Paul Scherrer Institut

Virtual image aligned with beam axis

Primary beam

Scintillating crystal

Ideal observation angle

Screen Monitor

Rasmus Ischebeck
### Task: Measurement of Transverse Profiles

#### Technical Requirements

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam Size</td>
<td>5 ... 500 µm rms</td>
</tr>
<tr>
<td>Bunch Charge</td>
<td>10 pC ... 200 pC</td>
</tr>
<tr>
<td>Field of View</td>
<td>4 mm (h) × 15 mm (v)</td>
</tr>
</tbody>
</table>

#### Operational Requirements

<table>
<thead>
<tr>
<th></th>
<th>Observation</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquisition Rate</td>
<td>10 Hz</td>
<td>100 Hz</td>
</tr>
<tr>
<td>Synchronized Data Acquisition</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Use for Feedbacks</td>
<td>No*</td>
<td></td>
</tr>
</tbody>
</table>

* With the possible exception of the last monitor before the beam dump
Distribution in SwissFEL

> 23 Screen Monitors:

**Table 1: Section Distribution**

<table>
<thead>
<tr>
<th>Section</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIN</td>
<td>14</td>
</tr>
<tr>
<td>S10/20/30</td>
<td>3</td>
</tr>
<tr>
<td>SAR</td>
<td>5</td>
</tr>
<tr>
<td>SAT (Phase I)</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 2: Type Distribution**

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>10</td>
</tr>
<tr>
<td>Measurement</td>
<td>13</td>
</tr>
</tbody>
</table>
Measurement Principle

> Combination of two monitors:
  > Scintillating crystal
  > Optical transition radiation

> Wire scanners: See Gian Luca’s presentation
Design Considerations

> Scheimpflug imaging principle

Observation of the Scheimpflug imaging principle allows to image the entire screen without depth-of-field issues. To avoid astigmatism, the lens is not tilted, but the detector is tilted. For a 1:1 imaging, we tilt the CMOS sensor by 15°.

> Snell’s law of refraction

The YAG / LuAG scintillators are observed at such an angle that Snell’s law of refraction is observed. As a consequence, we can image beams that are smaller than the thickness of the scintillator.
Implementation
Implementation: Prototype installed in SITF
The smallest beam in this measurement is 50 µm rms. Beams of 10 µm rms have been measured.
Measurements with the Prototype

Slice emittance measurement of a 10 pC beam
Measurements with the Prototype

> Slice emittance measurement of a 1.3 pC beam
## Status / Time Plan

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requirements Defined</td>
<td>01/2012 ✓</td>
</tr>
<tr>
<td>Decision on Measurement Principle</td>
<td>01/2012 ✓</td>
</tr>
<tr>
<td>Prototyping</td>
<td>2012 ✓</td>
</tr>
<tr>
<td>Prototype Tested</td>
<td>12/2012 ✓</td>
</tr>
<tr>
<td>Design for Series Production</td>
<td>2013</td>
</tr>
<tr>
<td>Ready for Fabrication</td>
<td>Q4/2013</td>
</tr>
<tr>
<td>Fabrication</td>
<td>2014</td>
</tr>
<tr>
<td>System Acceptance Test</td>
<td>Q3/2014</td>
</tr>
<tr>
<td>Ready for Installation</td>
<td>Q1/2015</td>
</tr>
</tbody>
</table>

- Fabrication by external company planned
- Presently starting industrialization study
Time Plan

Prototyping Phase
- Requirements defined by project management
- Parliament decision
- Agreement on activities and resources
- WP defined
- Release of resources

Order / Production Phase
- Prototyping Phase activities
- Informal design review
- Final design review
- Design freeze
- Informal design review
- Final design review
- Design freeze

Installation / Commissioning Phase
- Prototyping Phase activities
- Installation of linac
- T&U photonics
- Component tests
- Control system tests
- Calibration
- Final acceptance test
- Commissioning with beam
- Linac 1st beam
- SwissFEL 1st photons

2012
- Q1: Requirements defined by project management
- Q2: Parliament decision
- Q3: Agreement on activities and resources
- Q4: WP defined
- Q1: Release of resources

2013
- Q1: Assembly
- Q2: Fabrication
- Q3: Industrialization study
- Q4: Procurement / production readiness review

2014
- Q1: WTO call for tender
- Q2: Placement of order
- Q3: Training installation crew
- Q4: Installation SwissFEL injector

2015
- Q1: Component tests
- Q2: Control system tests
- Q3: Calibration
- Q4: Final acceptance test
- Q1: Commissioning with beam

2016
- Q1: Linac installation finished
- Q2: Linac 1st beam

2017
- Q1: SwissFEL 1st photons
Resources
Open Issues / Questions to the Committee

> Please evaluate the presented solution with respect to
  > Suitability of the chosen concepts
  > Appropriateness of the design for the given specifications
  > Feasibility of the technical designs

> Assess whether the presented time plans and resource planning is appropriate
  > Time plan
  > Material resources
  > Personnel planning
Budget for Prototype