SIRTF INSTRUMENT POINTING FRAME
KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 602095
REPORT TYPE: IOC EXECUTION (FINE)

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

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

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1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN602095. In particular, this Focal Point Survey calibrates the instrument: MIPS_24um_center (95), as part of the IOC Fine Survey. The main calibration results from the IPF filter execution have been documented in IF602095 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 33 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 1.5. 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.

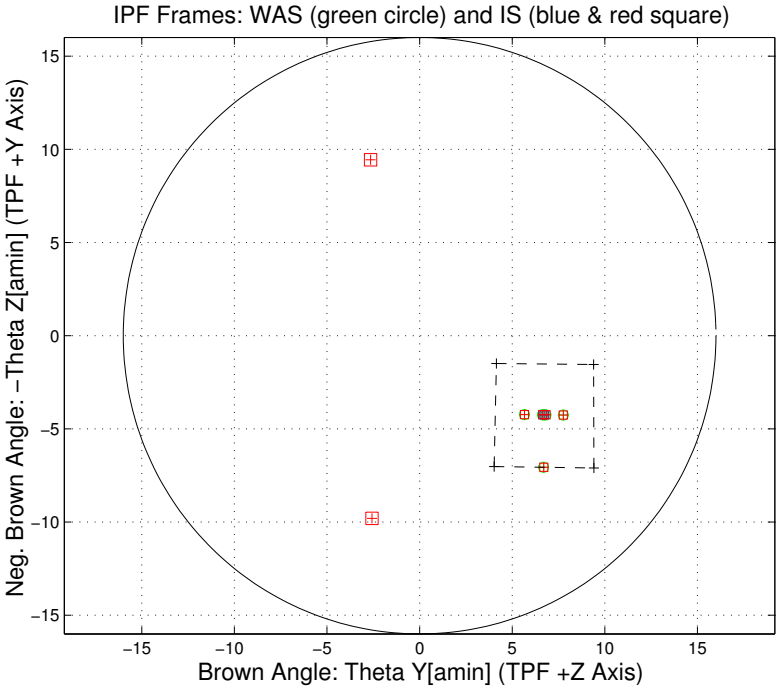

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA601095	AA601095
AS601095	AS601095
CA601095	CA901095
CB601095	CB601095
CS601095	CS601095

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V3.0.0B
Frame Table Version Used	BodyFrames_FTU_14a
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
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	9.45293165E-001
Total Number of Maneuvers	15

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	1	1	1	1	0	0	0	0	1	1	1	1	1	1	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	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: IOC Fine Survey.
INSTRUMENT NAME: MIPS_24um_center NF: 95
`PIX2RADW: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]`
`PIX2RADV: 1.25959084E-005[rad/pixel] = 2.5981E+000[arcsec/pixel]`

FRAME	DESCRIPTION	IPF[1]	SF[2]	TOTAL	REQ
095(P)	MIPS_24um_center	0.0224	0.0855	0.0884	0.14
096(I)	MIPS_24um_plusY_edge	0.0328	0.0855	0.0916	N/A
099(I)	MIPS_24um_small_FOV1	0.0214	0.0855	0.0881	N/A
100(I)	MIPS_24um_small_FOV2	0.0214	0.0855	0.0881	N/A
103(I)	MIPS_24um_large_FOV1	0.0224	0.0855	0.0884	N/A
104(I)	MIPS_24um_large_FOV2	0.0224	0.0855	0.0884	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	2.4059	0.1785	0.1634	arcsec
W-Axis	1.4388	0.1059	0.0892	arcsec
V-Axis	1.9283	0.1437	0.1369	arcsec
Radial	0.9401	0.0697	0.0637	pixels
W-Axis	0.5771	0.0425	0.0358	pixels
V-Axis	0.7422	0.0553	0.0527	pixels

Table 1.5: Science 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: 0.945293. 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 0.0517 arcseconds, given that ARW = 100 $\mu deg/\sqrt{hr}$, with 5.567000e+002 second Maneuver time (max), and 15 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_FTU_14a					
NF	NAME	WAS	IS	CHANGE	UNIT
095	theta_Y	+6.716105	+6.721826	+0.005721	arcmin
095	theta_Z	+4.246060	+4.243820	-0.002240	arcmin
095	angle	+0.637930	+0.628212	-0.009717	deg
096	theta_Y	+6.695190	+6.703859	+0.008670	arcmin
096	theta_Z	+7.060913	+7.055562	-0.005350	arcmin
096	angle	+0.637930	+0.628212	-0.009717	deg
099	theta_Y	+7.756798	+7.762937	+0.006139	arcmin
099	theta_Z	+4.259313	+4.257169	-0.002144	arcmin
099	angle	+0.637930	+0.628212	-0.009717	deg
100	theta_Y	+5.659609	+5.665074	+0.005465	arcmin
100	theta_Z	+4.234140	+4.231696	-0.002444	arcmin
100	angle	+0.637930	+0.628212	-0.009717	deg
103	theta_Y	+6.819955	+6.825711	+0.005755	arcmin
103	theta_Z	+4.247316	+4.245090	-0.002225	arcmin
103	angle	+0.637930	+0.628212	-0.009717	deg
104	theta_Y	+6.633060	+6.638755	+0.005695	arcmin
104	theta_Z	+4.245067	+4.242815	-0.002252	arcmin
104	angle	+0.637930	+0.628212	-0.009717	deg

Table 1.6: IPF Brown angle summary

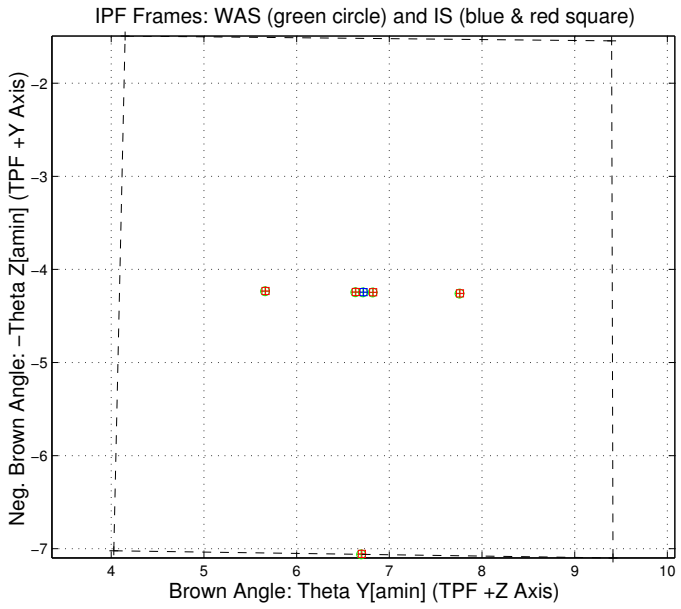

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 IPF INPUT FILE HISTORY

STATUS	FILENAME	START TIME	END TIME
WAS	AA601095	753575500.4	753587499.3
IS	AA601095	753575500.4	753587499.3
WAS	CA601095	753576046.5	753586613.5
IS	CA901095	753576046.5	753586613.5
WAS	CB601095	753575861.9	753586745.4
IS	CB601095	753575861.9	753586745.4

Table 2.1: IPF input file begin and end times

WAS	SIZE	IS	SIZE	REMOVED	PATCHED
AA601095	119990	AA601095	119990	0	0
CA601095	467	CA901095	460	7	N/A
CB601095	126	CB601095	126	0	N/A

Table 2.2: IPF input file editing status

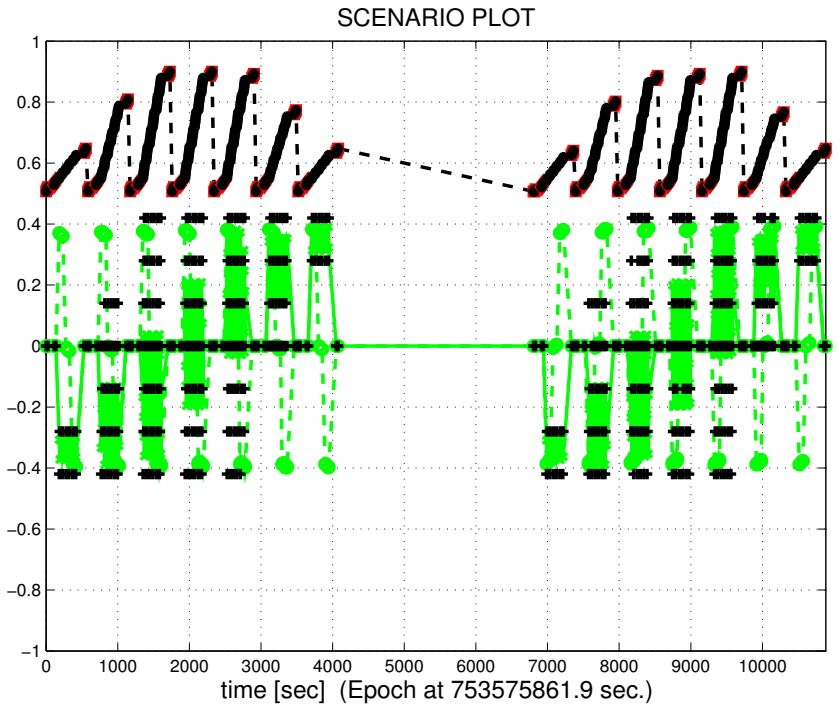

Figure 2.1: Scenario Plot

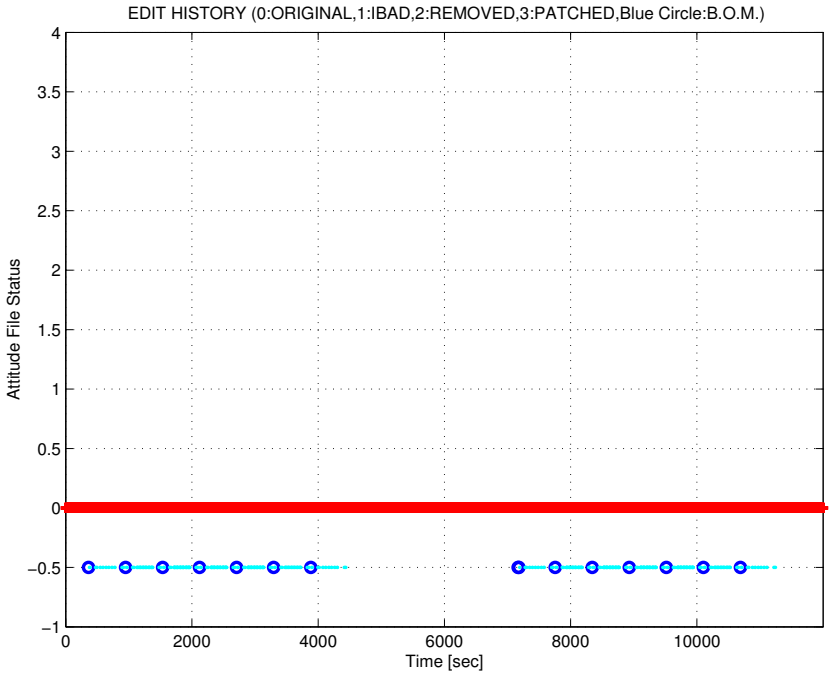

Figure 2.2: Attitude file edit history

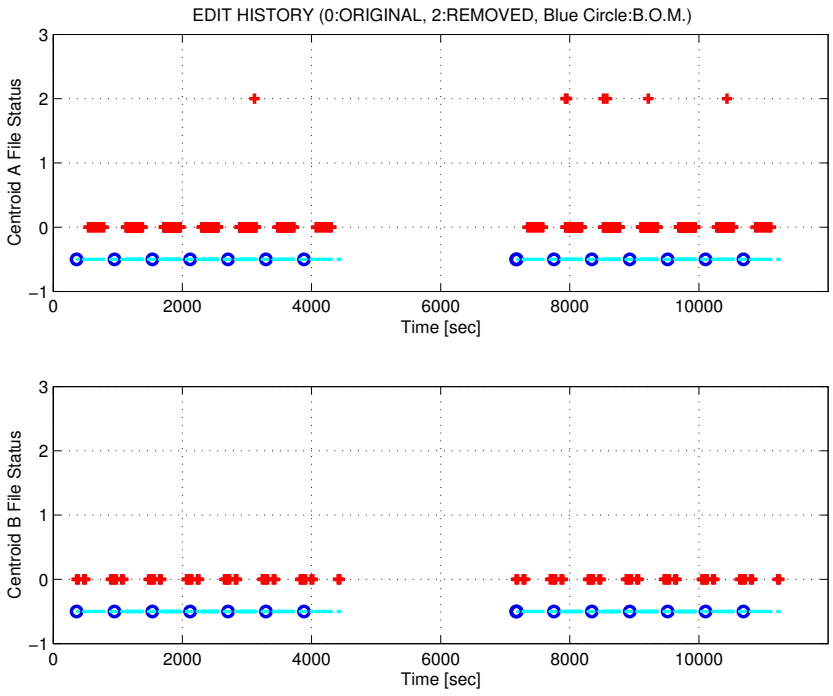

Figure 2.3: Centroid file edit history

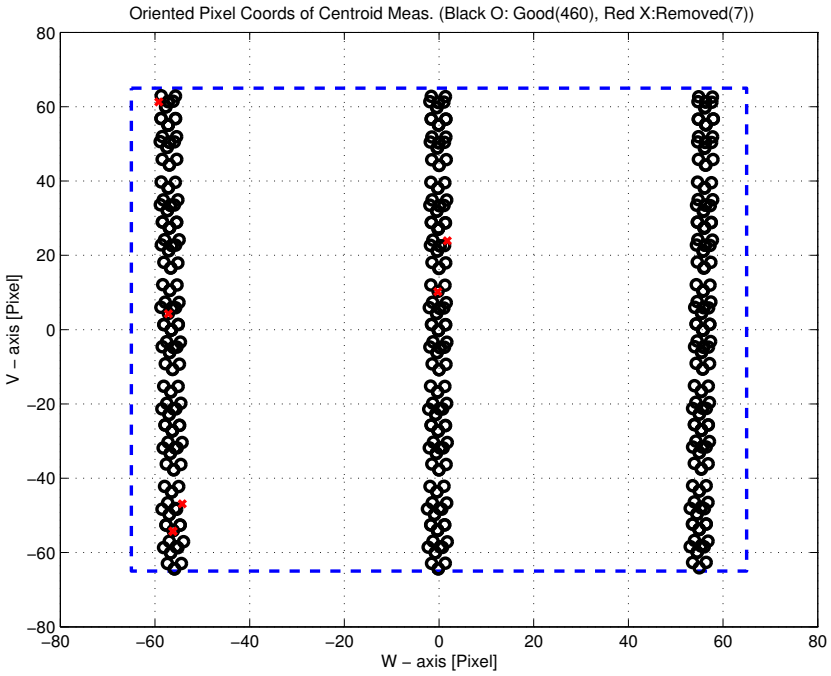

Figure 2.4: Oriented Pixel Coords of Centroid Meas. Edited Centroids

LIST OF REMOVED SCIENCE CENTROIDS									
185	246	251	283	294	351	444			

Table 2.3: List of Removed Centroids (Original CA File Row Index)

LIST OF REMOVED PCRS CENTROIDS									

Table 2.4: List of Removed PCRS Centroids (Original CB File Row Index)

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 Quiver Plot in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.4	A-priori prediction error
Figure 3.5	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
Figure 3.6	Oriented Pixel Coords of measurements and a-priori predicts (Zoomed, PCRS only)
Figure 3.7	Oriented (W,V) Pixel Coords of A-Priori PCRS Prediction Error Quiver Plot
Figure 3.8	A-priori PCRS prediction error
IPF filter performance (post run results)	
Figure 3.9	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.10	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.11	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.12	IPF parameter symbol table
Figure 3.13	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.14	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.15	KF and LS parameter errors sigma plot (Figure 3.13 & Figure 3.14 combined)
Figure 3.16	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.17	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)

Table 3.1: Table of figures I (IPF run)

