LQ→μq: > 712 GeV
eq→LQ→τq :> 479 GeV

Appropriate value to compare LHC to HERA is $\beta = 0.5$; the CMS limit is ~ 300 GeV for which H1 excludes couplings in the range $\lambda = 0.2 - 0.3$



Dave South

NA 48/2 and NA62 @CERN

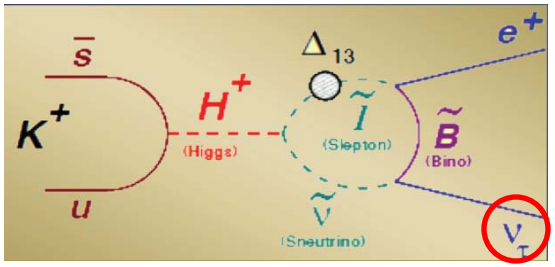
Lepton Flavor and Lepton Number Violation in Kaon Decays

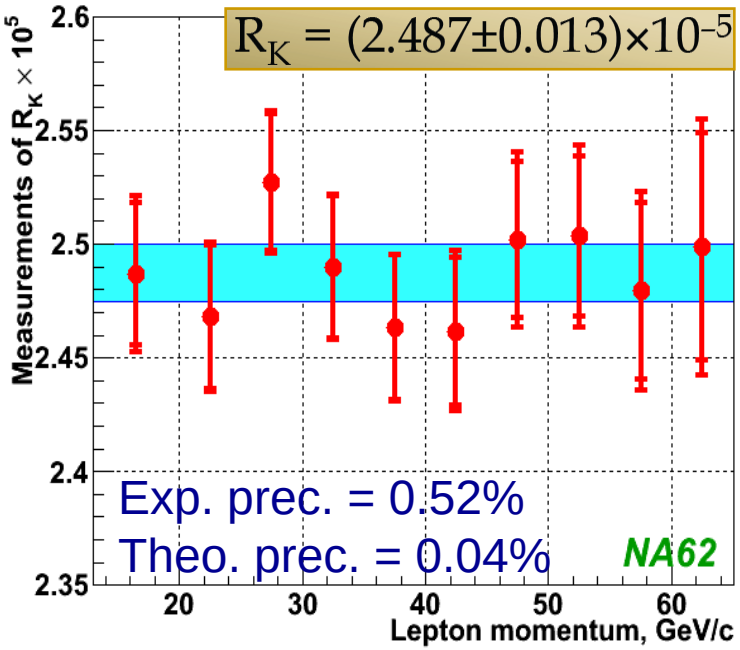
Sensitive to **LFV**

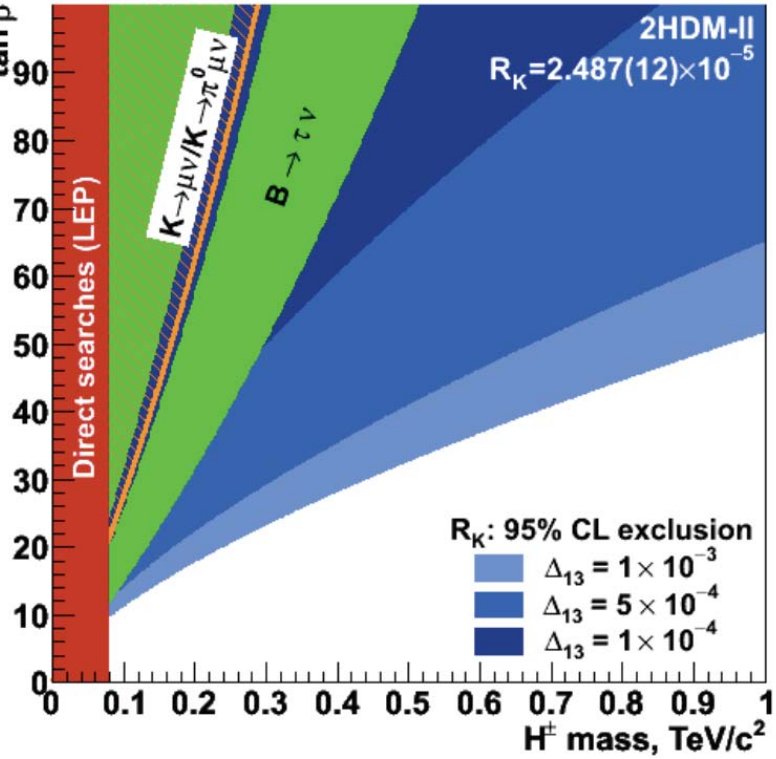
Mauro Raggi

$$R_K = \frac{\Gamma(K^\pm \to e^\pm \nu)}{\Gamma(K^\pm \to \mu^\pm \nu)} \qquad R_K^{LFV} \approx R_K^{SM}\left[1 + \left(\frac{m_K^4}{M_{H^\pm}^4}\right)\left(\frac{m_\tau^2}{M_e^2}\right)|\Delta_{13}|^2 \tan^6\beta\right]$$

