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GPI 2.0: Upgrade Status of the Gemini Planet Imager

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ABSTRACT

The Gemini Planet Imager (GPI) is a dedicated high-contrast imaging facility instrument designed for the direct detection and characterization of young Jupiter mass exoplanets. After six years of operation at Gemini South, GPI has helped establish that the occurrence rate of Jovian planets peaks near the snow line (∼3 AU), and falls off toward larger separations. This motivates an upgrade of GPI to achieve deeper contrasts, especially at small inner working angles, to extend GPI's operating range to fainter stars, and to broaden its scientific capabilities, all while leveraging its historical success. GPI was packed and shipped from Gemini South in 2022, and is undergoing a major science-driven upgrade as part of a relocation to Gemini North (GN). We present

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the status and purpose of the upgrades including an EMCCD-based pyramid wavefront sensor, broadband low spectral resolution prisms, new apodized-pupil Lyot coronagraph designs, upgrades of the calibration wavefront sensor and increased queue operability. We discuss the expected performance improvements in the context of GPI 2.0's enhanced science capabilities which are scheduled to be made available at GN in 2024.

Keywords: Adaptive optics; extrasolar planets; coronagraphy; integral field spectrograph

1. INTRODUCTION

The search for and discovery of extrasolar planets has dramatically changed our understanding of planetary formation and where our solar system stands with respect to other solar systems in the galaxy. While thousands of exoplanets have now been discovered, revealing a wide diversity of planetary system configurations, only a few of the most massive or most widely separated ones have been observed spectroscopically. Direct imaging fills an important role in the understanding of exoplanets. Direct imaging allows for the discovery of planets on solar system-scale orbits, provides new insight into the formation and characteristics of extrasolar systems, and enables direct spectroscopic observations of their atmospheres.

The Gemini Planet Imager (GPI) is a facility class instrument designed to address the fundamental goal of directly imaging exoplanets (Figure 1). GPI was designed and built to directly image and spectroscopically characterize young, Jupiter-sized, self-luminous extrasolar planets and search for circumstellar debris disks that are sculpted by planetary systems. The primary motivation for creating GPI was to measure the frequency and distribution of wide-orbit, giant planets. While originally designed for either Gemini North or Gemini South, GPI was installed at Gemini South in the fall of 2013[1] and operated as part of the general suite of facility instruments until the fall of 2020.

1.1 Overview of exoplanet science with GPI

GPI 1.0 consisted of seven major subsystems: an adaptive optics (AO) system, apodized-pupil Lyot coronograph (APLC), a precision infrared wavefront sensor (CAL), a near-IR integral field spectrograph (IFS), an opto-mechanical subsystem to hold all of the components together (OMSS), a top-level computer (TLC), and a data reduction pipeline (DRP), written in IDL, to reconstruct raw IFS images into three-dimensional data cubes and provide basic PSF subtraction. The AO system consists of a 4096-actuator micro-electro-mechanical (MEMS) deformable mirror, a CILAS 11 actuator diameter piezoelectric DM in a woofer-tweeter configuration, and a Shack-Hartmann WFS with a Lincoln Labs CCID-66 sensor.[1,2] GPI uses an APLC to suppress coherent light from the central star.[3] GPI's science instrument is an IFS with 192x192 spatial pixels dispersed through a prism to provide a resolving power of R=∼30-100 depending upon the band. The GPI IFS has 5 individual filters in Y, J, H, and 2 in K-band (split into overlapping segments). The IFS further incorporates a Wollaston prism to allow for polarization measurements but only in broad band.[4,5]

