SUBJECT: **Angular scaling factors for the chop and jiggle movements of the BSM**

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KEYWORDS: **Chop, jiggle, scale factor**

COMMENTS: **This document presents data on the angular scale factors relating Beam steering mirror tilts to angles on the sky.**

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1. INTRODUCTION

The SPIRE detectors' views of space are modified by tilting the fourth optical component (CM4, also called the BSM, the Beam Steering Mirror). Two mutually perpendicular axes are available for tilting the mirror. One, called the 'Chop' axis, is used to displace the views out of (at 90 degrees to) the meridional plane of the photometer's optics. The other, called the 'Jiggle' axis, is used to displace the views nominally parallel to the plane of the photometer's optics (see figure 1). This note tabulates the two main scale factors used to predict the angular displacement of the boresight on the sky, for each one degree angular rotation of the BSM.

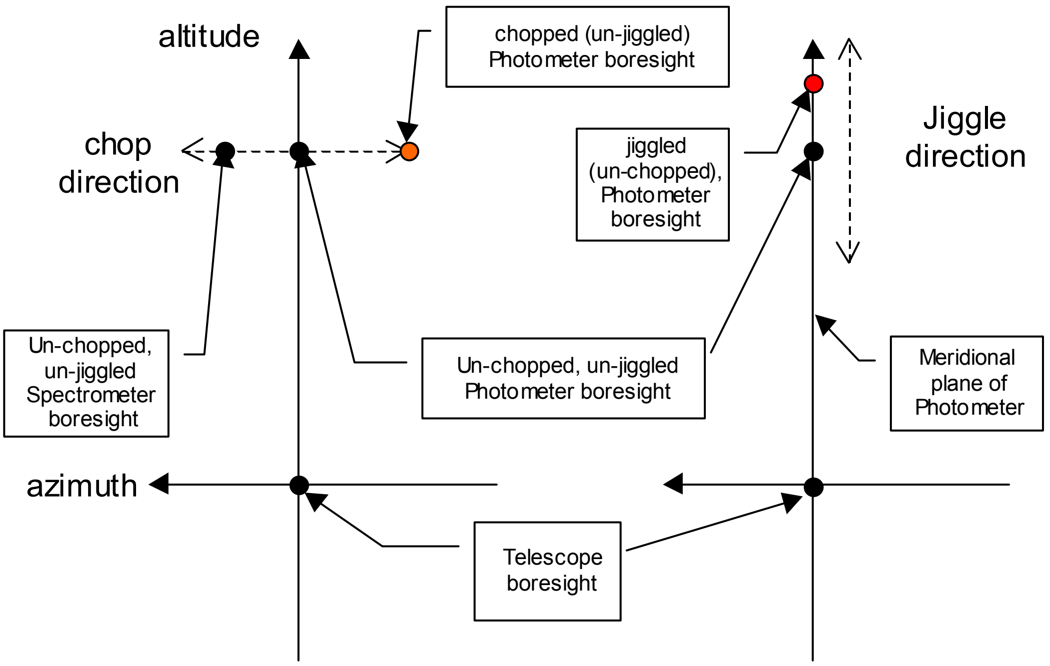

Figure 1-1 Effects of BSM 'chop' and 'jiggle' rotations on the photometer boresight.

The views of each instrument are simultaneously affected since CM4 is an optical surface common to both the photometer and the spectrometer. The chop movement moves the photometer boresight towards and away from the (original, undisplaced) spectrometer boresight, the jiggle movement displacing the boresights at 90 degrees to this direction.

2. DERIVATION AND TABULATION OF BSM ANGULAR SCALE FACTORS

The CODEV representations of the SPIRE instruments, which are presently in use at RAL, are versions identified as PH154B (photometer) and SP501E (spectrometer). Layout of the photometer optics has not changed since. The latest telescope model is incorporated. The photometer model permits reverse ray tracing from the detectors (rectangular 4' x 8'for the photometer) outwards to the telescope space. The photometer boresight was selected for study (defined by the point in the centre of a photometer detector) and rays were traced from the detector centre, through the centre of the secondary mirror, to a plane in front of the telescope's primary mirror. This was done for four angular settings of the BSM, namely +2.336 degrees chop, - 2.336 degrees chop, +0.573 degrees jiggle, - 0.573 degrees jiggle (for whichever tilt angle was changed from zero, then the other tilt angle was kept zero). The direction of the displaced boresight in the final optical space (beyond the telescope) was derived in terms of an altitude and an azimuth angular movement, tabulated in arc minutes. The results are shown in table 1, from which the scale factors, also shown, were derived in terms of arc seconds displacement on the sky for each 1-degree tilt of the BSM using

$$\frac{Arc\sec ondsskymovement}{each\deg reeBSMmovement} = \frac{(+veskymovement*60)-(-veskymovement*60)}{(+veBSMmovement)-(-veBSMmovement)}$$

BSM Chop	BSM Jiggle	Altitude displacement	Azimuthal displacement	BSM CHOP Scale factor	BSM JIGGLE Scale factor
+2.336 deg	0.0	2.000 arc min.	0.00825 arc min.	51.37 arc sec/degree	
-2.336 deg	0.0	-2.000 arc.min	0.00825 arc min.		
0.0	+0.573 deg	0.0	0.49847 arc min.		52.36 arc sec./degree
0.0	-0.573 deg	0.0	-0.50156 arc min.		

Table 2-1 BSM chop and jiggle data and scale factors

The values selected for the BSM chop and tilt angles were chosen to show the angles required to get nominal 2 arc minute chop and 0.5 arc minute jiggle movements on the sky. The table shows that the chop movement gives a slight curve to the track on the sky. This confirms similar computations that have been made in the reverse direction, which showed a slightly curved chop track on the detectors when the fixed gut ray was traced from space with CM4 rotated about its chop axis.