Typos, Corrections, and Text Improvements to Dispatch 1863

Thanks to all you sent comments to me concerning dispatch 1863. I received a total 8 sets of comments, who knew QCD was so popular. I have compiled here a list of most comments and suggestions (duplicate not repeated) along with the action that I took, obviously, some of the suggestions will need to be discussed on July 5th during the Public Reading.

Title

▶ Gabi: Title: I suggest removing "(MZ)" from the title as you also measure the running of alpha_s ⇒***Implemented***

Abstract

▶ Gabi: lines 3+: ... and correspond to energies of 91 GeV, 130-136 GeV and 161-209 GeV. The jet rates are determined using four different jet finding algorithms. The differential two-jet rate and the average jet rate with the Durham and Cambridge algorithms are used to measure alpha_s in the LEP energy range by fitting ... Combining the measurements at different centre-of-mass energies the value of alpha_s(MZ) is determined to be ... ⇒***Implemented***

▶ Marina - in front of the result I would put $\alpha_s(M_{Z^0}) = ...$ ⇒***Implemented***

Section 1 Introduction,

Paragraph 1,

Original:

In the Standard Model of elementary particle interactions the strong interaction depends on one fundamental parameter, the strong coupling α_s. The value of this parameter is expected to be dependent on the scale at which the interaction takes place. It is therefore important to experimentally determine the value of α_s at as many different energies using as many different techniques as possible in order to test the theory which describes the strong interaction, Quantum Chromodynamics (QCD).

Pippa **Rephrased as,**

In the Standard Model of elementary particle interactions, the strong interaction is described by the theory of Quantum Chromodynamics (QCD),

and depends on just one fundamental parameter, the strong coupling α_s. The value of α_s is expected to depend on the energy scale of the interaction. It is therefore an important test of the theory to determine the value of α_s experimentally at as many different energies using as many different techniques as possible.

$\Rightarrow$***Implemented***

Paragraph 2,

▶ Pippa: line 1 - add comma after "Indeed" $\Rightarrow$***Implemented***
▶ Pippa: line 5 - do you mean pp or ppbar collisions? Or maybe both? (ISR, Tevatron?) $\rightarrow$ add $p\bar{p}$ to list $\Rightarrow$***Implemented***
▶ David: end - need to define sqrt(s) $\rightarrow$ ...the value of $\alpha_s(\sqrt{s})$, *where* $\sqrt{s}$ *corresponds energy scale at which the interaction takes place.* $\Rightarrow$***Implemented***

Comments (Otmar, Thorsten)

- reference very specific publications for low energy α_s determinations
- no references for high energy determinations

Proposals

1. add references to high energy determinations(e^+e^-, pp, $p\bar{p}$, or ep)
2. remove low energy references, replace with a more general reference, ie [49]. $\Rightarrow$Add sentence: A more complete description of these methods of determining $\alpha_s(\sqrt{s})$ is given in [49]. $\Leftarrow$ ***My preference***

Paragraph 3,

▶ David: line 3 - replace $e^+e^- \rightarrow q\overline{q}$ with "$e^+e^- \rightarrow$hadrons" $\Rightarrow$***Implemented***

Paragraph 4,

▶ Pippa: Begin with - The analysis presented in this paper used data collected... $\Rightarrow$***Implemented***
▶ Pippa: line 3 - Here you already say that you determine values of alpha_s(roots) at 13 centre-of-mass energies, which is never really shown in the rest of the paper. $\Rightarrow$ this is a relic of an old draft that slipped through the cracks, I have editted the line

Original: ...were used to determine values of α_s ($\sqrt{s}$) at the 13 centre-of-mass energies comprised within the LEP1.5 and LEP2 datasets.
New: ...were used to determine values of α_s ($\sqrt{s}$) at the 4 combined centre-of-mass energies comprised of data within the LEP1.5 and LEP2 datasets.

▶ David: line 4 - a theoretical prediction -> theoretical predictions ⇒***Implemented***
▶ Torsten: line 4 - You speak more then once about "fitting the data to the theory" - but you fit the theory to the data, I hope. Please invert. ⇒***Implemented***

Paragraph 5,

▶ Gabi: Start with "The paper is organised as follows." ⇒***Implemented***
▶ Pippa: section —> Section ⇒***Implemented***
▶ Pippa: line 1 - concise description —> summary ⇒***Implemented***
▶ David: line 4 - theoretical ... Section 5 - not true ⇒ ***removed reference***

Section 2 OPAL Detector,

Paragraph 1,

▶ Otmar: line 1 - use "crucial" instead of "critical" ⇒***Implemented***
▶ Pippa: line 5 - I wonder why you mention dE/dx, since you make no use of it elsewhere. ⇒ Yes, I have removed the reference to dE/dx
▶ David: line 6 "x–y" – need to define the coordinated system here ⇒ I have moved the footnote from pg. 3 here ... it could even be moved earlier to the reference to the beam axis as it is the event shapes draft.
▶ Gabi: footnote 1: "The right-handed OPAL coordinate system... " ⇒***Implemented***
▶ David: footnote - I don't think we can speak of an "r axis". r is the distance away from the z axis. ⇒***Fixed***
▶ Pippa: end - change the fraction sigma_p/p to be in line, rather than one on top of the other, so that the symbols aren't quite so small ⇒***Implemented***
▶ Pippa: end - GeV/c should have GeV roman and c italic ⇒***Implemented***
▶ Pippa: end - I would move the sentence about the luminosity measuremnet using FD and SW from section 3 to section 2 ⇒ I cut and pasted the line to follow just after the next paragraph.

Paragraph 2,

▶ Otmar: Just drop the last to sentences. You don't need this at all. Oth-

erwise add appropriate references. ⇒ I include the hadron calorimeter since hadronic information is used by MT, although this is not explicitly mentioned in my MT description.

