JOURNEY THROUGH THE THESIS WRITING

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LHCb UK student seminar
29.6.2023

DISCLAIMER

CERN EP R&D

- I am **not** a professional writer, just sharing my experience and what worked for me
- Your mileage may (**and will**) vary!!

- Will summarize:
  - Planning of the durations
  - What (I think) makes difference
- My thesis for reference (apparently people liked it):
  - https://cds.cern.ch/record/2806219


MANCHESTER 1824
The University of Manchester

DOCTORAL THESIS

Developing a Silicon Pixel Detector for the Next Generation LHCb Experiment

Peter Švihra
Supervisor: Prof. Chris Parkes, PhD.

A thesis submitted to The University of Manchester for the degree of Doctor of Philosophy

in the

Department of Physics and Astronomy
Faculty of Science and Engineering

2021

PLANNING

THE PLAN

CP: chapters and lengths look reasonable

CP: send chapters when you are done, will correct within 2 weeks

PARTS	CHAPTERS	SECTIONS	SUBSECTIONS	PAGES	PAGE SUMMARY	ESTIMATE	weeks
abstract, table of contents,...				XX		x	0
introduction				3	3	x	0
upgrade 1	theory	LHCb in general		5	38	end of may	4
		semiconductor detectors	general	15			
			rad damage	7			
		VELO	vacuum	3		end of april	1
			cooling	3			
			readout	5			
	VELO modules	construction		7	49	end of april	2
		metrology		7			
		testing		10			
		database		15		mid july	2
		analysis		10			
	VELO commissionin	CCE	toy studies	15	15	end of july	2
	conclusions			2	2	x	0
upgrade 2	theory	LHCb plan in general		3	10	late june	3
		detectors	fast timing	7			
	sensor development	TCAD simulations		15	15	mid august	2
		device testing		5	5	end of june	1
	conclusions			2	2	x	0
bibliography, acronyms, ...				XX		x	0
HEV				XX		x	1
TOTAL COUNT				139			17

CP: 139 pages is a little short, might aim for 150-200 but do not worry now

- Plan produced at the beginning of April 2021, deadline end of September 2021
- Verify the feasibility with your supervisor and agree on the process of corrections!
- All good! Will be done mid August, still a month to spare before the end of funding!

…. right ….

