False Positives and Shallow Eclipsing Binaries

as will be seen by PLATO 2.0

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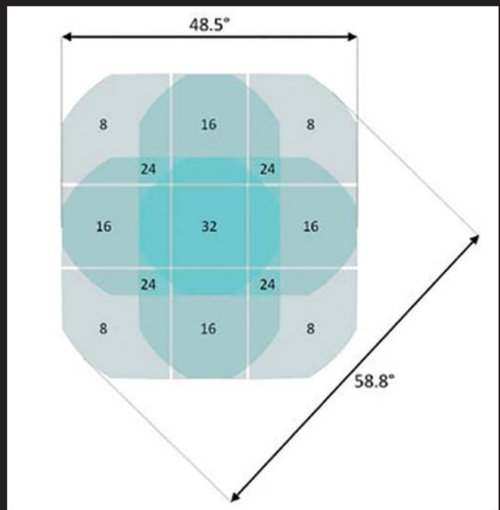
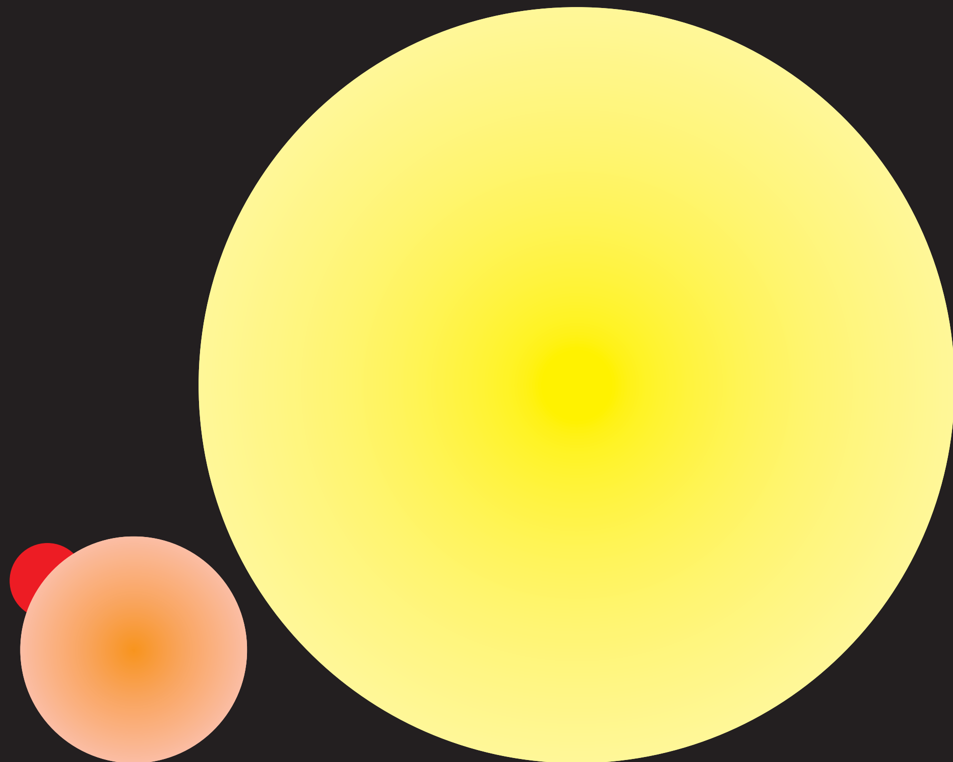
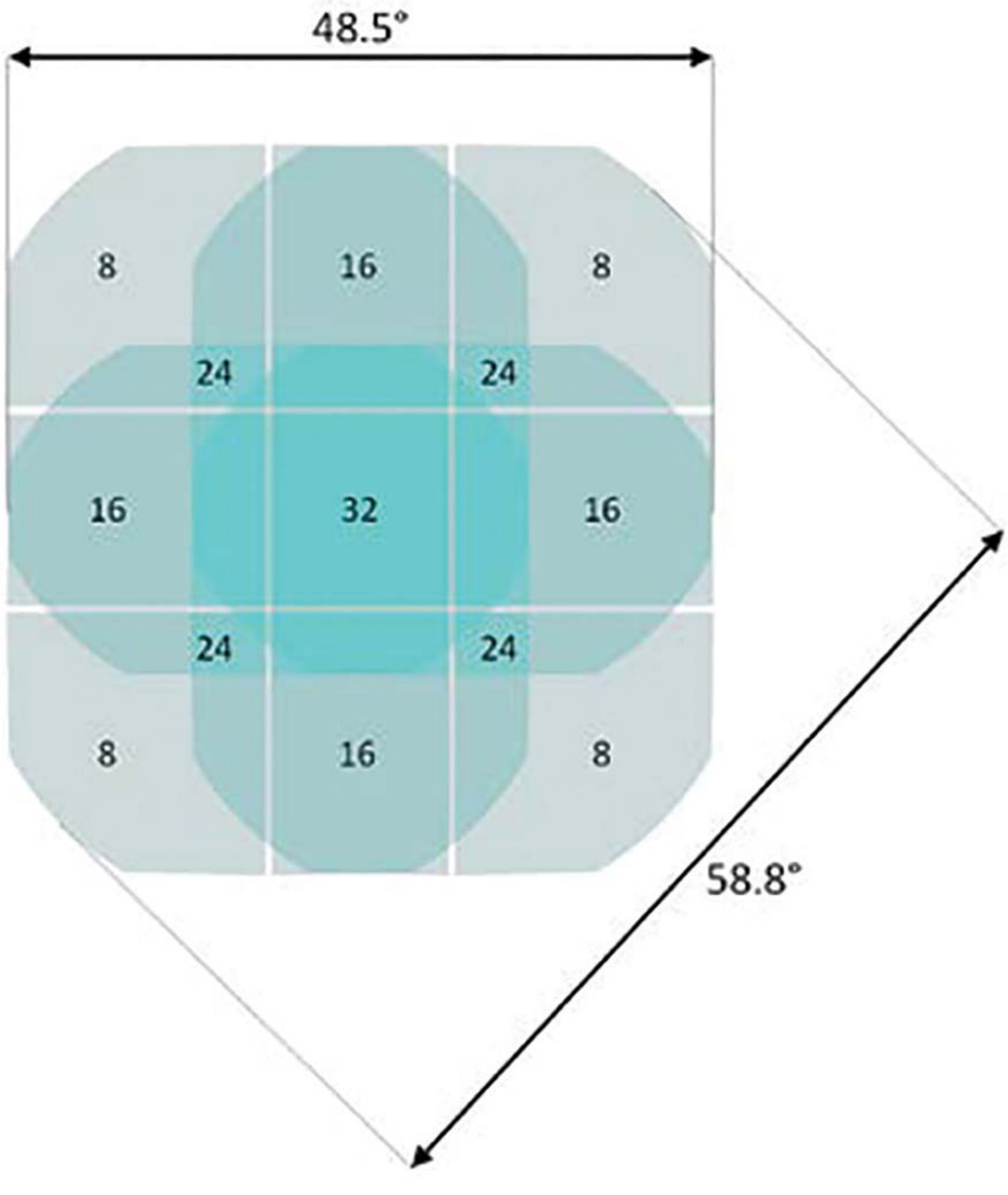
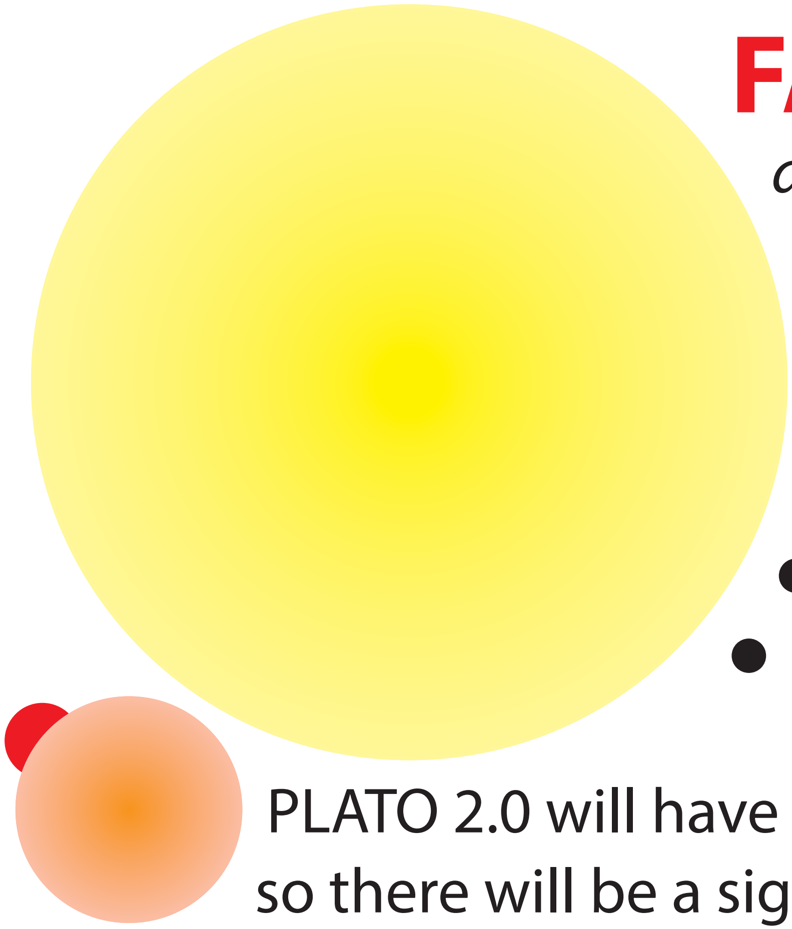





