# SPIRE Temperature Control/ Sub-K Thermal Model

Version 0.2

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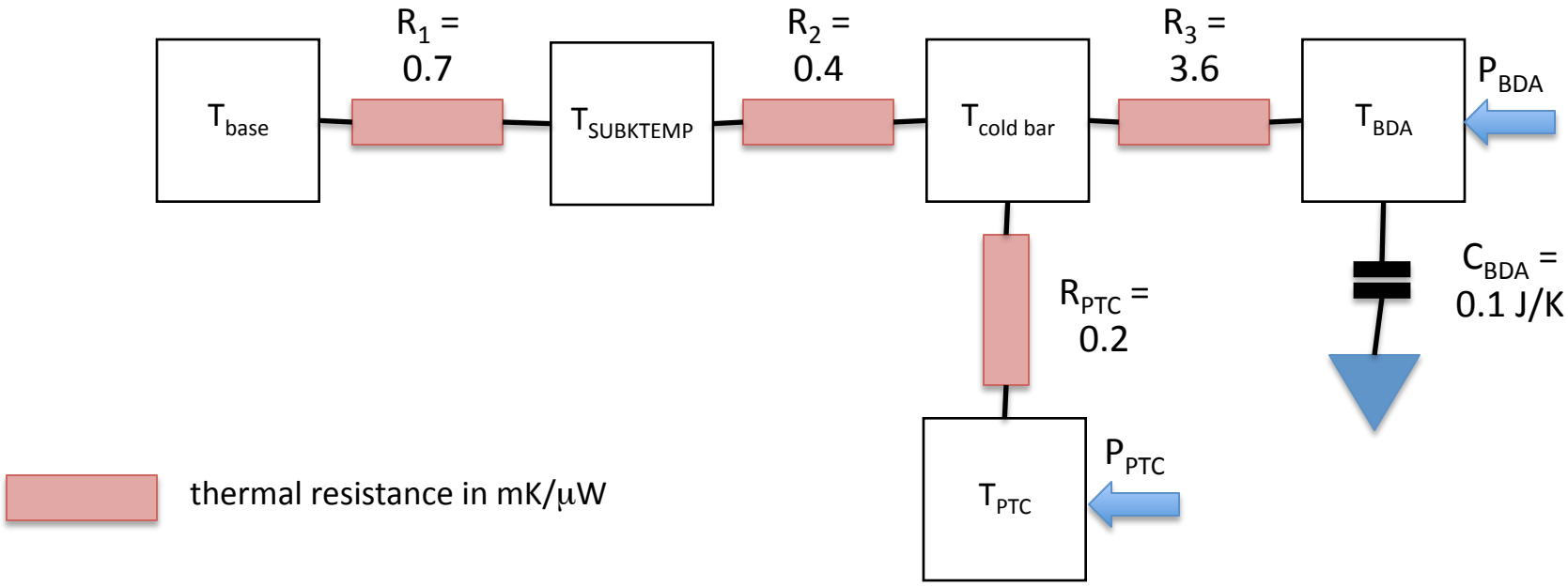
2009 Jun 15