FIGURE NO.	DESCRIPTION
IPF filter performance (post run results) - CONTINUE	
Figure 3.18	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.19	Histograms of science a-posteriori residuals (or innovations)
Figure 3.20	A-Posteriori Science Centroid Prediction Error Quiver (Att. Cor.)
Figure 3.21	Normalized A-Posteriori Science Centroid Prediction Errors
Figure 3.22	KF innovations with (o) and w/o (+) attitude corrections (PCRS)
Figure 3.23	Histograms of PCRS a-posteriori residuals (or innovations)
Figure 3.24	A-posteriori PCRS Prediction Summary
Figure 3.25	A-posteriori PCRS Prediction (PCRS 1 Only)
Figure 3.26	A-posteriori PCRS Prediction (PCRS 2 Only)
Figure 3.27	A-Posteriori PCRS Prediction Errors Quiver (Att. Cor.)
Figure 3.28	Normalized A-Posteriori PCRS Prediction Errors
Figure 3.29	W-axis KF innovations and 1-sigma bound
Figure 3.30	V-axis KF innovations and 1-sigma bound
Figure 3.31	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.32	Optical Distortion Plot: total (x5 magnification)
Figure 3.33	Optical Distortion Plot: constant plate scales (x5 magnification)
Figure 3.34	Optical Distortion Plot: linear plate scale (x5 magnification)
Figure 3.35	Optical Distortion Plot: gamma terms (x5 magnification)
Figure 3.36	Scan Mirror Chops
Figure 3.37	IPF Frame Reconstruction
Figure 3.38	Center Pixel Reconstruction
IPF parameter trending plots	
Figure 3.39	Estimated attitude corrections (Body frame)
Figure 3.40	Estimated attitude error sigma plot (Body frame)
Figure 3.41	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.42	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.43	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.44	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.45	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.2: Table of figures II (IPF run)

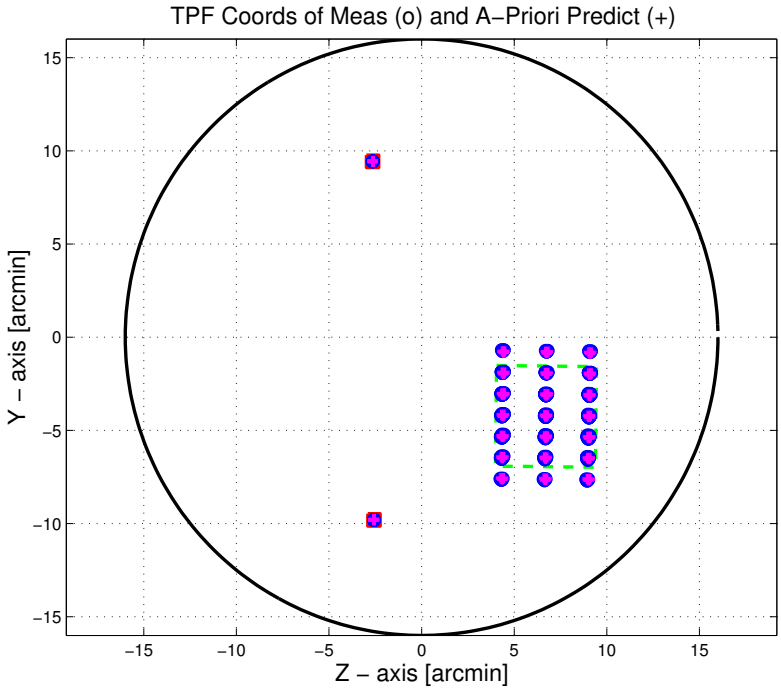

Figure 3.1: TPF coords of measurements and a-priori predicts

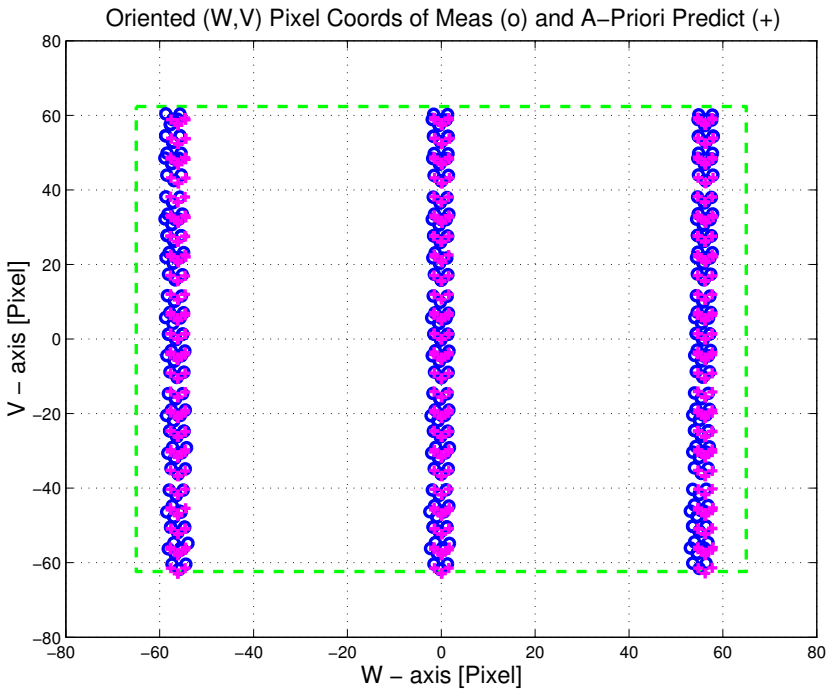

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

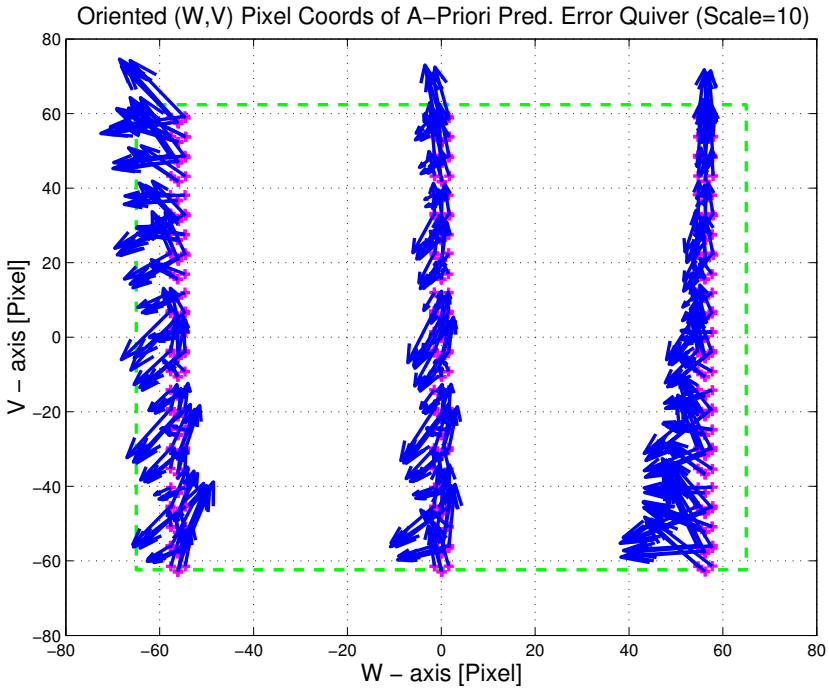

Figure 3.3: Oriented (W,V) Pixel Coords of A-Priori Prediction Error Quiver Plot

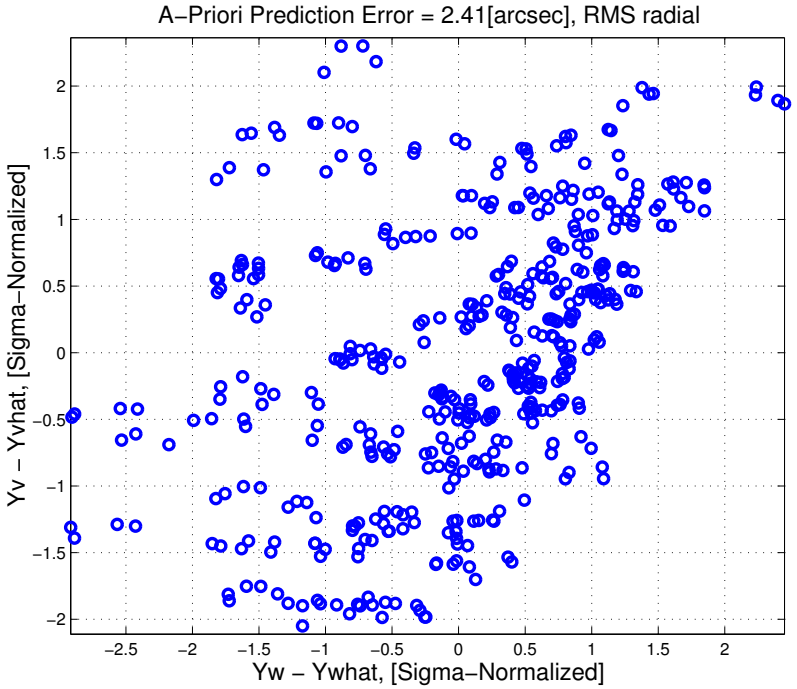

Figure 3.4: A-priori prediction error (Science Centroids)

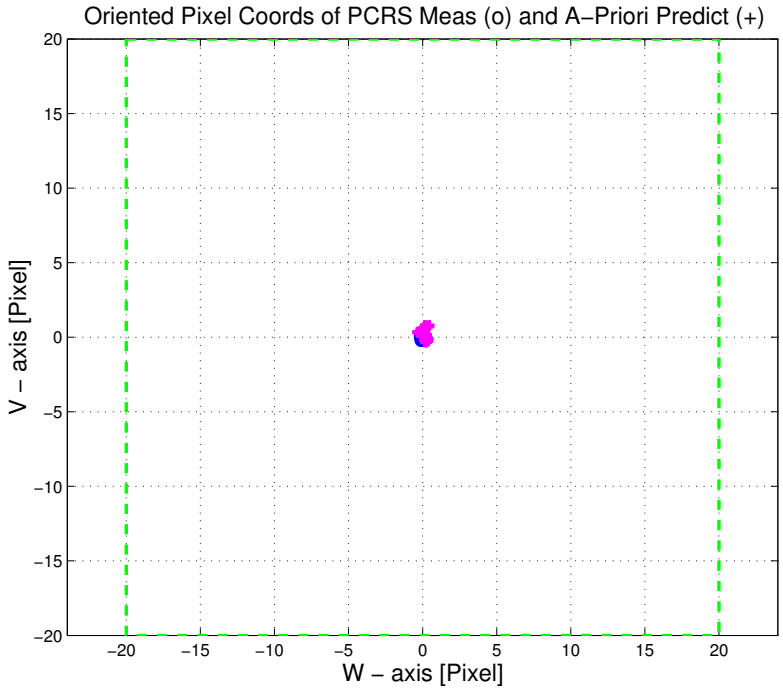

Figure 3.5: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

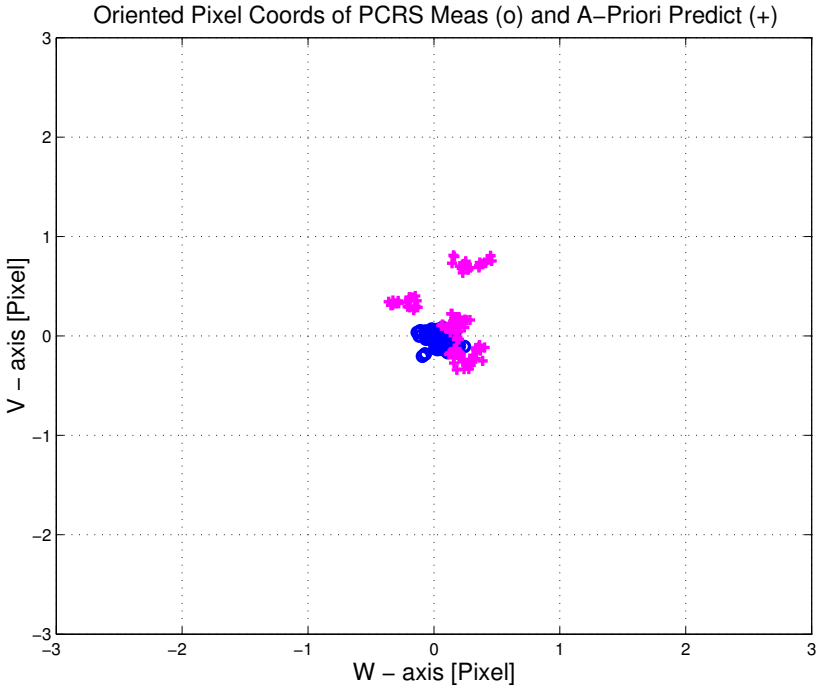

Figure 3.6: Oriented Pixel Coords of measurements and a-priori predicts (Zoomed, PCRS only)

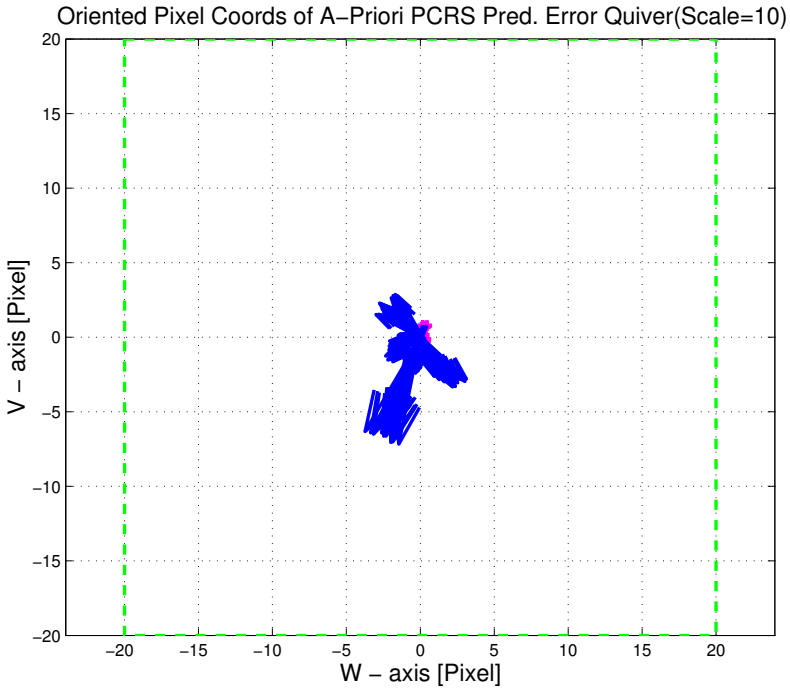

Figure 3.7: Oriented (W,V) Pixel Coords of A-Priori PCRS Prediction Error Quiver Plot

