Signals of Parity Restoration at CDF and DØ

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for the CDF and DØ Collaborations

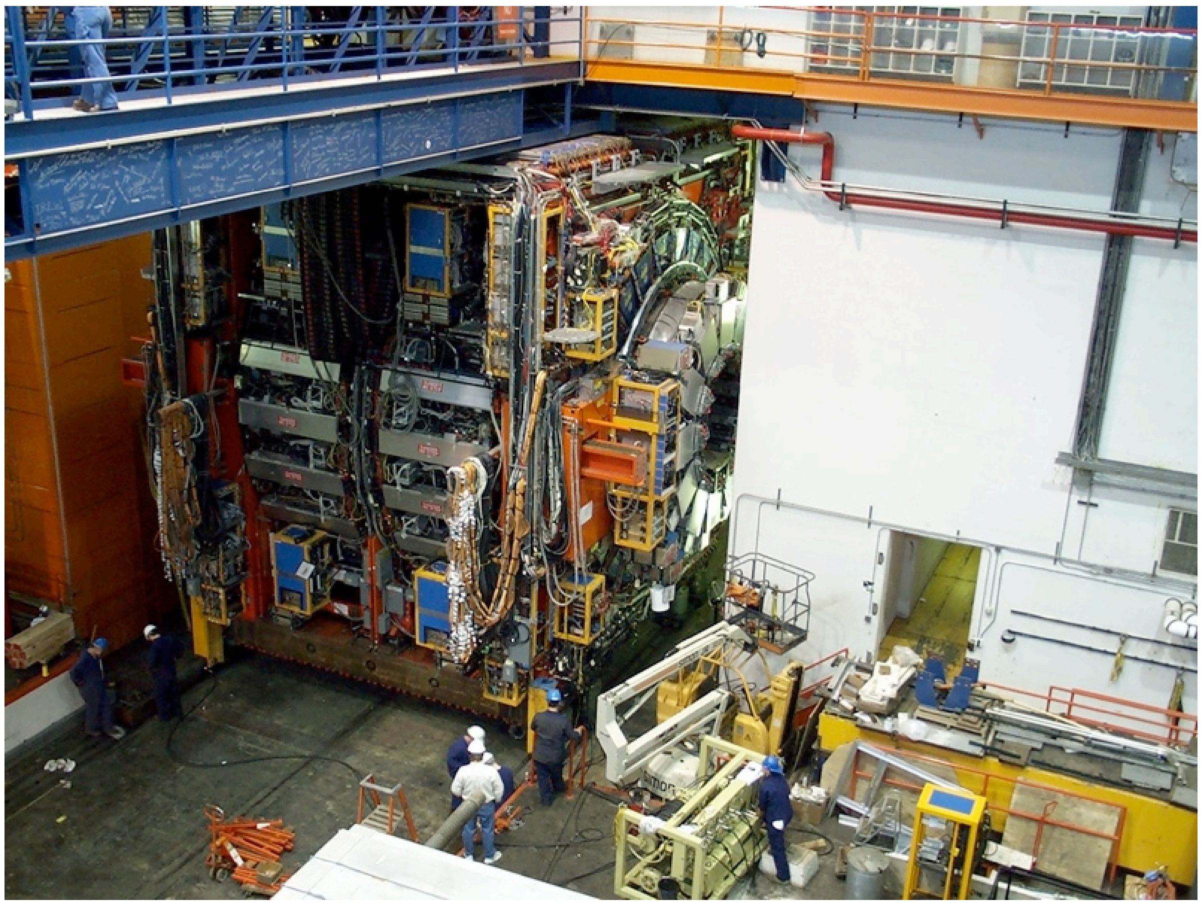
The Tevatron

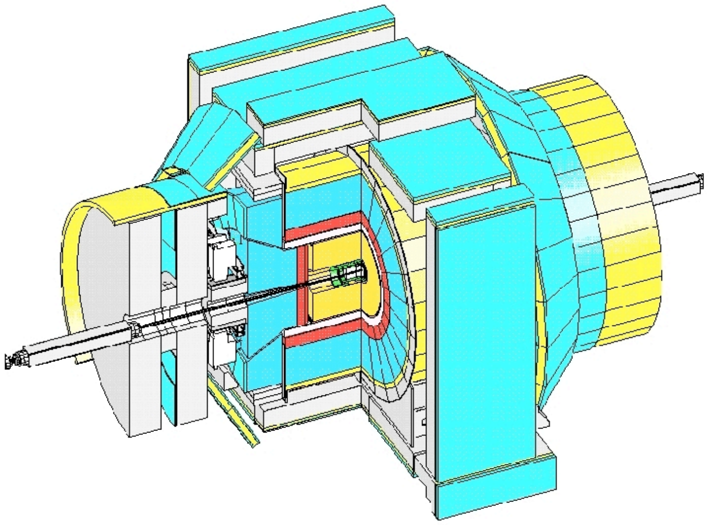
- Proton-antiproton collider at 1.96 TeV center of mass energy
- Particle bunches cross at 2.5 (1.7) MHz
  - Run I led to discovery of top quark
  - Run II measurements of B_s mixing frequency, evidence for single top quark production, ...

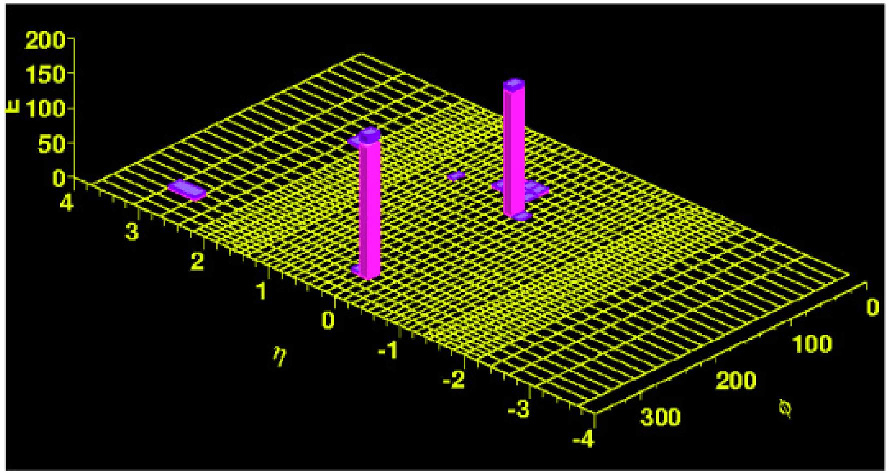
Running since 2001, expect → 2009

CDF

- "Typical" hadron collider detector: precision tracking, (time of flight), calorimetry and muon system
  - Sophisticated trigger & DAQ

