# SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 103121
REPORT TYPE: IOC EXECUTION (COARSE)

PRIME FRAME: MIPS_SED_center (121)
INFERRED FRAMES: (105) (106) (116) (117) (122) (123) (125) (126)


# 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: RN103121. In particular, this Focal Point Survey calibrates the instrument: MIPS_SED_center (121), as part of the IOC Coarse Survey. The main calibration results from the IPF filter execution have been documented in IF103121 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 7 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.

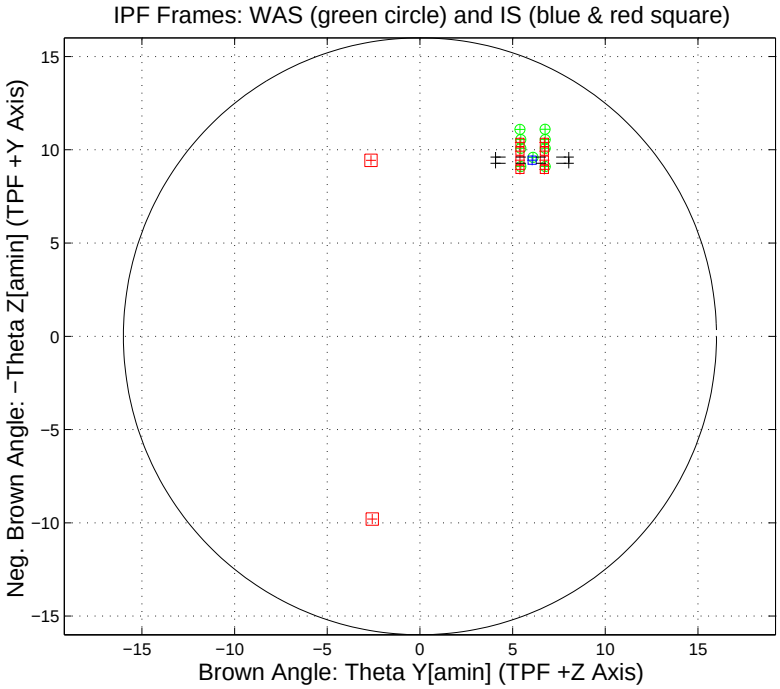


Figure 1.1: A-priori and a-posteriori IPF frames

| RAW | FINAL (After Editing) |
|---|---|
| AA101121 | AA101121 |
| AS101121 | AS101121 |
| CA102121 | CA902121 |
| CB102121 | CB102121 |
| CS102121 | CS102121 |

Table 1.1: IPF filter input files

| EXECUTION CONFIGURATION ITEM | CURRENT STATUS |
|---|---|
| IPF Filter Version Used | IPF.V2.0.0D |
| Frame Table Version Used | BodyFrames_FTU_11a |
| Scan-Mirror Employed? | YES |
| IPF Filter Mode | LITE-MODE(3):FLT |
| SLIT-MODE Operation | ENABLED |
| Kalman Filter Operation | ENABLED |
| Least-Squares Data Analysis | ENABLED |
| IBAD Screening | ENABLED |
| User-Specified Data Editing | DISABLED |
| Total Number of Iterations | 90 |
| LS Residual Sigma Scale | 9.78222978E-001 |
| Total Number of Maneuvers | 6 |

Table 1.2: IPF filter execution configuration

| Con. Plate Scale | | | $\Gamma$ Dependent | | | | $\Gamma^2$ Dependent | | | | Linear Plate Scale | | | | | | Mirror | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $a_{00}$ | $b_{00}$ | $c_{00}$ | $a_{10}$ | $b_{10}$ | $c_{10}$ | $d_{10}$ | $a_{20}$ | $b_{20}$ | $c_{20}$ | $d_{20}$ | $a_{01}$ | $b_{01}$ | $c_{01}$ | $d_{01}$ | $e_{01}$ | $f_{01}$ | $\alpha$ | $\beta$ |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| IPF (T) | | | Alignment R | | | | | | | | | Gyro Drift Bias | | | | | | |
| $\theta_1$ | $\theta_2$ | $\theta_3$ | $a_{rx}$ | $a_{ry}$ | $a_{rz}$ | $b_{rx}$ | $b_{ry}$ | $b_{rz}$ | $c_{rx}$ | $c_{ry}$ | $c_{rz}$ | $b_{gx}$ | $b_{gy}$ | $b_{gz}$ | $c_{gx}$ | $c_{gy}$ | $c_{gz}$ | |
| 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | |
| 0 | 1 | 1 | 1 | 1 | 1 | 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 Coarse Survey.**
**INSTRUMENT NAME: MIPS_SED_center NF: 121**
`PIX2RADW: 4.79222664E-005[rad/pixel] = 9.8847E+000[arcsec/pixel]`
`PIX2RADV: 4.84813226E-005[rad/pixel] = 1.0000E+001[arcsec/pixel]`

| FRAME | DESCRIPTION | IPF[1] | SF[2] | TOTAL | REQ |
|---|---|---|---|---|---|
| 121(P) | MIPS_SED_center | 1.6046 | 0.0855 | 1.6069 | 1.15 |
| 105(I) | MIPS_SED_9 | 1.6046 | 0.0855 | 1.6069 | N/A |
| 106(I) | MIPS_SED_10 | 1.6046 | 0.0855 | 1.6069 | N/A |
| 116(I) | MIPS_SED_7 | 1.6046 | 0.0855 | 1.6069 | N/A |
| 117(I) | MIPS_SED_8 | 1.6046 | 0.0855 | 1.6069 | N/A |
| 122(I) | MIPS_SED_1 | 1.6046 | 0.0855 | 1.6069 | N/A |
| 123(I) | MIPS_SED_2 | 1.6046 | 0.0855 | 1.6069 | N/A |
| 125(I) | MIPS_SED_3 | 1.6046 | 0.0855 | 1.6069 | N/A |
| 126(I) | MIPS_SED_4 | 1.6046 | 0.0855 | 1.6069 | 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 | 4.7847 | 1.6322 | 1.6130 | arcsec |
| W-Axis | 1.3160 | 0.7877 | 0.7494 | arcsec |
| V-Axis | 4.6002 | 1.4296 | 1.4283 | arcsec |
| Radial | 0.4789 | 0.1637 | 0.1617 | pixels |
| W-Axis | 0.1331 | 0.0797 | 0.0758 | pixels |
| V-Axis | 0.4600 | 0.1430 | 0.1428 | 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: 0.978223. 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 0.0837 arcseconds, given that ARW = 100 $\mu deg/\sqrt{hr}$, with 5.833999e+002 second Maneuver time (max), and 6 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_11a | | | | | |
| NF | NAME | WAS | IS | CHANGE | UNIT |
| 121 | theta_Y | +6.099911 | +6.055286 | -0.044625 | arcmin |
| 121 | theta_Z | -9.595594 | -9.441871 | +0.153723 | arcmin |
| 121 | angle | +0.000044 | +0.000049 | +0.000005 | deg |
| 105 | theta_Y | +6.748000 | +6.714264 | -0.033736 | arcmin |
| 105 | theta_Z | -11.101000 | -9.441871 | +1.659129 | arcmin |
| 105 | angle | +0.000000 | +0.000049 | +0.000049 | deg |
| 106 | theta_Y | +5.398000 | +5.396308 | -0.001692 | arcmin |
| 106 | theta_Z | -11.095000 | -9.441872 | +1.653128 | arcmin |
| 106 | angle | +0.000000 | +0.000049 | +0.000049 | deg |
| 116 | theta_Y | +6.758889 | +6.714264 | -0.044625 | arcmin |
| 116 | theta_Z | -9.102260 | -8.948537 | +0.153723 | arcmin |
| 116 | angle | +0.000044 | +0.000049 | +0.000005 | deg |
| 117 | theta_Y | +5.440932 | +5.396307 | -0.044625 | arcmin |
| 117 | theta_Z | -9.102261 | -8.948538 | +0.153723 | arcmin |
| 117 | angle | +0.000044 | +0.000049 | +0.000005 | deg |
| 122 | theta_Y | +6.758890 | +6.714265 | -0.044625 | arcmin |
| 122 | theta_Z | -10.077261 | -9.923538 | +0.153723 | arcmin |
| 122 | angle | +0.000044 | +0.000049 | +0.000005 | deg |
| 123 | theta_Y | +5.440933 | +5.396308 | -0.044625 | arcmin |
| 123 | theta_Z | -10.077261 | -9.923538 | +0.153723 | arcmin |
| 123 | angle | +0.000044 | +0.000049 | +0.000005 | deg |
| 125 | theta_Y | +6.758890 | +6.714265 | -0.044625 | arcmin |
| 125 | theta_Z | -10.548928 | -10.395205 | +0.153723 | arcmin |
| 125 | angle | +0.000044 | +0.000049 | +0.000005 | deg |
| 126 | theta_Y | +5.440933 | +5.396308 | -0.044625 | arcmin |
| 126 | theta_Z | -10.548928 | -10.395205 | +0.153723 | arcmin |
| 126 | angle | +0.000044 | +0.000049 | +0.000005 | deg |

Table 1.6: IPF Brown angle summary

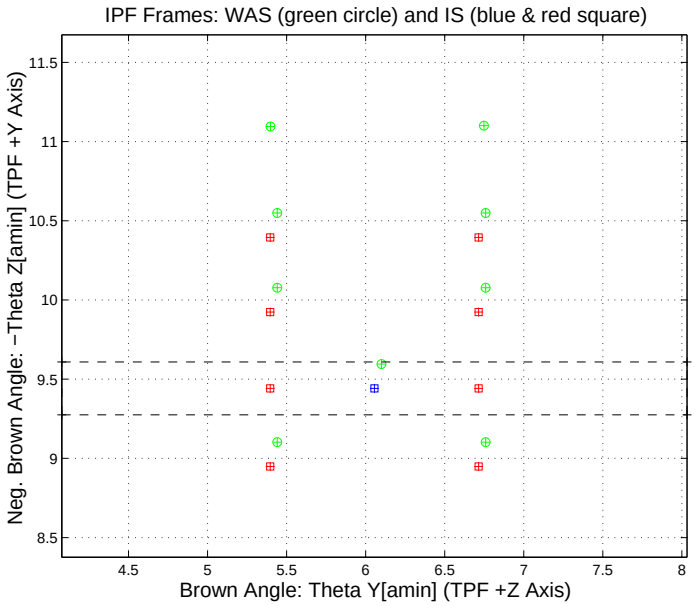


Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

# 2 IPF INPUT FILE HISTORY

| STATUS | FILENAME | START TIME | END TIME |
|---|---|---|---|
| WAS | AA101121 | 751357000.4 | 751363000.3 |
| IS | AA101121 | 751357000.4 | 751363000.3 |
| WAS | CA102121 | 751358389.5 | 751361587.5 |
| IS | CA902121 | 751358389.5 | 751361587.5 |
| WAS | CB102121 | 751358132.4 | 751361779.4 |
| IS | CB102121 | 751358132.4 | 751361779.4 |

Table 2.1: IPF input file begin and end times

| WAS | SIZE | IS | SIZE | REMOVED | PATCHED |
|---|---|---|---|---|---|
| AA101121 | 60000 | AA101121 | 60000 | 0 | 0 |
| CA102121 | 12 | CA902121 | 11 | 1 | N/A |
| CB102121 | 36 | CB102121 | 36 | 0 | N/A |

