NATIONAL ACCELERATOR LABORATORY

DESIGN REVIEW REPORT	Report Date: April 27, 2010

The Design Review Report Shall include at a minimum:

- The title of the item or system
- A description of the item
- Design Review Report Number
- The type of design review
- The date of the review
- The names of the presenters
- The names, institutions and department of the reviewers
- The names of all the attendees (attach sign-in sheet)
- Completed Design Checklist
- Findings/List of Action Items – these are items that require formal action and closure in writing for the review to be approved. See Document *SLAC-I-020-00100-001* for Design Review Requirements and Guidelines
- Concerns/Recommendations – these are comments that require action by the design/engineering team, but a response is not required to approve the review
- Observations – these are general comments and require no response

TYPE OF REVIEW: MECi Controls PDR

WBS: 1.05

Title of the Review	MECi Controls PDR	
Presented By:	Name of presenters Gunther Haller, Sheng Peng	
Report Prepared By:	Name of review chairperson David Nelson	**Review Date: March 31, 2010**
Reviewers/Lab :	Name – David Nelson/SLAC	
Distribution:	Gunther Haller, Sheng Peng Greg Hays, Gene Holden Richard M Boyce, Richard F. Boyce	
Attachments:	X Review Slides ☐ Design Checklist ☐ Calculations X Other	

Purpose/Goal of the Review:

The purpose of the review the Controls and DAQ for: x-ray beam-line and diagnostics system (with target chamber), Laser system, Target Diagnostics system, and User interface/controls.

Introduction and outcome summary of the review:

A detailed overview and status of the MECi Controls & Data-Systems was presented by Gunther Haller. The MECi Laser Control Systems was presented by Sheng Peng. Both presentations are posted at https://confluence.slac.stanford.edu/display/PCDS/MEC.

The design and status of the MECi Controls and Data-System is currently at a state to warrant advanced procurement and fabrication, at least for the X-ray beam-line and for the laser system. Nearly all hardware and systems software is duplicated from previous LCLS experiments. This should provide a low risk, cost effective, implementation of this experimental system. The target diagnostics chamber requirement to controls still need to be better defined.

Findings/Action Items:

1. Need to review the design of the thermal system of the FEL Deflecting Mirror and Thermal enclosure. The requirement appears to be 0.01C accuracy. The idea is to copy the M2H design in the FEE. It is not clear that the M2H system meets the requirements.
2. Need to review the Photon Stopper design. They need more information.
3. The reference laser is intended to be like the reference laser in CXI. The needs to be defined so the Controls interface components can be determined.
4. A review of the Target stage motor drive system should be revisited to verify the requirements and specifications to see if the Newport system would be a better solution rather than the targeted PhysikInstruments. The Newport system is already used in several area in LCLS.
5. Need to review the requirements for the fast scope.
6. There is TBDs for the X-ray Emission Spectroscopy controller and interface
7. There is TBDs for the Pinhole Camera.
8. Target Diagnostics system still needs to provide detailed requirements to controls

Concerns/Recommendations:

Concerns

1. Rack profiles were presented that provided little extra space. The rack locations, size, and quantity appear not to be optimized. It is recommended that this be reviewed.
   A. Rack locations in XRT discussed; will install 4 new racks in XRT for MECI located at 60M and 175M location. It was noted that the cost of extending PCW cooling to the racks is not in Controls budget.
   B. Laser racks: MECI to verify location for 2 full height racks on South side of H6. Timing rack to go under laser table as will limited number of short racks for laser motor controls. This is still under discussion and may change.
   C. Hutch 6 racks: two racks needed on North side of H6, one currently exists for network; one additional to be placed adjacent to the existing one. 6 racks will be placed on the mezzanine to support x-ray transport hardware (slits, harmonic

rejections mirror, PIM, IPM, focusing lenses, etc). Target Diagnostics controls could not be defined as the diagnostic hardware is still at conceptual stage.

2. Is the interface clear between Controls and the MECI team producing the hardware? Recommend that a controls and MECI representative go over detailed items to clearly understand who is to produce what at the interface level.
3. It was noted that the Attenuators for LUSI have motorized actuators and not pneumatic; what is MECI building? (Richard F. needs to review the detailed drawings and confirm with Controls). Same concern regarding motors - MECI is building off of archived drawings which may or may not reflect verbal communications between LUSI and Controls; need to review the specific items being built for MECI.
4. Deflecting Mirror: MECI building duplicate of FEE mirror system - however, it was noted that the motors have been changed- Richard F. to verify. Environmental enclosure for MECI will be duplicate of FEE design, therefore controls need to be provided. Also, a request to change the LVDT was made by Controls, this needs follow-up.
5. MECI alignment laser is duplicate of that used in CXI (hutch 5), so controls "should" be the same.

Recommendations.

1. Controls rack locations and routing of cables need to be decided on.
2. Linux computer requirements for H6
   ```
   -1 desktop workstation with 2, 24" monitors
   -1 laptop tethered to the controls network.
   ```
3. Suggest investigating lower costs power meter controllers.
4. Need to spec the in-vacuum camera.
5. The laser controls ESD should reference the 2 laser ESDs.
   ```
   - SP-391-001-06 R0 ESD for the fs-laser system
   - SP-391-001-07 R0 ESD for the ns-Laser system
   ```
6. Make provisions to change the Femtosource oscillator controls to a Coherent Micra laser system.

Observations:
The presentation material was more than adequate for a PDR.

X-ray transport system: The requirements for controls are well defined and the associated controls are in a more advanced state than required for a PDR. The beam line and the controls group need to keep working together closely and update the requirements document in case there are changes to the beam-line, so the controls system can be modified accordingly. The requirement document is in a good state and posted at https://confluence.slac.stanford.edu/display/PCDS/MEC (SP 391-004-27 MECI X-Ray Transport Controls ESD). It is being signed off and looks to be very mature.

Laser control system: The requirements for controls are well defined and the associated controls are in a more advanced state than required for a PDR. The laser and the controls group need to keep working together closely and update the requirements document in case there are changes to the laser system, so the controls system can be modified accordingly. The requirement document is in a good state and posted at https://confluence.slac.stanford.edu/display/PCDS/MEC (SP 391-004-29 MECI Laser Controls ESD).

Target Chamber: This system still needs to provide detailed requirements to controls. Apparently that is in progress but the requirements document is only in a draft state, posted at https://confluence.slac.stanford.edu/display/PCDS/MEC
(SP 391-004-28 MECI Target Chamber and Diagnostics Controls ESD)

Holden, G. Gene

From: Boyce, Richard M.
Sent: Thursday, June 24, 2010 11:22 AM
To: Boyce, Richard M.; Haller, Gunther; Boyce, Richard F.; Lee, Hae Ja; Hays, Greg; Peng, Sheng
Cc: Holden, G. Gene; Boyce, Richard M.
Subject: RE: Action Items from MECi Controls PDR
Attachments: MECI Controls PDR-Response to Findings.docx

Folks,
I view this as the formal, and final, response to the Controls PDR action items. Note that there are comments and highlighted areas that affect controls of equipment in question. It is Controls responsibility to resolve any issues that remain, and it is your responsibility (WBS managers) to respond to Controls queries to ensure they have the right data.
Thanks,
RB

-----Original Message-----
From: Boyce, Richard M.
Sent: Friday, May 28, 2010 10:47 AM
To: Haller, Gunther; Boyce, Richard F.; Lee, Hae Ja; Hays, Greg
Cc: Holden, G. Gene; Boyce, Richard M.
Subject: RE: Action Items from MECi Controls PDR

Controls PDR response document updated from input; There are three questions (2, 3 & 5) that need Gunther and Hae Ja to answer please. Also note the yellow highlights in the lower part of the report that you need to address (not formally) as we move forward. Let's get the answers for the three questions by today so we can close out this response.
Thanks,
RB

-----Original Message-----
From: Boyce, Richard M.
Sent: Tuesday, May 25, 2010 3:51 PM
To: Haller, Gunther; Boyce, Richard F.; Lee, Hae Ja; Hays, Greg
Cc: Boyce, Richard M.; Holden, G. Gene
Subject: RE: Action Items from MECi Controls PDR

Folks,
I took a crack at addressing the action items from the Controls PRD in the attached word document. It seems that there are items that need to be addressed by each of you to allow Gunther to finalize this. The purpose is to define our response to these action items to show that we have a plan to reach resolve each item.
You should be reading the Concerns and Recommendations portions (which do not require a formal response) and if there is something there that you feel can be addressed then please do so. Again, goal is to plan our response and DO what you plan.
Thanks,
RB

-----Original Message-----
From: Holden, G. Gene
Sent: Tuesday, May 25, 2010 11:47 AM
To: Haller, Gunther
Cc: Boyce, Richard M.
Subject: Action Items from MECi Controls PDR

Gunther,

The MECi Controls PDR is posted at:
https://slacspace.slac.stanford.edu/sites/aed/eng_standards/Design_Review/MECi%20Controls%20PDR.pdf

The Findings/Action Items, Concern/Recommendations and Observations are as follows:

Findings/Action Items:

1. Need to review the design of the thermal system of the FEL Deflecting Mirror and Thermal enclosure. The requirement appears to be 0.01C accuracy. The idea is to copy the M2H design in the FEE. It is not clear that the M2H system meets the requirements.

2. Need to review the Photon Stopper design. They need more information.
3. The reference laser is intended to be like the reference laser in CXI. The needs to be defined so the Controls interface components can be determined.
4. A review of the Target stage motor drive system should be revisited to verify the requirements and specifications to see if the Newport system would be a better solution rather than the targeted PhysikInstruments. The Newport system is already used in several area in LCLS.
5. Need to review the requirements for the fast scope.
6. There is TBDs for the X-ray Emission Spectroscopy controller and interface 7. There is TBDs for the Pinhole Camera.
8. Target Diagnostics system still needs to provide detailed requirements to controls

Concerns

1. Rack profiles were presented that provided little extra space. The rack locations, size, and quantity appear not to be optimized. It is recommended that this be reviewed.
A. Rack locations in XRT discussed; will install 4 new racks in XRT for MECI located at 60M and 175M location. It was noted that the cost of extending PCW cooling to the racks is not in Controls budget.
B. Laser racks: MECI to verify location for 2 full height racks on South side of H6. Timing rack to go under laser table as will limited number of short racks for laser motor controls. This is still under discussion and may change.
C. Hutch 6 racks: two racks needed on North side of H6, one currently exists for network; one additional to be placed adjacent to the existing one. 6 racks will be placed on the mezzanine to support x-ray transport hardware (slits, harmonic Report No: Page 3 of 4 rejections mirror, PIM, IPM, focusing lenses, etc). Target Diagnostics controls could not be defined as the diagnostic hardware is still at conceptual stage.
2. Is the interface clear between Controls and the MECI team producing the hardware? Recommend that a controls and MECI representative go over detailed items to clearly understand who is to produce what at the interface level.
3. It was noted that the Attenuators for LUSI have motorized actuators and not pneumatic; what is MECI building? (Richard F. needs to review the detailed drawings and confirm with Controls). Same concern regarding motors - MECI is building off of archived drawings which may or may not reflect verbal communications between LUSI and Controls; need to review the specific items being built for MECI.
4. Deflecting Mirror: MECI building duplicate of FEE mirror system - however, it was noted that the motors have been changed- Richard F. to verify. Environmental enclosure for MECI

will be duplicate of FEE design, therefore controls need to be provided. Also, a request to change the LVDT was made by Controls, this needs follow-up.
5. MECI alignment laser is duplicate of that used in CXI (hutch 5), so controls "should" be the same.

Recommendations

1. Controls rack locations and routing of cables need to be decided on.
2. Linux computer requirements for H6
-1 desktop workstation with 2, 24" monitors
-1 laptop tethered to the controls network.
3. Suggest investigating lower costs power meter controllers.
4. Need to spec the in-vacuum camera.
5. The laser controls ESD should reference the 2 laser ESDs.
- SP-391-001-06 R0 ESD for the fs-laser system
- SP-391-001-07 R0 ESD for the ns-Laser system 6. Make provisions to change the Femtosource oscillator controls to a Coherent Micra laser system.

Observations

The presentation material was more than adequate for a PDR.

X-ray transport system: The requirements for controls are well defined and the associated controls are in a more advanced state than required for a PDR. The beam line and the controls group need to keep working together closely and update the requirements document in case there are changes to the beam-line, so the controls system can be modified accordingly. The requirement document is in a good state and posted at https://confluence.slac.stanford.edu/display/PCDS/MEC (SP 391-004-27 MECI X-Ray Transport Controls ESD). It is being signed off and looks to be very mature.

Laser control system: The requirements for controls are well defined and the associated controls are in a more advanced state than required for a PDR. The laser and the controls group need to keep working together closely and update the requirements document in case there are changes to the laser system, so the controls system can be modified accordingly. The requirement document is in a good state and posted at https://confluence.slac.stanford.edu/display/PCDS/MEC (SP 391-004-29 MECI Laser Controls ESD).

Target Chamber: This system still needs to provide detailed requirements to controls. Apparently that is in progress but the requirements document is only in a draft state, posted at https://confluence.slac.stanford.edu/display/PCDS/MEC (SP 391-004-28 MECI Target Chamber and Diagnostics Controls ESD)

MECI Controls PDR

Response to Findings – 6/24/10

The Findings/Action Items, Concern/Recommendations and Observations are as follows:

Findings/Action Items:

1. Need to review the design of the thermal system of the FEL Deflecting Mirror and Thermal enclosure. The requirement appears to be 0.01C accuracy. The idea is to copy the M2H design in the FEE. It is not clear that the M2H system meets the requirements.
    a. The existing design has been reviewed and is close to meeting the thermal requirements of the FEE; therefore MECI will duplicate the HOMS enclosure design and incorporate any improvements to the control system implemented into HOMS M2H.
2. Need to review the Photon Stopper design. They need more information.
    a. The Photon Stopper for MECI is already fabricated and is a duplicate of those stoppers used for all other hutches; therefore the mechanical design and controls requirements are documented.
3. The reference laser is intended to be like the reference laser in CXI. The needs to be defined so the Controls interface components can be determined.
    a. MECI is duplicating the CXI reference laser design; therefore the controls shall be identical to CXI.
4. A review of the Target stage motor drive system should be revisited to verify the requirements and specifications to see if the Newport system would be a better solution rather than the targeted Physik Instruments. The Newport system is already used in several area in LCLS.
    a. Both the Newport and PI hexapods are technically suitable for the MECI requirements. However the Newport design is significantly more affordable, and from a domestic vendor. Moreover it uses Newport's XPS controllers, which the controls group already uses widely across LCLS.
5. Need to review the requirements for the fast scope.
    a. The oscilloscope is required to control the diode detector. Its readout will be synchronized with LCLS beam up to 120 Hz and the output signal is a micro-second pulse. Therefore, Tektronix TDS3054B of 4 channel and 500 MHz analog bandwidth meets our requirement. However, this scope is not currently within the budget of MECI and will be a future addition.
6. There is TBDs for the X-ray Emission Spectroscopy controller and interface
    a. The XES PRD is on hold pending a management review of the requirements- 6/24/10.
7. There is TBDs for the Pinhole Camera.
    a. The Pinhole Camera has been removed from the scope of work and no longer requires controls.
8. Target Diagnostics system still needs to provide detailed requirements to controls
    a. The Target Diagnostics system is in design phase with the PRD's completion expected in June. Final definition of the control requirements will come after the PRD's are final.

Concerns

1. Rack profiles were presented that provided little extra space. The rack locations, size, and quantity appear not to be optimized. It is recommended that this be reviewed.
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5. MECI alignment laser is duplicate of that used in CXI (hutch 5), so controls "should" be the same.

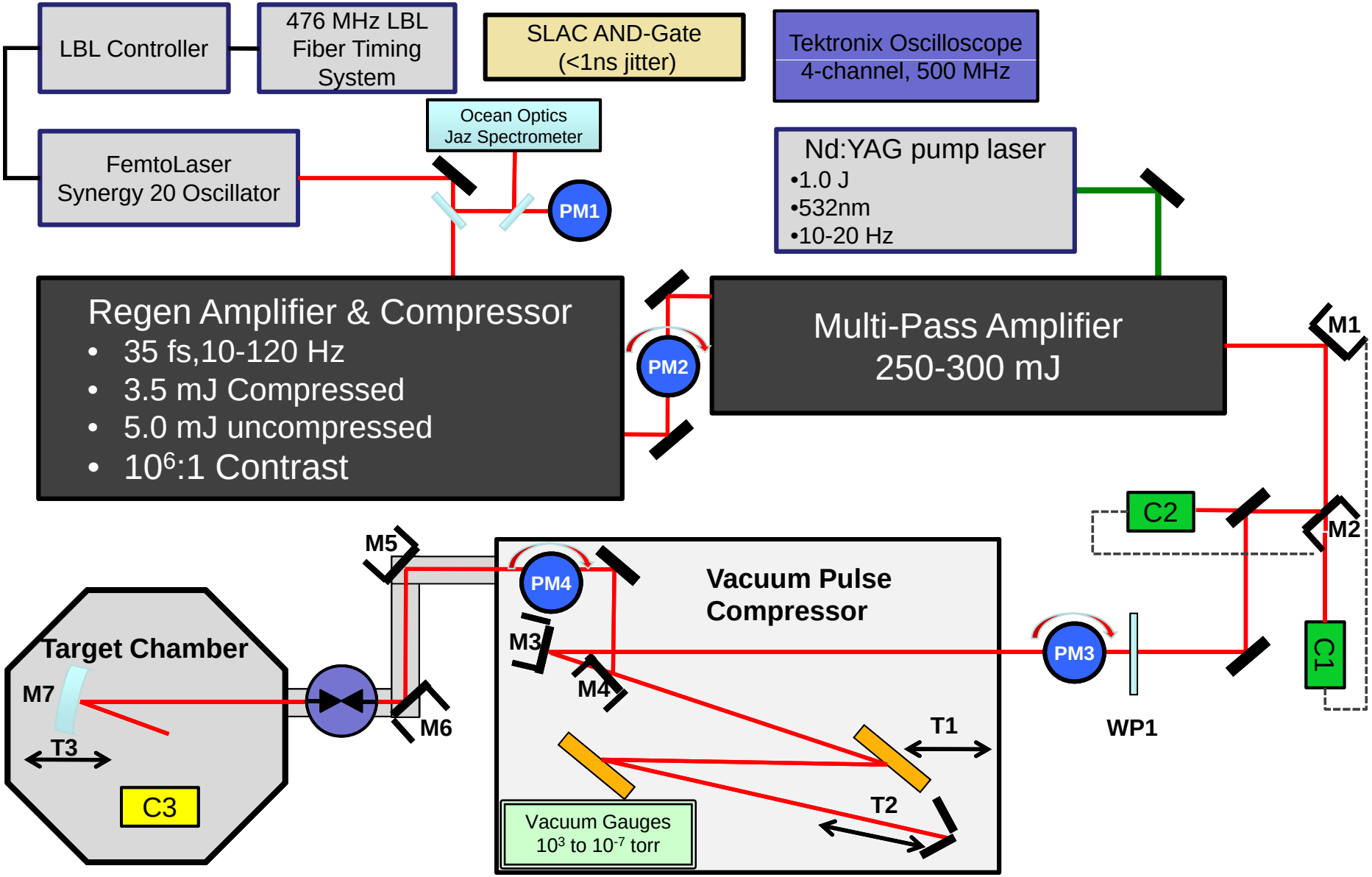
Recommendations

1. Controls rack locations and routing of cables need to be decided on.
2. Linux computer requirements for H6
    a. 1 desktop workstation with 2, 24" monitors
    b. 1 laptop tethered to the controls network.
3. Suggest investigating lower costs power meter controllers.
4. Need to spec the in-vacuum camera.
5. The laser controls ESD should reference the 2 laser ESDs.
6. SP-391-001-06 R0 ESD for the fs-laser system
7. SP-391-001-07 R0 ESD for the ns-Laser system
8. Make provisions to change the Femtosource oscillator controls to a Coherent Micra laser system.

