

Generation of Sub-fs X-Ray Pulses at the European XFEL

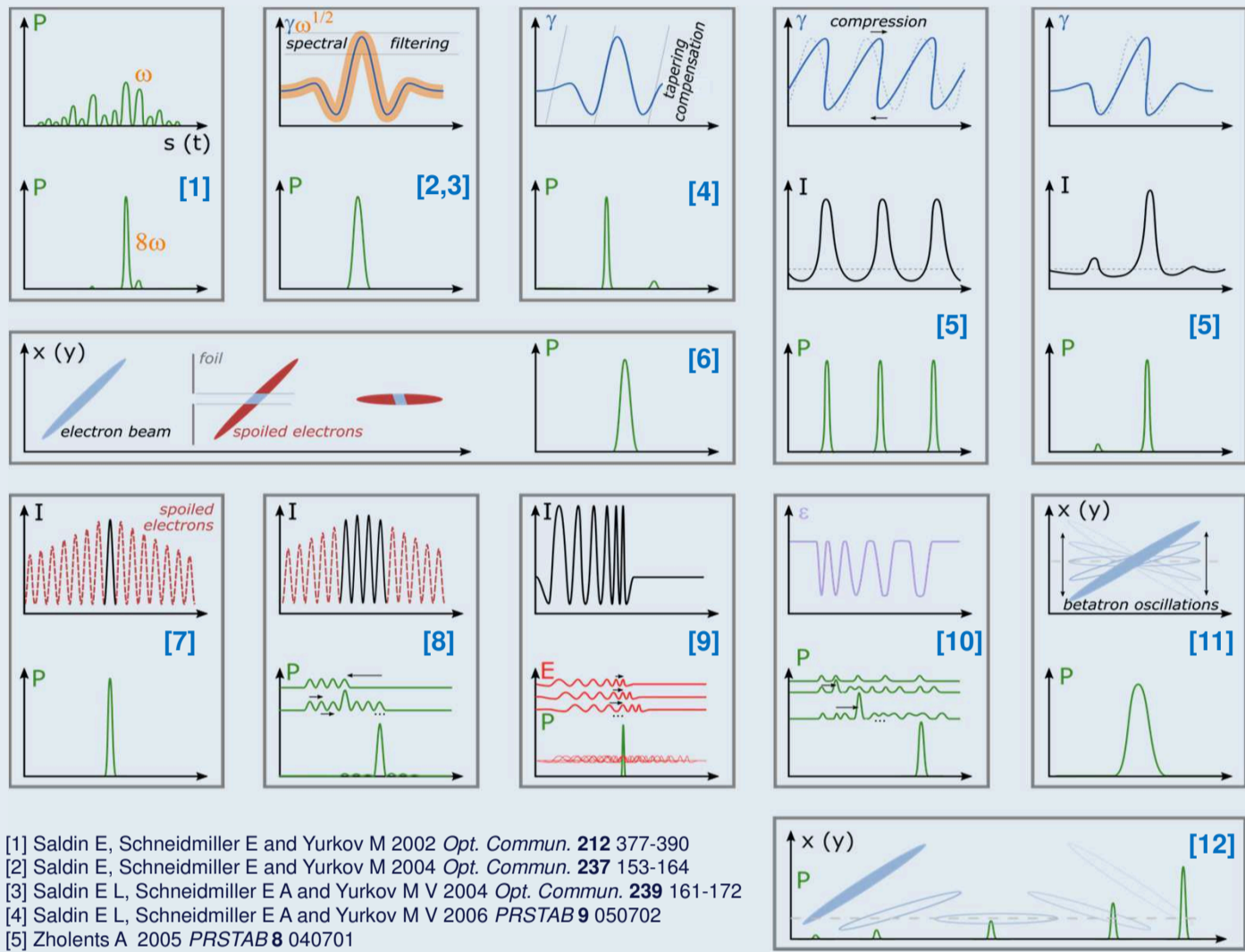


