CHARA TECHNICAL REPORT

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Beam-Compressor Mirror Specifications, Requirements and Invitation to Bid

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1. INTRODUCTION AND GENERAL INFORMATION

The CHARA[1] Array will employ five 1-m size, alt-azimuth style telescopes at a site on Mount Wilson in southern California. The telescopes will be housed separately and operated remotely from a central laboratory. Light from each telescope will be directed by subsequent flat mirrors through vacuum pipes to additional optics and instrumentation at the central laboratory.

This document describes specifications for the manufacture of beam compressor optics for the CHARA Array. The beams from the telescopes will be reduced from 125 to 25 mm for beam combination (interference) in the Beam Combining Laboratory (BCL) building. Our general design for the beam compressor is basically two confocal paraboloids in a Cassegrain design. Rather than requesting two off-axis paraboloids, we require simpler, but larger on-axis optics in which the primary is 14 in diameter. These mirrors will be illuminated only on one side.

The information and specifications provided herein are intended to enable prospective suppliers (hereafter called "vendors") of polished mirrors to respond to an ITB ("Invitation To Bid"). It is expected that these specifications will become part of any contract for mirror fabrication that may result from the ITB.

2. INVITATION TO BID

CHARA invites bids to fabricate optics for:

- *Five (5) afocal Cassegrain beam compressors, each consisting of a concave parabolic primary mirror and a convex parabolic secondary mirror.*

CHARA will supply properly selected and dimensioned ULE substrates, as described in Table 1. Supplied substrates will have been ground with #80 grit or finer, and beveled approximately 0.03 inch at 45°. Blank dimensions will be satisfactory as supplied. Finished thickness specification allows optional removal of additional material during further fine grinding. Bids are invited to fine grind, polish and figure the mirror surfaces.

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Quoted prices will be f.o.b. delivery point, including shipment costs to the CHARA Array site in California, and the mirrors must be packed in containers suitable for protecting them from damage during shipment. The first primary-secondary set is to be delivered no later than the December 1, 1998, with the subsequent four systems to follow at intervals no greater than 2 months.

TABLE 1. Mirror substrates dimensions.

Item	Pieces	Shape	Diameter (inch)	Thickness (inch)
1	5	Circular Flat	14.00 (+0.04/ − 0.00)	2.00 (+0.04/ − 0.00)
1	5	Circular Flat	3.00 (+0.04/ − 0.00)	0.56 (+0.04/ − 0.00)

3. MIRROR CHARACTERISTICS AND MATERIAL PROPERTIES

The primary and secondary mirror configuration is shown in Figure 1. The central hole in the primary mirror is concentric with the outer radius of the mirror, with a tolerance of 0.04 inch. Table 2 describes the dimensions and optical figures.

TABLE 2. Mirror Description

Mirror	Primary	Secondary
Total quantity	5	5
Diameter (inches)	14.0 $\pm$0.02	3.000 $\pm$0.02
Bevel (inches)	0.04	0.03
Hole (inches)	2.920 $\pm$0.01 (see Fig 1)	
Surface figure	parabolic concave	parabolic convex
Focal length (inches)	50.4 $\pm$ 1%	7.56 $\pm$ 1%
Combined Focal Length (inches):	∞ (i.e. flat)	
Thickness (inches)	2.0 $\pm$ 0.02	0.56 $\pm$ 0.02
Material	ULE	ULE
Surface quality	60/20	60/20
Optomechanical concentricity (inches)	<0.04	<0.04
Coatings	None	None
Nominal Beam Diam (inches)	5.20	1.04
Stress condition (nm/cm)	$\leq$ 15	$\leq$ 15

4. MIRROR SURFACE SPECIFICATIONS

For description of the surface quality specifications, we distinguish between the figured aperture, the full aperture, and the clear aperture, as defined in Table 3. The figured aperture is the diameter of the mirror surface that is optically finished to a a parabolic

