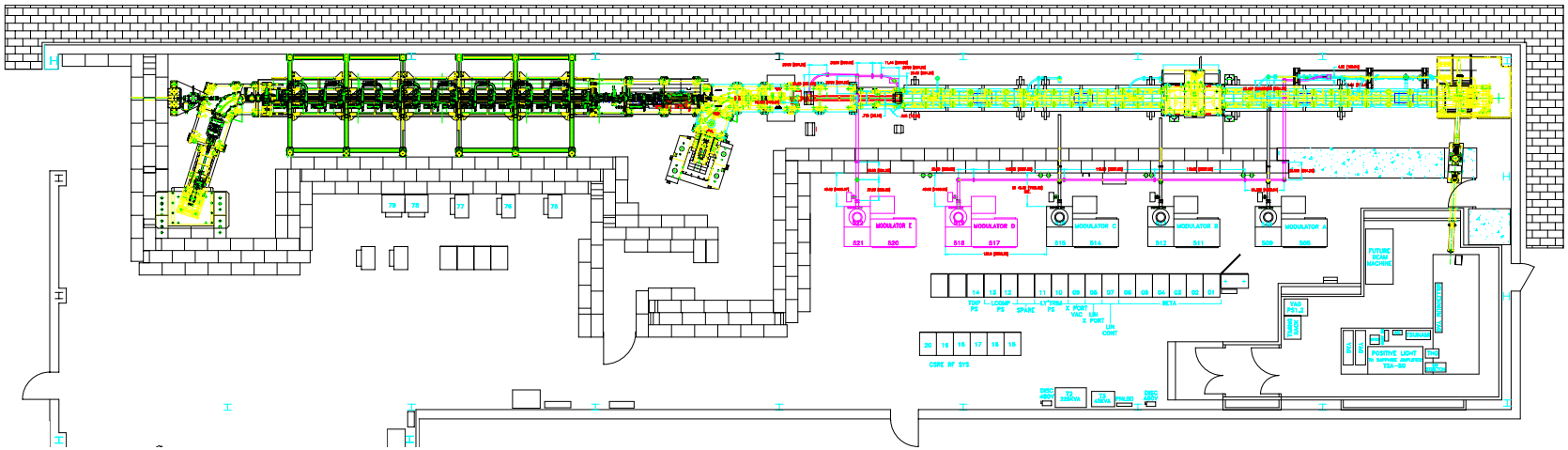
First Lasing of 193 nm SASE, 4th Harmonic HGHG & E-SASE FELs at the NSLS SDL



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BROOKHAVEN NATIONAL LABORATORY

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Outline

- Intro: Source Development Lab (SDL)
- Our First Lasing of FELs Below 200 nm @ NSLS SDL
  1. SASE @193 nm
  2. 4^{th} harmonic HGHG: 795 nm $\rightarrow$ 199 nm
  3. First E-SASE lasing
- Summary

