Status of DØ

Detector

Physics

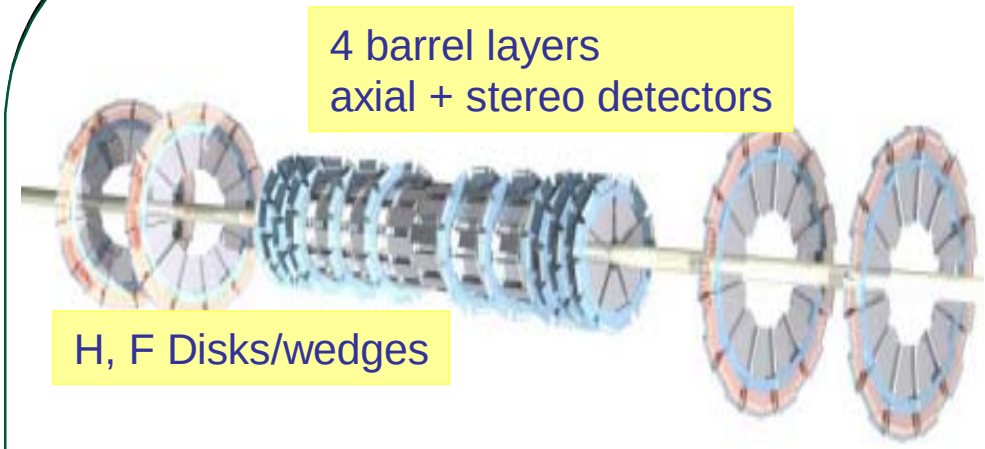
Run IIb Upgrade

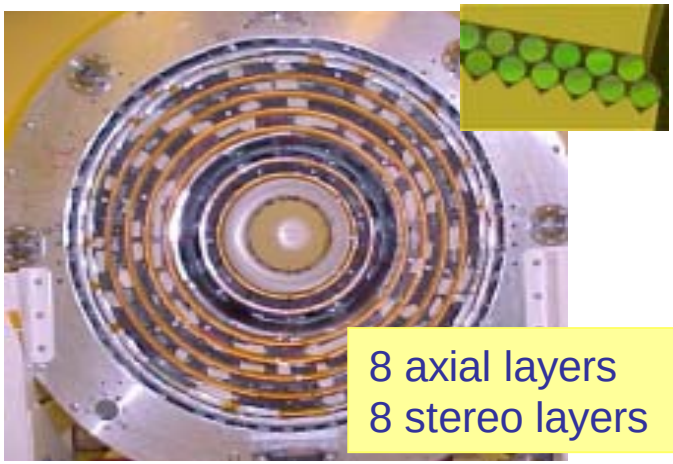
Aurelio Juste (Fermilab)
Physics Advisory Committee
March 28-29, 2003

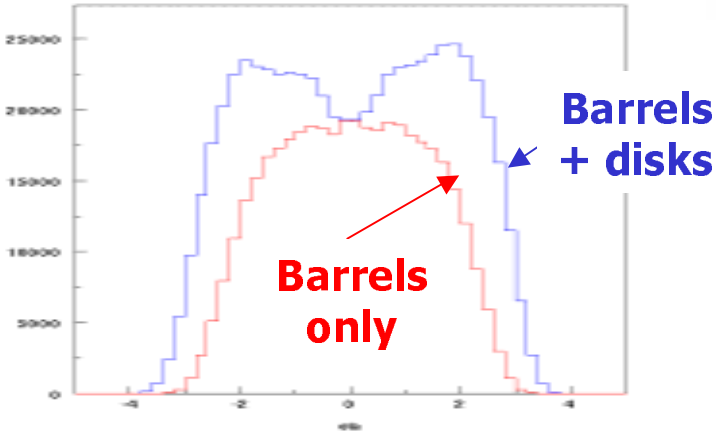
Overview

- Detector fully installed
  - Integrating forward proton detector
  - Making increasing use of tracking triggers
  - Silicon track trigger installed this summer
- Operating stably and efficiently
- Event reconstruction < 3 days
- Intense work on reconstruction improvements: tracking efficiency, object identification, etc
- Broad range of physics presentations for spring conferences and beyond
- Run IIb upgrade progressing well. Current forecast remains ahead of baseline dates

Central Tracking System



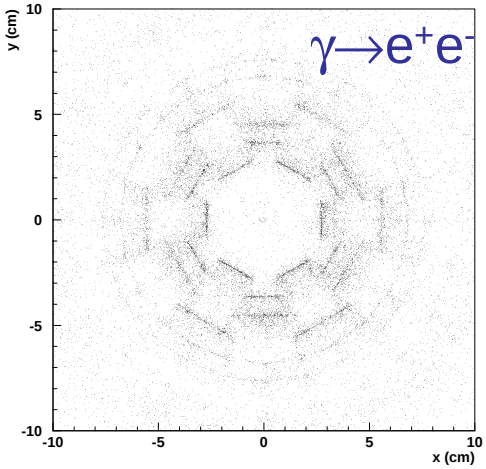


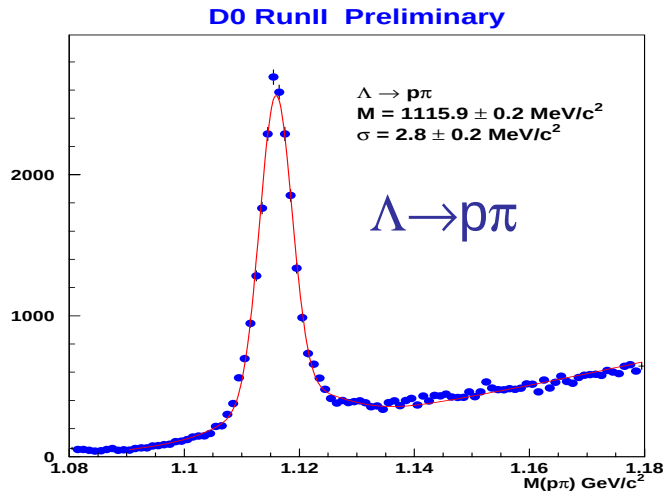


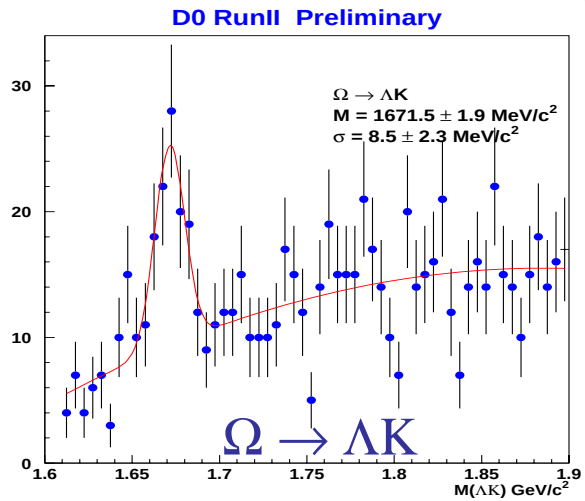
- Active Channels: 91% of 800k
- S/N: > 10 all devices
- Cluster Efficiency: > 97%
- No fiducial loss

