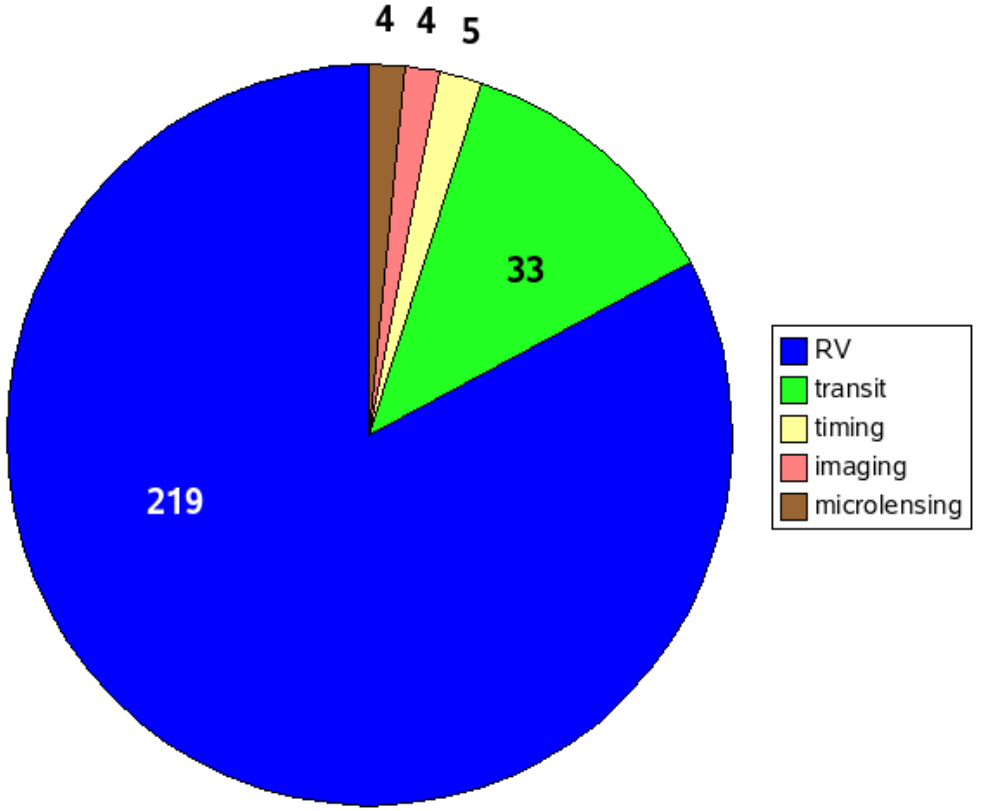
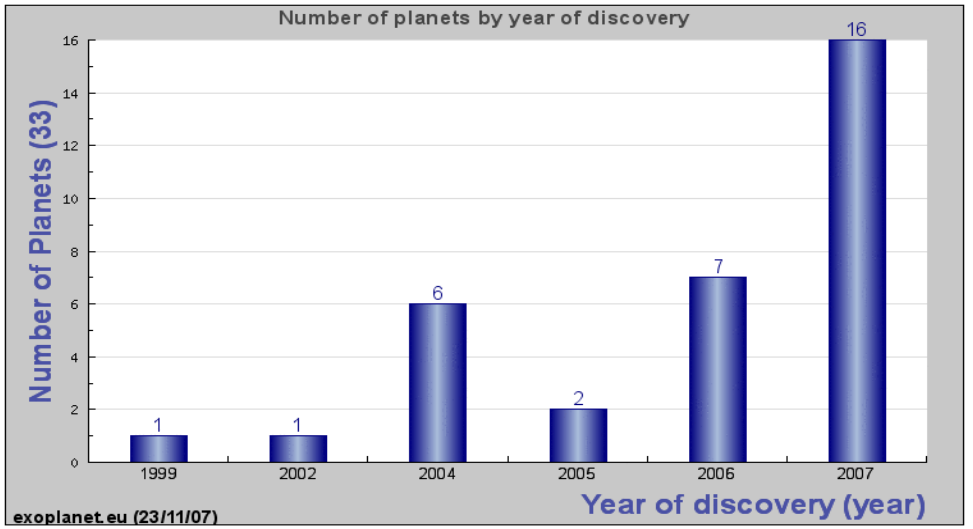
Searching for transiting Extra-Solar planets "Pre-OmegaTranS" 2007-2008

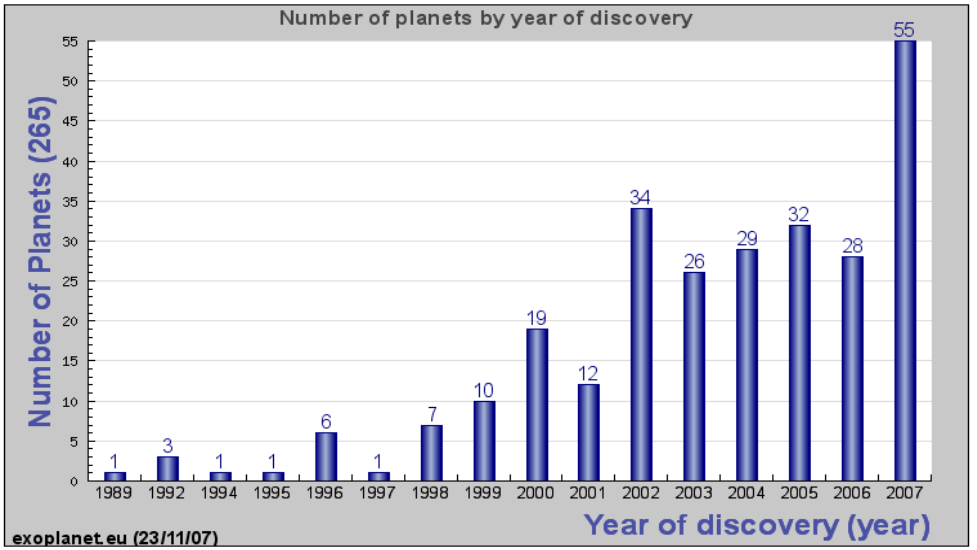
Datareduction in AstroWISE

global statistics:

265 planets found



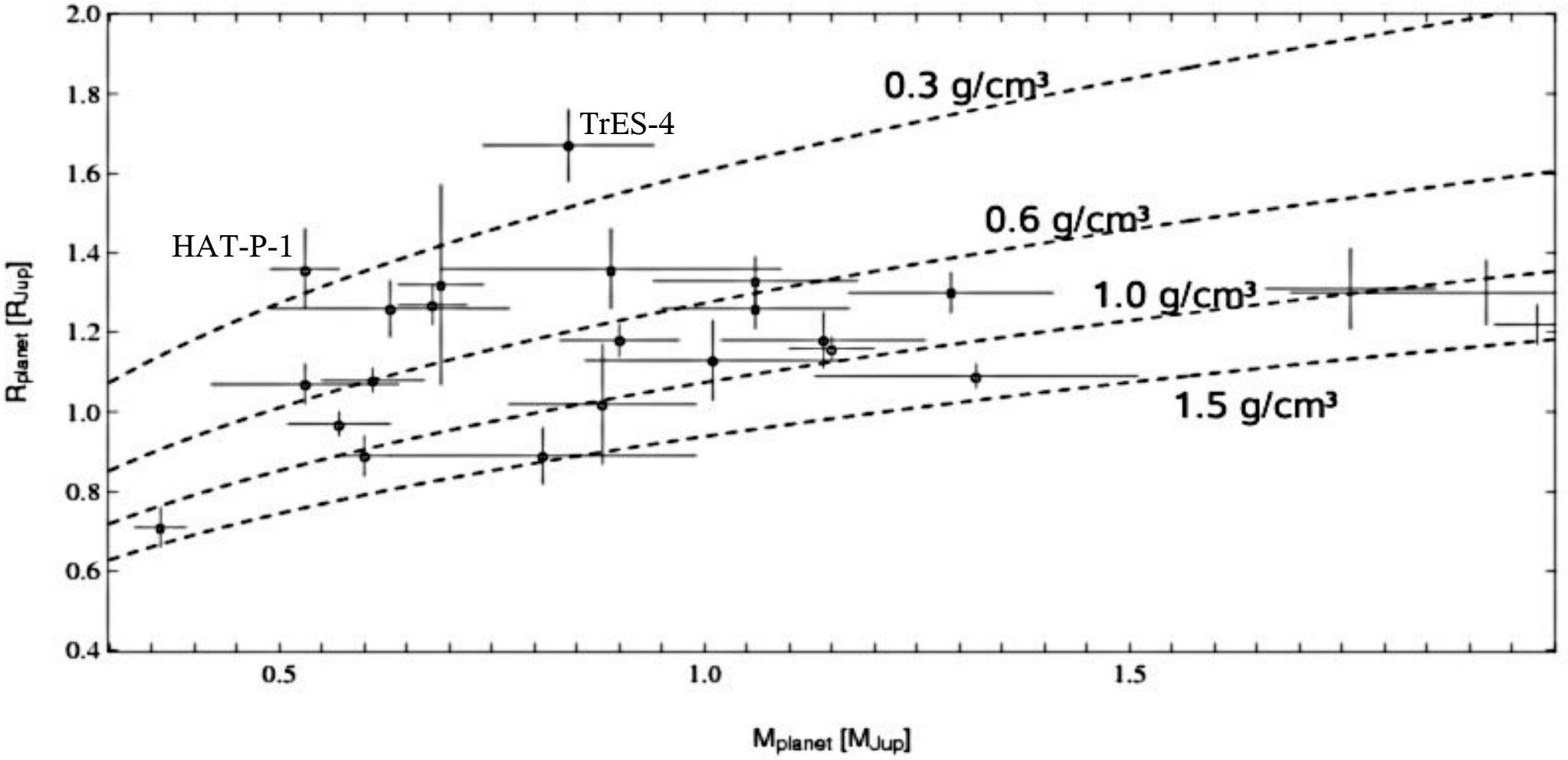




source: www.exoplanet.eu (J. Schneider)

measuring radius and density:

$\Delta F/F = (R_{pl}/R_*)^2 \quad \Rightarrow \rho$!!!



measuring thermal emission:

TrES-1b: T = 1060K +/- 50K

(Charbonneau et al. 2005)

