



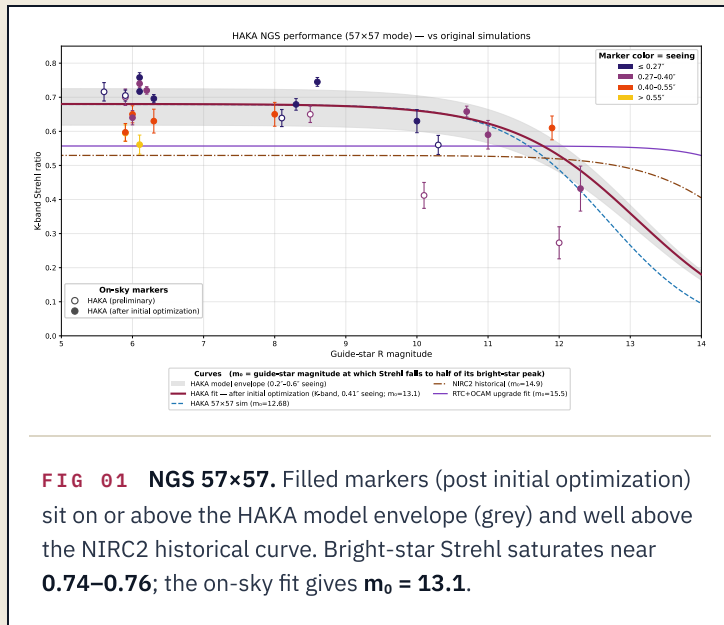
— HIGH-ORDER DM UPGRADE — KECK II ADAPTIVE OPTICS —

# On-sky 57×57 performance *meets* — *and beats* — the original HAKA prediction models.

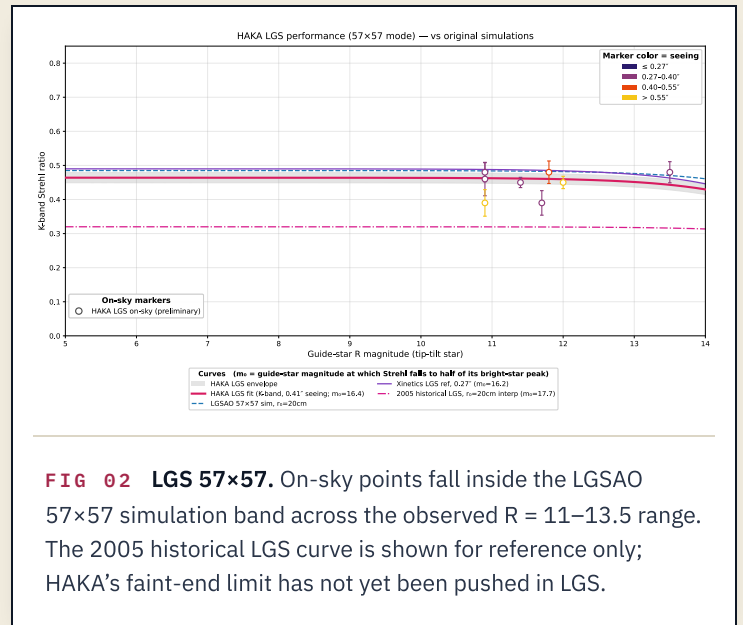
Early on-sky data from the HAKA high-order DM upgrade tracks the design-phase simulation envelope across both natural- and laser-guide-star modes. In 57×57, NGS Strehl on bright stars is significantly higher than the previous K2AO system, and LGS Strehl sits inside the predicted band. Figures show K2AO for reference only.

## 01 / VALIDATION On-sky 57×57 vs. original simulations

K-BAND STREHL · R MAGNITUDE



**FIG 01 NGS 57×57.** Filled markers (post initial optimization) sit on or above the HAKA model envelope (grey) and well above the NIRC2 historical curve. Bright-star Strehl saturates near **0.74–0.76**; the on-sky fit gives  **$m_0 = 13.1$** .



**FIG 02 LGS 57×57.** On-sky points fall inside the LGS AO 57×57 simulation band across the observed  $R = 11–13.5$  range. The 2005 historical LGS curve is shown for reference only; HAKA’s faint-end limit has not yet been pushed in LGS.

**WHY X-AXIS STOPS AT R = 14** Faint guide-star data on-sky is still sparse — we have not yet observed enough targets at  $R > 14$  to fit there with confidence. The faint end of each plot will extend as we collect more nights, particularly in LGS where the tip-tilt-star faint limit has not been pushed.

PEAK NGS STREHL · K-BAND

**0.76** sr

57×57 · bright TT star · seeing ≤ 0.27"

PEAK LGS STREHL · K-BAND

**0.48** sr

57×57 ·  $R \approx 11$  tip-tilt · 0.27–0.40" seeing

NGS FAINT-END ·  $M_0$  SHIFT

**13.1** vs 12.7 sim

On-sky NGS fit beats the original 57×57 simulation by **~0.4 mag**. LGS faint-end remains to be characterized.