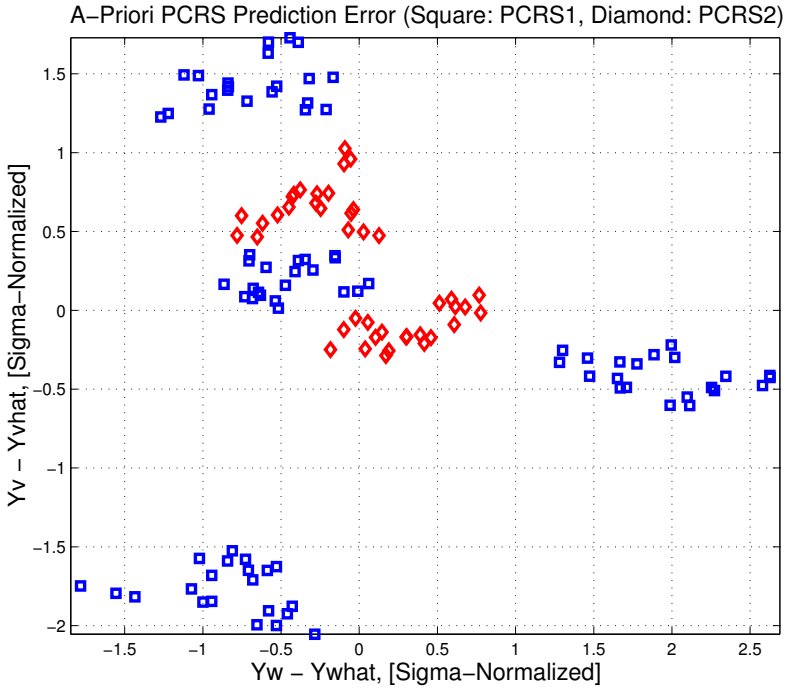

Figure 3.8: A-priori PCRS prediction error

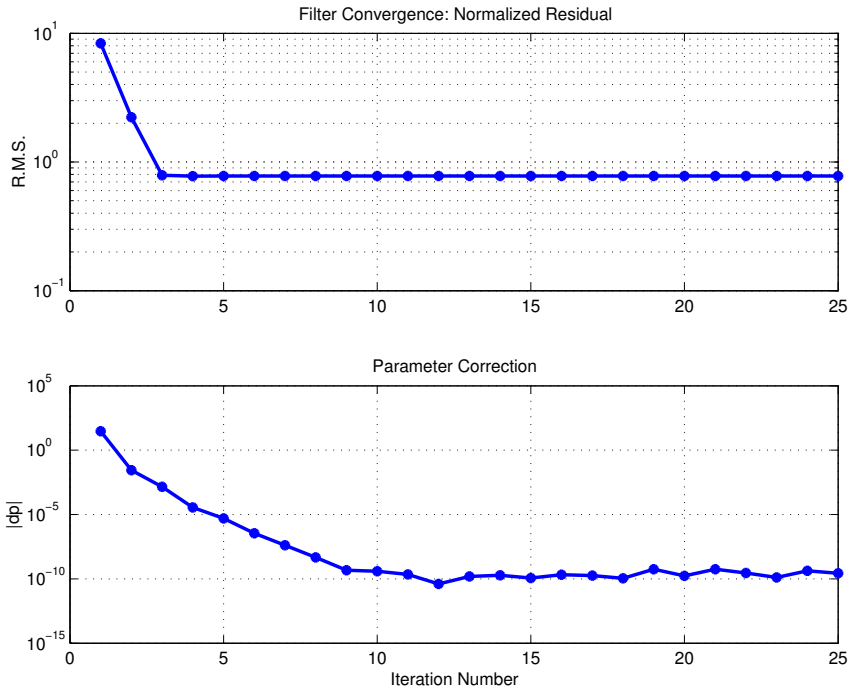

Figure 3.9: IPF execution convergence, chart 1

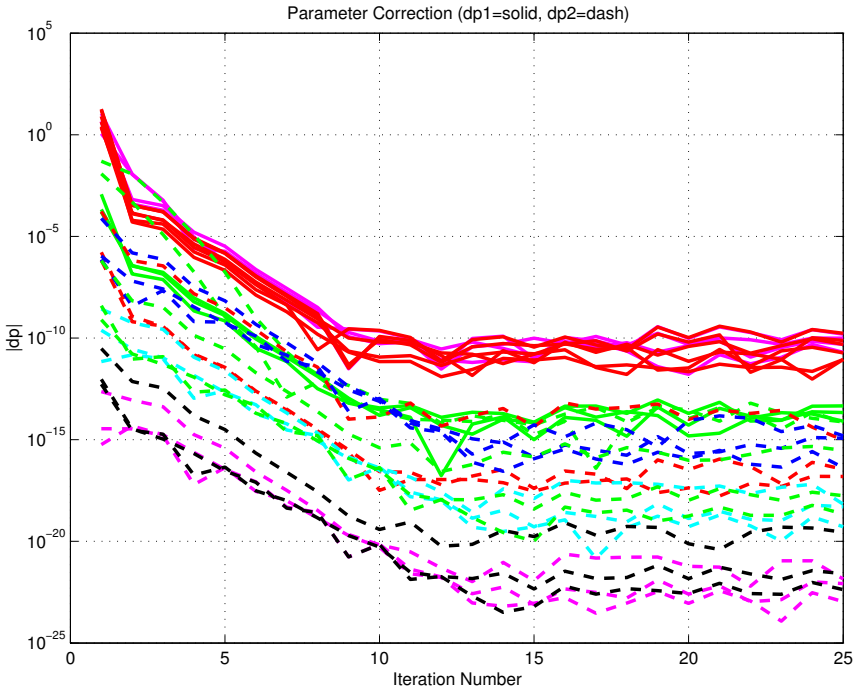

Figure 3.10: IPF execution convergence, chart 2

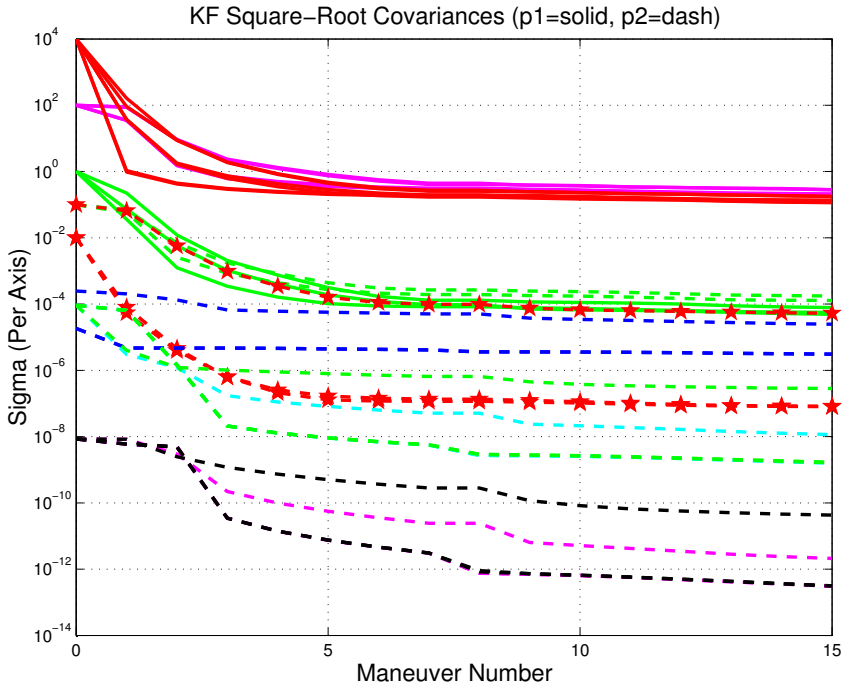

Figure 3.11: Parameter uncertainty convergence

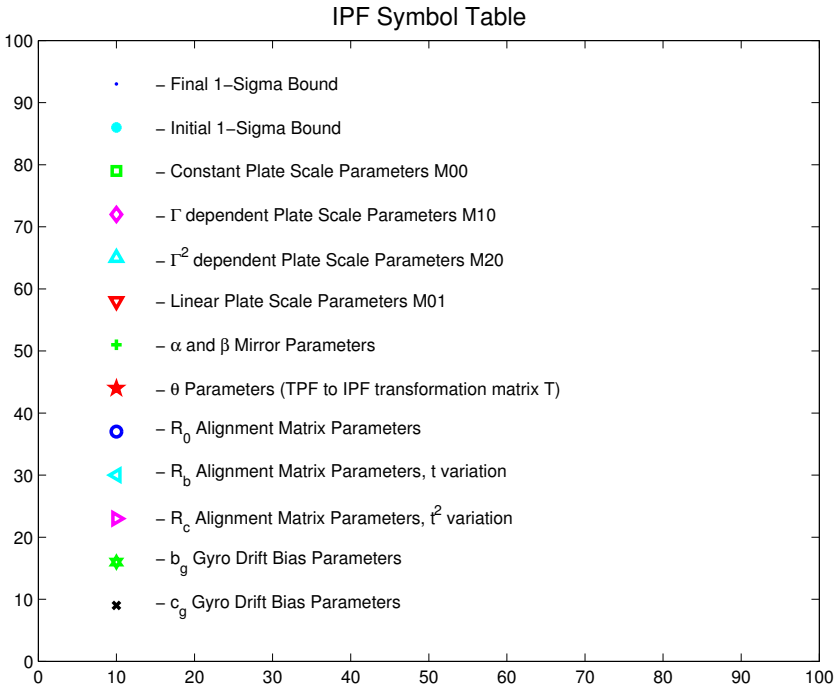

Figure 3.12: IPF parameter symbol table

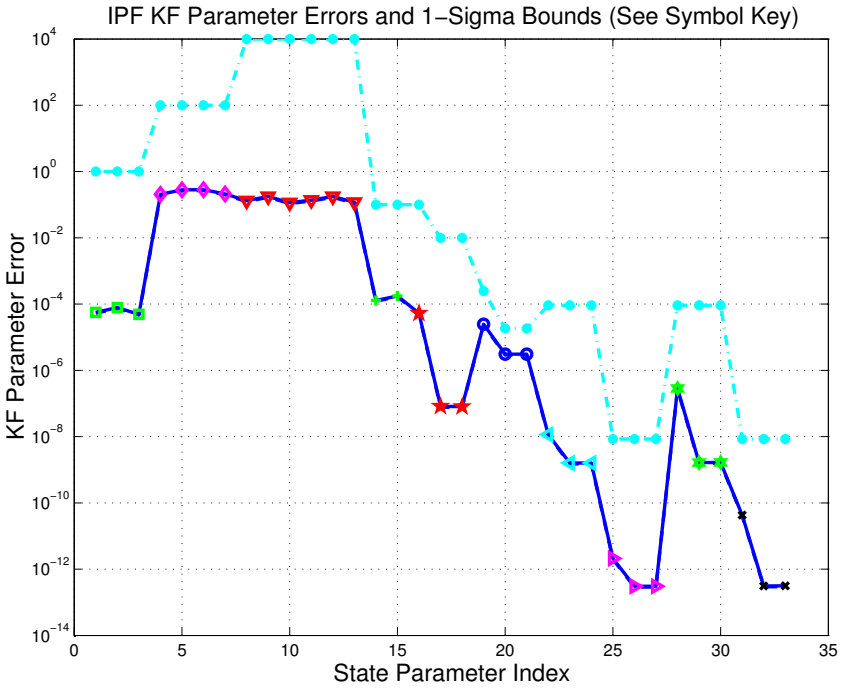

Figure 3.13: KF parameter error sigma plots

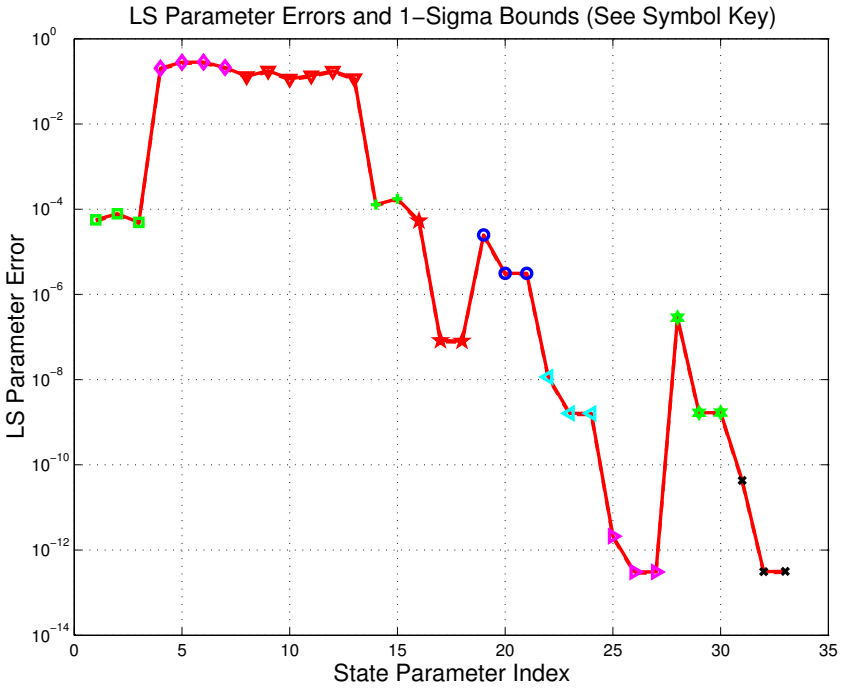

Figure 3.14: LS parameter error sigma plot

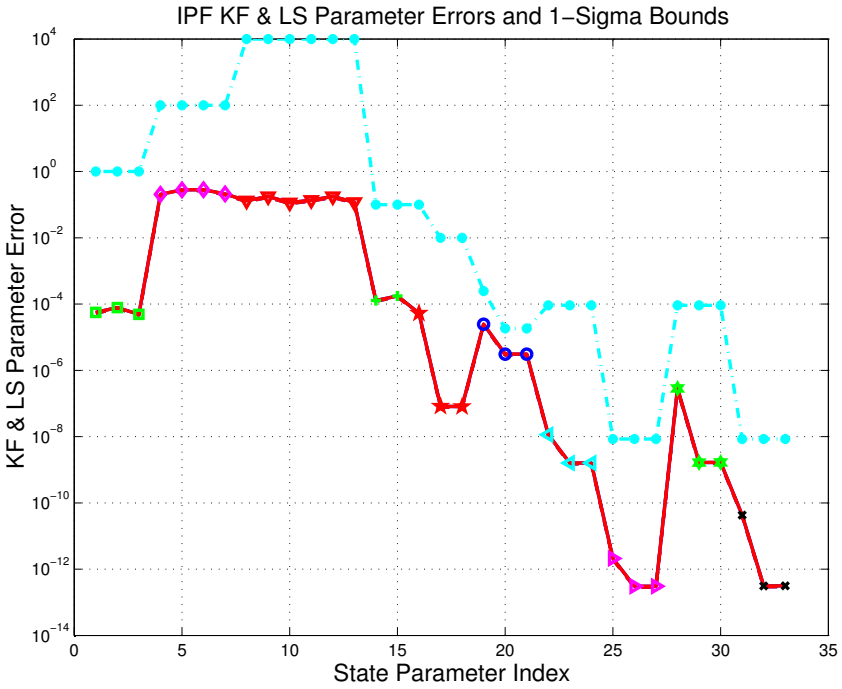

Figure 3.15: KF and LS parameter error sigma plot

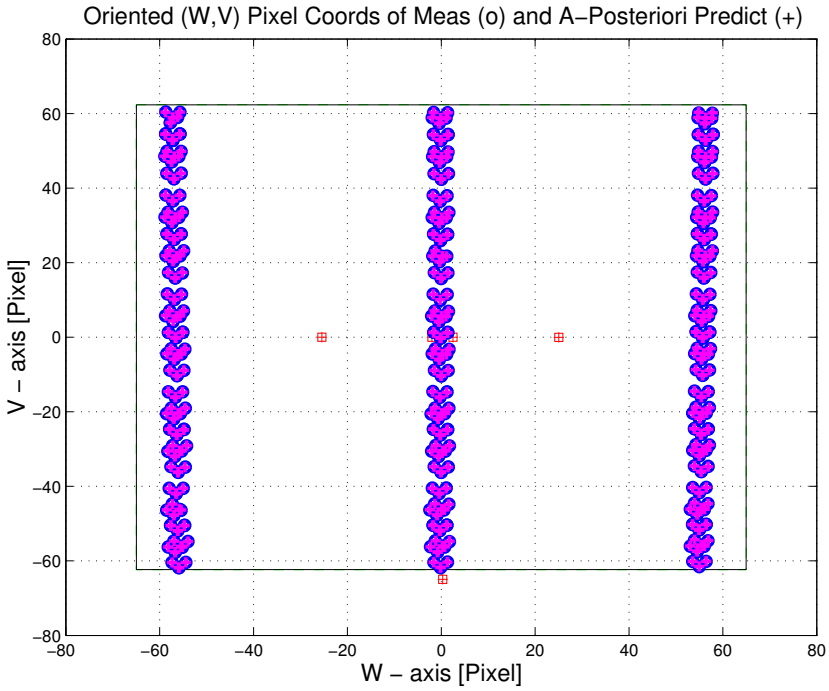

Figure 3.16: Oriented Pixel Coords of meas. and a-posteriori predicts

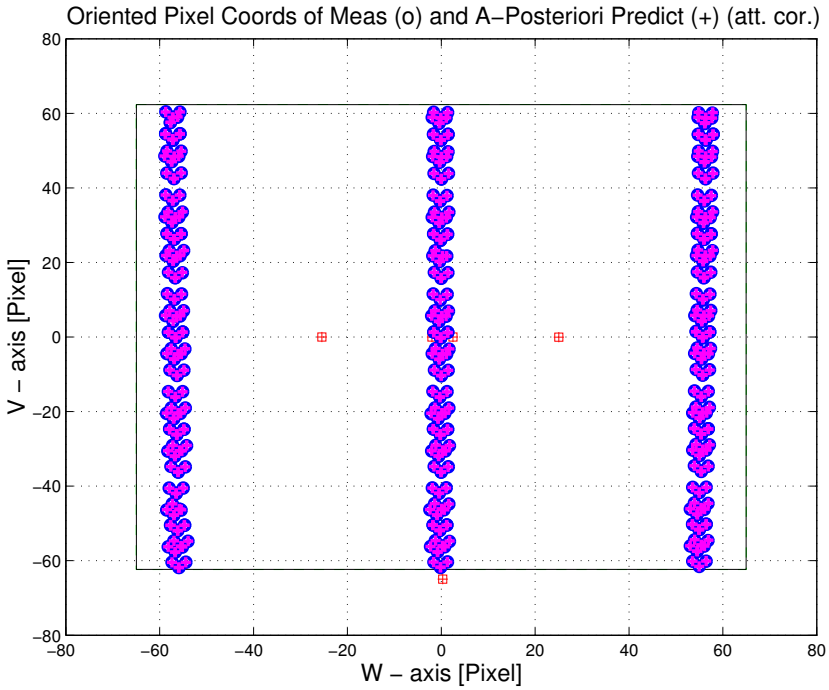

Figure 3.17: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

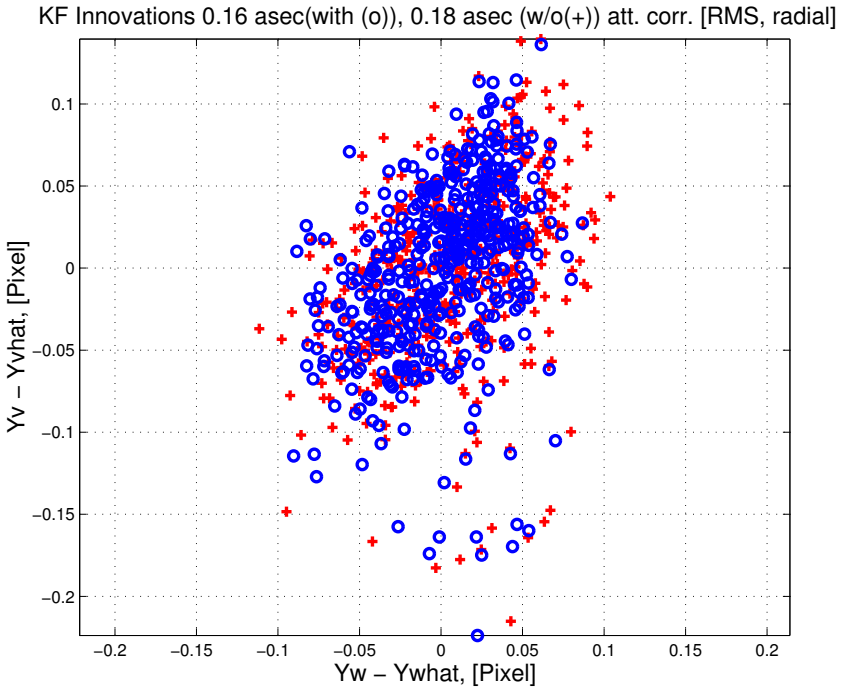

Figure 3.18: KF innovations with (o) and w/o (+) attitude corrections

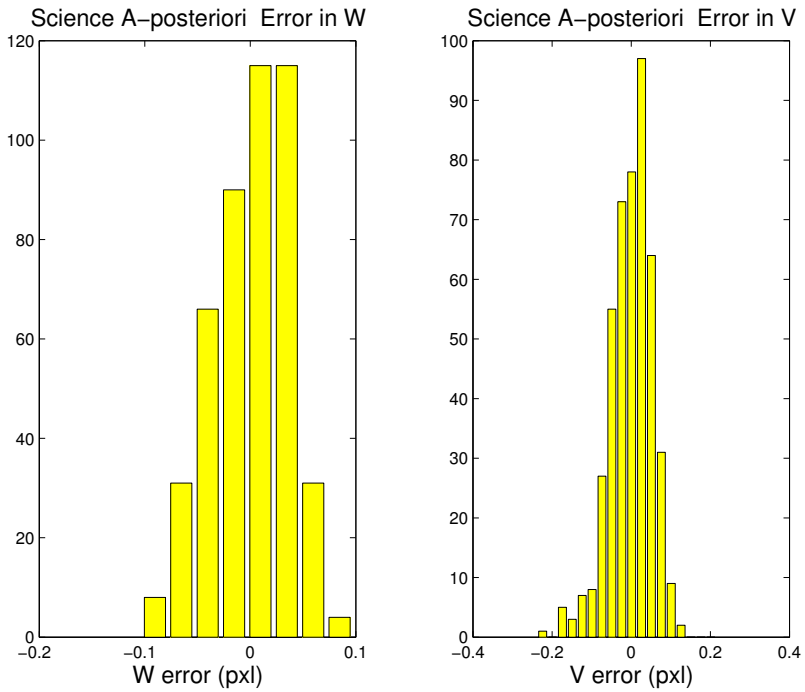

Figure 3.19: Histograms of science a-posteriori residuals (or innovations)

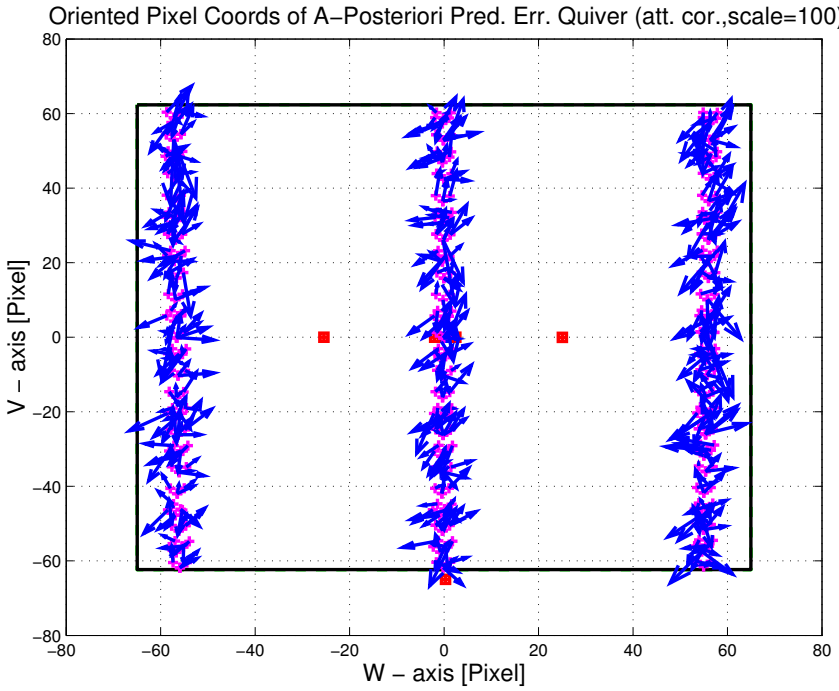

