

Tiltmeter Monitoring Report: m032

A. Peens-Hough, 03/02/2020

Data Used

Sensor data is collected from the database, filtering for the pattern followed by AP_rate_test.py.

The time period that was queried is: **2019-02-01 10:00:00 - 2020-01-27 10:00:00 UTC**

Measured Data

The time period spanned by the data is: **2019-06-13 01:04:15 - 2019-12-20 00:06:13 UTC**

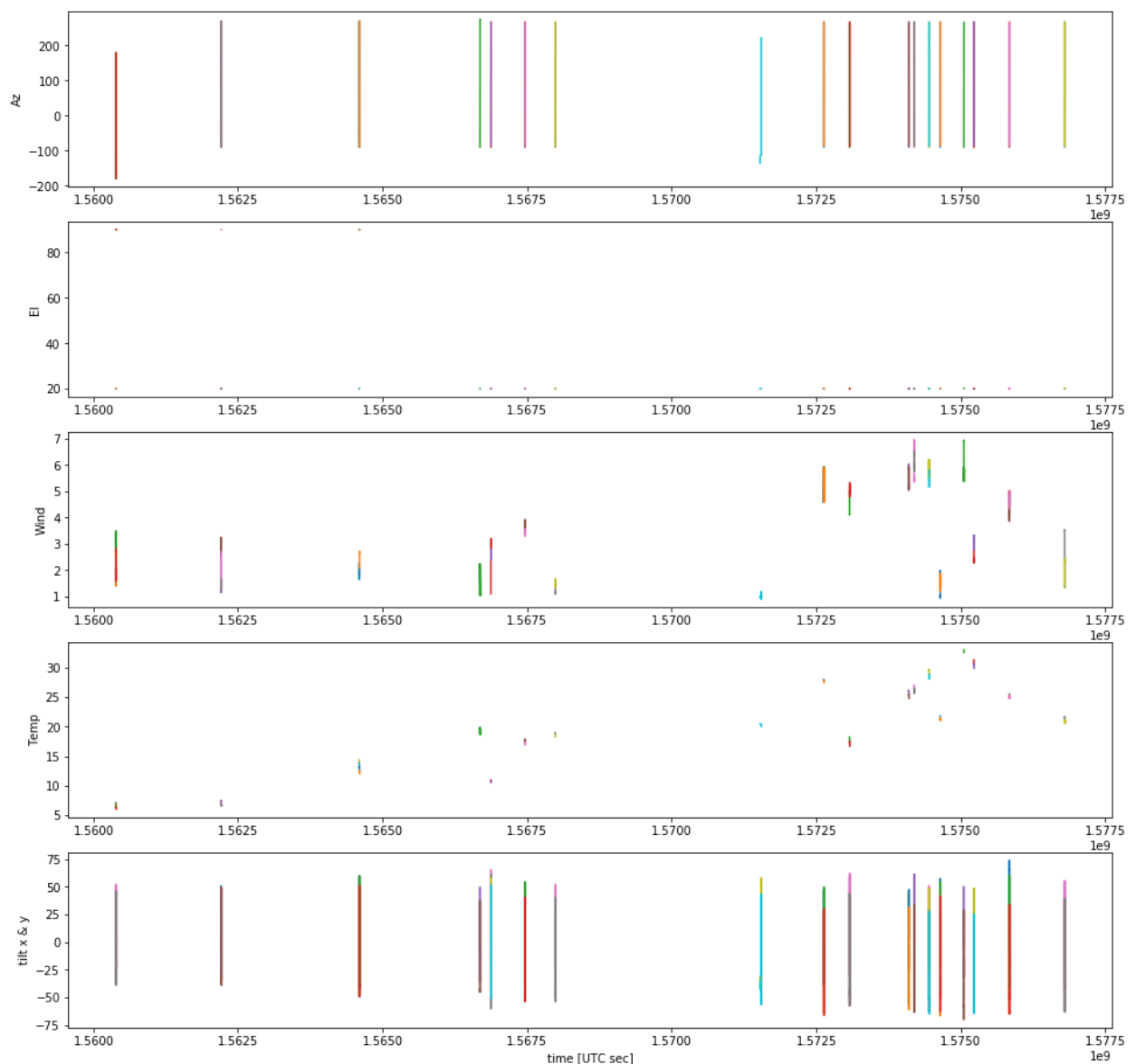


Figure 1: Overview of raw data record for m032.

