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Résumé des conférences d'hiver
IRFU, avril 2009

Résumé des Rencontres de Moriond QCD 2009

Philippe Gras, IRFU/SEDI

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Introduction

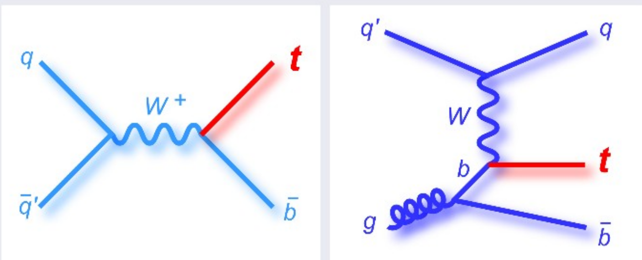
- 101 présentations
  - Théorie: 30
  - Tevatron: 21
  - LHC: 16
  - Belle et BaBar: 6; KLOE: 2; CLEO: 2; NA48: 1
  - HERA: 6; BES: 2
  - RHIC: 5
  - Thérorie: 30
- Sélection en 24 transparents:
  - Résultats Tevatron: single top, top, SM Higgs, di-bosons
  - Physique de la saveur: $J/\psi \to 3\gamma$, η_b, X,Y,Z...
  - Mesures α_s
  - Nouvelle approche ajustement PDF
  - Lattice QCD
- Note: résultats préliminaires pas systématiquement indiqués comme tels.

Première observation de la production Single top

CDF & D0
D. Gillberg

Electroweak single top production:

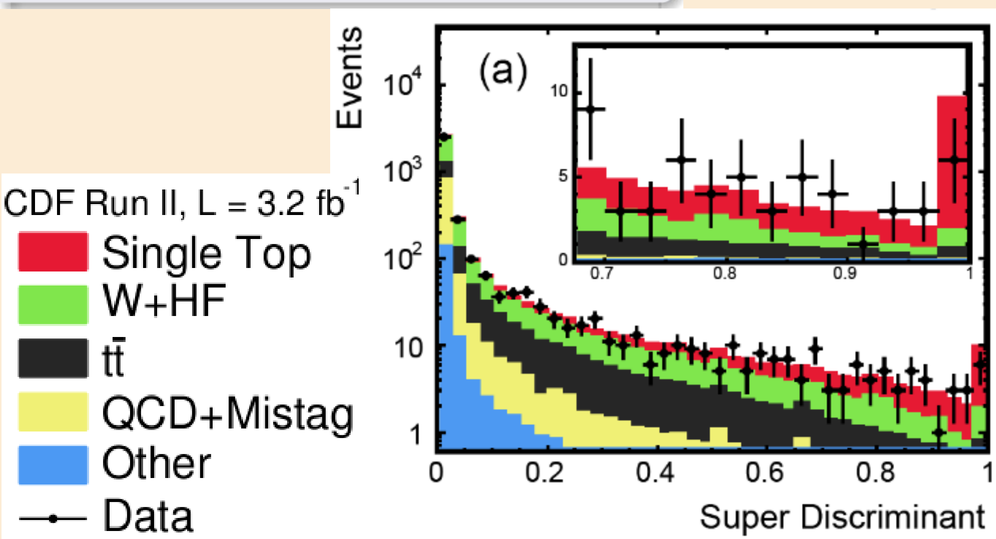
	s-channel (tb)	*t*-channel (tqb)

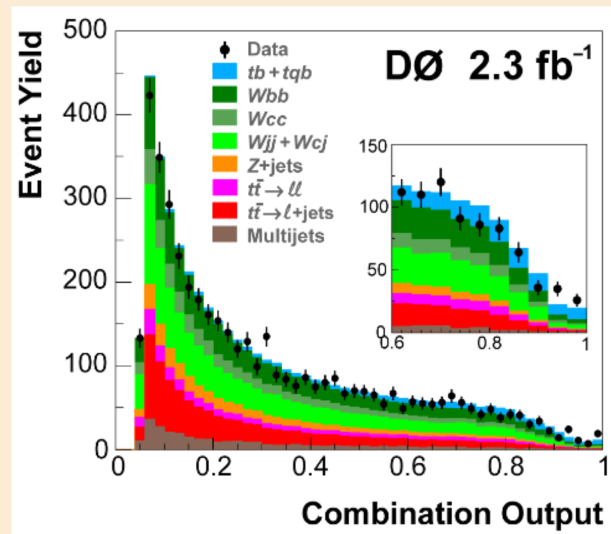


	s-channel (tb)	*t*-channel (tqb)
σ_{NLO}[†]	0.88 ± 0.11 pb	1.98 ± 0.25 pb (m_t=175 GeV)
$\sigma_{(N)NLO}$[‡]	1.12 ± 0.05 pb	2.34 ± 0.13 pb (m_t=170 GeV)

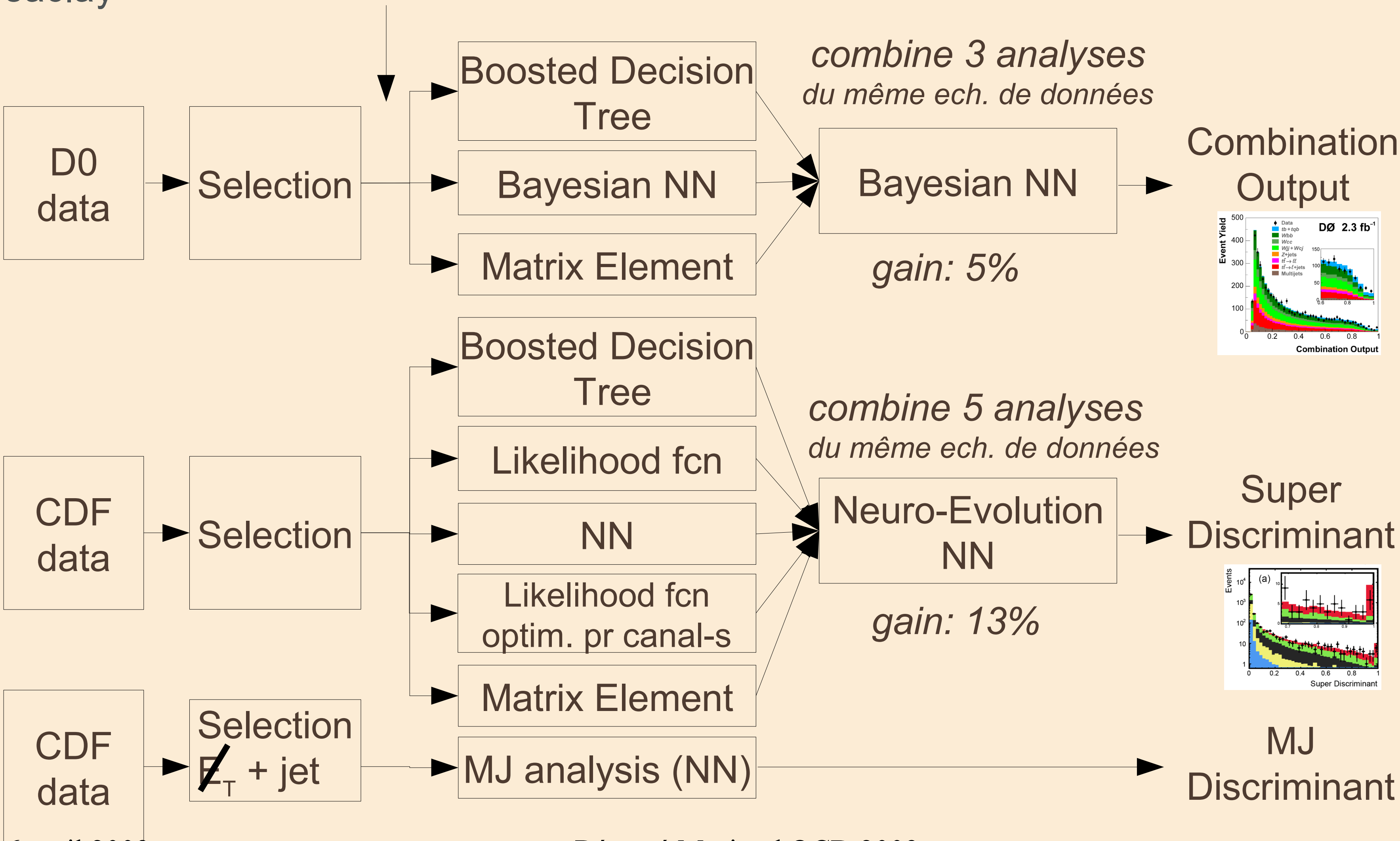
Combined Results

	$\mathcal{L}$ [fb^{-1}]	Significance Exp.	Significance Obs.	σ_{s+t} [pb]	
DØ	2.3	4.5σ	5.0σ	$3.9^{+0.9}_{-0.9}$	(m_{top} = 170 GeV/c^2)
CDF	3.2	5.9σ	5.0σ	$2.3^{+0.6}_{-0.5}$	(m_{top} = 175 GeV/c^2)





Single top. Principe d'analyse



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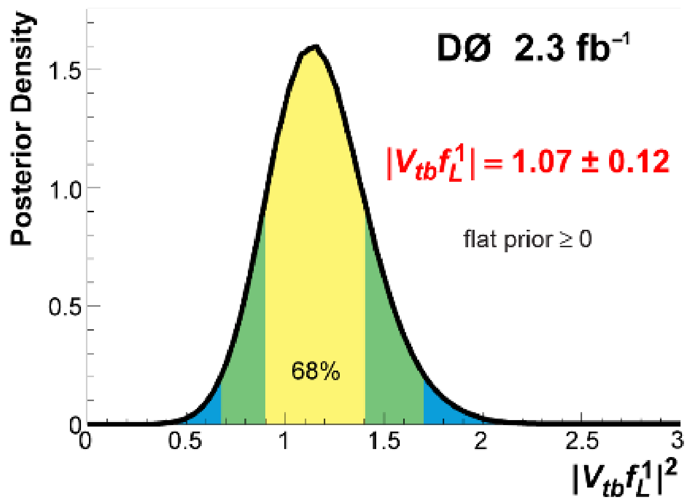
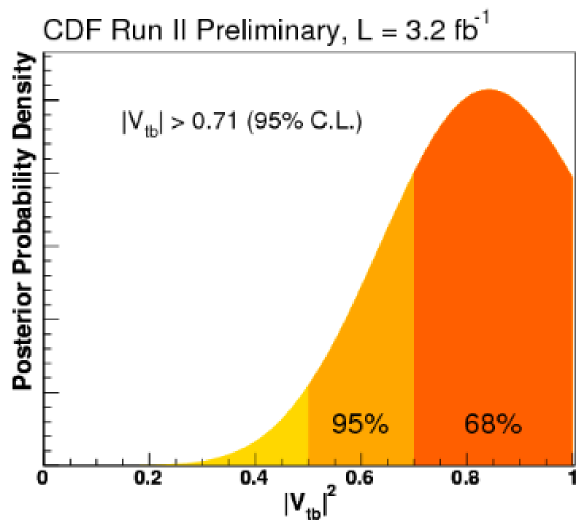
Mesure directe de V_{tb}

CDF & D0
D. Gillberg

- Assuming $|V_{td}|^2 + |V_{ts}|^2 \ll |V_{tb}|^2$ and pure $V-A$ and CP-conserving Wtb interaction
- No assumption about number of quark families or CKM unitarity
- Since the single top cross section proportional to $|V_{tb}|^2$, $|V_{tb}|$ essentially is measured as $\sqrt{\sigma_{meas}/\sigma_{SM}}$ but more systematic uncertainties need to be considered





