

OPERATING GUIDELINES FOR AØPI LASER

-J. Santucci, M. Fitch et. al. September 24, 2004

Abstract:

The laser of the AØ Photoinjector is a Class IV laser system based on a Nd:YLF oscillator and a chain of Nd:glass amplifiers. This paper is intended to be filed with the laser safety officer (LSO) as documentation of the laser operating procedures, including turn-on and shut-down. The hardware interlocks, entry and exit procedures are discussed elsewhere, and are not described in detail here. Also, many details about optimization of the laser performance by the laser operators are discussed in the document "*Tuning Guidelines for AØPI Laser*". The laser is located in room A0C-102 with interlocked doors. The doors are always locked from the outside and always unlocked from the inside. Keys (PAD 657) are controlled by the Beams Division ES&H group and issued only to qualified laser operators; there is also one key that can be issued by the Main Control Room, and one key behind glass in the "Laser Room Fire Key" box.

Laser Description:

There is a Nd:YLF oscillator seeding a chain of Nd:glass amplifiers. Once all the amplifiers are in place, the output will be a pulse train of up to 800 (typically 1 - 10) pulses spaced 1µS apart with a 1Hz repetition rate. Each pulse will have the nominal integrated energy of 400µJ and nominal pulse-width of 3ps. This pulse train is in the infrared, at a wavelength of 1054nm. A nonlinear optical crystal does frequency doubling of the infrared to green (527nm) with approximately 30% efficiency. A second crystal doubles the green to ultraviolet (263nm). The nominal UV energy is 20µJ per pulse.

Oscillator:

The oscillator can be configured to produce a continuous output of 1.5W infrared. Currently it produces an 81.25 MHz pulse train with <20nJ energy per pulse, and <0.3ns pulse width. It is pumped by an arc lamp with up to 30 Amps at about 200VDC (or 6kW). There is a safety shutter inside the cavity of the oscillator that, when closed, prevents lasing. Note that this is different from merely blocking the output beam. The oscillator is the only "stand-alone" laser in the system. Under normal conditions, the rest of the amplifier chain will not produce laser light without seed pulses from the oscillator.

Multipass Amplifier:

This is a cavity with a Nd:glass rod pumped by flash lamps. During normal operation, it amplifies the pulse train up to about 100µJ/pulse. There is a shutter blocking the output path (which is identical to the input path) of the Multipass amplifier. Under certain conditions, the Multipass cavity could produce free-lasing output, so there is also a shutter inside the cavity, which when closed prevents lasing and prevents amplification.

2-pass Amplifiers:

These are Nd:glass rods pumped by flash lamps. During normal operation, they amplify the pulse train up to about 400µJ/pulse. As currently configured, these devices are not arranged as a cavity and cannot free-lase. Therefore they are not protected by a shutter.¹

1. "*Laser Operating Procedures for the AØ Photo-Injector Laser*" by MJF 06/19/97.

Turning on the Laser

→NOTE: If laser is in “Stand-by” mode, you need only complete steps 3, 12-14, & 18.

1. Ensure that you have read and understand the first page of this document.
2. Ensure that the LCW water chillers are on: To turn on the *Oscillator & 2 pass-1 & 2 pass-2* chiller's, toggle the on/off switch up to the “**START**” position and release. (They are the blue Neslab chillers (“HX-300” & “SYSTEM II”) units located in the high bay, just outside the Laser Water Room & just inside the Laser Water Room). Turn the *M pass* chillers on/off power switches to the “**ON**” position. (They are located further into the Laser Water Room).
3. →Access the Laser Room in accordance with the document “*Access Guidelines for AØ Laser Room*”.
4. Turn these diagnostic boxes “ON”:
 - *Tek TDS640* Oscilloscope (Gray relay rack along West wall by Optics Bench)
 - *Tek 2245A* Oscilloscope (Atop filing cabinet along West wall by Oscillator P.S.)
 - *HP (OSA)* Optical Spectrum Analyzer (West side of North optical table enclosure roof)
5. Turn these Pockels Cell Drivers “ON”:
 - “*Pulse Picker*” Conoptics 25D (North/West end of South optical table enclosure roof)
 - “*Q Switch*” Conoptics 25D (South/West end of South optical table enclosure roof)
6. Ensure that the LCW cooling water has been on for at least 5 minutes before performing step 7: This allows the water temperatures and de-ionization to stabilize.
7. Turn the Oscillator lamp power supply “ON”:
 1. Ensure that Oscillator cooling water is turned on. Chiller located in Highbay just outside the Laser Lab door.
 2. Turn the “**CURRENT**” knob to “**MIN**”.
 3. Turn the power key-switch to “**LOCAL**”.
 4. Press the “**ENABLE**” button for at least 1 second. Wait for the audible tone to stop and the yellow “**ARMED**” LED to become lit.
 5. Press the “**START**” button. Wait for 2nd tone to stop & yellow “**LAMP ON**” LED to light.
 6. Observe that the Oscillator lamp (in the cavity box on the optics table) is lit. Slowly turn the Current knob clockwise to the labeled set point current. (The Oscillator PS is the light gray Analog Modules chassis located in the short black relay rack in the Northwest corner of the Laser Room).
8. Open the Oscillator shutter: Ensure that the Shutter Controller power is “**ON**”, all 3 Safety System “**CRASH BUTTON**”s are pulled out and lit, and the room is interlocked. “**RESET**” the shutter control box. Flip the OPEN/CLOSE switch to “**N.O.**” (Normally Open). (The UniBlitz shutter control box is on top of the roof of the Oscillator optical table enclosure).
9. Ensure that Laser Amplifier’s lamps flashing have been disabled: Disconnect the BNC cable “**Flashlamp Trigger**” from spigot “**EXT TRIG**” on “*Amplifiers Flashlamp Trigger Delay*” **SRS DG-535**. (It is the left DG-535 timing box atop of the Southwest optical table).

