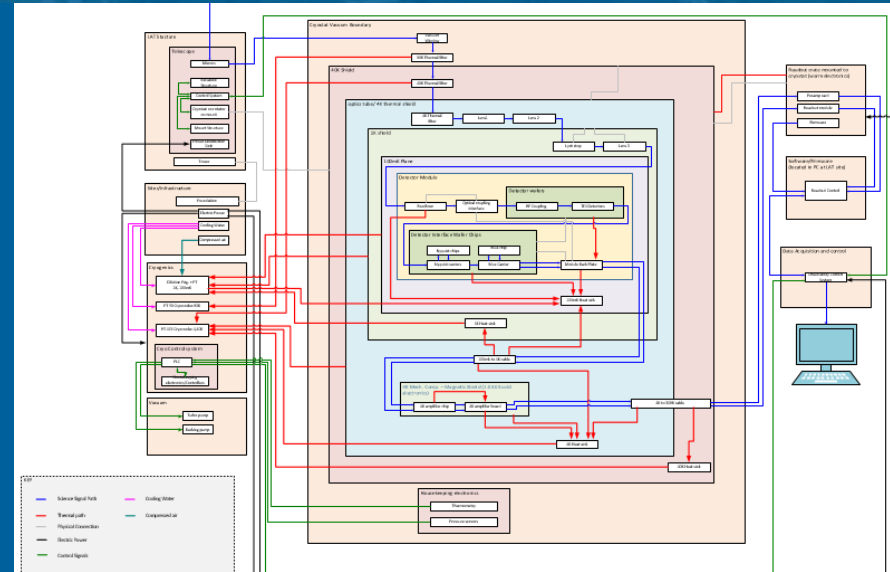


MARCH 31, 2020

# THOUGHTS FOR READOUT SYSTEMS ENGINEERING



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# PURPOSE OF THIS TALK

- Main intent is to share what has been developed starting with the LAT and to develop a conversation between readout and SE
  - Identify what help readout needs from Systems Engineering function
- We have developed a block diagram/signal flow diagram for the LAT side of the experiment.
  - Based upon reference design although generic w.r.t. site
  - Initial purpose to help clarify highest level interfaces, particularly those across WBS
  - This is a work in progress, feedback welcome and encouraged
  - It is modified here in context of readout
- Note: Systems Engineering Management Plan is still in development and so detailed plans for handling req.'s, ICD's, etc. is still evolving.
  - therefore this includes my opinions

# NEAR TERM STEPS

- Requirements need to be written down – agreed upon by various stakeholders
  - Ideally, design reviews simply map requirements to verification
  - General format for requirements
    - Requirement
    - Supporting rationale
    - Verification method, plan
    - Supporting/reference documents
  - A req. template has been proposed and circulate through IPO
- Need to identify external interfaces and show agreement – and written down in a document documentation