Analysis Results

Raw data along with residuals (below, 'model' is for un-weighted global fit).

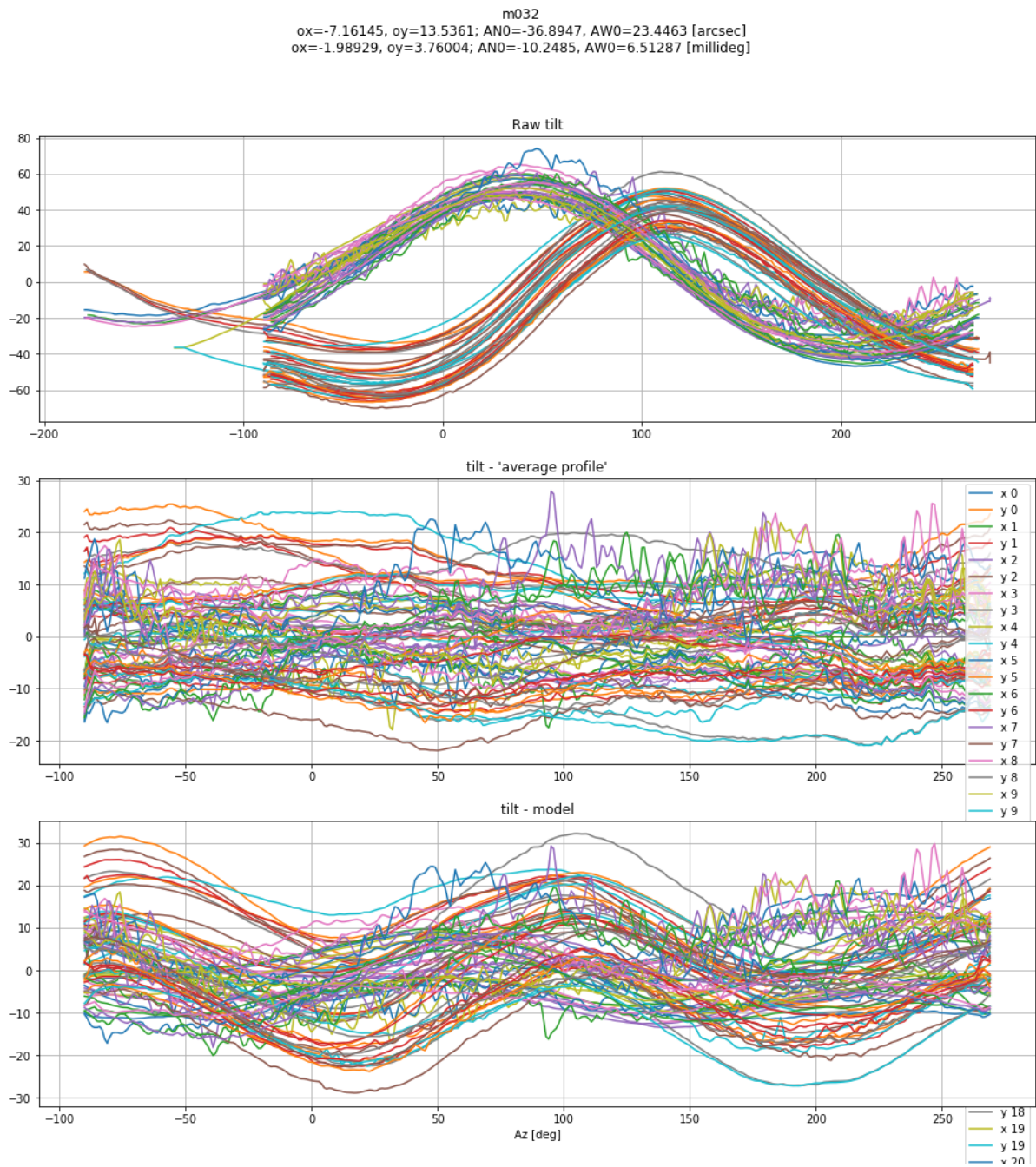
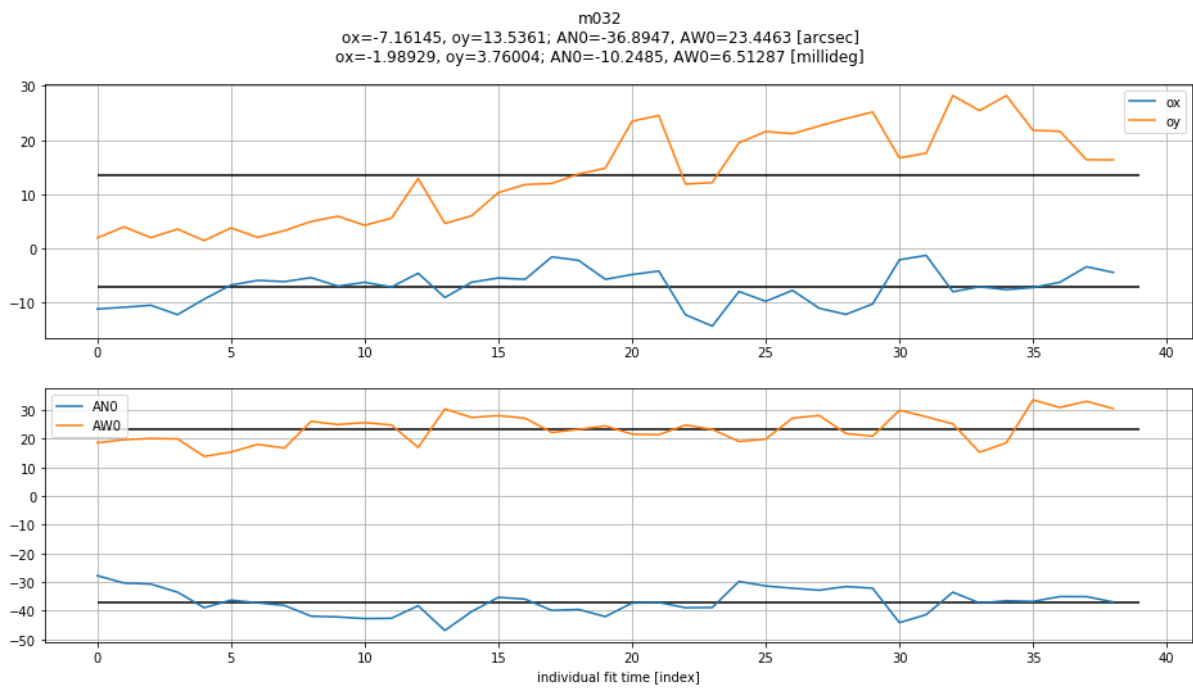
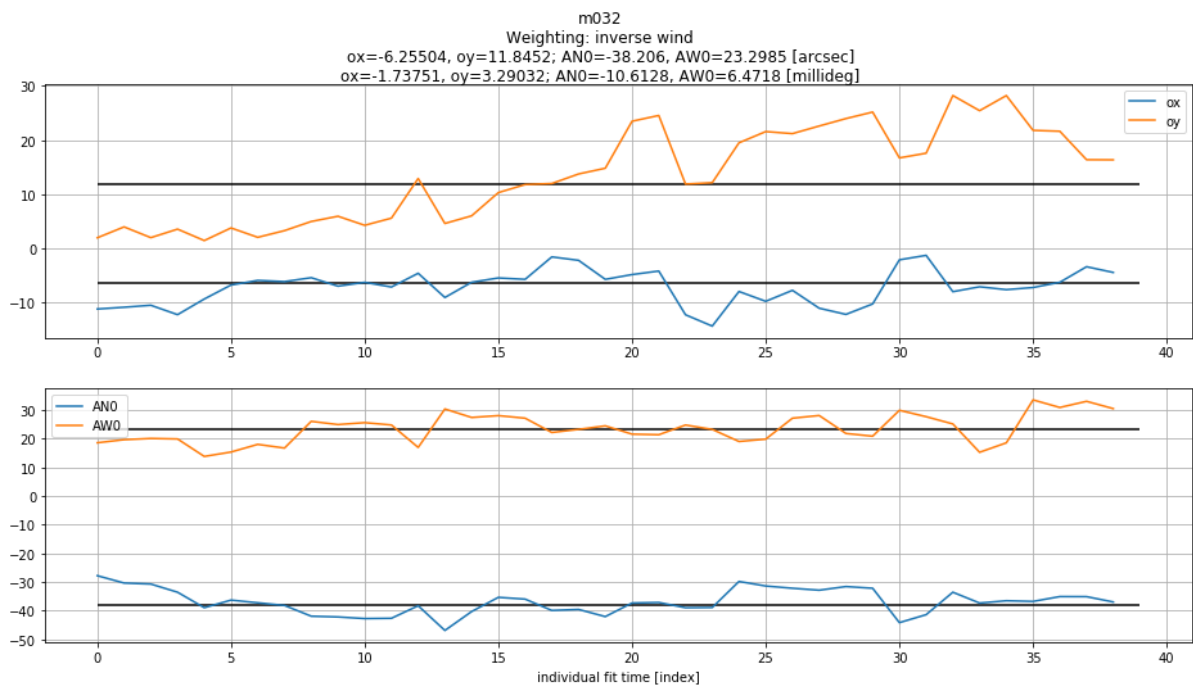