THE REALITY

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Plan

PARTS	CHAPTERS	SECTIONS	SUBSECTIONS	PAGES	PAGE SUMMARY	ESTIMATE	weeks
abstract, table of contents,...				XX		x	0
introduction				3	3	x	0
upgrade 1	theory	LHCb in general		5	38	end of may	4
		semiconductor detectors	general	15			
			rad damage	7			
		VELO	vacuum	3		end of april	1
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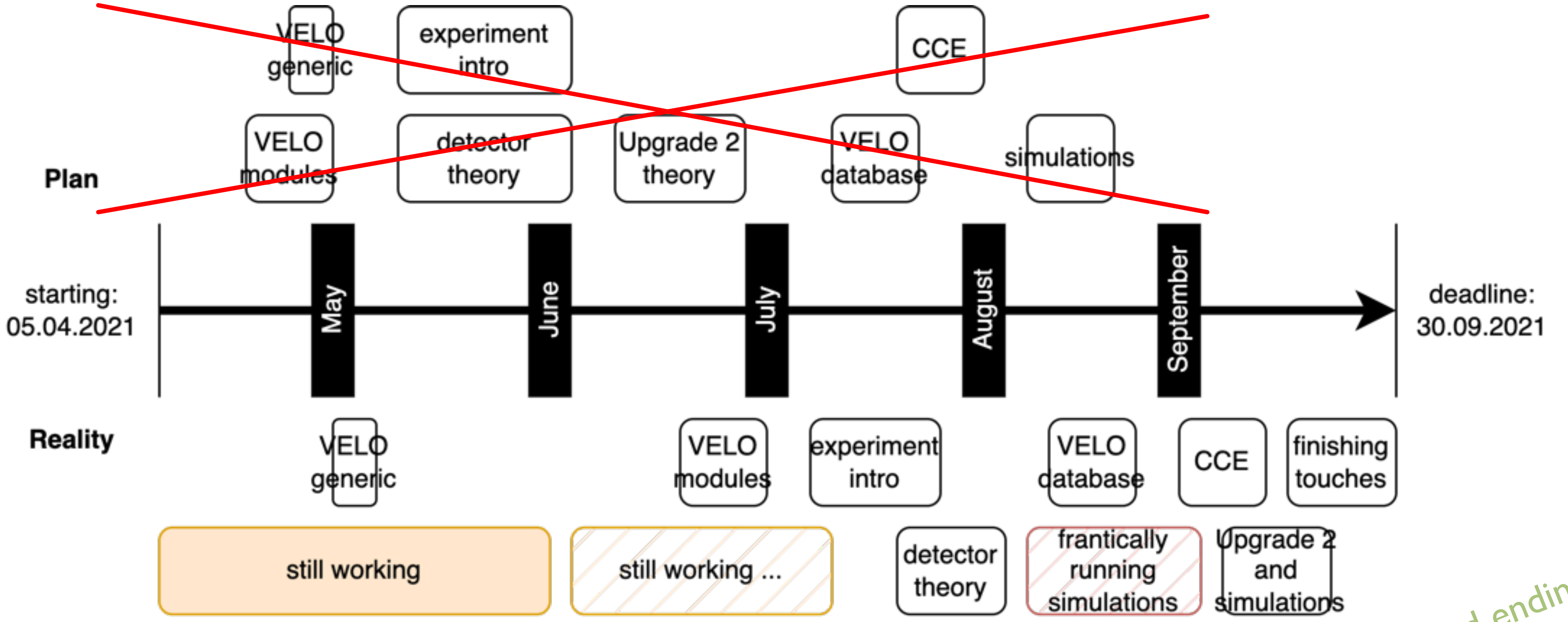
		analysis		10			
	VELO commissioning	CCE	toy studies	15	15	end of july	2
	~~conclusions~~			2	2	x	0
upgrade 2	theory	LHCb plan in general		3	10	late june	3
		detectors	fast timing	7			
	sensor development	TCAD simulations		15	15	mid august	2
		~~device testing~~		5	5	end of june	1
	~~conclusions~~			2	2	x	0
bibliography, acronyms, ...				XX		x	0
HEV				XX		x	1
TOTAL COUNT				139			17

Reality

PARTS	CHAPTERS	SECTIONS	SUBSECTIONS	PAGES	PAGE SUMMARY	REALITY	weeks
abstract, table of contents,...				35	35		
preface				3	3		
upgrade 1	LHCb experiment and its Upgrade	CERN and LHC		3	25	end of july	3
		LHCb and LHCb Upgrade		11			
		VELO Upgrade	mechanics	2			
			cooling	2			
			electronics	6			
		Summary		1			
	Semiconductor detectors	Interaction of radiation		4	24	early august	2
		Semiconductors		13			
		Radiation damage		6			
		Summary		1			
	VELO Upgrade modules	Assembly		7	24	end of june	2
		Metrology		4			
		Module installation		5			
		Module performance testing		7			
		Summary		1			
	Database and quality assurance	Database		6	35	mid august	2
		Assembly		1			
		Metrology		11			
		Electrical testing		13			
		Evaluation		3			
		Summary		1			
	Charge collection efficiency scans	CCE		12	13	early september	2
		Summary		1			
upgrade 2	Future upgrades	LHCb Upgrade II		3	21	mid september	3
		Ultra fast silicon detectors		5			
		Sensor simulations		2			
		iLGAD simulation		10			
		Summary		1			
Summary and Conclusions				3	3		
bibliography, acronyms, ...				10	10		
HEV				30	30		
TOTAL COUNT					223		14

- Outline changed a bit
- Page estimate ballpark OK (142 without extras)
- Got **very** delayed (about 2 months)

COMPARISON



- It takes **months** to actually stop working and start writing
  - Be sure to set a deadline after which you stop joining meetings
  - Plan for time needed for corrections!

