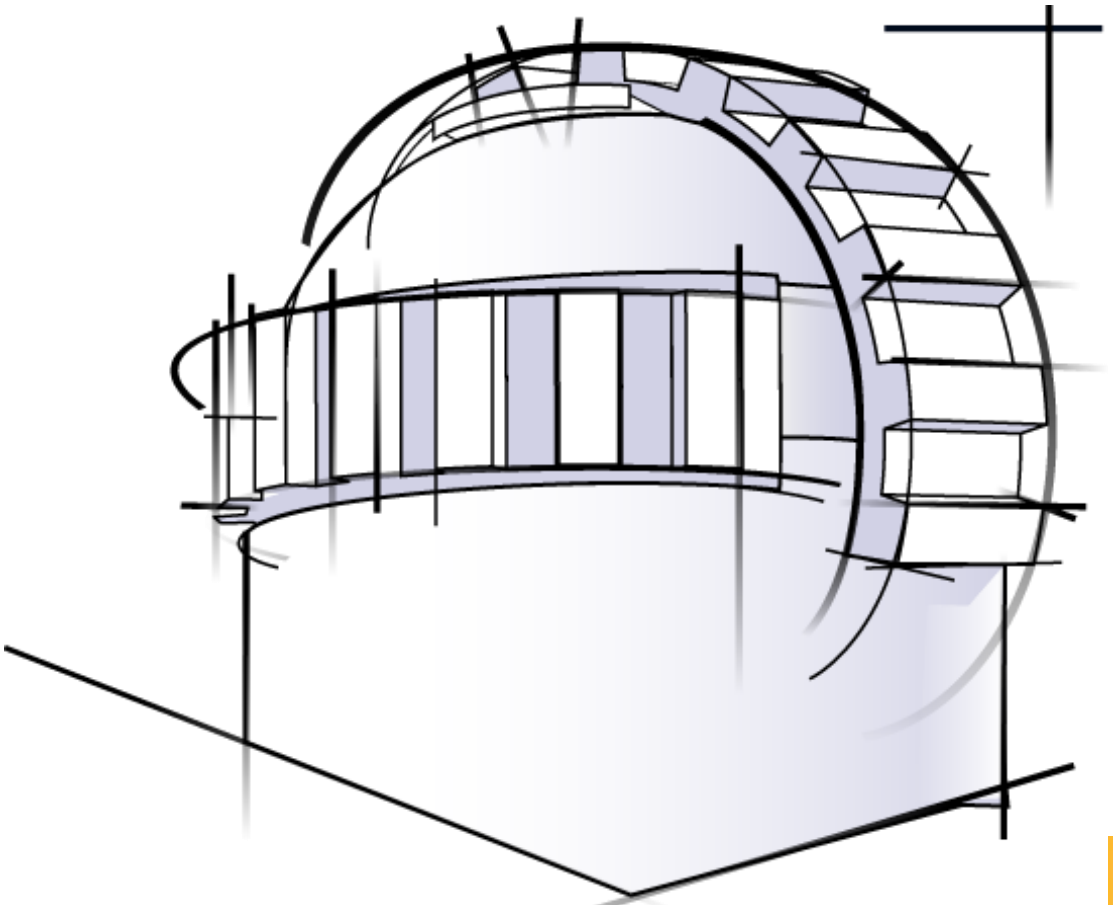
Gemini Planet Imager

GPI Feasibility and Phase II Checks



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The goal of this presentation is to be able to do a proper technical asessment of a GPI proposal and spot the most common GPI Phase II issues.

It should be noted that GPI is offered in 14B in Shared Risk. Most if not all Performance numbers are expected to change for 15B and it is planned to Streamline/simplify OT even more.

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Technical Assessment

From a Feasibility point of view GPI consists of 4 components as these are setting the constraints on feasible targets.

1. OIWFS (The Adaptive Optics, AOWFS), a high order, fast (1KHz) AO system that corrects for the atmospheric turbulence. Sets the limit on allowed brightness in I-band.

2. LOWFS (The CAL unit), low order, slow AO (0.1Hz) system that is designed to keep the object on the mask. Sets the limit on allowed brightness in H-band.

