XFEL
X-Ray Free-Electron Laser

DESY

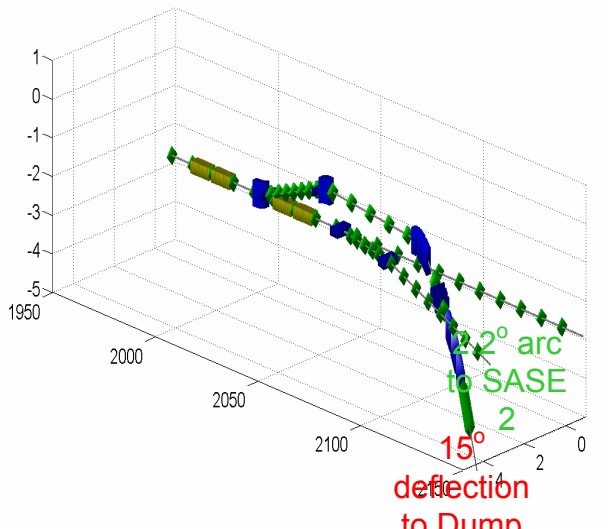
Specifications for the XFEL Beam Switchyard Kickers

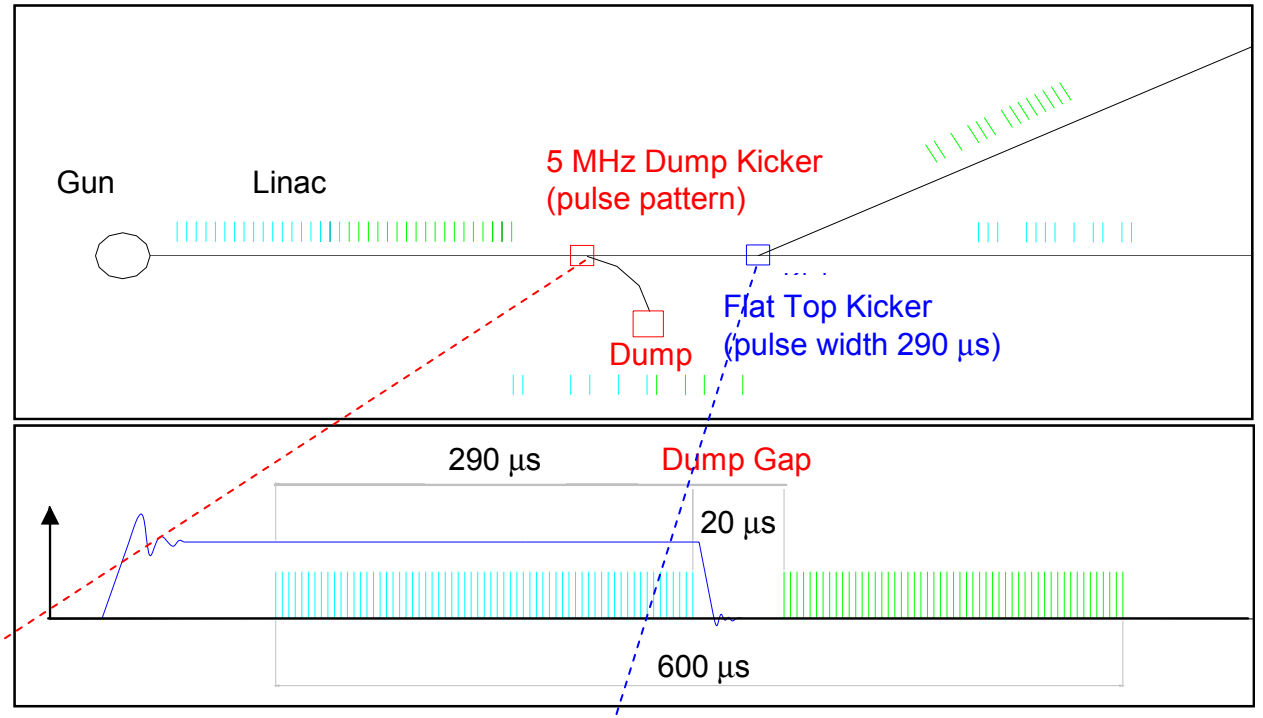
Winni Decking

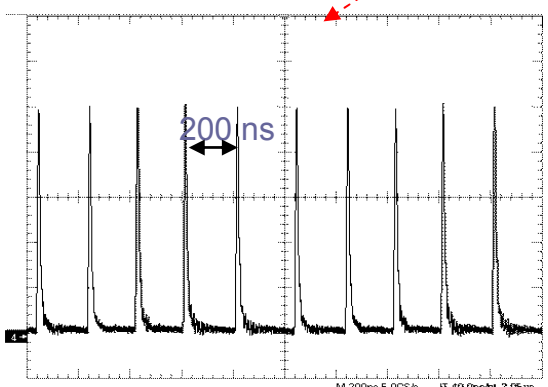
