OmegaCAM Commissioning period 1B

Record 26 April - 9 May, 2011

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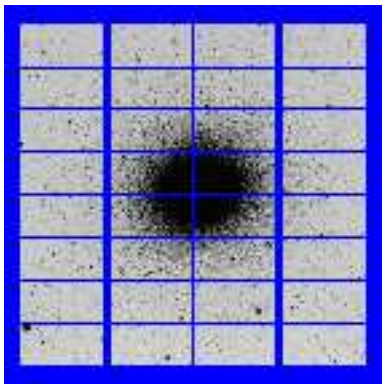

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Contents

1 Introduction

The commissioning plan (VST-PLA-OCM-23100-3100) for OCAM1 has been fully executed.

In addition to the plan, PR images on M17, Omega Cent. and the Hercules cluster have been taken.

As the work is fully on schedule, during the last nights already an OCAM2 OB could be exercised: pointing the standard field SA110 on each of the 32 chips in the g band.

The establishment of the settings of the amplifiers and final configuration of hardware was achieved only 2 nights before the end of the run. This was not scheduled, but during the last two days and nights most critical calibration observations could be repeated, leading to a first internally consistent set. Observations taken earlier then the last two nights should be avoided for characterization purposes, when possible.

The various pipelines were successfully applied to the data and the data analysis was executed as planned. The unplanned much shorter period between OCAM1 and OCAM2 implied a prime attention to those issues possibly impacting on the OCAM2 programme. Also, a full report was not planned at this state and should await the final characterization. The present writings in the following sections are very preliminary and are a draft or incomplete, as we have higher priorities at this moment. In fact, the full internal documentation is residing on the consortium Wiki pages. We have copied some of this information here.

Many of the detector/amplifyer test were already done in OCAM1A (see report doc nr) and indicated an overall very good performance, conform the lab testing in Garching (see report doc nr). No major non-conformances were noted in COM1B, though the slightly higher readnoise (*** e/sec, *** ADU/sec) implies that for u band exposures extra attention should be paid to optimizing integration times and number of dithers (perhaps N=4 is preferred over N=5).

Significant crosstalk was observed between CCDs *** (FIERRA) . First analysis indicates that these can be suppressed quite will in the datahandling.

The overall ghosting is certainly not worse than expected. A few anomalies were observed and further characterized when a bright star is positioned on or near the crosses of segmented filters, or near, but outside, the edge of the field (the latter was experimentally confirmed to be due to *** at *** mm of the edge of the field).

In OCAM1B the instrument was for the very first time exposed to the dome screen of the calibration lamps (calibration unit) and the twilight sky. A thorough analysis indicates:

- The illumination of the screen by the lamps is quite homogenous, better than 5% and with little straylight gradients
- The illumination in u is very poor, as expected, (no output of lamp) and dominated by straylight- its useage in u is questionable.
- The overall performance of the calibration unit is very good and promising Considerable straylight gradients on the sky have been deduced from the data: at least 15% (center-corner) circular symmetric in g and with more substructure, non-symmetric but with a smaller amplitude in r,i,z . In B,V the straylight gradients are much less. The interference filters are much more sensitive to the gradients, due to the input angle criterion of FPs. Perhaps we are the first to observe with such large interference filters.
- Three different methods give consistent straylight gradient results, confirming that the ratio of raw dome-to-sky images provide a good insight on the sky straylight gradients.

Zeropoints have been derived from the standard fields and are TBD compared to ETC and our own throughput estimates.

The OBs of the calibration templates have been all handled over to Paranal staff and parameter values have been fine tuned and executed. The current and subsequent characterization observations were and are to be done with this set of OBs/templates.

At large Zenit distance fields with overlapping images have been observed as a start to settling optimal field center separation, how much overlap is required to obtain photometric cross-checks over fields and what is the influence of the large straylight gradients in the corners.

It was noted that for longer visit of a field at large ZD (45 degrees) it was difficult and time consuming to maintain the AO of the telescope. While DIM seeing reported 0.7-0.8 arcsec a lot of effort was required to achieve 1.1 arcsec images, while originally the observations gave 1.4 arcsec. Obviously, faster and better acquisition would help to improve on this. During OCAM2 the improvements on the VST AO and/or OmegaCAM AO will be assessed again.

The relatively long acquisition times and the uncertainties on the improvements thereof dominate the effective verification of ETCs and this should wait for OCAM2. The zeropoints will be affected by the straylight gradients, but the strategy to characterize 32 independent chips is in our favour (as the gross of the affect will be absorbed in individual chip zeropoints).

For OCAM2 the original Com plan is applicable and will be executed as such. Extra attention will be given to observations putting standard field (SA107, SA 104 and ***) on 32 chips to maximize our understanding of the substantial straylight, the handling over of the real-time health check (lamp and monitor on the sky), large ZD fields and survey overlaps. We will have plenty opportunity to observe the straylight from the moon.

2 About this document

In the individual requirement sections tables are inserted, as a representation of the detector mosaic as defined in pixels. The orientation of the CCDs is such:

ccd #89	ccd #90	ccd #91	ccd #92	ccd #93	ccd #94	ccd #95	ccd #96
ccd #81	ccd #82	ccd #83	ccd #84	ccd #85	ccd #86	ccd #87	ccd #88
ccd #73	ccd #74	ccd #75	ccd #76	ccd #77	ccd #78	ccd #79	ccd #80
ccd #65	ccd #66	ccd #67	ccd #68	ccd #69	ccd #70	ccd #71	ccd #72

3 Req 5.2.1/CP 8.1 - Cat I: CCD Read noise - doit

Required accuracy, constraints:

- Readout noise less than 5e$^-$
- Variation in readout noise w.r.t. reference value less than 0.5e$^-$

Results:

Read-out noise $[ADU]$ and $[e^-]$							
ccd #89	ccd #90	ccd #91	ccd #92	ccd #93	ccd #94	ccd #95	ccd #96
ccd #81	ccd #82	ccd #83	ccd #84	ccd #85	ccd #86	ccd #87	ccd #88
ccd #73	ccd #74	ccd #75	ccd #76	ccd #77	ccd #78	ccd #79	ccd #80
ccd #65	ccd #66	ccd #67	ccd #68	ccd #69	ccd #70	ccd #71	ccd #72
Template: 2011-05-07 13:03:16 $[ADU]$							
2.75	2.47	2.28	2.36	2.01	2.02	2.53	2.19
2.03	1.97	2.04	2.05	2.16	2.08	2.14	2.07
1.96	2.08	2.03	2.04	2.24	1.96	2.01	2.01
1.98	1.97	2.09	2.13	2.12	2.10	2.00	2.02
Template: 2011-05-07 13:03:16 $[e^-]$							
6.52	6.23	5.98	6.03	5.15	5.61	6.90	5.17
5.20	5.05	5.22	5.06	5.19	4.82	5.10	5.22
4.70	5.18	5.12	4.97	5.95	5.31	5.36	5.17
4.73	5.10	5.20	5.42	5.28	4.69	5.08	4.83

Remarks:

- The read-out noise values are roughly 2.1 ADU, consistent with earlier lab tests.
- Using the gain to convert to read-out noise in electrons are roughly 5.1 e^- with 5 CCDs having read-out noise between 6 and 7 e^-.

