



# Template for writing LHCb papers

LHCb collaboration<sup>†</sup>

## 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. These guidelines are here to help proponents write a good paper, but they also implement the “LHCb style”. This style is based on previous decisions by the Editorial Board. They are neither wrong or right, but help keeping a similar look-and-feel for all LHCb papers.

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  $\LaTeX$  compiler is `pdflatex`, which requires figures to be in pdf format. To change to plain  $\LaTeX$ , edit line 10 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.

This template now lives on gitlab at <https://gitlab.cern.ch/lhcb-docs/templates/>. It can be downloaded and used locally, or used to create a new gitlab project, or a project on <https://www.overleaf.com/>. The latter will be required for paper drafts during EB process. It is recommended to maintain the general file structure of the template: the file `body.tex` should contain the full text of the paper, supplemental, appendix and supplementary material should go in the corresponding files, and all figure files must be placed within the `figs/` folder. This will ease finding text and comments in <https://www.overleaf.com/> and is needed for the creation of the public LHCb page for the paper.

## 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.

- 44 2. Standard English should be used (British rather than American) for LHCb notes  
45 and preprints. Examples: colour, flavour, centre, metre, modelled and aluminium.  
46 Words ending on -ise or -isation (polarise, hadronisation) can be written with -ize  
47 or -ization ending but should be consistent. The punctuation normally follows the  
48 closing quote mark of quoted text, rather than being included before the closing  
49 quote. Footnotes come after punctuation. Papers to be submitted to an American  
50 journal can be written in American English instead. Under no circumstance should  
51 the two be mixed.
- 52 3. Use of jargon should be avoided where possible. “Systematics” are “systematic  
53 uncertainties”, “L0” is “hardware trigger”, Monte-Carlo” is “simulation”, “penguin”  
54 diagrams are best introduced with an expression like “electroweak loop (penguin)  
55 diagrams”, “cuts” are “selection requirements”. The word “error” is ambiguous as  
56 it can mean the difference between the true and measured values or your estimate  
57 thereof. The same applies to event, that we usually take to mean the whole  $pp$   
58 collision; candidate or decay can be used instead.” Use the sentence “In the selection  
59 (or trigger), X% of the events are randomly discarded .... “ (and motivate for this)  
60 instead of using the word “prescale” The misnomer “data-driven” is popular in  
61 economics or programming to mean inspired by data rather than theory. In that  
62 sense the LHCb simulation is data-driven, which is not what is usually meant in  
63 papers. “Using the data” is a more correct alternative.
- 64 4. It would be good to avoid using quantities that are internal jargon and/or are  
65 impossible to reproduce without the full simulation, *i.e.* instead of “It is required  
66 that  $\chi_{\text{vtx}}^2 < 3$ ”, to say “A good quality vertex is required”; instead of “It is required  
67 that  $\chi_{\text{IP}}^2 > 16$ ”, to say “The track is inconsistent with originating from a PV”;  
68 instead of “A DLL greater than 20 is required” say to “Tracks are required to be  
69 identified as kaons”. However, experience shows that some journal referees ask for  
70 exactly this kind of information, and to safeguard against this, one may consider  
71 citing the LHCb performance paper [3] (Run 1–2) or [4] (Run 3), or the subdetector-  
72 specific ones in Table 3. In some cases, one can consider giving some requirements  
73 the paper, since even if the exact meaning may be LHCb-specific, it still conveys  
74 some qualitative feeling for the significance levels required in the various steps of  
75 the analysis.
- 76 5.  $\LaTeX$  should be used for typesetting. Line numbering should be switched on for  
77 drafts that are circulated for comments.
- 78 6. The abstract should be concise, and not include citations or numbered equations,  
79 and should give the key results from the paper. Note that that arXiv has introduced  
80 a limit of 1920 characters.
- 81 7. Apart from descriptions of the detector, the trigger and the simulation, the text  
82 should not be cut-and-pasted from other sources that have previously been published.  
83 If this cannot be avoided, inform the EB chair and reviewer in advance.
- 84 8. References should usually be made only to publicly accessible documents. Refer-  
85 ences to LHCb conference reports and public notes should be avoided in journal  
86 publications, instead including the relevant material in the paper itself.

- 87 9. The use of tenses should be consistent. It is recommended to mainly stay in the  
88 present tense, for the abstract, the description of the analysis, *etc.*; the past tense is  
89 then used where necessary, for example when describing the data-taking conditions.
- 90 10. It is generally preferable to use the passive voice (*e.g.* “the mass is measured”  
91 rather than “we measure the mass”), but the active voice is also acceptable, if the  
92 proponents have a preference for it, or where it improves clarity or flow. The use  
93 of “I” should be avoided, and “we” should not be used excessively, particularly in  
94 the abstract or the opening lines of the introduction or conclusion. Authors are  
95 encouraged to strike a balance between styles, with some flexibility to accommodate  
96 personal preferences.
- 97 11. A sentence should not start with a variable, a particle or an acronym. A title or  
98 caption should not start with an article.
- 99 12. Incorrect punctuation around conjunctive adverbs and the use of dangling modifiers  
100 are the two most common mistakes of English grammar in LHCb draft papers. If in  
101 doubt, read the wikipedia articles on conjunctive adverb and dangling modifier.
- 102 13. When using natural units, at the first occurrence of an energy unit that refers to  
103 momentum or a radius, add a footnote: “Natural units with  $\hbar = c = 1$  are used  
104 throughout.” Do this even when somewhere a length is reported in units of mm.  
105 It’s not 100% consistent, but most likely nobody will notice. The problem can be  
106 trivially avoided when no lengths scales in natural units occur, by omitting the  $\hbar$   
107 from the footnote text.
- 108 14. Papers dealing with amplitude analyses and/or resonance parameters, other than  
109 masses and lifetimes, should use natural units, since in these kind of measurements  
110 widths are traditionally expressed in MeV and radii in  $\text{GeV}^{-1}$ . It’s also the convention  
111 used by the PDG.
- 112 15. Papers quoting upper limits should give the both the 90% and 95% confidence  
113 level values in the text. Only one of these needs to be quoted in the abstract and  
114 summary. Use “at XX% CL” when using the abbreviated form and “at the XX%  
115 confidence level” when spelling it out.

## 116 3 Layout

- 117 1. Unnecessary blank space should be avoided, between paragraphs or around figures  
118 and tables.
- 119 2. Figure and table captions should be concise and use a somewhat smaller typeface  
120 than the main text, to help distinguish them. This is achieved automatically with  
121 the latest version of the file `preamble.tex`. Figure captions go below the figure,  
122 table captions go above the table.
- 123 3. Captions and footnotes should be punctuated correctly, like normal text. The use of  
124 too many footnotes should be avoided: typically they are used for giving commercial

Table 1: Background-to-signal ratio estimated in a  $\pm 50 \text{ MeV}/c^2$  mass window for the prompt and long-lived background sources, and the minimum bias rate. In this table, as the comparison of numbers among columns is not critical, the value  $11 \pm 2$  may also be typeset without the space.

Channel	$B_{\text{pr}}/S$	$B_{\text{LL}}/S$	MB rate
$B_s^0 \rightarrow J/\psi\phi$	$1.6 \pm 0.6$	$0.51 \pm 0.08$	$\sim 0.3 \text{ Hz}$
$B^0 \rightarrow J/\psi K^{*0}$	$11 \pm 2$	$1.5 \pm 0.1$	$\sim 8.1 \text{ Hz}$
$B^+ \rightarrow J/\psi K^{*+}$	$1.6 \pm 0.2$	$0.29 \pm 0.06$	$\sim 1.4 \text{ Hz}$

125 details of companies, or standard items like coordinate system definition or the  
126 implicit inclusion of charge-conjugate processes.<sup>1,2,3</sup>

127 4. Tables should be formatted in a simple fashion, without excessive use of horizontal  
128 and vertical lines. Numbers should be vertically aligned on the decimal point and  $\pm$   
129 symbol. (`\phantom{0}`, `\phantom{-}`, or the shorter `\phz` and `\phm`, may help, or  
130 defining column separators as `@{\: $\pm$ \:}`.) See Table 1 for an example.

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

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

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

137 7. Displayed results like

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

138 should in general not be numbered.

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

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

143 10. Equations in text should be put between a single pair of `$` signs. `\mbox{...}`  
144 ensures they are not split over several lines. So  $\epsilon_{\text{trigger}} = (93.9 \pm 0.2)\%$   
145 is written as `\mbox{\$ \epsilon_{\text{trigger}} = (93.9 \pm 0.2) \%}` and not

<sup>1</sup>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.

<sup>2</sup>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.”

<sup>3</sup>The LHCb coordinate system is right-handed, with the  $z$  axis pointing along the beam axis,  $y$  the vertical direction, and  $x$  the horizontal direction. The  $(x, z)$  plane is the bending plane of the dipole magnet.

146 as `\epsilon_{\text{trigger}}=(93.9\pm0.2)\%` which generates the oddly-  
147 spaced  $\epsilon_{\text{trigger}}=(93.9\pm0.2)\%$ .

148 11. Subsectioning should not be excessive: sections with more than three levels of index  
149 (1.1.1) should be avoided.

150 12. Acronyms should be defined the first time they are used, *e.g.* “A dedicated boosted  
151 decision tree (BDT) is designed to select doubly Cabibbo-suppressed (DCS) decays.”  
152 The abbreviated words should not be capitalised if it is not naturally written with  
153 capitals, *e.g.* quantum chromodynamics (QCD), impact parameter (IP), boosted  
154 decision tree (BDT). Avoid acronyms if they are used three times or less. A sentence  
155 should never start with an acronym and its better to avoid it as the last word of a  
156 sentence as well.

157 13. Section (and subsection) titles containing maths symbols should use boldmath.

## 158 4 Typography

159 The use of the L<sup>A</sup>T<sub>E</sub>X typesetting symbols defined in the file `lhcb-symbols-def.tex` and  
160 detailed in the appendices of this document is strongly encouraged as it will make it much  
161 easier to follow the recommendation set out below.

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

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

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

166 4. Units are in roman type, except for constants such as *c* or *h* that are italic: GeV,  
167 GeV/*c*<sup>2</sup>. The unit should be separated from the value with a thin space (“\,”),  
168 and they should not be broken over two lines. Correct spacing is automatic when  
169 using predefined units inside math mode: `\$3.0\gev\$` → 3.0 GeV. Spacing goes  
170 wrong when using predefined units outside math mode AND forcing extra space:  
171 `3.0\,\gev` → 3.0 GeV or worse: `3.0~\gev` → 3.0 GeV.

172 5. If factors of *c* are kept, they should be used both for masses and momenta, *e.g.*  
173  $p = 5.2 \text{ GeV}/c$  (or  $\text{GeV}c^{-1}$ ),  $m = 3.1 \text{ GeV}/c^2$  (or  $\text{GeV}c^{-2}$ ). If they are dropped this  
174 should be done consistently throughout, and a note should be added at the first  
175 instance to indicate that units are taken with  $c = 1$ . Note that there is no consensus  
176 on whether decay widths  $\Gamma$  are in MeV or  $\text{MeV}/c^2$  (the former is more common).  
177 Both are accepted if consistent.

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

181 7. Ranges should be formatted consistently. The recommended form is to use a dash  
182 with no spacing around it: 7–8 GeV, obtained as `7--8\gev`. Another possibility is  
183 “7 to 8 GeV”.

- 184 8. Italic is preferred for particle names (although roman is acceptable, if applied  
185 consistently throughout). Particle Data Group conventions should generally be  
186 followed:  $B^0$  (no need for a “d” subscript),  $B_s^0 \rightarrow J/\psi\phi$ ,  $\overline{B}_s^0$ , (note the long bar,  
187 obtained with `\overline`, in contrast to the discouraged short `\bar{B}` resulting in  
188  $\overline{B}$ ),  $K_S^0$  (note the uppercase roman type “S”). This is most easily achieved by using  
189 the predefined symbols described in Appendix C.
- 190 Italic is also used for particles whose name is an uppercase Greek letter:  $\Upsilon$ ,  $\Delta$ ,  $\Xi$ ,  
191  $\Lambda$ ,  $\Sigma$ ,  $\Omega$ , typeset as `\Upsilonres`, `\Deltares`, `\Xires`, `\Lambdares`, `\Sigmares`,  
192 `\Omegares` (or with the appropriate macros adding charge and subscripts). Paper  
193 titles in the bibliography must be adapted accordingly. Note that the  $\Lambda$  baryon has  
194 no zero, while the  $\Lambda_b^0$  baryon has one. That’s historical.
- 195 9. Unless there is a good reason not to, the charge of a particle should be specified if  
196 there is any possible ambiguity ( $m(K^+K^-)$  instead of  $m(KK)$ , which could refer to  
197 neutral kaons).
- 198 10. Decay chains can be written in several ways, depending on the complexity and the  
199 number of times it occurs. Unless there is a good reason not to, usage of a partic-  
200 ular type should be consistent within the paper. Examples are:  $D_s^+ \rightarrow \phi\pi^+$ , with  
201  $\phi \rightarrow K^+K^-$ ;  $D_s^+ \rightarrow \phi\pi^+$  ( $\phi \rightarrow K^+K^-$ );  $D_s^+ \rightarrow \phi(K^+K^-)\pi^+$ ; or  $D_s^+ \rightarrow [K^+K^-]_\phi\pi^+$ .
- 202 11. Variables are usually italic:  $V$  is a voltage (variable), while 1 V is a volt (unit). Also  
203 in combined expressions:  $Q$ -value,  $z$ -scale,  $R$ -parity *etc.*
- 204 12. Subscripts and superscripts are roman type when they refer to a word (such as T for  
205 transverse) and italic when they refer to a variable (such as  $t$  for time):  $p_T$ ,  $\Delta m_s$ ,  
206  $t_{\text{rec}}$ .
- 207 13. Standard function names are in roman type: *e.g.* cos, sin and exp.
- 208 14. Figure, Section, Equation, Chapter and Reference should be abbreviated as Fig.,  
209 Sec. (or alternatively Sect.), Eq., Chap. and Ref. respectively, when they refer to a  
210 particular (numbered) item, except when they start a sentence. Table and Appendix  
211 are not abbreviated. The plural form of abbreviation keeps the point after the s,  
212 *e.g.* Figs. 1 and 2. Equations may be referred to either with (“Eq. (1)”) or without  
213 (“Eq. 1”) parentheses, but it should be consistent within the paper.
- 214 15. Common abbreviations derived from Latin such as “for example” (*e.g.*), “in other  
215 words” (*i.e.*), “and so forth” (*etc.*), “and others” (*et al.*), “versus” (*vs.*) can be used,  
216 with the typography shown, but not excessively; other more esoteric abbreviations  
217 should be avoided.
- 218 16. Units, material and particle names are usually lower case if spelled out, but often  
219 capitalised if abbreviated: amps (A), gauss (G), lead (Pb), silicon (Si), kaon ( $K$ ),  
220 but proton ( $p$ ).
- 221 17. Counting numbers are usually written in words if they start a sentence or if they  
222 have a value of ten or below in descriptive text (*i.e.* not including figure numbers  
223 such as “Fig. 4”, or values followed by a unit such as “4 cm”). The word ‘unity’ can

