Jet Energy Scale and Top quark charge at CDF

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CZ – SK Collider Physic Workshop

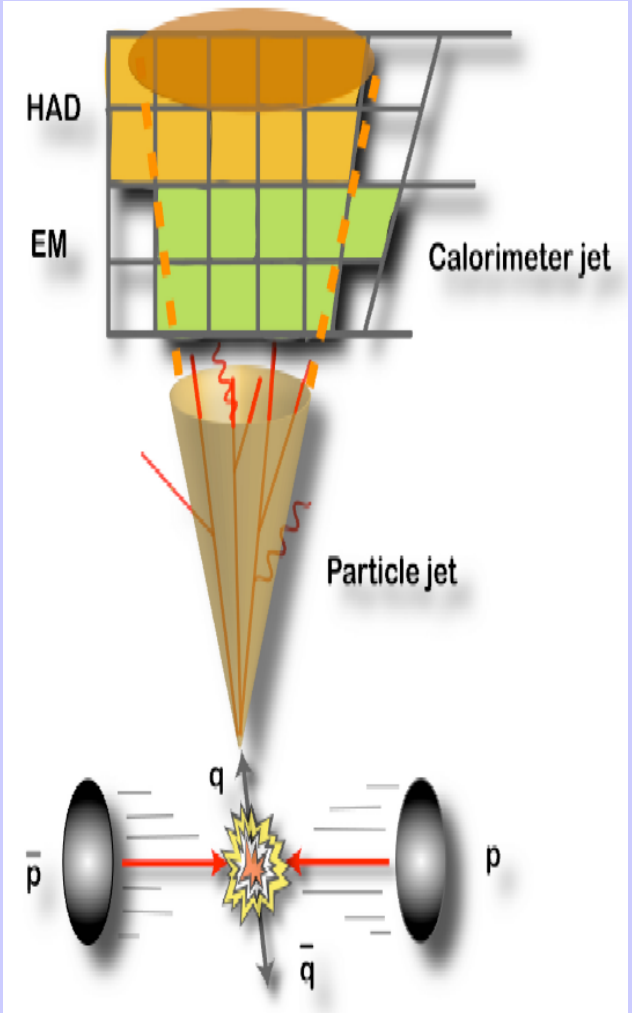
Jet energy scale (JES) motivation

- Jets are observed as clustered energy deposition in calorimeters
- Measured energy is corrected due to many efects (see next slide)
- JES play role in systematic errors (for top mass is dominant syst.err)

JES method

$$p_T^{parton} = (p_T^{jet} \times C_\eta - C_{MI}) \times C_{Abs} - C_{UE} + C_{OOC} = p_T^{particle} - C_{UE} + C_{OOC}$$

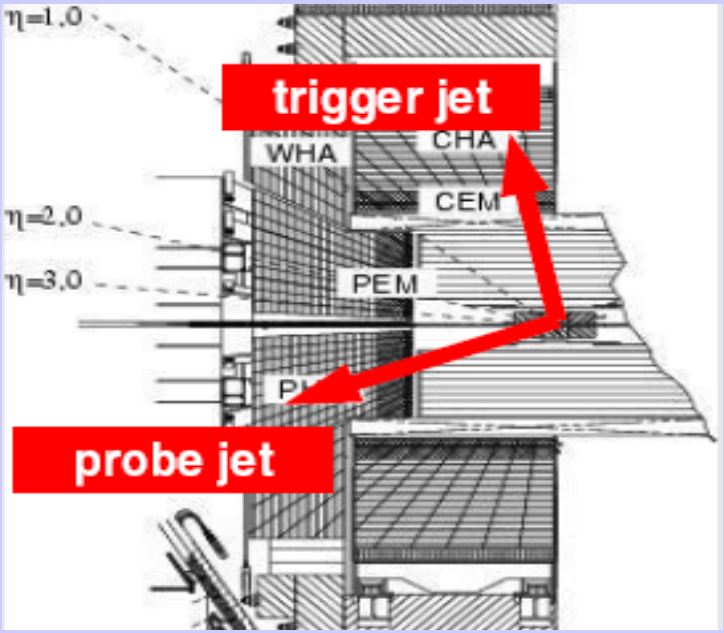
- C_η – relative correction
- C_{MI} – multiple interaction corr.
- C_{Abs} – absolute corr.
- C_{UE} – underlying events corr.
- C_{OOC} – out of cone corr.



