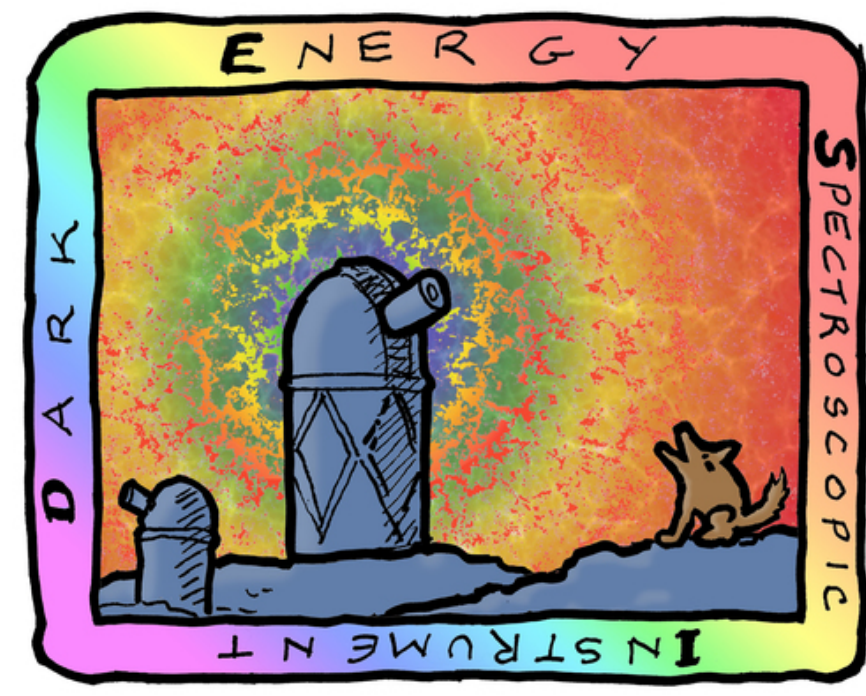


Performance of Kitt Peak's Mayall 4-meter Telescope During DESI Commissioning

Aaron M. Meisner¹, Behzad Abareshi¹, Arjun Dey¹, Connie Rockosi², Richard Joyce¹, David Sprayberry¹, Robert Besuner³, Klaus Honscheid⁴, David Kirkby⁵, Hui Kong⁴, Martin Landriau³, Michael Levi³, Ting Li⁶, Bob Marshall¹

