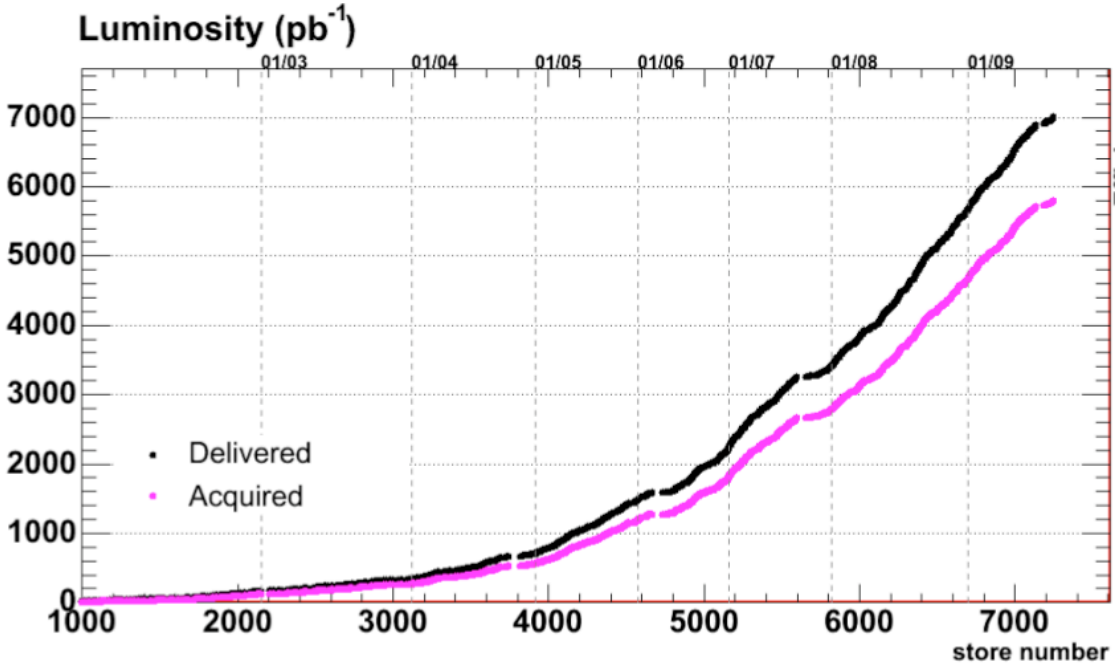
CDF Status and Plans

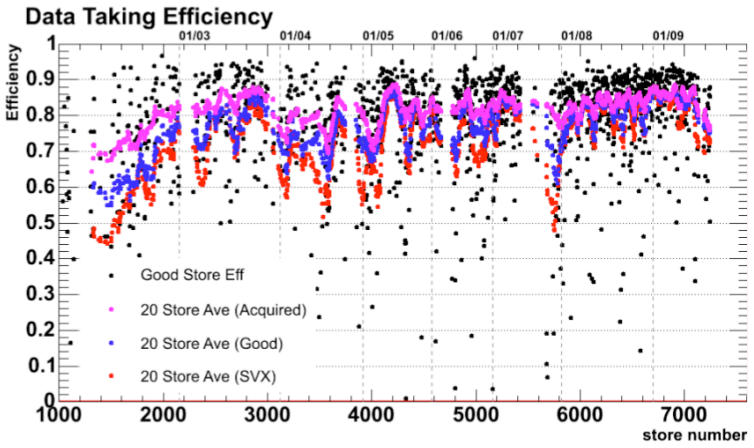
Simona Rolli
Tufts University

Outline

- Status of the experiment
  - People and responsibilities
- CDF activities
  - Service work
    - PerfIDia
    - Code management and code migration
  - Physics analysis
    - Very Exotic Processes
    - Search for LeptoQuarks
    - Top Quark Mass and Cross Section
    - B-barions studies
- Miscellanea (talks, presentations)

CDF Status





The experiment is doing very well

- Data are accumulated at fast rate continuously
- The machine and the detectors are performing very well
  - systematic uncertainties are very well under control

CDF Status

- Measurements are becoming very precise
  - Top quark mass known with precision < 2%
- New analyses are now looking for the needle in the hay stack
  - low cross section phenomena
  - The search for Higgs
  - Physics beyond the Standard Model

Tufts has been an institution member of the CDF collaboration since the early beginning (K.Sliwa, S.Rolli, B. Whitehouse, M. Hare, A.Napier)

CDF Service Work

- Tufts has had several specific software responsibilities over the years:
  - evtNtuple (SR)
  - TRGSim++ (SR)
  - PerfIDia (SR)
  - Offline Release Coordination (SR)
  - PSM - Power Supply online Monitoring (B. Whitehouse)
- and general tasks to fulfill
  - Shifts (ALL)
  - GodParenting Committees (none in 2009)

CDF Physics Analyses

- Top Quark cross-section and mass measurement
  - Ben Whitehouse and Krzysztof Sliwa - measurement of the top cross section using a Supporting Vector Machine
  - Matt Hare and Krzysztof Sliwa - measurement of the top quark mass using Dalitz-Goldstein method

Next talk

- Exotic Searches
  - Simona Rolli, Gabriel Dunn - Searches for 1st and 2nd generation Leptoquarks
  - Simona Rolli at al.
    - VEP group analyses:
      - Z' searches
      - Multijets bump searches
      - Anomalous events in MET + jets
      - Fermiophobic Higgs in 4-γ final state
      - Search for W' in e-ν

CDF Physics Analysis (cont'd)

- Studies of Λ_c (A.Napier)
  - There have been recent observations of resonant states in the decay of $\Lambda_b \rightarrow \Lambda_c \pi\pi\pi$

$$\Lambda_c(2595)^+ \text{ and } \Lambda_c(2625)^+ \text{ states are clearly observed}$$

  - Motivated by these studies Austin intends to address the following topics:
    - Is the broad (50 MeV), statistically significant peak at 2765 MeV in $\Lambda_c^+\pi^+\pi^-$ an excited state of the Λ_c^+, a Σ_c^+, or a combination of overlapped states?
    - A narrow (5.8 ± 1.1 MeV) peak known as the $\Lambda_c(2880)^+$ is seen in $\Lambda_c^+\pi^+\pi^-$ and in pD^0 decays, but not in pD^+, suggesting it is not a Σ_c^+. It is also observed to decay into $\Sigma_c^{0,++}\pi^\pm$. This state may be visible in the CDF Two Track Triggers. Can we uncover new information about its properties? Can we confirm that its spin is 5/2?
    - A fairly narrow peak ($17 \pm 8 \pm 6$ MeV) of "good statistical significance" has been observed in pD^0 final states, and classified as $\Lambda_c(2940)^+$. Since it is not seen in pD^+, it is likely not a Σ_c^+. Can we observe this state in our data, in particular in the $pK^-\pi^+$ final state?
    - The b-baryons have enough mass to allow semi-leptonic decays with tau leptons in the final state, and it will be interesting to see whether we can reconstruct Λ_b^0 decays to taus. However, the narrow state $\Lambda_c(2940)^+$ is massive enough to allow semi-leptonic decays to a tau. Can we find tau decays in the Two Track Triggers?

