

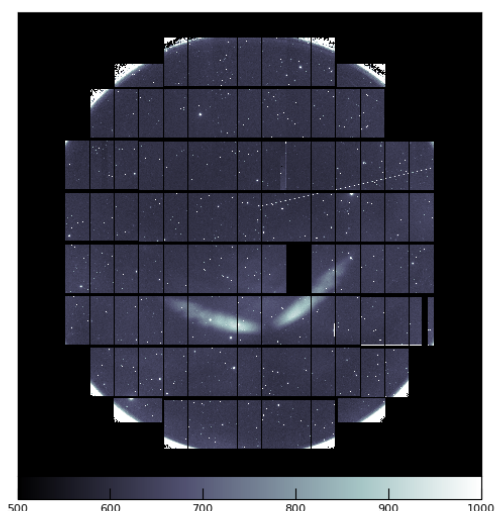
Ghost in HSC images taken at low elevation

Mar 16, 2021

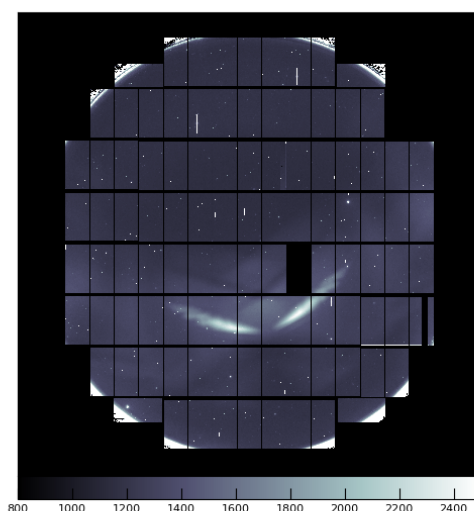
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1. Stray light in science exposures

- Large ghost appeared in HSC science images taken with the r2-band filter at low elevation ($EL \sim 30^\circ$) toward around the east ($AZ \sim 80^\circ$) during evening twilight in February 2021.
- Although the same field was taken under the almost same conditions in the evenings of consecutive 4 nights, the ghost appeared only in the images obtained on the 1st and 3rd nights. There was no ghost in the images on the 2nd and 4th nights.
- The rear vent was opened in the 1st and 3rd nights, while it was closed in the 2nd and 4th nights.



1st night: 51 minutes after sunset
r2-band, $AZ=79^\circ$, $EL=29^\circ$, $InR=-77^\circ$



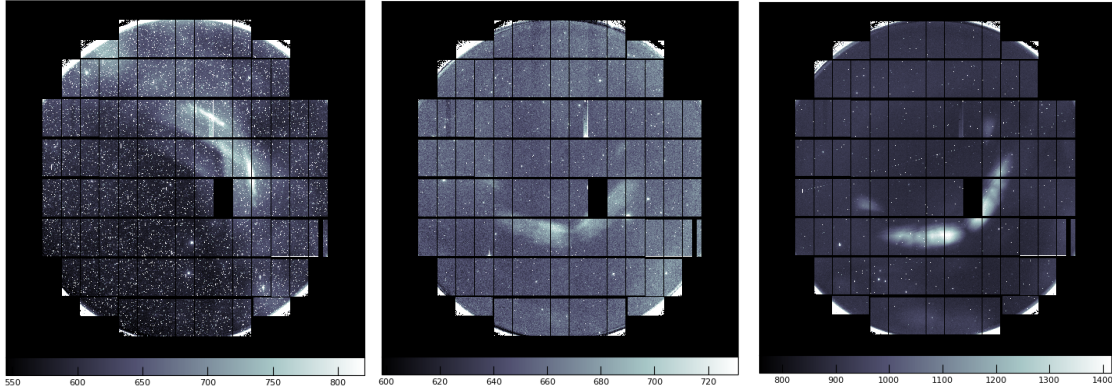
3rd night: 45 minutes after sunset
r2-band, $AZ=79^\circ$, $EL=30^\circ$, $InR=-77^\circ$

[Ventilator status]

	Front	Rear	Side A	Side B	Side C	Side D
1st night	Opened	Opened	Opened	Opened	Closed	Closed
2nd night	Closed	Closed	Opened	Opened	Closed	Closed
3rd night	Closed	Opened	Closed	Closed	Opened	Opened
4th night	Closed	Closed	Closed	Closed	Closed	Closed

2. Past data

- Ghosts with the similar pattern were found in several of the past HSC data in the r2-band taken at low elevation toward around the east during evening twilight.
- The same kind of ghosts also appeared in the past data taken at low elevation toward the west during morning twilight.



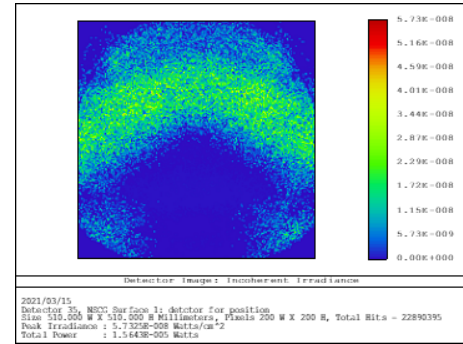
Jul 2017: 51 min after sunset
r2-band, AZ=121°, EL=31°

Nov 2018: 52 min after sunset
r2-band, AZ=80°, EL=24°

May 2020: 49 min after sunset
r2-band, AZ=119°, EL=28°

3. Ray tracing calculation

- The ghost image on HSC's detectors was calculated by ray tracing assuming the case that the telescope is inclined at 60° from the zenith and there is a light source of 9m × 3m at the rear vent (about 20 m away from the elevation axis).
- The resulting image (see the right figure) is consistent with those in the actual data if the light source is located at ~6 m in height from the elevation axis.



(created by Yoko Tanaka)

4. Conclusion

- The results of our investigation for this issue indicate that the stray lights were caused by **the afterglow of sunset** intruding into the dome inside through **the rear vent**.
- When we make an HSC imaging **at low elevation** (< 35°) toward around the east before the end of evening twilight or toward around the west after the start of morning twilight, **the rear vent should be closed** to avoid the occurrence of large ghost in the science data.