- 224 be useful to express the special meaning of the number one in expressions such as:  
 225 “The BDT output takes values between zero and unity”.
- 226 18. Numbers larger than 9999 have a small space between the multiples of thousand:  
 227 *e.g.* 10 000 or 12 345 678. The decimal point is indicated with a point rather than a  
 228 comma: *e.g.* 3.141.
- 229 19. The use of consistent rounding rule over the document is highly recommended. We  
 230 suggest to use either the rounding rules of the PDG [5]<sup>4</sup> or a simplified version of it,  
 231 using two significant digits. In all cases, the central value is given with a precision  
 232 that matches that of the uncertainty. So, for example, the result  $0.827 \pm 0.119$   
 233 should be written as  $0.83 \pm 0.12$ ,  $0.827 \pm 0.367$  should turn into  $0.8 \pm 0.4$  or  
 234  $0.83 \pm 0.37$ , and  $14.674 \pm 0.964$  becomes  $14.7 \pm 1.0$  or  $14.67 \pm 0.96$ . When writing  
 235 numbers with uncertainty components from different sources, *i.e.* statistical and  
 236 systematic uncertainties, the rule applies to the uncertainty with the best precision,  
 237 so  $0.827 \pm 0.367$  (stat)  $\pm 0.179$  (syst) goes to  $0.83 \pm 0.37$  (stat)  $\pm 0.18$  (syst) and  
 238  $8.943 \pm 0.123$  (stat)  $\pm 0.995$  (syst) goes to  $8.94 \pm 0.12$  (stat)  $\pm 1.00$  (syst).
- 239 20. When rounding numbers, avoid padding with unnecessary zeroes at the end, as it  
 240 can falsely imply additional precision. For example,  $51237 \pm 4561$  should be rounded  
 241 as  $(5.12 \pm 0.46) \times 10^4$  rather than  $51200 \pm 4600$ . However, zeroes may be retained  
 242 when reporting yields that represent exact integer counts.
- 243 21. When rounding numbers in a table, some variation of the rounding rules above may  
 244 be required to achieve uniformity.
- 245 22. Hyphenation should be used where necessary to avoid ambiguity, but not excessively.  
 246 For example: “big-toothed fish” (to indicate that big refers to the teeth, not to  
 247 the fish), but “big white fish”. A compound modifier often requires hyphenation  
 248 (*CP*-violating observables, *b*-hadron decays, final-state radiation, second-order poly-  
 249 nomial), even if the same combination in an adjective-noun combination does not  
 250 (direct *CP* violation, heavy *b* hadrons, charmless final state). Adverb-adjective  
 251 combinations are not hyphenated if the adverb ends with ‘ly’: oppositely charged  
 252 pions, kinematically similar decay. Words beginning with “all-”, “cross-”, “ex-”  
 253 and “self-” are hyphenated *e.g.* cross-section and cross-check. “two-dimensional” is  
 254 hyphenated. Words beginning with small prefixes (like “anti”, “bi”, “co”, “contra”,  
 255 “counter”, “de”, “extra”, “infra”, “inter”, “intra”, “micro”, “mid”, “mis”, “multi”,  
 256 “non”, “over”, “peri”, “post”, “pre”, “pro”, “proto”, “pseudo”, “re”, “semi”, “sub”,  
 257 “super”, “supra”, “trans”, “tri”, “ultra”, “un”, “under” and “whole”) are single words  
 258 and should not be hyphenated *e.g.* semileptonic, pseudorapidity, pseudoexperiment,  
 259 multivariate, multidimensional, reweighted,<sup>5</sup> preselection, nonresonant, nonzero,  
 260 nonparametric, nonrelativistic, antiparticle, misreconstructed and misidentified. Ex-  
 261 ceptions are cases in which the last and first letters of the two words are the same  
 262 (non-negligible, re-evaluated, *etc.*)

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<sup>4</sup>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.

<sup>5</sup>Note that we write weighted unless it’s the second weighting.

- 263 23. Minus signs should be in a proper font ( $-$ ), not just hyphens (-); this applies to  
264 figure labels as well as the body of the text. In L<sup>A</sup>T<sub>E</sub>X, use math mode (between  
265  $\$$ 's) or make a dash (“--”). In ROOT, use `#minus` to get a normal-sized minus  
266 sign.
- 267 24. Inverted commas (around a title, for example) should be a matching set of left- and  
268 right-handed pairs: “Title”. The use of these should be avoided where possible.
- 269 25. Single symbols are preferred for variables in equations, *e.g.*  $\mathcal{B}$  rather than BF for a  
270 branching fraction.
- 271 26. Parentheses are not usually required around a value and its uncertainty, before  
272 the unit, unless there is possible ambiguity: so  $\Delta m_s = 20 \pm 2 \text{ ps}^{-1}$  does not need  
273 parentheses, whereas  $f_d = (40 \pm 4)\%$  or  $x = (1.7 \pm 0.3) \times 10^{-6}$  does. The unit does  
274 not need to be repeated in expressions like  $1.2 < E < 2.4 \text{ GeV}$ .
- 275 27. The same number of decimal places should be given for all values in any one  
276 expression (*e.g.*  $5.20 < m_B < 5.34 \text{ GeV}/c^2$ ).
- 277 28. Apostrophes should be avoided for abbreviations; if the abbreviated term is capi-  
278 talised or otherwise easily identified then the plural can simply add an s, otherwise  
279 it is best to rephrase: *e.g.* HPDs, pions, rather than HPD's,  $\pi^0$ 's,  $\pi$ s.
- 280 29. Particle labels, decay descriptors and mathematical functions are not nouns, and  
281 need often to be followed by a noun. Thus “background from  $B^0 \rightarrow \pi^+\pi^-$  decays”  
282 instead of “background from  $B^0 \rightarrow \pi^+\pi^-$ ”, and “the width of the Gaussian function”  
283 instead of “the width of the Gaussian”.
- 284 30. In equations with multidimensional integrations or differentiations, the differential  
285 terms should be separated by a thin space and the d should be in roman. Thus  
286  $\int f(x, y) dx dy$  instead  $\int f(x, y) dx dy$  and  $\frac{d^2\Gamma}{dx dQ^2}$  instead of  $\frac{d^2\Gamma}{dx dQ^2}$ .
- 287 31. Double-barrelled names are typeset with a hyphen ( $-$ ), as in Gell-Mann, but joined  
288 named use an n-dash ( $--$ ), as in Breit–Wigner or Cabibbo–Kobayashi–Maskawa is  
289 preferable to indicate the collaboration between these individuals.
- 290 32. Avoid gendered words. Mother is rarely needed. Daughter can be a decay product  
291 or a final-state particle. Bachelor can be replaced by companion.

## 292 5 Detector, simulation and analysis

293 This section will cover the detector description for the Run 1 and 2 detector. For additional  
294 considerations concerning the upgraded LHCb detector, please see Sec. 5.1 below.

295 The paragraph below can be used for the detector description. Modifications may be  
296 required in specific papers to fit within page limits, to enhance particular detector elements  
297 or to introduce acronyms used later in the text. For journals where strict word counts  
298 are applied (for example, PRL), and space is at a premium, it may be sufficient to write,  
299 as a minimum: “The LHCb detector is a single-arm forward spectrometer covering the  
300 pseudorapidity range  $2 < \eta < 5$ , described in detail in Refs. [1,3]”. A slightly longer version

301 could specify the most relevant subdetectors, *e.g.* “The LHCb detector [1,3] is a single-arm  
302 forward spectrometer covering the pseudorapidity range  $2 < \eta < 5$ , designed for the study  
303 of particles containing  $b$  or  $c$  quarks. The detector elements that are particularly relevant  
304 to this analysis include: a silicon-strip vertex detector surrounding the  $pp$  interaction  
305 region that allows  $c$  and  $b$  hadrons to be identified from their characteristically long flight  
306 distance; a tracking system that provides a measurement of the momentum,  $p$ , of charged  
307 particles; and two ring-imaging Cherenkov detectors that are able to discriminate between  
308 different species of charged hadrons.”

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

316 The LHCb detector [1,3] is a single-arm forward spectrometer covering the  
317 pseudorapidity range  $2 < \eta < 5$ , designed for the study of particles containing  $b$  or  
318  $c$  quarks. The detector used to collect the data analysed in this paper includes a high-  
319 precision tracking system consisting of a silicon-strip vertex detector surrounding the  $pp$   
320 interaction region [6]\*, a large-area silicon-strip detector located upstream of a dipole  
321 magnet with a bending power of about 4 T m, and three stations of silicon-strip detectors  
322 and straw drift tubes [7,8]\*<sup>6</sup> placed downstream of the magnet. The tracking system  
323 provides a measurement of the momentum,  $p$ , of charged particles with a relative uncer-  
324 tainty that varies from 0.5% at low momentum to 1.0% at 200 GeV/ $c$ . The minimum  
325 distance of a track to a primary  $pp$  collision vertex (PV), the impact parameter (IP),  
326 is measured with a resolution of  $(15 + 29/p_T) \mu\text{m}$ , where  $p_T$  is the component of the  
327 momentum transverse to the beam, in GeV/ $c$ . Different types of charged hadrons are  
328 distinguished using information from two ring-imaging Cherenkov detectors [9]\*. Photons,  
329 electrons and hadrons are identified by a calorimeter system consisting of scintillating-pad  
330 and preshower detectors, an electromagnetic and a hadronic calorimeter. Muons are  
331 identified by a system composed of alternating layers of iron and multiwire proportional  
332 chambers [10]\*. The online event selection is performed by a trigger [11]\*, which consists of  
333 a hardware stage, based on information from the calorimeter and muon systems, followed  
334 by a software stage, which applies a full event reconstruction. Triggered data further  
335 undergo a centralised, offline processing step to deliver physics-analysis-ready data across  
336 the entire LHCb physics programme [12].

337 A more detailed description of the ‘full event reconstruction’ could be:

- 338 • The trigger [11]\* consists of a hardware stage, based on information from the  
339 calorimeter and muon systems, followed by a software stage, in which all charged  
340 particles with  $p_T > 500$  (300) MeV are reconstructed for 2011 (2012) data. For trig-  
341 gers that require neutral particles, energy deposits in the electromagnetic calorimeter  
342 are analysed to reconstruct  $\pi^0$  and  $\gamma$  candidates.

---

<sup>6</sup>Cite Ref. [7] for Run 1 analyses and Ref. [8] if Run 2 data is used.

343 The trigger description has to be specific for the analysis in question. In general, you  
344 should not attempt to describe the full trigger system. Below are a few variations that  
345 inspiration can be taken from. First from a hadronic analysis, and second from an analysis  
346 with muons in the final state. In case you have to look up specifics of a certain trigger, a  
347 detailed description of the trigger conditions for Run 1 is available in Ref. [13]. **Never**  
348 **cite this note in a PAPER or CONF-note.**

- 349 • At the hardware trigger stage, events are required to have a muon with high  $p_T$  or  
350 a hadron, photon or electron with high transverse energy in the calorimeters. For  
351 hadrons, the transverse energy threshold is 3.5 GeV. The software trigger requires a  
352 two-, three- or four-track secondary vertex with a significant displacement from any  
353 primary  $pp$  interaction vertex. At least one charged particle must have a transverse  
354 momentum  $p_T > 1.6 \text{ GeV}/c$  and be inconsistent with originating from a PV. A  
355 multivariate algorithm [14, 15]<sup>7</sup> is used for the identification of secondary vertices  
356 consistent with the decay of a  $b$  hadron.
- 357 • The  $B^0 \rightarrow K^{*0} \mu^+ \mu^-$  signal candidates are first required to pass the hardware trigger,  
358 which selects events containing at least one muon with transverse momentum  
359  $p_T > 1.48 \text{ GeV}/c$  in the 7 TeV data or  $p_T > 1.76 \text{ GeV}/c$  in the 8 TeV data. In the  
360 subsequent software trigger, at least one of the final-state particles is required to  
361 have  $p_T > 1.7 \text{ GeV}/c$  in the 7 TeV data or  $p_T > 1.6 \text{ GeV}/c$  in the 8 TeV data, unless  
362 the particle is identified as a muon in which case  $p_T > 1.0 \text{ GeV}/c$  is required. The  
363 final-state particles that satisfy these transverse momentum criteria are also required  
364 to have an impact parameter larger than 100  $\mu\text{m}$  with respect to all PVs in the  
365 event. Finally, the tracks of two or more of the final-state particles are required to  
366 form a vertex that is significantly displaced from any PV.”

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

- 369 • The online event selection is performed by a trigger which consists of a hardware  
370 stage followed by a two-level software stage. In between the two software stages,  
371 an alignment and calibration of the detector is performed in near real-time and  
372 their results are used in the trigger [16]. The same alignment and calibration  
373 information is propagated to the offline reconstruction, ensuring consistent and  
374 high-quality particle identification (PID) information between the trigger and offline  
375 software. The identical performance of the online and offline reconstruction offers  
376 the opportunity to perform physics analyses directly using candidates reconstructed  
377 in the trigger [11, 17] which the present analysis exploits. The storage of only the  
378 triggered candidates enables a reduction in the event size by an order of magnitude.

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

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

---

<sup>7</sup>Ref. [15] is only for Run 2.

384 If relevant to your analysis and workflow, please consider adding further information  
385 about the data processing to complement the **Stripping**-related sentence Triggered data  
386 further undergo a centralised, offline processing step to deliver physics-analysis-ready data  
387 across the entire LHCb physics programme [18].

