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Template for writing LHCb papers

LHCb collaboration[†]

Abstract

Guidelines for the preparation of LHCb documents are given. This is a "living" document that should reflect our current practice. It is expected that these guidelines are implemented for papers before they go into the first collaboration wide review. Please contact the Editorial Board chair if you have suggestions for modifications. This is the title page for journal publications (PAPER). For a CONF note or ANA note, switch to the appropriate template by uncommenting the corresponding line in the file `main.tex`.

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1 Introduction

This is the template for typesetting LHCb notes and journal papers. It should be used for any document in LHCb [1] that is to be publicly available. The format should be used for uploading to preprint servers and only afterwards should specific typesetting required for journals or conference proceedings be applied. The main Latex file contains several options as described in the Latex comment lines.

It is expected that these guidelines are implemented for papers already before they go into the first collaboration wide review.

This template also contains the guidelines for how publications and conference reports should be written. The symbols defined in `lhcb-symbols-def.tex` are compatible with LHCb guidelines.

The front page should be adjusted according to what is written. Default versions are available for papers, conference reports and analysis notes. Just comment out what you require in the `main.tex` file.

This directory contains a file called `Makefile`. Typing `make` will apply all Latex and Bibtex commands in the correct order to produce a pdf file of the document. The default Latex compliler is pdflatex, which requires figures to be in pdf format. To change to plain Latex, edit line 9 of `Makefile`. Typing `make clean` will remove all temporary files generated by (pdf)latex.

There is also a PRL template, which is called `main-prl.tex`. You need to have REVTeX 4.1 installed [2] to compile this. Typing `make prl` produces a PRL-style PDF file. Note that this version is not meant for LHCb-wide circulation, nor for submission to the arXiv. It is just available to have a look-and-feel of the final PRL version. Typing `make count` will count the words in the main body.

2 General principles

The main goal is for a paper to be clear. It should be as brief as possible, without sacrificing clarity. For all public documents, special consideration should be given to the fact that the reader will be less familiar with LHCb than the author.

Here follow a list of general principles that should be adhered to:

1. Choices that are made concerning layout and typography should be consistently applied throughout the document.

2. Standard English should be used (British rather than American) for LHCb notes and preprints. Examples: colour, flavour, centre, metre, modelled and aluminium. Words ending on -ise or -isation (polarise, hadronisation) can be written with -ize or -ization ending but should be consistent. The punctuation normally follows the closing quote mark of quoted text, rather than being included before the closing quote. Footnotes come after punctuation. Papers to be submitted to an American journal can be written in American English instead. Under no circumstance should the two be mixed.

3. Use of jargon should be avoided where possible. “Systematics” are “systematic uncertainties”, “L0” is “hardware trigger”, “penguin” diagrams are best introduced with an expression like “electroweak loop (penguin) diagrams”.

4. It would be good to avoid using quantities that are internal jargon and/or are impossible to reproduce without the full simulation, *i.e.* instead of "It is required that $\chi^2_{\rm vtx} < 3$", to say "A good quality vertex is required"; instead of "It is required that $\chi^2_{\rm IP} > 16$", to say "The track is inconsistent with originating from a PV"; instead of "A DLL greater than 20 is required" say to "Tracks are required to be identified as kaons". However, experience shows that some journal referees ask for exactly this kind of information, and to safeguard against this, one may consider given some of it in the paper, since even if the exact meaning may be LHCb-specific, it still conveys some qualitative feeling for the significance levels required in the varies steps of the analysis.

5. Latex should be used for typesetting. Line numbering should be switched on for drafts that are circulated for comments.

6. The abstract should be concise, and not include citations or numbered equations, and should give the key results from the paper.

7. Apart from descriptions of the detector, the trigger and the simulation, the text should not be cut-and-pasted from other sources that have previously been published.

8. References should usually be made only to publicly accessible documents. References to LHCb conference reports and public notes should be avoided in journal publications, instead including the relevant material in the paper itself.

9. The use of tenses should be consistent. It is recommended to mainly stay in the present tense, for the abstract, the description of the analysis, *etc.*; the past tense is then used where necessary, for example when describing the data taking conditions.

10. It is recommended to use the passive rather than active voice: "the mass is measured", rather than "we measure the mass". Limited use of the active voice is acceptable, in situations where re-writing in the passive form would be cumbersome, such as for the acknowledgements. Some leeway is permitted to accommodate different author's styles, but "we" should not appear excessively in the abstract or the first lines of introduction or conclusion.

11. A sentence should not start with a variable, a particle or an acronym. A title or caption should not start with an article.

12. Incorrect punctuation around conjunctive adverbs and the use of dangling modifiers are the two most common mistakes of English grammar in LHCb draft papers. If in doubt, read the wikipedia articles on conjunctive adverb and dangling modifier.

13. When using natural units, at the first occurence of an energy unit that refers to momentum or a radius, add a footnote: "Natural units with $\hbar = c = 1$ are used throughout." Do this even when somewhere a length is reported in units of mm. It's not 100% consistent, but most likely nobody will notice. The problem can be trivially avoided when no lengths scales in natural units occur, by omitting the $\hbar$ from the footnote text.

14. Papers dealing with amplitude analyses and/or resonance parameters, other than masses and lifetimes, should use natural units, since in these kind of measurements widths are traditionally expressed in MeV and radii in GeV^{-1}. It's also the convention used by the PDG.

15. Papers quoting upper limits should give the both the 90% and 95% confidence level values in the text. Only one of these needs to be quoted in the abstract and summary.

3 Layout

1. Unnecessary blank space should be avoided, between paragraphs or around figures and tables.

2. Figure and table captions should be concise and use a somewhat smaller typeface than the main text, to help distinguish them. This is achieved by inserting `\small` at the beginning of the caption. (NB with the latest version of the file `preamble.tex` this is automatic) Figure captions go below the figure, table captions go above the table.

3. Captions and footnotes should be punctuated correctly, like normal text. The use of too many footnotes should be avoided: typically they are used for giving commercial details of companies, or standard items like coordinate system definition or the implicit inclusion of charge-conjugate processes.[1,2]

4. Tables should be formatted in a simple fashion, without excessive use of horizontal and vertical lines. See Table 1 for an example.

5. Figures and tables should normally be placed so that they appear on the same page as their first reference, but at the top or bottom of the page; if this is not possible, they should come as soon as possible afterwards. They must all be referred to from the text.

6. If one or more equations are referenced, all equations should be numbered using parentheses as shown in Eq. 1,

$$V_{us}V_{ub}^* + V_{cs}V_{cb}^* + V_{ts}V_{tb}^* = 0\ . \tag{1}$$

7. Displayed results like

$$\mathcal{B}(B_s^0 \to \mu^+\mu^-) < 1.5 \times 10^{-8} \text{ at } 95\% \text{ CL}$$

   should in general not be numbered.

8. Numbered equations should be avoided in captions and footnotes.

[1]If placed at the end of a sentence, the footnote symbol normally follows the punctuation; if placed in the middle of an equation, take care to avoid any possible confusion with an index.

[2]The standard footnote reads: "The inclusion of charge-conjugate processes is implied throughout." This may need to be modified, for example with "except in the discussion of asymmetries."

Table 1: Background-to-signal ratio estimated in a $\pm 50\,\mathrm{MeV}/c^2$ mass window for the prompt and long-lived backgrounds, and the minimum bias rate.

Channel	B_{pr}/S	B_{LL}/S	MB rate
$B^0_s \to J/\psi\,\phi$	1.6 ± 0.6	0.51 ± 0.08	~ 0.3 Hz
$B^0 \to J/\psi\,K^{*0}$	5.2 ± 0.3	1.53 ± 0.08	~ 8.1 Hz
$B^+ \to J/\psi\,K^{*+}$	1.6 ± 0.2	0.29 ± 0.06	~ 1.4 Hz

9. Displayed equations are part of the normal grammar of the text. This means that the equation should end in full stop or comma if required when reading aloud. The line after the equation should only be indented if it starts a new paragraph.

10. Sub-sectioning should not be excessive: sections with more than three levels of index (1.1.1) should be avoided.

11. Acronyms should be defined the first time they are used, *e.g.* "Monte Carlo (MC) events containing a doubly Cabibbo-suppressed (DCS) decay have been generated." The abbreviated words should not be capitalised if it is not naturally written with capitals, *e.g.* quantum chromodynamics (QCD), impact parameter (IP), boosted decision tree (BDT). Avoid acronyms if they are used three times or less. A sentence should never start with an acronym and its better to avoid it as the last word of a sentence as well.

4 Typography

The use of the Latex typesetting symbols defined in the file `lhcb-symbols-def.tex` and detailed in the appendices of this document is strongly encouraged as it will make it much easier to follow the recommendation set out below.

1. LHCb is typeset with a normal (roman) lowercase b.

2. Titles are in bold face, and usually only the first word is capitalised.

3. Mathematical symbols and particle names should also be typeset in bold when appearing in titles.

4. Units are in roman type, except for constants such as c or h that are italic: GeV, GeV/c^2. The unit should be separated from the value with a thin space ("`\,`"), and they should not be broken over two lines. Correct spacing is automatic when using predefined units inside math mode: `$3.0\gev$` $\to$ $3.0\,\mathrm{GeV}$. Spacing goes wrong when using predefined units outside math mode AND forcing extra space: `3.0\,\gev` $\to$ 3.0 GeV or worse: `3.0~\gev` $\to$ 3.0 GeV.

