PFS

SM1 Hexapod positioning and repeatibility

ALF

Draft version 20201006

Hexapod vs CCD coordinate system

VIS cameras have the same relationship.

Figure 4 Hexapod mechanical axis

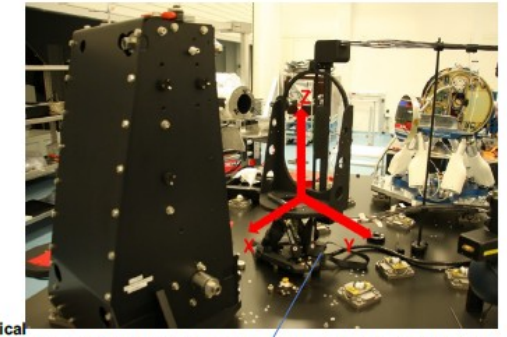
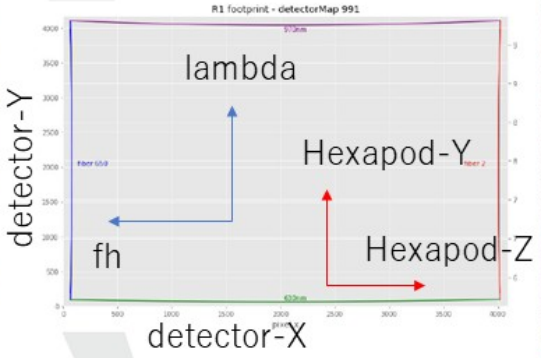
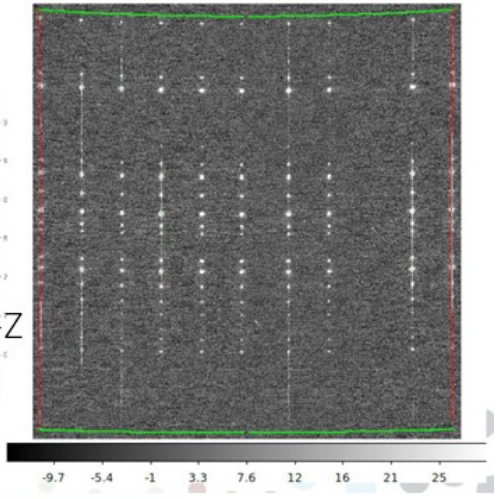


Figure 5 :Definition of the slit reference axis wrt to the bench

within requirement



LAM_Subaru_SM1_20200721.pdf



LAM_PFS_1041_FSA1_alignment_report-Onechannel.pdf

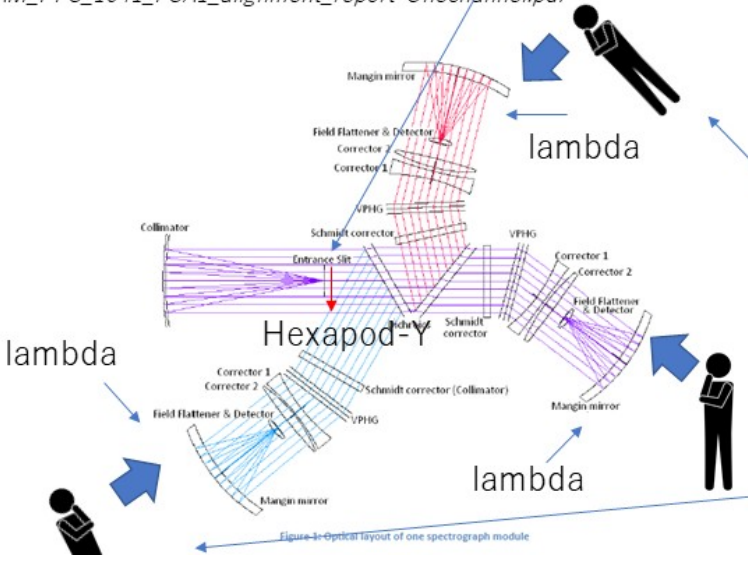


Figure 1: Optical layout of one spectrograph module

PFS-SPS-PRU000160-01_slitanddetectors.pdf

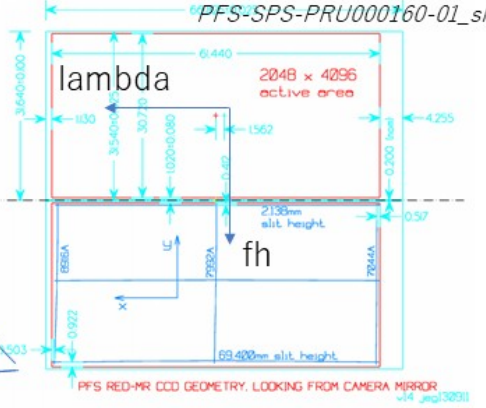


Figure 4. Layout of the PFS spectra on the red medium resolution CCD, lower half. The spectra are symmetric about the centerline. The layout is shown looking from the camera mirror toward the spectrograph.