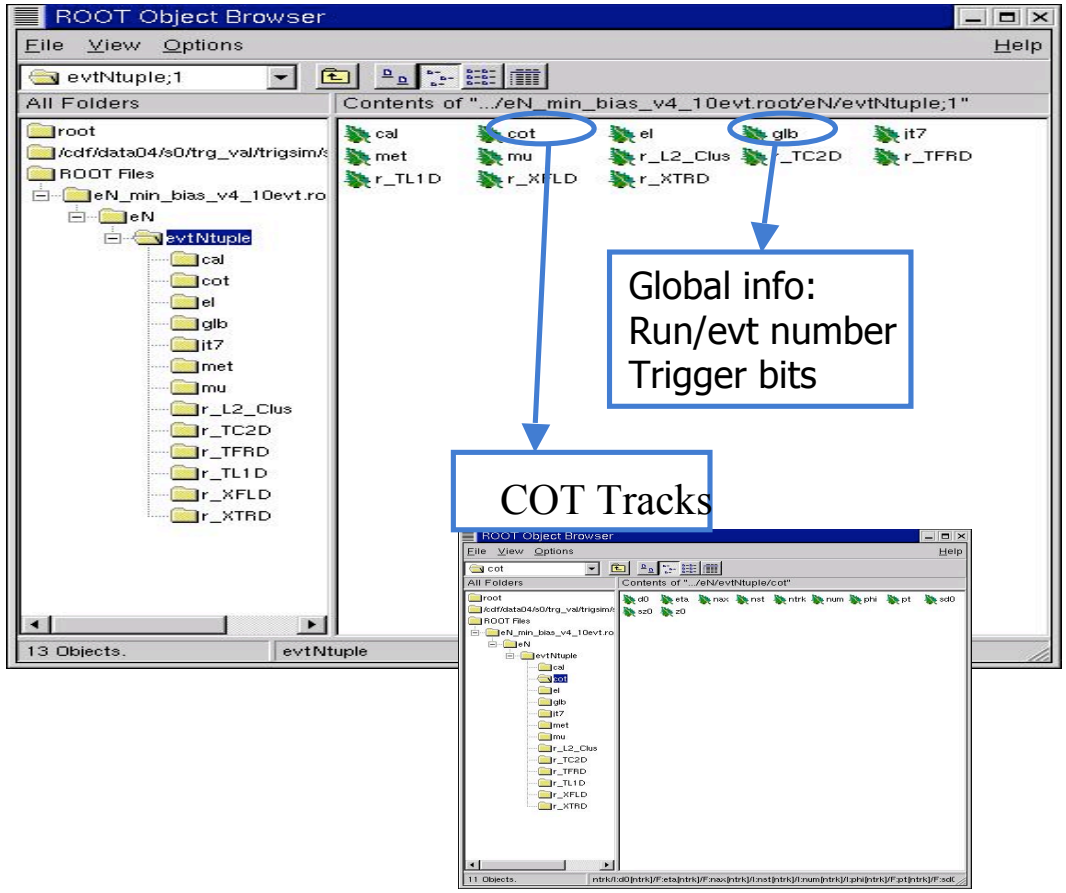
Service Work

evtNtuple

2001-present

Event information is translated into ROOT branches:

- **High Level Objects**
- **Trigger Information**
- **Raw Data Information**
- **Simulated information**



eN has been one of the analysis tools used in CDF until recently

http://ncdf70.fnal.gov:8001/talks/eN/eN.html

S.R.,A.Yagil, C.Ferretti

TRGSim++

2000-present (Simona Rolli)

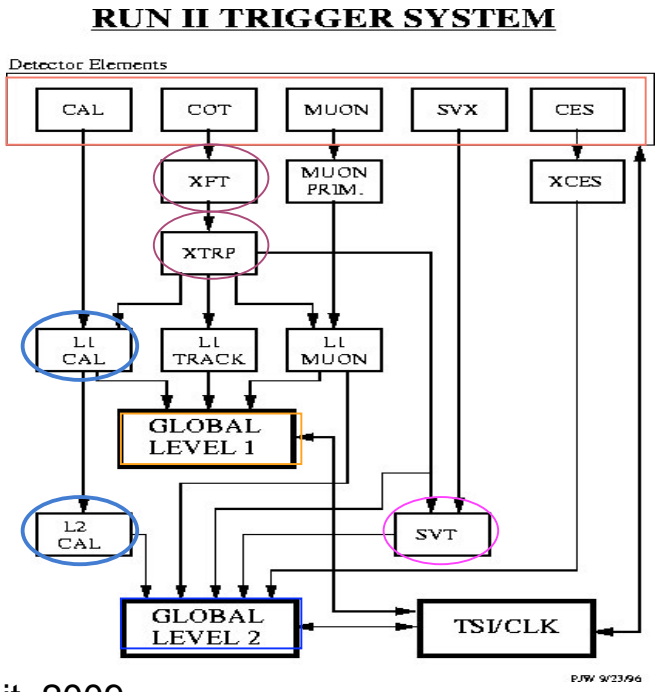
set of (C++) packages which emulate the various trigger levels decision steps (CDF trigger is fully digital)

- **offline tool to calculate rates and efficiencies;**
- **online monitoring tool.**

TRGSim++ modules run off detector raw data and produce emulated trigger data identical to real hardware data.
Trigger decision steps: A_C++ modules, organized in packages:

- CalTrigger
- MuonTrigger
- XFTSim
- SVTSim
- XTRPSim
- L2/L1GlobalTrigger
- TriggerMods
- TriggerObjects

http://ncdf70.fnal.gov:8001/trigsim/trgsim.html



PSM monitoring software

Online software to control Power Supplies and monitor their operations.
Running in Control Room at all times.

