Preliminary investigation of GFA sky brightness measurements

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General Considerations

approximate r band sky brightness range of interest:

Sky Brightness Data		
Lunar Age	**R (Vega/arcsec2)**	**r (AB/arcsec2)**
0	20.9	21.1
3	20.8	20.9
7	20.6	20.6
10	20.3	20.2
14	19.9	19.7
Vega data from https://www.noao.edu/kpno/manuals/dim/		

(table from DESI-4731)

General Considerations

- Median of per-camera, per-amp raw ADU zeropoints measured from stars in photometric GFA data is r = 25.63 AB
  - https://desi.lbl.gov/trac/wiki/Commissioning/Planning/gfachar/zp_dense_fields
- => at sky brightness of r = 21.1 AB per sq. asec, sky signal is ~65 ADU/s/sq. asec
- GFA pixel solid angle is 0.0418 sq. asec (averaged over guide cameras, based on my template WCS trained on stars in real data, consistent across guide cameras to within < 0.1%)
- => r = 21.1 AB per sq. asec corresponds to ~2.7 ADU/pix/s

General Considerations

- Dark current on average ~11 ADU/pix/s and changes by ~2.5 ADU/pix/s/degree C at 11 C (D. Kirkby, DESI-5315)
    - Will want CCD temperatures good to ~0.1 deg C or better for accurate sky brightness measurements in dark sky conditions
- Per-amp bias offset observed to vary from exposure to exposure at the ~20 ADU level
    - for typical ~5 s short GFA exposures this matters at a substantial (order unity) level in dark sky conditions

Sky brightness measurement approach

- Detrend raw images

- Analyze “good” region of each amp to determine sky background level in ADU/pix, divide by EXPTIME to get sky count rate in ADU/pix/s, then convert this to mag per sq. asec using measured zeropoint and pixel solid angle values

- Combine per-amp sky brightness measurements into per-camera measurements

- An alternative approach would be to perform a template linear regression with free parameters for the bias offset, dark current multiplicative scaling and sky signal multiplicative scaling (not sure how well that could actually work in practice)

Detrending

- Subtract master bias image with a per-amp offset applied based on median of each raw image's overscan pixel values for that amp
- Subtract master dark scaled linearly with temperature according to D. Kirkby's DESI-5315 coefficients
    - Currently using my own master dark images
- Divide by a master flat that's normalized to have a median value of 1 within each amp

Sky signal value

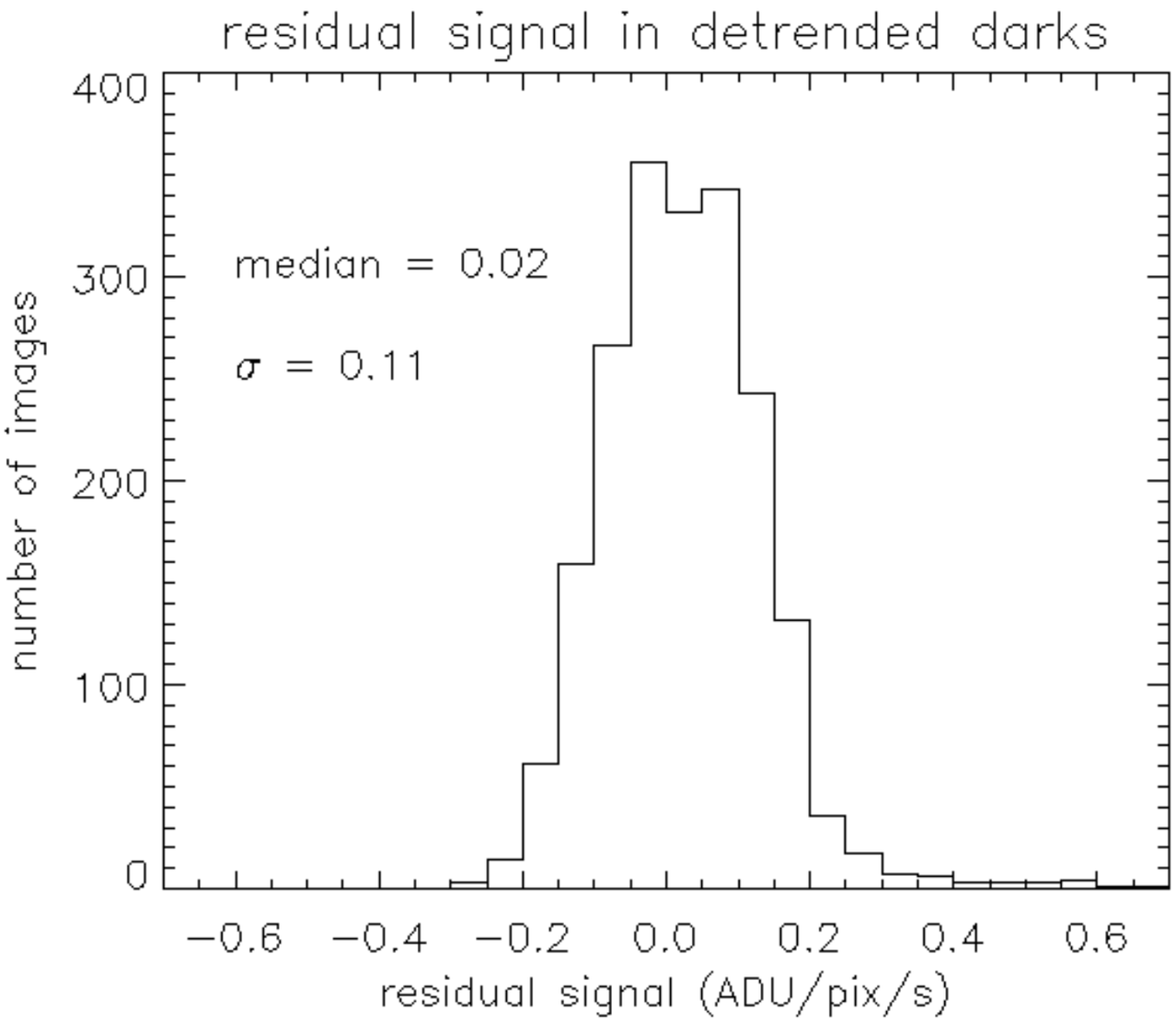
22597 ; GUIDE2 ; 30.0 s ; focus scan ; 20191029

Occasionally see dark regions around image edges not present in master flat; discard these regions when computing sky level

Detrended images also show lower-level vertically oriented background variations which I have not yet accounted for in this sky brightness analysis

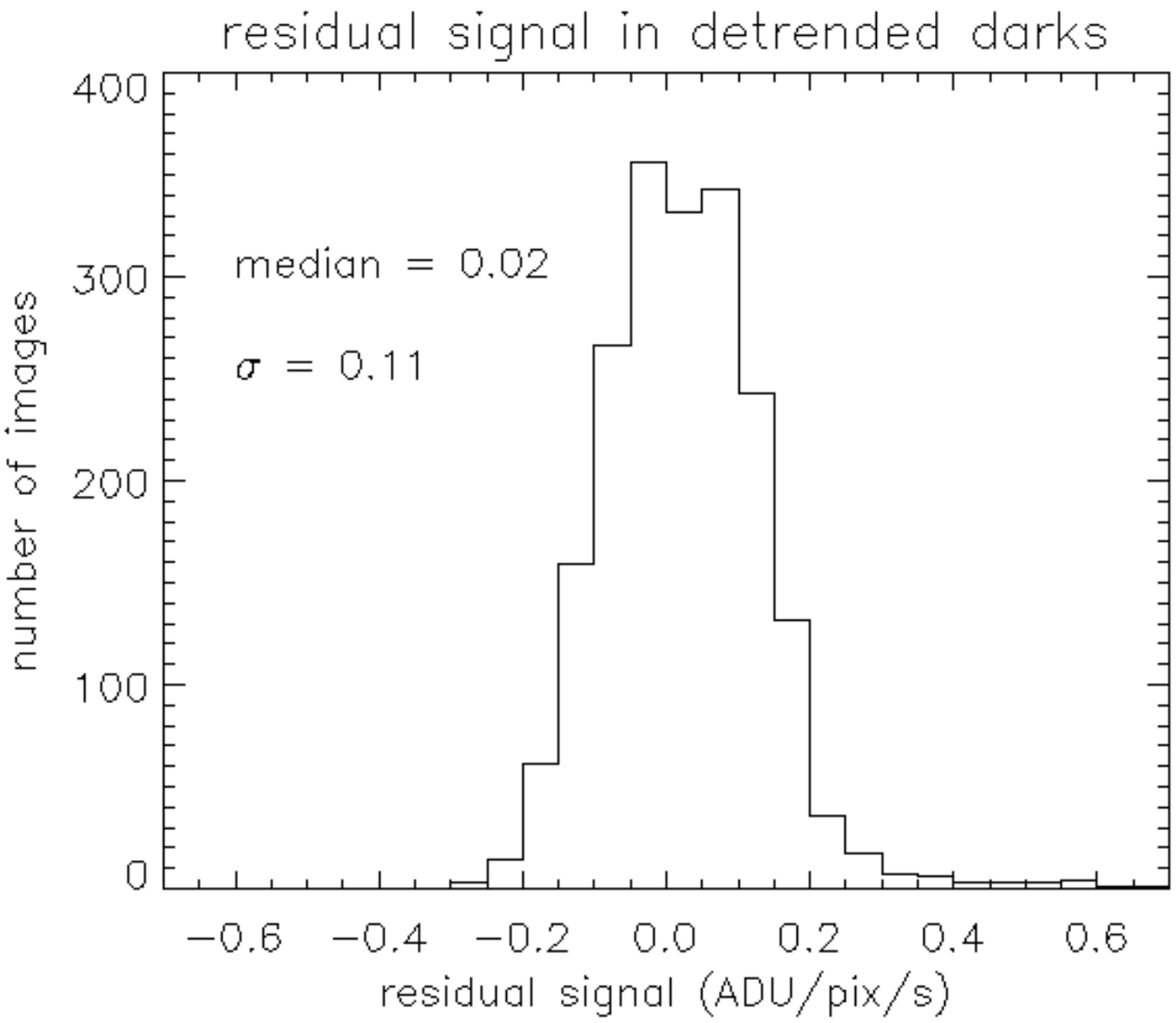
- Restrict to “good” pixels in regions away from image edges
- After detrending, measure per-amp sky level in ADU using median with iterative outlier rejection for robustness against compact sources

Null tests on darks



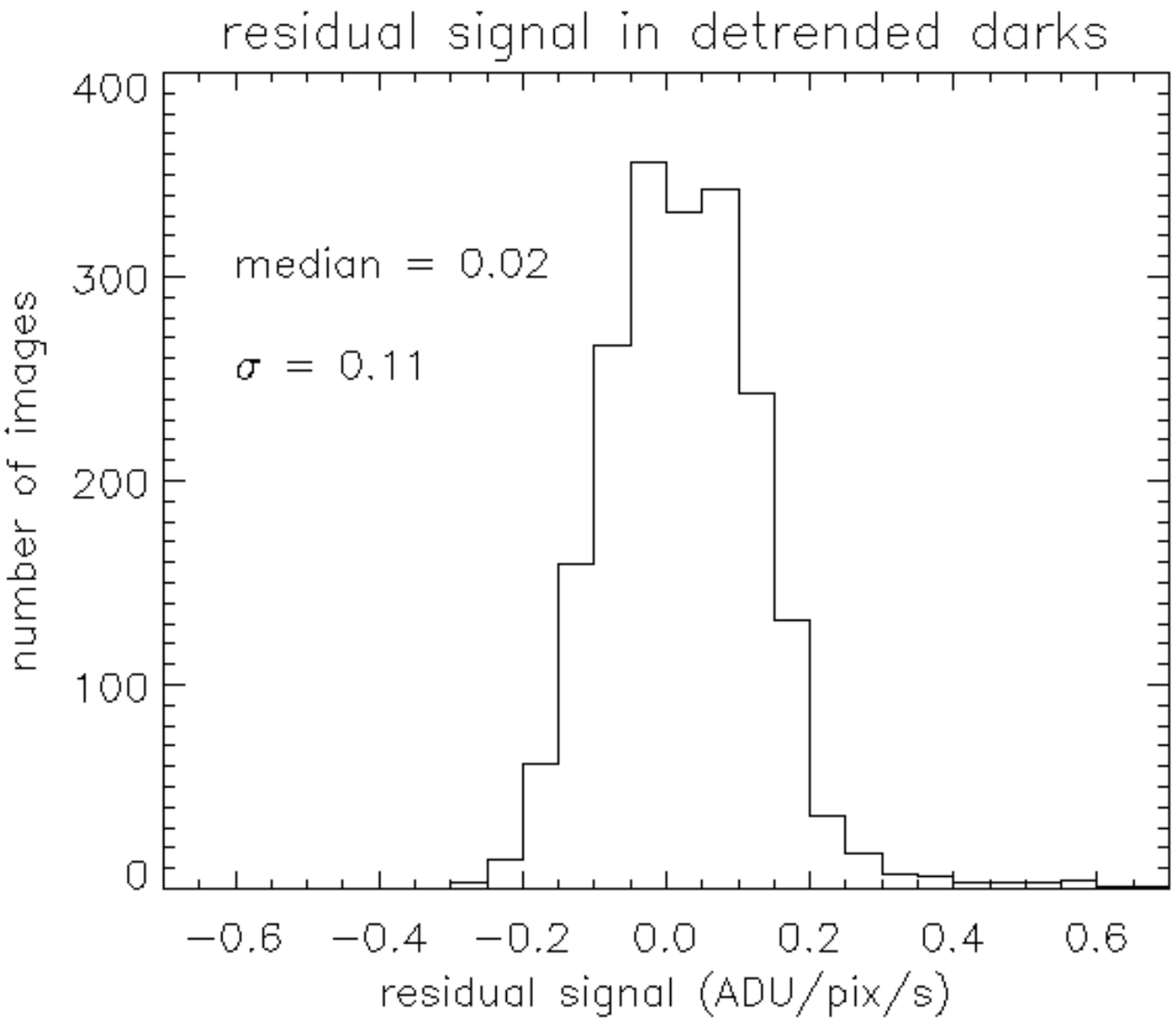
- Apply detrending to darks and then measure residual count rate to get a sense for the expected accuracy that can be achieved

Null tests on darks



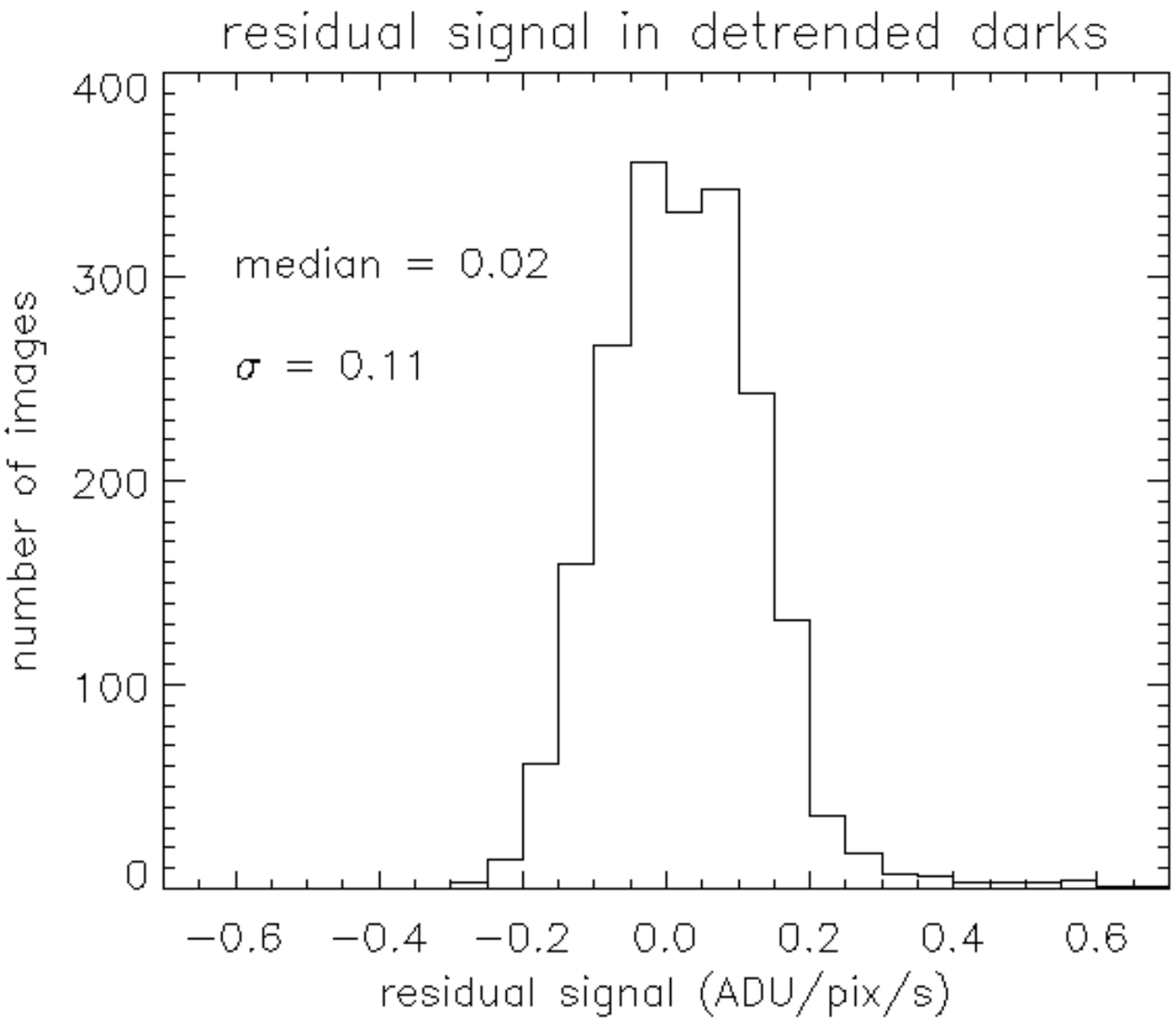
- ~1,000 dark exposures used: 22168-22191 (600 s), 10 sets of ~100 darks from DESI-5315 (5 s), ~100 darks from 20191123 (5 s, colder than DESI-5315 temperature dependence fitting range)

Null tests on darks



- Dispersion of 0.11 ADU/pix/s would translate to a 1 sigma temperature error of ~0.045 deg C, which is within a factor of 2 of the CCD temperature accuracy estimate from D. Kirkby in DESI-5315
- Could shrink these residuals slightly by restricting to subset of pixels with relatively low values in master dark

Null tests on darks



- Would be better to do this using only darks that didn't contribute to creation of the master dark or fitting of the dark current temperature dependence

