



# ATLAS NOTE

16th October 2014



## A template for ATLAS papers

ATLAS Publication Committee

### Abstract

This is a template ATLAS paper. It contains the structure, style files and hints on how to produce a paper for which a minimum amount of time is necessary to spend on typographic details. This template can be found on the web pages of the ATLAS Publication Committee. You can find the technical details about to use the template in a separate document.

This document was generated using version 01-03-05 of the ATLAS  $\LaTeX$  package.

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# 1 Front page

Before we get to the meat of the document, a few remarks about the paper front page.

## 1.1 Title

The title should be concise, clear and descriptive, and should include the word “ATLAS”.

## 1.2 Author list

The author list will be provided by the Authorship Committee and Physics Office. It will be created by the Physics Office at the time of the first draft announcement by PubCom, and added to the CDS record for the paper as a separate document from the paper itself. Requests for exceptional authorship or for removal of names should be made to the Spokesperson and Authorship Committee while the first draft is circulating. The author list will be archived when the second draft announcement is made by Publication Committee, and again added to the CDS record as a separate document from the paper. The front page of the paper should name “The ATLAS Collaboration” as the author.

## 1.3 Abstract

The abstract should also be clear, descriptive and concise. It should consist of a single paragraph, occupying no more than half a page. It should stand on its own and the main text of the paper should not depend on it. The abstract should state what was measured; where the measurement was made and with what dataset / luminosity; what method was used; what are the primary results and main conclusions. Citations, footnotes, references etc. should be avoided in the abstract. If only Monte Carlo data are used in the publication, this fact should be stated explicitly in the abstract.

### Example of a Search Analysis Abstract

A search for the Standard Model Higgs boson in the two photon decay channel is reported, using  $1.08 \text{ fb}^{-1}$  of proton-proton collision data at a centre-of-mass energy of 7 TeV recorded by the ATLAS detector. No significant excess is observed in the investigated mass range of 110 GeV to 150 GeV. Upper limits on the cross-section times branching ratio of between 2.0 and 5.8 times the Standard Model prediction are derived for this mass range.

(From “Search for the Standard Model Higgs boson in the two photon decay channel with the ATLAS detector at the LHC”)

### Example of a Standard Model Measurement Analysis Abstract

This Letter presents a measurement of the  $WW$  production cross section in  $\sqrt{s} = 7 \text{ TeV}$   $pp$  collisions by the ATLAS experiment, using  $34 \text{ pb}^{-1}$  of integrated luminosity produced by the Large Hadron Collider at CERN. Selecting events with two isolated leptons, each either an electron or a muon, 8 candidate events are observed with an expected background of  $1.7 \pm 0.6$  events. The measured cross section is  $41^{+20}_{-16}(\text{stat.}) \pm 5(\text{syst.}) \pm 1(\text{lumi.}) \text{ pb}$ , which is consistent with the standard model prediction of  $(44 \pm 3) \text{ pb}$  calculated at next-to-leading order in QCD.

(From “Measurement of the  $WW$  cross section in  $\sqrt{s} = 7 \text{ TeV}$   $pp$  collisions with ATLAS”)

## 2 Introduction

This should be fairly brief. State the measurement being made, motivate its importance experimentally and theoretically. It is considered bad form to point out being the first to publish something as a motivation. Include a summary of what has already been published on this subject, as well as the most appropriate theory references. For a longer paper, give a brief outline of the paper, especially if the structure is unusual. Even for a long paper, the introduction should generally not exceed one page.

Your first action before embarking on writing a paper should be to read the ATLAS Publication Policy [1], available from the web pages of the Publication Committee. Chapter 3 of this document details the refereeing and approval procedures that you will need to follow; Chapter 4 gives information on the style.

