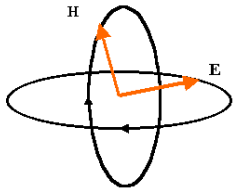
GEMINI A&G POLARISATION MODULE
Functional and Performance Requirements Document V 3.0



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1 Purpose of this Document

The Purpose of the Function and Performance Requirements Document (FPRD) for the Gemini Polarisation Unit (GPOL) is to provide engineers with the requirements for the design of GPOL. The FPRD is the specification derived from the GPOL Operational Concept Description Document (OCDD). If the requirements of the FPRD do not match the concepts in the OCDD, the OCDD takes precedent. Any discrepancies should be highlighted.

The design must meet the requirements in this document completely. Every design feature must be traceable to this FPRD. This document will be updated as required as the design progresses. Should any of the requirements prove impossible to realise or prohibitively expensive, a concession of that requirement can be sought. Should this concession be agreed the FPRD will be updated to reflect this change.

Note: Requirements and goals 6.n do not occur in the OCDD.

2 Applicable Documents

2.1 General Documents

The following documents will be useful in the GPOL design.

1. RPT-0-G0047 Gemini Telescope f/16 Design Summary, 6 July 1994
2. PG-I-G0010 Gemini instrument safety policy
3. SPE-I-G0074 Programmatic Requirements for Gemini Instrumentation Development

2.2 Relevant Interface Control Documents

ICD-G0013 Gemini Environmental Requirements
ICD 1.12 GPOL Introductory ICD (to be written)
ICD 1.6/1.12 A&G system to GPOL (Physical space in the A&G unit for mounting GPOL)
ICD 1.6 A&G System
ICD 1.12/xxx GPOL to xxx instrument interface (Requirements in instruments for polarisation capability
ICD 1.5.3 ISS Introductory ICD
ICD 1.12/xxx GPOL to DHS
ICD 1.12/xxx GPOL to TCS

2.3 Acronym List

A&G	Acquisition and Guidance Unit
EPICS	Experimental Physics and Industrial Control System
ISS	Instrument Support Structure
IGPO	International Gemini Project Office
OCS	Observatory Control System
DHS	Data Handling System
TCS	Telescope Control System
FPRD	Functional and Performance Requirements Document
OCDD	Operational Concept Definition Document
GPOL	Gemini Polarisation Unit

3 Polarisation Functional and Performance Requirements

3.1 Hardware Location

The GPOL hardware resides inside the ISS and A&G Unit. A space[1] has been left in the A&G and as far as practical this should not be exceeded. It physically mounts in the base unit of the A&G (Module 1) below the Science Fold Mirror. Figure 1 show the approximate location of the GPOL inside the ISS.

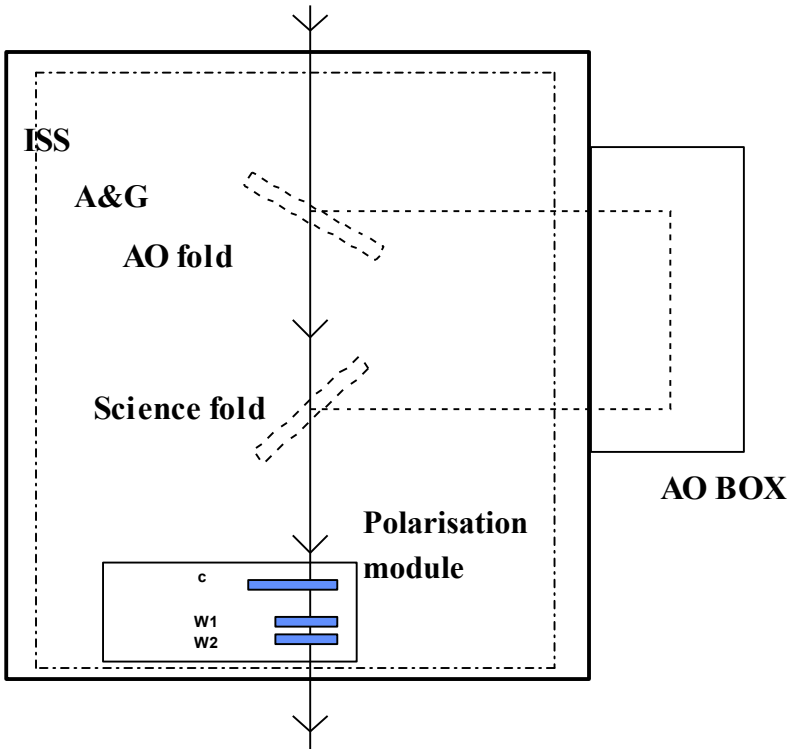

Figure 1: Gemini ISS showing location of Polarisation Module

GPOL will be designed assuming that the control cards can be housed in the Gemini A&G VME control rack. If possible the motor controllers should also be housed in the A&G thermal cabinet.

