

Multi-site All-Sky CAmeRA **MASCARA**



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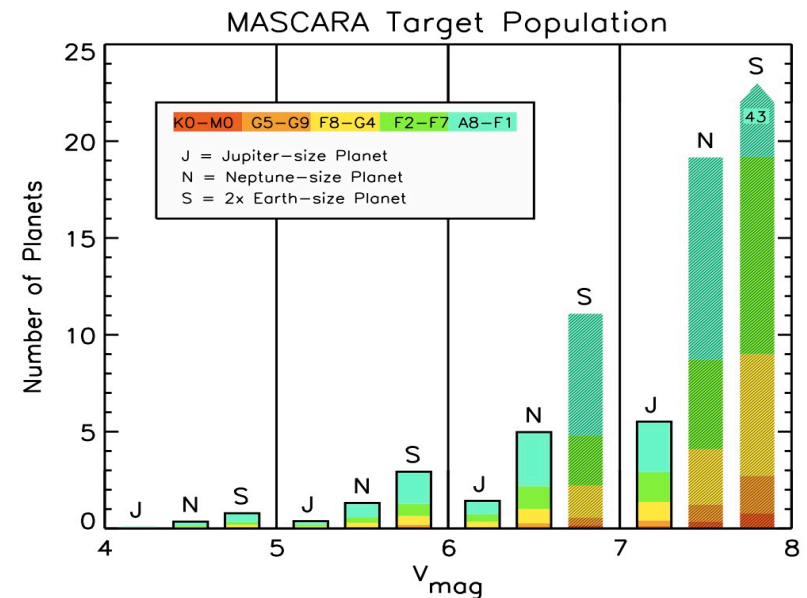
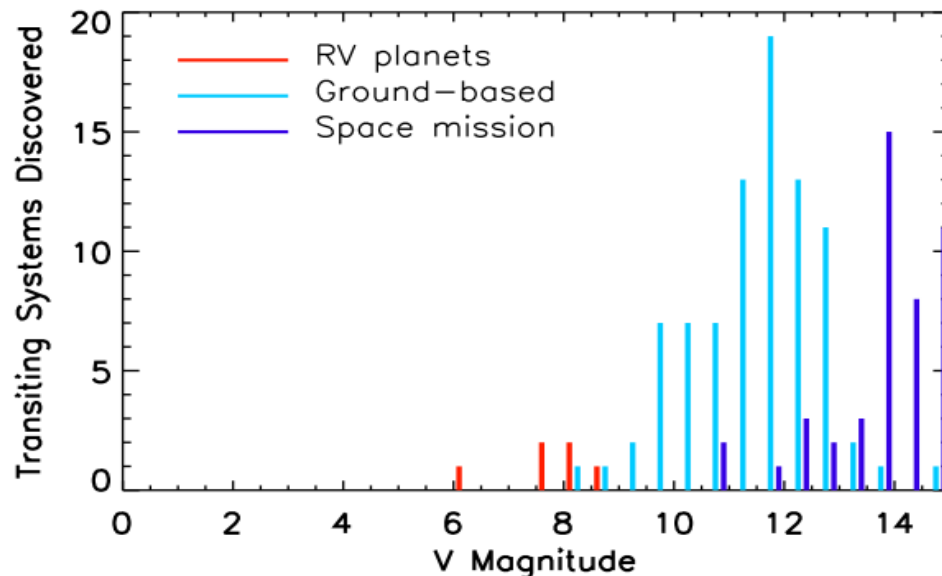
- **Aim:** To find the brightest transiting exoplanets in the sky
Key-targets for exoplanet atmosphere studies
- **Concept:** Two stations – each, battery of wide-field cameras
Monitoring near-entire sky at each location
low-cost components



MASCARA Science



- RV and Transit surveys → population transiting systems at $V=4-8$.
- Current transit surveys do not cover this magnitude regime
- All known transiting planet at $V < 8$ were found first by RV
only small fraction of stars is RV monitored
- We need a bright-star transit survey → MASCARA



MASCARA time line



Funding secured	2012
Project Start	August 2012
Design Phase	Jan 2013 – Jul 2013
Construction	July 2013 – July 2014
Operation La Palma Station	From Oct 2014 (Jan 2015)
Operation La Silla Station	From July 2016

Great synergy with NASA TESS mission (2017)