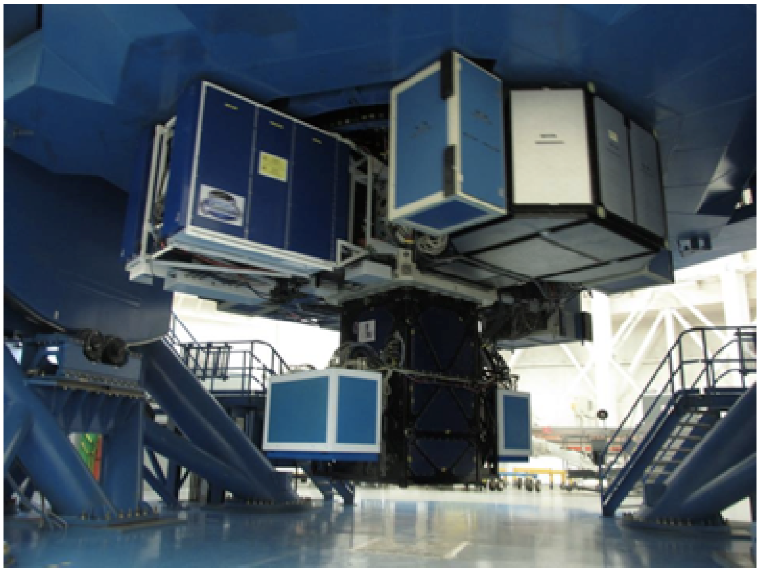

Figure 1: GPI (bottom) mounted on the Cassegrain mount of the Gemini South telescope, Chile.

In this work, we will present the status of the upgrades being made to GPI, known as GPI 2.0. In Section 2 we discuss the current capabilities of GPI, its historical usage, and significant results. In Section 3 we discuss the next generation science drivers which drove the hardware upgrades of GPI. In Section 4 we present the upgraded hardware for GPI 2.0 and finally in Section 5 we present the status of the instrument upgrades and updated timeline.

2. SUMMARY OF GPI 1.0

GPI was shipped to and installed at Gemini South in 2013. GPI was commissioned during 2013B and 2014A and began routine science operations as part of the 2014B semester. Before GPI was completed, in 2011, Gemini Observatory made a call for campaign proposals requesting between 200 and 1000 queue hours of telescope time, with the Gemini Science Committee (GSC) recommending that the total allocation of GPI Campaign Science not exceeding 1400 hours. As part of this Gemini Campaign Science call the GPIES survey of 890 hours was awarded in priority visitor mode. In addition to the large-scale exoplanet survey (GPIES), there have been two Large and Long Programs (LLP) which span multiple semesters, 90 accepted regular proposals, 8 Director's Discretionary Time, and 14 through Gemini's Fast Turnaround program. These proposals were from 58 unique principal investigators. Based on their titles, about half of the accepted programs are related to exoplanet detection and/or characterization, and one third are exploiting GPI's polarimetric capability to characterize circumstellar material around both young and more evolved stars. The remaining programs are focused on topics ranging from astrometric monitoring of young binaries to characterizing degenerate companions. Excluding time allocated for the GPIES campaign and the science verification programs, between the start of general science operations in 2014B and end of GPI's availability in 2020A, 848 hours have been queued to GPI observations resulting in an approximately even time award between GPIES and general observer proposals.

GPI has been scientifically productive with several high-impact results such as the discovery of 51 Eri b.[6] GPI observations have been used to constrain both the orbital parameters[7] and the atmospheric composition and fundamental properties[8] of the planet. GPI has been used to spectroscopically characterize previously known substellar companions.[9–15] The work of GPI 1.0 has resulted in 78 peer-reviewed articles by many users across the US and international partners. The papers produced by GPI have been cited 3287 times (an instrument h-index of 33).

One of GPI's major scientific goals was to measure the frequency of wide-orbit (10–100 au) massive (5–13 $\mathrm{M_{Jup}}$) planets. GPI measured this frequency to be $8.9^{+4.0}_{-3.6}\%$, for stars more massive than 1.5 $\mathrm{M_{\odot}}$.[16] The occurrence rate is strongly dependent on stellar mass, with all detected planet-hosting stars being above 1.5 $\mathrm{M_{\odot}}$. Combined with Doppler and microlensing rates, this indicates that systems with giant planets are rare—perhaps 0.25 such planets per Sun-like star, with a peak in the distribution near the snow line, ∼5-10 au. These results are most consistent with these wide-separation giant planets forming via core accretion, rather than gravitational instability. GPI's spectral and polarimetric capabilities have also been used to search for and characterize transition disks[17–21] and debris disks[22–24] around nearby young stars. These observations have been used to determine the geometry and composition of circumstellar disks[25] and postulate the presence of unseen planetary-mass companions based on asymmetries or structure resolved within the disk.[26,27]

