Recent results on high P_T physics from CDF

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Introduction

CDF is finally producing Run II results !

several different physics groups
- Top quark
- W/Z physics
- Exotics

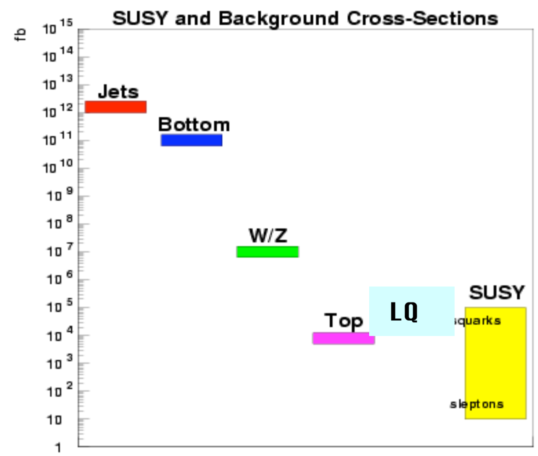
} High P_T

Cross sections for various physics processes vary over many orders of magnitude:
- processes of interest are often buried under heavy background
- need good rejection factors, selection and analysis strategies

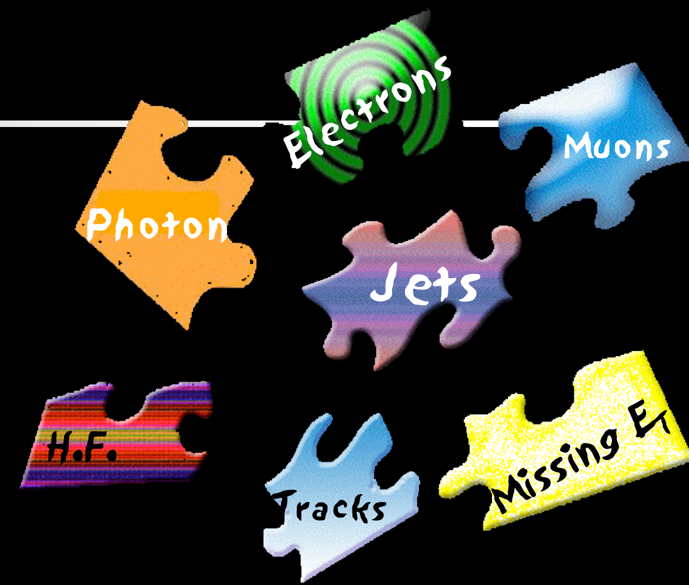
Optimize event selections for SM physics and new physics as in both cases the composition of the samples are important

Common datasets

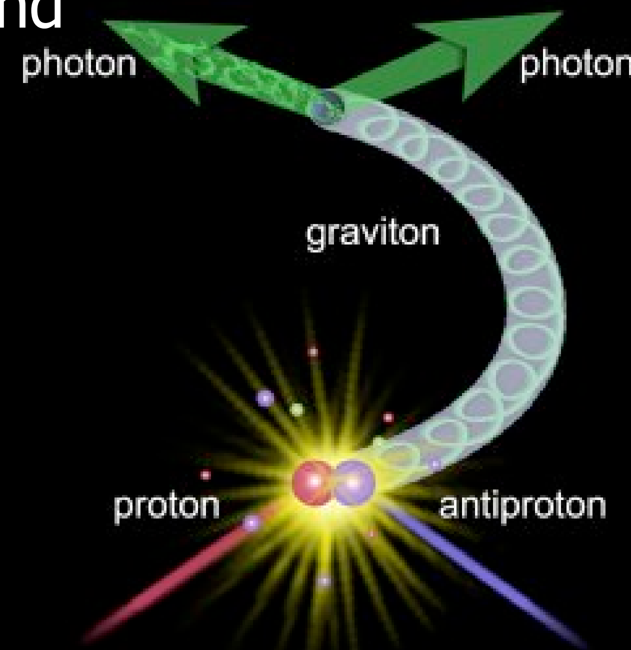
Common identification/reconstruction cuts



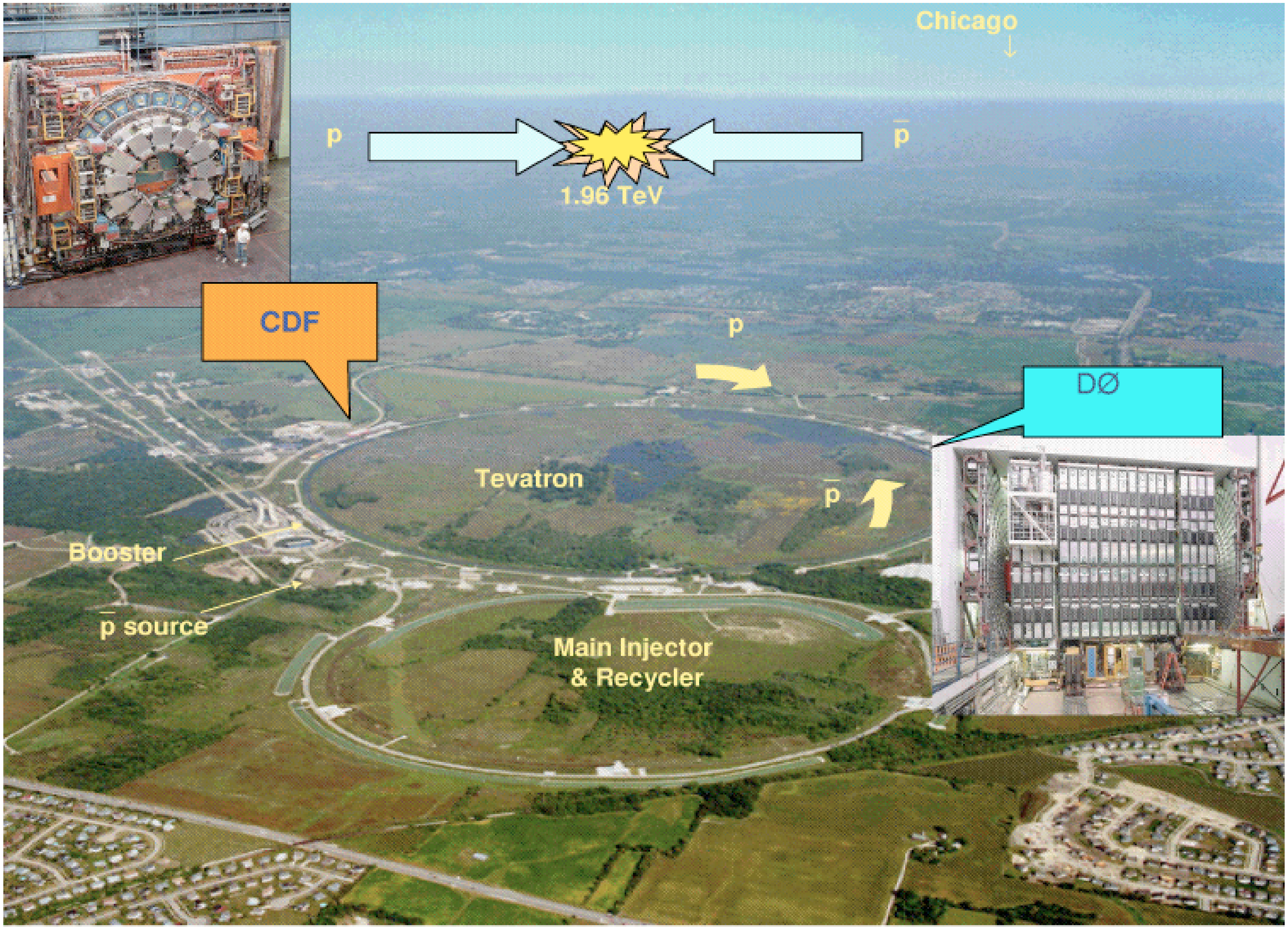
Outline of the talk



- **The Experimental Apparatus**
  - the Fermilab TeVatron
  - The CDF detector
- **Physics Processes and their Signatures**
  - From W/Z to jets, the SM and beyond
  - **Leptons-only final states (and isolated tracks)**
  - **… + Missing Energy and Photons**
  - **… + Jets and heavy flavors**
- **The puzzle of Nature….**

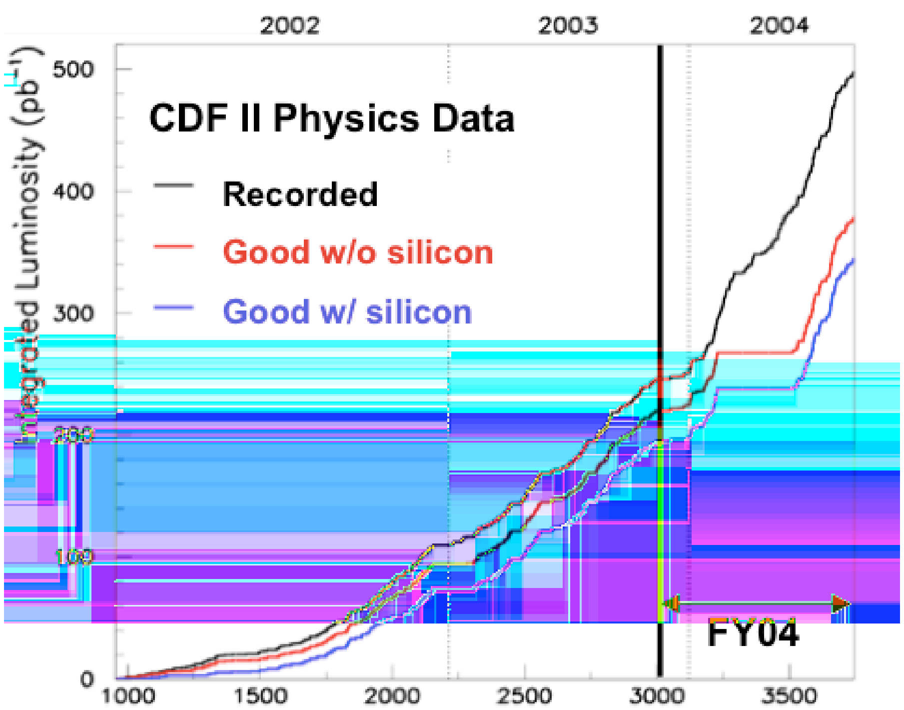


The Experimental Apparatus

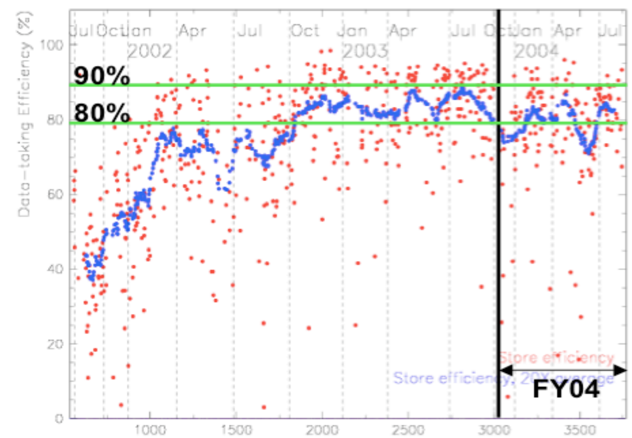


Run II Luminosity

Data for Physics 340 - 390 pb^{-1}
excluding "compromised COT performance period"



Data Taking Efficiency
L(recorded) / L(delivered):
beam losses, Triggers/DAQ,
COT related, other systems



Run II Goal > 90%

Error on luminosity is ± 6%

- 1.6% due to CLC systematic error on CLC rate
- 4.0% due to CLC acceptance sys
- 3.8% due to limited by knowledge of pp inelastic cross section.

The Thrill of Discovery: A Brief History of CDF

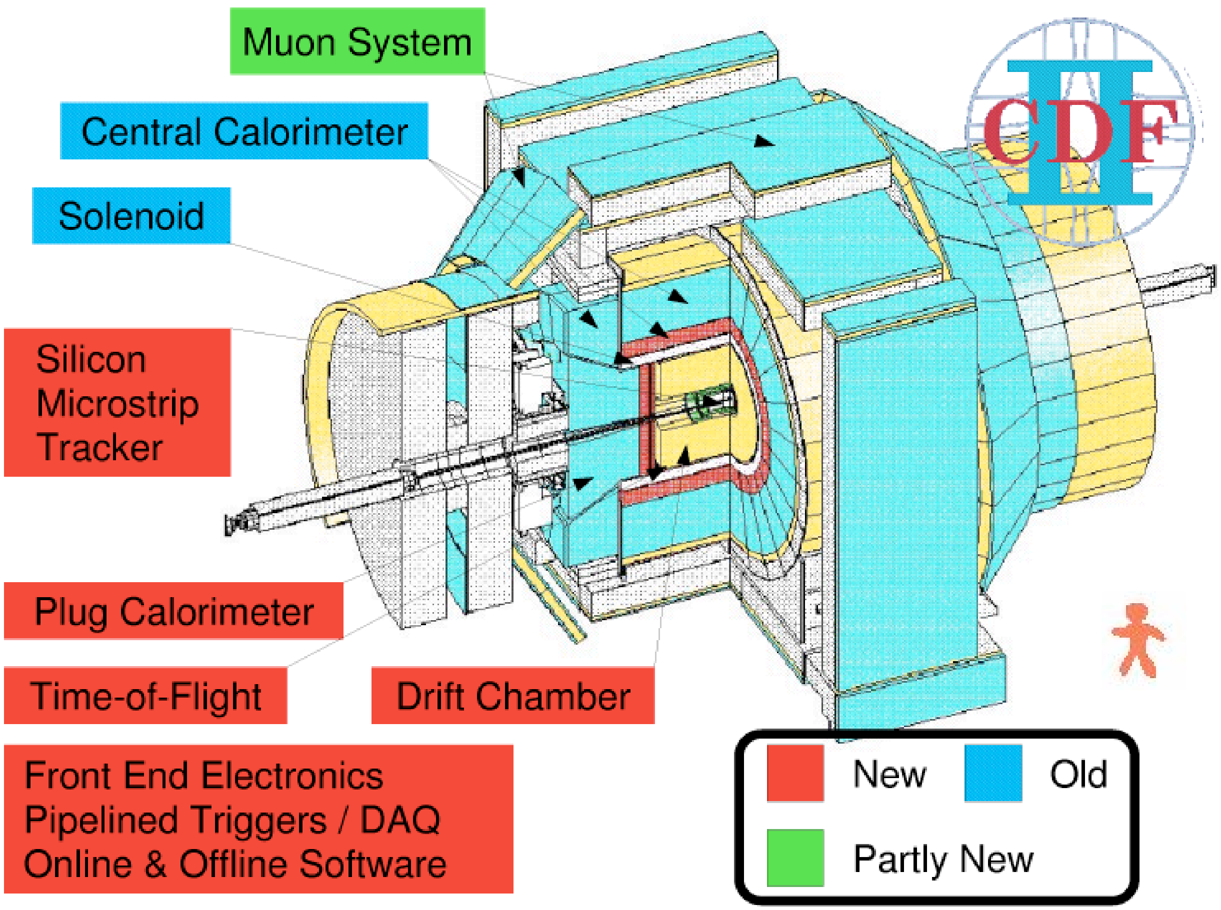
- 1985: First collisions with partial detector
- 1987: Core detector in place. Jet Physics
- 1988-89: "Run 0" 4x the expected data, seen lots of W/Z's
- 1992-1995 : "Run I" -added silicon detector. Top quark discovered!

- 2001-present: Run II era begins with essentially a new detector, higher collisions energy and more data.
- 2004: First Run II physics papers published

12 countries, 59 institutions
706 physicists

The CDF Detector

The Experiment studies interesting collisions between protons and antiprotons



Transparent tracking in a magnetic field

Absorb most particles with calorimeters

Surround the outside with muon chambers

Electronics to read out each subsystem

Computers to record and analyze data

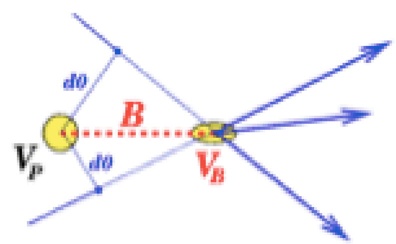
Trigger and DAQ

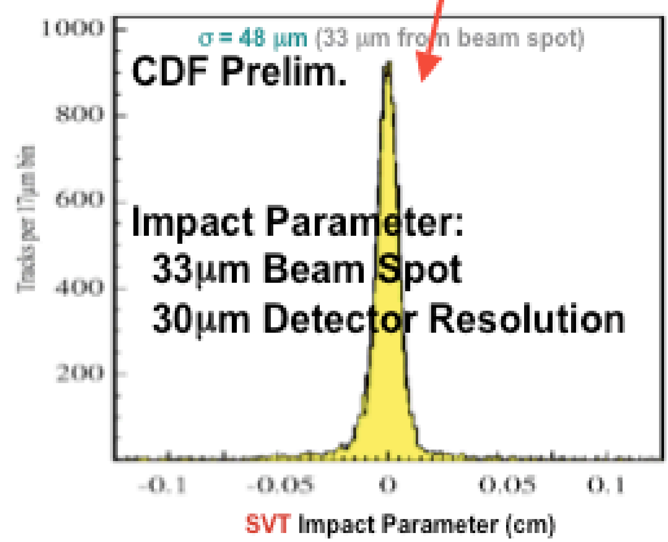
Level	Input / Output	Rejection Rate	# Paths	Information
1	1.7MHz / 25kHz	~70	40	Tracks, EM/Had Cal, Muon
2	25kHz / 350Hz	~70	120	Shower Max, SVT Algorithms run in Processor
3	350Hz / 70Hz(20MB/s)	~5	300	Full Detector Readout Offline Reconstruction

Trigger Paths:

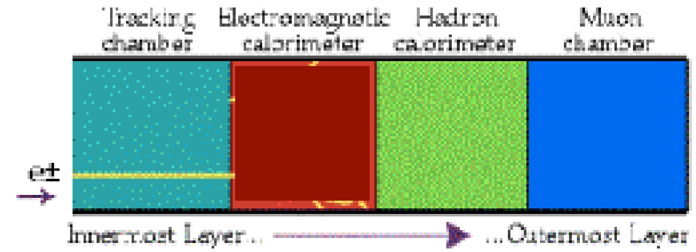
- e, μ, τ, γ, track, jet, B, ν, …
- Combinations of these objects

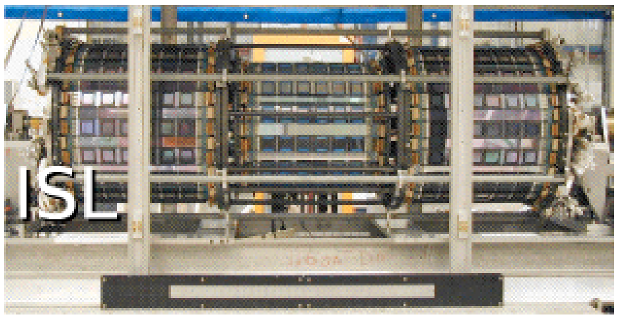
Silicon Vertex Trigger (SVT)