Requirement 1.1	For highest precision (P≤ 0.05%), the polarisation module should be before any non-symmetric reflections
Requirement 1.2	When not in use the polarimetry module must not vignette a 7 arcmin diameter fov.
Goal 1.2	When not in use the polarimetry module should not vignette a 10 arcmin diameter fov.
Requirement 1.3	The waveplates should retract into a dust cover when not deployed.
Requirement 1.4	minimal disruption to the A&G hardware as defined in ICD 1.6/1.12
Goal 1.4	No disruption to the A&G hardware

[1] ICD 1.6/1.12

Requirement 1.5	The control hardware will be mounted external to the ISS
Goal 1.5	The WFS control hardware will be utilised to drive the various mechanisms

3.2 GPOL Functional Requirements

The functional requirements detailed here refer to a system utilising rotating polarisation waveplates as modulators. This is not a requirement though is thought at this time to be the practical implementation. If an alternative system is adopted, these requirements will change to reflect this. Figure 2 shows the basic layout for such a system. Essentially it has three components:

1. Waveplates
2. Calibrators
3. Analyser (mounted in instrument)

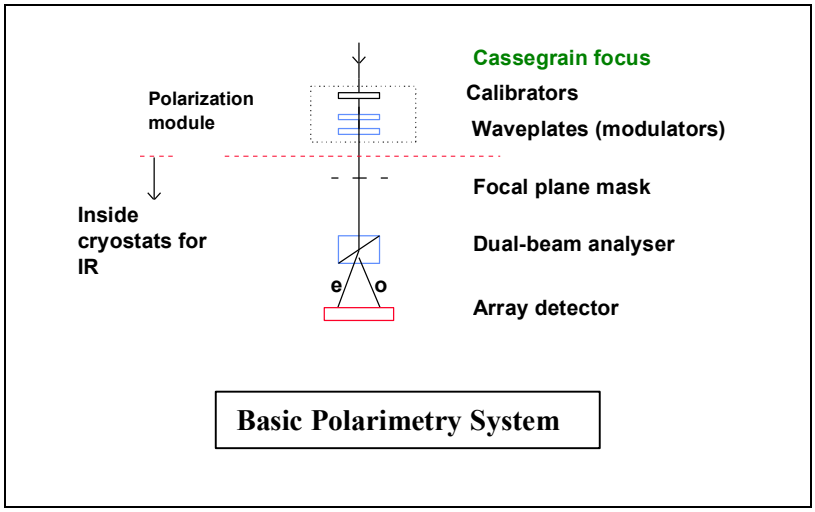

Figure 2: Basic Gemini Polarimetry Unit Layout

Requirement 2.1	A single (superachromatic) waveplate to cover 0.3 to 1.1μm and a single (achromatic) waveplate to cover 0.9 to 2.5μm; first-order plate to cover the L band (M-band plates are not in the baseline).
Goal 2.1	A single (superachromatic) waveplate to cover 0.3 to 2.5μm.
Requirement 2.2	Waveplates to provide λ/2 retardances (quarter-wave retarders - for circular polarimetry - are not in the baseline).
Requirement 2.3	A set of 3 non-rotating calibration plates, that cover the wavelength range of Gemini polarimeters and be automatically deployable
Requirement 2.4	The GPOL will need to operate two waveplates together.
Goal 2.4	GPOL should contain at least three waveplates that can be accessed and operated remotely
Requirement 2.5	Waveplate clear apertures to be a minimum of 95mm
Requirement 2.6	Wedge angle of the waveplates to be less than 0.5 arcmin
Requirement 2.7	Rotation axis of waveplates to be normal to the waveplate

	to within 16 arcmin
Requirement 2.8	Clear aperture of rotating assembly to be 165mm. Optical thickness of waveplate and clear aperture to be uniform to 1%.

3.3 GPOL Performance Requirements

In addition to the functional requirements detailed in section 3.2, the GPOL design must achieve the following performance requirements

Requirement 3.1	Waveplates should be introduced and withdrawn with the minimum disruption
Requirement 3.2	The on-axis centering should be better than ±0.5mm.
Requirement 3.3	Waveplate identification to be electronically encoded
Requirement 3.4	Waveplates must not be able to rotate in their holders.
Requirement 3.5	The waveplate optical axes to be aligned in the same direction with a precision of a quarter degree.
Requirement 3.6	Waveplates to be rotated continuously or in step-and-stare mode
Requirement 3.7	Sensors, attached to the rotating assembly, should be used to define the usual operating positions: 0, 22.5, 45, 67.5, 90 and 135 degrees.
Requirement 3.8	The sensors should be magnetic or, if optical, should be powered off when the operating position has been reached.
Requirement 3.9	Rotate one or two waveplates, either in continuous or step and stare mode.
Requirement 3.10	Sense of rotation should be switchable in engineering mode, but always default to the same sense in observing mode.
Requirement 3.11	Any angular position, in steps of a half-degree or less, should be available by offsetting from the 0-degree position.
Requirement 3.12	Each of the set waveplate positions should be accurate to better than 0.2 degrees relative to the zero-degree position
Requirement 3.13	Intermediate waveplate positions should be accurate to better than 0.2 degrees relative to the zero-degree position
Requirement 3.14	The minimum rotation period (τ_{min}) should be an integral number of half-seconds Waveplates and rotating assembly to produce beam-wander of less than 0.050arcsec at the focal plane.
Requirement 3.15	τ_{min} = 5 sec
Goal 3.15	τ_{min} to be 4 sec
Requirement 3.16	Rotation periods should be programmable with τ ranging from to τ_{min} to $10\tau_{min}$ in steps of $0.5\tau_{min}$
Requirement 3.17	Continuous rotation should be uniform to 1 part in 200 and with a long-term precision of 1%.
Requirement 3.18	Motors to be in standby mode when stationary, but to retain sufficient torque to stop any slippage.

