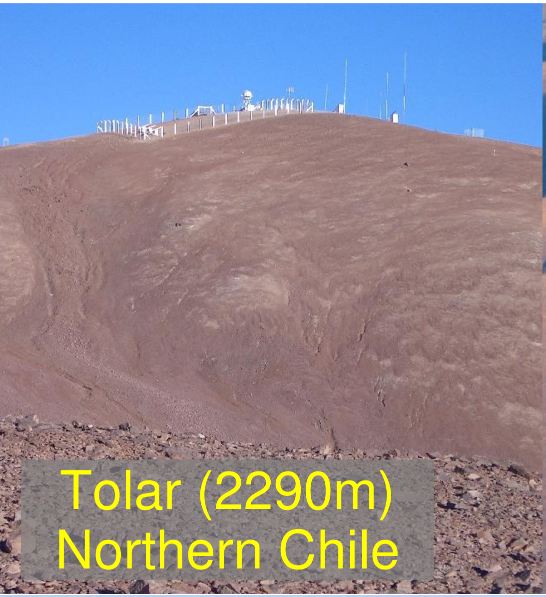
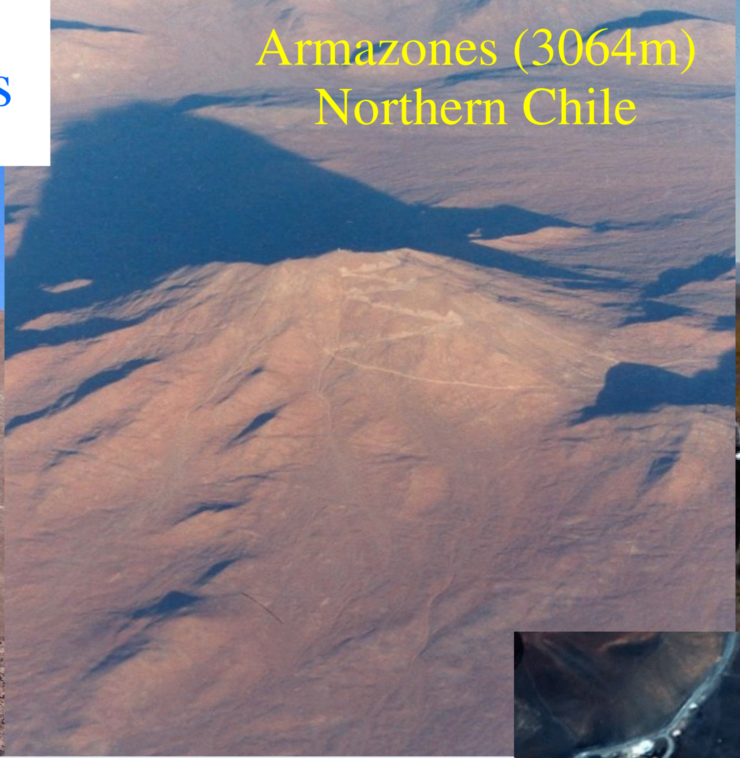
Characterizing the TMT Site Selection Equipment

Matthias Schöck
for the TMT Site Selection Team

Symposium on Seeing
Kona – March 20, 2007

The Candidate Sites





The Instruments

TMT Site Selection Basics
Results Verifications

- Principles of TMT site characterization
  - Comparison of candidate sites with identical equipment
  - Results not useful unless we know the errors bars
  - Instruments need to be calibrated by comparison with each other and, if possible, with other instruments
- Computation Fluid Dynamics (CFD) modelling
  - See talk by Konstantinos Vogiatzis
- Cloud cover and PWV analysis
  - D. André Erasmus satellite studies; results verification and longer temporal baseline

