

Minutes of the QDC Meeting held on the 8th April 1992

Present : D. Candlin, G. Cowan, P. Ghez, F. Le Diberder, J. Lefrançois, T. Lohse,
R. Miquel, M. Schmelling, H. Schmidt, R. Settles.

For all of these subjects, see attached transparencies for details.

1. F. Le Diberder : Status of $\alpha_s(\tau)$ paper.

François explained that the main controversy centers around extending the operator product expansion calculation of R_τ to the non-perturbative region. This region should in principle only affect 4th and higher order terms, but some theorists feel it may affect the 2nd order term. The paper will consist of combined determination of $\alpha_s(\tau)$ from B_e and B_μ , from the τ lifetime, and from the W^2 distribution and fitting terms in the standard R_τ expansion at the same time. Then the non-perturbative question above will be addressed by fitting the 2nd order term, with and without varying the quark masses.

2. A. Vayaki : HVFL02 Studies

Anna showed how to use ALPHA properly to make HVFL02 agree with Gerald Rudolph's fitted numbers for various distributions.

3. G. Cowan : Hadronization Paper Status.

The paper is ready finally. Glen discussed a small problem with the values of ϵ_c and ϵ_b used in the fit.

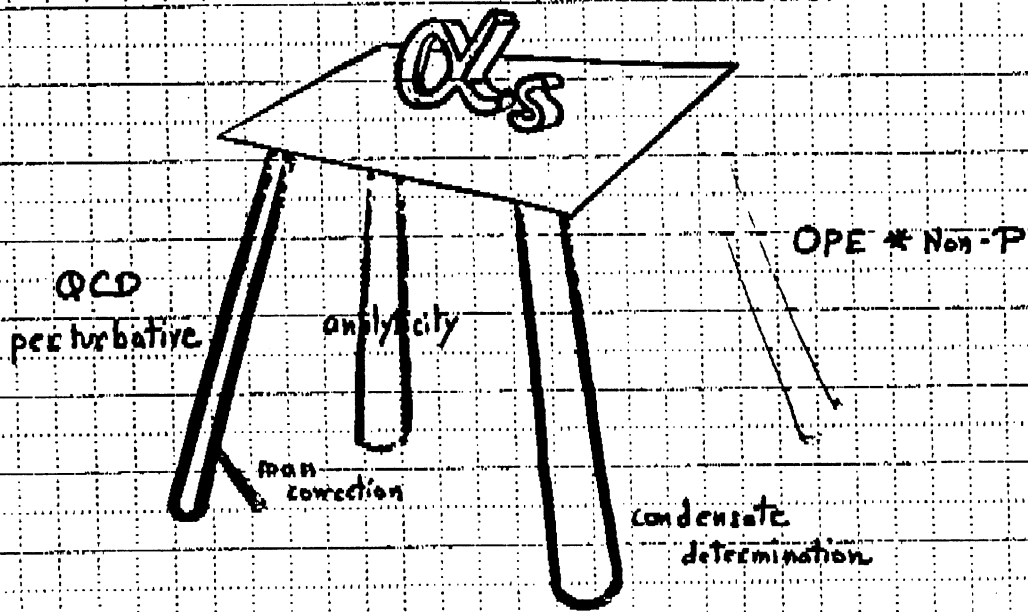
4. R. Settles : Future QCD Studies in ALEPH.

First were mentioned briefly other papers in preparation, not discussed today: η' (S. Haywood), $\gamma\gamma$ (A. Finch), V^0 's (B. Rensch), Multiplicity Studies (Y. Xie). Then R. Settles reviewed the updated list of possible QCD studies. We still have no one working on the angular and energy distribution of 3-jet events. It seems that one promising avenue for the future is to use events with tagged b-quarks for QCD studies. An especially clean measurement of gluon jet properties can be made with ALEPH. A high p_T lepton sample is in preparation (B. Maitland, M. Parsons) and VDET tagging is close to working (D. Brown, who will use it for electroweak studies). Persons interested in contributing to such topics (there are many openings) should come to the next QCD Meetings (29 April, 12 May), where the tools are being reviewed. They could also be interesting for studying other methods of tagging gluon jets. In the discussion, G. Cowan underlined the interest in studying further particle content in hadronic events. T. Lohse issued a plea that the "all orders resummation of α_s " using energy-energy correlation has no one working on it at the moment, but should have.