Conclusions:

- The read-out noise is slightly outside specs. Significant time was spent during this commissioning period to try to change CCD firmware settings to bring this noise down. The results in the table show the situation at the final settings.

4 Req 5.2.2/CP 8.25 - Cat I: Hot pixels

Required accuracy, constraints:

- Number of hot pixels to be determined by experience/lab values.
- The total number of bad pixels (hot pixels + cold pixels) is less than 80000 (checked in req.535 Cold pixels)
- Difference in number of hot pixels w.r.t. reference value, less than 100.

Results:

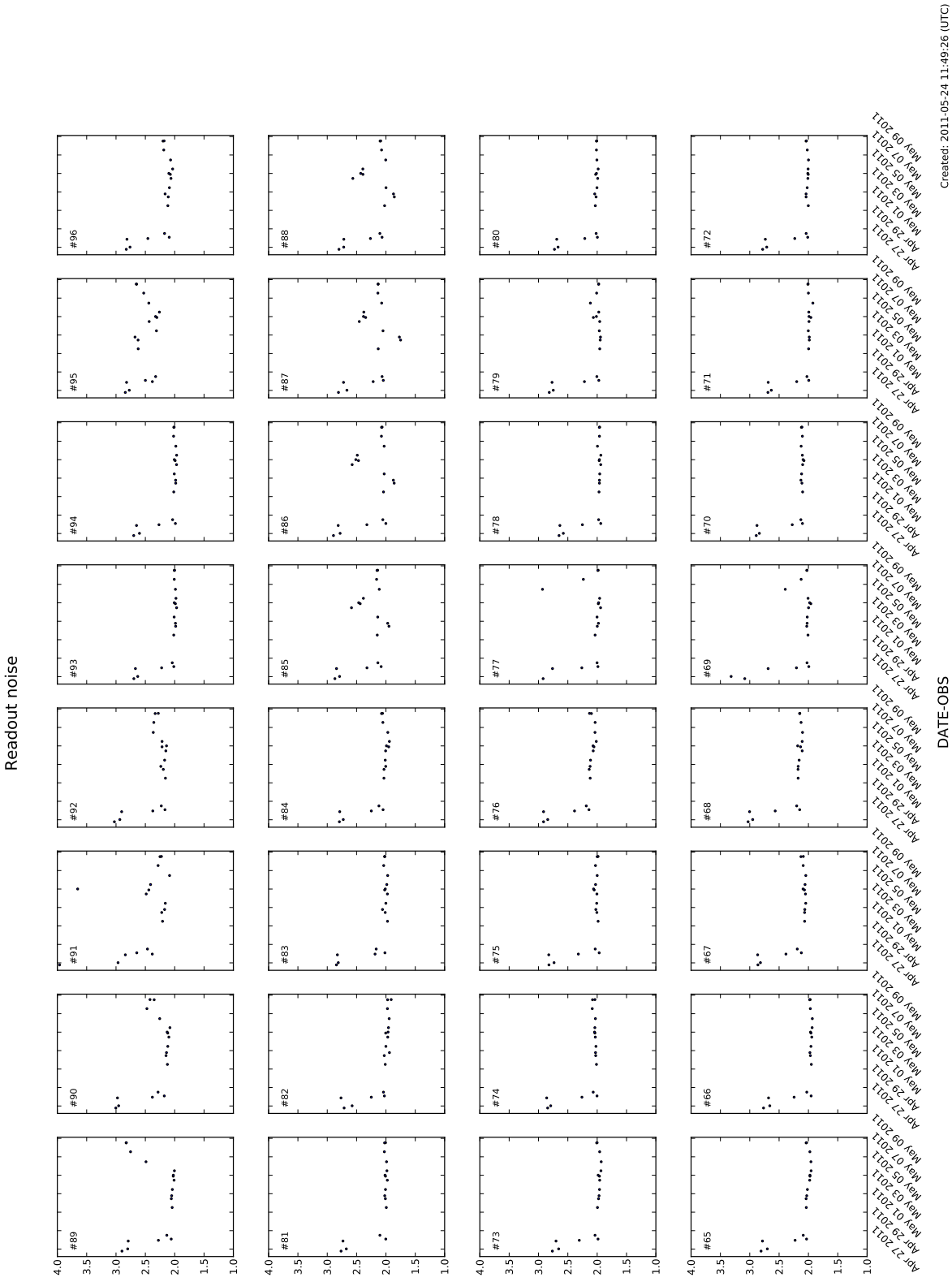

Figure 1: Trend of read-out noise value over time.