# Thermal Model



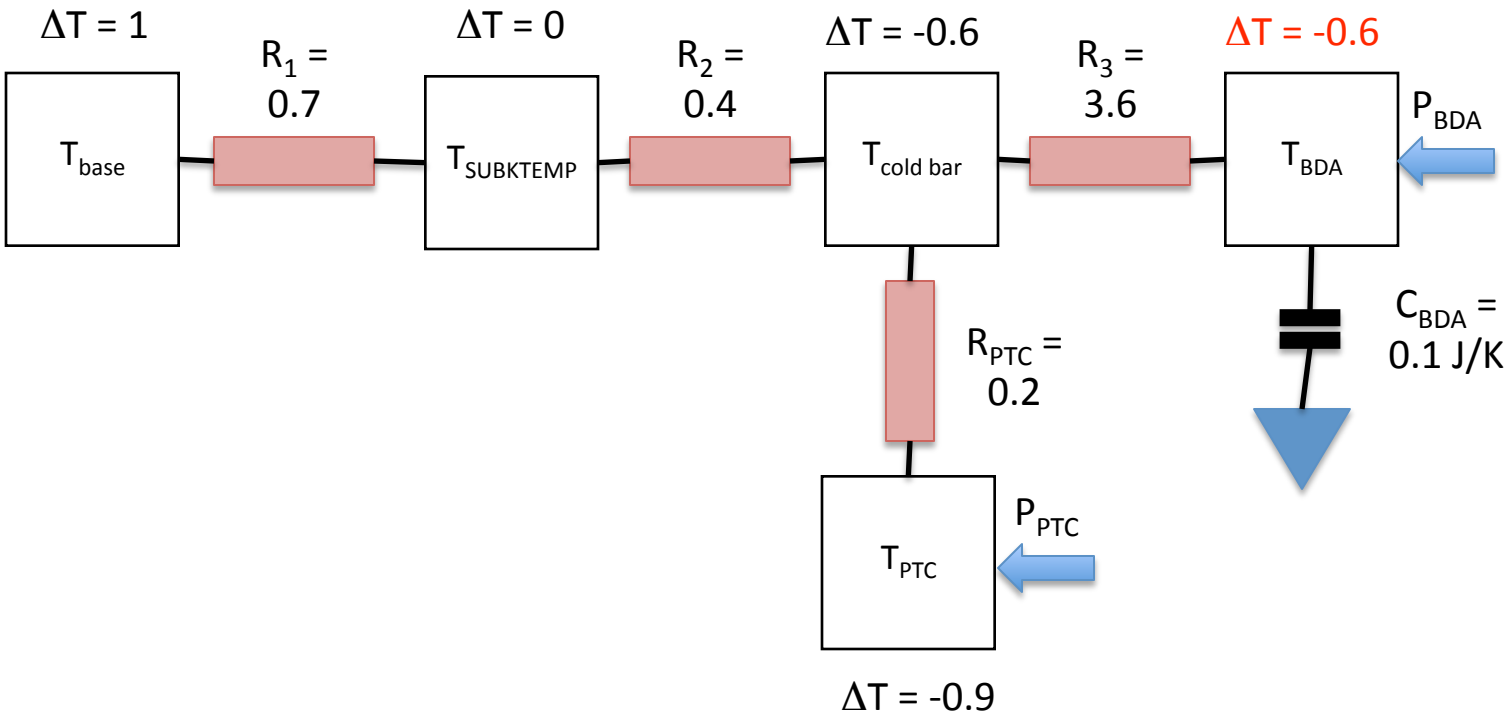

- Parameter heritage:
  - $R_1$, $R_2$, $R_3$, $R_{PTC}$ from Jamie's "PTC Analysis_3.doc" and "PTC_IST_1.doc"
    - caveat: mostly from PFM5 data.
    - $R_1$ looks about the same in flight (PTC power up test).
  - $C_{BDA}$ is based on observed flight $\tau_{BDA}$ of ~400 sec.

# Temperature Fluctuations in Absence of Control

- Caused by (at least) two effects:
  - Variable $T_{base}$ over fridge cycle
  - Variable $P_{BDA}$ power input from L0 temperature fluctuations