3. NEXT GENERATION SCIENCE GOALS

In 2018, GPI was reviewed for a possible relocation from Gemini South to Gemini North.[28,29] At the time, GPI had been in operation since 2013 without any significant overhauls. Since GPI was originally designed to operate at Gemini North or Gemini South it satisfied all interface control specifications for both observatories and was expected to operate normally at Gemini North. The report also recommended that GPI undergo a significant inspection or overhaul in the next two to three years to ensure GPI up-time. It was recognized that any move from Chile to Hawaii would require significant disassembly of the instrument. The report recommended that the timing of a relocation to Gemini North be closely coordinated with the time period under which GPI would need to undergo major servicing. In 2017 and 2018 it was proposed by the instrument team investigating the relocation that this relocation and maintenance cycle would be an ideal time to improve the instrument with hardware upgrades to address the next generation of science requirements. To consider which components would be most valuable to upgrade, a series of science cases were evaluated in 2017 and 2018 as part of a process to decide prioritization of hardware upgrades in GPI. Requirements for hardware upgrades were derived from several proposed science cases. The key identified science areas were low-mass stars, young nearby stars, solar system objects, planet formation in disks, and planet variability.

3.1 Low Mass Stars

The census of low-mass stars within nearby, young moving groups has been greatly expanded with astrometric measurements from the Gaia data releases. These M-stars are ideal targets for direct imaging as the contrast between star and planet is reduced by a factor of between 100 and 1000 relative to planets around A-type stars. Although previous surveys have found evidence suggesting the planet occurrence scales with star mass, their sensitivity to close-in companions is limited. Combining an improved limiting magnitude with increased sensitivity at the closest separations would allow searches for planets close to these stars, complementing current RV surveys of older stars, and previous direct imaging surveys.

3.2 Imaging Exoplanets around Nearby Young Stars

51 Eridani b[6,8] is an example of an unambiguous detection of an exoplanet consistent with the predictions of a "cold-start" formation scenario. The planet lies at the sensitivity limit of GPI, with observations of 51 Eri b analogues only possible around ∼16 other stars in the GPIES survey. For GPI 2.0, a major goal is to improve on the constraints of the distribution of giant planets as a function of semi-major axis, and to differentiate between the two canonical planet formation processes; the low-entropy "cold-start" models[30] and the high-entropy "hot-start" models.[31] "Cold-start" evolutionary models predict a similar luminosity for exoplanets of 2-13 $\mathrm{M_{Jup}}$ and between 10-100 Myrs. This degeneracy exists at the youngest ages, after which the lowest-mass planets cool more rapidly to match the predictions of the "hot-start" formation models. Models suggest that a modest increase in contrast of 1-2 magnitudes would lead to a significant increase in the area of the mass/semi-major axis phase space that GPI could probe. As seen in Figure 2, while cold start models predict low-luminosity planets, the overlap of models at $\sim 2 \times 10^{-6} \mathrm{L}_\odot$ means a small increase in achieved contrast around a young star will rapidly switch from no sensitivity to cold start planets to being sensitive to cold start planets between 2 and 10 M_{Jup}. This is a stark difference from hot-start planets, where luminosity increases gradually and monotonically with mass.

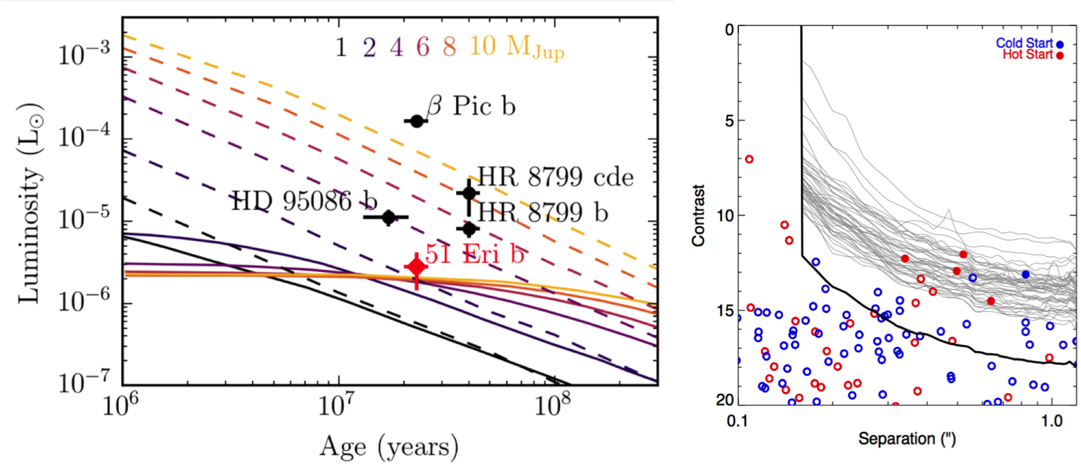

Figure 2: **Left:** Hot-start (dashed) vs cold-start evolutionary models for 1-10M_j with age vs luminosity.[30] Several known planets are indicated. **Right:** In gray are typical GPI contrast curves with the present instrument. In black is a prediction of improving GPI's contrast by 3.2 magnitudes. The planet population is modeled using a distribution of planets consistent with radial velocity and direct imaging surveys. Filled circles represent planets that could be detected with the current observations, open circles would fall below the contrast curve for their particular host star.

