SMOS Calibration: Approach and Expectations

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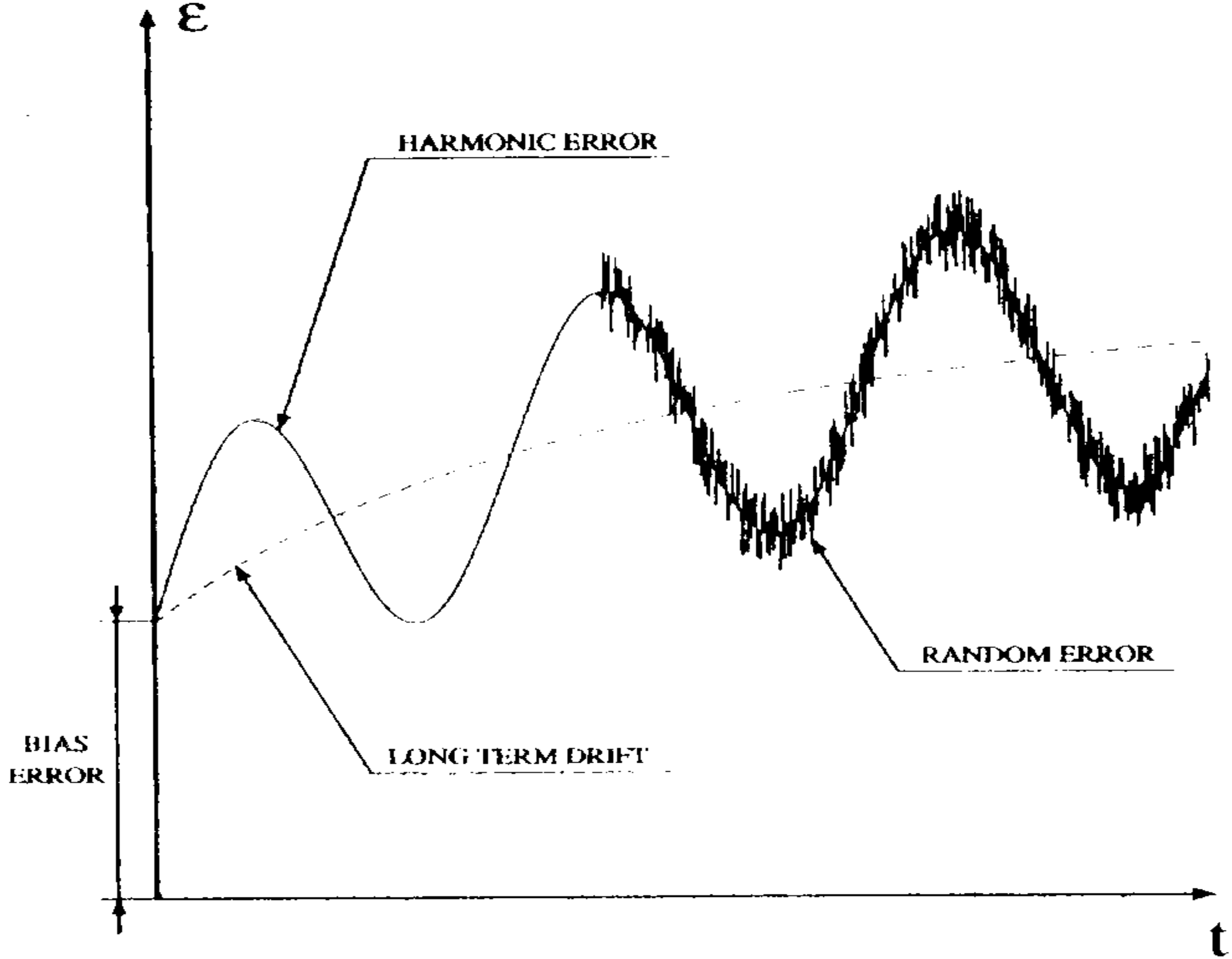
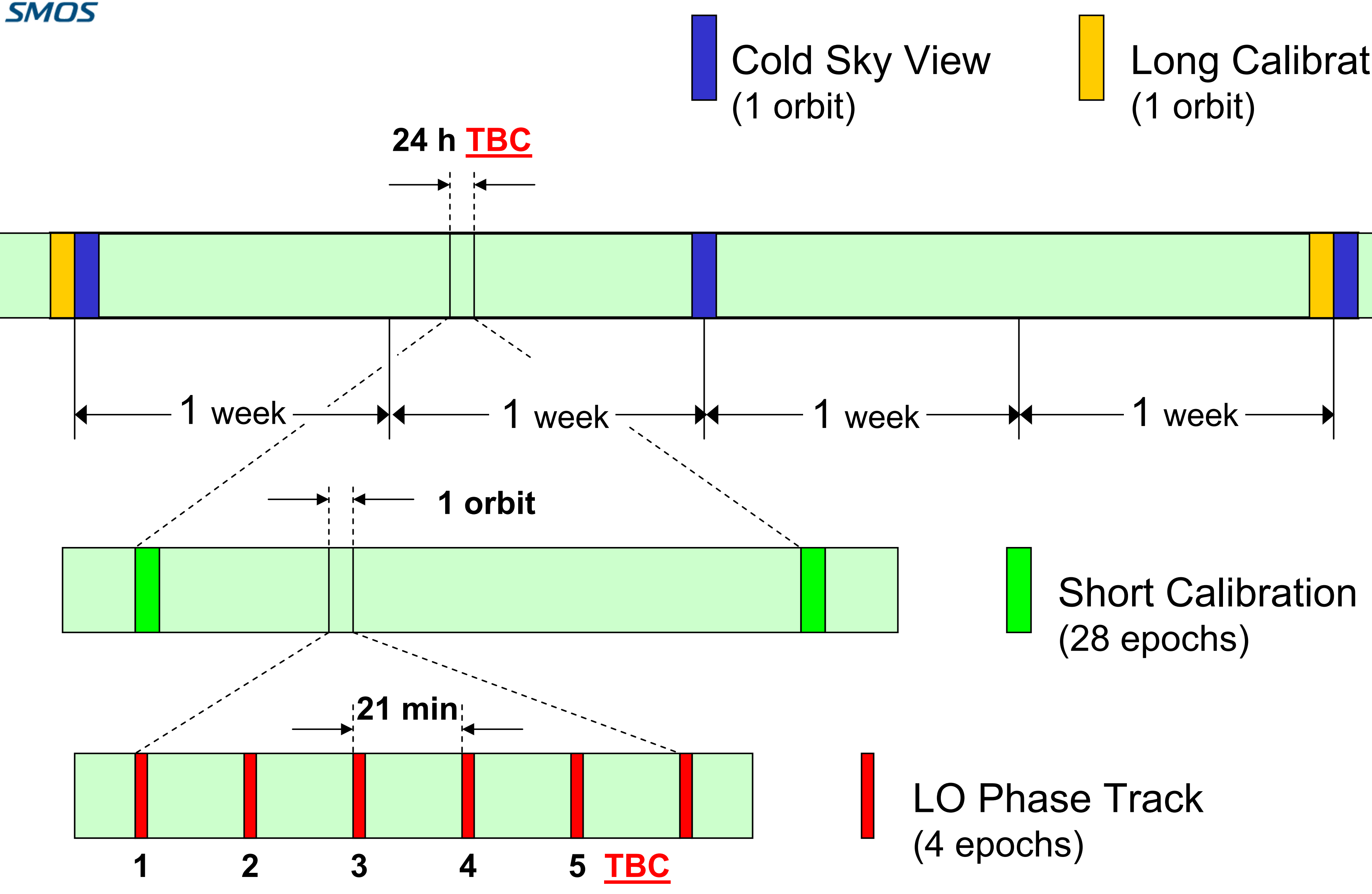


Calibration Approach



Calibration Approach

The in-orbit calibration of SMOS is based on the following strategy:

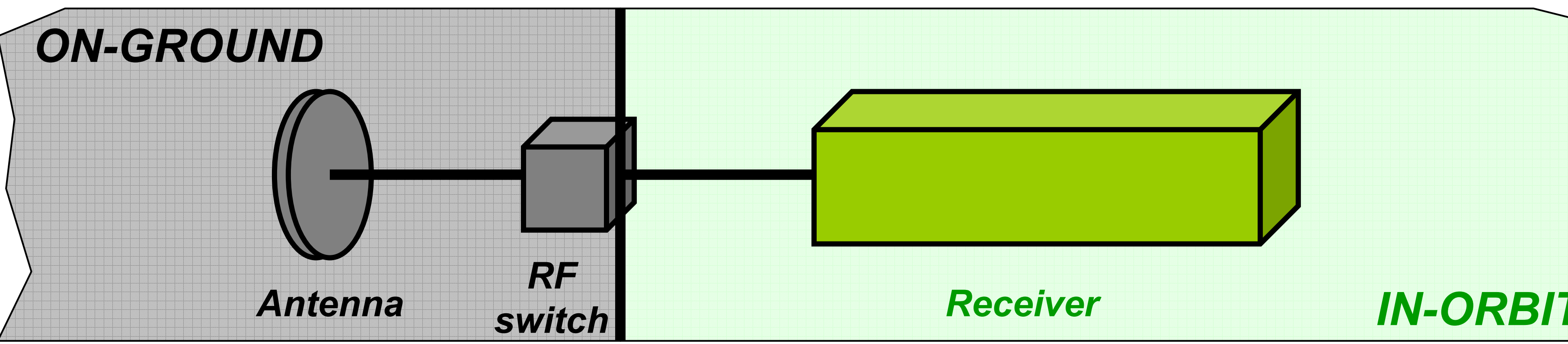
1.- Calibration of NIR and CAS based on 2 calibration standards;