388 A good example of a description of long and downstream  $K_S^0$  is given in Ref. [19]:

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

395 Before describing the simulation, explain in one sentence why simulation is needed.  
396 The following paragraph can act as inspiration but with variations according to the level  
397 of detail required and if mentioning of *e.g.* PHOTOS and ReDecay is required.

- 398 • Simulation is required to model the effects of the detector acceptance and the  
399 imposed selection requirements. In the simulation,  $pp$  collisions are generated  
400 using PYTHIA (see Table 2 for the specific citations) with a specific LHCb  
401 configuration [20]. Decays of unstable particles are described by EVTGEN [21], in  
402 which final-state radiation is generated using PHOTOS [22]. The interaction of the  
403 generated particles with the detector, and its response, are implemented using the  
404 GEANT4 toolkit [23] as described in Ref. [24]. The underlying  $pp$  interaction is  
405 reused multiple times, each with an independently generated signal decay [25].<sup>8</sup>

406 A sentence useful to describe simulation reweighting to match data is: The simulated  
407 samples are corrected to account for known data-simulation differences in the  $B/B^0/B_s^0A_b^0$   
408 production kinematics and detector occupancy, as well as track reconstruction, particle  
409 identification and trigger efficiencies.

410 A quantity often used in LHCb analyses is  $\chi_{\text{IP}}^2$ . When mentioning it in a paper, the  
411 following wording could be used: “. . .  $\chi_{\text{IP}}^2$  with respect to any primary interaction vertex  
412 greater than X, where  $\chi_{\text{IP}}^2$  is defined as the difference in the vertex-fit  $\chi^2$  of a given PV  
413 reconstructed with and without the track under consideration/being considered.”<sup>9</sup> This  
414 definition can then be used to define the associated PV.<sup>10</sup> However,  $\chi_{\text{IP}}^2$  should not be  
415 defined just to explain which PV is taken as associated. Instead one can write “The PV  
416 that fits best to the flight direction of the  $B$  candidate is taken as the associated PV.”

417 Many analyses depend on boosted decision trees. It is inappropriate to use TMVA [26]  
418 as sole reference as that is merely an implementation of the BDT algorithm. Rather  
419 it is suggested to write: “In this paper a boosted decision tree (BDT) classifier [27, 28]  
420 implemented in the TMVA toolkit [26] is used to separate signal from background”.

421 When describing the integrated luminosity of the dataset, do not use expressions like  
422 “ $1.0 \text{ fb}^{-1}$  of data”, but *e.g.* “data sample corresponding to an integrated luminosity of  
423  $1.0 \text{ fb}^{-1}$ ”, or “a sample of data obtained from  $3 \text{ fb}^{-1}$  of integrated luminosity”.

---

<sup>8</sup>This sentence is to be added only if ReDecay is used.

<sup>9</sup>If this sentence is used to define  $\chi_{\text{IP}}^2$  for a composite particle instead of for a single track, replace “track” by “particle” or “candidate”.

<sup>10</sup>known as “best” PV in DAVINCI. Use the word “associated”, not “best”.

424 For analyses where the periodical reversal of the magnetic field is crucial, *e.g.* in  
425 measurements of direct  $CP$  violation, the following description can be used as an example  
426 phrase:

- 427 • The magnetic field deflects oppositely charged particles in opposite directions and  
428 this can lead to detection asymmetries. Periodically reversing the magnetic field  
429 polarity throughout the data taking almost cancels the effect. The configuration  
430 with the magnetic field pointing upwards (downwards), *MagUp* (*MagDown*), bends  
431 positively (negatively) charged particles in the horizontal plane towards the centre  
432 of the LHC ring.

433 Only use the *MagUp*, *MagDown* symbols if they are used extensively in tables or figures.

434 If the momentum scaling has been applied and is relevant, add text along the lines of

435 **Run 1–2:** The momentum scale is calibrated using samples of  $J/\psi \rightarrow \mu^+\mu^-$  and  
436  $B^+ \rightarrow J/\psi K^+$  decays collected concurrently with the data sample used for this  
437 analysis [29, 30]. The relative accuracy of this procedure is estimated to be  $3 \times 10^{-4}$   
438 using samples of other fully reconstructed  $b$  hadrons,  $\Upsilon$  and  $K_S^0$  mesons.

439 **Run 3:** The momentum scale is calibrated using samples of  $J/\psi \rightarrow \mu^+\mu^-$  and  
440  $B^+ \rightarrow J/\psi K^+$  decays collected concurrently with the data sample used for this  
441 analysis [31]. The relative accuracy of this procedure is estimated to be  $2 \times 10^{-4}$   
442 using samples of  $\Upsilon$  mesons. This number does not consider any uncertainty due  
443 to mismodelling of energy loss. This may be important if you have soft tracks,  
444 *e.g.*  $\psi(2S)$ , and may require an additional systematic uncertainty to be evaluated,  
445 assigned and described.

446 However depending on the actual momentum range the latter value can be underestimated,  
447 particularly for soft tracks or EW physics. Consult with specialists.

448 When describing "blind analysis", consider adding the following sentence:

- 449 • In order to avoid experimenter's bias, the results of the analysis were not examined  
450 until the full procedure had been finalised.

451 In case you want describe the rejections of clones, consider the following sentence:  
452 "background including duplicate tracks from the same particle hits is rejected offline with  
453 a requirement on the minimum angle between each pair of tracks".

## 454 5.1 LHCb Upgrade detector

455 For analyses using Run 3 data, the detector description will be different, of course. The  
456 very short and short forms, could read the same, but with an added reference:

- 457 • The LHCb Run 3 detector is a single-arm forward spectrometer covering the pseu-  
458 dorapidity range  $2 < \eta < 5$ , described in detail in Refs. [4, 32].
- 459 • The LHCb Run 3 detector [4, 32] is a single-arm forward spectrometer covering the  
460 pseudorapidity range  $2 < \eta < 5$ , designed for the study of particles containing  $b$  or  $c$   
461 quarks. It was installed during LHC long-shutdown 2, to allow effective operation  
462 at about five times the luminosity with respect to the Run 1–2 detector [1, 3]. The

LHCb Run 3 detector keeps the general organisation of subsystems of the original LHCb detector [1, 3] though most subsystems were changed.

The detector elements that are particularly relevant to this analysis include: a silicon-pixel 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 the momentum,  $p$ , of charged particles; and two ring-imaging Cherenkov detectors that are able to discriminate between different species of charged hadrons, an electromagnetic calorimeter to reconstruct electrons and photons and a muon system to identify muons.

The longer version could read something like the following:<sup>11</sup>

- The LHCb Run 3 detector [4, 32] is a single-arm forward spectrometer covering the pseudorapidity range  $2 < \eta < 5$ , designed for the study of particles containing  $b$  or  $c$  quarks. Installed prior to the start of Run 3 data taking in 2022, it represents a major upgrade of the detector system. The new configuration was designed to match the performance of the Run 1–2 detector [1, 3], while allowing it to operate at approximately five times the luminosity.

The high-precision tracking system consists of a silicon-pixel vertex detector surrounding the  $pp$  interaction region [33]\*, a large-area silicon-strip detector [34]\* located upstream of a dipole magnet with a bending power of about 4 T m, and three stations of scintillating-fibre detectors. [34]\* The magnet polarity is flipped on a regular basis, and XX% (YY%) of the data in this analysis are collected under the configuration with the magnet field pointing upwards (downwards). Different types of charged hadrons are distinguished using information from two ring-imaging Cherenkov detectors, equipped with photon detection systems. Photons, electrons and hadrons are identified by a calorimeter system consisting of electromagnetic and hadronic calorimeters. Muons are identified by a system composed of alternating layers of iron and multiwire proportional chambers [35]\*.

The readout of all LHCb subsystems at the bunch-crossing frequency and the subsequent processing of the data in an all-software trigger [36–39] is a central feature of the upgraded detector, enabling the reconstruction and selection of events in real time. The trigger system is implemented in two stages: a GPU-based inclusive stage (HLT1) focused primarily on charged particle reconstruction, which reduces the data volume by roughly a factor of 20 [39], followed by a CPU-based stage (HLT2), which performs the physics-analysis-quality reconstruction and selection of physics signatures [36]. A large disk buffer is placed between these stages to hold the data while the real-time alignment and calibration is being performed. Owing to the removal of the hardware trigger present during Run 1 and Run 2 and the new optimised inclusive HLT1 trigger [40]\*, a higher reconstruction efficiency of low transverse momentum candidates is achieved for fully hadronic decays. The measurement presented in this article also benefits from a series of HLT2 triggers that exclusively select the final state particles based on their topology. Triggered data further undergo a centralised, offline processing step to deliver physics-analysis-ready data across the entire LHCb physics programme [18, 41].

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<sup>11</sup>For the time being the TDRs are cited. They will be replaced by performance papers as they appear.

506 Note that it will generally be appropriate to add more detail on the trigger algorithms  
507 used, but this will depend on the specific analysis.

508 If SMOG was used one could add one of

- 509 • An additional interaction region is generated by the SMOG2 cell [42, 43], which  
510 allows LHCb to inject different species of gases, including non-noble ones such as  
511 hydrogen, approximately 340 mm upstream of the nominal LHC interaction point.  
512 This leads to fixed-target collisions that occur in parallel to the collisions of LHC  
513 beams at a nucleon-nucleon centre of mass energy of  $\sqrt{s_{\text{NN}}} = 113$  GeV for a proton  
514 beam with 6.8 TeV energy and of  $\sqrt{s_{\text{NN}}} = 70.9$  GeV for 5.36 TeV lead beams.
- 515 • Part of the data was taken with gas injected in upstream of the nominal LHC  
516 interaction point producing fixed-target collisions that occur in parallel to the  
517 collisions of the LHC beams [42, 43].

## 518 6 Figures

519 A standard LHCb style file for use in production of figures in ROOT is in GIT at  
520 <https://gitlab.cern.ch/lhcb-docs/lhcbstyle>. It is not mandatory to use this style,  
521 but it makes it easier to follow the recommendations below. For labelling the axis and  
522 legends it is recommended to use (as in the examples) the same text fonts as in the main  
523 text. When using ROOT to produce the plots, use the upright symbol font for text. The  
524 slanted font exists, but does not look good. It is also possible to use consistently upright  
525 sans-serif fonts for the text (slide style). However, styles should not be mixed. For particle  
526 symbols, try to use the same font (roman/italic) as is used in the text.

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

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

- 536 1. Before you make a figure you should ask yourself what message you want to get across.  
537 You don't make a plot "because you can" but because it is the best illustration of  
538 your argument.
- 539 2. Figures should be legible at the size they will appear in the publication, with suitable  
540 line width. Their axes should be labelled, and have suitable units (e.g. avoid a mass  
541 plot with labels in  $\text{MeV}/c^2$  if the region of interest covers a few  $\text{GeV}/c^2$  and all the  
542 numbers then run together). Spurious background shading and boxes around text  
543 should be avoided.
- 544 3. For the  $y$ -axis, "Entries" or "Candidates" is appropriate in case no background sub-  
545 traction has been applied. Otherwise "Yield" or "Decays" may be more appropriate.  
546 If the unit on the  $y$ -axis corresponds to the yield per bin, indicate so, for example  
547 "Entries / ( $5 \text{ MeV}/c^2$ )" or "Entries per  $5 \text{ MeV}/c^2$ ".

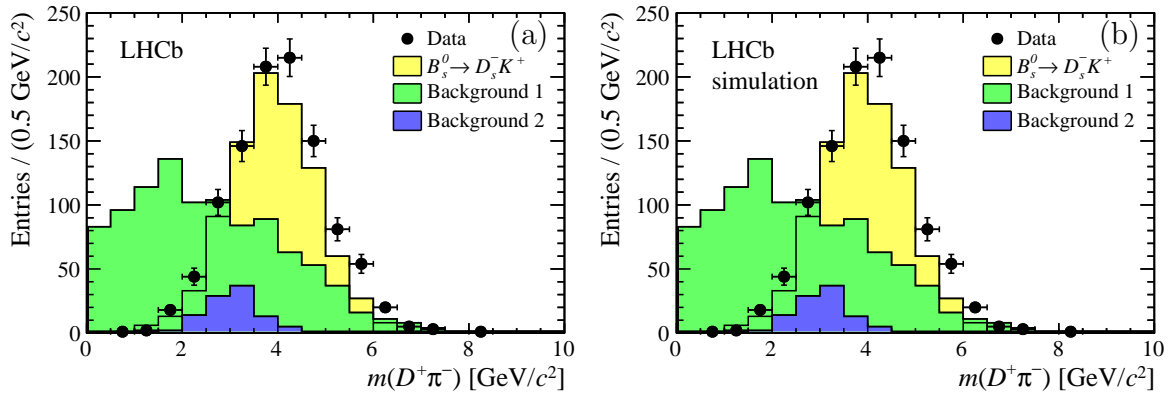


Figure 1: Example plots for (a) data and (b) simulation using the LHCb style from the URANIA package `RootTools/LHCbStyle`. The signal data is shown as points with the signal component as yellow (light shaded), background 1 as green (medium shaded) and background 2 as blue (dark shaded).

- 548 4. Fit curves should not obscure the data points, and data points are best (re)drawn  
549 over the fit curves. In this case avoid in the caption the term “overlaid” when  
550 referring to a fit curve, and instead use the words “shown” or “drawn”.
- 551 5. Colour may be used in figures, but the distinction between differently coloured  
552 areas or lines should be clear also when the document is printed in black and white,  
553 for example through differently dashed lines. The LHCb style mentioned above  
554 implements a colour scheme that works well but individual adjustments might be  
555 required.
- 556 In particular for two-dimensional plots, never use the default “rainbow” palette from  
557 ROOT, as both extreme values will appear dark when printed in black-and-white, or  
558 viewed by colour-blind people. Printer-friendly palettes are advised. You can make  
559 your own using [colorbrewer2.org](http://colorbrewer2.org).
- 560 6. Using different hatching styles helps to distinguished filled areas, also in black  
561 and white prints. Hatching styles 3001-3025 should be avoided since they behave  
562 unpredictably under zooming and scaling. Good styles for “falling hatched” and  
563 “rising hatched” are 3345 and 3354.
- 564 7. Figures with more than one part should have the parts labelled (a), (b) *etc.*, with  
565 a corresponding description in the caption; alternatively they should be clearly  
566 referred to by their position, e.g. Fig. 1 (left). In the caption, the labels (a), (b) *etc.*  
567 should precede their description. When referencing specific subfigures, use “see Fig.  
568 1(a)” or “see Figs. 2(b)-(e)”.
- 569 8. All figures containing LHCb data should have “LHCb” written on them. For  
570 preliminary results, that should be replaced by “LHCb preliminary”. Figures that  
571 only have simulated data should display “LHCb simulation”. Figures that do not  
572 depend on LHCb-specific software (*e.g.* only on PYTHIA) should not have any label.
- 573 9. All figures containing LHCb data should have the corresponding luminosity written  
574 on them. For example, if all Run 1&2 data were analysed, write “9 fb<sup>-1</sup>” in a

575 new line underneath "LHCb". Alternatively the luminosity could be added as  
 576 "data symbol Data 9 fb<sup>-1</sup>". For cross-section or heavy-ion papers it might be more  
 577 useful to give centre-of-mass energy " $\sqrt{s} = 13 \text{ TeV}$ " instead of luminosity.