48.5°
8
16
8
24
24
16
32
16
24
24
8
16
8
58.8°



FALSE POSITIVE

a signal mimicking that arising from an exoplanet but actually arising from another astrophysical body

Typically

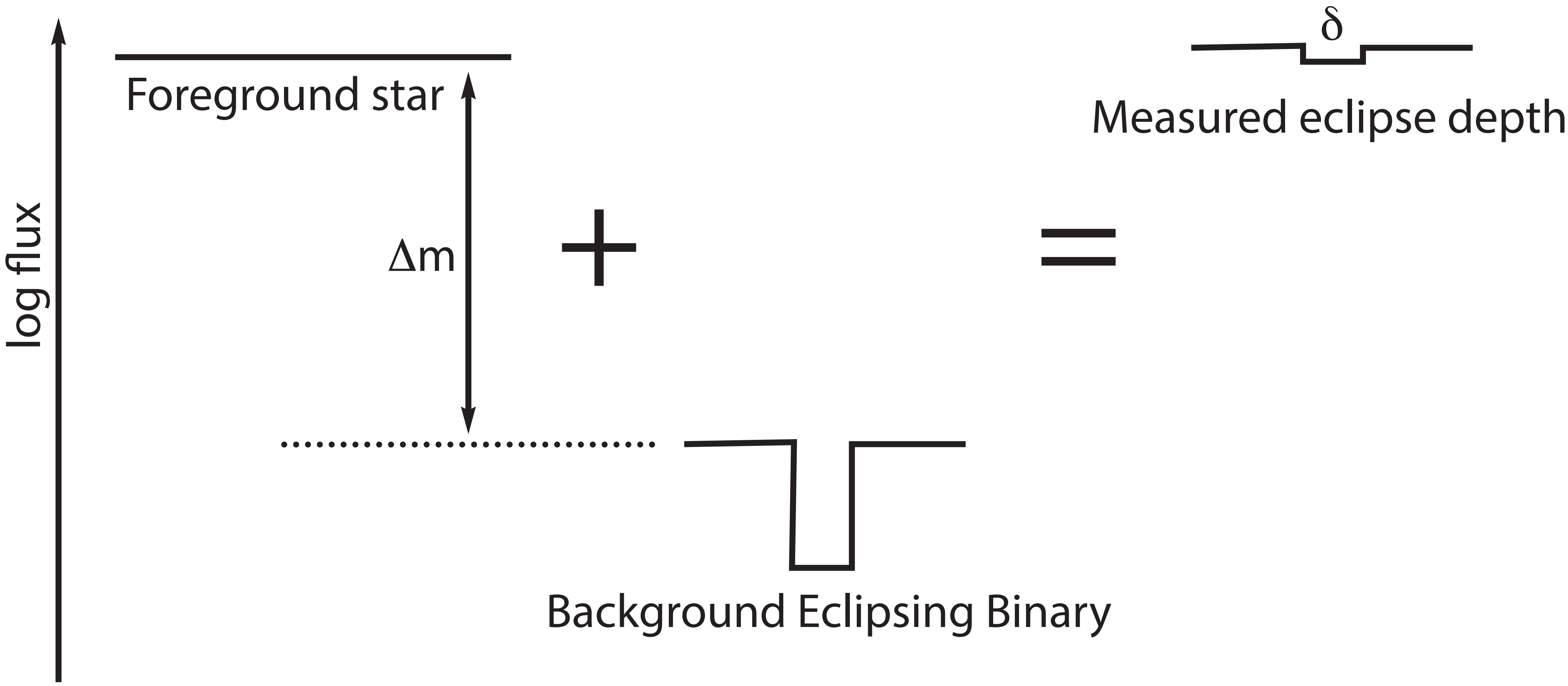
- a grazing eclipsing binary
- a white dwarf or brown dwarf
- blends with a background eclipsing binary

PLATO 2.0 will have a large pixel size of 15″ x 15″ so there will be a significant blending problem.

Research question (part of PLATO Input Catalogue work packages (PSPM WP132,300, PLATO field contaminants, led by U. Kolb)):

How close to the Galactic plane can PLATO 2.0 gaze, allowing more genuine exoplanets to be detected, before the numbers of false positives become unmanageable?

