The members of the D0 collaboration express their appreciation for the award of the 2019 European Physical Society Prize for High Energy and Particle Physics.

(Some of the nearly 1500 collaborators over 36 years on the occasion of the Tevatron shutdown Sept. 30, 2001)

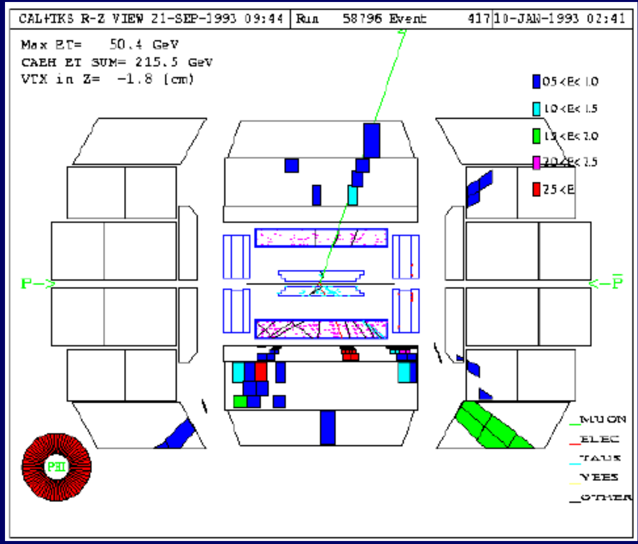
DØ thumbnail history

D0 began in 1983 to complement CDF, which had a 4 year head start. The original detector emphasized finely segmented calorimetry (U LAr), large coverage muon detection but no magnetic field and small (R<75 cm) tracking.

Run I operation began in 1992. The 2nd publication (1994) set the last lower limit on the top quark mass and showed a striking e μ $\not{E}_T$ +2 jets event.

Its 5th publication (1995) reported the "Observation of the Top Quark".

Run I ended in 1996 and gave 132 publications.

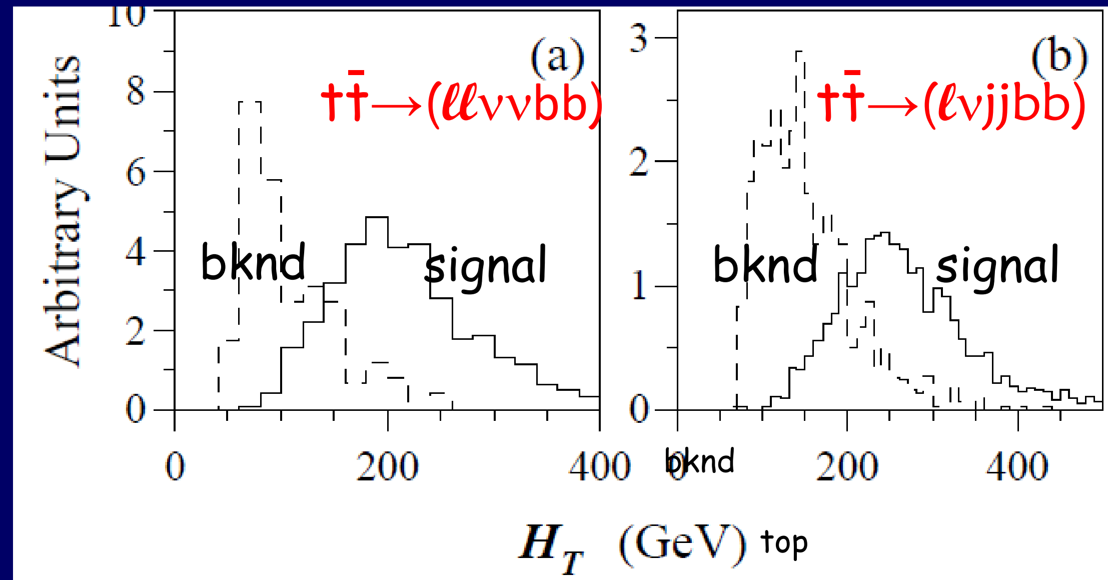


A substantial upgrade was mounted for Run II, including a 2T solenoid magnet, silicon strip vertex detector, scintillating fiber tracking, new muon scintillators and mini-drift chambers, preshower detectors, new calorimeter electronics and expanded triggers.

Run II began in 2000 and ended with the Tevatron shutdown Sept.30, 2011. To date, 498 publications with more to come.

