Element of Astronomical Site Survey

DIMM Seeing Monitors at IAO Hanle

A Presentation Series for the IAO Engineers

May 25, 2021

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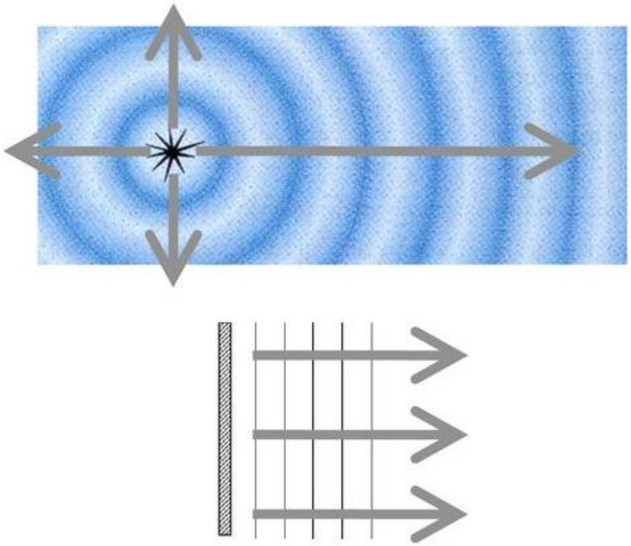
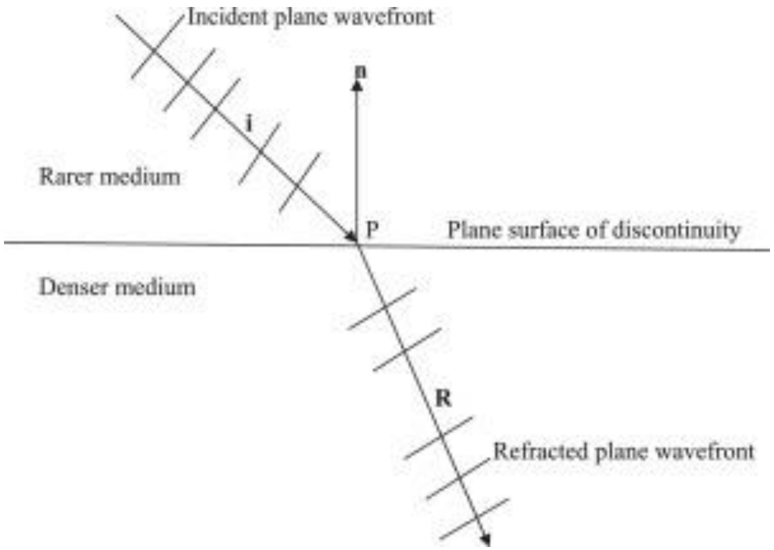
Outline

- Physical Optics
- Atmospheric Seeing
- DIMM seeing Monitor: Basic principle
- Old HCT DIMM Seeing monitor
- New DIMM for the NLOT project
- Chinese effort to search for new sites
- Need to run a campaign to explore seeing in Ladhak

