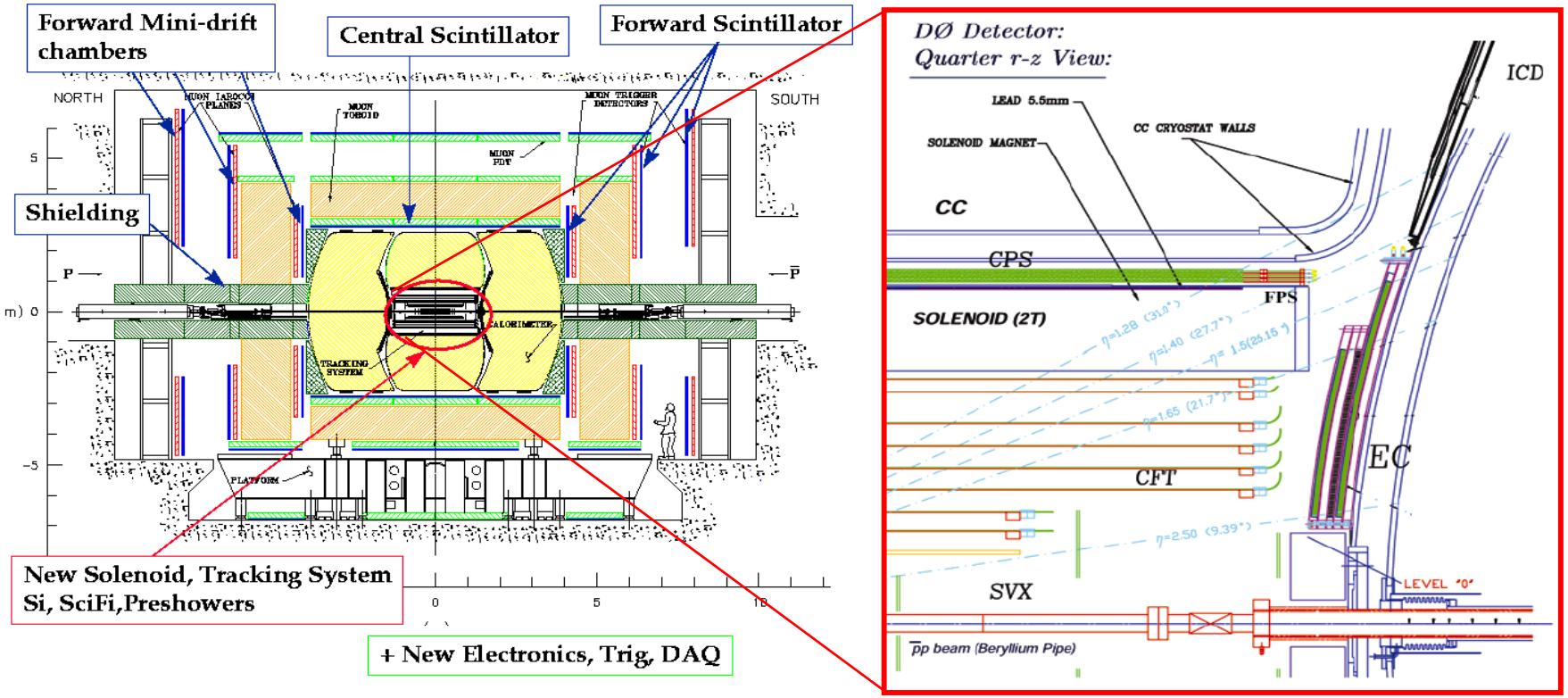
Tagging jets from *b* quarks at DØ in Run II

- Run II started March 2001
- Delivered ~25pb^{-1} at 1.96TeV in first year
- DØ Upgrade detector complete
- Starting to understand *b*–tagging methods
- All results are preliminary

Upgrade Detector

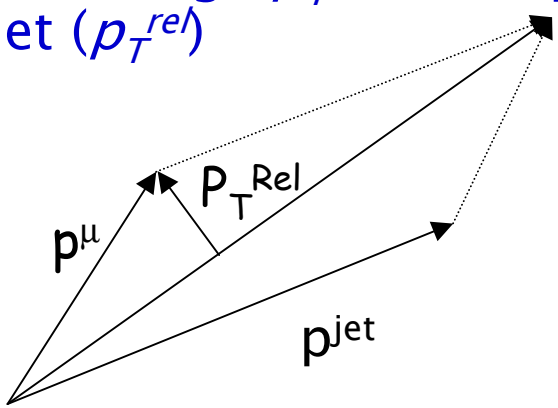
o **Building on traditional strengths:**
- Faster readout for calorimeter detectors
- New Preshower Detectors (CPS, FPS)
- Upgraded muon system for better muon ID

o **New tracking systems:**
- Silicon Microstrip Tracker (SMT)
- Central Fiber Tracker (CFT)
- 2T Solenoid Magnet



