

<b>ENGINEERING SPECIFICATION DOCUMENT (ESD)</b>	<b>Doc. No. SP-391-001-24 R0</b>	<b>LUSI SUB-SYSTEM XCS</b>
<b>Engineering Specifications for the XCS Instrument Controls DRAFT</b>		
Perry Anthony Author	_____	_____
	Signature	Date
Gunther Haller PCDS Manager	_____	_____
	Signature	Date
Aymeric Robert Instrument Physicist	_____	_____
	Signature	Date
Eric Bong Instrument Engineer	_____	_____
	Signature	Date
Darren Marsh Quality Control	_____	_____
	Signature	Date
Thomas Fornek LUSI Project Manger	_____	_____
	Signature	Date
	_____	_____

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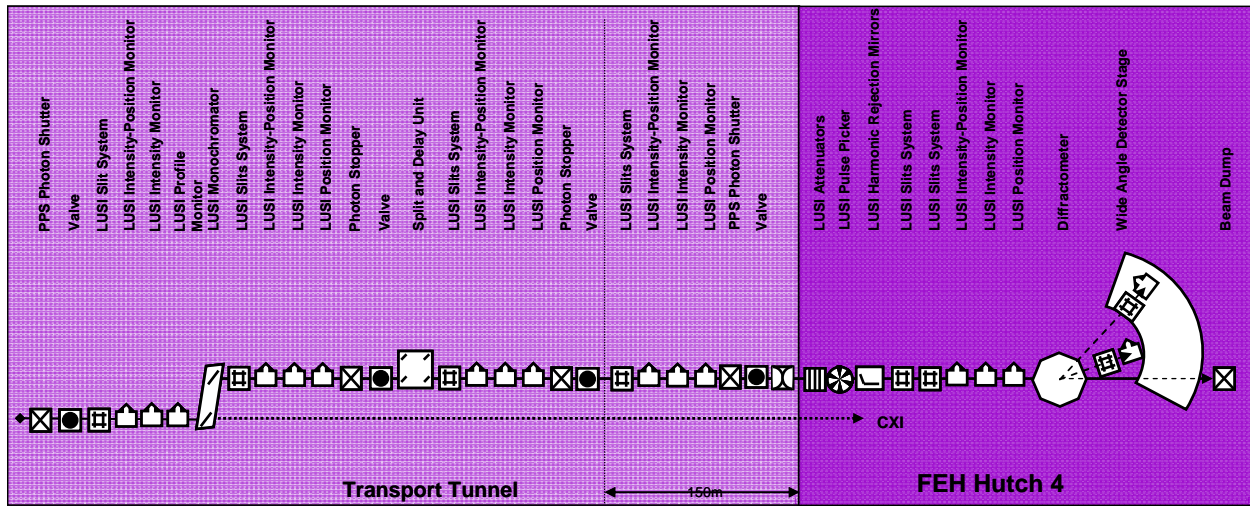
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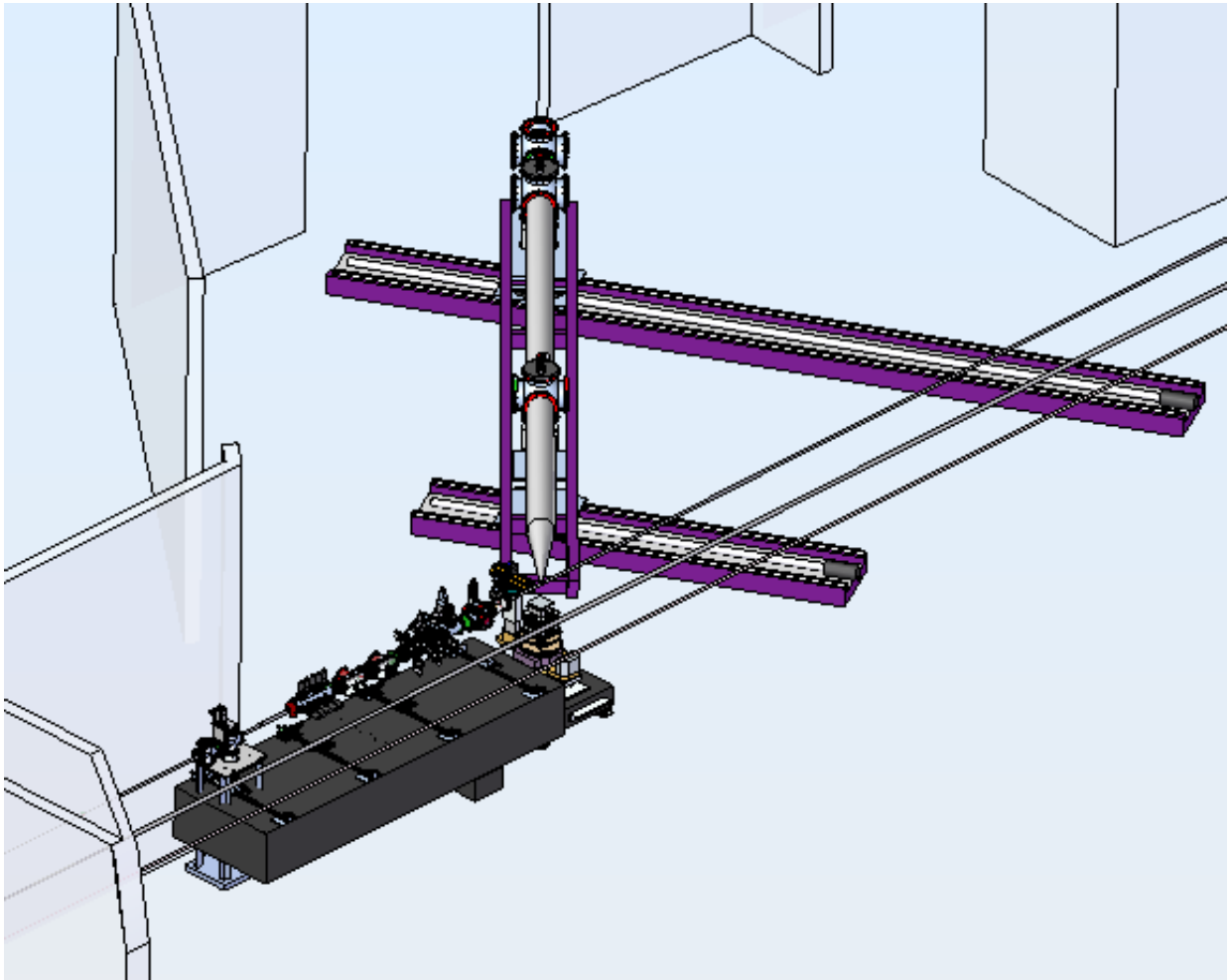
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### 1. Applicable Documents

