# Engineering Specifications for Hutch 6 of the FEH

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<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Jerome Hastings</td>
<td></td>
<td>10/24/08</td>
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<tr>
<td>Author, XFD Deputy</td>
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<td></td>
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<tr>
<td>William White</td>
<td></td>
<td>10/23/08</td>
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<tr>
<td>LCLS Laser Systems</td>
<td></td>
<td></td>
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<tr>
<td>Hal Tompkins</td>
<td></td>
<td></td>
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<tr>
<td>LCLS Photon Systems</td>
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<td></td>
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<tr>
<td>John Arthur</td>
<td></td>
<td>10/22/08</td>
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<tr>
<td>Photon Systems Manager</td>
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<tr>
<td>Lori Shewchuk</td>
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<td>10/23/08</td>
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<tr>
<td>FEH Hutch Project Engineer</td>
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<tr>
<td>David Saenz</td>
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<tr>
<td>FEH Hutch Project Manager</td>
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<tr>
<td>Richard M. Boyce</td>
<td></td>
<td>10/23/08</td>
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<tr>
<td>LCLS System Manager</td>
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<td></td>
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<tr>
<td>Darren Marsh</td>
<td></td>
<td>10/23/08</td>
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<tr>
<td>Quality Assurance Manager</td>
<td></td>
<td></td>
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<tr>
<td>John Galayda</td>
<td></td>
<td>01/23/08</td>
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<tr>
<td>Director, LCLS Construction</td>
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This document describes the requirements for experimental hutch #6 of the LCLS, located in the Far Experimental Hall (FEH). This hutch will be used for the sixth x-ray instrument. This document will serve as a room data sheet for this hutch.
## Change History Log

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<th>Rev Number</th>
<th>Revision Date</th>
<th>Sections Affected</th>
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<td>10/22/08</td>
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1. Physics Requirements

Hutch #6 in the Far Experimental Hall (FEH) will house the sixth x-ray instrument. This section describes the justifications for the requirements listed in the rest of the document.

1.1. Hutch Dimensions

The Materials in Extreme Environments (MEE, formerly HEDS) instrument will be used as a basis for design of hutch 6. However, this hutch will be suitable for a generic hard x-ray instrument. The MEE instrument is based on a main chamber which is 100 inches in diameter and has access doors around its periphery. Since this is the last hutch in the FEH, access to both sides of the beam is possible permitting the use of all access ports.

There are no plans for crane coverage in the present design.

As with hutches #4 and #5 a future second floor would be of great importance and it is necessary to keep the ceiling of the hutch not too high in order to leave sufficient space for a second floor. Since the hutch heights of hutches #4 and #5 are designed to accommodate a bridge crane, matching this height will leave the option for crane installation open.

1.2. Water Cooling

Provision should be made for removal of the heat generated inside the hutch expected to come from electronics such as motor controllers and power supplies. Water cooled racks are being used for removing all this heat in the other x-ray hutches. Each rack will be able to remove up to 8kW of heat and will require 5 gallons per minute of process cooling water at 68 degrees Fahrenheit. A generic x-ray instrument is expected to require up to 5 racks for a total of 25 GPM of process cooling water. On top of that, an extra 10 GPM is needed for miscellaneous use. Therefore a total of 35 GPM is required inside the hutch. Water cooling will be needed at various places throughout the entire length of the hutch, so three water points of use are required along the South wall.

Chilled water (44 degrees Fahrenheit) will not be used directly. However, there should be a sufficient supply of chilled water in the FEH to allow for the addition of an extra heat exchanger if the supply of process cooling water becomes insufficient.

1.3. Temperature Control

Some of the heat will be removed using water. It is expected that 20 kW of heat will need to be removed from the hutch with the HVAC system. Some of the devices will be required to have good temperature stability in order to maintain their alignment. The temperature inside the hutch must be controlled to within ±1°F to keep these devices stable. Temperature gradients throughout the hutch are acceptable (for example warmer air near the ceiling) provided each point is stable to within the ±1 degree Fahrenheit tolerance.

