(Very) Recent Results and Comparison for the Laser Heater Setup

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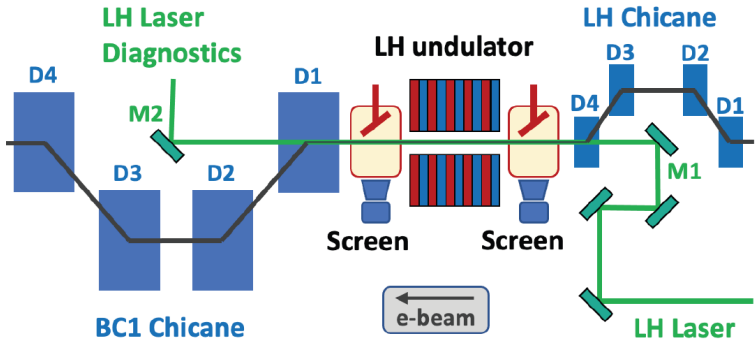
Overview

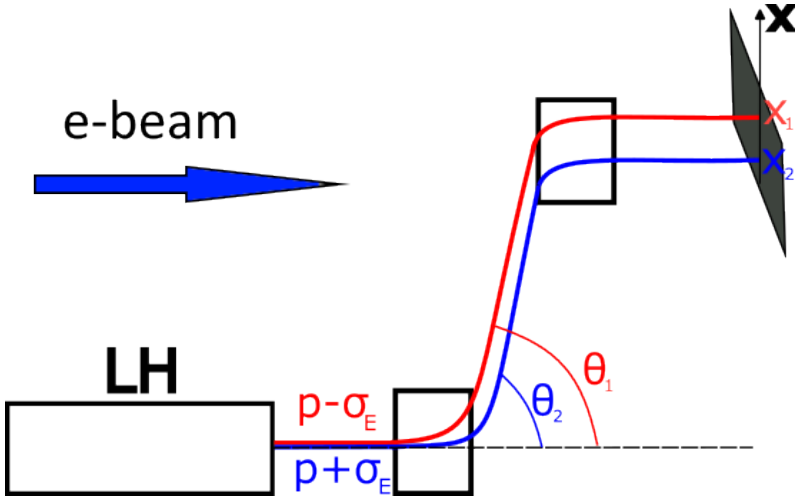
- Layout of the Laser Heater
- Idea for the energy spread measurement
- Simulation results
- First experimental results

Concept: Layout



Ref: C. Gerth et al., “Layout of the Laser Heater for FLASH2020+”, in Proc. 12th Int. Particle Accelerator Conf. (IPAC’21), Campinas, Brazil, May 2021, pp. 1647-1650.

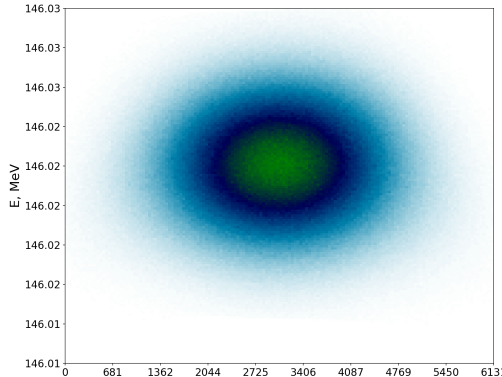
Energy spread measurement with BC1 OTR screen



Optimizing e-beam for the measurement

- normally we have chirp for bunch compression
- screen can't distinguish uncorrelated energy spread from correlated one
- reduce correlations (chirp, 2nd order, 3rd order)

- ACC1 accelerates on-crest with 157.95 MV
- ACC39 decelerates on-crest with 17.55 MV



Simulations: parameters

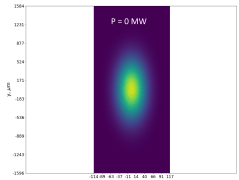
Gaussian bunch (4.7 ps rms, 0.4nC) is generated by ELEGANT, propagated through ACC1, ACC39, LH and the first half of BC1

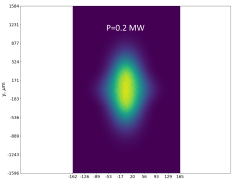
Central energy	Slice Energy Spread	Beam size rms
146 MeV	3 keV	316 μm

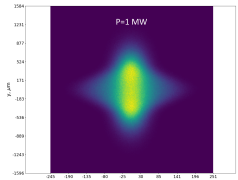
UND period	# of periods	B (K)
43 mm	11	0.356 T (1.43)

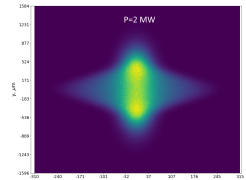
Laser wavelength	Max peak power	Waist size	Pulse length rms
532 nm	4 MW	316 μm	4.7 ps*