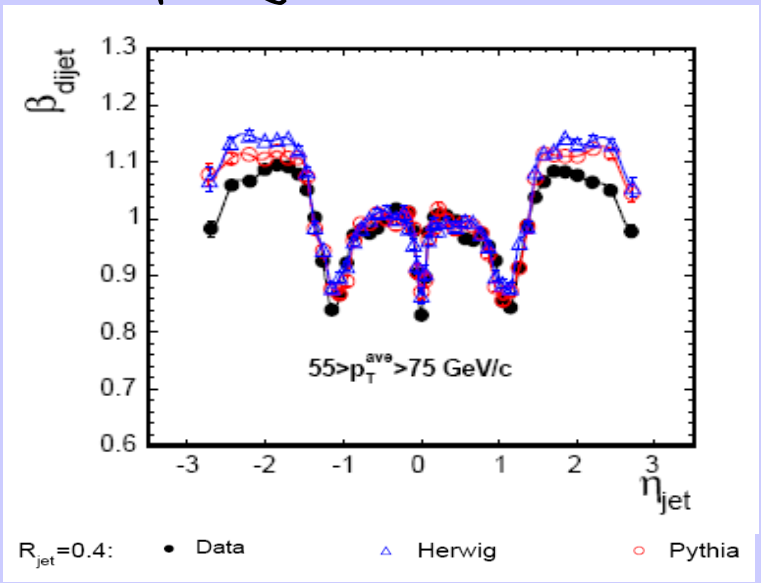
Relative correction C_η

→ different response of central and plug calorimeter

dijets events



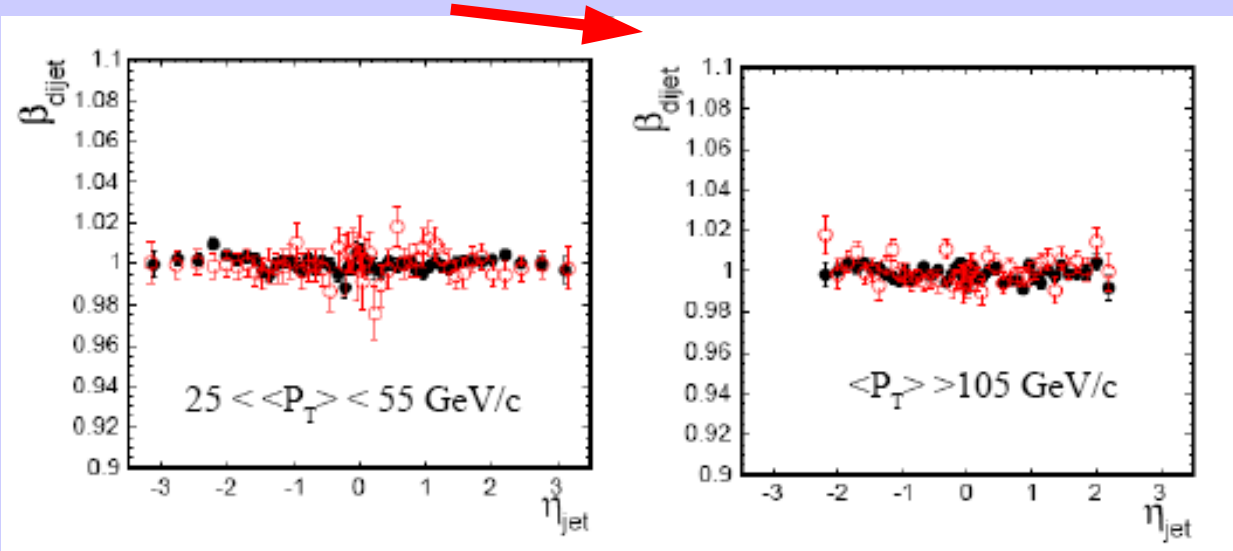
$$C_\eta = \frac{1}{\beta_{dijet}}$$



$$f_b = \frac{p_T^{probe} - p_T^{trig}}{p_T^{probe} + p_T^{trig}/2}$$

$$\beta_{dijet} = \frac{2 + < f_b >}{2 - < f_b >}$$

after corrections



Multiple interaction cor. C_{MI}

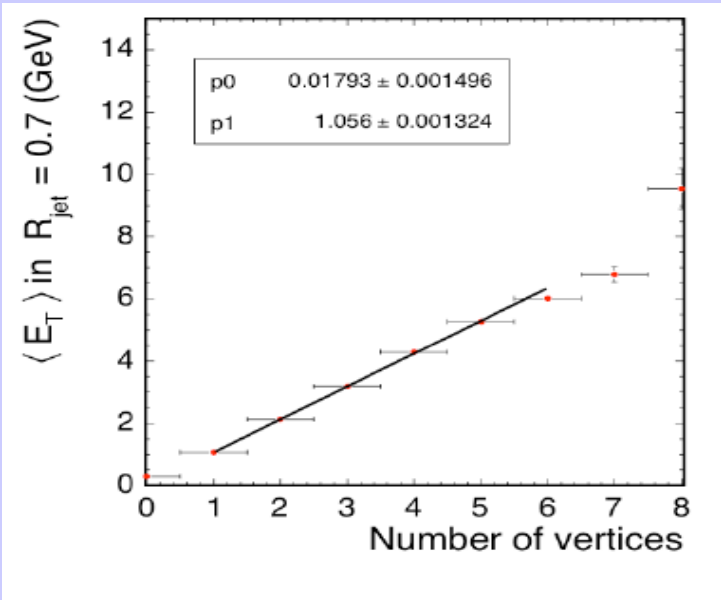
→ Number of extra interaction per one bunch crossing depends on luminosity