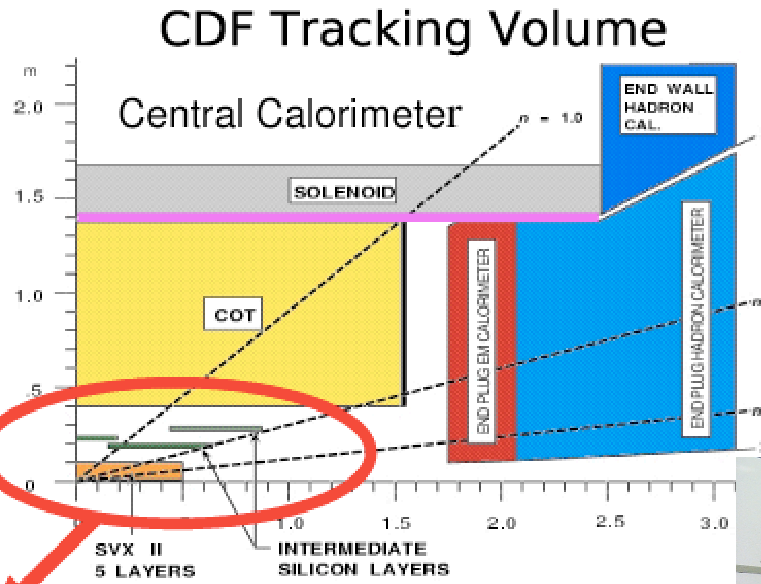




Tracking

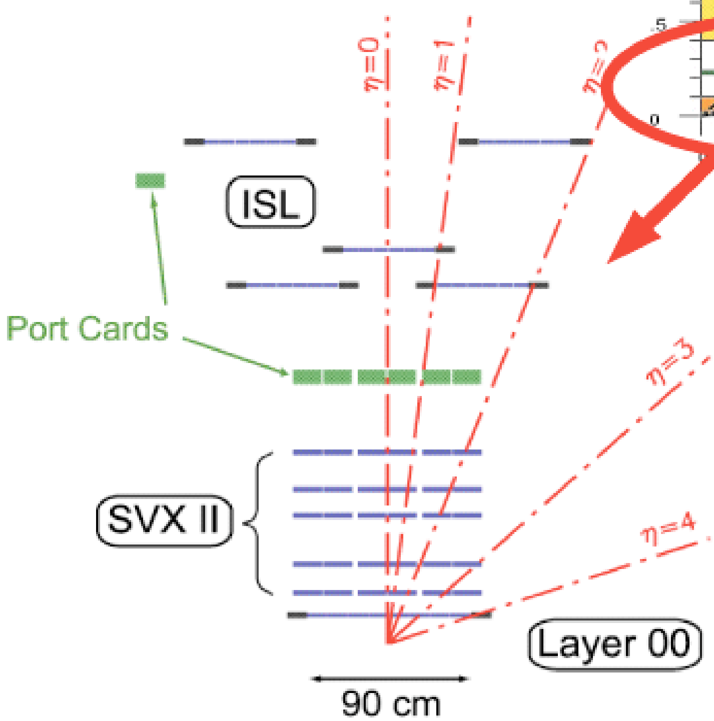


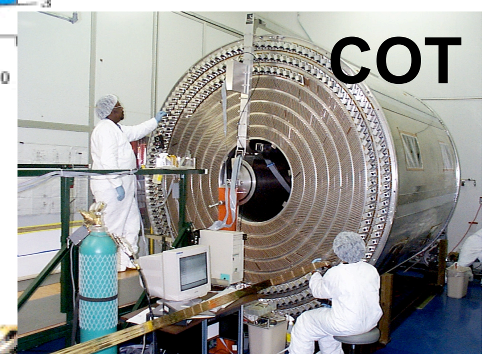


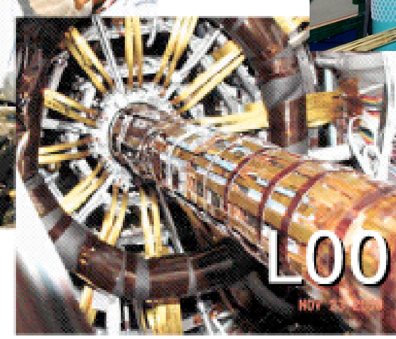


COT: open cell drift chamber

$\eta = -\log(tg\theta)$

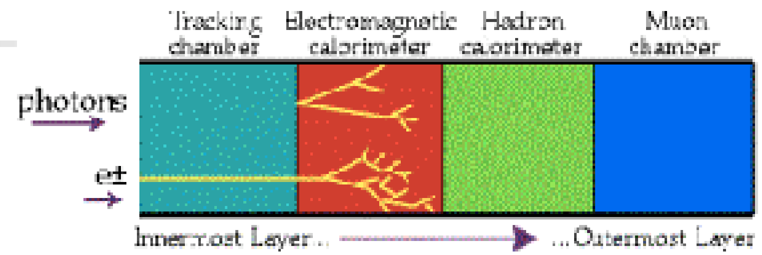


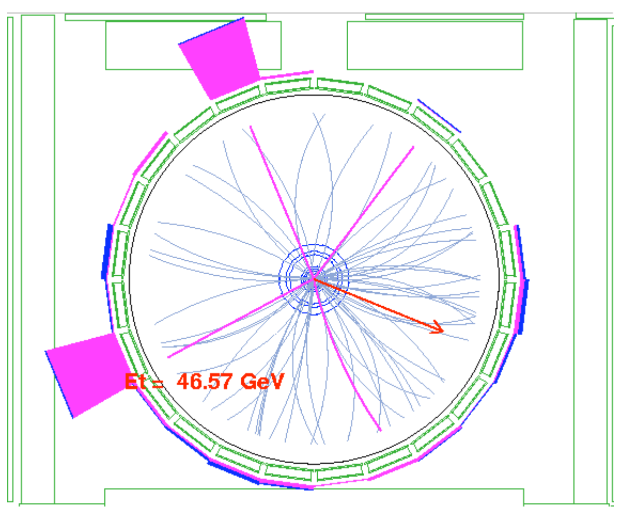


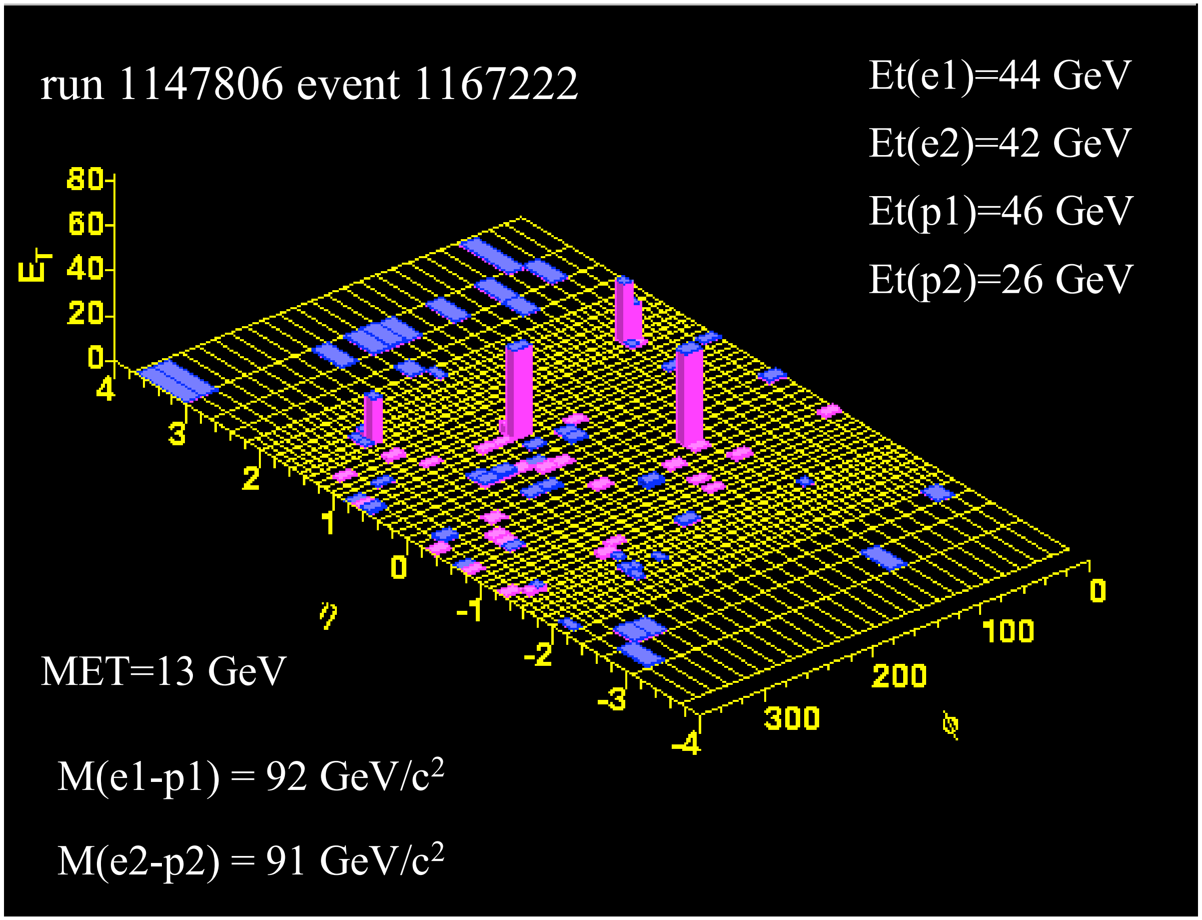


Electrons and Photons

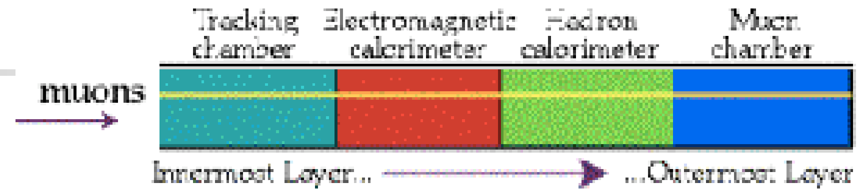
- Electrons and Photons get easily absorbed by the calorimeter
- Tracking association gives the ability to identify a charge particle, the electron.



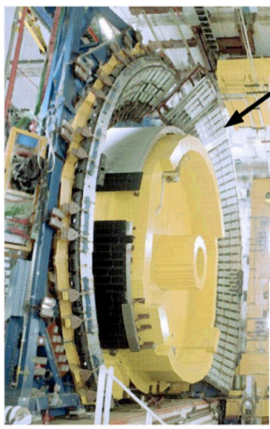




Muons and Neutrinos

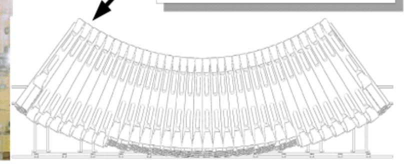


- Muon can penetrate lots of material before getting absorbed.
- Easily identified as coincidence between tracks and muon chambers hits: MIP



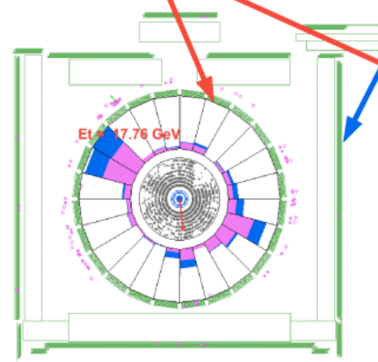
CMX
0.6 < |eta| < 1.0

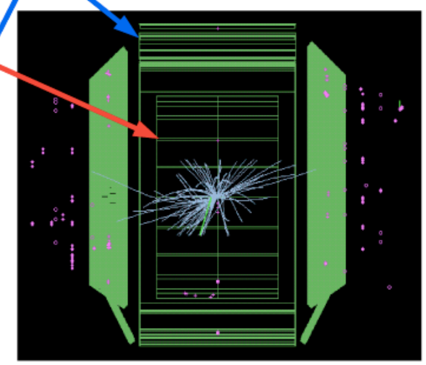
CMX Miniskirt:
Wedges 16-19



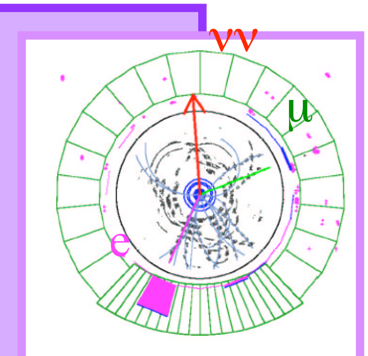
CMP
|eta| < ~0.6

CMU
|eta| < ~0.6



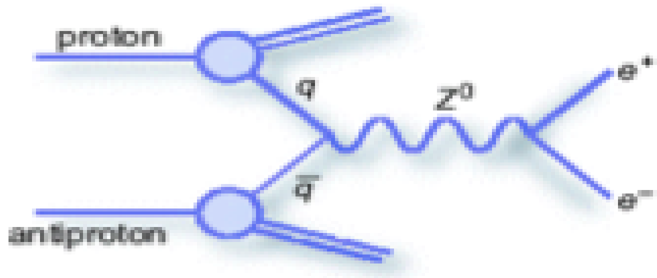


- Neutrinos rarely interact at all.
  - Since they have no charge, there is no track associated to them.
  - They don't leave energy in the calorimeter
  - They leave the detector undisturbed…
- The presence of the neutrino is inferred by its absence!
- Missing energy to the total energy of the event.

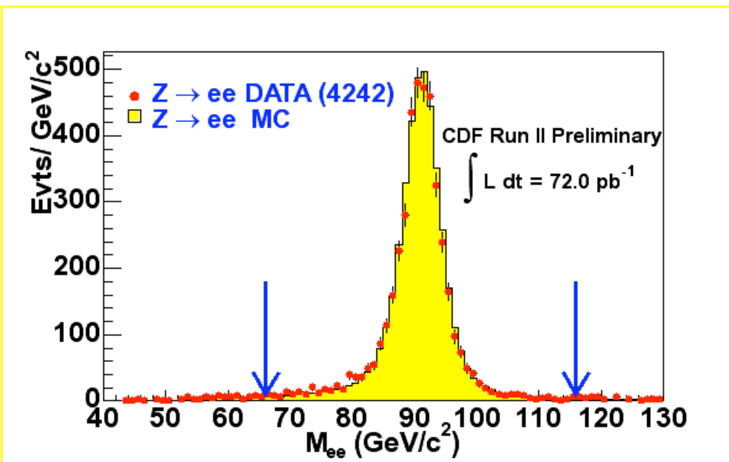


First pieces of the Puzzle

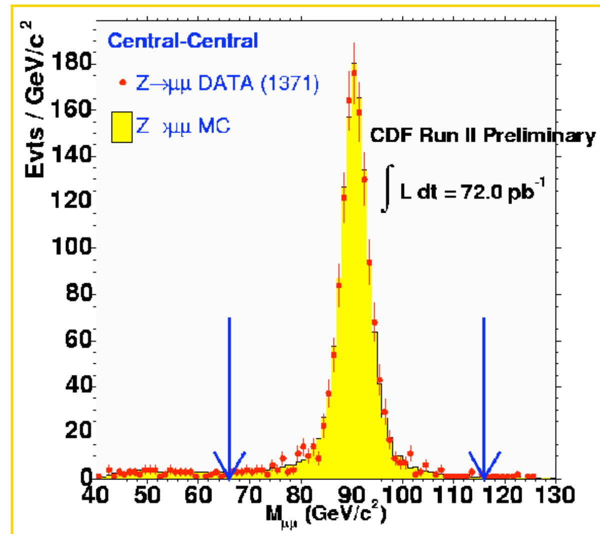
Z^0 Vector Boson Production



Very low backgrounds (QCD, Z→ττ, cosmics) : < 1%
Important systematics : PDF's, Material Descriptions



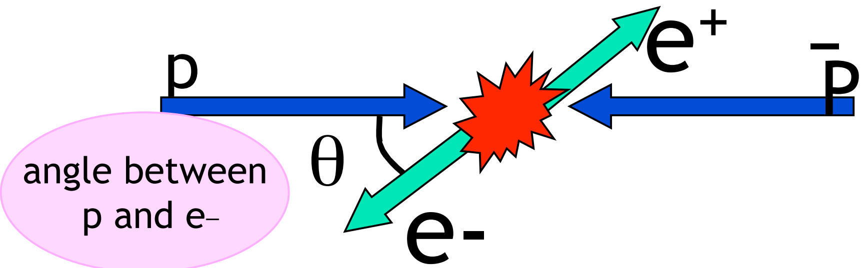
Standard candle



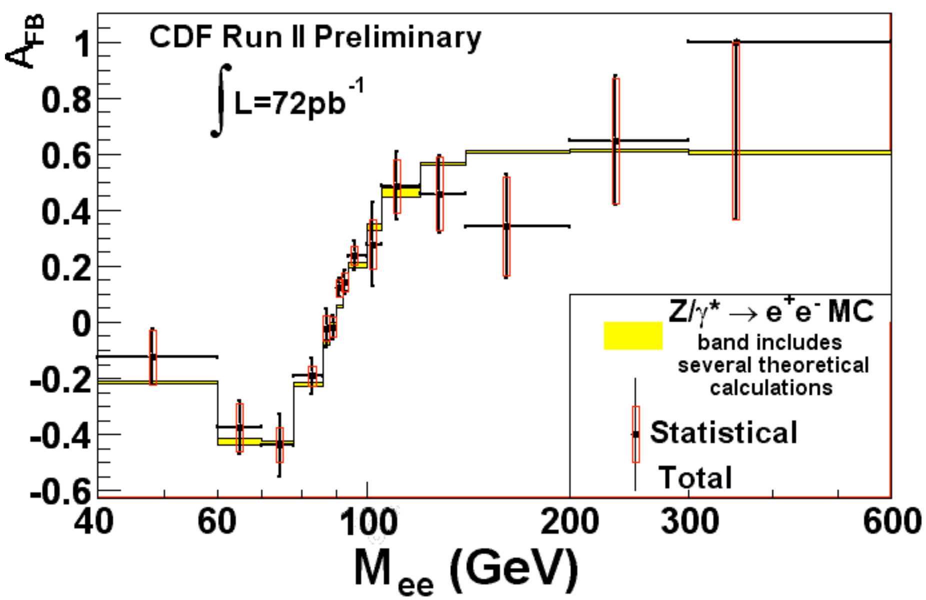
$\sigma \times BR(Z \to ee) = 255.2 \pm 3.9(stat) \pm 5.5(sys) \pm 15.3(lum)$ pb
$\sigma \times BR(Z \to \mu\mu) = 248.9 \pm 5.9(stat)\ ^{+7.0}_{-6.2}(sys) \pm 14.9(lum)$ pb

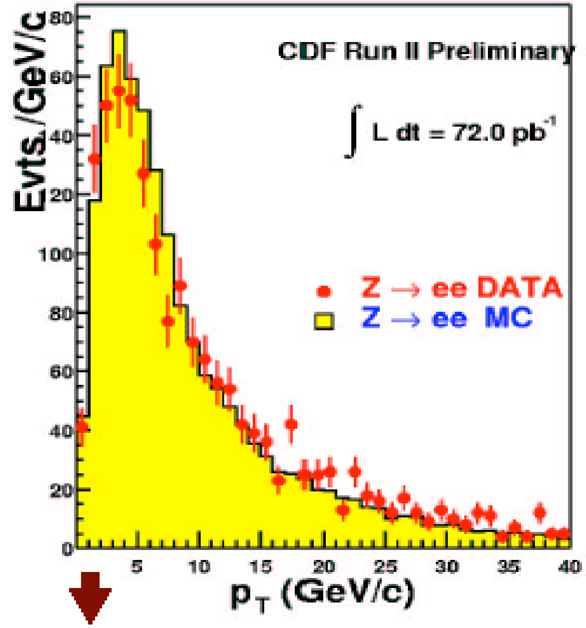
→ Extended measurements of cross section are well advanced