- Active Channels: 99% of 77k
- Excellent light yield
- Hit efficiency > 98%

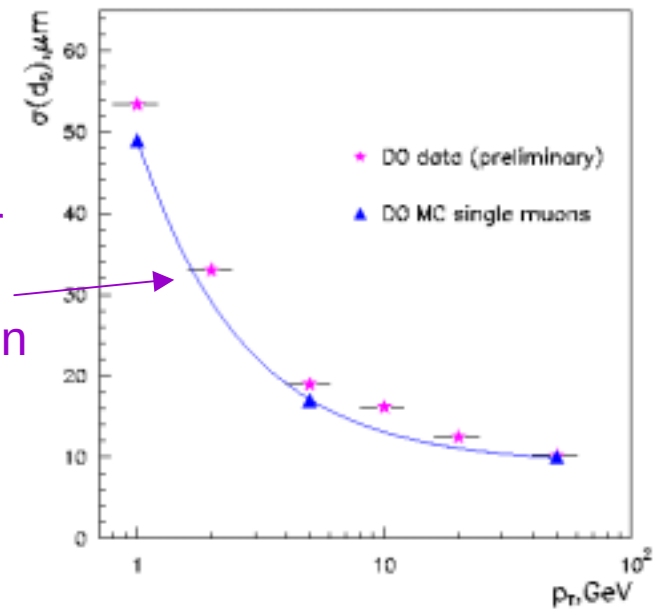
Tracking Performance

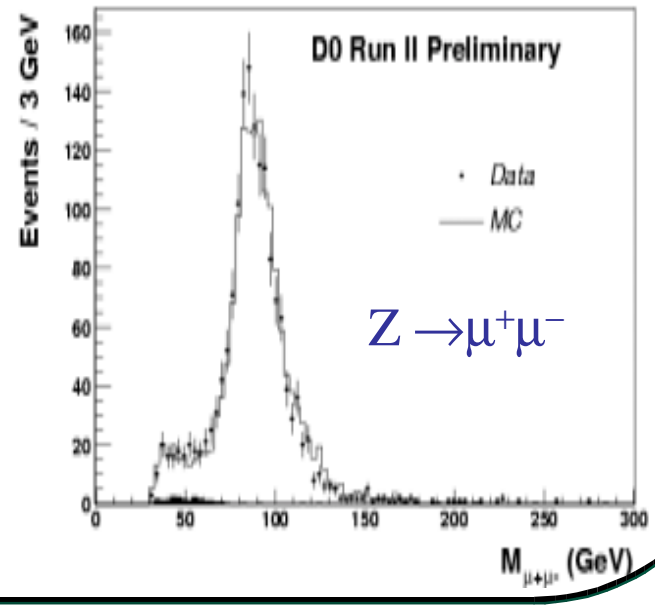






Impact parameter resolution getting close to expectation





Calorimeter

Liquid argon calorimeter with uranium absorber

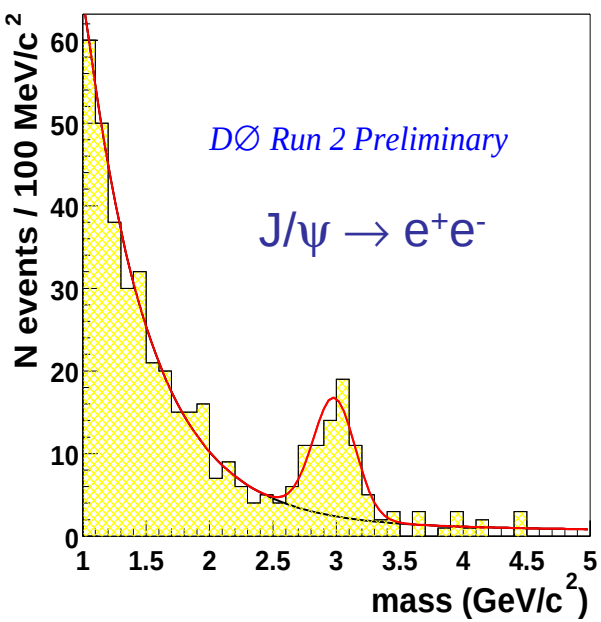
- Active Channels:99.9% of 50K
- Working well at low and high energies

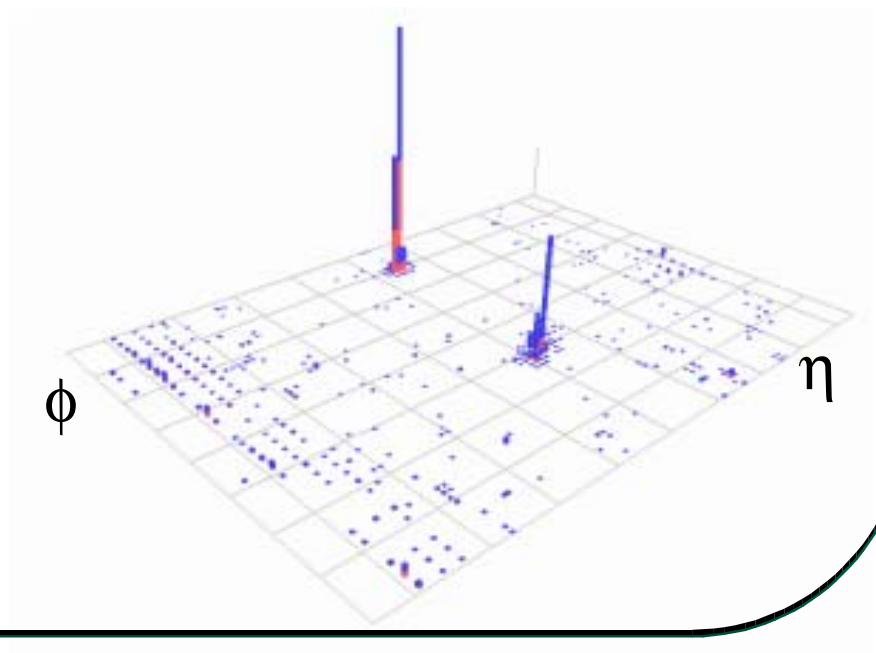
<u>DØ Run II Highest Mass DiJet Event</u>

E_T : 432, 396 GeV (within $|\eta|<0.5$)

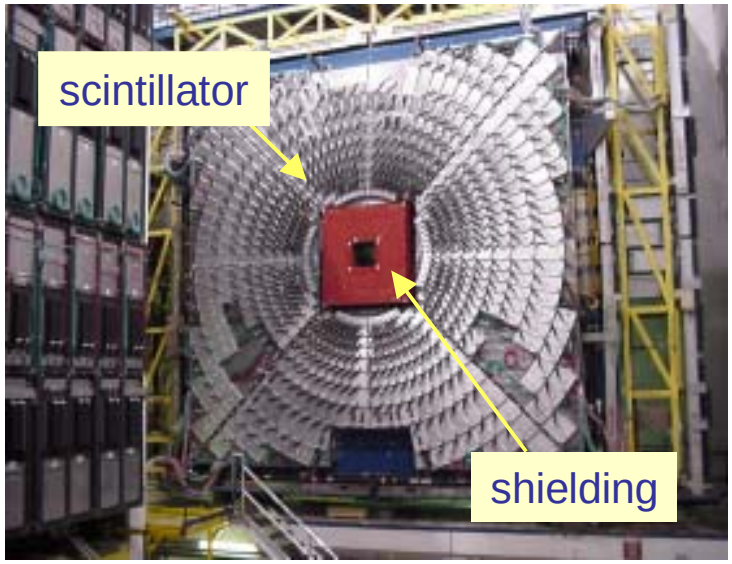
Dijet Mass: 838 GeV

x ~ 0.4





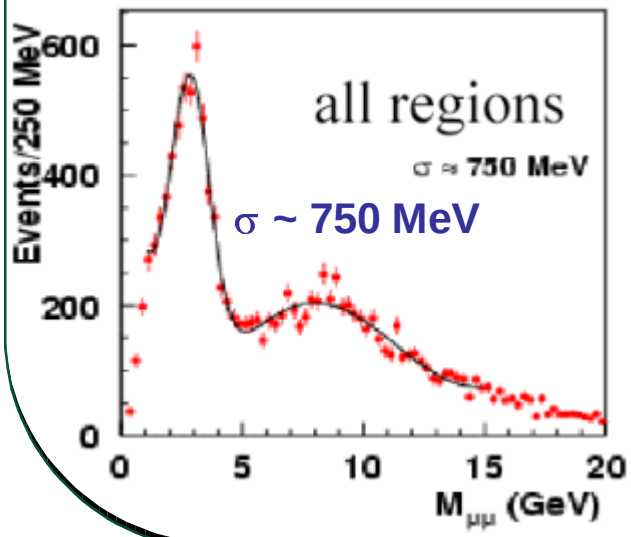
Muon System

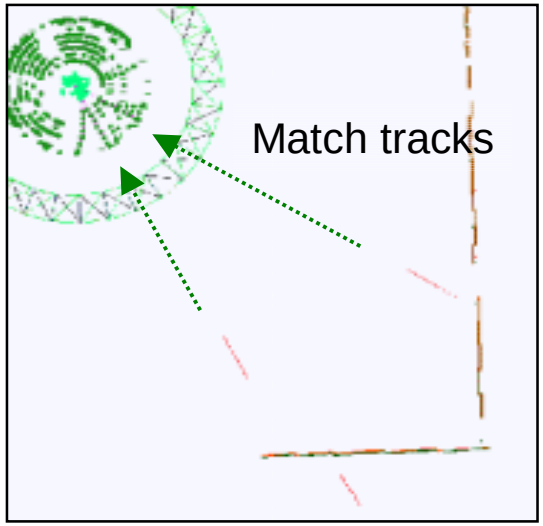


- Coverage to $|\eta|<2$.
- Three layers of triggering scintillator planes. 99.9% active
- Three layers of precise tracking drift tubes. 99.5% active