Paragraph 3,

▶ David: line 1 - "all" –> "most" ⇒***Implemented***
▶ David: line 3 - "event was" –> "events were" ⇒***Implemented***

Section 3 Data Samples and Event Selection,

Paragraph 1,

▶ David: line 2 - "14.5" - Matthew quotes 14.7 ⇒
▶ David: line 2 - "10.4" should be "11.3" according to Table 1 ⇒ Yes, 11.3 is used in my jobs and is now fixed
▶ David: line 3 - "710.9" - the numbers in Table 1 add up to 706.5 Matthew's numbers add up to 707.4. ⇒ The number should be 707.4
▶ The difference is at 205 GeV, where in Table 1 you quote 81.0 while Matthew has 82.0 (in agreement with Stefan's web page). ⇒ This is a typo on my part and is now fixed in the table.
▶ Pippa, Torsten: - "207" to "209" ⇒***Implemented*** I do indeed use the whole LEP2 data set, I just fell into the habit of calling the highest energy dataset 207.
▶ Otmar: line 5 - '...were primarily collected for use in calibrating parameters...' –>'...were primarily collected for calibrating parameters...' ⇒***Fixed***
▶ Pippa: Maybe add a sentence saying that you use the Z0 data from the LEP2 data taking so as to have the same detector configuration as the other energy points? ⇒ added the line: "This M_{Z^0} sample had the same detector configuration as the other centre-of-mass engery points."

Paragraph 2,

▶ Otmar: I miss a motivation why the whole integrated lumi was split-up such unevenly across the four sets (okay, I exclude 91 GeV, but why was 189-207 chosen so big while 161-183 is so little?) ⇒ There are two quoted reasons, first, under this configuration the no combined sample is dominated by a single energy and second, this is the configuration adopted by the LEP WG and is thus used here for the sake of consistency.
▶ Pippa: I'm not sure it's fair to say the statistical power was improved. You could have made an average alpha_s which had the same statistical precision, even though you'd fitted at more energy points. ⇒ Yes, you are right I have

removed the phrase about increasing statistical precision
▶ Pippa: You also should mention that the LEP2 data has a spread of centre-of-mass energies, and that your 13 points represent the main samples. ⇒***Implemented*** I have added the following line to the end of Paragraph 1: "The thirteen points in Table 1 represent the main samples of the spread of energies in the LEP1.5 and LEP2 data."

Section 3.1 Monte Carlo Samples,
Paragraph 1,

lines 1 − 2: A number of Monte Carlo samples were created to correct for potential detector mismodelling and hadronization effects as well as to investigate the size of potential non-QCD backgrounds with the selected datasets. Each Monte Carlo dataset has undergone a full detector simulation[16], followed by the same reconstruction process as that for the datasets.

▶ Pippa **Rephrased**: A number of Monte Carlo samples were created to correct for detector acceptance and resolution effects, to correct for hadronization effects, and to estimate the contribution of background processes. These Monte Carlo datasets were produced using a full simulation of the detector [16], followed by the same reconstruction and selection alogorithms as applied to the real data, and are referred to as "detector level" samples. Other samples without the full detector simulation are discussed in Section 3.3.

▶ David: line 3 - the use of the word "dataset" is a bit unclear here. I suggest changing to "sample" in line 3 and "data" in line 4.⇒***Implemented***
▶ Pippa: Then start a new paragraph to discuss PYTHIA etc. ⇒***Implemented***
▶ Otmar: line 7 - '...with alternative Monte Carlo samples.' –>'...with an alternative Monte Carlo sample.' (you considered only Herwig) ⇒***Fixed***
▶ David: line 14 - "descrided" –< "implemented" ⇒***Implemented***
▶ David: line 14 - "relative" - You don't give the relative sizes of the MC samples, you give the actual sizes. ⇒***Fixed*** I removed the word "relative"

Comment(David): I wonder whether it is necessary to give this info at all; we don't usually do so
Proposal: Remove MC numbers from Table 1 - They are not used in any context later in the draft

Paragraph 2,

▶ Pippa: You say the main background is 4-fermion for all but the Z0, but then later you say that the LEP 1.5 data have no significant 4f background either, so rephrase the first sentence:

Above the W-pair production threshold (161 GeV), the main background was expected to come from four-fermion events, in particular those events in which two or more of the fermions are quarks. ⇒***Implemented***

▶ Otmar: line 1 - 'two or more of the fermions are quarks'... –> 'two or four of the fermions are quarks'... ⇒***Implemented***
▶ Otmar: line 1 - Hmm, isn't KoralW a WW generator? However, there are also 4-fermion processes of the kind ee-¿qqqq which do not include Ws. Are those also generated by KoralW? If not, can these ee-¿qqqq be neglected safely? If so, add a statement.
▶ Thorsten: I would omit the remark about KORALW samples not being available, and just state what was used ⇒***Implemented***
▶ Pippa: please add "at these energies" at the end of the sentence about using grc4f at 161 and 172 GeV. ⇒***Implemented***
▶ Gabi: last two sentences - Where did you get the 1.2% background rate? You could add a reference. ⇒ this number comes from Stefan - MC 7301 (e+e- –> qqqq at 133 GeV) was recently processed and was discovered that the expect bkgd was 1.2%. "... 1.2% of the combined LEP1.5 data sample and it was neglected in the analysis." ⇒***Implemented***

Section 3.2 Selection Method,

Paragraph 1,

▶ Pippa: line 7 - change $\tau\tau$ to $\tau^+\tau^-$ ⇒***Fixed***

line 8 & bullets: Good tracks were defined as those which

- registered at least 40 hits in the jet chamber
- had at least 150 MeV/c transverse momentum relative to the beam axis.
- point of closest approach to the interaction point in the $r - \phi$ plane, $d_0 \leq 2$ cm

- along the z axis, $z_0 \leq 25$ cm.

