What is special about ATF

- Electron beam parameters
- Nd:Yag, Yb:glass and terawatt CO2 lasers parameters
- Sharing of the expertise between experiments
- Great place for students to learn and work

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Electron beam core capabilities

- Electron beam energy 20 to 76 MeV
- Electron beam charge continuously variable.
  - Single micropulse charge from 5pC to a few nanoculombs.
  - Bunch train charge up to about 50 nC.
- Electron beam emittance (rms, normalized) depends on various factors, e.g. peak current, beam charge/length etc. We have measured:
  - 2.6 mm micron with a FWHM bunch length of 10 ps and 1nC charge
  - 0.8 mm micron with a FWHM bunch length of 5 ps and 0.5nC charge.
- Short term stability (rms):
  - Timing: 0.5 ps (laser / RF phases)
  - Position: 1% of beam diameter pointing
  - charge 1%-2%.
  - Relative Energy 10^{-3}
- Temporal structure:
  - Repetition rate 1.5 PPS to 6 PPS
  - Macro pulse length up to 3 microseconds.
  - Micropulse repetition period 12.25 ns or 24.5 ns.
  - Beam length variable from about 0.5 ps FWHM to 10 ps FWHM. (chicane compressor increases the possibilities)
  - IFEL produced micro bunching with 10.6 micron period

Nd:YAG Laser System

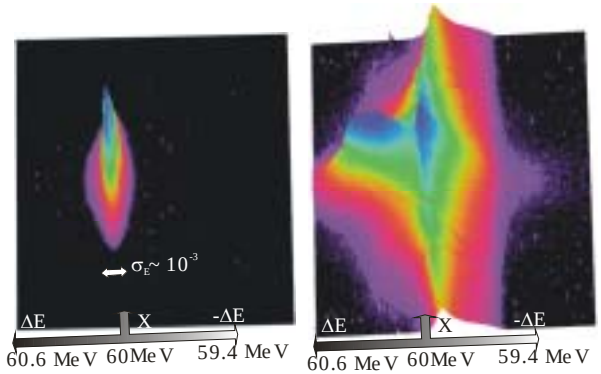
- An actively mode-locked CW Nd:YAG oscillator generates a train of 1 nJ, 12 ns spaced pulses of linearly-polarized radiation synchronized with the linac RF field.
- A Pockels cell switch, in combination with a polarizer, cuts out single 15 ps FWHM pulses at a ATF repetition rate.
- After a 4-pass preamplifier and a double-pass amplifier, pulses acquire 30 mJ of energy.
- Part of this energy is directed through second and, then, fourth harmonic crystals to a photocathode generating ~10 ps electron bunches.

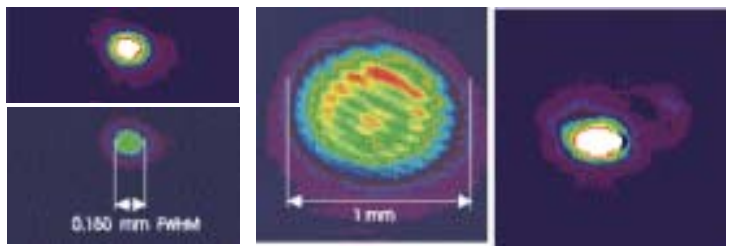
Picoseconds terawatt CO_2 Laser

- ~10-30 ps long with up to 20 J energy of the pulse at 10.6 μm with ~1 pulse per minute
- Pulse from Nd:Yag laser used to synchronize laser pulse with electron beam
- Up to 0.1 J the CO_2 energy available from preamplifier at mach higher rep. rate.

Different types of experiments…

- Novel acceleration:
  - Inverse Free Electron Laser Acceleration
  - Inverse Cherenkov Acceleration
  - Staged Mono-energetic laser acceleration
  - CO2 laser channeling in plasma
  - In plasma Wakefield
  - Dielectric Wakefield
  - …
- Sources:
  - Photo injectors…
  - High-Gain Harmonic Generation
  - Visible SASE
  - Thomson scattering
  - …
- Diagnostics...



