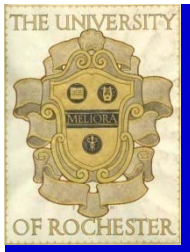

Search for long-lived b' at Tevatron

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For CDF and D0 collaborations

Beyond the 3rd generation workshop

CERN

4-5 September 2008

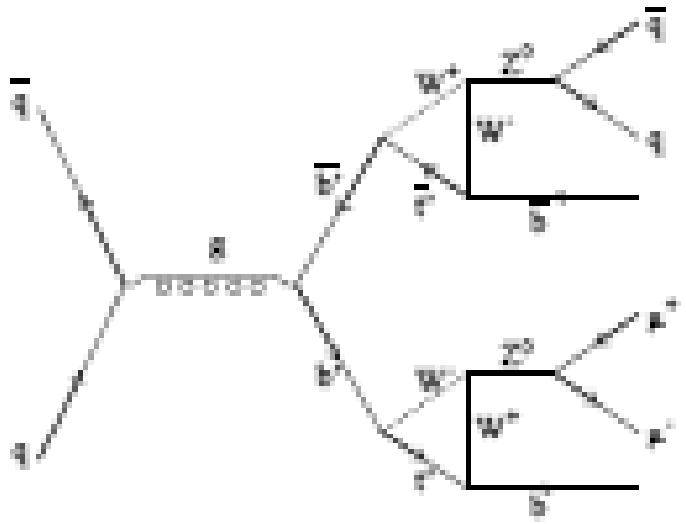
Outline

- Motivation and strategies
- Vertex reconstruction
- CDF result
- D0 result
- Conclusions

b'→bZ

Long-lived Z bosons

$$b\bar{b}' \rightarrow bZ\bar{b}Z$$

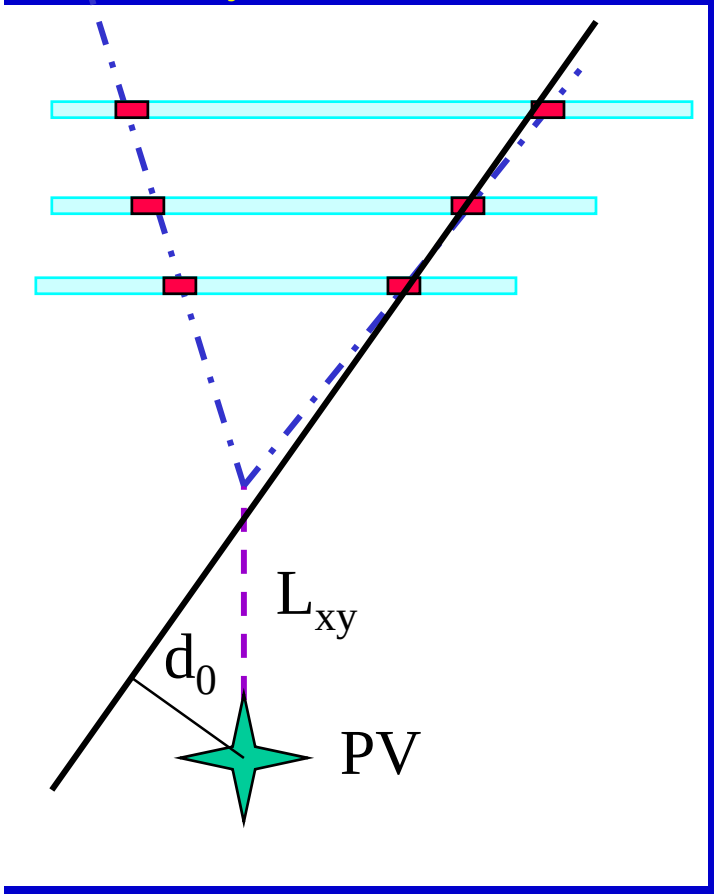


- If 4th generation b' quark is lighter than top quark it most likely will decay to b quark and Z boson.
- Since the decay goes through a loop diagram it could be significantly suppressed and thus b' would be long-lived.
- Strategy: search for long-lived parents of Z bosons.
- Both experiments identified at least one Z boson through its decays to leptons
  - CDF: Z→μμ
  - D0: Z→ee
- CDF used the power of its silicon tracker to reconstruct the decay lifetime : sensitive to ctau 0.1 cm – 10 cm
- D0 took advantage of highly segmented EM calorimeter and preshower to reconstruct "vertex" of two EM objects: sensitive to ctau 1 cm – 100 cm