5. If factors of c are kept, they should be used both for masses and momenta, *e.g.* $p = 5.2\,\mathrm{GeV}/c$ (or $\mathrm{GeV}c^{-1}$), $m = 3.1\,\mathrm{GeV}/c^2$ (or $\mathrm{GeV}c^{-2}$). If they are dropped this should be done consistently throughout, and a note should be added at the first instance to indicate that units are taken with $c = 1$.

6. The % sign should not be separated from the number that precedes it: 5%, not 5 %. A thin space is also acceptable: 5 %, but should be applied consistently throughout the paper.

7. Ranges should be formatted consistently. The recommendend form is to use a dash with no spacing around it: 7–8 GeV, obtained as `7--8\gev`.

8. Italic is preferred for particle names (although roman is acceptable, if applied consistently throughout). Particle Data Group conventions should generally be followed: B^0 (no need for a "d" subscript), $B^0_s \to J/\psi\,\phi$, $\overline{B}{}^0_s$, (note the long bar, obtained with `\overline`, in contrast to the discouraged short `\bar{B}` resulting in $\bar{B}$), K^0_S (note the uppercase roman type "S"). This is most easily achieved by using the predefined symbols described in Appendix C. Unless there is a good reason not to, the charge of a particle should be specified if there is any possible ambiguity ($m(K^+K^-)$ instead of $m(KK)$, which could refer to neutral kaons).

9. Decay chains can be written in several ways, depending on the complexity and the number of times it occurs. Unless there is a good reason not to, usage of a particular type should be consistent within the paper. Examples are: $D^+_s \to \phi\pi^+$, with $\phi \to K^+K^-$; $D^+_s \to \phi\pi^+$ $(\phi \to K^+K^-)$; $D^+_s \to \phi(\to K^+K^-)\pi^+$; or $D^+_s \to [K^+K^-]_\phi\pi^+$.

10. Variables are usually italic: V is a voltage (variable), while 1 V is a volt (unit). Also in combined expressions: Q-value, z-scale, R-parity *etc.*

11. Subscripts and superscripts are roman type when they refer to a word (such as T for transverse) and italic when they refer to a variable (such as t for time): p_T, Δm_s, t_rec.

12. Standard function names are in roman type: *e.g.* cos, sin and exp.

13. Figure, Section, Equation, Chapter and Reference should be abbreviated as Fig., Sect. (or alternatively Sec.), Eq., Chap. and Ref. respectively, when they refer to a particular (numbered) item, except when they start a sentence. Table and Appendix are not abbreviated. The plural form of abbreviation keeps the point after the s, *e.g.* Figs. 1 and 2. Equations may be referred to either with ("Eq. (1)") or without ("Eq. 1") parentheses, but it should be consistent within the paper.

14. Common abbreviations derived from Latin such as "for example" (*e.g.*), "in other words" (*i.e.*), "and so forth" (*etc.*), "and others" (*et al.*), "versus" (*vs.*) can be used, with the typography shown, but not excessively; other more esoteric abbreviations should be avoided.

15. Units, material and particle names are usually lower case if spelled out, but often capitalised if abbreviated: amps (A), gauss (G), lead (Pb), silicon (Si), kaon (K), but proton (p).

16. Counting numbers are usually written in words if they start a sentence or if they have a value of ten or below in descriptive text (*i.e.* not including figure numbers such as "Fig. 4", or values followed by a unit such as "4 cm"). The word 'unity' can be useful to express the special meaning of the number one in expressions such as: "The BDT output takes values between zero and unity".

17. Numbers larger than 9999 have a comma (or a small space, but not both) between the multiples of thousand: *e.g.* 10,000 or 12,345,678. The decimal point is indicated with a point rather than a comma: *e.g.* 3.141.

18. We apply the rounding rules of the PDG [3]. The basic rule states that if the three highest order digits of the uncertainty lie between 100 and 354, we round to two significant digits. If they lie between 355 and 949, we round to one significant digit. Finally, if they lie between 950 and 999, we round up and keep two significant digits. In all cases, the central value is given with a precision that matches that of the uncertainty. So, for example, the result 0.827 ± 0.119 should be written as 0.83 ± 0.12, 0.827 ± 0.367 should turn into 0.8 ± 0.4, and 14.674 ± 0.964 becomes 14.7 ± 1.0. When writing numbers with uncertainty components from different sources, *i.e.* statistical and systematic uncertainties, the rule applies to the uncertainty with the best precision, so $0.827 \pm 0.367\,(\text{stat}) \pm 0.179\,(\text{syst})$ goes to $0.83 \pm 0.37\,(\text{stat}) \pm 0.18\,(\text{syst})$ and $8.943 \pm 0.123\,(\text{stat}) \pm 0.995\,(\text{syst})$ goes to $8.94 \pm 0.12\,(\text{stat}) \pm 1.00\,(\text{syst})$.

19. When rounding numbers, it should be avoided to pad with zeroes at the end. So 51237 ± 4561 should be rounded as $(5.12 \pm 0.46) \times 10^4$ and not 51200 ± 4600.

20. When rounding numbers in a table, some variation of the rounding rules above may be required to achieve uniformity.

21. Hyphenation should be used where necessary to avoid ambiguity, but not excessively. For example: "big-toothed fish" (to indicate that big refers to the teeth, not to the fish), but "big white fish". A compound modifier often requires hyphenation (*CP*-violating observables, *b*-hadron decays, final-state radiation, second-order polynomial), even if the same combination in an adjective-noun combination does not (direct *CP* violation, heavy *b* hadrons, charmless final state). Adverb-adjective combinations are not hyphenated if the adverb ends with 'ly': oppositely charged pions, kinematically similar decay. Words beginning with "all-", "cross-", "ex-" and "self-" are hyphenated *e.g.* cross-section and cross-check. "two-dimensional" is hyphenated. Words beginning with small prefixes (like "anti", "bi", "co", "contra", "counter", "de", "extra", "infra", "inter", "intra", "micro", "mid", "mis", "multi", "non", "over", "peri", "post", "pre", "pro", "proto", "pseudo", "re", "semi", "sub", "super", "supra", "trans", "tri", "ultra", "un", "under" and "whole") are single words and should not hyphenated *e.g.* semileptonic, pseudorapidity, pseudoexperiment, multivariate, multidimensional, reweighted, preselection, nonresonant, nonzero, nonparametric, nonrelativistic, antiparticle, misreconstructed and misidentified.

22. Minus signs should be in a proper font (-1), not just hyphens (-1); this applies to figure labels as well as the body of the text. In Latex, use math mode (between `$$`'s) or make a dash ("`--`"). In ROOT, use `#font[122]{-}` to get a normal-sized minus sign.

23. Inverted commas (around a title, for example) should be a matching set of left- and right-handed pairs: "Title". The use of these should be avoided where possible.

24. Single symbols are preferred for variables in equations, *e.g.* $\mathcal{B}$ rather than BF for a branching fraction.

25. Parentheses are not usually required around a value and its uncertainty, before the unit, unless there is possible ambiguity: so $\Delta m_s = 20 \pm 2\,\mathrm{ps}^{-1}$ does not need parentheses, whereas $f_d = (40 \pm 4)\%$ or $x = (1.7 \pm 0.3) \times 10^{-6}$ does. The unit does not need to be repeated in expressions like $1.2 < E < 2.4\,\mathrm{GeV}$.

26. The same number of decimal places should be given for all values in any one expression (*e.g.* $5.20 < m_B < 5.34\,\mathrm{GeV}/c^2$).

27. Apostrophes are best avoided for abbreviations: if the abbreviated term is capitalised or otherwise easily identified then the plural can simply add an s, otherwise it is best to rephrase: *e.g.* HPDs, π^0 s, pions, rather than HPD's, π^0's, πs.

28. Particle labels, decay descriptors and mathematical functions are not nouns, and need often to be followed by a noun. Thus "background from $B^0 \to \pi^+\pi^-$ decays" instead of "background from $B^0 \to \pi^+\pi^-$", and "the width of the Gaussian function" instead of "the width of the Gaussian".

29. In equations with multidimensional integrations or differentiations, the differential terms should be separated by a thin space. Thus $\int f(x,y) dx\,dy$ instead $\int f(x,y) dxdy$ and $\frac{d^2\Gamma}{dx\,dQ^2}$ instead of $\frac{d^2\Gamma}{dxdQ^2}$. The d's are allowed in either roman or italic font, but should be consistent throughout the paper.