- This doesn't really test anything about the flat field correction

Analysis details

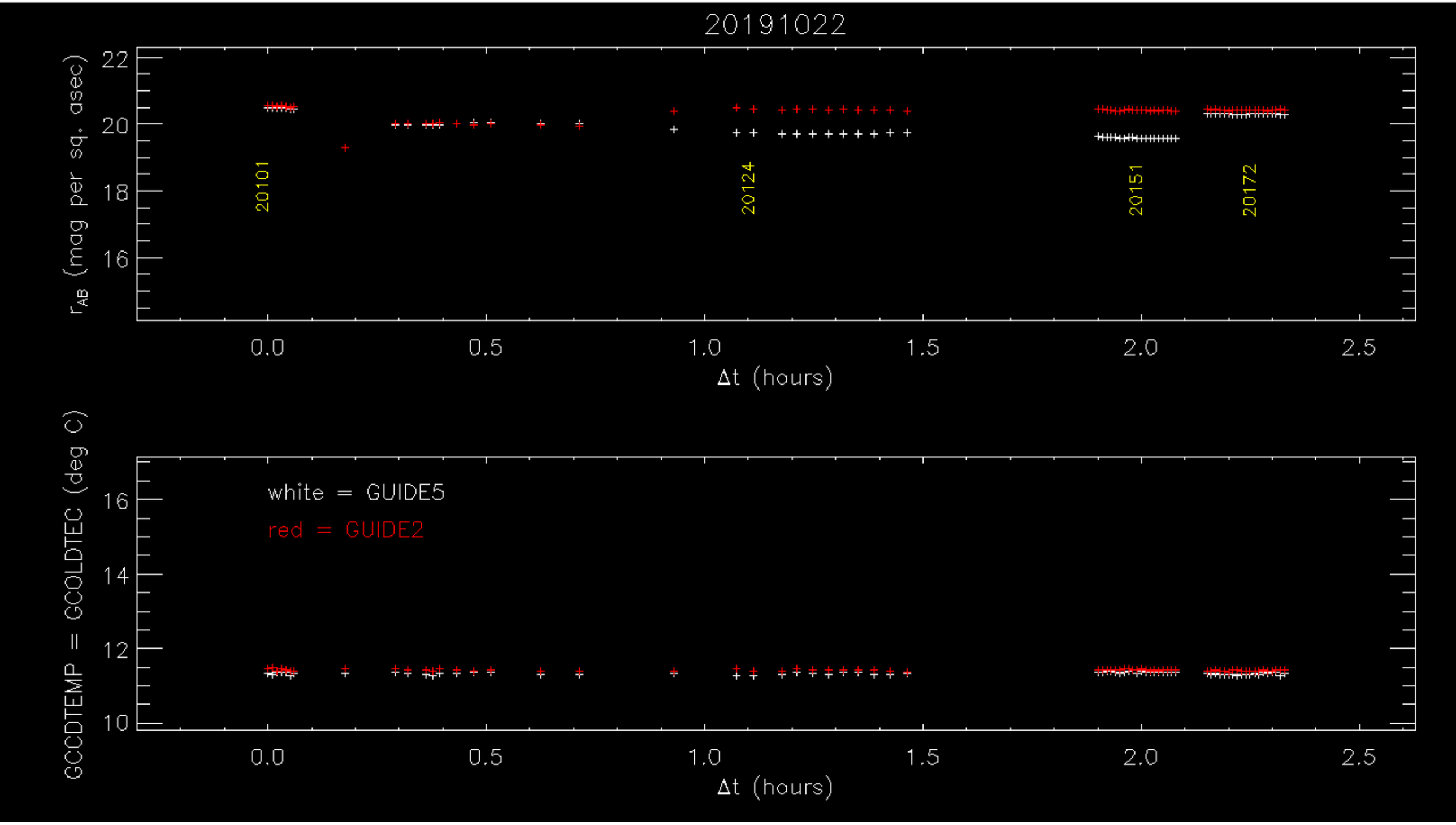
- Analyze all flavor=science gfa*.fits.fz exposures from nights 20191022-20191117

- For now use GUIDE2 and GUIDE5 only, since I seem to be detrending those much better than the other guide cameras

- Filter out e.g., dome screen data by requiring a good astrometric solution (contrast > 2)

Results

- Summary FITS file:
    - /project/projectdirs/desi/users/ameisner/GFA/files/skymags-prelim.fits
    - /project/projectdirs/desi/users/ameisner/GFA/files/skymags-prelim.README
- The following plots show all sky brightness measurements on a per night basis, restricted to images with successful astrometric solutions (contrast > 2)


20191022
r_{AB} (mag per sq. asec)
22
20
18
16
20101
20124
20151
20172
0.0
0.5
1.0
1.5
2.0
2.5
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
white = GUIDE5
red = GUIDE2
16
14
12
10
0.0
0.5
1.0
1.5
2.0
2.5
Δt (hours)

20191023

r_{AB} (mag per sq. asec)

22
20
18
16

20254
20275
20373
20416
20458
20499
20539
20570
20593
20631

0
2
4
6
8

Δt (hours)

GCCDTEMP = GCOLDTEC (deg C)

white = GUIDE5
red = GUIDE2

16
14
12
10

0
2
4
6
8

Δt (hours)

20191024

r_{AB} (mag per sq. asec)

22
20
18
16

20682
20714
20748
20791
20833
20868
20917
20938

0
2
4
6
8

Δt (hours)

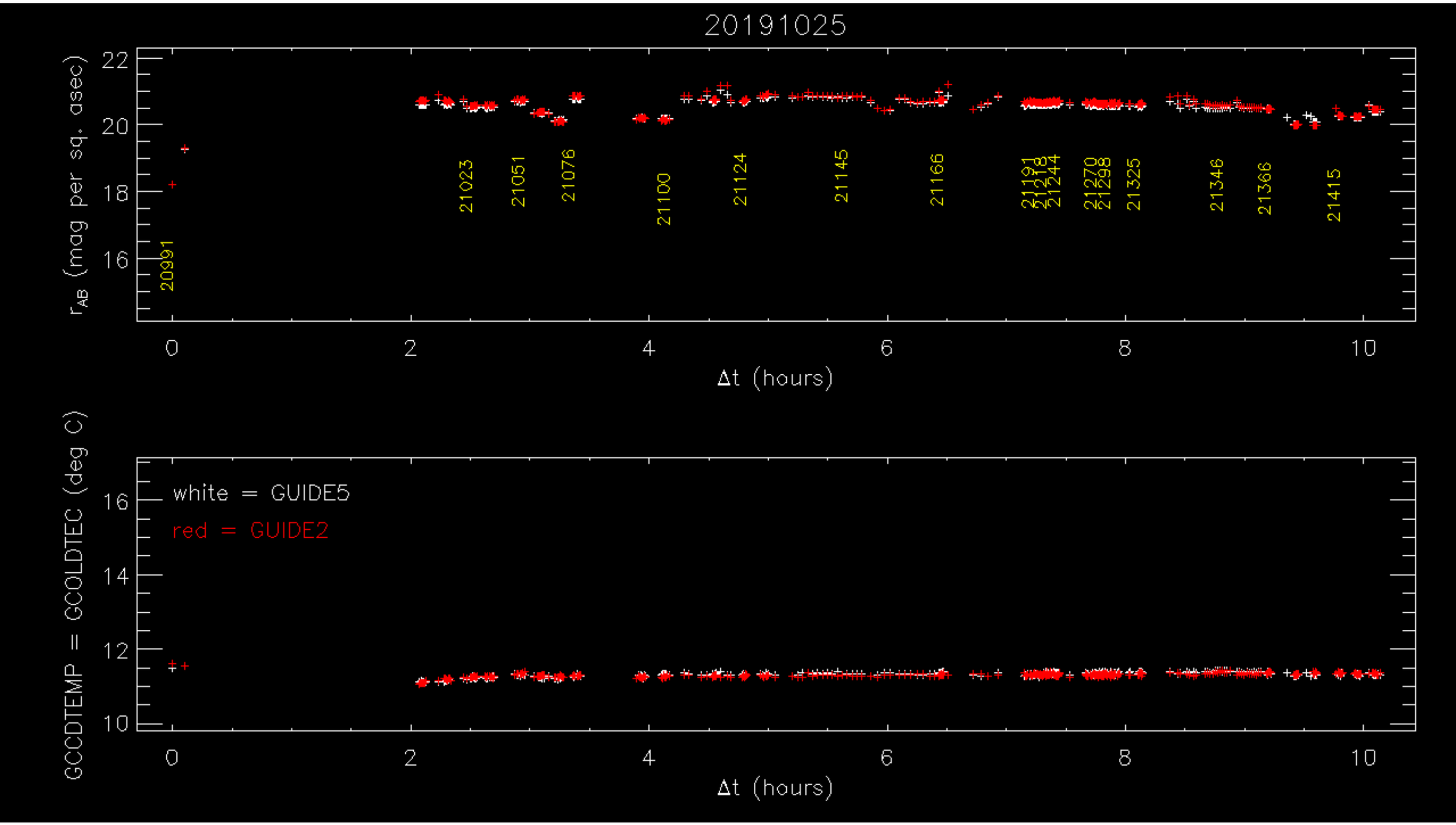
GCCDTEMP = GCOLDTEC (deg C)

16
14
12
10

white = GUIDE5
red = GUIDE2

0
2
4
6
8

Δt (hours)


20191025
r_{AB} (mag per sq. asec)
22
20
18
16
20991
21023
21051
21076
21100
21124
21145
21166
21191
21218
21244
21270
21298
21325
21346
21366
21415
0
2
4
6
8
10
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
white = GUIDE5
red = GUIDE2
16
14
12
10
0
2
4
6
8
10
Δt (hours)

20191026

r_{AB} (mag per sq. asec)

22
20
18
16

21531
21558
21581
21601
21622
21642
21664
21710
21730
21750

0
2
4
6

Δt (hours)

GCCDTEMP = GCOLDTEC (deg C)

white = GUIDE5
red = GUIDE2

16
14
12
10

0
2
4
6

Δt (hours)

20191028

r_{AB} (mag per sq. asec)

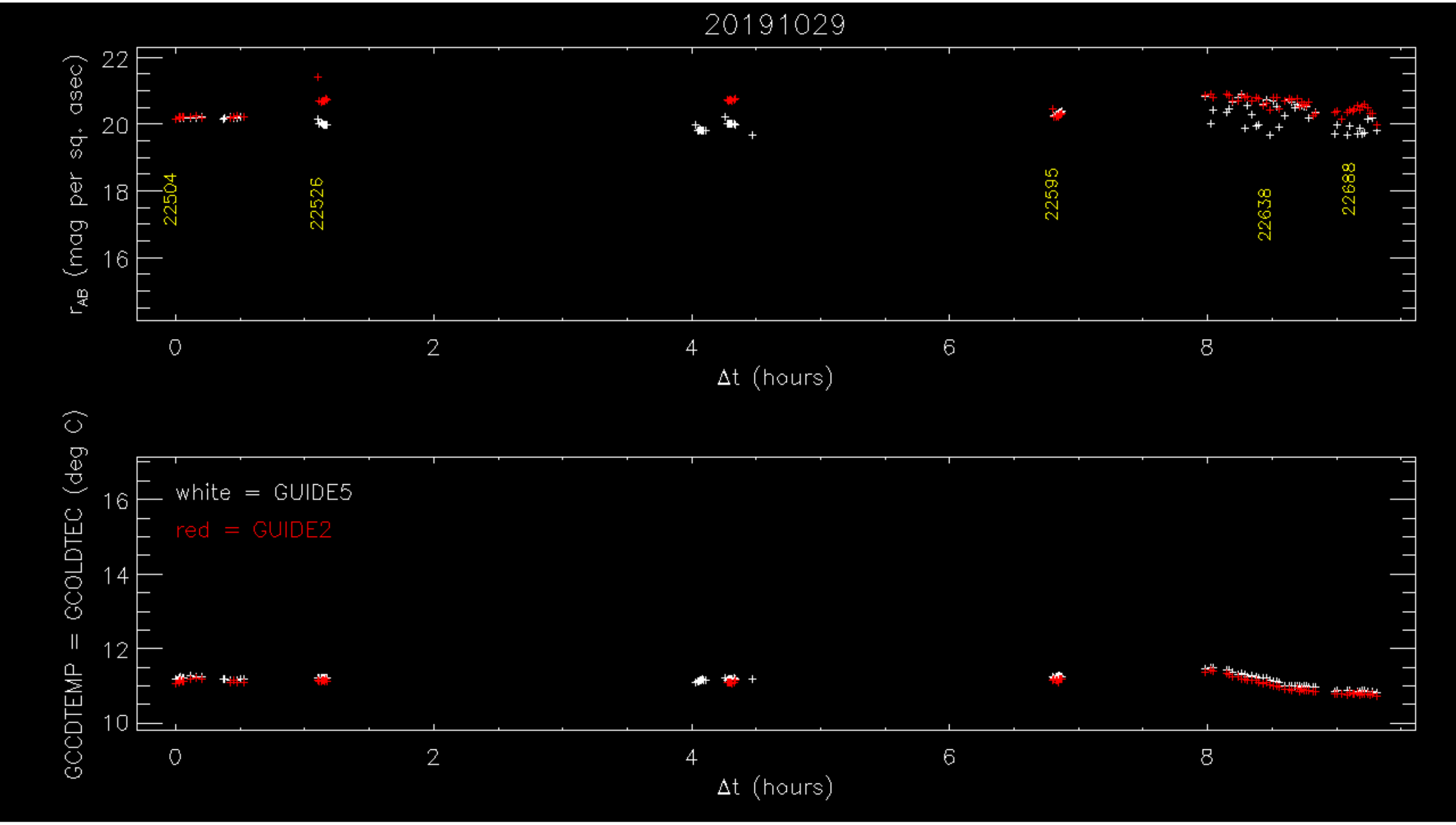
22269 22333 22370 22392 22414

Δt (hours)

white = GUIDE5
red = GUIDE2

GCCDTEMP = GCOLDTEC (deg C)

Δt (hours)


20191029
r_{AB} (mag per sq. asec)
22
20
18
16
22504
22526
22595
22638
22688
0
2
4
6
8
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
white = GUIDE5
red = GUIDE2
16
14
12
10
0
2
4
6
8
Δt (hours)

20191030

r_{AB} (mag per sq. asec)

22785
22811
22909
22933
22956
22979
23003
23026
23051
23080
23120
23164

Δt (hours)

white = GUIDE5
red = GUIDE2

GCCDTEMP = GCOLDTEC (deg C)

Δt (hours)

20191031

r_{AB} (mag per sq. asec)

22
20
18
16

23204
23240
23264
23299
23341
23378
23399
23421

0
2
4
6
8

Δt (hours)

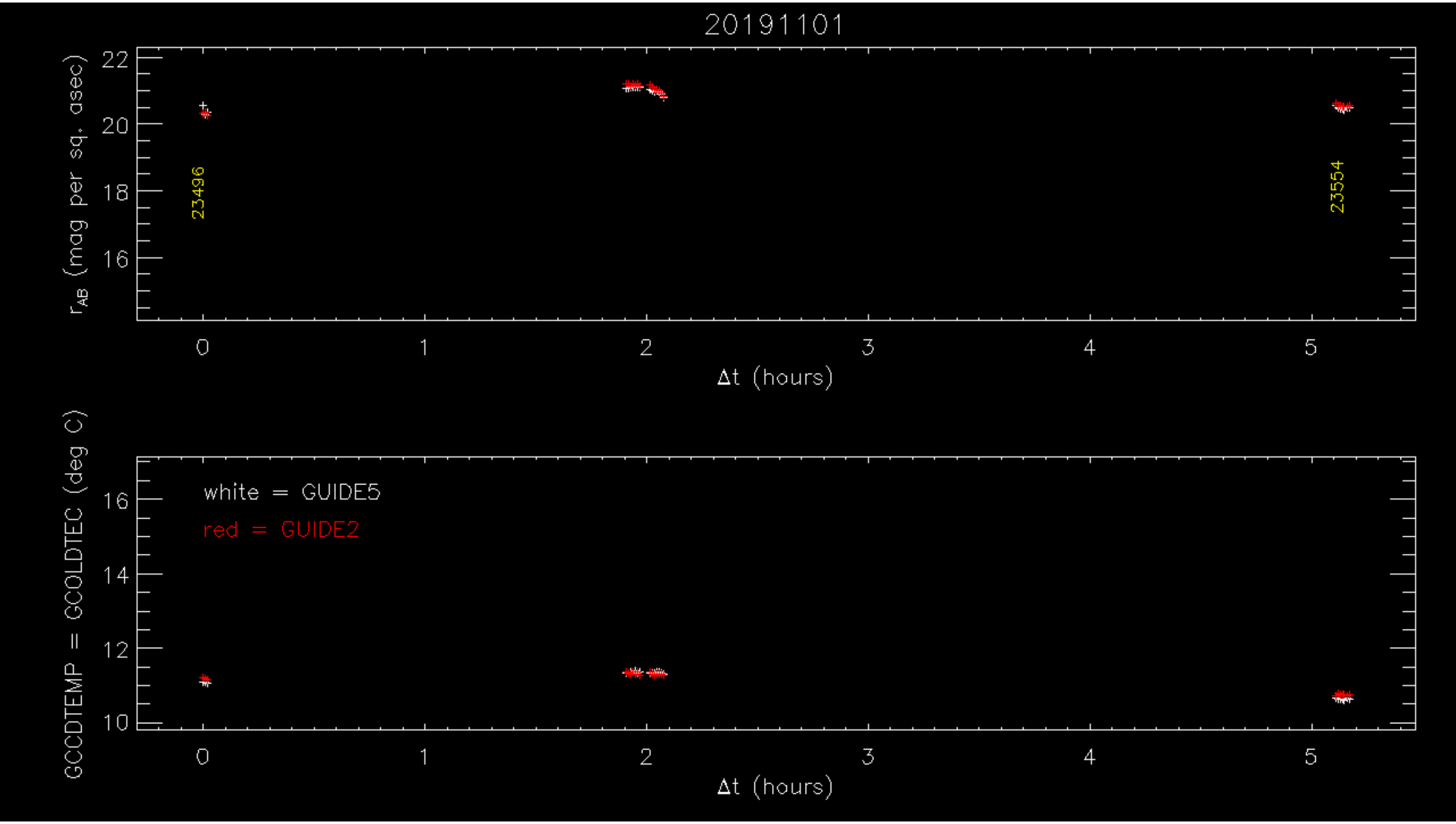
GCCDTEMP = GCOLDTEC (deg C)

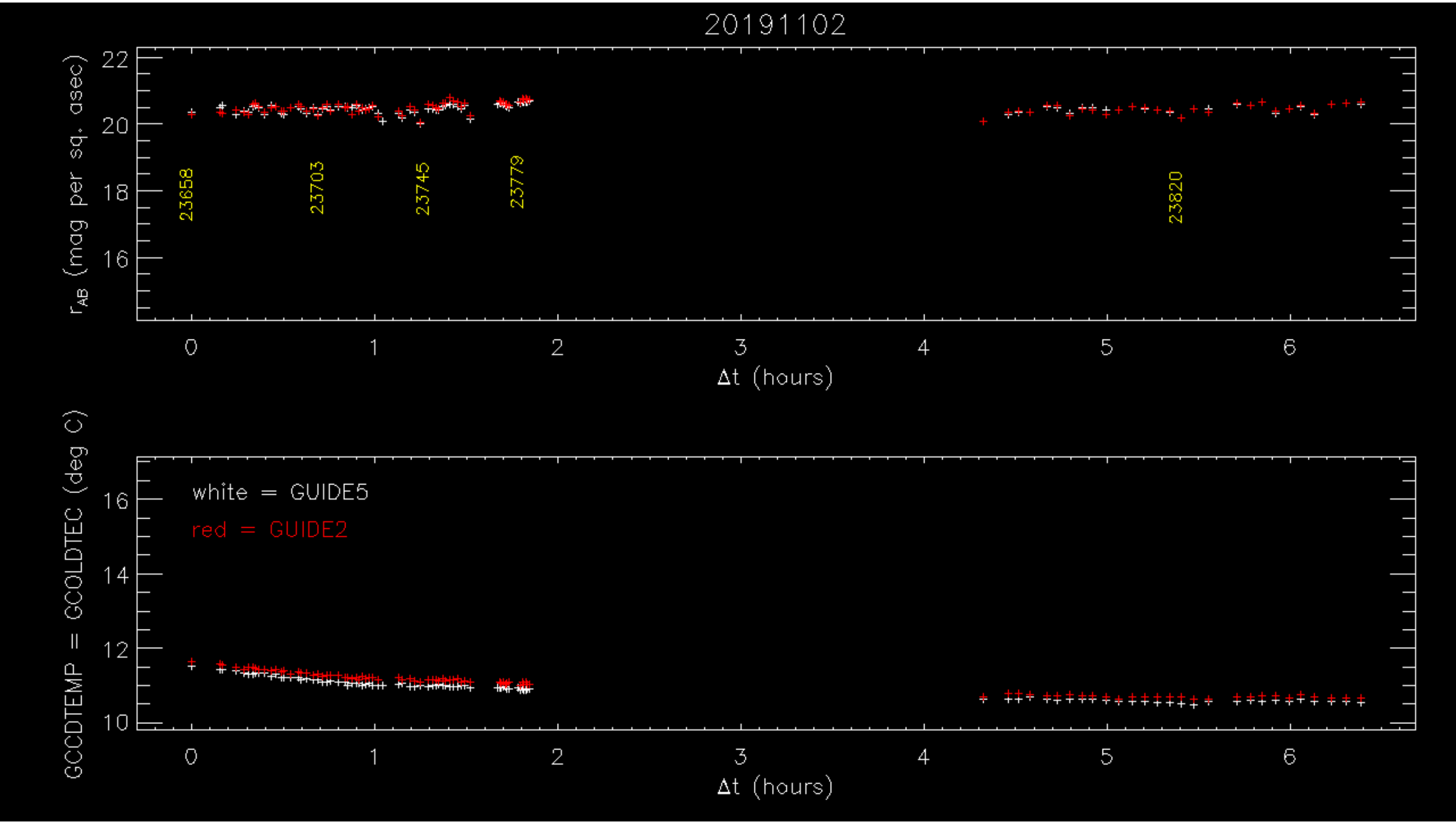
white = GUIDE5
red = GUIDE2

16
14
12
10

0
2
4
6
8

Δt (hours)


