INGRID - Mechanical System Overview

Authors: P Jolley

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Revision History

0.1 First draft

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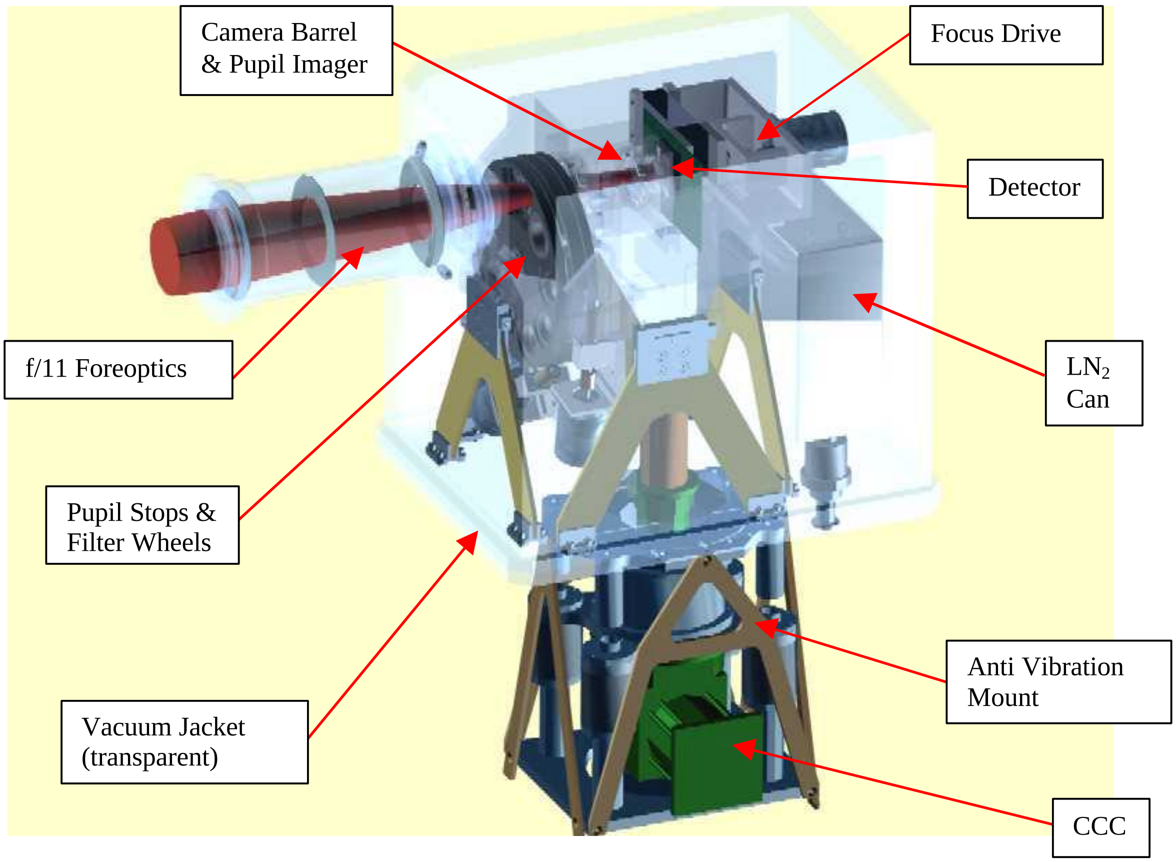
1 Introduction

This document provides an overview of the mechanical systems and cooling regiem within INGRID. The mechanisms included are pupil stop wheel, filter wheels, focus drive and the pupil imager. The cooling componants are the closed cycle cooler (CCC) and liquid nitrogen can.



2 Pupil Stop Wheel

This is the first mechanism within INGRID that interrupts the light beam. It consists of a geared wheel, which is mounted on tapered roller bearings from the main casting. The bearings are coated with WS_2 which acts as a lubricant (absolutely no grease/oil is used as this will solidify and hamper the mechanism). The wheel is driven by a delrin worm drive, again mounted on the casting. A stepper motor is used to provid the motive force. This has been specially prepared to operate at 77K and in a vacuum. Note they are used for all the mechanisms inside INGRID.