Figure 3.20: A-Posteriori Science Centroid Prediction Error Quiver (Att. Cor.)

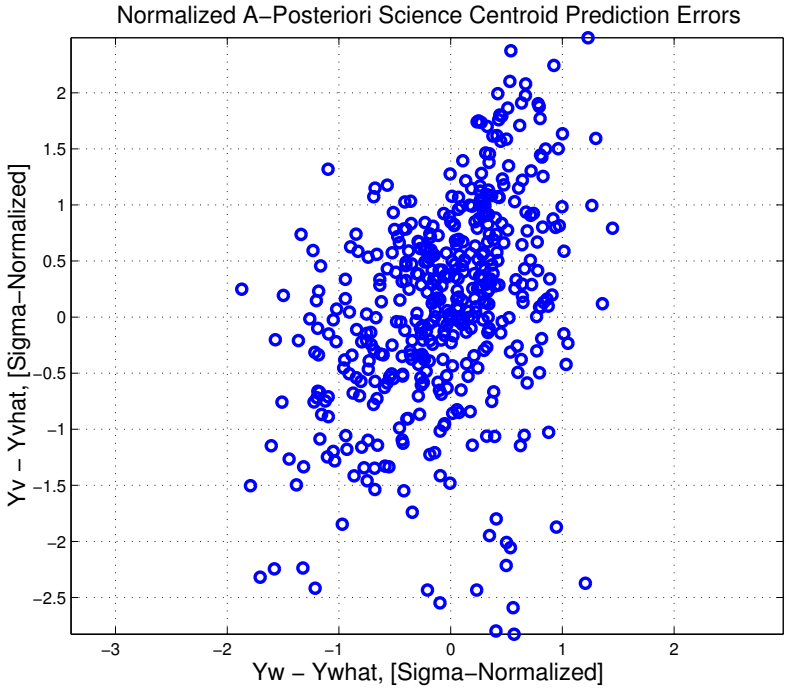

Figure 3.21: Normalized A-Posteriori Science Centroid Prediction Errors

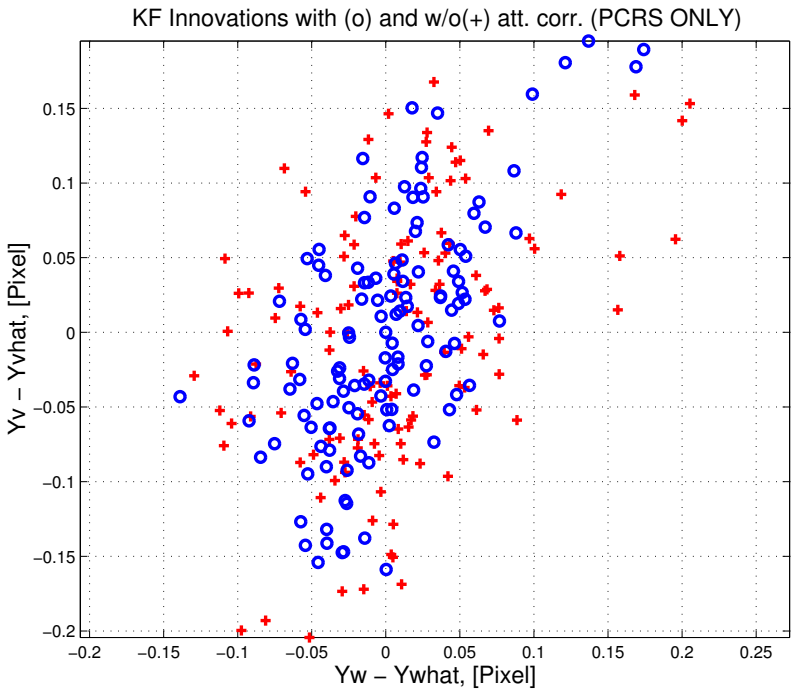

Figure 3.22: KF innovations with (o) and w/o (+) attitude corrections (PCRS)

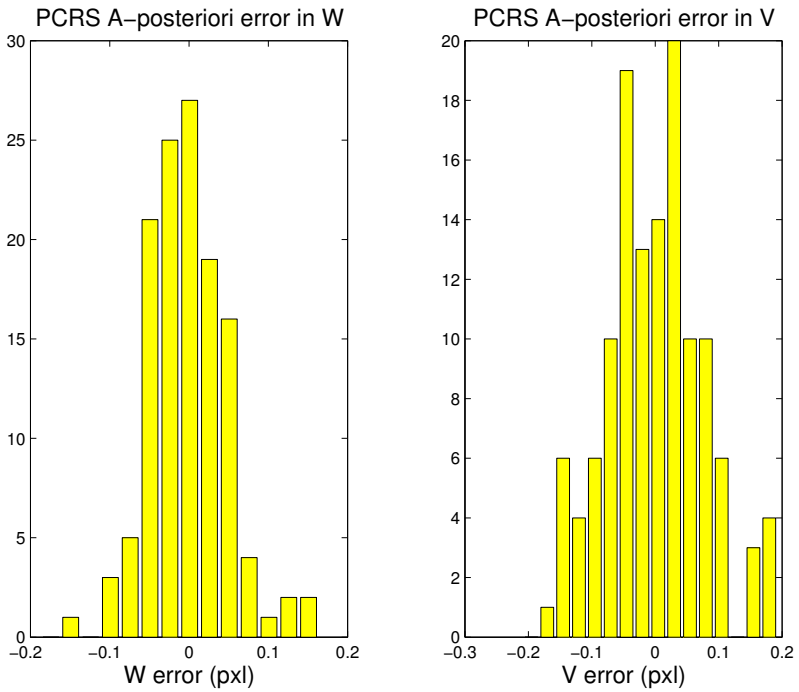

Figure 3.23: Histograms of PCRS a-posteriori residuals (or innovations)

IPF PCRS SUMMARY						
PCRS 1 (Total of 84 centroids)						
RMS	**MEAN**		**SIGMA**			
METRIC	APOST.	ATT. COR.	APOST.	ATT. COR.	STAT. CONF.	UNITS
Radial	0.0077	0.0059	0.1144	0.1034	0.0113	arcsec
W-axis	0.0069	-0.0000	0.0705	0.0559	0.0061	arcsec
V-axis	0.0035	0.0059	0.0901	0.0869	0.0095	arcsec
PCRS 2 (Total of 42 centroids)						
METRIC	APOST.	ATT. COR.	APOST.	ATT. COR.	STAT. CONF.	UNITS
Radial	0.0185	0.0132	0.0785	0.0588	0.0091	arcsec
W-axis	0.0076	0.0000	0.0474	0.0346	0.0053	arcsec
V-axis	-0.0168	-0.0132	0.0625	0.0475	0.0073	arcsec
Combined (Total of 126 centroids)						
METRIC	APOST.	ATT. COR.	APOST.	ATT. COR.	STAT. CONF.	UNITS
Radial	0.0079	0.0005	0.1043	0.0914	0.0081	arcsec
W-axis	0.0071	-0.0000	0.0638	0.0499	0.0044	arcsec
V-axis	-0.0033	-0.0005	0.0825	0.0766	0.0068	arcsec

