

Status of the Hard X-ray Self-Seeding Project at the European XFEL



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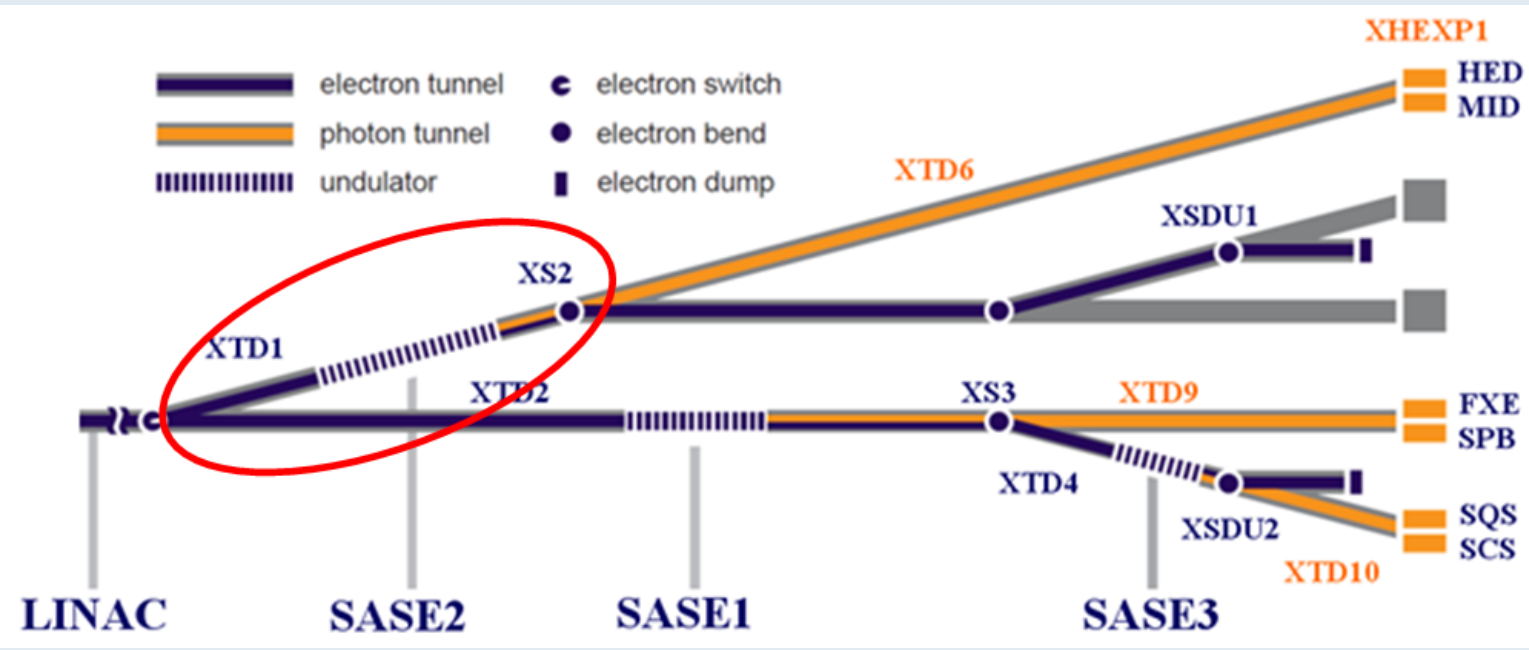
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- ³ European XFEL, Holzkoppel 4, Schenefeld, Germany
- ⁴ ANL, Argonne, Illinois, USA