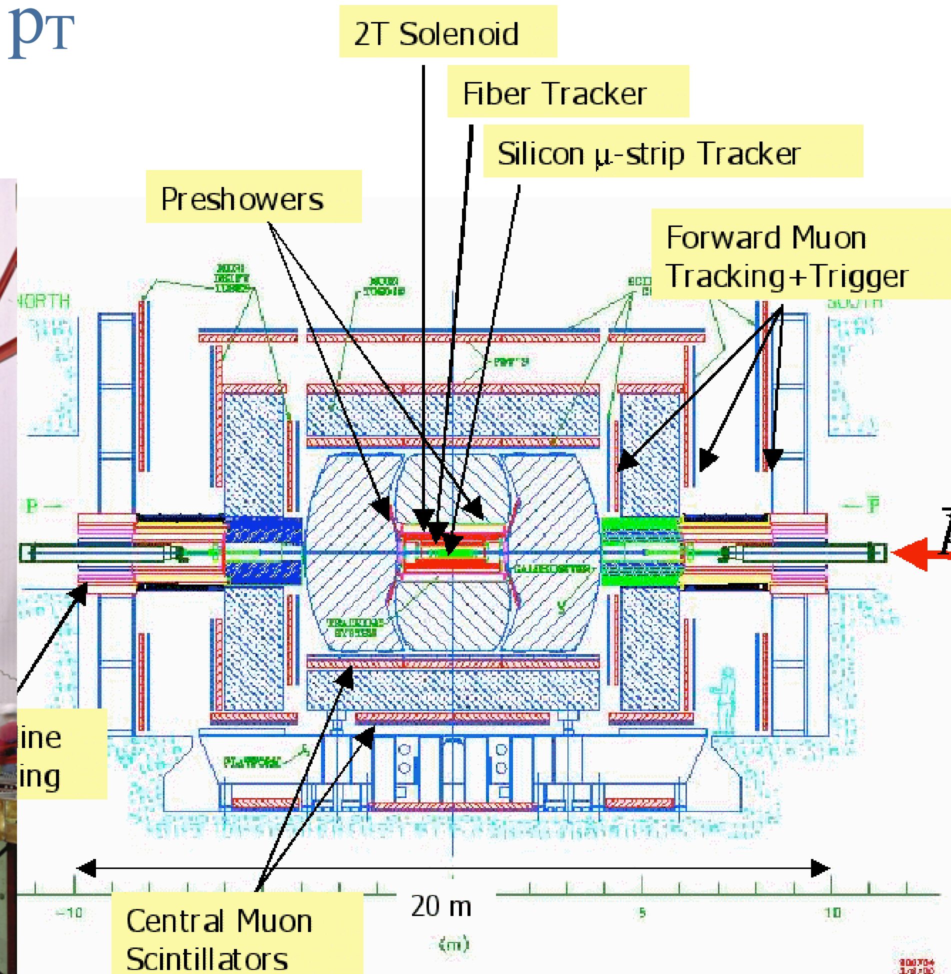






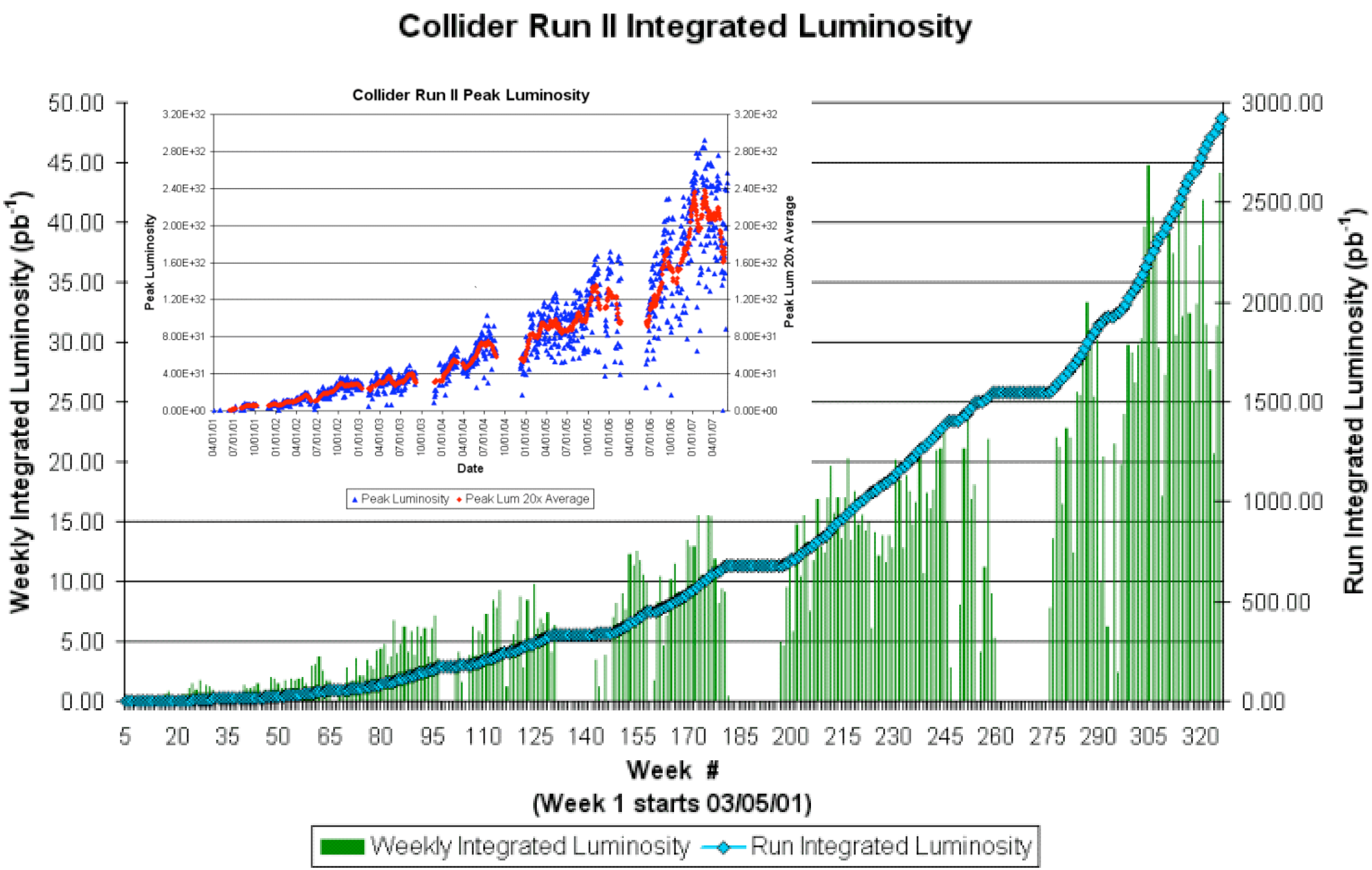
DØ

- Also "typical", some different choices
  - Similar performance at high p_T



Tevatron Performance

Antiproton Production Rate Remains Limiting Factor

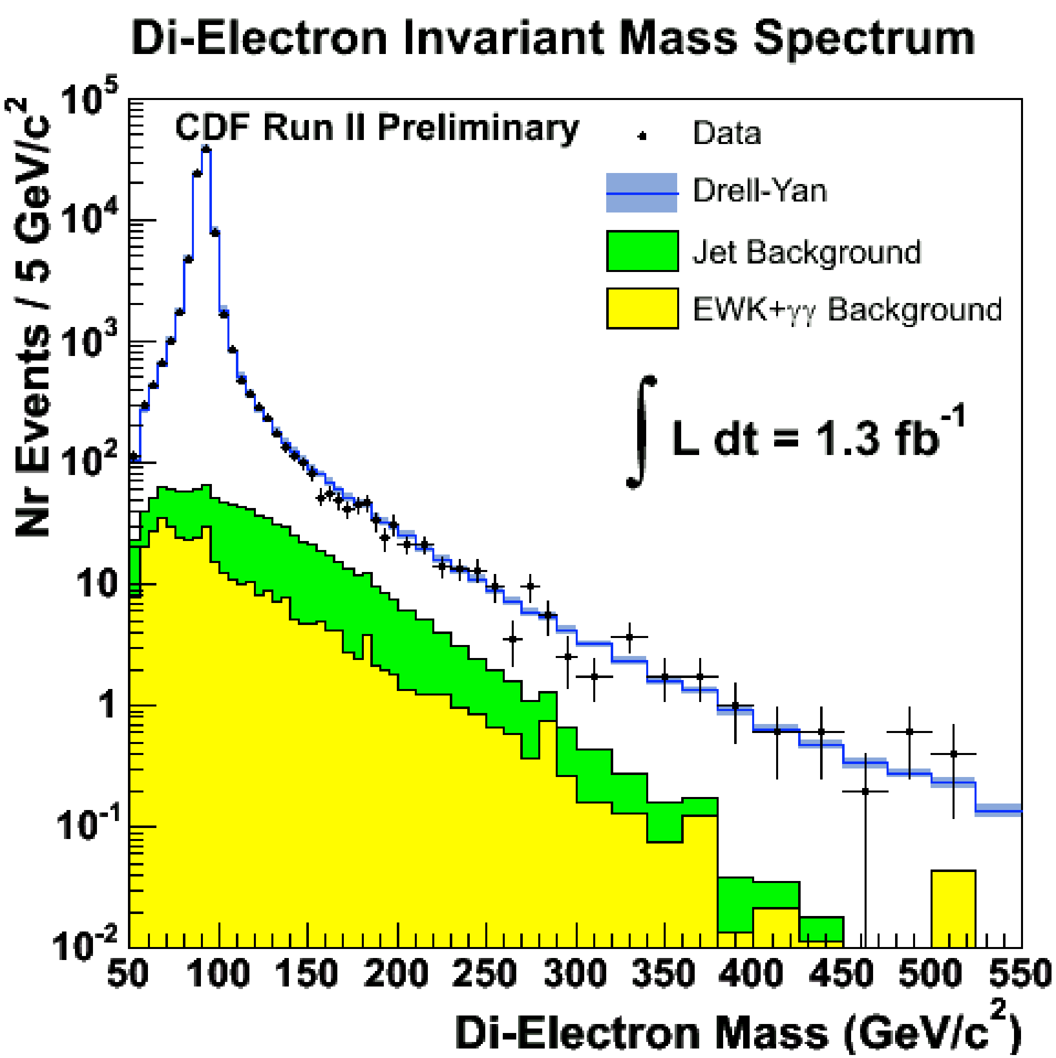


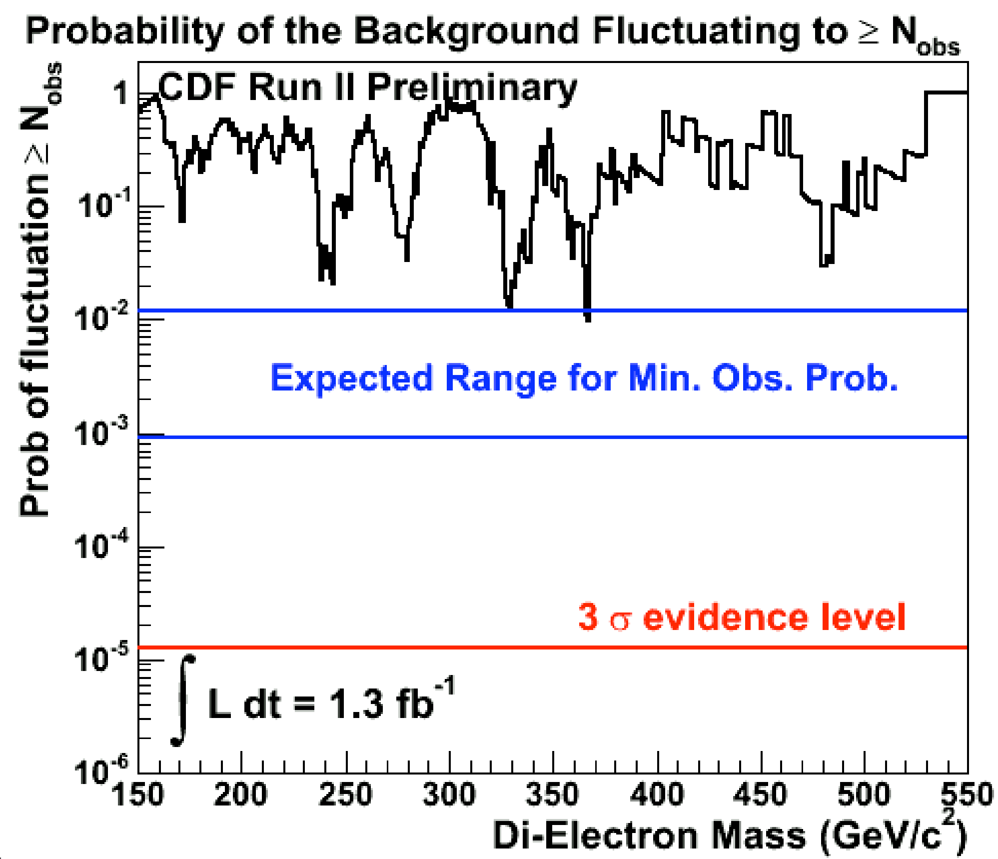
Dilepton Resonances

- "Self-calibrating" analyses
  - Z peak used to measure electron identification efficiencies, estimate backgrounds, measure or verify integrated luminosity
  - Typical rate at which a jet fakes an electron ~ 10^{-3} - 10^{-4}
  - Muon fake rate small, but background from real muons from heavy flavor decays
    - These muons typically embedded in a jet -> isolation criteria
  - Hadronic tau decays suffer from much larger backgrounds
  - At given p_T, dijet cross-section ~10^5 x Drell-Yan
    - Dijet background typically 10-10^3 x smaller than DY continuum

