Top Physics at DØ

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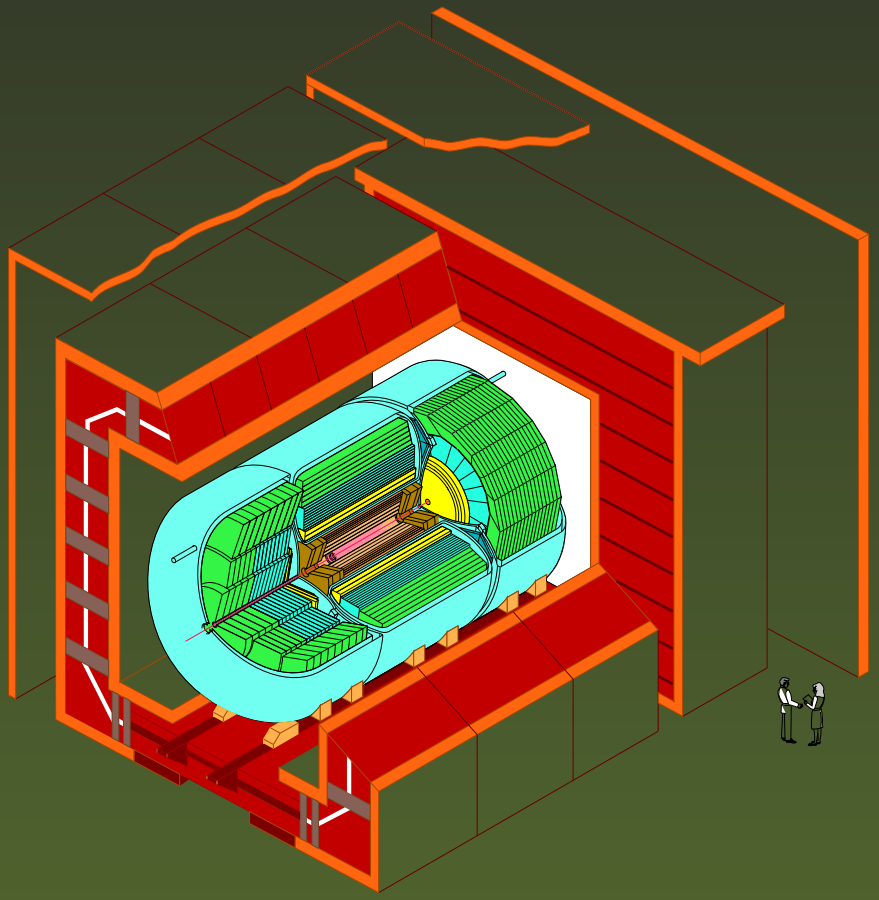
Outline

- Intro to DØ
- Introduction to Top at the Tevatron
- Top Results from RunI (review)
- The Upgrade
- Top Results from RunII (future)
- Current Status

Intro to DØ

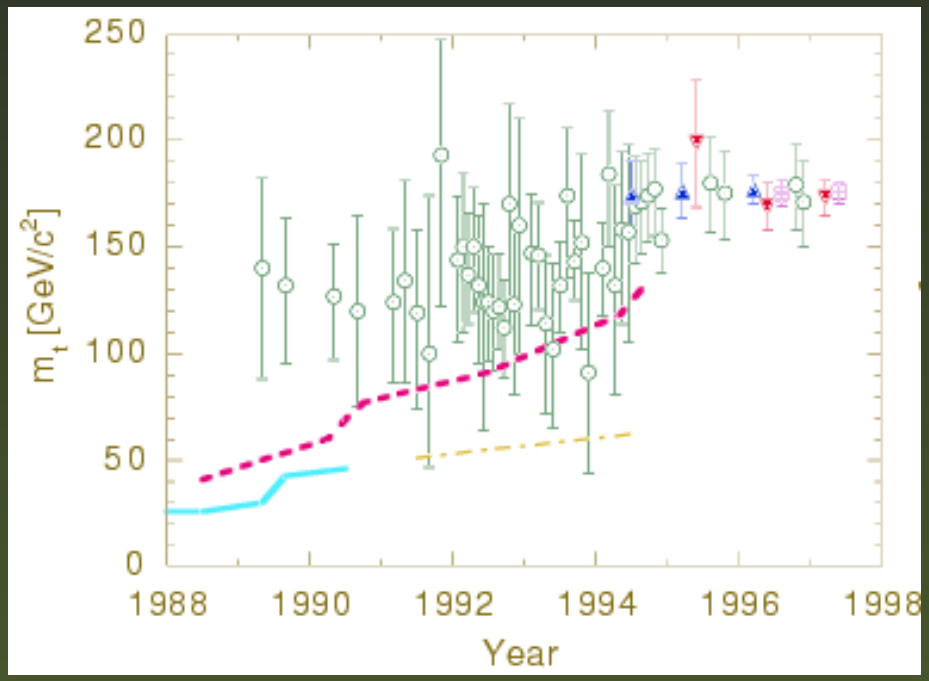
- General purpose detector at the Fermilab Tevatron



DØ Detector

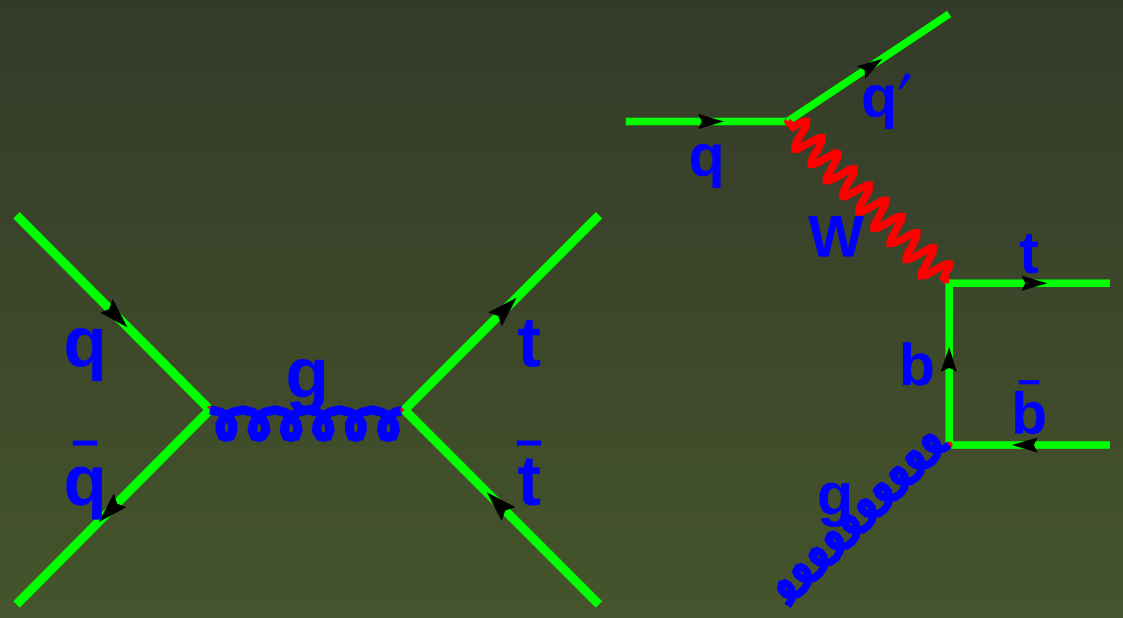
DØ History

1983	first meeting
1985-87	Detector R&D
1988-91	Construction
1992-96	RunI
1995	Top Discovery
1996-00	Upgrade
2000	100th Paper
2001-	RunII