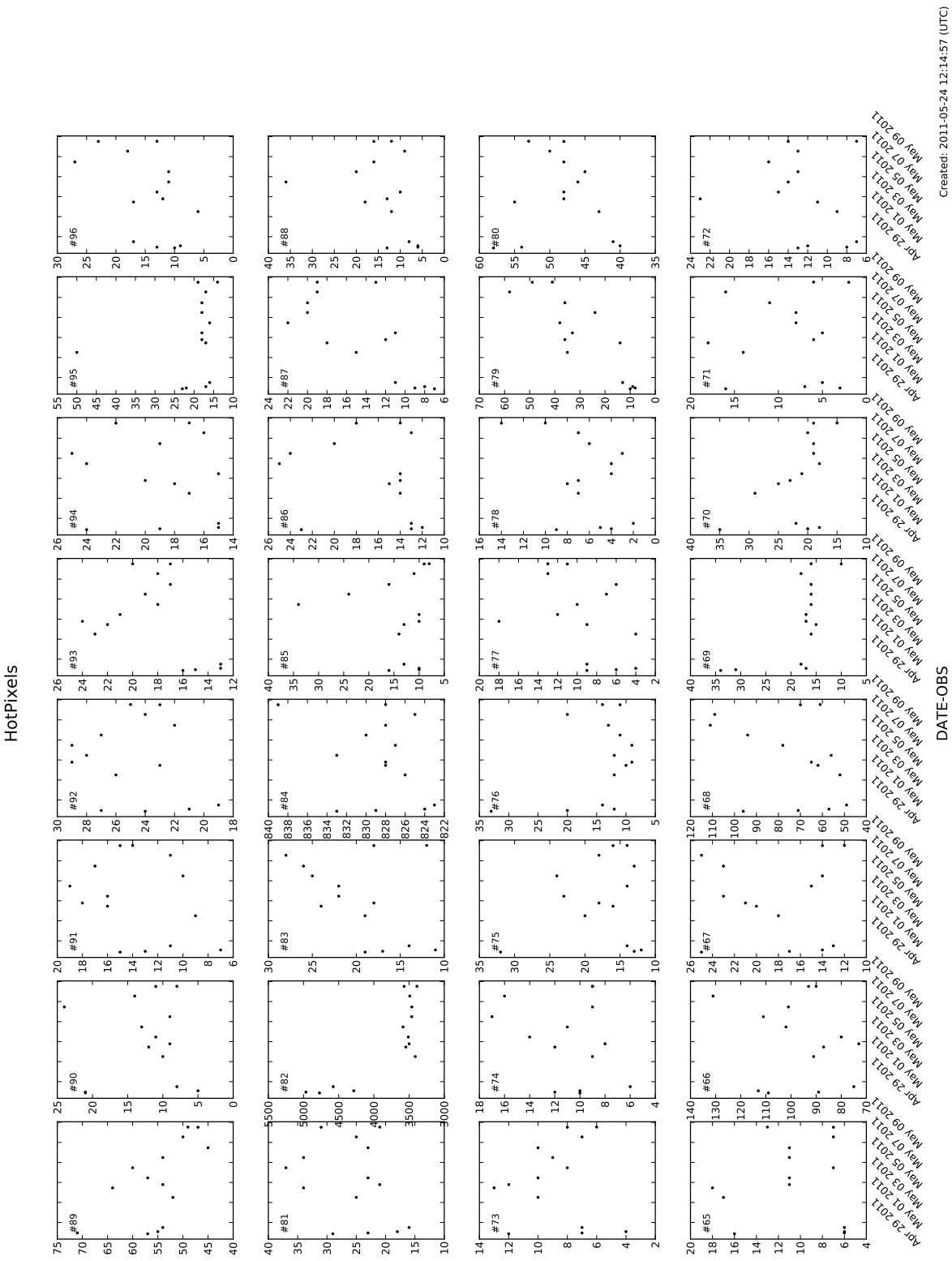

Figure 2: The caption

Hot pixel counts							
ccd #89	ccd #90	ccd #91	ccd #92	ccd #93	ccd #94	ccd #95	ccd #96
ccd #81	ccd #82	ccd #83	ccd #84	ccd #85	ccd #86	ccd #87	ccd #88
ccd #73	ccd #74	ccd #75	ccd #76	ccd #77	ccd #78	ccd #79	ccd #80
ccd #65	ccd #66	ccd #67	ccd #68	ccd #69	ccd #70	ccd #71	ccd #72
Template: 2011-05-07 13:07:01							
50	14	11	24	18	16	17	18
25	3490	28	825	11	13	19	9
7	16	18	20	13	7	58	50
7	131	25	109	18	20	16	13

Remarks:

- From visual inspection of raw bias images the hot pixels appear very few in number; the CCDs look excellent in this regard.

Conclusions:

- Very few hot pixels are seen; well within specs.

5 Req 5.2.3/CP 8.6 - Cat I: CCD Gain

Required accuracy, constraints:

- Accuracy: In units of e^-/ADU, from lab values or found empirically. Variation in time less than 1%.

Results:

Gain $[e^-/ADU]$							
ccd #89	ccd #90	ccd #91	ccd #92	ccd #93	ccd #94	ccd #95	ccd #96
ccd #81	ccd #82	ccd #83	ccd #84	ccd #85	ccd #86	ccd #87	ccd #88
ccd #73	ccd #74	ccd #75	ccd #76	ccd #77	ccd #78	ccd #79	ccd #80
ccd #65	ccd #66	ccd #67	ccd #68	ccd #69	ccd #70	ccd #71	ccd #72
Date: 2011-05-06 11:57:32							
2.37	2.52	2.62	2.56	2.56	2.78	2.73	2.37
2.57	2.56	2.56	2.46	2.40	2.32	2.39	2.52
2.40	2.48	2.52	2.44	2.66	2.71	2.67	2.57
2.39	2.59	2.49	2.55	2.48	2.23	2.54	2.39

Remarks:

-

Conclusions:

-

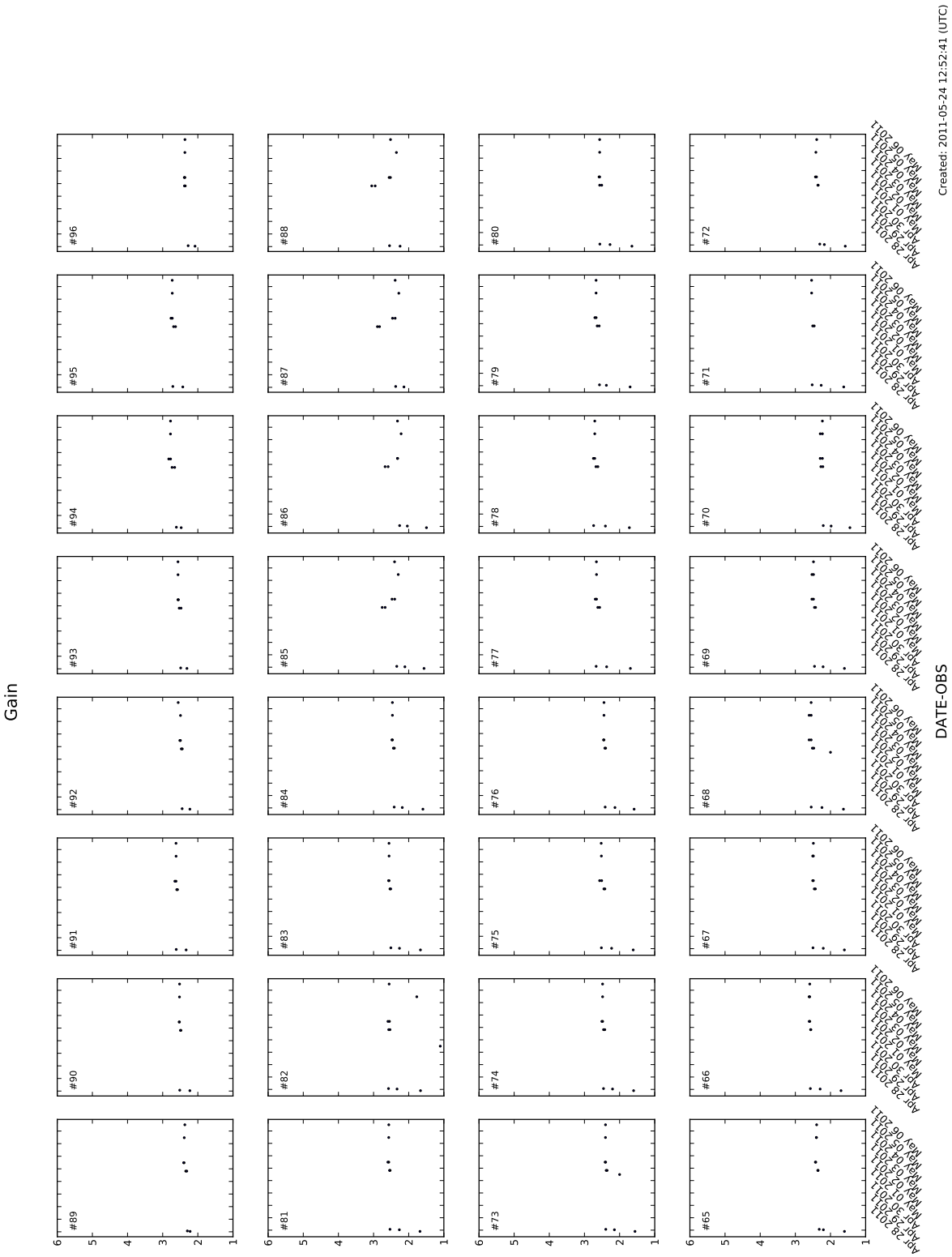

Figure 3: The caption

6 Req 5.2.4/CP 8.19 - Cat III: Electromagnetic Compatibility

Required accuracy, constraints:

- Difference between read noise under operational conditions and the standard read noise measurement should be smaller than 20% for external and 10% for internal causes of interference

Remarks:

See report "Commissioning 1B - Technical Tasks" (VST-TRE-OCM-23100-3602).