10. Turn on all 3 Laser Amplifier Lamp Power Supplies: Ensure that power keys are on (clockwise) on the **Multipass**, **Two pass-1**, and **Two pass-2** amplifier power supplies. Ensure that the "**E Stop**" (Emergency Stop) buttons are pulled out. Let the amplifiers run their test setups. When the display says "STANDBY", push the "**RDY**" (Ready) buttons located in the top right of their control panels. (The Laser Amplifier power supplies are the three black Kigre LCS500 chassis under the Southwest optical table, labeled "M pass", "2 pass" & "10mm Head").
11. Make sure that all (6) of the lamps are simmering equally! If a lamp is not, push the "**STBY**" button on its power supply, then push the "**RDY**" button, then recheck the lamp. Repeat as necessary.
12. **→Close both Multipass shutters**: Flip both ("MULTIPASS INJECTION" & "MULTIPASS CAVITY") shutter switches to "**N.C.**" (Normally Closed). (The two UniBlitz shutter control boxes are on top the Southwest corner of the Amplifier optical table enclosure).
13. **→Connect Laser Amplifier trigger cables**: Connect the BNC cable "**Flashlamp Trigger**" to spigot "**EXT TRIG**" on "Amplifiers Flashlamp Trigger Delay" **SRS DG-535**. (It is the left DG-535 timing box atop of the Southwest optical table).
14. **→Connect Laser Pockell's Cells trigger cables**: Connect the BNC cable "**IRM Gated 1MHz Trigger**" to spigot "**EXTTRIG**" on "Pockell's Cells Trigger Delay" **SRS DG-535**. (It is the right DG-535 timing box atop of the Southwest optical table).
15. **→Allow Amplifier lamps to flash for at least 30 seconds**.
16. Tune the Oscillator in accordance with the document "*Tuning Guidelines for AØPI Laser*".
17. Lock in the Laser to the RF: Toggle the "*Lightwave*" box switch to "**RESET**" and then to "**LOCK**". (North optical table enclosure roof)
18. **→Open both Multipass shutters**: "**RESET**" both shutter control boxes. Flip both "**SHUTTER**" switches to "**N.O.**" (Normally Open). (The two UniBlitz shutter control boxes are on top the Southwest corner of the Multipass optical table enclosure).
19. Optimize the timing and then tune the beam to the cathode in accordance with the document "*Tuning Guidelines for AØPI Laser*".
20. Exit the Laser Room in accordance with the document "*Access Guidelines for AØ Laser Room*".

Turning off the Laser

~ *For short periods of not running, steps 1-5 put the laser in "Stand-by" mode.* ~

1. → Close the UV laser "SHUTER" (channel 5aa:140) via ParamPage. **!!! MUST DO !!!**
2. Access the Laser Room in accordance with the document "*Access Guidelines for AØ Laser Room*".
3. Close the MP amplifier shutters: Flip the OPEN/CLOSE switch to "N.C." (Normally Closed). (The UniBlitz shutter control boxes are on the Southwest top of the roof of the Multipass optical table enclosure).
4. Disable Laser Amplifier trigger: Disconnect the BNC cable "**Flashlamp Trigger**" from spigot "**EXT TRIG**" on "Amplifiers Flashlamp Trigger Delay" **SRS DG-535**. (It is the left DG-535 timing box atop of the Southwest optical table).
5. Disable Laser Pockell's Cells trigger: Disconnect the BNC cable "**IRM Gated 1MHz Trigger**" from spigot "**EXT TRIG**" on "Pockell's Cells Trigger Delay" **SRS DG-535**. (It is the right DG-535 timing box atop of the Southwest optical table).

~ *For long periods of not running, please continue with the following steps...* ~

6. Turn off the laser amplifier power supplies for the "**Multipass**", "**Two pass**", and "**10mm Head**": Push the "**STNDBY**" (Standby) buttons (located in the top right of the control panels). Wait until the red "> 100 VDC" indicator lamps go out. Depress the red "**E Stop**" (Emergency Stop) buttons. (The three amplifier power supplies are the three black Kigre chassis under the Southwest optical table).
7. Turn off the Oscillator power supply: First turn the current all the way down (counter-clockwise). Depress the red "**Emergency Stop**" button. (The Oscillator PS is the light gray Analog Modules chassis located in the short black relay rack in the Northwest corner of the Laser Room):
8. Turn "OFF" these diagnostic boxes:

Tek TDS640 Oscilloscope	(West wall by Optics Bench)
Tek 2245A Oscilloscope	(West wall by Oscillator P.S.)
HP (OSA) Optical Spectrum Analyzer	(North optical table enclosure roof)
9. Turn "OFF" these Pockels Cell Drivers:

"Pulse Picker" Conoptics 25D	(North optical table enclosure roof)
"Q Switch" Conoptics 25D	(South optical table enclosure roof)
10. Exit the Laser Room in accordance with the document "*Access Guidelines for AØ Laser Room*" ensuring the door is closed and locked behind you.
11. If you have checked out the "*AØPI Laser Room*" key from the MCR, please return it.