

HEAT RELEASE RATE Updates

2018 March Materials Meeting
Savannah, GA USA

Materials Working Group

Michael Burns, FAA Tech Center

March, 2018



Federal Aviation
Administration



AGENDA

- HR2 Update
 - ✓ Thermopile Change / Calibration Process
 - ✓ HR2 Manufacturer Update
 - ✓ DOE
- New Prototype Heater Development
- Prototype Heat Flux Calibrator
- NEXT



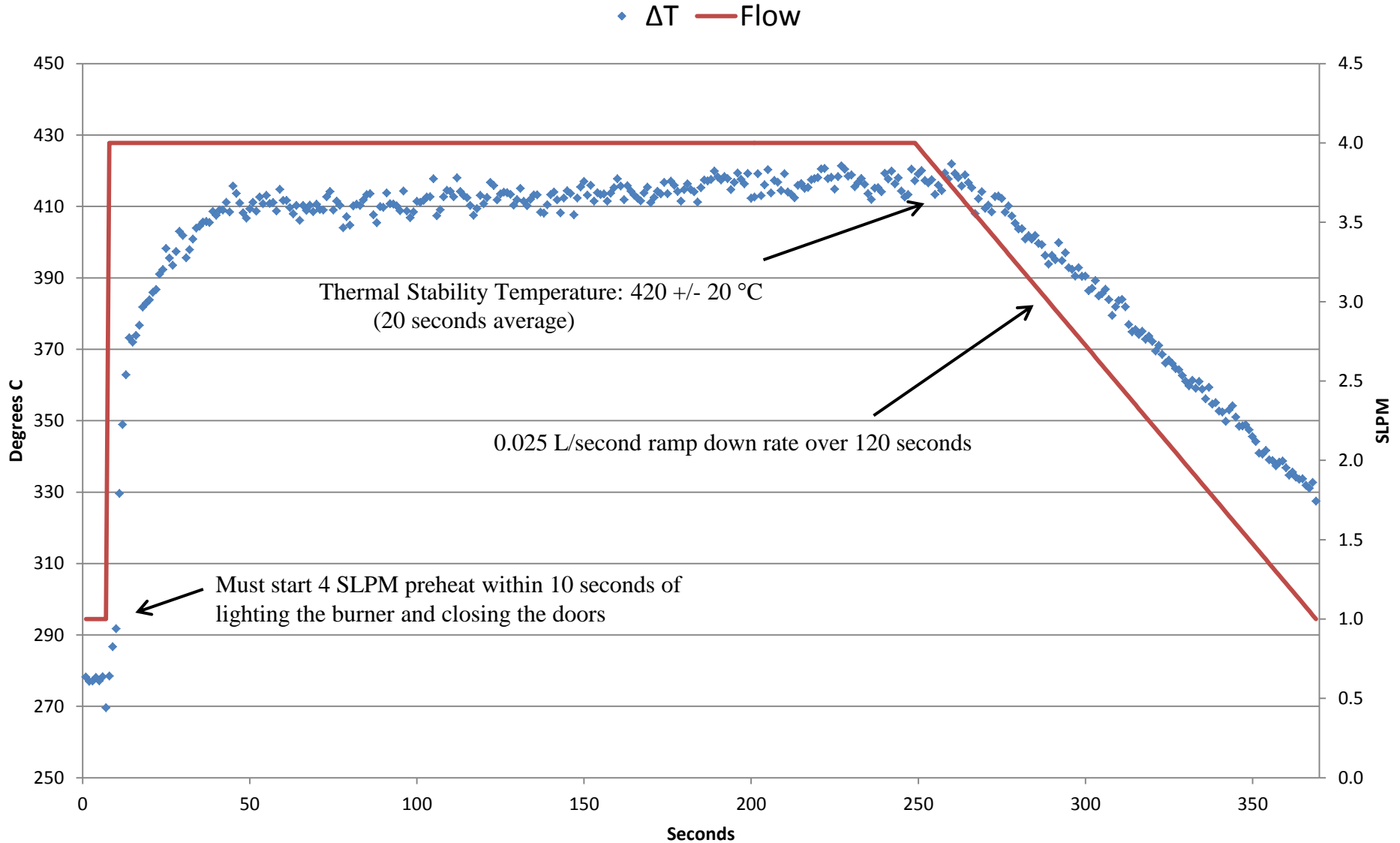
HR2 Status

Thermopile Change

