APF Spectrograph Stages and I/O

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Purpose – This document describes the opto-mechanical and electrical sub-assemblies comprising the APF spectrograph. These components move and/or change electrical state under computer control. They are defined in terms of the actuators, mechanical slides, sensors, and inputs associated with them.

Stage Design Philosophy – the various mechanical stages will be electrically and logically similar. They will all be Galil controlled, dual closed-loop encoded, and will include primary and secondary limits, as well as a home fiducial. They will be horizontally oriented in a non-changing gravity vector. Consequently, it is expected they will require little or no motor power to maintain position.

Hatch Stage ("HAT") – this is a barrier, serving as a dust and debris shield when the spectrograph is offline. It is currently envisioned as a traversing plane shutter on a linear stage.

- Operation: binary linear motion (fully open / fully closed)
- Mechanism: linear slide, with motor driven timing belt or leadscrew
- Travel: approximately 125 mm
- Repeatability: 1.0 mm or better
- Motor/Controller: Galil
- Primary limits: Hall Effect
- Secondary limits: electromechanical switch (Honeywell Microswitch)
- Fiducial / home sensor: Hall Effect Vane Switch (Cherry #VN101501)
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: magnetic incremental linear (Turck Kubler)

ADC Stage ("ADC") – moves the 2nd prism of the ADC prism pair to compensate for atmospheric dispersion. Trombone stage will be fixed to elevation bearing and rotates with telescope in elevation. Stage travel will be a function of elevation angle, ambient temperature, and atmospheric pressure.

- Operation: continuously variable linear motion
- Mechanism: linear slide, with motor driven timing belt or leadscrew
- Travel: approximately 305 mm
- Repeatability: 0.1 mm or better
- Motor/Controller: Galil
- Primary limits: Hall Effect
- Secondary limits: electromechanical switch (Honeywell Microswitch)
- Fiducial / home sensor: Hall Effect Vane Switch (Cherry #VN101501)
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: magnetic incremental linear (Turck Kubler)

Guide Camera Focus Stage ("CAM") – stage moves a guider camera, fed by a fixed, 4% reflectance pellicle, in and out of focus as needed. Camera will initially be provided by EOST, but may later be replaced with a "Wei camera".

- Operation: continuously variable, linear motion
- Mechanism: linear slide, with motor driven timing belt or leadscrew
- Travel: approximately +/- 15 mm from a nominal home position
- Repeatability: 0.1 mm or better
- Motor/Controller: Galil
- Primary limits: Hall Effect
- Secondary limits: electromechanical switch (Honeywell Microswitch)
- Fiducial / home sensor: Hall Effect Vane Switch (Cherry #VN101501)
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: magnetic incremental linear (Turck Kubler)

Calibration Source Mirror Stage ("CMR") – positions a mirror in/out of light path in order to inject calibration light into spectrograph. Motion is in plane of mirror to minimize aiming errors generated by stage.

- Operation: binary linear motion, in plane of mirror
- Mechanism: linear slide, with motor driven timing belt or leadscrew
- Travel: approximately 50 mm
- Repeatability: 1.0 mm or better
- Motor/Controller: Galil
- Primary limits: Hall Effect
- Secondary limits: electromechanical switch (Honeywell Microswitch)
- Fiducial / home sensor: Hall Effect Vane Switch (Cherry #VN101501)
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: magnetic incremental linear (Turck Kubler)

Calibration Light Source Stage ("CAL") - selects from one of five light sources, three of which are currently defined. Their light is sent through fixed optics and a pupil plate, and is directed onto the Calibration Source Mirror mentioned above.

- Operation: linear motion, with 5 discrete stopping positions
- Mechanism: linear slide, with motor driven timing belt or leadscrew
- Travel: approximately +/- 150 to 175mm
- Repeatability: 0.25 mm or better
- Motor/Controller: Galil
- Primary end of travel limits: Hall Effect
- Secondary limits: electromechanical switch (Honeywell Microswitch)
- Fiducial / home sensor: Hall Effect Vane Switch (Cherry #VN101501)
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: magnetic incremental linear (Turck Kubler)

The light sources are:

- Primary Thorium – this is a single thorium lamp, filled with a mixture of 90% neon and 10% argon. Lamp is to be driven with a dedicated power supply, and will be either fully on, or off. Power supply current sensing will be used to confirm lamp operation.