FRANCOIS Le DIBERDER
8. April 1992

$\alpha_s(\tau)$

(1)




———— reinforced

———— measured

$$R_z = \frac{\Gamma(z + \text{hadrons})}{\Gamma(z + c_V)}$$

$$R_z = R_z^0 \oplus : \text{perturbative massless QCD}$$

G.A.  + R_z^2 : perturbative mass correction
CLEAN

NON PERTURBATIVE + R_z^4 \oplus : $\langle m \bar{\psi} \psi \rangle$ and $\langle \frac{G}{\Lambda^2} GG \rangle \approx \text{OK}$

G.A. safe + R_z^6 \oplus : less clean

\oplus extracted from the data : α_s ; $\langle \frac{G}{\Lambda^2} GG \rangle$; c_6 (and c_8)

\Rightarrow **IMPORTANT POINT** R_z^2 receives no non-perturbative correction!
crucial
 not only for R_z duality needs it too

connected to gauge invariance :

	$\bar{\psi} \psi$		GeV^4
$\langle 0 $	$G_{\mu\nu} G_{\mu\nu}$	$ 0 \rangle$	GeV^4
	$\bar{\psi} \Gamma \psi \bar{\psi} \Gamma \psi$		GeV^6
	$\frac{1}{\Lambda^2} A A$		GeV^2

There is no gauge invariant GeV^2 operator

paper structure

• assuming standard condensate determination

$$1) \quad B_e, B_\mu \rightarrow R_C \rightarrow \alpha_s(m_Z^2) \rightarrow \alpha_s(M_Z^2)$$

$$2) \quad \tau \text{ lifetime}$$

$$3) \quad W^2 \text{ distribution} \rightarrow \alpha_s(M_Z^2)$$

$$4) \quad \text{Combined fit} \quad \alpha_s, \langle GG \rangle, D=6, D=8$$

• "probing" OPE ~~+~~

$$5) \quad \underline{C_2} \quad \bullet \text{ fixing } C_{i>2} \text{ to the previous result}$$

$$\rightarrow \alpha_s ; C_2$$

$$\bullet \text{ same but } m_g \rightarrow g m_g \text{ globally}$$

$$\rightarrow \alpha_s ; g$$

a) • Data analysis • systematic review (Z. Zhang)

[until April 24th busy on thesis]

b) • Theoretical support • paper I available CERN-TH

• paper II in progress

c) • Theoretical controversy G. Altarelli \rightarrow Anshu QCD

QCD meeting 7/4/92

A. Vaydi

HV FLO2 & fitting parameters.

1. with the help of G. Rudolf,
the fitted numbers and
those of KIRGAL level
for HV FLO2 were seen
to agree

2. The difference was in
the use of ALPHA for
the analysis of KIRGAL
output, instead of LUTABU
in Kingol.

Alpha pit falls

- 1) double counting K^0, Λ, Σ , etc
- 2) $K_{STABC} > 1$ excludes some
of the byproducts of the
above decays. One should use
 $K_{LUMPS} < 2$
- 3) statistics from events
and not histograms

Then the numbers agree

note

- AT KIRGAL DECAYS ARE ACTIVATED FOR K^0_{ST} .
- ALPHA IGNORES some decay products
probably because of the decay vertices
(small effect)

Update on Hadronization Paper

Glen Cowan
8.4.92

JETSET

- used in fit $\left[\begin{array}{l} \epsilon_c = 0.020 \\ \epsilon_b = 0.015 \end{array} \right. \quad \left. \begin{array}{l} \langle x \rangle_D = 0.54 \\ \langle x \rangle_B = 0.66 \end{array} \right.$

- ALEPH measures: $\left[\begin{array}{l} \langle x \rangle_D = 0.50 \pm 0.02 \\ \langle x \rangle_B = 0.67 \pm 0.04 \end{array} \right.$

which implied: $\left[\begin{array}{l} \epsilon_c = 0.050 \\ \epsilon_b = 0.006 \end{array} \right.$