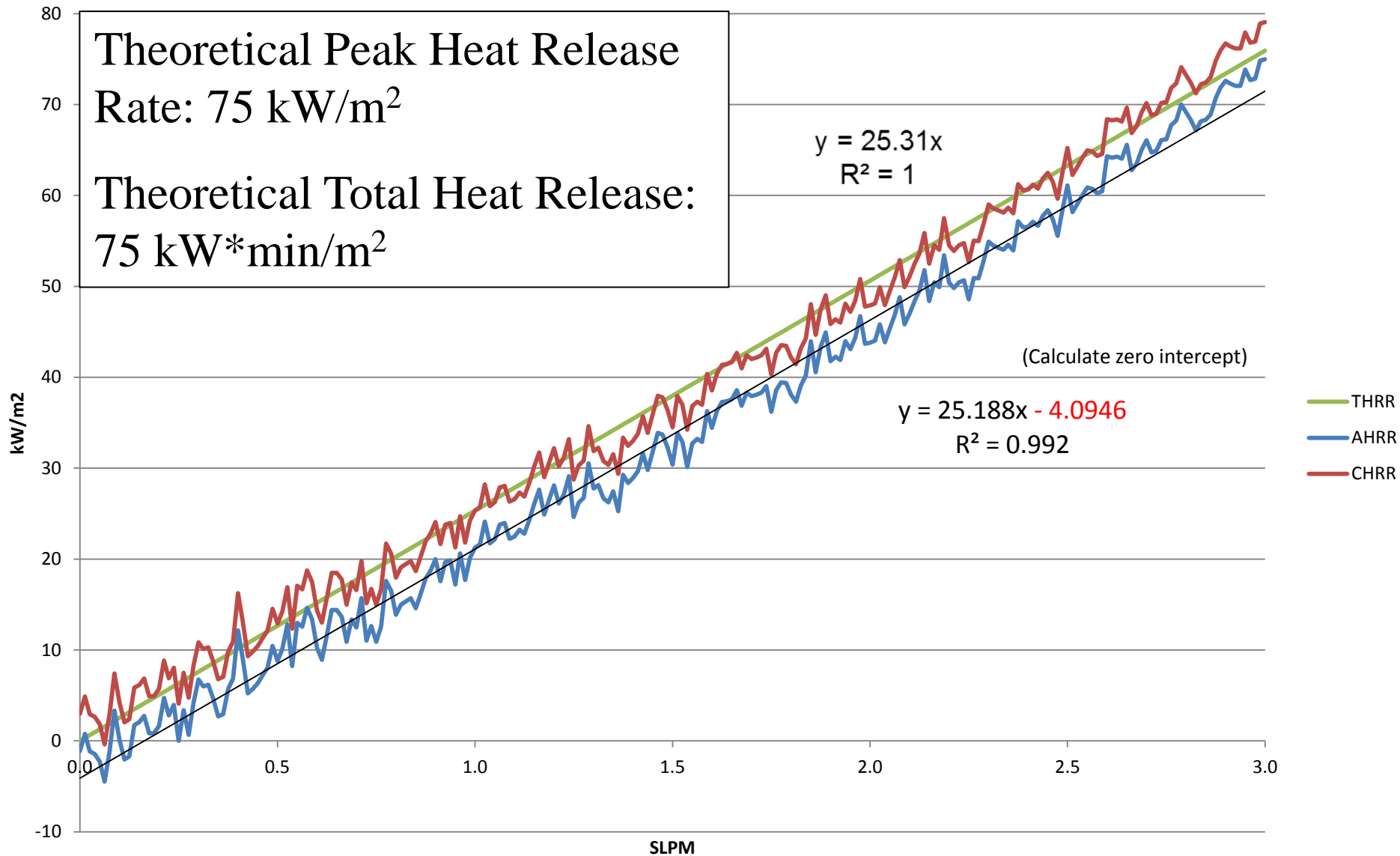
- Calculate the average of the 5 hot TC's then subtract reference temperature and display as thermopile temperature rise (Air entering/leaving).
- The Thermopile stability requirement to reference temperature in place of mV during warm up.
- The Thermal Stability Voltage (TSV) changed to Thermal Stability Temperature (TST).
- Install new calibration routine that includes Calibration / Validation of results



