Status and perspectives @ DØ

some

E. Kajfasz

Centre de Physique des Particules de Marseille — CPPM

CNRS — IN2P3

for ...

Institutions:

- 92 Total
- 39 US, 53 non-US

Collaborators

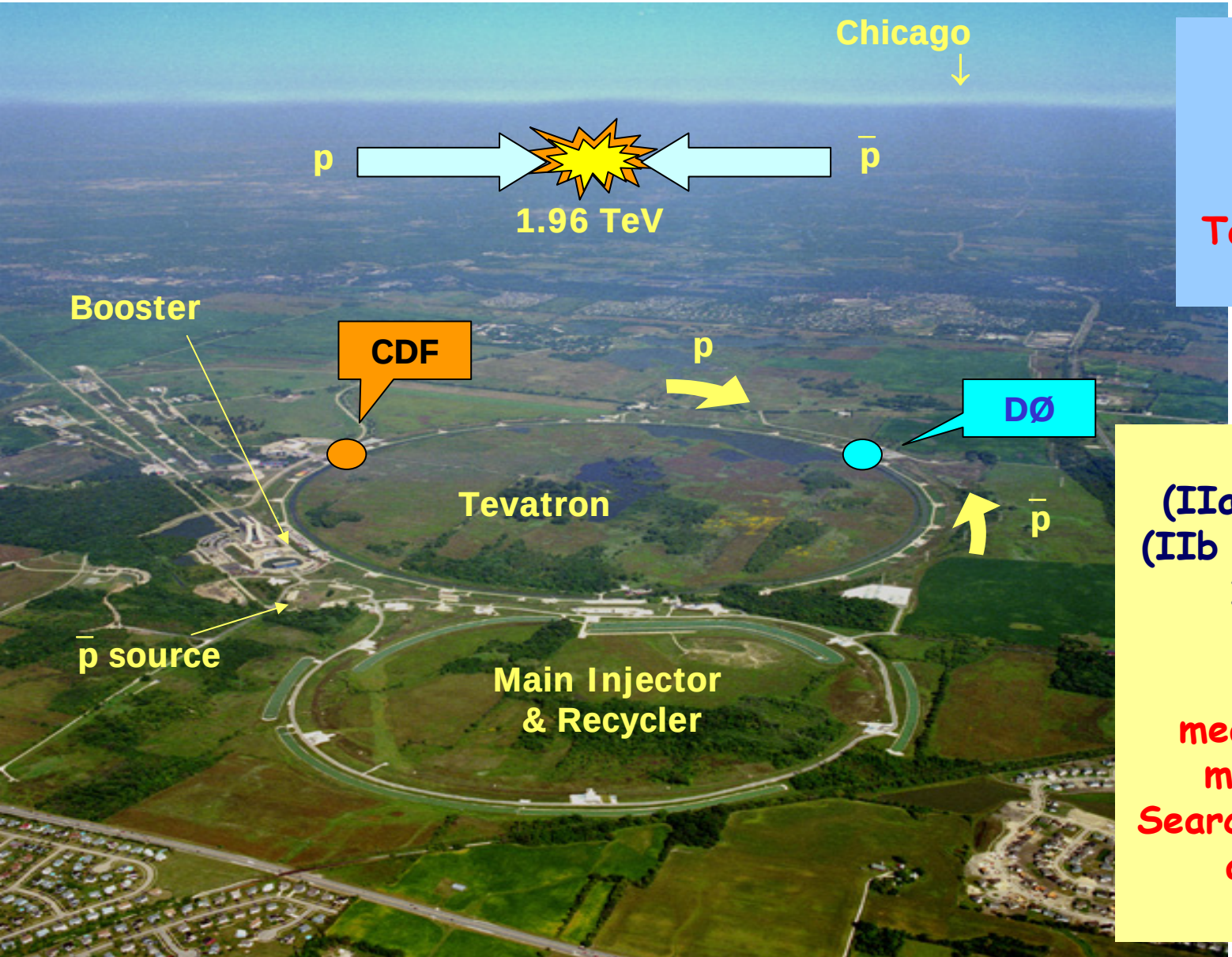
- ~ 671 Total
- ~ 50% from non-US institutions
- ~ 100 post-docs
- ~ 140 graduate students

The Stage

- Status of the Tevatron
- Status of the experiment
- Detection of signals with small cross-sections
  - di-boson physics
  - single top production
  - SM Higgs search
- Conclusions

Warning: most of our analyses are still being worked on to provide updated results at winter and summer conferences => my hands are a bit tied on what I can show you ...

Fermilab, Tevatron and DØ

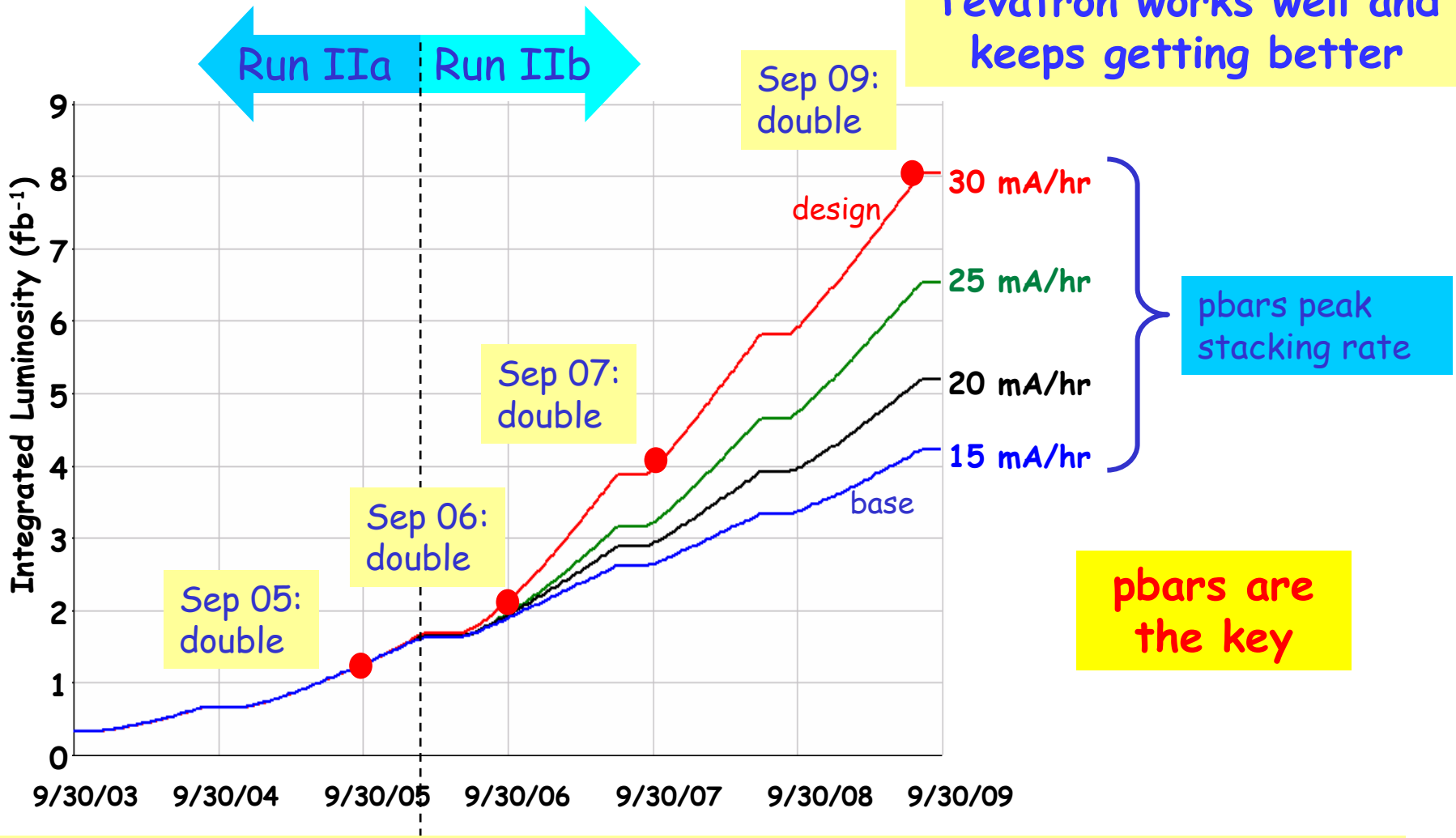


Run I
(92-96)
1.8 TeV
~0.1 fb^{-1}
Top discovery
...

Run II
(IIa 01-Feb 06)
(IIb Jun 06 ->...)
1.96 TeV
-> 8fb^{-1}
Precision measurements:
m_t, m_W, Δm_s
Searches for Higgs and BSM
...

Luminosity evolution for Run II

Tevatron works well and keeps getting better

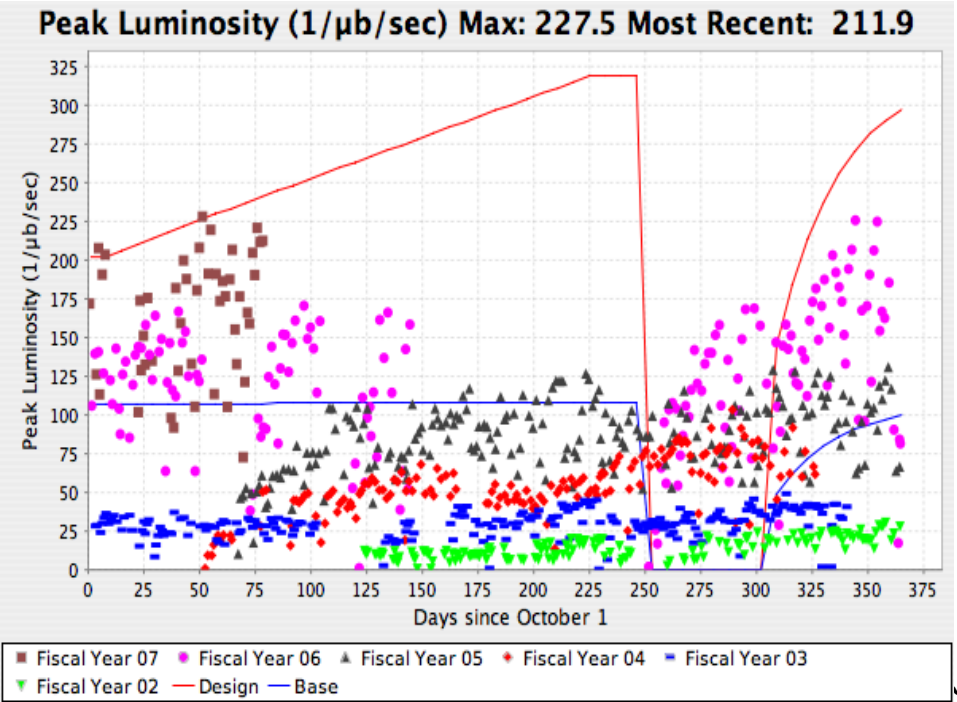


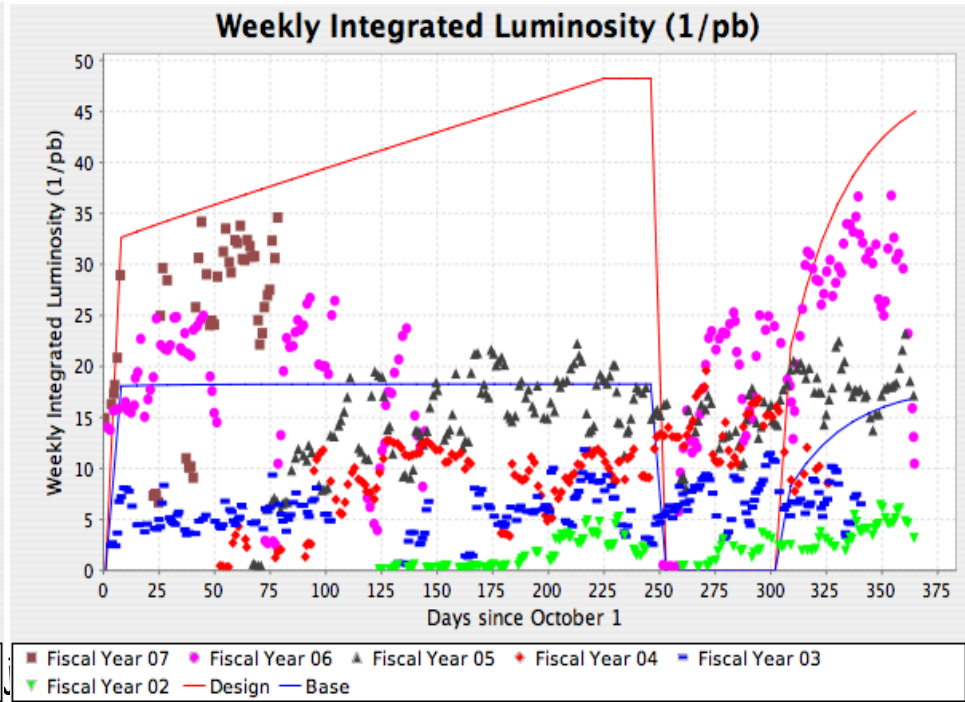
pbars are the key

- last shutdown started ~ Mar 1, 2006 => transition Run IIa/Run IIb
- Run IIb first store occured on Jun 9: D0 was ready to take data

Pbars improvements

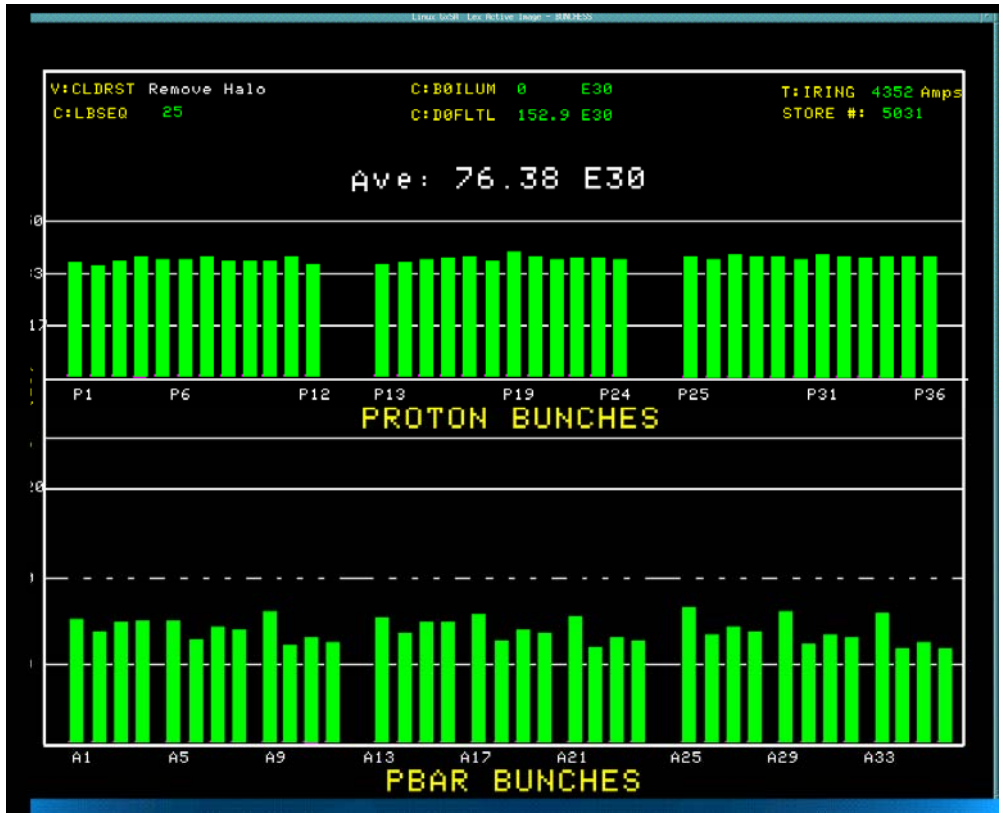
- New Lithium lens with higher gradient in pbar source
- Rapid pbar transfer from Accumulator to Recycler
  - Also working on other pbar cooling/transfer improvements
- New helix with 2 new separators in Tevatron
  - Reduced beam-beam effects → Better store life time





Pbar Bunch Leveling

- RF feed forward in mining pbars from Recycler
- Bunch-to-bunch leveling of pbar bunch intensity
- Goal is to level within 5-10%
- Implemented during the mouse shutdown.



S... happens!

Feeder 46b glitch

Oct 10: mouse walked over a power supply

=> Tevatron feeder 46b glitch.

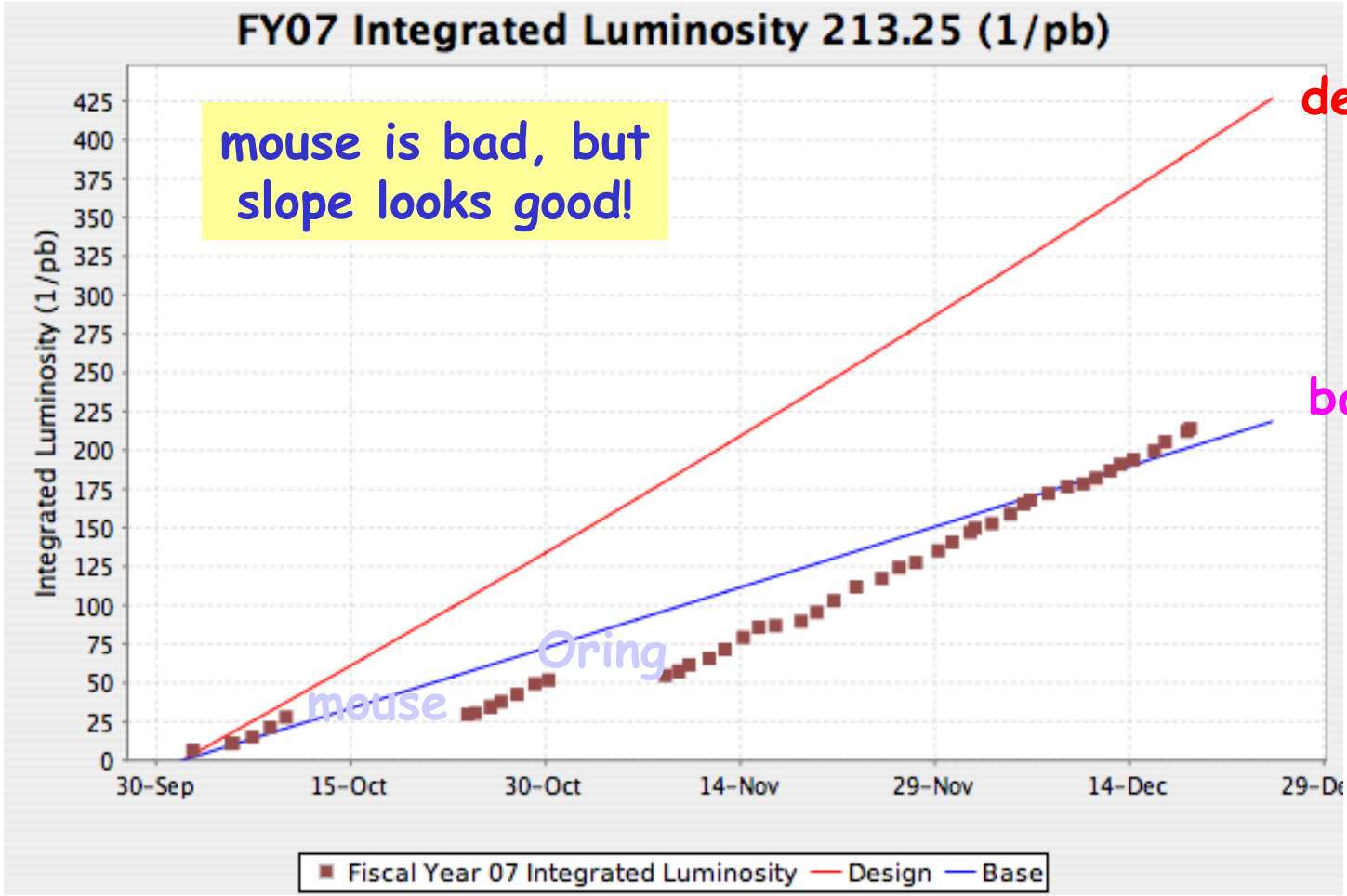
D-sector dipole had to be replaced

=> 12 days of shutdown

Oct 30: Failed O-ring in E-sector

=> 8 day shutdown

FY07 Integrated Luminosity



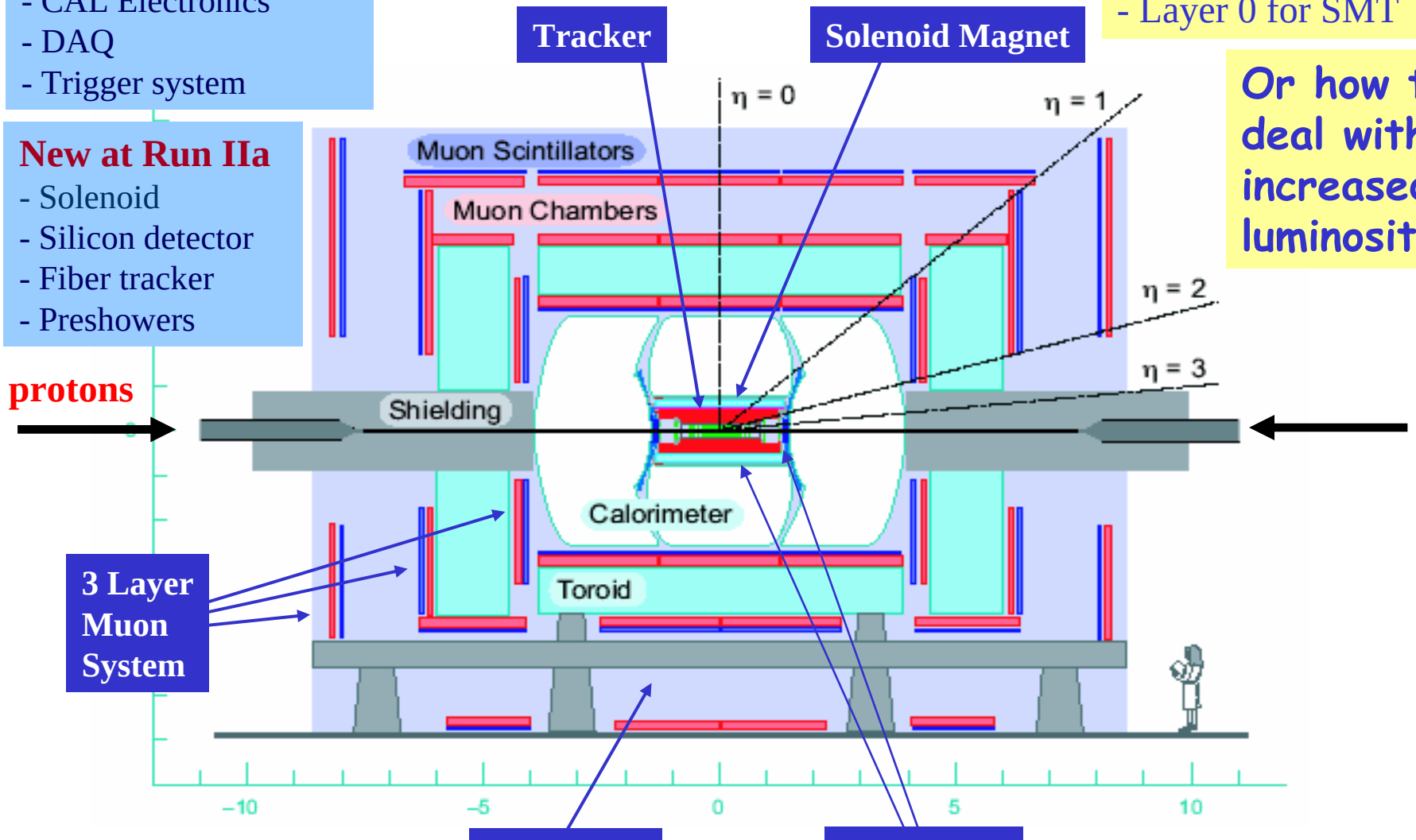
Upgrades for Run II

Run IIa Upgades
- Muon system
- CAL Electronics
- DAQ
- Trigger system

New at Run IIa
- Solenoid
- Silicon detector
- Fiber tracker
- Preshowers

New at Run IIb
- L1 CAL
- L1 Track
- Layer 0 for SMT

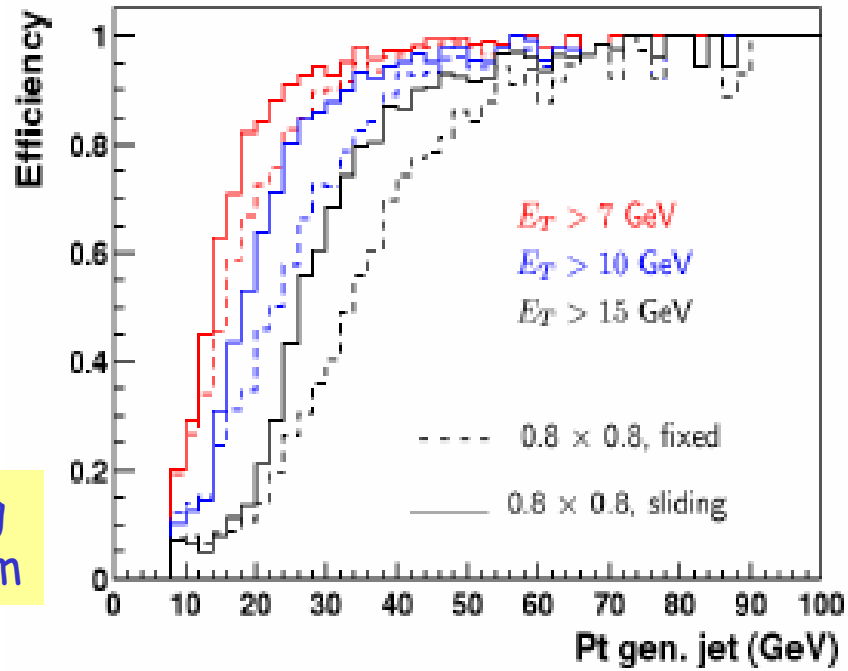
Or how to deal with increased luminosity



