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# ISHELL INSTRUMENT CONTROLLER OVERVIEW

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## Revision History

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## 1 Introduction / Document Purpose

This document describes the plans for the iSHELL Instrument Controller. The Instrument Controller is one of the three primary control systems in iSHELL. These 3 control systems are listed below.

- Spectrograph Camera System - The computer, controller, and associated electronics use to readout the H2RG spectrograph array
- Guiding Camera System - The computer, controller, and associated electronic used to readout the Aladdin guider array.
- Instrument Controller System - computers, controllers, and associated electronics used to command motorized mechanism, temperature monitors and controllers, lamp A/C power, and other utility functions of the instrument.

Essentially the Instrument Controller is the non-imaging portion of iSHELL. The user will perform their observations using the spectrograph and guider systems. Each camera system will have its own Graphical User Interface (GUI). The spectrograph and guiding systems will typically be used together, but can also operate independently. For example, the guider can be used as a standalone imager. The GUIs for the camera systems will contain widgets for controlling and monitoring the hardware controlled by Instrument Controller System. Some of the hardware components are unique to each camera system, like each array's temperature controller. Some mechanisms are common to both systems, like the image rotator, which is in the optical path of each camera. The instrument controller must provide status and control of these shared and dedicated hardware components to each camera system.

## 2 Requirements

This section summarizes the Instrument Controller requirements. Its high level requirement can be listed as:

- Command of 12 mechanisms using stepper motors
- Sensing of ~23 mechanism position sensors or switches.
- Command of 5 temperature controllers (2 Arrays, 2 Gratings, Gas Cell)
- Monitor 10 temperature sensors.
- Command the AC power for 3 calibration lamps.
- Communicate seamlessly with the Spectrograph and Guiding Controller Systems.
- Run the software using the CentOS 6.x

## 2.1 Summary Table for the Instrument Controller

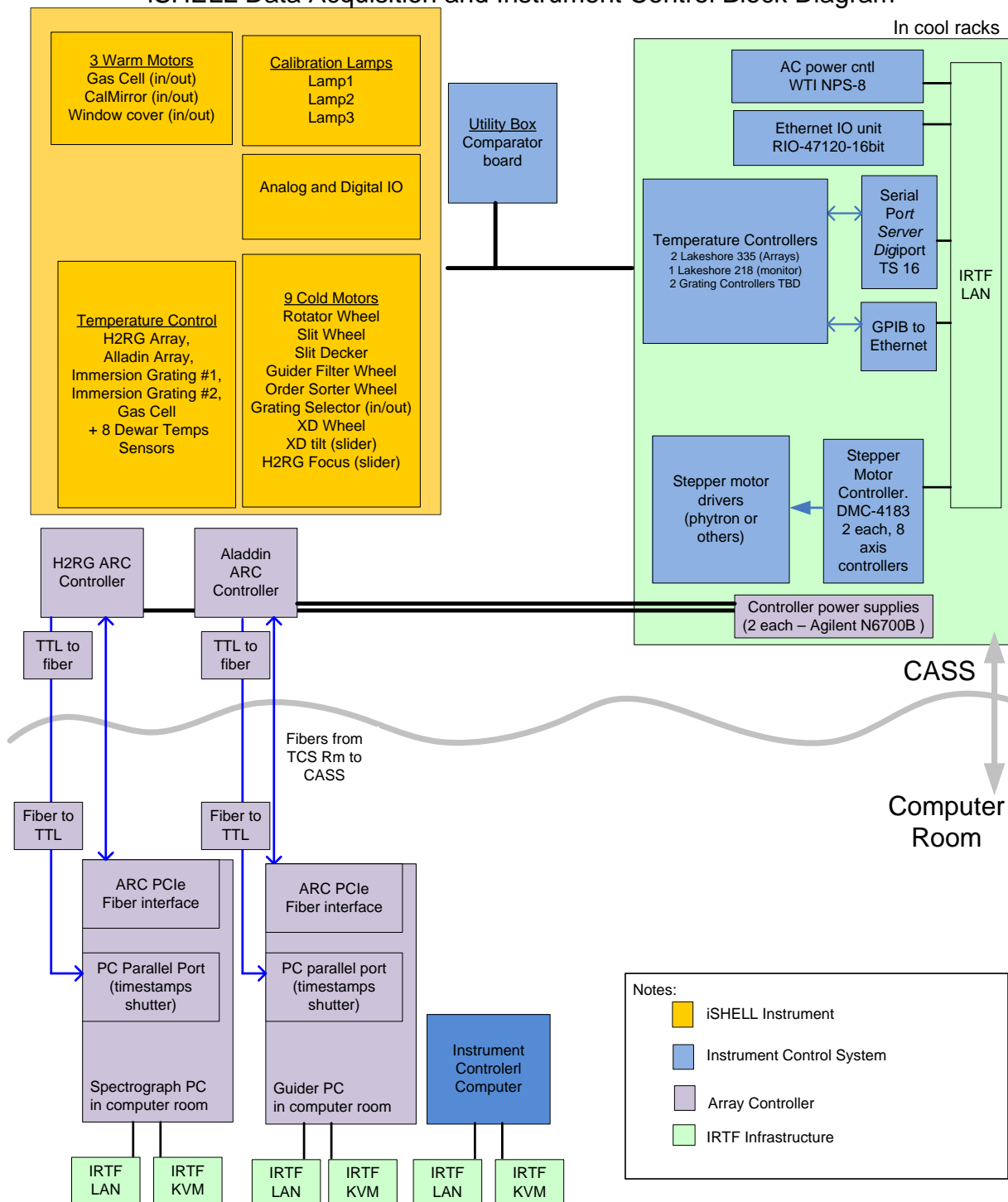
The blue text indicates warm mechanisms.