Drell-Yan Measurements



$$A_{fb} = \frac{\sigma(\cos\theta > 0) - \sigma(\cos\theta < 0)}{\sigma(\cos\theta > 0) + \sigma(\cos\theta < 0)}$$

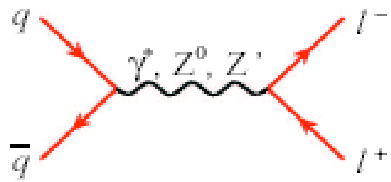


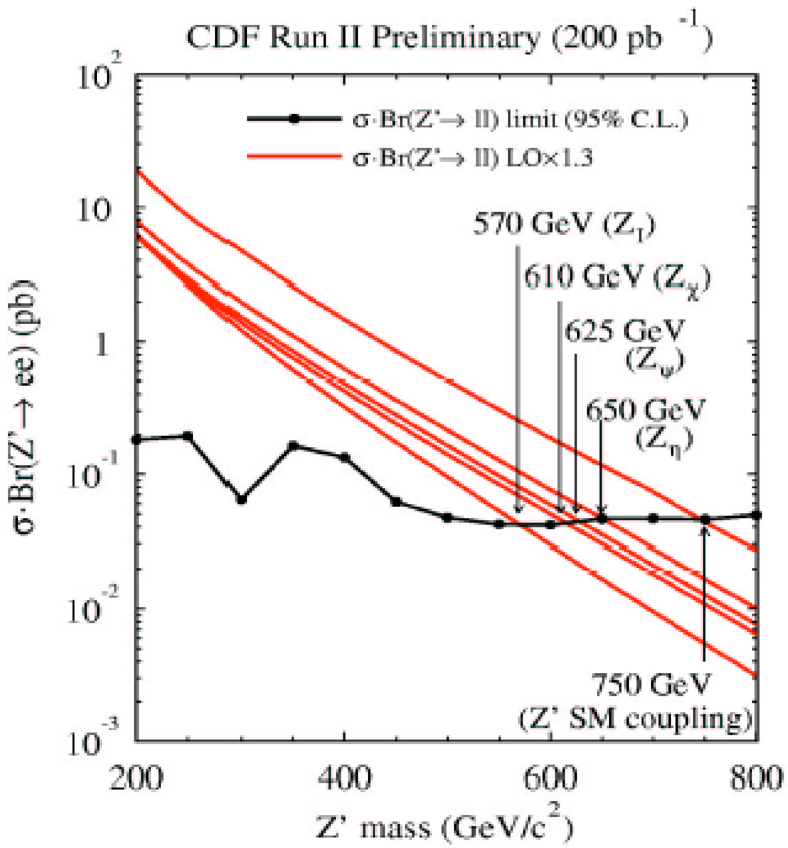


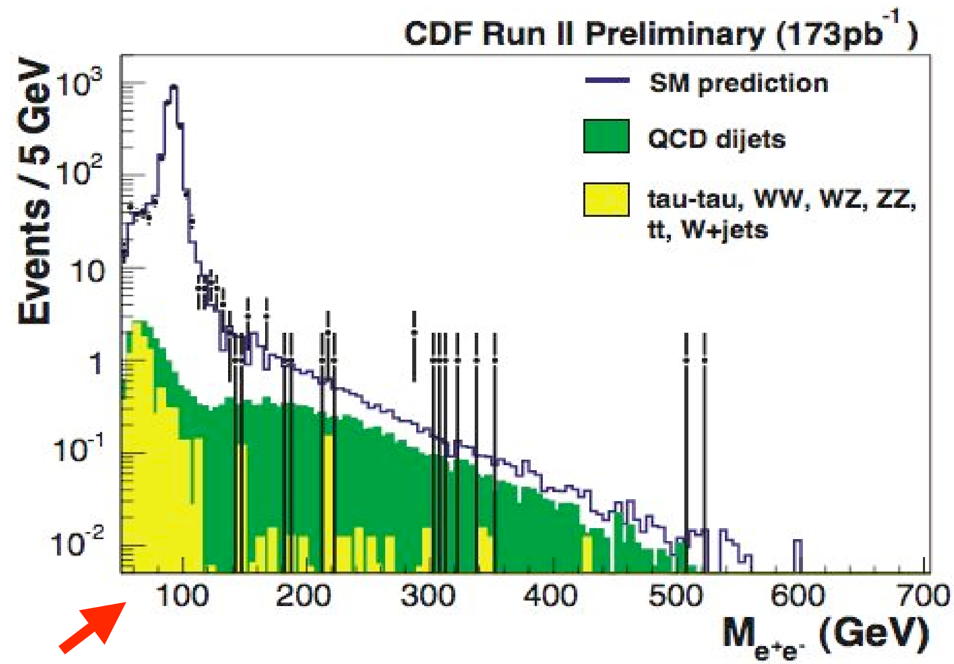
- Production properties : eventually feed into precision measurements (M_W)

- $|\eta^e|<3.0$: using full detector coverage
- extract quark, lepton couplings & $\sin^2\vartheta_W$
- sensitive to new physics

Searches in dileptons

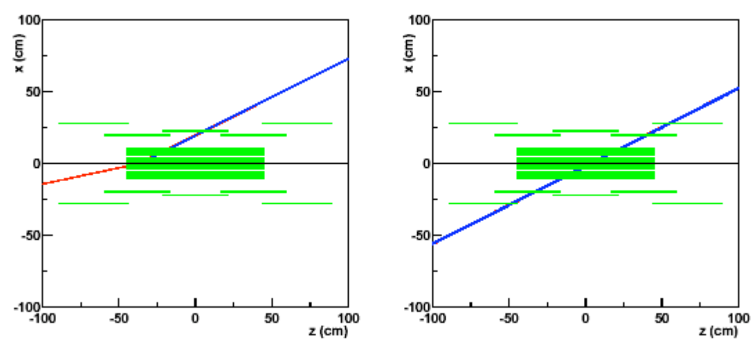






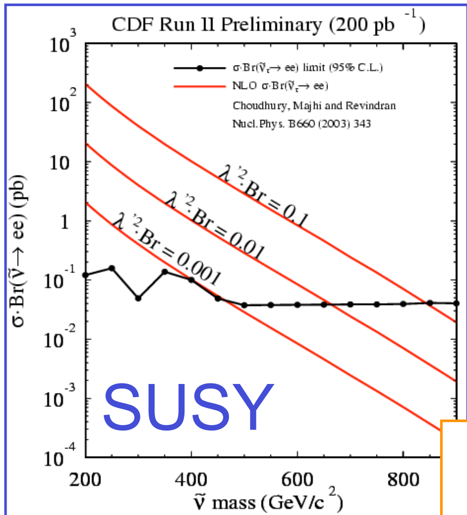
Forward electrons : $1.2 < |\eta| < 2.5$

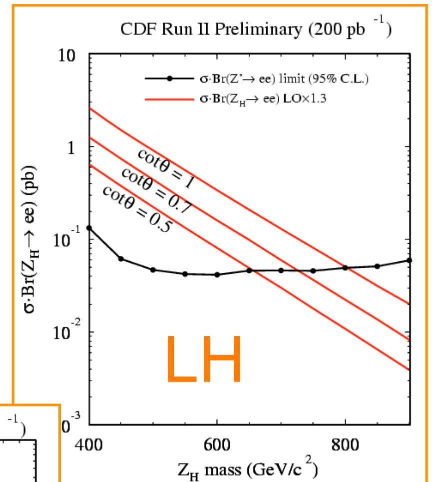
Calorimeter seeded Si tracking

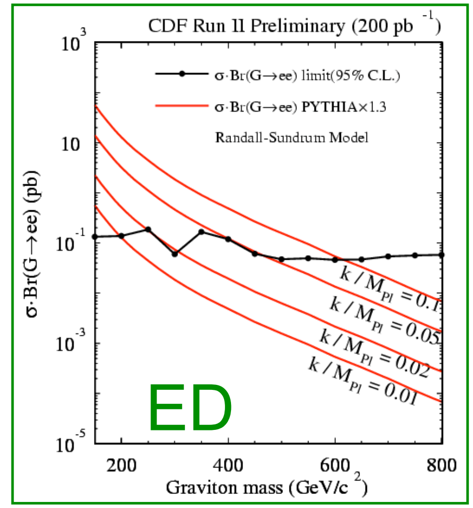


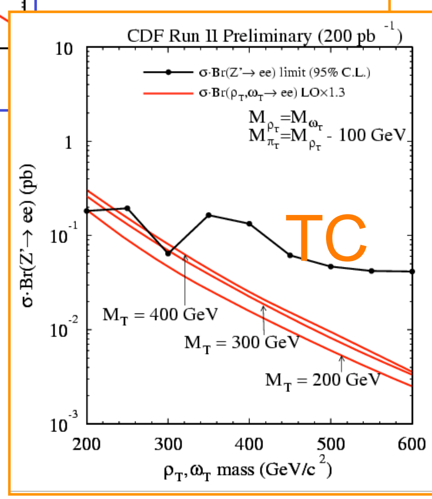
New Physics in Dileptons

Calculate the acceptances for resonant states for 3 different spin assumption (0,1,2)

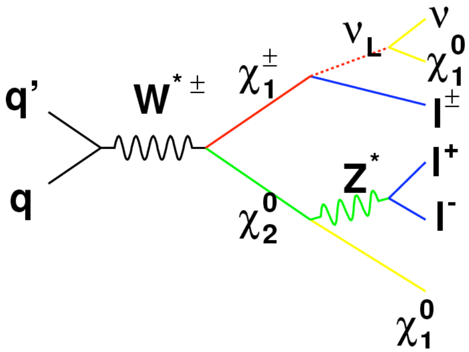






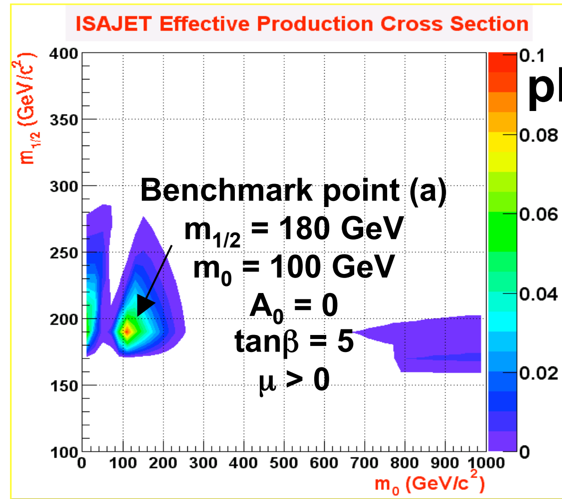


SUSY in trileptons



Signature: 3 isolated leptons and large MET

$$\sigma(qq' \to \chi_1^\pm \chi_2^0) \cdot BR(\chi_1^\pm, \chi_2^0 \to lll)$$



Sensitivity study for trilepton channel in mSUGRA scenario

Detailed scan of the parameter space: $m_{1/2}, m_0, A_0, \tan\beta, \mathrm{sign}(\mu)$

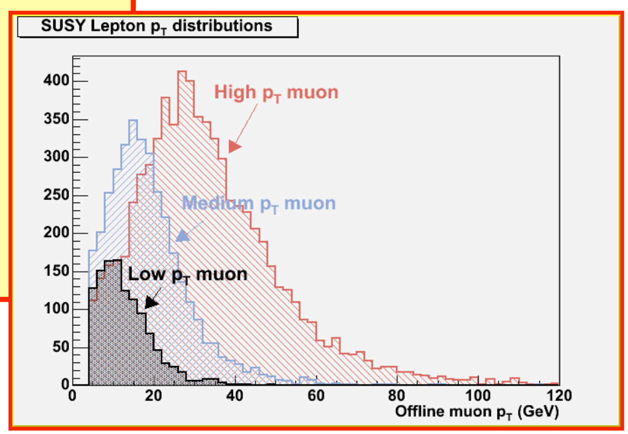
- Current limits

LEP (2000):

$m(\chi_1^\pm) > 103.5$ GeV/c^2

$m(\chi_1^0) > 46$ GeV/c^2

D0 Run II: $\sigma \times BR < 0.4$ pb



4 independent analyses to maximize acceptance

High p_t μμ + lepton & ee + lepton

Low p_t μμ + lepton & ee + track

SUSY in trileptons: ee channel

In mSUGRA: 3 leptons+$\not{E}_T$

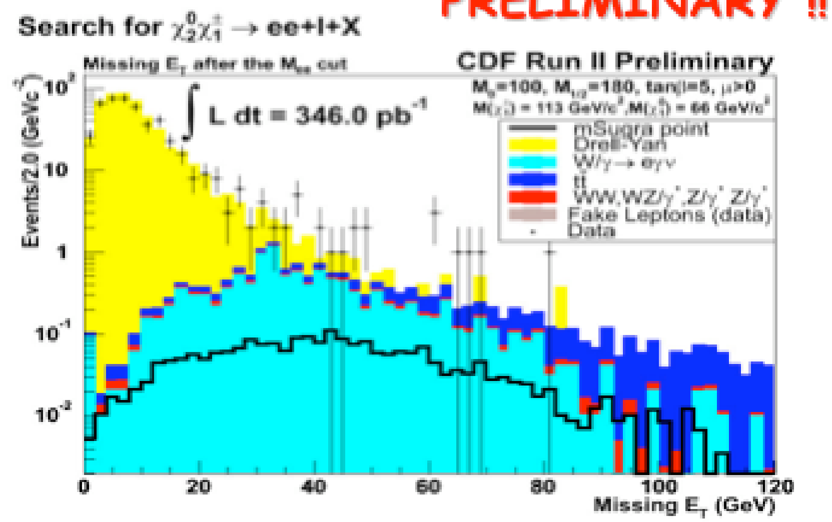
➡ $\sigma \times BR \sim 0.1$ pb

SELECTION:

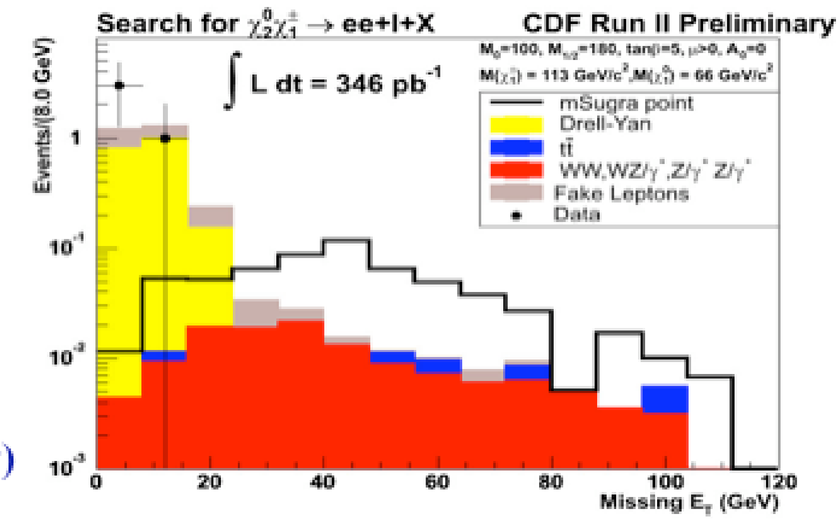
- 2 electrons+ ℓ (ℓ =e,μ) |η|<1
- large $\not{E}_T$
- $15 < M_{ll} < 76$, >106 GeV/c^2
- $|\Delta\phi| < 160$
- Njets(20 GeV) <2

ee+l (SUSY signal)	0.5
TOT SM Expected	0.16±0.07
OBSERVED	0

PRELIMINARY !!

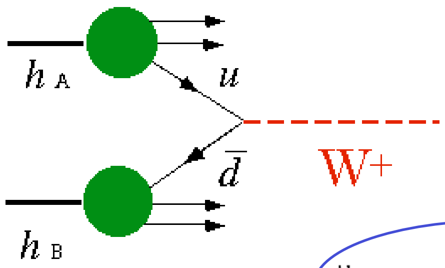


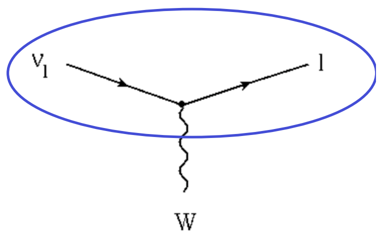
Asking for the third lepton:



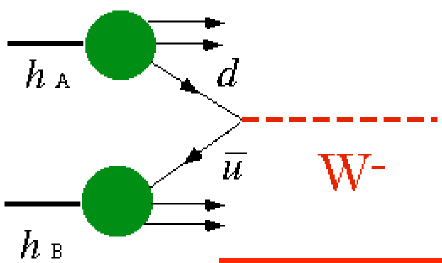
$W^{\pm}$ vector boson production

W^{+} Production

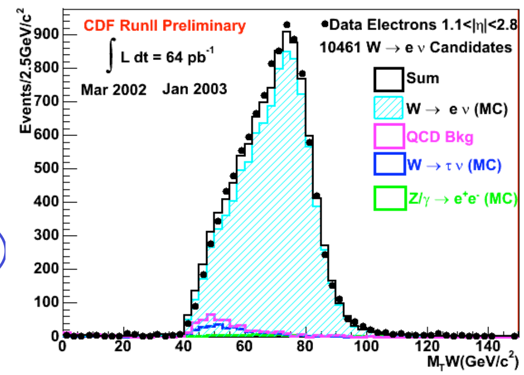




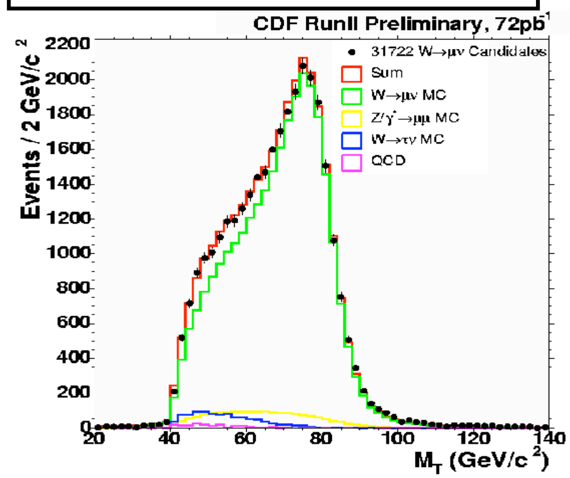
W^{-} Production



Transverse Mass W→eν

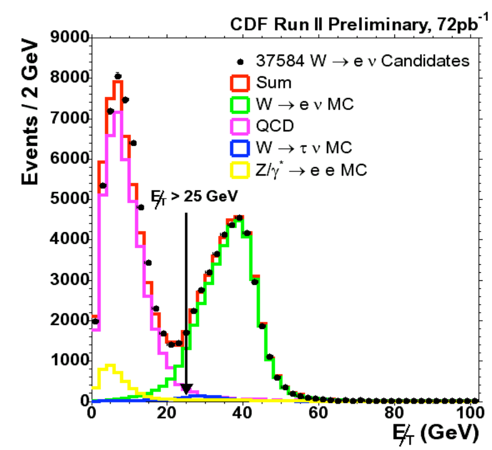


Transverse Mass - W→μν



Backgrounds (QCD, W→τν, Z, cosmics) : 6% (e), 11% (μ).