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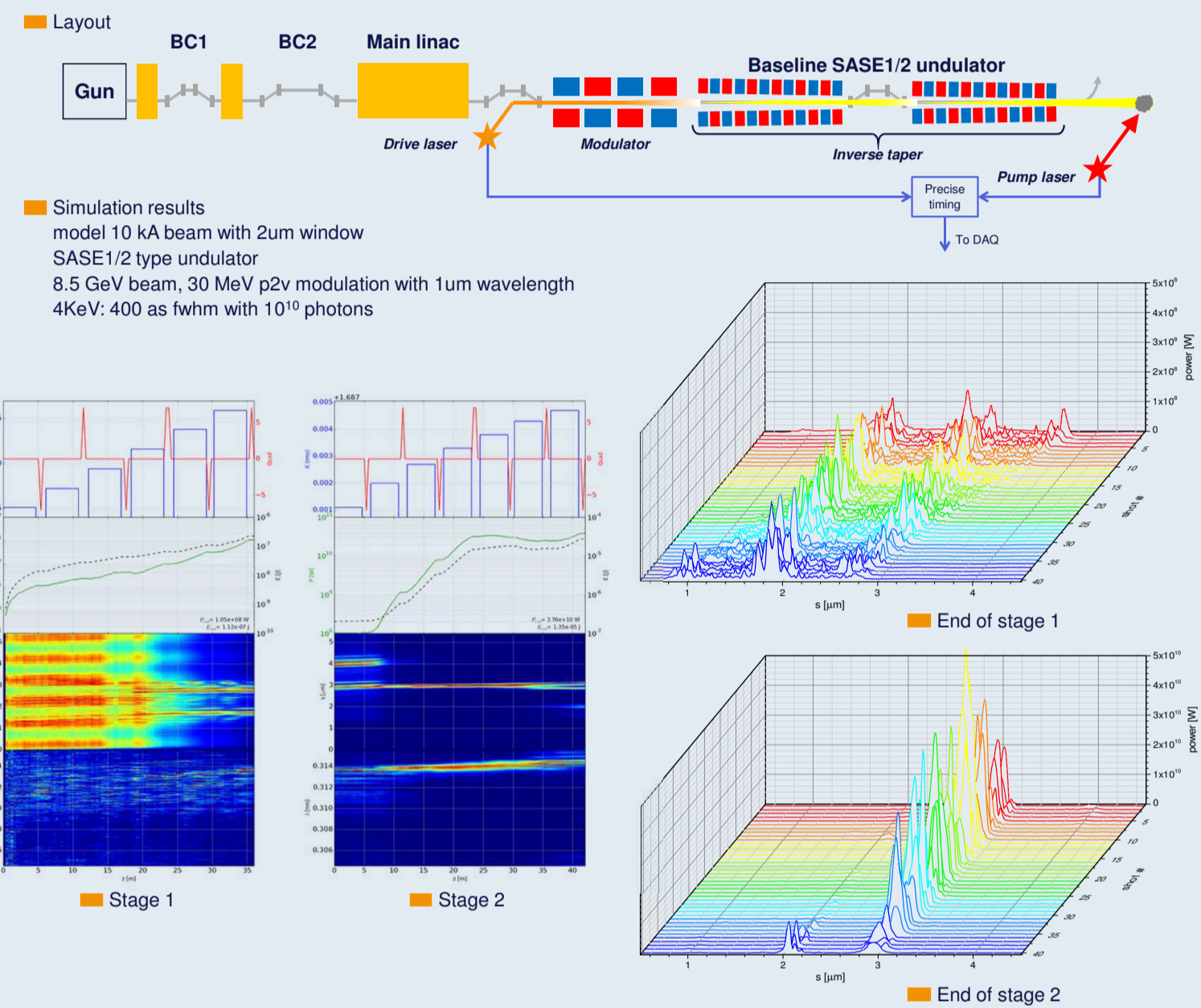
Attosecond FEL methods



