

*The White Pomeron, Color Sextet Quarks
and Cosmic Ray Anomalies*

Critical Pomeron

Diffractive (DPE) WW & ZZ Production ???

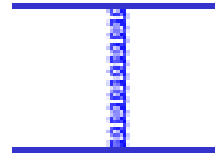
Color Sextet Quarks

Knee in Cosmic Ray Spectrum

High ET Jet Excesses

What next?

(Critical) Pomeron plays a key role in this theory



Pomeron has two parts:

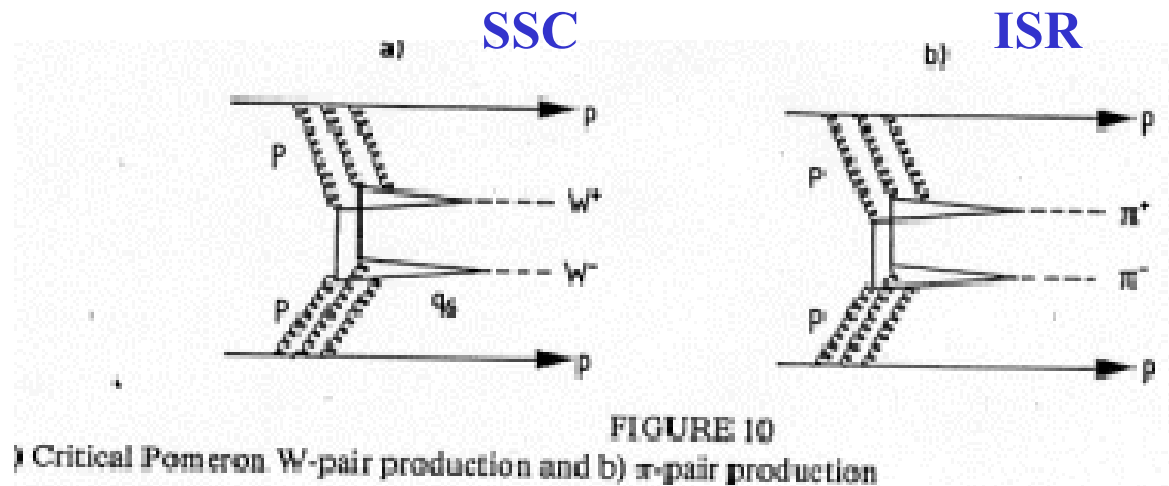
“Reggeized gluon” : single g in LO QCD is “sick”: not gauge invariant.
Reggeized gluon from summing procedure \rightarrow gauge invariant.

Infinite number of “wee gluons”: no momentum even in infinite momentum frame.
wee gluons have properties of vacuum: in a sense they are the vacuum.
 R_g color compensated at large distance by accompanying w_g “cloud”.

w_g couple strongly to *color sextet* Q and hence to W, Z once energy $\sim EW$

At LHC and above, diffractive W/Z production may be prolific

Alan White, Confinement and the Pomeron, Blois Workshop 1989 (NWU)
NPB (Proc Supp) 12 (1990) p.190