2.- Injection of known signals (CAS) right after the antenna (through an RF swi

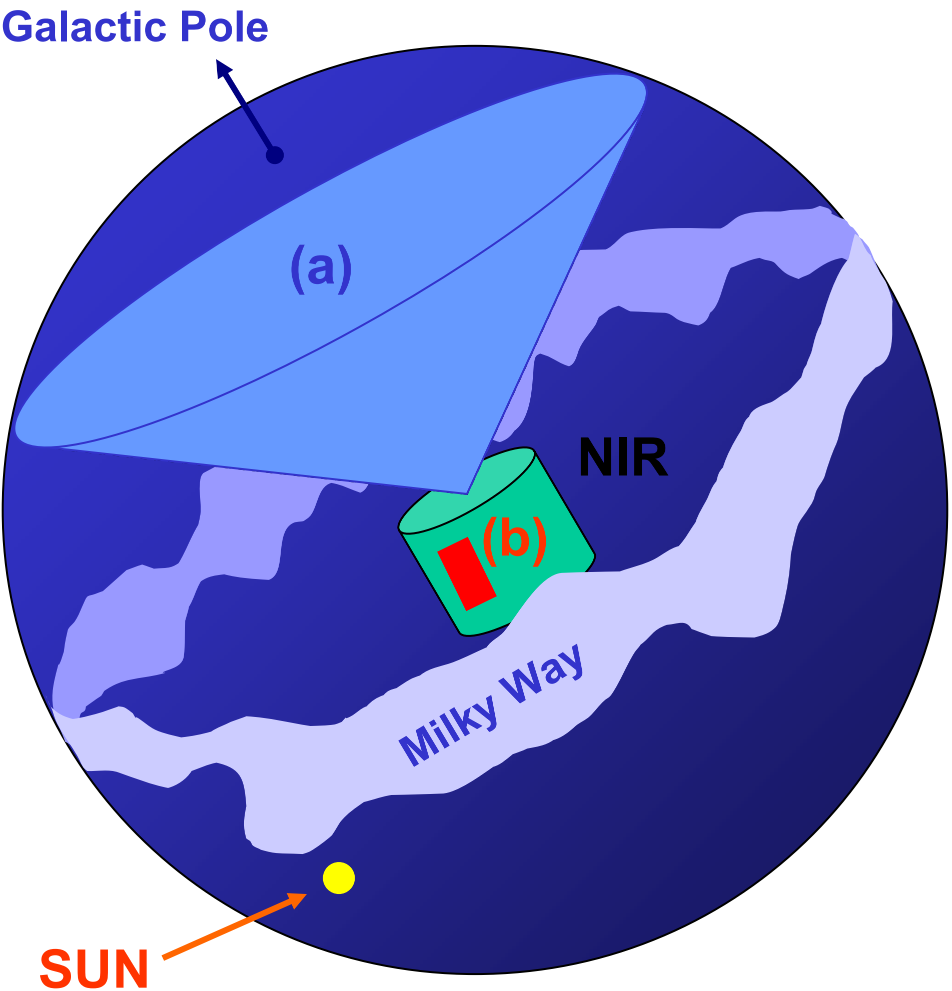
3.- On-ground characterisation of antenna and RF switch;

4.- Temperature correction of all parameters in-between NIR/CAS calibrations.

ASSUMPTION: ANTENNA PATTERNS REMAIN CONSTANT



Calibration Standards used in SMOS



SMOS is using two standards for in-orbit calibration:

a) The Cold Sky

Realised by inertial pointing of MIRA to the galactic poles.

b) One Matched Load

It is placed in NIR.
Its physical temperature is ambient and is well monitored.

Visibilities Calibration

Visibility Key Elements

NIR

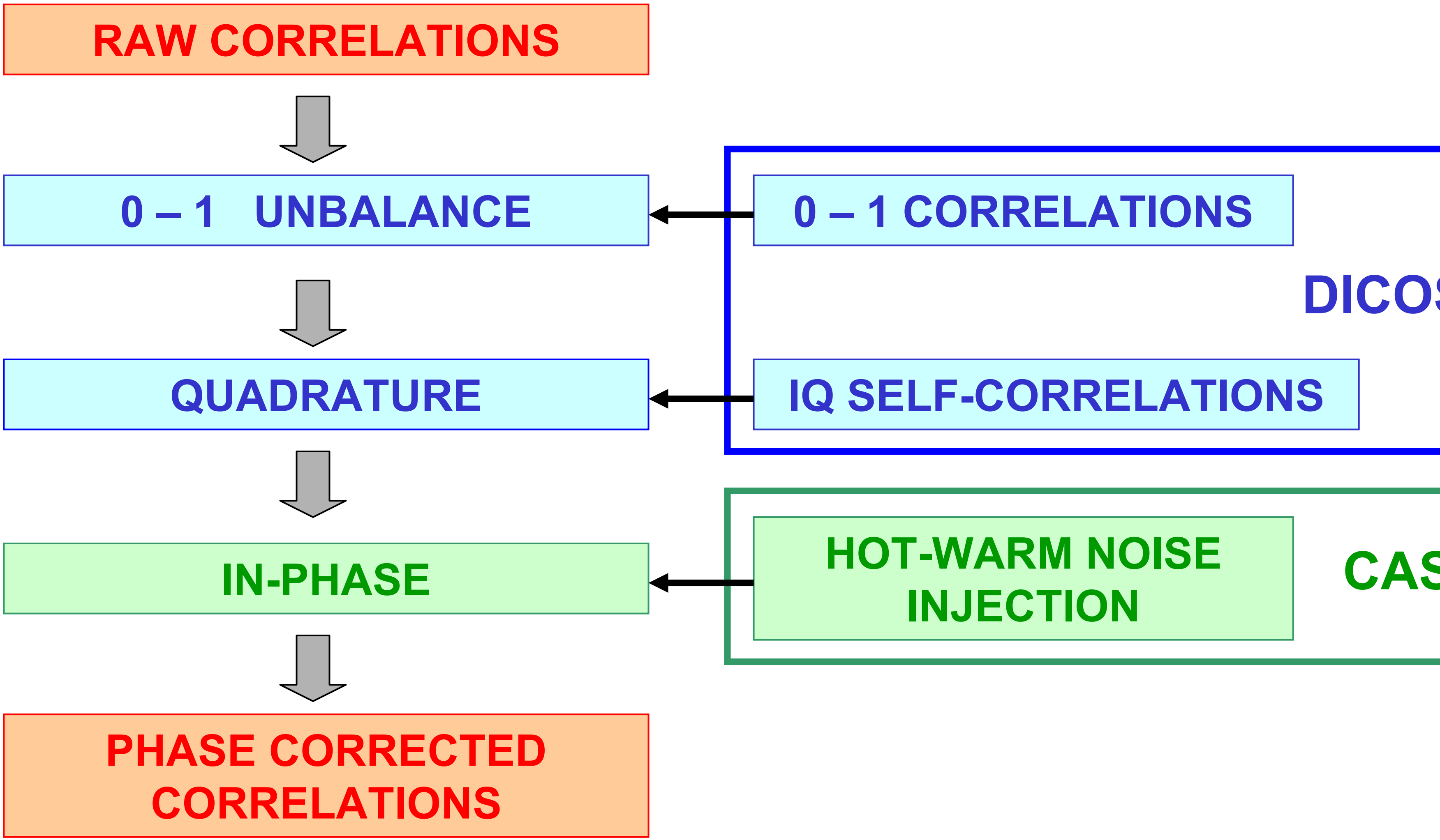
$$V_{kj} = \frac{\sqrt{T_{sys,k}\,T_{sys,j}}}{G_{kj}} M_{kj}$$

Correlations

PMS

SMOS

Phase Calibration



Amplitude Calibration (I)

