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Status Of the CLARA Control System

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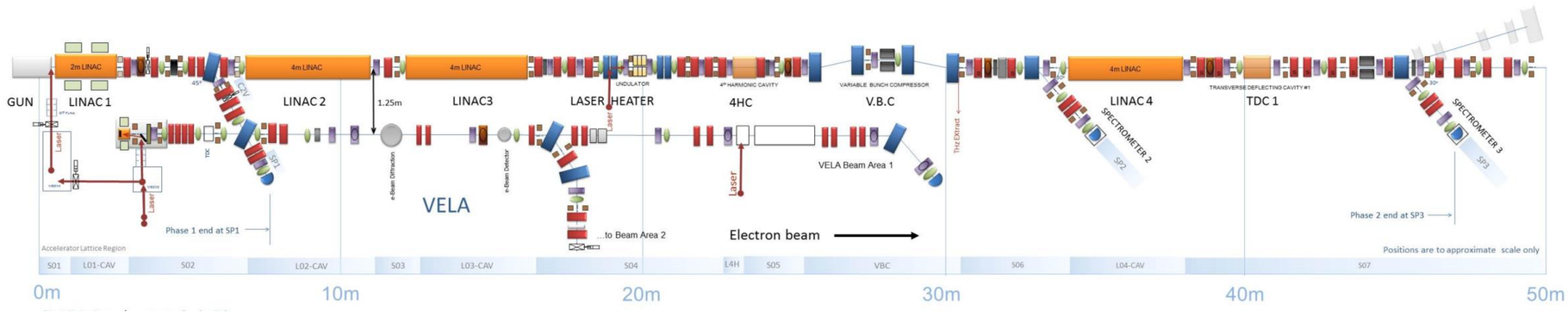


Exploitation with EPICS

CLARA (Compact Linear Accelerator for Research and Applications) is a test facility for Free Electron Laser (FEL) research and other applications at STFC's Daresbury Laboratory. The installation and commissioning of Phase 1 comprising of the photo-injector, RF gun and the first linac was completed during 2018. Subsequent machine development and beam exploitation took place during late 2018/early 2019.

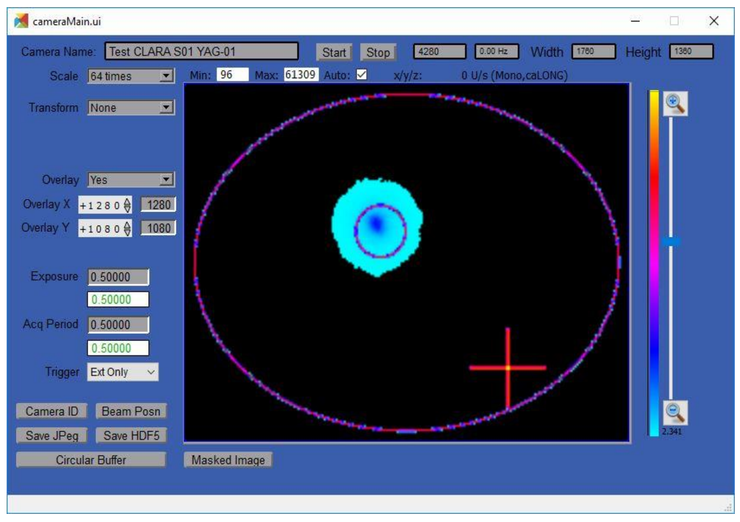
The EPICS control system proved reliable and flexible throughout exploitation phase. New features required for particular experiments were easily added due to the scalable nature of support modules like AreaDetector and the flexibility of the MRF timing system. Virtualisation of the accelerator and the hardware running the control system has allowed for offline development of IOCs and other services.

Cameras

Very low noise cameras with 5.5 megapixel resolution and a pixel pitch of 6.5um manufactured by PCO have been installed for viewing diagnostic screens. They are capable of operating at 100fps via their fibre optic Camera Link High Speed (CLHS) interface. These are used alongside lower resolution GigE cameras.

