

# Expected Performance of the ALPSIIc Optical System

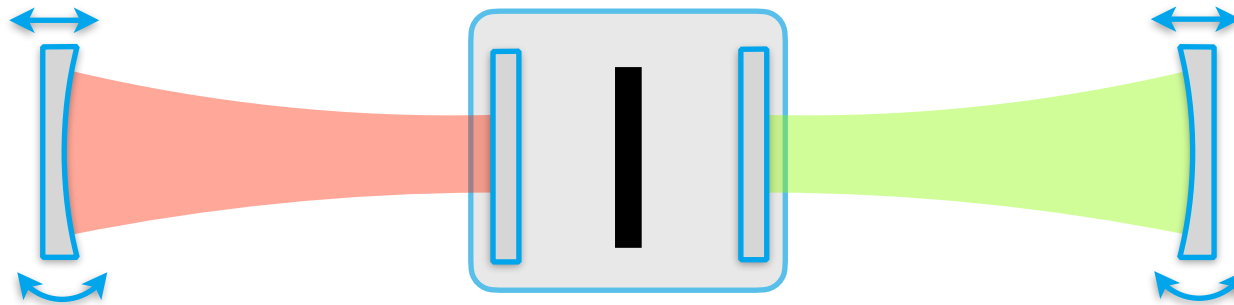
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ALPS Collaboration Meeting, June 8-9, 2020

# ALPS IIa results

## Fast length actuator

- PC Length must track RC length changes
- Current actuator appears capable of meeting 0.2 radian requirements on short time scales



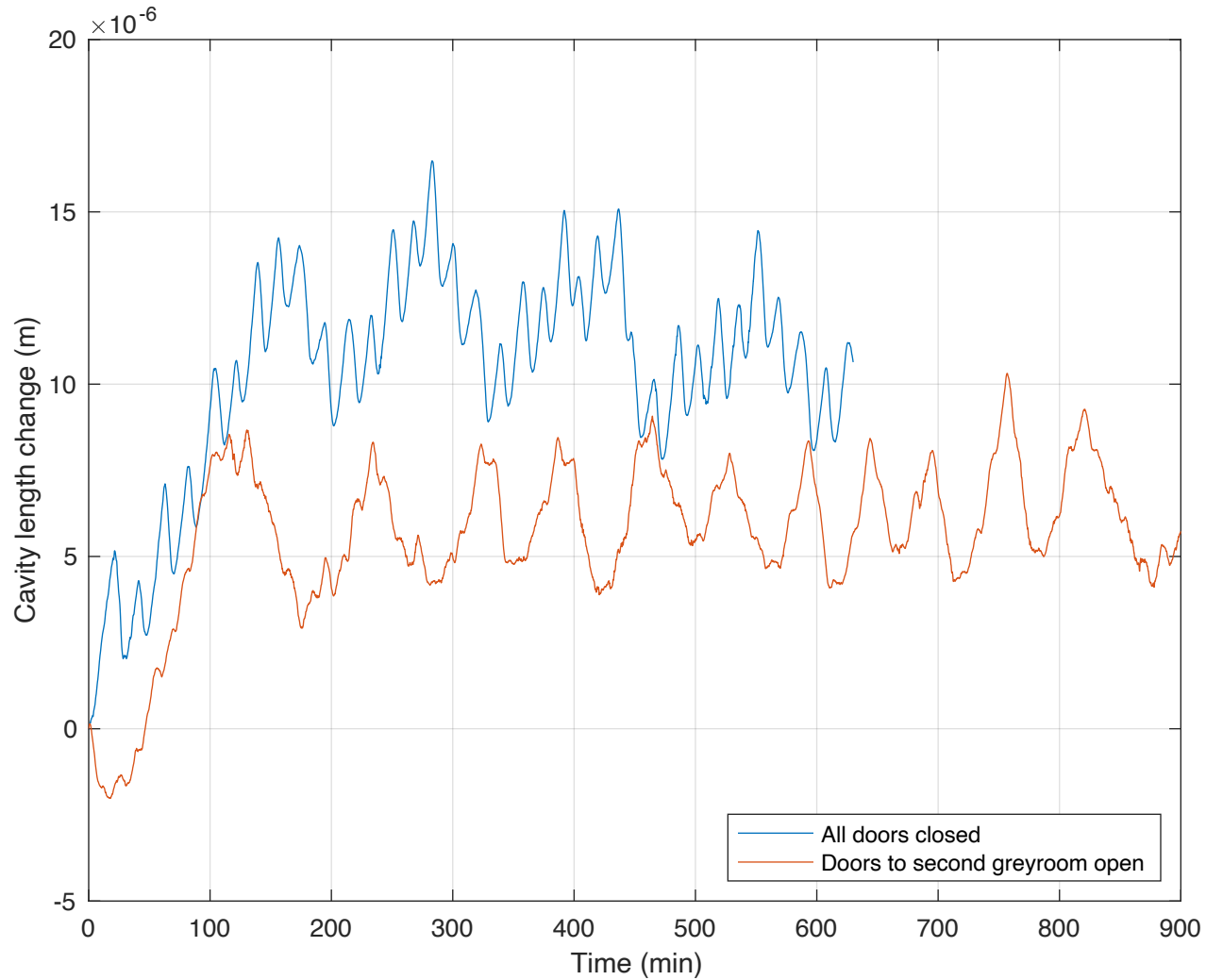
- What about the dynamic range and pointing?