5 Detector and simulation

The paragraph below can be used for the detector description. Modifications may be required in specific papers to fit within page limits, to enhance particular detector elements or to introduce acronyms used later in the text. For journals where strict word counts are applied (for example, PRL), and space is at a premium, it may be sufficient to write, as a minimum: "The LHCb detector is a single-arm forward spectrometer covering the pseudorapidity range $2 < \eta < 5$, described in detail in Refs. [1, 4]". A slightly longer version could specify the most relevant sub-detectors, *e.g* "The LHCb detector [1, 4] is a single-arm forward spectrometer covering the pseudorapidity range $2 < \eta < 5$, designed for the study of particles containing b or c quarks. The detector elements that are particularly relevant to this analysis are: a silicon-strip vertex detector surrounding the pp interaction region that allows c and b hadrons to be identified from their characteristically long flight distance; a tracking system that provides a measurement of momentum, p, of charged particles; and two ring-imaging Cherenkov detectors that are able to discriminate between different species of charged hadrons."

```
In the following paragraph, references to the individual detector
performance papers are marked with a * and should only be included
if the analysis relies on numbers or methods described in the specific
papers. Otherwise, a reference to the overall detector performance
paper~\cite{LHCb-DP-2014-002} will suffice. Note also that the text
defines the acronyms for primary vertex, PV, and impact parameter, IP.
Remove either of those in case it is not used later on.
```

The LHCb detector [1, 4] is a single-arm forward spectrometer covering the pseudorapidity range $2 < \eta < 5$, designed for the study of particles containing b or c quarks. The detector includes a high-precision tracking system consisting of a silicon-strip vertex detector surrounding the pp interaction region [5]*, a large-area silicon-strip detector located upstream of a dipole magnet with a bending power of about 4 Tm, and three stations of silicon-strip detectors and straw drift tubes [6]* placed downstream of the magnet. The tracking system provides a measurement of momentum, p, of charged particles with a relative uncertainty that varies from 0.5% at low momentum to 1.0% at 200 GeV/c. The minimum distance of a track to a primary vertex (PV), the impact parameter (IP), is measured with a resolution of $(15 + 29/p_{\mathrm{T}})$ μm, where p_{T} is the component of the momentum transverse to the beam, in GeV/c. Different types of charged hadrons are distinguished using information from two ring-imaging Cherenkov detectors [7]*. Photons, electrons and hadrons are identified by a calorimeter system consisting of scintillating-pad and preshower detectors, an electromagnetic calorimeter and a hadronic calorimeter. Muons are identified by a system composed of alternating layers of iron and multiwire proportional chambers [8]*. The online event selection is performed by a trigger [9]*, which consists of a hardware stage, based on information from the calorimeter and muon systems, followed by a software stage, which applies a full event reconstruction.

A more detailed description of the 'full event reconstruction' could be:

- The trigger [9]* consists of a hardware stage, based on information from the calorimeter and muon systems, followed by a software stage, in which all charged particles with $p_{\mathrm{T}} > 500\,(300)$ MeV are reconstructed for 2011 (2012) data. For triggers that require neutral particles, energy deposits in the electromagnetic calorimeter are analysed to reconstruct π^0 and γ candidates.

The trigger description has to be specific for the analysis in question. In general, you should not attempt to describe the full trigger system. Below are a few variations that inspiration can be taken from. First from a hadronic analysis, and second from an analysis with muons in the final state. In case you have to look up specifics of a certain trigger, a detailed description of the trigger conditions for Run 1 is available in Ref. [10]. **Never cite this note in a PAPER or CONF-note.**

- At the hardware trigger stage, events are required to have a muon with high p_{T} or a hadron, photon or electron with high transverse energy in the calorimeters. For hadrons, the transverse energy threshold is 3.5 GeV. The software trigger requires a two-, three- or four-track secondary vertex with a significant displacement from any primary pp interaction vertex. At least one charged particle must have a transverse momentum $p_{\mathrm{T}} > 1.6$ GeV/c and be inconsistent with originating from a PV. A multivariate algorithm [11] is used for the identification of secondary vertices consistent with the decay of a b hadron.

- The $B^0 \to K^{*0}\mu^+\mu^-$ signal candidates are first required to pass the hardware trigger, which selects events containing at least one muon with transverse momentum $p_{\mathrm{T}} > 1.48$ GeV/c in the 7 TeV data or $p_{\mathrm{T}} > 1.76$ GeV/c in the 8 TeV data. In the subsequent software trigger, at least one of the final-state particles is required to have $p_{\mathrm{T}} > 1.7$ GeV/c in the 7 TeV data or $p_{\mathrm{T}} > 1.6$ GeV/c in the 8 TeV data, unless the particle is identified as a muon in which case $p_{\mathrm{T}} > 1.0$ GeV/c is required. The final-state particles that satisfy these transverse momentum criteria are also required to have an impact parameter larger than 100 μm with respect to all PVs in the event. Finally, the tracks of two or more of the final-state particles are required to form a vertex that is significantly displaced from the PVs."

For analyses using the 2015 Turbo stream, the following paragraph may be used to describe the trigger.

- The online event selection is performed by a trigger. This consists of a hardware stage, which, for this analysis, randomly selects a pre-defined fraction of all beam-beam crossings at a rate of 300 kHz, followed by a software stage. In between the hardware and software stages, an alignment and calibration of the detector is performed in near real-time [12] and updated constants are made available for the trigger. The same alignment and calibration information is propagated to the offline reconstruction, ensuring consistent and high-quality particle identification (PID) information between the trigger and offline software. The identical performance of the online and offline reconstruction offers the opportunity to perform physics analyses directly using candidates reconstructed in the trigger [9, 13] which the present analysis exploits. The storage of only the triggered candidates enables a reduction in the event size by an order of magnitude.

An example to describe the use of both TOS and TIS candidates:

- In the offline selection, trigger signals are associated with reconstructed particles. Selection requirements can therefore be made on the trigger selection itself and on whether the decision was due to the signal candidate, other particles produced in the *pp* collision, or a combination of both.

A good example of a description of long and downstream K^0_S is given in Ref. [14]:

- Decays of $K^0_S \to \pi^+\pi^-$ are reconstructed in two different categories: the first involving K^0_S mesons that decay early enough for the daughter pions to be reconstructed in the vertex detector; and the second containing K^0_S that decay later such that track segments of the pions cannot be formed in the vertex detector. These categories are referred to as *long* and *downstream*, respectively. The long category has better mass, momentum and vertex resolution than the downstream category.

The description of our software stack for simulation is often causing trouble. The following paragraph can act as inspiration but with variations according to the level of detail required and if mentioning of *e.g.* PHOTOS is required.

- In the simulation, *pp* collisions are generated using PYTHIA [15] (In case only PYTHIA 6 is used, remove `*Sjostrand:2007gs` from this citation; if only PYTHIA 8 is used, then reverse the order of the papers in the citation.) with a specific LHCb configuration [16]. Decays of hadronic particles are described by EVTGEN [17], in which final-state radiation is generated using PHOTOS [18]. The interaction of the generated particles with the detector, and its response, are implemented using the GEANT4 toolkit [19] as described in Ref. [20].

A quantity often used in LHCb analyses is $\chi^2_{\rm IP}$. When mentioning it in a paper, the following wording could be used: "…$\chi^2_{\rm IP}$ with respect to any primary interaction vertex greater than X, where $\chi^2_{\rm IP}$ is defined as the difference in the vertex-fit χ^2 of a given PV reconstructed with and without the track under consideration/being considered."[3]

Many analyses depend on boosted decision trees. It is inappropriate to use TMVA as the reference as that is merely an implementation of the BDT algorithm. Rather it is suggested to write: "In this paper we use a boosted decision tree (BDT) [21, 22] to separate signal from background".

When describing the integrated luminosity of the data set, do not use expressions like "$1.0\,\mathrm{fb}^{-1}$ of data", but *e.g.* "data sample corresponding to an integrated luminosity of $1.0\,\mathrm{fb}^{-1}$", or "a sample of data obtained from $3\,\mathrm{fb}^{-1}$ of integrated luminosity".

For analyses where the periodical reversal of the magnetic field is crucial, *e.g.* in measurements of direct *CP* violation, the following description can be used as an example phrase: "The polarity of the dipole magnet is reversed periodically throughout data-taking. The configuration with the magnetic field vertically upwards, *MagUp* (downwards, *MagDown*), bends positively (negatively) charged particles in the horizontal plane towards the centre of the LHC." Only use the *MagUp*, *MagDown* symbols if they are used extensively in tables or figures.

6 Figures

A standard LHCb style file for use in production of figures in ROOT is in the URANIA package `RootTools/LHCbStyle` or directly in SVN at `svn+ssh://svn.cern.ch/reps/lhcb/Urania/trunk/RootTools/LHCbStyle`. It is not mandatory to use this style, but it makes it easier to follow the recommendations below. For labelling the axis and legends it is recommended to use (as in the examples) the same text fonts as in the main text. When using ROOT to produce the plots, use the upright symbol font for text. The slanted font exists, but does not look good. It is also possible to use consistently upright sans-serif fonts for the text (slide style). However, styles should not be mixed. For particle symbols, try to use the same font (roman/italic) as is used in the text.

Pull plots are control plots, which are useful in analysis notes. Normally they are not shown in papers, unless one wants to emphasise regions where a fit does not describe the data. For satisfactory fits, in a paper it is sufficient to simply state the fact and/or give the χ^2/ndf.

Figure 1 shows an example of how to include an eps or pdf figure with the `\includegraphics` command (eps figures will not work with `pdflatex`). Note that if the graphics sits in `figs/myfig.pdf`, you can just write `\includegraphics{myfig}` as the `figs` subdirectory is searched automatically and the extension `.pdf` (`.eps`) is automatically added for `pdflatex` (`latex`).