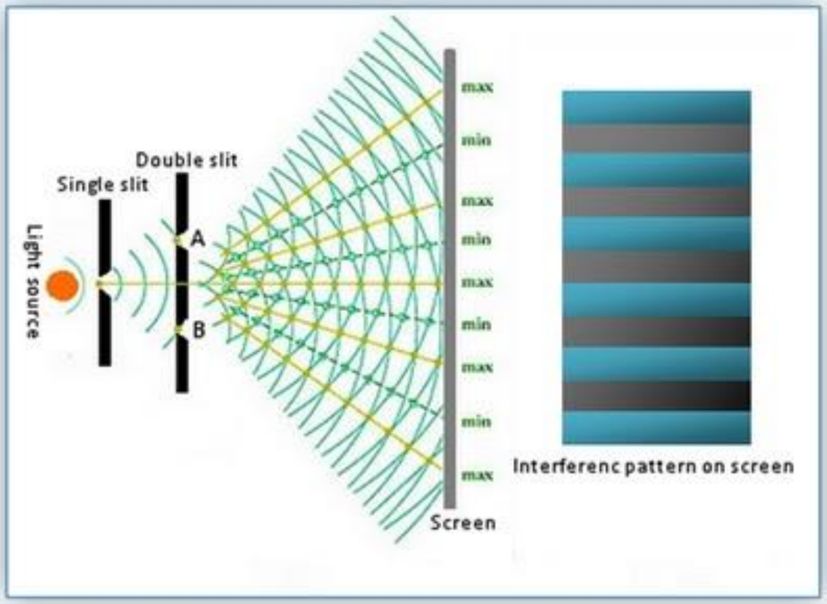
The Physical Optics





The Physical Optics

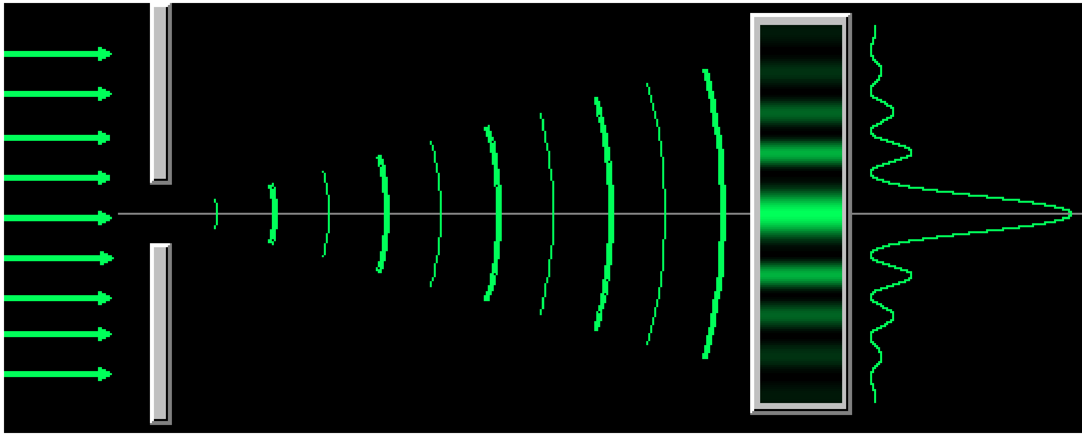
Interference

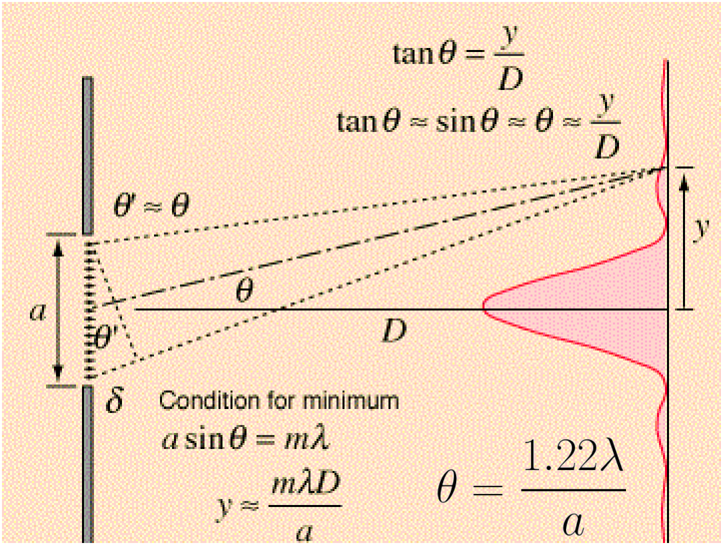


$$y_1 = a_1 \sin(wt)$$
$$y_2 = a_2 \sin(wt + \emptyset)$$
$$y = y_1 + y_2$$
$$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos(\phi)$$

