Kisműholdas exobolygókutatás a CHEOPS misszió tükrében

Kiss László
MTA CSFK KTM CSI

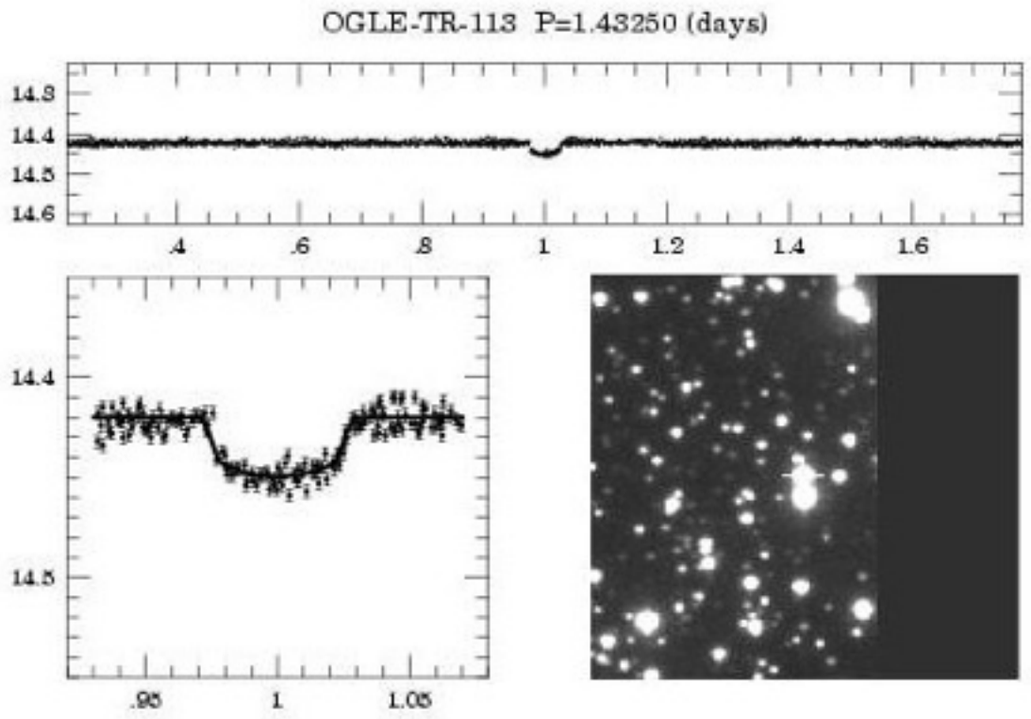
“Kisműholdas missziók hazai lehetőségei”

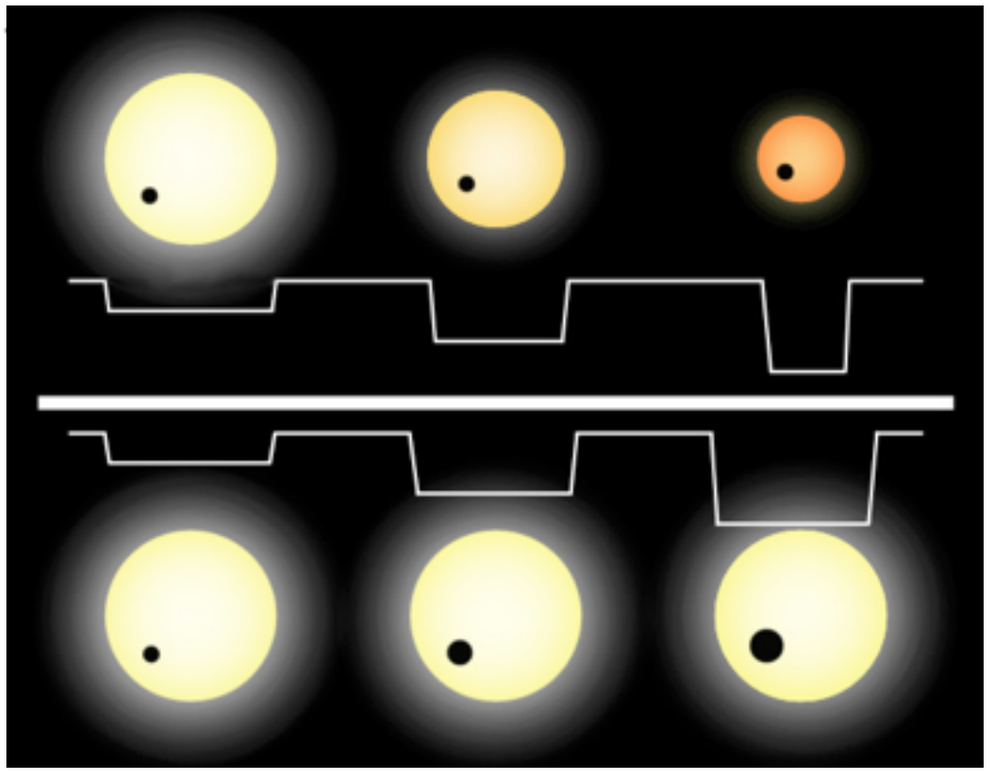
Miskolc, 2014.04.09.

A bolygó átvonulása (tranzitja)

A bolygó elhalad a csillag előtt és kitakarja

- valós méret (a csillagsugár arányában)
- sűrűség
- bolygó szerkezete!
- bolygólégkör színképe
- visszavert fény
- bolygólégkör szerkezete
- csillag légkörének szerkezete





Kepler-űrtávcső

A Kepler célja Föld típusú, lakható bolygók felfedezése a fedési módszerrel

Szimultán észlelt több mint 150 ezer csillagot

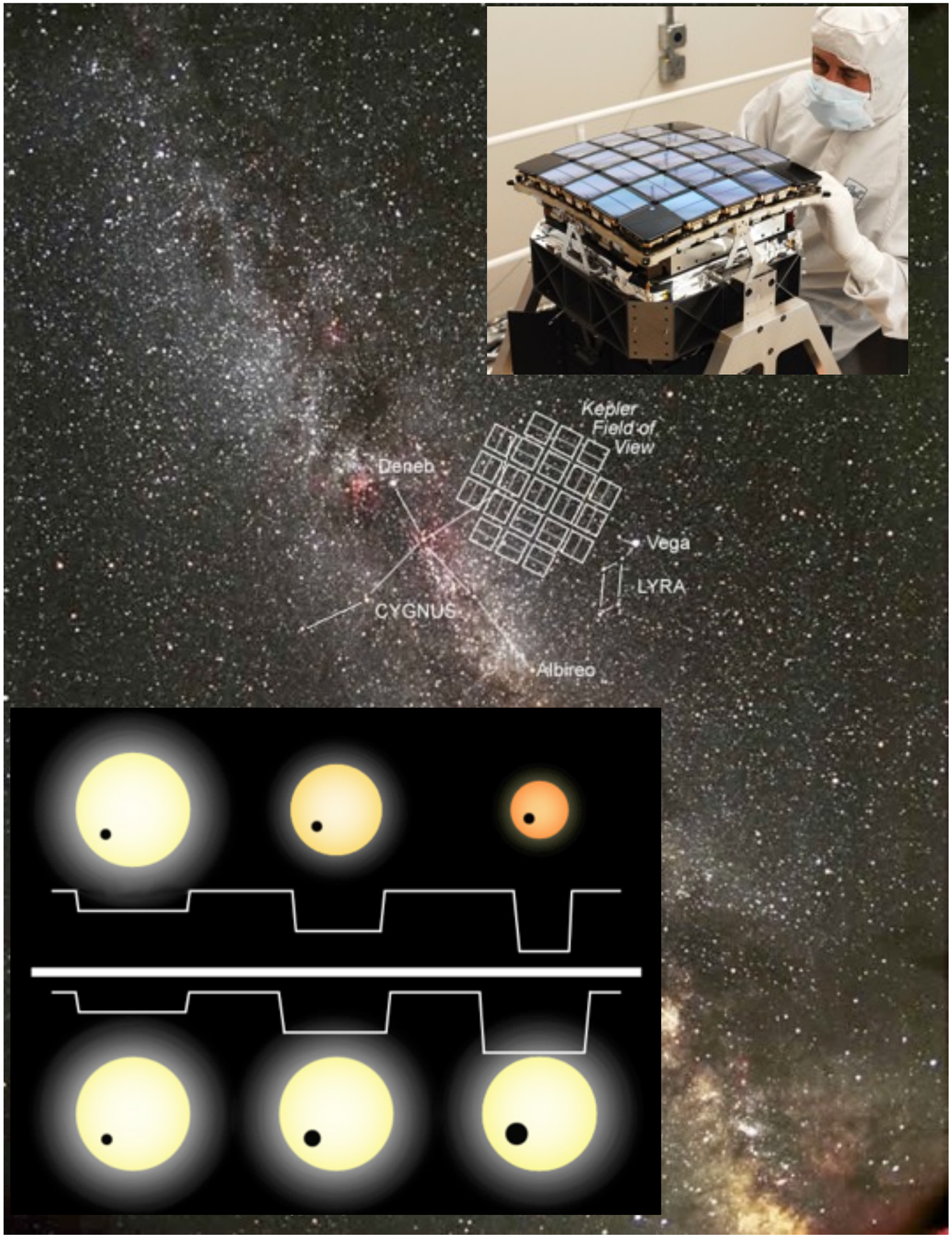
95 cm-es belépő nyílású Schmidt-távcső, látómezeje mintegy 100 négyzetfok, 42 CCD-ből álló mozaikkal