$|V_{tb}f_{L1}| = 1.07 \pm 0.12$,
$|V_{tb}| > 0.78$ at 95% CL

$|V_{tb}| = 0.91 \pm 0.11$,
$|V_{tb}| > 0.71$ at 95% CL

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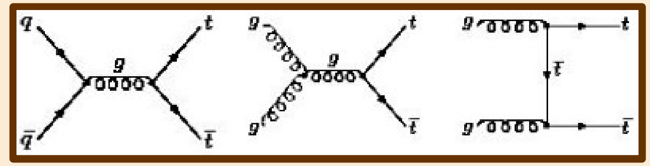
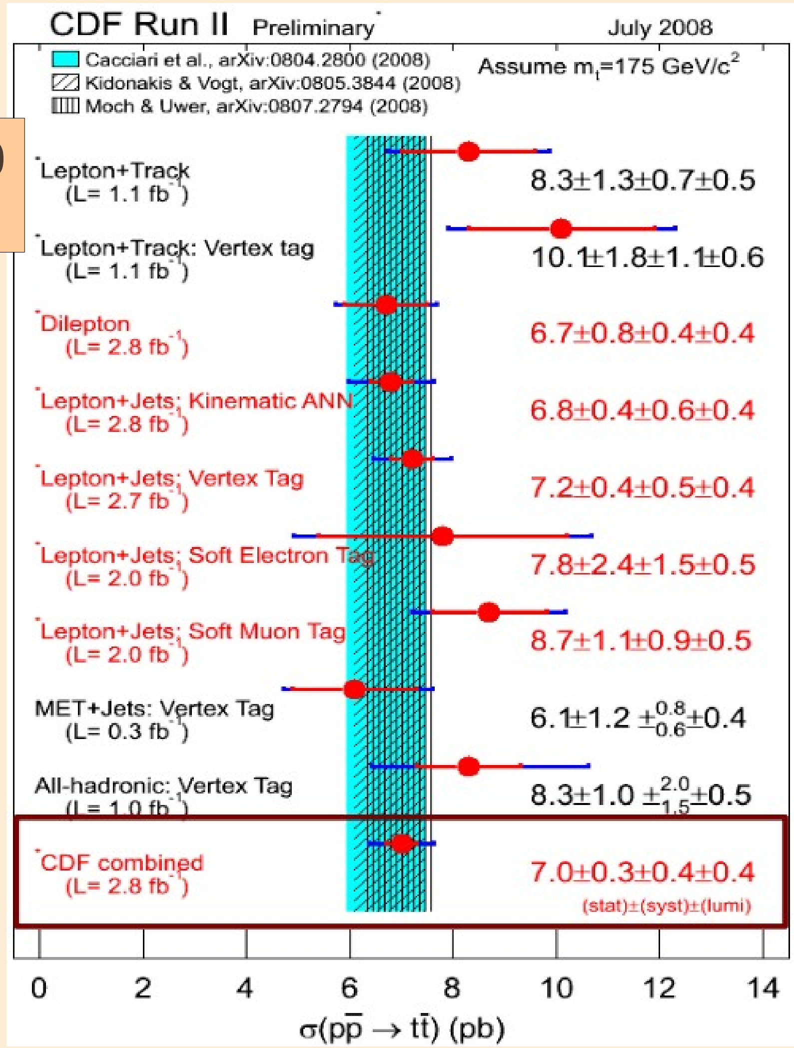
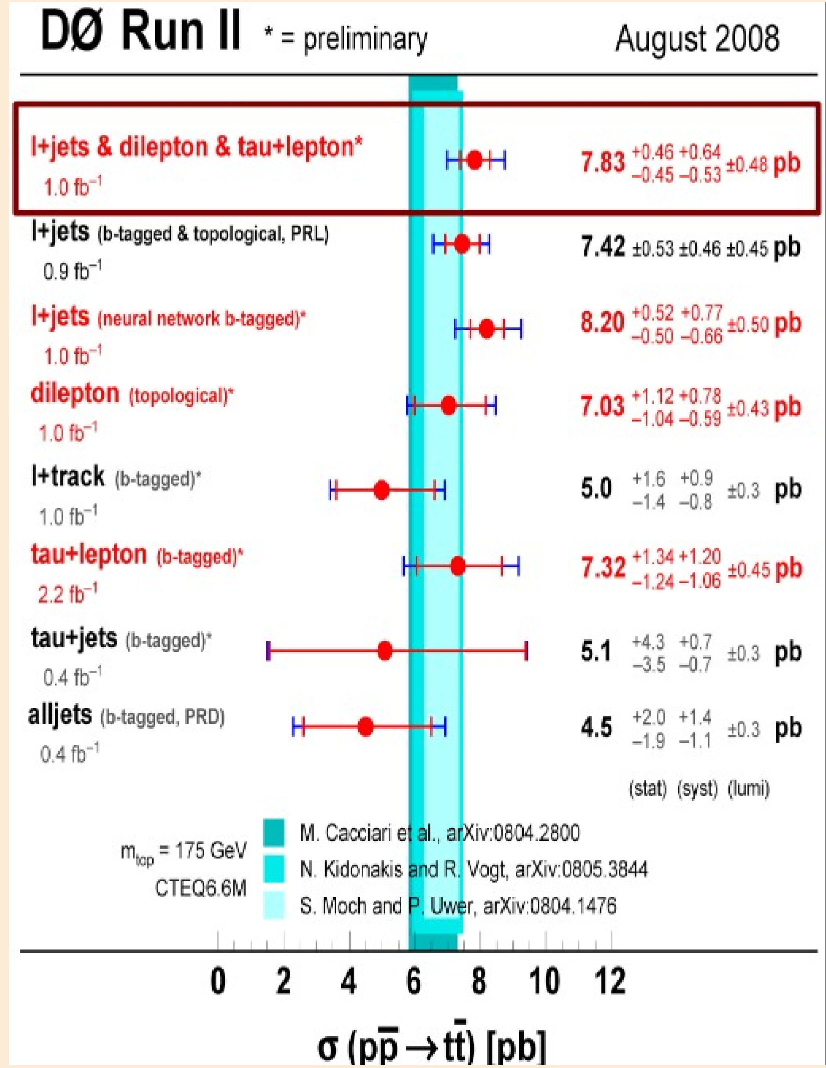
Production du quark top



CDF & D0
V. Shary





Mesure de la masse du top à partir de sa section efficace de production

V. Shary

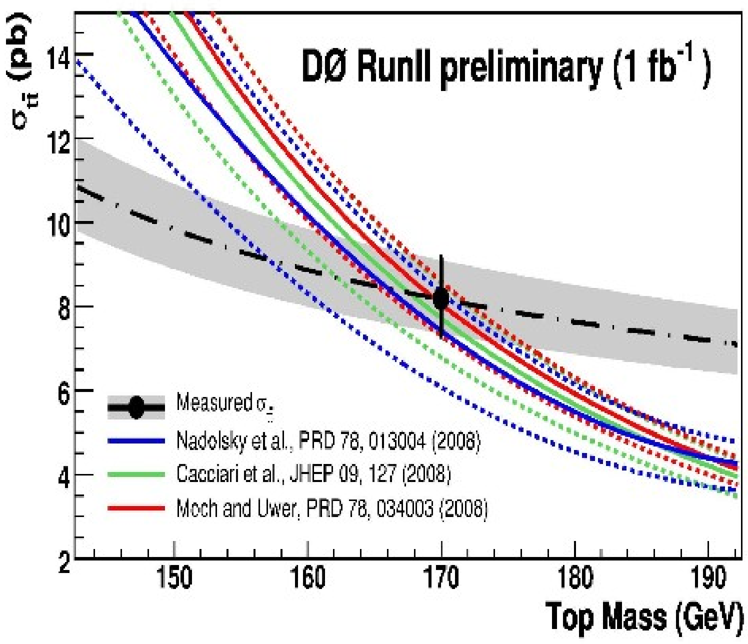
- Motivation: complementary measurement to the direct top mass measurement. Less sensitive to the non-perturbative QCD effects.
- Define theory likelihood according to PDF and scales uncertainties from

  (1) P. M. Nadolsky et al., Phys. Rev. D 78 013004 (2008); W. Beenakker et al., Phys. Rev. D 40, 54 (1989).

  (2) M. Cacciari et al., JHEP 09, 127 (2008);

  (3) S. Moch and P. Uwer, Phys. Rev. D 78, 034003 (2008);

  (4) N. Kidonakis and R. Vogt, Phys. Rev. D 78, 074005 (2008);
- Construct likelihood with measurements: Gauss(σ,$\delta\sigma$). Multiply the theory and measurement likelihoods to obtain a joint likelihood. Integrate over the cross section to get a likelihood function that depends only on the top-quark mass and calculate 68% C.L.



Theoretical computation	m_t (GeV)
NLO [1]	$165.5^{+6.1}_{-5.9}$
NLO+NLL [2]	$167.5^{+5.8}_{-5.6}$
approximate NNLO [3]	$169.1^{+5.9}_{-5.2}$
approximate NNLO [4]	$168.2^{+5.9}_{-5.4}$

Mesure de la masse du quark top

CDF & D0
R. Kehoe

New World Average Top Mass

- Combination of all CDF results:
  - Runs I and II
  - Dilepton, l+jets, all-jets

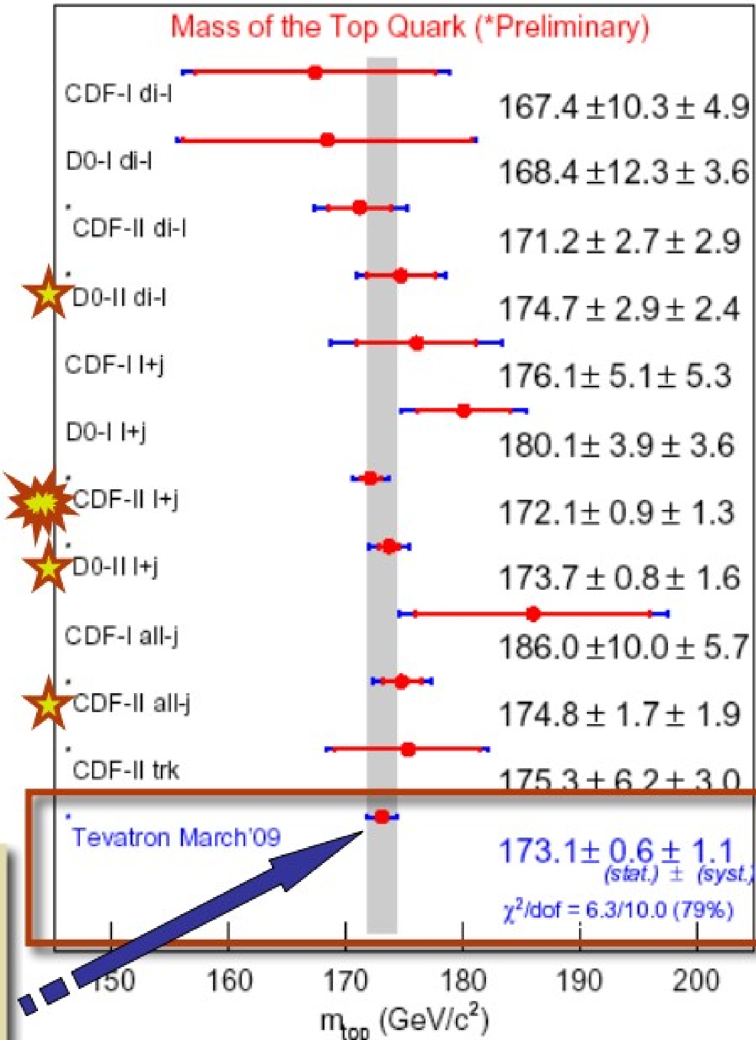
$$m_t = 172.6 \pm 0.9(\text{stat}) \pm 1.2(\text{syst})\ \text{GeV (CDF)}$$