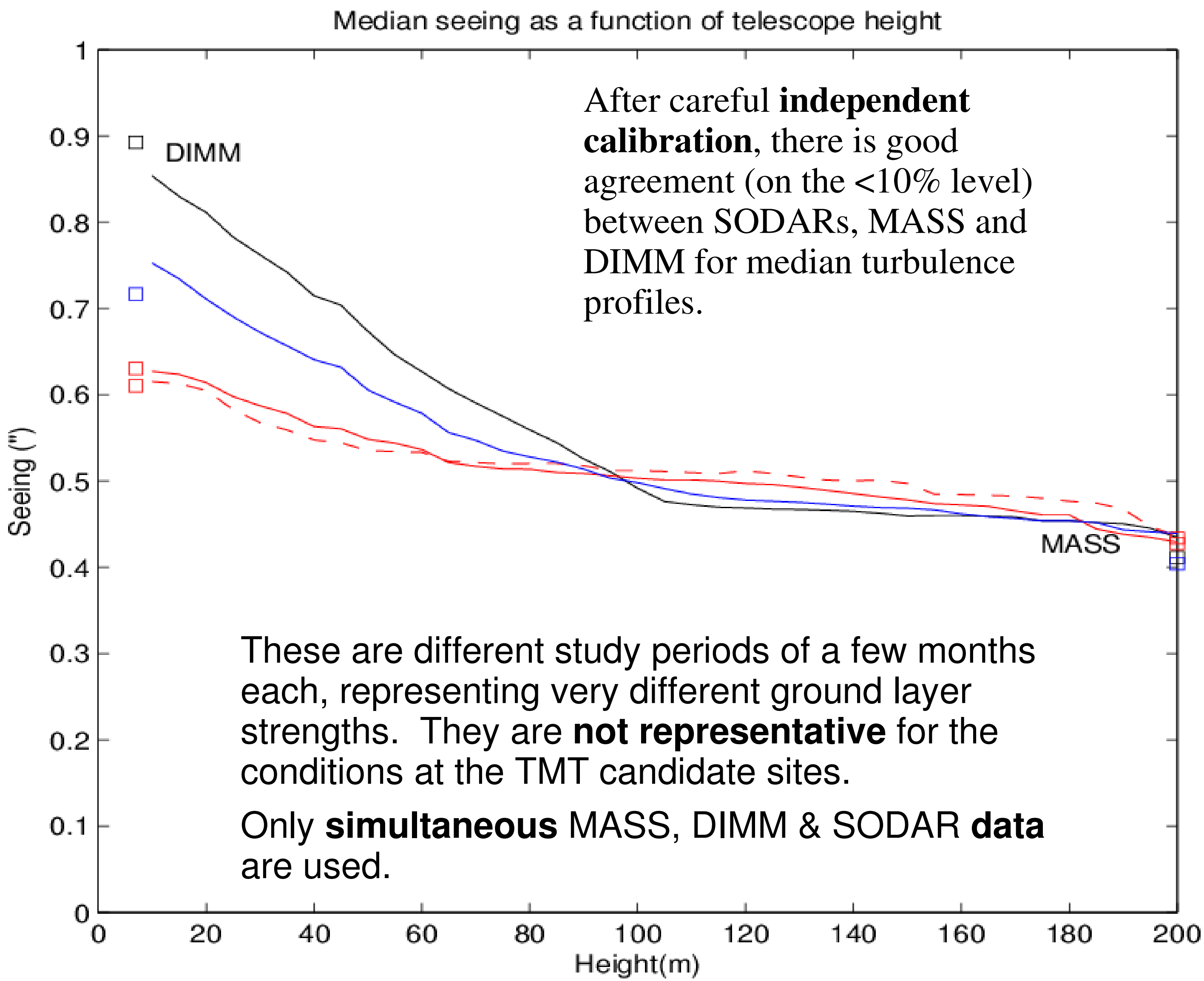
TMT
THIRTY METER TELESCOPE

Instrument Calibrations
Turbulence Instruments

	Relative Error	Absolute Accuracy	Comments
DIMM (see presentation by Warren Skidmore)			
Seeing	0.02”	similar	
Isoplanatic angle	---	---	Used for verification of MASS only
Coherence time	---	---	Currently not implemented
MASS (see presentation by Sebastian Els)			
Free-atm. seeing	0.05”	similar	Dominated by low layer precision
Indiv. layer seeing	<0.1”	<0.1”	
Isoplanatic angle	0.01”	<0.2”	
Coherence time	≈20%	≈20%	Estimate of MASS team (not yet implemented)
Transparency	<0.1mag	<0.1mag	
SODARs			
Ground layer seeing	10%	10%	
Individual layer seeing	depends on conditions		Structures, noise sources cause problems
Wind profiles	20%	20%	
Sonic anemometers			
Turbulence strength	tbd	tbd	
Wind speed	<15%	<15%	
Wind direction	few deg	few deg	Dominated by setup precision
Sonic temperature	<2° K	<2° K	Offsets between instruments exist

Note: Error bars given are on the statistical properties, not individual data points.

Example: DIMM / MASS and SODAR
Turbulence Profile Comparison



After careful **independent calibration**, there is good agreement (on the <10% level) between SODARs, MASS and DIMM for median turbulence profiles.

These are different study periods of a few months each, representing very different ground layer strengths. They are **not representative** for the conditions at the TMT candidate sites.

Only **simultaneous** MASS, DIMM & SODAR **data** are used.

Instrument Calibrations
Other Instruments

	Relative Error	Absolute Accuracy	Comments
Weather stations			
Wind speed	<15%	<15%	
Wind direction	few deg	few deg	Dominated by setup precision
Temperature	<0.1° K	<0.1° K	Requires some care to get this accuracy
Humidity	<5%	<5%	
Pressure	5 hPa	5 hPa	
Solar irradiance	n/a	n/a	
Precipitation	n/a	n/a	
Heat flux	5%	5%	
Net radiation	3%	3%	
IRMA PWV radiometer			
PWV		?	Accuracy depends on atmospheric model
Dust sensor			
Particle count	10%	n/a	
All-sky camera			
Cloud cover	2%	2%	
Transparency	?	?	Under investigation
Light pollution	?	?	Under investigation
Sky brightness	?	?	Under investigation

Example: SODAR Calibration

- Combined SFAS-XFAS profiles can be compared with GL turbulence obtained from DIMM and MASS. Such comparisons quantify the relative error of the SODAR data and the noise level.
- Successful identification and removal of white noise in the SODAR data.
- Generally, agreement within 10 – 20 % between the instruments. But : problems at sites with structures, trees, etc.