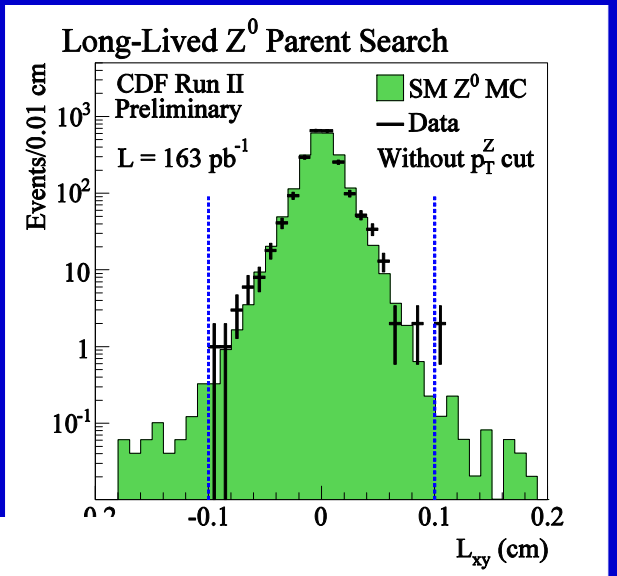
Precision of silicon tracker (CDF) and EM pointing resolution (D0) – key detector features in the two searches

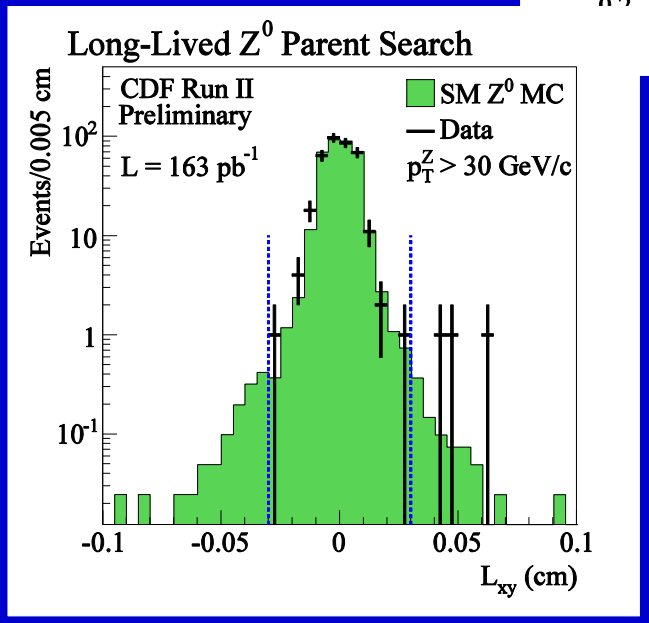
Vertex reconstruction in CDF

- Select Z→μμ (81<Mμμ<101 GeV)
  - Muon tracks are reconstructed in the drift chamber and have at least 3 associated hits in the silicon system



