X-FEL Beam Dynamics Meeting
Minutes #3 01.10.03

Topics:

- General
- Possibilities for beam distribution
- Next meeting

General

On October 7th there will be a meeting with colleagues from PSI and Elettra on the topic of beam stabilization and beam distribution. The agenda is attached as transparencies.

Possibilities for beam distribution

Reinhard Brinkmann gives an overview about possible beam distribution scenarios.

- A fast switching device would allow for highest flexibility.
- Mikhail Yurkov points out that the SASE process can be suppressed for individual bunches with a small deflection (couple of sigma) in front of the undulator. The still existing spontaneous radiation can be collimated before the experiment.
- A kicker/septum geometry should be included in the switchyard design. Such a separation scheme will work for any switching device and allows to follow various routes. Civil engineering questions have to be addressed.
- The question of an additional 3rd beamline with a 'straight' beam path was discussed.

Vladimir Balandin points out that many questions have to be addressed before a realistic design of the collimation system and beam switchyard is feasible.

Next meeting:

Next meeting October 15th, 15:30.

Tentative program:

- Thoughts on bunch compressor optimization (Torsten)

Attachments:

- Agenda Feedback Meeting
- Transparencies Reinhard Brinkmann

Proposed Meeting Agenda

Location: DESY, Bld. 30 (next to 30b), room 505 (5. floor)

Morning Session	**Introduction and General Aspects**	
10:00-10:20	General X-FEL Layout	Decking
10:20-10:40	Expected jitter and tolerance estimates	Decking
10:40-11:00	Time Structure and Beam Distribution	Brinkmann
11:00-12:00	Discussion	
12:00-13:30	Working Lunch (formal aspects of collabroation)	
Afternoon Session	**Technical Aspects**	
13:30-13:50	TTF transverse FB	Duhme
13:50-14:10	Kickers for TTF/TESLA DR	Obier
14:10-14:30	BPMs at TTF	Nölle
14:30-15:30	Distribution of work responsibilites	

Some considerations on XFEL beam distribution

R. Brinkmann, Oct. 2003

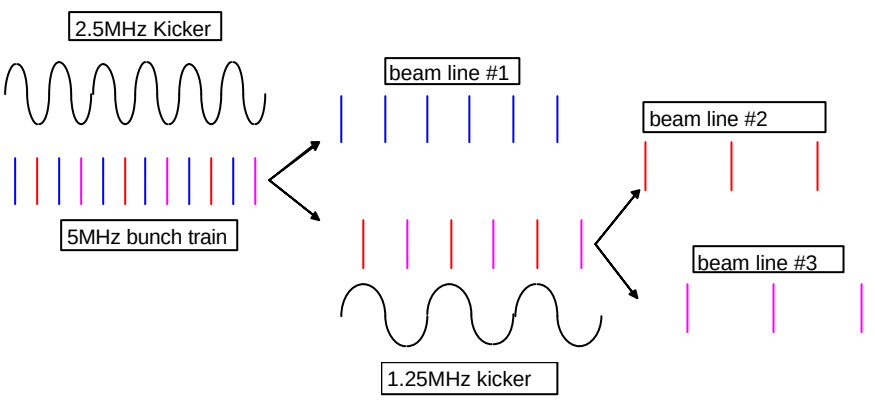
Options for the distribution system

Method	**Pro**	**Con**	**Comment**
DC magnet	trivial device, safe and stable	only one beam line operational at a time	useful for commissioning, startup after shutdown, machine studies, etc.
Switch magnet (pulse-to-pulse)	safety and stability relatively easy	macroscopic duty cycle reduced by # of beam lines, different bunch patterns must be generated at source	suitable for initial operation with 2 beam lines, not a real option for multi-user facility
High-Q resonant kicker at $f_{bunch}/2$ (2.5MHz for 200ns bunch spacing)	rather conventional device, high Q helps for stability & safety	same time structure for all beam lines, unless special bunch patterns generated at source	suitable for multi-user operation at full rep rate for every beam line