20191101
r_{AB} (mag per sq. asec)
22
20
18
16
23496
23554
0
1
2
3
4
5
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
white = GUIDE5
red = GUIDE2
16
14
12
10
0
1
2
3
4
5
Δt (hours)


20191102
r_{AB} (mag per sq. asec)
22
20
18
16
23658
23703
23745
23779
23820
0
1
2
3
4
5
6
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
white = GUIDE5
red = GUIDE2
16
14
12
10
0
1
2
3
4
5
6
Δt (hours)

20191103

r_{AB} (mag per sq. asec)

22
20
18
16

23857
23880
23900
23920
23964
23991
24038
24078
24118

0 2 4 6 8 10

Δt (hours)

GCCDTEMP = GCOLDTEC (deg C)

white = GUIDE5
red = GUIDE2

16
14
12
10

0 2 4 6 8 10

Δt (hours)

20191104

r_{AB} (mag per sq. asec)

22
20
18
16

24263
24322
24362
24399

0 1 2 3 4 5

Δt (hours)

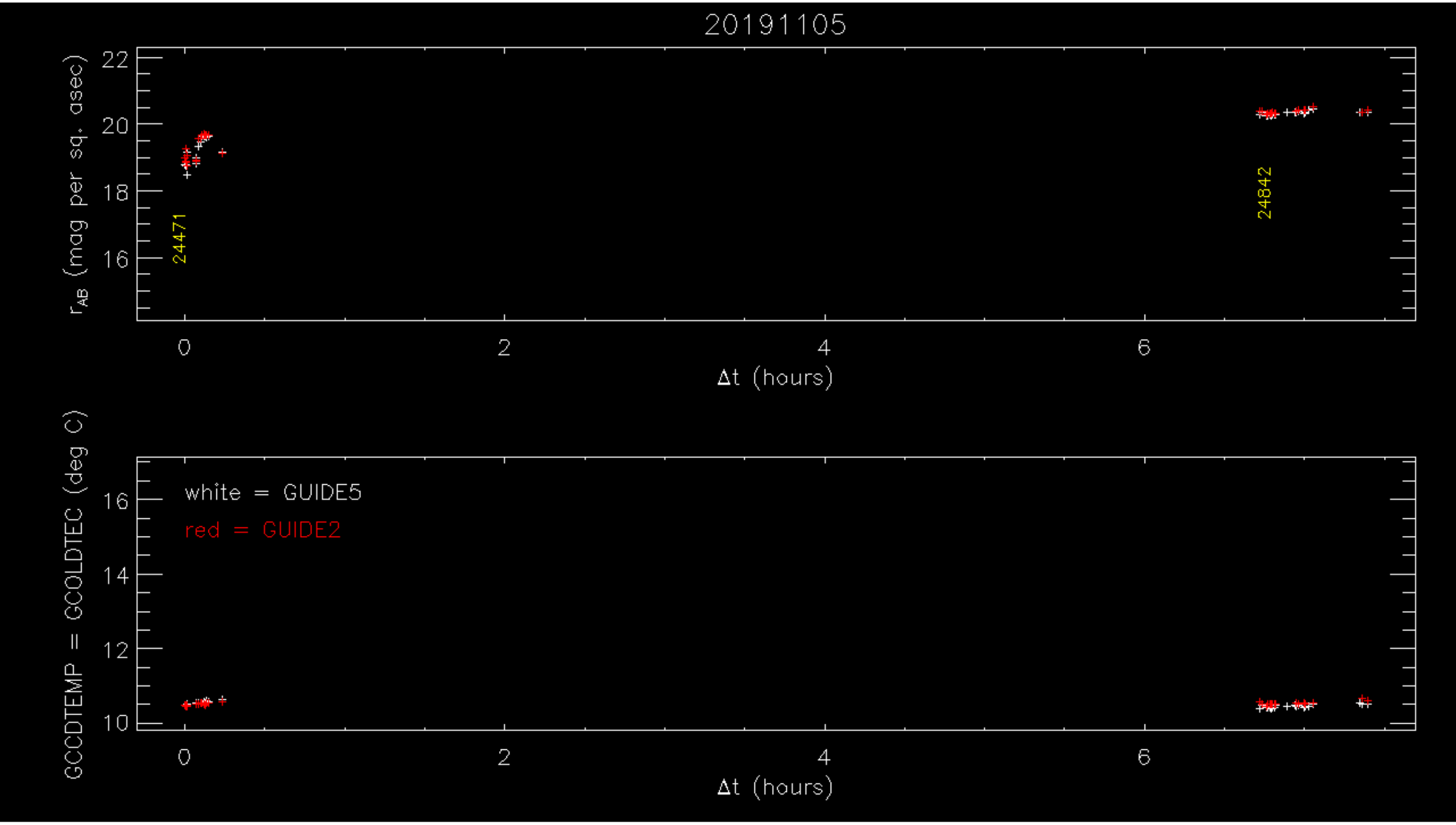
GCCDTEMP = GCOLDTEC (deg C)

16
14
12
10

white = GUIDE5
red = GUIDE2

0 1 2 3 4 5

Δt (hours)


20191105
r_{AB} (mag per sq. asec)
22
20
18
16
24471
24842
0
2
4
6
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
16
14
12
10
white = GUIDE5
red = GUIDE2
0
2
4
6
Δt (hours)

20191106

r_{AB} (mag per sq. asec)

22
20
18
16

24927
24981
25026
25056
25154
25176

0
2
4
6
8

Δt (hours)

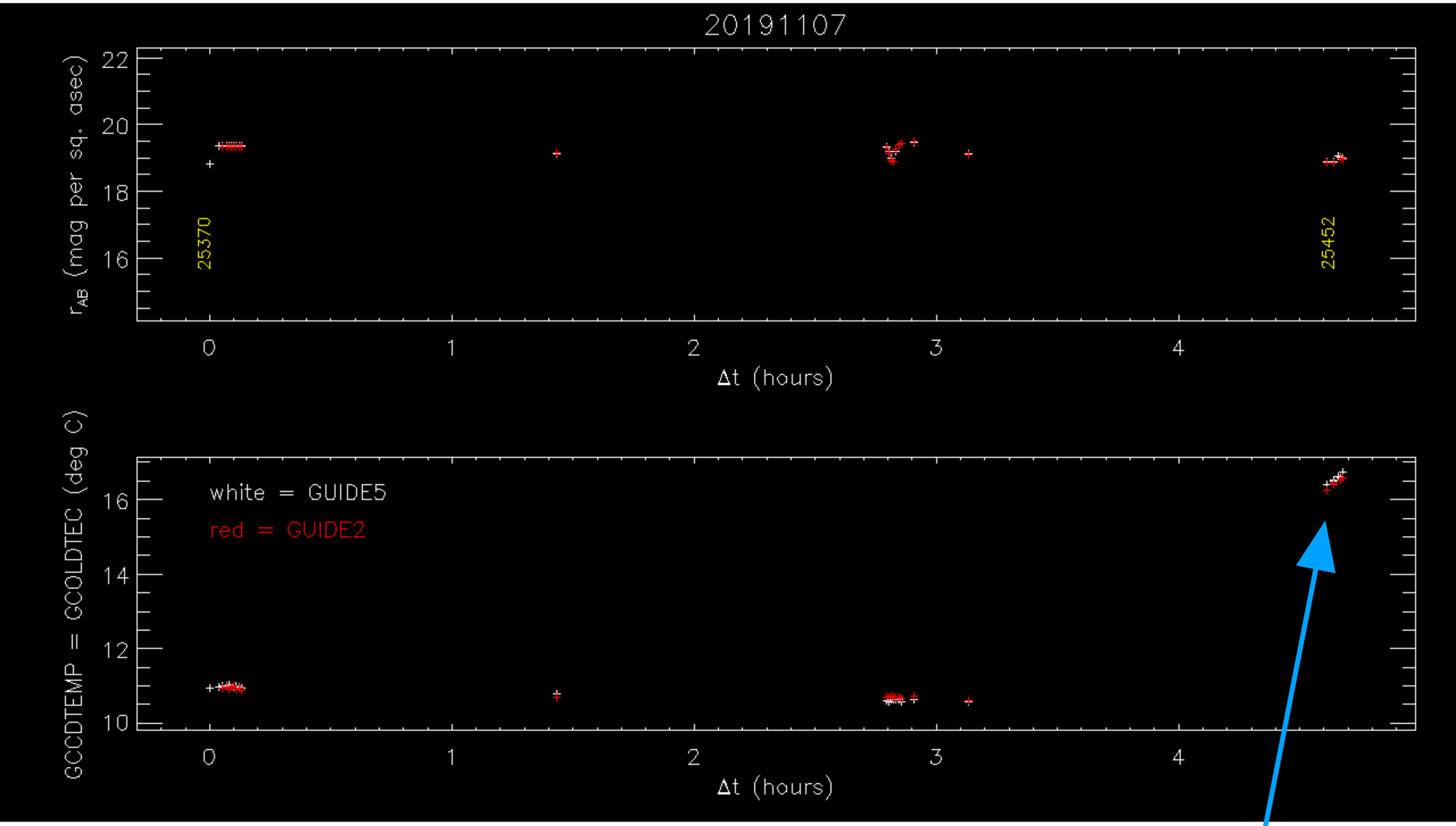
GCCDTEMP = GCOLDTEC (deg C)

16
14
12
10

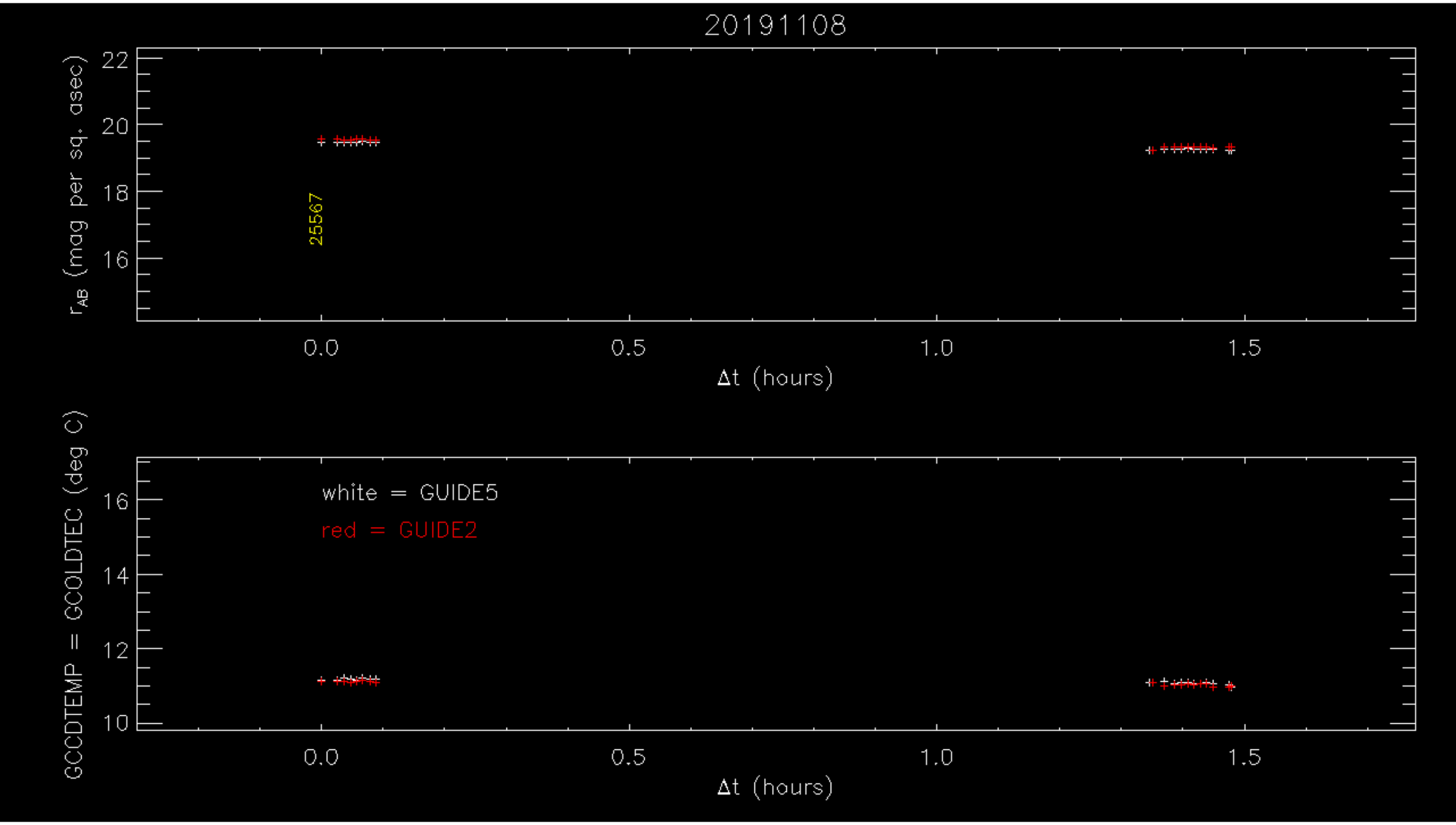
white = GUIDE5
red = GUIDE2

0
2
4
6
8

Δt (hours)



unusually high GFA CCD temperatures; corresponding sky estimate not obviously unreasonable


20191108
r_{AB} (mag per sq. asec)
22
20
18
16
25567
0.0
0.5
1.0
1.5
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
16
14
12
10
white = GUIDE5
red = GUIDE2
0.0
0.5
1.0
1.5
Δt (hours)

20191109

r_{AB} (mag per sq. asec)

22
20
18
16

25669

25803

0
2
4
6
8

Δt (hours)

GCCDTEMP = GCOLDTEC (deg C)

16
14
12
10

white = GUIDE5

red = GUIDE2

0
2
4
6
8

Δt (hours)

20191111

r_{AB} (mag per sq. asec)

22
20
18
16

27088
27118
27159
27191
27243
27303

0
2
4
6
8

Δt (hours)

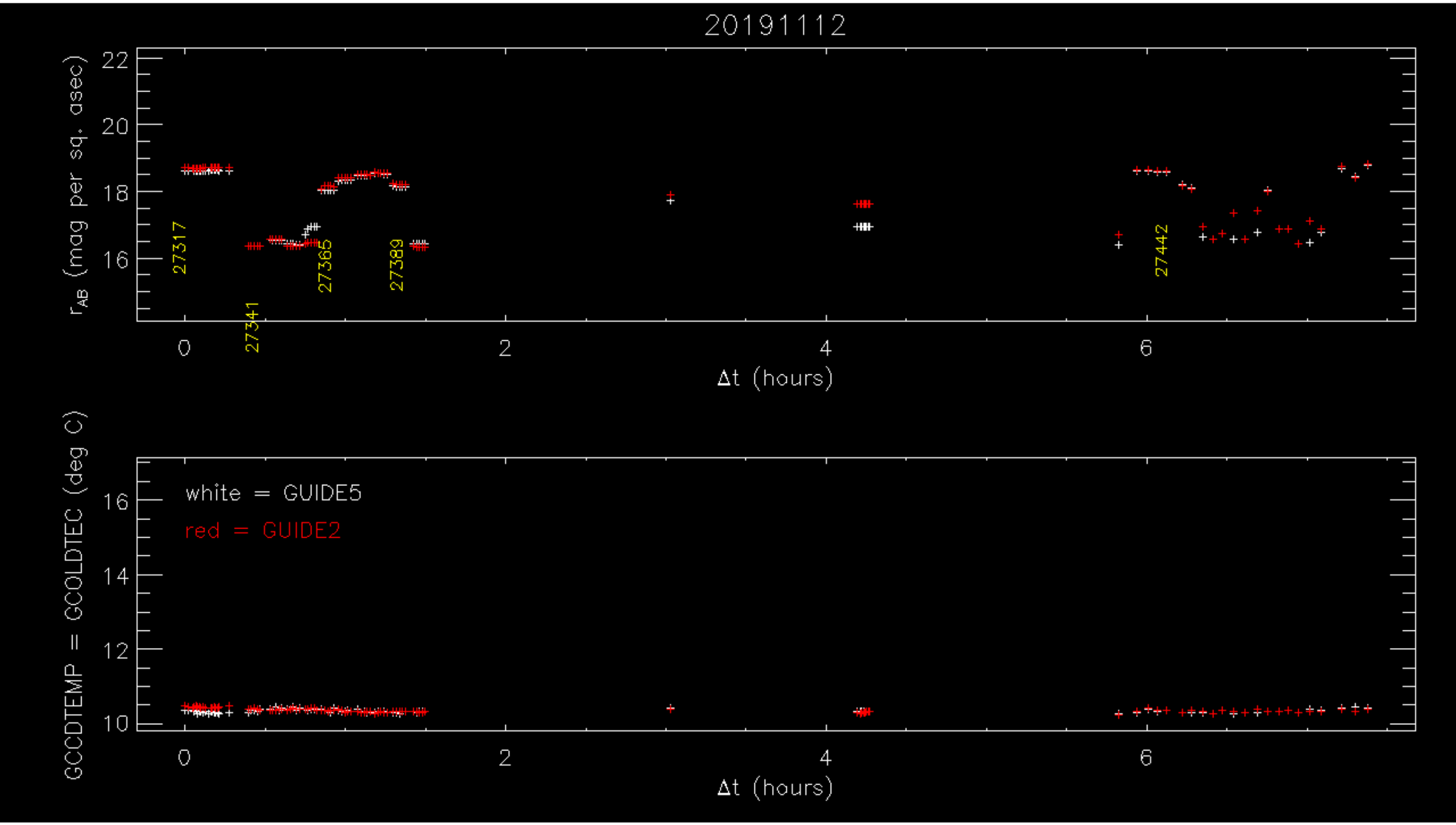
GCCDTEMP = GCOLDTEC (deg C)

white = GUIDE5
red = GUIDE2

16
14
12
10

0
2
4
6
8

Δt (hours)


20191112
r_{AB} (mag per sq. asec)
22
20
18
16
27317
27341
27365
27389
27442
0
2
4
6
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
16
14
12
10
white = GUIDE5
red = GUIDE2
0
2
4
6
Δt (hours)

20191113

r_{AB} (mag per sq. asec)

22
20
18
16

27540
27579
27631
27664

0 2 4 6 8 10

Δt (hours)

GCCDTEMP = GCOLDTEC (deg C)

16
14
12
10

white = GUIDE5
red = GUIDE2

0 2 4 6 8 10

Δt (hours)

20191114

r_{AB} (mag per sq. asec)

22
20
18
16

27673
27704
27732
27758
27795
27835
27875
27915
27954
27977

0
2
4
6

Δt (hours)