FEL-Beam-Dynamics-Meeting

29.10.2007

Beam Distribution

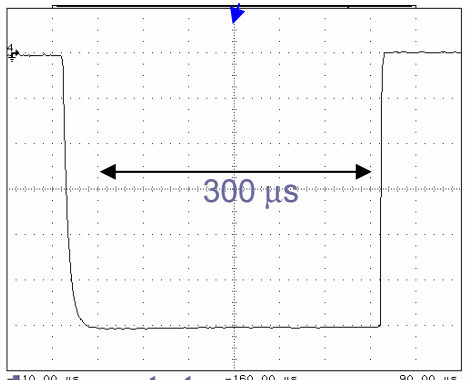






pulser prototype measurement

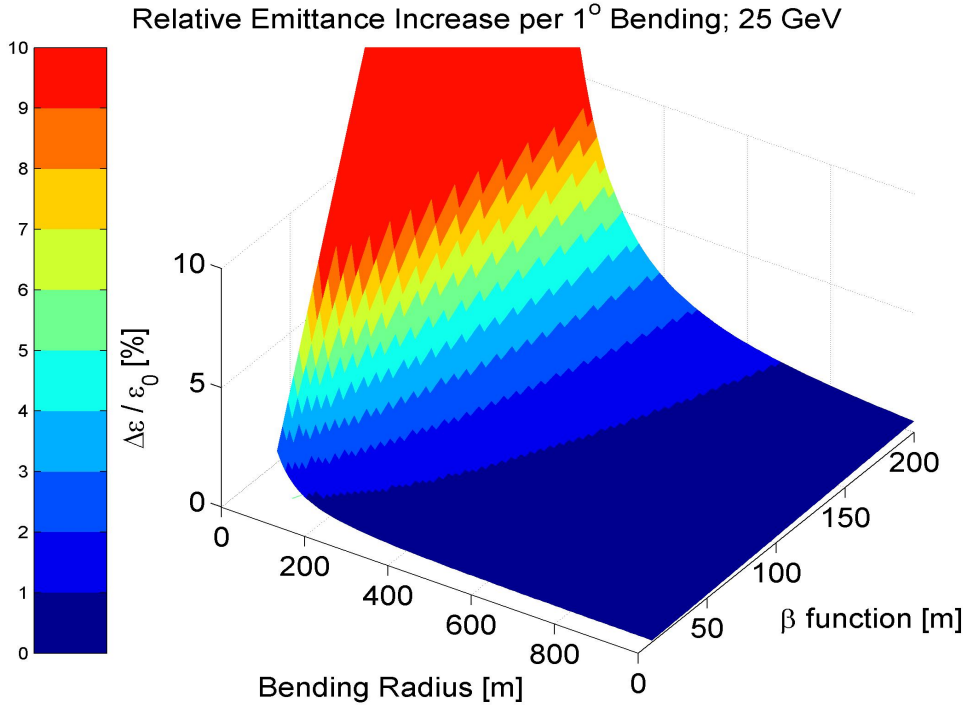
- low accuracy (>1 %)
- 5 MHz burst operation