Story with a good ending:
Submitted night 28-29.09.2021

WHAT (I THINK) MAKES A DIFFERENCE

GENERICS

- Leave the abstract, preface and conclusions as the **last** thing (before that you do not fully know what you write about)

Acronyms

Notation	Description	Page List
AC-LGAD	AC coupled LGAD	169, 170
ADC	Analog-Digital Converter	41, 76, 148
ALICE	A Large Ion Collider Experiment	37, 38
APD	Avalanche Photodiodes	166
API	Application Programming Interface	47, 48
ASIC	Application Specific Integrated Circuit	29, 30, 40, 53, 55–60, 66, 76, 77, 85, 89, 90, 93, 97, 98, 103–107, 111, 116, 121–124, 126, 129–131, 133–137, 148, 154, 156, 158, 159, 165, 179, 188
ATLAS	A Toroidal LHC ApparatuS	37, 38, 102

- Start with the acronyms from the **beginning**, it would be a pain to add them later
  - Try to use them for everything and to get used to it

- Make sure your tables of contents/figures/tables populate well
  - Use shortened descriptions, make sure it plays well with citations and acronyms!

→

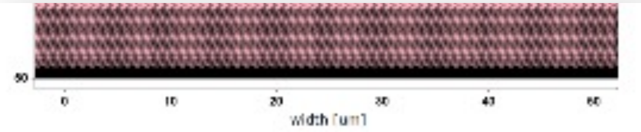


Figure 6.10: Meshing map of the simulated diode with thickness 50 µm. The meshing is more refined in the implant regions in order to better simulate the avalanche process in the multiplication layer.

GENERICS

- Leave the abstract, preface and conclusions as the **last** thing (before that you do not fully know what you write about)

- Start with the acronyms from the **beginni**... to add them later

ATLAS A Toroidal LHC ApparatuS 37, 38, 102

...40, 53, 55–60, 66, 76, 77, 85, 89, 90, 93, 97, 98, 103–107, 111, 116, 121–124, 126, 129, 131, 133–137, 148, 154, 156, 158, 159, 165, 179, 188

Start with the template and populate text with **Lorem Ipsum**
- it is a nice excuse of "I already started writing"
- you have quick turnaround of changes
- eases you into changing your work pattern

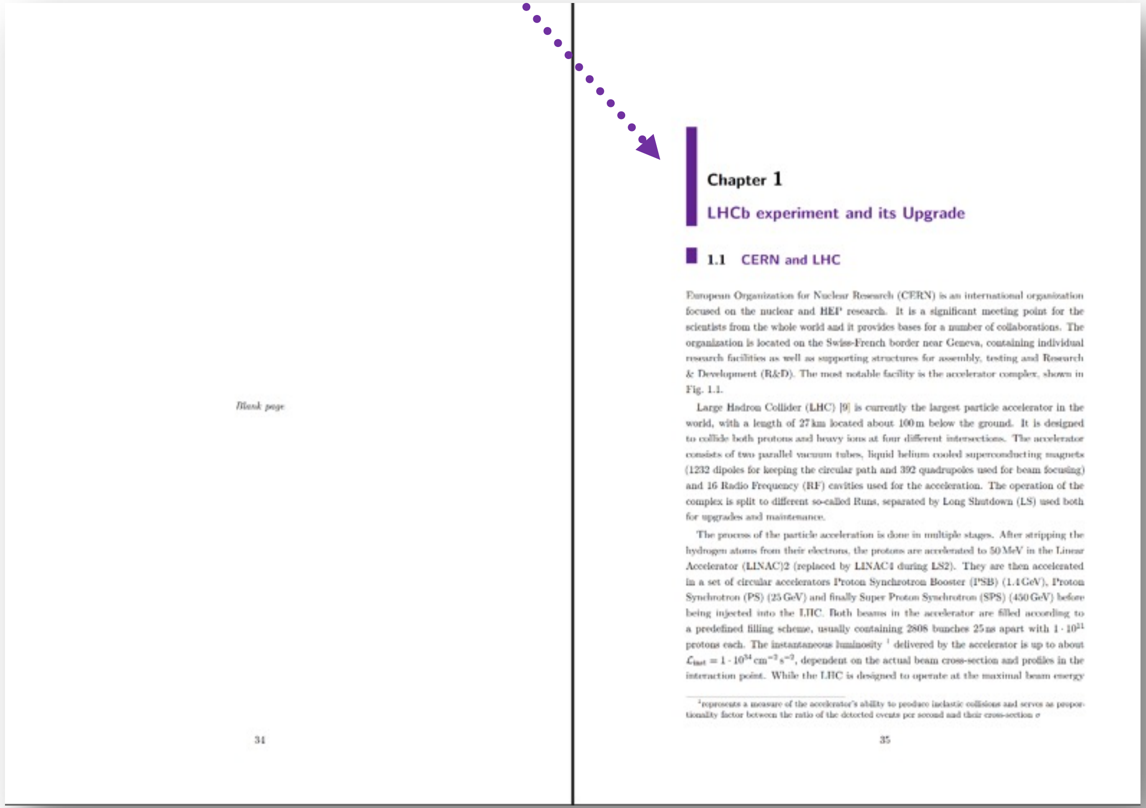
- Make s... ...ents/figures/tables populate well
  - Use s... ...ened descriptions, make sure it plays well with citations and acronyms!