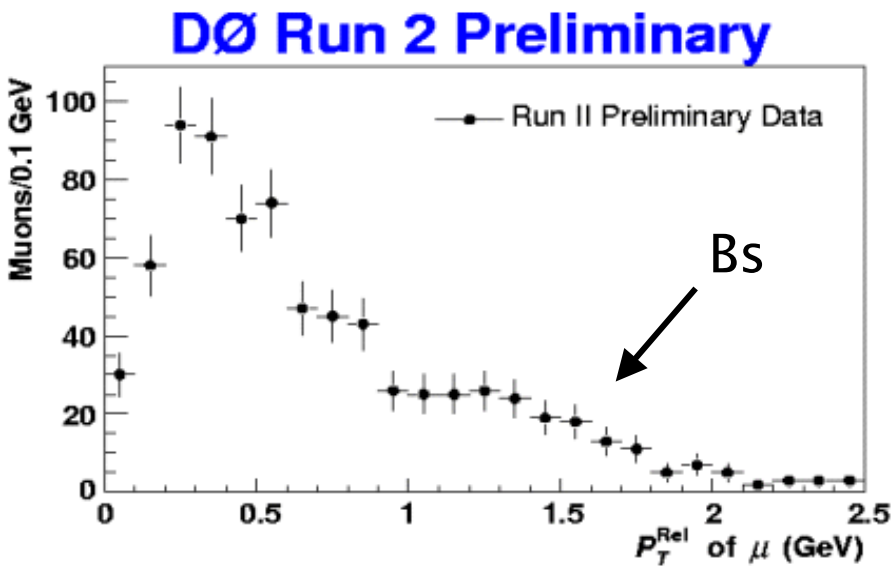
Lepton Tagging: Muons

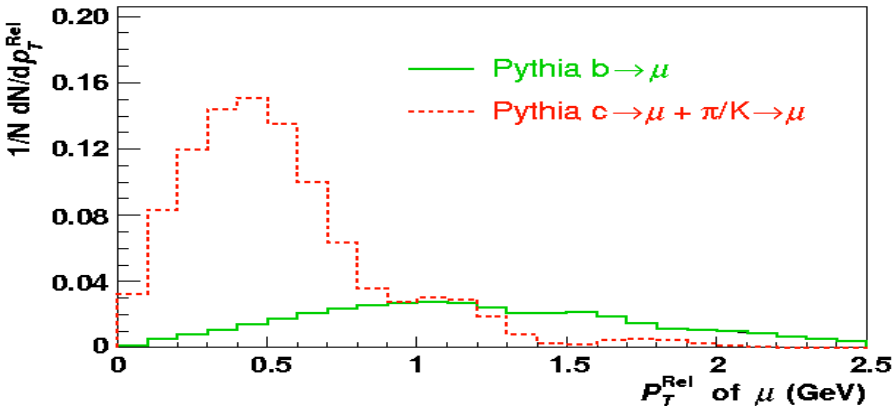
- Muons from b decays will have large p_T with respect to jet (p_T^{rel})



- Longitudinal p_μ/E_{jet} gives additional discriminative power
- High purity, but suffers from low branching ratio

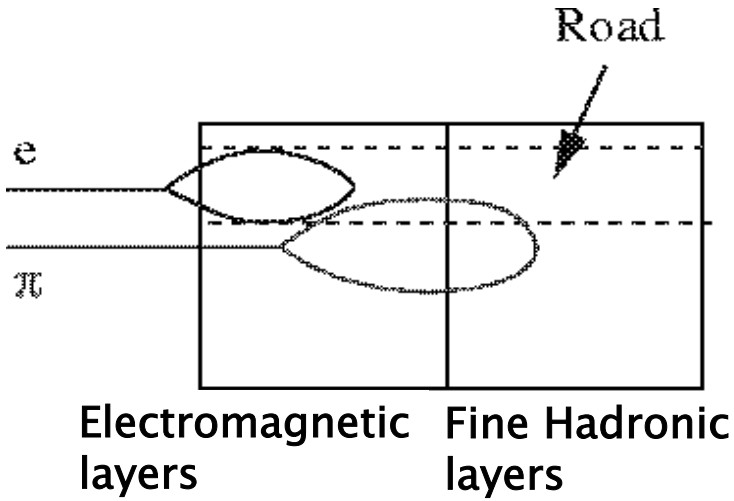
  ($b \to \mu \nu_\mu X \sim 10\%$)
- Use MC templates to determine b–content