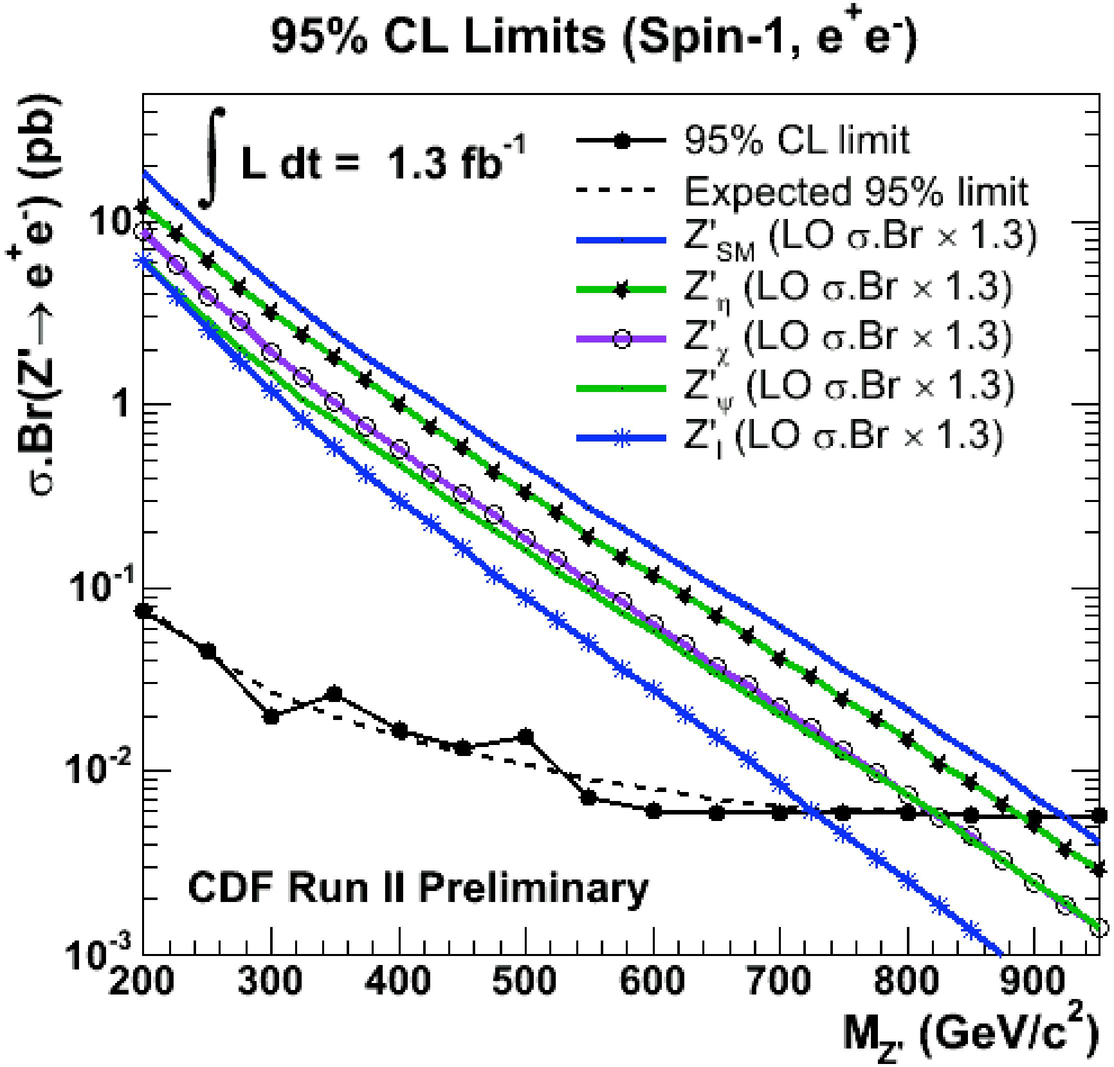
Dielectron Resonances

- CDF result with 1.3 fb^{-1}



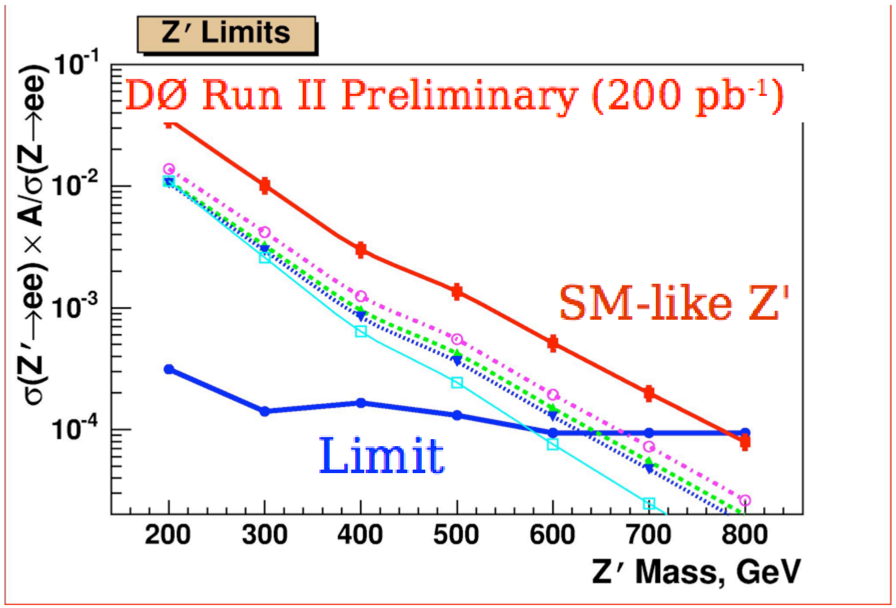


- Limits



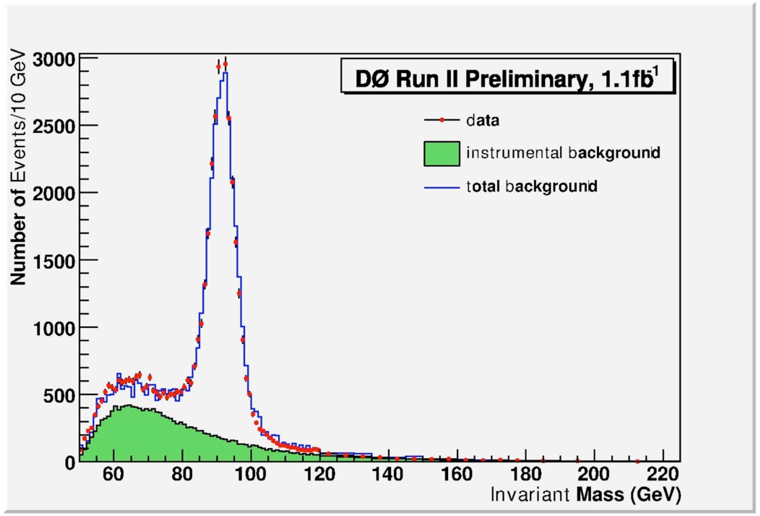
Limits *seem* strong given that data only goes out to ~ 500 GeV: expect strong enhancement in cross-section (as for Z)

