Beam induced heat loads on the beam-screens of the twin-bore magnets in the IRs of the HL-LHC

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Abstract

The expected heat load induced on the beam screens has been evaluated for all the twin-bore magnets in the Insertion Regions (IRs) of the HL-LHC. The contribution from the impedance of the beam screen has been evaluated taking into account the presence of a longitudinal weld in the beam screen and the impact of the temperature and of the magnetic field on the resistivity of the surface. The contribution coming from electron cloud effects has been evaluated for different values of the Secondary Electron Yield of the surface based on PyECLoud build-up simulations.
1 Introduction

The operation of the Large Hadron Collider (LHC) at the beginning of Run 2 has shown that beam induced heat loads on the beam screens of the cold magnets can pose serious limitations to the achievable machine performance [1]. It is therefore important to assess the potential impact that these effects could have in the High Luminosity LHC (HL-LHC) era.

This document, in particular, provides a comprehensive survey on the heat loads expected on the beam screens of the twin-bore magnets in all the Insertion Regions (IRs). For this purpose two main contributions have been considered, namely the one coming from electron cloud effects and the one coming from the longitudinal beam coupling impedance of the beams screens. For these magnets, the heat load contribution coming from synchrotron radiation was found to be small by previous studies [2, 3, 4].

The set of beam parameters defined by HL-LHC parameter table v4.2.1 [5] has been used for this study.

2 Evaluation of the impedance contribution

The evaluation of the power deposition from impedance effects has been carried out following the approach presented in [6,7,8] where it is shown that a good estimate can be obtained using the classical resistive wall formula for the power loss of Gaussian bunches, assuming a single layer of copper and no interactions between different bunches. Under these assumptions the power deposition per unit length can be written as:

\[ P_{RW} = \frac{1}{2\pi R} \Gamma \left( \frac{3}{4} \right) \frac{M}{b} \left( \frac{N_{b}e}{2\pi} \right)^{2} \sqrt{\frac{\varepsilon \rho Z_{0}}{2}} \sigma_{t}^{-\frac{3}{2}} \]  

(1)

where \((2\pi R)\) is the accelerator circumference, \(\Gamma\) is the Gamma function [9], \(M\) is the number of bunches, \(b\) is the radius of the largest circle inscribed in the beam pipe, \((N_{b}e)\) is the bunch charge, \(\rho\) is the resistivity of the copper layer of the beam screen, \(Z_{0}\) is the impedance of free space, \(\sigma_{t}\) is the r.m.s. bunch length (in time). The dependence of the resistivity on the temperature of the beam screen has been taken into account using the curve from experimental measurements shown in Fig. [1]. The effect of the applied magnetic field can be taken into account using Kohler’s formula [10]:

\[ \frac{\Delta \rho}{\rho_{0}} = \frac{\rho \left( B, T \right) - \rho_{0} \left( T \right)}{\rho_{0} \left( T \right)} = 10^{-2.69} \left( F_{RRR} B \right)^{1.055} \]

(2)

where \(\rho_{0}\) it the resistivity in the absence of an applied magnetic field and \(F_{RRR}\) is the Residual Resistivity Ratio given by:

\[ F_{RRR} = \frac{\rho_{0} \left( T = 273K \right)}{\rho_{0} \left( T = 4K \right)} \]

(3)
The presence of a longitudinal weld in the beam screen (stainless steel exposed to the beam) is taken into account by correcting the power loss using the following scaling:

\[ P_{Weld} = P_{RW} \sqrt{\frac{\rho_{SS}}{\rho_{Cu}}} \frac{\Delta_{Weld}}{2\pi b} \]  

(4)

where \( \rho_{SS} \) is the resistivity of the weld region and \( \Delta_{Weld} \) is the thickness of the weld.

3 Evaluation of the electron cloud contribution

The heat loads from electron cloud effects have been estimated using build-up simulations performed with the PyECLOUD simulation code [11]. The different beam screen geometries were characterized by performing simulations for:

- Different values of the bunch population, in the range from 0.1 p/bunch to 2.5 p/bunch;
- Different values of Secondary Electron Yield (SEY) in the range from 1.0 to 1.6;
- Four different field configurations:
  - Horizontal dipole (1.5 T);
  - Vertical dipole (1.5 T);
  - Quadrupole (150 T/m);
- Field free.