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Conclusions:

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7 Req 5.2.5/CP 8.20 - Cat III: CCD Electrical cross talk

Required accuracy, constraints:

- 10^{-5}

Remarks:

- Cross talk is evident between CCDs 93, 94, 95, 96.
- The effect is visually apparent for bright saturated stars, especially those saturated enough to cause overflow of the electron wells.
- All pixels are affected, depending on exposure level in the same pixel on adjacent CCD (which one(s)?).

  Both Dietrich and Koen have commented on this, and Koen has devised a procedure to correct the effect on the image level.

Conclusions:

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8 Req 5.3.1/CP 8.7 - Cat I: CCD Dark Current - doit

Required accuracy, constraints:

- Dark count rate should be less than 1.5 ADU/pixel/hour.

Results:

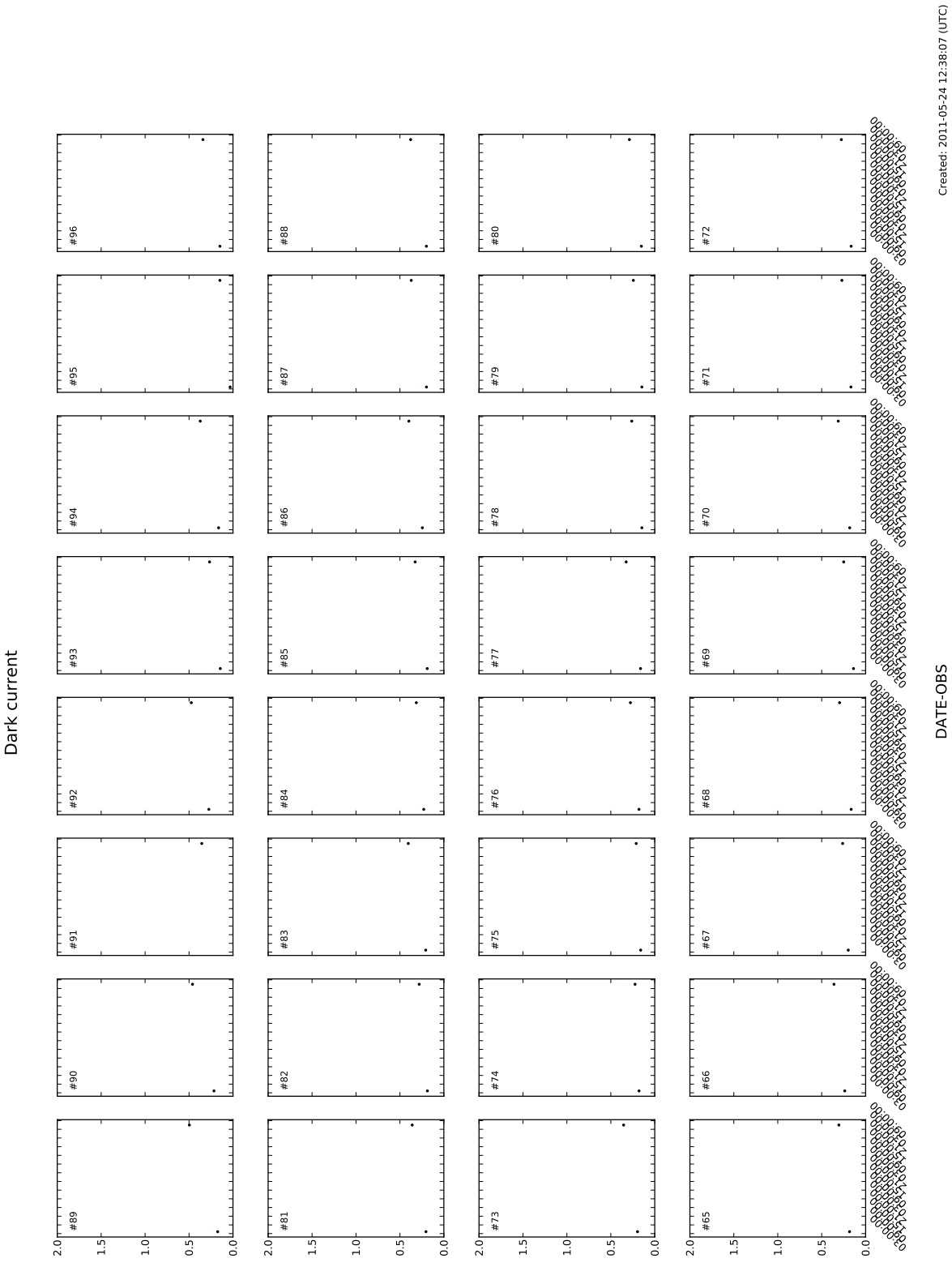

Figure 4: Dark current

Dark current [$ADU/pixel/hour$]							
ccd #89	ccd #90	ccd #91	ccd #92	ccd #93	ccd #94	ccd #95	ccd #96
ccd #81	ccd #82	ccd #83	ccd #84	ccd #85	ccd #86	ccd #87	ccd #88
ccd #73	ccd #74	ccd #75	ccd #76	ccd #77	ccd #78	ccd #79	ccd #80
ccd #65	ccd #66	ccd #67	ccd #68	ccd #69	ccd #70	ccd #71	ccd #72
Template: 2011-05-08 05:57:20							
0.50	0.46	0.36	0.47	0.27	0.37	0.15	0.34
0.36	0.28	0.41	0.31	0.33	0.40	0.37	0.38
0.35	0.22	0.21	0.28	0.33	0.26	0.24	0.29
0.30	0.36	0.26	0.30	0.25	0.31	0.27	0.28

Remarks:

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Conclusions:

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9 Req 5.3.2/CP 8.26 - Cat I: CCD Particle Event Rate

Required accuracy, constraints:

- better than 1 particle/cm^2/hour.
- Particle event rates should be identical for each chip.