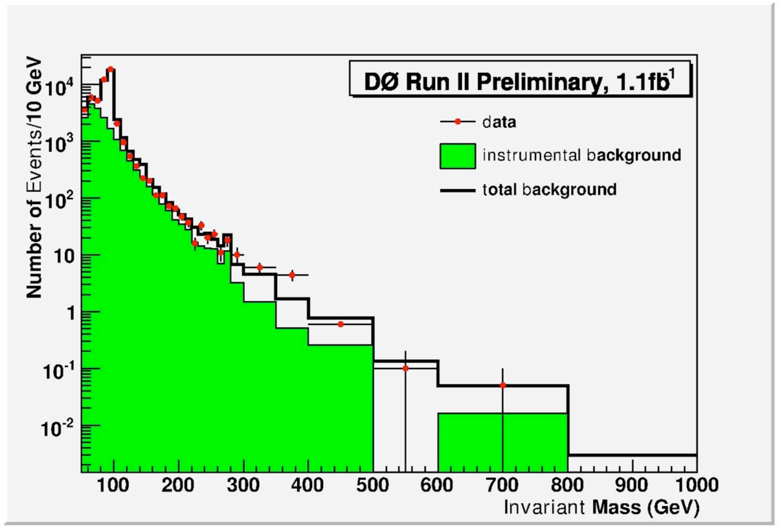
2004 DØ Result

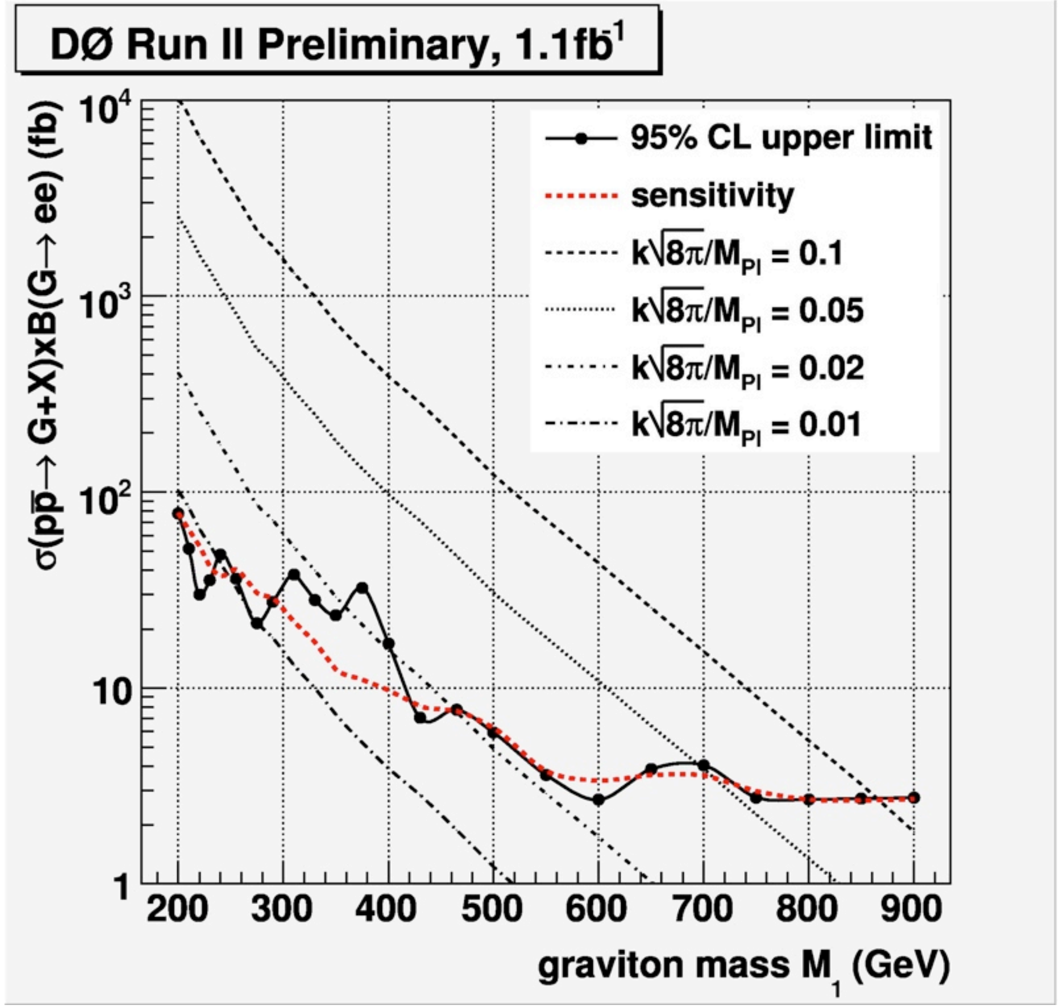


“Di-EM” Resonances

- DØ analysis searches for Randall-Sundrum gravitons: doesn’t try to distinguish electrons and photons

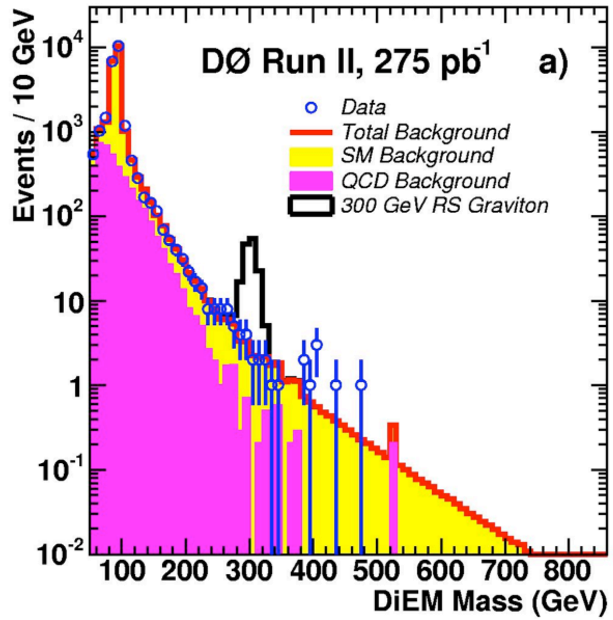


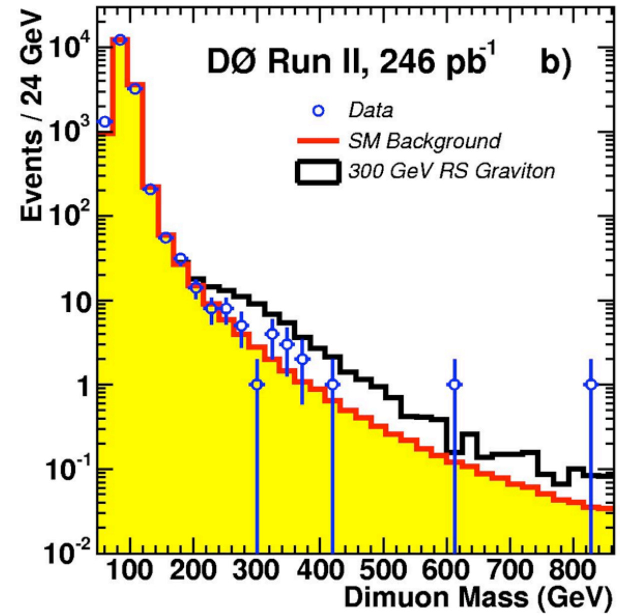


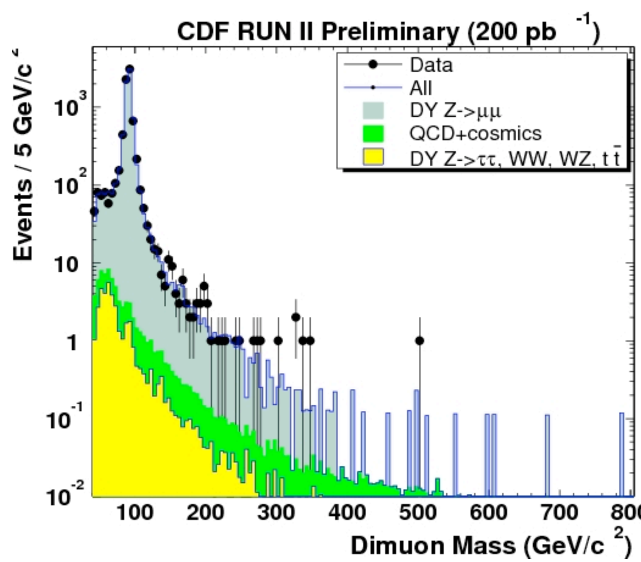


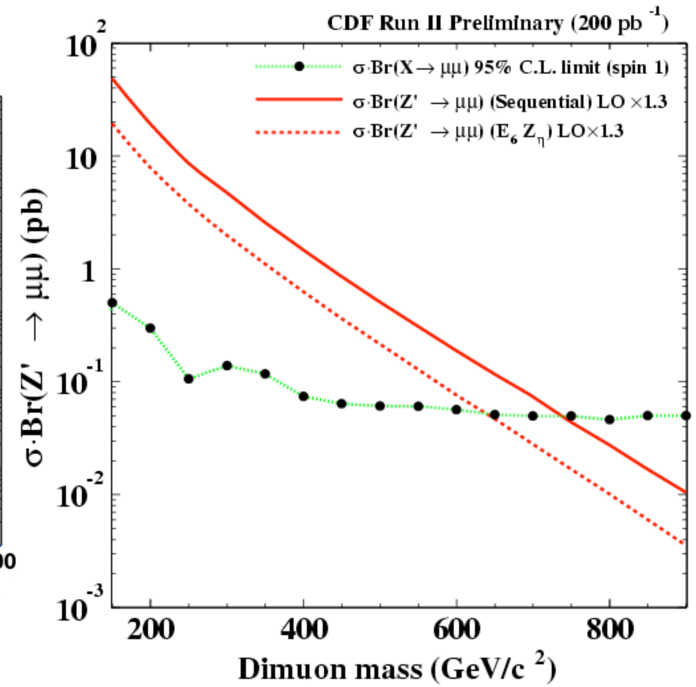
Dimuons

- At high energy, resolution much better for electrons (calorimeter vs tracker)
- Can correct obviously mismeasured muons based on assumption object is ~at rest