▶ Pippa **Rephrased**: Good tracks were defined as those which had

- at least 40 hits in the jet chamber
- at least 150 MeV/c transverse momentum relative to the beam axis.
- the distance of closest approach to the interaction point in the $r - \phi$ plane satisfying $d_0 \leq 2$ cm
- the distance of closest approach to the interaction point in the $r - z$ plane satisfying $|z_0| \leq 25$ cm.

▶ Otmar: end of last line - 'reconstructed tracks were said to pass preselection' –>'reconstructed good tracks pass the preselection' ⇒***Fixed***
▶ Note footnote has been moved into Section 2

Paragraph 2,

▶ Pippa: Replace paragraph with the following:
All of the good quality tracks and clusters in the event were used to define "objects" representing particles using an algorithm to correct for double counting of energy. This matching and compensation process, termed the MT algorithm [28,29] produced a uniquely defined array of track and cluster objects. The trajectories of the tracks ... extrapolated (ok) ... calorimeters. If a spatial association was established, then the track momentum and cluster energy were compared. If the energy of the cluster was less than expected from the track, then the cluster was omitted to avoid double counting of energy, since the momentum resolution for tracks was typically better than the calorimeter energy resolution. If the energy of the cluster was larger than expected ...(ok) "neutral" particles.

Comment(Otmar): I feel it's sufficient to mention the MT algorithm and to have a reference to it. You don't need to describe it in such detail. Just say that 'MT matches tracks to clusters and accounts/compensates for the double counting of energy from charged particles measured by the tracking chambers and by the calorimeters.'
Proposal: Since the details of the MT algorithm are not used later and they are more completely described in the references, I propose to include only

the first two sentences of the paragraph above.

Section Containment,

▶ Pippa: line 1 - "We ensure" to "We ensured" ⇒***Fixed***
▶ Pippa: line 1 - "are" to "were" ⇒***Fixed***
▶ David: line 1 - "all" –> "most" ("all" is certainly inaccurate). ⇒***Fixed***
▶ David: line 2 - define or give reference for thrust axis. ⇒ added reference: S. Brandt, *et al*, Phys. Lett. **12**, 57 (1964).
▶ Pippa: replace last two sentences with:
Note the thrust axis direction was determined from all tracks and clusters in the event, without correcting for double counting with the MT algorithm.

Section ISR Cuts,

▶ Pippa: Rephrase as follows:

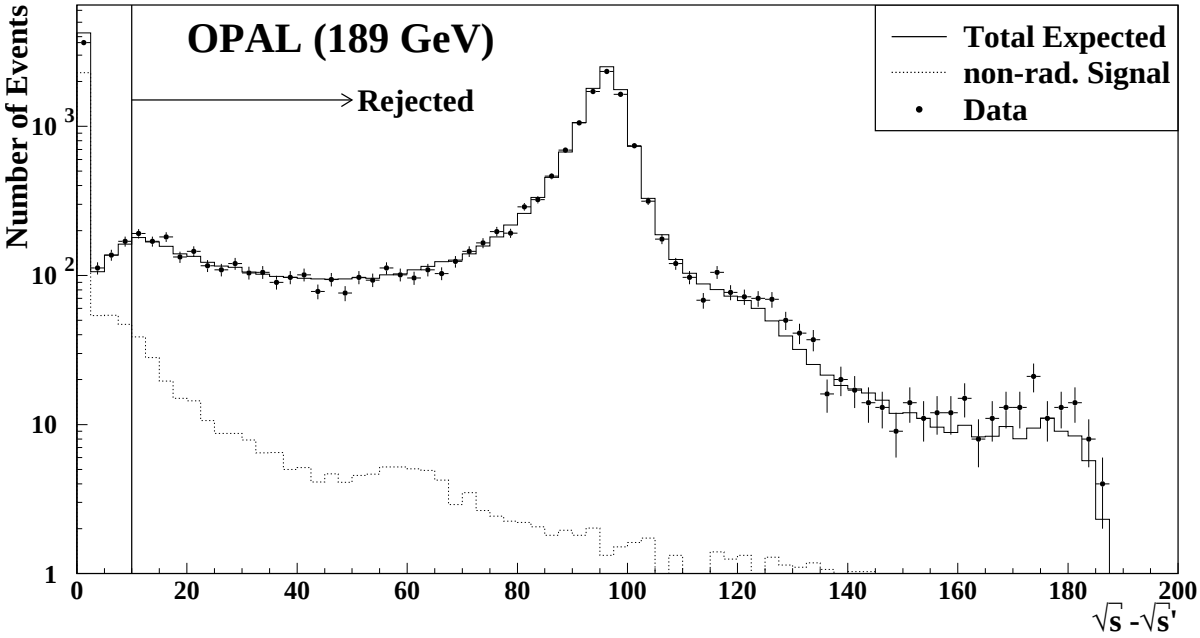
The events of interest for this analysis were $e^+e^- \rightarrow q\overline{q}$ events where final state $q\overline{q}$ pair has the full centre-of-mass energy. The effective centre-of-mass energy of the e+e- collision can be reduced by the emission of one or more ISR photons. At LEP2, approximately three quarters of the multihadronic events are such radiative return events, where the invariant mass of the qqbar pair is close to the Z^0 mass. The effective centre-of-mass energy of the collision, $\sqrt{s'}$ [30], was evaluated, and the requirement,

- $\sqrt{s} - \sqrt{s'} < 10$ GeV

was imposed to select full energy events.

To calculate rootsprime, all isolated photon candidates with energies greater than 10 GeV were identified. The Durham jet reconstruction algorithm [31] was then used to group the remaining tracks and clusters (OR MT OBJECTS????) into jets. ISR photons are often emitted close to the beam direction. Three kinematic fits were performed, under the assumptions that

- there were two undetected photons (in opposite directions along the beam pipe)
- there was one undetected photon
- all photons were observed in the detector.



