FIRST

SCIENTIFIC

POINTING MODES

PT-SP-04673

September 1997

	Name	Signature
Prepared by	M. Anderegg ESA/ESTEC/PIP	
Approved by	J.A.Steinz (PI) FIRST Project Manager (Acting)	

DISTRIBUTION LIST

COMPANY	NAME	DIVISION	No. of COPIES
ESA/ESTEC	Anderegg, M.	PIP	1
	Brunner, O.	YMD	1
	Collaudin, B.	YCT	1
	Cornelisse, J.	PF	3
	Felici, F.	PL	1
	Guillaume, B.	PIS	1
	Hoegen, M. von	PIQ	1
	Oremus, R.	PIC	1
	Paßvogel, T.	PTP	1
	Philippe, C.	WSC	1
	Pilbratt, G.	SA	15
	Reynaud, P.	ECP	1
	Steinz, J.A.	PI	1
	Ulbrich, G.	XA	1
	Vandenbussche, F.	PLS	1
	FIRST Project File	PT	5
ESA/ESOC	Hechler, M.	MOD	1
	Matussi, S.	MOD	1
	Robson, A.	MOD	1
Aerospatiale			

DOCUMENT CHANGE RECORD

Issue/Rev.	Date	Pages affected/ Brief description of change
Issue 1	September 1997	Complete new document

TABLE OF CONTENTS

1. INTRODUCTION

To perform Scientific Observations, in particular to make maps of extented objects, or to make high sensitivity measurements, FIRST will need pointing modes not in the satellite Requirements. However, these modes can all be implemented using as building blocks slews and pointing modes presently in the FIRST/Planck Satellite System Specifications PL-0000231.

2. RASTER POINTING

Normal raster pointing

Raster pointing is a series of fine pointing observations of equal duration (*t*), separated by slews, in order that the pointing of the telescope axis moves in a raster pattern as defined in Fig. 1. In this figure the following notations are used:

- M is the number of pointings per line.
- N is the number of lines.
- d_1 is the angular distance between successive steps.
- d_2 is the angular distance between successive lines.

The pattern axes are defined with respect to local celestial perpendicular axes.

The raster parameters, M, N, d_1 and d_2 are within the following range and resolution:

- M: 2 - 32
- N: 1 - 32
- d_1: 2 arcsec - 4 arcmin; resolution: 0.5 arcsec
- d_2: 2 arcsec - 4 arcmin or 0; resolution: 0.5 arcsec

Note that d_2 being zero, means that it shall be possible to scan N times the points of a single line.

The duration of stable pointing at any position, t, will be between 10s and 30 minutes.

Raster pointing with OFF-position

Raster pointing with OFF-position is a special form of raster pointing where, after a specified number of raster points (ON positions), the spaceraft slews to a predefined point (the OFF position), after which it resumes its raster pointing where it left the raster before going to the OFF position. The number of raster pointings (K) before going to the OFF position is determined by the timing characteristics of the raster pointing such that the time between each subsequent OFF position is less than some characteristic stability time of the instrument. This form of raster pointing is shown in Fig. 2.

For the ON positions, the raster is defined by the parameters M, N, d_1 and d_2, with for each position an equal observation time *t*. The definition of these parameters is given above for normal raster pointing and its range and resolution are specified below.

The OFF position is defined by the parameters d_{1off} and d_{2off}, specifying the coordinates of the OFF position with respect to the centre of the raster map in two orthogonal directions which coincide with the direction of the lines and the normal to the lines, respectively.

K is the number of consecutive ON positions before going to the OFF position, and t_{off} is the time of stable pointing in the OFF position.

The pattern is followed line by line and where after each K ON positions the spacecraft moves to the OFF position. After each OFF position, the raster pointing shall be resumed for the next K ON positions, etc. (Fig. 2).