The chosen strengths for the different magnetic configurations are within the typical range of settings for the IR quadrupoles and corrector dipoles at 7 TeV. Previous simulation studies [12] had shown that the dependence on these parameters, as well as on the transverse size of the beam, is quite weak. Based on 2015-16 observations, we assume that the average e-cloud density reaches saturation after the 30th bunch of the train. The heat load obtained from the simulations is plotted for the different types of beam screen as function of the SEY in Figs. 2-7 and as a function of the bunch population in Figs. 8-13.
Figure 2: Heat load as a function of the surface SEY for the beam screen of type BSMQ_1, under different magnetic field conditions. Results for different values of the bunch population are shown in different colors.
Figure 3: Heat load as a function of the surface SEY for the beam screen of type BSMQ_2, under different magnetic field conditions. Results for different values of the bunch population are shown in different colors.
Figure 4: Heat load as a function of the surface SEY for the beam screen of type BSMB_1, under different magnetic field conditions. Results for different values of the bunch population are shown in different colors.
Figure 5: Heat load as a function of the surface SEY for the beam screen of type BSMB_2, under different magnetic field conditions. Results for different values of the bunch population are shown in different colors.
Figure 6: Heat load as a function of the surface SEY for the beam screen of type BSHL_D2, under different magnetic field conditions. Results for different values of the bunch population are shown in different colors.
Figure 7: Heat load as a function of the surface SEY for the beam screen of type BSHL_Q4, under different magnetic field conditions. Results for different values of the bunch population are shown in different colors.
Figure 8: Heat load as a function of the bunch intensity for the beam screen of type BSMQ_1, under different magnetic field conditions. Results for different values of surface SEY are shown in different colors.
Figure 9: Heat load as a function of the bunch intensity for the beam screen of type BSMQ_2, under different magnetic field conditions. Results for different values of surface SEY are shown in different colors.
Figure 10: Heat load as a function of the bunch intensity for the beam screen of type BSMB_1, under different magnetic field conditions. Results for different values of surface SEY are shown in different colors.
Figure 11: Heat load as a function of the bunch intensity for the beam screen of type BSMB_2, under different magnetic field conditions. Results for different values of surface SEY are shown in different colors.
Figure 12: Heat load as a function of the bunch intensity for the beam screen of type BSHL_D2, under different magnetic field conditions. Results for different values of surface SEY are shown in different colors.
Figure 13: Heat load as a function of the bunch intensity for the beam screen of type BSHL_Q4, under different magnetic field conditions. Results for different values of surface SEY are shown in different colors.
4 Computation of the heat loads

The heat load for the beam screen in each of the cryostats installed in the IRs has been evaluated by applying the following procedure:

1. A list of the IR cryostats has been prepared with their length and the list of included magnets (MBs, MQs, MCBs).

2. The HL-LHC MAD-X model is used to:
   2.1. Identify the type of chamber in each magnet and the corresponding orientation;
   2.2. Identify the field configuration (main dipoles, main quadrupoles, horizontal or vertical dipole corrector);
   2.3. For each cryostat, the length not attributed to any magnet is considered to be drift space (the chamber is assumed to the same as for the other elements in cryostat).

3. The heat load from the beam screen impedance is computed following the approach described in Sec. 2:
   3.1. The radius of the inscribed circle is evaluated from the chamber profile;
   3.2. The magnitude of the magnetic field on the considered circle is evaluated assuming typical strength values for each type of magnet, i.e. 5 T for the main dipoles, 150 T/m for the main quadrupoles and 1.5 T for the dipole correctors;
   3.3. The conductivity of copper is evaluated at the operating temperature of 20 K using the measured curve as shown in Fig. 1 and the effect of the magnetic field is taken into account applying Eq. 2;
   3.4. The resistive heating is computed using Eq. 1;
   3.5. The presence of the longitudinal weld is taken into account by applying Eq. 4.

4. The electron cloud contribution to the heat load is computed interrogating the database of simulation results produced as described in Sec. 3.