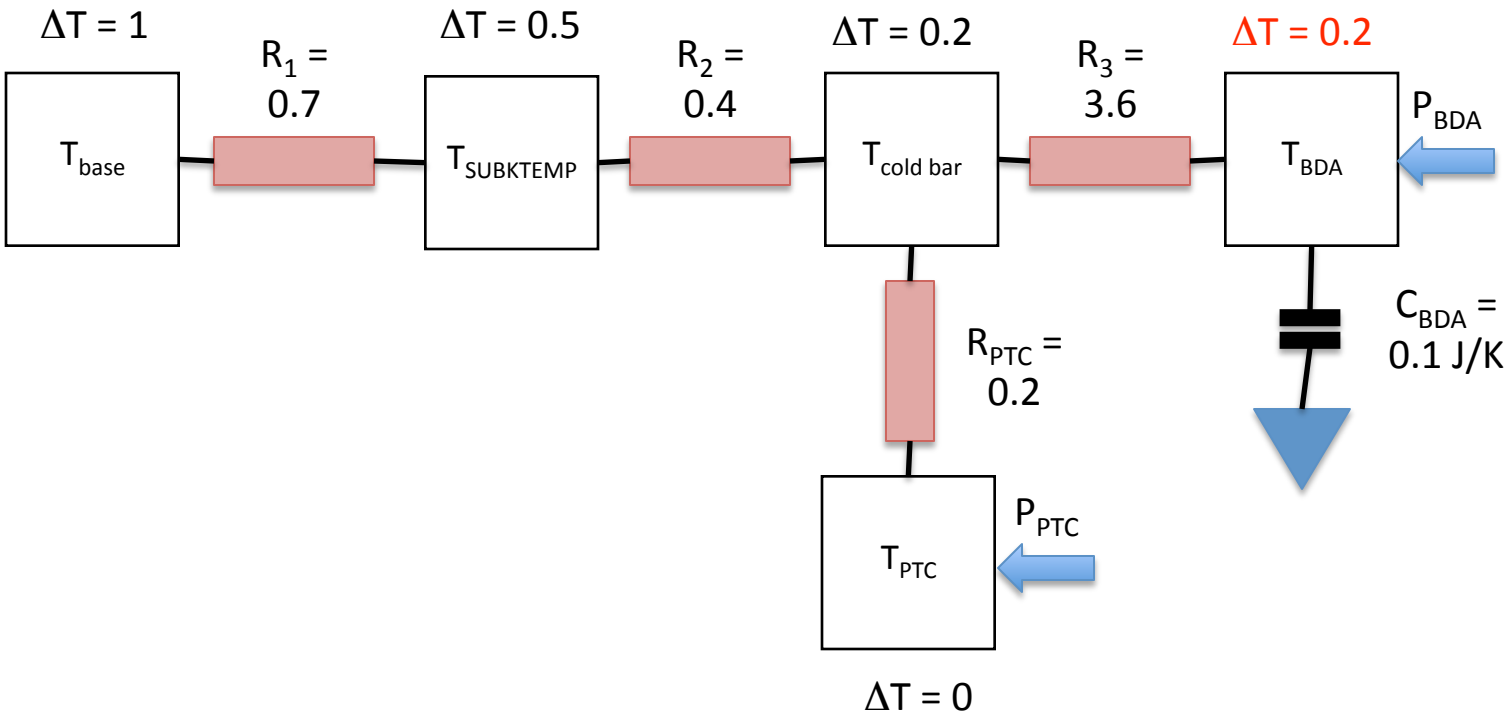
- Strong constraint on control: only control power is $P_{PTC}$

