The AstraLux Capabilities

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[www.MPIA.de/ASTRALUX]

[This presentation: www.MPIA.de/ASTRALUX/ASTRALUX_Capabilities_2018.pdf]

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AstraLux in a nutshell

High-speed Electron-Multiplying CCD cameras recording large number of frames (~10000) at frame rates ≥33 Hz

Applying the *Lucky Imaging* technique, nearly diffraction limited images can be achieved

The Lucky Imager AstraLux Norte
at the Calar Alto Observatory 2.2m telescope

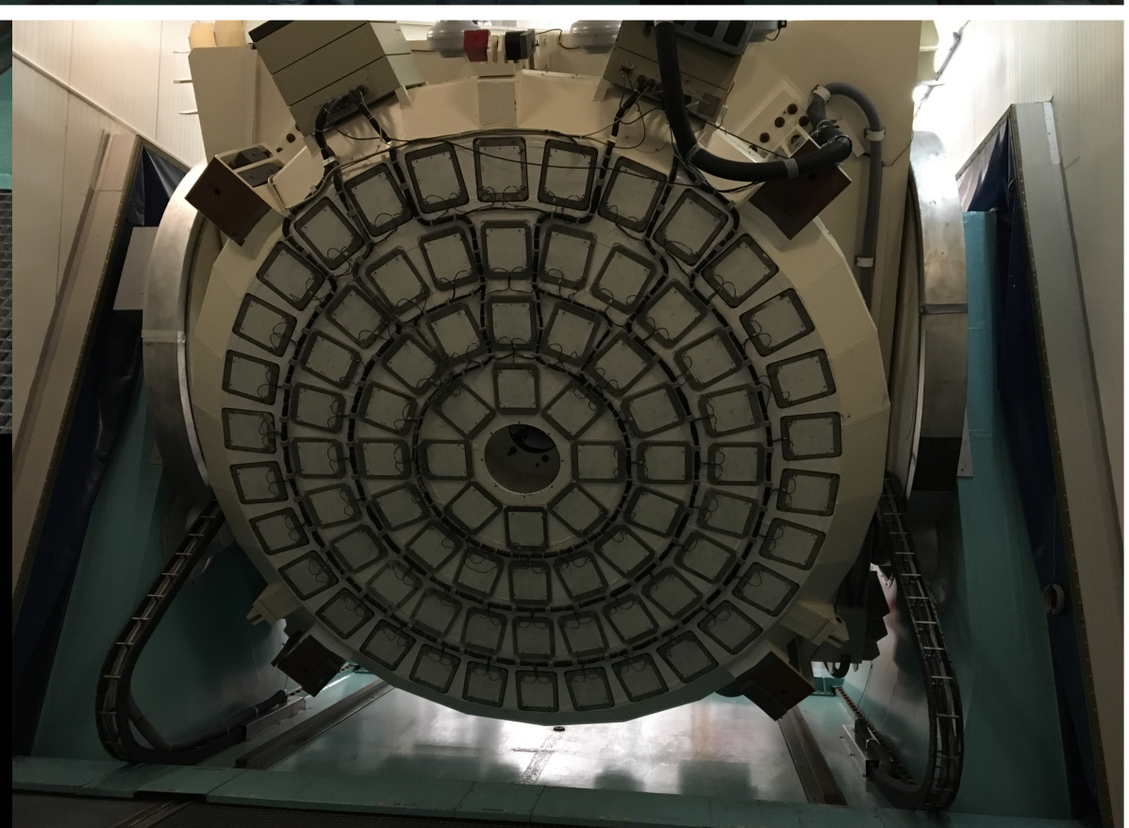
Calar Alto Observatory 2.2m telescope

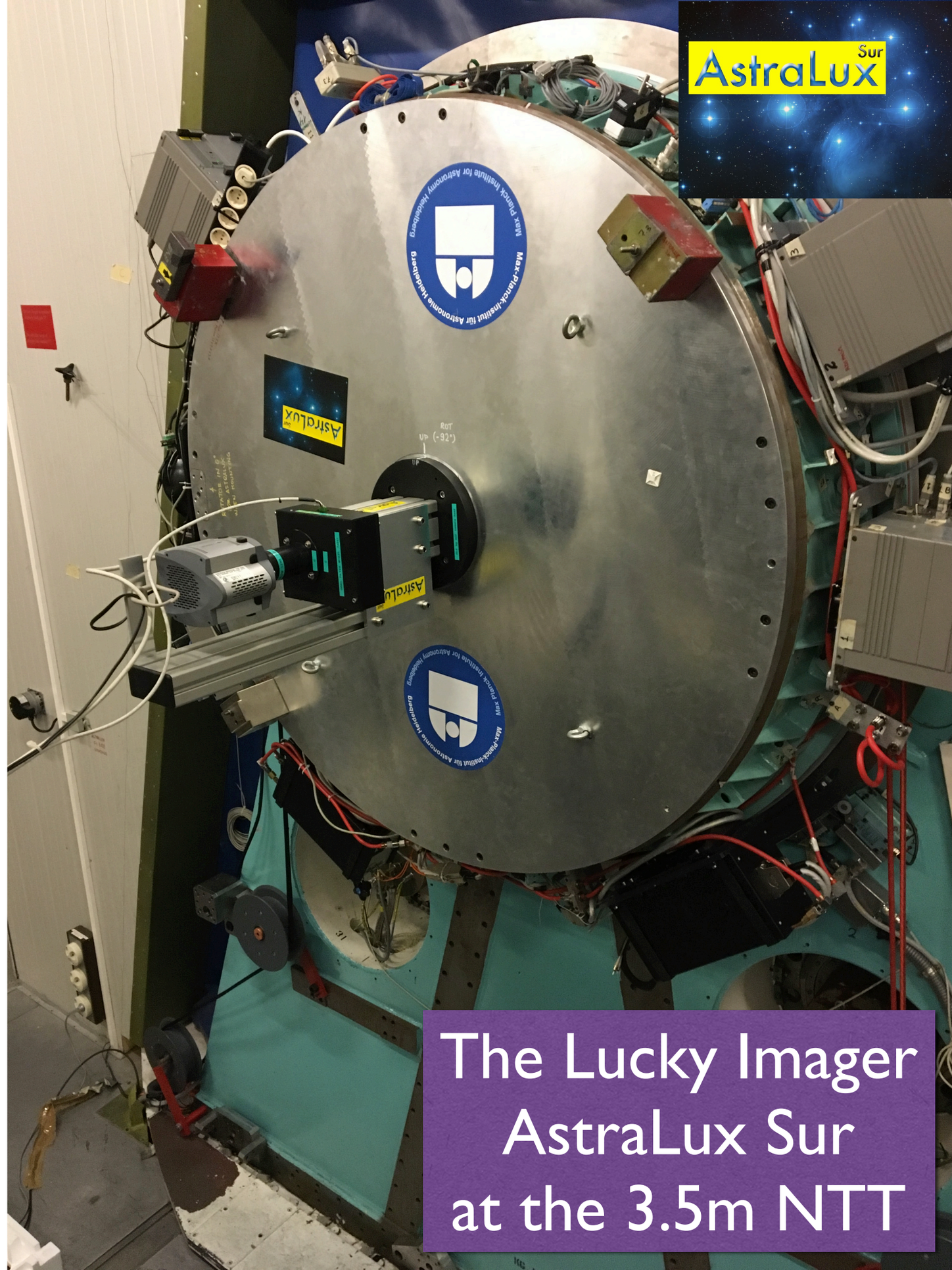
AstraLux

AstraLux Sur

La Silla Observatory
3.5m NTT

Credit: P. Horálek/ESO



