

# XFEL Photocathode Laser Operator Training

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FSLA

# Overview

## XFEL Photocathode Laser Operator Training

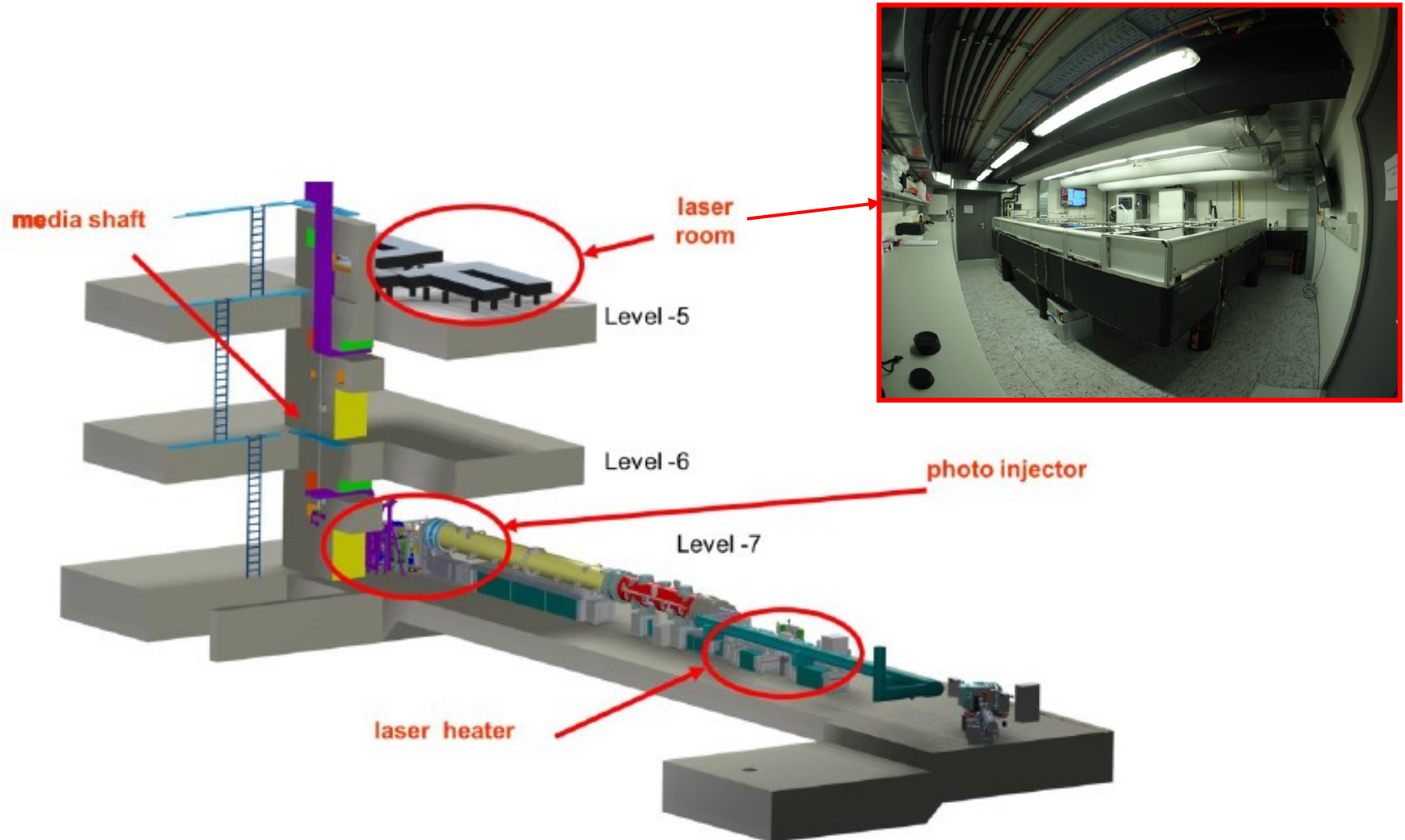
- 1. The Laser System**
- 2. Status & Troubleshooting via DOOCS**
- 3. Control via DOOCS**

# The Laser System

# The Light

- IR laser light (1030nm) is split into two portions.
- One portion is converted to UV (257nm) via fourth harmonic generation, then used to create electrons from the photocathode.
- Second portion is used as a “Laser Heater”, heating the electron bunch for greater electron energy.
- Picosecond bursts at 4.5MHz, 1.1MHz and 500kHz in bunch patterns and energies as commanded by the Laser Operators (you!)

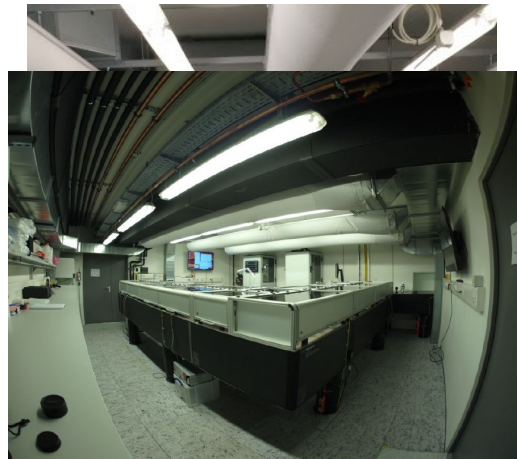
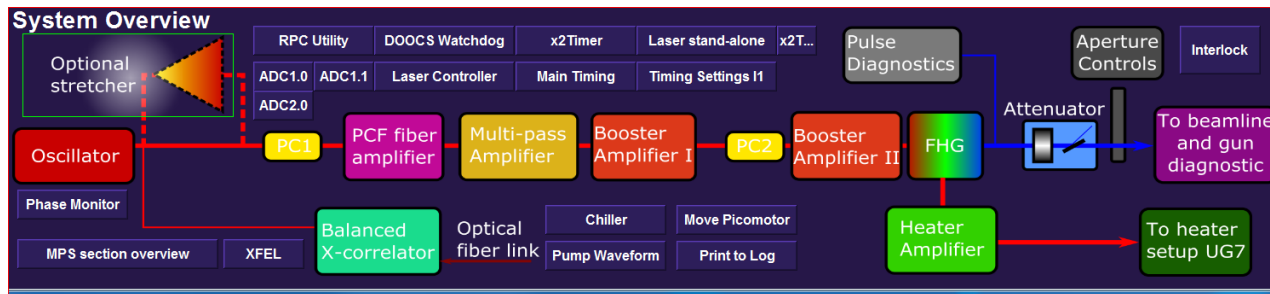
# Photocathode Laser Building



