MODIS

BCS to OBC Calibration Transfer

BCS to OBC Calibration Transfer Method

- The calibration coefficients (a_0,a_1,a_2) are determined by a least square fitting routine applied to the data from views of the BCS and SVS

$$a_0^{BCS} + a_1^{BCS} dn_{BCS} + a_2^{BCS} dn_{BCS} = \rho_{BCS}^{mir} \varepsilon_{BCS} L(T_{BCS}) + (\rho_{SVS}^{mir} - \rho_{BCS}^{mir}) L(T_{mir})$$

(Eq.1)

where $dn_{BCS} = DN_{BCS} - DN_{SVS}$

$L(T,\lambda)$ = Planck function

T_{BCS} and T_{MIR} are the measured BCS and Scan mirror temperatures, respectively

ρ_{BCS} and ρ_{BCS} are the Scan mirror reflectivities at BCS and SVS angle

BCS to OBC Calibration Transfer Method - continued

- MODIS views OBC and SVS, and use calibration coeffs. (a_0,a_1,a_2) to determine OBC emissivity and Temp correction
  - Using the measuerd OBC and SVS DNs ($dn_{OBC}=DN_{OBC}-DN_{SVS}$)

$$\Delta L_{OBC}\left(\{a_{BCS}\}, dn_{OBC}\right) = a_0^{BCS} + a_1^{BCS}\ dn_{OBC} + a_2^{BCS}\ dn_{OBC}^2 \qquad \text{(Eq.2)}$$

  - Using the measured OBC, Scan Mirror and Cavity temperatures

$$\Delta L_{OBC}\left(\rho_s^{mir}, \varepsilon_{OBC}, \delta T_{OBC}, T_s\right) \qquad \text{(Eq.3)}$$

$$= \rho_{OBC}^{mir}\varepsilon_{OBC} L\left(T_{OBC}\right) + \left(\rho_{SVS}^{mir} - \rho_{OBC}^{mir}\right) L\left(T_{mir}\right) + (1-\varepsilon_{OBC})\rho_{OBC}^{mir}\varepsilon_{cav} L\left(T_{cav}\right)$$

where ε_{OBC} and δT_{OBC} (T_{OBC} correction) are to be determined

  - Using Least-Square fitting of the OBC radiance of (Eq.3) to the OBC radiance of (Eq.4) to determine OBC parameters .

BCS to OBC Calibration Transfer Method - continued

- Scan Mirror reflectivities (ρ_{SVS}, ρ_{BCS}, ρ_{OBC})have measurement and fitting errors (<1.0%), which effect the OBC parameters
- A five parameter optimization routine will automatically adjust ρ_{SVS}, ρ_{BCS}, ρ_{OBC} , as well as ε_{OBC} and δT_{OBC} to minimize the χ^2 as

$$\chi^2 = \sum_{i=1}^{\#collects} \left[\Delta L_{OBC}\left(\{a_{BCS}\}, dn_{OBC}\right) - \Delta L_{OBC}\left(\rho_s, \varepsilon_{OBC}, \delta T_{OBC}, T_s\right) \right]^2$$

where calibration coeffs $\{a_{BCS}\}$ are also a function of ρ_{SVS}, ρ_{BCS}.

- Optimization process enforces the boundary conditions of

  $\rho_{SVS} >= \rho_{BCS} >= \rho_{OBC}$, $\rho_{SVS}<=1$, $\varepsilon_{OBC}<=1$
- This optimization will be done band by band and channel by channel

BCS to OBC Calibration Transfer Method - continued

- Step 1: Solve 5 parameter minimization routine for ε_{OBC}, ΔT_{OBC}, ρ_{SVS}, ρ_{BCS}, ρ_{OBC} with the physical constraints:

  $\rho_{SVS} >= \rho_{BCS} >= \rho_{OBC}$, $\rho_{SVS}<=1$, $\varepsilon_{OBC}<=1$

- Step 2: Determine average temperature offset for all bands
- Step 3: Solve 4 parameter minimization routine for ε_{OBC}, ρ_{SVS}, ρ_{BCS}, ρ_{OBC} with the physical constraints:

  $\rho_{SVS} >= \rho_{BCS} >= \rho_{OBC}$, $\rho_{SVS}<=1$, $\varepsilon_{OBC}<= 1$ and ΔT_{OBC} = band average temperature offset