Ramp Down Calibration Profile (6 Total Minutes)



Theoretical / Actual / Corrected HRR (2 minutes)



Calibration / System Validation Test (Continued)

Presentation of Data

When the calibration is completed the following information to be displayed:

- Thermal Stability Temperature (TST): 420 ± 20 °C
- Calibration Factor: 18 ± 2 W/ °C (Pass / Fail)

Theoretical / Corrected Heat Release data

- AHRR/L zero intercept value as kW/m²/L
- PHRR (Theoretical & Corrected) kW/m²
- THR (Theoretical & Corrected) kW*min/m²
- % Delta (PHRR & THR)



HR2 Status

DEATAK Tech Center Visit (December)

- Completed Thermopile Hardware / Software mods
 - Mounting Lower Plenum TC
 - Thermocouple Wiring to DAQ
 - Software Installation / Review
- Remaining minor software punch list items



Correction to the calculation of calibration factor K_h

$$\text{From: } K_h = \frac{(210.8-22)\text{kCal}}{\text{mol}} * \frac{\text{mol (CH}_4\text{)}}{22.41\text{L}} * \frac{\text{Watt*min}}{0.01433 \text{ kCal}} * \frac{\text{kW}}{1000\text{W}} * \frac{\Delta F}{\Delta mV} \text{ kW/mV}$$

$$\text{To: } K_h = \frac{(210.8-22)\text{kCal}}{\text{mol}} * \frac{\text{mol (CH}_4\text{)}}{22.41\text{L}} * \frac{\text{Watt*min}}{0.01433 \text{ kCal}} * \frac{1000 \text{ W}}{1000 \text{ W}} * \frac{\Delta F}{\Delta^\circ\text{C}} \text{ W/}^\circ\text{C}$$

Removed

(Correct)

$$\text{To: } K_h = \frac{(210.8-22) \text{ kCal}}{\text{mol}} * \frac{\text{mol (CH}_4\text{)}}{22.41 \text{ L}} * \frac{\text{Watt*min}}{0.01433 \text{ kCal}} * \frac{\Delta\text{Flow (L/min)}}{\Delta \text{Temperature (}^\circ\text{C)}} \text{ W/}^\circ\text{C}$$

DOE Test Plan (Round II)

- Randomize 4 main parameters
- No Materials Tested; Only looking at impact to Thermopile response
- DOE Results showed much improvement
- Advance into next step: Materials Testing

Parameter	DESCRIPTION	Min. (round I)	Avg.	Max. (round I)
System Air Flow rates	SCFM	19.6 (19)	20.0	20.4 (21)
Heat Flux (W/cm ²)	Center	3.60	3.65	3.70
Upper Pilot	Air (SLPM)	0.98 (0.8)	1.00	1.02 (1.2)
	Methane (SLPM)	1.47 (1.3)	1.50	1.53 (1.7)