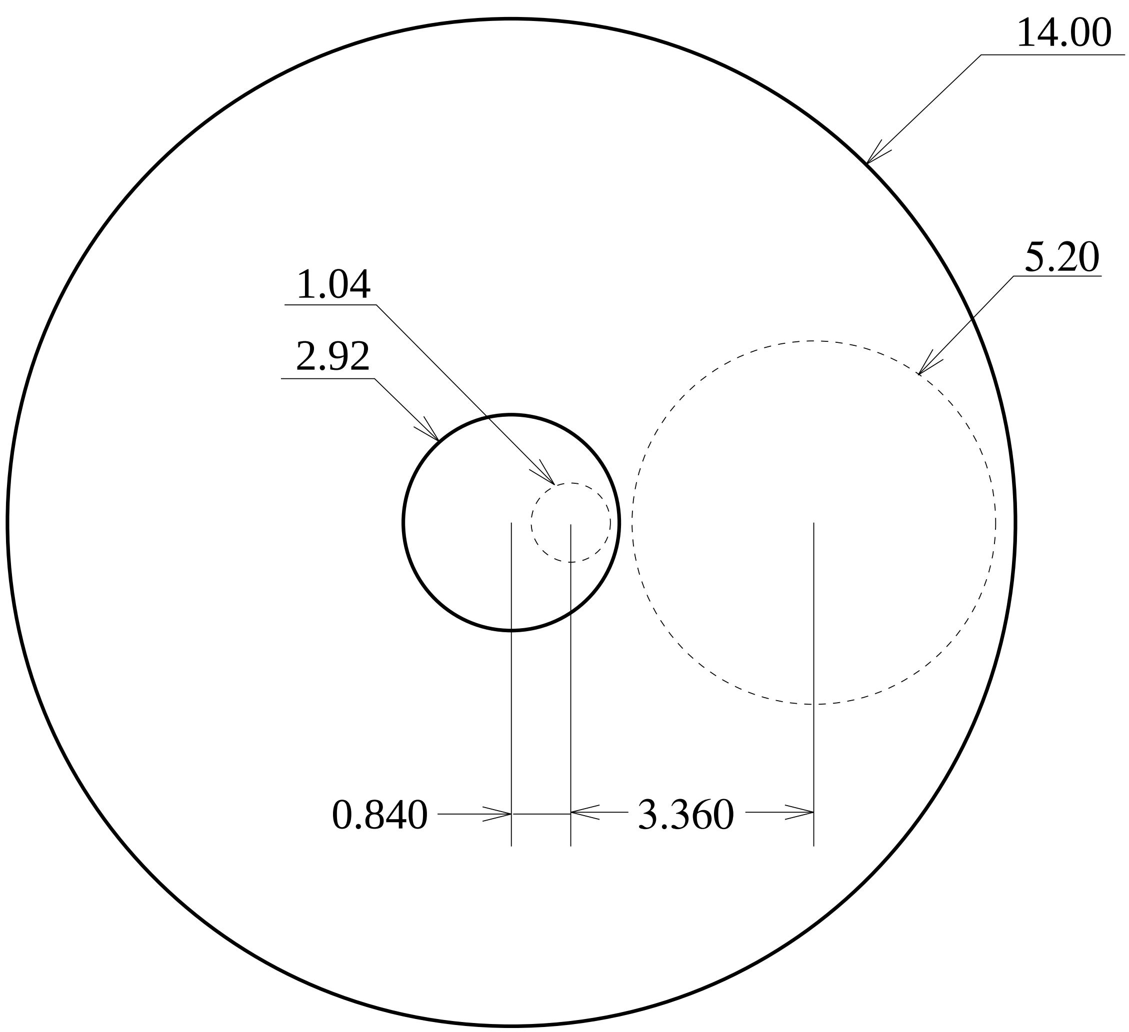

FIGURE 1. CHARA Primary BRT Dimensions. Dashed circles are input and reduced output beams. Outline of mirror and center hole shown in solid lines. **Dimensions are given in inches.**

figure. The full aperture is utilized for alignment, but has relaxed tolerances. The clear aperture is utilized for beam compression, and has the more stringent specification.

The polished mirror surfaces will conform to the requirements set out in Table 4. The table describes the "combined surface" wavefront specification. This means the wavefront quality produced by the optics when employed as a beam compressor. The vendor is free to allocate the figure error between the two elements.

Each optical element can be tested separately. Then the net "combined surface" wavefront in beam compressor configuration must be estimated by the sum (not root-sum-square) combination of the wavefront errors for the separately tested primary and secondary. Vendor will provide the wavefront error maps for the individual components.

Alternatively, the wavefront error can be determined by assembling the optics in beam compressor configuration and testing the optics as a system (pairing of components must be

TABLE 3. Mirror aperture.

Mirror	Figured	Full	Clear
Primary (inches)	13.90	13.40	5.2
Secondary (inches)	2.92	2.68	1.04

documented). Vendor will provide wavefront error maps for both the individual components and the combined components.

Vendor shall provide a scribe mark on the side of each mirror to identify the position of the clear aperture validated during testing.

TABLE 4. Combined Surface Specifications.

Wavefront (clear aperture) (RMS @ 633 nm)	0.06λ
Wavefront (clear aperture) (P-V @ 633 nm)	0.24λ
Wavefront (full aperture) (RMS @ 633 nm)	0.12λ
Wavefront (full) (P-V @ 633 nm)	0.60λ

5. OPTICAL TESTING

Optical surface testing for acceptance purposes shall be performed with interferometric testing equipment, or equipment with similar performance approved by CHARA, capable of resolving errors at least 50% smaller than the surface deviation specification given above, and capable of resolving the surface to spatial scales of 2 mm.