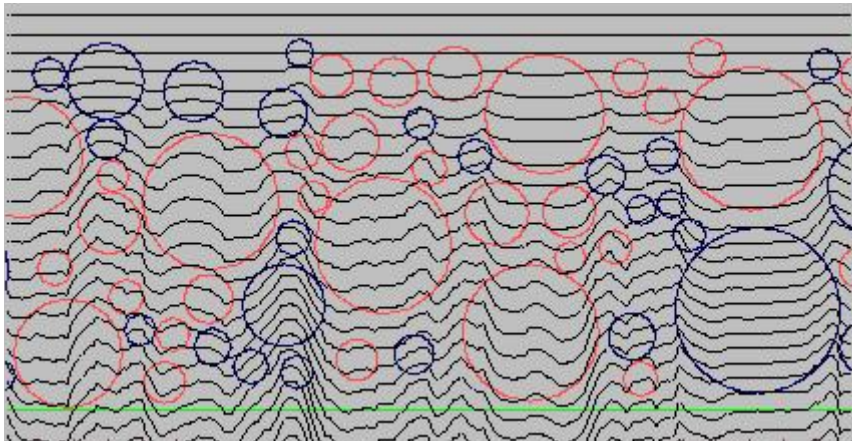
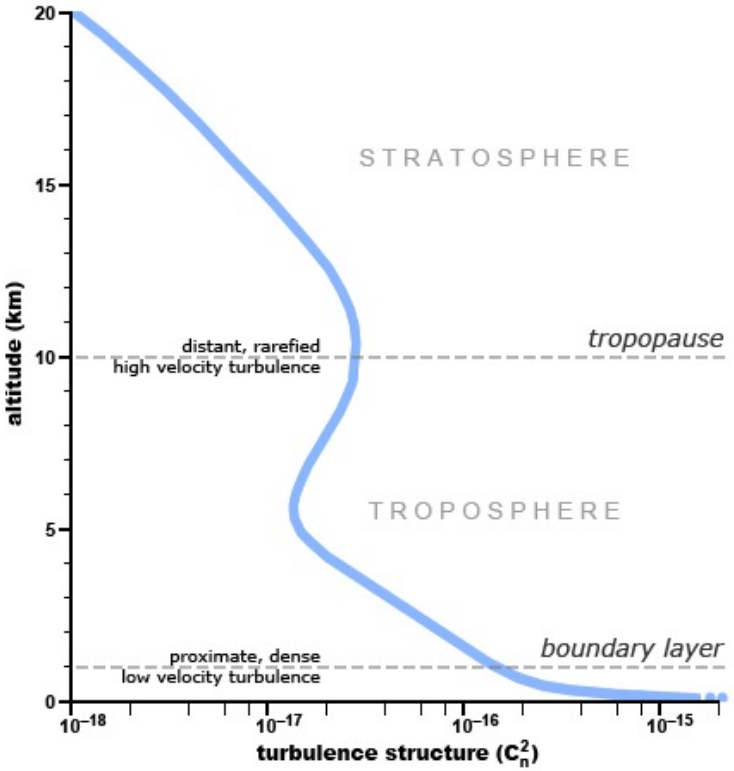
Strumentazione Astronomica: Seeing, Ottica Adattiva e Attiva

Turbolenza atmosferica: seeing





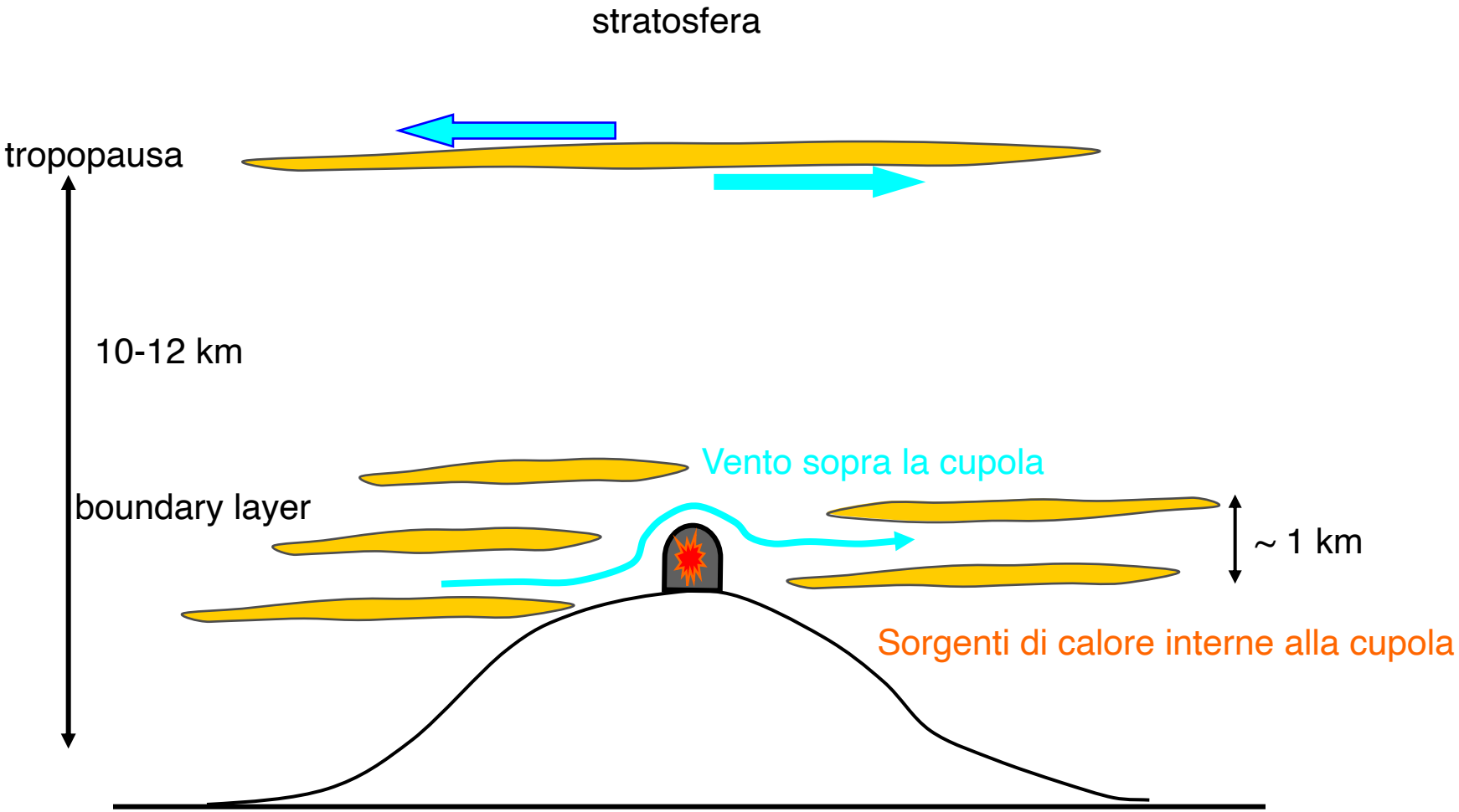
Densità spettrale delle fluttiazioni di fase

$$D_\phi(\vec{r}) \cong \left\langle \left[\phi(\vec{x}+\vec{r}) - \phi(\vec{x})\right]^2 \right\rangle$$ Kolmogorov

$$D_\phi(\vec{r}) \cong 6.88\left(\frac{|\vec{r}|}{r_0}\right)^{5/3}$$ Per fluttuazioni gaussiane

$$r_0 \propto \lambda^{6/5}$$

La turbolenza si innesca a diverse quote



Turbolenza atmosferica: seeing

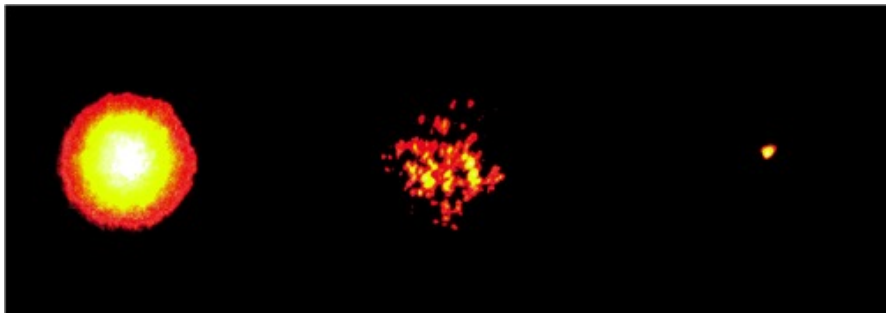
Lunghezza di coerenza di Fried:

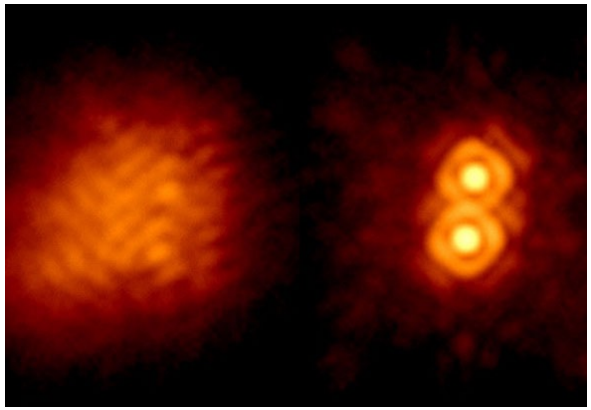
$$r_0 \cong 0.114\left(\frac{\lambda \cdot \cos z}{550}\right)^{0.6} m \qquad \lambda(\mathrm{nm}) \quad z(\textit{angolo zenitale})$$

distanza oltre la quale la differenza di fase supera 1 radiante

A 550 nm e allo zenith, r_0=0.114 m! (1.5”)

Angolo isoplanatico $\vartheta_0 \cong 0.31\frac{r_0}{h}$ *h ~5 Km*





La regione di cielo che e' interessata dalla medesima cella di turbolenza atmosferica si chiama ***area isoplanatica*** e puo' essere piccola qualche secondo d'arco

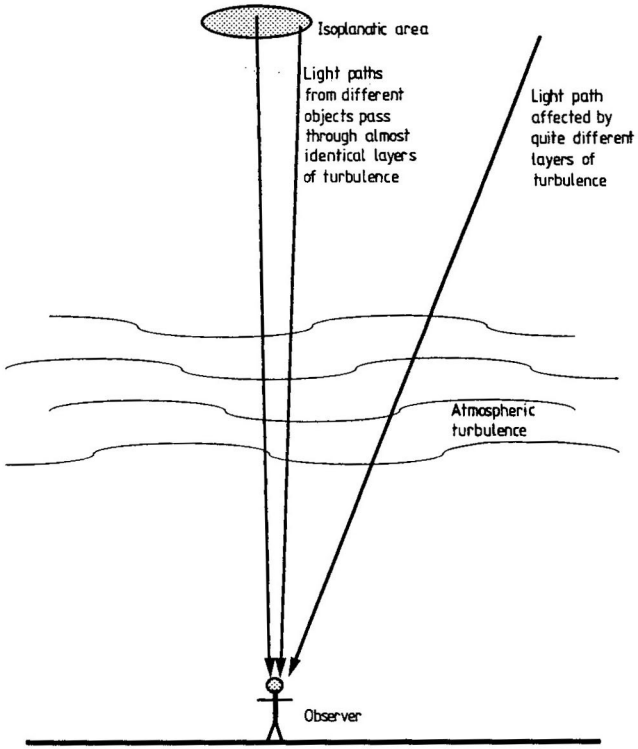
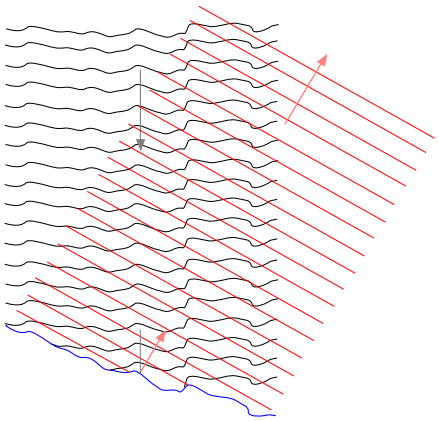
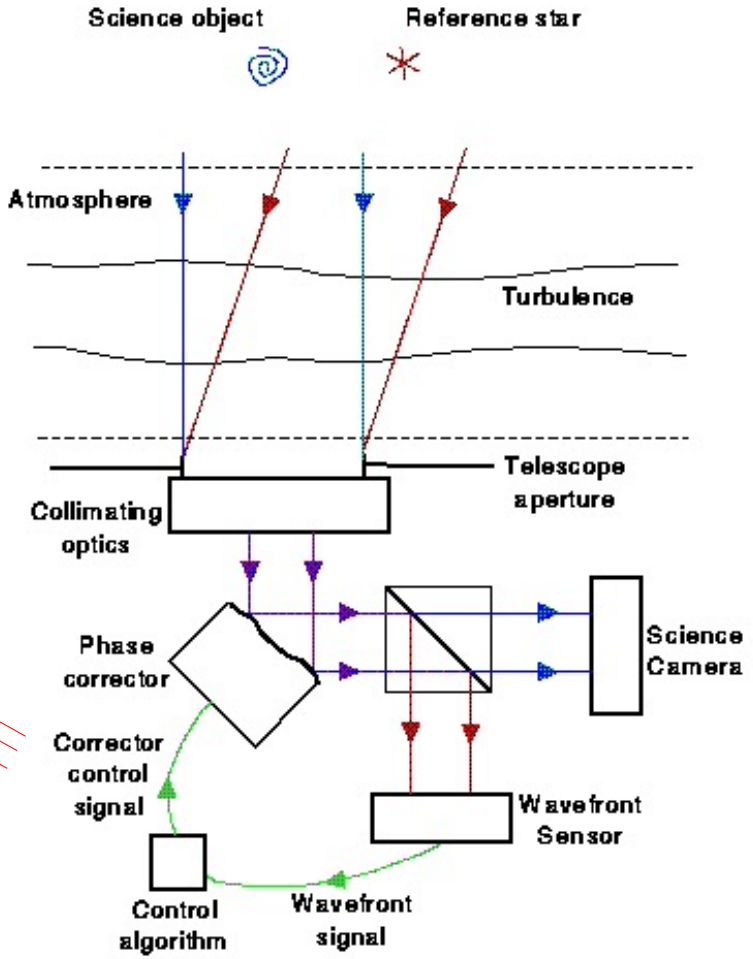


Figure 1.1.53. The isoplanatic area.