Ben Whitehouse has been the main responsible person until March 2009:

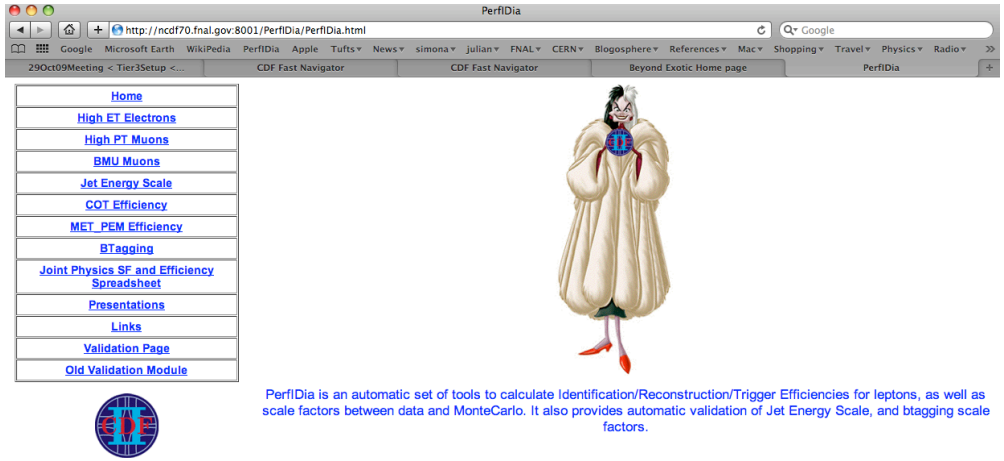
Since inception :
• He has updated the whole software converting it over from Visual Basic 6 to Visual Studio 2005 visual basic when the machine was updated to Windows XP (from NT).
• Many cosmetic updates to software interface on Voltman PC (ie Shows Power supply type)
• Update web scripts to plot voltage histories when the online webserver was replaced.
• Changed / Created new PS "types" to only alarm on voltages from the supplies that are actually used (rather then any that goes out of tolerance on the supply).
• Been the PSM pager carrier until Spring 2009 .
• Updates to the software that are required when there are (additions / changes / removals) of Power Supplies from the system per OPs requests.

PerfIDia (Performance and ID instant answer)

2007-present (Simona Rolli)

Much of the analysis infrastructure at CDF is now run in an automatic way to guarantee smooth results delivery in the final years of the experiment

Some aspects of all analyses are in common:
lepton ID efficiency,
reconstruction,trigger
Jet Energy corrections
B-tagging Scale factors
tau reconstruction
……



We are providing a common software framework which incorporates all the relevant piece of code and produces output tables, plots and documentation on the web for every new batch of processed data.
One coordinator (SR) and several experts on call

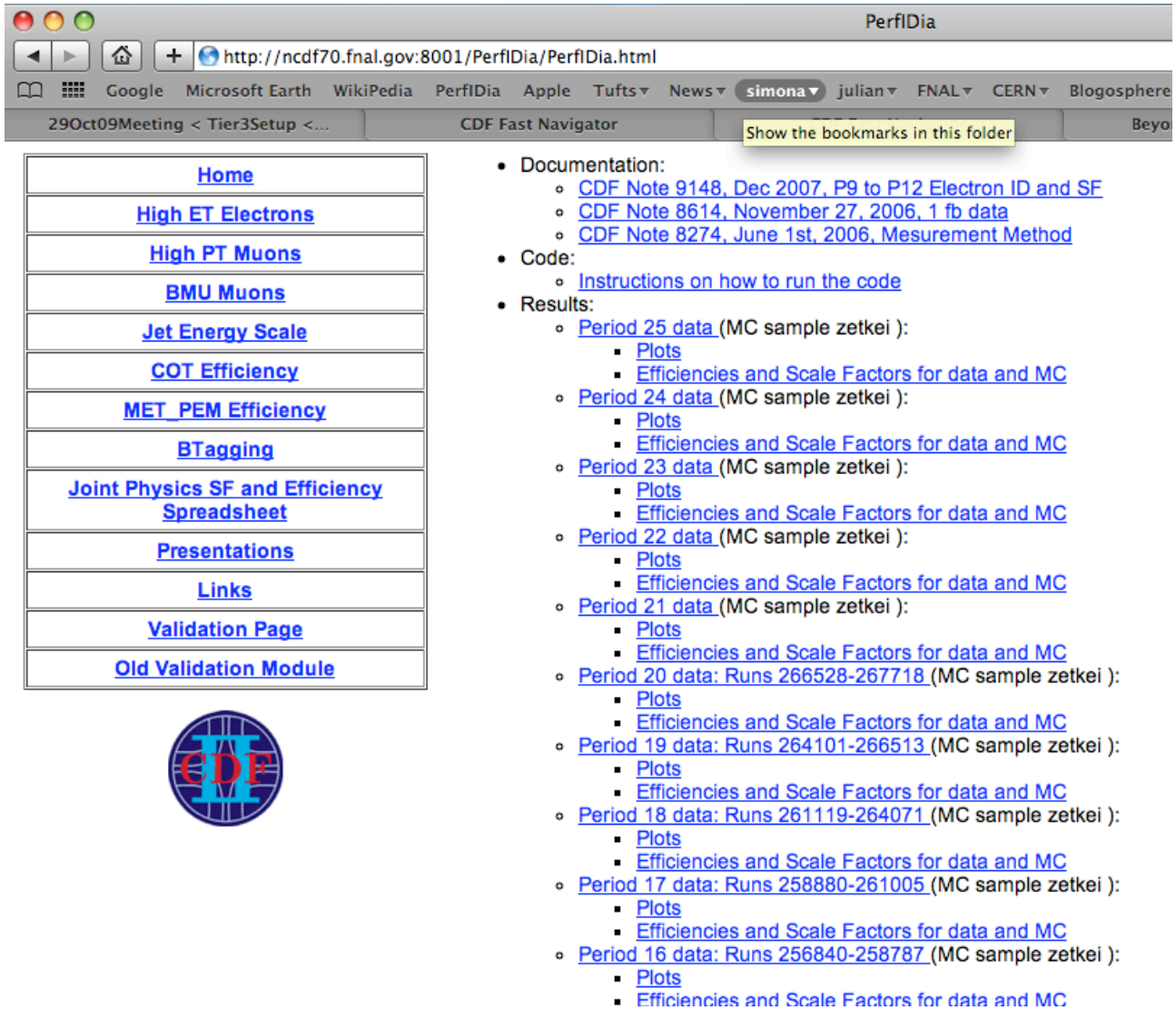
PerfIDia (cont'd)

- Automatic tool to check data stability (high PT Leptons)
  - All code in one common place (cvs)
- TopNt and StNtuple produced shortly after Production data is available: target 4-6 weeks after Production. Turnover rate ~2.5 months.
- The ID code is launched to validate the new ntuples and determine the various efficiencies and SF
  - Dependency on several tasks:
    - Good Run List
    - Skimmed Data (to avoid large volumes of files)
    - …
- Output is posted as plots and tables onto PerfIDia web page
- Joint Physics group does the final sign off