COLD SKY + LOAD

↓

NIR NOISE DIODE OK ← NIR-AR Mode: COLD SKY VIEW + PHYSICAL TEMPERATURE

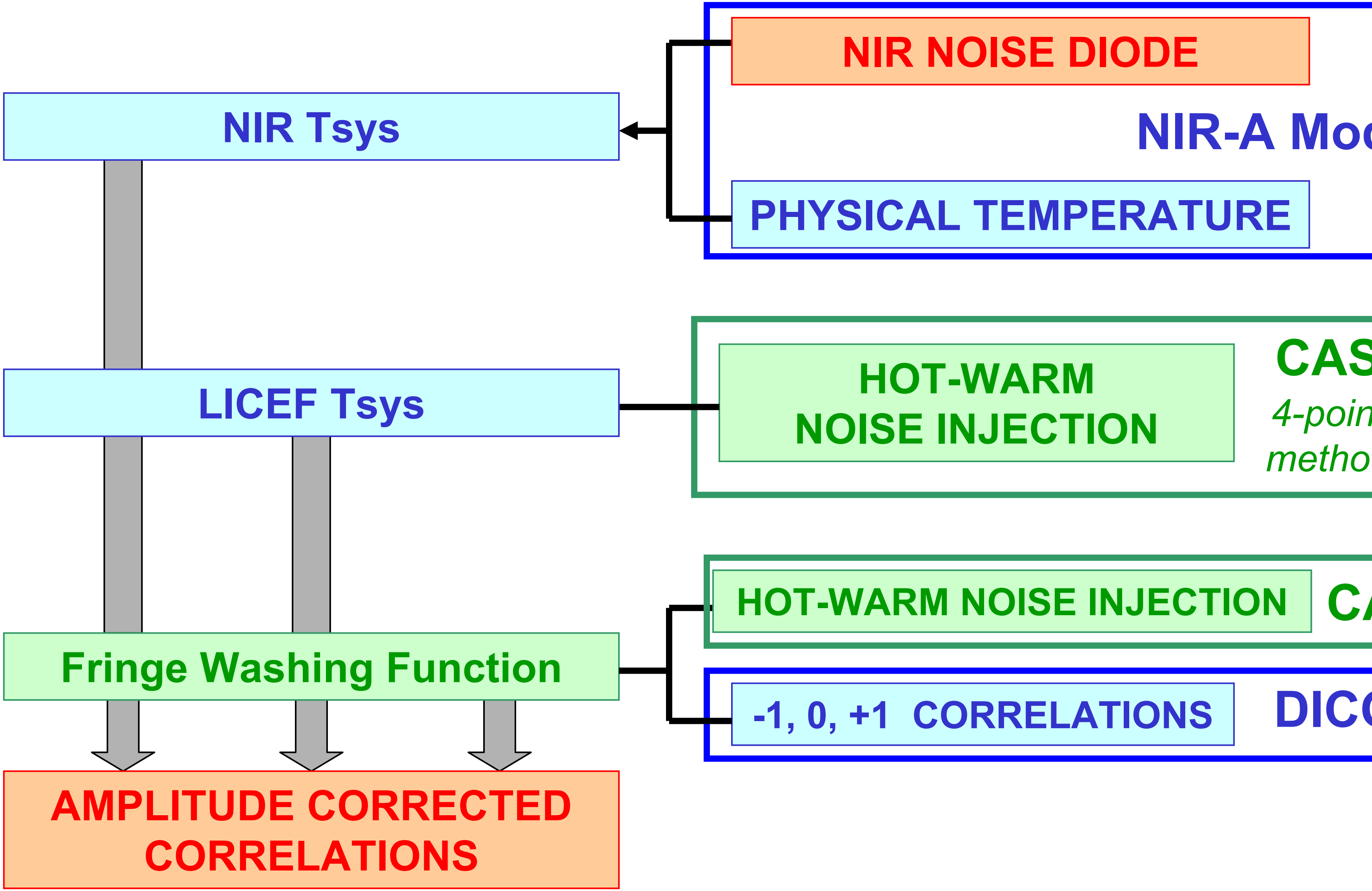
↓

CAS NOISE DIODES OK ← NIR-R Mode: NIR NOISE DIODE + PHYSICAL TEMPERATURE

↓

Visibilities Calibration

Amplitude Calibration (II)



Visibilities Calibration

Offset Calibration

AMPLITUDE AND PHASE CORRECTED CORRELATIONS ← U-NOISE INJECTION — LICE

↓

CALIBRATED VISIBILITIES

↓

IMAGE RECONSTRUCTION ← TUD ANTENNA PATTERNS — TUD

IMAGE RECONSTRUCTION ← IVT TEST — ESTE

SMOS

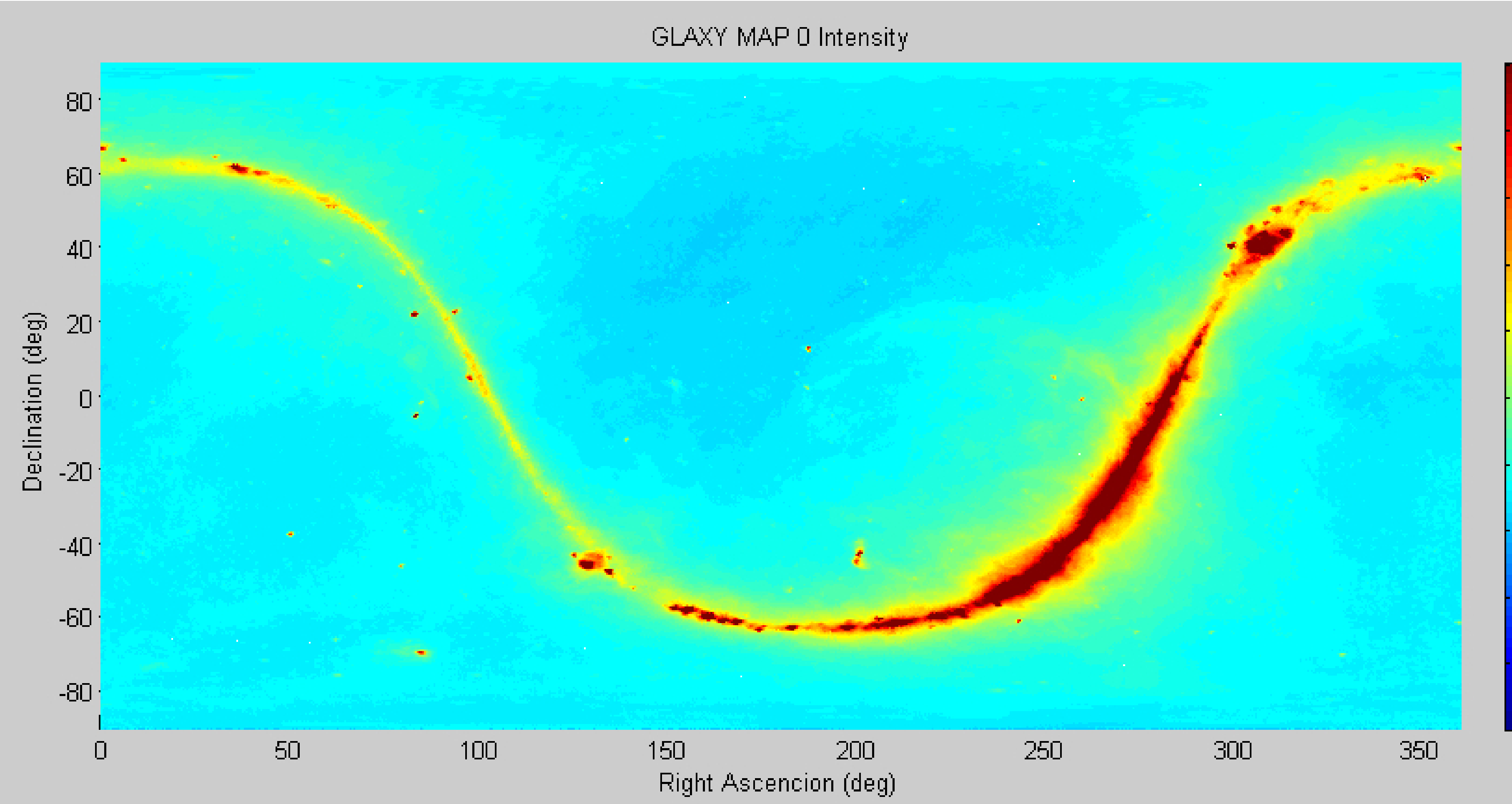
Corbella Equation

$$V_{ij}^{pq}(u,v) = 2k_B\sqrt{B_iB_j}\,\alpha_i\alpha_j\frac{1}{\sqrt{\Omega_i^p\Omega_j^q}}\times$$

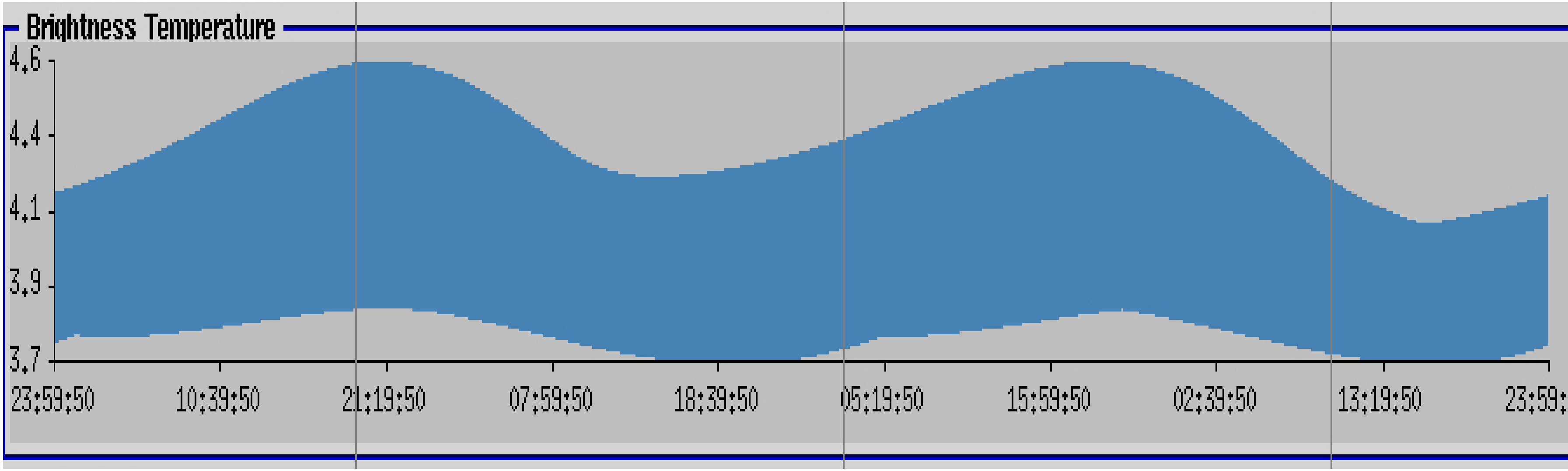
$$\iint_{\xi^2+\eta^2\le 1} F_{n,i}^{\alpha,p}(\xi,\eta)\,F_{n,j}^{\beta,q\,*}(\xi,\eta)\,\frac{T_B^{\alpha\beta}(\xi,\eta)-\delta_{\alpha\beta}T_r}{\sqrt{1-\xi^2-\eta^2}}$$