1.4. Compressed Air
Compressed air is needed for actuating up to 8 valves as well as multiple pneumatically driven diagnostic devices. Compressed air will be needed throughout the entire length of the hutch, so multiple air points of use are required along the South wall. Capacity to be > 5 CFM.

1.5. Telephone Lines
Communication between users inside the hutch and an operator at the control station inside the control cabin is required. Two phone lines are needed for that purpose. The location will be determined when the hutch is assigned to a specific instrument.

1.6. Data Lines
Public data ports are needed for user-supplied devices. They are also needed for connecting temporary workstations during maintenance or installation. A private data network will be built by the Controls group for the control system. At least one data location is needed on every wall. Multiple ports (at least 2) are needed at each location.

1.7. Low Profile Conduits
All fixtures and conduits (lighting, electrical, HVAC, etc.) must be low profile and recessed into the ceiling in order to leave sufficient space for a future overhead crane.

1.8. Doors
The main access to the hutch must be through the control cabin for rapid access to the experiment by the users.

Large equipment will from time to time be moved into the hutch and a large equipment door is needed. This door should not be through the control cabin so as to avoid the necessity of passing through 2 doors to access the hutch.

1.9. Gases
Many experiments could require gases. The ability to install a gas cabinet in the future should be provided if needed.

1.10. Walls
Users will supply their own equipment such as racks. These will be required to be secured to the walls in case of an earthquake. Provisions must be made for securing devices to walls in the future without requiring holes to be drilled in the radiation shielding. Extruded aluminum (Model TSLOTS TS15-15) imbedded in the walls is the preferred solution but Unistrut (Model Unistrut P3000) is also an acceptable option.

1.11. Lighting
The lighting level inside the hutch must be higher than normal since users are expected to work with lasers that require dark eye protection. Also, when working with the lasers, it may be necessary to completely or partially darken the hutch. Dimmers or lighting on separate switches is required.
1.12. Cable Trays

The lowest cable tray and its support must be higher than 8 ft 6 inches in order for the racks to fit under them. The preference is for 1 ft wide cable trays. A total of two 1 ft wide trays are needed all the way around the hutch. The preference is a stacked arrangement of two 1 ft wide trays vertically.

2. Overview

- Name of Building: FEH Hutch 6
- Dimensions: Height: 13 feet
  Width: ~27 feet
  Length: ~45 feet
- Hours of Operation: 24 hours a day, 7 days a week and 365 days a year
- Users/Occupancy: 5 (non-occupied room with maximum occupancy of 5)

The experimental hutches and related rooms are being built for the Linac Coherent Light Source (LCLS) project at the SLAC National Accelerator Laboratory (SLAC), operated by Stanford University, hereinafter referred to as the University.

The University requires that the Vendor be responsible for assurance that the hutches meet all the requirements of this specification. Inspection and approval of designs and documents by the University does not alter that responsibility in any way. No deviation from this specification or those stipulated herein shall be permitted without prior written permission by the University, including alternatives specified as "University Approved Equal."

When approval by the University is required, it is understood that the University refers to the LCLS project and specifically the Photon Systems group.

3. Applicable Documents

3.1. SLAC Drawing

a. SLAC Drawing LO-391-750-38, - "LUSI Integration Conventional Facilities FEH Walls and Doors"

b. SLAC Drawing LO-391-750-39, - "LUSI Integration Conventional Facilities FEH Stay-Clear Hutch & Utl"

4. Functional Objective

Hutch 6 located in the Far Experimental Hall will be used to house experimental equipment for the generic sixth instrument. Housing this equipment in a radiation tight and laser tight environment is the sole purpose of this hutch and the requirements of the instrument should be the driving force behind all the design decisions of the hutch. The design of the hutches shall be fully consistent with the presence of a potential future second floor in the FEH as well as the presence of a crane attached to the support structure of the ceiling inside the
hutch. The roof of the hutch shall constitute the floor of the second level. The hutch shall be considered as non-occupied space for fire safety purposes.