3. The IFS, Hawaii 2 NRG chip, field of view 2.4”x2.4”, minimum exposure time 1.49s, maximum exposure time 999s. Sets the limit on allowed brightness in the science band and the maximum field of view.

4. Coronographic Mask or Direct. Sets the limit on Inner Working distance and brightness.

Main webpage**: http://www.gemini.edu/sciops/instruments/gpi/instrument-performance**

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OIWFS and LOWFS Limits

http://www.gemini.edu/sciops/instruments/gpi/instrument-performance?q=node/12166

GPI limiting magnitudes are determined by several components, the OI WFS (I-band), the LOWFS (H-band), and the IFS (selected science filter).

In addition the observing conditions add another layer of limits. Thus the brightest of the science object is limited in **I**-band from the AOWFS, in **H**-band from the LOWFS (not a constraint in DIRECT mode as then no coronographic mask is used and no LOWFS is possible).

	Maximum brightness [mag]	**Minimum brightness [mag]**
I-band (AOWFS)	1	9.0
H-band (LOWFS)*	1	9.0

*Only valid in **Coronographic** mode, in the **Direct** mode there is no LOWFS and thus no constraint imposed by the LOWFS.

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OIWFS and LOWFS Weather Limits

http://www.gemini.edu/sciops/instruments/gpi/instrument-performance?q=node/12166

The given magnitude limits for the AOWFS and the LOWFS (if used) should be modified in the following way for worse than IQ70 CC50 conditions:

Observing conditions	**Decrease of faintness limit [in magnitudes]****
IQ70 CC70	1.5
IQ85 CC50	1.5
IQ85 CC70	3

**Note that the decrease in magnitudes is ONLY applied to the faint end, it does not mean that brighter than normal targets can be observed. This is to make operations safe and avoiding locking on noise in the control loops.

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IFS Limiting Magnitudes

http://www.gemini.edu/sciops/instruments/gpi/instrument-performance?q=node/12166

The selected observing mode is strongly affecting the brightness of the target that can be observed with the IFS without saturating in the selected science wavelength by the IFS.

The principal four modes (each that can be done in all the filters Y, J, H, K1 and K2) are Coronographic Spectroscopy (the "-coro" modes), Coronographic polarization (the "-coron-pol" modes), Direct (the "-direct") observations with either spectroscopy or polarization. Note that this limit is applicable to the relevant science wavelength.

Observing Mode	Maximum brightness [mag]
[Y...K2]-coro	1
[Y...K2]-coron-pol	3
[Y...K2]-direct	8
[Y...K2]-direct-pol	11