5. The total heat load is computed for all magnets, all cryostats and all straight sections.

The results for all the twin-bore IR cryostats are reported in Tabs. 1-16, which include also the breakdown of the heat load among the different magnetic elements. For the electron cloud contribution two scenarios have been considered: SEY=1.3, which is the lowest value presently achieved in the LHC by beam induced scrubbing (at least in the quadrupole magnets), and SEY=1.1, which can be obtained with special surface treatments like amorphous-Carbon coating [13] or laser treatments [14]. It can be noticed that in many cases a significant contribution to the heat load comes from dipole correctors and drift sections.
<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2L1</td>
<td>13.2 m</td>
<td></td>
<td>BSHL_D2</td>
<td>3.6 W</td>
<td>227.0/46.3 W</td>
<td>230.6/49.9 W</td>
</tr>
<tr>
<td>MBRD.4L1.B1</td>
<td>7.8 m</td>
<td>dip</td>
<td>BSHL_D2</td>
<td>2.2 W</td>
<td>110.6 W/31.5 W</td>
<td></td>
</tr>
<tr>
<td>MCBRDH.4L1.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSHL_D2</td>
<td>0.5 W</td>
<td>25.6 W/7.3 W</td>
<td></td>
</tr>
<tr>
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<td>dip</td>
<td>BSHL_D2</td>
<td>0.5 W</td>
<td>25.5 W/7.3 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.8 m</td>
<td>drift</td>
<td>BSHL_D2</td>
<td>0.4 W</td>
<td>65.3 W/0.2 W</td>
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</tr>
<tr>
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<td>9.0 m</td>
<td></td>
<td>BSHL_Q4</td>
<td>3.1 W</td>
<td>155.1/12.8 W</td>
<td>158.2/15.9 W</td>
</tr>
<tr>
<td>MQYY.4L1.B1</td>
<td>3.8 m</td>
<td>quad</td>
<td>BSHL_Q4</td>
<td>1.4 W</td>
<td>107.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
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<td>dip</td>
<td>BSHL_Q4</td>
<td>0.6 W</td>
<td>24.1 W/6.3 W</td>
<td></td>
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<tr>
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<td>dip</td>
<td>BSHL_Q4</td>
<td>0.6 W</td>
<td>23.3 W/6.2 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.6 m</td>
<td>drift</td>
<td>BSHL_Q4</td>
<td>0.5 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q5L1</td>
<td>8.7 m</td>
<td></td>
<td>BSMQ_2</td>
<td>4.2 W</td>
<td>120.8/0.6 W</td>
<td>125.0/4.8 W</td>
</tr>
<tr>
<td>MQY.5L1.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
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<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
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<tr>
<td>MCBYH.5L1.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
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<tr>
<td>MCBYV.B5L1.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td>Q6L1</td>
<td>6.9 m</td>
<td></td>
<td>BSMQ_1</td>
<td>5.3 W</td>
<td>112.2/0.4 W</td>
<td>117.4/5.7 W</td>
</tr>
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<td>MQML.6L1.B1</td>
<td>4.8 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>3.7 W</td>
<td>111.9 W/0.2 W</td>
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<td>MCBCH.6L1.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.2 m</td>
<td>drift</td>
<td>BSMQ_1</td>
<td>0.8 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>631.3/76.3 W</strong></td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Heat load estimates for the Long Straight Section on the right side of IP1.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
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<tbody>
<tr>
<td>D2R1</td>
<td>13.2 m</td>
<td></td>
<td>BSHL_D2</td>
<td>3.6 W</td>
<td>227.0/46.3 W</td>
<td>230.6/49.9 W</td>
</tr>
<tr>
<td>MBRD.4R1.B1</td>
<td>7.8 m</td>
<td>dip</td>
<td>BSHL_D2</td>
<td>2.2 W</td>
<td>110.6 W/31.5 W</td>
<td></td>
</tr>
<tr>
<td>MCBRDH.4R1.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSHL_D2</td>
<td>0.5 W</td>
<td>25.6 W/7.3 W</td>
<td></td>
</tr>
<tr>
<td>MCBRDV.4R1.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSHL_D2</td>
<td>0.5 W</td>
<td>25.5 W/7.3 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.8 m</td>
<td>drift</td>
<td>BSHL_D2</td>
<td>0.4 W</td>
<td>65.3 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q4R1</td>
<td>9.0 m</td>
<td></td>
<td>BSHL_Q4</td>
<td>3.1 W</td>
<td>155.1/12.8 W</td>
<td>158.2/15.9 W</td>
</tr>
<tr>
<td>MQYY.4R1.B1</td>
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<td>quad</td>
<td>BSHL_Q4</td>
<td>1.4 W</td>
<td>107.5 W/0.1 W</td>
<td></td>
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<tr>
<td>MCBYYH.4R1.B1</td>
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<td>dip</td>
<td>BSHL_Q4</td>
<td>0.6 W</td>
<td>24.1 W/6.3 W</td>
<td></td>
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<td>MCBYYV.4R1.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSHL_Q4</td>
<td>0.6 W</td>
<td>23.3 W/6.2 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.6 m</td>
<td>drift</td>
<td>BSHL_Q4</td>
<td>0.5 W</td>
<td>0.2 W/0.2 W</td>
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</tr>
<tr>
<td>Q5R1</td>
<td>8.7 m</td>
<td></td>
<td>BSMQ_2-R</td>
<td>4.2 W</td>
<td>120.8/0.6 W</td>
<td>125.1/4.8 W</td>
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<tr>
<td>MQY.5R1.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
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<tr>
<td>MCBYH.A5R1.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
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<td>MCBYV.5R1.B1</td>
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<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
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<tr>
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<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
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<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td>Q6R1</td>
<td>6.9 m</td>
<td></td>
<td>BSMQ_1-R</td>
<td>5.3 W</td>
<td>112.2/0.4 W</td>
<td>117.4/5.7 W</td>
</tr>
<tr>
<td>MQML.6R1.B1</td>
<td>4.8 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>3.7 W</td>
<td>111.9 W/0.2 W</td>
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<td>MCBCV.6R1.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1-R</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.2 m</td>
<td>drift</td>
<td>BSMQ_1-R</td>
<td>0.8 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>631.3/76.3 W</strong></td>
<td></td>
</tr>
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</table>
Table 3: Heat load estimates for the Long Straight Section on the left side of IP2.