MECi Laser System Controls

Greg Hays, Laser Physicist
Sheng Peng
March 9, 2010

Short-Pulse Laser Controls



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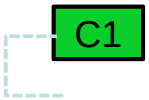
Controls Legend for Short-Pulse Laser

- Machine Synchronous Camera



- Machine synchronous Camera coupled to feedback loop

- Vacuum compatible Machine Synchronous Camera

- Stationary power/energy meter

- Insertable power/energy meter on a rotation stage

- Motorized mirror mount (x and y axis)

- EPICS controlled vacuum gate valve with position read back

Short-Pulse Laser Motorized Mirrors

Name	Description	Motor	Quantity
M1	Motorized mirror mount in feedback loop 1	½”	2
M2	Motorized mirror mount in feedback loop 1	½”	2
M3	Motorized Mirror Mount in compressor tank, vacuum compatible	½”	2
M4	Motorized Mirror Mount in compressor tank, vacuum compatible	½”	2
M5	Motorized mirror mount	1”	2
M6	Motorized mirror mount	1”	2
M7	Motorized parabola mount (tip-tilt), vacuum compatible	1”	2
WP1	Motorized Rotation Mount, $\lambda/2$ waveplate for energy throttle	1” Ø rotation	1

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Cameras, Power Meters, Linear Stages

Name	Description	Stage	Quantity
C1	IR Camera, machine synchronous,10-30 Hz, 1st camera in Feedback Loop 1		1
C2	IR Camera, machine synchronous,10-30 Hz, 2nd camera in Feedback Loop 1		1
C3	IR Camera, machine synchronous, 10 Hz, Vacuum Compatible		1
P1	Power Meter, fixed position, CW data rate		1
P2	Pulsed Energy Meter, insertable on rotation stage, 120 Hz,	1” Ø rotation	1
P3	Pulsed Energy Meter, insertable on rotation stage, 10-30 Hz,	1” Ø rotation	1
P4	Pulsed Energy Meter, insertable on rotation stage, 10-30 Hz,	1” Ø rotation	1
T1	Linear translation stage, vacuum compatible, grating stage for compressor	100 mm Linear	1
T2	Linear translation stage, vacuum compatible, vertical retro-mirror stage for compressor	100 mm Linear	1
T3	Linear translation stage, vacuum compatible, stage for target chamber parabola	50 mm Linear	1

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Vacuum and Other Controls

Name	Description	Control	Quantity
G1	Compressor Tank Vacuum Gauge, (760 to 10^{-3} torr)	pirani	1
G2	Compressor Tank Vacuum Gauge, (10^{-7} torr)	Ion	1
V1	Vacuum gate valve, 4” Ø, between compressor and target chamber, position read back		1
AND Gate	High speed AND gate, 8-channel, SLAC built, <1ns accuracy		1
Scope	Tektronix Oscilloscope, 4 channel, 500 MHz	Ethernet	1
TC	Thermocouples for Hutch 6, Type J or K	Ethernet	40
WC	Web Camera, X-Y adjustable position	Ethernet	4
Jaz Spectrometer	Oscillator Spectrometer, Ethernet Control	Ethernet	1
Oscillator Remote Control	Oscillator Remote Controls, SLAC built	RS232	1
476MHz LBL timing	LBL fiber timing system, Synchronized 476MHz, locally synchronized EVR Triggers with stabilized RF		1

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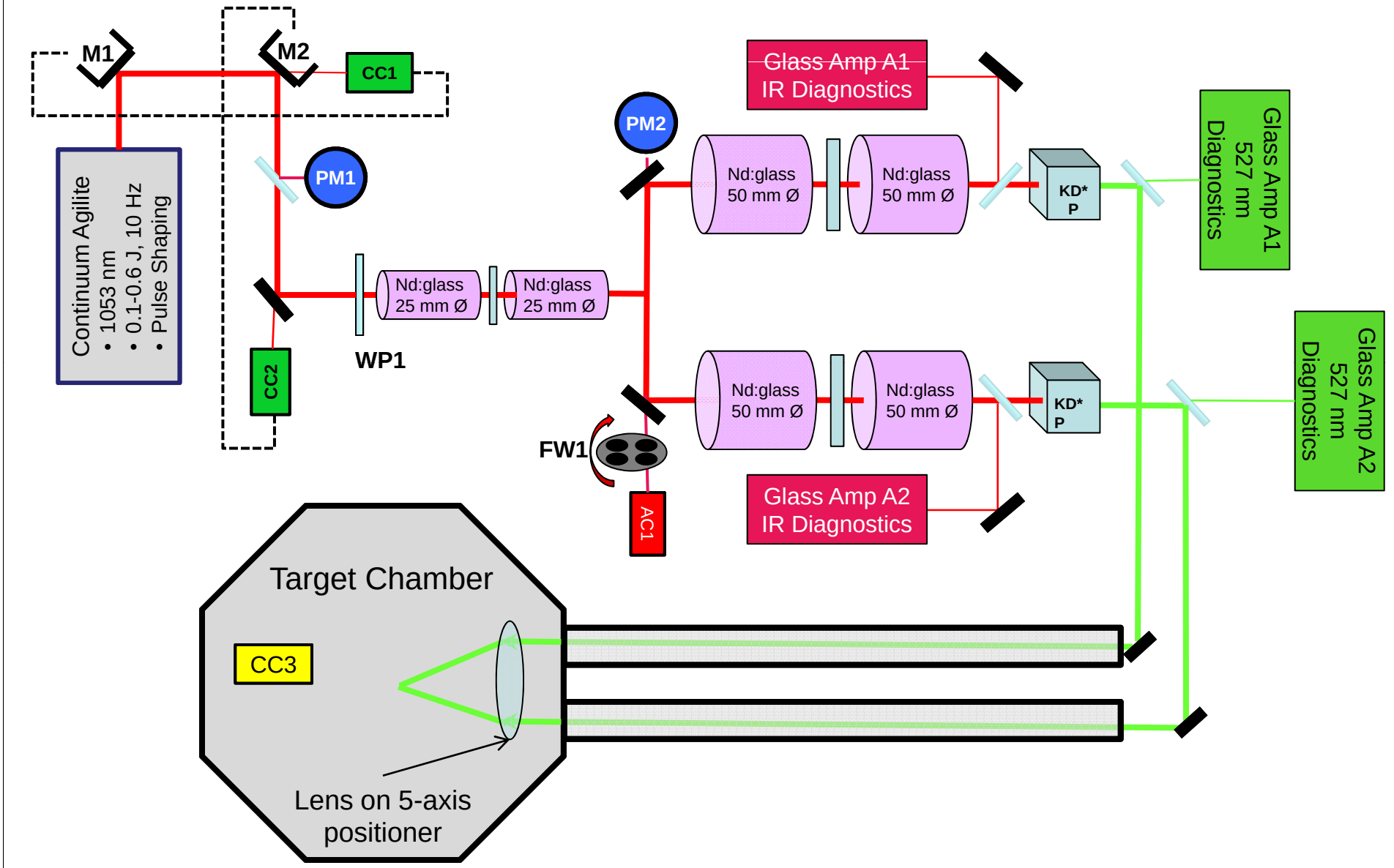
Long-Pulse Laser System



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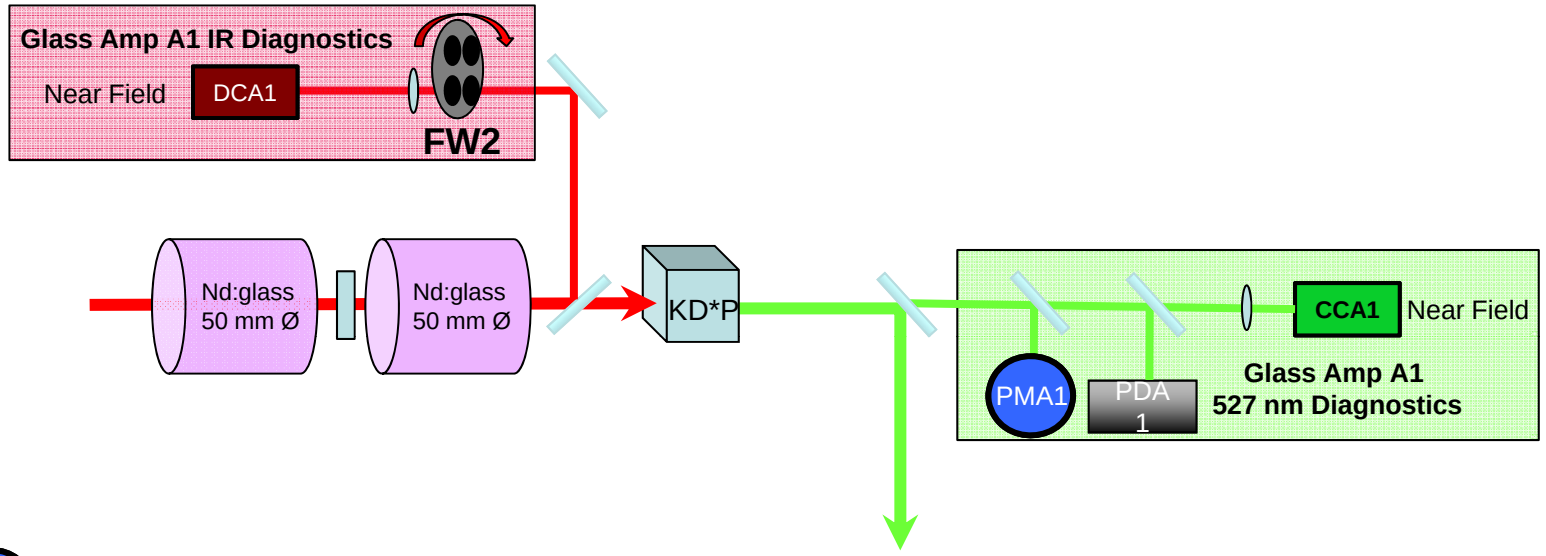
Amplifier Diagnostic Packages

Diagnostics Suite for each 50mm Nd:glass Rod Pair



- PMA1 • Pulsed Energy Meter, fixed position
- DCA1 • Non-EPICS Camera, triggerable single-shot
- CCA1 • EPICS Camera, laser synchronous, single-shot
- PDA1 • Fast Photodiode, sampled by 5 GHz oscilloscope, 4-channel
- • Rotating Filter Wheel

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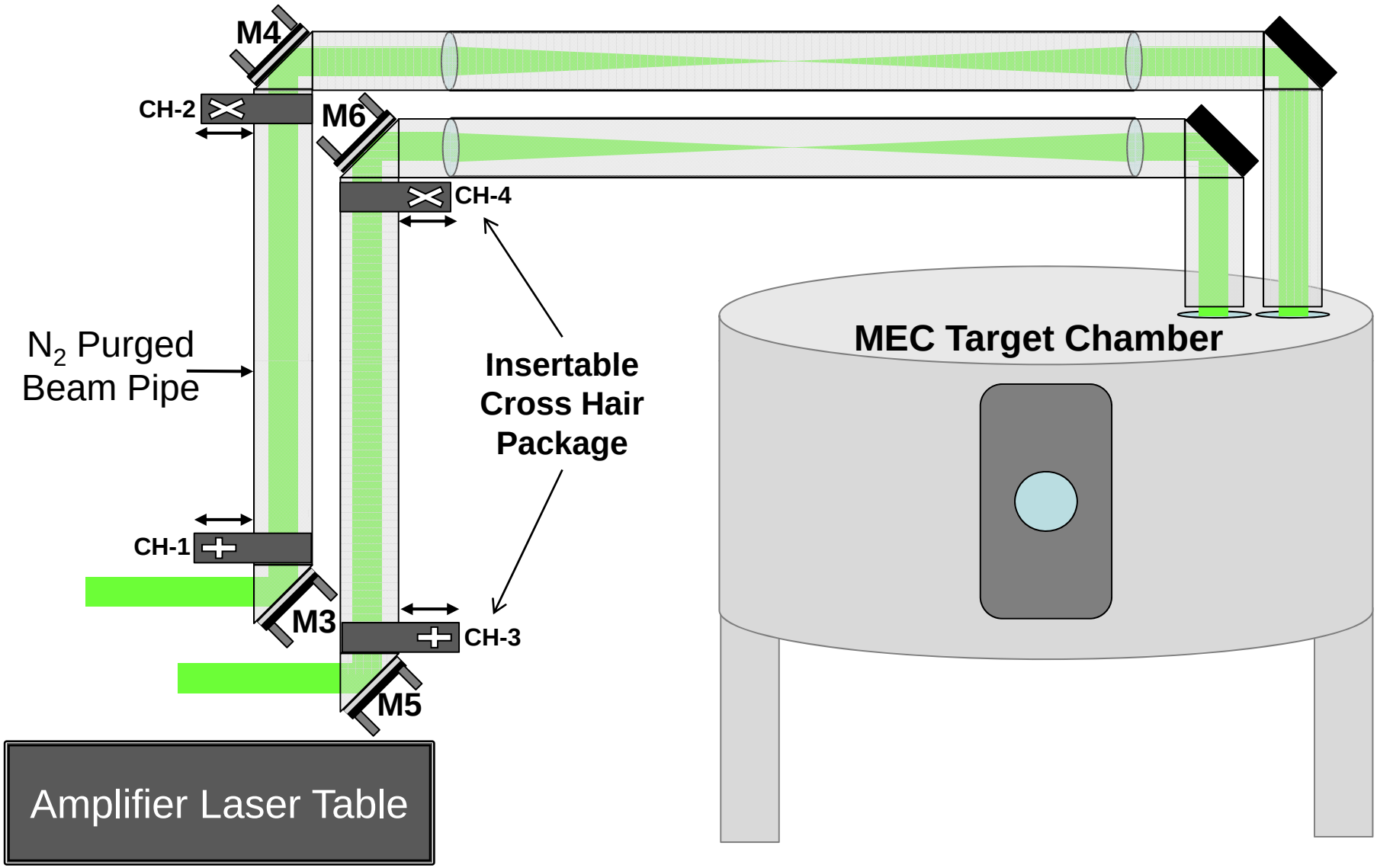
ns-laser beam transport



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ns-Laser Motorized Mirrors

Name	Description	Motor	Quantity
M1	Motorized mirror mount in feedback loop 1, A-line amplifier	½”	2
M2	Motorized mirror mount in feedback loop 1 A-line amplifier	½”	2
M3	Motorized mirror mount, Beam Transport SLAC-built custom mount	1”	2
M4	Motorized mirror mount, Beam Transport SLAC-built custom mount	1”	2
M5	Motorized mirror mount, Beam Transport SLAC-built custom mount	1”	2
M6	Motorized mirror mount, Beam Transport SLAC-built custom mount	1”	2
WP1	Motorized Rotation Mount, λ/2 waveplate for energy throttle A-line	1” Ø rotation	1

Greg Hays
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ns-Laser front end cameras and power meters

Name	Description	Model	Quantity
CC1	Control Camera, machine synchronous, 10 Hz IR, 1st camera in Feedback Loop 1, image stored in data stream		1
CC2	Control Camera, machine synchronous,10 Hz, IR, 2nd camera in Feedback Loop 1, image stored in data stream		1
AC1	Alignment Camera, Non-EPICS, laser synchronous, IR, single-shot to 10 Hz, A-line 25 mm rod alignment		1
PM1	Pulsed Energy Meter, fixed Position, machine synchronous, single-shot to 10 Hz, output Agilite A		1
PM2	Pulsed Energy Meter, fixed Position, machine synchronous, single-shot to 10 Hz, output 25mm rod A		1
FW1	Rotating Filter Wheel	Newport 1”Ø rotation	1

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ns-Laser Amplifier Diagnostics Controls

Name	Description	Model/Stage	Quantity
DC-A1	Alignment Camera, Non-EPICS, laser synchronous, single-shot to 10 Hz, Near Field Diagnostic		2
CC-A1	Control Camera, machine synchronous, single-shot to 10 Hz Visible (527nm), Near Field Diagnostic, image stored in data stream		2
PM1	Pulsed Energy Meter, fixed Position, machine synchronous, single-shot to 10 Hz		2
PD1	Fast photodiode, 10 GHz bandwidth, 527 nm Coupled to 5 GHz, 4 Channel Tektronix Oscilloscope, Scope traces are saved to the data stream.	EOT ET-4000	2
FW2	Rotating Filter Wheel	Newport 1”Ø rotation	2
Scope	Tektronix Oscilloscope, 4 channel, 10 GHz	Tektronix DPO/DSA 7080	1

Greg Hays
haysgr@slac.stanford.edu

ns-laser vacuum and other controls

Name	Description	Control	Quantity
G1	Vacuum Telescope Vacuum Gauge, (760 to 10^{-3} torr)	pirani	1
G2	Vacuum Telescope Vacuum Gauge, (10^{-7} torr)	Ion	1
Scope	Tektronix Oscilloscope, 4 channel, 500 MHz	Ethernet	1
CH1	Insertable Cross Hair, Smart Motor Drive, 6” travel, limit switches, position read back		4
CC3	Visible Camera, machine synchronous, 10 Hz, Vacuum Compatible		1

Greg Hays
haysgr@slac.stanford.edu

Laser Controls Summary

Name	fs-laser system	ns-laser system	Total
Newport Actuator (TRA25CC/TRA12CC)	8 (1 inch *4, ½ inch *4)	12 (1 inch *8, ½ inch *4)	20
Newport Actuator (Vac TRA25PPV6/TRA12PPV6)	6 (1 inch *2, ½ inch *4)		6
Newport 1”Ø Rotation Mounts (PR50CC/FW102B)	4 (1 WP + 3 PM)	4 (1 WP + 3 Filter Wheels)	8
Newport Long Travel Stages (Vac UTS150PPV6/UTS100PPV6)	3 (4 inch *2, 2 inch*1)		3
Newport XPS-C8 Channels/Drivers/Cable	21	16	37
Smart Motors (6” stage with IMS Mdrive+)		4	4
EPICS Camera Systems (UP685CL-10B, Vac TBD)	2 + 1 (Vacuum)	4 (DAQ) + 1 (Vacuum)	8
Alignment Cameras (UP685CL-10B)		3	3
Pulsed Energy Meter Channels (Coherent LabMax-Top)	4	4	8
Thermocouple Channels (Beckhoff)	40		40
Vacuum Gauges (10^{-3} torr) (MKS937A Pirani)	1	1	2
Vacuum Gauges (10^{-7} torr) (MKS937A Cold Cathod)	1	1	2
Vacuum Ion Pump		1	1
Vacuum Gate Valve (4”Ø) (AutomationDirect PLC with VAT valve)	1		1
Ocean Optics Jaz Spectrometer	1		1
Oscillator Remote Controls (SLAC built)	1		1
High Speed AND Gate (SLAC built)	1		1
LBL Timing	1		1
Oscilloscope, 500 MHz, 4 channel (Tektronix)	1	1	2
Oscilloscope, 10 GHz, 4 channel (LeCroy) for Fast Diode ET-4000		1 (2 channels)	1
Web Cameras (AXIS PTZ213)	4		4

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Control Interface

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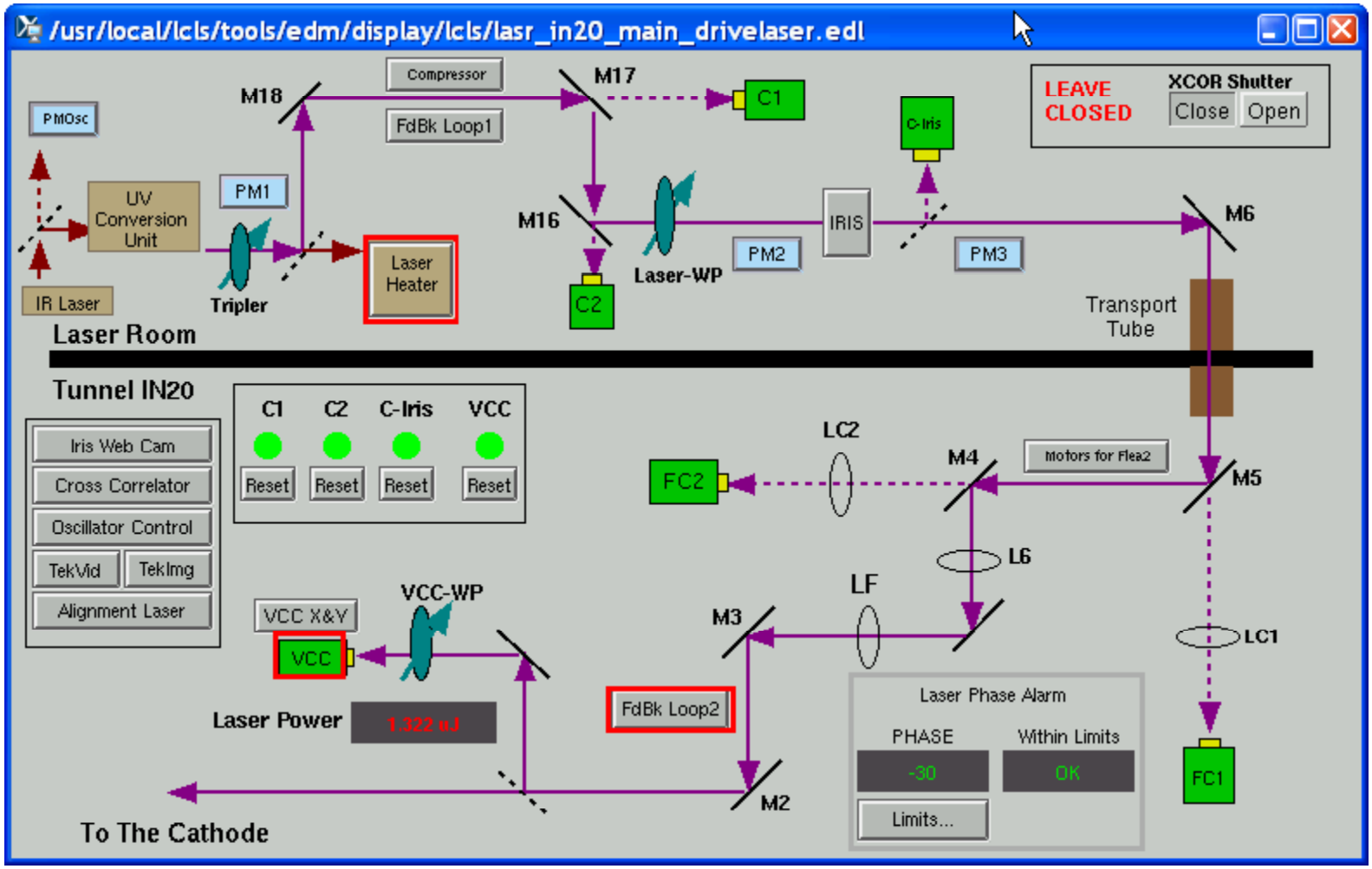
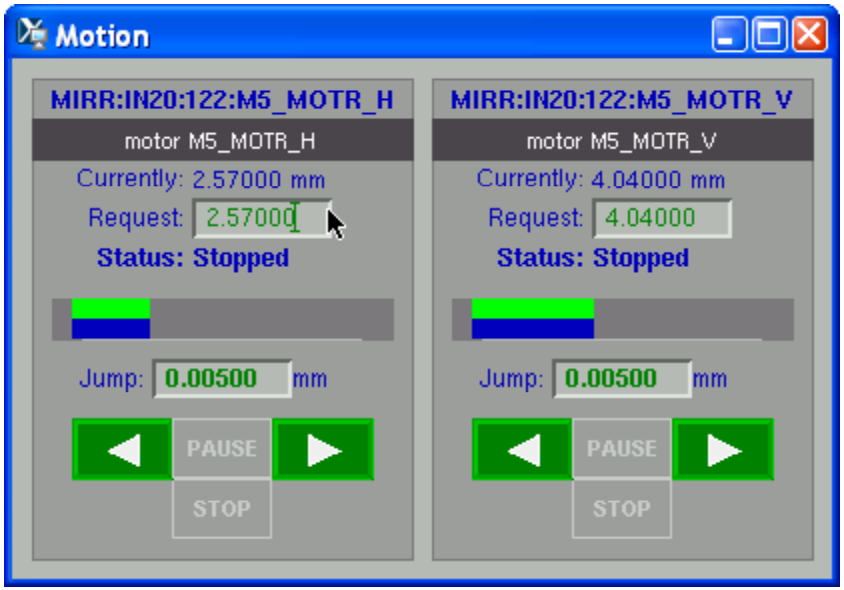
NEH Laser System