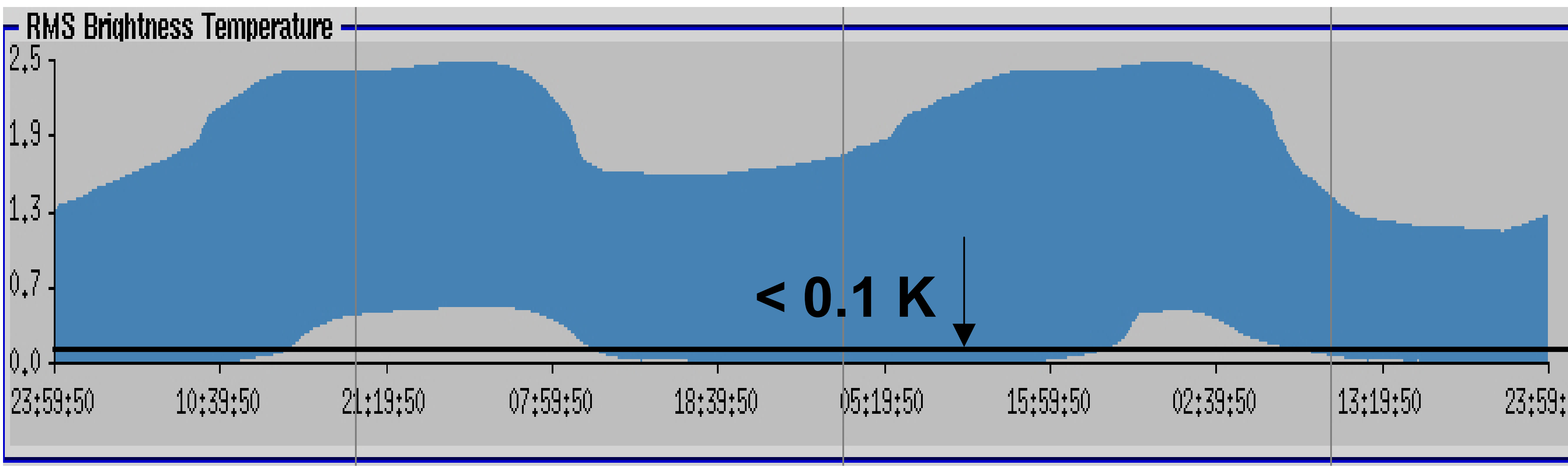
$$\tilde{r}_{ij}\left(-\frac{u\xi+v\eta}{f_o}\right)e^{-j2\pi(u\xi+v\eta)}\,d\xi\,d\eta$$

Flat Target Response (1)

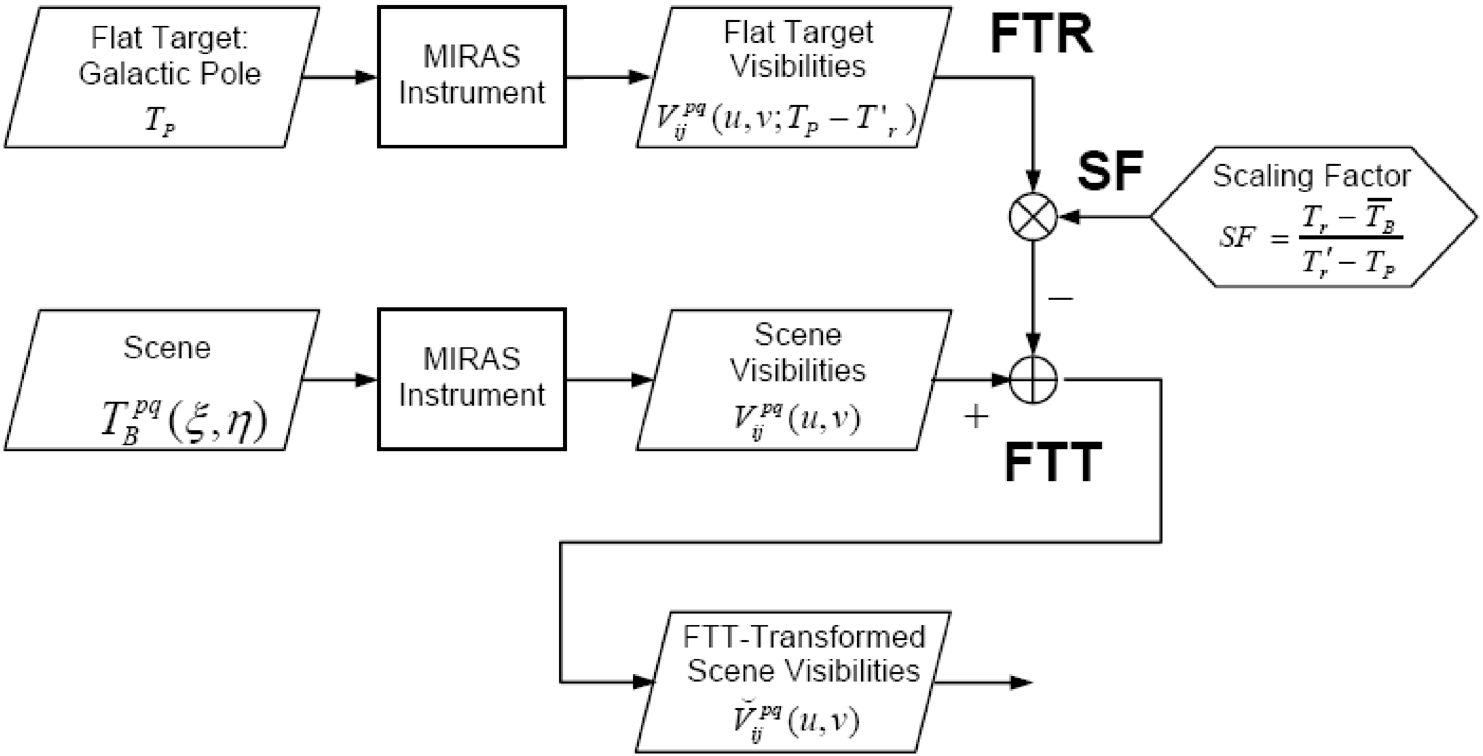


Flat Target Response (2)





Flat Target Transformation



$$\breve{V}_{ij}^{pq}(u,v) = V_{ij}^{pq}(u,v) - \frac{T_r - \overline{T}_B}{T'_r - T_P}\, V_{ij}^{pq}(u,v;T_P - T'_r)$$

Flat-Target-Transformed Corbella Equation

$$V_{ij}^{pq}(u,v) = 2k_B\sqrt{B_iB_j}\,\alpha_i\alpha_j\,\frac{1}{\sqrt{\Omega_i^p\Omega_j^q}}\times$$

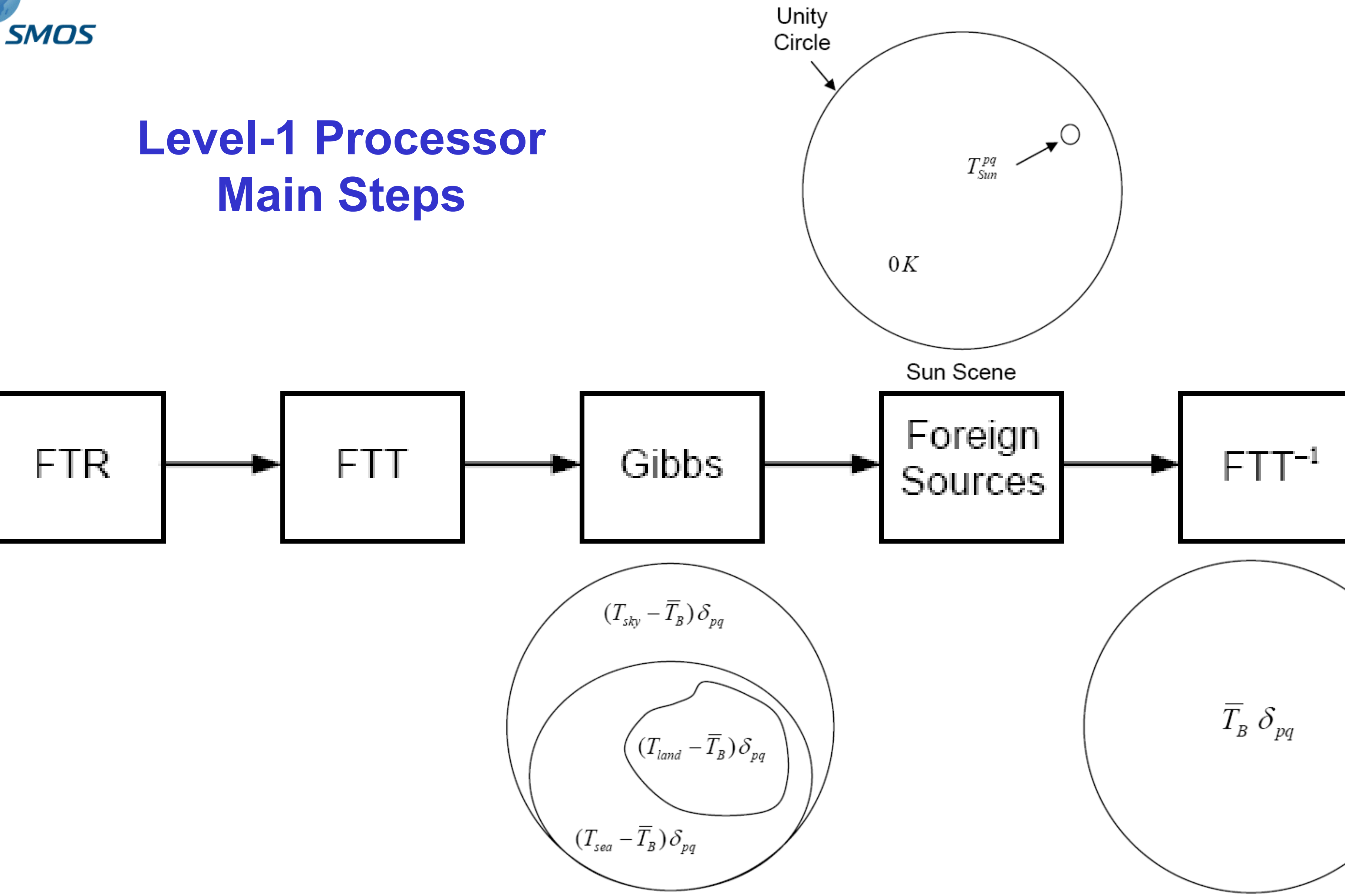
$$T_r \rightarrow$$

$$\iint\limits_{\xi^2+\eta^2\le 1} F_{n,i}^{\alpha,p}(\xi,\eta)\,F_{n,j}^{\beta,q*}(\xi,\eta)\,\frac{T_B^{\alpha\beta}(\xi,\eta)-\delta_{\alpha\beta}\overline{T}_B}{\sqrt{1-\xi^2-\eta^2}}$$

$$\tilde{r}_{ij}\left(-\frac{u\xi+v\eta}{f_o}\right)e^{-j2\pi(u\xi+v\eta)}\,d\xi\,d$$