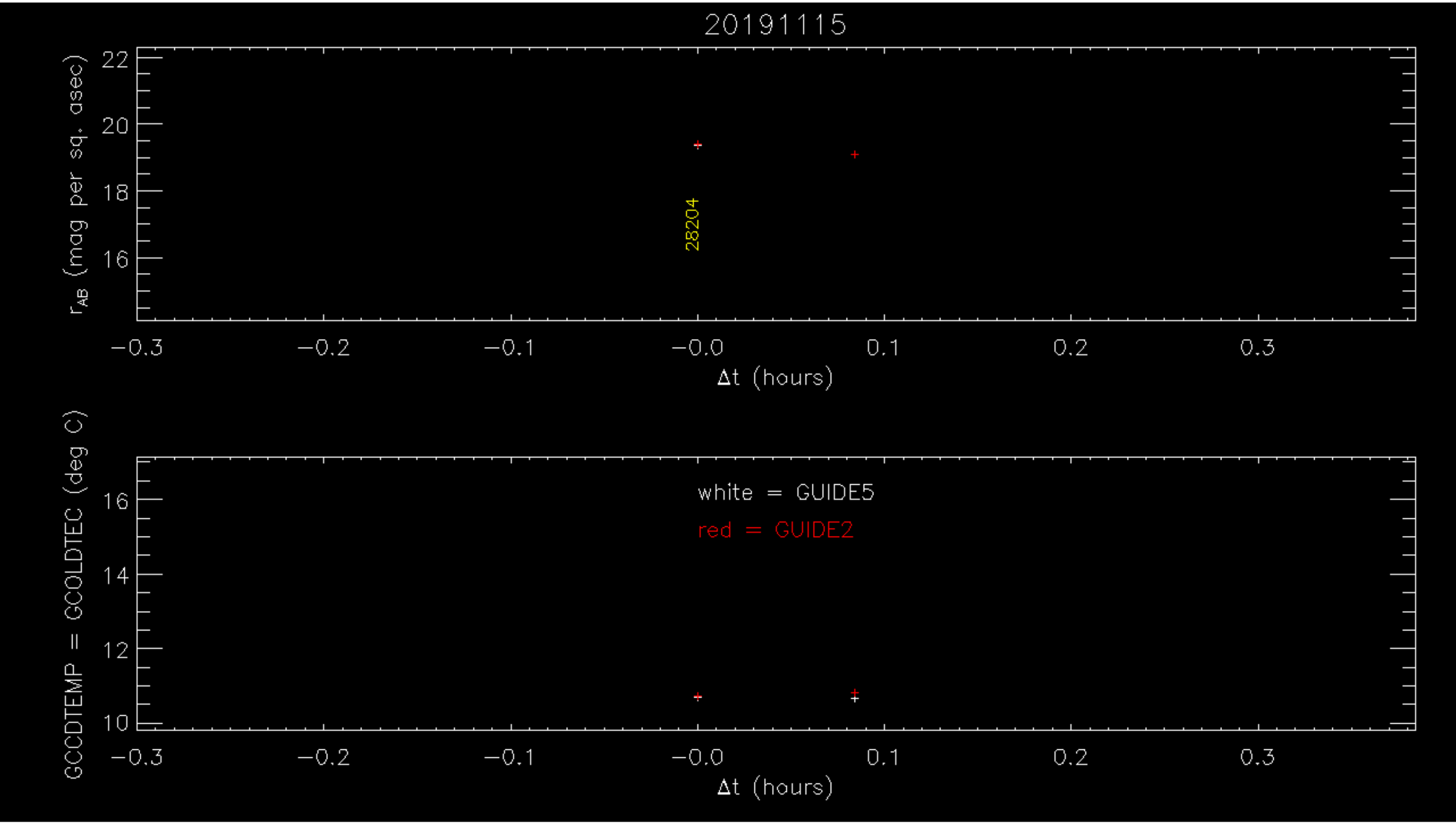
GCCDTEMP = GCOLDTEC (deg C)

white = GUIDE5
red = GUIDE2

16
14
12
10

0
2
4
6

Δt (hours)


20191115
r_{AB} (mag per sq. asec)
22
20
18
16
28204
−0.3
−0.2
−0.1
−0.0
0.1
0.2
0.3
Δt (hours)
GCCDTEMP = GCOLDTEC (deg C)
16
14
12
10
white = GUIDE5
red = GUIDE2
−0.3
−0.2
−0.1
−0.0
0.1
0.2
0.3
Δt (hours)

20191116

r_{AB} (mag per sq. asec)

22
20
18
16

28524
28554
28576
28599
28622
28644
28667
28690
28712
28737
28773
28811
28851
28890

0
2
4
6

Δt (hours)

GCCDTEMP = GCOLDTEC (deg C)

white = GUIDE5
red = GUIDE2

16
14
12
10

0
2
4
6

Δt (hours)

20191117

r_{AB} (mag per sq. asec)

22
20
18
16

28979
29012
29074
29115
29155
29196
29227
29247
29269

0
2
4
6
8

Δt (hours)

GCCDTEMP = GCOLDTEC (deg C)

white = GUIDE5
red = GUIDE2

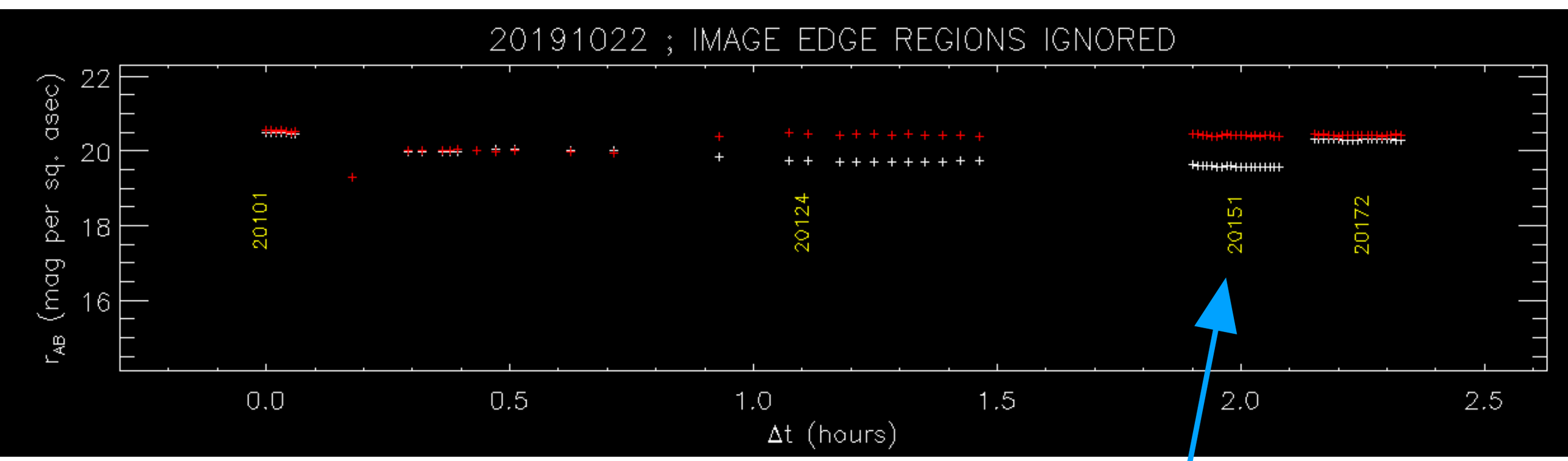
16
14
12
10

0
2
4
6
8

Δt (hours)

What causes camera to camera disagreements?

- Bottom panels in the previous plots do not indicate to me any clear link between GUIDE2 vs. GUIDE5 disagreements and reported CCD temperatures.



use this expid as an example of major disagreement; in this case GUIDE5 looks like its sky measurement is ~0.85 mag too bright, causing the discrepancy

Step-like background level discontinuity

in expid = 20151, GUIDE5 shows a step-like discontinuity of ~160 ADU starting at y = 1023-1024 and continuing until the top of the image, y = 1031, and spanning all columns in the image area of amps G, H

expid = 20151 ; GUIDE5 ; amps G, H ; raw data ; night = 20191022 ; exptime = 30 seconds

Step-like background level discontinuity

in expid = 20151 this step-like discontinuity in the image area is not correspondingly present in the overscan (or prescan); this is also the case for the other exposures showing such a discontinuity that I spot checked

expid = 20151 ; GUIDE5 ; amps G, H ; raw data ; night = 20191022 ; exptime = 30 seconds

Step-like background level discontinuity

using a sky value based on only the top 8 rows (1024 <= y <= 1031) would bring the GUIDE5 sky brightness measurement into good agreement with that of GUIDE2, and also with GUIDE5 sky brightness measurements from earlier/later in the night

expid = 20151 ; GUIDE5 ; amps G, H ; raw data ; night = 20191022 ; exptime = 30 seconds

Step-like background level discontinuity

this discontinuity is NOT present in GUIDE2 of the same exposure, although a weaker roll-off in the flat field can be seen in the very top few rows; flat field roll-off near the top of the image is a distinct behavior from the step-like discontinuity seen in GUIDE5, and the flat field roll-off gets corrected by the master flat during detrending

expid = 20151 ; GUIDE2 ; amps G, H ; raw data ; night = 20191022 ; exptime = 30 seconds

Step-like background level discontinuity

The step-like discontinuity is only sometimes present. Here's the upper portion of another GUIDE5 image from the same night and with the same exposure time, but with no such discontinuity.

expid = 20172 ; GUIDE5 ; amps G, H ; raw data ; night = 20191022 ; exptime = 30 seconds

Reversing Course

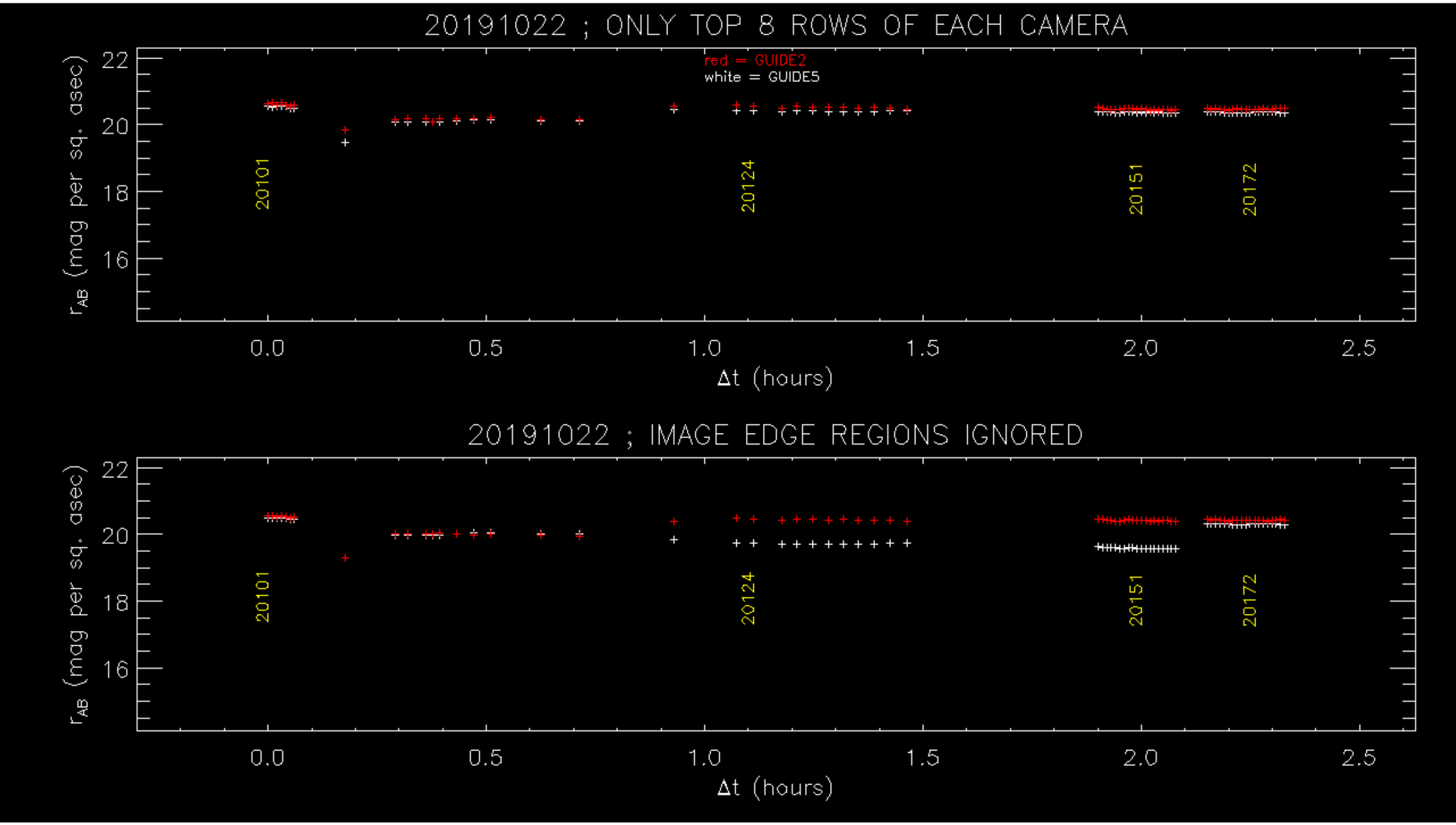
- Spot checking various other cases of anomalously bright sky brightness values suggests these would also be rectified by only using the top 8 rows to compute the sky level

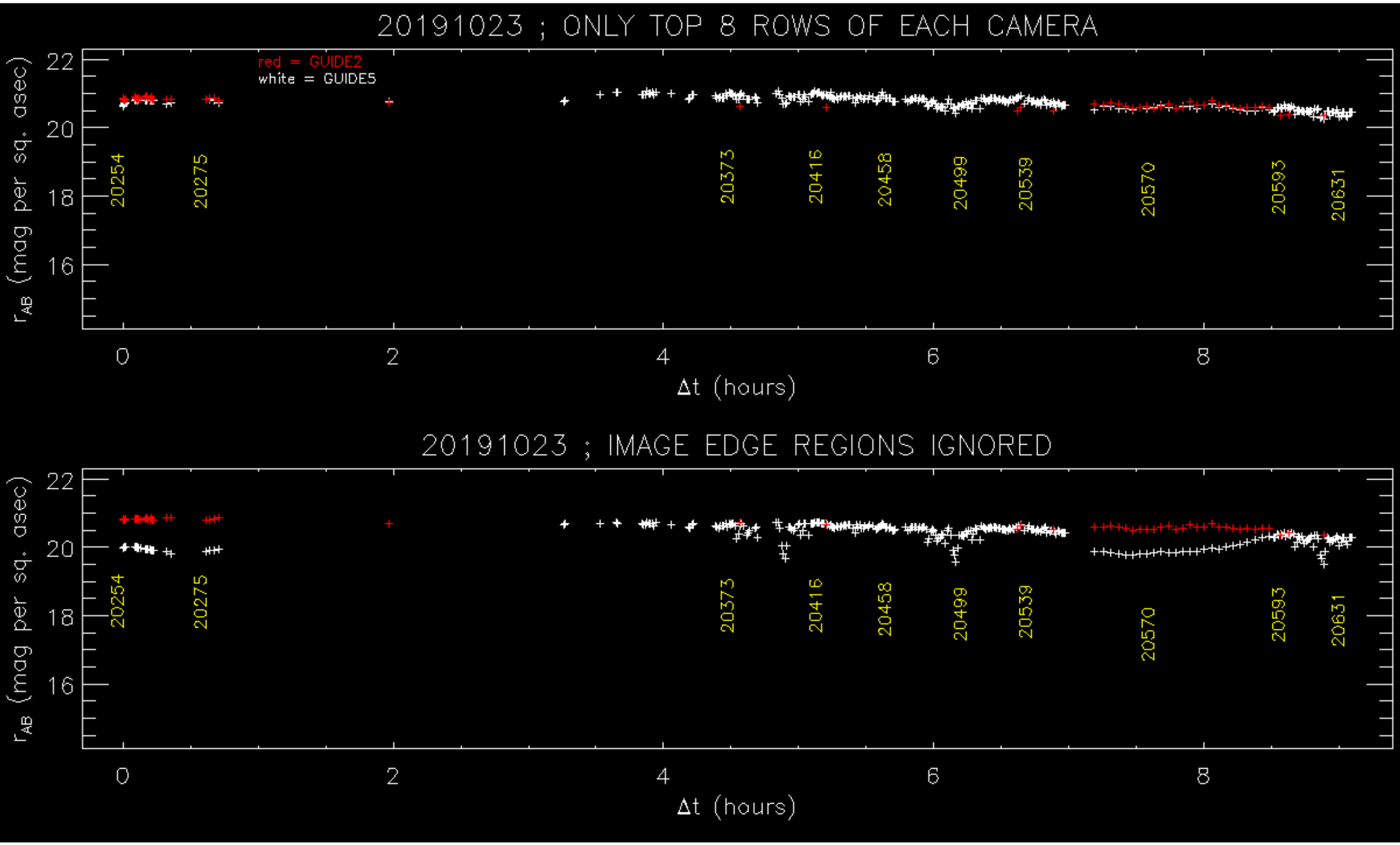
- What if I only use pixels very near the top of each GFA image (1024 <= y <= 1031) to measure the sky level, instead of using all pixels except those near the image edges?

- Comparison plots in the following slides: upper panel uses only top 8 rows, lower panel uses all pixels except those near image boundaries

- On the whole I would say that using just the top 8 rows provides a big improvement in camera to camera agreement

- I have labeled causes for a few of the remaining disagreements; some remaining camera to camera disagreement may be real e.g., under bright+cloudy conditions


20191022 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
20101
20124
20151
20172
0.0
0.5
1.0
1.5
2.0
2.5
Δt (hours)
20191022 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
20101
20124
20151
20172
0.0
0.5
1.0
1.5
2.0
2.5
Δt (hours)


20191023 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
20254
20275
20373
20416
20458
20499
20539
20570
20593
20631
0
2
4
6
8
Δt (hours)
20191023 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
20254
20275
20373
20416
20458
20499
20539
20570
20593
20631
0
2
4
6
8
Δt (hours)

20191024 ; ONLY TOP 8 ROWS OF EACH CAMERA

red = GUIDE2
white = GUIDE5

r_{AB} (mag per sq. asec)

22
20
18
16

20682
20714
20748
20791
20833
20868
20917
20938

0
2
4
6
8

Δt (hours)

20191024 ; IMAGE EDGE REGIONS IGNORED

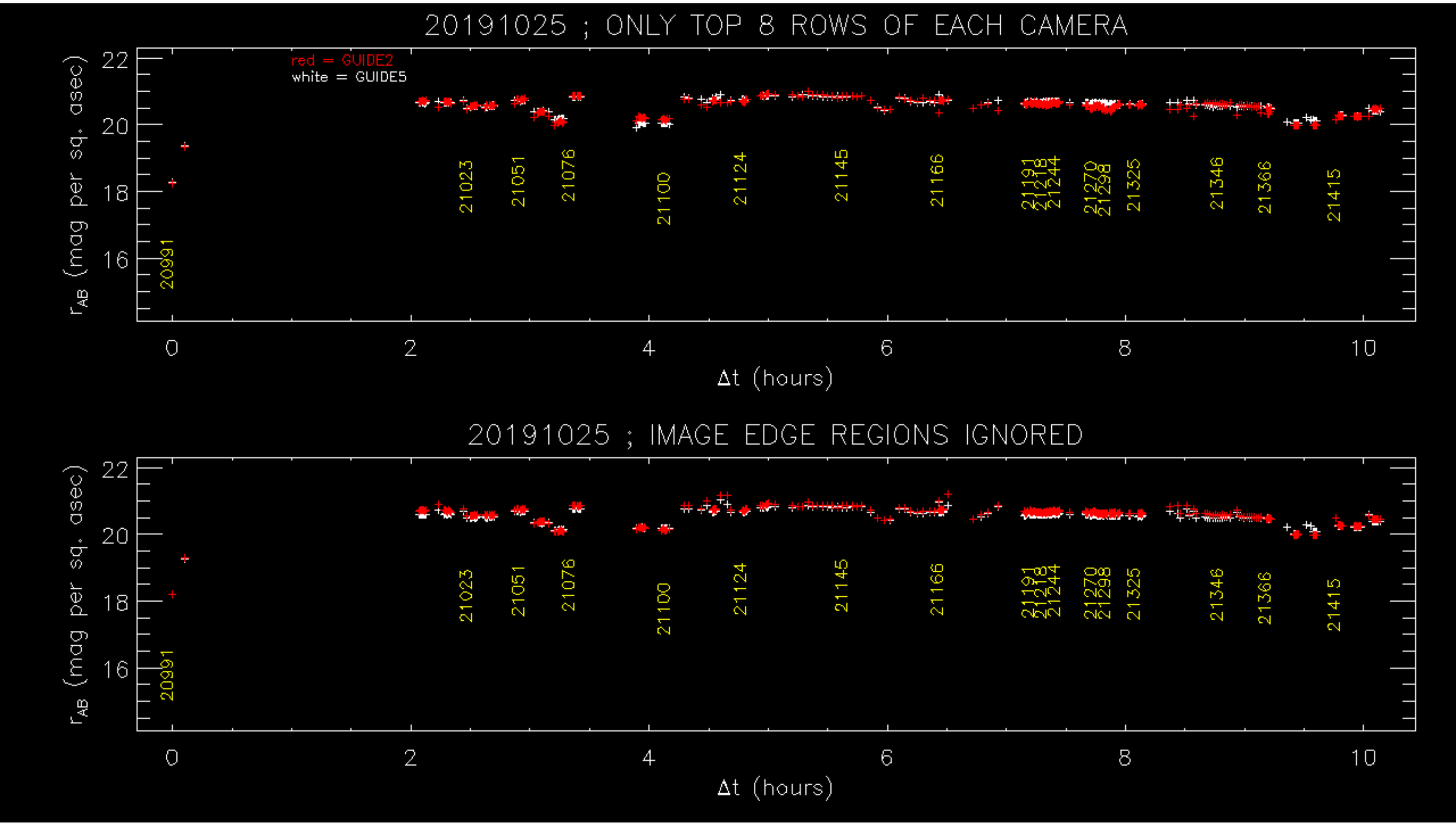
r_{AB} (mag per sq. asec)