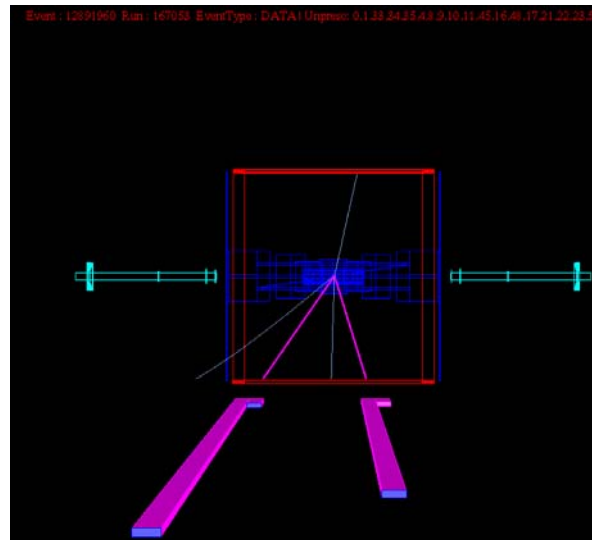
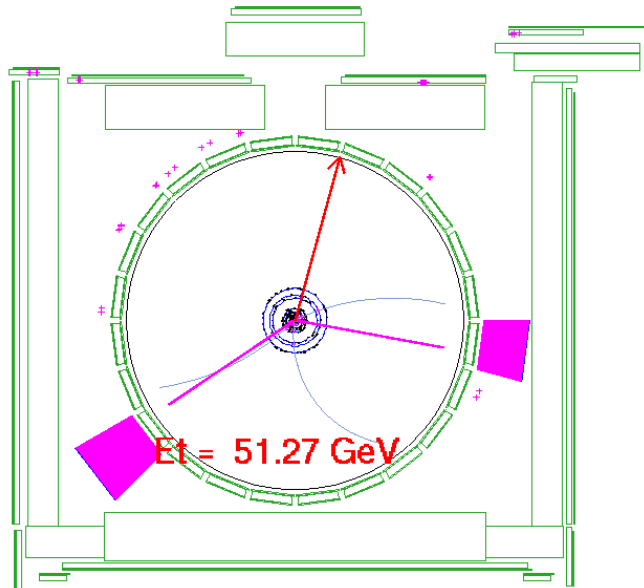
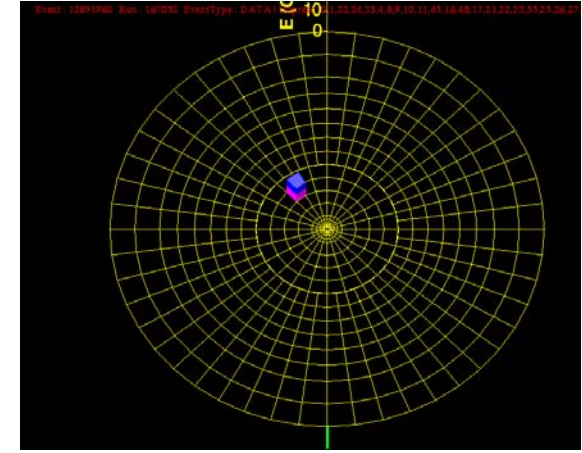
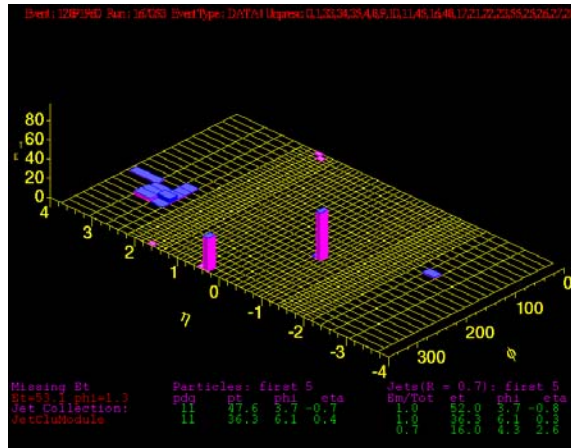
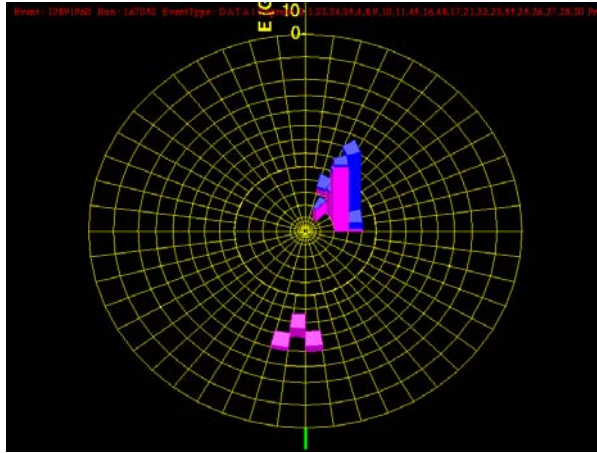


“... direct and strong WW and ZZ production by pomerons in Alan White’s critical pomeron theory ...”