Table 2.2: IPF input file editing status

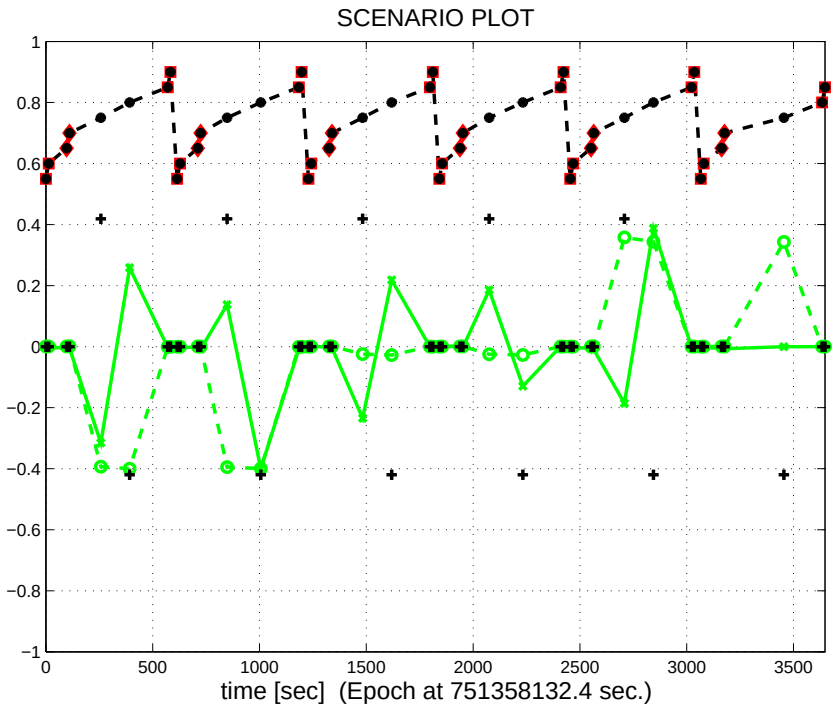


Figure 2.1: Scenario Plot

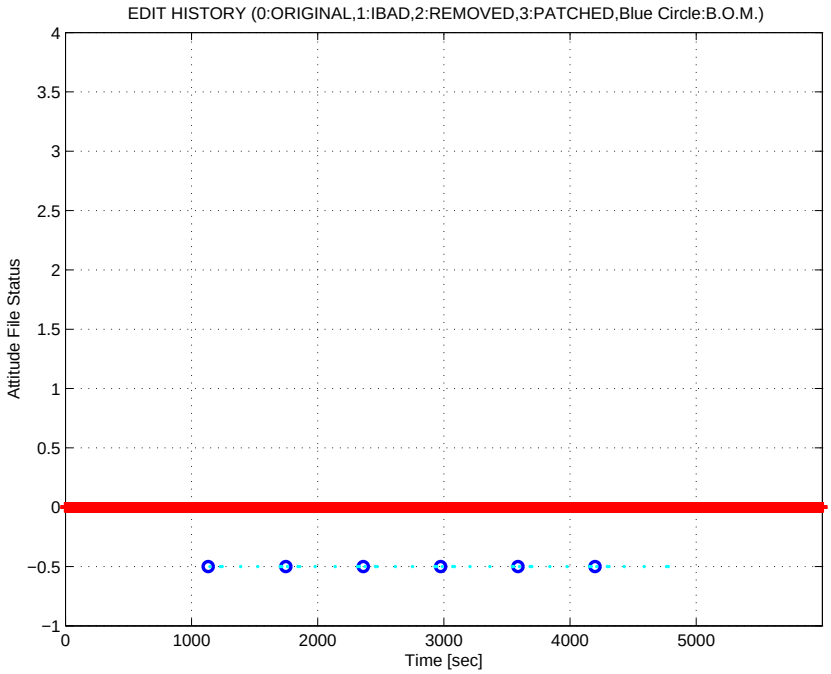


Figure 2.2: Attitude file edit history

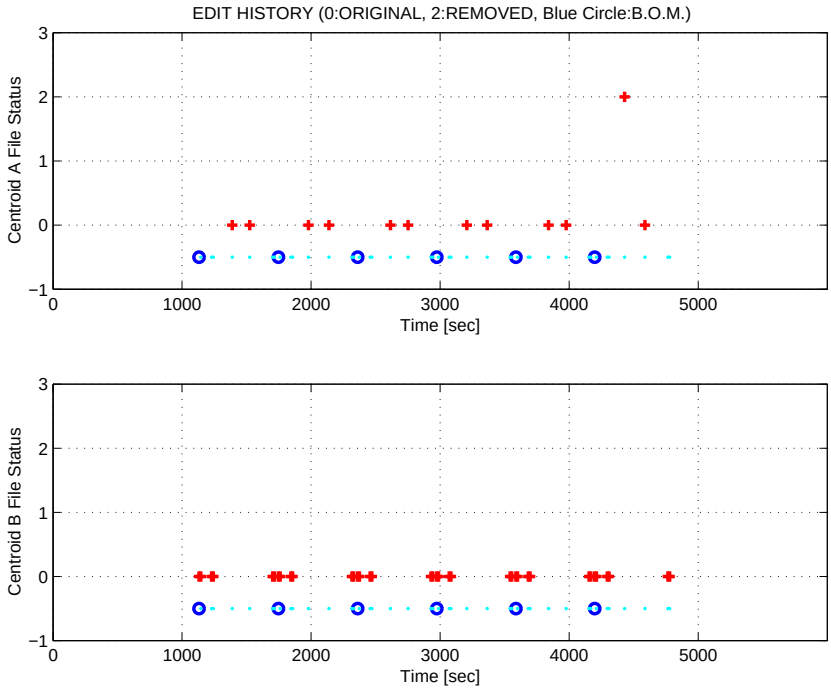


Figure 2.3: Centroid file edit history

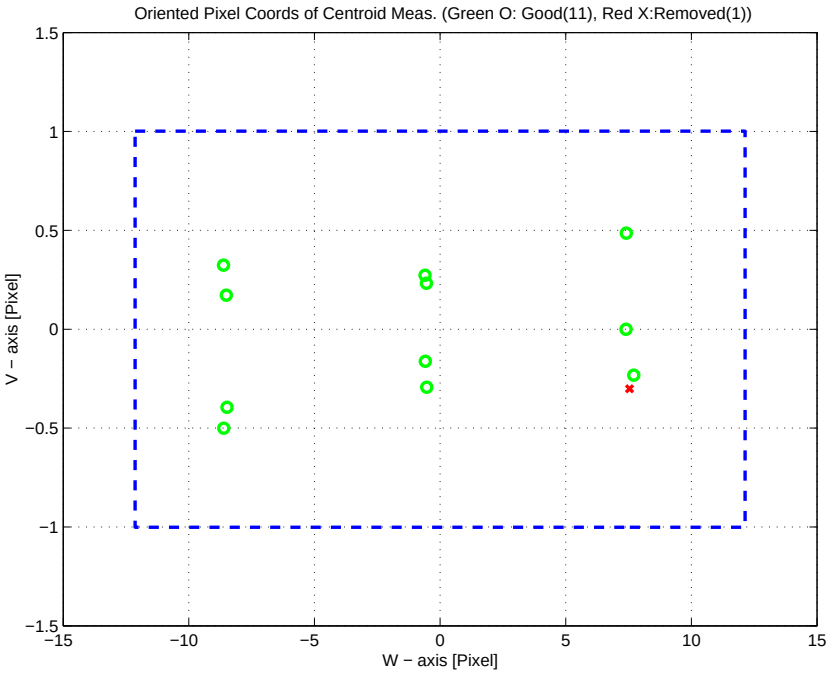


Figure 2.4: Oriented Pixel Coords of Centroid Meas. Edited Centroids

| LIST OF REMOVED CENTROIDS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | | | | | | | | | |

Table 2.3: List of Removed Centroids (Original CA 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 | KF innovations with (o) and w/o (+) attitude corrections (PCRS) |
| Figure 3.21 | Histograms of PCRS a-posteriori residuals (or innovations) |
| Figure 3.22 | A-Posteriori Science Centroid Prediction Error Quiver (Att. Cor.) |
| Figure 3.23 | Normalized A-Posteriori Science Centroid Prediction Errors |
| Figure 3.24 | A-Posteriori PCRS Prediction Errors Quiver (Att. Cor.) |
| Figure 3.25 | Normalized A-Posteriori PCRS Prediction Errors |
| Figure 3.26 | W-axis KF innovations and 1-sigma bound |
| Figure 3.27 | V-axis KF innovations and 1-sigma bound |
| Figure 3.28 | Array plot with (solid) and w/o (dashed) optical distortion corrections |
| Figure 3.29 | Optical Distortion Plot: total (x5 magnification) |
| Figure 3.30 | Optical Distortion Plot: constant plate scales (x5 magnification) |
| Figure 3.31 | Optical Distortion Plot: linear plate scale (x5 magnification) |
| Figure 3.32 | Optical Distortion Plot: gamma terms (x5 magnification) |
| Figure 3.33 | Scan Mirror Chops |
| Figure 3.34 | IPF Frame Reconstruction |
| Figure 3.35 | Center Pixel Reconstruction |
| **IPF parameter trending plots** | |
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| Figure 3.37 | Estimated attitude error sigma plot (Body frame) |
| Figure 3.38 | Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords) |
| Figure 3.39 | Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame) |
| Figure 3.40 | Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords) |
| Figure 3.41 | Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords) |
| Figure 3.42 | Systematic error attributed to gyro drift bias (equiv. angle in Body frame) |

Table 3.2: Table of figures II (IPF run)

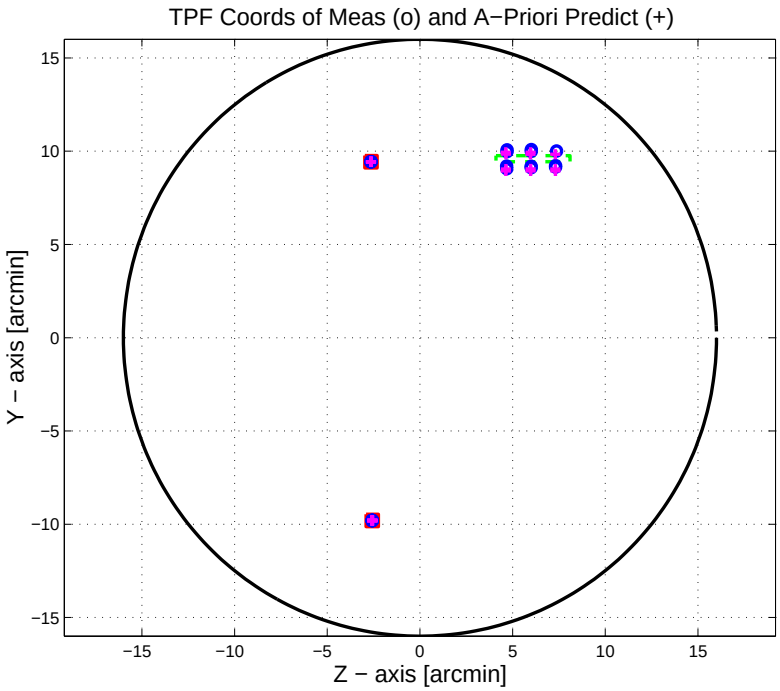


Figure 3.1: TPF coords of measurements and a-priori predicts

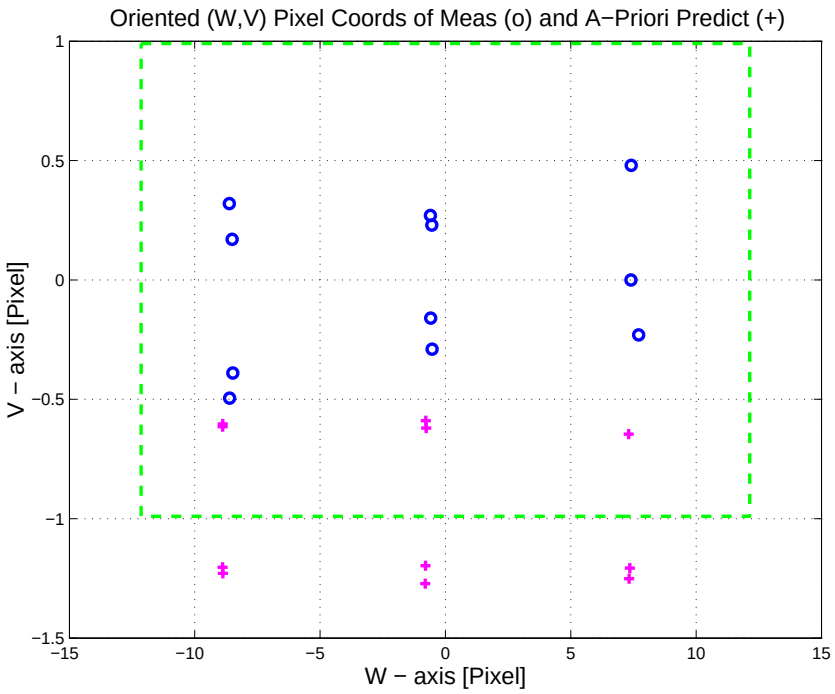


Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

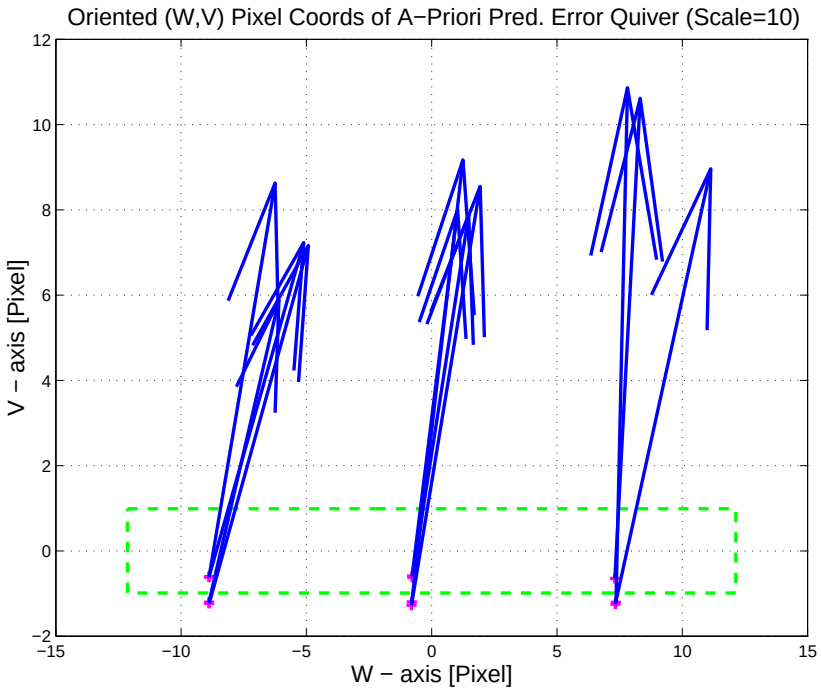


Figure 3.3: Oriented (W,V) Pixel Coords of A-Priori Prediction Error Quiver Plot

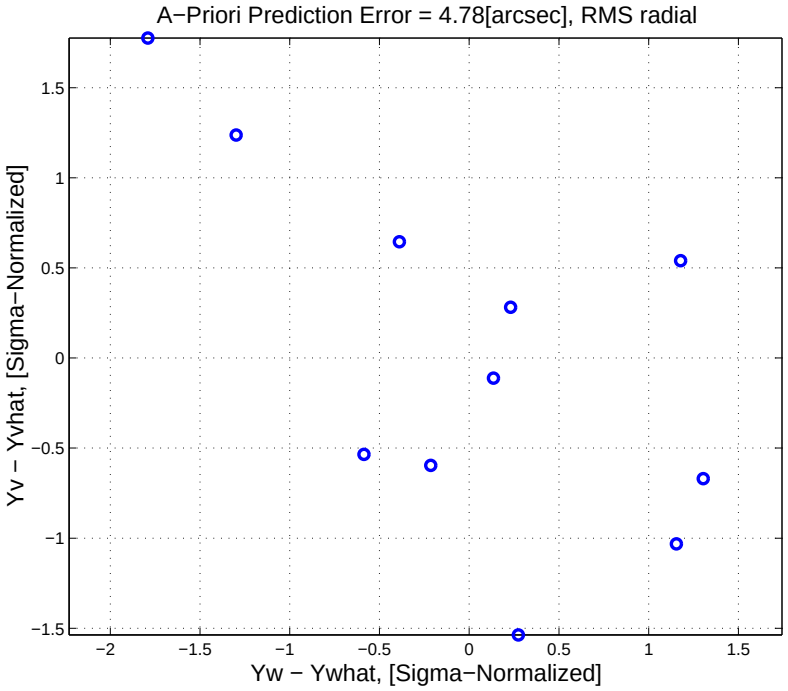


Figure 3.4: A-priori prediction error (Science Centroids)

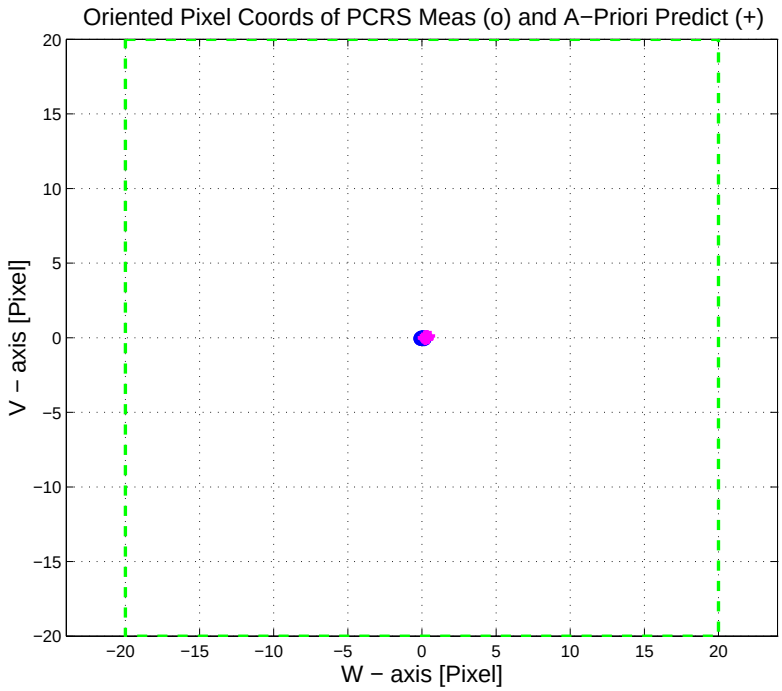


Figure 3.5: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

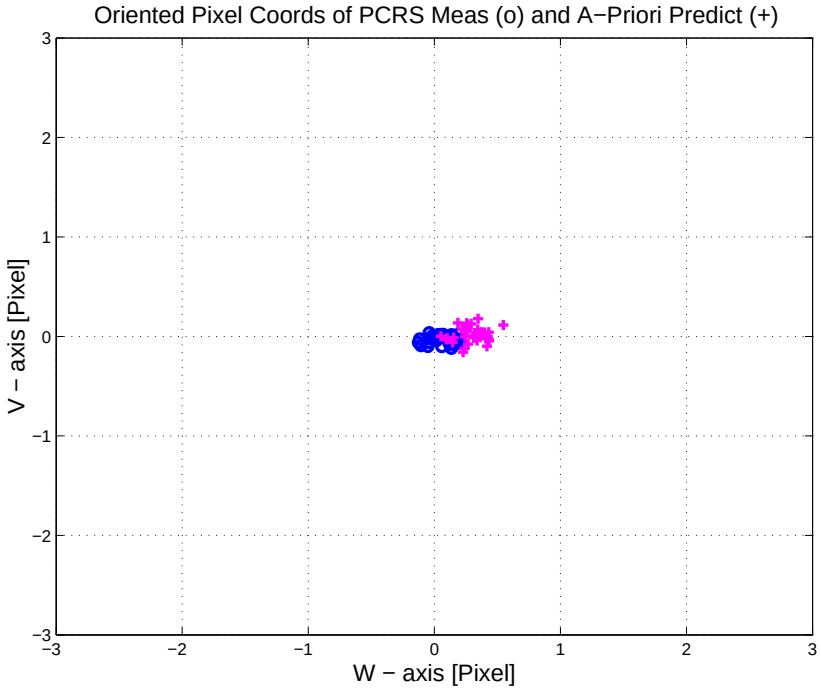


Figure 3.6: Oriented Pixel Coords of measurements and a-priori predicts (Zoomed, PCRS only)