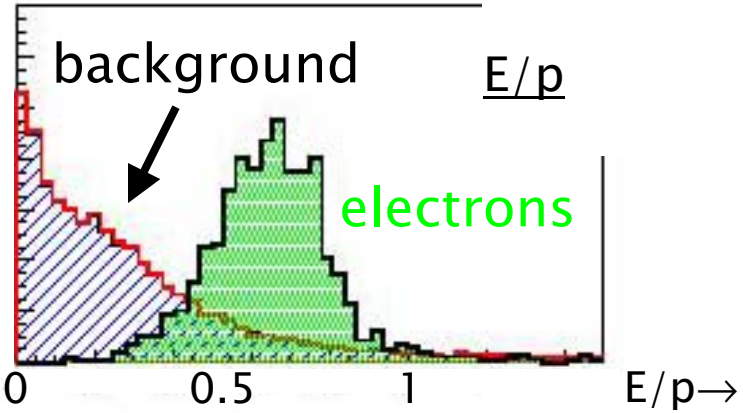


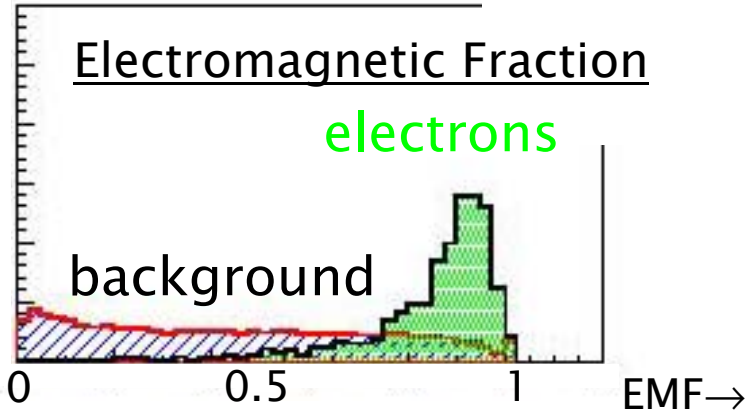
Lepton Tagging: Electrons

- Electrons inside jets harder to find than muons
- Electron ID relies on projecting tracks into calorimeter: Road Method
- Preshower detector multiplicity helps reject background



