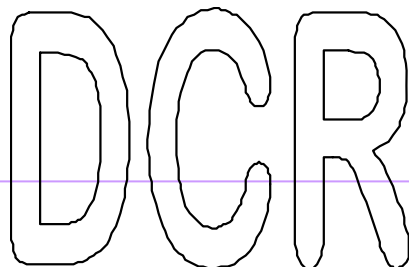


|   |                                      |                                |
|---|--------------------------------------|--------------------------------|
| <b>ENGINEERING<br/>SPECIFICATION DOCUMENT<br/>(ESD)</b>               | <b>Doc. No.<br/>SP-391-001-21 R0</b> | <b>LUSI SUB-SYSTEM<br/>XPP</b> |
| <b>Engineering Specifications for the XPP Instrument<br/>Controls</b> |                                      |                                |
| Perry Anthony<br>Author   | _____                                | _____                          |
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|   | Signature                            | Date                           |
| J. Brian Langton<br>Instrument Engineer                               | _____                                | _____                          |
|   | Signature                            | Date                           |
| Darren Marsh<br>Quality Control                                       | _____                                | _____                          |
|   | Signature                            | Date                           |
| Thomas Fornek<br>LUSI Project Manager                                 | _____                                | _____                          |
|   | Signature                            | Date                           |
|   | _____                                | _____                          |

| <b>Revision</b> | <b>Date</b> | <b>Description of Changes</b> | <b>Approved</b> |
|-----------------|-------------|-------------------------------|-----------------|
| R0              | 24Jul08     | Initial release               |                 |
|                 |             |                               |                 |
|                 |             |                               |                 |



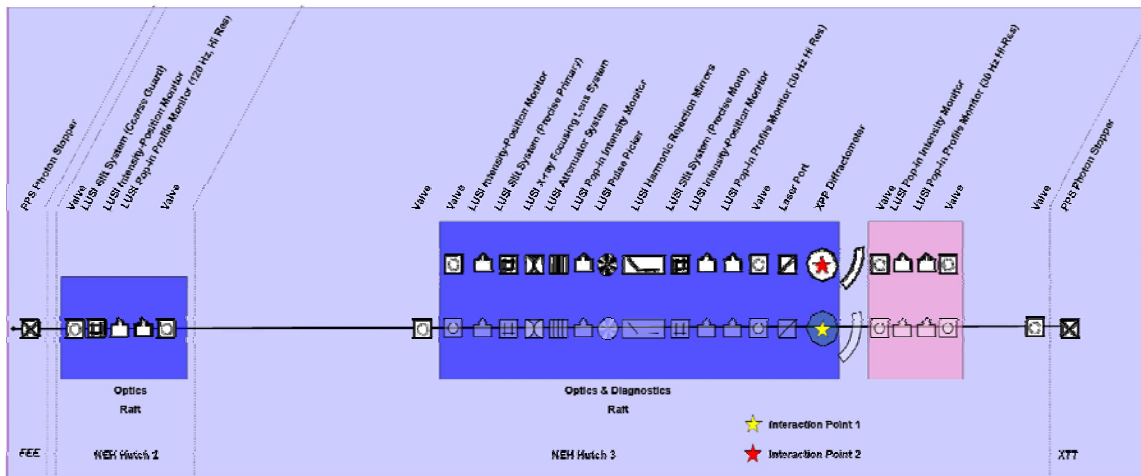
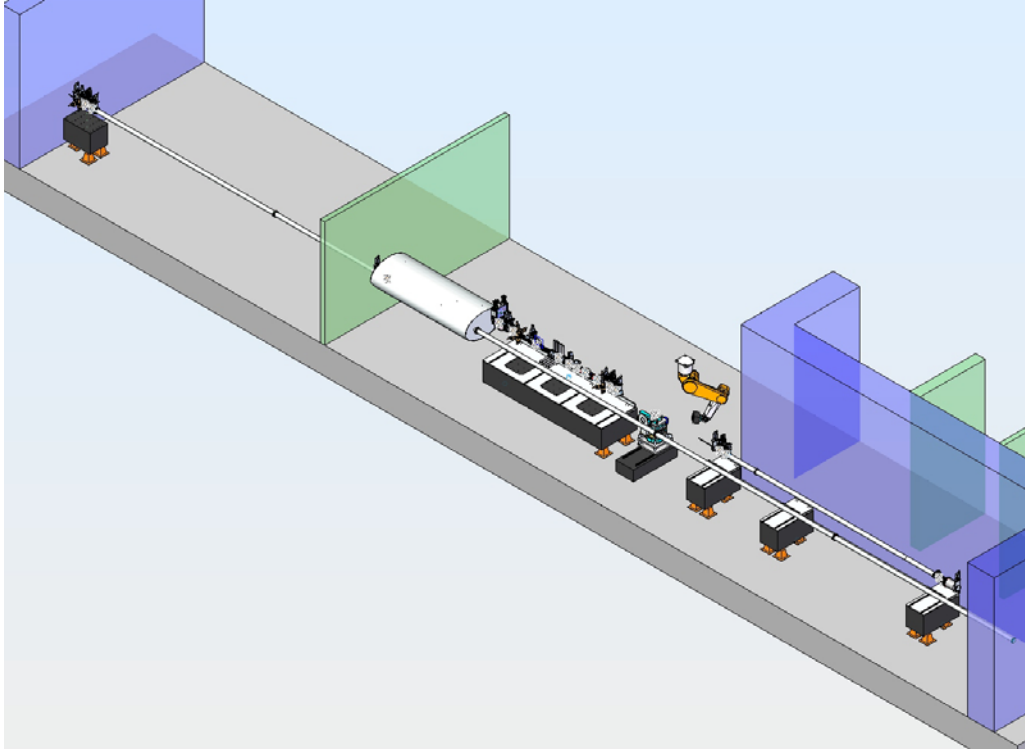
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### 1. Applicable Documents

