Theoretical best performance analysis

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*Abstract*— Given that DAC commands are assumed to be discrete integer values with a certain level of repeatability there is a theoretical best performance as errors will scale with distance.

# Repeatibility

Currently the methods used for calibration uses retroreflective targets combined with a routine to find the middle point of the target. Since averaging is employed in theory, DAC commands can be calculated to better precision than 1 DAC unit.

However, in current implementation, integer DAC commands are taken to generate analog outputs. In testing, targets are rescanned and the error is also roughly within 1 DAC count from calibration to calibration.

# Model

If we consider the unit vector that describes the ray output from the second mirror as a function of the mirror angles, we can quantify the results of deviation.

|  |  |  |
| --- | --- | --- |
|  |  | (1) |

Using the dot product of the gradient of each component, a linear approximation to can be made.

|  |  |
| --- | --- |
|  | (2) |
|  | (3) |

Thus, the change in the direction unit vector can be roughly described by the equation below.

|  |  |
| --- | --- |
|  | (4) |

# Results

In order to get an estimate of the performance we can simply substitute the nominal values for the mirror positions. The error is then approximated by multiplying the slope of the DAC to radian conversions.

We can substitute the nominal position

|  |  |
| --- | --- |
|  | (5) |
|  | (6) |
|  | (7) |
|  | (8) |

The norm of the difference vector in Eq. 8 is an approximation of the angle between the nominal vector and the actual vector caused by random error.

Suppose that we wish to constrain this error to .

Then

We will simply use as the accuracy of the metrology system used to measured positions.

Thus, calibration done on points more than approximately 20ft are not very useful since we cannot generate the commands precisely enough to pass through these points with integer commands.