L1 Trigger upgrade

- Major upgrade to manage rates when luminosity increases
- L1 upgrades for Calorimeter, CTT, CalTrackMatch
- L2 upgrades for STT, L2 processors
- Increase in processing capacity for L3, ...
- New electronics for CFT (AFEII-t boards) to deal with the increase in occupation with luminosity

L1Cal:
- Improve turn-on curves
- More topological criteria

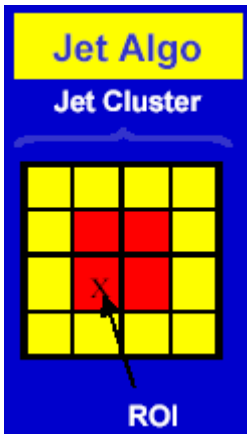


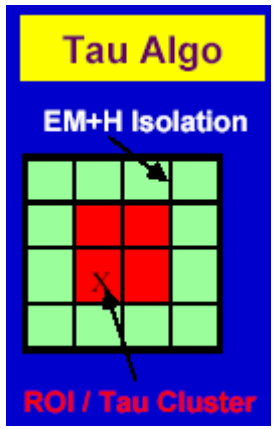
effect of sliding window algorithm

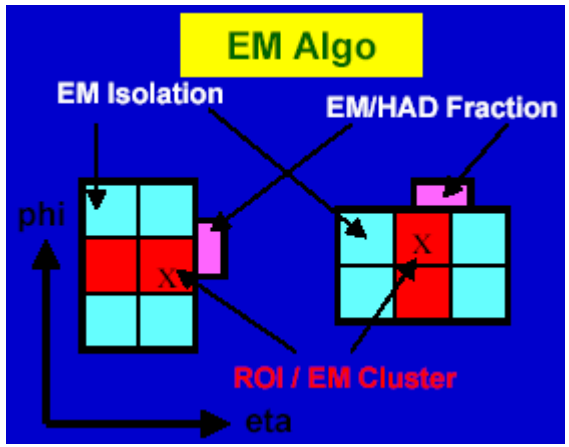
L1Cal upgrade

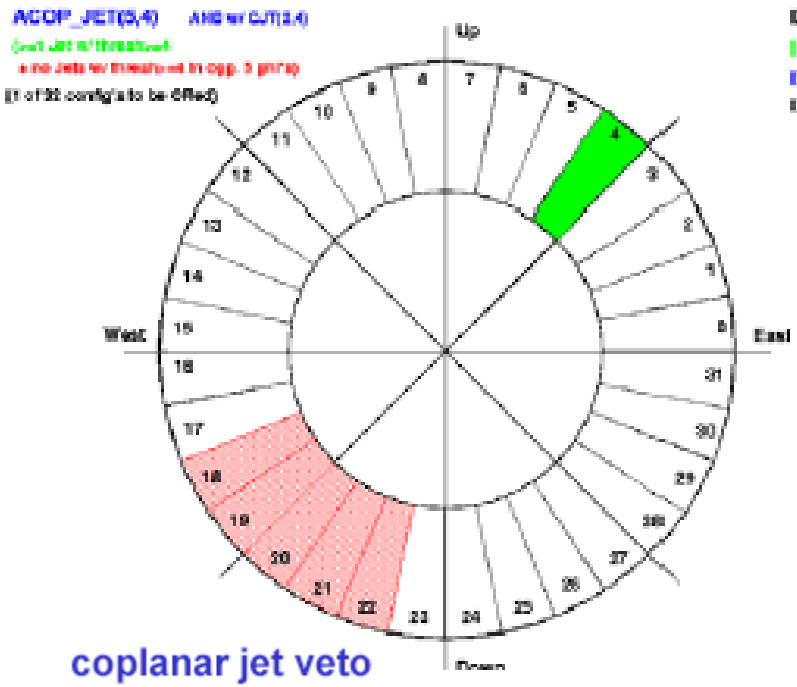
Clustering

Topological

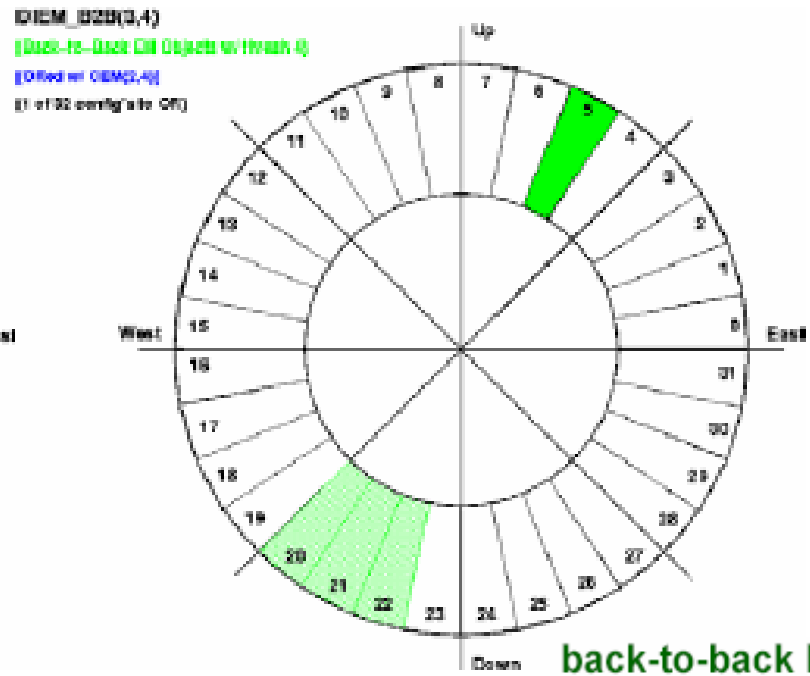








coplanar jet veto



back-to-back EM

AFEII-t

- AFE1 hardware has some limitations and problems
  - Tick to tick variation
  - Chan to chan variation
  - Discriminator to analog crosstalk
  - SVX saturation
  - Preshower dynamic range
  - Rough z information from timing
- The problems become much worse as luminosity grows
- New "time of hit arrival" capability is (almost) free

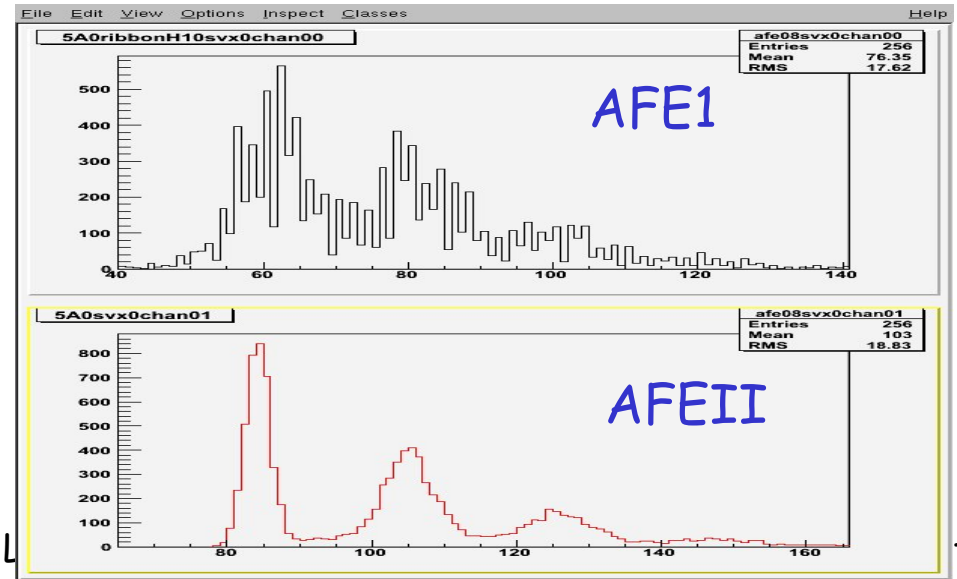
Fermilab developed a new IC to replace SVXIIe

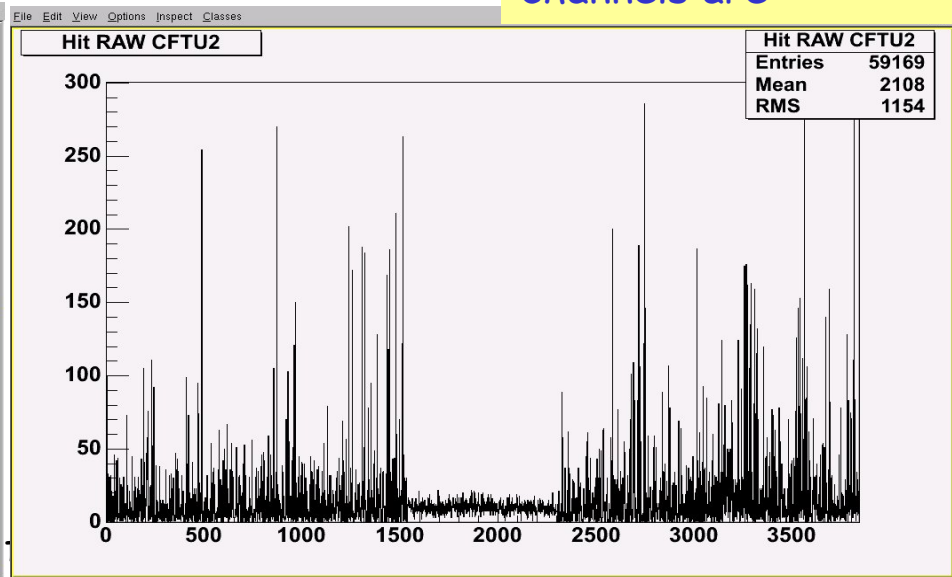
- TriP-t: trigger and pipeline chip with time measurement
- Not a "better SVX" – different design philosophy

- AFEII working in AFE1 mode, but w/o the AFE1 problems

- Future: take full advantage of unique features of AFEII-t

Guess where the AFEII instrumented channels are



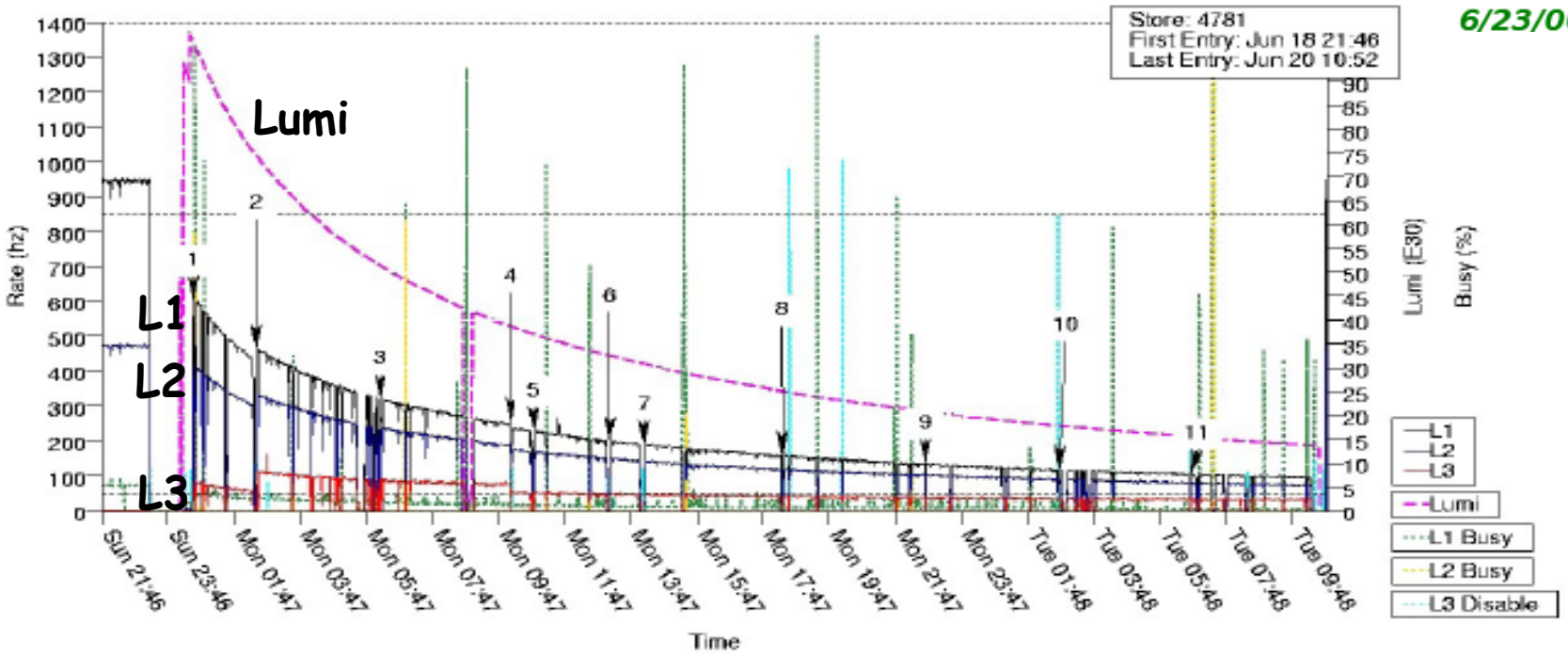


Trigger commissioning

Run IIb installation and commissioning is a success !

big contribution of the French groups

Started data taking within minutes of first Run IIb sore

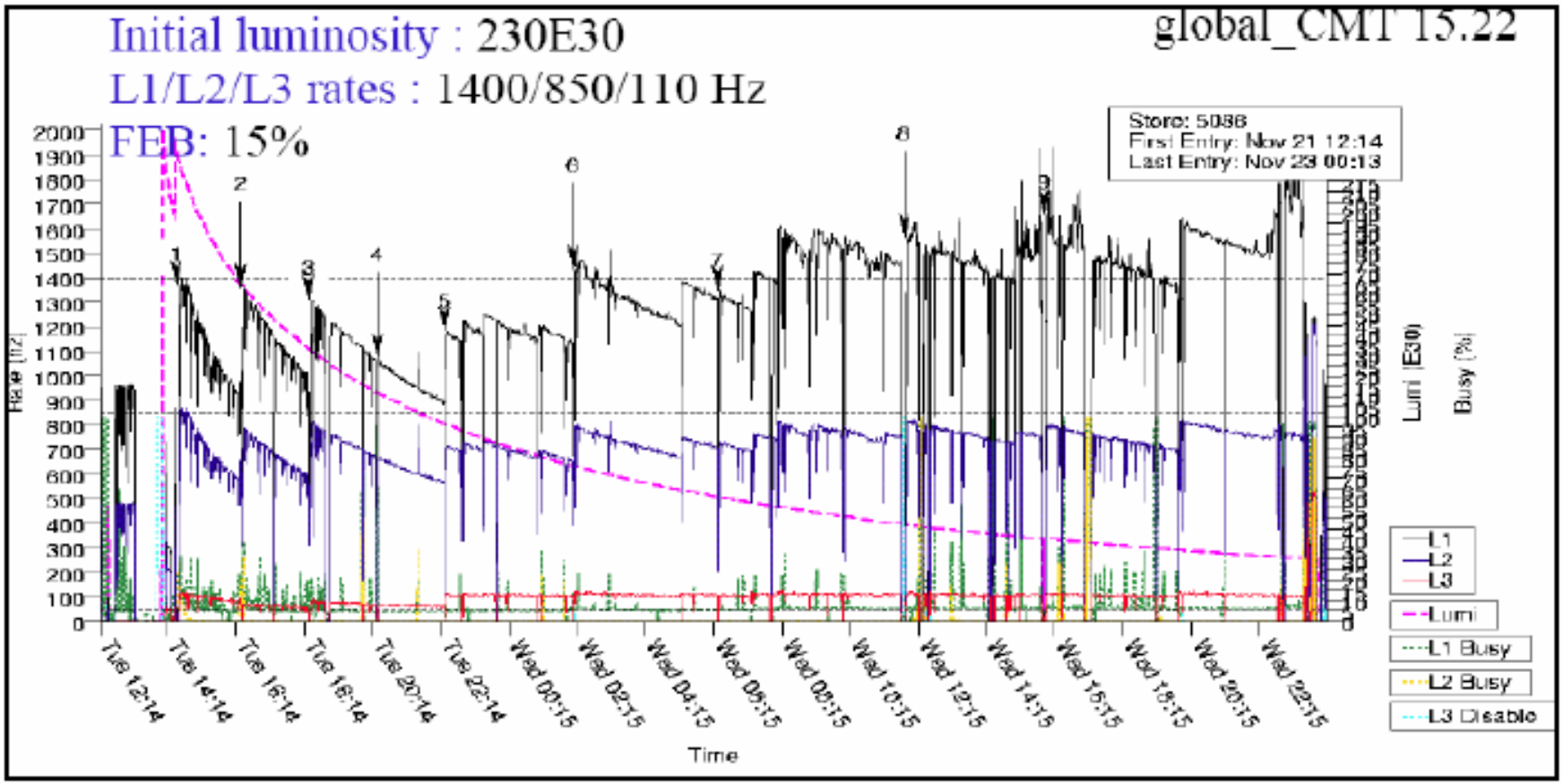


Store: 4781
Initial luminosity: 100E30
Triggerlist: global_CMT-15.01.xml
L1/L2/L3 rates (Hz): 600/400/80

Trigger List V15

Efficiently select events for physics analysis up to L=300E30
- Utilize existing Run II triggering tools and Run IIb upgrade improvements
- V15 started with first Run IIb store

Running successfully up to ~230E30

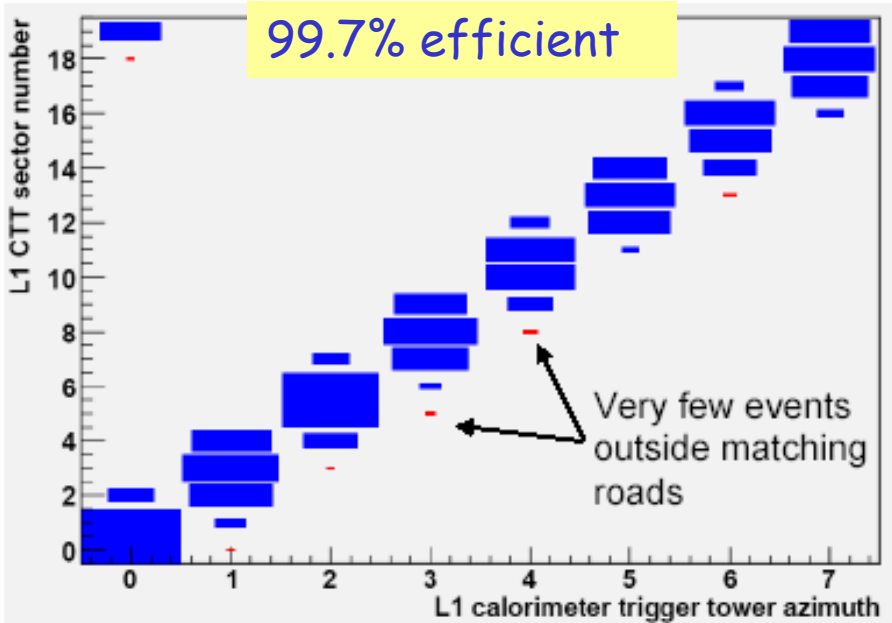


L1CalTrack Trigger

There are still improvements expected
- Caltrack trigger is close to be used on-line
- Level 3 triggering still awaiting substantial Run IIb updates

- L1CalTrack gets inputs from L1CTT, L1CAL, (L1FPS)
- Trigger formed from octant cards each receives 10 L1CTT sectors and 12 L1CAL slices
- Triggers formed by matching tracks to electrons or jets

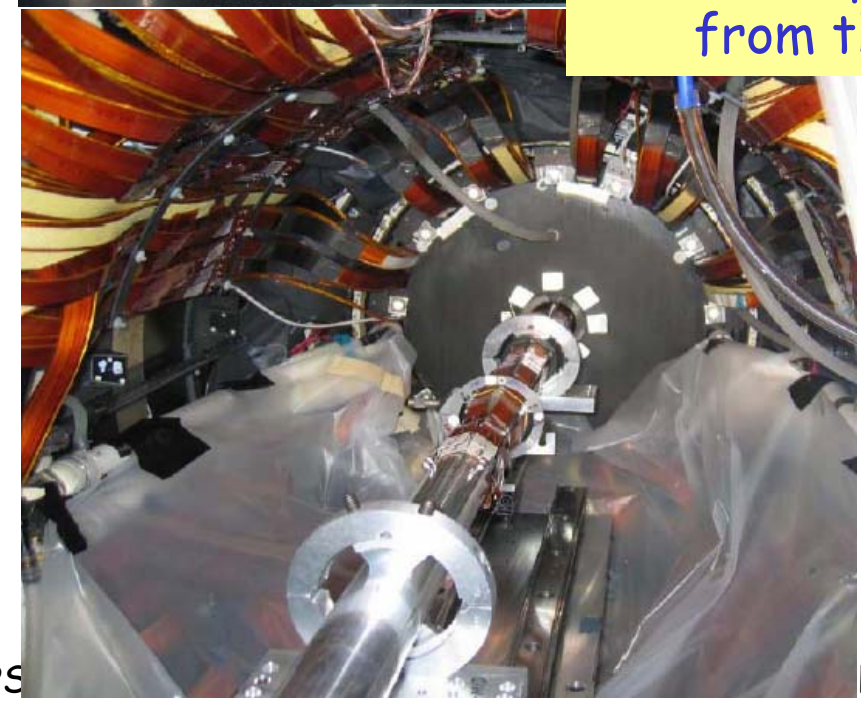
- reduced rates
=> thresholds on electron triggers can be lowered
- improves tau triggering
- fake EM rejection doubled
- fake tau rejection x10



Layer 0 Commissioning

L0 is installed

Threaded inside the existing detector on a new beam pipe at 1.6 cm from the beams

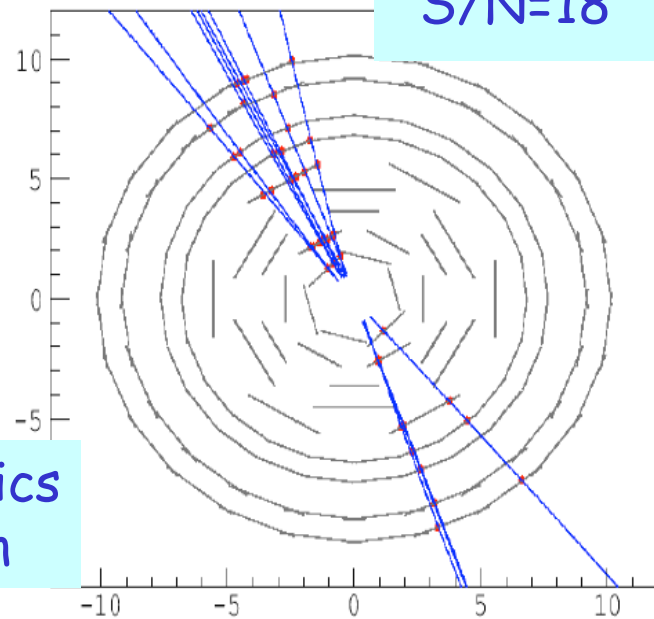


and operational

cosmic run

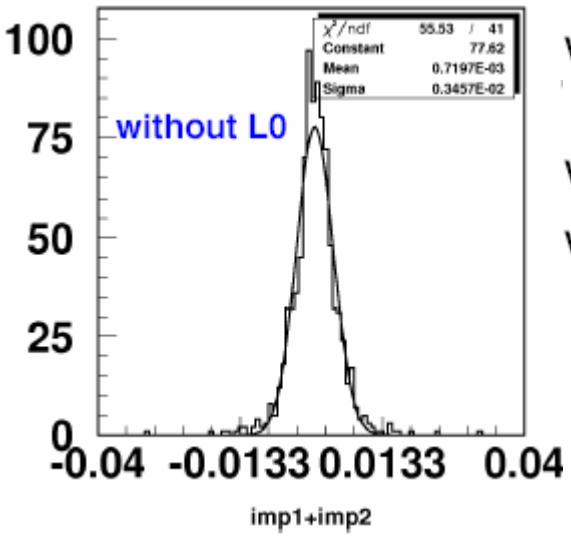
S/N=18

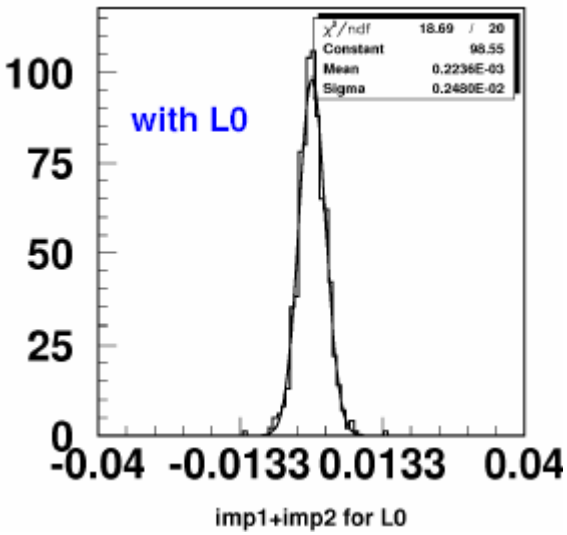
Physics run



Benefits of Layer 0

Impact parameter resolution





for pt>5 GeV

without L0: σ=25 μm

with L0: σ=18 μm

5>pt>1 GeV

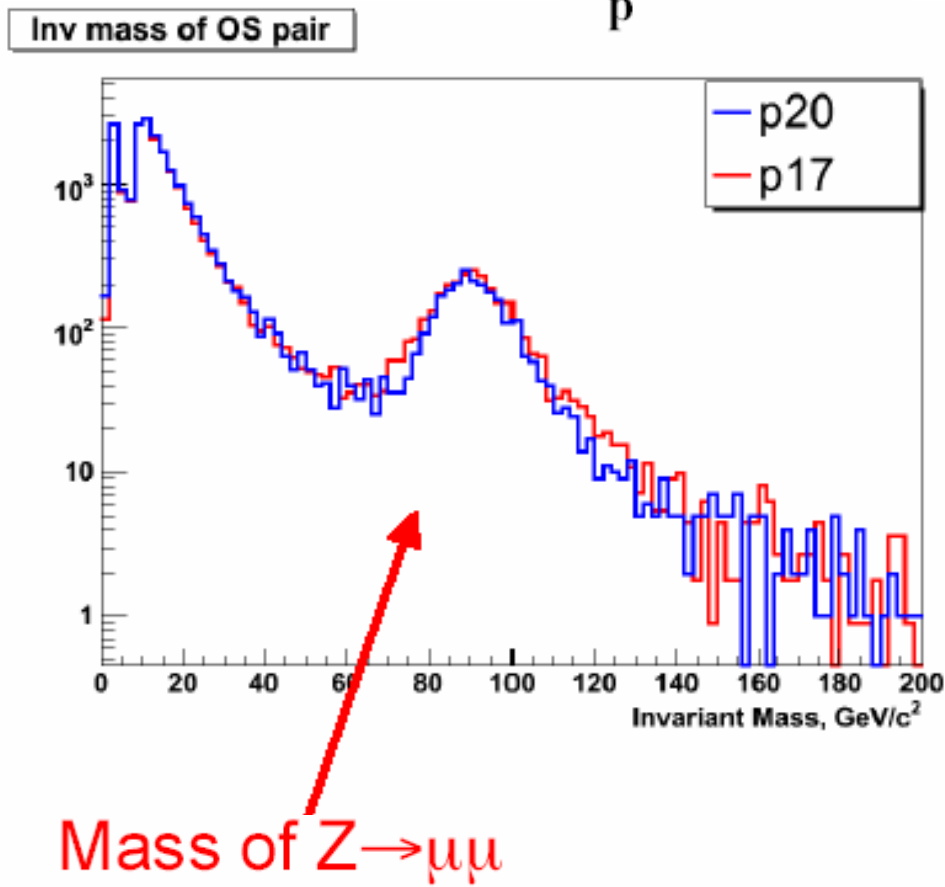
without L0: σ=41.2 μm

with L0: σ=26.5 μm

momentum resolution:

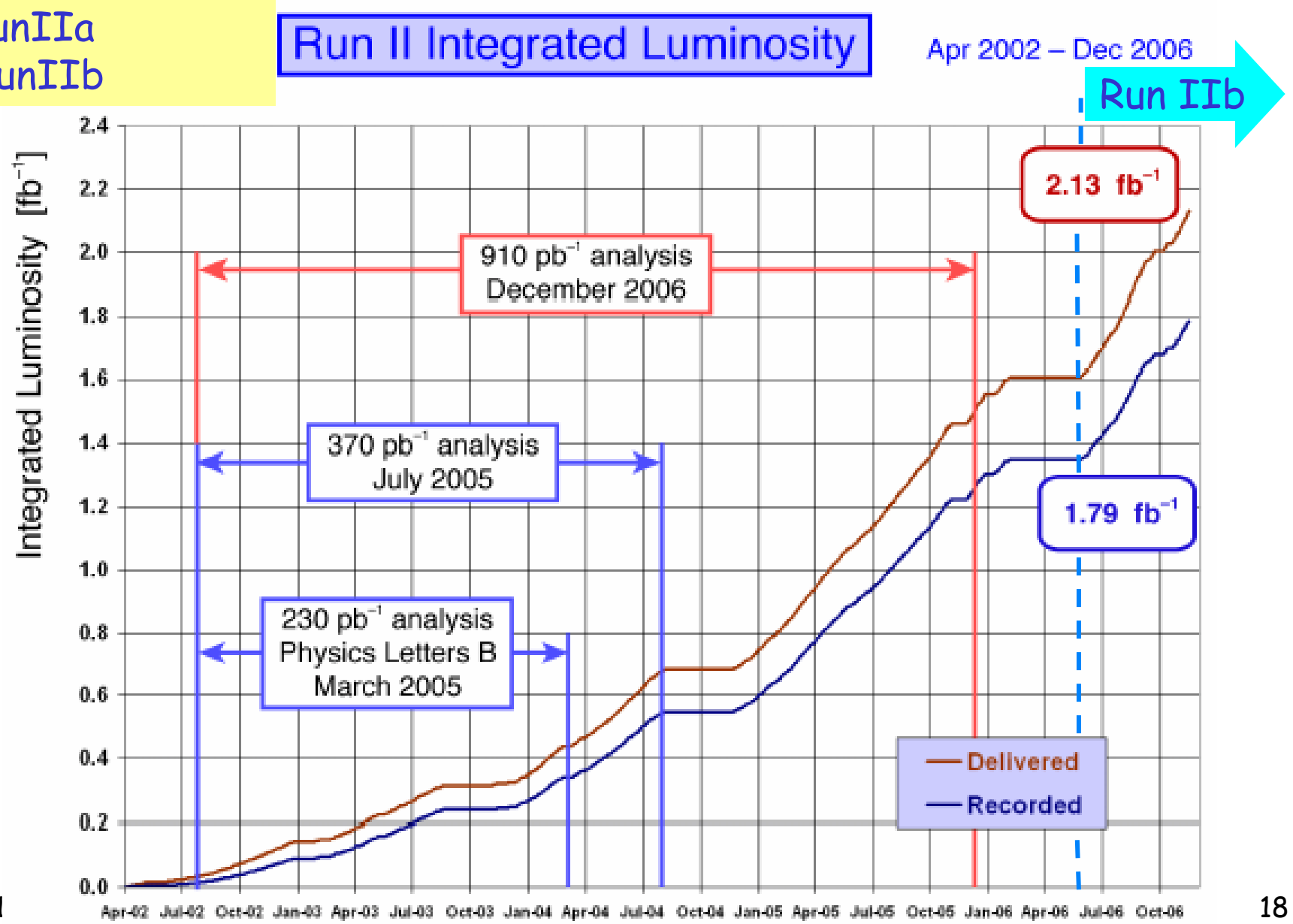
without L0: $\frac{\sigma(p)}{p} = 0.024 \cdot p$

with L0: $\frac{\sigma(p)}{p} = 0.0215 \cdot p$



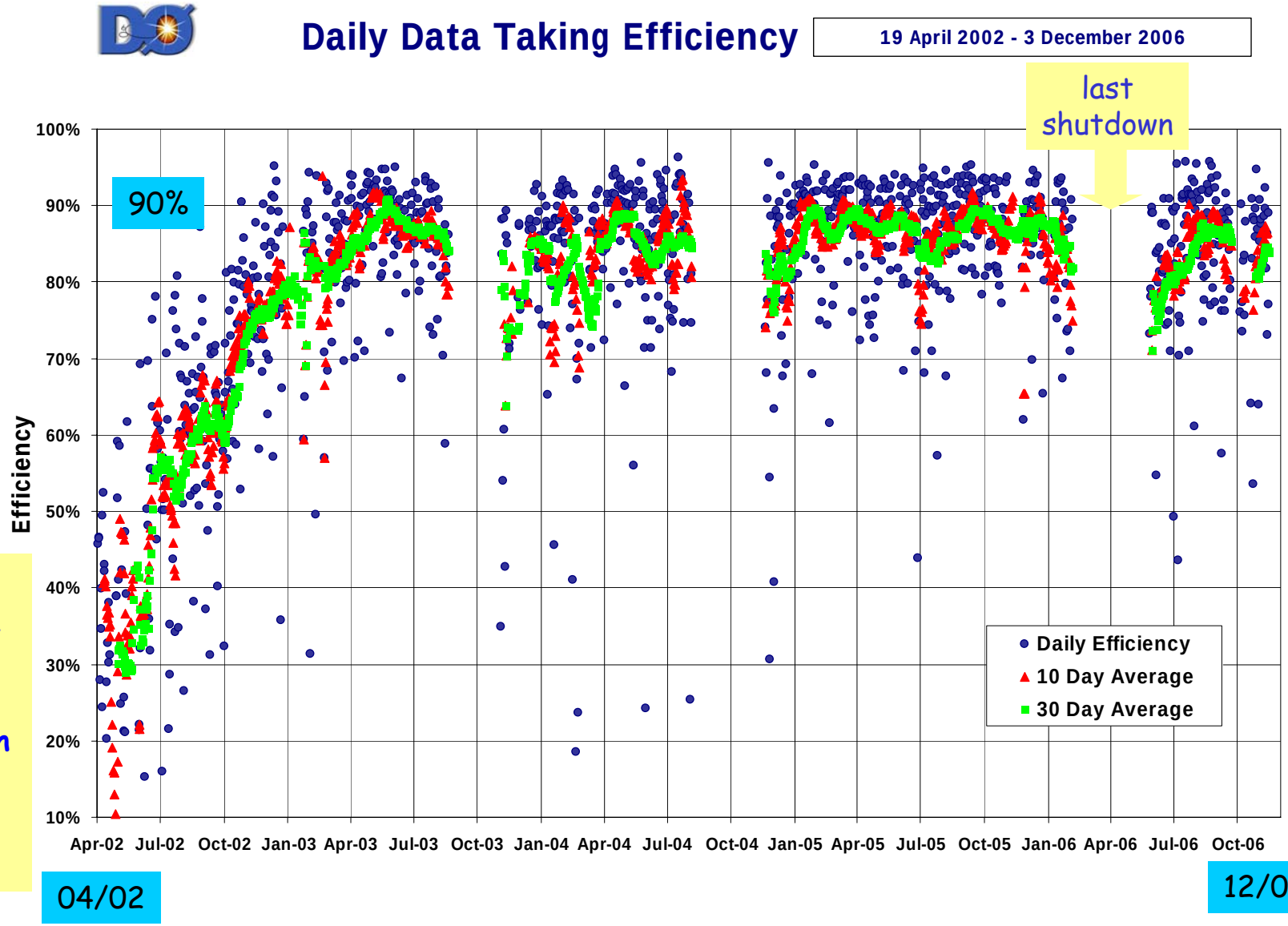
Run II Integrated Luminosity

reconstruction code:
p17: RunIIa
p20: RunIIb



Run II Data Taking Efficiency

Efficiency back to ~90% by the third month of Run IIb operations



Detector/ trigger/DAQ downtime ~ 5%

Store and run transitions ~ 2-3%

FEB ~ 3-5%

Summary of the upgrade

- Accelerator complex
  - Fermilab is actively supporting efforts to increase pbar production
  - => Pbar production is improving
  - Many small improvements being made to the complex to increase the delivered integrated luminosity
  - Initial luminosities up to 4.E32 are also been discussed
- D0 detector
  - 2.19 fb^{-1} of delivered luminosity; 1.83 pb^{-1} recorded, so far
  - All elements of Run IIb upgrade are working very well:
    - **Layer 0, CTT upgrade, STT upgrade, and L1Cal are a part of everyday running.**
    - **Almost all AFEIIs installed and read out.**
    - **Getting to implement L1Cal track match**
  - Improved calorimeter performance and understanding
    - e.g. ICD, calibrations, JES

Big contribution from the French groups

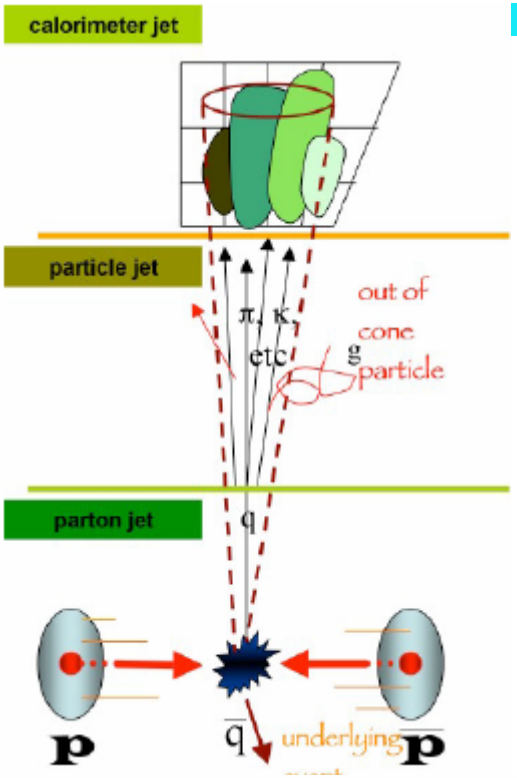
Some tools improvements

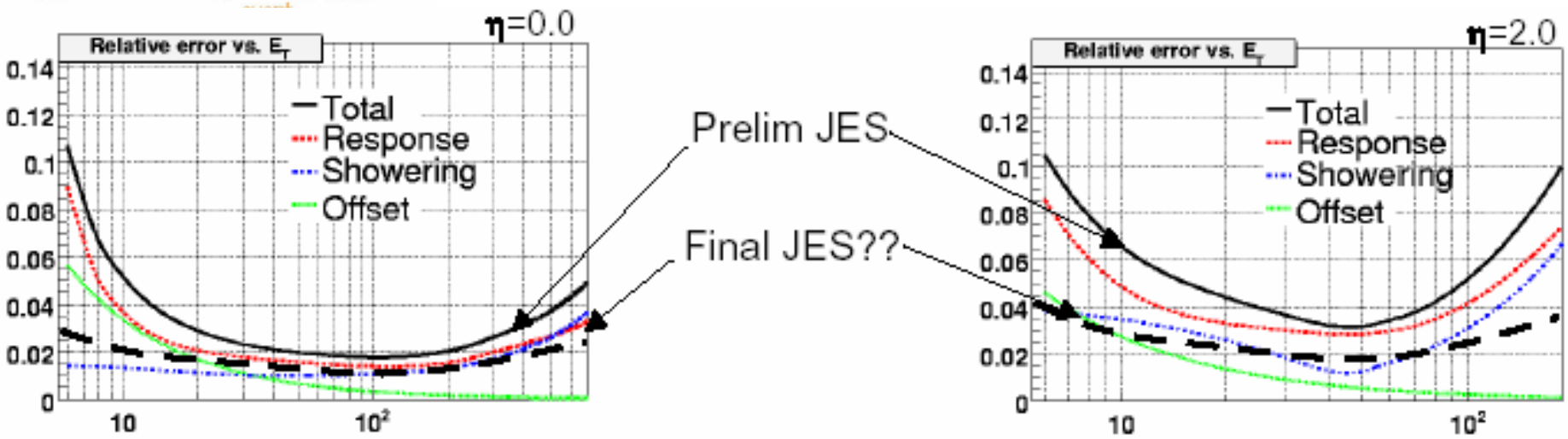
Jet Energy Scale

Jet energy corrected to the particle level defined as:

$$E_{jet}^{ptcl} = \frac{E_{jet}^{det} - O}{R_{jet} S}$$

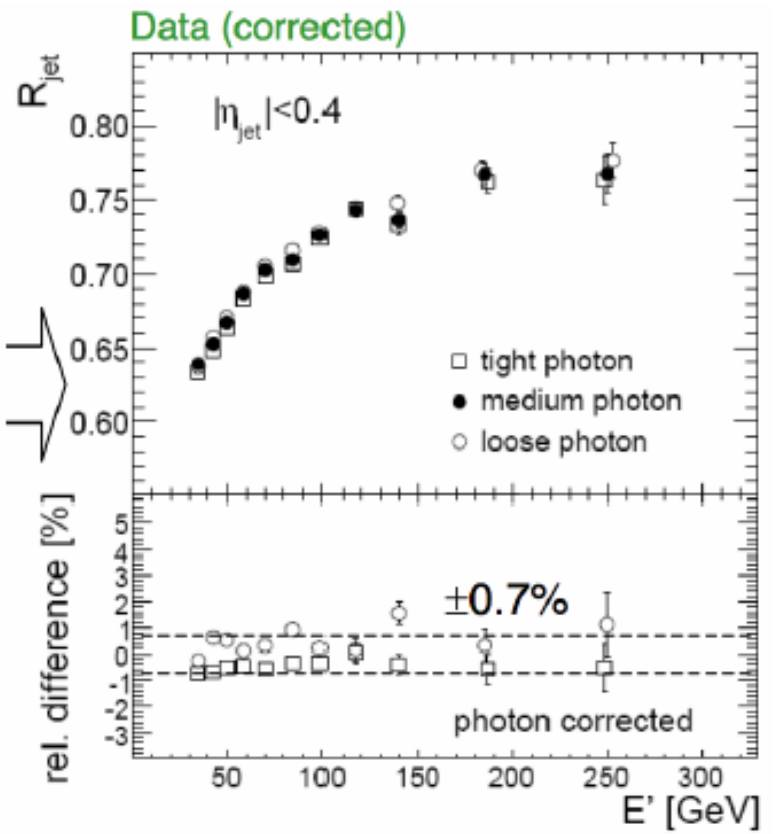
- Offset (O): energy not associated with the hard-scatter (multiple interactions, pileup, noise)
- Response (R_{jet}): calorimeter response to a jet
- Showering (S): fraction of energy from particles nominally inside (outside) the jet cone which is deposited outside (inside) the jet cone because of the finite size of showers in the calorimeter



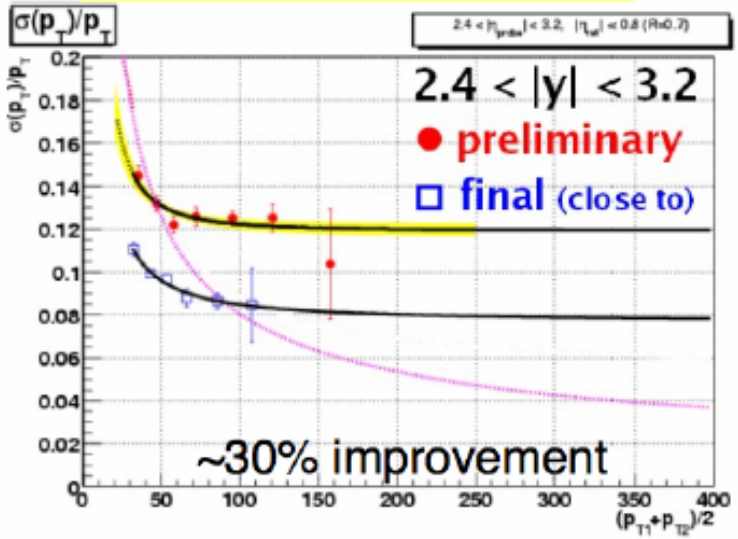


Jet Energy Scale

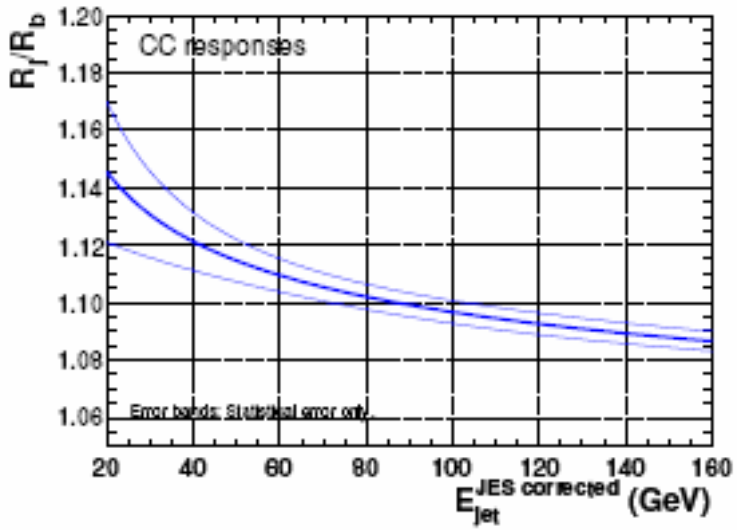
Reduced sensitivity to photon ID systematics



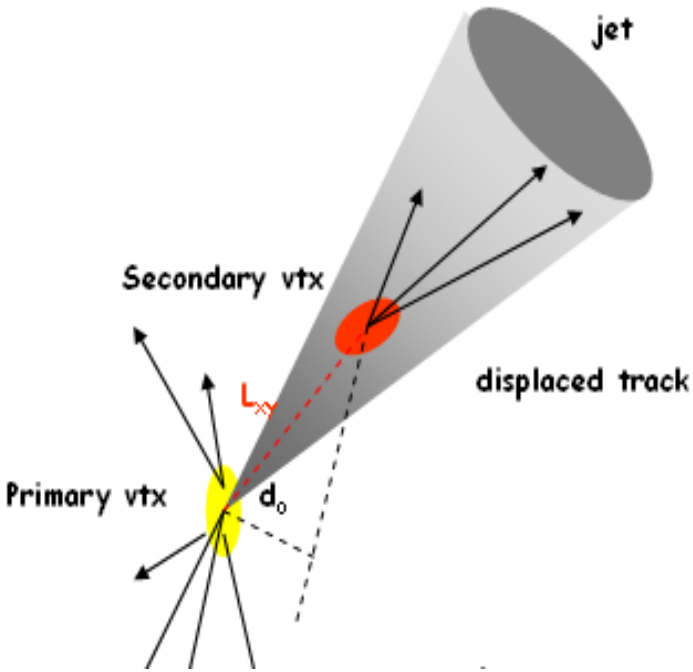
Significantly improved jet energy resolution



b-jet specific corrections



b-ID: different tagging algorithms ...



- **Secondary Vertex** (SVT)
- **Jet Lifetime Impact Parameter** (JLIP)
- Counting Signed Impact Parameter (CSIP)
- Soft Lepton

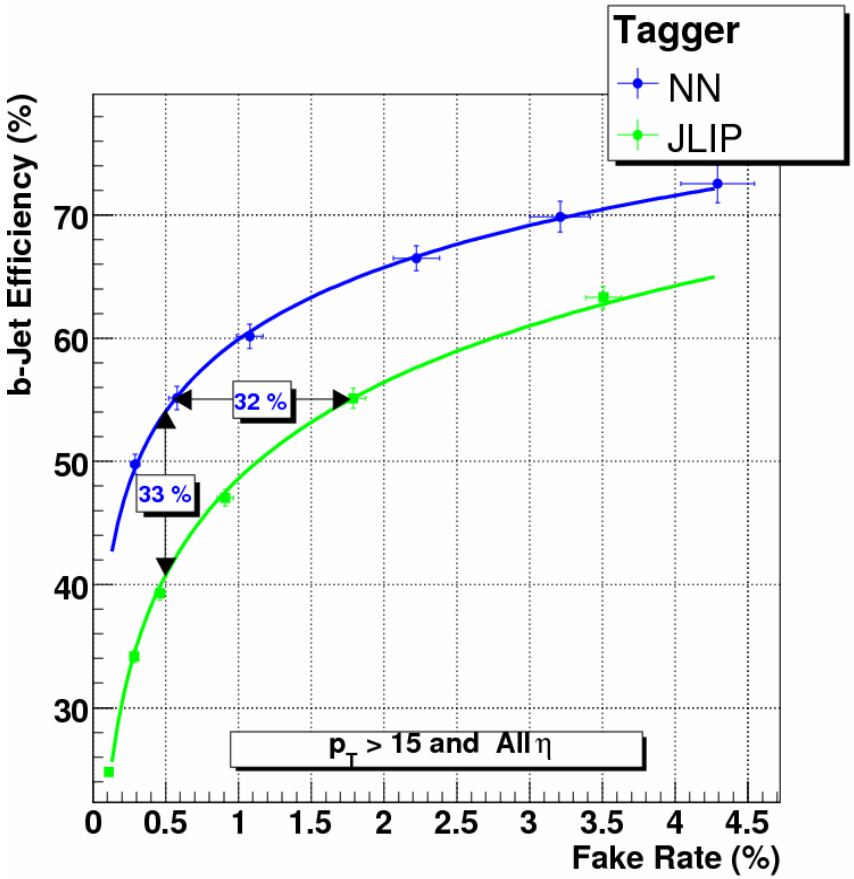
New b-tagging tool

- Combines various variables from the track based b-tagging tools in a Neural Network

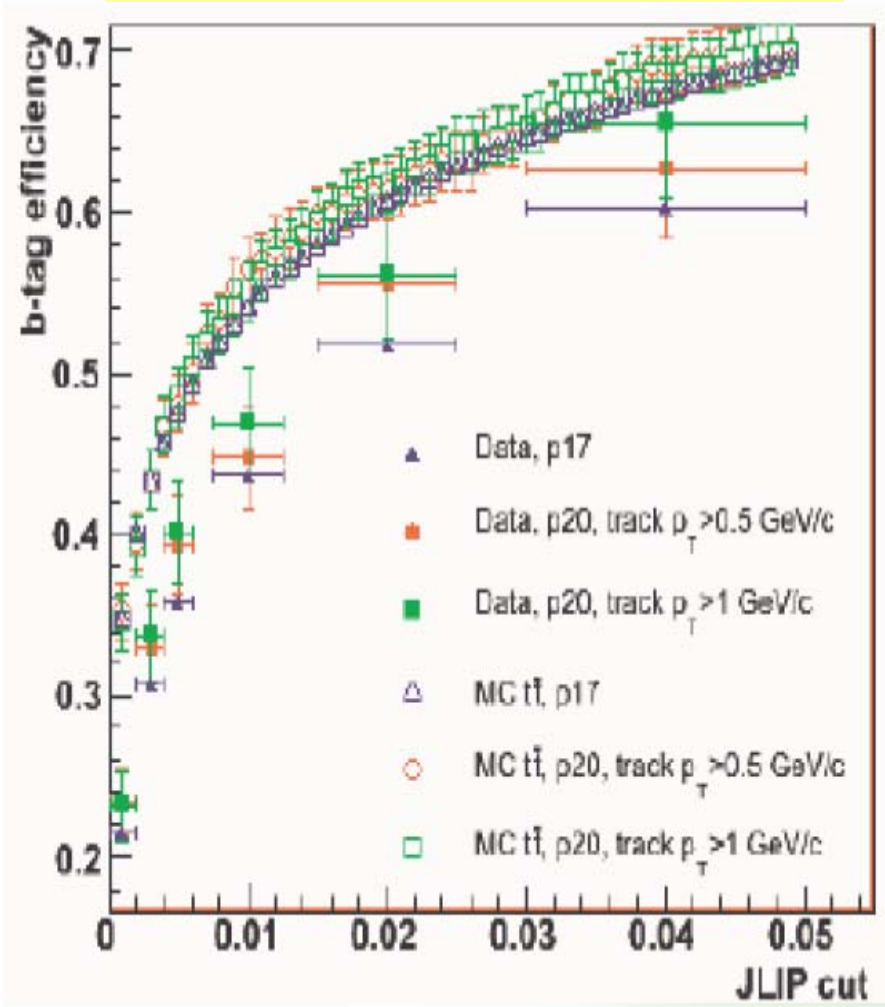
- Substantial improvement in performance over constituent input b-taggers

b-ID: different tagging algorithms ...

