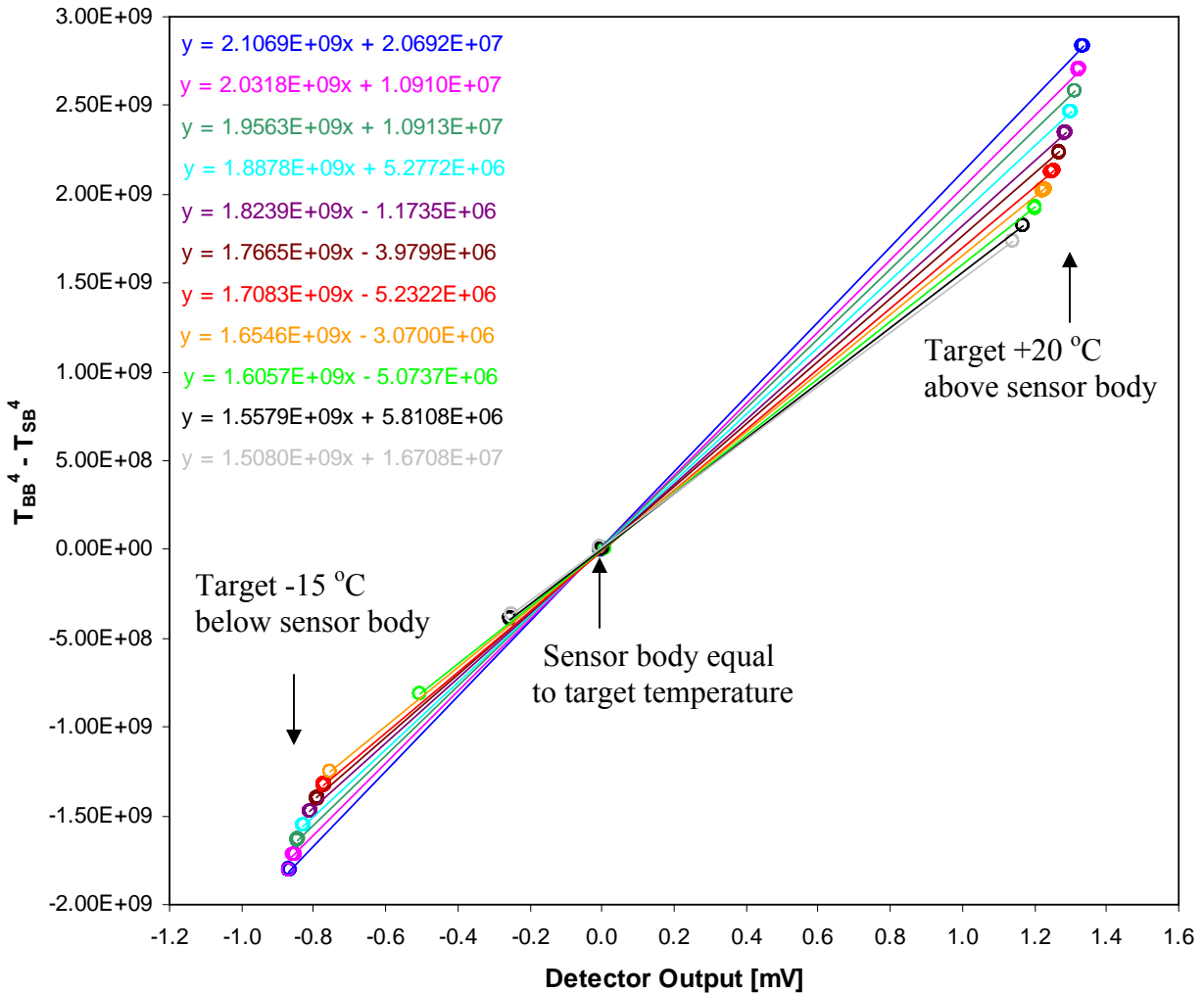


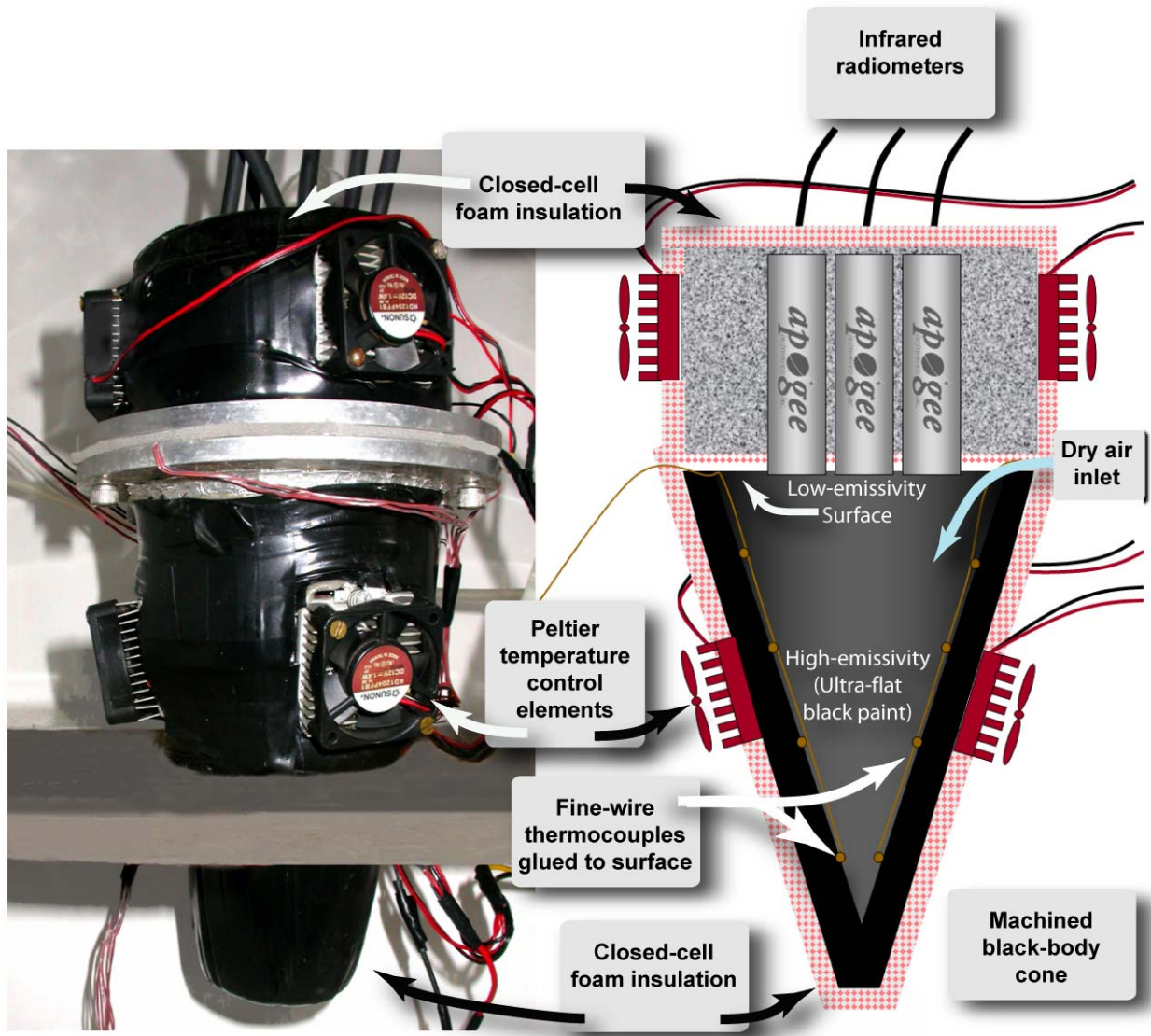
## Infra-red Radiometer (IRR) Calibration Procedure

The figure below shows linear equations fit to the blackbody target ( $T_{BB}$ ) and sensor body temperature ( $T_{SB}$ ) difference ( $T_T^4 - T_{SB}^4$ ) as a function of the mV output of the thermopile detector. Kalma et al. (Calibration of small infra-red surface temperature transducers, Agricultural and Forest Meteorology, 1988, 43:83-98.) found that  $T_T^4 - T_{SB}^4$  was linear function of mV according to the equation shown below, which is a modified version of the Stefan-Boltzmann Law where emitted energy is proportional to temperature to the fourth power.

The data points in the graph below are from a typical IRR calibration in the blackbody calibrator at Apogee Instruments (shown on the following page). Each set of data points and the equation fit to them is for a different value of  $T_{SB}$ , starting at 45 °C and incrementing down at 5 °C intervals to -5 °C. The  $r^2$  values for all data fits are  $\geq 0.9999$ . The  $T_{BB} - T_{SB}$  ranges from +20 to -15 °C (+20 to -10 °C for  $T_{SB}$  of 5; +20 to -5 °C for  $T_{SB}$  of 0 and -5 °C) with an intermediate point at 0 °C.