Table 3.3: PCRS measurement prediction error summary

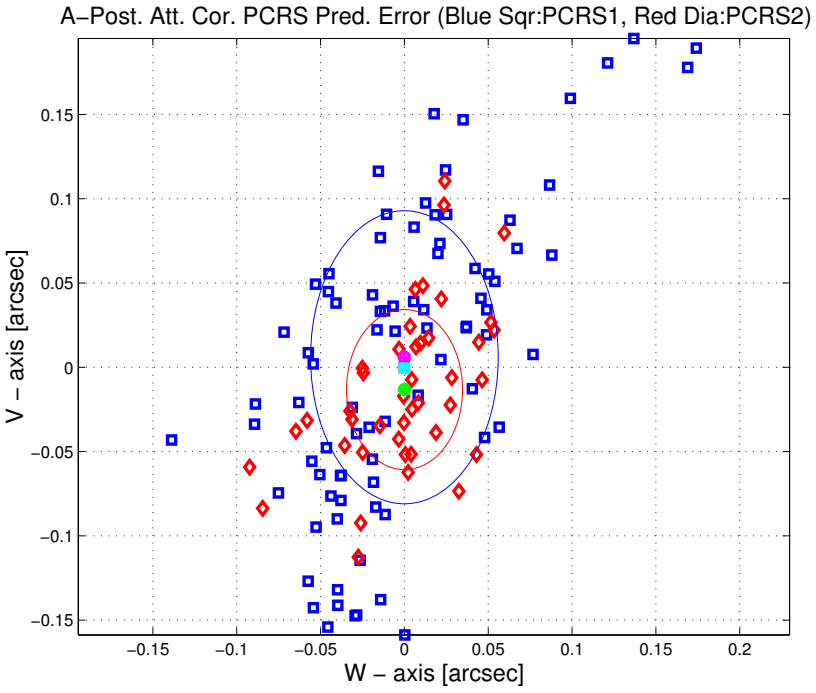

Figure 3.24: A-posteriori PCRS Prediction Summary

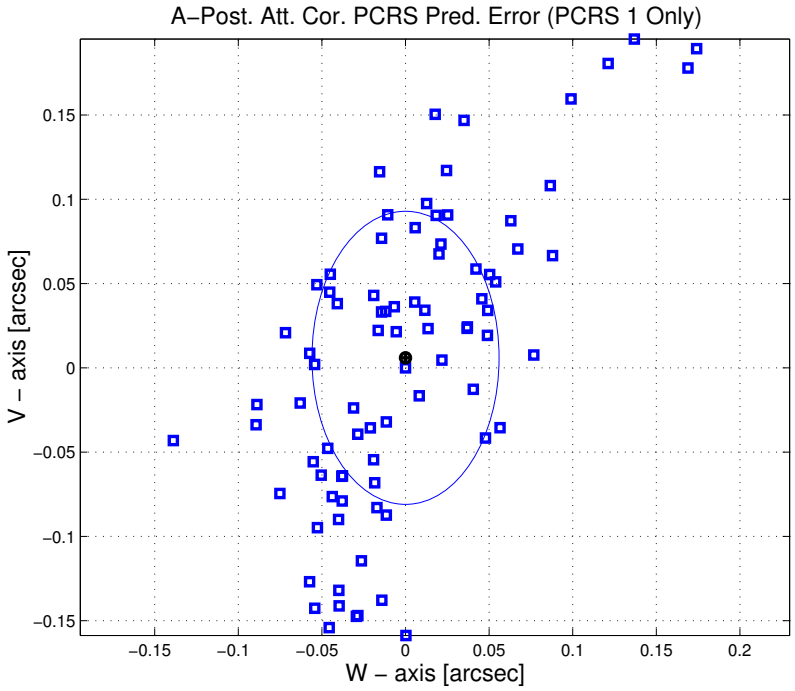

Figure 3.25: A-posteriori PCRS Prediction (PCRS 1 Only)

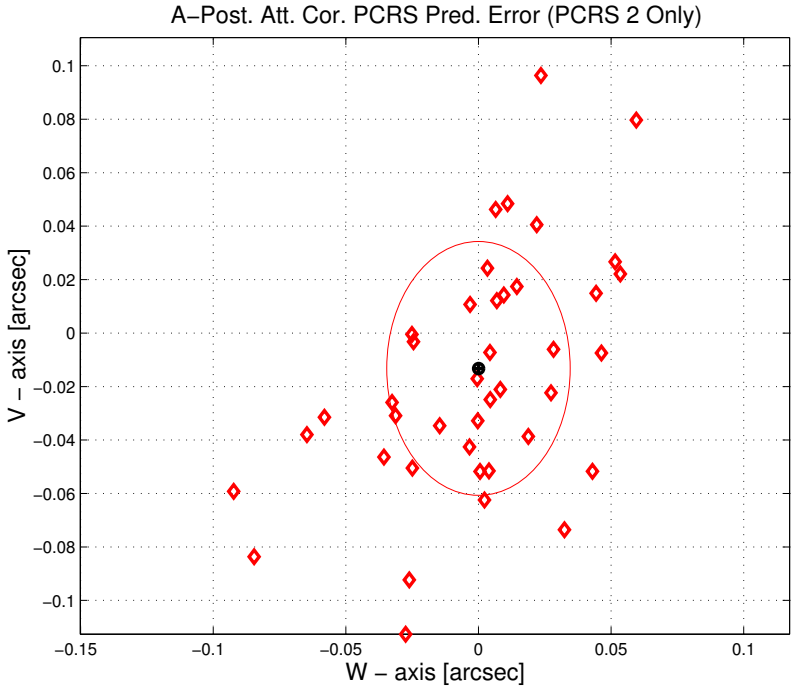

Figure 3.26: A-posteriori PCRS Prediction (PCRS 2 Only)

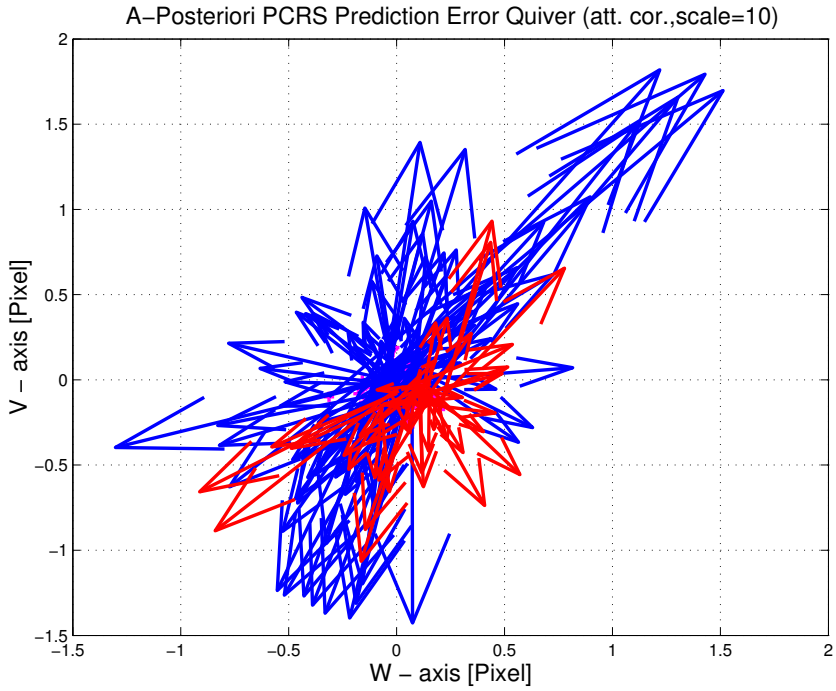

Figure 3.27: A-Posteriori PCRS Prediction Errors Quiver (Att. Cor.)

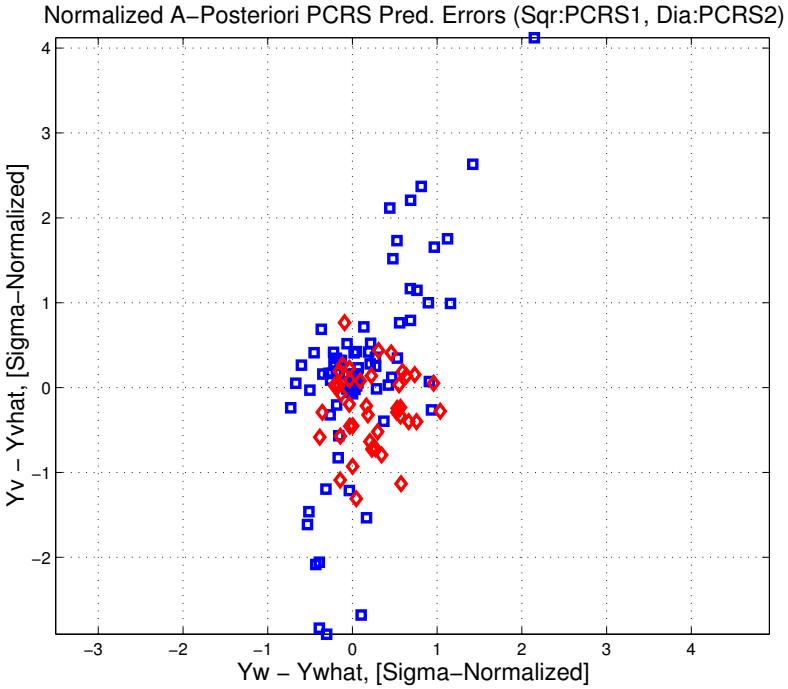

Figure 3.28: Normalized A-Posteriori PCRS Prediction Errors

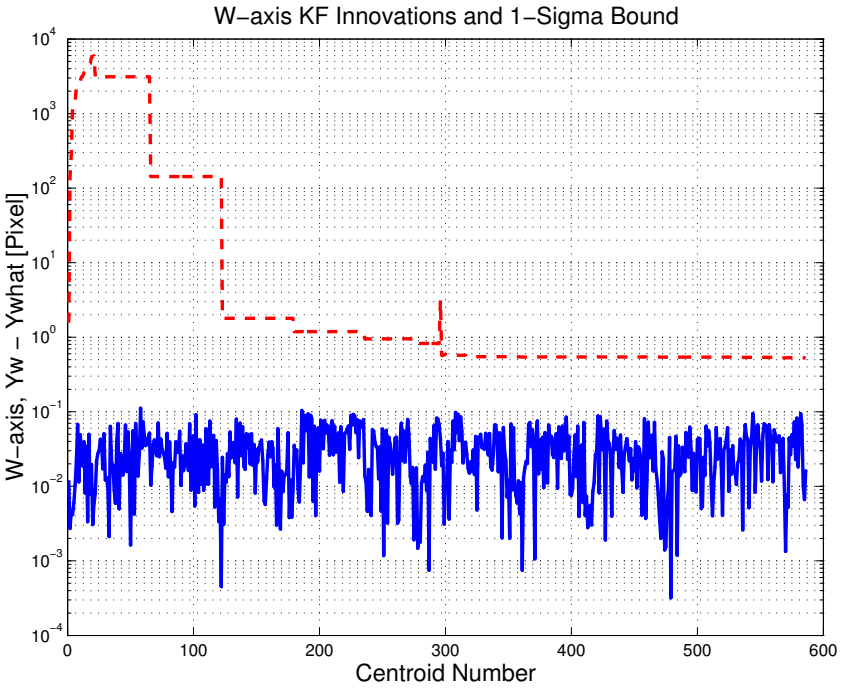

Figure 3.29: W-axis KF innovations and 1-sigma bound

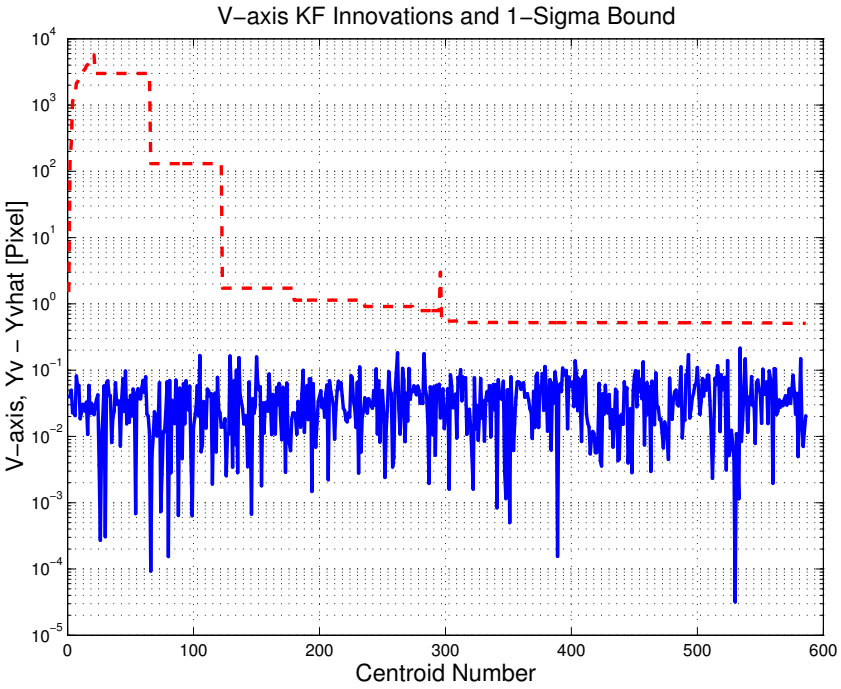

Figure 3.30: V-axis KF innovations and 1-sigma bound

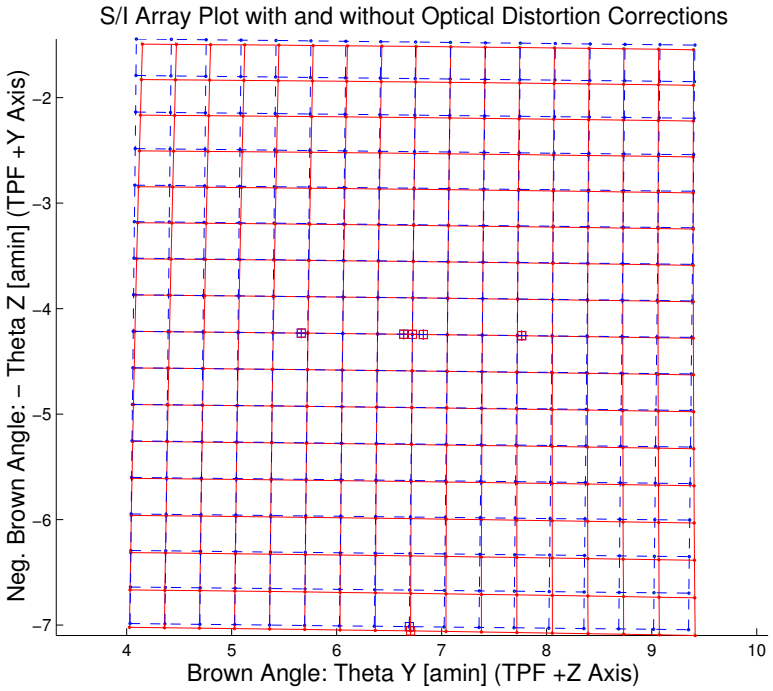

Figure 3.31: Array plot with (solid) and w/o (dashed) optical distortion corrections

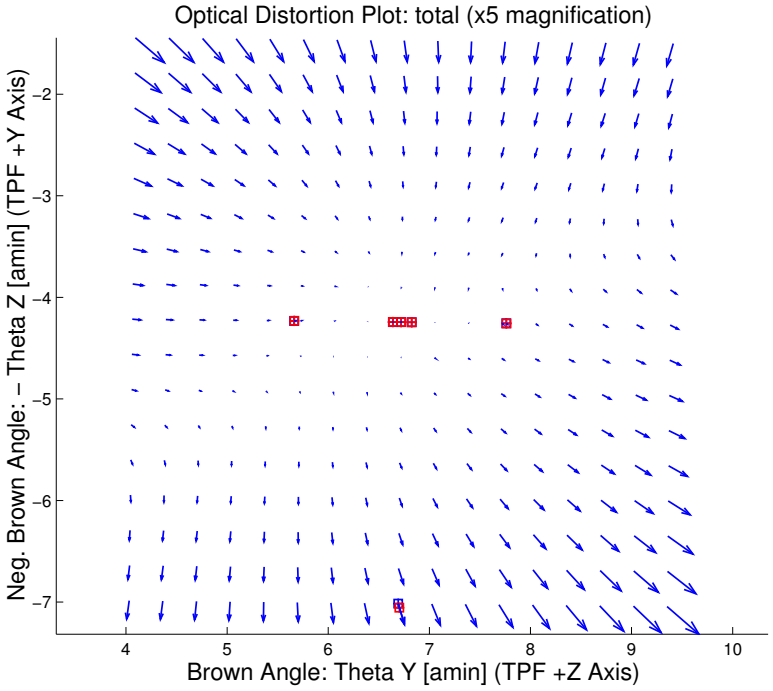

Figure 3.32: Optical Distortion Plot: total (x5 magnification)