CDF-NOTE-9714

- Combination of all D0 results
  - Runs I and II
  - Dilepton, l+jets

$$m_t = 174.2 \pm 0.9(\text{stat}) \pm 1.5(\text{syst})\ \text{GeV(D0)}$$

D0-CONF-5900



New Tevatron March '09 combined Mass
FERMILAB-TM-2427-E
arXiv:0903.2503

3/17/09 Ro... Top Mass Measurements 14

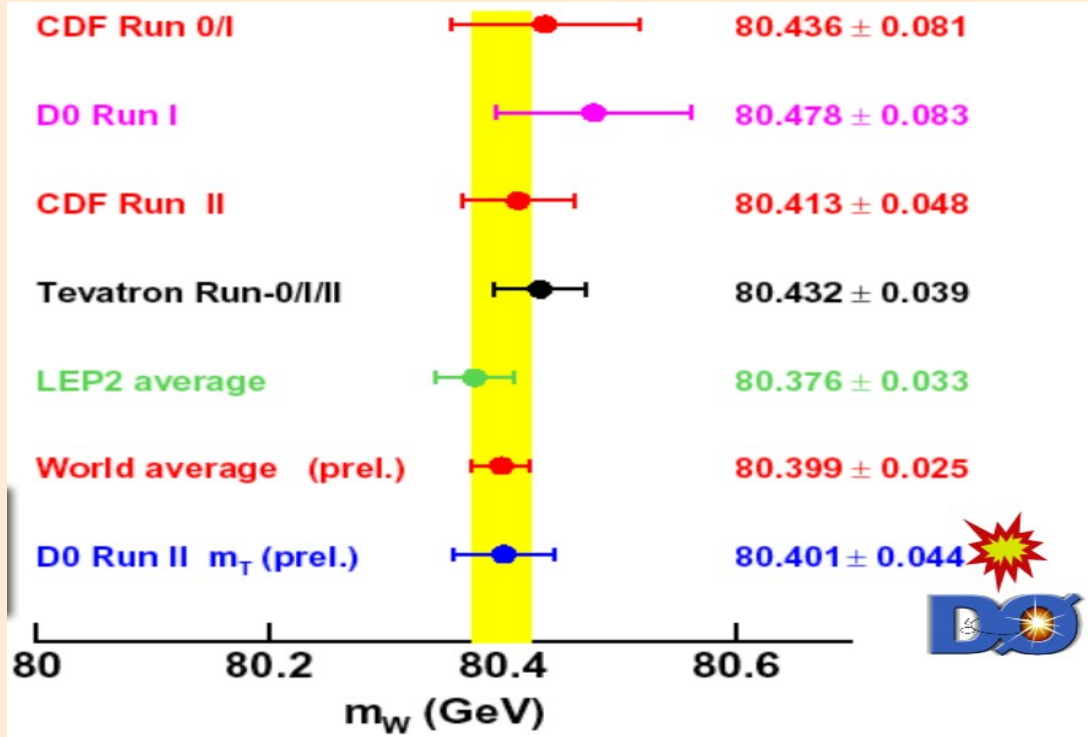
W mass measurement from D0

R. Kehoe

- W→eν mode in 1 fb^{-1}
  - Central electrons (|η|<1.05)
  - 499,830 W's
  - 18,725 Z→ee's
  - Statistics and calorimeter enable precision measurement
- Template analysis using

$$m_T = \sqrt{2 p_T^e p_T^\nu (1 - \cos(\phi_e - \phi_\nu))}$$

  - p_T^e and E_T^{miss}

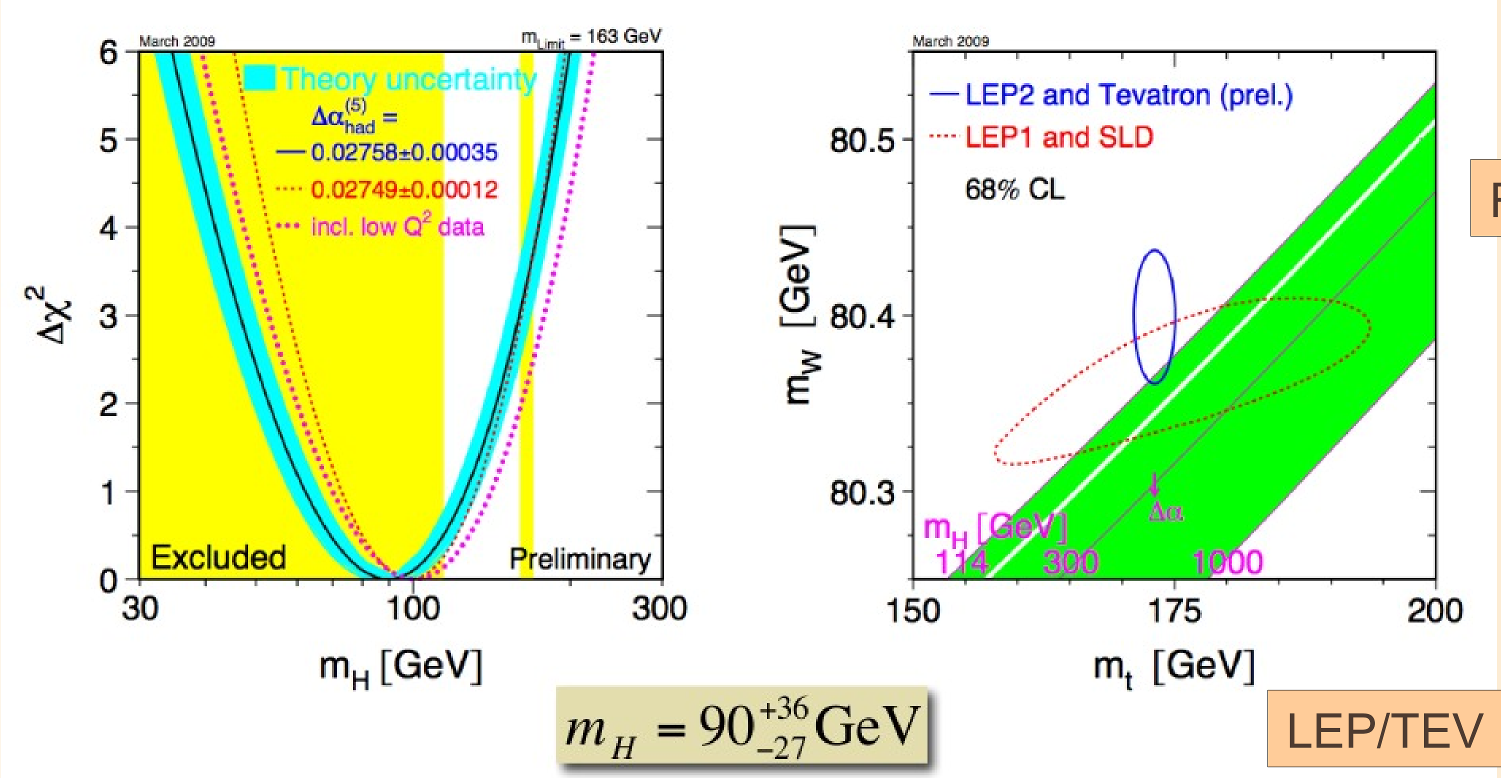


$$M_W = 80.400 \pm 0.027(\text{stat}) \pm 0.040(\text{syst})\ \text{GeV with } p_T^e$$
$$= 80.402 \pm 0.023(\text{stat}) \pm 0.044(\text{syst})\ \text{GeV with } E_T^{miss}$$
$$M_W = 80.401 \pm 0.023(\text{stat}) \pm 0.037(\text{syst})\ \text{GeV with } m_T$$

not 100% correlated: combination coming

Electroweak fit

- Incoporation des resultats de CDF et D0 dans l'ajustement electrofaible (m_{top} et exclusion Higgs):



R. Kehoe

$$m_H = 90^{+36}_{-27}\,\mathrm{GeV}$$

LEP/TEV EW WG

Limites CDF et D0 sur le Higgs SM

CDF & D0
Y. Enari, D. Benjamin (Moriond-EW 2009)
T. Gadfort, S. Pagan Griso

- Combinaison inclus les canaux:
  - pour CDF:

Channel	Luminosity (fb^{-1})	m_H range (GeV/c^2)
$WH \to \ell\nu bb$ 2×(TDT,LDT,ST)	2.7	100-150
$ZH \to \nu\bar{\nu}b\bar{b}$ (TDT,LDT,ST)	2.1	105-150
$ZH \to \ell^+\ell^-b\bar{b}$ 2×(TDT,LDT,ST)	2.7	100-150
$H \to W^+W^-$ (low,high s/b)×(0,1 jets)+(2+ jets)	3.6	110-200
$WH \to WW^+W^- \to \ell^\pm\nu\ell^\pm\nu$	3.6	110-200
$H + X \to \tau^+\tau^- + 2$ jets	2.0	110-150
$WH + ZH \to jjb\bar{b}$	2.0	100-150

  - pour D0:

Channel	Luminosity (fb^{-1})	m_H range (GeV/c^2)
$WH \to \ell\nu bb$ 2×(ST,DT)	2.7	100-150
$WH \to \tau\nu b\bar{b}$ 2×(ST,DT)	0.9	105-145
$VH \to \tau\tau b\bar{b}/q\bar{q}\tau\tau$	1.0	105-145
$ZH \to \nu\bar{\nu}b\bar{b}$ (DT)	2.1	105-145
$ZH \to \ell^+\ell^-b\bar{b}$ 2×(ST,DT)	2.3	105-145
$WH \to WW^+W^- \to \ell^\pm\nu\ell^\pm\nu$	1.1	120-200
$H \to W^+W^- \to \ell^\pm\nu\ell^\mp\nu$	3.0–4.2	115-200
$H \to \gamma\gamma$	4.2	100-150
$t\bar{t}H \to t\bar{t}b\bar{b}$ 2×(ST,DT,TT)	2.1	105-145

- Techniques d'analyse:
  - Réseau de neurones, Boosted Decision Tree, Elements de matrice

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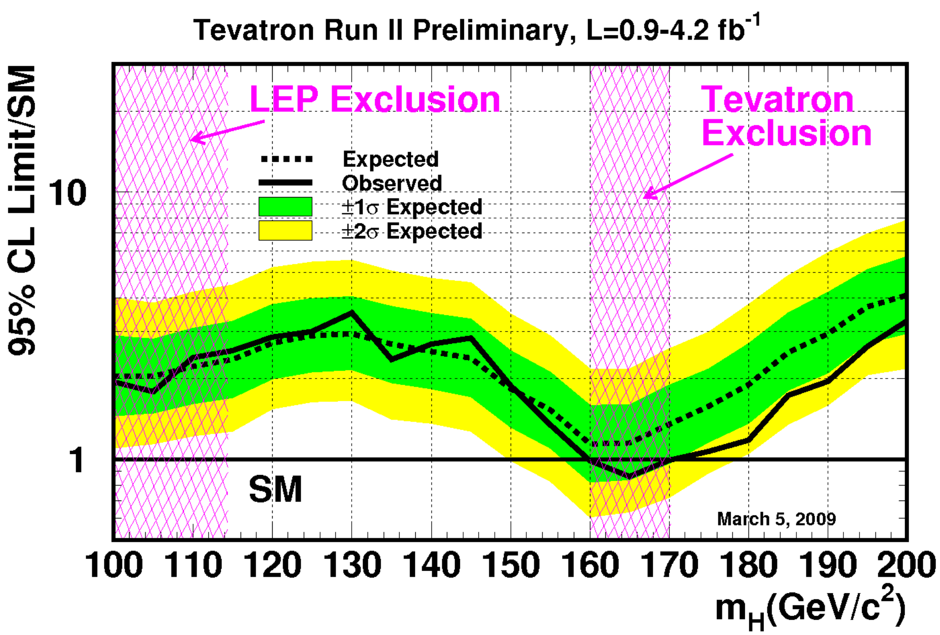
Limites CDF et D0 sur le Higgs SM

