JET PROPULSION LABORATORY **SIRTF IPF REPORT**

JPL ID01P095
September 26, 2003

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 01P095
REPORT TYPE: IOC EXECUTION (PRECOARSE)

PRIME FRAME: MIPS_24um_center (95)
INFERRED FRAMES: (96) (99) (100) (103) (104)

IPF TEAM

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1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN01P095. In particular, this Focal Point Survey calibrates the instrument: MIPS_24um_center (95), as part of the IOC Precoarse Survey. The main calibration results from the IPF filter execution have been documented in IF01P095 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 8 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

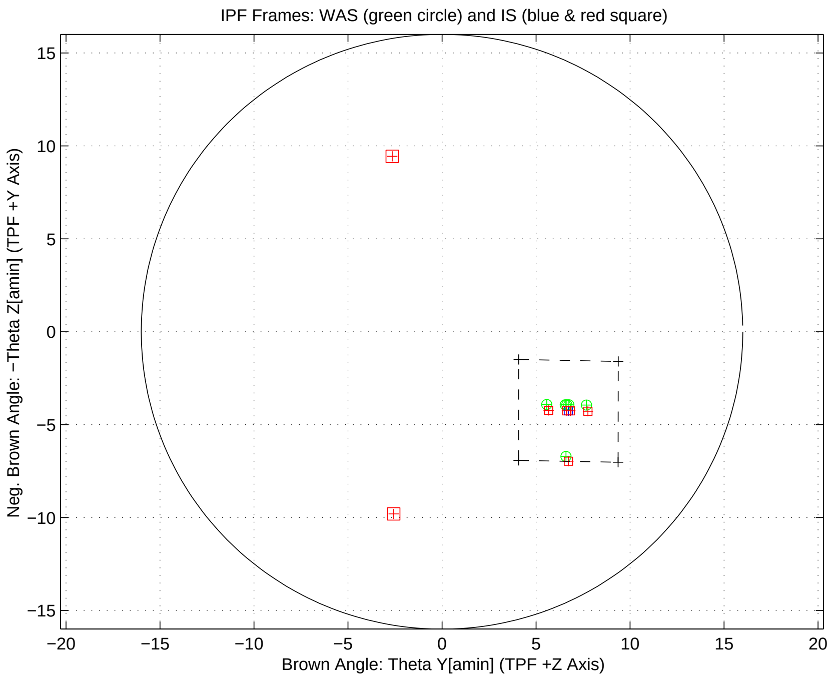

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA02P095	AA02P095
AS01P095	AS01P095
CA01P095	CA01P095
CB91P095	CB91P095
CS03P095	CS03P095

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.0B
Frame Table Version Used	BodyFrames_SPC_06a
Scan-Mirror Employed?	YES
IPF Filter Mode	LITE-MODE(3):FLT
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	25
LS Residual Sigma Scale	3.03086823E+000
Total Number of Maneuvers	1