DØ Run II Monte Carlo

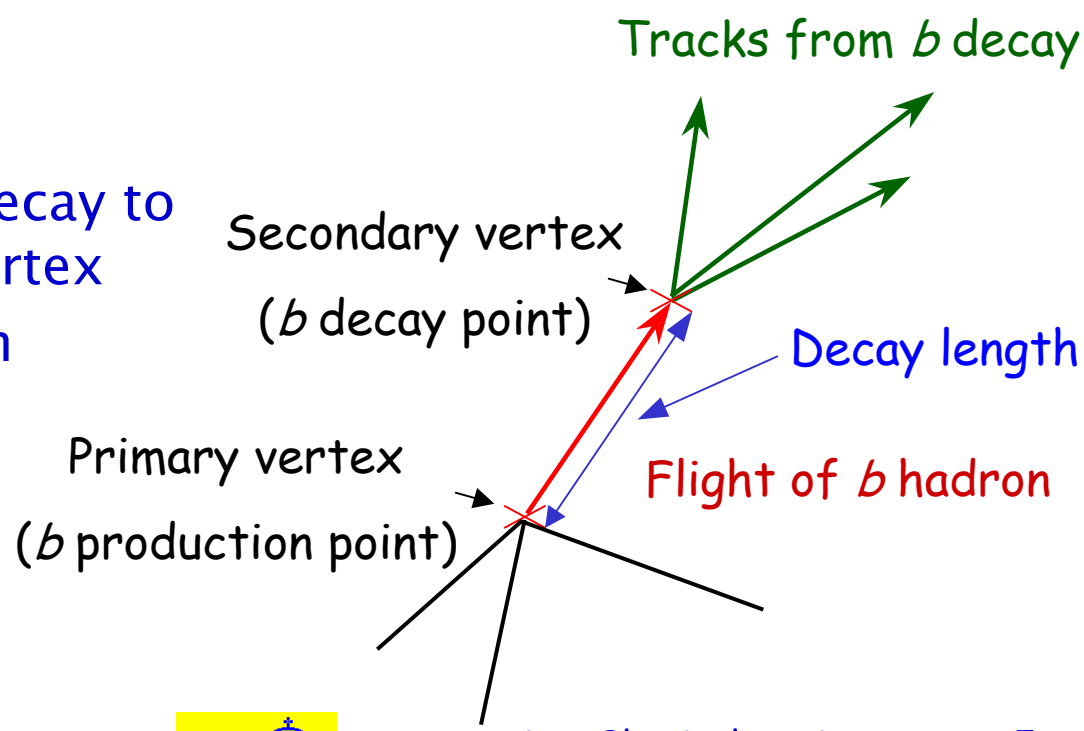




Secondary Vertices

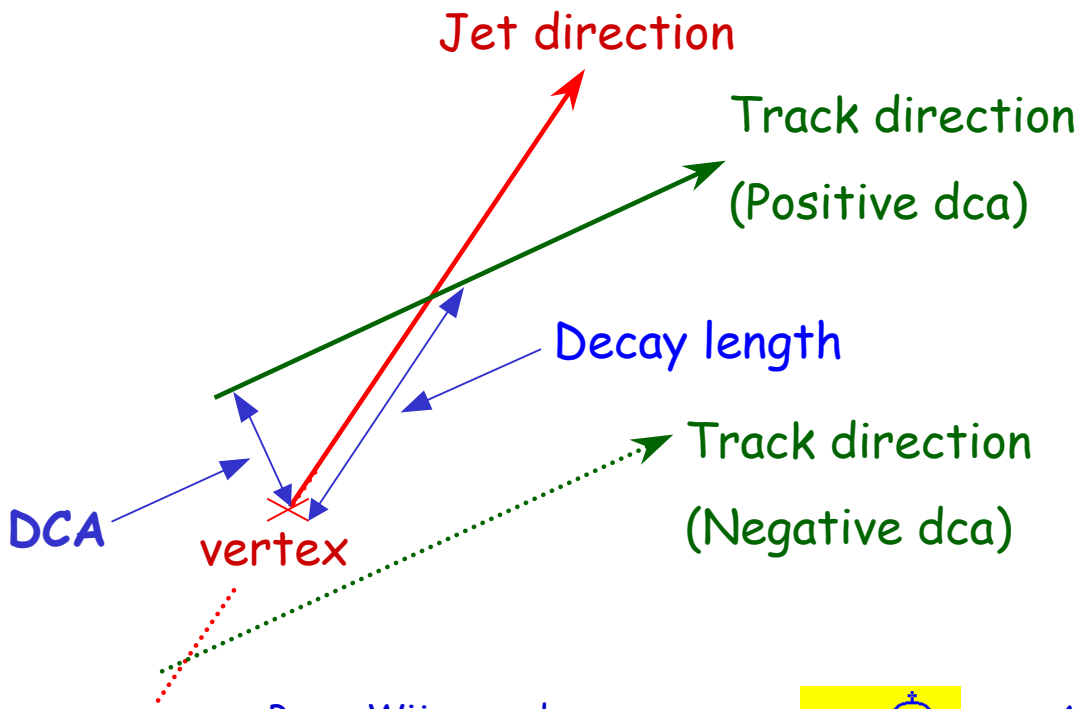
- *b* hadron lifetime ~1.5ps
  $\Rightarrow$ can use decay length of *b* hadron to tag event
- Mean decay lengths $\mathcal{O}$(mm)
  $\approx$ 6mm for $t \rightarrow Wb$
  $>$ 5mm for $H \rightarrow bb$
- Use tracks from *b*–decay to reconstruct decay vertex
- Cut on distance from primary vertex