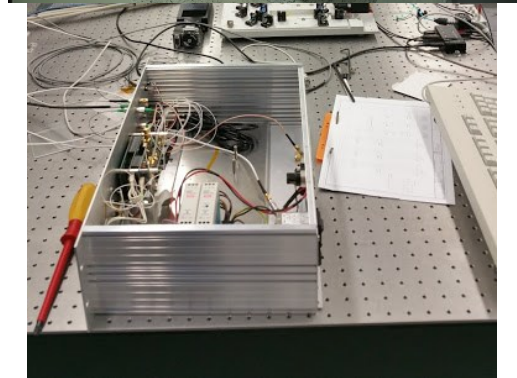
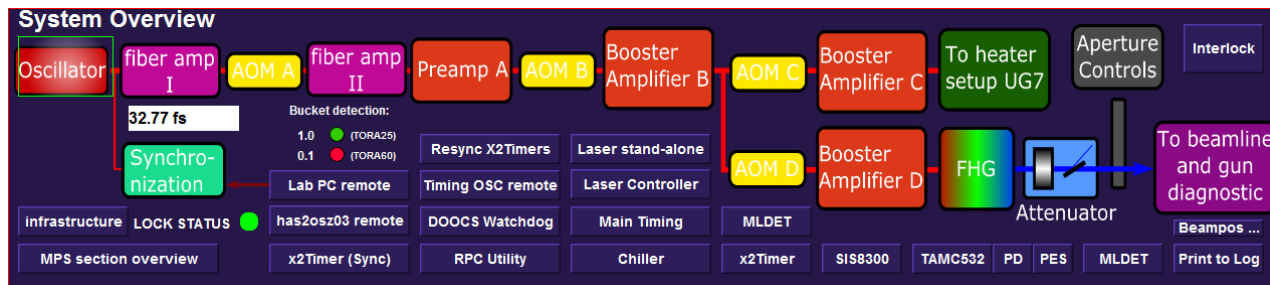
# Laser 1 and Laser 2

- Two operational laser systems to provide backup and multiplexed simultaneous operation.
- Currently **XInLas1** provides the light for the laser heater, **XInLas2** provides the UV light for the photocathode.