At some point during the writing of an ATLAS paper, you should decide what journal it will be submitted to. Please keep in mind that each journal makes specific demands on length and style. Most journals use regular capitalisation for titles (i.e. capitalise the first word and all proper nouns, e.g. “The search for large extra dimensions”). The notable exception is Physical Review Letters, which capitalizes the first word and all other important words, e.g. “The Search for Large Extra Dimensions”.

The L<sup>A</sup>T<sub>E</sub>X file and Postscript versions of this template can be found on the web pages of the ATLAS Publication Committee. Example macros for figures can be found there as well. Comments and/or suggestions on improvements to this template are very welcome and should be given to the Publication Committee.

The `atlasphysics.sty` style file contains a set of particles, reactions, etc. that may be useful. For example, the missing- $E_T$  symbol ( $E_T^{\text{miss}}$ ) is defined there. A separate document [`atlas_physics`] contains a list of the commands in `atlasphysics.sty`.

This paper template has been tested using L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>. You should get this version automatically. If you have problems check which L<sup>A</sup>T<sub>E</sub>X version you are running.

## 3 Theory

Sometimes combined with the introduction in shorter papers. This should be a brief overview of the theory relevant for this paper, with proper referencing. This is a good place to define important quantities which will be used later. State how the measurement of interest is actually performed, and how the parameters are extracted from the data. If quantities are extracted with a fit to the data, describe the fit procedure; if a limit is set, state what kind of limit-setting technique is used. If these explanations need to be a bit longer, separate sections may be appropriate.

Give here a brief explanation of the theory relevant for this paper, with proper referencing. Use, for example, `\cite{Glashow:1961tr,Weinberg:1967tq,sm_salam}` to cite the Standard Model [2–4].

Define important quantities that will be used later. State how the measurement of interest is actually performed, and how parameters are extracted from the data. If quantities are extracted with a fit to the data, describe the fit procedure. If the explanation needs to be a bit longer, a separate section may be appropriate.

## 4 Experimental setup

The Publication Committee provides a standard texts giving examples for description of the ATLAS detector, and the appropriate references. This text is included in the paper template provided with this

package. If necessary for your analysis, describe a subdetector in more detail.

The section on the experimental setup should also describe the dataset: when were the data taken, under what special circumstances (if any), and what was the integrated luminosity.

Examples of descriptions can be found below.

#### 4.1 ATLAS detector example from a Letter

The ATLAS experiment [5] at the LHC is a multi-purpose particle detector with a forward-backward symmetric cylindrical geometry and a near  $4\pi$  coverage in solid angle.<sup>1</sup> It consists of an inner tracking detector surrounded by a thin superconducting solenoid providing a 2 T axial magnetic field, electromagnetic and hadron calorimeters, and a muon spectrometer. The inner tracking detector covers the pseudorapidity range  $|\eta| < 2.5$ . It consists of silicon pixel, silicon micro-strip, and transition radiation tracking detectors. Lead/liquid-argon (LAr) sampling calorimeters provide electromagnetic (EM) energy measurements with high granularity. A hadron (iron/scintillator-tile) calorimeter covers the central pseudorapidity range ( $|\eta| < 1.7$ ). The end-cap and forward regions are instrumented with LAr calorimeters for both EM and hadronic energy measurements up to  $|\eta| = 4.9$ . The muon spectrometer surrounds the calorimeters and is based on three large air-core toroid superconducting magnets with eight coils each. Its bending power is in the range from 2.0 to 7.5 T m. It includes a system of precision tracking chambers and fast detectors for triggering. A three-level trigger system is used to select events. The first-level trigger is implemented in hardware and uses a subset of the detector information to reduce the accepted rate to at most 75 kHz. This is followed by two software-based trigger levels that together reduce the accepted event rate to 400 Hz on average depending on the data-taking conditions during 2012.