Results:

Particle event rate [$particles(events)/cm^2/hour$]							
ccd #89	ccd #90	ccd #91	ccd #92	ccd #93	ccd #94	ccd #95	ccd #96
ccd #81	ccd #82	ccd #83	ccd #84	ccd #85	ccd #86	ccd #87	ccd #88
ccd #73	ccd #74	ccd #75	ccd #76	ccd #77	ccd #78	ccd #79	ccd #80
ccd #65	ccd #66	ccd #67	ccd #68	ccd #69	ccd #70	ccd #71	ccd #72
Template: 2011-05-08 05:57:20							
122.55	111.12	117.79	116.20	114.12	119.41	113.02	116.45
114.96	113.20	117.12	117.61	122.02	119.30	118.60	108.93
116.80	113.91	111.82	113.73	115.07	112.99	108.79	110.41
111.68	168.14	110.98	114.15	108.97	110.73	112.21	111.93

Remarks:

-

Conclusions:

-

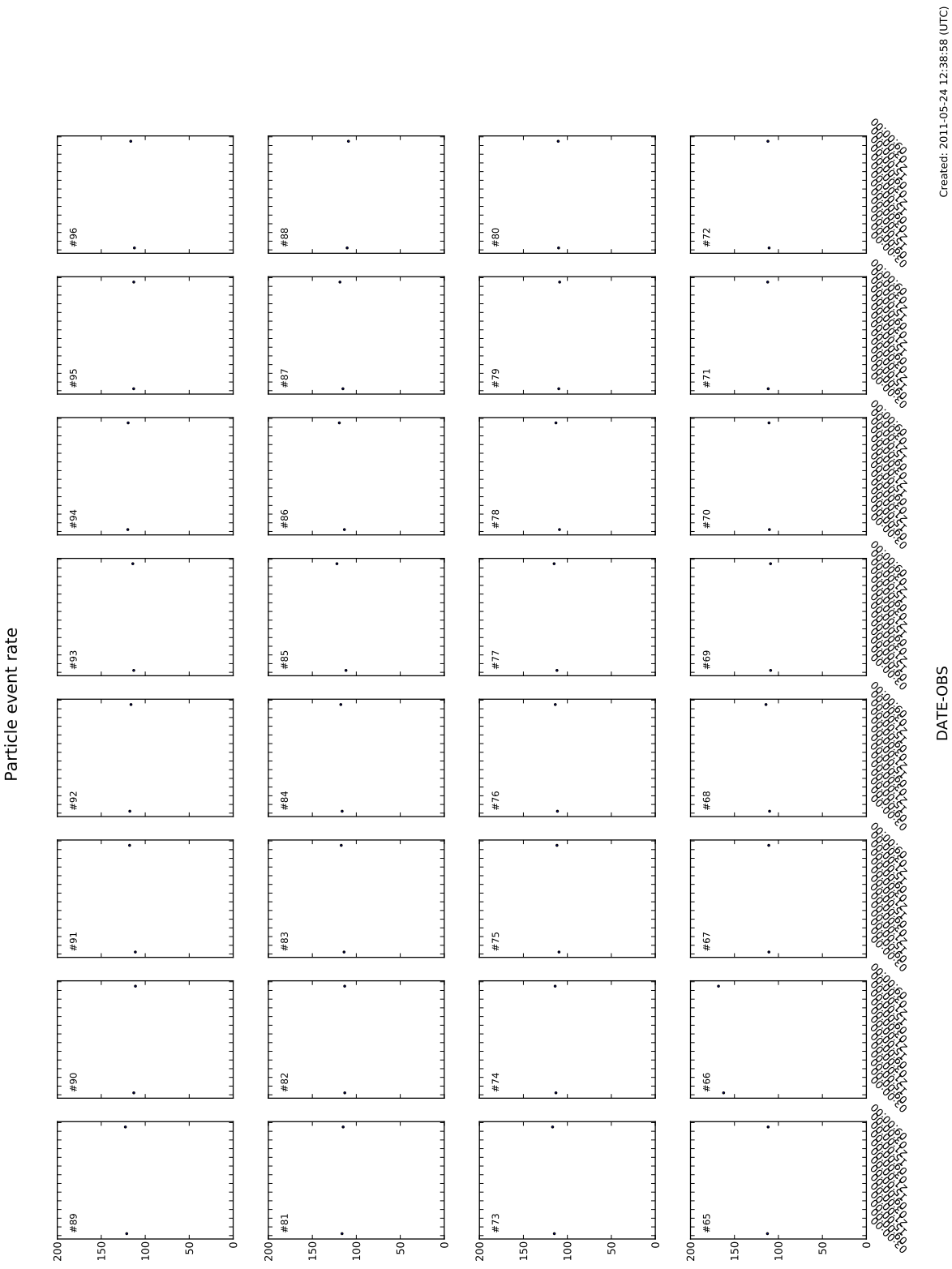

Figure 5: The caption

10 Req 5.3.3/CP 8.27 - Cat I: CCD Linearity

Required accuracy, constraints:

- better than 1% on the photometric scale

Results:

Remarks:

-

Conclusions:

-

11 Req 5.3.4/CP 8.21 - Cat III: CCD Charge Transfer Efficiency

Required accuracy, constraints:

- CTE > 0.999995 per parallel of serial shift

Remarks:

-

Conclusions:

-

12 Req 5.3.5/CP 8.28 - Cat I: CCD Cold Pixels

Required accuracy, constraints:

- Quality Check: Number of hot pixels to be determined by experience/lab values. The total number of bad pixels (hot pixels + cold pixels) is less than 80000. Difference in number of cold pixels w.r.t. reference version less than 100.

Results:

Cold pixel counts							
ccd #89	ccd #90	ccd #91	ccd #92	ccd #93	ccd #94	ccd #95	ccd #96
ccd #81	ccd #82	ccd #83	ccd #84	ccd #85	ccd #86	ccd #87	ccd #88
ccd #73	ccd #74	ccd #75	ccd #76	ccd #77	ccd #78	ccd #79	ccd #80
ccd #65	ccd #66	ccd #67	ccd #68	ccd #69	ccd #70	ccd #71	ccd #72
Template: 2011-05-07 12:15:57							
3143	16719	8891	4926	7037	15038	10134	7222
8698	2816	9611	5713	9742	6420	8570	9553
3811	2692	2765	2802	2683	2660	2911	4329
2807	5363	2956	4163	3003	5783	7371	4191