2 Higgs Doublet Models at one-loop level







LNV in $K^+ \to \pi^-\mu^+\mu^+$ proceeds if the neutrino is a Majorana particle

$BR(K^+ \to \pi^-\mu^+\mu^+) < 1.1\times10^{-9}$ (90% CL) allowing a bound on the effective Majorana neutrino mass, $m_{\mu\mu}$, < of 300 GeV

Parity Violating DIS

PV DIS @ CEBAF 6 GeV

e (↑L)
e (↓R)

$$A_{PV} = \frac{\sigma_{\uparrow} - \sigma_{\downarrow}}{\sigma_{\uparrow} + \sigma_{\downarrow}}$$

PV Asymmetries in DIS
Electroweak couplings or sin$^2\theta_W$

- World's highest accuracy measurement of coupling constant combination $(2C_{2u} - C_{2d})$

$$C_{2u} = g_V^e g_A^u = -\frac{1}{2} + 2\sin^2(\theta_W)$$
$$C_{2d} = g_V^e g_A^d = \frac{1}{2} - 2\sin^2(\theta_W)$$

- Constrain the hadronic effect (with High Resolution Spectrometer) providing guide for PVDIS 12 GeV upgrade
- Two kinematics: $Q^2 = 1.1(\text{GeV})^2$
  $Q^2 = 1.9(\text{GeV})^2$

Kai Pan

Jefferson Lab

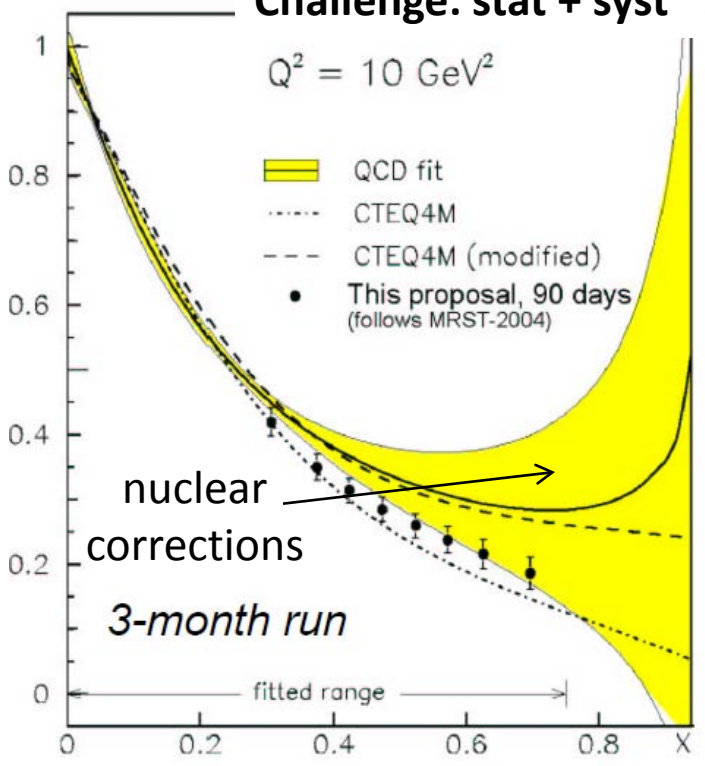
PV DIS with SOLID

Paul Souder

(New Solenoidal Spectrometer)

