Final Report on DOE grant FG02-07ER41513

Developing the Optimal Technique for Cluster Photometric Redshift Determination: an Essential Ingredient in Measuring Dark Energy with Cluster Abundances.

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We received partial funding for our proposal, with the specific task of designing, procuring and evaluating dichroic (i.e. wavelength-selective) beamsplitters for use in multiband imaging systems. We have broken this project into 5 stages, and the status of each of these is described below. The funding we received from DOE under this grant went exclusively to item (2) below, the procurement of beamsplitter components, but this report places that in the broader project context.

1. Optimized Design for Immunity to Systematics

We have evaluated two conceptual optical designs. One of these collimates the light from the telescope, and then passes it through dichroic beamsplitters. The disadvantage of this approach is the sensitivity of the optical transmission to angle of incidence, especially for 45 degree configurations. This leads to significant variation in the effective passband with position in the focal plane, and corresponding systematic errors in photometric redshifts. We have therefore adopted a different approach, in which a telecentric converging beam impinges on the beamsplitter. For this design, the envelope of angles of arrival on the dichroic is the same across the entire field of view. We settled on a triplet-cube design, as shown in Figure 1 below. Four focal planes are simultaneously fed in distinct optical passbands.

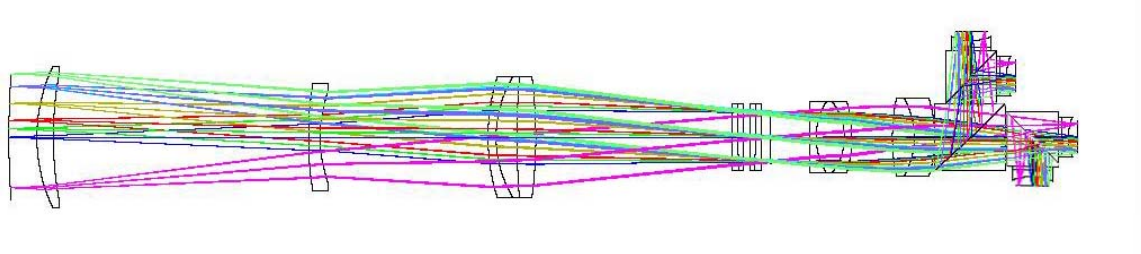

Figure 1. Design of simultaneous four-band imaging system, using a triplet of cube beamsplitters. The cube triplet splits the beam into four distinct optical passbands, each of which is imaged on a focal plane array.

2. Fabrication of Optical Components

Once the optimal design was determined, we sought bids from vendors who could both produce the interference filters needed on the diagonal faces of the three beamsplitter

cubes, and who could also bond the three cubes into a single, precisely aligned, optical component. A competitive bidding process led to the selection of Barr Associates of Westford, MA as the vendor. The funds received under this DOE grant were applied to the procurement of the beamsplitter optical component. This does not have a separate property tag since it will be incorporated into a full instrument in the next 6 months.

The optical filters have been produced with thin film interference filters, and have been shown to meet our transmission specifications. The next step is assembling the cubes into a precisely aligned optical module.

3. Assembly of Beamsplitter cube

We have provided Barr with a set of three “practice” cubes that mimic the beamsplitter units, for developing and validating the bonding technique they will use for the final assembly step. We have proceeded carefully in order to ensure the bonding step does not compromise the optical quality of the thin film filters on the cube diagonal faces.

The final assembly process is now well under way, and we anticipate final delivery of the finished product by June 2009.

4. Benchtop testing and Characterization

Upon delivery of the beamsplitter cube we will perform benchtop characterization and testing, with quantitative evaluation of transmission properties and uniformity, and optical quality.

5. On-sky Testing.

The cube triplet will be incorporated into the multiband imager for on-sky testing, and integration with photometric redshift determination code. We hope for this to happen by the end of calendar 2009.