Neural Net Tagger
certified operating points



b-tagging in RunIIb:
8-10% increase <= Layer 0
And Scale Factor closer to 1



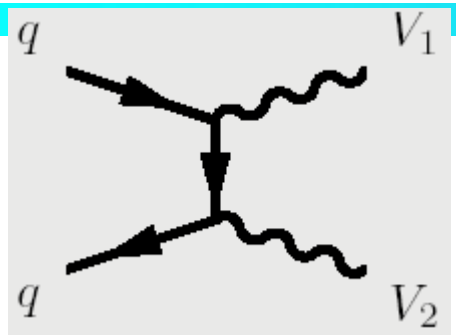
Vector bosons Physics

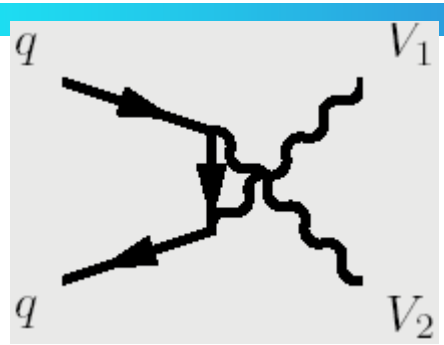
Laboratory to test the SM

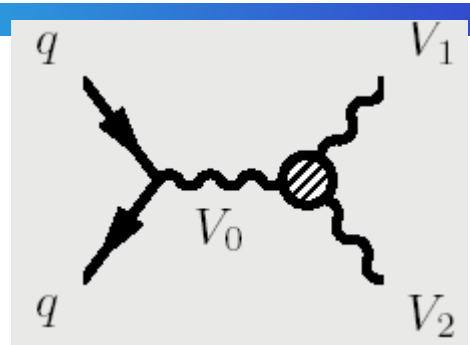
anomalous couplings

bump hunts

Wγ radiation zero







Balance of the three diagrams in the SM leads to destructive interference

Manifests as a zero in the angle distribution between the photon and the incoming quark in the center of mass frame:

$\cos(\theta^*) = \pm 1/3$ where + is for W-

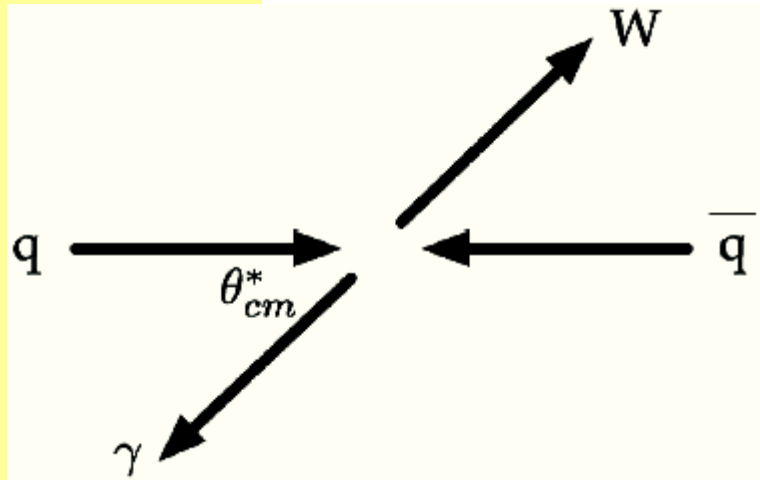
Unknown ν direction makes $\cos(\theta^*)$ ambiguous

But, W and γ directions correlated,

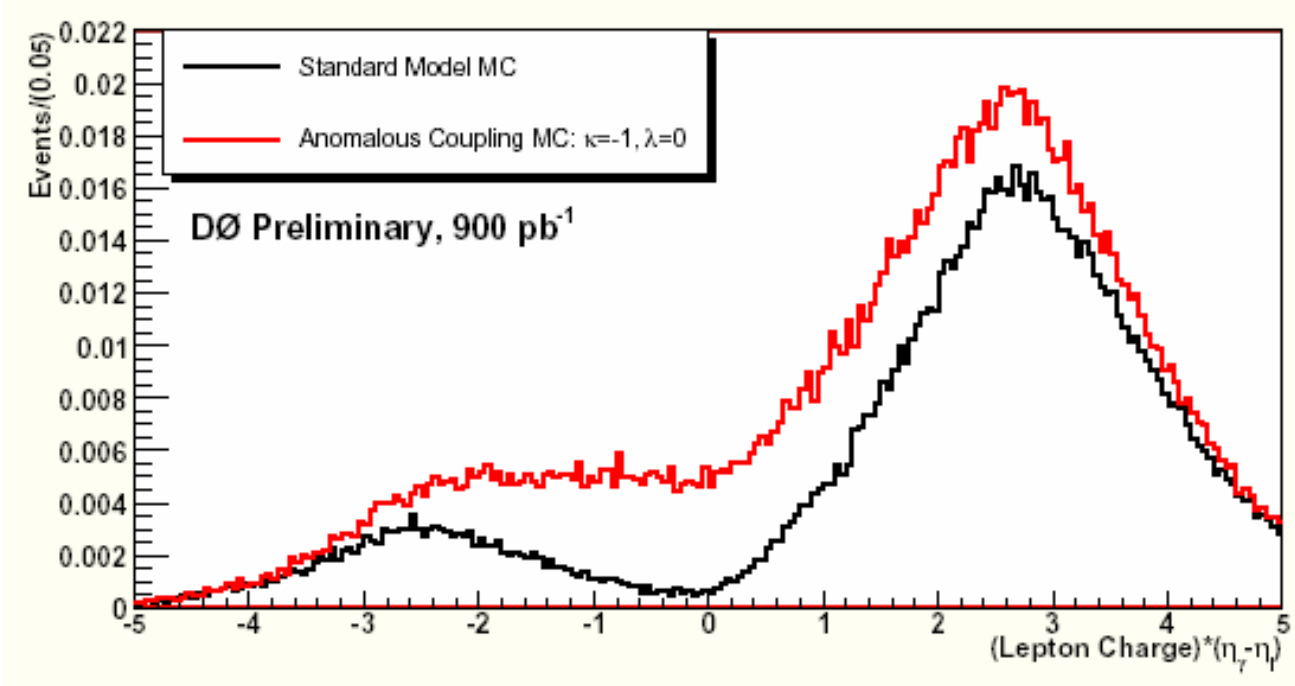
=> lepton (from W) and γ directions are correlated

Measure the charge-signed rapidity difference

In SM, sign(l)*[y(γ) - y(l)] ~ -0.3



Wγ radiation zero

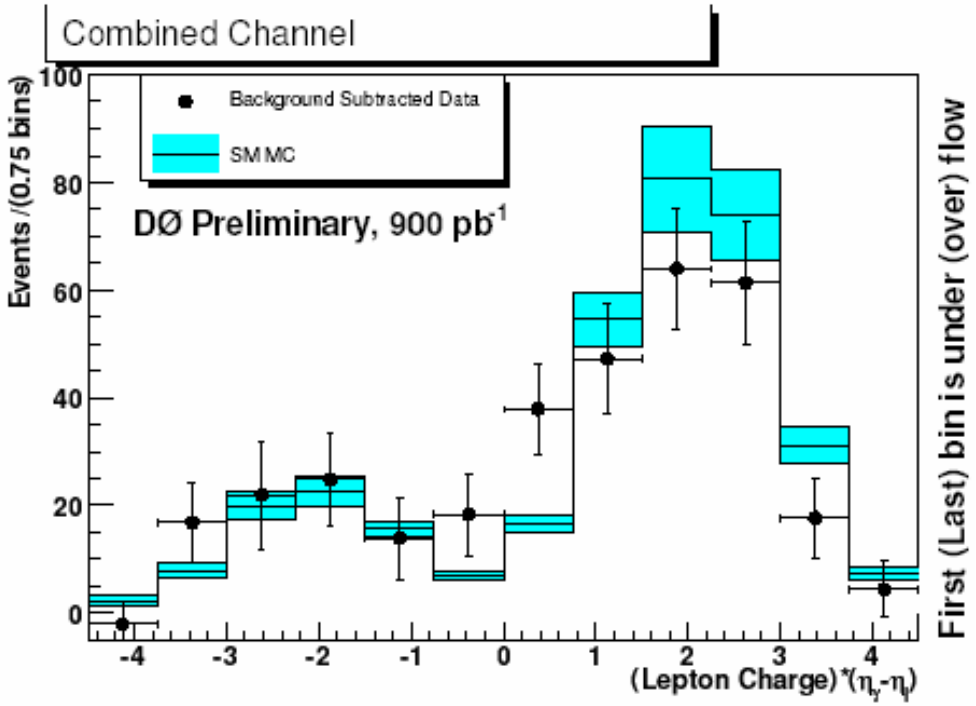


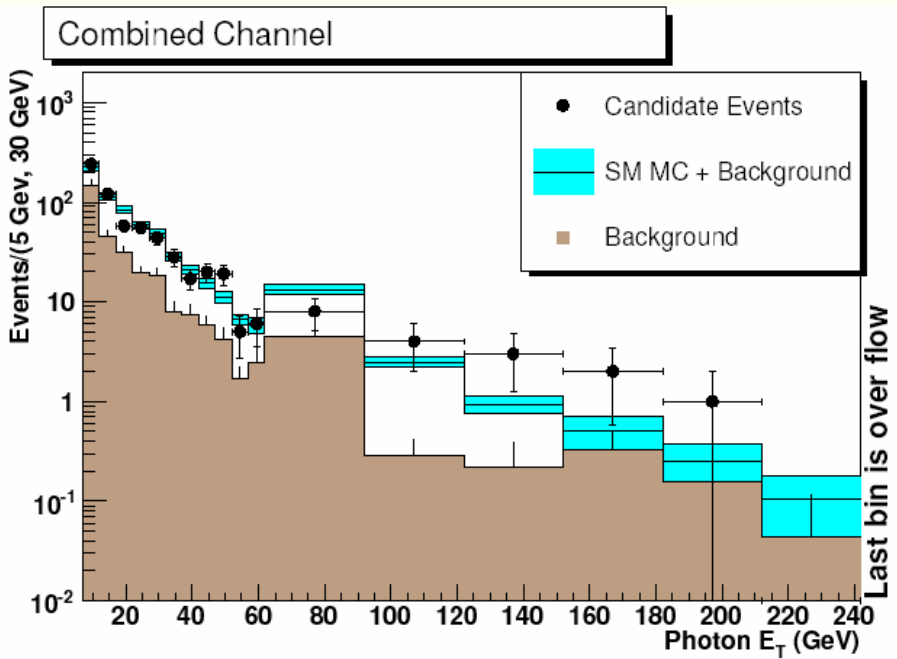
- with E_γ > 7 GeV, $\Delta R_{l,\gamma}$ > 0.7, Three body mass > 110 GeV to reduce FSR
- Integral of curves normalized to their expected cross sections with respect to the SM, which is set to unity

W(e/μ,ν)γ production

SM NLO:
σ(Wγ)xB(W->e/μ+ν) = 3.2 ± 0.8 pb

DØ: 933 pb^{-1}
- 389 eνγ candidates observed
- 211 ± 14 expected signal
- 183 ± 17 background
- σ(Wγ)xB(W->eν) = 3.1 ± 0.5 pb

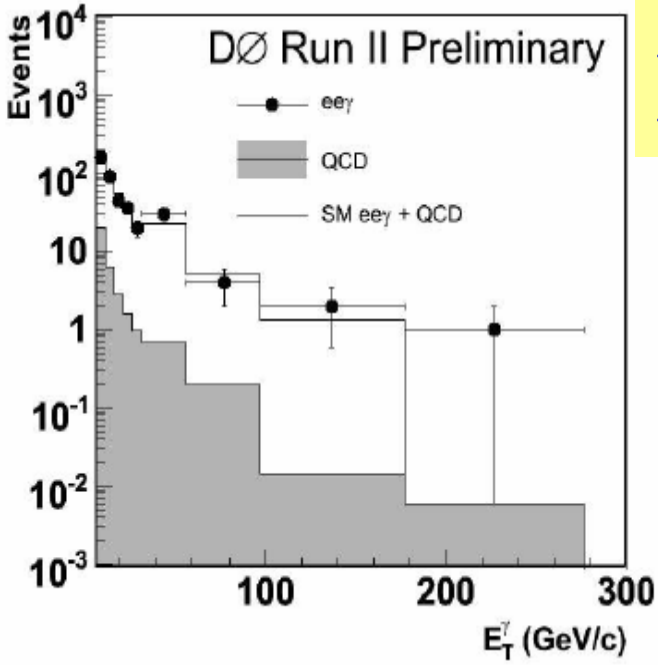




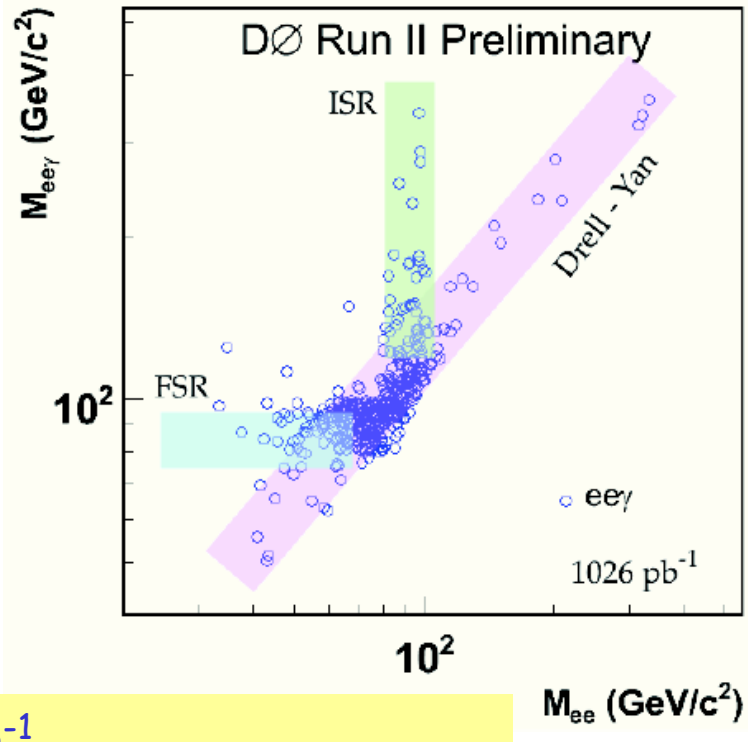
Consistent with SM expectations
Evidence for radiation zero

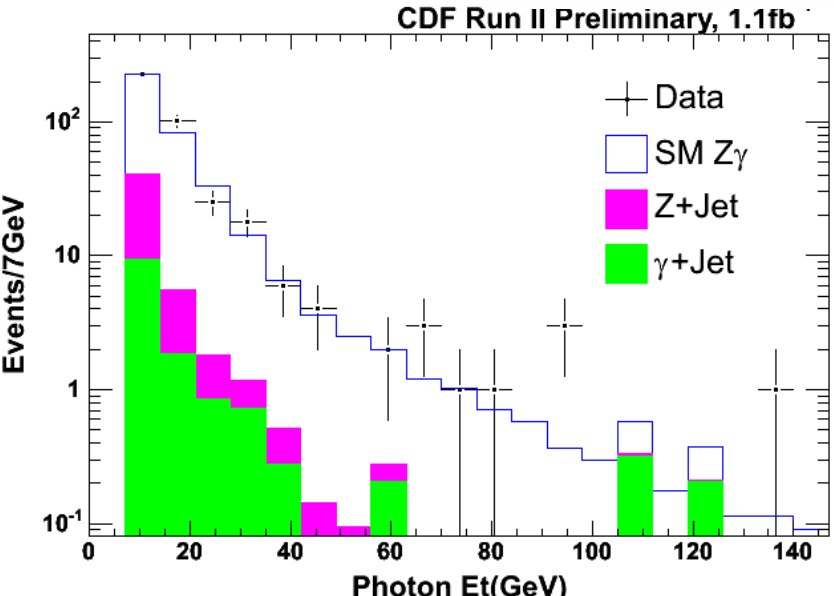
Z(ee)γ production

SM NLO:
σ(Zγ)xB(Z->ee) = 4.7 ± 0.4 pb



DØ: 1026 pb^{-1}
- 387 eeγ candidates observed
- 360 ± 21 expected
- 33 ± 6 background
- σ(Zγ)xB(Z->ee) = 4.5 ± 0.5 pb





CDF: 1.1 fb^{-1}
- 390 eeγ candidates observed
- 375 ± 23 expected
- 51 ± 16 background
- σ(Zγ)xB(Z->ee) = 4.9 ± 0.5 pb

WW production

e and μ channels

Backgrounds:
- Drell-Yan
- ttbar
- WZ and ZZ
- Wγ where γ fakes an electron
- W+jets where a jet fakes a lepton

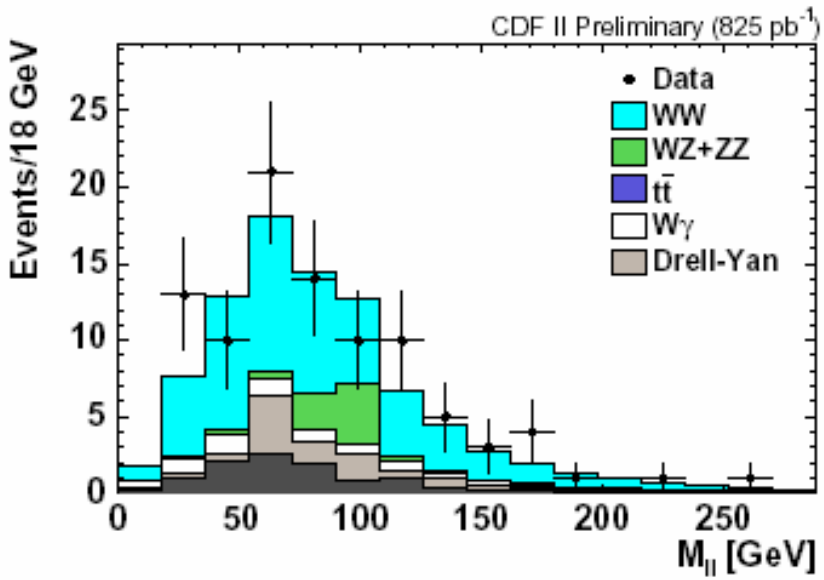
SM NLO:
$\sigma(WW) = 12.4 \pm 0.8$ pb

D0: 240 pb^{-1}
- 25 events observed
- 24.1 ± 0.5 expected
- 8.1 ± 0.5 background

$\sigma(WW) = 13.8^{+4.6}_{-4.0}$ pb

CDF: 825 pb^{-1}
- 95 events observed
- 90 ± 6 expected
- 38 ± 5 background

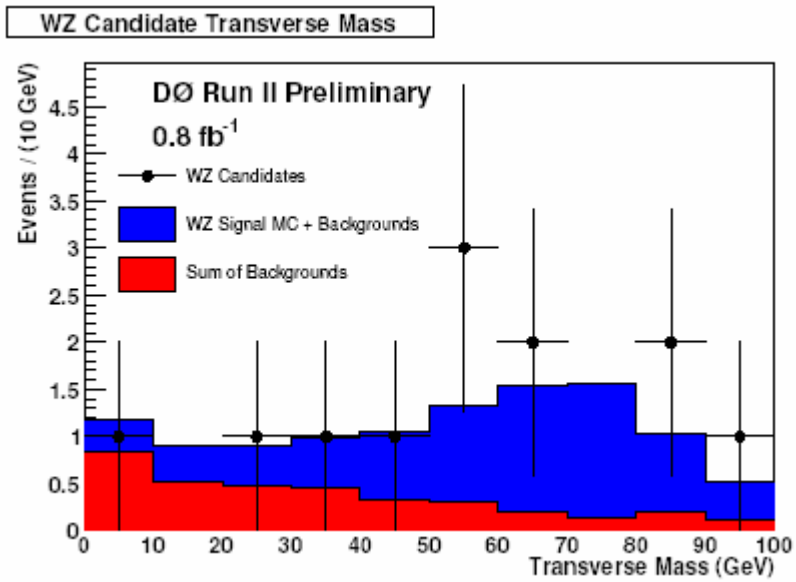
$\sigma(WW) = 13.6 \pm 3.1$ pb



WZ production

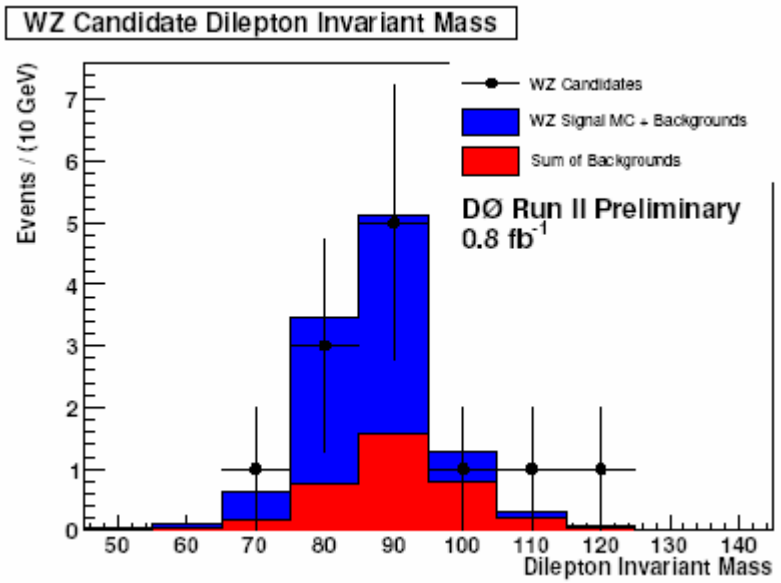
e and μ channels

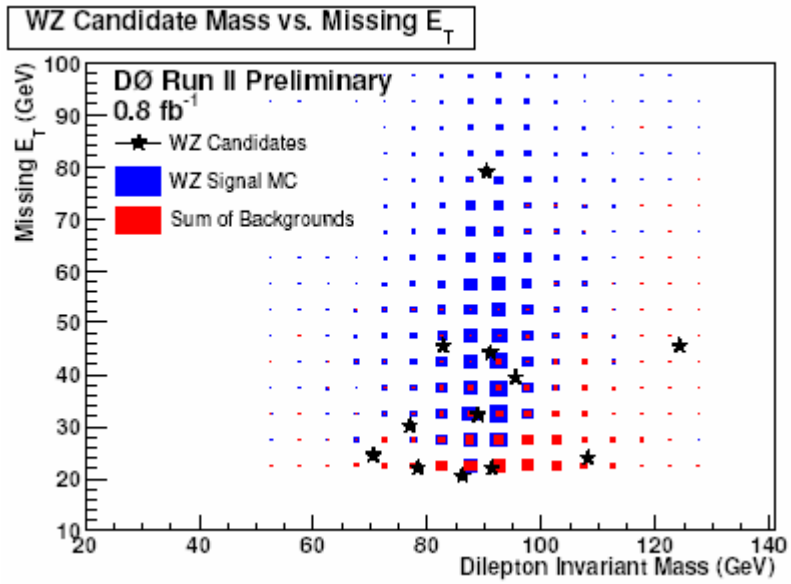
SM NLO:
$\sigma(WZ) = 3.7 \pm 0.1$ pb



DO: 0.8 fb^{-1}
- 12 candidates
- 11.2 ± 1.2 expected
- 3.6 ± 0.2 background
  (Z+jets, W+Drell-Yan, ZZ, Zg, ttbar)
- Significance ~ 3.3σ
- $\sigma(WZ) = 4.0\ ^{+1.9}_{-1.5}$ pb

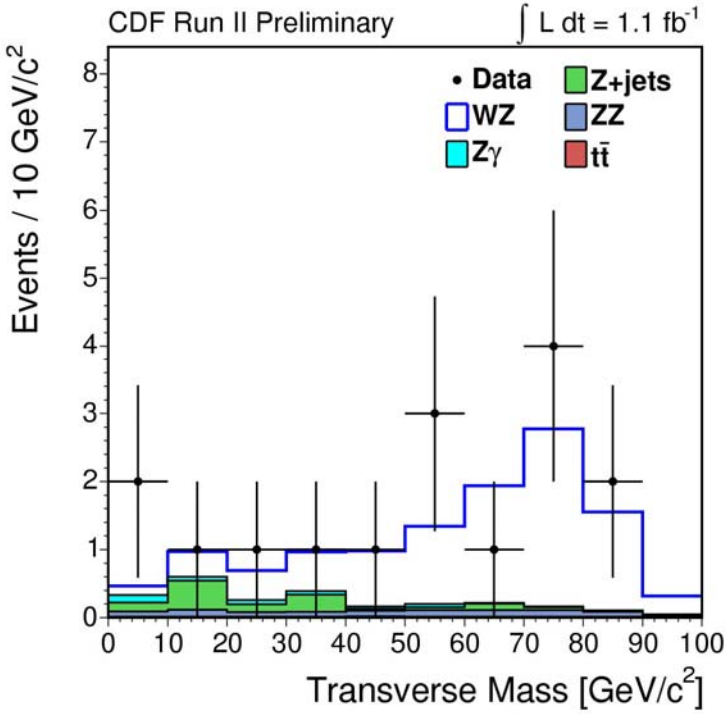
AC analysis underway.