Additionally, increasing the contrast will allow for searches for higher-mass planets around stars that are somewhat older (300-500 Myr) but that are significantly closer to the Sun (20-30 pc). The proximity of these stars will allow an upgraded GPI to probe separations that are consistent with the location of the peak of the occurrence rate distribution as measured for Solar-type stars from previous radial velocity (RV) surveys,[32] allowing for better constraints on the separation distribution of giant planets and providing further insight into the evolution and atmospheric properties of these objects as they radiate away their formative heat.

3.3 Probing planet formation in disks

The relocation of GPI from Gemini South to Gemini North changes the young moving groups GPI has access to. For example, Upper Scorpius (Upper Sco) and Taurus both host numerous young, bright, nearby stars. With the improved performance of an upgraded AO system on faint stars plus new coronagraphs that enable probes of the tightest inner working angles, surveys of these two regions could reveal a number of newly formed planets that can shed light on the distribution and atmospheric properties of targets shortly after formation. By identifying these sources and comparing their demographics with those of the adolescent planets probed by current direct imaging surveys, we can constrain important processes that occur in the early lifetimes of planets, such as migration timescales or atmospheric chemistry evolution. Due to the distance to these targets, GPI will not be sensitive to the closest regions to the star. However, given the youth of these sources, GPI will be broadly sensitive to a range of hot-start planet masses. Figure 3 shows GPI's expected performance on two example targets at 145 pc in Upper Sco and Taurus, each of which have H=7.5 with I=7.5 and I=10.5, respectively.

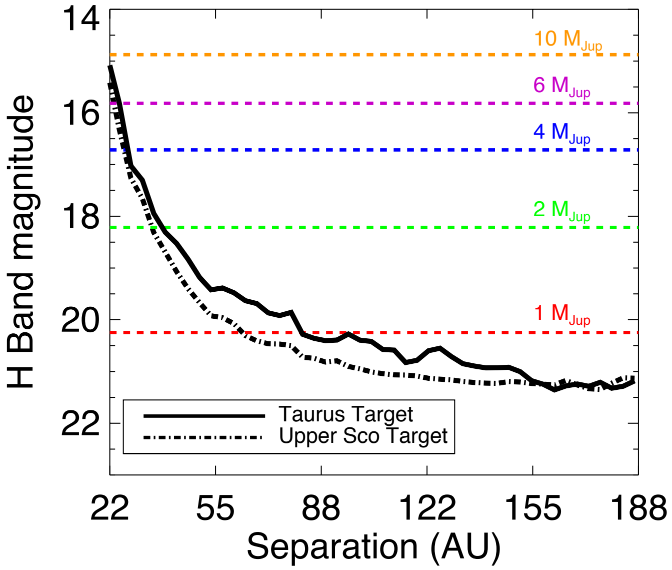

Figure 3: GPI 2.0 sensitivity predictions for very young planets in Upper Sco and Taurus. Contrast curves for two example targets with similar H-band magnitudes but different I band magnitudes are shown. These curves are based on predictions from current GPI performance. The predicted brightnesses of hot-start planets at these ages are shown as dashed colored lines. Note that we will be sensitive to planets as small as 4 M_{Jup} at all separations and down to 1 M_{Jup} at wider separations.

While surveying these sources for planetary companions, their disks can be probed in detail. There is a wide variety of planet formation science that can be explored by high contrast imaging of transition disks. Previous studies of transition disks have explored their morphologies, with a wide range of structures such as gaps or spirals thought to be caused by ongoing interactions with forming planets. To enable this science, GPI will require being able to operate on fainter stars with a goal of 14th magnitude. With an improved magnitude limit for GPI 2.0, a number of transition disk hosts become observable, allowing for a detailed study of a range of sources as a function of age and host star mass. This is particularly important for the transition disks in Taurus—the very youngest available to us, fainter and only accessible from the Northern hemisphere.

