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THE POST COSTAR ROTATION MATRICES FOR CALCULATING V2, V3 OFFSETS IN MODE 2 FOS TARGET ACQUISITION

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INTRODUCTION

The post co-star rotation matrices YFMTRXA and YFMTRXB used to determine the V2, V3 offsets are calculated. The rotation matrices transform from the FOS coordinates, at the FOS detector photo cathode, to the telescope V2, V3 coordinates. The rotation matrices are used to determine FOS offsets during binary search and firmware modes. The values in the matrices will change after the repair mission due to the change in FOS plate scale and the change in the angle between FOS X, Y co-ordinate axes with respect to the V2, V3 axes.

THE EXPECTED POST CO-STAR VALUES

In the FOS due to the introduction of the corrective mirrors in the optical path, the image is rotated and hence the angle between the FOS X, Y coordinate axes changes with respect to the V2, V3 axes. The expected angle between V2,V3 and FOS X, Y co-ordinate axes for the red detector (θ_R) is 98.1898, while the expected angle for the blue detector (θ_B) is 171.8102 (BALL Systems Engineering Report -OPT 152 and Lupie 1993 in prep).

Once again, due to the corrective mirrors the focal length of the FOS changes. The COSTAR corrector output beam to the FOS is F/30 (BALL Systems Engineering Report -OPT 047 and 049), which leads to a change in the plate scale. The expected average plate scale is 3.070"/mm.

CALCULATION OF THE ROTATION MATRICES

From Figure 1 we see that

$$V2 = X\cos\theta + Y\sin\theta$$
$$V3 = -X\sin\theta + Y\cos\theta$$

i.e.

$$\begin{pmatrix} V2 \\ V3 \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix} \begin{pmatrix} X \\ Y \end{pmatrix}$$

The transformation is in units of $(1/32)\mu$ for the FOS coordinate frame and 2^{-27} radians for the V2, V3 coordinate frame. Further, to accommodate NSSC-1 integer arithmetic, the matrices are scaled by 2^{-17}. Therefore, the rotation matrix for the red side (*YFMTRXA*) and the rotation matrix for the blue side (*YFMTRXB*) are given by

$$YFMTRXA = S_R \begin{pmatrix} \cos\theta_R & \sin\theta_R \\ -\sin\theta_R & \cos\theta_R \end{pmatrix}$$

and

$$YFMTRXB = S_B \begin{pmatrix} \cos\theta_B & \sin\theta_B \\ -\sin\theta_B & \cos\theta_B \end{pmatrix}$$

where the scale factors S_R and S_B are in units of $\left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$ multiplied by 2^{17}.

Using the values of θ_R and θ_B given above, and the scale factors S_R and S_B determined in the next section the correct rotation matrices were calculated as

$$YFMTRXA = 1.6365\times10^4 \begin{pmatrix} \cos(98.1898) & \sin(98.1898) \\ -\sin(98.1898) & \cos(98.1898) \end{pmatrix} \left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$$

$$YFMTRXA = \begin{pmatrix} -2331.223 & 16198.077 \\ -16198.077 & -2331.223 \end{pmatrix} \left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$$

and

$$YFMTRXB = 1.6333\times10^4 \begin{pmatrix} \cos(171.8102) & \sin(171.8102) \\ -\sin(171.8102) & \cos(171.8102) \end{pmatrix} \left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$$

$$YFMTRXB = \begin{pmatrix} -16166.336 & 2326.68 \\ -2326.68 & -16166.336 \end{pmatrix} \left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$$

CALCULATION OF THE SCALE FACTORS

The plate scale for the red side implies

$$600\mu = 3.6840\,arcsec$$

and

$$1\,radian = 206264.81\,arcsec$$

These two equations imply that

$$(1/32)\mu = 1.91875\times10^{-4}\,arcsec = 9.3024\times10^{-10}\,radians$$

Therefore in units of $\left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$,

$$1=0.12485\left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$$

and the scale factor for the red side is

$$S_R = 2^{17}\times 0.12485\left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)=1.6365\times 10^4\left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$$