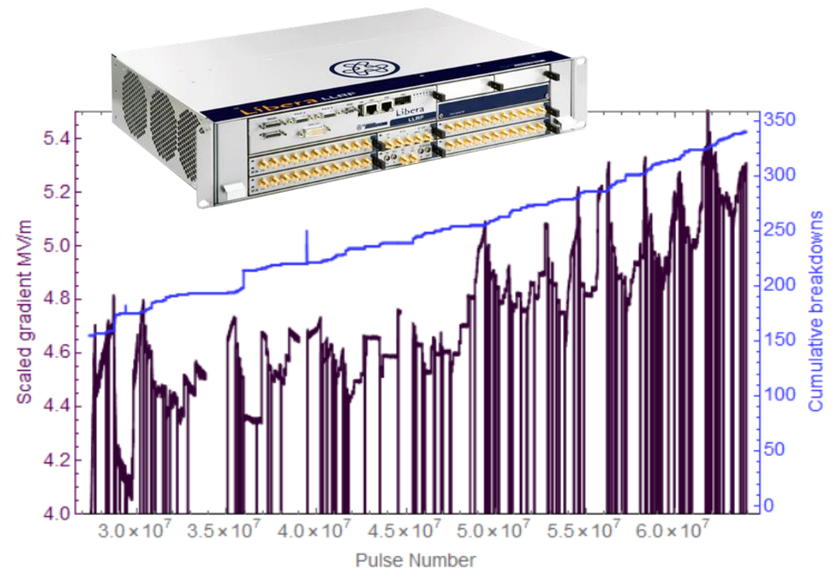
The PCO cameras are integrated into the EPICS control system via x64 Linux IOCs with a dedicated fibre optic PCIe frame-grabber per camera. Extensive use of the areaDetector framework and plug-ins has been made in the overall system implementation with multiple outputs to cover user requirements.

Accelerator physicists develop their own applications in Python that run in parallel with and use data from IOCs. Events determined in these analysis applications can be used to trigger storage of data from circular buffer plug-ins.



Unmanned RF Conditioning

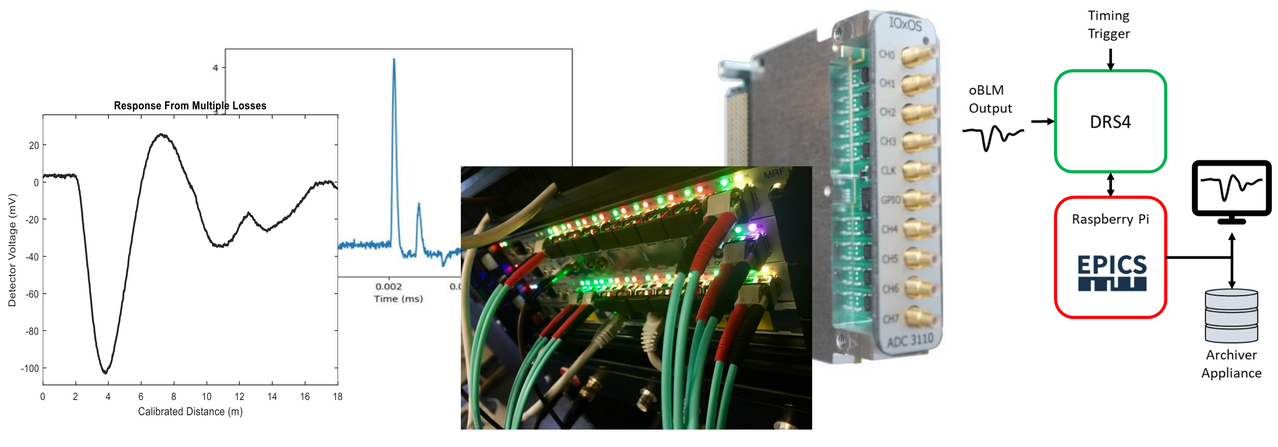
To facilitate faster conditioning of the CLARA 400Hz, an unmanned conditioning system was developed. The EPICS Sequencer was used to monitor all the relevant safety and machine interlocks for failures, log the failures when they occurred, and then to reset the RF systems to bring them back online. This was improved by checking the error log to ensure that certain failures were only allowed to happen a certain number of times in a given time period before the system would shut down the RF and notify the appropriate personnel via email.



This new development was successfully used alongside software that automatically adjusts power levels of the RF to utilise the evenings and nights of CLARA's exploitation period for conditioning the high repetition rate RF gun, time which otherwise wouldn't have been used. This system has the potential to save weeks of conditioning time for the linacs of Phase 2.

Data Acquisition

Signals previously determined from oscilloscope traces are now acquired using dedicated data acquisition hardware from IOxOS (ADC3110) and PSI (DRS4). Waveforms and parameters are acquired at the full machine repetition rate of up to 100Hz. Where possible parameters are determined from the waveforms e.g. charge, laser energy. They are then saved using the EPICS Archiver Appliance. Data is timestamped using NTP and triggered from an MRF timing system



Virtualization

Virtualisation has been achieved using a combination Kernel-based Virtual Machine (KVM), and Linux container (LXC). KVM simulates a server but requires the full memory of that server. LXC uses the kernel to simulate a full Linux OS but only requires the memory used by the application. Both systems have been shown to use CPU and memory within only a few percent difference to a native server.