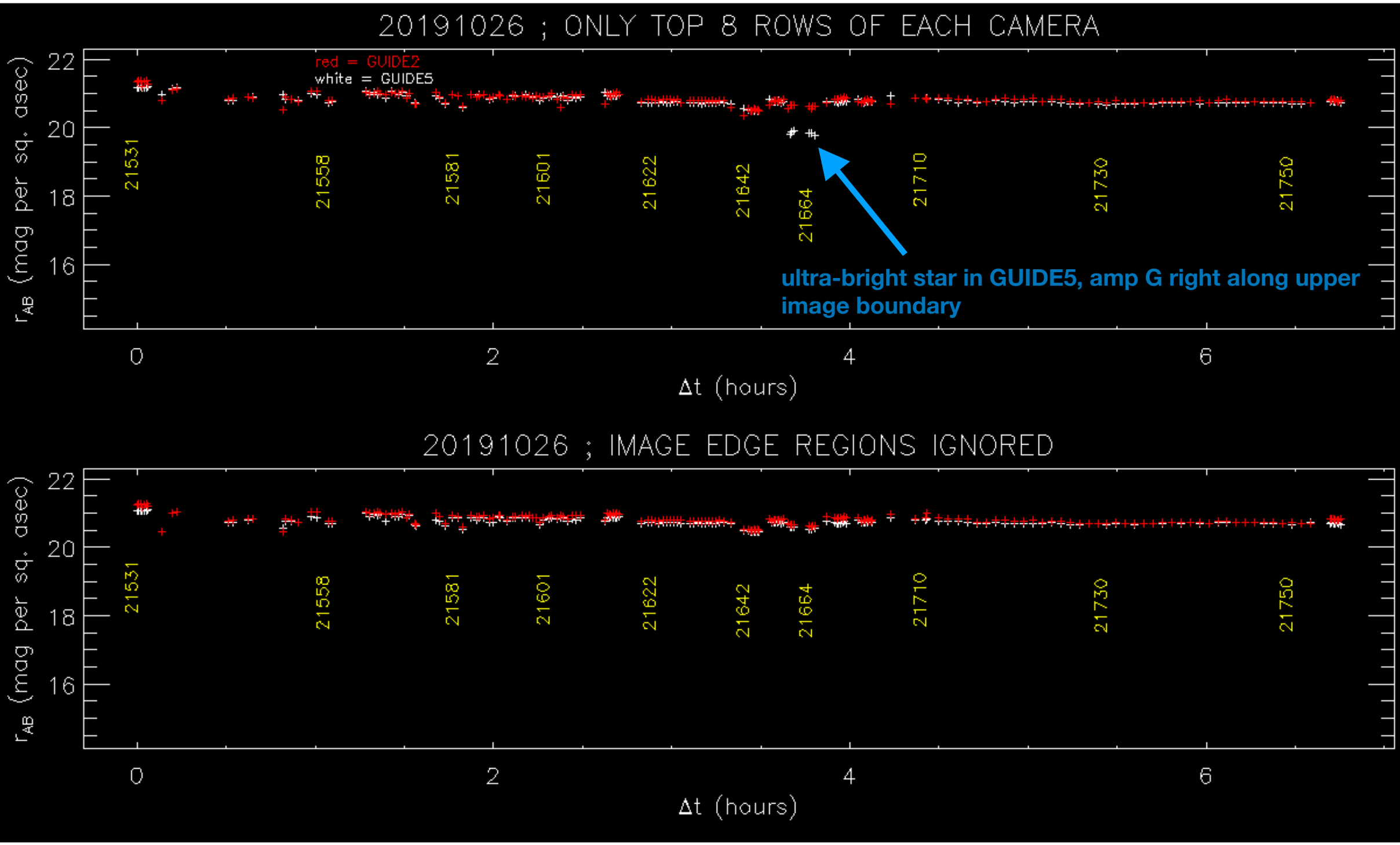
22
20
18
16

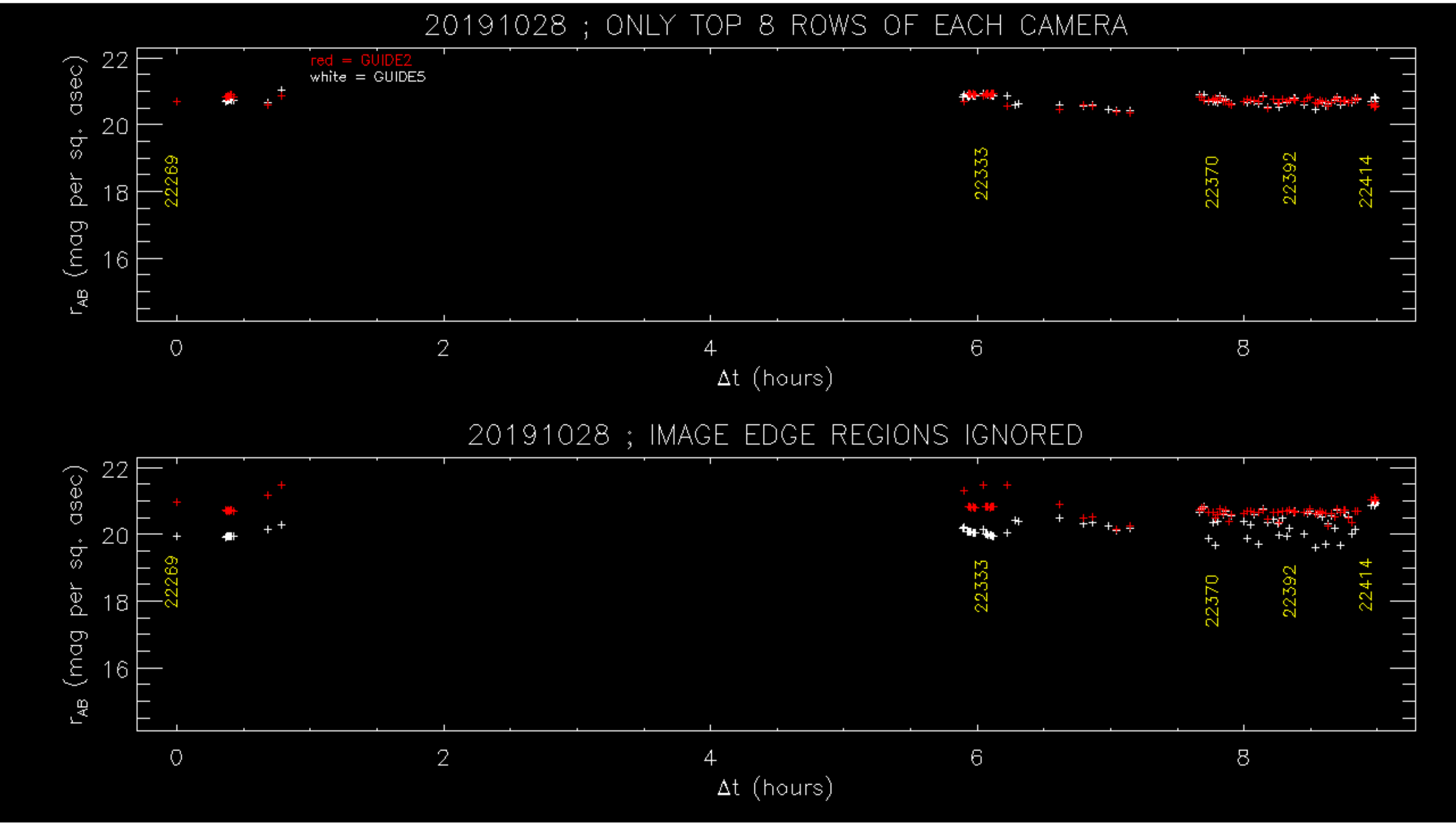
20682
20714
20748
20791
20833
20868
20917
20938

0
2
4
6
8

Δt (hours)


20191025 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
20991
21023
21051
21076
21100
21124
21145
21166
21191
21218
21244
21270
21298
21325
21346
21366
21415
0
2
4
6
8
10
Δt (hours)
20191025 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
20991
21023
21051
21076
21100
21124
21145
21166
21191
21218
21244
21270
21298
21325
21346
21366
21415
0
2
4
6
8
10
Δt (hours)


20191026 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
21531
21558
21581
21601
21622
21642
21664
21710
21730
21750
ultra-bright star in GUIDE5, amp G right along upper image boundary
0
2
4
6
Δt (hours)
20191026 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
21531
21558
21581
21601
21622
21642
21664
21710
21730
21750
0
2
4
6
Δt (hours)


20191028 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
22269
22333
22370
22392
22414
0
2
4
6
8
Δt (hours)
20191028 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
22269
22333
22370
22392
22414
0
2
4
6
8
Δt (hours)

20191029 ; ONLY TOP 8 ROWS OF EACH CAMERA

red = GUIDE2
white = GUIDE5

r_{AB} (mag per sq. asec)

22504 22526 22595 22638 22688

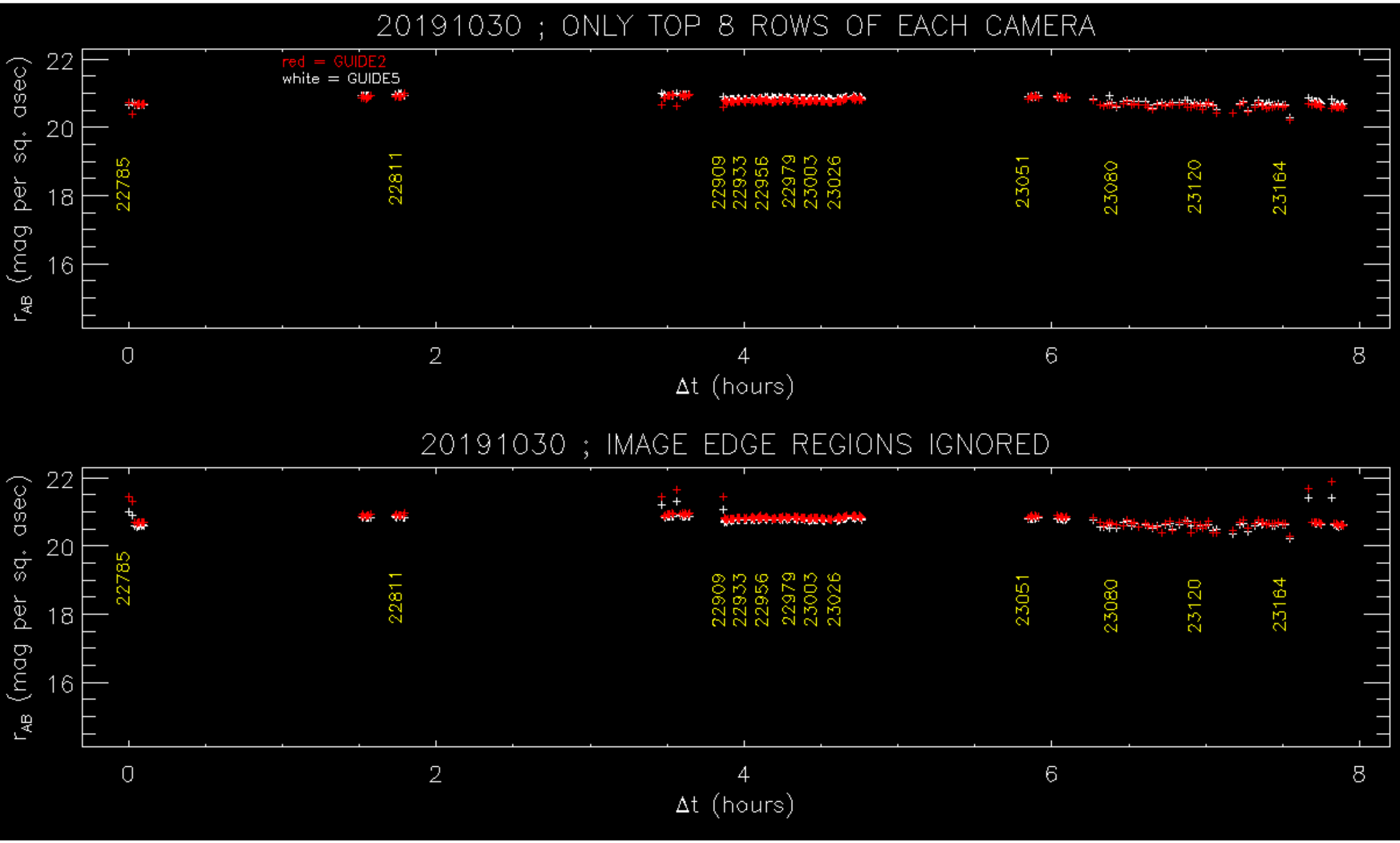
Δt (hours)

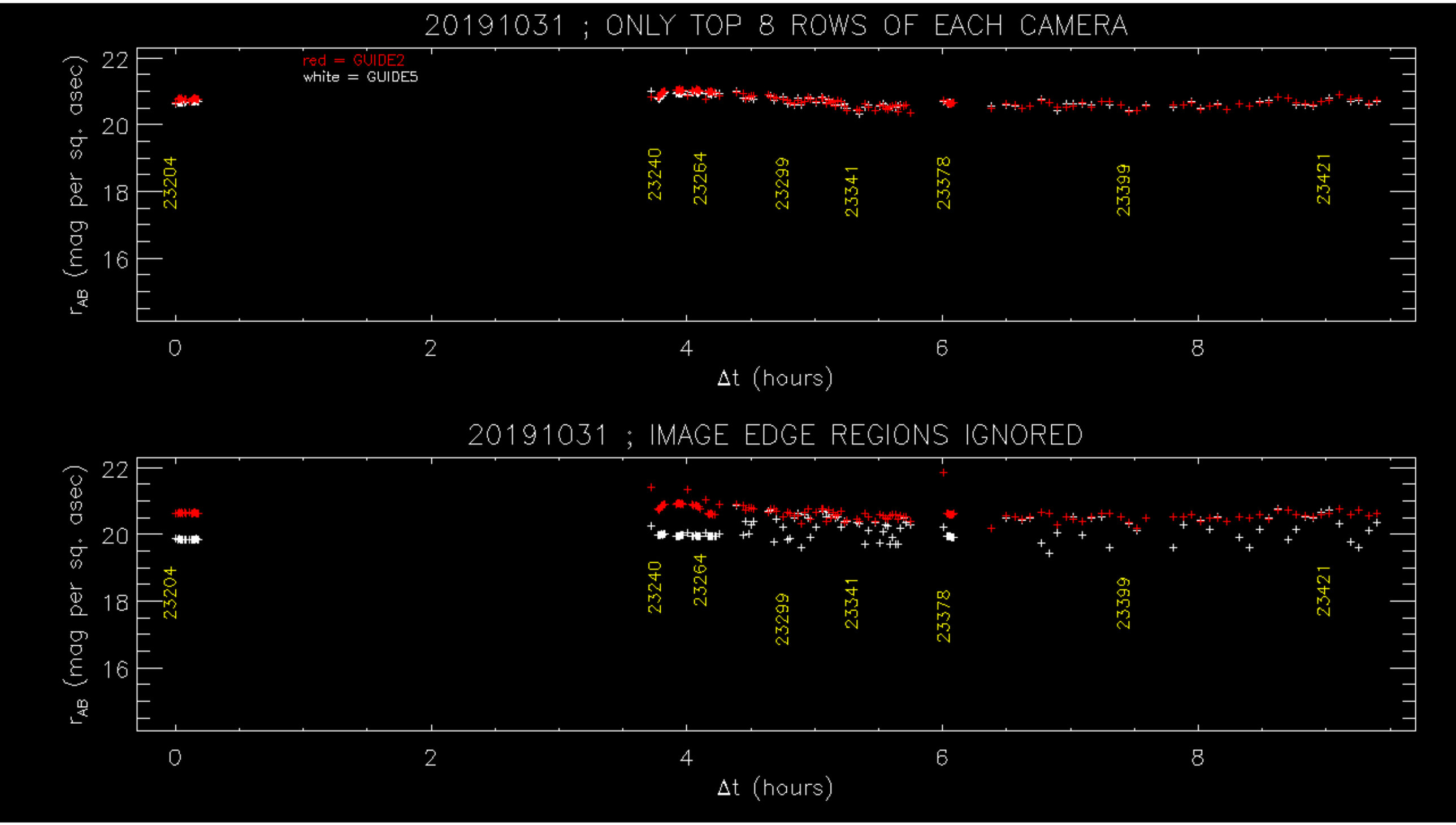
20191029 ; IMAGE EDGE REGIONS IGNORED

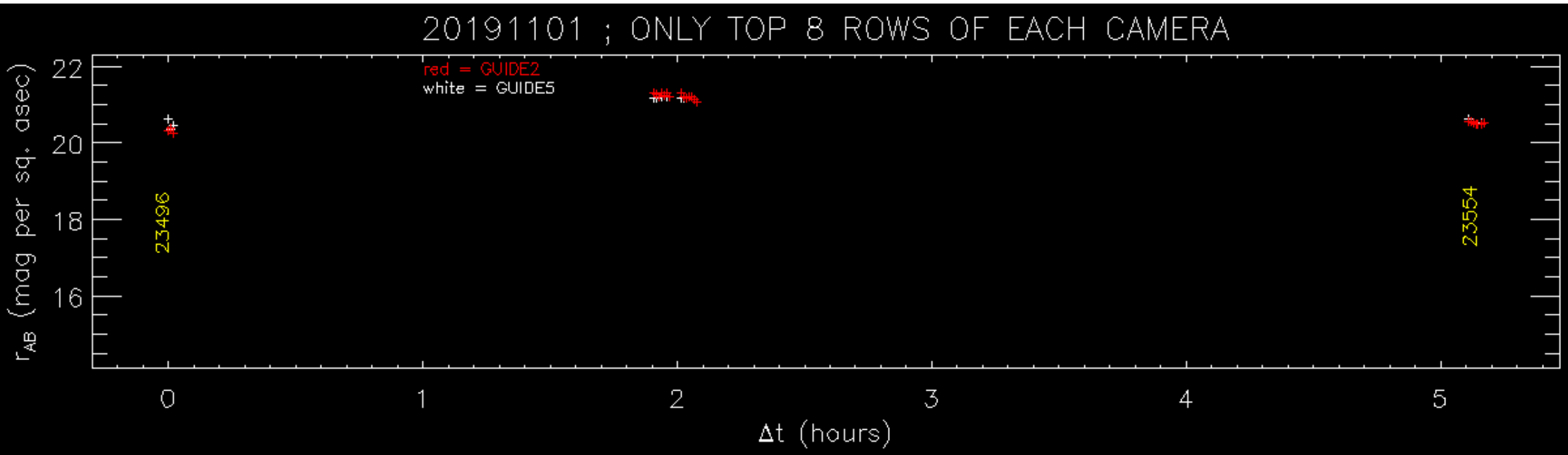
r_{AB} (mag per sq. asec)