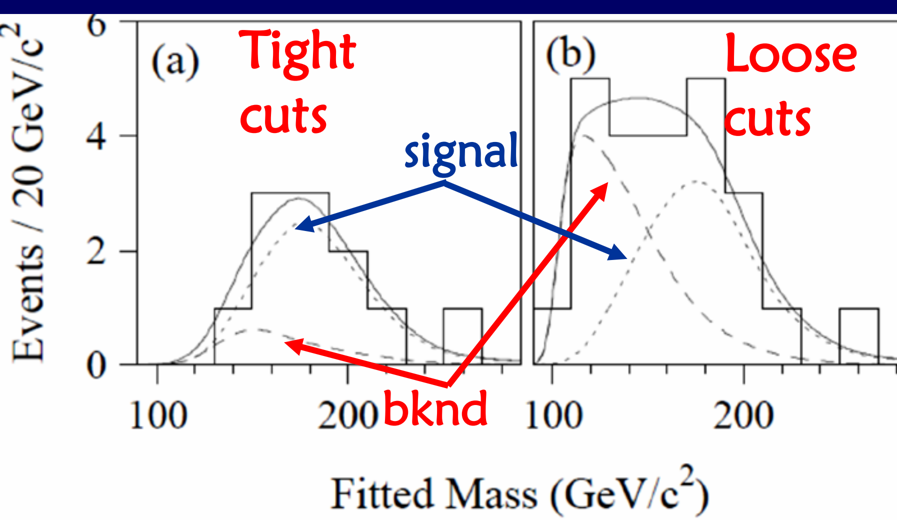
DØ Top quark discovery paper, Feb. 25, 1995

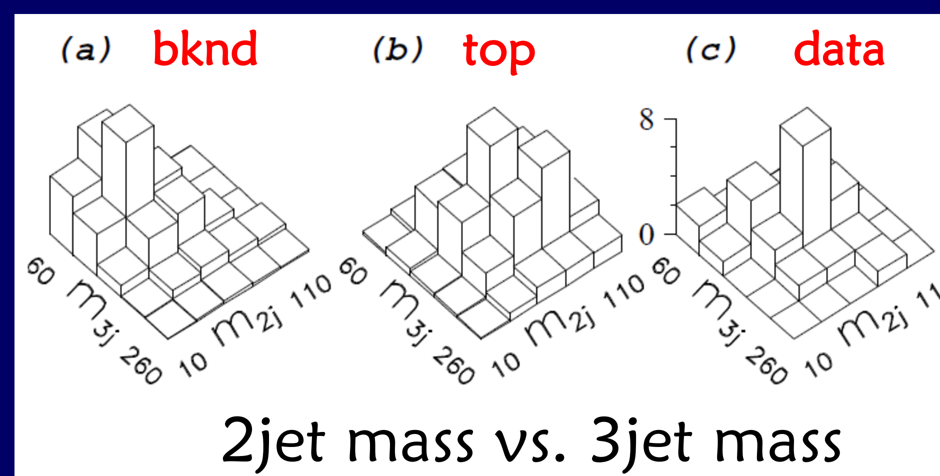
D0 had no displaced vertex tagger, so relied on topological variables Aplanarity, H_T



With tight cuts: found 17 events, 3.8±0.6 background

Reject background-only hypothesis at 4.6σ





Top quark announcement

March 2, 1995: Joint CDF/DØ seminar announcing the top quark discovery

Top quark properties

The 50 pb^{-1} used for discovery ultimately grew to 10 fb^{-1}.

There were many detailed measurements of $t\bar{t}$ pair and single top production, including differential and total production cross sections, polarizations, spin correlations, forward-backward asymmetries, CPT tests, searches for high mass W', t' and tt resonances, color flow, and tests of Lorentz Invariance.

Top decay measurements included branching ratios, W helicities, and searches for decays to charged Higgs.

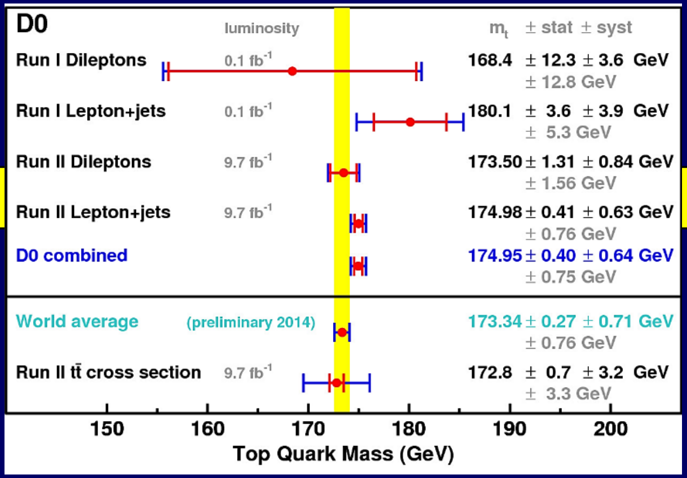
Top quark properties were measured: mass, spin, anomalous vector, axial-vector & tensor couplings.