|                    |   |
|--------------------|---|
| PRD# SP-391-000-33 | Physics Requirements for the XPP Instrument |
| PRD# SP-391-000-03 | LUSI Controls and Data System               |
| PRD# SP-391-000-13 | XPP Diffractometer System                   |
| PRD# SP-391-000-18 | XPP Laser System                            |
| SOW# PS-391-000-86 | XPP Robot Characterization                  |
| PRD# SP-391-000-97 | XPP 2-D Detector                            |
| ESD# SP-391-001-19 | LUSI Common Instruments Controls            |

## 2. Overview



This document contains the specifications for the control system for the XPP instrument components and the specifications for the data acquisition system for this instrument.

Separate Engineering Specification Documents cover the Laser System (laser room and optics table in NEH Hutch 3) used by XPP and the Electron-Optics diagnostics system, which is located in the Linac To Undulator (UTR) region.

### 3. XPP Instrument Control

#### 3.1. Instrument Components

The XPP is composed of various photon beam-line components. Each component is detailed below, with XPP instrument packages, made up of these components, are summarized later in this section.

EPICS control system will allow the user to select system to view summary status of components and to select individual components for detailed control.

##### 3.1.1. LUSI Common Diagnostics (*PRDs SP-391-000-04, 08, 09, 10, 14, 15, 23, ESDs SP-391-000-54, 60, 66, 89, 91, 92*)

LUSI common optics and diagnostic instruments are used to define, measure and monitor the beam. XPP controls common diagnostic devices locate in NEH Hutch 2 and in the XPP experimental hutch, NEH Hutch 3.

LUSI common diagnostic instruments located in NEH Hutch 2 include:

- LUSI Coarse Guard Slit System: qt. 1
- LUSI In-situ Intensity-Position Monitor: qty. 1
- LUSI Pop-in Profile Monitor with High-Res modification: qty. 1

LUSI common diagnostic instruments located in FEH Hutch 5 include:

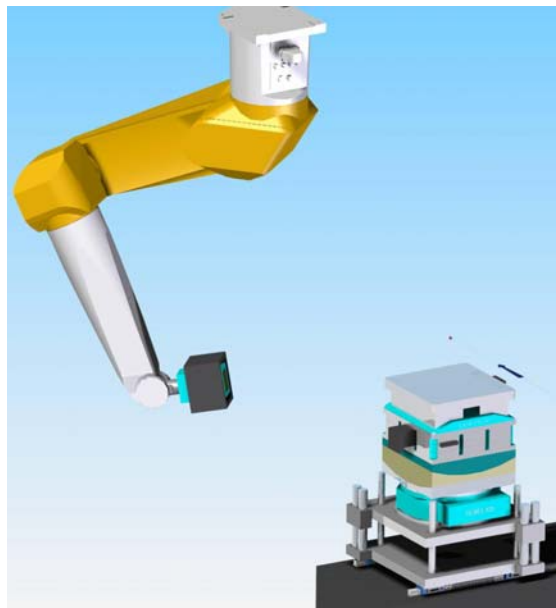
- LUSI In-situ Intensity-Position Monitor: qty. 2
- LUSI Precise Primary and Precise Mono Slit Systems: qt. 1 each
- LUSI X-Ray Focusing Lens System with Z motion: qt. 1
- LUSI Attenuator: qty. 1
- LUSI Pop-in Intensity Monitor: qty. 2
- LUSI Pulse Picker: qty. 1
- LUSI Harmonic Rejection Mirrors: qty. 1
- LUSI Pop-in Profile Monitor with High-Res modification: qty. 2

The EPICS control system will implement all controls and calibrations for these devices as defined in the LUSI Common Diagnostics Controls ESD #SP-391-001-19.