Figure 2: Summary of measured tilt data and residuals to "reference models".

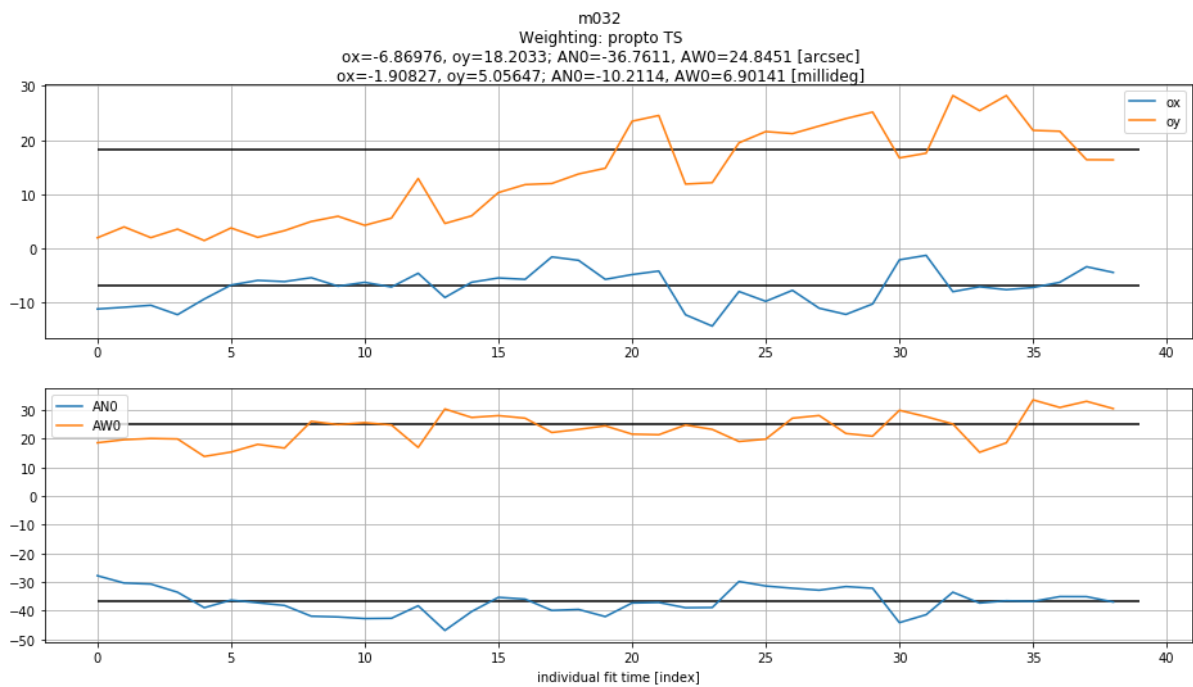
Coefficients fitted to all data, global fit with no weighting applied