1. Figures should be legible at the size they will appear in the publication, with suitable line width. Their axes should be labelled, and have suitable units (e.g. avoid a mass plot with labels in MeV/c^2 if the region of interest covers a few GeV/c^2 and all the

[3] If this sentence is used to define $\chi^2_{\rm IP}$ for a composite particle instead of for a single track, replace "track" by "particle" or "candidate"

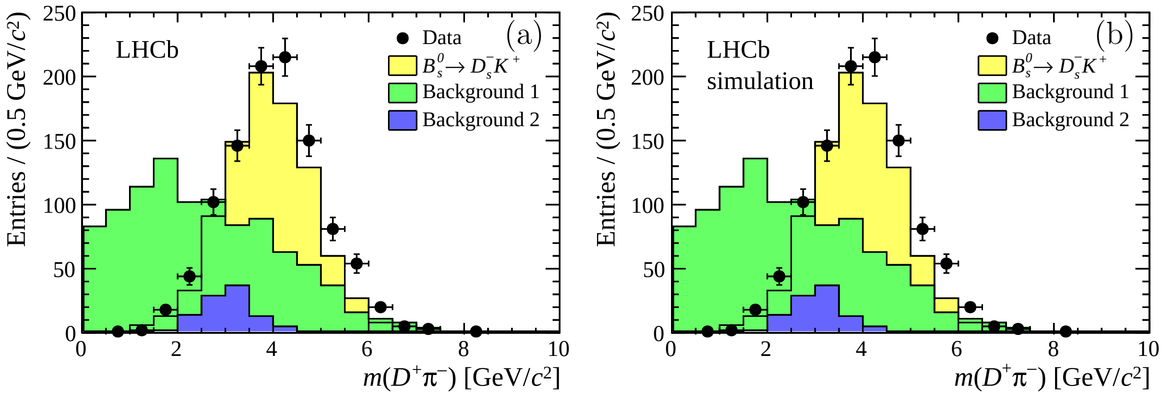

Figure 1: Example plots for (a) data and (b) simulation using the LHCb style from the Urania package `RootTools/LHCbStyle`. The signal data is shown as points with the signal component as yellow (light shaded), background 1 as green (medium shaded) and background 2 as blue (dark shaded).

numbers then run together). Spurious background shading and boxes around text should be avoided.

2. For the y-axis, "Entries" or "Candidates" is approriate in case no background subtraction has been applied. Otherwise "Yield" or "Decays" may be more appropriate. If the unit on the y-axis corresponds to the yield per bin, indicate so, for example "Entries / (5 MeV/c^2)" or "Entries per 5 MeV/c^2".

3. Fit curves should not obscure the data points, and data points are best (re)drawn over the fit curves. In this case avoid in the caption the term "overlaid" when referring to a fit curve, and instead use the words "shown" or "drawn".

4. Colour may be used in figures, but the distinction between differently coloured areas or lines should be clear also when the document is printed in black and white, for example through differently dashed lines. The LHCb style mentioned above implements a colour scheme that works well but individual adjustments might be required.

5. Using different hatching styles helps to disinguished filled areas, also in black and white prints. Hatching styles 3001-3025 should be avoided since they behave unpredictably under zooming and scaling. Good styles for "falling hatched" and "rising hatched" are 3345 and 3354.

6. Figures with more than one part should have the parts labelled (a), (b) *etc.*, with a corresponding description in the caption; alternatively they should be clearly referred to by their position, e.g. Fig. 1 (left). In the caption, the labels (a), (b) *etc.* should precede their description. When referencing specific sub-figures, use "see Fig. 1(a)" or "see Figs. 2(b)-(e)".

7. All figures containing LHCb data should have LHCb written on them. For preliminary results, that should be replaced by "LHCb preliminary". Figures that only have simulated data should display "LHCb simulation". Figures that do not depend on LHCb-specific software (*e.g.* only on Pythia) should not have any label.

7 References

References should be made using BibTEX [23]. A special style `LHCb.bst` has been created to achieve a uniform style. Independent of the journal the paper is submitted to, the preprint should be created using this style. Where arXiv numbers exist, these should be added even for published articles. In the PDF file, hyperlinks will be created to both the arXiv and the published version.

1. Citations are marked using square brackets, and the corresponding references should be typeset using BibTEX and the official LHCb BibTEX style. An example is in Ref. [15].

2. For references with four or less authors all of the authors' names are listed [24], otherwise the first author is given, followed by *et al.*. The LHCb BibTEX style will take care of this.

3. The order of references should be sequential when reading the document. This is automatic when using BibTEX.

4. The titles of papers should in general be included. To remove them, change `\setboolean{articletitles}{false}` to `true` at the top of this template. Note that the titles in `LHCb-PAPER.bib` are in plain LaTex, in order to correspond to the actual title on the arXiv record. Some differences in style can thus be noticed with respect to the main text, for example particle names that use capital Greek letters are not slanted in the reference titles (Λ vs $\mathit{\Lambda}$)

5. Whenever possible, use references from the supplied files `main.bib`, `LHCb-PAPER.bib`, `LHCb-CONF.bib`, and `LHCB-DP.bib`. These are kept up-to-date by the EB. If you see a mistake, do not edit these files, but let the EB know. This way, for every update of the paper, you save yourself the work of updating the references. Instead, you can just copy or check in the latest versions of the `.bib` files from the repository.

6. For those references not provided by the EB, the best is to copy the BibTEX entry directly from `Inspire`. Often these need to be edited to get the correct title, author names and formatting. For authors with multiple initials, add a space between them (change `R.G.C.` to `R. G. C.`), otherwise only the first initial will be taken. Also, make sure to eliminate unnecessary capitalisation. Apart from that, the title should be respected as much as possible (*e.g.* do not change particle names to PDG convention nor introduce/remove factors of c). Check that both the arXiv and the journal index are clickable and point to the right article.

7. The `mciteplus` [25] package is used to enable multiple references to show up as a single item in the reference list. As an example `\cite{Mohapatra:1979ia,*Pascoli:2007qh}` where the `*` indicates that the reference should be merged with the previous one. The result of this can be seen in Ref. [26]. Be aware that the `mciteplus` package should be included as the very last item before the `\begin{document}` to work correctly.

8. It should be avoided to make references to public notes and conference reports in public documents. Exceptions can be discussed on a case-by-case basis with the

review committee for the analysis. In internal reports they are of course welcome and can be referenced as seen in Ref. [27] using the `lhcbreport` category. For conference reports, omit the author field completely in the BibTEX record.

9. To get the typesetting and hyperlinks correct for LHCb reports, the category `lhcbreport` should be used in the BibTEX file. See Refs. [28] for some examples. It can be used for LHCb documents in the series `CONF`, `PAPER`, `PROC`, `THESIS`, `LHCC`, `TDR` and internal LHCb reports. Papers sent for publication, but not published yet, should be referred with their `arXiv` number, so the `PAPER` category should only be used in the rare case of a forward reference to a paper.

10. Proceedings can be used for references to items such as the LHCb simulation [20], where we do not yet have a published paper.

There is a set of standard references to be used in LHCb that are listed in Appendix A.

8 Inclusion of supplementary material

Three types of supplementary material should be distinguished:

- A regular appendix: lengthy equations or long tables are sometimes better put in an appendix in order not to interrupt the main flow of a paper. Appendices will appear in the final paper, on arXiv and on the CDS record and should be considered integral part of a paper, and are thus to be reviewed like the rest of the paper. An example of an LHCb paper with an appendix is Ref. [29].

- Supplementary material for CDS: plots or tables that would make the paper exceed the page limit or are not appropriate to include in the paper itself, but are desireable to be shown in public should be added to the paper drafts in an appendix, and removed from the paper before submitting to arXiv or the journal. See Appendix D for further instructions. Examples are: comparison plots of the new result with older results, plots that illustrate cross-checks. An example of an LHCb paper with supplementary material for CDS is Ref. [30]. Supplementary material for CDS cannot be referenced in the paper. Supplementary material should be included in the draft paper to be reviewed by the collaboration.

- Supplementary material for the paper. This is usually called "supplemental material", which distinguishes it from supplementary material for CDS only. Most journals allow to submit files along with the paper that will not be part of the text of the article, but will be stored on the journal server. Examples are plain text files with numerical data corresponding to the plots in the paper. The supplemental material should be cited in the paper by including a reference which should say "See supplemental material at [link] for [give brief description of material]." The journal will insert a specific link for [link]. The arXiv version will usually include the supplemental material as part of the paper and so should not contain the words "at [link]". Supplemental material should be included in the draft paper to be reviewed by the collaboration. An example of an LHCb paper with supplemental material is Ref. [31]

9 Acknowledgements paragraph

Include the following text in the Acknowledgements section in all paper drafts. It is not needed for analysis notes or conference reports.

The text below are the acknowledgements as approved by the collaboration board. Extending the acknowledgements to include individuals from outside the collaboration who have contributed to the analysis should be approved by the EB. The extra acknowledgements are normally placed before the standard acknowledgements, unless it matches better with the text of the standard acknowledgements to put them elsewhere. They should be included in the draft for the first circulation. Except in exceptional circumstances, to be approved by the EB chair, authors of the paper should not be named in extended acknowledgements.

Acknowledgements

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Appendices

A Standard References

Below is a list of common references, as well as a list of all LHCb publications. As they are already in prepared bib files, they can be used as simply as `\cite{Alves:2008zz}` to get the LHCb detector paper. The references are defined in the files `main.bib`, `LHCb-PAPER.bib`, `LHCb-CONF.bib`, `LHCb-DP.bib` `LHCb-TDR.bib` files, with obvious contents. Each of these have their `LHCb-ZZZ-20XX-0YY` number as their cite code. If you believe there is a problem with the formatting or content of one of the entries, then get in contact with the Editorial Board rather than just editing it in your local file, since you are likely to need the latest version just before submiting the article.