3.4 Asteroids & Solar System Objects

Asteroids in our solar system are metallic, rocky and icy objects ranging in size from a few meters to a few hundred kilometers. Characterizing physical properties would allow us to address entirely new questions regarding the earliest stages of planetesimal formation and their subsequent collisional and dynamical evolution. Operating GPI at a lower visible magnitude limit for its AO system while maintaining high contrast capabilities will allow expansion of the number of targets studied. If the GPI 2.0 AO system were able to achieve a limiting magnitude of V=14 then $\sim$ 1300 objects would be available for study.

3.5 Planet Variability

Current models of the characterization of exoplanets indicate the presence of both non-equilibrium chemistry and patchy clouds. As planets rotate, variable cloud cover induces modulation in the flux of a planet. This variability has been used to measure the rotation rates and study the atmospheres of free-floating planetary-mass bodies and brown dwarfs. Spectrophotometric monitoring can be used to probe different pressures within the photosphere to help characterize the bulk properties and vertical distribution of the clouds, with polarimetric measurements providing further constraints on their spatial distribution. In order to study this variability for a significant number of targets, it is estimated that GPI would need to improve its capabilities to achieve 1% photometric stability on the brightest targets.

4. GPI 2.0 INSTRUMENT UPGRADES

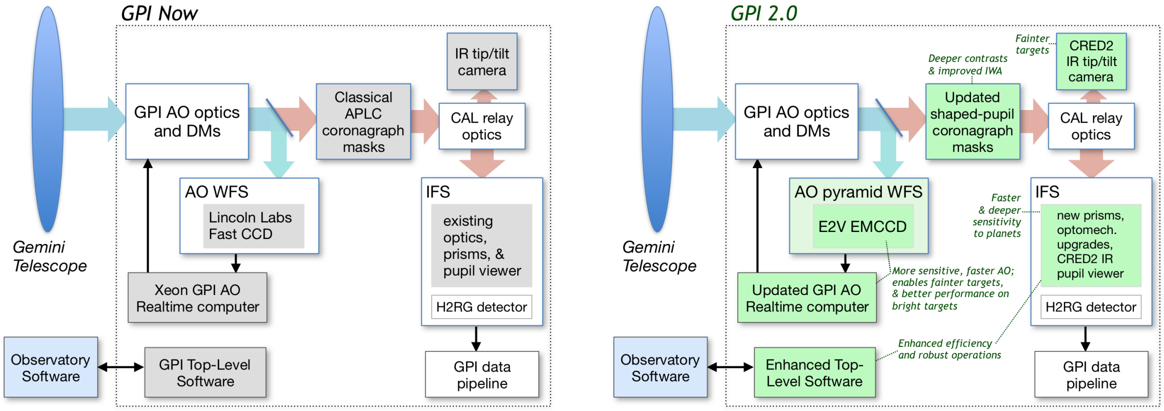

Figure 4: Schematic of GPI subsystems with the original as built system (**Left**) and the upgraded subsystems (**Right**)

4.1 AO Upgrade: Improving contrast and limiting magnitude

GPI 1.0's adaptive optics (AO) system used a spatially-filtered, Shack-Hartmann wavefront sensor (WFS), designed around a Lincoln Labs CCID-66 sensor, along with a CILAS 95-actuator piezoelectric deformable mirror (DM) and a Boston Micromachines 4096-actuator micro-electro-mechanical (MEMS) DM. The original GPI science case focused on observations of moderate-mass stars in nearby moving groups. The AO system was designed to with a limiting magnitude of $I = 9$, with a goal of $I = 10$ due to the brightness of the vast majority of the identified targets GPI would be interested in observing in these moving groups. Further, a conventional CCD detector was used rather than the novel (at the time) near-zero-noise EMCCD.