## Laser 1



## Laser 2



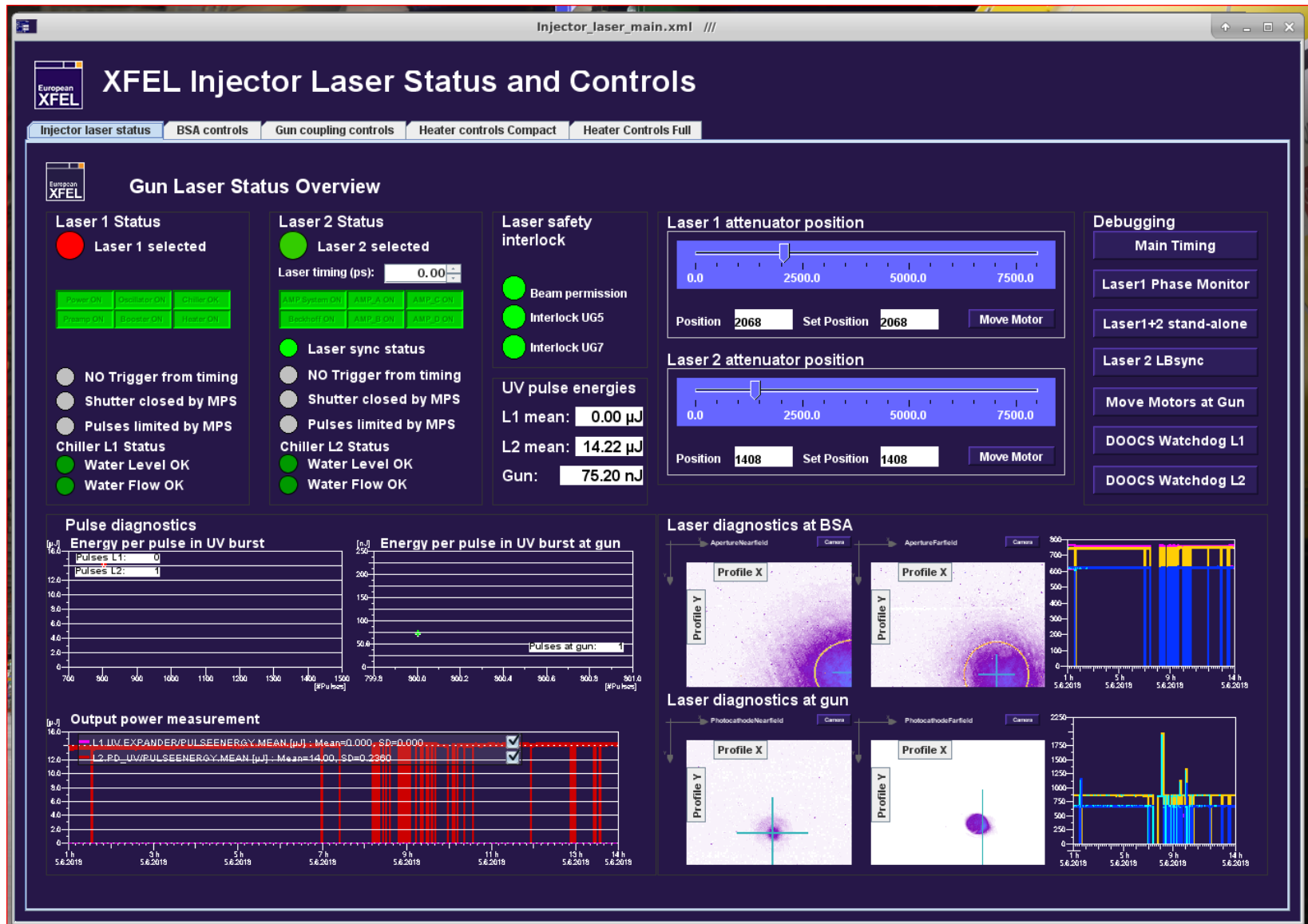
# Troubleshooting & Control via DOOCS

# How To Get To The Laser Controls

The image displays the XFEL Main Taskbar and the Laser Controls interface. The top window, titled "jddd 1.9.63/18.7.59 T4.6.3 chouda@xfeluser2 XFELMainTaskbar.xml", shows a main menu with buttons for Status, Operations, Procedures, Feedbacks, Automation, Diagnostics, and Tools. The "Operations" button is highlighted with a green box, and a green arrow points from it to the "Injector" button in the "Laser" section of the main menu. The "Injector" button is also highlighted with a green box. A blue arrow points from the "Injector Laser Controls" button in the "Laser" section to the "XFEL Injector Laser Status and Controls" window. This window displays various status indicators, including "Gun Laser Status Overview", "Laser 1 Status", "Laser 2 Status", "Laser safety interlock", "Laser 1 afterglow position", "Laser 2 afterglow position", "Pulse diagnostics", and "Output power measurement". The "Laser 1 Status" and "Laser 2 Status" sections show "Laser 1 selected" and "Laser 2 selected" respectively. The "Laser safety interlock" section shows "Laser safety interlock" and "Laser safety interlock" with "OK" and "Not OK" buttons. The "Laser 1 afterglow position" and "Laser 2 afterglow position" sections show "Laser 1 afterglow position" and "Laser 2 afterglow position" with "OK" and "Not OK" buttons. The "Pulse diagnostics" section shows "Pulse diagnostics" and "Pulse diagnostics" with "OK" and "Not OK" buttons. The "Output power measurement" section shows "Output power measurement" and "Output power measurement" with "OK" and "Not OK" buttons.