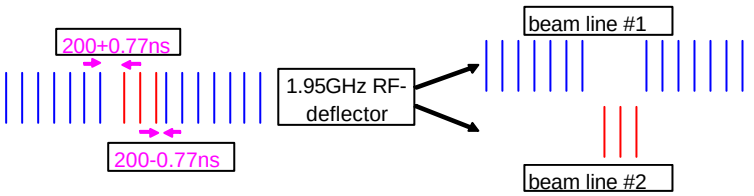
Options… (cont'd)

Method	Pro	Con	Comment
High-Q RF deflector at $(n+1/2)*f_{RF}$ + fast bucket-switch with optical delay at gun laser	deflector relatively stable & safe due to high Q, flexible regarding time structures	scheme for more than two beam lines gets quite involved	Could be OK for 2 beam lines, perspective for multi-user facility questionable
Fast (<200ns), high Rep rate (max 5MHz) kicker	allows to pick out bunches with arbitrary time pattern from 5MHz bunch train	challenging device, stability & safety issues	ideal solution for optimum flexibility of beam distribution to several users, if feasible, well suited together with concept of using intra-train feedback with pilot bunches for beam stabilisation

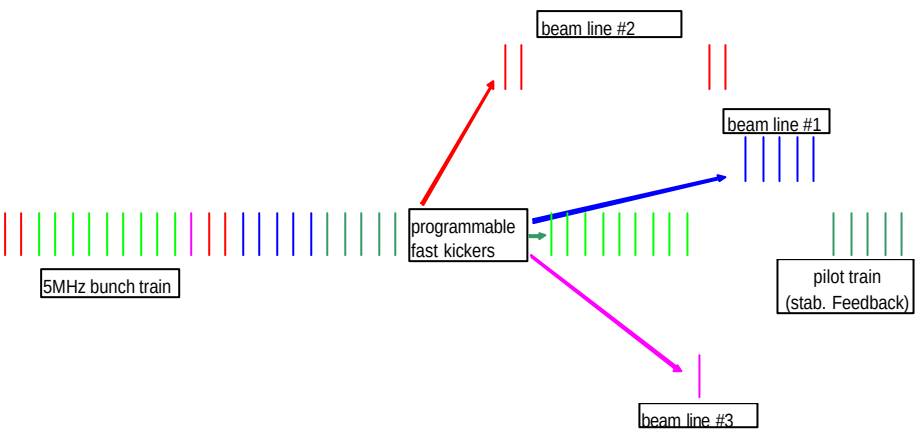
Resonant deflector device at sub-harmonic of bunch frequency



s.c. deflecting mode cavity + “bucket switch” by optical delay of RF gun laser beam



Programmable, large bandwidth fast kickers



Lattice layout to be reviewed… accommodate beam switchyard for 1st stage & later upgrades/more beam lines

- Use kicker + DC-septum concept – minimize deflection angle for fast device!
- Lattice layout/optics with large beta & 90 deg. Phase advance kicker→septum
- Failure safety considerations important: e.g. split up kicker in # of independent units such that single failure does not cause beam loss, inclusion of "sacrificial" collimators, possibility of system function check before beam pulse is launched?, etc.
- Relation of distr. System to orbit stabilisation system:
  - Intra-train feedback components could be "low power" version of distr. System
  - Fast, high bandwidth kicker concept would match perfectly with "pilot train"+ "user train" Ansatz for beam stabilisation

Rough estimate of parameters (to be adjusted with progress in lattice design and tech. Component development)

beam energy	20 GeV
bunch spacing	(≥) 200 ns
beta function at kicker/septum	100 m (90 deg. Phase adv.)
beam size σ	60 μm
angular spread σ'	0.6 μrad
deflection angle θ	0.3 mrad
field strength	0.02 Tm
jitter tolerance *) $\delta\theta/\theta$ ($<0.1\sigma'$)	$< 2 \cdot 10^{-4}$

*): tolerance must be met for kicked bunches as well as those which should pass through unaffected! (rise/fall time and "ringing" issues)

How to proceed?

- Decision with which beam distribution concept(s) we want to go ahead (Oct. 2003)
- Definition of a technical R&D programme towards realisation of prototype(s) for the most critical device(s) of the system, including possibility of tests with beam
- Distribution of work & responsibilities between the collaborating partners
- Estimate of a time schedule (milestones), required human and financial resources

→ start work!