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TUNG FEST
12 MAY '07

THE FUTURE OF THE PARTON MODEL

I. INTRODUCTION

II. PARTON SPECTRA vs. MULTIHADRON DISTRIBUTIONS

III. TRANSVERSE COORDINATES vs. TRANSVERSE MOMENTA

IV. THE LEGO PLOT REVISITED

V. INELASTIC DIFFRACTION AT THE PARTON LEVEL

VI. WHAT ABOUT THE LHC ??

VII. CONCLUSIONS

VIII. BOTTOM LINE

I. INTRODUCTION

PARTON MODEL A LA CTEQ HAS A LONG FUTURE.

IS THE PARTON MODEL A RIGOROUS CONSEQUENCE OF QCD ??

YES, FOR LEPTON-HADRON (??)

NO, FOR HADRON-HADRON (??)

* THE MULTIPARTON DESCRIPTION OF HADRONS.

PARTON SPECTRA vs. MULTIHADRON DISTRIBUTIONS

FAST PROTON

⇓

POPULATION OF PARTONS

⇓

INCLUSIVE DISTRIBUTIONS

PROTON-PROTON COLLISION

⇓

POPULATION OF PRODUCED HADRONS

⇓

MULTIPLICITY DISTRIBUTIONS

INCLUSIVE DISTRIBUTIONS

MULTIPARTICLE DISTRIBUTIONS

CORRELATION FUNCTIONS

FACTORIAL MOMENTS

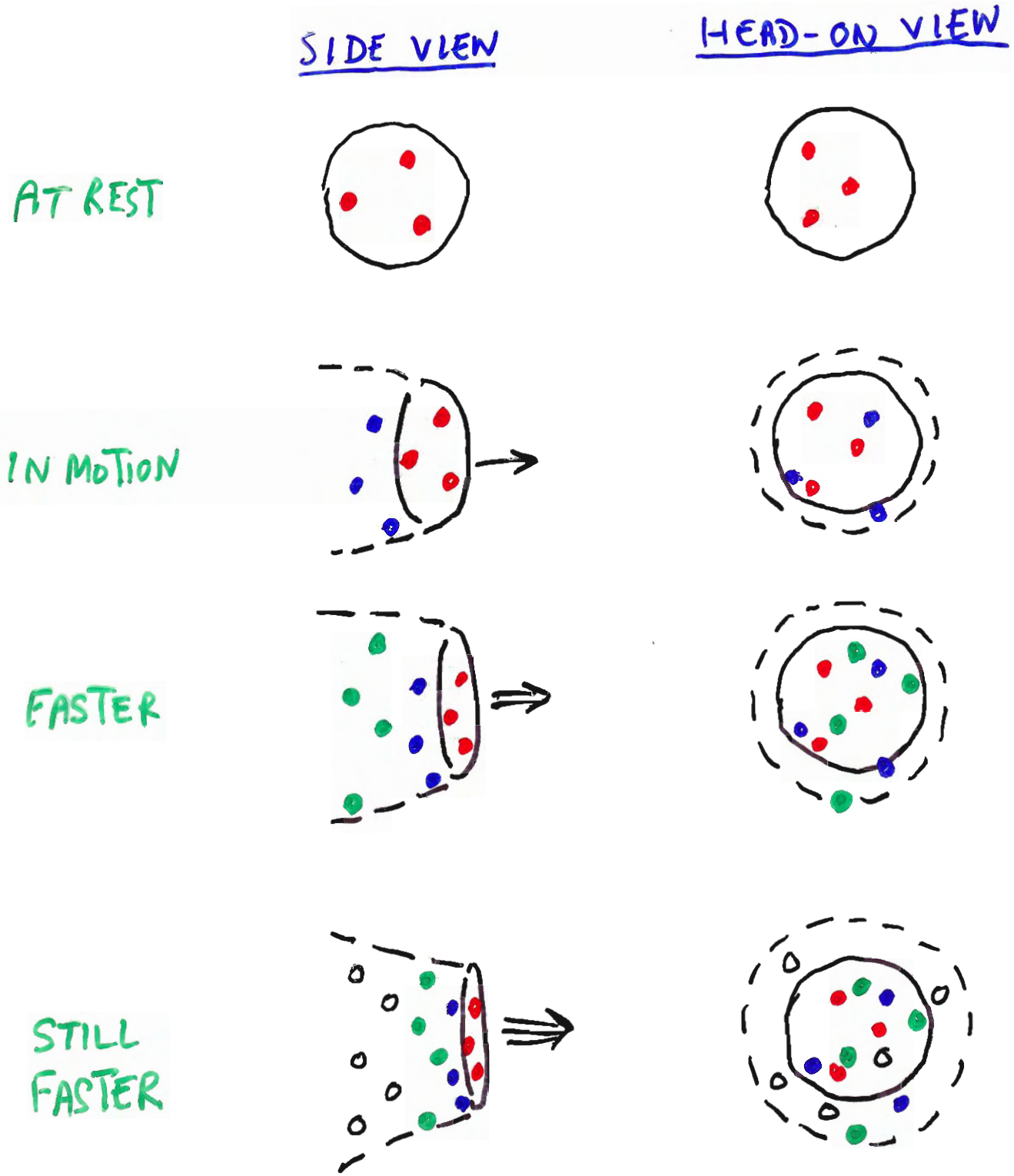
CUMULANTS

GENERATING FUNCTION(AL)S

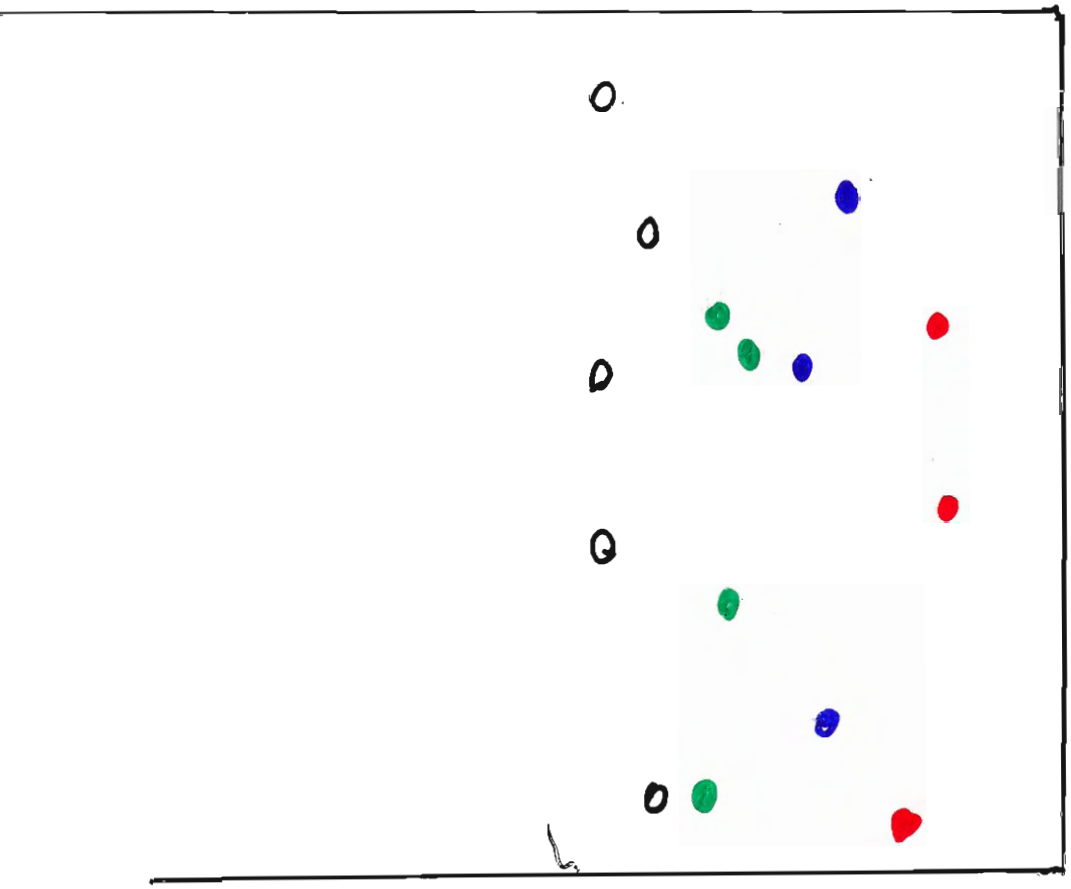
(cf. DREMIN, DE WOLF, KITTEL)

