Conclusion.

$$\begin{tikzcd}[column sep=small] & \text{Improve Data} \arrow[dl] \arrow[dr] & \\ \text{Solar } \nu \arrow[dr] & & \text{Atmospheric } \nu \arrow[dl] \\ & \text{Super KAMIOKANDE} & \end{tikzcd}$$

早く!!

September 30, 1989

TeV領域の物理

Recent Results from CDF

CDF Collaboration

Presented by K. Yasuoka

Univ. of Tsukuba
Ibaraki-ken 305, Japan

- Accelerator (TEVATRON)
- CDF(Collider Detector at Fermilab) Detector
- $\bar{P}P$ Collider Experiment

Data Taking | 1987RUN | 27 nb^{-1}

1988–1989RUN | 4.7 pb^{-1}

Calibration

Physics

0) Minimum Bias

1) Jet

2) Electroweak

$\sigma \cdot B(W \to e\nu) / \sigma \cdot B(Z \to e^+e^-)$

M_W, M_Z, $\sin^2\theta_W$, ρ, Δr

p_T^W, p_T^Z , Charge Asymmetry

5000 $W \to e\nu$

600 $Z \to e^+e^-$

3) Top Quark Search

e + jets , $e + \mu$

4) Super Symmetry Search

- Large missing E_T + jets

2 photons + jets + large missing E_T

5) Others

- Future Prospects

The CDF Collaboration

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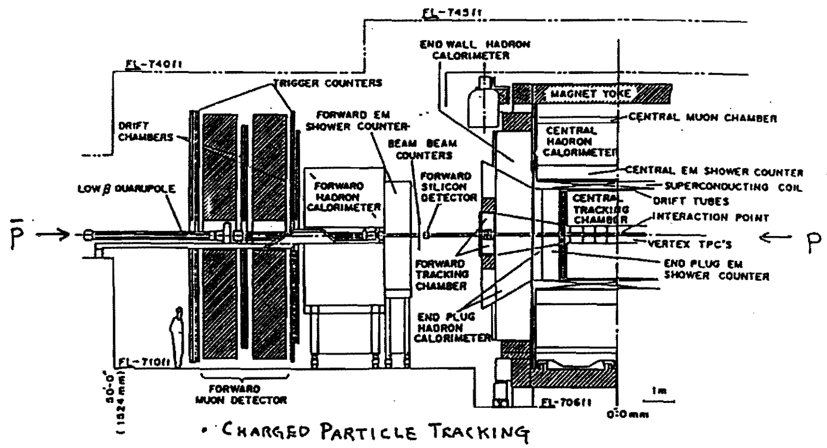
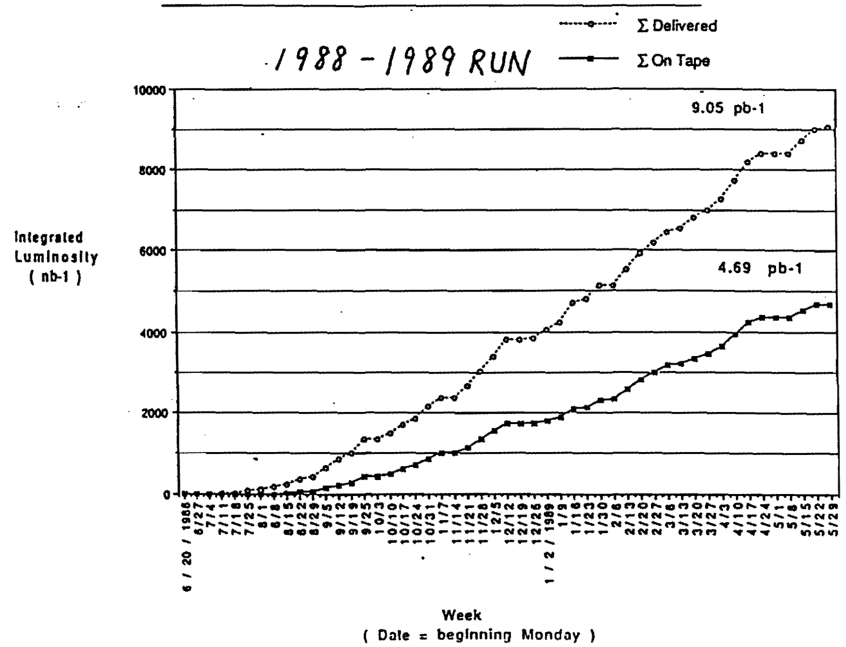
(Received 19 July 1989)

A Cut-Away View through the Forward Half of CDF



- Charged Particle Tracking
- Magnetic Momentum Analysis
- Fine-Grained Calorimetry

Integrated Luminosity



Calorimeter Calibration

All calorimeters were calibrated in a test beam.

Calibrations were tracked by sources.

17,000 high quality electrons from data were used to map central towers using E/P where P was measured from central tracking chamber.

Overall scale of E/P was adjusted using ≈1000 W decay electrons.

$$\left(\frac{\sigma_E}{E}\right)^2 = \left(\frac{13.5\%}{\sqrt{E \sin\theta}}\right)^2 + (1.7\%)^2$$

for central EM calorimeter.

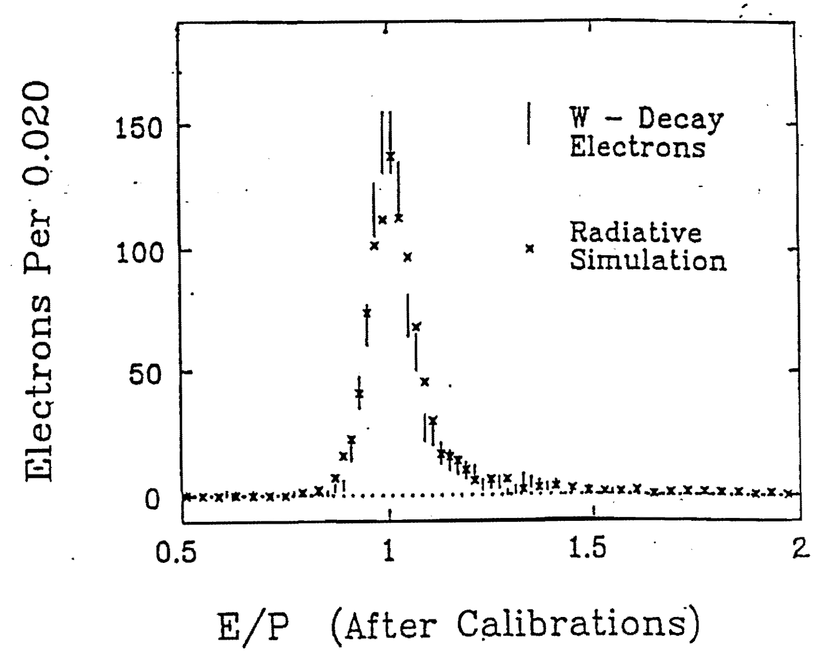


Figure 6: E/P comparison of golden W electrons to radiative simulation.

CTC Calibration

CTC is calibrated each run with minimum bias events to get t_0 and drift velocity constants.

Measure beam position using "Electroweak" DST production stream events.

Use W-decay electrons and beam position constraint to adjust wire layer individual rotations to make positive and negative tracks have the same |E/P|.

Use cosmic ray muons that pass through the center of the CTC to check that positive and negative tracks match.

Momentum resolution:

$$\frac{\Delta P_T}{P_T^2} = 0.11\% \quad (\mathrm{GeV}/c)^{-1}$$

Magnitude of Magnetic Field

Studied $K_S^0 \to \pi^+\pi^-$, $J/\psi \to \mu^+\mu^-$, $\Upsilon(1S) \to \mu^+\mu^-$ decays.

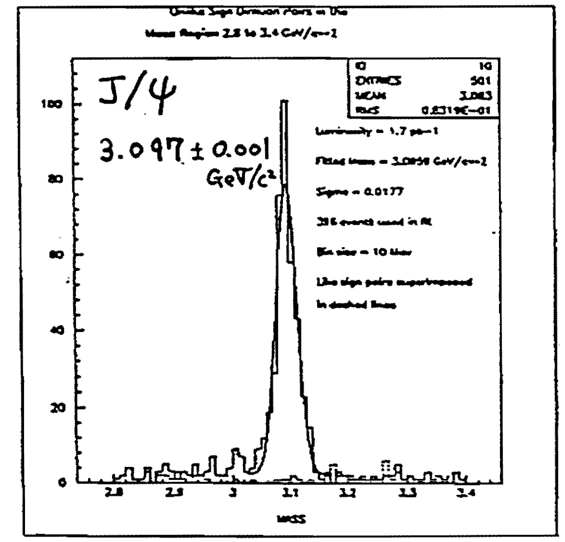
Reconstructed mass of :

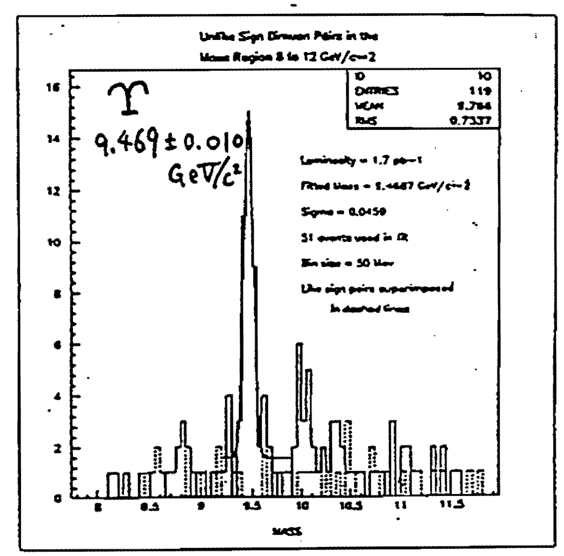
$M_{K_S^0}$ = 0.498 ± 0.002 GeV/c^2
$M_{J/\psi}$ = 3.097 ± 0.001 GeV/c^2
M_{Υ} = 9.469 ± 0.010 GeV/c^2

These numbers agree well with the world averages.

