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Mapping Exoplanets Across the Milky Way:

A Representative Transit Census of the Galactic Disk with Rubin

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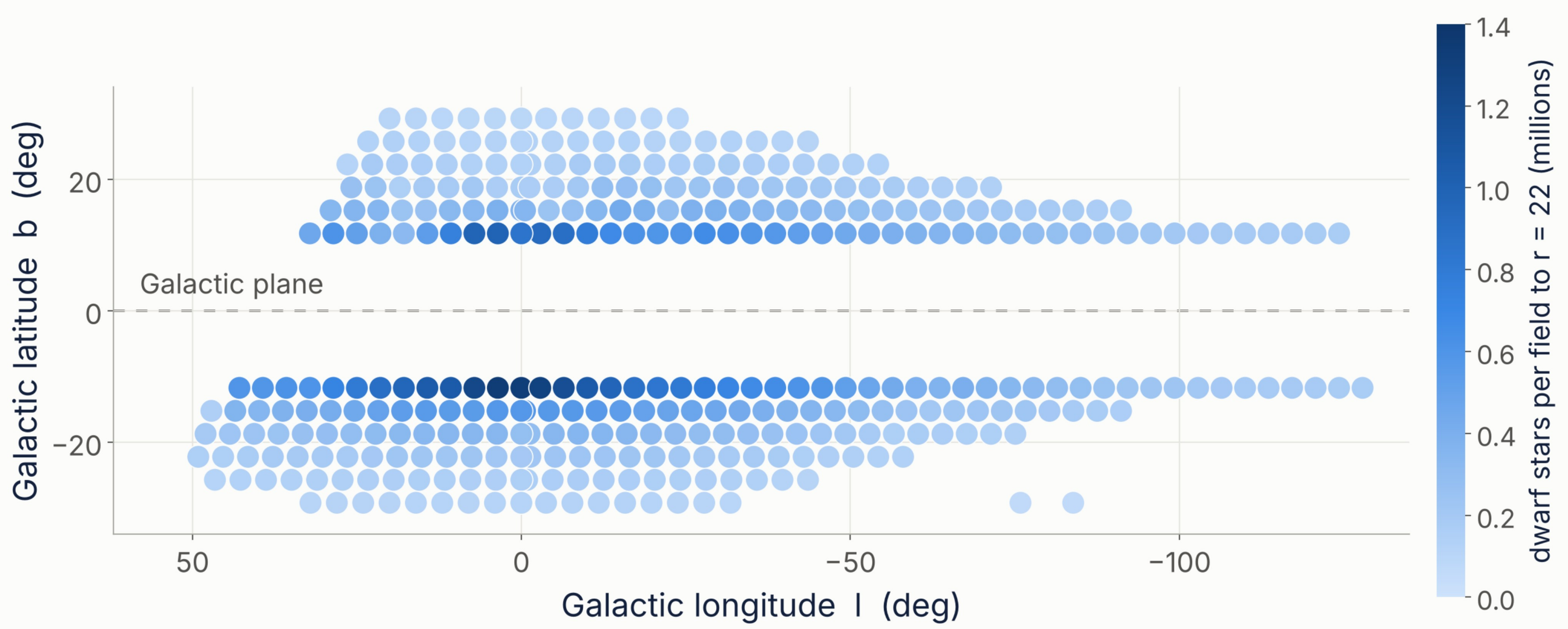
Why a Galactic census?

Our best measurements of planet occurrence come from a single line of sight, the Kepler field. How occurrence changes with stellar age, metallicity and Galactic environment is still largely unmeasured.

A dedicated post-LSST Rubin transit survey could sample the disk systematically, making occurrence versus Galactic environment a measurement in its own right.

