Bunch parameters of the 50 ns LHC type beam for the Q26 and Q20 optics in 2012

T. Bohl

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Introduction

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▶ BCT, BQM data, 50 ns LHC type beam (4 batches of 36 bunches)
▶ 2012-07-13 - 2012-09-16: Q26, LHC BP INJPHYS, SPS LHC_50NS_D_2011 (ID: 387)
▶ 2012-09-24 - 2012-12-05: Q20, LHC BP INJPHYS, SPS LHCMC_50NS_D_Q20_2011_V1 (ID: 768)
▶ further selection criteria
  ▶ LHC request
  ▶ no. of bunches at flat top exactly 144
  ▶ BQM flag OK
▶ Q26: 118 cycles, Q20: 186 cycles
RF Voltage Programmes I

RF voltage for cycle LHC_50NS_D_2011_V1

Figure: RF voltage for cycle LHC_50NS_D_2011_V1 (2012-07-13 till 2012-09-16). 200 MHz voltage (left), usually 3 MV at flat bottom and 7.1 MV at flat top. The voltage was below 3.0 MV at the flat bottom only between 2012-09-05 15:25 and 16:12. The higher voltage at flat top was used 2012-07-21 between 15:03 and 15:09. 800 MHz voltage (right), always 650 kV at flat top.
RF Voltage Programmes II

RF voltage for cycle LHCMD_50NS_D_Q20_2011_V1

Figure: RF voltage for cycle LHCMD_50NS_D_Q20_2011_V1 (2012-09-24 till 2012-12-05). 200 MHz voltage (left), usually 4.5 MV at flat bottom and 7.0 MV at flat top. The 800 MHz voltage (right) was 560 kV at flat bottom till 2012-10-05 08:26 and then 450 kV. The 800 MHz voltage was always 700 kV at flat top.
## RF Voltage Programmes III

<table>
<thead>
<tr>
<th>Date</th>
<th>200 MHz Voltage Flat Bottom [MV]</th>
<th>Ramp Max [MV]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-09-24 13:52</td>
<td>4.5</td>
<td>6.2</td>
</tr>
<tr>
<td>2012-09-26 19:01</td>
<td>3.0</td>
<td>6.2</td>
</tr>
<tr>
<td>2012-09-26 19:07</td>
<td>4.5</td>
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</tr>
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<td>2012-09-26 19:10</td>
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<td>2012-09-28 18:57</td>
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<td>6.2</td>
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<td>2012-09-28 19:41</td>
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<td>2012-10-21 19:41</td>
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<td>6.9</td>
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<td>2012-10-29 13:40</td>
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<td>6.2</td>
</tr>
<tr>
<td>2012-10-29 13:43</td>
<td>4.5</td>
<td>7.2</td>
</tr>
</tbody>
</table>

**Table:** Summary of 200 MHz voltage trims during the 2012 run with the Q20 optics. Ramp Max is the maximum RF voltage during acceleration.
Data Acquired I

Data acquired per SPS cycle

$N_Q$ average number of charges per bunch at flat top

$\lambda$ bunch length of one bunch

$\lambda_{min}$ at injection: min. bunch length of all injected bunches of the first batch; at flat top: min. bunch length of all 144 bunches

$\lambda_{mean}$ at injection: mean bunch length of all injected bunches of the first batch; at flat top: mean bunch length of all 144 bunches

$\lambda_{min}$ at injection: max. bunch length of all injected bunches of the first batch; at flat top: max. bunch length of all 144 bunches

$\sigma$ standard deviation
Data Acquired II

Data plotted are those of one LHC fill ($\mathcal{O}(25)$ cycles), one LHC period of Beam Process INJPHYS

$\langle N_Q \rangle$ mean of $N_Q$

$\langle \lambda_{\text{min}} \rangle$ mean of $\lambda_{\text{min}}$

$\langle \lambda_{\text{mean}} \rangle$ mean of $\lambda_{\text{mean}}$

$\langle \lambda_{\text{max}} \rangle$ mean of $\lambda_{\text{max}}$

$\langle \sigma \rangle$ mean of standard deviation
Data Acquired III

Longitudinal emittance at flat top

- Q26 cycle: 200 MHz RF voltage of 7.1 MV, 800 MHz RF voltage of 650 kV
- Q20 cycle: 200 MHz RF voltage of 7.0 MV, 800 MHz RF voltage of 700 kV
Time Series I

$\langle N_Q \rangle$ at flat top as function of time

- intensity step 2012-10-29
- at about the same time: 200 MHz RF voltage during ramp increased by about 10%
Time Series II

$\langle \lambda \rangle$ at injection as function of time

$\lambda_{\text{min}}$

$\lambda_{\text{mean}}$

$\lambda_{\text{max}}$
Time Series III

Figure: \( \langle \sigma(\lambda) \rangle \) at injection as function of time.
Time Series IV

⟨λ⟩ at flat top as function of time

λ_{min}

λ_{mean}

λ_{max}
Time Series V

$\langle \lambda_{\text{mean}} \rangle$ and $\langle \sigma(\lambda) \rangle$ at flat top

- 2012-08-08: Longitudinal damper adjustment
Figure: Longitudinal emittance at flat based on $\langle \lambda_{\text{mean}} \rangle$ at flat top.
Figure: $\langle \lambda_{\text{mean}} \rangle$ at injection versus $N_Q$ at flat top. Q26 (left), Q20 (right).
Figure: $\langle \sigma(\lambda) \rangle$ at injection versus $N_Q$ at flat top. Q26 (left), Q20 (right).
Figure: $\langle \lambda_{\text{mean}} \rangle$ at flat top versus $N_Q$ at flat top. Q26 (left), Q20 (right).
Figure: $\langle \sigma(\lambda) \rangle$ at flat top $N_Q$ at flat top. Q26 (left), Q20 (right).
Correlations V

Figure: $\langle \lambda_{\text{mean}} \rangle$ at flat top versus $\langle \lambda_{\text{mean}} \rangle$ at injection. Q26 (left), Q20 (right).
Correlations VI

Figure: $\langle \sigma(\lambda) \rangle$ at flat top versus $\langle \sigma(\lambda) \rangle$ at injection. Q26 (left), Q20 (right).