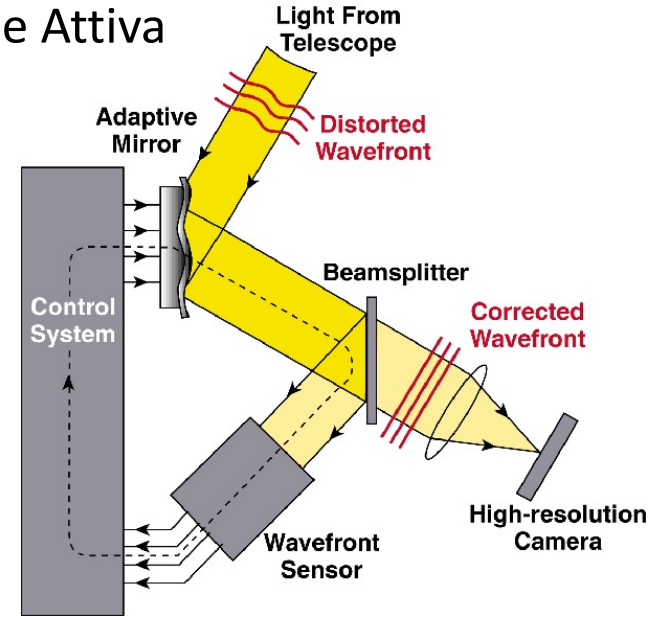
Si usa una stella guida nel campo per corregger la turbolenza atmosferica

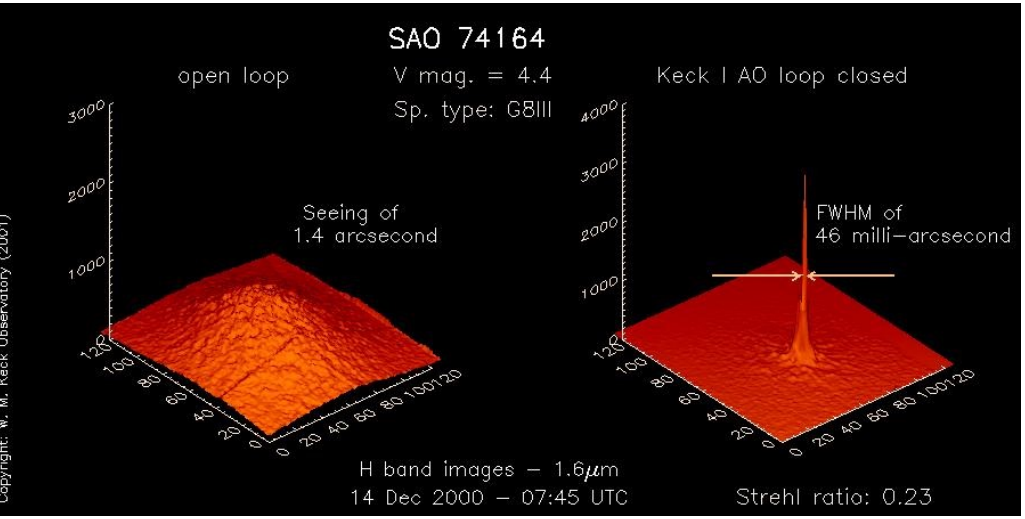


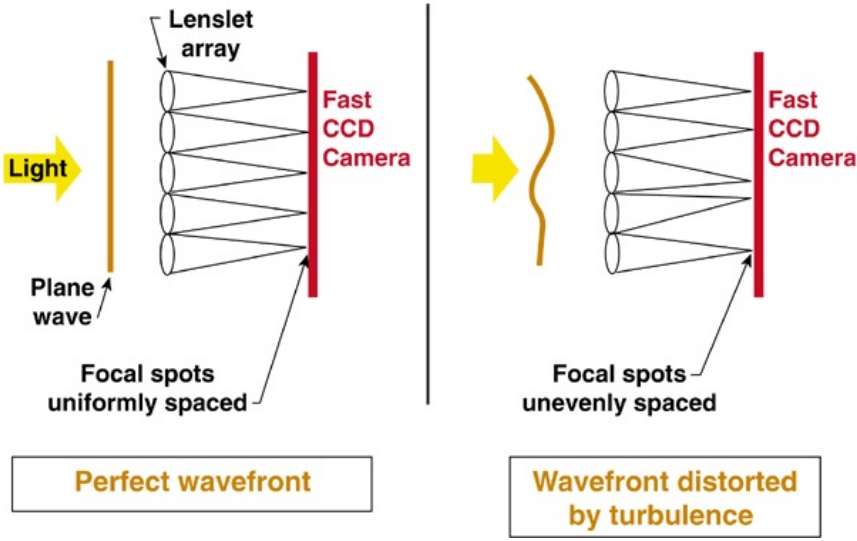


Ottica adattiva

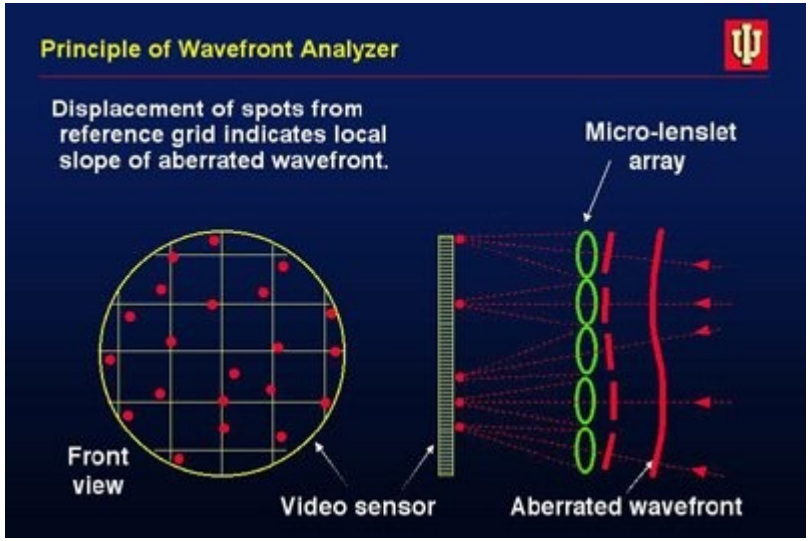
Si analizza il fronte d'onda con un array bidimensionale di sensori che in tempo reale attuano delle deformazioni su degli specchi sottili che riportano "puntiforme" l'immagine di stelle di riferimento