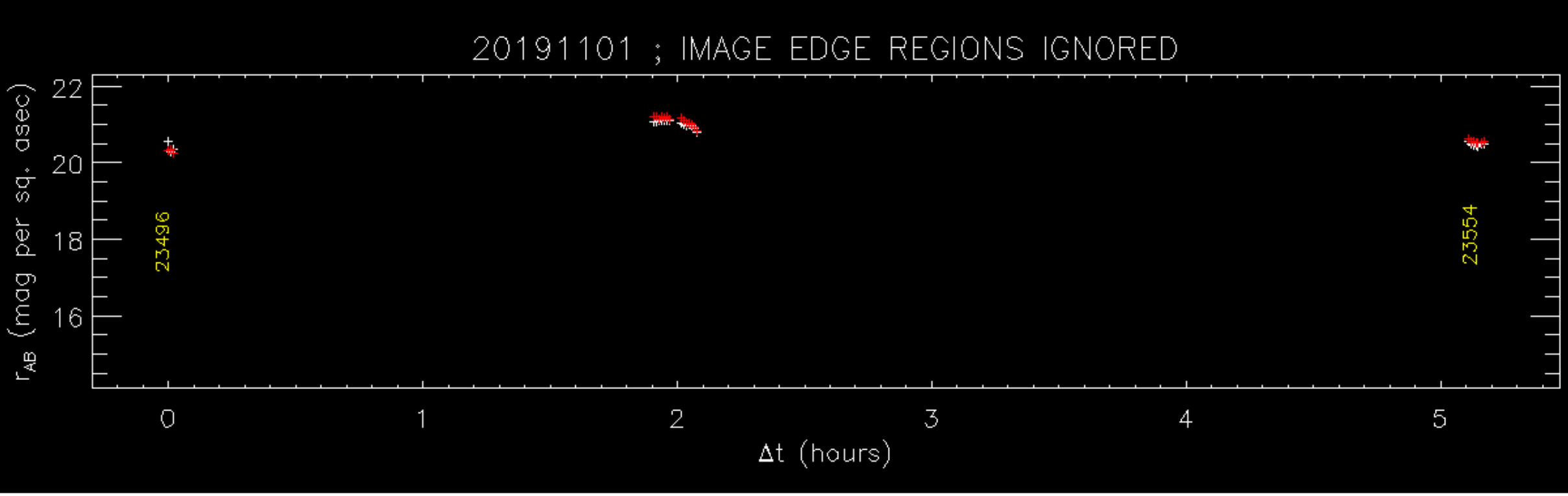
22504 22526 22595 22638 22688

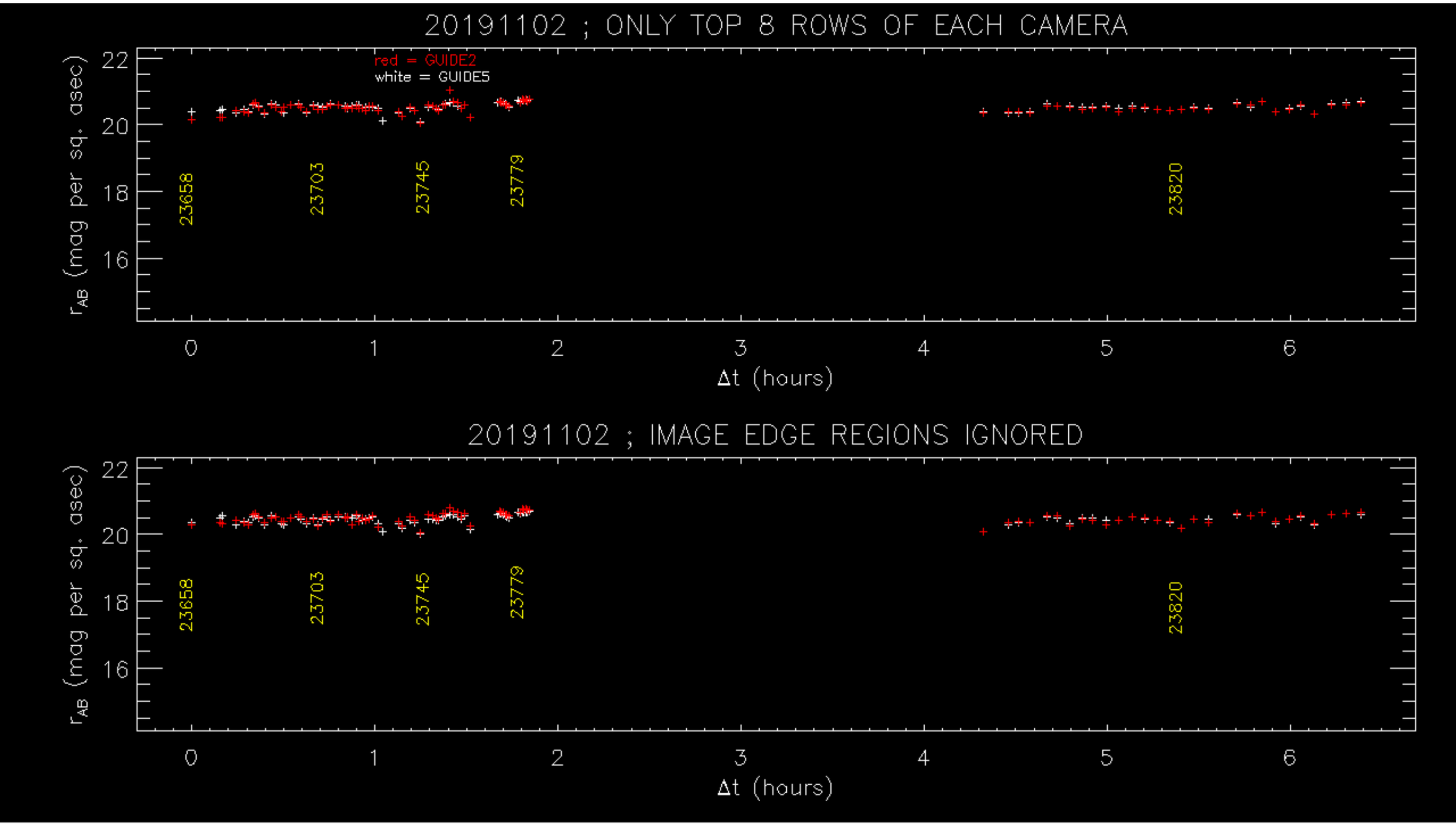
Δt (hours)

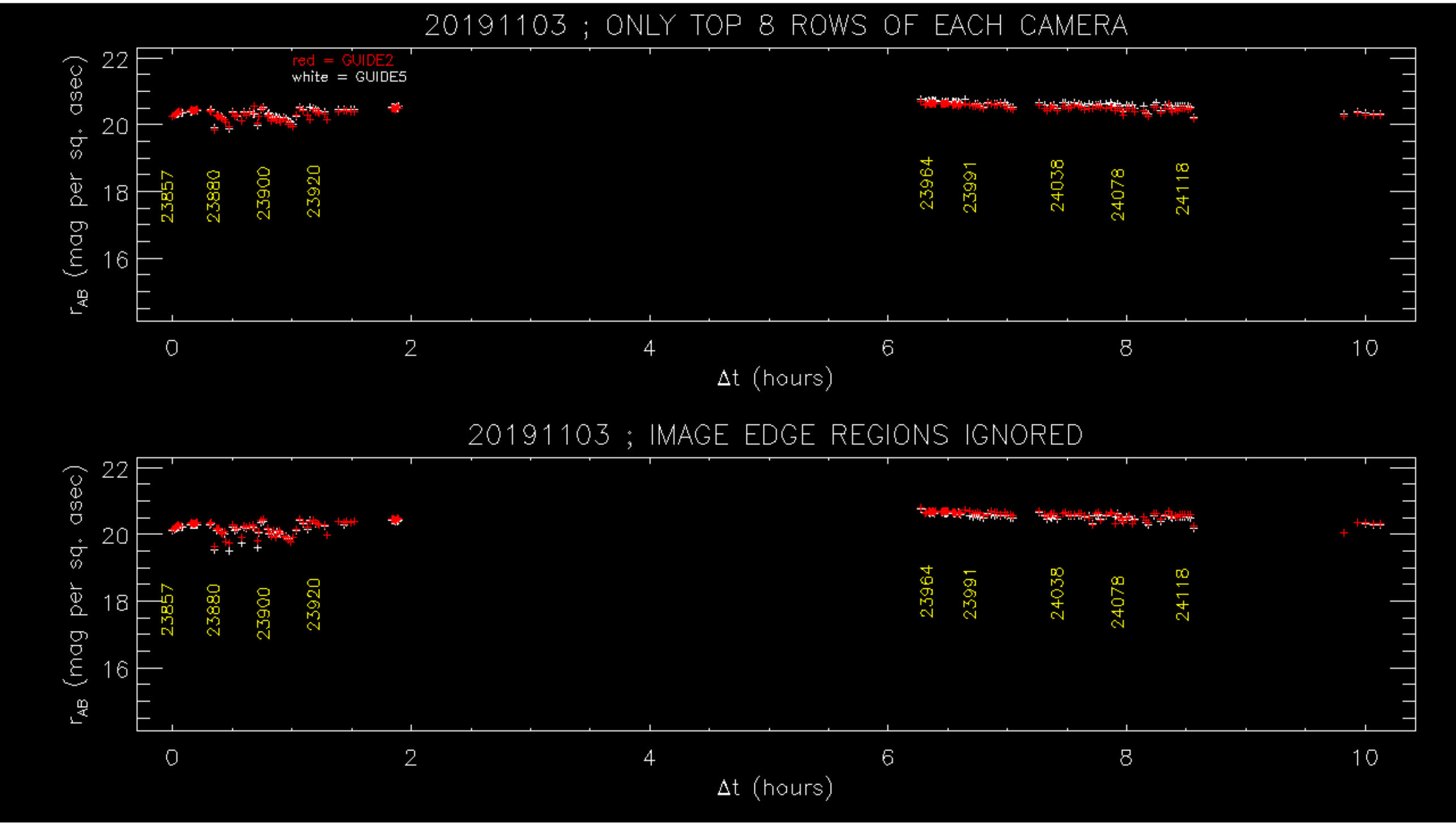

20191030 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
22785
22811
22909
22933
22956
22979
23003
23026
23051
23080
23120
23164
0
2
4
6
8
Δt (hours)
20191030 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
22785
22811
22909
22933
22956
22979
23003
23026
23051
23080
23120
23164
0
2
4
6
8
Δt (hours)

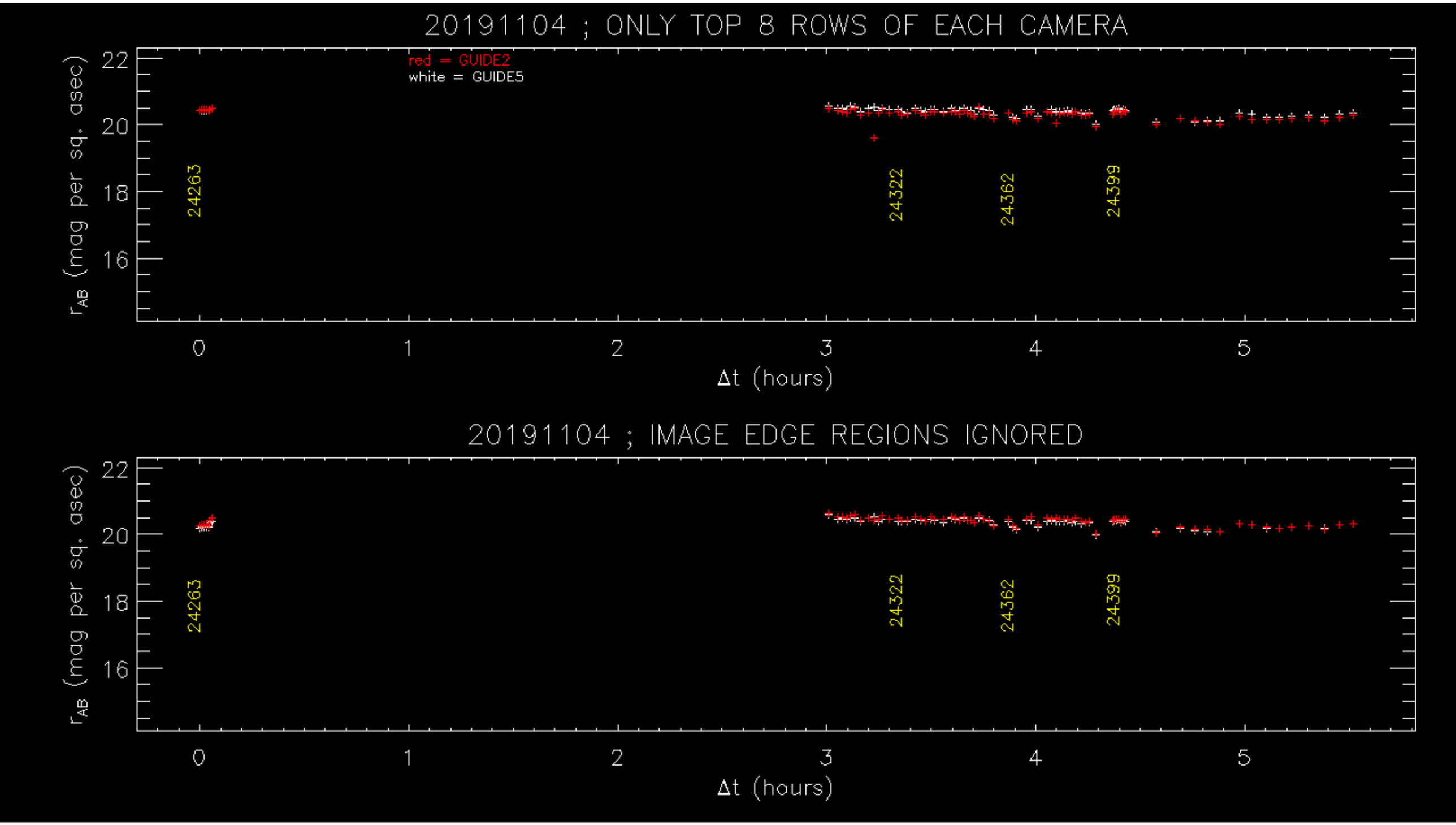

20191031 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
23204
23240
23264
23299
23341
23378
23399
23421
0
2
4
6
8
Δt (hours)
20191031 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
23204
23240
23264
23299
23341
23378
23399
23421
0
2
4
6
8
Δt (hours)

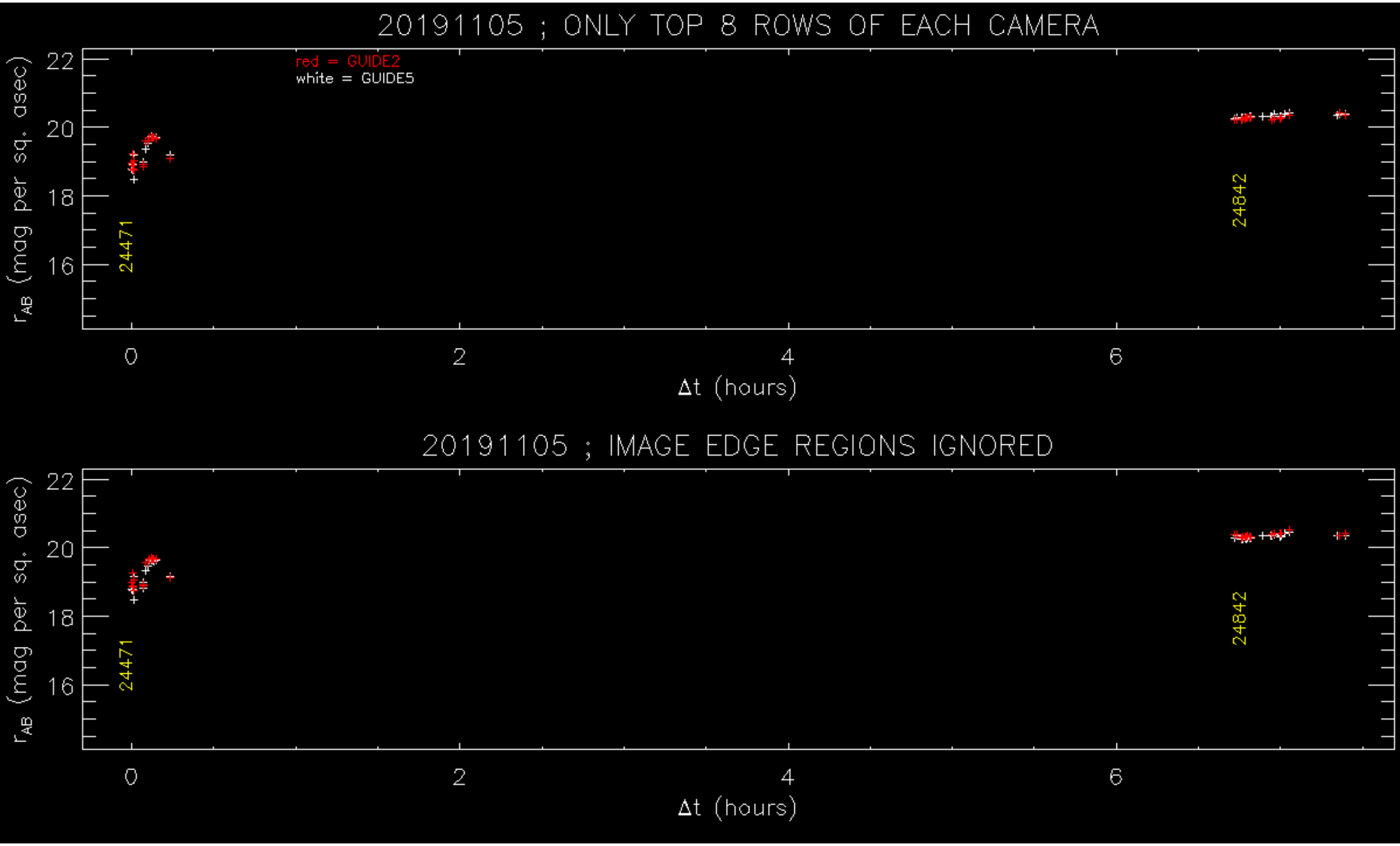

20191101 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
23496
23554
r_{AB} (mag per sq. asec)
22
20
18
16
0
1
2
3
4
5
Δt (hours)

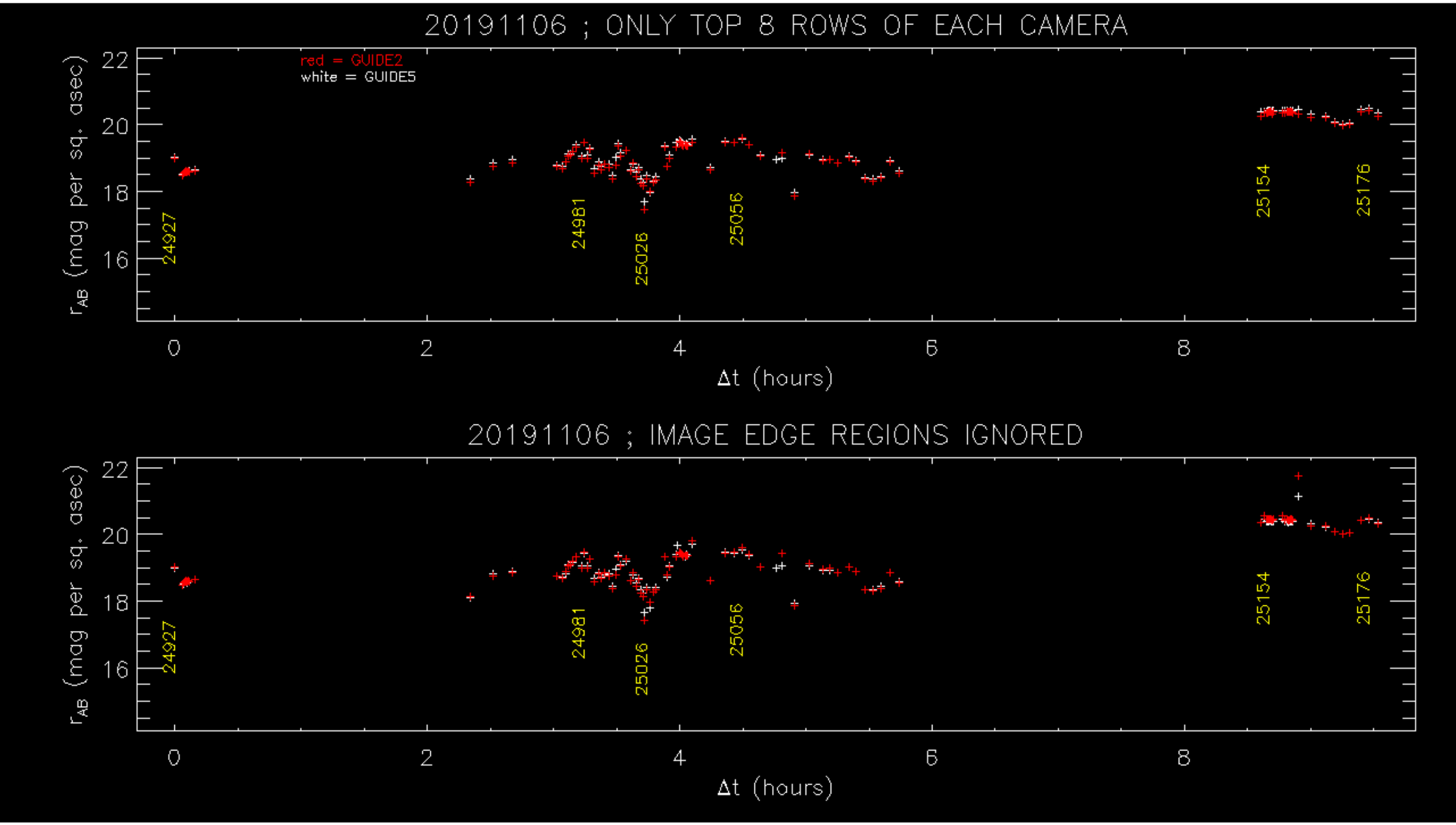

20191101 ; IMAGE EDGE REGIONS IGNORED
23496
23554
r_{AB} (mag per sq. asec)
22
20
18
16
0
1
2
3
4
5
Δt (hours)