- The whole system will be controlled by EPICS, same as drive laser



Motion Control Software

- Motion Control EPICS software will be running on a RTEMS IOC
- EDM screen will be provided for manual operation
- Some motors will be controlled by feedback loop



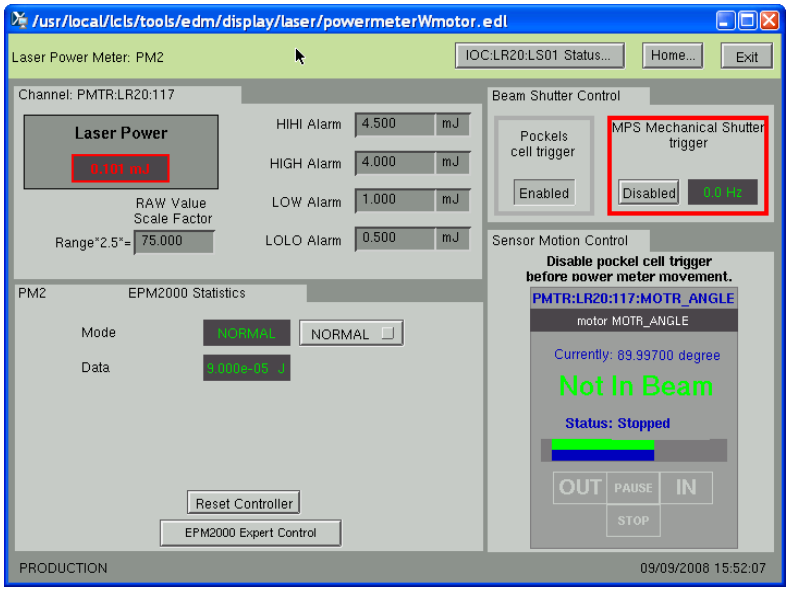
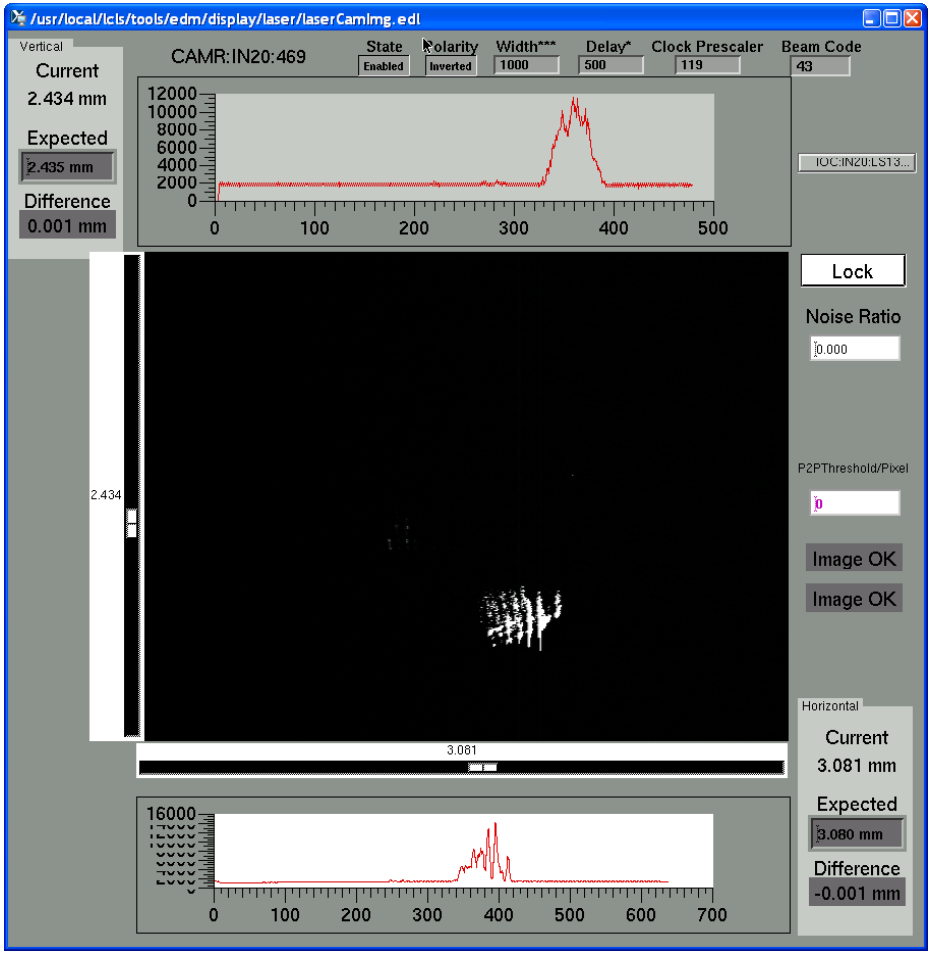


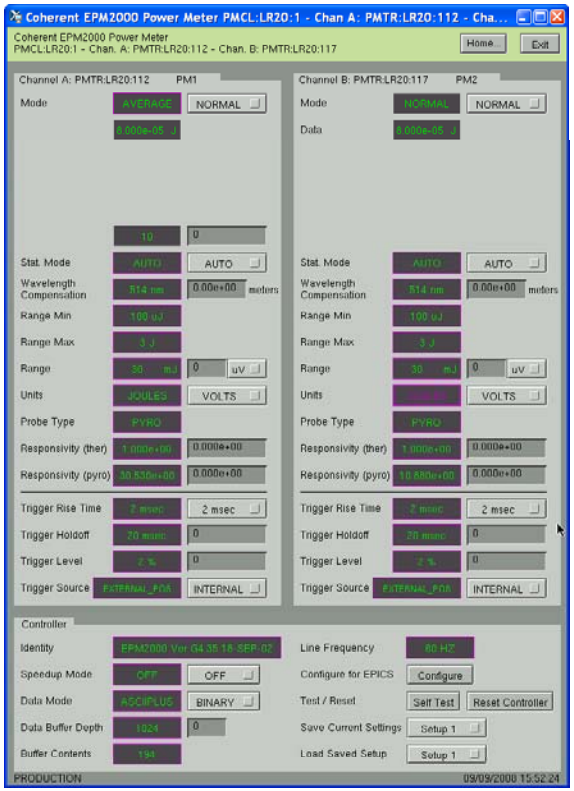
Image Acquisition Software

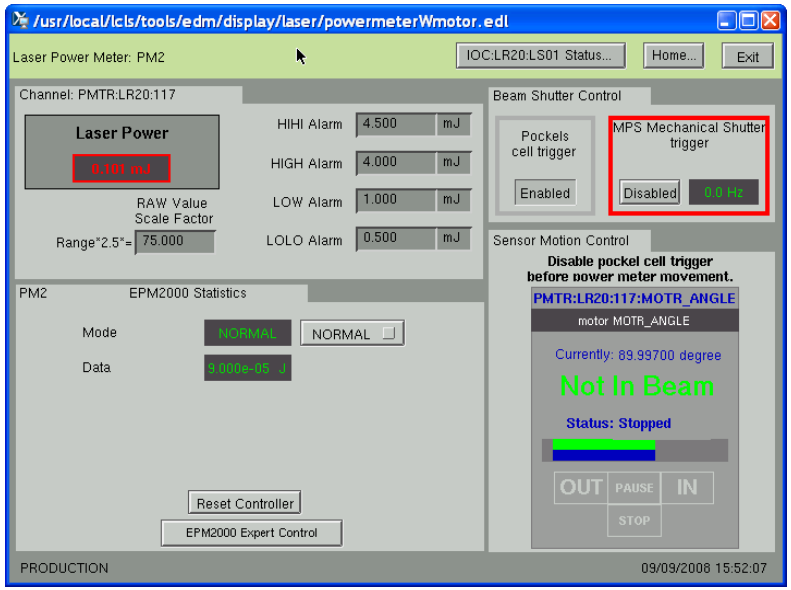
- Image will be displayed by EDM screen
- Preliminary image processing will done in IOC
- More image processing and finer display could be done by high level apps



Laser Power/Energy Measurement Software

- Motion control will be provided to move power/energy sensor in/out laser beam
- Interlock between laser and sensor motion might be provide
- Pulse-by-pulse read back and detailed power meter configuration will be available





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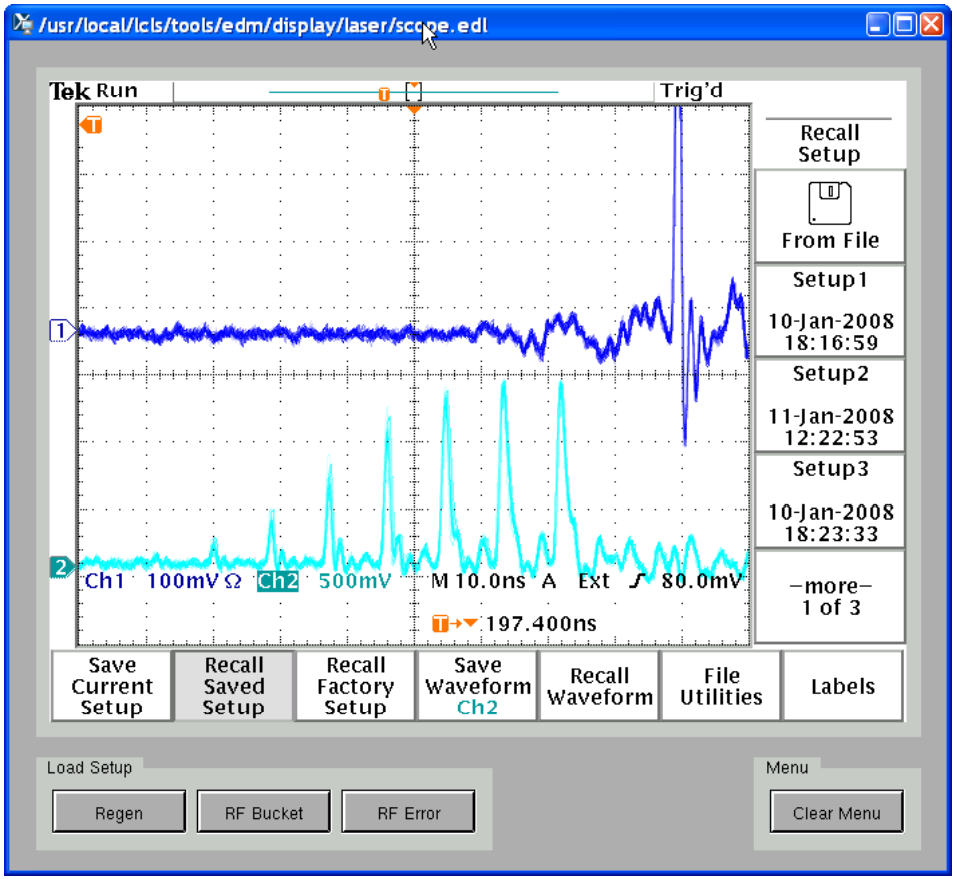
Miscellaneous

- All the devices will be accessible from EPICS
  - Scope
  - Vacuum
  - Oscillator
  - Thermocouple
  - …



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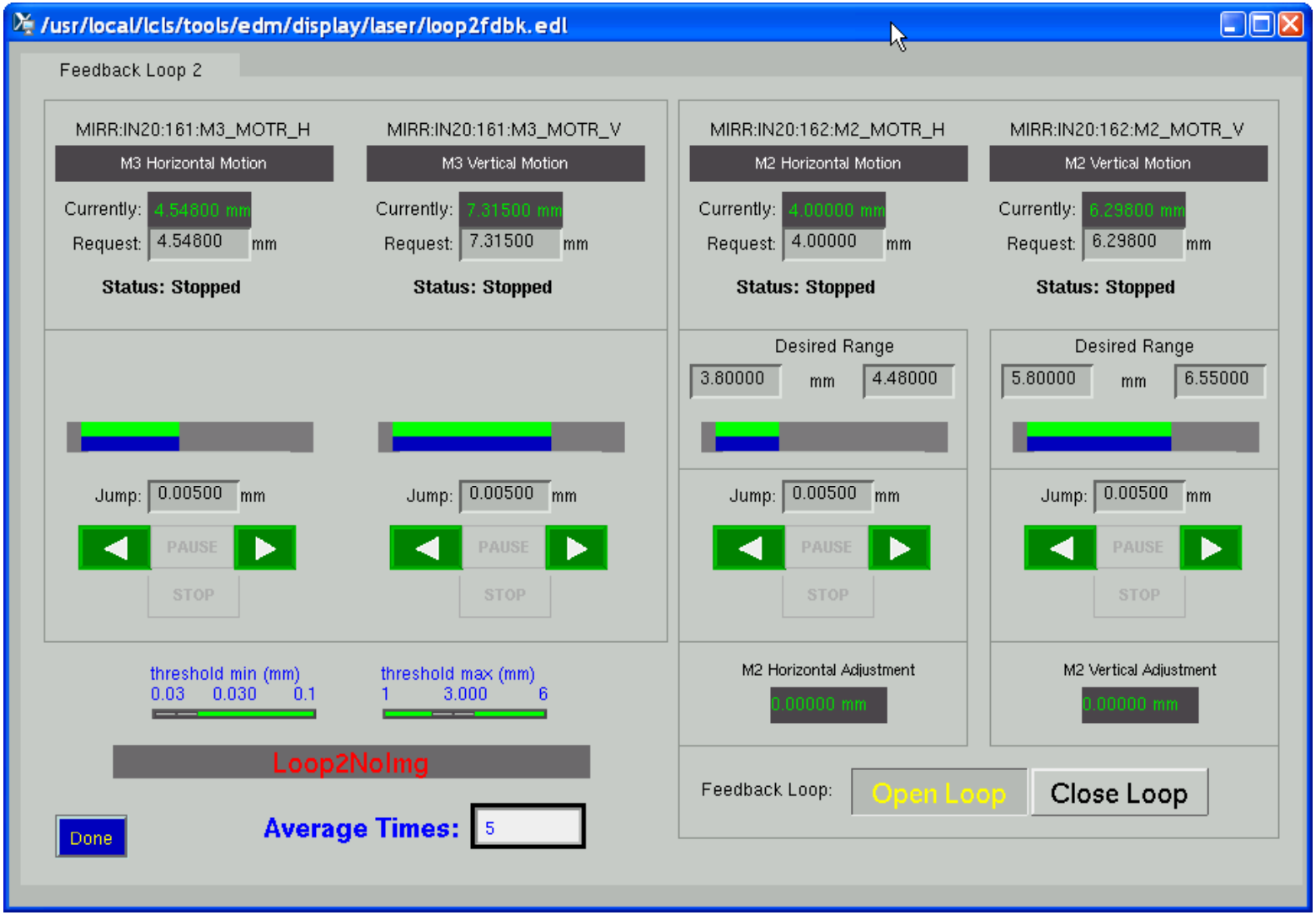
Feedback Loops

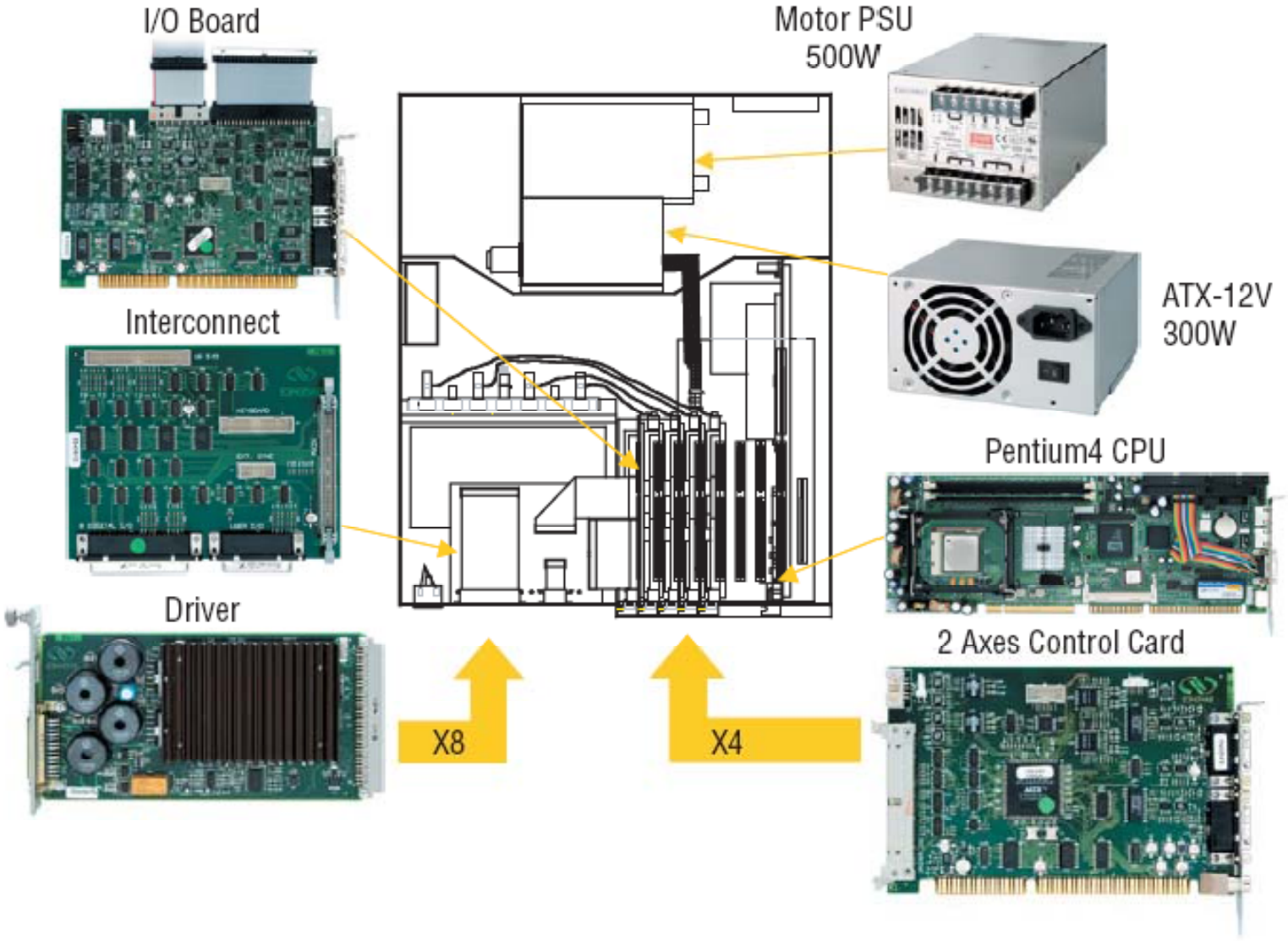


Components

Newport is used for Laser Optical Motion

- Newport XPS-C8
  - Ethernet based
  - 8 channels per controller
  - Auto-recognize Newport motors
  - Encoder built-in
  - Driver DRV01: 3 Amps, 48V

Newport XPS


I/O Board
Motor PSU
500W
Interconnect
ATX-12V
300W
Pentium4 CPU
Driver
2 Axes Control Card
X8
X4

Most of Newport Stages/Actuators are compatible

CMA-12CCCL/CMA-25CCCL

SR50CC

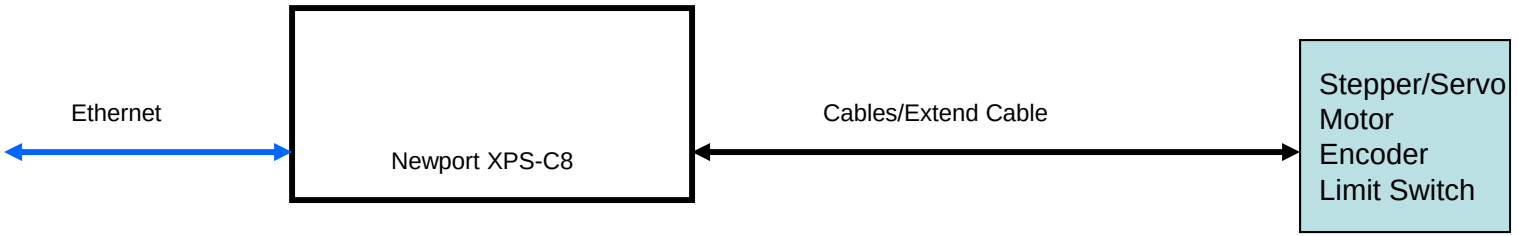
ILS150CC

UTS150PPV5/UTS100PPV6

TRA12CC/TRA25CC/TRA12PPV6/TRA25PPV6

PR50PP

Newport System Block Diagram



- Note:

IMS MDrivePlus Stepper

- ~20 models
- 14NEMA to 42NEMA
- RS422/485 control interface

- Digi PortServer TS16 MEI

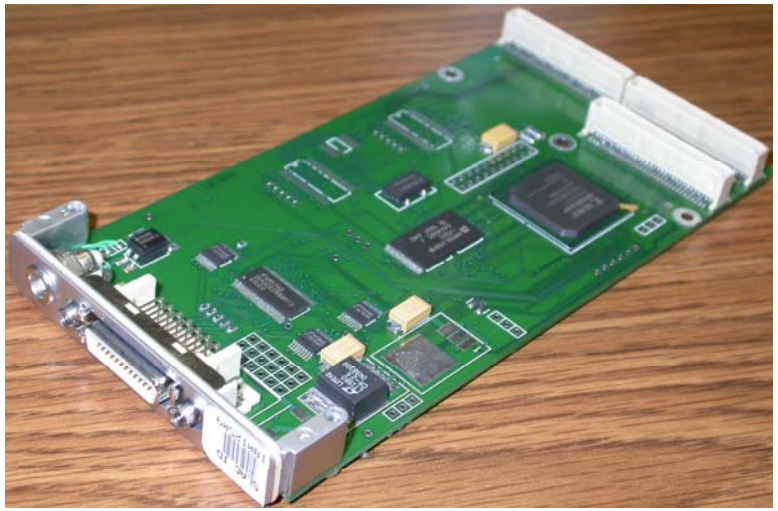
UniqVision UP685CL-10B Camera

- UniqVision UP685CL-10B (http://www.uniqvision.com/spec/up685&685cl.pdf)
- CameraLink Interface to EDT PMC card
  - MDR 26-pin connector (LVDS signals)
- Additional interface
  - 12V power
- About $2k

CCD:	1/2”
Shutter:	Full Frame
UV option:	No
Resolution:	640x480
Cell Size	9.9umx9.9um
Progressive:	Yes
External Trigger:	Yes
Full scan:	120Hz
Cameralink:	Yes

EDT DV CameraLink Interface

- EDT DV C-Link (http://www.edt.com)
- LEMO connector
  - Receives electrical trigger signal (VINIT) from EVR
  - Trigger (VINIT) is delivered to camera thru CameraLink interface
- CameraLink Interface to Camera
  - Fiber interface (old picture here)



- EDT PMC DV Fox
  - CameraLink compatible
  - 32bit/66MHz PCI
  - External trigger input
- EDT RCX
  - Convert CameraLink to fiber to extend distance
  - $800/each
- About $1k

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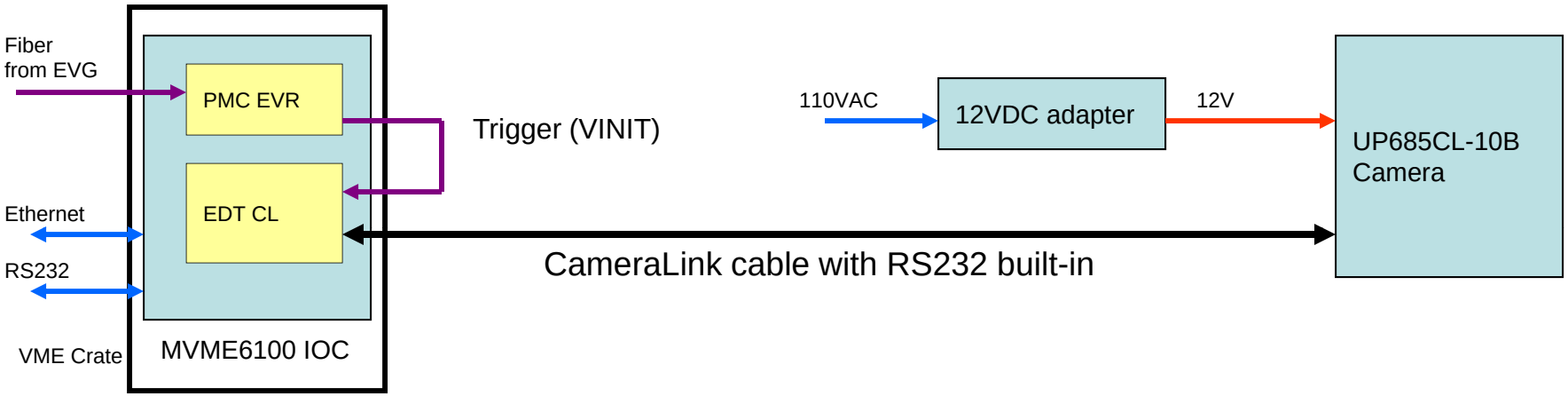
Camera Control Block Diagram



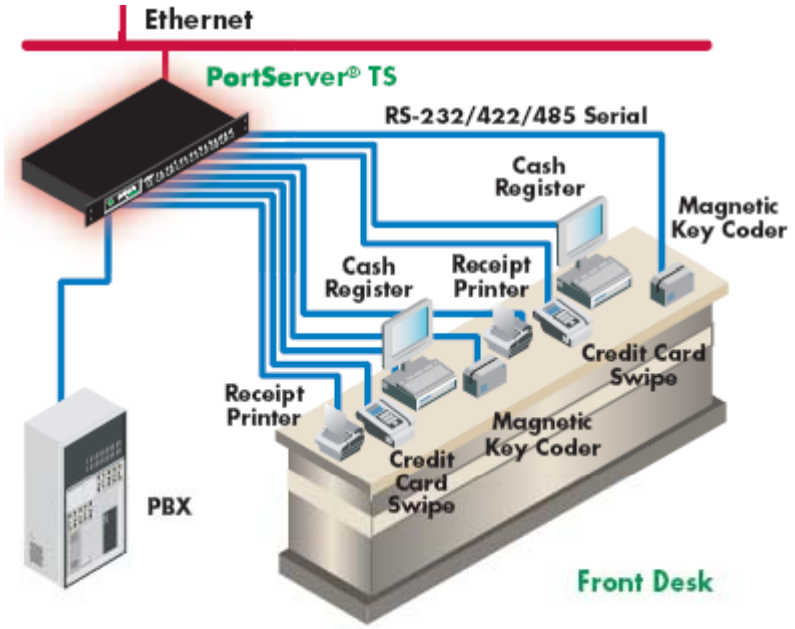
Note:

- Trigger is connected from EVR to EDT CL
- For > 10m, we can convert CameraLink cable to fiber (Multimode :300M, Singlemode:2KM) by EDT RCX converter.

Laser Power Measurement

- Coherent LabMax-Top is used to measurement laser power
- RS232 interface for configuration
- Analog output gives voltage proportional to laser power and update at 120Hz
- Acromag IP-330AE is used to measure analog output

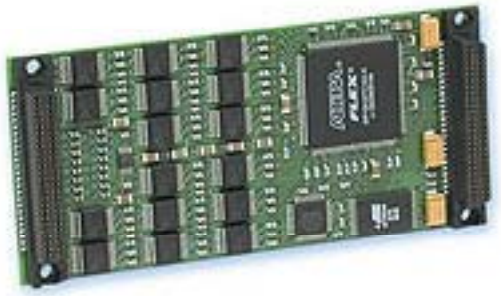
Digi RS-232 Port Server



- http://www.digi.com/products/serialservers/portserverts816.jsp
  - Digi PortServer TS 16 RJ-45 Terminal Server Manufacturer Part #70001733
  - $1,363.00

Acromag Analog I/O IP

- AVME9670E
  - VME64, Non-Intelligent, IP Carrier Card
  - $800
- IP330AE
  - 16 bit, 16 ch diff or 32 SE
- Trans 200 Transition card
  - For what?
  - $200



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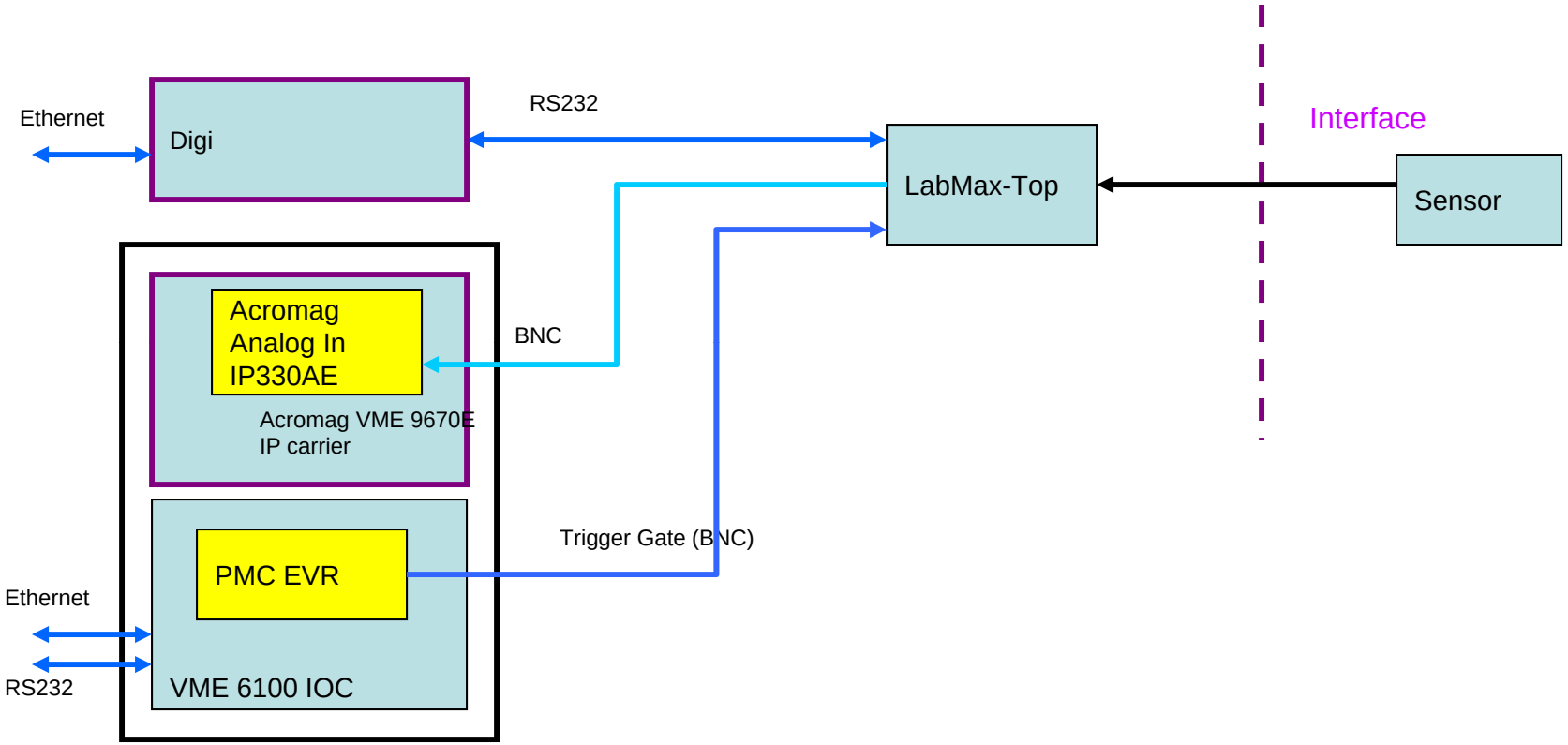
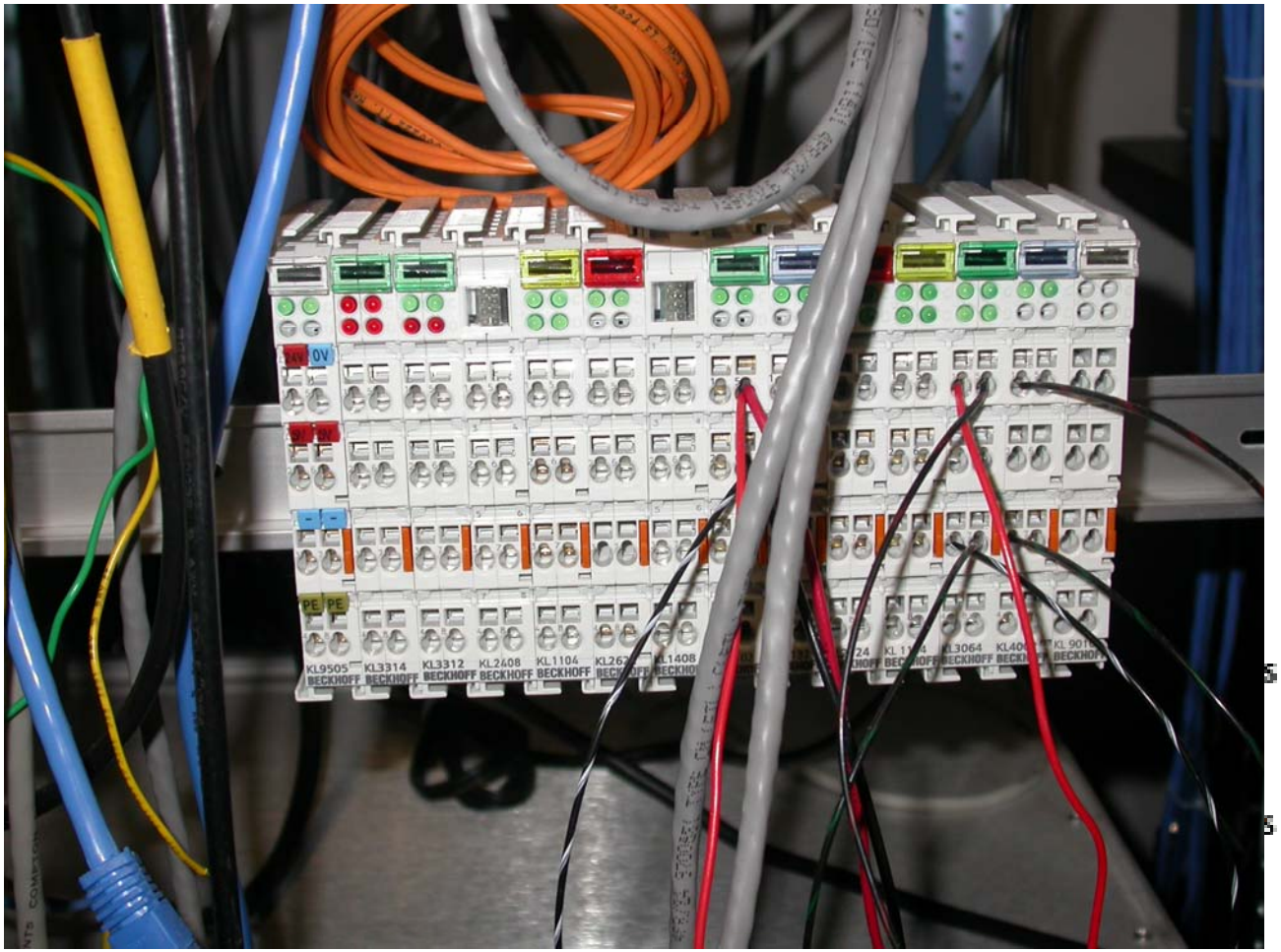
Power Meter Block Diagram

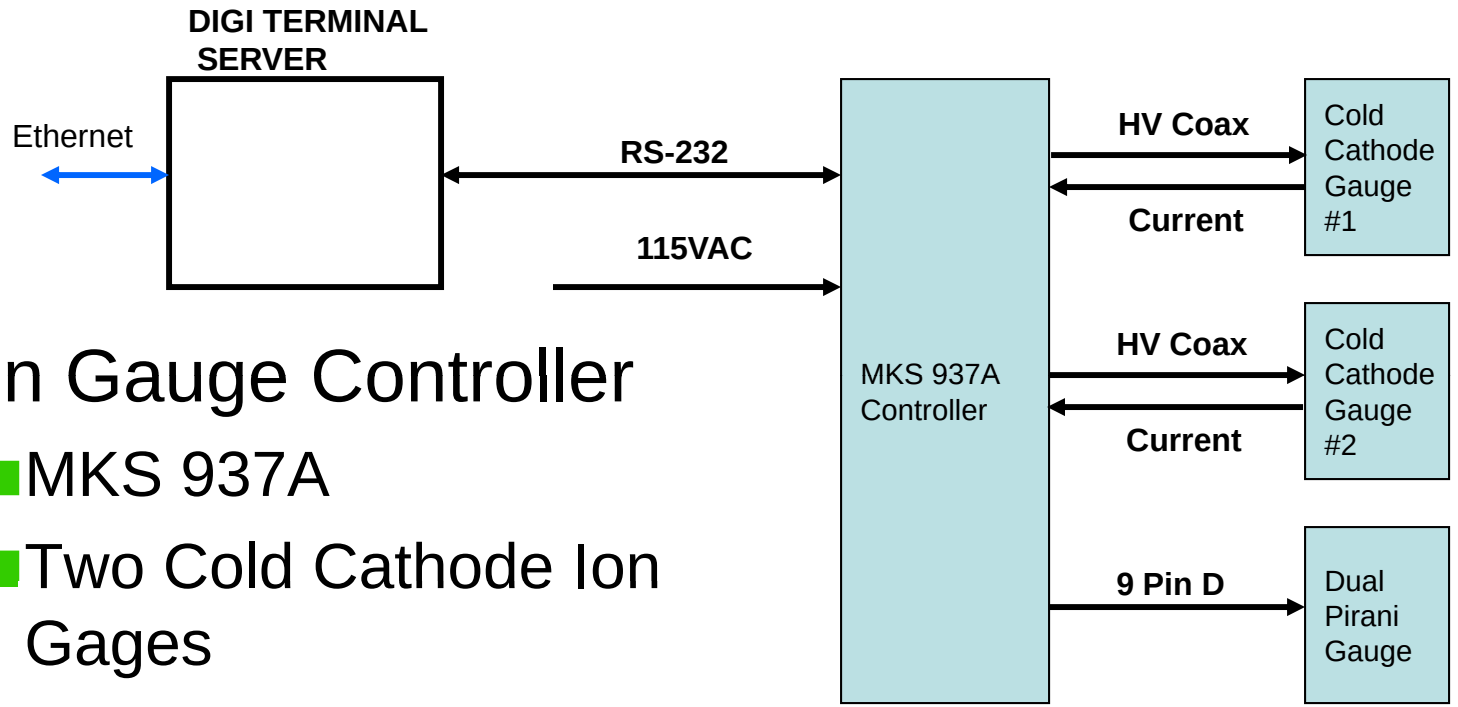


- EPM2000 has dual-channel version
- EPM2000 supports both RS232 and GPIB. RS232 with Digi is preferred.

Beckhoff Ethernet-Based IO



Ion Gauge System Block diagram (Cold Cathode)

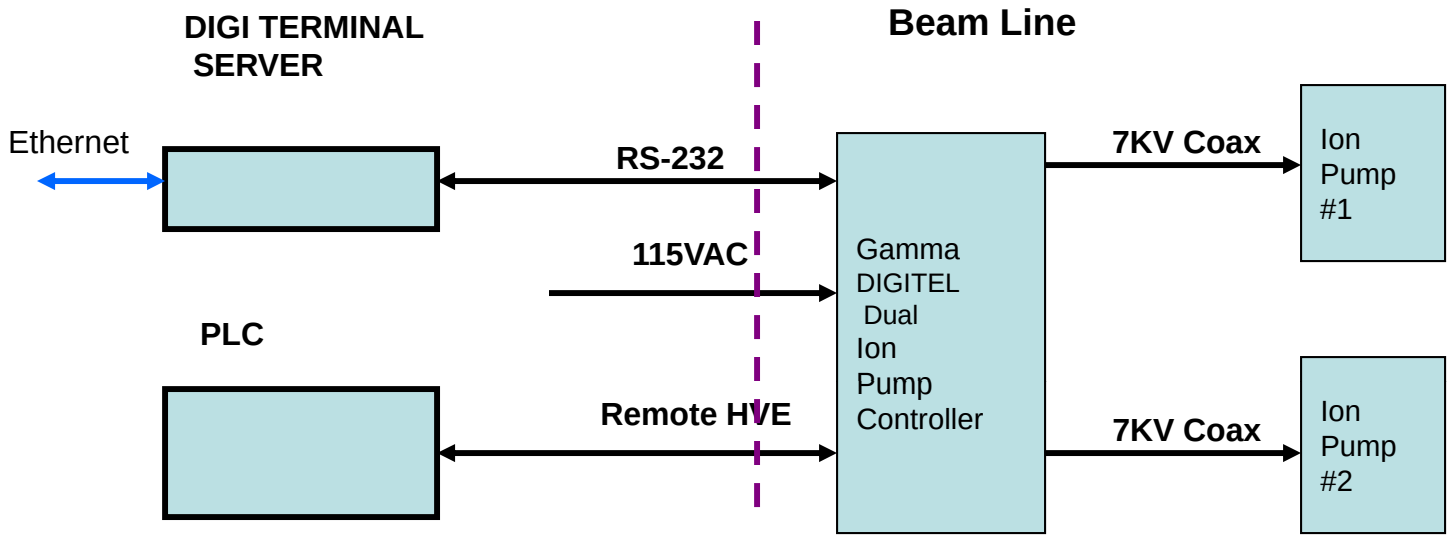


- Ion Gauge Controller
  - MKS 937A
  - Two Cold Cathode Ion Gages
  - Two Pirani Gauges
  - http://www.mksinst.com/