**STATUS & CAVEATS**

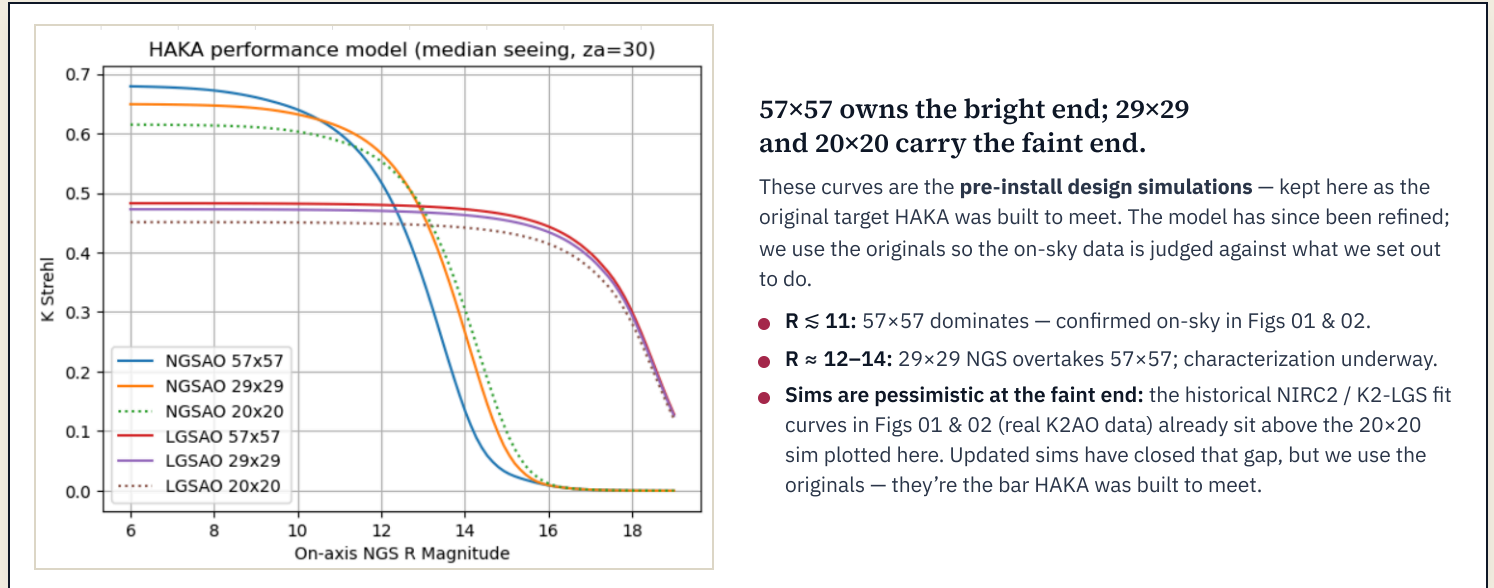
All on-sky data shown is **early and preliminary**. Characterization is ongoing for both **LGS** operation and the **29×29** mode; numbers and fits will be updated as additional nights are reduced. Figures reflect 57×57 mode after initial optimization passes.



— FORWARD LOOK & OPEN CHARACTERIZATION —

02 / ROADMAP **All-modes performance model — where 57×57 sits**

MEDIAN SEEING · ZA = 30°



**57×57 owns the bright end; 29×29 and 20×20 carry the faint end.**

These curves are the **pre-install design simulations** — kept here as the original target HAKA was built to meet. The model has since been refined; we use the originals so the on-sky data is judged against what we set out to do.

- **R ≤ 11:** 57×57 dominates — confirmed on-sky in Figs 01 & 02.
- **R ≈ 12–14:** 29×29 NGS overtakes 57×57; characterization underway.
- **Sims are pessimistic at the faint end:** the historical NIRC2 / K2-LGS fit curves in Figs 01 & 02 (real K2AO data) already sit above the 20×20 sim plotted here. Updated sims have closed that gap, but we use the originals — they're the bar HAKA was built to meet.

03 / WHAT'S NEXT **Open characterization — to test on upcoming nights**

PRIORITY LIST

**01 · FAINT END**

**57×57 at faint guide-star magnitudes**

Push the  $m_0$  fits beyond R = 14 to confirm where 57×57 actually falls off on sky.

NGS LGS

**02 · MID SUB-APERTURE MODE**

**29×29 on-sky performance**

Validate the predicted crossover where 29×29 takes over from 57×57 in the R ≈ 12–14 regime.

NGS LGS

**03 · OFF-AXIS**

**Off-axis LGS tip-tilt performance**

Characterize how Strehl degrades as the tip-tilt star moves off axis.

LGS

**04 · HIGH-CONTRAST**

**Contrast at small inner working angles**

Measure raw and post-processed contrast to quantify HAKA's gain over K2 AO for companion detection.

IMAGING

**STATUS & CAVEATS**

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