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Progress Report

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Project Aqueous

5

6

Number 6

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School of Physics and Astronomy

9

University of Glasgow

10

November 2025

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¹²

Abstract

¹³ A brief summary of the report.

Acknowledgements

¹⁵ The contributions of Number 2 and Number 1 are acknowledged.

Contents

¹⁶	Abstract	i
¹⁷	Acknowledgements	ii
¹⁸	Contents	iii
¹⁹	List of Figures	iv
²⁰	List of Tables	v
²¹	Introduction	2
²²	0.1 Higgs bosons	2
²³	1 A title for chapter 1	3
²⁴	1.1 Section 1	3
²⁵	1.1.1 Time	3
²⁶	1.1.2 Units and units typesetting	4
²⁷	1.1.3 Mathematics	4
²⁸	1.1.4 Lists	5
²⁹	1.1.5 Code	6
³⁰	1.1.6 Images	7
³¹	1.1.7 References	8
³²	1.1.8 ROOT	9
³³	1.1.9 Some paragraphs	10

35	1.1.10 tables	12
36	2 Example of the use of bold mathematics in chapter titles while corre-	
37	sponding bold text is used in contents: the Standard Model Higgs boson	
38	in $t\bar{t}H$ ($b\bar{b}$)	13
39	2.1 Further example of the use of bold mathematics in section titles while corre-	
40	sponding normal text is used in contents: the Standard Model Higgs boson	
41	in $ttH(H \rightarrow bb)$	13
42	3 A title for future	14
43	3.1 future plans and considerations	14
44	References	16

⁴⁵ **List of Figures**

⁴⁶	1.1	Parallel job processor: large efficiency improvement as a result of parallelisation	7
⁴⁷	1.3	Feynman diagram	8
⁴⁸	1.2	parallel job processor	8
⁴⁹	1.4	Reco_tf.py usage	12
⁵⁰	3.1	Gantt chart of work	15

⁵¹ **List of Tables**

⁵² Introduction

⁵³ 0.1 Higgs bosons

⁵⁴ Higgs bosons are particles that arise through electroweak symmetry breaking. A principal
⁵⁵ motivation for the Large Hadron Collider physics programme was the testing of the theory
⁵⁶ of electroweak symmetry breaking, through the observation of Higgs bosons. In July of
⁵⁷ 2012, the existence of the Higgs boson was confirmed by the ATLAS and CMS experiments.
⁵⁸ Following this discovery, further studies have been ongoing in order to examine the character
⁵⁹ of the particle.

60 **Chapter 1**

61 **A title for chapter 1**

62 **1.1 Section 1**

63 This is content.

64 **1.1.1 Time**

65 A few time representations follow:

66 • 2025-11-26

67 • 26 November 2025

68 • November 2025

69 • 181942

70 • 1819

71 • 2025-11-26T181942

72 • 2025-11-26T1819

73 **1.1.2 Units and units typesetting**

- 74 • $a^b m^2$ – correct unit typesetting (manual siunitx function) (preferred for mathematics
75 mode, though note that the function for this is provided by aqueous [see below for
76 manual equivalent method not dependent on aqueous])
- 77 • 10 kg – correct unit typesetting (siunitx)
- 78 • 10 kg – incorrect unit typesetting (mathematics, textnormal)
- 79 • 10 kg – incorrect unit typesetting (literally)
- 80 • 10kgms^{-2} – correct unit typesetting (siunitx)
- 81 • $10^{-28} m^2$ – correct unit typesetting, though very manual (siunitx)
- 82 • $a^b m^2$ – correct unit typesetting, though manual (siunitx) (preferred for mathematics
83 mode)
- 84 • $a^b m^2$ – dodgy, manual correct unit typesetting (siunitx)
- 85 • $a^b m^2$ (siunitx)
- 86 • The angle is 14° .
- 87 • The temperature is 14°C . – correct unit typesetting (siunitx)

88 Kerning is the aesthetic adjustment of the horizontal spacing of characters. The kerning of
89 the unit symbol for the electron-volt can be improved over the default L^AT_EX kerning with
90 commands like the following:

```
91    \newcommand{\eV}{\text{e}\kern-0.15ex V}\xspace  
92    \newcommand{\MeV}{\text{M}\text{\eV}}\xspace  
93    \newcommand{\GeV}{\text{G}\text{\eV}}\xspace  
94    \newcommand{\TeV}{\text{T}\kern-0.1ex \text{\eV}}\xspace
```

95 So, TeV becomes TeV.

96 **1.1.3 Mathematics**

97 The following is a referenced equation:

$$E = mc^2 \quad (1.1)$$

₉₈ This is a reference to equation 1.1.