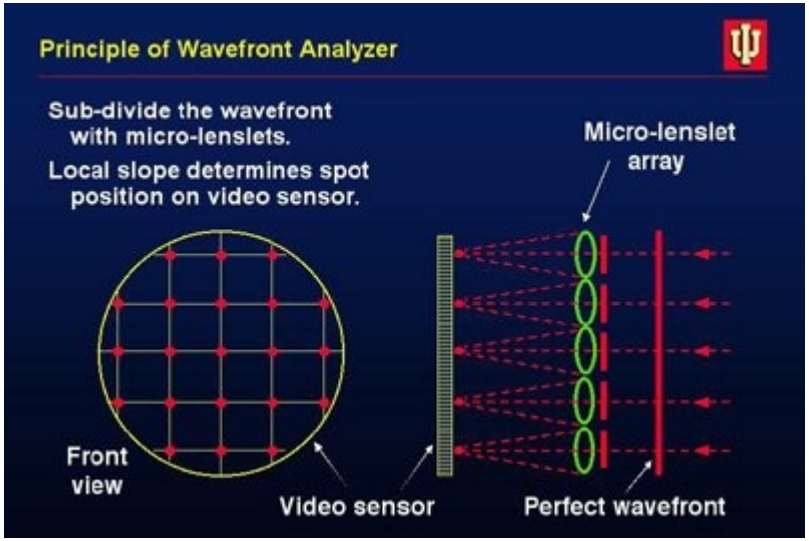


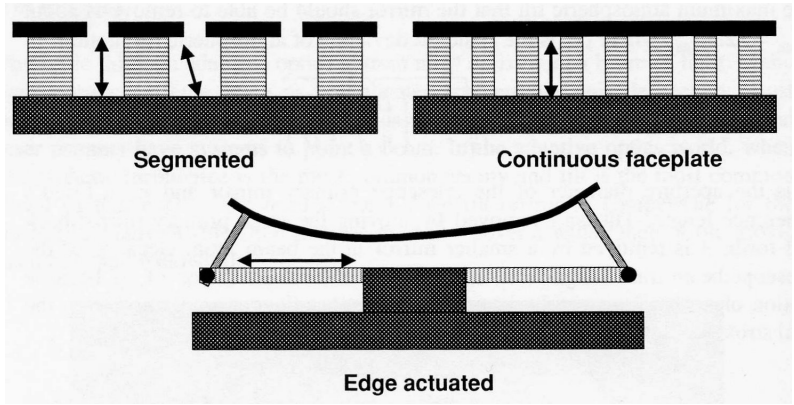


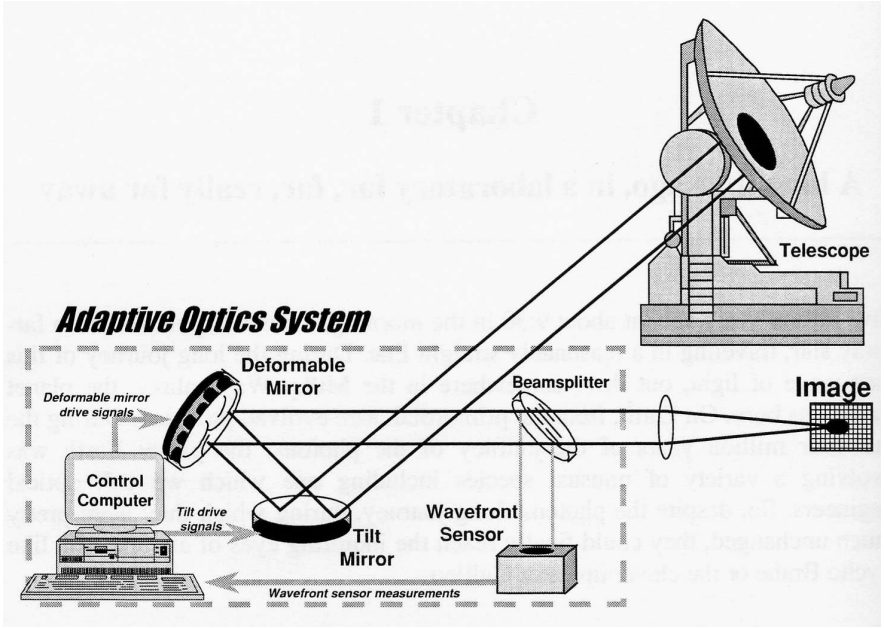


Strumentazione Astronomica: Seeing, Ottica Adattiva e Attiva



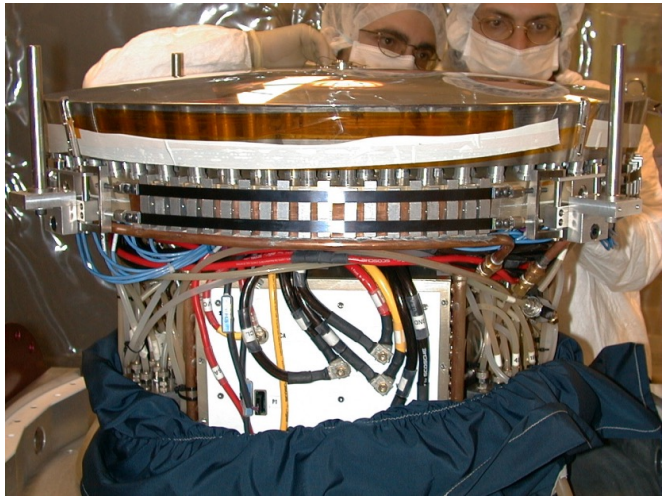


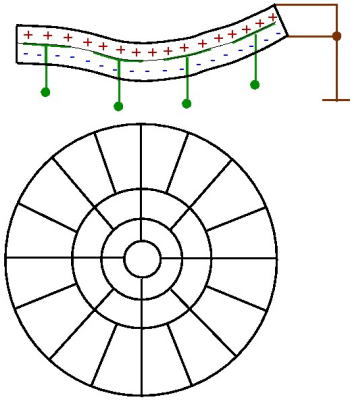




Strumentazione Astronomica: Seeing, Ottica Adattiva e Attiva

Come si implementa:
-Specchi deformabili
-Tip-Tilt
-Specchi segmentati
-Bimorfi





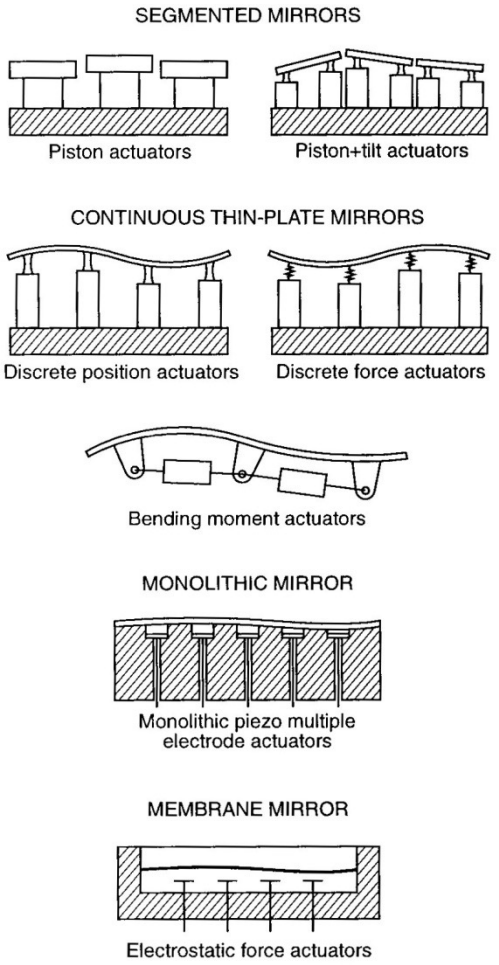
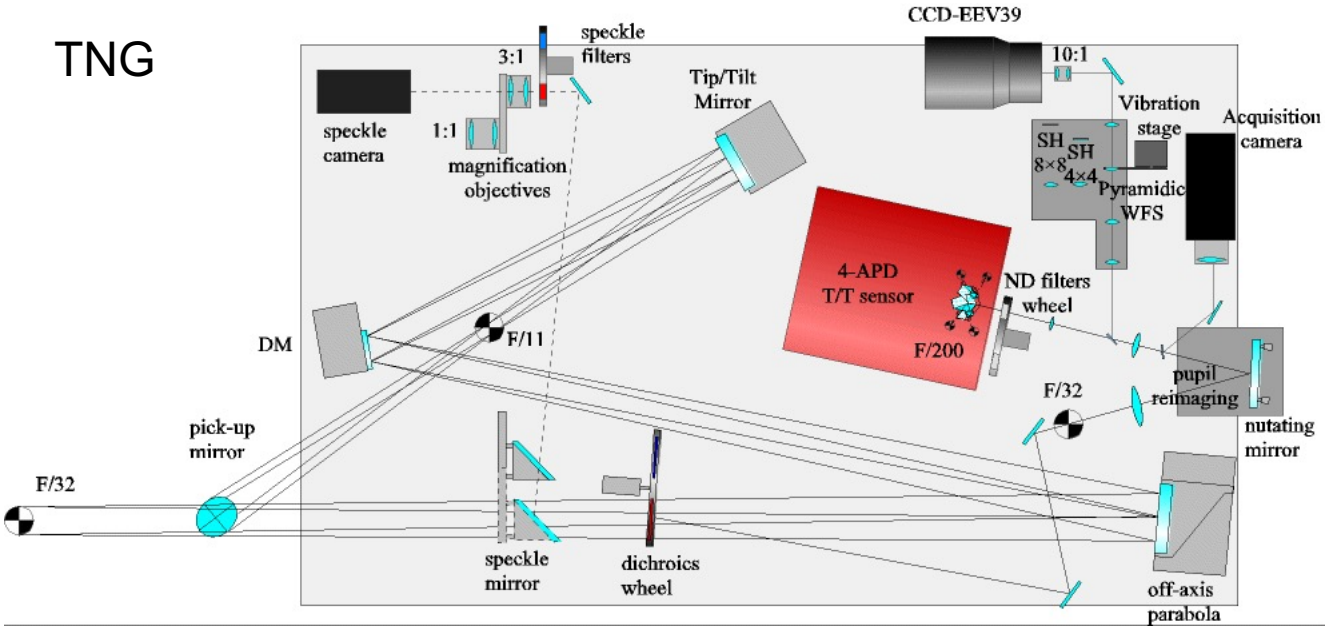
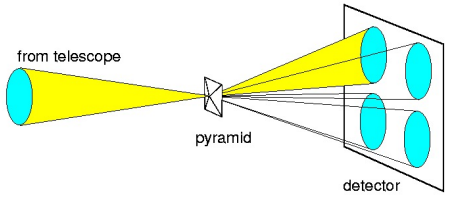