Fotometriai pontosság:

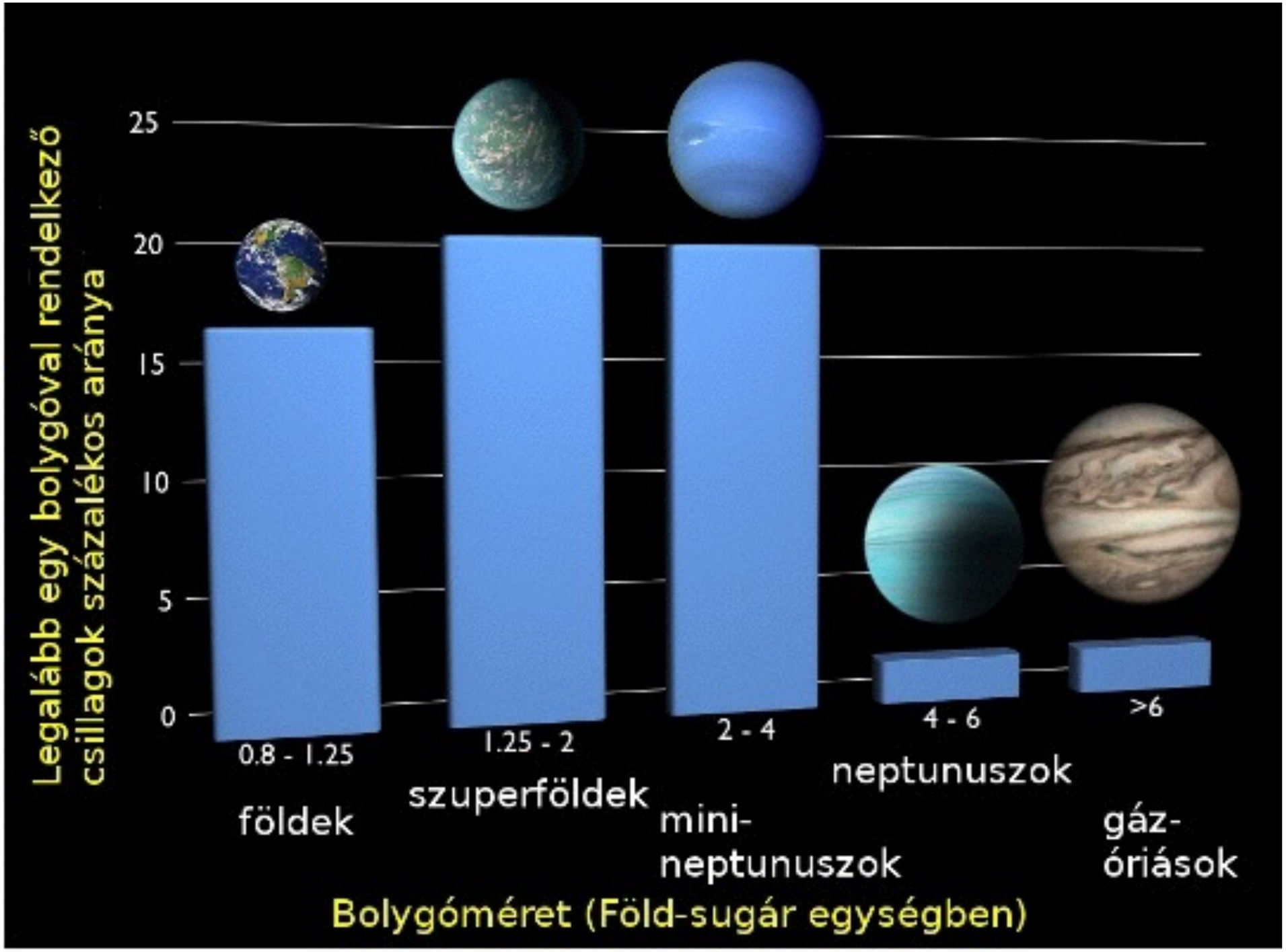
A zaj < 20 ppm 6,5 órányi mérés után egy 12 magn. Nap típusú csillagra

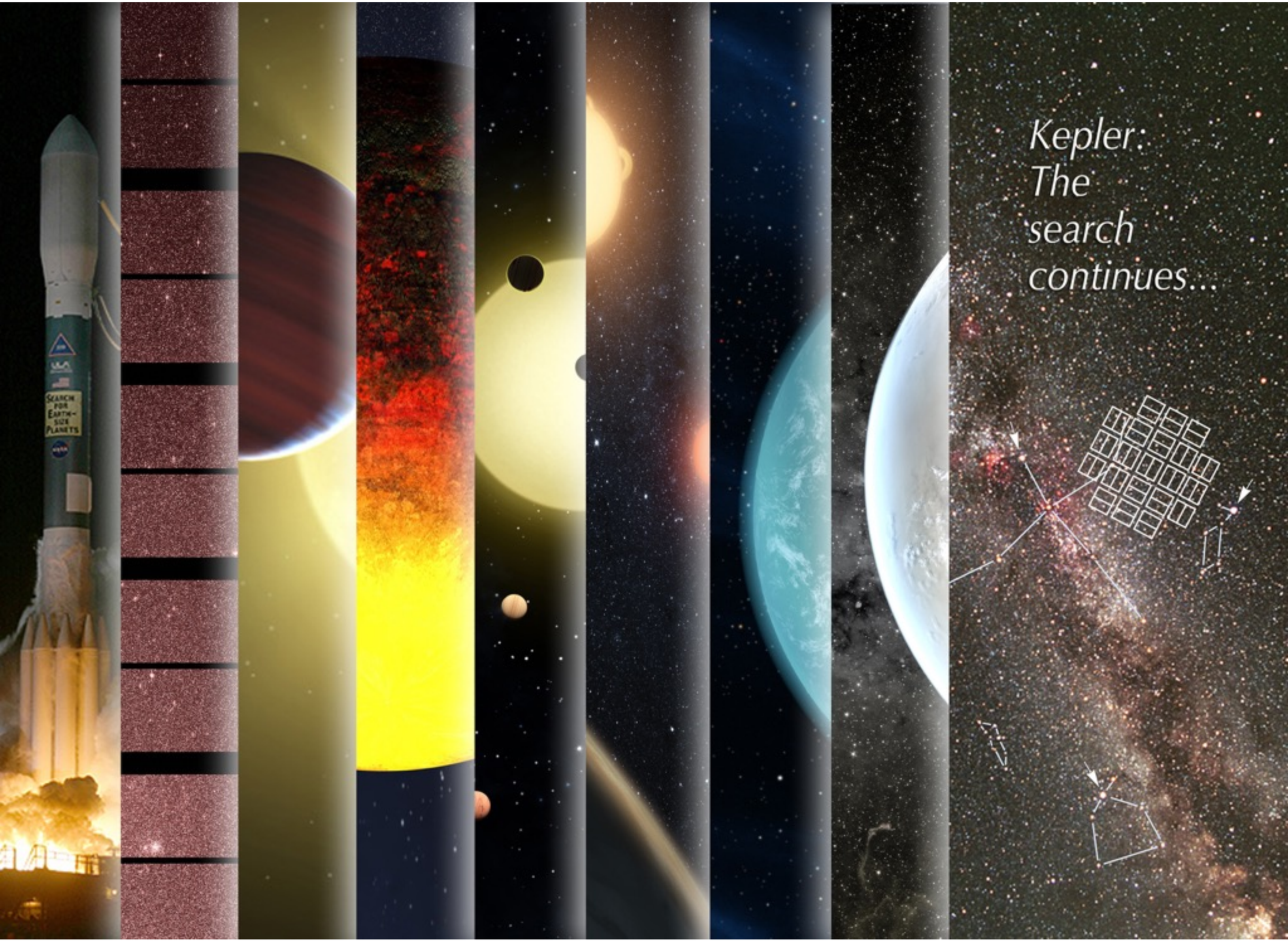
=> 4-szigma detektálás egy exoföld tranzitja esetén.