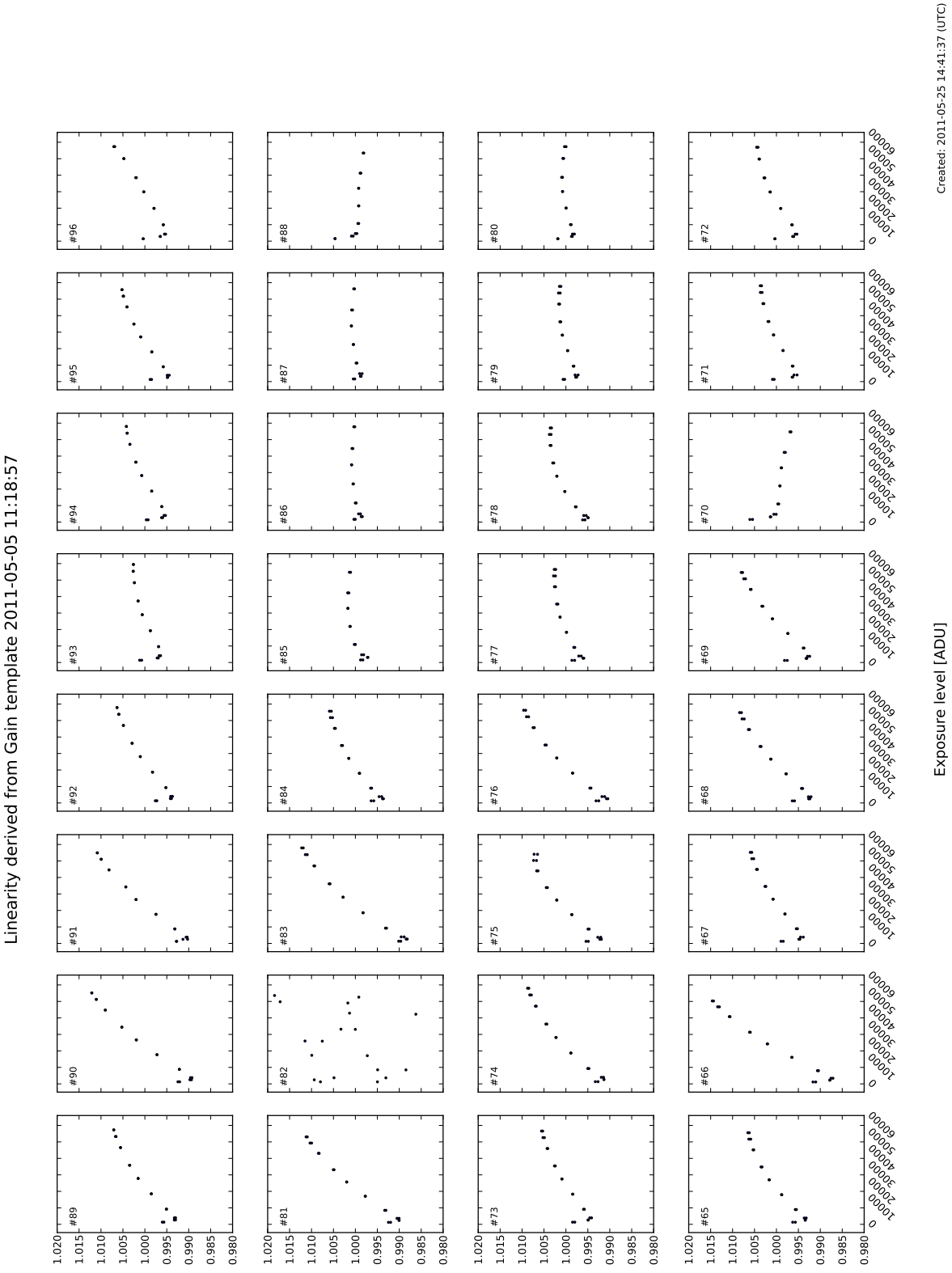

Figure 6: Linearity plot for gain template on 5 May.

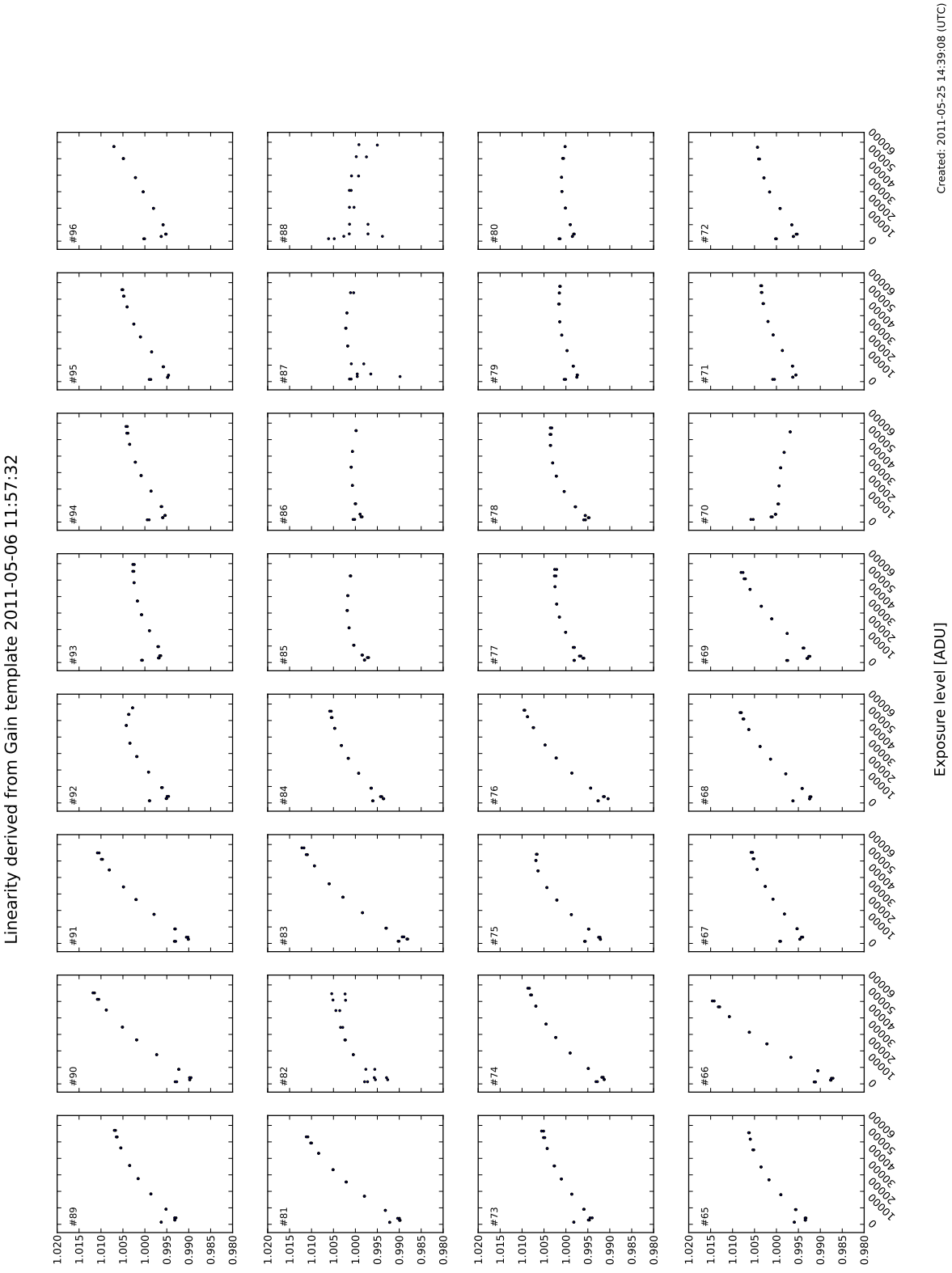

Figure 7: Linearity plot for gain template on 6 May.

Remarks:

-

Conclusions:

-

13 Req 5.3.6/CP 8.22 - Cat III: CCD Hysteresis, strong signal

Required accuracy, constraints:

Results:

Remarks:

-

Conclusions:

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14 Req 5.4.1/CP 8.2 - Cat I: Bias - doit

Required accuracy, constraints:

- The required accuracy per pixel in the master bias frame is "nominal read-out noise/$\sqrt{N}$", where N is the number of input raw bias images. For the quality check: Since an overscan correction is performed, the deviation of the mean level of the master bias (bias level) from zero, should be less than TBD.