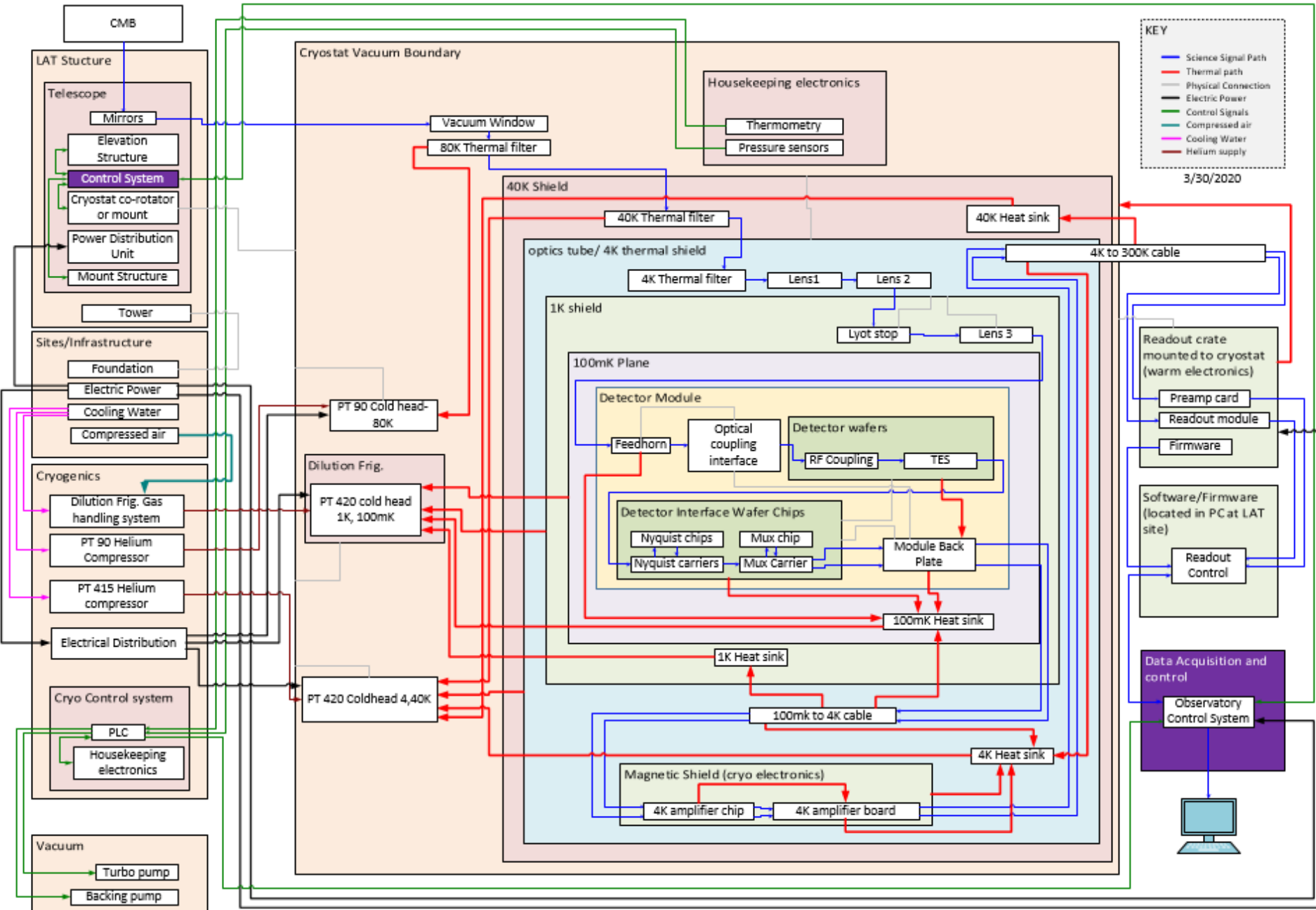
# LAT Block Diagram Interfaces CMBS4-doc-166