High precision + short baseline

VS

lower precision +long baseline

Designing and building MASCARA



Julien Spronck



Anna-Lea Lesage



Remko Stuik

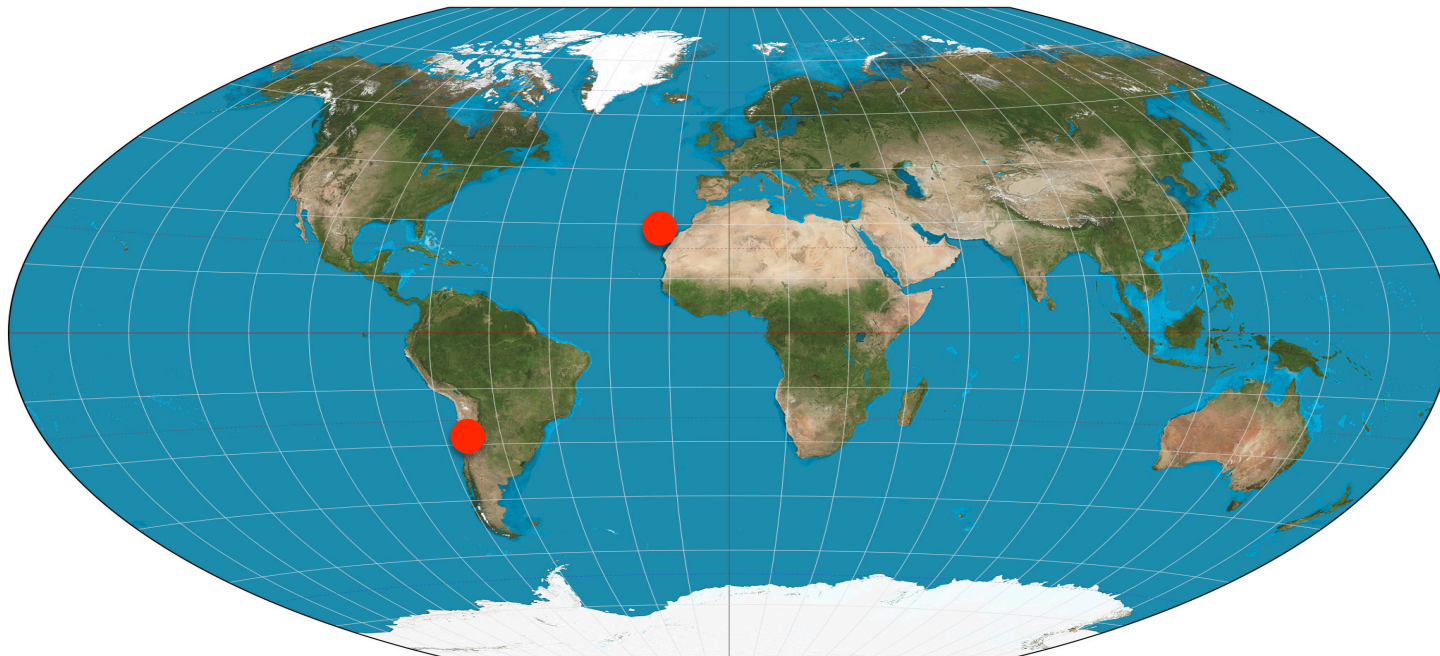


Geert Jan Talens

MASCARA design considerations



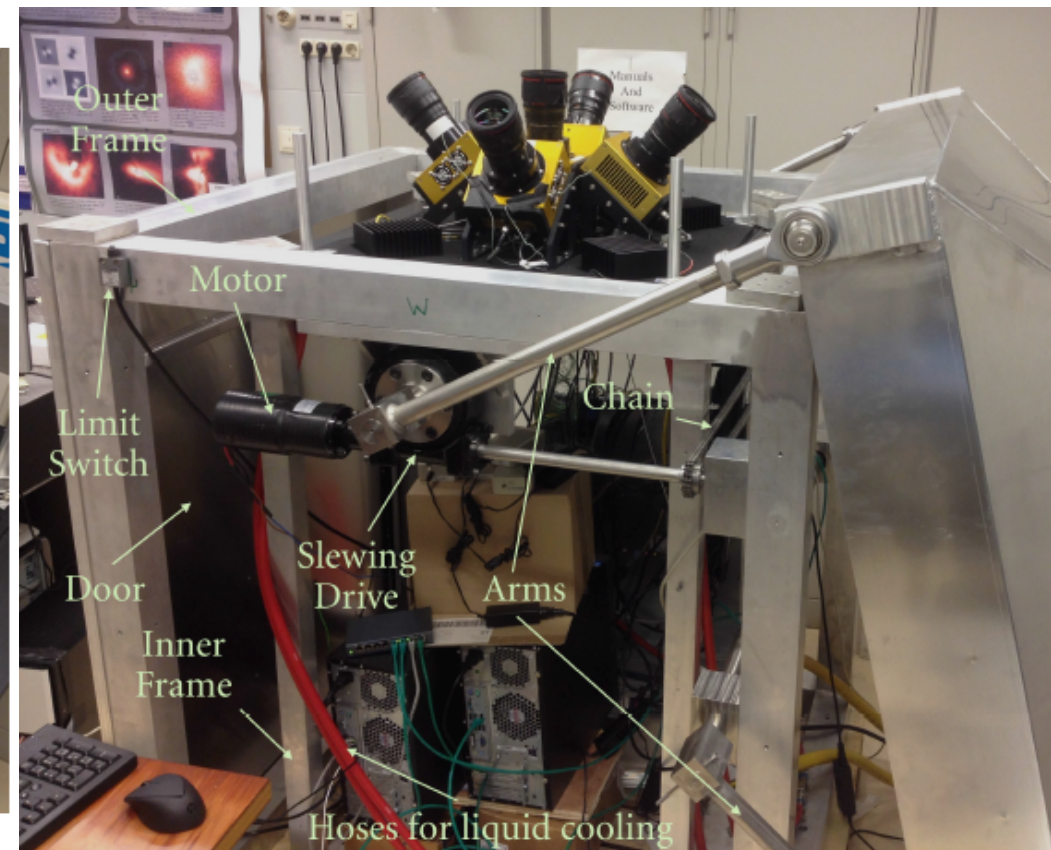