Description	`cite` code	Reference
LHCb detector	`Alves:2008zz`	[1]
LHCb simulation	`LHCb-PROC-2011-006`	[20]
PDG 2016 (+ 2017 updates)	`PDG2017`	[32]
PDG 2016	`PDG2016`	[3]
PDG 2014 (+ 2015 updates)	`PDG2014`	[33]
HFLAV 2016	`HFLAV16`	[34]
HFAG (pre-2016)	`Amhis:2014hma`	[35]
PYTHIA	`Sjostrand:2006za, *Sjostrand:2007gs`	[15]
LHCb PYTHIA tuning	`LHCb-PROC-2010-056`	[16]
GEANT4	`Allison:2006ve, *Agostinelli:2002hh`	[19]
EVTGEN	`Lange:2001uf`	[17]
PHOTOS	`Golonka:2005pn`	[18]
DIRAC	`Tsaregorodtsev:2010zz, *BelleDIRACAmazon`	[36]
Crystal Ball function[4]	`Skwarnicki:1986xj`	[37]
Hypatia	`Santos:2013gra`	[38]
Wilks' theorem	`Wilks:1938dza`	[39]
BDT	`Breiman`	[21]
BDT training	`AdaBoost`	[22]
HLT2 topo	`BBDT`	[11]
DecayTreeFitter	`Hulsbergen:2005pu`	[40]
sPlot	`Pivk:2004ty`	[41]
Punzi's optimization	`Punzi:2003bu`	[42]
f_s/f_d	`fsfd`	[43]
LHC beam energy uncertainty	`PhysRevAccelBeams.20.081003`	[44]
CL_s method	`CLs`	[45]
Continued in next table		

[4]A valid alternative for most papers where the normalisation is not critical is to use the expression"Gaussian function with a low-mass power-law tail" or "Gaussian function with power-law tails". In that case, no citation is needed

Description	`cite` code	Reference
Continued from previous table		
CKMfitter group	`CKMfitter2005`	[46]
CKMfitter group	`CKMfitter2015`	[47]
UTfit (Standard Model/CKM)	`UTfit-UT`	[48]
UTfit (New Physics)	`UTfit-NP`	[49]
Scikit	`Scikit`	[50]
RooUnfold	`Adye:2011gm`	[51]
EW Baryogenesis & *CP*	`Huet:1994jb`	[52]
Baryon asymmetry & SM *CP*	`Gavela:1994dt`	[53]
Baryon asymmetry & SM *CP*	`Gavela:1993ts`	[54]

`LHCb-DP` number	Title
`LHCb-DP-2018-002` [55]	VeLo material map using SMOG
`LHCb-DP-2018-001` [56]	PIDCalib for Run 2
`LHCb-DP-2017-001` [57]	Performance of the Outer Tracker - Run 2
`LHCb-DP-2016-003` [58]	HeRSCheL
`LHCb-PROC-2015-018` [59]	Topological trigger reoptimization - Run 2
`LHCb-PROC-2015-011` [12]	Turbo and real-time alignment - Run 2
`LHCb-DP-2016-001` [13]	TESLA project - Run 2
`LHCb-DP-2014-002` [4]	LHCb detector performance
`LHCb-DP-2014-001` [5]	Performance of the LHCb Vertex Locator
`LHCb-DP-2013-004` [60]	Performance of the LHCb calorimeters
`LHCb-DP-2013-003` [6]	Performance of the LHCb Outer Tracker
`LHCb-DP-2013-002` [61]	Measurement of the track reconstruction efficiency at LHCb
`LHCb-DP-2013-001` [62]	Performance of the muon identification at LHCb
`LHCb-DP-2012-005` [63]	Radiation damage in the LHCb Vertex Locator
`LHCb-DP-2012-004` [9]	The LHCb trigger and its performance in 2011
`LHCb-DP-2012-003` [7]	Performance of the LHCb RICH detector at the LHC
`LHCb-DP-2012-002` [8]	Performance of the LHCb muon system
`LHCb-DP-2012-001` [64]	Radiation hardness of the LHCb Outer Tracker
`LHCb-DP-2011-002` [65]	Simulation of machine induced background ...
`LHCb-DP-2011-001` [66]	Performance of the LHCb muon system with cosmic rays
`LHCb-DP-2010-001` [67]	First spatial alignment of the LHCb VELO ...

LHCb-TDR number	Title
LHCb-PII-EoI [68]	Expression of interest for Phase-II upgrade
LHCb-TDR-016 [69]	Trigger and online upgrade
LHCb-TDR-015 [70]	Tracker upgrade
LHCb-TDR-014 [71]	PID upgrade
LHCb-TDR-013 [72]	VELO upgrade
LHCb-TDR-012 [73]	Framework TDR for the upgrade
LHCb-TDR-011 [74]	Computing
LHCb-TDR-010 [75]	Trigger
LHCb-TDR-009 [76]	Reoptimized detector
LHCb-TDR-008 [77]	Inner Tracker
LHCb-TDR-007 [78]	Online, DAQ, ECS
LHCb-TDR-006 [79]	Outer Tracker
LHCb-TDR-005 [80]	VELO
LHCb-TDR-004 [81]	Muon system
LHCb-TDR-003 [82]	RICH
LHCb-TDR-002 [83]	Calorimeters
LHCb-TDR-001 [84]	Magnet

Table 4: LHCb-PAPERs (which have their identifier as their cite code). Note that LHCb-PAPER-2011-039 does not exist.

LHCb-PAPER-2018-016 [85]	LHCb-PAPER-2018-015 [86]
LHCb-PAPER-2018-014 [87]	LHCb-PAPER-2018-013 [88]
LHCb-PAPER-2018-012 [89]	LHCb-PAPER-2018-011 [90]
LHCb-PAPER-2018-010 [91]	LHCb-PAPER-2018-009 [92]
LHCb-PAPER-2018-008 [93]	LHCb-PAPER-2018-007 [94]
LHCb-PAPER-2018-006 [95]	LHCb-PAPER-2018-005 [96]
LHCb-PAPER-2018-004 [97]	LHCb-PAPER-2018-003 [98]
LHCb-PAPER-2018-002 [99]	LHCb-PAPER-2018-001 [100]
LHCb-PAPER-2017-050 [101]	LHCb-PAPER-2017-049 [102]
LHCb-PAPER-2017-048 [103]	LHCb-PAPER-2017-047 [104]
LHCb-PAPER-2017-046 [105]	LHCb-PAPER-2017-045 [106]
LHCb-PAPER-2017-044 [107]	LHCb-PAPER-2017-043 [108]
LHCb-PAPER-2017-042 [109]	LHCb-PAPER-2017-041 [110]
LHCb-PAPER-2017-040 [111]	LHCb-PAPER-2017-039 [112]
LHCb-PAPER-2017-038 [113]	LHCb-PAPER-2017-037 [114]
LHCb-PAPER-2017-036 [115]	LHCb-PAPER-2017-035 [116]
LHCb-PAPER-2017-034 [117]	LHCb-PAPER-2017-033 [118]
LHCb-PAPER-2017-032 [119]	LHCb-PAPER-2017-031 [120]
LHCb-PAPER-2017-030 [121]	LHCb-PAPER-2017-029 [122]
LHCb-PAPER-2017-028 [123]	LHCb-PAPER-2017-027 [124]
LHCb-PAPER-2017-026 [125]	LHCb-PAPER-2017-025 [126]
LHCb-PAPER-2017-024 [127]	LHCb-PAPER-2017-023 [128]
LHCb-PAPER-2017-022 [129]	LHCb-PAPER-2017-021 [130]
LHCb-PAPER-2017-020 [131]	LHCb-PAPER-2017-019 [132]
LHCb-PAPER-2017-018 [133]	LHCb-PAPER-2017-017 [134]

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LHCb-PAPER-2017-016 [135]	LHCb-PAPER-2017-015 [136]
LHCb-PAPER-2017-014 [137]	LHCb-PAPER-2017-013 [138]
LHCb-PAPER-2017-012 [139]	LHCb-PAPER-2017-011 [140]
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LHCb-PAPER-2016-046 [170]	LHCb-PAPER-2016-045 [171]
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LHCb-PAPER-2015-044 [232]	LHCb-PAPER-2015-043 [233]
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LHCb-PAPER-2014-066 [279]	LHCb-PAPER-2014-065 [280]
LHCb-PAPER-2014-064 [281]	LHCb-PAPER-2014-063 [282]
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LHCb-PAPER-2014-058 [287]	LHCb-PAPER-2014-057 [288]
LHCb-PAPER-2014-056 [289]	LHCb-PAPER-2014-055 [290]
LHCb-PAPER-2014-054 [291]	LHCb-PAPER-2014-053 [292]
LHCb-PAPER-2014-052 [293]	LHCb-PAPER-2014-051 [294]
LHCb-PAPER-2014-050 [295]	LHCb-PAPER-2014-049 [296]
LHCb-PAPER-2014-048 [297]	LHCb-PAPER-2014-047 [298]
LHCb-PAPER-2014-046 [299]	LHCb-PAPER-2014-045 [300]
LHCb-PAPER-2014-044 [301]	LHCb-PAPER-2014-043 [302]
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LHCb-PAPER-2014-036 [309]	LHCb-PAPER-2014-035 [310]
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LHCb-PAPER-2014-032 [313]	LHCb-PAPER-2014-031 [314]
LHCb-PAPER-2014-030 [315]	LHCb-PAPER-2014-029 [316]

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LHCb-PAPER-2014-028 [317]	LHCb-PAPER-2014-027 [318]
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LHCb-PAPER-2014-024 [321]	LHCb-PAPER-2014-023 [322]
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LHCb-PAPER-2014-020 [325]	LHCb-PAPER-2014-019 [326]
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Table 5: LHCb-CONFs (which have their identifier as their cite code). Note that LHCb-CONF-2011-032 does not exist.

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[5] If you cite the gamma combination, always also cite the latest gamma paper as `\cite{LHCb-PAPER-2013-020,*LHCb-CONF-2014-004}` (unless you cite LHCb-PAPER-2013-020 separately too).

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Some LHCb papers quoted together will look like [506–510]. The combination of CMS and LHCb results on $B^0_{(s)} \to \mu^+\mu^-$ should be cited like [549].

B Standard symbols

As explained in Sect. 4 this appendix contains standard typesetting of symbols, particle names, units etc. in LHCb documents.