5. **Building Orientation Requirements**

5.1. Walls shall be parallel to FEH cavern, not parallel to the LCLS beam.

6. **Size Requirements**

SLAC drawing LO-391-750-38 shows a recommended hutch layout and should be used as a guideline to meet the specifications in this document. The north and south walls are also defined in this drawing.

6.1. FEH Hutch 6 shall be at least 45 feet long along the beam direction.

6.2. The North wall of the hutch shall be an extension of the North wall of FEH hutch 5.

6.3. The South wall of the hutch shall be the FEH cavern South wall and used as is and left uncovered.

7. **General Requirements**

7.1. The hutch shall allow the instrument located in it to be fully functional regardless of the status of the other LCLS hutches. Each LCLS hutch shall be capable of independent operations.

7.2. The hutch shall have a flexible design to the extent possible that allows for future expansion or modification, without major financial impact and shall follow the general layout shown in SLAC drawing LO-391-750-38. The walls of the hutch shall not be load-bearing walls. If significant cost savings could be achieved by adding load bearing supports near the hutch walls, these shall be communicated and approved by the University prior to the completion of Title 1 drawings.

8. **Floor Requirements**

The floor of the room already exists and building the floor is not within the scope of this document. However the following requirements still apply.

8.1. The floor shall be painted with durable grey epoxy floor paint that meets federal color standard FS16515. Alternative color shall be approved by the University.
9. Finishes Requirements

Walls

9.1. The walls shall be painted with a minimum of two coats of flat white paint meeting federal color standard FS27875. Alternative color shall be approved by the University.

9.2. The walls shall have a flexible (non-load bearing) design that allows for future expansion or modification.

9.3. The walls shall provide adequate radiation protection for users outside the hutch consistent with the requirements outlined in document RP-RPG-080606-MEM-01. The South wall does not require additional shielding.

9.4. There shall be penetrations through the wall for cables. These penetrations shall not allow a direct line of sight for the X-rays or laser light to escape the hutch area and the design shall be approved by Radiation Physics. The details and locations of the approved penetrations will be shown in a drawing to be provided.

9.5. There shall be extruded aluminum (Model TSLOTS TS15-15) frame or Unistrut (Model Unistrut P3000) surface-mounted on the walls that would allow equipment up to 1000 pounds to be fixed to the wall but not supported by the wall (such as gas bottles for example) without requiring holes to be drilled into the wall. Such mounting structures shall be surface-mounted on the walls vertically at a regular 6 feet interval. The pieces of aluminum or Unistrut shall extend from 3 ft to 8 ft height. They shall also allow equipment up to 100 lbs/ft to be supported on shelves. They shall also be capable of supporting utility lines such as water and air pipes.

Ceiling

9.6. The ceiling shall be painted with a minimum of two coats of flat white paint meeting federal color standard FS27875. Alternative color shall be approved by the University.

9.7. The clear height of the hutch shall be 13 feet.

9.8. The ceiling height and the thickness of the ceiling shall not preclude the addition of a second floor to the FEH directly above the hutch. This second floor height shall be a minimum of 8 feet (ceiling). The second floor does not need to cover the entire hutch area. Due to the cylindrical shape of the Far Experimental Hall, the coverage of the second floor will be less than the first floor.

9.9. The dimensions of the second floor shall be maximized by minimizing the thickness of the structure supporting the second floor.

9.10. The support structure of the ceiling shall allow a 1-ton crane to be anchored to it.

10. Doors and Fenestrations

Doors

10.1. There shall be 1 sliding door to access the hutch opening on the outside of the hutch. The door shall open from left to right when standing outside the hutch.
10.2. The door shall run in a groove.
10.3. The door shall allow a 7 feet high entry.
10.4. The door width shall allow 44 inches of entry space.
10.5. The door shall interface with the Personnel Protection System (PPS).
10.6. The door shall open a passage from Hutch 6 into the control Room as shown on drawing LO-391-750-38.
10.7. The door locking mechanism shall be electronic with no physical key needed to access the hutch.

