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| <b>INTERFACE CONTROL DOCUMENT (ICD)</b>    | <b>Doc. No.<br/>SP-391-001-25 R0</b> | <b>LUSI SUB-SYSTEM<br/>XCS</b> |
| <b>XES PCDS to LUSI XCS Instrument ICD</b> |                                      |                                |
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## Table of Contents

|                                  |    |
|----------------------------------|----|
| Table of Contents .....          | 2  |
| 1. Applicable Documents .....    | 2  |
| 2. Introduction .....            | 3  |
| 3. XCS Instrument Packages ..... | 4  |
| 4. Other Systems .....           | 11 |

### 1. Applicable Documents

|                    |                                  |
|--------------------|----------------------------------|
| PRD# SP-391-001-35 | XCS Instrument                   |
| PRD# SP-391-001-33 | XCS Wide Angle Detector Stage    |
| PRD# SP-391-001-32 | XCS Diffractometer System        |
| PRD# SP-391-000-98 | XCS 2-D Detector                 |
| ESD# SP-391-001-19 | LUSI Common Instruments Controls |
| ESD# SP-391-001-24 | XCS Controls ESD                 |
| ESD# SP-391-001-26 | XCS DAQ ESD                      |

## 2. Introduction

This document defines the interface between the XCS Experiment instrument and the XES Photon Controls and Data Systems. Input for this document comes from the XCS Controls Engineering Specification Document (Controls ESD) and the XCS Data Acquisition Engineering Specification Document (DAQ ESD).

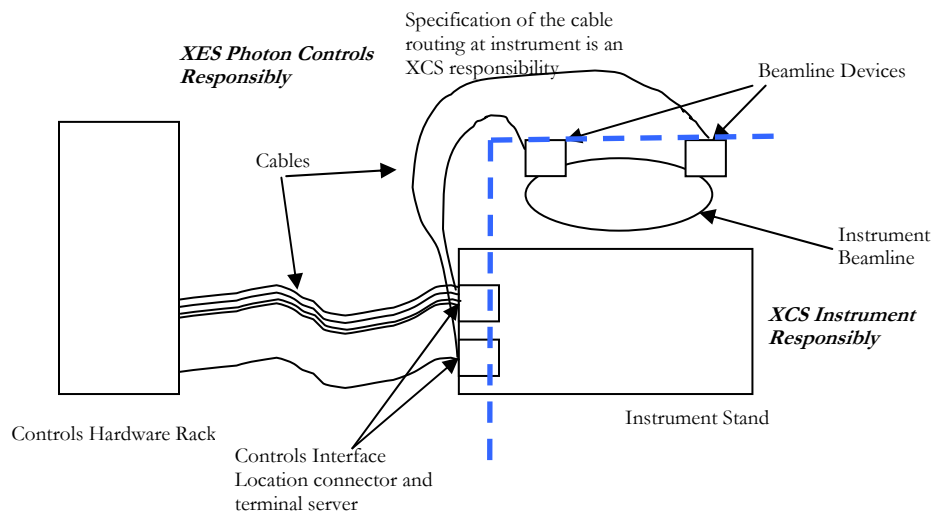
### 2.1. Scope

This document establishes the areas of responsibility for XCS Instrument and XES Photon Controls and defines the interface components. This includes all components for Vacuum, Motion, Vision, DAQ, and Power as well as interfaces to other services including MPS, networking, and timing systems.

### 2.2. Areas of responsibility

In general, the XCS Instrument is responsible for the acquisition and installation of all beam line devices for vacuum, pressure monitoring, motion, vision, and specifying the cable routing from the Controls Interface Location connector to the beam line devices. The Controls/Data Acquisition Group is responsible for the Controls Interface Location connector, all cabling from the Controls Interface Location connector to the controlling hardware (rack based), and is responsible for the acquisition and installation of all controls hardware. Controls is also responsible for the procurement and installation of cables from the Interface connector to the beamline devices. For certain components, due to their complexity, the XCS instrument will be responsible for the cabling to the fixed Controls Interface Location connector – eg. the Diffractometer.