Blue line represents the science signal path from universe to data

**KEY**

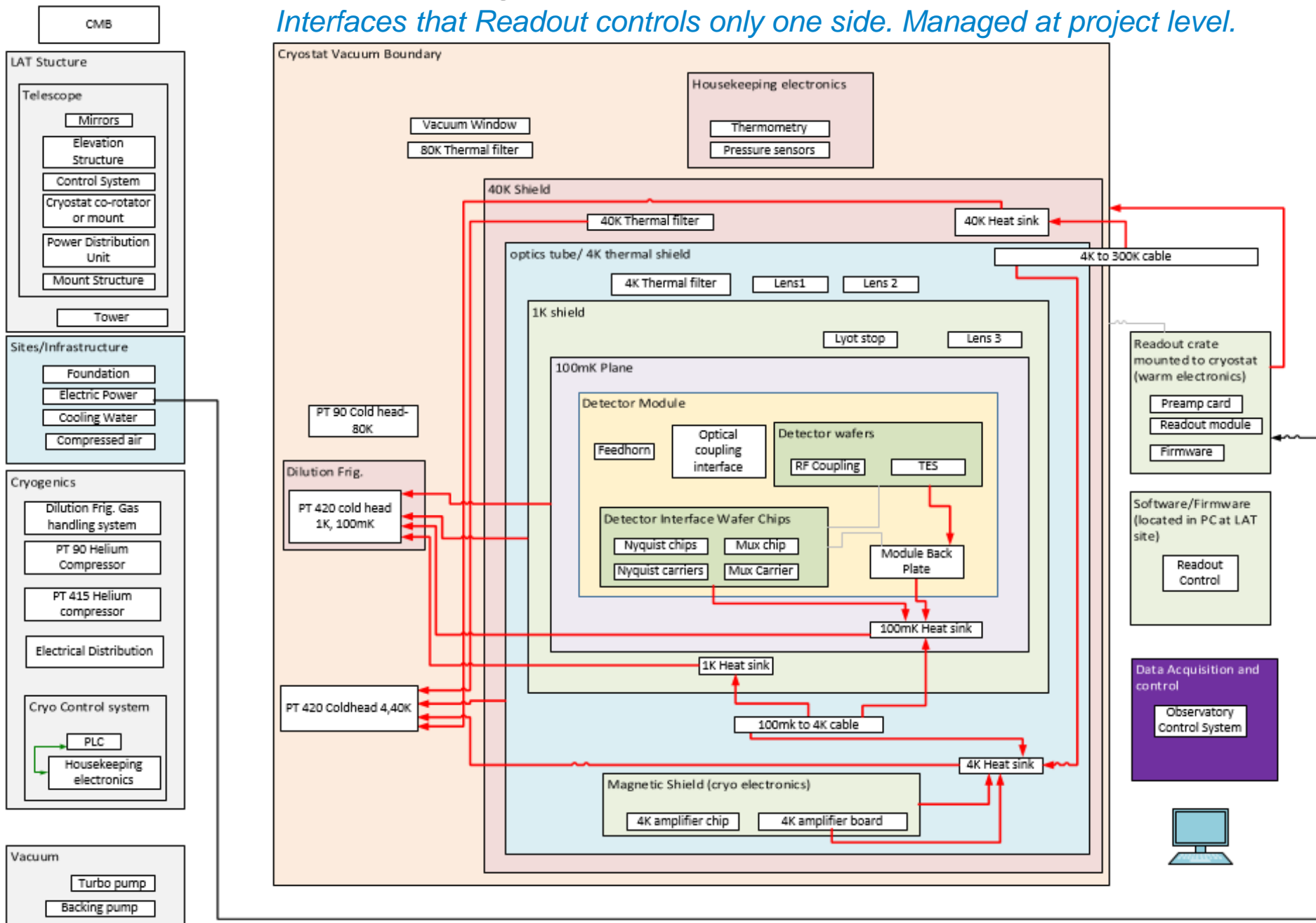
- Science Signal Path (Blue line)
- Thermal path (Red line)
- Physical Connection (Grey line)
- Electric Power (Black line)
- Control Signals (Green line)
- Compressed air (Light blue line)
- Cooling Water (Pink line)
- Helium supply (Dark red line)