In the file `lhcb-symbols-def.tex`, which is included, a large number of symbols is defined. While they can lead to quicker typing, the main reason is to ensure a uniform notation within a document and between different LHCb documents. If a symbol like `\CP` to typeset *CP* violation is available for a unit, particle name, process or whatever, it should be used. If you do not agree with the notation you should ask to get the definition in `lhcb-symbols-def.tex` changed rather than just ignoring it.

All the main particles have been given symbols. The B mesons are thus named B^+, B^0, B^0_s, and B^+_c. There is no need to go into math mode to use particle names, thus saving the typing of many $ signs. By default particle names are typeset in italic type to agree with the PDG preference. To get roman particle names you can just change `\setboolean{uprightparticles}{false}` to `true` at the top of this template.

There is a large number of units typeset that ensures the correct use of fonts, capitals and spacing. As an example we have $m_{B^0_s} = 5366.3 \pm 0.6\,\mathrm{MeV}/c^2$. Note that $\mathrm{\mu m}$ is typeset with an upright $\mathrm{\mu}$, even if the particle names have slanted greek letters.

A set of useful symbols are defined for working groups. More of these symbols can be included later. As an example in the Rare Decay group we have several different analyses looking for a measurement of $\mathcal{C}_7^{\prime(\mathrm{eff})}$ and $\mathcal{O}_7^{\prime}$.

C List of all symbols

C.1 Experiments

`\lhcb`	LHCb	`\atlas`	ATLAS	`\cms`	CMS
`\alice`	ALICE	`\babar`	BaBar	`\belle`	Belle
`\cleo`	CLEO	`\cdf`	CDF	`\dzero`	D0
`\aleph`	ALEPH	`\delphi`	DELPHI	`\opal`	OPAL
`\lthree`	L3	`\sld`	SLD	`\cern`	CERN
`\lhc`	LHC	`\lep`	LEP	`\tevatron`	Tevatron

569 ### C.1.1 LHCb sub-detectors and sub-systems

570

`\velo`	VELO	`\rich`	RICH	`\richone`	RICH1
`\richtwo`	RICH2	`\ttracker`	TT	`\intr`	IT
`\st`	ST	`\ot`	OT	`\herschel`	HERSCHEL
`\spd`	SPD	`\presh`	PS	`\ecal`	ECAL
`\hcal`	HCAL	`\MagUp`	*MagUp*	`\MagDown`	*MagDown*
`\ode`	ODE	`\daq`	DAQ	`\tfc`	TFC
`\ecs`	ECS	`\lone`	L0	`\hlt`	HLT
`\hltone`	HLT1	`\hlttwo`	HLT2		

571 ## C.2 Particles

572 ### C.2.1 Leptons

573

`\electron`	e	`\en`	e^-	`\ep`	e^+
`\epm`	$e^\pm$	`\epem`	e^+e^-	`\muon`	μ
`\mup`	μ^+	`\mun`	μ^-	`\mumu`	$\mu^+\mu^-$
`\tauon`	τ	`\taup`	τ^+	`\taum`	τ^-
`\tautau`	$\tau^+\tau^-$	`\lepton`	ℓ	`\ellm`	ℓ^-
`\ellp`	ℓ^+	`\ellell`	$\ell^+\ell^-$	`\neu`	ν
`\neub`	$\overline{\nu}$	`\neue`	ν_e	`\neueb`	$\overline{\nu}_e$
`\neum`	ν_μ	`\neumb`	$\overline{\nu}_\mu$	`\neut`	ν_τ
`\neutb`	$\overline{\nu}_\tau$	`\neul`	ν_ℓ	`\neulb`	$\overline{\nu}_\ell$

574 ### C.2.2 Gauge bosons and scalars

575

`\g`	γ	`\H`	H^0	`\Hp`	H^+
`\Hm`	H^-	`\Hpm`	$H^\pm$	`\W`	W
`\Wp`	W^+	`\Wm`	W^-	`\Wpm`	$W^\pm$
`\Z`	Z				

576 ### C.2.3 Quarks

577

`\quark`	q	`\quarkbar`	$\overline{q}$	`\qqbar`	$q\overline{q}$
`\uquark`	u	`\uquarkbar`	$\overline{u}$	`\uubar`	$u\overline{u}$
`\dquark`	d	`\dquarkbar`	$\overline{d}$	`\ddbar`	$d\overline{d}$
`\squark`	s	`\squarkbar`	$\overline{s}$	`\ssbar`	$s\overline{s}$
`\cquark`	c	`\cquarkbar`	$\overline{c}$	`\ccbar`	$c\overline{c}$
`\bquark`	b	`\bquarkbar`	$\overline{b}$	`\bbbar`	$b\overline{b}$
`\tquark`	t	`\tquarkbar`	$\overline{t}$	`\ttbar`	$t\overline{t}$

C.2.4 Light mesons

`\hadron`	h	`\pion`	π	`\piz`	π^0
`\pizs`	$\pi^0\,\mathrm{s}$	`\pip`	π^+	`\pim`	π^-
`\pipm`	$\pi^\pm$	`\pimp`	$\pi^\mp$	`\rhomeson`	ρ
`\rhoz`	ρ^0	`\rhop`	ρ^+	`\rhom`	ρ^-
`\rhopm`	$\rho^\pm$	`\rhomp`	$\rho^\mp$	`\kaon`	K
`\Kb`	$\overline{K}$	`\KorKbar`	$\overset{(-)}{K}$	`\Kz`	K^0
`\Kzb`	$\overline{K}^0$	`\Kp`	K^+	`\Km`	K^-
`\Kpm`	$K^\pm$	`\Kmp`	$K^\mp$	`\KS`	K^0_{S}
`\KL`	K^0_{L}	`\Kstarz`	K^{*0}	`\Kstarzb`	$\overline{K}^{*0}$
`\Kstar`	K^*	`\Kstarb`	$\overline{K}^*$	`\Kstarp`	K^{*+}
`\Kstarm`	K^{*-}	`\Kstarpm`	$K^{*\pm}$	`\Kstarmp`	$K^{*\mp}$
`\etaz`	η	`\etapr`	η'	`\phiz`	ϕ
`\omegaz`	ω				

C.2.5 Heavy mesons

`\D`	D	`\Db`	$\overline{D}$	`\DorDbar`	$\overset{(-)}{D}$
`\Dz`	D^0	`\Dzb`	$\overline{D}^0$	`\Dp`	D^+
`\Dm`	D^-	`\Dpm`	$D^\pm$	`\Dmp`	$D^\mp$
`\Dstar`	D^*	`\Dstarb`	$\overline{D}^*$	`\Dstarz`	D^{*0}
`\Dstarzb`	$\overline{D}^{*0}$	`\Dstarp`	D^{*+}	`\Dstarm`	D^{*-}
`\Dstarpm`	$D^{*\pm}$	`\Dstarmp`	$D^{*\mp}$	`\Ds`	D^+_s
`\Dsp`	D^+_s	`\Dsm`	D^-_s	`\Dspm`	$D^\pm_s$
`\Dsmp`	$D^\mp_s$	`\Dss`	D^{*+}_s	`\Dssp`	D^{*+}_s
`\Dssm`	D^{*-}_s	`\Dsspm`	$D^{*\pm}_s$	`\Dssmp`	$D^{*\mp}_s$
`\B`	B	`\Bbar`	$\overline{B}$	`\Bb`	$\overline{B}$
`\BorBbar`	$\overset{(-)}{B}$	`\Bz`	B^0	`\Bzb`	$\overline{B}^0$
`\Bu`	B^+	`\Bub`	B^-	`\Bp`	B^+
`\Bm`	B^-	`\Bpm`	$B^\pm$	`\Bmp`	$B^\mp$
`\Bd`	B^0	`\Bs`	B^0_s	`\Bsb`	$\overline{B}^0_s$
`\Bdb`	$\overline{B}^0$	`\Bc`	B^+_c	`\Bcp`	B^+_c
`\Bcm`	B^-_c	`\Bcpm`	$B^\pm_c$		

C.2.6 Onia

`\jpsi`	J/ψ	`\psitwos`	$\psi(2S)$	`\psiprpr`	$\psi(3770)$
`\etac`	η_c	`\chiczero`	χ_{c0}	`\chicone`	χ_{c1}
`\chictwo`	χ_{c2}	`\OneS`	$\Upsilon(1S)$	`\TwoS`	$\Upsilon(2S)$
`\ThreeS`	$\Upsilon(3S)$	`\FourS`	$\Upsilon(4S)$	`\FiveS`	$\Upsilon(5S)$
`\chic`	χ_c				