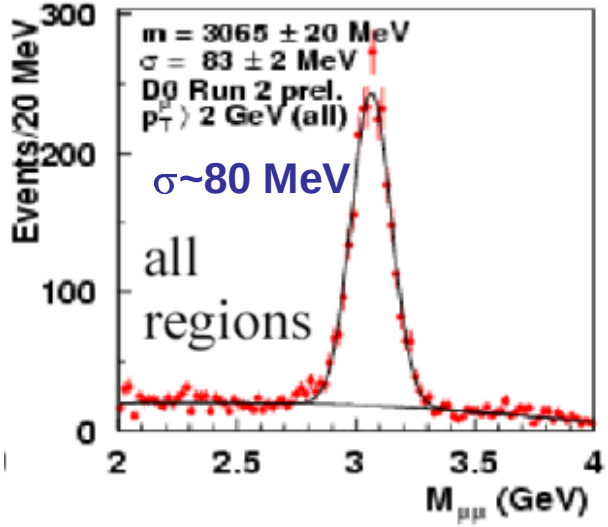
$J/\psi \rightarrow \mu^+\mu^-$

Muon System Only





Global Tracking System



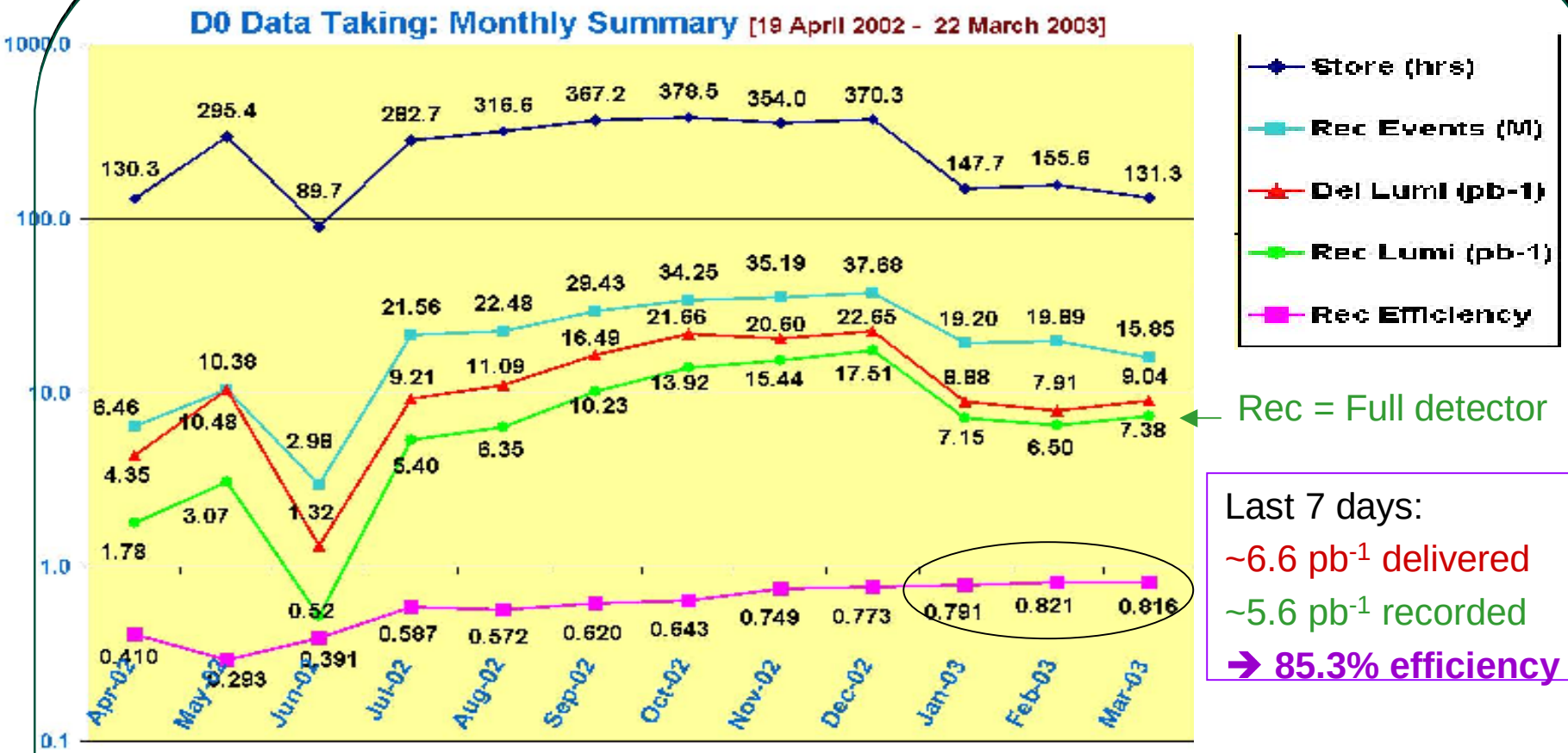
Trigger and DAQ System

	Level 1	Level 2	Level 3	tape
Spec:	5 kHz	1000 Hz	50 Hz	
Operating:	1.2 kHz	600 Hz	50 Hz	

- Runs comfortably up to 4×10^{31} $cm^{-2}s^{-1}$ and will keep pace with luminosity growth as tracking triggers completed, CPUs added.
- L1: >100 independent trigger bits
  - Operating with Cal & Muon
  - CTT & PS integration underway
- L2:
  - Operating with Cal, Muon, Global
  - CTT, STT integration underway
  - Input rate expansion w/ processor replacements
- L3: Extensive suite of filters available

- DAQ:
  - Working to reduce Front End Busy rate.
  - All commodities solution easily meets 1 kHz L2 accept specification.

Data Taking Efficiency



Rec = Full detector

Last 7 days:

~6.6 pb^{-1} delivered

~5.6 pb^{-1} recorded

➔ **85.3% efficiency**

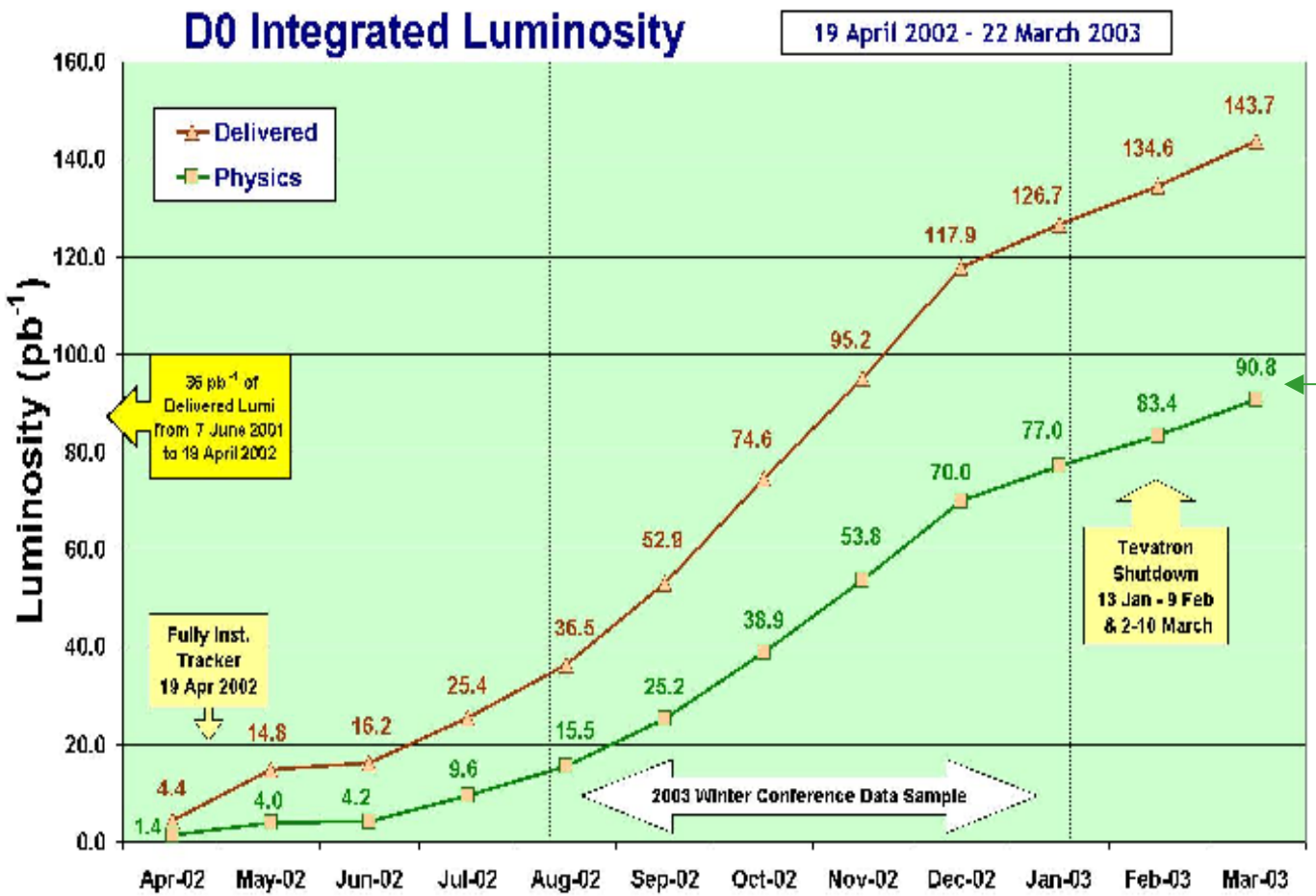
Factors Determining Inefficiency:

~5% front-end busy

~5% are losses due to store & run transitions

~5% “incidentals”

Integrated Luminosity



91 pb^{-1} currently

Definition of "2003 Winter Conference Data Sample" (~60 pb^{-1}) to take advantage of improved reconstruction with a single version.

Offline Event Reconstruction and Analysis

DØ Reconstruction Farm (240 1.8 GHz dual CPU machines)

- 20M event/week capacity
- operates at 85% efficiency
- events processed within days of collection
- 400M events processed in Run II so far

Globally Distributed Resources

6 remote Monte Carlo Farms

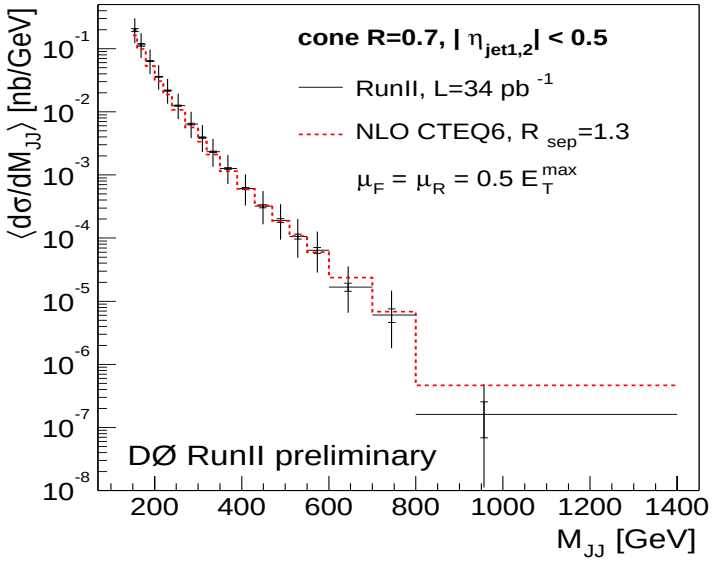
- 0.6M event/week capacity
- Running full GEANT, D0 reconstruction and trigger simulation.

