Solar adaptive optics: A general discussion

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Solar observations are largely motivated today by our increased vulnerability to solar events. A repetition of the 1859 solar superstorm, where telegraph systems across the world became inoperable, would have devastating consequences today if they happened without prompt forewarning.

The New Solar Telescope (NST) on Big Bear Lake, California, has a 1.6m off-axis primary mirror and is equipped with a 97 element adaptive-optics system. Diffraction limited resolution is attained in the visible after speckle reconstruction. Without speckle reconstruction, and under good atmospheric conditions, the resolution approaches the diffraction limit in the infrared. However, with a single deformable mirror, the atmospheric turbulence is corrected only inside the isoplanatic patch, typically 10" in diameter.
Sunspots and active regions extend over roughly 1' to 2'. To attain the diffraction-limit over such field sizes, multi-conjugate adaptive optics (MCAO) applies a wavefront correction that varies inside the field. At the NST we will use two deformable mirrors to correct for the atmospheric turbulence inside a field of 60". The optimum conjugation heights of the two mirrors have been assessed after an atmospheric monitoring campaign.
The adaptive-optics development at NST prepares the way for the 4m off-axis Advanced Technology Solar Telescope (ATST) which will be built on Maui, Hawaii.