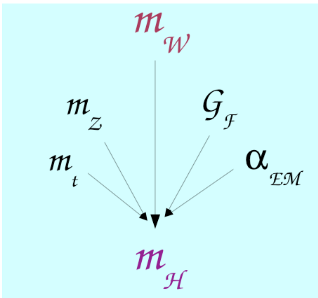
Important systematics : PDF's, Energy Scales, Material Description



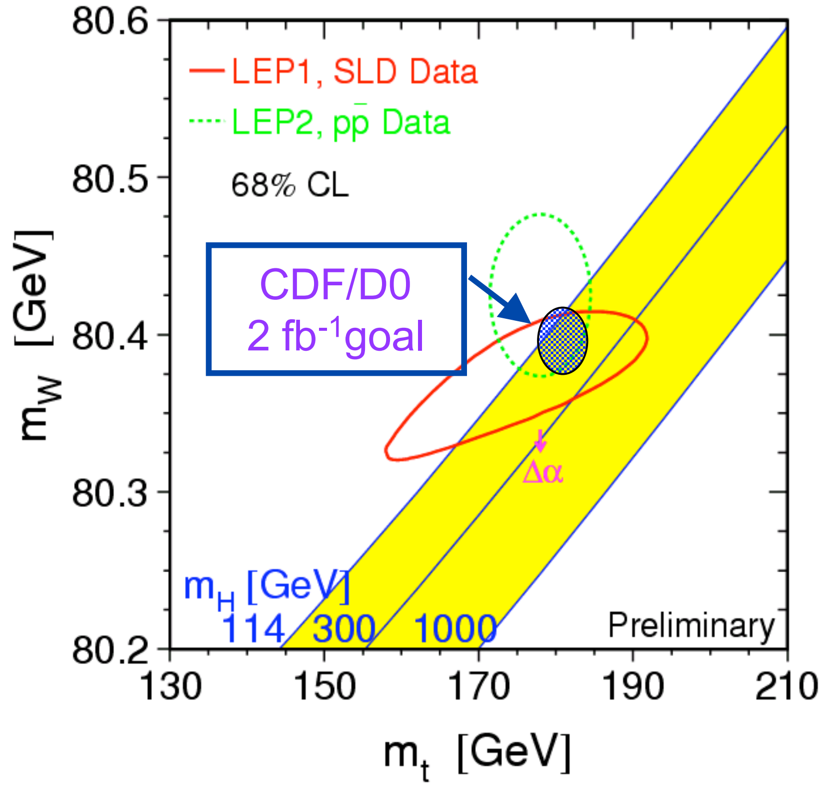
$$\sigma \cdot \mathrm{BR}(p\bar{p} \to W \to e\nu) = 2782 \pm 14(stat)^{+61}_{-56}(syst) \pm 167(lum)\,\mathrm{pb}$$

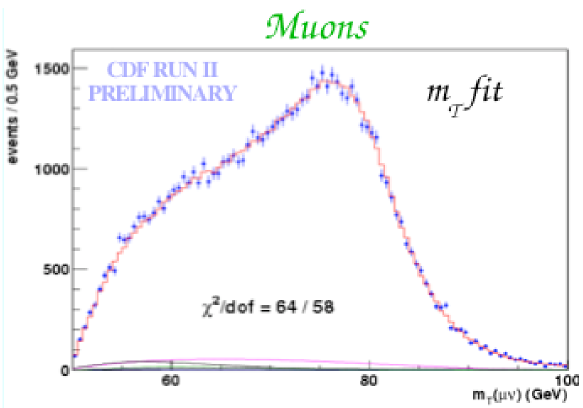
$$\sigma \cdot \mathrm{BR}(p\bar{p} \to W \to \mu\nu) = 2772 \pm 16(stat)^{+64}_{-60}(syst) \pm 166(lum)\,\mathrm{pb}$$

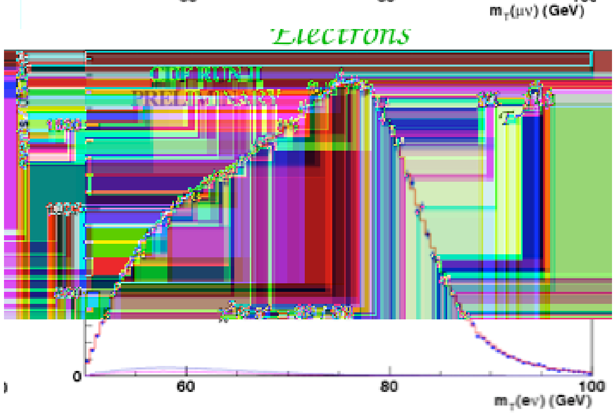
W mass measurement



Together with the top mass a precise determination of m_W is crucial to infer properties of the Higgs boson







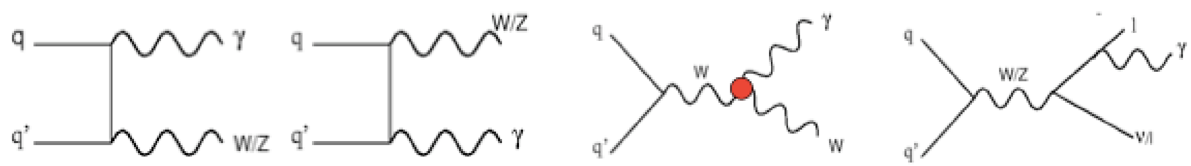
Run 2 analyses in advanced stages

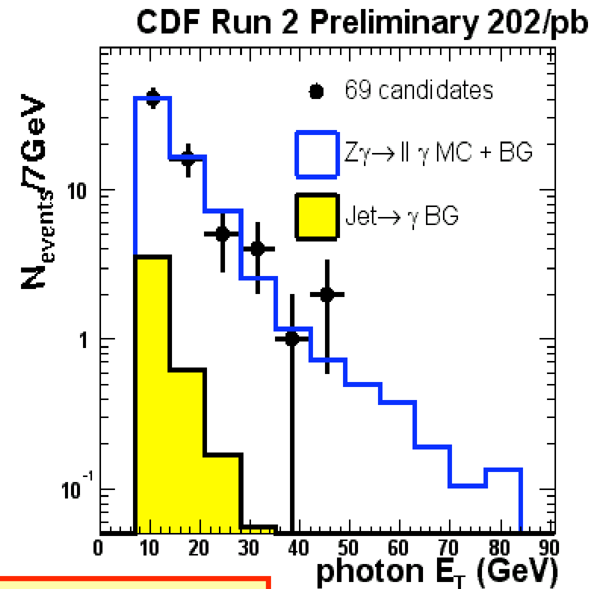
- *200 pb^{-1} analyzed at CDF and uncertainties determined*
  - *Total uncertainty (76 MeV) already lower than Run 1 (79 MeV)*
- *DØ finalizing calorimeter calibrations*

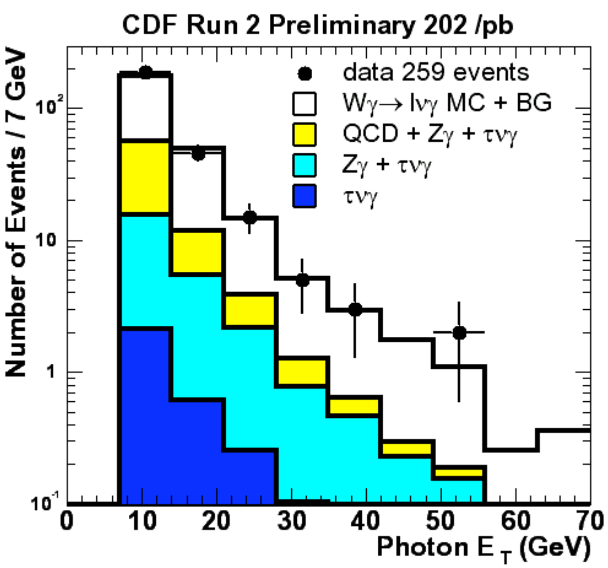
Wγ and Zγ

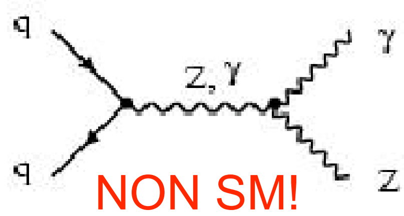
Test of gauge couplings (as predicted by the SM) and a window on new physics

u- or t-channel s-channel final-state radiation



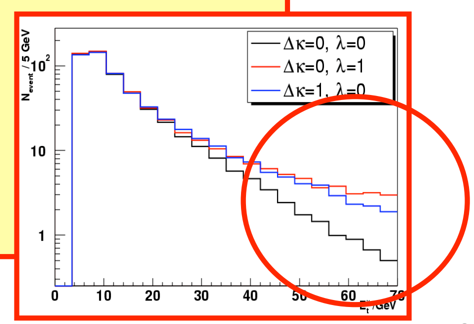






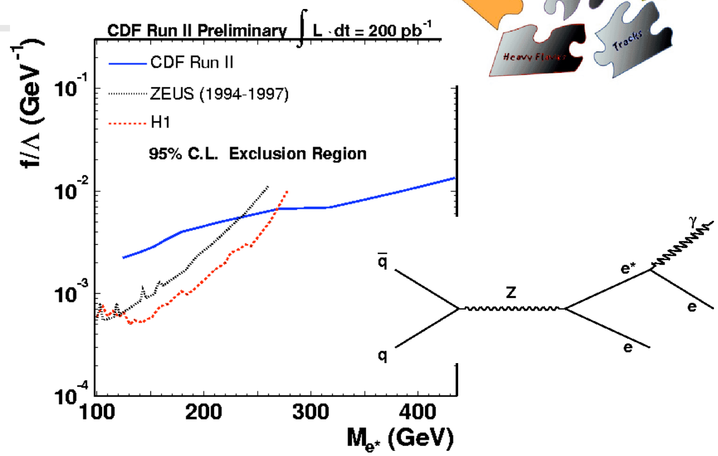
Now V+γ cross-sections well established, we are:

- optimizing sensitivity to anomalous coupling and new physics
- testing the Standard Model in ways unique to the TeVatron (e.g. observing RAZ in W γ production)



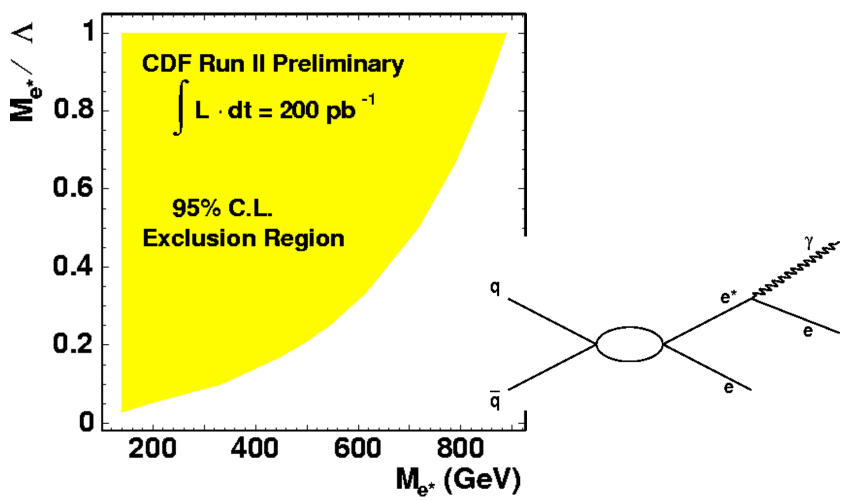
Excited electrons

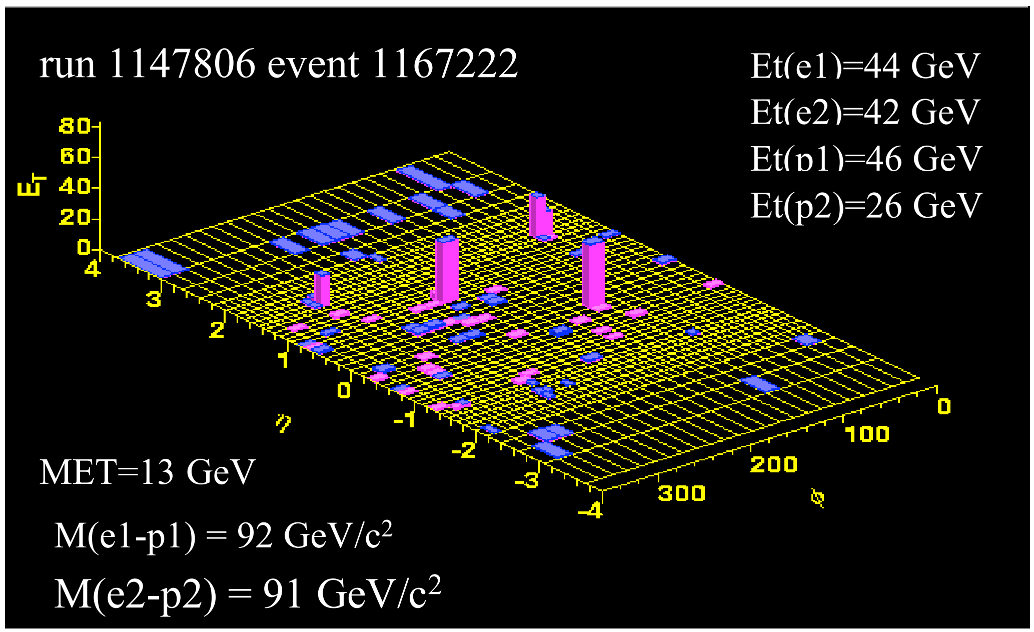
Observation of excited states of quarks and leptons might confirm the hypothesis that they are not elementary particles , but composite states



Select events with eeγ in the final state and look for resonance in M(eγ)

At Tevatron, e^* can be produced via contact interactions or gauge mediated interactions



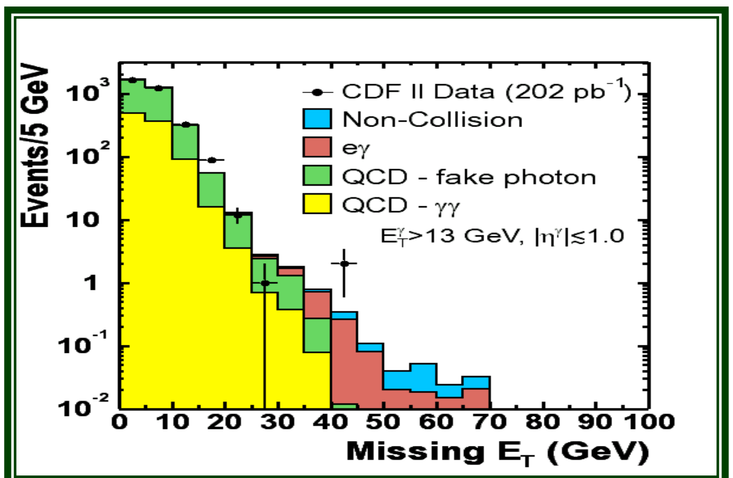


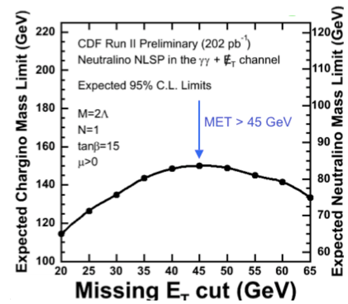
SUSY searches in diphoton + $\not{E}_T$

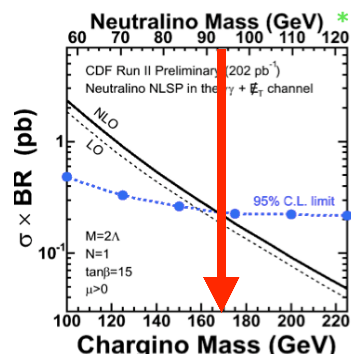
GMSB scenario
NLSP = $\chi^0_1 \rightarrow \gamma$ G

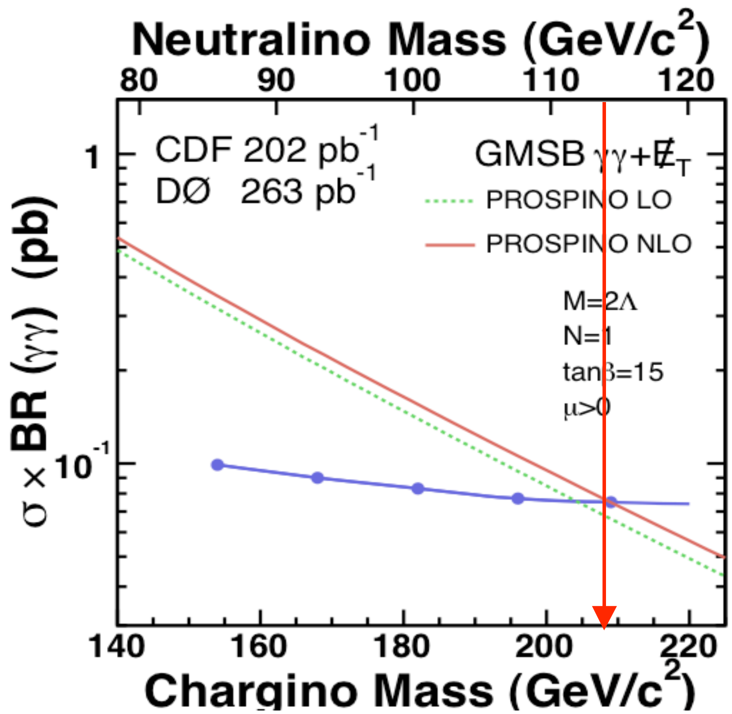
$p\bar{p} \rightarrow (X \rightarrow) \chi^0_1 \chi^0_1$ → $2\gamma + \not{E}_T$

Sample selection
- 2 central photons E_T > 13 GeV
- cosmic rays and beam halo rejection









For Missing Energy > 45 GeV
Expected: 0.60 ± 0.50
Observed : 0

NLO Limit at 95% C.L.
$m(\tilde{\chi}^\pm_1) > 168$ GeV/c^2
$m(\tilde{\chi}^0_1) > 93$ GeV/c^2

(209)
(114)