#### 4.2 ATLAS detector example from a paper making use of the whole detector

The ATLAS detector [5] at the LHC covers nearly the entire solid angle around the collision point. It consists of an inner tracking detector surrounded by a thin superconducting solenoid, electromagnetic and hadronic calorimeters, and a muon spectrometer incorporating three large superconducting toroid magnets. The inner-detector system (ID) is immersed in a 2 T axial magnetic field and provides charged particle tracking in the range  $|\eta| < 2.5$ . The high-granularity silicon pixel detector covers the vertex region and typically provides three measurements per track, the first hit being normally in the innermost layer. It is followed by the silicon microstrip tracker which usually provides four two-dimensional measurement points per track. These silicon detectors are complemented by the transition radiation tracker, which enables radially extended track reconstruction up to  $|\eta| = 2.0$ . The transition radiation tracker also provides electron identification information based on the fraction of hits (typically 30 in total) above a higher energy deposit threshold corresponding to transition radiation. The calorimeter system covers the pseudorapidity range  $|\eta| < 4.9$ . Within the region  $|\eta| < 3.2$ , electromagnetic calorimetry is provided by barrel and end-cap high-granularity lead liquid-argon (LAr) electromagnetic calorimeters, with an additional thin LAr presampler covering  $|\eta| < 1.8$ , to correct for energy loss in material upstream of the calorimeters. Hadronic calorimetry is provided by the steel/scintillating-tile

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<sup>1</sup>ATLAS uses a right-handed coordinate system with its origin at the nominal interaction point (IP) in the centre of the detector and the  $z$ -axis along the beam pipe. The  $x$ -axis points from the IP to the centre of the LHC ring, and the  $y$ -axis points upwards. Cylindrical coordinates  $(r, \phi)$  are used in the transverse plane,  $\phi$  being the azimuthal angle around the beam pipe. The pseudorapidity is defined in terms of the polar angle  $\theta$  as  $\eta = -\ln \tan(\theta/2)$ . Angular distance is measured in units of  $\Delta R \equiv \sqrt{\Delta\eta^2 + \Delta\phi^2}$ .

calorimeter, segmented into three barrel structures within  $|\eta| < 1.7$ , and two copper/LAr hadronic endcap calorimeters. The solid angle coverage is completed with forward copper/LAr and tungsten/LAr calorimeter modules optimised for electromagnetic and hadronic measurements respectively. The muon spectrometer (MS) comprises separate trigger and high-precision tracking chambers measuring the deflection of muons in a magnetic field generated by superconducting air-core toroids. The precision chamber system covers the region  $|\eta| < 2.7$  with three layers of monitored drift tubes, complemented by cathode strip chambers in the forward region, where the background is highest. The muon trigger system covers the range  $|\eta| < 2.4$  with resistive plate chambers in the barrel, and thin gap chambers in the endcap regions. A three-level trigger system is used to select interesting events [6]. The Level-1 trigger is implemented in hardware and uses a subset of detector information to reduce the event rate to a design value of at most 75 kHz. This is followed by two software-based trigger levels which together reduce the event rate to about 200 Hz.

## 5 Monte Carlo

All Monte Carlo generators and calculators used must be clearly named with the full version number and reference. A brief description may be useful if it is a less well known generator. It is usually necessary to say to what order it calculates (LO, NLO, NNLO...) and to specify any corrections, tunings or special parameter settings. The PDF sets used should be listed, also with the full version numbers and references. Statistics should be given if the number of simulated events gives rise to a non-negligible uncertainty.

## 6 Event selection

List the trigger and offline selection criteria, and number of events passing.

## 7 Data characteristics

Discuss here the characteristics of the data, in terms of primary quantities and backgrounds.

## 8 Systematic uncertainties

Give a detailed list of systematic uncertainties, the method by which they were obtained, and a justification of the resulting values. Use “systematic uncertainty” instead of “systematic error”. The latter sounds as if you have made a mistake systematically.

## 9 Results

State the results without interpretations here.

## 10 Discussion

Put the results into the context of the theory or a model. If the results lead to exclusion plots, make sure that it is clear which region on the plot is excluded. Please also make sure that statistical interpretations

and limit setting are done following the current ATLAS Statistics Tools and Guidelines

## 11 Summary and conclusion

Please make sure that there is a conclusion! The concluding statements should reflect what is in the abstract. Reiterate the main points of the paper and the primary results and conclusions.

