THO4-P181
MIRI Cooler System Design Update

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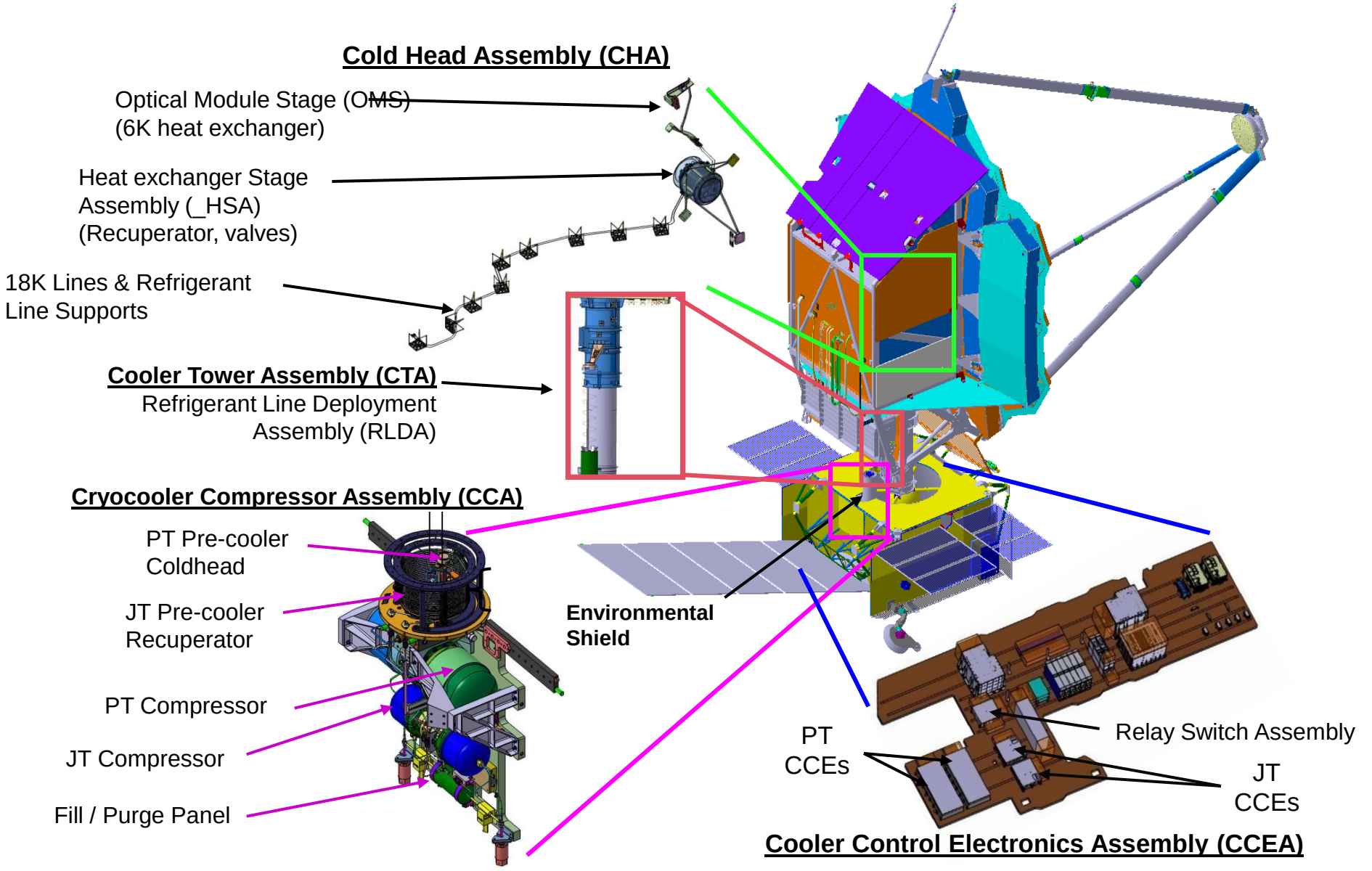
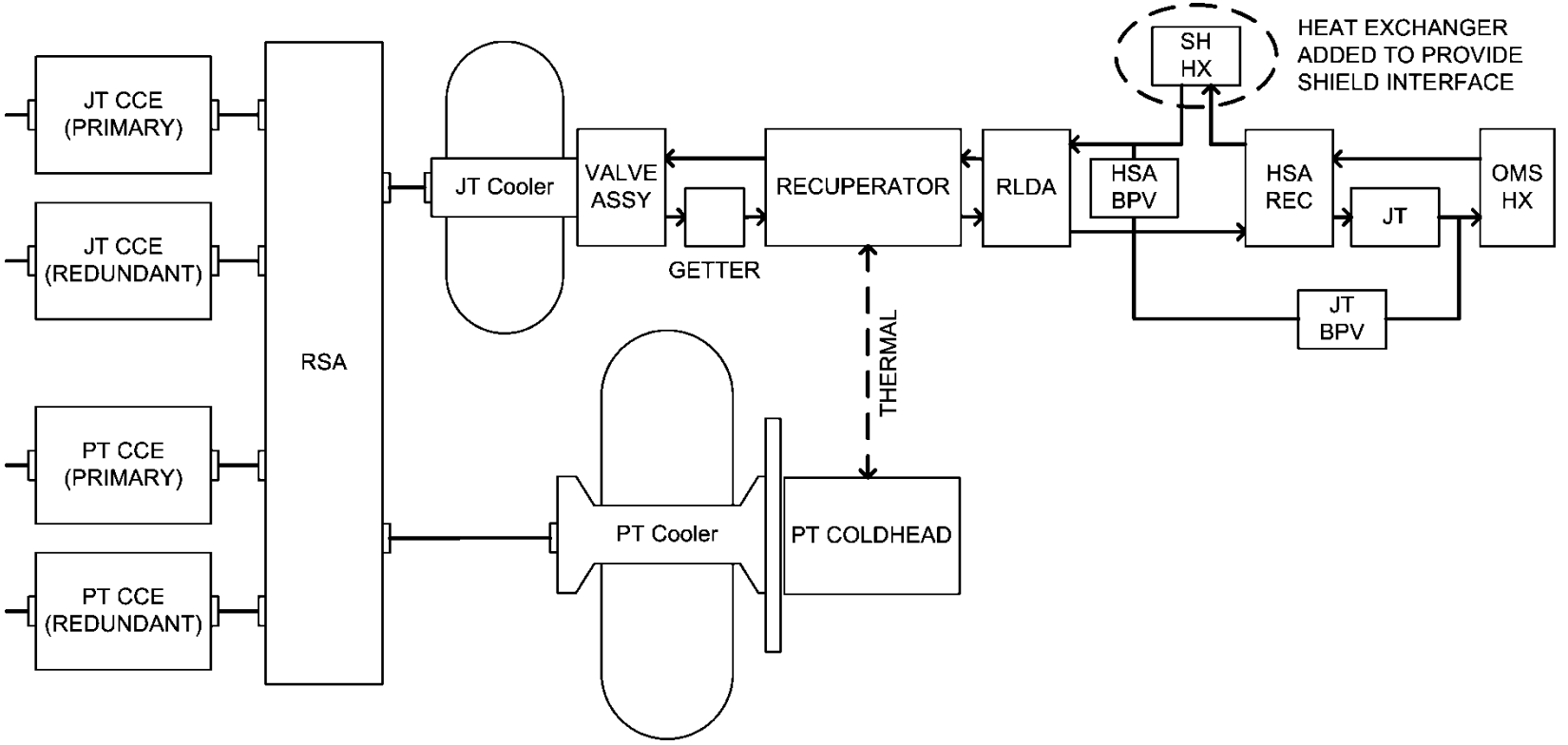
MIRI Cooler Subsystem