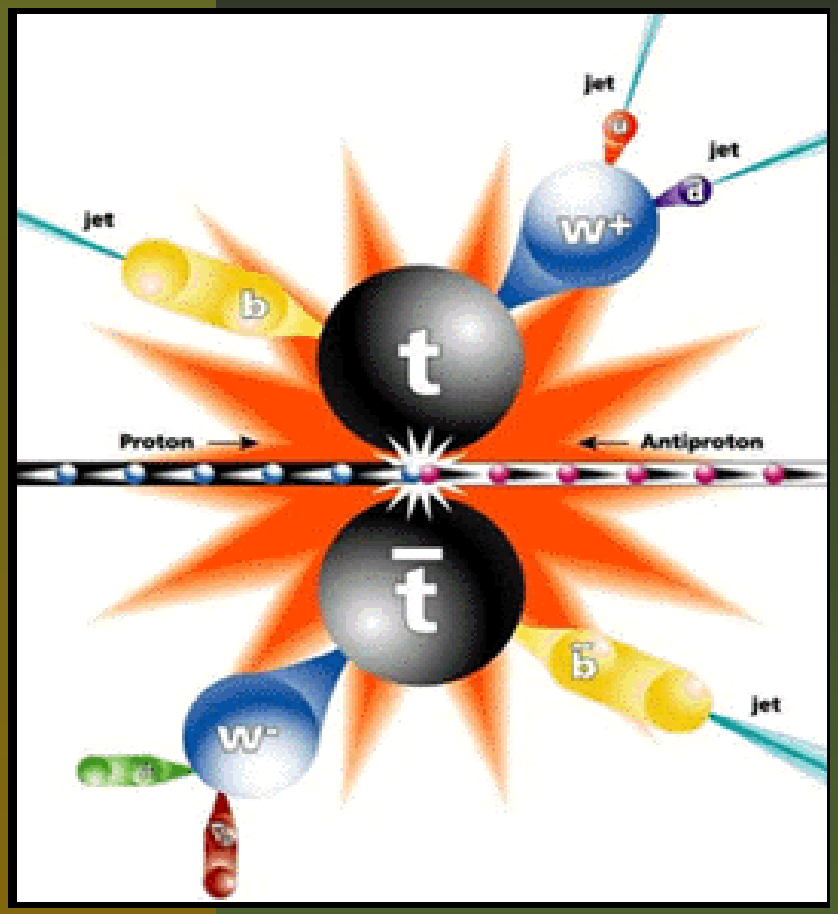
Intro to Top at Tevatron

- A few different ways to make a top at the Tevatron



- Dominant diagrams for $t\bar{t}$ and EW top production shown.