III. TRANSVERSE COORDINATES vs. TRANSVERSE MOMENTA

(THE NAIVE PROTON)



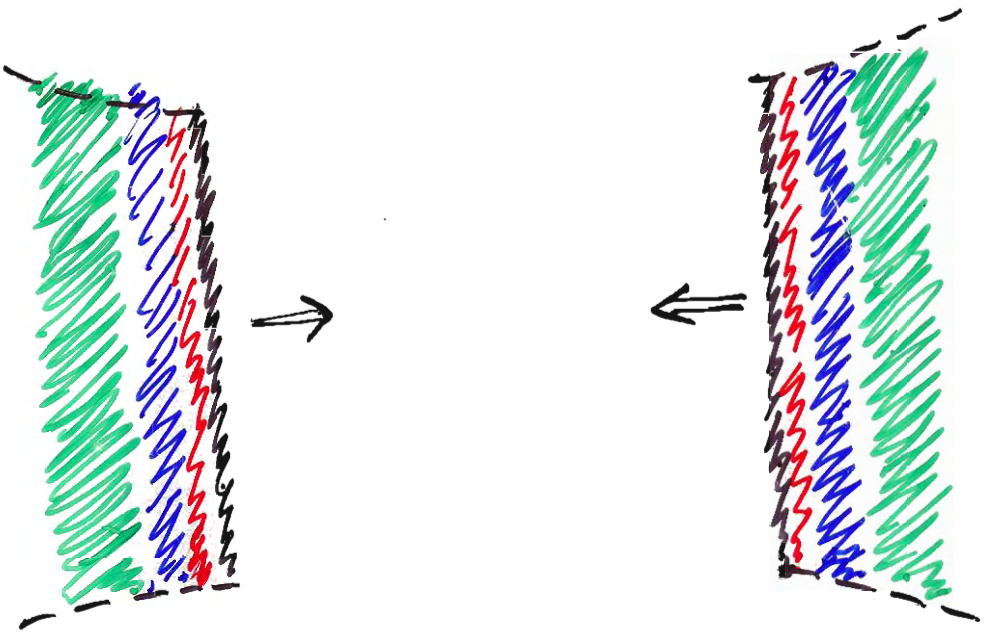
THE LEGO PLOT



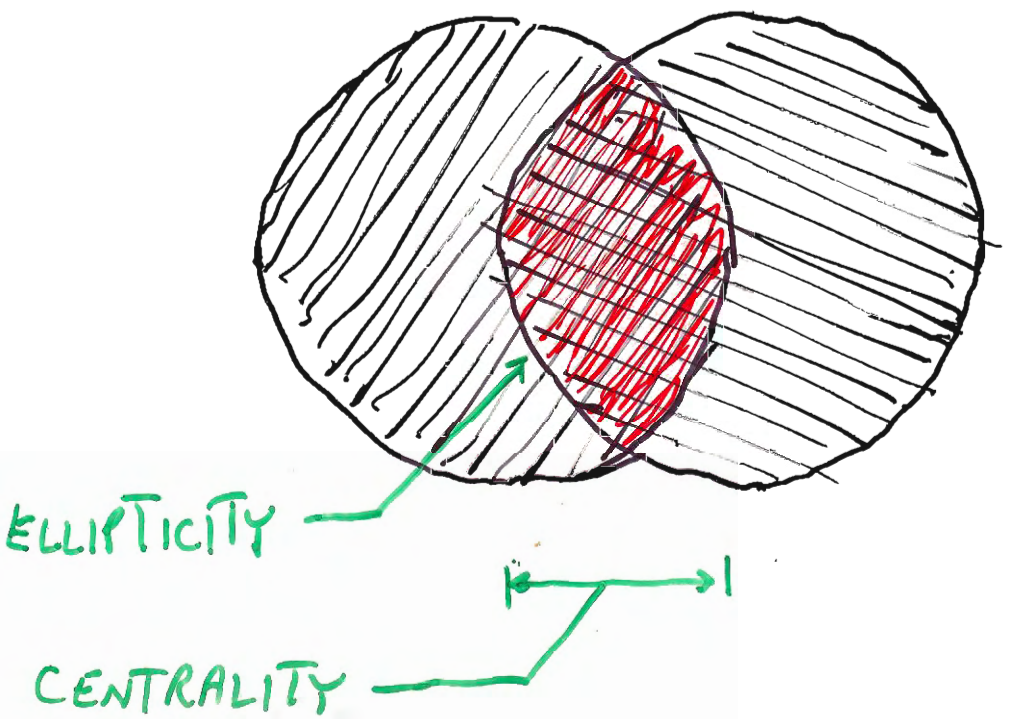
X = LONGITUDINAL MOMENTUM FRACTION

HEAVY-ION COLLISIONS

SIDE VIEW

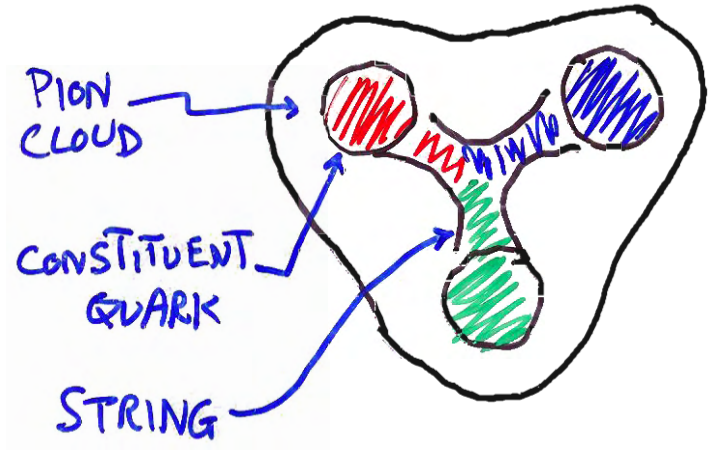


HEAD-ON VIEW