Mass scale error < 0.2% due to systematic momentum-scale uncertainties.

MASS (μ^+, μ^-)





Z^0 Mass and Width $\quad \mathcal{L} = 4.7\ pb^{-1}$

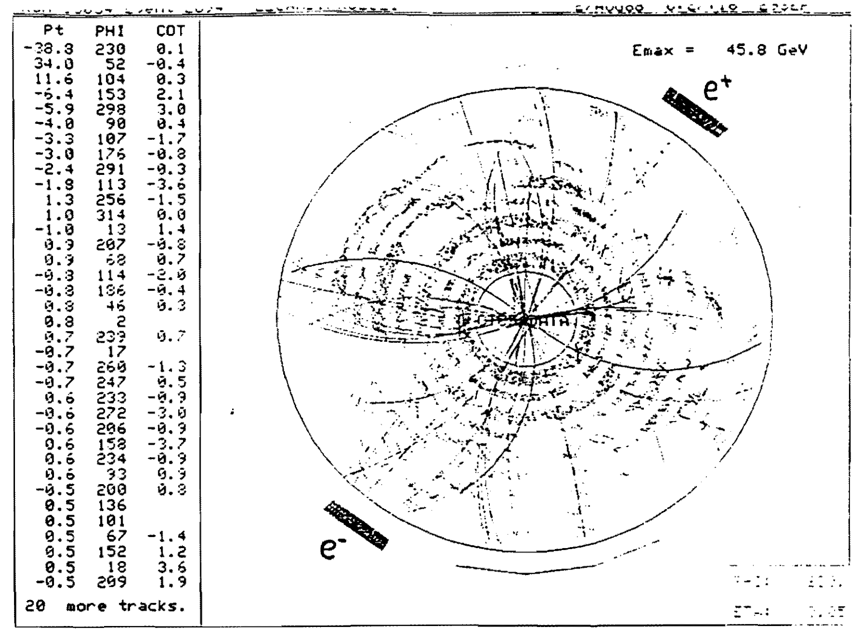
Triggers:

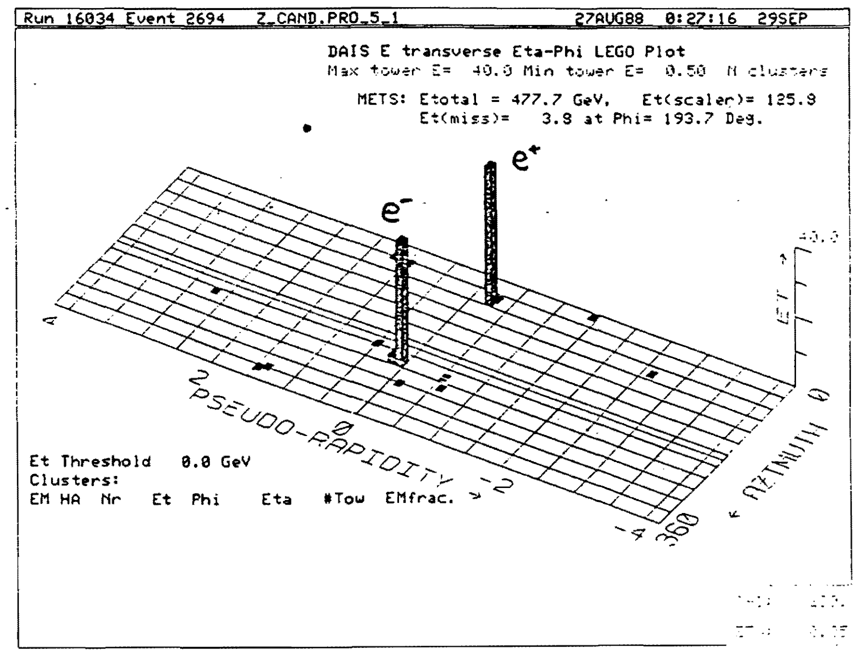
1) "Electron" trigger:
   EM transverse energy > 12 GeV within a "trigger tower" ($\Delta\eta = 0.2$, $\Delta\phi = 15°$) associated with a on-line track of $P_T > 6$ GeV/c.
2) "Di-photon" trigger:
   Two or more EM clusters each with $E_T > 10$ GeV and with no track requirements.
3) "Muon" trigger:
   A muon track segment in the central muon chambers matching an on-line track with $P_T > 9$ GeV/c.

e^+e^- event selection:

Select events with 2 central electrons.

- Fiducial cuts on electrons, which are several cm away from calorimeter edges (ϕ-cracks, 90° crack) so as to have its shower fully contained.
- Cut on energy in hadronic component, HAD/EM < 0.10 .
- Require |E/P| < 1.4 .
- A transverse shower profile in the strip chambers must be consistent with an electron shower: Z and R-ϕ profile $\chi^2 < 10.0$.
- A strip-chamber shower position must match an extrapolated track position:
  $\Delta Z < 3.0$ cm, $\Delta(R\phi) < 1.5$ cm





Z^0 Mass and Width (Cont'd)

$\mu^+\mu^-$ event selection:

Select events with 2 central muons.

First muon:

- $P_T > 20$ GeV/c
- Electromagnetic energy ≤ 2.0 GeV
- Hadronic energy ≤ 6.0 GeV

) minimum ionizing

- Muon stub must match an extrapolated CTC track position: $\Delta(R\phi) < 10$ cm

Second muon:

- Muon stub and "Minimum ionizing" in the calorimeter with $P_T > 20$ GeV/c

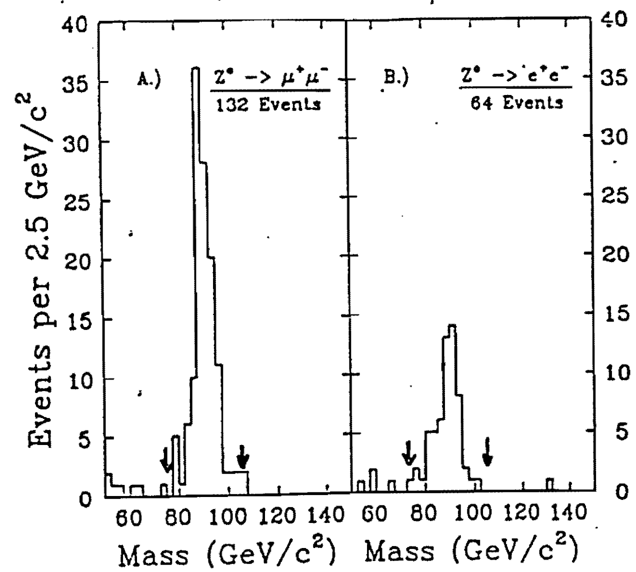
Then remove cosmic rays:

$|\Delta\phi - 180°| < 1.5°$, $|\Delta\eta| < 0.10$.

and remove QCD jet backgrounds:

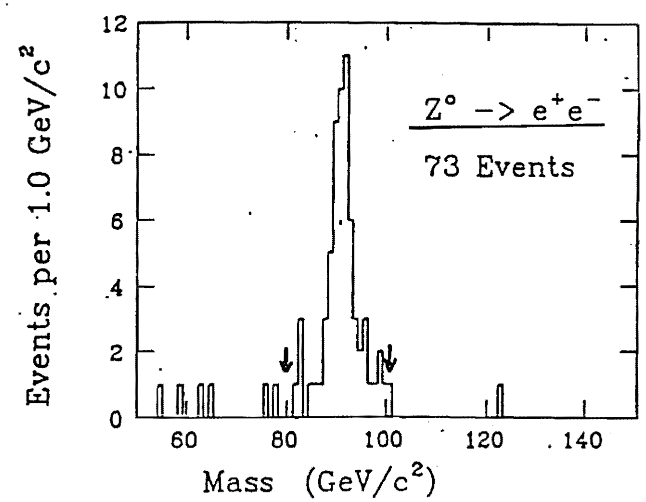
No jets with $E_T > 15$ GeV within 10° of these tracks.

TRACKING



The mass distribution for $Z^0 \to \mu^+\mu^-$ was fitted in the range 75 to 105 GeV/c^2 using a maximum-likelihood fit with a signal modeled by a relativistic Breit-Wigner form convoluted with a Gaussian resolution in $1/P_T$.

CALORIMETRY



Corrections and uncertainties in the Z^0 mass

	$Z^0 \to \mu^+\mu^-$ (Tracking)	$Z^0 \to e^+e^-$ (Tracking)	$Z^0 \to e^+e^-$ (Calorimeter)
Events	123	58	65
Fit Mass	90.41±0.40	89.27±0.80	90.93±0.34
Rad. Corr.	+0.22 ±0.03	+2.19 ±0.30	+0.11 ±0.03
Strct. Functs.	+0.08 ±0.03	+0.08 ±0.03	+0.08 ±0.03
E/P Calibration	... ...	... ...	... ±0.38
Mass Scale	... ±0.20	... ±0.20	... ±0.
Corrected Mass	90.7±0.4±0.2	91.5±0.8±0.4	91.1±0.3±0.4
Width	4.0±1.2±1.0	--	3.6±1.1±1.0

(All units are in GeV/c^2)

The best value for the Z^0 mass is a weighted mean of the tracking measurement of the $\mu^+\mu^-$ sample and the calorimeter measurement of the e^+e^- sample.