<table>
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<tr>
<th>Name</th>
<th>Length</th>
<th>Field config</th>
<th>Chamber</th>
<th>Impedance (T_{BS}=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
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<tbody>
<tr>
<td>Q4L2</td>
<td>12.7 m</td>
<td>BSMB_2-R</td>
<td>6.2 W</td>
<td>222.8/0.8 W</td>
<td>229.0/7.0 W</td>
<td></td>
</tr>
<tr>
<td>MQY.B4L2.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMB_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MQY.A4L2.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMB_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.B4L2.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.B4L2.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
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<tr>
<td>MCBYV.A4L2.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
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<td>3.2 m</td>
<td>drift</td>
<td>BSMB_2-R</td>
<td>1.4 W</td>
<td>0.4 W/0.4 W</td>
<td></td>
</tr>
<tr>
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<td>75.7/0.6 W</td>
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<td>75.4 W/0.4 W</td>
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<tr>
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<td>drift</td>
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<td>0.3 W/0.2 W</td>
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<td>Q5L2</td>
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<td>BSMB_2-R</td>
<td>6.4 W</td>
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<td>231.8/7.1 W</td>
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<td>MQY.B5L2.B1</td>
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<td>BSMB_2-R</td>
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<td>104.5 W/0.1 W</td>
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<td>quad</td>
<td>BSMB_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.B5L2.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.B5L2.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.A5L2.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.5 m</td>
<td>drift</td>
<td>BSMB_2-R</td>
<td>1.5 W</td>
<td>0.5 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Q6L2</td>
<td>12.0 m</td>
<td>BSMB_1-R</td>
<td>9.1 W</td>
<td>191.7/0.8 W</td>
<td>200.8/9.9 W</td>
<td></td>
</tr>
<tr>
<td>MQML.6L2.B1</td>
<td>4.8 m</td>
<td>quad</td>
<td>BSMB_1-R</td>
<td>3.7 W</td>
<td>111.9 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>MQM.6L2.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMB_1-R</td>
<td>2.6 W</td>
<td>79.3 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBCV.6L2.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMB_1-R</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
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<tr>
<td>Drifts</td>
<td>2.9 m</td>
<td>drift</td>
<td>BSMB_1-R</td>
<td>2.0 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
</tbody>
</table>

Total LSS 742.6/29.9 W
Table 4: Heat load estimates for the Long Straight Section on the right side of IP2.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length (m)</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2R2</td>
<td>11.4</td>
<td>BSMB_2</td>
<td>5.2</td>
<td>75.7/0.6 W</td>
<td>80.9/5.8 W</td>
<td></td>
</tr>
<tr>
<td>MBRC.4R2.B1</td>
<td>9.5</td>
<td>dip</td>
<td>BSMB_2</td>
<td>4.5 W</td>
<td>75.4/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.9</td>
<td>drift</td>
<td>BSMB_2</td>
<td>0.8 W</td>
<td>0.3 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q4R2</td>
<td>12.7</td>
<td>BSMQ_2-R</td>
<td>6.2</td>
<td>225.4/0.7 W</td>
<td>231.6/7.0 W</td>
<td></td>
</tr>
<tr>
<td>MQY.A4R2.B1</td>
<td>3.4</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MQY.B4R2.B1</td>
<td>3.4</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.A4R2.B1</td>
<td>0.9</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.4R2.B1</td>
<td>0.9</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.B4R2.B1</td>
<td>0.9</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.2</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.4 W</td>
<td>0.4 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Q5R2</td>
<td>13.0</td>
<td>BSMQ_1-R</td>
<td>9.8</td>
<td>162.0/1.0 W</td>
<td>171.8/10.8 W</td>
<td></td>
</tr>
<tr>
<td>MQM.B5R2.B1</td>
<td>3.4</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>2.6 W</td>
<td>79.3 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MQM.A5R2.B1</td>
<td>3.4</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>2.6 W</td>
<td>79.3 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBCV.A5R2.B1</td>
<td>0.9</td>
<td>dip</td>
<td>BSMQ_1-R</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.5R2.B1</td>
<td>0.9</td>
<td>dip</td>
<td>BSMQ_1-R</td>
<td>0.7 W</td>
<td>2.8 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBCV.B5R2.B1</td>
<td>0.9</td>
<td>dip</td>
<td>BSMQ_1-R</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.5</td>
<td>drift</td>
<td>BSMQ_1-R</td>
<td>2.5 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
<tr>
<td>Q6R2</td>
<td>12.0</td>
<td>BSMQ_1</td>
<td>9.1</td>
<td>191.7/0.8 W</td>
<td>200.8/9.9 W</td>
<td></td>
</tr>
<tr>
<td>MQML.6R2.B1</td>
<td>4.8</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>3.7 W</td>
<td>111.9 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>MQM.6R2.B1</td>
<td>3.4</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>2.6 W</td>
<td>79.3 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.6R2.B1</td>
<td>0.9</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.9</td>
<td>drift</td>
<td>BSMQ_1</td>
<td>2.0 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>685.2/33.5 W</strong></td>
<td></td>
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</table>
Table 5: Heat load estimates for the Long Straight Section on the left side of IP3.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q6L3</td>
<td>12.0 m</td>
<td></td>
<td>BSMQ_1</td>
<td>9.1 W</td>
<td>182.4/0.9 W</td>
<td>191.5/10.0 W</td>
</tr>
<tr>
<td>MQTLH.F6L3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.E6L3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.D6L3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.C6L3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.B6L3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.A6L3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.6L3.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.3 m</td>
<td>drift</td>
<td>BSMQ_1</td>
<td>2.3 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>191.5/10.0 W</strong></td>
</tr>
</tbody>
</table>