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How was the data taken ?

DitheredArcs sequence :

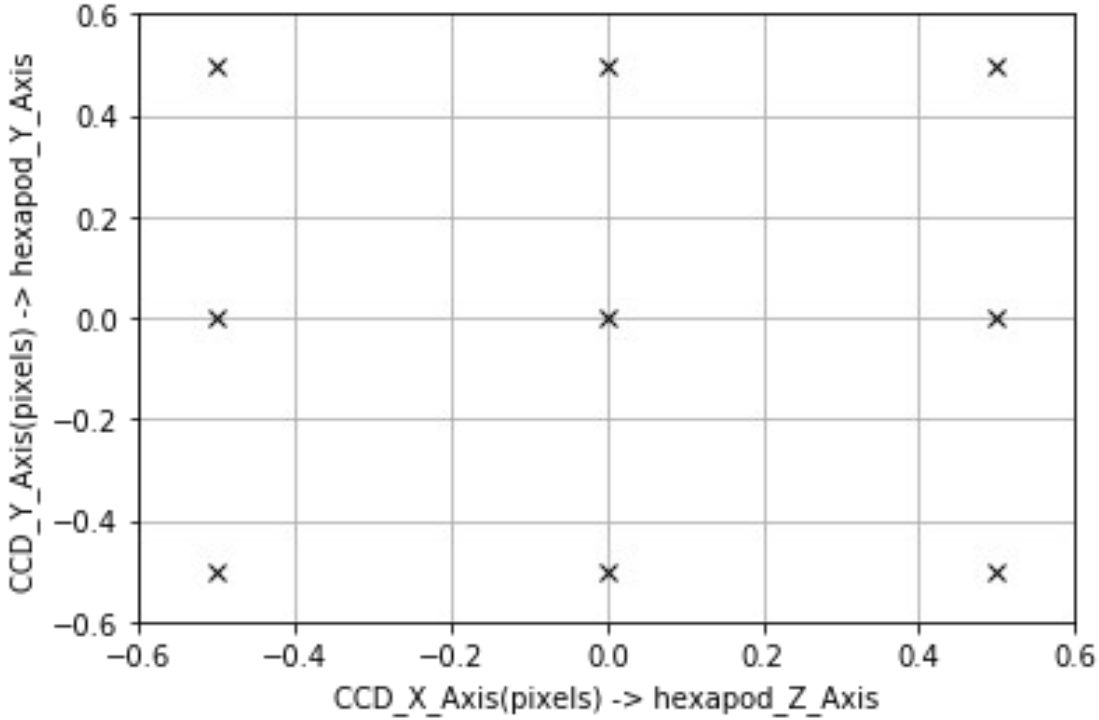
* 0.5 pixels shift in both direction.
Translated in hexapod reference using
Neven's last measurement :
0.5 pixels in x_axis → 17.24 microns (Z_Axis)
0.5 pixels in y_axis → 16.6 microns (Y_Axis)

* Including negative shift

* 3 duplicates

* R1 CCD

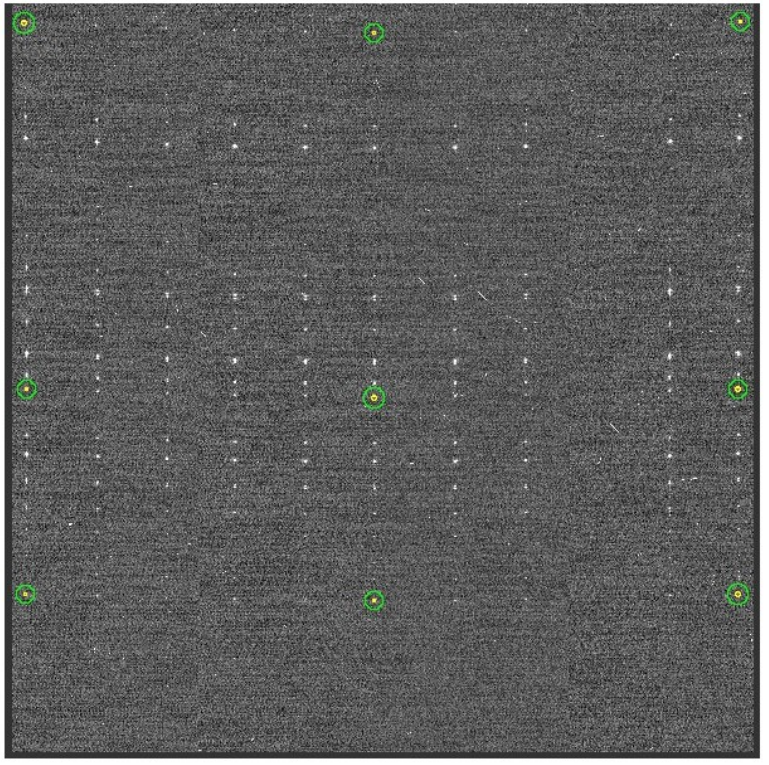
* Argon lamp (45 seconds)



