SOFT SIDE OF QCD

IN HIGH-ENERGY COLLISIONS

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ANTWERP, 20 SEPTEMBER 2010

TO UNDERSTAND

THE SOFT SIDE OF QCD

WE WANT TO KNOW (AT LEAST)

(1) STRUCTURE OF COLLIDING OBJECTS IN TERMS OF QUARK & GLUONS

(2) HOW QUARKS & GLUONS INTERACT AND REARRANGE DURING THE COLLISION

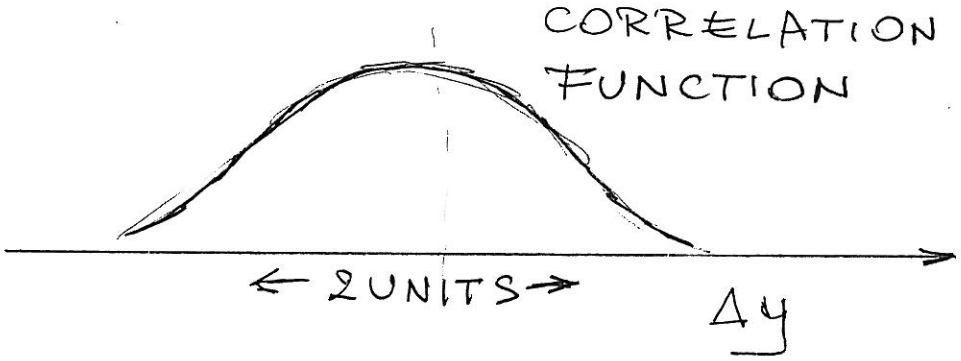
(3) HOW QUARKS & GLUONS FORM FINAL HADRONS

NO REAL THEORY BUT SOME HINTS

TODAY : (a) SHORT-RANGE INTERACTIONS

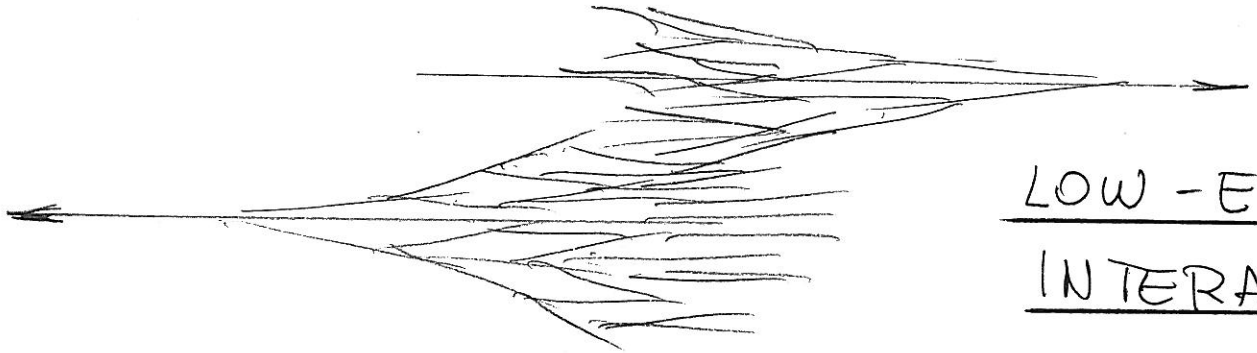
(b) DIFFRACTION

SHORT RANGE MULTIPARTICLE CORRELATIONS



$$\Delta E \simeq m_\perp e^{\Delta y} \sim 2\text{-}3\ \text{GeV}$$

STANDARD EXPLANATION (FEYNMAN):
INTERACTION DOMINATED BY "WEE" PARTONS

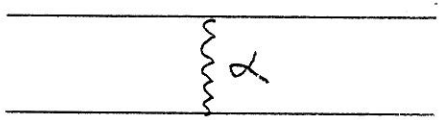


LOW-ENERGY
INTERACTION

PROBLEM:

SPIN OF THE GLUON

ENERGY DEPENDENCE OF A CROSS-SECTION
IS DETERMINED BY THE SPIN OF EXCHANGED OBJECT



$\sigma \propto s^{\alpha-1}$

GLUON EXCHANGE: $\alpha = 1 \Rightarrow$ ENERGY-INDEPENDENT CROSS-SECTION

$\Rightarrow$ INTERACTION INDEPENDENT OF Δy

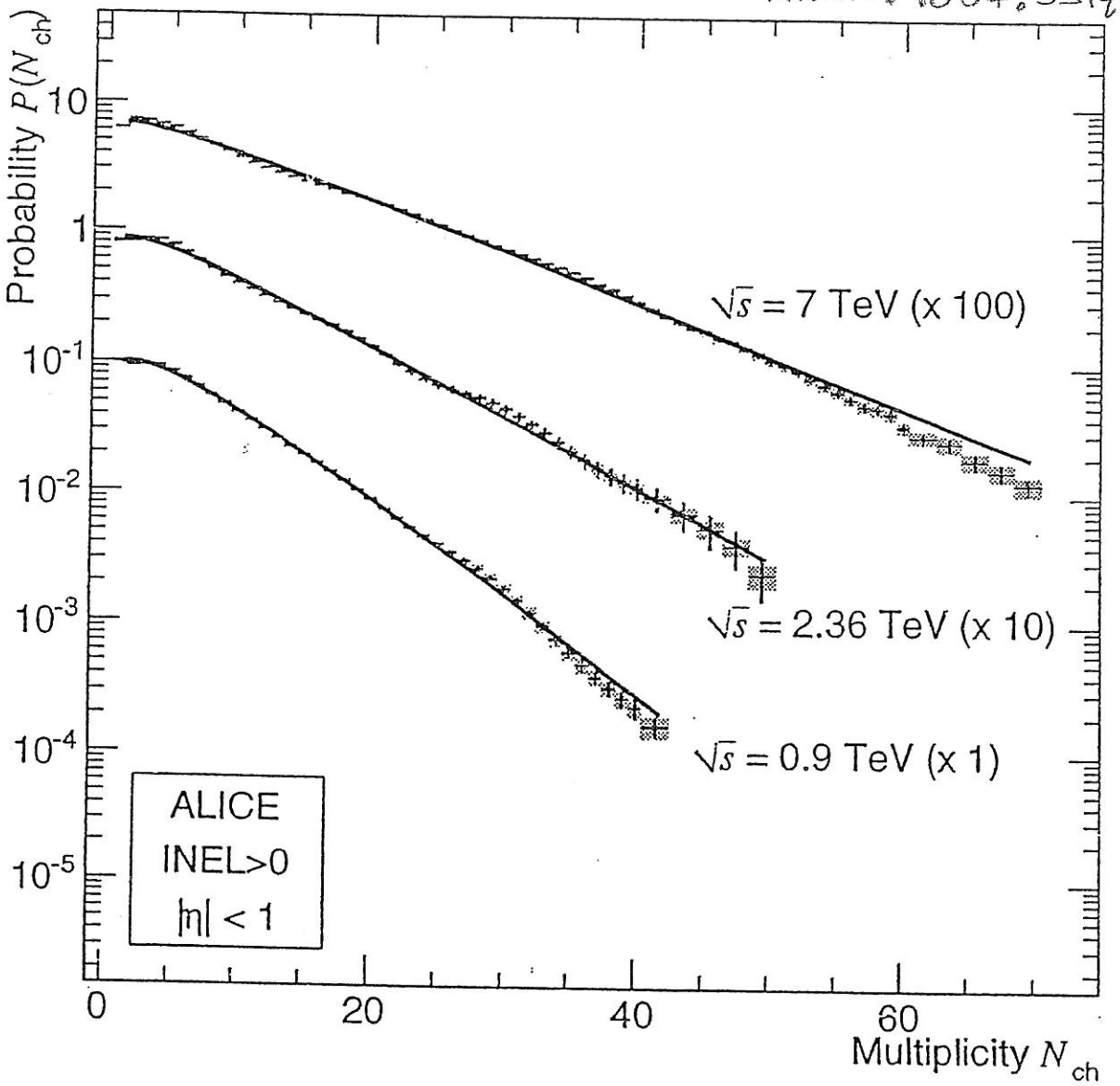
$\Rightarrow$ LONG RANGE CORRELATIONS?