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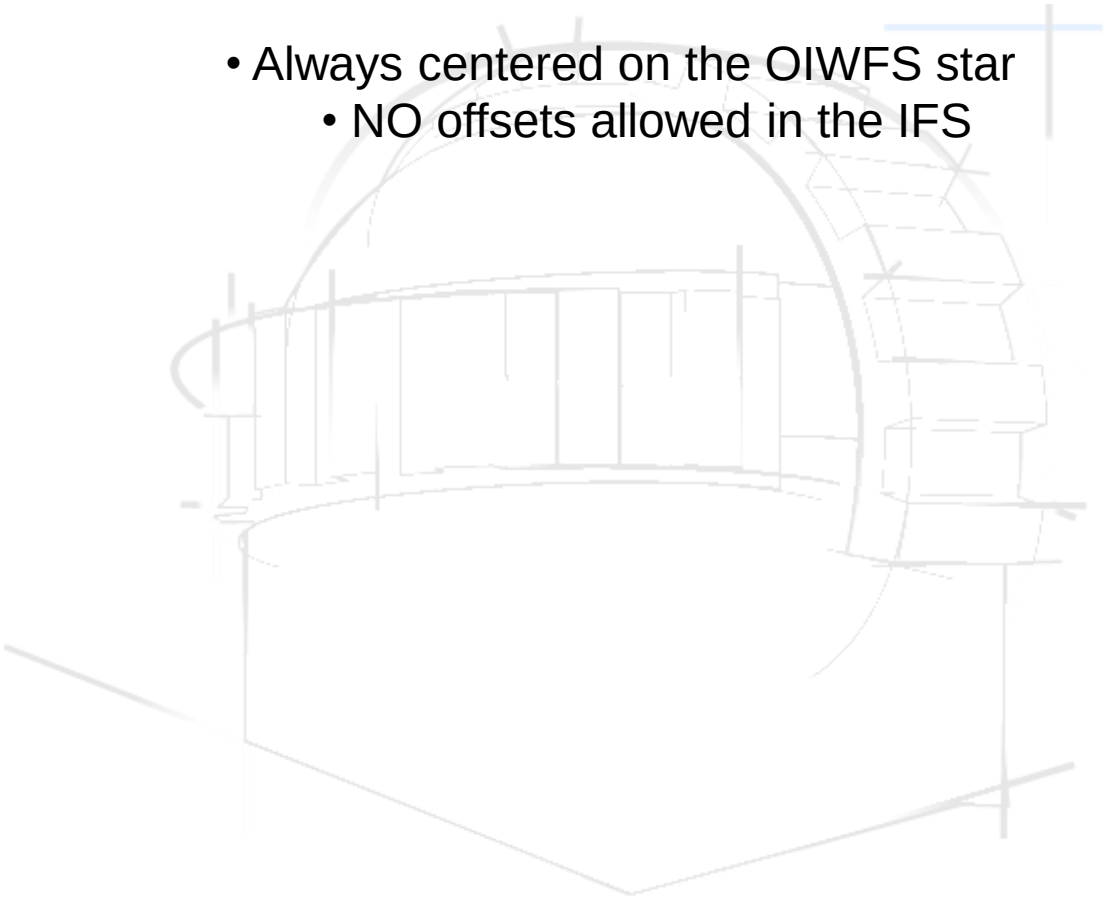
IFS Limiting Field of View

The GPI IFS has a field of View of 2.4”x2.4”

- Always centered on the OIWFS star
- NO offsets allowed in the IFS



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Coronographic Mask/Mode

http://www.gemini.edu/node/11550

The tables below list the properties of the standard GPI coronagraphic configurations. GPI will automatically select appropriate apodizer, focal plane masks, and Lyot stops for each wavelength.

Configuration	Filter	**Wavelength range (1/2 power bandpass, microns)**	Spectral resolution (per 2 pixels)	**Coronagraph focal plane mask diameter (mas)**
Y-coron/coron-pol	Y	**0.95 - 1.14**	34-36	**156**
J-coron/coron-pol	J	**1.12 - 1.35**	35-39	**184**
H-coron/coron-pol	H	**1.50 - 1.80**	44-49	**246**
K1-coron/coron-pol	K1	**1.9 - 2.19**	62-70	**306**
K2-coron/coron-pol	K2	**2.13 - 2.4**	75-83	**306**

Thus the choosen mode will set three important parameters for feasibility:

1. Inner Working Distance
2. Spectral Resolution
3. Wavelength range

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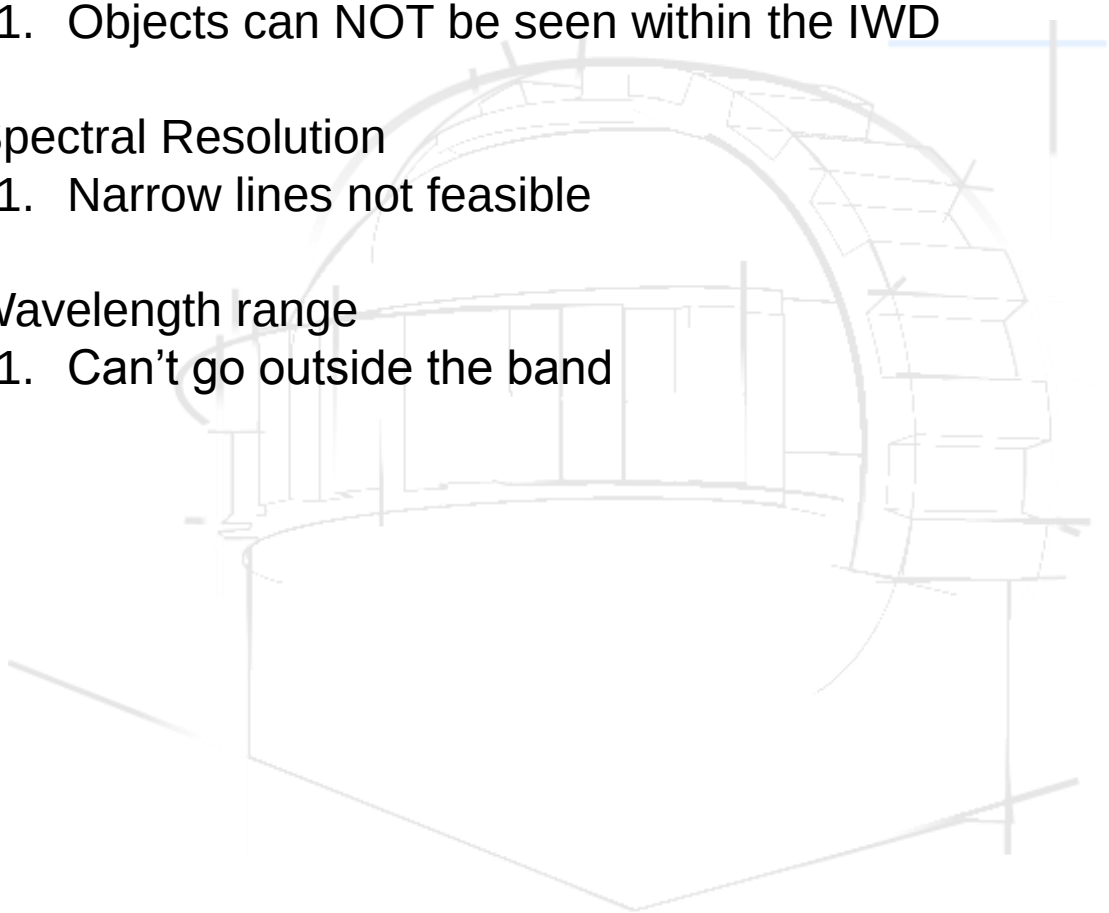
Coronographic Mask/Mode

1. Inner Working Distance
    1. Objects can NOT be seen within the IWD

2. Spectral Resolution
    1. Narrow lines not feasible

3. Wavelength range
    1. Can’t go outside the band



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Performance

http://www.gemini.edu/sciops/instruments/gpi/instrument-performance?q=node/11552

GPI Performance has one fundamental parameter, which is the measured Contrast.

Nominally this is simple but varies with:

- I-band magnitude → Limits OIWFS
- IQ (nominal performance for IQ70, NO guarantee on performance in IQ85)
- Airmass → Nominal performance ZD=<40, allowed <=50
- Size of the object Extended objects <<2”
- Peak contrast reached ~0.3-0.4” from the object

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Performance Assessment Checks

- IQ
  - PI loosens the constraints but still uses Contrast for IQ70
- Airmass
  - PIT has “built-in” constraints but it means that Dec ~< +15 and Dec >~ 75
  - For the semester the target must be above the ZD~45 for at least 2h to be suitable.
- Size of the object
  - Contrast less for extended object, WIP on details

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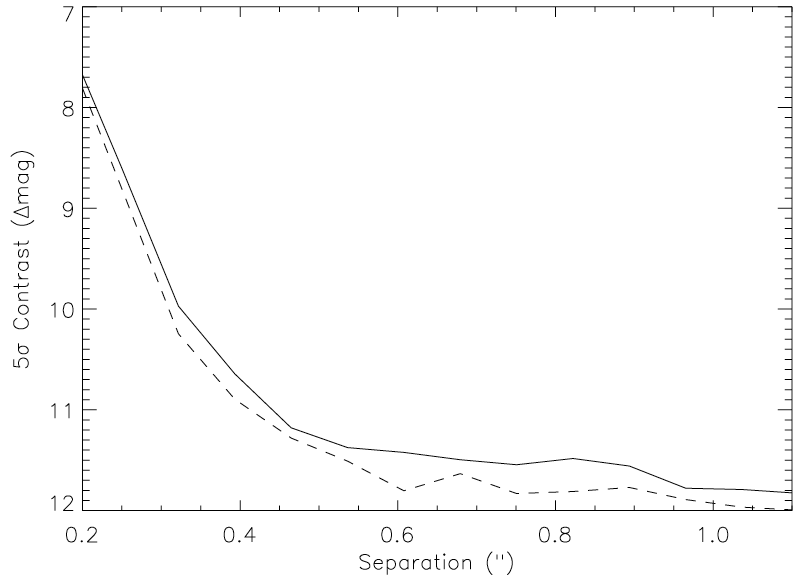
Performance Assessment Checks II