- MC Vertex resolutions:
  Primary: 15–30 μm in(x, y)
  Secondary: 100–150 μm

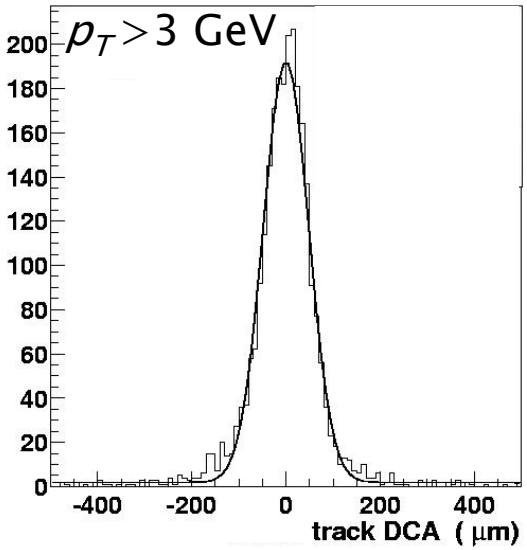


Impact Parameter Tagging

- Use information carried by tracks without reconstructing secondary vertices
- Look at "Distance of Closest Approach" (DCA)
- Significance = DCA / σ(DCA)
- Sign is positive for "downstream" tracks

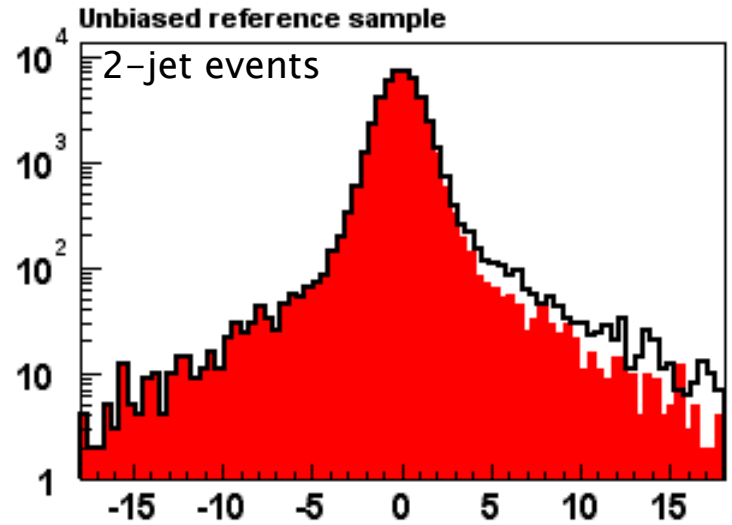


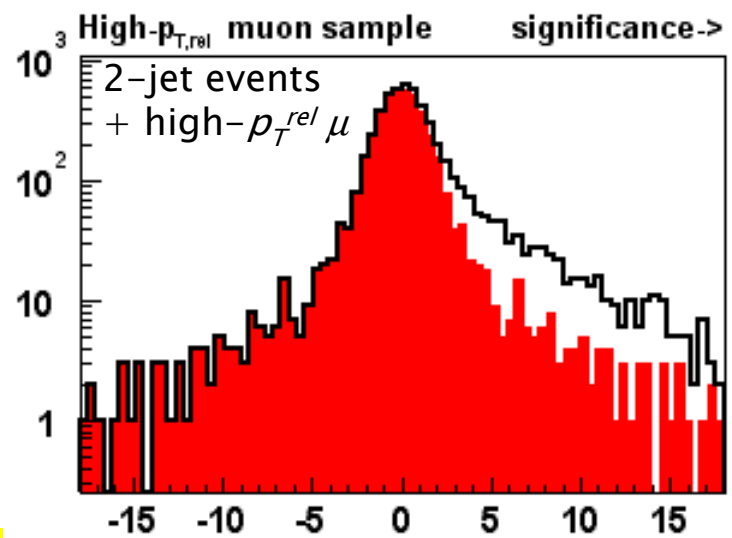
DCA resolution ~ 50 μm
Beam spot ~ 30-40 μm



Significance Distribution

- Negative side of significance distribution due to resolution smearing only
- Positive side contains lifetime information
- Compare unbiased sample to *b* enriched sample
  - 2-jet events with a muon with $p_T^{rel} > 1$ GeV
- Need to apply cuts:
  - Track quality cuts
  - Real background: long-lived particles (K_s, Λ)
    $\Rightarrow$ remove tracks with large dca (> 1mm) and low p_T (< 1.5 GeV)