¹NSF's NOIRLab, ²UCSC, ³LBNL, ⁴OSU, ⁵UCI, ⁶Carnegie

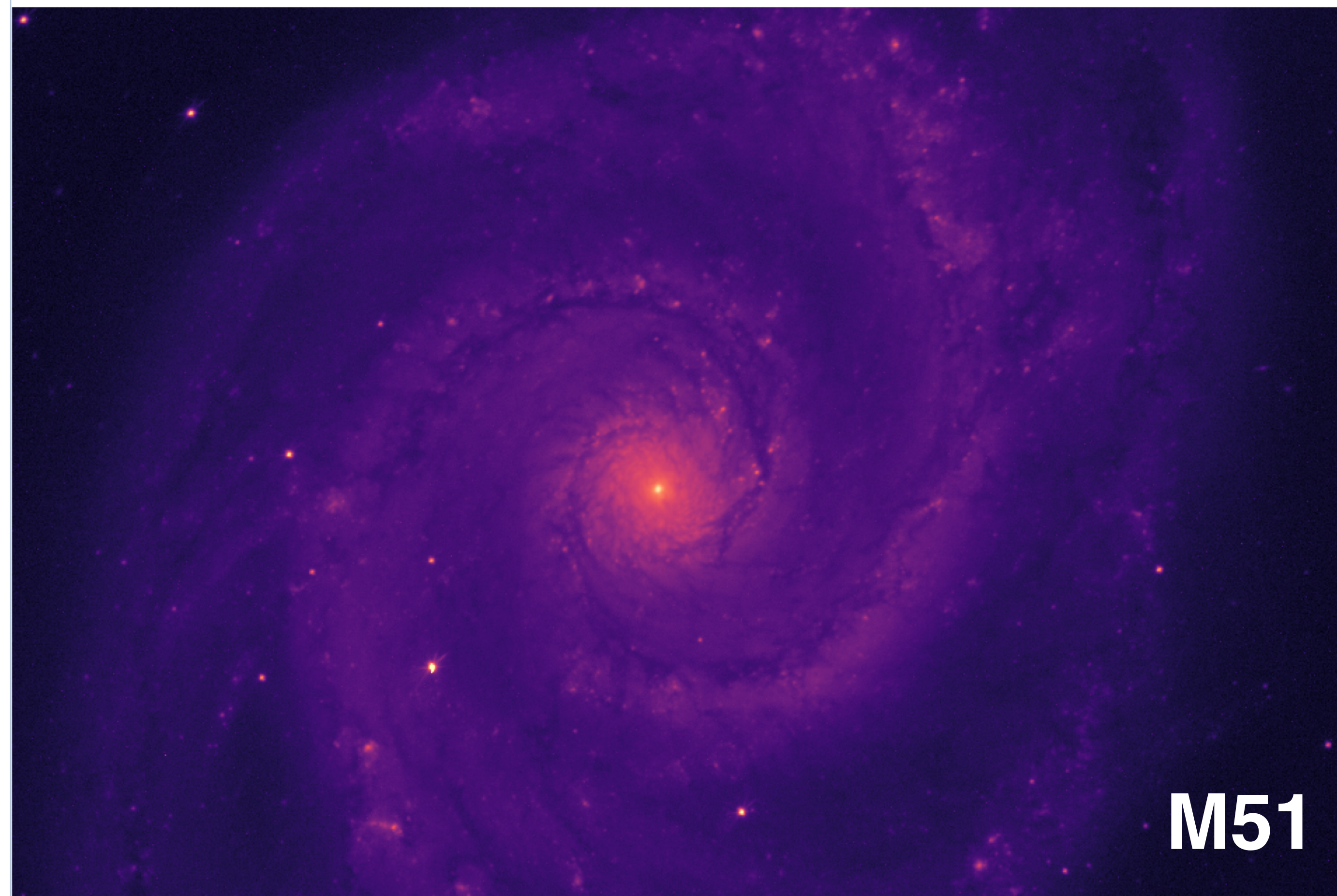


INTRODUCTION

In preparation for the Dark Energy Spectroscopic Instrument (DESI¹), a new top end was installed on the Mayall 4-meter telescope at Kitt Peak National Observatory. The refurbished telescope and the DESI instrument were successfully commissioned on sky between 2019 October and 2020 March. Here we describe the pointing, tracking and imaging performance of the Mayall telescope equipped with its new DESI prime focus corrector, as measured by six guider cameras sampling the outer edge of DESI's focal plane.