Lxy>0.1 cm
Nev=3
Nbg=0.72+-0.27

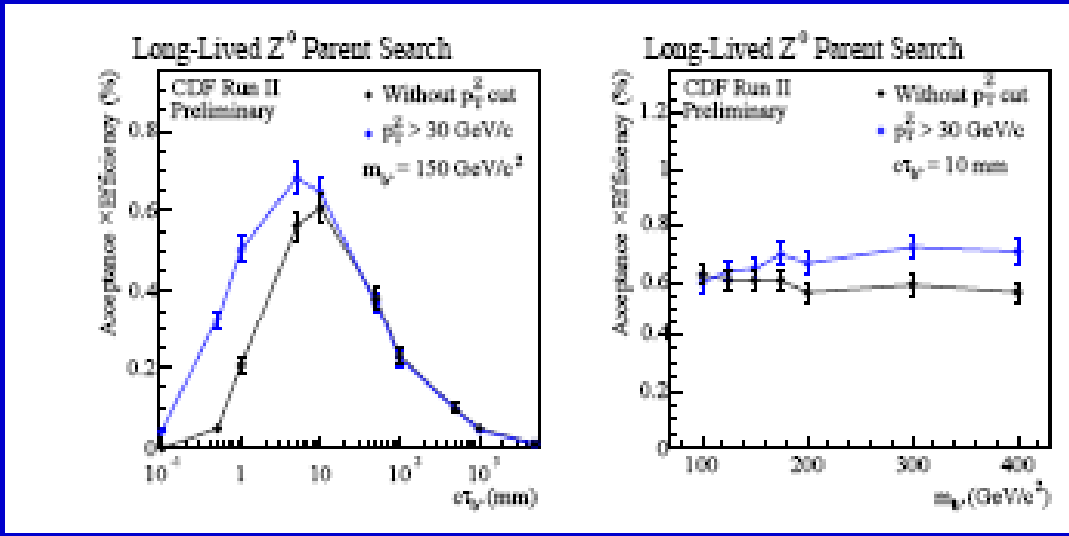


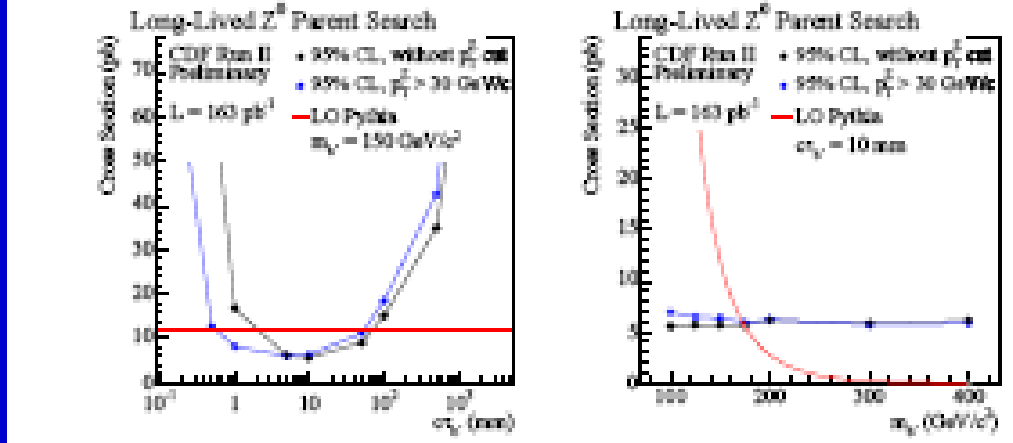


p_{TZ}>30 GeV
Lxy>0.03 cm
Nev=2
Nbg=1.1+-0.8

Long lived Z search in CDF

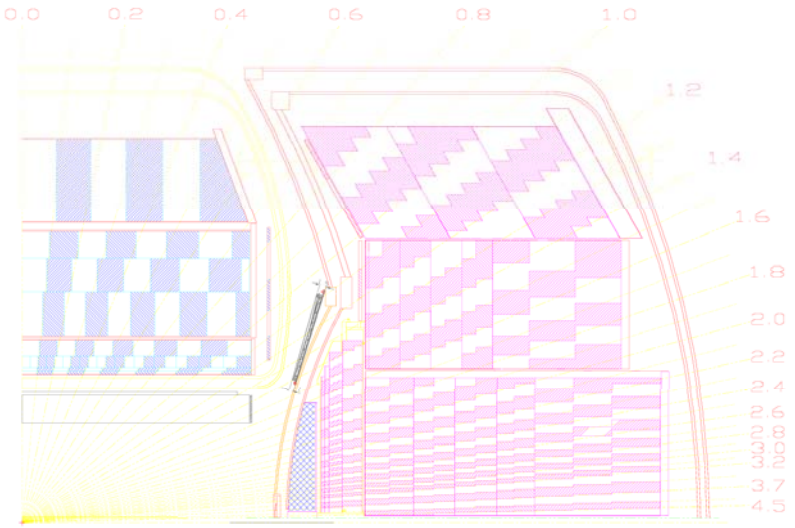
- Efficiency is a low for small lifetime, because of the cut on Lxy,
- It also drops for high life time because of the number of silicon hits requirement
- The production cross section does not depend on b' lifetime
- Efficiency is fairly independent on b' mass, but the cross section is dropping for high b' mass





