TWOCRYST: Preparing Proof-of-Principle Experiment for Future Charm Physics

Myrra Small

8 August 2024

What is TWOCRYST?

- **Proof-of-principle for future ALADDIN experiment**

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- **"Parasitic" set-up**

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- **"Parasitic" set-up**
  - Channel halo particles from LHC with two *bent crystals*
  - One crystal induces electric and magnetic dipole moments (EDM/MDM) precession

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- **"Parasitic" set-up**

  - Channel halo particles from LHC with two *bent crystals*

  - One crystal induces electric and magnetic dipole moments (EDM/MDM) precession
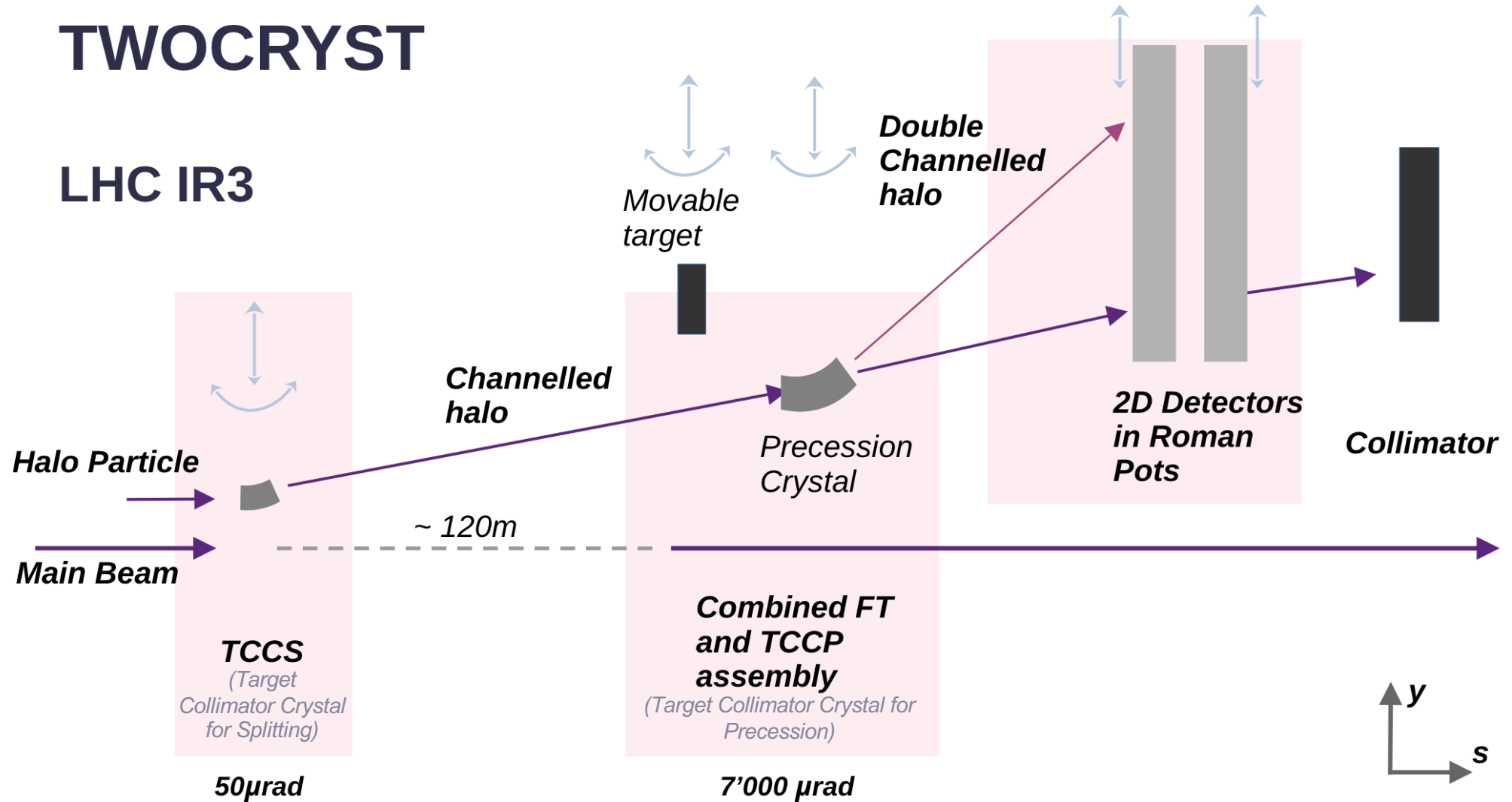
- **Motivation: Expand charm physics**

What is TWOCRYST?

- **Proof-of-principle for future ALADDIN experiment**

- **"Parasitic" set-up**
  - Channel halo particles from LHC with two *bent crystals*
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- **Motivation: Expand charm physics**
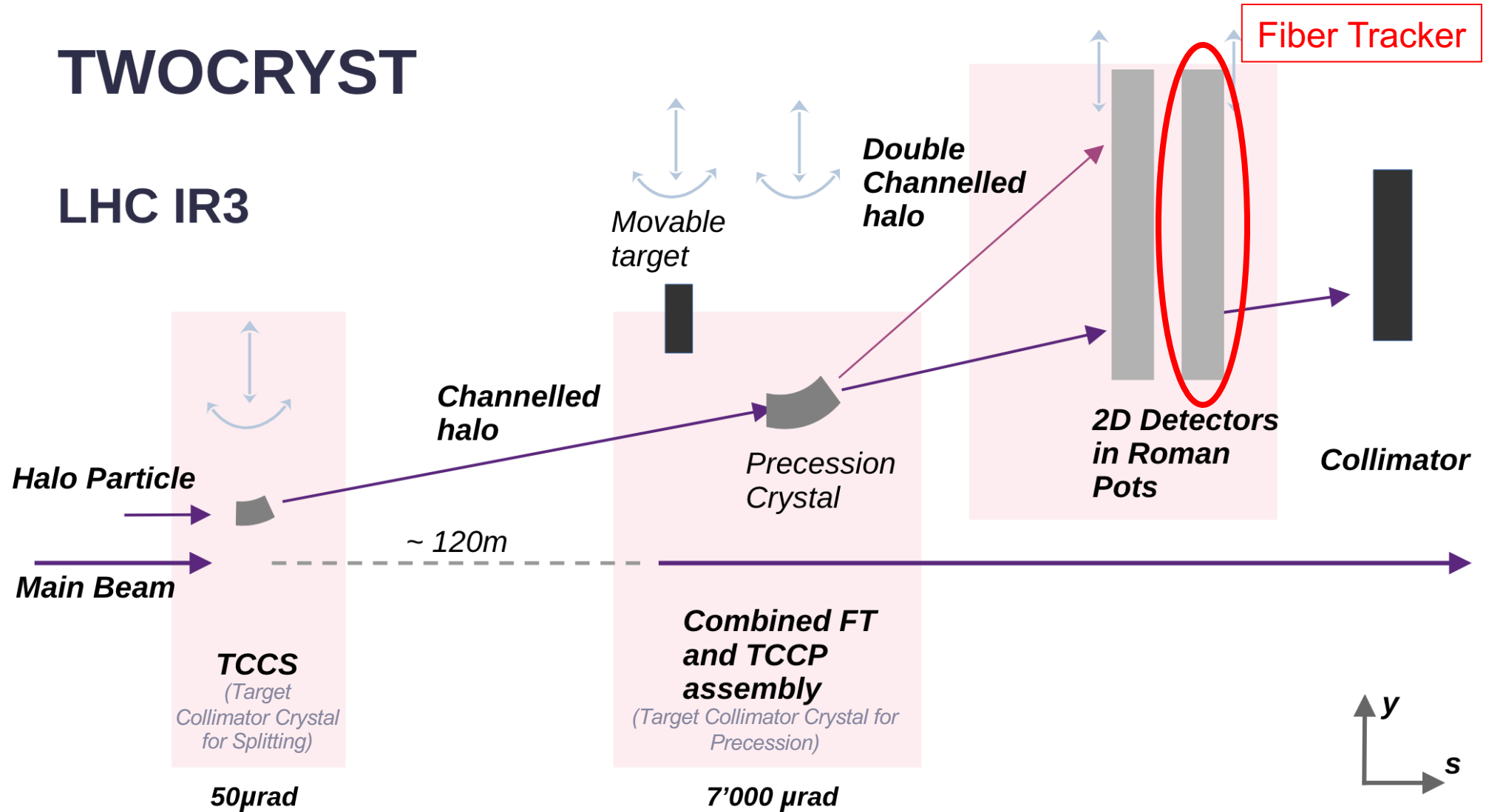 - Measure charmed baryon EDM/MDM
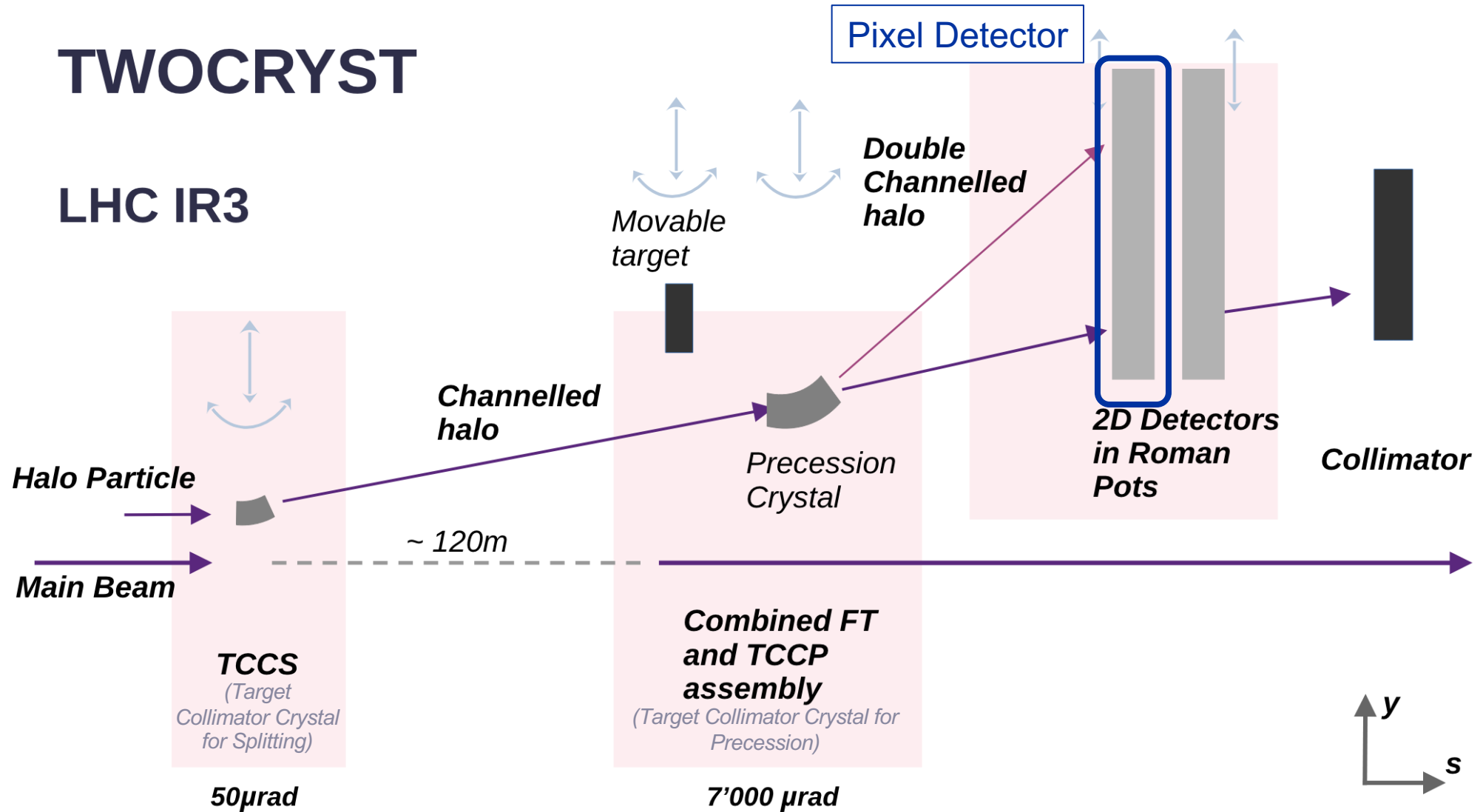
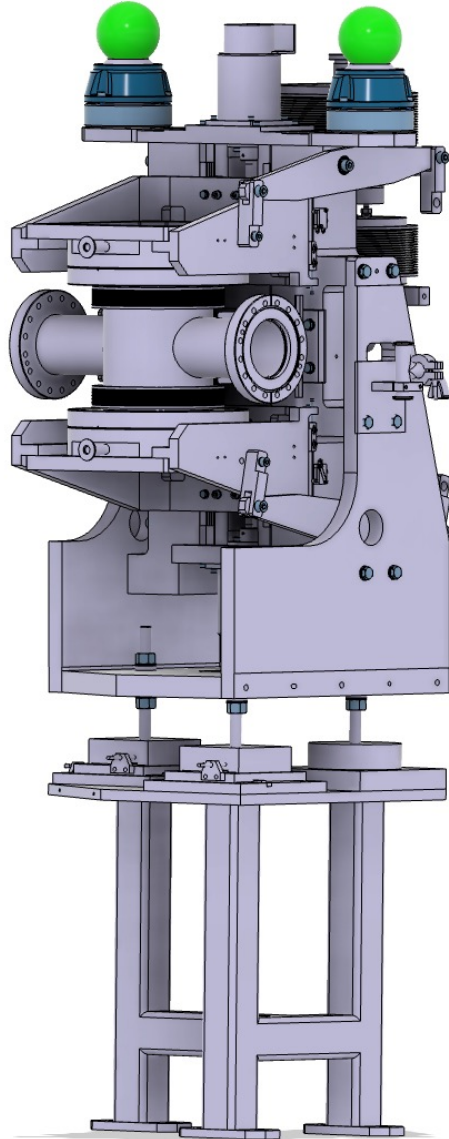# What is TWOCRYST?

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TWOCRYST

LHC IR3

What is TWOCRYST?

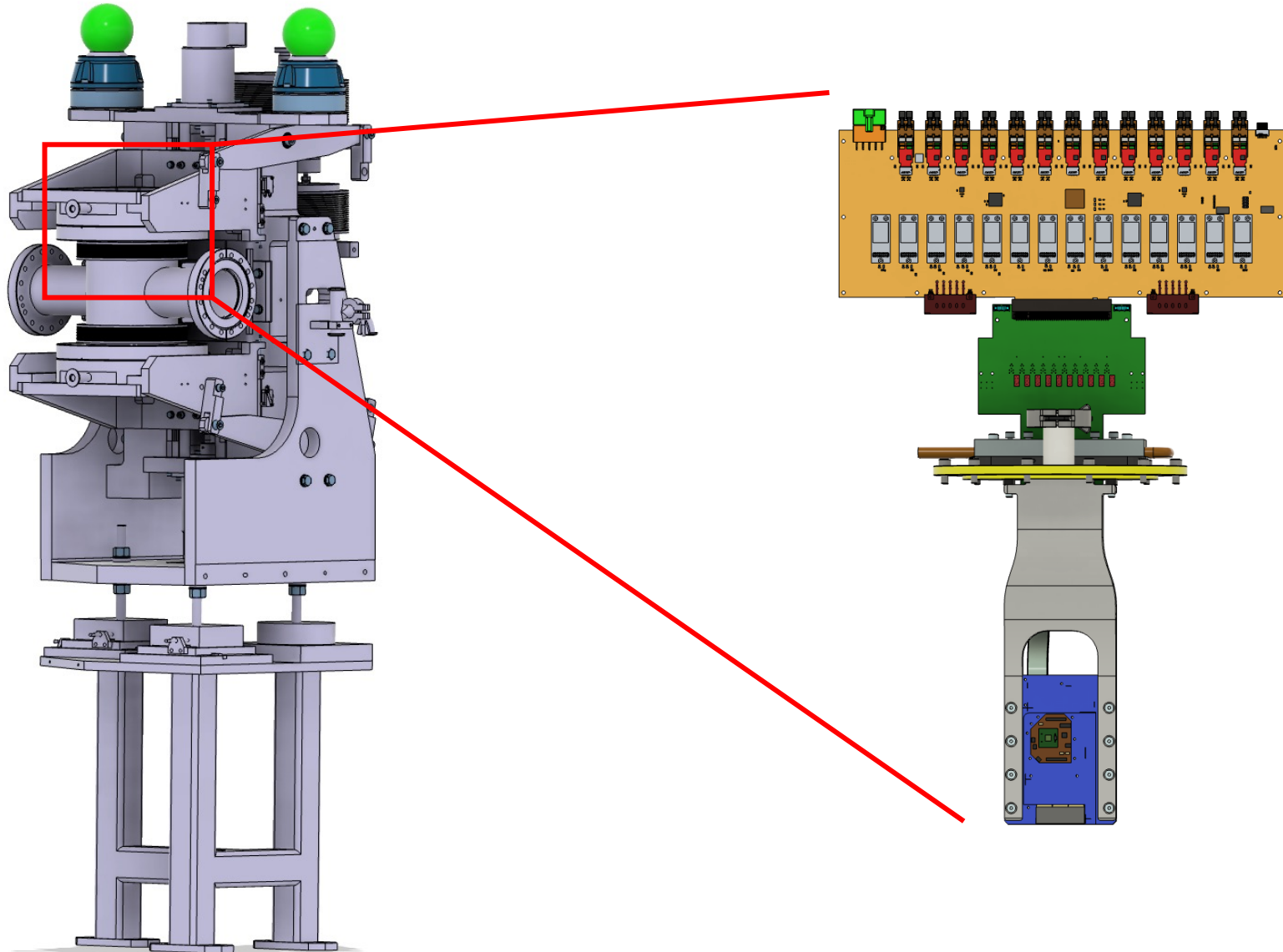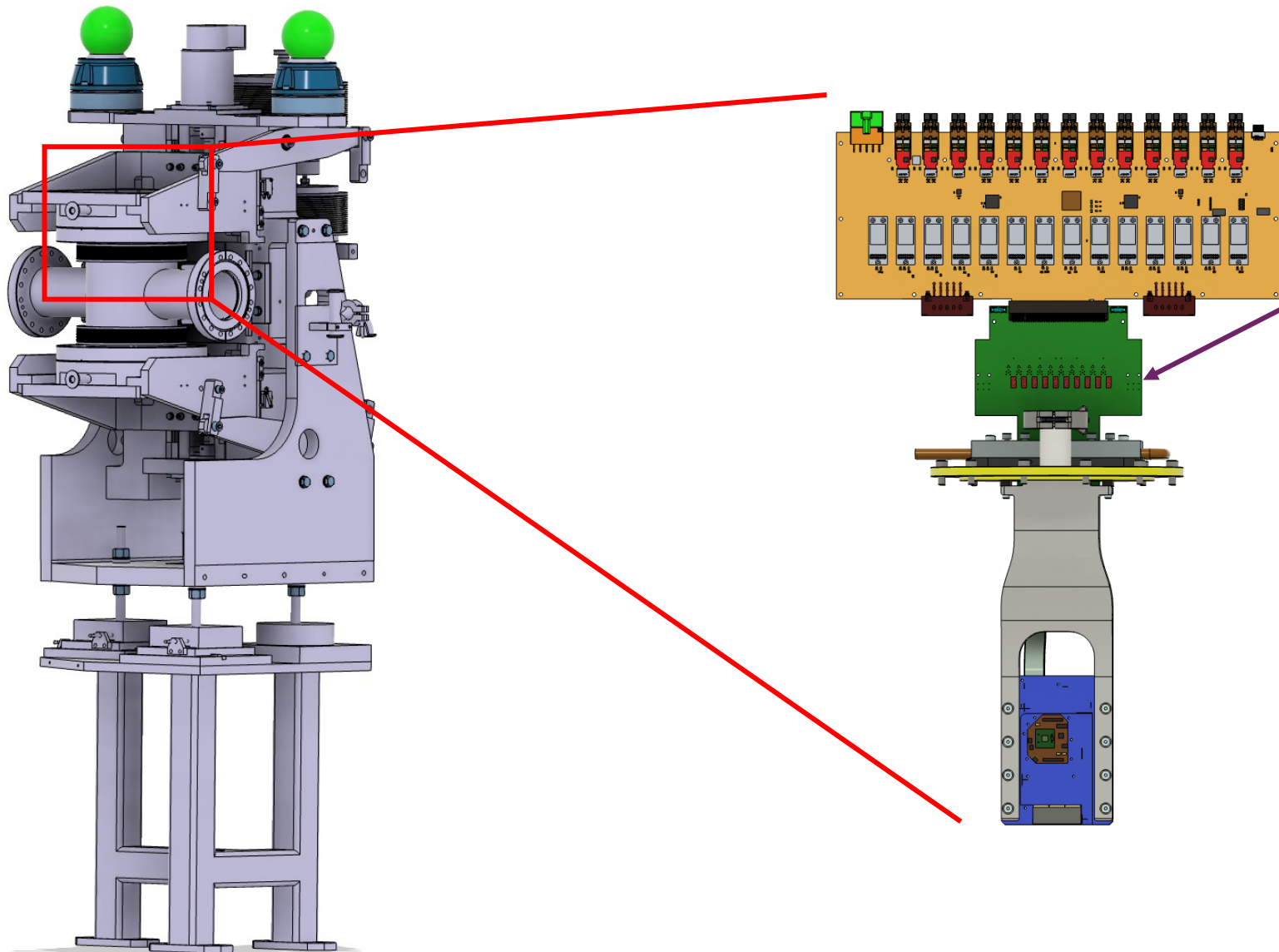## TWOCRYST