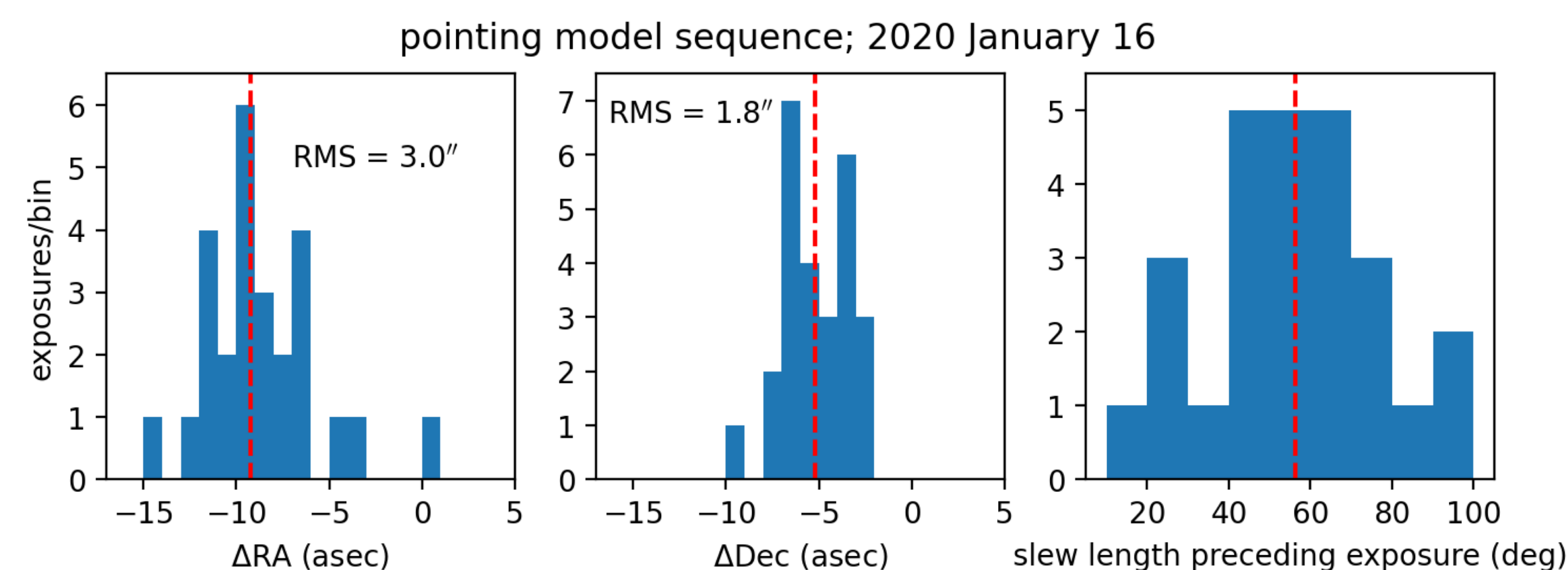
Kitt Peak's Mayall 4-meter telescope equipped with its new DESI top end, including the DESI corrector barrel (black) and top ring (white).