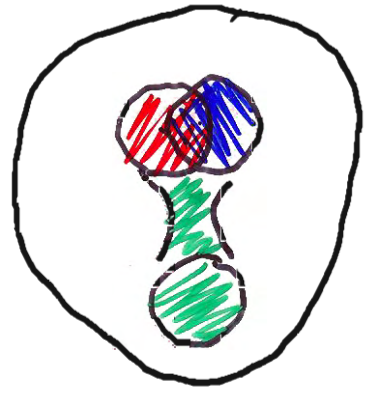


THE NOT-SO-NAIVE PROTON

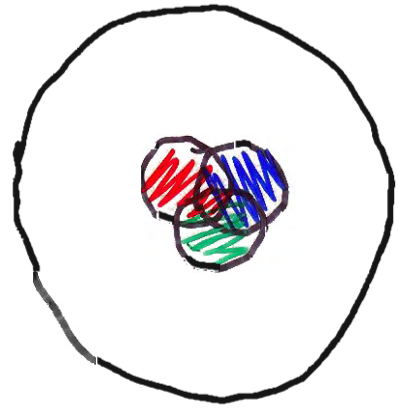
HEAD-ON VIEW

1. 

3-QUARK

2. 

QUARK-DIQUARK

3. 

TRIQUARK

14 CLASSES OF PROTON-PROTON COLLISIONS

IT'S YOUR HOMEWORK PROBLEM

THE VERY HIGH-ENERGY LIMIT:

OPAQUE PION CLOUD

MANY MANY SOFT GLUONS

HEAVY-ION-LIKE ?