OBC->BCS Transfer Method Applied to PFM Data

- RC-02 Data, BCS warm up, used for calibration coefficients (DN vs. L) determination.
  - cold plateau, UAID1315-1337
  - hot plateau, UAID1402-1426
  - nominal plateau, UAID1506-1526
- MFI-09 Data, OBC warm up / cool down used for the determination of the OBC parameters and scan mirror reflectivity adjustment
  - cold plateau, cool down UAID1340
  - hot plateau, cool down UAID1454, warm up UAID1455
  - nominal plateau, cool down UAID1542, warm up UAID1544

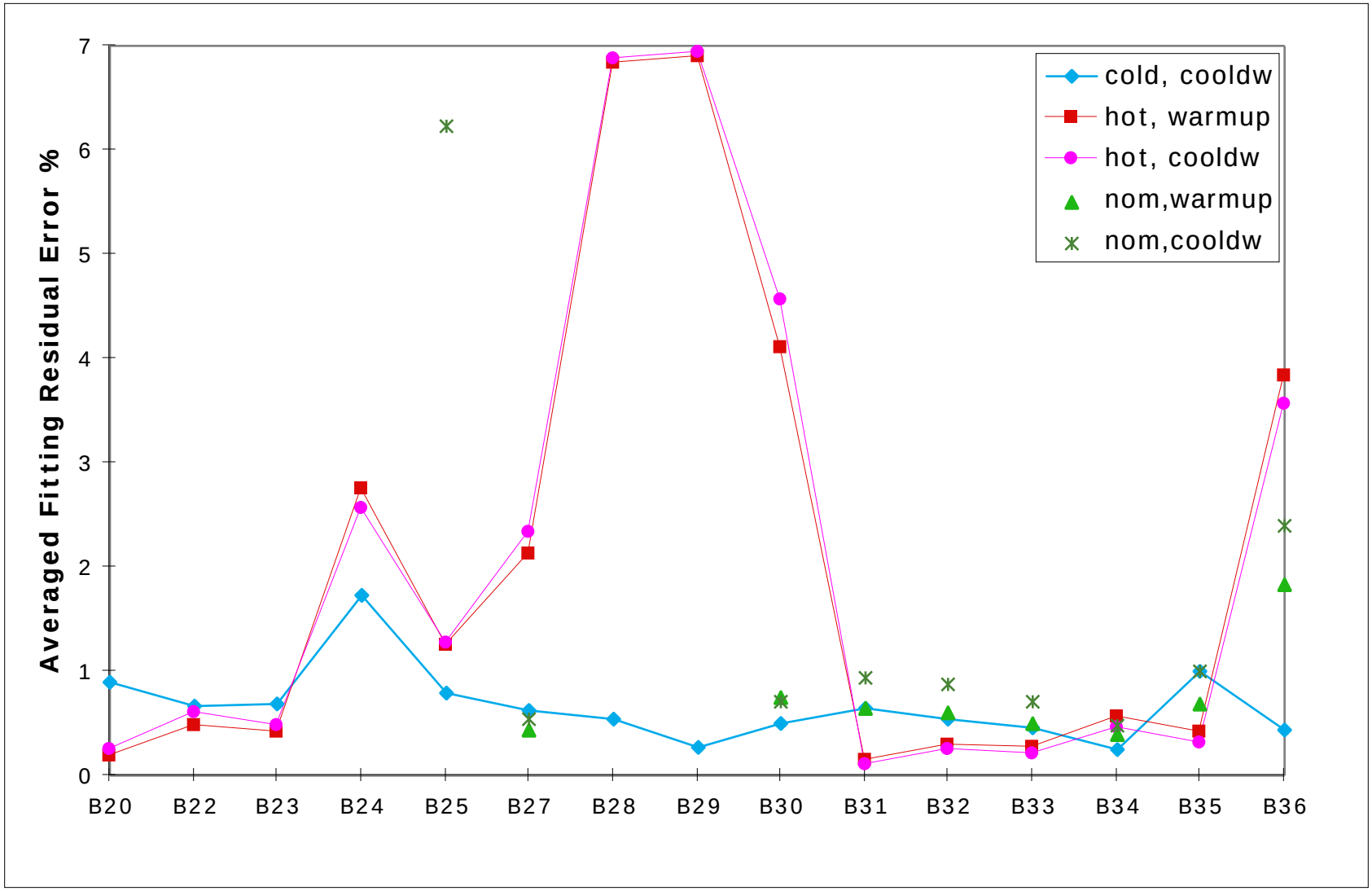
OBC Blackbody Warm Up and Cool Down Data Collects (MFI-09)