937A Controller

Cold Cathode Gage

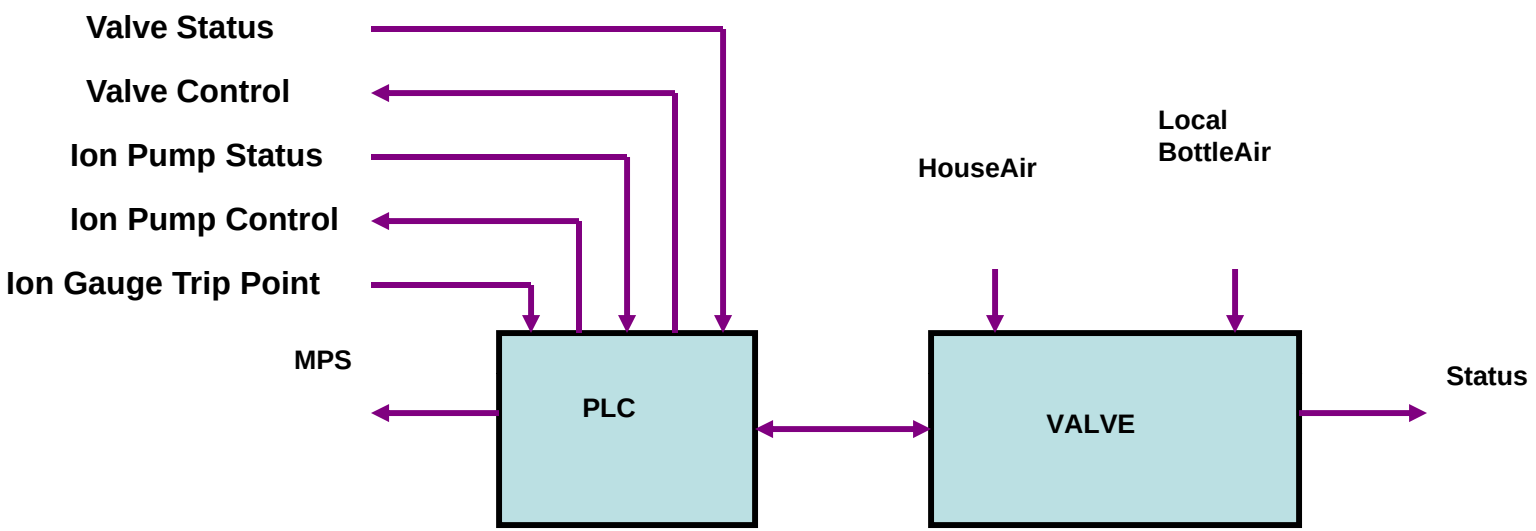
Ion Pump System Block diagram



- Ion Pump Controller
  - Gamma DIGITEL Dual
  - http://www.gammavacuum.com/
  - Self protected
  - Local on/off only

Gamma Pump Controller

Vacuum System Components Valve Control



- DirectLOGIC 205 PLC
  - Standard I/Os
  - Communications
    - Ethernet
    - RS232
  - EPICs supported

Oscilloscopes

- Tektronix TDS3054B
  - 4 Channel
  - 500MHz analog bandwidth
  - Up to 5GS/s
  - 9-bit vertical resolution
  - Up to 10K points memory
  - Ethernet interface

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Oscilloscopes for XPP

- LeCroy (TBD)
  - Up to 50GS/s
  - 4GHz analog bandwidth
  - 8-bit vertical resolution?
  - Ethernet interface

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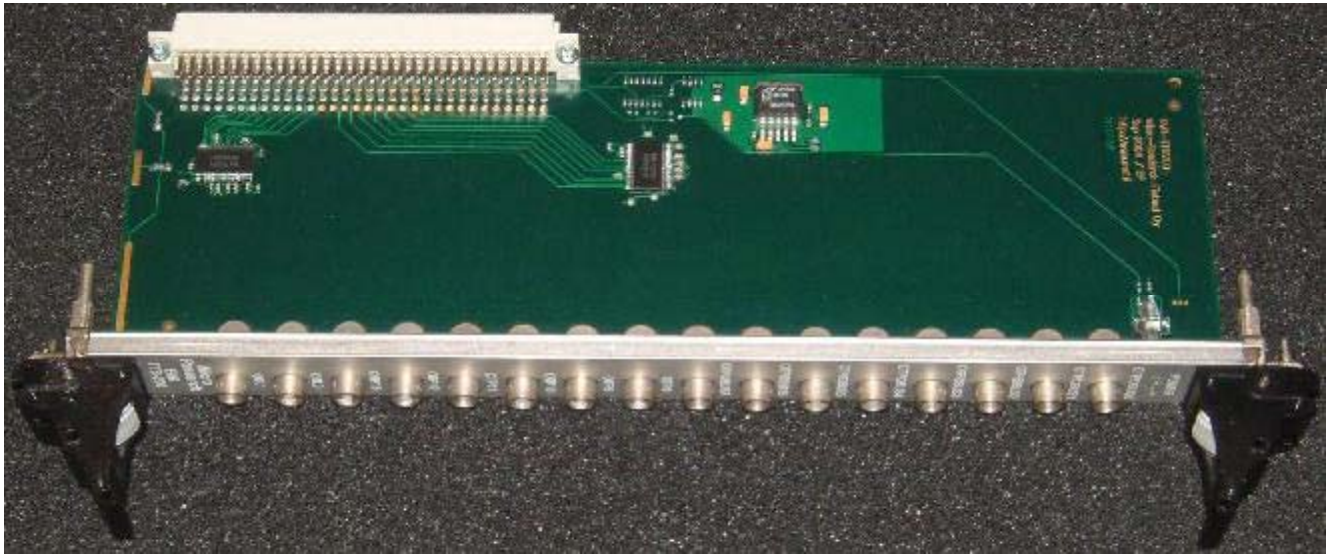
PMC EVR

- Micro-Research Finland PMC-EVR-200
- http://www.mrf.fi
- Receives timing information via fiber from Machine Event Generator (EVG)
- PMC EVR has three trigger outputs on front panel
  - With transition module (EVR-TTB-200) we have up to 13 triggers
- About $2k

EVR-TTB-200 EVR Transition Card

- The Event Receiver TTL Level Transition Card provides 16 TTL level outputs on LEMO connectors capable of driving 50 ohm ground terminated loads. The Event Receiver output signals available are
  - Programmable width pulses 0-13
  - Distributed bus outputs 0-7 (multiplexed with programmable width pulses)
  - Two gate outputs



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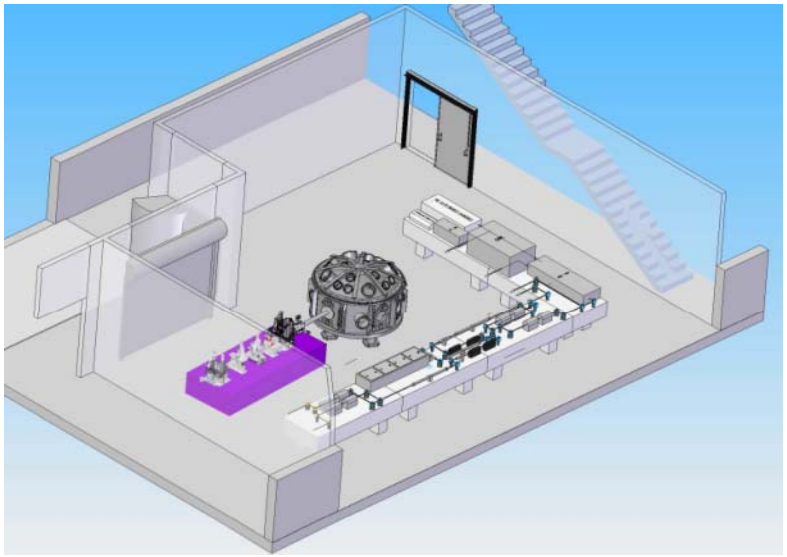
MEC
Controls and Data-Systems
WBS 1.05

Preliminary Design Review

Gunther Haller, Sheng Peng



Outline

- Overview
- Main Sub-System Component Descriptions
  - Controls
  - Data Acquisition
- User Interface
- Online & Offline Data Processing
- Safety
- Milestones

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Review

- Preliminary Design Review (see LCLS Design Review Guidelines)
  - System
  - Components
  - Interfaces
  - Performance

A PDR is held when the design is advanced sufficiently to begin some testing and /or the fabrication of design models. Detail designs are not expected at this time, but design analyses is required to demonstrate compliance with requirements. A presentation of the design and interfaces by means of block diagrams, signal flow diagrams, schematics, logic diagrams, configuration and layout sketches, analyses, modeling and any early results are required. Supporting data and analyses for mechanical, power, thermal, reliability assessments, should be shown.

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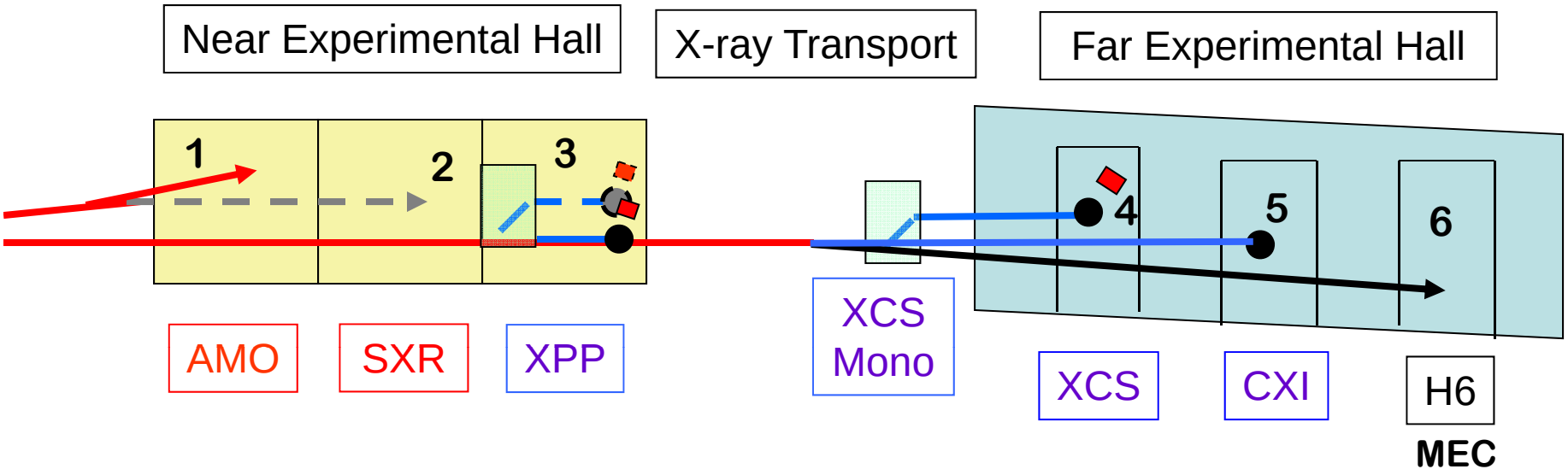
Background



- Common Controls and DAQ System Design for LCLS, LUSI, MEC
  - Benefit from development and commissioning of earlier experiments
  - Many controller to be used for MEC will have been in operation at earlier LCLS experiments

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LCLS and MEC

- Common services for all hutches
  - Hutch protection system
  - Accelerator timing interface
  - 120 Hz beam-quality data interface
  - Machine protection system interface
  - User safeguards
  - Network interface
- Two main sub-systems
  - Controls
  - Data (including Data-Acquisition)

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Scope

- Controllers and DAQ
  - Vacuum, motion, viewing for
    - X-ray tunnel MEC beamline components
    - Hutch 6 beamline components
    - Hutch 6 laser components (also power measurement)
    - Hutch 6 diagnostics chamber components
  - Data acquisition, processing
    - XRT and hutch 6 components
      - Diode signal readout, detector& camera control & readout
- Common services
  - Servers, network switches, data-cache, online processors, timing components, MPS components, temperature measurement components
- Hutch 6 Laser Safety System
  - Programmable logic controller, switches
- Racks and cabling
  - XRT, hutch 6, mezzanine, including cabling to beamline
- Installation

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ESD's

Engineering Specification Docs

TYPE	PREFIX	DOCUMENT #	REV	TITLE
ESD	SP	391-004-27	0	MECI X-Ray Transport Controls ESD
ESD	SP	391-004-28	0	MECI Target Chamber Controls ESD
ESD	SP	391-004-29	0	MECI Laser Controls ESD

ICD to follow

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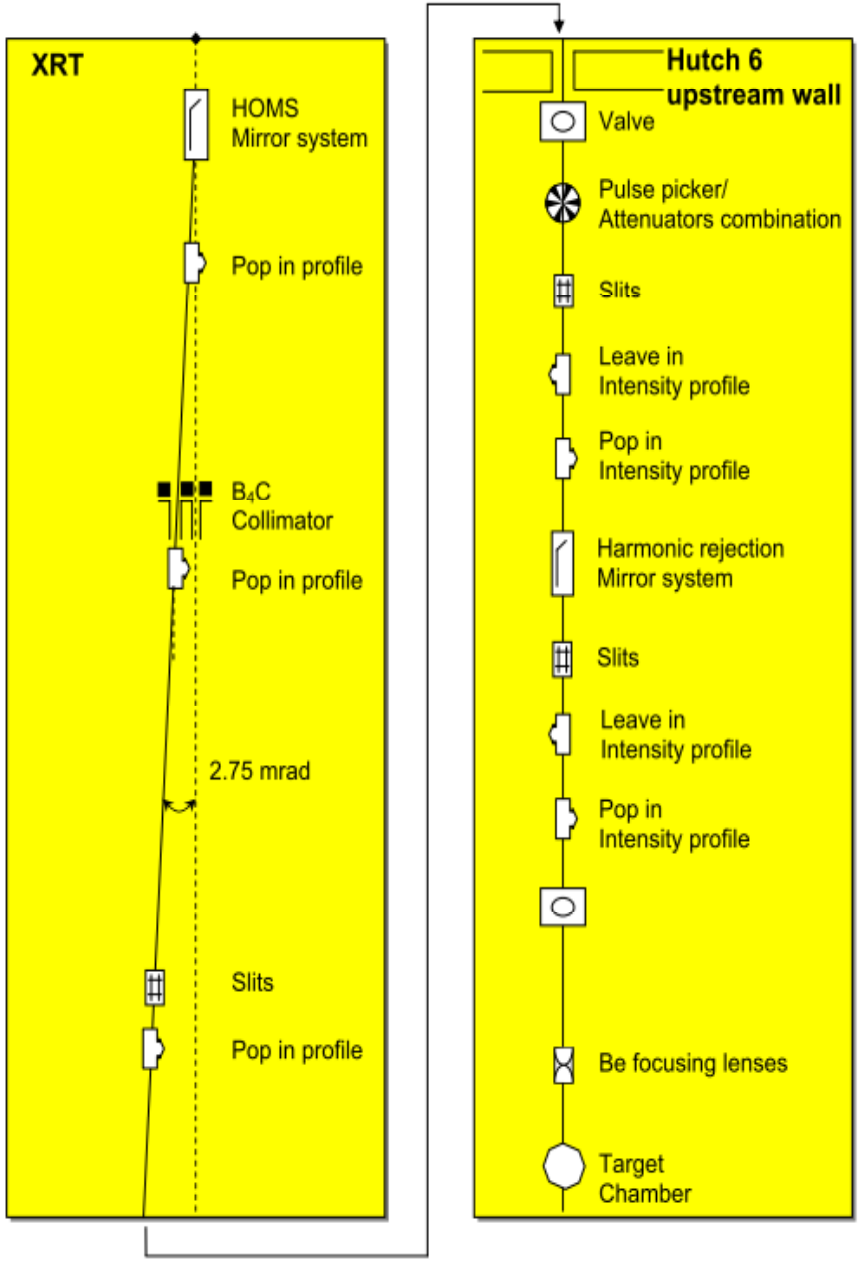
Diagram of the X-Ray Optics & Diagnostics Layout



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Beamline (1)

Item (# of units if more than 1)	Purpose	Locations	Sub-Components for a single unit	Controller	Interface	Notes
Valve (6)	Vacuum isolation	XRT: 4 Hutch 6: 2	PLC	DirectLogic PLC	Ethernet	DIN Rail Wiring
Intensity-Position Monitor (3)	Measure Incident FEL intensity on every pulse (120 Hz)	XRT: 1 Hutch 6: 2	Motion stages (serial) (2) Linear Encoders (2) Limit Switches (4) Front-End Elect readout (serial) Power Supplies (12V, up to 4 channels)	IMS MDrive+; IPMB;	RS485 RS232	
Pop-in Profile Monitor (1)	Measure FEL intensity	XRT: 1	Motion stages (serial) (1) Linear Encoders (1) Limit Switches (2) Zoom lens (1) Camera (1) Camera Link	IMS MDrive+; Navitar Lens; UP900	RS485 RS485 CameraLink	
Pop-in Profile-Intensity Monitor (2)	Measure FEL intensity & Spatial beam profile	Hutch 6: 2	Motion stages (serial) (1) Linear Encoders (1) Limit Switches (2) Zoom lens (1) Camera (1) Camera Link Front-End Elect readout (serial) Power Supplies (12V, up to 4 channels)	IMS MDrive+; Navitar Lens; UP900; IPMB;	RS485 RS485 CameraLink RS232	
Attenuators/Pulse Picker (1)	Attenuate FEL	XRT: 1	Pneumatic Actuators (10)	SLAC Solenoid Controller SD-385-001	IP440/IP445	

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Beamline (2)

Item (# of units if more than 1)	Purpose	Locations	Sub-Components for a single unit	Controller	Interface	Notes
X-ray Slits (3)	Define X-ray spot size	Hutch 6: 3	Motion stages (serial) (4) Encoders (4) Limit Switches (8)	IMS MDrive+	RS485	
X-ray Focusing Lenses (1)	Increase incident x-ray fluence	Hutch 6: 1	Motion stages (serial) (2) Encoders (2) Limit Switches (4)	IMS MDrive+	RS485	
Harmonic Rejection Mirror System (1)	Isolate fundamental FEL radiation	Hutch 6: 1	Motion stages (serial) (6) Encoders (6) Limit Switches (12)	IMS MDrive+	RS485	
Ion Pump (12)	Hold vacuum in beam pipe	XRT: 9 Hutch 4: 1 Hutch 5: 1 Hutch 6: 1	Serial	Gamma DIGITEL DUAL	RS232	
Vacuum Gages (24)	Measure vacuum pressure	XRT: 18 Hutch 4: 2 Hutch 5: 2 Hutch 6: 2	Serial	MKS937A	RS232/PLC	
FEL Deflecting Mirror + Thermal Enclosure (1)	Like M2H in FEE	XRT: 1	design, need info.	IMS MDrive+	RS485	
Photon Stopper (1)	Like Photon Stopper in XRT	XRT: 1	Photon Stopper design, need info.	SLAC Solenoid Controller SD-385-001	IP440/IP445	
Reference Laser (1)	Like Reference Laser in CXI	Hutch 6: 1	Reference Laser design, need info.	TBD	TBD	

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, Target Chamber Vacuum (3)

Item (# of units if more than 1)	Purpose	Locations	Sub-Components for a single unit	Controller	Interface	Notes
Target Chamber						
Valves (4)	Target Chamber isolation	Hutch 6: 4	PLC	DirectLogic PLC	Ethernet	
Turbo Pump (1)	Target Chamber vacuum system	Hutch 6: 1	Serial	Varian/LeyBold	RS232	
Cryo- Pump (2)	Target Chamber vacuum system	Hutch 6: 2	Serial	Sumitomo Marathon Cryo Pump Controller	RS232	CXI
Mechanical Roughing Vacuum Pump	Target Chamber vacuum system	Hutch 6: 1	Serial	???	???	Do we ever control a roughing pump?

