Overview of SwissFEL Diagnostics

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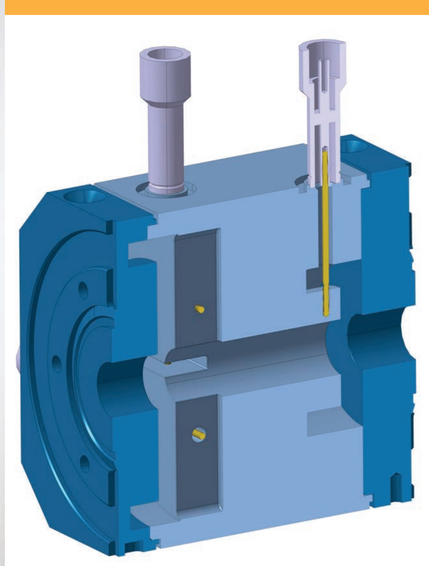
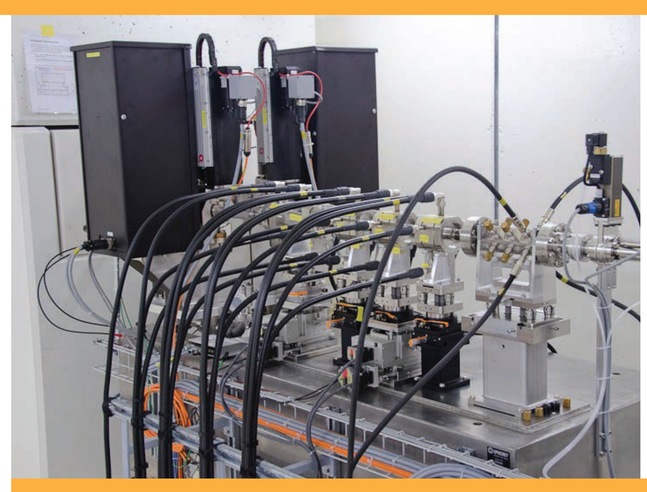
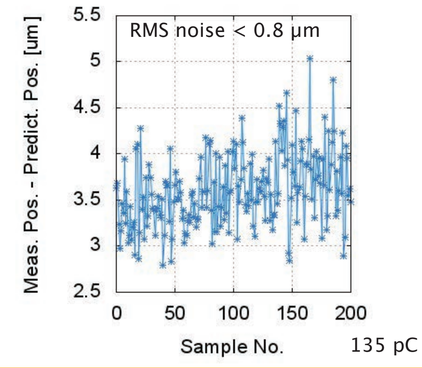
SwissFEL will provide users with brilliant X-ray pulses in 2017. A comprehensive suite of diagnostics is needed for the initial commissioning, for changes to the operating point, and for feedbacks. The development of instrumentation for SwissFEL is well underway, and solutions have been identified for most diagnostics systems. I will present here an overview of the instrumentation for SwissFEL, and give details on some recent developments.

Beam Position Monitor



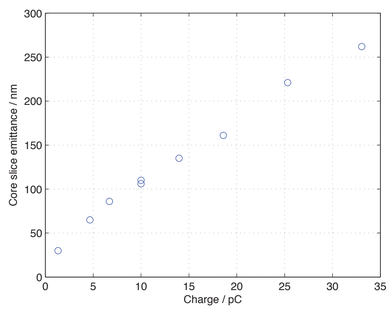


SwissFEL BPM16 position resolution measurement: difference between SwssFEL and XFEL.EU (extrapolated) BPM position reading

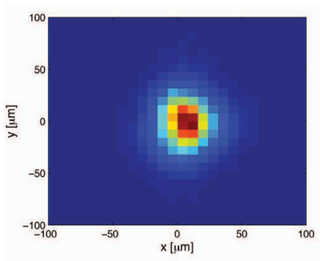


Transverse Profile Imager

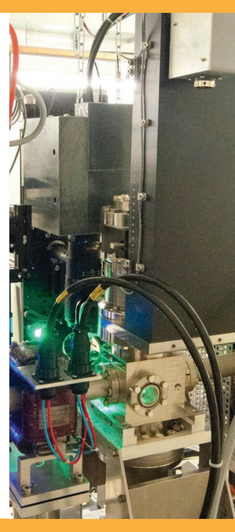
Design of the transverse profile imager takes Snell's law of refraction and the Scheimpflug imaging condition into account to achieve good resolution over a large field of view. Coherent OTR is directed away from the imaging system.