LED in diphoton

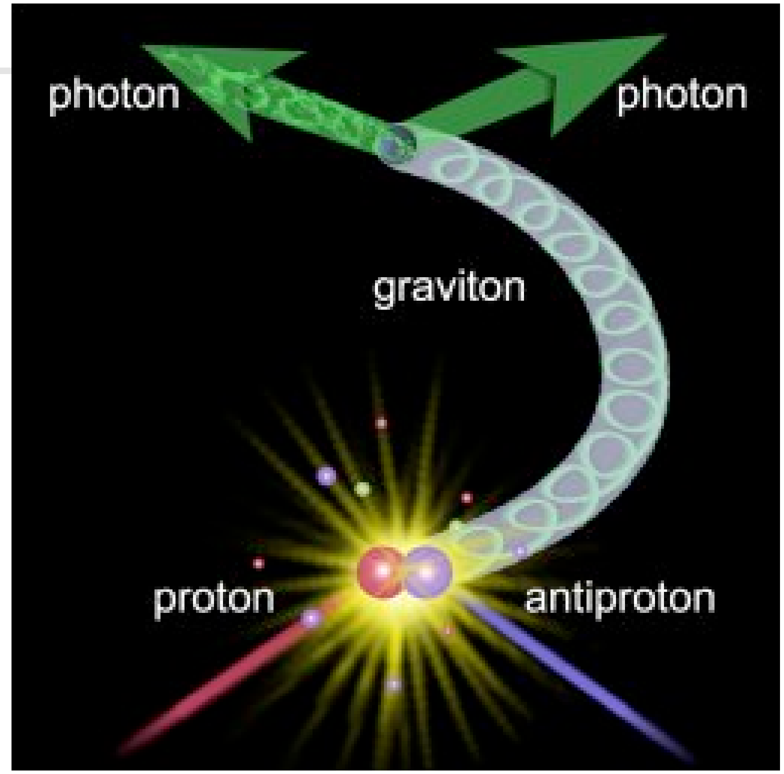
- Randall-Sundrum graviton model

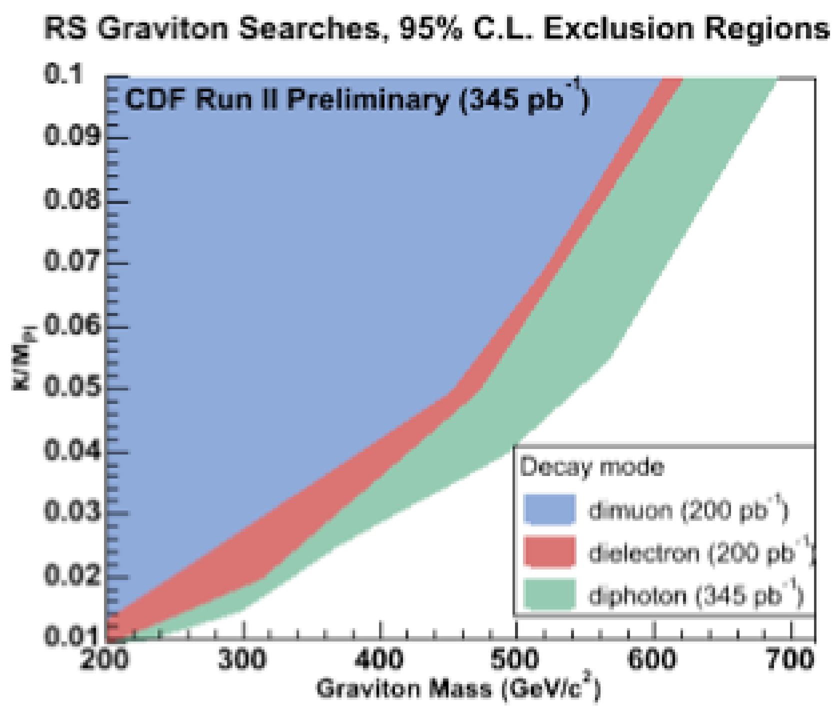
  4-dimensional metric multiplied by *warp* factor exponentially changing with the additional dimension

  Generating a large hierarchy does not require a large r_c

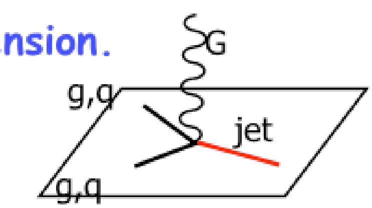
  The coupling of individual KK states to matter is set by the weak scale (parameters : M_G and $k/M_{P\ lanck}$)

  KK states can be observed as spin 2 resonances





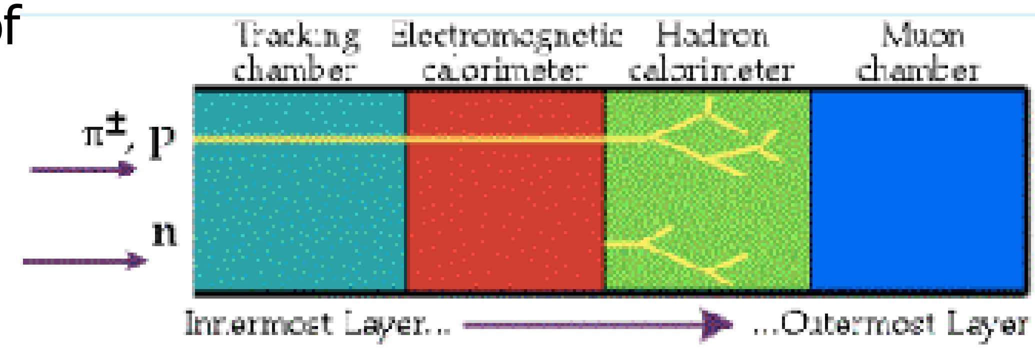
Mono-jet channel where a jet recoils against the graviton which leaves the usual 3D dimension.

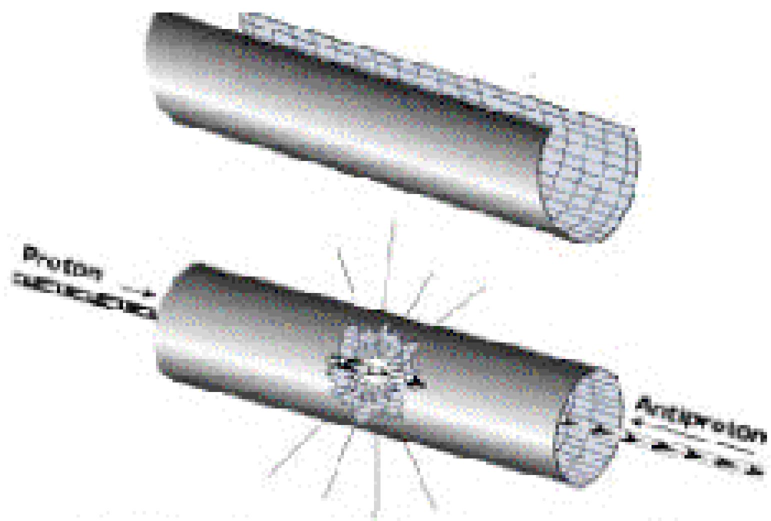


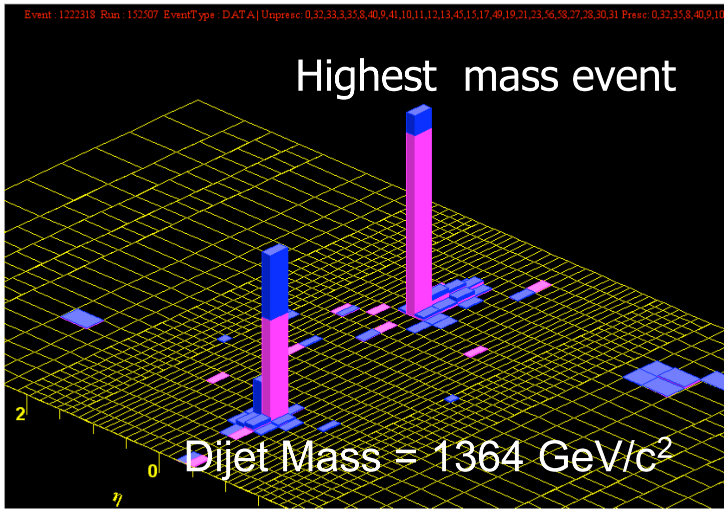
Not tested at CDF yet

Jets

- A quark or gluon flying out of the interaction point will generate lots of hadrons moving in the same general direction: a jet.





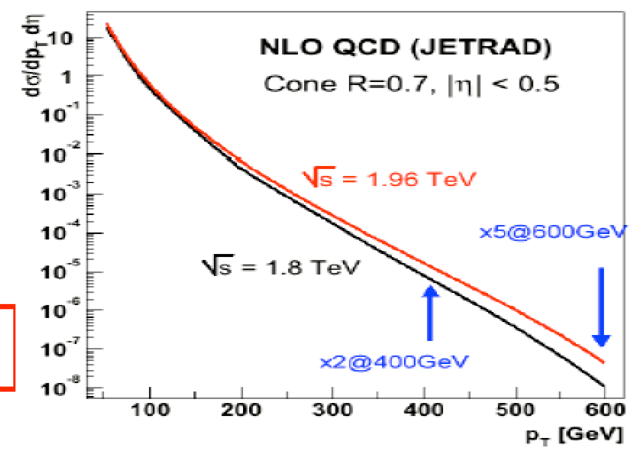


QCD and Jet Physics

The Tevatron is a Jet Factory: all production processes are "QCD realated"

Optimal understanding is basic for all analyses:

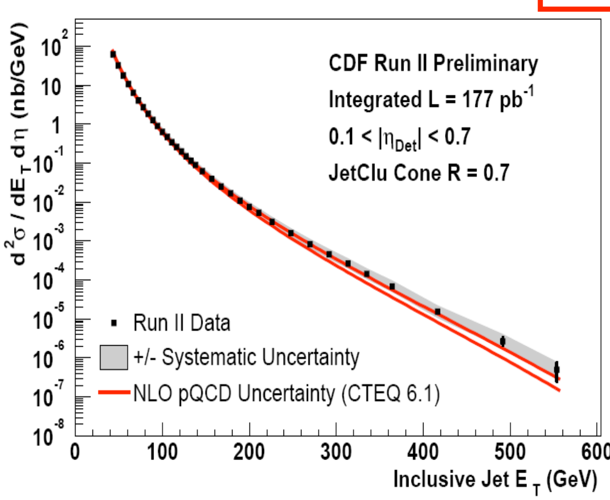
- -Main parameters (ex: gluon PDF's in high x)
- -Non perturbative regime (ex: underlying event studies)
- -Studies of specific processes where QCD is important

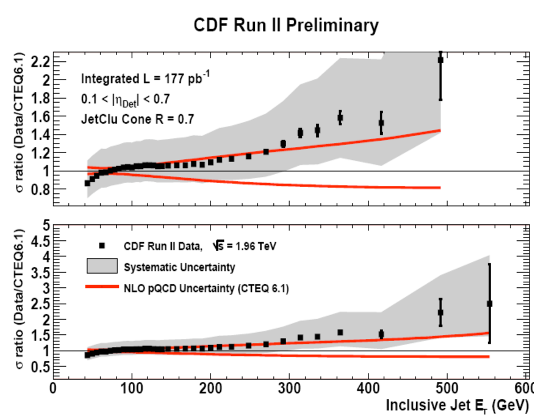


Probing higher energy scales:

- Precise test of perturbative QCD at NLO
- Look for deviations from SM predictions as a sign of new physics

Increase in the kinematic range

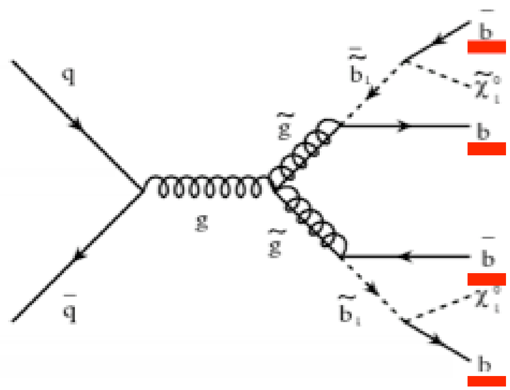




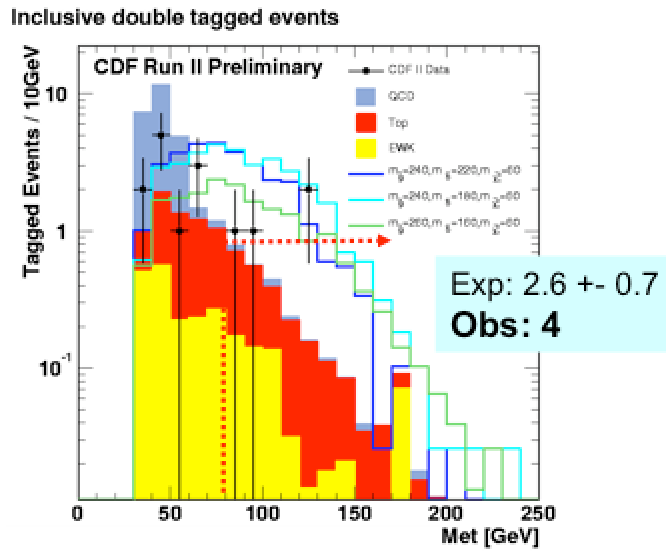
The error band shows the change in the cross section due to the 5% energy scale uncertainty

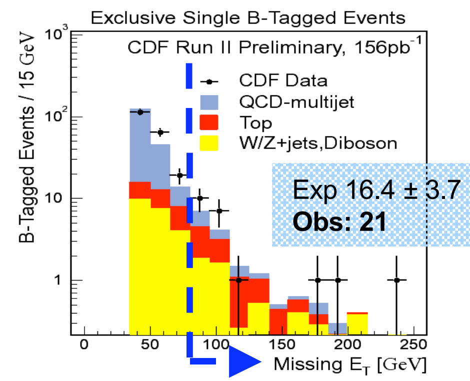
SUSY: sbottom from gluinos

If the sbottom is significantly lighter than the other squarks, the two body decay of gluino into bottom/sbottom is kinematically allowed

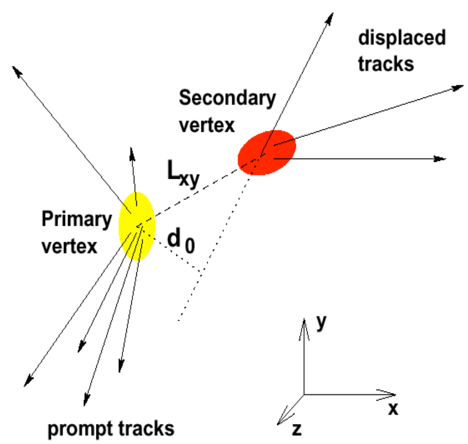


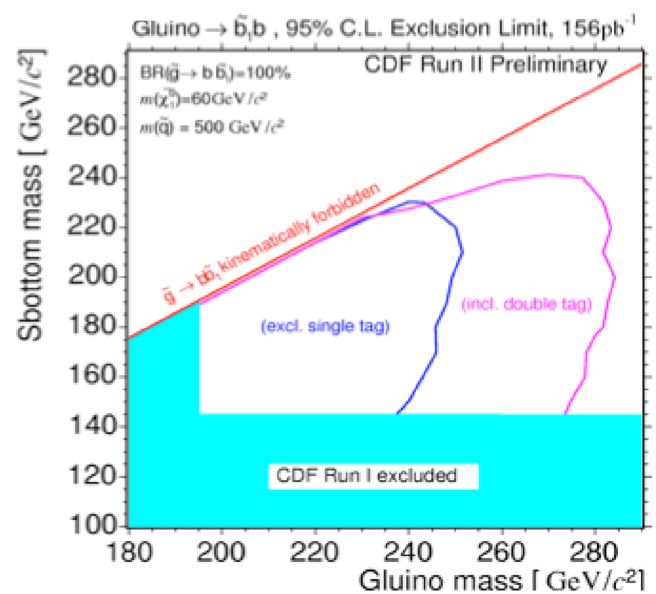
The sbottom decays into a bottom and LSP, giving rise to a final state with 4 b-jets and missing energy





b-tagging

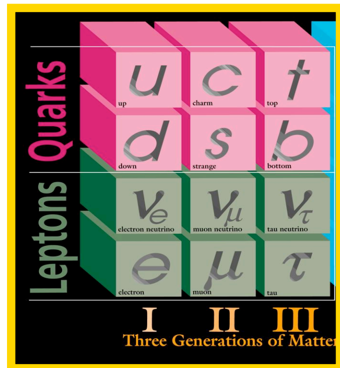




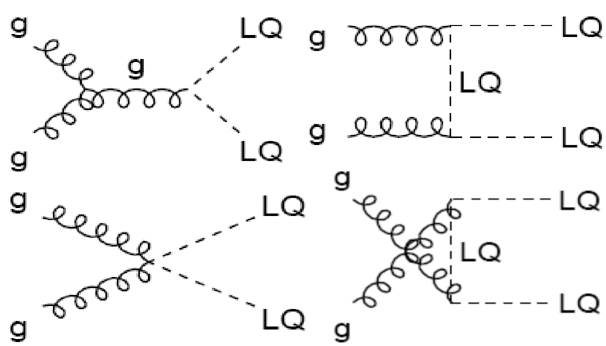
Completing the Puzzle….

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

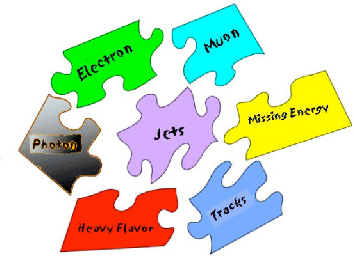
–Yang-Mills coupling: $k_G = \lambda_G = 0$

–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

Leptoquark Decay



Each generation can decay into 3 final states: $\beta = Br(LQ \rightarrow lq)$

Exclusive to the Tevatron

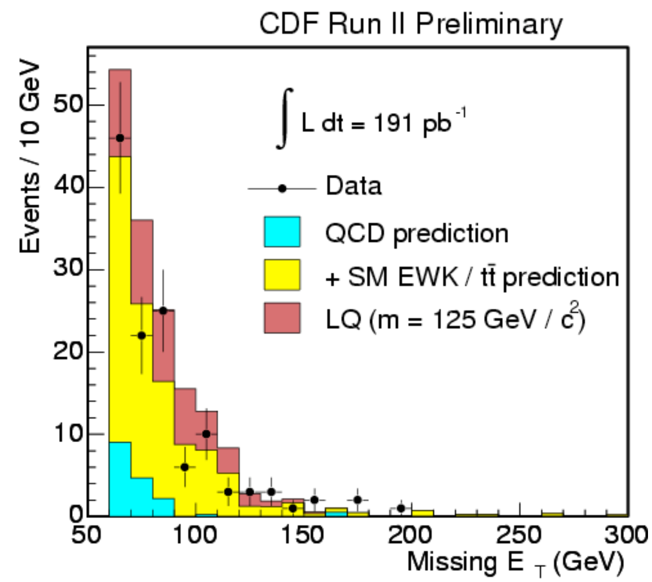
	1st Generation	2nd Generation	3rd Generation
$\beta = 1$	$LQ\,\overline{LQ} \rightarrow e^- e^+ q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \mu^+ \mu^- q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \tau^+ \tau^- q\bar{q}$
$\beta = 0.5$	$LQ\,\overline{LQ} \rightarrow e^{\pm} \nu_e q_i q_j$	$LQ\,\overline{LQ} \rightarrow \mu^{\pm} \nu_\mu q_i q_j$	$LQ\,\overline{LQ} \rightarrow \tau^{\pm} \nu\, q_i q_j$
$\beta = 0$	$LQ\,\overline{LQ} \rightarrow \nu_e \nu_e q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \nu_\mu \nu_\mu q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \nu_\tau \nu_\tau q\bar{q}$

$LQ\, LQ \rightarrow llqq$	2l+2j	$BR = \beta^2$
$LQ\, LQ \rightarrow l\nu qq$	l+MET+2j	$BR = 2\beta(1-\beta)$
$LQ\, LQ \rightarrow \nu\nu qq$	MET+2j	$BR = (1-\beta)^2$

LQ search in ννjj

$\beta' = BR(LQ \rightarrow \nu q) = 1$

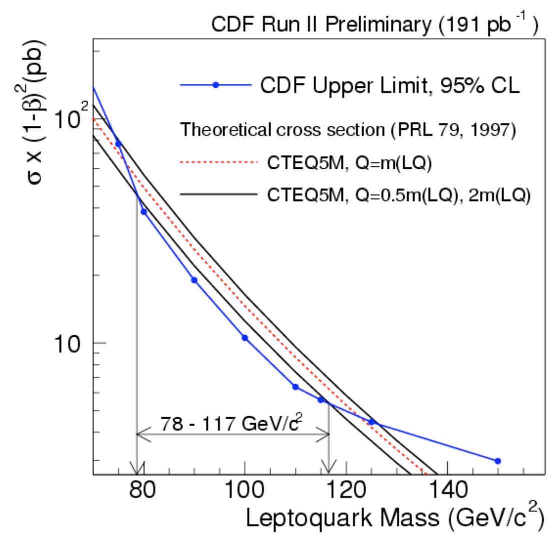
Signature: Large MET and 2 jets



Sample Composition:
- W/Z + jets
- top
- QCD fakes

Expected =118±14

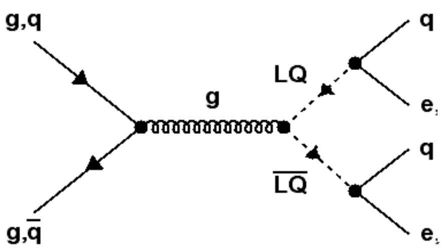
124 events seen after analysis cuts



M(LQ) > 117 GeV/c² @ 95 % C.L.