HD209485b: T = 1130 K +- 60K

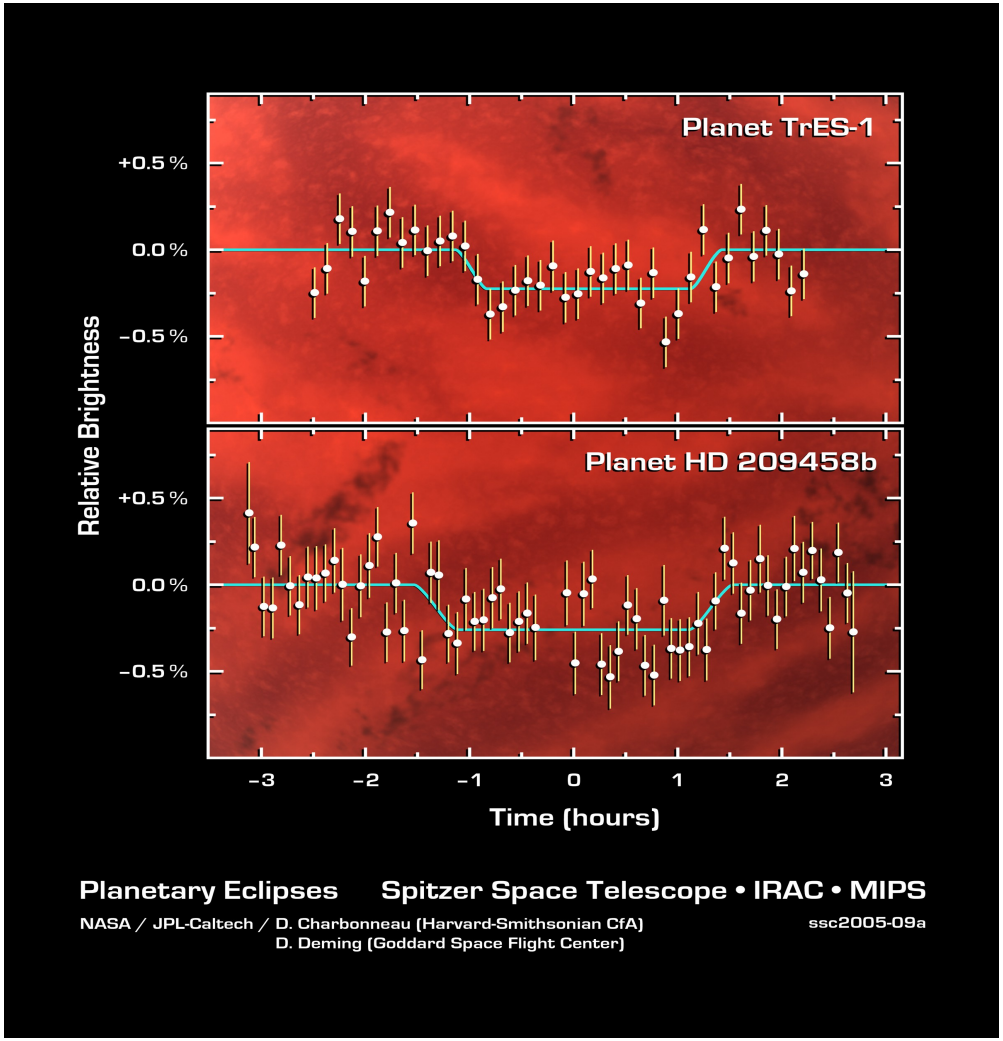
(Deming et al. 2005)

GJ436b: T = 717K +- 35K

(Demory et al. 2007)

HD189733b: T = 1212K +/- 11K(day)
T = 973K +/- 33K(night)

(Knutson et al. 2007)



measuring the spin-orbit alignment:

209458b: $\lambda = -4.4^{o} \pm 1.4^{o}$

(Winn et al. 2005)

HD 189733: $\lambda = -1.4^{o} \pm 1.1^{o}$

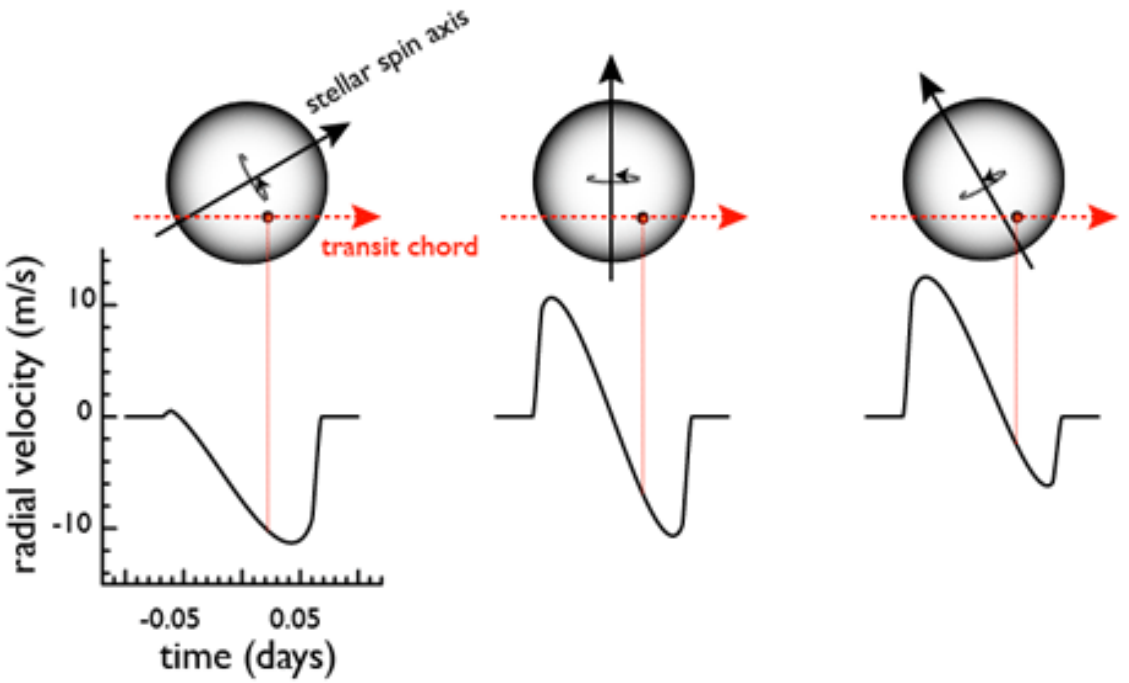
(Winn et al. 2006)

HD149026b: $\lambda = -12^{o} \pm 15^{o}$

(Wolf et al. 2007)

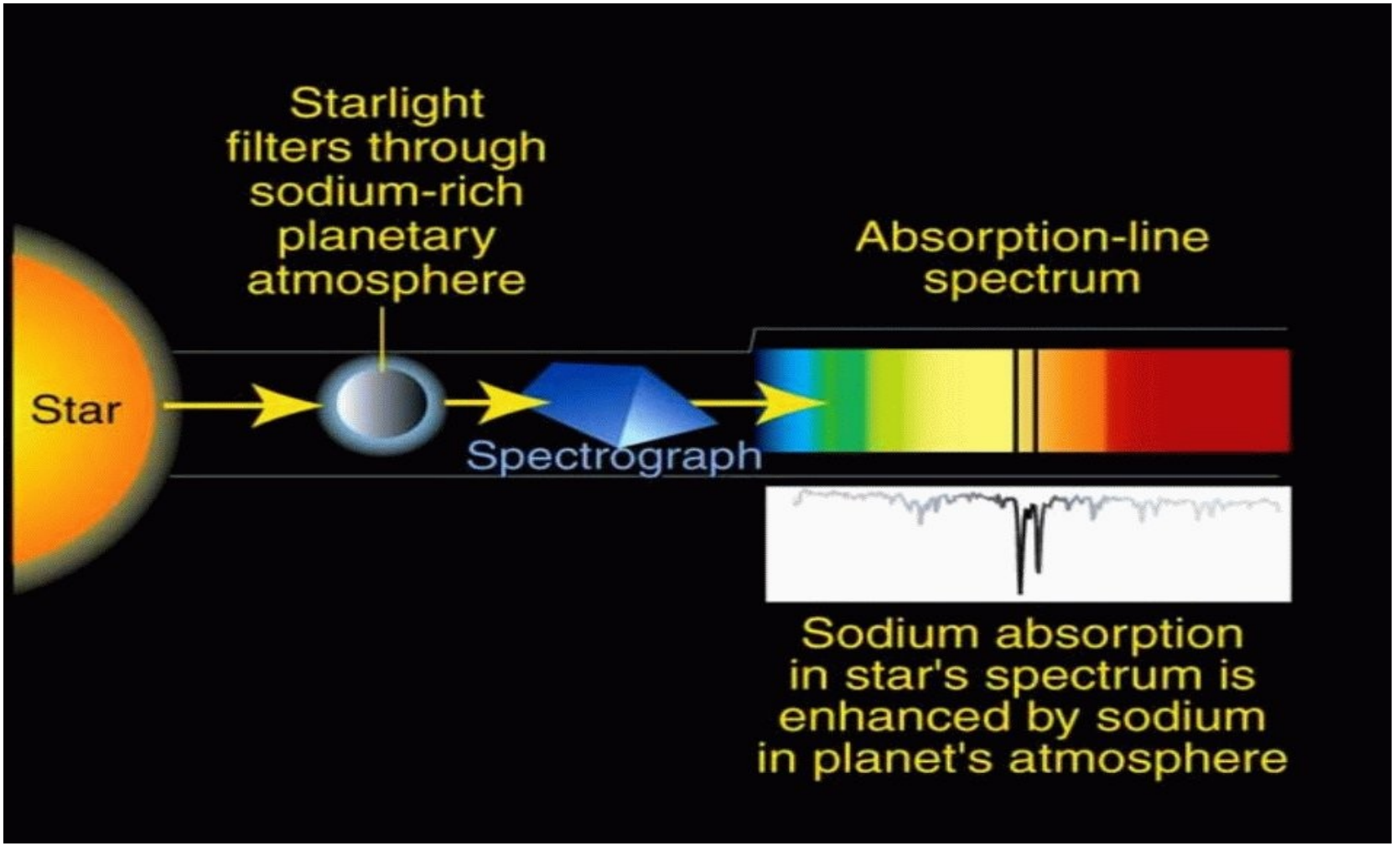
HAT-P-2b: $|\lambda| < 14^{o}$

(Winn et al. 2007)



