Laser Safety in the Upgrade and New Short Pulse Lasers

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Old Laser Safety System Capabilities

- All User Labs had the same LSS design. Entry door indicated state:
  - **Open access** – No lights on. Anyone can enter the lab.
  - **Hutch Mode** – Green light on. Laser beam confined to a class I hutch. Only approved users allowed in the Lab using a smart card.
  - **Alignment Mode** – Yellow light on. Limited duty cycle beam available. Approved users allowed in the lab but must wear eye protection. Default mode when not in BEAM PERMIT.
  - **Exclusionary Mode** – Red light on. Full power beam available in the lab with no hutch. No access permitted.
- User Labs 3 and 6 had hutches. If you would like to do an experiment in a hutch, we can show you how it's done. Change from exclusionary mode to hutch mode made for entire runs only.
- Note that the sweep procedure is identical for all modes. It assumes that you are starting into exclusionary mode.

New LSS Features

- **New alignment mode** – Alignment mode is now 4.678 MHz for 250 µsec. at 2 Hz. Energy per macropulse is similar to before. No 10 msec. 60 Hz mode.
- **Weak visible beam –** When fully operational the FEL can produce a great deal of light as tunable visible harmonics. We cannot easily restrict accessible wavelengths. There will therefore be a dichroic filter inserted during alignment mode to attenuate the visible harmonics.
- **Goggles –** Goggle selection can be more of a problem. This will get worse when we have UV present. We will indicate, using a sign on the door, which goggles are appropriate at any given time. *Be careful*.
- **Training –** Due to long down, I assume that you have forgotten how the laser safety system works. We will retrain users as they start using the machine. Training will be good for two years. Until your training is up-to-date, your access cards will not work.
- **New Smart Cards –** Can now get dual use smart cards.

Proposed LSS Features

- **Chopper duty cycle control** – The electro-optic cells would be enhanced with a chopper that completely eliminates the electron beam current between macropulses. This means that alignment mode failure would present less of a hazard.
- **Limited Duty Cycle Mode** – In this mode, the accelerator would be limited to a duty cycle of 0.1% or less. The power during this time would not be limited. Could have macropulse energy as high as 1 J/pulse. No alignment would be permitted in this mode.
- **Smart goggles** – Goggles would have a smart chip on them so you could not get into the lab without the correct goggles.

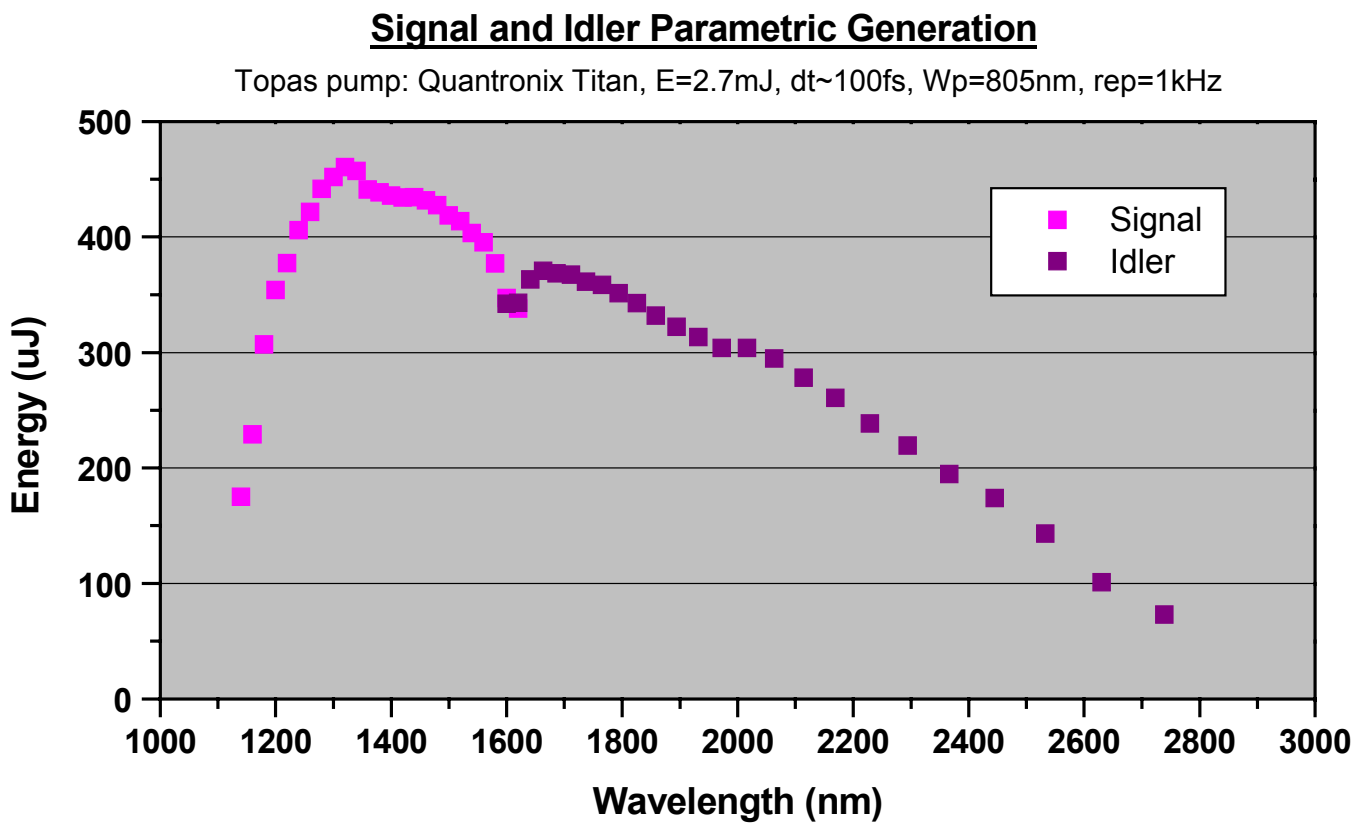
Conventional Lasers

- Conventional lasers available in alignment mode when the FEL vault is *not* in BEAM PERMIT.
- When the FEL vault *is* in BEAM PERMIT, the state of the lab follows the FEL mode unless the lab is in hutch mode. Conventional laser operations is not permitted in hutch mode.
- 10 W cw CO_2 laser. (User Lab 2)
- 150 W cw Nd:YAG laser (User Lab 2)
- Spectra Physics Tsunami
  - Synchronized to FEL to better than 0.5 psec.
  - 1.4 W at 800 nm
  - Tunable from 700–1000
  - Micropulse width 80 fsec
- Coherent Mira / Quantronix Titan (Cavity dumper laser)
  - Regenerative amplifier operated a 1 kHz
  - Tunable from 700-950 nm
  - Pulse length 100 fsec
  - Average power 2.5 W

Conventional Lasers (cont.)

- Coherent Mira/Quantronix Titan/Quantronix Topas
  - System owner is Gunter Luepke at William and Mary. For more information see him.
  - Regenerative amplifier with OPA and frequency conversion
  - 1 kHz repetition rate
  - Titan
    - 1 psec pulse width
    - 3 W at 800 nm
  - Topas
    - Tunable from deep UV to over 10 microns using OPA and frequency difference, doubling, quadrupling, and frequency summing.

Topas Tuning Curve



Conclusion

- The upgraded user facility will have more capabilities and much more flexibility. With this added flexibility comes added hazards. We have tried to change the laser systems to alleviate these new hazards while allowing users to take advantage of the new capabilities.
- New class IV lasers are also available They are available when the FEL is not. See system owners to explore the possibility of using them.