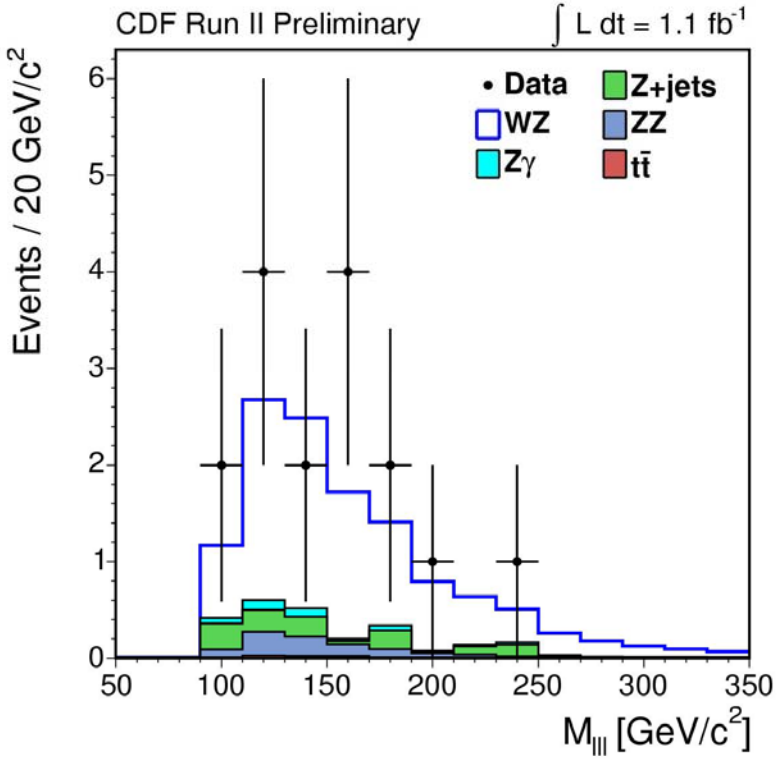


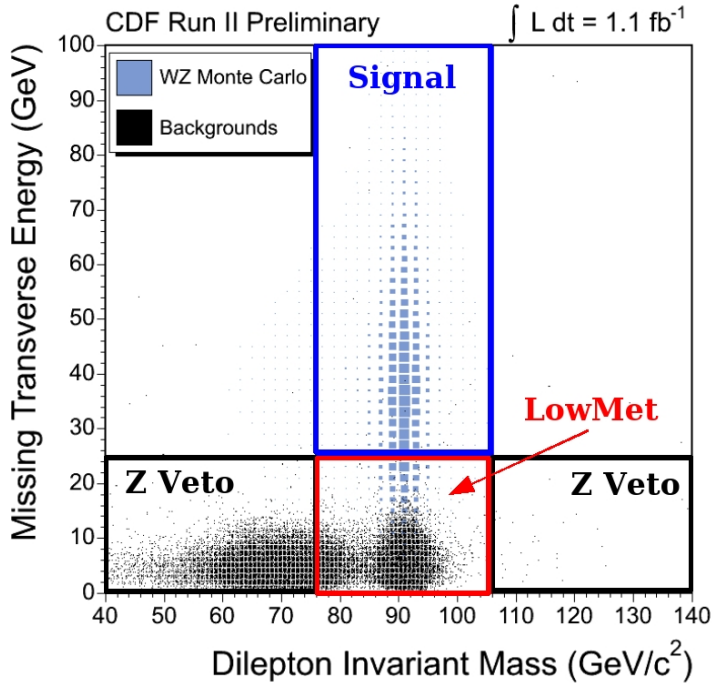


WZ production

CDF: 1.1 fb^{-1}
- 16 candidates
- 12.5 ± 0.9 expected
- 2.7 ± 0.4 background (Z+jets, ZZ, Zg, ttbar)
- Significance ~ 5.9 σ
- $\sigma(WZ) = 5.0\ ^{+1.8}_{-1.6}$ pb

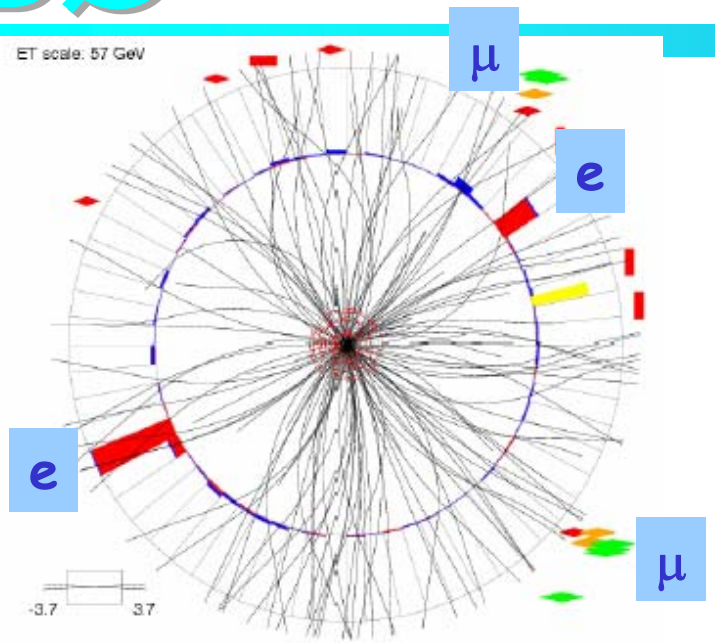






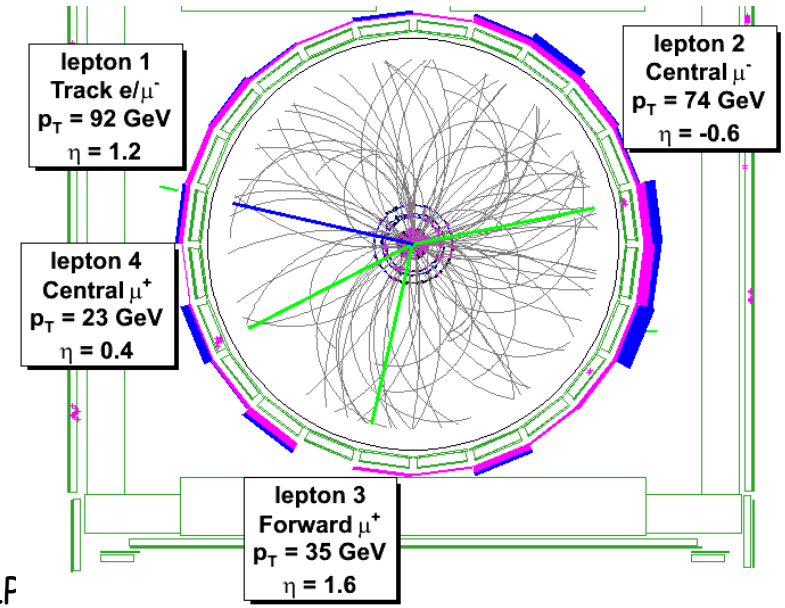
ZZ production

e and μ channels



SM NLO: $\sigma(ZZ) = 1.4 \pm 0.1$ pb

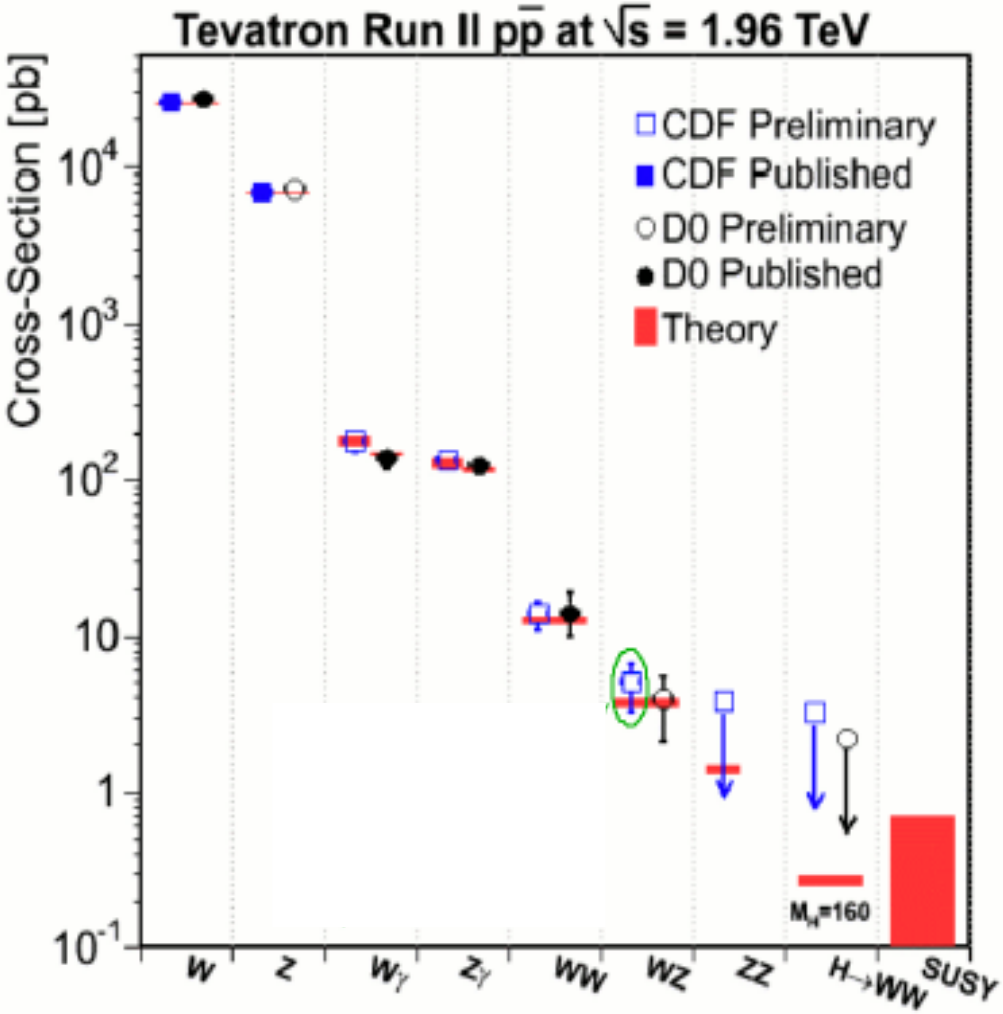
D0:
- Extensive effort to increase efficiency and acceptance
- One candidate event
- Ongoing work on background estimates



CDF:
- 1 event observed
- 1.9 ± 0.1 expected
- 0.01 ± 0.01 background (Z+jets, Zγγ)

=> $\sigma(ZZ) < 3.8$ pb @ 95% C.L.

Vector bosons physics



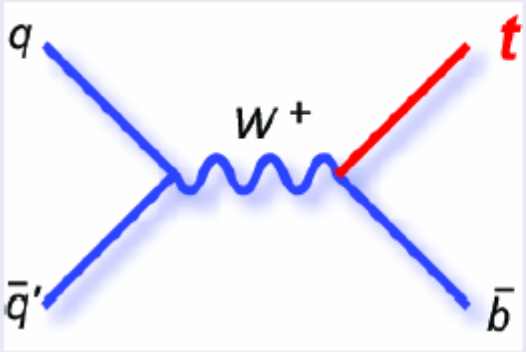
For D0, the first half of 2007 should be very productive:

- W mass
- Results to 1/fb for all di-boson modes.
- Cross-sections, asymmetries to improve PDFs, and maybe luminosity

Single Top Production

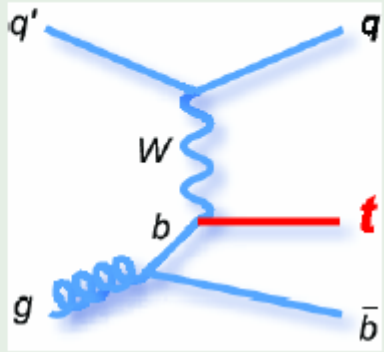
Single top production

s-channel (tb)



- $\sigma_{NLO} = 0.88 \pm 0.11$ pb(*)
- current limits (95% C.L.):
  Run II DØ: < 5.0 pb (370pb^{-1})
  Run II CDF: < 3.1 pb (700pb^{-1})

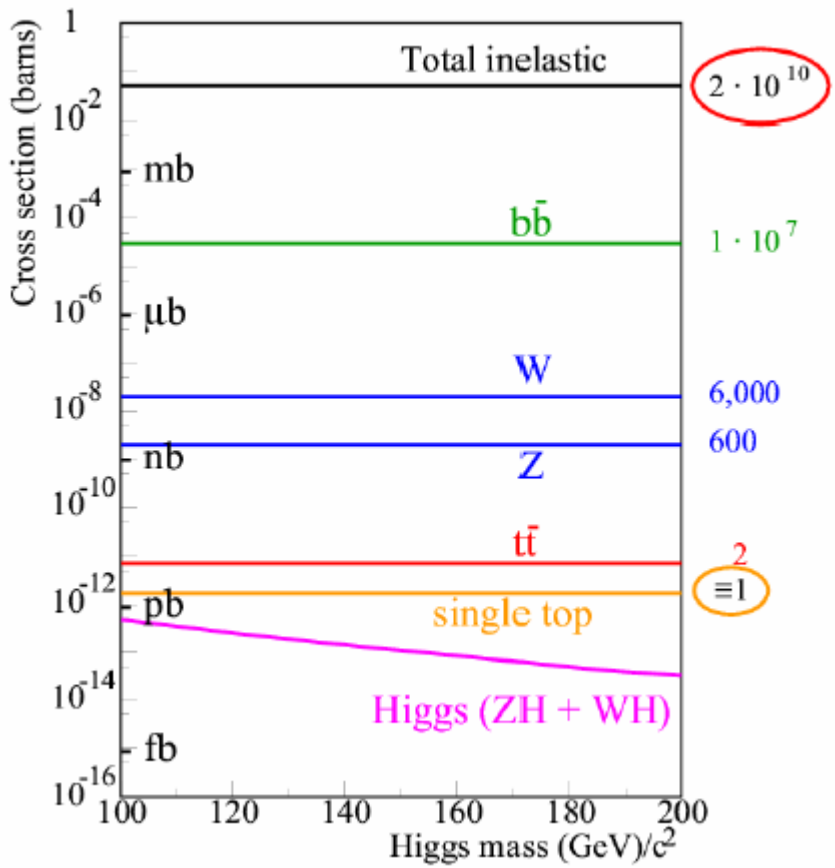
t-channel (tqb)

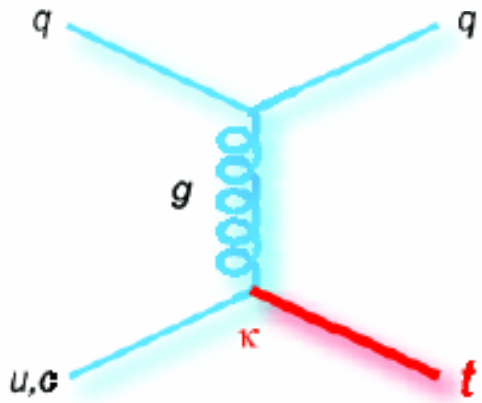


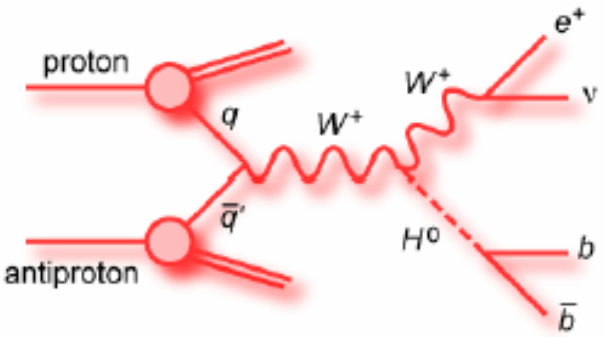
- $\sigma_{NLO} = 1.98 \pm 0.25$ pb (*)
- current limits (95% C.L.):
  Run II DØ: < 4.4 pb (370pb^{-1})
  Run II CDF: < 3.2 pb (700pb^{-1})

Motivations

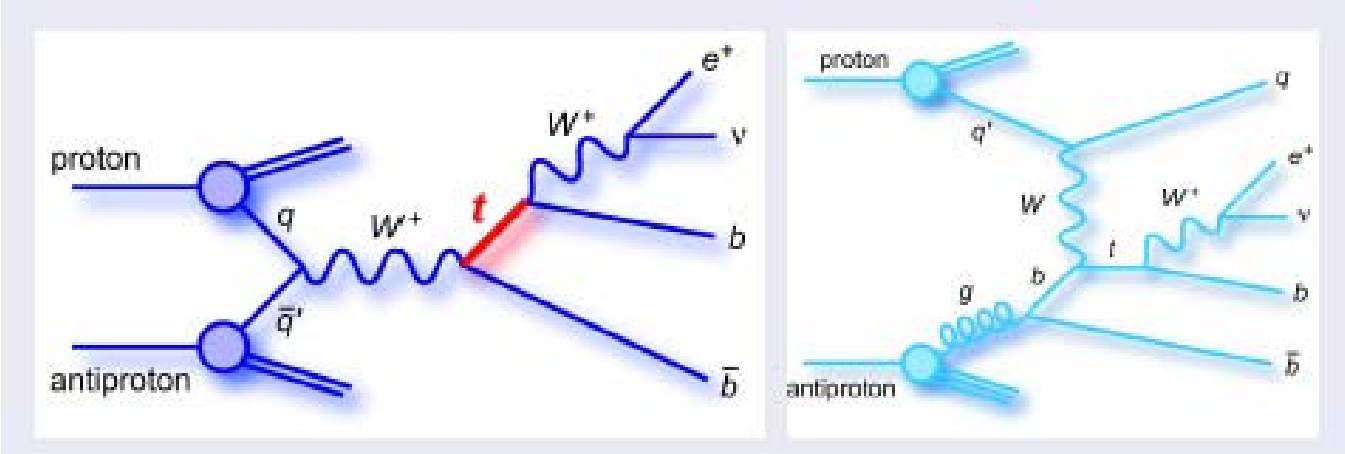
- Directly measure |Vtb|
- Cross section sensitivity to beyond the SM processes
- Source of polarized top quarks. Spin correlations measurable in decay products.
- Important background to Higgs search
- Test of techniques to extract a small signal out of a large background







Event selection

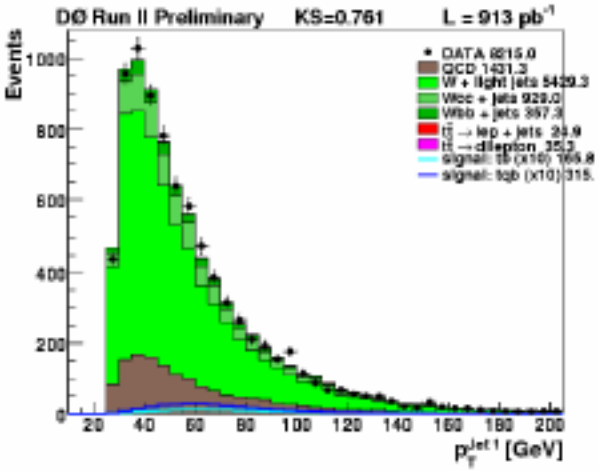


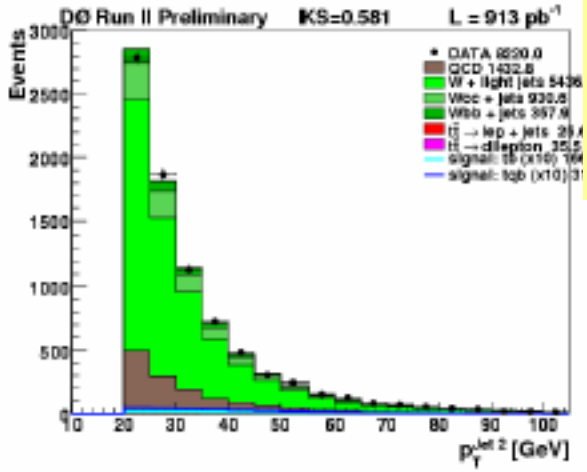
- Only one tight and no other loose lepton:
  - electron: $p_T > 15$ GeV and $|\eta_{det}| < 1.1$
  - muon: $p_T > 18$ GeV and $|\eta_{det}| < 2$
- $15 < \text{MET} < 200$ GeV
- 2-4 jets with $p_T > 15$ GeV and $|\eta_{det}| < 3.4$
  - at least 1 b-jet
  - Leading jet with $p_T > 25$ GeV and $|\eta_{det}| < 2.5$
  - Second leading jet $p_T > 20$ GeV

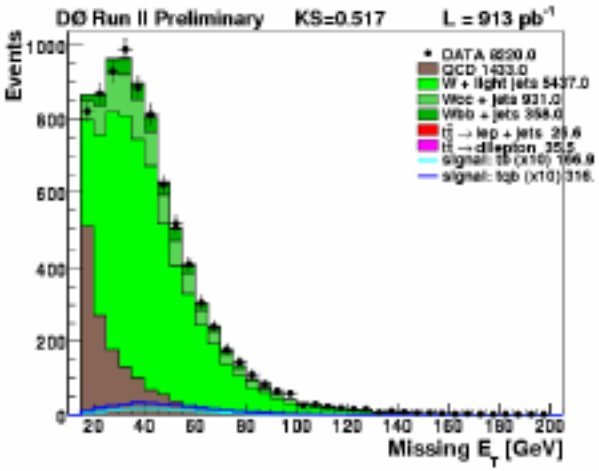
Event selection

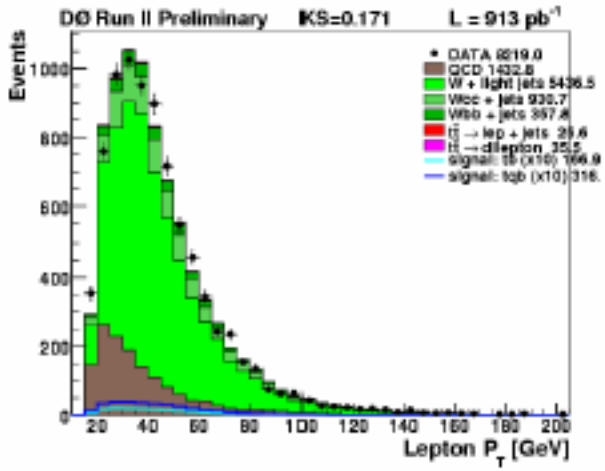
- Normalize W+multijet to data **before tagging**
- Checked 90 variables, 3 jet multiplicities, 1-2 tags, e + μ
- Good data description

Before tagging









Event selection

Source	Event Yields in 0.9 fb^{-1} Data Electron+muon, 1tag+2tags combined 2 jets	3 jets	4 jets
tb	16 ± 3	8 ± 2	2 ± 1
tqb	20 ± 4	12 ± 3	4 ± 1
$t\bar{t} \to ll$	39 ± 9	32 ± 7	11 ± 3
$t\bar{t} \to l$+jets	20 ± 5	103 ± 25	143 ± 33
$W+b\bar{b}$	261 ± 55	120 ± 24	35 ± 7
$W+c\bar{c}$	151 ± 31	85 ± 17	23 ± 5
$W+jj$	119 ± 25	43 ± 9	12 ± 2
Multijets	95 ± 19	77 ± 15	29 ± 6
Total background	686 ± 131	460 ± 75	253 ± 42
Data	697	455	246

Percentage of single top *tb+tqb* selected events and S:B ratio (white squares = no plans to analyze)

Electron + Muon	1 jet	2 jets	3 jets	4 jets	≥ 5 jets
0 tags	10% 1 : 3,200	25% 1 : 390	12% 1 : 300	3% 1 : 270	1% 1 : 230
1 tag	6% 1 : 100	21% 1 : 20	11% 1 : 25	3% 1 : 40	1% 1 : 53
2 tags		3% 1 : 11	2% 1 : 15	1% 1 : 38	0% 1 : 43

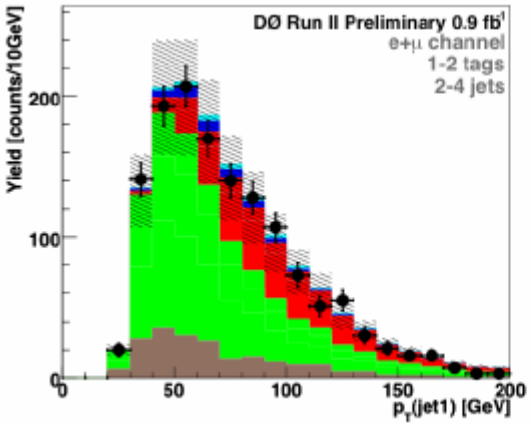
No way to use a simple counting method (1398 data vs 62 signal!!)
3 multivariate methods used to get the signal out:
- Boosted Decision Trees
- Matrix Elements
- Bayesian Neural Network