Table 6: Heat load estimates for the Long Straight Section on the right side of IP3.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q6R3</td>
<td>12.0 m</td>
<td></td>
<td>BSMQ_1-R</td>
<td>9.1 W</td>
<td>182.4/0.9 W</td>
<td>191.5/10.0 W</td>
</tr>
<tr>
<td>MQTLH.A6R3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.B6R3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.C6R3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.D6R3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.E6R3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.F6R3.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.6R3.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1-R</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.3 m</td>
<td>drift</td>
<td>BSMQ_1-R</td>
<td>2.3 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>191.5/10.0 W</strong></td>
</tr>
</tbody>
</table>
Table 7: Heat load estimates for the Long Straight Section on the left side of IP4.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field</th>
<th>Chamber</th>
<th>Impedance (T_{BS}=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D3L4</td>
<td>11.2 m</td>
<td>BSMB_2-R</td>
<td>5.2 W</td>
<td>49.8/0.6 W</td>
<td>54.9/5.8 W</td>
<td></td>
</tr>
<tr>
<td>MBRS.5L4.B1</td>
<td>9.5 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>4.5 W</td>
<td>49.5 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.7 m</td>
<td>drift</td>
<td>BSMB_2-R</td>
<td>0.7 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q5L4</td>
<td>6.7 m</td>
<td>BSMQ_2</td>
<td>3.2 W</td>
<td>108.4/0.5 W</td>
<td>111.6/3.7 W</td>
<td></td>
</tr>
<tr>
<td>MQY.5L4.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.5L4.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.4 m</td>
<td>drift</td>
<td>BSMQ_2</td>
<td>1.0 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td>D4L4</td>
<td>11.4 m</td>
<td>BSMB_2-R</td>
<td>5.2 W</td>
<td>49.8/0.7 W</td>
<td>55.0/5.9 W</td>
<td></td>
</tr>
<tr>
<td>MBRB.5L4.B1</td>
<td>9.5 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>4.5 W</td>
<td>49.5 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.0 m</td>
<td>drift</td>
<td>BSMB_2-R</td>
<td>0.8 W</td>
<td>0.3 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q6L4</td>
<td>6.9 m</td>
<td>BSMQ_2</td>
<td>3.3 W</td>
<td>108.4/0.5 W</td>
<td>111.8/3.8 W</td>
<td></td>
</tr>
<tr>
<td>MQY.6L4.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.6L4.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>333.4/19.2 W</strong></td>
<td></td>
</tr>
</tbody>
</table>