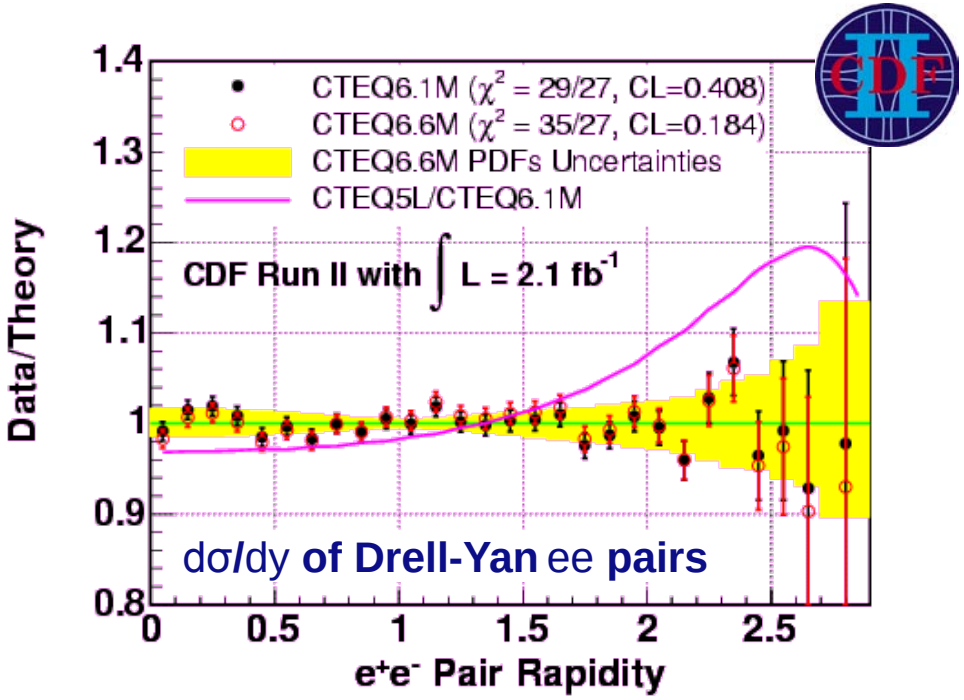
- SM Test: extraction of the electroweak coupling constant as well as sin$^2\theta_W$ from the asymmetry free from hadronic effects
- *PV Asymmetries in DIS*
- Charge Symmetry Violation at quark level
- Proton d/u PDFs at high x