The fit with the most acceptable chisquared (IS IT CLEAR WHAT THIS MEANS? DO YOU JUST MEAN THE LOWEST?) was selected, and $\sqrt{s}'$ was calculated from the invariant mass of the jets, excluding any photons.

The power of this cut can be seen in Figure 1. The efficiency for selecting non-radiative qqbar events is given in Table 2. Non-radiative $q\overline{q}$ events are defined as those in which $\sqrt{s}$-$\sqrt{s}'_{\rm true}$ <1 GeV, where $s'_{\rm true}$ is determined from generator level information in the PYTHIA samples.

▶ David: after bullets - "as seen in Figure 1" I don't think Fig 1 really illustrates your point. It just shows that data and MC are consistent. If you added the non-rad component of the MC to the plot, this would show that the cut has the effect you claim. ⇒ added non-radiative signal to Figure 1
▶ Pippa: Move the comments on hadron and parton level MC events to section 3.3 ⇒***Implemented***
▶ David: last line - "sqrt(s)>MZ0" - to be pedantic, 91.5 (the c.m. energy for the Z0 calib sample according to table 1) is greater than MZ (91.188). Maybe rephrase more carefully? ⇒ changed to: This ISR is applied to all analyzed datasets with the exception of the Z^0 calibration data.

Section Final Cuts,

▶ David: wouldn't "four-fermion cuts" be a better heading? ⇒ this title was suggested by the editorial board to be consistent with PR362.

Paragraph 1,

▶ Pippa: line 4 - 'dataset' –> 'datasets' ⇒***Fixed***

▶ Gabi: line 7 - non-QCD four-quark events arise also from ZZ –> qqqq ⇒ Yes, of course you are right, perhaps it would be best to say "... a non-QCD four-quark or semi-leptonic event:" ⇒***Implemented***

▶ David: last line - mode "in each of the LEP2 datasets" after "cuts". ⇒***Implemented***

Paragraph 2,

▶ David: line 1 - the qqqq likelihood selection uses 4 variables, and the correct reference is PR321. ⇒***Fixed***

▶ David: last line - "comprises" –> "constitutes" ⇒***Implemented***

Paragraph 3,

▶ Several comments about garbled last line ⇒ this has been removed as my orginal intent was to say that the line labelled qqll in Figure 2 contained contributions from WW→ $q\bar{q}'\ell\nu$ and ZZ→ $q\bar{q}\ell\bar{\ell}$, however this is not true as the line was histogram corresponds to a KORALW Monte Carlo which does not include ZZ simulations. The ZZ contribution to the background is much smaller than that from WW and by in large should also be removed by the two likelihood cuts, as is mentioned in the next paragraph.

Paragraph 4,

▶ Everyone: "geq" –> "\geq" ⇒***Implemented***

Paragraph 5,

▶ Pippa: lines 3-4 - cross out the first "on the datasets" to avoid repetition. ⇒***Implemented***

▶ Otmar: last line - '..after the likelihood cuts this jumpts to a purity ...' what is jumping here? purity? ⇒ perhaps the line could be rephrased to read:

"...after the likelihood cuts the purity of the samples increase dramatically to 93–95%." ⇒***Implemented***

Section 3.3 Monte Carlo Corrections,
Paragraph 2,

▶ Pippa: line 3 - to avoid repetition, don't start a new sentence, but change: ". A correction was also made for residual ISR" to "and for residual ISR" ⇒***Implemented***

▶ Pippa: line 8 - Here you just say "initial radiation was not simulated". In fact I understand from the sentence in the previous section that ISR was generated, but excluded from the sample by a cut on s'_true. Please state this explicitly. I think it would be quite a different thing to turn off ISR in KK2f, rather than just to throw away some events. ⇒ Yes you are right ISR is indeed simulated and a $\sqrt{s}$-$\sqrt{s}'_{\rm true}$ <1 GeV is applied to get an ISR "free" hadron or parton level sample. I have changed the line to read:

Original:"... and initial state radiation was not simulated."

New:"... and a requirement that $\sqrt{s} - \sqrt{s}'_{\rm true}$ <1 GeV was imposed."

▶ David: last line - "mismodelling" again seems the wrong word ⇒ changed

Original:"... any detector biases or detector mismodelling."

New:"... any detector biases determined over the full acceptance without any limitations arising from limited resolution."

Alternately(Thorsten) on the bottom of page 5 you first say the sample did no undergo detector simulation, and then state that the distributions dont have detector effect, which is obvious given the first statement. Please remove.

Paragraph 3,

▶ Otmar: line 4 - 'The hadron level was used ... then determining all jet rate distributions;' Does it mean you determined jet rate distributions from the hadron level? ⇒ the line has been rewritten as follows:

Original:"The hadron level was used in this analysis when determining all jet rate distributions ..."

New:"In this analysis the jet rate distributions are determined at the detector level and then corrected to the hadron level ...."

▶ Otmar: line 5 - '..the theoretical predictions to which these distributions were fitted' does is mean, you fit measured distributions to theory predictions? ⇒ another rewrite required here:

Original:"...however, the theoretical predictions to which these distributions were fitted ..."

New:" ...however, the theorectical predictions which were fitted to these distributions ..."
▶ Otmar: line 9 - 'Monte Carlo sample produced at the parton level followed the cascade of generator-level partons as they were produced until they entered hadronization' What do you mean? Please rephrase! ⇒ rewritten:
New:"The parton level Monte Carlo sample is built from quarks and gluons that are produced during the parton cascade simulated by the generator before the hadronization phase begins."
▶ Thorsten: on page 6 above eqn 2 you say "Another correction factor.." But in fact this IS the correction factor you were just talking about, covering the difference between hadron and parton level. The way this is written it creates the impression this is something else - please change to: A correction factor was determined ... and applied to ... ⇒***Fixed***
▶ Otmar: Eqn (2) - Hmm, I thought you decided to correct bin-by-bin the cumulative distributions from parton to hadron level? As far as I understood Stefan, this will be done for the event shapes... ⇒ Yes, the event shapes analysis is using cumulative distributions as is Jochen with the four jet analysis - Eqn(2) is a departure from the analysis set down by the QCD group which I only recently discovered ... I am investigating the impact of difference.