MGA NPB (Proc. Supp) 12 (1990) p.291

SSC, LHC? TeV???

CDF Run II event: Run 167053, Event 12891960



$ZZ \rightarrow ee (88.1 \text{ GeV})\nu\nu$
MET = 51.3 GeV
(or WW?)

$p_T > 0.4 \text{ GeV}/c, |\eta| < 1$
 $n_{\text{ass}} = 2$

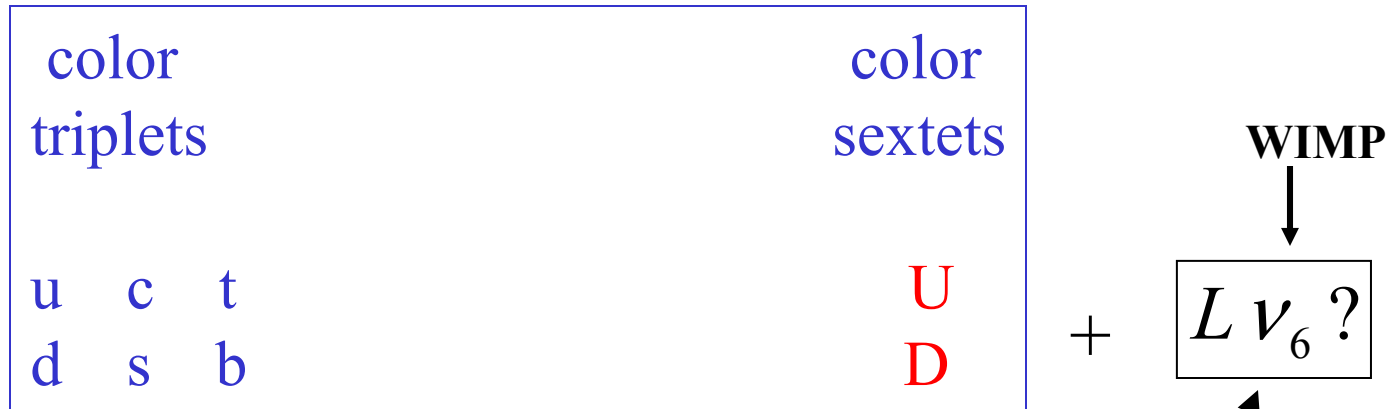
“CLC,MP” E&W
low forward activity.

Color Sextet Quarks: a Kindergarten Introduction

Asymptotic Freedom is saturated in ARW's Critical Pomeron theory:

→ **16 color triplet quark q flavors**. We know only 6.

(Higher) **Color Sextet Quarks Q** count $5 \times q$: so two Q's {U,D} will saturate.



Q's have 0 current mass, EW scale constituent mass. Stronger color charge than q.
Electric charges like $\bar{q} \rightarrow$ **Can form "SuperHadrons"**:

$$P_6 = \{UUD\}; N_6 = \{UDD\}$$

STABLE

Several (?) stable heavy neutrals!

$$\{UDD\}$$

Dark Matter?

SIMP at EWK scale, WIMP at low Q^2
UHE Cosmic rays (AUGER)?

Hadrons : $Q\bar{Q} \Rightarrow \{\Pi^-\Pi^0\Pi^+\} \quad \eta_6$

$\{\Pi^+\Pi^0\Pi^-\}$ are composite zero-helicity

components of $\{W^-Z^0W^+\}$

(Get "eaten" by massless $\{W^-Z^0W^+\}$)

η_6 plays role of Higgs, EW symmetry breaking

There is no Higgs Boson in this theory!