M_{Z^0} = 90.9 ± 0.3 (stat+syst) ± 0.2 (scale) GeV/c^2
Γ_{Z^0} = 3.8 ± 0.8 ± 1.0 GeV

Phys. Rev. Lett. 63, 720 (1989)

W mass

$\mathcal{L} = 4.7\ pb^{-1}$

Event Selection

Select events with:

- Missing transverse energy $\not{E}_T > 25$ GeV
- Missing transverse energy significance $\not{E}_T / \sqrt{\Sigma E_T} > 2.4$
- E_T of electron cluster > 25 GeV
- Electromagnetic fraction EM/TOTAL > 85%
- Seed tower of electron cluster must be located in the central detector ($|\eta| < 1.0$).
- E/P < 2.0
- Electron fiducial cuts:
  - More than 1.5° away from the central ϕ crack.
  - 12 cm or further from the 90° crack.
- One and only one track pointing at the electron seed tower.

- Removed γ conversions.
- Required no cluster of E_T > 5 GeV opposite in ϕ electron with E_T > 15 GeV. Removed di-jet

- Restricted to events with no clusters (other than the electron) with E_T greater than 7 GeV.

<u>Transverse Mass</u>

Since neutrino Pz is not measured, we used transverse mass

$$M_T = \sqrt{2E_T \not{E}_T(1\text{-COS}(\phi_e\text{-}\phi_\nu))}$$,

which is less sensitive to P_T distribution of W.

E_T : Transverse energy of electrons measured by calorimetry after E/P calibration.

$\not{E}_T$: Missing transverse energy --> Transverse energy of neutrino.

<u>Neutrino energy corrections</u>

Sum of E_T over all calorimetry towers with $|\eta|<3.8$.

Remove electron from event and remake $\not{E}_T$ from underlying event.

Correct for calorimetry low energy non-linearities by multiplying $\not{E}_T$ from underlying event by 1.4.

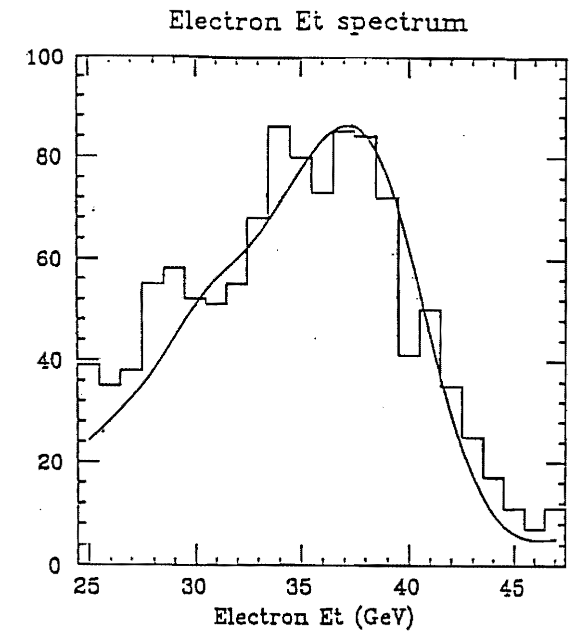
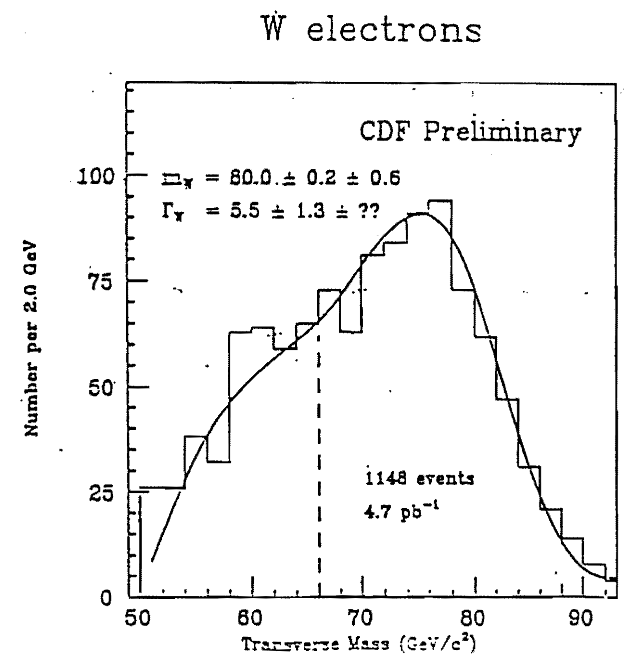


Figure 13: W electron E_t spectrum + simulation.



W mass(Cont'd)

Uncertainties in fitting the W mass

Uncertainty	Size (MeV)
Statistical	WIDTH FIXED 200 WIDTH FREE (380)
1. Energy Scale	320
2. Radiative Corrections	100
3. Proton Structure Function	230
4. Resolution, P_T^W, etc.	
Electron Resolution	< 100
$\not{E}_T$ Resolution $.56\sqrt{\Sigma E_T}$ (min. bias ev)	150
Residual width/overflow NON-GAUSSIAN	400
5. Background	< 50
6. Binned Fitting	250
Systematics 2-6	540
Overall	650 (730)

$\left\{ \begin{array}{l} \text{MRS-E} \\ \text{MRS-B} \\ \text{EHLQ} \\ \text{DO-1} \\ \text{DO-2} \end{array} \right.$

Preliminary

$$M_W = 80.0 \pm 0.2 \text{ (stat)} \pm 0.3 \text{ (scale)} \pm 0.5 \text{ (sys)}$$

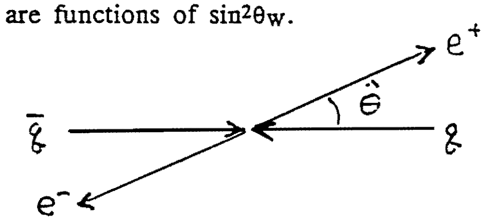
Charge Asymmetry in $\bar{p}p \to \gamma, Z \to e^+e^-$

Lowest order cross section is:

$$\frac{d\sigma}{d\cos\hat{\theta}} = \sum_q \int dX_1 dX_2 dQ^2 \, f(x_1,Q^2)\, f(x_2,Q^2)$$
$$[G(1+\cos^2\hat{\theta}) + I_{G,Z}((1+\cos^2\hat{\theta}) + \beta \cdot \cos\hat{\theta})$$
$$+ Z((g^2_{V_q}+g^2_{A_q})(g^2_{V_e}+g^2_{A_e})(1+\cos^2\hat{\theta}) + 8 g_{V_q} g_{A_q} g_{V_e} g_{A_e} \cos\hat{\theta})]$$

$$= A(1+\cos^2\hat{\theta}) + B\cos\hat{\theta}$$

A and B are functions of $\sin^2\theta_W$.



Use Collins snd Soper [Phys. Rev.D16, 2219(1977)] formalism that chooses the mean of the p and $\bar{p}$ directions in the rest frame of the Z^0 as the orientation against which to define $\cos\hat{\theta}$.

If acceptance is charge independent, acceptance is independent of the sign of $\cos\hat{\theta}$.

Assume q comes from proton, sea-sea interactions introduce symmetric dilution.

Use events with electron pairs which have invariant mass > 50 GeV.

Electron Selection

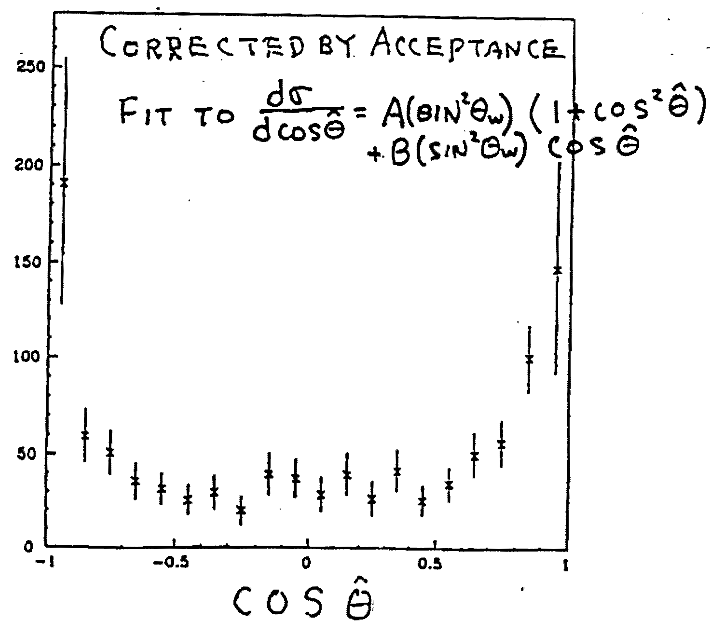
- ET > 15 GeV
- E/P < 2.0 if central
- Track-Strip match if central
- Shower profile consistent with electron
- All events were hand scanned

Apply "Negative Log Likelihood Fit" to $\frac{d\sigma}{d\cos\hat{\theta}}$

If acceptance is symmetric in $\cos\hat{\theta}$, ln L is independent of acceptance.

Preliminary result is:

$$\boxed{\sin^2\theta_W = 0.216 \pm 0.015 \text{ (stat)} \pm 0.010 \text{ (sys)}}$$



W/Z Cross Section Ratio

$$R = \frac{\sigma_W(W \to e\nu)}{\sigma_Z(Z \to e^+e^-)} = \frac{\sigma_W}{\sigma_Z} \frac{\Gamma(W \to e\nu)}{\Gamma(Z \to e^+e^-)} \frac{\Gamma_Z}{\Gamma_W}$$

Advantage over the direct measurement is that the integrated luminosity and efficiencies are cancelled out in the first order.

Select central electron in the same way for both W and Z.