Comment (David) line 3+ - "distributions" This discussion seems a bit out of place here, because we don't introduce the distributions to be corrected until sect 4. Also the whole phrasing in terms of distributions and bins seems a bit odd, when the basic things we measure aren't binned like a histogram, they are jet rates at fixed values of ycut. Then the Dn's and <N>'s are derived from these.

Proposal Move Section 4 to precede Section 3 this will help define the distributions that are being used. It will also improve the over flow: selection to correction to systematic variations without a digression into the jet rate definition. It may also be helpful to indicate (as done in the event shapes draft) that a values for Rn, Dn and <N> are determined for each event as functions of ycut and are subsequently saved in a histogram, for instance add the following to the top of Paragraph 1:
"The values of R_n, D_n and $\langle N \rangle$ are determined for each accepted event in the data sample as a function of y_{cut}, using the MT corrected tracks and clusters. These values are then compiled into histograms with bins of varying size of

$y_{\rm cut}$."

Section 4 Jet Rates,
Paragraph 1,

▶ David: line 1 - delete "a"; "algorithm" –> "algorithms" ⇒***Fixed***
▶ Gabi: line 1 - "Jets were formed from the final state objects by applying a jet clustering algorithm." ⇒***Implemented***
▶ Gabi: line 2 - hadrons –> objects ⇒***Implemented***
▶ David: line 4 - I don't like the word "variants" - the algorithm is the same; we just look at the jet rates as a function of two separate parameters which underpin the algorithm. ⇒ slight modification:
Original:"...and the R and ε variants of the CONE algorithm"
New:" ...and the CONE algorithm'
and remove subsequent reference to the separate R and ε variants of CONE
▶ David: line 8 - add i after "particle" ⇒***Fixed***
- "and Evis is..." this is only correct at the detector level; at the hadron or parton level, you would use Ecm in the expression for yij. Should clarify this. ⇒ rephrase:
Original:"...where $E_{\rm vis}$ is the total visible energy in the event."
New:" ...where $E_{\rm vis}$ is the sum of the energy of all the visible particles in the event"
▶ David: line 10 - I don't think this description is quite clear. You form yij for all pairs of particles, take the smallest, and if it is < ycut you merge etc etc. The bit about combining the smallest first is missing. ⇒***Fixed***
Original:"...in the event, and compare it to a predefined parameter, $y_{\rm cut}$, called the jet resolution parameter. If ..."
New:"...in the event. The pair that produces the smallest value of y_{ij} is chosen first. The value of this test variable is compared to a predefined parameter, $y_{\rm cut}$, called the jet resolution parameter. If ..."
▶ David & Pippa: And we never explain the difference between Durham and Cambridge. They are identical as far as the description we give goes. ⇒ Yes the description of Cambridge is missing:
" The Cambridge algorithm differs slightly from Durham in its implementation. In the Cambridge algorithm particles are first paired together by minimising the variable $v_{ij} = 2(1 - \cos\theta_{ij})$. The standard test variable is then constructed and compared to the jet resolution parameter, $y_{\rm cut}$. The procedure followed is then identical to that of the Durham algorithm, ex-

cept that only the lowest energy (pseudo)particle is taken as the jet when $y_{ij} > y_{\rm cut}$. " ⇒***Implemented***

Comment(Otmar): drop this whole paragraph (including the two lines on p.7). It's more than sufficient to have the references for Durham, Cambridge, and JADE.
Reply I would prefer to keep the description, an analysis that relies on jet clustering should probably include a small section on how it was done, however, these are well established algorithms and understanding their details is not really relevant to the overall my $\alpha_{\rm s}$ determinations.

Paragraph 4,

▶ David: line 5 - "corresponds" –> "is" ⇒***Fixed***
▶ David: equ(4) - "d"s in roman please. ⇒***Fixed***
▶ Otmar: eqn(4) does it mean, you calculated D_n really as the derivate of the measured R_n ? I guess, your description is a mixture of experimental and theoretical approaches for determining distributions. ⇒ actually I use the y-flip values to determine D_n. I have added a line to indicate that D2 = y23.
▶ Pippa: You refer to "four" distributions. I'm not clear if you mean differential and average jet rates with each of Cambridge an Durham (2x2=4) and that you do this at 4 energies, giving a total of 16? ⇒ I am referring to four observalble 2 D2 and 2 $\langle N \rangle$, I replaced "distributions" with "observables"
▶ David: 2 lines after equ(6) - "." –> ","; "Thus" –> "thus" ⇒***Implemented***
▶ David: 4 lines after equ(6) - "App" –> "Appendix" ⇒***Fixed***
▶ Thorsten: at the end of section 4 you should give a reason for using only Durham and Cambridge ⇒***Implemented***

Section 5 Systematic Variatons,

▶ Gabi: title: Systematic Studies? ⇒ okay
▶ Otmar: line 1 - What do you mean by 'detector conditions ... were varied'? ⇒okay the detector isn't varied, perhaps if I change the line to "Several selection algorithms and selection cuts were varied ..."?
▶ Pippa: I wonder if you could just put one statement at the beginning of the section to say that in each case you compare the results of a modified analysis with the standard analysis ⇒ I have added the line "In all cases the result from the variation was compared to the result from the standard selection, the difference was then taken as a contribution total systematic

error."
▶ Gabi: remove "and are given as follows" ⇒***Implemented***

Section 5.1 Experimental Systematic Variations,

Paragraph Tracking,

▶ Pippa: I have no idea what you mean by "This alternative method used all selected tracks and clusters with matching" ⇒ That should read without matching, I have rephrased the sentence read: "The alternative method used all selected tracks and clusters taking into account the possibility of double counting."