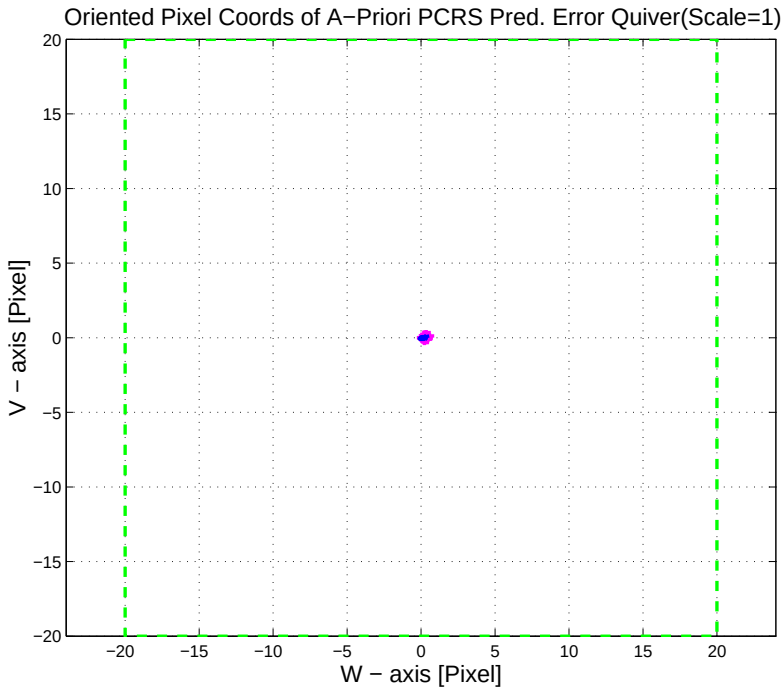


Figure 3.7: Oriented (W,V) Pixel Coords of A-Priori PCRS Prediction Error Quiver Plot