Rossiter-McLaughlin-Effect

transmission spectroscopy:



209458b: detection of Na and H (Charbonneau et al. 2002)
detection of O and C (Vidal-Madjar et al 2004)

Transit Surveys:

- **wide angle surveys:** small apertures
  bright stars, many fields
  HAT-P, TrES, WASP, XO, TEST, ...
- **deep surveys:** big apertures
  faint stars, few fields
  OGLE (GITPO, Pan-Planets, OmegaTranS, ...)
- **space surveys:** bright and faint stars
  outstanding photometric precision
  detection of Earth-sized planets
  SWEEPS, CoRoT, (Kepler, PLATO?, ...)

transit surveys at USM/MPE

(Saglia, Koppenhöfer, Bender)

- **2002-2004: Wendelstein Extra-Solar Planet Search (WESPS)**
- **2005-2014: OmegaTranS with OmegaCam@VST (GTO) (Sterrewacht Leiden / INAF Napoli)**
- **2006-2008: pre-OmegaTranS with WFI@ESO/2.2m**
- **2008-2012: Pan-Planets (MPIA & Pan-Starrs consortium)**
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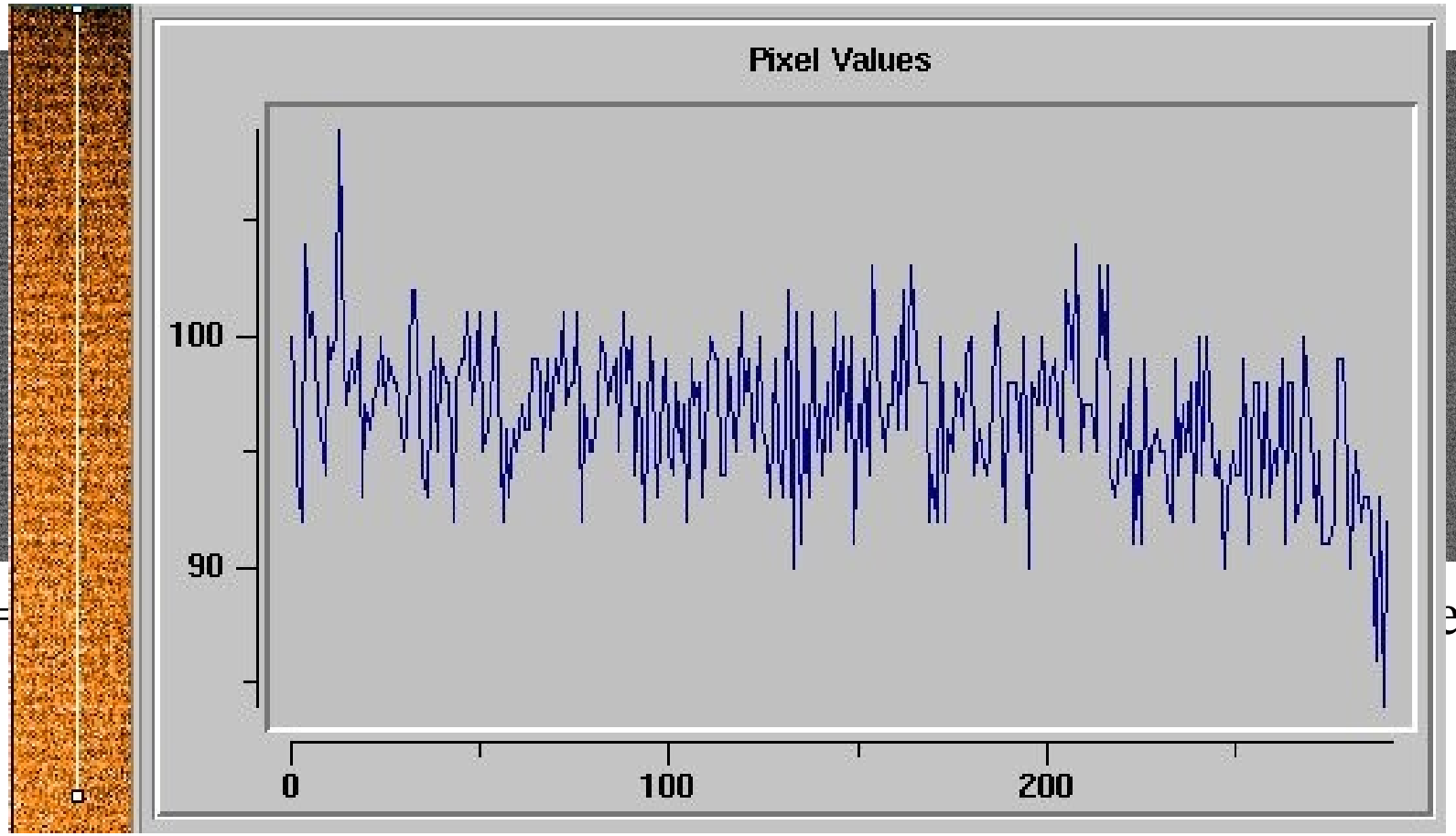
The data:

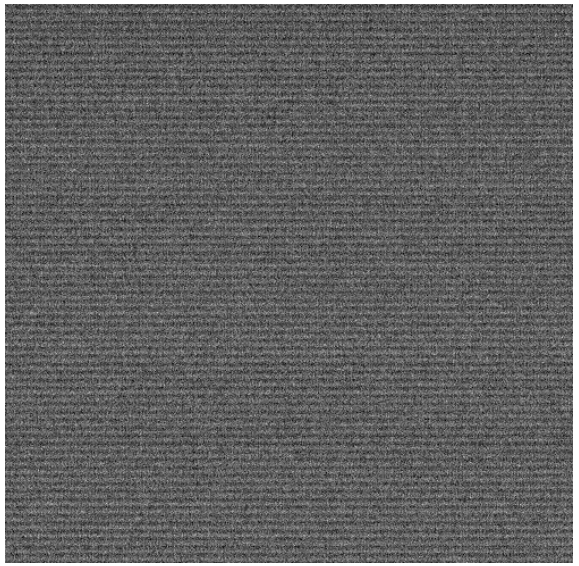
- 110h observation time
- R-band (#844), 25-30s exposure time, 1.5min cycle
- 4418 science images, one WFI field
- 964 calibration images
- 0.8 TByte raw data (75% science / 25% calibrations)

overscan correction method:

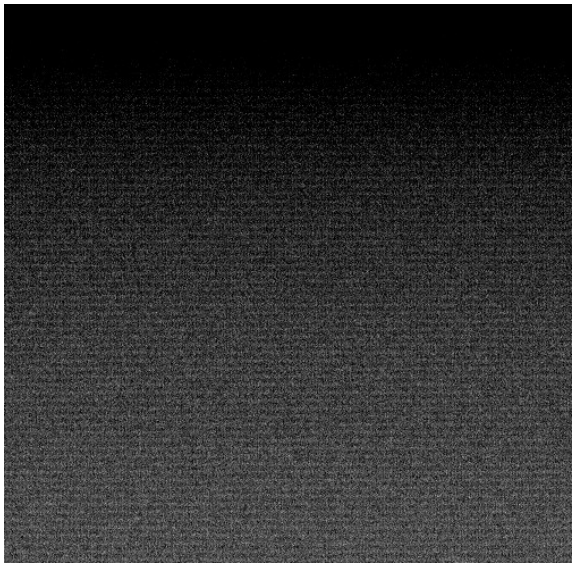


oc= ew)

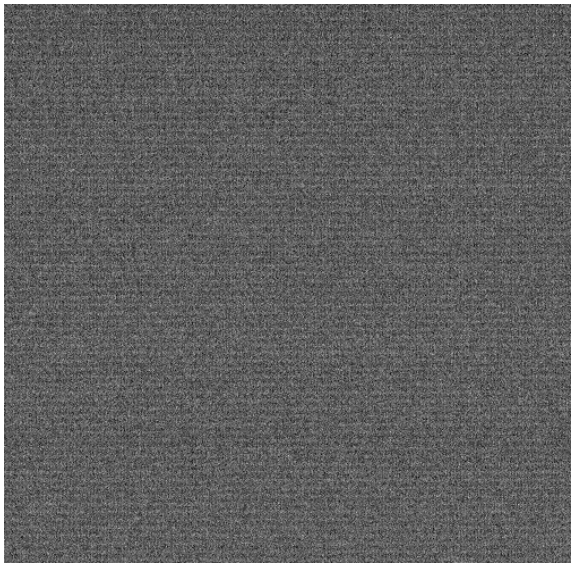
overscan correction method:



oc=6 (default)

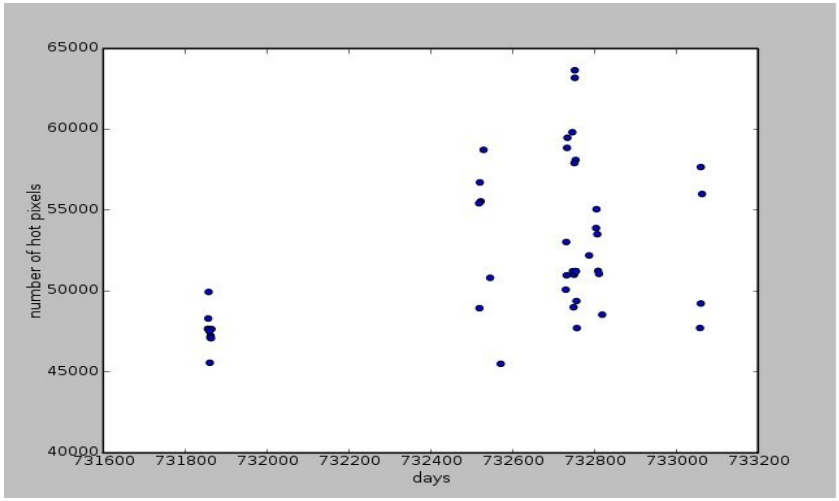


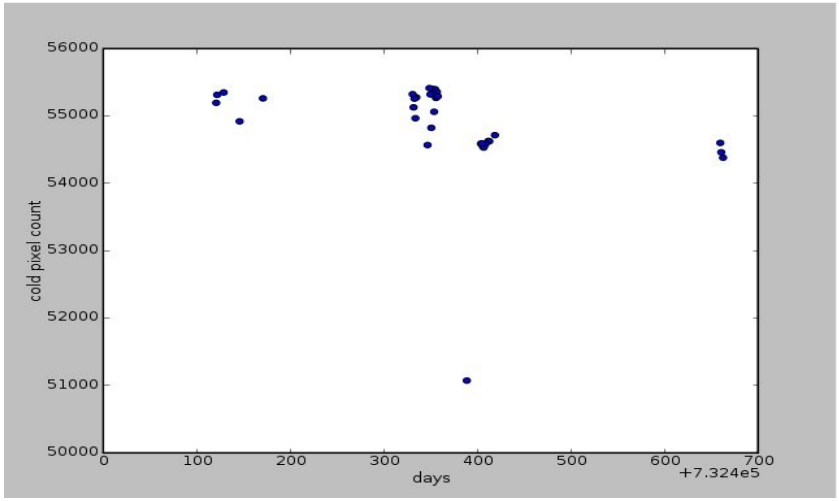
oc=2 (y-smoothed)