20191102 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
23658
23703
23745
23779
23820
r_{AB} (mag per sq. asec)
Δt (hours)
20191102 ; IMAGE EDGE REGIONS IGNORED
23658
23703
23745
23779
23820
r_{AB} (mag per sq. asec)
Δt (hours)

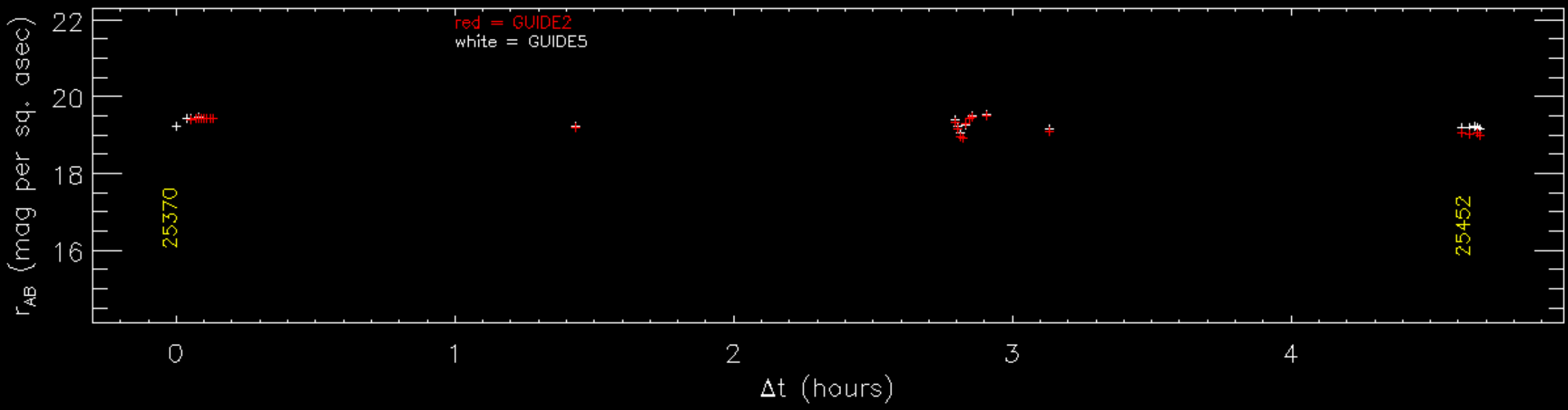

20191103 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
23857
23880
23900
23920
23964
23991
24038
24078
24118
0
2
4
6
8
10
Δt (hours)
20191103 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
23857
23880
23900
23920
23964
23991
24038
24078
24118
0
2
4
6
8
10
Δt (hours)


20191104 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
24263
24322
24362
24399
0
1
2
3
4
5
Δt (hours)
20191104 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
24263
24322
24362
24399
0
1
2
3
4
5
Δt (hours)

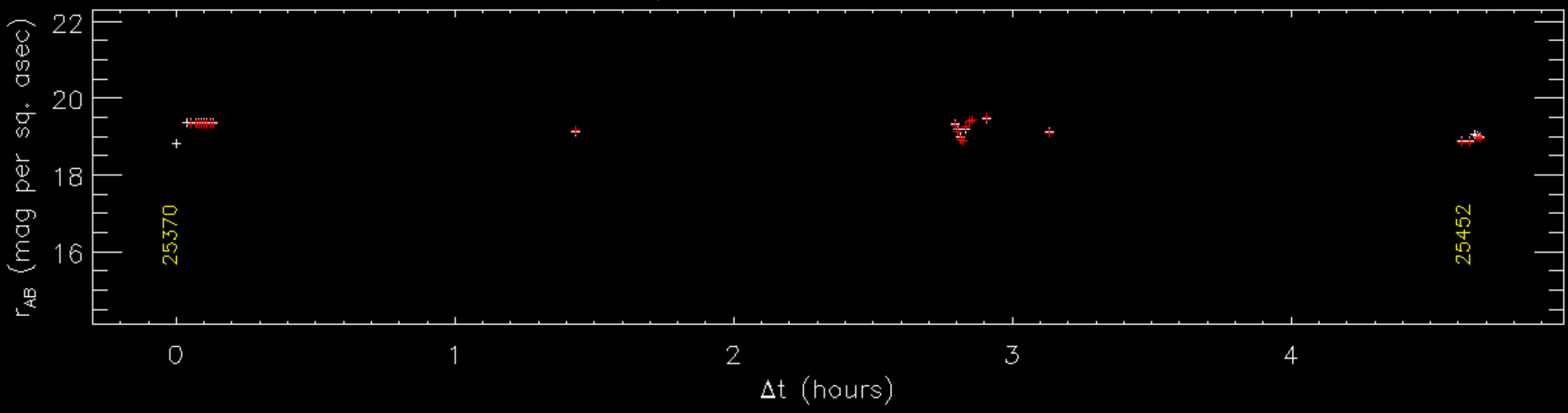

20191105 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
22
20
18
16
r_{AB} (mag per sq. asec)
24471
24842
0
2
4
6
Δt (hours)
20191105 ; IMAGE EDGE REGIONS IGNORED
22
20
18
16
r_{AB} (mag per sq. asec)
24471
24842
0
2
4
6
Δt (hours)


20191106 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
24927
24981
25026
25056
25154
25176
0
2
4
6
8
Δt (hours)
20191106 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
24927
24981
25026
25056
25154
25176
0
2
4
6
8
Δt (hours)

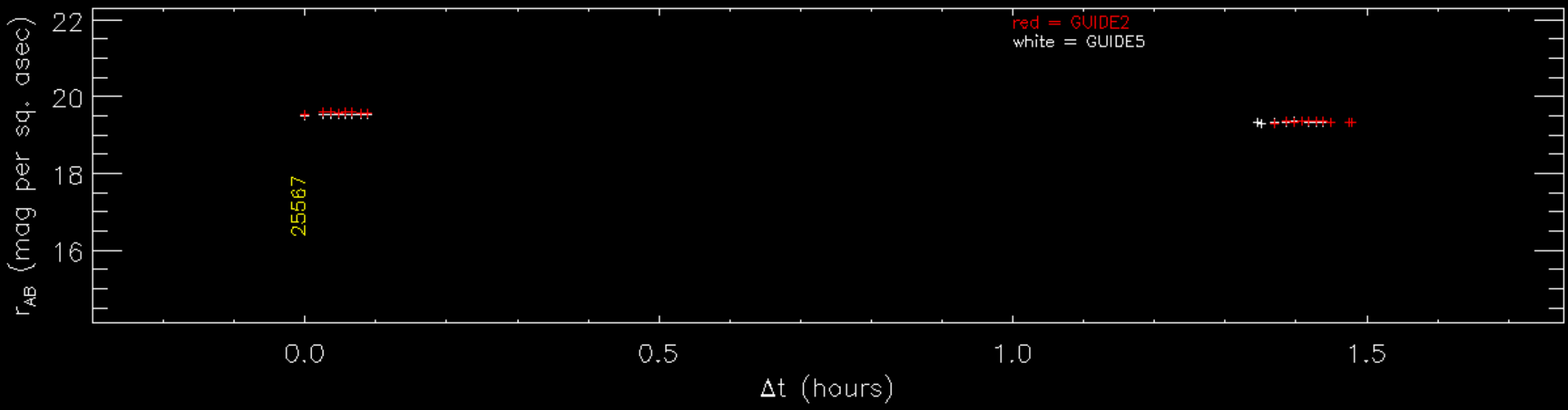
20191107 ; ONLY TOP 8 ROWS OF EACH CAMERA



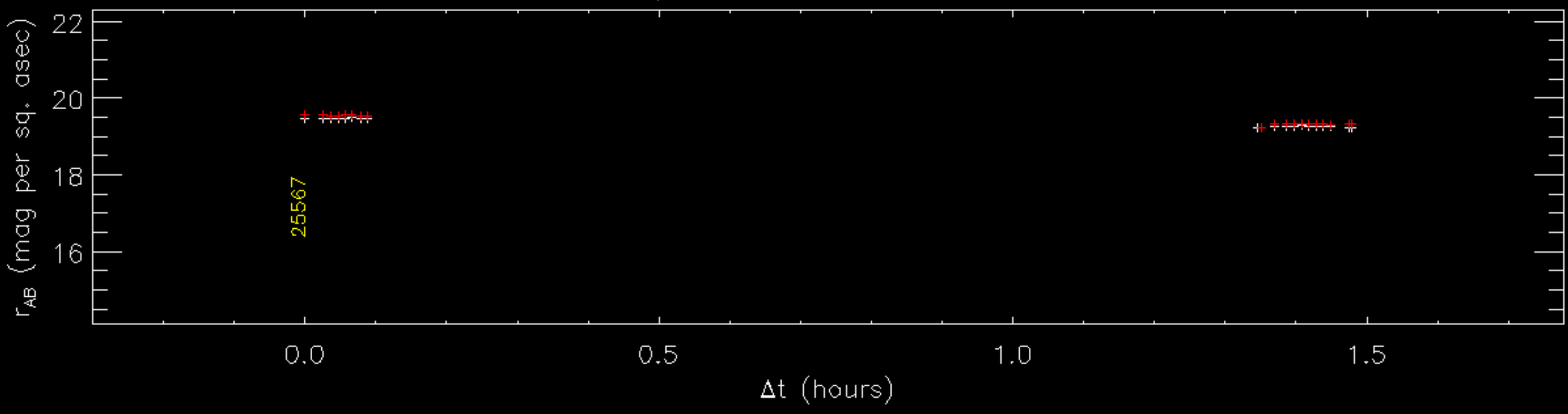
20191107 ; IMAGE EDGE REGIONS IGNORED



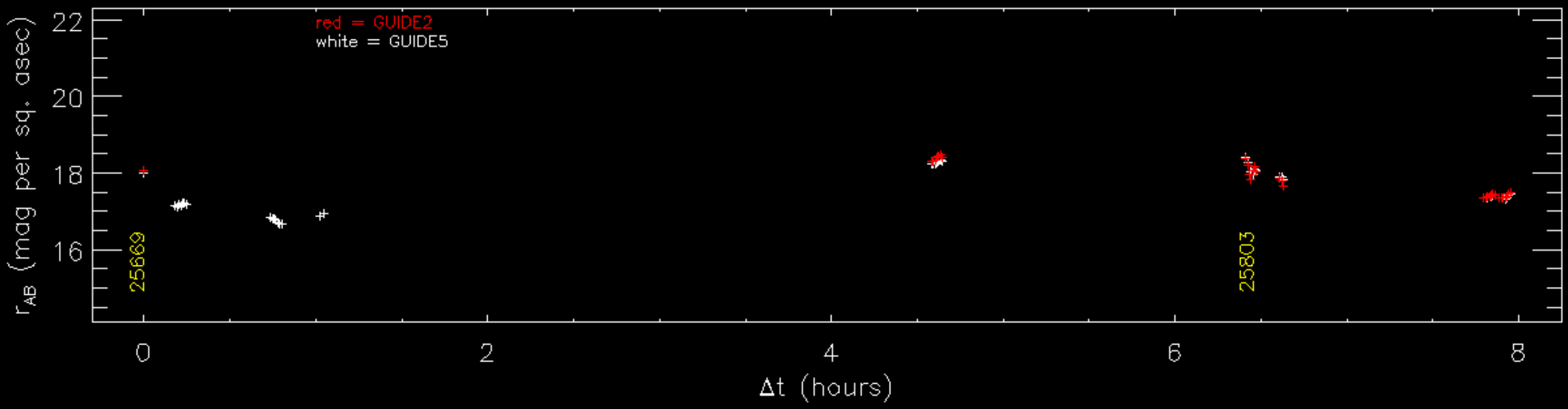
20191108 ; ONLY TOP 8 ROWS OF EACH CAMERA



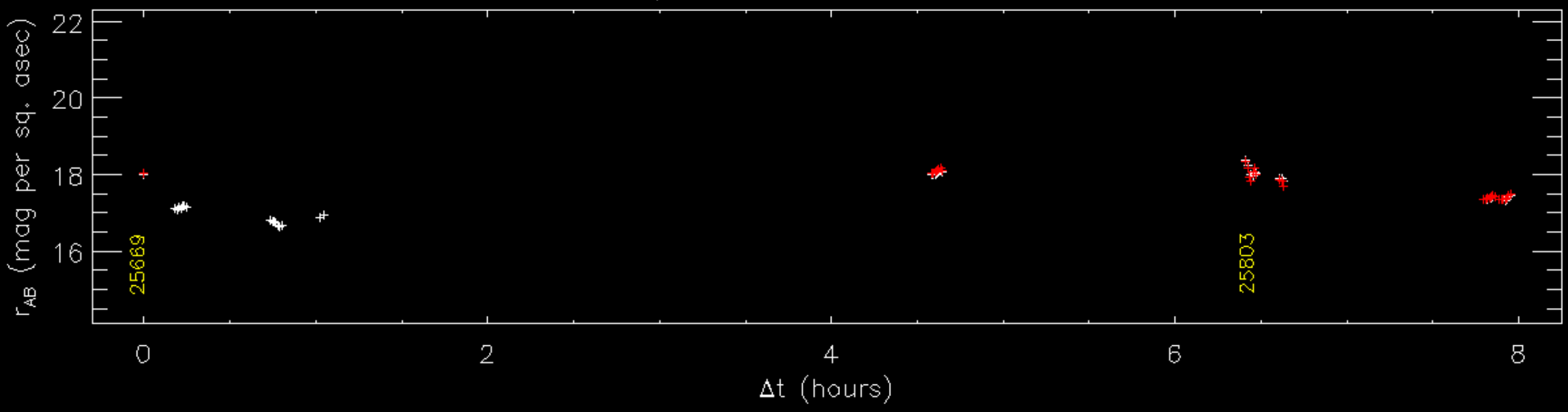
20191108 ; IMAGE EDGE REGIONS IGNORED



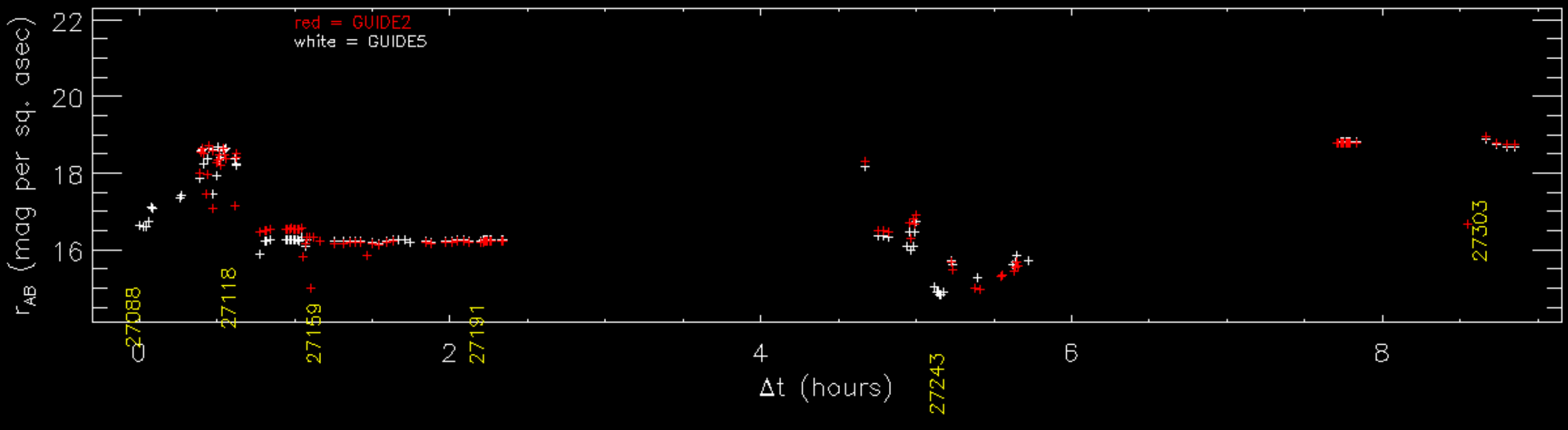
20191109 ; ONLY TOP 8 ROWS OF EACH CAMERA