578 10. Keep captions short. They should contain the information necessary to understand  
 579 the figure, but no more. For instance the fit model does not need to be repeated.  
 580 Describe the data first, then mention the fit components.

581 11. An example diagram depicting the angles in a  $B_s^0 \rightarrow K^{*0} \bar{K}^{*0}$  decay is shown in Fig. 2.  
 582 The source code is provided in Figures/diagram.tex and can be adapted to any  
 583 four-body decay.<sup>12</sup>

## 584 7 References

585 References should be made using BibT<sub>E</sub>X [44]. A special style LHCb.bst has been created  
 586 to achieve a uniform style. Independent of the journal the paper is submitted to, the  
 587 preprint should be created using this style. Where arXiv numbers exist, these should be  
 588 added even for published articles. In the PDF file, hyperlinks will be created to both the  
 589 arXiv and the published version, using the doi for the latter.

590 Results from other experiments should be cited even if not yet published.

591 1. Citations are marked using square brackets, and the corresponding references should  
 592 be typeset using BibT<sub>E</sub>X and the official LHCb BibT<sub>E</sub>X style.

593 2. For references with four or less authors all of the authors' names are listed [45],  
 594 otherwise the first author is given, followed by *et al.*. The LHCb BibT<sub>E</sub>X style will  
 595 take care of this. The limit of four names can be changed by changing the number 4  
 596 in "#4 'max.num.names.before.forced.et.al :=" in LHCb.bst, as was done in  
 597 Ref. [46].

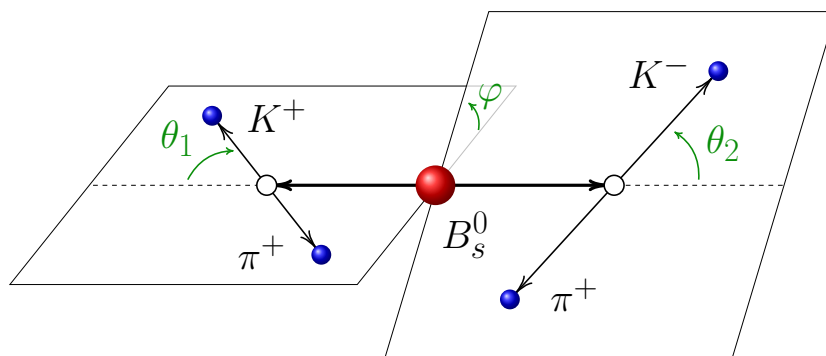


Figure 2: Definition of the angles  $\theta_1$ ,  $\theta_2$  and  $\varphi$  in the  $B_s^0 \rightarrow K^{*0} \bar{K}^{*0}$  decay. Image by Julian Garcia Pardinás.

<sup>12</sup>This is example of a footnote that goes below a floating object thanks to the footmisc package. Some argue this is horrid.

- 598 3. The order of references should be sequential when reading the document. This is  
599 automatic when using Bib<sub>T</sub>EX.
- 600 4. The titles of papers should in general be included. To remove them, change  
601 `\setboolean{articletitles}{false}` to `true` at the top of this template.
- 602 5. Whenever possible, use references from the supplied files `main.bib`, `LHCb-PAPER.bib`,  
603 `LHCb-CONF.bib`, and `LHCb-DP.bib`. These are kept up-to-date by the EB. If you see  
604 a mistake, do not edit these files, but let the EB know. This way, for every update  
605 of the paper, you save yourself the work of updating the references. Instead, you  
606 can just copy or check in the latest versions of the `.bib` files from the repository.  
607 **Do not take these references from inspirehep instead** (“Aaaij:20XXxyz”),  
608 as `inspirehep` sometimes adds mistakes, does not handle errata properly and does  
609 not use LHCb-specific macros.
- 610 6. For references to the PDG, make sure to refer to the version that you took the  
611 numbers from. This should preferably be the latest version available at the time of  
612 submission, but if you took the numbers from an older version and it is too late in  
613 the review to change it, use that. If the average you use is coming from HFLAV,  
614 cite HFLAV directly instead. If the “average” is just from a single measurement,  
615 reference the original paper instead of the PDG.
- 616 7. For references to HFLAV, the reference should be made to the applicable Zenodo  
617 record found in the [HFLAV community](#) rather than to the HFLAV website. This  
618 ensures that the reference is to a specific version of the HFLAV averages, and that it  
619 will be properly cited in the future. Copy the `HFLAV23-Zenodo-XXXXXX` entry from  
620 `LHCb/standard.bib` into `main.bib` and update the three instances of `XXXXXX` with  
621 the applicable Zenodo record number. If the HFLAV averages are not yet available  
622 on Zenodo at the time of submission, use the old style “HFLAV23” reference, but  
623 update it to the Zenodo record as soon as it becomes available.
- 624 8. For those references not provided by the EB, the best is to copy the Bib<sub>T</sub>EX entry  
625 directly from [inspirehep](#). Often these need to be edited to get the correct title,  
626 author names and formatting. The warning about special UTF8 characters should  
627 never be ignored. It usually signals a accentuated character in an author name.  
628 For authors with multiple initials, add a space between them (change `R.G.C.` to `R.  
629 G. C.`), otherwise only the first initial will be taken. Also, make sure to eliminate  
630 unnecessary capitalisation. Apart from that, the title should be respected as much as  
631 possible (*e.g.* do not change particle names to PDG convention nor introduce/remove  
632 factors of *c*, but do change Greek capital letters to use our slanted font.). Check that  
633 both the arXiv and the journal index are clickable and point to the right article.
- 634 9. The `mciteplus` [47] package is used to enable multiple references to  
635 show up as a single item in the reference list. As an example  
636 `\cite{Cabibbo:1963yz,*Kobayashi:1973fv}` where the `*` indicates that the ref-  
637 erence should be merged with the previous one. The result of this can be seen in  
638 Ref. [48]. Be aware that the `mciteplus` package should be included as the very last  
639 item before the `\begin{document}` to work correctly.

- 640 10. It should be avoided to make references to public notes and conference reports in  
641 public documents. Exceptions can be discussed on a case-by-case basis with the  
642 review committee for the analysis. In internal reports they are of course welcome  
643 and can be referenced as seen in Ref. [49] using the `lhcbreport` category. For  
644 conference reports, omit the author field completely in the BibTeX record.
- 645 11. To get the typesetting and hyperlinks correct for LHCb reports, the category  
646 `lhcbreport` should be used in the BibTeX file. See Refs. [50] for some examples.  
647 It can be used for LHCb documents in the series `CONF`, `PAPER`, `PROC`, `THESIS`, `LHCC`,  
648 `TDR` and internal LHCb reports. Papers sent for publication, but not published yet,  
649 should be referred with their `arXiv` number, so the `PAPER` category should only be  
650 used in the rare case of a forward reference to a paper.
- 651 12. Proceedings can be used for references to items such as the LHCb simulation [24],  
652 where we do not yet have a published paper.
- 653 13. External software should be cited whenever possible. A list of references to com-  
654 mon software tools is available in the `standard.bib`. To check for possible soft-  
655 ware citations, there is a helpful command that will automatically scan your repo  
656 and give some useful feedback, it can be found in the EB FAQ entry [Publishing-  
657 FAQ#How\\_do\\_I\\_cite\\_software](#).

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

## 659 8 Acknowledgements paragraph

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

662 The text below are the acknowledgements as approved by the collaboration board.  
663 Extending the acknowledgements to include individuals from outside the collaboration who  
664 have contributed to the analysis should be approved by the EB. The extra acknowledge-  
665 ments are normally placed before the standard acknowledgements, unless it matches better  
666 with the text of the standard acknowledgements to put them elsewhere. They should  
667 be included in the draft for the first circulation. Except in exceptional circumstances,  
668 to be approved by the EB chair, authors of the paper should not be named in extended  
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## 692 9 Inclusion of supplementary material

693 Three types of supplementary material should be distinguished:

- 694 • A regular appendix: lengthy equations or long tables are sometimes better put in  
695 an appendix in order not to interrupt the main flow of a paper. Appendices will  
696 appear in the final paper, on arXiv and on the CDS record and should be considered  
697 integral part of a paper, and are thus to be reviewed like the rest of the paper. An  
698 example of an LHCb paper with an appendix is Ref. [51].
- 699 • Supplementary material for CDS: plots or tables that would make the paper exceed  
700 the page limit or are not appropriate to include in the paper itself, but are desirable  
701 to be shown in public should be added to the paper drafts in an appendix, and  
702 removed from the paper before submitting to arXiv or the journal. See Appendix D  
703 for further instructions. Examples are: comparison plots of the new result with  
704 older results, plots that illustrate cross-checks. An example of an LHCb paper  
705 with supplementary material for CDS is Ref. [52]. Supplementary material for CDS  
706 cannot be referenced in the paper. Supplementary material should be included in  
707 the draft paper to be reviewed by the collaboration.
- 708 • Supplementary material for the paper. This is usually called “supplemental material”,  
709 which distinguishes it from supplementary material for CDS only. Most journals  
710 allow to submit files along with the paper that will not be part of the text of  
711 the article, but will be stored on the journal server. Examples are plain text files  
712 with numerical data corresponding to the plots in the paper. The supplemental  
713 material should be cited in the paper by including a reference which should say  
714 “See supplemental material at [link] for [give brief description of material].” The  
715 journal will insert a specific link for [link]. The arXiv version will usually include the  
716 supplemental material as part of the paper and so should not contain the words “at  
717 [link]”. Supplemental material should be included in the draft paper to be reviewed  
718 by the collaboration. An example of an LHCb paper with supplemental material is  
719 Ref. [53]

## 720 Appendices

### 721 A Standard References

722 Below is a list of common references, as well as a list of all LHCb publications. As they are  
 723 already in prepared bib files, they can be used as simply as `\cite{LHCb-DP-2008-001}`  
 724 to get the LHCb detector paper. The references are defined in the files `main.bib`,  
 725 `LHCb-PAPER.bib`, `LHCb-CONF.bib`, `LHCb-DP.bib` `LHCb-TDR.bib` files, with obvious con-  
 726 tents. Each of these have their `LHCb-ZZZ-20XX-0YY` number as their cite code. If you  
 727 believe there is a problem with the formatting or content of one of the entries, then get in  
 728 contact with the Editorial Board rather than just editing it in your local file, since you  
 729 are likely to need the latest version just before submitting the article.

Table 2: Standard references.

Description	Ref.	cite code
Lee, Weinberg, Zumino	[45]	Lee:1967iu
Cabibbo, Kobayashi, Maskawa	[48]	Cabibbo:1963yz,*Kobayashi:1973fv
Quark Model	[54]	GellMann:1964nj,*Petermann:1965qlk,*Zwe
Baryon asymmetry & SM <i>CP</i>	[55]	Gavela:1994dt
Baryon asymmetry & SM <i>CP</i>	[56]	Gavela:1993ts
EW Baryogenesis & <i>CP</i>	[57]	Huet:1994jb
Dalitz Plot <sup>13</sup>	[58]	Dalitz:1953cp,*Fabri:1954zz
PDG 2024	[5]	PDG2024
PDG 2022	[59]	PDG2022
PDG 2020	[60]	PDG2020
HFLAV Zenodo record <sup>14</sup>	[61]	HFLAV23-Zenodo-XXXXXX
HFLAV 2023 <sup>15</sup>	[62]	HFLAV23
HFLAV 2021	[63]	HFLAV21
HFLAV 2018	[64]	HFLAV18
CKMfitter group	[65]	CKMfitter2005
CKMfitter group	[66]	CKMfitter2015
UTfit (Standard Model/CKM)	[67]	UTfit-UT
UTfit (New Physics)	[68]	UTfit-NP
PYTHIA 8.3	[69]	10.21468/SciPostPhysCodeb.8,*10.21468/S
PYTHIA 8.2	[70]	Sjostrand:2014zea
PYTHIA 8.1	[71]	Sjostrand:2007gs,*Sjostrand:2006za
PYTHIA 6		use only Sjostrand:2006za
LHCb PYTHIA tuning	[20]	LHCb-PROC-2010-056
EVTGEN	[21]	Lange:2001uf
PHOTOS	[22]	davidson2015photos
GEANT4	[23]	Allison:2006ve,*Agostinelli:2002hh
LHCb simulation	[24]	LHCb-PROC-2011-006

<sup>13</sup>Dalitz invented the method, Fabri added relativistic corrections.

<sup>14</sup>See Sec. 7 for usage.

<sup>15</sup>Use the Zenodo record instead.

– continued from previous page.