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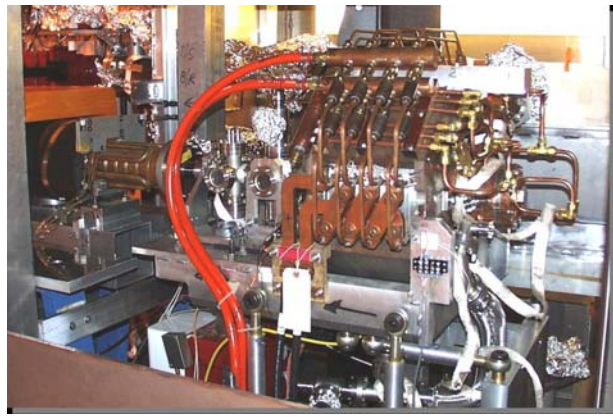
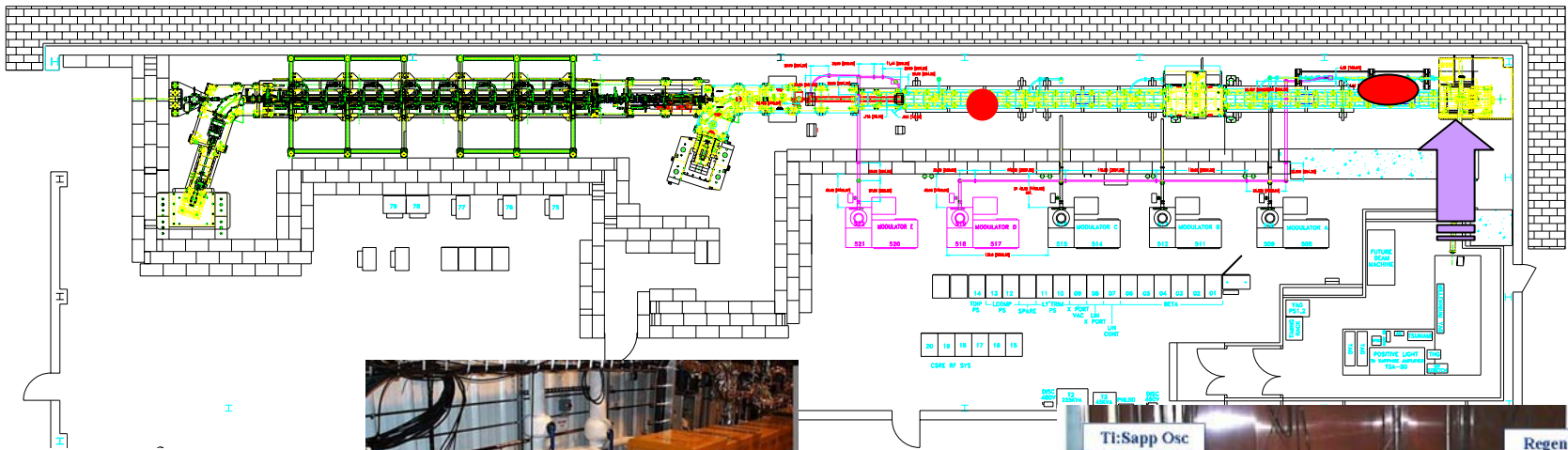
Layout of the SDL Facility

