Single-arm Design Method for Multiple Aperture Imaging Telescopes

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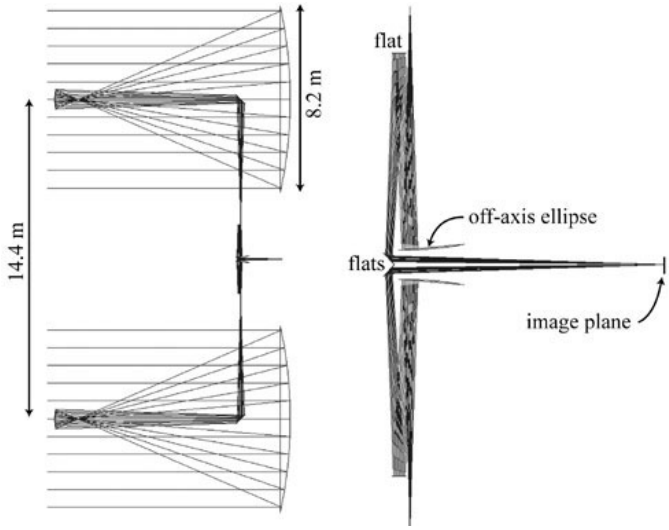
The performance of wide-field multiple-aperture imaging systems is dominated by easily understood, low-order errors. Each aperture produces an individual image, each pair of apertures produces a set of fringes under a diffraction envelope, and the system bandwidth produces a coherence envelope. For wide-field imaging, each of these elements must be coincident in the image plane as the field angle changes. The above physical errors will appear in system wave fans as pistons, tilts, and defocus errors. Each type of error can be corrected by the method listed in the table below.

PISTON ERRORS BETWEEN SYSTEM BRANCHES	
effect on image	fringes shift away from the individual images
correct constant	match axial pathlengths at 0 field
correct linear	satisfy sine condition for all axial rays
TILT ERRORS BETWEEN SYSTEM BRANCHES	
effect on image	images separate laterally
correct constant	set correct pointing in all arms
correct linear	match focal lengths in all arms
correct quadratic	match or zero distortions in each arm
DEFOCUS ERRORS BETWEEN SYSTEM BRANCHES	
effect on image	images separate longitudinally
correct constant	change displacement or power in mismatched arm
correct linear	match tilt of the image surfaces for each arm
correct quadratic	match or zero field curvatures



If the interferometer consists of several identical branches, the correction methods in the above table can be applied to just a single arm of a multiple aperture system. This allows quick optimization of the system, without the need for more complicated raytrace models of the complete system. This method was used by Phil Hinz to create a beam combiner for the Large Binocular Telescope. A schematic of the combined system is shown above. Wave fans before and after correction for beam-combining are shown below. Correcting one arm without regard to beam-combining properties usually causes the combined system to be dominated by linear piston errors, as shown in the wavefront plot on the left.