# ALPS IIa results

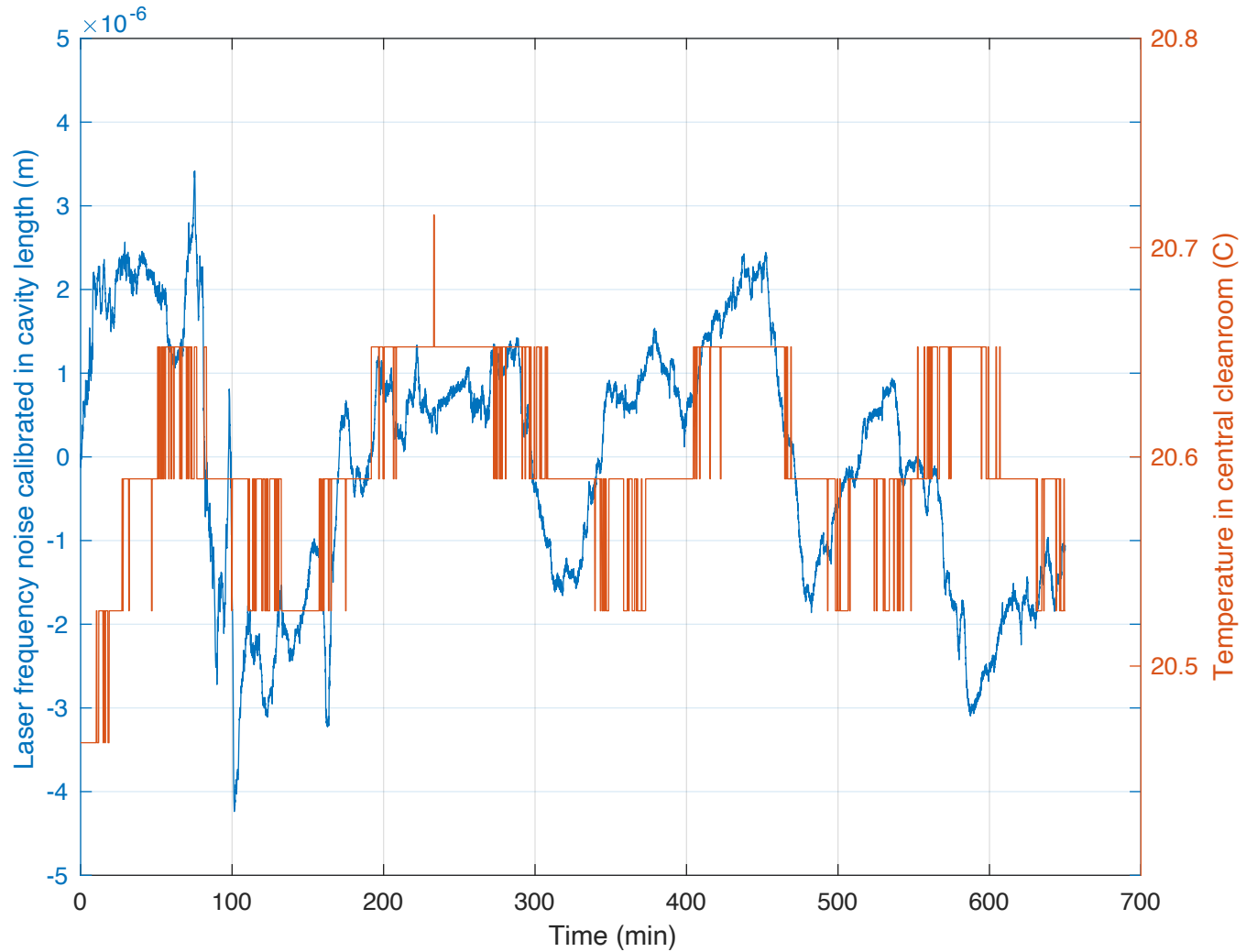
## Measured long term cavity drift (thanks to Todd!)