Flavor independent

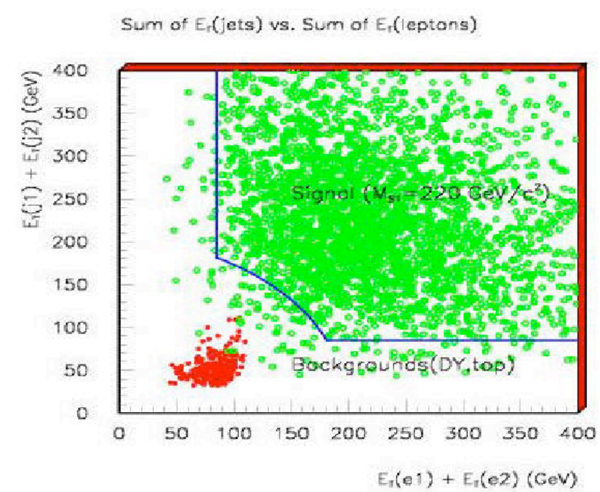
Search for LQ in dileptons + jets



Selection

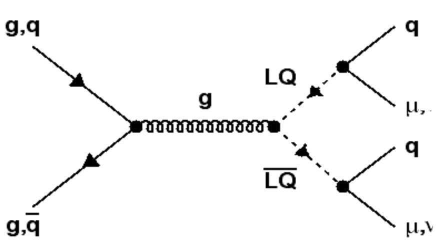
- ✓ 2 electrons (CC,CF) E_T > 25 GeV
- ✓ 2 jets, $E_T(j1)$ > 30 GeV, $E_T(j2)$ > 15 GeV
- ✓ Z Veto (76 < $M_{\mu\mu}$ < 110) GeV
- ✓ Electrons/Jets: $E_T^{j1(e1)} + E_T^{j2(e2)}$ > 85 GeV
- ✓ $((E_T(j_1) + E_T(j_2))^2 + (E_T(e_1) + E_T(e_2))^2)^{1/2}$ > 200 GeV

SM background
- ➢ Drell-Yan+2jets
- ➢ Top (W→eν)
- ➢ QCD/Fakes

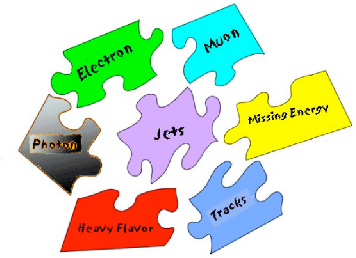


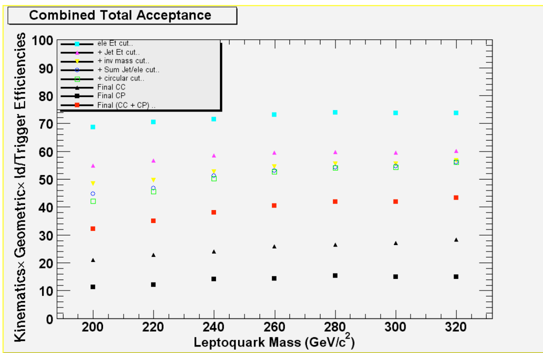
Selection

- ❖ 2 muons with P_T > 25 GeV
- ❖ 2 jets with $E_T(j1,j2)$ > 30,15 GeV
- ❖ Dimuon Mass Veto:
  - ❖ 76 < $M_{\mu\mu}$ < 110, $M_{\mu\mu}$ < 15 GeV
- ❖ $E_T(j_1) + E_T(j_2)$ > 85 GeV and $P_T(\mu_1) + P_T(\mu_2)$ > 85 GeV
- ❖ $((E_T(j_1) + E_T(j_2))^2 + (P_T(\mu_1) + P_T(\mu_2))^2)^{1/2}$ > 200 GeV

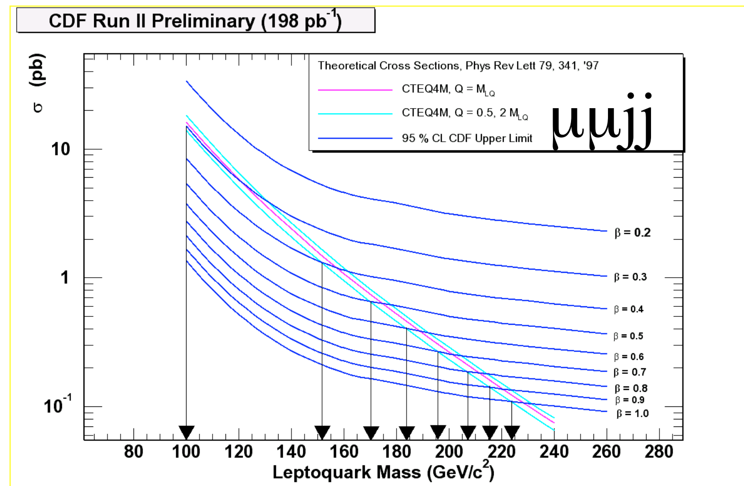


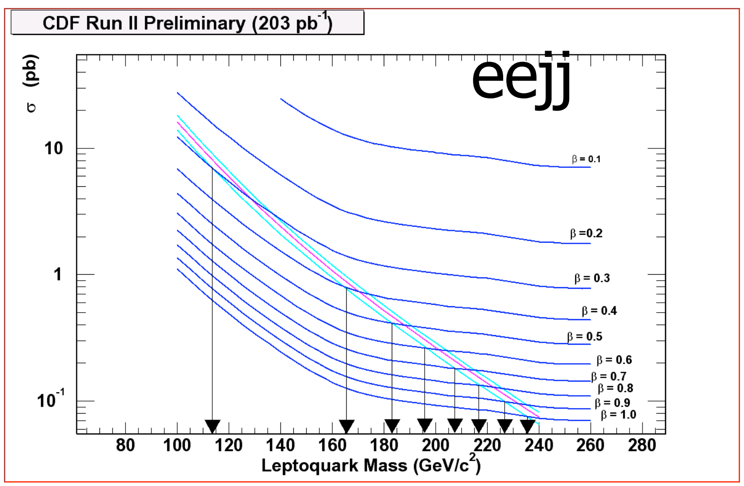
Scalar LQ in dileptons + jets

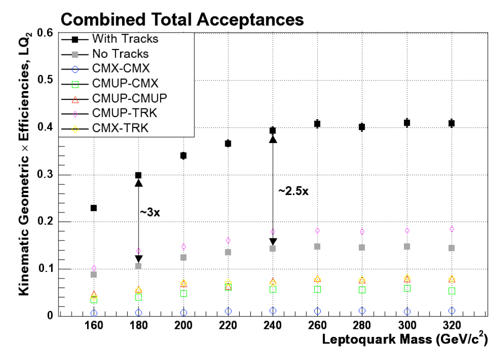




Exclude at 95% CL M_{LQ}<224 GeV/c^2 for β = 1.0

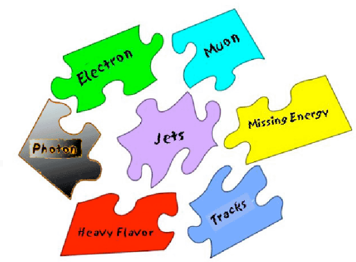


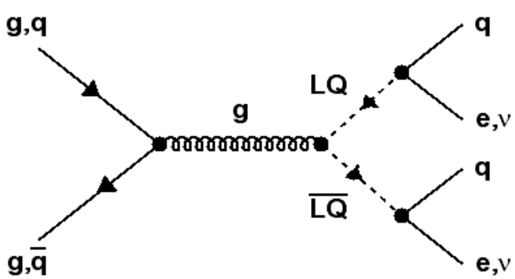




Exclude at 95% CL M_{LQ}<235 GeV/c^2 for β = 1.0

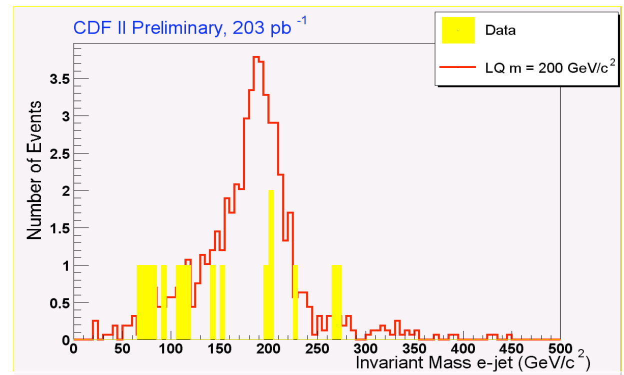
Search for LQ in lepton + MET + jets





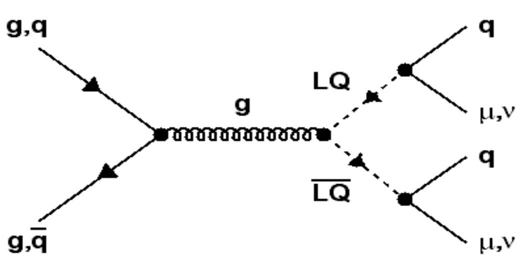
Selection

- 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
- $\Delta\phi$ (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



Selection

Z veto (tight/loose pair)

No 2nd muon (CMUP, CMX, or stubless)

$P_T(\mu)$ > 25 GeV

$\not{E}_T$ > 60 GeV

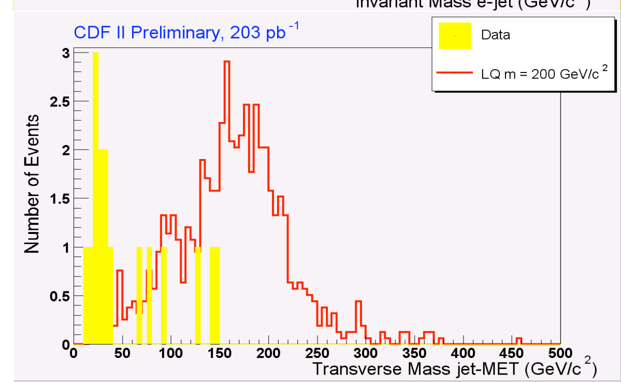
2 jets, @ E_T>30GeV

$\Delta\phi(\mu,\not{E}_T)$<175°, $\Delta\phi(\not{E}_T$,jets)>5°

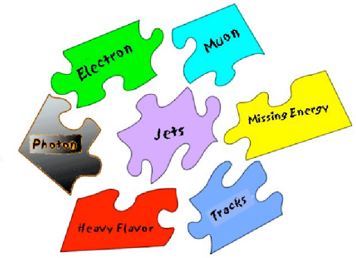
E_T(jet1)+E_T(jet2) > 80 GeV

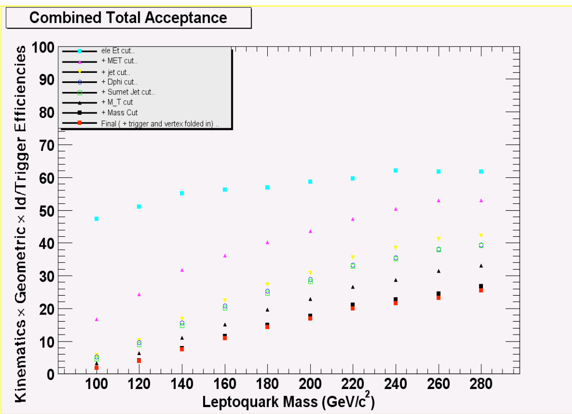
$M_T(\not{E}_T$,Muon) > 120 GeV/c²

Mass Cut

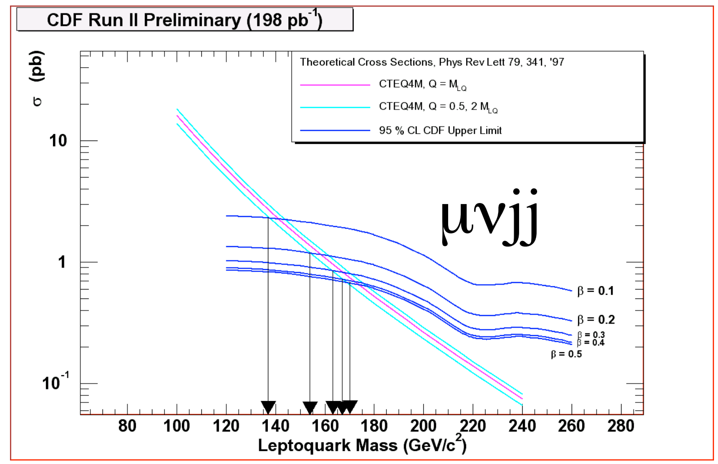


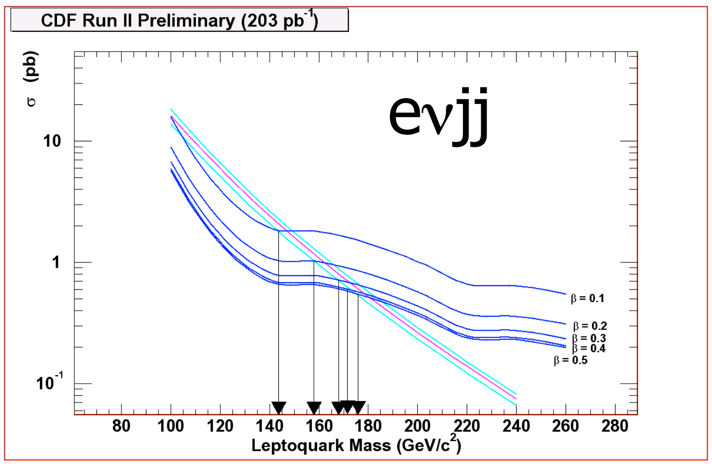
Scalar LQ in lepton + MET + jets

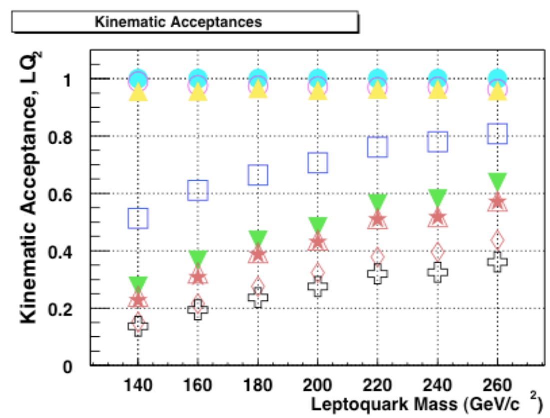




Exclude at 95% CL M_{LQ}<170 GeV/c^2 for β = 0.5







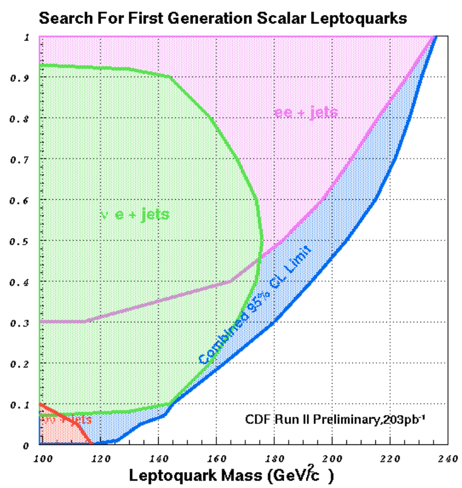
Exclude at 95% CL M_{LQ}<176 GeV/c^2 for β = 0.5

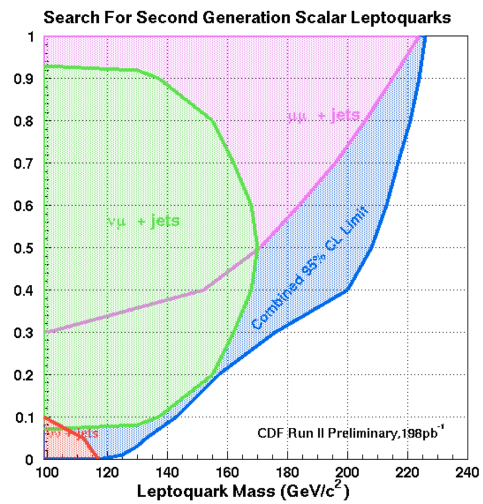
Final Combined Limits

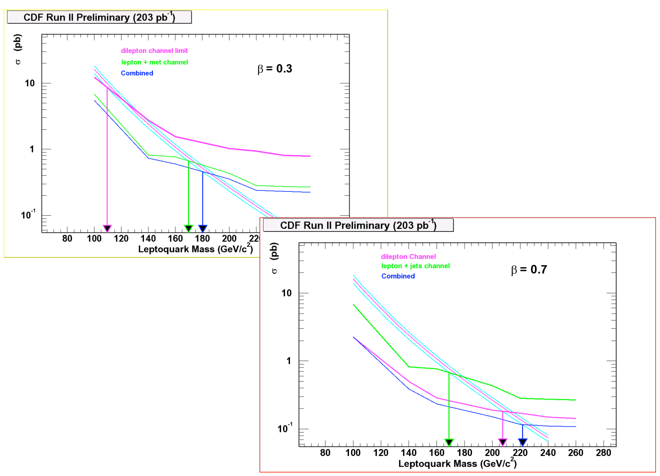
- Joint likelihood formed from the product of the individual channels likelihood.
- The searches in the dileptons and lepton + MET channels use common criteria and sometime apply the same kind of requirements (for example on the tight electron identification) so the uncertainties in the acceptances have been considered completely correlated (which gives the most conservative limit).
- When calculating the limit combination including also the $\nu\nu jj$ channel the uncertainties in the acceptances have been considered uncorrelated.A correlation factor of 0.5 has also been considered (no difference)