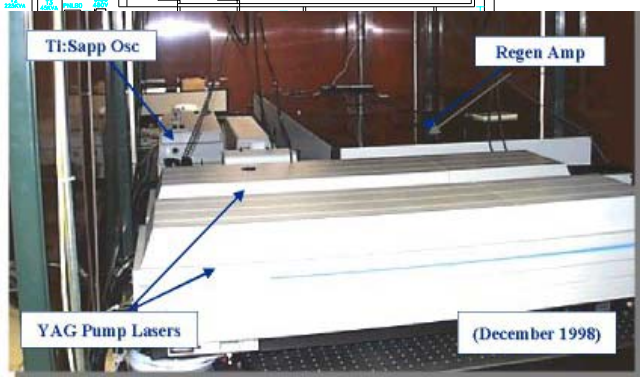
250 MeV Linac

BNL Photoinjector IV



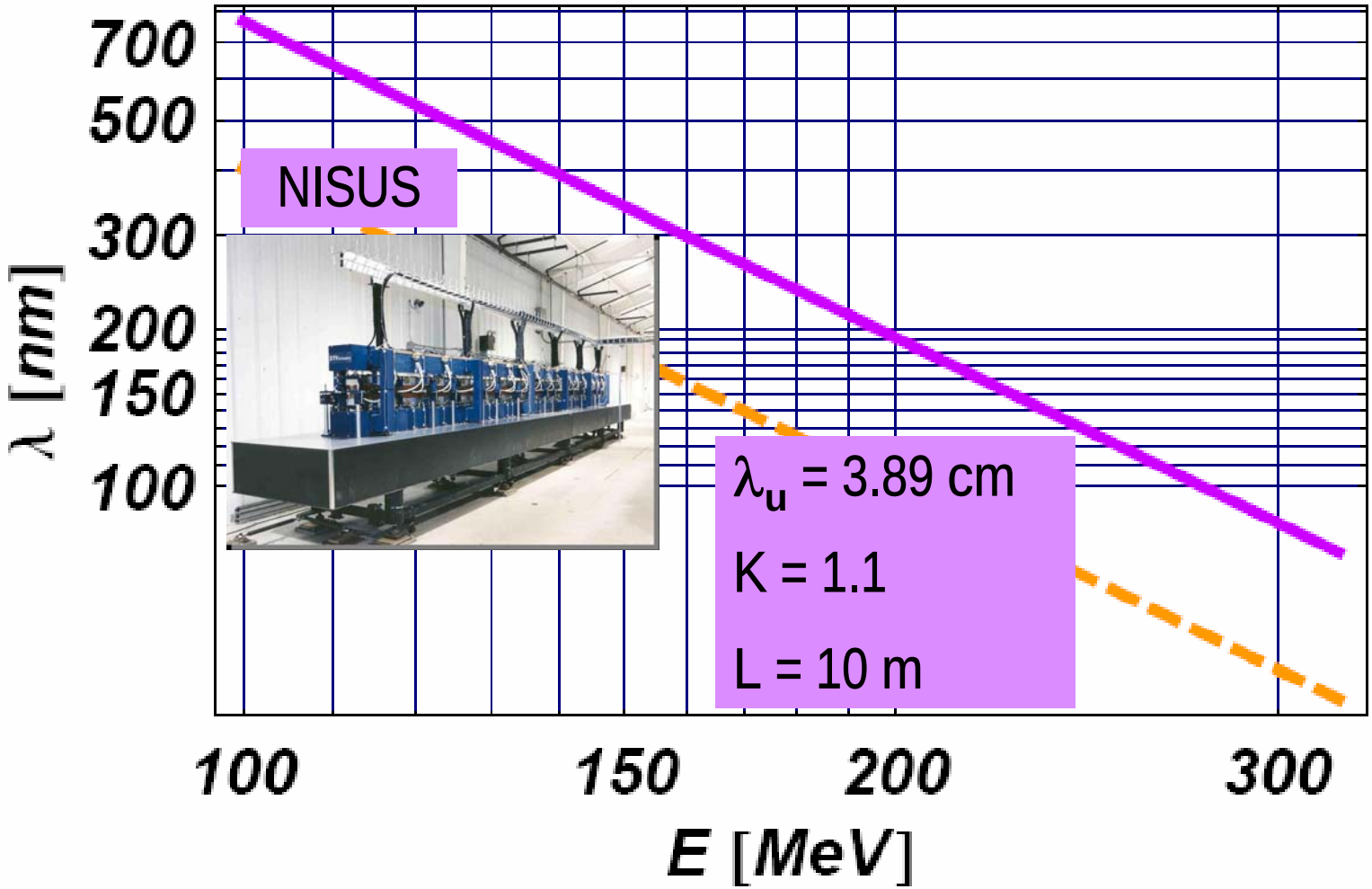


Chicane Bunch Compressor



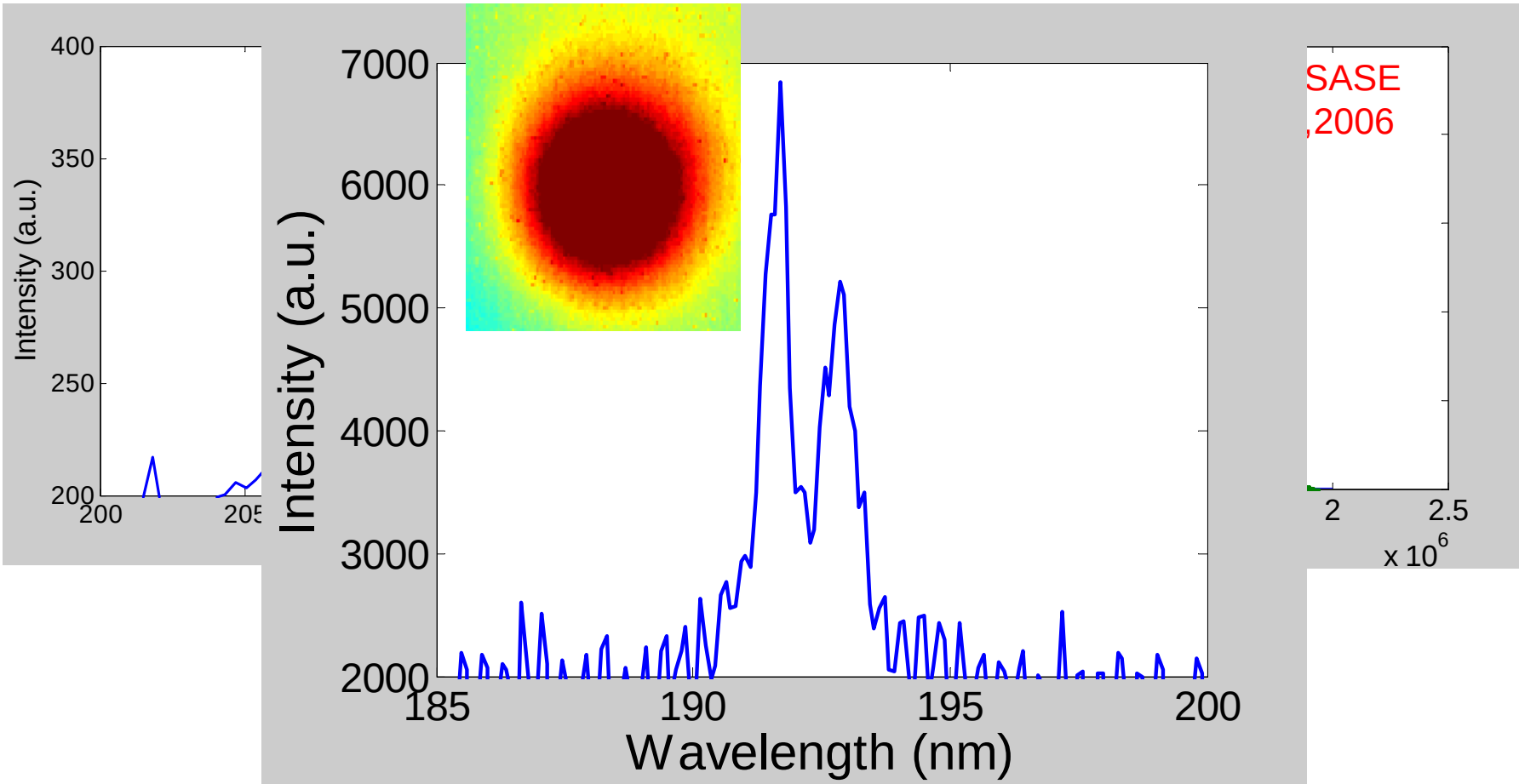
Titanium Sapphire Laser