3/30/2020



# Readout External high level Interfaces on LAT side

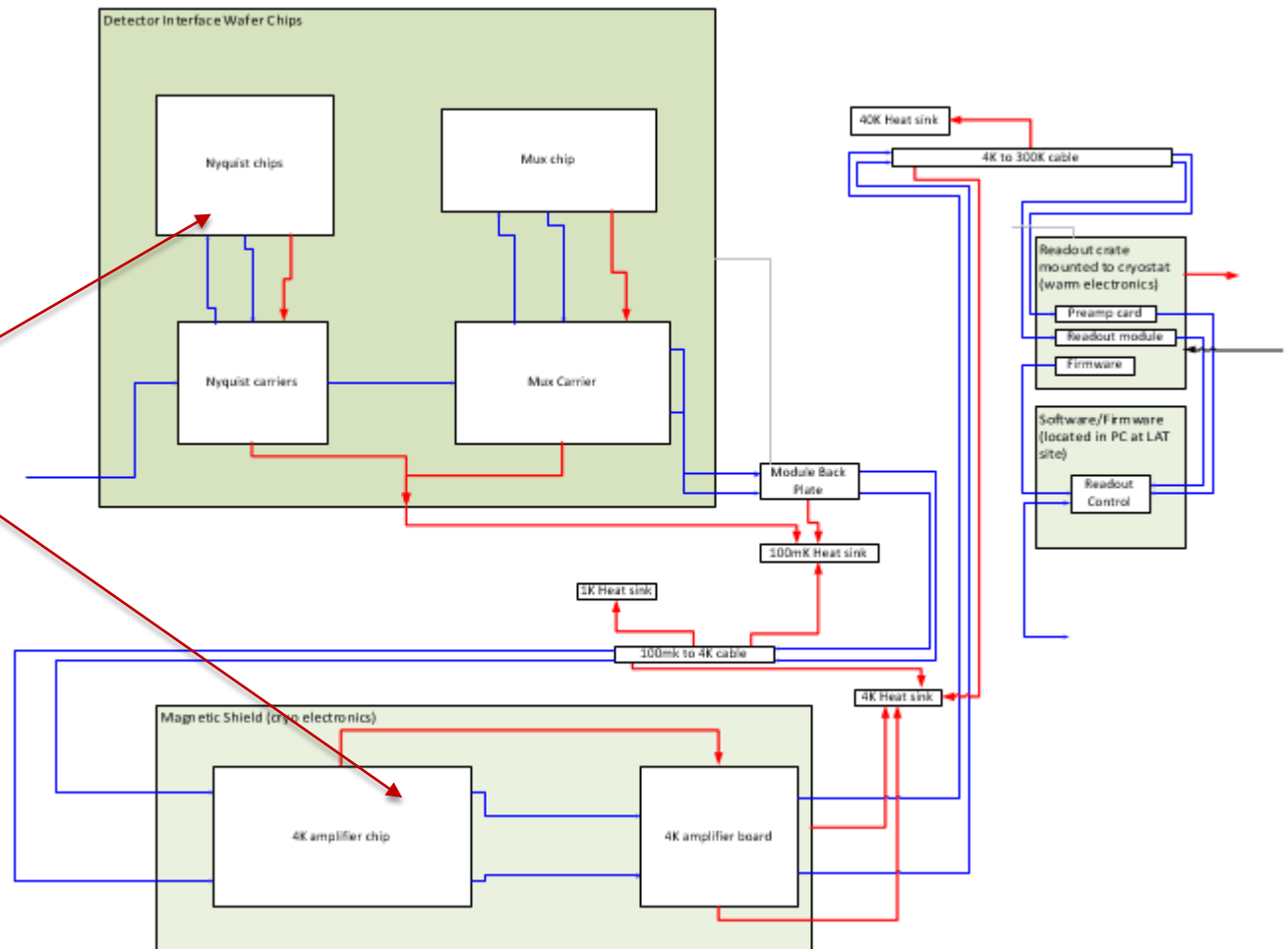
*Interfaces that Readout controls only one side. Managed at project level.*



# Readout Internal high level Interfaces

*Interfaces between deliverables of two different groups where readout controls both sides. Managed by Readout L2/Readout SE/Readout LE...*

Is there additional detail that can be added that will help communication and ensure interfaces are captured? i.e. ...



# LAT INTERFACE DIAGRAM AT L1

	DAQ-Telescope control system	Detector Module Assembly	Sites- Foundation, Power, Water, Air	LAT-Telescope Tower	DAQ-Observation control system	Data Management ?	LAT-Receiver/Cryostat	LAT-Cryogenics	Readout-Cryo electronics	Readout-Cold electronics	Readout- warm electronics
DAQ-Telescope control system											
Detector Module Assembly											
Sites- Foundation, Power, Water, Air											
<b>LAT-Telescope Tower</b>			M,E								
DAQ-Observation control system	E			E							
Data Management ?											
<b>LAT-Receiver/Cryostat</b>		M,E									
<b>LAT-Cryogenics</b>		T	M,E,T		E		T,M				
Readout-Cryo electronics		T,E,M					M	T			
Readout-Cold electronics		E					M,E	T	E		
Readout- warm electronics					E		M,T,E		T	E	

