LCLS Linac Mode Manager Interface

A high-level application that helps makes sense of how much beam goes where.

T. Summers, C. Bianchini Mattison, M. Gibbs, T. Kabana, P. Krejcik, J. Mock
SLAC National Accelerator Laboratory, Menlo Park, California, USA.

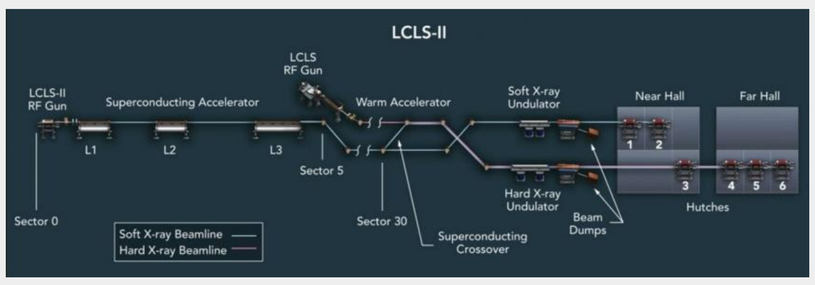
ABSTRACT

With the successful commissioning of the new superconducting (SC) Linac, the Linac Coherent Light Source (LCLS) now has the capability of interleaving beams from either the normal conducting (NC) Linac or the SC Linac to two different destinations, the soft (SXR) and hard (HXR) X-ray undulator beamlines. A mode manager user interface has been created to manage the beamline configuration to transport beam pulses to multiple destinations, which include the numerous intermediate tune-up dumps and safety dumps between the injectors and the final beam dumps. The mode manager interfaces with the timing system which controls the bunch patterns to the various locations, and the machine protection system which prevents excess beam power from being sent to the wrong destination.

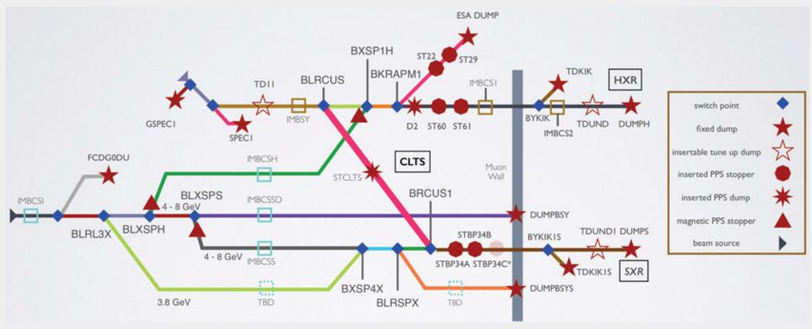
MOTIVATION

Originally a single linac with one undulator line, operators now need to mix and match electron beams of very different rate and power from two linacs into one or both undulator lines, meeting scientific program objectives while satisfying requirements of the Machine Protection and Timing Systems.

Geographical overview of SLAC LCLS facility



LCLS linac and beamline schematic



Functional (subway) map of the various paths, and the stoppers, magnets, and kickers that define them.

OPERATING MODES

A number of operating ‘modes’, such as the sample here, are defined as the combination of beamline components that define the path of possible beam from electron gun to final destination. Each of these modes may be compatible with other modes, so that beam pulses from one linac can be directed to multiple destinations.

Mode	Name	Description
SC10	SC Laser	Full power, 1 MHz
SC13	SC DIAG0 Line	120 Hz max
SC14	SC BSY Dump	120 kW, 100 kHz
SC17	SC HXR Dump	120 kW, 100 kHz
SC18	SC SXR Dump	120 kW, 100 kHz
NC0	NC Laser	Full charge, 120 Hz
NC7	NC HXR Tuning	Full charge, 10 Hz
NC8	NC HXR Dump	Full charge, 120 Hz
NC11	NC SXR Tuning	Full charge, 10 Hz
NC12	NC SXR Dump	Full charge, 120 Hz

INTERFACE REQUIREMENTS

The interface should:

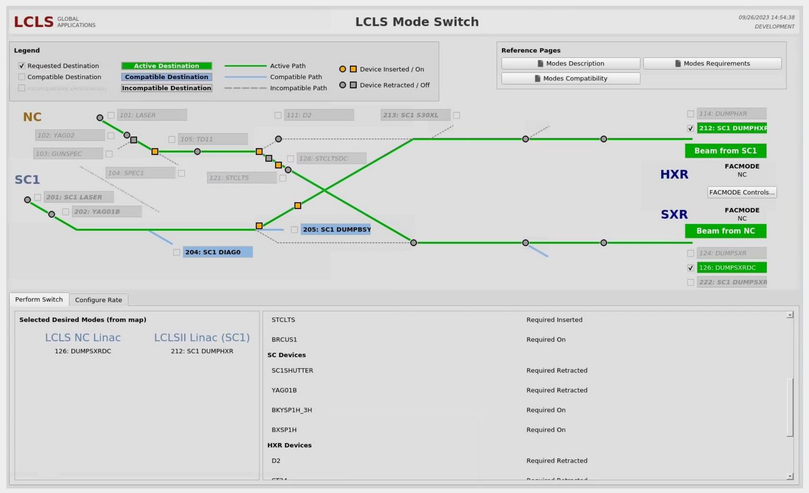
- Compute and indicate active machine mode.
- Identify modes compatible with current or selected paths.
- Assist operators transition between modes.
- Provide status of faults from other systems such as PPS or MPS.
- Aid the operator in configuring equipment in the state appropriate for selected modes.
- Automate switching procedures as available.

The interface should not:

- Manipulate any accelerator safety system such as PPS or MPS.
- Become a dependency for accelerator safety systems.
- Assert its own latches as a necessary part of operation.
- Be the sole application for modifying the current beampath.

INTERFACE IMPLEMENTATION

An EPICS IOC was created to host the selection, status, and calculation PVs. This was chosen to enforce a single source of truth with statuses updating in real time as the input links change. The PVs are archived, write restricted to the control room, and available to be read in configuration save sets and displayed on other interfaces.



Mode Switch Interface

Focus is on the map showing the actual state of the machine.

As target destinations are selected, compatible paths are highlighted.

Required states of relevant equipment is listed.

A “FACMODE” PV is set by operators to automatically prompt devices in common areas, such as BPMS, that need to switch between SC and NC timing systems for their triggers.

Once a mode is selected and the devices configured to satisfy the MPS system, the operator switches to timing selection. For the NC linac this is simply selecting 1 of 14 predefined patterns such as “HXR 0 / SXR 120” or “HXR 60 / SXR 60”. The SC linac is more complicated and requires making selections on the Timing Pattern Selection page.

Superconducting Linac Timing Pattern Selection Interface

Each destination has different rates based on the MPS allowed power class.

Dynamic lists of available rates per destination are populated based on the selected mode combinations.

The final pattern is loaded to the TPG and applied.

CONCLUSION AND ONGOING WORK

The Mode Switch Interface aids operators in understanding the current state of the accelerators, with switching from one configuration to another, and selecting multiple compatible beam destinations. Currently, the interface provides a list of magnets, kickers, and stoppers and the state they need to be in for the selected mode to be implemented and allowed by the MPS system. Once the mode is chosen, operators can use the SC timing pattern selection interface to choose what rate to send to each destination.

Commissioning is ongoing, and the operations group is gaining experience setting up ‘normal’ operating modes for both linacs. Currently, they switch modes and configure the beamlines manually following their standard methods and procedures. As these procedures become routine, commonly executed sequences are expected to be migrated into sequence records in EPICS IOCs for automation.

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tsummers@slac.stanford.edu