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: IOC Precoarse Survey.
INSTRUMENT NAME: MIPS_24um_center NF: 95

```
PIX2RADW: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]
PIX2RADV: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	TOTAL	REQ
095(P)	MIPS_24um_center	4.2949	0.0855	4.2958	1.00
096(I)	MIPS_24um_plusY_edge	4.5722	0.0855	4.5730	N/A
099(I)	MIPS_24um_small_FOV1	4.3079	0.0855	4.3088	N/A
100(I)	MIPS_24um_small_FOV2	4.3037	0.0855	4.3045	N/A
103(I)	MIPS_24um_large_FOV1	4.2953	0.0855	4.2961	N/A
104(I)	MIPS_24um_large_FOV2	4.2948	0.0855	4.2957	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[3]	A POSTERIORI[3]	ATT. CORRECTED[4]	UNITS
Radial	20.8889	1.4895	1.4893	arcsec
W-Axis	5.1420	1.1569	1.1570	arcsec
V-Axis	20.2462	0.9381	0.9377	arcsec
Radial	8.3783	0.5974	0.5973	pixels
W-Axis	2.0624	0.4640	0.4640	pixels
V-Axis	8.1205	0.3763	0.3761	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 3.030868. It is assumed that the gyro Angle Random Walk contribution is captured with the Least Squares scaling. The gyro ARW contribution can be approximately calculated as 0.1712 arcseconds, given that ARW = 100 $\mu deg/\sqrt{hr}$, with 4.069530e+002 second Maneuver time (max), and 1 independent Maneuvers.

[2]Gyro Scale Factor(GSF) assumes 95 ppm error over 0.250 degree maneuver.

[3]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[4]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY					
FRAME TABLE USED: BodyFrames_SPC_06a					
NF	NAME	WAS	IS	CHANGE	UNIT
095	theta_Y	+6.641000	+6.724001	+0.083001	arcmin
095	theta_Z	+3.931000	+4.258239	+0.327239	arcmin
095	angle	+0.000000	+0.577299	+0.577299	deg
096	theta_Y	+6.595000	+6.721218	+0.126218	arcmin
096	theta_Z	+6.712000	+6.970374	+0.258374	arcmin
096	angle	-0.000000	+0.577299	+0.577299	deg
099	theta_Y	+7.687000	+7.758095	+0.071095	arcmin
099	theta_Z	+3.943000	+4.277861	+0.334861	arcmin
099	angle	-0.000000	+0.577299	+0.577299	deg
100	theta_Y	+5.574000	+5.669225	+0.095225	arcmin
100	theta_Z	+3.918000	+4.238226	+0.320226	arcmin
100	angle	+0.000000	+0.577299	+0.577299	deg
103	theta_Y	+6.746000	+6.827410	+0.081410	arcmin
103	theta_Z	+3.932000	+4.260201	+0.328201	arcmin
103	angle	+0.000000	+0.577299	+0.577299	deg
104	theta_Y	+6.558000	+6.641274	+0.083274	arcmin
104	theta_Z	+3.930000	+4.256670	+0.326670	arcmin
104	angle	+0.000000	+0.577299	+0.577299	deg

Table 1.6: IPF Brown angle summary

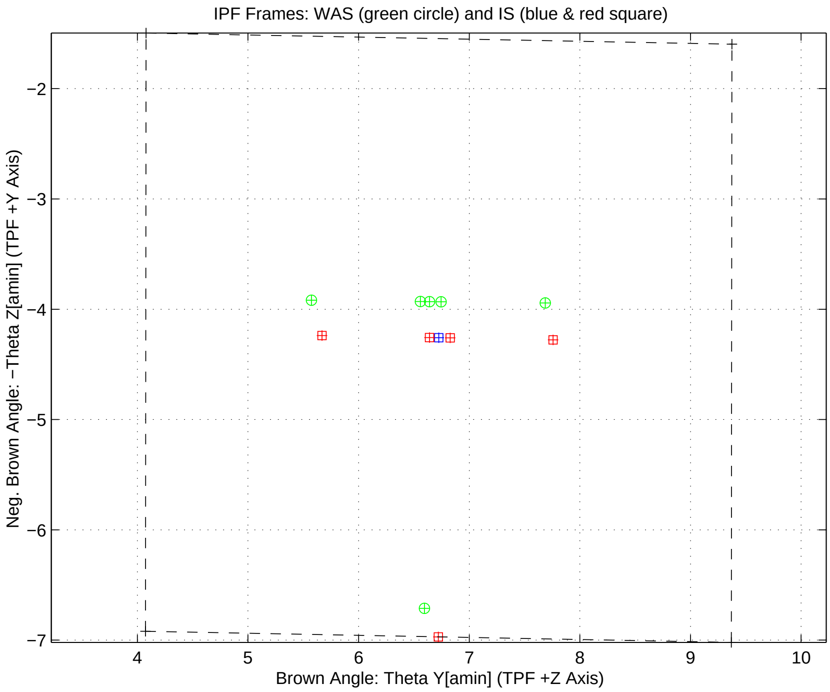

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 IPF INPUT FILE HISTORY

WAS	SIZE	IS	SIZE	REMOVED	PATCHED
AA02P095	UNCHANGED	AA02P095	UNCHANGED	0	0
CA01P095	UNCHANGED	CA01P095	UNCHANGED	0	N/A
CB91P095	UNCHANGED	CB91P095	UNCHANGED	0	N/A

Table 2.1: IPF input file editing status

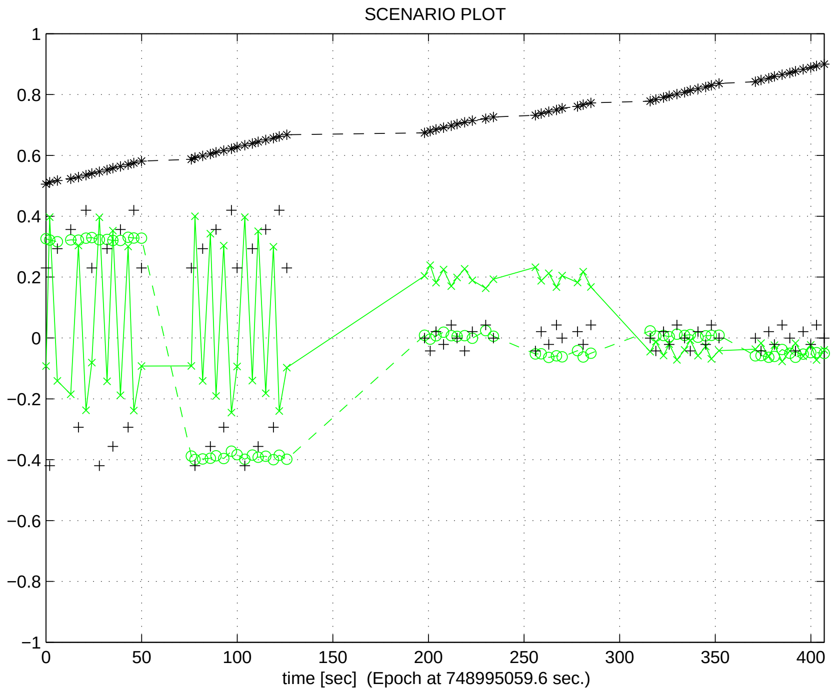

Figure 2.1: Scenario Plot

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
	Predicted performance prior to IPF run
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
	IPF filter performance (post run results)
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.13	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	KF innovations with (o) and w/o (+) attitude corrections (PCRS)
Figure 3.17	W-axis KF innovations and 1-sigma bound
Figure 3.18	V-axis KF innovations and 1-sigma bound
	IPF parameter trending plots
Figure 3.19	Estimated attitude corrections (Body frame)
Figure 3.20	Estimated attitude error sigma plot (Body frame)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.22	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.25	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

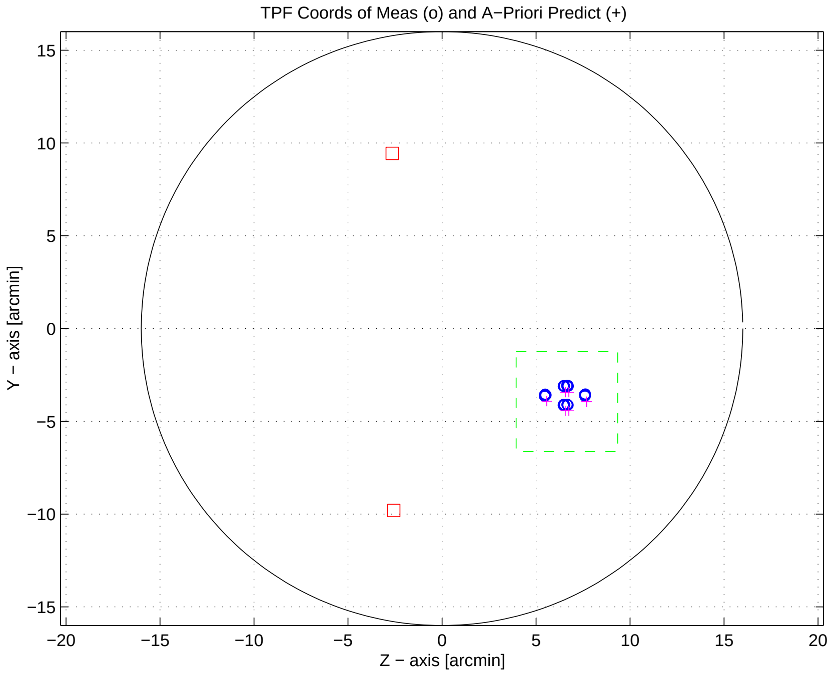

Figure 3.1: TPF coords of measurements and a-priori predicts

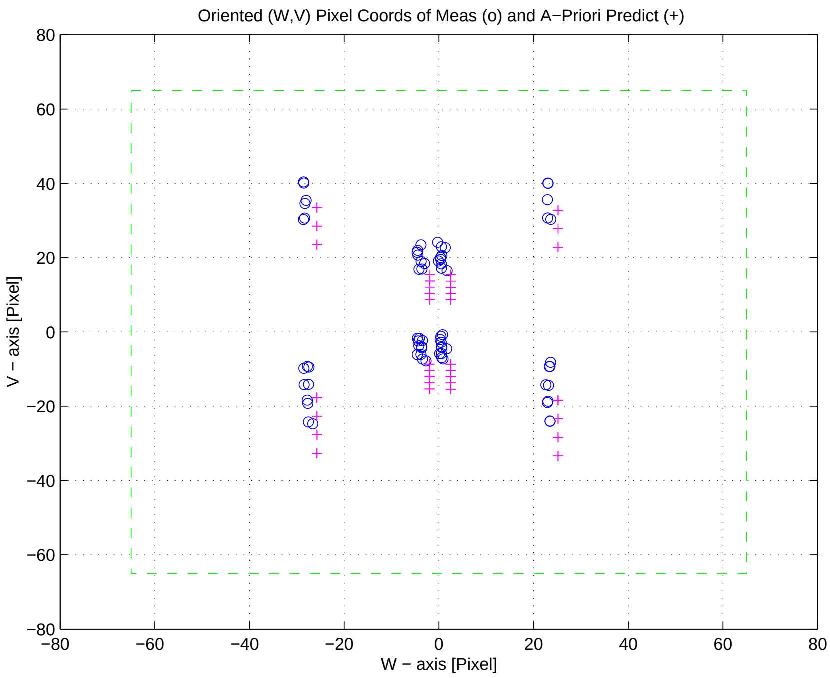

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

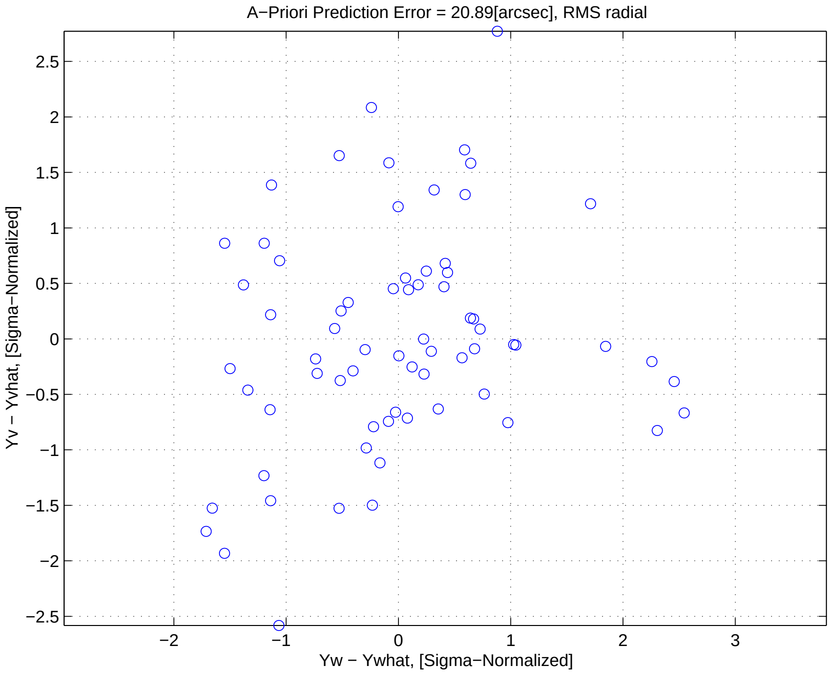

Figure 3.3: A-priori prediction error

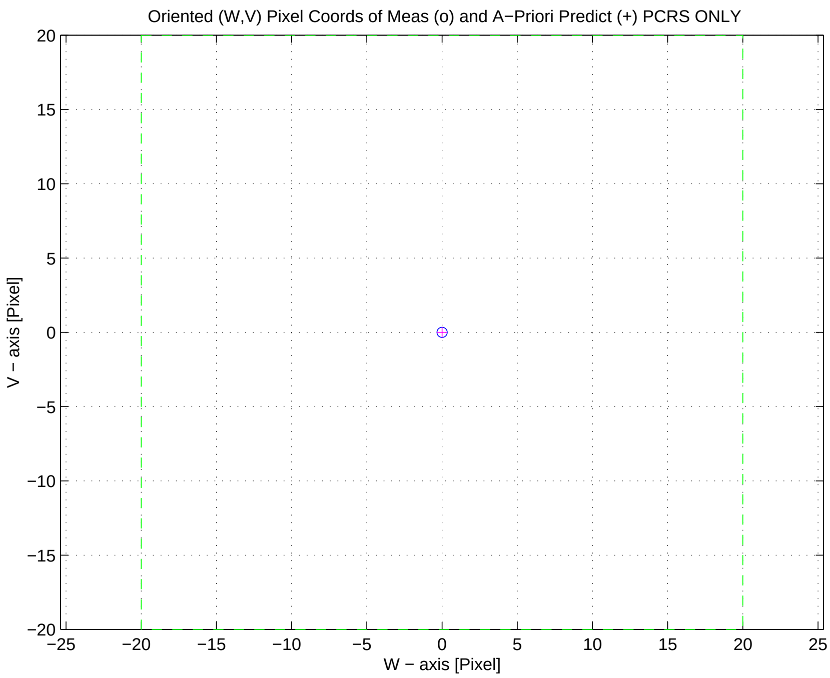

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

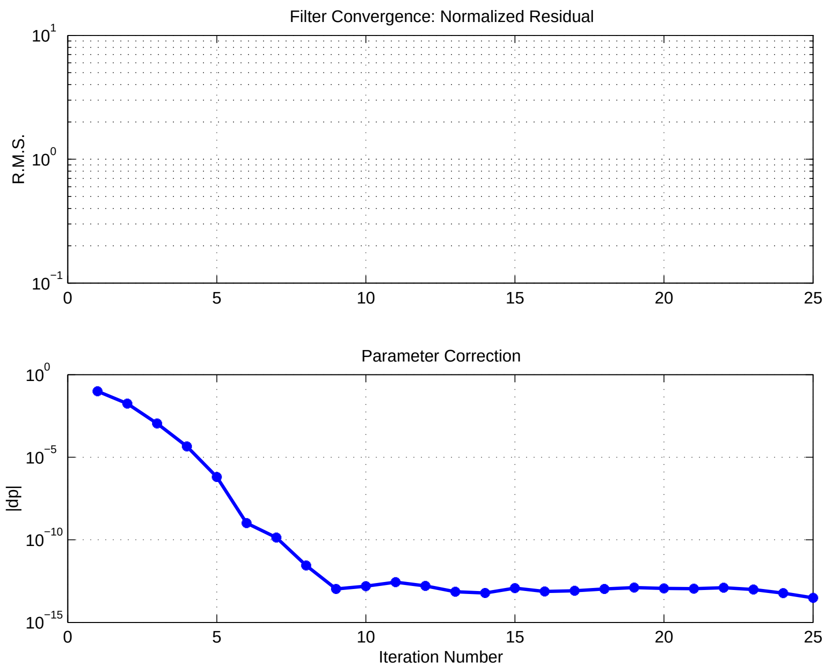

Figure 3.5: IPF execution convergence, chart 1

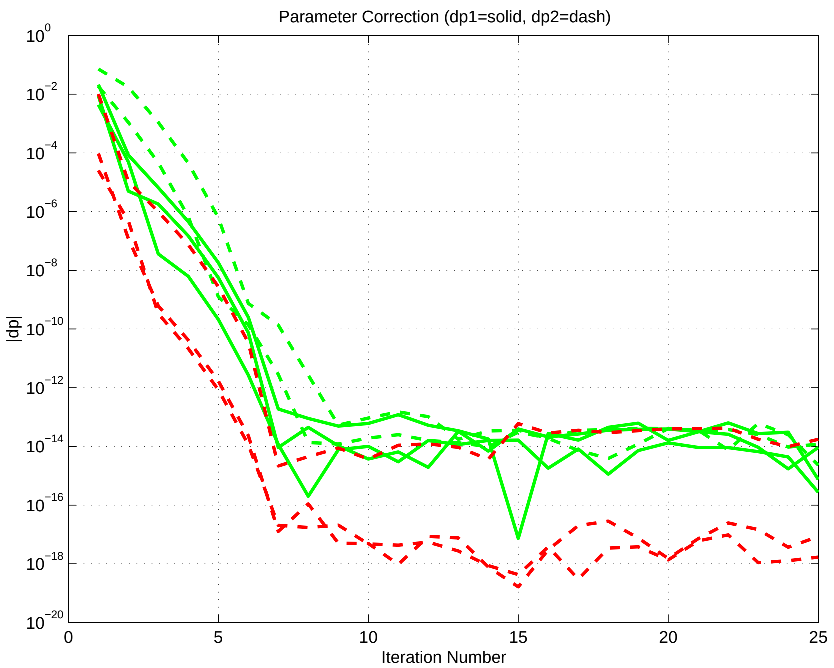

Figure 3.6: IPF execution convergence, chart 2

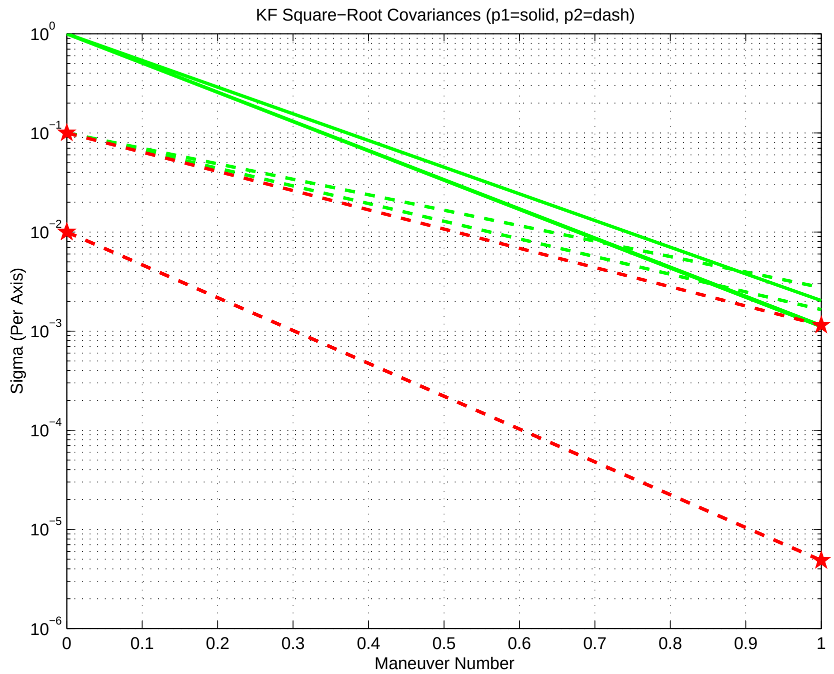

Figure 3.7: Parameter uncertainty convergence

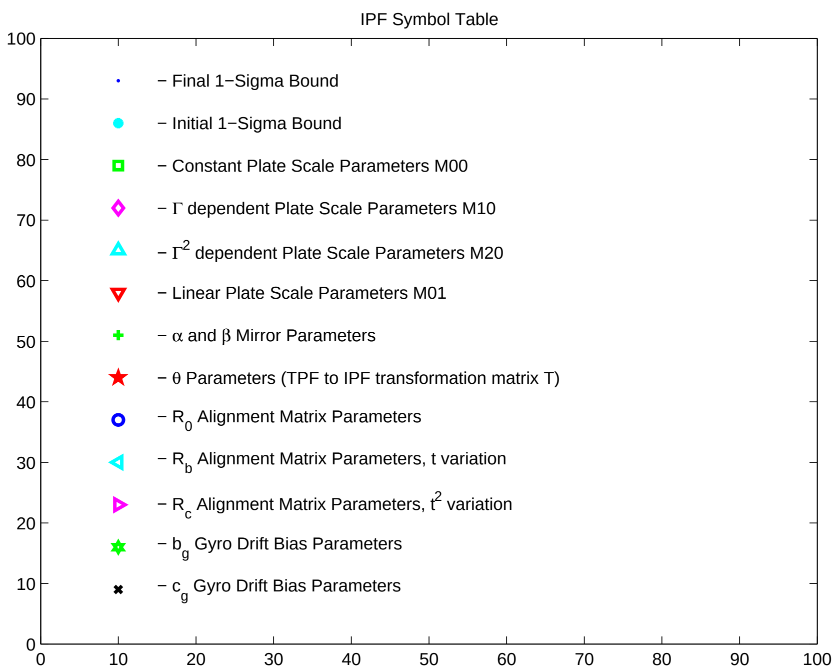

Figure 3.8: IPF parameter symbol table

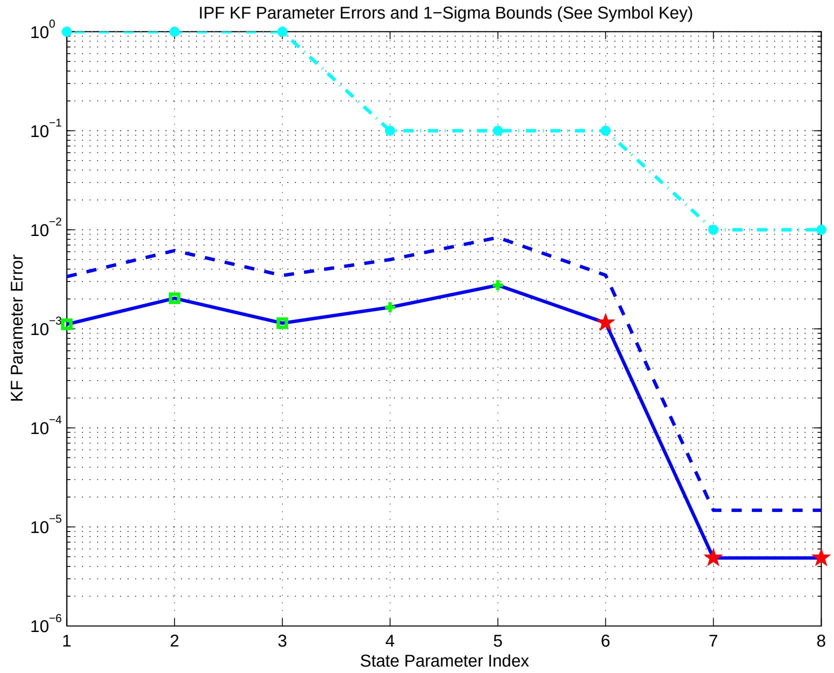

Figure 3.9: KF parameter error sigma plots

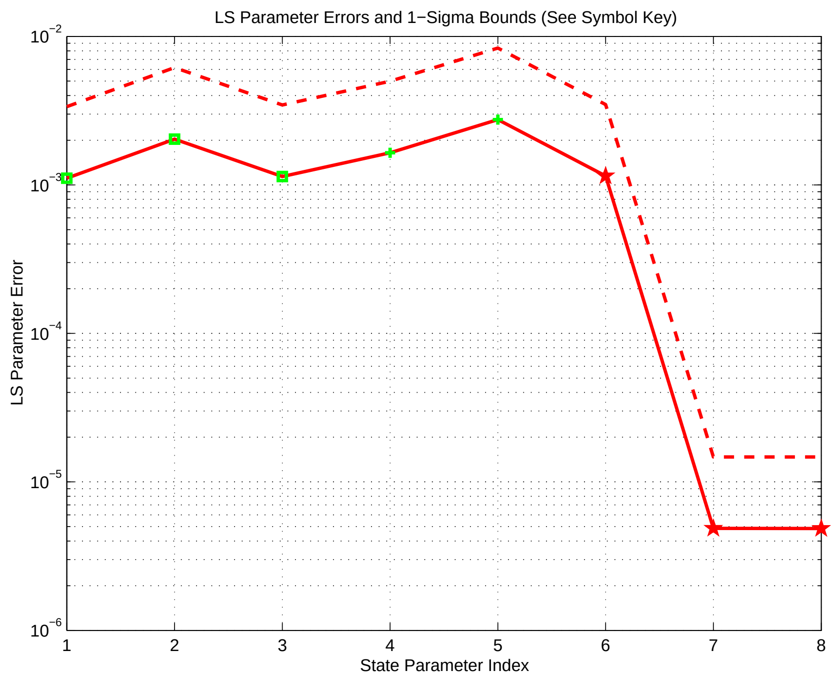

Figure 3.10: LS parameter error sigma plot

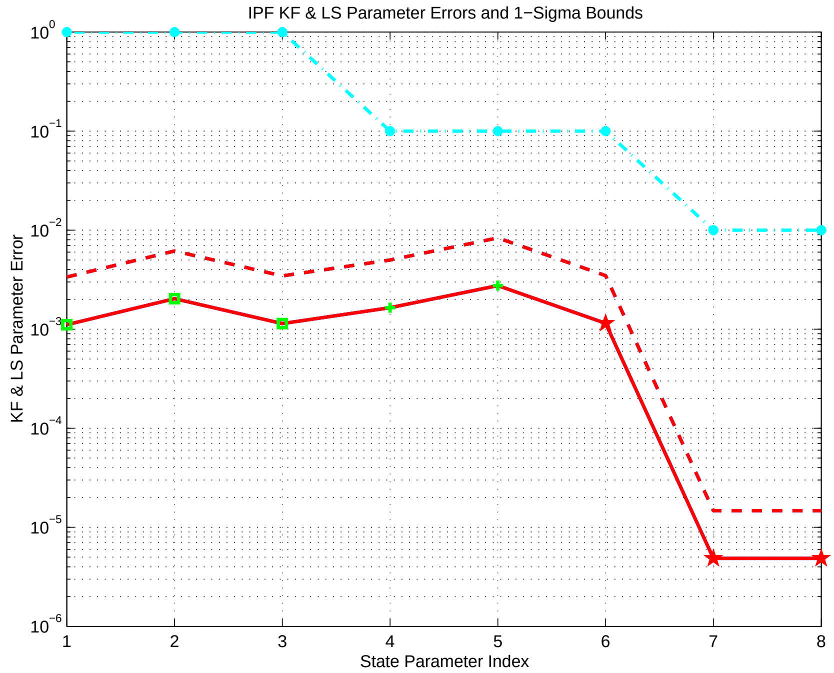

Figure 3.11: KF and LS parameter error sigma plot

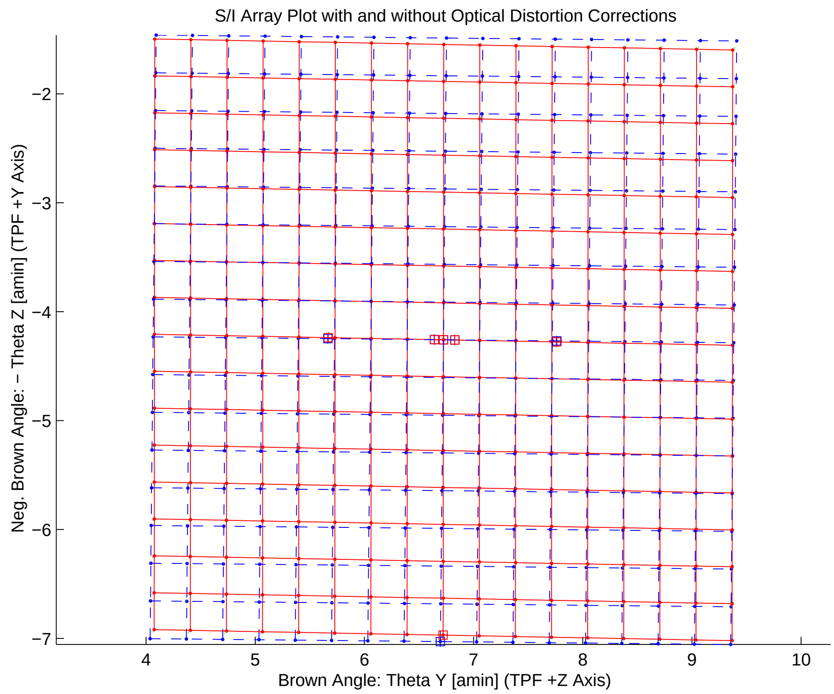