Red highlights interfaces between LAT and other WBS

# LAT INTERFACE LIST

## Notional tracking Interface ID and Documents

Interface ID [CMB-####]	ICD [CMBS4-doc-####]	Interface group (left/right)	Left interface	Left interface	Right interface	Detailed information needed
1	####	Sites / LAT	Electric power	Site power distribution	Telescope main electrical distribution panel	Connection details
2			Compressed air	??	Dilution Fridge	Connection details
3			Cooling water	??	Dilution Fridge, PT Cryocoolers	heat load, connection details
4			Telescope mount	Foundation/Pad	Telescope Tower	loading, connection details
5	####	Detector Modules Assembly / LAT	Mount	Detector	??	heat load, connection details
6			Detector cooling	Module Main plate	Cryostat/ 100mK heat sink	heat load, connection details
7			Feedhorn cooling	Feedhorn array	Cryostat/ 100mK heat sink	heat load, connection details
8	####	Readout / LAT	Cryo electronics cooling	Detector Interface Wafer	Cryostat/ 100mK heat sink	heat load, connection details
9			Cable routing - cryo to cold electronics	100mK - 4K cable	Cryostat 100mK plane , 1K thermal shield, 4K thermal shield	heat load, connection details for heat tap, routing path
10			Cable cooling- cryo to cold electronics	100mK - 4K cable	Cryostat/ 100mK, 1K, 4K heat sinks	cable path, cable connection to housing
11			cold electronics cooling	Detector Interface Wafer	Cryostat/ 100mK heat sink	heat load, connection details for heat tap, routing path
12			Cable routing - cold to warm electronics	4K -300K cable	Cryostat 4K thermal shield, vessel feedthrough, outer cryostat surface	cable path, cable connection to housing
13			Cable cooling- cold to warm electronics	4K -300K cable	Cryostat/ 4K, 40K heat sinks	heat load, connection details for heat tap, routing path
14			Warm electronics mount	Warm electronics enclosure	Cryostat	cable path, cable connection to housing
15			####	DAQ / LAT	Telescope motion control	Telescope control system
16	Cryostat housekeeping data: thermometry, vacuum, etc.:	Observation control			Cryogenic control system PLC	list of sensors, data format, cable connection
17	Cryostat housekeeping data cable and routing	Observation control			Cryogenic control system PLC	Cable in out, routing path

-Individual interfaces tracked and grouped in reduced number of interface control documents with common approval path

-Tradeoff between number of documents and approval complexity (number of approvers)



# INTERFACE LIST Notional tracking Interface ID and Documents

Interface ID [CMB-####]	ICD [CMBS4-doc-####]	Interface group (left/right)	Left interface	Left interface	Right interface	Detailed information needed
8	####	Readout / LAT	Cryo electronics cooling	Detector Interface Wafer	Cryostat/ 100mK heat sink	heat load, connection details
9	Cable routing - cryo to cold electronics		100mK - 4K cable	Cryostat 100mK plane , 1K thermal shield, 4K thermal shield	heat load, connection details for heat tap, routing path	
10	Cable cooling-cryo to cold electronics		100mK - 4K cable	Cryostat/ 100mK, 1K, 4K heat sinks	cable path, cable connection to housing	
11	cold electronics cooling		Detector Interface Wafer	Cryostat/ 100mK heat sink	heat load, connection details for heat tap, routing path	
12	Cable routing - cold to warm electronics		4K -300K cable	Cryostat 4K thermal shield, vessel feedthrough, outer cryostat surface	cable path, cable connection to housing	
13	Cable cooling-cold to warm electronics		4K -300K cable	Cryostat/ 4K, 40K heat sinks	heat load, connection details for heat tap, routing path	
14	Warm electronics mount		Warm electronics enclosure	Cryostat	cable path, cable connection to housing	
##	####		Readout / Detector			
##	####	Readout / Detector Modules Assembly				
##	####	Readout / DAQ				
##	####	Readout / SAT				

# INTERFACE DOCUMENTS

- A template is needed and one has been developed but not agreed yet
- Nominally ICD includes (i.e.):
  - Electrical
    - Power requirements
    - Wiring paths
    - Connector pinouts
    - etc.
  - Thermal interfaces
    - Heat loads
    - Connections details
  - Mechanical/Physical
    - Layout drawings
    - bolt patterns
    - Mechanical loads
- Signed off by all parties that the interface effects