# SUBKTEMP Control / $T_{base}$ Fluctuations



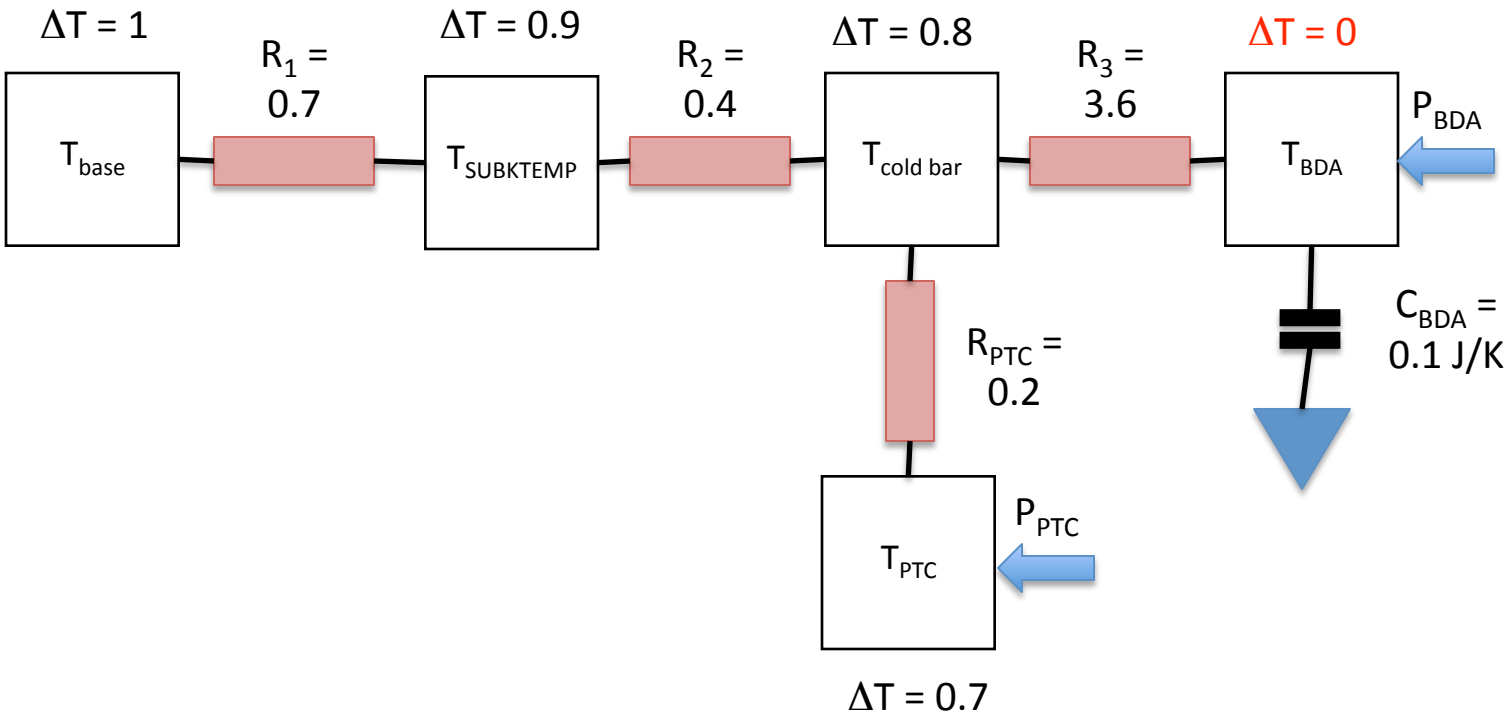

- 4/7 = 0.6 of $T_{base}$ fluctuations leak through to focal plane (at low frequency, even with perfect control on SUBKTEMP).

# PTC Control / $T_{base}$ Fluctuations



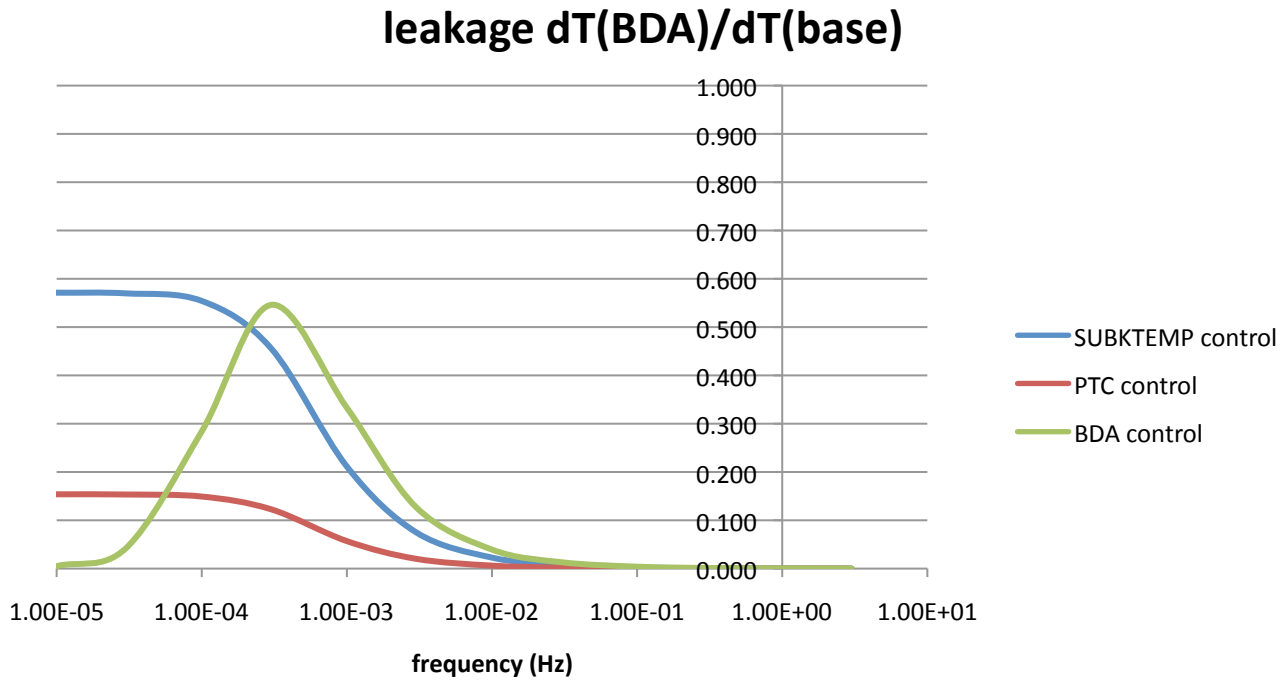

- 2/13 = 0.2 of $T_{base}$ fluctuations leak through to focal plane (at low frequency, with perfect control on PTC).

