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Characterization of Atmospheric Properties with the Rubin Auxiliary Telescope

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ABSTRACT

This is the abstract.

1. INTRODUCTION

- Discuss how atmosphere affects photometry, systematic errors result most strongly due to water, but also O2, O3 and aerosols
- Strongly affects supernovae cosmology but also galaxy colors etc (Li et al. 2016)
- Analogous strategy was used for DES (Li et al. 2014)
- Meeting photometric accuracy requirements mean correction for these errors, requires measurements being made at the same time as LSST observes, ideally along the same line of sight
- Can keep up with main telescope so need different strategy, which means understanding atmospheric transmission temporal and spatial structure functions
- Discuss how these functions will dictate how the AuxTel will move in coordination with LSST.
- A scheduler for the AuxTel will then operate in tandem with the main telescope position/schedule (Jones 2020) to maximize observing efficiency whilst minimizing systematics.

2. RUBIN AUXILIARY TELESCOPE

- Previously known as the Calypso Telescope on Kitt Peak
- Underwent major refurbishment by ACE, optics and most mechanical aspects remain the same
- Electronics all replaced. New Heindeinhein ring encoders installed on all axes, each with three read heads
- New top end with PI H-824 Hexapod installed.

- Changed mirror cover to use a 4-petal design
- Now located on Calibration hill in 2 story building. Grating floor used to assist airflow.
- Using a 30ft ash-dome with 4 motors, all 30-phase
- using 4 vent gates, two of which have fans to increase airflow in low-wind conditions
- slew speeds max out at 2 degrees per second (for now), short slew-settle is 7s therefore slightly slower than main telescope. This affects observation strategy. Big slews are much slower.

3. LATISS INSTRUMENT DESCRIPTION

- Instrument designed to minimize systematic error in measurements, not optimized for throughput. Designed for use with Ronchi grating (no 2nd order contamination)
- Opted to use a LSST sensor and build a pathfinder instrument for the survey (single CCD but driven by CCS)
- Kept as similiar to LSST camera/ComCam as possible
- results in 2x oversampling but allows the full wavelength range of LSST. Using a focal reducer possible but would have made instrument very compact and increased complexity.
- two wheels, one fixed in translation (filters), wheel holding gratings on a translation stage. Useful for changing spectral resolution from Ronchi gratings.
- Have good and poor seeing modes, R$\sim$120 is required to pull out water vapour with sufficient accuracy
- Camera built at Harvard uses ITL chip controlled by a WREB (REBs were not built yet). Cooled to -100 using Polycold chiller.
- Camera electronics mounted externally to dewar, therefore not under vacuum nor temperature controlled. Expectation of possible gain changing, but measured values show it's very minor (and degenerate with clouds).
- Cable wrap driven by the rotator itself to minimize complexity.
- Camera readout and image handling utilizes a subset of camera hardware and majority of camera software.
- Utilizes header service. Control software used as pathfinder for main telescope (Jones 2020)
- Driven by same scriptQueue and has a scheduler

4. OUTLINE OF DATA REDUCTION/ANALYSIS AND HOW ATMOSPHERE PARAMETERS ARE DESCRIBED

Data reduction to be written/described by Merlin/Jeremy. They will provide a description of this area shortly.

5. TARGET SELECTION AND INSTRUMENT CONFIGURATION(S)

- Targets are pre-selected to avoid crowding and any other possible background contamination
- Discussion of stellar type preferences
- Discussion of available targets in the required magnitude range as a function of sky position
- Discussion of instrument configuration, and how observations need to adapt in inclement weather

6. A SURVEY TO MEASURE OF THE SPATIAL AND TEMPORAL STRUCTURE FUNCTION OF THE ATMOSPHERE ABOVE EL PENON

- Survey conducted to measure and monitor temporal and spatial structure functions
- Chose series of well characterized standards as stars
- monitored set of X stars through the night as they changed in airmass
- Telescope sampled at different cadences, sometimes short and nearby, others accross the sky
- Goal was to determine if coordination of main and auxTel positions are critical or if independent operation is acceptable (more like what atmCam does)

7. RESULTS OF STRUCTURE FUNCTION SURVEY

TBD

8. AUXTEL SCHEDULED OBSERVING DURING THE SURVEY

8.1. *AuxTel Scheduler*

- AuxTel scheduler uses same code as main scheduler, but only a single science case
- Critical inputs to AuxTel Scheduler that differ from the main scheduler are seeing, and main telescope position. Seeing affects spectral resolution.
- clouds and seeing affect required exposure time
- Targets are from the list in section 5

8.2. *Observing Strategy during the Survey*

- Discuss how AuxTel Scheduler uses information from the structure functions to inform observing pattern
- Discuss interactions between Main telescope position and how it affects AuxTel position
- Discuss how observing strategy or instrument setup changes depending on conditions

APPENDIX

A. REFERENCES

REFERENCES

Jones, L. 2020, The LSST Scheduler Overview and Performance

Li, T., DePoy, D. L., Marshall, J. L., et al. 2014, Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, Vol. 9147, Monitoring the atmospheric throughput at Cerro Tololo Inter-American Observatory with aTmCam, 91476Z

Li, T. S., DePoy, D. L., Marshall, J. L., et al. 2016, AJ, 151, 157

B. ACRONYMS

Acronym	Description
CCD	Charge-Coupled Device
CCS	Camera Control System
ComCam	The commissioning camera is a single-raft, 9-CCD camera that will be installed in LSST during commissioning, before the final camera is ready.
DES	Dark Energy Survey
LATISS	LSST Atmospheric Transmission Imager and Slitless Spectrograph
LSST	Legacy Survey of Space and Time (formerly Large Synoptic Survey Telescope)
PI	Principle Investigator
PSTN	Project Science Technical Note
TBD	To Be Defined (Determined)