- Peak contrast reached ~0.3-0.4” from the object
  - Contrast drops sharply within this distance
  - DIRECT mode is still WIP on contrast but expect at a minimum one order (2.5 mag) worse contrast.
  - Postprocessing works great, but not more than ~3 magnitudes



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Various Items

1. Acquisition **must** be done for each requested mode (15m)

2. NO change of modes inside an observation, this includes filters.

3. Baseline calibrations includes:
    1. PSF standards
    2. Telluric cancellation standards
    3. Polarization standards
4. Close binaries are NOT allowed:
    1. Affects OIWFS
    2. May also saturate the IFS as the second is unblocked (direct)

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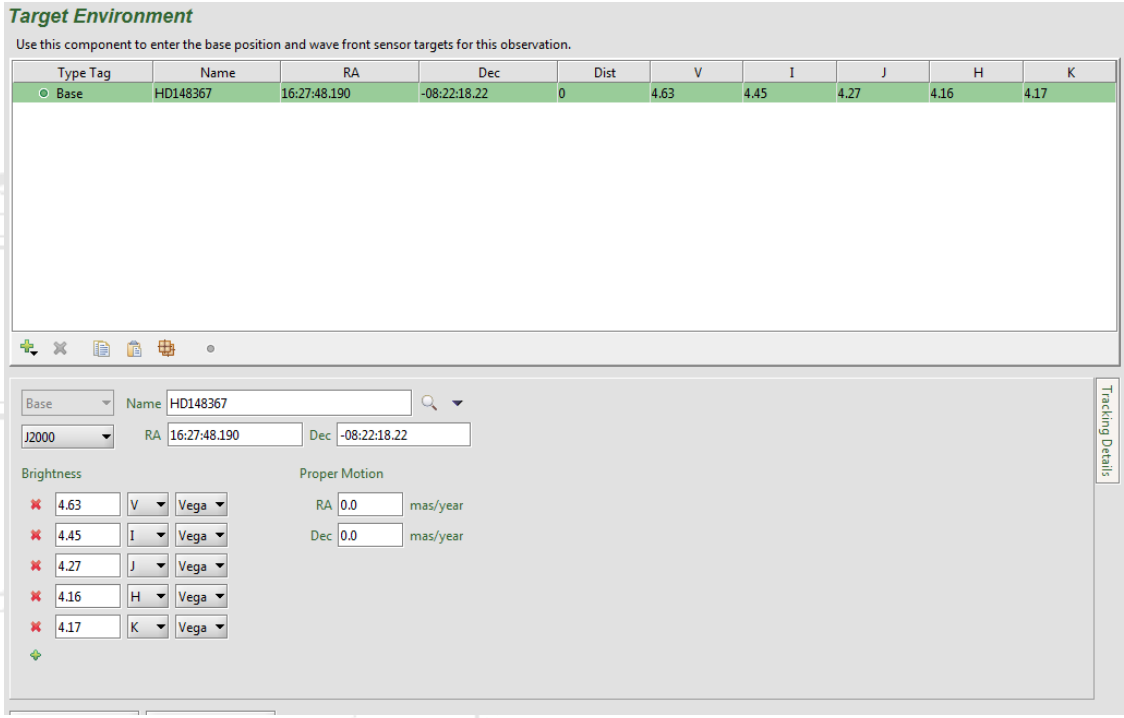
Phase II Checking

OT has a lot of built-in checks on magnitudes and modes. But sometimes issues slips through.