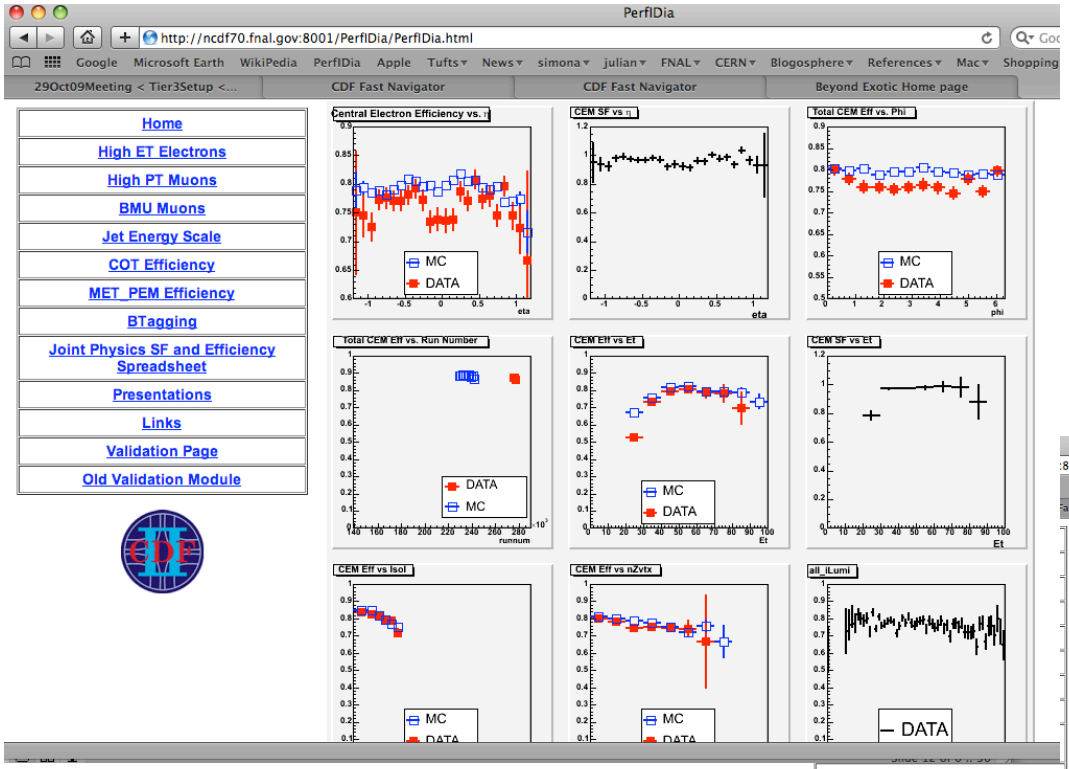
Typical timeline for result production

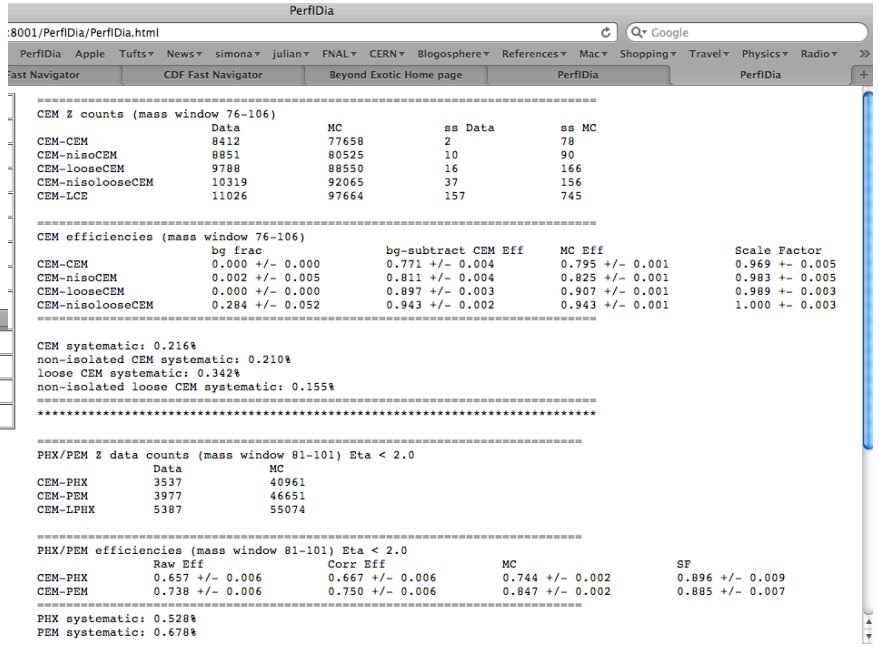
- **Period 25**
  - Blessing of P25 high PT Lepton Efficiencies and SF, October 21st 2009
  - Pre-Blessing of P25 high PT Lepton Efficiencies and SF, October 7th 2009
- **Period 24**
  - Blessing of P24 high PT Lepton Efficiencies and SF, September 23 2009
  - Pre-Blessing of P24 high PT Lepton Efficiencies and SF, September 9 2009
- **Period 23**
  - Blessing of P23 high PT Lepton Efficiencies and SF, July 1st 2009
  - Pre-Blessing of P23 high PT Lepton Efficiencies and SF, June 17 2009
- **Period 22**
  - Blessing of P22 high PT Lepton Efficiencies and SF, June 17 2009
  - Pre-blessing of P22 high PT Lepton Efficiencies and SF, May 20 2009
- **Period 21**
  - Blessing of P21 high PT Lepton Efficiencies and SF, May 13 2009
  - Pre-Blessing of P21 high PT Lepton Efficiencies and SF, April 8 2009
- **Period 20**
  - Blessing of P20 high PT Lepton Efficiencies and SF, March 4th 2009
  - Pre-Blessing of P20 high PT Lepton Efficiencies and SF, Feb 11 2009
- **Period 19**
  - Blessing of P19 high PT Lepton Efficiencies and SF, Feb 11 2009
  - Pre-Blessing of P19 high PT Lepton Efficiencies and SF, Jan 14 2009
- **Period 18**
  - Blessing of P18 high PT Lepton Efficiencies and SF, Dec 17 2008 update (CMX trigger eff and ele ID update)
  - Blessing of P18 high PT Lepton Efficiencies and SF, Dec 10 2008
  - Preliminary Look at high PT Leptons P18 data, Nov 26 2008
- **Period 17**
  - Blessing of P17 high PT Lepton Efficiencies and SF, July 9 2008
  - Preliminary Look at high PT Leptons P17 data, July 2 2008
- **Period 16**
  - Blessing of P16 high PT Lepton Efficiencies and SF, July 2 2008
  - Preliminary Look at high PT Leptons P16 data, June 25 2008