- Temperature dependence apparent
  - Component with period of ~20 min
    - Temperature changes in 3rd CR (Cavity length changes)
  - Component with period of ~2 hours
    - Temperature changes in 2nd CR
      - Could be RL temperature or cavity length changes
      - Measured PLL long term drift as well
        - Not totally conclusive

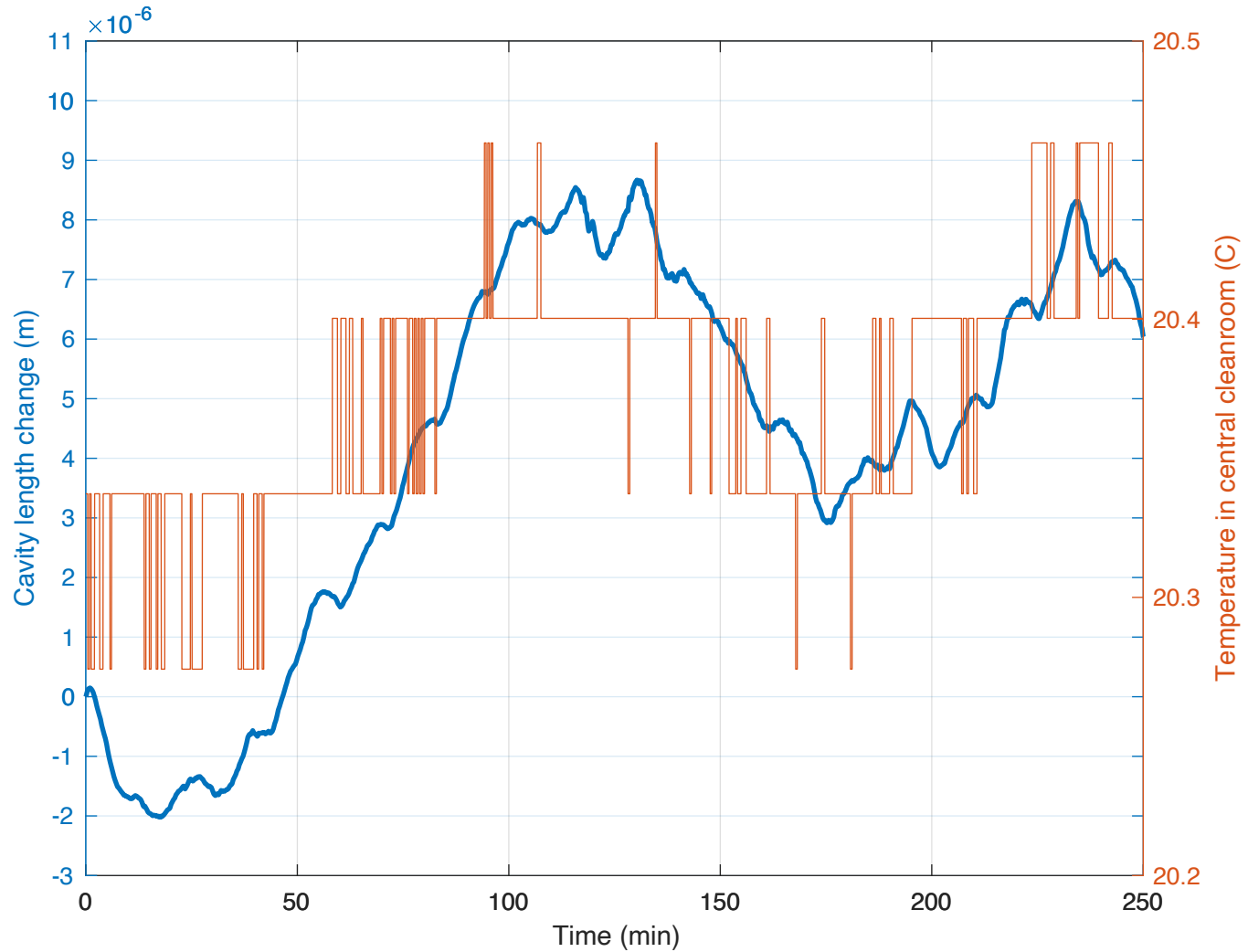
# ALPS IIa Longterm Cavity Results



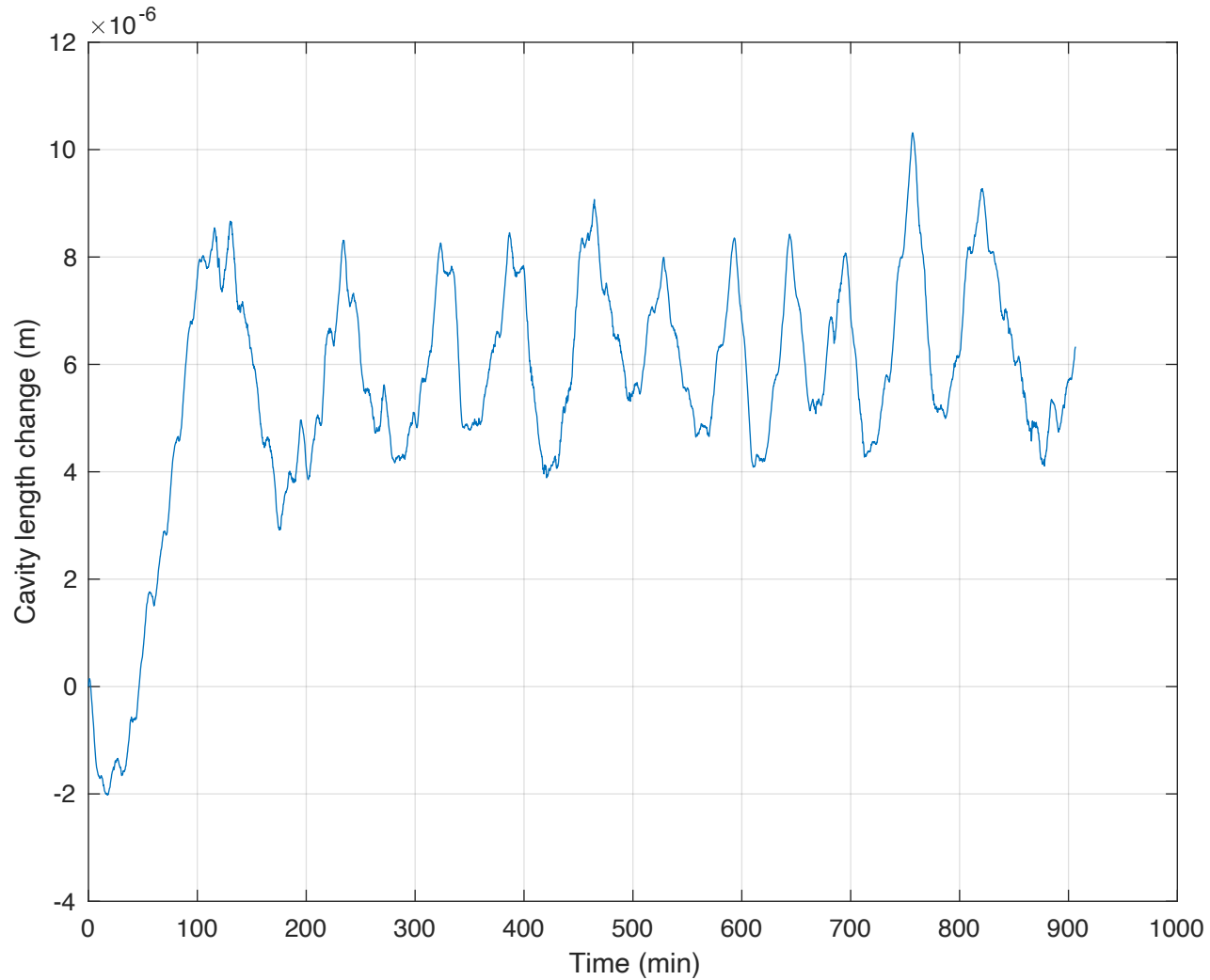
# ALPS IIa Longterm PLL results



# ALPS IIa Longterm Cavity Results



# ALPS IIa Longterm Cavity Results



# Length lock PLL and Dual Resonance

## Piezo Range in ALPSIIa

- Results from ALPIIa: 0.2 C temp noise, 4um Cavity length change