**Figure 2.2.1** Conceptual layout showing areas of responsibility and interface points



### 2.3. Controls Interface Location Connector

The Controls Interface Location connector is a connection point between the Controls/Data Acquisition cabling and the device. This multipurpose connection point (e.g. DIN-rail) is generally located on the experiment stand containing the devices being controlled and read out. In special situations, the Controls Interface Location may be at the particular device itself (e.g. HV power for Ion pumps). For serial controls, the Controls Interface Location connector is an Ethernet connected terminal server located on the instrument stand.

## 3. XCS Instrument Packages

### 3.1.1. Optics & Diagnostics Table 1 in XRT

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

- LUSI Slit System
- LUSI In-situ Intensity Position Monitor
- LUSI Pop-in Profile Monitor
- LUSI Pop-in Intensity Monitor (note, may be combined with the Profile Monitor)

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 and Intensity Monitor Front End Electronics | 12 Volt supply                            | 2        | 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-1402CL</a>          | 1        | CameraLink   |
| Vision              | Zoom lens ( <a href="#">Navitar 1-62523</a> )   | SLAC Profile Monitor Controller (TBD)     | 1        | VME w/Acromag IP-445                                     |

|     |  |            |   |                   |
|-----|--|------------|---|-------------------|
| DAQ | Camera   | CameraLink | 1 | 120Hz DAQ Readout |
| DAQ | Intensity-Position Monitor and Intensity Monitor | SLAC built | 2 | Serial            |

### 3.1.2. Monochromator in XRT

This instrument package contains the following items (vacuum component discussed in Vacuum Section):

- LUSI Monochromator

Summary of EPICS control elements:

| EPICS Control Group | Device                              | Model Number   | Quantity | Interface Type   |
|---------------------|-------------------------------------|--|----------|--|
| Motion              | Stepper Motor                       | <a href="#">TBD, may be Mdrive Plus smart motors or Mdrive smart controllers</a> | 10       | Serial/ combined with power supply in custom chassis     |
| Power               | Power supply for the stepper motors | SLAC custom built  | 1        | Combined with Serial control interface in custom chassis |

### 3.1.3. Optics & Diagnostics Table 2 in XRT

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

- LUSI Slit System
- LUSI In-situ Intensity Position Monitor
- LUSI Pop-in Profile Monitor
- LUSI Pop-in Intensity Monitor (note, may be combined with the Profile Monitor)
- XSC Beam Stop

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 |
| Motion              | Pneumatic positioners (beam stop)                                 | SLAC Solenoid Controller SD-385-001       | 1        | Digital IO to IP digital IO boards on VME cpu        |
| Power               | Power supply for Intensity-Position Monitor and Intensity Monitor | 12 Volt supply                            | 2        | NA   |

| Front End Electronics |  |                                       |   |  |
|-----------------------|--|---------------------------------------|---|--|
| 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-1402CL</a>      | 1 | CameraLink   |
| Vision                | Zoom lens ( <a href="#">Navitar 1-62523</a> )    | SLAC Profile Monitor Controller (TBD) | 1 | VME w/Acromag IP-445                                     |
| DAQ                   | Camera   | CameraLink                            | 1 | 120Hz DAQ Readout  |
| DAQ                   | Intensity-Position Monitor and Intensity Monitor | SLAC built                            | 2 | Serial   |

### 3.1.4. Split & Delay in XRT

This instrument package contains the following items (vacuum component discussed in Vacuum Section):

- Split & Delay System

Summary of EPICS control elements:

| EPICS Control Group | Device                         | Model Number | Quantity | Interface Type |
|---------------------|--------------------------------|--------------|----------|----------------|
| Miscellaneous       | Device specific control system | NA           | 1        | Enet           |