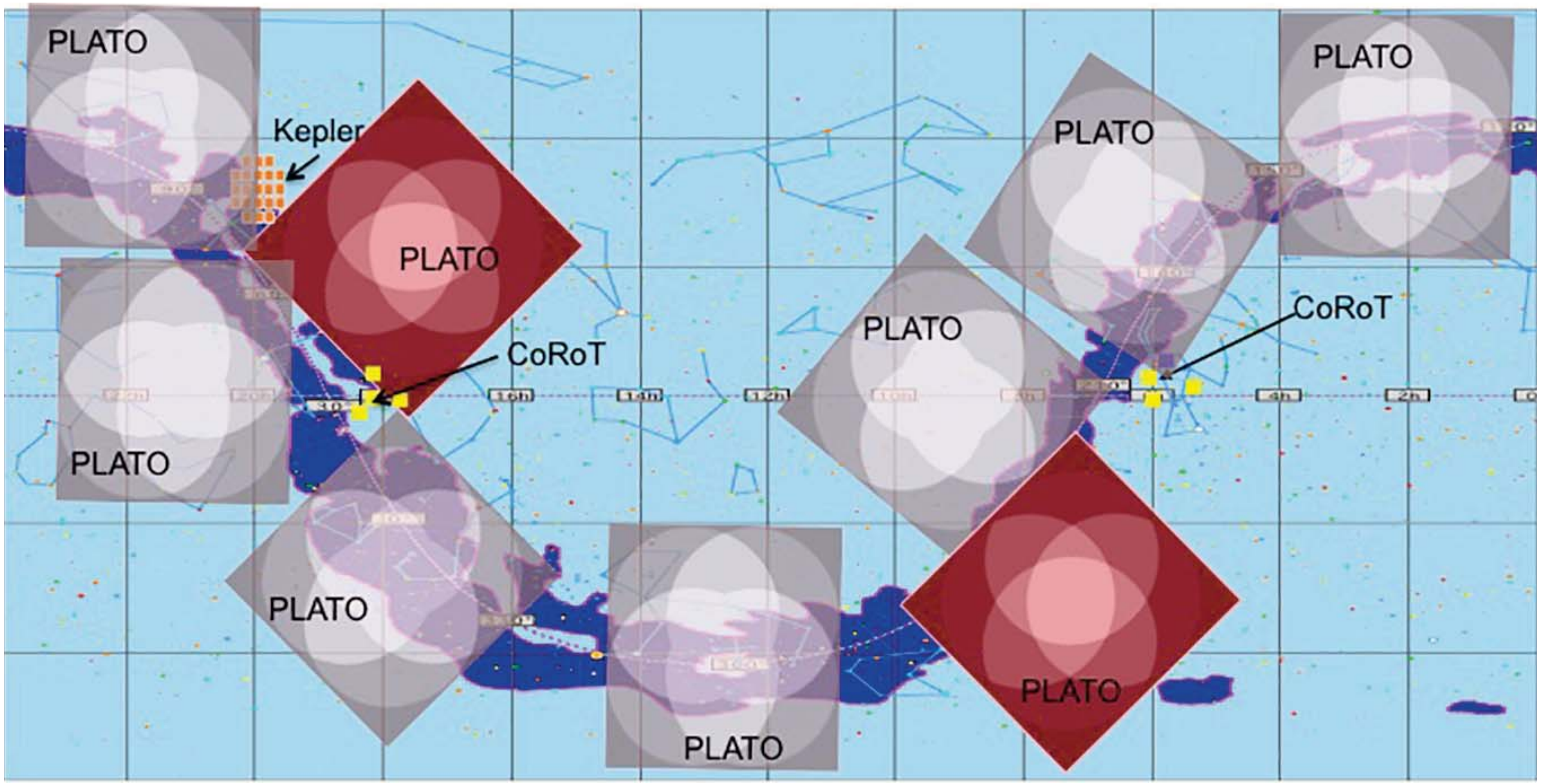
Blends: why are they a problem?



$$\log(2\delta) = -0.4\Delta m_{max}$$

This is the maximum eclipse depth in an MS/MS system

PLATO 2.0 proposed fields of view



Red squares: the two “Long Look” fields: PLATO 2.0 will spend 2-3 years observing these fields.

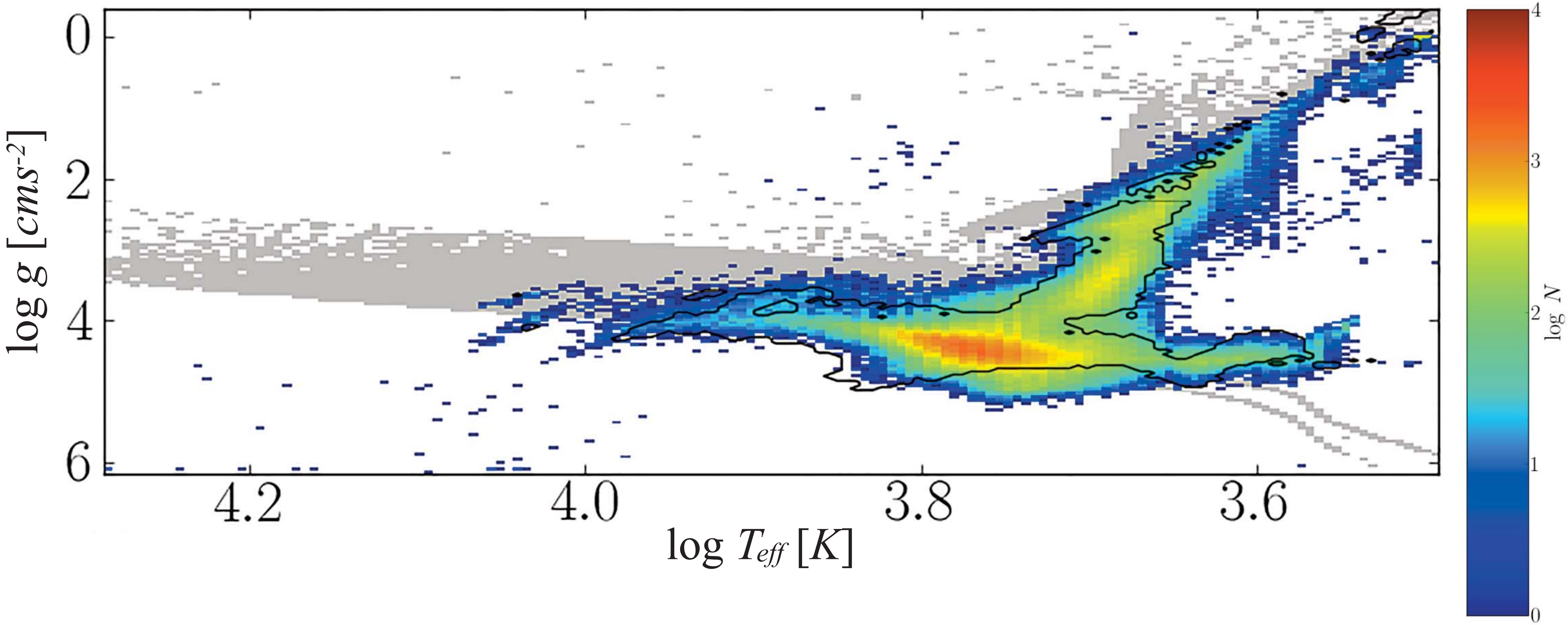
Grey squares: Step-and-stare phase, up to five months per field.