Example: Electron ID



Example: Electron ID

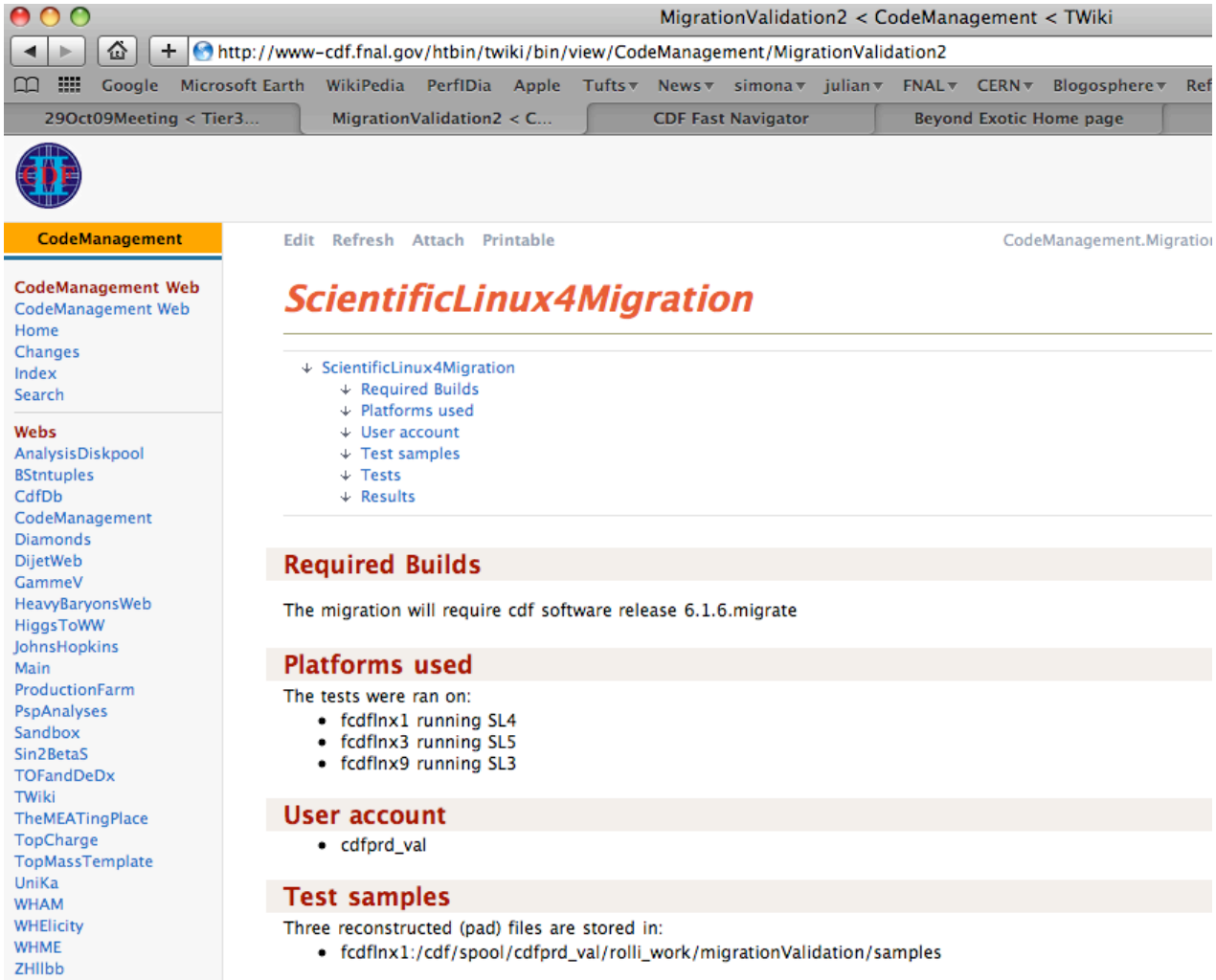




CDF Code migration

- Since 2008 - Simona Rolli -software migration validation
- CDF software releases pretty much stable
  - A few hurdles to fix yet:
    - MC release to be brought up to date with data release
      - Simona Rolli , C.Vellidis (Athens), R.Tesarek(FNAL)
    - OS migration (SL3 to SL4 and SL5)
      - Simona Rolli ,L.Garren (FNAL),J.Bellinger (UW Madison), S. Lammel (FNAL)

Code migration (cont'd)



Common tasks

Shifts:

S.R. SciCo shift Jan 2009

K. Sliwa SciCo shift May 2009

A. Napier CO shift Feb 2009

B. Whitehouse CO shift Feb 2009

Talks and Presentations

- Simona Rolli, BNL Forum, BNL, November 2008
  - Recent Results from the TeVatron
- Simona Rolli, Cipanp09, San Diego, May 2009
  - Results on searches for new physics at the TeVatron
- Simona Rolli, Fermilab Users Meeting, FNAL, June 2009
  - Searches for physics BSM at the TeVatron
- Krzysztof Sliwa, XLI I I Rencontres de Moriond, La Thuile, Italy, March 2009
  - Chairman of the Top Mass Session
- Krzysztof Sliwa, EPS 2009, Krakow, July 2009
  - W & Z boson production at CDF

Physics Analyses

Searches for LeptoQuarks

- **Leptoquarks (LQ)** are hypothetical particles which appear in many SM extensions to explain **symmetry between leptons and quarks**
  - SU(5) GUT model
  - superstring-inspired models
  - 'colour' SU(4) Pati-Salam model
  - composite models
  - technicolor

•LQs are **coupled to both leptons and quarks** and carry SU(3) color, fractional electric charge, baryon (B) and lepton (L) numbers

•LQs can have:

–spin 0 (scalar)

•couplings fixed, i.e., no free parameters

•Isotropic decay

–spin 1 (vector)

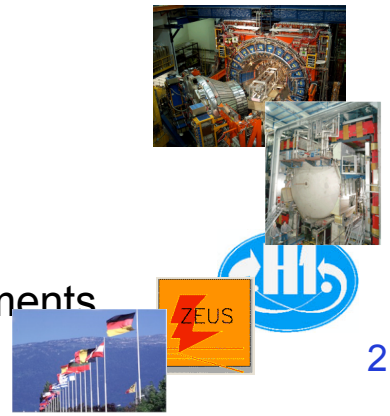
•anomalous magnetic (k_G) and electric quadrupole (λ_G) model-dependent couplings

–Yang-Mills coupling: $k_G = \lambda_G = 0$

–Minimal coupling: $K_G = 1$, $\lambda_G = 0$

–Decay amplitude proportional to $(1 + \cos\theta^*)^2$

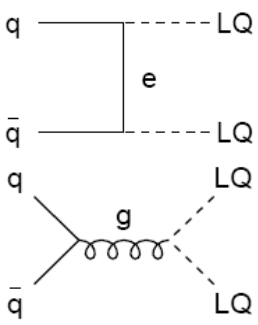
- **Experimental evidence searched:**
  - indirectly: LQ-induced 4-fermion interactions
  - directly: production cross sections at collider experiments



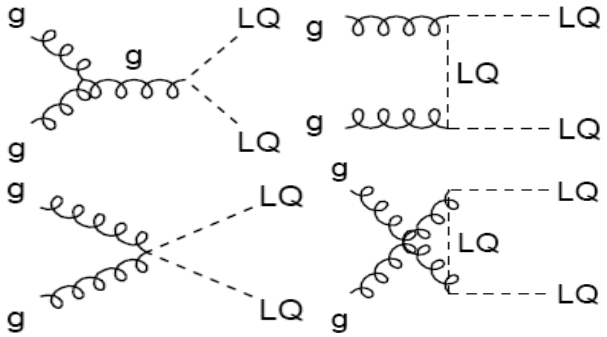
LQ at Hadron Colliders

- **Pair production**
  - Practically independent of Yukawa coupling λ (only g-LQ-LQ vertex)
  - Depends mainly on LQ mass