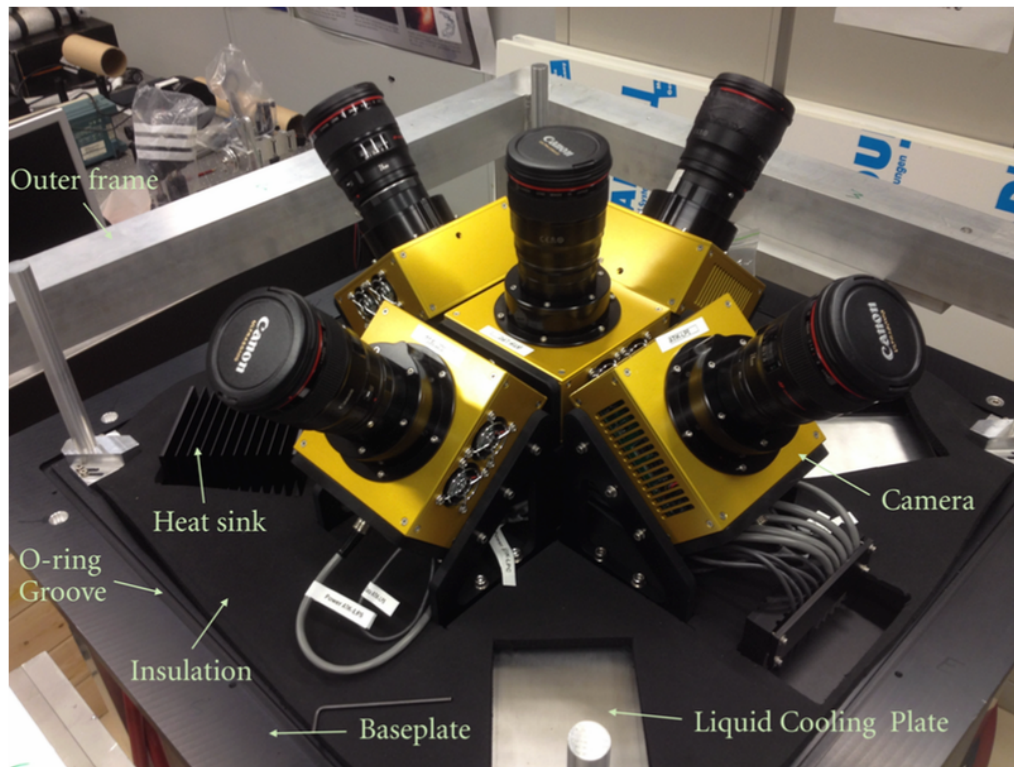
- Magnitude range: $4 < V < 8$
- SNR = 100 per hour for $V=8$ star (we get SNR=100 per 5 mins)
- All sky - airmass < 2 (< 3)
- Automatic, low maintenance, low cost, 3-5 yr lifetime
- Northern and Southern hemisphere coverage (≥ 2 stations).