Level-1 Processor Overview

Level-1 Processor Main Steps



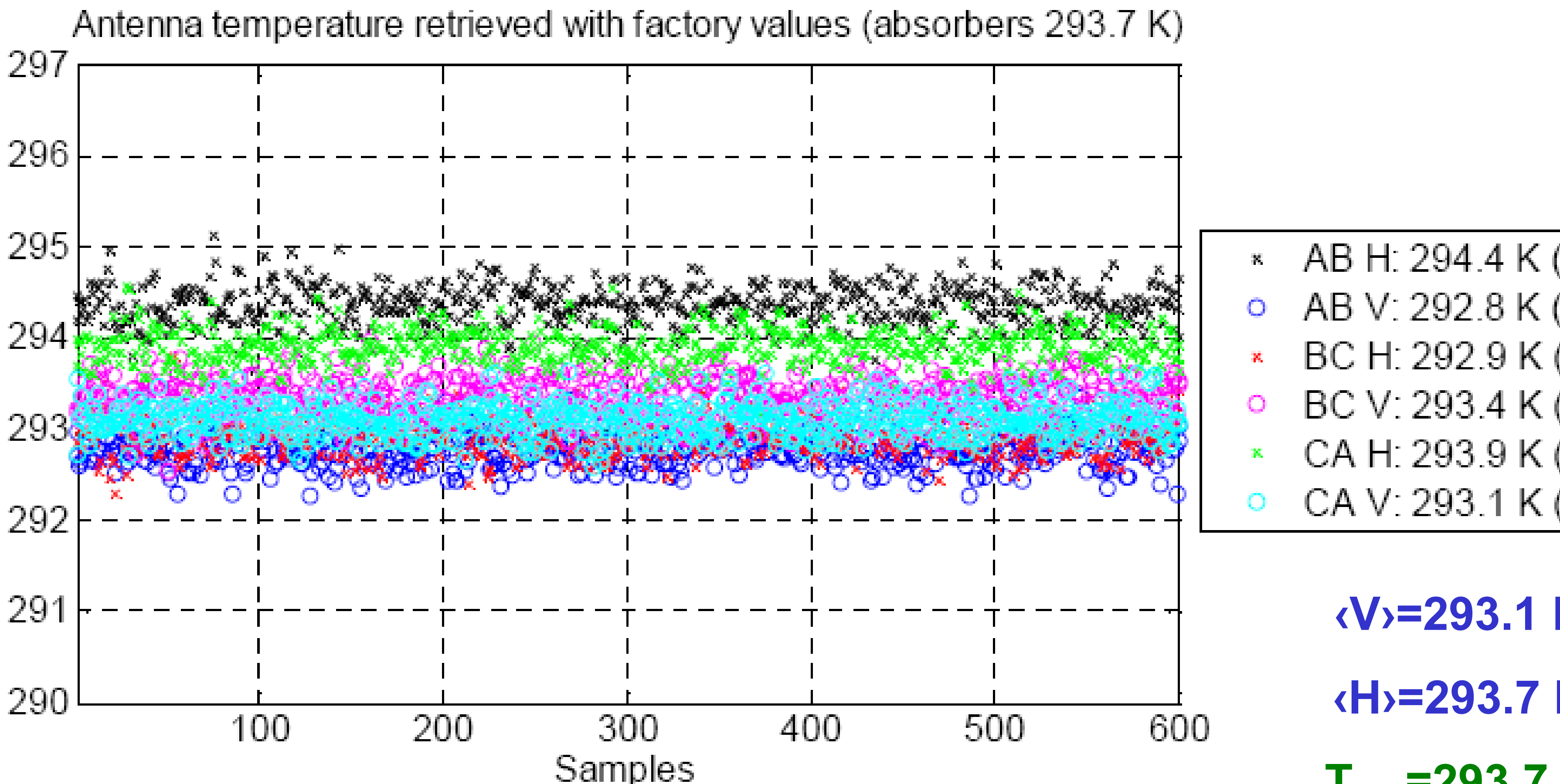
SMOS

NIR Variation over Temperature

$$V_{kj} = \frac{\sqrt{T_{sys,k} T_{sys,j}}}{G_{kj}} M_{kj}$$

Temperature Drift for a 220 K Scene (K/C)				
	10 C --> 35 C		35 C --> 10 C	
NIR Unit	HOT	WARM	HOT	WARM
AB H	0.15	0.22	0.11	0.18
AB V	0.02	0.09	0.02	0.04
BC H	0.02	0.02	0.02	0.09
BC V	0.07	0.09	0.02	0.07
CA H	0.07	0.11	0.04	0.11
CA V	0.07	0.09	0.02	0.04
Specification	< 0.2 K/C ; 0.02 K/C with compensation			

NIR Accuracy (using factory values)