EPICS control system shall allow for CXI and XCS control system use of diagnostic devices in NEH Hutch 2 and 3 during non-XPP running cycles.

Slit Systems, In-situ Intensity-Position Monitors, and the Attenuator all generate BLD headers for the DAQ system.

### 3.1.2. XPP Diffractometer and Wide Angle Detector Mover (SP-391-000-13)



The Diffractometer and Wide Angle Detector Mover consists of several components requiring motion control. The Diffractometer system will have 17 stepper motors; though only 14 will be in use at one time – two interchangeable final mounts have 3 similar motors each – requiring 14 control interfaces. The control software shall include provisions for specifying which final mount is installed and control appropriately. Associated with the Diffractometer is a “beam stop” device requiring X and Y position control. The wide angle detector has a number of motions to cover a spherical region around sample. The wide angle detector will be mounted on articulated arm with multi-axis motion.

EPICS to display, control, and archive all motions. EPICS to coordinate orientation of samples and movement of detector in reciprocal space, with scan modes.

Provides information to BLD headers on sample and detector positions.

| Component                              | Device           | Model Number                      | Quantity   | Interface Type |
|--|------------------|-----------------------------------|------------|----------------|
| <b>Diffractometer with “beam stop”</b> | Motors on stages | <a href="#">Mdrive Plus</a>       | 19 (only   | Serial         |
|  | TBD              | <a href="#">(smart motor) TBD</a> | 16 active) |                |
| <b>Wide Angle Mover</b>                | Robotic Arm      | <a href="#">TBD</a> (robotic arm) | 1          | Ethernet (XML) |

### 3.1.3. XPP 2-D X-ray Detector

The 2-D X-ray detector is a 1024x1024 pixel array. Readout uses similar electronics as the Cornell detector.

EPICS controls power supplies for front end electronics, providing displays, controls, and archiving of settings. Other functions TBD.

| Component                 | Device                      | Model Number                | Quantity | Interface Type    |
|---------------------------|-----------------------------|-----------------------------|----------|-------------------|
| <b>2-D X-ray Detector</b> | SLAC built interface module | SLAC built interface module | 1        | Enet/Timing Fiber |

### 3.2. Instrument packages

#### 3.2.1. Optics Table in Hutch 2

This instrument package contains the following items from upstream to downstream on the instrument stand (vacuum components discussed in Vacuum Section):

- LUSI Coarse Guard Slit System
- LUSI In-Situ Intensity-Position Monitor
- LUSI Pop-in Profile Monitor with high resolution option.

Summary of EPICS control elements:

| EPICS Control Group | Device  | Model Number  | Quantity | Interface Type   |
|---------------------|---|---|----------|--|
| Motion              | Stepper Motor   | <a href="#">Mdrive Plus (smart motor)</a>                             | 9        | Serial/ combined with power supply in custom chassis     |
| Power               | Power supply for Intensity-Position Monitor Front End Electronics | 12 Volt supply  | 1        | NA   |
| Power               | Power supply for the stepper motors                               | SLAC custom built   | 1        | Combined with Serial control interface in custom chassis |
| Power               | Camera  | 12 Volt supply  | 1        | NA   |
| Vision              | Camera  | <a href="#">Pulnix TM-6710CL</a> or <a href="#">Imperx IPX-VGA210</a> | 1        | CameraLink   |
| DAQ                 | Camera  | CameraLink  | 1        | 120Hz DAQ Readout  |
| DAQ                 | Intensity-Position Monitor  | SLAC built  | 1        | Serial   |

### 3.2.2. Optics & Diagnostics Table in Hutch 3

This instrument package contains the following items from upstream to downstream on the instrument stand (vacuum components discussed in Vacuum Section):

- LUSI In-Situ Intensity Position Monitor
- LUSI Precise Primary Slit System
- LUSI X-Ray Focusing Lens System with Z motion
- LUSI Attenuator System
- LUSI Pop-in Intensity Monitor
- LUSI Pulse Picker
- LUSI Harmonic Rejection Mirrors
- LUSI Precise Mono Slit System
- LUSI In-Situ Intensity-Position Monitor
- LUSI Pop-in Profile Monitor with high resolution option
- XPP Diffractometer and Wide Angle Detector Mover