LHC IR3

TWOCRYST Pixel Detector

ALFA Roman Pot

TWOCRYST Pixel Detector

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TWOCRYST Pixel Detector
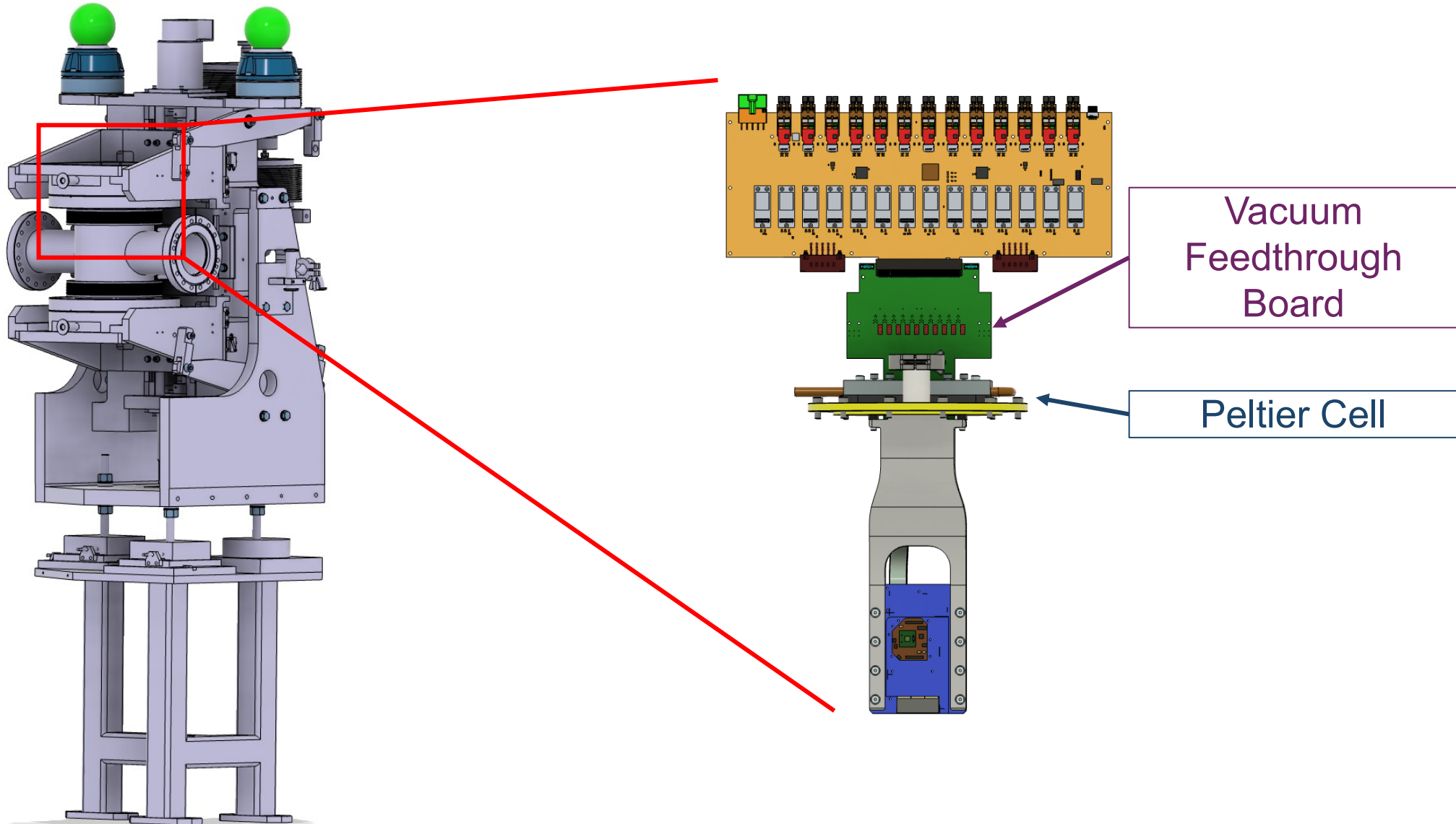

ALFA Roman Pot

Vacuum Feedthrough Board

TWOCRYST Pixel Detector

ALFA Roman Pot

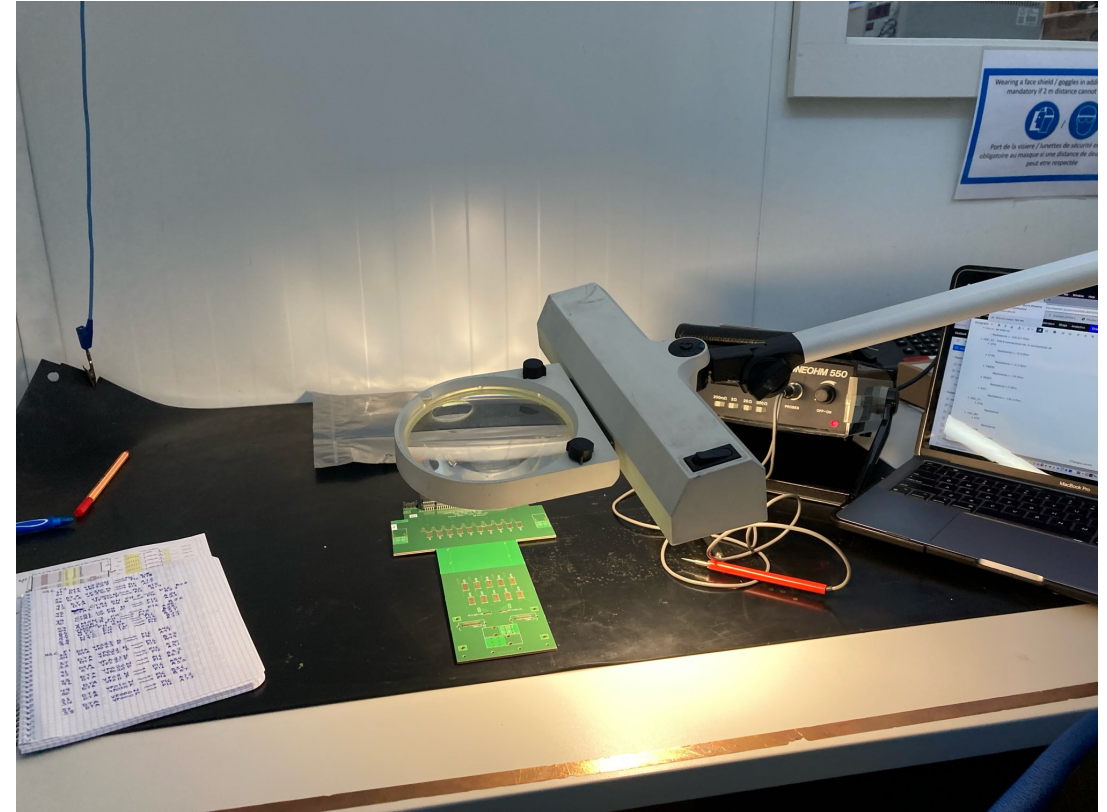Vacuum Feedthrough Board

Peltier Cell

Vacuum Feedthrough Boards

- **Highway for signal and voltage exchange**

Vacuum Feedthrough Boards

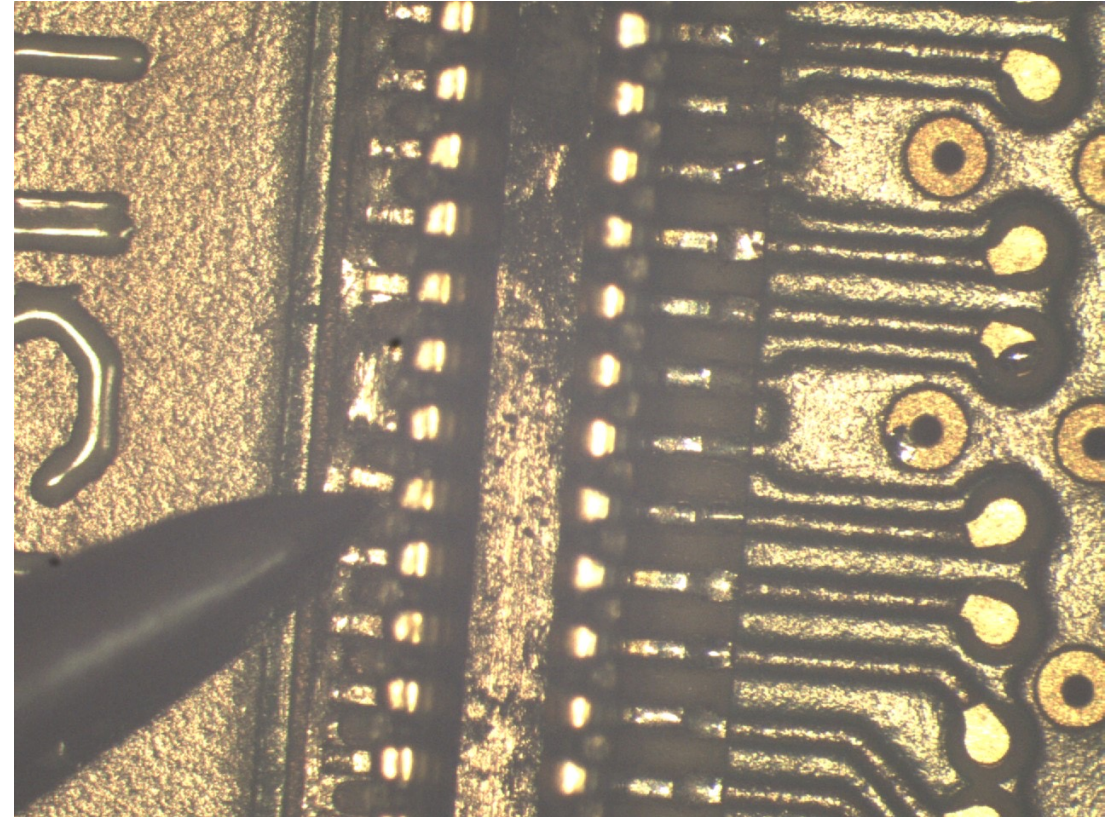- **Highway for signal and voltage exchange**
- **Two lines of inspection:**

Vacuum Feedthrough Boards

- **Highway for signal and voltage exchange**

- **Two lines of inspection:**
  - Continuity testing

Vacuum Feedthrough Boards

- **Highway for signal and voltage exchange**

- **Two lines of inspection:**
  - Continuity testing
  - Visual inspection

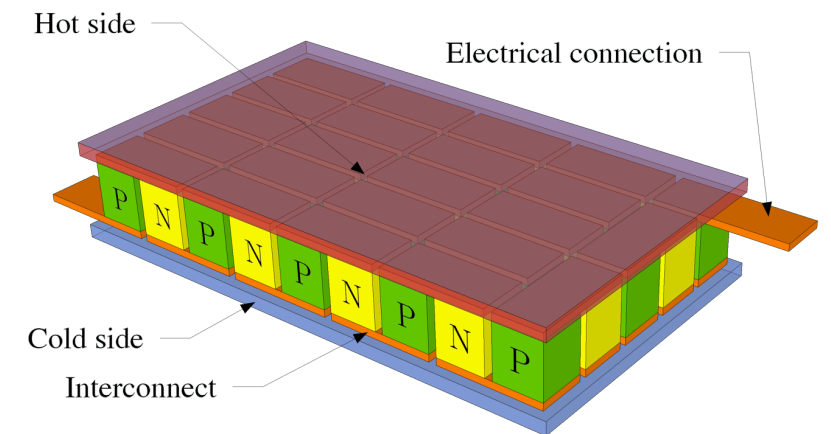Close-up of HSC F2 connection on Board 2

Vacuum Feedthrough Boards

- **Highway for signal and voltage exchange**

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- **All boards (mostly) ok**

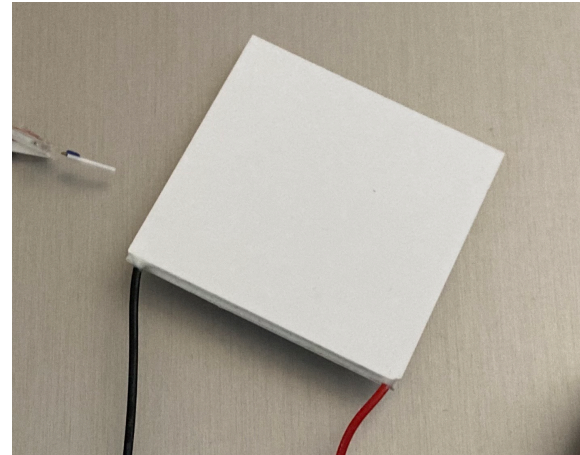# Vacuum Feedthrough Boards

- **Highway for signal and voltage exchange**

- **Two lines of inspection:**
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Board Number	Number of Shorts[a]	PT100 Disconnects	Ground Disconnects
1	19	2	1
2	30	2	1
3	30	0	0
4	5	1	0
5	31	0	1

[a] All shorts on ground pins

Vacuum Feedthrough Boards

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Recommended Boards {

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Crash Course on Peltier Cooling

Hot side

Electrical connection

Cold side

Interconnect

Credit: Wikipedia (MichBich)

Crash Course on Peltier Cooling

- **Related to Seebeck effect**
  - Temperature gradient produces current

Hot side

Electrical connection

Cold side
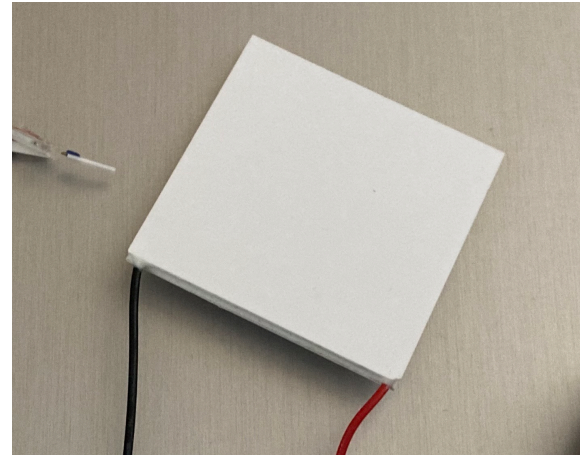
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Crash Course on Peltier Cooling

- **Related to Seebeck effect**
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- **Current flow produces temperature gradient**
  - Electrons/holes act as both charge and heat carrier

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Crash Course on Peltier Cooling

- **Related to Seebeck effect**
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Experimental Set-Up
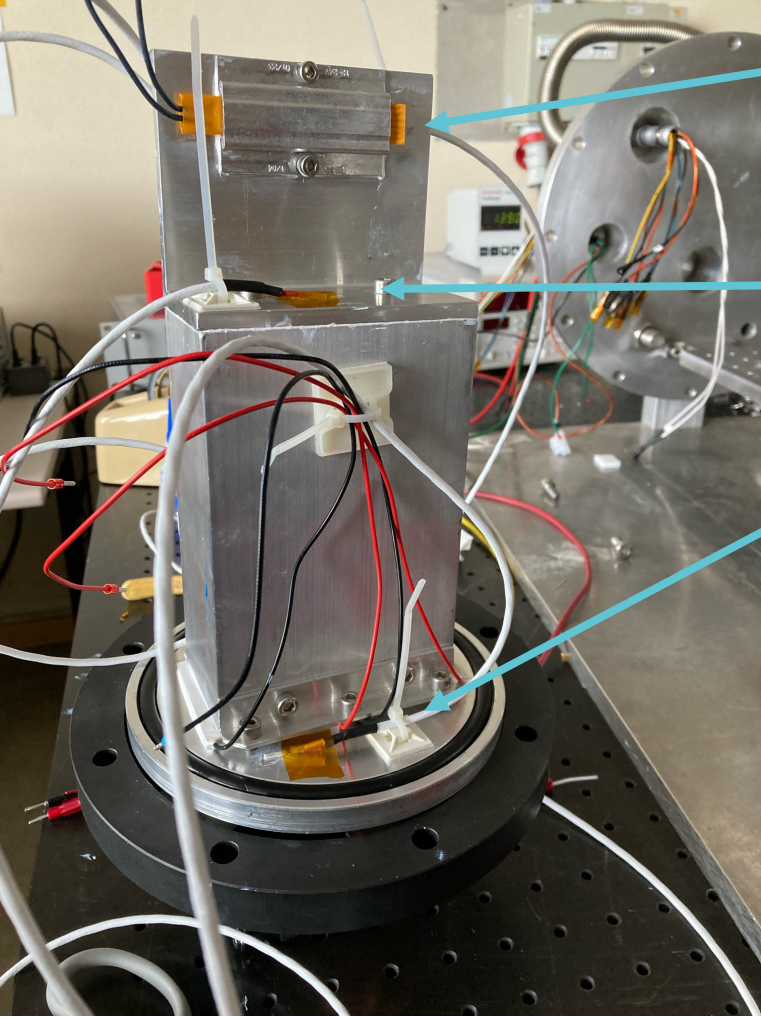
Heater (15 W < P < 20 W), simulate detector