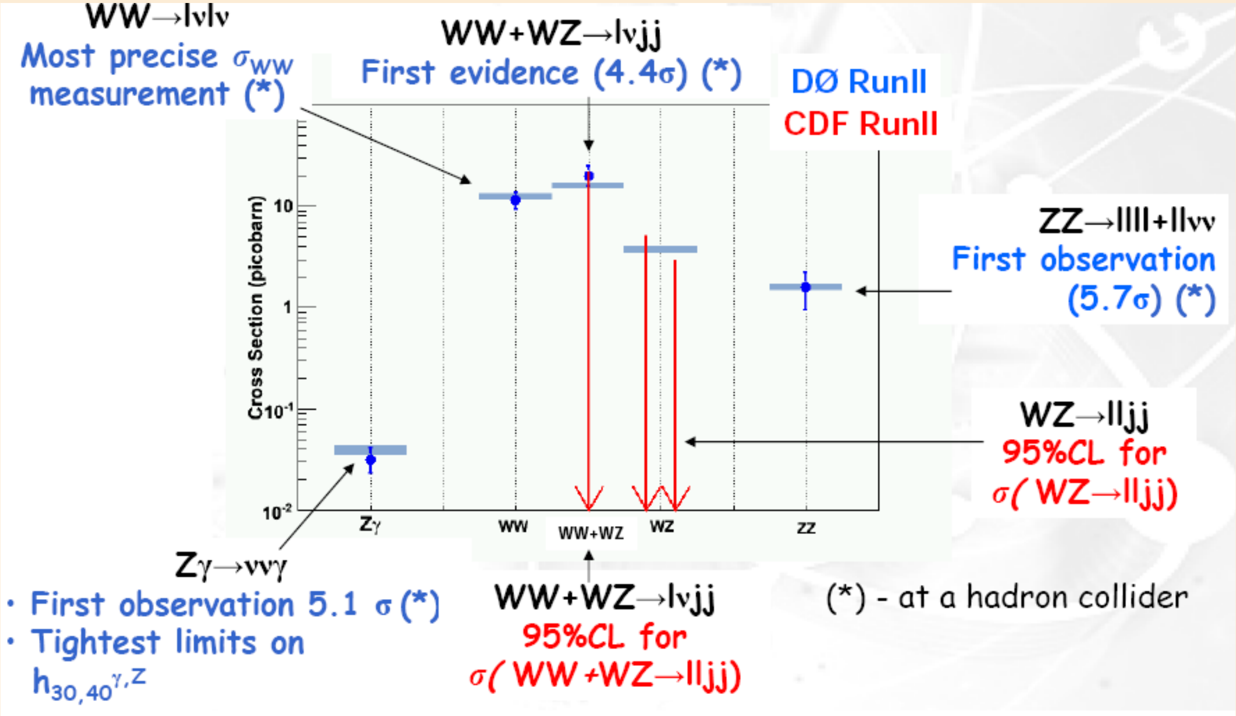


- Excluent la région de masse 160-170 GeV/c^2
- limite 95% CL M_H = 115GeV/c^2:

  2.5 x σ_{SM} (exp. 2.4 x σ_{SM})

CDF & D0
Y. Enari, D. Benjamin (Moriond-EW 2009)
T. Gadfort, S. Pagan Griso

Di-boson production @Tevatron



CDF & D0
J. Sekaric

- Première observation (D0) de:

  $ZZ \rightarrow llll+ll\nu\nu$

  et $Z\gamma \rightarrow \nu\nu\gamma$
- Première indication de production de WZ (CDF).
- Limites sur couplage anormal. $\nu\nu\gamma$ (3.6 /fb) + $ll\gamma$ (1 /fb):

  $|h_{30}^{\gamma,Z}| < 0.033$

  $|h_{40}^{\gamma,Z}| < 0.017$
- Bon accord avec SM

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Détermination de α_s

- A partir de l'analyse NNLO+NNLA event shape sur les données de JADE

  ➔ $\Delta\alpha_s(M_Z)$~4%

S. Kluth

NNLO:

$$\alpha_S(M_Z) = 0.1210 \pm 0.0007(\text{stat.}) \pm 0.0021(\text{exp.}) \pm 0.0044(\text{had.}) \pm 0.0036(\text{theo.})$$
$$= 0.1220 \pm 0.0061(\text{tot.})$$

NNLO+NLLA:

$$\alpha_S(M_Z) = 0.1172 \pm 0.0006(\text{stat.}) \pm 0.0020(\text{exp.}) \pm 0.0035(\text{had.}) \pm 0.0030(\text{theo.})$$
$$= 0.1172 \pm 0.0051(\text{tot.})$$

- HERA:

➢ Inclusive jet and 2(3)-jet production allows a precise test of coupling running over 2 orders of magnitude in energy. Precise determination of $\alpha_S(M_Z)$:

Jets in DIS (Q^2>150 GeV^2 - H1):

$$\alpha_S(M_Z) = 0.1168 \pm 0.0007(\text{exp.})^{+0.0046}_{-0.0030}(\text{th.}) \pm 0.0016(\text{PDF})$$

Jets in γp (ZEUS):

$$\alpha_S(M_Z) = 0.1123 \pm 0.0022\ (\text{exp.}) \pm 0.0030(\text{th.})$$

H1 & ZEUS
M. Gouzevitch

NNPDF

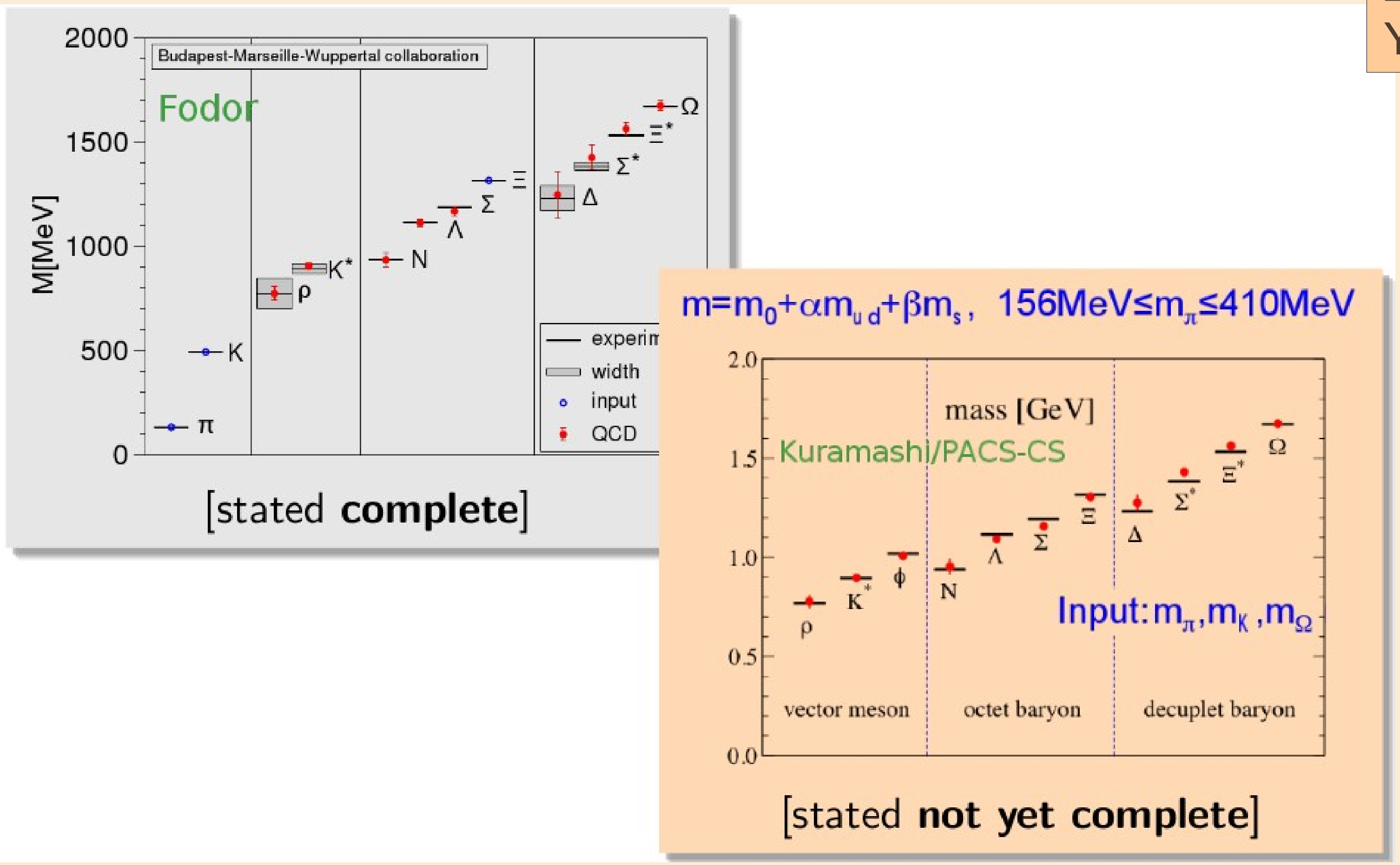
L. Del Debbio

- Motivation:
  - obtention de PDF sans biais avec une estimation fiable de leurs erreurs.
- Approche prise par NNPDF:
  - Réplique les données par des expériences Monte Carlo afin d'obtenir l'ensemble des PDF
    - ➔ Mesure directe des incertitudes. MSTW/CTEQ utilse $\Delta\chi^2$=50
  - Utilise un réseau de neurones comme paramatrisation des PDF
    - ➔ Parameterisation sans biais
- Status:
  - v1.0 disponible dans LHAPDF, v1.1 depuis http://sophia.ecm.ub.es/nnpdf
  - à venir: inclusion des effets quarks lourds et des données p-p
  - une fois inclus, sérieuse alternative à CTEQ et MSTW

NNPDF collaboration: R. D. Ball, L. Del Debbio, S. Forte, A. Guffanti, J.I. Latorre, A. Piccione, J. Rojo, M. Ubiali

Lattice QCD

R. Brownson
Z. Fodor
Y. Kuramashi



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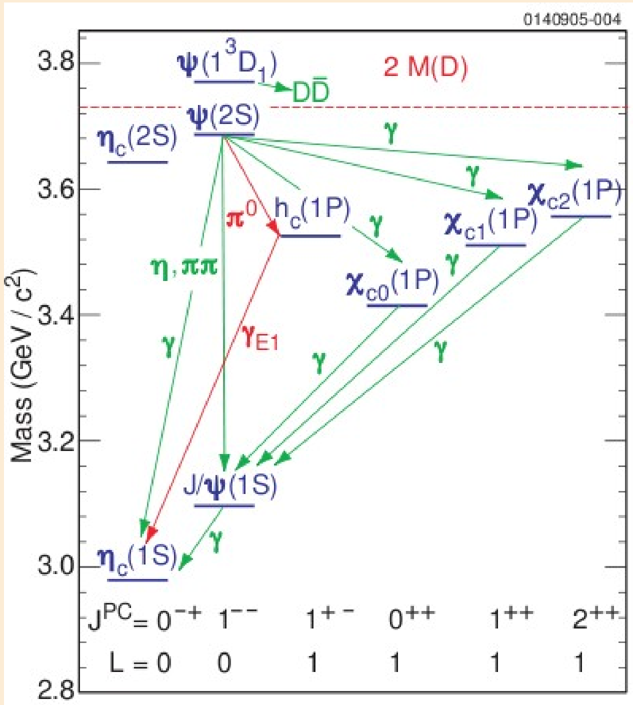
Charmonium decays

CLEO
T. Pedlar



- $J/\psi \to 3\gamma$ (PRL 101, 10180, 2008)
  - First 3γ decay of any hadron
  - S/B = 37/12.8
  - Tag J/ψ through $\psi' \to \pi^+\pi^- J/\psi$
  - $BR = (1.17^{+0.34}_{-0.29} \pm 0.14) \times 10^{-5} (6\sigma)$
- Y(2175) observed at BES in $J/\psi \to \eta\, \varphi\, f_0$

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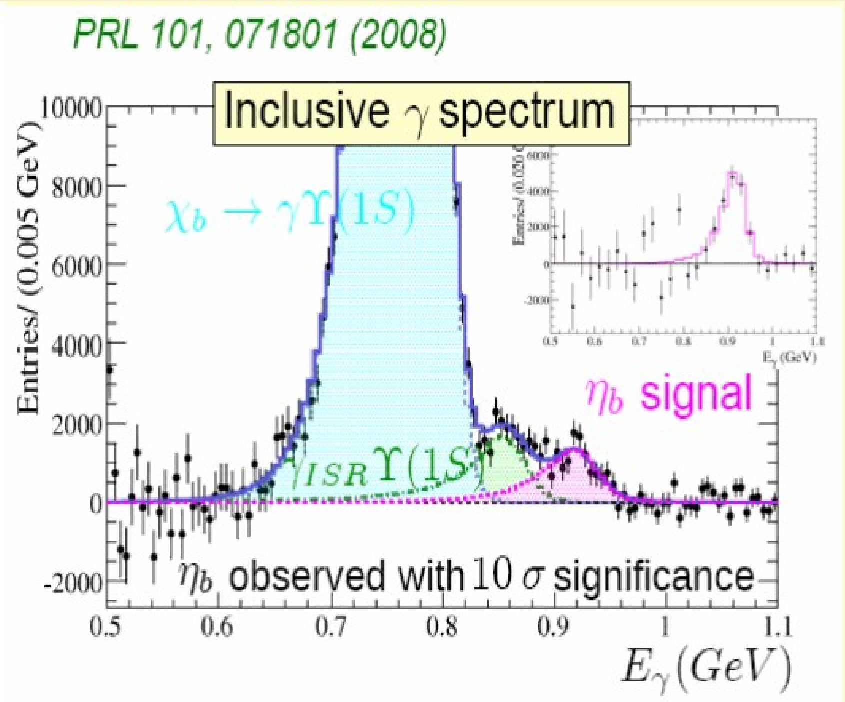
Observation de η_b