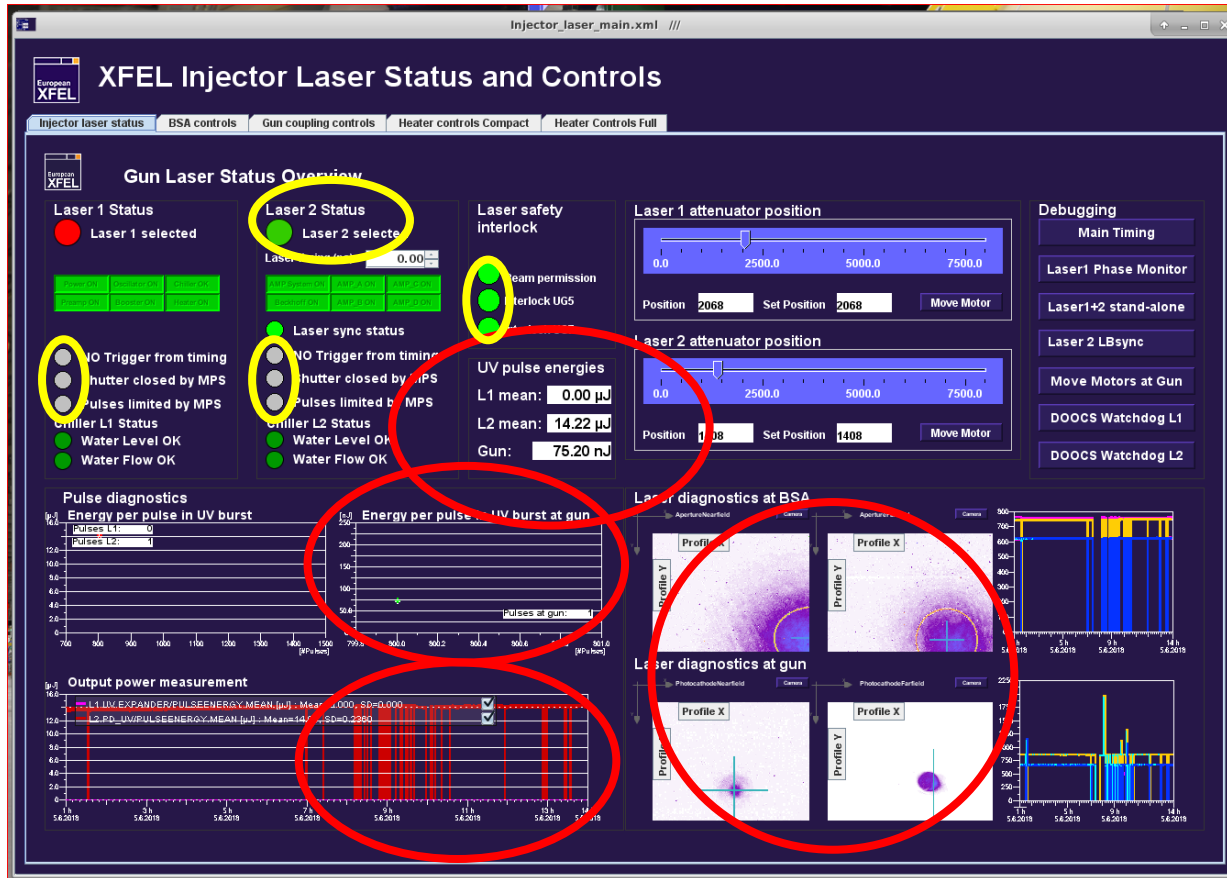


# Injector Laser Status & Controls: Status



# Common Issues

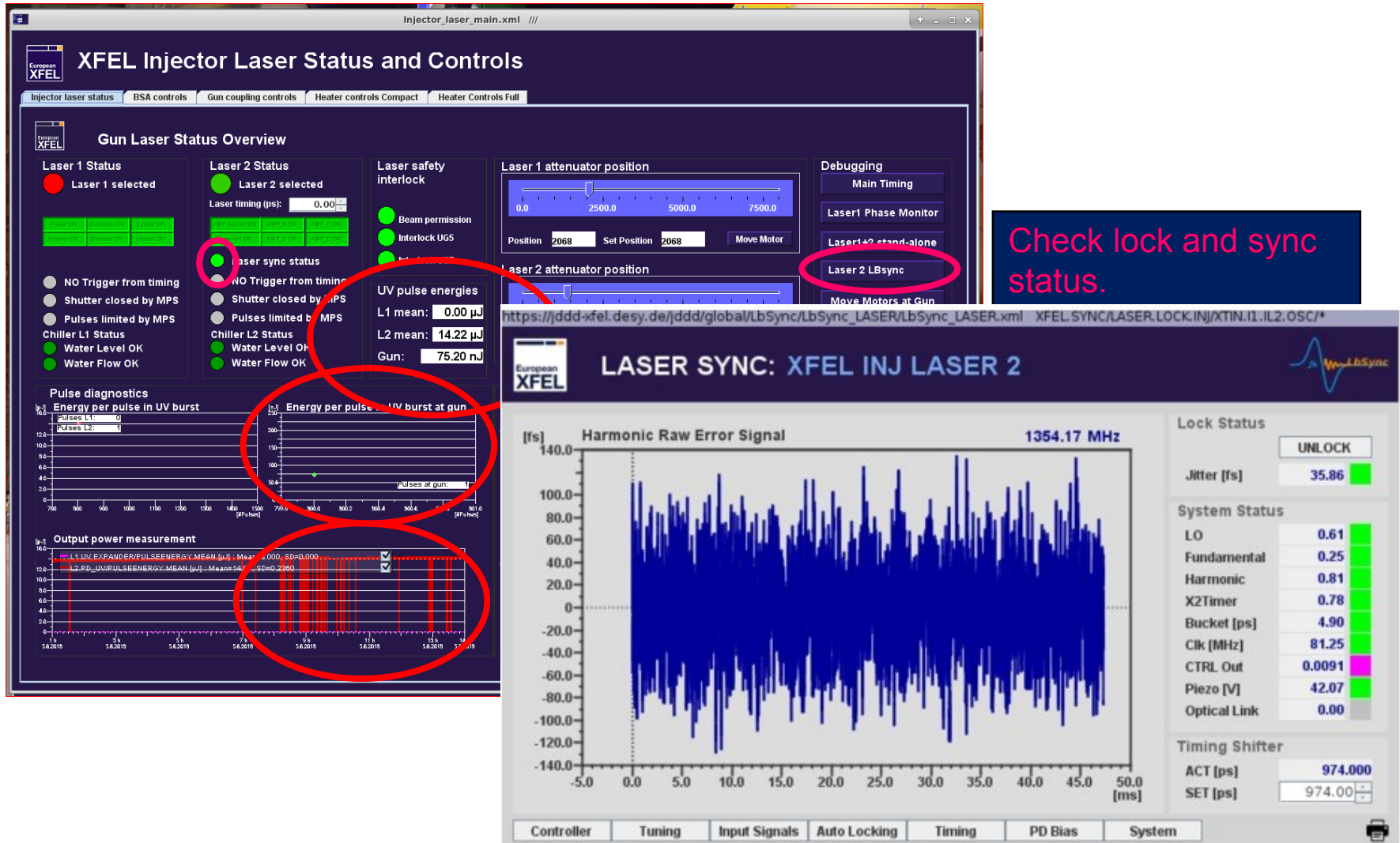
## No Pulses?



Check shutter, trigger, beam permission and interlock status.

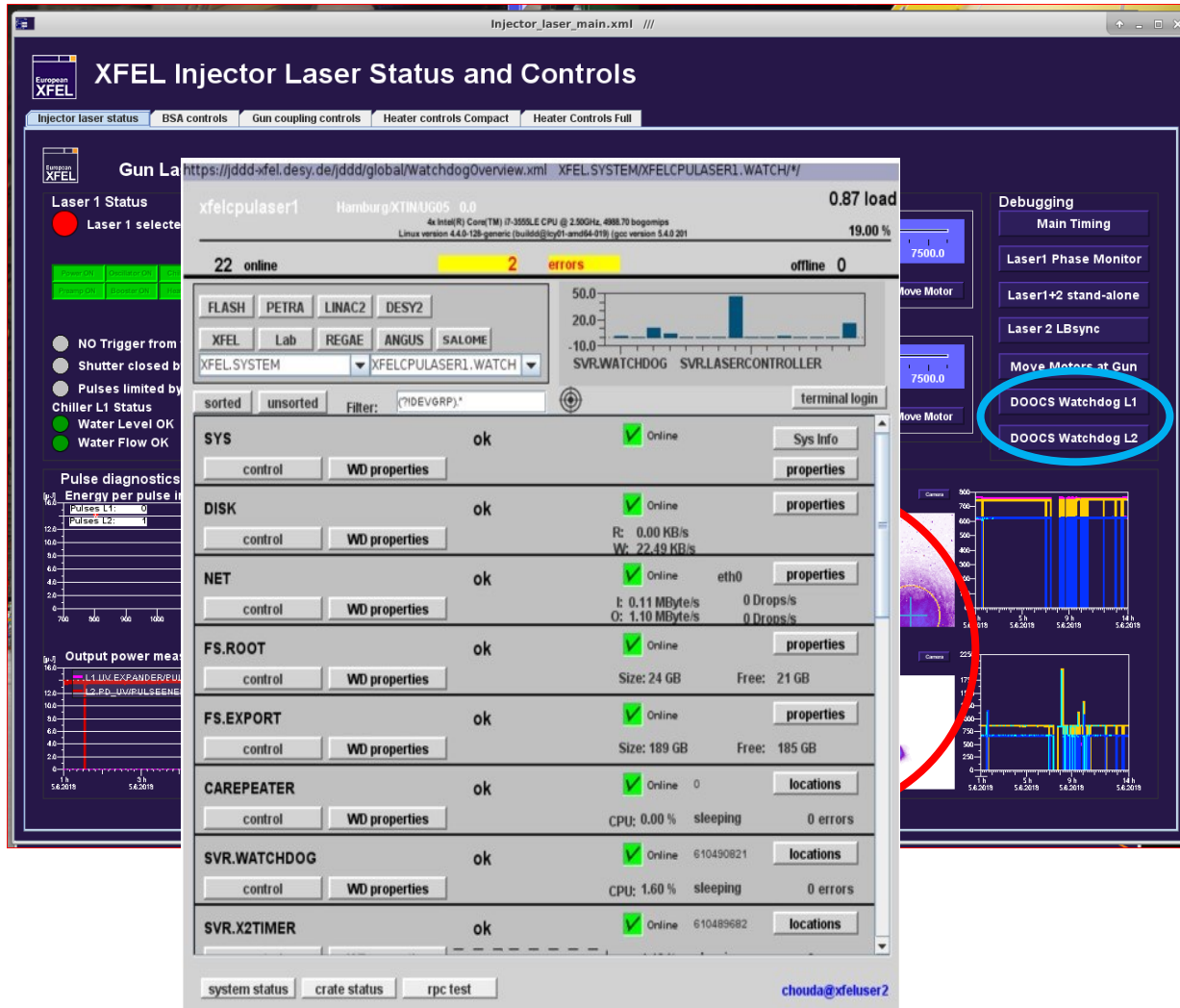
# Common Issues

## No Pulses?



# Common Issues

## No Pulses?



Check DOOCS Watchdog.