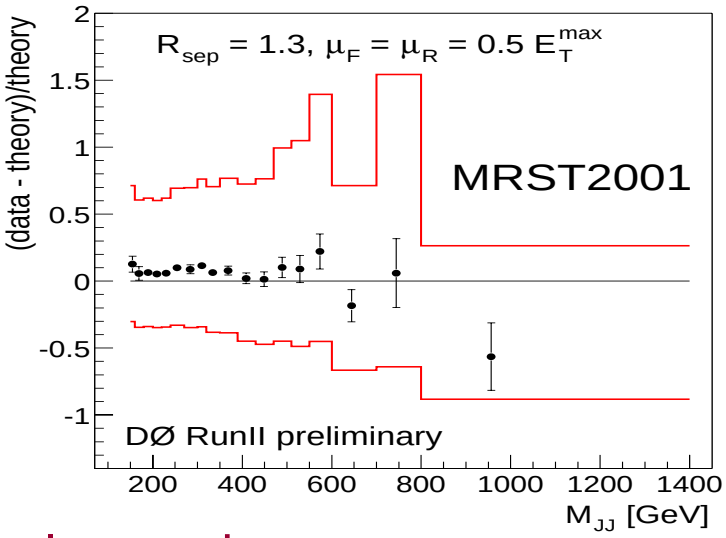
15 SAM stations for remote analysis

QCD Physics: Dijet Mass Cross-section

- Probe of:
  - QCD
  - Proton structure at large x
  - New Physics search (resonances, compositeness)
- Increased center-of-mass energy extends the reach:

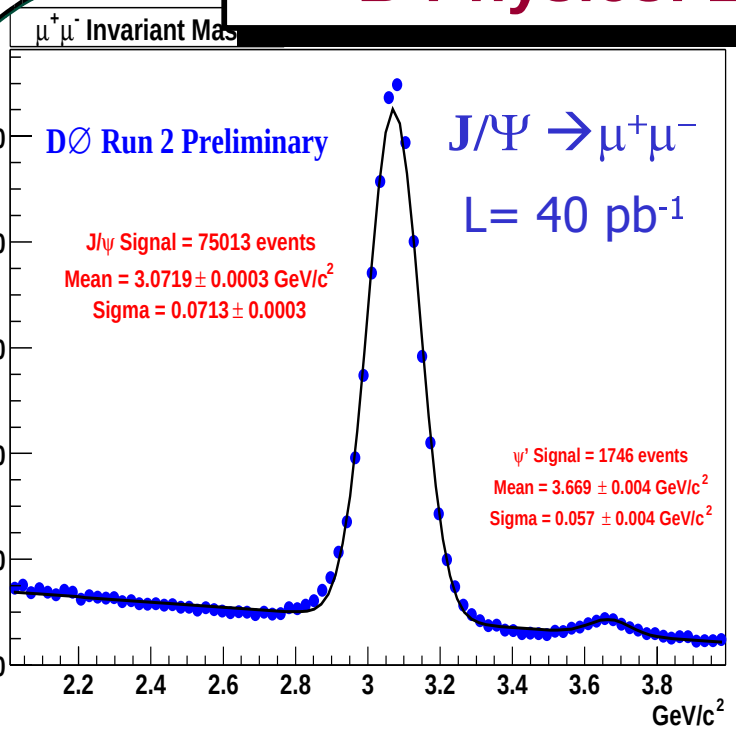
  twice σ at M_{JJ} = 1.2 TeV
- Data sample:
  - L = 34 pb^{-1}
  - 2 leading R = 0.7 cone jets in the central region (|η | < 0.5),
  - Overall 10% uncertainty on luminosity,
  - Jet Energy Scale dominant source of systematic uncertainty,
  - Consistent with Run I result.
- Good agreement between data and NLO QCD prediction.



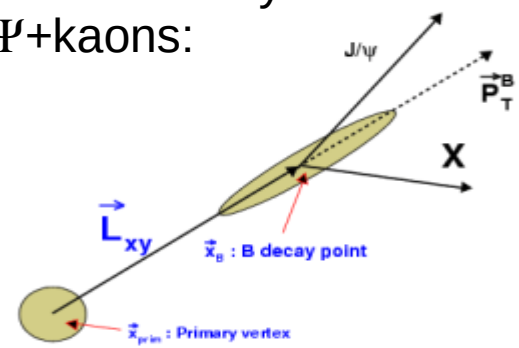


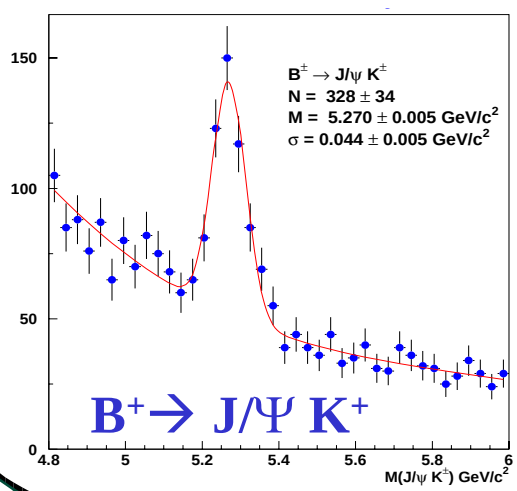
* Inclusive jet cross-section analysis also ready.

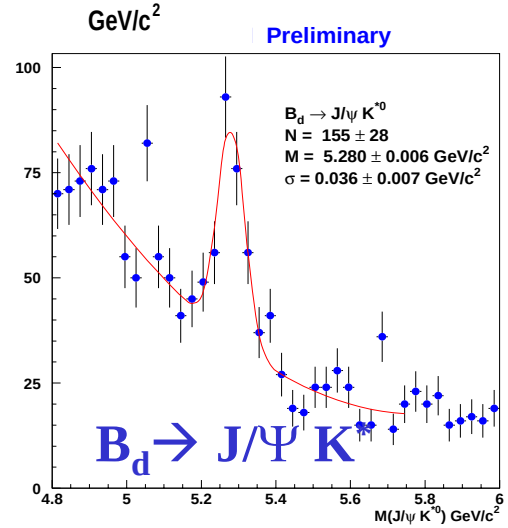
B-Physics: Exclusive B Decays

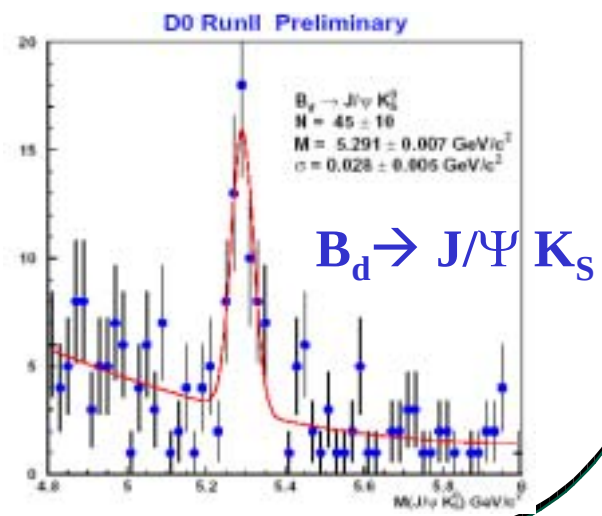


- For now focus on $J/\Psi \rightarrow \mu^+\mu^-$ sample:
  - Useful for calibration
  - Easy trigger and provides large number of B mesons.
- Explicit secondary vertex reconstruction of J/Ψ+kaons:



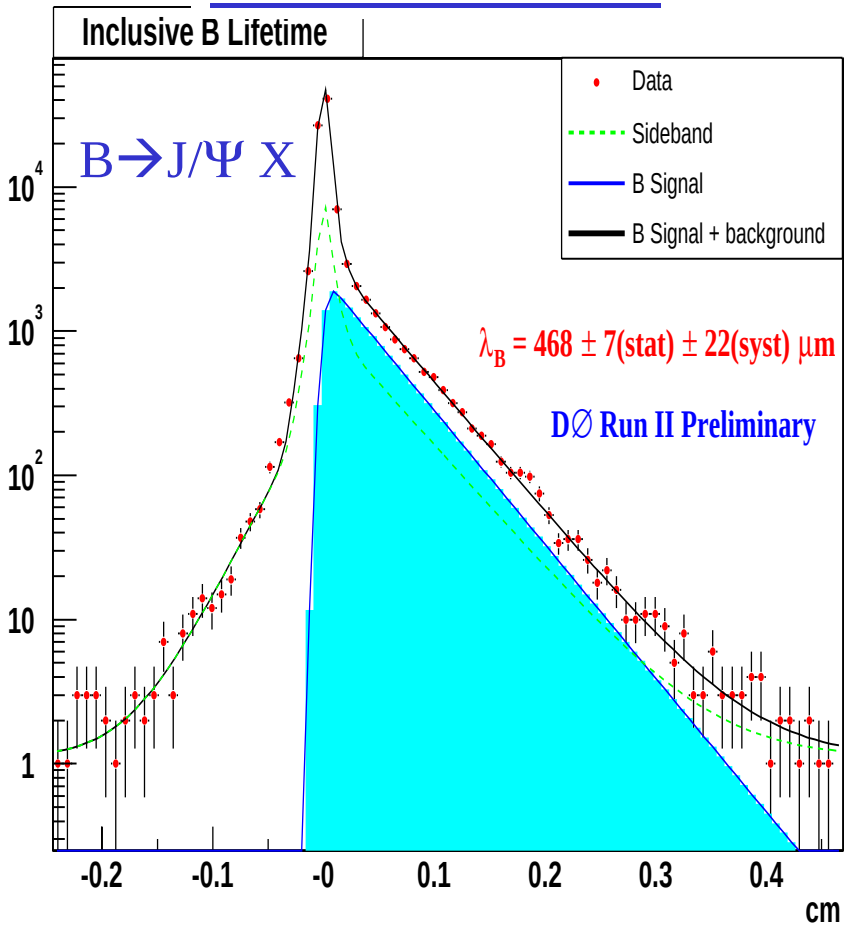






B-Physics: Average B Lifetime

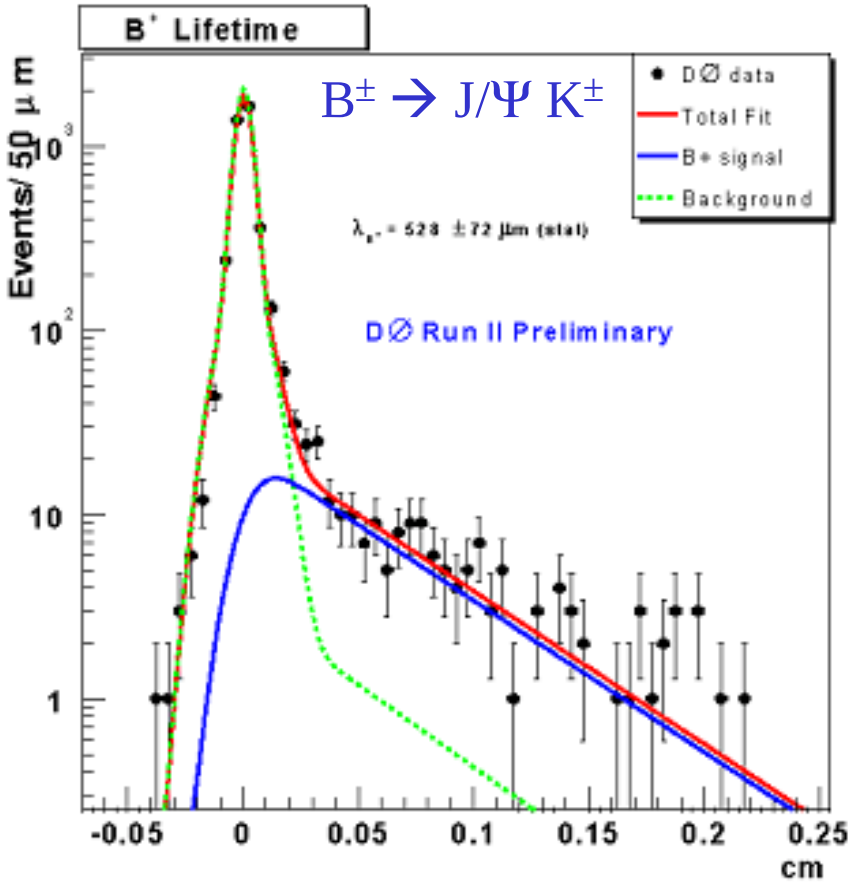
Inclusive B Lifetime



τ =1.561±0.024(stat) ±0.074(syst) ps

1.564±0.014 ps (PDG)

$B^{\pm}$ Lifetime



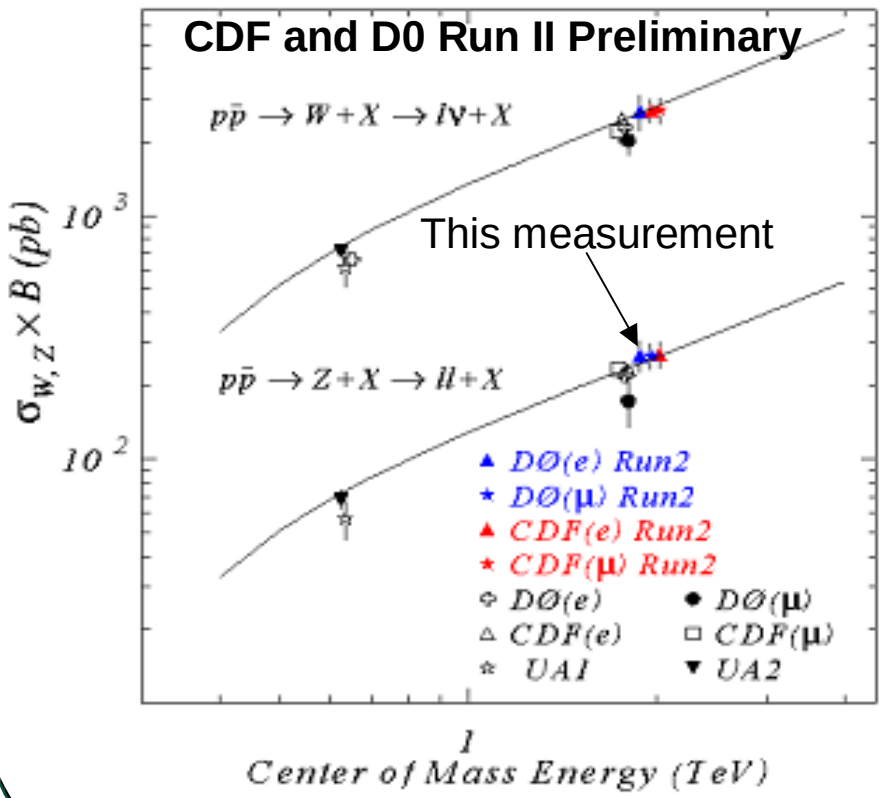
τ =1.76±0.24(stat) ps

1.674±0.018 ps (PDG)

Electroweak Physics

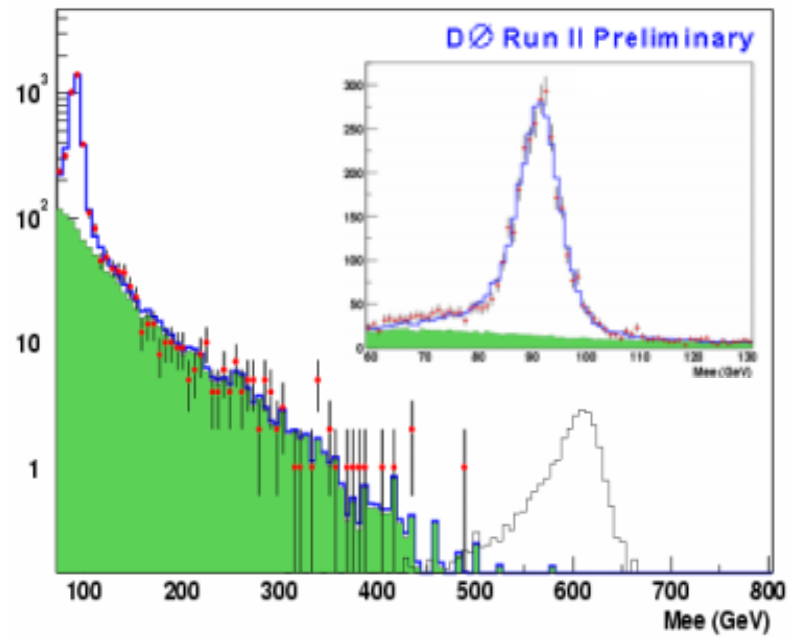
$\sigma(Z(\rightarrow\mu\mu)+X)$

- Data sample: 32 pb^{-1}
- 2 opposite-sign isolated high p_T muons (p_T>15 GeV, $|\eta|$<1.8)
- 1585 events selected



$Z' \rightarrow e^+e^-$ Search

- Data sample: 50 pb^{-1}
- 2 EM objects, E_T>25 GeV, $|\eta|$<2.5



- Data and expected background agree well at high mass. No excess observed

$M_{Z'}$ > 620 GeV @ 95% CL

$\sigma(Z(\rightarrow\mu\mu)+X)$ = 263.8±6.6(stat) ±17.3(syst)±26.4(lum) pb

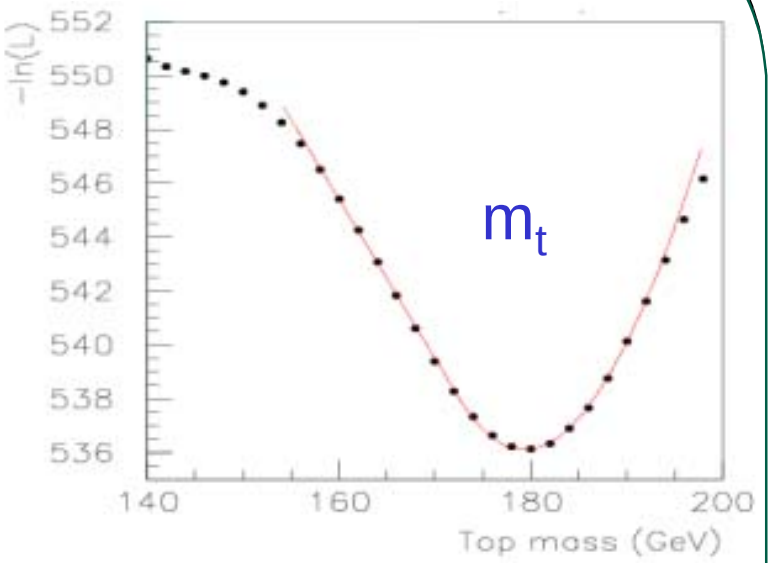
Top-Physics: Run I Top Mass in lepton+jets