Note that many readers look mostly at the title, abstract and conclusion. The conclusion should be interesting enough to make them want to read the whole paper. It is not good style just to repeat the abstract. If your paper is short and only has one result quoted at the end of the paper, then you should consider whether conclusions are necessary.

Try not to end your conclusions with a sentence such as “All the results in this paper are in good agreement with the Standard Model, the current world average and recent measurements by other experiments.” This might lead a referee (internal or external) to wonder why it is worth publishing this paper!

Note that all figures and tables should be output before the start of the “Summary and conclusion”. This can be achieved using the macro `\FloatBarrier` that is part of the `placeins` package.

## Acknowledgements

A standard template for the acknowledgements is available on the web pages of the Publication Committee. See reference [1] for the URL.

The acknowledgements should be in an unnumbered section.

## References

- [1] *ATLAS Publication Policy*,  
URL: <http://atlas.web.cern.ch/Atlas/GROUPS/GENERAL/SCINOTES/scinotes.html>.
- [2] S. L. Glashow, “Partial Symmetries of Weak Interactions”, *Nucl. Phys.* 22 (1961) 579–588,  
doi: [10.1016/0029-5582\(61\)90469-2](https://doi.org/10.1016/0029-5582(61)90469-2).
- [3] S. Weinberg, “A Model of Leptons”, *Phys. Rev. Lett.* 19 (1967) 1264–1266,  
doi: [10.1103/PhysRevLett.19.1264](https://doi.org/10.1103/PhysRevLett.19.1264).
- [4] A. Salam, “Weak and Electromagnetic Interactions”, *Elementary Particle Theory*,  
ed. by N. Svartholm, Stockholm: Almqvist and Wiksell, 1968 367.
- [5] ATLAS Collaboration, “The ATLAS Experiment at the CERN Large Hadron Collider”,  
*JINST* 3 (2008) S08003, doi: [10.1088/1748-0221/3/08/S08003](https://doi.org/10.1088/1748-0221/3/08/S08003).
- [6] ATLAS Collaboration, “Performance of the ATLAS Trigger System in 2010”,  
*Eur. Phys. J. C* 72 (2012) 1849, doi: [10.1140/epjc/s10052-011-1849-1](https://doi.org/10.1140/epjc/s10052-011-1849-1),  
arXiv: [1110.1530](https://arxiv.org/abs/1110.1530) [hep-ex].
- [7] *Users guide to the ATLAS L<sup>A</sup>T<sub>E</sub>X templates*, URL: <http://twiki.cern.ch/twiki/pub/AtlasProtected/PubComTemplates/atlas-latex.pdf>.
- [8] *Symbols defined in atlasphysics.sty*,  
URL: <https://twiki.cern.ch/twiki/pub/AtlasProtected/PubComTemplates/atlas-physics.pdf>.

# Appendices

In general, you use the appendices to include all the technical details of your work that are relevant for the ATLAS Collaboration only (e.g. dataset details, software release used). In an ATLAS paper auxiliary plots and tables that are supposed to be made public should be collected in an appendix.

Use the following commands to start the Appendices section:

```
\newpage
\appendix
\part*{Appendices}
\addcontentsline{toc}{part}{Appendices}
```

In this document the appendices contain some general remarks on the style to use in ATLAS papers and some technical aspects on how to implement the style. More details on how to use the ATLAS L<sup>A</sup>T<sub>E</sub>X templates to help you follow these recommendations can be found in other documents:

- ATLAS style guide [[atlas\\_style](#)].
- ATLAS L<sup>A</sup>T<sub>E</sub>X guide [[atlas\\_latex](#)];
- ATLAS B<sub>I</sub>B<sub>T</sub>E<sub>X</sub> guide [[atlas\\_bibtex](#)];
- ATLAS physics symbols [[atlas\\_physics](#)].
- Rounding in ATLAS [[atlas\\_rounding](#)];

## A General Style

We recommend the use of British English. However, whatever you decide to choose, be consistent throughout the paper. For much more detailed information on writing, spelling and typographic style, etc. please see the ATLAS Style Guide [[atlas\\_style](#)]. The ATLAS Glossary [[atlas\\_glossary](#)] contains a list of ATLAS detector acronyms.