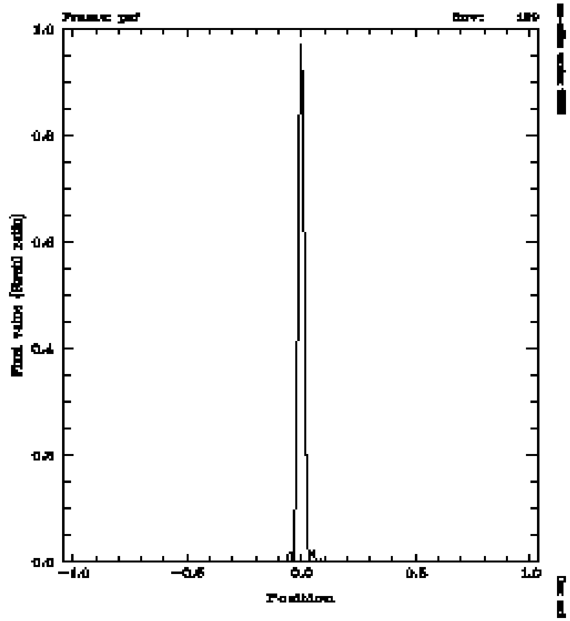
I are Intensities & ϕ is the phase

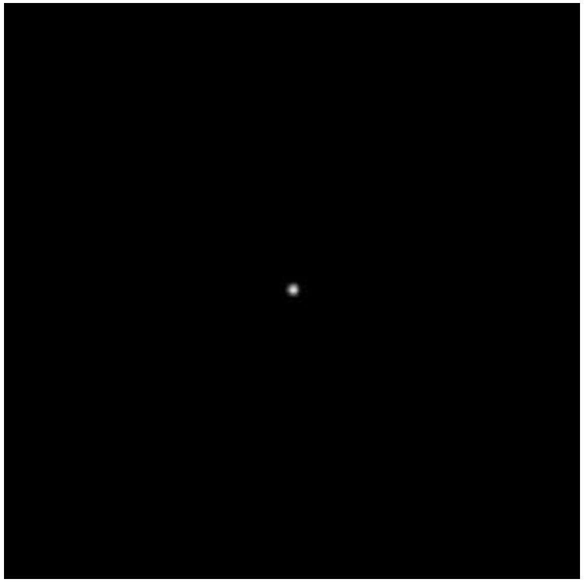
Diffraction





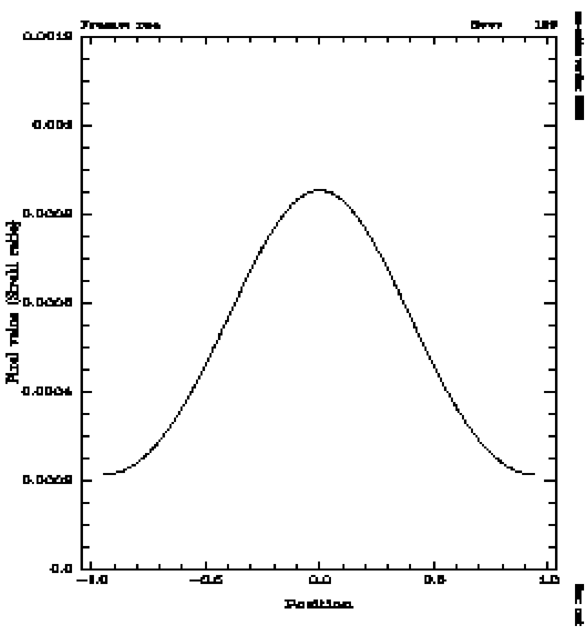
Atmospheric Seeing

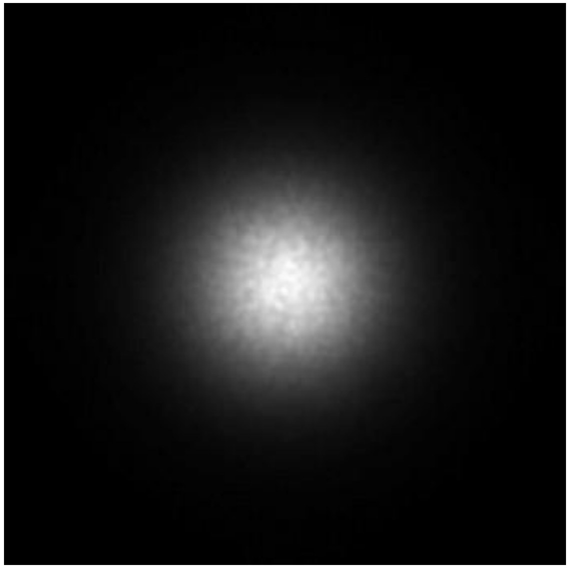


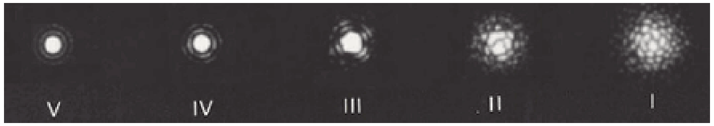


Resolution of the telescope

$$\theta = \frac{1.22\lambda}{D}$$







Atmospheric Seeing