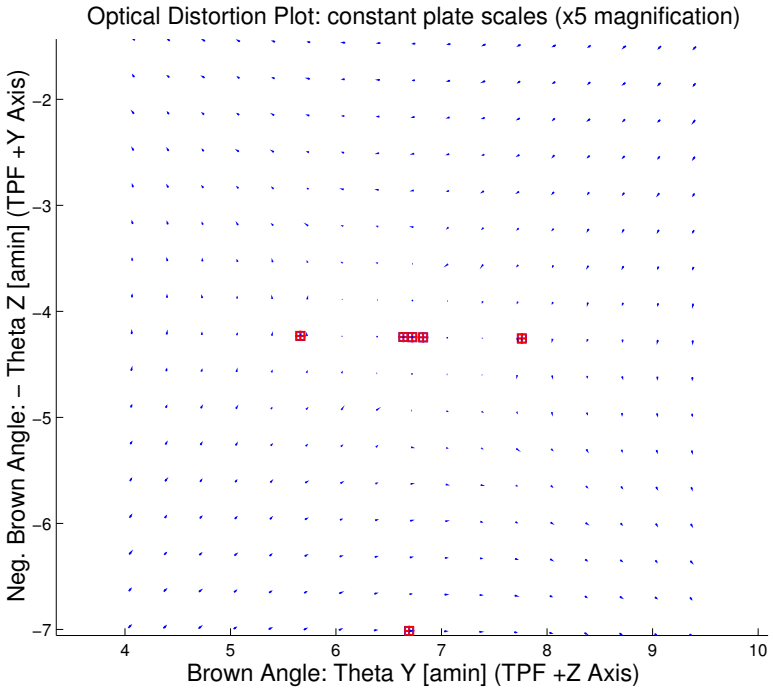

Figure 3.33: Optical Distortion Plot: constant plate scales (x5 magnification)

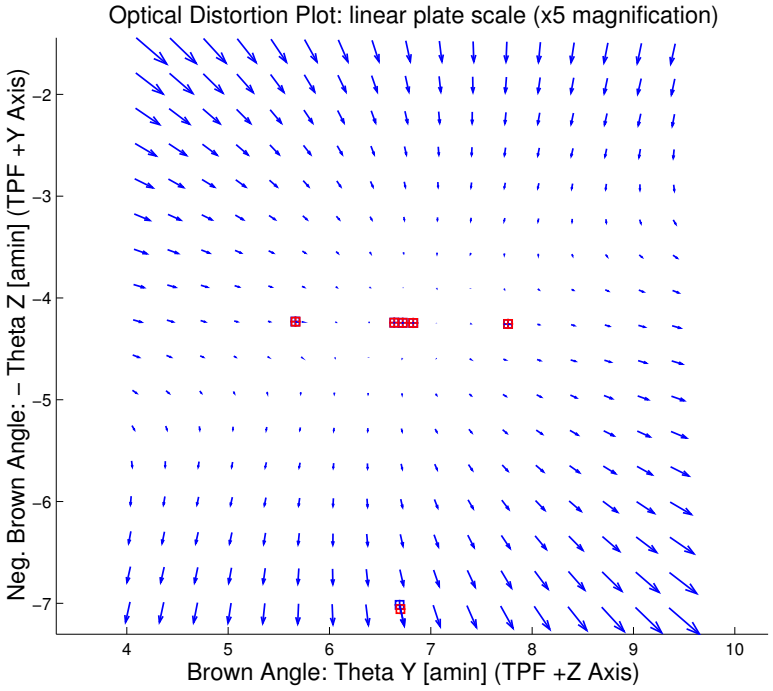

Figure 3.34: Optical Distortion Plot: linear plate scale (x5 magnification)

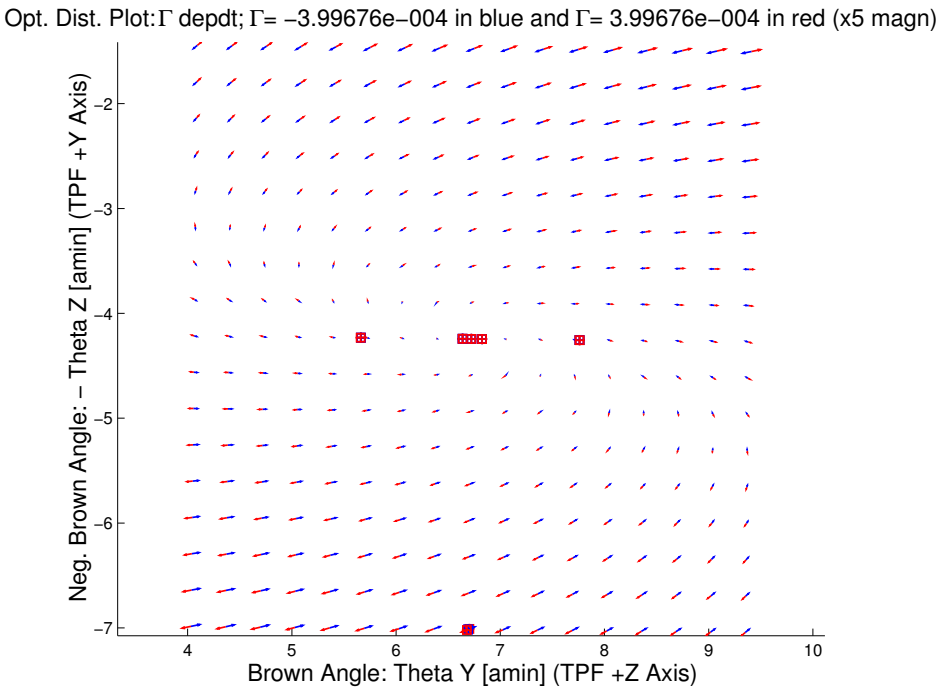

Figure 3.35: Optical Distortion Plot: gamma terms (x5 magnification)

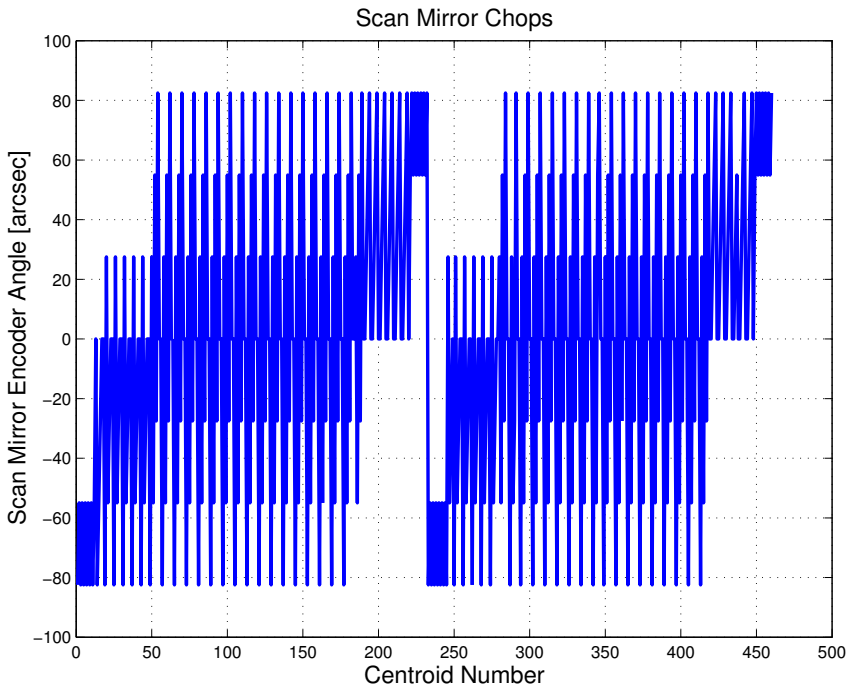

Figure 3.36: Scan Mirror Chops

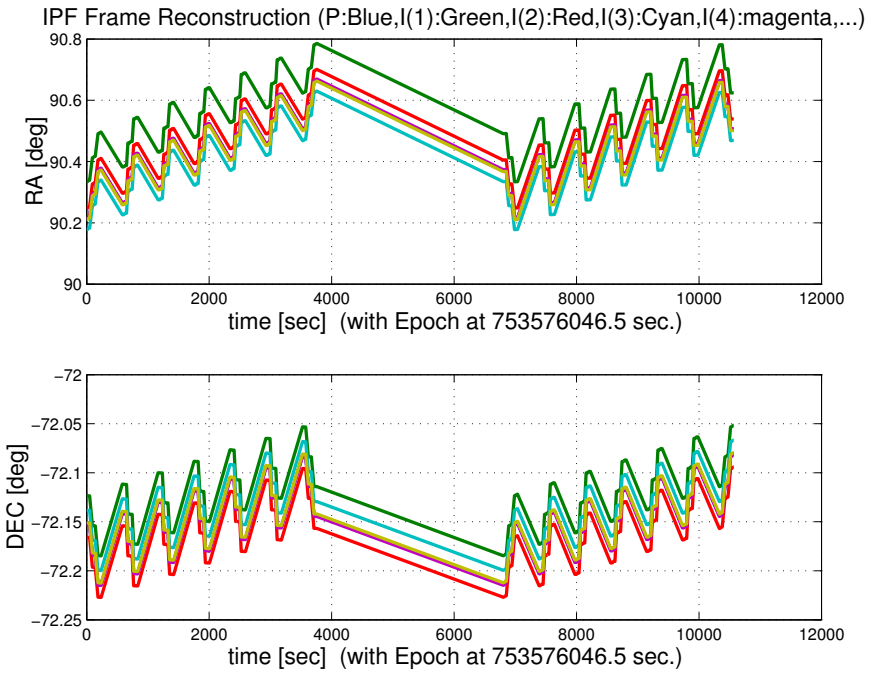

Figure 3.37: IPF Frame Reconstruction

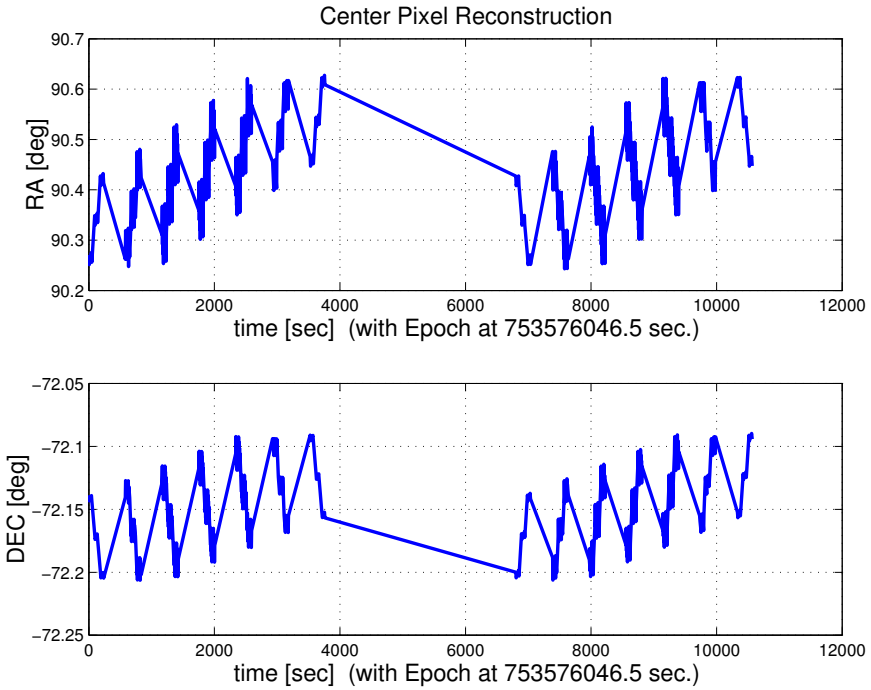

Figure 3.38: Center Pixel Reconstruction

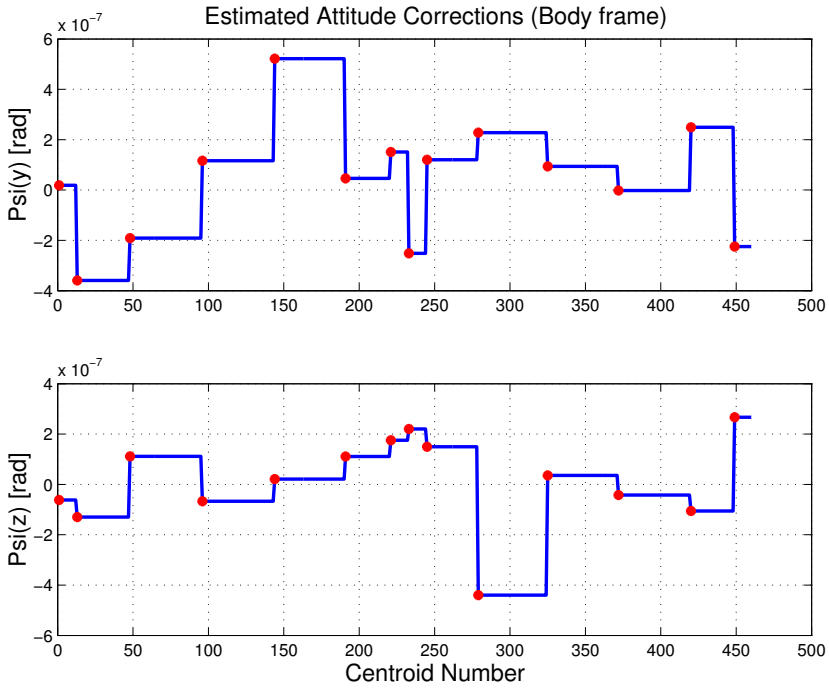

Figure 3.39: Estimated attitude corrections (Body frame)

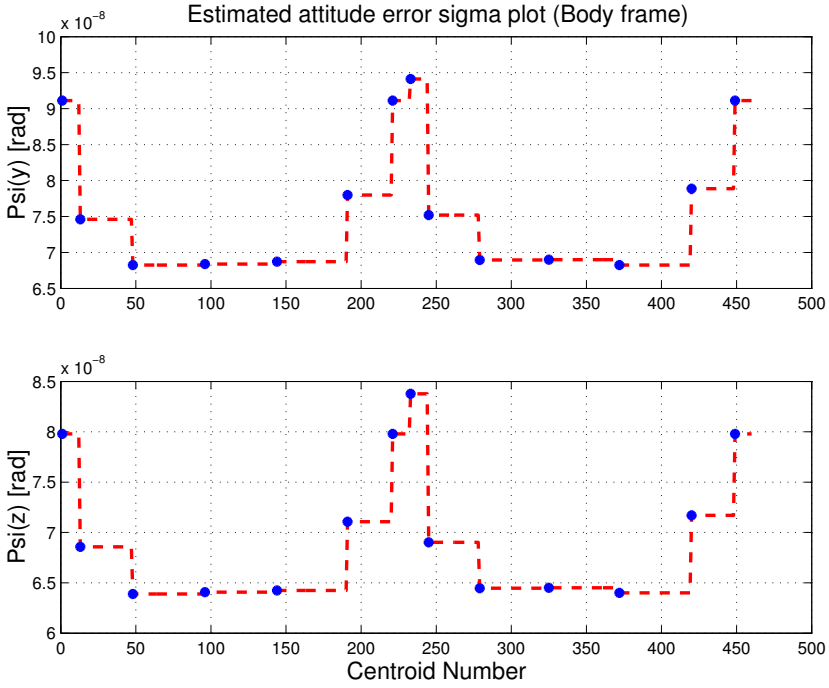

Figure 3.40: Estimated attitude error sigma plot (Body frame)