### A.1 Emphasis

Use italics for emphasis sparingly: too many italicised words defeat their purpose. When you do italicise a word, really italicise it: do not use math mode! Note the difference between *per se* (`\emph{per se}`) and *per se* (`$per se$`). Abbreviations like i.e., e.g., etc., and et al. should *not* be italicised! For program names we recommend to use small capitals: `\textsc{Pythia}` produces PYTHIA.

## B Tables

All tables appearing in the paper must be mentioned in the text. The tables should appear in the same order as mentioned in the text. Do not abbreviate the word “Table”. Capitalise the first word of any row or column heading. Label all rows/columns, including units if appropriate. Units are given in brackets, e.g. “Energy [GeV]”. Horizontal and vertical lines should be kept to a minimum and only used as necessary to make the table entries clear. The table caption appears below the table. Any



symbols/variables used in the table must be defined in the caption. Always use labels to refer to tables and figures. Note that the label must be included in the body of the caption.

If table entries include uncertainties, the entries should be aligned on the “ $\pm$ ” sign. Numbers look best when aligned on the decimal point. Otherwise, column entries should be left-aligned. Table 1 shows the use of  $\pm$  as the intercolumn character for alignment. An alternative, as shown in Table 2, is to use `\phantom` to put in extra space equal to the width of a number if you have different numbers of decimal places in the table. The note on rounding [atlas\_rounding] contains more examples on how to format tables.

The `booktabs` package provides the macros `\toprule`, `\midrule`, `\bottomrule` which are to be preferred over `\hline`, as, among other things, they introduce some extra spacing around the lines, which is useful.

Category	$\mu$	$e$
$b \rightarrow \ell$	$65.2 \pm 0.4 \%$	$79.3 \%$
$b \rightarrow c \rightarrow \ell$	$7.8 \pm 0.3 \%$	$5.4 \%$
Total	$73.0 \pm 0.2 \%$	$9.1 \%$

Table 1: Monte Carlo estimates of the fraction of each process in the single lepton data sample. This table uses “S” format from `siunitx` and “ $\pm$ ” as the intercolumn separator.

Category	$\mu$	$e$
$b \rightarrow \ell$	$65.2 \pm 0.4 \%$	$79.3 \%$
$b \rightarrow c \rightarrow \ell$	$7.8 \pm 0.3 \%$	$5.4 \%$
Total	$73.0 \pm 0.2 \%$	$9.1 \%$

Table 2: Monte Carlo estimates of the fraction of each process in the single lepton data sample. This table uses `\phantom`.

## C Figures

The Publication Committee has a root macro to create figures in ATLAS style, it can be found on the Publication Committee web pages. Use this style consistently throughout the paper. An example figure can be seen in Figure 1.

Figures should be always made available in both `eps` (or `pdf`) and `png` format. Additionally, a `pdf` version of the plots can be useful in case `pdflatex` is used to produce a publication.

All figures appearing in the paper must be mentioned in the text. The figures should appear in the same order as mentioned in the text. At the beginning of a sentence, use the full word “Figure”. Within a sentence, the abbreviation “Fig.” may be used. If a figure appears in two or more parts, refer to it as “Fig. 1(a)” and “Fig. 1(b)”. Both “(a)” and “(b)” should appear in the text, in the figure, and in the caption. The word “ATLAS” (or “ATLAS Preliminary”, if appropriate) should appear prominently somewhere in the figure. This becomes important when the figure is copied and shown out of context. If appropriate, it is useful to include information about the luminosity corresponding to a figure.