Coefficients fitted to all data, global fit weighting inverse proportional to max wind



Coefficients fitted to all data, global fit down-weighting older measurements



Comparison with Current Configuration

On 27/01/2020 at 14h00 UTC the ACU configuration reflects the following

	ACU parameter*.ini	ap.tilt-param	propto TS	inverse wind
ox [millideg]	+1.31	N/A	[-] 1.91	[-] 1.74
oy [millideg]	-2.66	N/A	[+] 5.06	[+] 3.29
AN0 [millideg]	-4.560	-4.561	-10.21	-10.64
AW0 [millideg]	+0.363	+0.364	+6.90	+6.47

From the sensor history it can be seen that the value for tilt-param-aw0 changed on 30 October 2019 from the earlier value 0 to the value reflected in the table above. This was the desired outcome of ACU release VA_AP-1.2.5 that was installed on that date.

(Note that the ACU does not report the values configured for "ox" and "oy", it is explicitly excluded from the AP-CAM ICD.)



Figure 4: Sensor log record for m032.ap.tilt-param-aw0

Summary

The m032 tilt sensor appears to still be in its linear range (as of 20 December 2019).

The fitted coefficients show a clear drift in the 'oy' coefficient over the period spanning from around 31 July 2019 (fit index ~7) until around 18 November 2019 (fit index ~24). This coefficient represents the offset of the tilt sensor platform relative to the pedestal. There is no significant evidence for drift in the orientation of the pedestal itself. Such a drift is unexpected from a physical design perspective and may be an indication that the sensor's temperature scale factor is configured incorrectly **ACTION1**.

The tilt parameters reported by the ACU appear to be correct (reflecting the values in the ACU configuration files) since the installation of API VA_AP-1.2.5 on 30 October 2019. A similar sequence of events can be seen for other antennas, spread over the course of the year 2019. For example, m000 on 21 August 2019; m002 on 2 October 2019, m062 on 18 December 2019, as they were updated to VA_AP-1.2.5. **ACTION2**

Tony Foley has reported that m032's pointing model failed to converge from as early as November 2019. It is now suspected that the tilt corrections computed and applied by the ACU changed dramatically when VA_AP-1.2.5 was installed (now correctly calculated without zero values for AN0 & AW0). Since the configured tilt parameters are significantly off from the current best fit, the antenna pointing would have been systematically forced, requiring higher order modes to the pointing model or failing to converge in the way that's been observed **ACTION3**.

Follow-up Actions

ACTION1: investigate the cause of the drift of 'oy'- first confirm that tilt sensor temperature scale factor agrees with calibration certificate.

~~ACTION2: follow up why only m019 has VA_AP-1.1.1 while all others have VA_AP-1.2.5? It seems to have the A?0 bug fixed at least.~~

ACTION3: calibrate and update tilt parameters (finalise the characterisation study currently underway by SE.)

References

[1] [Notebook \(read-only view\)](#)

Appendix: Follow-up Status

ACTION1

Work in progress as of 30/01/2020

The following from eB:

m032 = AP001

SATR-1012033-30000-01-01 (NB: SATR-1012033-30000-0* are not yet linked to AP's in eB, and are all "draft unapproved")

From [SATR-1012033-30000-01-01] par 4.3.4.2

Tilt meter S/N = AS1005

ACTION2

<from Werner Bode> M019 was on AP version 1.2.5 until 9 Jan 2020 when Priscilla on site requested me to roll the software back to conduct a test. I have not received instruction from then to go back to version 1.2.5 yet.