# Common Issues

## Call Injector Laser Support

- **Stand-Alone Mode**→ was the beam allowed without turning the physical key in UG5?
- **Beam Drift**
- **Laser is not locked/synchronized**
- **Shutter is stuck**
- **Burst is not flat**

## Contact

**DESY.** Deutsches  
Elektronen-Synchrotron

**First Contact: Ara Choudhuri, xt. 6347**

Expert: Lutz Winkelmann, xt. 6385

Deputy: Sarper Haydar Salman, xt. 6083

[www.desy.de](http://www.desy.de)

**Laser On-Call: 5581**

**Ticket System: [laser-operations@desy.de](mailto:laser-operations@desy.de)**

# Controlling the Laser(s)

The image illustrates the workflow for controlling the laser system. It starts with the MainTaskbar, where the 'Injector' icon is selected. This leads to the MainTiming interface, where the 'Laser Controller' is accessed. Finally, the INJ1 LASER PULSE CONTROLLER window is shown, which provides detailed control over the laser pulse parameters.

**Top Screenshot: MainTaskbar**

- File View Help
- Status (i)
- Operations (highlighted with a green box)
- Procedures
- Feedbacks
- Automation
- Diagnostics
- Tools
- 28Mb/1820Mb

**Middle Screenshot: MainTiming**

- File View Help
- Status (i)
- Operations
- Procedures
- Feedbacks
- Automation
- Diagnostics
- Tools
- 27Mb/1820Mb
- Injector (highlighted with a green box)
- Timing/Bunches
- Laser
- Beamline
- RF Gun
- RF Gun Tools
- Gun Conditioning
- Gun Phase Scan
- Gun conditioning (SMAC)
- Gun Signals
- Water
- Temperature List
- Gun Temperature History
- Beam Based Alignment
- Laser Heater
- Solenoid
- Gun Interlocks
- System Overview

**Bottom Right Screenshot: INJ1 LASER PULSE CONTROLLER**

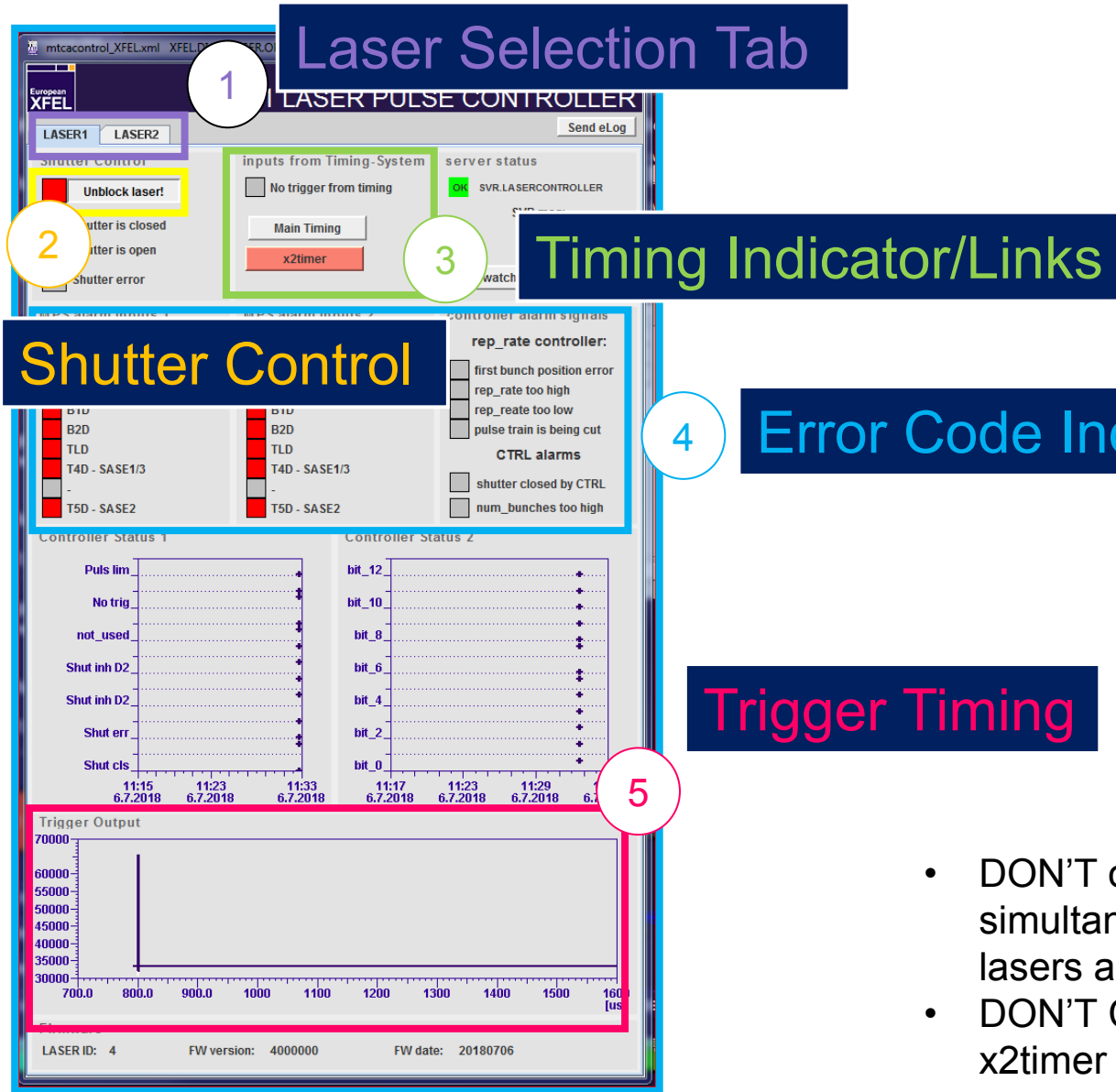
- XFEL INJ1 LASER PULSE CONTROLLER
- Shutter Control
- Inputs from Timing System
- server status
- MPS alarm inputs 1
- MPS alarm inputs 2
- Protections-call inhibit:
- shutter inhibit:
- Controller Status 1
- Controller Status 2
- Trigger Output

**Bottom Left Screenshot: Main Timing Controls**

- XFEL MainTiming.xml XFEL DIAG/TIMER/CENTRAL/MASTER/SASE
- Main Operating
- Special Bunches
- Bunch Pattern Table
- MPS Values
- Main Timing Controls
- Operation mode: SASE1.2 and TLD ok
- Bunch Train Part 1
- Bunch Train Part 2
- Bunch Train Part 3
- Special Bunches: A: disabled B: disabled C: disabled D: disabled

- Laser Operators cannot control the lasers explicitly (e.g. turn on specific amplifier stages).
- Laser Operators can command laser output.