All axes must be labelled, including units (i.e. “Energy [GeV]”). The vertical axis units should

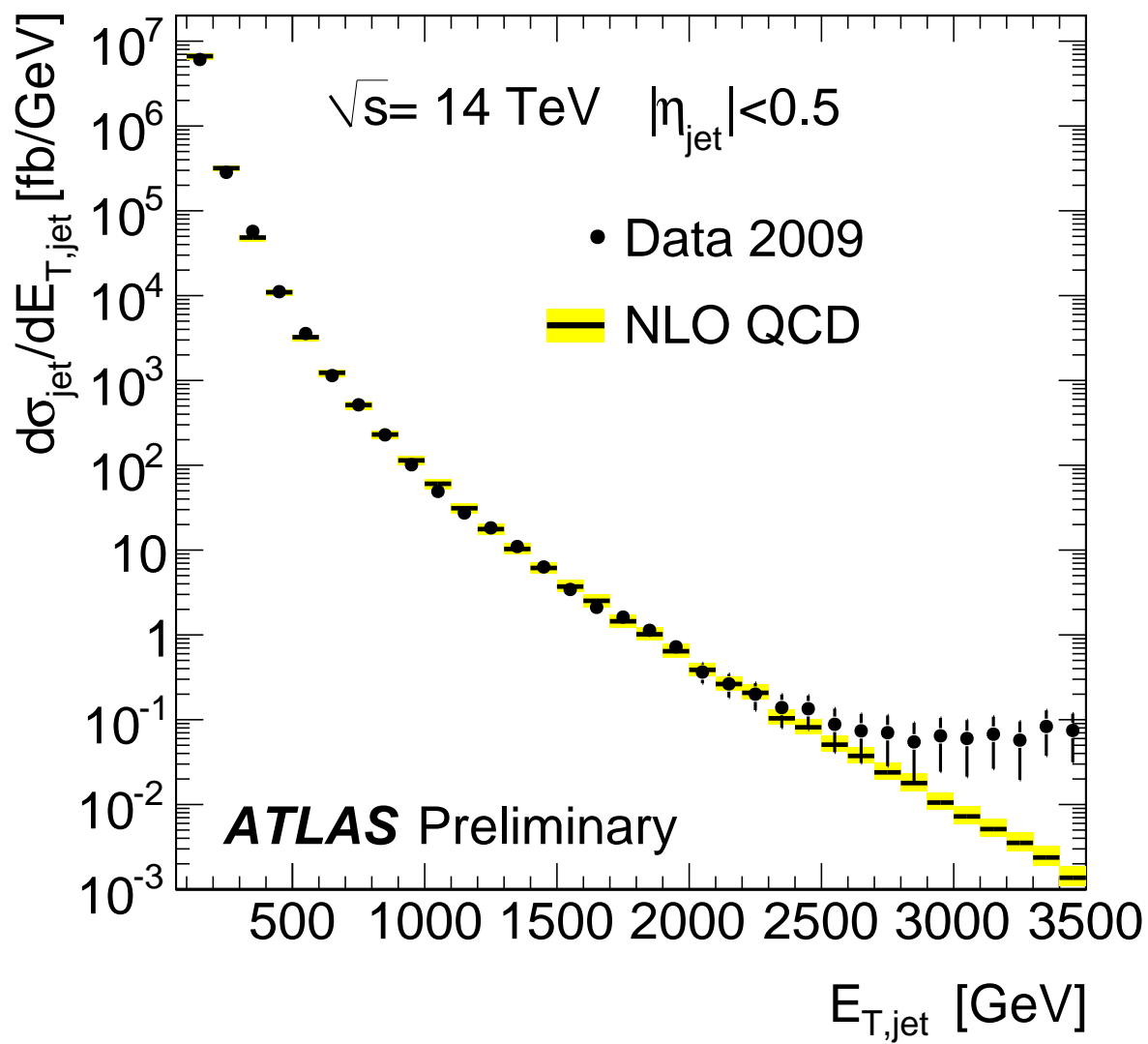


Figure 1: An example ATLAS figure.

specify the bin width, unless arbitrarily normalized. A legend box explaining all plotting symbols must appear somewhere in the figure.