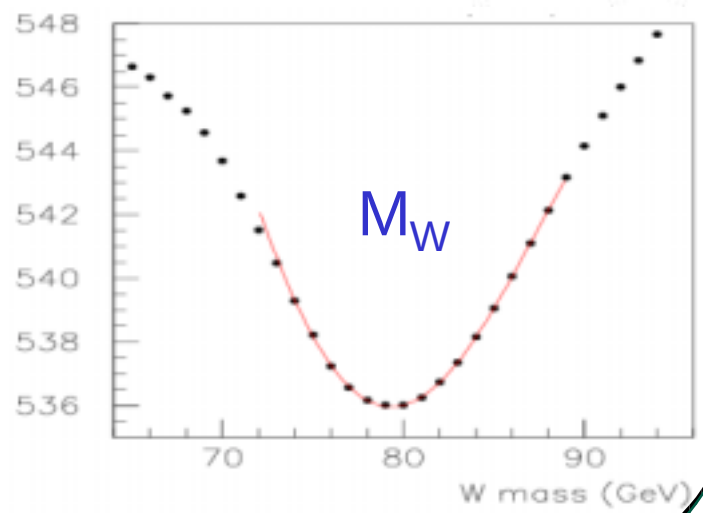
- Likelihood method using most of available information (fit to whole event topology)
- Uses D0 Run I statistics (125 pb^{-1}) and selection in the lepton+jets channel: 91 events
- Additional cuts:
  - 4 jets exclusively: 71 events
  - Cut on background probability: 22 events

m_t = 179.9 ±3.6 (stat) ±6.0 (syst) GeV

↳ (5.6 GeV from 1998 PRD)

- Large improvement in the statistical uncertainty (equivalent to a factor ~2.4 increase in statistics)
- Expect a substantial improvement in the JES systematic from the use of available W mass constraint.



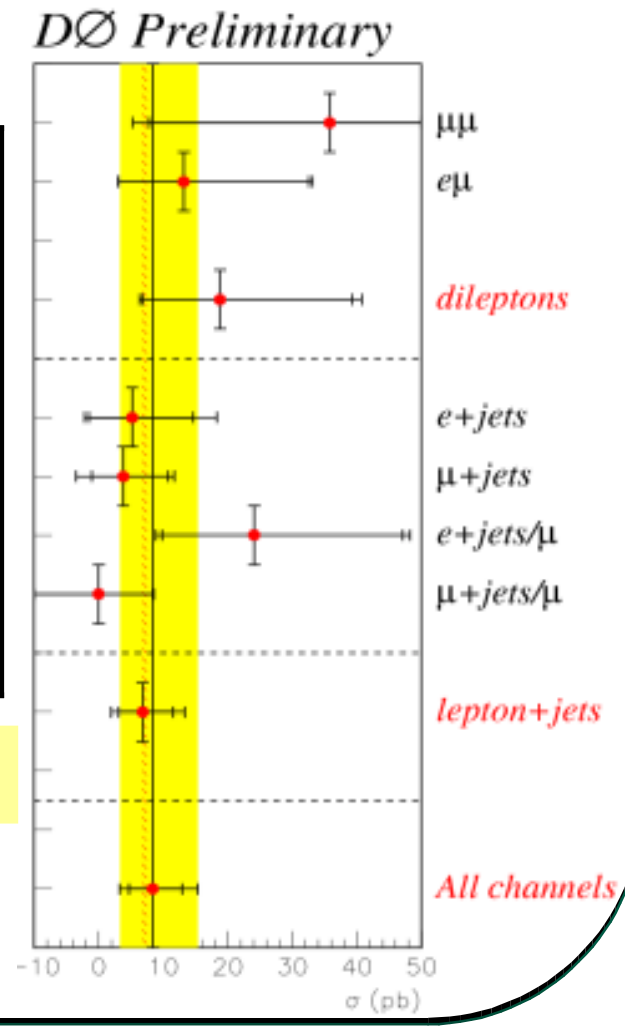


Top-Physics: Run II Top Pair Cross-section

- First measurement at $\sqrt{s}$ = 1.96 TeV.
- σ_{tt}(NLO) = 6.7-7.5 pb (30% higher than at $\sqrt{s}$ =1.8 TeV)
- Six analysis channels completed so far (lepton+jets: topological and soft-muon tagging)

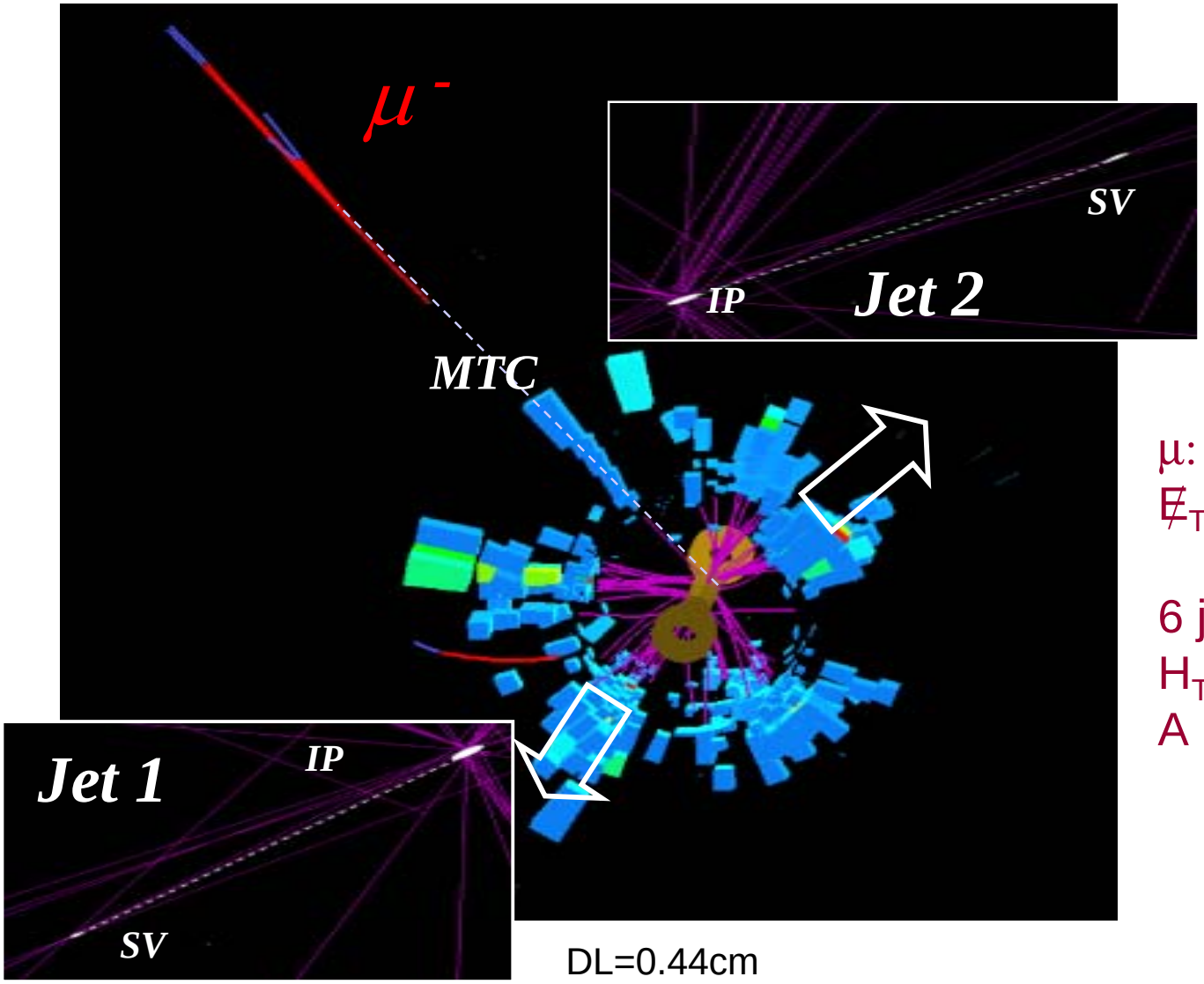
Channel	Lum (pb^{-1})	Expected Background	Expected Signal	Obs.
e+jet	50	2.7+/-0.6	1.8	4
μ+jet	40	2.7+/-1.1	2.4	4
e+jet/μ	50	0.2+/-0.1	0.5	2
μ+jet/μ	40	0.6+/-0.3	0.4	0
μμ	43	0.60+/-0.30	0.30+/-0.04	2
eμ	33	0.07+/-0.01	0.50+/-0.01	1

$$\sigma = 8.4\,^{+4.5}_{-3.7}\,(\text{stat})\,^{+5.3}_{-3.5}\,(\text{syst}) \pm 0.8(\text{lumi})\text{pb}$$



- Dielectron and lifetime tagging analyses being finalized.