1 of 5 PT100 sensors

2 Peltier cells

PLC

Vacuum chamber

Fan

Peltier Characterization

Example of System Evolution:
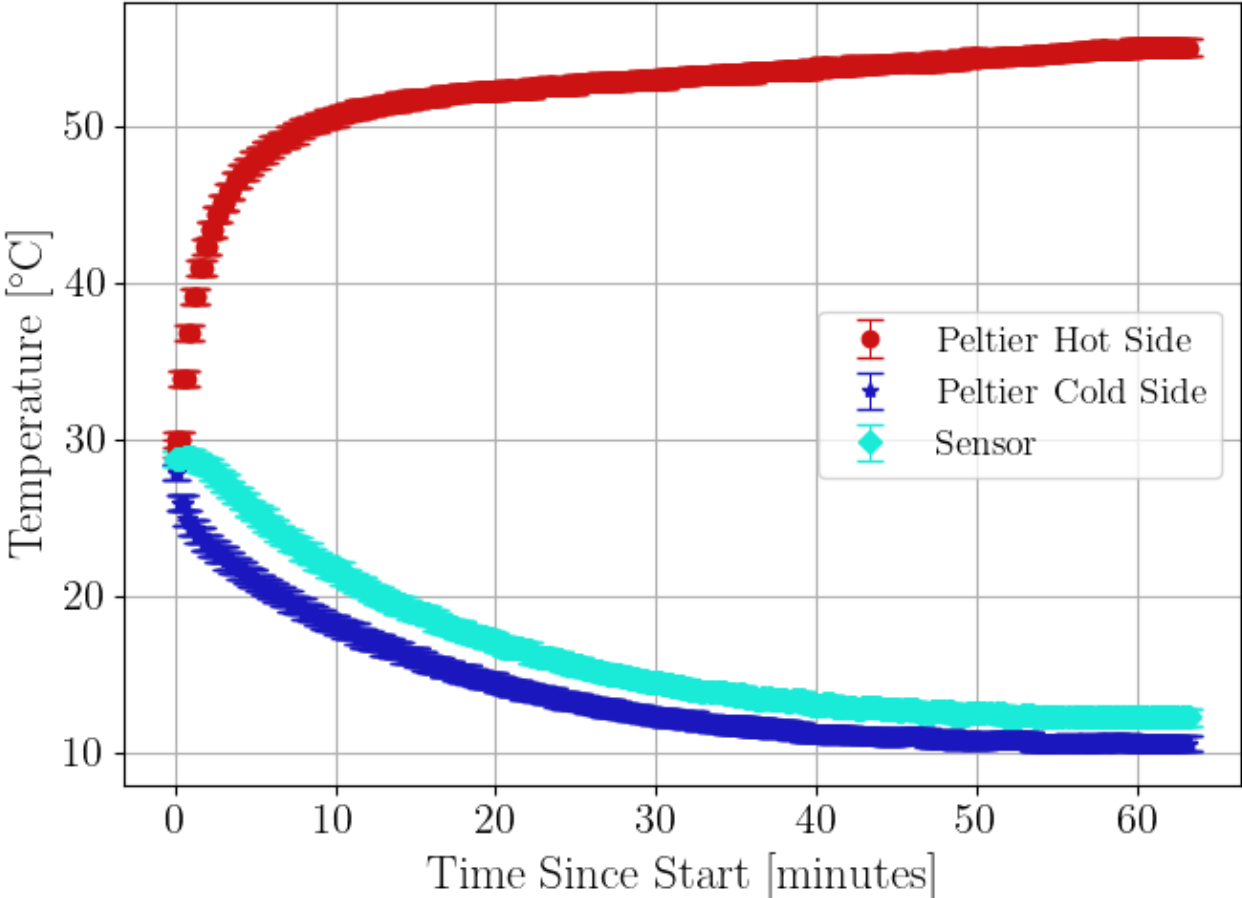
No active cooling, no heating

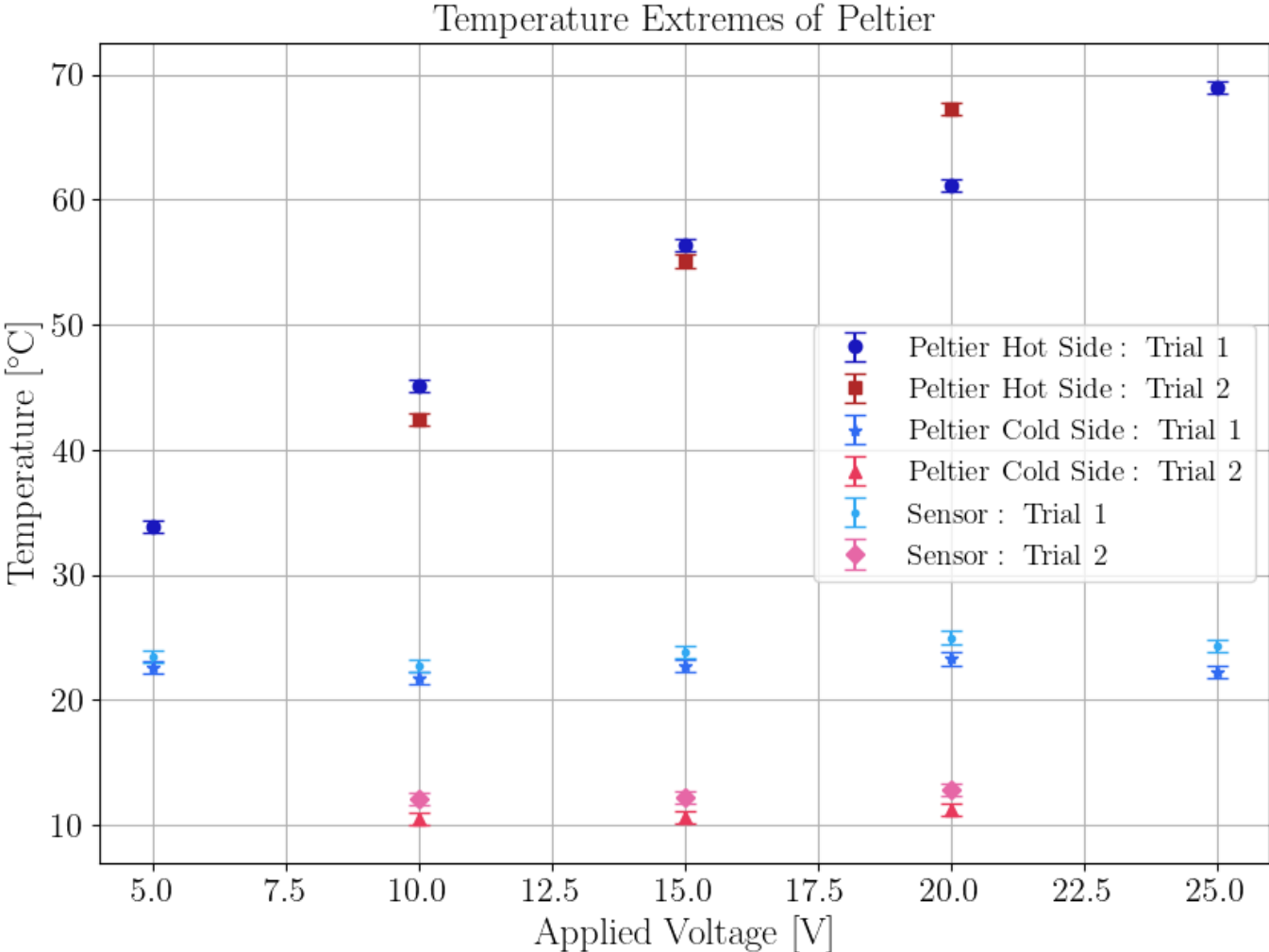# Peltier Characterization
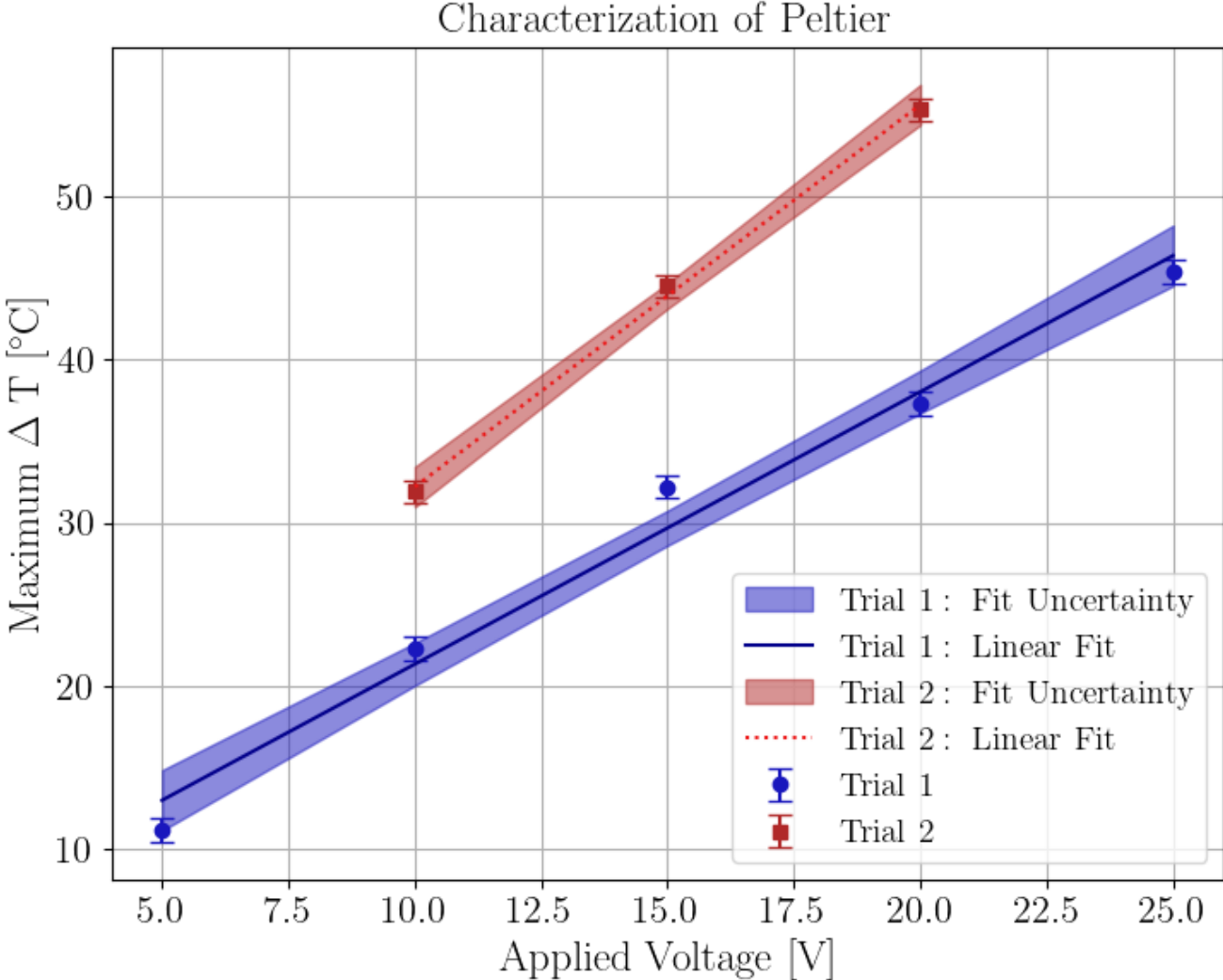
Trial 1: Two Peltier cells, only one on

Trial 2: One Peltier

Peltier Characterization
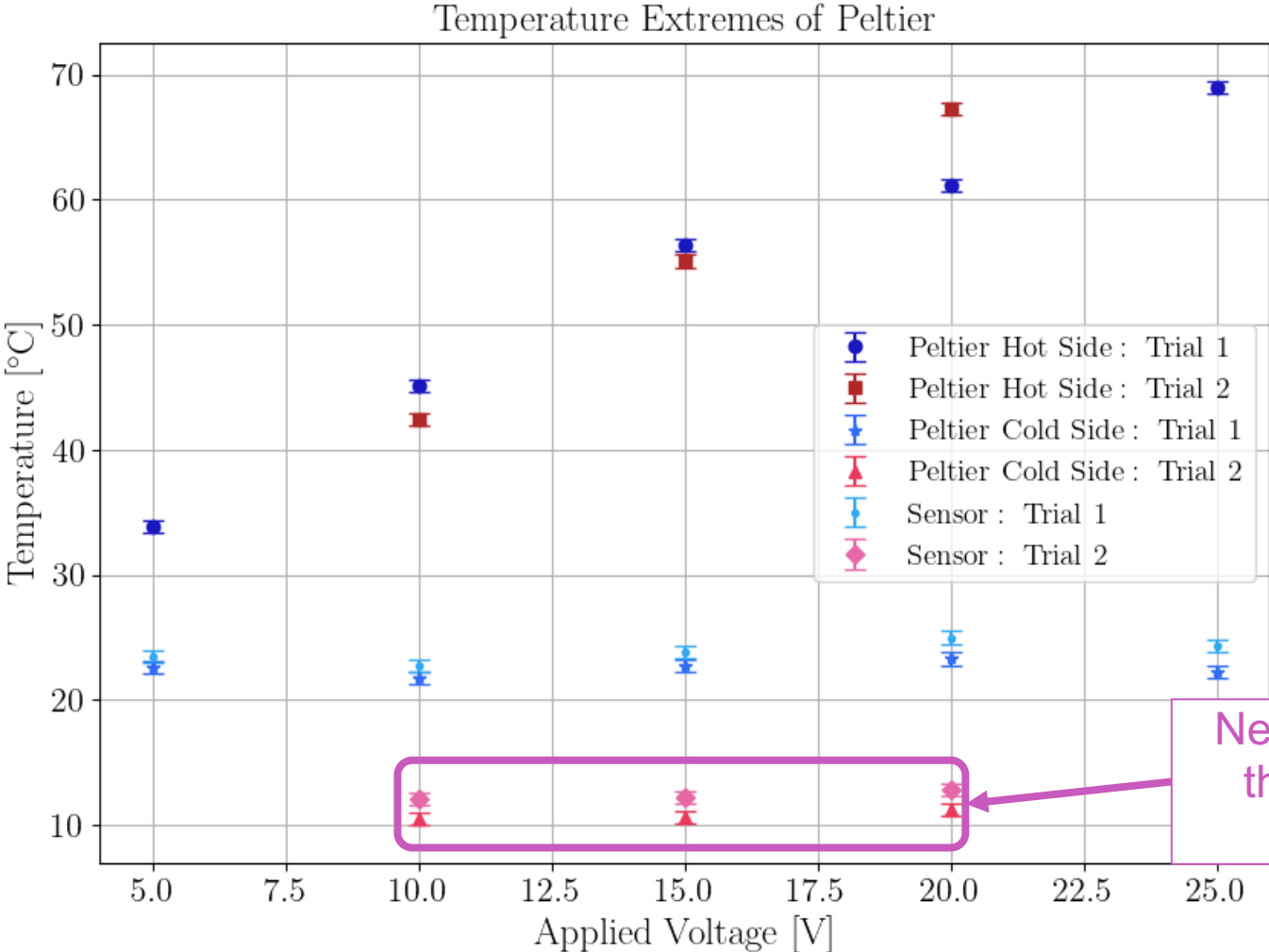
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Characterization of Peltier
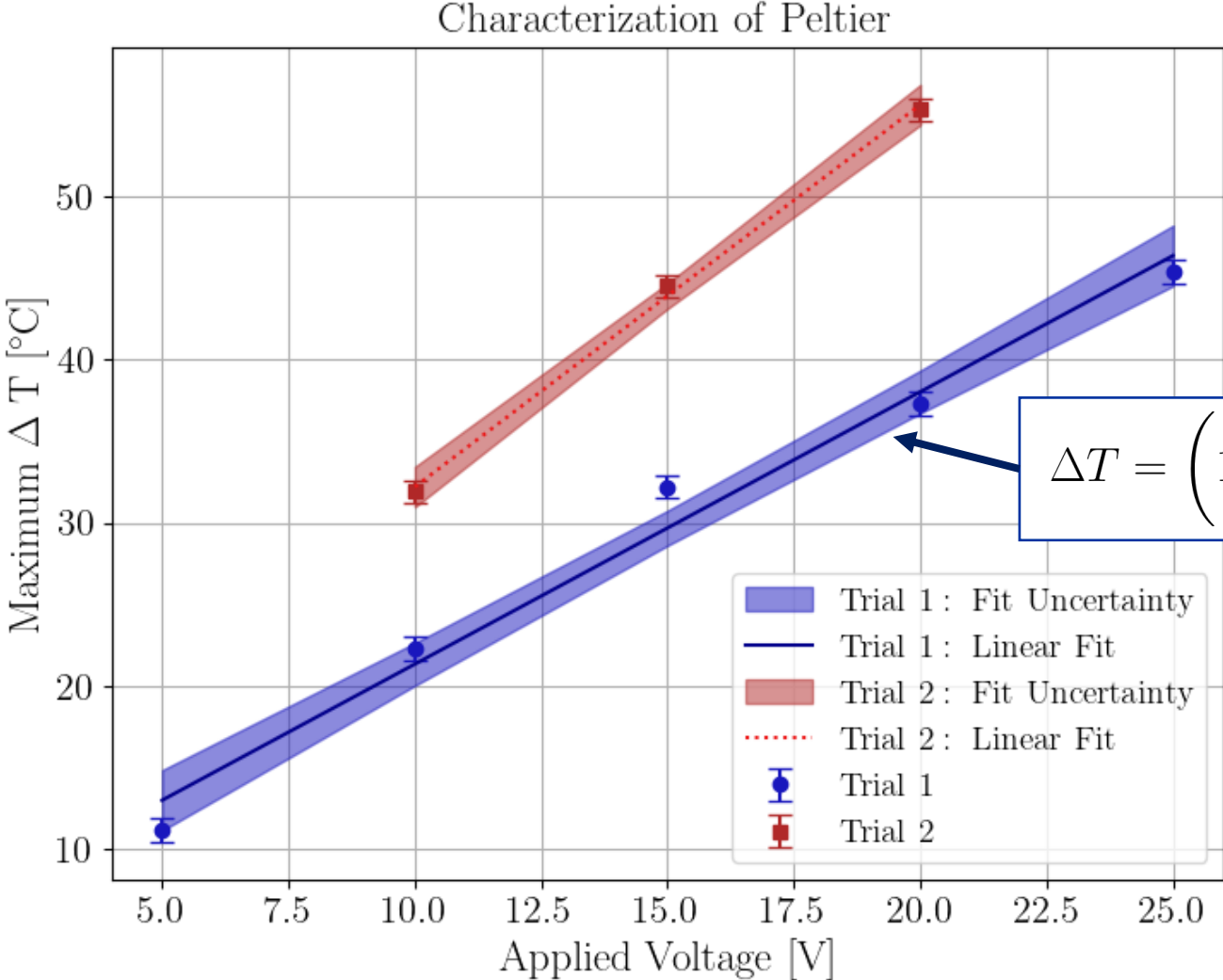
$$\Delta T = \left(1.7 \pm 0.1\ \frac{°C}{V}\right) V_{app} + (5 \pm 2\ °C)$$