Many of these remain competitive today, despite the high energy and large data sets at the LHC …

Top quark mass

- M_t, as simulated in MC, can be measured quite precisely, but its meaning is not clear

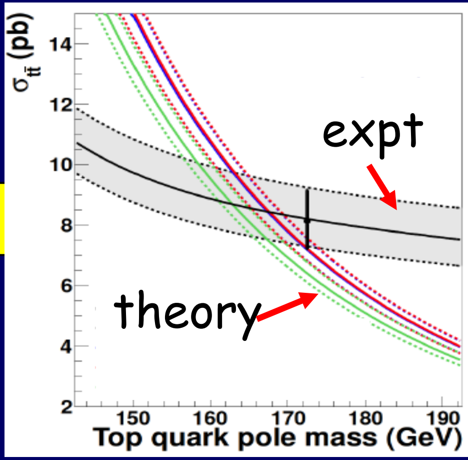
m_{MC} (D0) = 174.95±0.75 GeV



m_{MC} (CMS) = 172.35±0.51 GeV

- Theoretically well-defined pole mass is determined from the intersection of measurements and NNLO theory as function of m_t

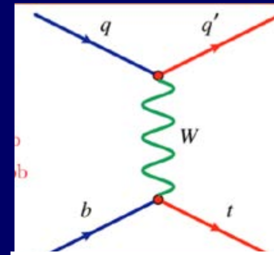
m_{pole} (D0) = 169.1±2.5GeV (prelim)



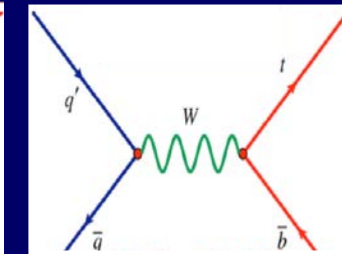
m_{pole} (ATLAS) = 173.2±1.7GeV

Single top

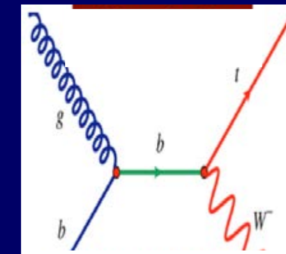
Lower XS than tt by 1/2, fewer final objects, so larger background. 2009 discovery required extensive use of multivariate methods.



t-channel



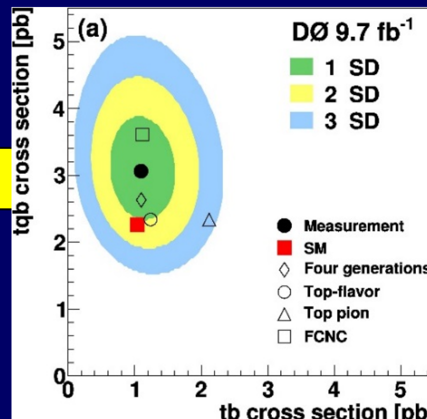
s-channel



t-W prod.
(s-chann. b)