HXRSS Position and layout

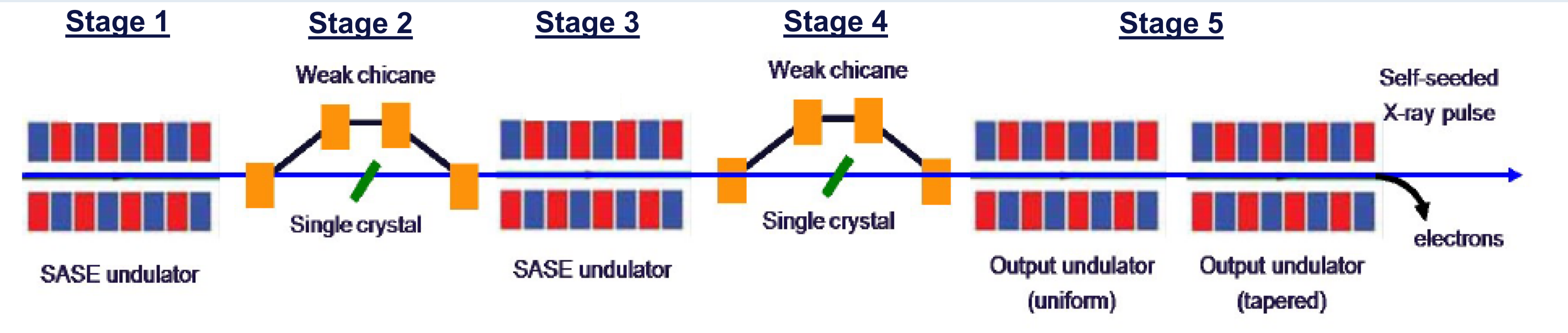
A Hard X-ray Self-Seeding setup is currently under realization at the European XFEL, and will be ready for installation in 2018.

The SASE2 hard X-ray line (3keV-25keV) will be the first to be equipped with HXRSS. Specific for the European XFEL:

- High repetition-rate
- Long undulators



Design based on a 2-chicane scheme

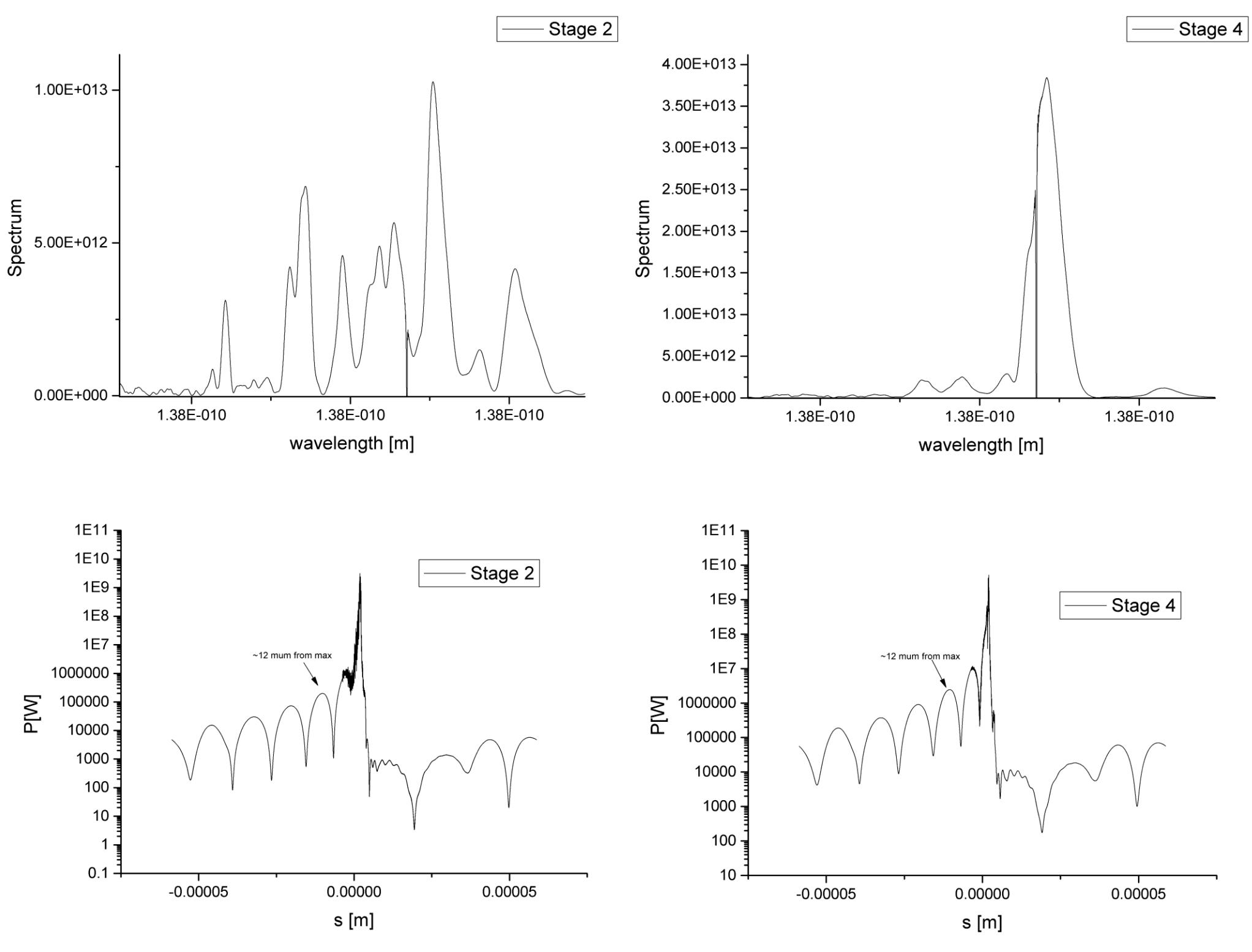


Increases signal-to-noise ratio by the ratio of SASE/seeded bandwidths

The undulators in Stage1 and Stage3 have the same magnetic lengths.

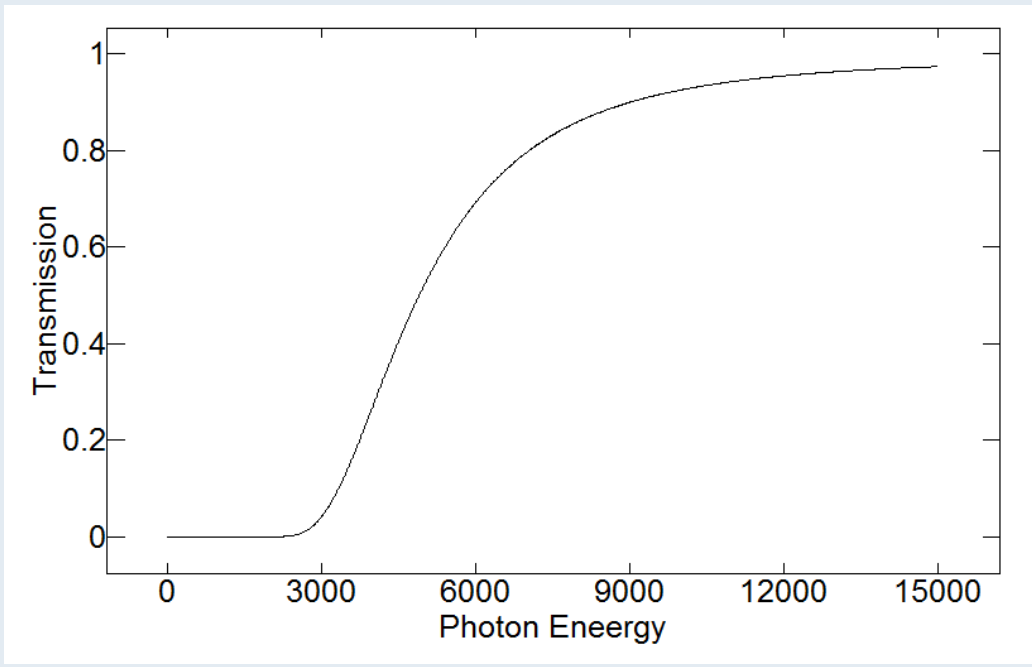
Stage4 suffers from poor S/N ratio but is almost Fourier limited

The seed signal in the time-domain is much better in Stage 4, compared to Stage 2