→ For Tevatron $L=2.10^{32}\ cm^{-2}s^{-1}$; $\langle N \rangle = 6$

→ energy in jets increase with extra interaction

→ linear correlation between number of interaction and number of vertices

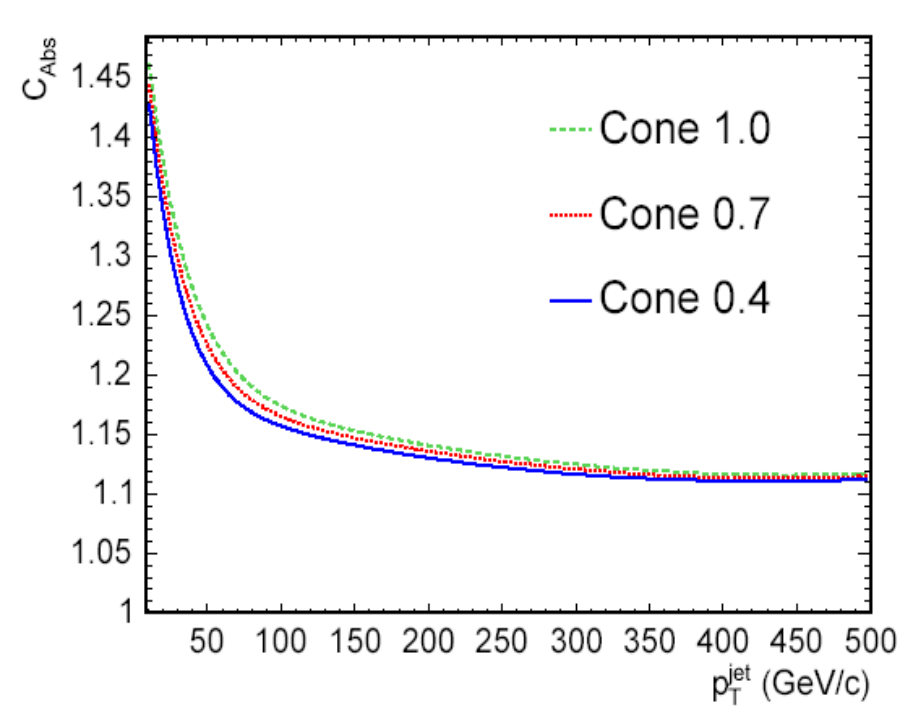
For cone R = 0.7



Absolute correction C_{Abs}

→ After this correction, jets are independent from detector

→ depends on multiplicity and p_T spectrum of particles in jet



Underlying events

→ particles from initial state radiation ISR

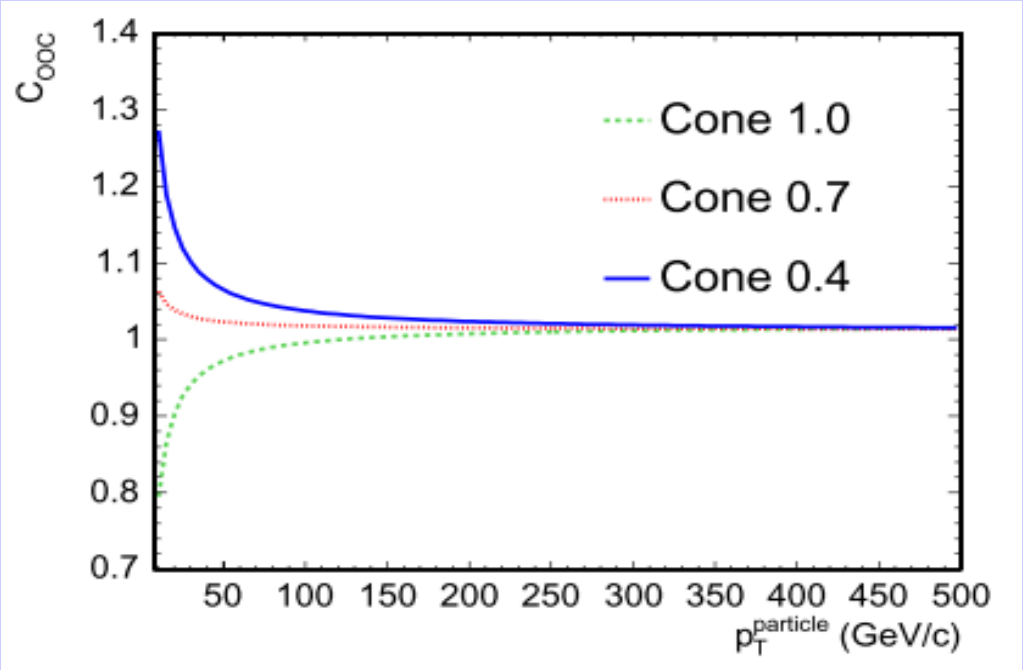
→ particles from spectator partons with color connection to the other parton from proton ("beam-beam remnant)

Out of cone correction

→ fraction of energy lost from jet cone due to the final state gluon radiation FSR

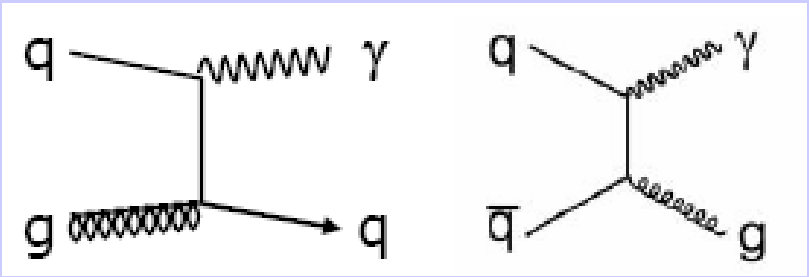
→ particle exiting the cone in fragmentation process

→ low p_T particles bending in magnetic field



Validation of JES

- → Z – jets events
- → dijets events
- → W → jj in ttbar events
- → γ – jets events