Many of the science cases for GPI 2.0 described in Section 3 require GPI to operate at a fainter magnitude of I=13-14. To meet this requirement GPI 2.0 will be removing the existing spatially-filtered, Shack-Hartmann wavefront sensor and replacing it with a pyramid WFS leveraging the existing design studies performed for NFIRAOS.[33] A pyramid WFS for GPI was simulated with PASSATA.[34] Simulations of a new PYWFS used existing knowledge of GPI's pupil, DM, and science operation goals to estimate performance and confirm that the system will meet requirements. Simulations showed that GPI 2.0 will be able to operate on stars between I=0 and I=14 with performance degrading gracefully for magnitude larger than I=13.[35] Simulations of End-to-End AO performance is estimated to produce a Strehl ratio in H-band of at least 0.9 until 12th magnitude and to continue to operate, albeit with decreased performance, past 14th magnitude. While the Gemini North M2 print-through[36] and the GPI MEMS DM dead and coupled actuators[37] will affect final GPI contrast and science performance, they do not inhibit the simulated operations of the new GPI Pyramid WFS provided appropriately applied mitigation strategies.

NRC Herzberg Astronomy and Astrophysics has designed the Pyramid WFS[33] and construction of the components is nearly complete. The construction, alignment and testing is being lead by the University of California, San Diego.[38] The optical leg of the AO system upgrade is being constructed as an independent sub-bench which can be installed onto GPI's existing optical bench. The upgraded design features four total mirrors, two of which are fold mirrors and two of which are field steering mirrors, one of which will also provide the pyramid's modulation. The upgraded AO system will operate at 2kHz and will incorporate NUVU's HNü 240 which uses an E2V CCD 220.[39] The choice to significantly reduce GPI 2.0's latency is driven by simulations showing GPI's performance vs latency which drives a requirement of 100 microseconds of latency from the RTC.[39, 40]

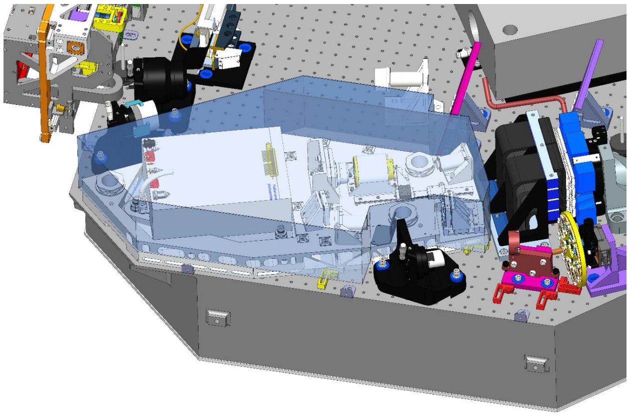

Figure 5: The layout of the upgraded Pyramid based AO bench.[33] Inside of the blue box is the location of the new AO sub-plate, new AO optical components, and PYWFS. Outside of the blue box is the existing GPI optical components which will remain.

4.2 Coronagraph Upgrade: Improving inner working angle and contrast

To obtain deeper contrasts, especially close to the star, and to improve performance on fainter stars GPI 2.0 will replace the existing apodized pupil Lyot coronagraph masks[41, 42] with a new generation of designs. This upgrade takes advantage of a decade of technology and concept development since the original GPI coronagraphs were designed. GPI currently uses a set of APLC masks designed to reach a raw contrast of 10^{-7} at 0.2 arcsec in 20% broadband light. A continuous prolate apodization was selected to optimize contrast and achieve quasi-achromatic solutions over the needed 20% bandpass.[43] However, because there was only a single degree of freedom in the definition of that apodizer, the raw performance was limited both in inner working angle (IWA) and contrast. Since that GPI coronagraph design circa 2008, the theory of APLC coronagraph design has considerably advanced, in particular to work with binary, shaped-pupil apodizations generated by full numerical optimization.[44–46] There are now solutions to produce extremely strong diffraction suppression, in broadband (18%), with relatively small inner working angle ($3\lambda/D$), and for complex telescopes including segmented pupils.[45] GPI 2.0 will retain the same focal plane masks as the original GPI but pair these with new pupil plane masks and lyot stops. The new apodizer and lyot mask combinations have been designed by Russel B. Makidon Optics Laboratory at the Space Telescope Science Institute.[47] All of the new designs have increased throughput, which will aid in fainter star operations. For example, using the existing design parameters for GPI[3] new, optimized designs were created that have a 76% transmition vs. the existing designs which only have a 46% transmission. Some of the designs have improved raw contrast at closer inner working angles at the cost of a smaller outer working angle.

