



WBS 1.08.03

L3: Observatory DAQ

Bolometer Readout Interfaces

L3 co-Lead - Abigail Crites

Outline

- Presenter Introduction
- Key L3 contributors
- Breakdown of this L3
- Key Requirements
- Interfaces with other L3s
- Technical Design / Scope
- Prototyping Plans
- Conclusion

Presenter Introduction

Name: Abigail Crites

Institution: Cornell / Caltech

Discipline: Physics / Astrophysics

Previous experience: Postdoc at Caltech working on development of a mm-wavelength spectrometer using TDM readout and TES bolometers. PhD at the University of Chicago developing the SPTpol camera.

Key Contributors in this L3

Abby Crites (Toronto)

Sasha Rahlin -- L3 co-Lead (FNAL)

Christopher Weaver (Michigan State)

Nathan Whitehorn (Michigan State)

Description of L4 WBSs for your L3

Lvl 2	Lvl 3	Lvl 4	
1.08 Observatory Control and Data Acquisition Systems	1.08.01 - DAQ Management	1.08.01.01 - DAQ Management	
		1.08.01.02 - DAQ System Design Engineering	
		1.08.01.03 - DAQ Reviews	
		1.08.01.04 - Interface Documentation	
		1.08.01.05 - Specification Tracking	
		1.08.01.06 - DAQ Milestones	
		1.08.01 - Observatory Control System	1.08.02.01 - Bolometer Readout Control
			1.08.02.02 - Telescope Platform Control - SP, Chile, LAT, SAT
	1.08.02.03 - Cryogenic Control		
	1.08.02.04 - Housekeeping Control		
	1.08.02.05 - Observatory Subsystem Control		
	1.08.02.06 - Build/Distribution System (Control System)		
	1.08.02.07 - Scheduling		
	1.08.02.08 - Control Framework		
	1.08.03 - Observatory Data Acquisition	1.08.03.01 - Bolometer Readout	
		1.08.03.02 - Telescope Readout Data Acquisition	
		1.08.03.03 - Housekeeping Data Acquisition	
		1.08.03.04 - Observatory DAQ Network Design	
		1.08.03.05 - Hardware Procurement	
		1.08.03.06 - Timing	
		1.08.03.07 - DAQ Build/Distribution	
		1.08.03.08 - File Format Specification	
	1.08.04 - Monitoring and Alarms	1.08.04.01 - Remote Monitoring Capability of Telescope, Housekeeping Subsystems	
		1.08.04.02 - Remote Monitoring and Real-Time Statistics Gathering	
1.08.04.03 - Non-Critical Alarms based on Bolometer + HK Monitors			
1.08.04.04 - Personnel and Equipment Protection Interfaces Propogated to Alarms			
1.08.04.05 - Personal Protection (PPE) Interfaces			
1.08.05 - Subsystem Development and Support			
1.08.06 - Deployment of DAQ and OCS			

Key Driving Requirements for DAQ Detector Readout Interface

CQ1,2

Data for detectors:
83 Mbps (per SAT)
1.7 Gbps (LAT)

- Acquire detector data from readout boards at speeds of up to 10 Gbit/s (500k detectors, 32-bit sample, 400 Hz rate) and associated meta-data.
- Acquire time-stamped data from auxiliary sensors (cryostat thermometers, pressure sensors, flow sensors, motor currents, etc.) with time stamps accurate to well less than the detector sampling interval (~ 1 ms).
- Acquire asynchronous data at a variety of cadences (up to ~ 100 Hz)
- Read out telescope position axes (azimuth, elevation, boresight, and perhaps other fast telescope housekeeping data) at rates up to ~ 200 Hz