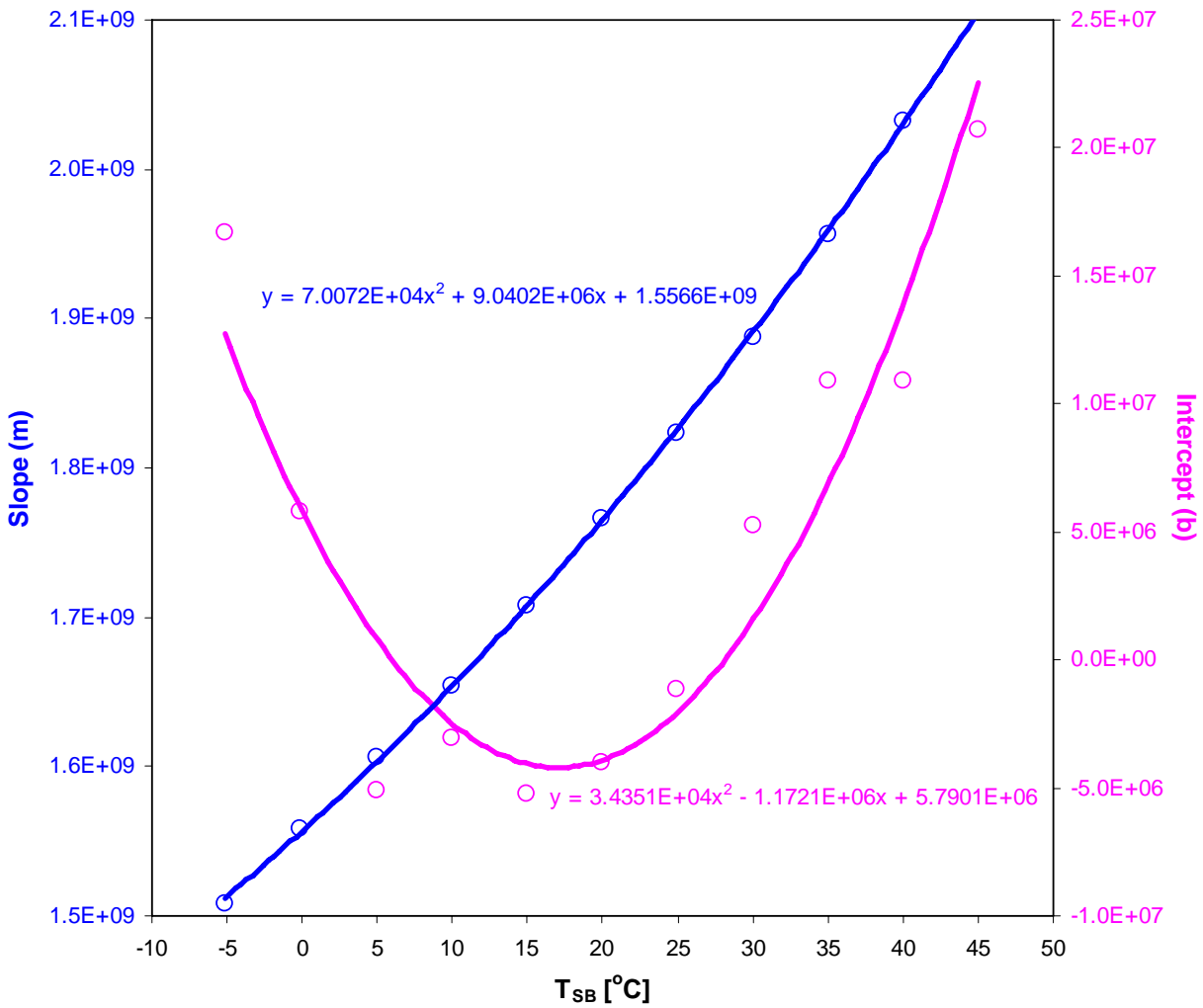
$$T_{BB}^4 - T_{SB}^4 = m \cdot mV + b$$





The figure below shows slope (m) and intercept (b) coefficients (from the linear equations in the first graph) plotted as a function of sensor body temperature ( $T_{SB}$ ). Second order polynomials are used to predict m and b at different values of  $T_{SB}$ , and are input into the equation shown below to calculate the measured target temperature ( $T_{MT}$ ) based on measured values of  $T_{SB}$  and the mV output of the thermopile detector (mV). The coefficients in the second order polynomials are custom calibration coefficients, and are specific to each IRR.

$$T_{MT} = \left( T_{SB}^4 + m \cdot mV + b \right)^{\frac{1}{4}}$$



The residual error ( $T_{MT} - T_{BB}$ ) for each measured point plotted as a function of black body target temperature ( $T_{BB}$ ) is shown in the graph below.

