

Installation of a Hot-Swappable Spare Injector Laser System For the SLAC Linac Coherent Light Source

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Abstract

In order to maintain high uptime (>95%) for the experimenters, operations rely on a maintenance program for active laser components as well as on built-in redundancy in case of failure. To accomplish this, a duplicate laser system was installed, allowing for quick swap between the active system and the spare in the event of a malfunction or for planned maintenance. As an added bonus, this redundant system provides additional possibilities for science as both laser systems can also be run to the cathode simultaneously to create multiple particle bunches. Diagnostics were put in place to maintain both spatial and temporal overlap and allow for the fast switching between systems by operations personnel while still remaining within the safety envelope.

Photocathode Injector uses two lasers:

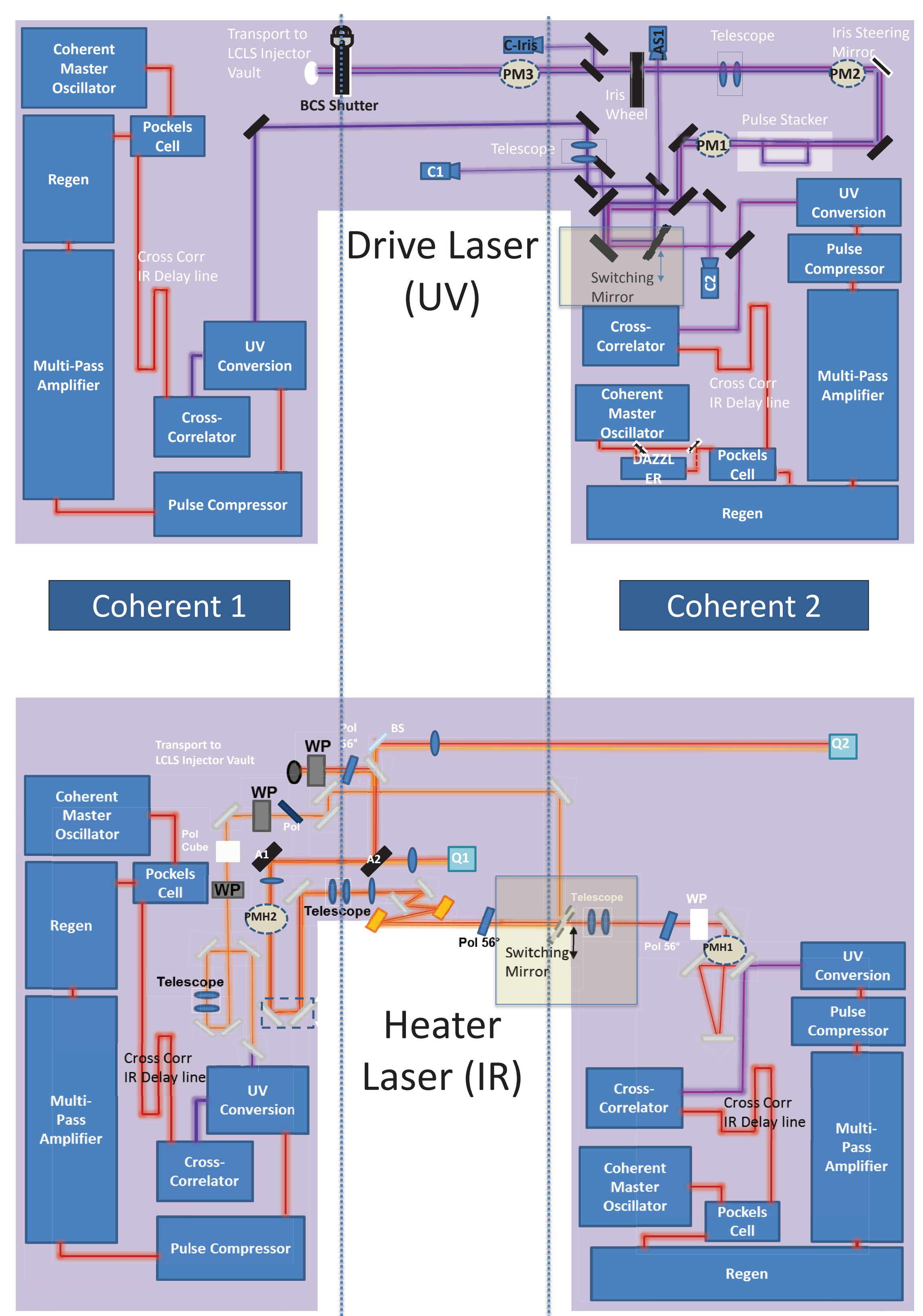
Drive Laser

- 253 nm (UV) pulsed laser incident on Cu cathode to create electron beam

Laser Heater

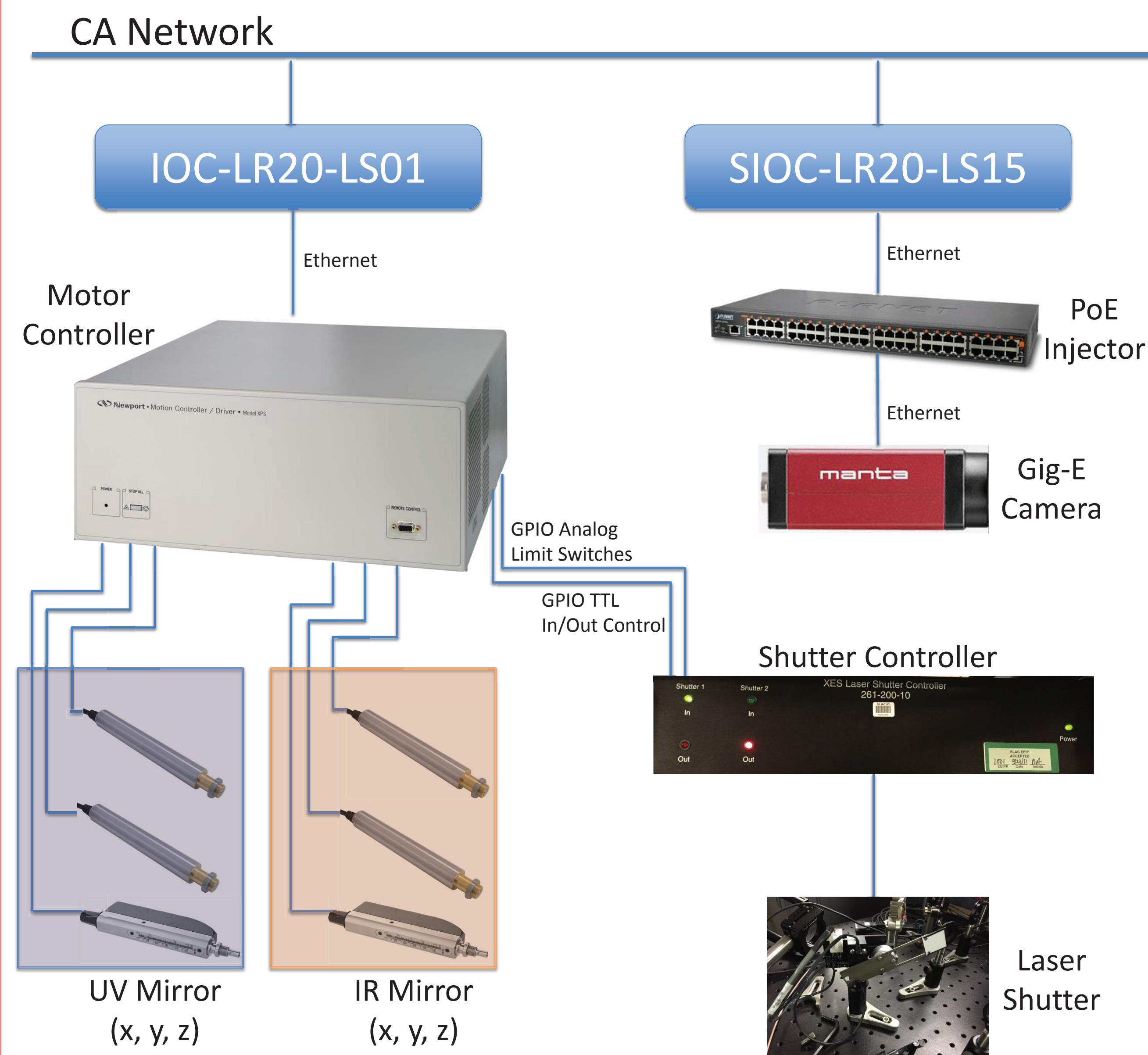
- Left over 760 nm (IR) laser from Drive laser UV conversion process
- Used to mitigate undesirable micro-bunching of e- beam before FEL creation

Both of these laser systems require a ready spare in case failure.