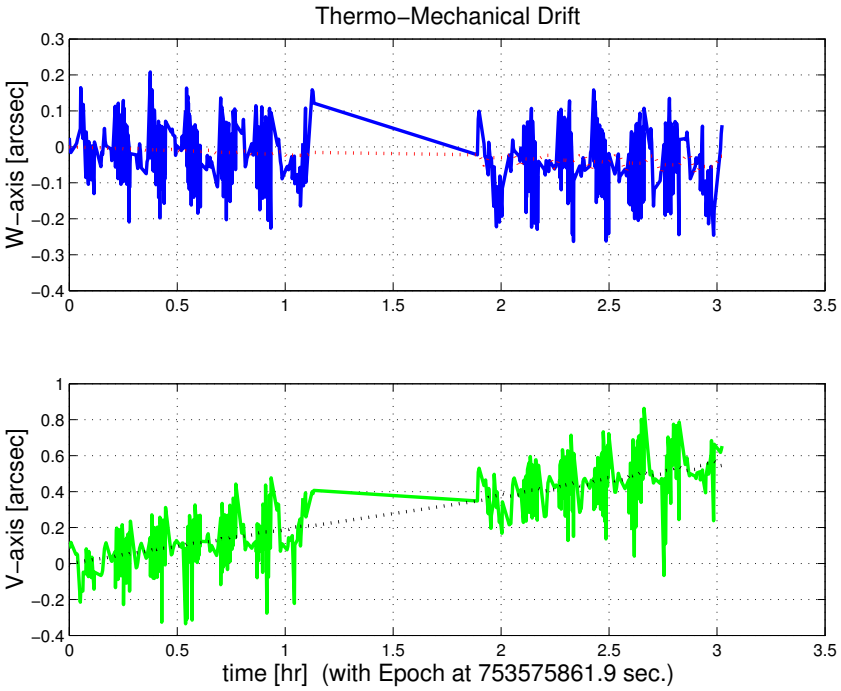

Figure 3.41: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

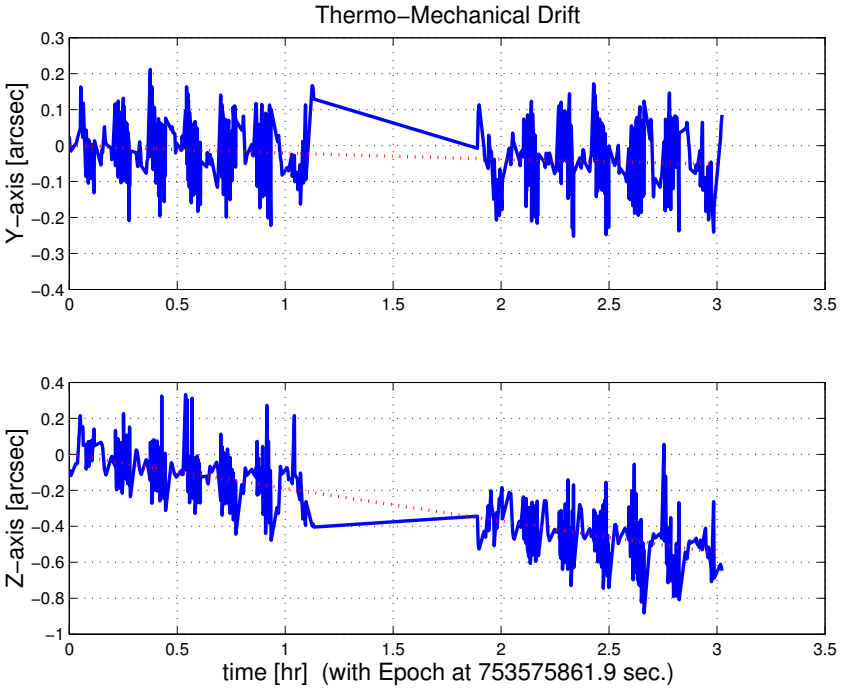

Figure 3.42: Thermo-mechanical boresight drift (equiv. angle in Body frame)

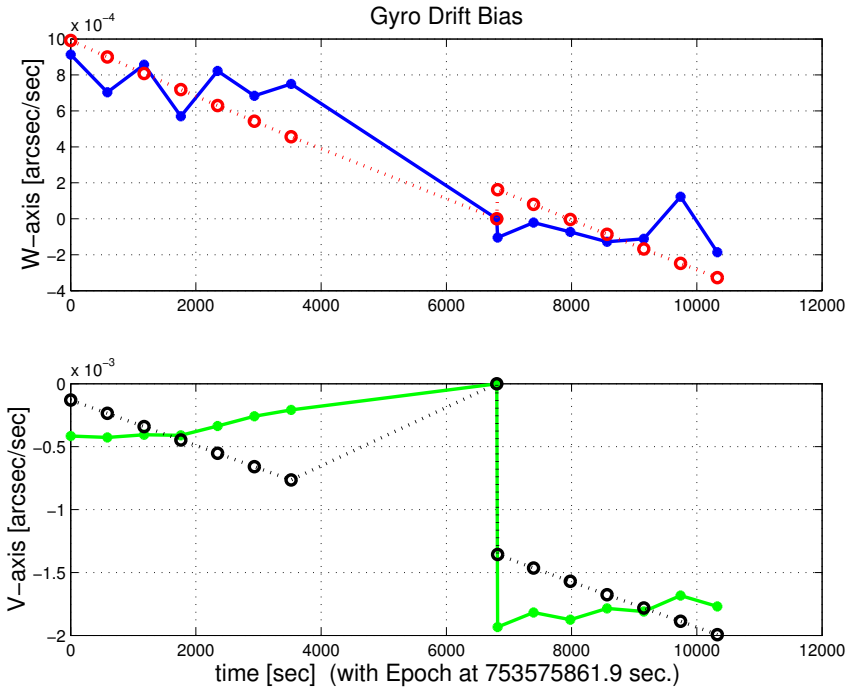

Figure 3.43: Gyro drift bias contribution (equiv. rate in (W,V) coords)

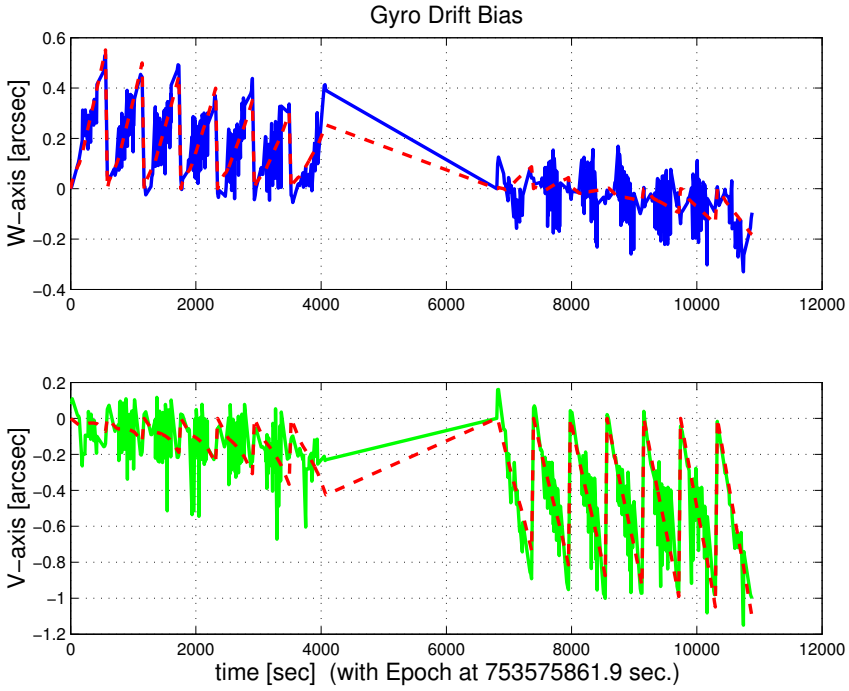

Figure 3.44: Gyro drift bias contribution (equiv. angle in (W,V) coords)

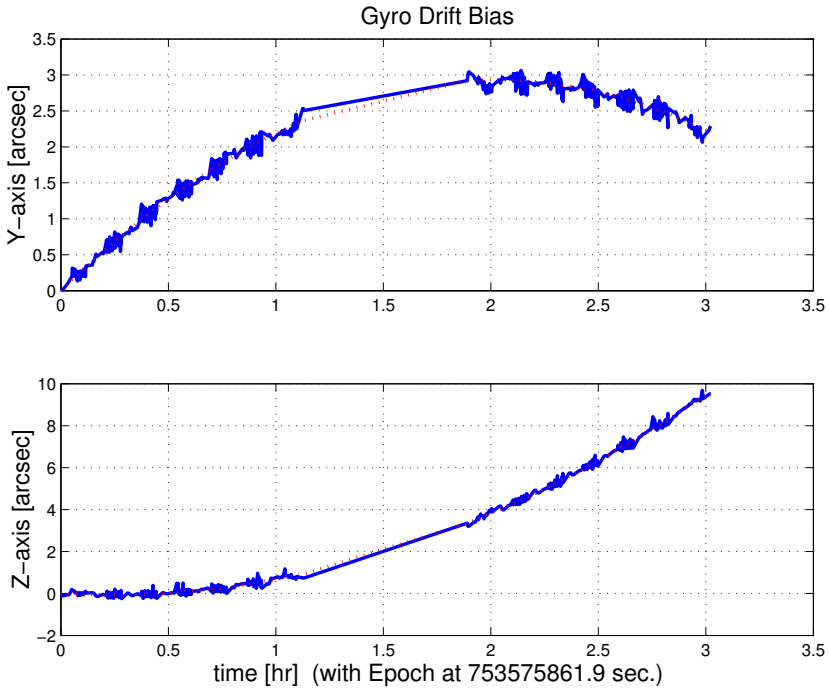

Figure 3.45: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini602095.dat   DATE: 02-Dec-2003   TIME: 19:18
INSTRUMENT NAME:  MIPS_24um_center   NF: 95
IPF FILTER VERSION: IPF.V3.0.0B       SW RELEASE DATE: November 3, 2003
FRAME TABLE USED: BodyFrames_FTU_14a
-------------------------------------------------------------------------------
--------------------------- 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     +6.716105  +4.246060   +0.637930        +6.721826  +4.243820   +0.628212
 096     +6.695190  +7.060913   +0.637930        +6.703859  +7.055562   +0.628212
 099     +7.756798  +4.259313   +0.637930        +7.762937  +4.257169   +0.628212
 100     +5.659609  +4.234140   +0.637930        +5.665074  +4.231696   +0.628212
 103     +6.819955  +4.247316   +0.637930        +6.825711  +4.245090   +0.628212
 104     +6.633060  +4.245067   +0.637930        +6.638755  +4.242815   +0.628212
-------------------------------------------------------------------------------
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)            +6.716105        +4.246060       +0.637930
IS (EST)            +6.721826        +4.243820       +0.628212
dT_EST              +0.005721        -0.002240       -0.009717
T_sSIGMA            +0.000268        +0.000261       +0.002879
dT_EST/T_sSIGMA    +21.373226        -8.591985       -3.375556
-------------------------------------------------------------------------
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)            +6.695190        +7.060913       +0.637930
IS (EST)            +6.703859        +7.055562       +0.628212
dT_EST              +0.008670        -0.005350       -0.009717
T_sSIGMA            +0.000390        +0.000383       +0.002879
dT_EST/T_sSIGMA    +22.245672       -13.953343       -3.375558
-------------------------------------------------------------------------
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)            +7.756798        +4.259313       +0.637930
IS (EST)            +7.762937        +4.257169       +0.628212
dT_EST              +0.006139        -0.002144       -0.009717
T_sSIGMA            +0.000255        +0.000251       +0.002879
dT_EST/T_sSIGMA    +24.118740        -8.550594       -3.375557
-------------------------------------------------------------------------
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)            +5.659609        +4.234140       +0.637930
IS (EST)            +5.665074        +4.231696       +0.628212
dT_EST              +0.005465        -0.002444       -0.009717
T_sSIGMA            +0.000258        +0.000246       +0.002879
dT_EST/T_sSIGMA    +21.179236        -9.944902       -3.375556
-------------------------------------------------------------------------
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)            +6.819955        +4.247316       +0.637930
IS (EST)            +6.825711        +4.245090       +0.628212
```

```
dT_EST              +0.005755        -0.002225       -0.009717
T_sSIGMA            +0.000267        +0.000261       +0.002879
dT_EST/T_sSIGMA    +21.528771        -8.536610       -3.375556
-----------------------------------------------------------------
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)            +6.633060        +4.245067       +0.637930
IS (EST)            +6.638755        +4.242815       +0.628212
dT_EST              +0.005695        -0.002252       -0.009717
T_sSIGMA            +0.000268        +0.000260       +0.002879
dT_EST/T_sSIGMA    +21.269327        -8.646350       -3.375556
-----------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
VARNAME             MEAN                    SIGMA                SCALED_SIGMA
a00        -1.587796219491186E-004 +5.607416771216999E-005 +5.300652747255651E-005
b00        -2.126304644490611E-004 +7.835892051525910E-005 +7.407215198149962E-005
c00        -1.190588046792164E-003 +4.920956872919262E-005 +4.651746897333786E-005
a10        +4.590373707124190E+000 +2.039517431383218E-001 +1.927941887827778E-001
b10        +4.461700489208871E+000 +2.809969268799663E-001 +2.656244743715428E-001
c10        +1.101218479691005E+001 +2.835917276865732E-001 +2.680773218386193E-001
d10        -1.149638806125334E+000 +2.114719242996343E-001 +1.999029646342863E-001
a01        +8.034888827276834E+000 +1.317514040809184E-001 +1.245437017596143E-001
b01        +4.281521875134070E+000 +1.771129216939898E-001 +1.674236343142313E-001
c01        -1.616011127024753E+001 +1.150620856399814E-001 +1.087674031085374E-001
d01        -2.218111635419564E+000 +1.372496113342738E-001 +1.297411194960802E-001
e01        -1.837723574669427E+001 +1.768835455224599E-001 +1.672068065870653E-001
f01        +2.553865592808130E+000 +1.179487249570938E-001 +1.114961235248846E-001
del_alpha  +7.114372025524007E-015 +1.284754972185160E-004 +1.214470093933399E-004
beta       +9.624518727269000E-001 +1.758174798117190E-004 +1.661990619572387E-004
del_theta1 +9.614196645833100E-016 +5.315134370349109E-005 +5.024360191459302E-005
del_theta2 -1.560398801475951E-017 +8.237091016744432E-008 +7.786465837784536E-008
del_theta3 +3.524325091640587E-017 +8.021123604136149E-008 +7.582313318778652E-008
del_arx    +1.562367835440962E-015 +2.477623960052689E-005 +2.342080994930114E-005
del_ary    -4.207457494473425E-017 +3.068115522348239E-006 +2.900268632770679E-006
del_arz    -1.173867181075158E-015 +3.068185792750764E-006 +2.900335058901890E-006
brx        +2.942159240558136E-009 +1.153841125092711E-008 +1.090718129070301E-008
bry        -3.132030464141953E-011 +1.592219618731396E-009 +1.505114322799159E-009
brz        -2.580246979240580E-010 +1.592189195828635E-009 +1.505085564237120E-009
crx        +1.854422160675008E-013 +2.099592369602288E-012 +1.984730316315325E-012
cry        +1.521205753147276E-015 +3.038518406237335E-013 +2.872290681206709E-013
crz        +2.229348925034853E-015 +3.038461224620642E-013 +2.872236627815283E-013
bgx        +6.275958680100814E-007 +2.847589607288819E-007 +2.691806992555004E-007
bgy        +3.915212319742944E-009 +1.645662295576033E-009 +1.555633319940822E-009
bgz        -7.833075926985066E-010 +1.670786886538435E-009 +1.579383424051529E-009
cgx        -3.069650771050412E-011 +4.301018761475213E-011 +4.065723637849681E-011
cgy        -5.391201559637515E-013 +3.098323036370428E-013 +2.928823589308131E-013
cgz        +9.321243399692201E-013 +3.135885763140681E-013 +2.964331378183604E-013
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +9.4529316502101757E-001
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.000000000000000E+000  +1.256526241980074E-002  +9.999210539732832E-001
a_mirror_tpf   -1.953318046176432E-003  +1.603632901001513E-003  +9.999968064499653E-001
beta                beta_0                    beta                    beta_total
               +2.804741000000001E-006  +9.624518727269003E-001  +2.699428227963918E-006
-------------------------------------------------------------------------------------------------------------
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
FrmTbl:   +5.566350370838700E-003 -9.802403444841519E-004 -6.121165977271000E-004 +9.999838399622690E-001
Estim:    +5.481551467217141E-003 -9.810187443064564E-004 -6.118694272006610E-004 +9.999843077826470E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -1.695988378828226E-004 -1.656862484957508E-006 +6.699585942039439E-007       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                 [rad]
Mean      +1.096437205234599E-002 -1.955299958297572E-003 -1.234477334067616E-003
```