PLATO 2.0 is ESA’s M3 mission, due for launch in 2024 and will operate at the L2 position.

Binary Population Synthesis *with* BiSEPS

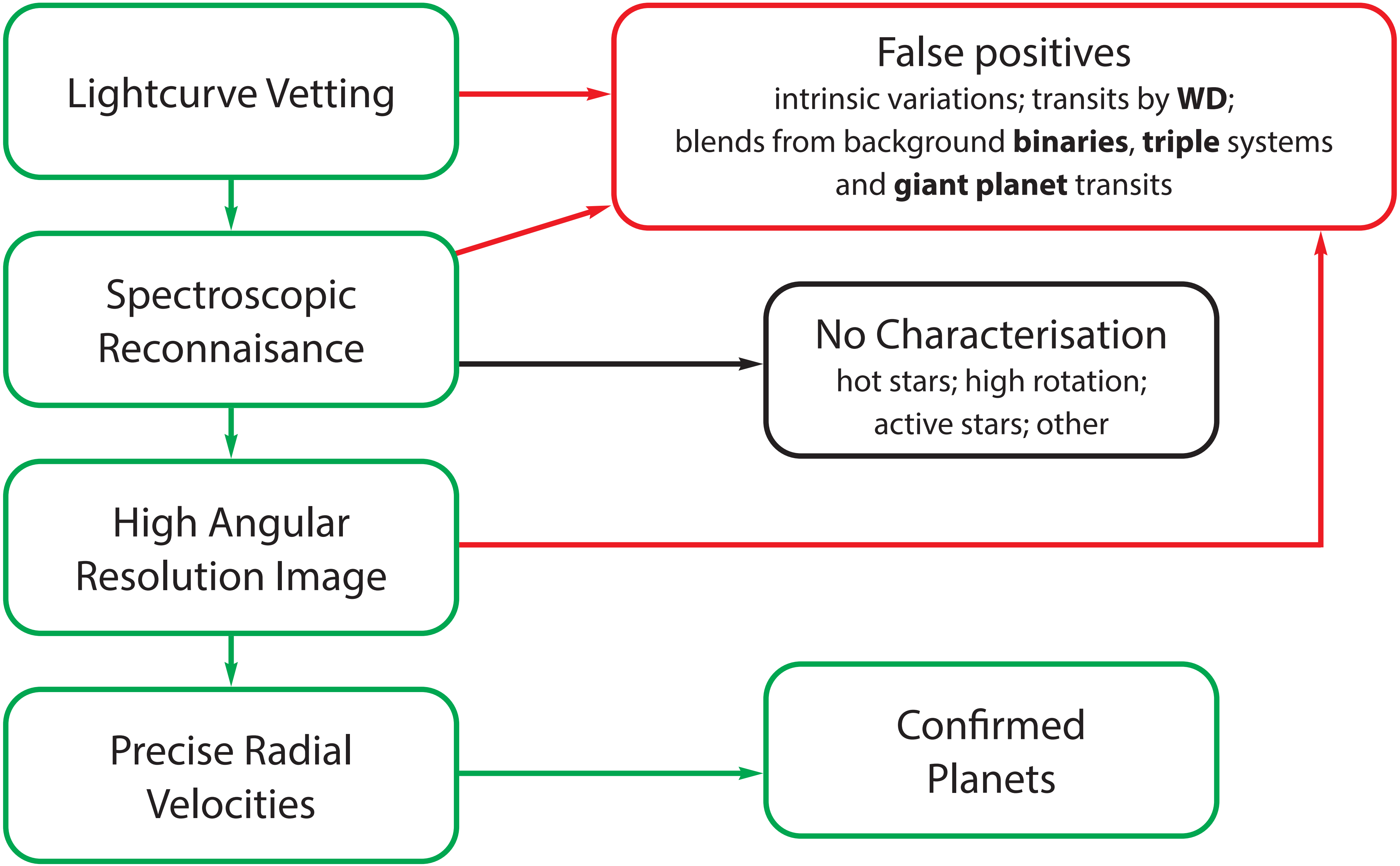
previous applications include

"The True Stellar parameters of the Kepler Target List", Farmer et al (2013)