The Image Motion & Speckle

16.1. Effects of Atmospheric Turbulence 411

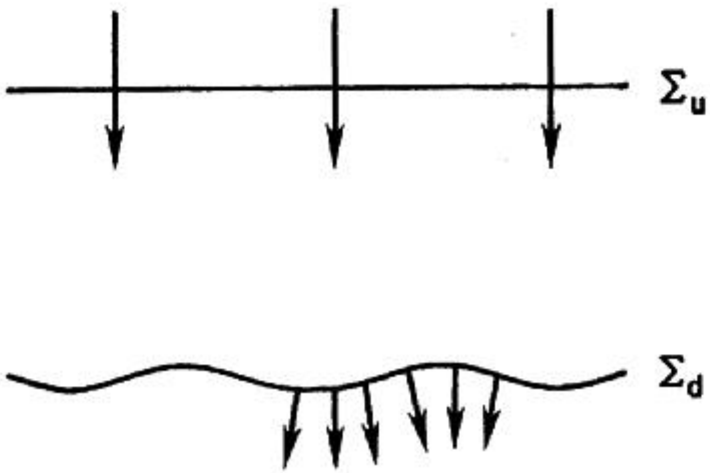
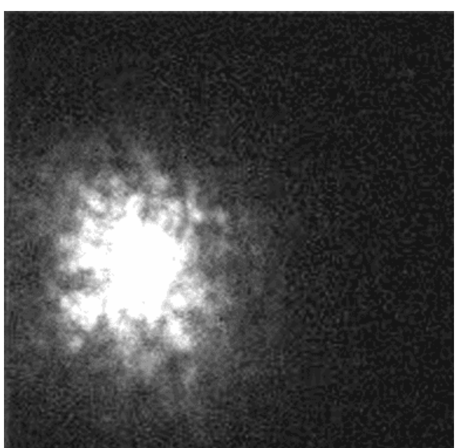
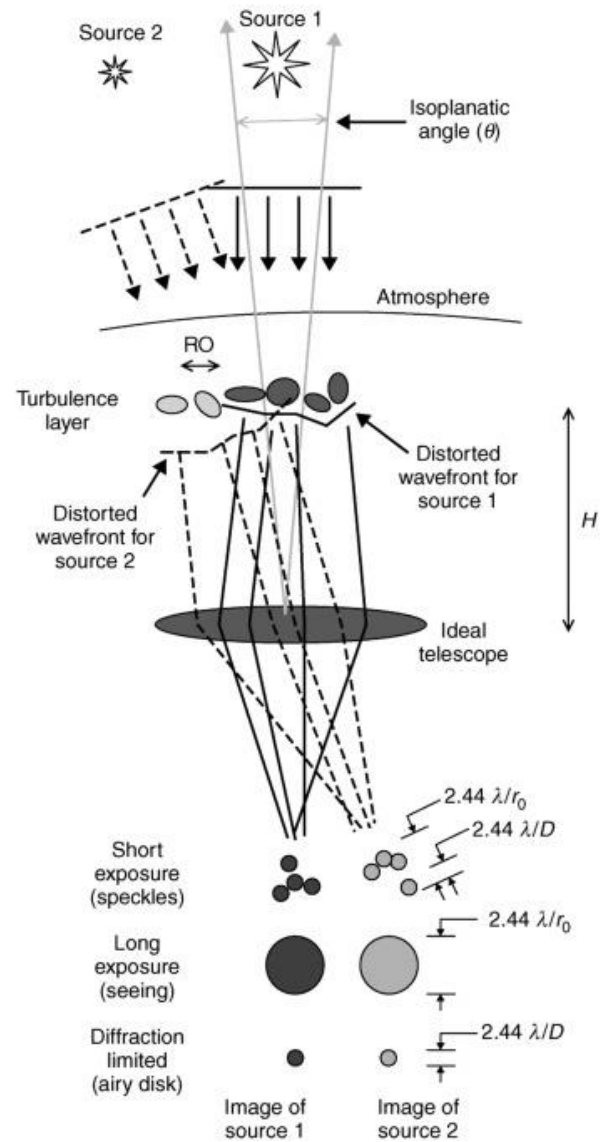
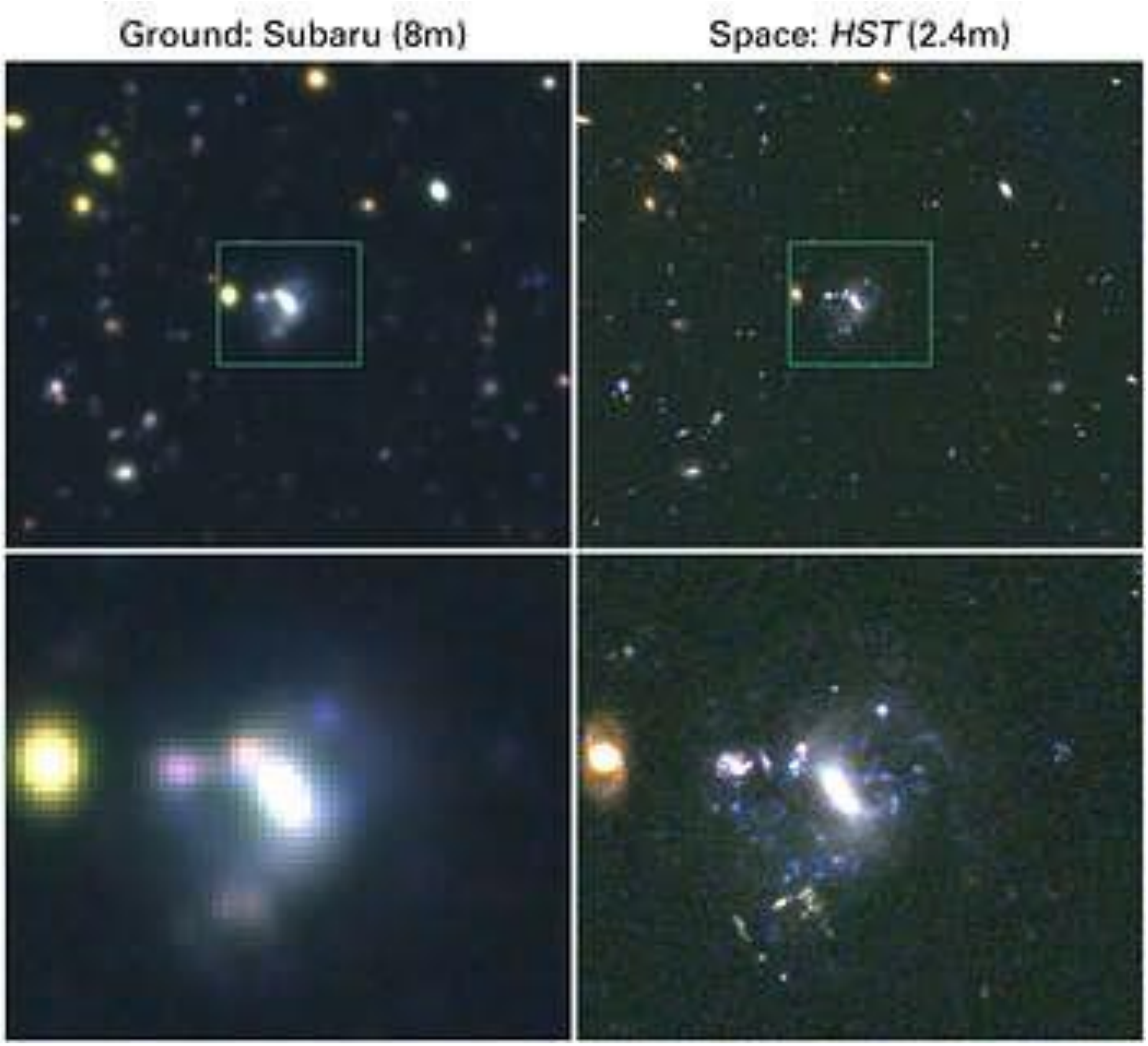


Fig. 16.1. Cross sections of undistorted wavefront Σ_u at top of atmosphere and distorted wavefront Σ_d at ground, after passage through turbulent atmosphere.