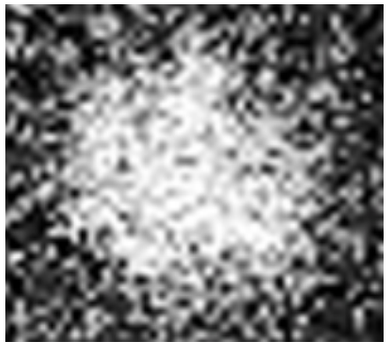


The Lucky Imager AstraLux Sur at the 3.5m NTT

Lucky imaging in words

- record short exposure images with individual exposure times close to the coherence time t_0 (**DIT <= 30ms**)
- calculate the Strehl ratio of all individual images
- sort all images according to their Strehl ratio
- select the highest 1%, 5%, 10% etc Strehl ratio images
- register (shift and add) each selected image using the brightest speckle
- resulting Lucky Image has Strehl ratio in I-band up to ~ 0.1 (factor of ~10 higher than long exposure)
- **typical FWHM achieved: 100 mas** (diffraction limits at 800nm: @2.2m=75 mas, @3.5m=47mas)

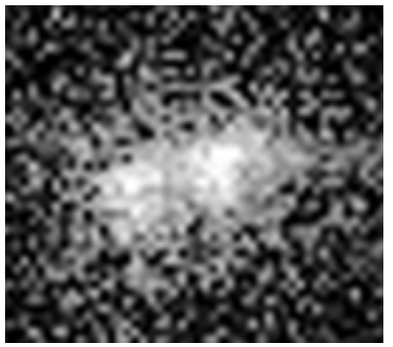
Lucky imaging visualized
[http://en.wikipedia.org/wiki/Lucky_imaging]