It leads to 9 positions * 3 = 27 frames

New control code (INSTRM-1051) :
For each move, hexapod goes 500 microns below in Z axis and then goes up to requested position.
(500 microns has been chosen purely arbitrary.)

How data is processed?



Analysis is performed independently on 9 different peaks
They are ~ homogeneously distributed on the detector
(argon has almost no lines below 800th rows)

* Calculate centroids using center of mass and gaussian fit.

* Sigma clipped-mean of the duplicate position :
  Criteria : Total ROI flux normalized by the total frame flux
  → Get rid of cosmic rays and lamp failures.

* Calculate centroids difference from position 0,0
→ 9 couple of pixels offsets from center

I've chosen centroids from gaussian fit because they are more stable.
Their absolute position might be erroneous, but I'm interested in pixel offsets, so I think that's fine.

Dataset 1

IIC moves both axes together :
→ leads to two hexapod motion
using hysteris compensation.

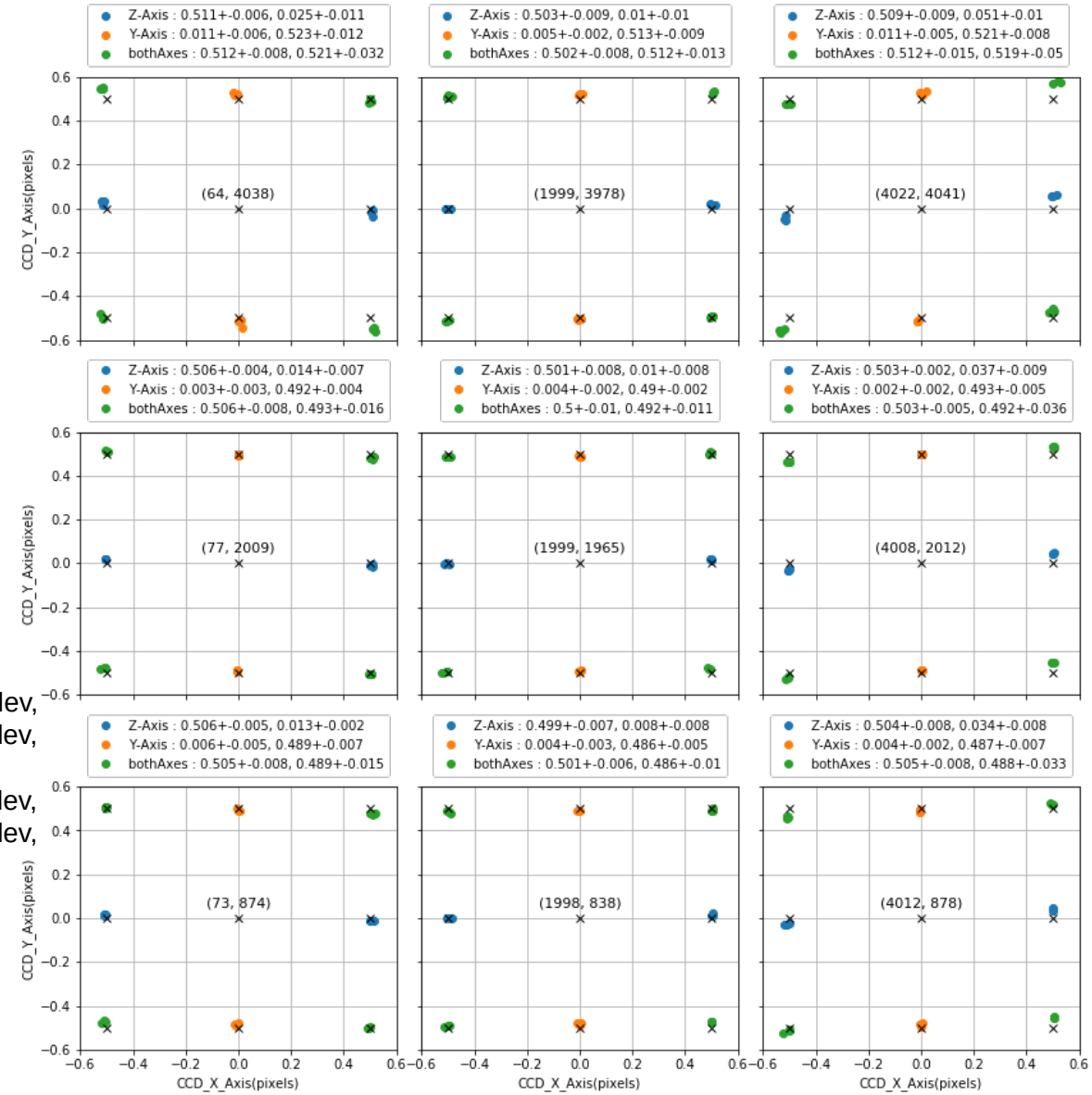
Sequence has been repeated
3 times.