Instrument Temperature	Blackbody Warmup ↑	Blackbody Cooldown ↓	Data Limitations
Cold Plateau T_{instr} = 256K		UAID 1340 BB temp range 292-273K	No Warmup data.
Nominal Plateau T_{instr} = 273K	UAIDs 1524,1543 BB temp range 284.9-305K	UAID 1544 BB temp range 312-282K Heater off	Due to incorrect setting of gains the PV bands are not useable for this dataset. Space view DNs are set to zero for several bands.
Hot Plateau T_{instr} = 283K	UAID 1454 BB temp range 287-315K Heater off	UAID 1455 BB temp range 312-290K	

Average OBC Temperature Offset result from 5 parameter minimization routine

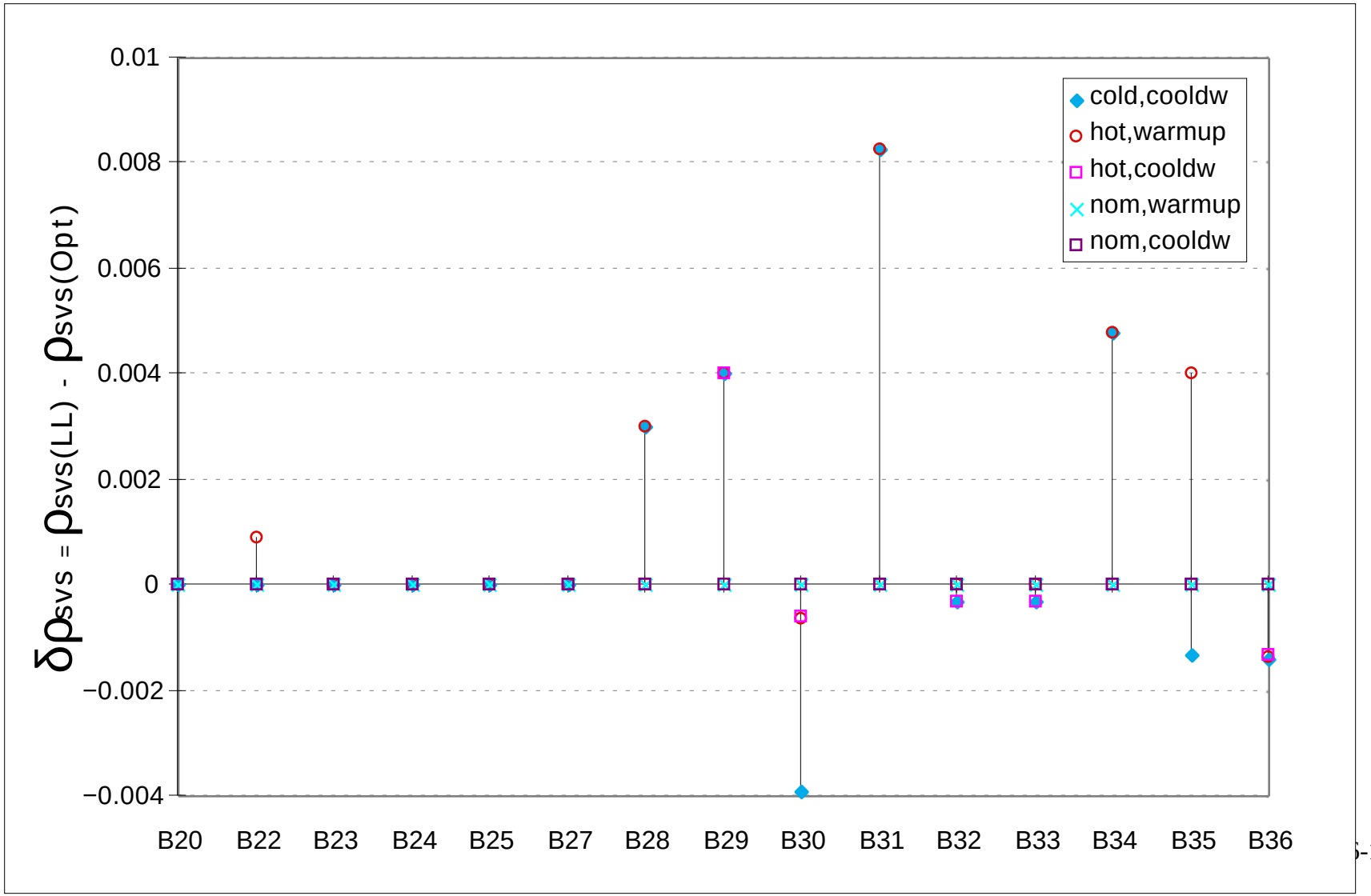
Instrument Temperature Plateau	$\frac{1}{15}\sum_{i-1}^{15\_Bands}\Delta T_i^{Retrieved}$	ΔT_{min} mK; Band #	ΔT_{max} mK; Band #
Cold (256 K) -cool down -warm up	 0.5 mK NA	 0.0 mK; B20 NA	 28 mK; B33 NA
Nominal (273K) -cool down -warm up	 0.0 0.0	 0.0 0.0	 0.0 0.0
Hot (283 K) -cool down -warm up	 4.7 mK 4.0 mK	 0.0 mK; B22 0.0 mK; B22	 23.0 mK: B27 19.5 mK; B30