Experimentaly, we measured:

$$R = \frac{N(W)}{N(Z)} \frac{A(Z)}{A(W)} \varepsilon$$

$$\varepsilon = \frac{f_{cc} \cdot M_{cc} \cdot c_1(2c_2 - c_1) + f_{cp} \cdot M_{cp} \cdot c_1 p + f_{cf} \cdot M_{cf} \cdot c_1 f}{c_1 \varepsilon_n}$$

f_{cc}, f_{cp}, f_{cf} = fraction of central, plug, or forward Z's

M_{cc}, M_{cp}, M_{cf} = Z mass cut efficiency in central, plug, or forward

c_1, c_2, p, f = efficiency for first central, second central, plug, or forward electron

Event Selection

Primary event selection

- Vertex cut (| Z_{vertex} | < 60 cm)

Central electron (| η | < 1.0)

- $E_T > 20$ GeV
- CTC track and strip chamber match :

  $\Delta(R\phi) < 2.5$ cm, $\Delta Z < 3.0$ cm
- HAD/EM < 0.05
- Isolation (R=0.4) < 0.1
- Tower energy sharing consistent (LSHR < 0.2)
- 0.5 < E/P < 2.0
- Fiducial cuts

W's

- central electron
- $\not{E}_T$ > 20 GeV
- No jets with $E_T > 10$ GeV

Z's

- central electron
- second electron with

  $E_T > 10$ GeV

  HAD/EM < 0.1

  Isolation (R=0.4) < 0.2

  0.5 < E/P < 2.0 if in central

  Fiducial cuts
- 65 GeV < M_Z < 115 GeV
- No jets with $E_T > 10$ GeV

$\mathcal{L} = 4.7\,pb^{-1}$

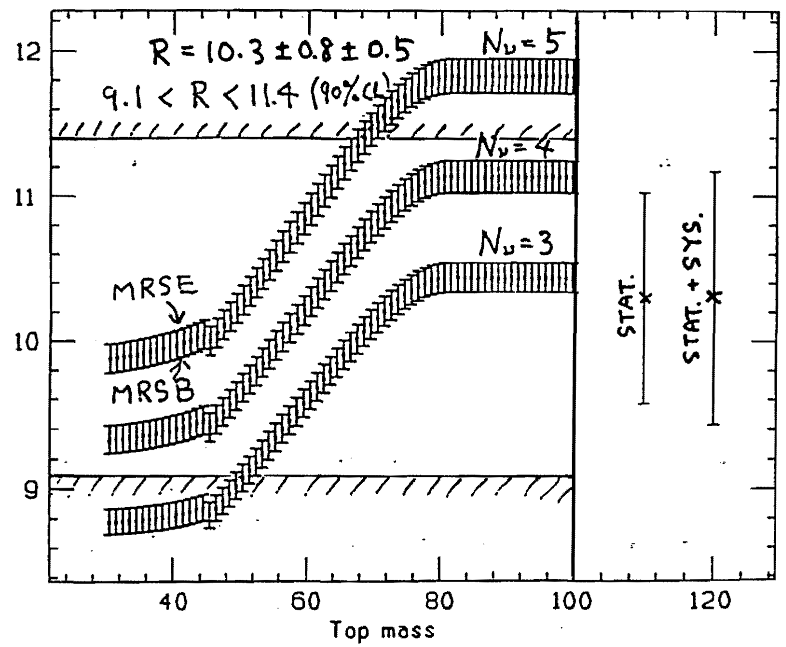
Summary of $\sigma B(W \to e\nu)/\sigma B(Z \to e^+e^-)$ Analysis

Quantity	Value (W)	Value (Z)
$N_{observed}$	1942 ± 44.0	208 ± 14.4
Background		
$W \to \tau\nu \to e$	77.7 ± 1.9	—
$Z \to e\,e$	13.4 ± 5.1	—
$Z \to \tau\tau$	4.7 ± 0.9	0.0
W + EM jet	—	0.0
QCD $b\bar{b}$	19.4 ± 9.7	7.0 ± 5.0
Total background	115 ± 11.2	7.0 ± 5.0
N(W) or N(Z)	1827 ± 41 ± 10	201 ± 14 ± 5
Acceptance		
A(W) or A(Z)	0.3508 ± 0.0011	0.3790 ± 0.0011
Efficiency		
f_{CC}	—	0.388
f_{CP}	—	0.477
f_{CF}	—	0.135
ϵ_{C1}	0.87 ± 0.03	0.87 ± 0.03
ϵ_{C2}	—	0.97 ± 0.02
ϵ_P	—	0.97 ± 0.03
ϵ_F	—	0.97 ± 0.03
ϵ_ν	0.965 ± 0.005	—
ϵ_W or ϵ_Z	0.83 ± 0.03	0.88 ± 0.03

PRELIMINARY

$$R = \frac{\sigma_W(W \to e\nu)}{\sigma_Z(Z \to e^+e^-)} = 10.3 \pm 0.8\ (\text{stat.}) \pm 0.5\ (\text{sys.})$$

$$R = \sigma B(W \to e\nu) / \sigma B(Z \to e^+e^-)$$



Theoretical Prediction:

$R = 10.4 \pm 0.1$ at $\sqrt{s} = 1.8$ TeV

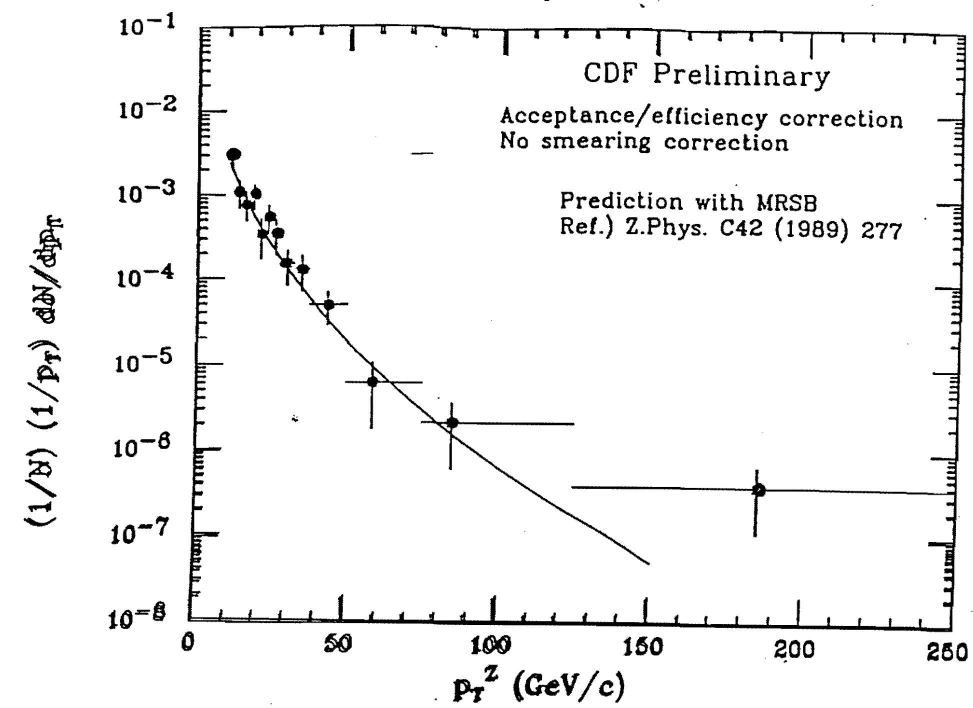
($N_\nu = 3$, $M_{top} > M_W$)

Martin et al., DTP/89/18 (1989)

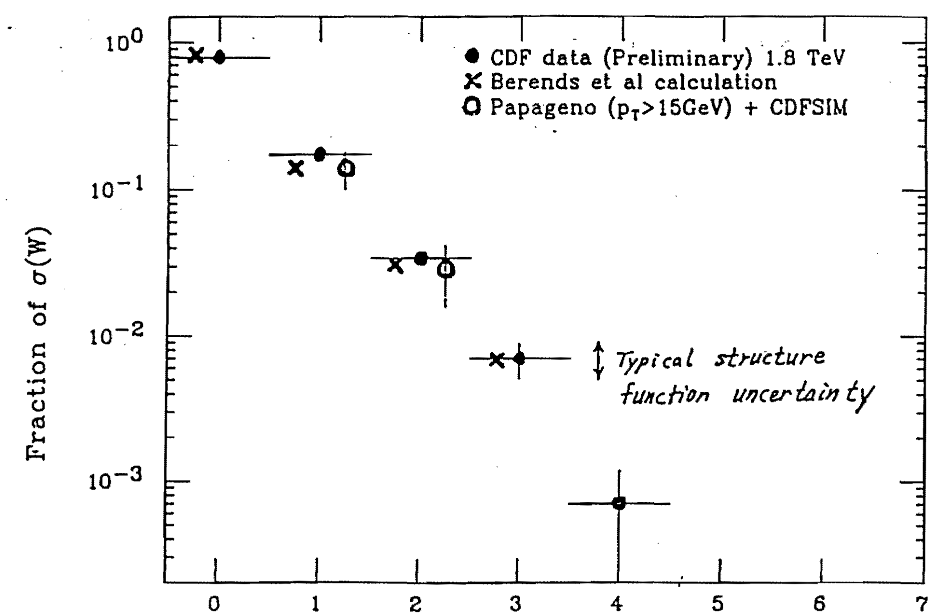
Other Experiments:

UA2 $R = 10.3^{+1.5}_{-1.0} \pm 0.3$

MARK II $N_\nu \leq 5.5$ (90% CL)



W + n Jet Fraction



Conclusion in Electroweak

Final Z^0 Mass
$90.9 \pm 0.3 \pm 0.2$ GeV/c^2

Preliminary $W^\pm$ Mass
$80.0 \pm 0.2 \pm 0.3 \pm 0.5$ GeV/c^2

Preliminary W/Z Cross Section Ratio
$10.3 \pm 0.8 \pm 0.5$
(Excluding a light top quark, or limiting the number of light ν generation to 5)

Preliminary $\sin^2\theta_W$
$0.216 \pm 0.015 \pm 0.010$
(from asymmetry)
0.229 ± 0.012
(from W/Z Mass ratio) $\sin^2\theta_W = 1 - \left(\frac{m_W}{m_Z}\right)^2$

Preliminary ρ from w.a.$\sin^2\theta_W$
1.002 ± 0.017 $\rho = \frac{m_W^2}{\cos^2\theta_W \, m_Z^2}$

Preliminary Δr
0.056 ± 0.018

$$m_W^2 = \frac{A_0^2}{(1-\Delta r)\sin^2\theta_W}$$

$$\left(A_0^2 = \frac{\pi\alpha}{\sqrt{2}\,G_F}\right)$$

Search for Supersymmetry Particles

Supersymmetry (SUSY) predicts the existance of a set of super symmetric partners to the elementary fermions and bosons:

gluino, photino, selectron, squark, etc.
$\tilde{g}$ $\tilde{\gamma}$ $\tilde{e}$ $\tilde{q}$

Assume that supersymmetry quantum number is conserved, SUSY particles are always pair produced with strong interaction cross sections.