CORRECTOR FIRST LIGHT



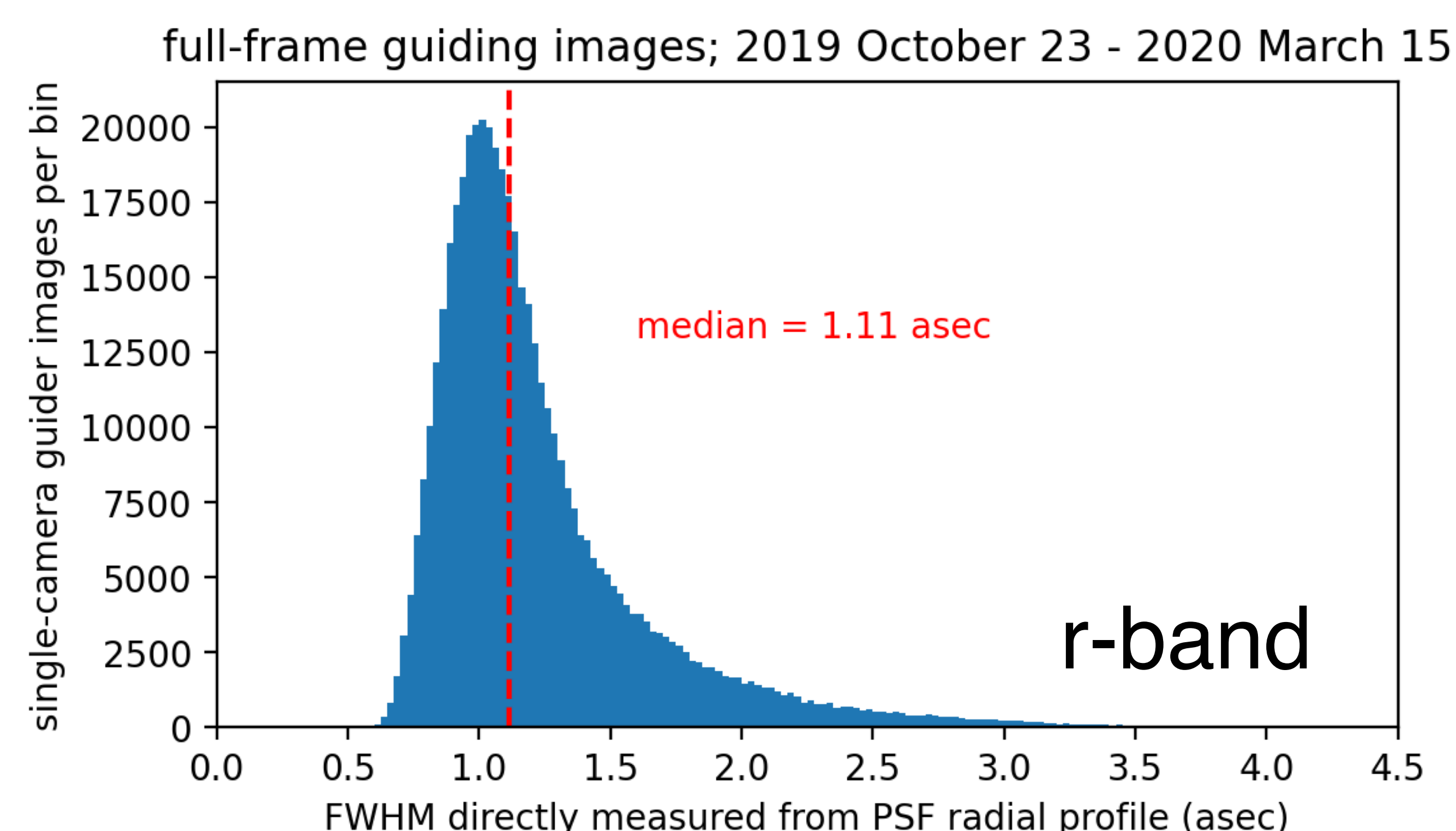
DESI corrector first light image (2019 April 1), acquired on-axis with the DESI Commissioning Instrument⁵ and 0.7" FWHM.