Peltier Characterization
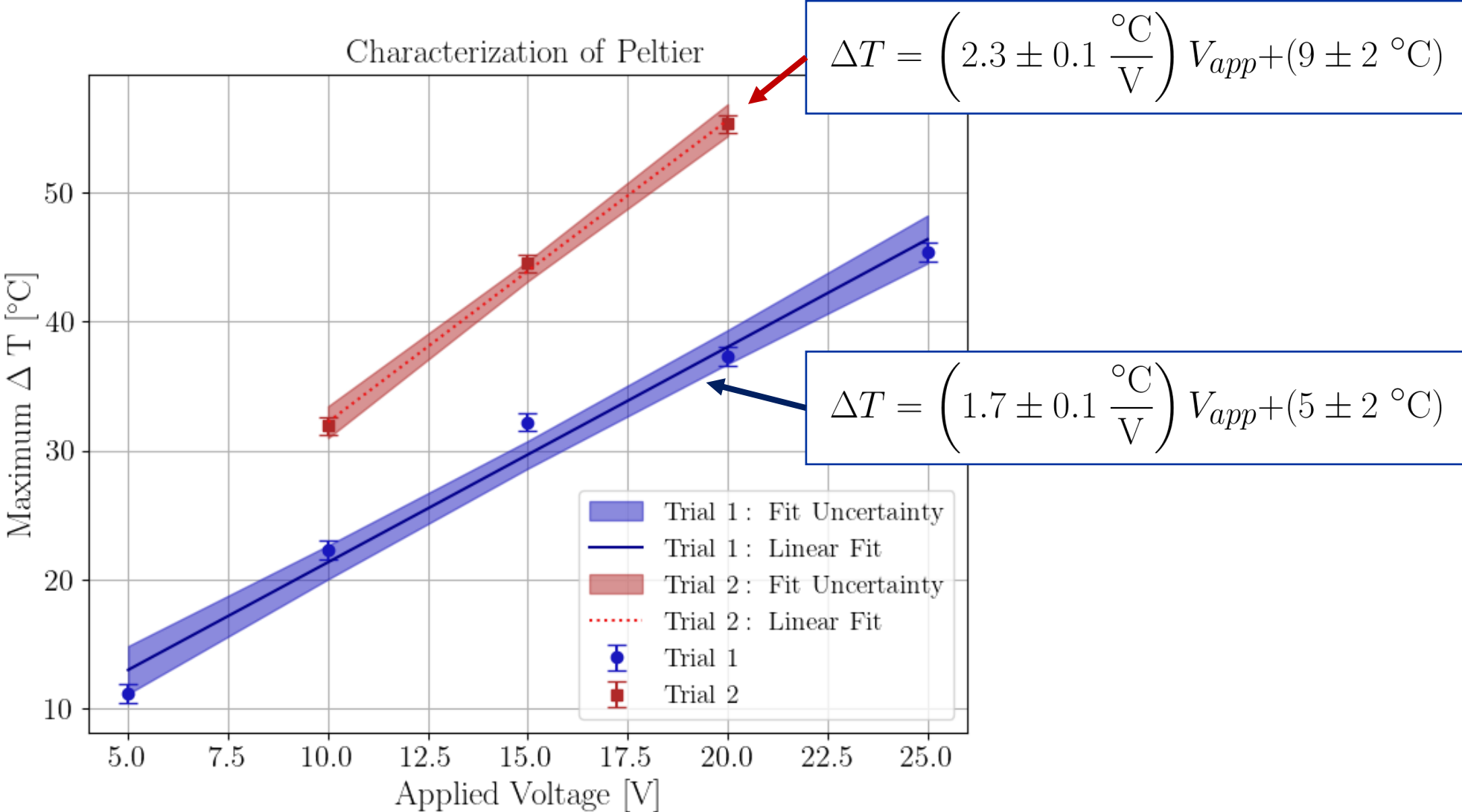
Trial 1: Two Peltier cells, only one on

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Characterization of Peltier

$$\Delta T = \left(2.3 \pm 0.1 \, \frac{^\circ \mathrm{C}}{\mathrm{V}}\right) V_{app} + (9 \pm 2 \, ^\circ\mathrm{C})$$

$$\Delta T = \left(1.7 \pm 0.1 \, \frac{^\circ \mathrm{C}}{\mathrm{V}}\right) V_{app} + (5 \pm 2 \, ^\circ\mathrm{C})$$

Legend:
- Trial 1 : Fit Uncertainty
- Trial 1 : Linear Fit
- Trial 2 : Fit Uncertainty
- Trial 2 : Linear Fit
- Trial 1
- Trial 2

Axis labels: Maximum Δ T [°C] vs Applied Voltage [V]

Peltier Characterization

Trial 1: Two Peltier cells, only one on

Trial 2: One Peltier

Peltier Characterization

Trial 1: Two Peltier cells, only one on

Trial 2: One Peltier

Need to remove any forms of thermal flowback for lower temperatures

Fan Cooling
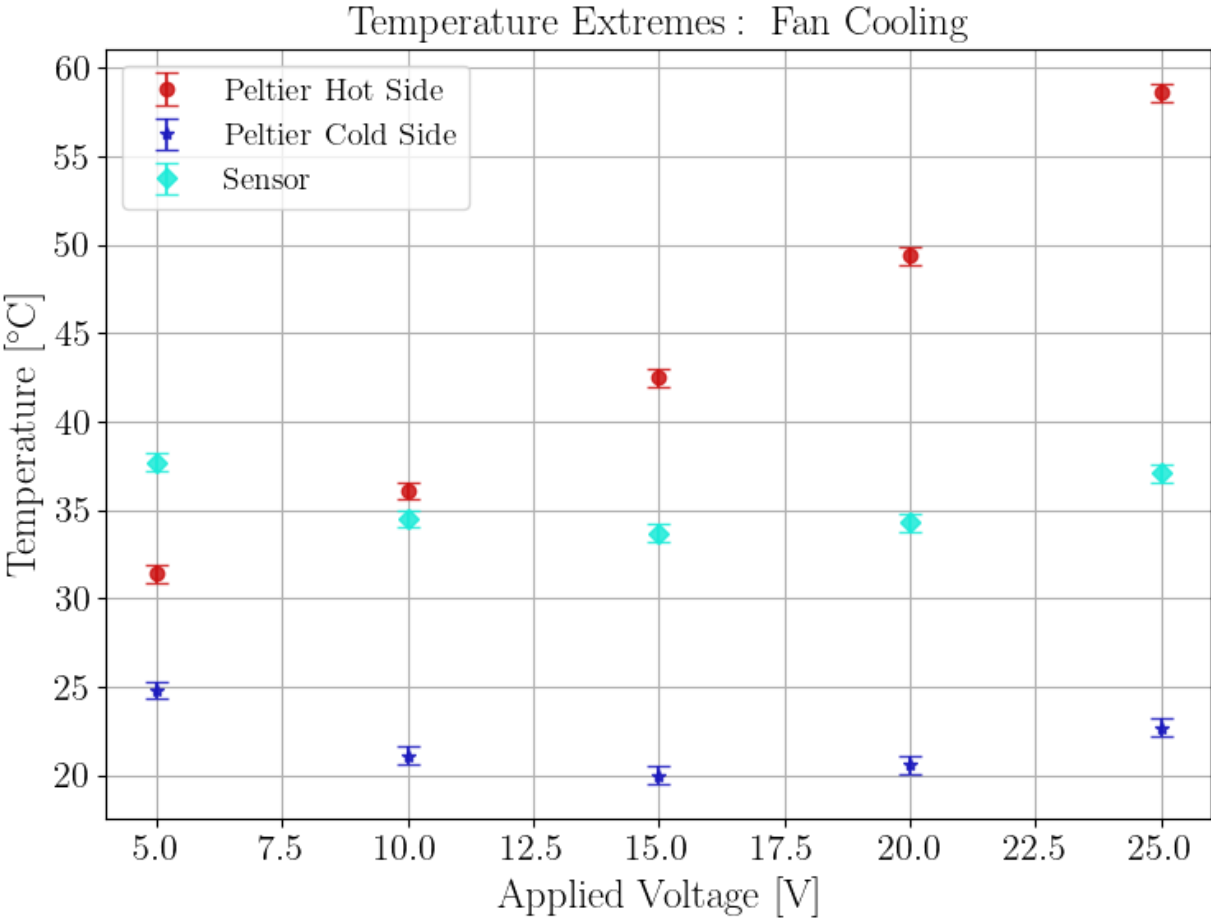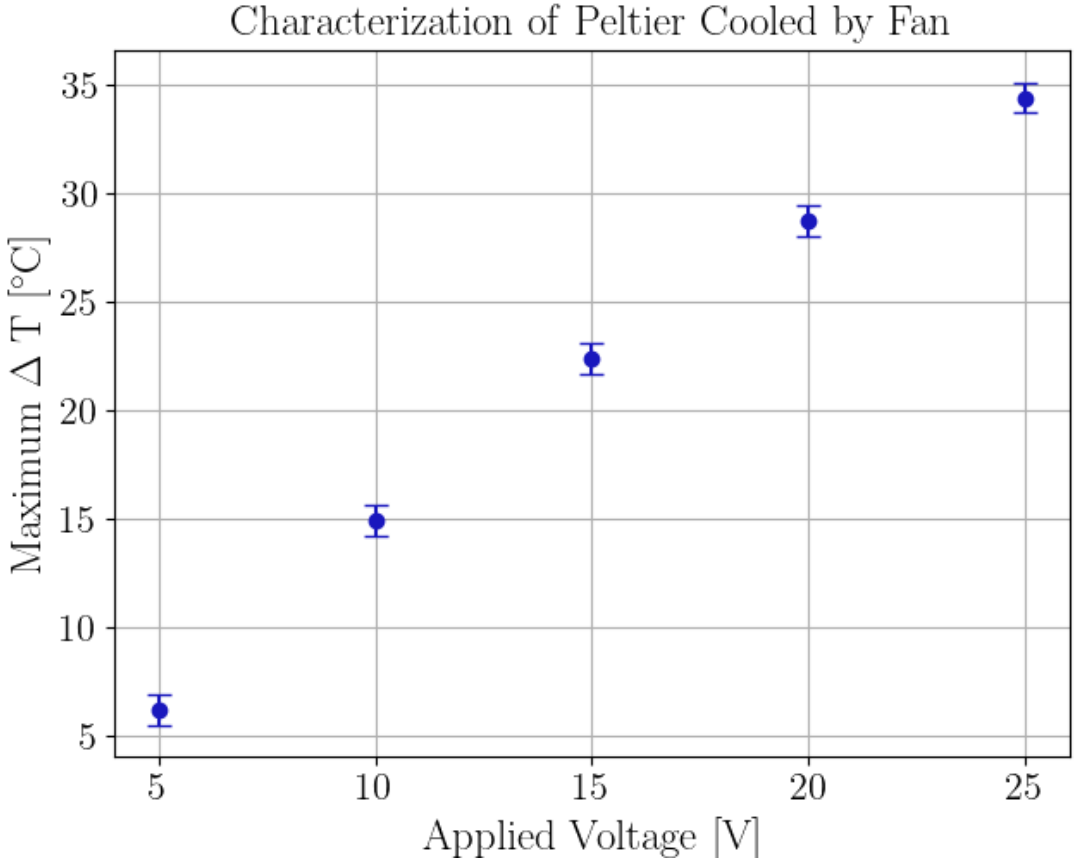
*Two Peltier cells, only one on