Table 8: Heat load estimates for the Long Straight Section on the right side of IP4.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field</th>
<th>Chamber</th>
<th>Impedance (T_{BS}=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D3R4</td>
<td>11.2 m</td>
<td>BSMB_2-R</td>
<td>5.2 W</td>
<td>49.8/0.6 W</td>
<td>54.9/5.8 W</td>
<td></td>
</tr>
<tr>
<td>MBRS.5R4.B1</td>
<td>9.5 m</td>
<td>dip</td>
<td>BSMB_2-R</td>
<td>4.5 W</td>
<td>49.5 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.7 m</td>
<td>drift</td>
<td>BSMB_2-R</td>
<td>0.7 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>D4R4</td>
<td>11.4 m</td>
<td>BSMB_2</td>
<td>5.2 W</td>
<td>75.7/0.6 W</td>
<td>80.9/5.9 W</td>
<td></td>
</tr>
<tr>
<td>MBRB.5R4.B1</td>
<td>9.5 m</td>
<td>dip</td>
<td>BSMB_2</td>
<td>4.5 W</td>
<td>75.4 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.0 m</td>
<td>drift</td>
<td>BSMB_2</td>
<td>0.8 W</td>
<td>0.3 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q5R4</td>
<td>6.7 m</td>
<td>BSMQ_2</td>
<td>3.2 W</td>
<td>108.4/0.5 W</td>
<td>111.6/3.7 W</td>
<td></td>
</tr>
<tr>
<td>MQY.5R4.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.5R4.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.4 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.0 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td>Q6R4</td>
<td>6.9 m</td>
<td>BSMQ_2</td>
<td>3.3 W</td>
<td>108.4/0.5 W</td>
<td>111.8/3.8 W</td>
<td></td>
</tr>
<tr>
<td>MQY.6R4.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.6R4.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
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<td></td>
<td></td>
<td></td>
<td><strong>359.2/19.1 W</strong></td>
<td></td>
</tr>
</tbody>
</table>
Table 9: Heat load estimates for the Long Straight Section on the left side of IP5.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2L5</td>
<td>13.2 m</td>
<td></td>
<td>BSHL_D2</td>
<td>3.6 W</td>
<td>227.0/46.3 W</td>
<td>230.6/49.9 W</td>
</tr>
<tr>
<td>MBRD.4L5.B1</td>
<td>7.8 m</td>
<td>dip</td>
<td>BSHL_D2</td>
<td>2.2 W</td>
<td>110.6 W/31.5 W</td>
<td></td>
</tr>
<tr>
<td>MCBRDH.4L5.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSHL_D2</td>
<td>0.5 W</td>
<td>25.6 W/7.3 W</td>
<td></td>
</tr>
<tr>
<td>MCBRDV.4L5.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSHL_D2</td>
<td>0.5 W</td>
<td>25.5 W/7.3 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.8 m</td>
<td>drift</td>
<td>BSHL_D2</td>
<td>0.4 W</td>
<td>65.3 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q4L5</td>
<td>9.0 m</td>
<td></td>
<td>BSHL_Q4</td>
<td>3.1 W</td>
<td>155.1/12.8 W</td>
<td>158.2/15.9 W</td>
</tr>
<tr>
<td>MQYY.4L5.B1</td>
<td>3.8 m</td>
<td>quad</td>
<td>BSHL_Q4</td>
<td>1.4 W</td>
<td>107.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYYH.4L5.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSHL_Q4</td>
<td>0.6 W</td>
<td>24.1 W/6.3 W</td>
<td></td>
</tr>
<tr>
<td>MCBYYV.4L5.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSHL_Q4</td>
<td>0.6 W</td>
<td>23.3 W/6.2 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.6 m</td>
<td>drift</td>
<td>BSHL_Q4</td>
<td>0.5 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q5L5</td>
<td>8.7 m</td>
<td></td>
<td>BSMQ_2</td>
<td>4.2 W</td>
<td>120.8/0.6 W</td>
<td>125.0/4.8 W</td>
</tr>
<tr>
<td>MQY.5L5.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.B5L5.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.5L5.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.A5L5.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td>Q6L5</td>
<td>6.9 m</td>
<td></td>
<td>BSMQ_1</td>
<td>5.3 W</td>
<td>112.2/0.4 W</td>
<td>117.4/5.7 W</td>
</tr>
<tr>
<td>MQML.6L5.B1</td>
<td>4.8 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>3.7 W</td>
<td>111.9 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.6L5.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.2 m</td>
<td>drift</td>
<td>BSMQ_1</td>
<td>0.8 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>631.3/76.3 W</strong></td>
<td></td>
</tr>
</tbody>
</table>
Table 10: Heat load estimates for the Long Straight Section on the right side of IP5.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T(_{BS}=20) K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2R5</td>
<td>13.2 m</td>
<td>BSFL_D2</td>
<td>3.6 W</td>
<td>227.0/46.3 W</td>
<td>230.6/49.9 W</td>
<td></td>
</tr>
<tr>
<td>MBRD.4R5.B1</td>
<td>7.8 m</td>
<td>dip</td>
<td>BSFL_D2</td>
<td>2.2 W</td>
<td>110.6 W/31.5 W</td>
<td></td>
</tr>
<tr>
<td>MCBRDH.4R5.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSFL_D2</td>
<td>0.5 W</td>
<td>25.6 W/7.3 W</td>
<td></td>
</tr>
<tr>
<td>MCBRDV.4R5.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSFL_D2</td>
<td>0.5 W</td>
<td>25.5 W/7.3 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.8 m</td>
<td>drift</td>
<td>BSFL_D2</td>
<td>0.4 W</td>
<td>65.3 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q4R5</td>
<td>9.0 m</td>
<td>BSFL_D2</td>
<td>3.1 W</td>
<td>155.1/12.8 W</td>
<td>158.2/15.9 W</td>
<td></td>
</tr>
<tr>
<td>MQYY.4R5.B1</td>
<td>3.8 m</td>
<td>quad</td>
<td>BSFL_Q4</td>
<td>1.4 W</td>
<td>107.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYYH.4R5.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSFL_Q4</td>
<td>0.6 W</td>
<td>24.1 W/6.3 W</td>
<td></td>
</tr>
<tr>
<td>MCBYYV.4R5.B1</td>
<td>1.8 m</td>
<td>dip</td>
<td>BSFL_Q4</td>
<td>0.6 W</td>
<td>23.3 W/6.2 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.6 m</td>
<td>drift</td>
<td>BSFL_Q4</td>
<td>0.5 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q5R5</td>
<td>8.7 m</td>
<td>BSFL_Q4</td>
<td>4.2 W</td>
<td>120.8/0.6 W</td>
<td>125.1/4.8 W</td>
<td></td>
</tr>
<tr>
<td>MQY.5R5.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSFL_Q4</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.5R5.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSFL_Q4</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.6R5.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSFL_Q4</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.A5R5.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSFL_Q4</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSFL_Q4</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td>Q6R5</td>
<td>6.9 m</td>
<td>BSFL_Q4</td>
<td>5.3 W</td>
<td>112.2/0.4 W</td>
<td>117.4/5.7 W</td>
<td></td>
</tr>
<tr>
<td>MQML.6R5.B1</td>
<td>4.8 m</td>
<td>quad</td>
<td>BSFL_Q4</td>
<td>3.7 W</td>
<td>111.9 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>MCBCV.6R5.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSFL_Q4</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.2 m</td>
<td>drift</td>
<td>BSFL_Q4</td>
<td>0.8 W</td>
<td>0.2 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>631.3/76.3 W</strong></td>
<td></td>
</tr>
</tbody>
</table>
Table 11: Heat load estimates for the Long Straight Section on the left side of IP6.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4L6</td>
<td>6.9 m</td>
<td>BSMQ_2-R</td>
<td>3.3 W</td>
<td>108.4/0.5 W</td>
<td>111.8/3.8 W</td>
<td></td>
</tr>
<tr>
<td>MQY.4L6.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.4L6.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td>Q5L6</td>
<td>6.9 m</td>
<td>BSMQ_2</td>
<td>3.3 W</td>
<td>108.4/0.5 W</td>
<td>111.8/3.8 W</td>
<td></td>
</tr>
<tr>
<td>MQY.5L6.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.5L6.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
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<td></td>
<td></td>
<td></td>
<td><strong>223.5/7.6 W</strong></td>
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</tr>
</tbody>
</table>

