Beam Sampling

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H.1. INTRODUCTION

The purpose of the beam sampling system is to transfer the seven output beams from the OPLE to the various data collection optical systems: the spectrograph, the visible fringe tracking and imaging system, and the infrared beam combiner. This section of the Array also contains the beam switching optics, atmospheric refraction and longitudinal dispersion correction subsystems, and some of the alignment optics.

H.2. LAYOUT

The layout of the beam sampling optics is shown in Figure H.1.

Having passed through the OPLE optics, all seven beams are reduced in size by a factor of five by off-axis paraboloids — herein referred to as the Beam Reducing Telescopes (BRTs). The resulting beam size is now 25 mm, the beam width used throughout the rest of the instrument. This is a convenient size for use with 'off the shelf' optical components while not being so small as to make working with the system difficult. The beams are then reflected by a set of flats so that they are parallel and evenly spaced. These flats are mounted on a set of precision slides so that each beam can be sent down any of the seven paths that reach the beam combining optics. In this way different baselines can be selected in the IR and visible systems without the need for moving parts in both systems.

A set of movable mirrors then follows so that the light from any combination of telescopes can be sent either to the spectrograph or on through to the beam combining systems, where dichroic beam splitters are used to separate the infrared and visible bands. In the visible light path, two sets of corrective optics are inserted: the atmospheric refraction correctors (ARC), for correcting the angular displacement of the beams due to refraction in the atmosphere; and the longitudinal dispersion correctors (LDC), for correcting differential dispersion in the OPLE system. Refer to Appendix N for a more complete description of the requirements for these optical assemblies.

Apart from the optics described above, a set of autocollimation mirrors are included. These are used during optical alignment of the beam combining subsystems and are placed along the line of equal phase across the beams. Note that the line of equal phase is not perpendicular to the beams but lies along a diagonal. These mirrors can be moved in and out of each beam independently and play no part in the observational mode of the array optics. The optical alignment strategy involving these mirrors is described in Appendix M.