Considered two SUSY models:

- (A) Minimal SUSY model (stable photino)
- (B) Extended SUSY model (unstable photino)

$\tilde{\gamma} \to \gamma + \tilde{h}$
$(2\gamma + \text{jets} + \not{E}_T)$

(A) SUSY Search with Stable Photino

Assume that the photino is the lightest SUSY particle (LSP). Primary decay modes of squarks and gluinos are:

$M_{\tilde{q}} > M_{\tilde{g}}$	$M_{\tilde{g}} > M_{\tilde{q}}$
$\tilde{q} \to q\tilde{g} \to qq\bar{q}\tilde{\gamma}$ $\tilde{g} \to q\bar{q}\tilde{\gamma}$	$\tilde{q} \to q\tilde{\gamma}$ $\tilde{g} \to g\tilde{q} \to gq\tilde{\gamma}$

Signature in detector:

- Large missing E_T carried off by photino.
- One or more energetic jets

Searched for such events in the 1987 data requiring:

- Missing $E_T > 40$ GeV
- Jet cluster with $E_T > 15$ GeV

Then found no events and set the mass limits at 90%CL:

$$\boxed{\begin{array}{l} M_{\tilde{g}} > 73\ \mathrm{GeV/c^2} \\ M_{\tilde{q}} > 74\ \mathrm{GeV/c^2} \end{array}}$$

(Published to Phys. Rev. Lett. 62 (1989),1825)

1988-1989 Data Analysis

- Used 4.6 pb^{-1} of the sample.
- Focusing on the missing $E_T + \geq 2$ jets signature, which has lower background rates from standard model sources.

Event Selection:

- Required large missing E_T:
  - $\not{E}_T > 40$ GeV
  - $\not{E}_T / \sqrt{\Sigma E_T} > 2.8$
- Required at least 2 jets with
  - $E_T > 15$ GeV
  - $0.1 <$ EM fraction < 0.9
  - $|\eta| < 3.5$
- Required at least 1 central jet with
  - $E_T > 15$ GeV
  - $0.1 <$ EM fraction < 0.9
  - $|\eta| < 1.0$
  - Charge fraction > 0.2
- Reject di-jet events
  - Cluster with $E_T > 5$ GeV $\pm 30°$ opposite leading cluster
- Reject cosmic ray events
  - Require HAD energy< 6 GeV out-of-time
- Reject e and γ events
  - Cluster with $E_T > 15$ GeV and EM fraction > 0.9
- Reject μ events
  - Any central μ with $P_T > 15$ GeV/c
- Hand scanned

- Backgrounds were estimated from the data of 2 pb^{-1}

Backgrounds

W + jets, Z + jets, Heavy quarks

	$\not{E}_T$ > 40 GeV	$\not{E}_T$ > 60 GeV
W-> eν	23 ± 14	5 ± 5
W-> τν	37 ± 18	0
W-> μν	19 ± 9	0
Z-> νν	37 ± 18	19 ± 14
Heavy Quarks (c, b) (ISAJET)	42 ± 18	14 ± 5
Total	158 ± 35	38 ± 17
CDF Data	184	34

Observed rate of events is consistent with Standard Model source.

Using the result from $\not{E}_T$ > 60 GeV, we improve the mass limits in the case $M_{\tilde{g}} > M_{\tilde{q}}$:

Preliminary

$M_{\tilde{q}}$ > 150 GeV/c²

$M_{\tilde{q}} > M_{\tilde{g}}$ case in progress.

$M_{\tilde{q}}$ vs $M_{\tilde{g}}$

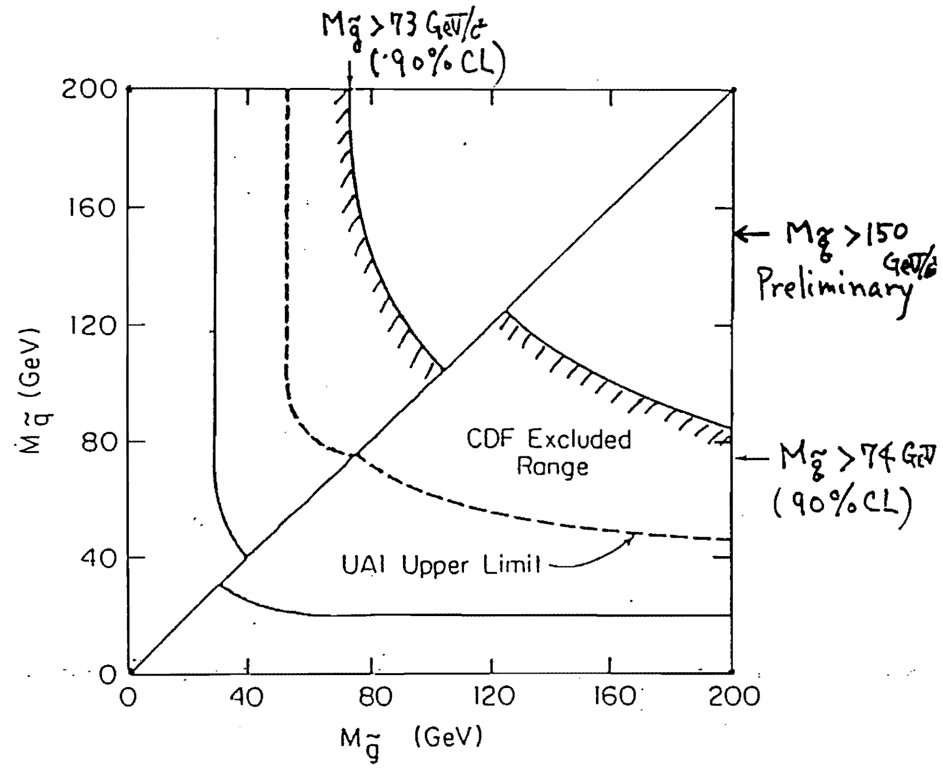


FIG. 2. The 90%-C.L. excluded region in the $(m_{\tilde{g}}, m_{\tilde{q}})$ ane.

Search for Top Quark

Standard Model (SM) requires the existence of a 6th quark, Top quark.

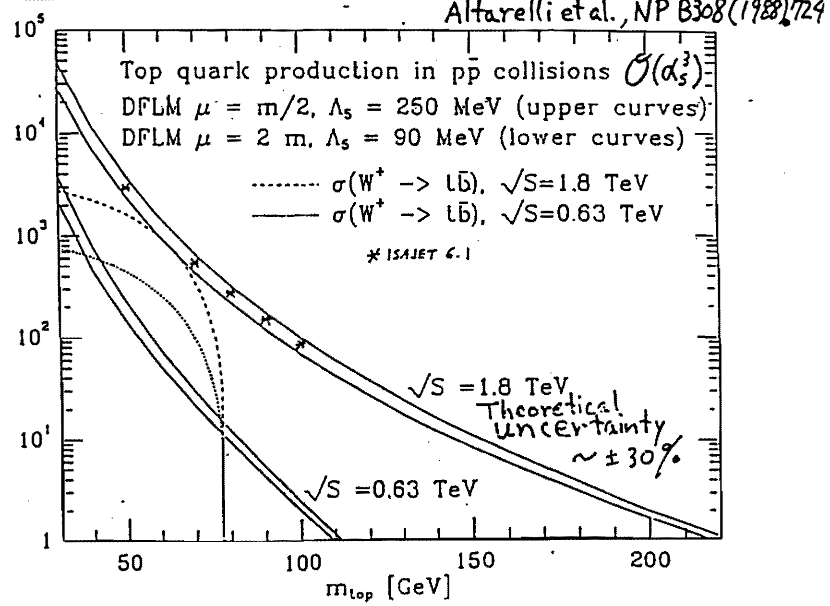
Several searches have been performed and set the top mass limits:

Exp. Group	Production Mode	Mass Limit (GeV)
AMY, VENUS	$e^+e^- \to$ hadrons	> 30.4
MARK II	$e^+e^- \to$ hadrons	> 38
UA1	$W \to tb$	> 69
UA2	$W \to tb$, $p\bar{p} \to t\bar{t}$	> 67
CDF	$W \to tb$, $p\bar{p} \to t\bar{t}$	unlikely unless > 60

Top Quark Production

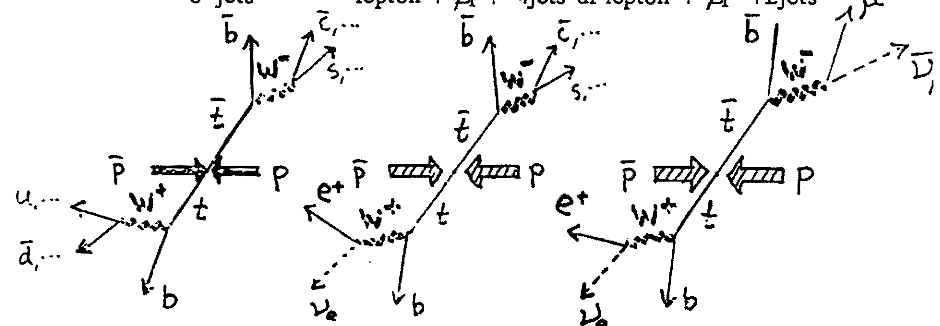
- Standard Model predicts that $t\bar{t}$ pair production is the dominant source of top quarks in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.8 TeV.