MASCARA design



- 5 Cameras – fixed (North, South, East, West, Central)
- 24 mm F/1.4 Canon lenses [53 x 74° FOV]
- Atik 11000 interline CCD: 4008x2672 (9x9 um) pixels [kodak]
- 6.4 sec exposures at fixed siderial times



MASCARA design



- Automated roof (the only moving part)
- Computer equipment in SuperWASP enclosure
- Temperature controlled camera box



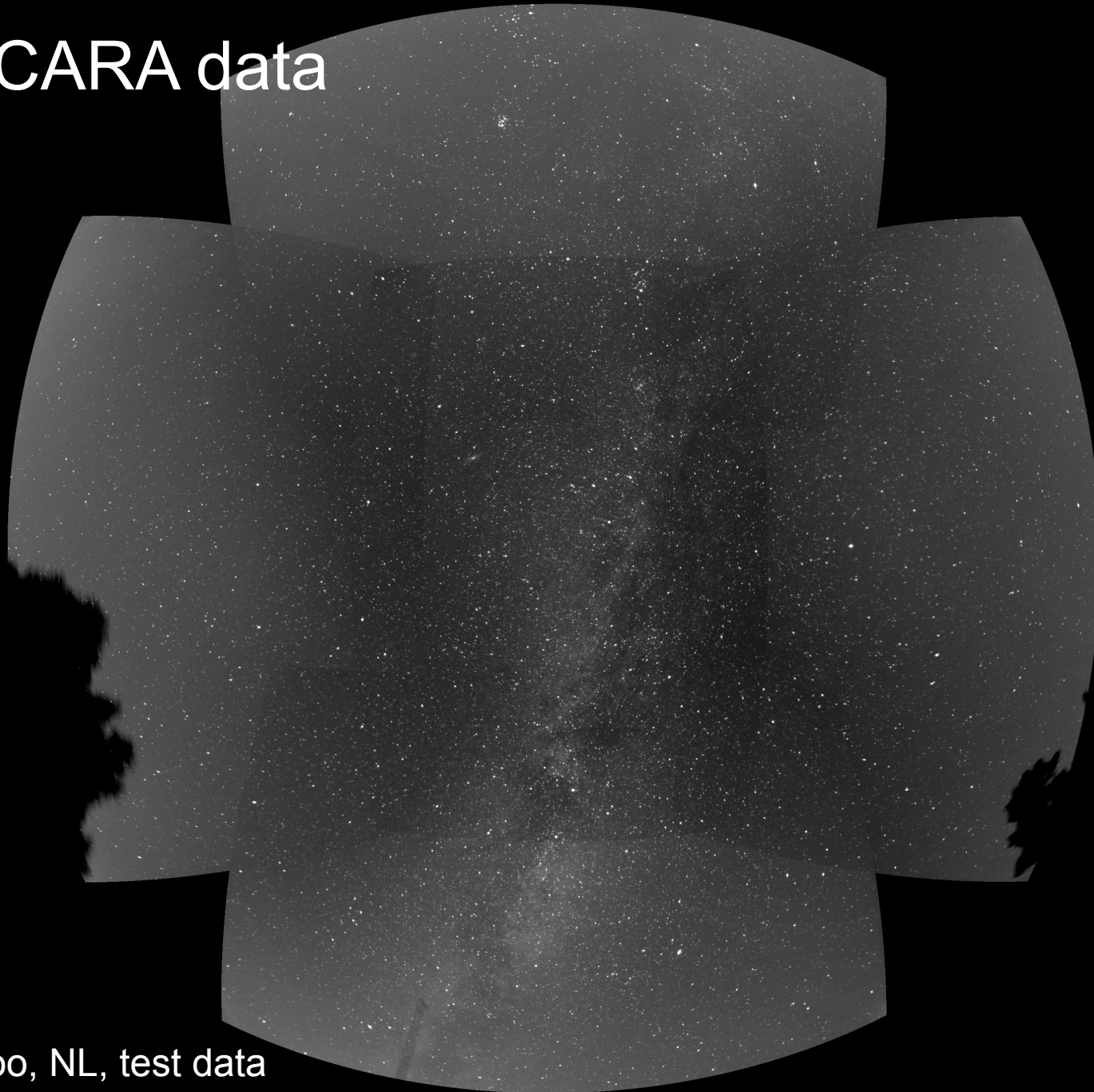
MASCARA design



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MASCARA data



Dwingeloo, NL, test data

MASCARA status



La Palma station fully operational since Jan 30, 2015

Operations so far:

645 hr (N); 1119 hr (E); 1065 hr(S); 892 hr(W); 1207 hr(C)
4938 Camera hours; 2.956.800 images; >100 Terabyte

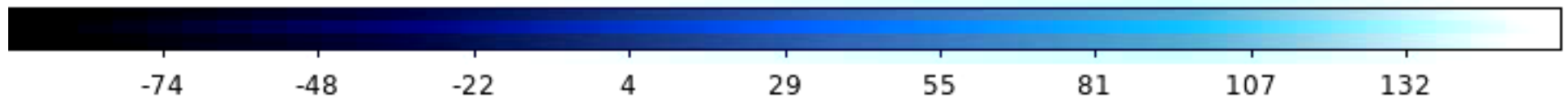
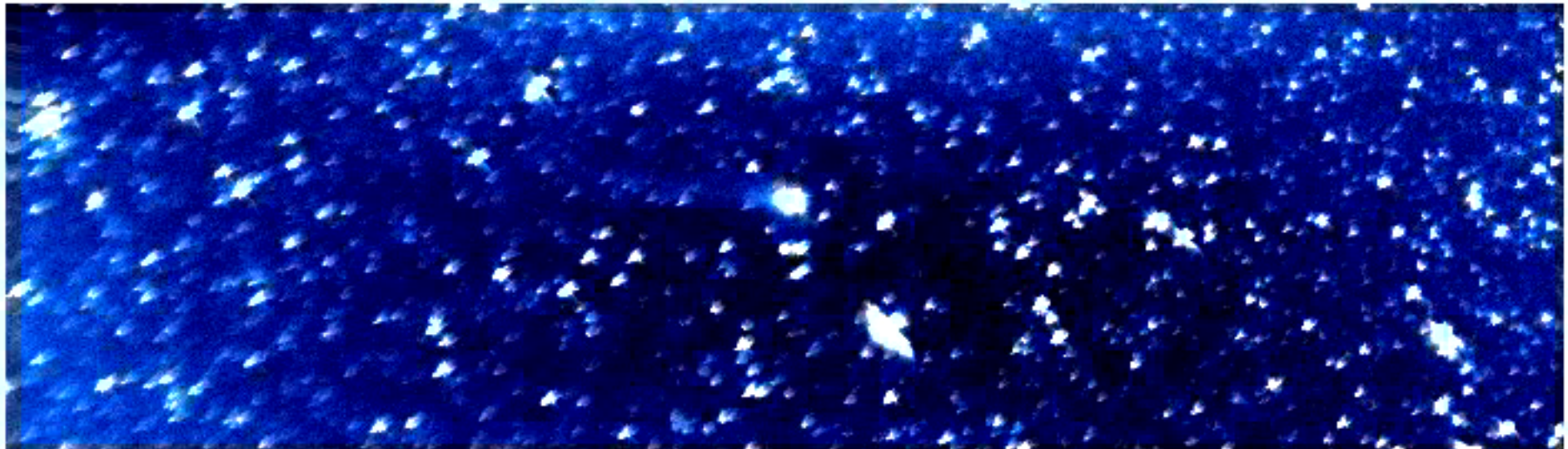
Pipeline operates since April (....)