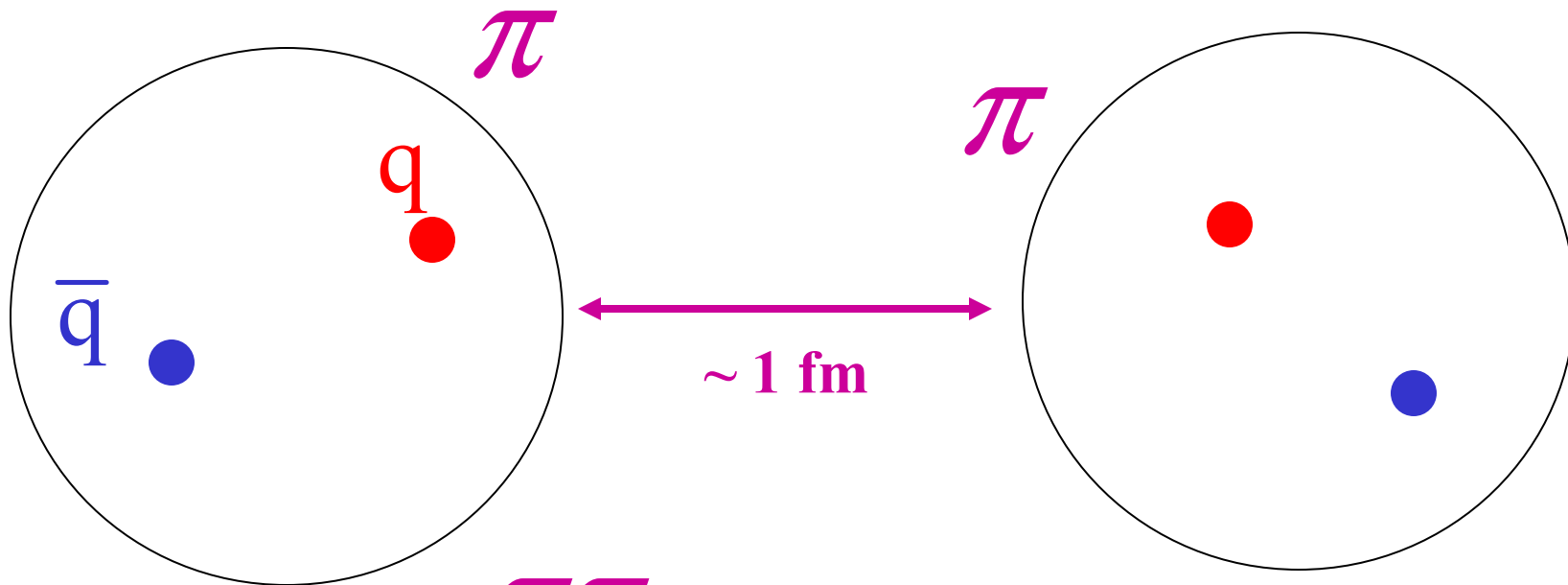
(η_6 has very different properties)

Once above ElectroWeak scale, should have prolific production of W's and Z's at **UHE Cosmic Ray** energies they are almost like pions! Auger project will see this.

CR energies will be underestimated, perhaps by big factor!

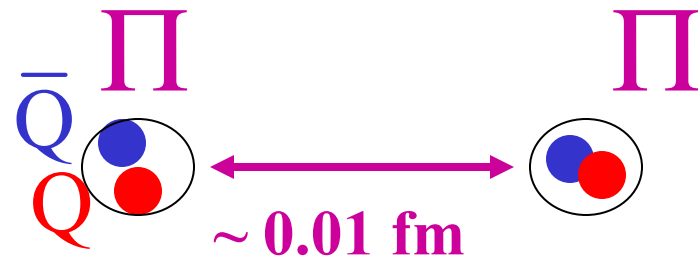
Perhaps we glimpse that?