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Target Diagnostics (1)

Item (# of units if more than 1)	Purpose	Locations (Hutch 6)	Sub-Components for a single unit	Controller	Interface	Notes
Target stage	Change sample position	In-vacuum	Micropositioner with controller (PI M-840 or M-824)	PhysikInstrumente Hexapod Controller M850.502	Ethernet/RS232	How about Newport?
Diode detector	Measure incident and transmitted FEL or laser intensity on every pulse (120 Hz)	In-vacuum	X-ray Photodiodes (3) Smart motor (1, for filters) Readout Electronics	IMS MForce IPMB (SLAC)	RS485 RS232	µs signal Need raw signal occasionally
XUV Spectrometer	Data acquisition	In-vacuum	Motors (4, for filters, grating, shutter…) X-ray CCD camera (1)	IMS MForce Princeton Instruments/Andor	RS485 USB2.0/PCI	Note 1: X-Ray Camera up to 10Hz. At least 1K *1K pixels with 14bits/pixel
X-ray Thomson Scattering	Data acquisition	In-vacuum	X-ray CCD camera (1)	Princeton Instruments/Andor	USB2.0/PCI	See Note 1
X-ray Emission Spectroscopy	Data acquisition	In-vacuum	Motors (2, for filters) X-ray CMOS detector(1)	IMS MForce TBD	RS485 TBD	
Pinhole Camera	Data acquisition	In-vacuum	X-ray framing CCD camera (1)	TBD		Might share CXI solution
Fourier Domain Interferometer (FDI)	Data acquisition	No vacuum	Optical CCD camera (1) Smart motor (1, for filters)	TBD (UP900?) IMS MDrive+	CameraLink RS485	Note 2: IR camera, up to 10Hz. At least 1K *1K pixels with 12bits/pixel

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Target Diagnostics (2)

Item (# of units if more than 1)	Purpose	Locations (Hutch 6)	Sub-Components for a single unit	Controller	Interface	Notes
Velocity Interferometer System for Any Reflector (VISAR)	Data acquisition	No vacuum	Optical streak camera (1) Laser System (timing signal)	Hamamatsu C7700 EVR Trigger	GPIB/Win32 RDP TTL	<<10FPS. Complicated Windows software. Remote Desktop.
Alignment Diagnostics	Motor control of focus Long distance microscope and data acquisition of webcam	No Vacuum	Motorized focus of Questar long distance microscope (2) Webcam (2)	Built-in motion Camera (TBD) AXIS PTZ213	RS232 (?) CameraLink Ethernet	See Note 2
Chamber Optics	Motor control of optical elements in target chamber	Vacuum	Motors for short pulse beam alignment (4) Motors for long pulse beam alignment (7)	IMS MForce	RS485	

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XRT Racks

Z Coor(m) Ref Start XRT	Z Coor(m) Ref LCLS	Item
10.07	815.88	Valve
10.47	816.28	ion pump - 2 gauges
11.30	817.11	FEL deflecting mirror
14.50	820.31	ion pump - 2 gauges
12.54	818.35	Valve
14.90	820.71	Pop-in profile monitor
67.23	873.05	Valve
85.34	891.15	ion pump - 2 gauges
109.70	915.51	ion pump - 2 gauges
134.11	939.92	ion pump - 2 gauges
163.67	969.48	ion pump - 2 gauges
174.85	980.66	Intensity position monitor
175.00	980.81	Atten/pulse picker
181.70	987.51	ion pump - 2 gauges
184.50	990.31	Photon stopper
184.50	990.31	ion pump - 2 gauges
185.13	990.94	Valve
185.13	990.94	ion pump - 2 gauges

- **2 racks in XRT**
- **One at about z = 60 m**
  - **Incl 5 GAMMA ion-pump controllers, 5 MKS gauge controllers, VME crate for LVDT, terminal server, super-micro server, smart-motor power supply**
- **one at about z = 175 m**
  - **Incl 2 GAMMA ion-pump controllers, 2 MKS gauge controllers, solenoid drivers, VME crate, terminal server, super-micro server, smart-motor power supply**
- **Rack profiles of two XRT racks see**

  https://confluence.slac.stanford.edu/display/PCDS/MEC
- **Existing racks in XRT:**
  - **Z(R01) = 15.95m**
  - **Z(R02) = 19.10m**
  - **Z(R29) = 134.31m**
  - **Z(R30) = 137.54m**
  - **And for reference:**
  - **Z(alcove wall at end of XRT) = 189.23 m**
  - **Z(Wall at hutch 4 in the alcove) = 199.60m**

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FEH Racks

- 2 on mezzanine for
  - H4, H5, H6 vacuum
    - Gamma Ion pump controllers, MKS gauge controllers, Programmable Logic Controller (for all MEC logic including XRT)
  - Camera servers
  - Timing distribution
- 1 full rack in H6 (closest to wall)
  - Already has network and MPS patch-panels (from phase 7 cable contract)
  - Beamline cryo/turbo pump controllers, motor power supplies and terminal servers, IPMB diode box terminal servers
- 4 short racks in H6 (under laser table)
  - #1 Laser power meter, Laser Newports
  - #2 Target Diag motor supplies, terminal server; Laser Newports, TC beckhoffs
  - # 3 LBL timing receivers, Laser ion-pump controller
  - #4 Switch, target Diag: terminal server, camera servers. PI M-840

Rack profiles of racks see

https://confluence.slac.stanford.edu/display/PCDS/MEC

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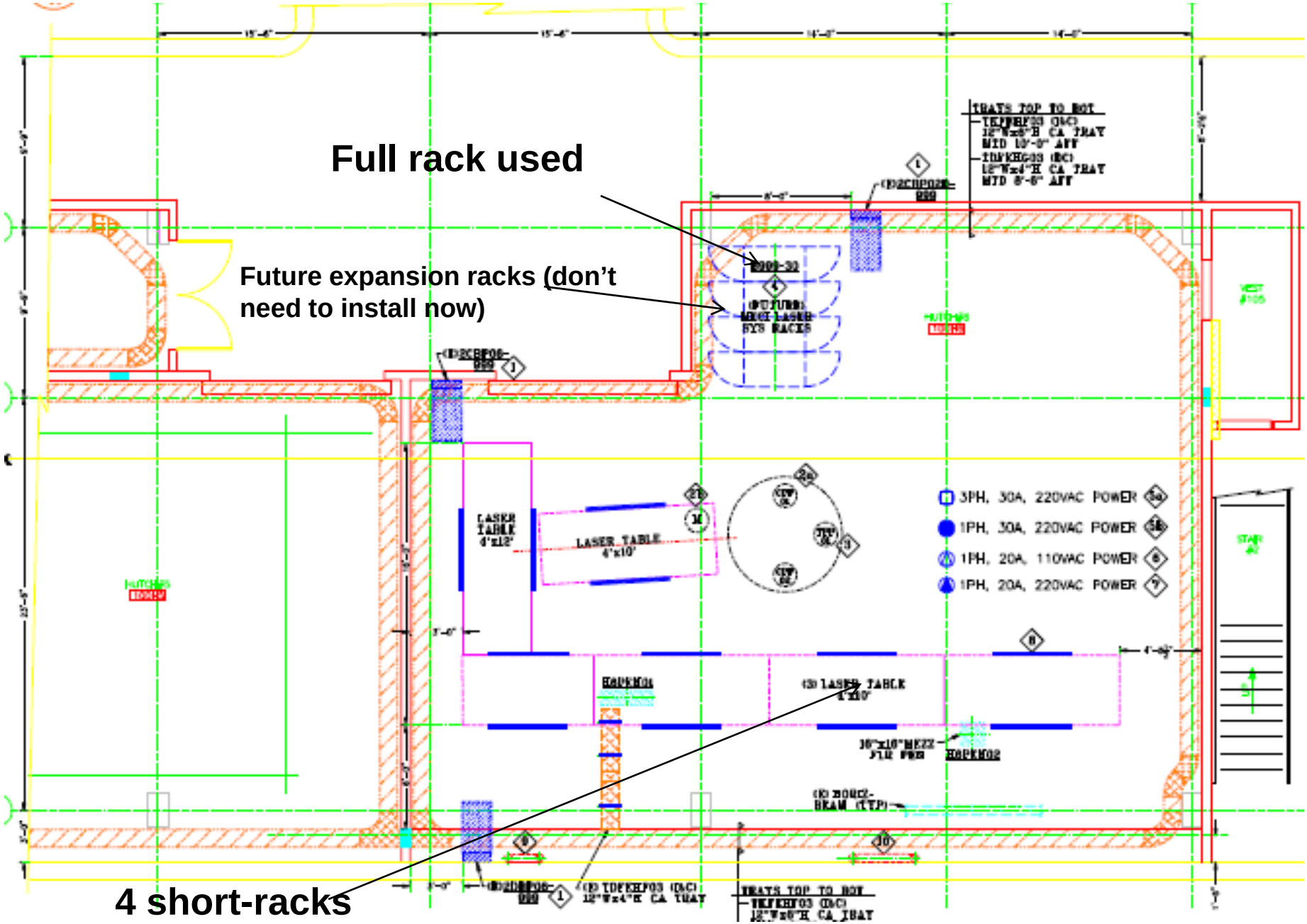
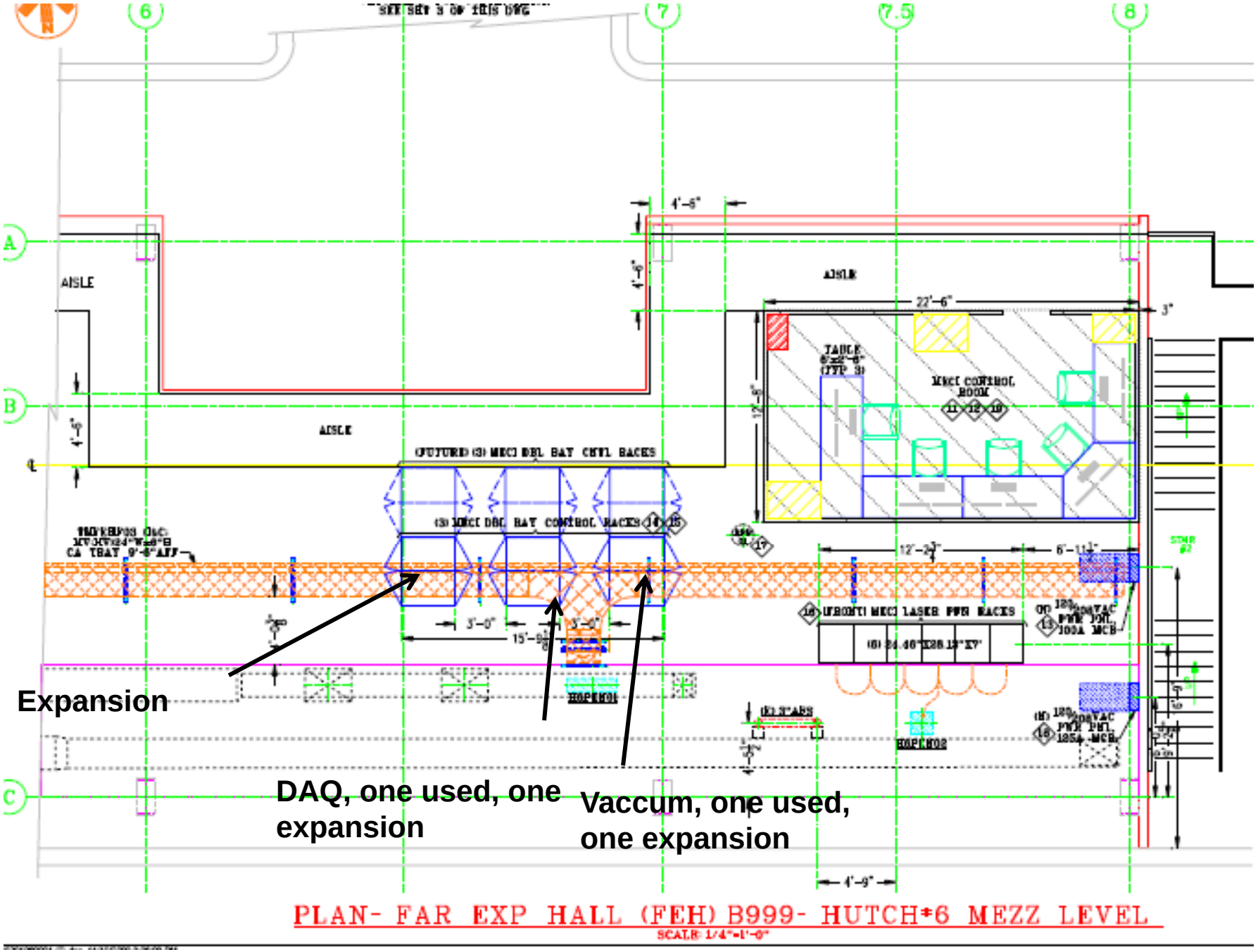

Full rack used
Future expansion racks (don't need to install now)
4 short-racks under table
3PH, 30A, 220VAC POWER
1PH, 30A, 220VAC POWER
1PH, 20A, 110VAC POWER
1PH, 20A, 220VAC POWER
LASER TABLE 4'x12'
LASER TABLE 4'x10'
(3) LASER TABLE 4'x10'
TRAYS TOP TO BOT


Expansion
DAQ, one used, one expansion
Vaccum, one used, one expansion
PLAN- FAR EXP HALL (FEH) B999- HUTCH#6 MEZZ LEVEL

Cooling

- We cool all the racks
- We have 12 gpm budgeted for XRT in the current cooling requirement document, which, if we needed 1.5 per rack would be enough for 8 racks.
- We are talking about adding 4 more racks to the existing 4 which would max out that capacity.
- In reality, some racks need very little water (as low as .3 gpm) so we think we have enough there. It would be good if we could double that 12 to 24 because of growing number of beam line components in the XRT.

Building Number & Name	Room Number	Room Name	PCW Flow Rate	
Building 960 - X-Ray Tunnel	100	Tunnel	12	
	101	Vestibule West	0	
	102	Vestibule East	0	
			XRT subtotal	**12**
Building 999 - Far Experimental Hall	100	Tunnel	0	
	100H1	Hutch 4	24	
	100H2	Hutch 5	24	
	100H3	Hutch 6	24	
	101	Access Tunnel	0	
	102	XCS Room	4	
	103	Common Room	15	
	104	CXI Room	4	
	105	MEC Room	4	
			FEH floor subtotal	**99**
		Mezzanine - West racks	24	
		Mezzanine - future H4 laser	15	
		Mezzanine - future H5 laser	15	
		Mezzanine - future H6 laser	15	
		Mezzanine - misc.	15	
			Mezzanine subtotal	**84**
			FEH Total (w/XRT)	**195**

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Controllers

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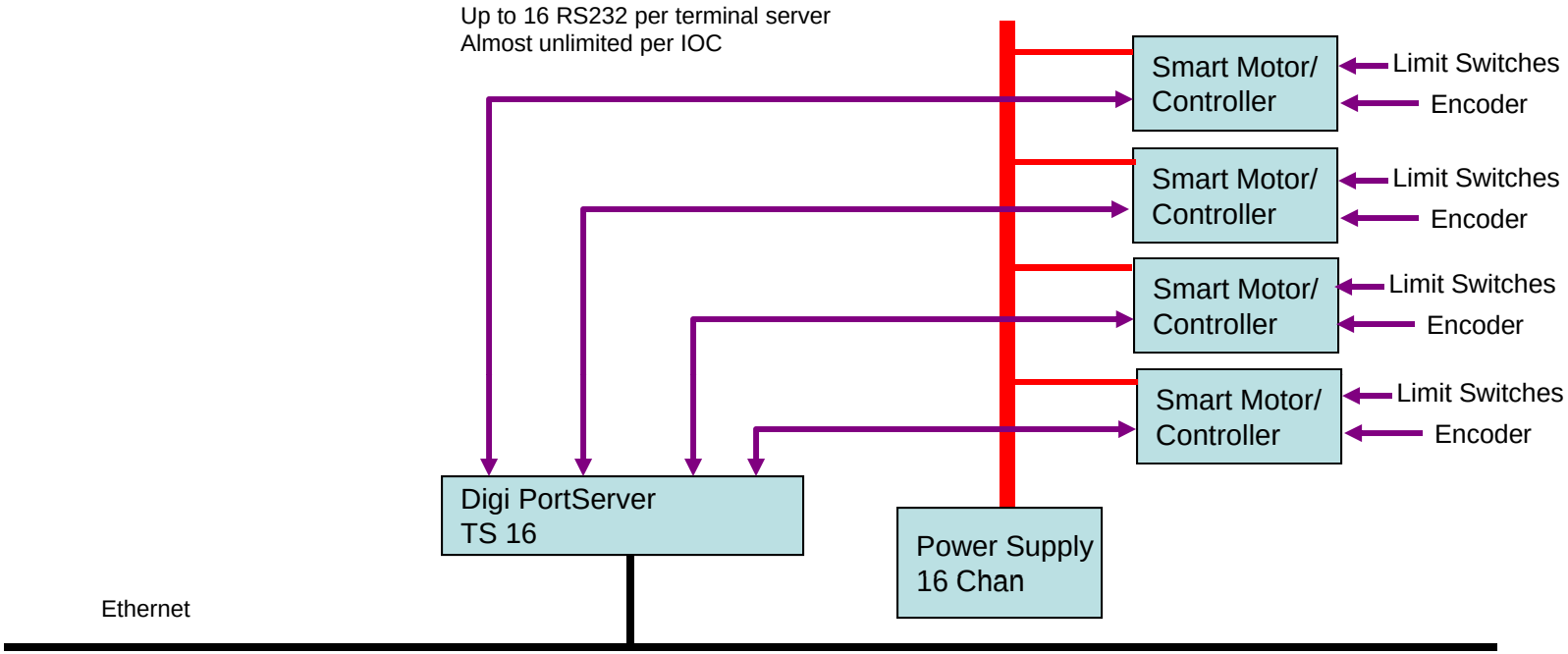
Smart Motor System Diagram



- **IMS Smart motors, either**
  - **External encoder then motor can not be ordered with internal encoder**
  - **No external encoder, only internal**

- **Beamline, chamber, laser needs to check with controls before buying motors**

LVDT

- Linear Variable Differential Transformer (LVDT) sensor measures motion distance
  - Often used in addition to motor encoder to verify location
- LVDT devices connect to VME crate based VME module: Highland Technology M550
  - 8 channel VME controller
  - http://www.highlandtechnology.com/
  - Cabling
    - One cable from LVDTs to M550 Controller
- VME crate with IOC CPU and above LVDT module

Cameras

- Web-Cams
  - AXIS-210 (fixed)
    - Just connect to PoE switch in rack
  - AXIS-213 (Pan-Tilt-Zoom)
    - Extra power-supply
- Slow control camera
  - Uniq Vision UP-900CL
  - Fiber connection from camera to Framegrabber in Linux server
  - Linux server also as EVR timing receiver, its TTL output connects to frame-grabber trigger input
  - Camera needs power from rack mounted DIN-Rail

Cameras

- DAQ cameras
  - OPAL-1000
  - Pulnix 6740CL
  - Framegrabber
    - Leutron PicPort-X-CL-Mono/64-PMC/PoCL
  - Cameras connect via fiber to Framegrabber in Linux server
  - Linux server also as EVR timing receiver, its TTL output connects to frame-grabber trigger input
  - Camera needs power from rack mounted DIN-Rail

Cameras

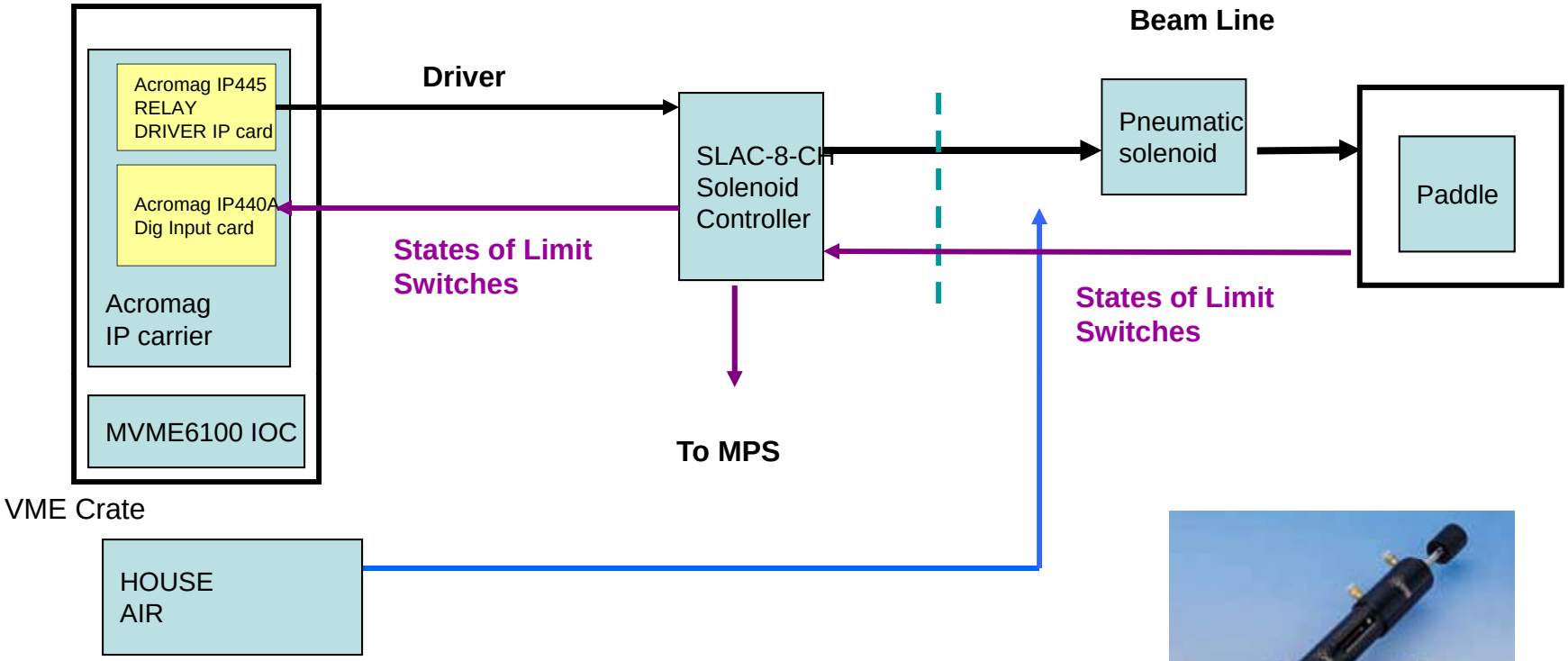
- PULNiX TM6740
  - up to 120 fps, 640x480, 8bits/pixel
  - Cameralink interface

- Uniq Vision UP-900CL

- Adimec OPAL-1000
  - CCD: 1/2”
  - Resolution: 8/10/12 bits
  - Effective Pixels: 1024 x 1024
  - Unit Cell Size 5.5um x 5.5um
  - Cameralink Interface