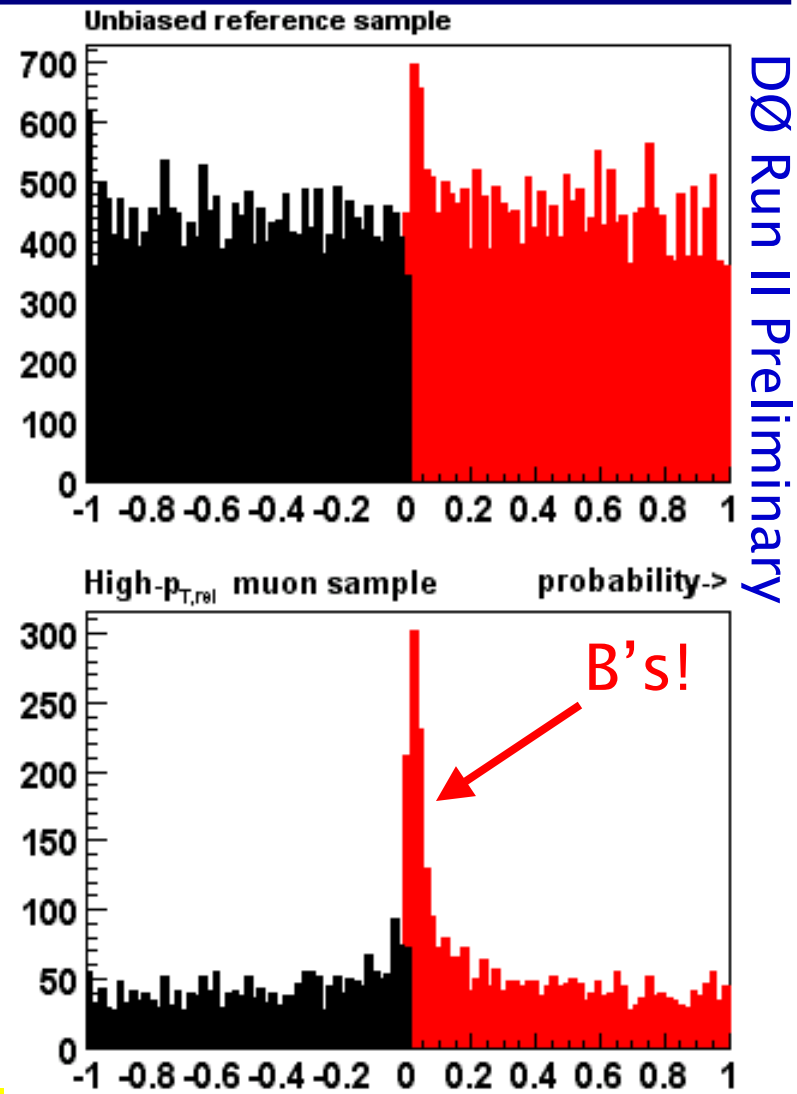
DØ Run II Preliminary

Track Probability

- Determine resolution from negative DCA side of reference sample
- Use resolution to compute probability that the track comes from 0 lifetime decay
- Definite excess for positive impact parameter tracks at small probability!

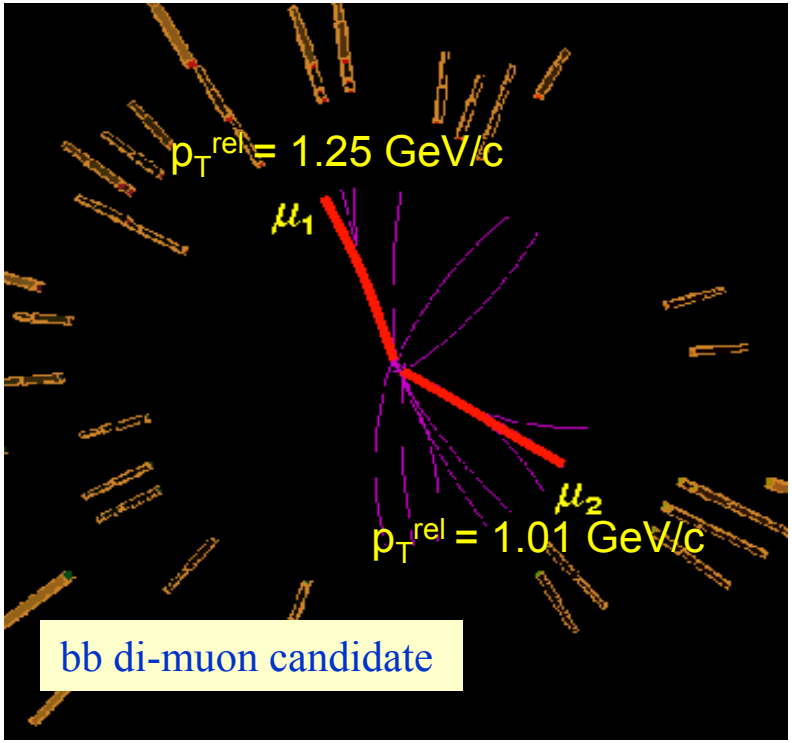
Black: (mirrored) probability for negative significance tracks (background)