4.3 CAL 2.0

The GPI CAL will be upgraded in two phases. The first is an upgrade to the low order WFS[48] to improve its operable range to fainter stars of an H-mag of 12 and to improve it accuracy and convergence time as part of improving GPI's efficiency on sky. The second phase of the upgrade is being carried out by NRC Herzberg Astronomy and Astrophysics (HAA). The NRC HAA research centre will replace the high-order WFS sub-system

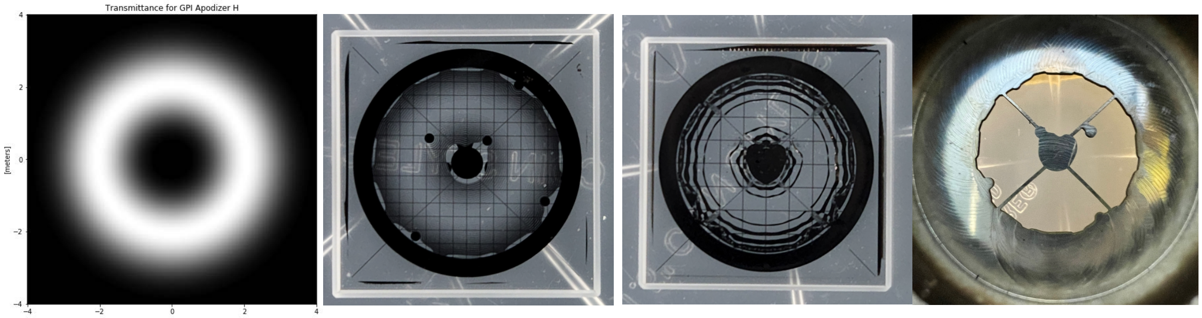

Figure 6: **Left:** GPI 1.0's H-band prolate apodization function. The throughput of this design is only 46%. **Center:** Two of the as built prototype apodizers for GPI 2.0 utilizing a generic design and a bounded outer working angle. These two designs have a significantly higher thoughput and lower contrast closer to the inner working angle. **Right:** A new Lyot stop matched to the new apodizers.

of GPI. Originally utilizing a dual-arm interferometer design, this system was implemented to measure and to correct for remaining uncorrected aberrations as seen on the science camera at a speed up to 100 Hz, but has never worked as intended due to vibrations. CAL 2.0's main focus is the Self Coherent Camera (SCC). The SCC uses a common-path interferometer design to enable focal plane wavefront sensing and control simply by acquiring science camera images showing fringes, which simultaneously allows (i) the measurement of the science focal plane electric field (a standard focal plane imaging science camera only measures intensity), and (ii) the removal of uncorrected stellar noise by post-processing and/or by a feedback loop to the adaptive optics (AO) deformable mirror. The design and overview of CAL 2.0 is discussed in depth in Marois et al.[49–52]

4.4 IFS Upgrade

The GPI IFS[4,5] is a cryogenic instrument sensitive from $0.95-2.4\ \mu$m that measures an image at multiple wavelengths simultaneously. The GPI 2.0 upgrade will modify the prisms inside of the IFS to enable new observing resolutions. We will add a new set of prisms to the IFS to enable a low-spectral-resolution observing mode ($R \sim 10$) and a higher resolution mode in line with GPI's original resolution but with a resolution more even across the filter bands. The design of these prisms, observing modes, and resolutions enabled by GPI are discussed in depth in Limbach et al.[54] and Peng et al.[48] GPI 2.0 will contain a low-resolution mode. This mode will operate from Y-K band simultaneously. The broad-band low-resolution mode is designed for searching for new and fainter planets to maximize observing efficiency. Additionally, the broader spectral range will provide increased leverage against calibration systematics and enable GPI to improve its photometric calibration between spectra. This is designed for searching for new and fainter planets to maximize observing efficiency. Secondly, the broader spectral range will provide increased leverage against several kinds of calibration systematics and enable GPI to improve its photometric calibration between spectra. Multiple different designs for prism combinations were considered, and a combination of N-SF66 and CaF_2 was ultimately chosen both for the low resolution prism set and for the replacement higher resolution individual filter band set.