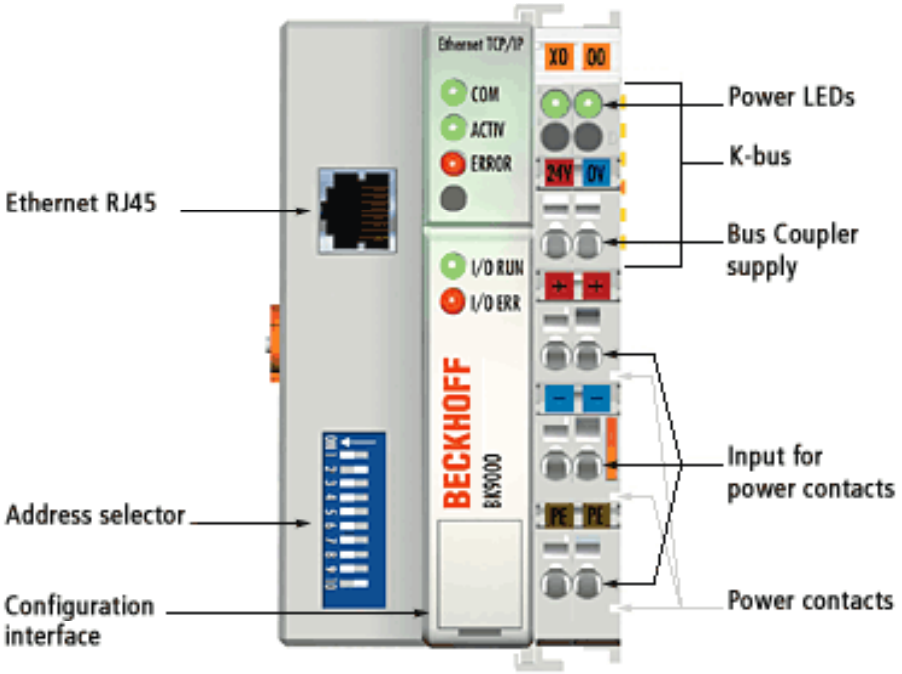
- EDT Cameralink
  - PMC card with electrical or optical IO to camera

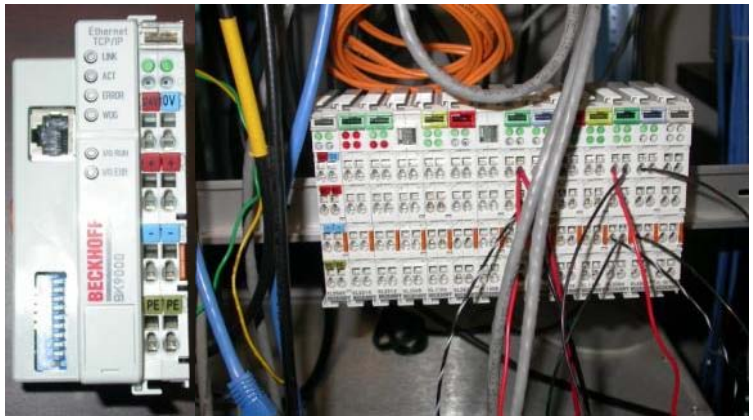
In/Out Control: Solenoid Actuated



Typical
Solenoid with
valve

Temperature: Beckhoff BK9000 Ethernet Remote IO





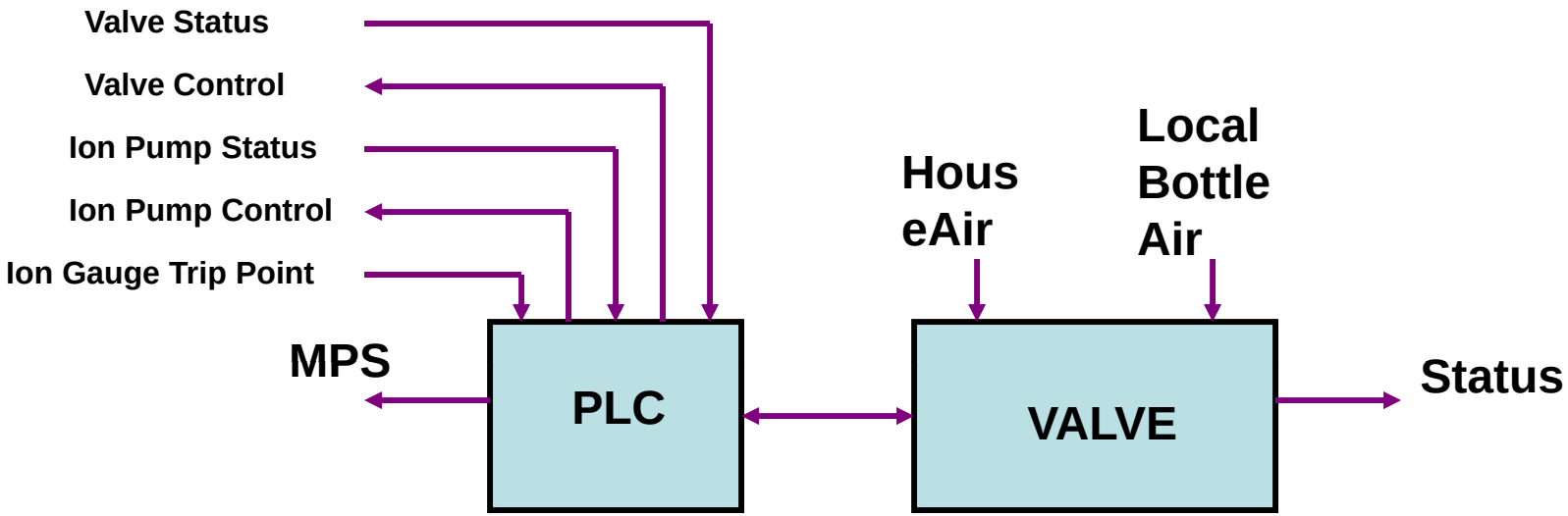
BK9000 coupler

- Support up to 64 DIN-Rail mounted terminals
- Support up to 128 channels analog in/out
- Support up to 512 channels digital in/out
- Need 24V power supply
- Low cost
  - Coupler is ~$300
  - IO terminal is ~$100
- 10/100MBase-T Ethernet-based coupler
- Expandable
- With KL3114 thermocouple terminal, support up to 128 thermocouples per coupler

Valves

- Isolate different regions to isolate vacuum
- Open/close via solenoid, voltage supplied by PLC
- Two status switches indicate IN and OUT status
  - Three valid states: IN, OUT, or not-IN and not-Out (e.g. when it is moving or stuck),
  - 4th state IN and OUT indicates it is “broken”
- IO: 3 pair cable (supply, IN switch, PUT switch)
- Some valves have two sets of switches
  - One set goes to PLC to indicate in/out status
  - Second set goes to MPS (Machine Protection System) if beam has to be turned off when valve is in so valve is not damaged
- **For MEC: if valve is part of MPS, need to have two sets of switches**
- If the valve has only one set of switches, then component has to be added in DIN-Rail to “copy” status of switches, one to PLC, and one to MPS
- Gate Valve has status switches, foreline valve has none

Vacuum System Components Valve Control



- DirectLOGIC 205 PLC
  - Standard I/Os
  - Communications
    - Ethernet
    - RS232
  - EPICs supported

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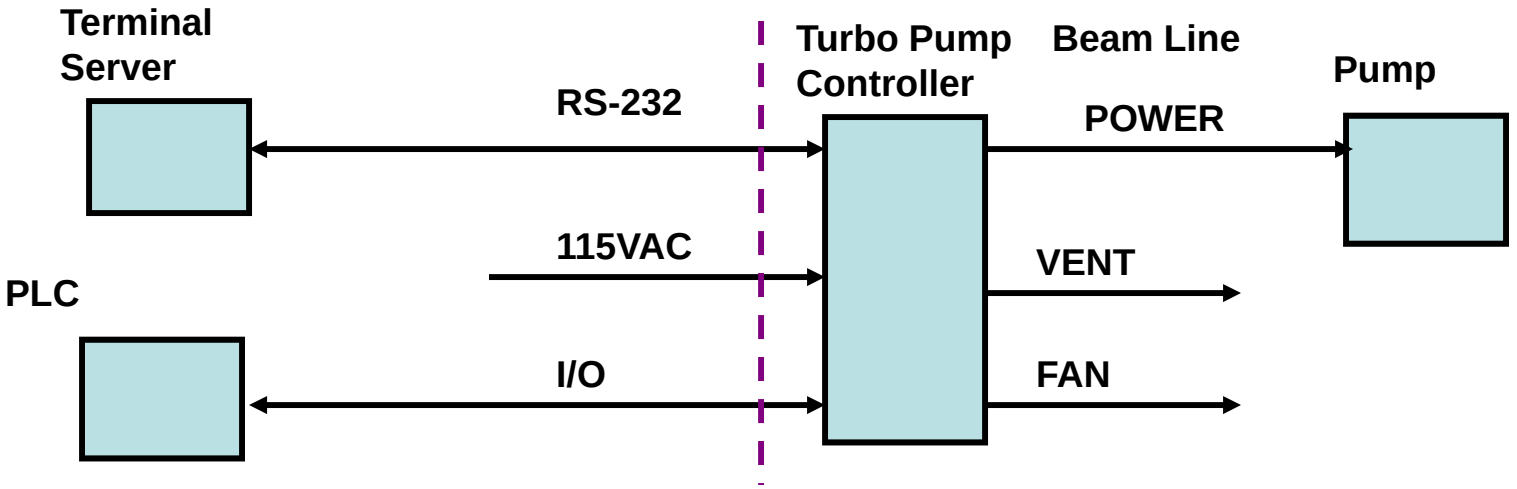
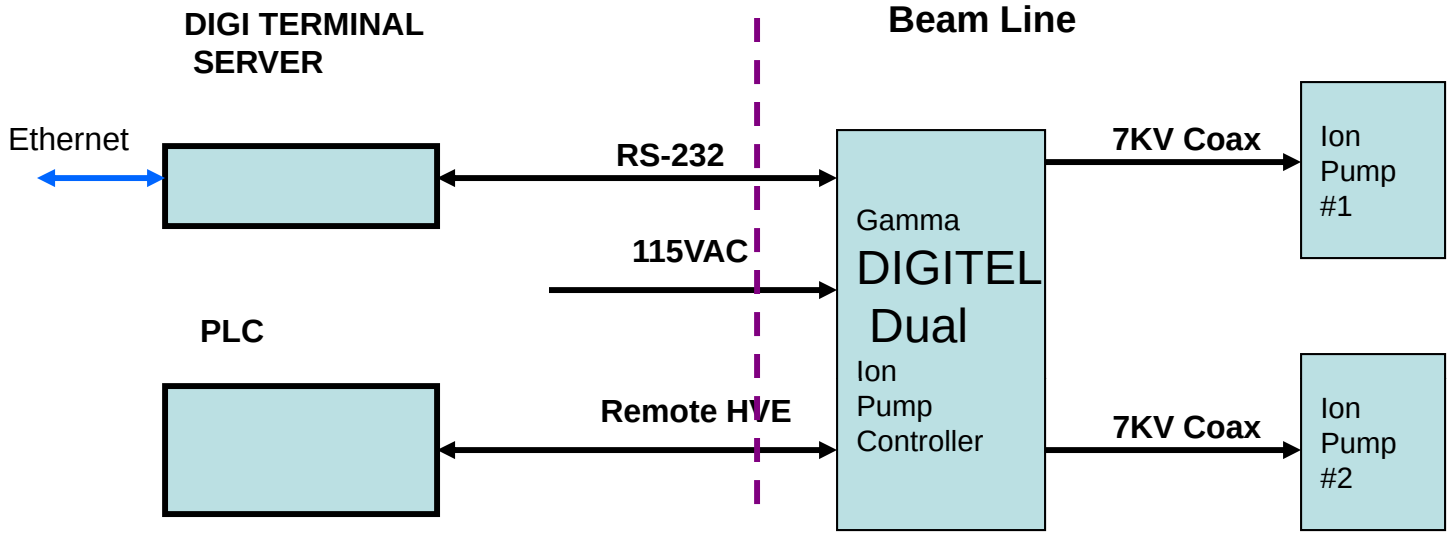
Vacuum System Components

- Turbo Pumps Examples
  - Alcatel
    - http://www.adixen.com/adixen_avt/download/docs/prod/doc1prod20.pdf
  - Leybold
    - http://www.oerlikon.com/leyboldvacuum/



Ion Pump System Block diagram



- Ion Pump Controller
  - Gamma DIGITEL Dual
  - http://www.gammavacuum.com/
  - Self protected
  - Local on/off only

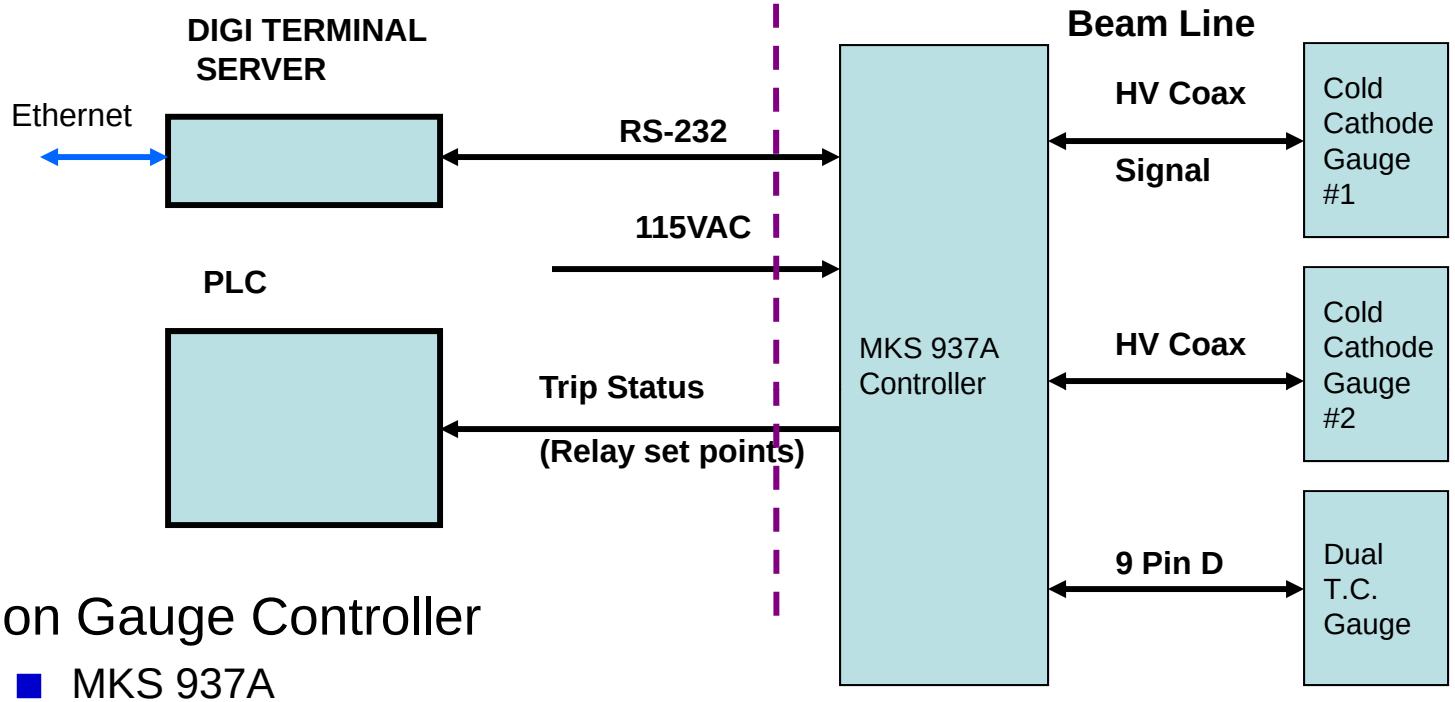
Gamma Pump Controller

Gauges

- One MKS937a has 3 slots and serves
  - Three Cold Cathode Ion Gauges
  - Or One CC Gauge
    - 2 or 4 TCs
    - 1 or 2 Manometer Or one ion-gauge/two thermo couples
  - So need to specify what plug-in cards to order

- IO:
  - Cold cathode cable MKS P/N 104220006,
    - CC cable has two connectors on each end: One HV and one signal
  - Or Pirani Thermocouple cable MKS P/N 100007450
    - Gauge PN 100006763
  - Device for manometer 722 Baratron manometer Gauge
    - Uses M1 slot"A", "B"
  - 115VAC, RS-232,
  - Cable to PLC

Ion Gauge System Block Diagram (Cold Cathode)



- Ion Gauge Controller
  - MKS 937A
  - http://www.mksinst.com/

Vacuum System Components (Cold Cathode)

- Ion Gauge Controller
  - MKS 937A
  - Three Gauge slots
    - Three Cold Cathode Ion Gauges
      - Or One CC Gauge
        - 2 or 4 TCs
        - 1 or 2 Manometer

Cold Cathode Gauge

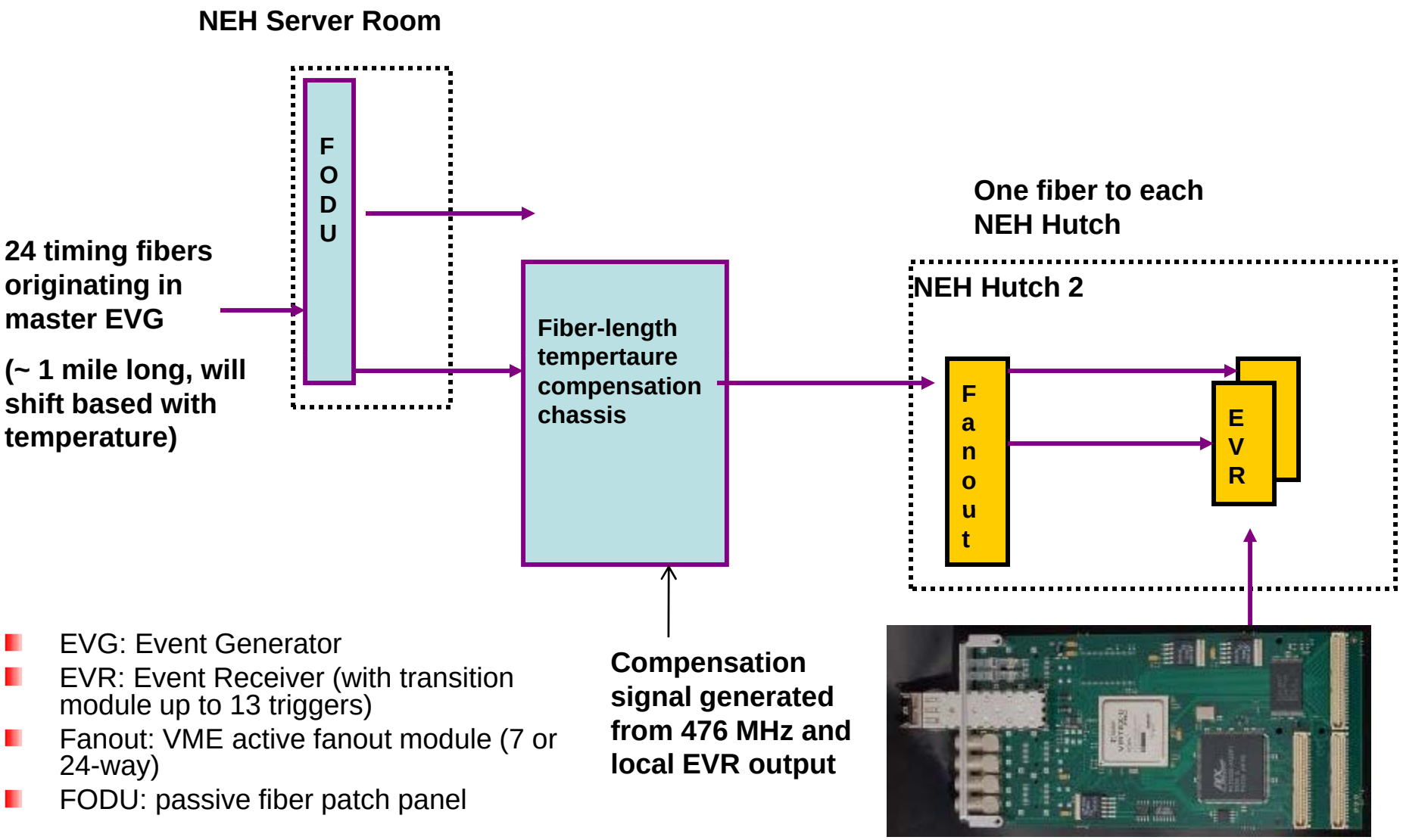
422 Cold Cathode Sensor

937A Controller

Manometer Gauge

TC Gauge

Machine Timing



- EVG: Event Generator
- EVR: Event Receiver (with transition module up to 13 triggers)
- Fanout: VME active fanout module (7 or 24-way)
- FODU: passive fiber patch panel

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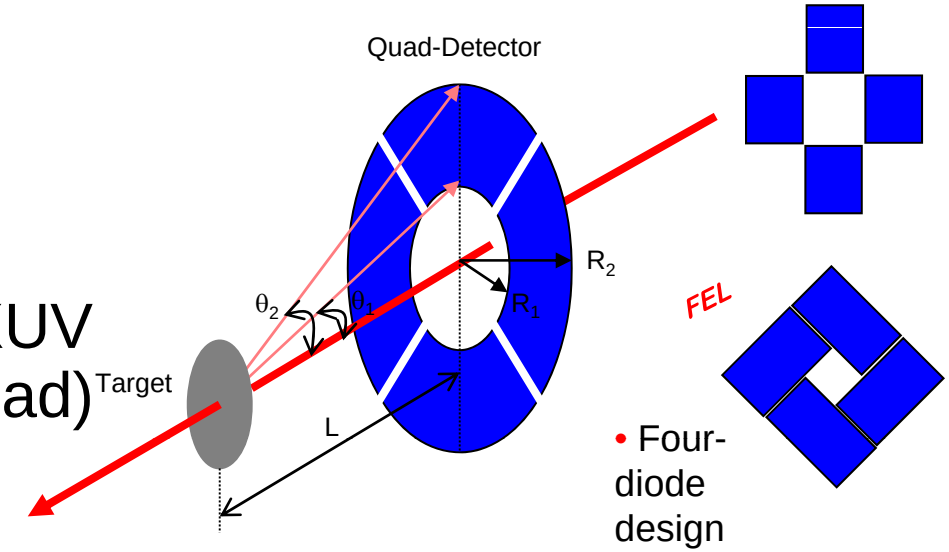
Intensity Position Intensity Monitor IPIM Module