RapidSim	[72]	Cowan:2016tnm
DIRAC	[73]	Tsaregorodtsev:2010zz,*BelleDIRAC
HLT2 topological trigger	[14]	BBDT
Topological trigger reoptimization — Run 2	[15]	LHCb-PROC-2015-018
Turbo and real-time alignment — Run 2	[16]	LHCb-PROC-2015-011
TisTos method	[11]	LHCb-DP-2012-004
Allen	[74]	Aaij:2019zbu
Networks use in HLT	[40]	Kitouni:2021fkh
Stripping	[12]	Stripping
Sprucing	[18]	Sprucing
PIDCalib	[75]	LHCb-PUB-2016-021
PID performance (for Run 1/Run 2)	[9]	LHCb-DP-2012-003/ ????
Ghost probability	[76]	DeCian:2255039
Primary vertex reconstruction	[77]	Kucharczyk:1756296
DecayTreeFitter	[78]	Hulsbergen:2005pu
SMOG	[79]	FerroLuzzi:2005em,*SmogPhDThesis
SMOG2	[80]	Smog2
Run 2 tagging	[81]	Fazzini:2018dyq
OS $K$ , $\mu$ , $e$ and VS tagging	[82]	LHCb-PAPER-2011-027
OS charm tagging	[83]	LHCb-PAPER-2015-027
SS kaon tagging	[84]	LHCb-PAPER-2015-056
SS proton and pion tagging	[85]	LHCb-PAPER-2016-039
Inclusive tagging	[86]	LHCb-PAPER-2025-024
Recommendations for multiple candidates	[87]	Koppenburg:2017zsh
Material in inner tracker	[88]	LHCb-2008-054
See also Table 3 for LHCb performance references.		
<i>sPlot</i>	[89]	Pivk:2004ty
sFit	[90]	Xie:2009rka
Punzi’s optimization	[91]	Punzi:2003bu
BDT	[27]	Breiman
BDT training	[28]	AdaBoost
TMVA <sup>16</sup>	[26]	Hocker:2007ht,*TMVA4
k-fold	[92]	kFold
RooUnfold	[93]	Adye:2011gm
scikit-learn	[94]	Scikit-learn-paper
pyhf:2021	[95]	py:pyhf:2021
uproot	[96]	py:uproot
hist	[97]	py:hist
particle	[98]	py:particle
mplhep	[99]	py:mplhep
scikit-hep:2020	[100]	py:scikit-hep:2020
boost-histogram	[101]	py:boost-histogram
hepstats	[102]	py:hepstats
iminuit	[103]	py:iminuit

<sup>16</sup>Do not cite this instead of the actual reference for the MVA being used.

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hepunits	[104] py:hepunits
vector	[105] py:vector
awkward-array	[106] py:awkward-array
zfit:2020	[107] py:zfit:2020
zfit	[108] py:zfit
phasespace:2019	[109] py:phasespace:2019
pytorch	[110] py:pytorch
LAURA <sup>++</sup>	[111] Back:2017zqt
hep_ml	[112] Rogozhnikov:2016bdp
root_numpy	[113] root-numpy
GammaCombo <sup>17</sup>	[116] GammaCombo
TENSORFLOW	[117] tensorflow2015-whitepaper
FunTuple	[41] FunTuple
Crystal Ball function <sup>18</sup>	[118] Skwarnicki:1986xj
Hypatia function	[119] Santos:2013gra
Modified Novosibirsk function	[120] Ikeda:1999aq
Bukin function	[121] Bukin:2007
Wilks’ theorem	[122] Wilks:1938dza [123] Cowan:2010js
CL <sub>s</sub> method	[124] CLs
BLUE method	[125] Nisius:2020jmf
Bootstrapping	[126] efron:1979
Blatt–Weisskopf barrier	[127] Blatt:1952ije
$f_s/f_d$ at 7–8 and 13 TeV	[128] LHCb-PAPER-2020-046
LHC beam energy uncertainty	[129] PhysRevAccelBeams.20.081003
Exotic hadron naming convention	[130] LHCb-PUB-2022-013
Measurement of the instrumental asymmetry for $K^-\pi^+$ -pairs at LHCb in Run 2	[131] LHCb-PUB-2018-004

730

Table 3: LHCb detector performance papers.

LHCb-DP number	Title
LHCb-DP-2026-006 [4]	Performances of the LHCb Run 3 detector
LHCb-DP-2025-007 [35]	Performance of the LHCb muon detector in Run 3
LHCb-DP-2025-006 [132]	A method for luminosity determination based on real-time hit ...
LHCb-DP-2025-005 [133]	Metal Foil Detectors assembly for the beam ...
LHCb-DP-2025-004 [134]	Deuteron identification via time of flight with LHCb
LHCb-DP-2024-003 [135]	Luminosity measurement with the LHCb RICH detectors in Run 3
LHCb-DP-2024-002 [42]	High-density gas target at the LHCb experiment

<sup>17</sup>Always cite this along with Ref. [114] (or Ref. [115] if referring to the determination of  $\gamma$  with charm mixing results) as `\cite{GammaCombo,*LHCb-PAPER-2016-032 (*LHCb-PAPER-2021-033)}` (unless LHCb-PAPER-2016-032 (LHCb-PAPER-2021-033) is cited elsewhere).

<sup>18</sup>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

– continued from previous page.

LHCb-DP-2024-001	[136]	The LHCb VELO Upgrade module construction
LHCb-DP-2023-004	[137]	Tracking of charged particles with nanosecond lifetimes at LHCb
LHCb-DP-2023-003	[31]	Momentum scale calibration of the LHCb spectrometer
LHCb-DP-2023-002	[138]	Helium identification with LHCb
LHCb-DP-2023-001	[139]	Curvature-bias corrections using a pseudomass method
LHCb-DP-2022-002	[32]	The LHCb Upgrade I
LHCb-DP-2022-001	[140]	Long-lived particle reconstruction downstream of the LHCb magnet
LHCb-DP-2021-006	[141]	Identification of charm jets at LHCb
LHCb-DP-2021-004	[142]	Performance of the LHCb RICH detectors during Run 2
LHCb-DP-2021-003	[143]	A comparison of CPU and GPU implementations for the LHCb ...
LHCb-DP-2021-002	[144]	Centrality determination in heavy-ion collisions with the LHCb detector
LHCb-DP-2021-001	[145]	A parametrized Kalman filter for fast track fitting at LHCb
LHCb-DP-2020-003	[146]	Long-term operation of the multi-wire-proportional-chambers ...
LHCb-DP-2020-002	[147]	Muon identification for LHCb Run 3
LHCb-DP-2020-001	[148]	Calibration and performance of the LHCb calorimeters in Run 1 and 2 ...
LHCb-DP-2019-004	[149]	Real-time discrimination of photon pairs using machine learning ...
LHCb-DP-2019-003	[150]	Measurement of the electron reconstruction efficiency at LHCb
LHCb-DP-2019-002	[151]	Real-Time analysis
LHCb-DP-2019-001	[152]	Run 2 trigger performance
LHCb-DP-2018-004	[25]	ReDecay
LHCb-DP-2018-003	[153]	Radiation damage in TT
LHCb-DP-2018-002	[154]	VeLo material map using SMOG
LHCb-DP-2018-001	[155]	PIDCalib for Run 2 (use Ref. [75] for Run 1)
LHCb-DP-2017-001	[8]	Performance of the Outer Tracker — Run 2
LHCb-DP-2016-003	[156]	HeRSChEL
LHCb-DP-2016-001	[17]	TESLA project — Run 2
LHCb-DP-2014-002	[3]	LHCb detector performance
LHCb-DP-2014-001	[6]	Performance of the LHCb Vertex Locator
LHCb-DP-2013-003	[7]	Performance of the LHCb Outer Tracker — Run 1
LHCb-DP-2013-002	[157]	Measurement of the track reconstruction efficiency at LHCb
LHCb-DP-2013-001	[158]	Performance of the muon identification at LHCb
LHCb-DP-2012-005	[159]	Radiation damage in the LHCb Vertex Locator
LHCb-DP-2012-004	[11]	The LHCb trigger and its performance in 2011
LHCb-DP-2012-003	[9]	Performance of the LHCb RICH detector at the LHC
LHCb-DP-2012-002	[10]	Performance of the LHCb muon system
LHCb-DP-2012-001	[160]	Radiation hardness of the LHCb Outer Tracker
LHCb-DP-2011-002	[161]	Simulation of machine induced background ...
LHCb-DP-2011-001	[162]	Performance of the LHCb muon system with cosmic rays
LHCb-DP-2010-001	[163]	First spatial alignment of the LHCb VELO ...
LHCb-DP-2008-001	[1]	LHCb detector

731

Table 4: LHCb TDRs.

LHCb-TDR number	Title
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LHCb-TDR-026	[164]	LHCb Upgrade II Scoping Document
LHCb-TDR-025	[165]	LHCb Data Acquisition Enhancement Technical Design Report
LHCb-TDR-024	[166]	LHCb Particle Identification Enhancement Technical Design Report
LHCb-TDR-023	[167]	Framework TDR for LHCb Upgrade II
LHCb-TDR-022	[168]	PLUME
LHCb-TDR-021	[39]	Allen
LHCb-TDR-020	[43]	SMOG Upgrade
LHCb-TDR-018	[38]	Upgrade computing model
LHCb-PII-Physics	[169]	Phase-II upgrade physics case
LHCb-PII-EoI	[170]	Expression of interest for Phase-II upgrade
LHCb-TDR-017	[37]	Upgrade software and computing
LHCb-TDR-016	[36]	Trigger and online upgrade
LHCb-TDR-015	[34]	Tracker upgrade
LHCb-TDR-014	[171]	PID upgrade
LHCb-TDR-013	[33]	VELO upgrade
LHCb-TDR-012	[172]	Framework TDR for the upgrade
LHCb-TDR-011	[173]	Computing
LHCb-TDR-010	[174]	Trigger
LHCb-TDR-009	[175]	Reoptimized detector
LHCb-TDR-008	[176]	Inner Tracker
LHCb-TDR-007	[177]	Online, DAQ, ECS
LHCb-TDR-006	[178]	Outer Tracker
LHCb-TDR-005	[179]	VELO
LHCb-TDR-004	[180]	Muon system
LHCb-TDR-003	[181]	RICH
LHCb-TDR-002	[182]	Calorimeters
LHCb-TDR-001	[183]	Magnet

732

Table 5: LHCb-PAPERS (which have their identifier as their cite code). DNE: Does not exist.

LHCb-PAPER-2026-040	[184]	LHCb-PAPER-2026-039	[185]	LHCb-PAPER-2026-038	[186]	LHCb-PAPER-2026-037	[187]	LHCb-PAPER-2026-036	[188]
LHCb-PAPER-2026-035	[189]	LHCb-PAPER-2026-034	[190]	LHCb-PAPER-2026-033	[191]	LHCb-PAPER-2026-032	[192]	LHCb-PAPER-2026-031	[193]
LHCb-PAPER-2026-030	[194]	LHCb-PAPER-2026-029	[195]	LHCb-PAPER-2026-028	[196]	LHCb-PAPER-2026-027	[197]	LHCb-PAPER-2026-026	[198]
LHCb-PAPER-2026-025	[199]	LHCb-PAPER-2026-024	[200]	LHCb-PAPER-2026-023	[201]	LHCb-PAPER-2026-022	[202]	LHCb-PAPER-2026-021	[203]
LHCb-PAPER-2026-020	[204]	LHCb-PAPER-2026-019	[205]	LHCb-PAPER-2026-018	[206]	LHCb-PAPER-2026-017	[207]	LHCb-PAPER-2026-016	[208]
LHCb-PAPER-2026-015	[209]	LHCb-PAPER-2026-014	[210]	LHCb-PAPER-2026-013	[211]	LHCb-PAPER-2026-012	[212]	LHCb-PAPER-2026-011	[213]
LHCb-PAPER-2026-010	[214]	LHCb-PAPER-2026-009	[215]	LHCb-PAPER-2026-008	[216]	LHCb-PAPER-2026-007	[217]	LHCb-PAPER-2026-006	[218]
LHCb-PAPER-2026-005	[219]	LHCb-PAPER-2026-004	[220]	LHCb-PAPER-2026-003	[221]	LHCb-PAPER-2026-002	[222]	LHCb-PAPER-2026-001	[223]
LHCb-PAPER-2025-074	[224]	LHCb-PAPER-2025-073	[225]	LHCb-PAPER-2025-072	[226]	LHCb-PAPER-2025-071	[227]	LHCb-PAPER-2025-070	[228]
LHCb-PAPER-2025-069	[229]	LHCb-PAPER-2025-068	[230]	LHCb-PAPER-2025-067	[231]	LHCb-PAPER-2025-066	[232]	LHCb-PAPER-2025-065	[233]
LHCb-PAPER-2025-065	[233]	LHCb-PAPER-2025-064	[234]	LHCb-PAPER-2025-063	[235]	LHCb-PAPER-2025-062	[236]	LHCb-PAPER-2025-061	[237]
LHCb-PAPER-2025-060	[238]	LHCb-PAPER-2025-059	[239]	LHCb-PAPER-2025-058	[240]	LHCb-PAPER-2025-057	[241]	LHCb-PAPER-2025-056	[242]
LHCb-PAPER-2025-055	[243]	LHCb-PAPER-2025-054	[244]	LHCb-PAPER-2025-053	[245]	LHCb-PAPER-2025-052	[246]	LHCb-PAPER-2025-051	[247]
LHCb-PAPER-2025-050	[248]	LHCb-PAPER-2025-049	[249]	LHCb-PAPER-2025-048	[250]	LHCb-PAPER-2025-047	[251]	LHCb-PAPER-2025-046	[252]
LHCb-PAPER-2025-045	[253]	LHCb-PAPER-2025-044	[254]	LHCb-PAPER-2025-043	[255]	LHCb-PAPER-2025-042	[256]	LHCb-PAPER-2025-041	[257]
LHCb-PAPER-2025-040	[258]	LHCb-PAPER-2025-039	[259]	LHCb-PAPER-2025-038	[260]	LHCb-PAPER-2025-037	[261]	LHCb-PAPER-2025-036	[262]
LHCb-PAPER-2025-035	[263]	LHCb-PAPER-2025-034	[264]	LHCb-PAPER-2025-033	[265]	LHCb-PAPER-2025-032	[266]	LHCb-PAPER-2025-031	[267]
LHCb-PAPER-2025-030	[268]	LHCb-PAPER-2025-029	[269]	LHCb-PAPER-2025-028	[270]	LHCb-PAPER-2025-027	[271]	LHCb-PAPER-2025-026	[272]
LHCb-PAPER-2025-025	[273]	LHCb-PAPER-2025-024	[86]	LHCb-PAPER-2025-023	[274]	LHCb-PAPER-2025-022	[275]	LHCb-PAPER-2025-021	[276]
LHCb-PAPER-2025-020	[277]	LHCb-PAPER-2025-019	[278]	LHCb-PAPER-2025-018	[279]	LHCb-PAPER-2025-017	[280]	LHCb-PAPER-2025-016	[281]
LHCb-PAPER-2025-015	[282]	LHCb-PAPER-2025-014	[283]	LHCb-PAPER-2025-013	[284]	LHCb-PAPER-2025-012	[285]	LHCb-PAPER-2025-011	[286]
LHCb-PAPER-2025-010	[287]	LHCb-PAPER-2025-009	[288]	LHCb-PAPER-2025-008	[289]	LHCb-PAPER-2025-007	[290]	LHCb-PAPER-2025-006	[291]
LHCb-PAPER-2025-005	[292]	LHCb-PAPER-2025-004	[293]	LHCb-PAPER-2025-003	[294]	LHCb-PAPER-2025-002	[295]	LHCb-PAPER-2025-001	[296]
LHCb-PAPER-2024-056	[297]	LHCb-PAPER-2024-055	[298]	LHCb-PAPER-2024-054	[299]	LHCb-PAPER-2024-053	[300]	LHCb-PAPER-2024-052	[301]
LHCb-PAPER-2024-055	[303]	LHCb-PAPER-2024-050	[304]	LHCb-PAPER-2024-049	[305]	LHCb-PAPER-2024-048	[306]	LHCb-PAPER-2024-047	[307]
LHCb-PAPER-2024-045	[308]	LHCb-PAPER-2024-044	[309]	LHCb-PAPER-2024-043	[310]	LHCb-PAPER-2024-042	[311]	LHCb-PAPER-2024-041	[312]
LHCb-PAPER-2024-040	[313]	LHCb-PAPER-2024-039	[314]	LHCb-PAPER-2024-038	[315]	LHCb-PAPER-2024-037	[316]	LHCb-PAPER-2024-036	[317]
LHCb-PAPER-2024-035	[318]	LHCb-PAPER-2024-034	[319]	LHCb-PAPER-2024-033	[320]	LHCb-PAPER-2024-032	[321]	LHCb-PAPER-2024-031	[322]
LHCb-PAPER-2024-030	[323]	LHCb-PAPER-2024-029	[324]	LHCb-PAPER-2024-028	[325]	LHCb-PAPER-2024-027	[326]	LHCb-PAPER-2024-026	[327]