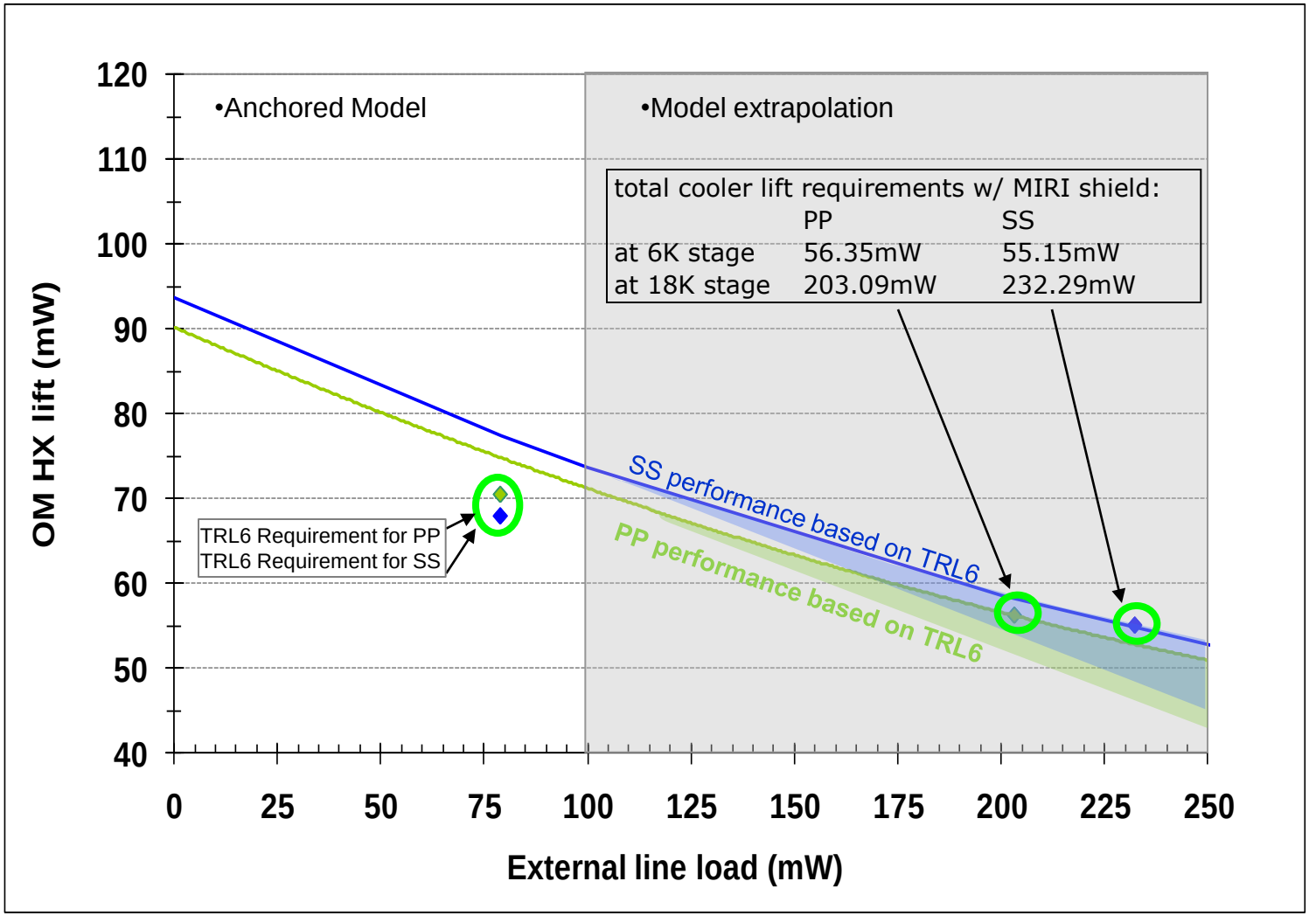
Functional Block Diagram



- **Heat Exchanger Added to Provide Interface to Actively Cooled Thermal Shield**
  - **Shield surrounds the MIRI OM to intercept thermal radiation and reduce the OM thermal load**
  - **Heat added at shield heat exchanger is equivalent to extra