# The Laser Controller



- DON'T open both shutters simultaneously (UV light from both lasers arrives at cathode)
- DON'T Change values in the x2timer

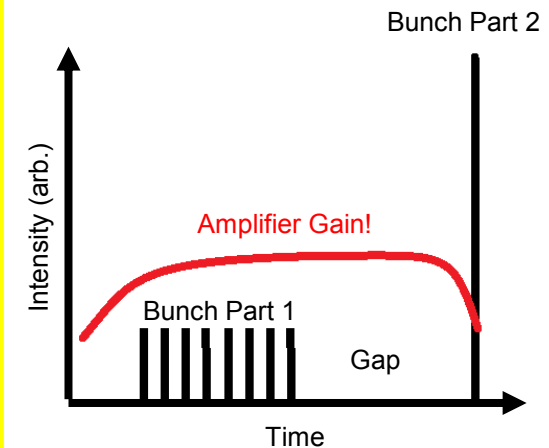


# Main Timing

The screenshot shows the 'XFEL\_MainTiming.xml' window with the following settings and callouts:

- 1 Beam Permission:** 'Allow beam' checkbox is checked.
- 2 Enable Bunch Train:** 'Enable' checkboxes for Bunch Train Part 1, 2, and 3 are checked.
- 3 Bunch Specifications:** A green box highlights the settings for Bunch Train Part 1, including Bunch Destination (TLD), Number of Bunches (1), Bunch Rep Rate (564 kHz), Charge per Bunch (0.25 nC), and Injector Laser (2).
- 4 Laser Rep Rate:** 'Laser Rep Rate' is set to 564kHz.
- 5 Bunch Timing:** A pink box highlights the 'Special bunches' section at the bottom, showing a timeline from 0.0 to 1600.0 with various bunches labeled A, B, C, and D.

- Keep rep rates consistent across bunch and both lasers.
- DON'T switch lasers through the bunch train.
- DON'T command a bunch pattern with gaps!





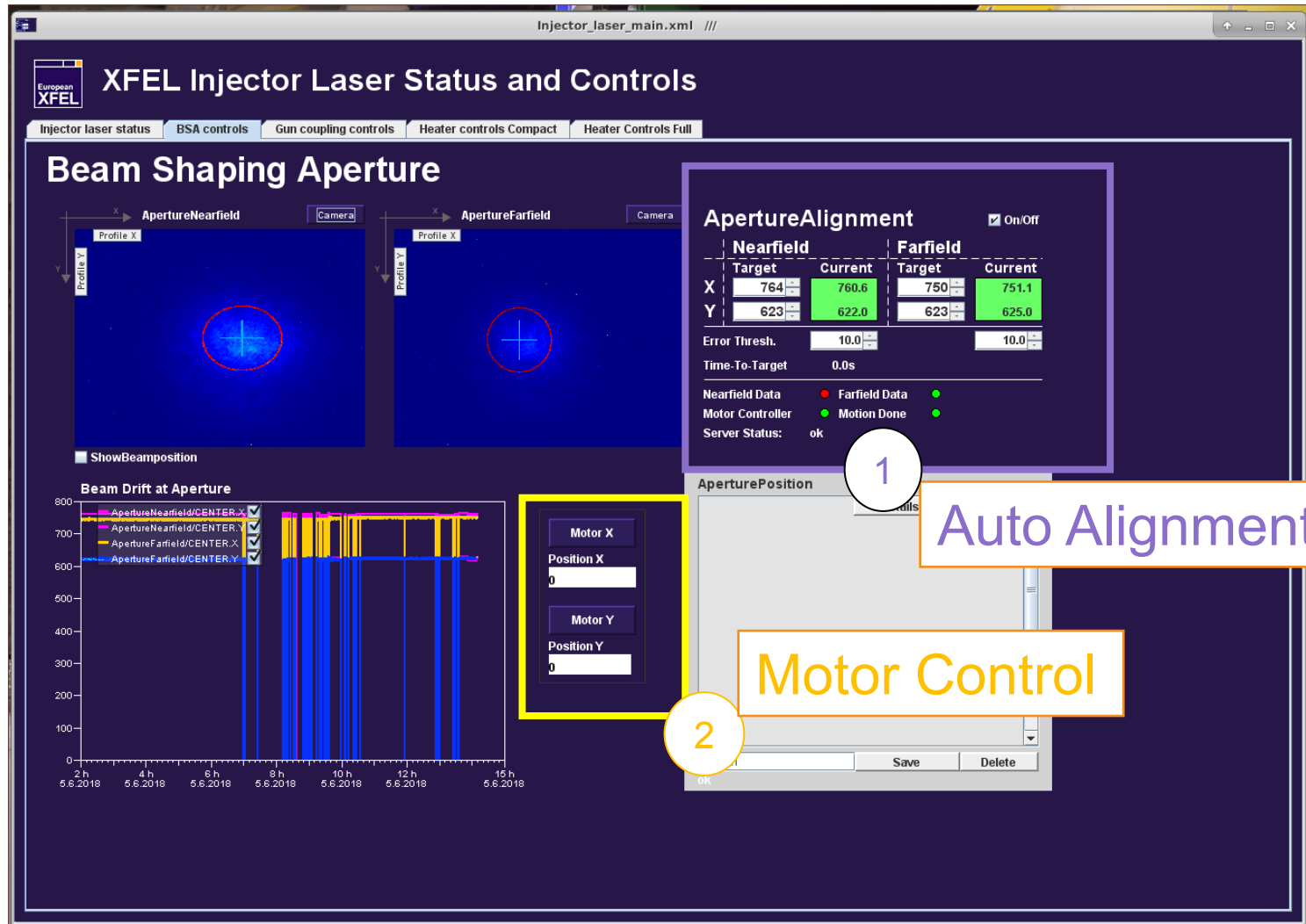
# Controls in the Injector Laser Status Panel