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

## 2. Overview





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

## 3. XCS Instrument Control

### 3.1. Instrument Components

The XCS is composed of various photon beam-line components. Each component is detailed below, with XCS instrument packages, made up of these components, presented 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. XCS controls common diagnostic devices located in the XRT and in the XCS experimental hutch, FEH Hutch 4.

LUSI common diagnostic instruments located in the XRT include:

- LUSI Slit Systems all types: qt. 4
- LUSI In-situ Intensity-Position Monitor: qty. 4
- LUSI Pop-in Profile Monitor: qty. 4
- LUSI Pop-in Intensity Monitor: qty 4
- LUSI Monochromator System: qty 1
- LUSI X-Ray Focusing Lens System: qty 1

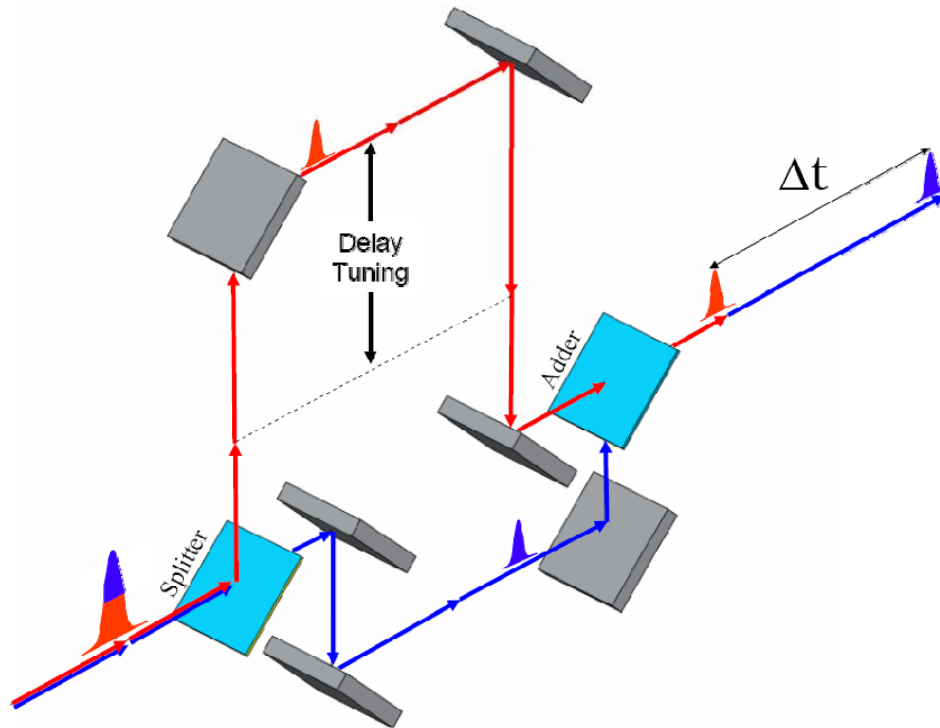
LUSI common diagnostic instruments located in FEH Hutch 4 include:

- LUSI Slit Systems: qt. 2
- LUSI In-situ Intensity-Position Monitor: qty. 1
- LUSI Pop-in Profile Monitor: qty. 1
- LUSI Pop-in Intensity Monitor: qty. 1
- LUSI Attenuator: qty. 1
- LUSI Pulse Picker: qty. 1
- LUSI X-Ray Focusing Lens System: qt. 1
- LUSI Harmonic Rejection Mirrors: qty. 1

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.

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

### 3.1.2. XCS Split & Delay



The XCS Split & Delay is designed to split the beam along two adjustable paths, recombining the two beams with an adjustable timing delay between the pulses. This device is provided with a self contained control system. Necessary vacuum components shall be integrated to the XCS Vacuum system. Ethernet access to the control system shall be provided.

The control system shall provide for the transfer of position information from the Split & Delay control system into the LCLS/LUSI beam line data packets, as well as archiving in EPICS.

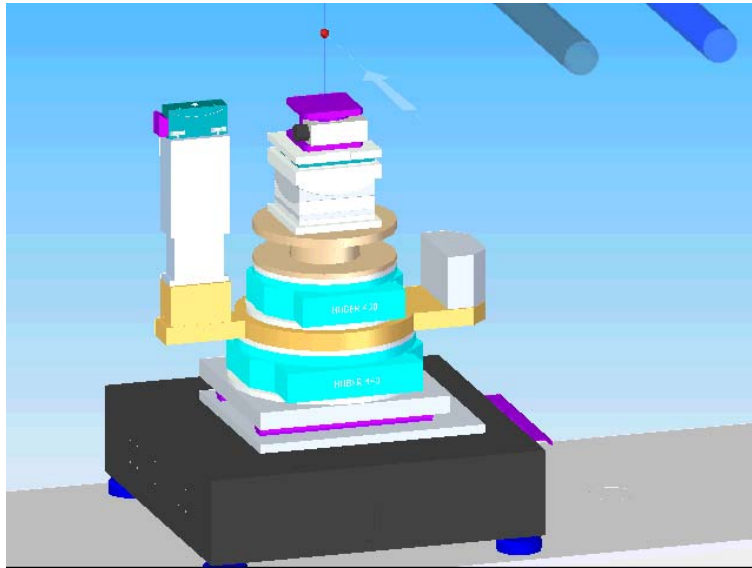
### 3.1.3. XCS Beam Stops

The XCS beam line will have two non-PPS controlled beam stops to allow for incremental testing of beamline optics. These beam stops are pneumatically inserted into the beam just down stream of the diagnostics for the Monochromator and the Split & Delay. Control will be similar to LUSI Attenuator System. Note that the position of the Beam Stop will be input into the MPS system to allow for vetoing of down stream MPS elements when a beam stop is inserted.