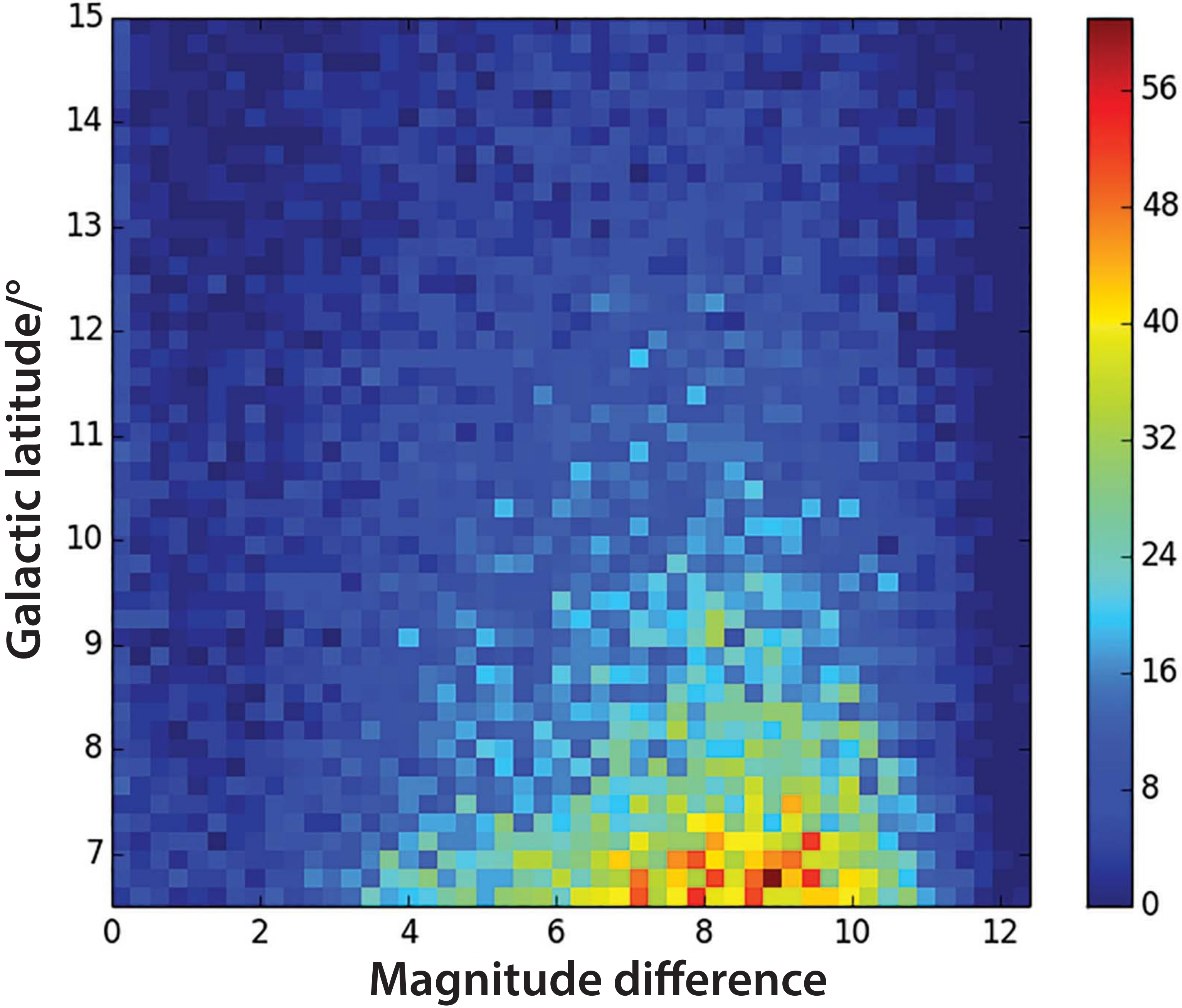
The distribution of the Kepler Q2 data set from the Kepler Stellar Classification Program (SCP). The contour indicates the region covered by the synthetic distribution after processing, while the grey-shaded area indicates the true parameters of the synthetic distribution.