Figure 3.12: Array plot with (solid) and w/o (dashed) optical distortion corrections

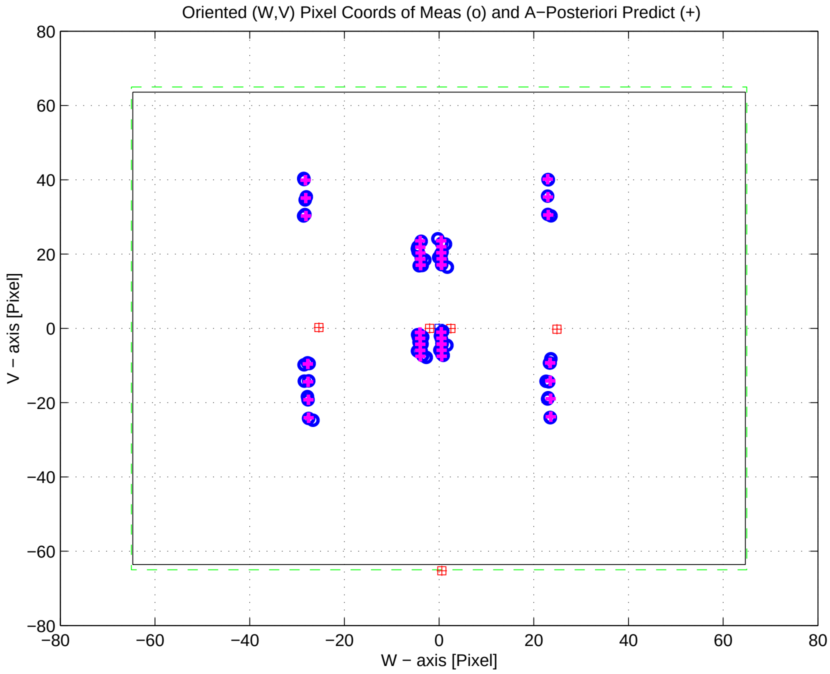

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts

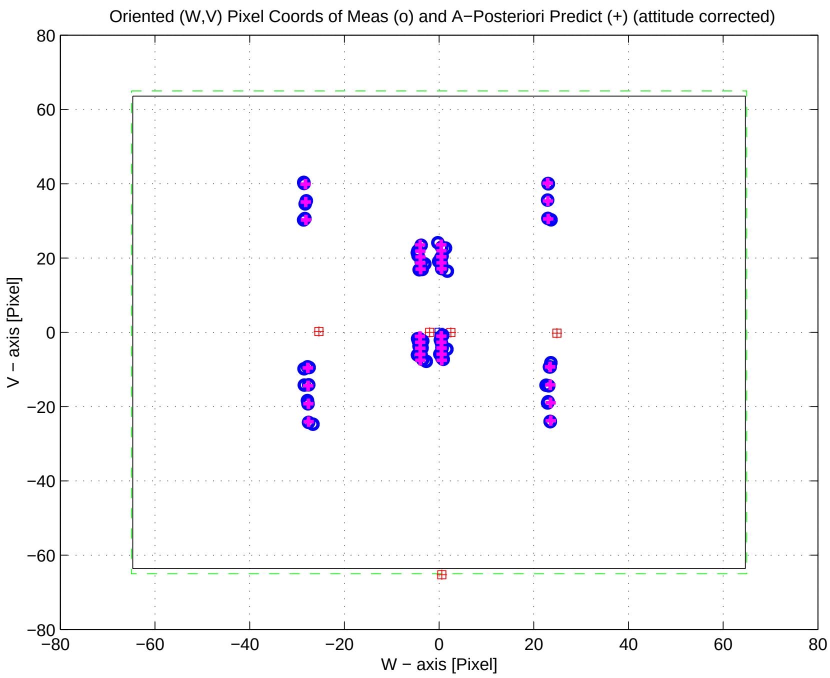

Figure 3.14: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

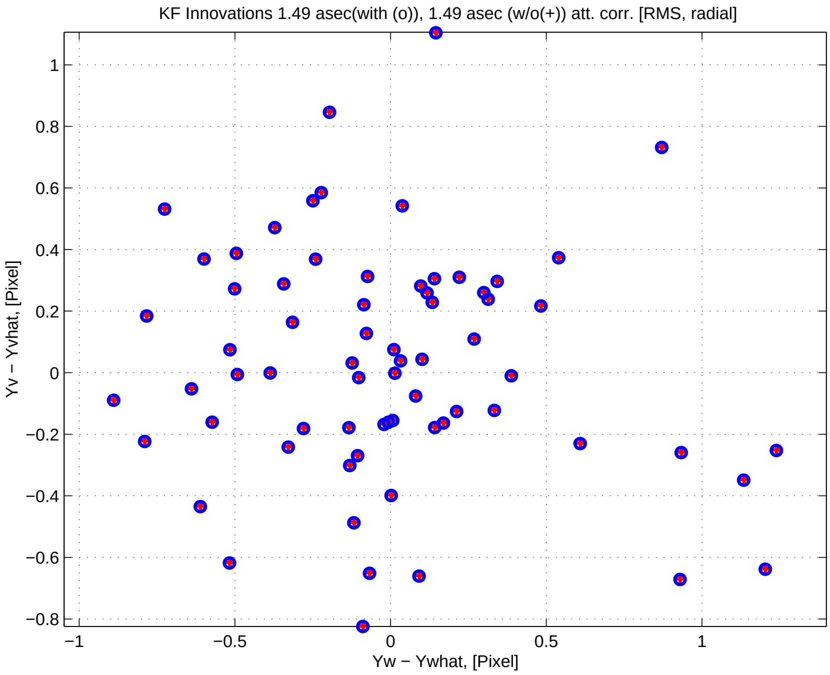

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

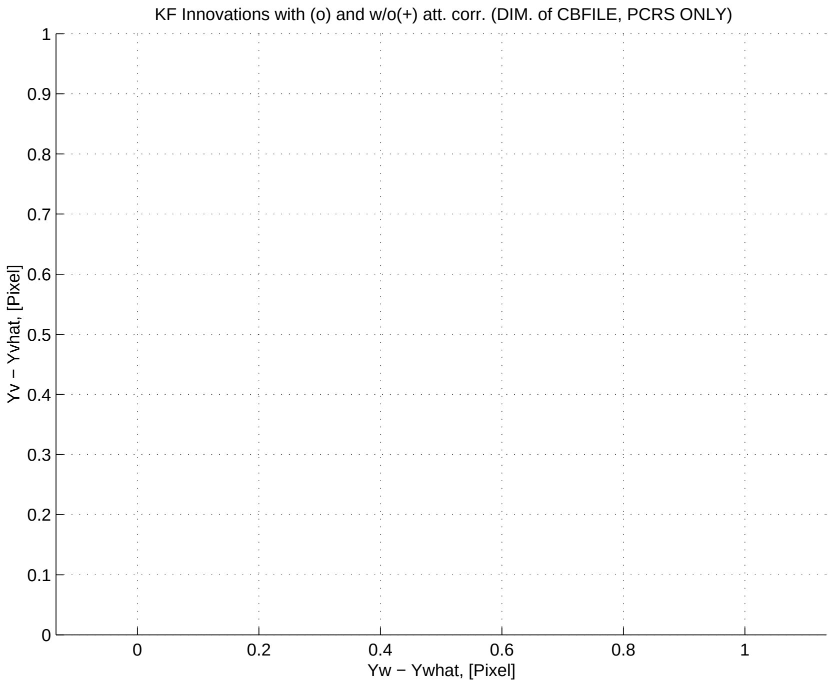

Figure 3.16: KF innovations with (o) and w/o (+) attitude corrections (PCRS)

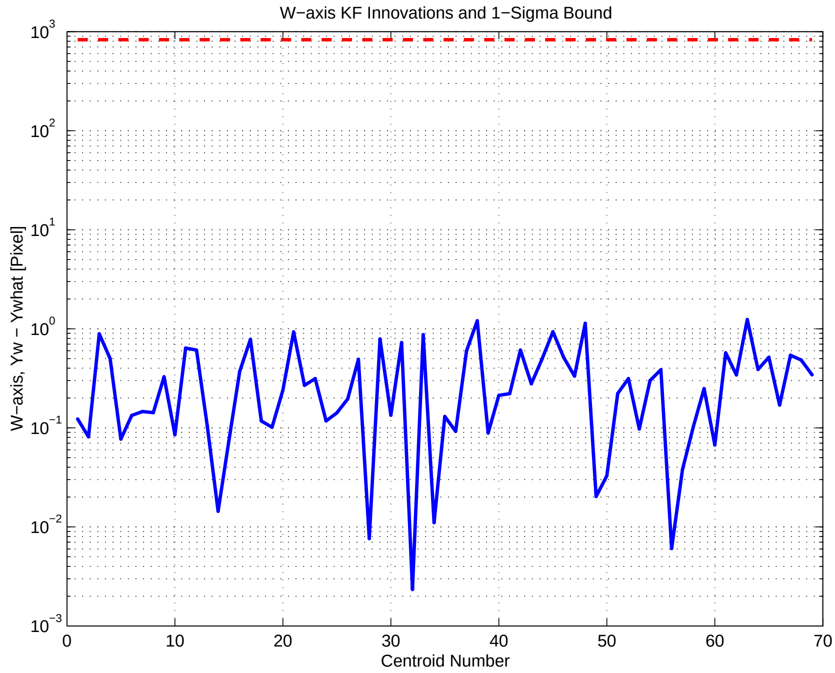

Figure 3.17: W-axis KF innovations and 1-sigma bound

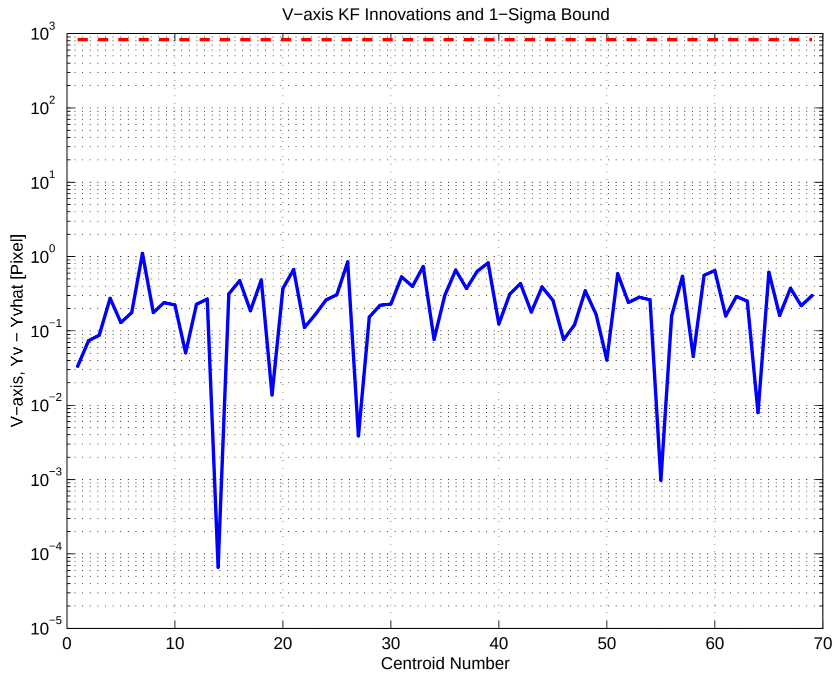

Figure 3.18: V-axis KF innovations and 1-sigma bound

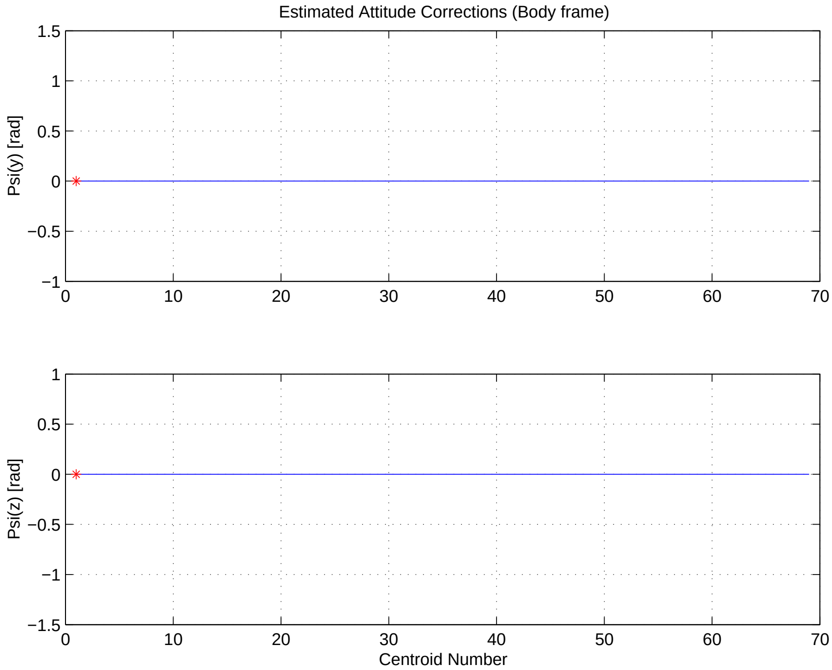

Figure 3.19: Estimated attitude corrections (Body frame)

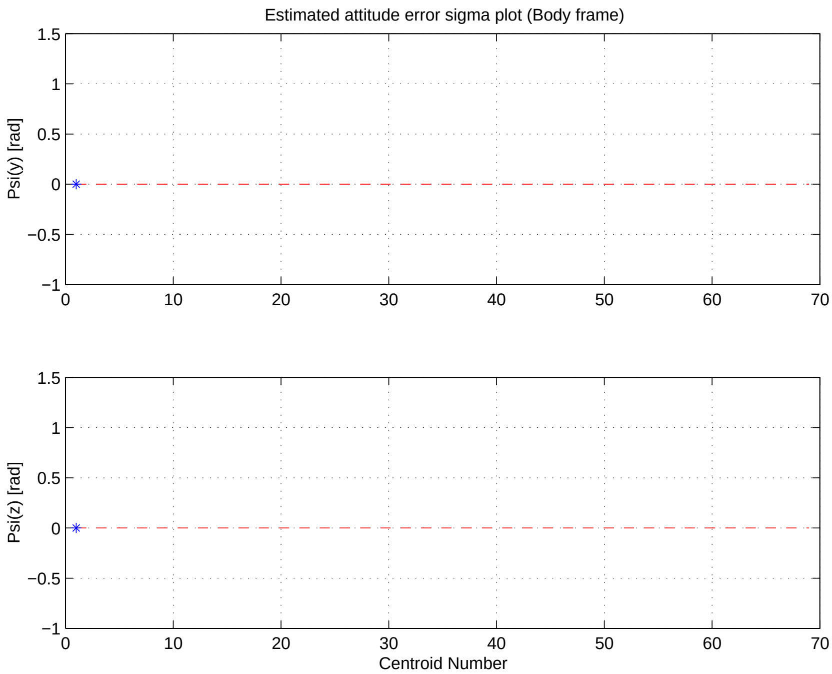

Figure 3.20: Estimated attitude error sigma plot (Body frame)

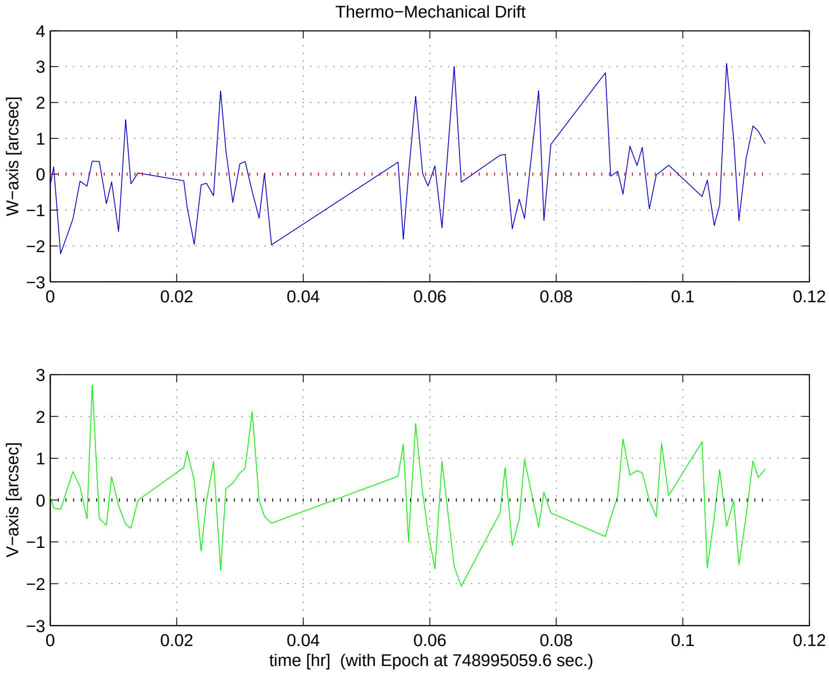

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

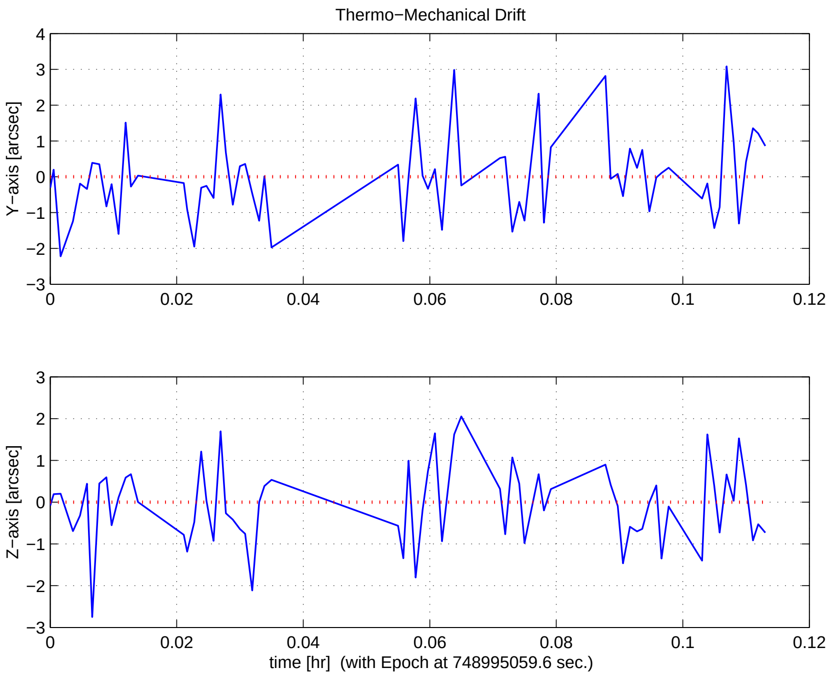

Figure 3.22: Thermo-mechanical boresight drift (equiv. angle in Body frame)

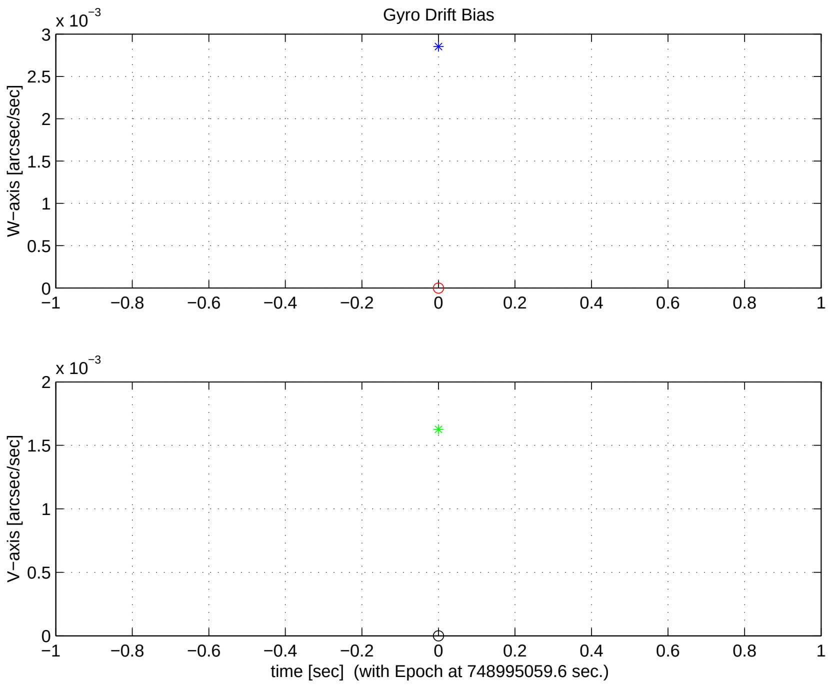

Figure 3.23: Gyro drift bias contribution (equiv. rate in (W,V) coords)

Figure 3.24: Gyro drift bias contribution (equiv. angle in (W,V) coords)

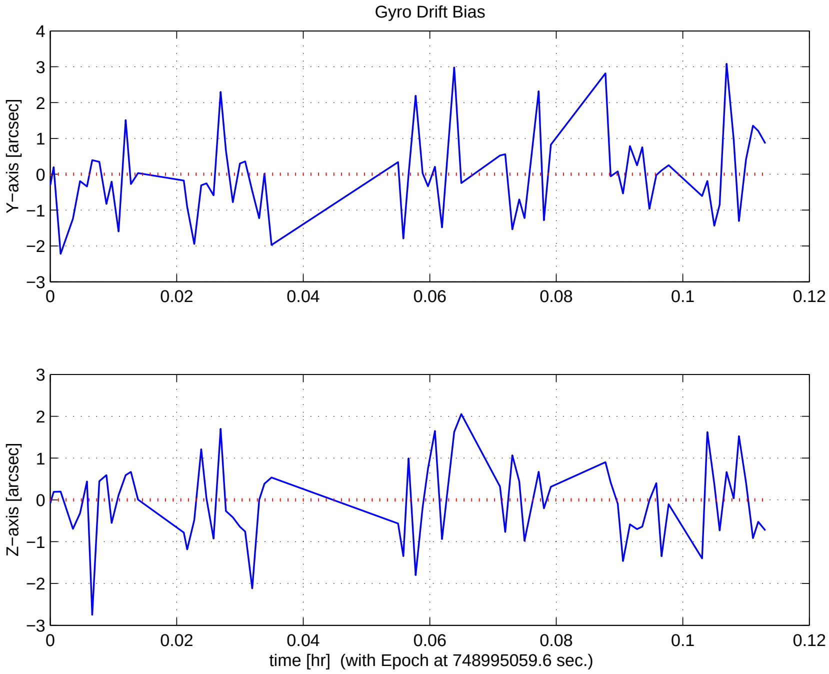

Figure 3.25: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini01P095.dat   DATE: 26-Sep-2003   TIME: 18:03
INSTRUMENT NAME:  MIPS_24um_center   NF: 95
IPF FILTER VERSION: IPF.V2.0.0B      SW RELEASE DATE: August 1, 2003
FRAME TABLE USED: BodyFrames_SPC_06a
--------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ----------------------------
--------------------------------------------------------------------------------
         ------------ WAS ------------          ------------ IS -------------
Frame    theta_Y     theta_Z     angle          theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)          (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 095     +6.641000  +3.931000   +0.000000       +6.724001  +4.258239   +0.577299
 096     +6.595000  +6.712000   -0.000000       +6.721218  +6.970374   +0.577299
 099     +7.687000  +3.943000   -0.000000       +7.758095  +4.277861   +0.577299
 100     +5.574000  +3.918000   +0.000000       +5.669225  +4.238226   +0.577299
 103     +6.746000  +3.932000   +0.000000       +6.827410  +4.260201   +0.577299
 104     +6.558000  +3.930000   +0.000000       +6.641274  +4.256670   +0.577299
--------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0              95            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.641000        +3.931000       +0.000000
IS (EST)            +6.724001        +4.258239       +0.577299
dT_EST              +0.083001        +0.327239       +0.577299
T_sSIGMA            +0.050623        +0.050609       +0.199440
dT_EST/T_sSIGMA     +1.639596        +6.465981       +2.894596
------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              96            +0.000           -64.000     pixels
OFFSET FRAME NAME: MIPS_24um_plusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.595000        +6.712000       -0.000000
IS (EST)            +6.721218        +6.970374       +0.577299
dT_EST              +0.126218        +0.258374       +0.577299
T_sSIGMA            +0.053758        +0.054010       +0.199440
dT_EST/T_sSIGMA     +2.347900        +4.783865       +2.894597
------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              99           +25.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.687000        +3.943000       -0.000000
IS (EST)            +7.758095        +4.277861       +0.577299
dT_EST              +0.071095        +0.334861       +0.577299
T_sSIGMA            +0.050770        +0.050769       +0.199440
dT_EST/T_sSIGMA     +1.400343        +6.595804       +2.894596
------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             100           -25.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.574000        +3.918000       +0.000000
IS (EST)            +5.669225        +4.238226       +0.577299
dT_EST              +0.095225        +0.320226       +0.577299
T_sSIGMA            +0.050722        +0.050716       +0.199440
dT_EST/T_sSIGMA     +1.877413        +6.314037       +2.894596
------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             103            +2.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.746000        +3.932000       +0.000000
IS (EST)            +6.827410        +4.260201       +0.577299