Altarelli et al., NP B308(1988)724



Top Quark Decays in SM

Fully Hadronic	Inclusive Leptonic	Multi-Leptonic
(44%)	(15% for each)	(1-2% for each)
⇓	⇓	⇓
6 jets	lepton + $\not{E}_T$ + 4jets	di-lepton + $\not{E}_T$ +2jets



jets	e + jets	e + μ
• Large fraction	• Large rate	• No Drell-Yan BG
• Relatively complicated	• Good e ID	• High BG rejection
	• Missing E_T	• Highest di-lep frac.

Studied e + jets channel and e + μ channel.

Electron + Jets

Electron Selection:

- Central EM cluster with $E_T > 12$ GeV
- HAD/EM < 0.05
- Tower energy sharing consistent with electron
- E/P < 1.5
- CTC track and strip chamber match:

  $\Delta(R\phi) < 1.5$ cm , $\Delta Z < 3.0$ cm
- A transverse shower profile in the strip chamber is consistent with an electron shower: $\chi^2 < 10$
- Remove γ conversions and Dalitz decays:

  (30% of inclusive electrons)

  - Required VTPC track
  - No 2'nd track with $M_{e^+e^-} < 0.5$ GeV/c^2
- Remove Z^0 Decays:

  - No 2'nd EM cluster with $M_{e^+e^-} > 70$ GeV/c^2
- Remove Semileptonic Heavy Quark(c,b) Decays:

  - Isolation of electron
  - Small energy in towers adjacent to CEM cluster ("border towers")

$$\sum_{\text{border towers}} E_T < 2\,\text{GeV}$$

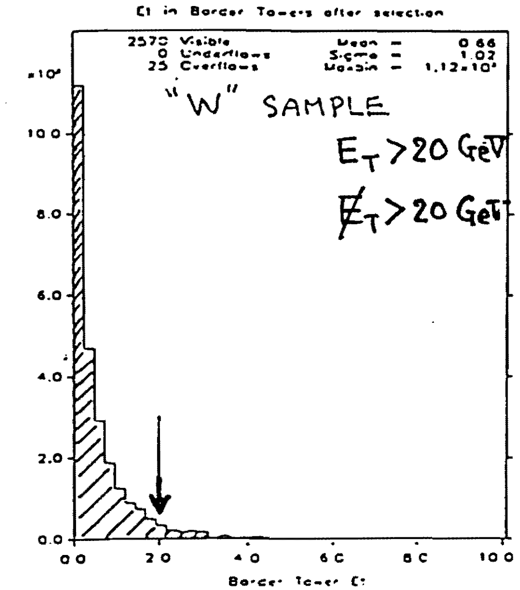
~95% efficient for W's

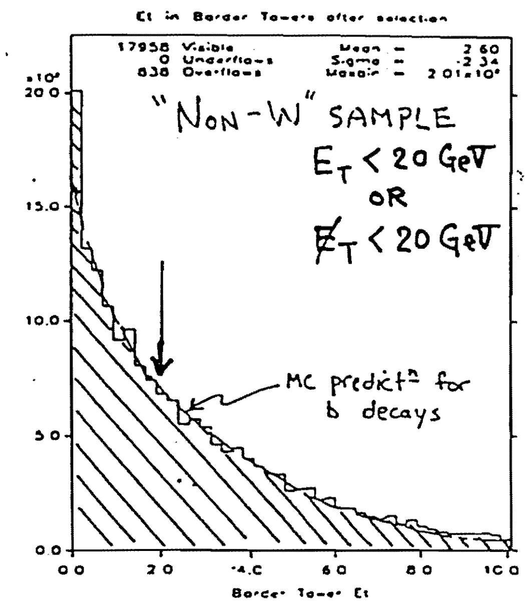
<50% " for b's

~85% " for t's

⇒ 12,000 events (3 nb) remaining

E_T IN BORDER TOWERS





$b\bar{b}$

In the Inclusive Electron Sample:

$b \rightarrow e^- \bar{\nu}_e c$

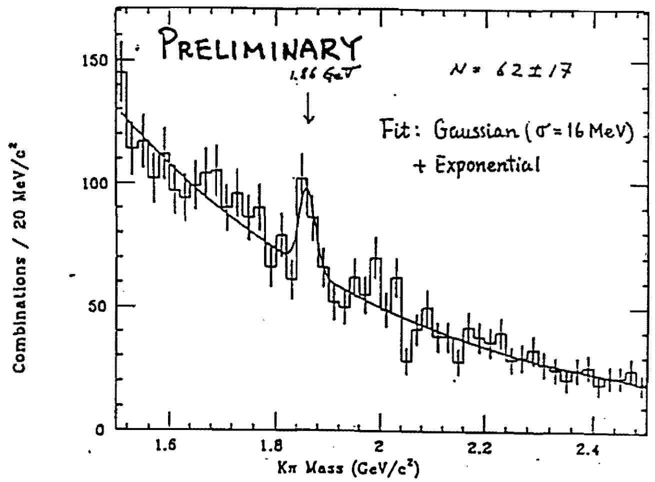
$\quad \llcorner \rightarrow D^0 X \quad (39\%)$

$\quad\quad \llcorner \rightarrow K^- \pi^+ \quad (3.8\%)$

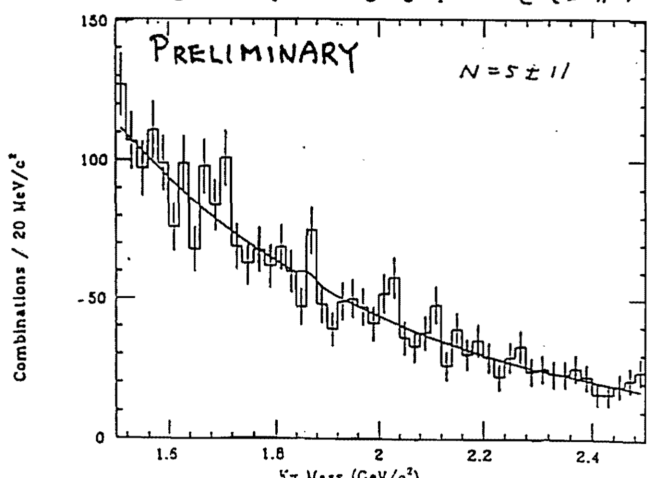
1.5% of b->eX

Take all combinations of -+ tracks in $\sqrt{\Delta\eta^2+\Delta\phi^2} < 1$ and assign K,π mass.

Signal sample: right sign pairs $e^-(K^-\pi^+)$



Signal sample: wrong sign pairs $e^-(K^+\pi^-)$



Jet Selection:

- Required 2 or more jets: $E_T > 10$ GeV and $|\eta| < 2$ 512 eve
- Reject backgrounds (b's, c's, QCD, etc.)

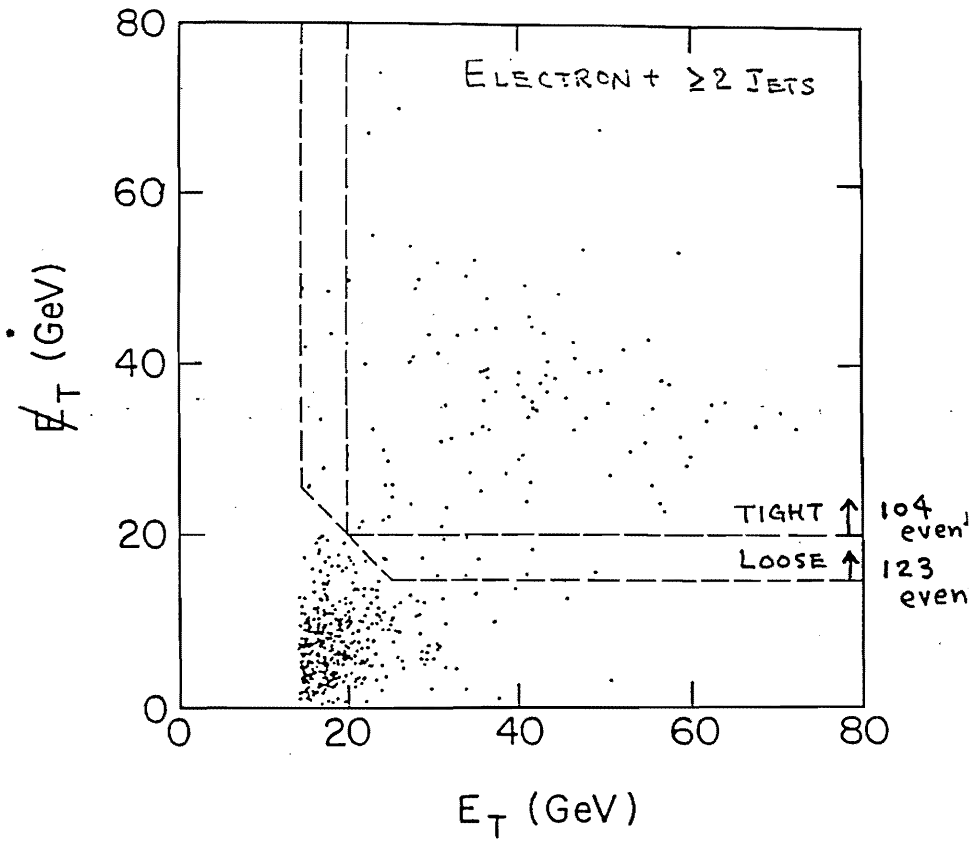
Tight cuts: $\not{E}_T > 20$ GeV, $E_T > 20$ GeV