→

Figure 6.10: Meshing map of the simulated diode with thickness 50 µm. The meshing is more refined in the implant regions in order to better simulate the avalanche process in the multiplication layer.

CONSISTENT DESIGN THAT YOU LIKE

- I colour matched the university theme, use the double sided layout to your advantage



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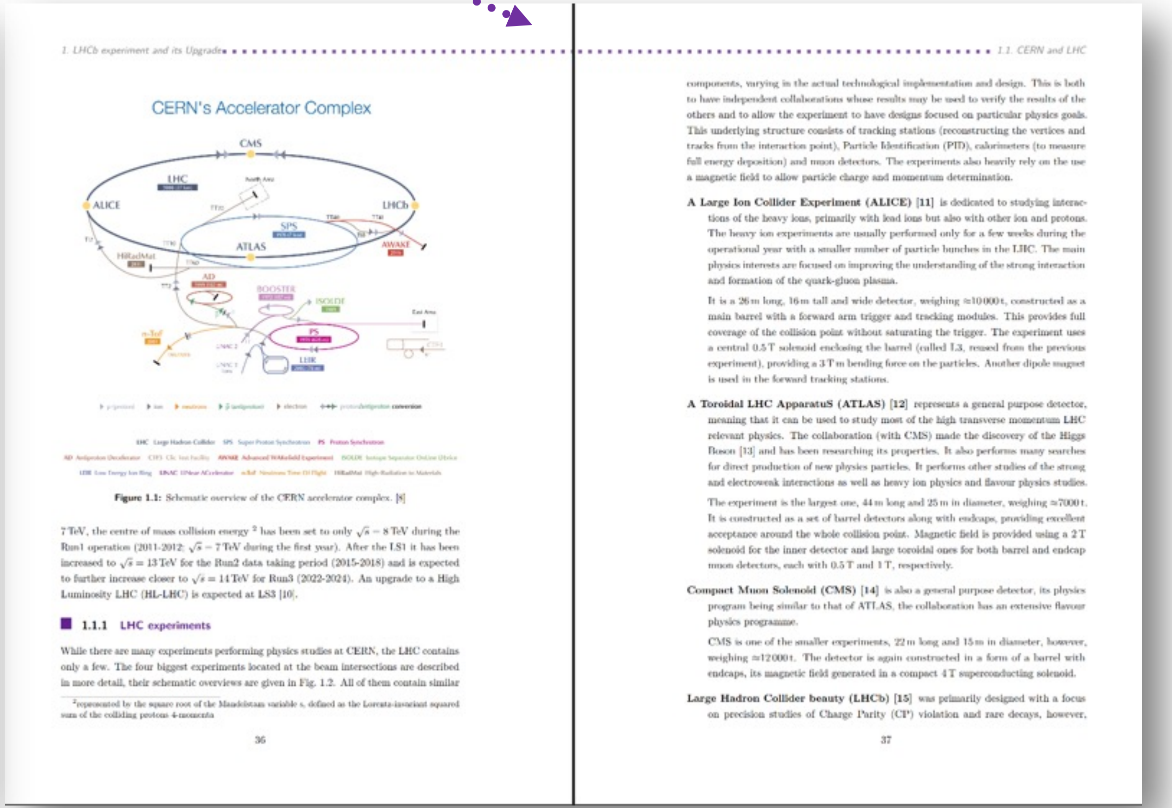
34

Chapter 1

LHCb experiment and its Upgrade

1.1 CERN and LHC

35



1. LHCb experiment and its Upgrade

1.1. CERN and LHC

Figure 1.1: Schematic overview of the CERN accelerator complex.