The image displays two screenshots of the XFEL Main Taskbar and the Injector Laser Status Panel. The top screenshot shows the Main Taskbar with the 'Injector' button highlighted by a green box. A green arrow points from this button to the bottom screenshot. The bottom screenshot shows the 'Injector Laser Controls' panel, which is a detailed interface for managing the injector laser system. It includes sections for 'Gun Laser Status Overview', 'Pulse diagnostics', 'Output power measurement', and 'Laser diagnostics at BSA'. The 'Gun Laser Status Overview' section shows the status of two lasers, Laser 1 and Laser 2, with various indicators for their operation. The 'Pulse diagnostics' section displays a graph of pulse energy over time. The 'Output power measurement' section shows a graph of output power over time. The 'Laser diagnostics at BSA' section displays four small plots showing laser beam profiles. The 'Injector Laser Controls' panel also includes a 'System Overview' section at the bottom, which shows a schematic diagram of the injector laser system.

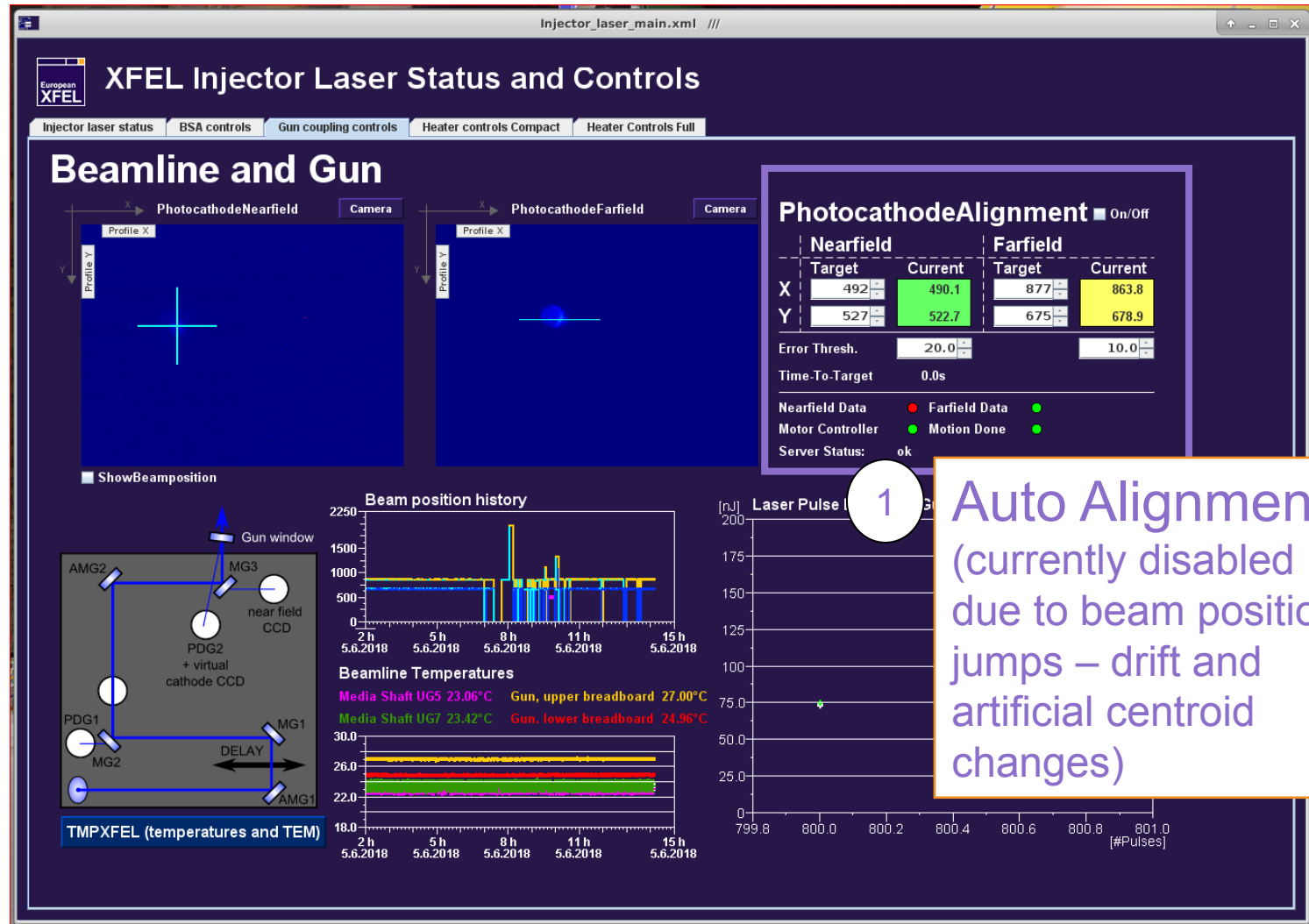
The top screenshot shows the XFEL Main Taskbar with the following buttons: Status, Operations, Procedures, Feedbacks, Automation, Diagnostics, and Tools. The 'Injector' button is highlighted by a green box. A green arrow points from this button to the bottom screenshot.

The bottom screenshot shows the 'Injector Laser Controls' panel, which is a detailed interface for managing the injector laser system. It includes sections for 'Gun Laser Status Overview', 'Pulse diagnostics', 'Output power measurement', and 'Laser diagnostics at BSA'. The 'Gun Laser Status Overview' section shows the status of two lasers, Laser 1 and Laser 2, with various indicators for their operation. The 'Pulse diagnostics' section displays a graph of pulse energy over time. The 'Output power measurement' section shows a graph of output power over time. The 'Laser diagnostics at BSA' section displays four small plots showing laser beam profiles. The 'Injector Laser Controls' panel also includes a 'System Overview' section at the bottom, which shows a schematic diagram of the injector laser system.

