

Project Name:		
LGS + PWFS1 Upgrades Project		
Business objective served by this project		
Upgrades to PWFS1 to support near 100% sky coverage with TTF for LGS with Altair at Gemini North		
Project Manager/Leader:	Project Sponsor:	PDS Version/Date:
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## Project Description

### Issue Statement:

The current operational mode of Gemini North's Laser Guide Star Adaptive Optics system is severely restricted by the field of view of the TT guider, STRAP. This means that Altair in LGS mode does not provide full sky coverage for prospective PIs, especially with targets far from the Galactic Plane where it quickly falls to under 20%. Initial on-sky measurements and modeling suggest that the proposed upgrade would result in an average FWHM of ~0.2" over almost the entire sky, effectively eliminating this shortcoming of our system, but with reduced resolution which is well matched for NIFS observations.

### Project Objective Statement (POS):

This project proposes to upgrade the following components and software of PWFS1 and Altair to achieve ~ 100% sky coverage with modest resources. The project will end with the commissioning and science verification of a new mode combining the two. The following is a top-level view of the proposed upgrades :

- Installation of a Sodium Notch filter into the filter wheel of PWFS1 (removing TBD filter)
- Installation of a 2x2 Shack-Hartmann wavefront sensor, replacing the 6x6 SH. This will be similar to the one used in PWFS2.
- Commissioning of the 50-500Hz setting for the bandwidth of the low pass filter for WFS -> Altair TT mirror corrections (previously only used with low bandwidth setting for NIFS OIWFS flexure corrections). Small modifications may also be needed to change the source of the corrections to PWFS1.
- Software modifications to provide a pathway for PWFS1 focus corrections to the LGS zoom, modifications of runtime parameters such as gains/rotation/etc., support for switching between PWFS1 and STRAP.
- Changes to High-level(OT/TCC) software to support this mode for Queue operations.
- Modifications to PWFS1 DC code to provide algorithm support for the 2 x 2 lenslet array. Also similar to the code used for PWFS2.
- A proposed non-essential upgrade of re-coating the PWFS1 fold mirror, will be pursued in parallel. This will give us an estimated 10% increase in reflectivity in this mirror.
- A separate ongoing project of addressing PWFS1 noise issues, will be pursued in parallel.

### Project Flexibility:

Flexibility Matrix	Least Flexible	Moderately Flexible	Most Flexible
Scope		X	
Schedule			X
Resources	X		

### Major Deliverables:

- An aligned, upgraded PWFS1 with a 2 x 2 SH WFS, and Sodium Notch filter, reinstalled in the telescope and verified, with upgraded software that allows the new PWFS1 to be used in conjunction with Altair in LGS mode to achieve near 100% sky coverage.
- A system that is fully characterized (magnitude limit, PSF, TT performance,...) and documented for future reference.
- Operational documentation and Training provided during the transition/commissioning period for the science staff on how to use this newly developed mode.

## Assumptions:

- Resources assigned from Eng, Science, and Dev groups to the project will be entered in PI and committed to.
- Gemini ADs will continue to support the goals, resource and cost allocation of this upgrade
- Initial work to define the project, investigate the feasibility, and estimate cost has eliminated much of the risks involved.
- PWFS1 in its current state can be used to tune M1 in the absence of Altair. The HRWFS could be used in its place but with lower efficiency.

## IS and IS NOT:

- **IS:** Full upgrade of the PWFS1 + Altair system to support this mode.
- **IS:** A selective and conscious reduction in the functionality of PWFS1. It will no longer be a tuning backup for Altair, and we will remove a rarely used filter(TBD) for the notch filter.
- **IS:** A demonstration of equivalent functionality required from the new A&G project.
- **IS NOT:** A patchwork prototype that only proves the implementation is possible.
- **IS NOT:** The primary project of any of the resources (including core team members), and will need to be balanced with other observatory responsibilities.

## Strategy and Resources

### Milestones and Stages:

- Stage I – Exploratory research and Concept stages
  - Kick off meeting to introduce team members and validate roles and responsibilities.
  - Initial Testing on-sky to develop confidence in the upgrade and to identify early problems.