BCS->OBC Transfer
Averaged Fitting Residual Error



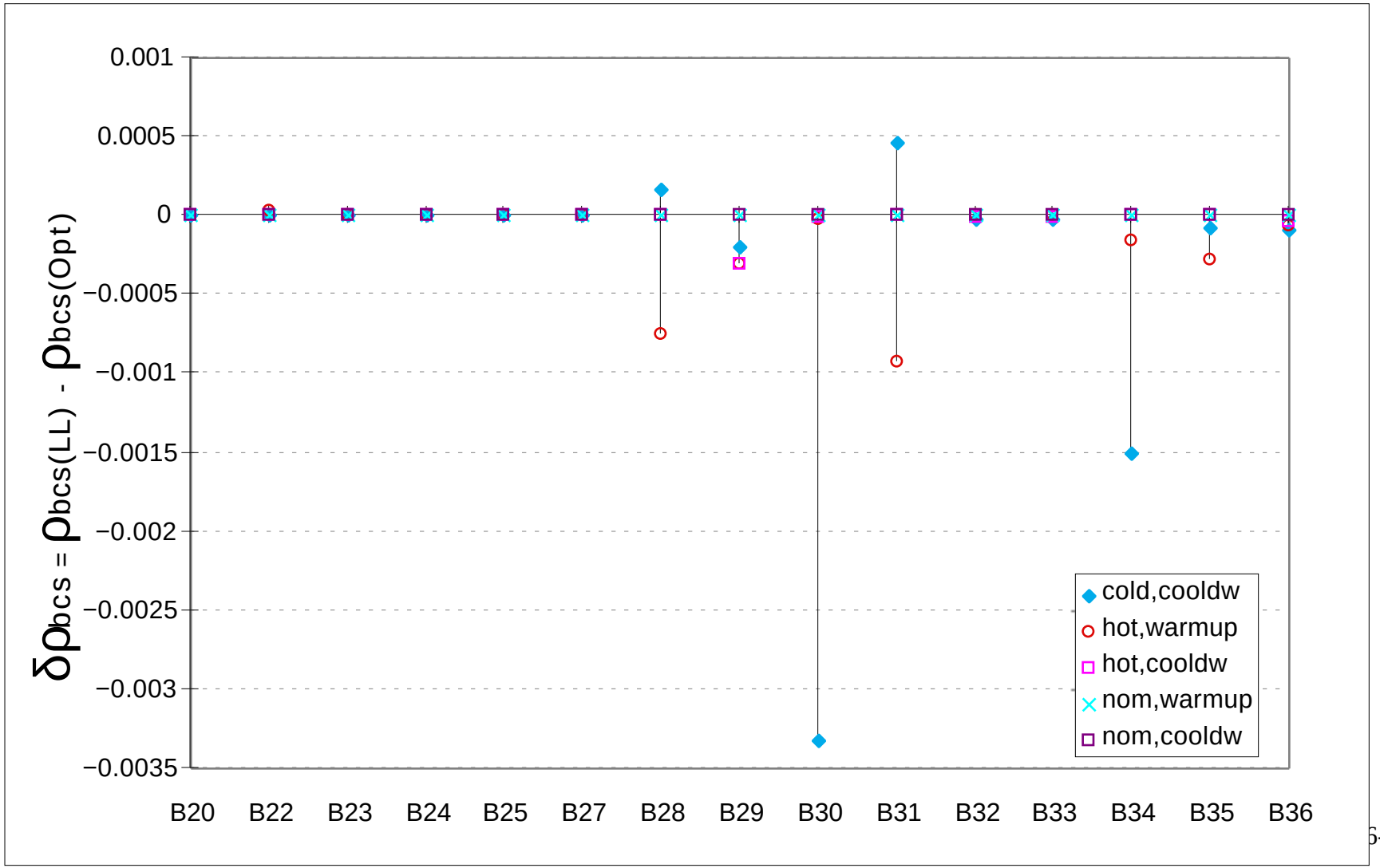
BCS->OBC Transfer

Retrieved Scan Mirror Reflectivity (ρ^{opt}_{SVS}) vs. Lincoln Lab witness sample measurement ($\rho^{LL}_{AOI=11.4;\ fitted}$)