The raster parameters, M, N, K, d_1 and d_2 are within the following range and resolution:

- M: 2 - 32
- N: 1 - 32
- K: 2 - M × N
- d_1: 2 arcsec - 1 arcmin; resolution: 0.5 arcsec
- d_2: 2 arcsec - 1 arcmin or 0; resolution: 0.5 arcsec

The maximum value of K being equal to the total number of ON positions implies normal raster pointing with only a single OFF position pointing at completion of the raster.

Like for normal raster pointing, d_2 being zero means that it shall be possible to scan N times the points of a single line.

The duration of stable pointing at any position, t, will be between 10s and 30 minutes.

The coordinates of the OFF position with respect to the centre of the map are within the following range and resolution:

- d_{1off}: ±(0 arcmin - 2 degrees); resolution: 0.5 arcsec
- d_{2off}: ±(0 arcmin - 2 degrees); resolution: 0.5 arcsec

The duration t_{off}, of stable pointing in the OFF position is within the range TBD s to TBD min.

3. LINE SCANNING

Normal line scanning

This is a scanning mode along short parallel lines, such that the telescope axis moves as shown in Fig. 4.3-3 with parameters as defined below:

- N is the number of lines.
- D_1 is the angular extent of the lines.
- d_2 is the angular distance between successive lines.

The pattern axes are defined with respect to local celestial perpendicular axes.

The pattern shall be followed line by line in the way shown by the arrows in Fig. 3.

The scan parameters, N, D_1 and d_2 are within the following range and resolution:

- N: 1 - 32
- D_1: 1 arcmin - 110 deg; resolution: 1 arcmin
- d_2: 2 arcsec - 4 arcmin or 0; resolution: 0.5 arcsec

Note that the minimum of d_2 being zero, means that it shall be possible to scan N times the same line.

The scan rate, r, shall be changeable by ground command and will be between 0.1 arcsec/s and 1 arcmin/s with a resolution of 0.1 arcsec/s.

Line scanning with OFF-position

Line scanning with OFF-position is a special form of line scanning where, after a specified number of lines, the spaceraft slews to a predefined point (the OFF position), after which it resumes its line scanning where it left the pattern before going to the OFF position. The number of lines (K) before going to the OFF position is determined by the timing characteristics of the operation such that the time between each subsequent OFF position is less than some characteristic stability time of the instrument. This form of line scanning is shown in Fig. 4.

The line scan pattern is defined by the parameters N, D_1 and d_2 as given above.

The OFF position is defined by the parameters d_{1off} and d_{2off}, specifying its coordinates with respect to the centre of the line scanning map in two orthogonal directions which coincide with the direction of the lines and the normal to the lines, respectively.

K is the number of consecutive lines before going to the OFF position, and t_{off} is the time of stable pointing in the OFF position.

The pattern shall be followed line by line in the way shown by the arrows in Fig. 4 and where after each K lines the spacecraft moves to the OFF position. After each OFF position, the line scanning shall be resumed for the next K lines, etc.

The scan parameters, N, D_1 and d_2 are command within the following range and resolution:

- N: 1 - 32
- K: 1 - N
- D_1: 1 arcmin - 2 deg; resolution: 1 arcmin
- d_2: 2 arcsec - 4 arcmin or 0; resolution: 0.5 arcsec

The maximum value of K being equal to the total number of lines implies normal line scanning with only a single OFF position pointing at completion of the line pattern.

The scan rate, r, is between 0.1 arcsec/s and 1 arcmin/s with a resolution of 0.1 arcsec/s.

The coordinates of the OFF position with respect to the centre of the map shall be changeable by ground command within the following range and resolution:

- d_{1off}: ±(0 arcmin - 2 degree); resolution: 0.5 arcsec
- d_{2off}: ±(0 arcmin - 2 degree); resolution: 0.5 arcsec

The duration t_{off}, of stable pointing in the OFF position is within the range TBD s to TBD min.