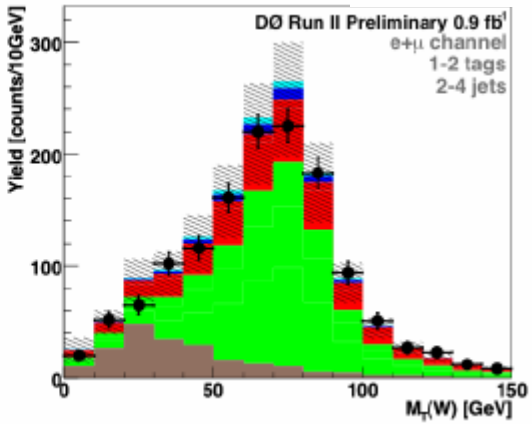
only Boosted Decision Trees described here

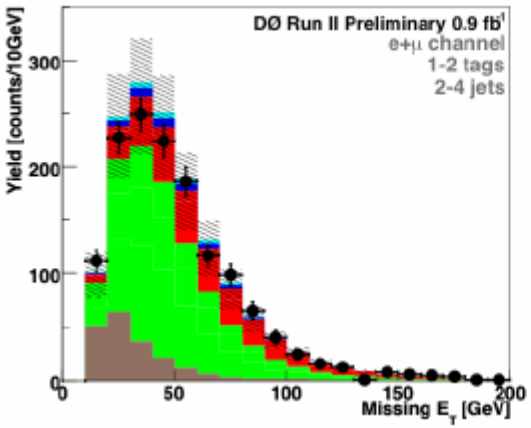
Systematics

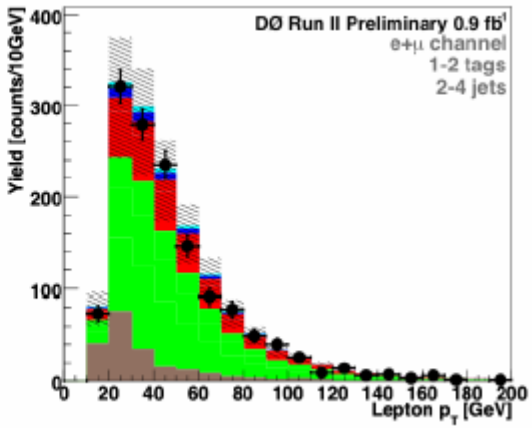
Examples of Relative Systematic Uncertainties	
$t\bar{t}$ cross section	18%
Luminosity	6%
Electron trigger	3%
Muon trigger	6%
Jet energy scale	wide range
Jet fragmentation	5–7%
Heavy flavor ratio	30%
Tag-rate functions	2–16%

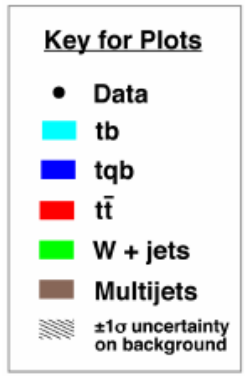
After tagging











Measuring cross section

Probability to observe data distribution D, expecting y:

$$y = \alpha l \sigma + \sum_{s=1}^{N} b_s \equiv a\sigma + \sum_{s=1}^{N} b_s$$

binned likelihood

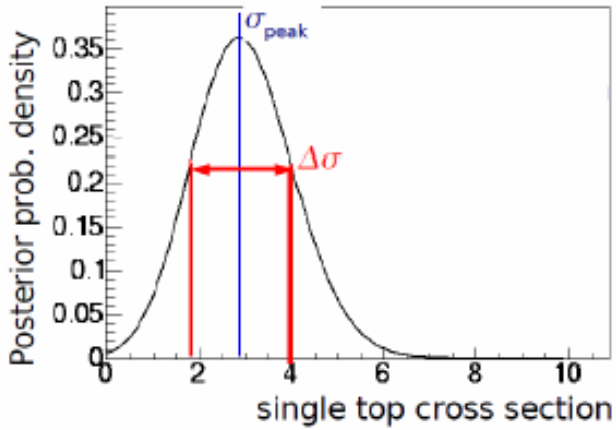
$$P(D|y) \equiv P(D|\sigma, a, b) = \prod_{i=1}^{nbins} P(D_i|y_i)$$

The cross section is obtained

$$Post(\sigma|D) \equiv P(\sigma|D) \propto \int_a \int_b P(D|\sigma, a, b) Prior(\sigma) Prior(a, b)$$

posterior prob. as a function of σ

peak = central measurement
68% around the pic => error band

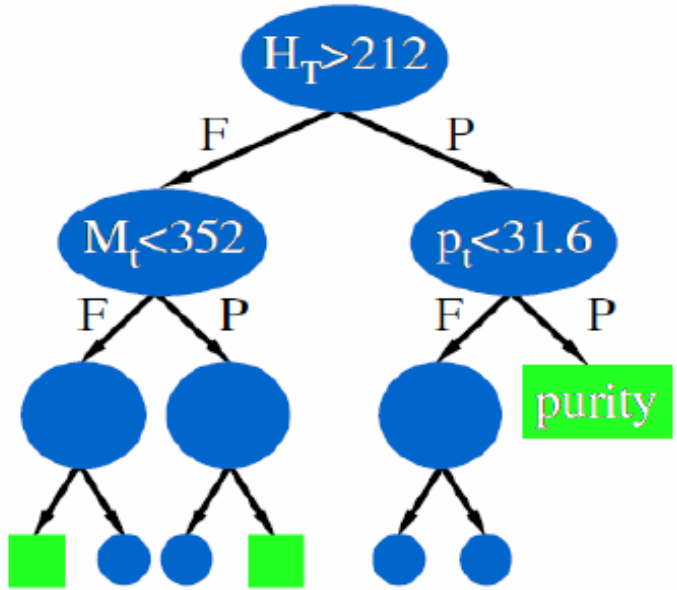


- Bayesian posterior probability density
- Shape and normalization systematics treated as nuisance parameters
- Correlations between uncertainties properly accounted for
- Flat prior in signal cross section

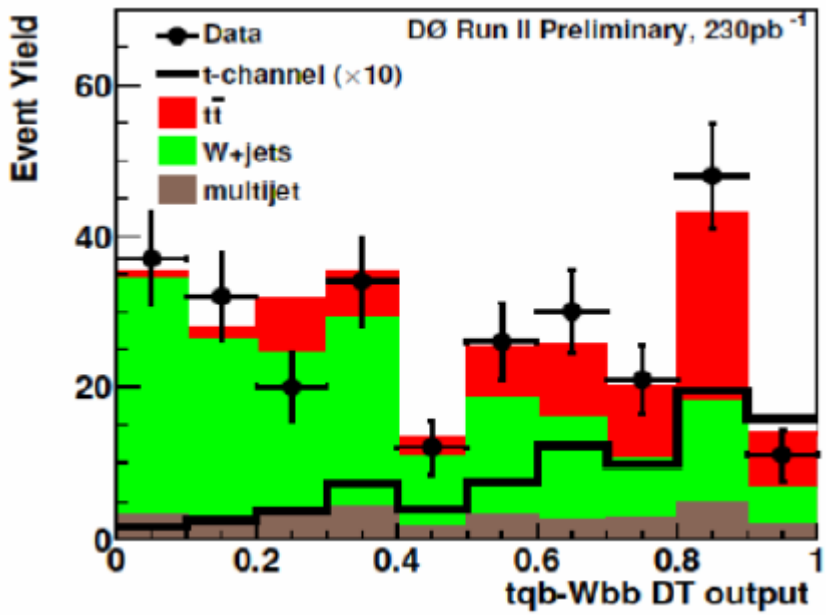
To verify that all of this machinery is working properly: test with many sets of pseudo-data

Decision Trees

TRAIN:
- Start with all events (first node)
- For each variable, find the splitting value with best separation between children (best cut).
- Select best variable and cut and produce **F**ailed and **P**assed branches
- Repeat recursively on each node
- Stop when improvement stops or when too few events left.
  Terminal node = leaf.



MEASURE AND APPLY:
- Take trained tree and run on independent simulated sample, determine purities.
- Apply to Data
- Should see enhanced separation (signal right, background left)
- Could cut on output and measure, or use whole distribution to measure.



binned likelihood

Decision Trees - Boosting

BOOSTING:
- Recent technique to improve performance of a weak classifier
- Recently used by GLAST and MiniBooNE
- Basic principal on DT:
  - Train a tree T_k
  - T_{k+1} = modify(T_k)

ADABOOST ALGORITHM:
- Adaptive boosting
- Check which events are misclassified by T_k
- Derive tree weight α_k
- Increase weight of misclassified events
- Train again to build T_{k+1}
- Boosted result of event i : $T(i) = \Sigma_k \alpha_k T_k(i)$

- Averaging dilutes piecewise nature of DT
- Usually improves performance

Ref: Freund and Schapire, "Experiments with a new boosting algorithm", in *Machine Learning: Proceedings of the Thirteenth International Conference*, pp 148-156 (1996)

Decision Trees

analysis strategy

- Train 36 separate trees:
  (s,t,s + t) x (e,μ) x (2,3,4jets) x(1,2 tags)
- For each signal train against the sum of backgrounds

use 1/3 of MC stat. for training

Object Kinematics

- p_T(jet1)
- p_T(jet2)
- p_T(jet3)
- p_T(jet4)
- p_T(best1)
- p_T(notbest1)
- p_T(notbest2)
- p_T(tag1)
- p_T(untag1)
- p_T(untag2)

Angular Correlations

- ΔR(jet1,jet2)
- cos(best1,lepton)$_{\mathrm{besttop}}$
- cos(best1,notbest1)$_{\mathrm{besttop}}$
- cos(tag1,alljets)$_{\mathrm{alljets}}$
- cos(tag1,lepton)$_{\mathrm{btaggedtop}}$
- cos(jet1,alljets)$_{\mathrm{alljets}}$
- cos(jet1,lepton)$_{\mathrm{btaggedtop}}$
- cos(jet2,alljets)$_{\mathrm{alljets}}$
- cos(jet2,lepton)$_{\mathrm{btaggedtop}}$
- cos(lepton, Q(lepton)$\times z$)$_{\mathrm{besttop}}$
- cos(lepton,besttopframe)$_{\mathrm{besttopCMframe}}$
- cos(lepton,btaggedtopframe)$_{\mathrm{btaggedtopCMframe}}$
- cos(notbest,alljets)$_{\mathrm{alljets}}$
- cos(notbest,lepton)$_{\mathrm{besttop}}$
- cos(untag1,alljets)$_{\mathrm{alljets}}$
- cos(untag1,lepton)$_{\mathrm{btaggedtop}}$

Event Kinematics

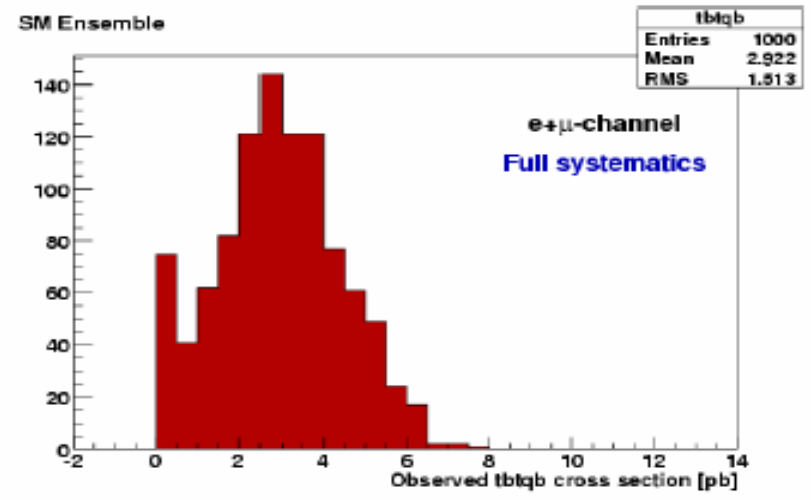
- Aplanarity(alljets,W)
- M(W,best1) ("best" top mass)
- M(W,tag1) ("b-tagged" top mass)
- H_T(alljets)
- H_T(alljets−best1)
- H_T(alljets−tag1)
- H_T(alljets,W)
- H_T(jet1,jet2)
- H_T(jet1,jet2,W)
- M(alljets)
- M(alljets−best1)
- M(alljets−tag1)
- M(jet1,jet2)
- M(jet1,jet2,W)
- M_T(jet1,jet2)
- M_T(W)
- Missing E_T
- p_T(alljets−best1)
- p_T(alljets−tag1)
- p_T(jet1,jet2)
- Q(lepton)$\times\eta$(untag1)
- $\sqrt{\hat{s}}$
- Sphericity(alljets,W)

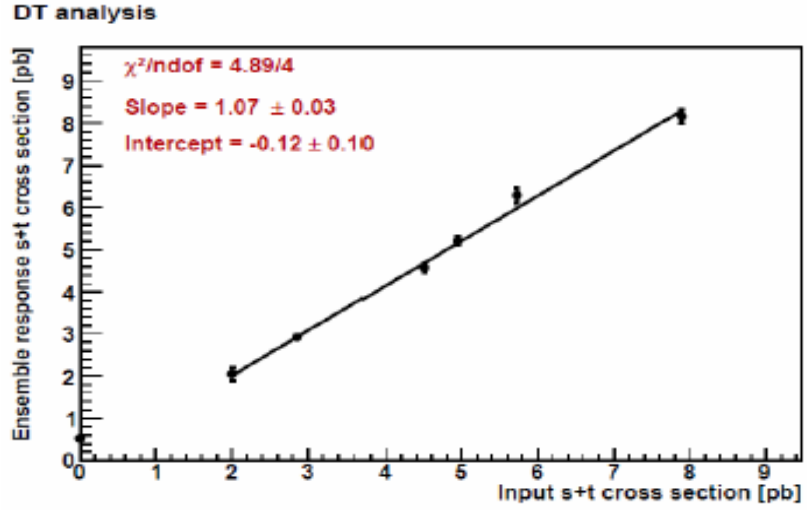
49 variables used

- adding variables does not degrade performance
- tested shorter lists, loose some sensitivity
- same list used for all channels

Decision Trees - Ensembles

- SM input is returned by DTs
- "Mystery" ensembles are unraveled by the DTs
- Linear response is achieved





SIGNIFICANCE/SENSITIVITY:

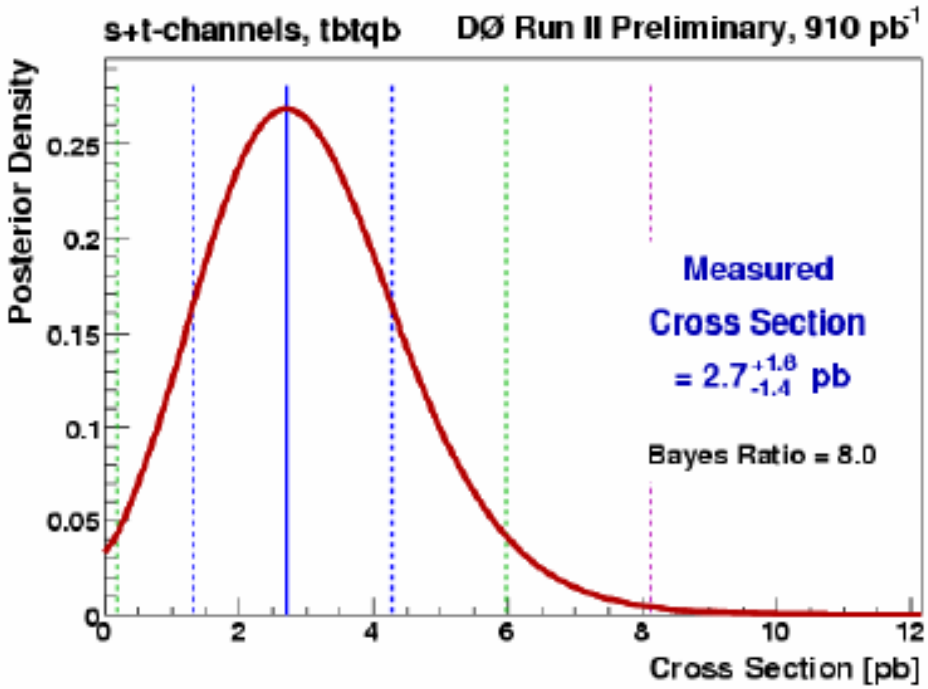
Use 0-signal ensemble to determine a significance for each measurement:

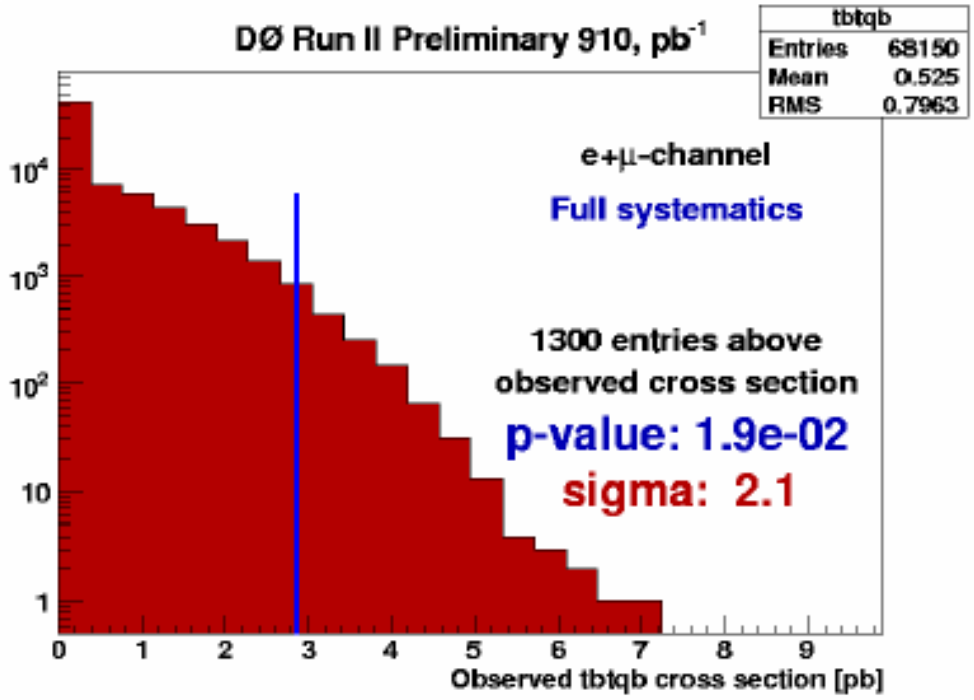
- **Expected p-value**: fraction of 0-signal pseudo-datasets in which we measure at least 2.9pb
- **Observed p-value**: fraction of 0-signal pseudo-datasets in which we measure at least the measured cross section

Use SM ensemble to see how compatible is measured value with SM

Decision Trees - expected

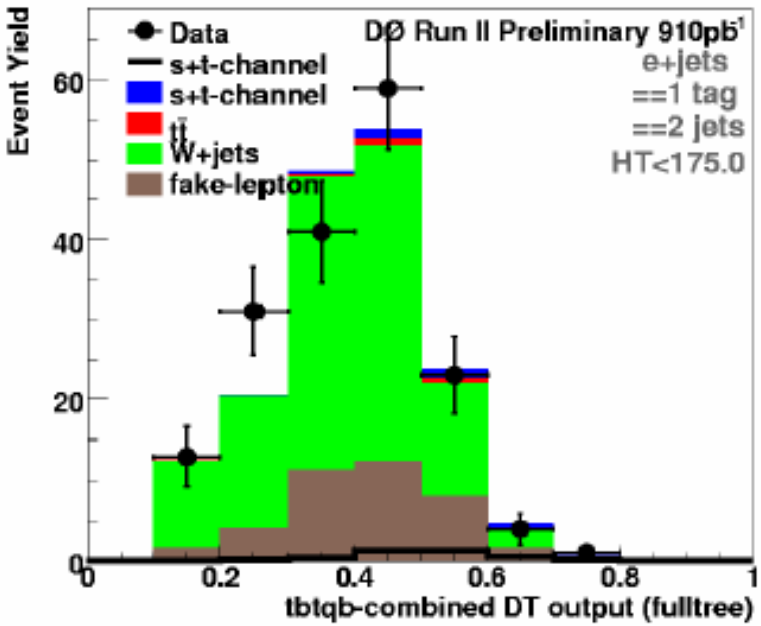
Expected p-value (s+t)

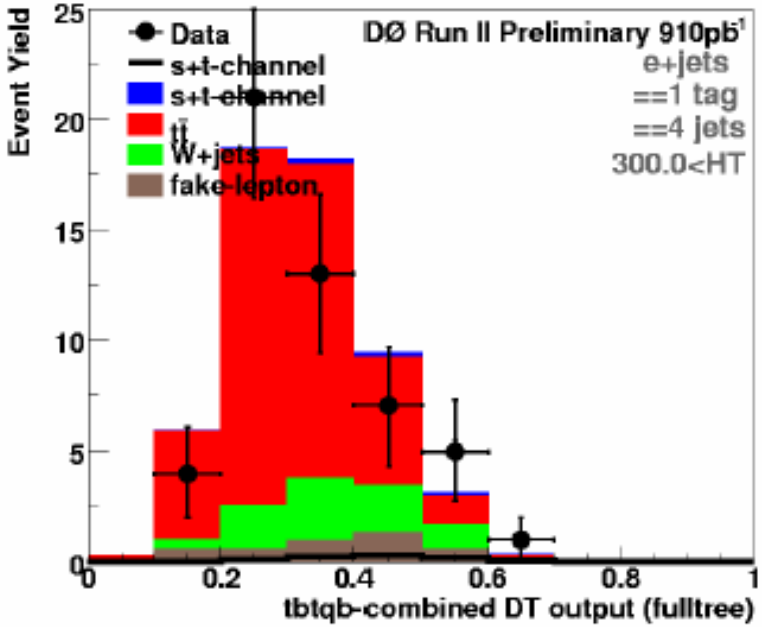




Cross-check samples

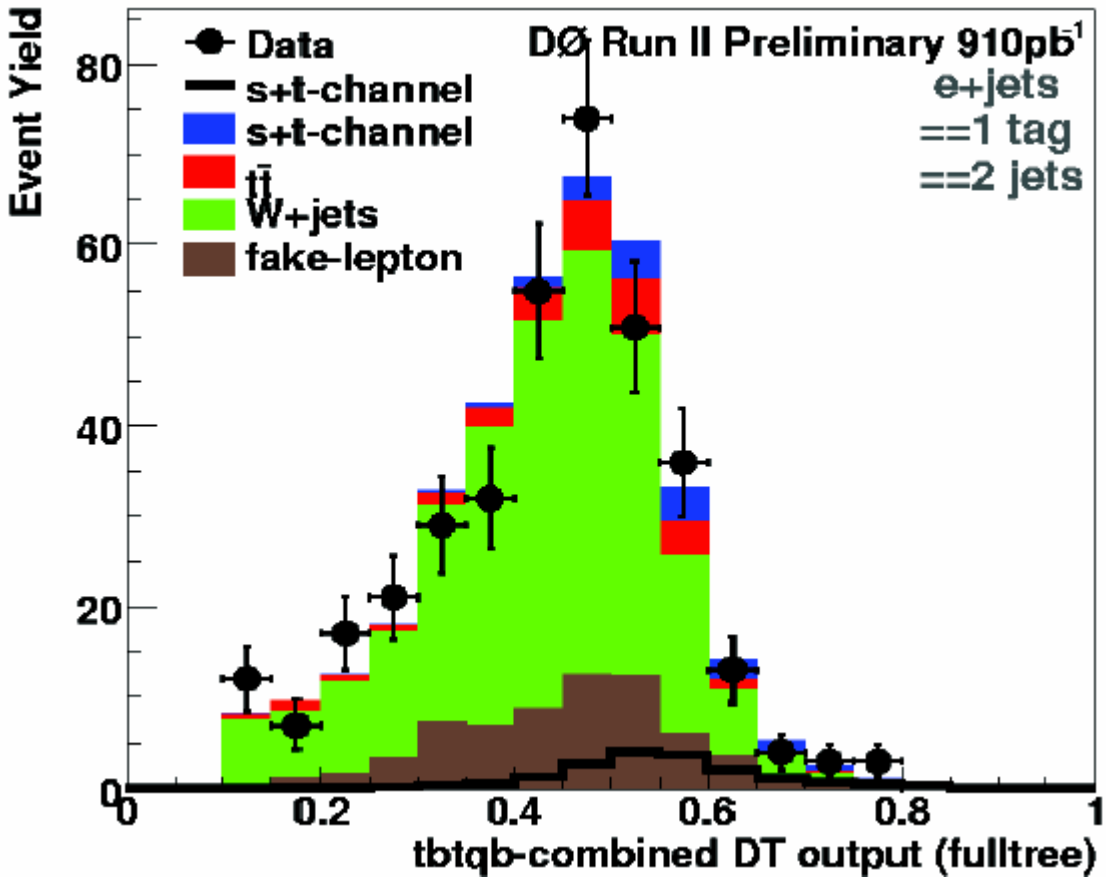
- "W+jets" = 2jets, HT (lepton, MET, alljets) < 175 GeV
- "ttbar" = 4jets, HT (lepton, MET, alljets) > 300 GeV
- Shown: tb+tqb DT output for e+jets
- Good agreement of model with data





Decision Trees on Data

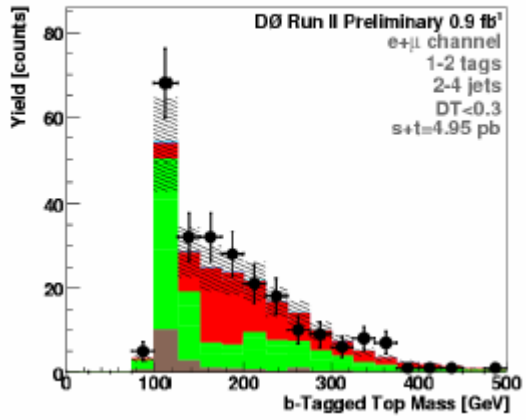
e.g. for one of the 36 trees



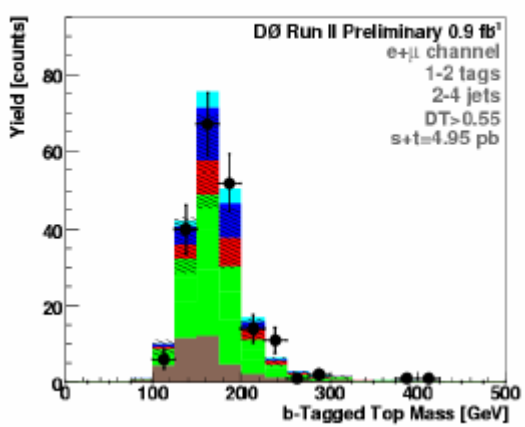
Decision Trees – events characteristics

M(W,b)

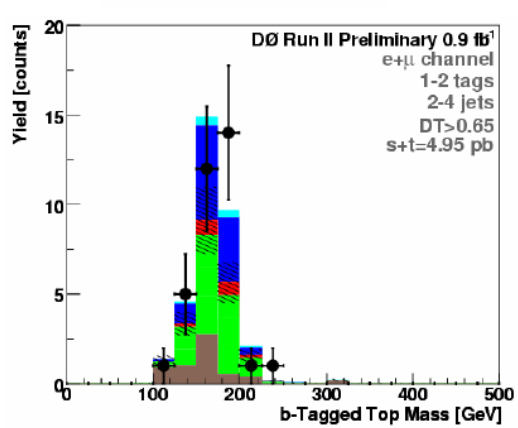
$DT < 0.3$



$DT > 0.55$



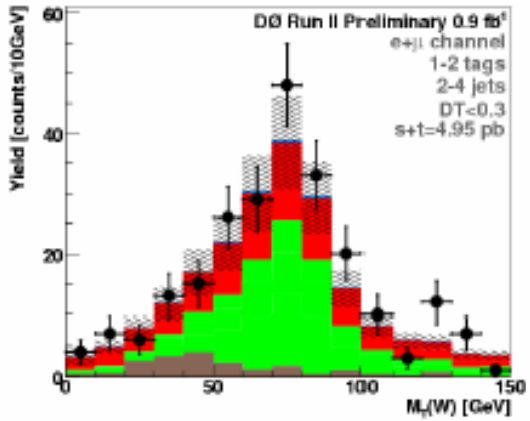
$DT > 0.65$



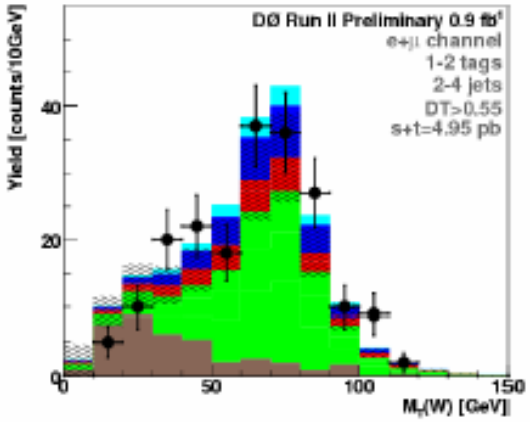
Excess in high DT output region.