PLATO 2.0 follow-up observations



Based on The PLATO 2.0 Mission, 2014, Rauer et al, p 51

Measured eclipsing binary depths from 2 x 10^{-2} to 1 x 10^{-5}



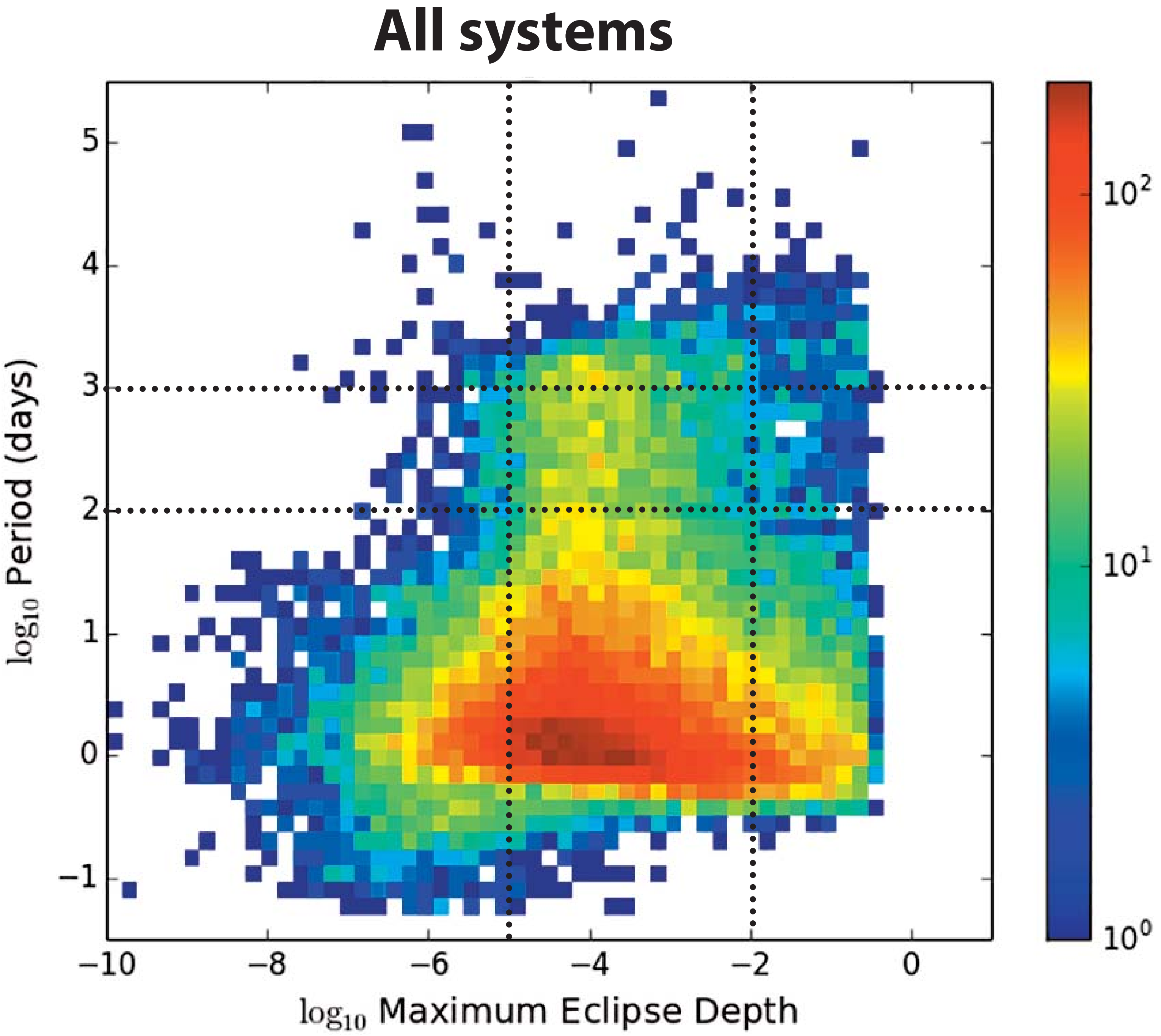
$m_r \leq 16$ (measured), l = 64.5°-65.5°, b = 6.5°-15.0°. Binning: b = 0.17° , $\Delta m \approx 0.25$.

Blended eclipsing binaries

Strip size:

$l = 64.5\text{-}65.5$ (1°)

$b = 6.5\text{-}54.5$ (48°)