pulser prototype measurement

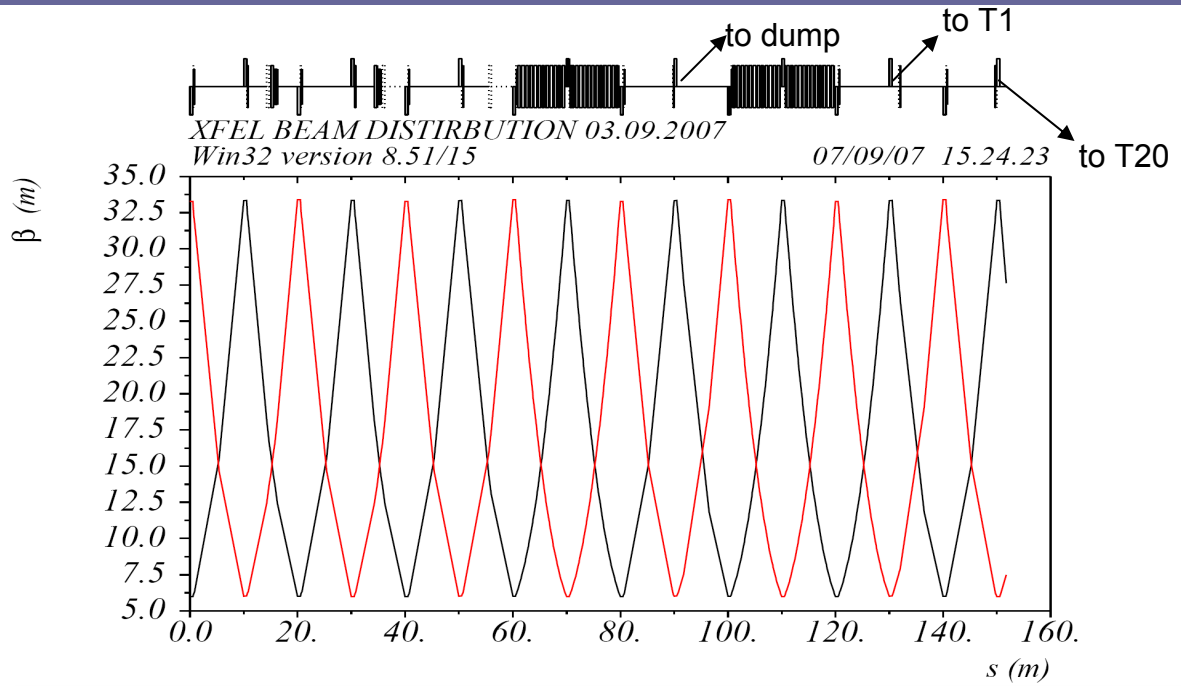
- high accuracy (< 0.01 %)
- 10 Hz operation

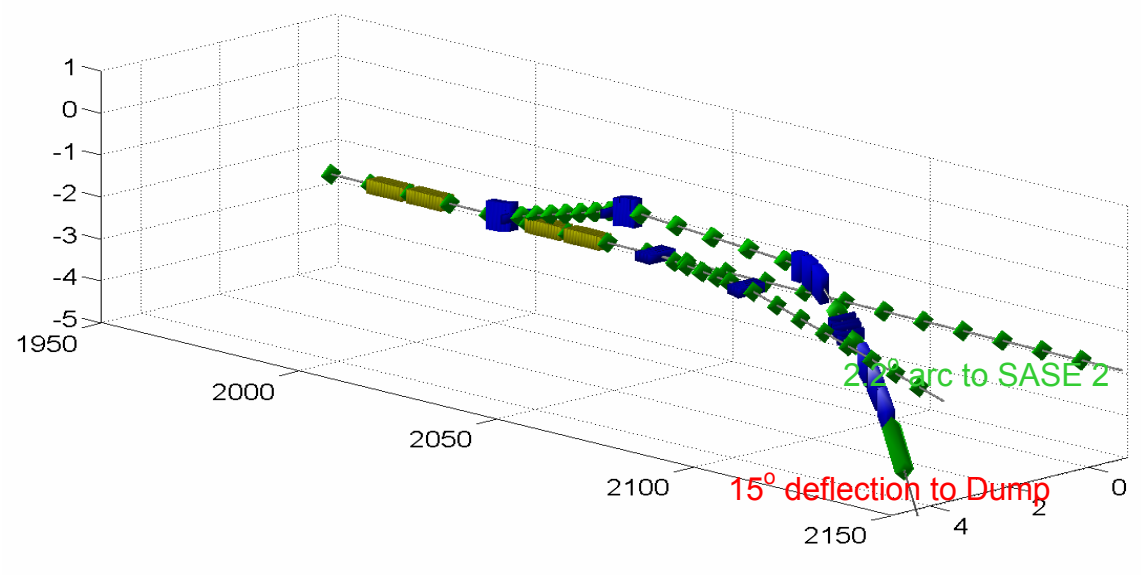
Emittance Growth due to incoh. Synchrotron Radiation



- Relative emittance growth per 1deg bend at 25 GeV
- Max. bending radius < 300 m (to allow for fast separation)
  => max beta-function ≈ 40 m