584 C.2.7 Baryons

	\proton	p	\antiproton	$\overline{p}$	\neutron	n
	\antineutron	$\overline{n}$	\Deltares	$\mathit{\Delta}$	\Deltaresbar	$\overline{\mathit{\Delta}}$
	\Xires	$\mathit{\Xi}$	\Xiresbar	$\overline{\mathit{\Xi}}$	\Lz	$\mathit{\Lambda}$
	\Lbar	$\overline{\mathit{\Lambda}}$	\LorLbar	$\overset{(-)}{\mathit{\Lambda}}$	\Lambdares	$\mathit{\Lambda}$
	\Lambdaresbar	$\overline{\mathit{\Lambda}}$	\Sigmares	$\mathit{\Sigma}$	\Sigmaresbar	$\overline{\mathit{\Sigma}}$
	\Sigmaresbarz	$\overline{\mathit{\Sigma}}^0$	\Omegares	$\mathit{\Omega}$	\Omegaresbar	$\overline{\mathit{\Omega}}$
585	\Lb	$\mathit{\Lambda}_b^0$	\Lbbar	$\overline{\mathit{\Lambda}}_b^0$	\Lc	$\mathit{\Lambda}_c^+$
	\Lcbar	$\overline{\mathit{\Lambda}}_c^-$	\Xib	$\mathit{\Xi}_b$	\Xibz	$\mathit{\Xi}_b^0$
	\Xibm	$\mathit{\Xi}_b^-$	\Xibbar	$\overline{\mathit{\Xi}}_b$	\Xibbarz	$\overline{\mathit{\Xi}}_b^0$
	\Xibbarp	$\overline{\mathit{\Xi}}_b^+$	\Xic	$\mathit{\Xi}_c$	\Xicz	$\mathit{\Xi}_c^0$
	\Xicp	$\mathit{\Xi}_c^+$	\Xicbar	$\overline{\mathit{\Xi}}_c$	\Xicbarz	$\overline{\mathit{\Xi}}_c^0$
	\Xicbarm	$\overline{\mathit{\Xi}}_c^-$	\Omegac	$\mathit{\Omega}_c^0$	\Omegacbar	$\overline{\mathit{\Omega}}_c^0$
	\Omegab	$\mathit{\Omega}_b^-$	\Omegabbar	$\overline{\mathit{\Omega}}_b^+$		

586 C.3 Physics symbols

587 C.3.1 Decays

588	\BF	$\mathcal{B}$	\BRvis	$\mathcal{B}_{\text{vis}}$	\BR	$\mathcal{B}$
	\decay[2] \decay{a }{b c }	$a \to bc$	\ra	$\rightarrow$	\to	$\rightarrow$

589 C.3.2 Lifetimes

590	\tauBs	$\tau_{B_s^0}$	\tauBd	τ_{B^0}	\tauBz	τ_{B^0}
	\tauBu	τ_{B^+}	\tauDp	τ_{D^+}	\tauDz	τ_{D^0}
	\tauL	$\tau_{\rm L}$	\tauH	$\tau_{\rm H}$		

591 C.3.3 Masses

592	\mBd	m_{B^0}	\mBp	m_{B^+}	\mBs	$m_{B_s^0}$
	\mBc	$m_{B_c^+}$	\mLb	$m_{\mathit{\Lambda}_b^0}$		

593 C.3.4 EW theory, groups

594	\grpsuthree	${\rm SU}(3)$	\grpsutw	${\rm SU}(2)$	\grpuone	${\rm U}(1)$
	\ssqtw	$\sin^{2}\!\theta_{\rm W}$	\csqtw	$\cos^{2}\!\theta_{\rm W}$	\stw	$\sin\theta_{\rm W}$
	\ctw	$\cos\theta_{\rm W}$	\ssqtwef	$\sin^{2}\!\theta_{\rm W}^{\rm eff}$	\csqtwef	$\cos^{2}\!\theta_{\rm W}^{\rm eff}$
	\stwef	$\sin\theta_{\rm W}^{\rm eff}$	\ctwef	$\cos\theta_{\rm W}^{\rm eff}$	\gv	$g_{\rm V}$
	\ga	$g_{\rm A}$	\order	$\mathcal{O}$	\ordalph	$\mathcal{O}(\alpha)$
	\ordalsq	$\mathcal{O}(\alpha^{2})$	\ordalcb	$\mathcal{O}(\alpha^{3})$		

595 C.3.5 QCD parameters

596	\as	α_s	\MSb	$\overline{\rm MS}$	\lqcd	$\Lambda_{\rm QCD}$
	\qsq	q^2				

C.3.6 CKM, CP violation

`\eps`	ε	`\epsK`	ε_K	`\epsB`	ε_B
`\epsp`	ε'_K	`\CP`	CP	`\CPT`	CPT
`\rhobar`	$\overline{\rho}$	`\etabar`	$\overline{\eta}$	`\Vud`	V_{ud}
`\Vcd`	V_{cd}	`\Vtd`	V_{td}	`\Vus`	V_{us}
`\Vcs`	V_{cs}	`\Vts`	V_{ts}	`\Vub`	V_{ub}
`\Vcb`	V_{cb}	`\Vtb`	V_{tb}	`\Vuds`	V_{ud}^*
`\Vcds`	V_{cd}^*	`\Vtds`	V_{td}^*	`\Vuss`	V_{us}^*
`\Vcss`	V_{cs}^*	`\Vtss`	V_{ts}^*	`\Vubs`	V_{ub}^*
`\Vcbs`	V_{cb}^*	`\Vtbs`	V_{tb}^*		

C.3.7 Oscillations

`\dm`	Δm	`\dms`	Δm_s	`\dmd`	Δm_d
`\DG`	$\Delta\Gamma$	`\DGs`	$\Delta\Gamma_s$	`\DGd`	$\Delta\Gamma_d$
`\Gs`	Γ_s	`\Gd`	Γ_d	`\MBq`	M_{B_q}
`\DGq`	$\Delta\Gamma_q$	`\Gq`	Γ_q	`\dmq`	Δm_q
`\GL`	$\Gamma_{\rm L}$	`\GH`	$\Gamma_{\rm H}$	`\DGsGs`	$\Delta\Gamma_s/\Gamma_s$
`\Delm`	Δm	`\ACP`	$\mathcal{A}^{CP}$	`\Adir`	$\mathcal{A}^{\rm dir}$
`\Amix`	$\mathcal{A}^{\rm mix}$	`\ADelta`	$\mathcal{A}^{\Delta}$	`\phid`	ϕ_d
`\sinphid`	$\sin\!\phi_d$	`\phis`	ϕ_s	`\betas`	β_s
`\sbetas`	$\sigma(\beta_s)$	`\stbetas`	$\sigma(2\beta_s)$	`\stphis`	$\sigma(\phi_s)$
`\sinphis`	$\sin\!\phi_s$				

C.3.8 Tagging

`\edet`	$\varepsilon_{\rm det}$	`\erec`	$\varepsilon_{\rm rec/det}$	`\esel`	$\varepsilon_{\rm sel/rec}$
`\etrg`	$\varepsilon_{\rm trg/sel}$	`\etot`	$\varepsilon_{\rm tot}$	`\mistag`	ω
`\wcomb`	$\omega^{\rm comb}$	`\etag`	$\varepsilon_{\rm tag}$	`\etagcomb`	$\varepsilon_{\rm tag}^{\rm comb}$
`\effeff`	$\varepsilon_{\rm eff}$	`\effeffcomb`	$\varepsilon_{\rm eff}^{\rm comb}$	`\efftag`	$\varepsilon_{\rm tag}(1-2\omega)^2$
`\effD`	$\varepsilon_{\rm tag}D^2$	`\etagprompt`	$\varepsilon_{\rm tag}^{\rm Pr}$	`\etagLL`	$\varepsilon_{\rm tag}^{\rm LL}$

C.3.9 Key decay channels

`\BdToKstmm`	$B^0\to K^{*0}\mu^+\mu^-$	`\BdbToKstmm`	$\overline{B}^0\to\overline{K}^{*0}\mu^+\mu^-$	`\BsToJPsiPhi`	$B_s^0\to J/\psi\,\phi$
`\BdToJPsiKst`	$B^0\to J/\psi\,K^{*0}$	`\BdbToJPsiKst`	$\overline{B}^0\to J/\psi\,\overline{K}^{*0}$	`\BsPhiGam`	$B_s^0\to\phi\gamma$
`\BdKstGam`	$B^0\to K^{*0}\gamma$	`\BTohh`	$B\to h^+h'^-$	`\BdTopipi`	$B^0\to\pi^+\pi^-$
`\BdToKpi`	$B^0\to K^+\pi^-$	`\BsToKK`	$B_s^0\to K^+K^-$	`\BsTopiK`	$B_s^0\to\pi^+K^-$

C.3.10 Rare decays

`\BdKstee`	$B^0\to K^{*0}e^+e^-$	`\BdbKstee`	$\overline{B}^0\to\overline{K}^{*0}e^+e^-$	`\bsll`	$b\to s\ell^+\ell^-$
`\AFB`	$A_{\rm FB}$	`\FL`	$F_{\rm L}$	`\AT#1 \AT2`	$A_{\rm T}^2$
`\btosgam`	$b\to s\gamma$	`\btodgam`	$b\to d\gamma$	`\Bsmm`	$B_s^0\to\mu^+\mu^-$
`\Bdmm`	$B^0\to\mu^+\mu^-$	`\ctl`	$\cos\theta_\ell$	`\ctk`	$\cos\theta_K$

607 ### C.3.11 Wilson coefficients and operators

608

`\C#1 \C9`	$\mathcal{C}_9$	`\Cp#1 \Cp7`	$\mathcal{C}_7'$	`\Ceff#1 \Ceff9`	$\mathcal{C}_9^{(\mathrm{eff})}$
`\Cpeff#1 \Cpeff7`	$\mathcal{C}_7^{\prime(\mathrm{eff})}$	`\Ope#1 \Ope2`	$\mathcal{O}_2$	`\Opep#1 \Opep7`	$\mathcal{O}_7'$

609 ### C.3.12 Charm

610

`\xprime`	x'	`\yprime`	y'	`\ycp`	y_{CP}
`\agamma`	A_{Γ}	`\dkpicf`	$D^0 \to K^-\pi^+$		

611 ### C.3.13 QM

612 `\bra[1] \bra{a}` $\langle a|$ `\ket[1] \ket{b}` $|b\rangle$ `\braket[2] \braket{a}{b}` $\langle a|b\rangle$