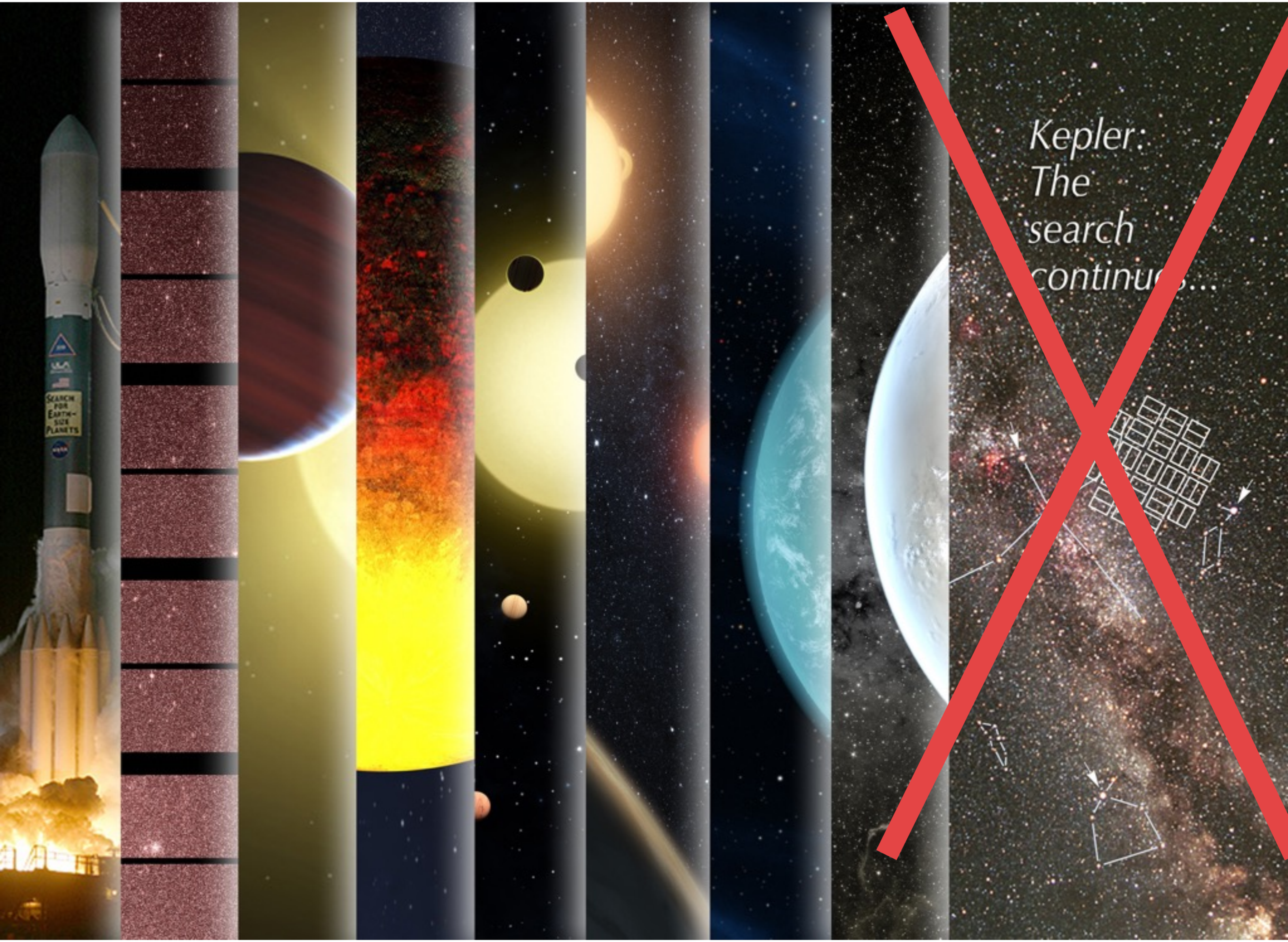
Heliocentrikus pálya, 2009-2013



Rövidperiódusú bolygók gyakorisága




SEARCH FOR EARTH-SIZE PLANETS
Kepler:
The
search
continues...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The
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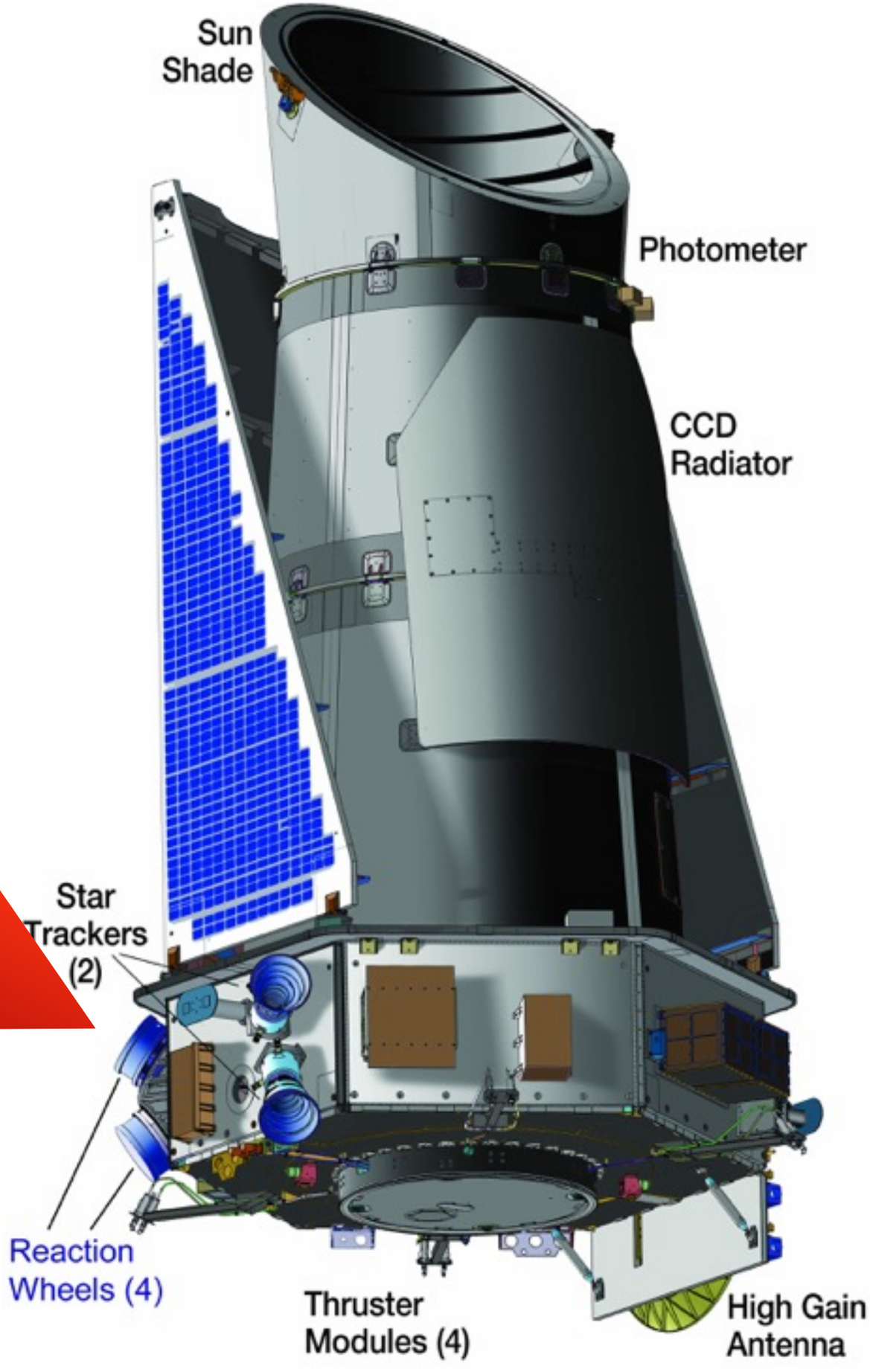
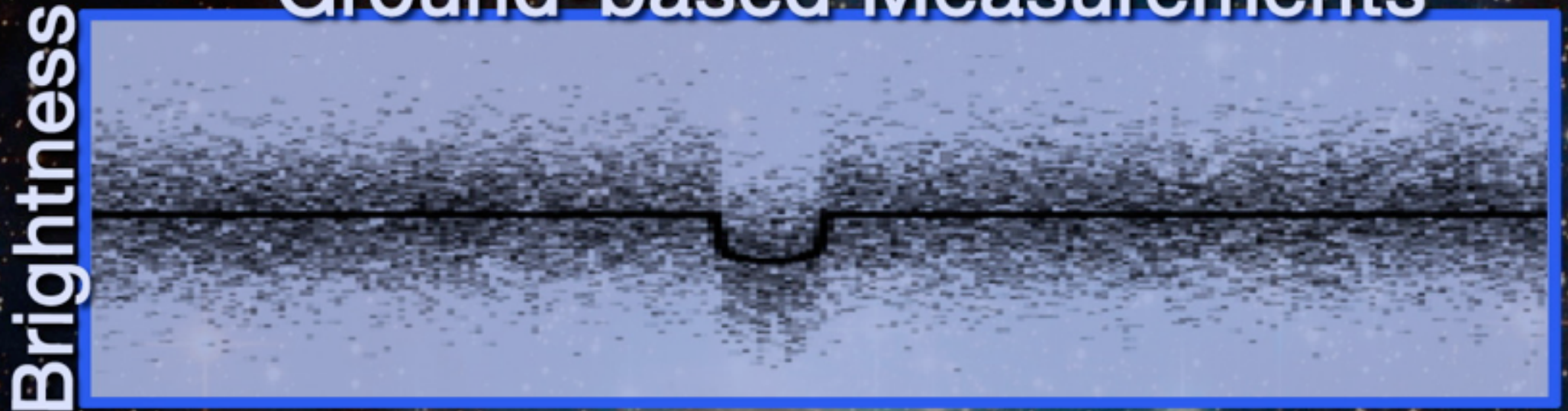
continues...