BaBar
J. Marks

- Découverte de $\eta_b(1S)$ dans $\Upsilon(3S)\rightarrow\gamma\eta_b$ à 10σ

  PRL 101, 071801 (2008)

- Observation confirmée dans $\Upsilon(2S)\rightarrow\gamma\eta_b$ à 3.5σ (prélim.) arXiv:0903.1124



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Observation de η_b

BaBar
J. Marks

- Branching fraction measurement

$$\mathcal{B}(\Upsilon(3S) \to \gamma\eta_b) = (4.8 \pm 0.5 \pm 0.6) \cdot 10^{-4}$$
$$\mathcal{B}(\Upsilon(2S) \to \gamma\eta_b) = (4.2^{+1.1}_{-1.0} \pm 0.9) \cdot 10^{-4}$$

$$R_{\mathcal{B}} = \frac{\mathcal{B}(\Upsilon(2S) \to \gamma\eta_b)}{\mathcal{B}(\Upsilon(3S) \to \gamma\eta_b)} = 0.89^{+0.25+0.12}_{-0.23-0.16}$$

$$R_{\mathcal{B}}^{Theory} \approx 0.3 - 0.7$$

Compatible with M1 transitions

S.Godfrey, J.L. Rosner
PR D64, 074011 (2001)

- Combined η_b mass

$$M_{\eta_b} = 9390.4 \pm 3.1\ MeV/c^2$$
$$M_{\eta_b}^{Theory} = 9380 \pm 10\ MeV/c^2$$

In agreement with unquenched lattice QCD calculations

T.-W. Chiu et al.
PL B651, 171 (2007)

- Hyperfine mass splitting

$$\Delta M_{\Upsilon(1S)-\eta_b} = 69.9 \pm 3.1\ MeV/c^2$$
$$\Delta M_{\Upsilon(1S)-\eta_b}^{Theory} = 61 \pm 14\ MeV/c^2$$

ΔM is larger than prediction from perturbative QCD
In agreement with Lattice QCD prediction

A.Gray et al.
PR D72, 094507 (2005)

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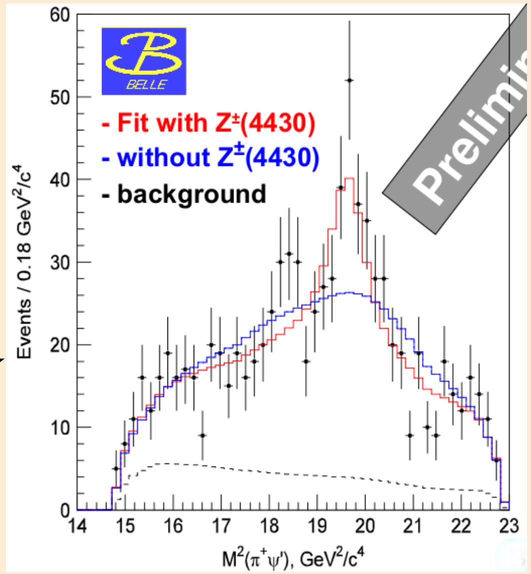
Etats charmonium-like X, Y, Z



- *Belle découvre X(3872) en 2003. Confirmé ensuite par CDF, D0, BaBar*
- Belle nous confirme les resultats initiaux de la résonance $Z^+(4430)$ dans $B \rightarrow \psi(2S)\pi^{\pm}K$

$$M = (4443^{+15+17}_{-12-13})\ MeV/c^2$$
$$\Gamma = (109^{+86+57}_{-43-52})\ MeV/c^2$$

(présenté à QWG6, déc. 2008)

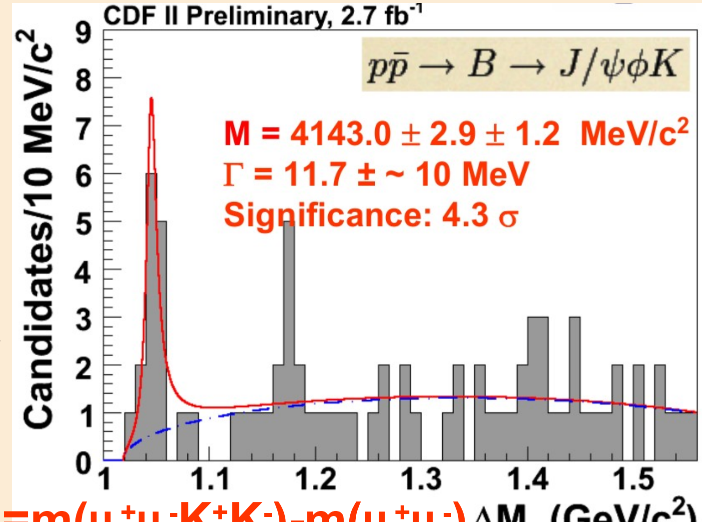
$Z_1^+(4050)$ et $Z_2^+(4250)$ dans $B0 \rightarrow K^- \pi^+ \chi_{c1}$

À confirmer. PRD 78, 072004 (2008)

- Indication d'une nouvelle résonance à CDF Y(4140)

M. Bracko

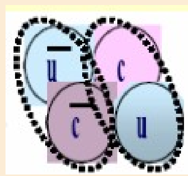
J. Nacthman

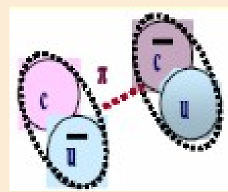


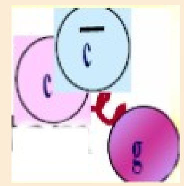
$\Delta M = m(\mu^+\mu^-K^+K^-) - m(\mu^+\mu^-)$

Etats charmonium-like X, Y, Z

- Tetraquarks? molécules? états charmonium hybride? Effect de seuil?







- « [the Ds spectrum and] the X’s (Y’s, Z’s,...) challenge our understanding of QCD », Eric Swanson

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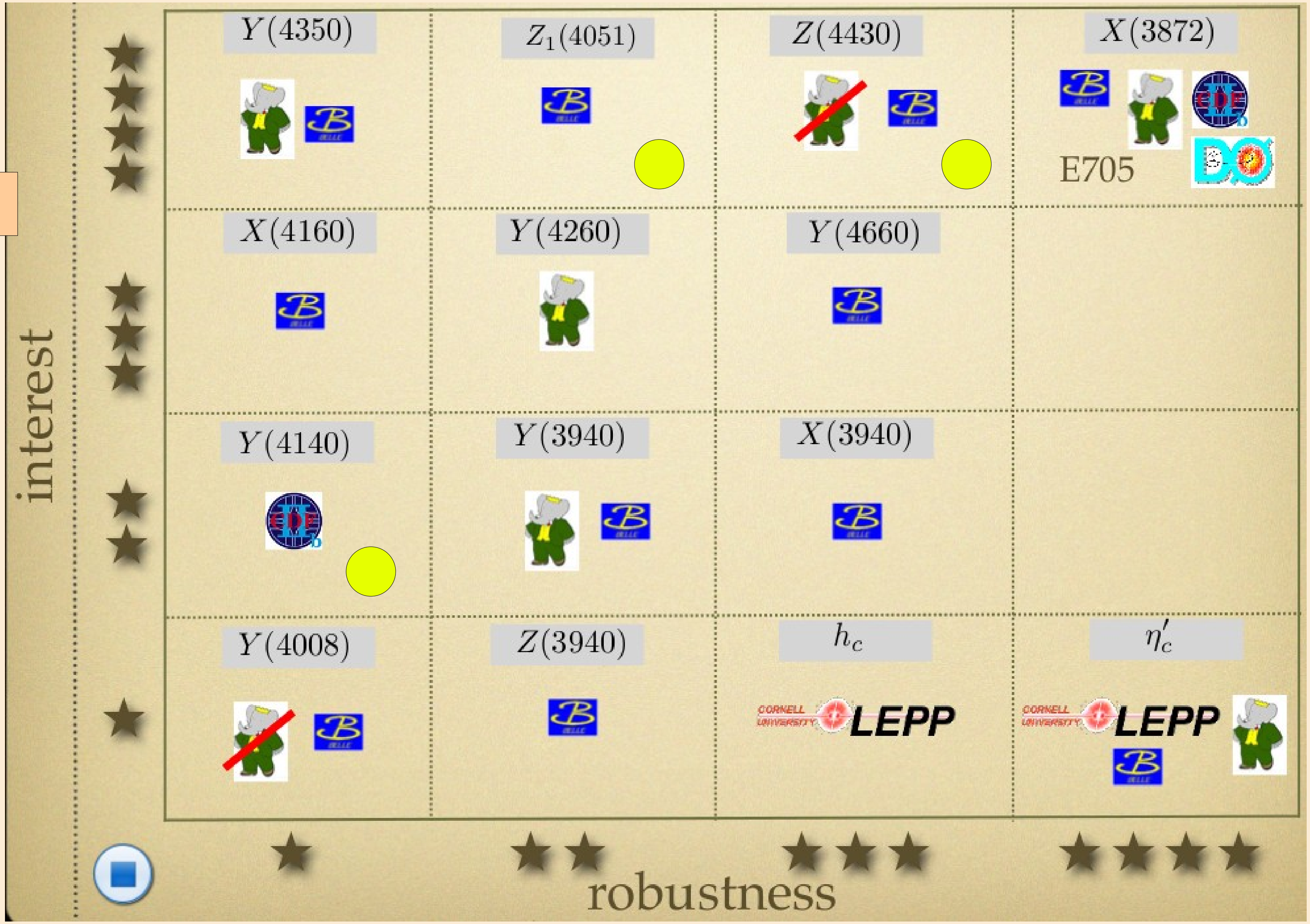
Etats charmonium-like X, Y, Z

E. Swanson



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Etats charmonium-like X, Y, Z

E. Swanson

interest \ robustness	★	★★	★★★	★★★★
★★★★	$Y(4350)$?	$Z_1(4051)$ tetraquark hadrocharmonium artefact	$Z(4430)$ tetraquark D^*D_1 molecule threshold effect artefact	$X(3872)$ DD^* molecule threshold effect tetraquark
★★★	$X(4160)$?	$Y(4260)$ hybrid (ccg) threshold effect	$Y(4660)$ radial hybrid (ccg) 5S vector $f_0\ \psi'$ molecule	
★★	$Y(4140)$ tetraquark artefact	$Y(3940)$ χ'_{cJ}	$X(3940)$ χ'_{cJ}	
★	$Y(4008)$?	$Z(3940)$ χ'_{c2} sets scale for 2P states (inverted?)	h_c tests long range spin dynamics	η'_c tests $O(1/m^2)$ dynamics

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Conclusion

- Nombreux résultats intéressants n'ont pu être abordés dans ce résumé:
  - Recherche SUSY et BSM à Tevatron. Voir Présentations de F. Couderc et R. Eusebi
  - GFitter
  - pp $\rightarrow$ VH, H$\rightarrow$ bb @ LHC
    Rubin: high-pt H. Jet substructure.
  - résultats NA48
  - résultats KLOE
  - Collisions d'ions lourds
  - et plus.
- Ensemble des transparents disponible sur
  - http://moriond.in2p3.fr/QCD/2009/MorQCD09Prog.html
    Excellents résumés de K. Jakobs (exp.) et G. P. Salam (théorie)