Results:

Remarks:

-

Conclusions:

-

15 Req 5.4.2/CP 8.41 - Cat I: Flat-field - dome key bands + user bands - doit

Required accuracy, constraints:

- Accuracy measuring pixel-to-pixel gain variations as small as 1%. Re-insertion of the filter shall not alter the flat field structure by more than 0.3% (rms, measured over the full detector area).

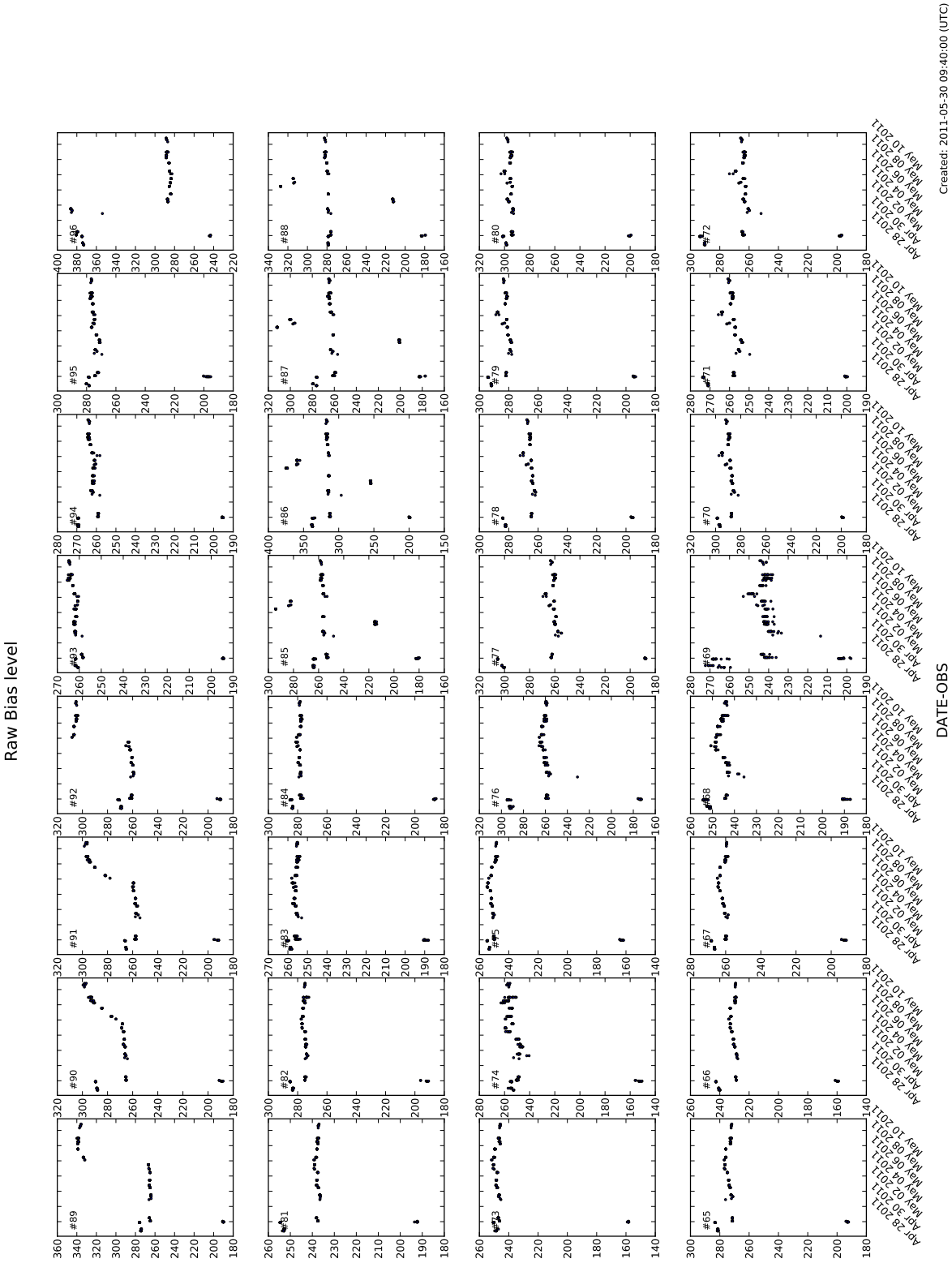

Figure 8: The caption

Results:

Remarks:

-

Conclusions:

-

16 Req 5.4.3/CP 8.42 - Cat I: Flat-field - twilight

Required accuracy, constraints:

- Mean levels should be approximately 20000 ADU.

Results:

Remarks:

-

Conclusions:

-

17 Req 5.4.7/CP 8.3 - Cat I: Quick detector responsivity check - doit

Required accuracy, constraints:

Results:
NB. **Outputs are in units of ADU.**

Remarks:

-

Conclusions:

-

18 Req 5.4.8/CP 8.17 - Cat II: Illumination correction - part 1 Quick

Required accuracy, constraints:

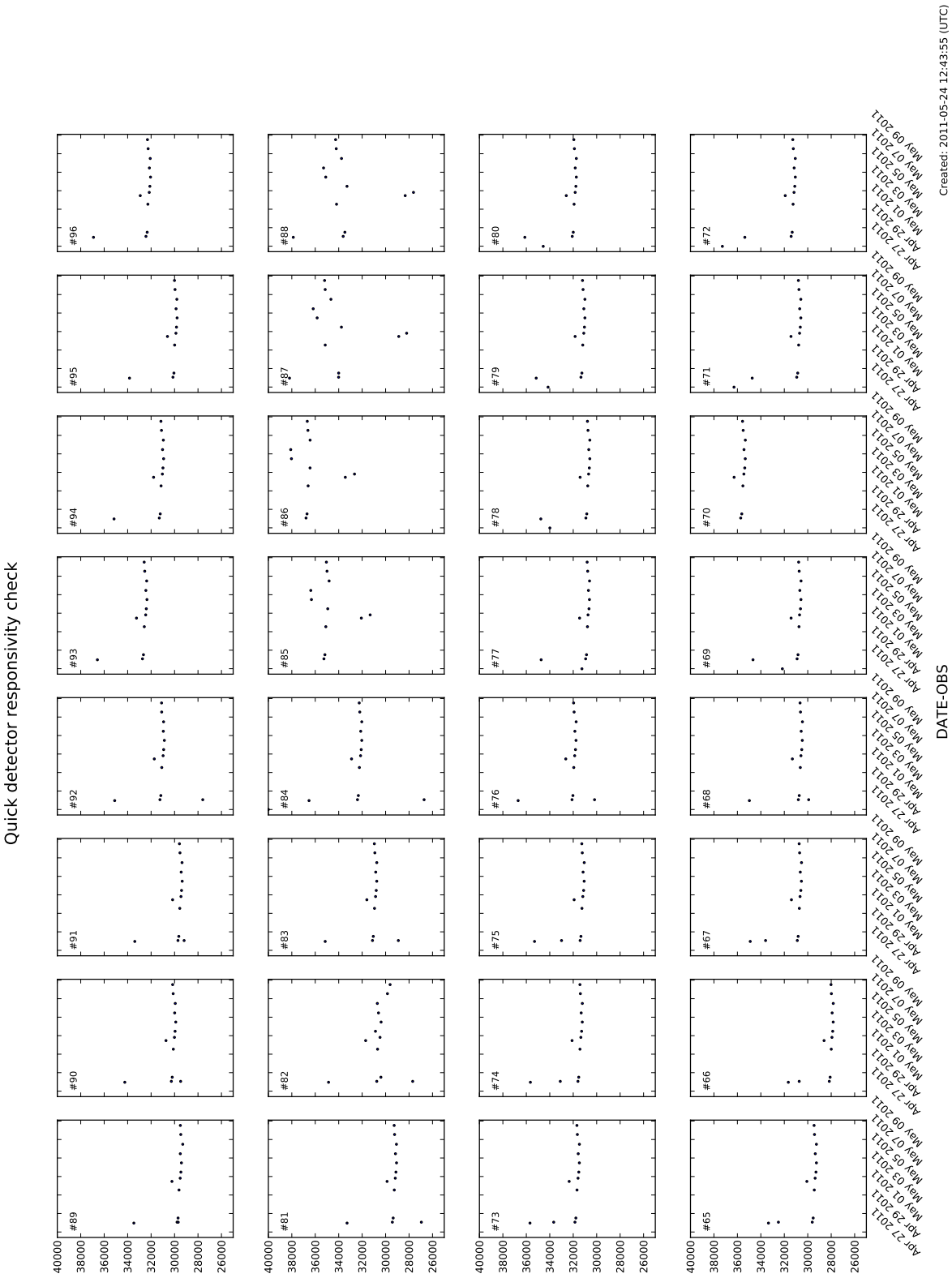

Figure 9: The caption

- better than 1% for the amplitude over a single CCD.

Results:
Remarks:

-

Conclusions:

-

19 Req 5.5.1/CP 8.14 - Cat III: Position of Camera in focal plane

Required accuracy, constraints:

- Internal precision: 0.3 pixel. External precision limited by reference catalog.

Results:
Remarks:

-

Conclusions:

-

20 Req 5.5.2/CP 8.10 - Cat III: Telescope Pointing and offsetting

Required accuracy, constraints:

- 1 arc second

Results:
Remarks:

-

Conclusions:

-

21 Req 5.5.3/CP 8.11 - Cat III: Telescope and Field Rotator tracking

Required accuracy, constraints:

VST requirements:

- free tracking better than 0.2 arcsec r.m.s.

- autoguiding tracking better than 0.05 arcsec

Results:
Remarks:

-

Conclusions:

-

22 Req 5.5.4/CP 8.12 - Cat III: PSF Anisotropy

Required accuracy, constraints:

- better than 1%

Results:
Remarks:

-

Conclusions:

-

23 Req 5.5.5/CP 8.50 - Cat I: The astrometric solution for templates -doit -see 6.3.4

Required accuracy, constraints:

-

Results:
Remarks:

-

Conclusions:

-

24 Req 5.5.6/CP 8.13 - Cat III: The astrometric solution for the Guide CCDs

Required accuracy, constraints:

- 1 arcsec rms for the accuracy with respect to the external standard;

- External precision is driven by the position of the reference catalog. This is in the case of the USNO-A2 catalog of the order 0.3" with possible systematic excursions to 1".

Results:
Remarks:

-

Conclusions:

-

25 Req 5.6.1/CP 8.18 - Cat III: Shutter Timing

Required accuracy, constraints:

- Timing error less than 0.2%

Results:

Remarks:

-

Conclusions:

-

26 Req 5.6.2/CP 8.37 - Cat I: Photometric Calibration - monitoring

Required accuracy, constraints:

- all photometry better than 1-2% on the photometric scale

Results:
Remarks:

-

Conclusions:

-

27 Req 5.6.3/CP 8.38 - Cat I: Photometric Calibration - zeropoint keybands -doit

Required accuracy, constraints:

- 1% on the photometric scale

Results:
Remarks:

-

Conclusions:

-

28 Req 5.6.4/CP 8.44 - Cat I: Photometric Calibration - zeropoint user bands

Required accuracy, constraints:

- 2% on the photometric scale for broad bands and 5% for narrow band filters

Results:
Remarks:

-

Conclusions:

-

29 Req 5.6.5/CP 8.24 - Cat III: Dependency on angle - ADC, rotator/reproducibility

Required accuracy, constraints:

- 1% on the photometric scale

Results:
Remarks:

-

Conclusions:

-

30 Req 5.6.8/CP 8.52 - Cat III: Detection limit and ETC calibration

Required accuracy, constraints:

- 10% in detection limit

Results:
Remarks:

-

Conclusions:

-

31 Req 5.7.1/CP 8.9 - Cat III: Camera focus/tilt

Required accuracy, constraints:

-

Results:
Remarks:

-

Conclusions:

-

Req.	**CP**	**Results**
5.5.2	8.10	Cat III: Telescope Pointing and offsetting Put text here Put text here Put text here Put text here Put text here Put text here Put text here Put text here Put text here Put text here .....
5.5.3	8.11	Cat III: Telescope and Field Rotator tracking
5.5.4	8.12	Cat III: PSF Anisotropy
5.5.5	8.50	Cat I: The astrometric solution for templates -doit -see 6.3.4
5.5.6	8.13	Cat III: The astrometric solution for the Guide CCDs
5.6.1	8.18	Cat III: Shutter Timing
5.6.2	8.37	Cat I: Photometric Calibration - monitoring
5.6.3	8.38	Cat I: Photometric Calibration - zeropoint keybands -doit
5.6.4	8.44	Cat I: Photometric Calibration - zeropoint user bands
5.6.5	8.45	Cat I: Filter band passes - user bands vs key bands
5.6.5	8.24	Cat III: Dependency on angle - ADC, rotator/reproducibility
5.6.7	8.43	Cat III: Linearity (as a function of flux)
5.6.8	8.52	Cat III: Detection limit and ETC calibration
5.6.9	8.46	Cat I: Secondary Standards
5.7.1	8.9	Cat III: Camera focus/tilt
5.7.2	8.23	Cat III: Ghosts - ADC

32 Delivered scripts

Three scripts are to be delivered to Paranal:

- Quick Detector Responsivity Check (**ready**).
- PSF Anisotropy (**delivered**).
- Photometric Monitoring (**not ready**).

33 Tasks for Commissioning 2

See Commissioning Plan.

- Req. 5.4.8 Illumination Correction - part 2 complate
- Req. 5.6.4 Photometric Calibration - zeropoints user bands (extensive)
- Req. 5.6.5 Dependency on angle - ADC, rotator/reproducibility
- Req. 5.6.7 Linearity (as a function of flux)
- Req. 5.6.9 Secondary Standards