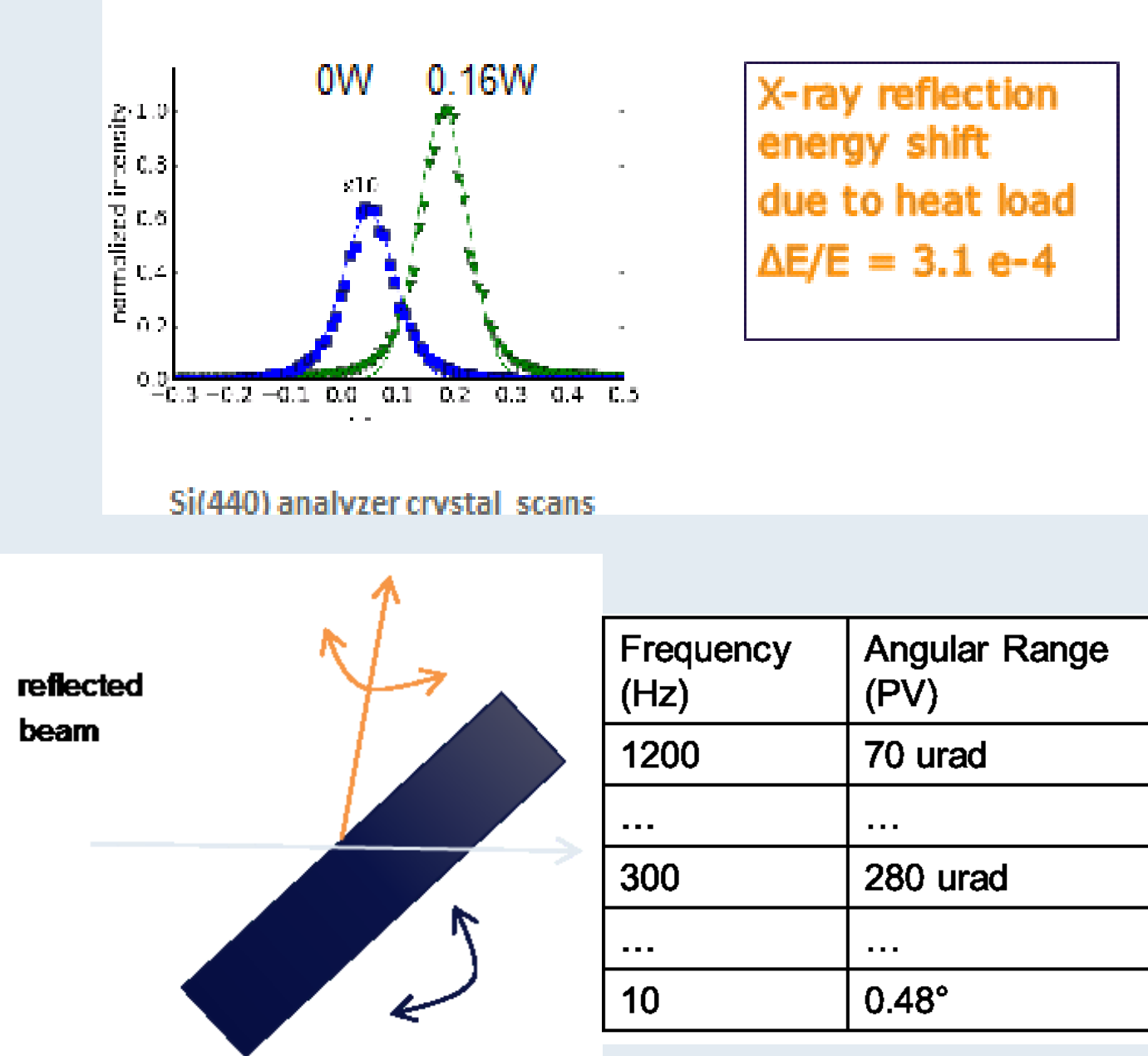
The 2-chicane scheme can be used to ease the heat-loading from the SASE/seeded signals, which depends on the fundamental. Pulse heats up crystal locally→slow heat diffusion w.r.t. rep. rate →T increase

- ω-shift beyond Darwin width→Spectrum broadening (can tolerate a few times more)
- Example: 100mm, C*400; 3μJ/pulse (0.7 μJ absorbed) incident at 8keV within the reflection BW in 1000 pulses
- 3.3keV: deposited 90%: 0.8μJ/pulse incident