**Equipment Door**

10.8. There shall be an equipment door, which is expected to be opened only occasionally, that will allow large equipment to enter the hutch.
10.9. The equipment door shall allow for a 10 feet wide and 8 feet high entry.
10.10. The equipment door shall be a roll-up door approved by Radiation Physics.
10.11. The entry into the hutch through the equipment door shall not be through the hutch #6 control room, nor shall it be through the adjacent hutches and it shall be located as shown on drawing LO-391-750-38.

**Fenestrations**

10.12. None.

11. **Stay Clear Requirements**

11.1. The stay clear areas are similar to those shown in SLAC drawing MR-391-750-44. Any non-experimental structures, utilities, lighting, fire sprinklers, electrical panels, etc. shall be outside of this stay clear zone. Exceptions to the stay clear shall be approved by the University.

12. **Acoustic Requirements**

12.1. None.

13. **Heating Ventilation and Air Conditioning (HVAC) Requirements**

**HVAC**

13.1. There shall be a heating system and an air conditioning system capable of maintaining the temperature at 72 +/-1 degree Fahrenheit. Time stability at any given point is required while spatial fluctuations greater than 1 degree F are allowable.
13.2. The HVAC system shall be capable of removing 20 kW of heat from the room.
13.3. The HVAC system shall provide clean air using pre-filters, high efficiency filters and HEPA filters in the air handling unit.
13.4. The air flow velocity in the hutch shall be minimized to prevent air currents while still maintaining the temperature stability of Requirement 13.1.

13.5. The HVAC system, including the ducts shall have minimal direct contact with the hutch structure and walls in order to prevent the propagation of vibrations from the HVAC system to the experimental area. The floor vibrations inside the hutch induced by the HVAC system shall meet the requirements of Section 22.

13.6. The HVAC ducts shall be located outside the room with penetrations through the roof of the room.

13.7. The HVAC inlet and outlet vents (registers) shall be located away from the interaction region between the LCLS beam and the sample so that air is not blown onto the sample area. A layout showing a proposed location of all ducting and registers is shown on drawing GP-391-750-40 and the final layout shall be approved by the University.

13.8. There shall be temperature sensors located inside the hutch to interface with the Direct Digital Control (DDC) system that controls the HVAC system. The proposed location of the sensors will be shown on a drawing to be provided.

13.9. The relative humidity inside the hutch shall be controlled at 45% +/- 10%.

13.10. There shall be an adequate smoke detection/fire suppression system consistent with the relevant norms and regulations consisting of a wet sprinkler system and a smoke detector.

**Direct Exhaust System**

13.11. There shall be a direct exhaust system with a capability of 500 cubic feet per minute at 1.5” W.C. external static pressure for each experimental hutch.

13.12. The exhaust system shall use a separate fan for each LCLS hutch.

13.13. The location of the intake of the exhaust system will be shown on drawing to be provided.

**14. Gas Requirements**

14.1. No centralized N₂ gas system will be provided in the FEH.

14.2. Provision for a gas cabinet shall be included in the design.

**15. Compressed Air Requirements**

15.1. The compressed air shall be provided to a point convenient to hutch #6 for future distribution needs defined when an instrument is selected.

15.2. The compressed air shall be clean, dry and oil-free at 10 cubic feet per minute and 100 psig.

15.3. There shall be 1 shut off valve per hutch.

15.4. There shall be 1 pressure gauge per hutch located close to one of the points of use.

**16. Communication Requirements**

*Telephone*
16.1. The phone cabling, jack locations and conduits shall be provided at a future date when the specific instrument for FEH hutch 6 is assigned and its needs are defined.

**Data ports**

16.2. The Ethernet data cabling and conduits and their exact locations shall be provided at a future date when the specific instrument for FEH hutch 6 is assigned and its needs are defined.

17. **Plumbing/Fire Protection Requirements**

**Fire Protection**

17.1. There shall be at least 1 fire alarm pull station inside the hutch or whatever is prescribed by the fire hazard analysis.

17.2. There shall be a smoke detection system linked to the fire suppression system.

17.3. The fire suppression system shall be attached as close to the ceiling as possible to minimize unusable space. The layout of the fire suppression system shall be approved by the University.