# BSA Controls

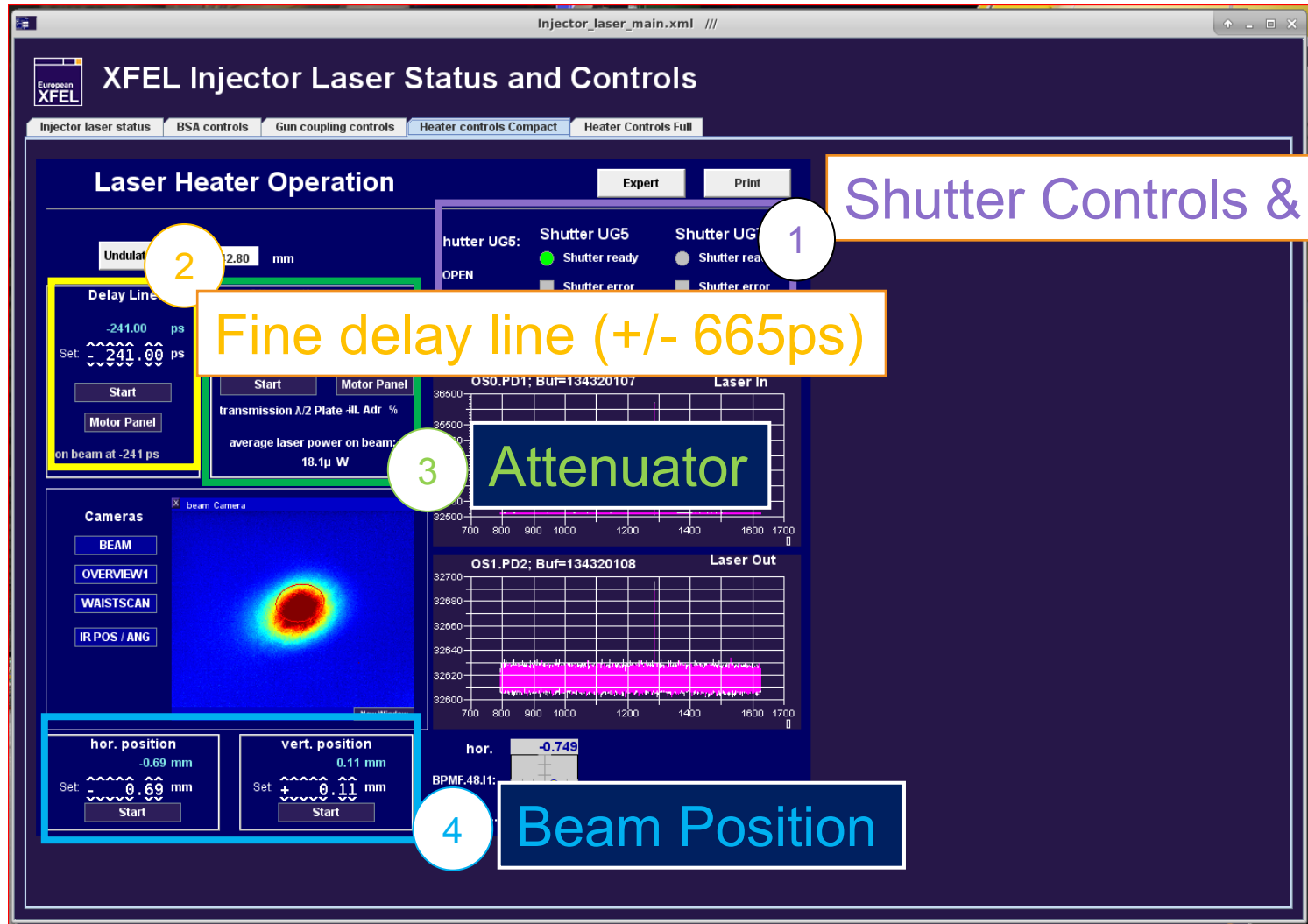


# Gun Coupling



1 Auto Alignment  
(currently disabled  
due to beam position  
jumps – drift and  
artificial centroid  
changes)

# Laser Heater



# Another Way of Getting to the Laser Heater...

The image shows a sequence of steps to access the Laser Heater Operation interface. It starts with the 'XFELMainTaskbar.xml' window, where the 'Injector' button is highlighted with a green box. An arrow points from this box to the 'Injector' button in the 'Timing/Bunches' section of the 'XFELMainTaskbar.xml' window. Another arrow points from the 'Laser Heater Operation' button in the 'Laser' section to a separate 'XFEL\_LaserHeater\_basic.xml' window. This window displays various parameters and graphs for the laser heater operation.

**XFELMainTaskbar.xml**

File View Help 28Mb/1820Mb

European XFEL

Status MPS

Operations **Injector** RF

Procedures

Feedbacks Automation

Diagnostics

Tools

Orbit Photons Beam Dynamics Magnets Vacuum Cryo Controls

**Timing/Bunches**

Bunch Pattern Server Main Timing Timing Settings II

**Laser**

Injector Laser Controls Laser Controller

**Laser Heater**

Laser Heater Operation Laser Heater Expert AutoLH

**Beamline**

Gun Overview Injector Beamline

**RF Gun**

Gun Conditioning Vacuum Gun Signals Water Temperature List Gun Temperature History

**RF Gun Tools**

Gun Phase Scan Gun Conditioning (SMAC)

**System Overview**

**XFEL\_LaserHeater\_basic.xml**

XFEL UTIL//

**Laser Heater Operation**

Shutter UG5 Shutter UG6 Shutter UG7

OPEN Shutter ready Shutter error Shutter ready Shutter error Shutter ready Shutter error

Close Shutter Shutter is closed Shutter is open Shutter is closed Shutter is open Shutter is closed Shutter is open

OS0.P01: Bu#161084508 Laser In

OS1.P02: Bu#161084508 Laser Out

hor. position 1.67 mm Set 0.72 mm Start

vert. position 6.72 mm Set 0.72 mm Start

hor. 0.000 0.000

vert. 0.000 0.000

# Demo (if possible)

## How-To

- Block and Unblock Laser
- Change UV pulse energy
- Change Repetition Rate, Number of Bunches
- Scan gun phase/match laser 1 timing → out of scope
- Change beam position on cathode

Injector Laser Support does not condone copyright infringement.

## Contact

**DESY.** Deutsches  
Elektronen-Synchrotron

[www.desy.de](http://www.desy.de)

**First Contact: Ara Choudhuri, xt. 6347**

Expert: Lutz Winkelmann, xt. 6385

Deputy: Sarper Haydar Salman, xt. 6083

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