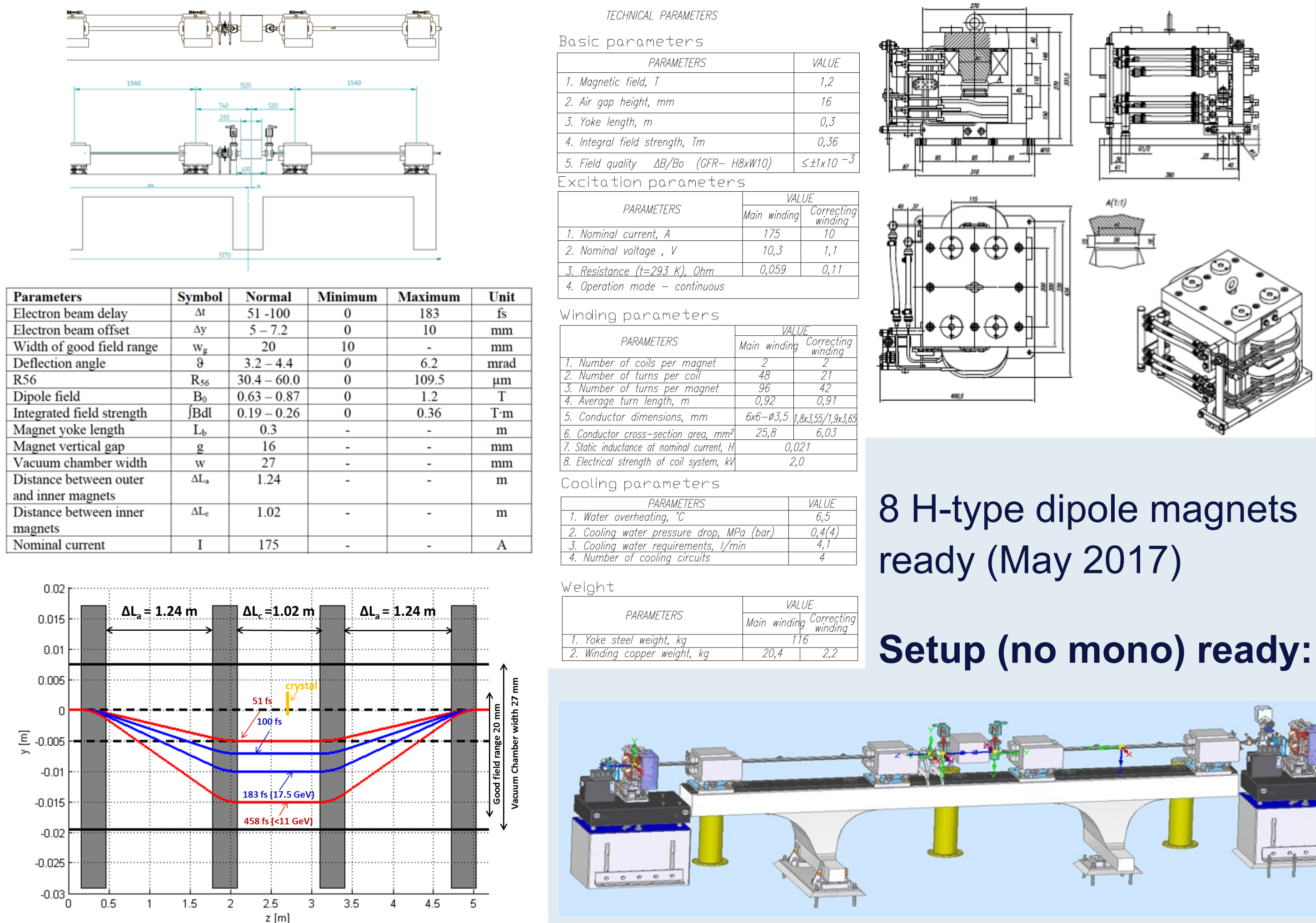


Heat-loading from the spontaneous signal: broad spectrum

- Total energy deposition for 8 segments, 100pC, 17.5GeV, 100μm crystal ~ 6μJ
- Effect of X-ray reflection energy shift was experimentally observed
- Pitch oscillator treated as an option to ease the spontaneous radiation heat-load (space foreseen/some development within mono design contract) → oscillate Bragg Angle to compensate temperature cycle during pulse train