CENTRALITY

ELLIPTICITY

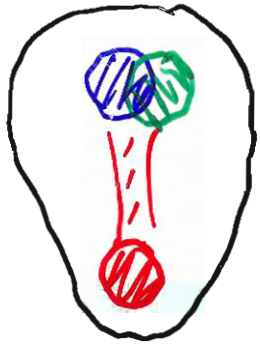
LEADING PARTICLES $\Leftrightarrow$ VALENCE STRUCTURE

IV. THE LEGO PLOT REVISITED

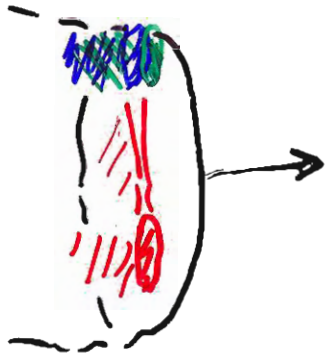
(SIDE VIEW)

LEGO PLOT

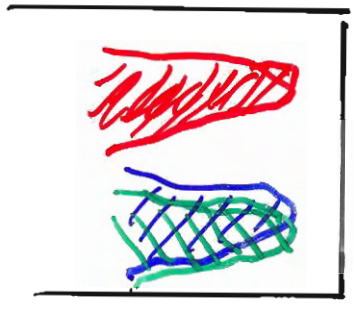
AT REST



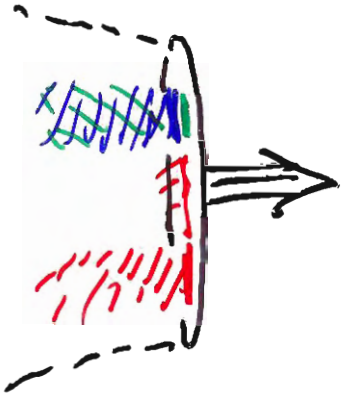
IN MOTION

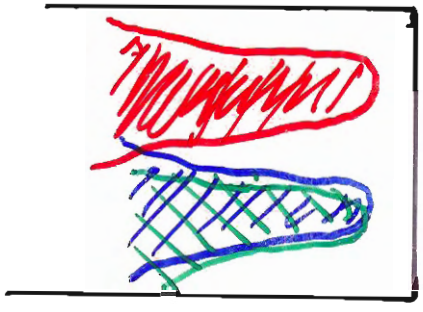


FASTER



STILL FASTER





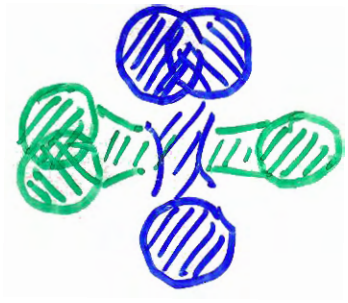
AZIMUTHAL ANGLE

RAPIDITY $\sim \log x$

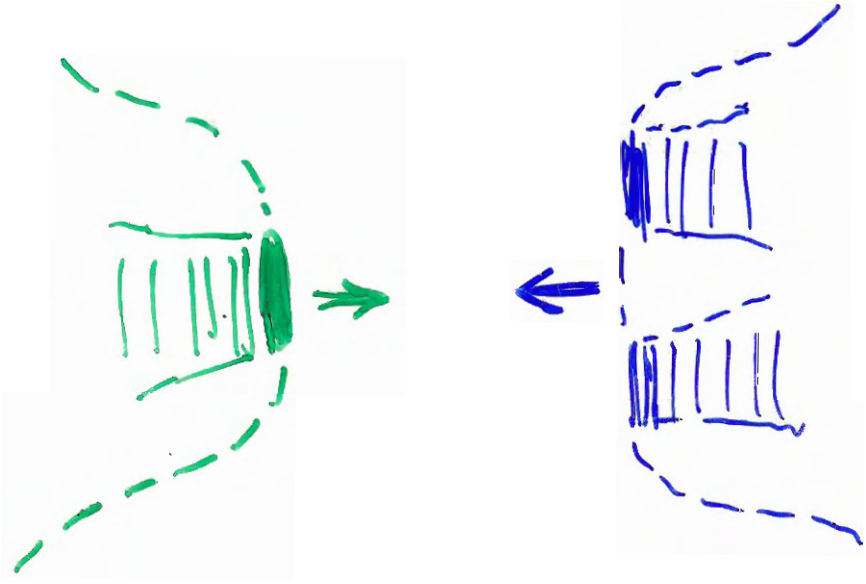
V. INELASTIC DIFFRACTION AT THE PARTON LEVEL