  - Current Range is 1-2um (single pass 0-400V)
    - Possible remote locking times of 5 to 10 minutes
  - With >20um range indefinite lock should be possible
- ALPS IIa results probably represent a best case scenario for ALPS IIc

## ALPSIIc

- Microseismic noise?
- Other effects on the longer baseline?



# Conclusions on Length Actuator

## Path forward for length actuator

- Length changes due to thermal processes in mounts and tables in cleanrooms on the order of 4 $\mu$ m, possibly less
- Length changes due to 120m baseline are unclear
- Possible to construct length actuator with longer range ( $\sim$ 100 $\mu$ m)

**Meeting dual resonance with current actuator looks possible for 5-10 minute periods as long as the environmental noise in ALPSIIc due to the long baseline is not substantially worse than ALPSIIa.**

**Design of a longer range actuator that may provide sufficient actuation for long term locks has also begun.**

**Lock acquisition of the PC PLL is a major issue that we are currently working on.**

# Maintaining Spatial Overlap

## Angular Pointing Coupling

- Horizontal:  $\sim 50$  nrad/V (20 $\mu$ rad/ $\mu$ m); Vertical:  $\sim 25$  nrad/V (10 $\mu$ rad/ $\mu$ m)
- $\pm 10$   $\mu$ rad (horizontal),  $\pm 5$   $\mu$ rad (vertical) w/ current actuator
- Long term pointing in ALPSIIa would allow for  $\sim 5$  minutes
  - Related to temperature stability?