POINTING & TRACKING



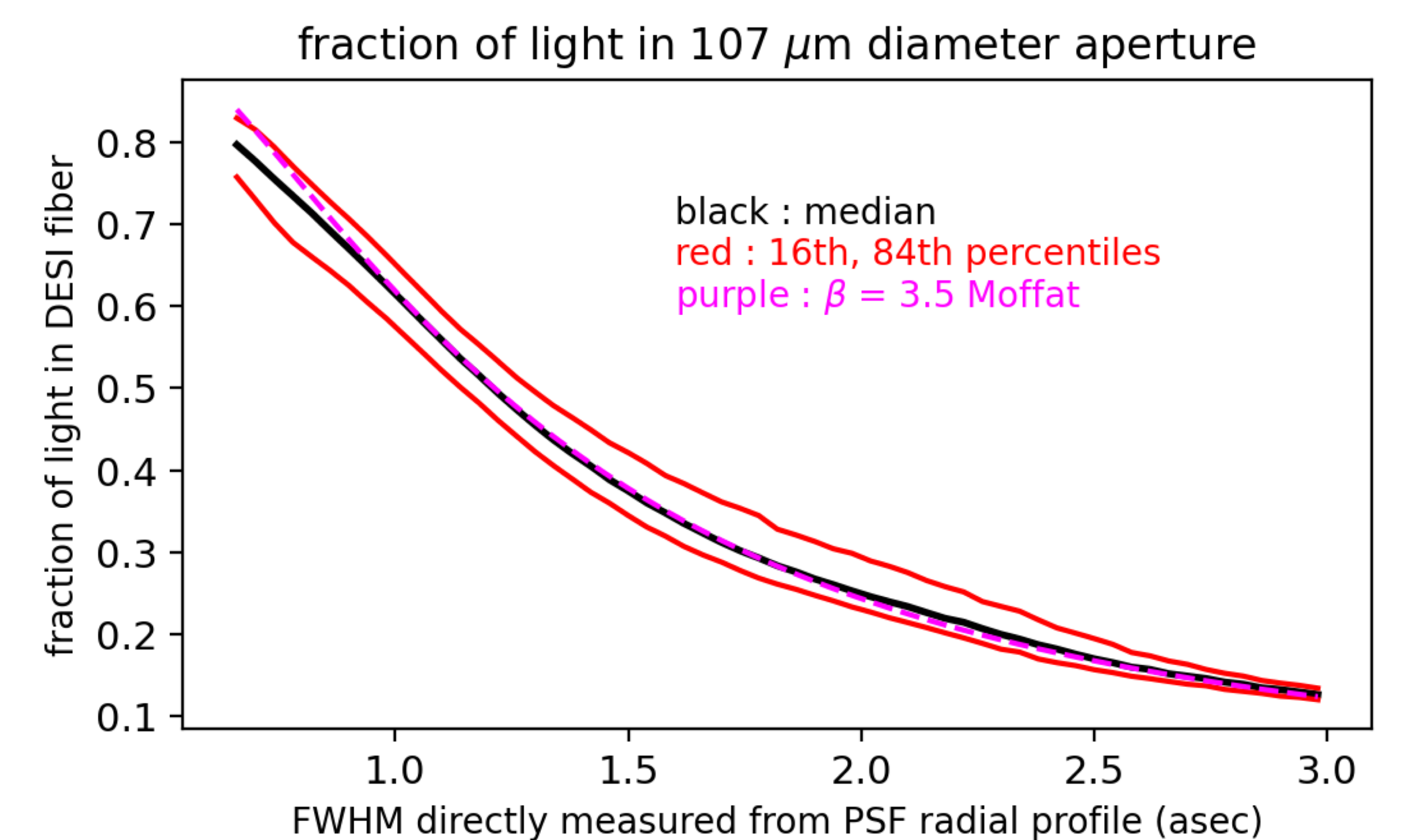
The Mayall/DESI RMS pointing accuracy is a few arcseconds per coordinate, similar to the Mayall's pre-DESI performance^{3,4}.