```
SigmaT    +5.3151343703491090E-005 +8.2370910167444326E-008 +8.0211236041361491E-008
-------------------------------------------------------------------------------------------------------------
qR              qR(1)                    qR(2)                    qR(3)                    qR(4)
ASFILE:   +7.0908659836277366E-004 +1.2693941826000810E-003 -1.6274217341560870E-004 +9.9999892711639404E-001
Estim:    +6.7021401262892203E-004 +1.2690468333789351E-003 -1.6213404774591299E-004 +9.9999895702238750E-001
DelThetaR       deltheta(1)              deltheta(2)              deltheta(3)
          -7.7746561927139013E-005 -7.0652015109420104E-007 +1.1180905698580830E-006       [rad]
EulAngR         angR(1)                  angR(2)                  angR(3)                  [rad]
Mean      +1.3400198337425455E-003 +2.5383110743363848E-003 -3.2256773609560835E-004
SigmaR    +2.4776239600526897E-005 +3.0681155223482390E-006 +3.0681857927507649E-006
-------------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                   Bg0(2)                   Bg0(3)
                  -4.3628790535876760E-007 -2.0367018294109582E-007 +3.6563167782333039E-007
Gyro Bias Correction      Bg(1)                    Bg(2)                    Bg(3)
                  +6.2759586801008147E-007 +3.9152123197429447E-009 -7.8330759269850663E-010
Total Gyro Bias           BgT(1)                   BgT(2)                   BgT(3)
                  +1.9130796265131386E-007 -1.9975497062135288E-007 +3.6484837023063188E-007

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)
                  -3.0696507710504126E-011 -5.3912015596375150E-013 +9.3212433996922011E-013
Total Gyro Bias Rate       CgT(1)                   CgT(2)                   CgT(3)
                  -3.0696507710504126E-011 -5.3912015596375150E-013 +9.3212433996922011E-013
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
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)  +5.565951730869750 5E-003 -9.7947717279747932E-004 -1.0215305487940502E-003 +9.9998350850458306E-001
IS (EST)  +5.4811525155637935E-003 -9.8064719308595767E-004 -1.0208285619320086E-003 +9.9998397647523896E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          -1.6959707968843197E-004 -2.5043864469100749E-006 +1.5842613813359985E-006
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +1.0964372052346001E-002 -1.9500735611944968E-003 -2.0523799062172440E-003
sSigmaT   +5.0243584669836031E-005 +1.1336452140473540E-007 +1.1153477724036373E-007
SigmaT    +5.3151325460730394E-005 +1.1992525239745584E-007 +1.1798961567429071E-007
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
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)  +5.5662538280227556E-003 -1.1316112973882811E-003 -6.1320141015468849E-004 +9.9998367999594084E-001
IS (EST)  +5.4814549312274070E-003 -1.1324503853494595E-003 -6.1298068602793580E-004 +9.9998414760567089E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          -1.6959870359077350E-004 -1.7785760671188138E-006 +6.4342528376222883E-007
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +1.0964372052346001E-002 -2.2581467337236217E-003 -1.2383603629807604E-003
sSigmaT   +5.0243598944541018E-005 +7.4034943636926656E-008 +7.2928823032608489E-008
SigmaT    +5.3151340561553628E-005 +7.8319558816740800E-008 +7.7149423830846171E-008
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
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)  +5.5664474678460652E-003 -8.2657205344854390E-004 -6.1123845851204566E-004 +9.9998397878604794E-001
IS (EST)  +5.4816485521974280E-003 -8.2731316353717825E-004 -6.1094873711210350E-004 +9.9998444679090903E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          -1.6959894022143765E-004 -1.5818002527745599E-006 +7.2857530851818151E-007
```

```
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +1.0964372052345999E-002 -1.6479033256415350E-003 -1.2309505320464277E-003
sSigmaT   +5.0243600215834255E-005 +7.5064747437668726E-008 +7.1485849787101995E-008
SigmaT    +5.3151341906420263E-005 +7.9408960326080163E-008 +7.5622941572324373E-008
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
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)  +5.5663407785030133E-003 -9.9534554975494265E-004 -6.1221510359754845E-004 +9.9998382503430572E-001
IS (EST)  +5.4815418756747926E-003 -9.9612894331162585E-004 -6.1197125806448135E-004 +9.9998429283512880E-001

DelTheta        deltheta(1)             deltheta(2)             deltheta(3)
Units             rad                     rad                     rad
          -1.6959882642182629E-004 -1.6668897429687183E-006 +6.6592701298160625E-007
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +1.0964372052345999E-002 -1.9855188063244685E-003 -1.2348466843772731E-003
sSigmaT   +5.0243601825243293E-005 +7.7765734904140290E-008 +7.5829670560737365E-008
SigmaT    +5.3151343608970432E-005 +8.2266261707722442E-008 +8.0218151750892407E-008
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
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)  +5.5663580350760848E-003 -9.6816128275258886E-004 -6.1203938908990752E-004 +9.9998385173448789E-001
IS (EST)  +5.4815591307850508E-003 -9.6893585960022605E-004 -6.1178944971230186E-004 +9.9998431957029466E-001

DelTheta        deltheta(1)             deltheta(2)             deltheta(3)
Units             rad                     rad                     rad
          -1.6959884680710352E-004 -1.6491837347564003E-006 +6.7340437919837531E-007
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +1.0964372052345999E-002 -1.9311354127426405E-003 -1.2341848862309360E-003
sSigmaT   +5.0243601953021452E-005 +7.7885823558244389E-008 +7.5754768032588598E-008
SigmaT    +5.3151343744143481E-005 +8.2393300237723269E-008 +8.0138914397952165E-008
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
              q(1)                    q(2)                    q(3)                    q(4)
PCRS1A: +5.3371888965461637E-007 +3.7444233778550031E-004 -1.4253684912431913E-003 +9.9999891405806784E-001
PCRS2A: -5.2779261998836216E-007 +3.8462959425181312E-004 +1.3722087221825403E-003 +9.9999898455099423E-001
-----------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +1.2087416876100000E-005  Row (1) TASTART:   +7.5357550039074707E+008
Row (02) PIX2RADY: +1.2595908372599999E-005  Row (2) TASTOP:    +7.5358749929079282E+008
Row (03) CX0:      +6.4500000000000000E+001  Row (3) S/C TIME:  +7.5355685689079285E+008
Row (04) CY0:      +6.4500000000000000E+001  Row (4) QR1:       +7.0908659836277366E-004
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +1.2693941826000810E-003
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       -1.6274217341560870E-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)
5.07582033E+000  3.78025944E-001  3.78557885E-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:  LG602095.dat
INSTRUMENT TYPE:              MIPS_24um_center
IPF FILTER EXECUTION DATE:    02-Dec-2003    TIME: 19:12
IPF FILTER VERSION USED:      IPF.V3.0.0B
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA601095 Loaded!        AAFILE dimension = 119990 X 21
ASFILE:  AS601095 Loaded!
CAFILE:  CA901095 Loaded!        CAFILE dimension = 460 X 15
CBFILE:  CB601095 Loaded!        CBFILE dimension = 126 X 15
CCFILE:  CC602095 Created!       CCFILE dimension = 586 X 19
CSFILE:  CS601095 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  1  1  1  1  0  0  0  0  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [-4.3628790535876760E-007 -2.0367018294109582E-007 +3.6563167782333039E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG602095.m     ACFILE CREATED:  AC602095.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 81 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.3371888965461637E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7444233778550031E-004                 +5.2236196154513707E-004
            -1.4253684912431913E-003                 -1.4047712280184723E-003
            +9.9999891405806784E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.2779261998836216E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8462959425181312E-004                 +5.3239763239987400E-004
            +1.3722087221825403E-003                 +1.3516841804518383E-003
            +9.9999898455099423E-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) = 1.0000000000000000E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 1.0000000000000000E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 1.0000000000000000E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 1.0000000000000000E+002
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) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+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  = +5.5663503708387055E-003  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.8024034448415285E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -6.1211659772710057E-004  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9998383996226992E-001
p2f(09) = qR1  = +7.0908659836277366E-004  Sigma_initial(23,23) = 2.4608271387666178E-004
p2f(10) = qR2  = +1.2693941826000810E-003  Sigma_initial(24,24) = 1.8327214933301909E-005
p2f(11) = qR3  = -1.6274217341560870E-004  Sigma_initial(25,25) = 1.8353004197221061E-005
p2f(12) = qR4  = +9.9999892711639404E-001
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 9.1882207525891937E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 9.1882207525891937E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 9.1882207525891937E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 8.4423400598310735E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 8.4423400598310735E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 8.4423400598310735E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 9.1882207525891937E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 9.1882207525891937E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 9.1882207525891937E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 8.4423400598310735E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 8.4423400598310735E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 8.4423400598310735E-009
-------------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ----------------------
Iteration#001: |dp|= +2.931688443113E+001   RMS(|Res|)=+1.312466543613E-005
Iteration#002: |dp|= +2.792118043707E-002   RMS(|Res|)=+3.187499974732E-006
Iteration#003: |dp|= +1.407678989580E-003   RMS(|Res|)=+8.739623074335E-007
Iteration#004: |dp|= +3.562101747727E-005   RMS(|Res|)=+8.653792127574E-007
Iteration#005: |dp|= +4.920224615036E-006   RMS(|Res|)=+8.654436226827E-007
Iteration#006: |dp|= +3.509608381056E-007   RMS(|Res|)=+8.654274024816E-007
Iteration#007: |dp|= +4.083383751390E-008   RMS(|Res|)=+8.654251881073E-007
Iteration#008: |dp|= +4.612615243796E-009   RMS(|Res|)=+8.654254783712E-007
Iteration#009: |dp|= +4.689038022258E-010   RMS(|Res|)=+8.654255587541E-007
Iteration#010: |dp|= +3.900892992912E-010   RMS(|Res|)=+8.654255555252E-007
Iteration#011: |dp|= +2.227629607895E-010   RMS(|Res|)=+8.654255530680E-007
Iteration#012: |dp|= +3.983523447278E-011   RMS(|Res|)=+8.654255530246E-007
Iteration#013: |dp|= +1.531989117596E-010   RMS(|Res|)=+8.654255530969E-007
Iteration#014: |dp|= +1.901053758388E-010   RMS(|Res|)=+8.654255530983E-007
Iteration#015: |dp|= +1.167043780404E-010   RMS(|Res|)=+8.654255530881E-007
Iteration#016: |dp|= +2.127068639119E-010   RMS(|Res|)=+8.654255530877E-007
Iteration#017: |dp|= +1.795147899522E-010   RMS(|Res|)=+8.654255530987E-007
Iteration#018: |dp|= +1.101381020253E-010   RMS(|Res|)=+8.654255530964E-007
Iteration#019: |dp|= +5.545373125133E-010   RMS(|Res|)=+8.654255530888E-007
Iteration#020: |dp|= +1.726548561226E-010   RMS(|Res|)=+8.654255530961E-007
Iteration#021: |dp|= +5.595079162538E-010   RMS(|Res|)=+8.654255530937E-007
Iteration#022: |dp|= +2.865394193017E-010   RMS(|Res|)=+8.654255531079E-007
Iteration#023: |dp|= +1.300212764247E-010   RMS(|Res|)=+8.654255530933E-007
Iteration#024: |dp|= +4.181617924385E-010   RMS(|Res|)=+8.654255530982E-007
Iteration#025: |dp|= +2.722229504306E-010   RMS(|Res|)=+8.654255530947E-007
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +2.7222295043063589E-010
```

```
---------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+3.275615343400E+009,   |dp|=+2.931682590468E+001
Iteration#002   COND#=+3.275611935260E+009,   |dp|=+2.819689078444E-002
Iteration#003   COND#=+3.275611898185E+009,   |dp|=+1.145539518074E-003
Iteration#004   COND#=+3.275611900129E+009,   |dp|=+2.863872747440E-005
Iteration#005   COND#=+3.275611899121E+009,   |dp|=+3.803407553147E-007
Iteration#006   COND#=+3.275611898413E+009,   |dp|=+4.851678447718E-009
Iteration#007   COND#=+3.275611900162E+009,   |dp|=+6.528415908106E-011
Iteration#008   COND#=+3.275611900128E+009,   |dp|=+3.620461227759E-011
Iteration#009   COND#=+3.275611900236E+009,   |dp|=+2.013070754749E-011
Iteration#010   COND#=+3.275611900500E+009,   |dp|=+3.230308055604E-011
Iteration#011   COND#=+3.275611901416E+009,   |dp|=+4.005494532998E-011
Iteration#012   COND#=+3.275611900096E+009,   |dp|=+3.053126443405E-011
Iteration#013   COND#=+3.275611901001E+009,   |dp|=+4.283235833126E-011
Iteration#014   COND#=+3.275611899785E+009,   |dp|=+4.871370271768E-011
Iteration#015   COND#=+3.275611899899E+009,   |dp|=+2.884653040892E-011
Iteration#016   COND#=+3.275611899660E+009,   |dp|=+1.544446910479E-011
Iteration#017   COND#=+3.275611900831E+009,   |dp|=+2.768188600431E-011
Iteration#018   COND#=+3.275611900269E+009,   |dp|=+3.132786640245E-011
Iteration#019   COND#=+3.275611899913E+009,   |dp|=+3.981586914644E-011
Iteration#020   COND#=+3.275611900422E+009,   |dp|=+3.304350752015E-011
Iteration#021   COND#=+3.275611900758E+009,   |dp|=+2.564746965544E-011
Iteration#022   COND#=+3.275611900102E+009,   |dp|=+2.200455082532E-011
Iteration#023   COND#=+3.275611900910E+009,   |dp|=+3.257997621227E-011
Iteration#024   COND#=+3.275611900664E+009,   |dp|=+4.400277971364E-011
Iteration#025   COND#=+3.275611898602E+009,   |dp|=+3.971705140677E-011
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +3.9717051406769921E-011
---------------------------------------------------------------------
Total Execution Time: 359 seconds
```

4 COMMENTS

Overall the data looked clean, and the filter converged nicely.

Comments:

1. The run was performed in normal IPF operating mode.

2. There were 15 sandwich maneuvers with 460 science centroids (7 centroids were removed from the original 467 centroids, at the 3-sigma level) and 126 PCRS measurements.

3. We estimated 33 parameters consisting of: 3 constant and 6 linear plate scales, 4 Gamma Dependent parameters, 2 mirror parameters, 3 IPF alignment angles, 3 STA-to-PCRS alignment angles, 6 STA-to-PCRS thermomechanical drift parameters, and 3 gyro bias and 3 gyro bias-drift parameters.

4. The linear plate scales were helpful in this run to estimate centroids accurately (see quiver plots in Figures 3-33 and 3-34). The constant plate scales were much smaller than the linear terms. The estimated plate scales (constant and linear) are consistent with those obtained earlier from the Coarse Focal Plane Survey results (i.e., run ID101095).

5. The scan mirror parameter estimates indicate that the mirror scan axis is tilted by 0.7 deg and the scan mirror scale factor is off by 4 percent. These values are consistent with those obtained earlier from the Coarse Focal Plane Survey results (i.e., run ID101095).

6. When we compare the recommended Brown angles in the current run (ID602095) to those recommended by the previous Fine Survey run (ID502095) (note - they both are with respect to the same "WAS" angles since ID502095 was not used in any FTU) the runs disagree by 1" in the V direction. This represents a relatively large discrepancy because these Fine Survey runs should be accurate to 0.1" and this disagreement is 10 times larger.

   Looking carefully at the past and current run, we feel that there is strong evidence that the actual frame changed in the V direction by 1" in the last 3 weeks. We did not think that this was possible and want to check further on this matter. One hypothesis is that there was some non-repeatability in the scan mirror Gamma angle on the order of 1".

We recommend updating frames 95, 96, 99, 100, 103 and 104 with the new quaternions listed in the IF file IF602095.dat. This contains adjustments of 0.35 and 0.13 arcseconds in Y and Z, and 0.01 deg in twist (for the prime frame). If the scan mirror is fully repeatable, this fine survey should be accurate to 0.09 arcsecond which satisfies its fine survey requirement of 0.14 arcseconds by a good margin. Note: If there is really a non-repeatability of the scan mirror on the order of 1", then these results should be revisited, and it may not be possible to meet the .14" Fine Survey requirement.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

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References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CSFILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.