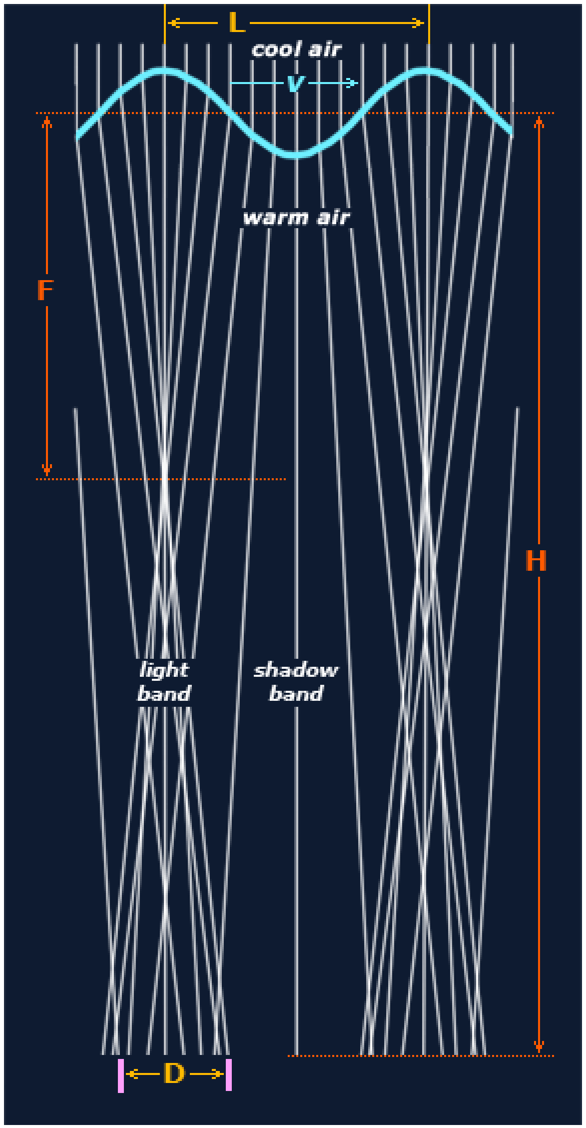




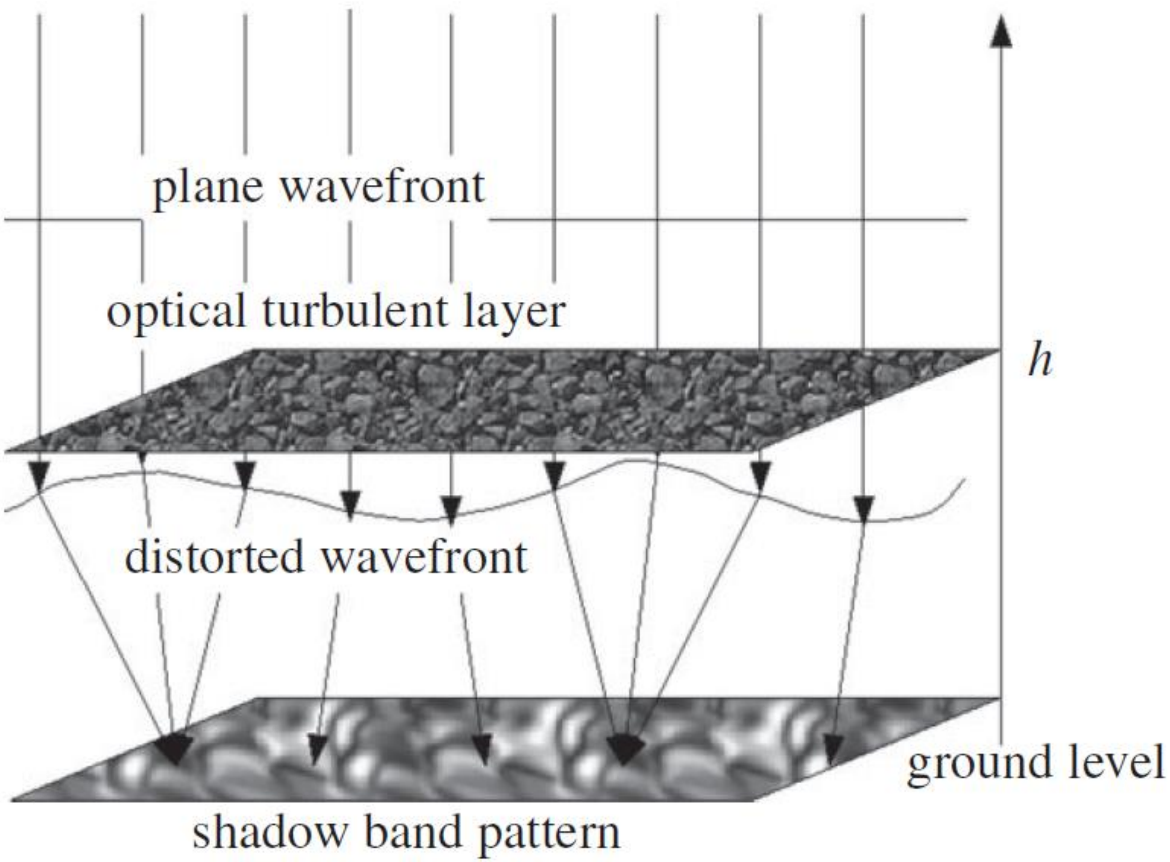
Atmospheric Seeing



Atmospheric Seeing



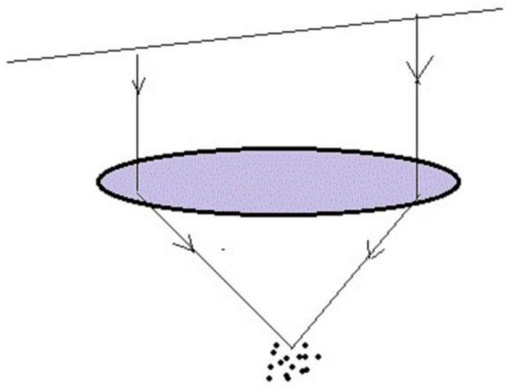
The Scintillation effect



DIMM seeing Monitor: Basic Principle

Absolute Image Motion

As per Kolomgorov Theory of Atmospheric Turbulance; Structure function



$$D_\phi(r) = 6.88\left(\frac{r}{r_0}\right)^{5/3}$$

$$r_0(\lambda) = \left[0.423\left(\frac{2\Pi}{\lambda}\right)^2 \sec(\varsigma)\int_0^\infty C_n^2(h)dh\right]^{-3/5}$$

Image motion of the telescope diameter d