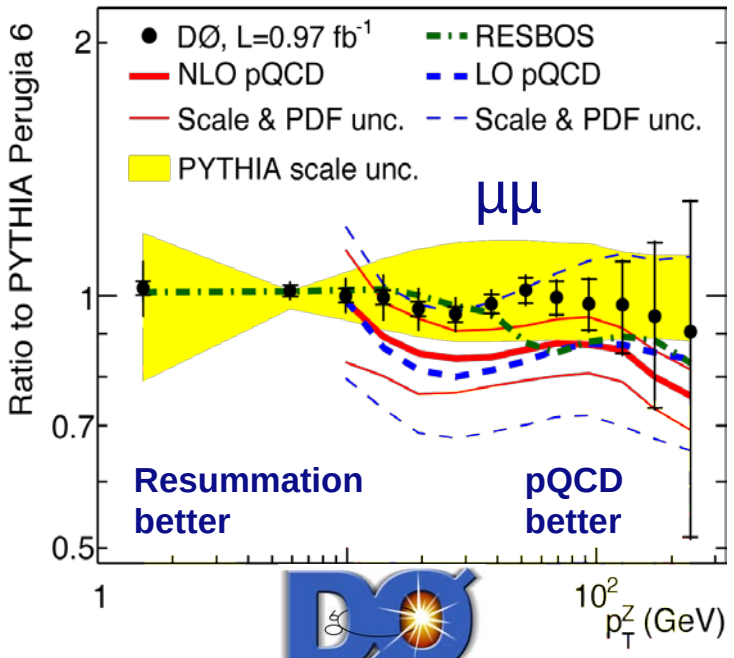
Challenge: stat + syst ~2%

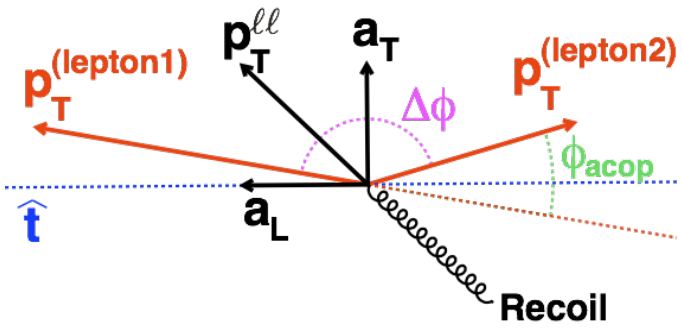


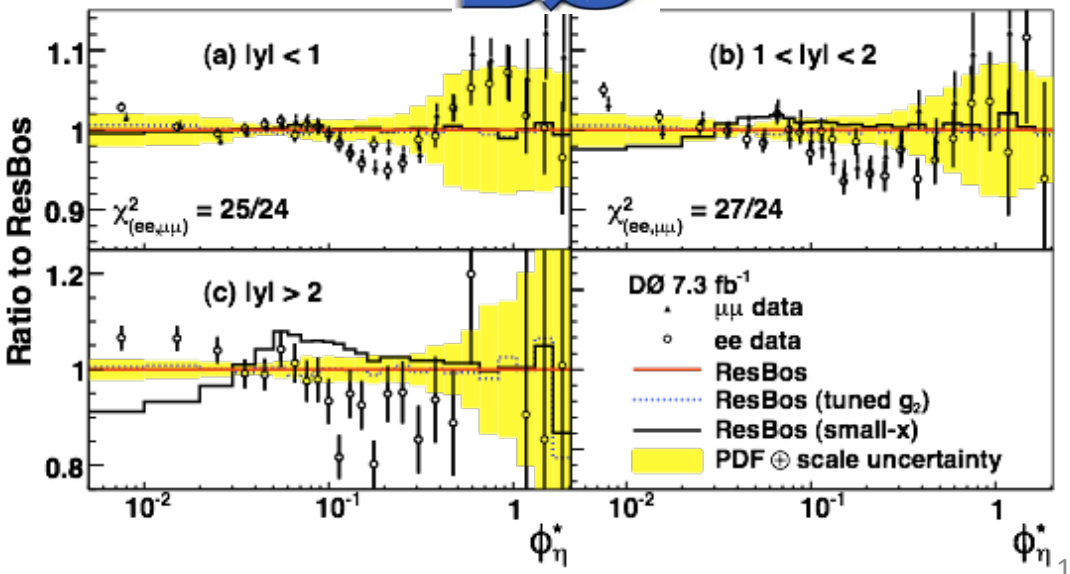
Single Boson Production @ Tevatron

Adam Lyon





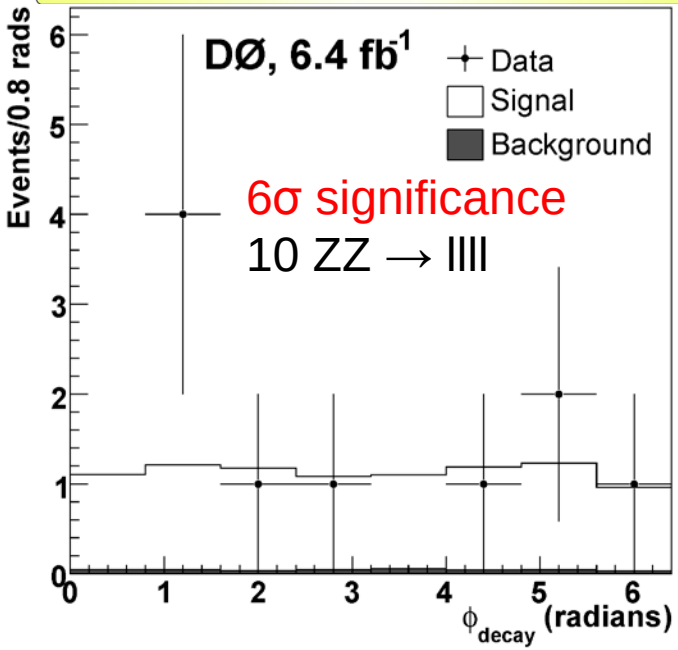




Diboson Production @ Tevatron

Joe Haley

$\sigma_{(p\bar{p}\to ZZ)} = 1.33^{+0.50}_{-0.40}\,(\text{stat}) \pm 0.15\,(\text{syst}+\text{lumi})$ pb



~ 5 /fb, $Z\gamma \to ll\gamma + \nu\nu\gamma$

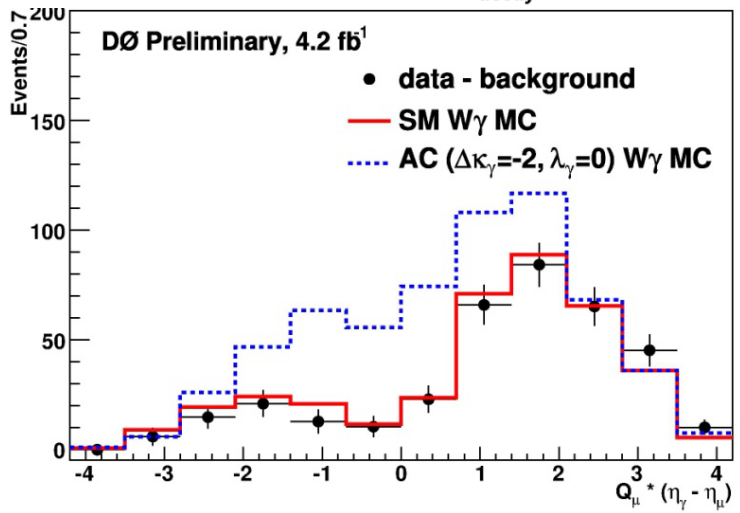
$$-0.017 < h_3^Z < 0.016$$
$$-0.017 < h_3^\gamma < 0.016$$
$$-0.0006 < h_4^Z < -0.0005$$
$$-0.0006 < h_4^\gamma < -0.0006$$