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LHCb-PAPER-2015-040 [781]	LHCb-PAPER-2015-039 [782]	LHCb-PAPER-2015-038 [783]	LHCb-PAPER-2015-037 [784]	LHCb-PAPER-2015-036 [785]
LHCb-PAPER-2015-035 [786]	LHCb-PAPER-2015-034 [787]	LHCb-PAPER-2015-033 [788]	LHCb-PAPER-2015-032 [789]	LHCb-PAPER-2015-031 [790]
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733

Table 6: LHCb-CONFs (which have their identifier as their cite code). Most CONF notes have been superseded by a paper and are thus retired. This is indicated in the bibtex entry. Do not cite retired CONF notes. DNE: Does not exist.

LHCb-CONF-2026-001 [1056]				
LHCb-CONF-2025-003 [1057]	LHCb-CONF-2025-002 [1058]	LHCb-CONF-2025-001 [1059]		
LHCb-CONF-2024-005 [1060]	LHCb-CONF-2024-004 [1061]	LHCb-CONF-2024-003 [1062]	LHCb-CONF-2024-002 [1063]	LHCb-CONF-2024-001 [1064]
LHCb-CONF-2023-004 [1065]	LHCb-CONF-2023-003 [1066]	LHCb-CONF-2023-002 [1067]	LHCb-CONF-2023-001 [1068]	
LHCb-CONF-2022-003 [1069]	LHCb-CONF-2022-001 [1070]			
LHCb-CONF-2021-005 [1071]	LHCb-CONF-2021-004 [1072]	LHCb-CONF-2021-003 [1073]	LHCb-CONF-2021-002 [1074]	LHCb-CONF-2021-001 [1075]
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<sup>19</sup>LHCb-PAPER-2011-039 does not exist.

<sup>20</sup>If you cite the gamma combination, always also cite the latest gamma paper as `\cite{LHCb-PAPER-2013-020,*LHCb-CONF-2018-002}` (unless you cite LHCb-PAPER-2013-020 separately too).

– continued from previous page.

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LHCb-CONF-2010-010 [1232]	LHCb-CONF-2010-009 [1233]	LHCb-CONF-2010-008 [1234]		

Earlier documents in LHCb-CONF series are actually proceedings.

734

## 735 B Standard symbols

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

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

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

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

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

755 **C List of all symbols**

756 **C.1 Experiments**

<code>\lhcb</code>	LHCb	<code>\atlas</code>	ATLAS	<code>\cms</code>	CMS
<code>\alice</code>	ALICE	<code>\babar</code>	BaBar	<code>\belle</code>	Belle
<code>\belletwo</code>	Belle II	<code>\besiii</code>	BESIII	<code>\cleo</code>	CLEO
<code>\cdf</code>	CDF	<code>\dzero</code>	D0	<code>\aleph</code>	ALEPH
757 <code>\delphi</code>	DELPHI	<code>\opal</code>	OPAL	<code>\lthree</code>	L3
<code>\sld</code>	SLD	<code>\cern</code>	CERN	<code>\lhc</code>	LHC
<code>\lep</code>	LEP	<code>\tevatron</code>	Tevatron	<code>\bfactories</code>	<i>B</i> Factories
<code>\bfactory</code>	<i>B</i> Factory	<code>\upgradeone</code>	Upgrade I	<code>\upgradetwo</code>	Upgrade II

758 **C.1.1 LHCb sub-detectors and sub-systems**

<code>\velo</code>	VELO	<code>\rich</code>	RICH	<code>\richone</code>	RICH1
<code>\richtwo</code>	RICH2	<code>\ttracker</code>	TT	<code>\intr</code>	IT
<code>\st</code>	ST	<code>\ot</code>	OT	<code>\herschel</code>	HERSCHEL
<code>\spd</code>	SPD	<code>\presh</code>	PS	<code>\ecal</code>	ECAL
759 <code>\hcal</code>	HCAL	<code>\MagUp</code>	<i>MagUp</i>	<code>\MagDown</code>	<i>MagDown</i>
<code>\ode</code>	ODE	<code>\daq</code>	DAQ	<code>\tfc</code>	TFC
<code>\ecs</code>	ECS	<code>\lone</code>	L0	<code>\hlt</code>	HLT
<code>\hlton</code>	HLT1	<code>\hltwo</code>	HLT2		

760 **C.2 Particles**

761 **C.2.1 Leptons**

<code>\electron</code>	$e$	<code>\en</code>	$e^-$	<code>\ep</code>	$e^+$
<code>\epm</code>	$e^\pm$	<code>\emp</code>	$e^\mp$	<code>\epem</code>	$e^+e^-$
<code>\muon</code>	$\mu$	<code>\mup</code>	$\mu^+$	<code>\mun</code>	$\mu^-$
<code>\mupm</code>	$\mu^\pm$	<code>\mump</code>	$\mu^\mp$	<code>\mumu</code>	$\mu^+\mu^-$
<code>\tauon</code>	$\tau$	<code>\taup</code>	$\tau^+$	<code>\taum</code>	$\tau^-$
<code>\taupm</code>	$\tau^\pm$	<code>\taump</code>	$\tau^\mp$	<code>\tautau</code>	$\tau^+\tau^-$
762 <code>\lepton</code>	$\ell$	<code>\ellm</code>	$\ell^-$	<code>\ellp</code>	$\ell^+$
<code>\ellpm</code>	$\ell^\pm$	<code>\ellmp</code>	$\ell^\mp$	<code>\ellell</code>	$\ell^+\ell^-$
<code>\neu</code>	$\nu$	<code>\neub</code>	$\bar{\nu}$	<code>\neue</code>	$\nu_e$
<code>\neueb</code>	$\bar{\nu}_e$	<code>\neum</code>	$\nu_\mu$	<code>\neumb</code>	$\bar{\nu}_\mu$
<code>\neut</code>	$\nu_\tau$	<code>\neutb</code>	$\bar{\nu}_\tau$	<code>\neul</code>	$\nu_\ell$
<code>\neulb</code>	$\bar{\nu}_\ell$				

763 **C.2.2 Gauge bosons and scalars**

<code>\g</code>	$\gamma$	<code>\H</code>	$H^0$	<code>\Hp</code>	$H^+$
<code>\Hm</code>	$H^-$	<code>\Hpm</code>	$H^\pm$	<code>\W</code>	$W$
764 <code>\Wp</code>	$W^+$	<code>\Wm</code>	$W^-$	<code>\Wpm</code>	$W^\pm$
<code>\Z</code>	$Z$				

765 **C.2.3 Quarks**

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

767 **C.2.4 Light mesons**

<code>\hadron</code>	$h$	<code>\pion</code>	$\pi$	<code>\piz</code>	$\pi^0$
<code>\pip</code>	$\pi^+$	<code>\pim</code>	$\pi^-$	<code>\pipm</code>	$\pi^\pm$
<code>\pimp</code>	$\pi^\mp$	<code>\rhomeson</code>	$\rho$	<code>\rhoz</code>	$\rho^0$
<code>\rhop</code>	$\rho^+$	<code>\rhom</code>	$\rho^-$	<code>\rhopm</code>	$\rho^\pm$
<code>\rhomp</code>	$\rho^\mp$	<code>\kaon</code>	$K$	<code>\Kbar</code>	$\bar{K}$
<code>\Kb</code>	$\bar{K}$	<code>\KorKbar</code>	$\overline{K}$	<code>\Kz</code>	$K^0$
768 <code>\Kzb</code>	$\bar{K}^0$	<code>\Kp</code>	$K^+$	<code>\Km</code>	$K^-$
<code>\Kpm</code>	$K^\pm$	<code>\Kmp</code>	$K^\mp$	<code>\KS</code>	$K_S^0$
<code>\Vzero</code>	$V^0$	<code>\KL</code>	$K_L^0$	<code>\Kstarz</code>	$K^{*0}$
<code>\Kstarzb</code>	$\bar{K}^{*0}$	<code>\Kstar</code>	$K^*$	<code>\Kstarb</code>	$\bar{K}^*$
<code>\Kstarp</code>	$K^{*+}$	<code>\Kstarm</code>	$K^{*-}$	<code>\Kstarpm</code>	$K^{*\pm}$
<code>\Kstarpmp</code>	$K^{*\mp}$	<code>\KorKbarz</code>	$\overline{K}^0$	<code>\etaz</code>	$\eta$
<code>\etapr</code>	$\eta'$	<code>\phiz</code>	$\phi$	<code>\omegaz</code>	$\omega$

769 **C.2.5 Charmed mesons**

<code>\Dbar</code>	$\bar{D}$	<code>\D</code>	$D$	<code>\Db</code>	$\bar{D}$
<code>\DorDbar</code>	$\overline{D}$	<code>\Dz</code>	$D^0$	<code>\Dzb</code>	$\bar{D}^0$
<code>\Dp</code>	$D^+$	<code>\Dm</code>	$D^-$	<code>\Dpm</code>	$D^\pm$
<code>\Dmp</code>	$D^\mp$	<code>\DpDm</code>	$D^+D^-$	<code>\Dstar</code>	$D^*$
<code>\Dstarb</code>	$\bar{D}^*$	<code>\Dstarz</code>	$D^{*0}$	<code>\Dstarzb</code>	$\bar{D}^{*0}$
<code>\theDstarz</code>	$D^*(2007)^0$	<code>\theDstarzb</code>	$\bar{D}^*(2007)^0$	<code>\Dstarp</code>	$D^{*+}$
770 <code>\Dstarm</code>	$D^{*-}$	<code>\Dstarpm</code>	$D^{*\pm}$	<code>\Dstarpmp</code>	$D^{*\mp}$
<code>\theDstarp</code>	$D^*(2010)^+$	<code>\theDstarm</code>	$D^*(2010)^-$	<code>\theDstarpm</code>	$D^*(2010)^\pm$
<code>\theDstarpmp</code>	$D^*(2010)^\mp$	<code>\Ds</code>	$D_s^+$	<code>\Dsp</code>	$D_s^+$
<code>\Dsm</code>	$D_s^-$	<code>\Dspm</code>	$D_s^\pm$	<code>\Dspm</code>	$D_s^\mp$
<code>\Dss</code>	$D_s^{*+}$	<code>\Dssp</code>	$D_s^{*+}$	<code>\Dssm</code>	$D_s^{*-}$
<code>\Dsspm</code>	$D_s^{*\pm}$	<code>\Dssmp</code>	$D_s^{*\mp}$	<code>\DporDsp</code>	$D_{(s)}^+$
<code>\DmorDsm</code>	$D_{(s)}^-$	<code>\DpmorDspm</code>	$D_{(s)}^\pm$		

771 **C.2.6 Beauty mesons**

<code>\B</code>	$B$	<code>\Bbar</code>	$\bar{B}$	<code>\Bb</code>	$\bar{B}$
<code>\BorBbar</code>	$\overline{B}$	<code>\Bz</code>	$B^0$	<code>\Bzb</code>	$\bar{B}^0$
<code>\Bd</code>	$B^0$	<code>\Bdb</code>	$\bar{B}^0$	<code>\BdorBdbar</code>	$\overline{B}^0$
<code>\Bu</code>	$B^+$	<code>\Bub</code>	$B^-$	<code>\Bp</code>	$B^+$
772 <code>\Bm</code>	$B^-$	<code>\Bpm</code>	$B^\pm$	<code>\Bmp</code>	$B^\mp$
<code>\Bs</code>	$B_s^0$	<code>\Bsb</code>	$\bar{B}_s^0$	<code>\BsorBsbar</code>	$\overline{B}_s^0$
<code>\Bc</code>	$B_c^+$	<code>\Bcp</code>	$B_c^+$	<code>\Bcm</code>	$B_c^-$
<code>\Bcpm</code>	$B_c^\pm$	<code>\Bds</code>	$B_{(s)}^0$	<code>\Bdsb</code>	$\bar{B}_{(s)}^0$
<code>\BdorBs</code>	$B_{(s)}^0$	<code>\BdorBsbar</code>	$\bar{B}_{(s)}^0$		