SDL FEL Scaling with NISUS



Lasing of SASE @ NSLS SDL below 200 nm

Prior 4/20/06 SDL Shortest Fundamental λ was 266 nm

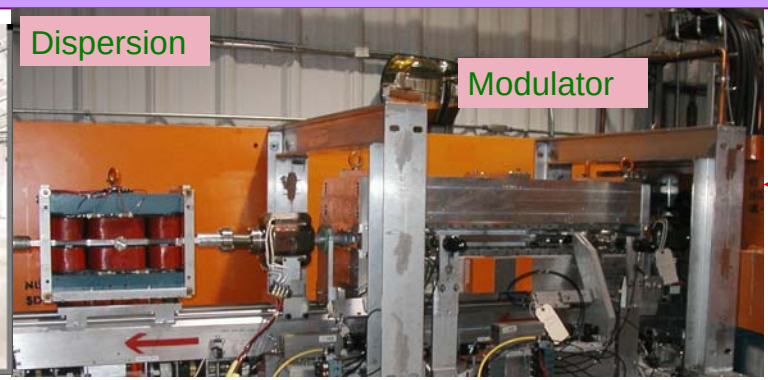


Beam energy 205 MeV

First Lasing of 4th Harmonic HGHG @ NSLS SDL

Seed laser 795 nm ⟹ 199 nm

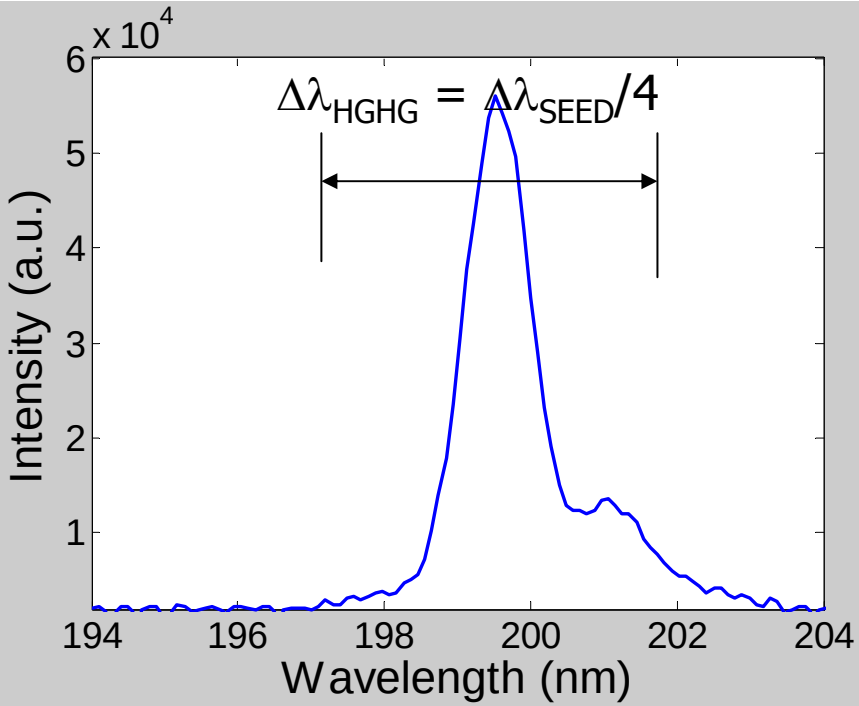
198 nm

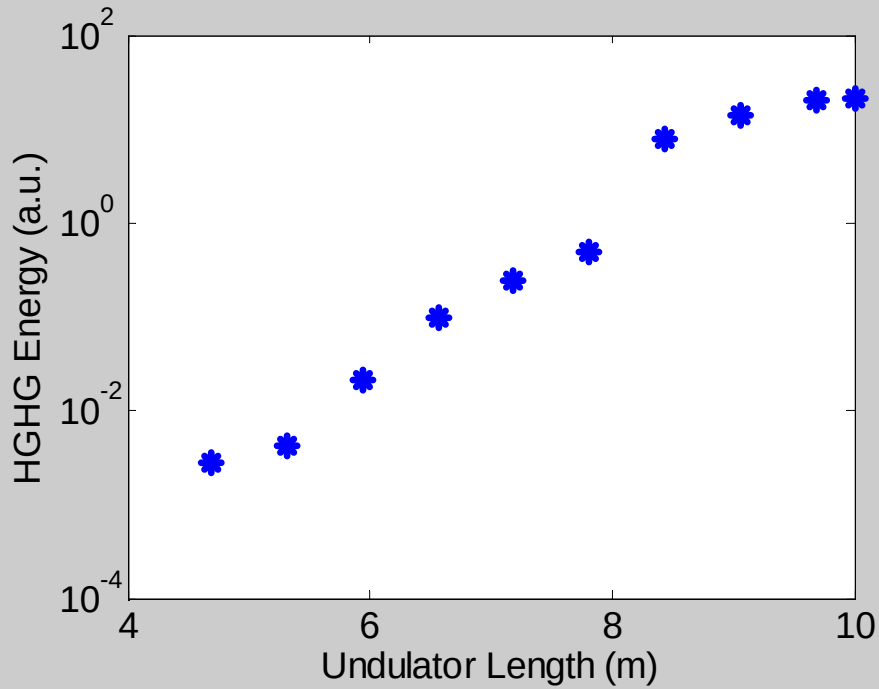


795 nm

Resonant at 795/4 =199 nm

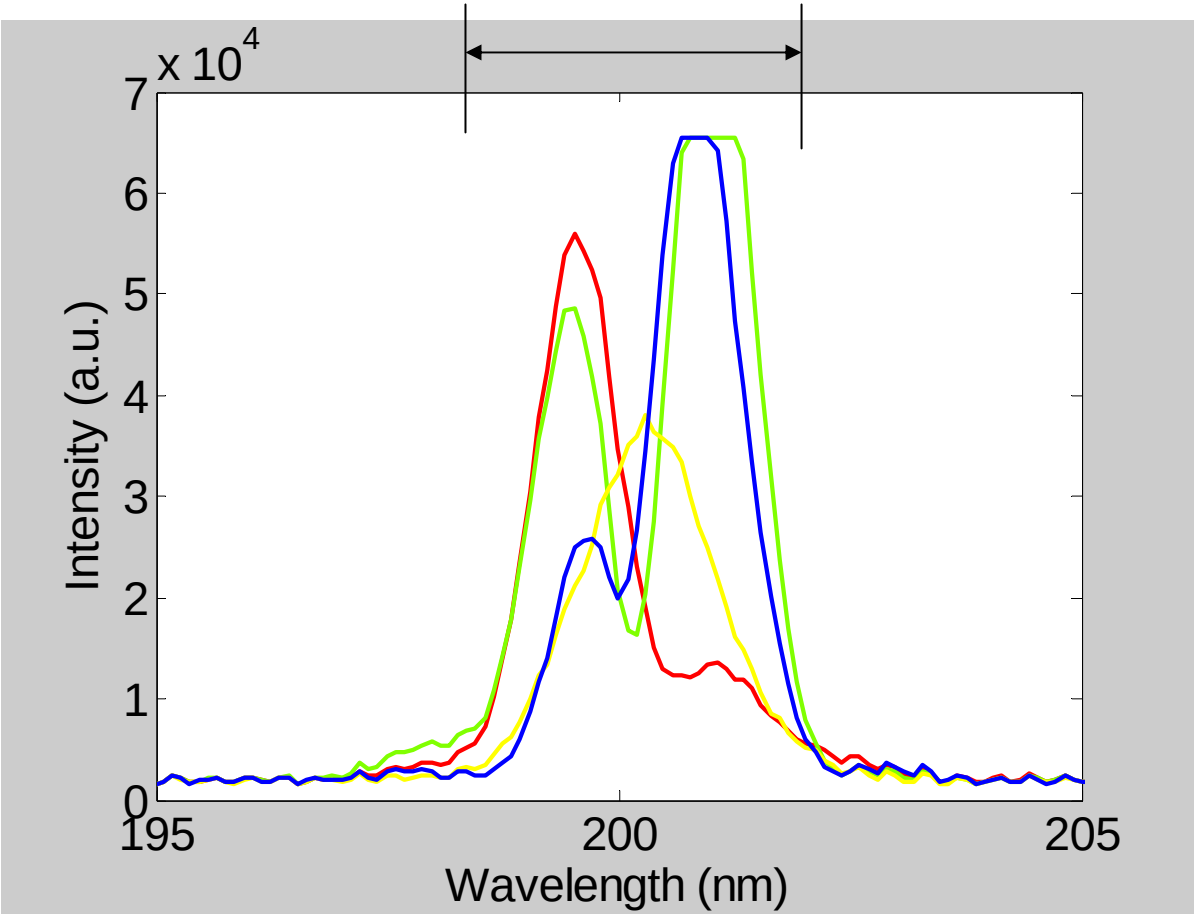
Resonant at 795 nm





HGHG Spectrum Fluctuations Due to E-Beam & Laser Fluctuations are within the Seed Laser Bandwidth

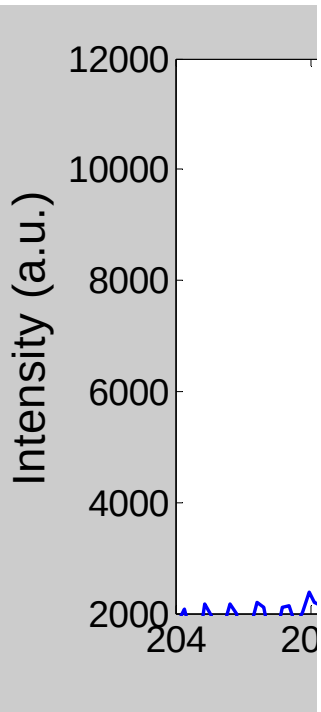
Maximum $\Delta\lambda_{HGHG} \leq \Delta\lambda_{SEED}/4$
FEL Amplification Reduces BW