4.1 /fb, $WZ \to l\nu ll$

$$\sigma(WZ) = 3.90^{+1.09}_{-0.90}\ \text{pb}$$

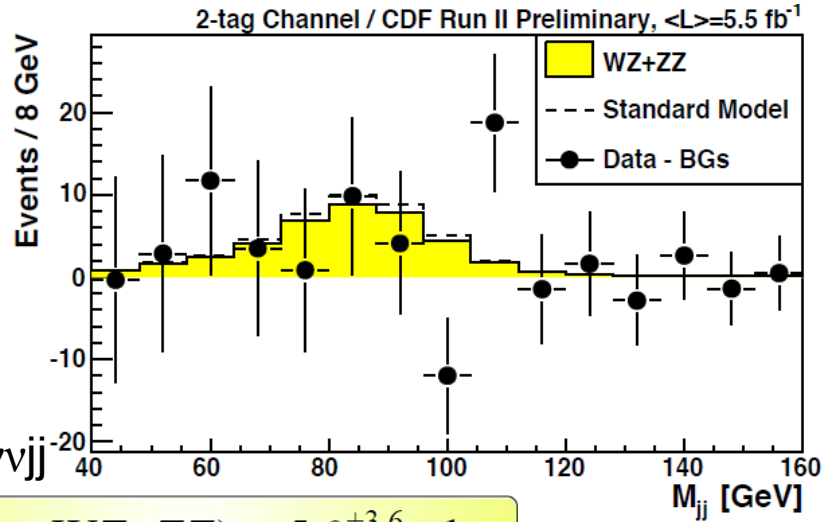
$$-0.075 < \lambda_Z < 0.093$$
$$-0.053 < \Delta g_1^Z < 0.156$$
$$-0.376 < \Delta\kappa_Z < 0.686$$

Tightest 95% CL limits on γZZ/γγZ TGCs and on WWZ TGCs from direct measurement



$\sigma\,(pp \to W\gamma) = 15.2 \pm 1.6\,(\text{stat+syst})$ pb

MET+jets
(b-tagging)
lνjj + jjνν + ννjj



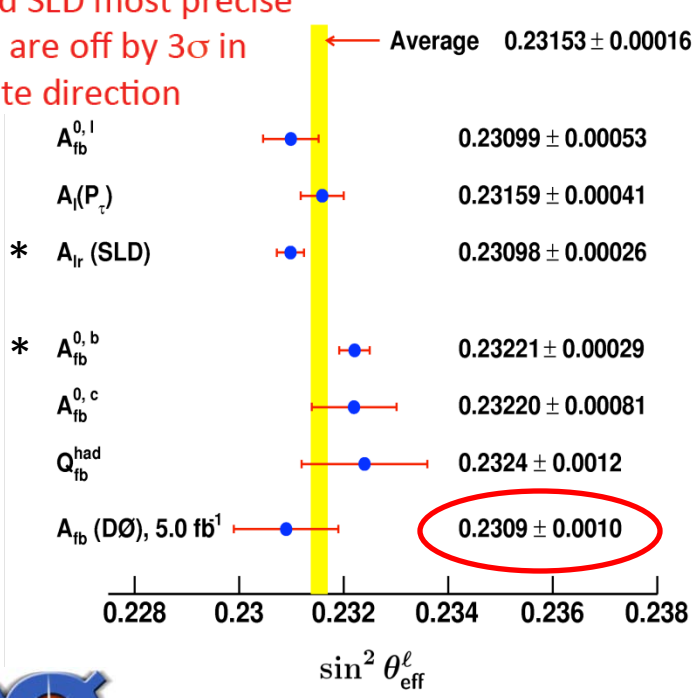
$\sigma\,(pp \to WZ+ZZ) = 5.0^{+3.6}_{-2.5}$ pb