Double-tagged μ+jets Candidate Event



DL=0.53cm
DL/σ(DL)=14.9

DL=0.44cm
DL/σ(DL)=32.1

μ: p_T = 47.9 GeV
$\not{E}_T$= 55.1 GeV

6 jets
H_T = 482 GeV
A = 0.16

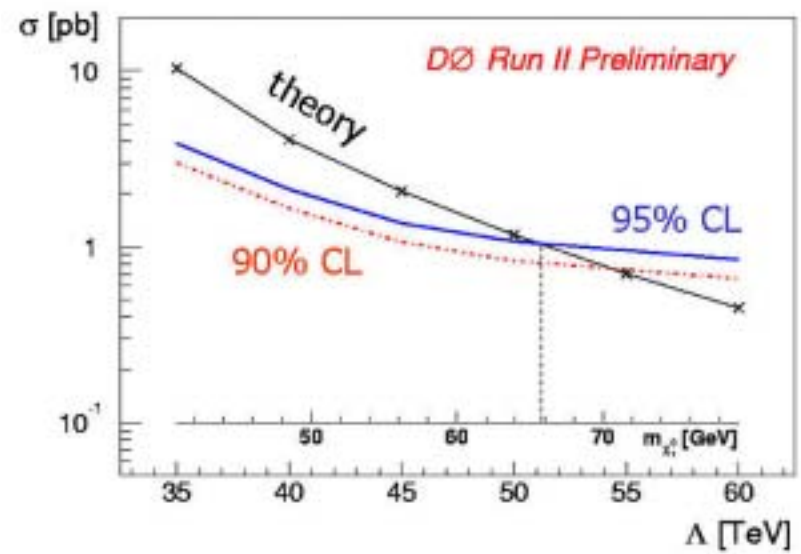
New Phenomena Searches

Seven analyses presented at the winter conferences.
Approaching Run I sensitivity.

Data samples: ~30-50 pb^{-1}

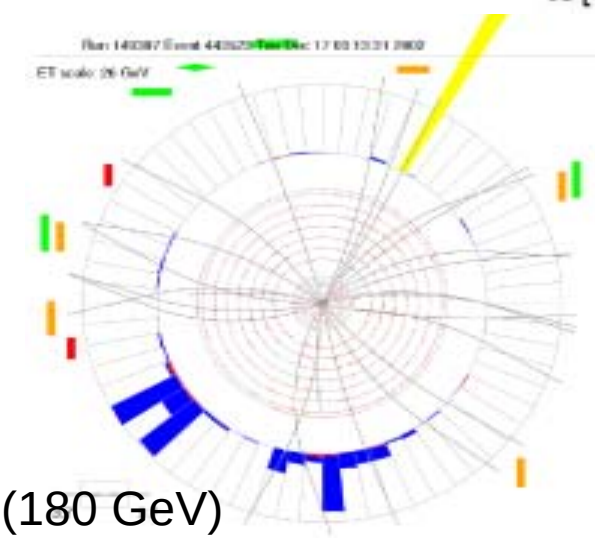
SUSY

- GMSB SUSY LSP Search:
  $2\gamma + ME_T$
  ➔m_{LSP} > 66 GeV @ 95% CL



- mSUGRA Chargino/Neutralino
  ee+lepton+ME_T (trilepton mode)
  ➔σxBR < 3.5 (2.2) pb @ 95% CL

- Standard SUGRA ($\tilde{\chi}^0$ LSP)
  2jets + ME_T
  ➔sets model independent cross-section limit vs ME_T

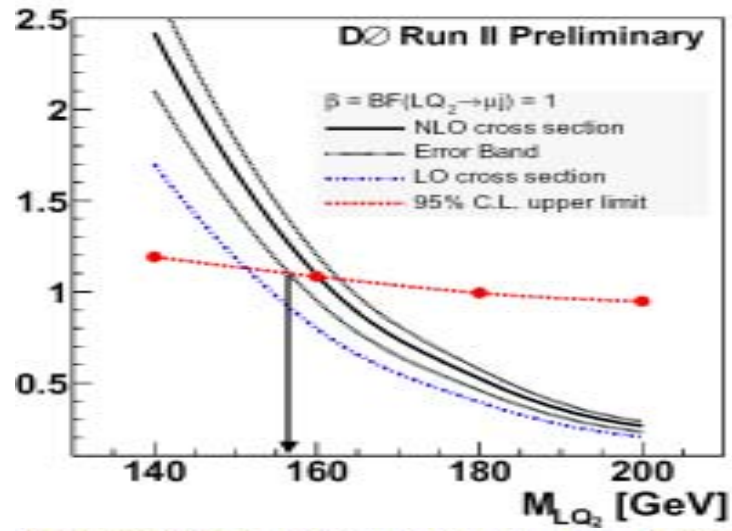


Highest MET event (180 GeV)

New Phenomena Searches

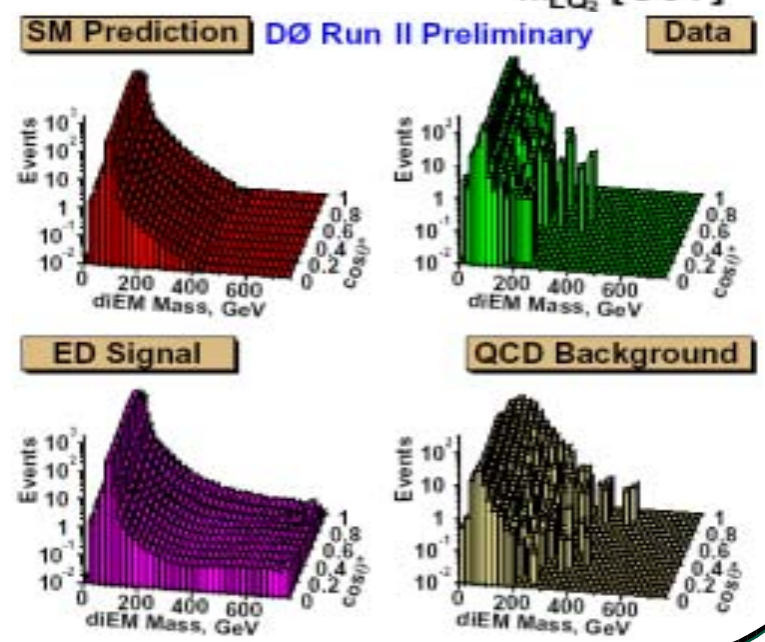
Non-SUSY

- 2nd Generation LQ
  2μ + 2jets
  ➔ m_{LQ} > 157 GeV @ 95% CL



- Search for deviations from SM in eμ+X channel
  ➔ sets model independent cross-section limit vs ME_T

- Search for large extra-dimensions in ee,γγ channel
- Search for large extra-dimensions in μμ channel (**New!**)



Lower limits on Λ_S(TeV)

	GRW	HLZ for n: 2	7	Hewett λ = +1
diEM	1.12	1.16	0.89	1.00
diMU	0.79	0.68	0.63	0.71

New Phenomena Searches: τ Channel

- The τ-lepton often plays a relevant role in models of Beyond the SM physics (trileptons in SUSY, 3rd generation LQs, Higgs decays).
  ➔ addition of this channel considerably extends the physics reach

- Need a SM channel for calibration: $Z \rightarrow \tau^+\tau^-$
- Two searches at DØ are seeing evidence for the decay $Z \rightarrow \tau^+\tau^-$:

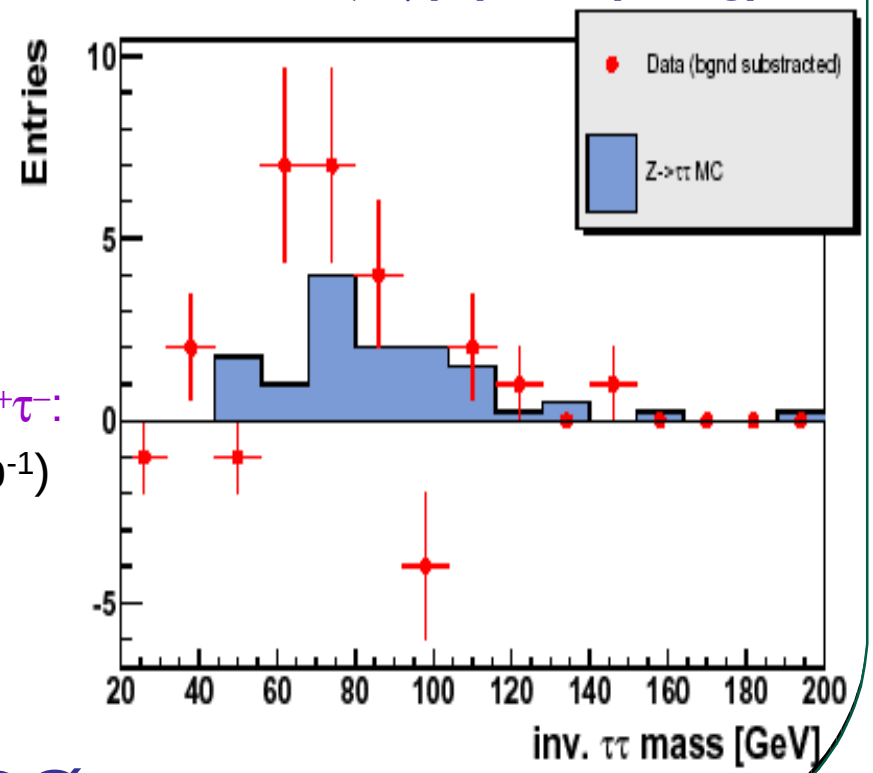
  $Z \rightarrow \tau(\rightarrow e)\tau(\rightarrow 1,2 \text{ prong})$

