Summary of the ASTEP South 2008-2010 campaigns

Nicolas Crouzet

ASTEP workshop
March 14-15, 2011

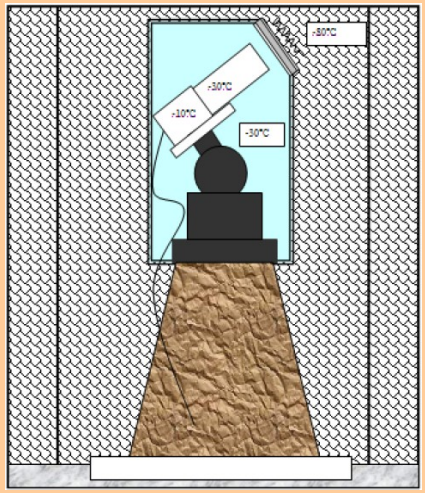




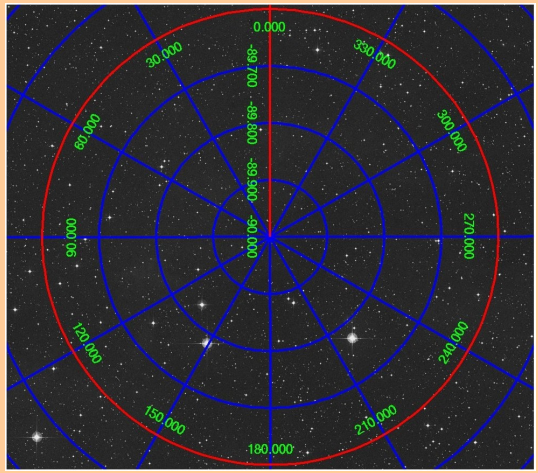


Summary of the ASTEP South 2008-2010 campaigns

The ASTEP South principle



A fixed 10 cm refractor and a CCD camera in a thermalized enclosure ...



... pointing continuously towards the celestial South pole



ASTEP South at Concordia, 2008

Continuous observations of a single field (4°x4°): - 2008: 1500 hours
- 2009: 2500 hours (~ all winter)
- 2010: all winter

Preliminary analysis: *Crouzet et al. 2010* & updates



Summary of the ASTEP South 2008-2010 campaigns

The ASTEP South setup

Installation of the instrument

Mount and telescope pointing

Station

Data acquisition
~ 2000 images / day

Run_astep

Email of a log file

Save_astep

Data transfer & save

Envoi d'un fichier log

Peliminary analysis

Control

Email of a result file

One image = 32 MB
Transfer = 5 MB



Summary of the ASTEP South 2008-2010 campaigns

ASTEP South: movie !!

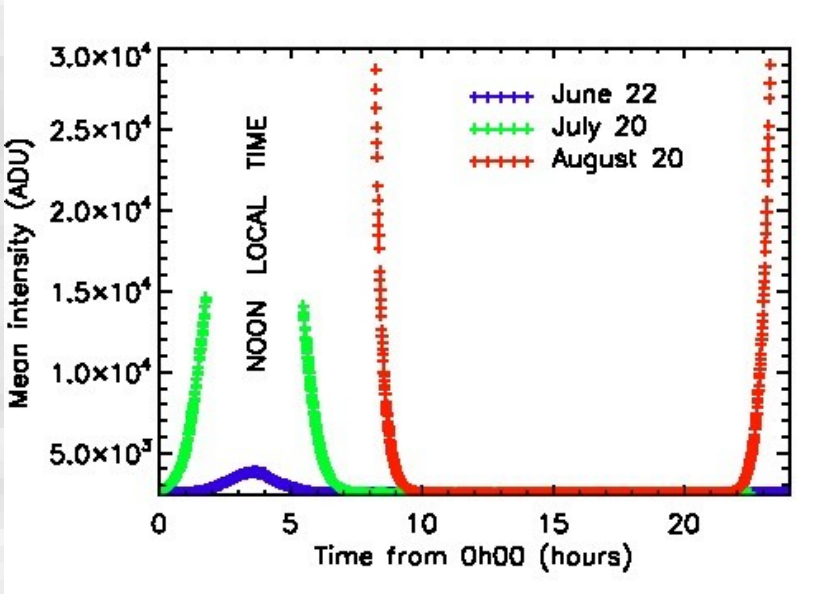


Summary of the ASTEP South 2008-2010 campaigns

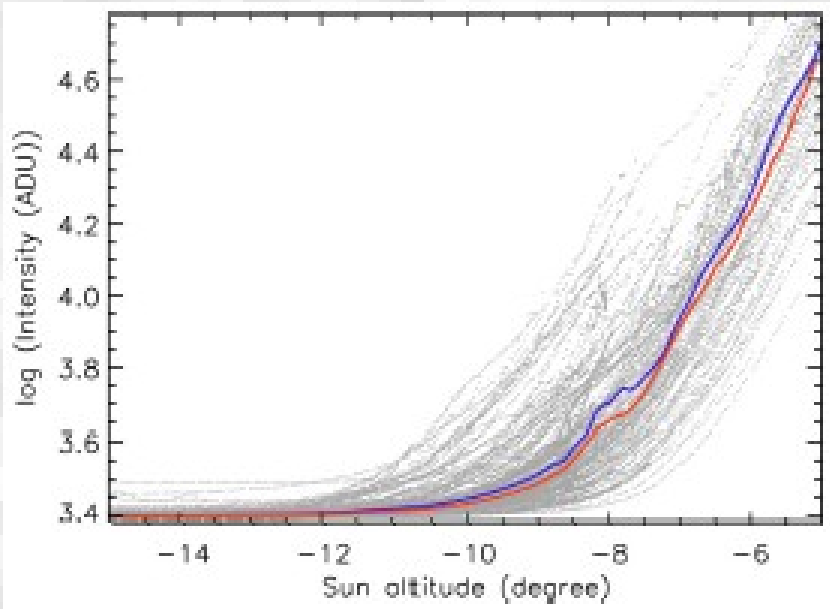
Can we observe continuously for 3 months ?

⇨ Sun : high sky background
few hours a day

⇨ - June : data usable
- July, August : several hours a day lost
(for our instrument)