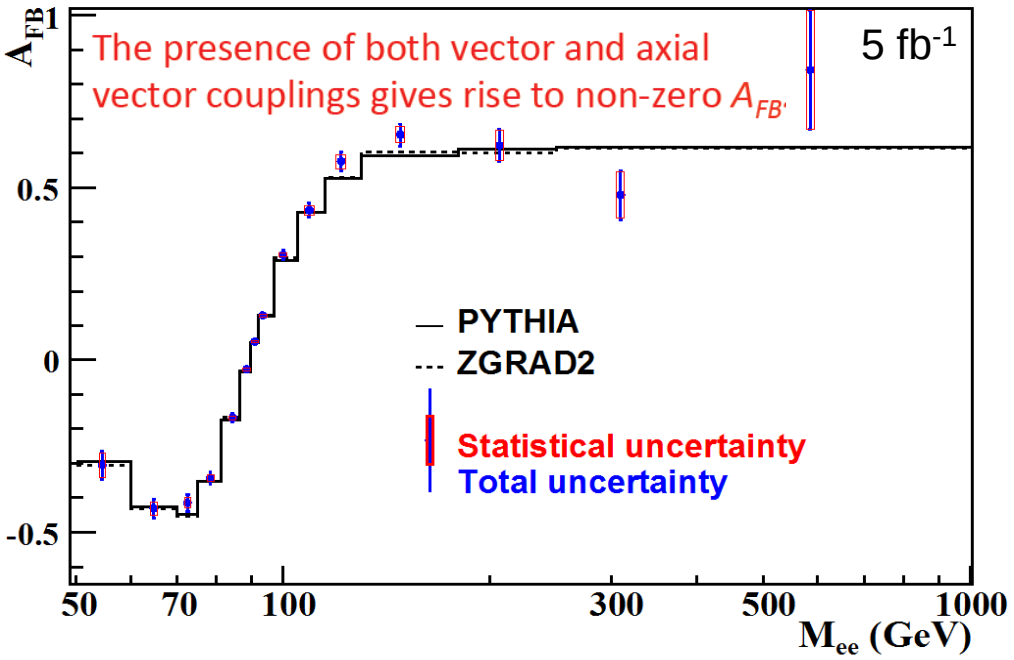
$\sigma\,(pp \to WZ+ZZ) < 13$ pb @ 95% CL

Forward Backward Charge Asymmetry at DØ

Hang Yin

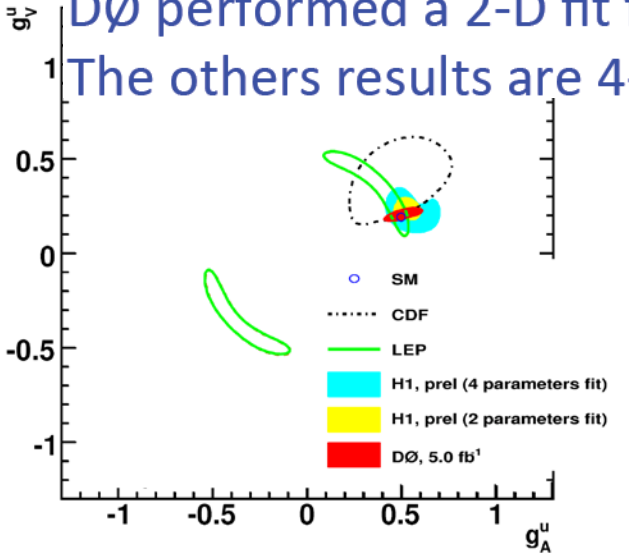
LEP and SLD most precise results are off by 3σ in opposite direction

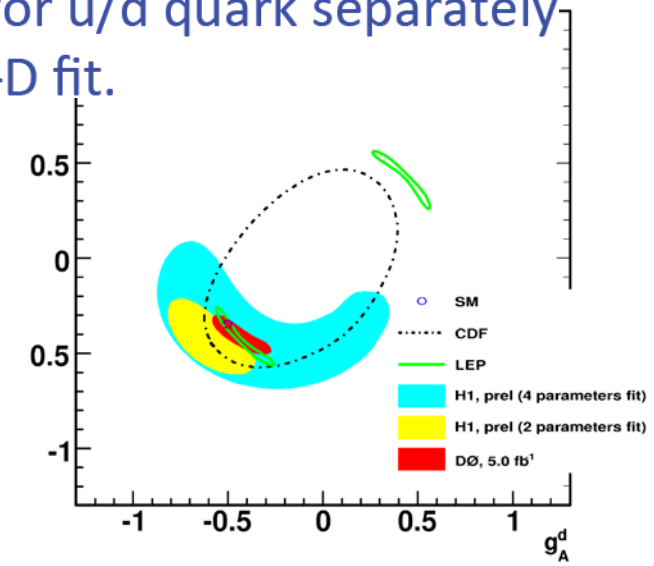




DØ performed a 2-D fit for u/d quark separately

The others results are 4-D fit.