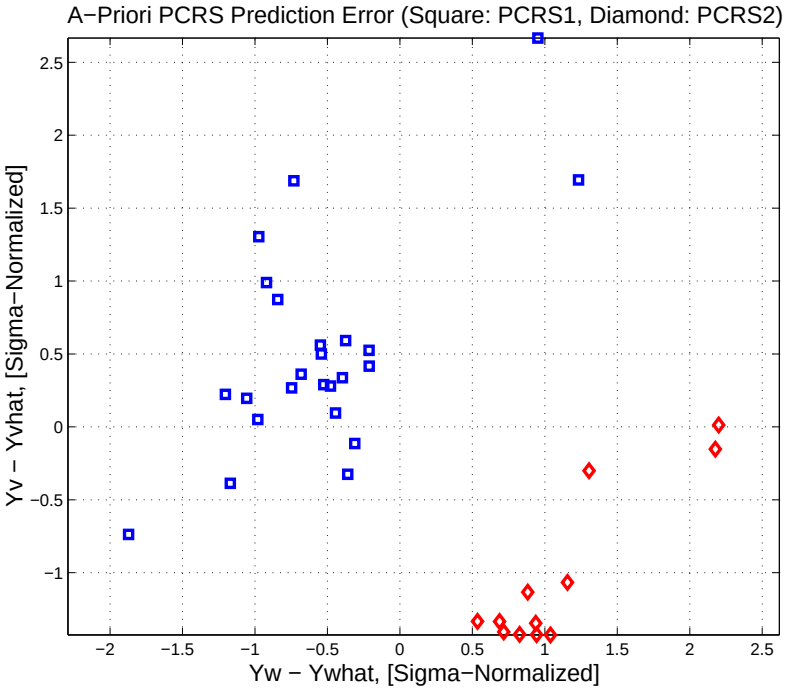


Figure 3.8: A-priori PCRS prediction error

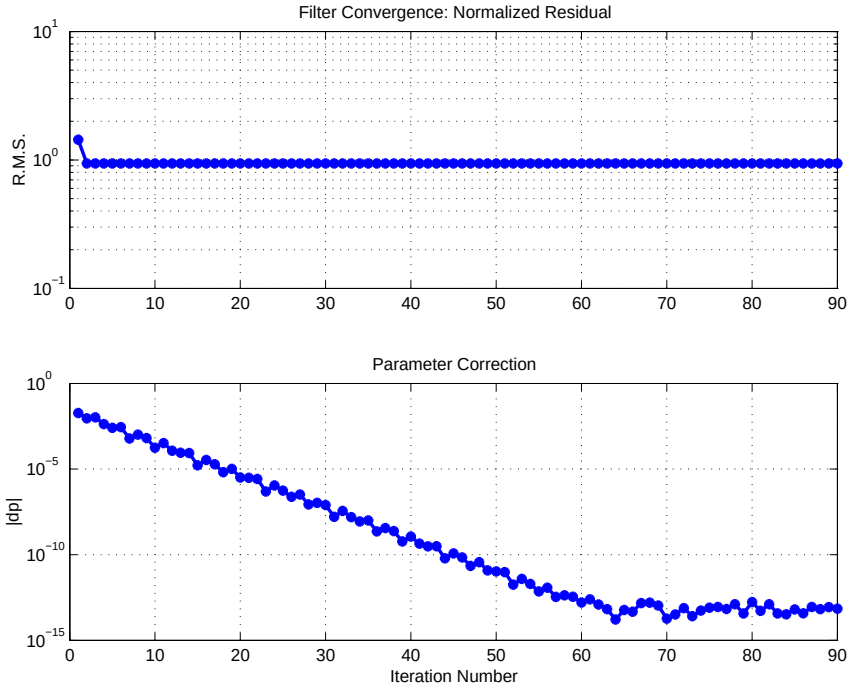


Figure 3.9: IPF execution convergence, chart 1

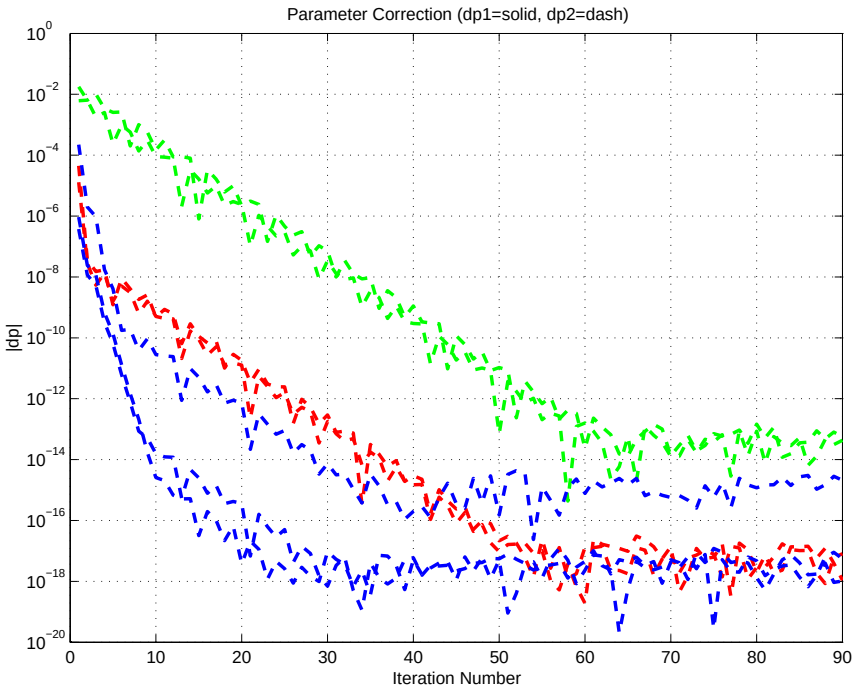


Figure 3.10: IPF execution convergence, chart 2

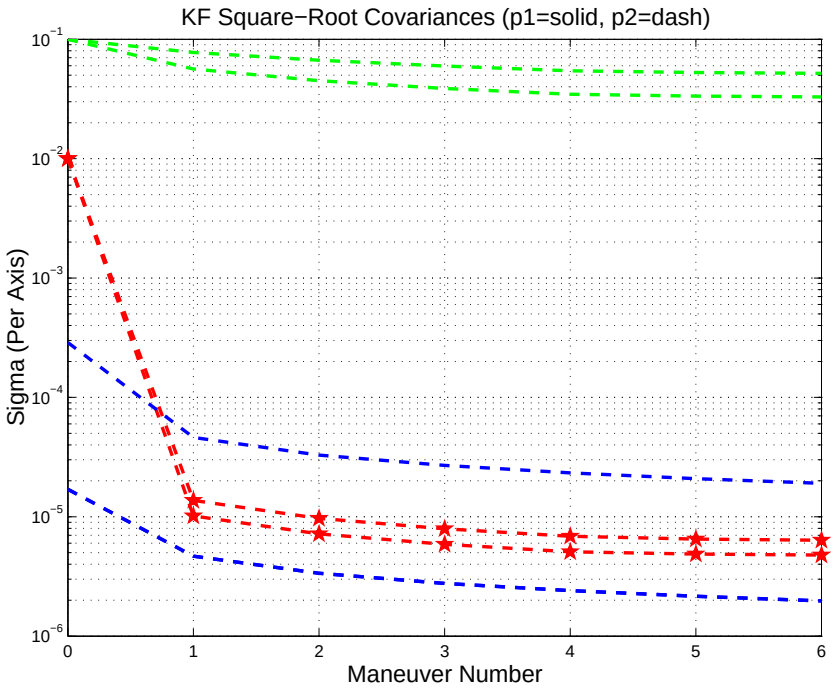


Figure 3.11: Parameter uncertainty convergence

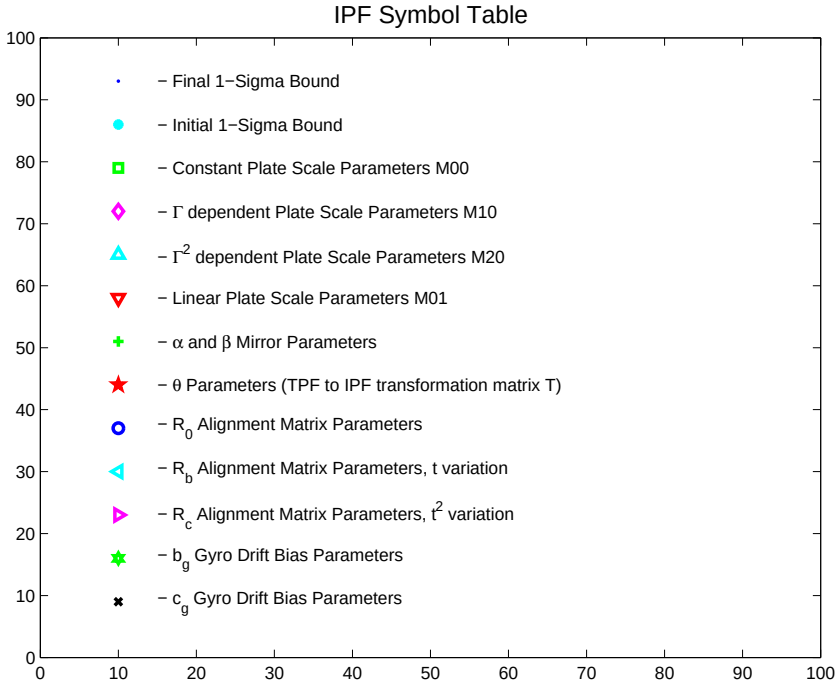


Figure 3.12: IPF parameter symbol table

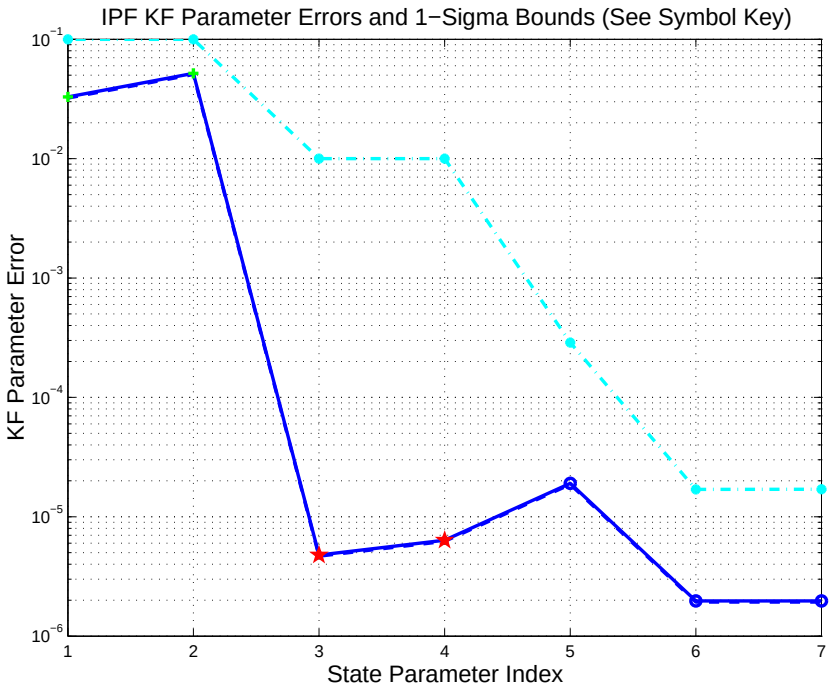


Figure 3.13: KF parameter error sigma plots

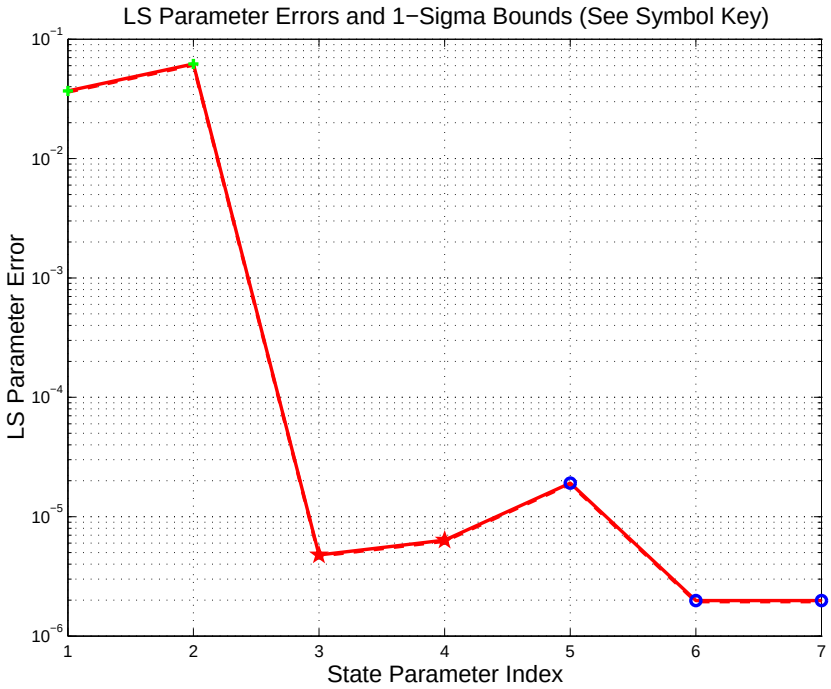


Figure 3.14: LS parameter error sigma plot

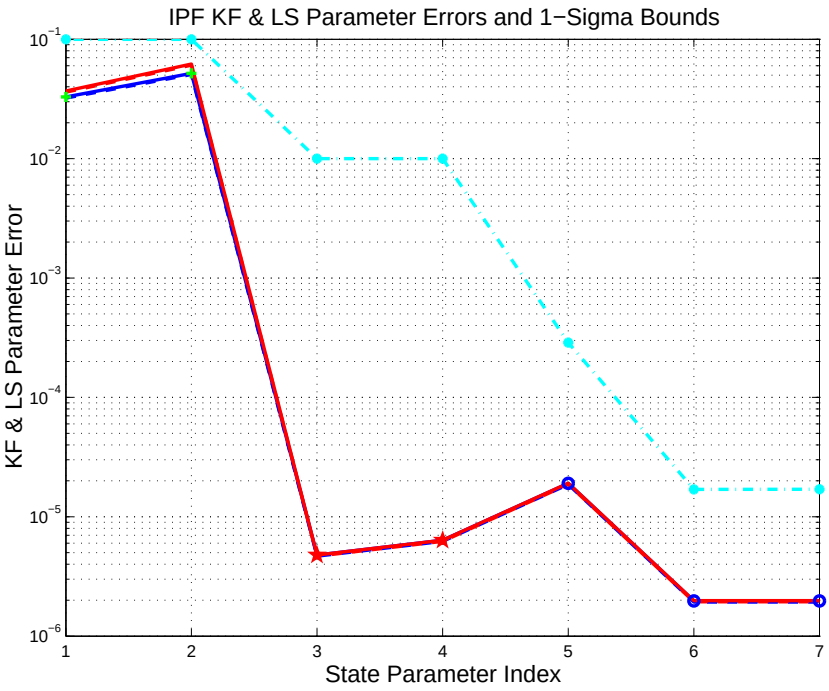


Figure 3.15: KF and LS parameter error sigma plot

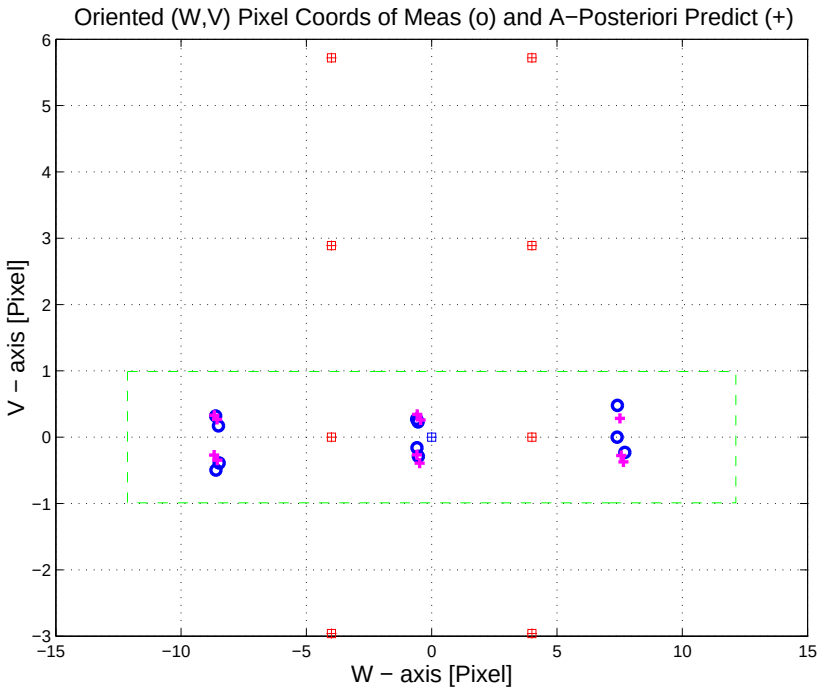


Figure 3.16: Oriented Pixel Coords of meas. and a-posteriori predicts

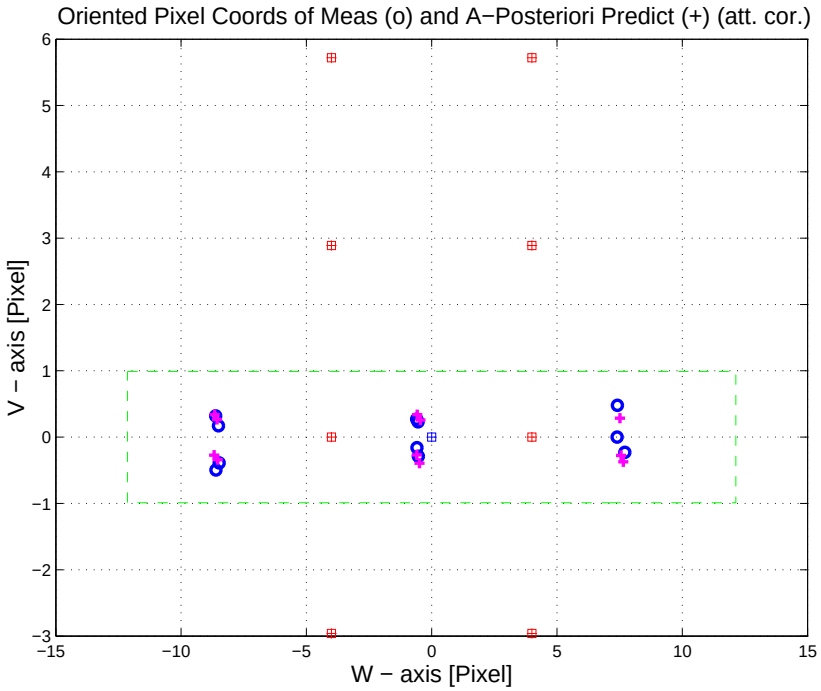


Figure 3.17: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

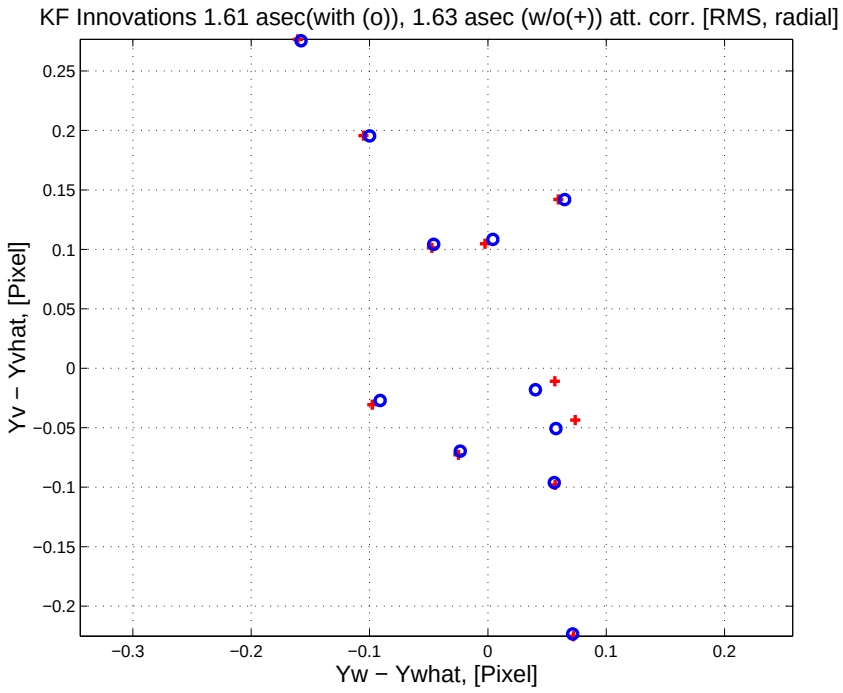


Figure 3.18: KF innovations with (o) and w/o (+) attitude corrections

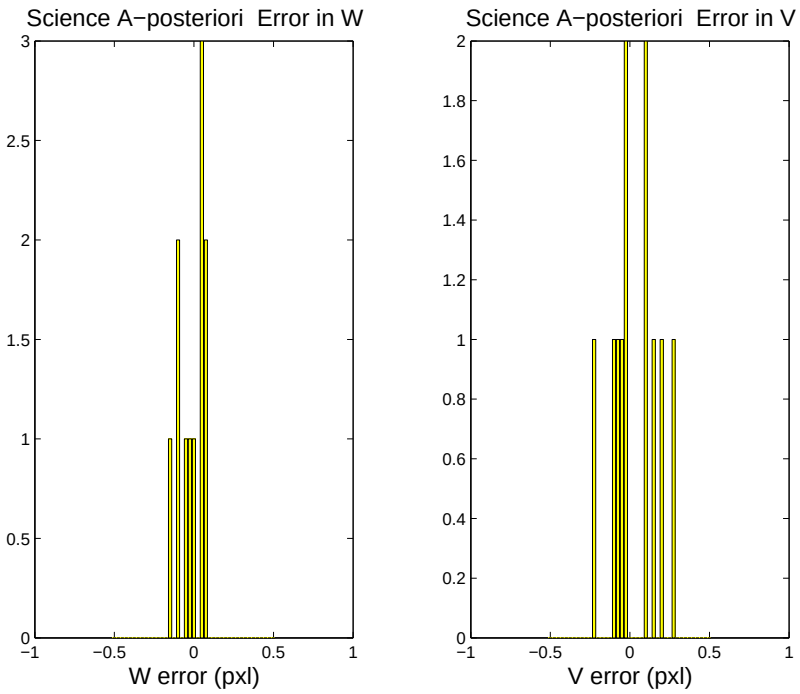


Figure 3.19: Histograms of science a-posteriori residuals (or innovations)

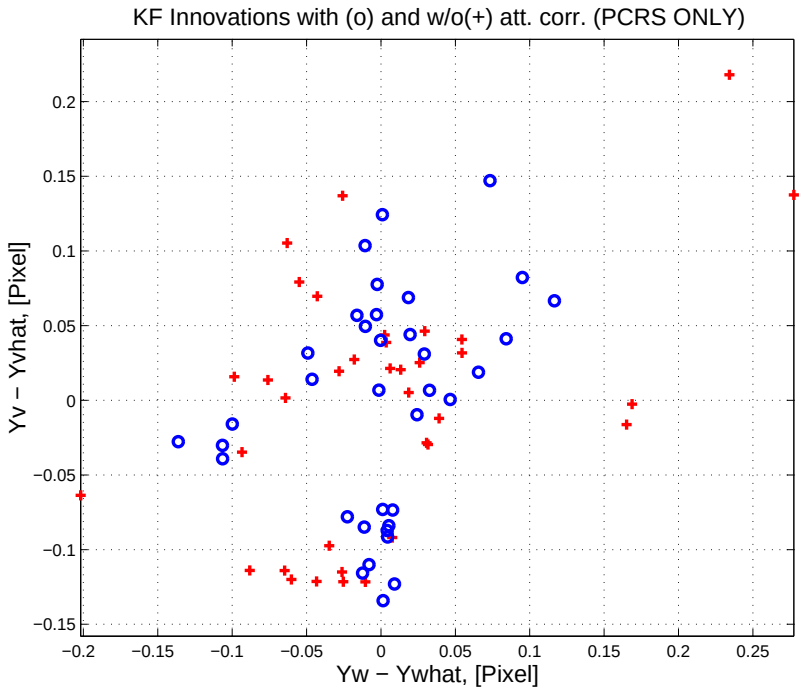


Figure 3.20: KF innovations with (o) and w/o (+) attitude corrections (PCRS)

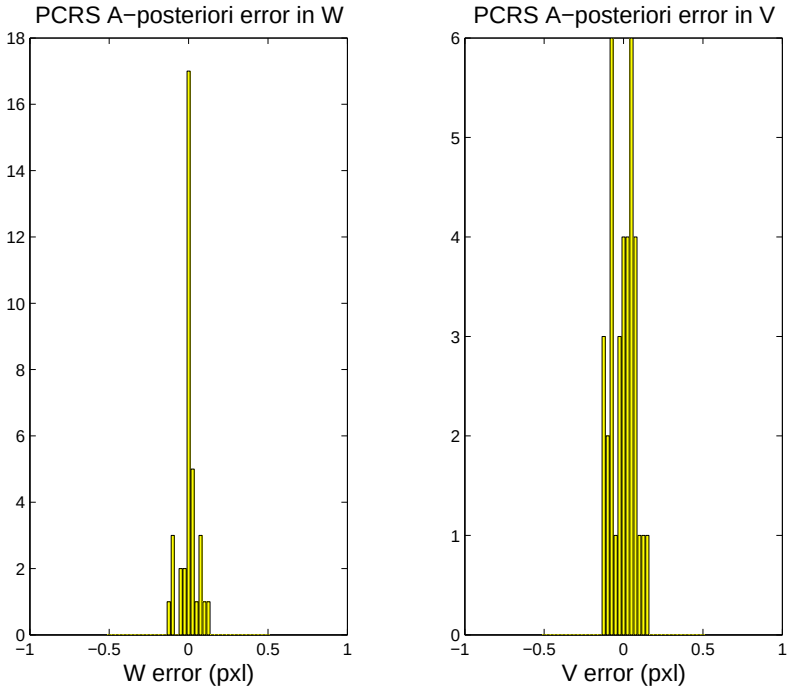


Figure 3.21: Histograms of PCRS a-posteriori residuals (or innovations)

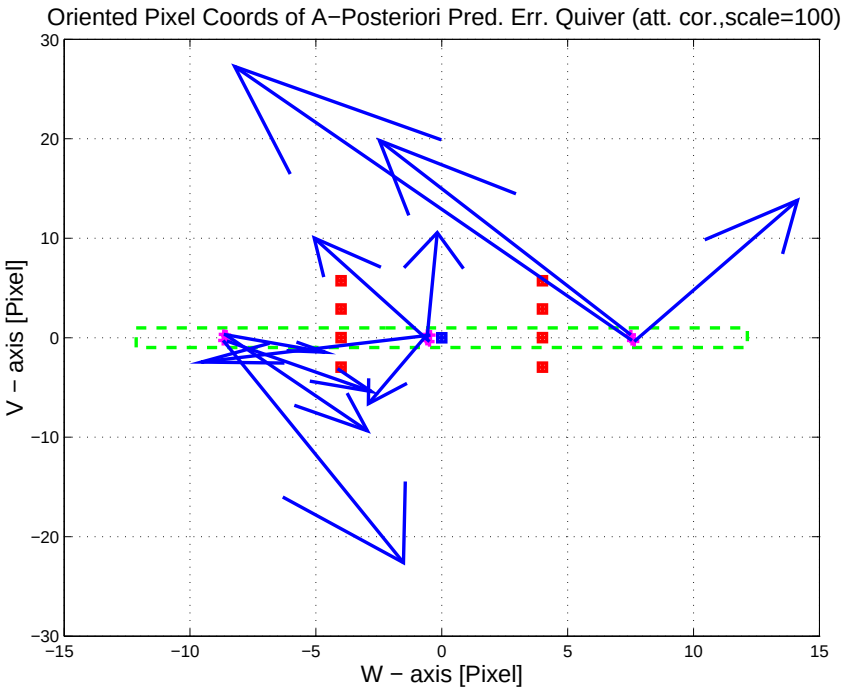


Figure 3.22: A-Posteriori Science Centroid Prediction Error Quiver (Att. Cor.)