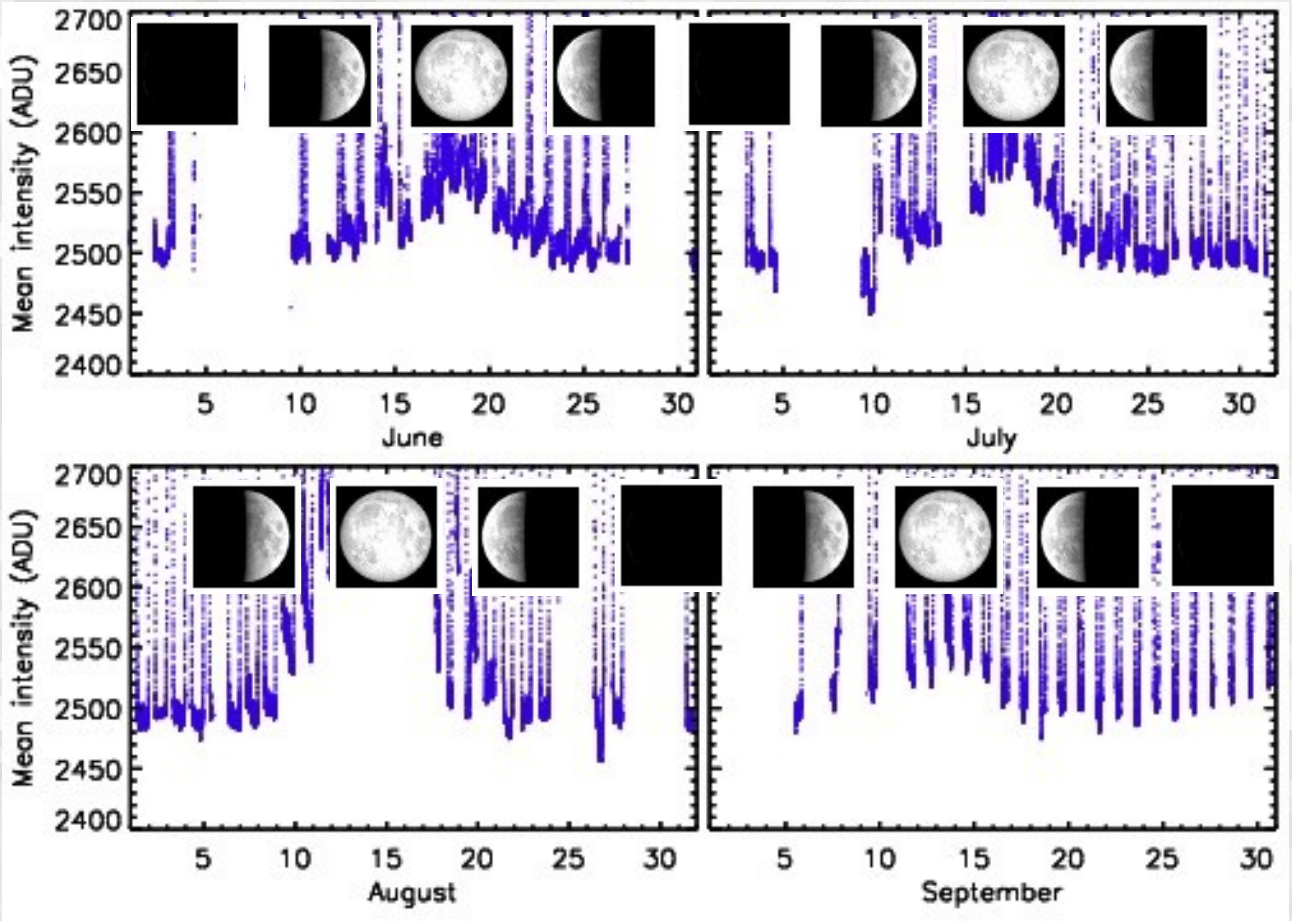
⇨ The sky brightness as a function of the Sun altitude is equivalent to the best astronomical sites in the world





Summary of the ASTEP South 2008-2010 campaigns

Dome C :
Can we observe continuously for 3 months ?



⇨ Moon : high sky background few days per month

Photometry is not affected



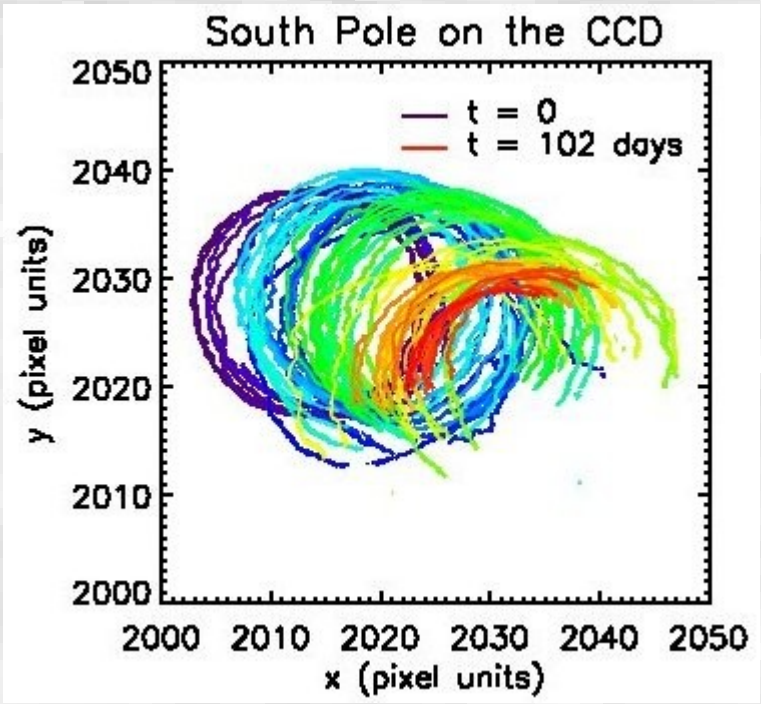
Summary of the ASTEP South 2008-2010 campaigns

Is the instrument stable ?

1) Mechanical stability

⇨ Position of the South pole on the CCD

2008:





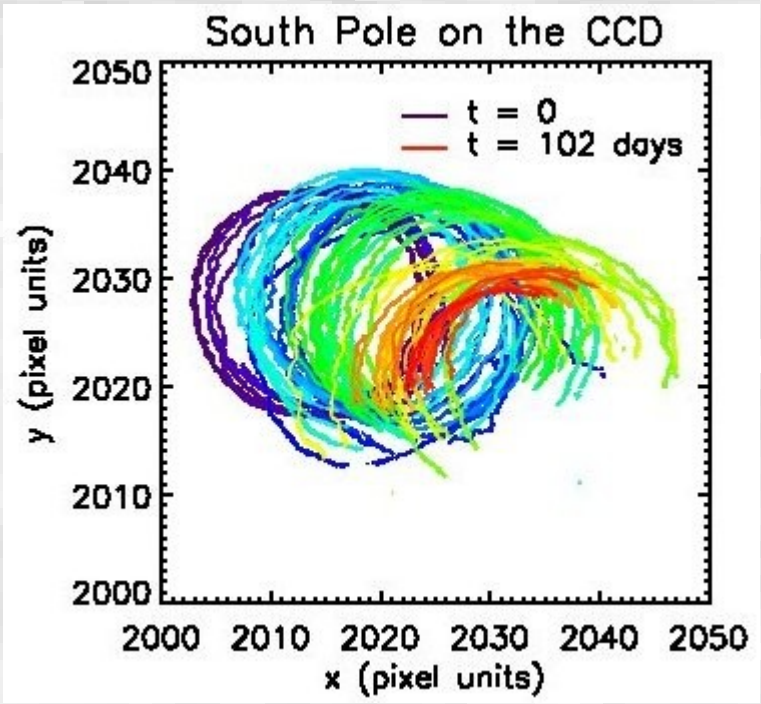
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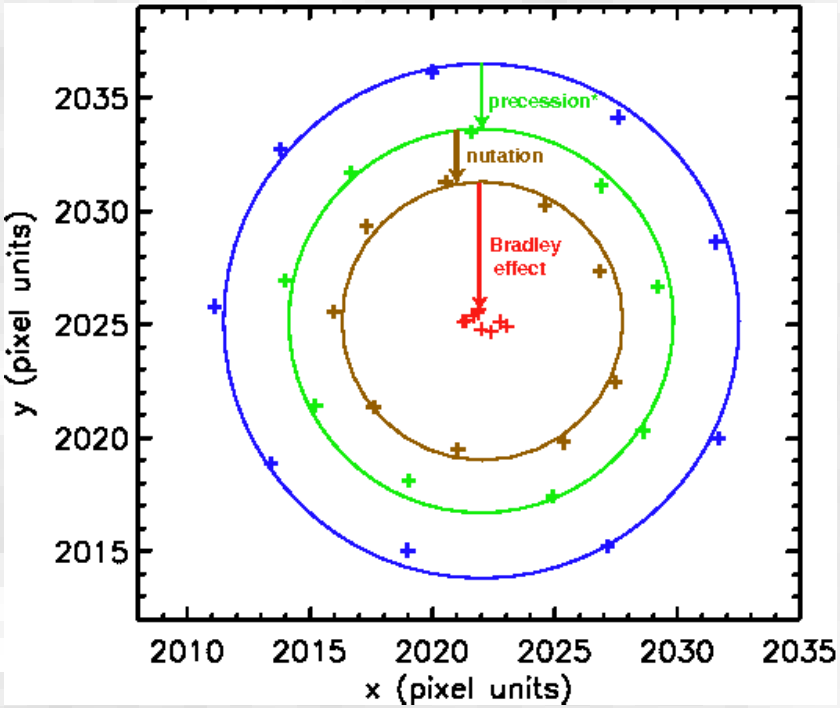
1) Mechanical stability