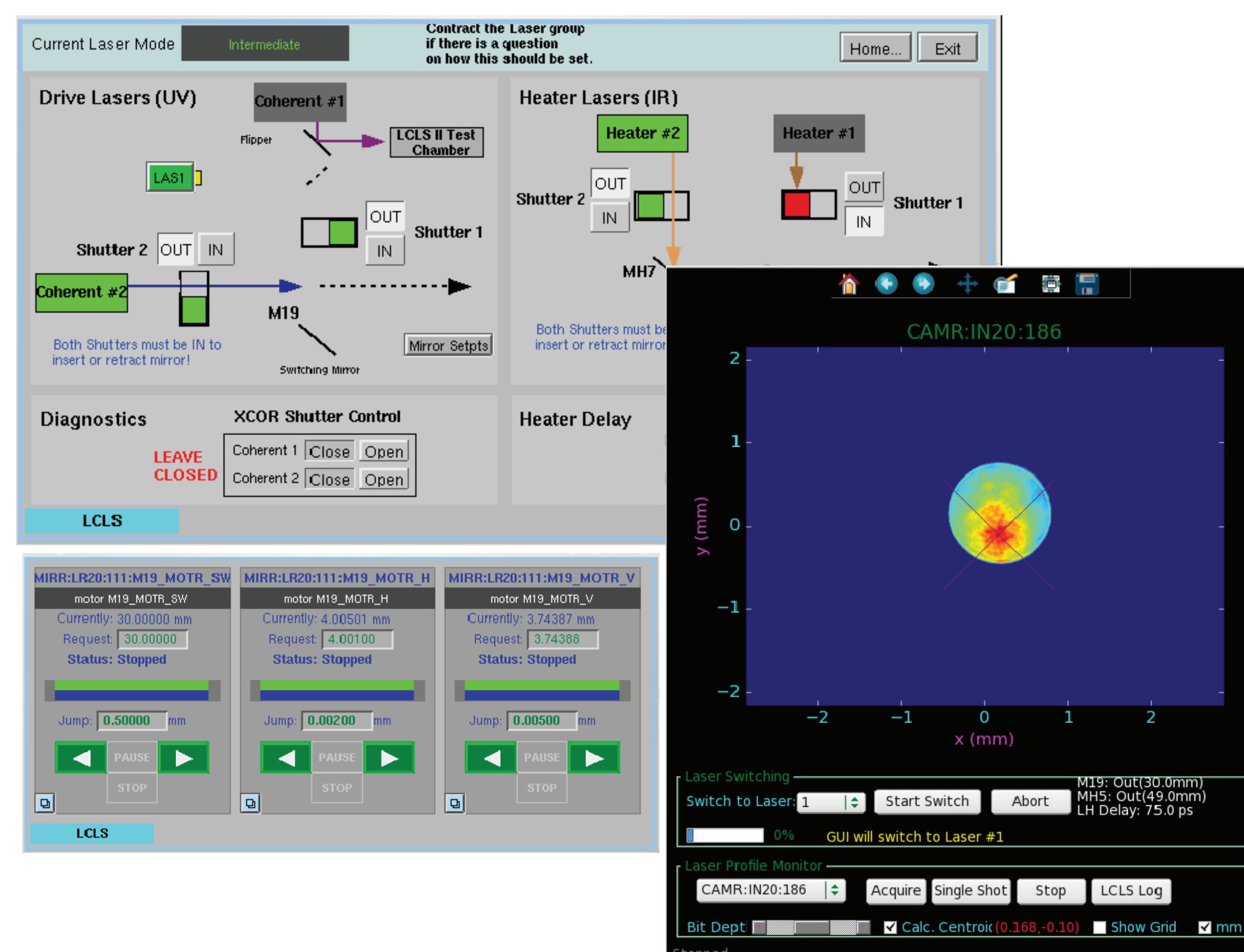
The Hardware

- 1 Newport XPS-Q8 motor controller
 - 4 TRA6CC stepper motors for mirror steering
 - 2 LTA-HS stepper motors for mirror in-out control
- 4 SLAC-built DC shutters
- 2 SLAC-built shutter controllers
- 1 AVT Manta G033B Gig-E PoE Camera