parasitic load on the refrigerant lines (including the RLDA)**
  - **Change to design leads to a large increase in the effective line load, a reduction in the OM load at 6.2 K, for a net increase in cooler requirement**

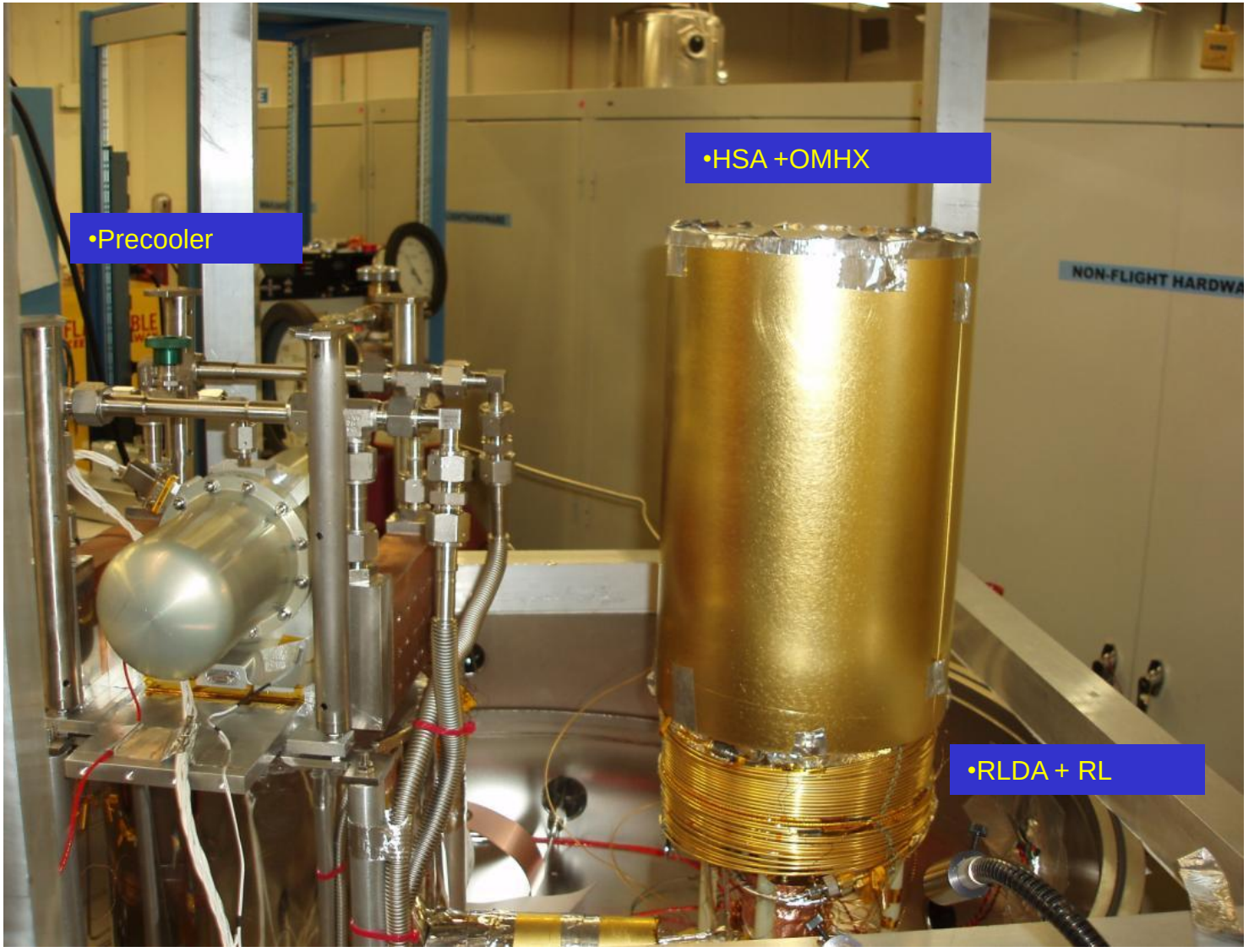
Anchored TRL 6 Model Extrapolated to New Requirements