⇨ Position of the South pole on the CCD

2008:



Correction for the equinox precession, nutation and Bradley effect



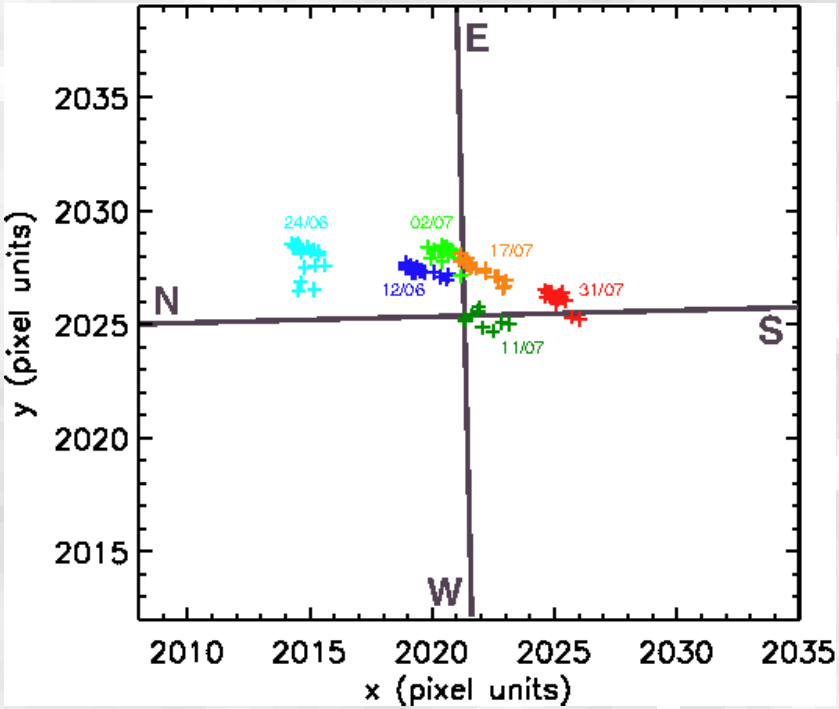


Summary of the ASTEP South 2008-2010 campaigns

Is the instrument stable ?

1) Mechanical stability

2008: - Stable within 10 arcsec over 1 day
- Drift of 34 arcsec over 50 days
(1 pixel ~ 4 arcsec)



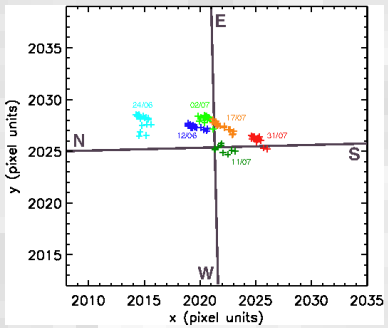


Summary of the ASTEP South 2008-2010 campaigns

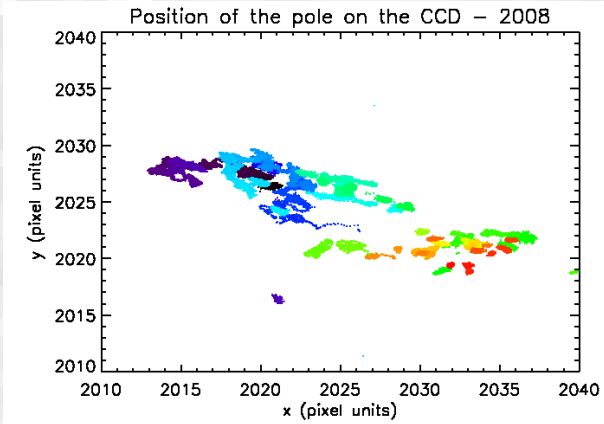
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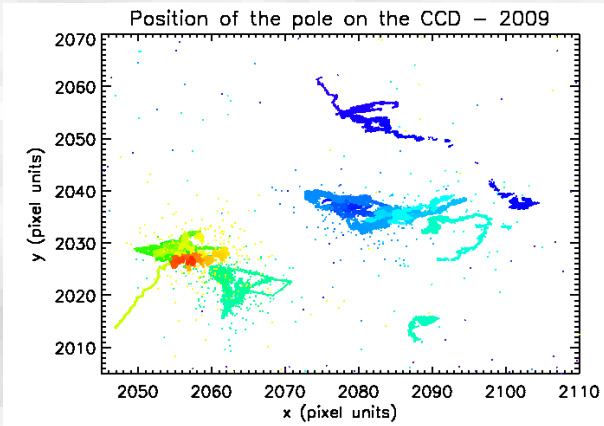
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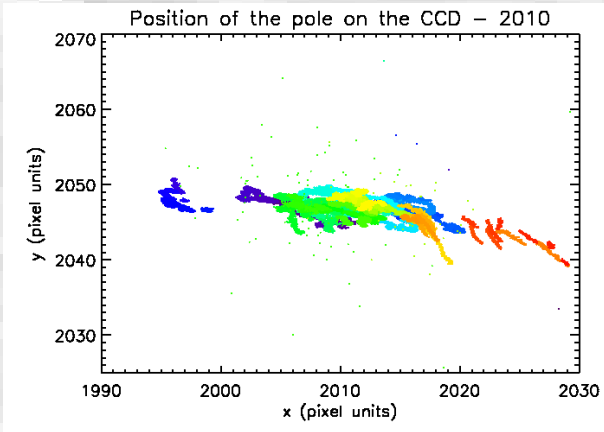
2008: - Stable within 10 arcsec over 1 day
- Drift of 34 arcsec over 50 days
(1 pixel ~ 4 arcsec)



2009-2010: - Drift in the same direction as 2008
- Same amplitude: 35 px (140 arcsec) over 6 months
- Several repointing during the 2009 winter
- **Direction = mean direction of the wind**
(210°, counted from North)









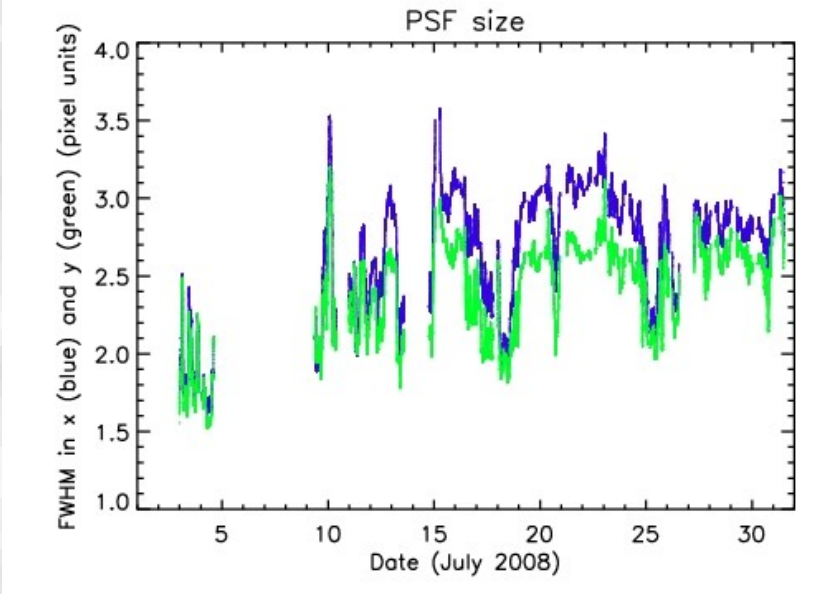
Summary of the ASTEP South 2008-2010 campaigns