In the legend, I have separated
Three kinds of motion with
the following information :

Z-Axis : mean absolute pixel offset X +- stddev,
mean absolute pixel offset Y +- stddev,

Y-Axis : mean absolute pixel offset X +- stddev,
mean absolute pixel offset Y +- stddev,

BothAxes :
mean absolute pixel offset X +- stddev,
mean absolute pixel offset Y +- stddev,

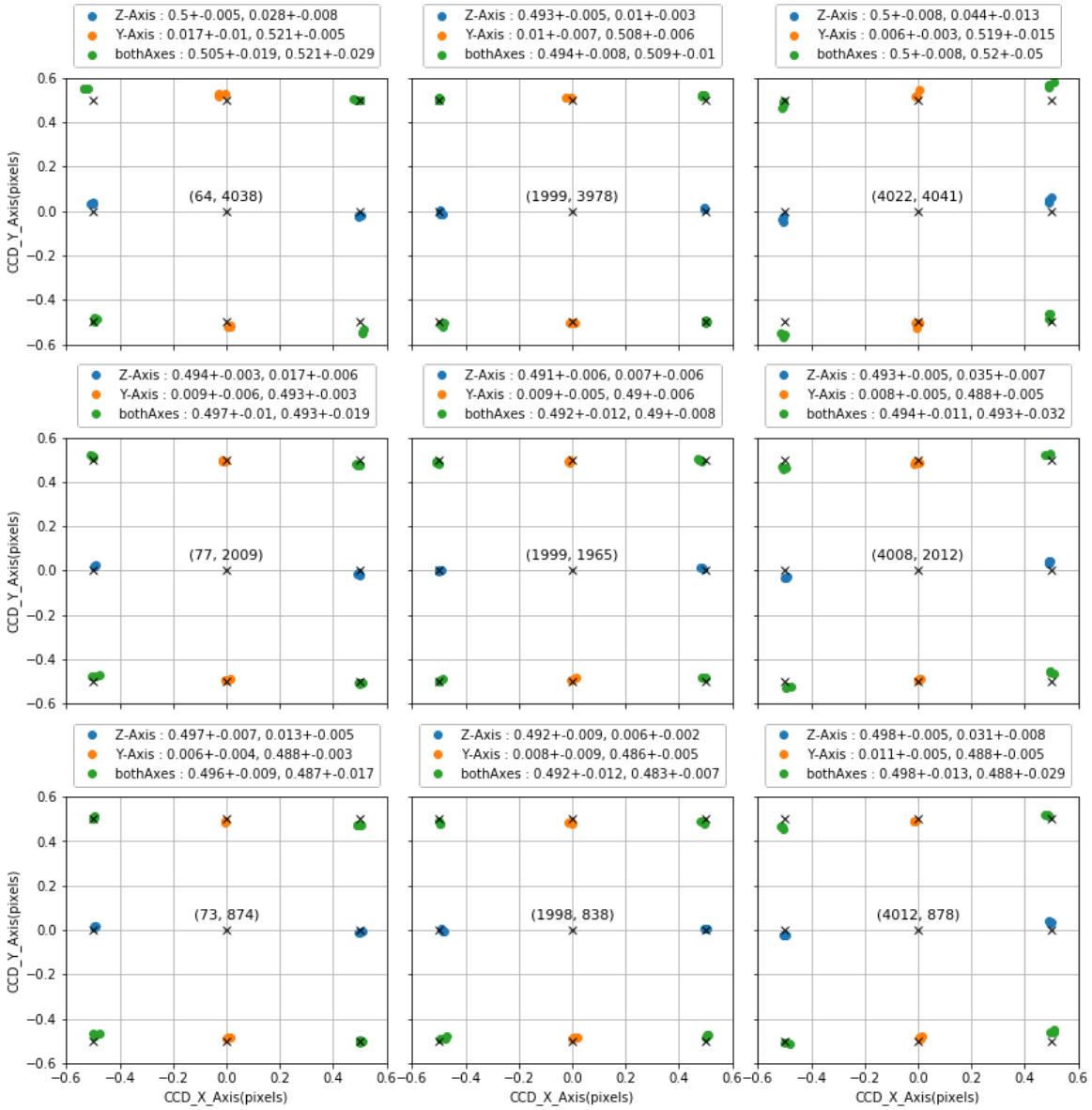


Dataset 2

IIC moves one axis after another :
→ leads to four hexapod motion using hysteris compensation.

Sequence has also been repeated 3 times.

Results does not appeared to be tremendously different which makes sense because hysteresis was already compensated in the first dataset.

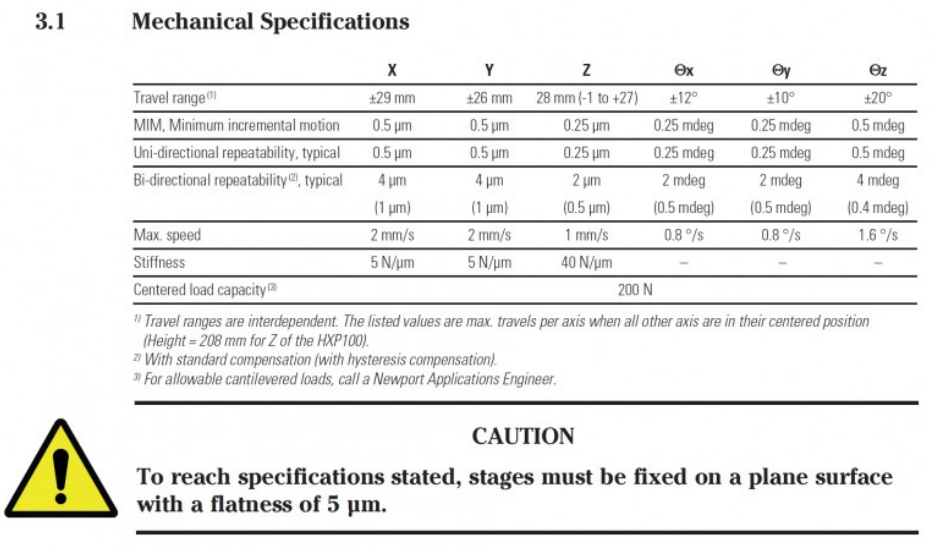


Conclusions

In both dataset, we can clearly see a positioning error more present on the edges than in the center.
I cannot tell whether it comes from a very small misalignment or due to some distorsions.
In anycase, I think the hexapod is behaving correctly and the repeatibility is coherent with NewPort spreadsheet.

Measure position variation (stddev) for each peak vs sequence Repeat (dataset 1).

