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# MOSFIRE General Application Note 01.03
# Flexure Compensation System

## 1 ABSTRACT


This document (1) is an advanced user's guide for the flexure compensation system (FCS) and (2) serves as the definitive reference for the FCS model parameters. Here we describe the flexure compensation model, the meaning of the flexure compensation parameters. The measurements of the flexure compensation system performed during MOSFIRE's integration and test phase in 2011 is described in detail in the cooldown 8 test report.

Version 01 includes parameter modifications from cooldown 9.
Version 02 updated from C9.
Version 03 uses data taken 24 Apr 2012 at Keck.
Version 04 uses version 3 data plus new data taken 4 May 2012 at Keck


## 2 INTRODUCTION

The `mfcs` server controls MOSFIRE's FCS. The server is responsible for converting the instrument position angle and elevation into a motion at the tip/tilt mirror. Three pistons behind the tip/tilt mirror control its articulation. Even the advanced user would rarely manually adjust piston values, because the MOSFIRE team has written an algorithm into `mfcs` that will convert a desired tip/tilt angle into piston values. The relationship between pixel coordinate and angle is shown in Figure 1 below:

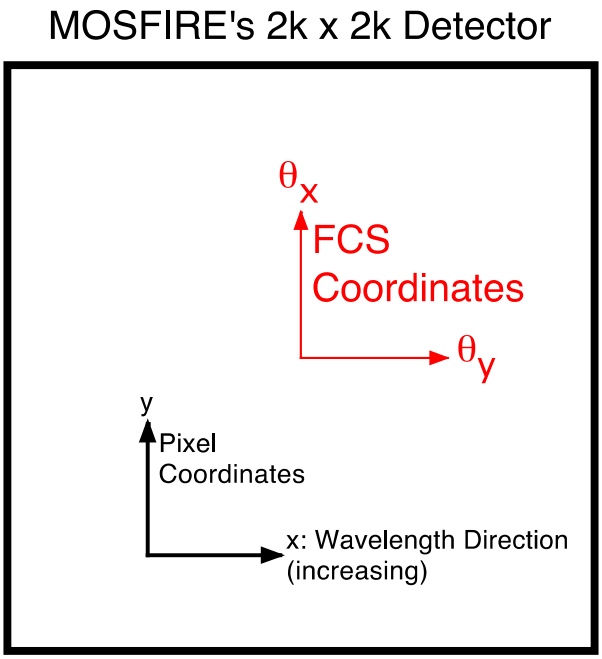


**Figure 1 -- MOSFIRE pixel versus FCS Coordinate System**

**Table 1 - The MOSFIRE fcs model parameters as of Cooldown #8. First column is the keyword to the "mfcs" server. These keywords are adjusted in configuration files.**

| | YJ | HK | Mirror |
|---|---|---|---|
| `centerx` [pixels] | 1.0 | 1.0 | 1.0 |
| `centery` [pixels] | 4.0 | 4.0 | 4.5 |
| `anamorph` [] | 1.48 | 1.46 | 1.00 |
| `k` | 0.187 | 0.157 | 0.202 |
| `beta` [degrees] | 12.0 | 9.5 | 25.1 |
| `ph` [degrees] | -114.3 | -114.3 | -127.2 |
| `a` [pixels] | 5.18 | 5.15 | 4.68 |
| `y02` [pixels] | 6.92 | 5.64 | 7.83 |
| `x02` [pixels] | 0.32 | 0.50 | 1.40 |
| `xscale` [µrad/pixel] | 63.5 | 63.5 | 63.5 |
| `yscale` [µrad/pixel] | 60.8 | 60.8 | 60.8 |

## 3 DESCRIPTION OF THE FCS MODEL

The FCS performs two actions. First, based on the instrument attitude a pixel shift is computed. Second, the pixel shift is converted into angle shifts on the FCS, which in turn are converted to piston values. These procedures are described by the following pseudo code:

--- First

Flexure compensation model
input
pa: position angle in degrees
Z: zenith angle in degrees
centerx, centery, k, beta, ph, a, x02, y02: model par ameters
returns
[pixel X, pixel Y] offsets

amp = a sin Z
Yc = y02 (1 - cos Z)
Xc = x02 (1 - cos Z)

DeltaX = Xc + amp cos(PA + ph) sin(beta) - amp k sin(PA + ph) cos beta
DeltaY = Yc + amp cos(PA + ph) cos(beta) + amp k sin(PA + ph) sin beta

return [DeltaX - centerx, DeltaY - centery]

**---- Second**

This model is built into the `mfcs` server. Once the flexure compensation model returns pixel offsets, the tip/tilt mirror is articulated as:

thetax = -(DeltaY - centery) yscale
thetay = -(DeltaX - centerX) xscale anamorph