SIMPS or WIMPS?



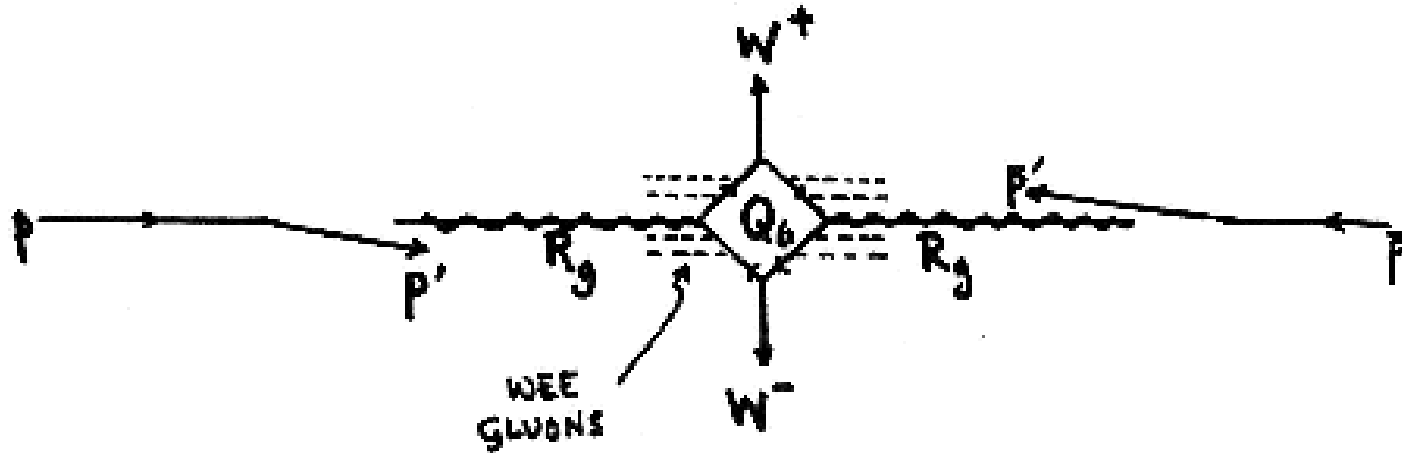
$\pi\pi$ force feeble at large distances

$\Pi\Pi = WW$ force weak
even at small distances, until ...



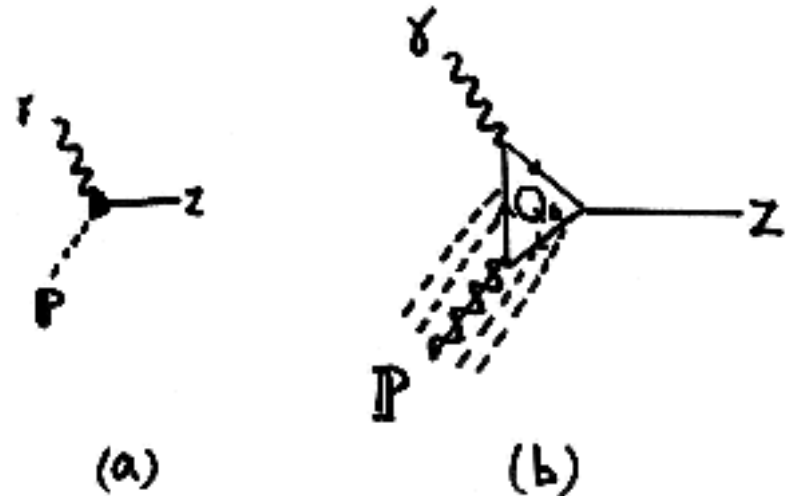
WIMPs at large distances
SIMPs at very small distances

Double Pomeron \rightarrow W^+W^- via Q6 Loop



Photon-Pomeron-Z vertex
via Q6 loop

$\rightarrow ep$
(eg LC+p (Tev,HERA,LHC))
could be *very* interesting!