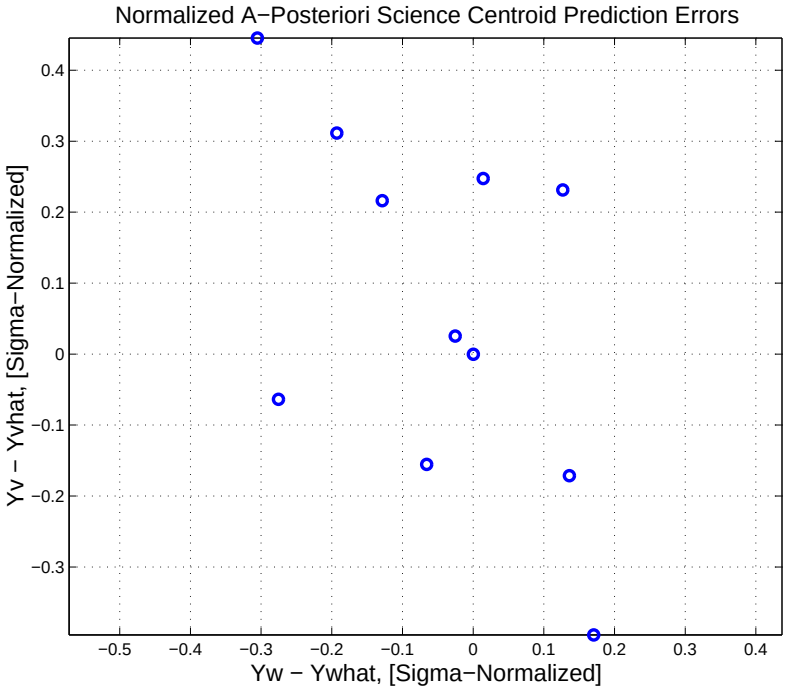


Figure 3.23: Normalized A-Posteriori Science Centroid Prediction Errors

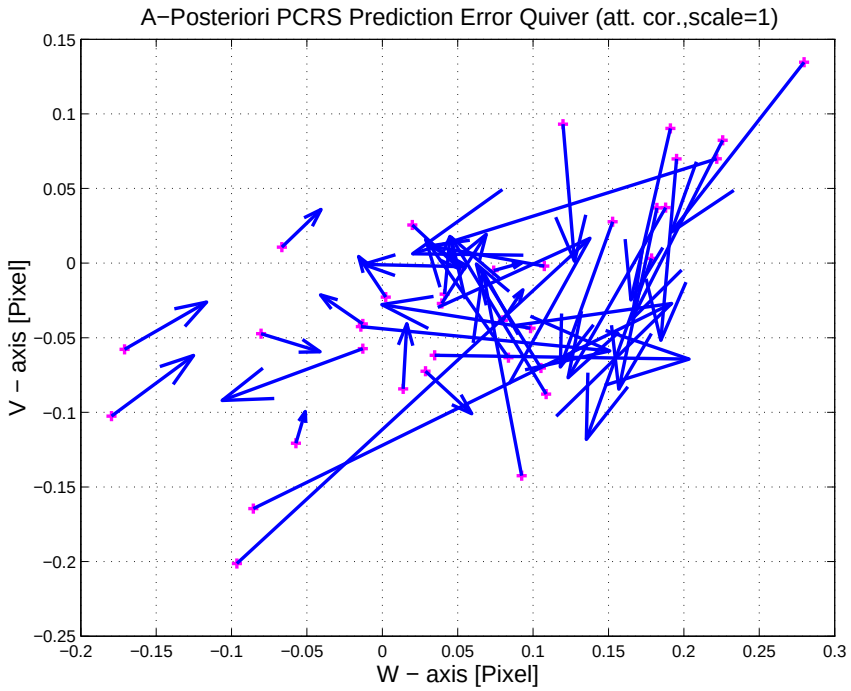


Figure 3.24: A-Posteriori PCRS Prediction Errors Quiver (Att. Cor.)

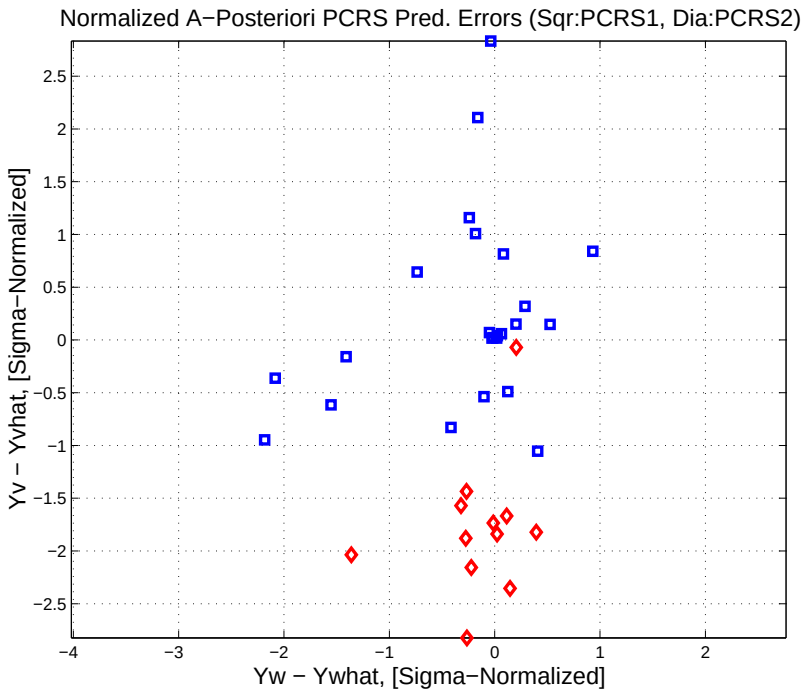


Figure 3.25: Normalized A-Posteriori PCRS Prediction Errors

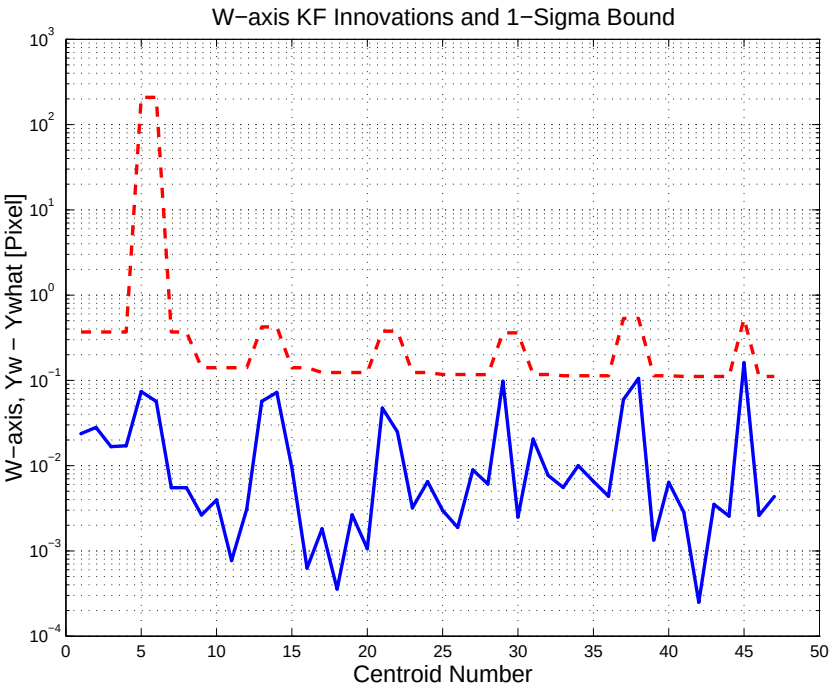


Figure 3.26: W-axis KF innovations and 1-sigma bound

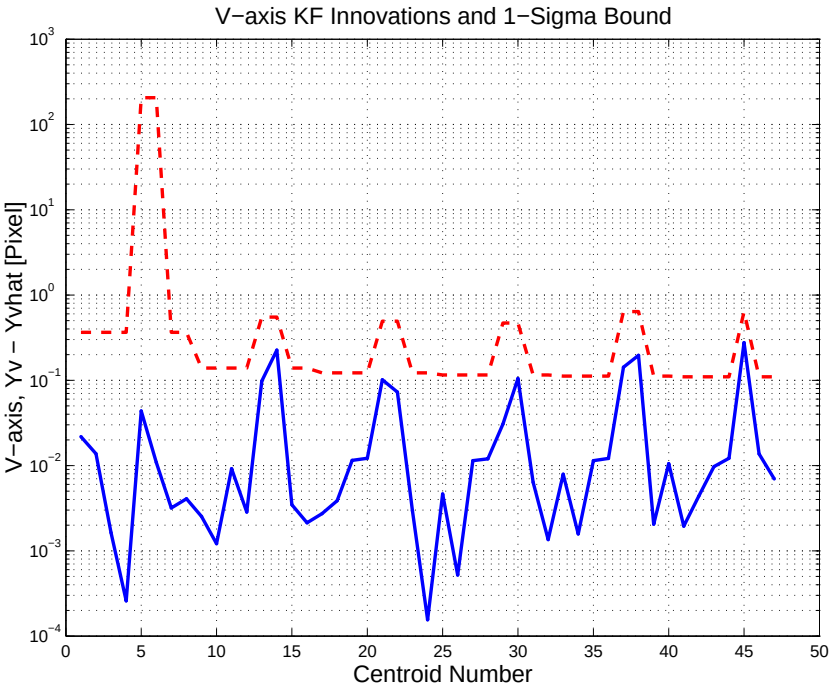


Figure 3.27: V-axis KF innovations and 1-sigma bound

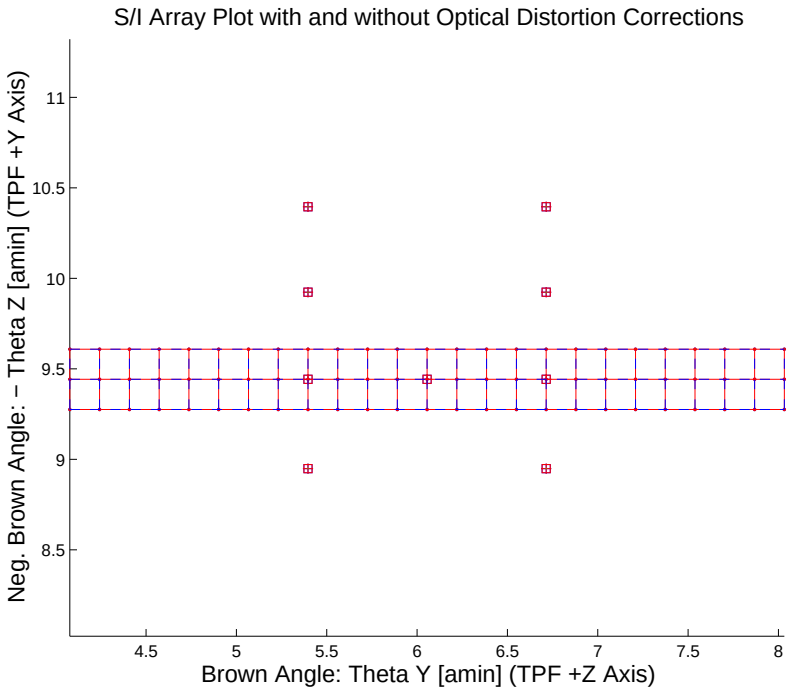


Figure 3.28: Array plot with (solid) and w/o (dashed) optical distortion corrections

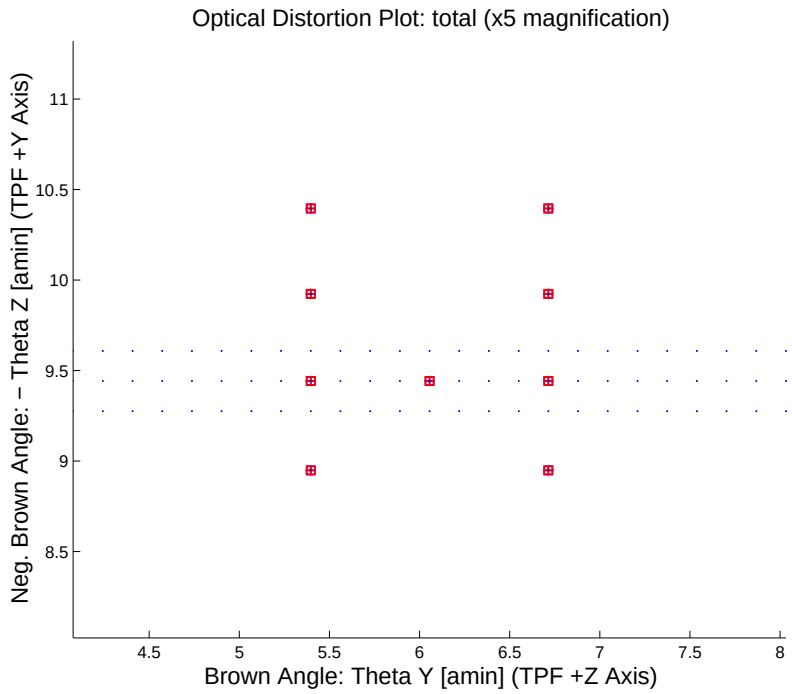


Figure 3.29: Optical Distortion Plot: total (x5 magnification)

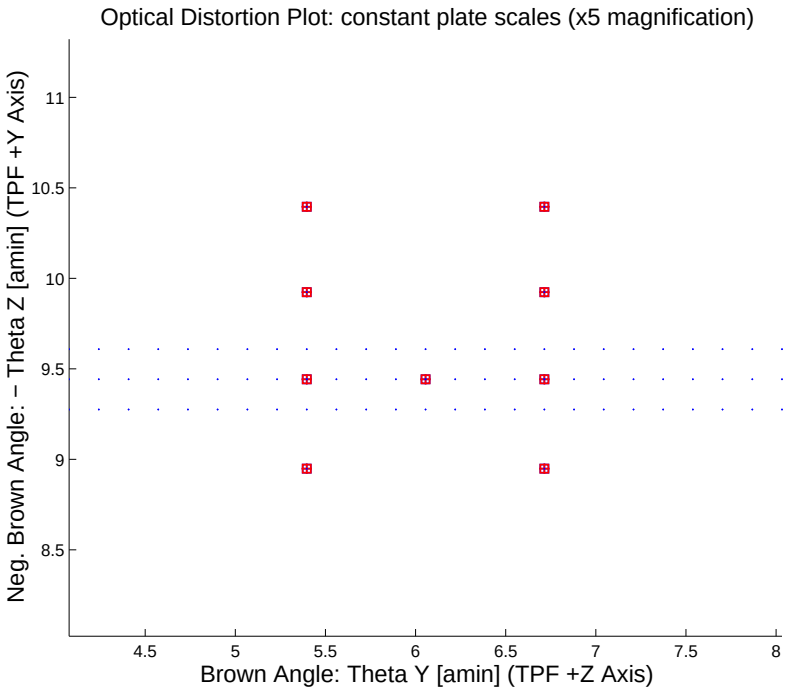


Figure 3.30: Optical Distortion Plot: constant plate scales (x5 magnification)