Complément

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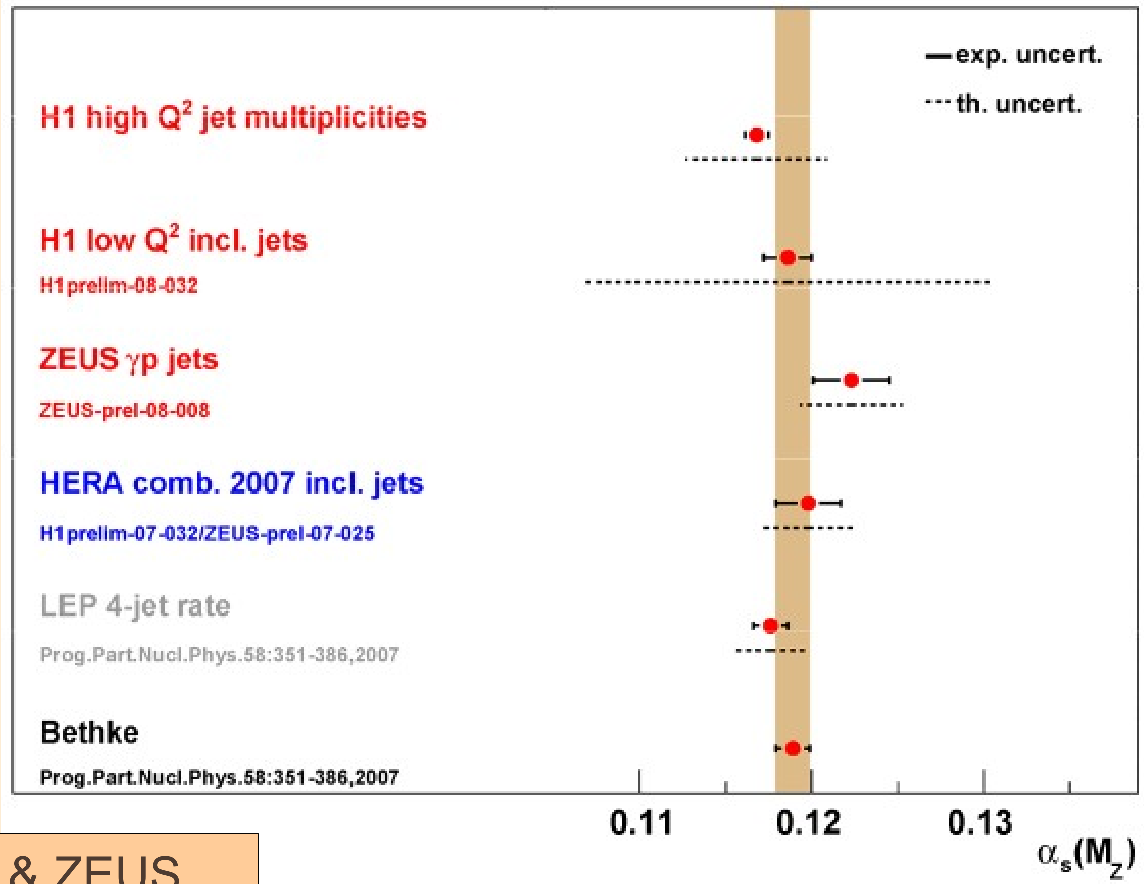
α_s à partir des données d'HERA



- New measurements in γp, low and high Q^2 compatible with LEP and the world average
- High experimental precision (0.6-2%)
- Dominated by NLO uncertainty
- H1-ZEUS combination is promising:
  - 2 times more data
  - inter-calibration of hadronic energy scales

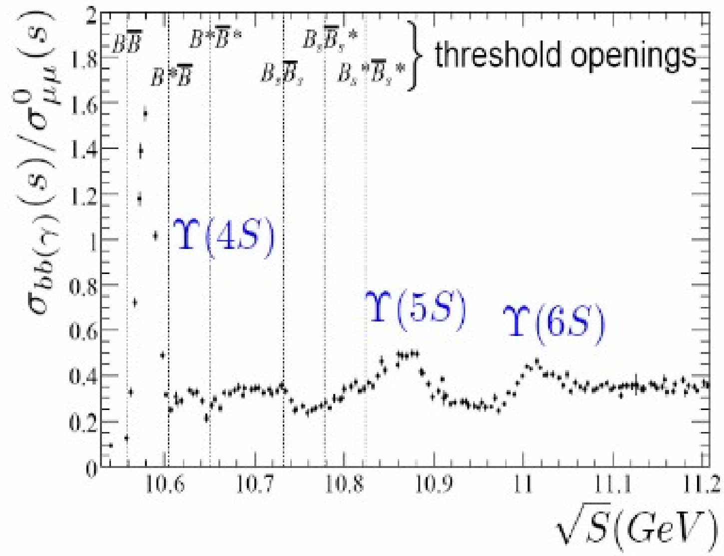
H1 & ZEUS
M. Gouzevitch

…beyond Y(4S):

J. Marks

- Inclusive bb cross-section

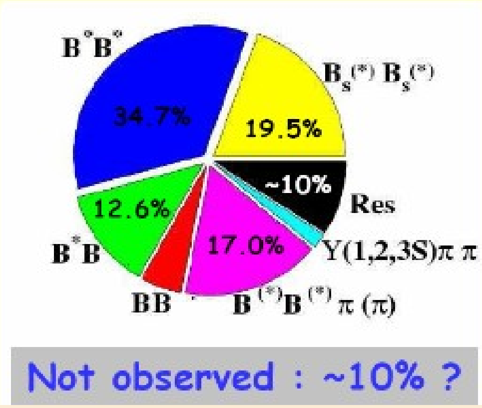
PRL 102, 012001 (2009)



- $\Upsilon(5S)$ and $\Upsilon(6S)$ candidates are affected by threshold effects and interference
- Fitted $\Gamma(\Upsilon(5S))$ and $\Gamma(\Upsilon(6S))$ smaller than PDG values

A. Drutskoi

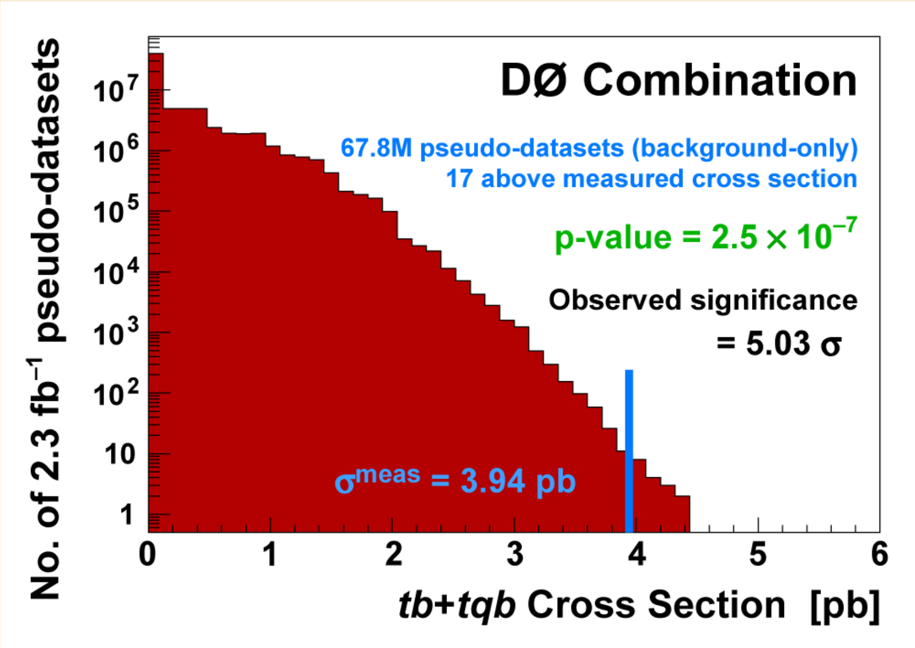
- **Belle results on Y(5S) running:**
  - Many **B_s decays** measured: $B_s \to D_s^- \pi^+$, $B_s \to D_s^- K^+$, $B_s \to J/\psi\ \phi$
  - B_s decays observed for the first time: $B_s \to J/\psi\ \eta$, $\to \phi\ \gamma$
  - Semileptonic branching ratio measured
  - Upper limit on $B_s \to \gamma\gamma$
  - **Y(5S) decays:** First observation of Y(5S) → Y(1,2,3S) ππ (unexpectedly large branching ratio)

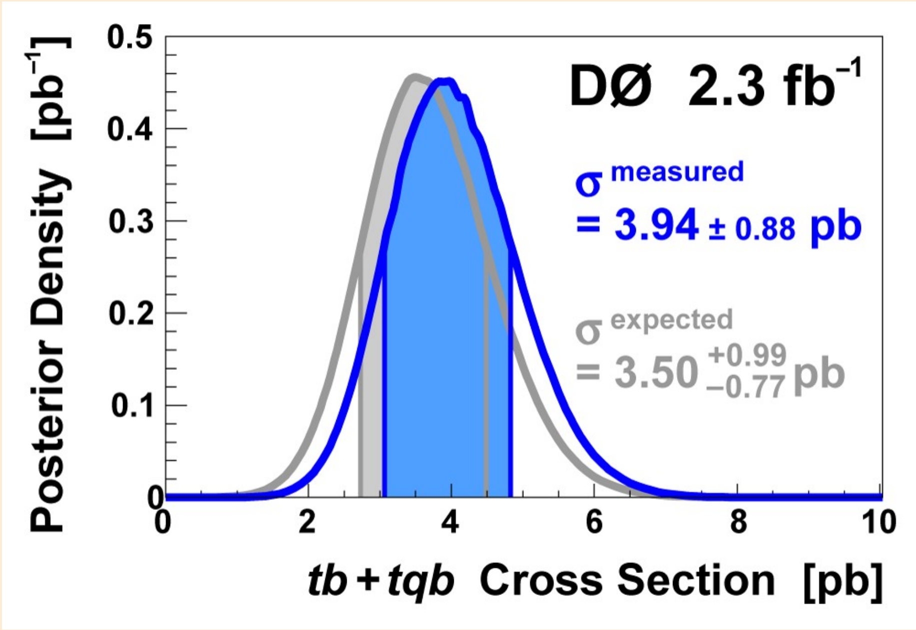


Transparent de K. Jakobs (exp. summary talk)