Paragraph Containment,

▶ Pippa: You could cross out all but the first sentence, if you add a comment at the beginning about how you evaluate each error. ⇒***Implemented***
▶ Bob: Why choose for comparison a cut that limits acceptance to the barrel region, this seems draconian and likely to lead to an unrealistically large estimate of the error from this source. Is it because there is a real doubt about the effect of including the endcaps in the acceptance? ⇒ this cut is more designed to limit the number out hadrons that are lost down the beampipe, depending on the event, there will be a cone or spread of hadrons around the thrust axis, so we restrict the angle of the axis most of the hadron stay within the detector.
Furthermore, since you take the difference in the results obtained with the barrel alone and with (barrel+endcaps) as an additional error, why bother with the endcaps at all?? ⇒ again this variation gives a systematic check on hadrons lost down the beampipe, with the thrust axis restricted to this extreme angle, pretty much all of the hadrons with interact in the detector

Paragraph $\mathcal{L}_{\mathrm{qqqq}}$ ...,

▶ Gabi: Need to add that the largest deviation was taken. ⇒***Implemented***

Paragraph Backgrounds,

▶ Otmar: please state why +-5% is conservative or add a reference ⇒ perhaps conservative should be omitted here, although a 5% variation is generally significantly larger than the one sigma error on the cross-section.
▶ Bob: Why 5%? Is there not an estimate of the error on the background, and why not use that? ⇒ 5% is a sonewhat arbitrary choice it is certainly

larger than the expected uncertainty on the MC cross-section. Even with this large variation this is generally one of the smallest systematic contributions.

Paragraph Detector Correction,

▶ Pippa: data sets –> datasets ⇒***Fixed***

Section 5.2 Hadronization Systematic Variations,

▶ David: Do you not use Ariadne also here? I know Matthew (and the LEP-QCD group) do, but maybe we never agreed on this point. ⇒ I believe this was a bit of a miscommunication with the OPAL QCD group, I was working under the impression that ARIADNE was only used as a check (as stated on Stefan's webpage), and so do not have ARIADNE samples for hadronization checks. This systematic should be dominated by the HERWIG variation and so missing ARIADNE should not have a significant impact.

Section 5.3 Theoretical Systematic Variations,

▶ David: line 1 - "Two..." - then you proceed to describe three things! ⇒***Fixed*** should be "Three"

▶ David: line 3 "Section 7.2" doesn't exist! 6.2.1? ⇒***Fixed*** - yes should be 6.2

▶ Otmar: Logarithm rescaling - either motivate the variation of x_L=4/9 and 9/4 or add an appropriate reference to these numbers ⇒ unfortunately I have yet to see a good reference to why we choose x_L=4/9 and 9/4 or x_mu=0.5 and 2.0, they have become the de facto standard values to vary. The LEP QCD group, I know have done studies on the appropriateness of these values, and they seem satisfied with the range.

▶ Marina: log rescaling: ln(1/x_L y_cut) –¿ ln(1/(x_L y_cut)) ⇒***Fixed***

▶ Pippa: I find it rather cumbersome that you spell outwhat you combine in quadrature, but maybe the EB requested it. ⇒ I have shortened it by a sentence, hopefully it is a little lighter now

▶ Otmar: Your description is unclear in that it does not explain what you did about asymmetric errors (e.g. from x_mu or hadronization). ⇒ I have added the following line to the last paragraph to help clarify things:"In the case of asymmetric errors, the error was symmetrized by taking the largest systematic variation and applying it as the full systematic contribution. "

Section 6 Results,

▶ Otmar: line 1 - '..datasets were used were used in this analysis..' –¿ '..datasets were used in this analysis..' ⇒***Fixed***
▶ David: line 2 - "combined" - how? What Ecm ranges were used?
lines 6-10 - seems largely to repeat things the reader has already been told.
para 2 line 2 - "predetermined" - how?
line 4 - "Taking into account" - how?
Reply These are all described later in the section.
▶ Otmar: This whole paragraph repeats what has been already stated in previous sections. So it could be dropped or moved to the summary or to the introduction.
Reply Given that this paragraph is mostly repeating what was stated previously and the following paragraph mentions things that haven't yet been introduced - perhaps it is best indeed just to drop these paragraphs?

Section 6.1 n-jet Fractions,

Paragraph 1,

▶ David: last line - "reasonably well, within ... errors" - seems a bit strong? There are clear systematic discrepancies. I think I'd remove "within ... errors" ⇒***Implemented***

Paragraph 2,

▶ David: line 5 - "the curves on all the plots..." True only for the curves on Figs 8 and 9. The curves on Figs 10,11 show the MC predictions for the average jet rates. ⇒***Fixed***

Section 6.2.1 Differential Two-jet Rates,

▶ David, Pippa: line 1 - "described in section 5 " untrue. You mean Appendix A. ⇒***Fixed***

"also hold for" –> "can also be applied to" ? ⇒***Fixed***

▶ David: equ(7) - Δy should be $\Delta y_{\rm cut}$ ⇒***Fixed***
▶ Pippa: I wondered if your equation (7) shouldn't be moved earlier in the paper, to where you first define the differential jet rates. You could explain there that in practice you use eq.(7). ⇒ Actually I do not use R2 to determine D2 but y23, R2 however is the observable for which the prediction exists an this is how it is implemented in the fitting program, however, it may be more natural to put this in Section 4. The main point is to tie D2 to the R2 theory predictions an note that D2 has small bin-to-bin correlation wrt R2.