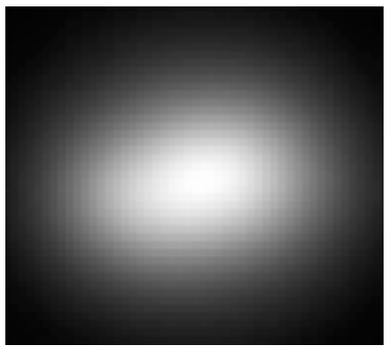


Frame with lowest Strehl ratio

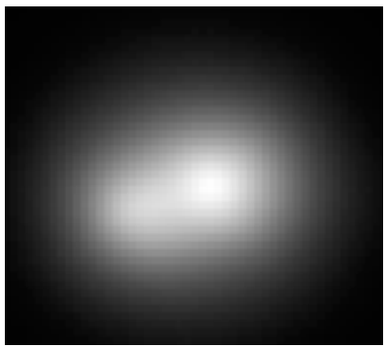
Stack of 50000 frames

Frame with highest Strehl ratio

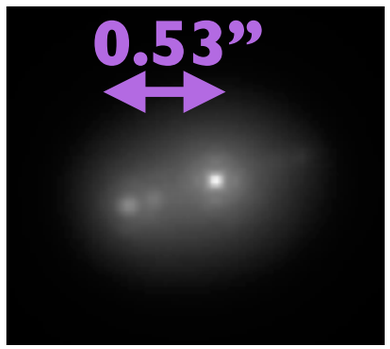




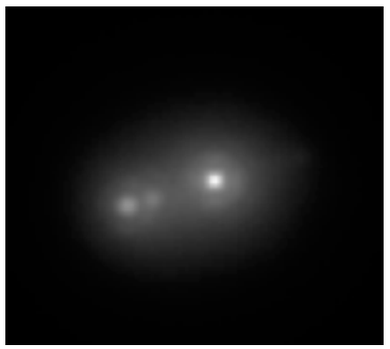
Sum of all 50000 frames



Sum of all 50000 frames with center of gravity shifted to the same reference position