Table 12: Heat load estimates for the Long Straight Section on the right side of IP6.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4R6</td>
<td>6.9 m</td>
<td>BSMQ_2</td>
<td>3.3 W</td>
<td>108.4/0.5 W</td>
<td>111.8/3.8 W</td>
<td></td>
</tr>
<tr>
<td>MQY.4R6.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.4R6.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td>Q5R6</td>
<td>6.9 m</td>
<td>BSMQ_2-R</td>
<td>3.3 W</td>
<td>108.4/0.5 W</td>
<td>111.8/3.8 W</td>
<td></td>
</tr>
<tr>
<td>MQY.5R6.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.5R6.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.6 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.2 W</td>
<td>0.3 W/0.3 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>223.5/7.6 W</strong></td>
<td></td>
</tr>
</tbody>
</table>
Table 13: Heat load estimates for the Long Straight Section on the left side of IP7.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_{BS}=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q6L7</td>
<td>12.0 m</td>
<td></td>
<td>BSMQ_1</td>
<td>9.1 W</td>
<td>182.4/0.9 W</td>
<td>191.5/10.0 W</td>
</tr>
<tr>
<td>MQTLH.F6L7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.E6L7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.D6L7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.C6L7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.B6L7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.A6L7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.6L7.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.3 m</td>
<td>drift</td>
<td>BSMQ_1</td>
<td>2.3 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>191.5/10.0 W</strong></td>
</tr>
</tbody>
</table>

Table 14: Heat load estimates for the Long Straight Section on the right side of IP7.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config.</th>
<th>Chamber</th>
<th>Impedance (T_{BS}=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q6R7</td>
<td>12.0 m</td>
<td></td>
<td>BSMQ_1-R</td>
<td>9.1 W</td>
<td>182.4/0.9 W</td>
<td>191.5/10.0 W</td>
</tr>
<tr>
<td>MQTLH.A6R7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.B6R7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.C6R7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.D6R7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.E6R7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MQTLH.F6R7.B1</td>
<td>1.3 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>1.0 W</td>
<td>30.3 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.6R7.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1-R</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.3 m</td>
<td>drift</td>
<td>BSMQ_1-R</td>
<td>2.3 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
<tr>
<td><strong>Total LSS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>191.5/10.0 W</strong></td>
</tr>
</tbody>
</table>
Table 15: Heat load estimates for the Long Straight Section on the left side of IP8.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field config</th>
<th>Chamber</th>
<th>Impedance (T_{BS}=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4L8</td>
<td>12.7 m</td>
<td></td>
<td>BSMQ_2-R</td>
<td>6.2 W</td>
<td>222.8/0.8 W</td>
<td>229.0/7.0 W</td>
</tr>
<tr>
<td>MQY.B4L8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MQY.A4L8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.B4L8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.4L8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.A4L8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.2 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.4 W</td>
<td>0.4 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>D2L8</td>
<td>11.4 m</td>
<td></td>
<td>BSMB_2</td>
<td>5.2 W</td>
<td>75.7/0.6 W</td>
<td>80.9/5.8 W</td>
</tr>
<tr>
<td>MBRC.4L8.B1</td>
<td>9.5 m</td>
<td>dip</td>
<td>BSMB_2</td>
<td>4.5 W</td>
<td>75.4 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.9 m</td>
<td>drift</td>
<td>BSMB_2</td>
<td>0.8 W</td>
<td>0.3 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q5L8</td>
<td>13.0 m</td>
<td></td>
<td>BSMQ_1</td>
<td>9.8 W</td>
<td>162.0/1.0 W</td>
<td>171.8/10.8 W</td>
</tr>
<tr>
<td>MQM.B5L8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>2.6 W</td>
<td>79.3 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MQM.A5L8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>2.6 W</td>
<td>79.3 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.B5L8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBCV.5L8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>2.8 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.A5L8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.5 m</td>
<td>drift</td>
<td>BSMQ_1</td>
<td>2.5 W</td>
<td>0.5 W/0.6 W</td>
<td></td>
</tr>
<tr>
<td>Q6L8</td>
<td>12.0 m</td>
<td></td>
<td>BSMQ_1-R</td>
<td>9.1 W</td>
<td>191.7/0.8 W</td>
<td>200.8/9.9 W</td>
</tr>
<tr>
<td>MQML.6L8.B1</td>
<td>4.8 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>3.7 W</td>
<td>111.9 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>MQM.6L8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_1-R</td>
<td>2.6 W</td>
<td>79.3 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBCV.6L8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1-R</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.9 m</td>
<td>drift</td>
<td>BSMQ_1-R</td>
<td>2.0 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
</tbody>
</table>