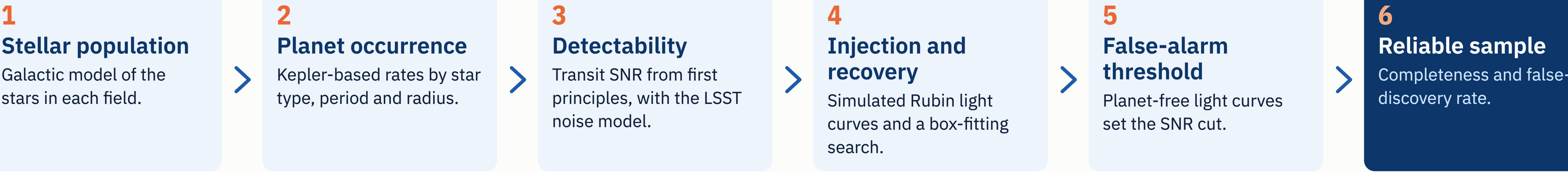
Numbers here are conditional on Kepler-derived occurrence rates (Dressing & Charbonneau 2015 for M dwarfs; Hsu et al. 2019 for K and G dwarfs).

Where Rubin would look



360 candidate Rubin fields (9.6 deg² each) in Galactic coordinates. The baseline design observes a subset in 30-night campaigns at 6-minute cadence over 5 seasons.

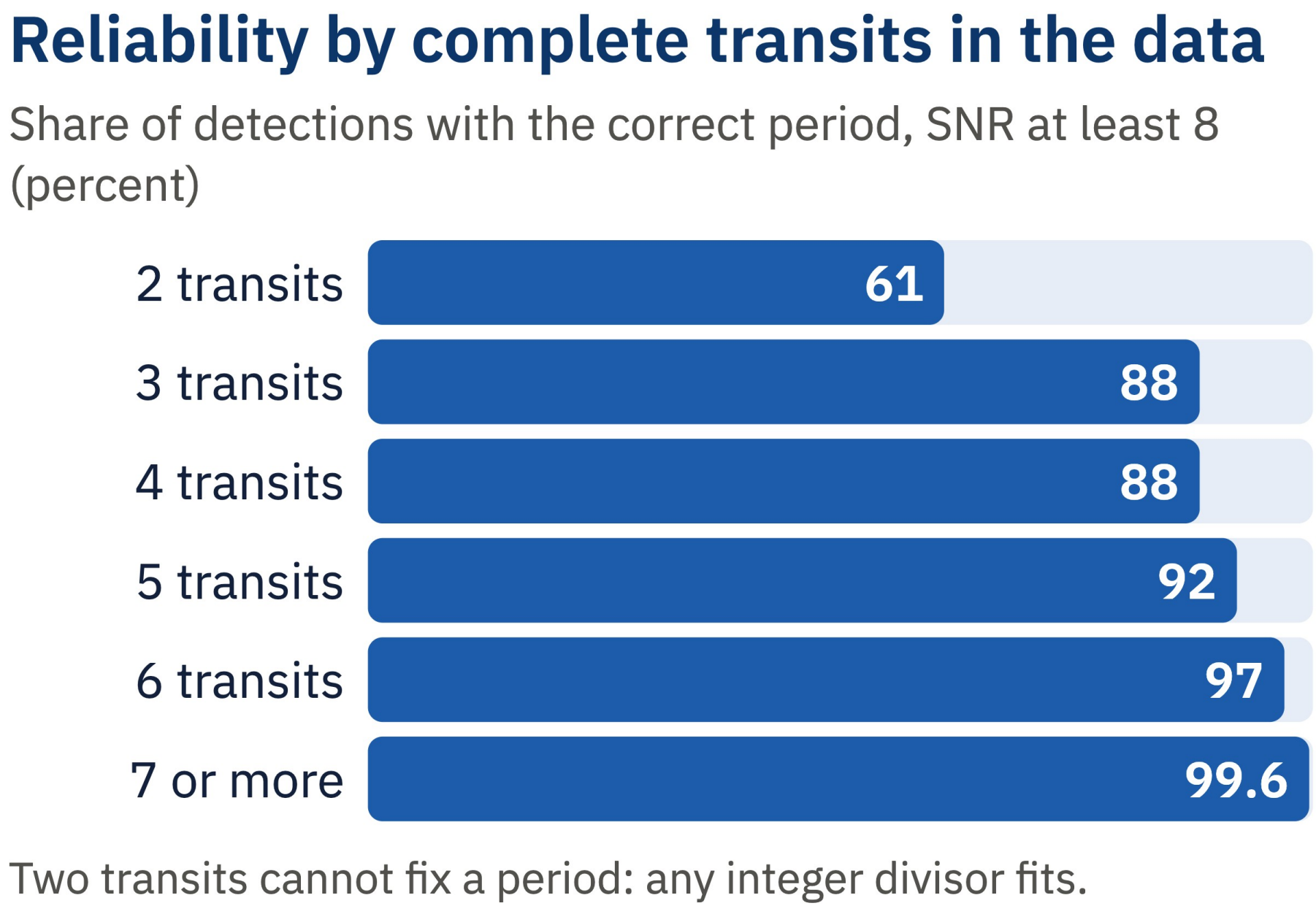
How we estimate what a survey could deliver