$q\bar{q} \rightarrow LQ\,\overline{LQ}$



$gg \rightarrow LQ\,\overline{LQ}$



Decay

- Each generation can decay into 3 final states:

β = Br (LQ→lq)

$\beta = 1$

$\beta = 0.5$

$\beta = 0$

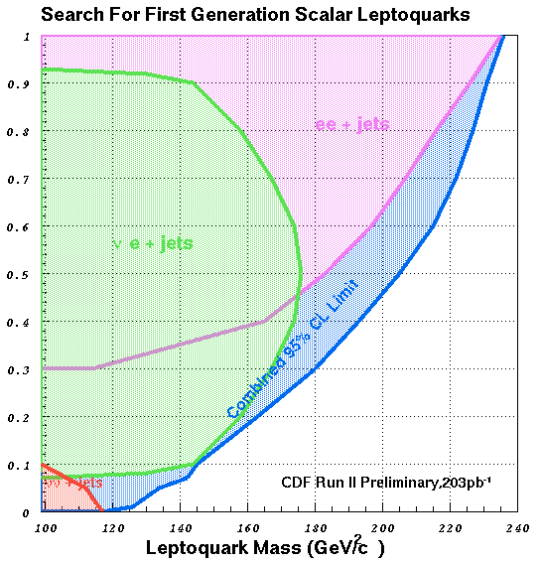
Exclusive to the Tevatron

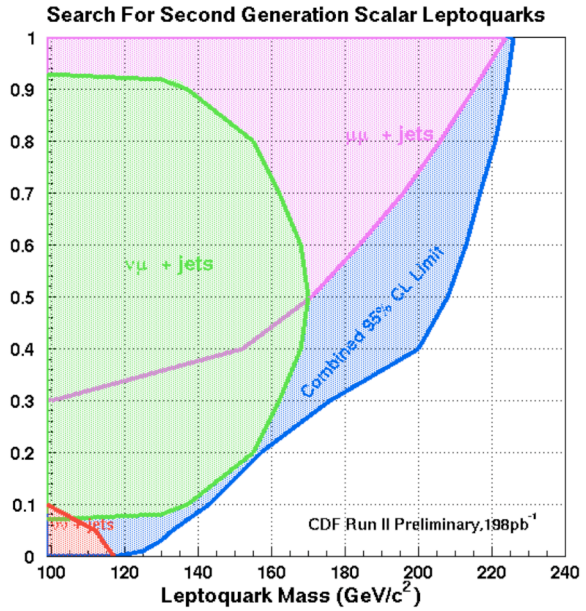
1st Generation	2nd Generation	3rd Generation
$LQ\,\overline{LQ} \rightarrow e^- e^+ q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \mu^+ \mu^- q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \tau^+ \tau^- q\bar{q}$
$LQ\,\overline{LQ} \rightarrow e^{\pm} \nu_e q_i q_j$	$LQ\,\overline{LQ} \rightarrow \mu^{\pm} \nu_\mu q_i q_j$	$LQ\,\overline{LQ} \rightarrow \tau^{\pm} \nu\, q_i q_j$
$LQ\,\overline{LQ} \rightarrow \nu_e \nu_e q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \nu_\mu \nu_\mu q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \nu_\tau \nu_\tau q\bar{q}$

LQ at CDF

Tufts is the primary institutions doing LQ searches in RunII:

- 1st gen, eeqq, eνqq + combined result (Simona - PhysRevD72 2005)
- 2nd gen:μμqq,μνqq + combined result (D. Ryan,S. Rolli, K.Sliwa - PhysRevD73 2006)
- 3rd gen:ττqq (H.Sun, S.R.,K.Sliwa - not published)





LQ at large..

Since October 2007 Simona Rolli has been on the PDG author list as the author of the LeptoQuark minireview

The Review of Particle Physics

Physics Letters **B667**, 1 (2008).

Particle Data Group

C. Amsler,[1] M. Doser,[2] M. Antonelli,[3] D.M. Asner,[4] K.S. Babu,[5] H. Baer,[6] H.R. Band,[7] R.M. Barnett,[8] E. Bergren, J. Beringer,[8] G. Bernardi,[9] W. Bertl,[10] H. Bichsel,[11] O. Biebel,[12] P. Bloch,[2] E. Blucher,[13] S. Blusk,[14] R.N. Cahn,[8] M. Carena,[15,13,16] C. Caso,[17*] A. Ceccucci,[2] D. Chakraborty,[18] M.-C. Chen,[19] R.S. Chivukula,[20] G. Cowan,[21] O. Dahl,[8] G. D'Ambrosio,[22] T. Damour,[23] A. de Gouvêa,[24] T. DeGrand,[25] B. Dobrescu,[15] M. Drees,[26] D.A. Edwards,[27] S. Eidelman,[28] V.D. Elvira,[15] J. Erler,[29] V.V. Ezhela,[30] J.L. Feng,[19] W. Fetscher,[31] B.D. Fields,[32] B. Foster,[33] T.K. Gaisser,[34] L. Garren,[15] H.-J. Gerber,[31] G. Gerbier,[35] T. Gherghetta,[36] G.F. Giudice,[2] M. Goodman,[37] C. Grab,[31] A.V. Gritsan,[38] J.-F. Grivaz,[39] D.E. Groom,[8] M. Grünewald,[40] A. Gurtu,[41,2] T. Gutsche,[42] H.E. Haber,[43] K. Hagiwara,[44] C. Hagmann,[45] K.G. Hayes,[46] J.J. Hernández-Rey,[47†] K. Hikasa,[48] I. Hinchliffe,[8] A. Höcker,[2] J. Huston,[20] P. Igo-Kemenes,[49] J.D. Jackson,[8] K.F. Johnson,[6] T. Junk,[15] D. Karlen,[50] B. Kayser,[15] D. Kirkby,[19] S.R. Klein,[51] I.G. Knowles,[52] C. Kolda,[53] R.V. Kowalewski,[50] P. Kreitz,[54] B. Krusche,[55] Yu.V. Kuyanov,[30] Y. Kwon,[56] O. Lahav,[57] P. Langacker,[58] A. Liddle,[59] Z. Ligeti,[8] C.-J. Lin,[8] T.M. Liss,[60] L. Littenberg,[61] J.C. Liu,[54] K.S. Lugovsky,[30] S.B. Lugovsky,[30] H. Mahlke,[62] M.L. Mangano,[2] T. Mannel,[63] A.V. Manohar,[64] W.J. Marciano,[61] A.D. Martin,[65] A. Masoni,[66] D. Milstead,[67] R. Miquel,[68] K. Mönig,[69] H. Murayama,[70,71,8] K. Nakamura,[44] M. Narain,[72] P. Nason,[73] S. Navas,[74†] P. Nevski,[61] Y. Nir,[75] K.A. Olive,[76] L. Pape,[31] C. Patrignani,[17] J.A. Peacock,[52] A. Piepke,[77] G. Punzi,[78] A. Quadt,[79] S. Raby,[80] G. Raffelt,[81] B.N. Ratcliff,[54] B. Renk,[82] P. Richardson,[65] S. Roesler,[2] S. Rolli,[83] A. Romaniouk,[84] L.J. Rosenberg,[11] J.L. Rosner,[13] C.T. Sachrajda,[85] Y. Sakai,[44] S. Sarkar,[86] F. Sauli,[2] O. Schneider,[87] D. Scott,[88] W.G. Seligman,[89] M.H. Shaevitz,[90] T. Sjöstrand,[91] J.G. Smith,[25] G.F. Smoot,[8] S. Spanier,[54] H. Spieler,[8] A. Stahl,[92] T. Stanev,[34] S.L. Stone,[14] T. Sumiyoshi,[93] M. Tanabashi,[94] J. Terning,[95] M. Titov,[96] N.P. Tkachenko,[30] N.A. Törnqvist,[97] D. Tovey,[98] G.H. Trilling,[8] T.G. Trippe,[8] G. Valencia,[99] K. van Bibber,[45] M.G. Vincter,[4] P. Vogel,[100] D.R. Ward,[101] T. Watari,[102] B.R. Webber,[101] G. Weiglein,[65] J.D. Wells, [103] M. Whalley,[65] A. Wheeler,[54] C.G. Wohl,[8] L. Wolfenstein,[104] J. Womersley,[105] C.L. Woody,[61] R.L. Workman,[106] A. Yamamoto,[44] W.-M. Yao,[8] O.V. Zenin,[30] J. Zhang,[107] R.-Y. Zhu,[108] P.A. Zyla[8]