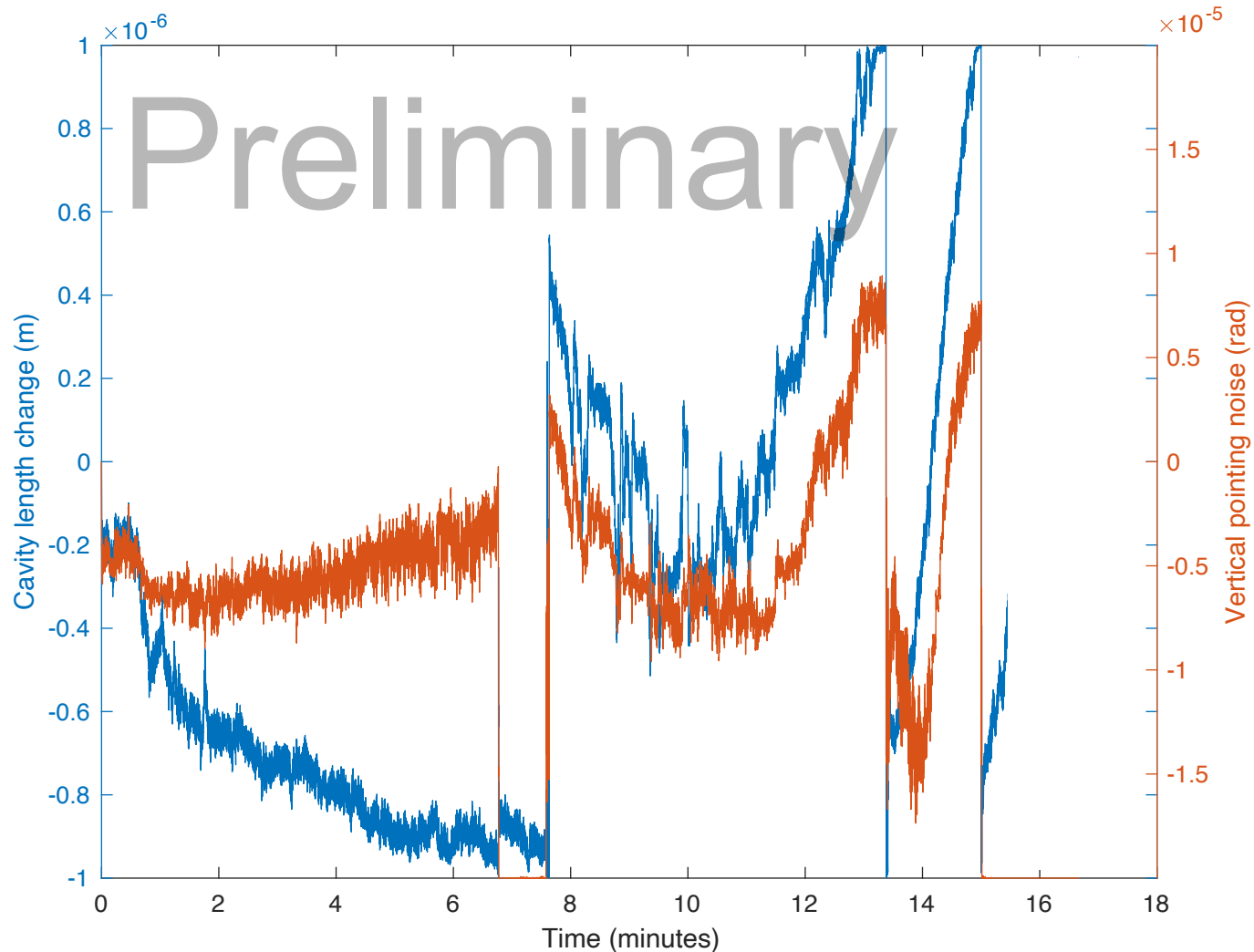
## Tunnel rough measurements

- $< 2$   $\mu$ rad pointing noise over 10-20min measurements

## Actuator Status

- No active actuator in current design
- Smaract actuators look to be too noisy for PLL