Using the blue side plate scale of $600\mu = 3.6768 arc\sec$ the scale factor for the blue side is

$$S_B = 1.6333\times 10^4\left(\frac{2^{-27}\,radians}{(1/32)\mu}\right)$$

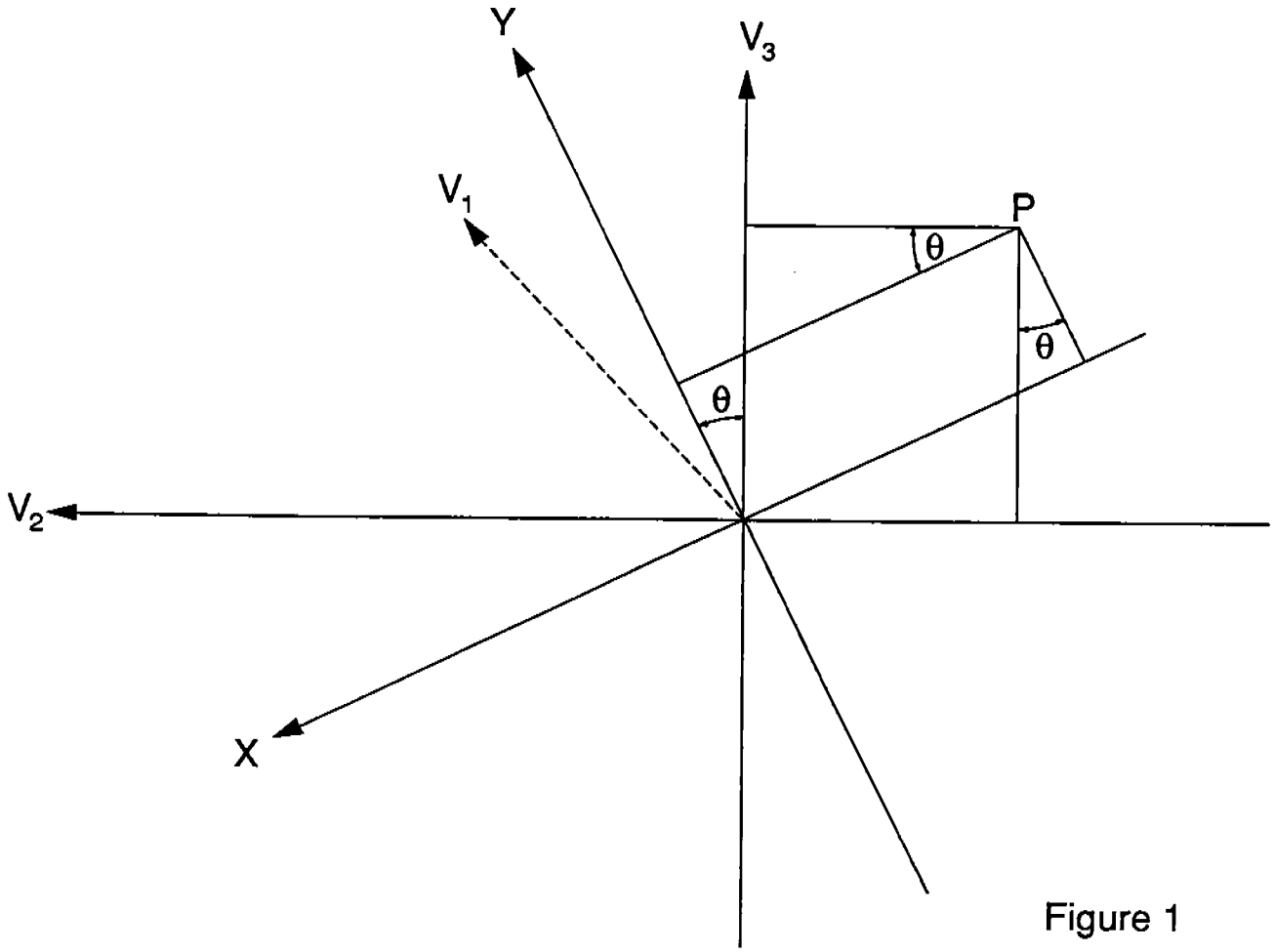

Figure 1

Fig. 1: The figure shows the orientation of the V2,V3 and FOS X, Y co-ordinate axes. θ id the rotation angle between the axes. P is the point for which the transformation from the FOS X, Y co-ordinate axes to the V2,V3 axes is to be determined.