‹V›=293.1

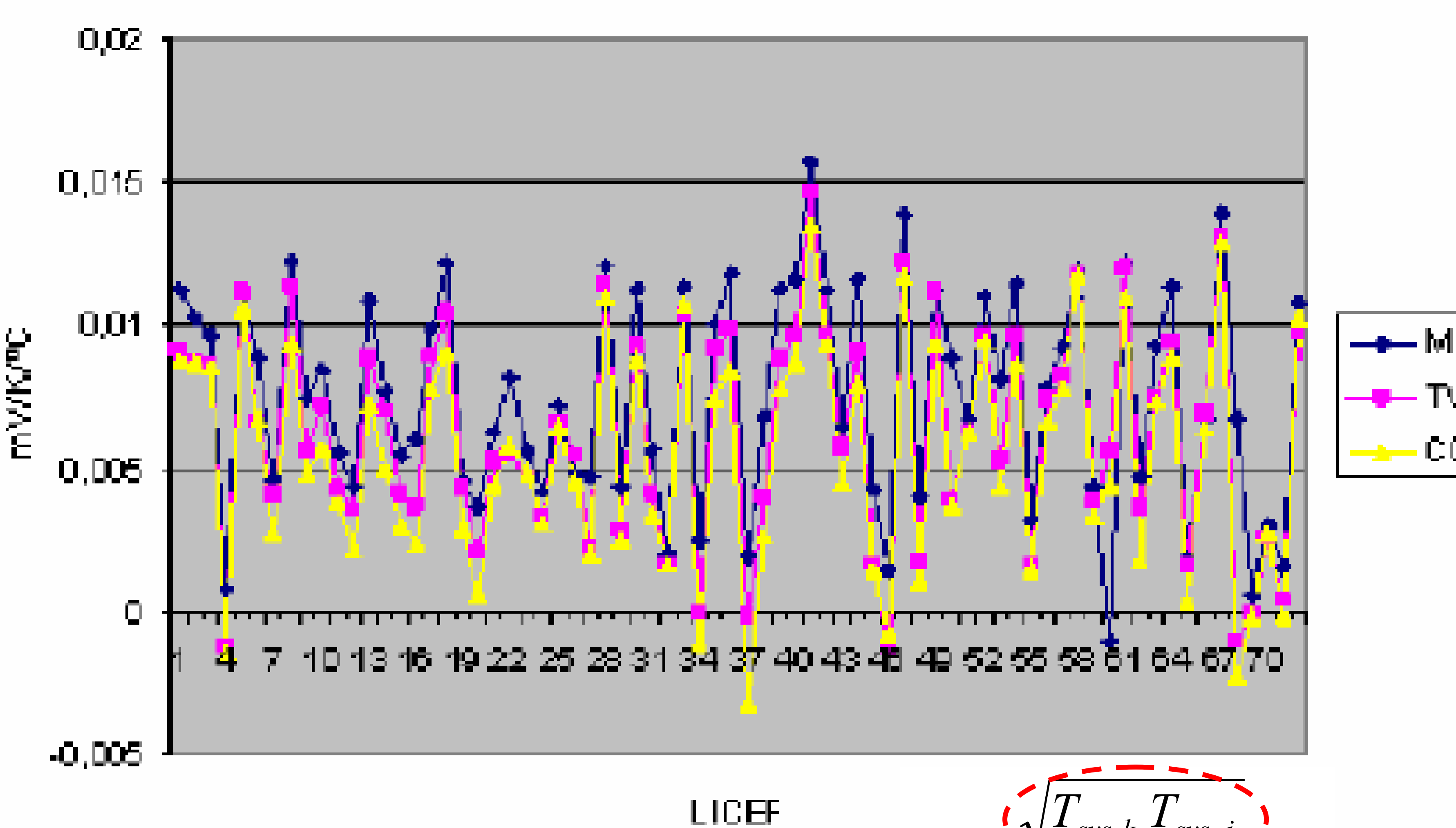
‹H›=293.7

T_{abs}=293.7

NIR antenna temperature using factory values

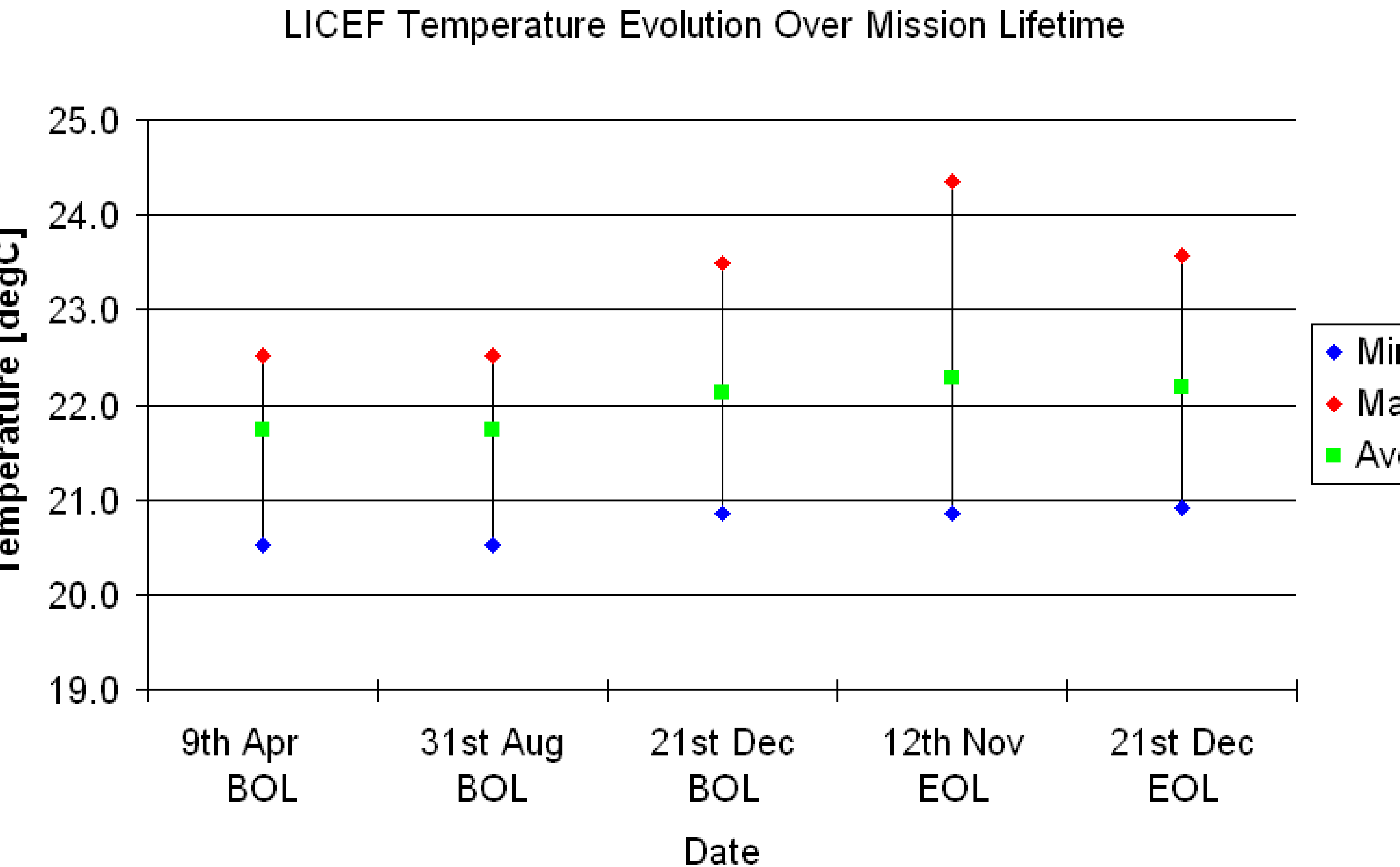
Performance over Temperature

PMS Variation over Temperature



$$V_{kj} = \frac{\sqrt{T_{sys,k}\, T_{sys,j}}}{G_{kj}} M_{kj}$$

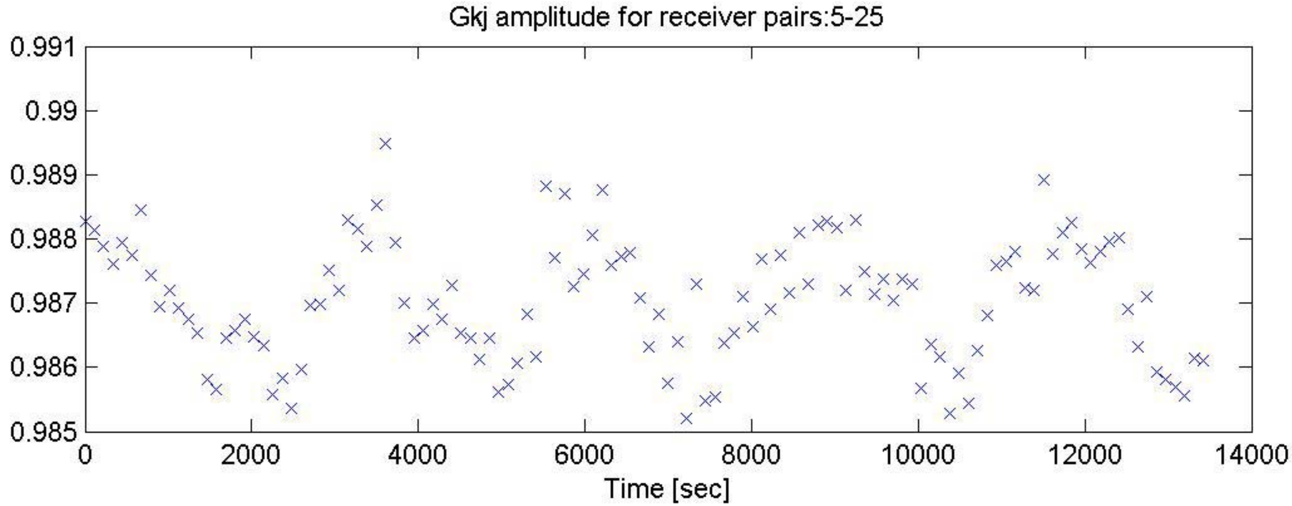
Performance over Temperature



Performance over Temperature

SMOS

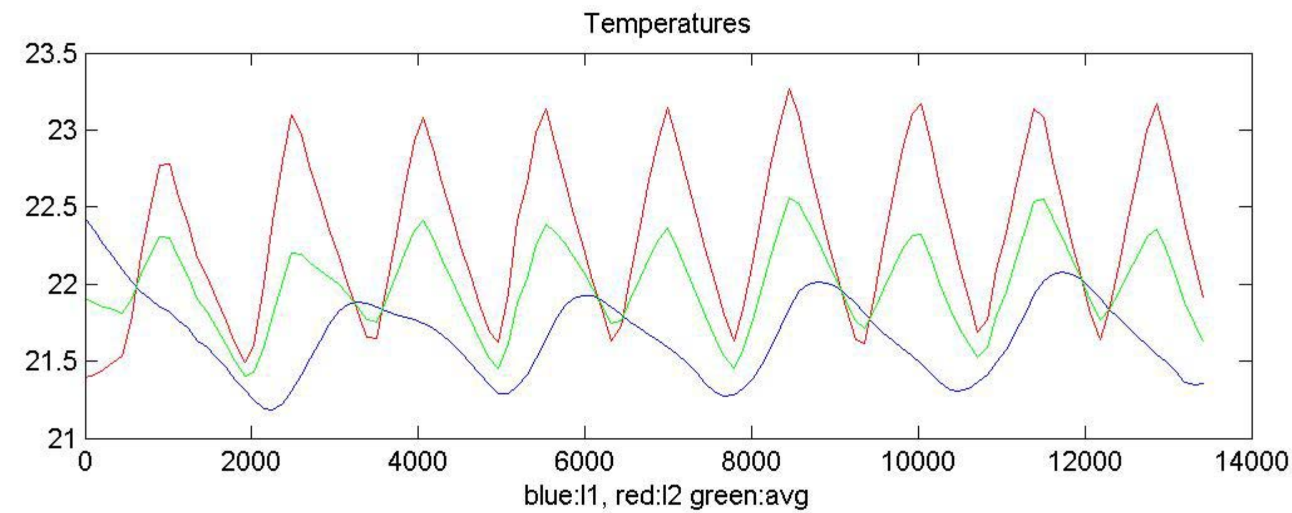
| Gkj | Variation over Temperature



$$V_{kj} = \frac{\sqrt{T_{sys,k} \, T_{sys,j}}}{G_{kj}}$$