The caption should be placed below the figure. All lines, all plotting symbols, and all variables used in the figure must be defined in the caption. Do not refer to any characteristic that is not distinguishable in black-and-white. If relevant, the normalization method of the plot should be specified.

A figure with subfigures can be made as shown in the example of Figure 2.

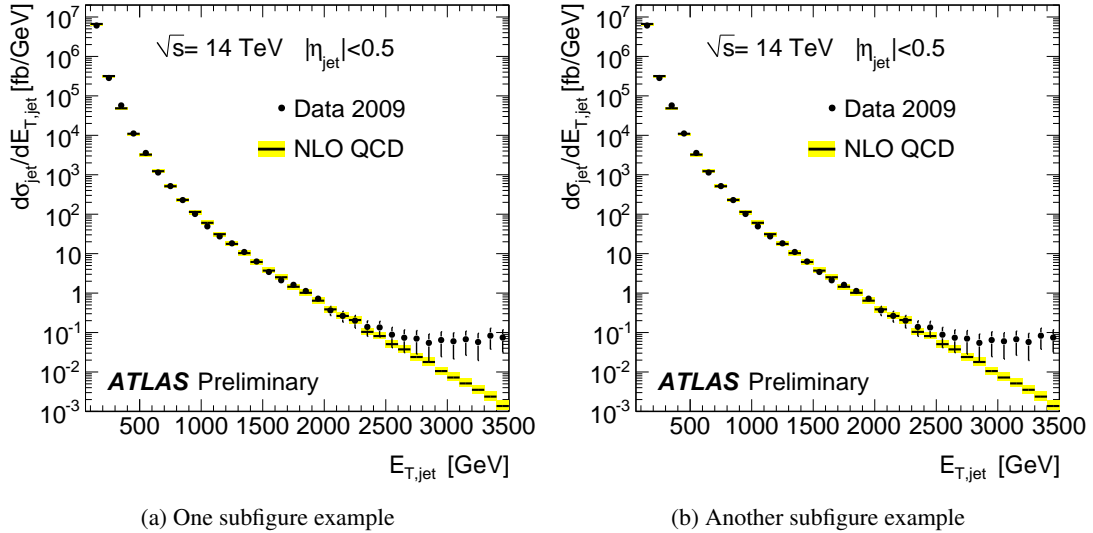


Figure 2: Subfigure example (2a) and (2b).

## D References

Only cite permanent, publicly available, or ATLAS approved references. Private references, not available to the general public, should be avoided. Caution should be used when referring to ATLAS notes. Only reference approved notes. Do not reference COM or INT notes, as these are not available outside ATLAS.

Whenever possible, cite the article’s journal rather than its preprint number. If possible, the arXiv number should be given in addition. Always double check references when copying them from another source.

Referencing styles are journal-dependent. See the ATLAS Publication Policy document for more information.

Use BibTeX for the references. Although it often appears harder to use at the beginning, it means that the number of typos should be reduced significantly and the format of the references will be correct, without you having to worry about formatting it. In addition the order of the references is automatically correct.

One or more files with the extension .bib (in this example: atlas\_paper.bib) should contain all the references. The files may also contain references that you do not use, so they may act like a library of references. The typical compilation cycle when using BibTeX looks like the following:

(pdf)latex instructions

```

bibtex instructions
(pdf)latex instructions
(pdf)latex instructions

```

BIBTEX will create a file with the extension .bbl, which will contain the actual references used, and LATEX will then take care to include them in your paper. Note that only after the third run of LATEX will all references be correct. Unless you change a reference you do not have to do the bibtex step again.