Work in progress as of 30/01/2020

ACTION3

Reference: <[Notebook \(read-only view\)](#)>

First round of updates

m032 Pointing model before tilt cal [1580221979: P1,3,4,5,6,7,8]

P5 (AN0); P6 (AW0): -0:03:50; 0:02:51

Post-facto residual dEI range (-400, +200) arcsec

Tilt calibration as on 29/01/2020 (reported on above).

Updated ACU (github branch: adriaanph-patch-1)

X offset: 1.31 -> 1.31 + -1.908 = -0.598

Y offset: -2.66 -> -2.66 + 5.056 = +2.396

AN0: -4.5600 -> -10.21

AW0: 0.3630 -> 6.90

Note: offsets were added to values configured at time of tilt cal

m032 Pointing model after above tilt cal [1580433590: P1,3,4,5,6,7,8]

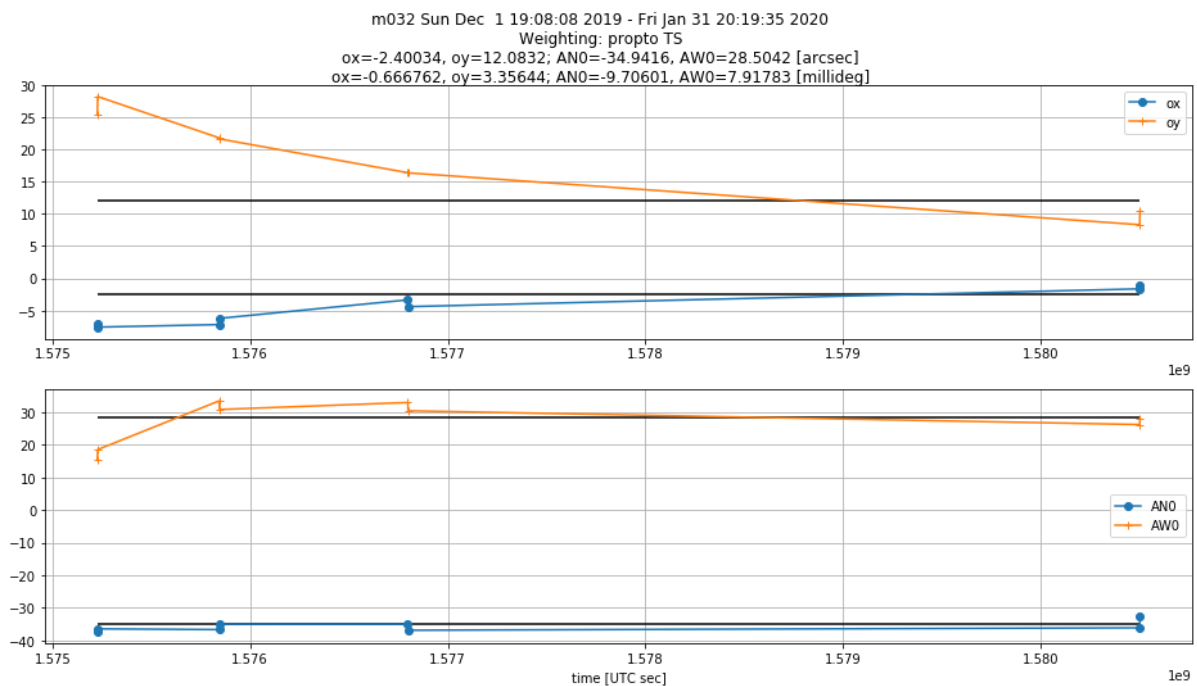
P5 (AN); P6 (AW): -0:02:27; 0:05:06

Post-facto residual dEI range (-4000, +400) arcsec

Assessment: It appears that m032 has improved (though still poor): dEI has been reduced and the AN & AW terms are closer to zero, as expected for good tilt sensor calibration.