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

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

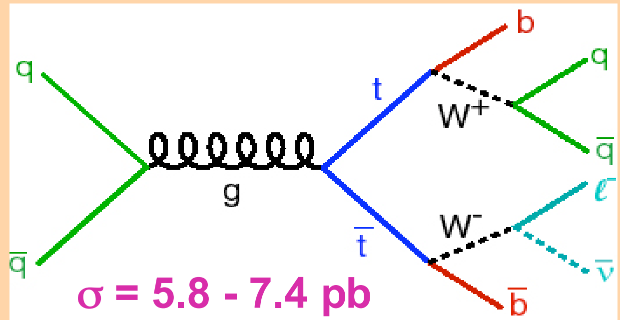


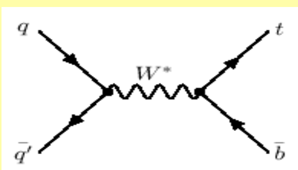




Top Quark

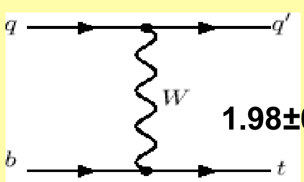
Pair production via strong interactions
- Central, spherical events
- Large transverse energy
- High P_T isolated leptons (tracks)
- Heavy-Flavored Jets



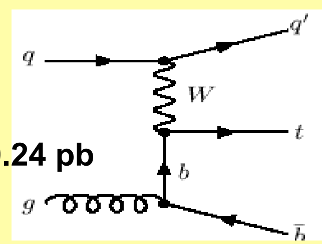


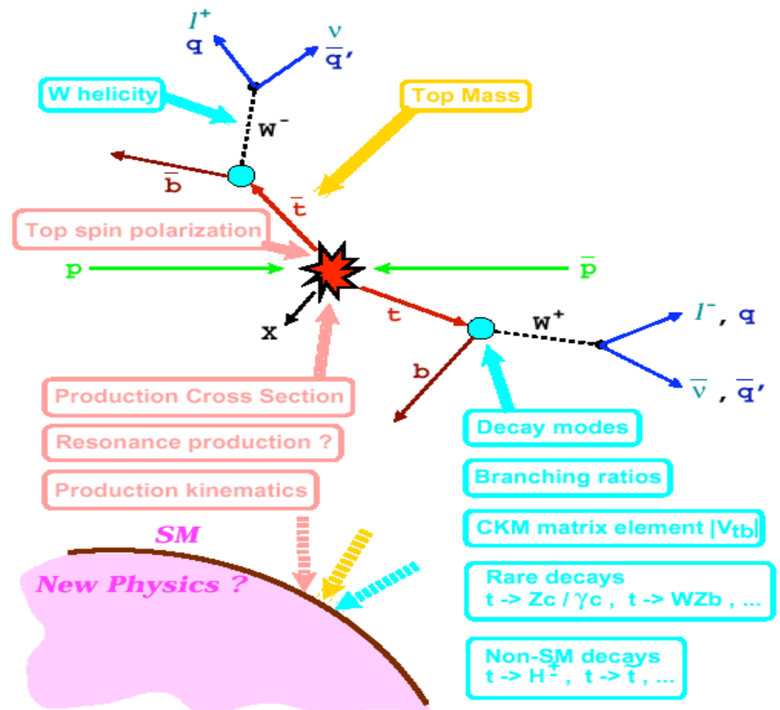
0.88±0.11 pb

EW single-top production,
x2 smaller rate, not (yet) seen



1.98±0.24 pb

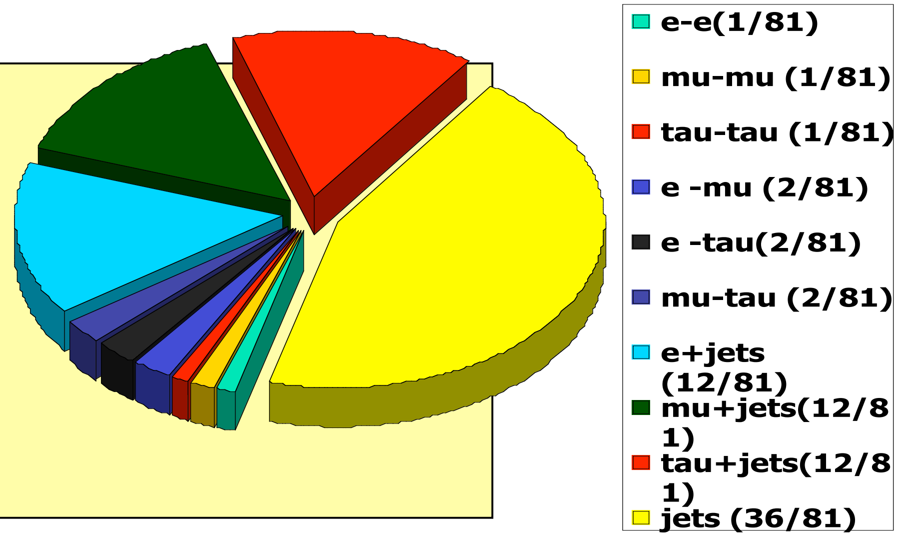


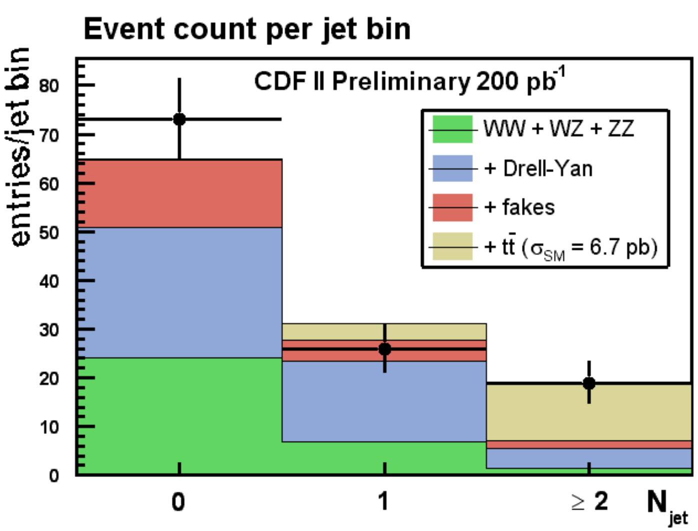


Top Data Samples

W's decay modes used
to classify the final states:
dileptons, lepton + jets, all-hadronic

B(t→Wb) = 100%



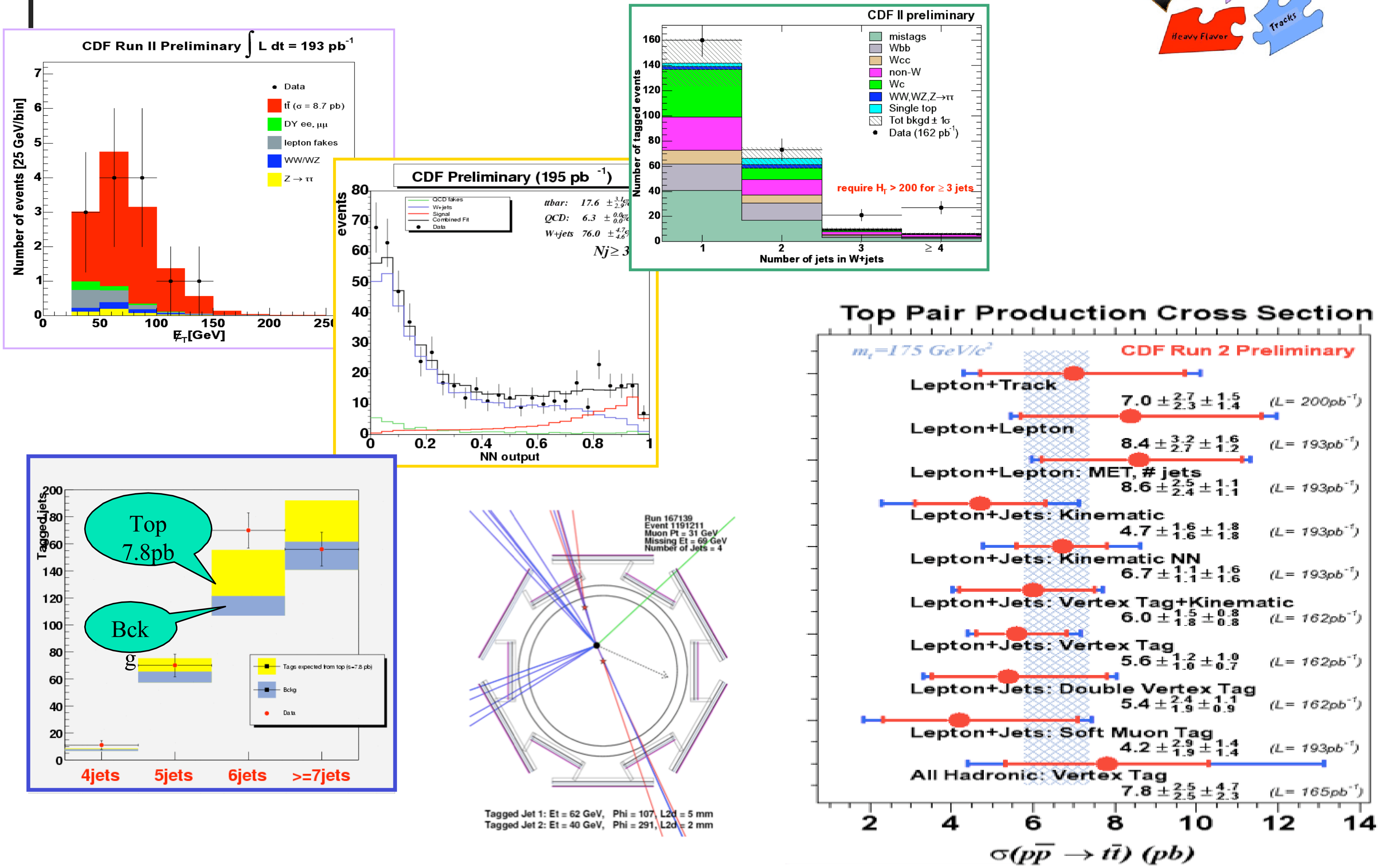


Samples are defined by counting leptons and jets

Cross section results validate
top-enriched samples

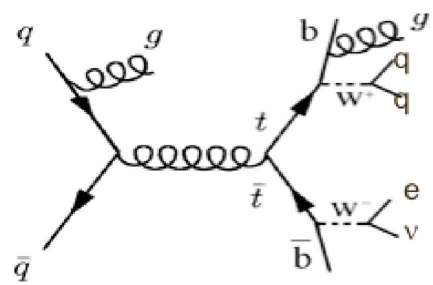
can also point toward new physics

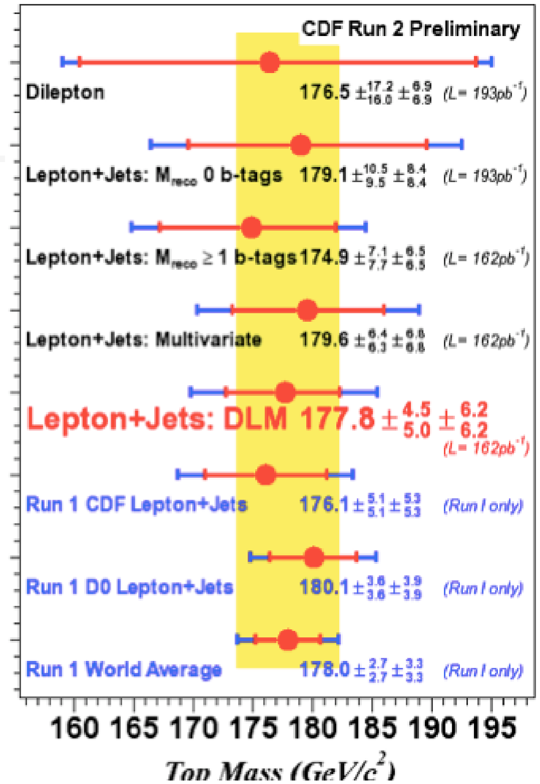
Top Cross Section



Top Mass Measurement

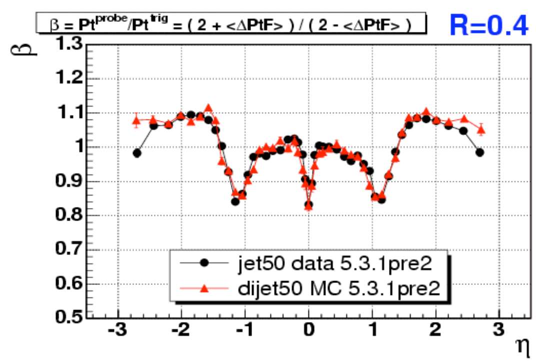
- Why so challenging?
  not just a calculation of M(W+b) !!!
  - missing neutrino
  - confusion in ID (additional jet from ISR/FSR, b-tag: not 100%)
  - jet energy scale

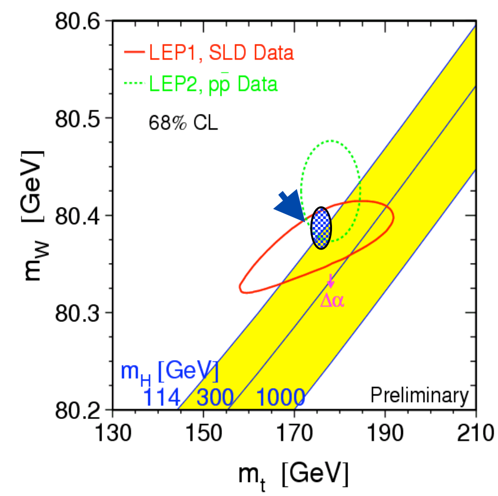




Link observables to parton-level energies

- Accurate detector simulation vital to precision physics measurements
- Large systematic uncertainty from energy scale





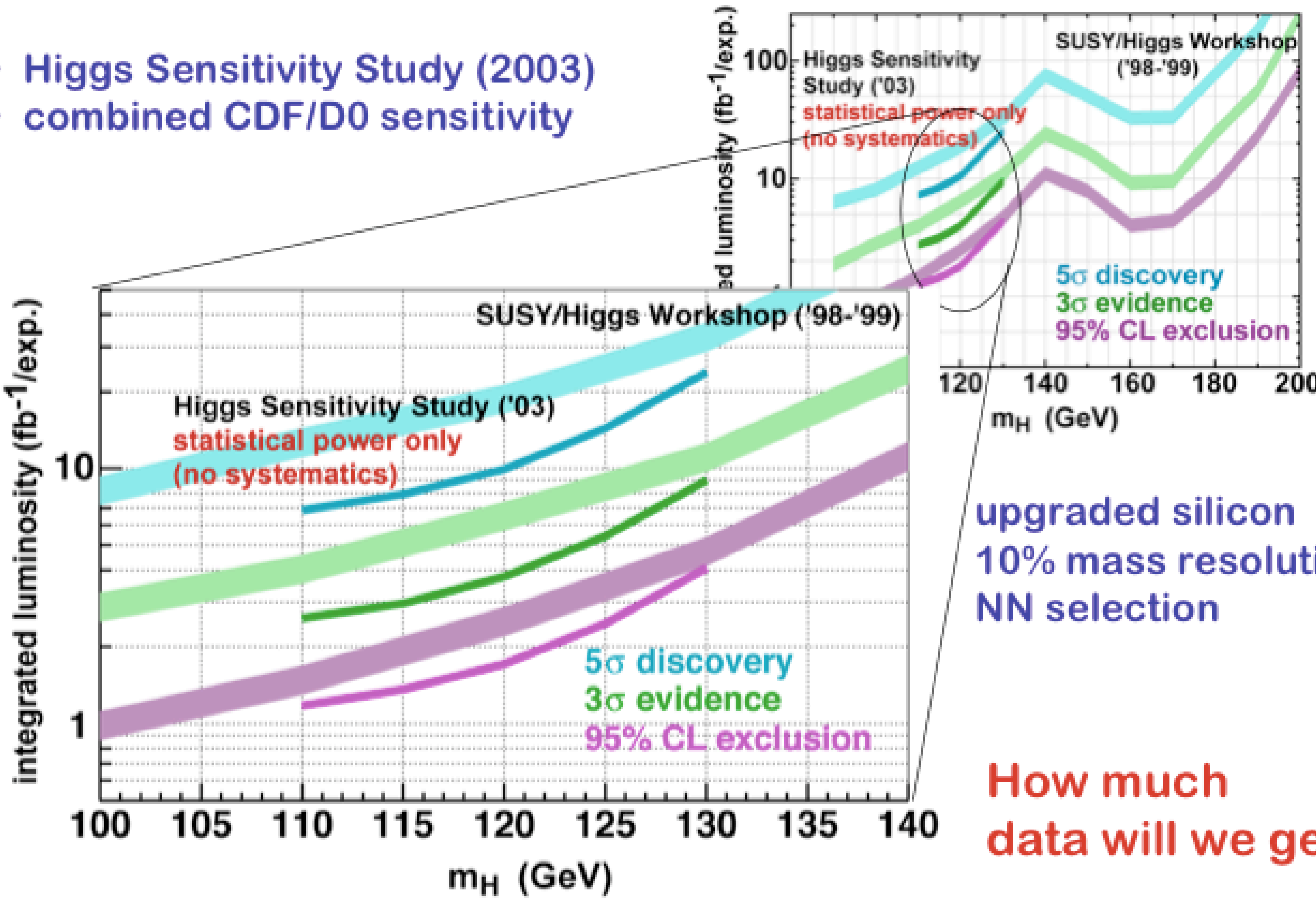
Method: reconstruct Mtop with 2 constraints
$M(W^+)=M(W^-)$, $M(t)=M(\bar{t})$

data is fitted to most likely mass template from Top MC

- Take the best combination over all 12 combinations
- Use all combinations(12) weighted by the diff. cross section (full kinematic info): dependence on $t\bar{t}$ event kinematics?