HR2 Status

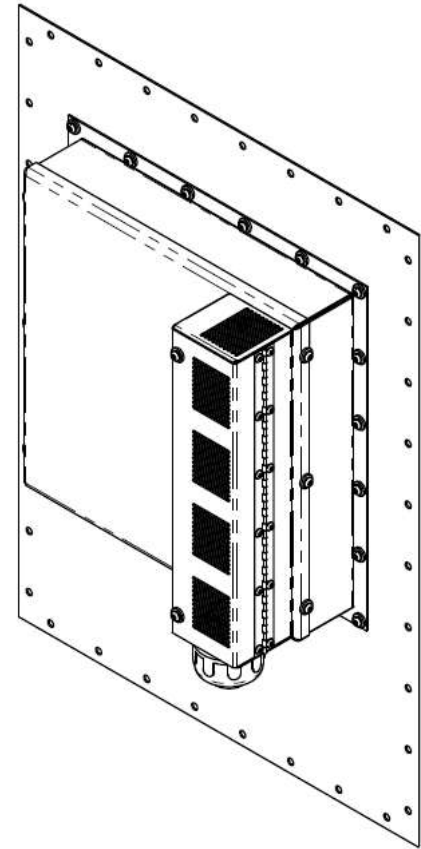
New Prototype Heater Development

- Dimensions: 10” W x 10” H x 2” D
- Zones: 2 (Upper / Lower)
- Flush mounted glass with rear wall (sealed)
 - Removed from air stream (internally)
- Replaces the following components:
 - Global pan (Global end penetrations), Diamond-shaped Mask & Rear Reflector Plate