Paragraph 2,

▶ David: para 2 line 4 - what is meant by "reduced" chi2? ⇒ χ^2 per degree of freedom ⇒***Implemented***

▶ Otmar: line 9 - * '..hadronization corrections were too large, ...' –¿ '..hadronization corrections are too large, ...' ⇒***Fixed***

▶ Pippa: line 10 - cross out "of the fit range" after endpoints (to avoid repetition) ⇒***Implemented***

▶ David: line 10 - "one of the endpoints ... sizable" - seems surprising that this is necessary - doesn't your procedure for minimising chi2 already remove cases where the end point makes a large contribution? ⇒ this generally is not the case - my method starts with a single sample 189 GeV, for which I determine an optimum fit range, that fit range is applied to the other samples directly (with the exception of 91 GeV) so it is possible that the endpoint of one of those samples may have an endpoint which has a large χ^2 contribution. Also, "sizable" –> "sizeable" (according to the OED) ⇒***Fixed***

▶ Otmar: line 11 - produced –> produces ⇒***Fixed***

Paragraph 3,

▶ David: line 1 - "An example" - you seem to be showing all the fits in the chosen fit range, not just an example. ⇒***Fixed***

Section 6.2.3 Running of α_s,

▶ Otmar: 'for each' used three times in the paragraph... ⇒ two 'for each' clauses phrased slightly differently

▶ Pippa: line 6, first word - is –> are ⇒***Fixed***

▶ David: equ(8) - V should be in italic ⇒***Fixed***

next line - uncorrelated - why? I know the answer, but the reader won't!

▶ Otmar: last line - '..systematic errors ...were considered to be uncorrelated...' ⇒ Rephrase plus some new information (as covers David's comment above) → systematics are only included on the diagonal of the covariance matrix to ensure positive weights, I have removed the comment about considering the systematics to be uncorrelated.

Paragraph 2,

▶ Pippa: line 1 - from the covariance matrix –> from the inverse covariance matrix ⇒***Fixed***

▶ Otmar: I'm not sure whether I understand your approach. Usually using V one could find an average <alpha_s> by minimizing chi2 = (alpha_s - <alpha_s>)$\hat{T}$ * V * (alpha_s - <alpha_s>) which in the case of a diagonal covariance matrix V yields the well-known formula for a weighted average. So, is your approach equivalent/identical? ⇒ I believe this approach should identical to minimizing the chi2.
▶ David: equ(9) - V and w italic. ⇒***Fixed***
▶ Otmar: In Eq.(9) you have sigma_stat and V_stat, so in the sentence before Eq.(9) you should write 'The _statistical_ errors on the combined...' ⇒***Fixed***
▶ Pippa: line 1 after eq (9) - systematic –> systematic variation ⇒***Implemented***
▶ David: 2 lines after equ(9) - an –> and ⇒***Fixed***
5 lines from end - show –> shown ⇒***Fixed***
▶ Otmar: Typo in your world average: [47] lists 0.1172 +- 0.002 ⇒***Fixed***
▶ Otmar: '..compared to the energy evolution of alpha_s...' –> '..compared to the O(alpha_s2) energy evolution of alpha_s...' ⇒***Implemented***

Section 7 Summary,

▶ David: line 2 - high –> higher (some can't really be described as high) ⇒***Fixed***
line 5 - this comment is out of place, but why didn't we compare with Ariadne as well? It is supposed to give the best description of jet rates.

Paragraph 2,

▶ David: line 2 - 2- 3- 4- and 5- - this statement is inaccurate for the CONE algorithm, where you looked at <=2, 3 and >=4. ⇒***Fixed***

Paragraph 3,

▶ David: line 4 - thirteen –> four ⇒***Fixed***
▶ Gabi: line 1 - have were made –> were performed ⇒***Fixed***

Paragraph 4,

▶ David: line 2 - Their –> There ⇒***Fixed***
line 4 - Need to define Q (or use something else) ⇒***Fixed***
▶ Pippa: I would move the sentence on the running of alphas further up, just after you say you determine alpha(roots) and before you talk about alpha(MZ) average. ⇒***Implemented***
▶ Otmar: Typo in your world average: [47] lists 0.1172 +- 0.002 ⇒***Fixed***
▶ Otmar: line 5 - 6 - '.. is slightly smaller than that for ...[11]' Now the result

quoted in the abstract of [11] is 0.1187+-0.0034/0.0019 ⇒ my text should say slightly larger however, at present I suspect my hadronization error may decrease when comparing differences in my analysis with event shapes, in particular with y_{23}^D which should be relatively identical with my D_2^D values. I this case the two α_s values are very similar but my hadronization and theory error is larger.
▶ Otmar: line 6 - '..[11] which used resummed predictions for D_2 and average jet rate distributions.' ⇒ my text should read "...[11] which also used resummend ..." ⇒***Fixed***
▶ Otmar: Moreover, you should mention that data of different sqrt(s)-energies (e.g. include 35 and 44 GeV) were used in [11] compared to your analysis. ⇒***Implemented***

Section Appendix,

▶ David: line 1 - Define Q here too. ⇒***Fixed***
line 7 - "y is a variable quantity of the observable" - what does this mean? ⇒***Fixed*** converted everything back to $y_{\rm cut}$

Paragraph 2,

▶ David: line 2 - remove second "the" ⇒***Fixed***
▶ David: line 3 - insert "as n increases" after "zero" ⇒***Fixed***
▶ David: last line - "invalid" –> "inaccurate" ⇒***Fixed***

Section A.1 Next-to-Leading Log Approx,

▶ David: equ(12) - at a quick glance I couldn't find this equation in [40] ⇒ actually this eqn is not explicitly given in [40], it is a simplified version of the <N> NLLA expression, I have editted the text to reflect the fact that a more specific description is given in [40] rather than implying the equation is actually given there
▶ Could you just check it - superficially it looks like it only involves even powers of alpha_s, which is a bit surprising. ⇒ I took the expression from [11], which Otmar has noted has a typo and should have everything as a function of $L\alpha_s \rightarrow$ this is fixed