Intro to top at Tevatron

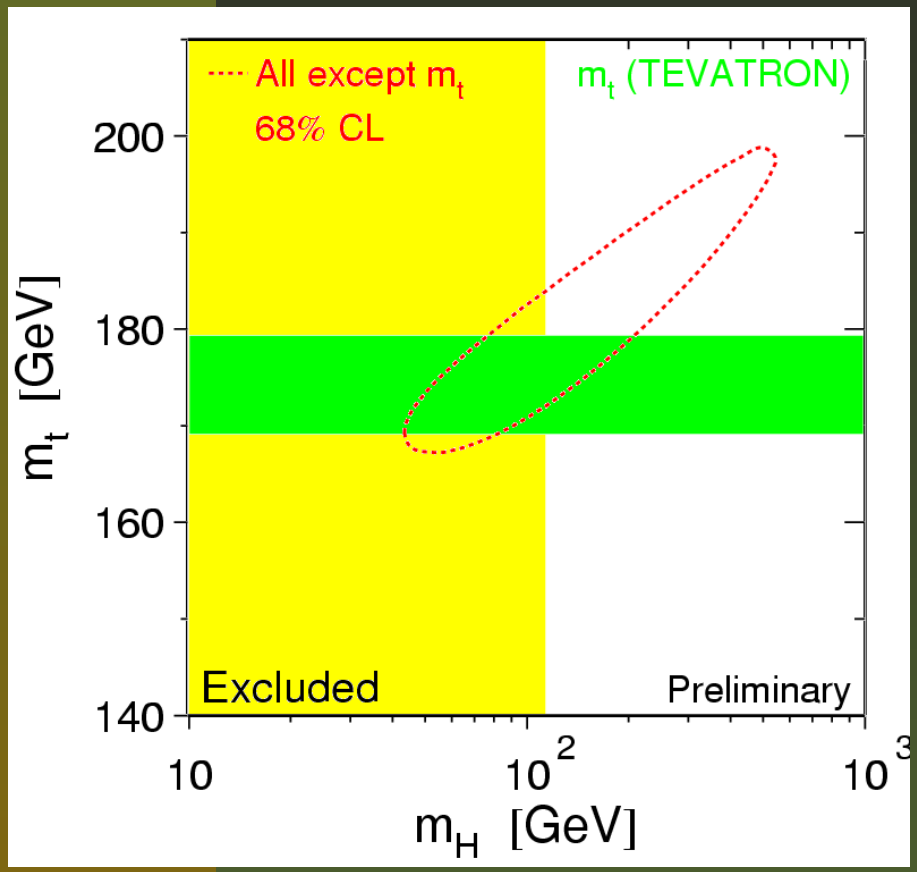


- Br(t→Wb)≃1
- Samples named by final state from W decay

dilepton (ee,eμ,$\mu\mu$)	5%
l + jets (l = e,μ)	30%
τ + X	21%
all jets	44%

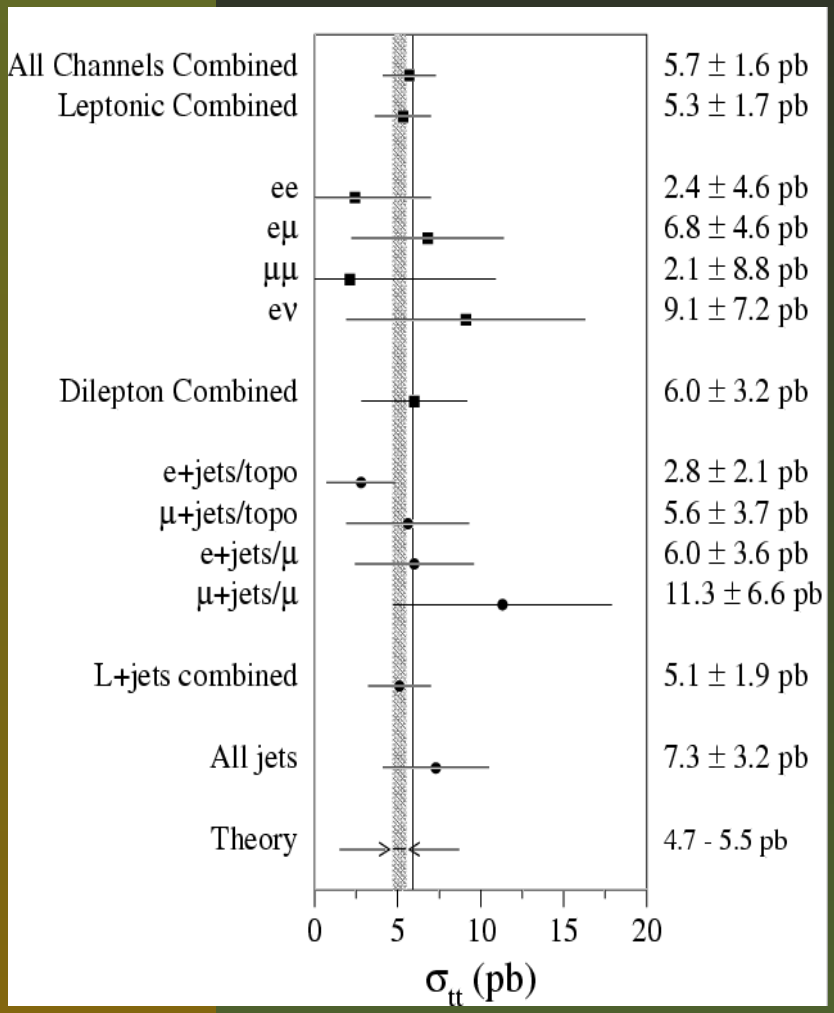
- Further by "class"
  - l + jets (lepton b-tag)
  - l + jets (topological)

RunI Review: Top Mass



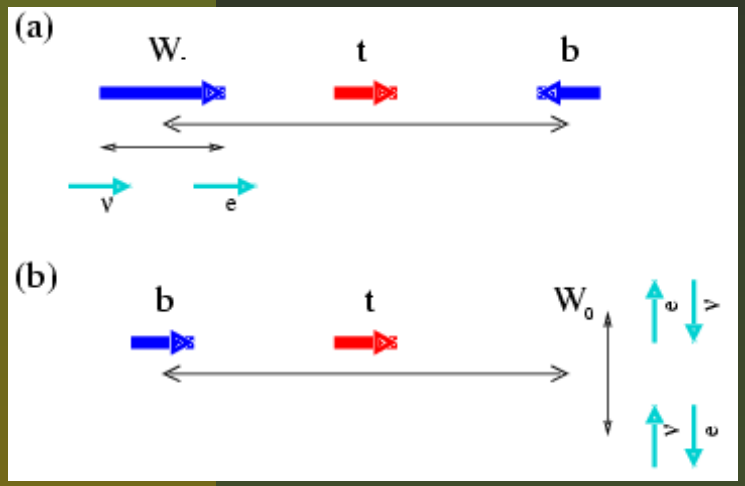
- Top mass measured using l + jets and dilepton samples
- DØ measures $m_t = 172.1 \pm 5.2 \pm 4.9$ GeV
- Combined DØ + CDF is $m_t = 174.3 \pm 5.1$ GeV

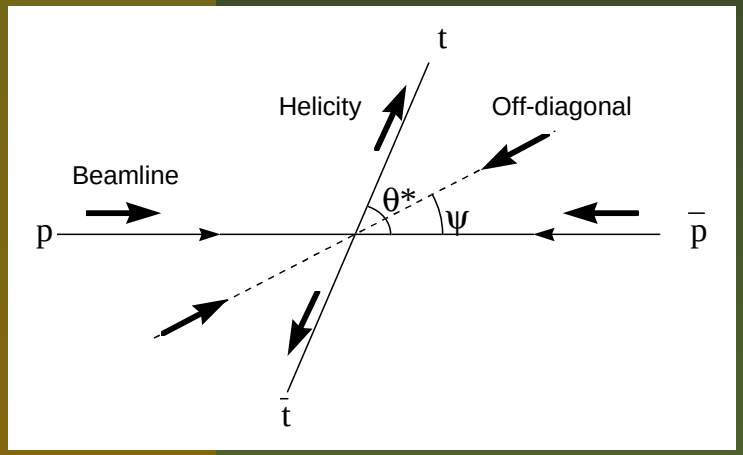
RunI Review: $t\bar{t}$ Cross-section



- Cross-section measured using all top events (80 events) in l + jets, dilepton and all-jet samples
- DØ measures $5.69 \pm 1.21 \pm 1.04$ pb

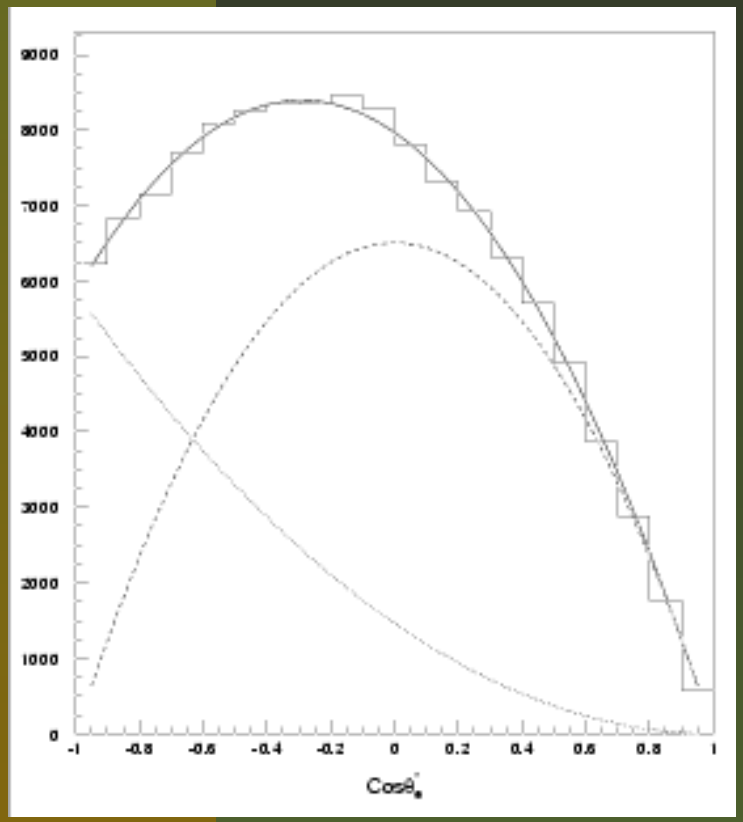
RunI Review: $t\bar{t}$ Spin Correlation