Second round of updates

Tilt calibration as on 01/02/2020:



Updated ACU (github branch: adriaanph-patch-1)

X offset: -0.598 -> -0.648

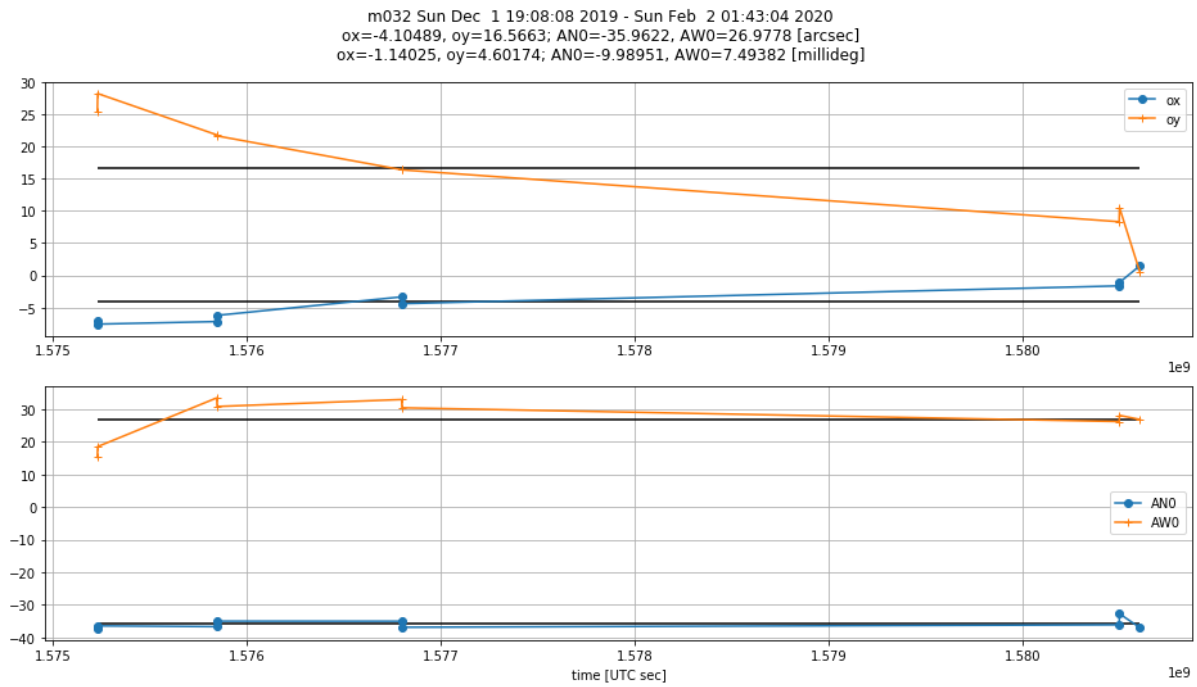
Y offset: 2.396 -> 3.305

AN0: -10.21 -> -9.699

AW0: 6.90 -> 7.930

Note: offsets were NOT added to values configured at time of tilt cal (trends do not seem to be influenced by config change, specifically offsets don't converge to zero as expected if necessary to add "configured" offsets)

Tilt calibration as on 02/02/2020:



Note: now it seems clear that the offsets are indeed influenced by configuration change, so it is correct to add "configured" offsets in force when tilt is measured for calibration!