# BDA Control / $T_{base}$ Fluctuations



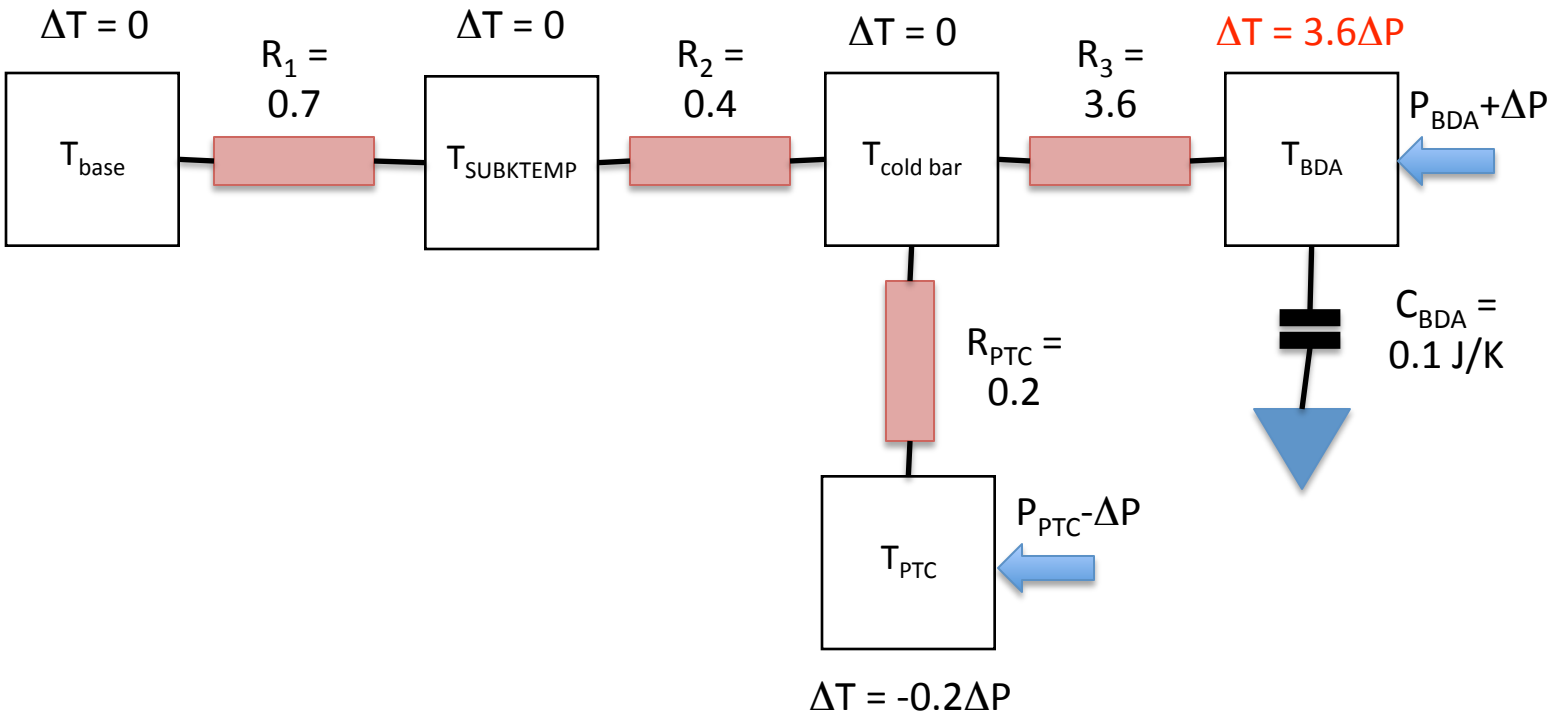

- No $T_{base}$ fluctuations leak through to focal plane at low frequency, but can't control fluctuations at intermediate frequencies.