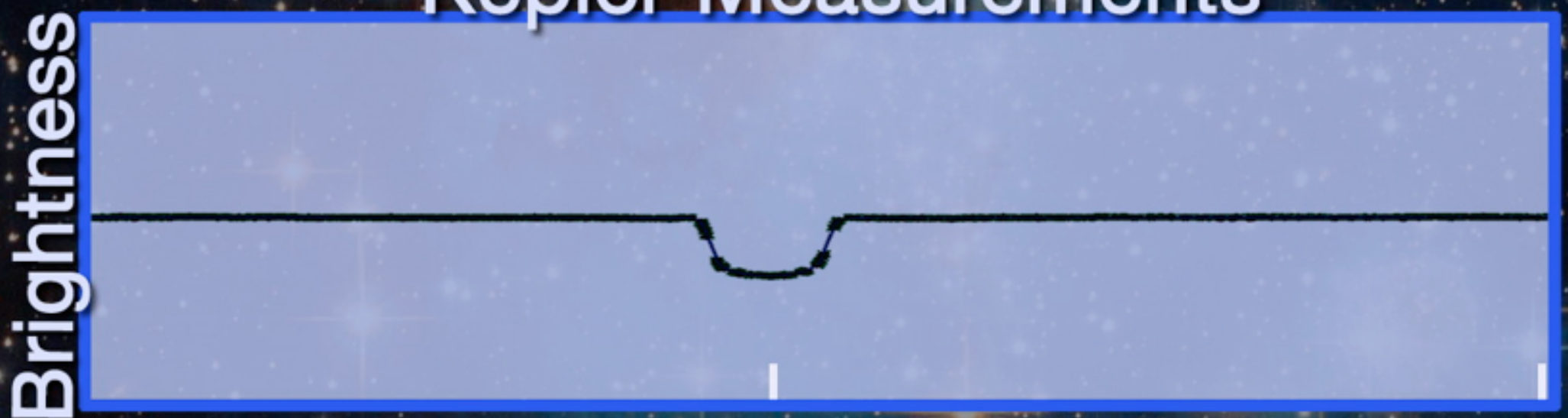

Sun
Shade
Photometer
CCD
Radiator
Star
Trackers
(2)
Reaction
Wheels (4)
Thruster
Modules (4)
High Gain
Antenna

HAT-P-7 Light Curves

Ground-based Measurements



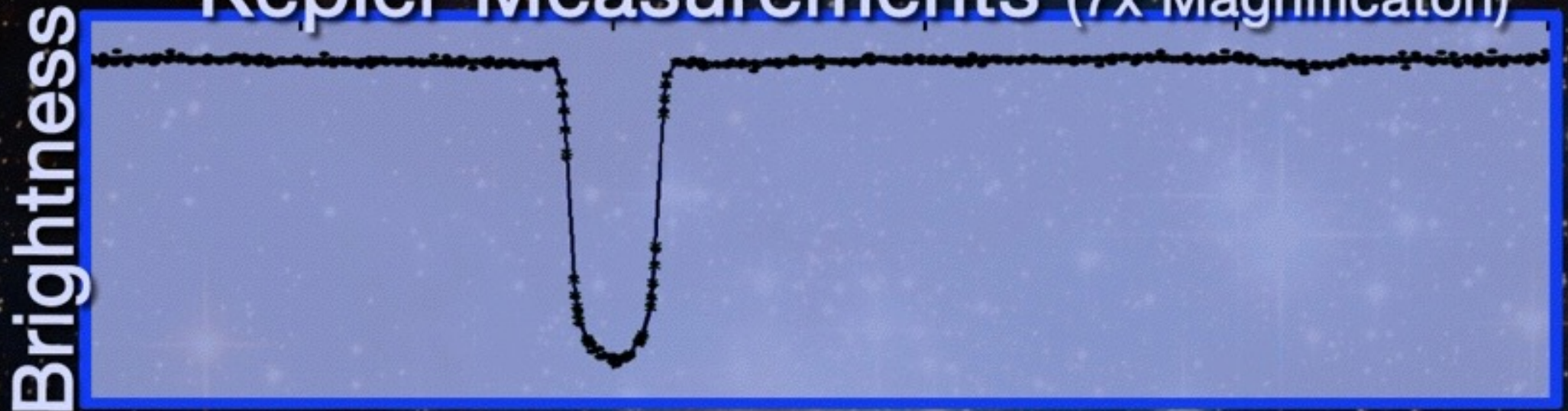
Kepler Measurements



Borucki et al. (2009)

HAT-P-7 Light Curves

Kepler Measurements (7x Magnificaton)



Kepler Measurements (100x Magnification)

Borucki et al. (2009)