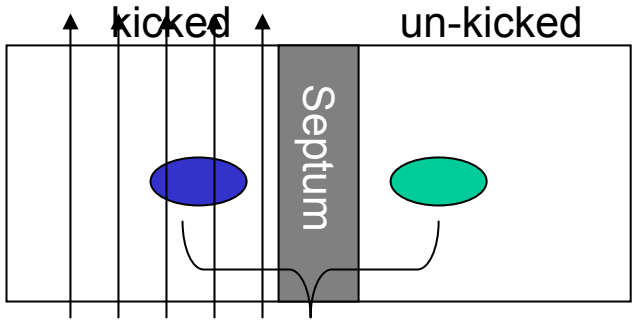
Beam Switchyard Optics





Winni Decking

Distribution: Kicker Strength & Stability



Septum thickness:	x_{septum}=5 mm
Tolerable jitter:	n_{jitter}=0.1 σ
Collimation depth:	$m_{collimation}$=85 σ
Beta at Septum:	β_{septum}=30 m
<Beta> at Kicker:	β_{kicker}=25 m

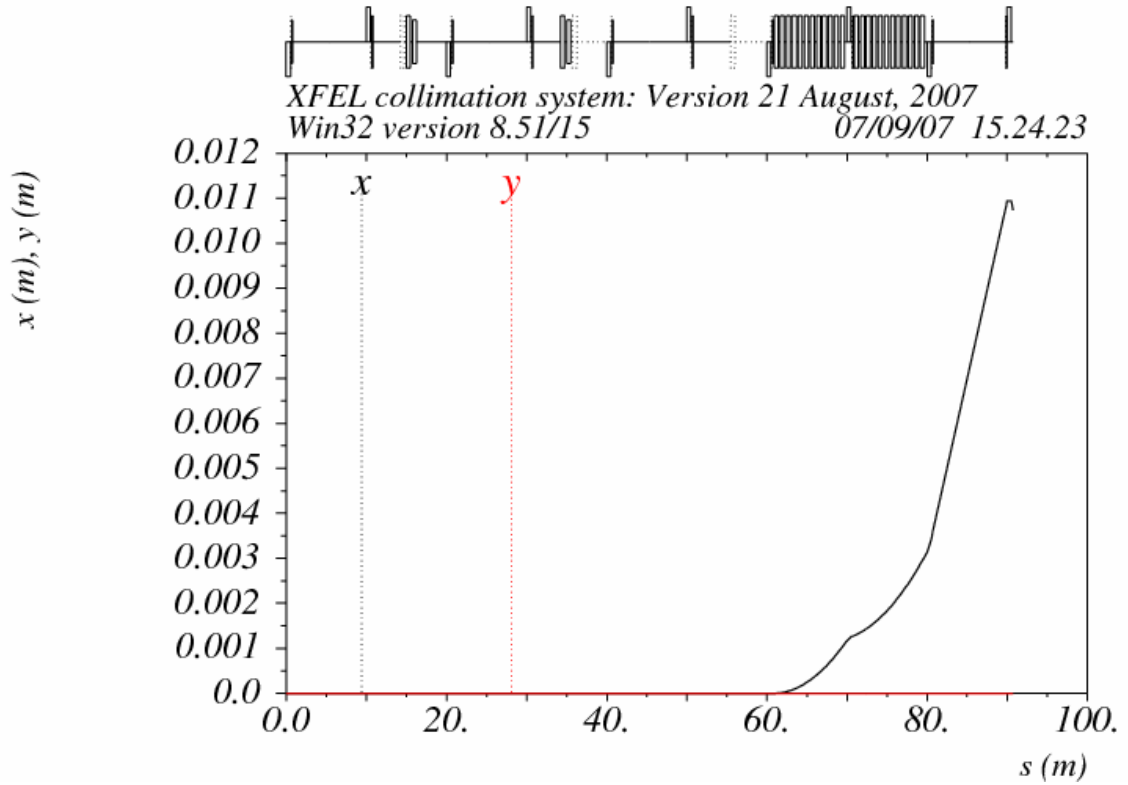
$$\Delta = x_{septum} + 2m_{collimation}\sqrt{\varepsilon\beta_{septum}} = \Theta_{kick}\sqrt{\beta_{septum}\beta_{kicker}}$$

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

$$\frac{\Delta\Theta}{\Theta} = \frac{n_{jitter}}{\left(2m_{collimation} + \frac{x_{septum}}{\sqrt{\varepsilon\beta}_{septum}}\right)}$$

$$\frac{\Delta\Theta}{\Theta} \approx 3\times10^{-4} \quad (< 5\times10^{-3}\ \text{measured at TTF})$$