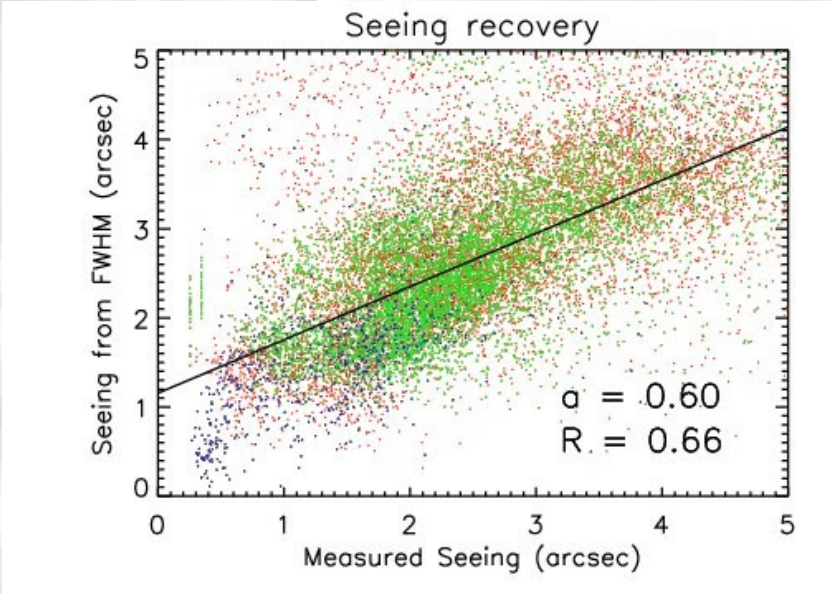
Is the instrument stable ?

2) Optical stability :

2008: Variations < 1 day: Correlated with seeing measurements (DIMM & GSM data)

Variations > 1 day: Instrumental variations (decollimation, astigmatism)







Summary of the ASTEP South 2008-2010 campaigns

Is the instrument stable ?

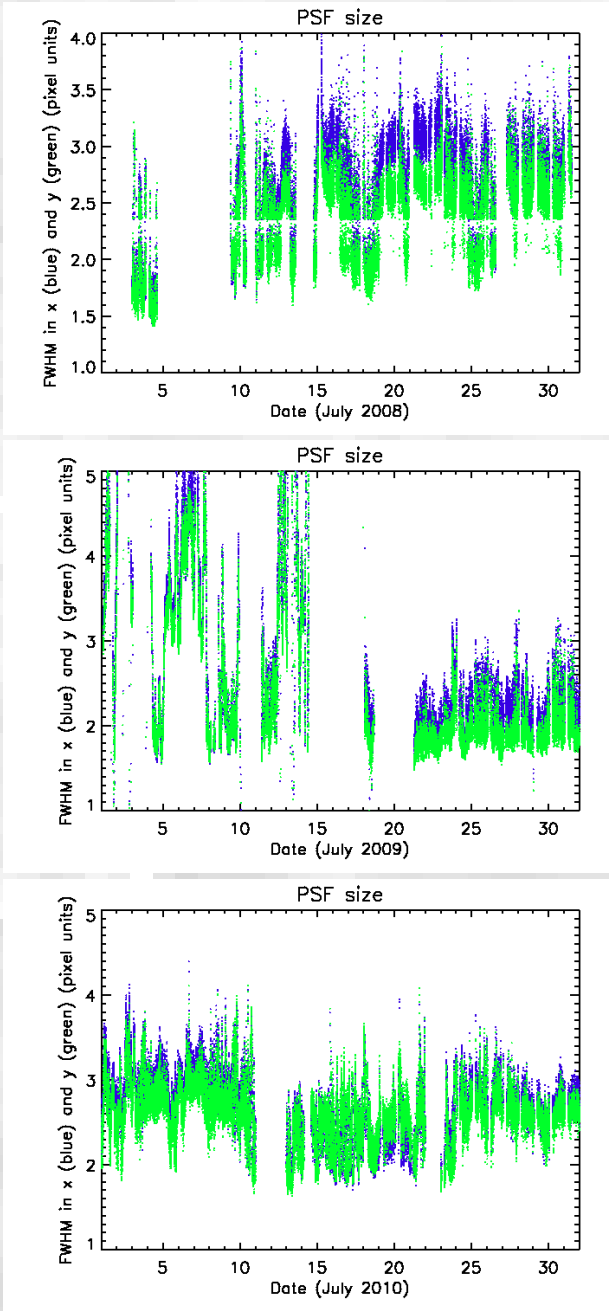
2) Optical stability:

2008: Variations < 1 day: Correlated with seeing measurements (DIMM & GSM data)

Variations > 1 day: Instrumental variations (decollimation, astigmatism)

2009: Improvement of the thermal control: no more long period variations

2010: PSF still relatively stable





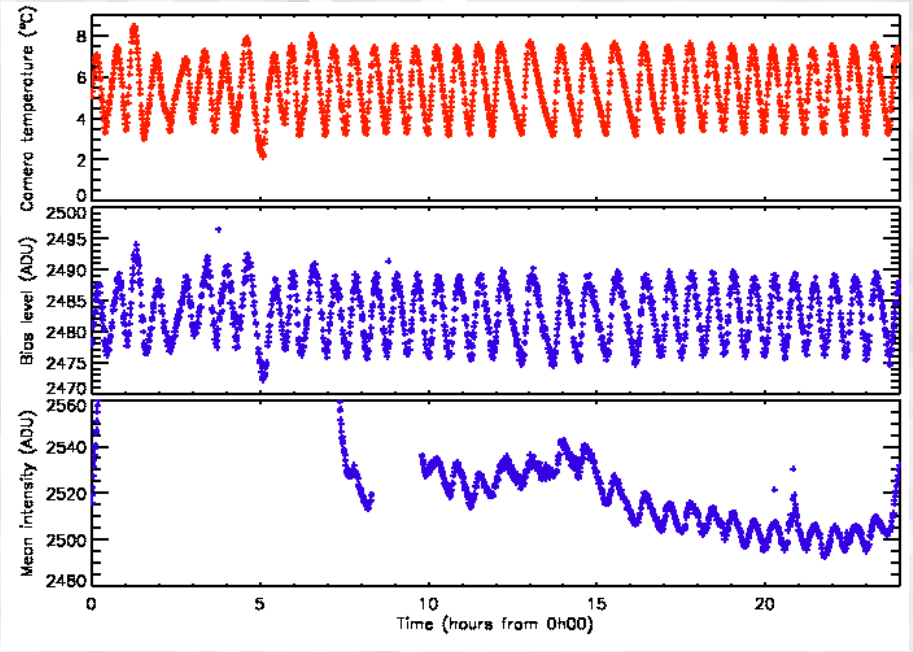
Summary of the ASTEP South 2008-2010 campaigns

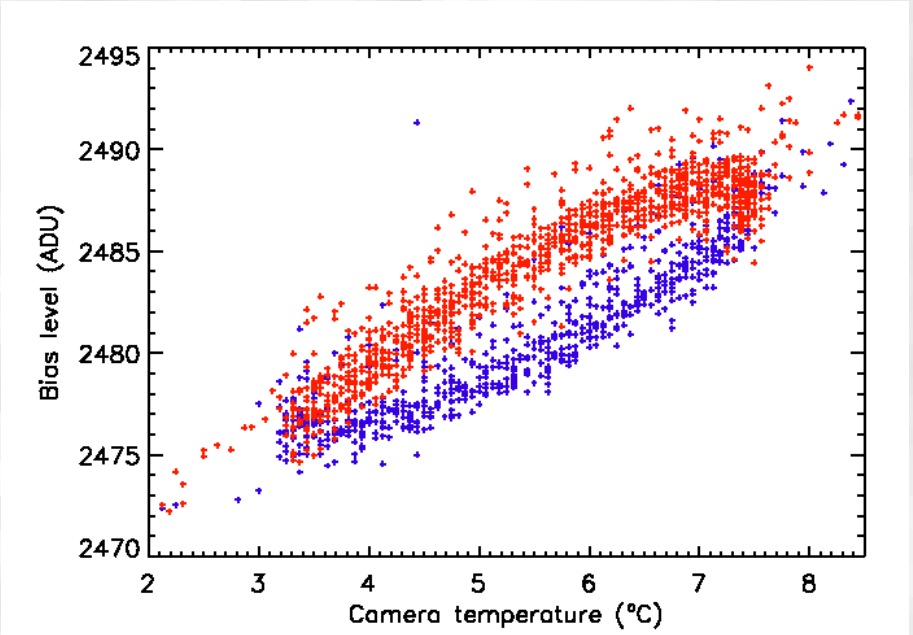
Is the instrument stable ?