ITEM	Desc	Stepper	HE / Mech Sensors	Power Control	Temp. control or monitoring	Others
CallLamp	Mirror: Out/In linear slide, warm Control power Supply for 3 Lamps.	1	2	3		
GasCell	Out/In linear slide, warm	1	2		1 sensor 1 heater	
Window Cover	Out/In Linear slide, warm	1	2			
Rotator	Continuous Wheel Mechanism. Cold	1	1 HE			
Slit Wheel	Detented Wheel Mechanism. Cold 10 positions. InDetent, Home sensor.	1	2 HE			
Slit Decker	Variable position linear slide, cold	1	2 HE			
Order Sorter	Detented Wheel Mechanism. Cold 10 positions. InDetent, Home sensor.	1	2 HE			
Immersion Grating	2 position Linear slide	1	2 HE			
XD Wheel	Detented Wheel Mechanism. Cold 12 positions. InDetent, Home sensor.	1	2 HE			
XD Tilt	Continuous Linear slide. Cold.	1	2 HE			
Spectrograph Focus	Continuous Linear slide. (Similar to spex). Cold.	1	2 HE			
Guider Filter	Detented Wheel Mechanism. Cold 10 positions. InDetent, Home sensor.	1	2 HE			
Active Temperature Control	Guider Array, Spectrograph Array, Immersion Grating Unit #1, Immersion Grating Unit #2.				4 sensors 4 heaters	
Temperature Monitoring	Various places in cryostat				10 sensors	
Summary		3 warm 9 cold	about 23	3	15 sensors 5 heaters	

### 3 Instrument Controller Overview

As of Jan 2013, SpeX Instrument upgrade is in-progress. This upgrade will completely replace SpeX's current array controllers, and its Instrument Control System with completely new hardware. One of the requirements for the SpeX upgrade is to build its instrument Controller so that the hardware selected and the software being written can be used by iSHELL. This will provide iSHELL with a proven design that can be implemented very quickly. Essentially, we will fork the SpeX control system and port it to iSHELL.

### iSHELL Data Acquisition and Instrument Control Block Diagram



This diagram shows the iSHELL Data Acquisition and Instrument Control Block diagram. The blue color shows the items that are part of the Instrument Controller System. Key concepts are:

- A separate computer to host the Instrument Controller Software. This computer is located in the TCS Room. The instrument Controller is independent from the Camera Acquisition Systems.
- Various hardware controllers are used for motor control, temperature control, analog and digital IO. These controllers communicate using Ethernet, and are located in the Cool Rack electronic racks on the telescope.

## 4 Instrument Control Electronics

This section presents some of the key hardware to be used in the Instrument Controller. All of the hardware presented have already been used at the IRTF, or is being used as part of the SpeX Instrument Controller. This gives us confidence that they will work well for iSHELL, and can be integrated into the iSHELL system very quickly.

### 4.1 Instrument Control Computer

- Modest PC (x86 PC with i3 CPU, 8GB RAM, Ethernet) running CentOS 6.x.

### 4.2 Stepper Motor Control

- DMC-4183 - Galil Ethernet based Stepper motor Controller.
- 8-axes of stepper motor control with Home, and limits inputs.
- 8 uncommitted analog input (one per axis), 16 Digital Input, 16 Digital Outputs.
- <http://www.galilmc.com/products/dmc-41x3.php>
- Using IM483-34P1 Microstepping Driver



### 4.3 Hall Effect Sensor Conditioning

- IRTF to manufacture an update version of the current spex comparator board.

### 4.4 Additional Analog or Digital IO

- Galil RIO-47120-16bit. Ethernet IO Unit.
- 8 analog inputs, 8 analog output, 16 Digital Input/Outputs
- Low cost, \$400 per unit.
- <http://www.galilmc.com/products/rio-47xxx.php>



#### 4.5 Temperature Control and Monitoring

- Lake Shore Model 335 Temperature Controller, 4 each (2 array, 2 gratings).
- <http://www.lakeshore.com/products/cryogenic-temperature-controllers/model-335/Pages/Overview.aspx>
- Lake Shore Model 218 Temperature Monitor. Eight sensor inputs. 1 each.
- <http://www.lakeshore.com/products/cryogenic-temperature-monitors/model-218/Pages/Overview.aspx>



#### 4.6 AC Power Control

- WTI NPS-8HD20-1 Network Power Switch. (8 outlets)
- Updated version of the WTI units currently used by the IRTF.
- <http://www.wti.com/p-186-nps-8hd20-1-network-power-switch-pdu-dual-20a-120v-85-15r.aspx>



#### 4.7 Serial Port Server

- DigiPort PortServer II 16 Rack
- Provides Ethernet access to 16 EIA-232 serial ports. Used for serial based controllers.
- <http://www.digi.com/products/serialservers/portserverii#overview>







#### ***4.8 Packaging, Cabling, Mounting***

- iShell's cassegrain electronics will be located in the NE (north-east) Coolrack. CSHELL currently occupies 2 coolrack (NEI and NEO). This space is available for ISHELL.
- 1 Cool rack location is about 28" of a 19-inch rack. This provides 16 Rack units (1 Rack Unit is 1.75 inches). Our goal to use just 1 of the 2 coolracks available.
- Electronic will be housed in 19" racks or shelves. Our goals to allow each rack to be pulled out while HOT for diagnosis.
- MIL-SPEC connectors will be used to connect cable to the electronic boxes.