Best 25000 frames with brightest pixel shifted to the same reference position

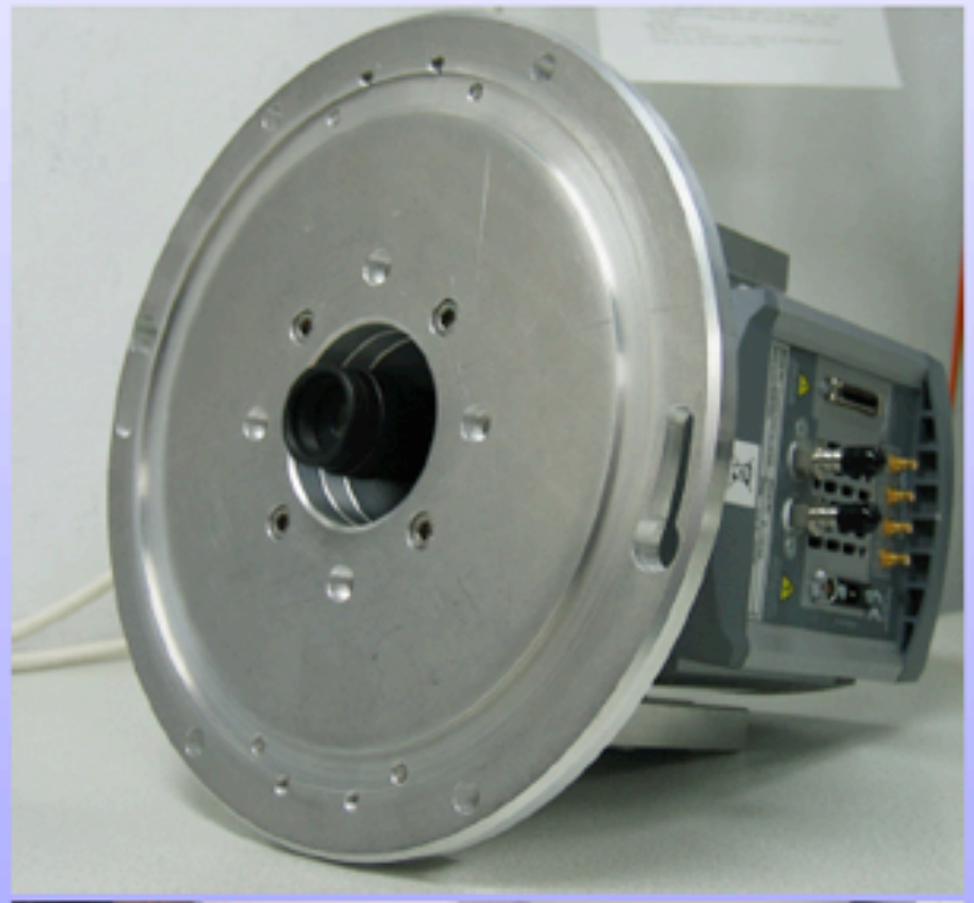


Best 5000 frames with brightest pixel shifted to the same reference position

Best 500 frames with brightest pixel shifted to the same reference position

Triple system (M4, M4.5, M5.5) discovered with Astralux Norte,
V~14.5, DIT: 25ms, RG830, Janson et al. 2012.

Norte



Barlow lens:

- Simple NIR-optimized Barlow lens, all components off-the-shelf
- Magnification $\approx$4
- 47mas/px at Calar Alto 2.2m
- Field of view: 24" x 24"

Filter wheel at Calar Alto:

- Existing wheel, just reactivated electronics
- 8 positions for standard 50mm filters
- Mounted in the refurbished IA-1

Sur

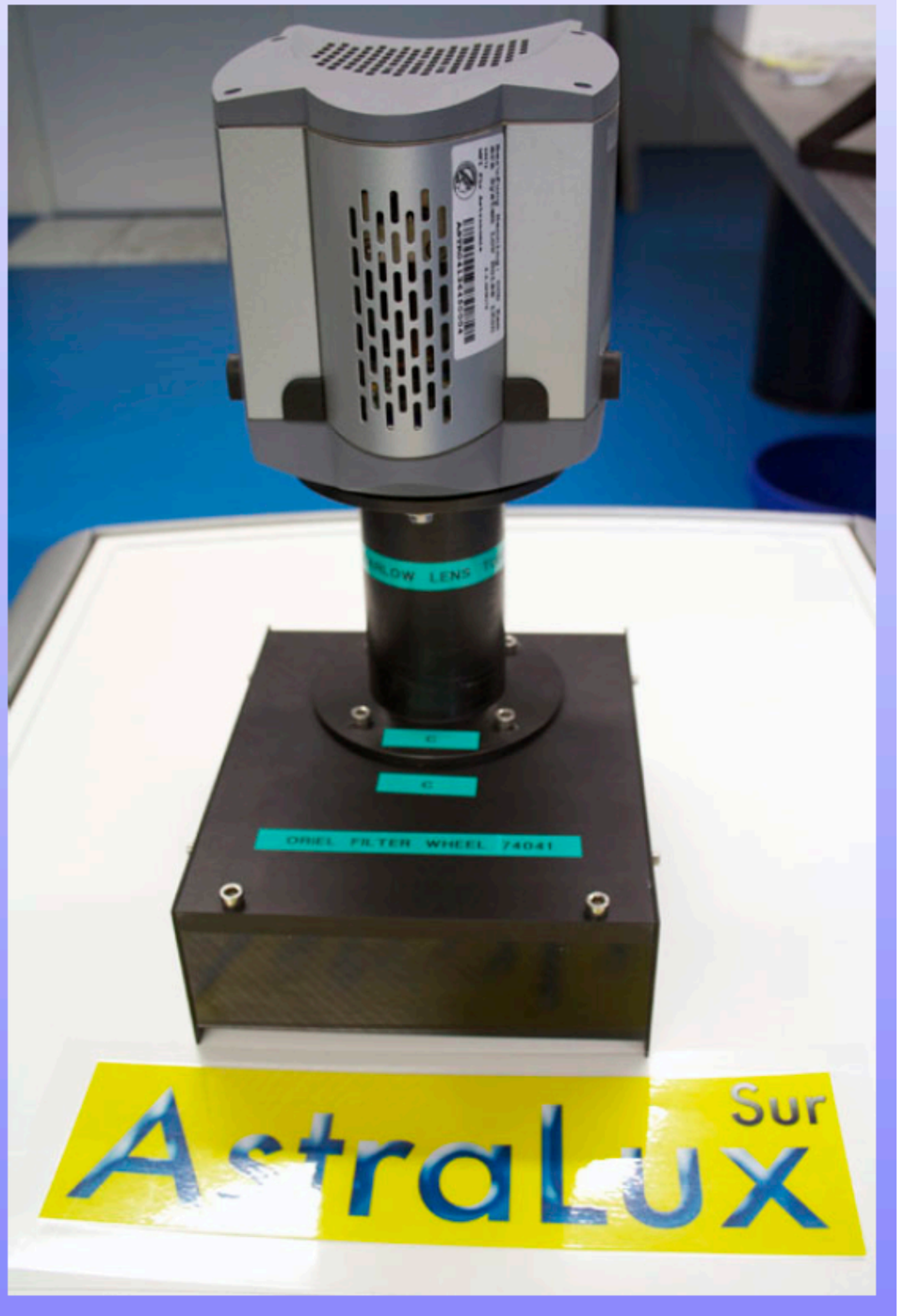
Barlow lens:

- Simple NIR-optimised Barlow lens, all components off-the-shelf
- Magnification ≈3
- 31mas/px at La Silla NTT
- Field of view: ≈16”x16”

Filter wheel at La Silla NTT:

- Oriel Filter Wheel System 74041 with RS232 interface
- 6 positions for standard 25.4mm (1 inch) filters

Image orientation: North is up and East points to the right.



Exemplary results I

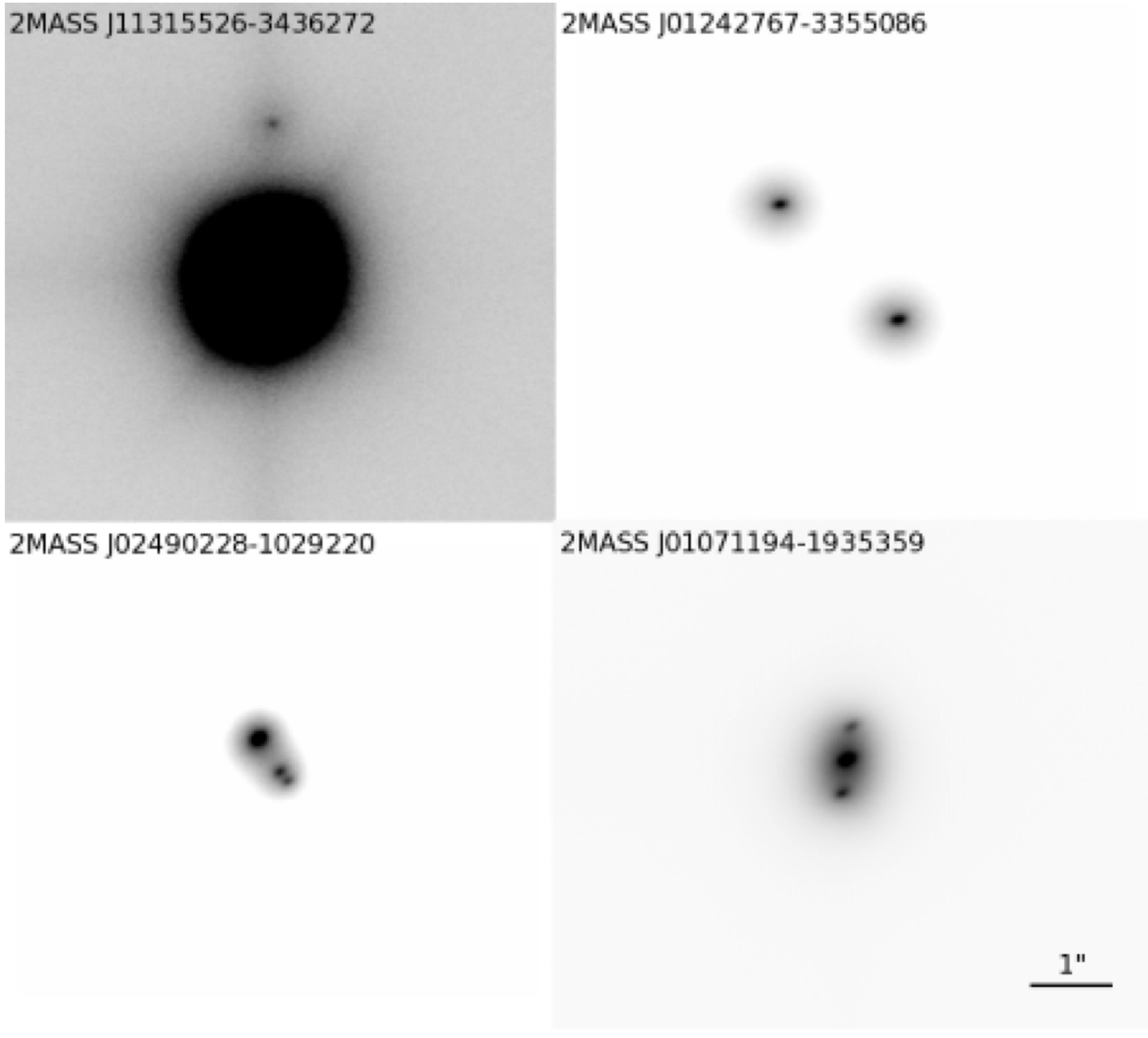


Figure 1. Four examples of multiple systems imaged in the AstraLux survey. Top left: a high-contrast binary. Top right: a low-contrast binary. Bottom left: a triple system. Bottom right: a binary displaying the fake triple effect, common for close low-contrast binaries. All images are in z', and in each case north is up and east is to the left.