- Model anchored with TRL 6 test data used to extrapolate to region of new requirements
- New requirements are far outside the range previously characterized



DM cooler test photos

•DM test TMU with 40K ISIM Shield Removed



Prototype Joule-Thomson Compressor

- **Flight-like construction and manufacturing processes**
- **Design changes led to efficiency improvement over previous laboratory version used in TRL 6 testing**

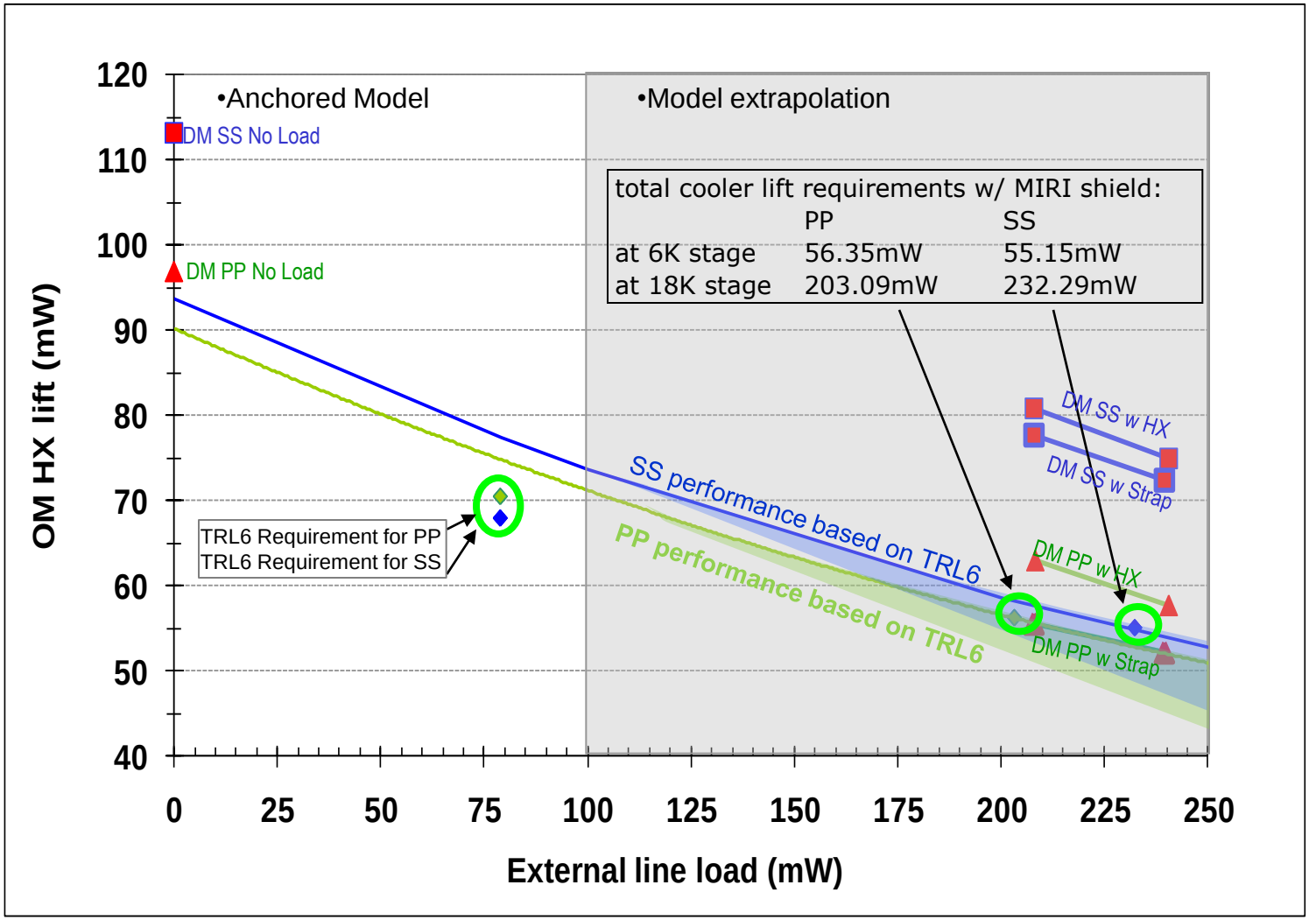
Summary of Key DM Test Measurements

- **The measured OM HX lift vs Line Load data is summarized in the table below**
- **The local slope of the OM HX lift vs Load allows extrapolation to other line loads**
- **The cooler has met the requirements of the test with**
  - **-0.3mW of OM HX lift for the "Strap" interface**
  - **+7.4mW of OM HX lift for the "HX" interface**

Measured							Extrapolated to current requirements			
Mode	Line Load	OM Lift	OM Temp	HSA T	Bus Power	Trej	Local slope	Line Load	OM Lift	OM req
Strap at Pinch Point							**Strap at Pinch Point**			
Strap PP	239mW	**52mW**	19.9K	20.0K	476 W	310K	-0.110mW/mW	203.1mW	**56.1mW**	56.4mW
Strap PP	208mW	**56mW**	19.0K	19.2K	471 W	310K				
No Load PP	0mW	**97mW**	15.2K	13.9K	470 W	310K				
Strap at Steady State							**Strap in Steady State**			
Strap SS	239mW	**72mW**	6.2K	22.0K	400 W	306K	-0.164mW/mW	232.3mW	**73.6mW**	55.2mW
Strap SS	208mW	**78mW**	6.2K	21.3K	400 W	306K				