*Is there evidence for the
Color Sextet Quark theory?*

...or something **unusual** happening around this energy?

- 1) Large excess of **high ET dijets (cores) in cosmic ray events** and (?) **CDF High ET jet excess** → anomalous appearance of α_S
- 2) Mystery “**knee**” in cosmic ray spectrum
- 3) **Dark Matter: evidence for some heavy neutral stable particles**

Cosmic ray showers in large emulsion chambers on mountains.

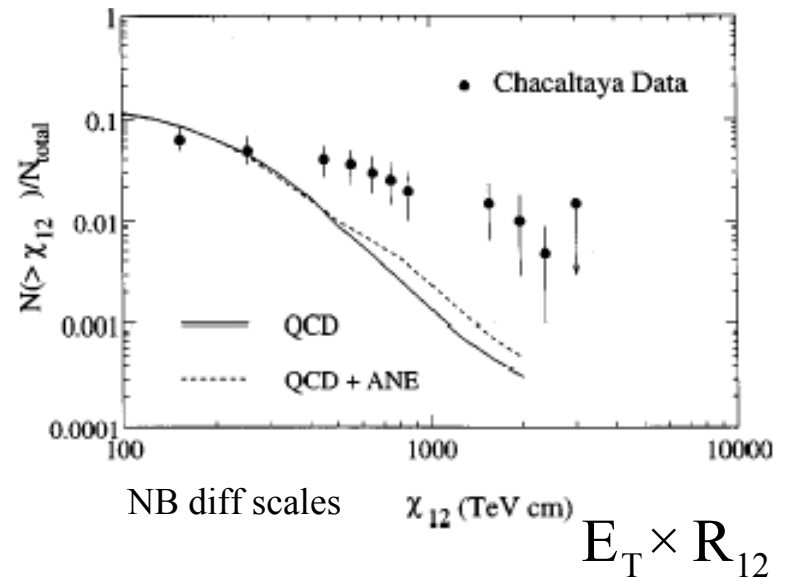
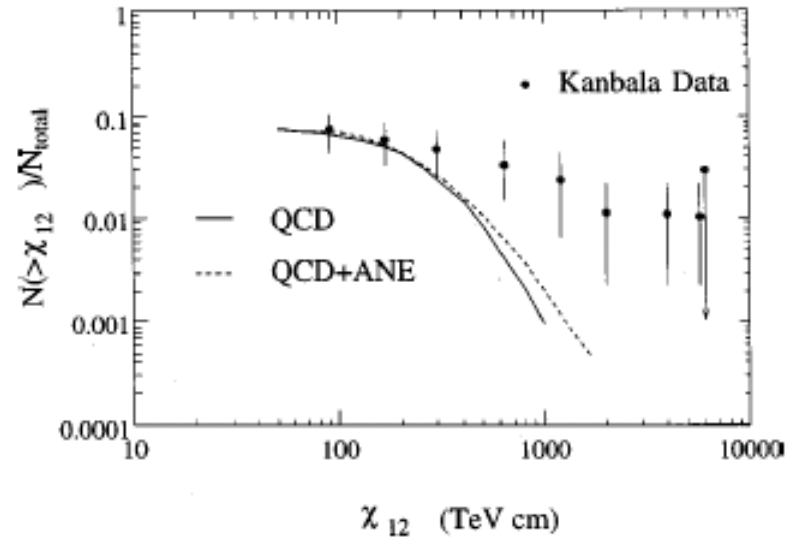
Above $\sqrt{s} \sim 5 \text{ TeV}$

QCD MC simulation tuned to FT and Collider data (including SppS and CDF)

Select two high ET jets (“cores”)

Large excess over QCD seen at large $E_T \times R_{12}$

Could be high pT W/Z jets !??