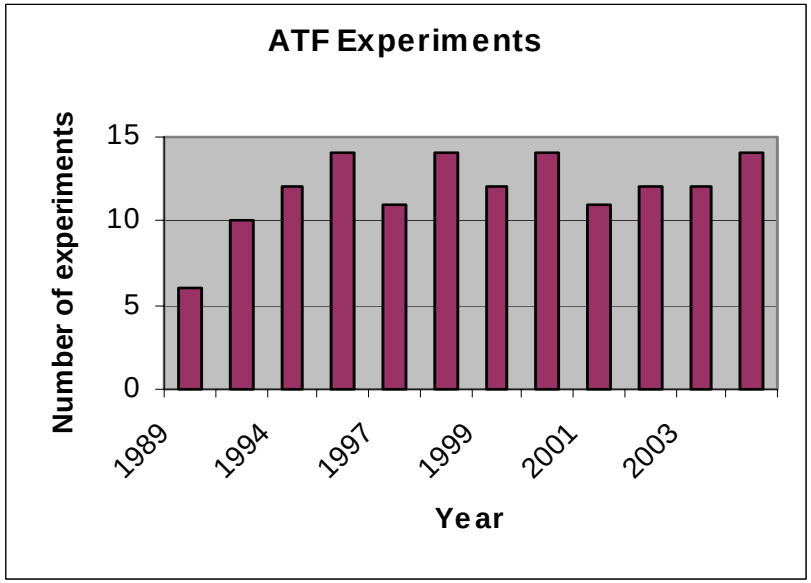


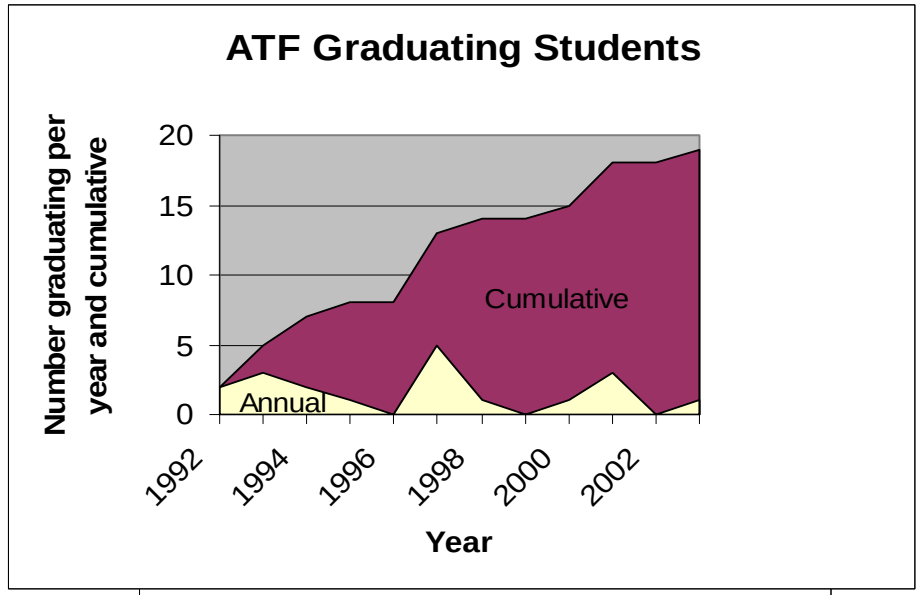
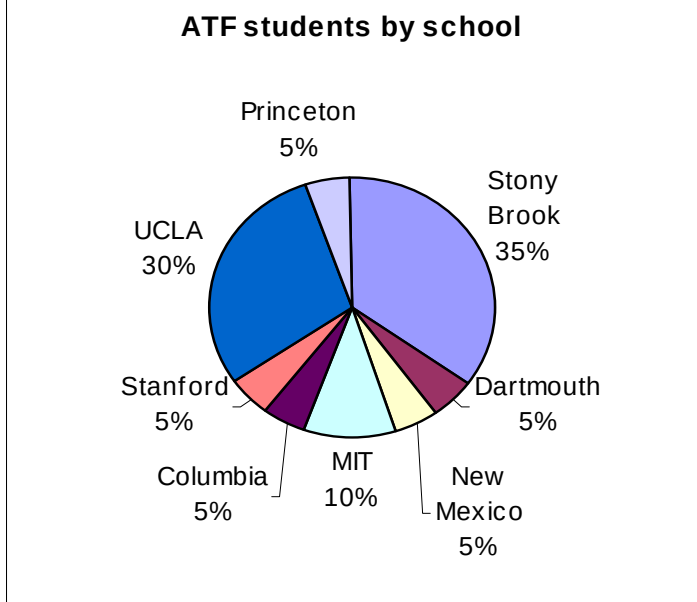
Effective sharing of expertise between experimental groups

Inverse Free Electron Laser (IFEL) is a good example.

- IFEL acceleration was first demonstrated at ATF *(Phys. Rev. Let. 77, 1996)* after it was suggested in*1972.*
- It was used to produce ~1 micron long micro bunches with 10 micron period *(Phys. Rev. Let. 80,1998)*
- IFEL was perfected in the staged acceleration experiments: STELLA *(Phys. Rev. Let. 86 2001)* and STELLA II *(Phys. Rev. Let. 92 2004).*
- It was utilized as a key element in the High Gain Harmonic Generation *(Science 289, 2000 , Phys. Rev. Let. 86 2001)* experiment, supported by BES.
- Currently, IFEL is a crucial principal part in
  - Multi bunch Plasma Wakefield experiment AE31 with micro bunched beam
  - Optical Stochastic Cooling project *(PRST/AB 2004)* at the ATF, with the main goal of improving the performance of the NP machine.

ATF Statistics





Run time: ~ 1000 hour / year
Graduated students: 19
Current number of experiments: 14
Staff members: 11, 1 visitor
Phys Rev X: ~ 3 / year since 1995