CERN-ACC-NOTE-2020-0015 MD

January 30, 2019

nicolo.biancacci@cern.ch

MD1787 – LHC TDI tune shift measurement at injection

D. Amorim / BE-ABP, N. Biancacci / BE-ABP, D. Carbajo Perez / EN-STI, L. R. Carver / BE-ABP, E. Métral / BE-ABP, T. L. Rijoff / BE-ABP, B. Salvant / BE-ABP, M. Soderen / BE-RF, D. Valuch / BE-RF

Keywords: LHC, TDI, impedance

Summary

This report summarises the results of the backup activity performed after cancellation of the MD1787. This MD was originally conceived to measure the instability growth rate versus chromaticity and damper settings at injection energy in the LHC, but, due to an RFQ issue in the Linac2 followed by an issue with the LHC cryogenic system, the original plan could not be executed. As a short backup activity on the available time given by the daylight saving on 30^{th} October 2016 and the kind cooperation with other LHC MD users, it was decided to characterize with beam the TDI impedance.

1 Introduction

Before LHC Long Shutdown 1 (LS1), the TDI suffered from beam induced RF screen deformation [1, 2]. The issue triggered a prompt reaction and the device was refurbished for the LHC Run II. In 2015, a significant impact of the device on tune shift was observed, pointing to a deterioration of the jaw material [3], subsequently confirmed by direct observation and wire impedance measurements [4]. In 2016 the main absorbers were replaced by copper coated graphite jaws. No relevant issues were observed during 2016 operation [5], but the additional time collected after MD1787 cancellation was considered favourable for an impedance verification by means of tune shift versus gap measurements. The original plan foreseen for MD1787 has then been moved to MD3308.

2 Procedure and Beam Conditions

The activity was performed on 30^{th} October 2016 between 5:00 am and 6:30 am, over the fill 5841 [6]. One bunch per beam of nominal intensity (1×10^{11} p) was injected in each ring, Q′ was set to 5/5 units in H/V planes, the ADT was set at nominal settings, and the MKQA [7] exciter prepared to kick with ∼15% of the maximum allowed amplitude. During the MKQA

This is an internal CERN publication and does not necessarily reflect the views of the CERN management

setup, the horizontal emittance was accidentally blown-up, but as a tune shift mostly in the vertical plane was expected, it was decided to proceeded with the measurement to save time.

We performed several kicks cycling 4 times the TDI gap between closed and open position. After the excitation, losses could be limited to maximum ∼2%. The tune shift was measured in post-processing using the SUSSIX algorithm [8].

3 Results of Impedance Measurements

Figures 1 and 2 show the vertical tune shift measured respectively for the TDI of B1 and B2. As expected the measured tune shift is larger in the vertical plane (plane of collimation) while it is within the measurement accuracy for the horizontal plane.

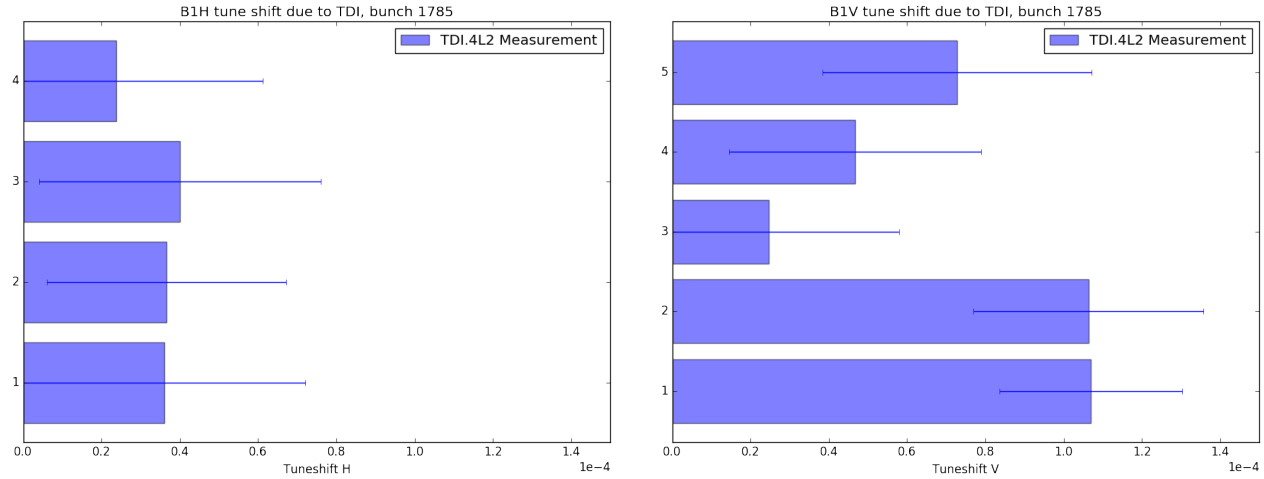

Figure 1: B1 horizontal (left) and vertical (right) TDI tune shift measured during the MD. Each histogram is the tune shift from a TDI gap cycle.