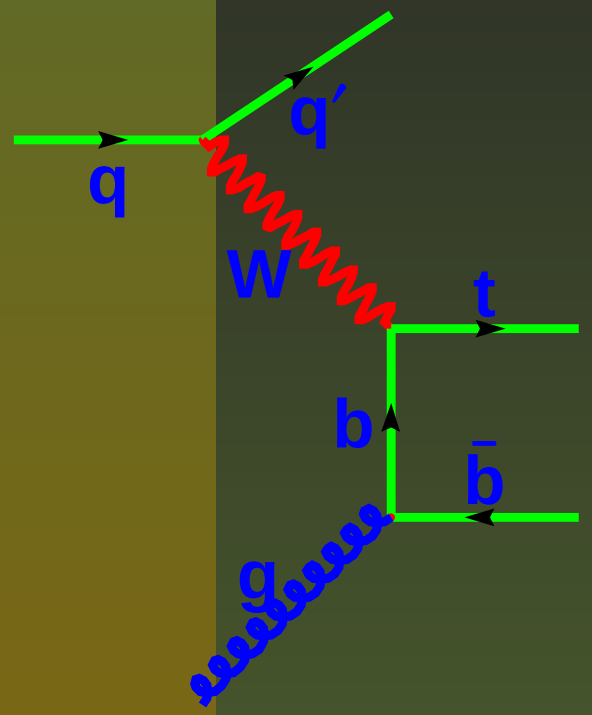
- Top from $t\bar{t}$ expected to be unpolarized
- Event by event spins of t and $\bar{t}$ are correlated
- Probe "free" quark, info about V_{tb}, seek new physics
- DØ did measurement in dilepton channel
- DØ measures $\kappa > -0.25$, SM says $\kappa = 0.88$

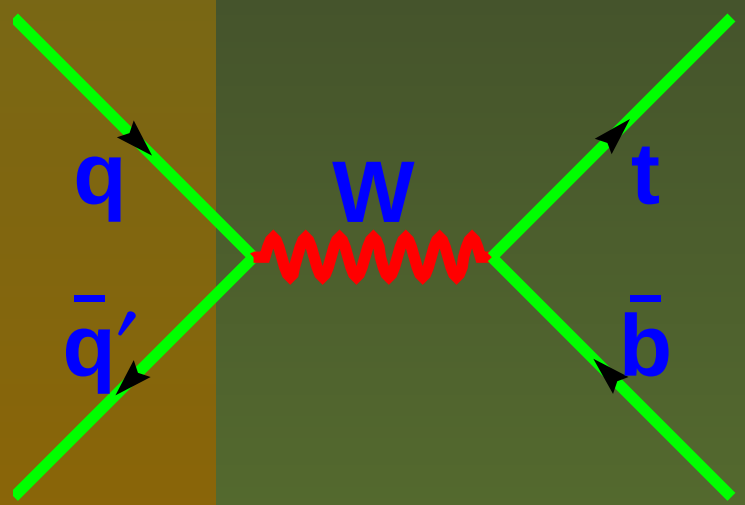
RunI Review: W helicity



- Top quarks decay to Wb nearly 100% of the time
- Produced Ws are never right-handed. 70% long., 30% left.
- Angular distribution of lepton sensitive to helicity of W.
- Can instead use P_t spectrum of lepton
- DØ RunI measurement in progress

RunI Review: Electroweak Top





- Haven't verified existence yet!
- Cross-section proportional to $|V_{tb}|^2$
- Source of polarized top quarks
- First chance to study polarization of a "bare" quark!
- DØ measures $\sigma < 17$pb for s-channel and $\sigma < 22$pb for t-channel in RunI (th. 0.75, 1.47 resp.)

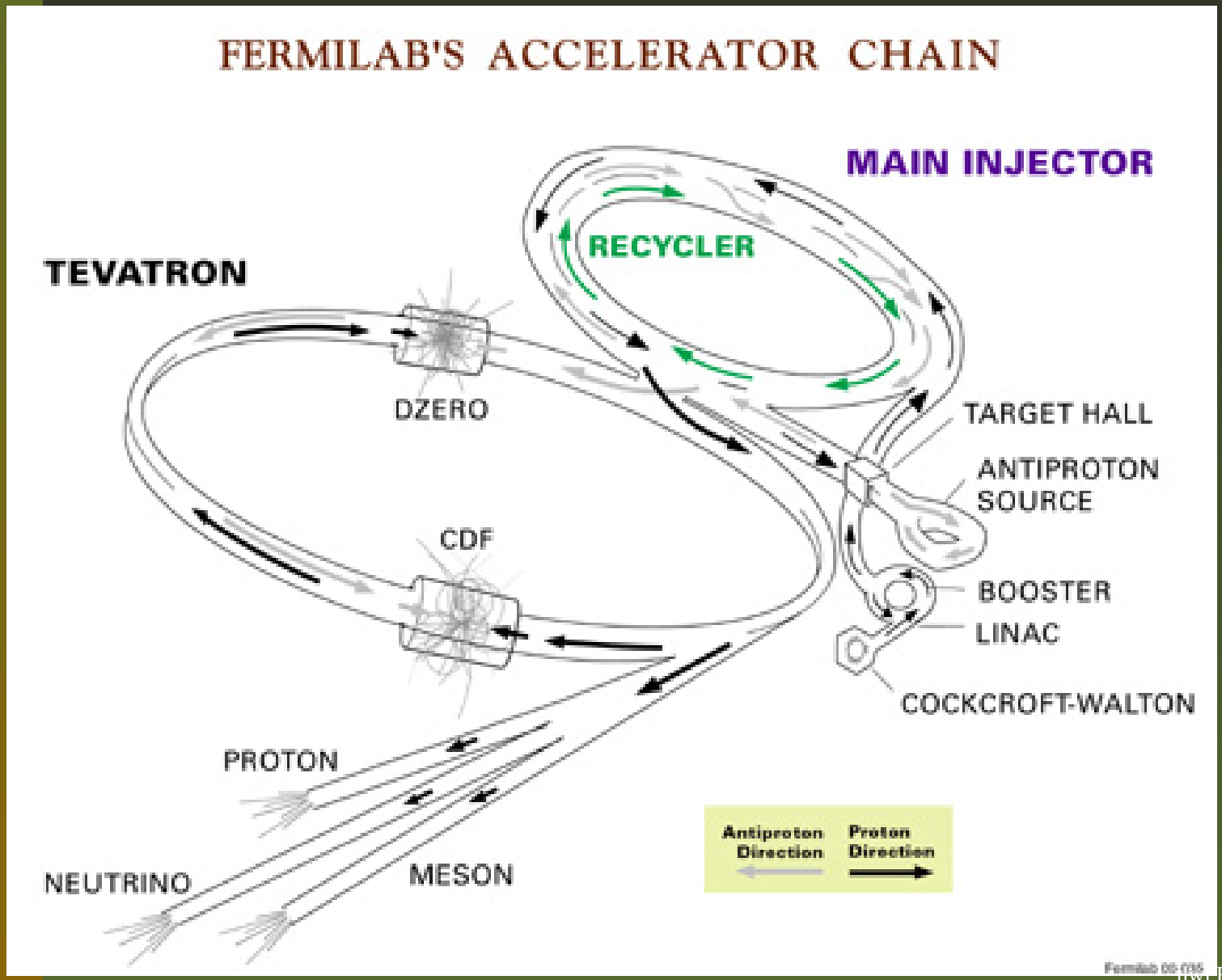
The Upgrade: Tevatron

- RunI ended in 1996. What has happened since?
- Tevatron upgrade. Energy, lumi, main injector
- Comparison:

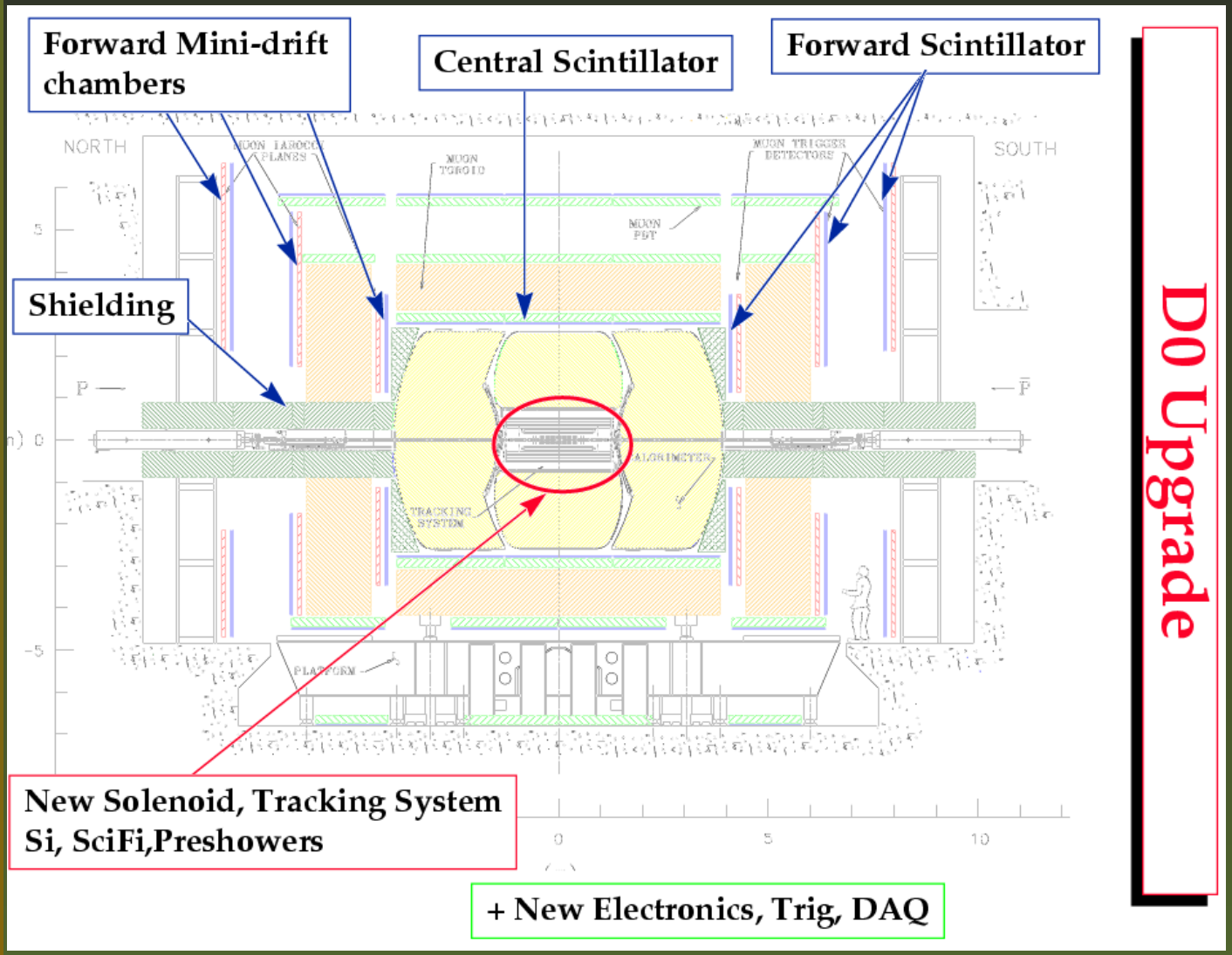
	RunI	RunIIa	RunIIb
Energy	1.8 TeV	1.96 TeV	1.96 TeV
$\mathcal{L}$	10^{31}	2×10^{32}	5×10^{32}
Bunch Spacing	3.5μs	396ns	132ns

- RunIIa = 2fb^{-1}, RunII = 15fb^{-1}.