**Process Cooling Water**

17.4. Process cooling water shall be provided inside each hutch at 35 gallons per minute, 15 PSI and at 68 ± 2 degrees Fahrenheit.

17.5. The supply and return process cooling water pipes shall each be terminated with a shut-off valve and pressure gauge at a height of 4 ft.

17.6. The process cooling water shall include filtration which is easily accessible for routine maintenance.

17.7. The piping for the process cooling water shall be attached as close to the wall as possible to minimize unusable space. The proposed layout of the process cooling water pipes, shut-off valves and pressure gauges will be shown on a drawing to be provided.

17.8. The exact locations of the process cooling water points of use will be determined at such time as the specific instrument is assigned to FEH hutch 6 and the instrument needs are established.

18. **Electrical Requirements**

**Power Supply**

18.1. 2 panels shall be provided with 120/208 volts, 3 phase power in each hutch. Each panel is to deliver 20 KVA. One panel shall be “clean” power and the second shall be “dirty” power. The proposed location is shown on a drawing to be provided.

18.2. Each panel shall have a main breaker with a 100 Amp capacity.

18.3. The transformers for all the power shall be located outside the hutch on the utilities platform area located above the hutches.
18.4. The location of the panels shall be specified on a drawing to be provided.
18.5. The panels shall be fixed to the wall directly and be as low profile as possible to minimize unusable space.

19. Cable Tray Requirements

19.1. Cable trays totaling 2 feet in width shall be installed along every wall all the way around the interior of the hutch. Two 1-foot wide trays shall be used in a vertical arrangement.
19.2. The cable trays and their mounting components shall be no lower than 8 feet 6 inches from the floor.
19.3. The cable trays shall be electrically grounded.
19.4. The cable trays shall be attached to the walls and mounted as close to the walls as possible to minimize unusable space. A proposed layout will be shown on a drawing to be provided.

20. Lighting Requirements

20.1. Light fixtures shall be provided to generate a lighting level of 75FC (foot candles). This level is higher than normal due to the dark laser protective goggles worn by the personnel.
20.2. All fixtures shall be low profile, surface mounted and recessed into the ceiling to minimize unusable space. The final layout shall be approved by the University.
20.3. All conduits shall be surface mounted to minimize unusable space. The final layout shall be approved by the University.
20.4. No night lighting shall be required.
20.5. It shall be possible to completely darken the room when required by the experiment.
20.6. It shall also be possible to partially darken the room with the use of dimmer switches.
20.7. Light switches next to the hutch door shall be provided both inside and outside the hutch.
20.8. There shall be an emergency lighting system provided.
20.9. Emergency lighting per Life Safety Code and Engineering Standards shall be provided inside the hutch.

21. Radiation/Seismic Requirements

21.1. All equipment (HVAC, cable trays, piping, panels, etc.) and systems shall be seismically braced and restrained per the requirements of 2007 Uniform Building Code and SLAC Seismic Safety.
21.2. Details for a preferred wall penetration shall be provided on drawing at a later date and final approval will be required by the University. This penetration scheme or the agreed upon solution shall be approved by Radiation Physics.

22. Vibration Requirements

22.1. The floor vibrations shall be less than 1 micron/sec in the vertical direction.
22.2. The floor vibrations shall be less than 0.5 micron/sec in the horizontal direction.
22.3. Equipment to be provided by Conventional Facilities shall not induce vibrations larger than the specifications of requirements 22.1 and 22.2.

23. Special Equipment Requirements

23.1. None

24. Management Requirements

24.1. Suggested routing of all utilities and conduits (phone, water, compressed air, lighting, fire suppression system, HVAC ducts and registers, power, electrical panels) shall be provided in drawings to the Photon Systems Manager of LCLS.

24.2. Any final specifications to be distributed to the Conventional Facilities group of LCLS and the FEH Hutch Project Manager shall be distributed to the authors of this ESD at least 2 days before so that they can identify possible issues and discuss possible solutions with the relevant people.