$M_T(W)$

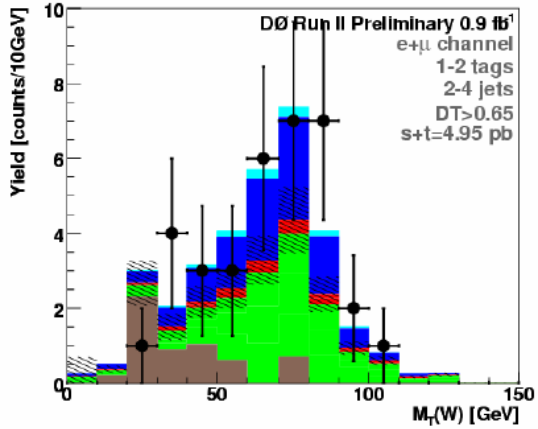
$DT < 0.3$



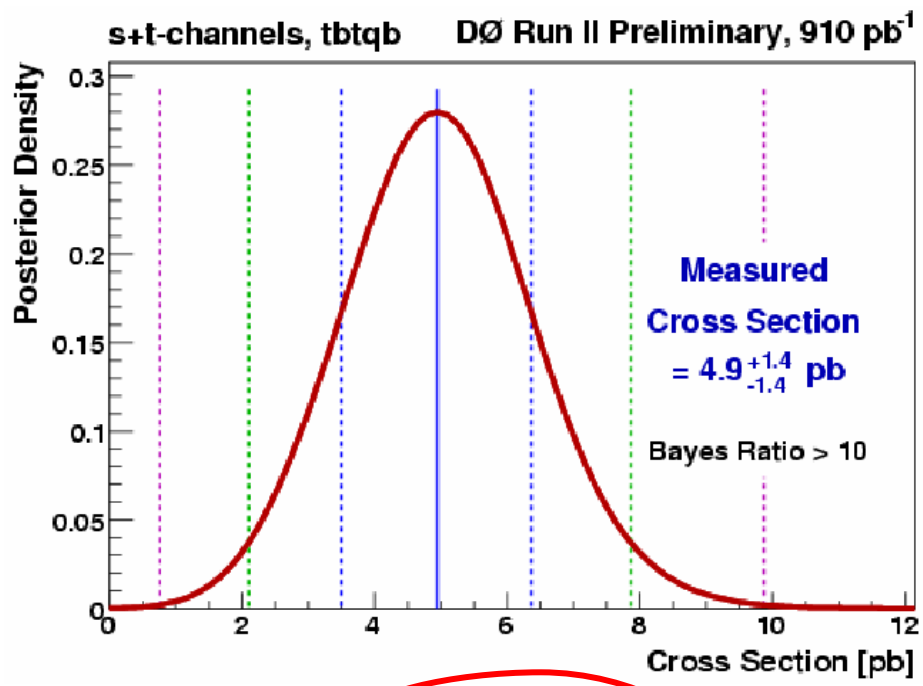
$DT > 0.55$



$DT > 0.65$

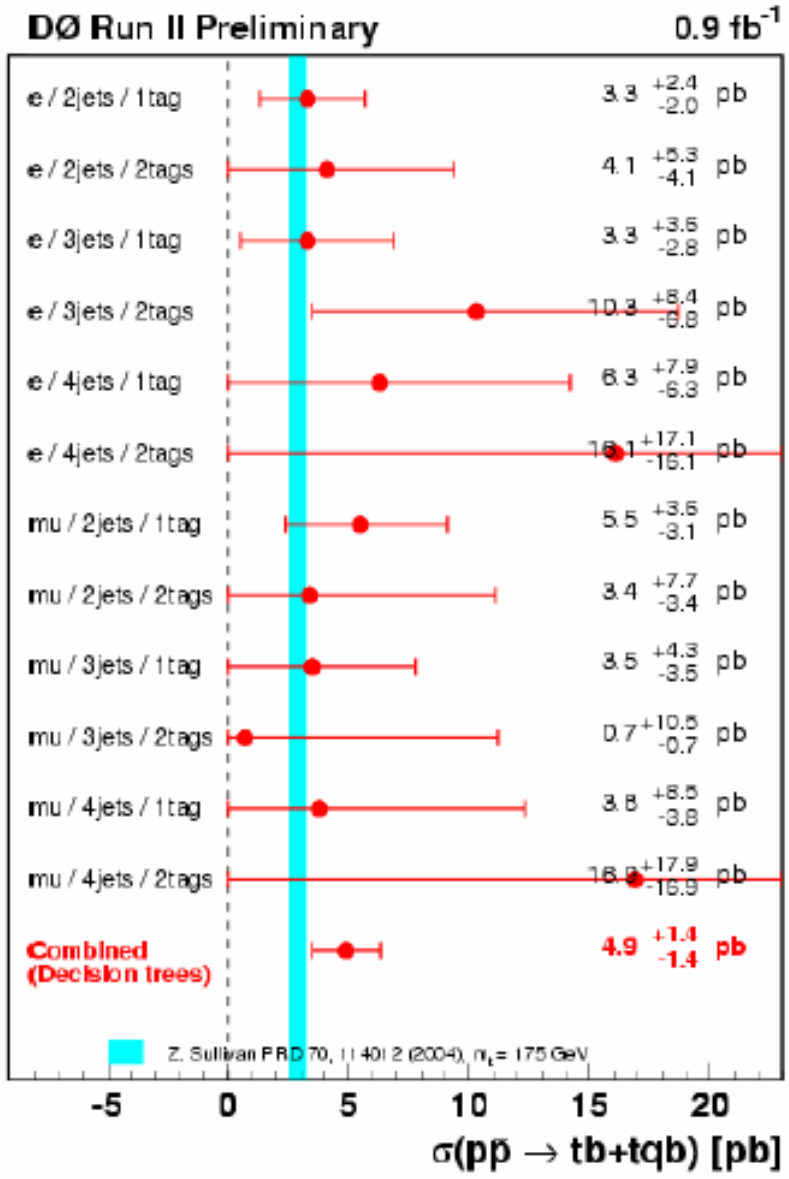


Decision Trees - observed



$\sigma(s+t) = 4.9 \pm 1.4$ pb
$\sigma(t) = 4.2^{+1.8}_{-1.4}$ pb
$\sigma(s) = 1.0 \pm 0.9$ pb

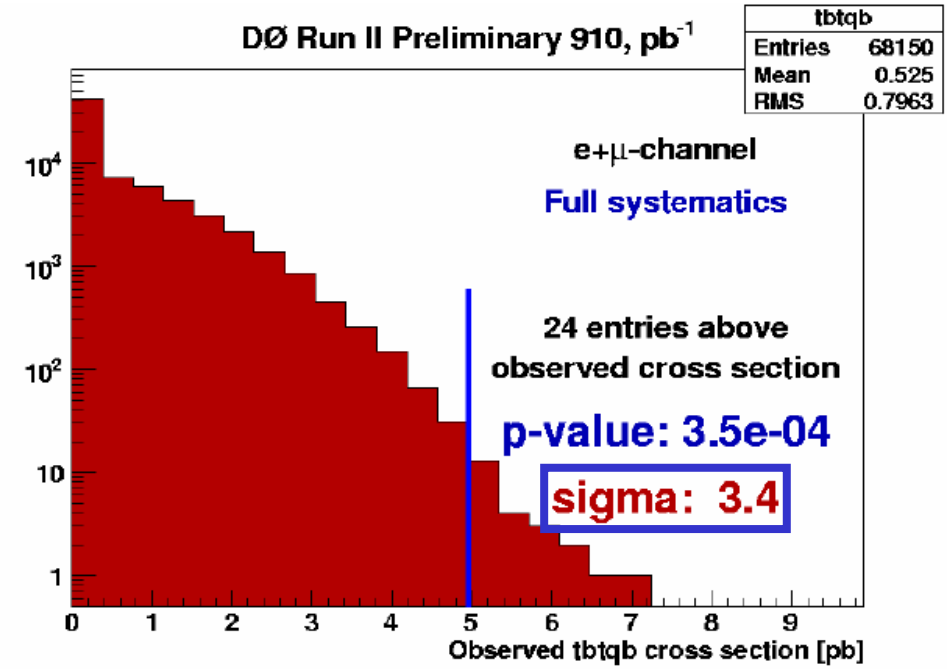
stat. contributes for 1.2 pb

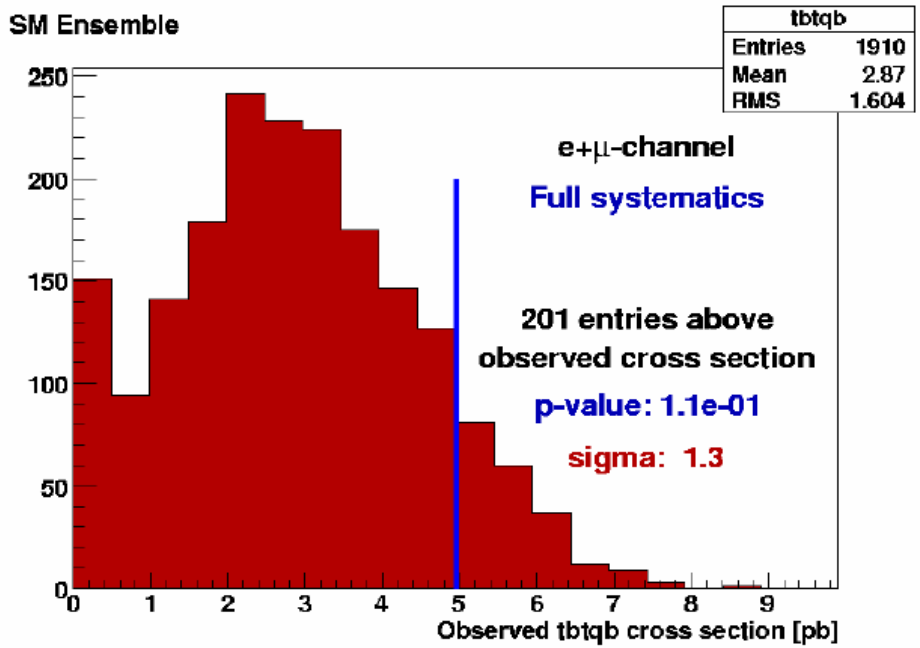


Decision Trees

observed p-value

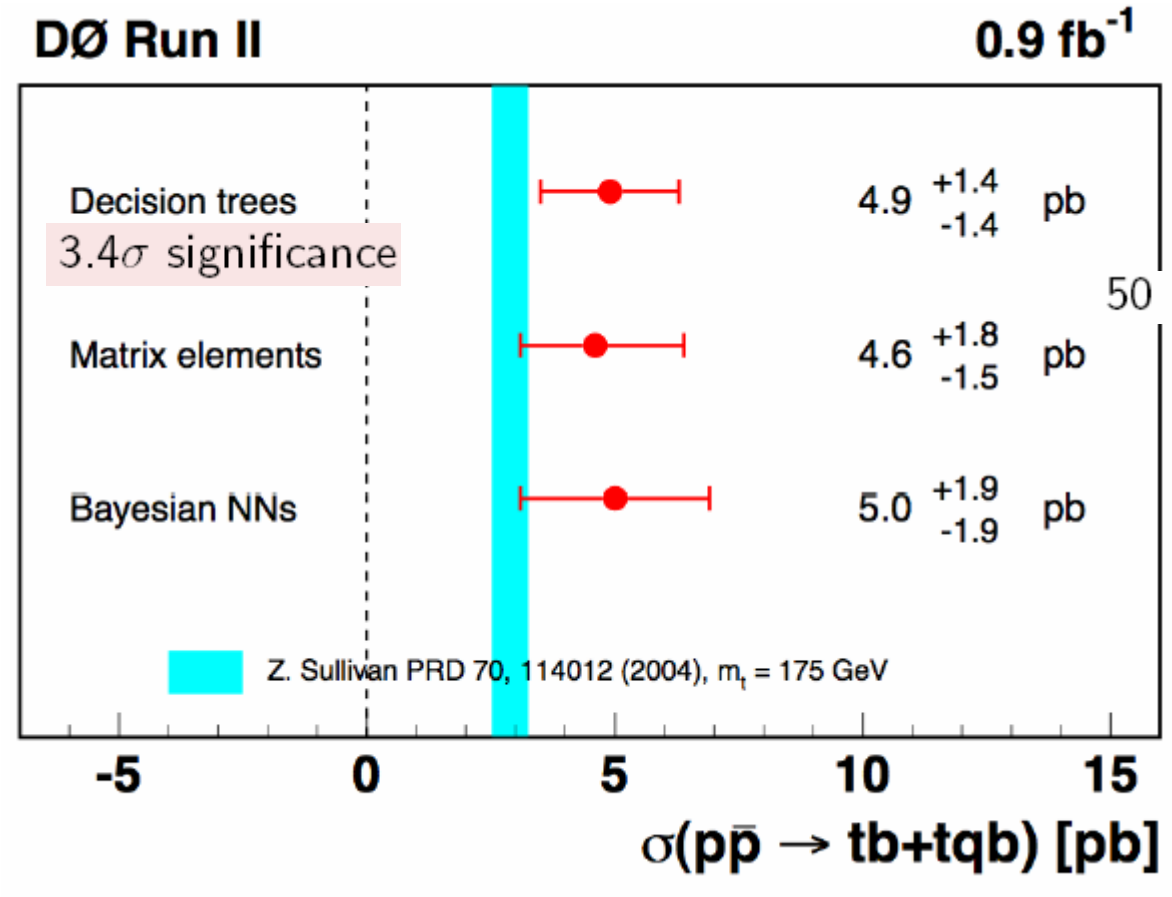
compatibility with SM





Evidence! ☺

(s+t) summary



correlations between methods

50 highest events in each discriminant look for overlap

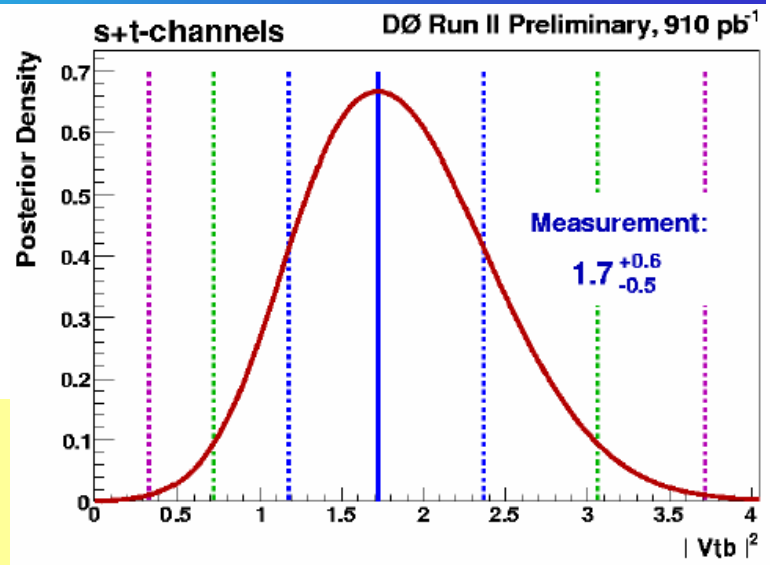
Technique	Electron	Muon
DT vs ME	52%	58%
DT vs BNN	56%	48%
ME vs BNN	46%	52%

CDF Matrix element method w/ 955 pb-1:
- $\sigma(s+t) = 2.7\ ^{+1.5}_{-1.3}$ pb
- expected p-value: 0.6%
- observed p-value: 1.0%

First Direct Measurement of V_{tb}

In SM: top must decay to a W and d, s or b quark
- $V_{td}^2 + V_{ts}^2 + V_{tb}^2 = 1$
- constraints on V_{td} and V_{ts}: $V_{tb} > 0.998$

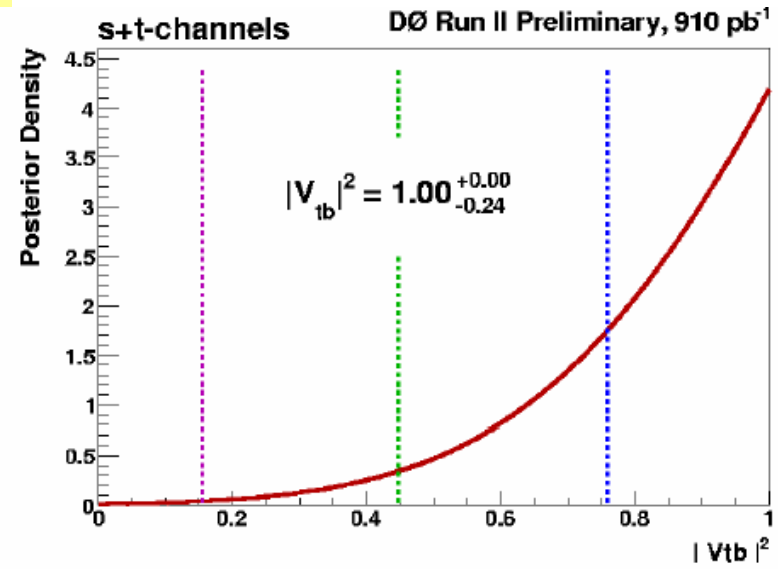
New physics that couples to the top quark:
- $V_{td}^2 + V_{ts}^2 + V_{tb}^2 < 1$
- no constraint on V_{tb}



- Measurement of the single top cross section
  => **first direct measurement of $|V_{tb}|$**
- Use the same infrastructure but make a posterior in $|V_{tb}|^2$

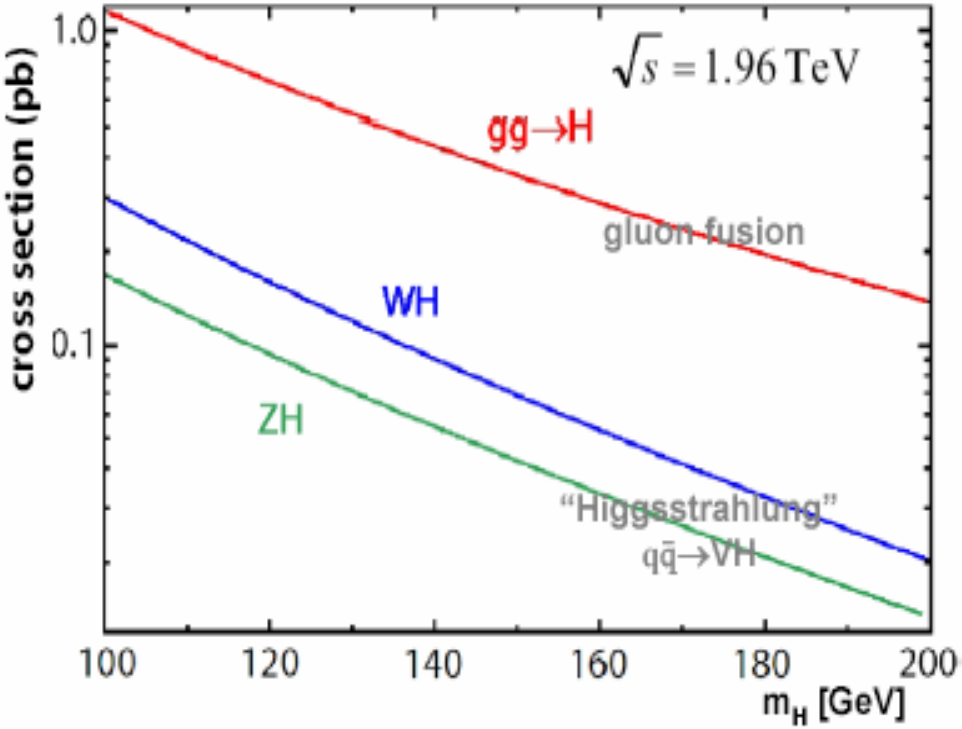
  -> assume SM top decays: $|V_{tb}| = 1.00\ ^{+0.00}_{-0.12}$

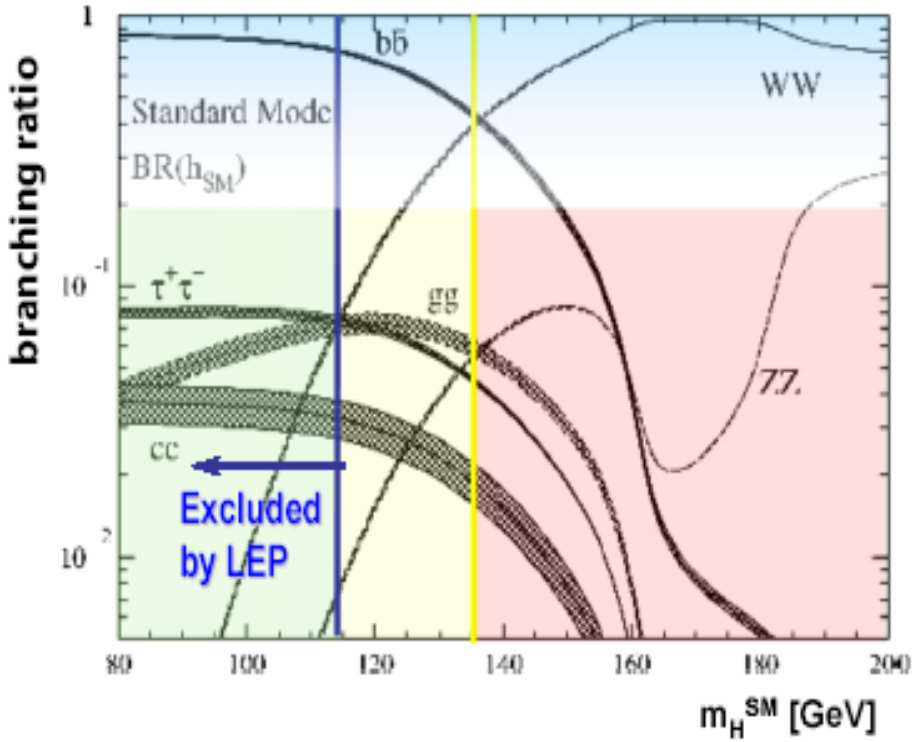
  -> measure $|V_{tb} x f^L_1|$
  w/ f^L_1 : anomalous CP conserving LH coupling
  just assuming $|V_{td}|^2 + |V_{ts}|^2 << |V_{tb}|^2$
  => $|V_{tb} x f^L_1| = 1.3 \pm 0.2$
  -> in SM, $f^L_1 = 1$ => $|V_{tb}| > 0.68$ @ 95% CL