- This ϵ_c, ϵ_b in JETSET (by GR) gives:

$$\left[\begin{array}{l} \langle x \rangle_D = 0.54 \\ \langle x \rangle_B = 0.70 \end{array} \right.$$

with similar χ^2 , all other parameters unchanged

QCD

IN

ALEPH

8 APRIL 1992

CONTENTS

- α_s
- 4 JETS
- 2 JETS
- 3 JETS
- COHERENCE
- HADRONIZATION
- INTERMITTENCY
- BOSE-EINSTEIN
- MULTI JETS
- $\gamma\gamma$ PHYSICS

PHYSICS

DISCUSSIONS 1990
Peter Zerwas
(ALEPH QCD WORKSHOP + PZ + ...)

$$\mathcal{L}_{int}^{strong} = g_s \bar{q} \not{D} q + g_s G G G + g_s^2 G G G G$$

\downarrow \downarrow
 $\Lambda_{\overline{MS}}$ m_p

• $d_s \rightarrow \Lambda_{\overline{MS}}$

- $\Lambda_{\overline{MS}}$ LINKS QCD(0.01 fm) \rightarrow QCD(1 fm)

$\Rightarrow m_p = c \Lambda_{\overline{MS}}$

• FOUR-JET EVENTS $\rangle \dots \langle$ 

- ANGULAR DISTRIBUTIONS TO TRY TO ISOLATE $g g g g$

- USE b's (VDET) TO COUNT NO. 4-QUARK FINAL STATES ($\Rightarrow 10^6$ Z's)

• TWO-JET EVENTS

- $1 + \cos^2 \theta, \cos 2\phi$ ANGL. DISTR. \hookrightarrow IN CASE POL. BEAMS

- A_{FB}, A_{FB}^b

- $A_{FB}^b = A_{FB}^{b0} \left(1 + K \frac{d_s}{\pi} \dots \right)$
 $\hookrightarrow \sim 0.5$

QCD IN ALEPH 4/92

TOPIC # PHYSICISTS (CRITICAL) (MASS=2-3) STATUS
0
1/2
1=DONE

d_s (ev. shapes) 1

$d_s \left(\frac{\Gamma_{lept}}{\Gamma_{had}} \right)$ E-W GROUP 1

d_s (EVENT SHAPES RESUM.) 3 1.

d_s (T LEPTONS) 3 1/2

d_s (b QUARKS) 1/2 1/2

TGV 2 1

b (hi-P LEPTON) 1/2 1/2

b (VDET) 0 0

\not{Z} DISTR. E-W GROUP 1

A_{FB} RICK 1

A_{FB}^b (hi-P LEPT) H-F GROUP 1?

A_{FB}^b (VDET) H-F? 1/2?

PHYSICS

ALEPH 4/92
 TOPIC # WORKING STATUS

• THREE-JET EVENTS

DEMONSTRATE THAT QCD

HAS CORRECT STRUCTURE

AS MANY CROSS-CHECKS AS POSSIBLE

- DALITZ PLOT $Z \rightarrow q\bar{q}g$ x_1, x_2, x_3

$$\rho = \frac{2ds}{3\pi} \frac{x_1^2 + x_2^2}{(1-x_1)(1-x_2)}$$

ρ 0 0

- GLUON SPIN

- ELLIS-KARLINER χ (PETRA:40)
- KÖRNER, SCHILLER, BARROW POLAR ASYMMETRY
- $\langle 1-T \rangle$

χ DISTR \Rightarrow SPIN g_{bar} 0 0

$\langle 1-T \rangle$ 3 1

- χ DISTR. REL. TO. BEAM AXIS

- THRUST REL. TO. BEAM: θ_T
- $e^+e^-q - q\bar{q}g$ PLANES: χ
- $\frac{d^2\sigma}{d\cos\theta_T d\chi} \sim (1+A(\chi)\cos^2\theta_T) \times (1+B(\chi)\cos 2\chi)$
- QCD: $B(\chi) = \frac{1}{2} \frac{1-A(\chi)}{3+A(\chi)}$