Exemplary results II

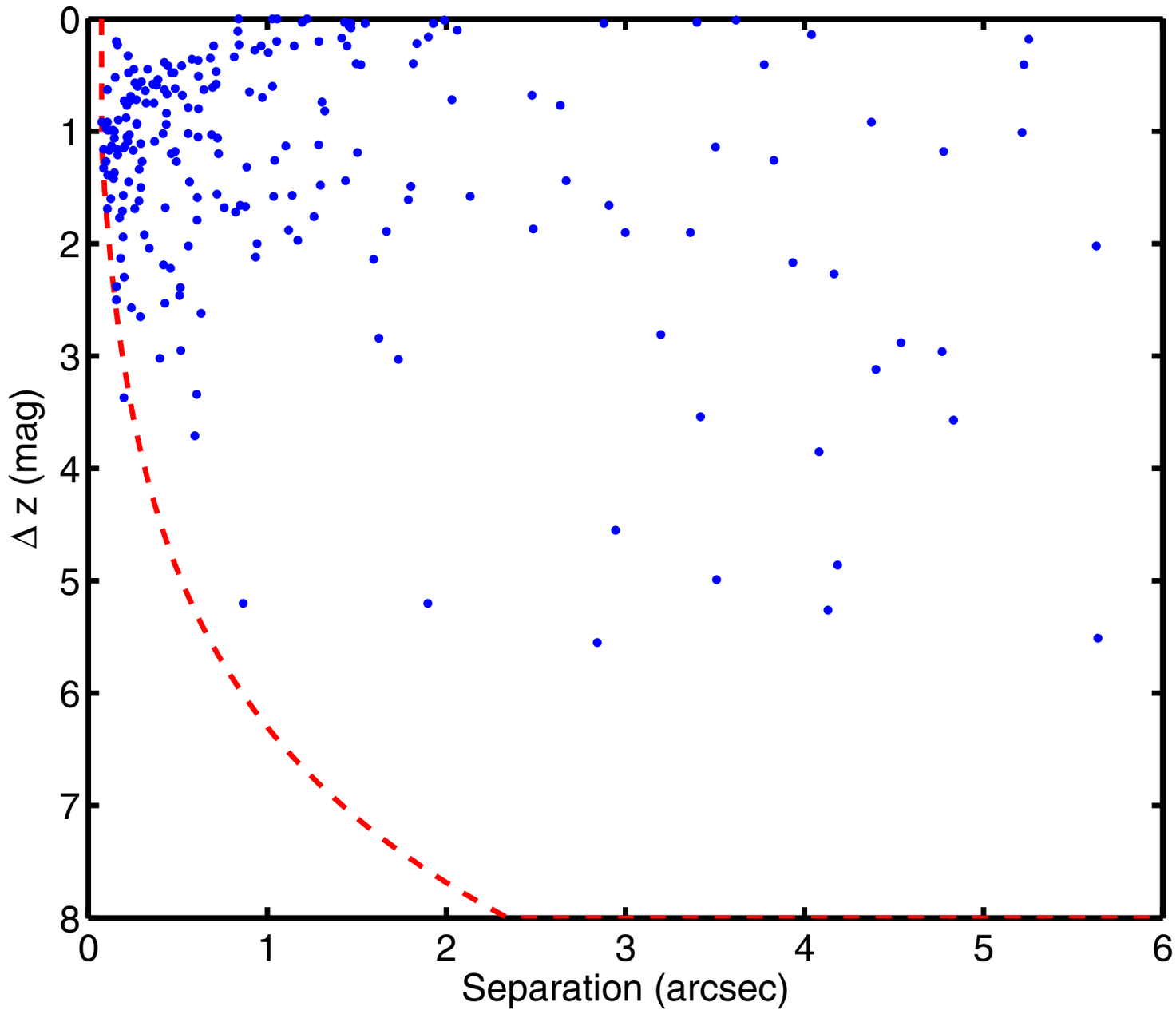
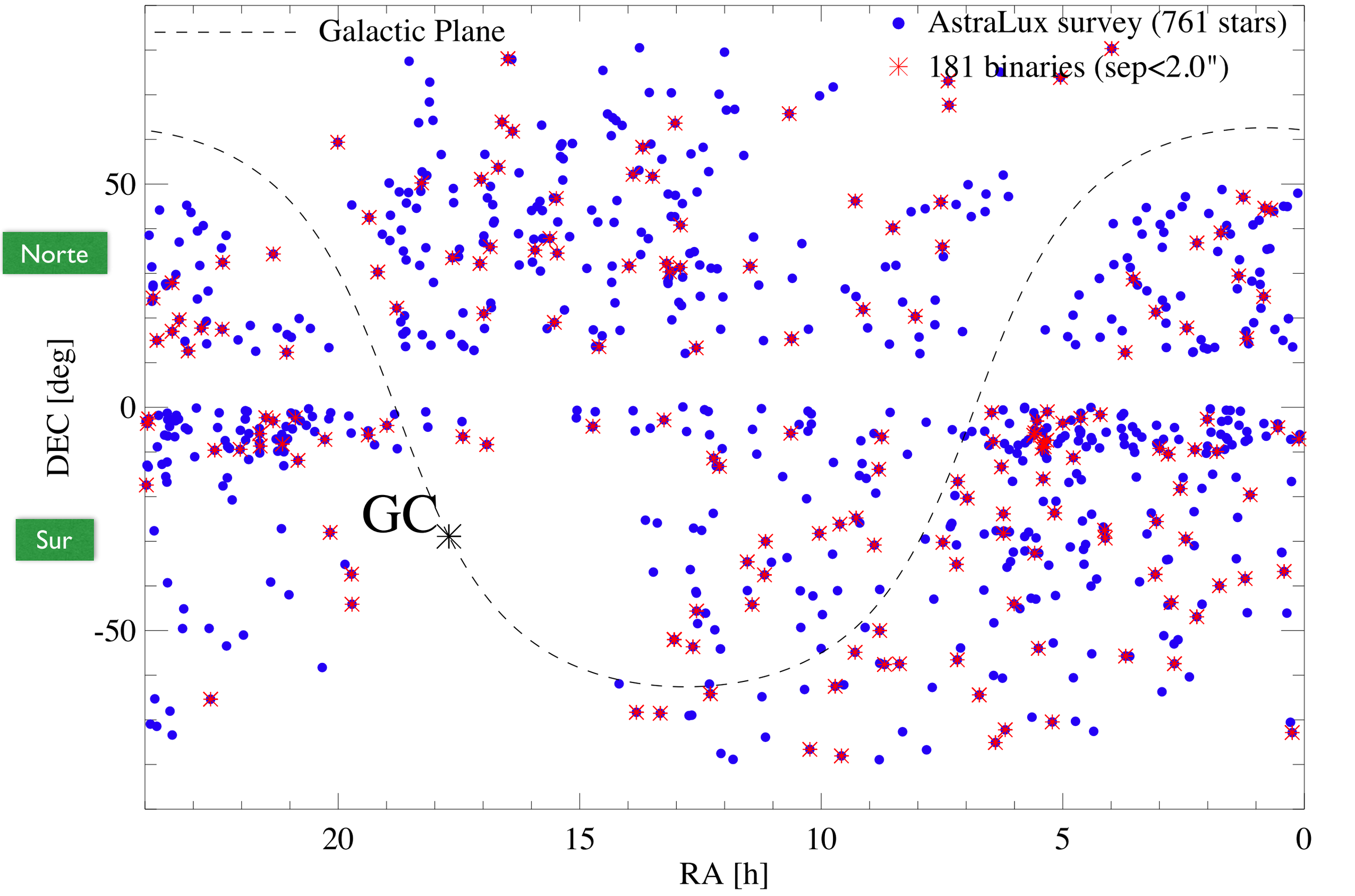


Figure 2. Separation and brightness difference in z' for all binary pairs detected with AstraLux, plotted along with the typical AstraLux detection limit. The small zone in the upper left that shows a lack of objects is likely due to a bias that tends to systematically overestimate the brightness difference for close pairs of nearly equal brightness.