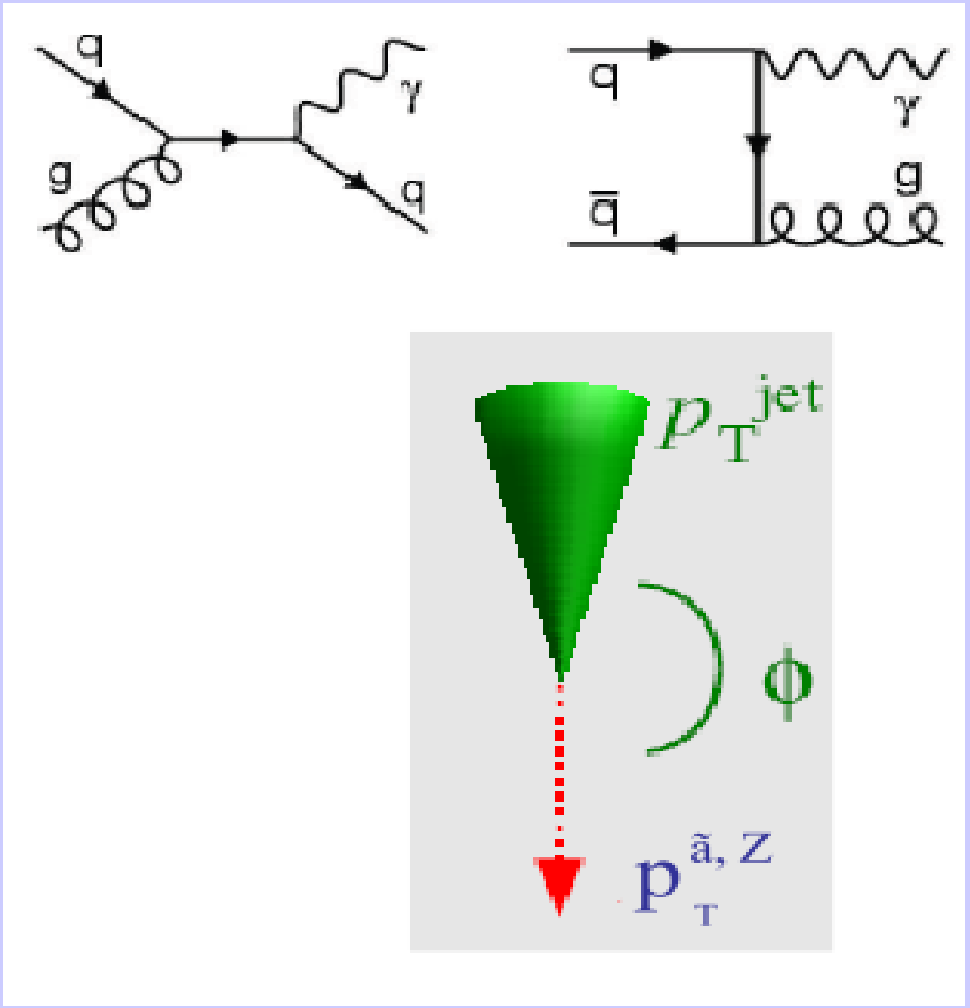
Validation of JES: γ – jets events

- Pho_25_tight trigger
- Photon with:

  $p_T^{\gamma} > 27$ GeV

  $|\eta^{\gamma}| < 0.9$

- One vertex
- $\Delta\varphi(\gamma, jet) > 3$
- 2nd jet $p_T^{jet\,2} < 3$ GeV



Validation of JES: γ – jets events

p_T balance after
all corrections

Agreement
Data/MC within 3%

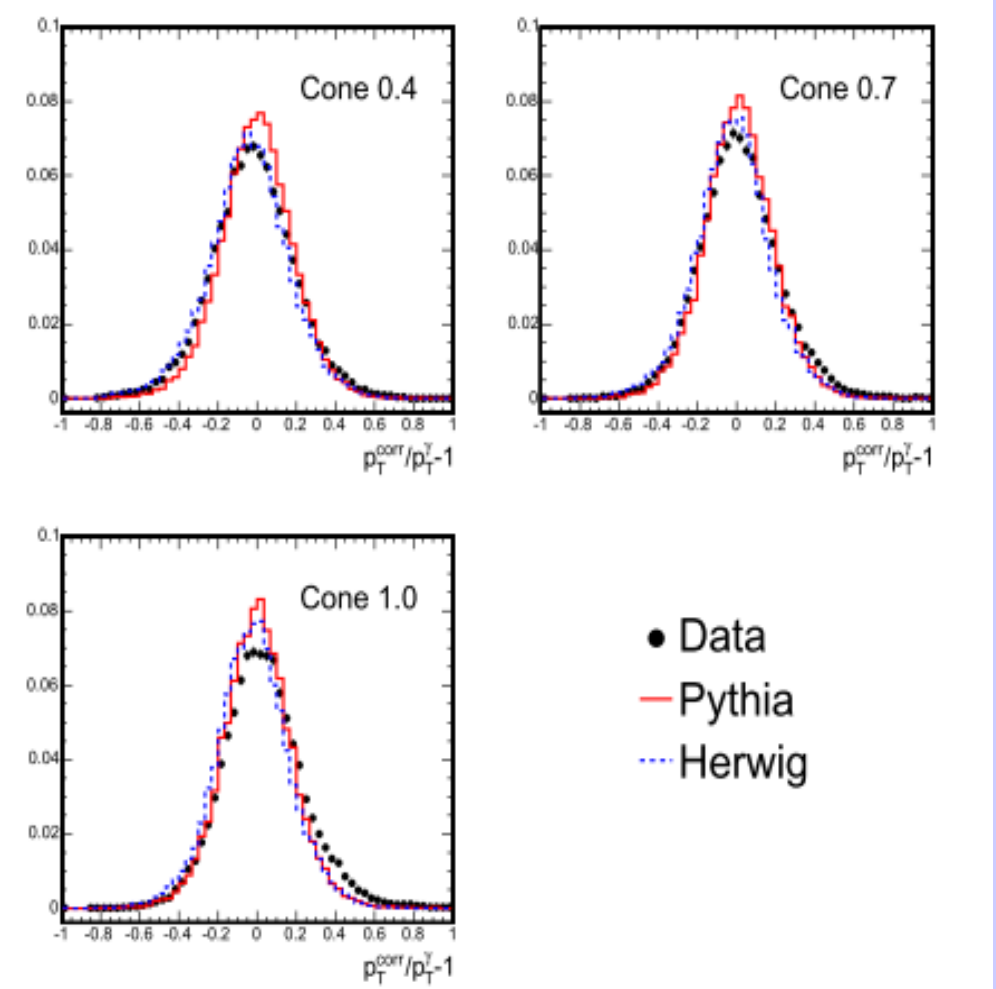


Figure 36: *γ-jet balance in data,* PYTHIA *and* HERWIG *using* R_{jet}*=0.4, 0.7 