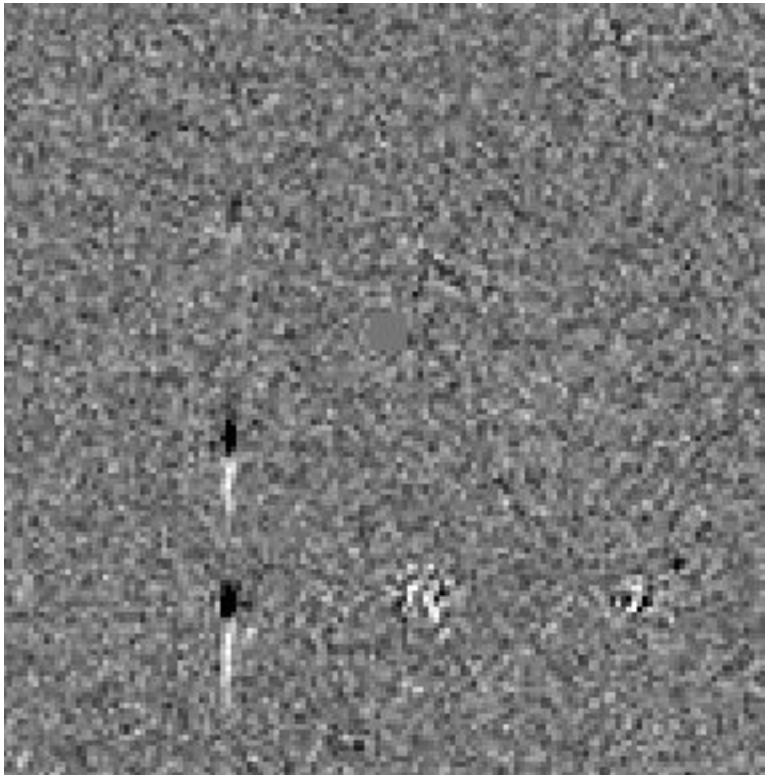


oc=10 (new)

hot, cold and bad pixels:

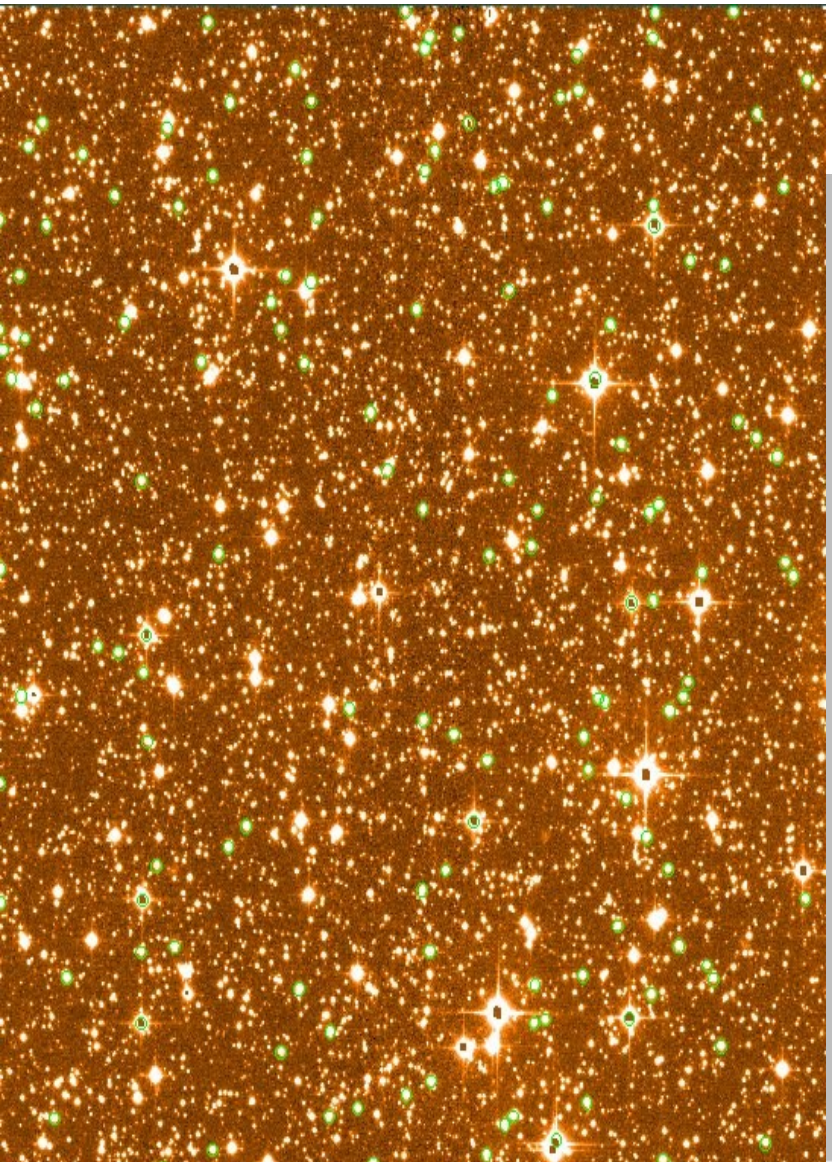


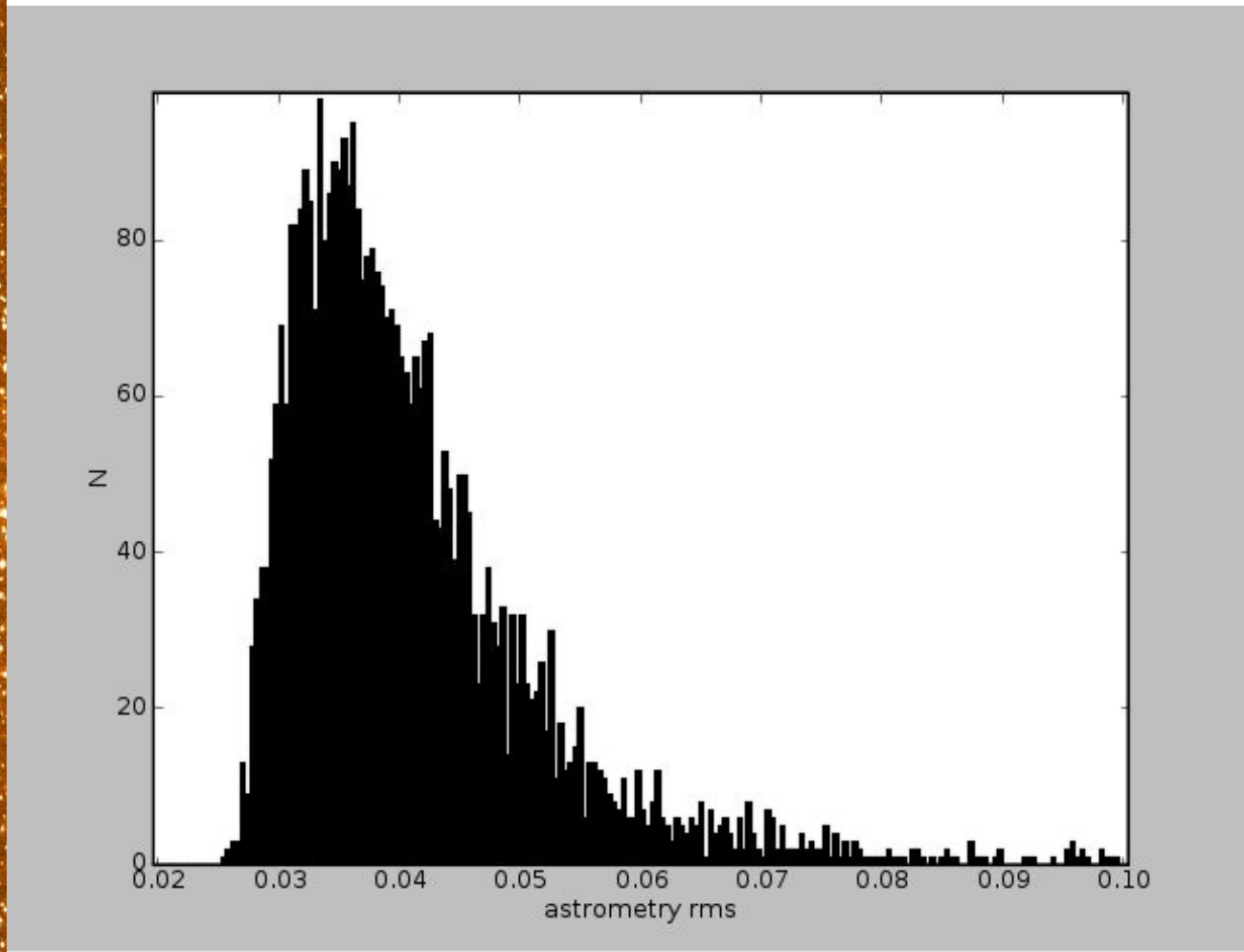




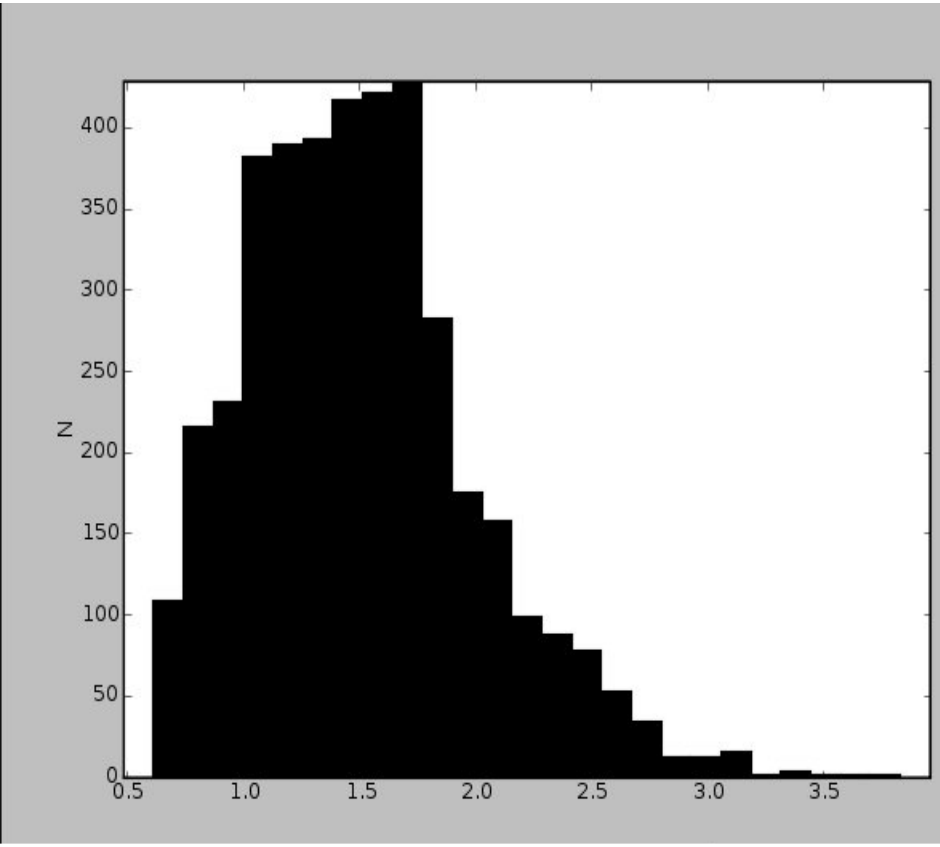
=> additional masking necessary

astrometry:

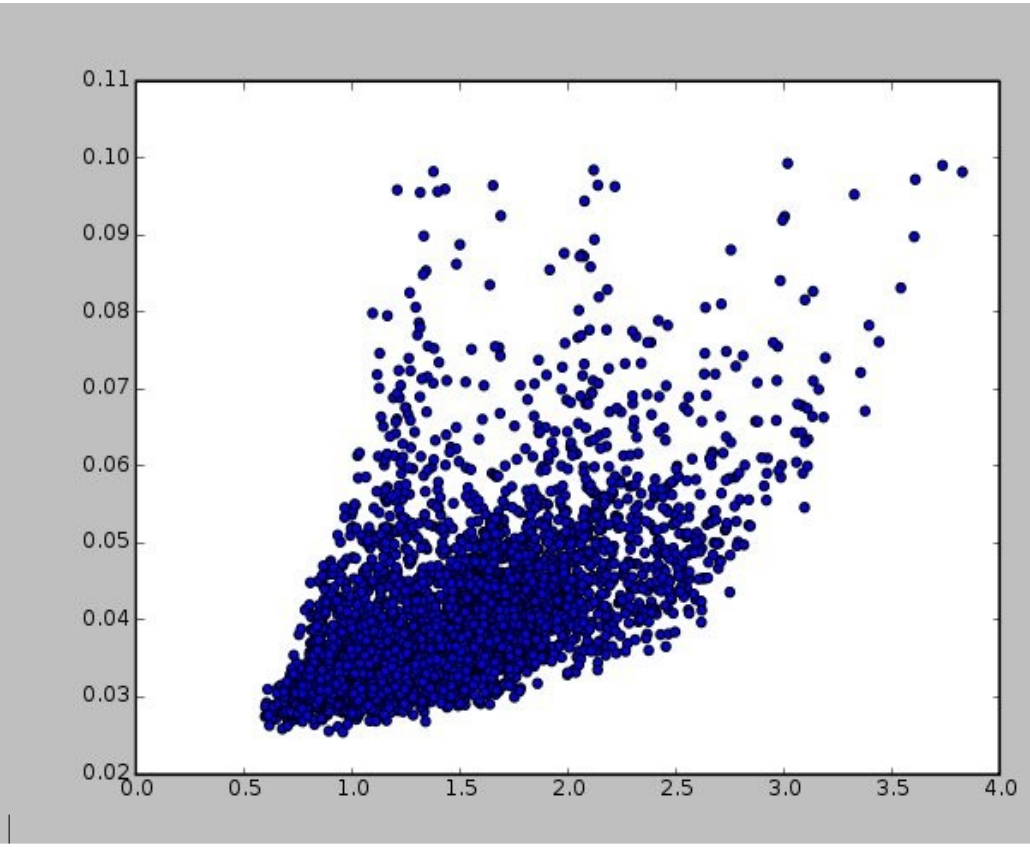



80
60
40
20
0
N
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
astrometry rms

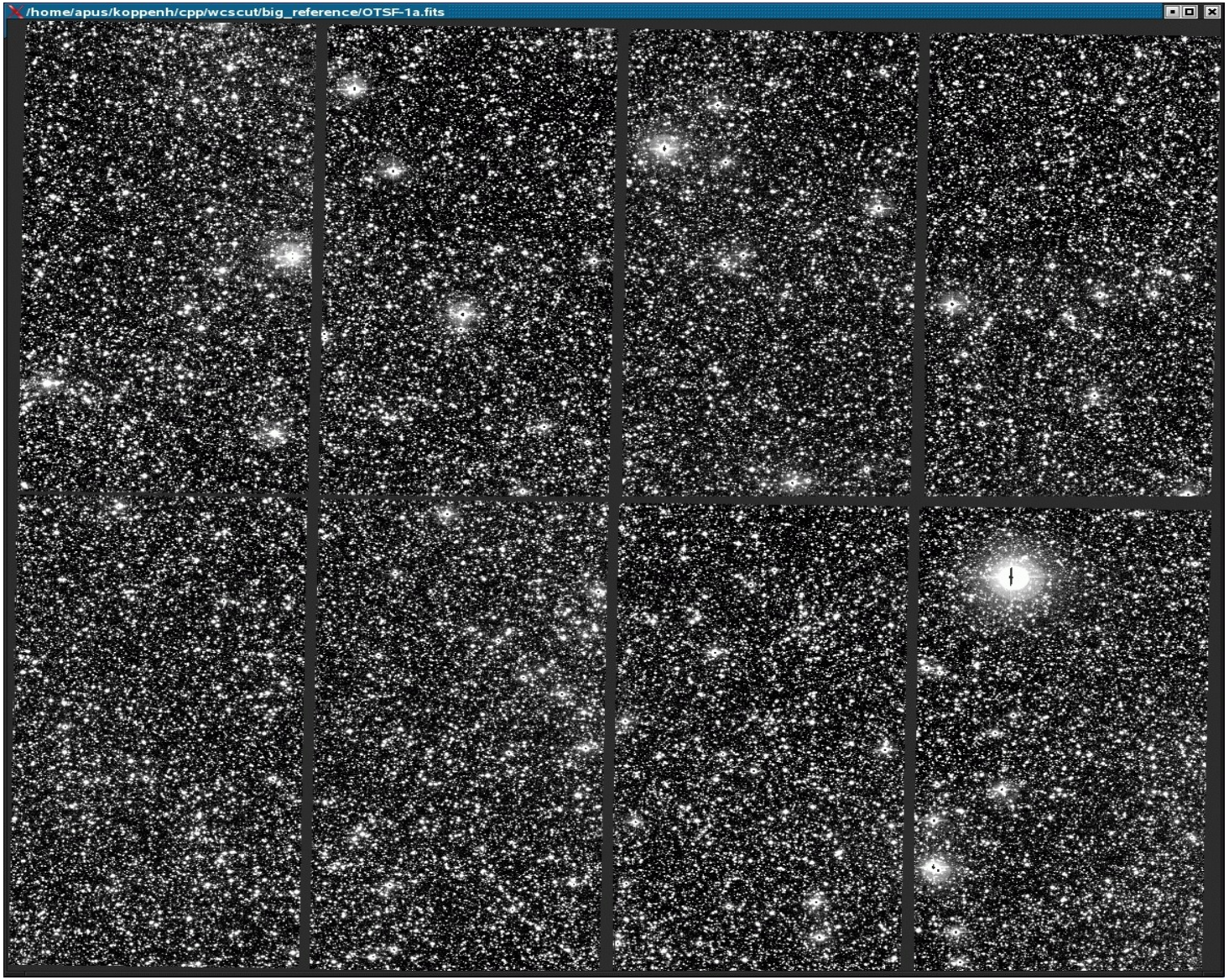
astrometry vs. seeing:



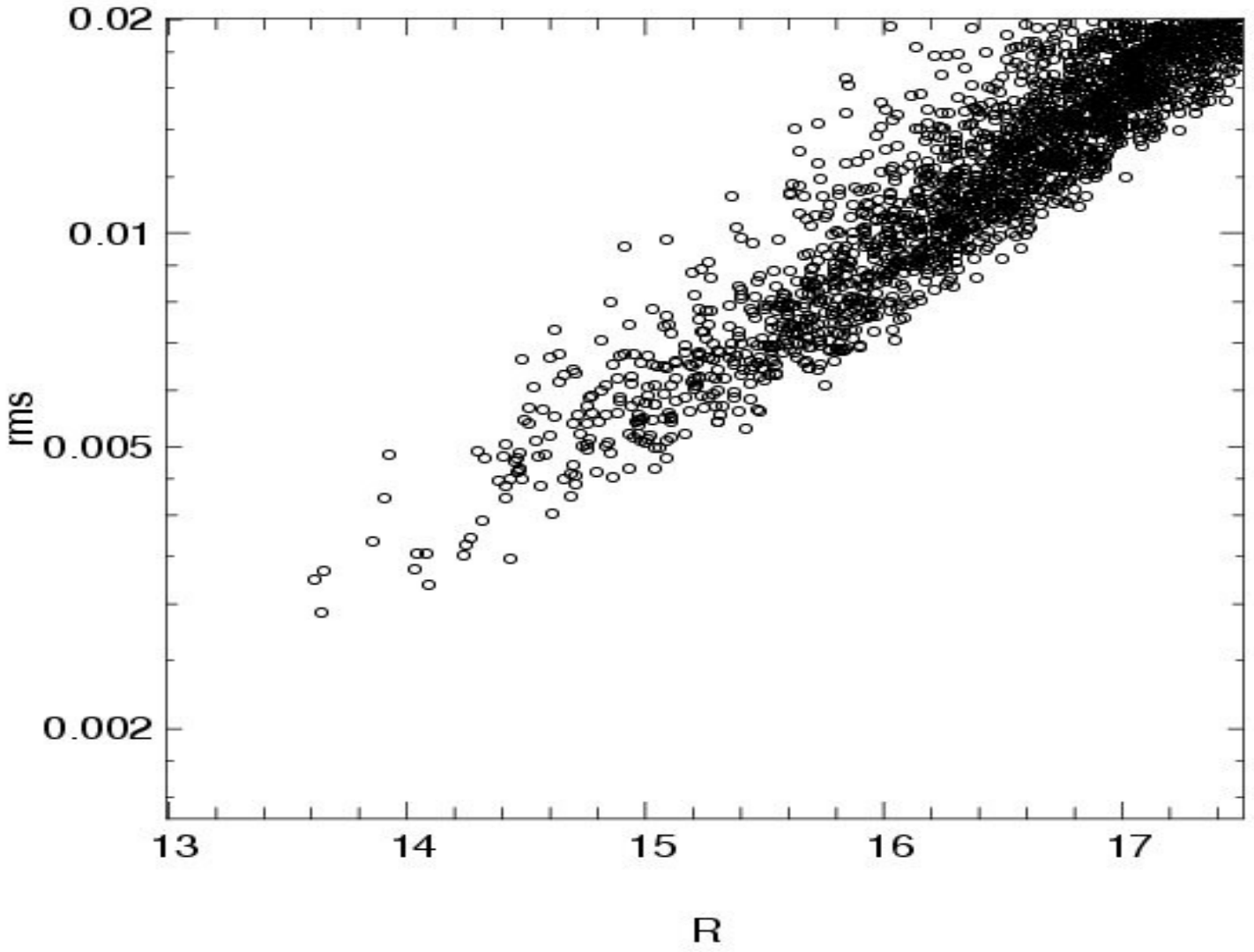
seeing [arcsec]



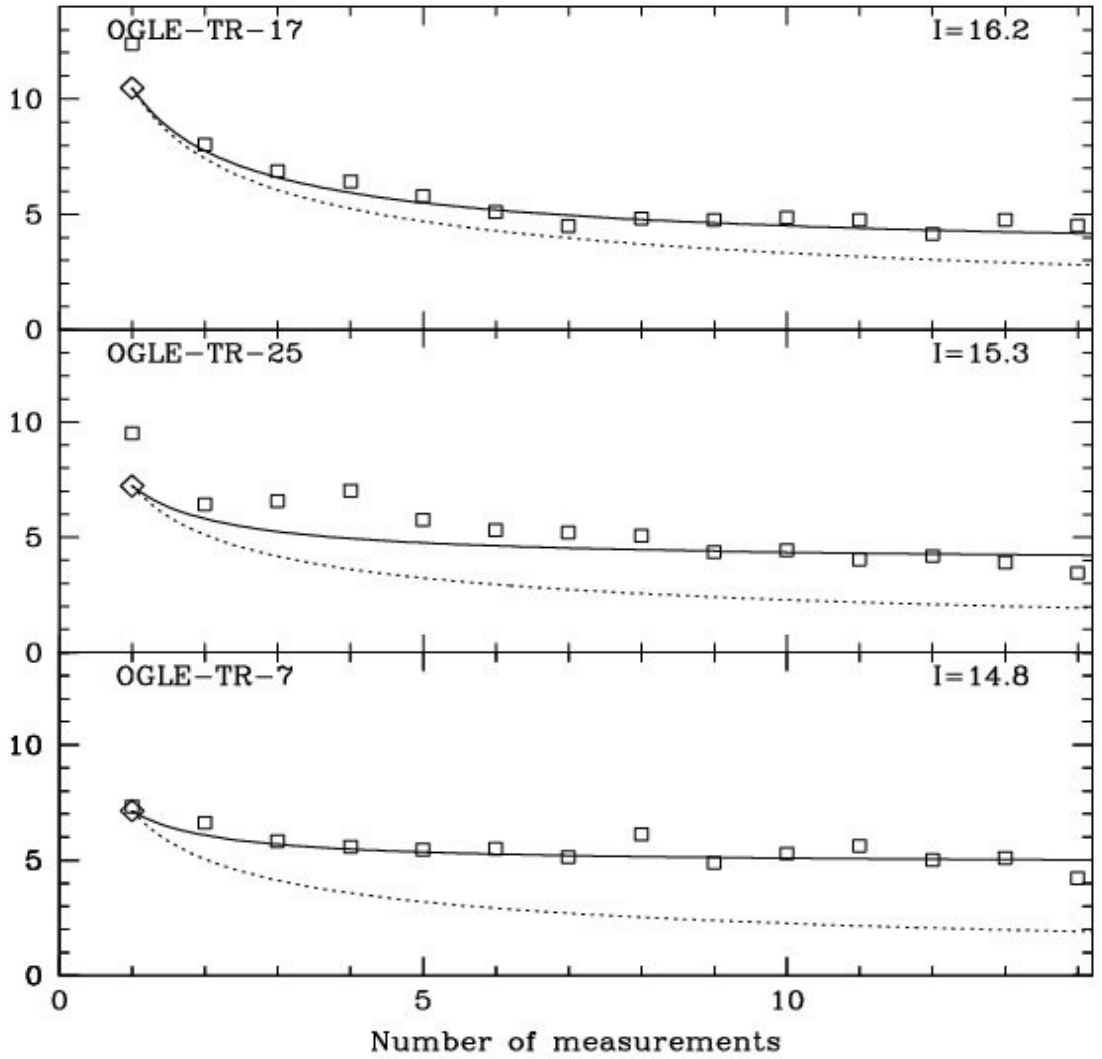
seeing [arcsec]


/home/apus/koppenh/cpp/wcscut/big_reference/OTSF-1a.fits

rms of the lightcurves:



correlated noise:



Pont et al. 2005

Gaussian (white) noise:

$\sigma_w(N) \sim 1 / \mathrm{sqrt}(N)$

correlated (red) noise:

$\sigma(N) = \mathrm{sqrt}(\sigma_w(N)^2 + \sigma_r^2)$

removing red noise:

method: sysrem proposed by Tamuz et al. (2006)
initial idea: correct for a color-dependent extinction residual r_{ij}

fit best colors c_i:

$$S_i^2 = \sum_j \frac{\left(r_{ij} - c_i a_j\right)^2}{\sigma_{ij}^2}$$

fit best airmasses a_j:

$$S_j^2 = \sum_i \frac{\left(r_{ij} - c_i a_j\right)^2}{\sigma_{ij}^2}$$

$$S^2 = \sum_{ij} \frac{\left(r_{ij} - c_i a_j\right)^2}{\sigma_{ij}^2}$$

i: star index, j: image index

removing re

method: sysrem propo
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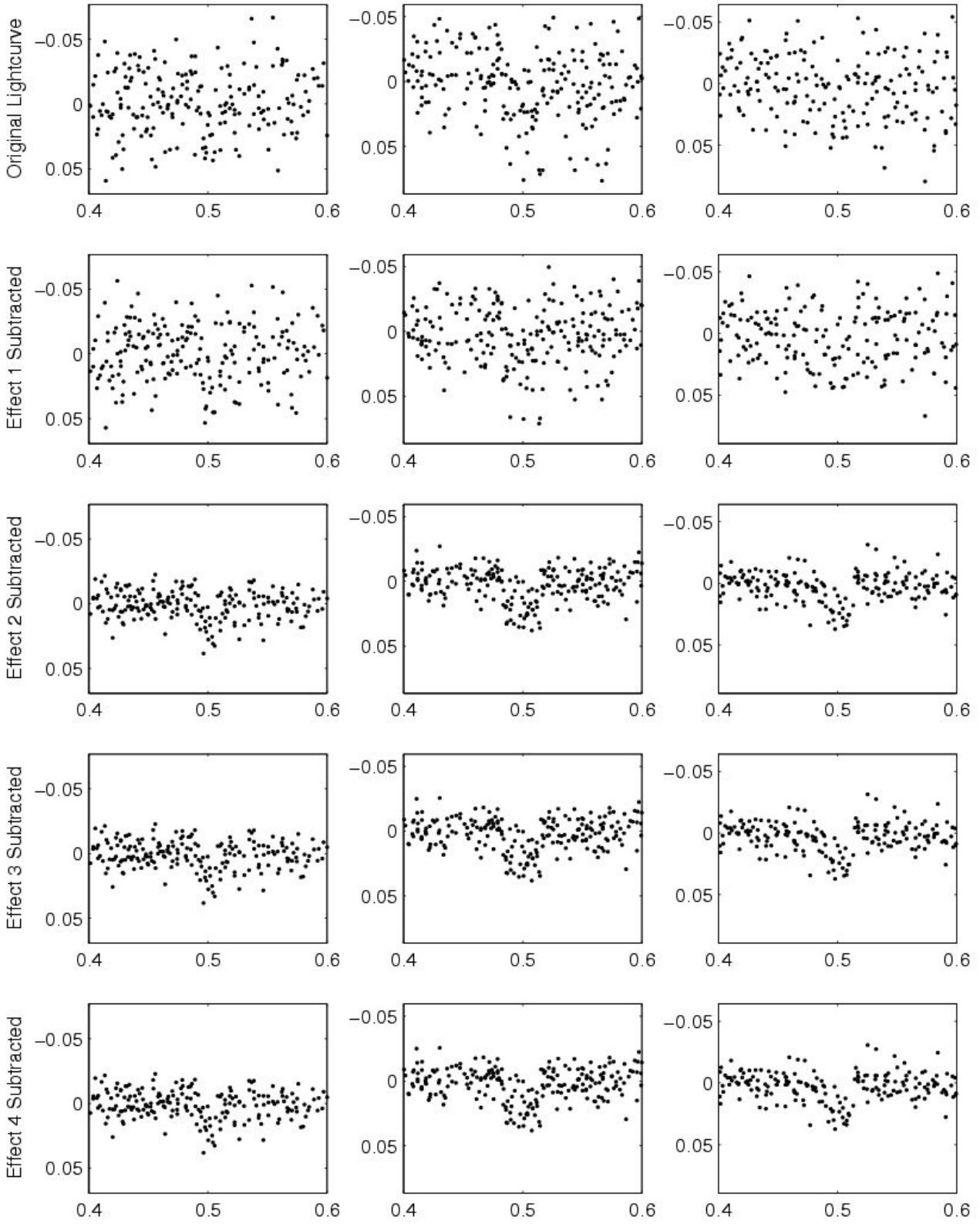
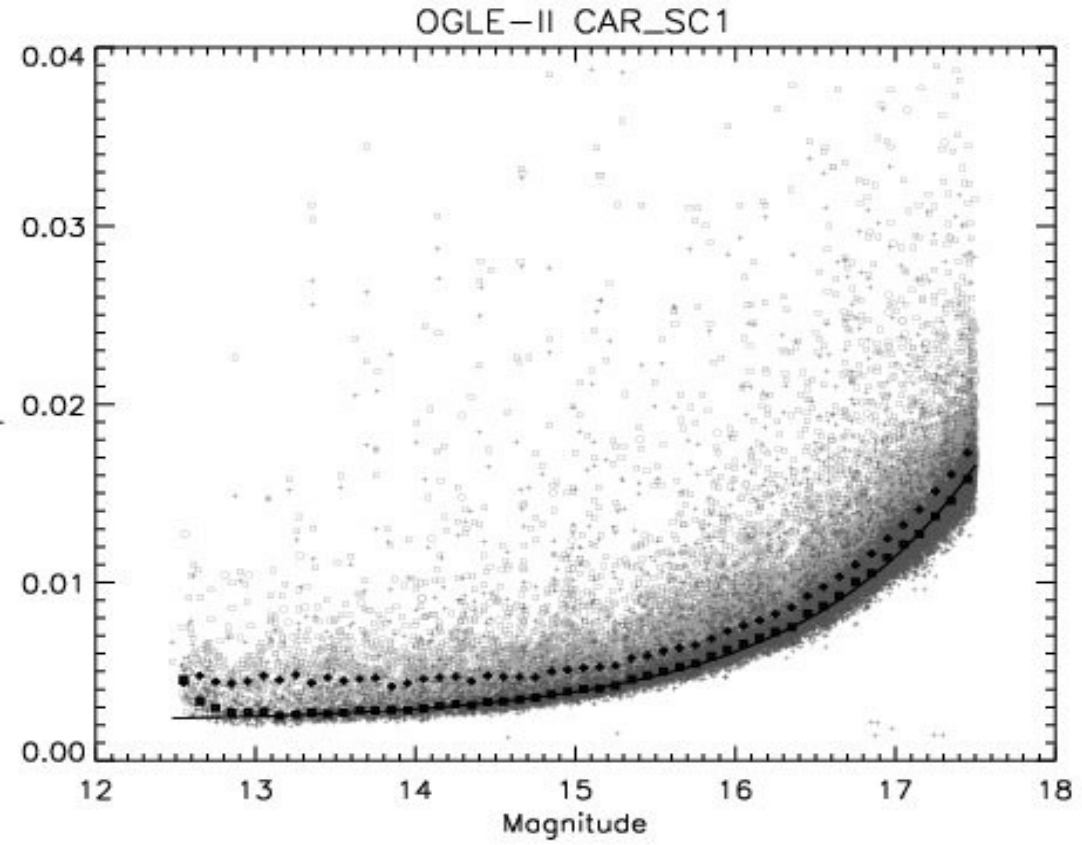
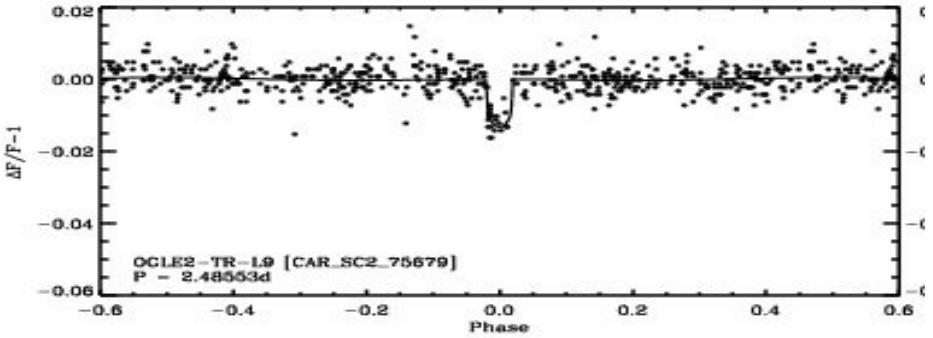


successful application of sysrem:

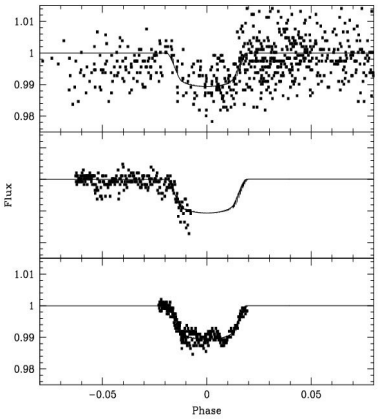


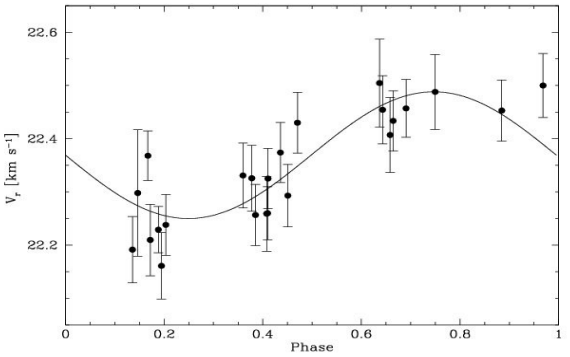
Snellen et al. 2007

OGLE2-TR-L9:



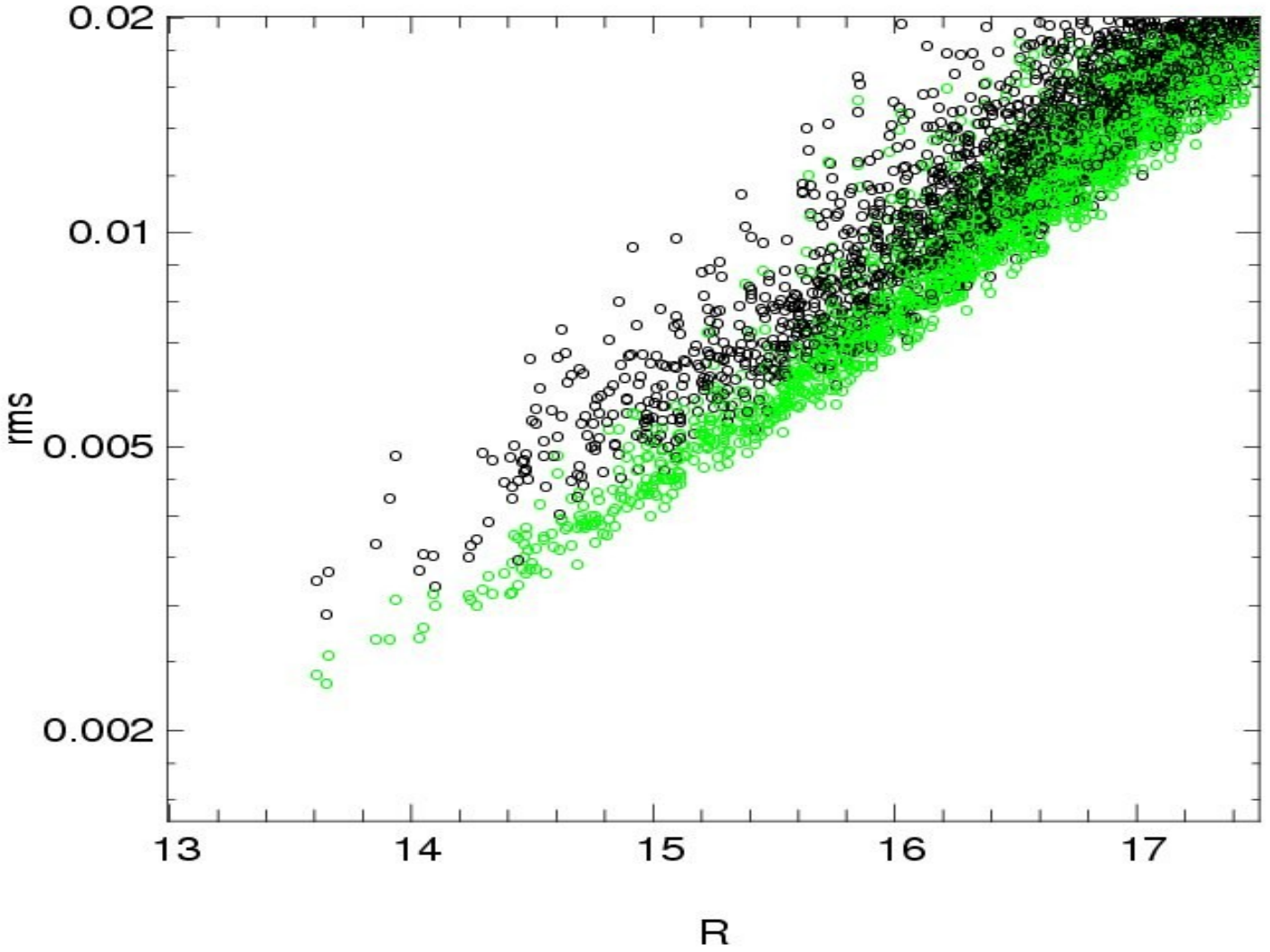
OGLE-TR-182:





Pont et al. 2007

red noise in WFI data:



lightcurve analysis:

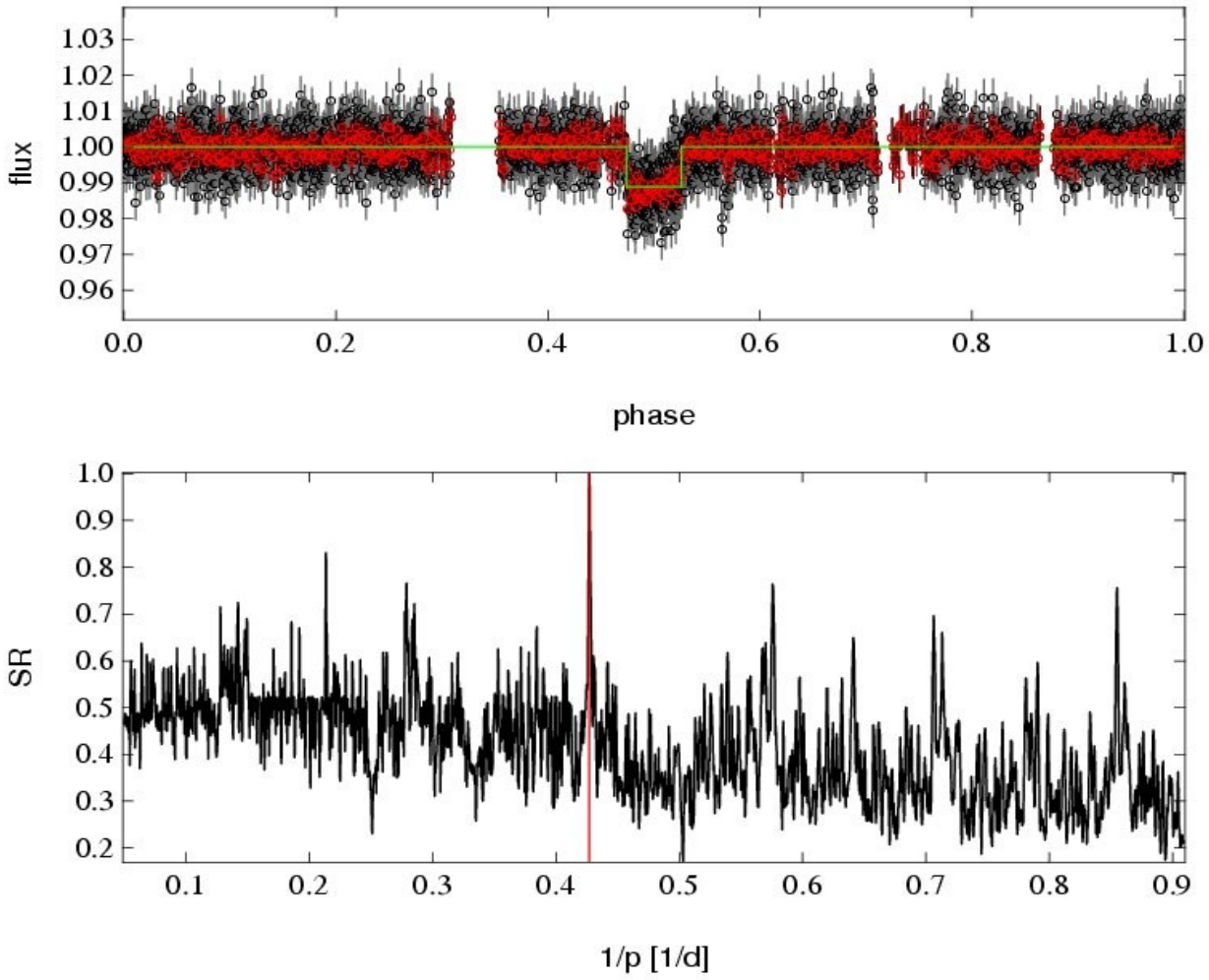
method: Box-Least-Square fitting (BLS) proposed by Kovacs et al. 2002

$$SDE := (SR_{peak} - \langle SR \rangle) / \sigma_{SR}$$

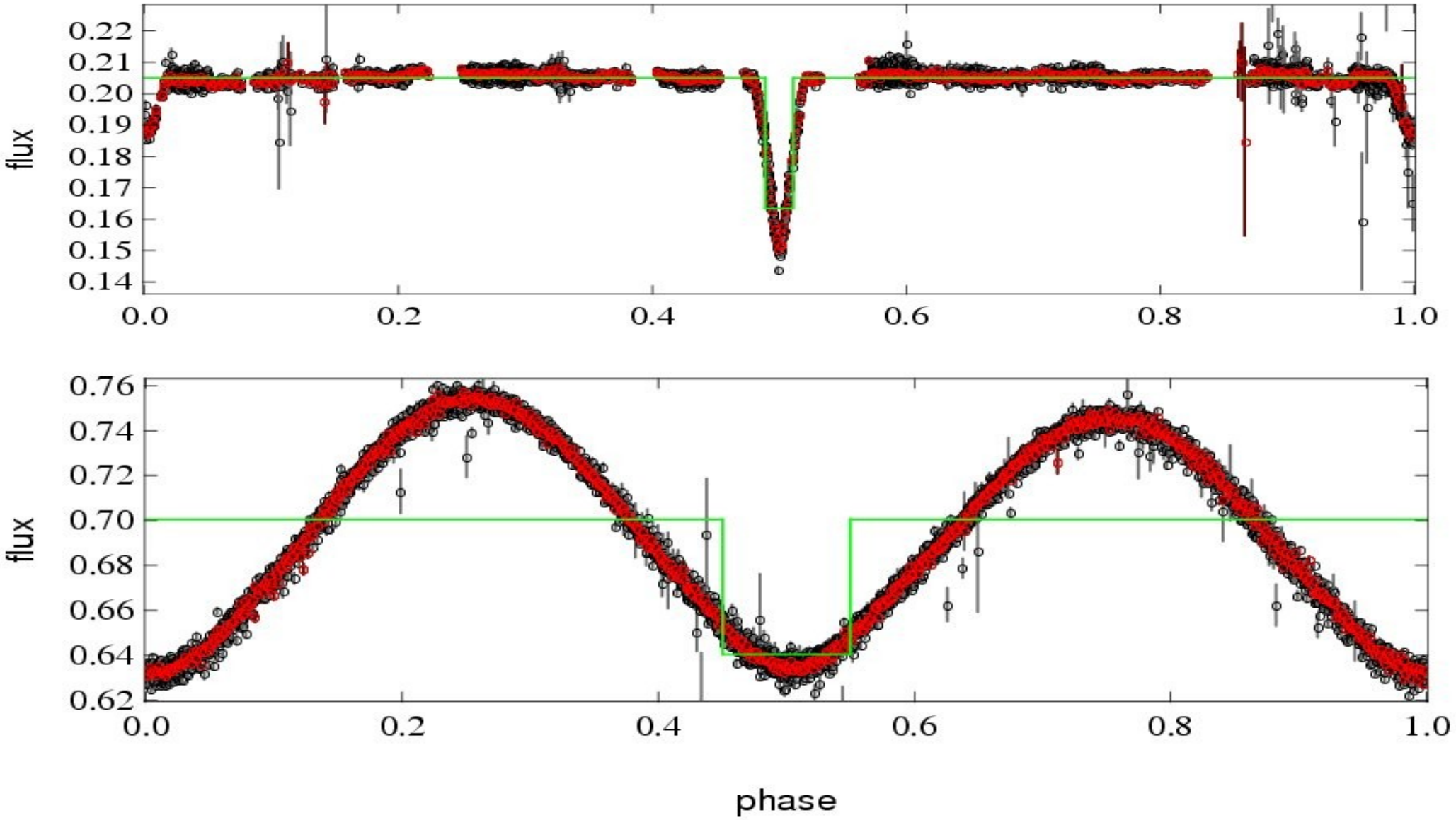
$$S/N = (\Delta F/F) / \sigma_{Transit}$$
$$= (\Delta F/F) * sqrt(N) / \sigma_0$$

good candidates S/N > 10!!!

BLS scored best in a blind test initiated by Moutou et al. 2005

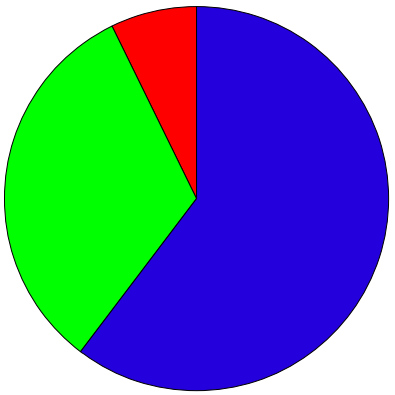
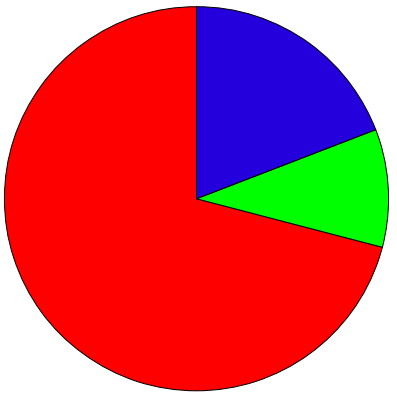
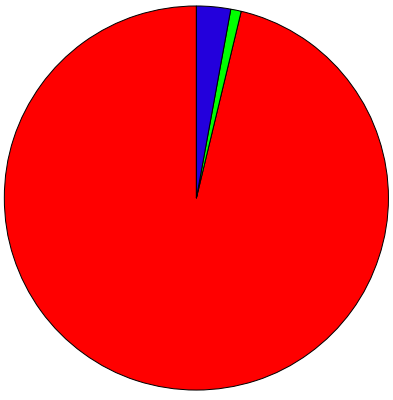


results: eclipsing binaries



Computation times:

	single cpu	16x2 cluster	128x4 cluster
Ingest	287.1h	287.1h	287.1h
Bias, Flat, etc.	30.6h	1.0h	0.1h
Reduce	763.2h	23.9h	1.5h
Astrometry	282.5h	8.8h	0.6h
Regrid	205.8h	6.4h	0.4h
Reference	32.0h	4.0h	4.0h
MDia	2353.1h	73.5h	4.6h
Total	**3954.3h**	**395.7h**	**298.3h**

summary & discussion:

- parallel ingestion needed
  -> already implemented?
- new overscan correction method useful for WFI data
  -> smoothing box size as process parameter?
- for WFI it is highly recommended to add a functionality of bad pixel mask application
- relative astrometry working good with rms ~0.03”
  -> ready for check-in