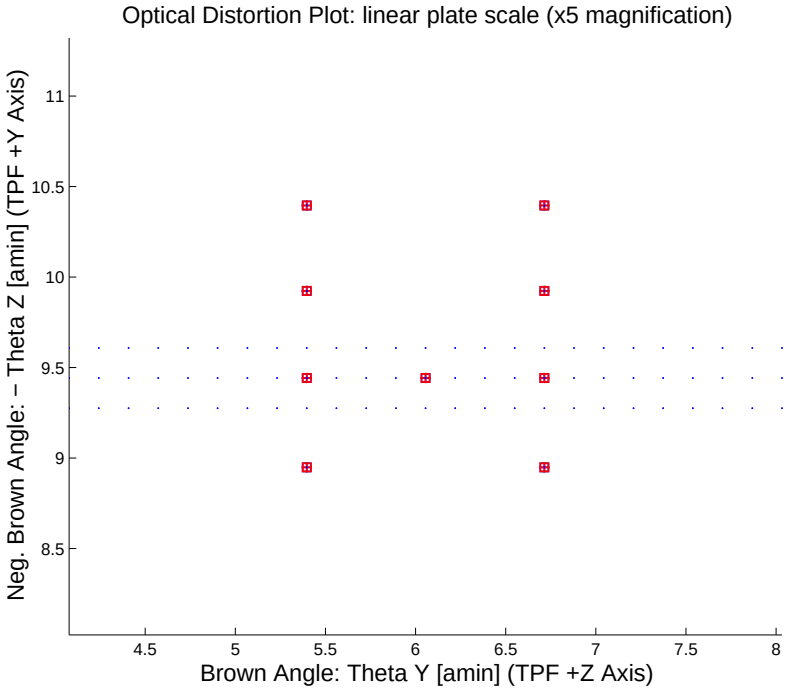


Figure 3.31: Optical Distortion Plot: linear plate scale (x5 magnification)

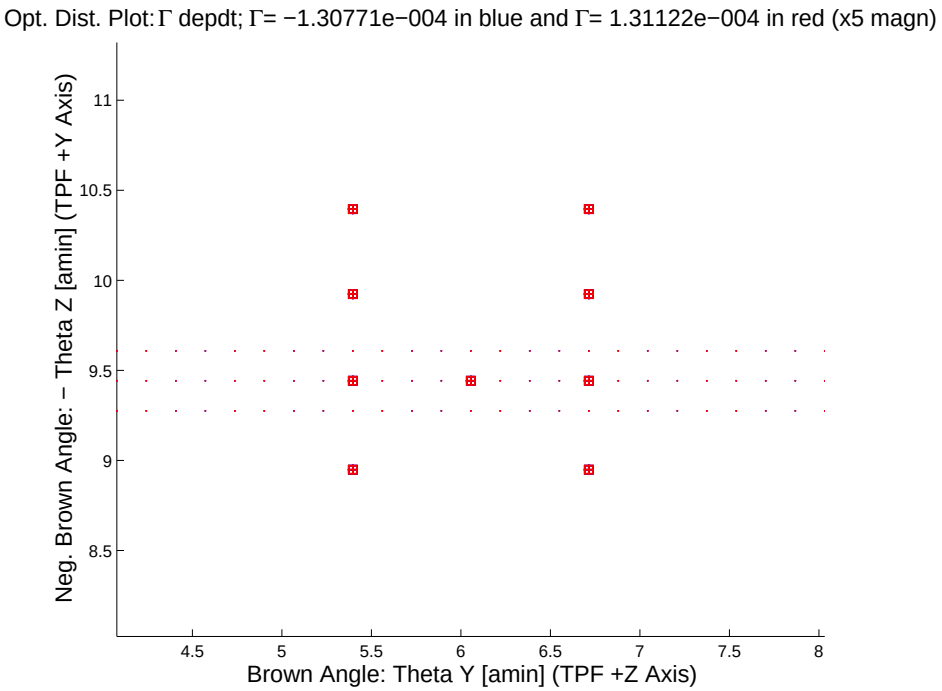


Figure 3.32: Optical Distortion Plot: gamma terms (x5 magnification)


Figure 3.33: Scan Mirror Chops

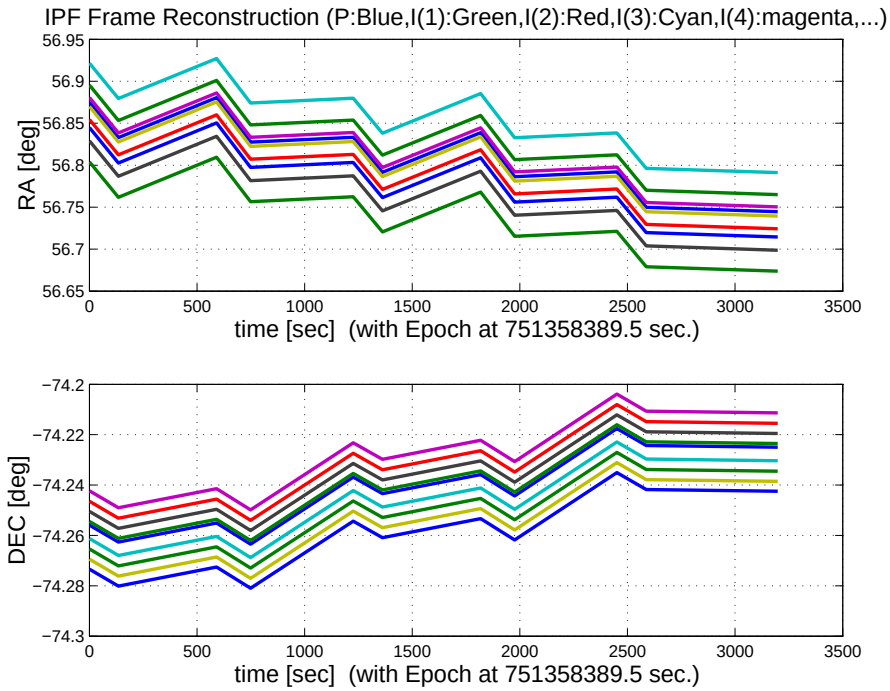


Figure 3.34: IPF Frame Reconstruction

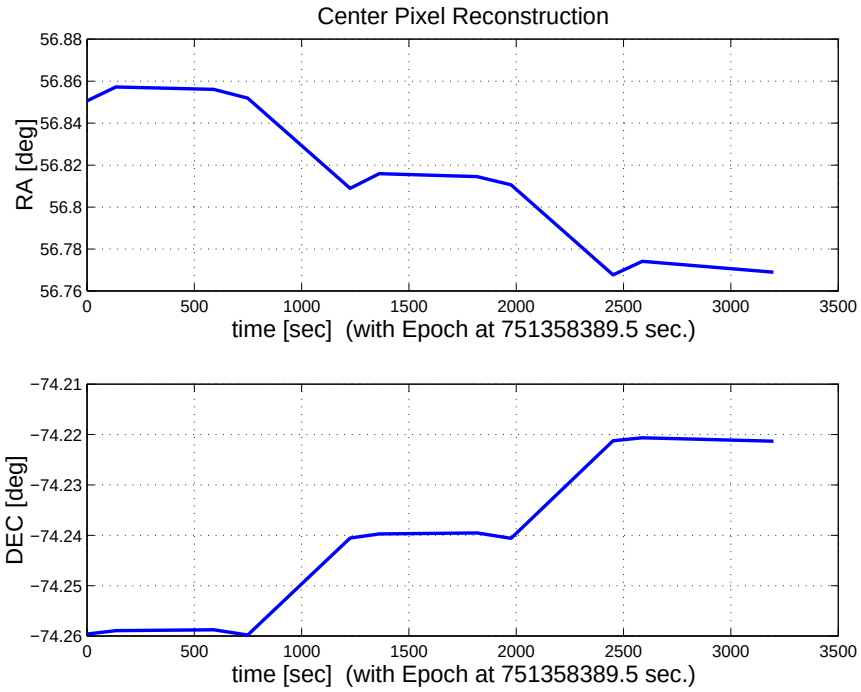


Figure 3.35: Center Pixel Reconstruction

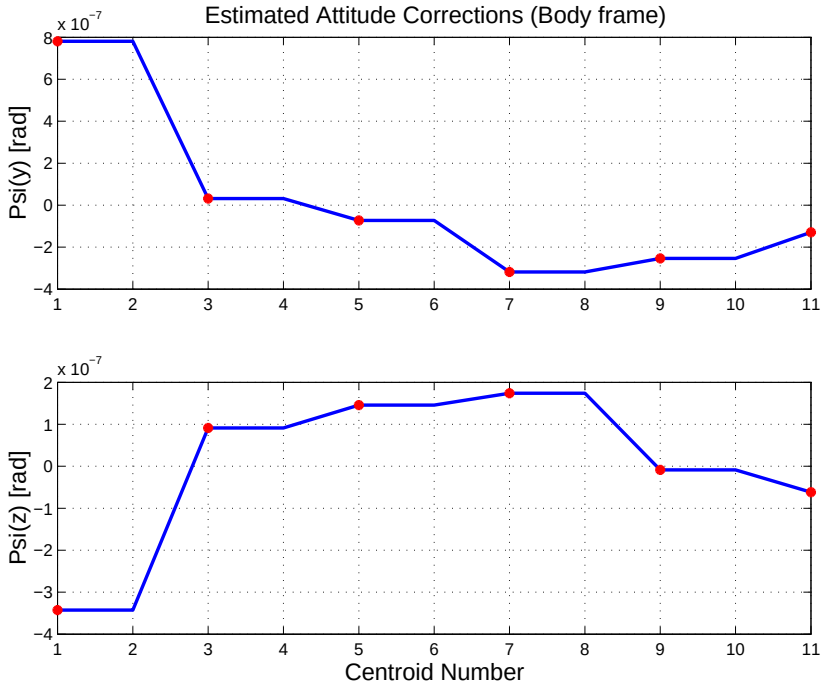


Figure 3.36: Estimated attitude corrections (Body frame)

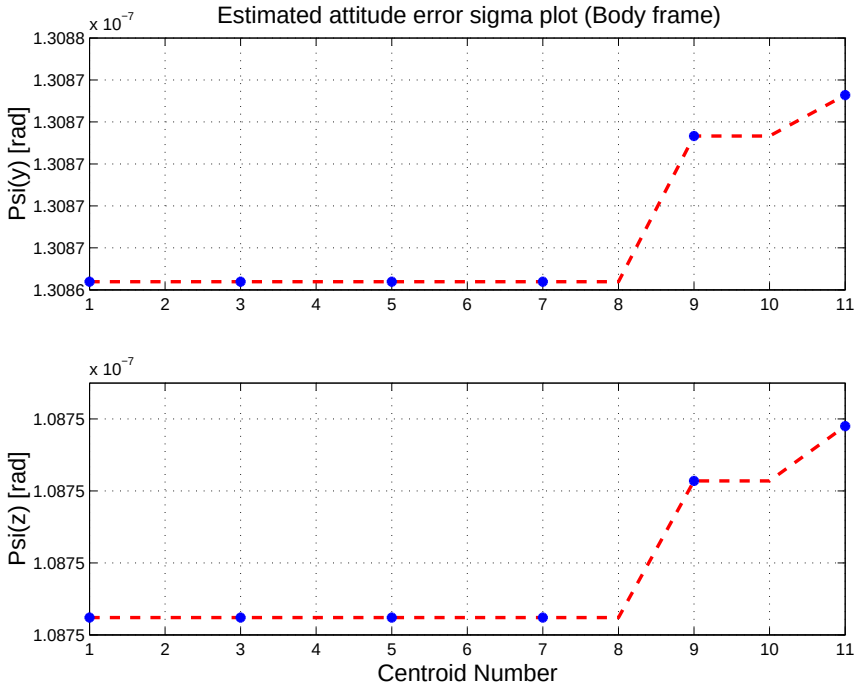


Figure 3.37: Estimated attitude error sigma plot (Body frame)

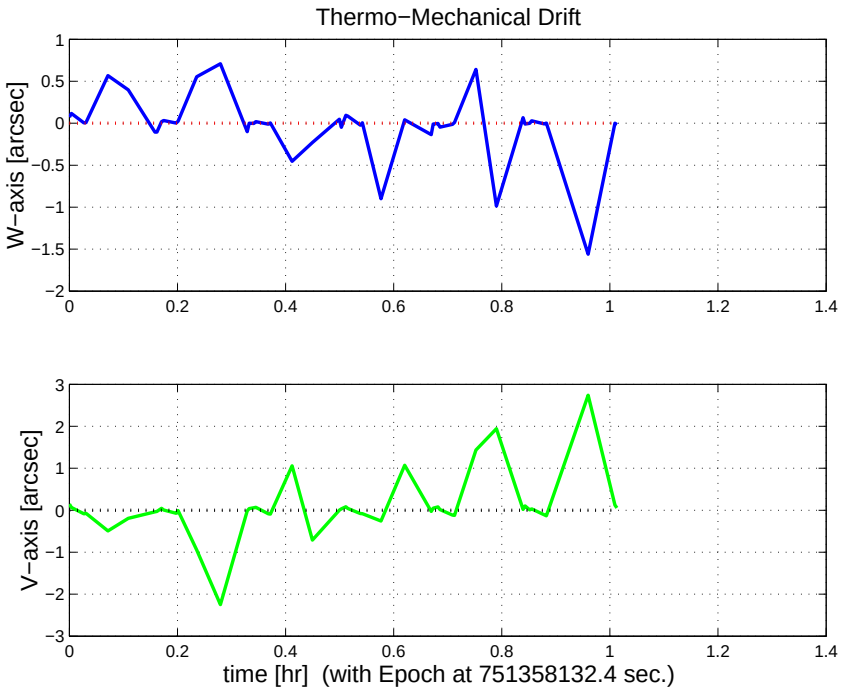


Figure 3.38: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

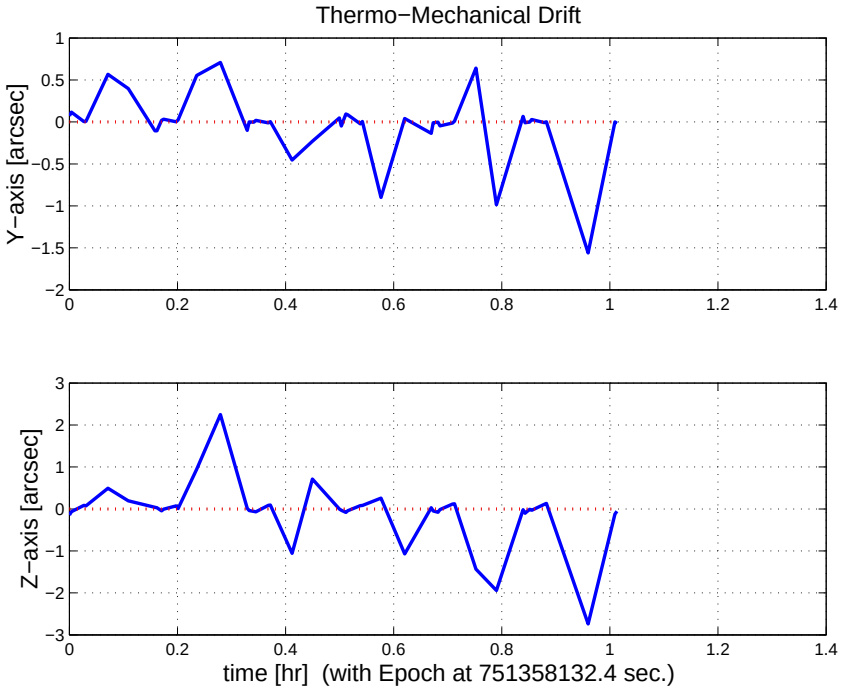


Figure 3.39: Thermo-mechanical boresight drift (equiv. angle in Body frame)