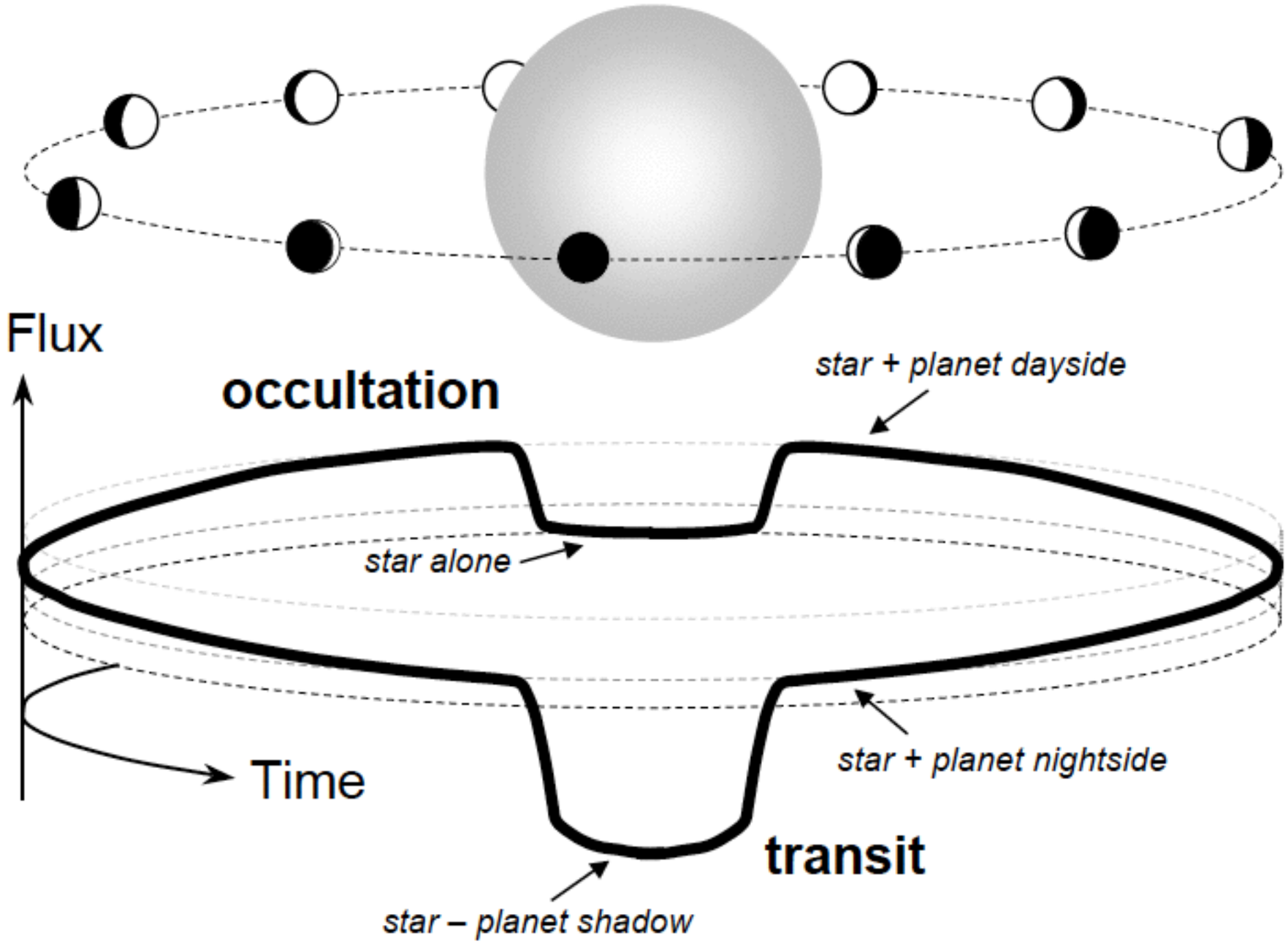
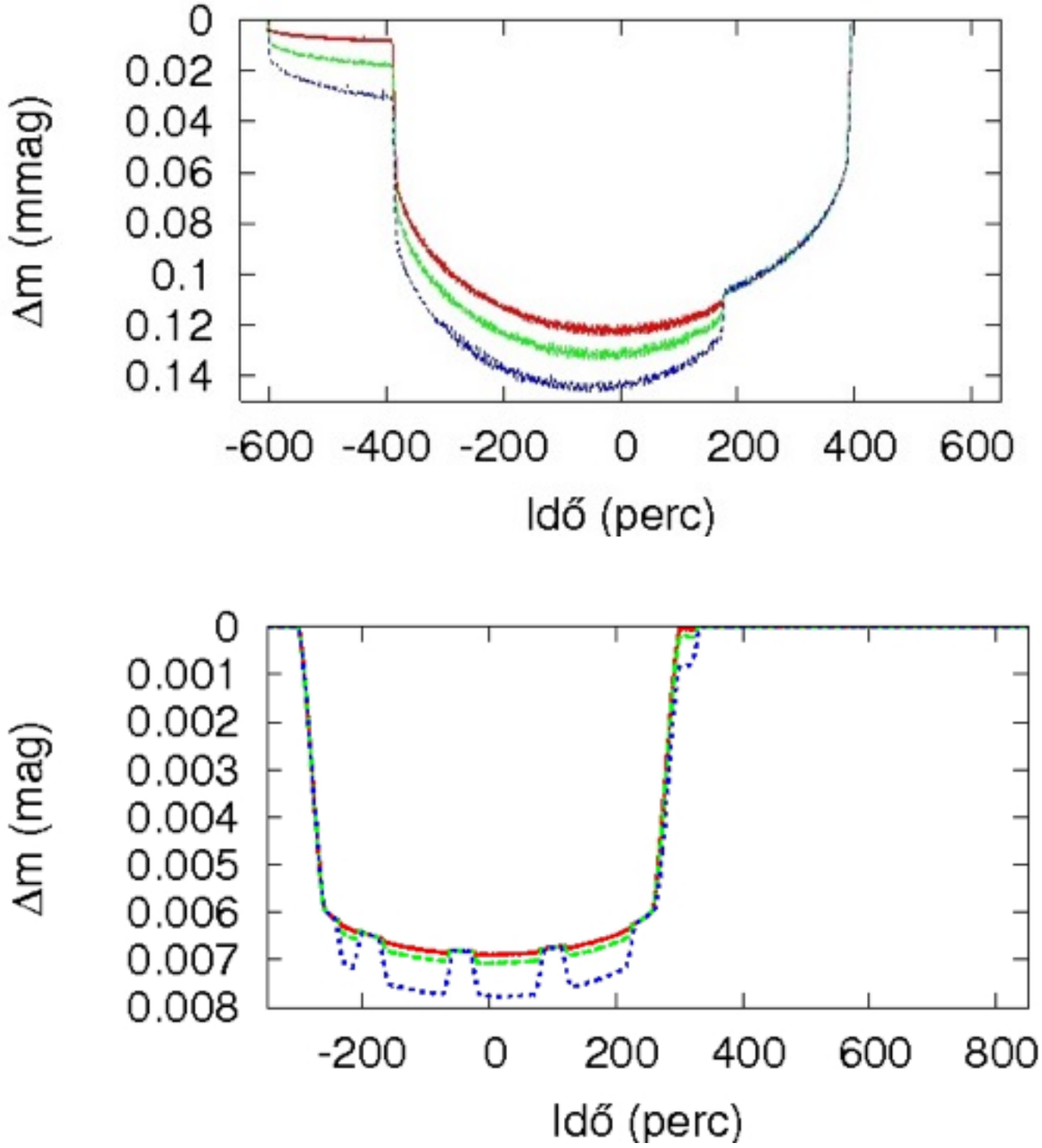
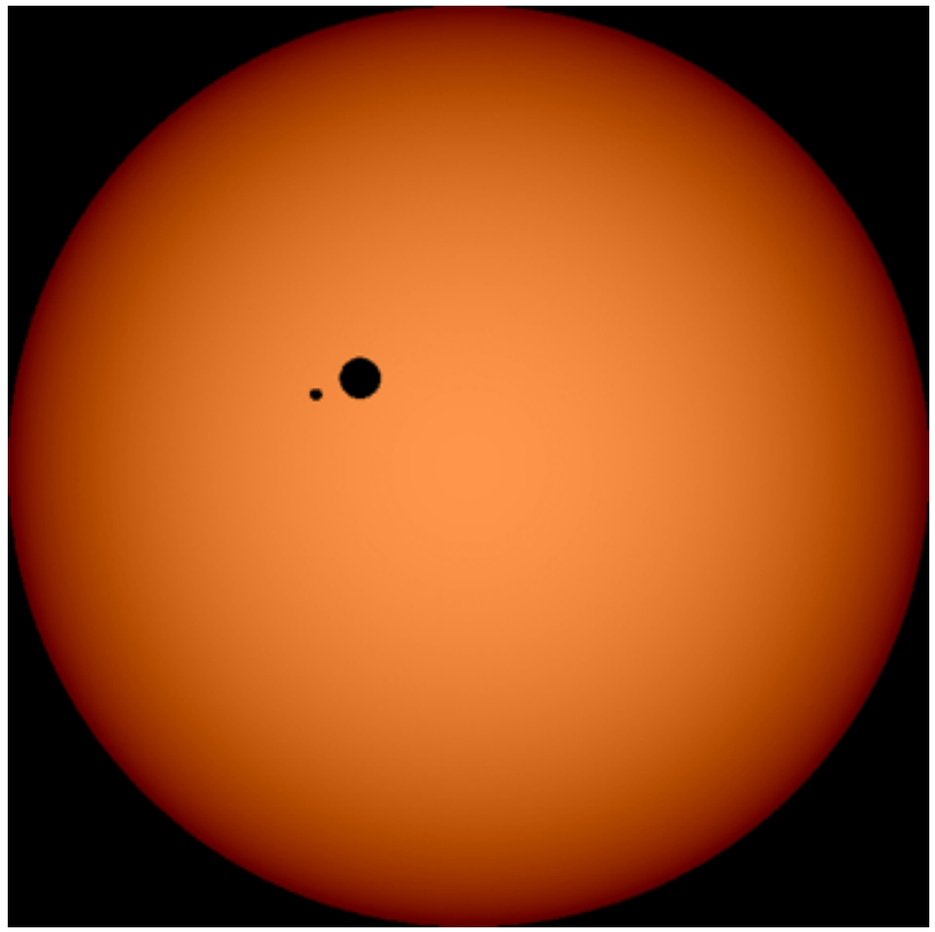