### 3.1.5. Optics & Diagnostics Table 3 in XRT

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

- LUSI Slit System
- LUSI In-situ Intensity Position Monitor
- LUSI Pop-in Profile Monitor
- LUSI Pop-in Intensity Monitor (note, may be combined with the Profile Monitor)
- XCS Beam Stop

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     |
| Motion              | Pneumatic positioners (beam stop)   | SLAC Solenoid Controller SD-385-001       | 1        | Digital IO to IP digital IO boards on VME cpu            |
| Power               | Power supply for Intensity-Position Monitor and Intensity Monitor Front End Electronics | 12 Volt supply                            | 2        | 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-1402CL</a>          | 1        | CameraLink   |
| Vision              | Zoom lens ( <a href="#">Navitar 1-62523</a> )   | SLAC Profile Monitor Controller (TBD)     | 1        | VME w/Acromag IP-445                                     |
| DAQ                 | Camera  | CameraLink                                | 1        | 120Hz DAQ Readout  |
| DAQ                 | Intensity-Position Monitor and Intensity Monitor  | SLAC built                                | 2        | Serial   |

### 3.1.6. Drift-End Optics & Diagnostics Table in XRT

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

- LUSI Slit System
- LUSI In-situ Intensity Position Monitor
- LUSI Pop-in Profile Monitor
- LUSI Pop-in Intensity Monitor (note, may be combined with the Profile Monitor)

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 and Intensity Monitor Front End Electronics | 12 Volt supply                            | 2 | 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-1402CL</a>          | 1 | CameraLink   |
| Vision | Zoom lens ( <a href="#">Navitar 1-62523</a> )   | SLAC Profile Monitor Controller (TBD)     | 1 | VME w/Acromag IP-445                                     |
| DAQ    | Camera  | CameraLink                                | 1 | 120Hz DAQ Readout  |
| DAQ    | Intensity-Position Monitor and Intensity Monitor  | SLAC built                                | 2 | Serial   |

### 3.1.7. Local Optics Table in XRT

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

LUSI X-Ray Focusing Lens

Summary of EPICS control elements:

| EPICS Control Group | Device                              | Model Number                              | Quantity | Interface Type   |
|---------------------|-------------------------------------|---|----------|--|
| Motion              | Stepper Motor                       | <a href="#">Mdrive Plus (smart motor)</a> | 2        | Serial/ combined with power supply in custom chassis     |
| Power               | Power supply for the stepper motors | SLAC custom built                         | 1        | Combined with Serial control interface in custom chassis |

### 3.1.8. Diagnostics Table in FEH Hutch 4

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



- LUSI Attenuator System
- LUSI Pulse Picker
- LUSI Harmonic Rejection Mirror
- LUSI Slit System
- LUSI Slit System
- LUSI In-situ Intensity Position Monitor
- LUSI Pop-in Profile Monitor
- LUSI Pop-in Intensity Monitor (note, may be combined with the Profile Monitor)

Summary of EPICS control elements:

| EPICS Control Group | Device  | Model Number                              | Quantity | Interface Type   |
|---------------------|---|---|----------|--|
| Motion              | Stepper Motor   | <a href="#">Mdrive Plus (smart motor)</a> | 21       | Serial/ combined with power supply in custom chassis     |
| Motion              | 10 pneumatically driven filters.  | SLAC Solenoid Controller SD-385-001       | 2        | Digital IO to IP digital IO boards on VME cpu.           |
| Power               | Power supply for Intensity-Position Monitor and Intensity Monitor Front End Electronics | 12 Volt supply                            | 2        | NA   |
| Power               | Power supply for the stepper motors   | SLAC custom built                         | 2        | Combined with Serial control interface in custom chassis |
| Power               | TTL Pulse to power supply for shutter (note, power supply part of shutter system)       | SLAC Trigger module                       | 1        | VME  |
| Power               | Camera  | 12 Volt supply                            | 1        | NA   |
| Vision              | Camera  | <a href="#">Pulnix TM-1402CL</a>          | 1        | CameraLink   |
| Vision              | Zoom lens ( <a href="#">Navitar 1-62523</a> )   | SLAC Profile Monitor Controller (TBD)     | 1        | VME w/Acromag IP-445                                     |
| DAQ                 | Camera  | CameraLink                                | 1        | 120Hz DAQ Readout  |
| DAQ                 | Intensity-Position Monitor and Intensity Monitor  | SLAC built                                | 2        | Serial   |