Fan Cooling

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Fan Cooling

Characterization of Peltier Cooled by Fan

Temperature Extremes : Fan Cooling
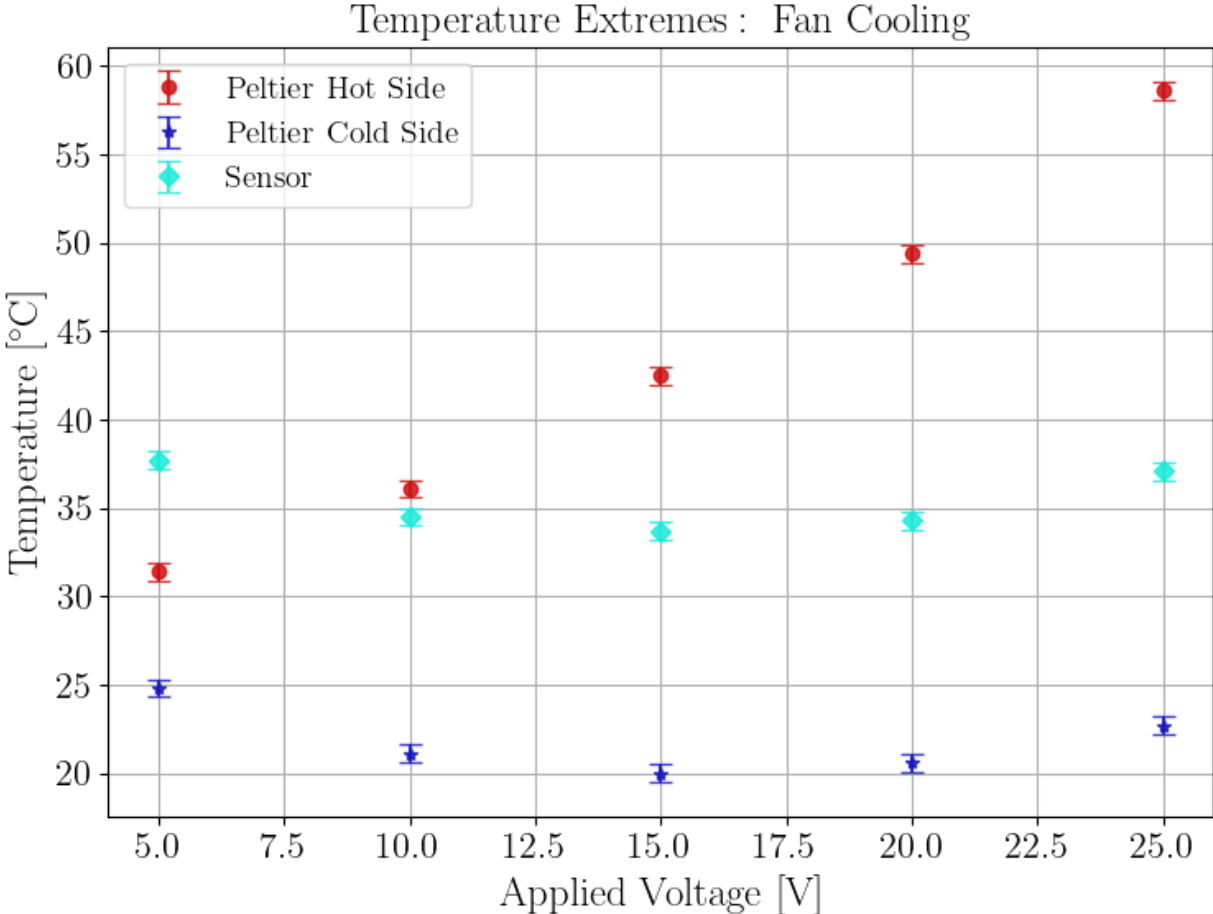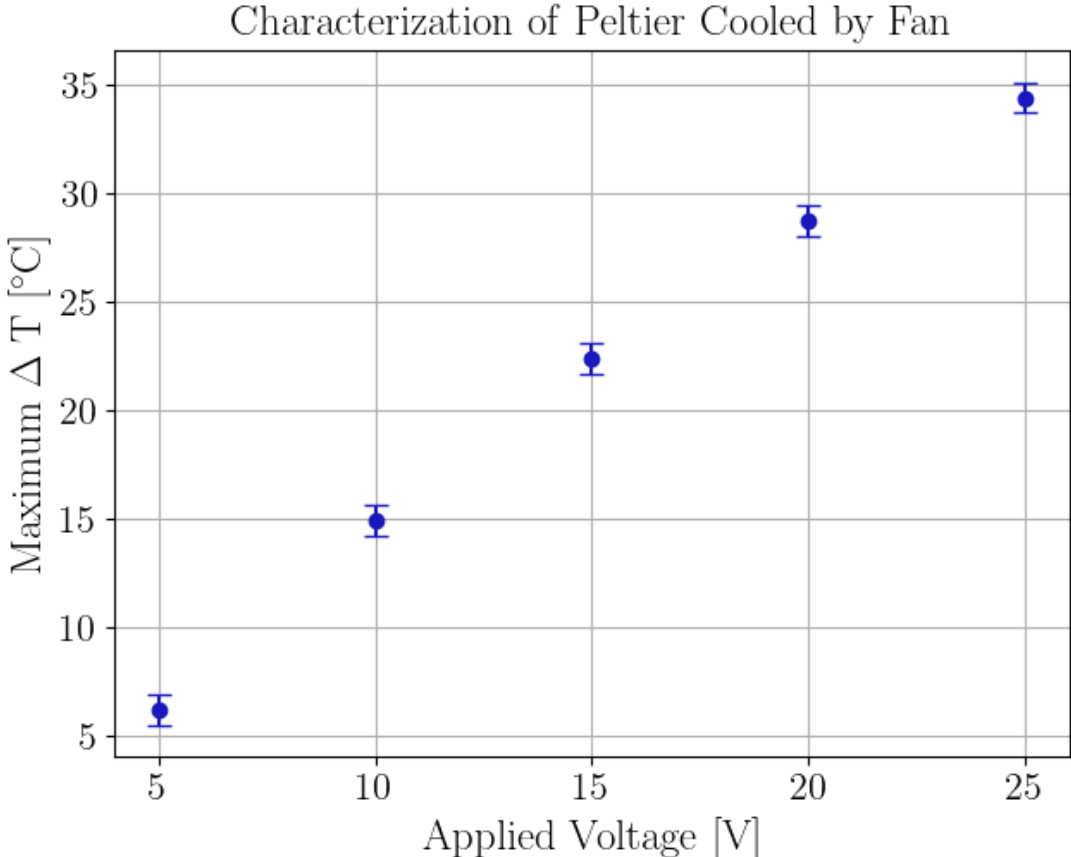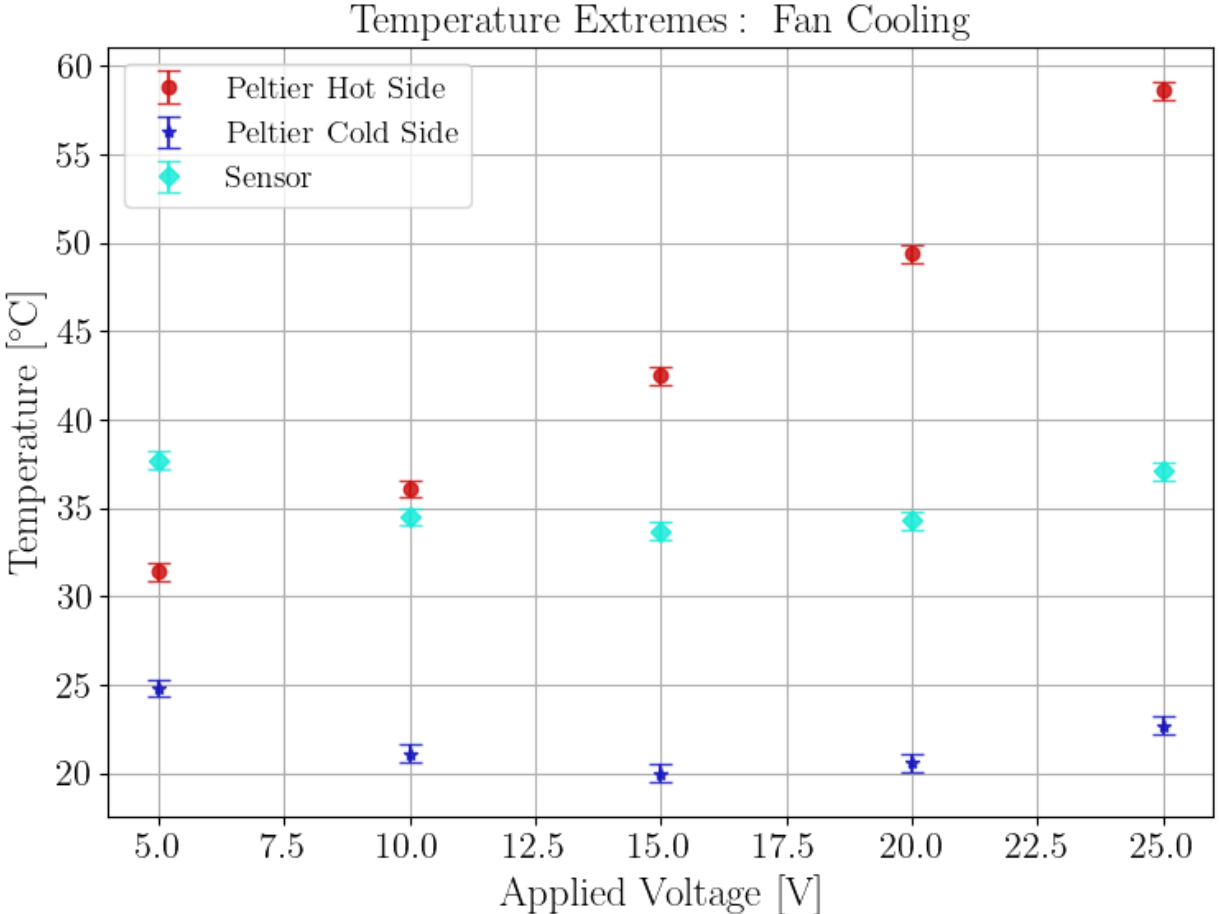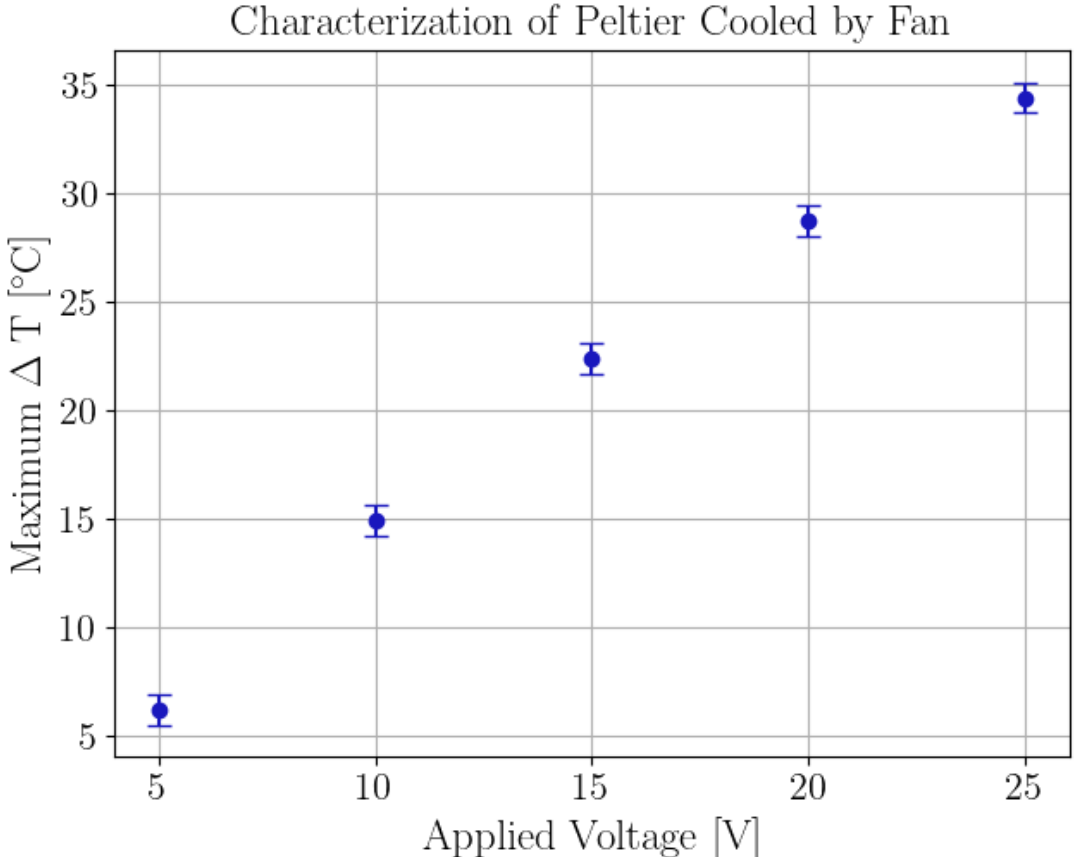
*Two Peltier cells, only one on

Want "active sensor" < 30 ˚C, not happening

Modified Set-Up with Water Cooling
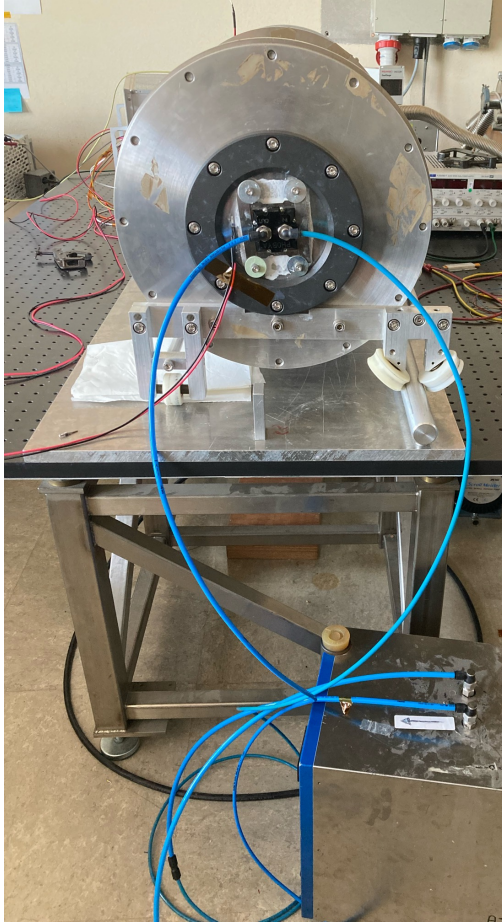
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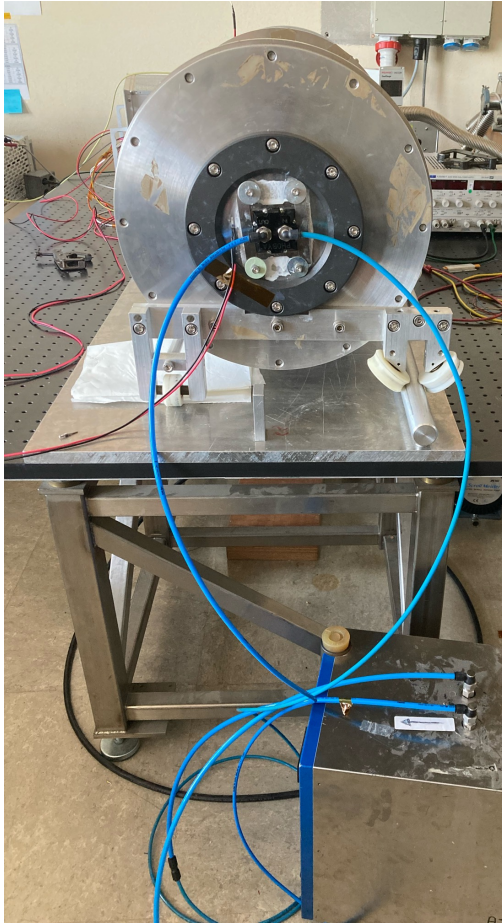
Surface area mismatch

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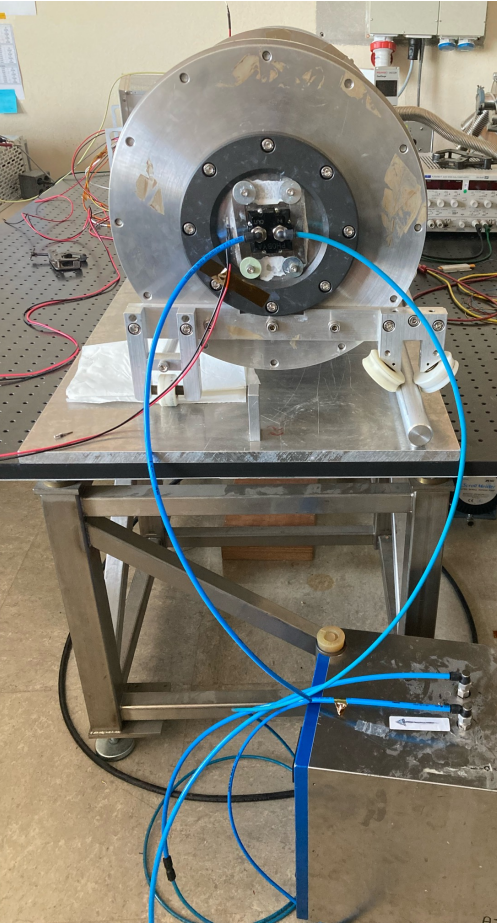
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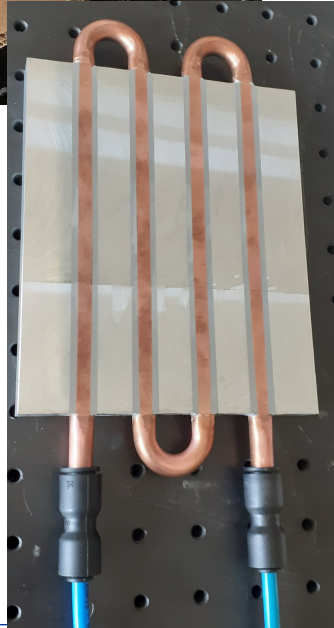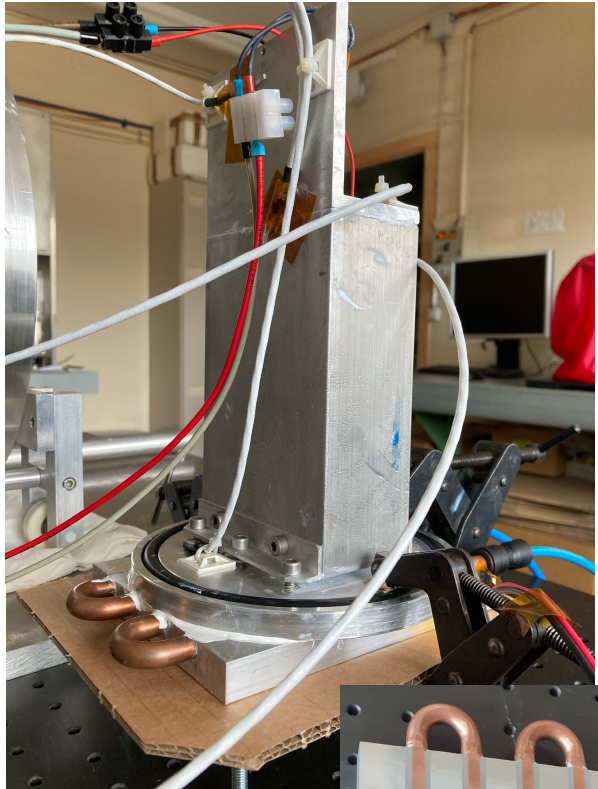