$\Rightarrow$ QUASI-PARTICLES?

$\Rightarrow$ HADRONIZATION?

NEGATIVE BINOMIAL FITS AT LHC

ARXIV: 1004.3514



NEGATIVE BINOMIAL DISTRIBUTION FROM SHORT-RANGE CORRELATIONS

(1) NBD SEEN EVERYWHERE

WHY ?

(2) EDDI'S ARGUMENT [APP B21 (1990) 611] :

NEAREST NEIGHBOUR INTERACTION (IN RAPIDITY)

$\Rightarrow$ NBD FOLLOWS

DIFFRACTION

J. PHYS. G 28 (2002) 1023

(1) UNITARITY ⇒ GLOBAL CONNECTION BETWEEN PARTICLE PRODUCTION & DIFFRACTION

(2) ANGULAR MOMENTUM CONSERVATION ⇒ UNITARITY

DIAGONAL IN IMPACT PARAMETER

ELASTIC MEASURES IMPACT PARAMETER DEPENDENCE OF PROTON STRUCTURE (ELASTIC AMPLITUDE)

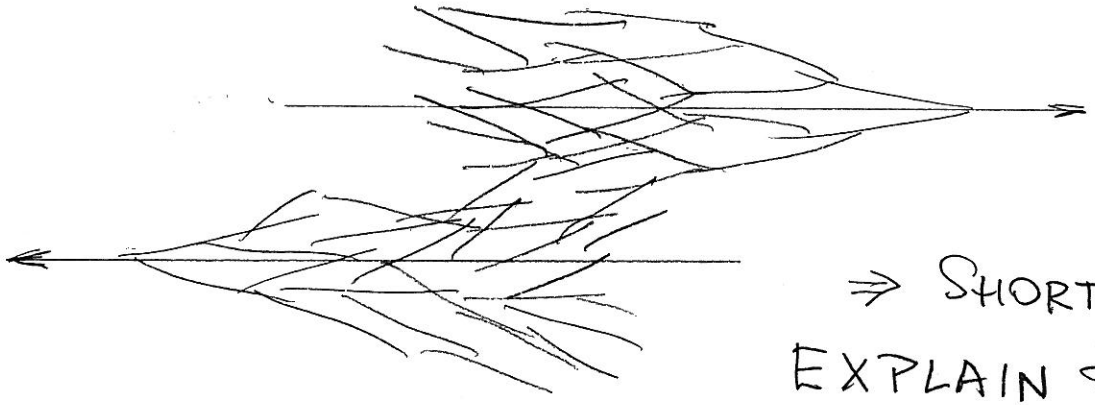
INELASTIC

HADRON-HADRON MEASURES FLUCTUATIONS OF PROTON STRUCTURE

PHOTON-HADRON MEASURES SQUARE OF THE ELASTIC AMPLITUDE

} COMPLEMENTARY!

DIFFRACTION: A WINDOW TO STUDY THE QCD CASCADE



(1) CASCADE LARGEST AT THE SOFT END ⇒

⇒ SHORT RANGE INTERACTIONS

EXPLAIN RISING CROSS-SECTIONS & SHRINKING

(2) CASCADE IMPLIES LARGE FLUCTUATIONS:

$n \sim e^{L}$ L = LENGTH OF CASCADE

DATA INDICATE THAT (MP PAPER)

(3) IN PHOTON-HADRON COLLISIONS THEY ARE (USUALLY) IGNORED

(4) LHC FORWARD PHYSICS PROGRAM ?

MIETTINEN & PUMPLIN

PRD 18 (1978) 1696

DATA FROM ALBROW et al. NP B108 (1976) 1.