Red : probability for positive significance tracks



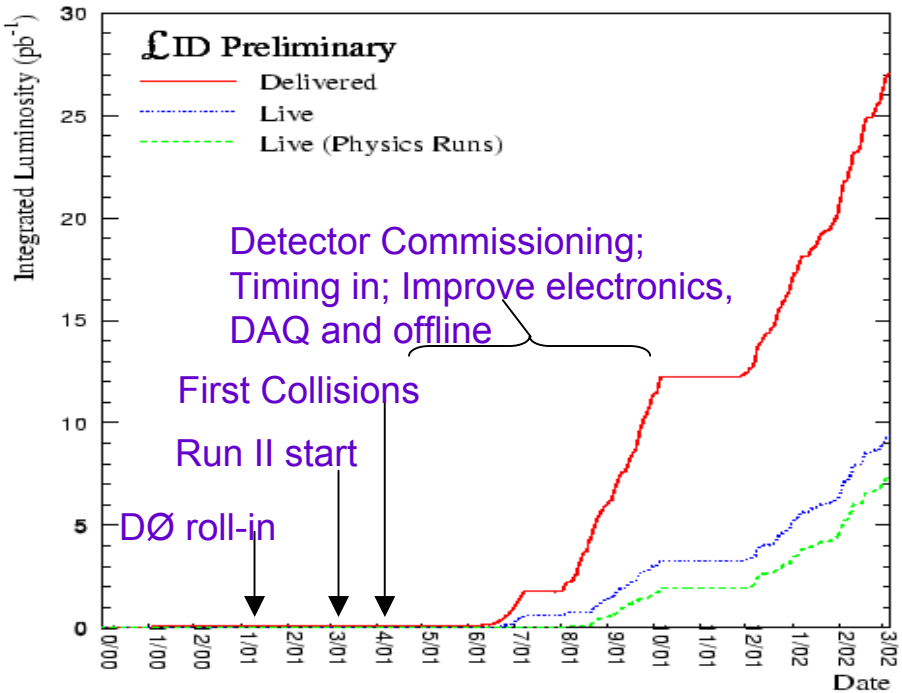
The Future of Run II

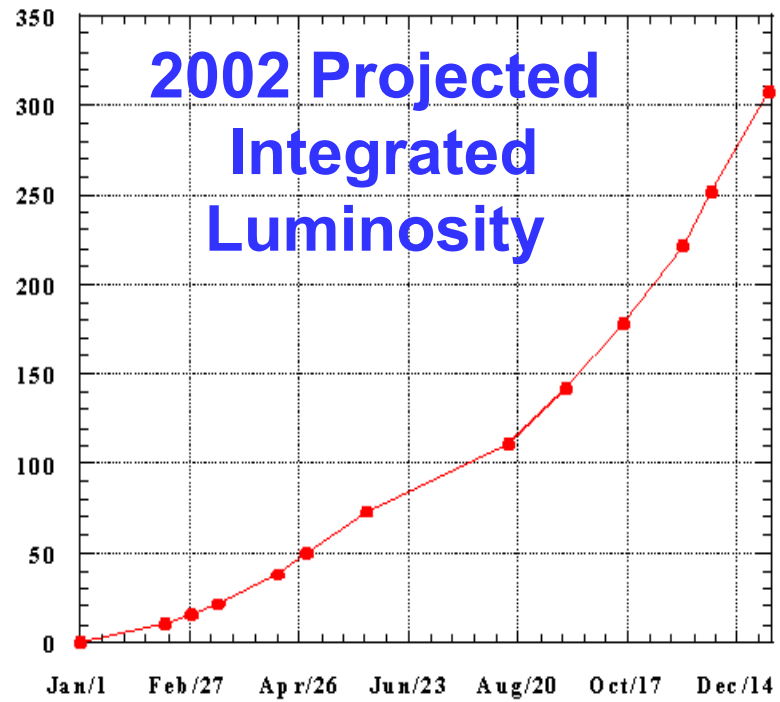
- Expect ~300pb^{-1} for 2002 (and up to 15fb^{-1} for Run II)
- Upgrade detector ready for *b*–measurements and searches
- Muon tag most developed
- Seeing signal in Impact Parameter tag
- Electron tag and Secondary Vertex tag coming soon