Kick Trajectory



0.5 mrad kick required

XFEL BD Kicker amd Septum Specs

		Fast single bunch kicker (for beam dump)	**Flat top kicker (for beam distribution)**
Pulse Form		Burst	Flat top
Repetition Rate	Hz	5×10^{6}	10
Max. Pulse Width	s	200×10^{-9}	300×10^{-6}
Rise/Fall Time	s	$< 100\times10^{-9}$	$\approx 20\times10^{-6}$
Rel. Amplitude Stability		0.01	3×10^{-4}
Relative Residual Ripple		3×10^{-4}	3×10^{-4}
Kick angle	mrad	0.5	0.5
Max. int. Field Strength	mT×m	42	42
Min. full aperture	mm	30	30
Max. system length	m	18	18

Kicker Layout

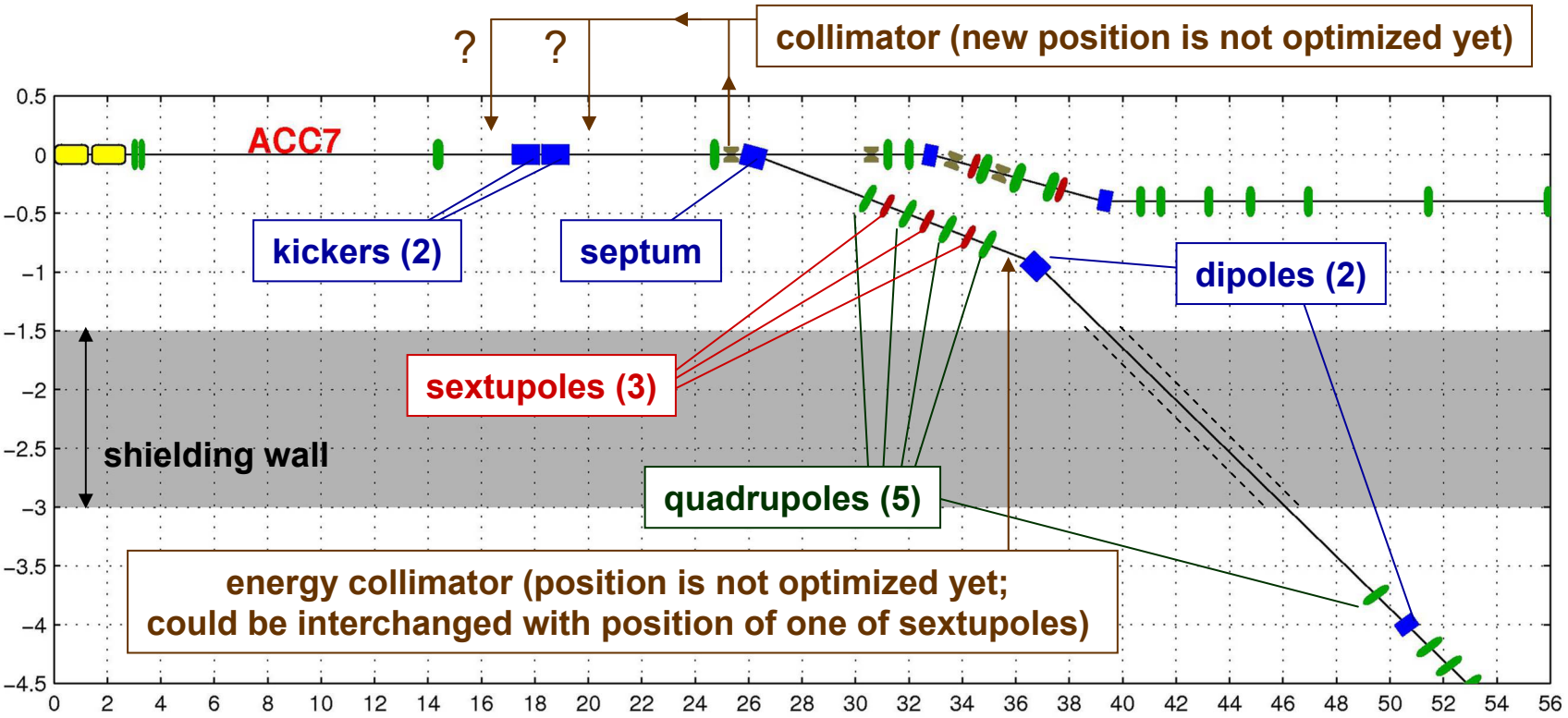
- In or out of vacuum stripline kicker with d= stripline distance

$$B[\mathrm{T}] = \mu_0 I / d$$

- Decrease of vacuum chamber size helpful
  - Test on ongoing for sputtering of d<20 mm ceramics
  - 100 σ at kicker location approx 3.5 mm

Possible Tests at FLASH

- 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



courtesy of Nina Golubeva and Vladimir Balandin