**Total LSS** 682.6/33.6 W
Table 16: Heat load estimates for the Long Straight Section on the right side of IP8.

<table>
<thead>
<tr>
<th>Name</th>
<th>Length</th>
<th>Field Config</th>
<th>Chamber</th>
<th>Impedance (T_BS=20 K)</th>
<th>e-cloud (SEY=1.3/1.1)</th>
<th>Total (SEY=1.3/1.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2R8</td>
<td>11.4 m</td>
<td>BSMB_2</td>
<td>5.2 W</td>
<td>75.7/0.6 W</td>
<td>80.9/5.8 W</td>
<td></td>
</tr>
<tr>
<td>MBRC.4R8.B1</td>
<td>9.5 m</td>
<td>dip</td>
<td>BSMB_2</td>
<td>4.5 W</td>
<td>75.4 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>1.9 m</td>
<td>drift</td>
<td>BSMB_2</td>
<td>0.8 W</td>
<td>0.3 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>Q4R8</td>
<td>12.7 m</td>
<td>BSMQ_2-R</td>
<td>6.2 W</td>
<td>225.4/0.7 W</td>
<td>231.6/7.0 W</td>
<td></td>
</tr>
<tr>
<td>MQY.A4R8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MQY.B4R8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.A4R8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.B4R8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.2 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.4 W</td>
<td>0.4 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Q5R8</td>
<td>13.0 m</td>
<td>BSMQ_2-R</td>
<td>6.4 W</td>
<td>222.8/0.8 W</td>
<td>229.2/7.1 W</td>
<td></td>
</tr>
<tr>
<td>MQY.A5R8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MQY.B5R8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_2-R</td>
<td>1.8 W</td>
<td>104.5 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.A5R8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYH.5R8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>6.2 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>MCBYV.B5R8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_2-R</td>
<td>0.4 W</td>
<td>3.6 W/0.0 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>3.5 m</td>
<td>drift</td>
<td>BSMQ_2-R</td>
<td>1.6 W</td>
<td>0.5 W/0.4 W</td>
<td></td>
</tr>
<tr>
<td>Q6R8</td>
<td>12.0 m</td>
<td>BSMQ_1</td>
<td>9.1 W</td>
<td>191.7/0.8 W</td>
<td>200.8/9.9 W</td>
<td></td>
</tr>
<tr>
<td>MQML.6R8.B1</td>
<td>4.8 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>3.7 W</td>
<td>111.9 W/0.2 W</td>
<td></td>
</tr>
<tr>
<td>MQM.6R8.B1</td>
<td>3.4 m</td>
<td>quad</td>
<td>BSMQ_1</td>
<td>2.6 W</td>
<td>79.3 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>MCBCH.6R8.B1</td>
<td>0.9 m</td>
<td>dip</td>
<td>BSMQ_1</td>
<td>0.7 W</td>
<td>0.1 W/0.1 W</td>
<td></td>
</tr>
<tr>
<td>Drifts</td>
<td>2.9 m</td>
<td>drift</td>
<td>BSMQ_1</td>
<td>2.0 W</td>
<td>0.5 W/0.5 W</td>
<td></td>
</tr>
</tbody>
</table>

**Total LSS** 742.6/29.9 W
5 Final remarks

The results presented in Tabs. [1-16] are summarized by the histogram in Fig. 14, which shows the heat load estimated for the different IRs and for the two considered values of SEY. It can be noticed how the application of surface treatments which lower the SEY of the surface to a value of 1.1 or below, provides a strong reduction of the total beam induced heat loads for all IRs. This is due to the fact that for an SEY of 1.3 (lowest presently achieved by scrubbing in the LHC quadrupoles) the electron cloud is by far the dominant contribution to heat loads for all IRs, while an SEY of 1.1 is sufficient to largely suppress the electron cloud in all devices (see Tabs. [1-16]).

The possibility of increasing the operational bunch length for the HL-LHC up to 9.7 cm r.m.s. is presently under consideration. The study presented in this document has been repeated for this bunch length. Detailed tables can be found in [15] and the corresponding summary histogram in shown in Fig. 15. The comparison against Fig. 14 shows that the impact of this change on the beam screen heat loads is extremely limited.

![Figure 14](image-url)

**Figure 14**: Total expected heat load on the beam screens of the IR cryostats for two different values of SEY of the surface. Calculation performed assuming machine and beam parameters from [5] (r.m.s. bunch length is 7.5 cm).

![Figure 15](image-url)

**Figure 15**: Total expected heat load on the beam screens of the IR cryostats for two different values of SEY of the surface. Calculation performed assuming machine and beam parameters from [5] with the r.m.s. bunch length increased to 9.7 cm.
Bibliography