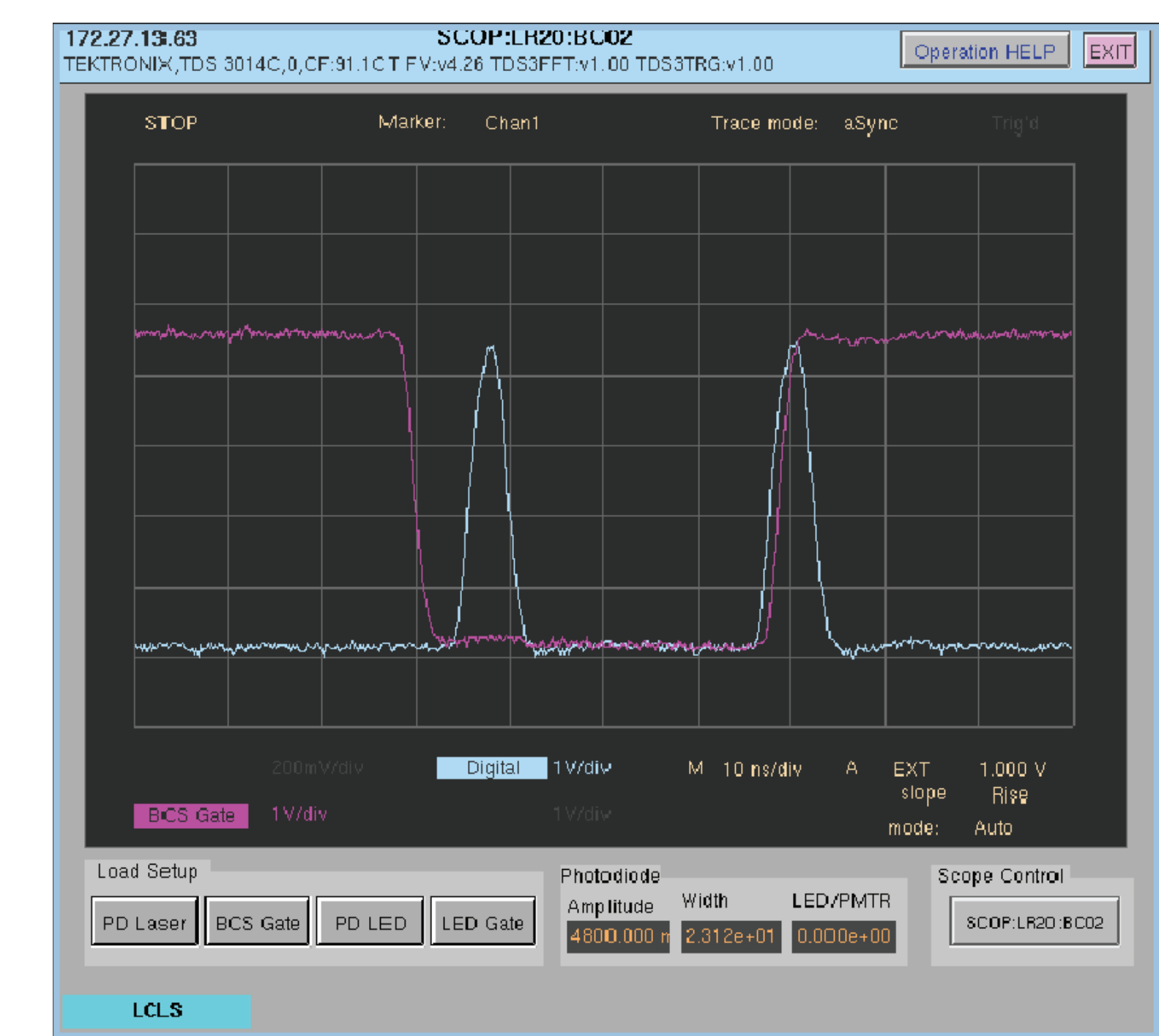
The Software

- Integrated with SLAC's EPICS based distributed control and data archiving system
- Standard Motor record interface with Newport XPS-Q8 motor controller over Ethernet
- AreaDetector EPICS interface for Gig-E camera
- Developed PyQt4 application with Operations Group for fast switching and configuration management along with EPICS helper PVs (setpoints, state readback, device control, etc.)