HEAD-ON VIEW

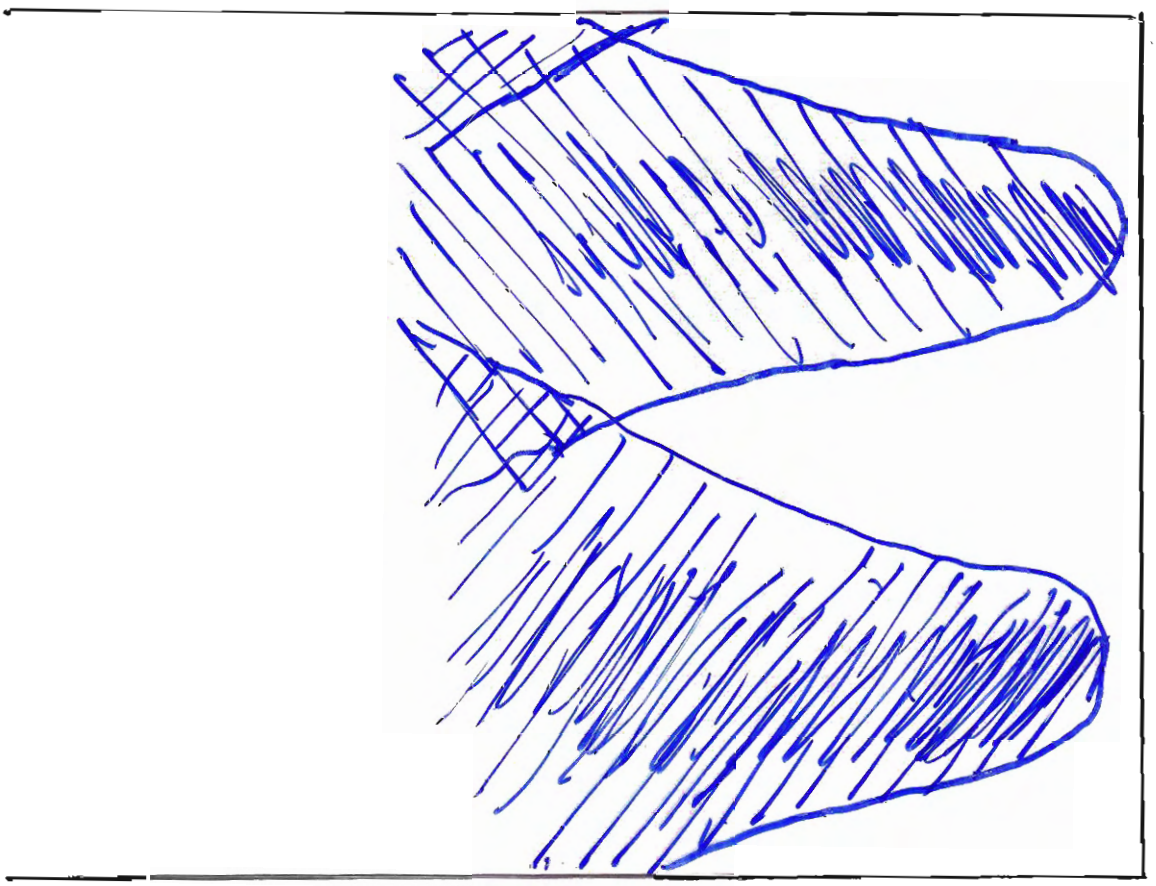
(PION CLOUDS OMITTED)



