CERN
CH-1211 Geneva 23
Switzerland

the
Large
Hadron
Collider
project

LHC Project Document No.
rev 0.1
CERN Div./Group or Supplier/Contractor Document No.
BE-ABP
EDMS Document No.

Date: 25-05-2018

LHC MD Test Program

MD3297: HEAT LOAD MEASUREMENTS WITH ORBIT BUMPS IN THE ARCS

Abstract

This note describes a Machine Development session to be performed in order to investigate the dependence of the heat load measured on the LHC beam screen on the transverse position of the beam with respect to the chamber.

Prepared by:	***Checked by:***	***Approved by:***
G. Iadarola **L. Mether** **G. Rumolo**		

Distribution list:

LHC operators

History of Changes

Rev. No.	***Date***	***Pages***	***Description of Changes***
0.1	25-May-2018	All	First version

Table of Contents

1. MOTIVATION AND DESCRIPTION

The MD aims at investigating the source of the differences observed in the heat loads on the beam screens of the eight arcs.

In particular it aims at assessing whether the observed heat loads depend on the transverse position of the beam within the chamber. For this purpose, orbit bumps will be made in selected arc cells to observe the effect on the heat loads.

For both beams, LSA knobs have been created that introduce two orbit bumps in each of the LHC arcs. In each arc, one beam is displaced exclusively in the horizontal plane and the other beam is displaced in the vertical plane (to avoid exposing "skew" aperture bottlenecks).

All bumps are 4-corrector bump as shown in Fig 1. The simulated orbit with all knobs set to 1 mm is shown in Fig. 2.

The peak orbit distortion will be limited at 4 mm. The SIS orbit interlocks will enforce this limit.

For Beam 1 the horizontal bumps are centered at:

Q23L3, Q29R2, Q13R4, Q33L5, Q29L7, Q23R6, Q27L1, Q23R8

For Beam 1 the vertical bumps are centered at:

Q31L2, Q25R1, Q31L4, Q25R3, Q21L6, Q17R5, Q25R7, Q21L8

For Beam 2 the horizontal bumps are centered at:

Q31L2, Q25R1, Q31L4, Q25R3, Q21L6, Q17R5, Q25R7, Q21L8

For Beam 2 the vertical bumps are centered at:

Q23L3, Q29R2, Q13R4, Q33L5, Q29L7, Q23R6, Q27L1, Q23R8

(Settings are in fact specular for the two beams).

As this test might expose unknown aperture bottlenecks in the arcs, a set of loss maps and asynchronous dump with low intensity will have to be performed with the modified orbit (knobs set at 4 mm and -4 mm) before conducting the real test with high intensity beams. The total intensity is limited to 876b., i.e. the minimum sufficient to have an acceptable resolution on the heat loads.