The Upgrade: Tevatron



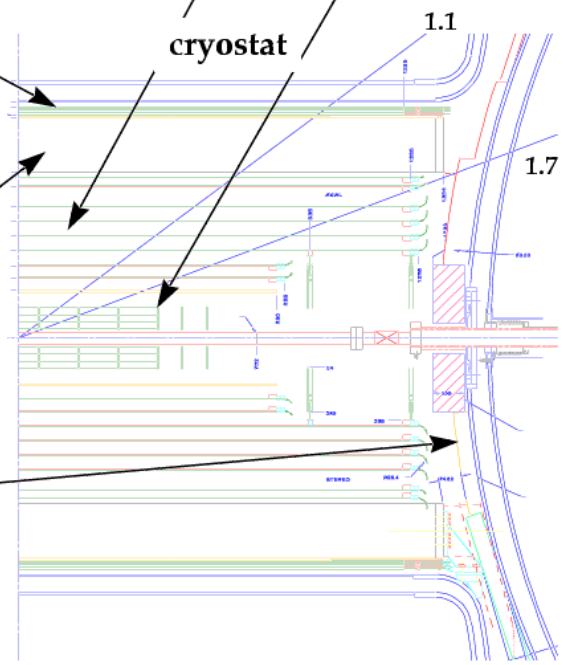
The Upgrade: DØ



The Upgrade: Tracking

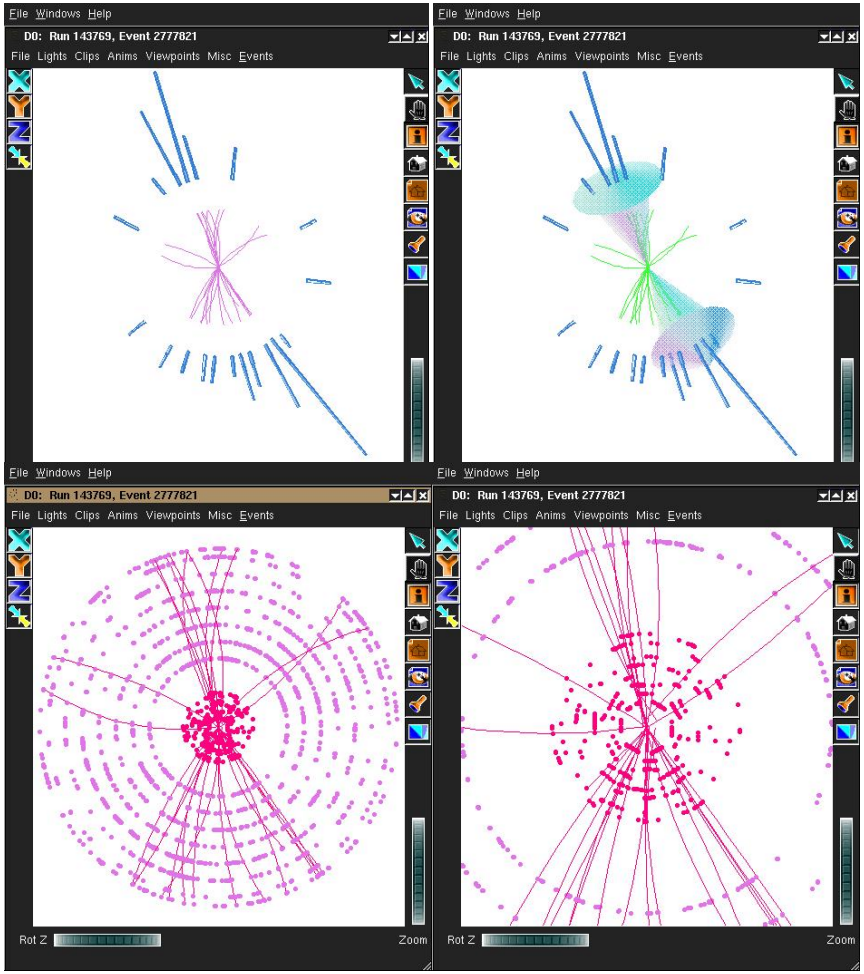
The D0 Upgrade - Tracking

- **Silicon Tracker**
  - Four layer barrels (double/single sided)
  - Interspersed double sided disks
  - 840,00 channels
- **Fiber Tracker**
  - Eight layers sci-fi ribbon doublets (z-u-v, or z
  - 74,000 830um fibers w/ VLPC readout
- **Central Preshower**
  - Scintillator strips, WLS fiber readout
  - 6,000 channels
- **Solenoid**
  - 2T superconducting
- **Forward Preshower**
  - Scintillator strips, stereo, WLS readout
  - 16,000 channels