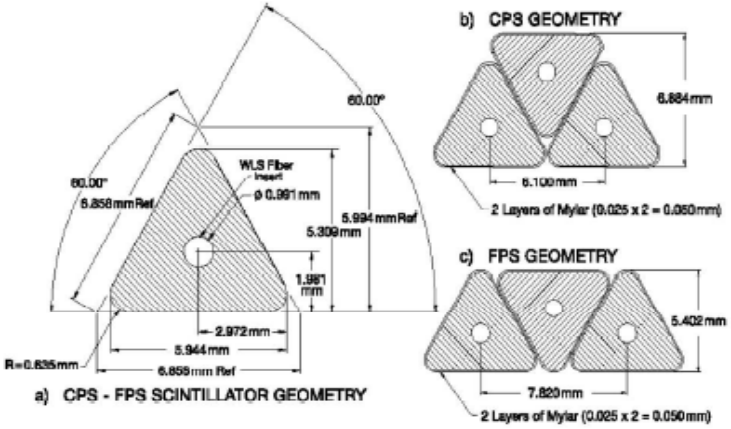
D0 strategy

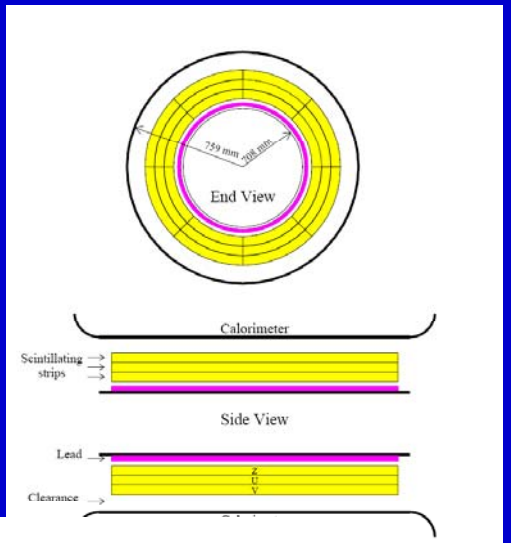
- **D0 used fine segmentation of its EM calorimeter and preshower to reconstruct displaced electrons from Z decay.**
- **Tracking efficiency can be very low for displaced electrons, most of them are reconstructed as photons.**
- **In fact the analysis require that there is NO matching track to EM cluster – efficient to signal with lifetime > 1cm and suppresses most of SM background**

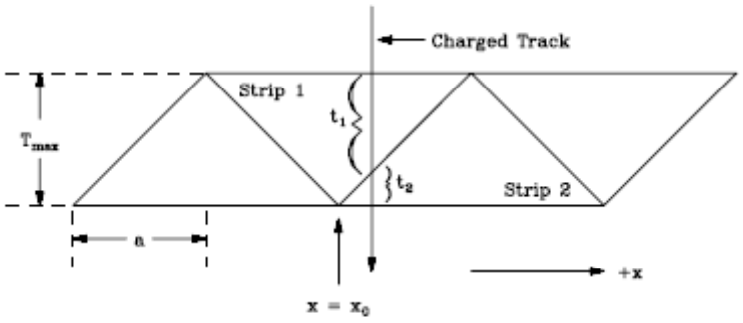


4 layers in EM: 2,2,7, 10 X_0
Segmentation in ηxϕ: 0.1x0.1 in all layers but layer3, where it is 0.05x0.05

Position reconstruction in preshower







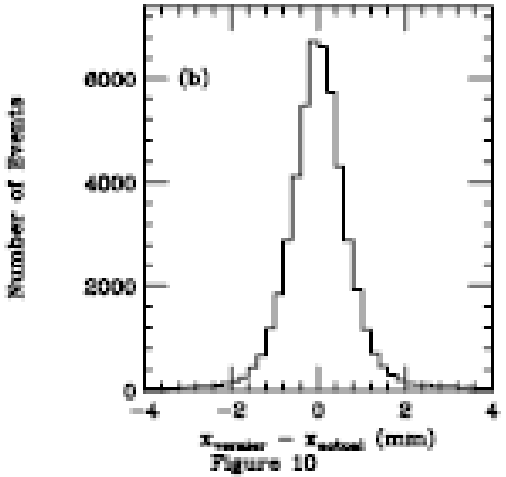


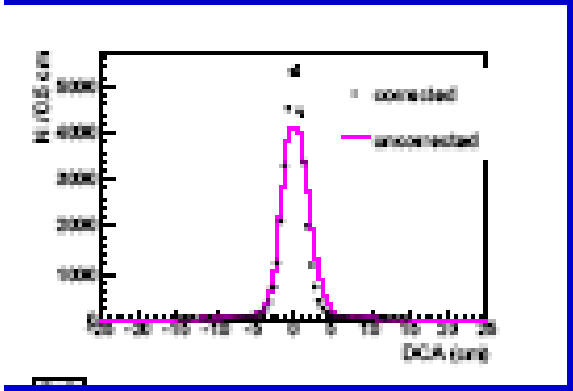
Figure 10

σ=567μm

Vertex reconstruction in D0

Electrons reconstructed using 5 points (preshower +4 EM) approximated by straight line