| Gkj | < 0.3 %

(worst baselin

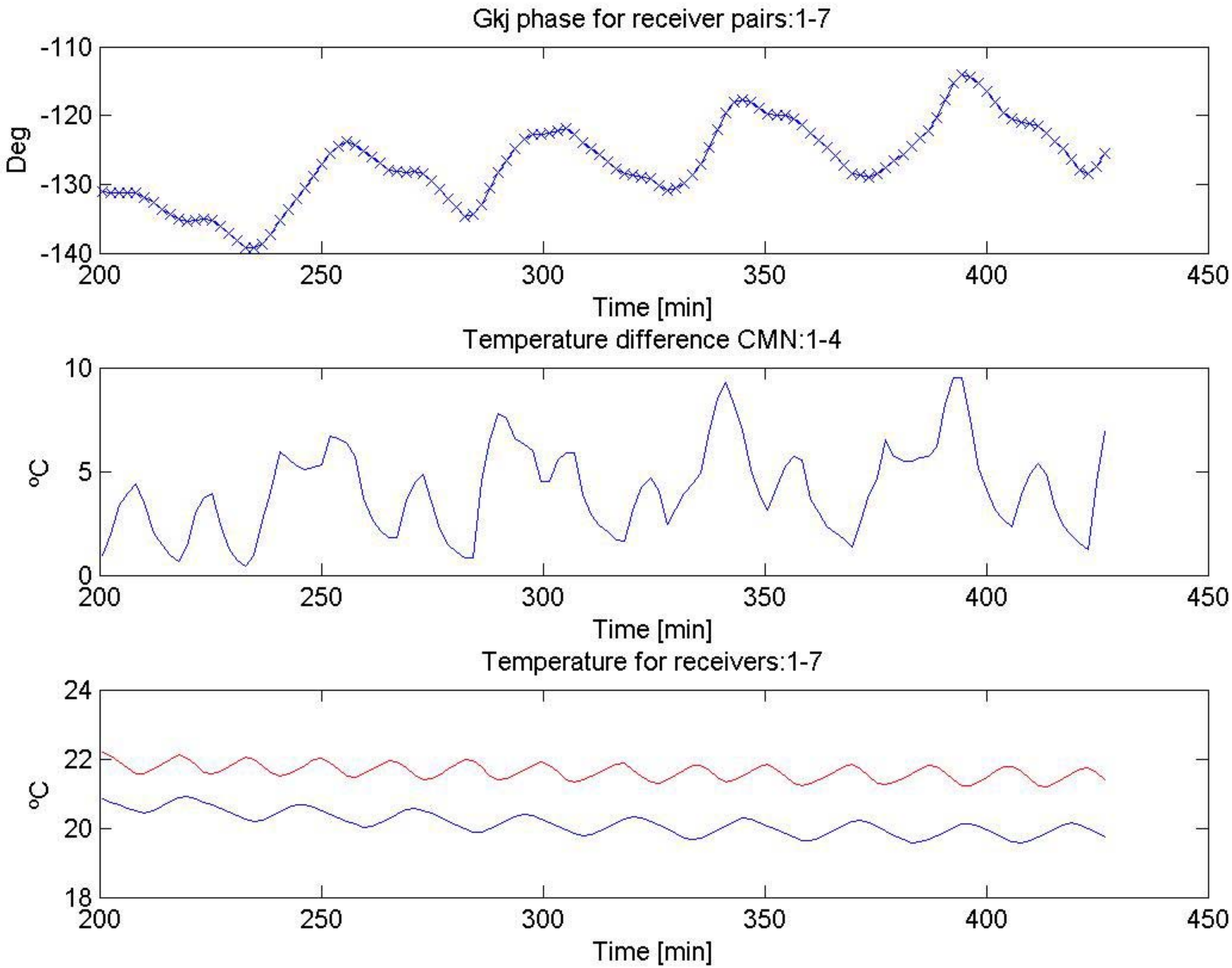


LICEF temperatu

(same baselin

SMOS

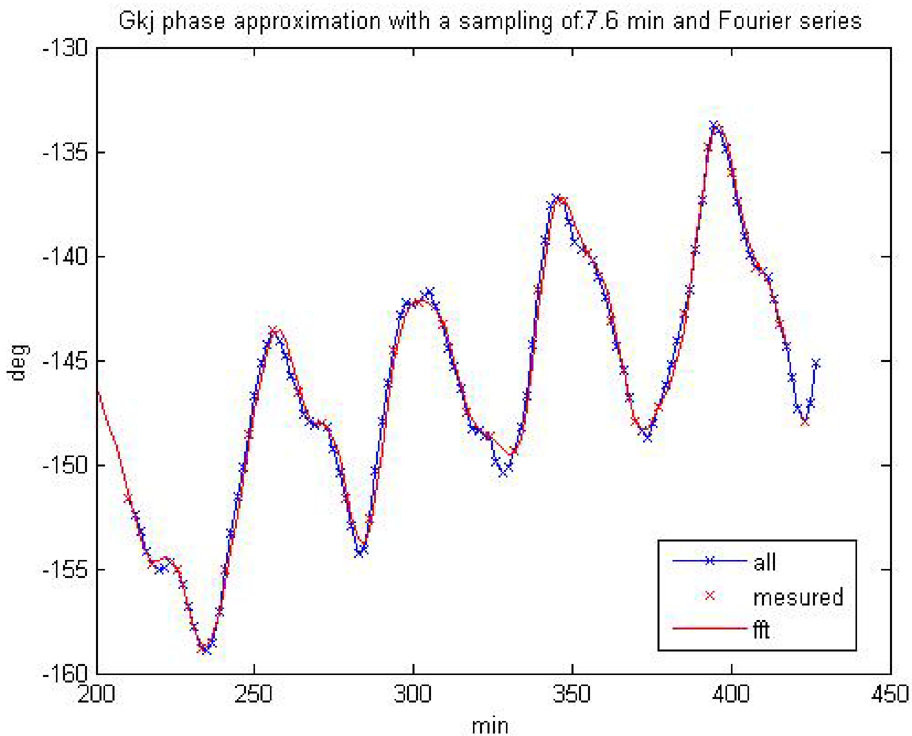
Phase of Gkj and Mkj over Temperature

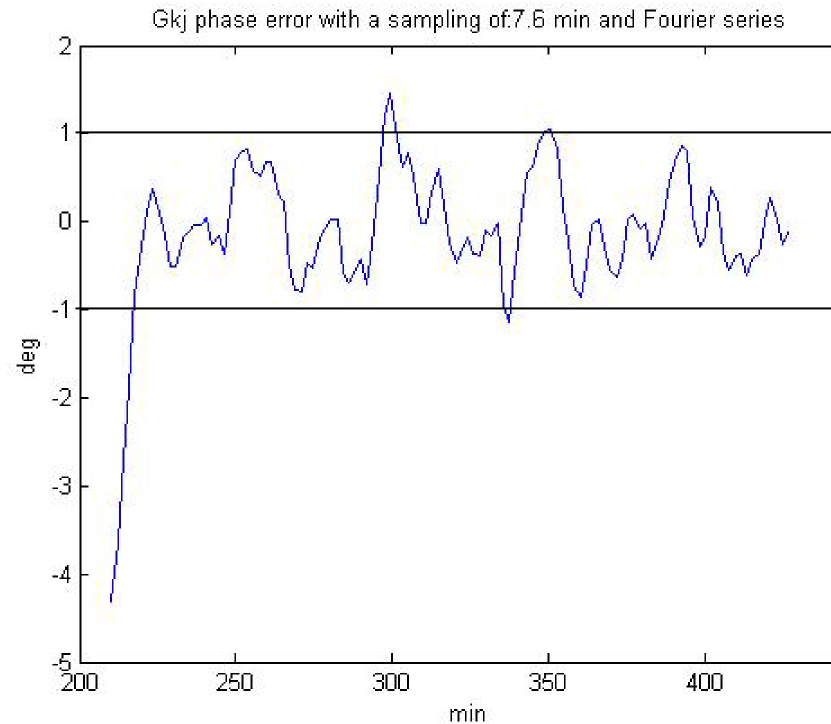


Arg {Gkj} = 16°

$$V_{kj} = \frac{\sqrt{T_{sys,k}\,T_{sys,j}}}{G_{kj}}$$

LO phase variation tracking (LO calibration)

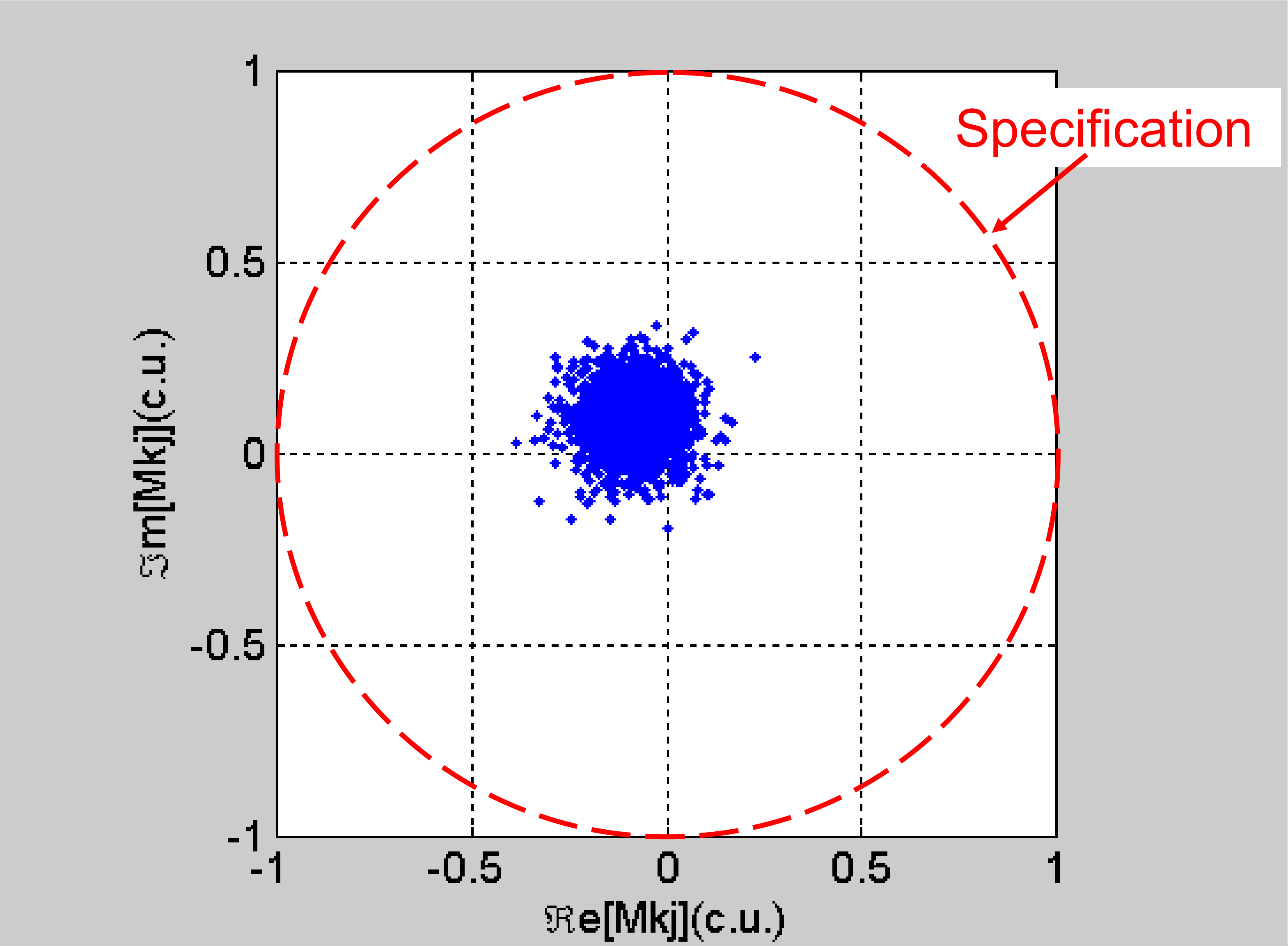




- requires periodic noise injections (LO calibration);
- objective is to have final peak-to-peak phase variations below 1°