```

```
dT_EST              +0.081410        +0.328201        +0.577299
T_sSIGMA            +0.050627        +0.050614        +0.199440
dT_EST/T_sSIGMA     +1.608053        +6.484458        +2.894596
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5             104            -2.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.558000        +3.930000        +0.000000
IS (EST)            +6.641274        +4.256670        +0.577299
dT_EST              +0.083274        +0.326670        +0.577299
T_sSIGMA            +0.050622        +0.050608        +0.199440
dT_EST/T_sSIGMA     +1.645022        +6.454908        +2.894596
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                     SIGMA                  SCALED_SIGMA
a00        -4.4259208080463484E-003 +1.1101830497216674E-003 +3.3648185390970533E-003
b00        -2.1389956984465781E-002 +2.0338203475367515E-003 +6.1642414845913766E-003
c00        -8.8571597161132293E-003 +1.1389268443680360E-003 +3.4519371932094068E-003
del_alpha  -1.1894565193903972E-014 +1.6467883217217958E-003 +4.9911984120882000E-003
beta       +9.4674995844571619E-001 +2.7556492786927501E-003 +8.3520098622649874E-003
del_theta1 -1.7341608766932408E-014 +1.1484796857305700E-003 +3.4808905966375765E-003
del_theta2 +1.6883906600246626E-018 +4.8585429559243097E-006 +1.4725603507630682E-005
del_theta3 -8.4919155778081872E-018 +4.8572470570150236E-006 +1.4721675808792320E-005
-------------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +3.0308682337931954E+000
-------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +1.9428645279009407E-002  +9.9981124605728589E-001
a_mirror_tpf   -1.9442578311008125E-003  +9.3563744836654434E-003  +9.9995433801649569E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +9.4674995844571619E-001  +2.6553884252009965E-006
------------------------------------------------------------------------------------------------------------
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
FrmTbl:    -5.5224103706934371E-007 -9.6589398881636961E-004 -5.7174047628006817E-004 +9.9999937008046424E-001
Estim:     +5.0372558129468184E-003 -9.8107368935810278E-004 -6.1440075534372461E-004 +9.9998664294079598E-001
DelTheta         deltheta(1)              deltheta(2)              deltheta(3)
           +1.0075588474062255E-002 -2.4144044773891207E-005 -9.5189891607115192E-005       [rad]
EulAngT          theta(1)                 theta(2)                 theta(3)                 [rad]
Mean       +1.0075772361046198E-002 -1.9559326297708575E-003 -1.2386716219272857E-003
SigmaT     +1.1484796857305700E-003 +4.8585429559243097E-006 +4.8572470570150236E-006
------------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                   Bg0(2)                   Bg0(3)
                   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Correction      Bg(1)                    Bg(2)                    Bg(3)
                   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Total Gyro Bias           BgT(1)                   BgT(2)                   BgT(3)
                   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000

Initial Gyro Bias Rate     Cg0(1)                   Cg0(2)                   Cg0(3)
                   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                    Cg(2)                    Cg(3)
                   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Total Gyro Bias Rate       CgT(1)                   CgT(2)                   CgT(3)
                   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             96            +0.000           -64.000     pixels
OFFSET FRAME NAME: MIPS_24um_plusY_edge
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)   -9.3639450226028116E-007 -9.5920326392183247E-004 -9.7622022412795586E-004 +9.9999906346070921E-001
IS (EST)   +5.0368688350518765E-003 -9.8265590121642162E-004 -1.0088615259627085E-003 +9.9998632317554215E-001

DelTheta         deltheta(1)              deltheta(2)              deltheta(3)
```

```
Units           rad                       rad                       rad
         +1.0075628177289433E-002 -3.6715431696437966E-005 -7.5157938041067916E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +1.0075772361046198E-002 -1.9551231624285949E-003 -2.0275997382008196E-003
sSigmaT  +3.4808891579751777E-003 +1.5637560793017668E-005 +1.5710743621020294E-005
SigmaT   +1.1484792110605124E-003 +5.1594327389966834E-006 +5.1835785686261810E-006
------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