- Secondary Thorium (hot backup) – same configuration as primary. If the primary source should fail, the backup would be used in its place. A separate dedicated power supply should be used here as well.

- Integrating Sphere - contains a pair of filtered halogen light sources, 10 watt and 50 watt, operating in unison or independently. There is an additional pair of halogen lights, serving as a hot backup. Input is on/off, independent for each light. Four dedicated power supplies, with current sensing are needed. The primary halogens and their backups could be mixed and matched depending on which lamps have failed.

- Additional light source, possibly a laser diode

- Additional light source or TV camera

Iodine Cell Stage ("IOD") – carries a cell containing iodine vapor, and an optically equivalent, clear, AR-coated compensation window. The stage can position either one into the beam feeding the spectrograph, or neither of them (clear aperture condition). The iodine cell operates at 50 degrees C., and will require a dedicated power supply, along with current and temperature sensing. A

cooling fan will be used to move residual heat away from the spectrograph optics. Fan health will be need to be sensed and monitored.

- Operation: linear motion, with 3 discrete stopping positions
- Mechanism: linear slide, with motor driven timing belt or leadscrew
- Travel: approximately +/- 100 mm
- Repeatability: 1.0 mm or better
- Motor/Controller: Galil
- Primary end of travel limits: Hall Effect
- Secondary limits: electromechanical switch (Honeywell Microswitch)
- Fiducial / home sensor: Hall Effect Vane Switch (Cherry #VN101501)
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: magnetic incremental linear (Turck Kubler)

Slit Decker Stage ("SLT") – precision linear stage carrying a thin plate with ten fixed-sized precision slits and round apertures.

- Operation: linear motion, with 10 discrete stopping positions
- Mechanism: precision linear stage, motor driven ball screw
- Travel: approximately +/- 40 mm
- Repeatability: 0.1 micron or better
- Motor/Controller: Galil
- Primary end of travel limits: Hall Effect
- Secondary limits: electromechanical switch (Honeywell Microswitch)
- Fiducial / home sensor: Renishaw fiducial
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: optical incremental linear (Renishaw)

Exposure Shutter ("EXP") – commercial, high reliability, normally closed iris or planar shutter. Operation is binary; either fully open or fully closed. Required clear aperture is a couple of millimeters. A method will need to be devised to sense shutter state. Also, heat may be a concern, depending on power consumption to maintain open condition. Shutter manufacturer TBD.

Corner-Cube Shutter ("CCS") – same type of shutter as above, but with a larger clear aperture. It will be opened in order to view slit with guider camera. This will be a relatively rare event.

Propeller Mirror with Exposure Meter ("PRO") – possibly needed instead of guider camera. (Note - leave room and hooks for this fall-back option)

- Operation: continuous rotary motion at a set speed, or stopped at home position
- Mechanism: mirror mounted directly to motor shaft
- Motor/controller: Galil
- Fiducial / home sensor: Hall Effect Vane Switch (Cherry #VN101501)
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: none