Simulations: changing LH laser power

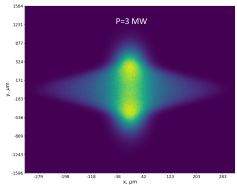


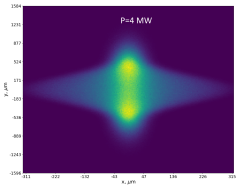




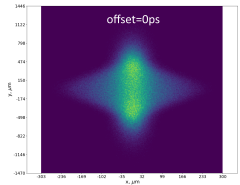


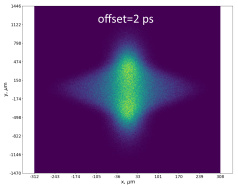
Power (MW)	σ_x (μm)	σ_E (keV)
0.0	29.4	3.0
0.2	34.7	9.2
1.0	50.5	19.6
2.0	65.1	27.6
3.0	77.0	33.7
4.0	87.3	38.9

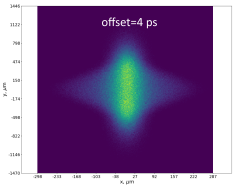


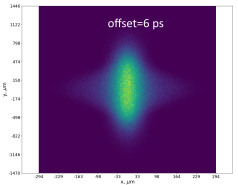


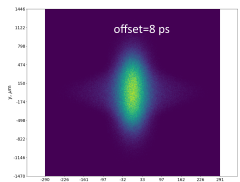
Simulations: changing longitudinal overlap

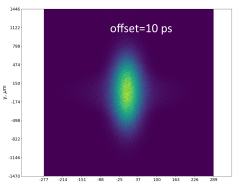


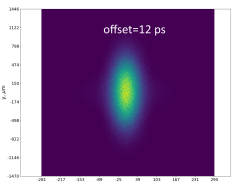


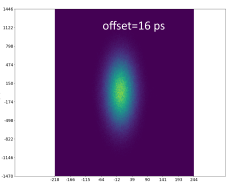




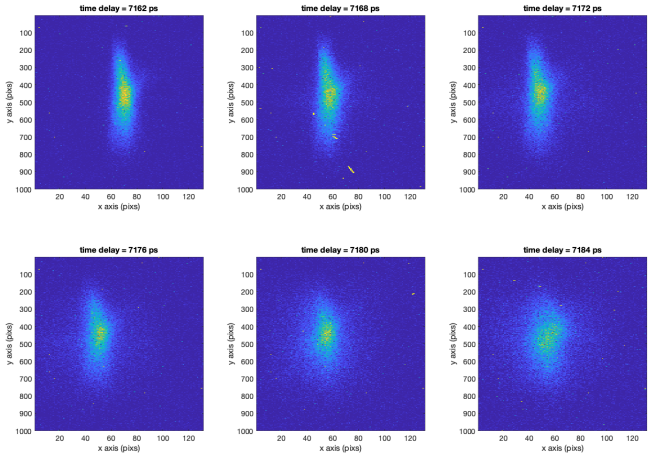




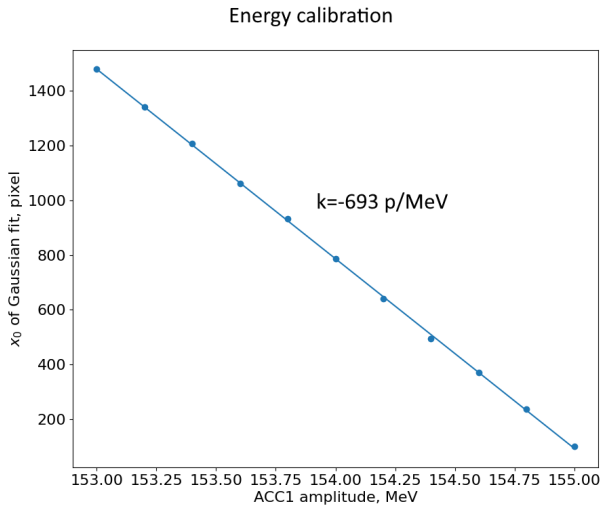




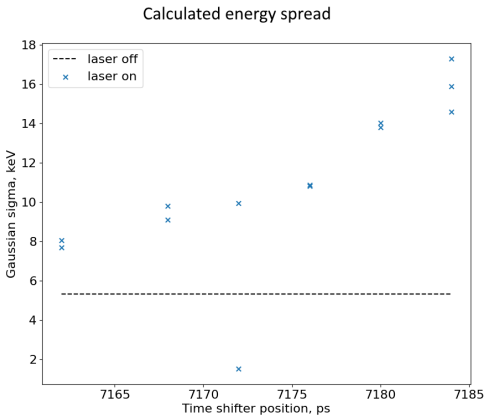
Experiment: observing heating



Experiment: energy calibration



Experiment: calculated energy spread



- ”laser off” should be the same as ”no overlap” and equal to $\approx$ 3 keV -> resolution limit and some remaining correlations
- maximum energy spread ≈ 16 keV -> $\sqrt{5}$ less than in simulations
- overall weak signal might effect the measured beam size -> can be underestimated

Summary

- we want to make sure that the LH heats the beam
- we discussed the measurement of LH-induced uncorrelated energy spread with BC1 OTR screen
- we used ELEGANT simulations to get an idea what to expect during the experiment
- we observed the heating during the first two short shifts
- we estimated the energy spread for the little data we managed to obtain and compared to simulations

Thank you!

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