Data products:

6.4 sec. Cadence light curves
50 stack images (~5 minutes bins)
Raw data is not stored (too expensive)

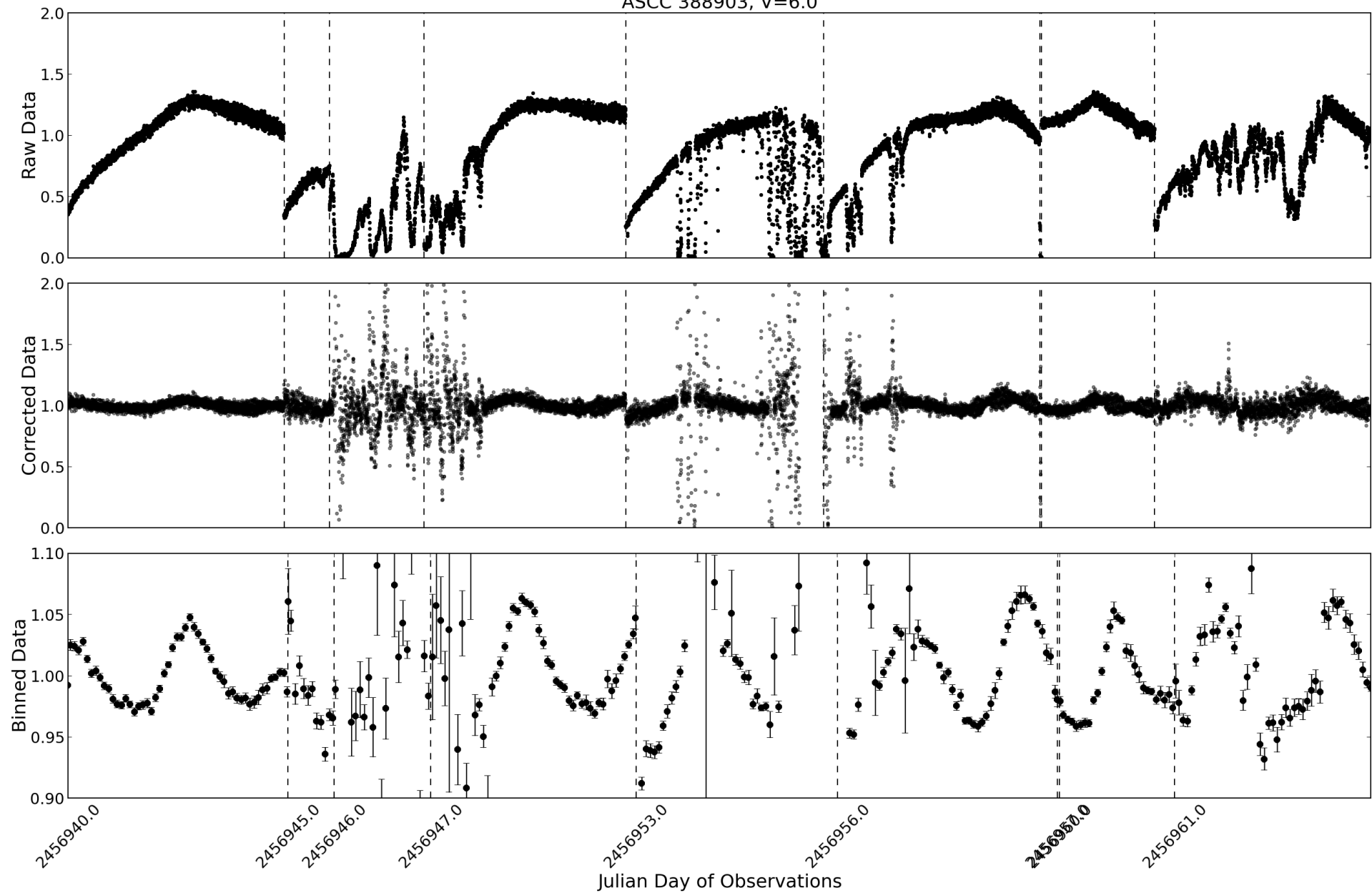
Difference Imaging of Comet Lovejoy

Feb 2 – 6 2015 – West Camera



5-minute stacked images