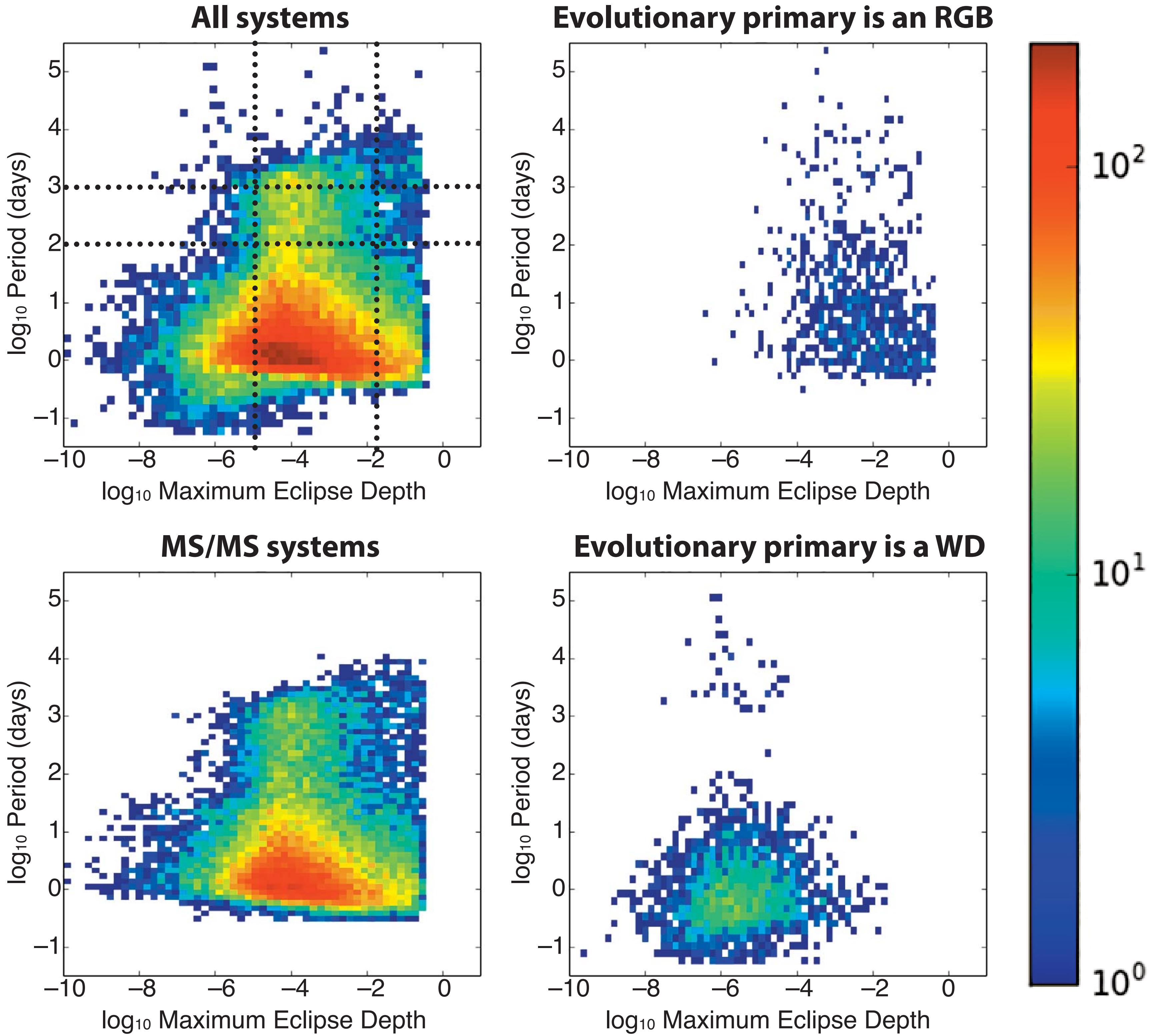


Blended eclipsing binaries

Strip size:

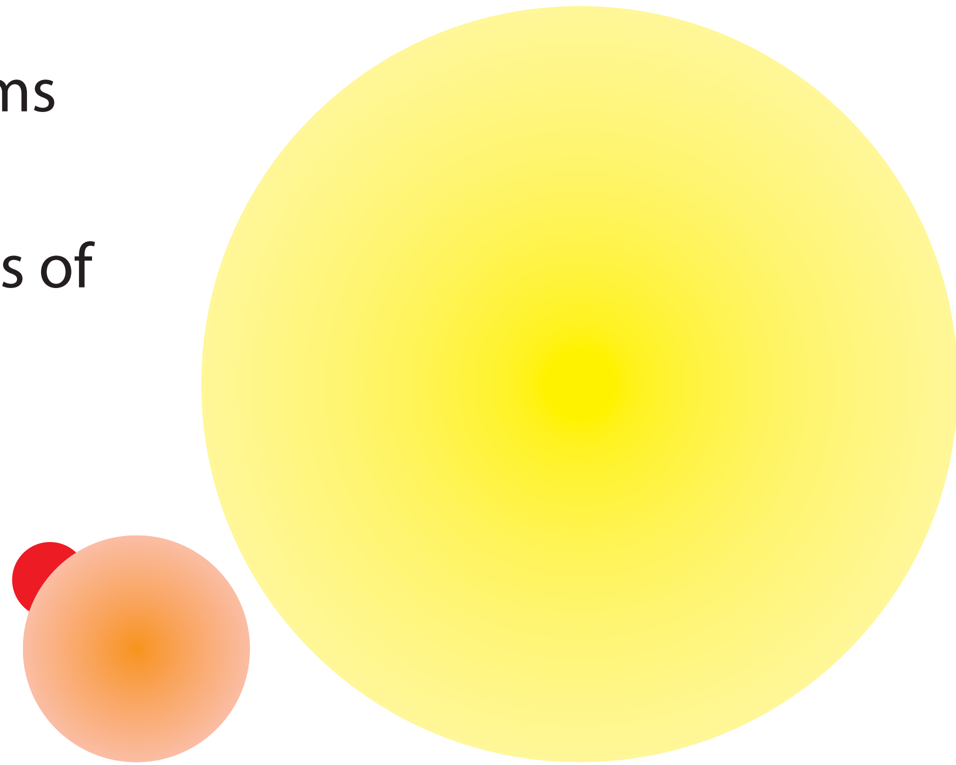
$l = 64.5\text{-}65.5$ (1°)

$b = 6.5\text{-}54.5$ (48°)



WHERE NEXT?

- Extend the coverage to the full sky at low latitudes (≤ b = 55°)
- Study the nature of the systems that may form false positives
- Extend BiSEPS to cover triple systems
- Consider contamination by giant planets of terrestrial planet signals



SUMMARY

- PLATO 2.0 seeks to discover Earth-like planets.

- The large point spread function means that false positives are a serious issue, especially at lower Galactic latitudes.

- We use binary population synthesis tools (BiSEPS) to study this problem.

- Early results indicate that, especially at low latitudes, systems that produce an Earth-like signal will probably have $\Delta m \approx 8$ and will be MS/MS systems with a non-grazing eclipse.