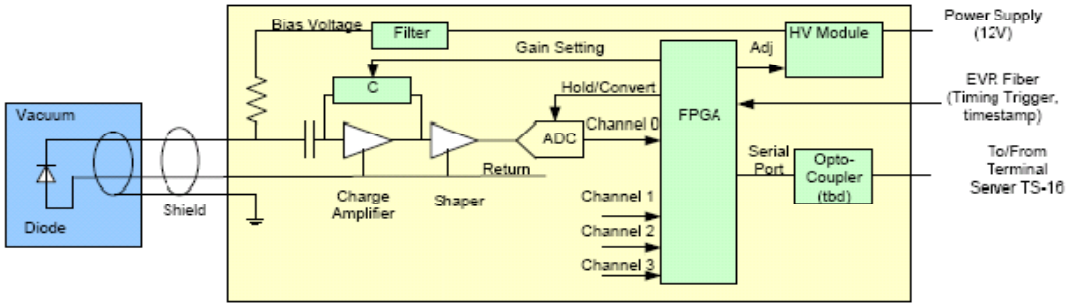
- Essentially provides bias to up to four sensor diodes and amplifies/shapes/digitizes the signals
- Interface is
  - 12V power
    - E.g. to DIN-Rail mounted supply
      - (what turns it on and off?)
  - Serial port
    - To Terminal Server
  - TTLTiming trigger
    - From EVR Timing receiver
  - (plus optional timing fiber for future use)

Common Diagnostics Readout

- E.g. intensity, profile monitor, intensity position monitors
- E.g. Canberra PIPS or IRD SXUV large area diodes (single or quad)
  - Amplifier/shaper/ADC for control/calibration/readout



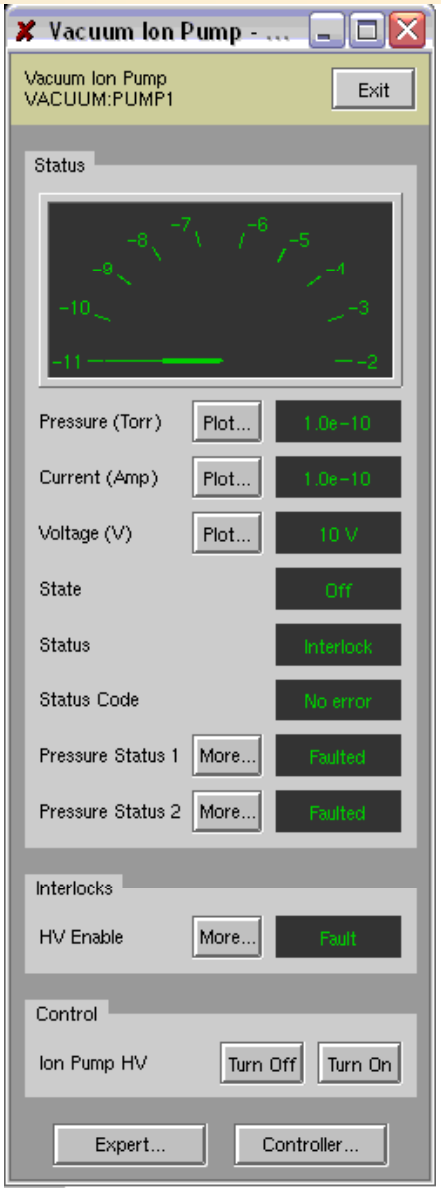
• Four-diode design



• On-board calibration circuits not shown

Applications/Software/Archive

- RTEMS Operating System
  - Running on VME and cPCI CPU Modules
- Linux Operating System
  - Running on servers and cPCI CPU modules
- EPICS Device Support Examples
    - Camera
    - Motion
    - Vacuum
    - Temperature
    - VME
      - E.g. ISEG High-Voltage module
    - cPCI
      - E.g. cPCI Acqiris waveform sampling module
    - Xantrex low-voltage supply (25V, 30A)
- EPICS Databases and EDM Screens



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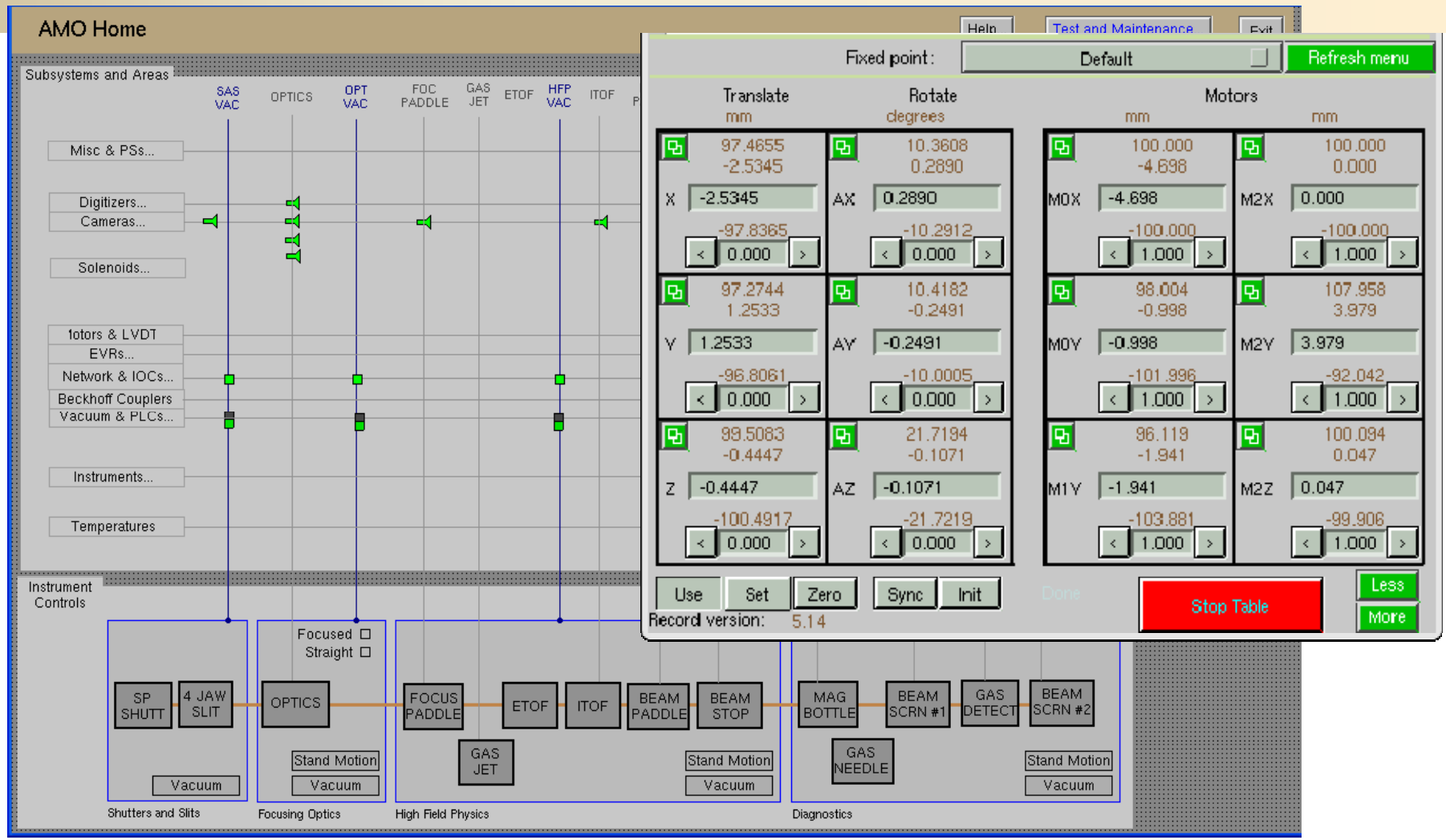
GUI Screens



Example of main interface screen and one motion screen (AMO shown, will be modified for MEC)

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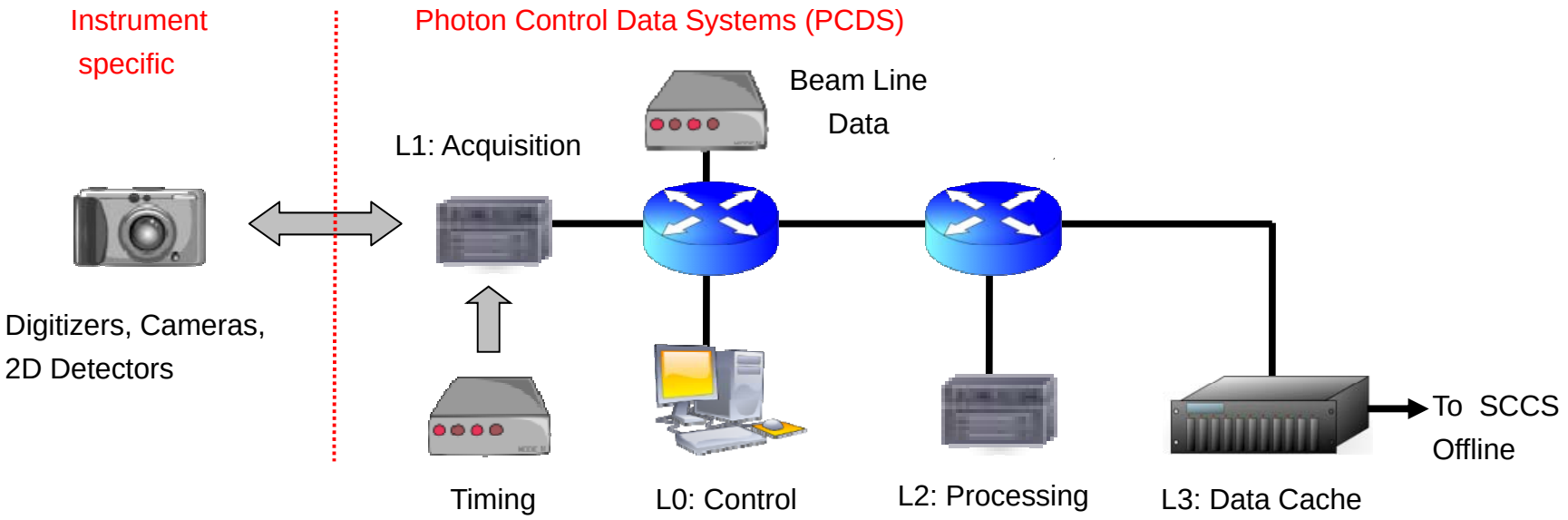
Data System Architecture



- Level 0: Control
  - Run & configuration control
  - Run & telemetry monitoring
- Level 1: Acquisition
  - Image acquisition, calibration
  - Event-building with beam-line data
  - Correction using calibration constants
  - Data reduction (vetoing, compression)
- Level 2: Processing
- Pattern recognition, sort, classify, alignment, reconstruction
  - Monitoring/Visualization
- Level 3: Online Archiving
  - NEH/FEH local data-cache
  - Offline will transport data to tape staging area in SCCS Computer Center

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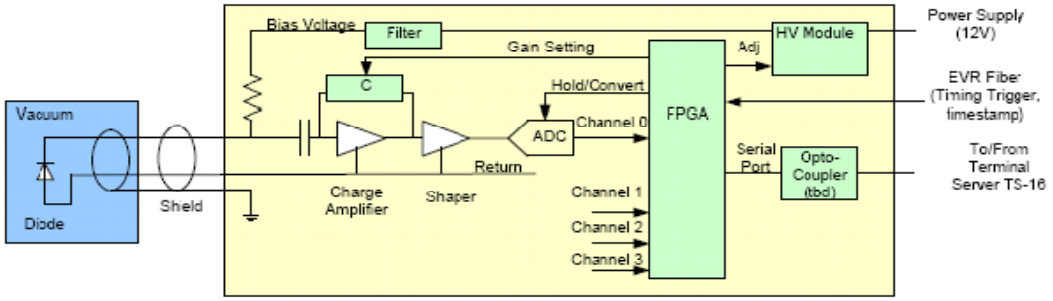
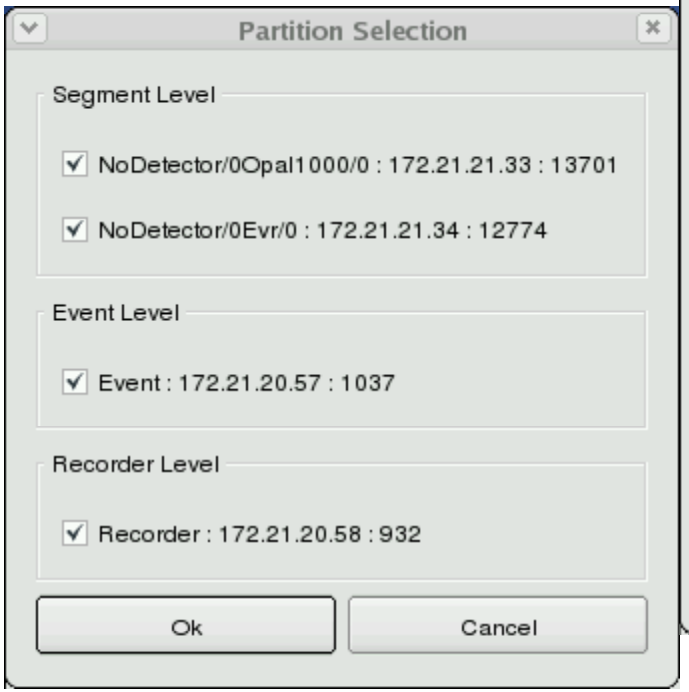
DAQ Screen Example

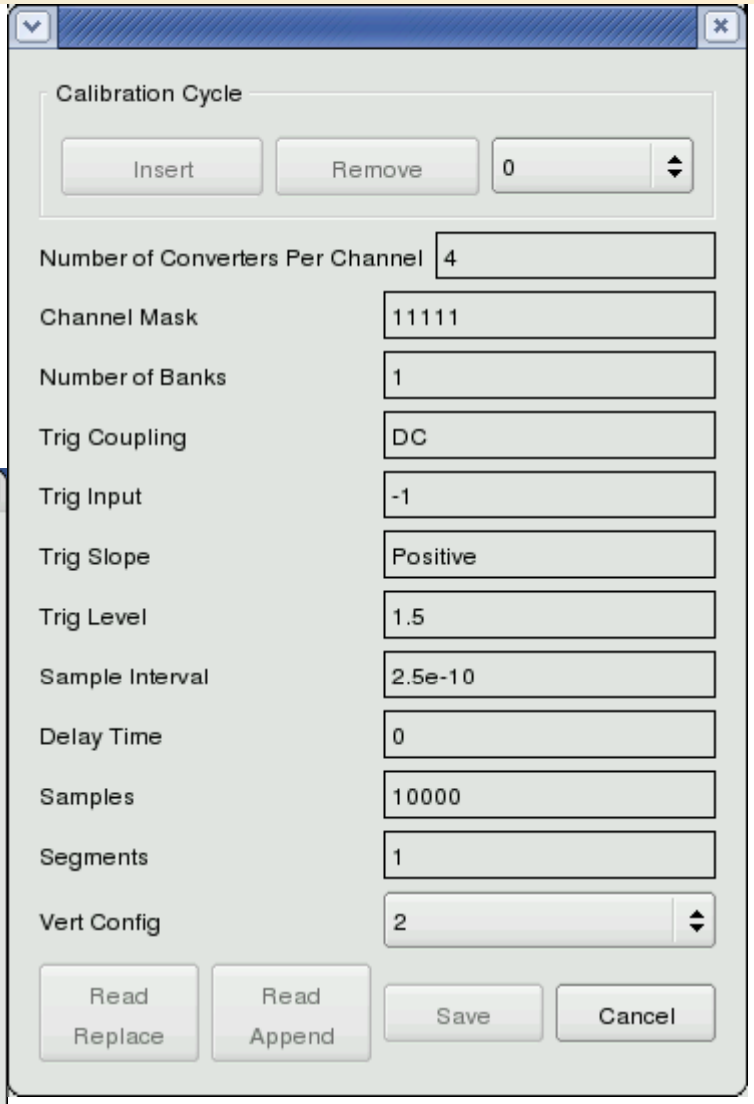
- Camera readout and processing
- Diode Readout and processing



Control State machine



Partition Control GUI



Config GUI

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Processing Examples

- Camera images (just examples):
  - Raw display (up to 5Hz)
    - integrating or single-shot
  - Projections
  - Mean (x,y) v time
  - TwoD Gaussian fits (shot-by-shot)
  - 1D histograms of x, y, x-size, y-size, xy-tilt
  - and versus time
- Plots auto-range, fixed ranges
- Save screenshots
- Detailed requirements for MEC for online processing still need to be created

- Online Processing/Visualization
  - Interface LCLS XTC data format
  - C or C++ code running on LCLS farms

- Offline
  - XTC and HDF5 data format
  - Can also write to delimited-format files

- Users can run code later on LCLS farms, or transport data offsite

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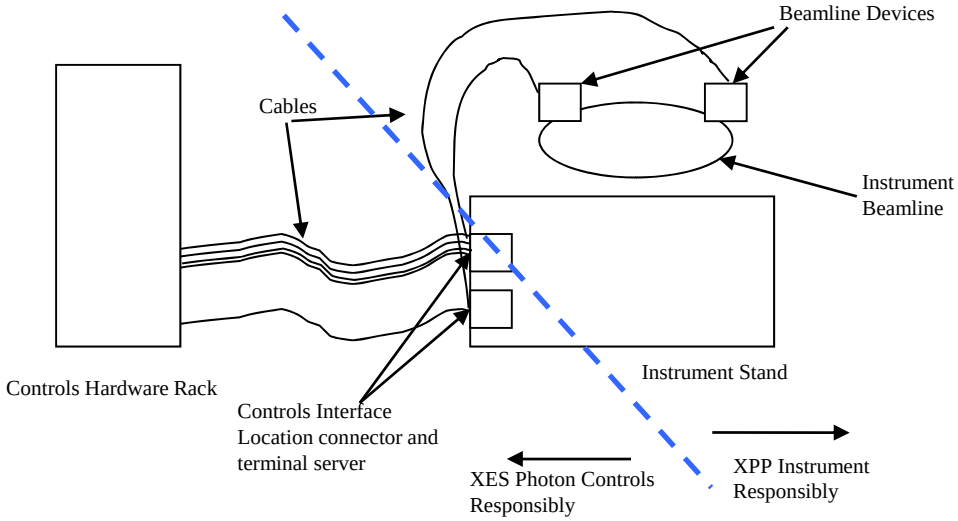
Instrument ← → Controls Interface

The Interface Control Document, tbd, specifies the areas of responsibility between PCDS and MEC:

Figure 2.2.1 Conceptual layout showing areas of responsibility and interface points Cables to the instrument are the responsibility of Controls, routing of the cables at the instrument specified by the Instrument.



Summary

- Described controls & DAQ architecture with examples
- Have controller/DAQ candidates for most areas
  - Most will have been used by other experiments before MEC
- Rack profiles presented
- Software & user interface described
- Moving and processing science data
  - Data acquisition via detectors, cameras, diode processing

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3 March 2010

List of MEC X-ray optics, diagnostics and vacuum equipment:

Item (# of units if more than 1)	**Purpose**	**Locations**	**Sub-Components for a single unit**
Valve (6)	Vacuum isolation	XRT: 4 Hutch 6: 2	PLC
Intensity-Position Monitor (3)	Measure Incident FEL intensity on every pulse (120 Hz)	XRT: 1 Hutch 6: 2	Motion stages (serial) (2) Linear Encoders (2) Limit Switches (4) Front-End Elect readout (serial) Power Supplies (12V, up to 4 channels)
Pop-in Profile Monitor (1)	Measure FEL intensity	XRT: 1	Motion stages (serial) (1) Linear Encoders (1) Limit Switches (2) Zoom lens (1) Camera (1) Camera Link
Pop-in Profile-Intensity Monitor (2)	Measure FEL intensity & Spatial beam profile	Hutch 6: 2	Motion stages (serial) (1) Linear Encoders (1) Limit Switches (2) Zoom lens (1) Camera (1) Camera Link Front-End Elect readout (serial) Power Supplies (12V, up to 4 channels)
Attenuators/Pulse Picker (1)	Attenuate FEL	XRT: 1	Pneumatic Actuators (10) SLAC Solenoid Controller SD-385-001
X-ray Slits (3)	Define X-ray spot size	Hutch 6: 3	Motion stages (serial) (4) Encoders (4) Limit Switches (8)
X-ray Focusing Lenses (1)	Increase incident x-ray fluence	Hutch 6: 1	Motion stages (serial) (2) Encoders (2) Limit Switches (4)
Harmonic Rejection Mirror System (1)	Isolate fundamental FEL radiation	Hutch 6: 1	Motion stages (serial) (6) Encoders (6) Limit Switches (12)
Ion Pump (12)	Hold vacuum in beam pipe	XRT: 9 Hutch 4: 1 Hutch 5: 1 Hutch 6: 1	Serial
Vacuum Gages (24)	Measure vacuum pressure	XRT: 18 Hutch 4: 2 Hutch 5: 2 Hutch 6: 2	Serial
FEL Deflecting Mirror + Thermal Enclosure (1)	Like M2H in FEE	XRT: 1	HOMS design, need info.
Photon Stopper (1)	Like Photon Stopper in XRT	XRT: 1	Photon Stopper design, need info.
Reference Laser (1)	Like Reference Laser in CXI	Hutch 6: 1	Reference Laser design, need info.
Target Chamber			
Valves (4)	Target Chamber isolation	Hutch 6: 4	PLC

Turbo Pump (1)	Target Chamber vacuum system	Hutch 6: 1	Serial
Cryo- Pump (2)	Target Chamber vacuum system	Hutch 6: 2	Serial
Mechanical Roughing Vacuum Pump	Target Chamber vacuum system	Hutch 6: 1	Serial