and 1.0 after η-dependent, absolute and OOC+UE corrections.*

Top quark charge at CDF

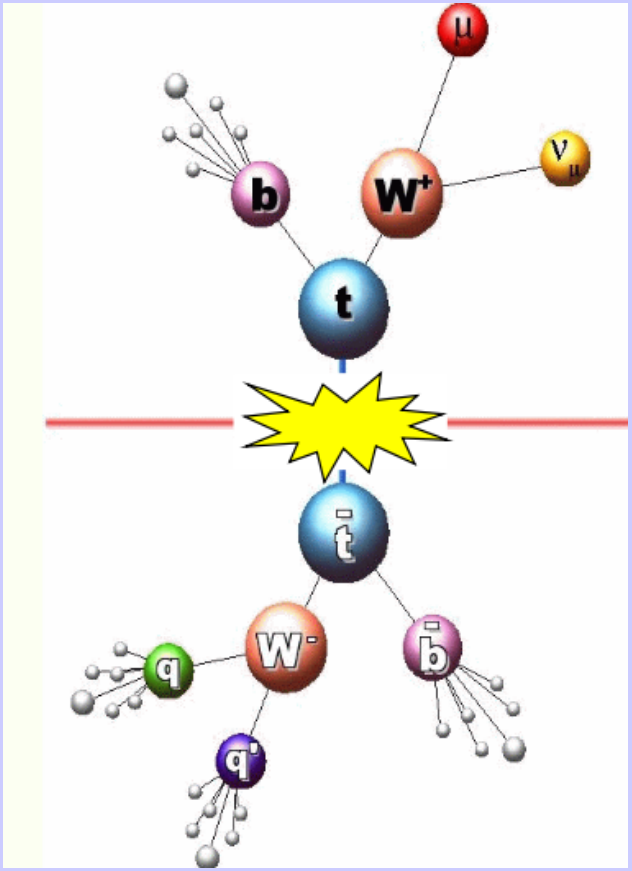
Top quark charge at CDF

→ Charge of W boson = lepton charge

- in hadronic branch Q(W)= − Q(l)

→ b−jet charge algorithm:

- weighting technique:



$$JetQ = \frac{\sum_i q_i (\hat{n} . \vec{p}_i)^w}{\sum_i (\hat{n} . \vec{p}_i)^w}$$