The Start of Run II

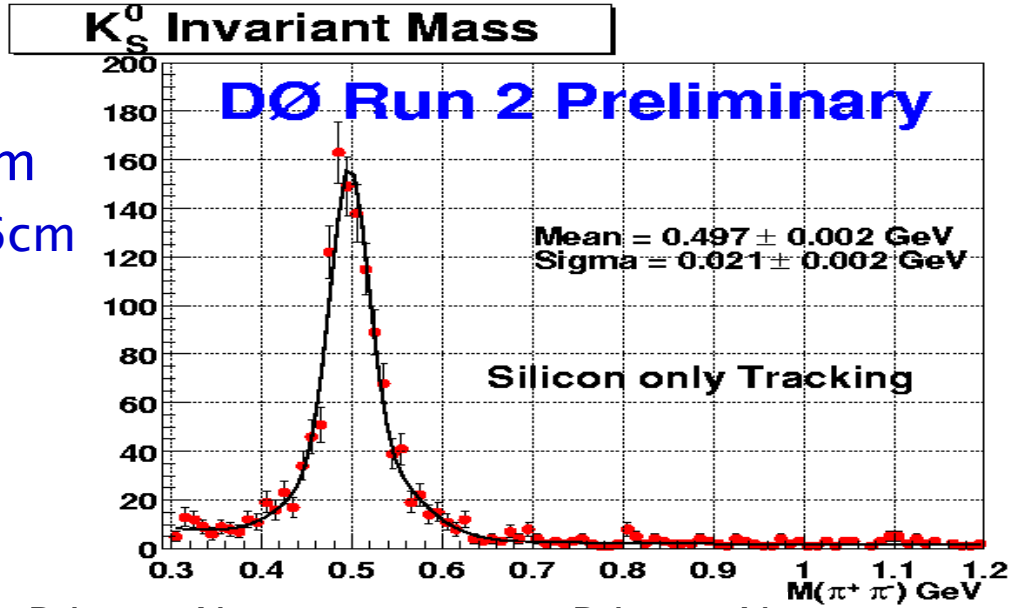
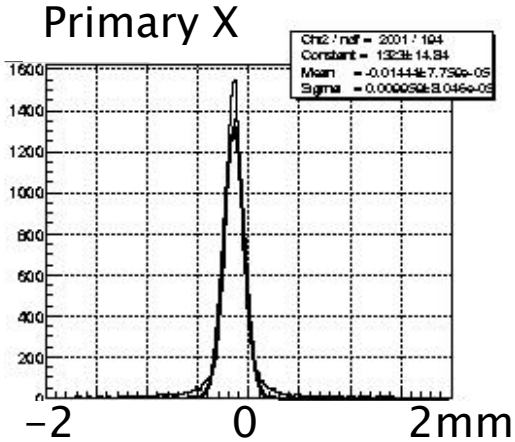
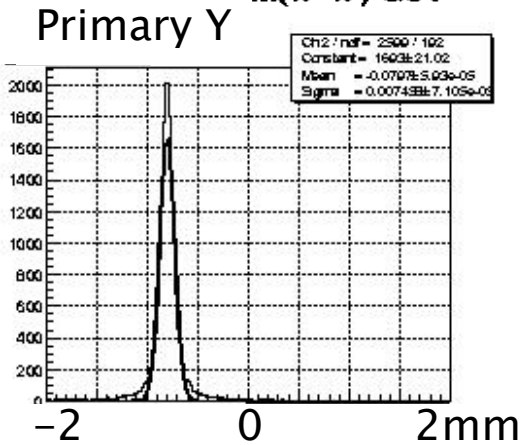
- Delivered ~25pb^{-1} in first year of running at 1.96TeV (recorded 100pb^{-1} in Run I)
- Significant amount of data used for commissioning
- Making good progress in object ID (e, μ, jets, ME_T etc…)
- Expect ~300pb^{-1} for 2002!





Secondary Vertices

- K^0_s reconstructed with secondary vertex algorithm
  - K^0_s mean decay length ≈6cm
  - Cut on 3.5mm



- Primary vertices