$$\sigma \simeq \frac{\lambda}{2\pi}\frac{[D_\phi(d)]^{1/2}}{d}$$
$$\simeq 0.0431\left(\frac{\lambda}{0.5\mu}\right)\left(\frac{r_0}{1\mathrm{m}}\right)^{-5/6}\left(\frac{d}{1\mathrm{m}}\right)^{-1/6}\text{arc sec}$$

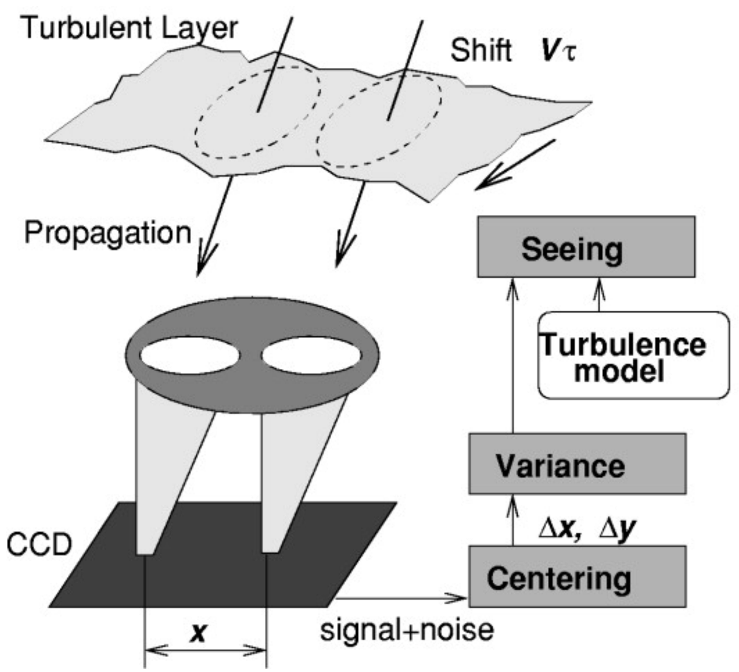
Telescope Diameter d

Martin 1987 PASP

$$FWHM(\lambda) = 0.98\frac{\lambda}{r_0}$$

DIMM seeing Monitor: Basic Principle

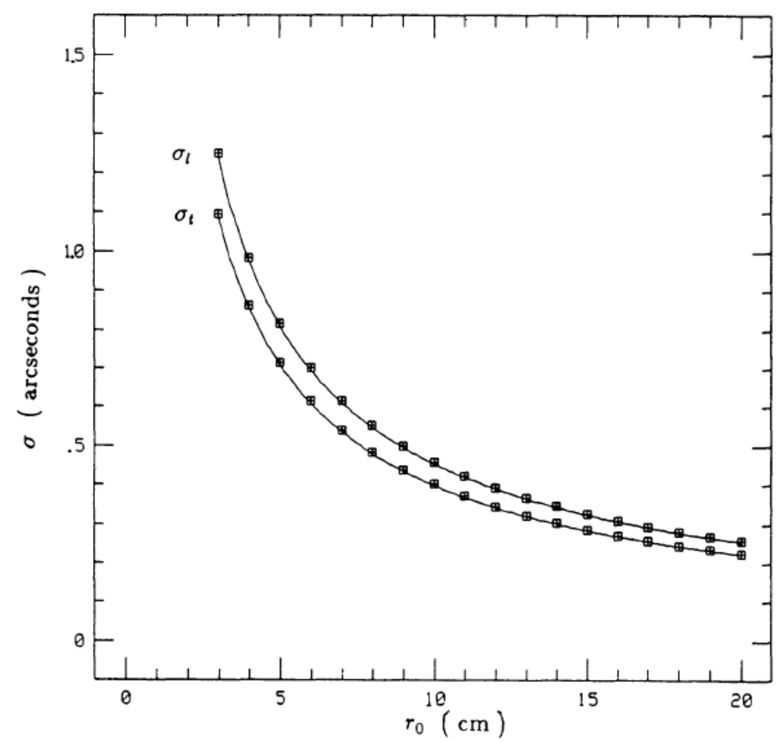
Differential Image Motion



$$\sigma_{\Updownarrow}^{2} = 2\left(0.18D^{-1/3} - 0.097d^{-1/3}\right)\lambda^{2}r_{0}^{-5/3}$$