  $Z \rightarrow \tau(\rightarrow \mu)\tau(\rightarrow 1,2 \text{ prong})$

- Comparison of opposite to like-sign gives an excess consistent with $Z \rightarrow \tau^+\tau^-$:

	Data	$Z \rightarrow \tau^+\tau^-$ (MC, 50 pb^{-1})
Opp sign	49	
Like sign	35	
Difference	14 ± 9	13± 4

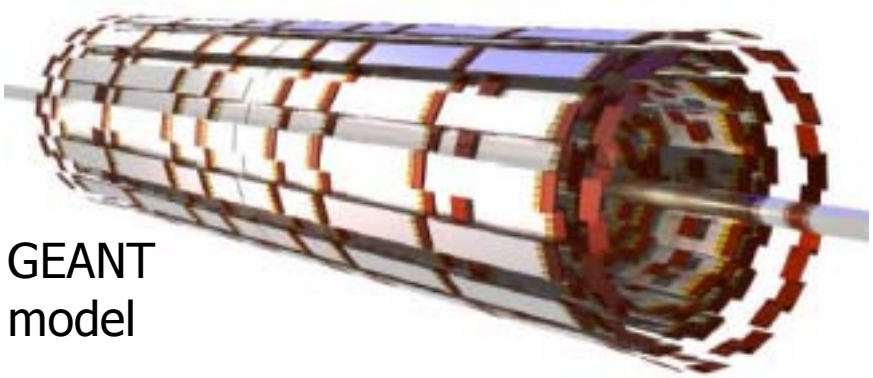
$Z \rightarrow \tau(\rightarrow \mu)\tau(\rightarrow 1,2 \text{ prong})$



➔A new capability for DØ

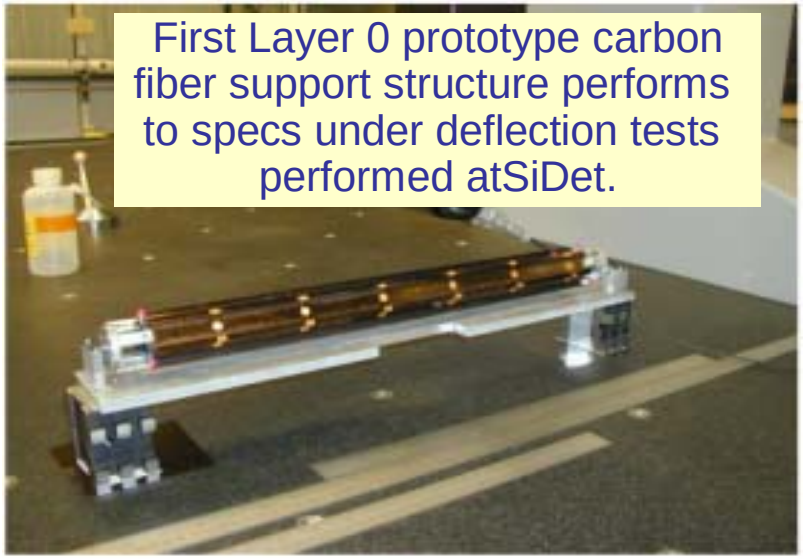
Run IIb Silicon Detector

- Single sided silicon, barrels only
- Inner (vertexing) layers 0, 1
  - Axial only
  - mounted on carbon support
- Outer (tracking) layers 2-5
  - Axial and stereo (tilted sensors)
  - Stave structures

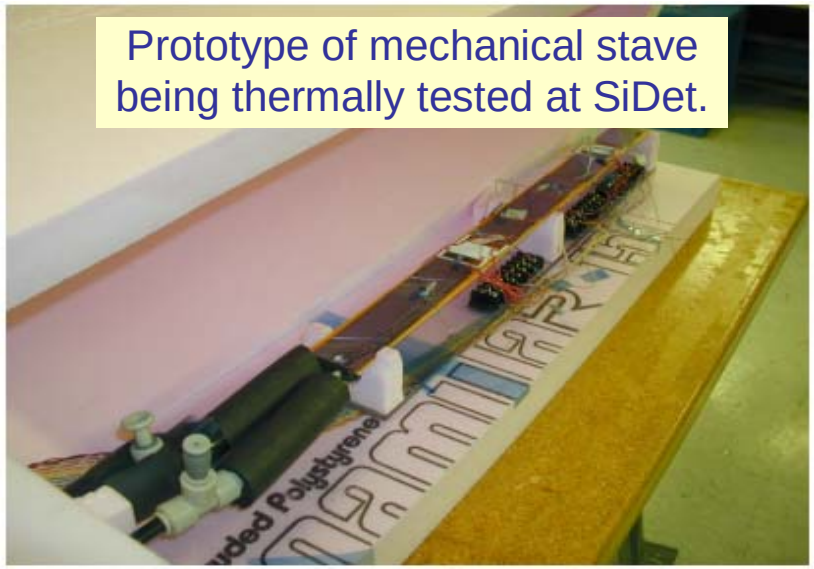


GEANT model

- Prototyping essentially done.



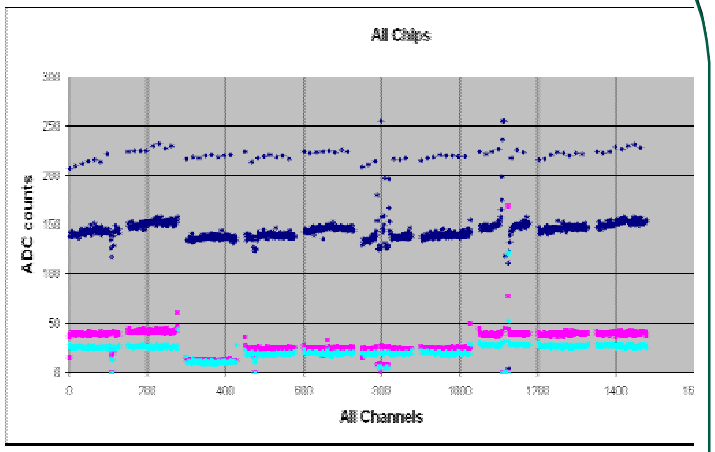
First Layer 0 prototype carbon fiber support structure performs to specs under deflection tests performed atSiDet.



Prototype of mechanical stave being thermally tested at SiDet.

Run IIb Silicon Detector: Status

Component	Vendor	Design	First Prototype		Second Prototype	
			Ordered	Delivered	Ordered	Delivered
L0 Sensors	ELMA	✓	✓	✓		
	HPK	✓				
L1 Sensors	ELMA	✓	✓	✓		
	HPK	✓	✓	✓		
L2 Sensors	HPK	✓	✓	✓		
Analogue Cable	Dycx	✓	✓	✓	✓ ✓	✓ ✓
L0 Hybrid	Amitr.	✓	✓			
L1 Hybrid	CPT	✓	✓	✓		
L2A Hybrid	CPT	✓	✓	✓		
	Amitr.	✓	✓	✓		
L2S Hybrid	CPT	✓	✓	✓		
Digital Cable	Honey	✓	✓	✓	✓	✓
	Basic	✓	✓	✓	✓	✓
Junction Card		✓	✓	✓		
Twisted Pr. Cable		✓	✓	✓	✓	
Adapter Card		✓	✓	✓		
Purple Card		✓	✓	✓	✓	✓
Test Stand Elctr.		✓	✓	✓		



- Electrical tests underway for first outer layer silicon module prototype (both axial and stereo readout)
- Sensor order near end of procurement

Run IIb Trigger Upgrade

System	Problems	Solutions
Cal	1-Trigger on $\Delta\eta\times\Delta\phi$=0.2×0.2 TTs ⇒ slow turn-on curve 2- Slow signal rise ⇒ trigger on wrong crossing	• Clustering • Digital Filter
Track	3- Rates sensitive to occupancy 4- Limited match to calorimeter	• Narrower Track Roads • Improve Cal-Track Match
Muon	No Additional Changes Needed!	• Requires Track Trigger

- Finished prototyping of three major boards of L1 trigger upgrade (items 1,2 and 4)
- Preparation for tests of full L1Cal prototype chain:

  Digital Filter → Clustering → Cal-Track Match

  beginning this summer.

  Installed analog splitter in L1Cal rack at the Movable Counting House for tests with real signals.
- Progress in firmware design for L1CTT (item 3)

Conclusions

- Detector is operating well and the performance keeps improving.
- Already producing lots of interesting physics: QCD, B, EW, Top, New Phenomena.
- Looking forward to new physics results this summer and beyond.
- The D0 upgrade, crucial to take full advantage of the available physics opportunities in Run IIb, is on track.