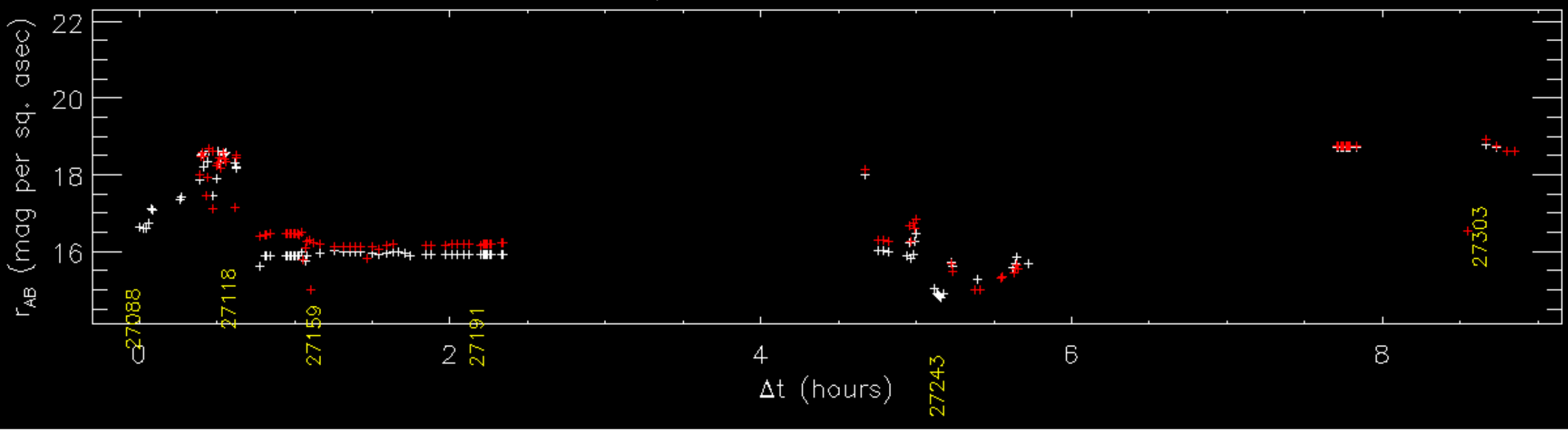
20191109 ; IMAGE EDGE REGIONS IGNORED

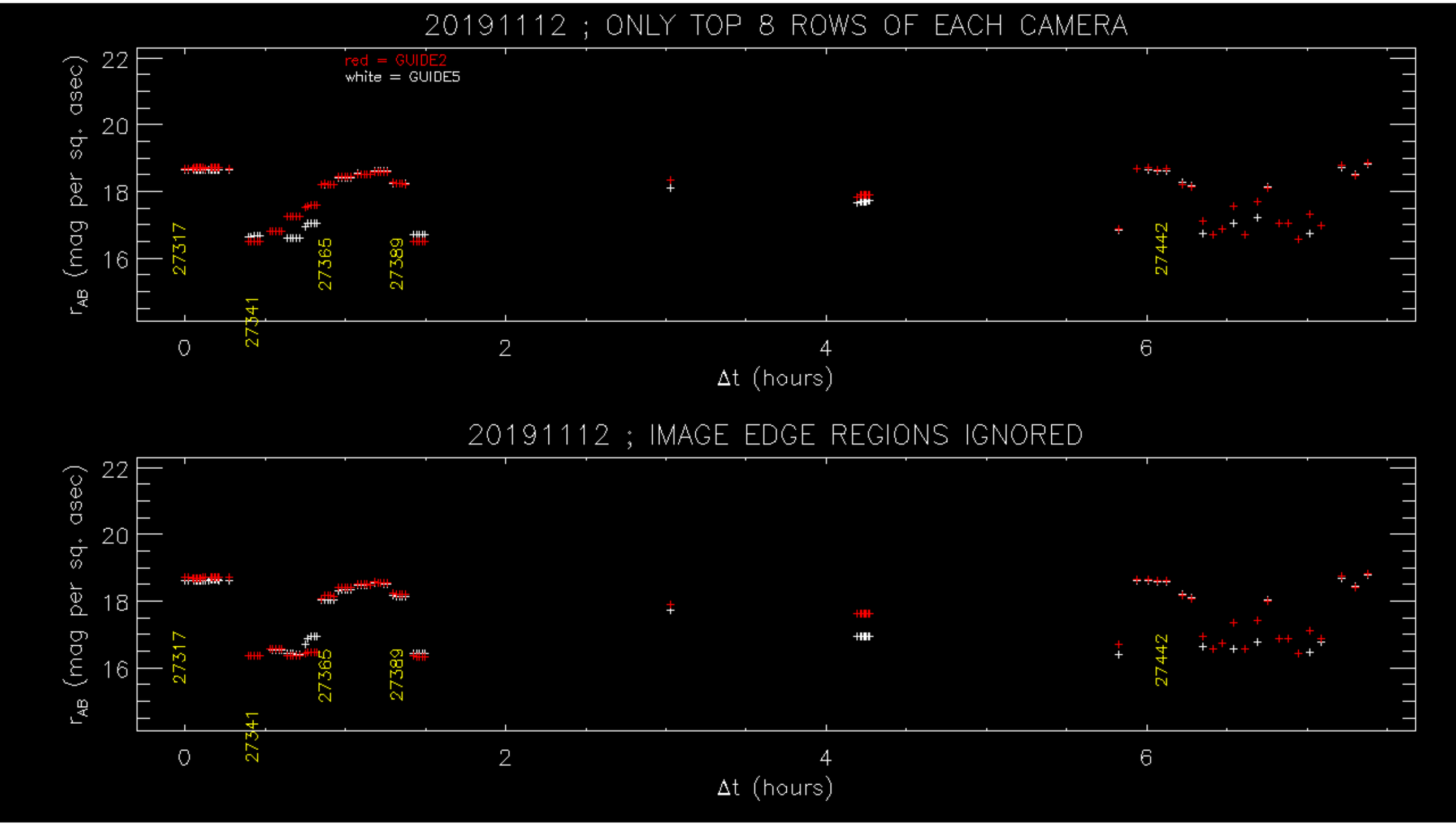


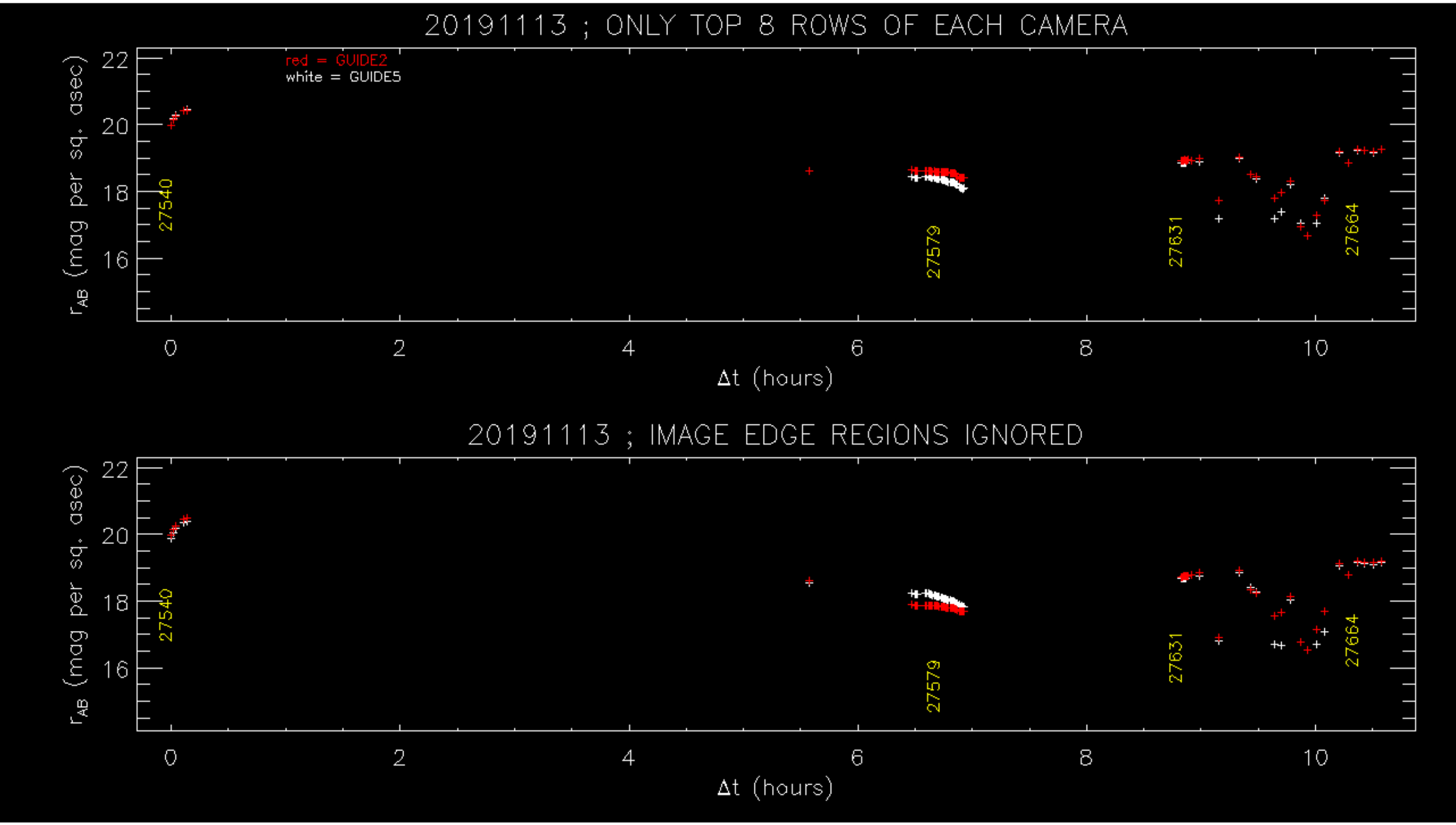
20191111 ; ONLY TOP 8 ROWS OF EACH CAMERA

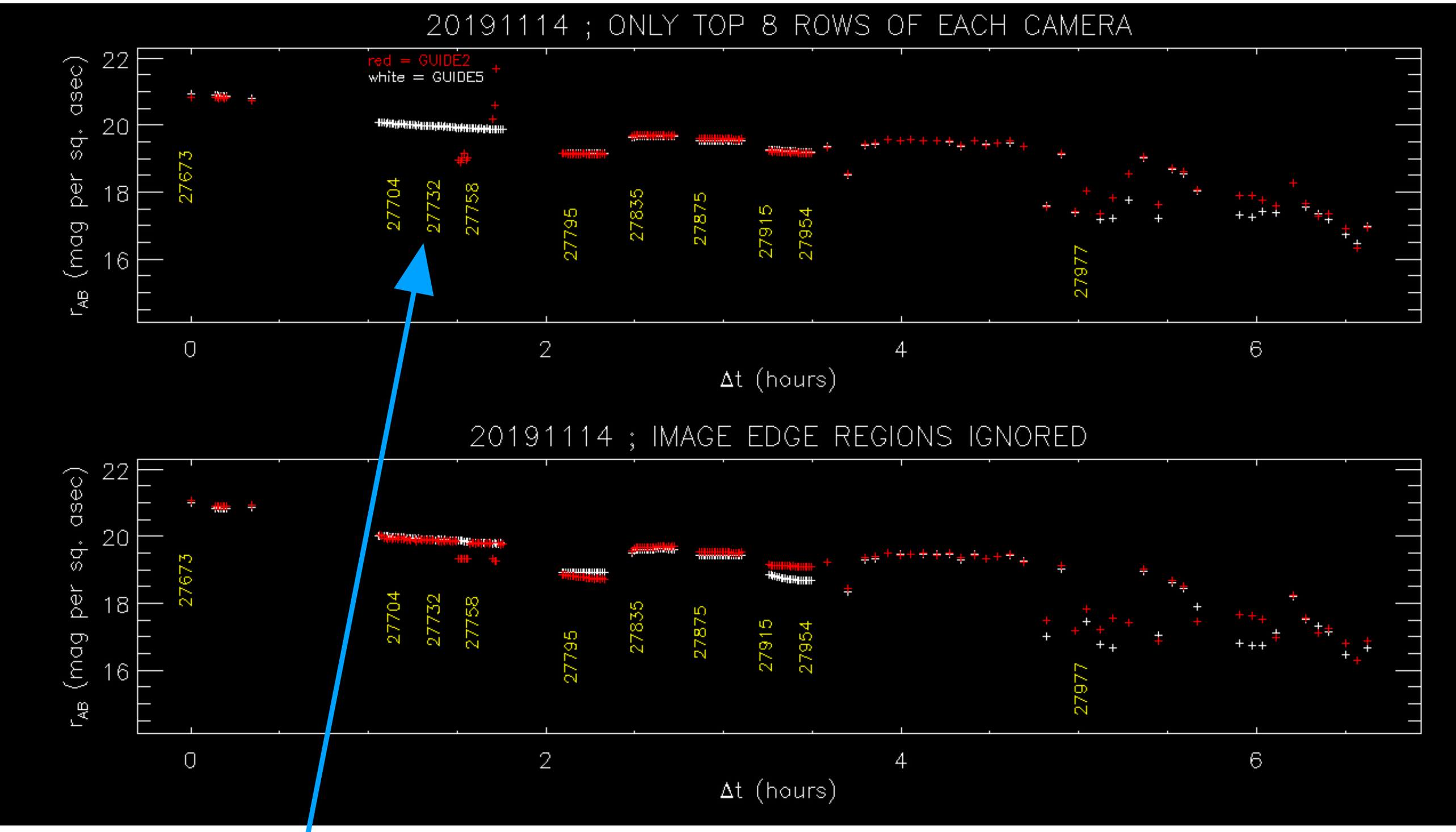


20191111 ; IMAGE EDGE REGIONS IGNORED

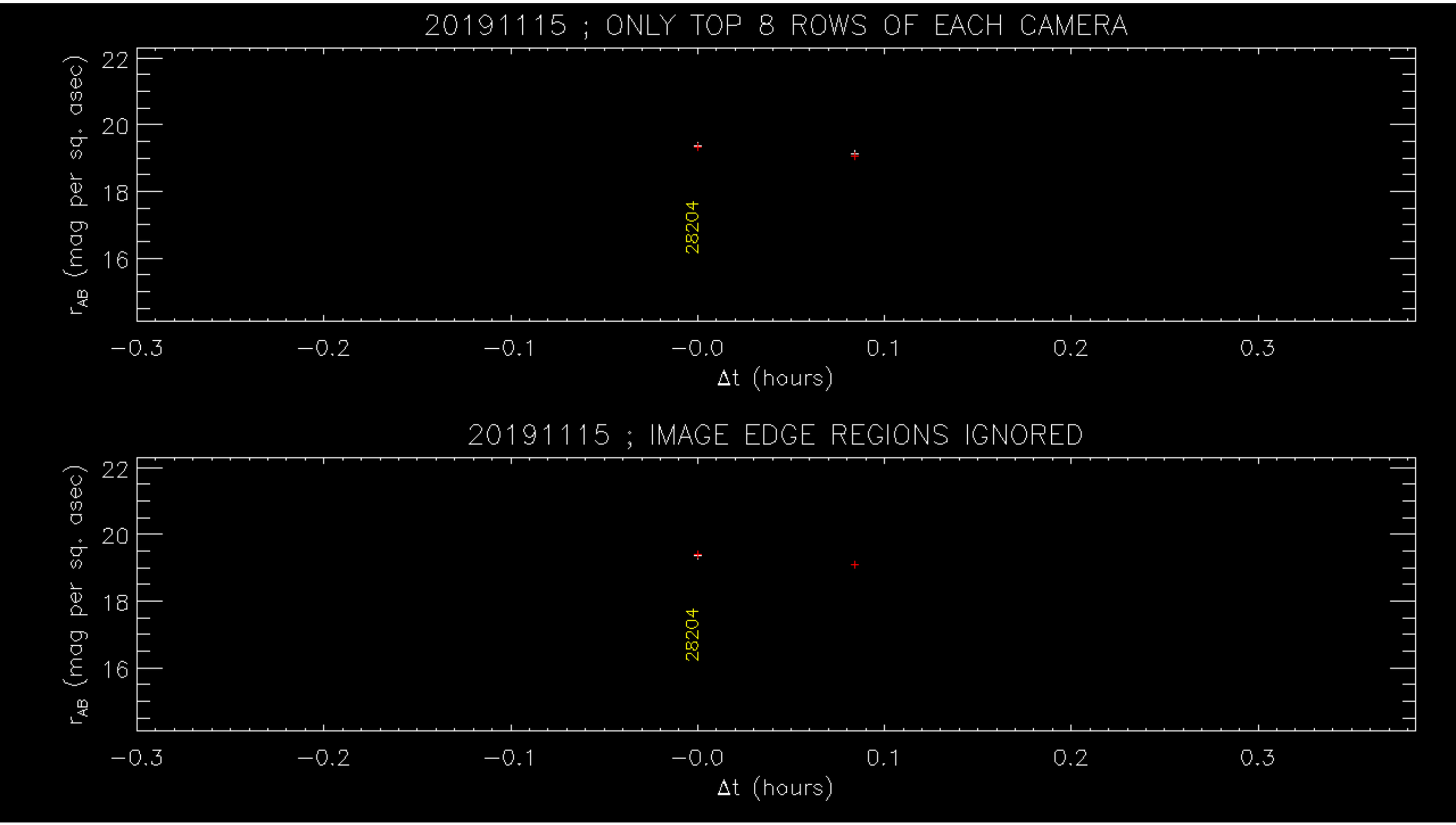


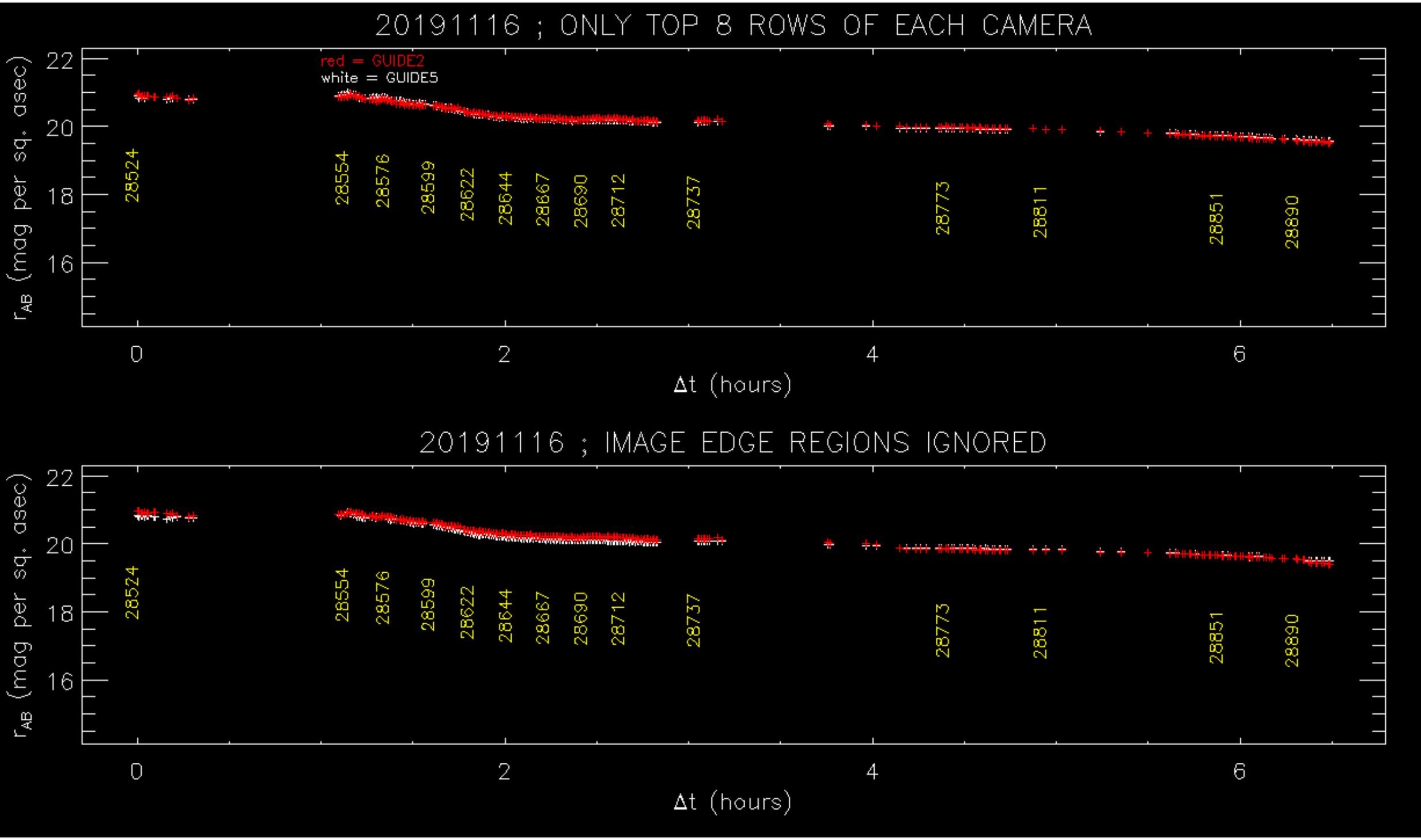

20191112 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
27317
27341
27365
27389
27442
0
2
4
6
Δt (hours)
20191112 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
27317
27341
27365
27389
27442
0
2
4
6
Δt (hours)


20191113 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
27540
27579
27631
27664
0
2
4
6
8
10
Δt (hours)
20191113 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
27540
27579
27631
27664
0
2
4
6
8
10
Δt (hours)



ultra-bright star in GUIDE2, amp G right along upper image boundary; checked that this is the problem for all GFA exposures with 27704 < expid < 27758


20191115 ; ONLY TOP 8 ROWS OF EACH CAMERA
r_{AB} (mag per sq. asec)
22
20
18
16
28204
−0.3
−0.2
−0.1
−0.0
0.1
0.2
0.3
Δt (hours)
20191115 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
28204
−0.3
−0.2
−0.1
−0.0
0.1
0.2
0.3
Δt (hours)


20191116 ; ONLY TOP 8 ROWS OF EACH CAMERA
red = GUIDE2
white = GUIDE5
r_{AB} (mag per sq. asec)
22
20
18
16
28524
28554
28576
28599
28622
28644
28667
28690
28712
28737
28773
28811
28851
28890
0
2
4
6
Δt (hours)
20191116 ; IMAGE EDGE REGIONS IGNORED
r_{AB} (mag per sq. asec)
22
20
18
16
28524
28554
28576
28599
28622
28644
28667
28690
28712
28737
28773
28811
28851
28890
0
2
4
6
Δt (hours)

20191117 ; ONLY TOP 8 ROWS OF EACH CAMERA

red = GUIDE2
white = GUIDE5

r_{AB} (mag per sq. asec)

22
20
18
16

28979
29012
29074
29115
29155
29196
29227
29247
29269

0
2
4
6
8

Δt (hours)

20191117 ; IMAGE EDGE REGIONS IGNORED

r_{AB} (mag per sq. asec)

22
20
18
16

28979
29012
29074
29115
29155
29196
29227
29247
29269

0
2
4
6
8

Δt (hours)

Remaining steps/questions

- Investigate camera to camera discrepancies that remain in the above plots even when using only the top 8 rows for sky estimation
    - Perhaps “noisy” i.e., problematic GFA readouts could explain some cases
    - also, I’ve not yet made any explicit minimum EXPTIME cut, so some very short GFA exposures may be plotted
- Incorporate more GFA cameras into sky brightness analysis beyond just GUIDE2 and GUIDE5
- Why is there a step-like background level discontinuity which sometimes decouples the overall background offset in most of the image area from the top 8 rows that seem well-explained by the sum of bias, dark current and sky signal?
- Other sanity checks beyond just camera to camera agreement?
- How to check agreement with “truth”? Need to wait for sky camera analysis? Any relevance of pointing camera data?