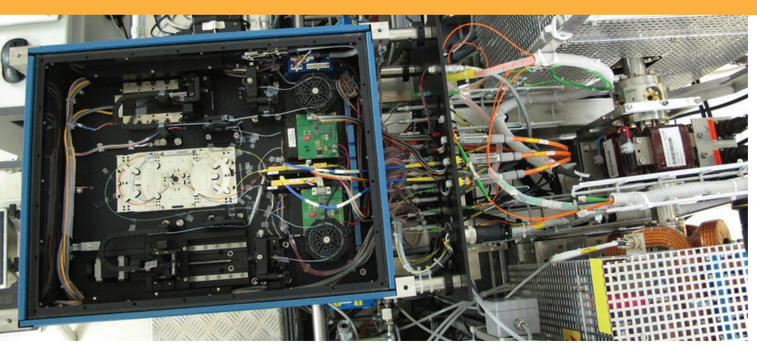
Slice emittance measurement as a function of bunch charge

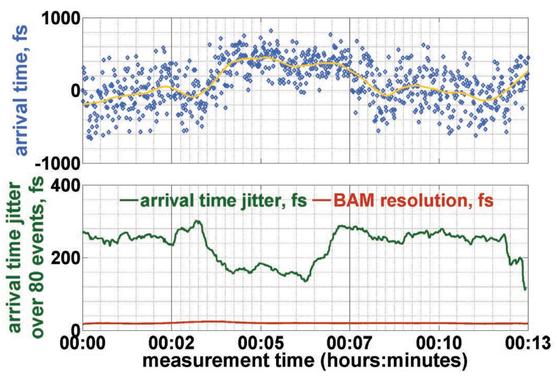


Optical resolution (ISO 12223): 8 µm
Field of view: 6 mm (h) x 16 mm (v)
Dynamic range > 20'000:1



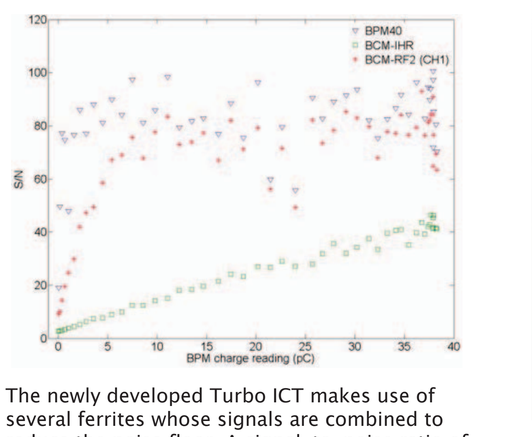
Bunch Arrival Monitor





Improvements 2014: button pick-ups equipped with 40 GHz vacuum feedthroughs, EOMs with 33 GHz bandwidth (40 Gs/s) and small half-wave voltage (4.6 V), DC-offset DAC, improved photoreceiver. Intrinsic resolution: 10 fs - 13 fs @ 90...200 pC, 13 fs - 40 fs @ 20...90 pC.

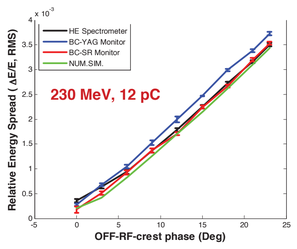
Current Measurement



The newly developed Turbo ICT makes use of several ferrites whose signals are combined to reduce the noise floor. A signal-to-noise ratio of more than 60 is obtained for the SwissFEL charge range of 10 to 200 pC. The measurement shown above is limited by the charge variations in the beam.

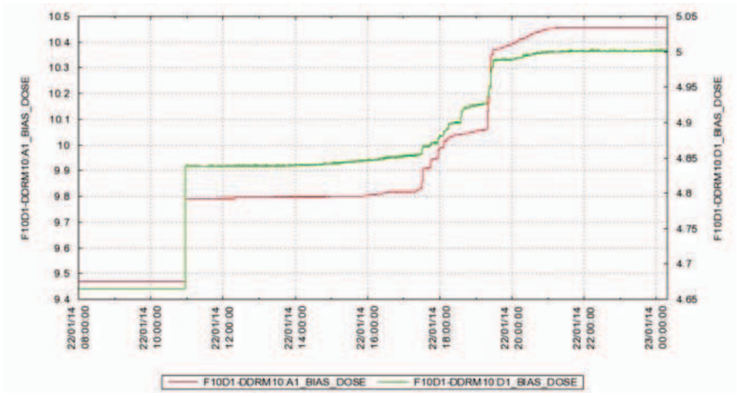
This monitor will be used for a beam-based calibration of the cavity BPMs.

SR Imager



Comparison of energy spread measurements using the SR imager with measurements using scintillators in the bunch compressor as well as just before the beam dump, and with a numerical model

