Specifications for the XFEL Beam Switchyard Kickers

Winni Decking
FEL-Beam-Dynamics-Meeting
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Beam Distribution

- High accuracy (<0.01 %)
- 5 MHz burst operation
- 10 Hz operation

- Low accuracy (>1 %)

Gun to Linac

Flat Top Kicker (pulse width 290 μs)

5 MHz Dump Kicker (pulse pattern)

Dump Gap

290 μs

20 μs

600 μs

15° deflection to Dump

2.2° arc to SASE

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• Relative emittance growth per 1 deg bend at 25 GeV
• Max. bending radius < 300 m (to allow for fast separation)
  => max beta-function $\approx 40$ m
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Beam Switchyard Optics

X-FEL BEAM DISTRIBUTION 03.09.2007
Win32 version 8.51/15
07/09/07 15.24.23

15° deflection to Dump
2.2° arc to SASE 2
to T1
to T20
to dump
to T1
Septum thickness: \( x_{\text{septum}} = 5 \text{ mm} \)
Tolerable jitter: \( n_{\text{jitter}} = 0.1 \sigma \)
Collimation depth: \( m_{\text{collimation}} = 85 \sigma \)
Beta at Septum: \( \beta_{\text{septum}} = 30 \text{ m} \)
\(<\beta> \) at Kicker: \( \beta_{\text{kicker}} = 25 \text{ m} \)

\[
\Delta = x_{\text{septum}} + 2m_{\text{collimation}} \sqrt{\epsilon \beta_{\text{septum}}} = \Theta_{\text{kick}} \sqrt{\beta_{\text{septum}} \beta_{\text{kicker}}}
\]

\[
\Theta_{\text{kick}} = 0.4 \text{ mrad} \quad (BdI = 33.6 \text{ mTm (25 GeV), } l_{\text{kick}} < 18 \text{ m})
\]

\[
\frac{\Delta \Theta}{\Theta} = \frac{n_{\text{jitter}}}{\left(2m_{\text{collimation}} + x_{\text{septum}} \sqrt{\epsilon \beta_{\text{septum}}} \right)}
\]

\[
\frac{\Delta \Theta}{\Theta} \approx 3 \times 10^{-4} \quad (< 5 \times 10^{-3} \text{ measured at TTF})
\]
0.5 mrad kick required
### XFEL BD Kicker and Septum Specs

<table>
<thead>
<tr>
<th></th>
<th>Fast single bunch kicker (for beam dump)</th>
<th>Flat top kicker (for beam distribution)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pulse Form</strong></td>
<td>Burst</td>
<td>Flat top</td>
</tr>
<tr>
<td><strong>Repetition Rate</strong></td>
<td>Hz</td>
<td>5×10^6</td>
</tr>
<tr>
<td><strong>Max. Pulse Width</strong></td>
<td>s</td>
<td>200×10^-9</td>
</tr>
<tr>
<td><strong>Rise/Fall Time</strong></td>
<td>s</td>
<td>&lt; 100×10^-9</td>
</tr>
<tr>
<td><strong>Rel. Amplitude Stability</strong></td>
<td>0.01</td>
<td>3×10^-4</td>
</tr>
<tr>
<td><strong>Relative Residual Ripple</strong></td>
<td>3×10^-4</td>
<td>3×10^-4</td>
</tr>
<tr>
<td><strong>Kick angle</strong></td>
<td>mrad</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Max. int. Field Strength</strong></td>
<td>mT×m</td>
<td>42</td>
</tr>
<tr>
<td><strong>Min. full aperture</strong></td>
<td>mm</td>
<td>30</td>
</tr>
<tr>
<td><strong>Max. system length</strong></td>
<td>m</td>
<td>18</td>
</tr>
</tbody>
</table>
• In or out of vacuum stripline kicker with \( d = \) stripline distance

\[
B[T] = \frac{\mu_0 I}{d}
\]

• Decrease of vacuum chamber size helpful
  – Test on ongoing for sputtering of \( d < 20 \) mm ceramics
  – 100 \( \sigma \) at kicker location approx 3.5 mm

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• Realization of the extraction scheme at FLASH (i.e. kicker + septum + beam dump) at an early stage would allow to test the complete hardware for the XFEL setup
• Installation can later be re-used for FLASH-II
• Only ‘minor’ redesign of upstream collimator beamline and bypass necessary

Possible Tests at FLASH

courtesy of Nina Golubeva and Vladimir Balandin