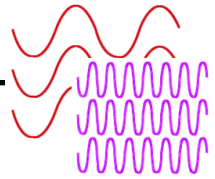
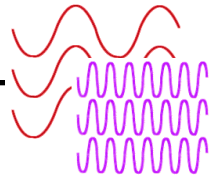


Highlights of the FEL 2002 Conference

Stephen Benson

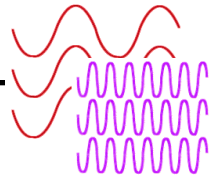
Thomas Jefferson National Accelerator Facility

General Observations



- Meeting held at Argonne so FEL and workshop focus was on SASE devices.
- Meeting severely hurt by U.S. intransigence on visas (Might not be held in U.S. again if situation does not improve).
- FEL Prize went to Lex Van der Meer and Alan Schwettman for enabling applications and thus showing what FELs can do.
- Most major projects are in transition.
- Not many new or exiting in applications
- Some interesting new ideas
- A few nice “easy” experiments

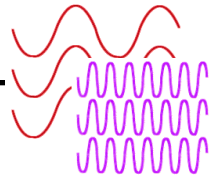
New Lasers



Each year we welcome new lasing groups to the community through the new lasing session. There were three talks this year but only one new laser:

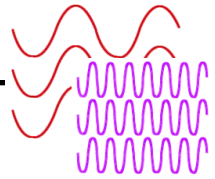
- SDL laser at Brookhaven (almost no wigglers are ever thrown out)
  - Uses Nisus wiggler from SDI work at Boeing
  - BNL gun, Q=300 pC, ε_n=4-5 mm-mrad, 200 MeV
  - Have seen gain at 400 nm and 266 nm
  - Measured gain length is 66 cm at both wavelength.
  - Seeded with tripled drive laser to get 10 μJ/pulse from 1 μJ
  - Plan on beginning user operations using HGHG this fall.
- JAERI lasing with energy recovery (discuss in high power lasers)
- Harmonic generation on the Duke FEL (discuss in SRFELs)

High Power Lasers



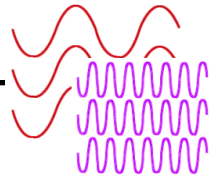
- George Neil had invited talk in Joint conference/workshop session discussing our 10 kW progress.
- Big news was lasing at JAERI with energy recovery
  - Achieved ~98% charge recovery but they don't have good way of measuring this to high precision.
  - Achieved 100 W during macropulse but system is not optimized.
  - Plan to upgrade injector with new klystrodes and modify gun to produce 40 mA beam (BBU threshold predicted to be 6 A). This produces 700 kW of electron beam power. This should allow them to get ~5kW of laser power extracted from the beam.
  - Still learning about energy recovery. Will not learn about problems with heating and small loss with pulsed operation.
- Los Alamos presented new design of the week. Now pushing amplifier instead of RAFEL.
- Most people anxiously awaiting us to produce 10 kW, expect us to do it.

SASE FELs



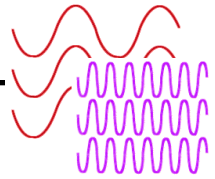
- Lots of new systems being planned or built:
  - Spring-8 - C-band room temperature accelerator using thermionic gun. Hope to have lasing at 60 nm in the 2004-2005 timeframe, 3.6 nm in 2006. Expect to get 2 μm emittance at 1 nC with thermionic gun.
  - SPARC project in Italy - 2.5 GeV S-band linac with LCLS like specifications and lasing down to 1.2 nm.
  - FERMI@ ELLETRA - In competition with SPARC, 1 GeV. Lase from 10 to 40 nm. Eventually upgrade to 3 GeV.
  - BESSY - Similar to SPARC. Still awaiting approval.
  - TTF2 - upgrade to 1 GeV and use for experiments in the soft X-ray
  - MIT Bates - Want high peak brightness soft X-ray machine.

Production of Bright Beams



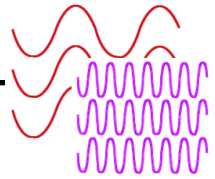
- Big news was production of 1.2 μm emittance at 1 nC bunch charge by Y. Yang at KEK in Japan [J. Appl. Phys. **92** (2002) 1608]. They used an approximation to a top-hat profile in the temporal regime.
- Xie Jie Wang has produced 10 fsec, kA beams at ATF using velocity bunching.
- Starting to get some measurements on thermal emittance of magnesium cathodes. They look borderline acceptable.
- Nice experiment at Brookhaven SDL where they modulated the temporal profile and looked at the enhancement in the CSR. Factor of 3 growth in energy spread.
- Gain of modulation due to CSR now focus of emittance preservation. LCLS proposes using Landau damping wiggler to reduce CSR gain.
- SRF gun "works". Still need to produce high charge.
- Los Alamos and AES presented room temperature high duty factor gun design.

Storage Ring FELs



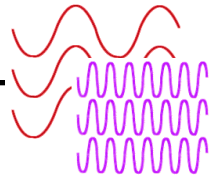
- Still stuck at 190 nm. Trying to get lower .
  - Duke has used harmonic generation 79-93 nm light with 7 μW average and 4 MW peak powers. Average brightness comparable to TTF SASE. Need $G/G_{th}>10$ to get giant pulses and produce harmonics.
  - NIJI-IV has increased gain to 8.5% at 200 nm using new vacuum chamber. Will try to go lower in wavelength. Need at least 20% gain at 160 nm.
- ELLETRA has lased at high energy, which allows FEL users to coexist with SR users. This is critical to get more beam time. It also enhances the power. Got 520 mW output at 1.3 GeV at 250 nm. Got 120 mW at 208 nm at 1.5 GeV.

FEL Technologies



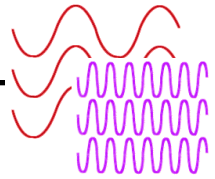
- Michelle did a good job of presenting our high power cavity design.
- David Garzella presented state of mirrors for FELs. Still have big problems in the DUV. Can get up to 70% reflectivity at 13 nm but don't know for how long.
- Steve Gottschalk presented some nice designs for permanent magnet beamline magnets. They have shown good repeatability in a prototype quadrupole. They can move the quadrupole centroid but add a sextapole component 1% of quadrupole for 1% of aperture change in the position.
- George started quite a firestorm by asking why LCLS prototype was not made by industry. Present design works but uses $7k/m of titanium for the yoke.
- Spring-8 has 27-m *in vacuo* undulator commissioned.

New Ideas



- Neatest new idea:
  - Litvinenko proposed using low current/low energy electron beam to replace optical cavity. Needs extremely isochronous transport.
- L. Giannessi proposes using optical klystrons instead of undulator in HGHG scheme. The OK picks out one narrow peak and produces bunching without much energy spread. The subsequent amplifier then has much higher gain. Can use this to cascade from conventional laser to soft X-ray.
- In a variation on Giannessi's scheme, MAXLab wants to have multiple optical klystrons feeding each other in a "fresh bunch" scheme. All beams of a racetrack microtron go through all the optical klystrons. They acknowledge that matching will be a problem.

Applications



- Groups are taking advantage of SASE devices immediately. Experiments have been carried out on TTF and are planned on LEUTL and SDL.
- FEL-SUT has carried out some isotope separation measurements on Silicon. This may be a good application for a high power FEL. They have found a process using SiF_4 instead of $Si_2F_{6.}$ Will have to prove that it can't be done using a CO_2 laser.
- Bob Austin gave a great talk on two-color experiments in protein dynamics. He is very exited about the possibility of a cavity dumper on our FEL.