Updated ACU (github branch: adriaanph-patch-1)

X offset: -0.648 -> -0.648 +0.579 = -1.23

Y offset: 3.305 -> 3.305 +0.398 = 3.70

AN0: -9.699 -> -10.32

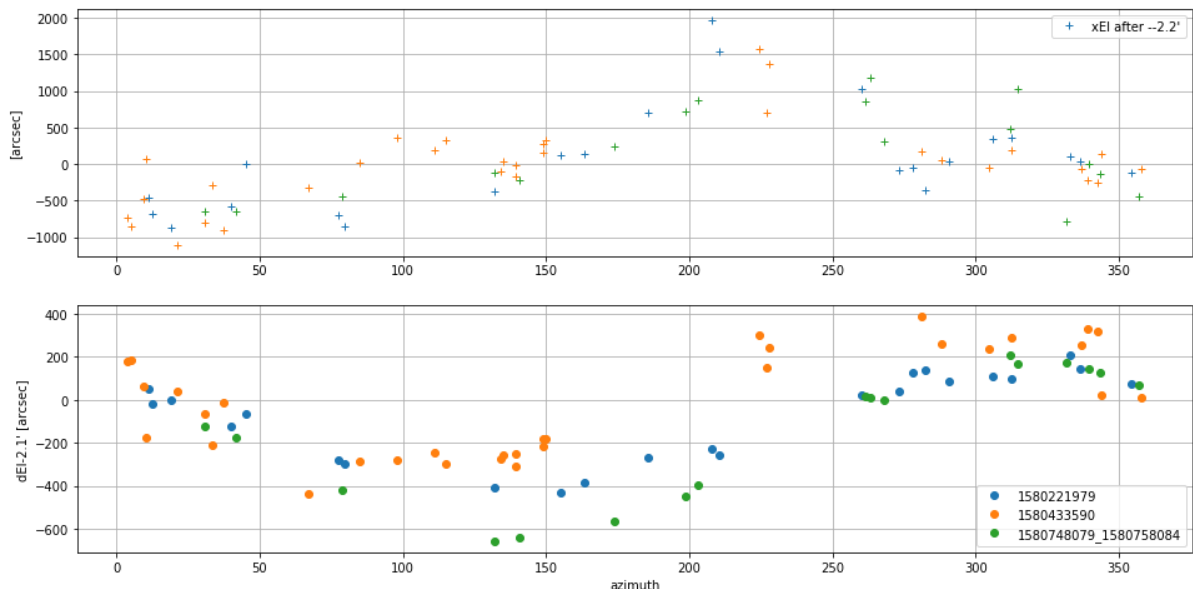
AW0: 7.930 -> 8.14

m032 Pointing model after above tilt cal [1580748079 & 1580758084: P1,3,4,5,6,7,8]

P5 (AN); P6 (AW): -0:05:46; 0:03:40

Post-facto residual dEI range (-600,+200) arcsec

Assessment: FAIL! dEI has not been reduced further and the AN & AW terms remain far from zero. Comparison of pointing residuals vs azimuth for m032 with 2019 calibration (blue), after first calibration update (orange) and after second calibration update (green). This is the only means available to assess the improvement from AN0,AW0.



These results show very little improvement from the calibration updates, suggesting that either the tilt sensor is faulty (in a systematic but non-physical way?) or there's a severe mechanical fault (also predominantly systematic).

Third round of updates

Tilt calibration as changed on 04/02/2020 in an attempt to start identifying the cause of the incorrect tilt readings:

Updated ACU (github branch: adriaanph-patch-1)

X offset: -0.648

Y offset: 3.305

AN0: 0.0

AW0: 0.0

Double-checking the tilt sensor's LAB calibration coefficients revealed that the tilt sensor's offsets and thermal sensitivity was calibrated for LOW GAIN. This is a divergence from the approved installation procedure since the required pointing corrections can only be realised when operating in HIGH GAIN mode. The LAB calibration was revised and the ACU updated as follows:

Updated ACU (github branch: adriaanph-patch-1)

X scale: 0.0955 -> 0.0965

X scale tempco: 0.00020 -> 0.00012

X zero shift: -4.191 -> -40.100

X zero shift tempco: 0.2676 -> 0.2200

Y scale: 0.0974 -> 0.0989

Y scale tempco: 0.000090 -> -0.000026

Y zero shift: 79.081 -> 35.800

Y zero shift tempco: -3.4801 -> -3.2900

X offset: 0.0

Y offset: 0.0

AN0: 0.0

AW0: 0.0