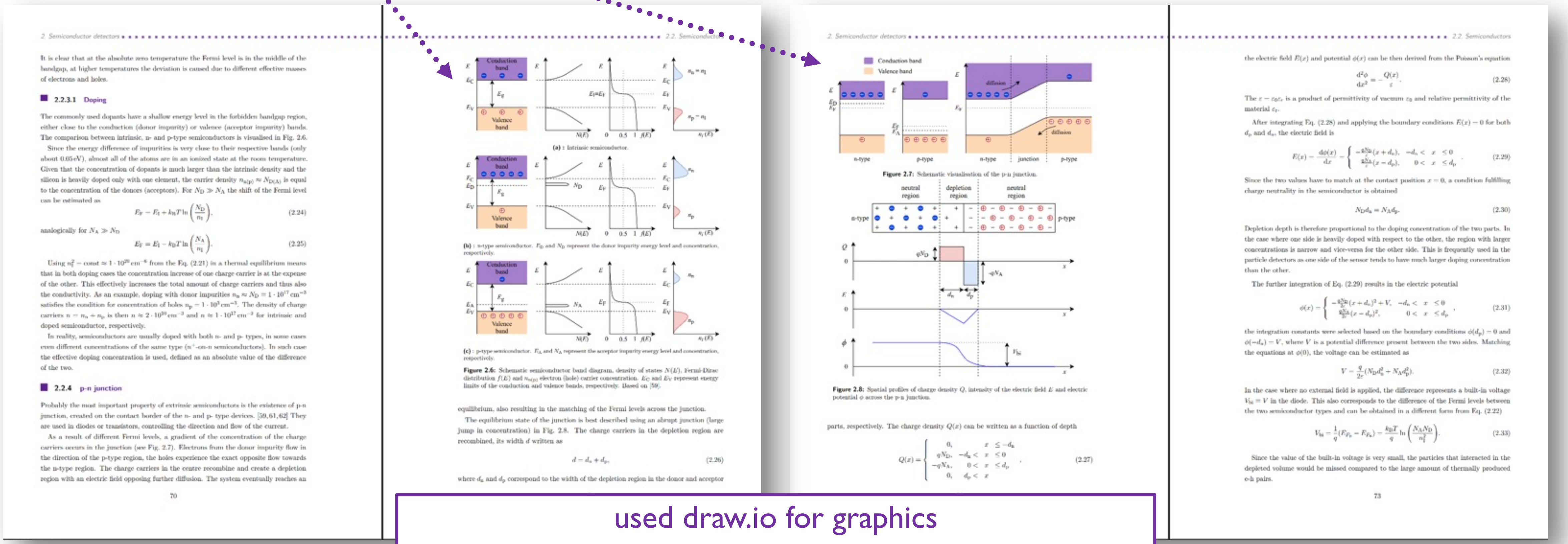
1.1.1 LHC experiments

36

37

CONSISTENT DESIGN THAT YOU LIKE

- I colour matched the university theme, use the double sided layout to your advantage
- Make your own graphics (where it makes sense) that match the style (takes time, but worth the effort)

