WFS Preliminary design phase report I

V. Velur, J. Bell, A. Moore, C. Neyman

Design Meeting (Team meeting #10)

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Agenda

- WBS definition
- Assumptions and parameters for different WFS
- Work products
- Time allocation

WBS definition

(Initially allocated: 240 hrs Estimated: 326 hrs.)

- Develop a design concept for each of the required NGAO wavefront sensors:
- 3.2.3.5.1 High Order LGS Wavefront Sensors: Given the functional and performance requirements, develop a design concept for the laser guide star high order wavefront sensors. Take into consideration the possible need for both open and closed loop wavefront sensing.
- 3.2.3.5.2 High Order NGS Wavefront Sensor: Given the functional and performance requirements, develop a design concept for the natural guide star high order wavefront sensor(s). Take into consideration the possible need for both open and closed loop wavefront sensing. Include consideration of ADC packaging (ADC design is covered in WBS 3.2.3.8).
- 3.2.3.5.3 Low Order NGS Wavefront Sensors: Given the functional and performance requirements, develop a design concept for the low order natural guide star wavefront sensors for the purpose of determining tip/tilt and other low order modes in laser guide star observing mode. Take into consideration the possible need for both open and closed loop wavefront sensing. Include consideration of ADC packaging (ADC design is covered in WBS 3.2.3.8).
- 3.2.3.5.4 Calibration Wavefront Sensor: Given the functional and performance requirements, develop a design concept for the calibration wavefront sensor which will use natural guide star light as a truth wavefront. This sensor will be periodically used to reset the references of the high order wavefront sensors in laser guide star mode. Include consideration of ADC packaging (ADC design is covered in WBS 3.2.3.8).

WFS design input parameters

WFS type	Location	Sensing band	Input PS (um/")	# of sub-apertures	Detector PS("/pixel)	Detector	Comments
NGS HOWFS	near NF sci.	g', r', i'	2254.383617	32x32, 64x64	1.5	CCID56	Steering mirrors for OSM
LGS HOWFS	after WF relay	589 nm	727.2205217	16x16, 32x32, 64x64	1.45	CCID56	Has to track Na layer, tilted focal plane, field dependent aberrations. Steering mirrors for OSM
TT	inside d-NIRI	J, H	727.2205217	1x1	0.030150754	PICNIC	will use d-NIRI OSM
TTFA	inside d-NIRI	J, H	727.2205217	2x2	0.030150754	PICNIC	will use d-NIRI OSM
Truth sensor	near NF sci.	g', r', i'	2254.383617	5x5	1.6	CCID56	do we need two (one at d-NIRI ?) OSM can be steering mirrors for the NF one, and d-NIRI default OSM for truth sensor at the d-NIRI channel

Assumptions:	
1	TT(FA) sensor shall guide only on point sources
2	32x32 NGS case: Planetary sources between 7-10 mag.
3	16x16 and 32x32 for LGS is for a de-scope option
4	Truth sensor works on a 21st mag. Star with 21 maSec (1D) jitter with 0.6" spot at 1 Hz

Justification for certain parameter choices

- Spot size at WFS governs the plate scale at detector. The spot sizes are based on error budget spreadsheet and accounts for the following effects:
  - No uplink correction
  - Finite spot size due to aberrations in the uplink beam (for LGS WFS)
  - Residual seeing in uplink beam (for LGS WFS)
  - Natural seeing at GS wavelength on downlink (for all WFS)
  - Elongation due to location of LLT (averaged for LGS).
  - Extended object guiding (for TWFS and NGS WFS)
  - For TWFS we assume that star is about 15” off-axis
- We will use f/46.5 for calculating plate scale at NF relay focal plane.
- NGS WFS needs to guide on slightly extended objects so its FoV is larger than the LGS WFS.
- All WFS are SHWFS.

Technical Challenges

- OSM details have to be figured out for each WFS
- It is a hard problem to package 9 LGS WFSs with:
  - 5 beacons that lie on a circle with variable radius (focal spots radius varying from 7 mm-146mm)
  - 3 roving beacons that go anywhere.
  - Individual translation stages to account for LGS focal plane with variable tilt.
  - Combination of doublet and one focusing lens to keep the pupil at the lenslet for a Na-layer object distance that varies from 90Km-180Km.Should we do this at all (refer to Brian's note).
  - The WFS has to move to account for the Na-layer distance varying with zenith angle.
  - Motion control: 1 lens 1D(T), each LGS WFS 1D(T), whole LGSWFS package 1D(T), radial in-out for each (but central) WFS 1D (T). OSM (field steering mirrors? 2x2D (tilt)), mechanism to pick off roving beacons! [(T)- translation]
  - Shearing spherical plates to create correct coma (do these just need to shear or rotate and sheer?)
- Switching lenslets/ relay optics to allow for multiple pupil sampling scales
- The question of on-axis (bright) TT star for guiding?
- IR sensors:
  - FoV vs. sky (DO we need to guide on extended sources?
  - OSM, optical design, ME design and packaging strongly dependent on d-NIRI progress.
  - TT WFS channels shall have individual MEMS DMs (1/2") to sharper TT stars.
- LGS WFSs will have a 1/2" pupil mirror in the design that can be replaced by a MEMS DM at a later stage.

Deliverables

- First order optical design
- Zemax design of each type of WFS (no tolerancing, commercial optics/ lenslets, not optimized for wavelength, no transmission budget)
- First order Mechanical packaging
- Design for a generic spatial filter/ adjustable field stop that can be used for all WFS's
- Preliminary mechanical design and 3D model (at least a cartoon showing the envelopes occupied by the WFSs.
- Acceptance and completeness of the design effort w/ information on what needs to be done during the detailed design phase.
- Preliminary costing
- Documentation for all the above.

Estimated of time required to complete task

Task	LGS HOWFS	NGS HOWFS	TT(FA)	TWFS/ Calibration	Total
First order design	16	8	12	8	**44**
Preliminary Zemax model	40	20	10	16	**86**
Mini-review of above					**16**
First order Mechanical packaging	8	4	16	4	**32**
Preliminary mechanical design and 3D model	16	12	24	16	**68**
~~**Design for a generic spatial filter/ adjustable field stop**~~					~~**20**~~
Last meeting to understand risks and look at the acceptance					**40**
Documentation of design and risks					**20**
Costing					**20**
Grand total					**326**