Contents

Acknowledgments v

Abstract vii

List of figures xviii

List of tables xix

1 Introduction 1
- 1.1 Physics prospects for a future Linear Collider . . . 1
- 1.2 CLIC overview . . . 2
- 1.3 The CLIC Damping Rings . . . 4
- 1.4 Scope of the thesis . . . 6

2 Beam dynamics and collective effects 7
- 2.1 Linear beam optics . . . 7
  - 2.1.1 Transverse betatron motion . . . 8
  - 2.1.2 Longitudinal synchrotron motion . . . 13
- 2.2 Synchrotron radiation damping and quantum excitation . . . 14
- 2.3 Wake fields and impedances . . . 16
  - 2.3.1 Longitudinal plane . . . 18
  - 2.3.2 Transverse plane . . . 19
  - 2.3.3 Effective impedance . . . 20
- 2.4 Electromagnetic simulation tools of wakefields and impedances . . . 21
  - 2.4.1 CST Studio Suite . . . 21
  - 2.4.2 ImpedanceWake2D . . . 21

3 Transverse impedance budget of the CLIC DR 23
- 3.1 Introduction . . . 23
- 3.2 The HEADTAIL code . . . 24
- 3.3 Transverse impedance budget . . . 25
  - 3.3.1 Impedance model with a broad-band resonator . . . 25
  - 3.3.2 Impedance model with a broad-band resonator and resistive wall . . . 31
- 3.4 Effect of coating thickness and properties at high frequencies . . . 37
- 3.5 Injection and extraction kickers . . . 40

Koukovini Platia, Eirini
High frequency effects of impedances and coatings in the CLIC ...
2015

digitalisiert durch
IDS Basel/Bern, im Auftrag der
Schweizerischen Nationalbibliothek

4 Electromagnetic properties of NEG at high frequencies **43**
4.1 Motivation . . . 43
4.2 Waveguide method and CST simulation . . . 43
4.2.1 Method . . . 43
4.2.2 Benchmark with known materials . . . 45
4.2.3 S parameters . . . 46
4.2.4 Network analyzer . . . 47
4.3 Measurements with a stainless steel waveguide in X-band . . . 47
4.4 Measurements with a copper waveguide in X-band . . . 51
4.5 Measurements of NEG on a copper waveguide in X-band . . . 54
4.5.1 NEG coating process . . . 54
4.5.2 NEG-coated Cu waveguide measurement results . . . 54
4.5.3 Error analysis for CST simulations . . . 57
4.5.4 Conclusions about the NEG conductivity in X-band . . . 63
4.6 NEG properties characterization above 200 GHz . . . 64
4.6.1 220-330 GHz: WR-3.4 waveguides . . . 64
4.6.2 500-750 GHz: WR-1.5 waveguides . . . 70
4.7 Effect of the non-uniform coating profile . . . 73
4.8 Effect on the transverse impedance budget of the DRs . . . 80

5 Studies on existing and future light sources **83**
5.1 Single bunch measurements in the ALBA storage ring . . . 83
5.1.1 TMCI measurements at 0 chromaticity and HEADTAIL simulations . . . 84
5.1.2 Study of the injection kickers . . . 90
5.1.3 TMCI measurements at 0 chromaticity to study the effect of the pinger magnet . . . 98
5.2 Impedance studies for the SLS2 upgrade . . . 101
5.2.1 Motivation . . . 101
5.2.2 Transverse resistive wall impedance and instability thresholds at zero chromaticity . . . 102
5.2.3 Transverse resistive wall impedance and instability thresholds at positive and negative chromaticity . . . 103
5.2.4 Comparative study with higher negative momentum compaction factor lattice (ca05q) . . . 109
5.2.5 Transverse resistive wall impedance and instability thresholds at zero chromaticity for the ca05q lattice . . . 109

Conclusions **113**

A HEADTAIL simulations parameters for the CLIC DR **115**
A.1 Broad-band resonator model with 0 chromaticity . . . 115
A.2 Broad-band resonator model with positive chromaticity . . . 117

B ImpedanceWake2D parameters **119**
B.1 Wigglers: 2 μm NEG coating on StSt chamber 119
B.2 Arcs: 2 μm NEG coating on StSt chamber 120
B.3 Rest: 2 μm NEG coating on StSt chamber 120
B.4 Wigglers: 1 μm or 2 μm NEG coating on StSt chamber 121
B.5 Wigglers: 0.5 μm or 1 μm aC coating on StSt chamber 122

C CST and ImpedanceWake2D comparison **123**
C.1 Compare coating feature for a lossy substrate 123

D Simulations parameters for SLS2 **124**
D.1 Resistive wall impedance calculation of SLS2 with ImpedanceWake2D 124

Curriculum Vitae **131**