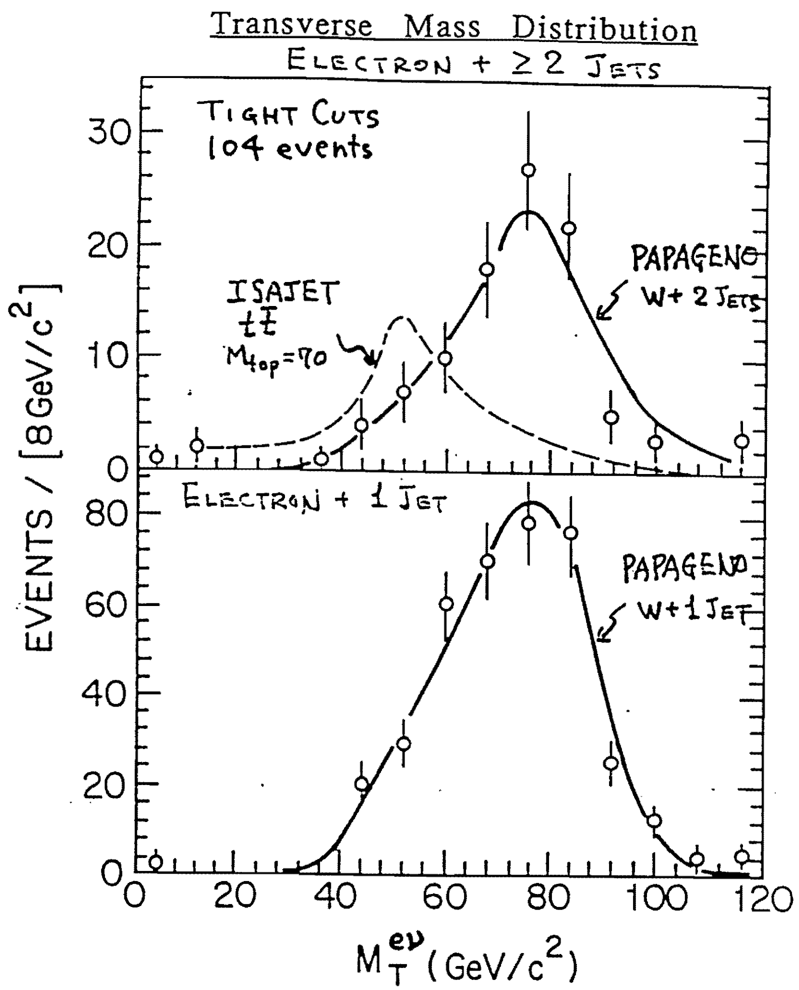
- Efficient for with $M_{top} > 50\text{-}60$ GeV

Loose cuts: $\not{E}_T > 15$ GeV, $E_T > 15$ GeV

$\not{E}_T + E_T > 40$ GeV

- Efficient even for $M_{top} < 50$ GeV





Backgrounds

	Tight Cuts	Loose Cuts
Unseen Conversion	1 %	3 %
Non-isolated $e^{\pm}$	12 %	15-20 %

The electron + ≥ 2 jet events appear consistent with W + multijet production in SM.

The electron + 1 jet events are also in good agreement with the Monte Carlo prediction.

- Transverse mass ($M_T^{e\nu}$) distribution for top and W + jets is quite different for $M_{top} < M_W + M_b$.
  - Use it to estimate the amount of top allowed by data
  - Fit observed $M_T^{e\nu}$ distribution to both the
    - (A) W + jets $M_T^{e\nu}$ distribution $W(M_T^{e\nu})$

    and

    - (B) Top $M_T^{e\nu}$ distribution $T(M_T^{e\nu})$

    as

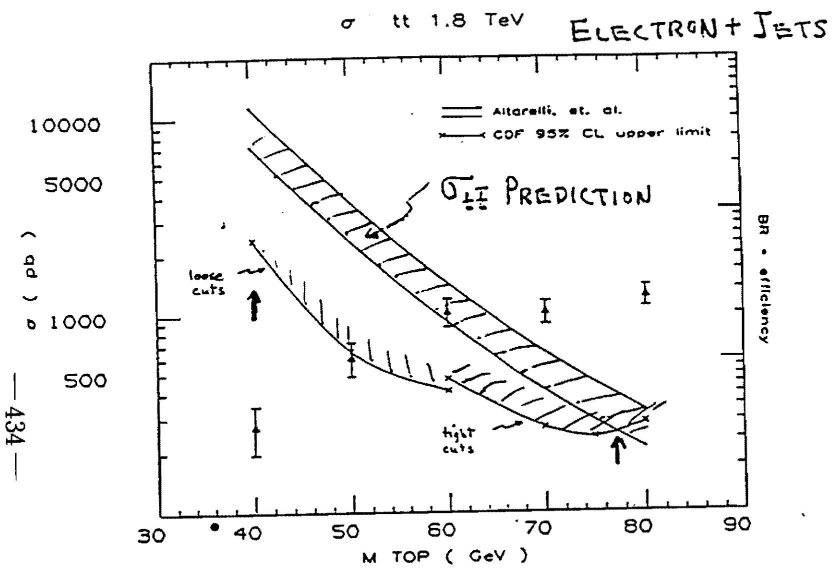
$$\frac{dN}{dM_T^{e\nu}} = \alpha T(M_T^{e\nu}) + \beta W(M_T^{e\nu})$$

  - α and β are normalized to 1.0 if the amount of top or W + 2 jets required in fit.
  - Use events with : tight cuts for $M_{top} > 60$ GeV/c²
    loose cuts for $M_{top} < 60$ GeV/c²
  - Results of likelihood fit over $24 < M_{top} < 120$ GeV/c² :

- Table 1. The number of predicted $t\bar{t}$ events, $n_{t\bar{t}}$, the fitted $t\bar{t}$ contribution to the e + ≥ 2 jet rate and the 95% CL upper limits on the acceptance corrected $t\bar{t}$ cross sections.

M_{top} (GeV/c²)	$n_{t\bar{t}}$ predicted	$\alpha \pm (stat) \pm (syst)$	$\sigma_{t\bar{t}}$ (pb)
40	130 ± 44	$0.07 \pm 0.05 \pm 0.02$	< 2410
50	123 ± 31	$0.06 \pm 0.05 \pm 0.03$	< 648
60	101 ± 22	$0.11 \pm 0.08 \pm 0.04$	< 408
70	43 ± 8	$0.00^{+0.12}_{-0.00} \pm 0.11$	< 266
80	32 ± 5	$0.00^{+0.27}_{-0.00} \pm 0.17$	< 281

$\beta = 1.28 \pm 0.15$



PRELIMINARY

> Exclude a top quark with
> $40 \text{ GeV}/c^2 < M_{top} < 77 \text{ GeV}/c^2$
> at 95 % CL

Electron + Muon

Electron Selection:

- Central EM cluster with $E_T > 15$ GeV in $|\eta| < 1.1$
- HAD/EM < 0.05
- Tower energy sharing consistent with electron
- E/P < 1.5
- CTC track and strip chamber match:
  $\Delta(R\phi) < 1.5$ cm , $\Delta Z < 2.0$ cm
- A transverse shower profile in the strip chamber is consistent with an electron shower: $\chi^2 < 10$
- Fiducial cuts
- Remove γ conversions and Dalitz decays:
  (30% of inclusive electrons)
  - Required VTPC track
  - No 2'nd track with $M_{e+e-} < 0.5$ GeV/c^2

Muon Selection:

In $|\eta| < 0.65$, use CTC, CMU, and calorimeter:

- Minimum ionizing in central calorimeter
  - EM < 2 GeV
  - HAD < 6 GeV
  - EM + HAD > 0 GeV
- CTC track with $P_T^{\mu} > 5$ GeV/c
- CTC-CMU track match
  - $\Delta(R\phi) < 10$ cm
  - Δ(slope) < 0.1
- Fiducial cuts

In $0.65 < |\eta| < 1.2$, use CTC and calorimeter:

- CTC track with $P_T^{\mu} > 10$ GeV/c

- Minimum ionizing in central calorimeter
  - EM < 2 GeV
  - HAD < 6 GeV
  - 0 < EM + HAD < 5 GeV
- Isolation of muon
  - Energy in $R = \sqrt{\Delta\eta^2 + \Delta\phi^2} < 0.4$ around muon < 5 GeV (excluding the energy in the tower traversed by the muon)
- Fiducial cuts