₉₉ This is bold mathematics within non-bold mathematics: $t\bar{t}\mathbf{H}(b\bar{b})$.

₁₀₀ This is bold mathematics: $\mathbf{t}\bar{t}\mathbf{H}(b\bar{b})$.

₁₀₁ 1.1.4 Lists

₁₀₂ This is a list:

₁₀₃ • function,

₁₀₄ • Job,

₁₀₅ • JobGroup,

₁₀₆ • ParallelJobProcessor and

₁₀₇ • pool.

108 This is a checklist:

109 ✓ item

110 ✓ item

111 ✓ subitem

112 ✓ subitem

113 ✓ subitem

114 ✓ item

115 ✗ item

116 **1.1.5 Code**

117 This is some code:

```
118     Reco_tf.py --inputBSFile data12.1234.RAW --outputESDFile data12.1234.ESD
```

119 Here is some more code. A single spin- $\frac{1}{2}$ particle is initially “up” along z , rotated around
120 the x -axis by angle θ , and we compute the probability that it is still “up” afterwards:

```
121     import numpy as np
122
123     sigma_x = np.array([[0, 1], [1, 0]], dtype=complex)
124     psi0 = np.array([1, 0], dtype=complex)                      # |^z>
125     theta = np.pi / 3                                         # rotation angle
126     U = np.cos(theta/2)*np.eye(2) - 1j*np.sin(theta/2)*sigma_x
127     psi = U @ psi0                                         # evolved state
128     P_up = np.abs(psi[0])**2                                # probability of |^z>
129     print(P_up)
```

130 This is a two-level quantum system, where U is the rotation operator $e^{-\frac{-i\theta\sigma_x}{2}}$, ψ is the
131 new state after rotation, and P_{up} is the Born-rule probability of measuring spin up along
132 z .

¹³³ **1.1.6 Images**

¹³⁴ This is a figure set to a defined width:

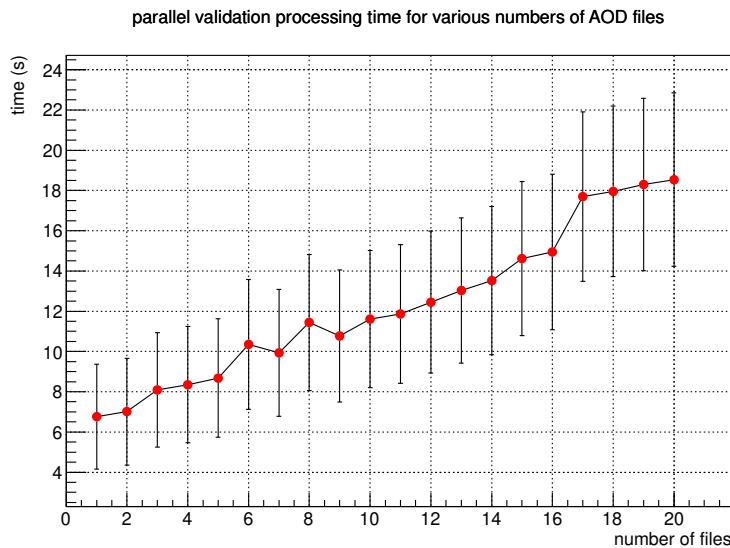


Figure 1.1: Parallel job processor: large efficiency improvement as a result of parallelisation

¹³⁵ This is a figure set to the text width:

Figure 1.3: Feynman diagram

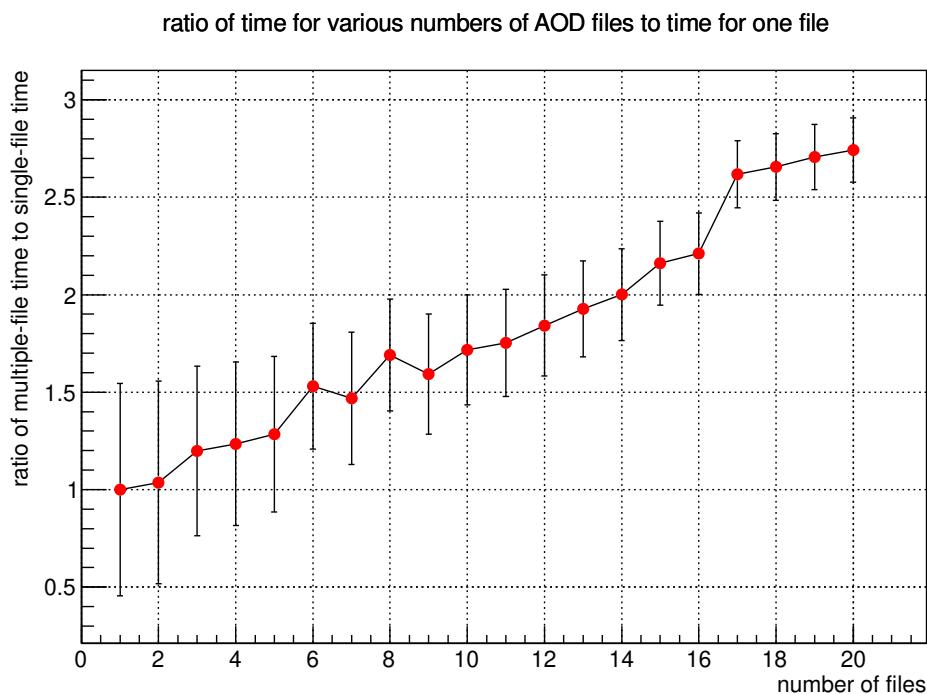


Figure 1.2: parallel job processor

¹³⁶ Here is a Feynman diagram:

¹³⁷ 1.1.7 References

¹³⁸ This is a reference to figure 1.2. This is a reference [1]. This is another reference [2]. This

¹³⁹ is a URL: <https://github.com/wdbm/aqueous>

¹⁴¹ 1.1.8 ROOT

¹⁴² ROOT [3] is an object oriented data analysis framework aimed at solving data analysis
¹⁴³ challenges in high energy physics. While *ROOT* is simply a name, a possible acronym for
¹⁴⁴ the system could be “*Rapid Object-Oriented Technology*” [4]. ROOT was developed in the
¹⁴⁵ context of the NA49 experiment at CERN. NA49 generated data of approximately 10 TB
¹⁴⁶ per run. This rate of data provided a test environment for the development of ROOT, as
¹⁴⁷ the next generation of data analysis. ROOT features *Cling*, a C++ interpreter.¹



¹This is a footnote.

148 **1.1.9 Some paragraphs**

149 Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Ut purus elit, vestibulum ut,
150 placerat ac, adipiscing vitae, felis. Curabitur dictum gravida mauris. Nam arcu libero,
151 nonummy eget, consectetuer id, vulputate a, magna. Donec vehicula augue eu neque. Pel-
152 lentesque habitant morbi tristique senectus et netus et malesuada fames ac turpis egestas.
153 Mauris ut leo. Cras viverra metus rhoncus sem. Nulla et lectus vestibulum urna fringilla
154 ultrices. Phasellus eu tellus sit amet tortor gravida placerat. Integer sapien est, iaculis
155 in, pretium quis, viverra ac, nunc. Praesent eget sem vel leo ultrices bibendum. Aenean
156 faucibus. Morbi dolor nulla, malesuada eu, pulvinar at, mollis ac, nulla. Curabitur auctor
157 semper nulla. Donec varius orci eget risus. Duis nibh mi, congue eu, accumsan eleifend,
158 sagittis quis, diam. Duis eget orci sit amet orci dignissim rutrum.