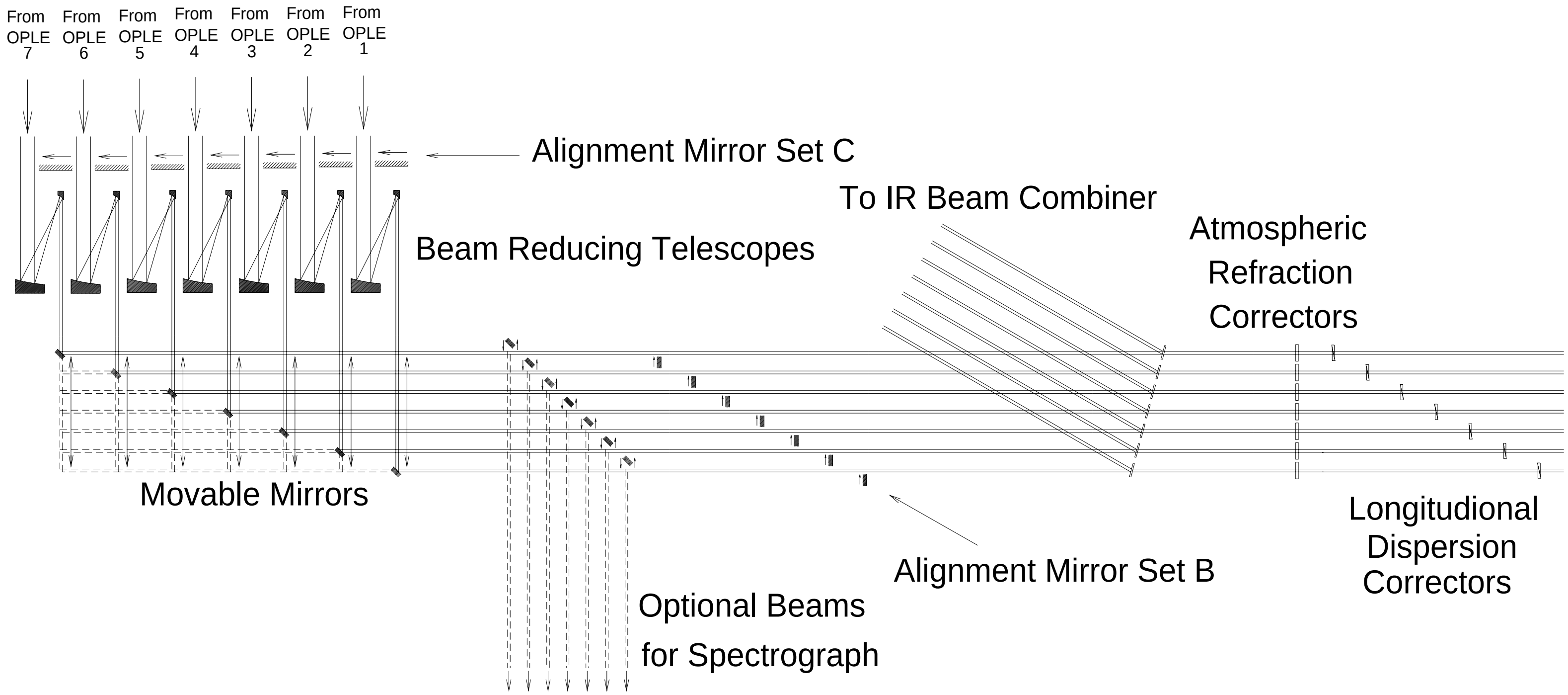

FIGURE H.1. Optical layout for the beam sampling subsystem.

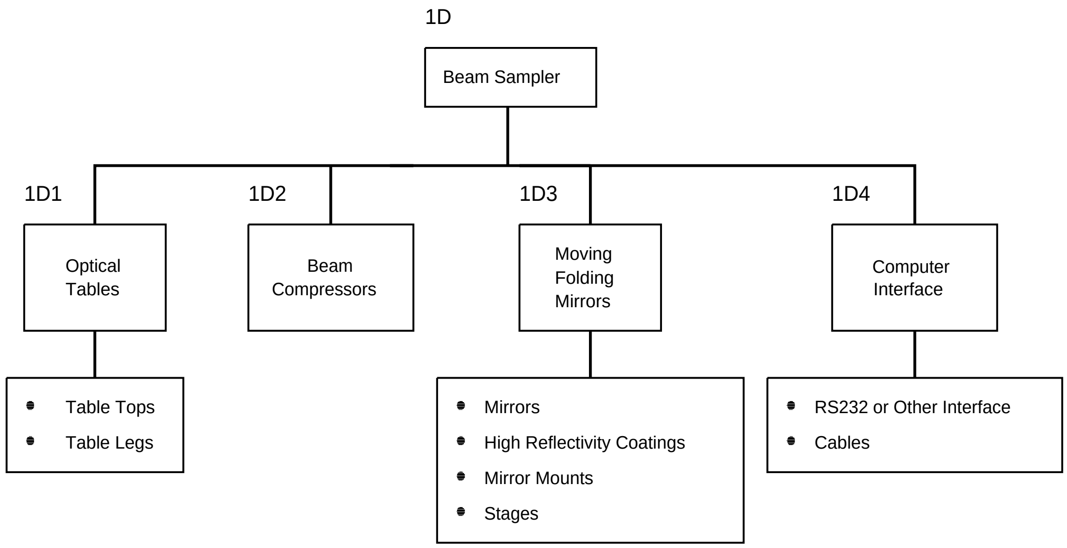

FIGURE H.2. Hardware tree for the beam sampling subsystem.

H.3. OPTICAL COMPONENTS

Most of the optics used in the beam sampling subsystem are standard components and will not be discussed in detail. However, the BRTs, ARCs and LDCs require some extra explanation. Refer to figure Figure H.2 for a hardware tree of the beam sampling subsystem.

H.3.1. Beam Reducing Telescopes

Off-axis paraboloids have been chosen for use in the beam reduction optics in order to avoid any further central obscuration of the beams. If the BRTs were on-axis paraboloids instead, the central obscuration would not match that of the telescopes. Furthermore, the alignment system requires that the part of the beam corresponding to the central obscuration in the primary of the telescopes be used for autocollimation. Since the beam size reaching each BRT is the same as that used in the OPLE system, it may be possible to cut the primaries of the BRTs from mirrors of the same design as those used in the OPLE carts.

H.3.2. Atmospheric Refraction Correctors

Atmospheric refraction results in a wavelength-dependent angular displacement of the beams. Unless this is corrected the bandwidth of the instrument will be severely affected. It is proposed to use standard Risley prisms for this correction. Since this effect is minimal in the infrared band only the visible light path contains these prisms. While it would be better to correct for atmospheric refraction at the telescopes, this would require very large pieces of glass that must be suitable for both the visible and infrared bands and would be prohibitively expensive. In Appendix N it is shown that it is possible to place the ARCs here as long as they are as close as possible to the BRTs.

H.3.3. Longitudinal Dispersion Correctors

Since the CHARA Array OPLE is in air rather than vacuum, differential dispersion will result in a wavelength-dependent path length within the instrument. As with atmospheric refraction, unless this is corrected the bandwidth of the instrument will be reduced. The LDCs use opposing wedges to add an adjustable thickness of glass to each beam. The use of this glass to compensate for dispersion is analogous to doublet lens design, where two glasses of different refractive index properties are used to optimize a lens for a specific pair of wavelengths. In this case the air path through the OPLE represents one part of the doublet, while the LDC takes the place of the other.