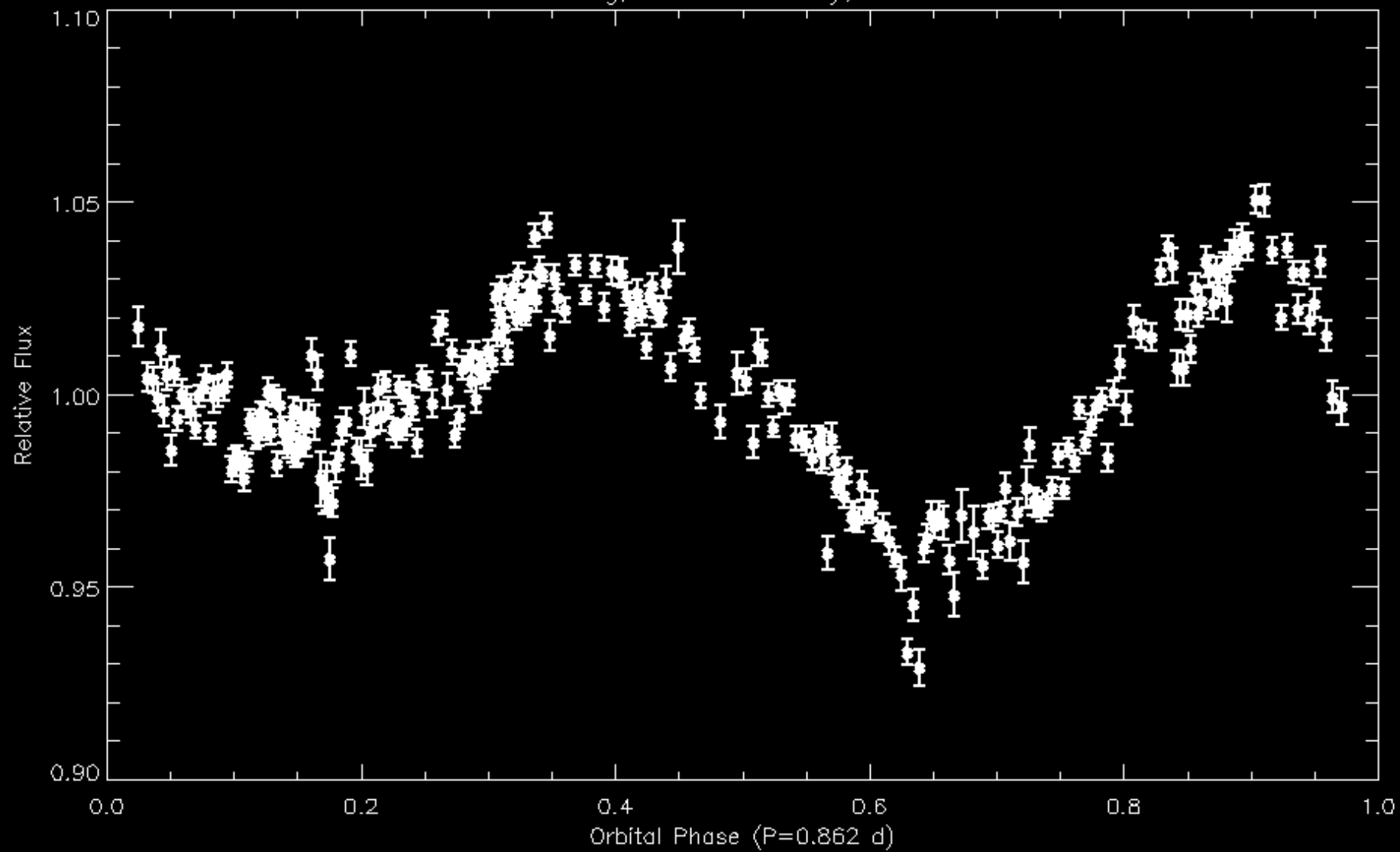
ASCC 388903, V=6.0



1% precision per 5 minute bin on V=8 star
 ~0.5% precision per 5 minute bin on V=6 star

IDL 0

PU Peg, contact binary, $V=7.97$



We are ready to look for planets in a few months....





RV follow-up:

Collaboration with Leuven:

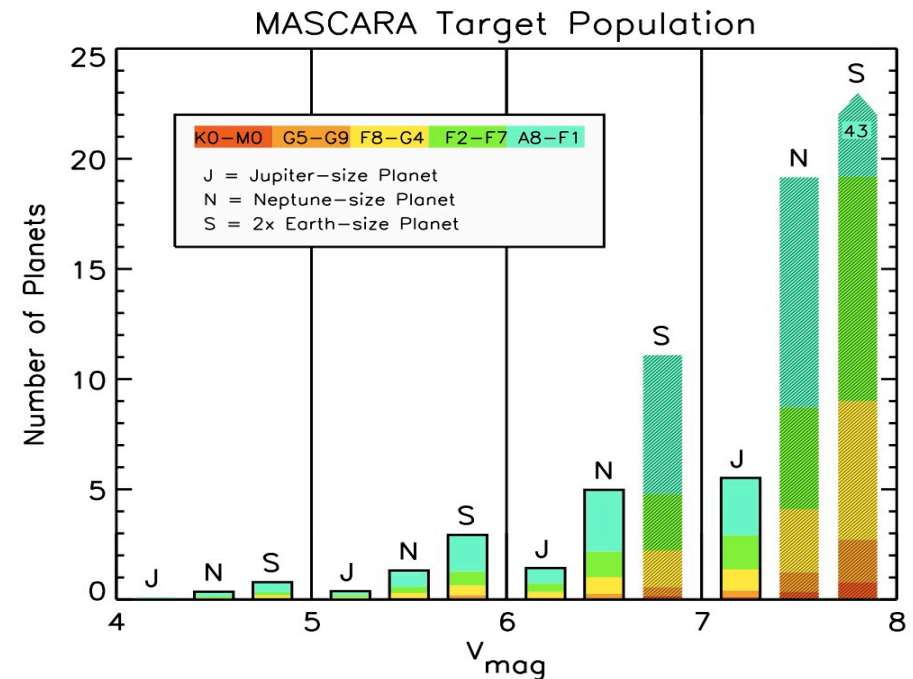
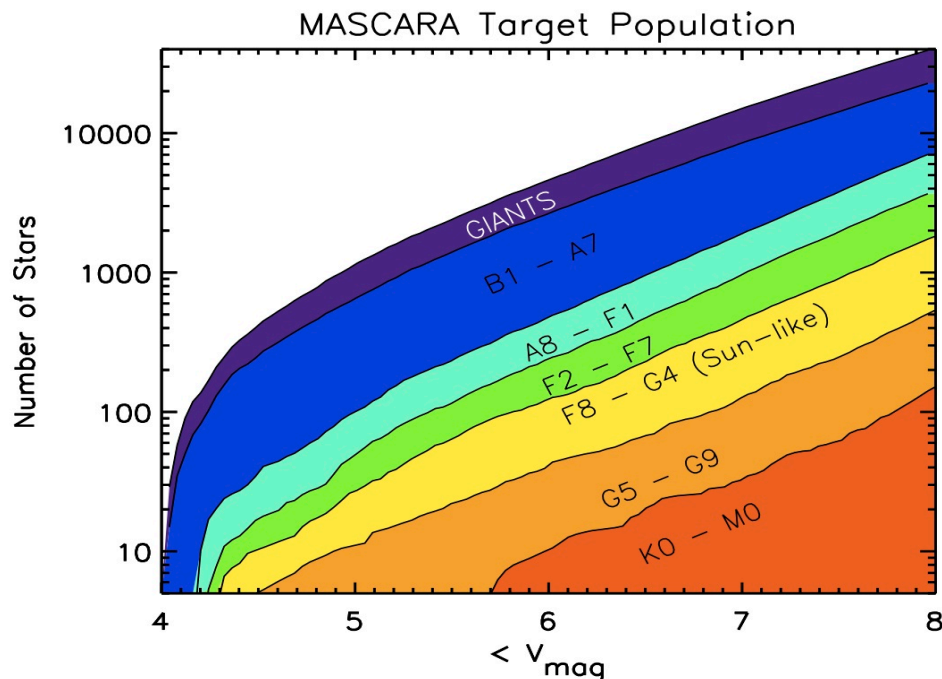
HERMES @ MERCATOR 1.2m telescope on La Palma



MASCARA: Planet Population



- Transits of Jupiter-size planets can be detected individually
- Neptune/Super-Earth planets are found by co-adding transits
55 Cnc e ($V=6$) detected at $\sim 3\sigma$ after 1 yr (7σ after 4 yr) of MASCARA operation.
- Target population is mainly hot, short-period planets
~5 Hot Jupiters, ~5 Hot Neptunes, ~5 Hot Super-Earths



Atik 11000 CCD Specs

Sensor type	CCD - Kodak KAI 11002
Sensor size	37.25 mm x 25.7 mm
Resolution	4008 x 2672 pixels
Pixel size	9 x 9 μm
Readout Noise	15 e- RMS
Dark current	0.03 e-/s at -20 degrees
Well depth	60,000 e-
Anti-blooming	> 1000 x
Quantum efficiency	50%
Cooling	Two stage Peltier with $\Delta T = -38^{\circ}\text{C}$

Table 1. Specifications of the Atik 11000 detector