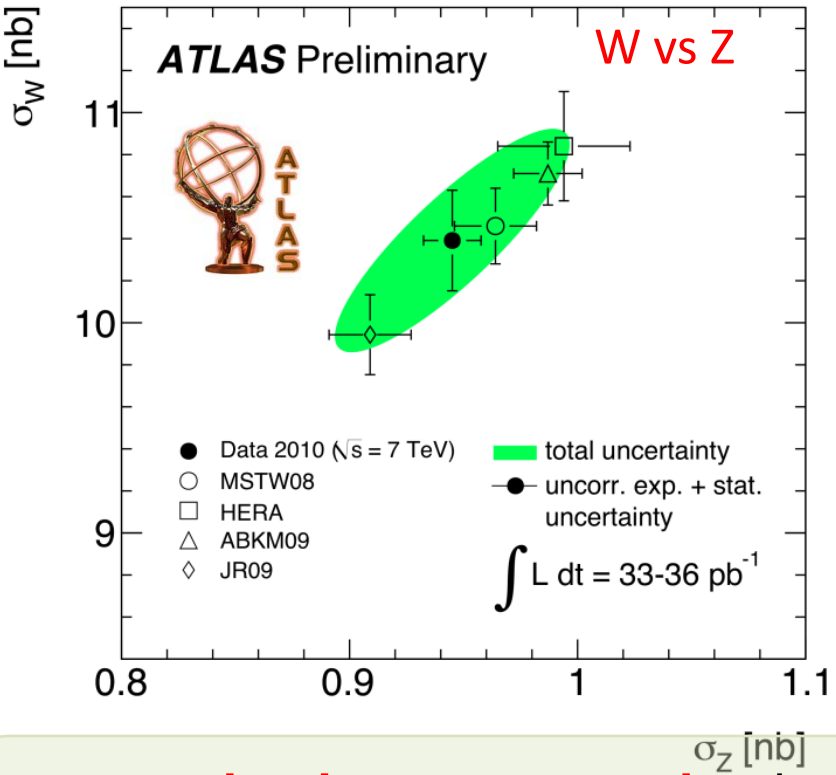
W and Z boson Production at LHC

W and Z boson cross sections

Markus Stoye

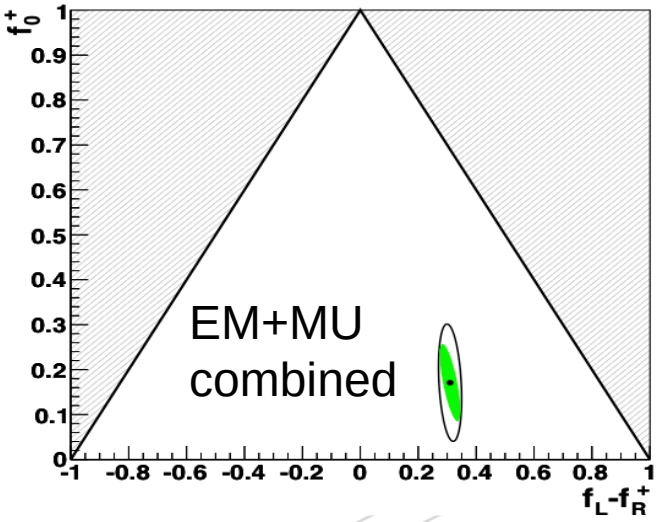
Experimental uncertainties ~ 2-3%
Comparison with NNLO predictions (5%)

Verena I. Martines Outschoorn



W polarization

Left-handed Ws dominant in pp-collisions
Polarization effects on W kinematics strong at high W pT
Measurement of (f_L-f_R) to ~ 5% precision