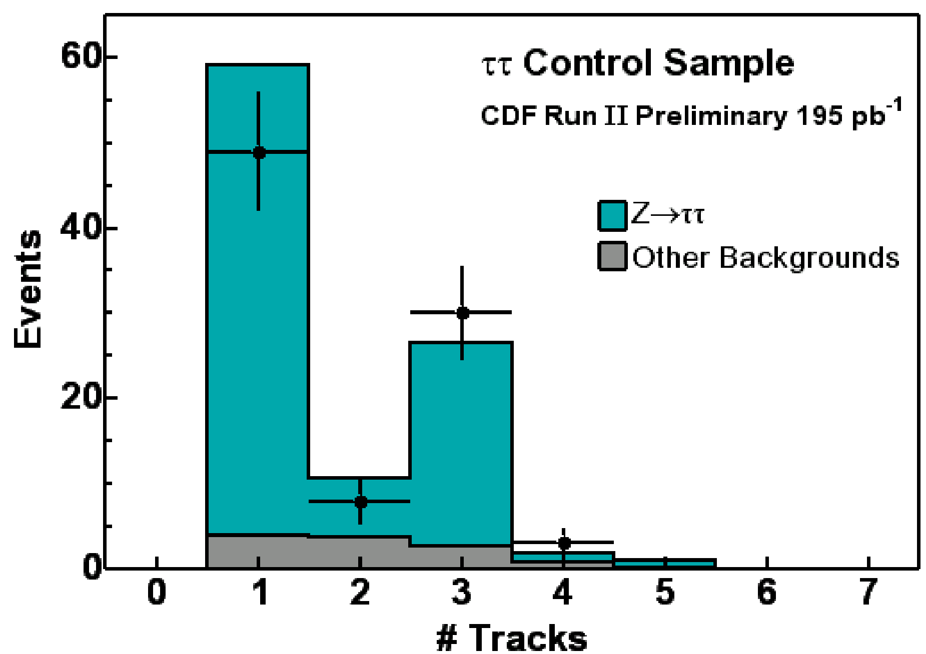




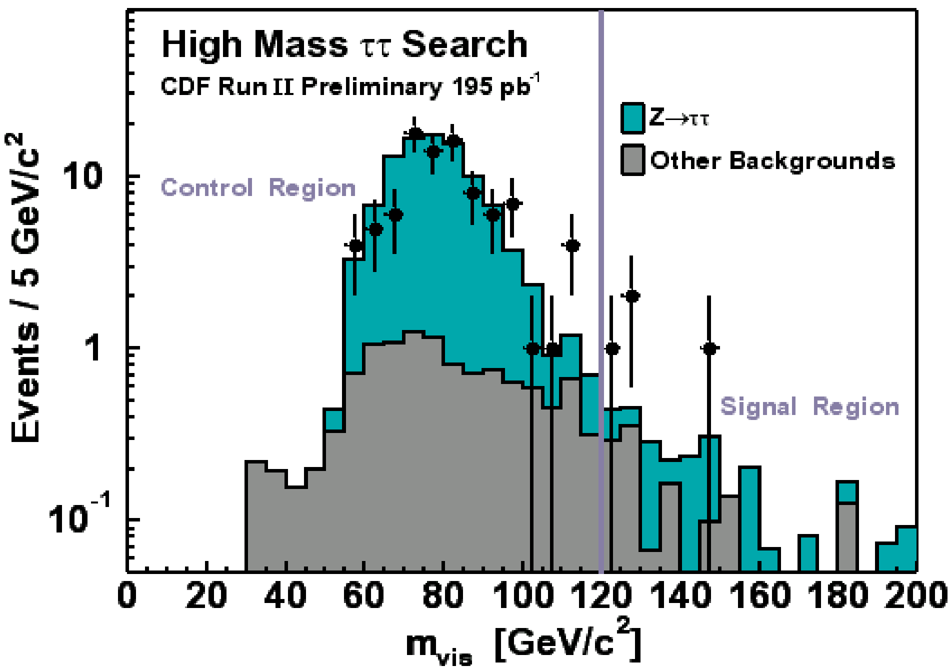
Ditaus

- To have acceptable rate, require that at least one tau decays hadronically
  - Large background from jets
  - Low efficiency compared to electrons & muons
- Can try to reconstruct di-tau mass using “collinear” approximation
  - Using visible mass has been shown to do better

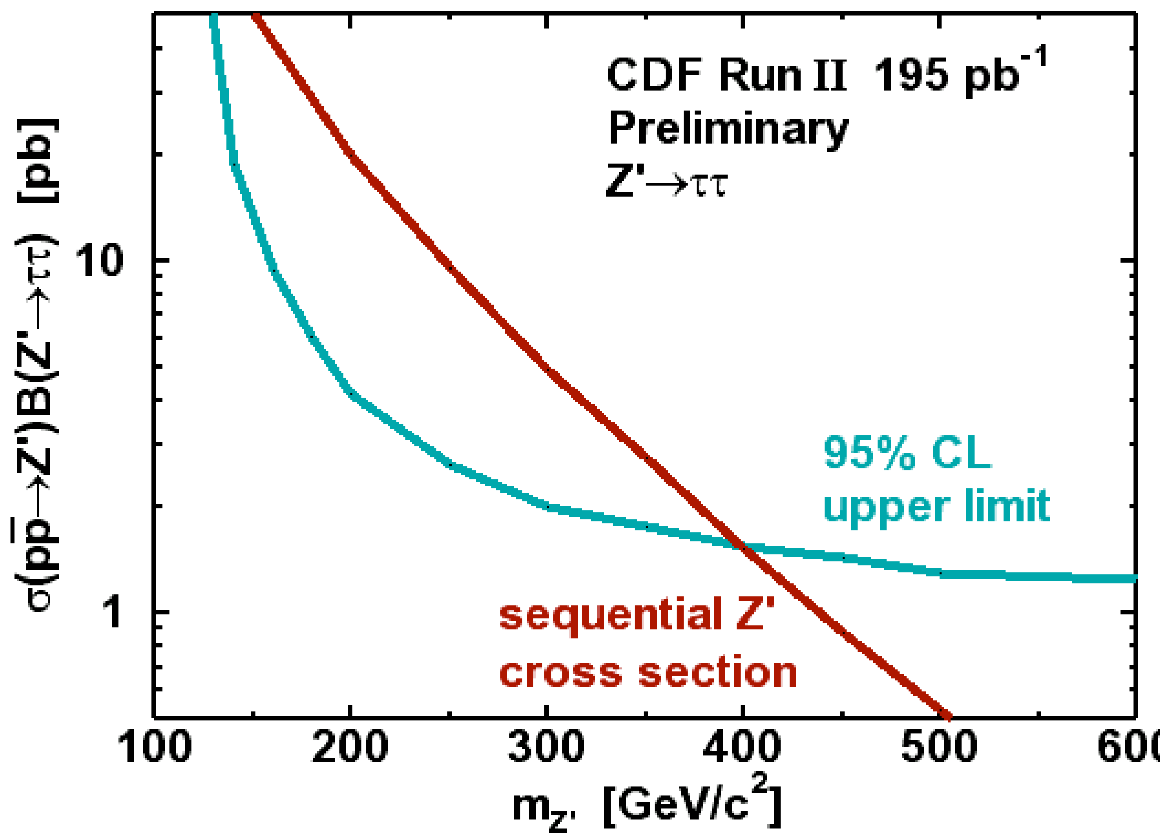
Hadronic Tau decays mostly have 1,3 charged pions
Dedicated reconstruction algorithms, + neural nets



Ditaus (2)