Fig. 1.— Illustration of transits and occultations. Only the combined flux of the star and planet is observed. During a transit, the flux drops because the planet blocks a fraction of the starlight. Then the flux rises as the planet's dayside comes into view. The flux drops again when the planet is occulted by the star.

Exoholdak: tranzitos exobolygók holddal





Simon Attila és mtsai.

FOTOMETRIAI FEJLŐDÉS

- Nagyságrendi ugrások a relatív pontosságban:
  - 100% : Mirák, (szuper)nóvák
  - 1-10%: geometriai és fizikai (pulzáló, eruptív és kataklizmikus) változócsillagok
  - 0,1% (1000 ppm): fedési exobolygók - forró jupiterek
  - 10-100 ppm: Nap típusú csillagrezgések, exoholdak, exoföldek, ??????

KISMŰHOLDAS LEHETŐSÉGEK

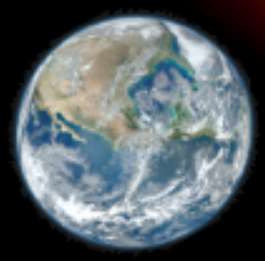
- Űrbéli mérések célja
  - földi légkör zavaró hatásaitól mentes adatgyűjtés
  - nappalok és éjszakák váltakozásaitól mentes mérések
  - fotonzaj-limitált adatok (0,1% - 1 millió foton)
  - kis távcső - fényes csillag!

MOST

Canada's first space telescope

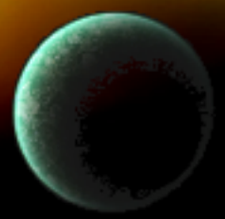
Microvariability & Oscillations of Stars Microvariabilité et Oscillations

Peering into the hidden hearts of stars
Finding and exploring exoplanets
Reading stellar life stories

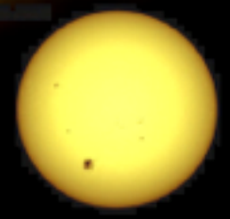


HOME

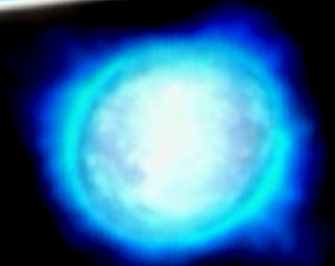
MISSION AT A GLANCE



NEWS



SCIENCE



GALLERY

LINKS

Scientific Goals (in astro-jargon)

- Asteroseismology of acoustic and gravity-mode oscillations in Sun-like stars, magnetic (rapidly oscillating Ap or roAp) stars, cool giants, pre-main-sequence delta Scuti pulsating stars, massive O and B stars, and other stellar classes, to probe uniquely their internal structures and evolutionary states
- Analyses of the transits and eclipses of exoplanets around Sun-like stars and red dwarf stars, to reveal their sizes, atmospheric compositions, magnetic fields and other properties
- Measurement of the turbulent variations in massive evolved (Wolf-Rayet) stars to understand

MOST: max. 60 napos folyamatos mérés, 15 cm-es távcső, 65 x 65 x 30 cm, 54 kg, 2003 óta

BRITE: max. 180-200 napos folyamatos mérés, 3 cm-es távcső, 20 x 20 x 20 cm, <8 kg, 2013 óta

CHEOPS

CHARACTERIZING EXOPLANET SATELLITE

esa

100% vapor

Mission Status & Summary

Mission Status

CHEOPS has been proposed as an S-class mission in response to the call for Proposals issued by ESA in March 2012.

On 19 October 2012 it was selected for study for the first S-class mission.

On 19 February 2014 CHEOPS was adopted by SPC.

Mission Summary:

The following table summarizes the mission.

Name	CHEOPS, CHaracterizing ExOPlanet Satellite
Primary Goal	Characterize transiting exoplanets on known bright and nearby host stars
Targets	Known exoplanet host stars with a V-magnitude < 12.5 (goal: 13) anywhere on the sky
Wavelength	Visible range : 400 to 1100 nm
Telescope	33 cm reflective an-axis telescope
Orbit	Sun-synchronous Low Earth Orbit, LTAN 6am, altitude 620-800 km
Lifetime	3.5 years
Type	S-class mission

(last update Feb 2014)