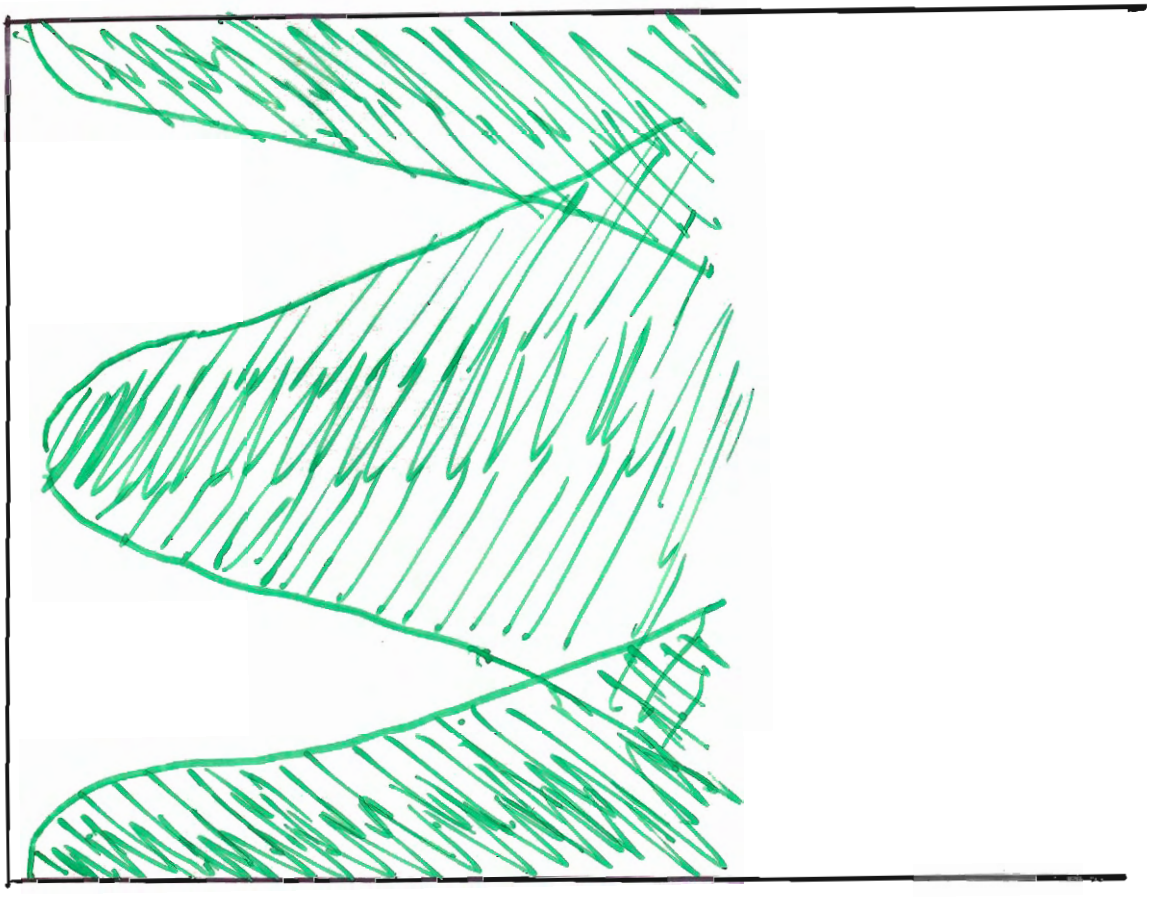
SIDE VIEW



LEFT-MOVER LEGO PLOT



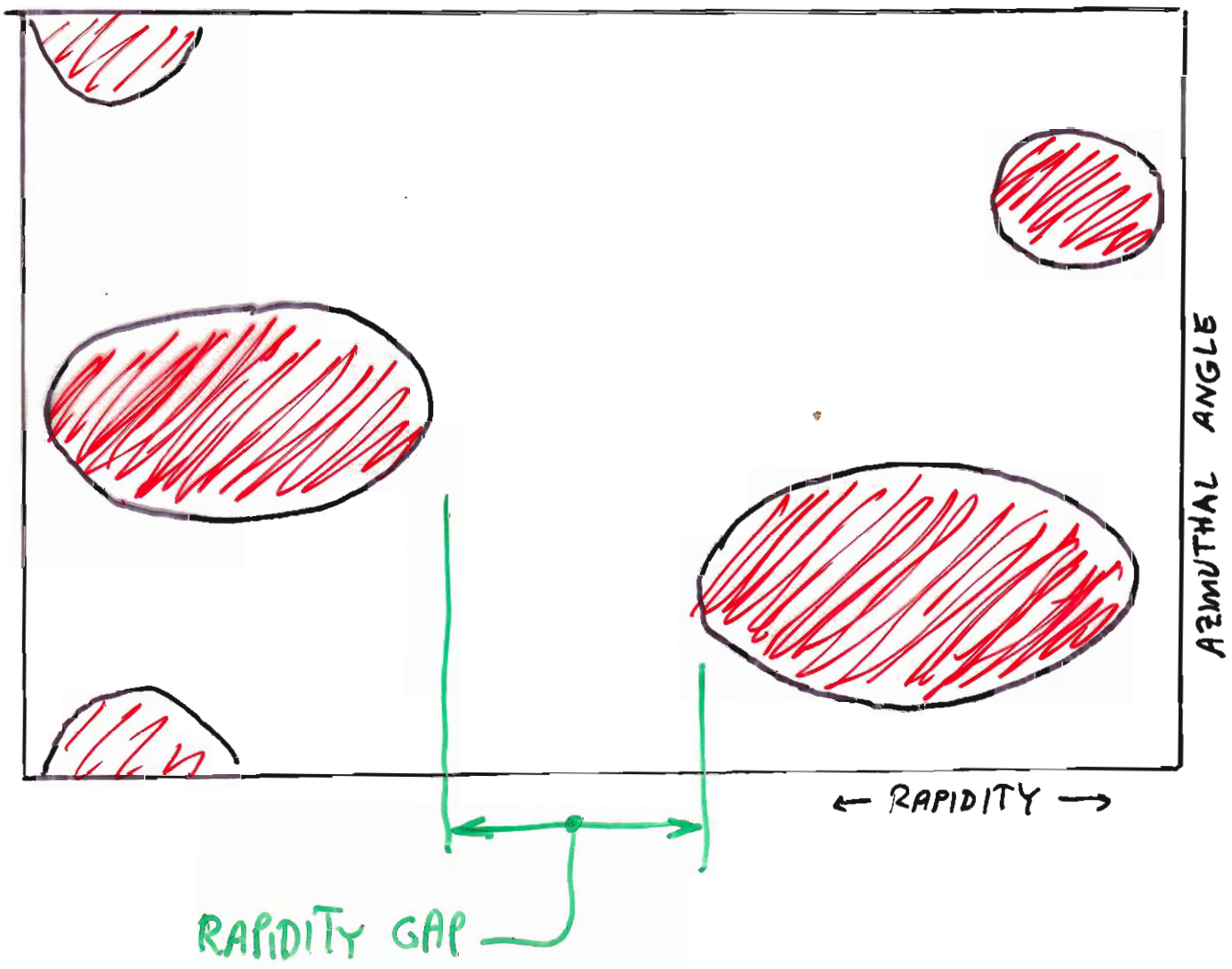
RIGHT-MOVER LEGO PLOT



SYNTHESIS:

ACTIVE vs. PASSIVE PARTONS

ONLY ACTIVE PARTONS ARE SHOWN



VI. WHAT ABOUT THE LHC ??

ONSET OF "SATURATION" (OPAQUE-DISK) REGIME ??

LEARN FROM RHIC

CENTRALITY
ELLIPTICITY

IS THERE DEPENDENCE ON THE INITIAL-STATE CONFIGURATION ??

LEADING PARTICLE TAGGING
DIFFRACTION TAGGING ??

IS INELASTIC DIFFRACTION LESS DOMINANT ??

MULTIGAP FRACTION DECREASES ?
GRAY-EDGE STRUCTURE
DIPS IN ELASTIC $d\sigma/dt$? } ??

VII. CONCLUSIONS

IMPACT-PLANE INTUITION NOT WELL-DEVELOPED FOR pp COLLISIONS

MUCH UNCERTAINTY IN MULTIPARTON PROPERTIES OF PROTON

MULTIPLICITY DISTRIBUTION
CORRELATIONS

THE SITUATION IS MORE SATISFACTORY (& SIMPLER) FOR ION-ION COLLISIONS

LEARN FROM THEM !!

THERE IS THE FOURIER BARRIER

THE MULTIPARTON DESCRIPTION WILL INCREASE IN IMPORTANCE AT LHC

IT MAY ALSO BE IMPORTANT FOR LEADING-PARTICLE PHYSICS (e.g. COSMIC RAYS)