Temperature Evolution with Heater and Water Cooling
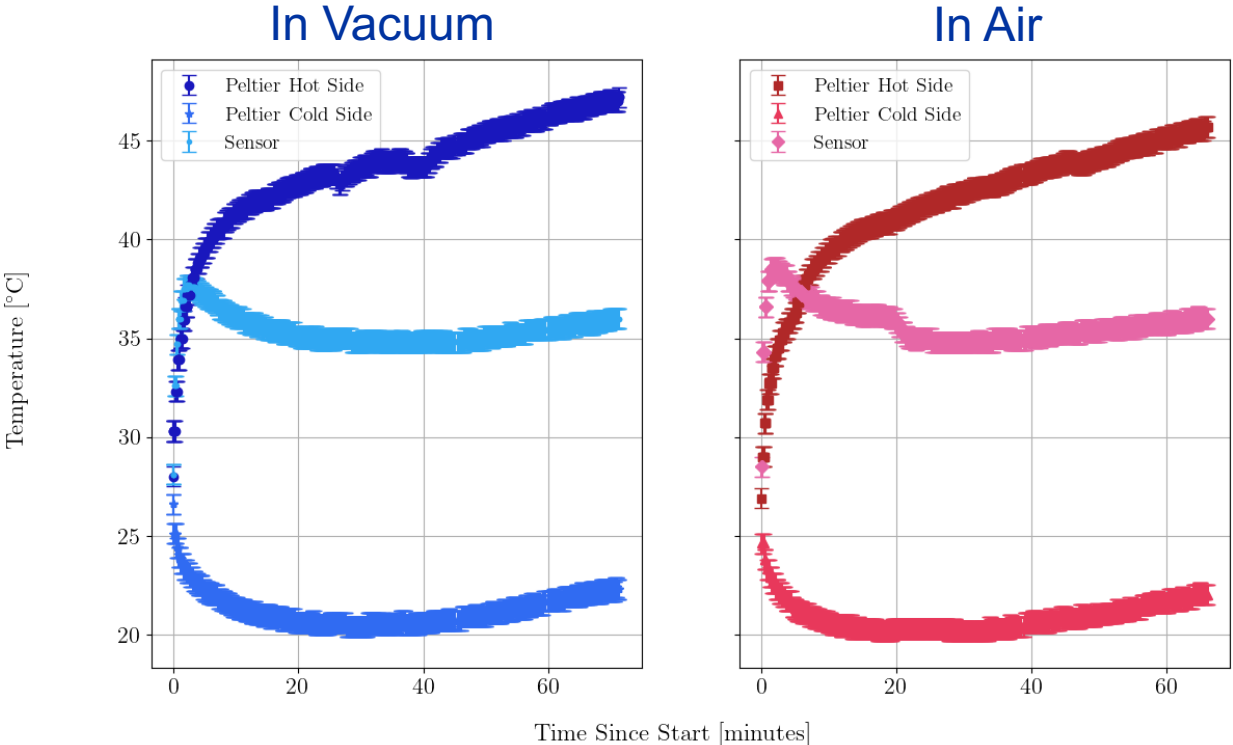
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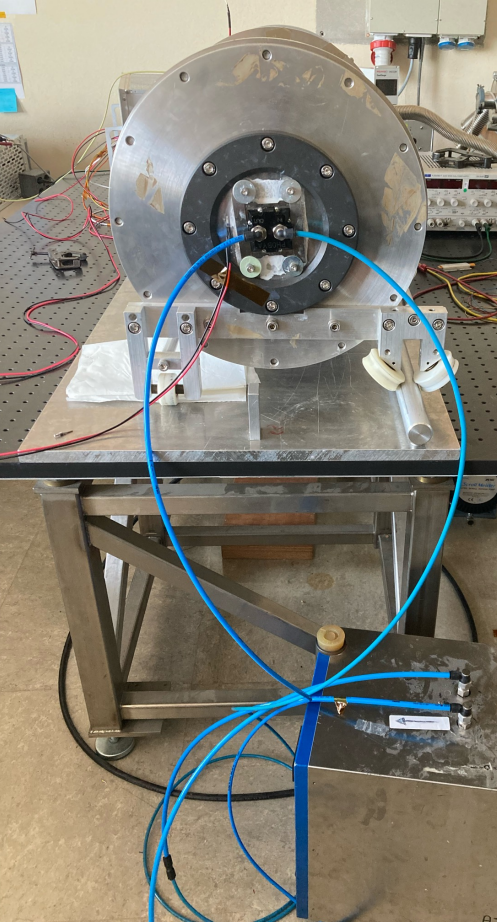
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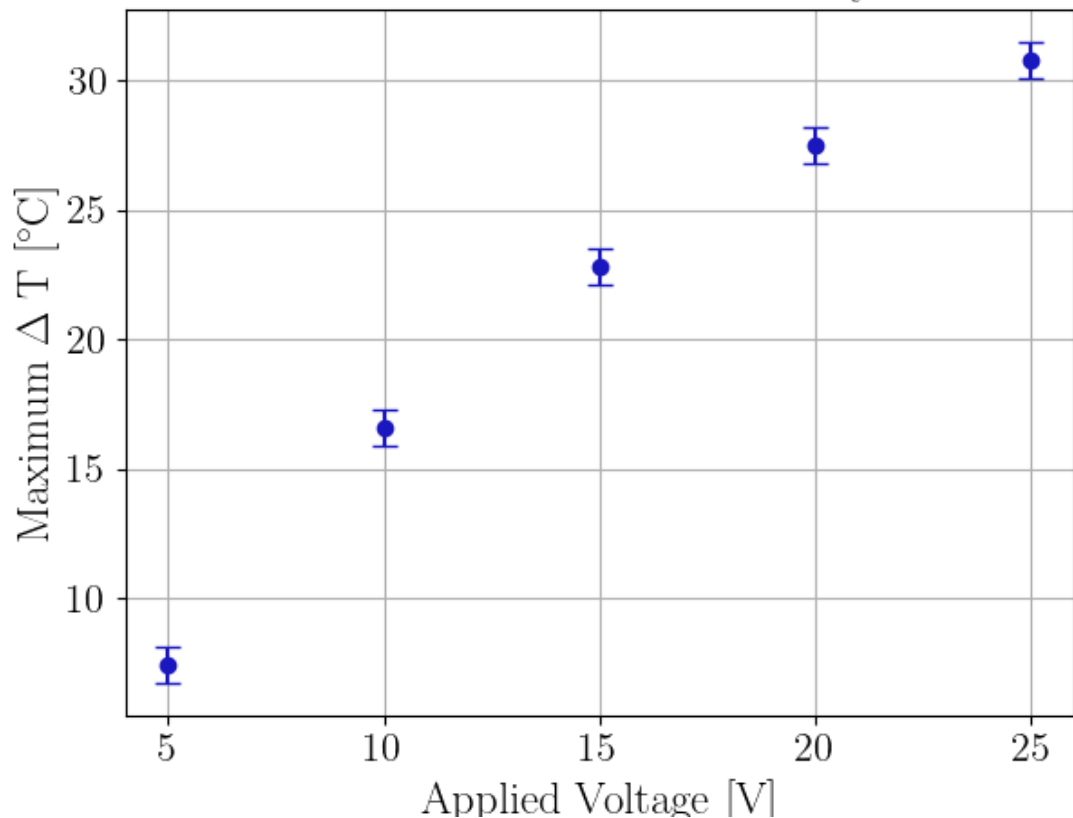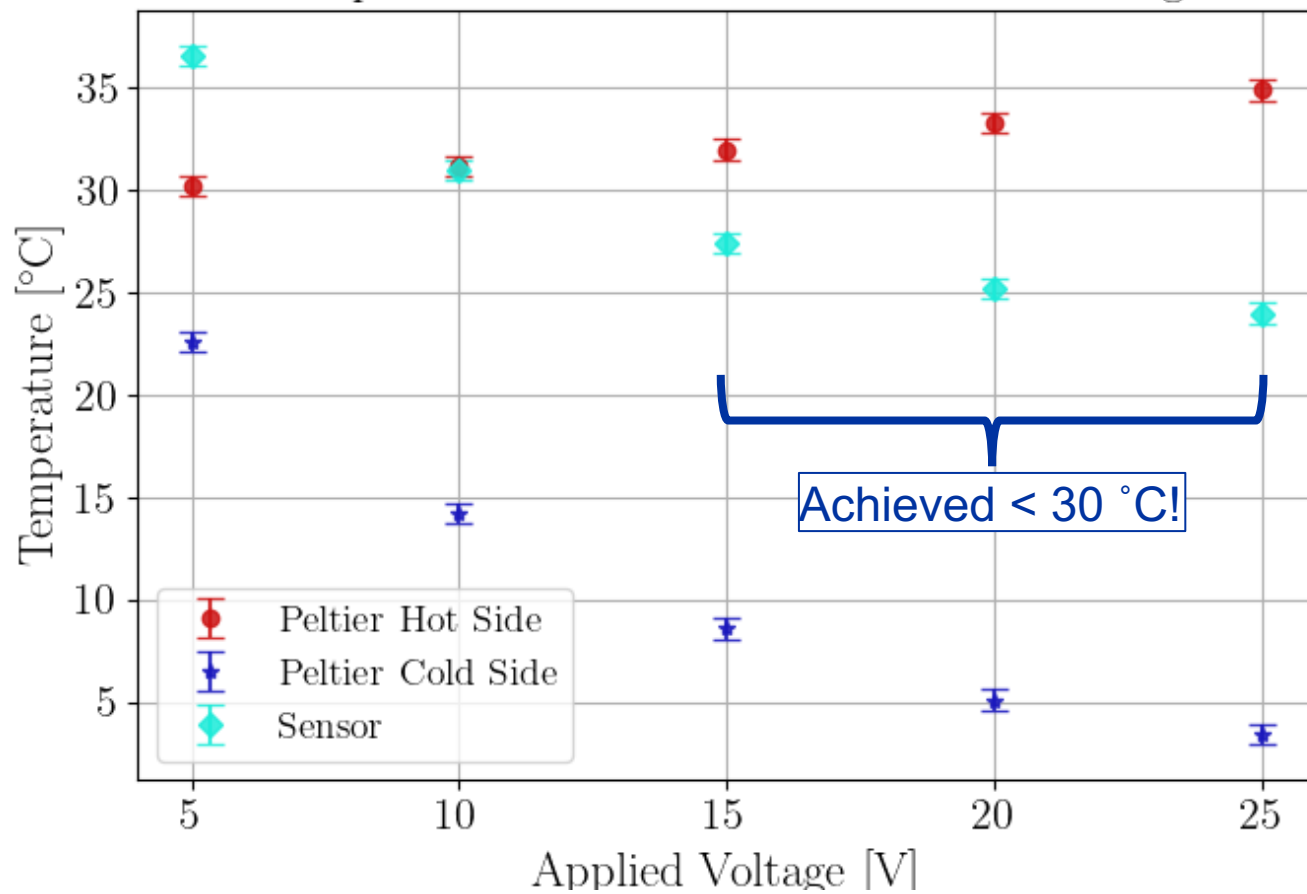Temperature Evolution with Heater and Water Cooling

In Vacuum

In Air

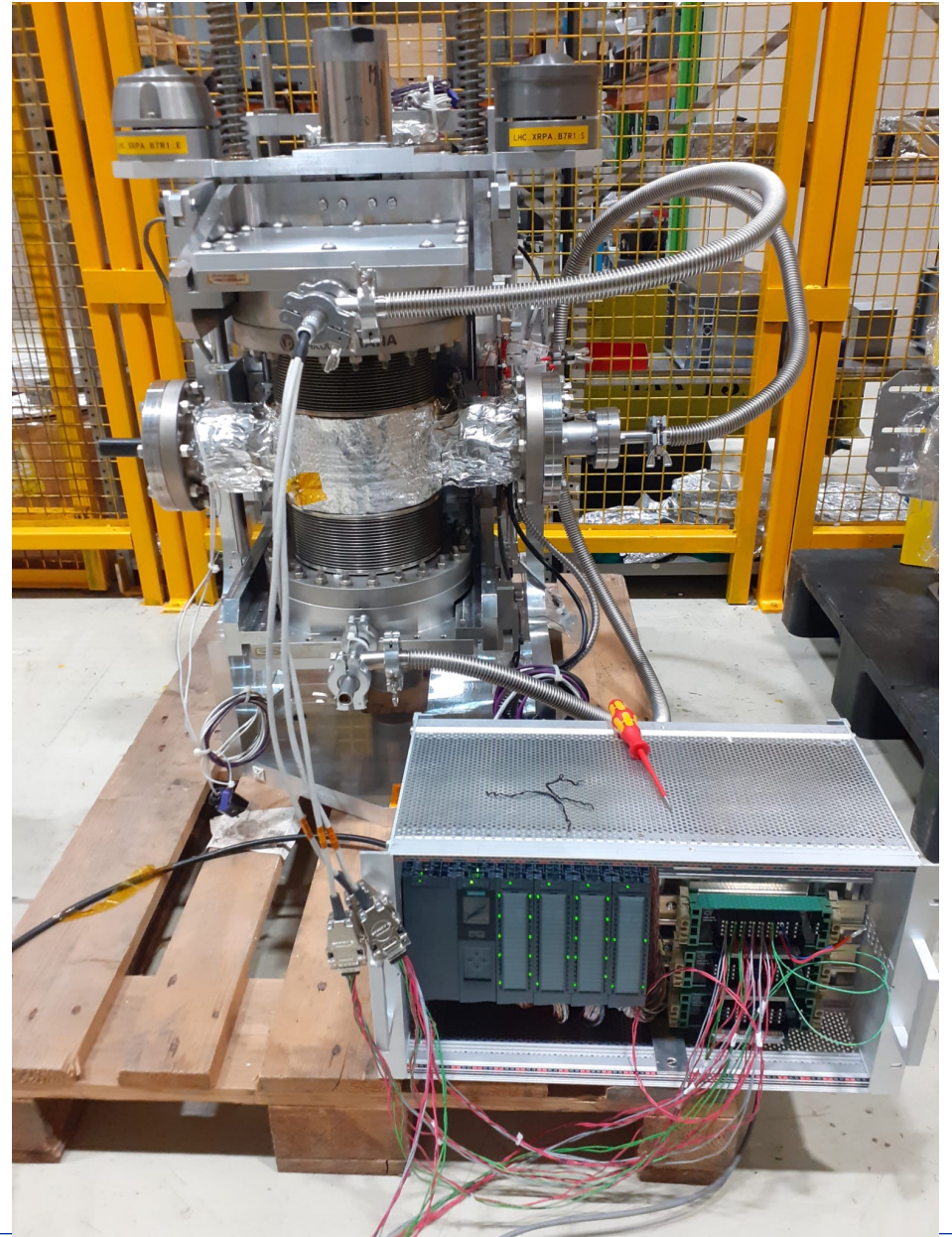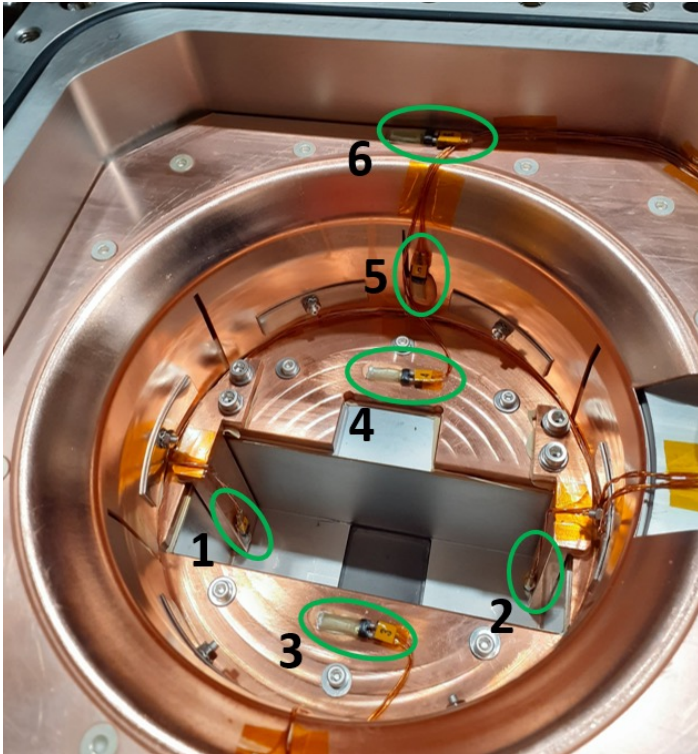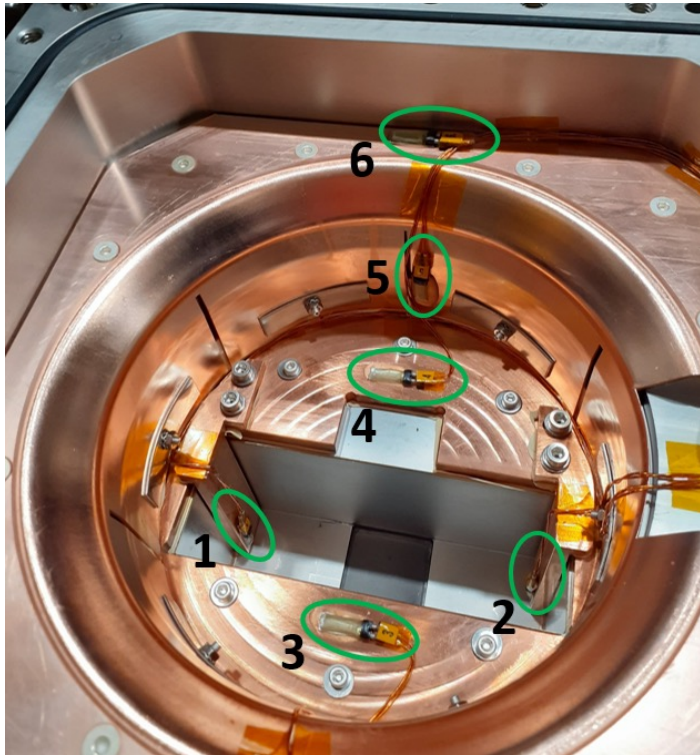# Water Cooling

Water Cooling

Interfacing with Roman Pots

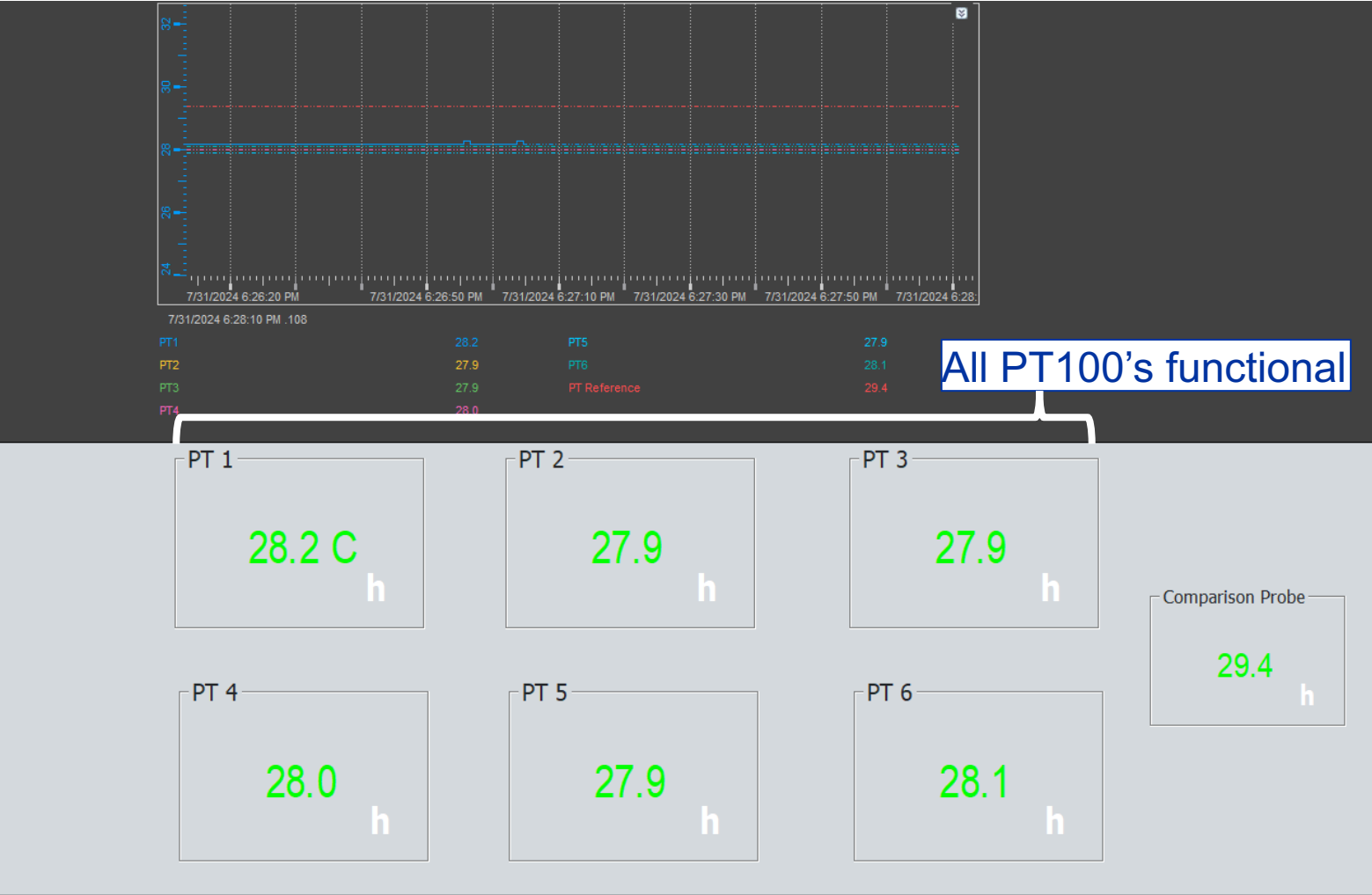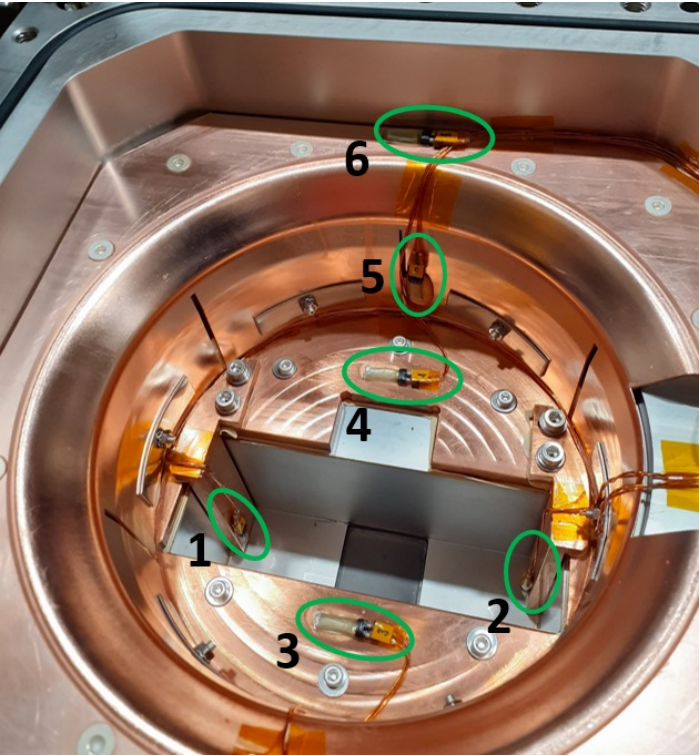- **Check if PLC could read out PT100's in Roman pot**