Inter-L3 Interfaces within this L2

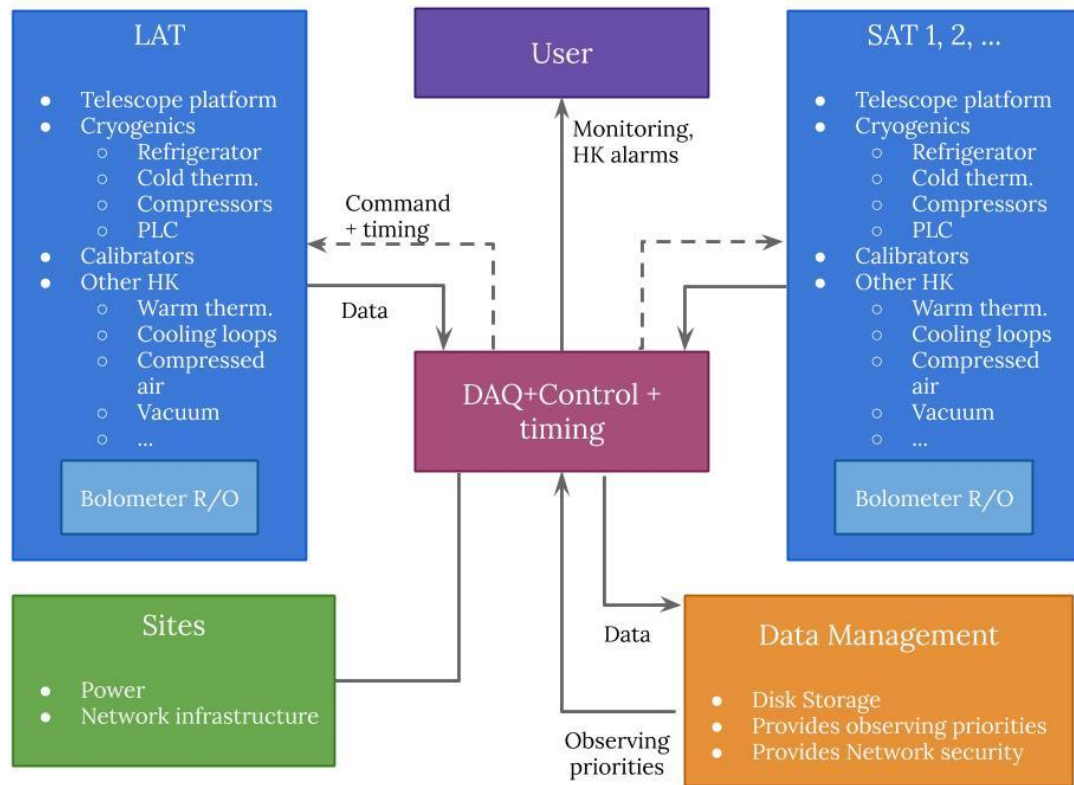
CQ2

- Bolometer Readout (1.08.03.01) is a part of DAQ (1.08.03) and will interact with OCS (1.08.02), Lab support (1.08.05), and Integration, deployment (1.08.06)

Technical Design / Scope

CQ2

Acquire and aggregate high-speed data from detectors (400 Hz per detector, ~ 10 Gbit/s total) and hand off to data management



Moving from Stage-3 to Stage-4: Detector Readout DAQ

Problem scope:

- Data rate increasing from ~20k detectors per site to 300k: order-of-magnitude in data rate

Reusability:

- Order-of-magnitude increase in data rate and new readout electronics mean Stage-3 code is probably not useful.
- Architecture is scalable however; synthetic testing of order-of-magnitude higher sampling rates on SPT-3G readout meet S4 throughput requirements

Summary:

- Stage-3 DAQ systems **demonstrate required throughput**, can serve as an architectural and resource-use guide for S4
- Limited applicability of stage-3 DAQ code and hardware for detector readout
- Substantial development effort required, but **little risk of unknown problems**

Technical Design / Scope

CQ2

What is the state of development of the design?

- Readout/DAQ Interfaces have been defined in ICD
- Data cable from readout will be 10 Gbit Ethernet
- Designed from existing approaches in SPT-3G, SO
- Software architecture for interface computer has been demonstrated
- Prototype readout boards will be available in late 2021

Prototyping Plans

- Prototype readout boards and software architecture have been demonstrated
- Readout L2 plans to provide an emulator for use by DAQ
- We should have prototype readout boards in the late 2021 and a workable system on that timescale with ~3 readout boards

Conclusions

The team has experience with readout/DAQ from Stage-3 experiments and a testing platform with timing ready to test the prototype readout boards and software system on the interface computer

DAQ will interact with OCS, Integration and Testing, and Lab Support L3's

DAQ will interact with Readout L2

Next steps will be to first test with an emulator from the Readout L2 and then test the prototype boards with the software architecture of the interface computer in late 2021 - early 2022.

Backup Slides