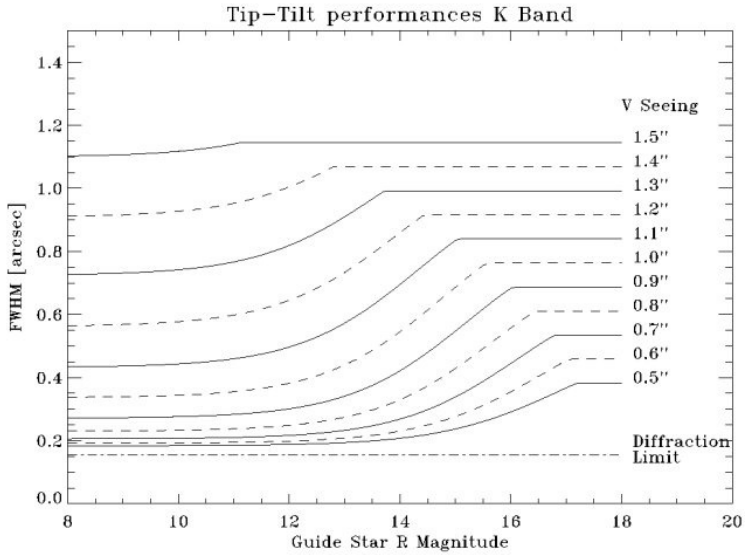
Fig. 5.10. Different types of deformable mirrors (from Merkle [5.44])