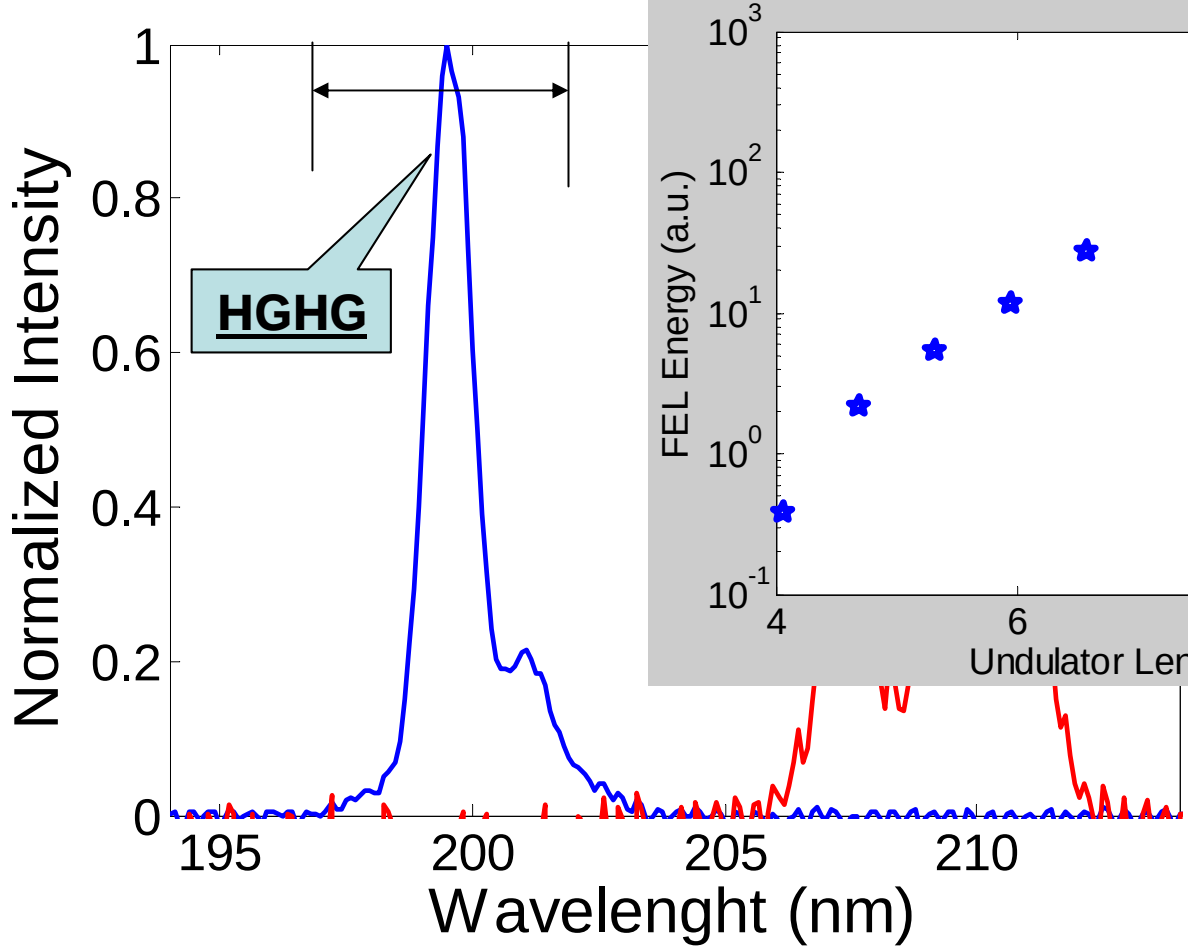


First E-SASE Lasing of a Seeded FEL @ 210 nm

HGHG
E_{res} = 202.5 MeV

E-SASE
E_{nonres} = 197 MeV

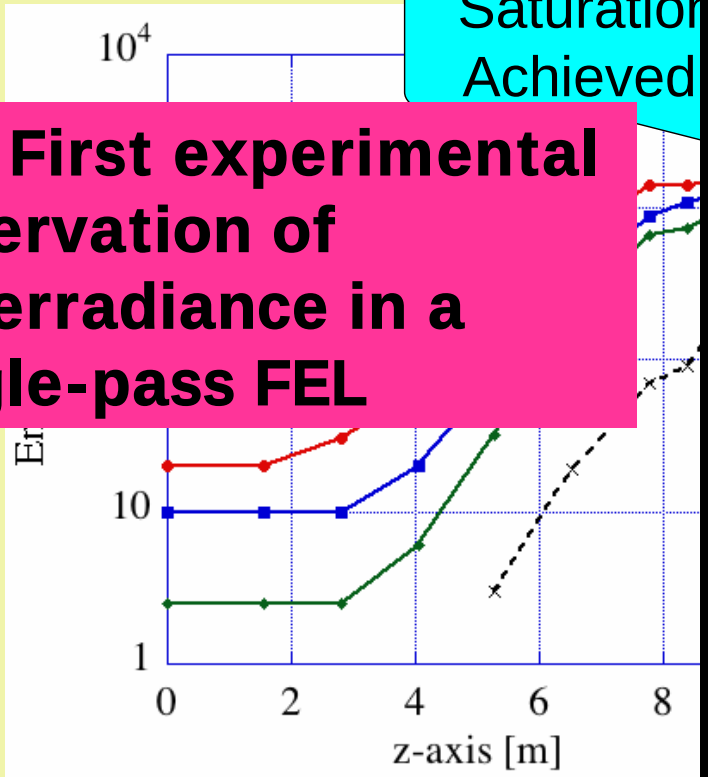




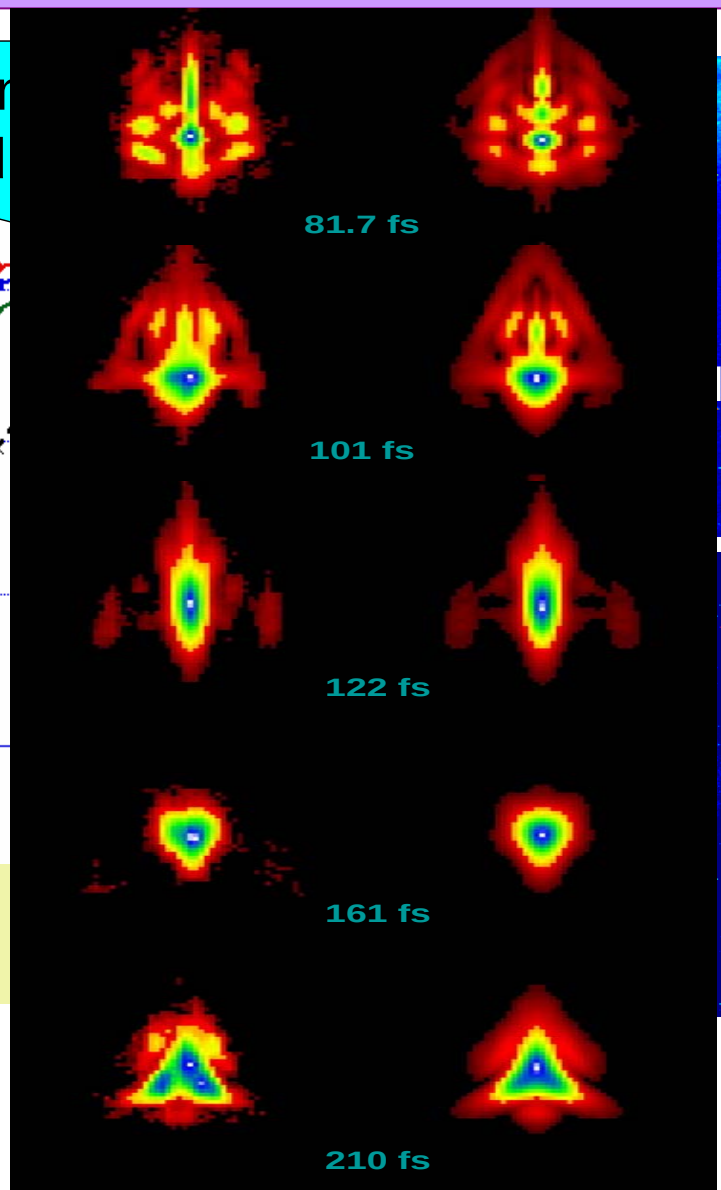
Laser seeded FEL Amplifier Experiments @ NSLS SDL

Saturation Achieved

The First experimental observation of superradiance in a single-pass FEL



Three orders of magnitude gain was observed.



Summary

We have successfully achieved our first lasing of:

- **SASE below 200 nm**
- **4th harmonic HGHG @199 nm**
- **E-SASE at 210 nm**

Our future program includes exploring:

- **Laser seeded FEL amplifier @ 1μm for ONR**
- **Kilo-Ampere & ultra-short e-beam generation**
- **5th harmonic HGHG (E = 226 MeV)**
- **HHG FEL**

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Other SDL Presentations

1. J.B. Murphy et al, MOPPH064," Longitudinal Coherence Preservation & Chirp Evolution in a High Gain Laser Seeded Free Electron Laser Amplifier", Monday afternoon.

2. T. Watanabe et al, MOPPH065, "Experimental Characterization of Efficiency Enhancement via Electron Energy Detuning in a Laser Seeded FEL Amplifier Experiment at the NSLS SDL ", Monday afternoon.