Impact parameter:



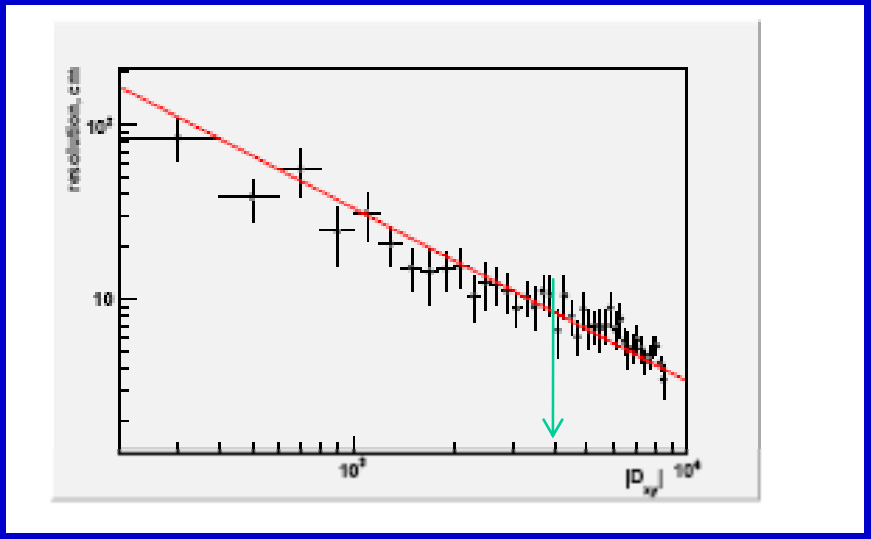
Require that the DCA>2cm

Two lines are intersected to reconstruct the decay vertex.