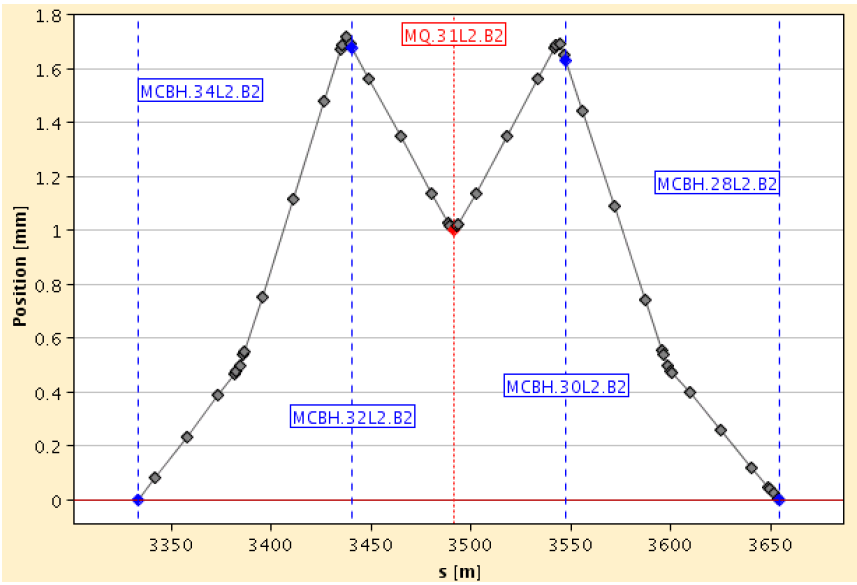

Figure 1 Example of 4-correctors orbit bump

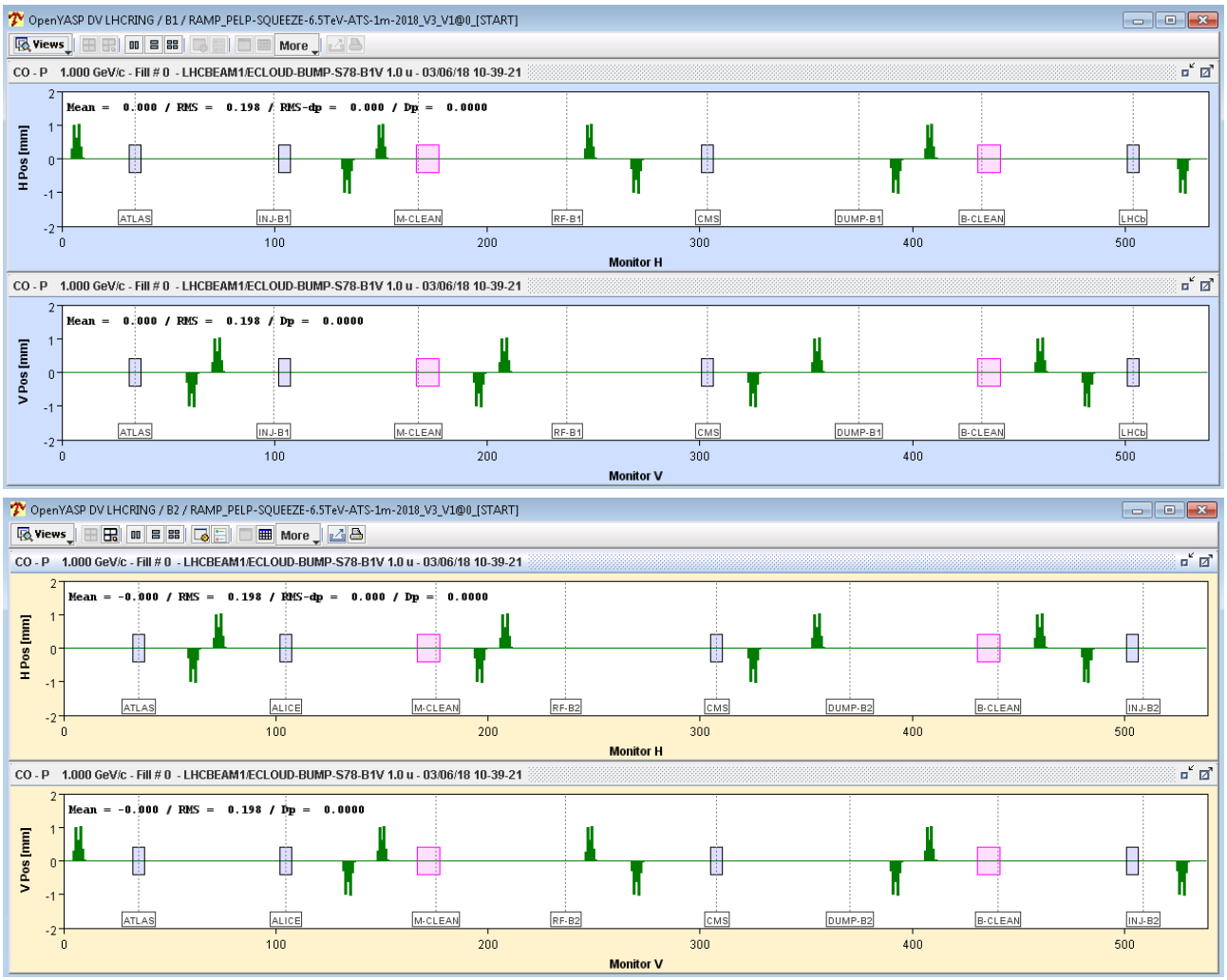

Figure 2 Orbit for the two beams with all knobs set at 1 mm.

The required machine & beam parameters can be found in the table below.

Time required [h]	4 h
Beams required [1, 2, 1&2]	1&2
Beam energy	450 GeV
Optics (injection, squeezed, special)	Injection
Bunch intensity [#p, #ions]	1.1 x 10^{11} p/bunch
Number of bunches	876
Transv. emittance [m rad]	2.0e-6
Bunch length [ns @ 4s]	1.2
Optics change [yes/no]	No
Orbit change [yes/no]	Yes
Collimation change [yes/no]	No
RF system change [yes/no]	No
Feedback changes [yes/no]	No
What else will be changed?	Nothing
Are parallel studies possible?	No
Other info/requests	None.

Table 1: Machine parameters during the MD

2. DETAILED STEPS TO BE TAKEN BEFORE, DURING AND AFTER THE MD

2.1 PREPARATION OF THE MD

1. Prepare knobs in LSA to apply pre-defined orbit bumps

2.2 STEPS TO BE TAKEN DURING THE MD

Before taking high intensity beam the machine configuration with the bumps applied will be qualified as follows:

1. With the bump-knobs set to zero, inject pilots in both beams (as many as needed for the following loss maps);
2. Retract the injection protections;
3. Set the bump-knobs to +4.0 mm (trimmed in steps of 1 mm);
4. Perform betatron and off-momentum loss maps;
5. Perform asynchronous dump tests.

Steps from 1 to 4 will be repeated with the knob-bumps set a -4 mm.

Results from the tests above will be analysed by the collimation and rMPP teams, to assess whether the following test with high intensity beam can safely take place.

In case of green light, the following steps will be executed:

1. Fill both rings with 876b (=12+6*144) bunches using injections of 3x48b;
2. Disable the injection kickers and retract the injection protections;
3. Lower chromaticity and octupoles to ensure a better lifetime (down to Q'=10/10, Octupole knob at -2.5);
4. Wait 15 min to get a preliminary heat load measurement;
5. Increase the bump knobs up to +4 mm in steps of 1 mm;
6. Collect e-cloud observables (e.g. heat loads, stable phases, beam quality evolution) for about 30 min.
7. Trim the bump knobs from +4 mm to -4 mm in steps of 1 mm.
8. Collect e-cloud observables (e.g. heat loads, stable phases, beam quality evolution) for about 30 min.

<u>All bumps will have to be at zero when injecting beam. The operational SIS interlock will enforce this.</u>

2.3 RECOVERY AFTER THE MD

No recovery is necessary.

3. CHANGES OF MACHINE PROTECTION SETTINGS DURING MD

3.1 CHANGES OF SAFE BEAM FLAGS

None.

3.2 CHANGES OF COLLIMATOR POSITIONS AND LIMITS

None.