Contrast vs separation

Sky chart

Janson et al. 2012



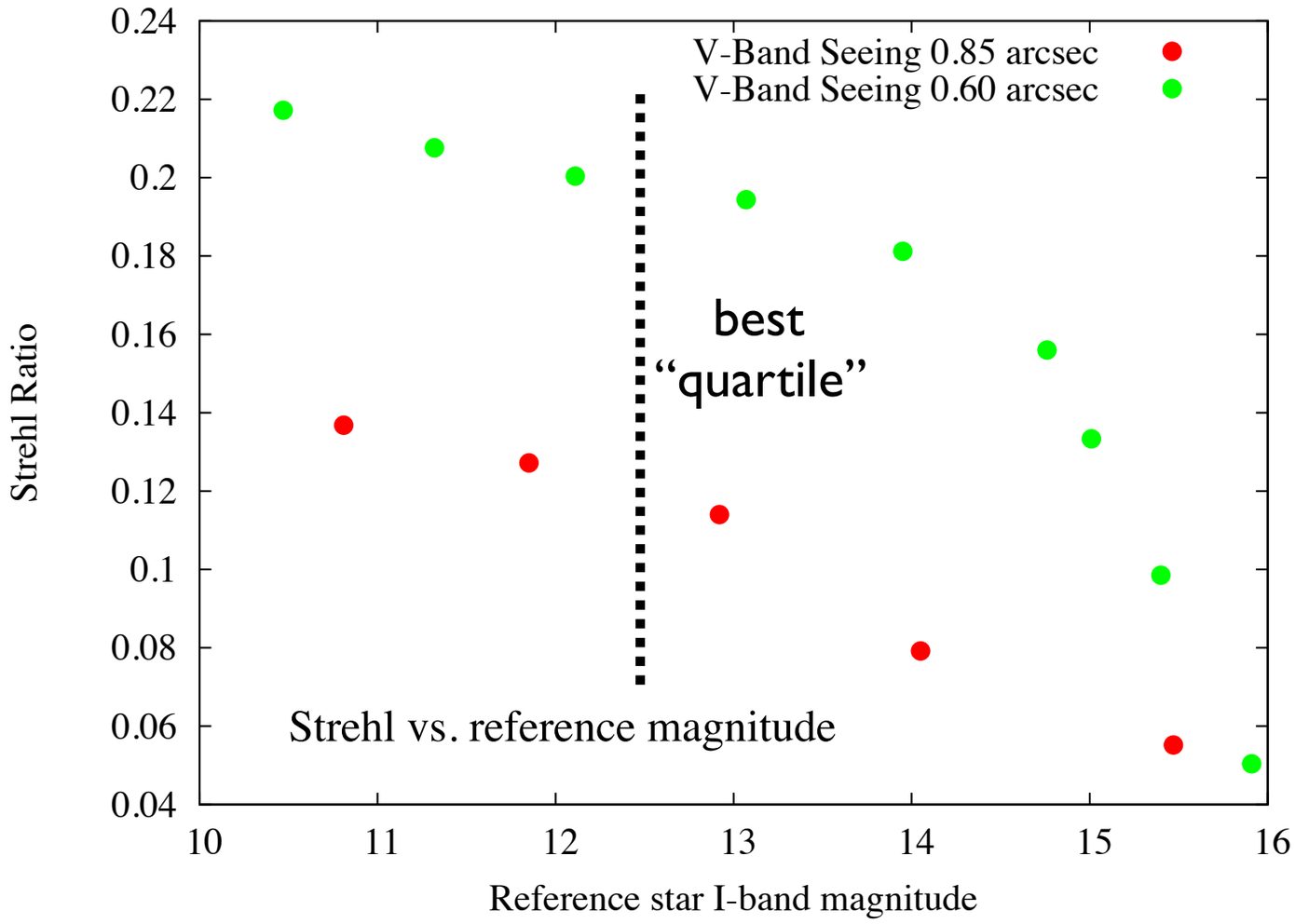


Figure 5.22. *Dependency of the final Strehl ratio on natural seeing and reference star magnitude. The plot is valid for observations with 30 ms single frame exposure times in SDSS z' and 1% image selection rate. All Strehl ratios were measured on stars that were less than 2″ separated from the reference source.*

Access 2018 and beyond

- Calar Alto, 2018b:
  MPIA receives 16 GTO nights at the 2.2m telescope. Available instruments are CAFOS, **AstraLux**, BUSCA and CAFE

- La Silla, P102: (AstraLux Sur=SpecialNTT)

NTT: The fraction of the available time on the NTT committed to ongoing Large Programmes is $\sim 35\%$, particularly in dark and grey conditions. Bright time is generally undersubscribed and proposers should consider whether their science case can successfully exploit these conditions.

Access beyond 2020 unclear; SOXS first light
https://www.eso.org/public/teles-instr/lasilla/ntt/soxs/

Option for La Silla: move AstraLux Sur to the MPG 2.2m telescope next door