***The Above two bullet points were completed as a part of SCI10-301, and the following are tasks that are upcoming work for this project which will rollover into 2011.***

  - Publish detailed project plan in PI, including estimates of FTEs required from each of the groups involved.
  - Receipt of project approval from Band 1 Projects Change Control Board.
  - Complete documentation of PWFS1 + LGS software requirements document
  - Draft Specs for Lenslet array and Sodium Notch filter
- Stage II – Development Stage (Project Implementation and V&V/I&T)
  - Finalize Lenslet Array Spec and procure
  - Finalize Sodium Notch filter Spec and procure
  - Finalize low and high level software Requirements, Verifications, and Resources, and begin implementation
  - Follow installation and alignment plan for the two components in PWFS1 (*Goal: January Shutdown*)
  - Lab Verification of the PWFS1 components (*Goal: January shutdown*)

***In order to meet the January shutdown goal, engineering resources will need to be made available for the specification of the sodium notch filter, the lenslet array, and the software upgrades. If this is not possible in 2010 then everything must slip by six months and into the July shutdown.***

  - Planning and documenting of the Operational and Support Stage Deliverables
  - Installation of PWFS1 module back into telescope
  - On-Sky V&V/Commissioning of system including Altair and Science staff training
  - On-Sky SV of system using shared risk observations
  - Project completion (Transition to Operational Stage/nighttime ops)
  - Successful completion of the project is determined by the performance of the upgrade in terms of delivered image FWHM and ease of operation for the SSA and observer.

### Estimated Costs:

- Lenslet Array – ~\$2000
- Sodium Notch filter – ~\$5000
- Resources – See PI plan for resource cost
- Spares - Possibly acquire 2x the entire order to either be used as a spare or to upgrade the GS system at a later date.

### Core Team Members(see Guidelines for Developing New Projects document):

- Julian Christou- Project Manager and Project Scientist
- Brian Walls- Systems Engineer

### Extended Core Team Members:

- Altair Team (Chad T., Richard M., Andy S.) – V&V, Commissioning and SV
- SSA(TBD) – Validation of Software Requirements, System V&V, and General support
- Gelys T. – Systems Engineering Support and Preparations starting a similar project for GS
- Mattieu Bec – Complete and Package already developed code for this project and train Angelic in its usage.
- Angelic Ebbers – Installation and modifications needed to the software package to support this upgrade
- Richard Oram – Lead Optical Engineer in charge of specing the optical elements and supporting the installation and alignment of the PWFS1 system.
- Maxime B. – Support for specing the optical elements
- John W. – Support for installation of physical upgrades

### Dependencies that require coordination:

- PWFS1 must be out of telescope for installation of lenslet array, notch filter, and alignment for an extended time. DONE (removed from the telescope during the July shutdown, and replaced by the dummy PWFS1 module.

### Risks and Issues:

- Resources assigned to project will be reassigned to other higher priority tasks (especially for core team members).
- Upper management redefines observatory projects and cancels project mid-stream.
- Small risk in parallel projects (pickoff re-coating) delaying alignment and subsequent installation on telescope. Contingency – Continuously monitor and halt parallel projects before they can affect schedule
- Project relies on untested software features (**200-500Hz setting for the bandwidth of the low pass filter for WFS -> Altair TT mirror corrections**), that have been present for many years. Expertise in these areas may be lacking, and we will need to relearn the algorithmic intended use and operation.
- Full understanding of the trade between elongation due to Atmospheric diffraction and notch filter cost need to be closely examined/modeled before final spec is issued.
- Sufficient on-sky engineering time is needed to test these upgrades.

### Supplemental Resources:

- Science Case: **Laser Guide Star Adaptive Optics with Peripheral Tip-Tilt tracking**; *Julian Christou, Dolores Coulson, Richard McDermid, Gelys Trancho, Chad Trujillo, Brian Walls*
- Initial Feasibility Document: **Feasibility study of Altair LGS PWFS1 upgrade**; *Gelys Trancho, Brian Walls, Julian Christou, Chad Trujillo, Richard McDermid, Matthieu Bec, Jesse Ball, Dolores Coulson*
- Project Structure: **Guidelines for Developing New Projects**; *Stephen Goodsell*
- Software Requirements Specification: *TBA*
- *PI Project*: *TBA*
- DMT Documentation Archive: *TBA*