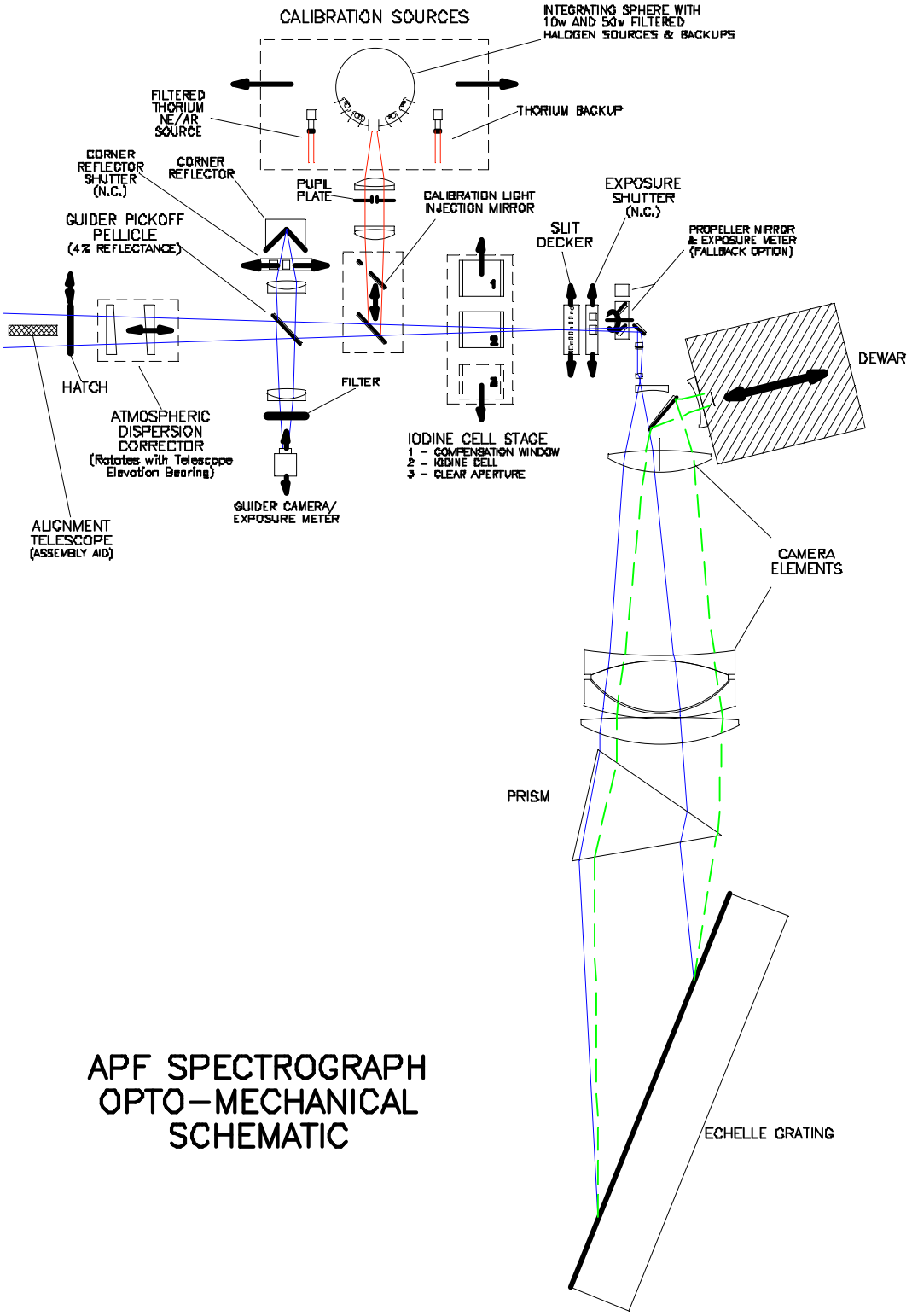
Dewar Focus Stage ("DEW") – focuses CCD by moving entire dewar along the axis of the spectrograph's outgoing light beam. Note – there is potential difficulty with placing the limit and home sensors/switches, due to the small amount of stage travel.

- Operation: continuous linear motion
- Mechanism: precision linear slide, with motor driven ball screw
- Travel: approximately +/- 5.0 mm
- Repeatability: 1.0 micron or better
- Motor/Controller: Galil
- Primary end of travel limits: Hall Effect
- Secondary end of travel limits: electromechanical switch (Honeywell Microswitch)
- Fiducial / home sensor: Renishaw fiducial
- Primary (motor rotation) encoder: incremental rotary (Galil)
- Secondary (load) encoder: optical incremental linear (Renishaw)

Enclosure Environment ("ENC") - spectrograph will be housed in an insulated enclosure, and fed with conditioned air, to facilitate a constant operating temperature. Internal and external enclosure temperature will need to be monitored to provide diagnostic and control information.

General Notes

- Output resolution of primary motor controller should be between four and eight times finer than that of secondary encoder.
- Where used, stray light from Renishaw encoder heads and other opto-electronic components must be thoroughly shielded from the spectrograph.



APF SPECTROGRAPH OPTO-MECHANICAL SCHEMATIC

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