DELIVERED IMAGE QUALITY

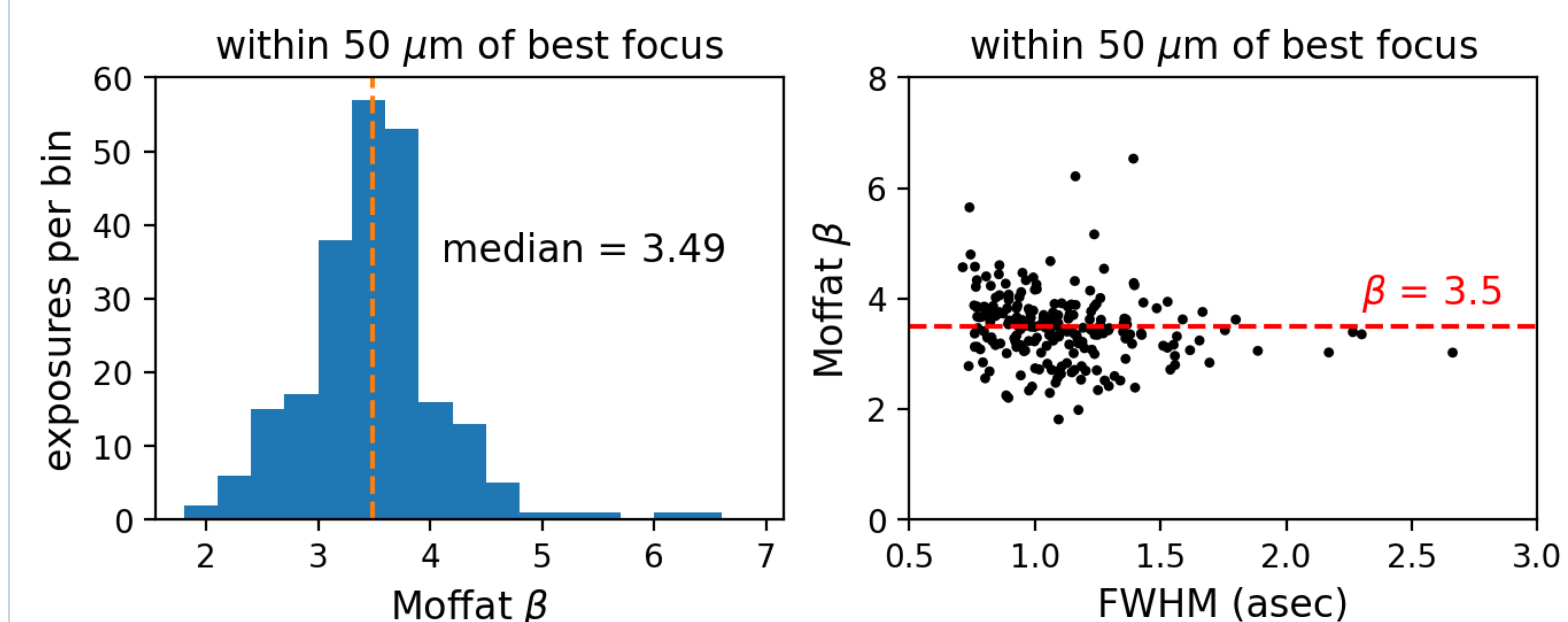


FWHM distribution for ~500,000 full-frame DESI guider images on 92 observing nights. The median FWHM of 1.11" is very similar to the pre-DESI R-band median⁶ FWHM of 1.17".

DELIVERED IMAGE QUALITY



Fraction of light entering a 107 micron diameter DESI fiber as a function of FWHM. The measured trend (black) is almost identical to that expected for a $\beta = 3.5$ Moffat profile (purple).



Left: distribution of Mayall/DESI Moffat β , with a median of $\beta = 3.49$. Right: there is little dependence of β on FWHM.

CONCLUSIONS

1. Mayall/DESI provides excellent pointing accuracy (~3" RMS), similar to the Mayall's pre-DESI pointing.
2. Mayall/DESI achieves tracking drift of ~20 mas/minute, similar to the Mayall's pre-DESI tracking.
3. Mayall/DESI provides median r-band delivered image quality of FWHM = 1.1", similar to the Mayall's pre-DESI image quality.

The Mayall/DESI image quality is all the more impressive since we are comparing DESI guider images that are 1.6 degrees off axis with the on-axis MOSAIC images from the Mayall's pre-DESI configuration.

REFERENCES

1. [M. Levi+ \(2013\)](#)
2. [DESI Collaboration \(2016\)](#)
3. [B. Abareshi+ \(2016\)](#)
4. [D. Sprayberry+ \(2016\)](#)
5. [A. Ross+ \(2018\)](#)
6. [A. Dey & F. Valdes \(2014\)](#)

The authors are honored to be permitted to conduct astronomical research on Iolkam Du'ag (Kitt Peak), a mountain with particular significance to the Tohono O'odham Nation.



Schematic diagram of DESI's focal plane², which resides at the Mayall's prime focus. The six DESI guider cameras (red) are located 1.57 degrees off axis and enable our telescope performance analysis. DESI's guiders observe in the r-band.