σ(t-ch) (D0)=3.07 pb ±16%

σ(s-ch) (D0)=1.10 pb ±47%

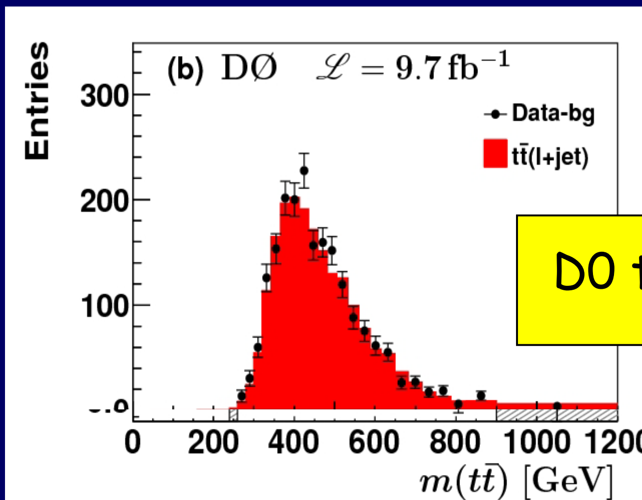


σ(t-ch) (CMS)=136.3 pb ±15%

σ(tW-ch) (CMS)=63.1 pb ±11%

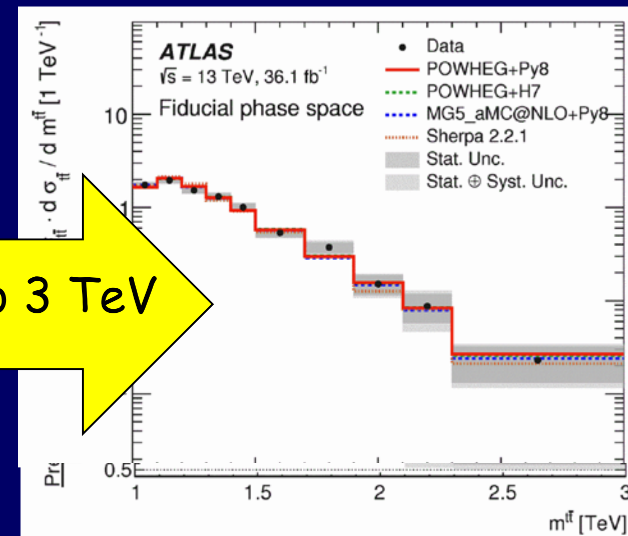
- Ratio of s-channel to t-channel XS is sensitive to non-SM models
- Combination of single top XS and W helicity in top decay constrains anomalous top couplings
- CKM matrix element $|V_{tb}| = 1.02^{+0.06}_{-0.05}$ (CDF & D0)
- Single top XS and BR($t \to Wb$) allow measurement $\Gamma_{tot} = 2.00^{+0.47}_{-0.43}$ GeV or top lifetime $\tau = (1/\Gamma) = 0.329^{+0.90}_{-0.63}$ ys, (agrees with SM)

Top –antitop production

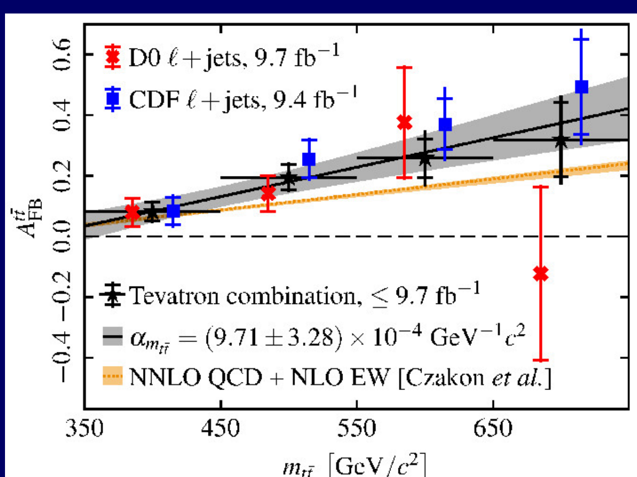


$t\bar{t}$ XS and resonances

D0 $t\bar{t}$ XS to 1 TeV; LHC XS to 3 TeV



And LHC observes ttW, ttZ, ttH Yukawa, & much more

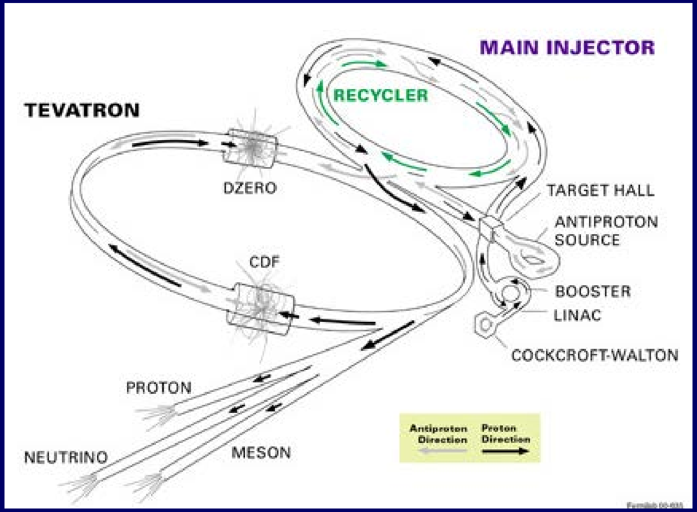


At $p\bar{p}$ Tevatron, A_{FB} measures the tendency for the top (anti-top) to be emitted in the proton (anti-proton) beam hemisphere. SM predicts small A_{FB}, growing with m_{tt}. (At pp LHC, A_{CF} is much smaller)

Early measurements sensed a discrepancy but more precise measurements and improved theory showed SM agreement.

Our thanks

Over the years, the 8 accelerators in the Tevatron complex raised the instantaneous luminosity by x400 over the initial design.



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Congratulations to all !