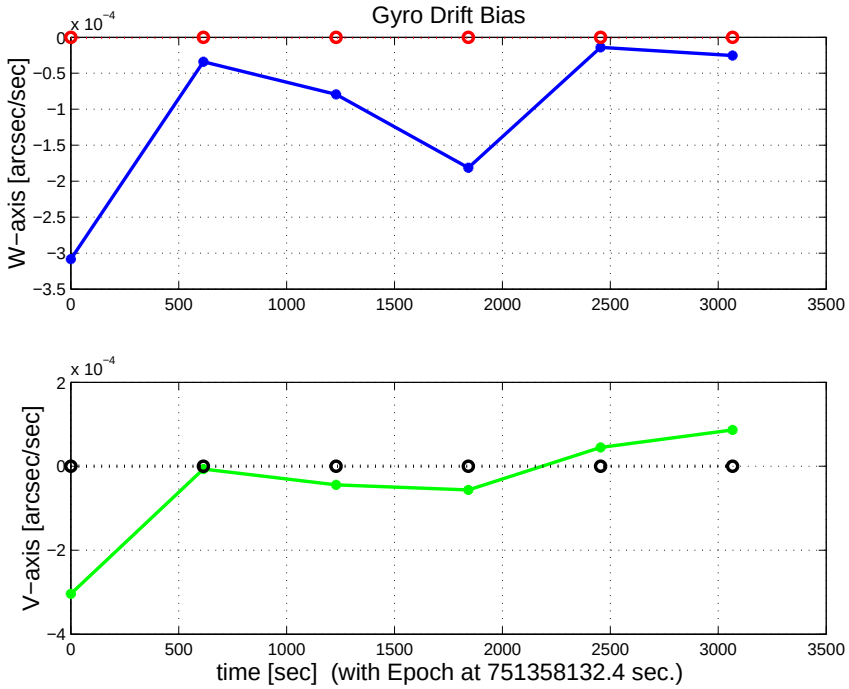


Figure 3.40: Gyro drift bias contribution (equiv. rate in (W,V) coords)

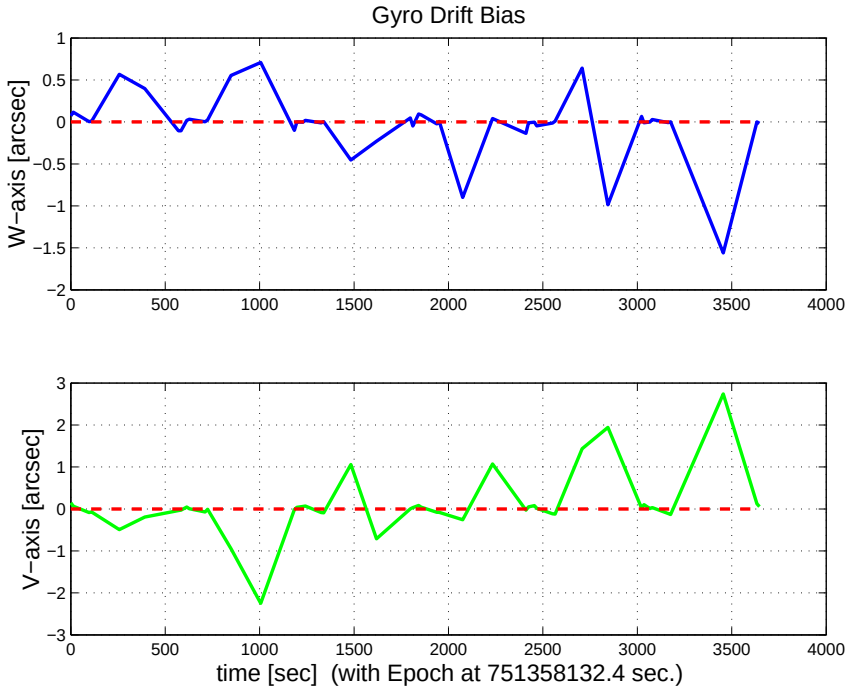


Figure 3.41: Gyro drift bias contribution (equiv. angle in (W,V) coords)

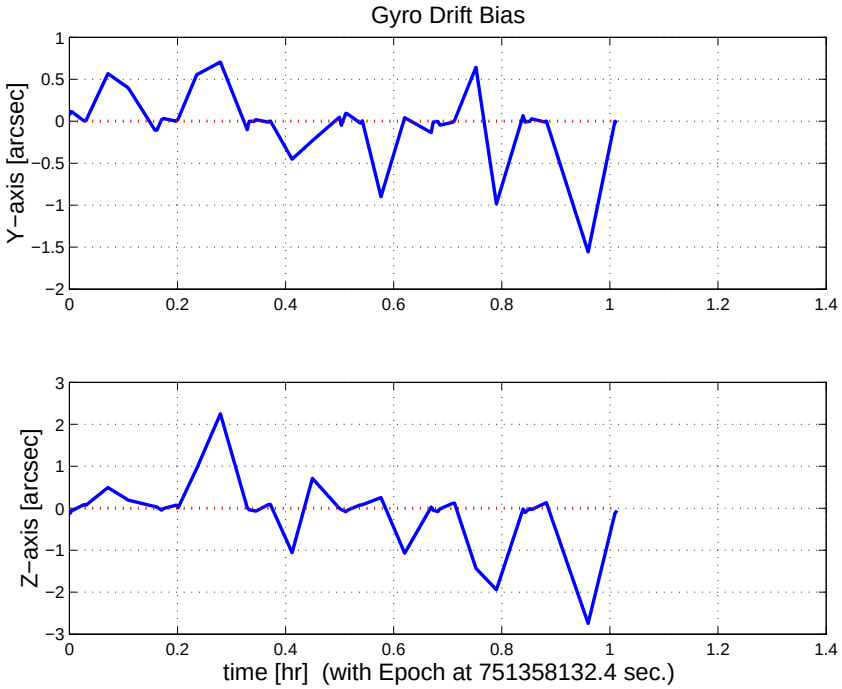


Figure 3.42: Gyro drift bias contribution (equiv. angle in Body frame)

## 3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini103121.dat   DATE: 27-Oct-2003   TIME: 12:49
INSTRUMENT NAME:  MIPS_SED_center   NF: 121
IPF FILTER VERSION: IPF.V2.0.0D       SW RELEASE DATE: August 1, 2003
FRAME TABLE USED: BodyFrames_FTU_11a
-------------------------------------------------------------------------------
--------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  ---------------------------------       ---------------------------------
 121     +6.099911  -9.595594   +0.000044        +6.055286  -9.441871   +0.000049
 105     +6.748000 -11.101000   +0.000000        +6.714264  -9.441871   +0.000049
 106     +5.398000 -11.095000   +0.000000        +5.396308  -9.441872   +0.000049
 116     +6.758889  -9.102260   +0.000044        +6.714264  -8.948537   +0.000049
 117     +5.440932  -9.102261   +0.000044        +5.396307  -8.948538   +0.000049
 122     +6.758890 -10.077261   +0.000044        +6.714265  -9.923538   +0.000049
 123     +5.440933 -10.077261   +0.000044        +5.396308  -9.923538   +0.000049
 125     +6.758890 -10.548928   +0.000044        +6.714265 -10.395205   +0.000049
 126     +5.440933 -10.548928   +0.000044        +5.396308 -10.395205   +0.000049
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             121            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_SED_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.099911        -9.595594       +0.000044
IS (EST)            +6.055286        -9.441871       +0.000049
dT_EST              -0.044625        +0.153723       +0.000005
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -2.778599        +7.188397     +999.999999
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             105            +4.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_SED_9
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.748000       -11.101000       +0.000000
IS (EST)            +6.714264        -9.441871       +0.000049
dT_EST              -0.033736        +1.659129       +0.000049
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -2.100565       +77.584301     +999.999999
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             106            -4.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_SED_10
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.398000       -11.095000       +0.000000
IS (EST)            +5.396308        -9.441872       +0.000049
dT_EST              -0.001692        +1.653128       +0.000049
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -0.105384       +77.303676     +999.999999
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             116            +4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_7
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.758889        -9.102260       +0.000044
IS (EST)            +6.714264        -8.948537       +0.000049
dT_EST              -0.044625        +0.153723       +0.000005
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -2.778602        +7.188399     +999.999999
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             117            -4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_8
```

```
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.440932        -9.102261       +0.000044
IS (EST)            +5.396307        -8.948538       +0.000049
dT_EST              -0.044625        +0.153723       +0.000005
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -2.778602        +7.188394     +999.999999
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5             122            +4.000            +2.890     pixels
OFFSET FRAME NAME: MIPS_SED_1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.758890       -10.077261       +0.000044
IS (EST)            +6.714265        -9.923538       +0.000049
dT_EST              -0.044625        +0.153723       +0.000005
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -2.778597        +7.188400     +999.999999
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6             123            -4.000            +2.890     pixels
OFFSET FRAME NAME: MIPS_SED_2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.440933       -10.077261       +0.000044
IS (EST)            +5.396308        -9.923538       +0.000049
dT_EST              -0.044625        +0.153723       +0.000005
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -2.778597        +7.188395     +999.999999
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7             125            +4.000            +5.720     pixels
OFFSET FRAME NAME: MIPS_SED_3
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.758890       -10.548928       +0.000044
IS (EST)            +6.714265       -10.395205       +0.000049
dT_EST              -0.044625        +0.153723       +0.000005
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -2.778595        +7.188401     +999.999999
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8             126            -4.000            +5.720     pixels
OFFSET FRAME NAME: MIPS_SED_4
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.440933       -10.548928       +0.000044
IS (EST)            +5.396308       -10.395205       +0.000049
dT_EST              -0.044625        +0.153723       +0.000005
T_sSIGMA            +0.016060        +0.021385     +999.999999
dT_EST/T_sSIGMA     -2.778595        +7.188396     +999.999999
-------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
VARNAME             MEAN                     SIGMA                SCALED_SIGMA
del_alpha  +4.2869787580945840E-014 +3.2905609024071185E-002 +3.2189022858881075E-002
beta       +1.0096985647325256E+000 +5.1788562058445890E-002 +5.0660761413302863E-002
del_theta2 -1.0872726669193013E-018 +4.7757356801566373E-006 +4.6717343801198690E-006
del_theta3 -8.0350604167726998E-018 +6.3590859715538866E-006 +6.2206040176980380E-006
del_arx    -2.0904519028351956E-015 +1.9067584499244749E-005 +1.8652349295855657E-005
del_ary    -1.0300549295877832E-018 +1.9705210590247294E-006 +1.9276089789571660E-006
del_arz    -5.5082420211049143E-018 +1.9706488541458682E-006 +1.9277339910811652E-006
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +9.7822297819602999E-001
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
                    a_mirror(1)              a_mirror(2)              a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +2.0565766508384722E-002  +9.9978850225831395E-001
a_mirror_tpf   -1.8175132918000197E-003  +2.0559999576068792E-002  +9.9978696884029594E-001
beta               beta_0                   beta                     beta_total
               +2.8047410000000001E-006  +1.0096985647325256E+000  +2.8319429621464687E-006
-------------------------------------------------------------------------------------------------------------
```

```
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
FrmTbl:   +1.6250689842247300E-006 -8.8719456244559195E-004 +1.3956219077790699E-003 +9.9999863256039401E-001
Estim:    +1.6358468638933755E-006 -8.8070411393688158E-004 +1.3732638926728415E-003 +9.9999866925104908E-001
DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
          -2.9001036903604932E-010 +1.2980841616855139E-005 -4.4716111704105509E-005       [rad]
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +8.5281237734255168E-007 -1.7614112875972232E-003 +2.7465289626911627E-003
SigmaT    +9.9999000000000000E+004 +4.7757356801566373E-006 +6.3590859715538866E-006
-------------------------------------------------------------------------------------------------------
qR              qR(1)                    qR(2)                    qR(3)                    qR(4)
ASFILE:   +7.0946419145911932E-004 +1.2707291170954704E-003 -1.6155670164152980E-004 +9.9999892711639404E-001
Estim:    +5.9768033834793264E-004 +1.2702785212094325E-003 -1.6122526008242955E-004 +9.9999900158805521E-001
DelThetaR       deltheta(1)              deltheta(2)              deltheta(3)
          -2.2356826960086379E-004 -9.3698621938133166E-007 +3.7955658201246269E-007       [rad]
EulAngR         angR(1)                  angR(2)                  angR(3)                  [rad]
Mean      +1.1949540226020017E-003 +2.5407499618287522E-003 -3.2093279861881784E-004
SigmaR    +1.9067584499244749E-005 +1.9705210590247294E-006 +1.9706488541458682E-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             105            +4.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_SED_9
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.5846346980260735E-006 -9.8145537921615219E-004 +1.6145735230807244E-003 +9.9999821494598995E-001
IS (EST)  +1.7674665389632484E-006 -9.7654851382626261E-004 +1.3732637295781963E-003 +9.9999858024729482E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          -9.4530720350741988E-008 +9.8130526234865983E-006 -4.8262028470192632E-004
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +8.5281237734255168E-007 -1.9531003508493011E-003 +2.7465287992160465E-003
sSigmaT   +1.1924217497125550E-009 +4.6717343801198707E-006 +6.2206039034109351E-006
SigmaT    +1.2189672255619422E-009 +4.7757356801566398E-006 +6.3590858547225449E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             106            -4.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_SED_10
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.2669287652085928E-006 -7.8510617230978031E-004 +1.6137011398793700E-003 +9.9999838978636579E-001
IS (EST)  +1.5042271581281103E-006 -7.8485970595722069E-004 +1.3732640431524043E-003 +9.9999874906864117E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          +9.7734932797310644E-008 +4.9214448350006434E-007 -4.8087495653477007E-004
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +8.5281237734255158E-007 -1.5697222243451455E-003 +2.7465291261661697E-003
sSigmaT   +1.1924217497125523E-009 +4.6717343801198699E-006 +6.2206039034109360E-006
SigmaT    +1.2189672255619395E-009 +4.7757356801566381E-006 +6.3590858547225457E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             116            +4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_7
```

```
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.6882959773091407E-006 -9.8303901681744653E-004 +1.3238693523596604E-003 +9.9999864049976528E-001
IS (EST)  +1.6973966518828202E-006 -9.7654856688597137E-004 +1.3015113355285713E-003 +9.9999867620825322E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          -8.8616130449659708E-009 +1.2980852636186509E-005 -4.4716107287885875E-005
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +8.5281237734255168E-007 -1.9531002083559533E-003 +2.6030238143220871E-003
sSigmaT   +1.3681801594493912E-009 +4.6717343325961580E-006 +6.2206039029277833E-006
SigmaT    +1.3986383370103336E-009 +4.7757356315749626E-006 +6.3590858542286374E-006
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             117            -4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_8
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.4345249762421910E-006 -7.9135019925322060E-004 +1.3238697004757511E-003 +9.9999881056520279E-001
IS (EST)  +1.4479114620504580E-006 -7.8485974259604168E-004 +1.3015116854428750E-003 +9.9999884502954339E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          +8.2816128011549443E-009 +1.2980853019441847E-005 -4.4716107890699301E-005
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +8.5281237734255158E-007 -1.5697220857994599E-003 +2.6030242381792582E-003
sSigmaT   +1.3677489477244903E-009 +4.6717343325962207E-006 +6.2206039030225629E-006
SigmaT    +1.3981975257285375E-009 +4.7757356315750262E-006 +6.3590858543255270E-006
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5             122            +4.000            +2.890     pixels
OFFSET FRAME NAME: MIPS_SED_1
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.8276990549600717E-006 -9.8303887771708683E-004 +1.4656772848250013E-003 +9.9999844270944793E-001
IS (EST)  +1.8358793410083534E-006 -9.7654843776767101E-004 +1.4433192696752535E-003 +9.9999848158847904E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          -8.8616370843917441E-009 +1.2980830221469581E-005 -4.4716114502273450E-005
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +8.5281237734255168E-007 -1.9531004511669781E-003 +2.8866400851879376E-003
sSigmaT   +1.3600530780947453E-009 +4.6717343336979065E-006 +6.2206039038825470E-006
SigmaT    +1.3903303320505306E-009 +4.7757356327012378E-006 +6.3590858552046557E-006
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6             123            -4.000            +2.890     pixels
OFFSET FRAME NAME: MIPS_SED_2
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.5467449455678799E-006 -7.9135009797488495E-004 +1.4656775605909999E-003 +9.9999861277499702E-001
IS (EST)  +1.5592110437274327E-006 -7.8485965069199622E-004 +1.4433195477687546E-003 +9.9999865040987967E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units             rad                      rad                      rad
          +8.2815937697439142E-009 +1.2980830604740707E-005 -4.4716113693653549E-005
EulAngT         theta(1)                 theta(2)                 theta(3)                 [rad]
Mean      +8.5281237734255168E-007 -1.5697223284258201E-003 +2.8866403175227197E-003
sSigmaT   +1.3604764753954719E-009 +4.6717343336979674E-006 +6.2206039037899172E-006
SigmaT    +1.3907631549448642E-009 +4.7757356327013005E-006 +6.3590858551099642E-006
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7             125            +4.000            +5.720     pixels
OFFSET FRAME NAME: MIPS_SED_3
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.8951367351895419E-006 -9.8303877495208199E-004 +1.5342783741593615E-003 +9.9998633980914499E-001
IS (EST)  +1.9028717754709417E-006 -9.7654834006580379E-004 +1.5119203599843519E-003 +9.9998638022196008E-001
```