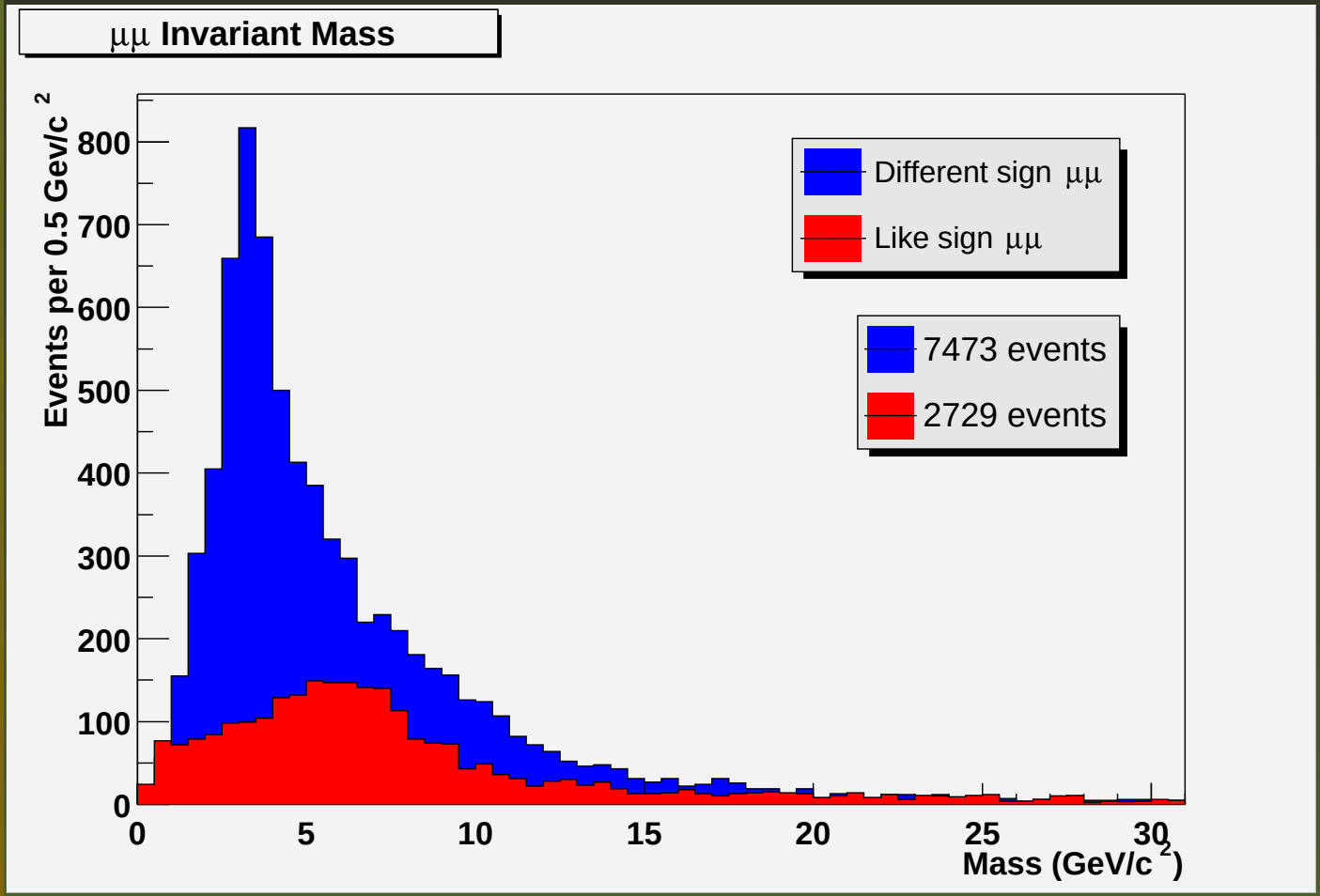
It Works: Tracking

Zoom in to run 143769 event # 2777821

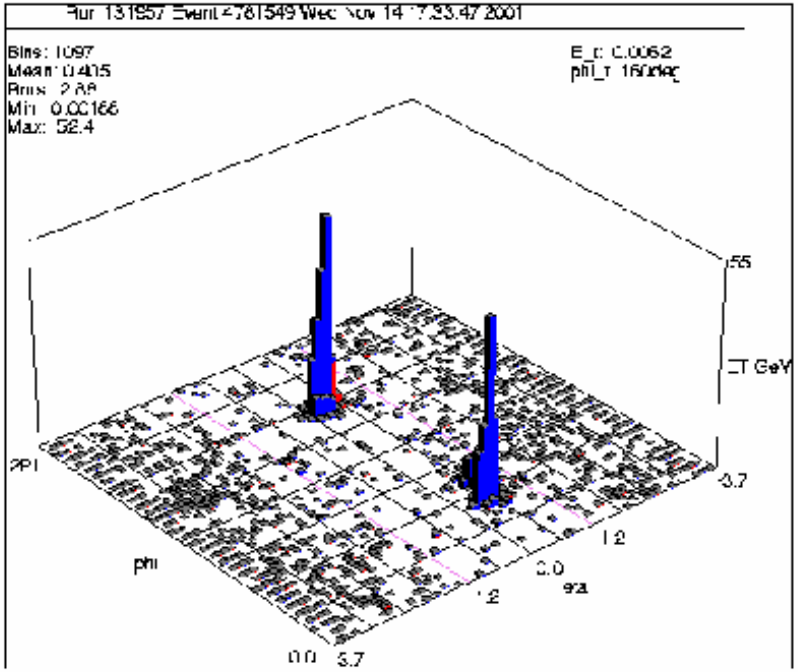


February 2002

It Works: Muon



It Works: Cal

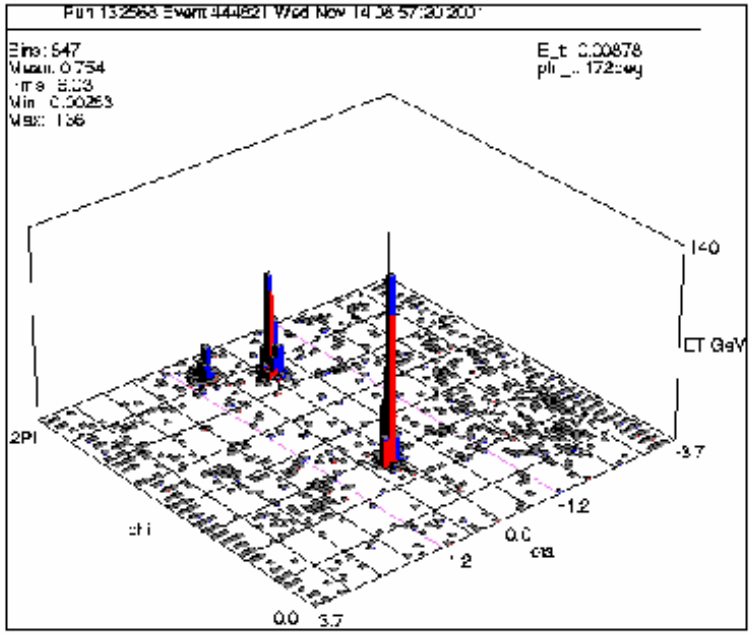


2- jet event

- E_T^{jet1}~230GeV
- E_T^{jet2}~190GeV

3- jet event

- E_T^{jet1}~310GeV
- E_T^{jet2}~240GeV
- E_T^{jet3}~110GeV
- E_T~8GeV



RunII: Top

- We will see a lot more top events in RunII!
- Increased Tevatron energy leads to $\simeq$40% increase in top cross-section. Increased luminosity gains more

channel	RunI	RunIIa
dilepton	6	$\simeq 200$
l + jets	30	$\simeq 1200$

- Larger samples also improve systematics errors (eg. larger control samples like Z+jets).
- Better detector also improves top measurement. Better b-id and jet energy calibration.

RunII: Top

- Using these numbers (with some scaling assumptions) we can project RunIIa numbers for top measurements

Measurement	RunI	RunIIa
Mass	± 7 GeV	$\pm$2-3 GeV
$\sigma(\mathrm{t\bar{t}})$	$\pm 27\%$	$\pm 8\%$
$\mathrm{t\bar{t}}$ spin	$\kappa > -0.25$	2σ
EW top	< 17, 22pb	$\delta \mathrm{V_{tb}} \simeq$ 10-15%