OFFSET           NF         Delta_CW         Delta_CV
  2              99          +25.000           +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV1
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB) -6.4117382846981564E-007 -1.1180284132340469E-003 -5.7348571352373249E-004 +9.9999921056278462E-001
IS (EST) +5.0371586372862263E-003 -1.1314889056829778E-003 -6.1649671362086066E-004 +9.9998648325740958E-001

DelTheta       deltheta(1)              deltheta(2)              deltheta(3)
Units           rad                       rad                       rad
         +1.0075554553509152E-002 -2.0680705924812100E-005 -9.7406774503614395E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +1.0075772361046198E-002 -2.2567383553302495E-003 -1.2443792292921743E-003
sSigmaT  +3.4808904197387094E-003 +1.4768301845407472E-005 +1.4768028507750048E-005
SigmaT   +1.1484796273648300E-003 +4.8726307797698722E-006 +4.8725405951638978E-006
------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
OFFSET           NF         Delta_CW         Delta_CV
  3              100         -25.500           +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV2
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB) -4.6198041860920160E-007 -8.1070521711647421E-004 -5.6984978266998100E-004 +9.9999950901391088E-001
IS (EST) +5.0373539303327211E-003 -8.2765014547835341E-004 -6.1226286617559016E-004 +9.9998678251004891E-001

DelTheta       deltheta(1)              deltheta(2)              deltheta(3)
Units           rad                       rad                       rad
         +1.0075621326903903E-002 -2.7699921940369425E-005 -9.3149741153985337E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +1.0075772361046198E-002 -1.6491107900087059E-003 -1.2328498693341429E-003
sSigmaT  +3.4808904524862632E-003 +1.4754303103610453E-005 +1.4752822256027981E-005
SigmaT   +1.1484796381695075E-003 +4.8680120564479740E-006 +4.8675234678759075E-006
------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
OFFSET           NF         Delta_CW         Delta_CV
  4              103          +2.500           +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV1
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB) -5.6111515131371191E-007 -9.8116560995659325E-004 -5.7188591179032191E-004 +9.9999935512990956E-001
IS (EST) +5.0372461391393957E-003 -9.9611521251996593E-004 -6.1461035168427971E-004 +9.9998662799056104E-001

DelTheta       deltheta(1)              deltheta(2)              deltheta(3)
Units           rad                       rad                       rad
         +1.0075585017450591E-002 -2.3681356512212800E-005 -9.5469757636172688E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +1.0075772361046197E-002 -1.9860132032283469E-003 -1.2392423823615513E-003
sSigmaT  +3.4808905931259736E-003 +1.4726719486245682E-005 +1.4722887913497780E-005
SigmaT   +1.1484796845719571E-003 +4.8589111601908484E-006 +4.8576469769758929E-006
------------------------------------------------------------------------------------------------------------
------------------------------------------------------------------------------------------------------------
OFFSET           NF         Delta_CW         Delta_CV
  5              104          -2.000           +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV2
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB) -5.4520033785992621E-007 -9.5382213577026277E-004 -5.7159503889057917E-004 +9.9999938175088265E-001
IS (EST) +5.0372635449913291E-003 -9.6904047066332917E-004 -6.1423307818932833E-004 +9.9998665473808712E-001

DelTheta       deltheta(1)              deltheta(2)              deltheta(3)
Units           rad                       rad                       rad
         +1.0075591088435516E-002 -2.4223307184630280E-005 -9.5024176278986922E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +1.0075772361046198E-002 -1.9318681710017926E-003 -1.2382150136282300E-003
```

```
sSigmaT   +3.4808905971783358E-003 +1.4725216286398177E-005 +1.4721254945145490E-005
SigmaT    +1.1484796859089872E-003 +4.8584151967468607E-006 +4.8571081979111741E-006
--------------------------------------------------------------------------------------------------------------
--------------------------------------------------------------------------------------------------------------
               q(1)                     q(2)                     q(3)                     q(4)
PCRS1A: +5.3376441636293240E-007 +3.7444188848489133E-004 -1.4254917867010713E-003 +9.9999891388248685E-001