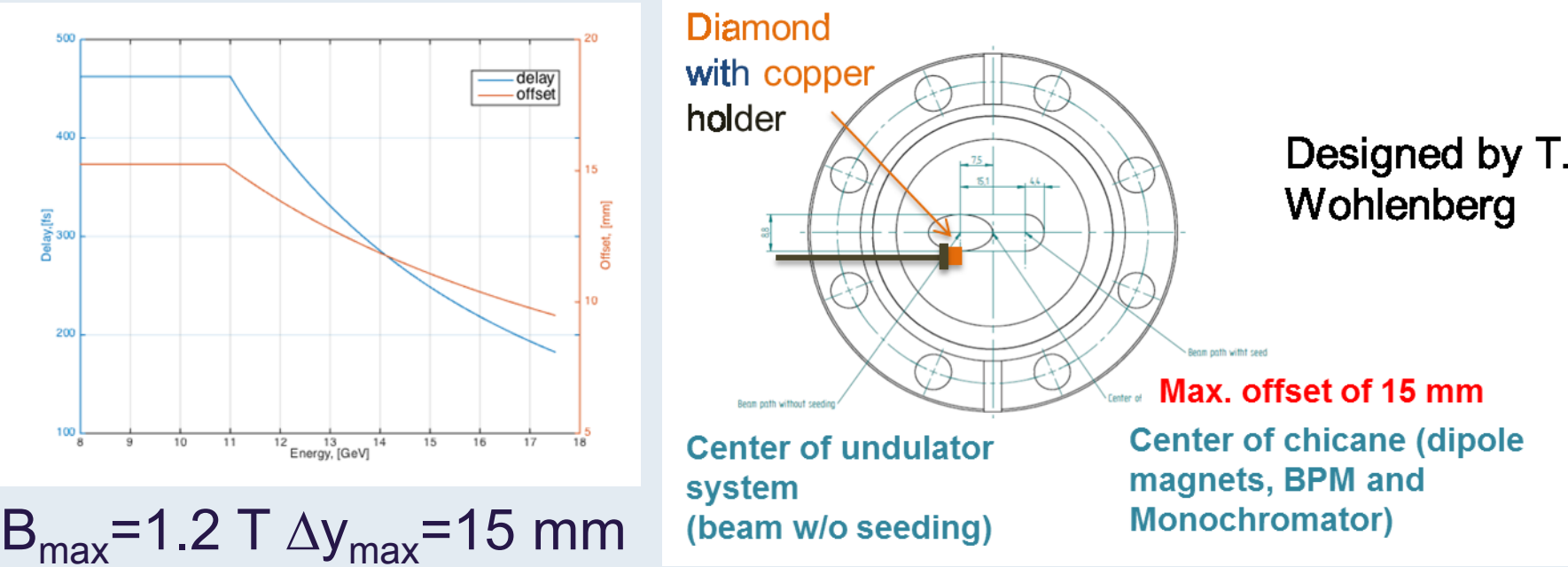
Chicane current status



Delay steps: 0.1 fs for autocorrelation → power supply requirements

$\langle P(t) \rangle = P_0 \exp [2L_w \text{Re}(\Lambda(t))]$	Power supply	Type	Max. Current	Resolution	Stability
$\langle P_2(t, \tau) \rangle = \langle P(t - \tau) \rangle \exp [2L_w \text{Re}(\Lambda(t))]$	Main coil	Bipolar	200 A	1/20 bit ($\sim 10^{-5}$ of max. current)	$10^{-6} - 10^{-5}$ (in hours)
$\langle P(t, \tau) \rangle = \langle P(t - \tau) \rangle \langle P(t) \rangle$	Trim coil	Bipolar	10 A	1/18 bit ($\sim 4 \times 10^{-6}$ of max. current)	$\sim 10^{-4}$ (in months)

Maximum delay: as large as possible for two-color applications



A shift of 7.5 mm is applied to chicane chamber center - > both the dipole magnets and the BPMs are shifted by 7.5 mm to insure a maximum offset of 15 mm

Minimum delay: depends on beam-halo; simulations indicate that 2mm might be reachable

Monochromator design