Section A.2 Matched Predictions,

▶ David: line after (13) - "identical" –> "equivalent" ⇒***Fixed***

Paragraph 3,

▶ David, Otmar: last line 1 - "expected" - needs a reference. ⇒***Implemented***

Section A.3 Renormalization Scale,

▶ David: line 1 - explain "renormalisation scale" (or at least a ref.)
▶ Otmar: line 1 - '... in any exact prediction...' –> '... in full order prediction...' ⇒***Implemented***
▶ David: line 10 - space before "must" ⇒***Fixed***
▶ Otmar: last line - 'Dependence on the renormalization scale was applied as a systematic...' –> 'Dependence on the renormalization scale was investigated as a systematic...' ⇒***Fixed***
▶ David: last line - "below" –> "above" ⇒***Fixed***

Section Biolgraphy,

▶ David: [1] - is there no proper published reference we can use?
▶ David: [18] - Give Sjostrand his umlaut. ⇒***Fixed***
▶ Pippa: [21] - accepted for publication, so you can write "to be published"
▶ David: [25] - doesn't look like a proper reference ⇒***Fixed***????
▶ Otmar: [25] - list all contributing collaborations and add the title ⇒***Fixed***
▶ David: [27] - add "Collaboration" ⇒***Fixed***
▶ David: [44,45] - "." at end, not "," ⇒***Fixed***
▶ David: [48] - why give hep-ph for something which is published? ⇒***Fixed***

Section Tables,

▶ David: Table 1 - Add "Integrated" before "Luminosity" ⇒***Fixed***
- is it useful to give all these numbers of events?
▶ Gabi: Table 1 - caption: remove the two commas from the 2nd sentence
remove the whole third sentence
specify the number of selected data events corresponds to which level of selection (presumably all LEP2 MHs) ⇒***Implemented***
▶ Pippa: Table 1 - Need to make clear that there's a range of energy especially for the LEP2 y2k datasets. ⇒ added a line in the caption stating: "The measured energy represents a spread of energies around the quoted value."
▶ David: Table 2 - is the "non-rad purity" a really useful number to give?
▶ Pippa: Table 2 - Could you left justify the column with the titles? ⇒***Implemented***
▶ David: Table 3 - "Alternate" –> "Alternative" ⇒***Fixed***
▶ Gabi: Table 4 and 5 - It would be useful to add a sentence that the theoretical uncertainty includes the uncertainty due to the choice of fit range and the renormalization scale, but not the uncertainty on the logarithm resum-

mation. ⇒***Implemented***
"Bin range" –> "Fit range" we should probably discuss the labels on the public reading... ⇒ I didn't want to use the same label twice in the same table ...
It is a bit unfortunate that you define the symbols D2C, D2D, ... in table captions. ⇒ I hadn't realized this I will try to find a place in the text to define them
▶ David: Table 4,5 - The text says that the larger of the xL and xmu variations is used to set the theoretical error. In the tables it looks line only xmu has been used. ⇒ In the text I say that only xmu has makes a contribution to the systematic errors, top of page 9 :"Hence this variation [referring to xL] is not used in the determination of the total systematic. The footnote makes this suggestion as how to one would combine them, and perhaps is misleading.

- Use a proper minus sign − for negative numbers, not a hyphen. (also later tables) ⇒***Fixed***

- need to explain the pair of numbers under xL and xmu (i.e. which is which).

Why only one in Table 6-7? ⇒ assymmetric errors for xmu will also be included here
▶ David: Table 5 - "0.+-0066" etc. ??? ⇒***Fixed***
▶ David: Table 5 - My biggest comment - why do the errors differ so much from Matthew's? I know the fit ranges are different (slightly), but otherwise we use the same data, and the same procedures. Your statistical errors are all larger, and so are the hadronization and theory errors, by a large amount. We can't possibly publish until this is understood.
⇒ currently there are two sources of discrepancy, first I have included the Monte Carlo statistical error on the hadronization correction factors in my determination of the total statistical error and second, when correcting the theoretical predictions to the hadron level have been using a 'raw' parton to hadron Monte Carlo correction, not the differential and cumulative distributions that Matthew, Christoph and Jochen have been using.
▶ Otmar: Table 9 caption - 'average of the individual centre-of-mass energy alpha_s determinations' –> 'average of the individual alpha_s results at each centre-of-mass energy' ⇒***Fixed***

Section Figures,

▶ Gabi: 8-9: How did you decide from which ycut you start to draw the MC

expectation for 3- and 4- jets? ⇒ I took all postive values of -D3 and -D4, if I try to spline a curve that extrapolates to a negative value on a log scale paw often does some funny things
▶ Otmar: 10-11: Couldn't one merge Cambridge $\langle N \rangle$ from all energies into a single figure (and likewise for all Durham $\langle N \rangle$)? ⇒ yes but I think it would get fairly cluttered - one plot with four energies, each with data points and two Monte Carlo comparisons, I will generate them an see how they turn out.
▶ David: Figs 12-15 - use OPAL fonts throughout. Add "OPAL" to the figure.
▶ Gabi: Figure 12, 13 - There are some shoulders on the fitted line (eg on fig 12(b) at ycut 3 10^2 and 10^1). Are they paw artifacts? ⇒ Actually I think it is more statistical, they are most pronounced in 12b and 13b which are low statistic LEP1.5. ▶ Otmar: 14-15: could you add the same kind of inserts showing fit residuals to these figures? ⇒ at one point I did include residuals/pulls here but since there is such a large bin-to-bin correlation, it does reveal much information.
▶ David: Fig 16 - why no tick marks on the y axis? ⇒ I removed the ticks so they would not appear in the legend box - I will move the box and return the ticks
▶ Otmar: 16+18: these figures show basically the same. Could you merge the two figures into one (like it was done for Fig.13 in [11]) ⇒ yes this shouldn't be a problem and will also save a page
▶ David: Fig 17 - add "OPAL". Add units to y axis label
▶ Otmar: 17: Please add asymmetric vertical lines to the points to indicate the range of centre-of-mass energies combined for each of the four datasets. ⇒ okay, that's a good idea.