3) Thermal stability :

2008: 1 hour period variations on the camera electronics temperature (due to the box heating)

- The bias level is affected (3 ADU/°C)







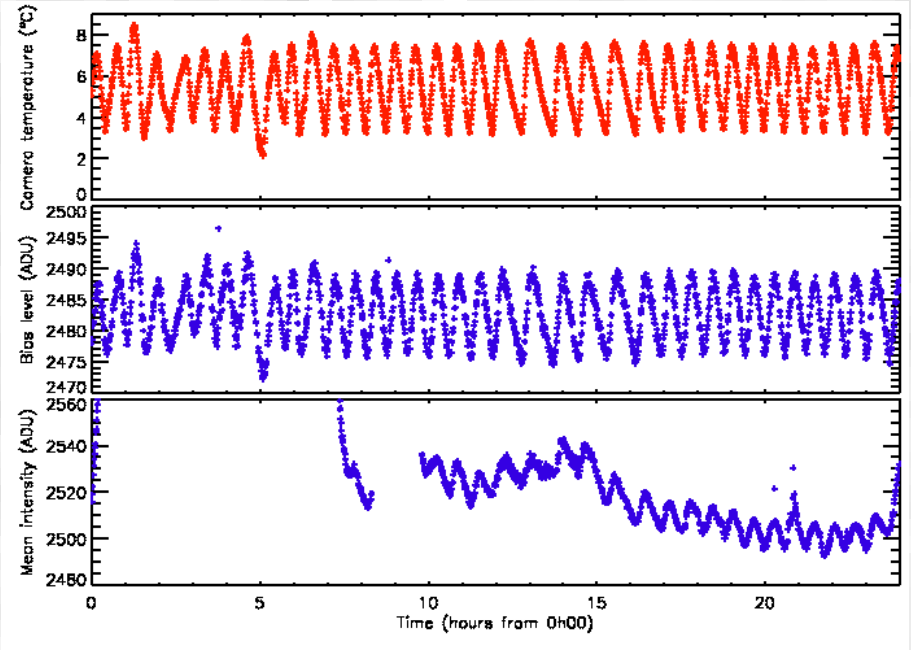
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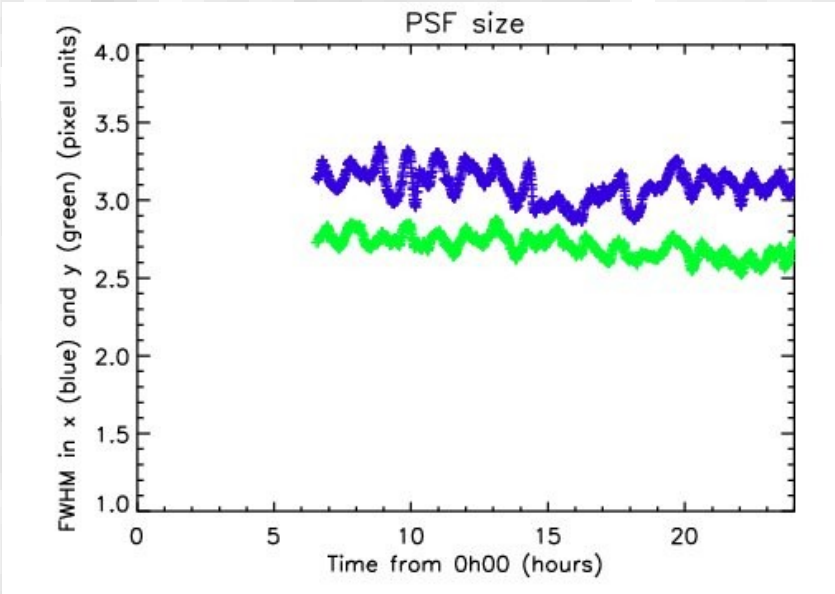
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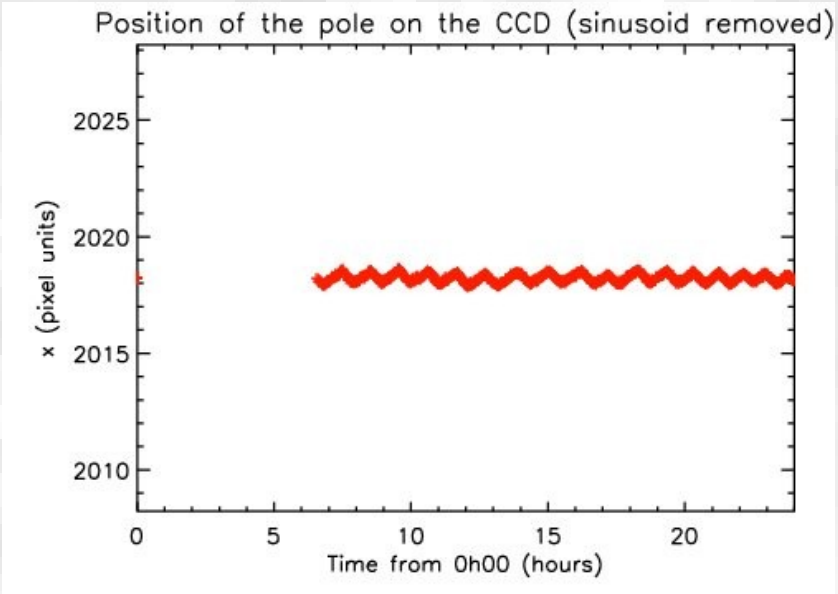
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<u>2008</u>: 1 hour period variations on the camera electronics temperature (due to the box heating)

- The bias level is affected (3 ADU/°C)
- The PSF and position of the South pole are also affected









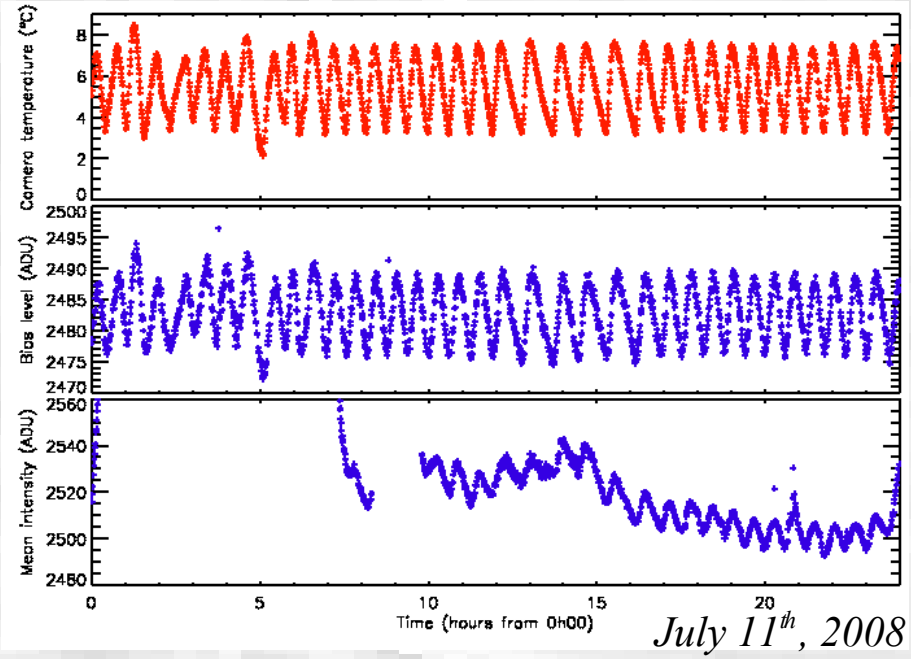
Summary of the ASTEP South 2008-2010 campaigns

Is the instrument stable ?