# Maintaining Spatial Overlap



# Conclusion

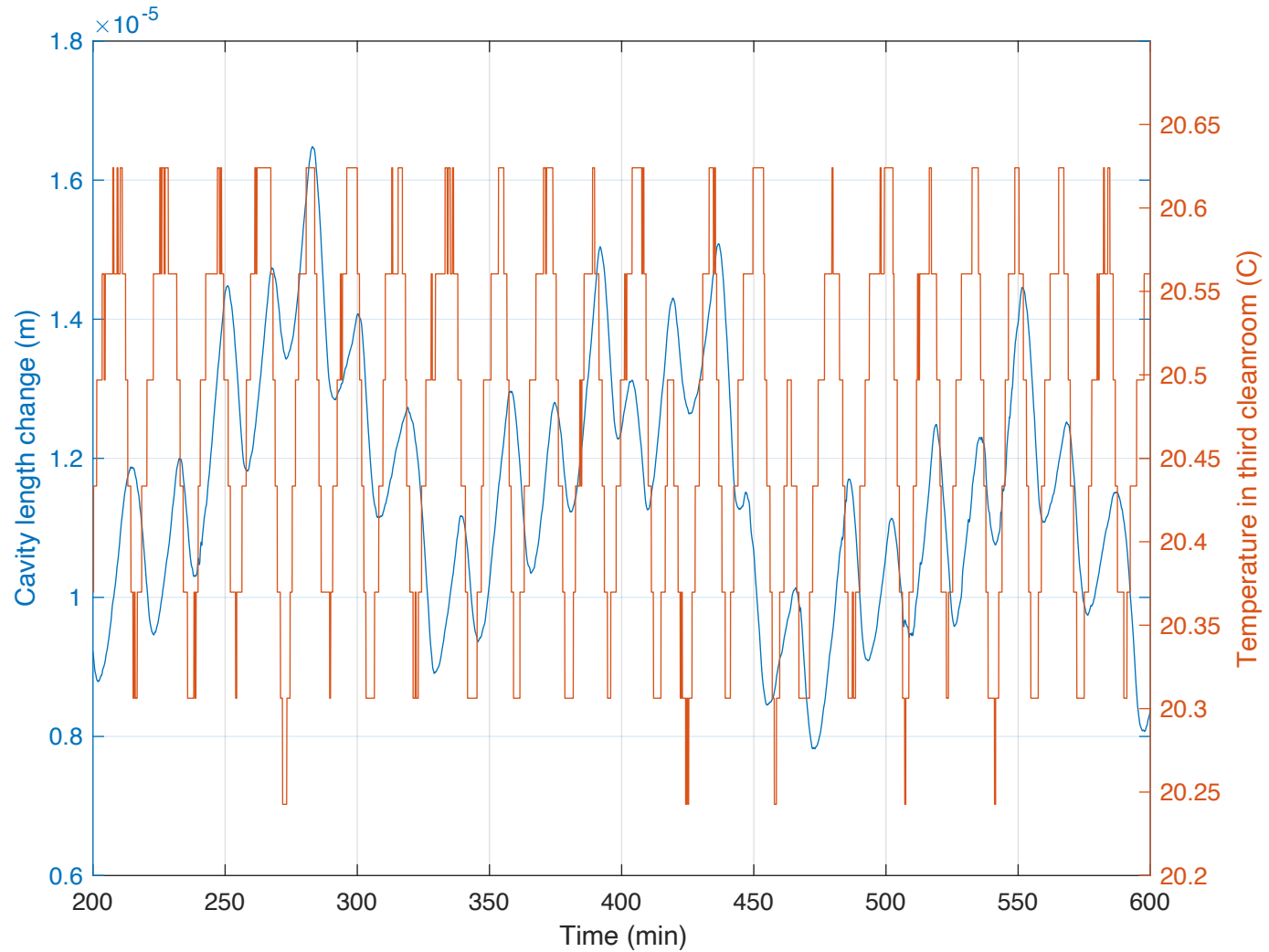
## Still some uncertainty in pointing noise

- Angular actuation is more problematic b/c there is no angular actuator at the moment on the cavities that meets our needs
  - Noise introduced by actuator shaking the Newport mount
    - Results in ALPSIIa appear to allow 5 minute spatial overlap
  - Table/concrete block pointing looks stable enough of 20 minutes
  - Pointing of COB in Hall unknown