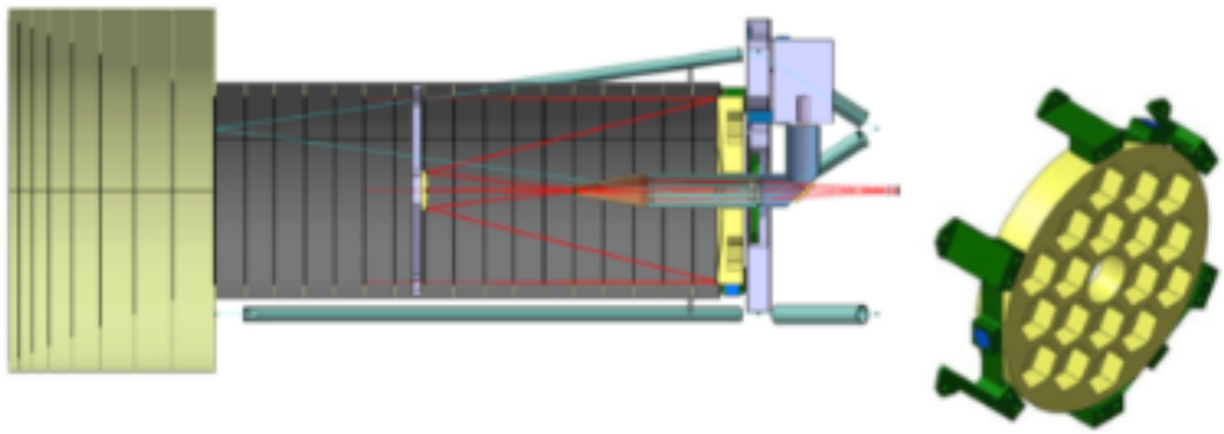
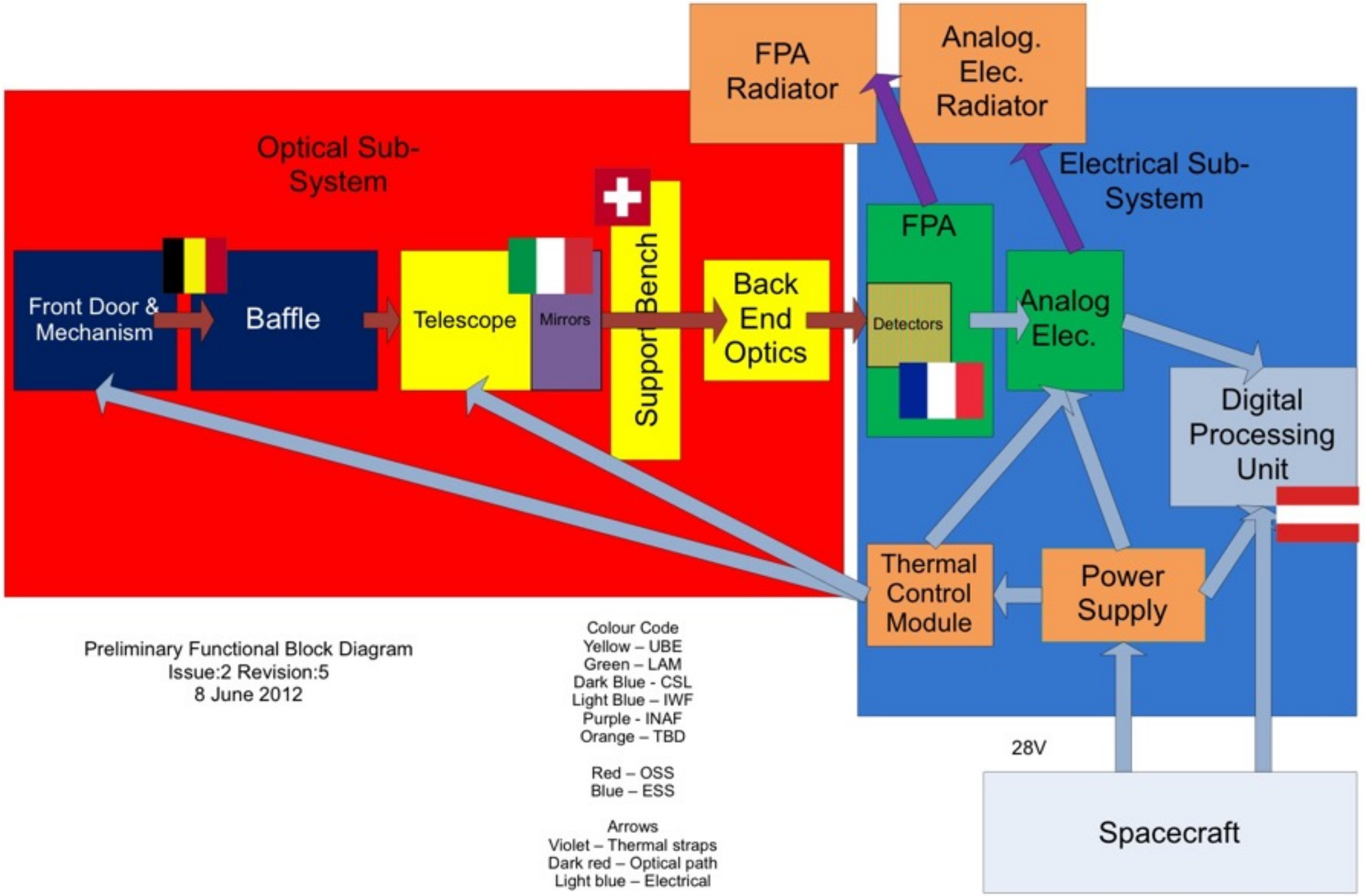


Fig. 2: Initial mechanical concept for the telescope and the lightweighted primary mirror

	Mass (kg, No Margin)	Mass (kg, incl.20% Margin)
Telescope Structure	14.6	17.5
Optical Bench	2.5	3.0
Focal Plane Assembly	2.0	2.4
Lens Assembly	2.0	2.4
Readout Electronics	5.0	6.0
Electronics Box (PCM, DPM, TCM)	5.6	6.7
Radiator	1.0	1.2
Outer Baffle Assembly	11.0	13.2
Total	46.1	55.3
Gyro Assembly	4.5	5.4
Star Tracker Assembly	1.1	1.3
Total (incl. PRS components)	48.3	58.0

Table 1: Current payload mass breakdown



Preliminary Functional Block Diagram
Issue:2 Revision:5
8 June 2012

Colour Code
Yellow – UBE
Green – LAM
Dark Blue - CSL
Light Blue – IWF
Purple - INAF
Orange – TBD

Red – OSS
Blue – ESS

Arrows
Violet – Thermal straps
Dark red – Optical path
Light blue – Electrical

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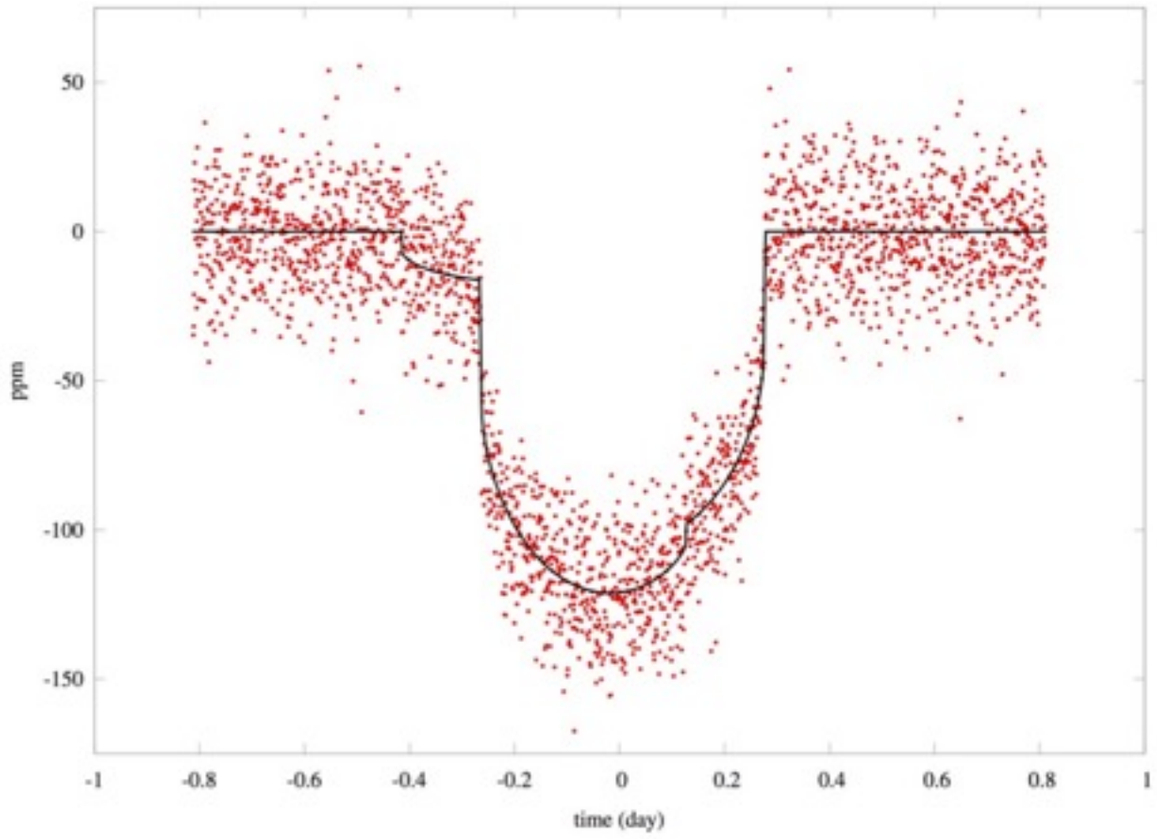