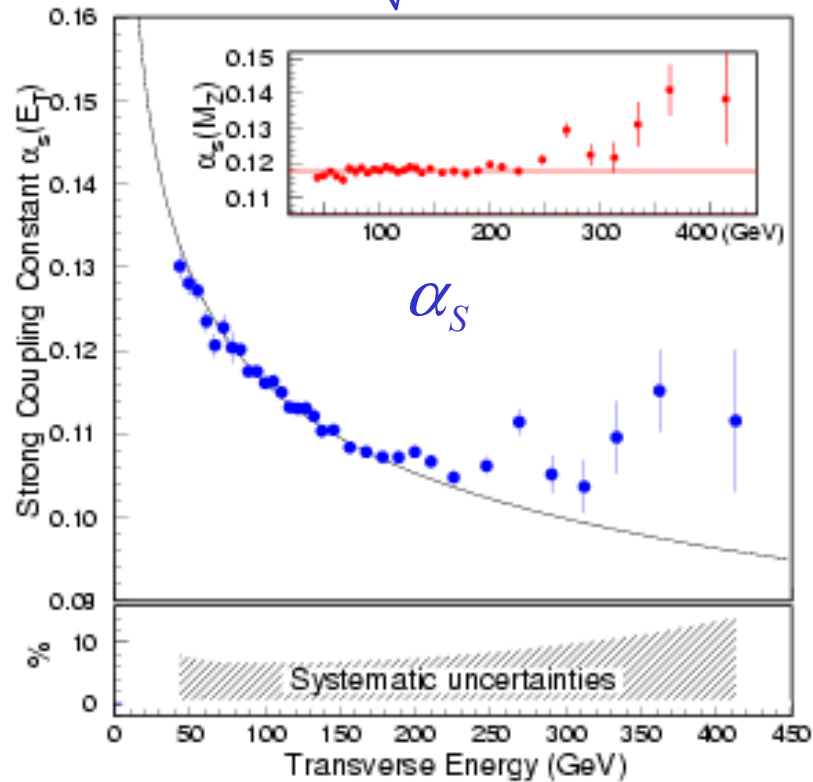


CDF High E T Jet Excess

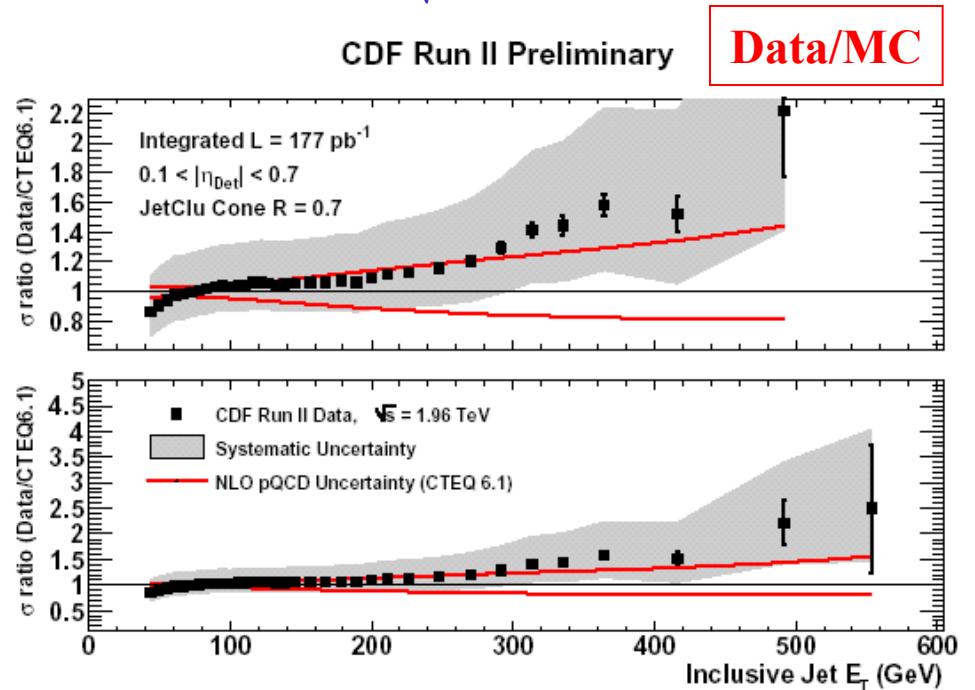
α_s running will slow down or plateau;
when Qs interactions become perturbative it will start falling again $\rightarrow 0$.