$$\sigma_{\leftarrow\!\lrcorner}^{2} = 2\left(0.18D^{-1/3} - 0.145d^{-1/3}\right)\lambda^{2}r_{0}^{-5/3}$$

$$FWHM(\lambda) = 0.98\frac{\lambda}{r_0}(\cos\gamma)^{3/5}$$



Sarazin & Roddier, 1990, A&A

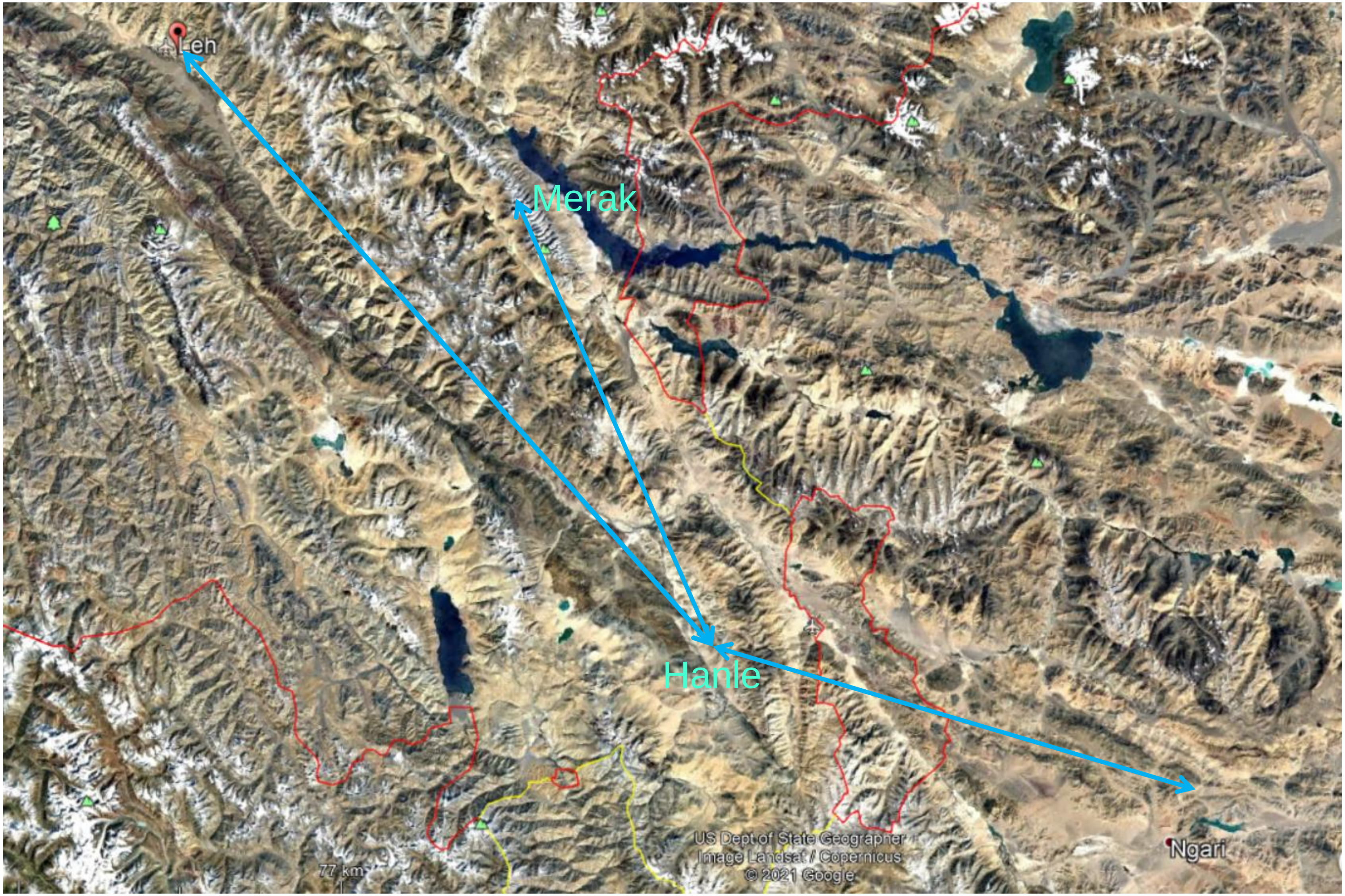
DIMM Seeing Monitor for the NLOT Project

Start of NLOT Project: Bit of History

(Oct-Nov 2007, BCB, Padmakar Eswar and Phonkchok)