613 ## C.4 Units

614 `\unit[1] \unit{kg}` kg

615 ### C.4.1 Energy and momentum

616

`\tev`	TeV	`\gev`	GeV	`\mev`	MeV
`\kev`	keV	`\ev`	eV	`\gevc`	GeV/c
`\mevc`	MeV/c	`\gevcc`	GeV/c^2	`\gevgevcccc`	GeV^2/c^4
`\mevcc`	MeV/c^2				

617 ### C.4.2 Distance and area

618

`\km`	km	`\m`	m	`\ma`	m^2
`\cm`	cm	`\cma`	cm^2	`\mm`	mm
`\mma`	mm^2	`\mum`	μm	`\muma`	μm^2
`\nm`	nm	`\fm`	fm	`\barn`	b
`\mbarn`	mb	`\mub`	μb	`\nb`	nb
`\invnb`	nb^{-1}	`\pb`	pb	`\invpb`	pb^{-1}
`\fb`	fb	`\invfb`	fb^{-1}	`\ab`	ab
`\invab`	ab^{-1}				

619 ### C.4.3 Time

620

`\sec`	s	`\ms`	ms	`\mus`	μs
`\ns`	ns	`\ps`	ps	`\fs`	fs
`\mhz`	MHz	`\khz`	kHz	`\hz`	Hz
`\invps`	ps^{-1}	`\invns`	ns^{-1}	`\yr`	yr
`\hr`	hr				

621 ### C.4.4 Temperature

622 `\degc` °C `\degk` K

623 C.4.5 Material lengths, radiation

624

`\Xrad`	X_0	`\NIL`	λ_{int}	`\mip`	MIP
`\neutroneq`	$\mathrm{n_{eq}}$	`\neqcmcm`	$\mathrm{n_{eq}/cm^2}$	`\kRad`	kRad
`\MRad`	MRad	`\ci`	Ci	`\mci`	mCi

625 C.4.6 Uncertainties

626

`\sx`	σ_x	`\sy`	σ_y	`\sz`	σ_z
`\stat`	(stat)	`\syst`	(syst)		

627 C.4.7 Maths

628

`\order`	$\mathcal{O}$	`\chisq`	χ^2	`\chisqndf`	χ^2/ndf
`\chisqip`	χ^2_{IP}	`\chisqvs`	χ^2_{VS}	`\chisqvtx`	χ^2_{vtx}
`\chisqvtxndf`	$\chi^2_{\mathrm{vtx}}/\mathrm{ndf}$	`\deriv`	d	`\gsim`	$\gtrsim$
`\lsim`	$\lesssim$	`\mean[1] \mean{x}`	$\langle x \rangle$	`\abs[1] \abs{x}`	$\lVert x \rVert$
`\Real`	$\mathcal{R}e$	`\Imag`	$\mathcal{I}m$	`\PDF`	PDF
`\sPlot`	*sPlot*	`\sFit`	*sFit*		

629 C.5 Kinematics

630 C.5.1 Energy, Momenta

631

`\Ebeam`	E_{BEAM}	`\sqs`	$\sqrt{s}$	`\sqsnn`	$\sqrt{s_{\mathrm{NN}}}$
`\ptot`	p	`\pt`	p_{T}	`\et`	E_{T}
`\mt`	M_{T}	`\dpp`	$\Delta p/p$	`\msq`	m^2
`\dedx`	$\mathrm{d}E/\mathrm{d}x$				

632 C.5.2 PID

633

`\dllkpi`	$\mathrm{DLL}_{K\pi}$	`\dllppi`	$\mathrm{DLL}_{p\pi}$	`\dllepi`	$\mathrm{DLL}_{e\pi}$
`\dllmupi`	$\mathrm{DLL}_{\mu\pi}$				

634 C.5.3 Geometry

635

`\degrees`	$^\circ$	`\krad`	krad	`\mrad`	mrad
`\rad`	rad				

636 C.5.4 Accelerator

637

`\betastar`	β^*	`\lum`	$\mathcal{L}$	`\intlum[1] \intlum{2 fb^{-1} }`	$\int\mathcal{L} = 2\ \mathrm{fb}^{-1}$

C.6 Software

C.6.1 Programs

`\bcvegpy`	Bcvegpy	`\boole`	Boole	`\brunel`	Brunel
`\davinci`	DaVinci	`\dirac`	Dirac	`\evtgen`	EvtGen
`\fewz`	Fewz	`\fluka`	Fluka	`\ganga`	Ganga
`\gaudi`	Gaudi	`\gauss`	Gauss	`\geant`	Geant4
`\hepmc`	HepMC	`\herwig`	Herwig	`\moore`	Moore
`\neurobayes`	NeuroBayes	`\photos`	Photos	`\powheg`	Powheg
`\pythia`	Pythia	`\resbos`	ResBos	`\roofit`	RooFit
`\root`	Root	`\spice`	Spice	`\urania`	Urania

C.6.2 Languages

`\cpp`	C++	`\ruby`	Ruby	`\fortran`	Fortran
`\svn`	SVN				

C.6.3 Data processing

`\kbytes`	kbytes	`\kbsps`	kbits/s	`\kbits`	kbits
`\kbsps`	kbits/s	`\mbsps`	Mbytes/s	`\mbytes`	Mbytes
`\mbps`	Mbyte/s	`\mbsps`	Mbytes/s	`\gbsps`	Gbytes/s
`\gbytes`	Gbytes	`\gbsps`	Gbytes/s	`\tbytes`	Tbytes
`\tbpy`	Tbytes/yr	`\dst`	DST		

C.7 Detector related

C.7.1 Detector technologies

`\nonn`	n^+-on-n	`\ponn`	p^+-on-n	`\nonp`	n^+-on-p
`\cvd`	CVD	`\mwpc`	MWPC	`\gem`	GEM

C.7.2 Detector components, electronics

`\tell1`	TELL1	`\ukl1`	UKL1	`\beetle`	Beetle
`\otis`	OTIS	`\croc`	CROC	`\carioca`	CARIOCA
`\dialog`	DIALOG	`\sync`	SYNC	`\cardiac`	CARDIAC
`\gol`	GOL	`\vcsel`	VCSEL	`\ttc`	TTC
`\ttcrx`	TTCrx	`\hpd`	HPD	`\pmt`	PMT
`\specs`	SPECS	`\elmb`	ELMB	`\fpga`	FPGA
`\plc`	PLC	`\rasnik`	RASNIK	`\elmb`	ELMB
`\can`	CAN	`\lvds`	LVDS	`\ntc`	NTC
`\adc`	ADC	`\led`	LED	`\ccd`	CCD
`\hv`	HV	`\lv`	LV	`\pvss`	PVSS
`\cmos`	CMOS	`\fifo`	FIFO	`\ccpc`	CCPC

C.7.3 Chemical symbols

`\cfourften`	C_4F_{10}	`\cffour`	CF_4	`\cotwo`	CO_2
`\csixffouteen`	C_6F_{14}	`\mgftwo`	MgF_2	`\siotwo`	SiO_2

652 ## C.8 Special Text

`\eg`	*e.g.*	`\ie`	*i.e.*	`\etal`	*et al.*
653 `\etc`	*etc.*	`\cf`	*cf.*	`\ffp`	*ff.*
`\vs`	*vs.*				

D Supplementary material for LHCb-PAPER-20XX-YYY

This appendix contains supplementary material that will posted on the public cds record but will not appear in the paper.

Please leave the above sentence in your draft for first and second circulation and replace what follows by your actual supplementary material. For more information about other types of supplementary material, see Section 8. Plots and tables that follow should be well described, either with captions or with additional explanatory text.

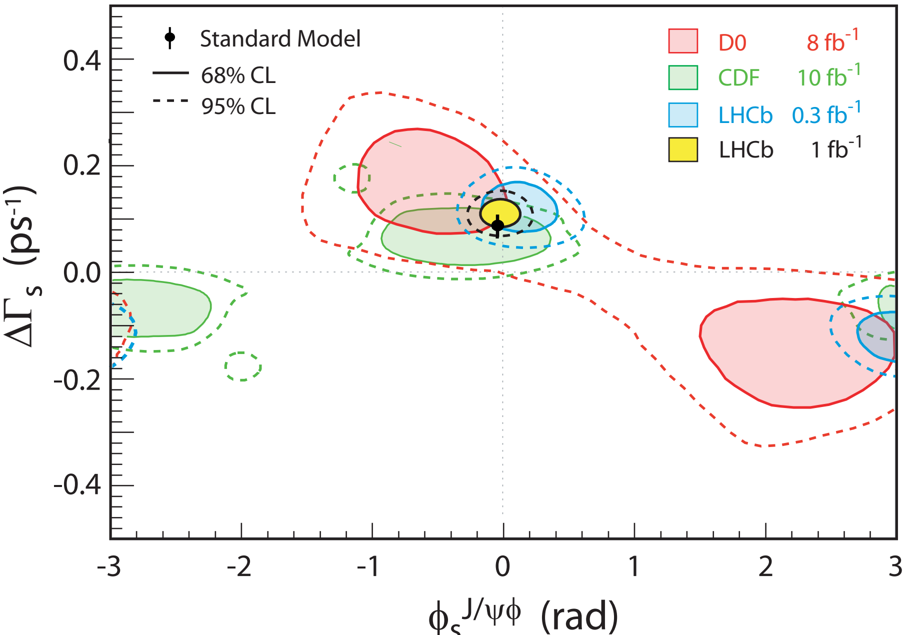

Figure 2: Comparison of our result to those from other experiments. Note that the style of this figure differs slightly from that of Figure 1

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