773 **C.2.7 Onia**

<code>\jpsi</code>	$J/\psi$	<code>\psitwos</code>	$\psi(2S)$	<code>\psiprpr</code>	$\psi(3770)$
<code>\etac</code>	$\eta_c$	<code>\psires</code>	$\psi$	<code>\chic</code>	$\chi_c$
<code>\chiczero</code>	$\chi_{c0}$	<code>\chicone</code>	$\chi_{c1}$	<code>\chictwo</code>	$\chi_{c2}$
<code>\chicJ</code>	$\chi_{cJ}$	<code>\Upsilonres</code>	$\Upsilon$	<code>\OneS</code>	$\Upsilon(1S)$
774 <code>\TwoS</code>	$\Upsilon(2S)$	<code>\ThreeS</code>	$\Upsilon(3S)$	<code>\FourS</code>	$\Upsilon(4S)$
<code>\FiveS</code>	$\Upsilon(5S)$	<code>\chib</code>	$\chi_b$	<code>\chibzero</code>	$\chi_{b0}$
<code>\chibone</code>	$\chi_{b1}$	<code>\chibtwo</code>	$\chi_{b2}$	<code>\chibJ</code>	$\chi_{bJ}$
<code>\theX</code>	$\chi_{c1}(3872)$				

775 **C.2.8 Light Baryons**

<code>\proton</code>	$p$	<code>\antiproton</code>	$\bar{p}$	<code>\neutron</code>	$n$
<code>\antineutron</code>	$\bar{n}$	<code>\Deltares</code>	$\Delta$	<code>\Deltaresbar</code>	$\bar{\Delta}$
<code>\Lz</code>	$\Lambda$	<code>\Lbar</code>	$\bar{\Lambda}$	<code>\LorLbar</code>	$\overline{\Lambda}$
<code>\Lambdares</code>	$\Lambda$	<code>\Lambdaresbar</code>	$\bar{\Lambda}$	<code>\Sigmares</code>	$\Sigma$
<code>\Sigmaz</code>	$\Sigma^0$	<code>\Sigmap</code>	$\Sigma^+$	<code>\Sigmam</code>	$\Sigma^-$
776 <code>\Sigmaresbar</code>	$\bar{\Sigma}$	<code>\Sigmapar</code>	$\bar{\Sigma}^0$	<code>\Sigmaparp</code>	$\bar{\Sigma}^+$
<code>\Sigmaparm</code>	$\bar{\Sigma}^-$	<code>\Xires</code>	$\Xi$	<code>\Xiz</code>	$\Xi^0$
<code>\Xim</code>	$\Xi^-$	<code>\Xiresbar</code>	$\bar{\Xi}$	<code>\Xibarz</code>	$\Xi^0$
<code>\Xibarp</code>	$\bar{\Xi}^+$	<code>\Omegares</code>	$\Omega$	<code>\Omegaresbar</code>	$\bar{\Omega}$
<code>\Omegam</code>	$\Omega^-$	<code>\Omegaparp</code>	$\bar{\Omega}^+$		

777 **C.2.9 Charmed Baryons**

<code>\Lc</code>	$\Lambda_c^+$	<code>\Lcbar</code>	$\bar{\Lambda}_c^-$	<code>\Sigmac</code>	$\Sigma_c$
<code>\Sigmacp</code>	$\Sigma_c^+$	<code>\Sigmacz</code>	$\Sigma_c^0$	<code>\Sigmacpp</code>	$\Sigma_c^{++}$
<code>\Sigmacbar</code>	$\bar{\Sigma}_c$	<code>\Sigmacbarp</code>	$\bar{\Sigma}_c^-$	<code>\Sigmacbarz</code>	$\bar{\Sigma}_c^0$
<code>\Sigmacbarm</code>	$\bar{\Sigma}_c^-$	<code>\Xic</code>	$\Xi_c$	<code>\Xicz</code>	$\Xi_c^0$
<code>\Xicp</code>	$\Xi_c^+$	<code>\Xicbar</code>	$\bar{\Xi}_c$	<code>\Xicbarz</code>	$\bar{\Xi}_c^0$
778 <code>\Xicbarm</code>	$\bar{\Xi}_c^-$	<code>\Omegac</code>	$\Omega_c^0$	<code>\Omegacbar</code>	$\bar{\Omega}_c^0$
<code>\Xicc</code>	$\Xi_{cc}$	<code>\Xiccbar</code>	$\bar{\Xi}_{cc}$	<code>\Xiccp</code>	$\Xi_{cc}^+$
<code>\Xiccpp</code>	$\Xi_{cc}^{++}$	<code>\Xiccbarm</code>	$\bar{\Xi}_{cc}^-$	<code>\Xiccbarmm</code>	$\bar{\Xi}_{cc}^{--}$
<code>\Omegacc</code>	$\Omega_{cc}^+$	<code>\Omegaccbar</code>	$\bar{\Omega}_{cc}^-$	<code>\Omegaccc</code>	$\Omega_{ccc}^{++}$
<code>\Omegaccbar</code>	$\bar{\Omega}_{ccc}^{--}$				

779 **C.2.10 Beauty Baryons**

<code>\Lb</code>	$\Lambda_b^0$	<code>\Lbbar</code>	$\bar{\Lambda}_b^0$	<code>\Siglab</code>	$\Sigma_b$
<code>\Siglabp</code>	$\Sigma_b^+$	<code>\Siglabz</code>	$\Sigma_b^0$	<code>\Siglabm</code>	$\Sigma_b^-$
<code>\Siglabpm</code>	$\Sigma_b^\pm$	<code>\Siglabbar</code>	$\bar{\Sigma}_b$	<code>\Siglabbarp</code>	$\bar{\Sigma}_b^+$
780 <code>\Siglabbarz</code>	$\bar{\Sigma}_b^0$	<code>\Siglabbarm</code>	$\bar{\Sigma}_b^-$	<code>\Siglabbarpm</code>	$\bar{\Sigma}_b^\pm$
<code>\Xib</code>	$\Xi_b$	<code>\Xibz</code>	$\Xi_b^0$	<code>\Xibm</code>	$\Xi_b^-$
<code>\Xibbar</code>	$\bar{\Xi}_b$	<code>\Xibbarz</code>	$\bar{\Xi}_b^0$	<code>\Xibbarp</code>	$\bar{\Xi}_b^+$
<code>\Omegab</code>	$\Omega_b^-$	<code>\Omegabbar</code>	$\bar{\Omega}_b^+$		

781 **C.2.11 New Naming Scheme for Hadrons**

782 Since 2024 a new naming scheme for exotic hadrons previously known as  $X, Y, Z$  states  
783 has been adopted by PDG. Please refer to Table 8.2 in “Naming scheme for Hadrons”  
784 review of Ref. [5].

785 **C.3 Physics symbols**

786 **C.3.1 Decays**

<code>\BF</code>	$\mathcal{B}$	<code>\BR</code>	$\mathcal{B}$	<code>\BRvis</code>	$\mathcal{B}_{\text{vis}}$
<code>\ra</code>	$\rightarrow$	<code>\to</code>	$\rightarrow$		

788 **C.3.2 Lifetimes**

<code>\tauBs</code>	$\tau_{B_s^0}$	<code>\tauBd</code>	$\tau_{B^0}$	<code>\tauBz</code>	$\tau_{B^0}$
789 <code>\tauBu</code>	$\tau_{B^+}$	<code>\tauDp</code>	$\tau_{D^+}$	<code>\tauDz</code>	$\tau_{D^0}$
<code>\tauL</code>	$\tau_L$	<code>\tauH</code>	$\tau_H$		

790 **C.3.3 Masses**

<code>\mBd</code>	$m_{B^0}$	<code>\mBp</code>	$m_{B^+}$	<code>\mBs</code>	$m_{B_s^0}$
791 <code>\mBc</code>	$m_{B_c^+}$	<code>\mLb</code>	$m_{\Lambda_b^0}$		

792 **C.3.4 EW theory, groups**

<code>\grpsuthree</code>	$SU(3)$	<code>\grpsutw</code>	$SU(2)$	<code>\grpuone</code>	$U(1)$
<code>\ssqtw</code>	$\sin^2\theta_W$	<code>\csqtw</code>	$\cos^2\theta_W$	<code>\stw</code>	$\sin\theta_W$
<code>\ctw</code>	$\cos\theta_W$	<code>\ssqtweff</code>	$\sin^2\theta_W^{\text{eff}}$	<code>\csqtweff</code>	$\cos^2\theta_W^{\text{eff}}$
793 <code>\stwef</code>	$\sin\theta_W^{\text{eff}}$	<code>\ctweff</code>	$\cos\theta_W^{\text{eff}}$	<code>\gv</code>	$g_V$
<code>\ga</code>	$g_A$	<code>\order</code>	$\mathcal{O}$	<code>\ordalph</code>	$\mathcal{O}(\alpha)$
<code>\ordalsq</code>	$\mathcal{O}(\alpha^2)$	<code>\ordalcb</code>	$\mathcal{O}(\alpha^3)$		

794 **C.3.5 QCD parameters**

<code>\as</code>	$\alpha_s$	<code>\MSb</code>	$\overline{\text{MS}}$	<code>\lqcd</code>	$\Lambda_{\text{QCD}}$
795 <code>\qsq</code>	$q^2$				

796 **C.3.6 CKM, CP violation**

<code>\eps</code>	$\varepsilon$	<code>\epsK</code>	$\varepsilon_K$	<code>\epsB</code>	$\varepsilon_B$
<code>\epspr</code>	$\varepsilon'_K$	<code>\CP</code>	$CP$	<code>\CPT</code>	$CPT$
<code>\T</code>	$T$	<code>\rhopbar</code>	$\bar{\rho}$	<code>\etabar</code>	$\bar{\eta}$
<code>\Vud</code>	$V_{ud}$	<code>\Vcd</code>	$V_{cd}$	<code>\Vtd</code>	$V_{td}$
797 <code>\Vus</code>	$V_{us}$	<code>\Vcs</code>	$V_{cs}$	<code>\Vts</code>	$V_{ts}$
<code>\Vub</code>	$V_{ub}$	<code>\Vcb</code>	$V_{cb}$	<code>\Vtb</code>	$V_{tb}$
<code>\Vuds</code>	$V_{ud}^*$	<code>\Vcbs</code>	$V_{cb}^*$	<code>\Vtds</code>	$V_{td}^*$
<code>\Vuss</code>	$V_{us}^*$	<code>\Vcss</code>	$V_{cs}^*$	<code>\Vtss</code>	$V_{ts}^*$
<code>\Vubs</code>	$V_{ub}^*$	<code>\Vcbs</code>	$V_{cb}^*$	<code>\Vtbs</code>	$V_{tb}^*$

798 **C.3.7 Oscillations**

<code>\dm</code>	$\Delta m$	<code>\dms</code>	$\Delta m_s$	<code>\dmd</code>	$\Delta m_d$
<code>\DG</code>	$\Delta\Gamma$	<code>\DGs</code>	$\Delta\Gamma_s$	<code>\DGd</code>	$\Delta\Gamma_d$
<code>\Gs</code>	$\Gamma_s$	<code>\Gd</code>	$\Gamma_d$	<code>\MBq</code>	$M_{B_q}$
<code>\DGq</code>	$\Delta\Gamma_q$	<code>\Gq</code>	$\Gamma_q$	<code>\dmq</code>	$\Delta m_q$
<code>\GL</code>	$\Gamma_L$	<code>\GH</code>	$\Gamma_H$	<code>\DGsGs</code>	$\Delta\Gamma_s/\Gamma_s$
799 <code>\Delm</code>	$\Delta m$	<code>\ACP</code>	$\mathcal{A}^{CP}$	<code>\Adir</code>	$\mathcal{A}^{\text{dir}}$
<code>\Amix</code>	$\mathcal{A}^{\text{mix}}$	<code>\ADelta</code>	$\mathcal{A}^\Delta$	<code>\phid</code>	$\phi_d$
<code>\sinphid</code>	$\sin\phi_d$	<code>\phis</code>	$\phi_s$	<code>\betas</code>	$\beta_s$
<code>\sbetas</code>	$\sigma(\beta_s)$	<code>\stbetas</code>	$\sigma(2\beta_s)$	<code>\stphis</code>	$\sigma(\phi_s)$
<code>\sinphis</code>	$\sin\phi_s$				

800 **C.3.8 Tagging**

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

802 **C.3.9 Key decay channels**

<code>\BdToKstmm</code>	$B^0 \rightarrow K^{*0} \mu^+ \mu^-$	<code>\BdbToKstmm</code>	$\bar{B}^0 \rightarrow \bar{K}^{*0} \mu^+ \mu^-$	<code>\BsToJPsiPhi</code>	$B_s^0 \rightarrow J/\psi \phi$
<code>\BdToJPsiKst</code>	$B^0 \rightarrow J/\psi K^{*0}$	<code>\BdbToJPsiKst</code>	$\bar{B}^0 \rightarrow J/\psi \bar{K}^{*0}$	<code>\BsPhiGam</code>	$B_s^0 \rightarrow \phi \gamma$
<code>\BdKstGam</code>	$B^0 \rightarrow K^{*0} \gamma$	<code>\BTohh</code>	$B \rightarrow h^+ h^-$	<code>\BdTopipi</code>	$B^0 \rightarrow \pi^+ \pi^-$
803 <code>\BdToKpi</code>	$B^0 \rightarrow K^+ \pi^-$	<code>\BsToKK</code>	$B_s^0 \rightarrow K^+ K^-$	<code>\BsTopiK</code>	$B_s^0 \rightarrow \pi^+ K^-$
<code>\Cpipi</code>	$C_{\pi^+ \pi^-}$	<code>\Spipi</code>	$S_{\pi^+ \pi^-}$	<code>\CKK</code>	$C_{K^+ K^-}$
<code>\SKK</code>	$S_{K^+ K^-}$	<code>\ADGKK</code>	$A_{K^+ K^-}^{\Delta \Gamma}$		

804 **C.3.10 Rare decays**

<code>\BdKstee</code>	$B^0 \rightarrow K^{*0} e^+ e^-$	<code>\BdbKstee</code>	$\bar{B}^0 \rightarrow \bar{K}^{*0} e^+ e^-$	<code>\bsll</code>	$b \rightarrow s \ell^+ \ell^-$
<code>\AFB</code>	$A_{FB}$	<code>\FL</code>	$F_L$	<code>\AT#1</code> <code>\AT2</code>	$A_T^2$
805 <code>\btosgam</code>	$b \rightarrow s \gamma$	<code>\btodgam</code>	$b \rightarrow d \gamma$	<code>\Bsmm</code>	$B_s^0 \rightarrow \mu^+ \mu^-$
<code>\Bdmm</code>	$B^0 \rightarrow \mu^+ \mu^-$	<code>\Bsee</code>	$B_s^0 \rightarrow e^+ e^-$	<code>\Bdee</code>	$B^0 \rightarrow e^+ e^-$
<code>\ctl</code>	$\cos \theta_\ell$	<code>\ctk</code>	$\cos \theta_K$		

