J-MAPS Technical Memorandum 08-23

J-MAPS Guide Stars

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ABSTRACT

In order to collect and calculate data on the ten brightest stars in a typical J-MAPS frame for instrument requirements, stellar counts from TM08-12 and photoelectron count rates from TM08-13 are used to calculate the number of stars, photoelectron counts, photoelectron count rates, signal to noise ratio (SNR), and the single measurement precision (SMP) of stars per frame.

1. Methodology

Roughly 34,375 J-MAPS frames are required to cover the entire sky. This study examines the 10 brightest stars expected per frame. According to TM08-12, the Johnson V-band 10^{th} magnitude is the brightest magnitude that will have 10 or more stars per frame, assuming an even stellar distribution. However, because the J-MAPS band is close to the near IR, 11^{th} Johnson V-band magnitude K and M stars have higher photoelectron count rates than 10^{th} Johnson V-band magnitude O, B, A, F, and G stars. Thus, on average, of the ten brightest stars in a J-MAPS frame, we predict 4 10^{th} magnitude K stars, 1 10^{th} magnitude M star, 1 11^{th} magnitude K star, and 4 11^{th} magnitude M stars.

The average number of K and M stars per frame is calculated by dividing the total number of stars of a given spectral type at the 10^{th} magnitude by the total number of frames. TM 08-13 lists the photoelectron count rate at 10^{th} and 11^{th} magnitude for spectral types K5 and M1. Because J-MAPS will read out data at 5 Hz, the rates are divided by 5 to get the photoelectron counts. The signal to noise ratio is estimated using the following equation:

$$SNR = \frac{I_p}{\sqrt{n_p^2 + n_r^2}} = \frac{I_p}{\sqrt{I_p + 15^2}} \tag{1}$$

where I_p is the number of photon counts, n_p is the photon noise (equal to $\sqrt{I_p}$), and n_r is the detector's read noise of 15 e^-. The single measurement precision is calculated using following equation:

$$SMP = \sqrt{\left(\frac{FWHM}{SNR}\right)^2 + 5^2} \tag{2}$$

where 5 is the systematic floor of the J-MAPS optical system, and FWHM is the 960 milli-arcsecond full width half maximum of the J-MAPS PSF.

2. Data

Table 1 presents the typical number of stars per frame, the corresponding photoelectron count rates and counts per read-out, as well as the signal to noise ratio (SNR) and single measurement precision (SMP) for both 10^{th} and 11^{th} Johnson V-band magnitude K and M stars.

Table 1: Data on Each J-MAPS Frame as a Function of Spectral Type

	10^{th} magnitude K	10^{th} magnitude M	11^{th} magnitude K	11^{th} magnitude M
Number of Stars Per Frame	4	1	1	4
Photoelectron Count Rate	47080	82880	18740	33000
Photoelectron Counts	9416	16576	3748	6600
SNR	95.9	127.9	59.5	79.9
SMP (mas)	11.2	9.0	16.9	13.0

3. Summary

The number of stars per frame, the photoelectron count rates and counts, the signal to noise ratio, and the single measurement precision are calculated for the ten brightest stars for the average J-MAPS field. This TM is a preliminary and approximate result and a follow-up TM will provide a more accurate and detailed analysis.

4. References

Dugan, Z. J-MAPS TM 08-12
Dugan, Z. J-MAPS TM 08-13