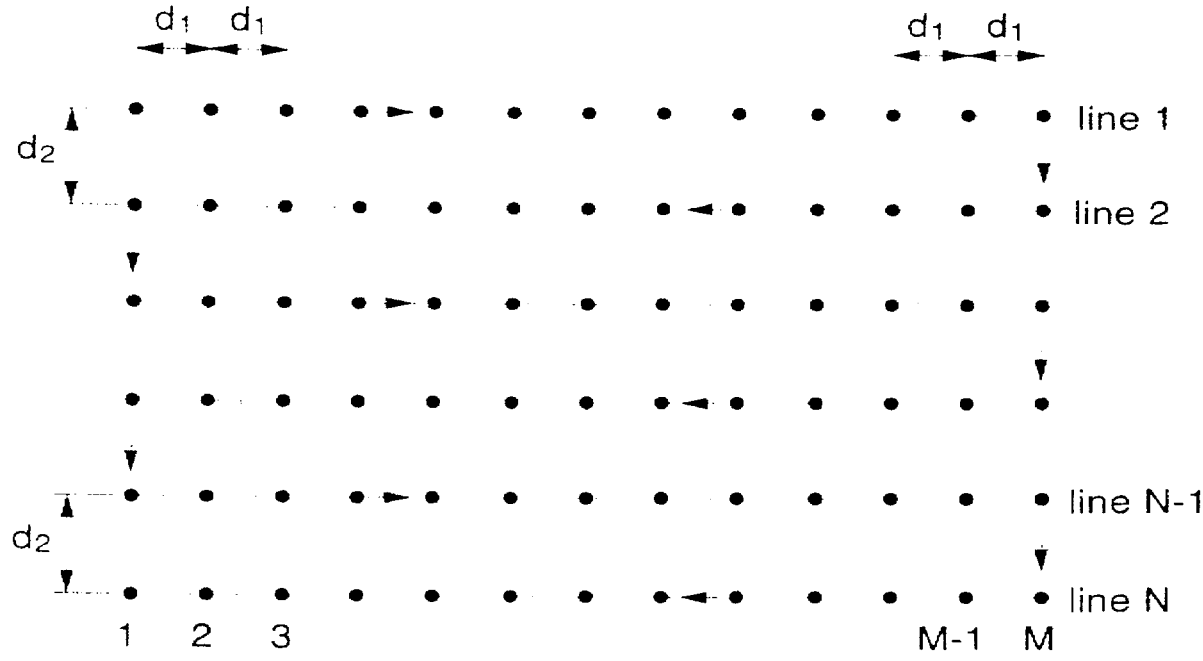

FIGURE 4.3-1 NORMAL RASTER POINTING

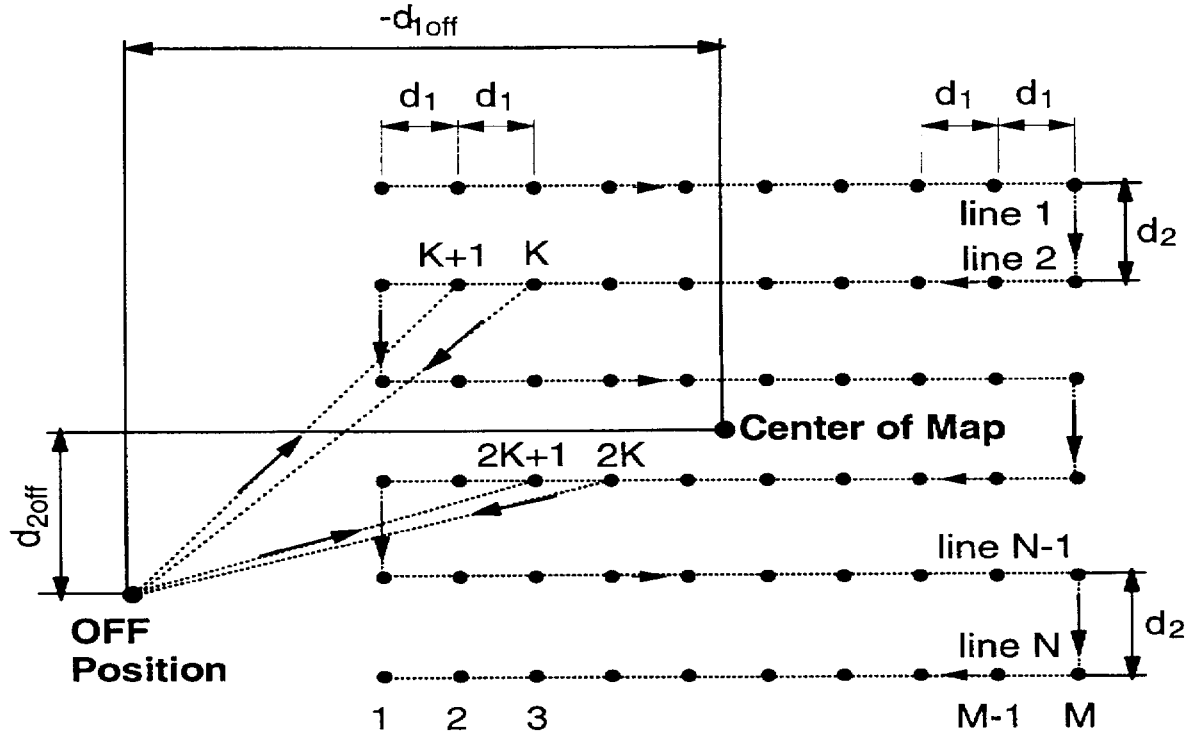

FIGURE 4.3-2 RASTER POINTING WITH OFF-POSITION

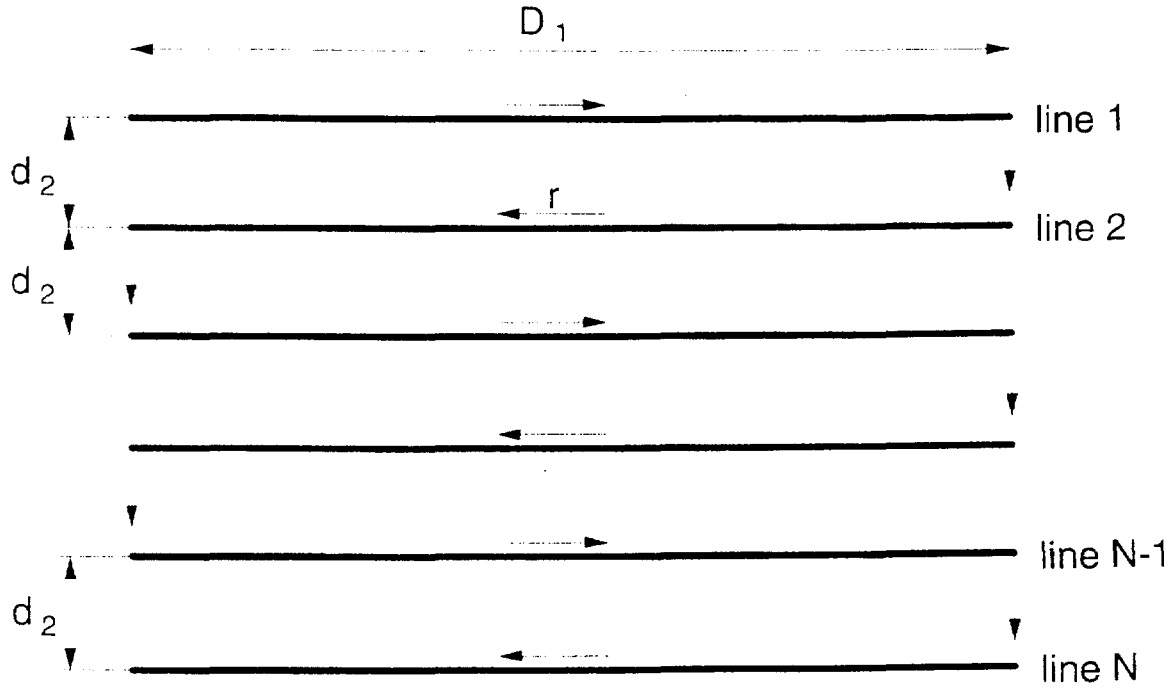

FIGURE 4.3-3 NORMAL LINE SCANNING

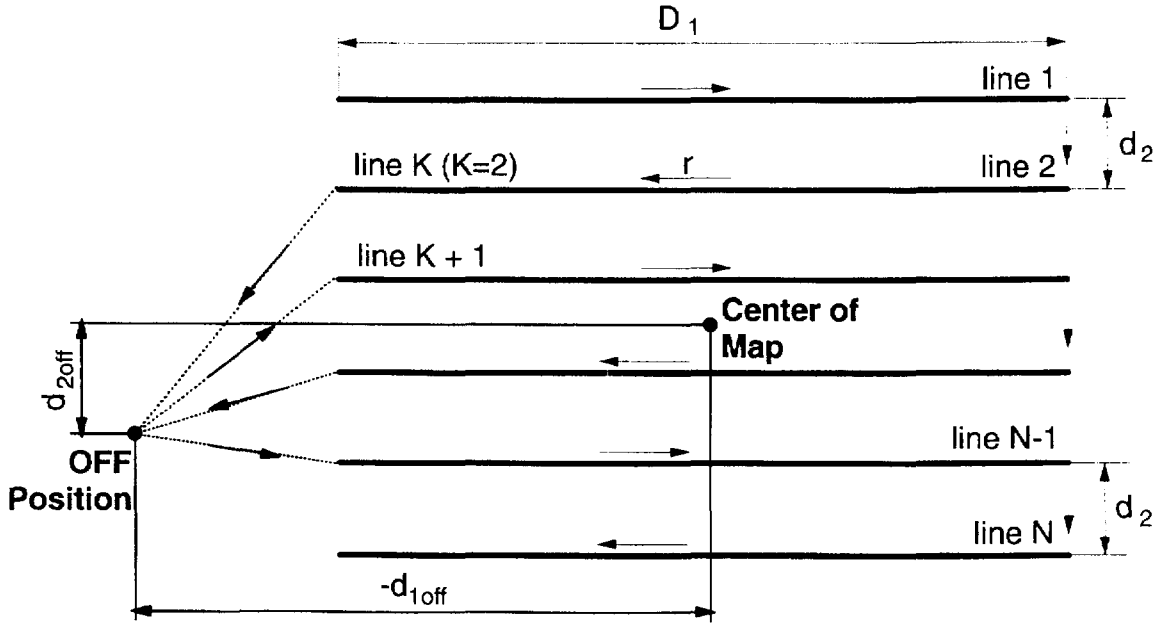

FIGURE 4.3-4 LINE SCANNING WITH OFF-POSITION

4. TRACKING OF SOLAR SYSTEM OBJECTS

The satellite will be able to follow, by ground command of a series of fine pointings, objects such as planets, comets, etc. having a maximum speed relative to the tracking star of 10 arcsec/min.

5. POSITION SWITCHING

Position switching is an observing mode in which the instrument line of sight is periodically changed between a target source and a position off the source.

Periodically the telescope pointing direction is changed between a target source and some position off the source.

The angular distance between the "off" position, which can be in any specified direction from the source, and the source ("on" position) lie between 2 arcsec and 2 degrees with a resolution of 0.5 arcsec.

The integration times in the "on" and "off" positions are equal and are within the range of 10 s (TBC) to 20 min (depending on the throw).

6. NODDING

Nodding is an observing mode in which the target source is moved from one instrument chop position to the other chop position. In this case the pointing direction will change in the direction of the instrument chopper throw.

Periodically the telescope pointing direction is changed such that the source is moved from one instrument chop position to the other position.

The angular distance between the two positions corresponds to the instrument chopper throw (between 2 arcsec and 16 arcmin with a resolution of 0.5 arcsec).

The integration times in both positions are equal and are within the range of 10 s (TBC) to 20 min (depending on the throw).

Specifically, for a throw of 5 arcmin, the total cycle time shall not exceed 3 min; i.e. 72 s integration in either position and two 5 arcmin slews lasting 18 s each (including settling time).