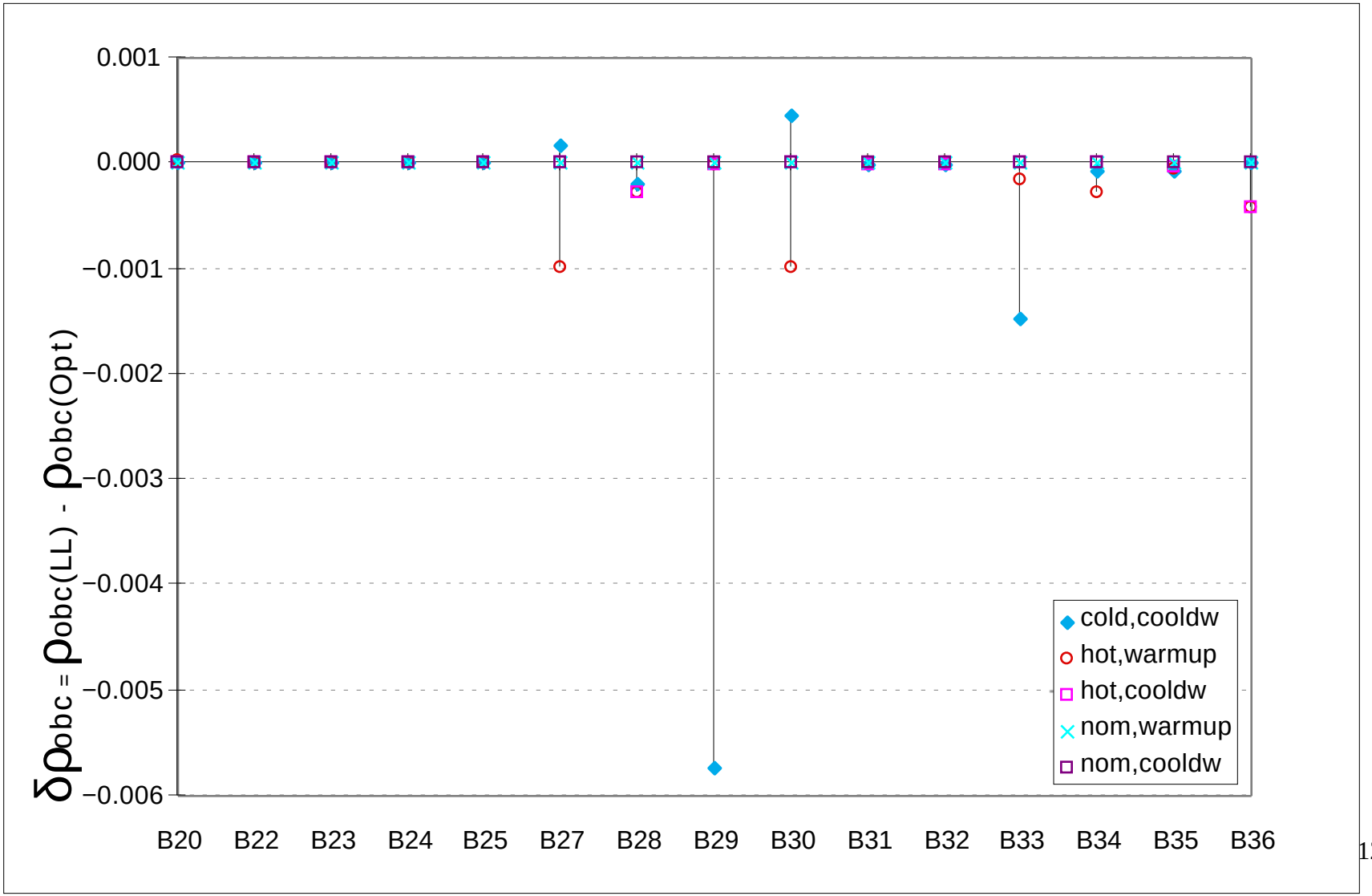
BCS->OBC Transfer

Retrieved Scan Mirror Reflectivity (ρ^{opt}_{BCS}) vs. Lincoln Lab witness sample measurement ($\rho^{LL}_{AOI=15.5;\ fitted}$)



BCS->OBC Transfer

Retrieved Scan Mirror Reflectivity (ρ^{opt}_{OBC}) vs. Lincoln Lab witness sample measurement ($\rho^{LL}_{AOI=26.3;\ fitted}$)



BCS->OBC Transfer

Retrieved OBC Emissivity (ε^{opt}_{OBC}) compared to the Nominal Value (0.997)