Resolution depends on the discriminant of the 2 equation system

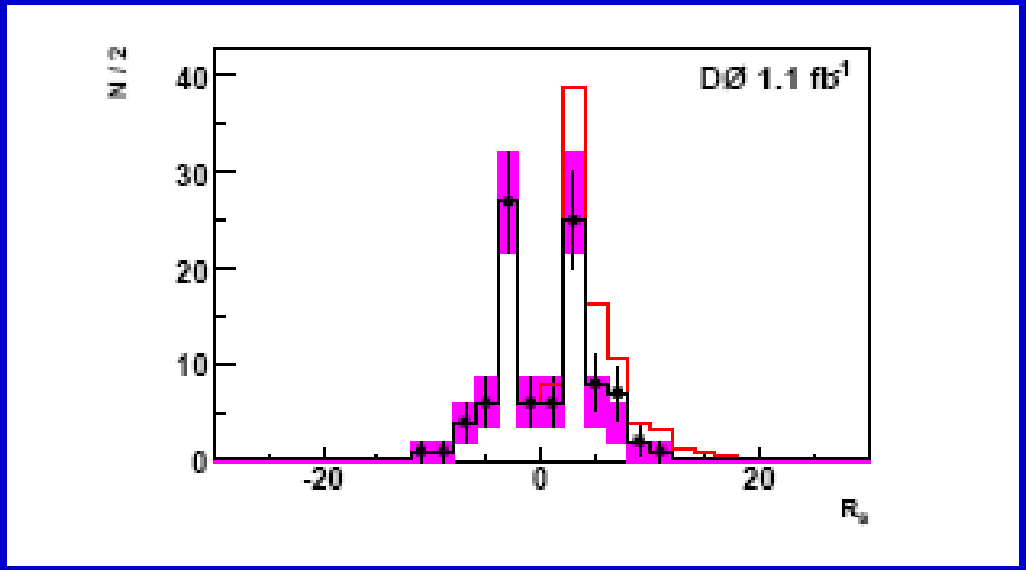
Require that D>4000 cm^2

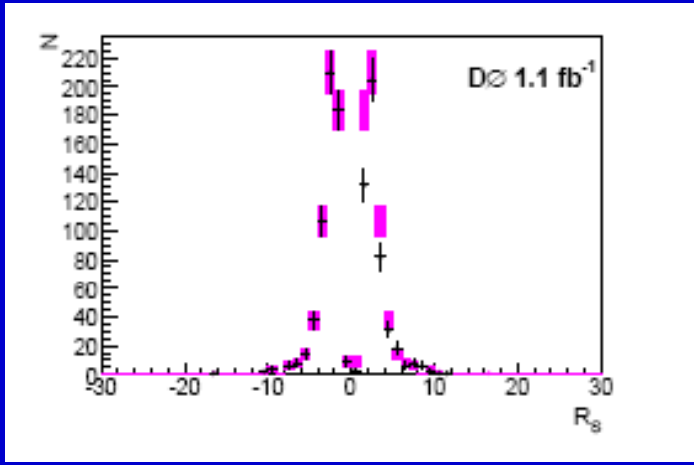
Resolution better than 10 cm



Background estimation

- Assume that the background comes primarily from misreconstructed prompt electrons and photons and thus is symmetric around zero in the decay length
- This assumption is cross checked on Z→ee sample with reconstructed tracks



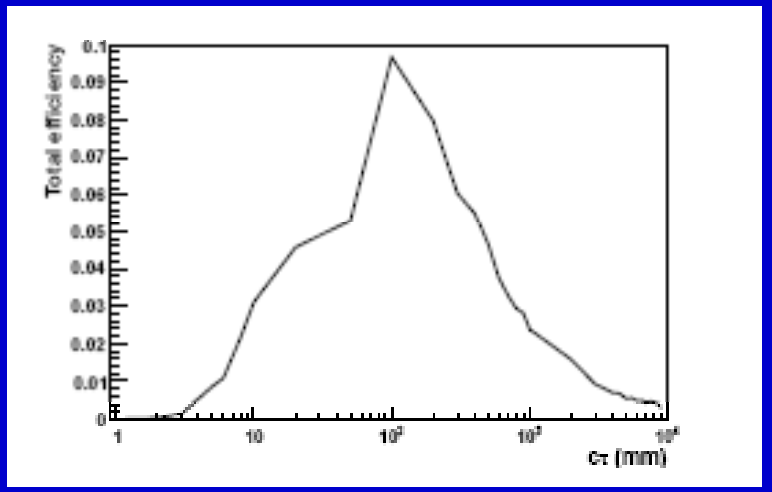


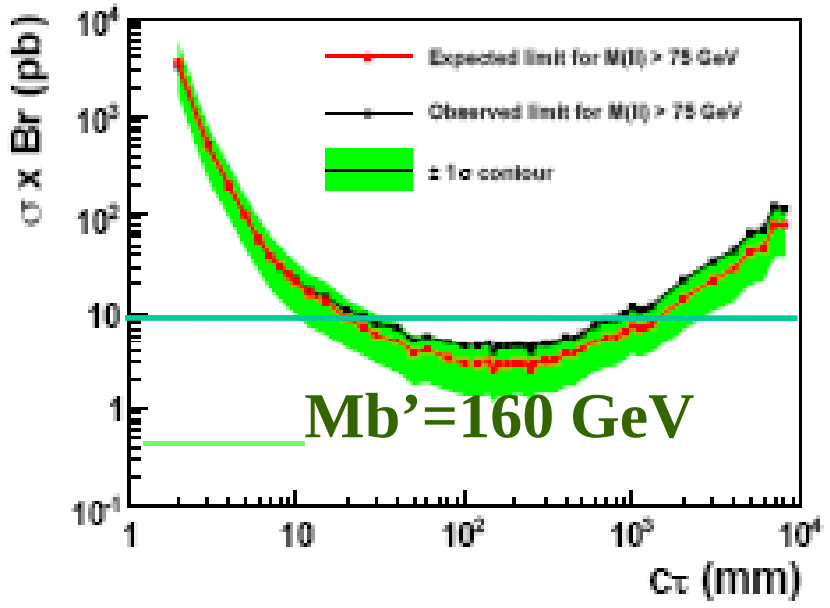
Mee>75 GeV

Number of observed events 49
Expected background 45+-6.7

Results of D0 search

- Efficiency is low for small lifetime, because of the “no-track” requirement and cut on DCA>2 cm
- Efficiency is dropping again for lifetimes longer than 1m, because b’ is decaying outside of EM calorimeter
- Production cross section does not depend on ctau, but is decreasing with b’ mass





Results

- DØ and CDF used complimentary strategies and thus are sensitive to different ranges of b' lifetime