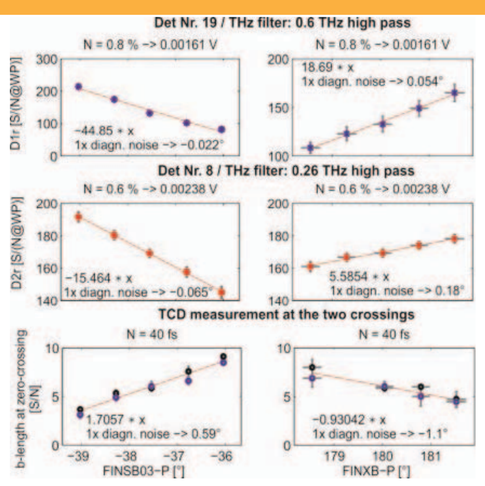
Dose Rate Monitor



On-line measurement of dose rate with a RadFET, during the undulator experiment

Bunch Compression Monitors

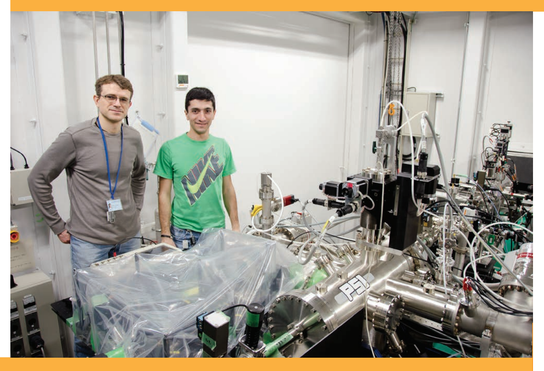
Bunch length after BC1: 250 - 500 fs rms. BCM measuring two different spectral bands (0.26 - 2 THz and 0.6 - 2 THz) by using "thick grid" high pass THz filters and fast Schottky diodes

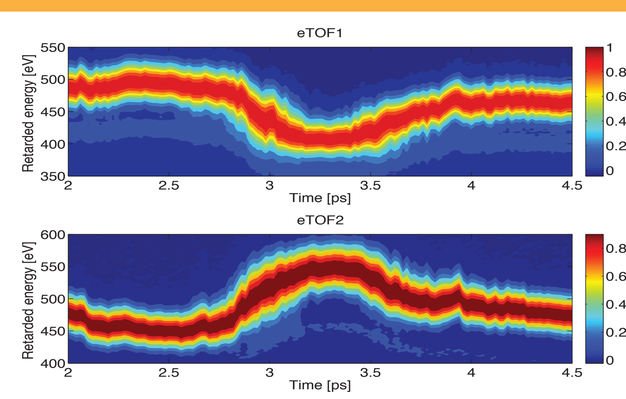


Experimental results on varying the compression phase (FINSB03-P) and the phase of the fourth harmonic (FINXB-P) for a bunch length of roughly 260 fs and a bunch charge of 20.5 pC (energy: 200 MeV). Top two raws: BCM signals integrated in the two spectral ranges, bottom raw: bunch length measured by the transverse deflecting cavity.

Bunch length after BC2: 3 - 75 fs. Design of a prism based spectrometer, using an MCT array, is currently under investigation.

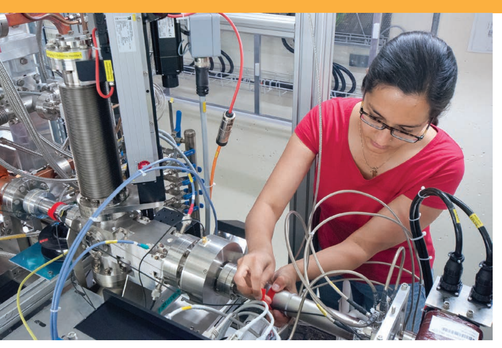
Terahertz Streak Camera

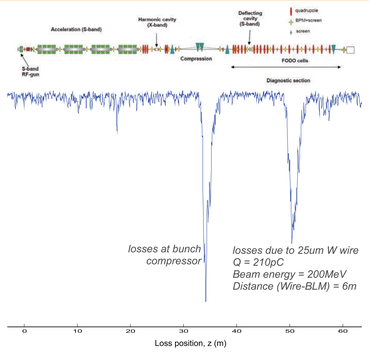




The normalized signal from the THz scan for 10 keV photon beam. The spectrum of the photoelectrons changes during the scan in accordance to the shape of the vector potential.

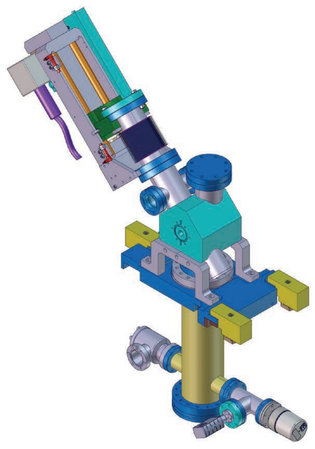
Loss Monitors

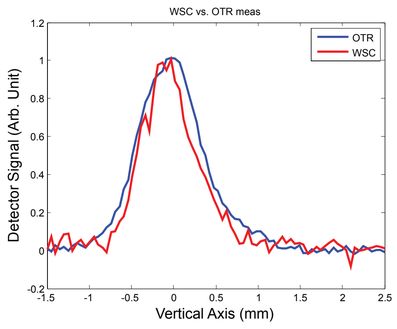




A longitudinal loss monitor, consisting of a fiber optic cable installed along the beamline, allows determining the location of beam losses

Wire Scanners





Wire fork inserted at 45° allows measurement of horizontal and vertical profile with one UHV feedtrhough