Standard Model Higgs

Higgs MS: production et désintégration



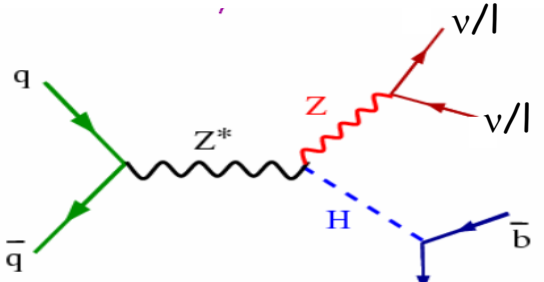


Two strategies:

- m_H < 135 GeV, use associated production with Higgs decaying in 2 b-jets
- m_H > 135 GeV, use gluon fusion and a "clean" leptonic final state

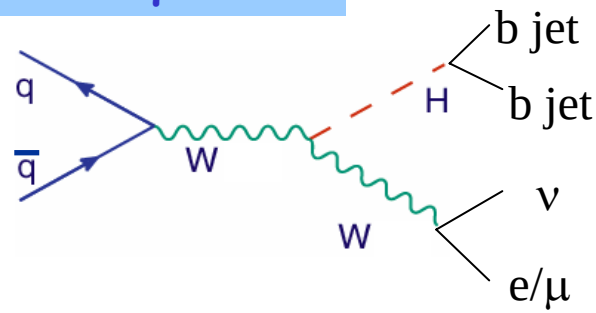
Channels explored as of now

Work in progress to take advantage of increased luminosity and improved analysis techniques



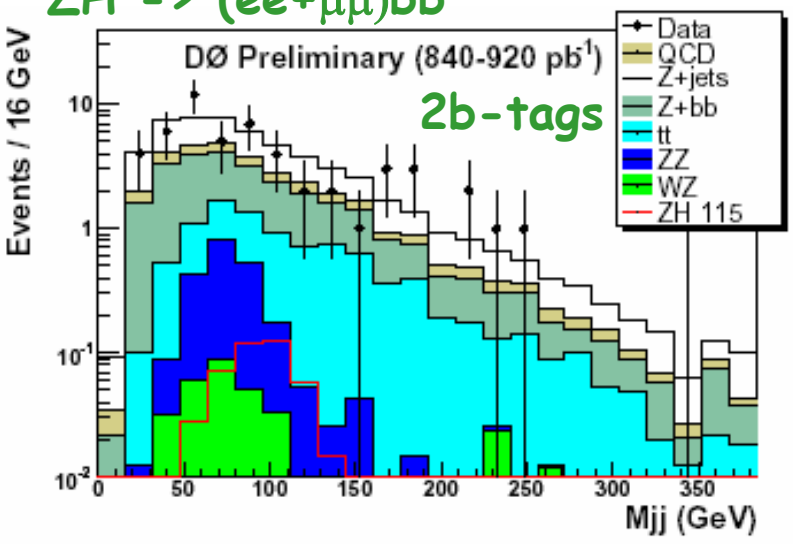
ZH -> νν/ll+bb

low mass



WH -> lνbb, l=e,μ

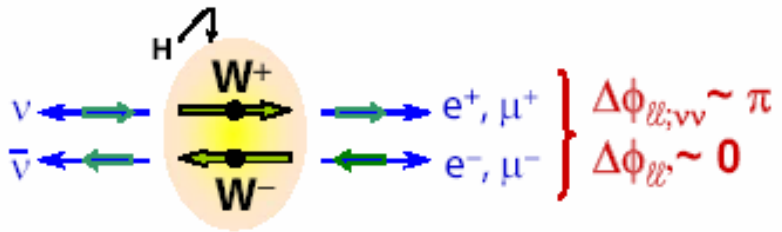
ZH -> (ee+μμ)bb



high mass

H -> WW* -> lνlν

leptons from H->WW prefer to point in the same direction

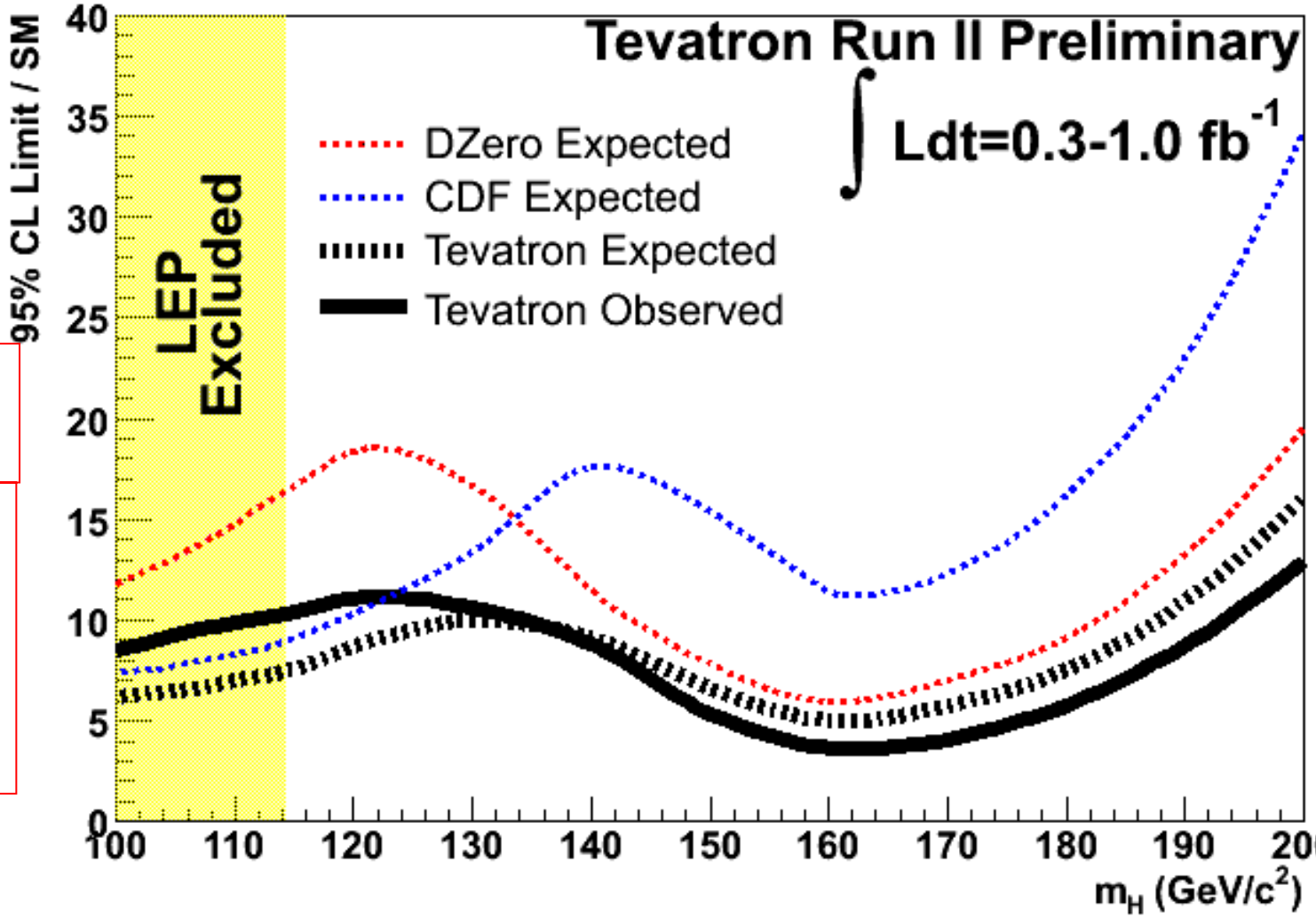


WH -> WWW* -> lνlνqq

Tevatron SM Higgs Combination

CDF and DØ results (14) combined ➔

m_H (GeV)	Limit/SM Exp.	Obs.
115	7.6	10.4
130	10.1	10.6
160	5.0	3.9
180	7.5	5.8



Note: the combined result is essentially equivalent to one experiment with 1.3 fb^{-1}, since both experiments have "complementary" statistics at low and high mass

➔ getting close to sensitivity required to exclude or "evidence" the Higgs

Higgs Winter 2007 Goals

- Continue improving the sensitivity of the analyses with advanced techniques.
- Efforts are already starting to pay off:
  e.g. first estimates of preliminary implementation of a Neural Net selection in (ZH→llbb) provide a 1.6 to 2.2 luminosity equivalent factor
- Keep improving the sensitivity on the data/mc as well. Dijet mass, b-tagging, understanding MC, efficiencies, using OR-ing of triggers ...

Thanks to Luminosity and hard work
..... We are getting there !

Conclusions

- October 2006 Fermilab's PAC:
  - Extremely pleased by the Tevatron and the experiments results
  - PAC summary: "The successful operation of the Tevatron, CDF, and DØ should remain the first priority of the Laboratory."
- P5 Panel presented its summary:
  - Tevatron operation to the end of 2008 is confirmed
  - Discussion about Tevatron run in 2009 and beyond will be started in summer of 2007
- Run IIb upgrade project is successfully completed
- Integrated Luminosity per month > entire Run I
- Operations and computing steadily providing data for analysis
- One paper is submitted every two weeks!

Conclusions

- WZ and single top are significant milestones on the road to the SM Higgs
- Didn't have time to cover, e.g.:
  - B physics
  - Top mass measurement
  - W mass measurement
  - New Phenomena

  But preliminary results with most of RunIIa statistics is already available or will be for winter and summer conferences http://www-d0.fnal.gov/Run2Physics/WWW/results.htm
- More integrated luminosity is on its way with an improved detector system
- Data set has doubled over last year, expect 8fb^{-1} by the end of RunII

Even more exciting years ahead!
Single top and V_{tb} today ...
maybe Higgs tomorrow ☺

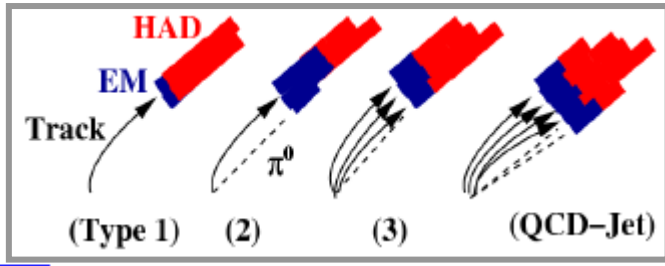
Conclusions

HAS A GOOD CHANCE TO BE

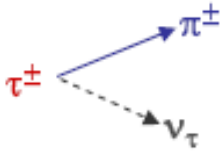
Back up

τ-ID

- narrow calorimeter energy clusters matched to tracks (narrow jet)
- separate τ's into 3 categories, defined by their decay mode
  - π-like (τ–type 1)
  - ρ-like (τ–type 2)
  - 3-prongs (τ–type 3)

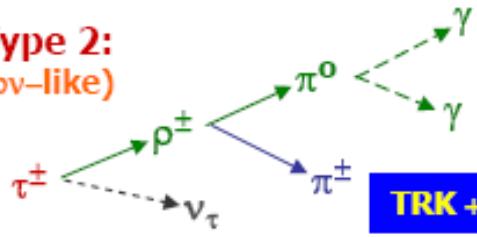


Type 1: (πν–like)



TRK + CAL

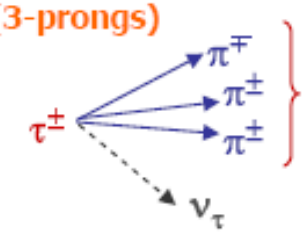
Type 2: (ρν–like)



no TRK, but EM sub-cluster

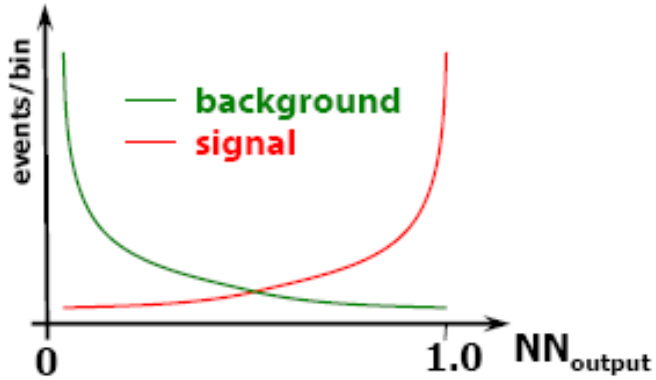
TRK + CAL

Type 3: (3-prongs)



≥ 1 TRK + wide CAL cluster

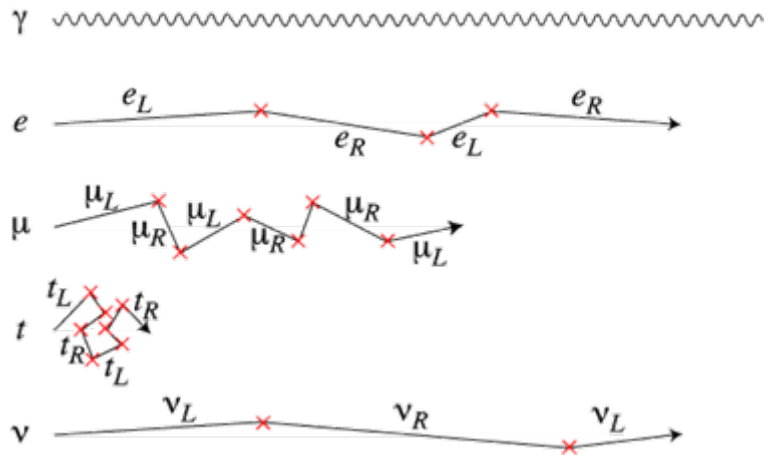
- implement neural nets (NN) for each τ–type to discriminate τ signal from QCD jets
  - NN input variables based on calorimeter and tracking quantities
  - convention: NN → 1.0 (signal), NN → 0.0 (background)
  - analysis ⇒ apply NN cut near 1.0 for τ–id



Standard Model

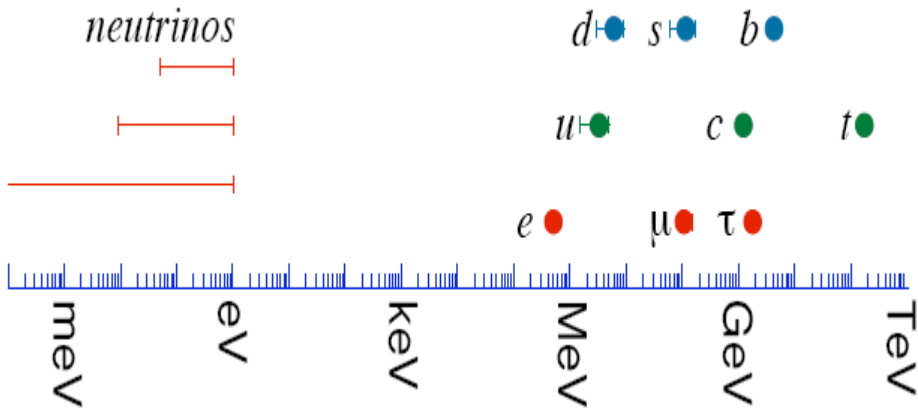
Based on:
- 4-D space-time
- Poincaré group
- $SU(3)_c \times SU(2)_L \times U(1)_Y$
- 3 generations of quarks and leptons
- Higgs mechanism

Phenomenologically **successful** so far, **but** many questions unanswered...

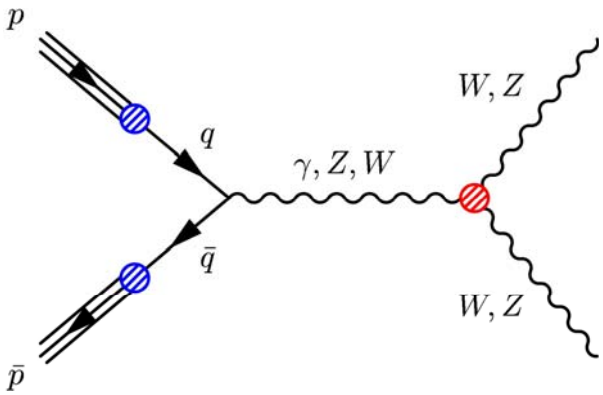


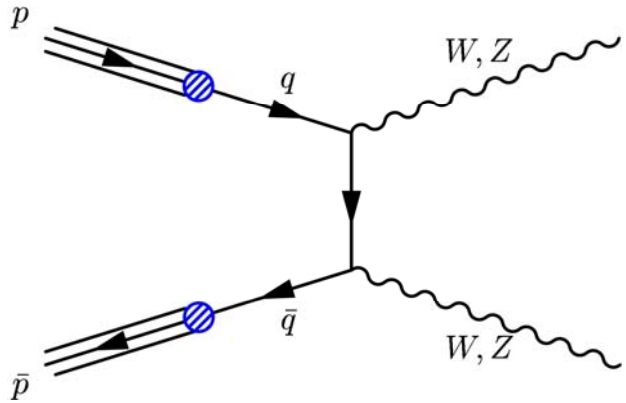
Higgs field filling our Universe and slowing down elementary particles. Is it elementary?

If so, some drawbacks:
- no dynamical explanation to EWSB
- unnatural, requires fine tuning
  -> M_H unstable against rad. corr.
- in GUTs, leads to hierarchy problem
  -> 2 very different scales
- no insight to flavor physics



WW, WZ, ZZ production



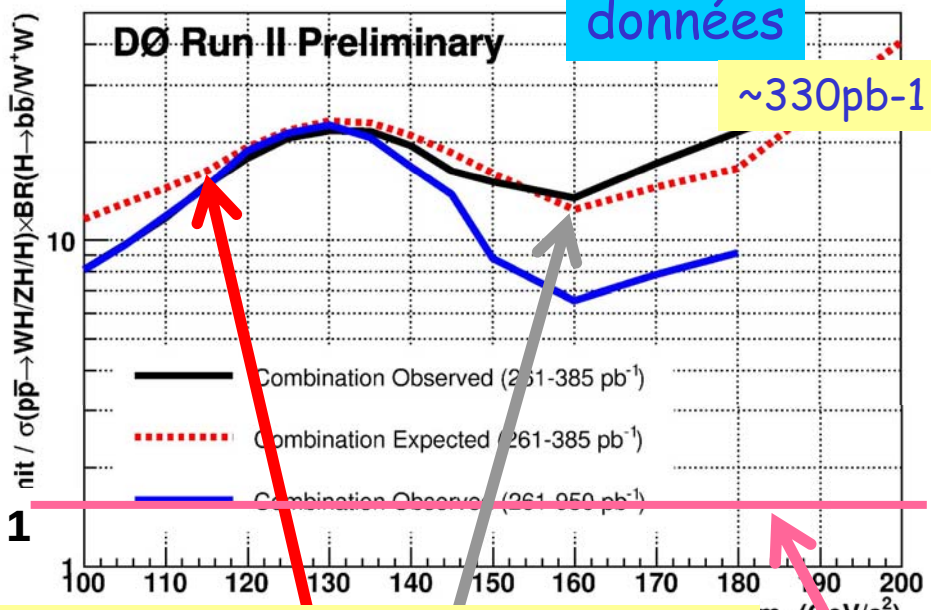


Another laboratory to test the SM

Higgs MS, la suite ...

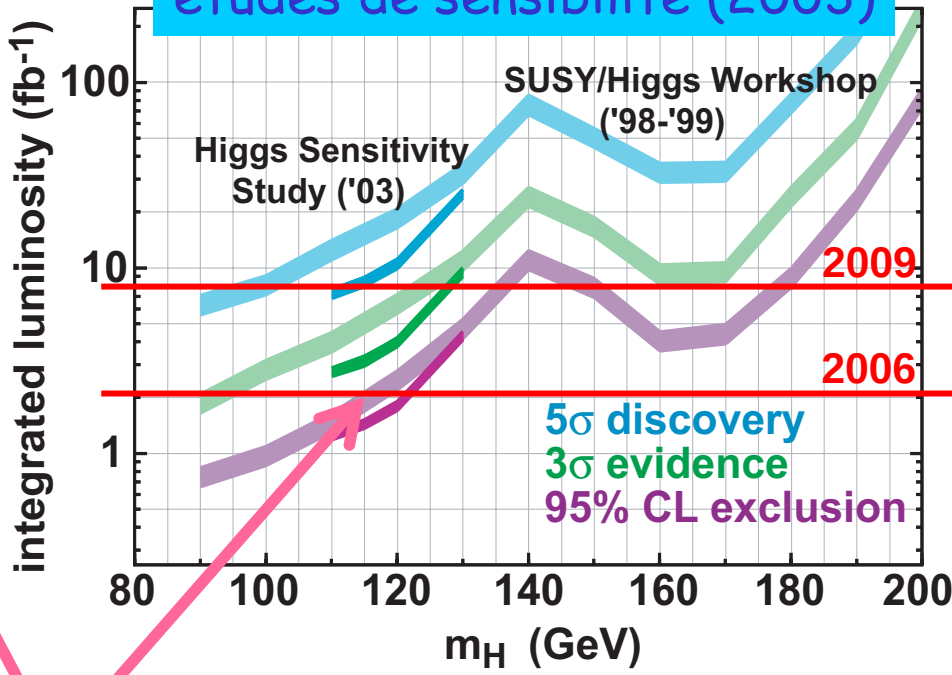
données

~330pb-1

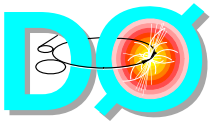


Facteur: 15 (12)
pour mH: 115 (160) GeV
nécessaire à partir des résultats sur ~330 pb^{-1} de données Run IIa pour ...

études de sensibilité (2003)

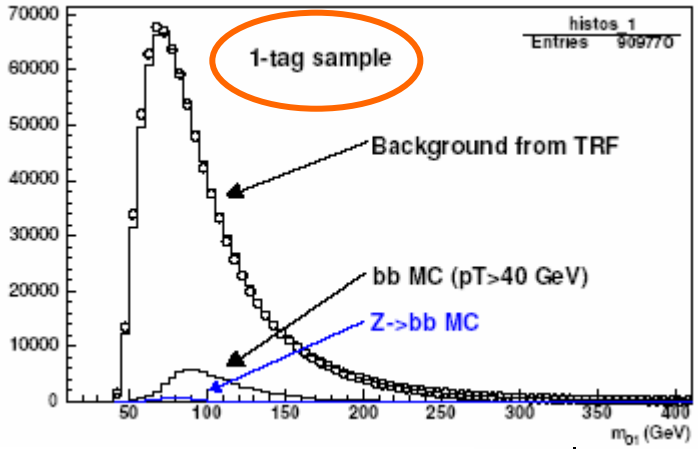


avoir avec 2 fb^{-1} une exclusion à 95%CL (ou évidence à 2σ) pour un Higgs à 115 GeV, comme dans l'étude de sensibilité réalisée en 2003

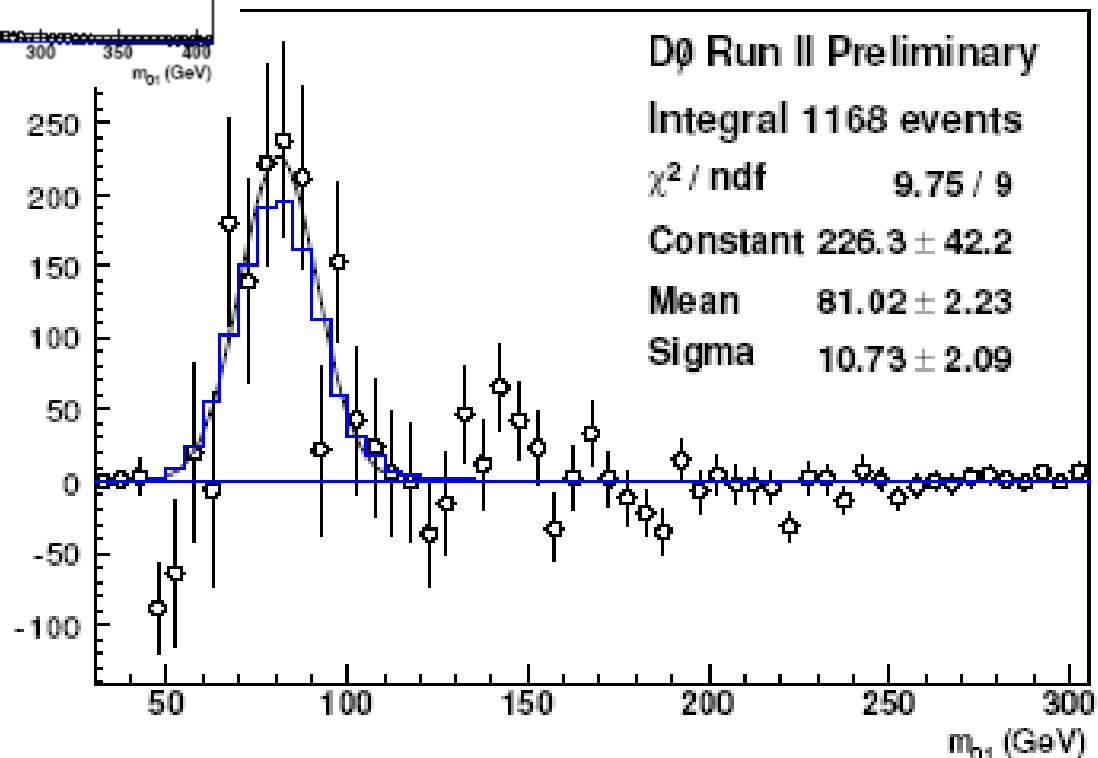


Low mass, use Z → bb

4.4 sigma evidence based on about 300 pb^{-1} of data, shown at ICHEP. Rate consistent with SM production.



After double b-tag and "shift" correction



MC:

83.3 GeV

13.0 GeV