```
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
         -8.8616461756919890E-009 +1.2980819003371950E-005 -4.4716117992289432E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +8.5281237734255158E-007 -1.9531005122461445E-003 +3.0238424810359508E-003
sSigmaT   +1.7604364046694644E-009 +4.6717341993648990E-006 +6.2206039043442604E-006
SigmaT    +1.7996269193307412E-009 +4.7757354953777331E-006 +6.3590858556766479E-006
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8             126            -4.000            +5.720     pixels
OFFSET FRAME NAME: MIPS_SED_4
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.6010325177073808E-006 -7.9135002042393546E-004 +1.5342786149252308E-003 +9.9999850987474659E-001
IS (EST)  +1.6130533703694935E-006 -7.8485957791016921E-004 +1.5119206033337689E-003 +9.9999854904341257E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
         +8.2815866062048090E-009 +1.2980819386651379E-005 -4.4716116500881171E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +8.5281237734255168E-007 -1.5697224004832587E-003 +3.0238426207197227E-003
sSigmaT   +1.7610837999210692E-009 +4.6717341993651404E-006 +6.2206039041608329E-006
SigmaT    +1.8002887267775452E-009 +4.7757354953779804E-006 +6.3590858554891368E-006
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
              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: +4.7922266400000000E-005  Row (1) TASTART:   +7.5135700039074707E+008
Row (02) PIX2RADY: +4.8481322570479732E-005  Row (2) TASTOP:    +7.5136300029077756E+008
Row (03) CX0:      +1.2500000000000000E+001  Row (3) S/C TIME:  +7.5133495129074097E+008
Row (04) CY0:      +1.5000000000000000E+000  Row (4) QR1:       +7.0946419145911932E-004
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +1.2707291170954704E-003
Row (06) GAMMA_E0: +3.2200000000000000E+003  Row (6) QR3:       -1.6155670164152980E-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)
5.94042726E+000  3.49937883E-001  3.50284578E-001  [arcsec]
---------------------------------------------------------
PIX2RADX = 4.792226640000E-005[rad/pixel]
XPIXSIZE = 9.8847[arcsec]
PIX2RADY = 4.848132257048E-005[rad/pixel]
YPIXSIZE = 10.0000[arcsec]
CX0 = 12.5[pixel] = 123.56[arcsec]
CY0 = 1.5[pixel] = 15.00[arcsec]
---------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 3220.00[encoder unit] = 1862.83[arcsec]
---------------------------------------------------------
                | +1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = -1
                | +0 | +1 |
---------------------------------------------------------
```

## 3.3 IPF EXECUTION LOG

```
**********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG103121.dat
INSTRUMENT TYPE:              MIPS_SED_center
IPF FILTER EXECUTION DATE:    27-Oct-2003    TIME: 12:49
IPF FILTER VERSION USED:      IPF.V2.0.0D
**********************************************************************

************************************
SLIT FLAG ENABLED! ENTERING SLIT MODE.
************************************


------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA101121 Loaded!        AAFILE dimension = 60000 X 21
ASFILE:  AS101121 Loaded!
CAFILE:  CA902121 Loaded!        CAFILE dimension = 11 X 15
CBFILE:  CB102121 Loaded!        CBFILE dimension = 36 X 15
CCFILE:  CC103121 Created!       CCFILE dimension = 47 X 19
CSFILE:  CS102121 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 = [ 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  0  1  1  1  1  1  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:  AG103121.m     ACFILE CREATED:  AC103121.m
----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 1 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) = 9.9999000000000000E+004
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 9.9999000000000000E+004
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 9.9999000000000000E+004
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  = +1.6250689842247302E-006  Sigma_initial(20,20) = 9.9999000000000000E+004
p2f(06) = qT2  = -8.8719456244559206E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.3956219077790701E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999863256039412E-001
p2f(09) = qR1  = +7.0946419145911932E-004  Sigma_initial(23,23) = 2.8800004073121951E-004
p2f(10) = qR2  = +1.2707291170954704E-003  Sigma_initial(24,24) = 1.6965467311628126E-005
p2f(11) = qR3  = -1.6155670164152980E-004  Sigma_initial(25,25) = 1.6982275567804755E-005
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|= +1.866045029740E-002   RMS(|Res|)=+4.787844819383E-005
Iteration#002: |dp|= +9.059349674253E-003   RMS(|Res|)=+8.454855596991E-006
Iteration#003: |dp|= +1.043750614682E-002   RMS(|Res|)=+8.105682795374E-006
Iteration#004: |dp|= +4.208660914376E-003   RMS(|Res|)=+7.879497315286E-006
Iteration#005: |dp|= +2.566789136945E-003   RMS(|Res|)=+7.886620083836E-006
Iteration#006: |dp|= +2.809827588256E-003   RMS(|Res|)=+7.911669894582E-006
Iteration#007: |dp|= +6.056278138942E-004   RMS(|Res|)=+7.931064864455E-006
Iteration#008: |dp|= +1.019296890332E-003   RMS(|Res|)=+7.925550971461E-006
Iteration#009: |dp|= +6.486740543361E-004   RMS(|Res|)=+7.911499982944E-006
Iteration#010: |dp|= +1.752411358975E-004   RMS(|Res|)=+7.908148646008E-006
Iteration#011: |dp|= +3.244627312983E-004   RMS(|Res|)=+7.911674747559E-006
Iteration#012: |dp|= +1.180472399295E-004   RMS(|Res|)=+7.914773663077E-006
Iteration#013: |dp|= +8.963228151307E-005   RMS(|Res|)=+7.914802583871E-006
Iteration#014: |dp|= +8.630703583848E-005   RMS(|Res|)=+7.913448673480E-006
Iteration#015: |dp|= +1.649579017411E-005   RMS(|Res|)=+7.912796922877E-006
Iteration#016: |dp|= +3.377670544496E-005   RMS(|Res|)=+7.913047110156E-006
Iteration#017: |dp|= +1.902762197710E-005   RMS(|Res|)=+7.913439470764E-006
Iteration#018: |dp|= +6.531560369242E-006   RMS(|Res|)=+7.913524127434E-006
Iteration#019: |dp|= +1.029055680398E-005   RMS(|Res|)=+7.913398884848E-006
Iteration#020: |dp|= +3.226438840850E-006   RMS(|Res|)=+7.913302943736E-006
Iteration#021: |dp|= +3.105106234712E-006   RMS(|Res|)=+7.913309453776E-006
Iteration#022: |dp|= +2.628780678695E-006   RMS(|Res|)=+7.913352926939E-006
Iteration#023: |dp|= +4.881901144539E-007   RMS(|Res|)=+7.913371143828E-006
Iteration#024: |dp|= +1.106514999514E-006   RMS(|Res|)=+7.913361608730E-006
Iteration#025: |dp|= +5.508413098719E-007   RMS(|Res|)=+7.913349343122E-006
Iteration#026: |dp|= +2.405436509318E-007   RMS(|Res|)=+7.913347449457E-006
Iteration#027: |dp|= +3.234097529366E-007   RMS(|Res|)=+7.913351700618E-006
Iteration#028: |dp|= +8.653698051552E-008   RMS(|Res|)=+7.913354546091E-006
Iteration#029: |dp|= +1.059461585642E-007   RMS(|Res|)=+7.913354127006E-006
Iteration#030: |dp|= +7.925838246288E-008   RMS(|Res|)=+7.913352727002E-006
Iteration#031: |dp|= +1.627842624056E-008   RMS(|Res|)=+7.913352228991E-006
Iteration#032: |dp|= +3.588153823997E-008   RMS(|Res|)=+7.913352578519E-006
Iteration#033: |dp|= +1.570693140752E-008   RMS(|Res|)=+7.913352956587E-006
Iteration#034: |dp|= +8.694289244546E-009   RMS(|Res|)=+7.913352991564E-006
```

```
Iteration#035: |dp|= +1.007181024908E-008   RMS(|Res|)=+7.913352849241E-006
Iteration#036: |dp|= +2.293623337608E-009   RMS(|Res|)=+7.913352765942E-006
Iteration#037: |dp|= +3.566287104246E-009   RMS(|Res|)=+7.913352785733E-006
Iteration#038: |dp|= +2.363698530855E-009   RMS(|Res|)=+7.913352830329E-006
Iteration#039: |dp|= +5.905445115213E-010   RMS(|Res|)=+7.913352843490E-006
Iteration#040: |dp|= +1.152304937188E-009   RMS(|Res|)=+7.913352831042E-006
Iteration#041: |dp|= +4.402281690580E-010   RMS(|Res|)=+7.913352819511E-006
Iteration#042: |dp|= +3.082073827687E-010   RMS(|Res|)=+7.913352819195E-006
Iteration#043: |dp|= +3.106169577808E-010   RMS(|Res|)=+7.913352823896E-006
Iteration#044: |dp|= +6.143399256160E-011   RMS(|Res|)=+7.913352826289E-006
Iteration#045: |dp|= +1.184183754493E-010   RMS(|Res|)=+7.913352825458E-006
Iteration#046: |dp|= +6.954197215072E-011   RMS(|Res|)=+7.913352824049E-006
Iteration#047: |dp|= +2.193220336378E-011   RMS(|Res|)=+7.913352823728E-006
Iteration#048: |dp|= +3.659999917743E-011   RMS(|Res|)=+7.913352824172E-006
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Iteration#061: |dp|= +2.460832081140E-013   RMS(|Res|)=+7.913352824342E-006
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Iteration#079: |dp|= +3.681644152457E-014   RMS(|Res|)=+7.913352824335E-006
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Iteration#085: |dp|= +6.319181633149E-014   RMS(|Res|)=+7.913352824341E-006
Iteration#086: |dp|= +3.802728868976E-014   RMS(|Res|)=+7.913352824340E-006
Iteration#087: |dp|= +8.907914496071E-014   RMS(|Res|)=+7.913352824355E-006
Iteration#088: |dp|= +6.630873409545E-014   RMS(|Res|)=+7.913352824329E-006
Iteration#089: |dp|= +8.640925854513E-014   RMS(|Res|)=+7.913352824343E-006
Iteration#090: |dp|= +6.990469359640E-014   RMS(|Res|)=+7.913352824353E-006
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +6.9904693596403689E-014
-------------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+3.305788234981E+004,   |dp|=+2.339959525885E-002
Iteration#002   COND#=+3.397699342871E+004,   |dp|=+2.120680571817E-002
Iteration#003   COND#=+3.384186998764E+004,   |dp|=+2.252568228575E-004
Iteration#004   COND#=+3.384353981097E+004,   |dp|=+9.496528577139E-006
Iteration#005   COND#=+3.384347739695E+004,   |dp|=+1.994062524707E-007
Iteration#006   COND#=+3.384347870918E+004,   |dp|=+4.233088291149E-009
Iteration#007   COND#=+3.384347868153E+004,   |dp|=+8.977271807550E-011
Iteration#008   COND#=+3.384347868196E+004,   |dp|=+1.863528823597E-012
```

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Iteration#010   COND#=+3.384347868201E+004,   |dp|=+7.364504922945E-014
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Iteration#012   COND#=+3.384347868186E+004,   |dp|=+1.051653842588E-013
Iteration#013   COND#=+3.384347868202E+004,   |dp|=+1.223678965397E-013
Iteration#014   COND#=+3.384347868199E+004,   |dp|=+3.498659548011E-014
Iteration#015   COND#=+3.384347868195E+004,   |dp|=+1.522833473921E-013
Iteration#016   COND#=+3.384347868201E+004,   |dp|=+3.562950008163E-014
Iteration#017   COND#=+3.384347868201E+004,   |dp|=+9.824898931159E-014
Iteration#018   COND#=+3.384347868194E+004,   |dp|=+8.707387739209E-014
Iteration#019   COND#=+3.384347868196E+004,   |dp|=+1.670433988402E-013
Iteration#020   COND#=+3.384347868204E+004,   |dp|=+1.327402228426E-013
Iteration#021   COND#=+3.384347868193E+004,   |dp|=+4.554492382602E-014
Iteration#022   COND#=+3.384347868193E+004,   |dp|=+2.083701753134E-014
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Iteration#025   COND#=+3.384347868205E+004,   |dp|=+6.970233943359E-014
Iteration#026   COND#=+3.384347868198E+004,   |dp|=+8.005980996162E-014
Iteration#027   COND#=+3.384347868197E+004,   |dp|=+1.893204166946E-013
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Iteration#035   COND#=+3.384347868188E+004,   |dp|=+1.484482956219E-013
Iteration#036   COND#=+3.384347868196E+004,   |dp|=+4.921544273930E-014
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Iteration#076   COND#=+3.384347868196E+004,   |dp|=+7.364674904599E-014
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Iteration#078   COND#=+3.384347868202E+004,   |dp|=+6.444180023319E-014
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Iteration#089   COND#=+3.384347868205E+004,   |dp|=+1.432185231471E-013
Iteration#090   COND#=+3.384347868196E+004,   |dp|=+2.020031736249E-013
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +2.0200317362494099E-013
---------------------------------------------------------------------
Total Execution Time: 50 seconds
```

# 4 COMMENTS

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

1. A polarity error in the V direction was detected when using the CS101121.m file. A new CS file (CS102121.m) was re-delivered which fixed the problem. Moreover, centroid number 11 was removed after consultation with Jocelyn because it had an error twice as large as the rest of the centroids.

2. We estimated only 2 Brown angles (no Twist) because of the large uncertainty in the science centroids.

3. We also estimated the mirror parameters (alpha and beta). Although the a-posteriori uncertainty in these parameters is large, they were found to be essential for eliminating a systematic error in the W direction.

4. The IPF filter was run in Lite Mode 3 (Observer based) for robustness with respect to large science centroiding errors.

5. This run used Offset file, FF002121.m, which redefined two inferred frames. Frames 113 and 114 are no longer included in the Offset file, while two new frames, 105 and 106, have been added. This explains the large (1.6') WAS to IS change associated with these two new frames in Table 1.6.

6. We also unofficially processed CA101121.m, which led to very similar results except for a larger mirror misalignment of 5 degrees compared to 1 degree in the present run.

We recommend updating the frame table entries for frames 121, 105, 106, 116, 117, 122, 123, 125, and 126 with the quaternions given in the IF file IF103121.dat. The recommended corrections are on the order of 9" in the V direction and 3" in the W direction with a knowledge error of about 1.6". While this knowledge error is larger than the desired Coarse Survey accuracy of 1.15", it is due to the fact that there were fewer science centroids than expected and they were less accurate than expected.

**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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