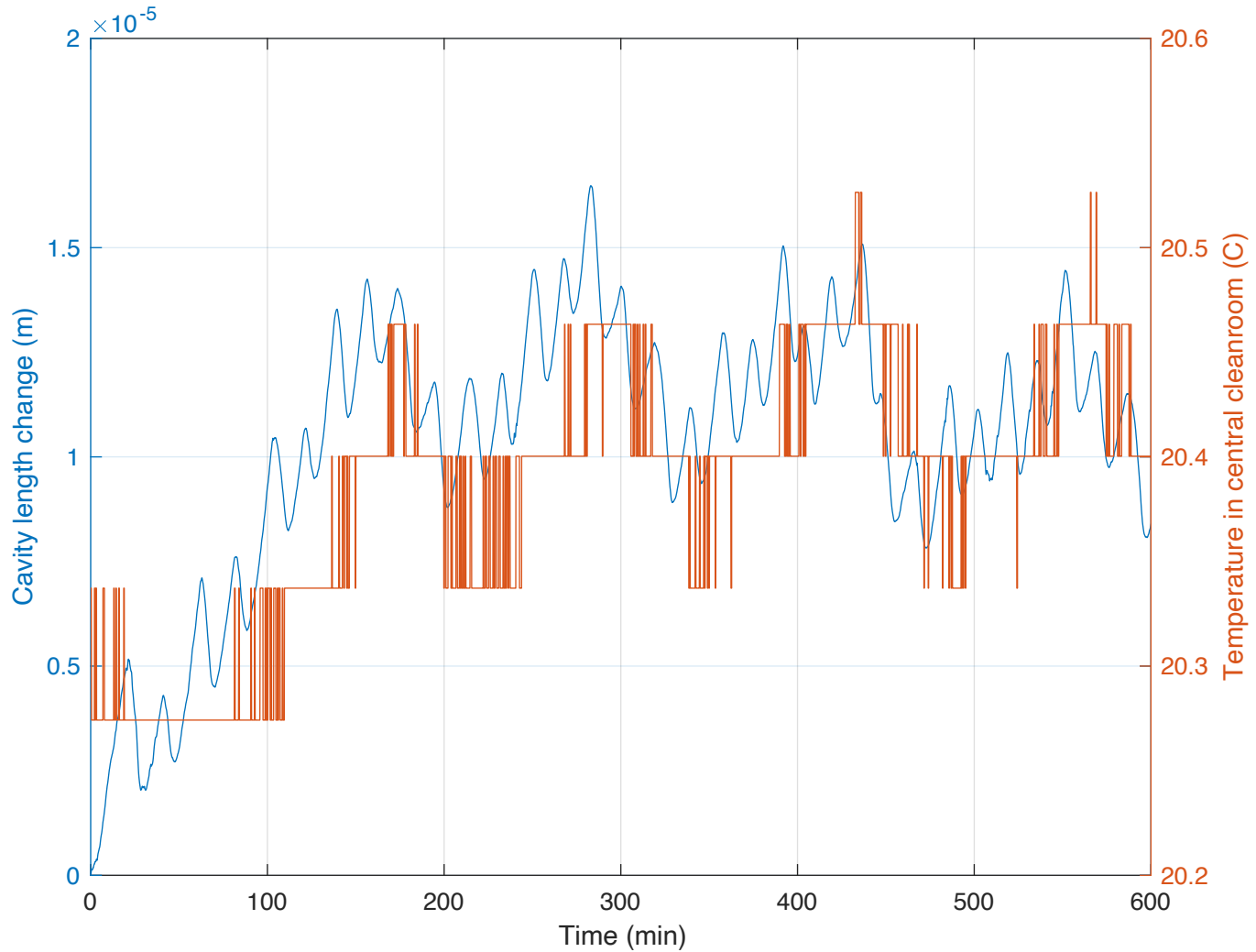
**Meeting spatial overlap requirements without actuation, looks possible for 'good' 5 minute periods as long as the environmental noise in ALPSIIc due to the long baseline is not substantially worse than ALPSIIa. (Maybe the temperature stability improves?)**

**Actuation concept will be discussed in upgrade talk, but at the moment this is not very mature.**

# ALPS IIa results



# ALPS IIa results



# Fast laser frequency locks

## Fast frequency locks

- Expected UGF 300kHz
  - Actuators should be able to deal with laser frequency noise and cavity length noise

## What do we do about cavities resonances at 1.2 MHz and above

- Will these interfere with the control loop?
  - Small line-width should help... and hurt...
  - What noise spectral density do we expect at those frequencies?

# Fast Cavity Actuation