Technical Associates: G. Harper,[8] V.S. Lugovsky,[30] P. Schaffner[8]

LQ Current activity

Simona Rolli and Gabriel Dunn are updating the currently published results with larger statistics

We do not expect to see LQ, but will be able to set higher limits before the LHC turns on

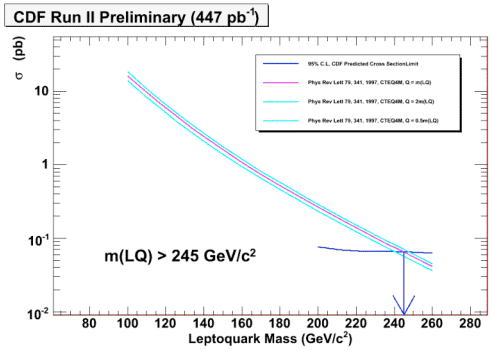
Expectations:

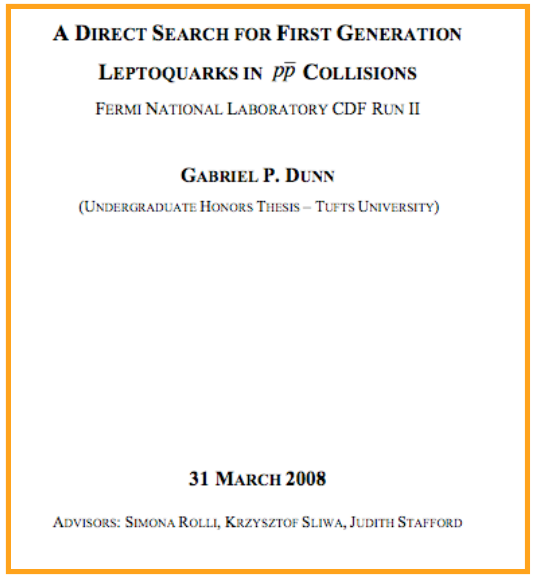
$\beta = 1$ mass limit up to 250-300 GeV/c^2

$\beta = 0.5$ mass limit up to 230-280 GeV/c^2

Phys.Rev.D71:057503,2005

In 2008 Gabe and I worked together for Gabe's undergraduate thesis. We revisited the 1st generation analysis with CC electrons and used twice the luminosity of the published results





A DIRECT SEARCH FOR FIRST GENERATION LEPTOQUARKS IN $p\bar{p}$ COLLISIONS

FERMI NATIONAL LABORATORY CDF RUN II

GABRIEL P. DUNN

(UNDERGRADUATE HONORS THESIS – TUFTS UNIVERSITY)

31 MARCH 2008

ADVISORS: SIMONA ROLLI, KRZYSZTOF SLIWA, JUDITH STAFFORD

LQ Current Activity (cont'd)

- In 2009 Gabriel Dunn was hired for the Summer at Fermilab and he will come back in January 2010 before going to graduate school
- We have kept working on 1st generation LQ→eeqq
  - Signal Efficiencies:
    - we used the same signal efficiencies as from the published analysis
      - We have generated new MC signal using a more recent release and checked that the efficiencies are the same (VEP meeting Feb 2009)
  - Background
    - We re-evaluated the Z+2 jets background as well as ttbar using the new MC (VEP meeting September 2009)
      - We did use the alpgen samples and cross section (x k-factor ~1.3)
    - We re-calculated the QCD fake contribution using SS method and Iso method;
  - Systematic uncertainty: we haven't reassessed it yet, so we applied a conservatively large stat+sys error in the calculation of the limit
  - We have looked at ~2.4fb^{-1} data so far (October 2009, VEP meeting presentation)

LQ Results

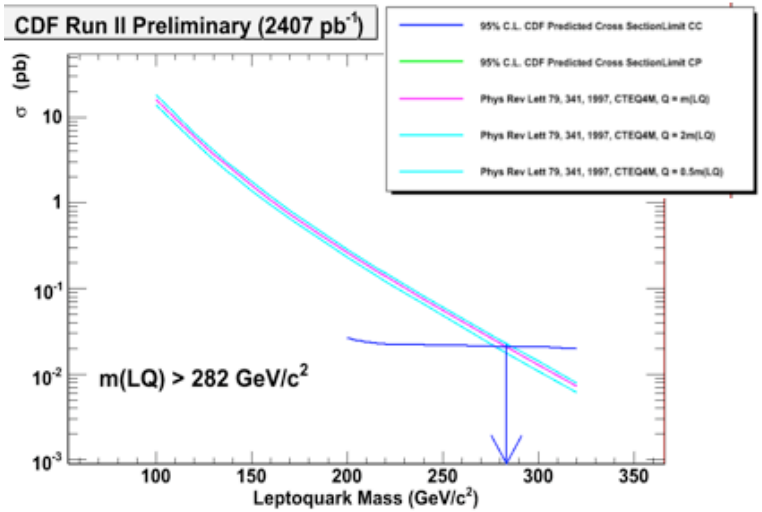
Preliminary limit with 2.4fb-1

October 6 2009

- We used a rather large uncertainty on the background:
  - 50% uncertainty on the number of predicted background (consistent with the 200 pb^{-1} analysis)
  - We used bayes to calculate the limit