806 **C.3.11 Wilson coefficients and operators**

807 <code>\C#1</code> <code>\C9</code>	$C_9$	<code>\Cp#1</code> <code>\Cp7</code>	$C'_7$	<code>\Ceff#1</code> <code>\Ceff9</code>	$C_9^{(\text{eff})}$
<code>\Cpeff#1</code> <code>\Cpeff7</code>	$C_7^{(\text{eff})}$	<code>\Ope#1</code> <code>\Ope2</code>	$O_2$	<code>\Opep#1</code> <code>\Opep7</code>	$O_7'$

808 **C.3.12 Charm**

809 <code>\xprime</code>	$x'$	<code>\yprime</code>	$y'$	<code>\ycp</code>	$y_{CP}$
<code>\agamma</code>	$A_\Gamma$	<code>\dkpicf</code>	$D^0 \rightarrow K^- \pi^+$		

810 **C.3.13 QM**

811 <code>\bra[1]</code> <code>\bra{a}</code>	$\langle a  $	<code>\ket[1]</code> <code>\ket{b}</code>	$  b \rangle$	<code>\braket[2]</code> <code>\braket{a}{b}</code>	$\langle a   b \rangle$
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812 **C.3.14 Units (these macros add a small space in front)**

813 **C.3.15 Energy and momentum**

814 <code>\tev</code>	TeV	<code>\gev</code>	GeV	<code>\mev</code>	MeV
<code>\kev</code>	keV	<code>\ev</code>	eV	<code>\gevgev</code>	GeV <sup>2</sup>
<code>\mevc</code>	MeV/c	<code>\gevc</code>	GeV/c	<code>\mevcc</code>	MeV/c <sup>2</sup>
<code>\gevcc</code>	GeV/c <sup>2</sup>	<code>\gevgevcc</code>	GeV <sup>2</sup> /c <sup>2</sup>	<code>\gevgevcccc</code>	GeV <sup>2</sup> /c <sup>4</sup>

815 **C.3.16 Distance and area (these macros add a small space)**

816 <code>\km</code>	km	<code>\m</code>	m	<code>\ma</code>	m <sup>2</sup>
<code>\cm</code>	cm	<code>\cma</code>	cm <sup>2</sup>	<code>\mm</code>	mm
<code>\mma</code>	mm <sup>2</sup>	<code>\mum</code>	μm	<code>\muma</code>	μm <sup>2</sup>
<code>\nm</code>	nm	<code>\fm</code>	fm	<code>\barn</code>	b
<code>\mbarn</code>	mb	<code>\mub</code>	μb	<code>\nb</code>	nb
<code>\invnb</code>	nb <sup>-1</sup>	<code>\pb</code>	pb	<code>\invpb</code>	pb <sup>-1</sup>
<code>\fb</code>	fb	<code>\invfb</code>	fb <sup>-1</sup>	<code>\ab</code>	ab
<code>\invab</code>	ab <sup>-1</sup>				

817 **C.3.17 Time**

<code>\sec</code>	s	<code>\ms</code>	ms	<code>\mus</code>	$\mu$ s
<code>\ns</code>	ns	<code>\ps</code>	ps	<code>\fs</code>	fs
818 <code>\mhz</code>	MHz	<code>\khz</code>	kHz	<code>\hz</code>	Hz
<code>\invps</code>	$\text{ps}^{-1}$	<code>\invns</code>	$\text{ns}^{-1}$	<code>\yr</code>	yr
<code>\hr</code>	hr				

819 **C.3.18 Temperature**

820 <code>\degc</code>	$^{\circ}\text{C}$	<code>\degk</code>	K
------------------------	--------------------	--------------------	---

821 **C.3.19 Material lengths, radiation**

<code>\Xrad</code>	$X_0$	<code>\NIL</code>	$\lambda_{\text{int}}$	<code>\mip</code>	MIP
822 <code>\neutroneq</code>	$n_{\text{eq}}$	<code>\neqcmcm</code>	$n_{\text{eq}}/\text{cm}^2$	<code>\kRad</code>	kRad
<code>\MRad</code>	MRad	<code>\ci</code>	Ci	<code>\mci</code>	mCi

823 **C.3.20 Uncertainties**

<code>\sx</code>	$\sigma_x$	<code>\sy</code>	$\sigma_y$	<code>\sz</code>	$\sigma_z$
824 <code>\stat</code>	(stat)	<code>\syst</code>	(syst)	<code>\lumi</code>	(lumi)

825 **C.3.21 Maths**

<code>\order</code>	$\mathcal{O}$	<code>\chisq</code>	$\chi^2$	<code>\chisqndf</code>	$\chi^2/\text{ndf}$
<code>\chisqip</code>	$\chi_{\text{IP}}^2$	<code>\chisqfd</code>	$\chi_{\text{FD}}^2$	<code>\chisqvs</code>	$\chi_{\text{VS}}^2$
<code>\chisqvtx</code>	$\chi_{\text{vtx}}^2$	<code>\chisqvtxndf</code>	$\chi_{\text{vtx}}^2/\text{ndf}$	<code>\deriv</code>	d
826 <code>\gsim</code>	$\gtrsim$	<code>\lsim</code>	$\lesssim$	<code>\mean[1]</code>	$\langle x \rangle$
<code>\abs[1]</code>	$\ x\ $	<code>\Real</code>	$\mathcal{R}e$	<code>\Imag</code>	$\mathcal{I}m$
<code>\PDF</code>	PDF	<code>\sPlot</code>	$sPlot$	<code>\sFit</code>	$sFit$

827 **C.4 Kinematics**

828 **C.4.1 Energy, Momenta**

<code>\Ebeam</code>	$E_{\text{BEAM}}$	<code>\sqs</code>	$\sqrt{s}$	<code>\sqsnn</code>	$\sqrt{s_{\text{NN}}}$
829 <code>\pt</code>	$p_{\text{T}}$	<code>\ptsq</code>	$p_{\text{T}}^2$	<code>\ptot</code>	$p$
<code>\et</code>	$E_{\text{T}}$	<code>\mt</code>	$M_{\text{T}}$	<code>\dpp</code>	$\Delta p/p$
<code>\msq</code>	$m^2$	<code>\dedx</code>	$dE/dx$		

830 **C.4.2 PID**

<code>\dllkpi</code>	$DLL_{K\pi}$	<code>\dllppi</code>	$DLL_{p\pi}$	<code>\dllepi</code>	$DLL_{e\pi}$
831 <code>\dllmupi</code>	$DLL_{\mu\pi}$				

832 **C.4.3 Geometry**

833 <code>\degrees</code>	$^{\circ}$	<code>\murad</code>	$\mu\text{rad}$	<code>\mrad</code>	mrad
<code>\rad</code>	rad				

834 **C.4.4 Accelerator**

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

836 **C.5 Software**

837 **C.5.1 Programs**

<code>\bcvegpu</code>	BCVEGPY	<code>\boole</code>	BOOLE	<code>\brunel</code>	BRUNEL
<code>\davinci</code>	DAVINCI	<code>\dirac</code>	DIRAC	<code>\evtgen</code>	EVTGEN
<code>\fewz</code>	FEWZ	<code>\fluka</code>	FLUKA	<code>\ganga</code>	GANGA
<code>\gaudi</code>	GAUDI	<code>\gauss</code>	GAUSS	<code>\geant</code>	GEANT4
<code>\lamarr</code>	LAMARR	<code>\hepmc</code>	HEPMC	<code>\herwig</code>	HERWIG
838 <code>\moore</code>	MOORE	<code>\neurobayes</code>	NEUROBAYES	<code>\photos</code>	PHOTOS
<code>\powheg</code>	POWHEG	<code>\pythia</code>	PYTHIA	<code>\resbos</code>	RESBOS
<code>\roofit</code>	ROOFIT	<code>\root</code>	ROOT	<code>\spice</code>	SPICE
<code>\tensorflow</code>	TENSORFLOW	<code>\urania</code>	URANIA	<code>\hepm1</code>	hep_ml
<code>\starlight</code>	STARLIGHT	<code>\superchic</code>	SUPERCHIC		

839 **C.5.2 Languages**

840 <code>\cpp</code>	C++	<code>\ruby</code>	RUBY	<code>\fortran</code>	FORTRAN
<code>\svn</code>	SVN	<code>\git</code>	GIT	<code>\latex</code>	L <sup>A</sup> T <sub>E</sub> X

841 **C.5.3 Data processing**

<code>\kbit</code>	kbit	<code>\kbits</code>	kbit/s	<code>\kbytes</code>	kB
<code>\kbyps</code>	kB/s	<code>\mbit</code>	Mbit	<code>\mbps</code>	Mbit/s
<code>\mbytes</code>	MB	<code>\mbyps</code>	MB/s	<code>\gbit</code>	Gbit
842 <code>\gbps</code>	Gbit/s	<code>\gbytes</code>	GB	<code>\gbyps</code>	GB/s
<code>\tbit</code>	Tbit	<code>\tbps</code>	Tbit/s	<code>\tbytes</code>	TB
<code>\tbyps</code>	TB/s	<code>\dst</code>	DST		

843 **C.6 Detector related**

844 **C.6.1 Detector technologies**

845 <code>\nonn</code>	$n^+$ -on- $n$	<code>\ponn</code>	$p^+$ -on- $n$	<code>\nonp</code>	$n^+$ -on- $p$
<code>\cvd</code>	CVD	<code>\mwpc</code>	MWPC	<code>\gem</code>	GEM

846 **C.6.2 Detector components, electronics**

<code>\tell1</code>	TELL1	<code>\uk11</code>	UKL1	<code>\beetle</code>	Beetle
<code>\otis</code>	OTIS	<code>\croc</code>	CROC	<code>\carioca</code>	CARIOCA
<code>\dialog</code>	DIALOG	<code>\sync</code>	SYNC	<code>\cardiac</code>	CARDIAC
<code>\gol</code>	GOL	<code>\vcsel</code>	VCSEL	<code>\ttc</code>	TTC
<code>\ttcrx</code>	TTCrx	<code>\hpd</code>	HPD	<code>\pmt</code>	PMT
847 <code>\specs</code>	SPECS	<code>\elmb</code>	ELMB	<code>\fpga</code>	FPGA
<code>\plc</code>	PLC	<code>\rasnik</code>	RASNIK	<code>\elmb</code>	ELMB
<code>\can</code>	CAN	<code>\lvds</code>	LVDS	<code>\ntc</code>	NTC
<code>\adc</code>	ADC	<code>\led</code>	LED	<code>\ccd</code>	CCD
<code>\hv</code>	HV	<code>\lv</code>	LV	<code>\pvss</code>	PVSS
<code>\cmos</code>	CMOS	<code>\fifo</code>	FIFO	<code>\ccpc</code>	CCPC

848 **C.6.3 Chemical symbols**

<code>\cfourften</code>	$C_4F_{10}$	<code>\cffour</code>	$CF_4$	<code>\cotwo</code>	$CO_2$
849 <code>\csixffouteen</code>	$C_6F_{14}$	<code>\mgftwo</code>	$MgF_2$	<code>\siotwo</code>	$SiO_2$

850 **C.6.4 Special Text**

<code>\eg</code>	<i>e.g.</i>	<code>\ie</code>	<i>i.e.</i>	<code>\etal</code>	<i>et al.</i>
851 <code>\etc</code>	<i>etc.</i>	<code>\cf</code>	<i>cf.</i>	<code>\ffp</code>	<i>ff.</i>
<code>\vs</code>	<i>vs.</i>				

852 **C.6.5 Helpful to align numbers in tables**

853 `\phz`

854 **D Supplementary material for LHCb-PAPER-20XX-**  
 855 **YYY**

856 This appendix contains supplementary material that will be posted on the public CDS  
 857 record but will not appear in the paper.

858 Please leave the above sentence in your draft for first and second circulation and  
 859 replace what follows by your actual supplementary material. For more information about  
 860 other types of supplementary material, see Section 9. Plots and tables that follow should  
 861 be well described, either with captions or with additional explanatory text.

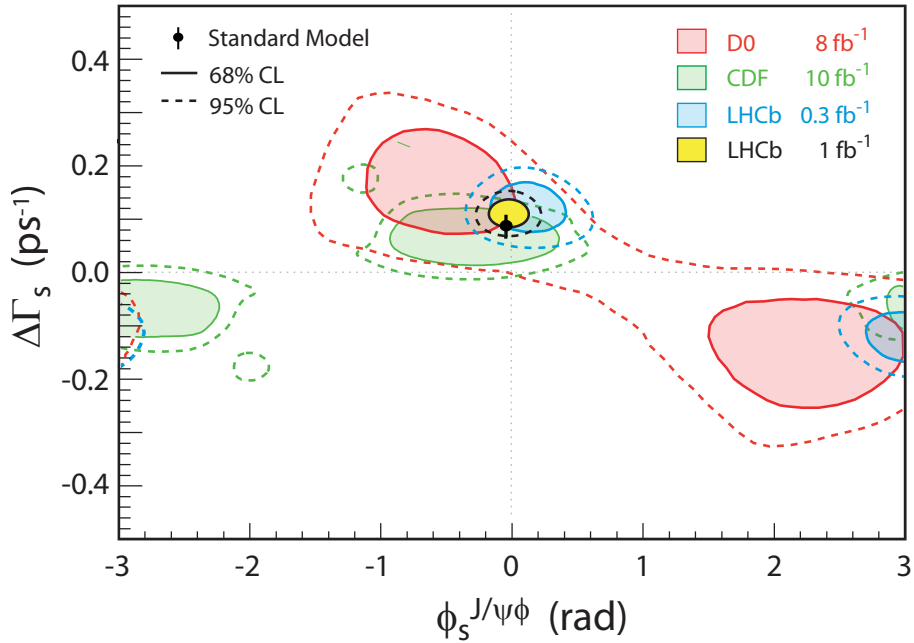


Figure 3: Comparison of our result to those from other experiments. Note that the style of this figure differs slightly from that of Figure 1

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