3) Thermal stability :

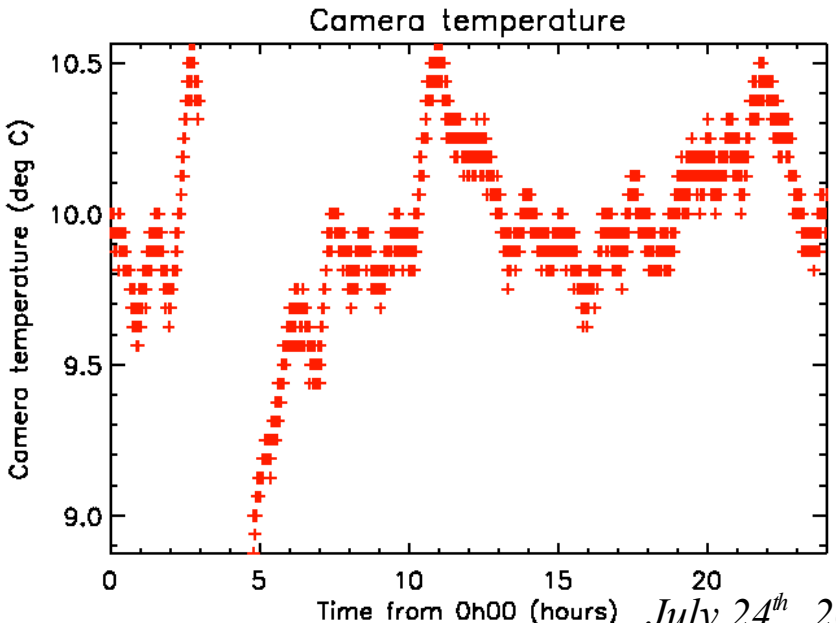
2008: 1 hour period variations on the camera electronics temperature (due to the box heating)

- The bias level is affected (3 ADU/°C)
- The PSF and position of the South pole are also affected



July 11th, 2008

2009-2010: Improvements of the thermal control:
- no more oscillations



July 24th, 2009



Summary of the ASTEP South 2008-2010 campaigns

Is the instrument stable ?

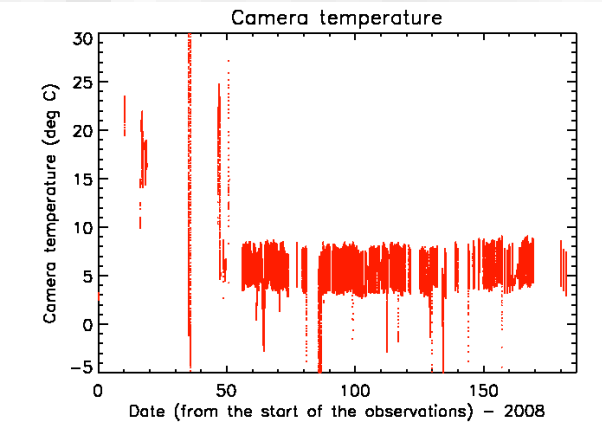
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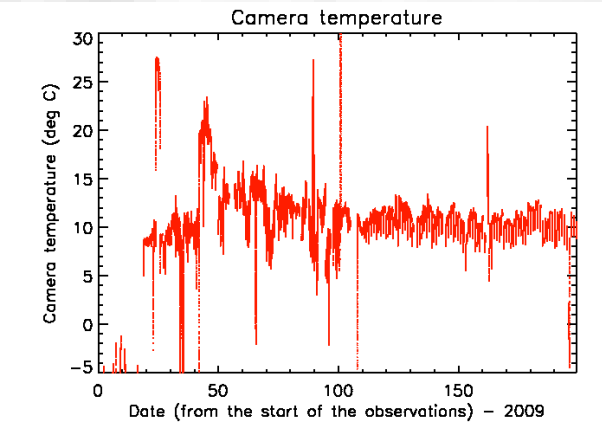
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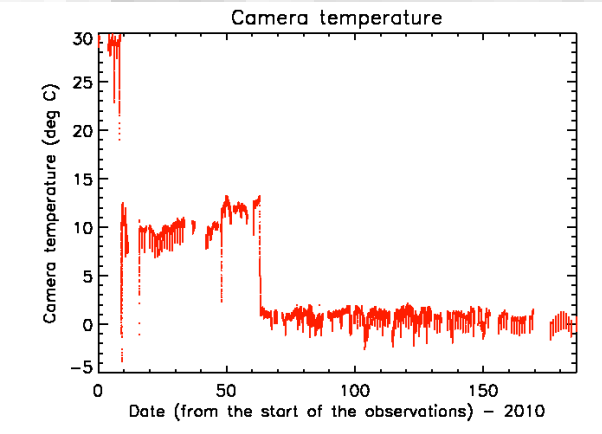
- The bias level is affected (3 ADU/°C)
- The PSF and position of the South pole are also affected

<u>2009-2010</u>: Improvements of the thermal control:

- no more oscillations
- big changes for the first half of 2009, then stable
- very stable in 2010