- [1] Saldin E, Schneidmiller E and Yurkov M 2002 *Opt. Commun.* **212** 377-390
- [2] Saldin E, Schneidmiller E and Yurkov M 2004 *Opt. Commun.* **237** 153-164
- [3] Saldin E L, Schneidmiller E A and Yurkov M V 2004 *Opt. Commun.* **239** 161-172
- [4] Saldin E L, Schneidmiller E A and Yurkov M V 2006 *PRSTAB* **9** 050702
- [5] Zholents A 2005 *PRSTAB* **8** 040701
- [6] Emma P et al. 2004 *PRL* **92** 074801
- [7] MacArthur J P et al. 2017 *Proc. IPAC17* 19-21
- [8] Tanaka T 2013 *PRL* **110** 1-5
- [9] Tanaka T 2015 *PRL* **114** 044801

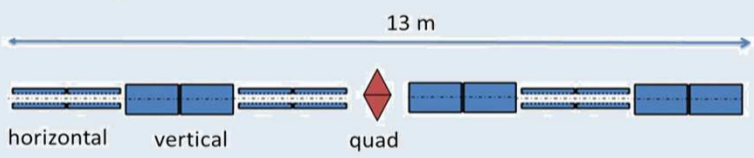
- [10] Prat E and Reiche S 2015 *PRL* **114** 244801
- [11] Prat E, Lohf F and Reiche S 2015 *PRSTAB* **18** 100701
- [12] Emma P and Huang Z 2004 *NIMA* **528** 458-462

[4]+[6]: Energy modulation + Inverse taper



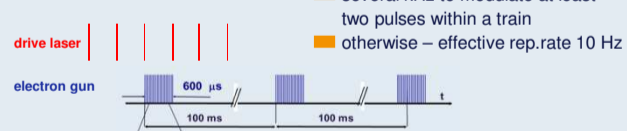
Ingredients

Corrugated structure

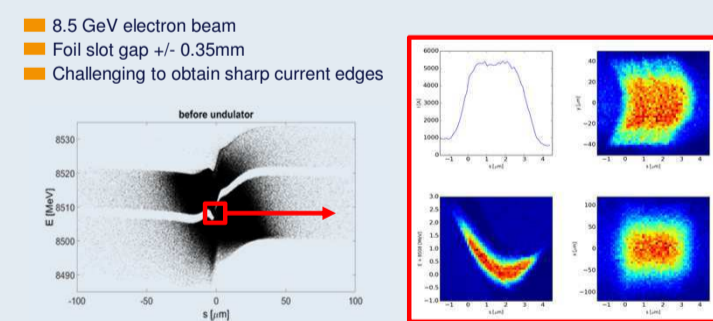


Depth, h	0.5 mm
Gap, r	0.25 mm
Period, p	0.5 mm
Half aperture, a	0.7 mm
Half width, w	0.6 mm