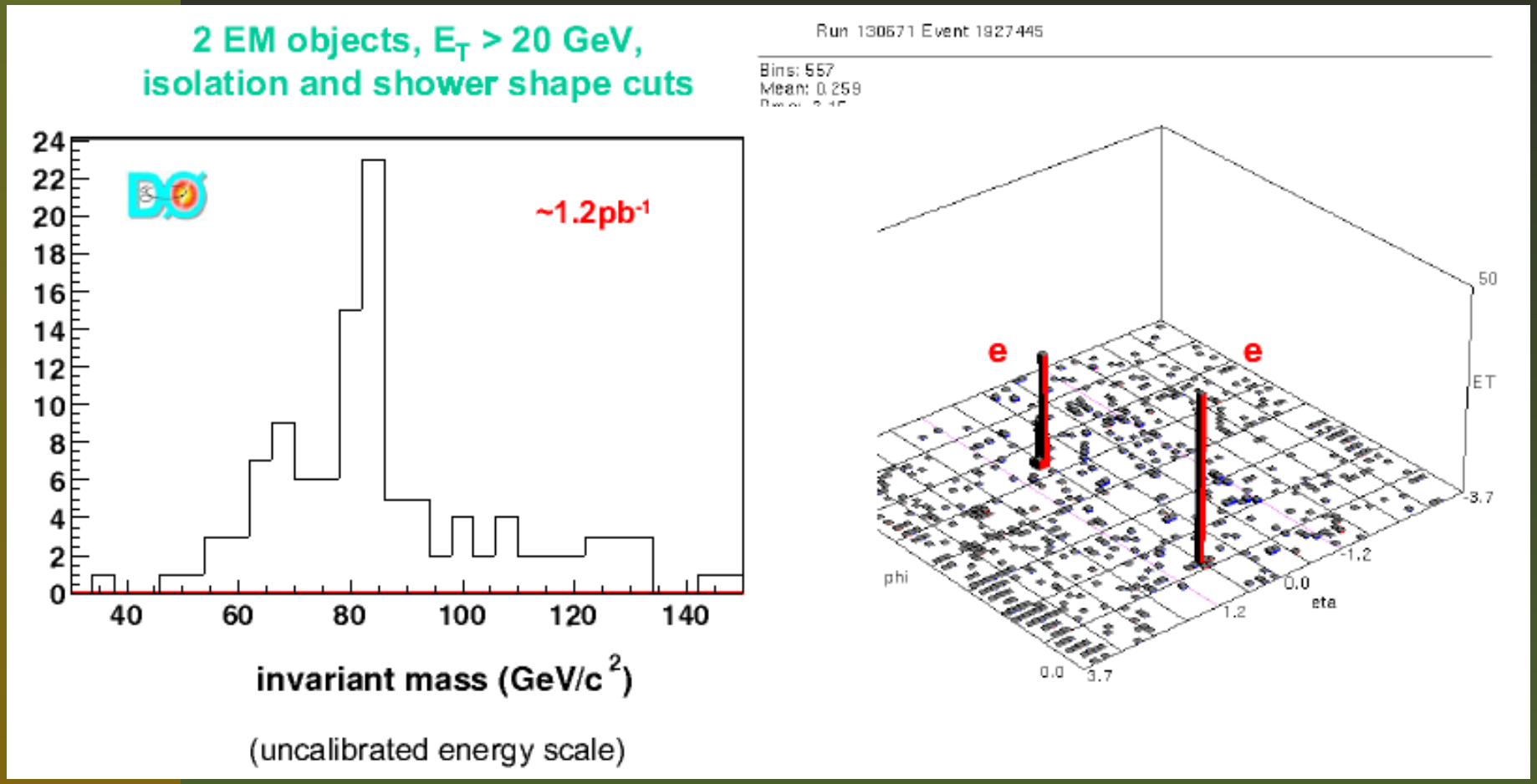
Current Status

- First collisions in April 2001.
- The accelerator and detectors have been gradually ramping-up ever since.
- Accelerator: Still below RunI luminosities, major upgrade this summer (recycler). New schedule:
  - $\sim$300 pb^{-1} by end 2002
  - 2001-2004: RunIIa, 2 fb^{-1}
  - Short shutdown for detector upgrades
  - 2005-2007: RunIIb, 15 fb^{-1}
  - 2007-?: depends on LHC

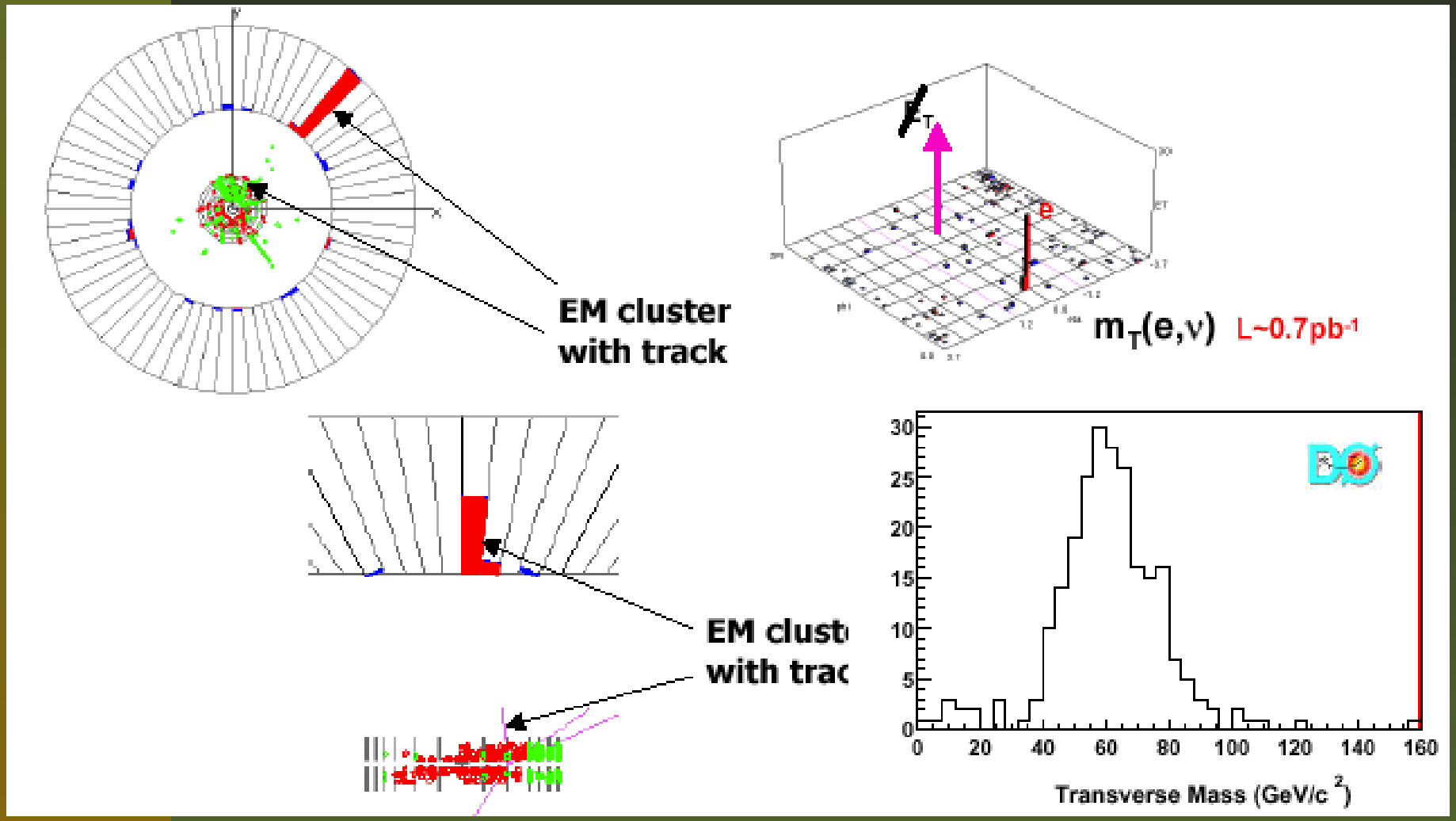
Current Status

- Detector was mechanically complete on roll-in in January 2001. However, not electronically complete.
- Pieces of readout and trigger electronics were missing. Have gradually been added since the beginning of the run.
  - Silicon 93% working
  - CFT full axial, 20% stereo
  - Data output at 25 Hz
- We have not made any startling physics discoveries yet, but....
- We have been making tremendous progress in understanding the detector! Remember, it is like a whole new experiment!

Current Status - Zs



Current Status - Ws



Summary

- RunI was a great success at DØ . Top discovered, many properties measured.
- DØ is a new detector in RunII
- Improve RunI measurements, new ones (2fb^{-1}):

Measurement	RunI	RunIIa
Mass	± 7 GeV	$\pm$2-3 GeV
$\sigma(\mathrm{t\bar{t}})$	$\pm 27\%$	$\pm 8\%$
$\mathrm{t\bar{t}}$ spin	$\kappa > -0.25$	2σ
EW top	< 17, 22pb	$\delta V_{tb} \simeq$ 10-15%

- DØ is taking data. Expect $\sim$300 pb^{-1} delivered by end of the year.