159 Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non
160 justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor
161 sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi
162 ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla.
163 Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.
164 Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus
165 mauris.

166 Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristi-
167 que, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus
168 adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae,
169 placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan
170 nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem.
171 Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim.
172 Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar
173 lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

174 Quisque ullamcorper placerat ipsum. Cras nibh. Morbi vel justo vitae lacus tincidunt
175 ultrices. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. In hac habitasse platea
176 dictumst. Integer tempus convallis augue. Etiam facilisis. Nunc elementum fermentum wisi.
177 Aenean placerat. Ut imperdiet, enim sed gravida sollicitudin, felis odio placerat quam, ac

¹⁷⁸ pulvinar elit purus eget enim. Nunc vitae tortor. Proin tempus nibh sit amet nisl. Vivamus
¹⁷⁹ quis tortor vitae risus porta vehicula.

180 1.1.10 tables

input file option	description
--inputHitsFile	input only
--inputBSFile	RAW data (BS = ByteStream), currently input only
--inputRDOFile	
--inputESDFile	
--inputAODFile	

output file option	description
--outputRDOFile valid	if starting from Hits
--outputESDFile valid	if starting from Hits, RDO or BS
--outputAODFile valid	if starting from ESD or anything else upstream
--outputNTUP_XXXFile	can be made from ESD or AOD, BS or RDO

Figure 1.4: Reco_tf.py usage

¹⁸¹ Chapter 2

¹⁸² Example of the use of bold
¹⁸³ mathematics in chapter titles

¹⁸⁴ while corresponding bold text is
¹⁸⁵ used in contents: the Standard
¹⁸⁶ Model Higgs boson in $t\bar{t}H$ ($b\bar{b}$)

¹⁸⁷ 2.1 Further example of the use of bold mathematics
¹⁸⁸ in section titles while corresponding normal text is
¹⁸⁹ used in contents: the Standard Model Higgs boson
¹⁹⁰ in $ttH(H \rightarrow bb)$

¹⁹¹ **Chapter 3**

¹⁹² **A title for future**

If we can hit that bullseye, the rest of the dominos will fall like a house of cards. Checkmate!

Zapp Brannigan

You hear the bird's gurgling?

Pedro Carolino in *English As She is Spoke* (1883), a book which was intended as a Portuguese–English phrase book, but which was written by Carolino using dictionaries as opposed to a comprehension of the English language, hence it is a sort of 19th century machine translation.

¹⁹³ **3.1 future plans and considerations**

¹⁹⁴ These are suggestions and plans for the future.

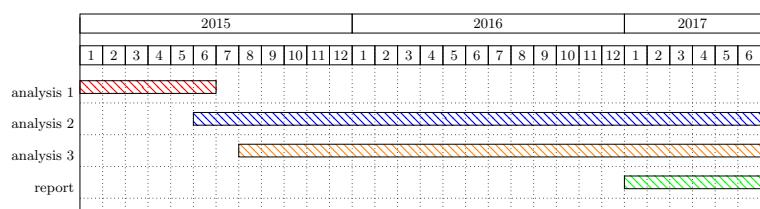


Figure 3.1: Gantt chart of work

195 References

- 196 [1] L. Li Tianjun, W. Xia, W. You-kai and Z. Shou-hua, *Distinguishing the Color Octet*
197 *Axial-Vector-like Particle for Top Quark Asymmetry via Color Flow Method at the LHC*
198 (June 2013), arXiv:1306.3586
- 199 [2] W. S. McCulloch and W. Pitts, *A logical calculus of the ideas immanent in nervous*
200 *activity*, The Bulletin of Mathematical Biophysics, 5 (4), 115–133 (1943)
- 201 [3] *ROOT: A Data Analysis Framework* (November 2012), URL <http://root.cern.ch>
- 202 [4] R. Brun, *Re: What does ROOT stand for?*, RootTalk (May 1998), URL <http://root.cern.ch/root/roottalk/roottalk98/0718.html>