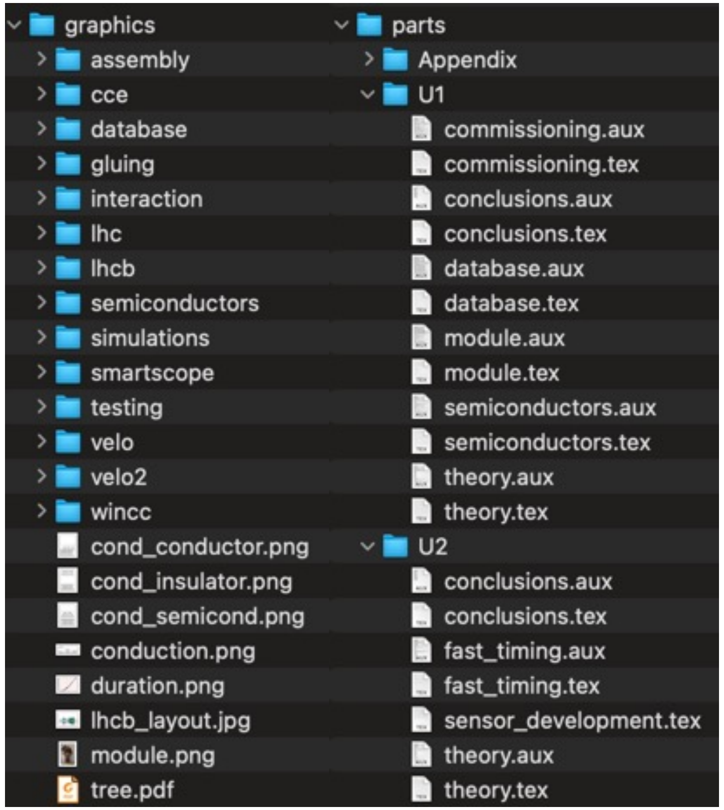


used draw.io for graphics
free software available online or as an app

GOOD WRITING PRACTICES

- Have git (-hub / -lab) repository where you push changes at least once a day
- Do not fully rely on overleaf, always have offline copies available (ideally, be able to compile offline …)

- Split the document based on chapters/sections (makes simpler navigation and compilation chapters)



- **!!! Have backups of everything !!!** (separate machines, all plots, figures, partially compiled pdfs …)
- You will most certainly have to remake some of the old plots
  - You will get stuck for days on this alone, don't be afraid of some MS-Paint magic for labels/fonts/…
- Don't forget references to everything!

GOOD WRITING PRACTICES

- Write a summary at the end of each chapter (just a few paragraphs)
  - Good both for you when thinking about what you forgot, but also for someone just skimming through your thesis

- You are not writing a novel, but does not mean it has to be boring – try to make a story out of it where possible

- Make sure you have forward/backward references where needed
  - e.g. My chapter 3 describes module assembly and tools for characterisation, but only Chapter 4 mentions the actual measurement results and overall metrics

3.1.2 Tiles attachment

Placement of the tiles on the modules is one of the tasks requiring the highest accuracy during the module construction, aiming at achieving a precision better than 30 µm. Furthermore, the thickness of the glue layer used for the tile attachment affects the final cooling performance of the whole module. The temperature of the tip of the overhanging tile is the most critical element, the targeted glue layer thickness underneath each tile is 80 µm. While the production steps are described further in the text, the metrology measurements are discussed in detail in Sect. 3.2.2 and 3.2.3 and their results in Sect. 4.3.2 and 4.3.3.

4.3.2 Glue layer thickness and tile flatness

This measurement is done for both UoM (described in Sect. 3.2.2) and Nikhef, once again the data-input from the two sites differ. The differences are bigger than for a simple substrate flatness measurement, therefore the calculation has to be performed differently as well. The results are not only needed to verify the uniformity but also used later in the cooling performance described in Sect. 4.4.5.

HOW TO FINALLY START WRITING

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- But **do not worry** if it takes you months

- Put your thoughts on screen
  - Whatever works for you, bullet-points, short text, … really just need to start
  - **Do not worry** if it is good or bad, the main point is you started!

- You will get better over time as you get to it, **do not worry** if you constantly rewrite paragraphs

- Find what helps you to sit down and write
  - set goals / go to a library / join writing (zoom) rooms / meet with friends in office / try pomodoro / …
  - Try to be in a good environment (family, friends, eat good food, sleep properly, have access to loads of chocolate and coffee, …)
  - **Really do not be afraid saying <u>no</u> to <u>work</u> and <u>no</u> to <u>meetings</u>**

SUMMARY AND LET'S DISCUSS

CONCLUSIONS

- It takes time and effort (last minute finishes, unexpected problems)
  - try to plan a bit and estimate how much time you need

  … it will **always** take longer !

- Really, just start
  - First with a template (**make it pretty!**)
  - Slowly ease into the full time writing frenzy

  … but to not forget to take breaks (even a holiday halfway through!)

- As with everything, ask for help whenever you think you need it