$\hat{n}$: os jetu

$\vec{p}_i$: p_T treku $(>1.5\,GeV)$

$N_{tracks} > 1$

w = 0.5, jet cone 0.4 (after optimalization)

Top quark charge at CDF

- W boson and b-jet pairing

$$\chi^2 = \sum_{i=l,\,4\text{jets}} \frac{(\hat{P}_T^i - P_T^i)^2}{\sigma_i^2} + \sum_{j=x,\,y} \frac{(\hat{P}_j^{UE} - P_j^{UE})^2}{\sigma_j^2} + \frac{(M_{jj} - M_W)^2}{\Gamma_W^2} +$$

$$+ \frac{(M_{l\nu} - M_W)^2}{\Gamma_W^2} + \frac{(M_{bjj} - M_t)^2}{\Gamma_t^2} + \frac{(M_{bl\nu} - M_t)^2}{\Gamma_t^2}$$

In fitter we constrain top quark mass to 175 GeV

b-jet – lepton pairing => 24 combinations

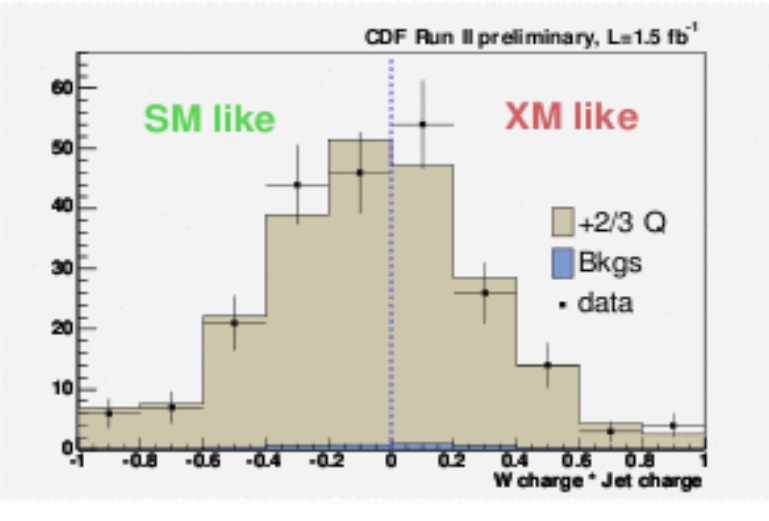
using combination with minimum χ^2

after optimization => χ^2 cut: $\chi^2_{min} < 9$

Top quark charge at CDF

- Latest results using this method L=1.5 fb^{-1}:

  → exotic model is exluded with 87% CL



Yield	Observed	After pairing	JQ defined	SM	XM
L + J	193	102	199 pairs	111	88
DIL	44	14	26 pairs	13	13
Total	237	116	225 pairs	124	101

- Come out with results for L=1.9 fb^{-1}
- Increase statistics to L=4.2 fb^{-1}

Plans in top quark charge

→ We are using tight leptons:

TCEM - isolated central electron

TCMUP - isolated central muon with stubs in both CMU and CMP muon detectors

TCMX - isolated central muon with stub in CMX muon detector and pass COT exit radius cut

→ Add so called Loose Muons (see next slide) to increase statistic

Plans in top quark charge

→ Loose Muons (diff. trigger as for tight lep.):

- TCMXNT - no isolated non-triggable muon with a stub in the CMX detector, no COT exit radius cut
- TCMU - isolated central muon with stub only in CMU
- TCMUNI - non-isolated central muon, stub only in CMU
- TCMP - isolated central muon with stub only in CMP
- TCMPNI - non-isolated central muon, stub only in CMP
- TCMIO - stubless muon, pass another cuts for muons
- TSCMIO - as TCMIO, but with stub in one of the muon detectors (CMU, CMP, CMX, BMU)

Thank you!

Back up

Top charge: Events selection

→ Lepton p_T > 20 GeV, lepton isolation < 0.1

→ MET > 20 GeV (neutrino)

→ at least 3 tight jets (p_T > 20 GeV & $|\eta|$ < 2)

and one loose jet (p_T > 12 GeV & $|\eta|$ < 2.4)

→ at least 2 b-tagged jets