# Control of $T_{base}$ Fluctuations



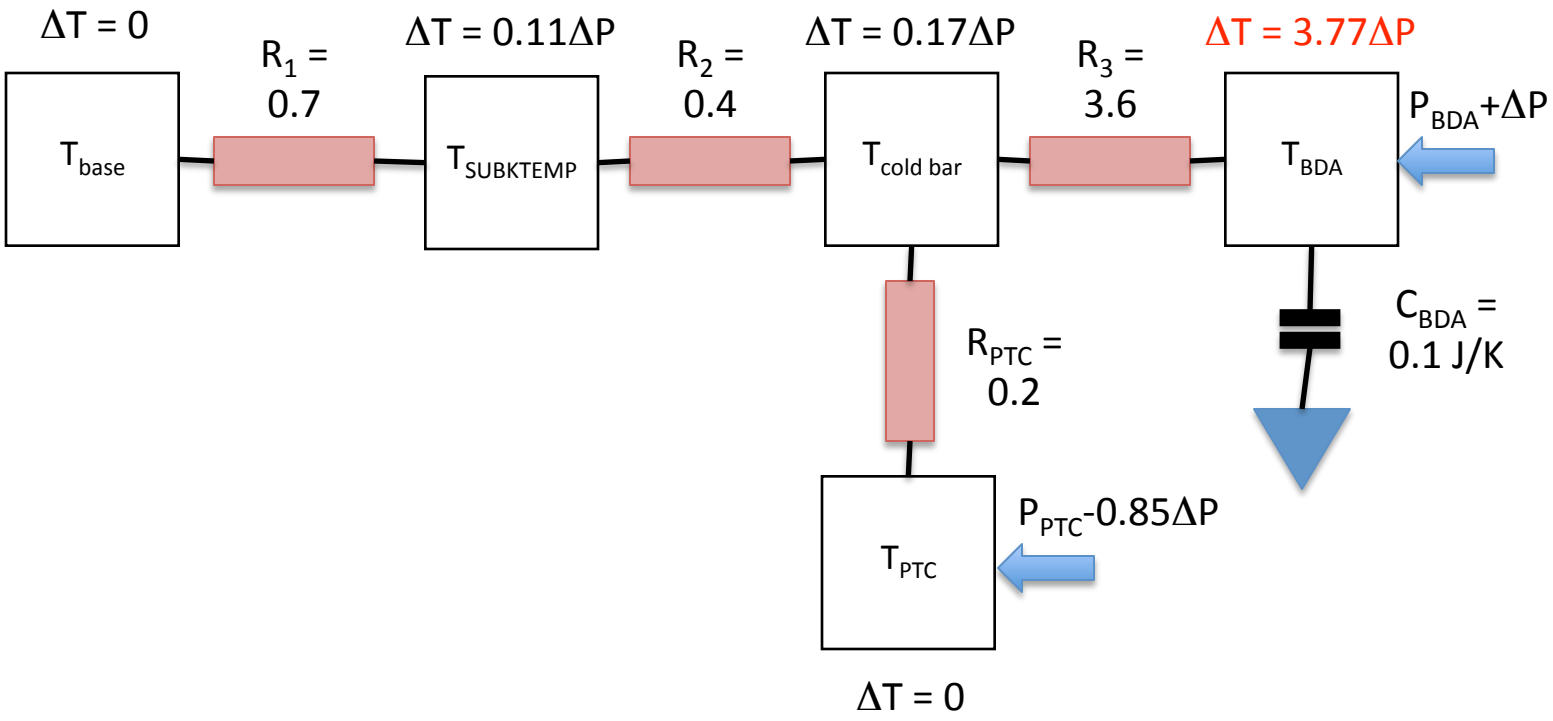

- Caveat: the curve for BDA control is only roughly confirmed through simulation.

# SUBKTEMP Control / $P_{BDA}$ Fluctuations




- Control acts to keep total power flowing into fridge constant.
- PTC has opposite temperature response of focal plane, with 1/18 of magnitude.

# PTC Control / $P_{BDA}$ Fluctuations




- Effect on BDA not much different from case of SUBKTEMP control.

# To-Do List

- Model AC response in case of $P_{BDA}$ fluctuations.

- Also need to describe issues from thermometer noise and operational constraints.