W^+W^- production cross-section in (ll+MET+0jets) final states

Jianbei Liu

8 W^+W^- candidates and **1.7 ± 0.6 bkg**

$$\sigma_{WW} = 40^{+20}_{-16}(\text{stat}) \pm 7(\text{syst})\ \text{pb}$$

σ@NLO: 46 ± 3 pb

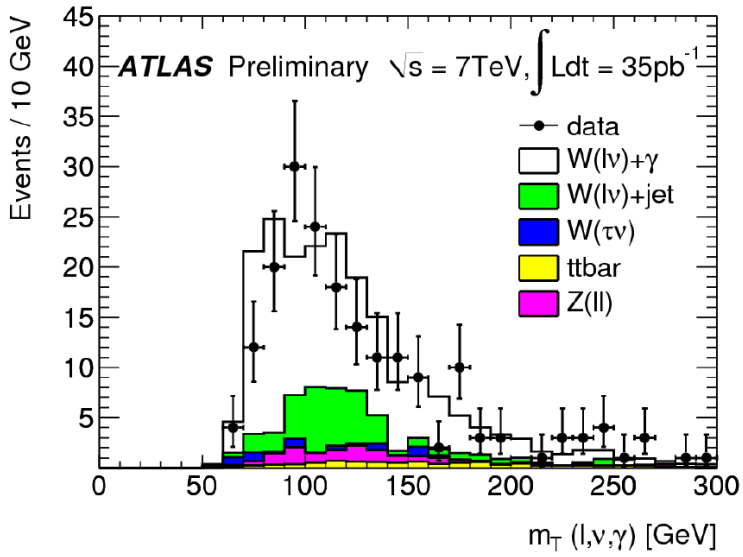
Still highly statistically dominated

W/Z+γ Production at ATLAS

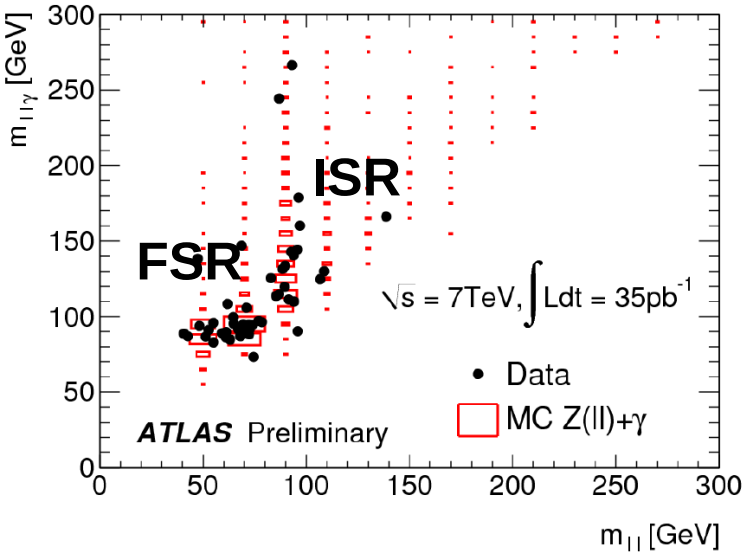
Andrea Bocci

	$\sigma^{total}[pb]$(measured)	$\sigma^{total}[pb]$(predicted)
$pp \to e\nu\gamma$	$73.9 \pm 10.5(stat) \pm 14.6(syst) \pm 8.1(lumi)$	$69.0 \pm 4.6(\text{syst})$
$pp \to \mu\nu\gamma$	$58.6 \pm 8.2(stat) \pm 11.3(syst) \pm 6.4(lumi)$	$69.0 \pm 4.6(\text{syst})$
$pp \to e^+e^-\gamma$	$16.4 \pm 4.5(stat) \pm 4.3(syst) \pm 1.8(lumi)$	$13.8 \pm 0.9(\text{syst})$
$pp \to \mu^+\mu^-\gamma$	$10.6 \pm 2.6(stat) \pm 2.5(syst) \pm 1.2(lumi)$	$13.8 \pm 0.9(\text{syst})$

$W\gamma$ Candidates: $m_T(l, E_T^{miss}, \gamma)$ Distribution



$Z\gamma$ Candidates: $m_{l,l,\gamma}$ vs. $m_{l,\gamma}$



Experimental measurements are in agreement with Standard Model expectations within the experimental errors

Summary

- **Wide range of results covered by:**

  CMS/ATLAS: running well, analyzing max available data providing most precise results, best limits

  CDF/D0: in high gear, high speed

  H1/ZEUS: full stat 0.5 /fb

  JLab, NA48/NA62

  THEORY

Not covered
"Direct Photon Measurements at ATLAS"
(Renat Ishmukhametov)

- **Thanks to speakers and Collaborations for their contributions at DIS2011**