Drive laser

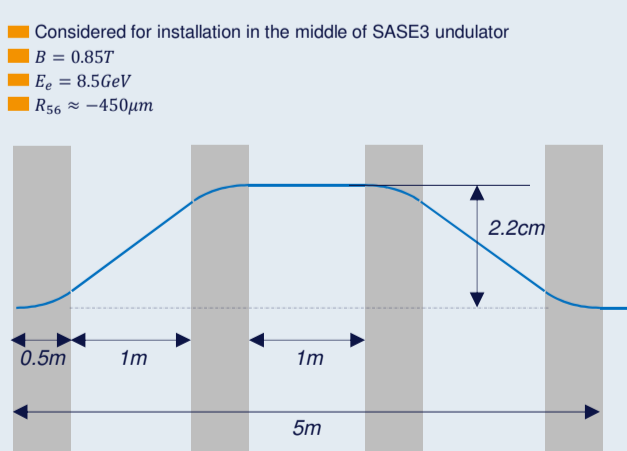


Emittance spoiler

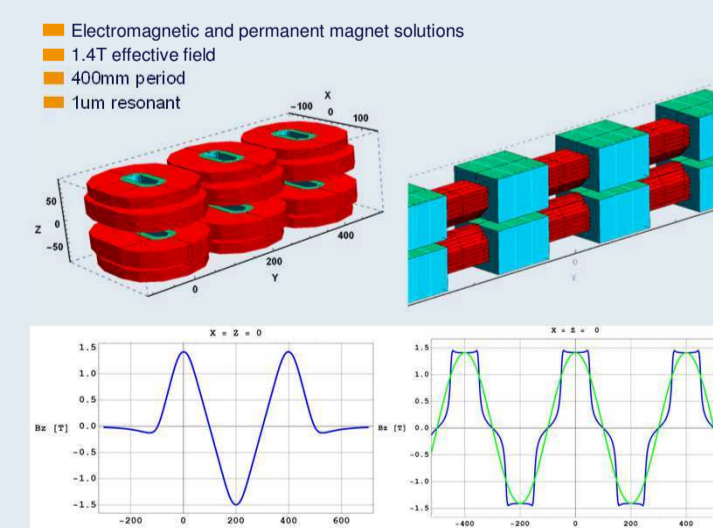


Titanium based regenerative amplifiers.					
wavelength	pulse duration	pulse energy	repetition rate	peak power	sync. possible
0.3um	100fs	10mJ	1-10kHz	10-50GW	yes
Ytterbium based diode-pumped regenerative amplifiers					
1.03um	200fs	10mJ	1kHz	50GW	yes
>2um amplifiers, e.g. Cr:ZnSe					
2.5um	185fs	1uJ	1kHz	5GW	TBD
Ho:YLF					
2.05um	3ps	30mJ	1kHz	>3GW	TBD
Parametric amplifiers					

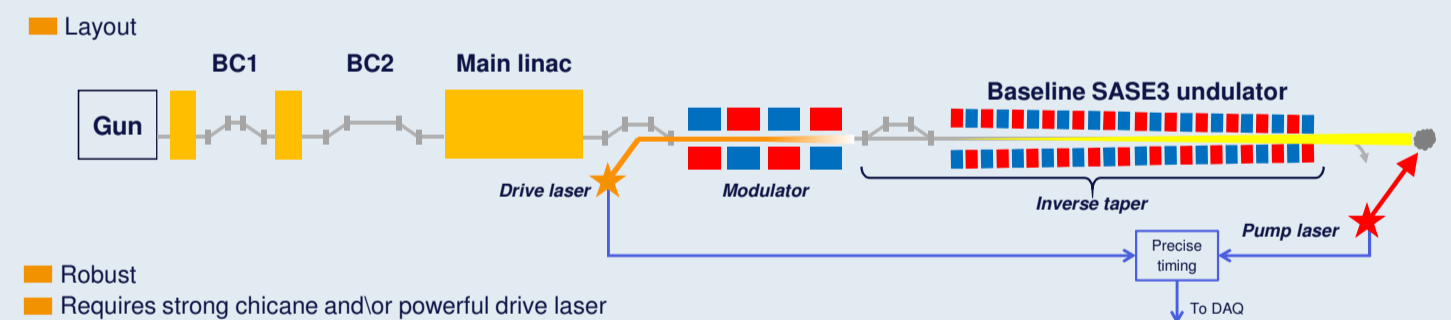
Chicane



Modulator



[7]: XLEAP



Photon energy (eV)	600	870	1000	1500	2300
Undulator cells	6	7	6/7	8	8
Duration (as, fwhm)	500	500	400/550	300	300
Peak power (GW)	600	500	100/650	800	400
Pulse energy (μJ)	350	300	45/350	250	100

Location

- SASE1: lots of space, needs chicane (upgradable to HXRSS)
- SASE2: 2 chicanes present, serious space limitations
- SASE3: chicane is foreseen, high scientific interest