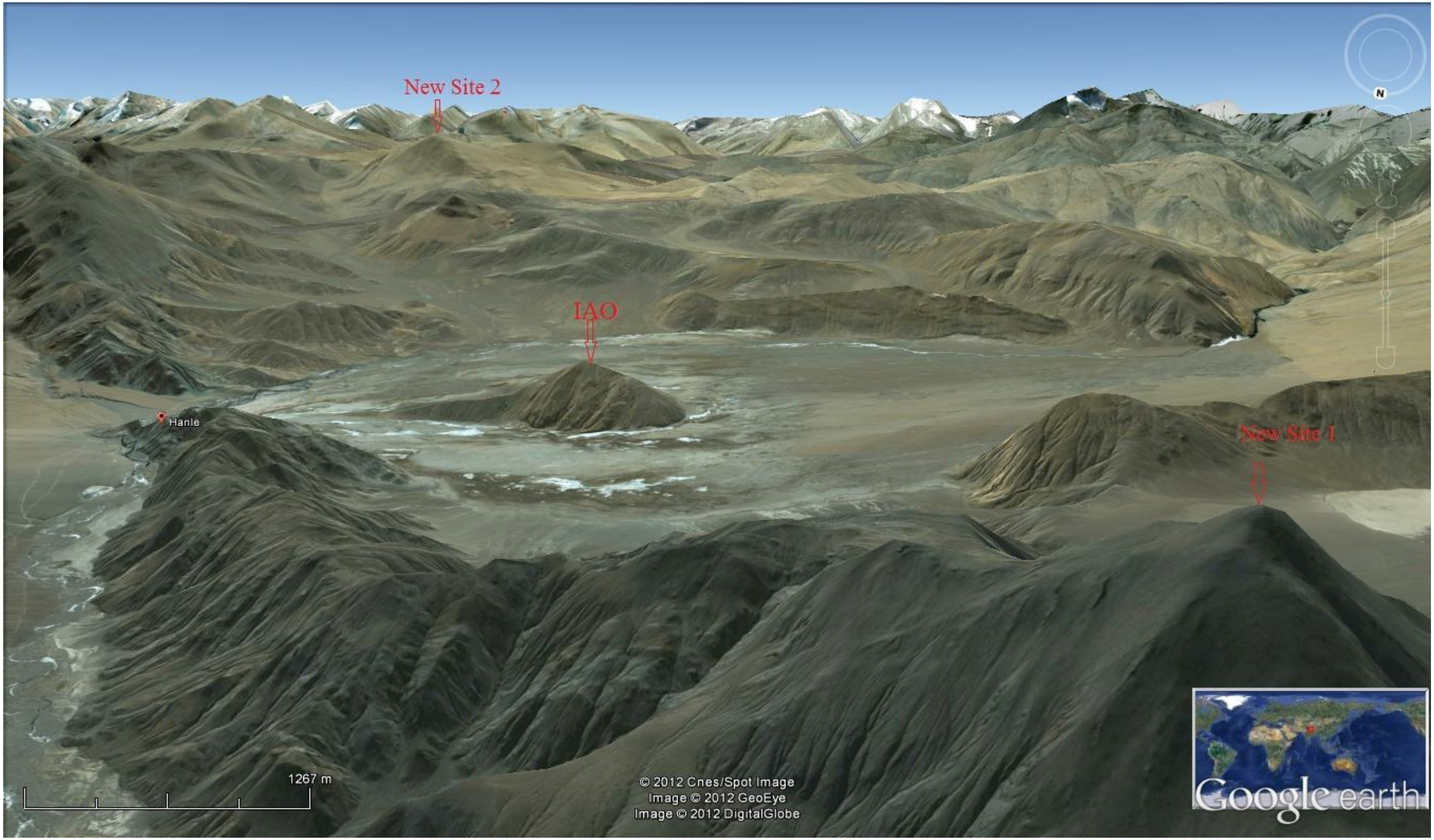
A campaign to search for good seeing in Ladakh

Hanle Merak Leh



A campaign to search for good seeing in Ladakh

IAO Randong Kalak-tartal



A campaign to search for good seeing in Ladakh

✓Running campaign to explore 3-4 sites using DIMM seeing monitor.

✓All these DIMM system can be made identical except telescope size.

✓If required then one DIMM system running at IAO can be made reference and all other can be cross checked with respect to this.

✓At present 3-4 Meade 12”-14” telescope can be arranged.

✓There are two inexpensive Baslar CCD in our disposal. 2-3 more CCD of the same make and model can be purchased.

✓DIMM at IAO Hanle and Merak can eb operated over longer period (2-3 years).

✓ Installation and operation of the DIMM can be done by IAO engineers.

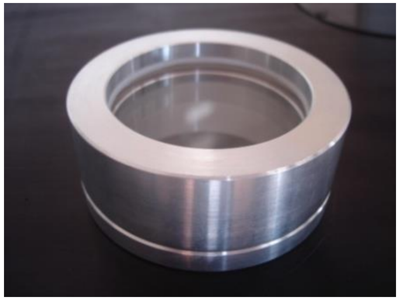
✓Data analysis can be done by scientist & engineers together.

Telescope

CCD

Mask

Prism



References

•Martin, 1987, PASP, 99, 1360, Image motion as a measure of seeing quality.

•Roddier & Sarazin, 1990, A&A 227, 294, The ESO differential image motion monitor

•Tokovinin, 2002, PASP,114, 1156, From Differential Image Motion to Seeing

•Project Report AMC College Students

•Report of NLOT DIMM

Thank You