3.4 Instrument Requirements

The known Gemini instruments have the following fov characteristics:

Instrument	fov (arcsec)	fov (mm)	Notes
NIRI	20, 50, 120	57, 74, 113	pixel scales 0.02, 0.05, 0.12 arcsec
NIRS	50 (long camera) 150 (short camera)	74 129	
MIRI			
HROS	60	79	long-slit mode
GMOS	330x330	229x229	long-slit mode
OIWFS	210	163	

For each instrument the following requirements are necessary to operate with GPOL.

Requirement 4.1 Two-beam polarising prisms to be used as analysers.

Requirement 4.2 With reflection gratings to have the two orthogonal polarisations making the same angle with the polarisation axis of the grating

Goal 4.2 With reflection gratings, to include quarter-wave retarders after the analyser

Requirement 4.3 Focal plane grid masks, with spacings matched to the separation of the orthogonally polarised beams. (See Figure 3)

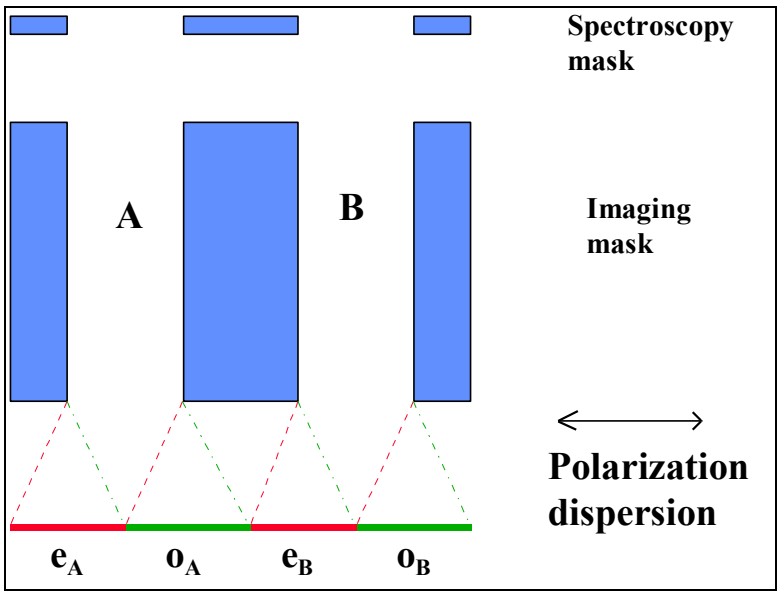

Figure 3: Focal Plane Grid Mask

3.5 Telescope Systems Requirements

These requirements are on other systems than the GPOL and will be the subject of relevant ICDs.

Requirement 5.1	In step-and-stare mode any beam wander resulting from the rotation of the waveplate can be corrected for by offsetting of the telescope
Requirement 5.2	The Gemini Cassegrain focus must be capable of increasing by up to 15mm.
Requirement 5.3	The PWFS focus needs to be mechanically adjustable by up to 15mm or a glass plate, or plates, of suitable optical thickness can be placed in the PWFS filter wheel
Requirement 5.4	Online data reduction to give Stokes parameters for individual integration and running average (with uncertainties)
Requirement 5.5	The TCS and OCS must inform the relevant instrument when the GPOL is in position to make and observation.
Requirement 5.6	The TCS must provide the top level control of GPOL
Requirement 5.7	The WFS must provide the top level VME processing and control hardware for the GPOL.

3.6 Site Conditions

3.6.1 Environmental Requirements

Requirement 6.1	System must conform to ICD-G0013 Gemini Environmental Requirements

3.6.2 Telescope Interfaces

Requirement 6.2	Mechanisms that are passively cooled must not raise the surrounding A&G structural temperature by >2° C
Goal 6.2	Mechanisms should be powered off when not in use.
Requirement 6.3	Handling equipment to be provided for safe lifting and movement of the unit and sub-assemblies (e.g. waveplate installation/removal jig).
Requirement 6.4	Mauna Kea available power is 120 V 60 Hz AC
Requirement 6.	Cerro Pachon available power is 110 V 50 Hz AC