	X(pixels)	Y(pixels)	X(microns)	Y(microns)
Z-Axis	0.0052	0.0045	0.1805	0.1493
Y-Axis	0.0048	0.0047	0.1649	0.1577
Both Axes	0.0065	0.0043	0.2258	0.1419



3.1 **Mechanical Specifications**

	X	Y	Z	θx	θy	θz
Travel range[1]	±29 mm	±26 mm	28 mm (-1 to +27)	±12°	±10°	±20°
MIM, Minimum incremental motion	0.5 µm	0.5 µm	0.25 µm	0.25 mdeg	0.25 mdeg	0.5 mdeg
Uni-directional repeatability, typical	0.5 µm	0.5 µm	0.25 µm	0.25 mdeg	0.25 mdeg	0.5 mdeg
Bi-directional repeatability[2], typical	4 µm (1 µm)	4 µm (1 µm)	2 µm (0.5 µm)	2 mdeg (0.5 mdeg)	2 mdeg (0.5 mdeg)	4 mdeg (0.4 mdeg)
Max. speed	2 mm/s	2 mm/s	1 mm/s	0.8 °/s	0.8 °/s	1.6 °/s
Stiffness	5 N/µm	5 N/µm	40 N/µm	–	–	–
Centered load capacity[3]	200 N					

[1] Travel ranges are interdependent. The listed values are max. travels per axis when all other axis are in their centered position (Height = 208 mm for Z of the HXP100).
[2] With standard compensation (with hysteresis compensation).
[3] For allowable cantilevered loads, call a Newport Applications Engineer.

CAUTION

To reach specifications stated, stages must be fixed on a plane surface with a flatness of 5 µm.