Strumentazione Astronomica: Ottica Adattiva

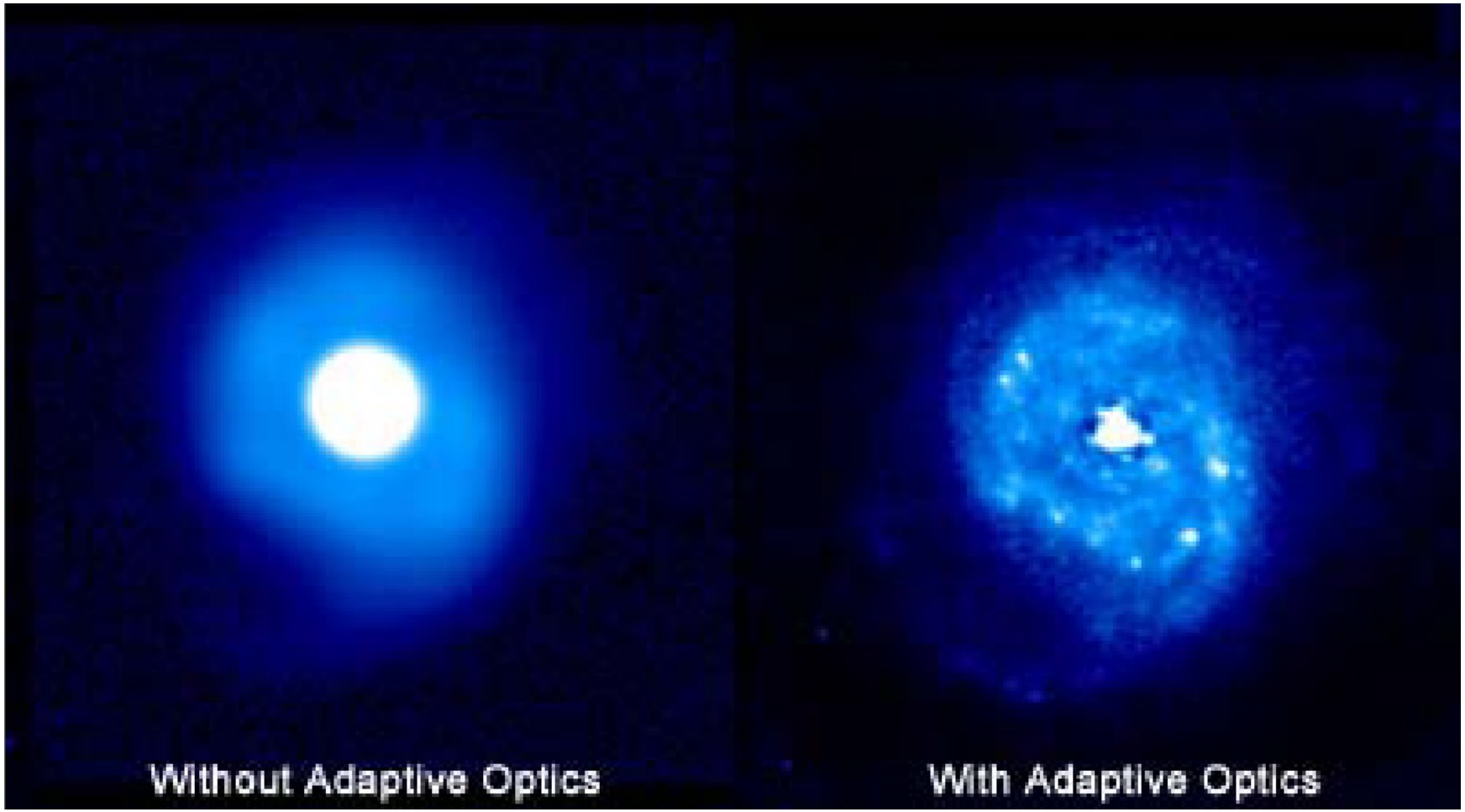
TNG





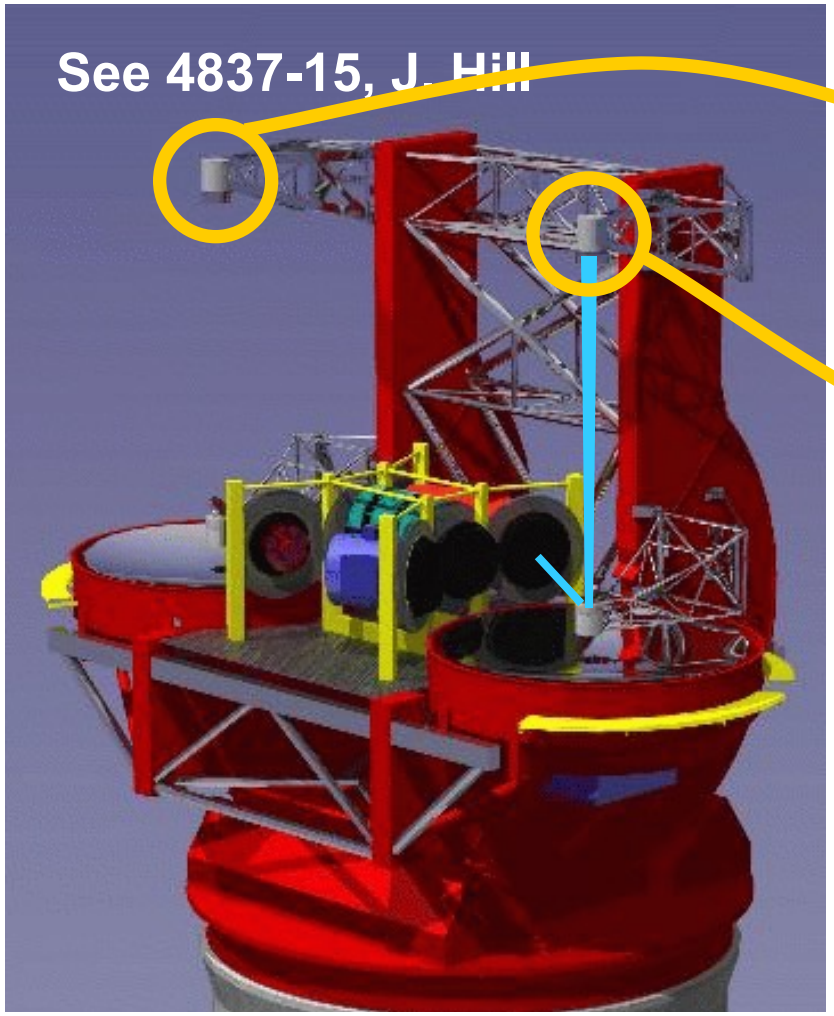


Strumentazione Astronomica: Ottica Adattiva

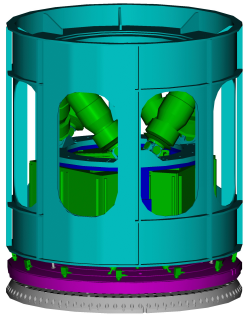


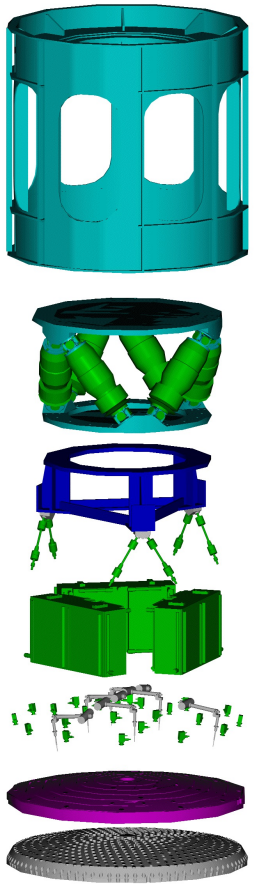
NGC 7469

Adaptive secondary in LBT



2x8.4m mirrors

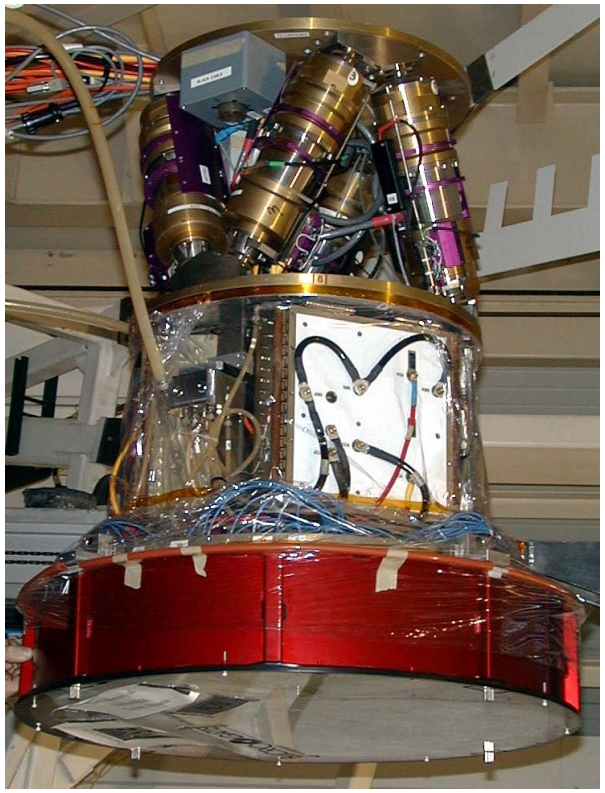




Each AdSec:
672 actuators
911mm diam.