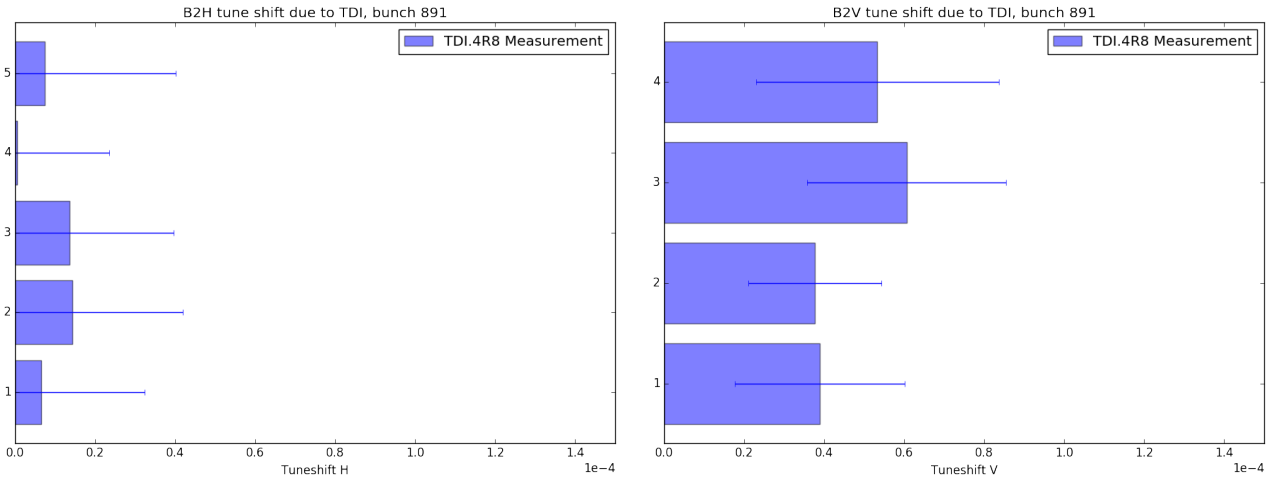

Figure 2: B2 horizontal (left) and vertical (right) TDI tune shift measured during the MD. Each histogram is the tune shift from a TDI gap cycle.

The measured tune shifts in the vertical plane are $\sim 6 \times 10^{-5}$ in B1 and $\sim 4 \times 10^{-5}$ in B2. From analytical computations, a tune shift of 3×10^{-5} was estimated, in agreement within a factor of 2 to the measurements. If the copper layer would have not been present, a higher tune

shift ($\sim 1 \times 10^{-4}$) could have been measured due to the the exposed graphite, confirming the good state of the TDI surface.

4 Conclusions

In this MD note we have summarized the backup activity performed on 30^{th} October 2016 after cancellation of MD1787 due to injectors and LHC related technical issues. The TDI impedance was measured observing the tune shift variation cycling the device gap between open and close positions. A tune shift within a factor of 2 with respect to the analytical estimation was computed, confirming the good condition of the copper coating layer on the TDI jaws.

Acknowledgements

We would like to thank the OP crew for the help during the measurement setup, and in particular G. Trad for the additional time allowed for this MD.

References

[1] M. Barnes et al., "Injection and lessons for 2012", Proceedings of Chamonix 2012 workshop on LHC Performance, Chamonix, France, 2012.

[2] A. Lechner et al., "TDI - past observations and improvements for 2016", 6th Evian Workshop on LHC beam operation, Evian Les Bains, France, 15 - 17 December 2015, pp.123-130.

[3] J. Uythoven, "Injection Absorber TDI Update", LMC, 30 September 2015, CERN, Geneva, Switzerland, https://indico.cern.ch/event/449746.

[4] N. Biancacci et al., "TDI impedance update", Impedance Meeting, 15 February 2016, CERN, Geneva, Switzerland, https://indico.cern.ch/event/496817/

[5] N. Biancacci et al., "Update on TDIS impedance and stability studies", TDIS review, 1 December 2016, CERN, Geneva, Switzerland, https://indico.cern.ch/event/579995/

[6] LHC e-logbook, https://op-webtools.web.cern.ch/elogbook/index.php?shiftID=1081132&lgbk[]=60

[7] R. Barlow et al., "Control of the MKQA tuning and aperture kickers of the LHC", TE-Note-2010-002 (2010), CERN, Geneva, Switzerland, https://cds.cern.ch/record/1232062/files/CERN-TE-Note-2010-001.pdf.

[8] R. Bartolini, F. Schmidt, "A Computer Code for Frequency Analysis of Non-Linear Betatron Motion", SL-Note-98-017-AP (1998), CERN, Geneva, Switzerland, https://cds.cern.ch/record/702438/files/sl-note-98-017.pdf