P8-P19

Plan to bless by the end of the year



Number of observed events: 11

$\sigma_{LIMIT} = N_{LIMIT}/(\mathcal{L} \times \varepsilon \times \beta\beta)$

$\beta = 1$

Expected background 8.97± 4.0

Limit improved of ~50 GeV

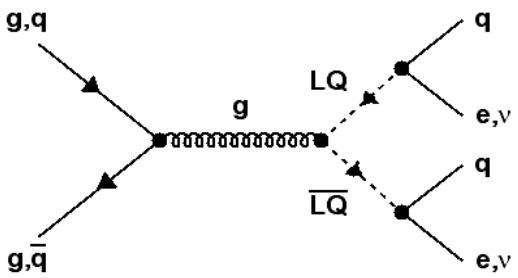
13

Simona Rolli - LQ

LQ Plans

We are planning to produce updated limits for eeqq, eνqq, μμqq and μνqq channels and combine the results with the β = 0 analysis into a final CDF paper with full statistics

lepton + MET + jets



Selection

1central electrons with E_T > 25 GeV
MET > 60 GeV
Veto on 2nd electron, central loose or Plug
2 jets with E_T > 30 GeV
Δφ (MET-jet) > 10°
E_T(j1) + E_T(j2) > 80 GeV
M_T(e-ν) > 120
LQ mass combinations

SM background

- **W +2jets**
- **Top (l + jets and dilepton)**
- **QCD/Fakes**

LQ Plans (cont'd)

Combined Limit

Joint likelihood formed from the product of the individual channels likelihood.
The searches in the dileptons and lepton + MET channels use common criteria and sometime apply the same kind of requirements (for example on lepton identification) so the uncertainties in the acceptances is considered completely correlated (which gives the most conservative limit).
When calculating the limit combination including also the ννjj channel the uncertainties in the acceptances are considered uncorrelated.

$$\sigma_{LIM} = N_{LIM}/(\varepsilon_{average} \times L)$$

$\varepsilon_{average} = (\beta^2\varepsilon(eejj) + 2\beta(1-\beta)\varepsilon(e\nu jj) + \beta^2\varepsilon(ee \text{ as } e\nu))$ for the 2 channels case and

$\varepsilon_{average} = (\beta^2\varepsilon(eejj) + 2\beta(1-\beta)\varepsilon(e\nu jj) + (1-\beta)^2\varepsilon(\nu\nu jj) + \beta^2\varepsilon(ee \text{ as } e\nu))$ for the 3 channels case.

VEP analyses

VEP group (a subgroup of the Exotic Physics Group)
S.R. has been a convener since May 2009 (second convener at CERN since June, so basically flying solo)

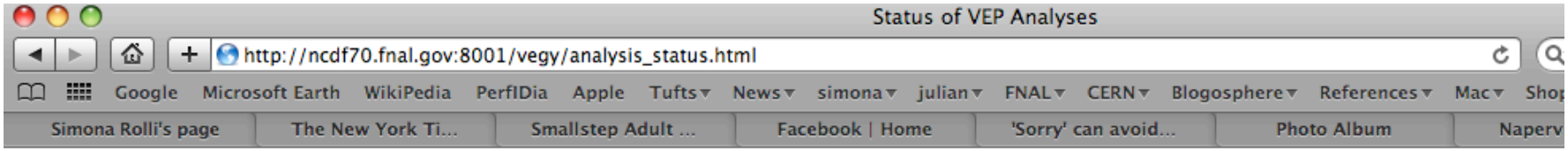
VEP is a working group:

- prepare analyses to proceed to Exotic forum for blessing. The details needs to be solved in the VEP group;

VEP is a small group, a few analyses ongoing

- Restructured meeting schedule: every other week on Tuesday, mandatory short status report from everybody;
- Larger status reports less frequently.
- Planning to complete and bless by end 2010

VEP Analyses



Status of VEP Analyses

Analyses presenting at VEP

Topic	Authors	Last VEP presentation
Z' in the muon channel	Edward Quinlan, Daniel Whiteson	October 6th 2009
Search for W' to e-nu	YuChul Yang, Jieun Kim, DongHee Kim	11 August 2009
Searches in Multijets	Tim Lou, Eva Halkiadakis, Amit Lath, Daryl Hare, Rouven Essig, Scott Thomas	September 9th 2009
Fermiophobic Higgs in the 4-gamma channel	Atsunari Hamaguchi, Toru okusawa, Yoshihiro Seiya, Kazuhiro Yamamoto	14 July 2009
Search for Anomalous Production of photon + jets	Sam Hewamanage, Jay Dittman, Nils Krumnack, Ray Culbertson, Sasha Pronko	16 June 2009
Search for 1st and 2nd generation leptoquarks	Simona Rolli	October 6th 2009

Backup Slides

LQ Analysis strategy

- Counting experiment:
  - We basically count how many events we observe in our sample which are consistent with LQ production and its irreducible background
    - If we observe a number of events which is consistent with the SM background expectation we will say that no LQ signal is observed an a 95% CL limit on the production cross section will be placed
    - If we observe more events than SM prediction, we will have found new physics …
    - We define a set of cuts that we place on the sample in order to enhance the possibility of observing signal while at the same time reducing as much as possible the background component.

Differences with previous analysis

Several things have changed since the previous analyses

•Ntuple format - we used eN ntuples previously but the package is not maintained anymore (plus we did the ntuple skimming)
    •we are using TopNtuple now

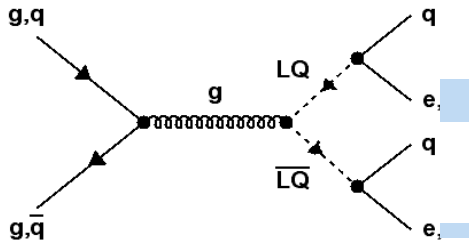
•MC Release - our previous analysis was based on gen5 MC
    •We have regenerated the signal samples with 6.1.4mc and recalculated our signal efficiencie
    •We are also using the Top group W+jets and ttbar samples generated with 6.1.4 (alpgen samples)

•These are the major changes, essentially in the infrastructure

Analysis cuts

Selection

- ✓ 2 electrons (CC,CF) E_T > 20 GeV
- ✓ 2 jets, E_T(j1) > 30 GeV, E_T(j2) > 15 GeV
- ✓ Z Veto (76 < $M_{\mu\mu}$ < 110) GeV
- ✓ **Electrons/Jets: $E_T^{j1(e1)} + E_T^{j2(e2)} > 85$ GeV**
- ✓ **$((E_T(j_1) + E_T(j_2))^2 + (E_T(e_1) + E_T(e_2))^2)^{1/2} > 200$ GeV**



SM background
Drell-Yan+2jets
Top (dilepton)
QCD/Fakes