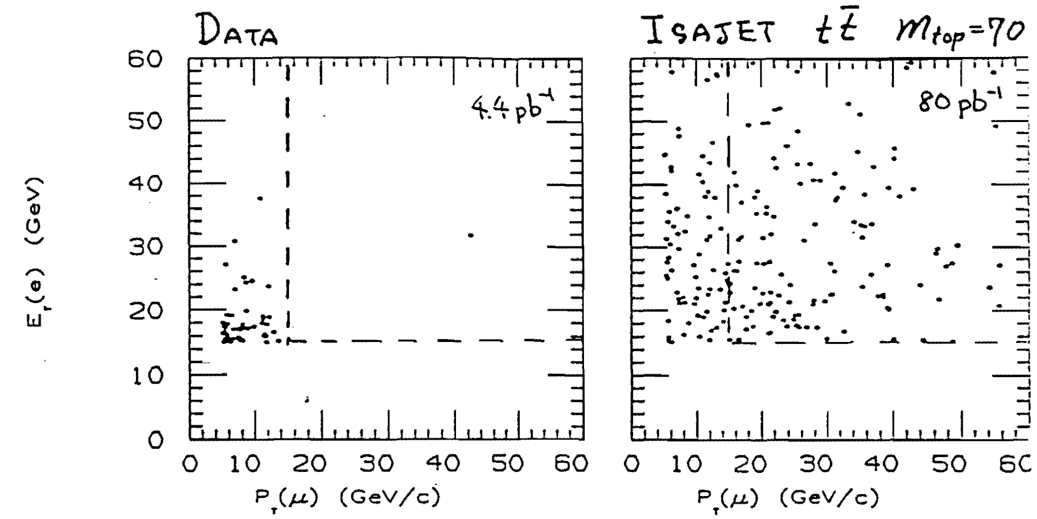


Figure 1: Plots of electron transverse energy vs. muon transverse momentum for the data (1a) and Monte Carlo $t\bar{t}$ events for $m_{top} = 70$ GeV/c^2 (1b). The sensitivities are 4.4 pb^{-1} for the data plot and 80 pb^{-1} for the Monte Carlo plot.

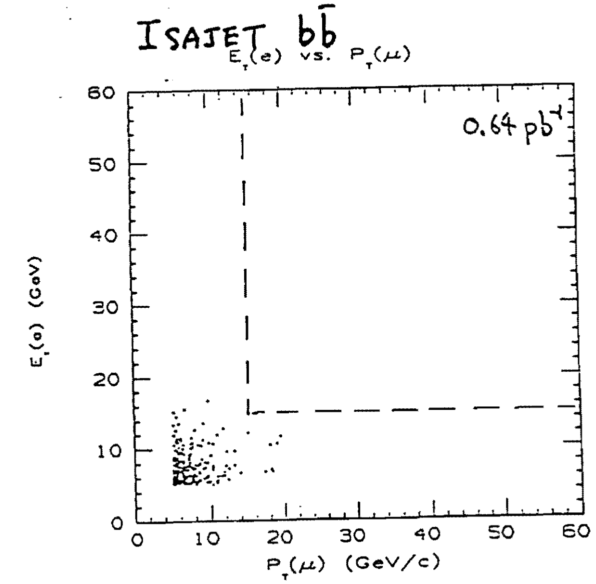


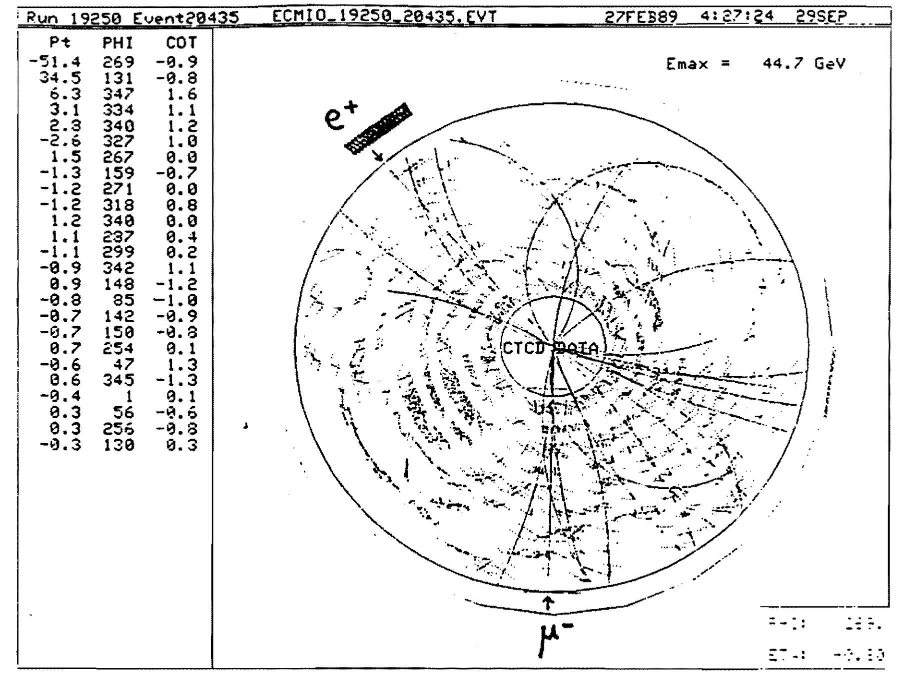
Figure 2: Plot of electron transverse energy vs. muon transverse momentum for simulated $b\bar{b}$ production, corresponding to an integrated luminosity of 0.64 pb^{-1}. The $E_T(e) > 15$ GeV requirement in Figure 1 has been reduced to $E_T(e) > 5$ GeV in this plot.

- Events clustered at low $E_T{}^c$ and $P_T{}^\mu$ are expected to be events from bottom production.
  - electron isolation is consistent with b's
  - electron and muon are typically back-to-back

- Require > 15 GeV and > 15 GeV/c to reject the backgrounds
  - <u>1 event passes all these cuts</u>
- Expected background rate is estimated:

Z -> ττ	0.5 events
WW production	0.15 events
WZ production	0.05 events
b, c production	<< 1 event

- Place an upper bound on the rate of e-m coming from tt production by convoluting a Poisson distribution with mean of 3.9 events together with the following systematic uncertainties:
  - Electron energy calibration (±1%)
  - Electron selection efficiency (± 5%)
  - Luminosity uncertainty (±15%)
  - Acceptance uncertainty (±20%)



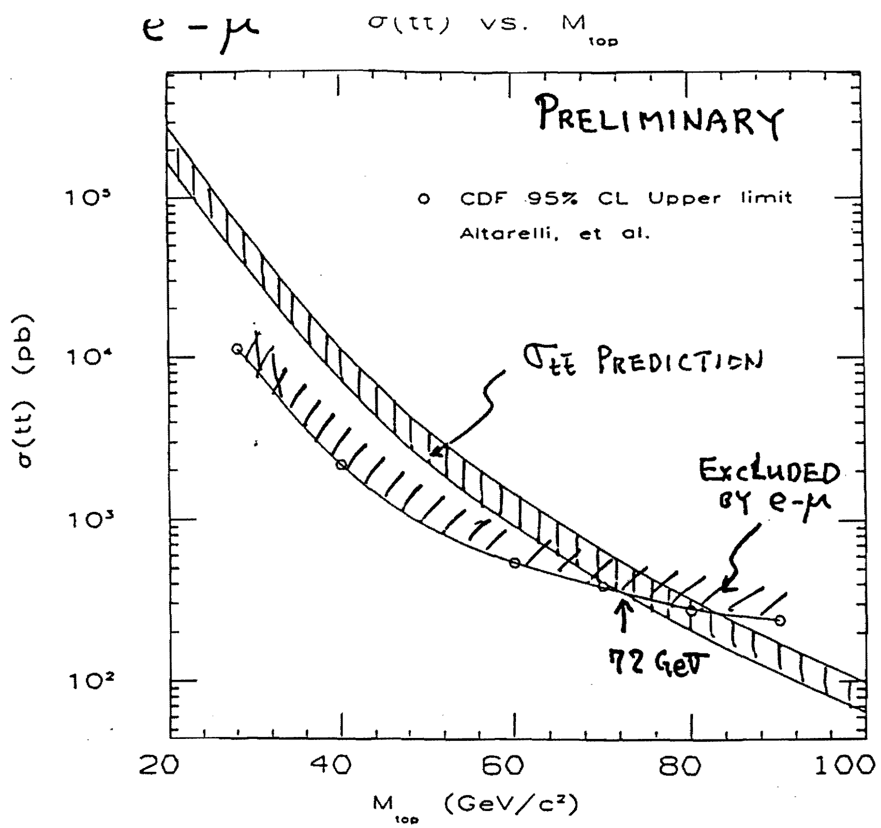


Figure 4: The 95% confidence level upper limit on the $t\bar{t}$ production cross section as a function of top quark mass. The shaded band shows the result of a theoretical calculation of the $t\bar{t}$ production cross section by Altarelli, et al.

> We exclude a top quark at 95% CL with
>
> 30 GeV/c^2 < M_{top} < 72 GeV/c$_2$

Conclusions

Preliminary Squark Mass Limit
(Minimul SUSY model)
$M_{\tilde{q}}$ > 150 GeV/c^2
in Case $M_{\tilde{g}} > M_{\tilde{q}}$

$M_{\tilde{q}} > M_{\tilde{g}}$ Case in Progress

Preliminary Top Quark Mass Limit
40 GeV/c^2 < M_{top} < 77 GeV/c^2
(at 95% CL)
from Electron + Jets Mode

30 GeV/c^2 < M_{top} < 72 GeV/c^2
(at 95% CL)
from Electron + Muon Mode

Future Prospects

1988-1989	1×10^{30} cm^{-2}s^{-1} (6 bunches)	5pb^{-1}
	Beam Test	Muon Upgrade
		SVX
1991	5×10^{30} cm^{-2}s^{-1} (6 bunches)	
		Calorimeter Upgrade
1994	5×10^{31} cm^{-2}s^{-1} (22-44 bunches)	100pb^{-1}

Top Search up to 200 GeV/c^2
W^+W^- Pair Production