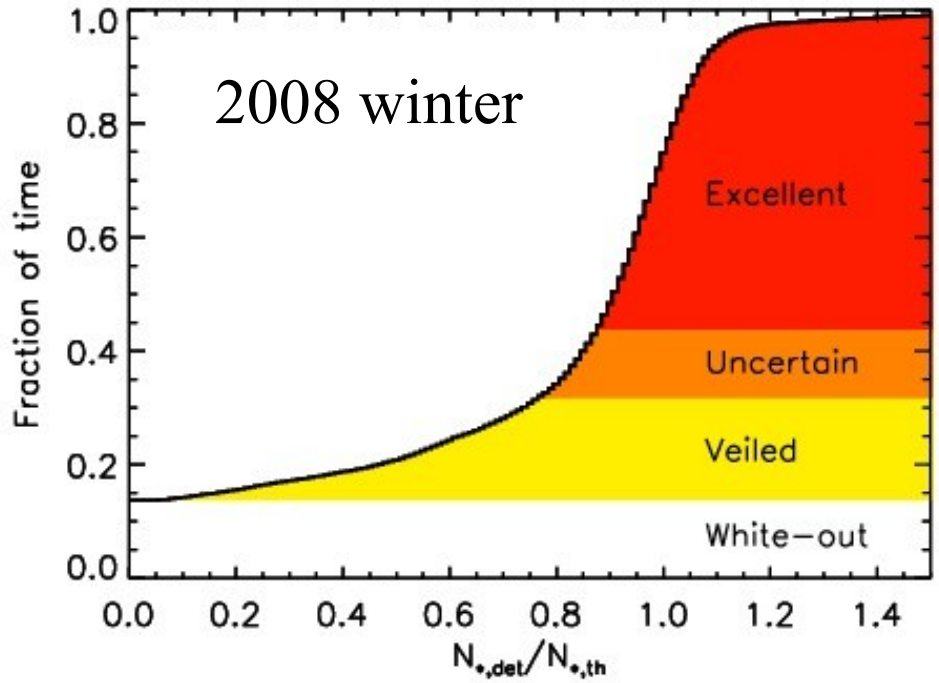


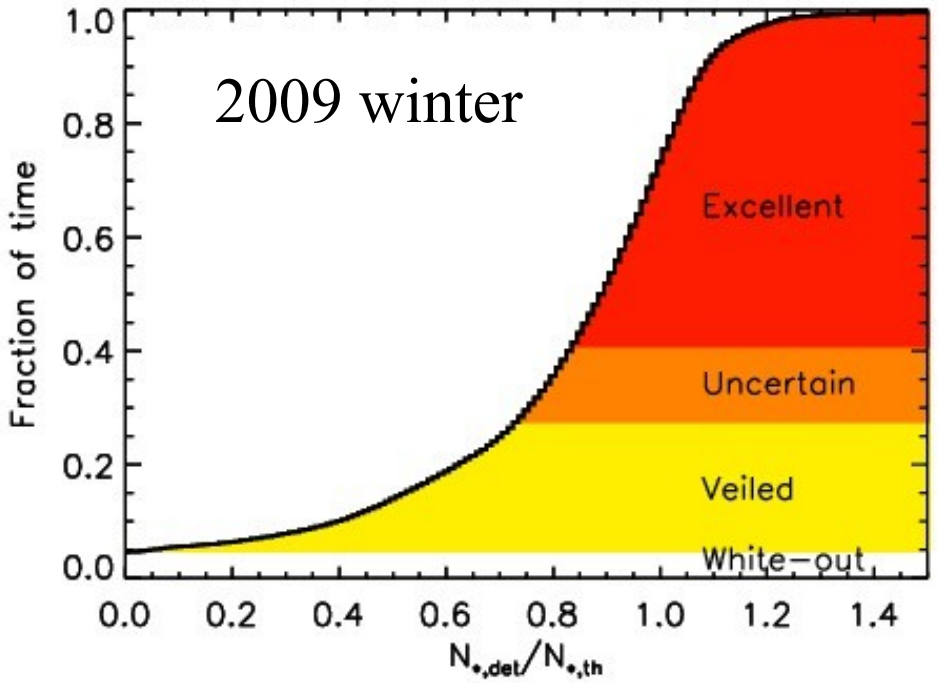




Summary of the ASTEP South 2008-2010 campaigns

Clear sky fraction at Dome C





Excellent weather: 56 to 68%

Excellent weather: 59 to 73%

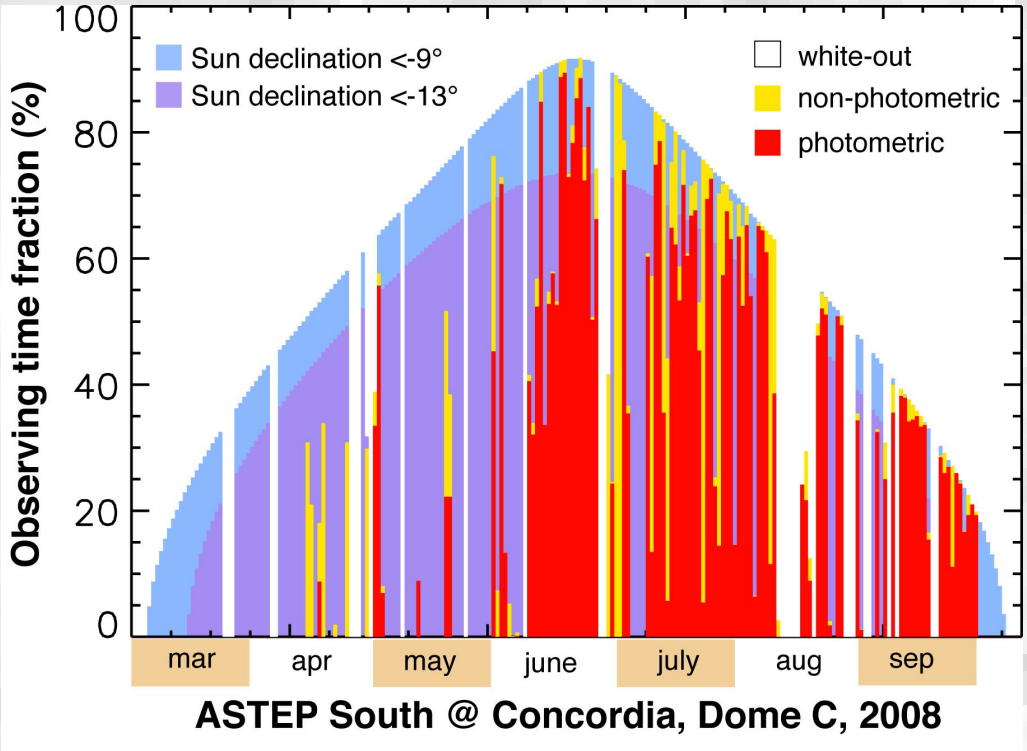
La Silla, Chile: 62 % - Mauna Kea, Hawaï: ~50 % - Paranal: 75 %

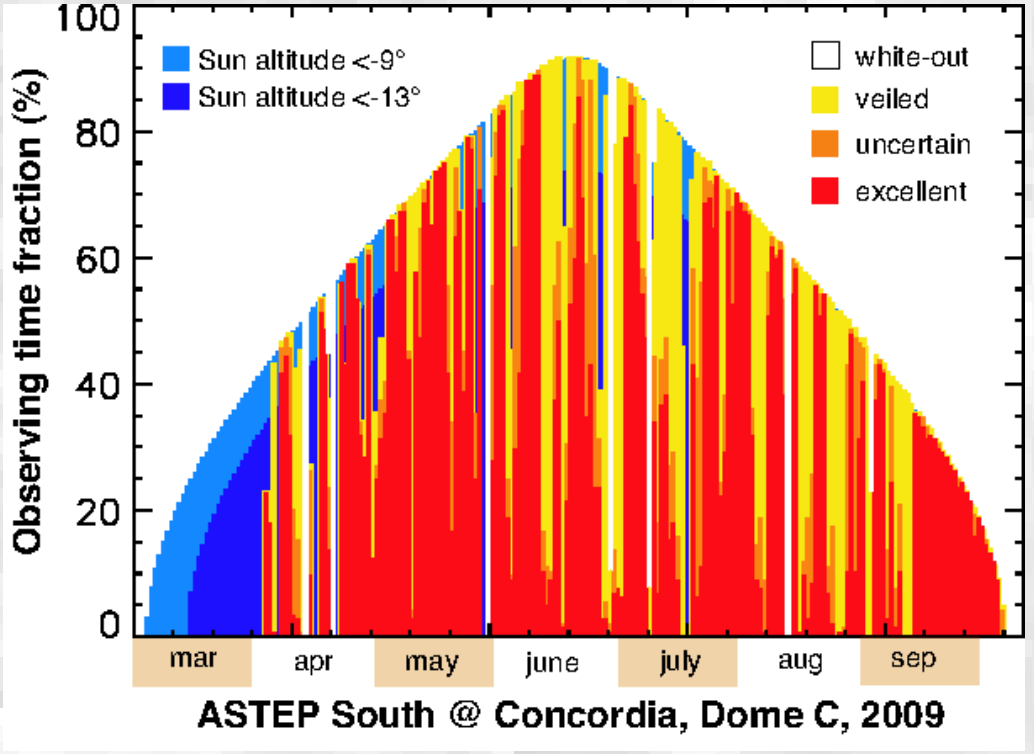
⇨ ***Dome C is competitive compared to the best astronomical sites in the world***



Summary of the ASTEP South 2008-2010 campaigns

Histograms of the ASTEP South data





2008: 1592 hours of data
1034 hours with excellent or uncertain weather

2009: 2990 hours of data (2442 w/Sun < 9°)
1754 hours with excellent or uncertain weather