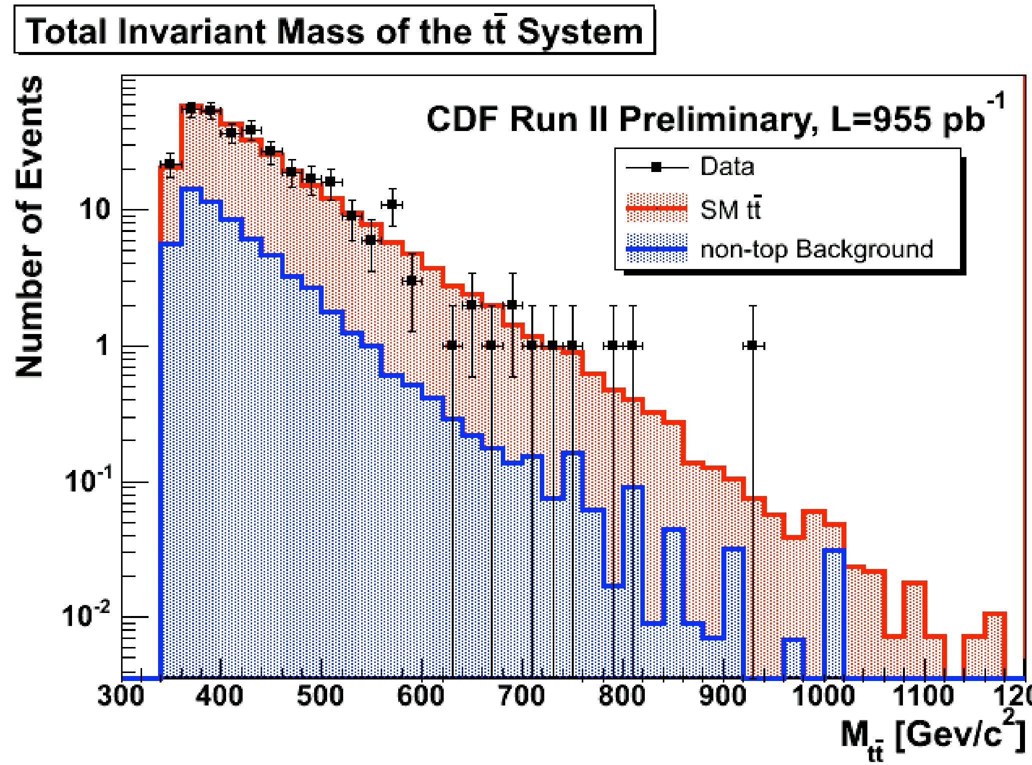


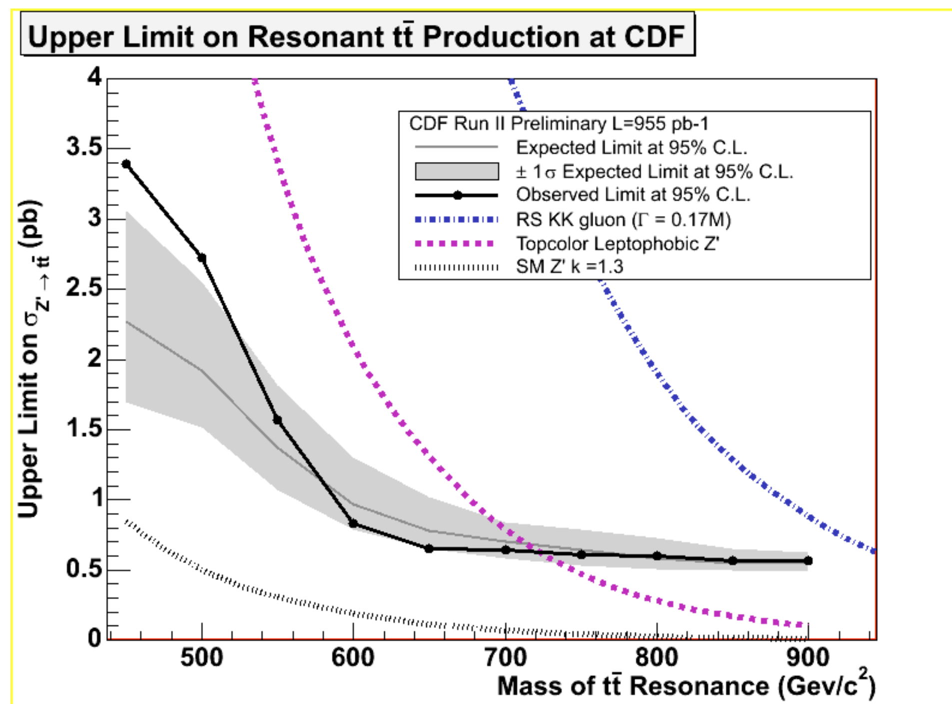
Use low mass region (Z) as control region
Look for excess at high mass



Di-top

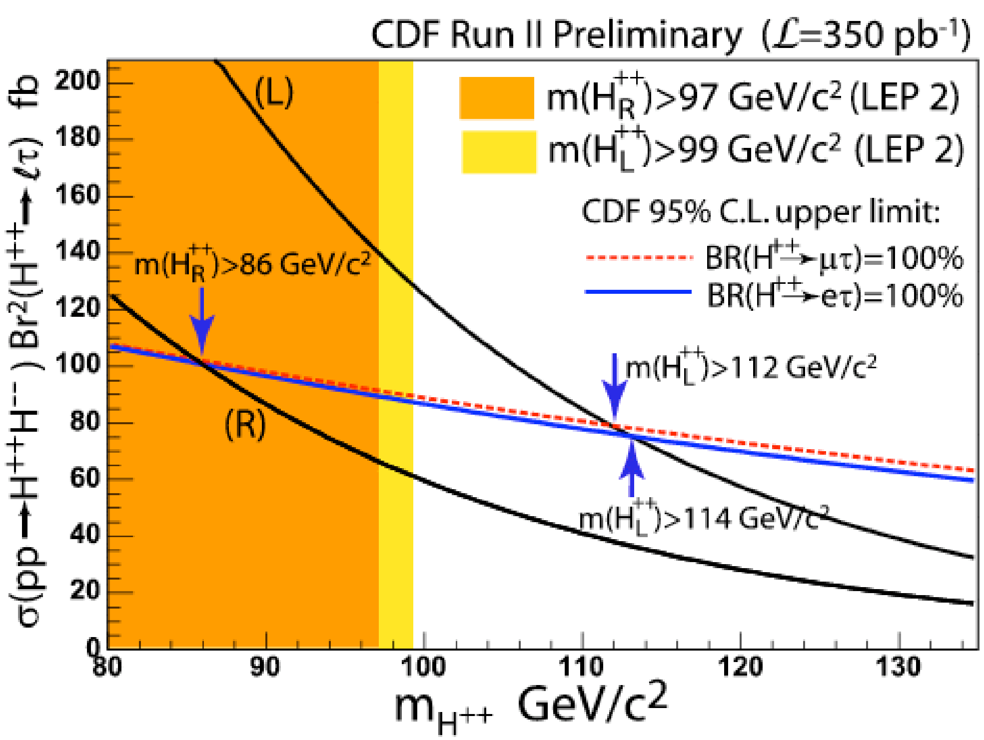
- Select “lepton+jet” di-top events and use b-tagging to reduce backgrounds from W +jets, etc
- Use a χ^2-based algorithm to reconstruct di-top mass
  - Constrain m_{top} = 175 GeV/c^2
  - Choose solution with lowest χ^2 and exclude if value is too large
  - Binned likelihood to determine sensitivity