Première observation de la production Single top

CDF & D0
D. Gillberg





Single top: signal region

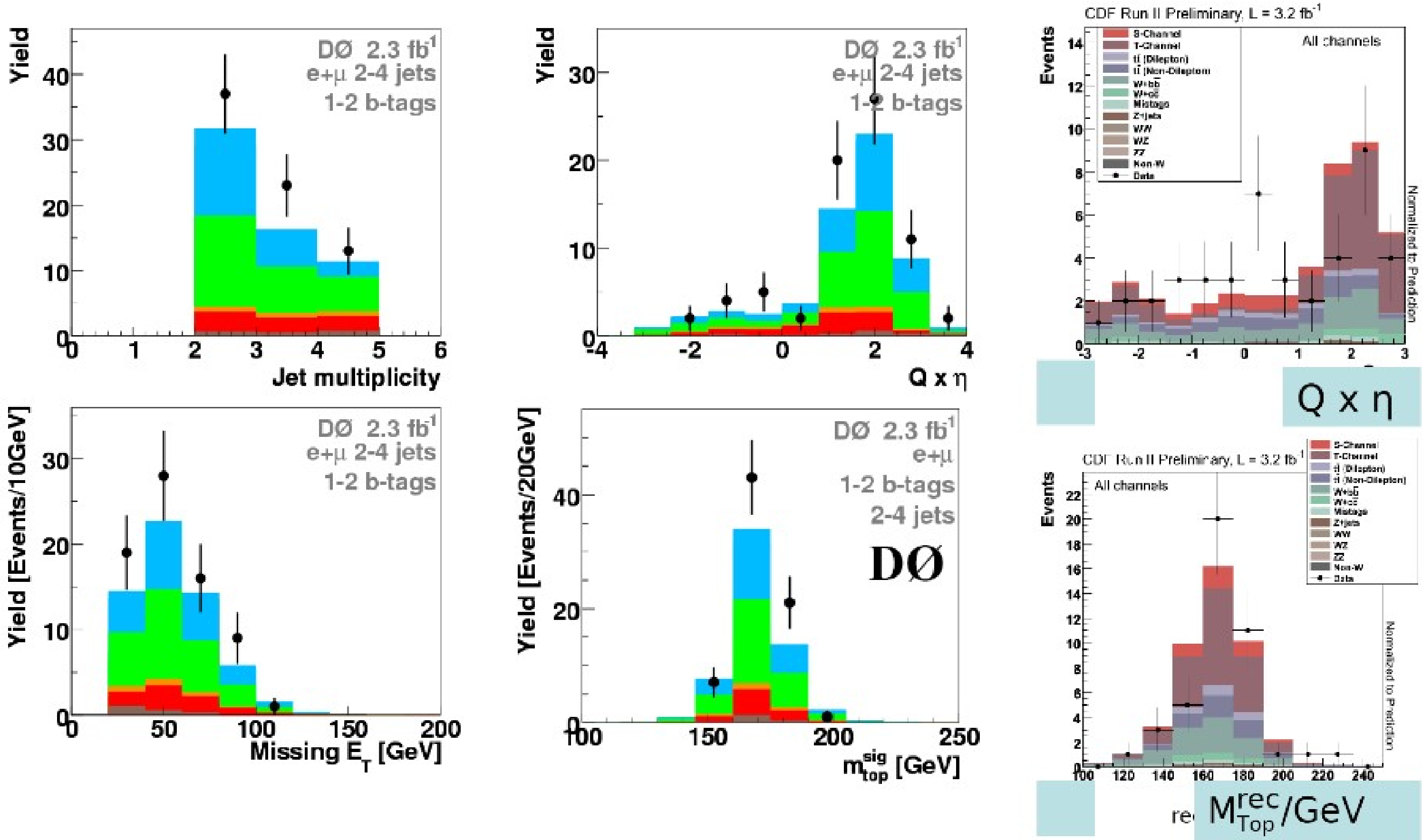
Closer look in the signal region

CDF & D0
D. Gillberg

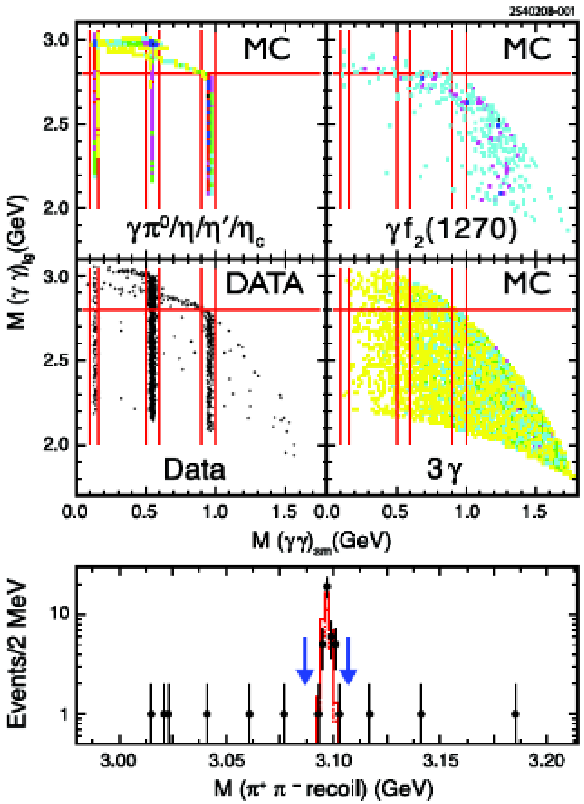
(BNN comb. output > 0.9)

(BNN comb. output > 0.9)

(Super Discriminant > 0.76)



$J/\Psi\to 3\gamma$



- Orthopositronium the only system known to decay directly to $\gamma\gamma\gamma$
- Previously, only upper limits: $Z, J/\psi, \omega$ all $< 2 \times 10^{-4}$
- Kwong predicts: $B(J/\psi\to\gamma\gamma\gamma) \sim 10^{-5}$
- Our analysis method:
  - Tag J/ψ through $\psi'\to\pi^+\pi^- J/\psi$: look for $\gamma\gamma\gamma$ alone
  - Kinematic fit of $\pi^+\pi^-\gamma\gamma\gamma$ to ψ' initial state
  - Hard cuts in $M_{\gamma\gamma,smallest}$ to reject $Ps\to\gamma\gamma$
  - Dominant background remaining: $J/\psi\to\gamma\pi^0\pi^0$, removed through kin. fit
- Signal/background $= 37/12.8$
- $\mathcal{B} = (1.17^{+0.34}_{-0.29} \pm 0.14) \times 10^{-5}$ (6σ)

CLEO
T. Pedlar

LUTHER COLLEGE

CESR CLEO

- First 3γ decay of any hadron. Agrees with leading order QED; NLO correction takes rate negative... (higher order hence highly important)
- Search for $\gamma\eta_c; \eta_c\to\gamma\gamma$ leads to upper limit: 3×10^{-4}, c.f. $(2.7 \pm 0.9) \times 10^{-4} (PDG)$

Observation de $Z^+(4050)$ & $Z^+(4250)$ par Belle

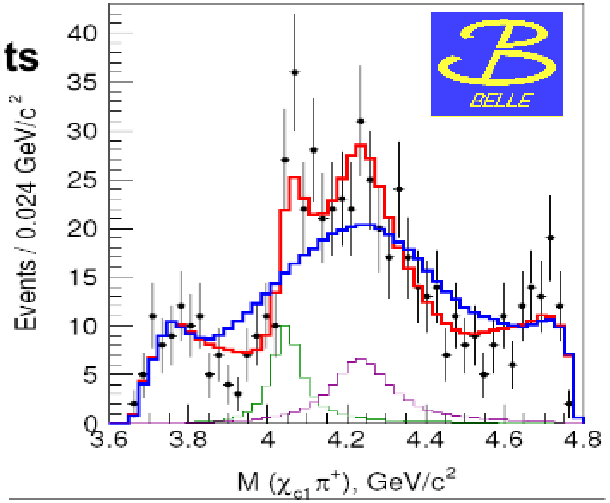
M. Bracko

PRD 78, 072004 (2008)
657 $B\bar{B}$

- Data favour fit with 2 resonant structures:
  one Z (10.7σ) ; Z_1 and Z_2 (13.2σ ; 5.7σ wrt. one Z)
- Spin of $Z_{1,2}$ is not determined:
  J=0 and J=1 hypotheses give comparable results
- $Z_{1,2}$ parameters:
  large syst. errors due to model uncertainties

	Z_1^+	Z_2^+
M/MeV	$4051 \pm 14^{+20}_{-41}$	$4248^{+44}_{-29}{}^{+180}_{-35}$
Γ/MeV	$82^{+21}_{-17}{}^{+47}_{-22}$	$177^{+54}_{-39}{}^{+316}_{-61}$
$\mathcal{B}_{\bar{B}^0} \times \mathcal{B}_{Z^+}$	$(3.1^{+1.5}_{-0.9}{}^{+3.7}_{-1.7}) \times 10^{-5}$	$(4.0^{+2.3}_{-0.9}{}^{+19.7}_{-0.5}) \times 10^{-5}$

M($\chi_{c1}\pi^+$) for $1<M^2(K^-\pi^+)<1.75$GeV



BF product comparable to $Z^+(4430)$, X(3872)…

- $Z^+(4050)$, $Z^+(4250)$ join $Z^+(4430)$ as charged charmonium-like exotics:

Tetraquark candidates

→ Experimental confirmation is still needed for all of them

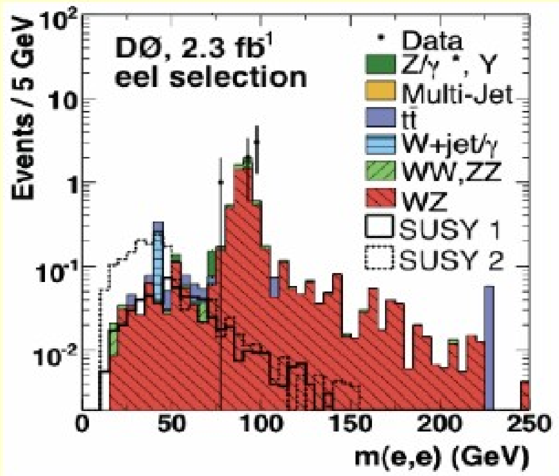
irfu

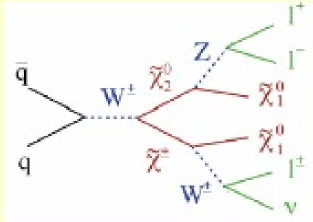
saclay

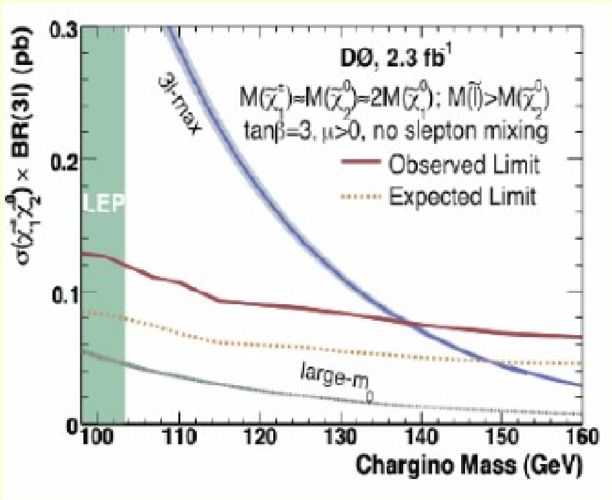
Search for SUSY at the Tevatron

(i) Charginos and Neutralinos in 3-ℓ final states: $\tilde{\chi}_2^0 \tilde{\chi}_1^\pm \rightarrow l^\pm l^\mp l^\pm \tilde{\chi}_1^0 \tilde{\chi}_1^0 X$

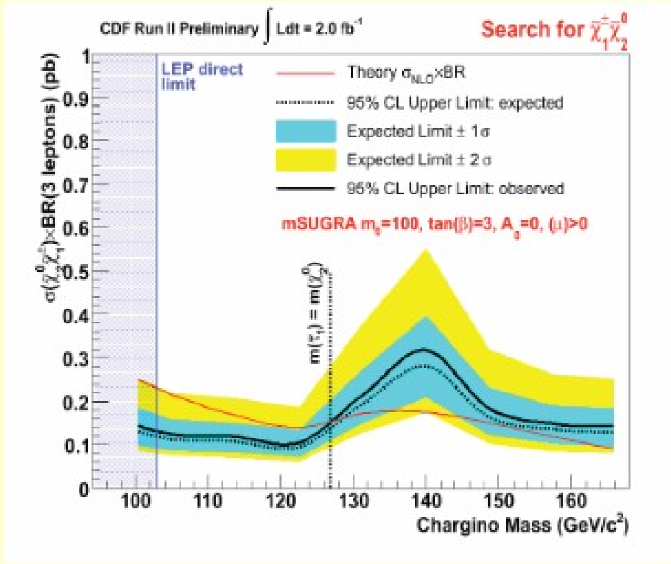
F. Couderc







Limits beyond LEP limits (for specific scenarios)



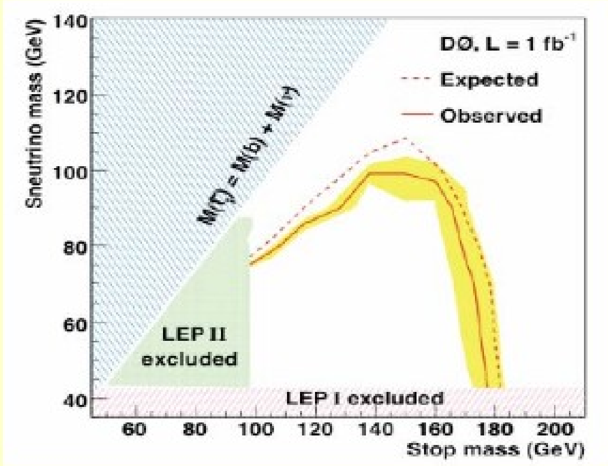
Transparent de K. Jakobs

Many other SUSY Searches going on….