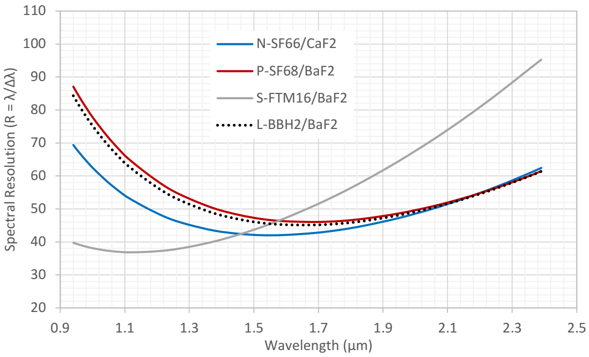

Figure 7: Spectral dispersion (for high resolution prisms) of P-SF68/BaF2, N-SF66/CaF2, L-BBH2/BaF2 and S-FTM16/BaF2. Higher spectral resolution is desired at shorter wavelengths in order to achieve equal spectral length in y, J, H and K band. P-SF68 and L-BBH2 (currently used in Subaru/CHARIS)[53] prisms provide near equal spectral lengths across all four bands. N-SF66 provides nearly equivalent performance but with improved manufacturability, and was ultimately chosen for the GPI upgrades. The S-FTM16/BaF2 prism was used in GPI 1.0.

In parallel with adding the low-resolution mode, the high resolution prisms will also be upgraded to enable all of K-band (2-2.4 micron) to be observed simultaneously, reducing the amount of telescope time needed to observe all of K-band by more than 50%. In the original GPI design, modeling showed $R > 40$ was needed for good temperature estimation from a single band. Given the prism materials available at the time, in order to obtain an $R\sim40$ in H-band, a higher resolution resulted in K-band and a lower in Y-band. Analysis using current model grids has shown that a lower resolution of around $R\sim10$ is sufficient combined with the wider spectral range to provide accurate temperature estimates and is useful in separating background objects, though the higher resolution set of prisms will likely be needed to help constrain gravity.[55]

4.5 GPI Operational & Usability Upgrade

While GPI's reliability has been extremely good, and GPI 1.0 was well integrated with Gemini South's computer systems, after several years of operations we have identified several improvements which could be made to make the entire system more robust and more operator friendly. Developing the observing checklist for GPI 1.0 resulted in approximately ten discrete user actions, depending upon the type of observations, that can be streamlined and reduced to one or two steps via software remediation. Additional error checking in the alignment and calibration process will reduce the number of steps and remove multiple human interventions required in the case of an alignment failure. Additionally, GPI 2.0 will involve an update of the open loop models which are used for internal alignment based upon temperature and telescope angle. Finally, GPI's high-level control library was implemented originally in Interactive Data Language (IDL). GPI 2.0 will port this library to the more modern language of Python to improve reliability of future instrument operations.

5. GPI UPGRADE STATUS

As of the Summer of 2022, GPI has shipped from Gemini South. As part of the process of shipping the instrument, a series of tests were preformed to evaluate the condition and to maintain a long term baseline and record of GPI's performance. These tests were originally part of the construction of GPI 1.0 and were preformed as part of the integration and testing of GPI 1.0 at the University of California Santa Cruz and at Gemini South after GPI was shipped, but before it was installed on the telescope. We preformed the same tests in 2021 at Gemini South to evaluate and verify its performance before shipping. GPI has currently shipped and in the late summer and early fall of 2022 the project will preform this standard set of tests before deconstructing the instrument at ND.[56]

When the GPI 2.0 upgrade was proposed, it was expected that GPI would continue science though the end of the 2020A semester and then in August and September of 2020 the instrument would be packed and shipped to the University of Notre Dame to be upgraded. Unfortunately, due to COVID-19 this packing and shipping process was delayed by about 2 years, with GPI arriving at the University of Notre Dame in June of 2022. The approximately two year delay, has resulted in an upgrade schedule which is also delayed by approximately two years. The project expects that the instrument will be available for shipping in the Fall of 2023 or Winter of 2024. Integration with the observatory is then expected to take six to nine months to complete.

6. CONCLUSION

While GPI was installed at Gemini South in 2013, many critical design decisions were made using the best available information in 2004. The technology and field of ExAO systems has greatly advanced in the intervening years. GPI is designed to be a robust and stable instrument enabling long term statistical studies. Since its construction, keeping in mind its science as a stable survey platform, GPI has not undergone any major hardware changes to the instrument. Using the results of the previous decade from multiple large scale surveys, and in-order to stay competitive with cutting edge instruments today, GPI is undertaking a significant upgrade to pursue a science driven upgrade of its hardware. This will accompany a move from Gemini South to Gemini North. These hardware changes and upgrade GPI to enable cutting edge science using GPI from Gemini North for many years.

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