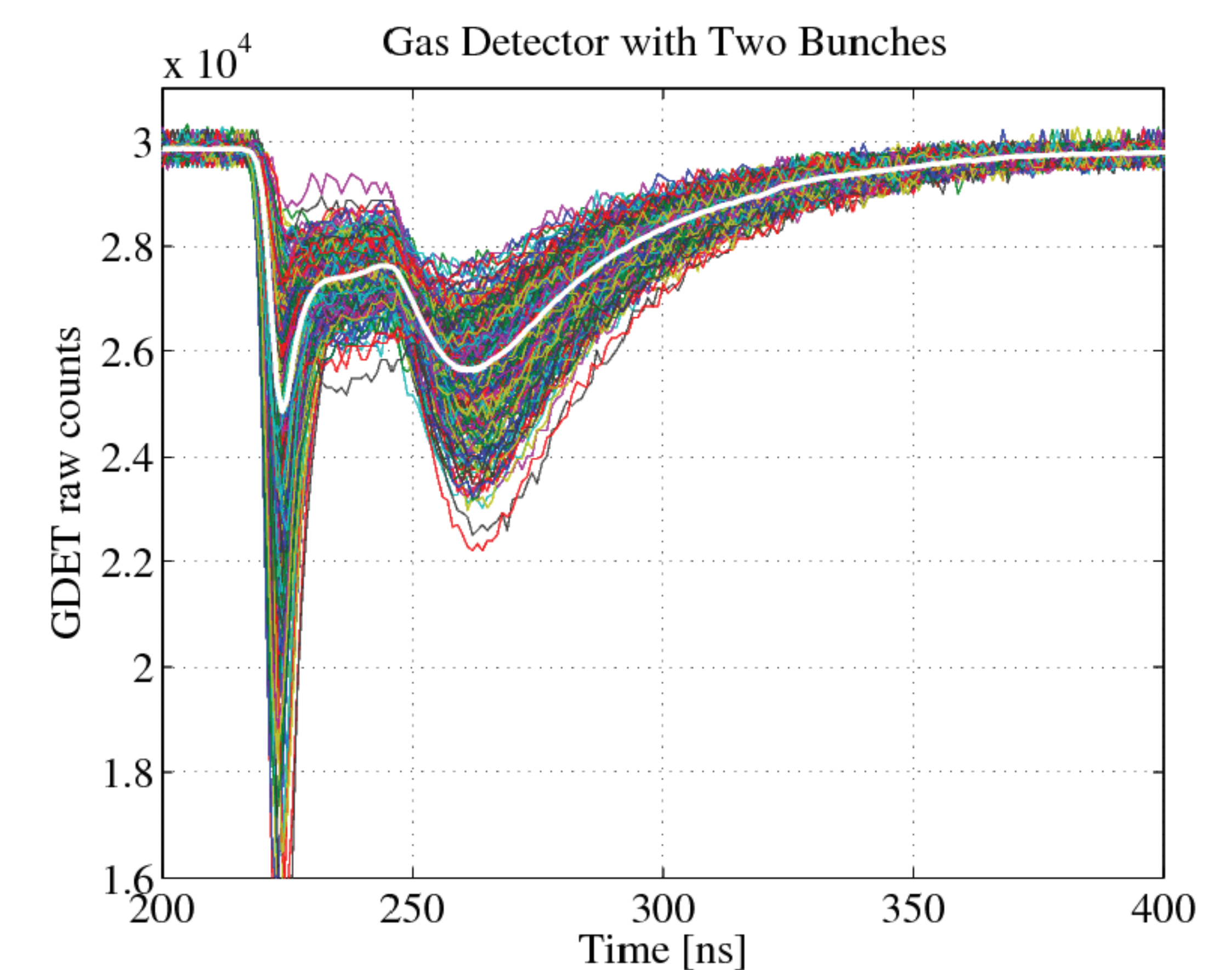


Results

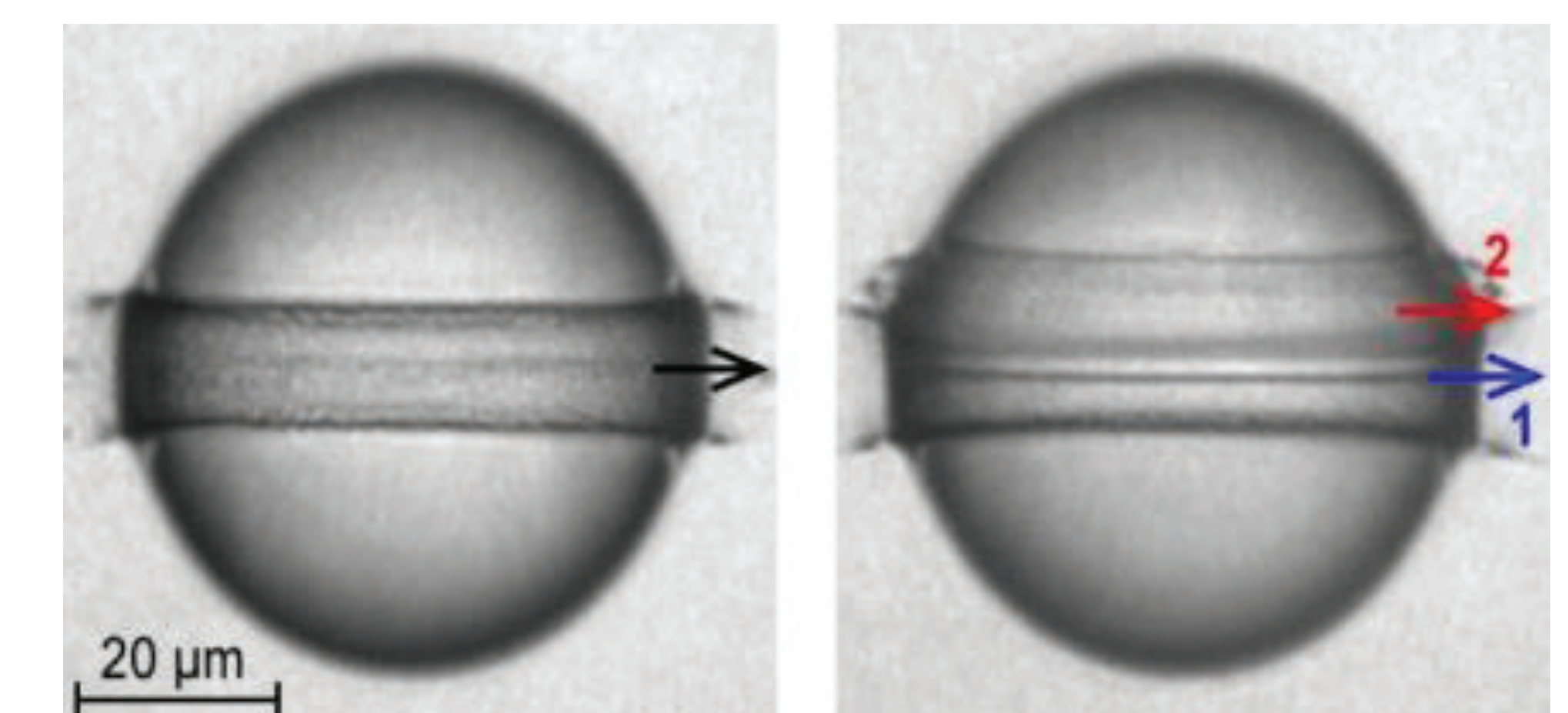
For the process of switching lasers, it often took hours to get an expert in to realign and make the switch on off shifts. With the new changes, Operators are typically able to make the change on the fly in less than 10 minutes. Additionally there have been several Physics shifts looking at the two-bunch running which have so far been quite successful as seen in the data below.



An optics box containing redundant beam splitters and photodiodes was used within the BCS Safety System to ensure that both laser pulses fell within the timing gate used by the Toroid Comparators downstream. Magenta trace shows the toroid timing gate and the blue trace shows the two laser pulses.



Gas Detector raw waveforms (above) show a 2.5:5 ratio after the laser heater was timed for the first bunch. The spike in the front is an instrumental reaction to coherent synchrotron radiation. Therefore the integrated GDET signal typically uses the counts from 250 to 400 ns.



XFEL beams imaged by camera in CXI experimental hutch hitting water droplets. Single bunch beam is seen on the left and two-bunch on the right. The arrows indicate the XFEL beams.