F. Couderc

- Stop production

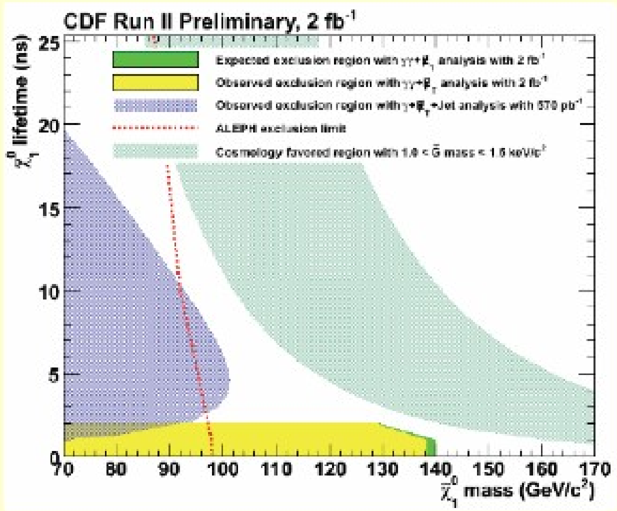
$$\tilde{t}_1\bar{\tilde{t}}_1 \rightarrow b\,b\,l\,l'\,\tilde{\nu}\,\bar{\tilde{\nu}}$$



- Gauge mediated SUSY searches
  - $\gamma(\gamma)$ + E_T^{miss} signature
  - …….

- R-parity violating SUSY
  - sneutrino production
  - …..

- Charged massive, quasi stable particles



Conclusion: interesting limits (partially beyond LEP), but so far no evidence for SUSY

Transparent de K. Jakobs

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R. Eusebi

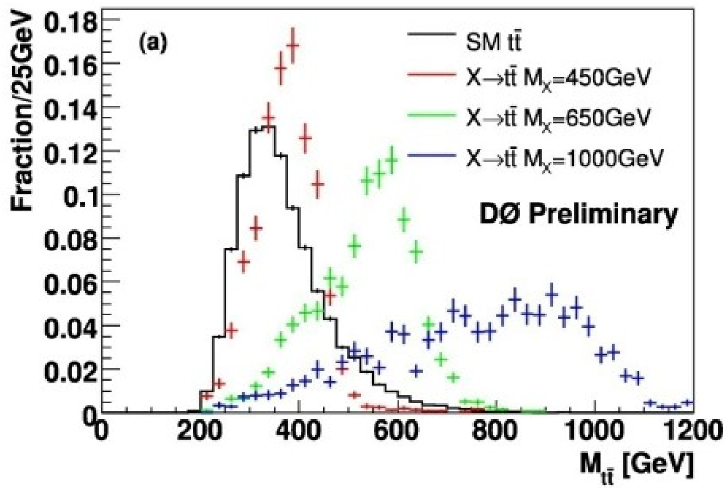
NEW Top Quark Pair Resonances

Search for $X \rightarrow t\bar{t}$

- $0.35\ \text{TeV} < M_X < 1.2\ \text{TeV}$.
- Width $\Gamma_X = 0.012\ M_X$
- Lepton, ME_T, ≥3 jets, ≥1 b-tag

Topcolor technicolor model

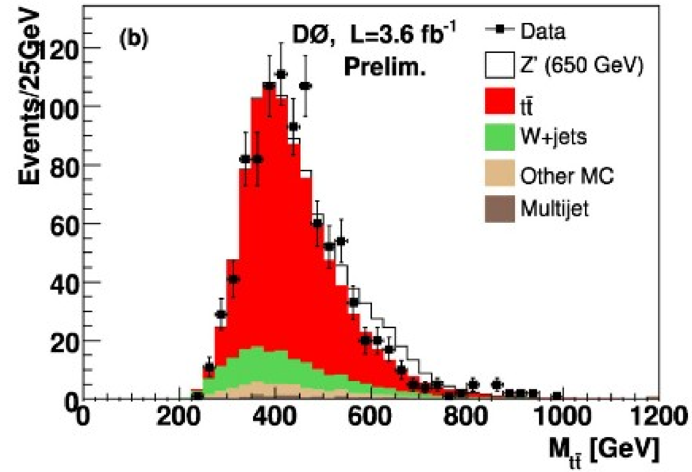
- Leptophobic Z' boson.

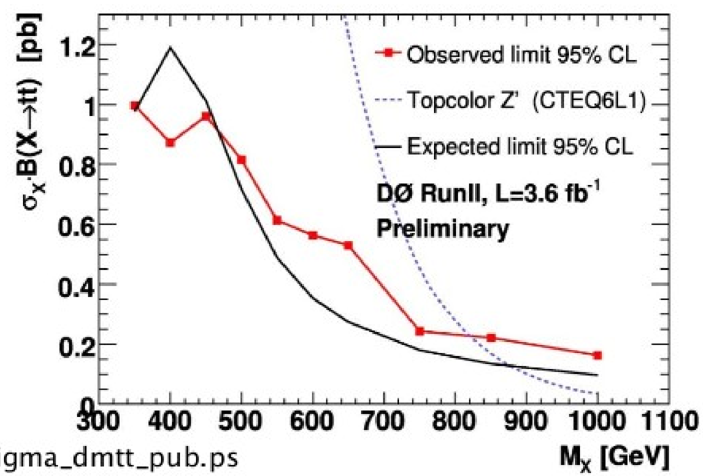


Excluded $M_{Z'}$<820 GeV @ 95% C.L.

See CDF result in conference note 9157
www-cdf.fnal.gov/physics/new/top/confNotes/cdf9157_dsigma_dmtt_pub.ps

Results

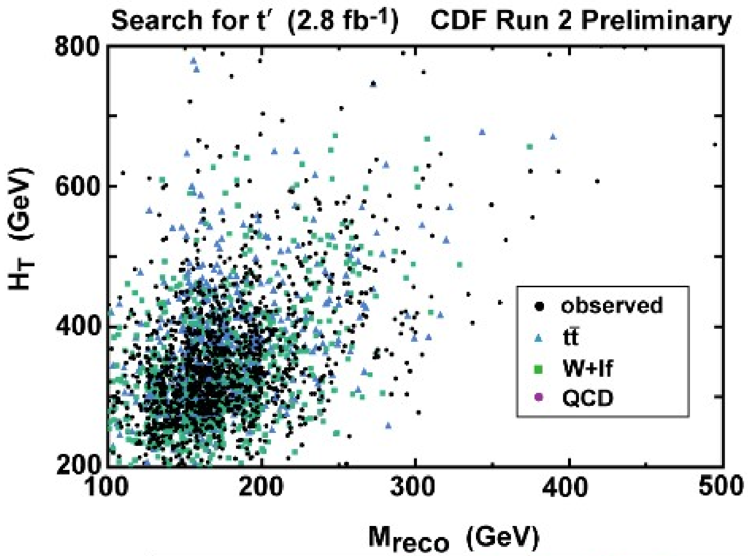




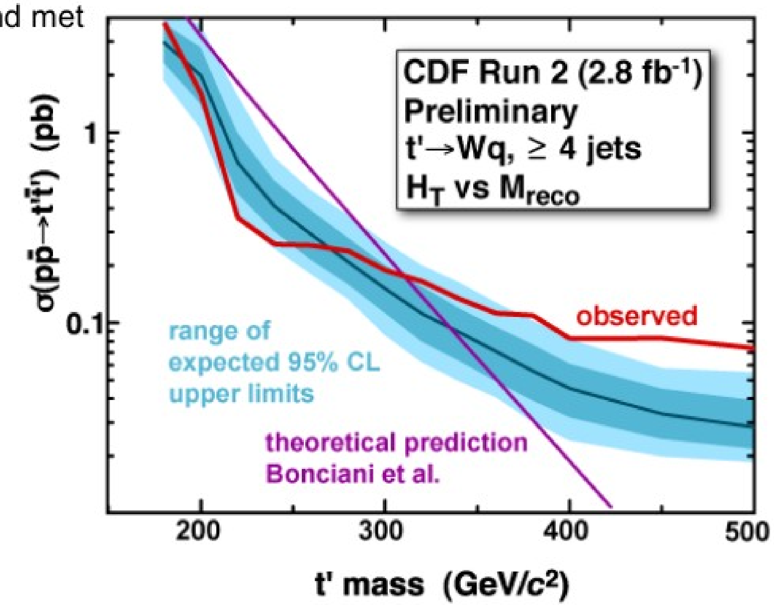
R. Eusebi

Search for 4th generation top (t')

- **Appear in some models**
  - Beautiful mirrors, Little Higgs
- **Search for t'→Wq in lepton+jets channel**
- **Use a 2D likelihood fit. In each event**
  - Reconstruct the stop mass
  - Compute H_T: scalar sum of the lepton, jets and met in the event.



- **EWK data:** can accommodate an extra chiral family without other new particles (hep-ph 0102144)
- **Results:**



Exclude t' below 311 GeV @ 95% C.L.

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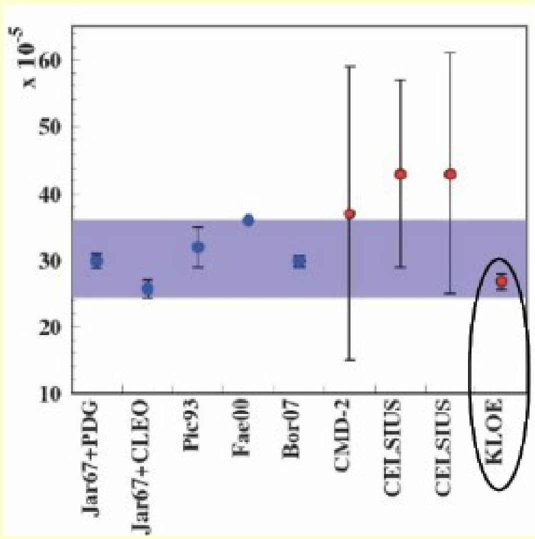
Recent results from KLOE

F. Nguyen
P. Beltrame

- Precise measurement of $\eta \to \pi^+\pi^- e^+e^- (\gamma)$
  BR = (26.8 ± 0.9 (stat) ± 0.4(norm) ± 0.6(syst)) $\cdot 10^{-5}$

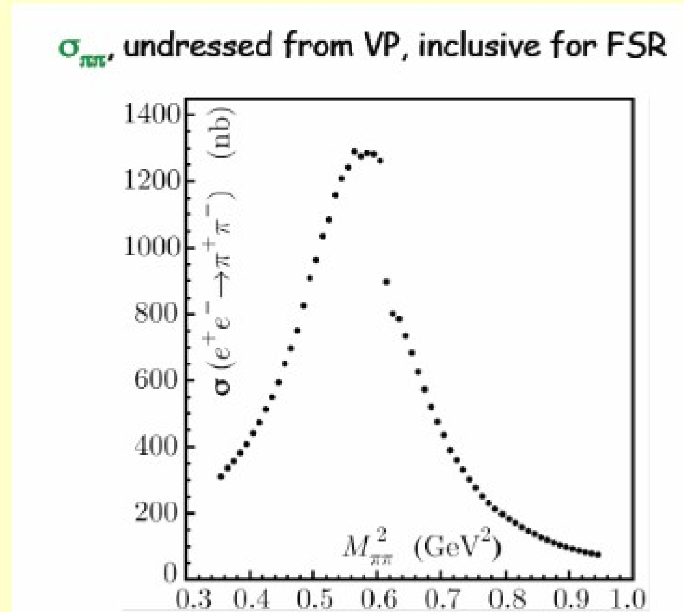


- First measurement of decay plane asymmetry
  A_ϕ = (-0.6 ± 2.5 (stat) ± 1.7(norm) ± 0.5(syst)) $\cdot 10^{-2}$

  (limits unconventional sources of CP violation)

- 3σ evidence for gluonium content in the η'

- New hadronic cross-section measurement (relevant for $(g-2)_\mu$)



$$a_\mu^{\pi\pi} = \frac{1}{4\pi^3}\int_{0.35}^{0.95} \sigma^{\pi\pi}(s) K(s) ds$$

$$(387.2 \pm 0.5_{stat} \pm 2.4_{sys} \pm 2.3_{theo}) \cdot 10^{-10}$$

Transparent de K. Jakobs