Interfacing with Roman Pots

- **Check if PLC could read out PT100's in Roman pot**
  - Designed WinCC panel

Interfacing with Roman Pots

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All PT100's functional

PT 1   28.2 C
PT 2   27.9
PT 3   27.9
PT 4   28.0
PT 5   27.9
PT 6   28.1
Comparison Probe   29.4

Acknowledgements

- **Nicola Neri and Massimiliano Ferro-Luzzi, for supervising me**

- **Raphael Dumps, for making everything work**

- **Federico Zangari and Sara Cesare, for helping with day-to-day activities**

- **TWOCRYST collaboration**

- **VELO (esp. Edgar Cid, Morag Williams, Federico De Benedetti)**

- **NSF Award #2243608, for funding this experience**

- **University of Michigan and CERN, for enabling this experience to happen**
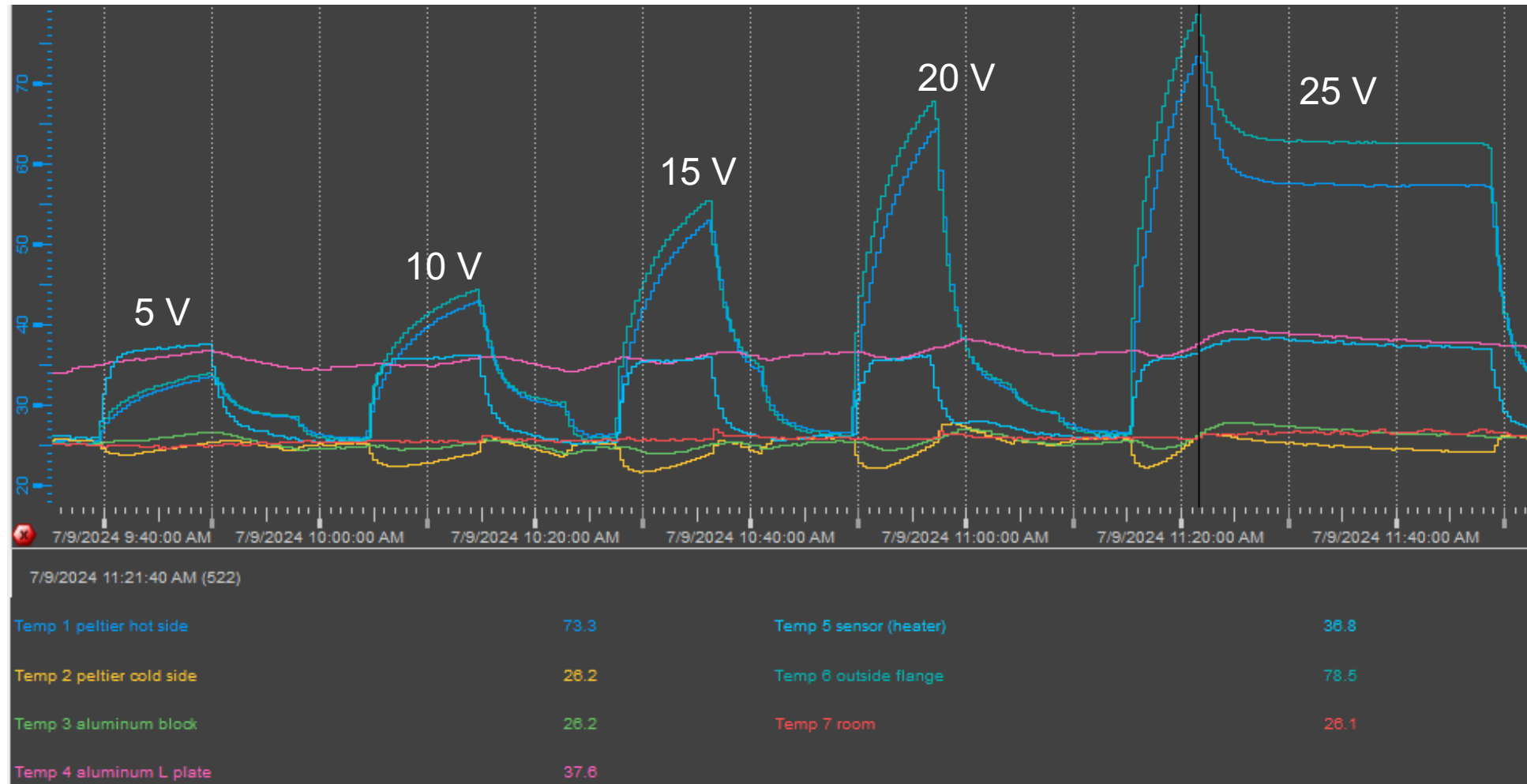
- **These two cats on CERN's campus**
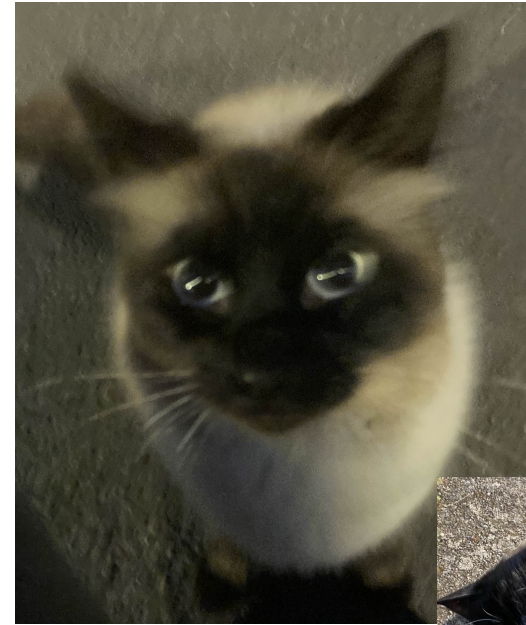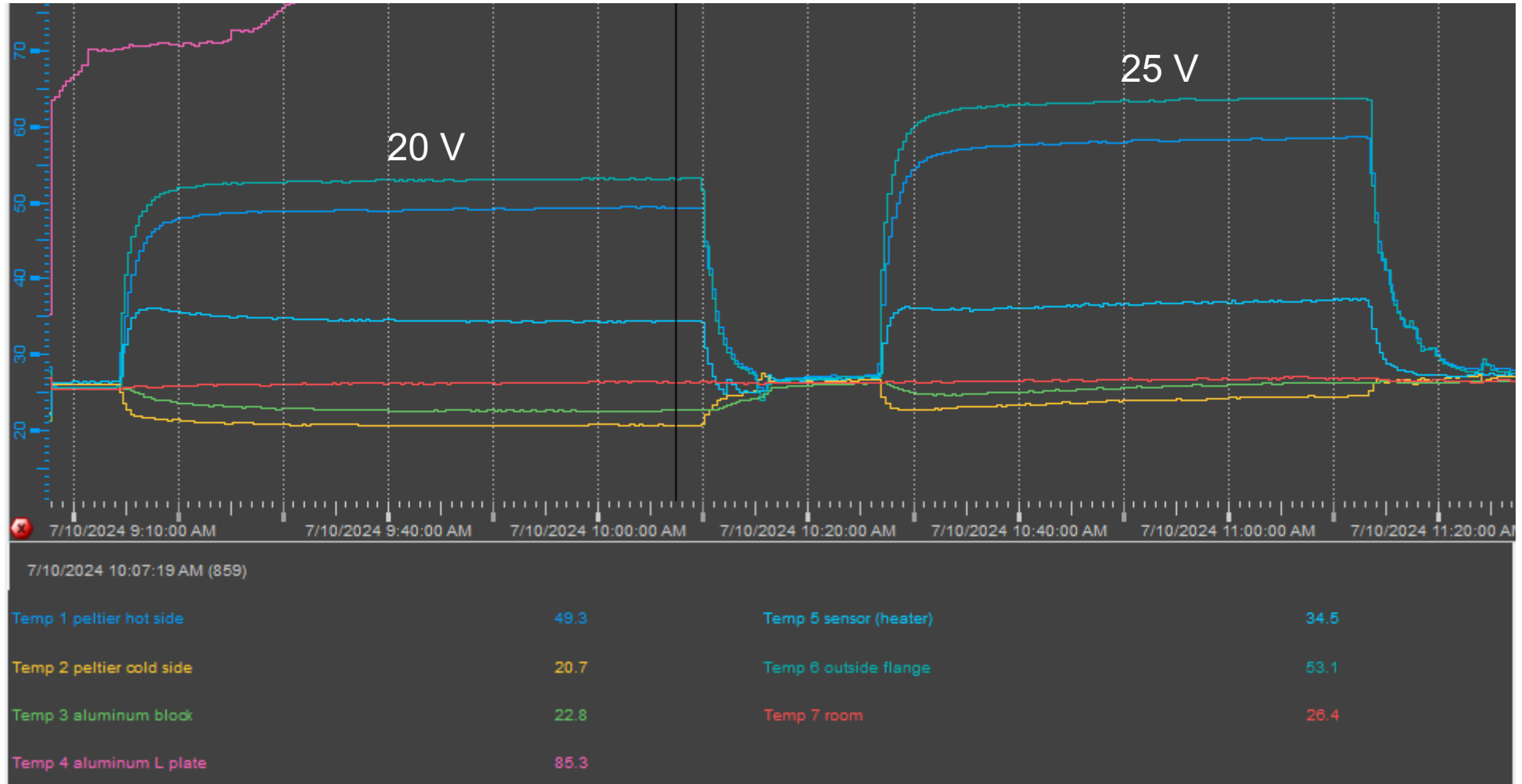
Supplemental Slides

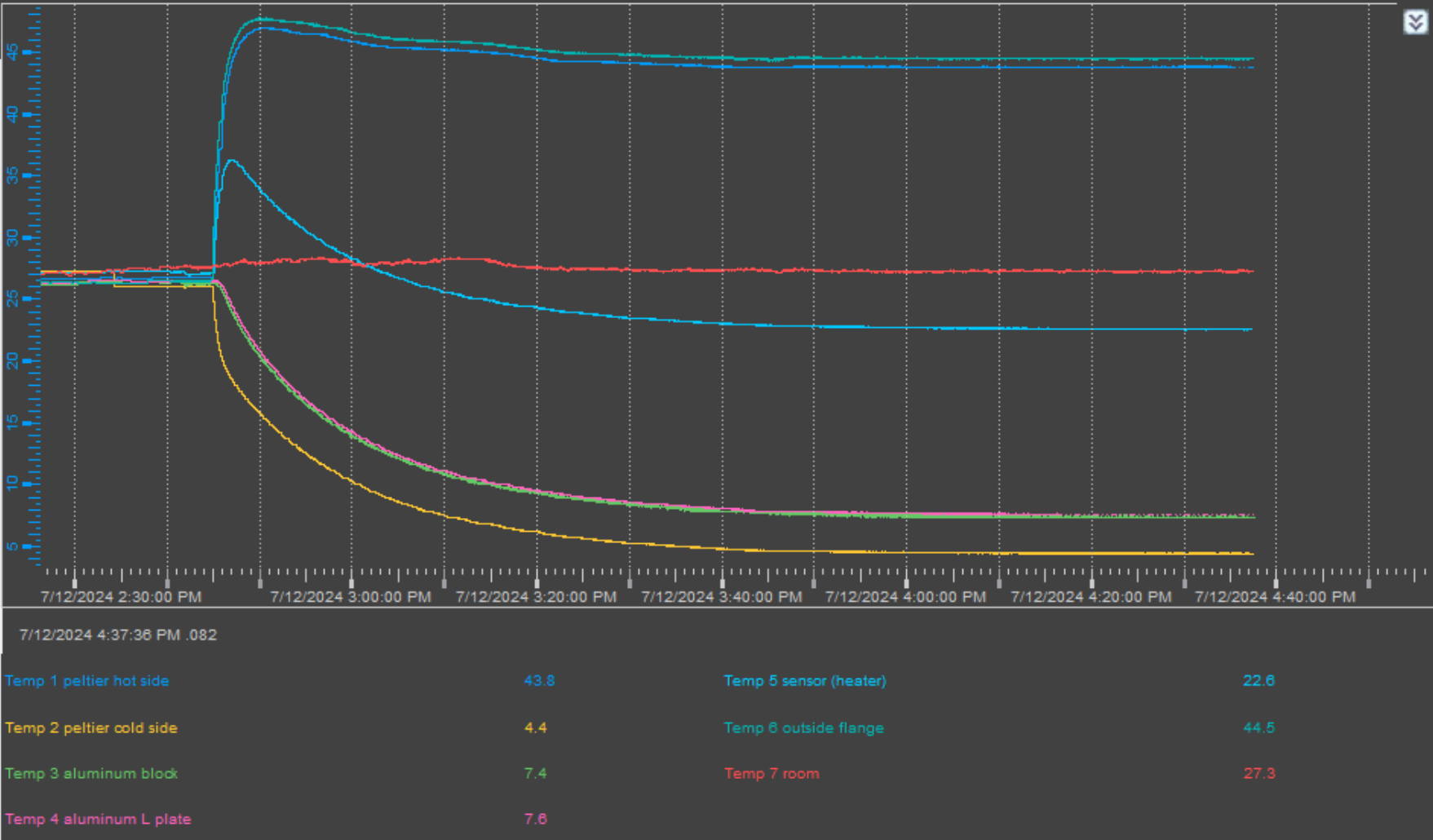# Full Voltage Scan of 2 Peltier (1 Powered) without Heating or Cooling
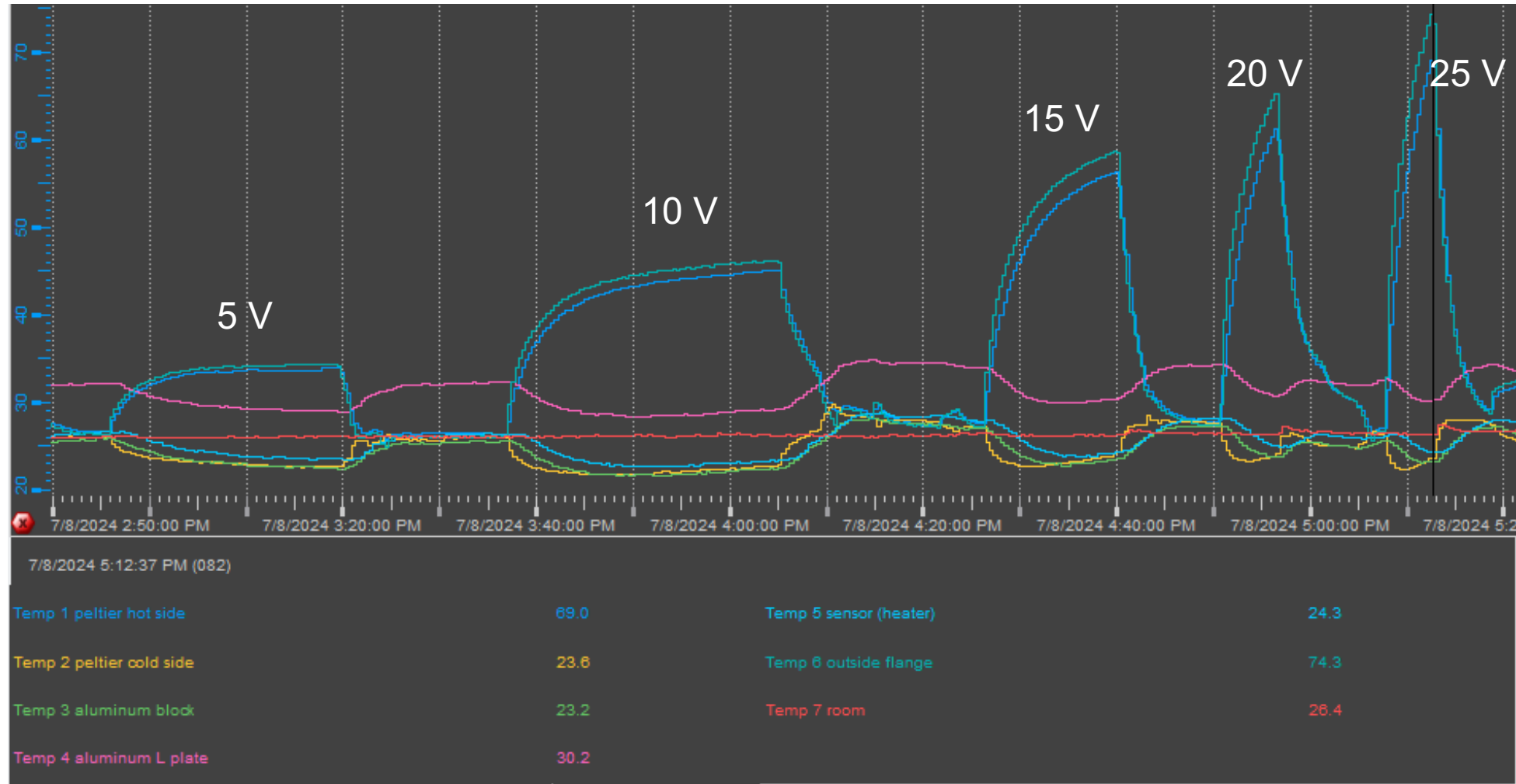
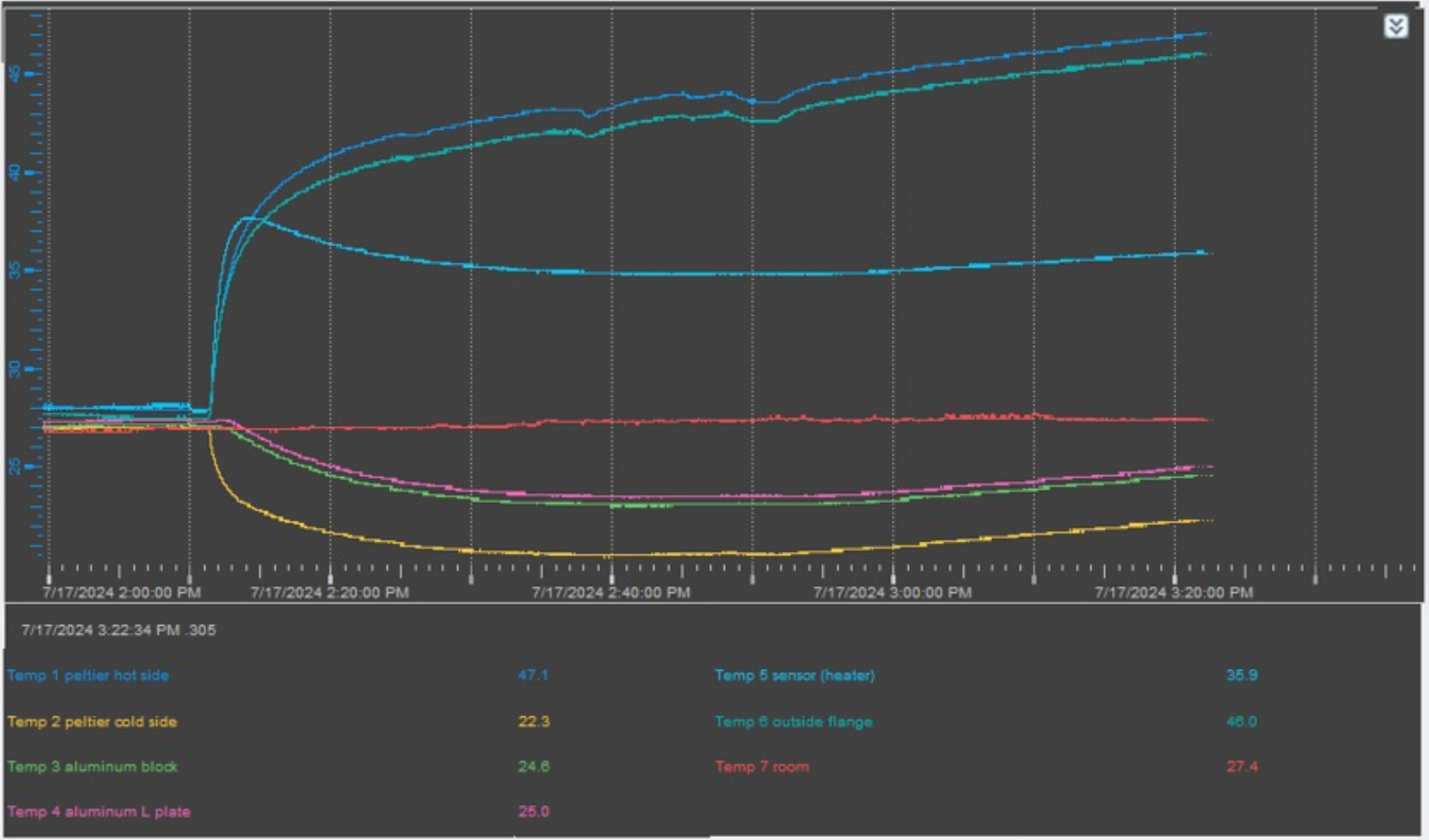# Full Voltage Scan of 2 Peltier (1 Powered) with Heating