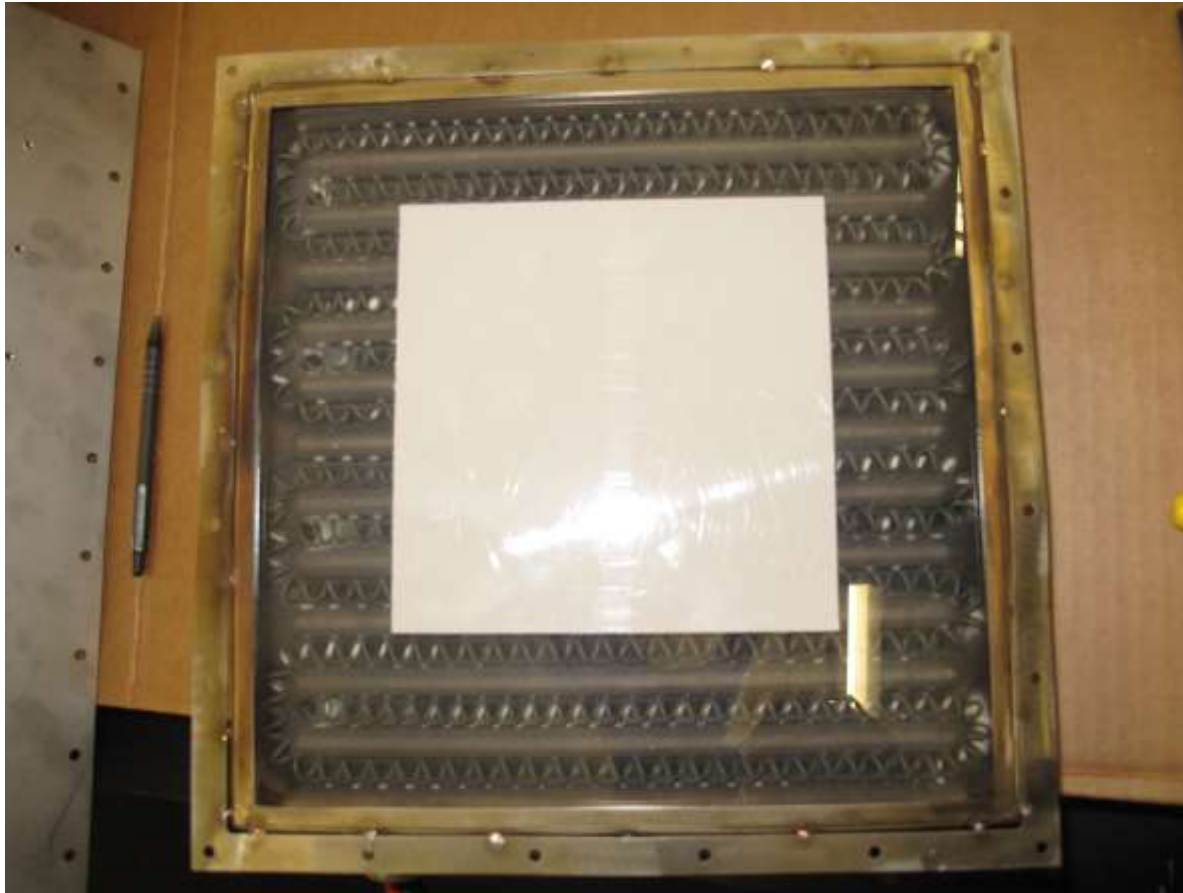
HR2 Status

New Prototype Heater Development

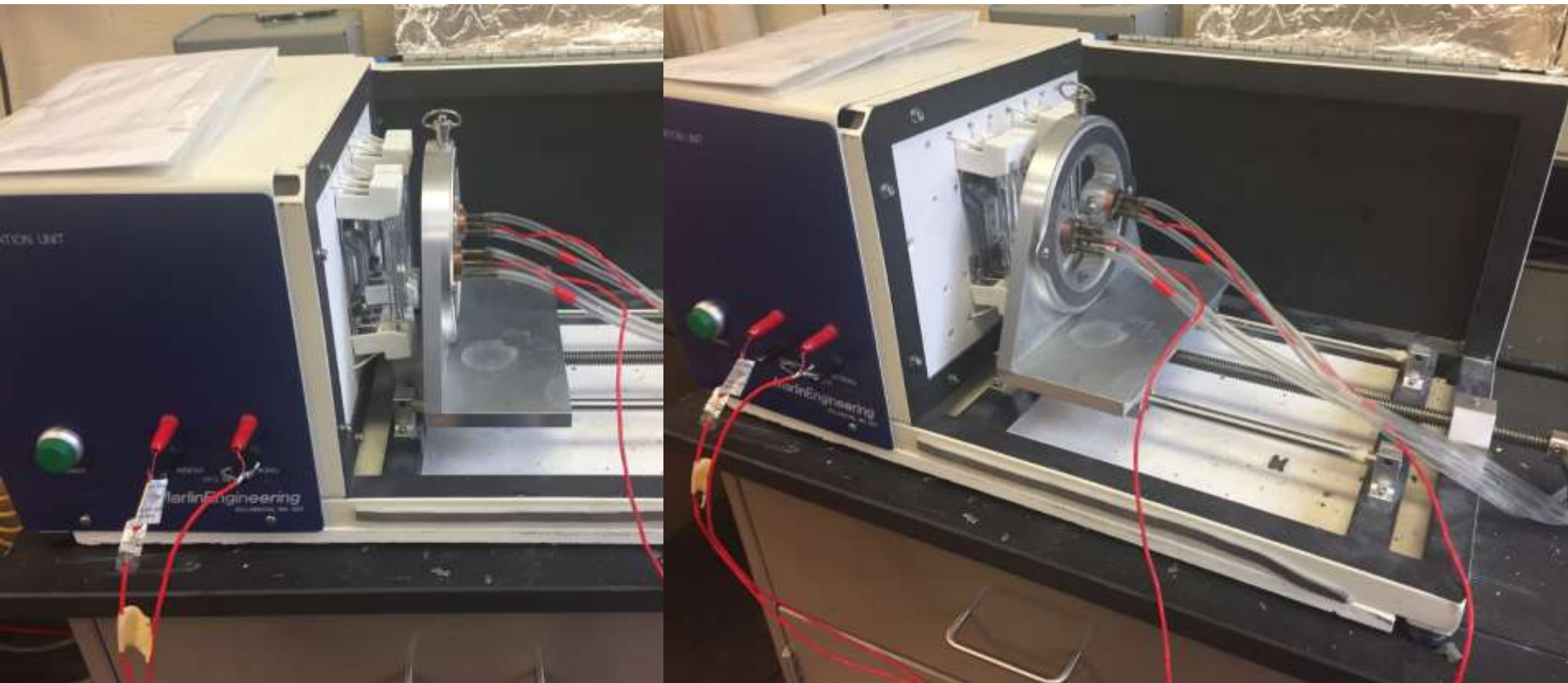


HR2 Status

New Prototype Heater Development



Prototype Heat Flux Calibrator

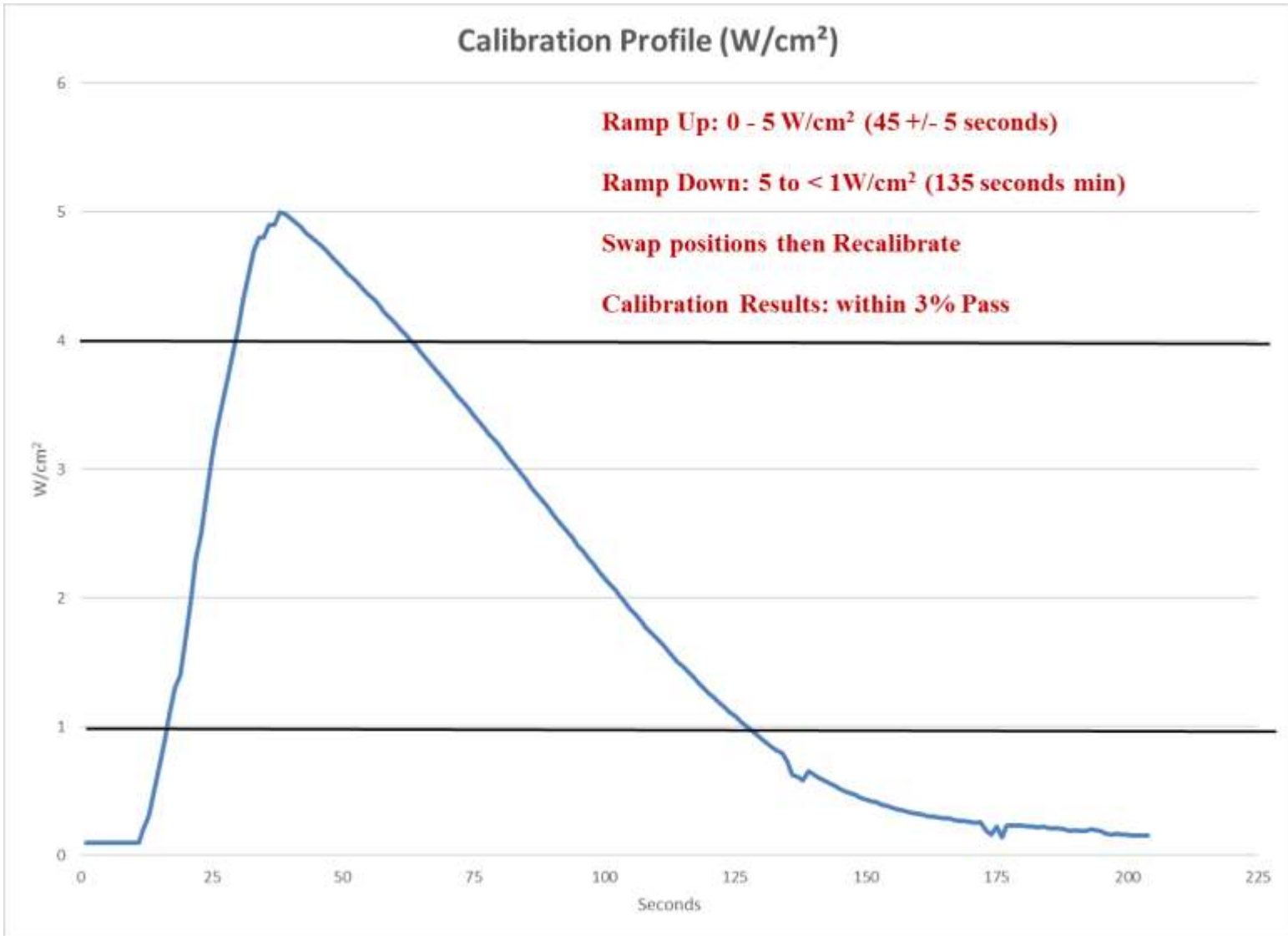


Prototype Heat Flux Calibrator Status

- Balance of radiant heat (adjustment of lights)
- Pass/Fail criteria change (3% then average)
- Remove repeatability criteria
- Software punch list issues



Prototype Heat Flux Calibrator



NEXT

- Task group discussions as needed
- Continue working hardware/software changes as needed
 - ✓ HR2 & Heat Flux Gauge Calibrator
- Input requested developing HFG RR using the new calibration apparatus



Questions?