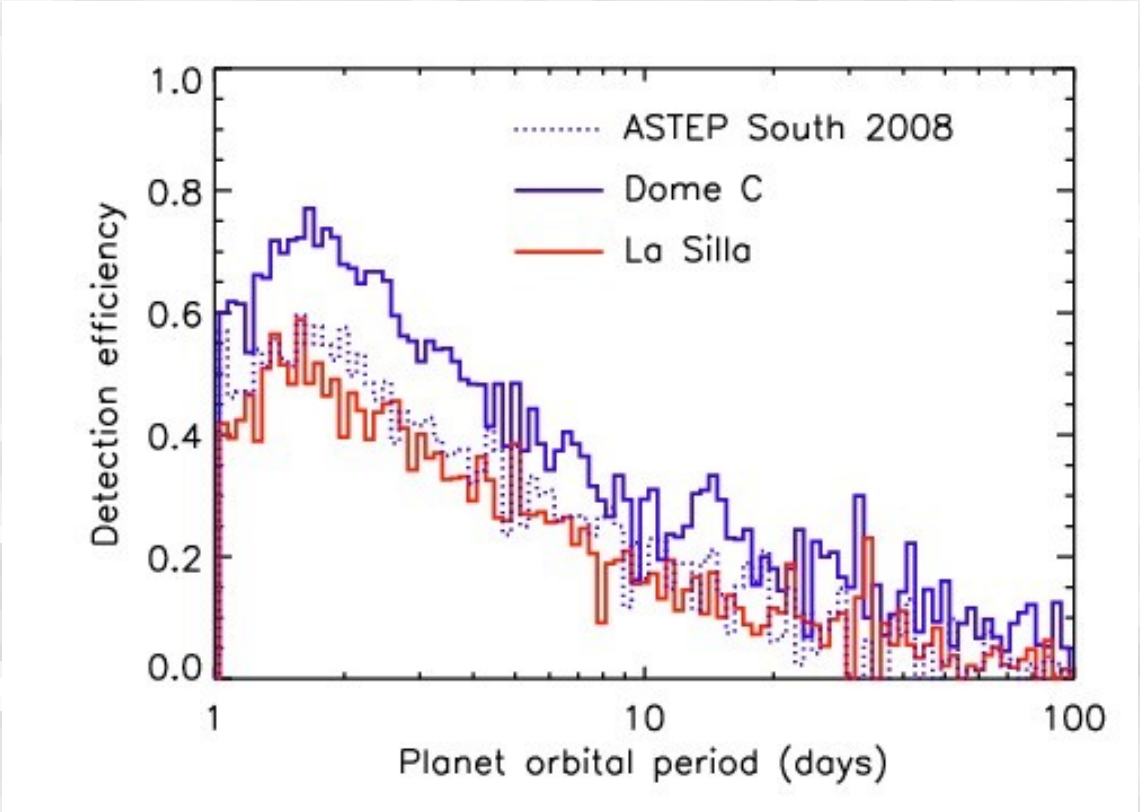
2010: observations all the winter



Summary of the ASTEP South 2008-2010 campaigns

Potential of Dome C for transit detection

Simulations for a single field observed during one complete year



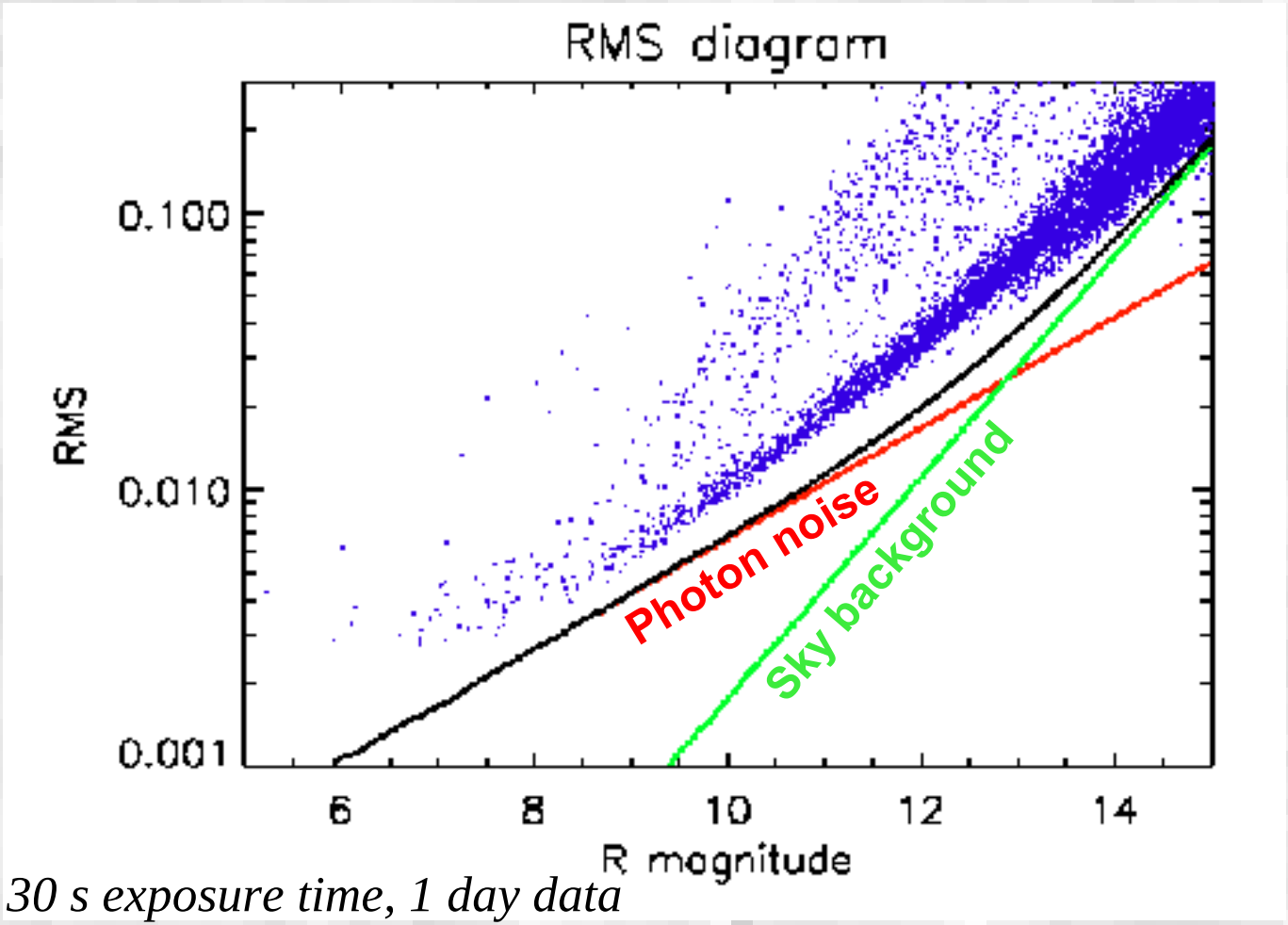
⇨ Detection efficiency: **69% at Dome C** vs **45% at La Silla** for 2-day period giant planets around 10 < V < 15 stars



Summary of the ASTEP South 2008-2010 campaigns

Lightcurve extraction

Image calibration
Point source identification (DAOPHOT)
Field matching to identify star with respect to a catalog
Aperture photometry (DAOPHOT)
Comparison with reference stars



30 s exposure time, 1 day data

3-4 mmag for the brightest stars



Summary of the ASTEP South 2008-2010 campaigns

Conclusion

3 years of data for 8000 stars

Unique data base for the South pole field

Clue information about running an instrument at Dome C

Qualification of Dome C for photometry: competitive compared to the best astronomical sites in the world

Long phase coverage: potential for detection of small planets, long period planets and stellar variability

CSTAR at Dome A
(Zou et al. 2010)