The Search for the Higgs Boson

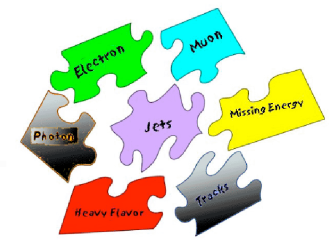
- Higgs Sensitivity Study (2003)
- combined CDF/D0 sensitivity



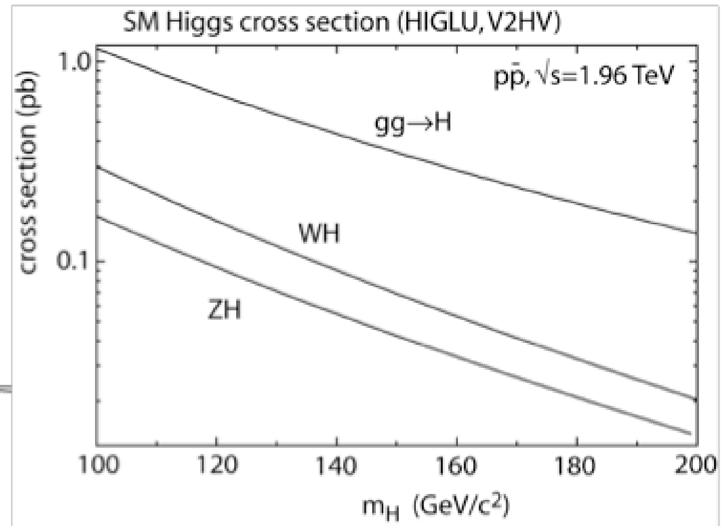
upgraded silicon
10% mass resolution
NN selection

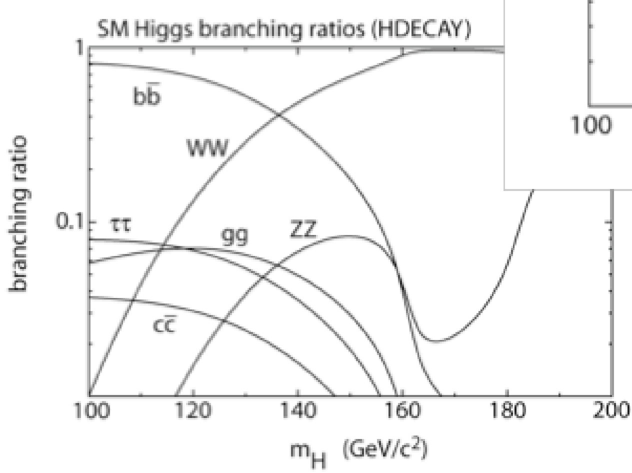
How much
data will we get?

The Search for the Higgs Boson



- gg→H dominates but dijet background too big…
- bb and WW decay modes are best!



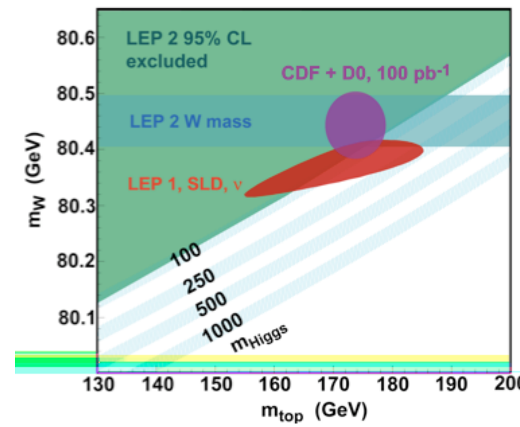


WH+ZH ~300 fb at 115 GeV

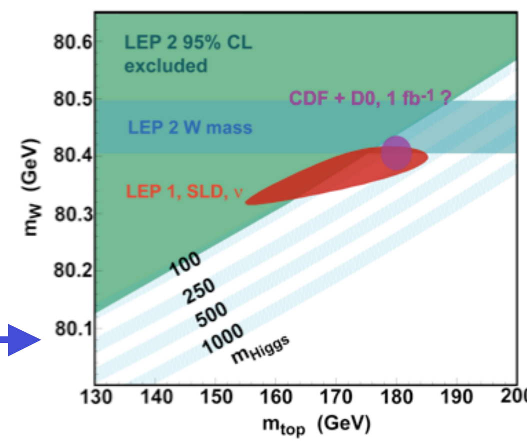
typical efficiencies ~ 2%

A daunting proposition!

Indirect Searches



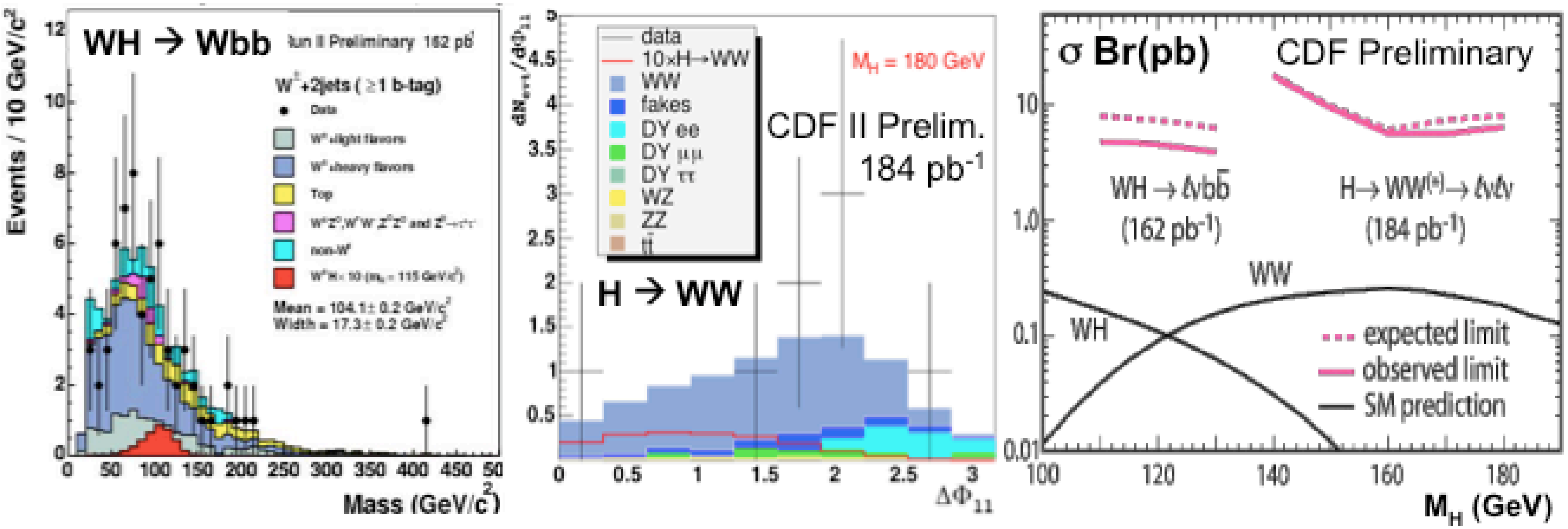
↓ ?



Evidence for New Physics! →

SM Higgs searches

M_H < 130 GeV: W,Z + H (→ bb), M_H > 130 GeV: H → WW



- SM: Limits already exceeding Run I results.
  Sensitivity beyond LEP exclusion starts at ~2 fb^{-1}.
- New Physics: Interesting sensitivity to other new physics sooner?
- Improvements expected from
  - Better *b* tagging, topological (spin 0) information, more channels(ZH), better mass resolution (Z → bb sample)

Conclusions

Many exciting results are currently produced at CDF!

Many of our results interplay nicely :
From testing the SM processes to searches for Exotica
same signature, different physics

The Puzzle is becoming more and
more interesting!

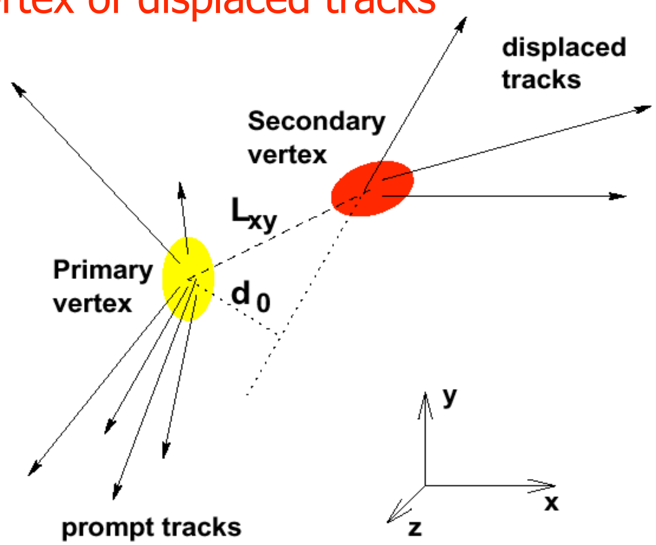
Backup Slides

Heavy Flavor jets: tagging tools

B hadrons in top signal events

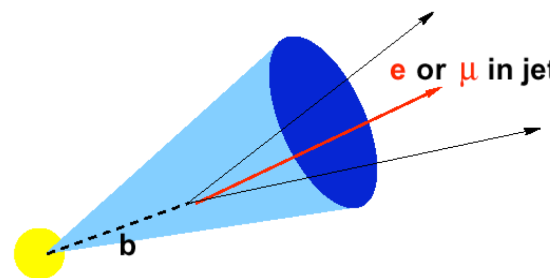
are long-lived and massive

Vertex of displaced tracks



may decay semileptonically

Identify low-pt muon from decay



- $b \to \ell \nu c$ (BR ~ 20%)
- $b \to c \to \ell \nu s$ (BR ~ 20%)

55%	**Top Event Tag Efficiency**	**15%**
0.5%	**False Tag Rate (QCD jets)**	**3.6%**

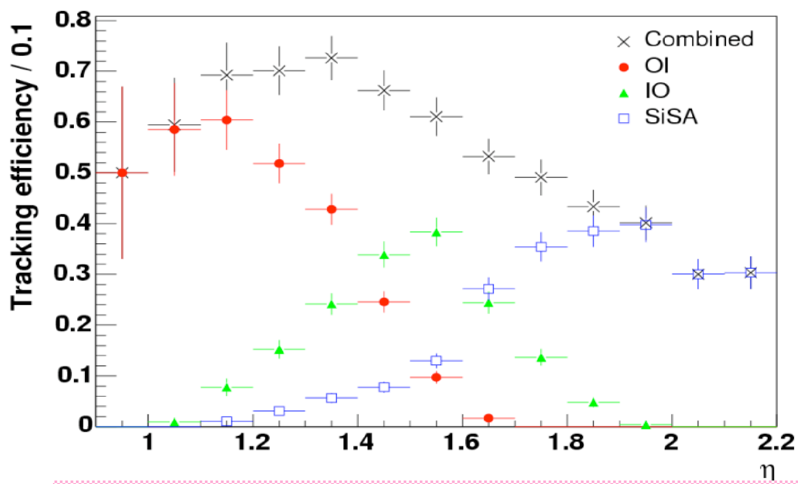
Inclusive W cross section (cont'd)

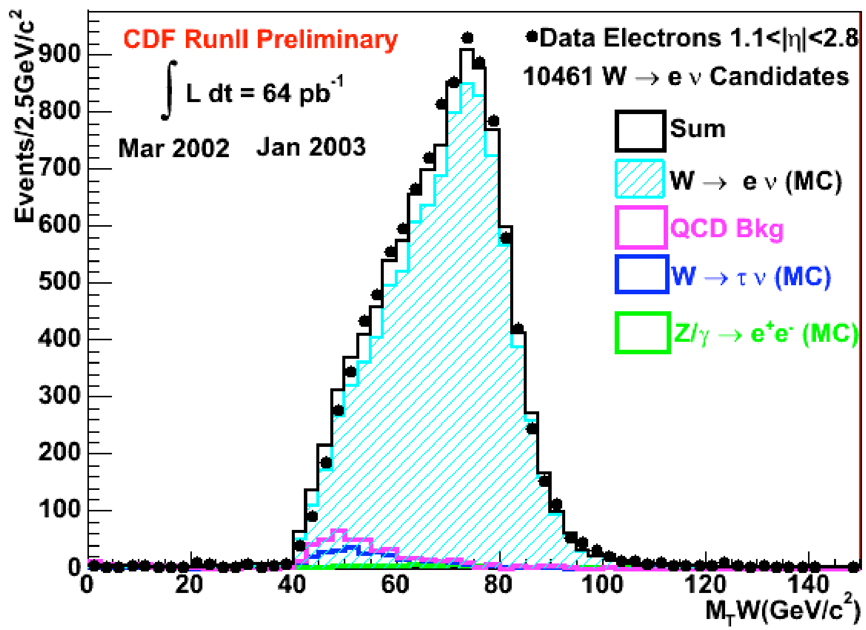
Following the same strategy pursued in the $|\eta| < 1$ region, full tracking is used in the forward region

EM cluster is matched to a 3D track reconstructed using the Silicon detector only in the region $1 < |\eta| < 2.8$

- Two 3-D hits & vertex seed silicon track (SISA)
- OI seeded by COT hits
- IO attaches COT hits to SISA

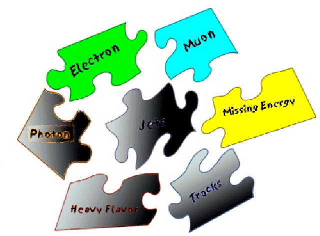
Tracking Efficiency

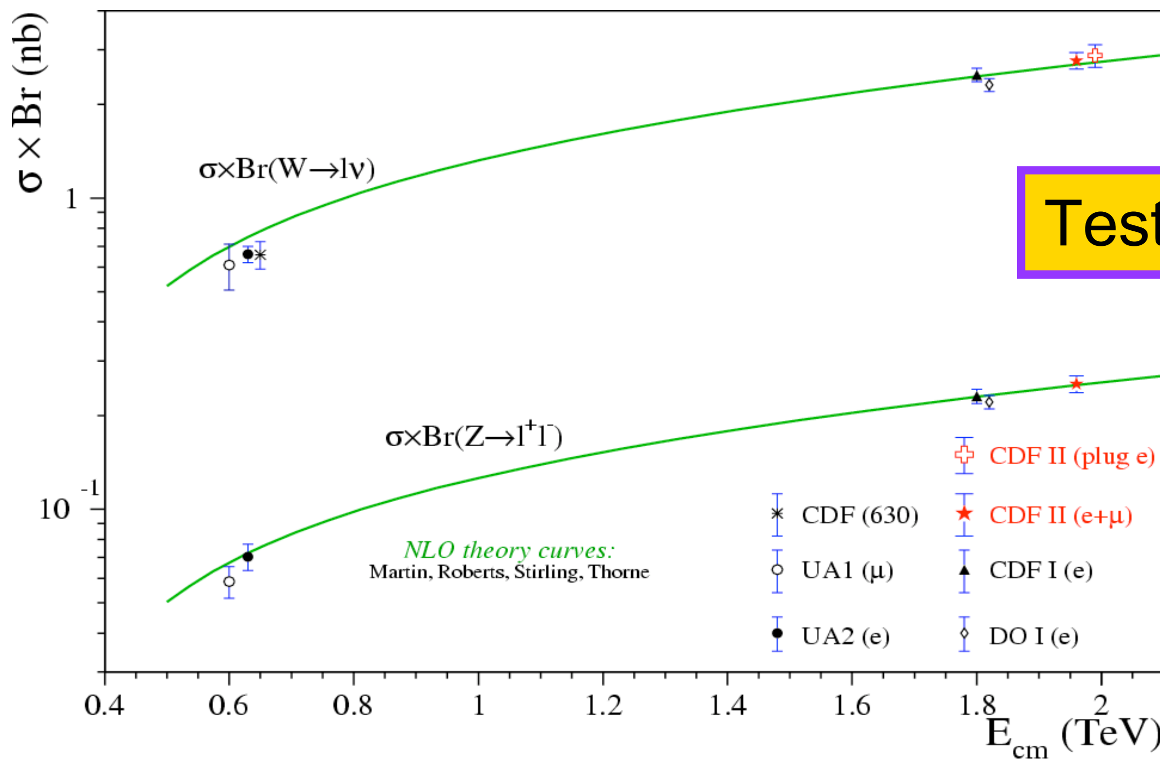




$\sigma \times BR(W \rightarrow e\nu) = 2874 \pm 34\ (stat) \pm 167\ (sys) \pm 172\ (lumi)\ pb$

Summary and X-Sections Ratio





Test of SM!

$$R = \frac{\sigma \cdot Br(p\bar{p} \to W \to \ell\nu)}{\sigma \cdot Br(p\bar{p} \to Z \to \ell^+\ell^-)} = \frac{\sigma(p\bar{p} \to W)}{\sigma(p\bar{p} \to Z)} \times \frac{\Gamma_Z}{\Gamma_Z(\ell^+\ell^-)} \times \frac{\Gamma_W(\ell\nu)}{\Gamma_W}$$

$$R_e = 10.86 \pm 0.18_{(stat)} \pm 0.16_{(syst)}$$

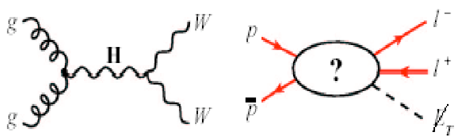
$$R_\mu = 11.10 \pm 0.27_{(stat)} \pm 0.17_{(syst)}$$

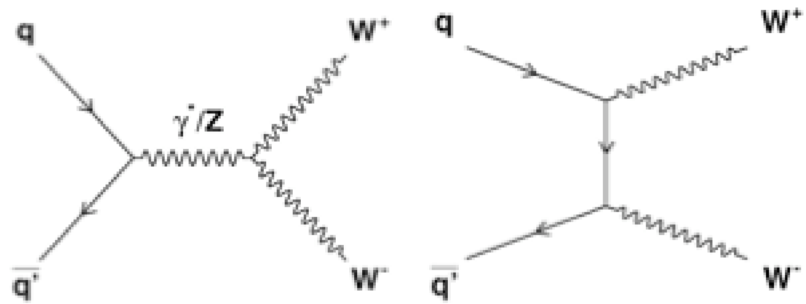
$$R = 10.94 \pm 0.15_{(stat)} \pm 0.13_{(syst)}$$

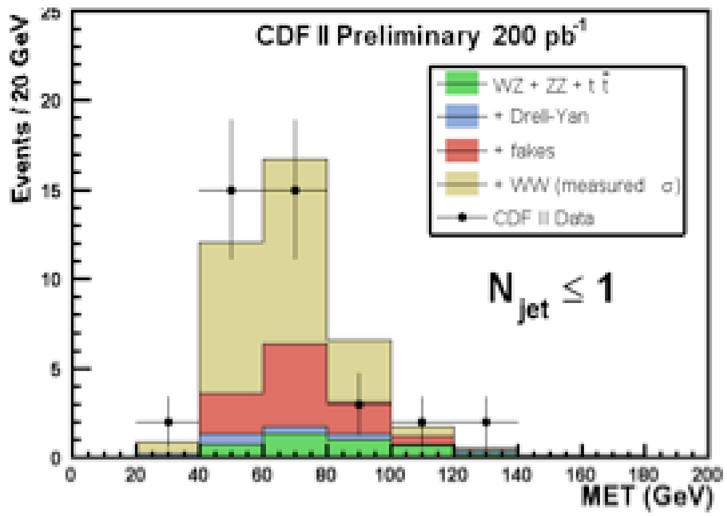
The combined ratio is precise at 1.8% independent on the luminosity

WW and WZ

- WW (SM 12.5 ± 0.8 pb)
  - Trilinear Gauge Coupling - hard to beat LEP (40k WW)
  - Tevatron can produce higher mass than LEP.
  - Important backgrounds to Higgs search (H -> WW)!







$$\sigma(WW) = 14.3 \pm^{5.6}_{4.9} \pm^{1.8}_{1.8} pb$$

- Still searching for WZ, ZZ (SM WW 5.2 ± 0.4 pb)

$$\sigma(WZ) < 13.9 pb @ 95\% \ C.L.$$

MSSM Higgs

at high tanβ:

- enhanced x-sections
- heavy flavor (b, τ) preferred

φ (from gg or qq) or bbφ production with φ → ττ