EPICS will allow for control and logging of Beam Stop position.

Component	Device	Model Number	Quantity	Interface Type
Beam Stops	Pneumatic positioners	SLAC Solenoid Controller SD-385-001	2	Digital IO to IP digital IO boards on VME cpu

### 3.1.4. XCS Diffractometer



The Diffractometer system will be used to precisely control the physical location and orientation of a variety of samples and sample environments with respect to the incoming X-Ray beam. It will allow moving the sample through 6 degrees of freedom using a combination of 12 translation/rotation stages, 11 controlled. The control system shall allow for the possibility of interchangeable final stages, with the software including provisions for specifying which final mount is installed and control appropriately.

In addition to the sample positioning, a local detector positioner is part of the system and provides for y and pitch adjustment of the local detector relative to the sample.

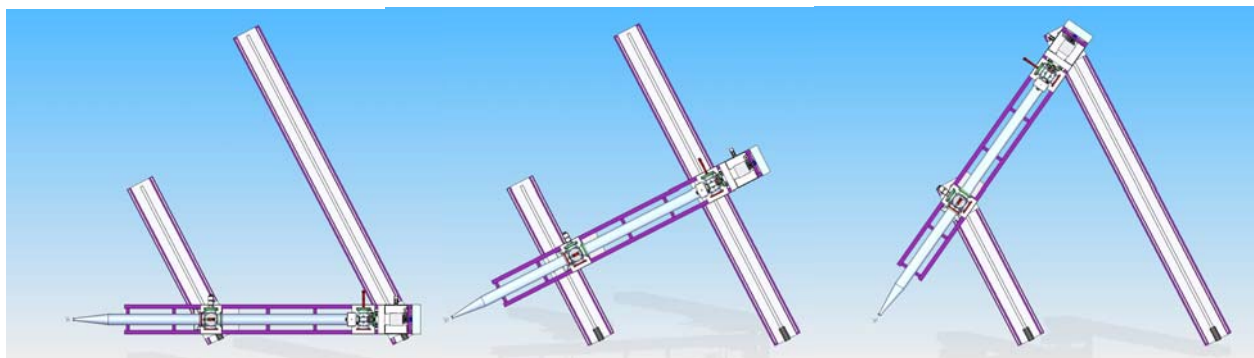
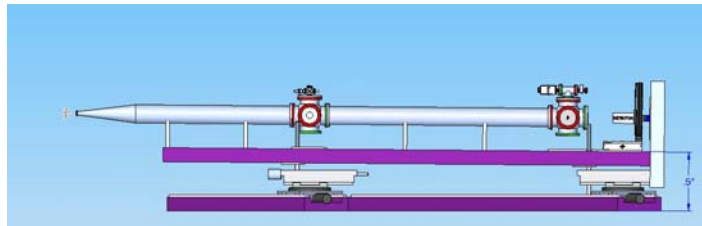
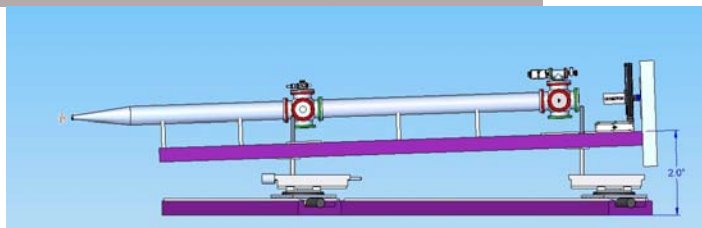
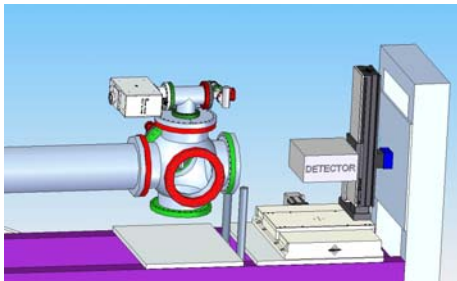
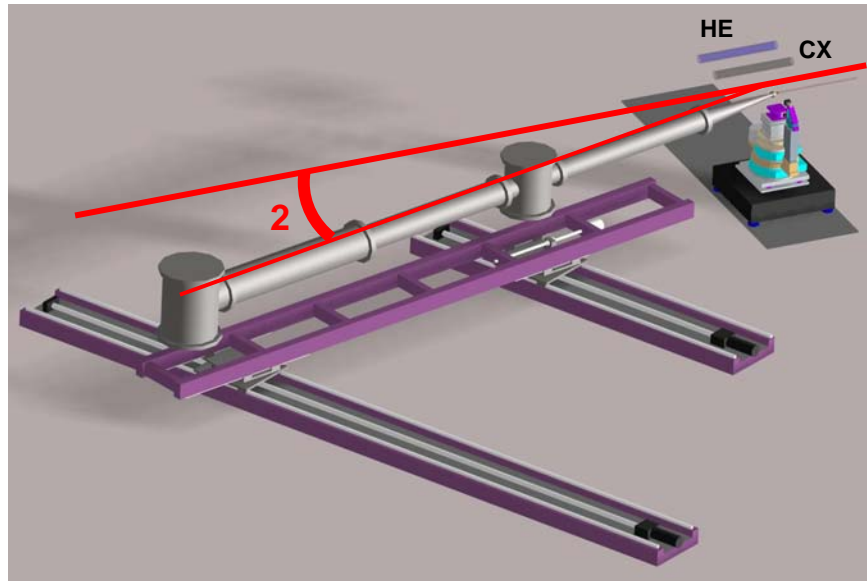
The local detector will be similar to the intensity monitor component of the LUSI Pop-in Intensity Monitor and will have similar power and readout support.