PCRS2A: -5.2784065890448333E-007 +3.8463004289789228E-004 +1.3723320176524409E-003 +9.9999898438162671E-001
-------------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +1.2087416876100000E-005  Row (1) TASTART:   +7.4899400049076843E+008
Row (02) PIX2RADY: +1.2595908372599999E-005  Row (2) TASTOP:    +7.4899600039072263E+008
Row (03) CX0:      +6.4500000000000000E+001  Row (3) S/C TIME:  +7.4890406949078369E+008
Row (04) CY0:      +6.4500000000000000E+001  Row (4) QR1:       +7.0843915455043316E-004
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +1.2700736988335848E-003
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       -1.6007969679776579E-004
Row (07) D11:      +1.0000000000000000E+000  Row (7) QR4:       +9.9999892711639404E-001
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       -1.0000000000000000E+000
-------------------------------------------------------------------------------------------
-----------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
4.71796087E+000  2.18437894E-001  2.18791273E-001  [arcsec]
-----------------------------------------------------------
PIX2RADX = 1.208741687610E-005[rad/pixel]
XPIXSIZE = 2.4932[arcsec]
PIX2RADY = 1.259590837260E-005[rad/pixel]
YPIXSIZE = 2.5981[arcsec]
CX0 = 64.5[pixel] = 160.81[arcsec]
CY0 = 64.5[pixel] = 167.58[arcsec]
-----------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-----------------------------------------------------------
                | +1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = -1
                | +0 | -1 |
-----------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
***********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG01P095.dat
INSTRUMENT TYPE:              MIPS_24um_center
IPF FILTER EXECUTION DATE:    26-Sep-2003    TIME: 18:03
IPF FILTER VERSION USED:      IPF.V2.0.0B
***********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA02P095 Loaded!        AAFILE dimension = 20000 X 21
ASFILE:  AS01P095 Loaded!
CAFILE:  CA01P095 Loaded!        CAFILE dimension = 69 X 15
CBFILE:  CB91P095 Loaded!        CBFILE dimension = 0 X 0
CCFILE:  CC01P095 Created!       CCFILE dimension = 69 X 19
CSFILE:  CS03P095 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------
```

```
------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
mask1 = [ 1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
IPF Filter in LITE MODE# 3
IPF LITE MODE WITH FILTERED STA QUATERNION!
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG01P095.m     ACFILE CREATED:  AC01P095.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 1 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.3376441636293240E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7444188848489133E-004                 +5.2236196154513707E-004
            -1.4254917867010713E-003                 -1.4047712280184723E-003
            +9.9999891388248685E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.2784065890448333E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8463004289789228E-004                 +5.3239763239987400E-004
            +1.3723320176524409E-003                 +1.3516841804518383E-003
            +9.9999898438162671E-001 ];              +9.9999894475050310E-001 ];
--------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 9.9999000000000000E+004
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 9.9999000000000000E+004
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 9.9999000000000000E+004
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 9.9999000000000000E+004
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-----------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -5.5224103706934371E-007  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6589398881636961E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -5.7174047628006817E-004  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999937008046424E-001
p2f(09) = qR1  = +7.0843915455043316E-004  Sigma_initial(23,23) = 9.9999000000000000E+004
p2f(10) = qR2  = +1.2700736988335848E-003  Sigma_initial(24,24) = 9.9999000000000000E+004
p2f(11) = qR3  = -1.6007969679776579E-004  Sigma_initial(25,25) = 9.9999000000000000E+004
p2f(12) = qR4  = +9.9999892711639404E-001
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 9.9999000000000000E+004
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 9.9999000000000000E+004
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 9.9999000000000000E+004
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 9.9999000000000000E+004
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 9.9999000000000000E+004