Two BIBTEX style files (bibtex/bst/atlasBibStyleWoTitle.bst and bibtex/bst/atlasBibStyleWoTitle.bst) are provided with the ATLAS LATEX package. You can use one of them in your text source file as follows:

```

\bibliographystyle{bibtex/bst/atlasBibStyleWoTitle}
\bibliography{atlas_paper}

```

Note that biblatex is a more modern replacement for BIBTEX that has a number of advantages. If you want to use this package, you should include commands like:

```

\usepackage[backend=biber,
  style=numeric-comp,sorting=none,block=ragged,firstinits=true]{biblatex}
\addbibresource{atlas_paper.bib}

```

in the preamble of our document. These are defined for you if you include atlaspackage with the option biblatex. Then include the command:

```

\printbibliography

```

where the bibliography should get printed. Use the command biber instead of bibtex to process the .bib files.

For further information on BIBTEX and on the standard ATLAS style for referencing, see the “ATLAS BIBTEX Guide” [atlas\_bibtex].

## E Remarks on units and symbols

It is highly recommended to use a units package to format your units properly. The package siunitx works very well and is the package of choice. Alternatives include units and hepunits, which is based on SIunits.

If you use a units package, it automatically set SI units in roman-type font and leaves a small space between the value and the units (e.g. 12 mm). In addition, it makes sure they end up always together on the same line. `\SI{12}{\mm}`. Natural units, where  $c = \hbar = 1$ , should be used for all ATLAS publications. Masses are therefore in GeV, not GeV/c.

Use math mode for all symbols (e.g. use  $c$  (`\mathit{c}`) rather than simply c). Momentum should be in lower case  $p$ . Transverse momentum is a lower case  $p$  with an upper case roman T subscript: `\pT` produces  $p_T$ . Energy is an upper case  $E$ , `\ET` produces  $E_T$ . Use `\mathcal` mode for luminosity  $\mathcal{L}$  or aplanarity  $\mathcal{A}$ .

Trigonometric functions should be in roman type. Natural logarithm should be  $\ln$  and log base 10 is  $\log$ . When in math mode, use `\ln`, `\sin`, etc. We recommend to specify the base of the logarithm: `\log_{10}`.

If your note makes use of cones, for example cone-jets, explain that these cones are constructed in  $\eta$ - $\phi$  space, and define  $\eta$ .

Add the word *events* as the unit when quoting the number of events: “The resulting background is  $4.0 \pm 1.3$  events.”. The number of expected events should be written as  $N_{\text{pred}}$  rather than  $N_{\text{exp}}$ , since the latter could also mean experimental.

For particle names and symbols, ATLAS uses the standards of the Particle Data Book. Intermediate vector bosons should be called *W boson(s)* and *Z boson(s)*, not just *W’s* or *Ws*. The Z boson should not have a superscript of 0. W without the word boson attached may be used in *W pair production*, and similar phrases. Other particle names should be spelled out when used in a sentence: muon(s), electron(s), tau lepton(s). *Top quark* should be used instead of *top* in most places: say “top quark mass” instead of “top mass”. Top quark and bottom quark may be shortened to *t* quark and *b* quark. The neutrino symbol  $\nu$  should not have any subscripts, unless necessary for understanding. For the  $J/\psi$  use the command `\Jpsi` from `atlasphysics.sty`: it will produce a lower case  $\psi$ .

When in doubt, use the PDG style.

## F The atlasdoc class

This paper has been typeset using the `atlasdoc.cls` class. This class implements the ATLAS template and can be used for papers, preprints, notes. The class is available from the web pages of the Publication Committee and from SVN. It also contains these guidelines and related files.

Details on how to use the templates can be found in a separate document `atlas_latex.pdf` [7].

The style file `atlasphysics.sty` defines a lot of useful macros for particles and more. See the separate document `atlas_physics.pdf` [8] for details.