

Sectilt process

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1. Purpose and scope

The sectilt process will control the WIYN secondary mirror articulation (tilt and focus), maintain a "WIYN page" display of the focus and tilt settings, and coordinate focus and tilt related commands to and from the rest of the telescope control system.

1.1 Focus tasks:

- Control initialization of the secondary to establish an absolute start position.
- Monitor the position of the tertiary mirror to determine which optical leg of the telescope is in use (WIYN, MOS, Folded Cass or Modified Cass).
- Maintain four tables of focus offsets (one table for each leg) that can be overwritten by instruments as the optical configuration changes (ie filter changes).
- Monitor the truss temperatures, determine an average value and a corresponding focus offset.
- Arbitrate between three autofocus processes: open loop from LUT's in the primary mirror system (PMS), based on truss temperature compensation (TC), based on optical autofocus feedback from the IAS (AF).
- Monitor and display the focus settings, offset, and truss temperature.
- Convert focus commands to motor steps.
- Insert extra steps to correct for focus stage non-perpendicularity.

1.2 Tilt tasks:

- Convert tilt commands to motor steps.
- Calculate pointing offsets so that there is zero net image motion due to secondary tilt.
- Monitor and display the tilt.

2. Initialization.

The OCS contains control code which will send the secondary to its limits, then hunt for the absolute fiducial position and park the system accurate to one step. This code requires separate commands for each secondary actuator; the secondary client will string these together to form a single "go home" command.

This will generally be followed by an "init" command to move a initial absolute start tilt and focus position calculated according to the formula:

$$Z_0 = D + A(p,1) + A(p,2) + A(p,3) + A(p,4) + Z(T)$$

where:

D is a "zero point" start position determined for the WIYN port
p is the port (WIYN, MOS, FC, MC)
Z(T) is an offset based on the truss temperature T.

A focus setting Z is defined as the average of the three secondary actuator step registers; the tilt setting is defined as the difference of each register from the average.

A is a 4x4 matrix of focus settings assigned as follows:

WIYN Port (p=1)

A(1,1) ADC offset
A(1,2) Filter offset
A(1,3) Detector offset
A(1,4) TBD

MOS Port (p=2)

A(2,1) WIYN to MOS offset
A(2,2) TBD
A(2,3) TBD
A(2,4) TBD

FC port (p=3)

A(3,1) WIYN to FC offset
A(3,2) TBD
A(3,3) TBD
A(3,4) TBD

MC port (p=4)

A(4,1) WIYN to MC offset
A(4,2) TBD
A(4,3) TBD

A(4,4) TBD

In addition to the numeric fields there will be an associated character field matrix to identify the nature of the offset. (see WIYN page display).

Sectilt will maintain the first column vector $A(p,1)$ in non-volatile memory. The rest of the matrix is a spread sheet to be filled and overwritten by instrument clients or by the operator. Independent registers will allow us to mix and match detectors, filters, correctors etc.

3. Operation

After initializing to the calculated start position the user will probably want to check and adjust the focus setting by examining the image in one of the cameras available in the IAS, or by other means specific to the instrument.

Focus commands can originate from the user, from clients subscribing to the WIYN routers including the operator, instrument clients, IAS client, and PMS; or from an autofocus process (AF) or from the hand paddle. In addition, focus commands based on the truss temperature compensation (TC) will be generated inside the sectilt process.

Commands can take two forms:

- Change a focus register (overwrite the A matrix described earlier).
- Change the focus an incremental value (adds to the previous value).

Both commands initiate a focus change - a change in the register value causes the focus to change by the difference between the new register value and the previous register value.

3.1 Arbitration

Since autofocus based on optical feedback may conflict with other commands, sectilt will:

- Distinguish between autofocus, PMS, temperature compensation, and all other focus commands (called "general user" commands).
- Disable autofocus while executing general user commands.
- Reset autofocus to lock on to new focus setting.
- Disable PMS and temperature based commands while autofocus is active.
- Allow the user to enable or disable focus compensation modes.

At this time it is not clear whether autofocus can be suspended and restarted automatically; these features will remain untried until the autofocus process is implemented.

Distinguishing the origin of focus commands implies that the originator will have to send an identity tag with the command. This can be done by assigning special commands to these functions to increment special registers stored by the sectilt process. These will consist of a 1x3 matrix E containing disable or enable flags (0's or 1's) reserved for the following processes:

E(1) PMS, normally on
E(2) TC, normally on
E(3) AF, normally off

When it is started, the autofocus process will issue a command to set the default E matrix (1,1,0) to (0,0,1) disabling PMS and TC commands. On receiving a user command (not specifically flagged as coming from PMS, TC or AF), or on receiving a change focus register command, the E matrix reverts to the default, and a command is issued to the autofocus process to stop. Once the secondary has reached its new position the sectilt process can command autofocus to lock onto the new focus setting.

Flagged incoming incremental commands C(n) will be multiplied by the enable vector and used to determine an incremental offset (accumulative) 1x3 I matrix:

$$I(n) = I(n) + E(n)*C(n)$$

Where I(1) accumulates incremental commands from PMS
I(2) accumulates incremental commands from TC
I(3) accumulates incremental commands from AF

This cumulative matrix is displayed on the WIYN secondary page. Any other (non-flagged) focus commands are termed user commands and are added to a cumulative register U.

The absolute focus setting at any one time can be found from:

$$Z = Z0 + I(1) + I(2) + I(3) + U$$

Calculating the secondary position in this way has some advantages. First, using the cumulative registers, the user can tell the source of the cumulative offsets. Second, this method of enabling or disabling additions to a cumulative register results in smooth transitions between various focus modes. For instance, one can switch between LUT based correction and active autofocus without introducing a step-wise focus change.

3.2 Tilts

On receiving a tilt command the sectilt process will convert from tilt in arcseconds of equivalent image motion to secondary actuator steps determining the correct step sequence to achieve tilt without defocus. Unless pointing compensation has been disabled, the sectilt process will issue a pointing correction to the TCS equal in value to the incoming command in arcseconds. The two commands should be issued simultaneously (or as near to as feasible) so that there is no net image motion at the focal plane. Pointing offsets are of the same type as guider offsets - they will not appear on any of the TCS pointing registers.

4.0 Specific Commands:

- Go home
- Initialize
- Change absolute offset matrix (row, column, value, character string)
- Change increment offset matrix (row, value)
- Clear increment offset matrix
- Clear user offset
- Autofocus on/off
- PMS correction on/off
- Temperature compensation on/off
- Automatic pointing compensation on/off
- Focus (value) [general user command]
- Tilt X,Y (value)
- Clear tilt registers

5.0 WIYN secondary page

The following is a rough layout of the WIYN secondary page.

WIYN secondary page

Focus setting (microns): ZZZZZZ.Z [Reverse video indicates not in position]

Truss temperature (C): TT

Tilt setting (arcsec) X: XXXXXX [ditto reverse]

 Y: YYYYYY

Pointing compensation: on [off in reverse video]

Offsets: WIYN port MOS port FC port MC port
 (active)

 ADC in AAAAAA on

 R filter AAAAAA on

 Dewar AAAAAA on

 TBD AAAAAA on

 User offset CCCCCC on

 look up table LLLLLL on

 Temp comp TTTTTT on

 autofocus AAAAAA off