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 9.9999000000000000E+004
```

```
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 9.9999000000000000E+004
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 9.9999000000000000E+004
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 9.9999000000000000E+004
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 9.9999000000000000E+004
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 9.9999000000000000E+004
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 9.9999000000000000E+004
-----------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +9.821436876397E-002   RMS(|Res|)=+9.821436876397E-002
Iteration#002: |dp|= +1.756288113269E-002   RMS(|Res|)=+1.756288113269E-002
Iteration#003: |dp|= +1.097980272211E-003   RMS(|Res|)=+1.097980272211E-003
Iteration#004: |dp|= +4.516132339930E-005   RMS(|Res|)=+4.516132339930E-005
Iteration#005: |dp|= +6.410146350891E-007   RMS(|Res|)=+6.410146350891E-007
Iteration#006: |dp|= +1.016352531831E-009   RMS(|Res|)=+1.016352531831E-009
Iteration#007: |dp|= +1.364501949828E-010   RMS(|Res|)=+1.364501949828E-010
Iteration#008: |dp|= +2.769987620369E-012   RMS(|Res|)=+2.769987620369E-012
Iteration#009: |dp|= +1.056548388327E-013   RMS(|Res|)=+1.056548388327E-013
Iteration#010: |dp|= +1.553084560156E-013   RMS(|Res|)=+1.553084560156E-013
Iteration#011: |dp|= +2.724432721722E-013   RMS(|Res|)=+2.724432721722E-013
Iteration#012: |dp|= +1.600730328961E-013   RMS(|Res|)=+1.600730328961E-013
Iteration#013: |dp|= +7.223978482413E-014   RMS(|Res|)=+7.223978482413E-014
Iteration#014: |dp|= +6.012931697650E-014   RMS(|Res|)=+6.012931697650E-014
Iteration#015: |dp|= +1.184190904619E-013   RMS(|Res|)=+1.184190904619E-013
Iteration#016: |dp|= +7.390854056595E-014   RMS(|Res|)=+7.390854056595E-014
Iteration#017: |dp|= +8.218892644655E-014   RMS(|Res|)=+8.218892644655E-014
Iteration#018: |dp|= +1.047091053283E-013   RMS(|Res|)=+1.047091053283E-013
Iteration#019: |dp|= +1.275504942874E-013   RMS(|Res|)=+1.275504942874E-013
Iteration#020: |dp|= +1.136262606851E-013   RMS(|Res|)=+1.136262606851E-013
Iteration#021: |dp|= +1.086250966339E-013   RMS(|Res|)=+1.086250966339E-013
Iteration#022: |dp|= +1.252089556054E-013   RMS(|Res|)=+1.252089556054E-013
Iteration#023: |dp|= +9.719742237025E-014   RMS(|Res|)=+9.719742237025E-014
Iteration#024: |dp|= +5.913731747986E-014   RMS(|Res|)=+5.913731747986E-014
Iteration#025: |dp|= +3.044537434909E-014   RMS(|Res|)=+3.044537434909E-014
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +3.0445374349091245E-014
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+6.730680656492E+002,   |dp|=+9.830219166094E-002
Iteration#002   COND#=+6.876016623349E+002,   |dp|=+1.762238741904E-002
Iteration#003   COND#=+6.872102211789E+002,   |dp|=+1.054189986288E-003
Iteration#004   COND#=+6.871199471359E+002,   |dp|=+4.078811727214E-005
Iteration#005   COND#=+6.871229613762E+002,   |dp|=+8.608421797566E-007
Iteration#006   COND#=+6.871228984334E+002,   |dp|=+1.714254934623E-008
Iteration#007   COND#=+6.871228996872E+002,   |dp|=+3.421505485933E-010
Iteration#008   COND#=+6.871228996622E+002,   |dp|=+6.983441353785E-012
Iteration#009   COND#=+6.871228996627E+002,   |dp|=+1.267410794902E-013
Iteration#010   COND#=+6.871228996627E+002,   |dp|=+2.808123392274E-014
Iteration#011   COND#=+6.871228996627E+002,   |dp|=+2.061582720747E-013
Iteration#012   COND#=+6.871228996627E+002,   |dp|=+1.797756726258E-013
Iteration#013   COND#=+6.871228996627E+002,   |dp|=+7.116012688779E-014
Iteration#014   COND#=+6.871228996627E+002,   |dp|=+4.143122626873E-014
Iteration#015   COND#=+6.871228996627E+002,   |dp|=+1.157123191219E-013
Iteration#016   COND#=+6.871228996627E+002,   |dp|=+1.616974573868E-013
Iteration#017   COND#=+6.871228996627E+002,   |dp|=+2.044402992173E-013
Iteration#018   COND#=+6.871228996627E+002,   |dp|=+3.038107335874E-014
Iteration#019   COND#=+6.871228996627E+002,   |dp|=+9.801780261511E-014
Iteration#020   COND#=+6.871228996627E+002,   |dp|=+1.542567915783E-013
Iteration#021   COND#=+6.871228996627E+002,   |dp|=+7.337842734230E-014
Iteration#022   COND#=+6.871228996627E+002,   |dp|=+9.238756551318E-014
Iteration#023   COND#=+6.871228996627E+002,   |dp|=+1.325828491526E-013
Iteration#024   COND#=+6.871228996627E+002,   |dp|=+4.552565575922E-014
Iteration#025   COND#=+6.871228996627E+002,   |dp|=+8.759646794699E-014
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +8.7596467946991228E-014
-----------------------------------------------------------------------
Total Execution Time: 44 seconds
```