Summary of EPICS control elements:

| EPICS Control Group | Device  | Model Number  | Quantity                              | Interface Type   |
|---------------------|---|---|---------------------------------------|--|
| Motion              | Stepper Motor   | <a href="#">Mdrive Plus (smart motor)</a>                             | 28+16 active motors on Diffractometer | Serial/ combined with power supply in custom chassis     |
| Motion              | Pneumatic positioners   | SLAC Solenoid Controller SD-385-001                                   | 2                                     | Digital IO to IP digital IO boards on VME cpu            |
| Motion              | Detector Mover  | Robotic controller  | 1                                     | Enet   |
| Power               | Power supply for the stepper motors                               | SLAC custom built   | 3                                     | Combined with Serial control interface in custom chassis |
| Power               | Power supply for Intensity-Position Monitor Front End Electronics | 12 Volt supply  | 3                                     | NA   |
| Power               | Camera  | 12 Volt supply  | 1                                     | NA   |
| Vision              | Camera  | <a href="#">Pulnix TM-6710CL</a> or <a href="#">Imperx IPX-VGA210</a> | 1                                     | CameraLink   |
| DAQ                 | Camera  | CameraLink  | 1                                     | 30 Hz DAQ Readout  |

|     |                            |            |   |                   |
|-----|----------------------------|------------|---|-------------------|
| DAQ | Intensity Monitor          | SLAC built | 1 | Serial            |
| DAQ | Intensity-Position Monitor | SLAC built | 2 | Serial            |
| DAQ | 2-D Detector readout       | SLAC Built | 1 | Enet/Timing Fiber |

### 3.2.3. Diagnostics Table in Hutch 3

This instrument package contains the following items from upstream to downstream on the instrument stand (vacuum components discussed in Vacuum Section):

- LUSI Pop-in Intensity Monitor
- LUSI Pop-in Profile Monitor with high resolution option

Summary of EPICS control elements:

| EPICS Control Group | Device   | Model Number  | Quantity | Interface Type   |
|---------------------|--|---|----------|--|
| Motion              | Stepper Motor  | <a href="#">Mdrive Plus (smart motor)</a>                             | 3        | Serial/ combined with power supply in custom chassis     |
| Power               | Power supply for Intensity Monitor Front End Electronics | 12 Volt supply  | 1        | NA   |
| Power               | Power supply for the stepper motors                      | SLAC custom built   | 1        | Combined with Serial control interface in custom chassis |
| Power               | Camera   | 12 Volt supply  | 1        | NA   |
| Vision              | Camera   | <a href="#">Pulnix TM-6710CL</a> or <a href="#">Imperx IPX-VGA210</a> | 1        | CameraLink   |
| DAQ                 | Camera   | CameraLink  | 1        | 30Hz DAQ Readout   |
| DAQ                 | Intensity Monitor  | SLAC built  | 1        | Serial   |



### 3.3. XPP Vacuum System

The XPP instrument will have its own vacuum system controlled by a PLC based system located in Hutch 3. This system will control all valves, pumps, and gauges associated with the XPP instrument components located in Hutch 2 and Hutch3. This system interfaces to the XTOD Vacuum System to coordinate control with installed XTOD components.

EPICS control system will allow the user to select system to view summary status of components and to select individual components for detailed control.

| Component                 | Device                                    | Model Number   | Quantity               | Interface Type |
|---------------------------|---|--|------------------------|----------------|
| <b>NEH Hutch 2 Vacuum</b> | Gate Valve                                | VAT Series 108 (pneumatic controller)  | 2                      | PLC controlled |
|                           | Ion Pumps                                 | <a href="#">Gamma Vacuum TiTan100L</a> with <a href="#">Digitel MPS Controller</a> | 1 pumps, 1 controllers | Serial         |
|                           | Cold Cathode Gauges and TBD Pirani Gauges | MKS with MKS 937A Gauge Controller   | 1                      | Serial         |
| <b>NEH Hutch 3</b>        | Gate Valve                                | VAT Series 108 (pneumatic controller)  | 6                      | PLC controlled |
|                           | Ion Pumps                                 | <a href="#">Gamma Vacuum TiTan100L</a> with <a href="#">Digitel MPS Controller</a> | 3 pumps, 2 controllers | Serial         |
|                           | Cold Cathode Gauges and TBD Pirani Gauges | MKS with MKS 937A Gauge Controller   | 3                      | Serial         |

### 4. Global Hutch Controls

Temperature monitoring of the hutch environment will be needed. Standard timing information will be needed to sync components (e.g. cameras).

| Control Requirement   | Control System Implementation  |
|---|--|
| LCLS pulse information/timing/triggers  | EVR  |
| Environmental controls<br>Logging of temperature in hutch (how frequent?)<br>Maintained by standard AC system | Temperature monitored in EPICS, sensor TBD.<br><br>EPICS will display and archive information. |

### 5. Machine Protection System (MPS) Interface

XRT and FEH Hutch 5 – Vacuum system interface to MPS.