# Voltage Scan of 2 Peltier (1 Powered) with Heating and Fan Cooling

Peltier Cells in Parallel (15 V) with Heating and 24 V Fan Cooling

7/12/2024 4:37:36 PM .082

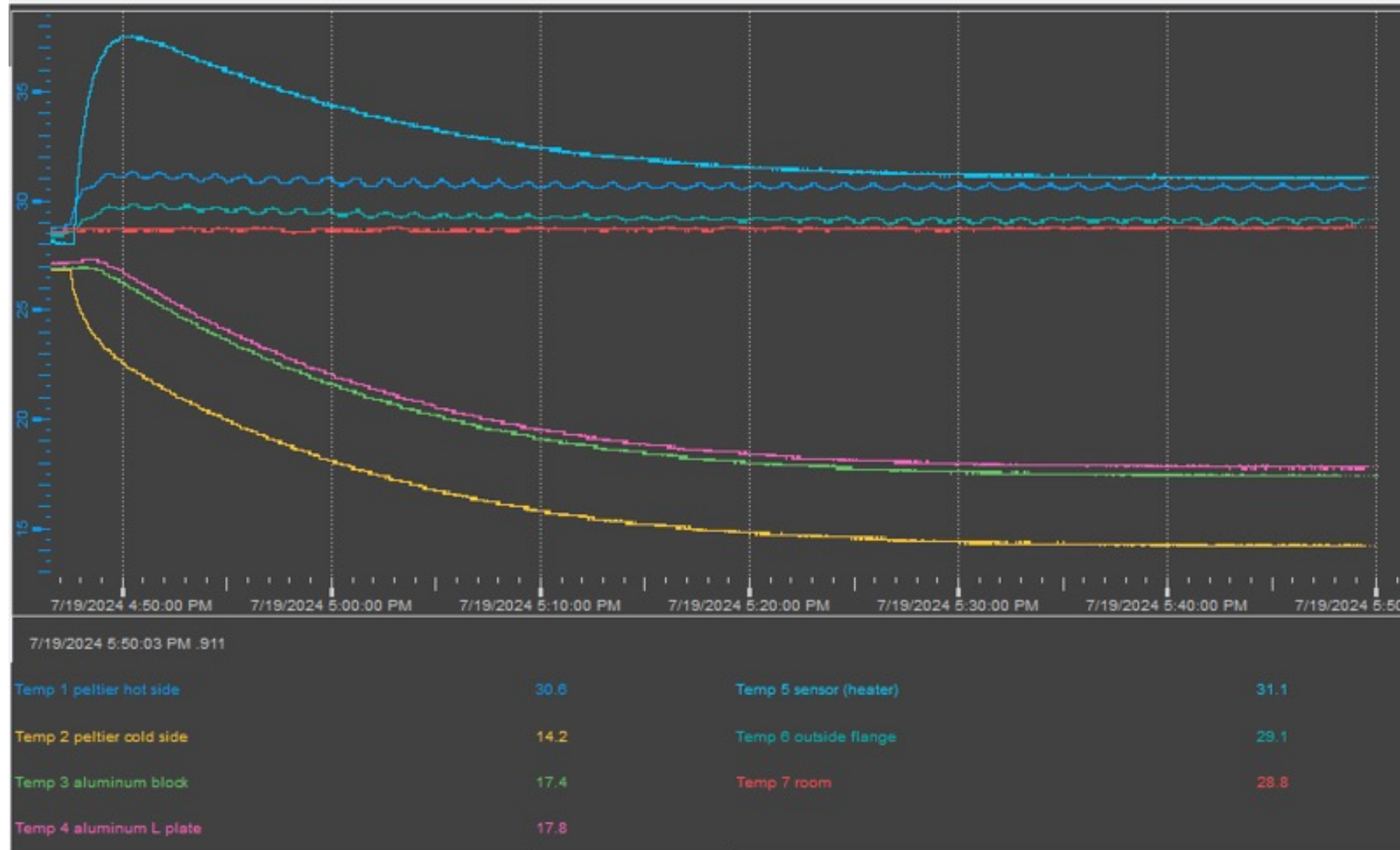|			
Temp 1 peltier hot side	43.8	Temp 5 sensor (heater)	22.6
Temp 2 peltier cold side	4.4	Temp 6 outside flange	44.5
Temp 3 aluminum block	7.4	Temp 7 room	27.3
Temp 4 aluminum L plate	7.6		

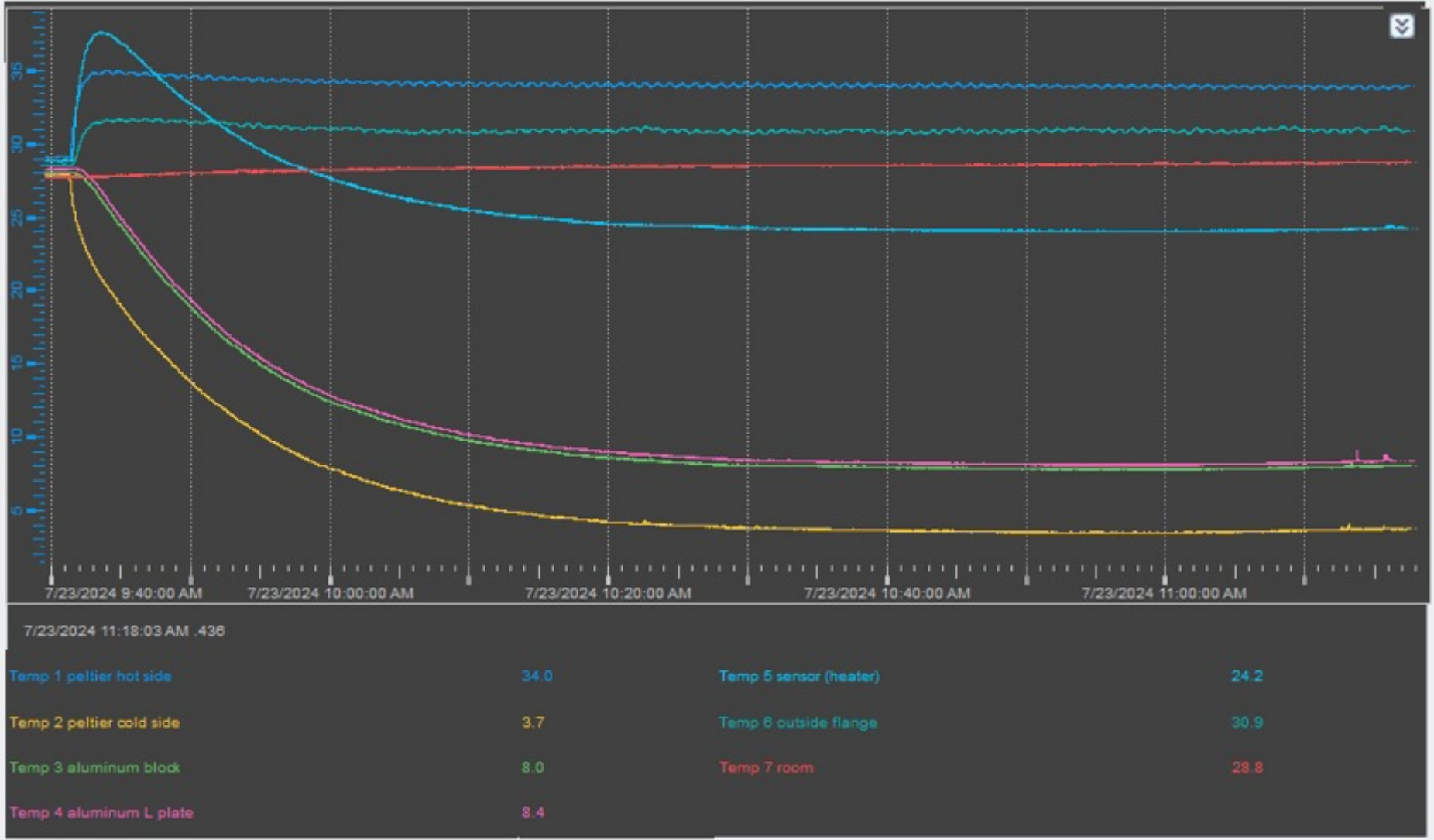# Single Peltier (10 V) with Heating and Water Cooling (Small)

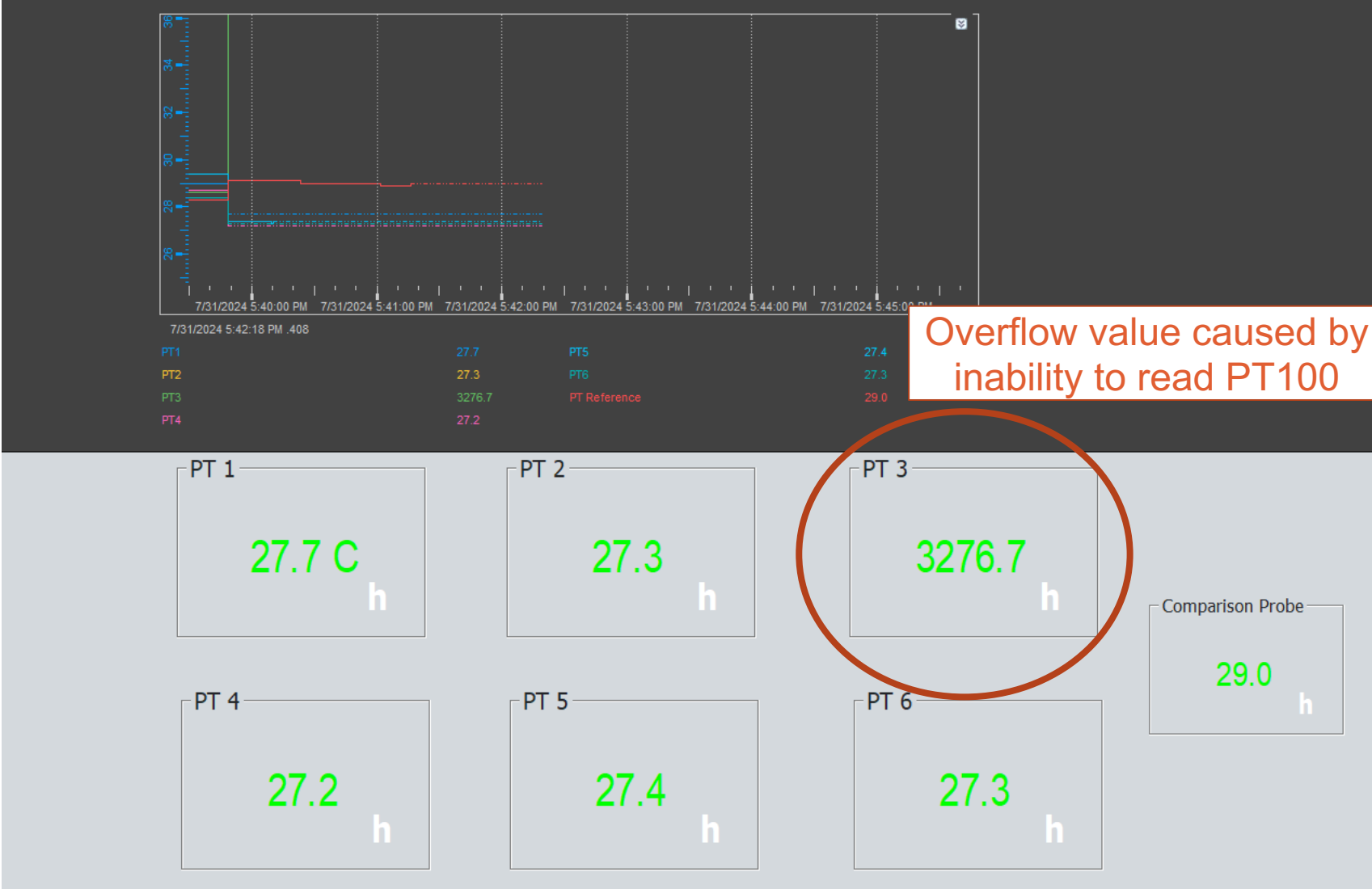# Single Peltier (5 V) with Heating and Water Cooling
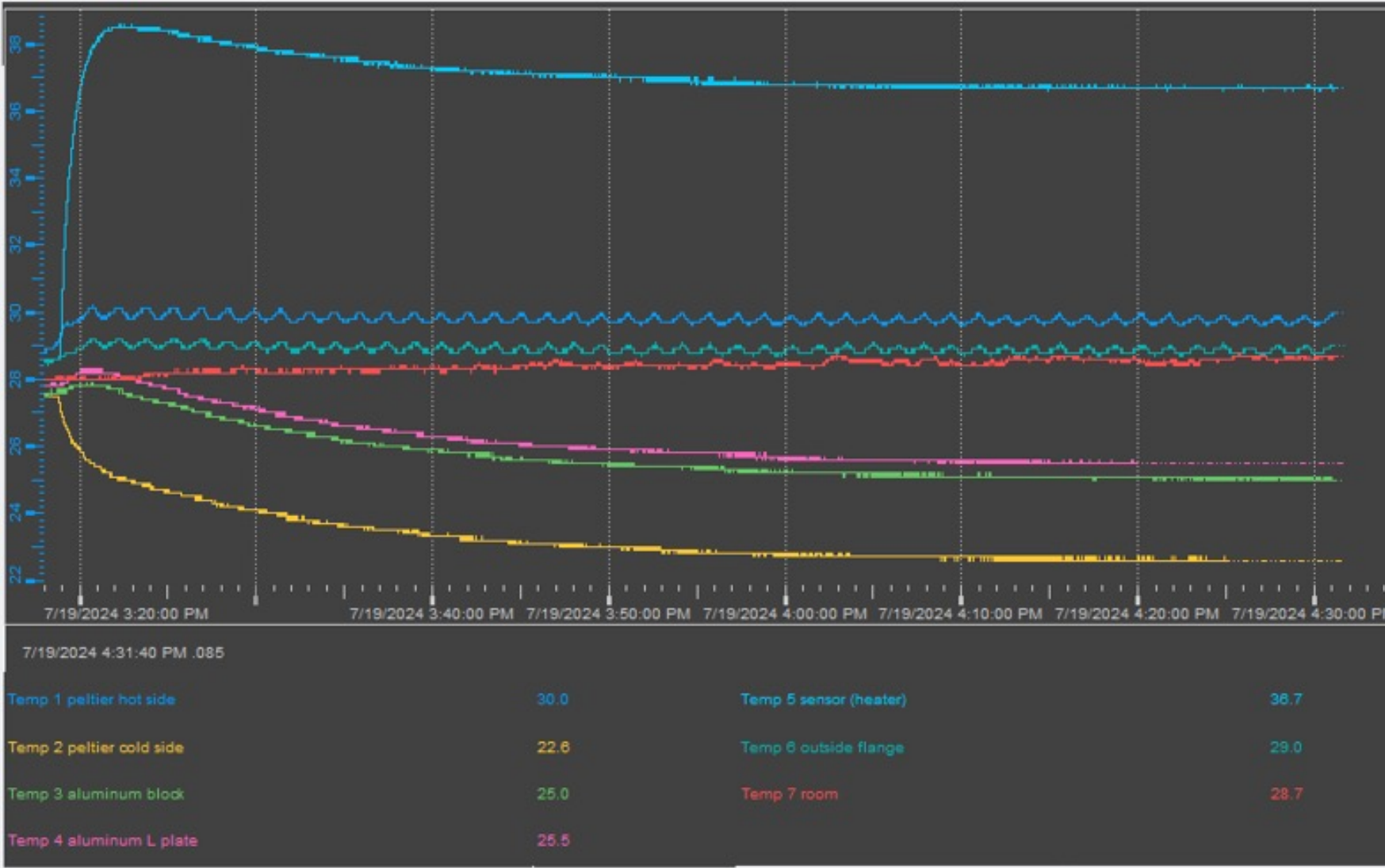
Single Peltier (10 V) with Heating and Water Cooling

Single Peltier (25 V) with Heating and Water Cooling

Example of Issue Interfacing with Roman Pot

home.cern