Common issues:

- I, Y, J, H, and K must have defined magnitudes
- Proper motions are critical, the OIWFS has a field of view of ~1” and thus wrong proper motions slows down acquisition, most stars that GPI can observe have pRA>0 and pDec>0
- For the same reason accurate source coordinates are important, use the search when possible.



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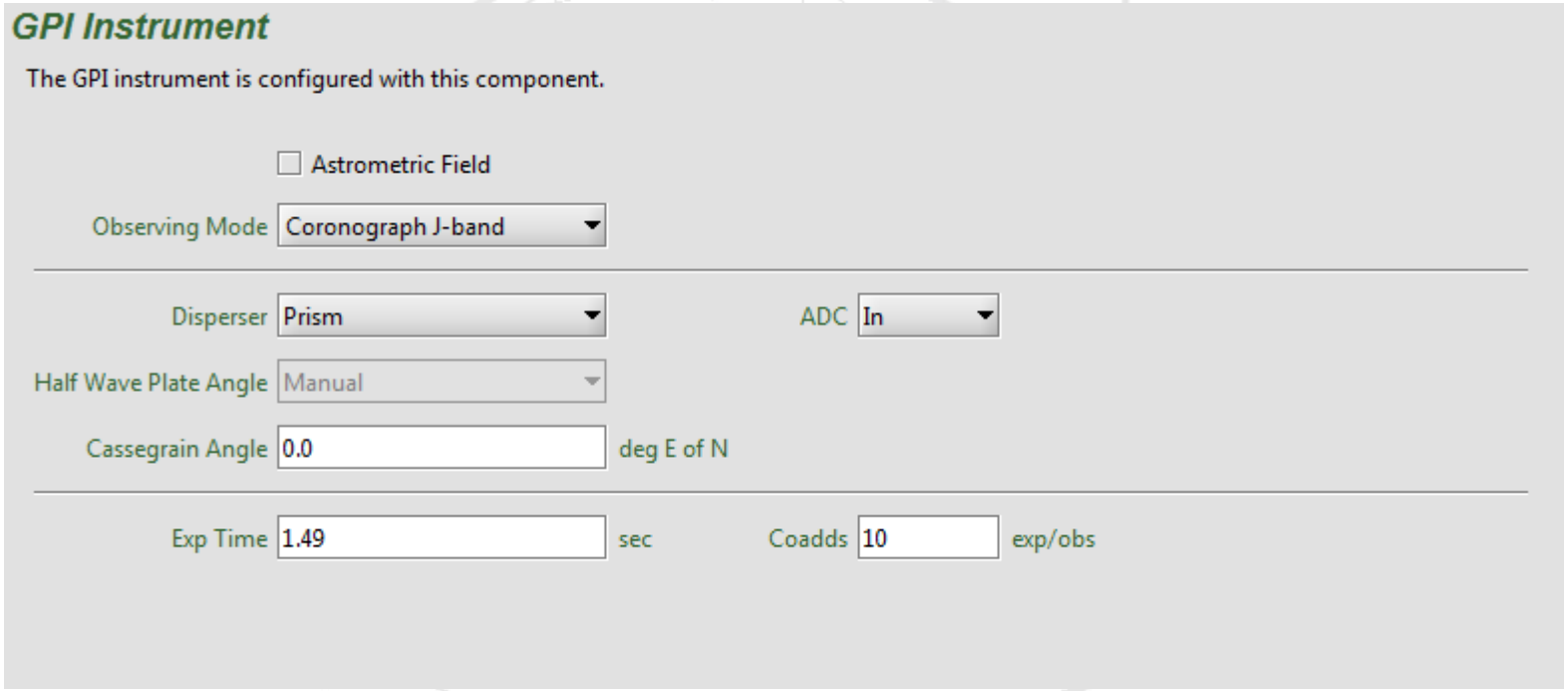
Phase II Checking

- Cassegrain angle ONLY 0.0 (will be removed in the future)
- Observing Mode **must** be selected.



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Phase II Checking

- The iterator is basically practical only for looping through exposure-times and coadds settings.

Actually we are looking at deprecating the looping in the sequencer as standard observations are not using the feature.