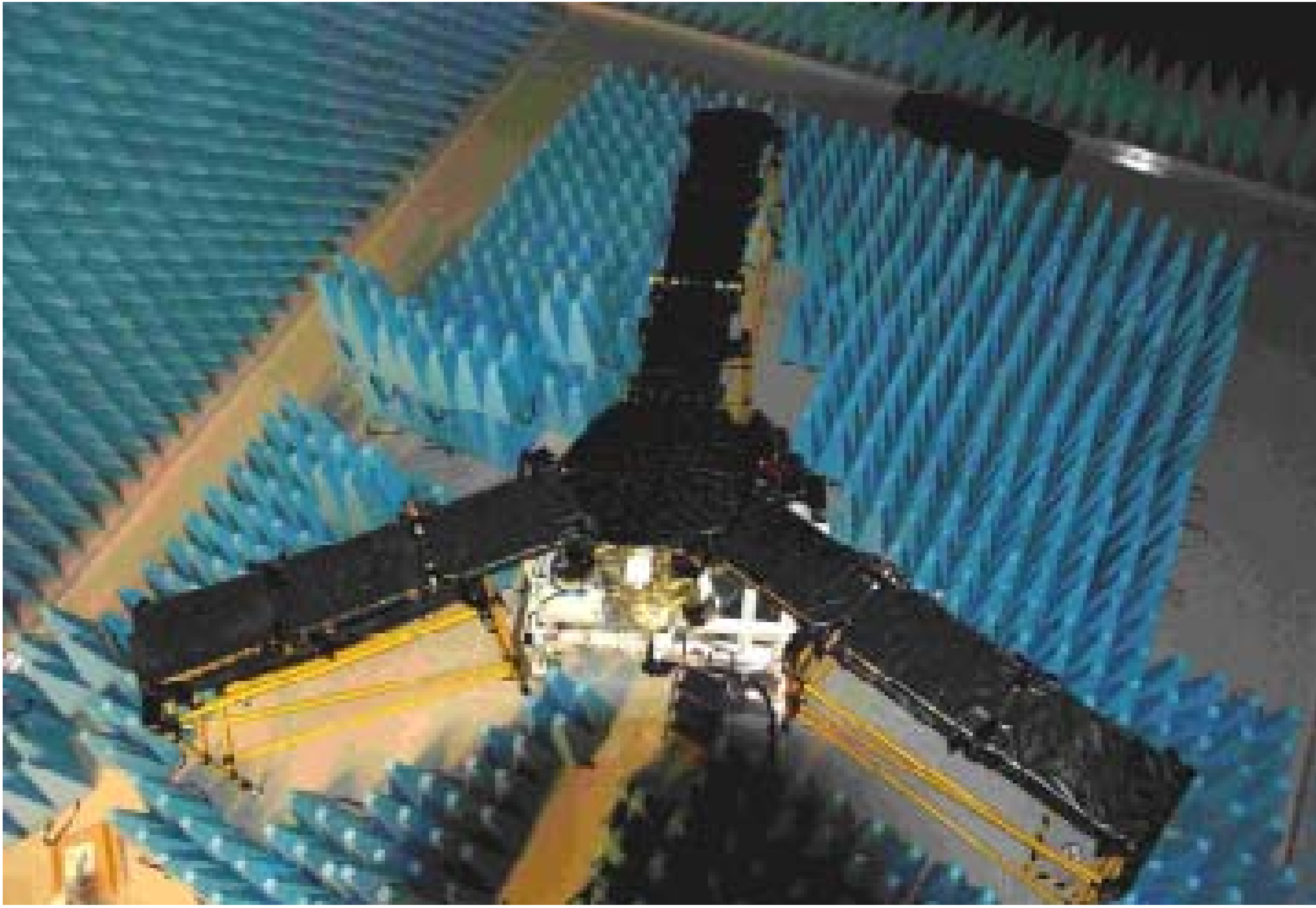
SMOS

Correlation Offsets (1 cu = 10^{-4})



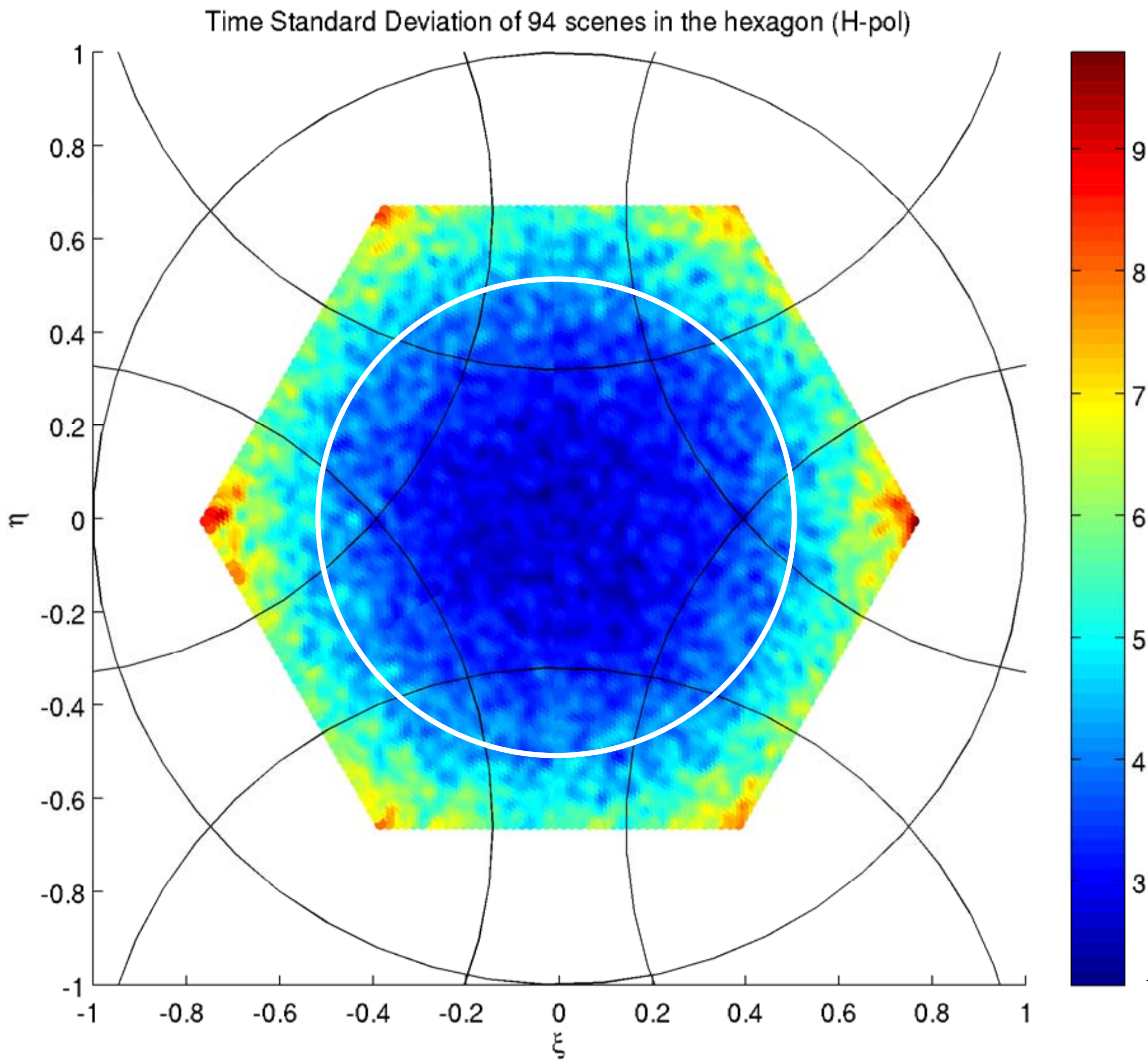
Sensitivity

MIRAS in the Maxwell EMC Chamber



SMOS

H-pol Final Image Radiometric Resolution



˜3 dB bea

4.6 K

boresig

2.3 K

Sensitivity

SRD Requirement	System Parameter	Specified Value	From IVT (IDEAL reconstruction)
R-4.5.2-002-a,b	Level-1 SM Radiometric Sensitivity 220 K	**3.5 K RMS (00)** **5.8 K RMS (32)**	**1.97 K RMS** **3.94 K RMS**
R-4.5.3-002-a,b	Level-1 OS Radiometric Sensitivity 150 K	**2.5 K RMS (00)** **4.1 K RMS (32)**	**1.65 K RMS** **3.31 K RMS**

- there are around 65 snapshots (H or V) along track;

- the along track effective sensitivity (per pass) for ocean is then

(1.65+3.31)/2sqrt(65) = 0.31 K