There is a friction brake mechanism to reduce backlash. Combined with this is an anti-backlash control sequence (the wheel always approaches the demand position from the same direction). Attached to the brake is a cold strap ensuring the whole wheel is at a similar temperature to the casting.

The datum function ensures a stable zero set for positioning the stops. The datum routine moves the wheels over the sensor in both directions. By averaging the switching position the zero point is obtained. The wheel, however, does not stop at zero after a datum comand. There is no feedback mechanism for the positioning of the stops, it is achieved by step counting the motor only.

Within the wheel are spaces to mount specialised pupil (cold) stops. These are sized for particular focal ratios (hence focal stations) and observing wavelengths.

Below is the technical data for the pupil stop wheel

Gear ratio	218:1 (Modulo 1)
Motor steps	400 step/rev (in half step mode)
Nominal Radius to optical axis	80mm
Number of positions	8 + 1 clear + 2 edges

3 Filter Wheels

There are two filter wheels located directly behind the pupil stop wheel. They are both exactly the same in design. Generally, the broad band filters are placed in the first filter wheel and narrow band in the second.

Again, the wheels are geared and driven via a delrin worm drive. They are mounted on the same axle as the pupil stop wheel on similar coated bearings. There is no brake mechanism on these wheels.

Again, the datum provides a stable zero set point. No feedback on demand position exists so positioning is achieved by step counting on the motor.

Within each wheel are spaces for the filters. These are angled at 5° to the optical beam (and in the opposite sense to the main cryostat window) to reduce ghosting.

Below is the technical data for both the filter wheels

Gear ratio	218:1 (Modulo 1)
Motor steps	400 step/rev (in half step mode)
Nominal Radius optical axis	80mm
Number of usable positions	10 + 1 clear
Nominal filter diameter	38.0
Max filter thickness	6.0mm

4 Focus Drive

The focus drive mechanism is driven by a stepper motor, which is coupled to a leadscrew. Note, the stepper motor is exacly the same as those used by the pupil stop and filter wheels. The leadscrew drives the detector mount over the required focus shift. Thin flexures ensure that the motion is linear over the focus range. This allows the detector to be positioned in the optimum focal plane with respect to the pupil stops.

There are two microswitches mounted on the unit. These provide an electrical cut-off in the event of over-travel. One of the switches also doubles up to provide the datum position.

Below is the technical data for the focus drive unit

Screw pitch	0.5mm
Motor steps	200 step/rev (in half step mode)
Maximum travel	±1.0mm

5 Pupil Imager (Not Commissioned)

This mechanism deploys a series of three lenses into the middle of the camera barrel inside INGRID. It is a two-position mechanism, in-beam or out-beam. The main swing arm is driven via a delrin worm drive. End stops provide positive location for the in beam position.

6 Cooling

Cooling the instrument is carried out via a closed cycle cooler from CTI Cryogenics. It is a single stage cooler using 99.9999% pure helium. The cold finger extends into INGRID and joins to the main casting via copper braids. The CCC is mounted within an ROE anti-vibration mount. This provides an attenuation of around 300 in the transmitted vibration.

The CCC can be stopped during vibration sensitive observing. However, in doing so not only is an important cooling point removed from the system, but an additional heat load is placed upon it. This will need to be soaked up by the liquid nitrogen. As a consequence the hold time is dramatically reduced. It is vital that the CCC is kept on for as long as possible.

Below is the technical data for the CCC

Cooling capacity	16W @ 77K
Heat load when not used	9W

In addition to the CCC a liquid nitrogen can has been included. This is firmly attached to the main casting. It provides a more rapid cool down, cooling when the CCC is not used (e.g. during NAOMI operation) and a heat sink to providing a more stable temperature. Filling while at cass is extremely problematical. In this mode the can is upside down and a special fill tube needs to be used.

Below is the technical data for the liquid nitrogen can

Max volume	4.3 litres