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

Provides information to BLD headers on sample and detector positions.

Component	Device	Model Number	Quantity	Interface Type
Diffractometer	Motors on stages TBD	<a href="#">Mdrive Plus</a> <a href="#">(smart motor)</a> <a href="#">TBD</a>	13	Serial

### 3.1.5. XCS Large Angle Detector Mover



The Large Angle Detector Mover will control the position of the 2-D Detector component. Motion includes rotation about the diffractometer, tilt of the detector assemble relative to the X-Ray beamline, and X and Y position of the 2-D detector.



Component	Device	Model Number	Quantity	Interface Type
<b>Large Angle Mover</b>	Motors on stages TBD	<a href="#">Mdrive Plus (smart motor)</a> TBD	4	Serial
<b>2-D Detector mover</b>	Motors on stages TBD	<a href="#">Mdrive Plus (smart motor)</a> TBD	2	Serial

### 3.1.6. XCS 2-D Detector

BNL Developed 1024 x 1024 detector array. SLAC developed readout electronics.

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 & 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

### 3.2.2. 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

### 3.2.3. 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)

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

### 3.2.4. 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

### 3.2.5. 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

### 3.2.6. 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

### 3.2.7. 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
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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

### 3.2.8. 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

### 3.2.9. 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 Monitor	SLAC built	1	Serial

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

Summary of EPICS control elements:

EPICS Control Group	Device	Model Number	Quantity	Interface Type
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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

### 3.3. 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</a> with <a href="#">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. 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 Logging of temperature in laser room and hutch (how frequent?) Maintained by standard AC system	Temperature monitored in EPICS, sensor TBD. EPICS will display and archive information.

## 5. Machine Protection System (MPS) Interface

XTT and FEH Hutch 3 – Vacuum system interface to MPS. Each valve will have an input to the MPS system. The two experiment beam stops in the XRT will also have input into the MPS.