Noise studies with Crab Cavities in the SPS for the HL-LHC project

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by

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Day Month Year

Abstract

Acknowledgments

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E	Energy
f_{rev}	Revolution frequency
V_{RF}	RF voltage
f_{RF}	RF frequency
V_{CC}	CC voltage
f_{CC}	CC frequency

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Chapter 1

Introduction

This is the introduction of my PhD thesis.

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Chapter 2

Basics of accelerator beam dynamics

Chapter 3

Theory of Crab Cavity noise induced emittance growth

Chapter 4

First experimental campaign in the SPS

In 2018, two prototype Crab Cavities (CCs) were installed in the SPS to be tested for the first time with proton beams. One of the operational issues that needed to be addressed concerned the expected emittance growth due to noise in their RF control system. A theoretical model had already been developed and validated by tracking simulations [1]. Based on those studies a dedicated experiment was performed to benchmark the models with experimental data and to confirm the analytical predictions. In particular, the idea was to inject various noise levels in the CC RF system and record the emittance evolution. In this chapter, the measurement results from the experiment are presented and discussed.

4.1 Experimental Setup

The measurements in the SPS were performed with four low intensity ($\sim 3 \cdot 10^{10}$ ppb) bunches at 270 GeV. Only one CC was used, providing a vertical kick to the beam. The linear chromaticity, Q', of the machine was corrected to small positive values (~ 1-2) in both transverse planes to minimise emittance growth from other sources [2]. The Landau octupoles were switched off; however, a residual non-linearity was present in the machine mainly due to multipole components in the dipole magnets [3, 4]. Some of the relevant SPS parameters during the experiment are listed in Table 4.1.

Table 4.1: SPS parameters during the 2018 MD studies.

Parameters	**Values**
E_b	270 GeV
f_{rev}	43.375 kHz
ν_x, ν_y	26.13, 26.18
ν_s	0.0051
V_{RF}, f_{RF}	5 MV, 200 MHz
$\beta_{x,\mathrm{CC}}$, $\beta_{y,\mathrm{CC}}$	30.31 m, 73.82 m
V_{CC}, f_{CC}	1 MV, 400 MHz

Chapter 5

Investigation of the discrepancy

Chapter 6

Simple model of describing the decoherence suppression from impedance

Chapter 7

Application and impact for HL-LHC

Chapter 8

Conclusion

Appendix A

Appendix Title

Bibliography

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