4 COMMENTS

This Pre-Coarse run should be used for sanity checking, and to make first rough corrections to the focal plane quaternions, plate scales, and scan mirror scale factor and alignment.

(1) The original CS file had incorrect polarities. The correct polarities were found by the IPF Team and a new corrected CS file (CS03P095.m) was generated by the MIPS team and used for the IPF run.

(2) We fixed units (from arcseconds/sec to rad/sec) on the GCF columns in the MIPL AA file. (An ISA has been written to correct this with MIPL in the future).

(3) This run was nonstandard in the sense that it was made with respect to a special frame table BodyFrames_SPC_06a which was created to include the results of a recent PAC filter run which updated frames 4 and 8 (i.e., PCRS1 and PCRS2).

(4) The IPF filter was run using LITE mode 3, which makes use of the onboard attitude estimates, and on-board estimate of the STA-to-TPF aligment quaternion. This was required because there were no PCRS measurements available.

(5) In addition to the Brown angles, this run also estimated constant plate scales, mirror alignment and mirror scale factor.

Based on this run, we recommend updating frames 95 and the corresponding inferred frames 96, 99, 100,103,104, with the new quaternions listed in the IF file IF01P095.dat. In our best judgment, these frames will be accurate to better than 5 arcseconds (disregard the accuracies quoted in the the tables which are not strictly valid due to lack of PCRS measurements).

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