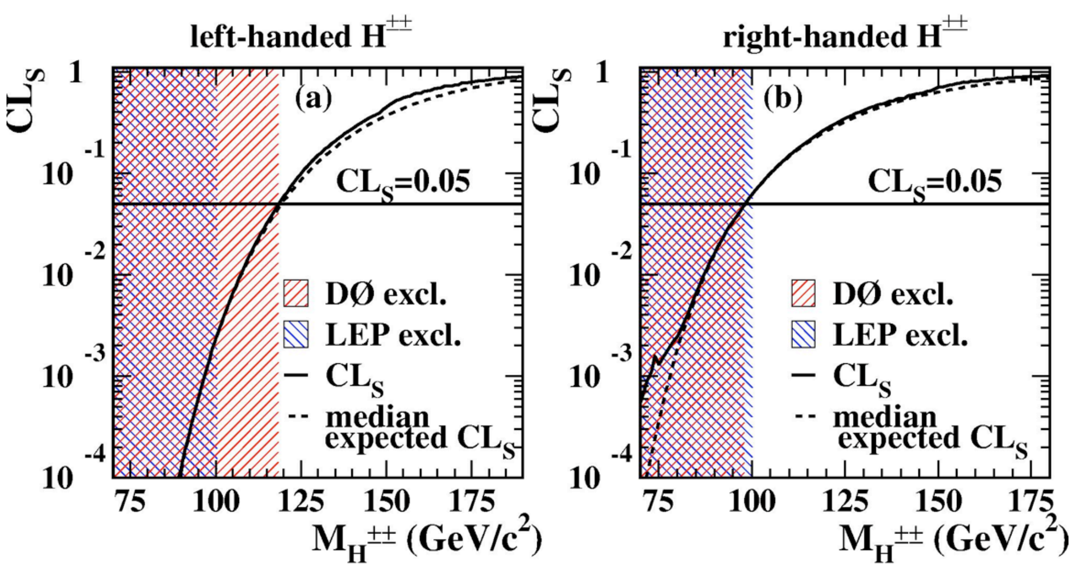


Doubly Charged Higgs

- Exist in models with Higgs triplets (like LRSM)
- CDF search in $H^{++} \rightarrow e\tau$, $\mu\tau$ channels
    - Assumed to be pair-produced: require at least 3 leptons → low backgrounds, no candidate events

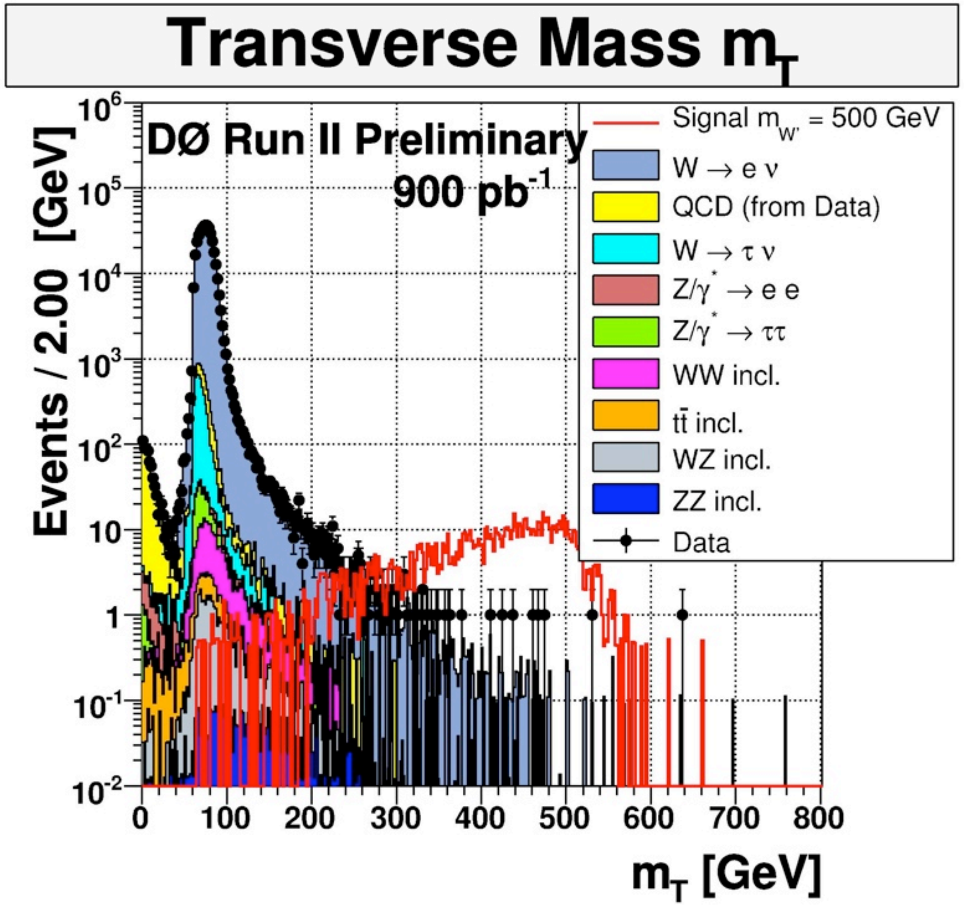


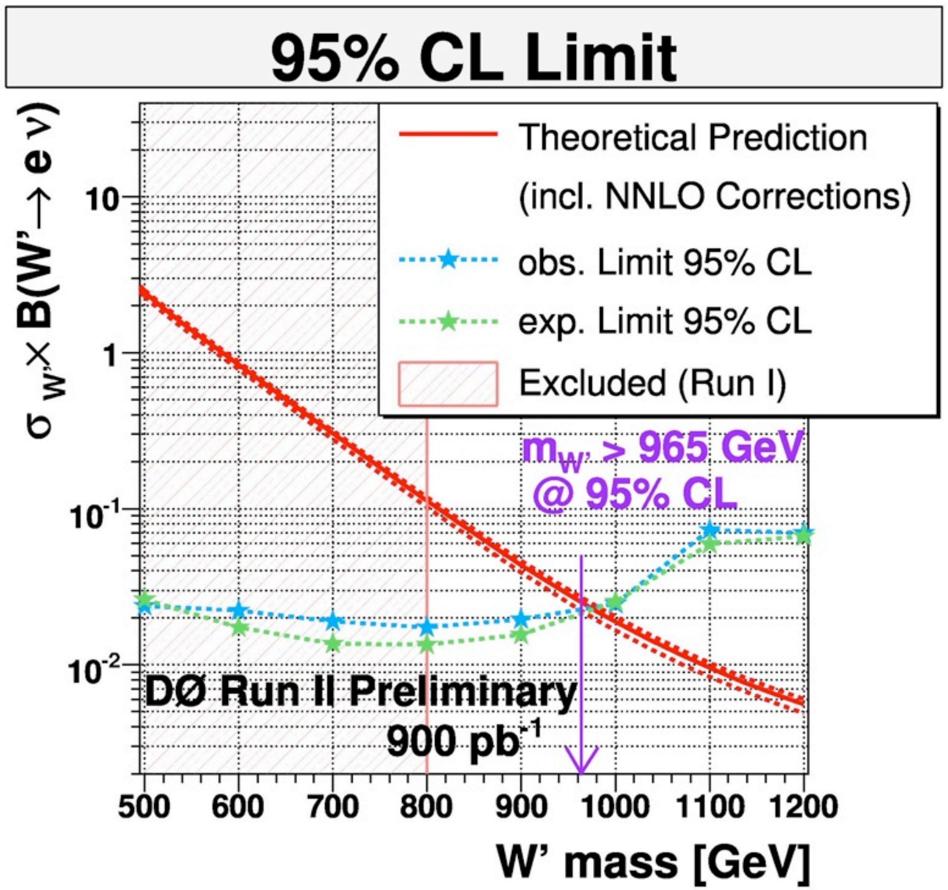
"Old" DØ result in dimuon channel (~100 pb^{-1})



W' -> eν

- New DØ result
  - CDF result with ~200 pb^{-1} has 95% CL limit $m_{W'} > 788\ GeV/c^2$





Conclusion

- Leptonic channels "golden" in search for new W and Z bosons
- Hadronic channels very difficult given large dijet backgrounds
  - Di-top result from CDF, sensitive to models with strong top coupling (and large cross-section)
  - There is a DØ limit from Run I
- Tevatron is setting stringent limits
  - Typical reach is getting close to 1 TeV, will get there by end of Tevatron run