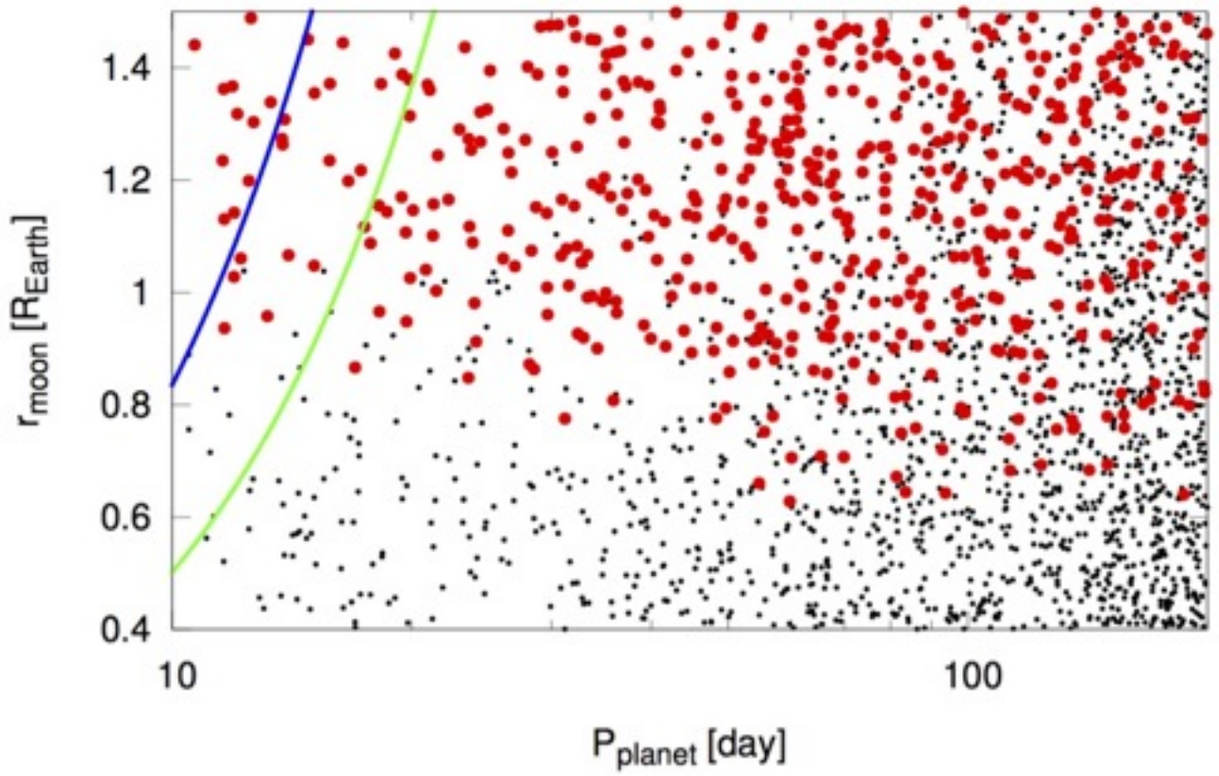


Figure 17 | ***Left panel****— Transit of an Earth-size exoplanet plus a 0.4×smaller moon is simulated when the photometric precision is set to ~20 ppm (the solid curve shows the underlying theoretical model).* ***Right panel****— Planet + moon systems have been generated with random planet periods and moon sizes (black dots). The blue and green curves show the 1- and 4.6-Gyr stability limits, respectively, of these systems (stable systems are on the right of the lines). The red dots are those systems for which the moon could be detected assuming* **CHEOPS** *observes five planetary transits.*

Horizon 2020

Search Topics

Calls

Call Updates

Other EU Programmes 2014-2020

Research Fund for Coal & Steel

COSME

3rd Health Programme

Consumer Programme

FP7 & CIP Programmes 2007-2013

Calls

H2020-LEIT-Space-Competitivenessof the European Space Sector-2015

H2020-COMPET-2015

Publication date	2013-12-11	**Deadline Date**	2014-11-27 17:00:00 (Brussels local time)
Total Call Budget	€36,500,000	**Main Pillar**	Industrial Leadership
Status	Open	**OJ reference**	OJ C 361 of 11.12.2013

Topic: Scientific exploitation of astrophysics, comets, and planetary data **COMPET-05-2015**

Topic Description | Topic Conditions & Documents | Submission Service

Specific Challenge: Three specific areas of space science where there is a significant underinvestment when compared to the potential scientific return for Europe are the exploitation of astrophysics, comets, and planetary data.

Europe has an impressive track record in space astrophysics, comets and planetary research. Astrophysics missions such as XMM-Newton, Herschel or Planck, and in coming years Gaia, JUICE, EUCLID, CHEOPS or the James Webb Space Telescope are an opportunity for European researchers. The challenge will however be to allow the European astrophysics community to make the best possible use of those missions by supporting

NASA gives planet-hunting TESS space telescope go-ahead for 2017 launch

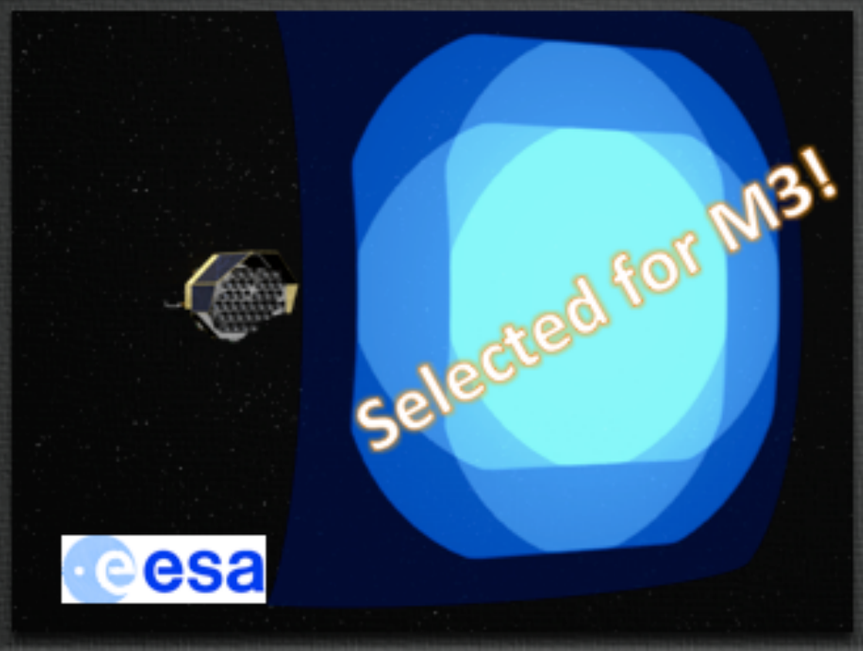
By **Donald Melanson** posted Apr 9th, 2013 at 3:01 PM

17

NASA's Kepler space telescope hasn't exactly been a slouch when it comes to planet

PLATO 2.0

An European Space Agency (ESA) Cosmic Vision 2015-2025 Project



ESA/SRE(2013)5 - The YellowBook

ESRE-F/2013.075 - Preliminary Requirement Review

PLATO 2.0 (PLAnetary Transits and Oscillations of stars) is a medium class (M class) mission studied in the framework of the ESA Cosmic Vision 2015-2025 program.

Project Status

On February 19th 2014 PLATO has been selected by the ESA SPC for the M3 slot, according to the proposal made by he ESA executive that followed the recommendation by the ESA Space Science Advisory Committee.

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