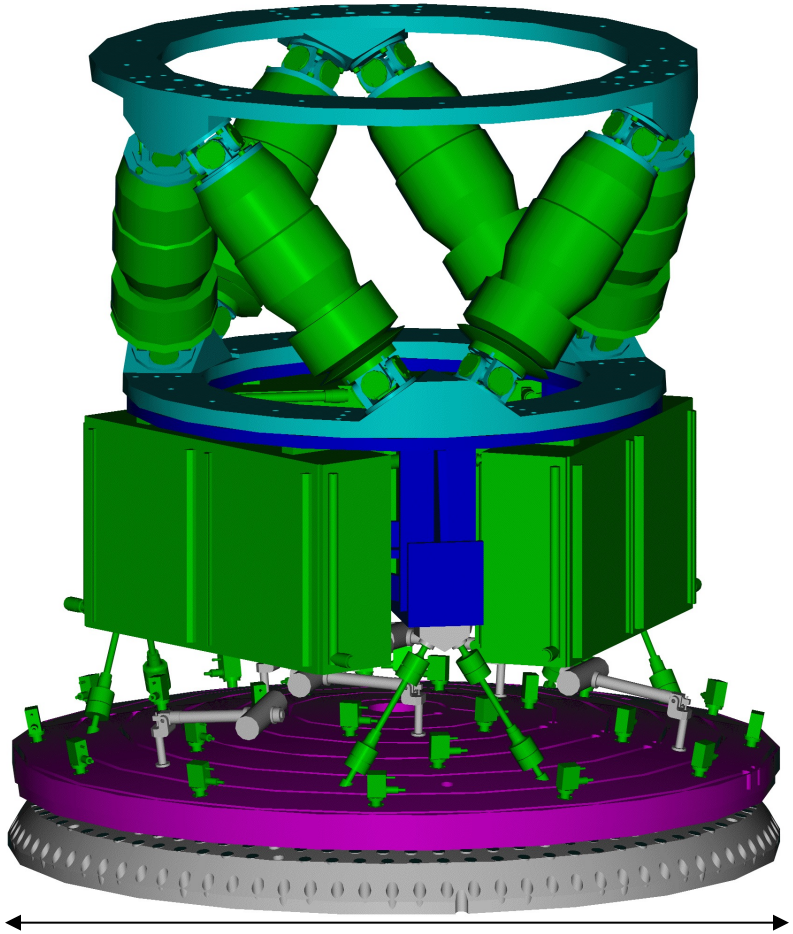
From MMT336 to LBT672

MMT: Cassegrain
336 actuators



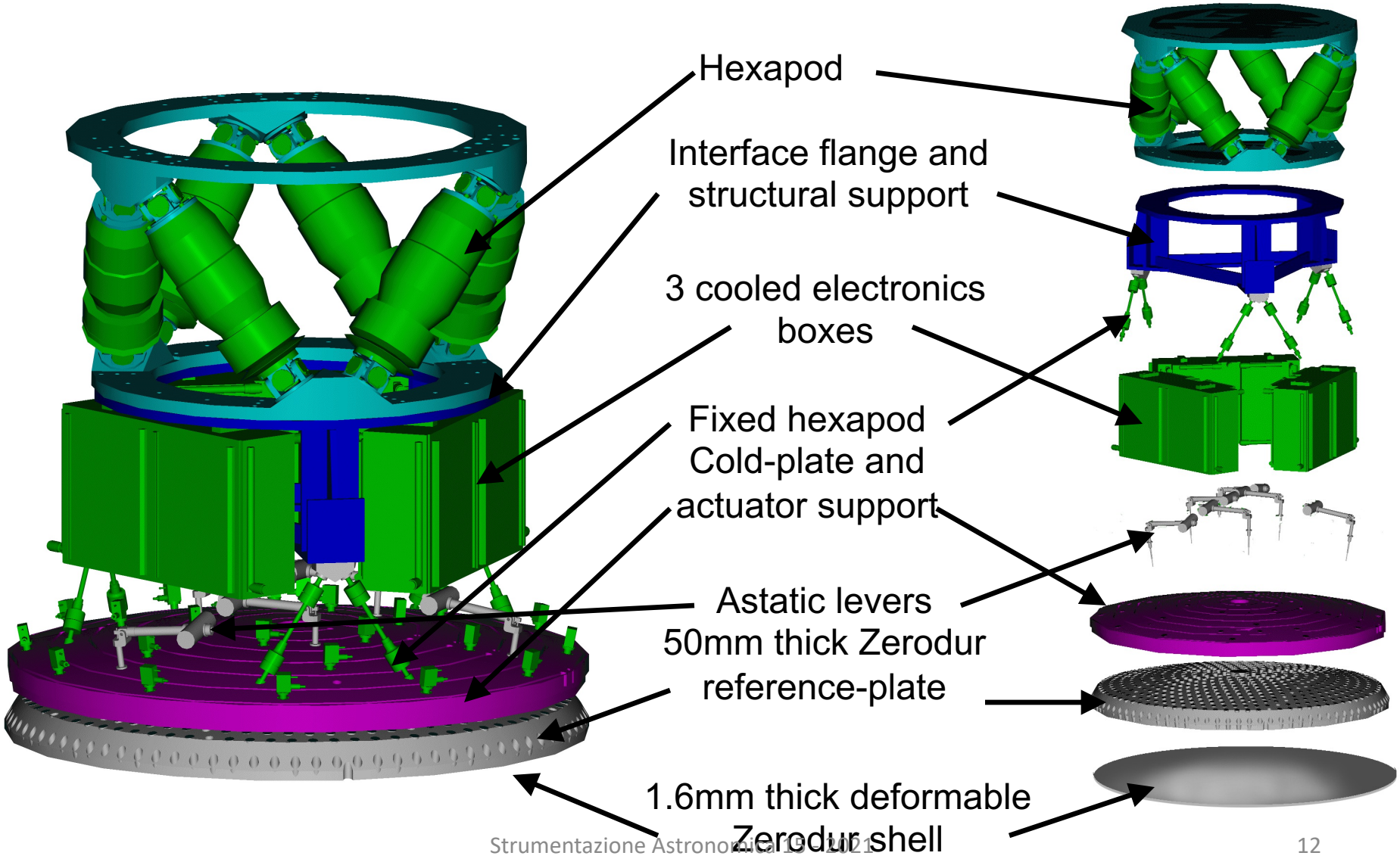
642mm

LBT: Gregorian
672 actuators



911mm

LBT672 layout



Strumentazione Astronomica: Seeing, Ottica Adattiva e Attiva

Stelle laser

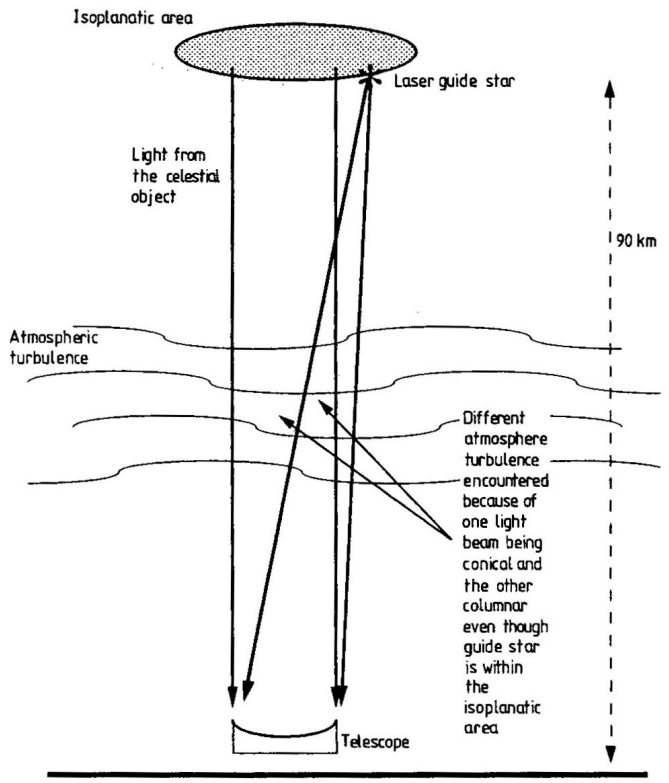
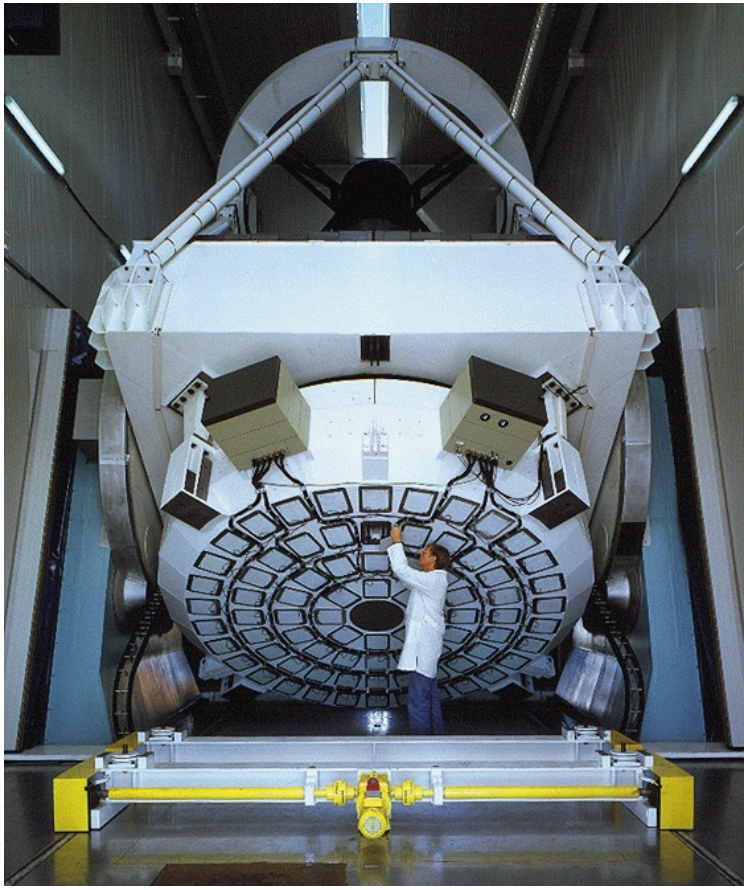