### 3.1.9. Diffractometer in FEH Hutch 4

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

Diffractometer Package

Summary of EPICS control elements:

| EPICS Control Group | Device  | Model Number                              | Quantity | Interface Type   |
|---------------------|---|---|----------|--|
| Motion              | Stepper Motor   | <a href="#">Mdrive Plus (smart motor)</a> | 13       | Serial/ combined with power supply in custom chassis     |
| Power               | Power supply for Intensity-Position Monitor and 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 |
| DAQ                 | Intensity-Position Monitor and Intensity Monitor  | SLAC built                                | 1        | Serial   |

### 3.1.10. Large Angle Mover & Detector in FEH Hutch 4

Summary of EPICS control elements:

| EPICS Control Group | Device                              | Model Number  | Quantity | Interface Type   |
|---------------------|-------------------------------------|---|----------|--|
| Motion              | Stepper Motor                       | <a href="#">TBD, may be Mdrive Plus (smart motor)</a> | 6        | Serial/ combined with power supply in custom chassis     |
| Motion              | Pneumatic positioners (beam stop)   | SLAC Solenoid Controller SD-385-001                   | 1        | Digital IO to IP digital IO boards on VME cpu            |
| Power               | Front End Electronics for diode     | 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               | Power supply for 2-D Detector       | TBD   | 1        | NA   |

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

### 3.1.11. XCS Vacuum System

The XCS instrument will have its own vacuum system controlled by a PLC based system located in Hutch 4. This system will control all valves, pumps, and gauges associated with the XCS instrument components located in the XRT and Hutch 4. This system will require an interface to the XTOD Vacuum System.

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>X-Ray Transport Tunnel Vacuum</b> | Gate Valve                                | VAT Series 108 (pneumatic controller)                              | 6                      | PLC controlled |
|                                      | Ion Pumps                                 | <a href="#">Gamma Vacuum TiTan100L with Digitel MPS Controller</a> | 5 pumps, 5 controllers | Serial         |
|                                      | Cold Cathode Gauges and TBD Pirani Gauges | MKS with MKS 937A Gauge Controller                                 | 5                      | Serial         |

## 4. Other Systems

### 4.1. XTOD Vacuum System

An interface exists between the XCS Instrument vacuum system and the XTOD vacuum system in the XRT. The XTOD vacuum system controller needs a VAC OK/VAC NOT OK signal from the XCS Instrument Vacuum system. This will be provided by using the vacuum trip output from the appropriate pressure gauges on various XCS instrument stands. Controls will implement a repeater relay on the Controls Interface Location connector at these stands to route this signal to the XTOD vacuum system controller.

### 4.2. Machine Protection System

A VALVE NOT OUT signal will be provided to the Machine Protection System for each gate valve on the XCS beam line. This signal, taken from the Valve Out position indicator on the gate valve will be routed to the MPS system via the Controls Interface Location connector on the instrument stand, Controls to implement. In addition, a Beam Stop In signal from the XCS removable beam stop limit switches (two beam stops) in the XRT will be provided to the MPS system to veto signals

from down stream gate valves when this beam stop is fully inserted. Controls will implement these signals.

### **4.3. AC Power**

AC Power will be proved at each instrument stand location. Two 30 Amp circuits with Quad distribution boxes will be provided at the location of each instrument stand as listed in section 3 above. Each PCDS rack will be equipment with two separate 3 phase, 208VAC, 30 Amp circuits.

### **4.4. Machine Timing**

Several devices require precise triggering with respect to the FEL pulse. As noted in the tables above, this timing comes from the Controls system via equipment (EVRs) in the support racks.