Does the search return the right period?

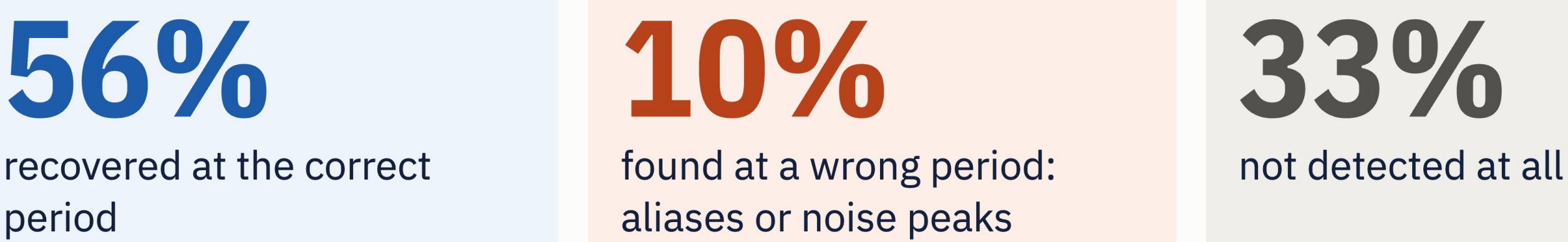
Recovery at the correct period							
Share of detectable planets recovered, SNR at least 8 (percent)							
10–20	98	94	84	76	24	16	4
4–10	80	83	73	49	30	7	1
2–4	16	54	52	32	13	2	0
1–2	38	32	34	26	12	0	0
0.5–1 1–2 2–4 4–6 6–10 10–20 20–30							
Injected period (days) · rows: radius (Earth radii)							

Reliability of detections							
Share of detections with the correct period, SNR at least 8 (percent)							
10–20	98	100	91	90	43	44	40
4–10	100	98	92	74	61	27	5
2–4	100	98	94	65	45	25	6
1–2	100	100	100	65	60	0	–
0.5–1 1–2 2–4 4–6 6–10 10–20 20–30							
Injected period (days) · dash: no detections							



3,400 injected planets from the model population; box-fitting search; white Gaussian noise; no limb darkening. Dashed cells have no detections.

A signal-to-noise cut is not a detection



Outcome for planets that a Kepler-style SNR 7.1 criterion counts as detectable, searched at SNR at least 8.

With Rubin's cadence and night-only window, the right period has to be recovered, and the false-alarm rate sets the threshold. Across about 6×10^7 searched stars, SNR 7.1 gives roughly 2,400 false detections from noise alone; SNR near 8 gives roughly 9 to 13. Red noise would push the needed threshold higher.

Follow-up, and questions for the workshop

Reliability, not the raw candidate count, should set the follow-up plan. Requiring at least 5 recovered events per detection lifts the overall reliability of the whole sample to 97% (the bars above are for planets with exactly that many transits, so they differ), but trims the total sample by about 10% and the smallest planets (under 4 Earth radii) by about 40%.

- Which facilities could supply host-star metallicity, kinematics and age indicators?
- What follow-up capacity is realistic for candidates in the southern disk fields?
- How should false-discovery rate and period reliability set follow-up priority?

Caveats. Box-fitting search and Gaussian noise: an upper bound. Stellar variability, crowding, blends and eclipsing binaries are not yet modelled.