No Load SS	0mW	**113mW**	6.2K	17.2K	395 W	307K				
HX at Pinch Point							**HX at Pinch Point**			
HX PP	241mW	**58mW**	19.1K	19.2K	475 W	310K	-0.160mW/mW	203.1mW	**63.8mW**	56.4mW
HX PP	208mW	**63mW**	18.3K	18.4K	476 W	310K				
No Load PP	0mW	**97mW**	15.2K	13.9K	470 W	310K				
HX at Steady State							**HX at Steady State**			
HX SS	241mW	**75mW**	6.2K	21.7K	400 W	306K	-0.159mW/mW	232.3mW	**76.2mW**	55.2mW
HX SS	208mW	**81mW**	6.2K	20.9K	400 W	306K				
No Load SS	0mW	**113mW**	6.2K	17.2K	395 W	307K				

DM Test Results Compared to Predictions

- Data in red shown on same graph as previous predictions indicate improvement due to heat exchanger approach and other design improvements



Summary of Performance Demonstration

- **Measurements Demonstrate MIRI Cooler Capability Meets New Requirements**
  - Steady State and Pinch Point requirements met for both options of thermal interface to OM shield
  - Heat exchanger approach shown to have improved performance over conductive strap approach—enables margin at the cooler level
- **Adaptation of Design Demonstrates Utility Over Range of Heat Loads**
  - Design capable of changing balance between intermediate temperature load and low temperature load without changing compressor or electronics designs
  - Model successfully used to guide design modification and accurately predicts performance—can be used to estimate performance in other space astronomy applications