Measurement of the Strong Coupling
from Inclusive Jet Production ...

Run I: $\sqrt{s} = 1800$ GeV



Run II: $\sqrt{s} = 1960$ GeV

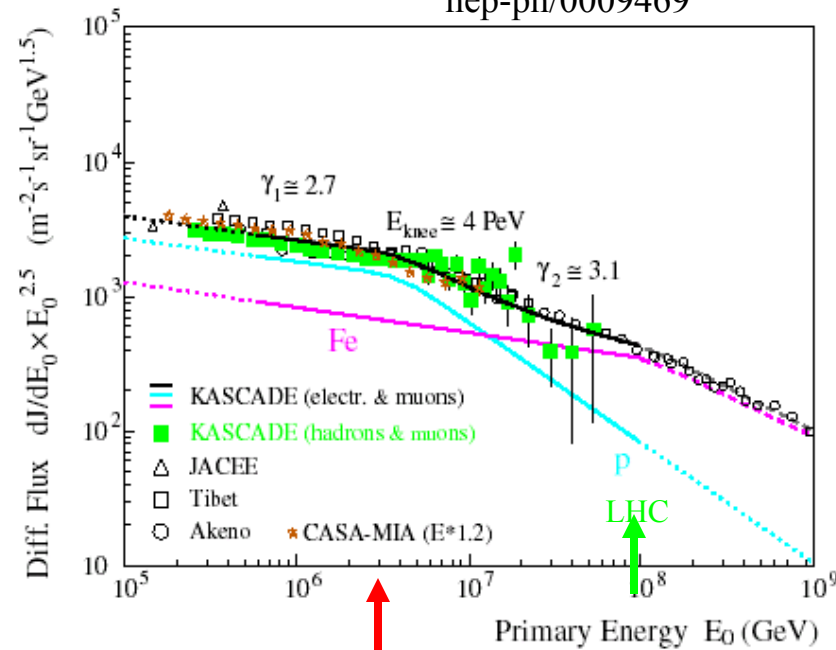


One can stretch gluon pdf ...

Cosmic Ray Spectrum

From M.Boratav and A.Watson
hep-ph/0009469

Region of the “knee”



$$E_0 \sim 3 \cdot 10^6 \text{ GeV} \Rightarrow \sqrt{s} = 2500 \text{ GeV}$$

In ARW theory **W's and Z's** start to be strongly pair produced and more of the interaction energy goes into **neutrinos**.

Also transverse profile broader than in SM.

Hence incoming energy underestimated (by Standard Models)

Hence spectrum seems to steepen. For Fe happens 56 x higher than for p

Some thoughts for future:

Intriguing, but belief will require (v) strong evidence from colliders.

CDF data with 200 pb^{-1} do not show a significant anomaly in WW/ZZ production. Perhaps need 2 fb^{-1} or more?

If we had precision roman pots E&W ...

If any events have both p & pbar detected →

M(WW/ZZ) Even ZZ → 4 neutrinos !! (in principle)

This can be done technically in Tevatron but would require a **3-4 month access** and perhaps **\$1M**, so it won't be done without a very strong case (5 sigma signal?)

Then we must wait for LHC (dramatic effect? ARW)