χ DISTR \Rightarrow 3-JETS 0 0

• IDENTIFY GLUON JETS

- MERCEDES STAR: $\frac{2}{3} q\bar{q}g$ vs. $q\bar{q}$

MERC. 1 1/2

- OR: USE, e.g., NEURAL NETWORK

NEURAL 1 1/2

- OR: USE VDET $\rightarrow b\bar{b} \Rightarrow g$

b (V-LEM) 1/2 1/2

• GLUON FRAGMENTATION

• $D_q^\pi(z)$ vs $\frac{9}{4} D_g^\pi(z)$

b (VDET) 0 0

• WIDTH $p_T(g)$ vs $p_T(q)$

(THICKNESS OF FLUX TUBE)

• PARTICLE CONTENT; $\sigma(g) = \frac{9}{4} \sigma(q)$

• BARYONS STILL ENHANCED?

PHYSICS

ALEPH 4/92

5
6

• REPLACE g BY γ

- ENRICH u -QUARKS, MEAS. v_u, a_u

- $d\sigma(\mu^+\mu^-\gamma) = d\sigma(q\bar{q}g)$

QCD, QED ISOMORPHIC

$$-\frac{\sigma(q\bar{q}\gamma)}{\sigma(q\bar{q}g)} = \frac{3}{4} \frac{d}{d_s} (1 + ?)$$

THEORY WORKING

• FINAL STATE PIONS (KHOZE)

- QCD COHERENCE OF SOFT

PIONS : LPHD \Rightarrow LOOKING

FOR PERT. QCD EFFECTS IN

FRAGMENTATION

- HEAVY / LIGHT QUARK :

SUPPRESSION OF COLLINEAR RADIATION

- STRING EFFECT

- CORRELATIONS

TOPIC #WORKING STATUS

FINAL STATE γ several 1

- 0 0

- 0 0

QCD COH. 1/2 1/2

b (hi- p_T) 1/2 1/2

b (VDET) 0 0

STRING 1 1/2

CORREL. 1 1/2

OTHER HADRONIZATION
TOPICS (ALEPH QCD WORKSHOP)

ALEPH 4/92

WE'LL NEVER UNDERSTAND
FRAGMENTATION IF WE
DON'T STUDY IT!

• HADRONIZATION

- EVENT PROPERTIES
- MODEL FITS
- MULTIPLICITY
- PARTICLE CONTENT dE/dx
- PARTICLE CONTENT V^0 's

TOPIC	# WORKING	STATUS
EVENT PROP. + FITS	2	1
MULTIPLICITY	2	1
dE/dx	1/2	1/2
V^0 's	1	1/2

• INTERMITTENCY

- SELF SIMILARITY
- INTERMITTENCY
- PHYSICAL ORIGIN

INTERMITTENCY (DIFF'L MOM)	2	1
INTERMITTENCY (GLOBAL MOM, 3-DIM)	1	1

• BOSE-EINSTEIN CONDENSATION

B-E	1	1
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• CALORIMETRIC JET DEFINITION

→ d_s

CAL-DEF	0	1/2
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• MULTIJETS

5-7 JET EVENTS

MULTI-JET	0	0
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• γ - γ PHYSICS

γ - γ	1	1/2
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CONCLUSION :

A NEW WINDOW FOR UNDERSTANDING QCD, HADRONIZATION, ETC IS NOW OPENED VIA b-TAGGING (HIGH- p_T LEPTON AND/OR VDET)

EVENT SAMPLES WITH 1 OR MORE b-TAGGED JETS HAVE AN ADDITIONAL HANDLE FOR MEASURING

- d_s (b-QUARKS)

- 3-JET EVENTS

- DALITZ PLOT, χ -DISTR OF 3-JETS

- IDENTITY OF GLUON JET :

- FRAGMENTATION FUNCTION

- MULTIPLICITY

- p_T -DISTR

- p - \bar{p} CONTENT (dE/dx)

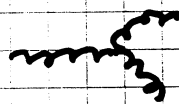
- V_0 CONTENT

- INTERMITTENCY

- STRING EFFECT

- 4-JET EVENTS

- TEST (PROOF) OF NON-ABELIAN NATURE OF QCD



USING b-TAGGING