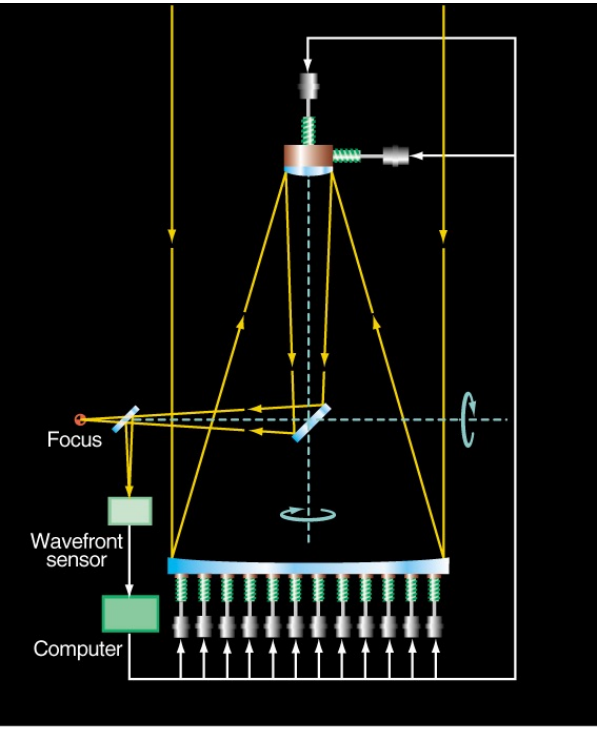
Figure 1.1.54. Light paths from a celestial object and a laser guide star to the telescope.

Se nel campo di vista non e' presente una stella sufficientemente brillante la si produce con un laser che eccita il sodio nell'alta atmosfera (~90 km)
Ci sono pero' dei problemi…

Ottica attiva



Da non confondere con quella adattiva.
Questa deforma il primario per compensare

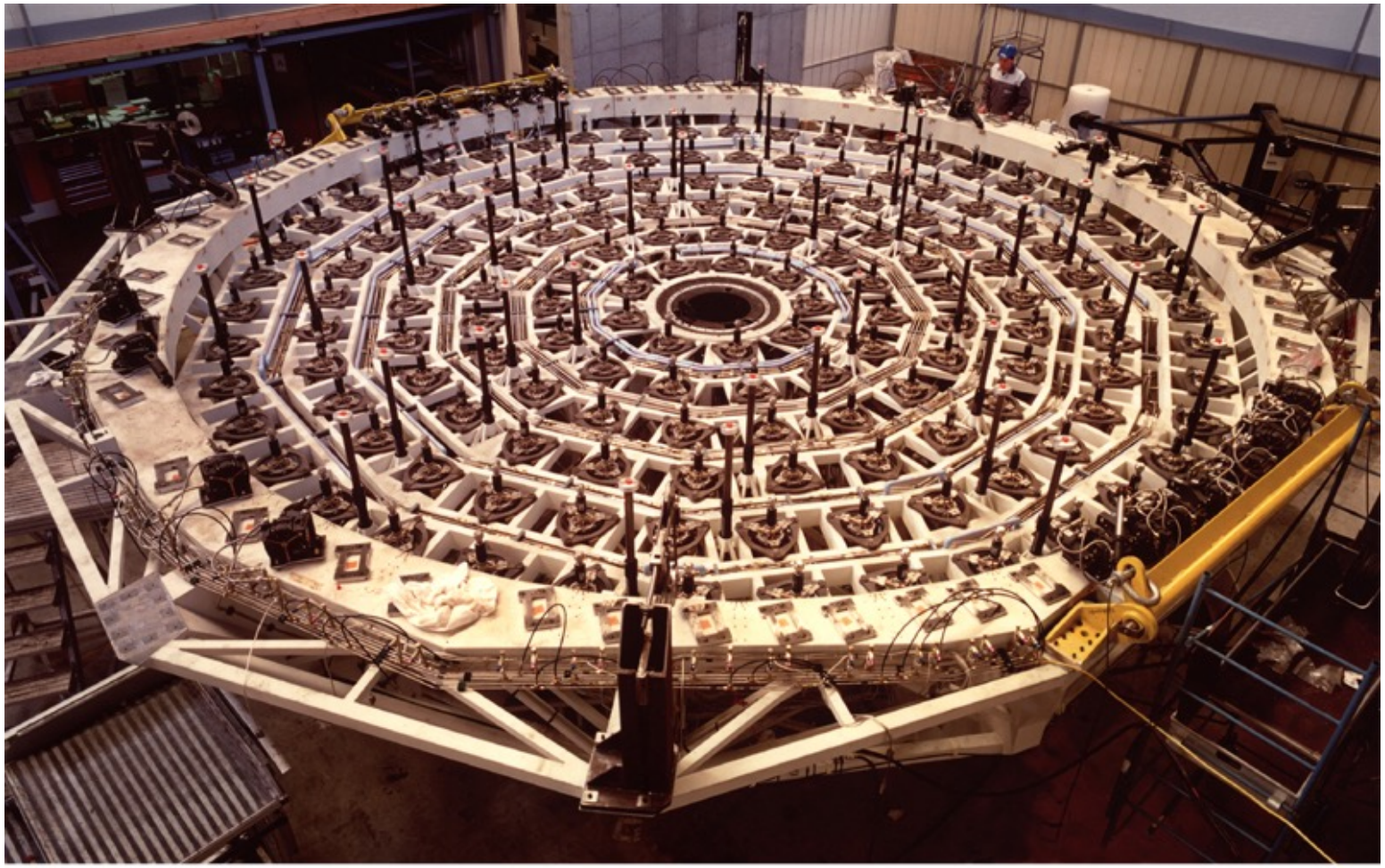


le deformazioni dovute allo stesso peso dello specchio primario del telescopio. La regola classica era un rapporto Diametro/Spessore pari a 5…

Lo specchio di VLT e' spesso 175 mm!

VLT Active Optics System

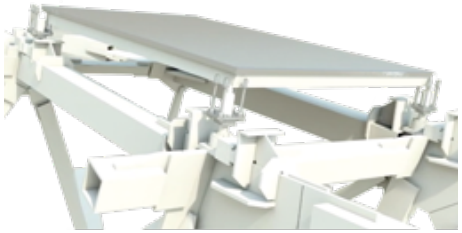
Strumentazione Astronomica: Seeing, Ottica Adattiva e Attiva



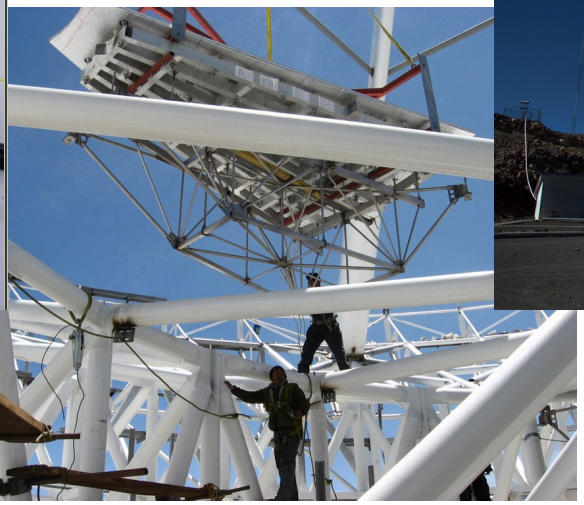
Active Mirror Supports in VLT M1 Cell

ESO PR Photo 34a/99 (13 August 1999)

Strumentazione Astronomica: Seeing, Ottica Adattiva e Attiva



SRT



LMT