CHAMP
CHARA Michigan Phase–tracker

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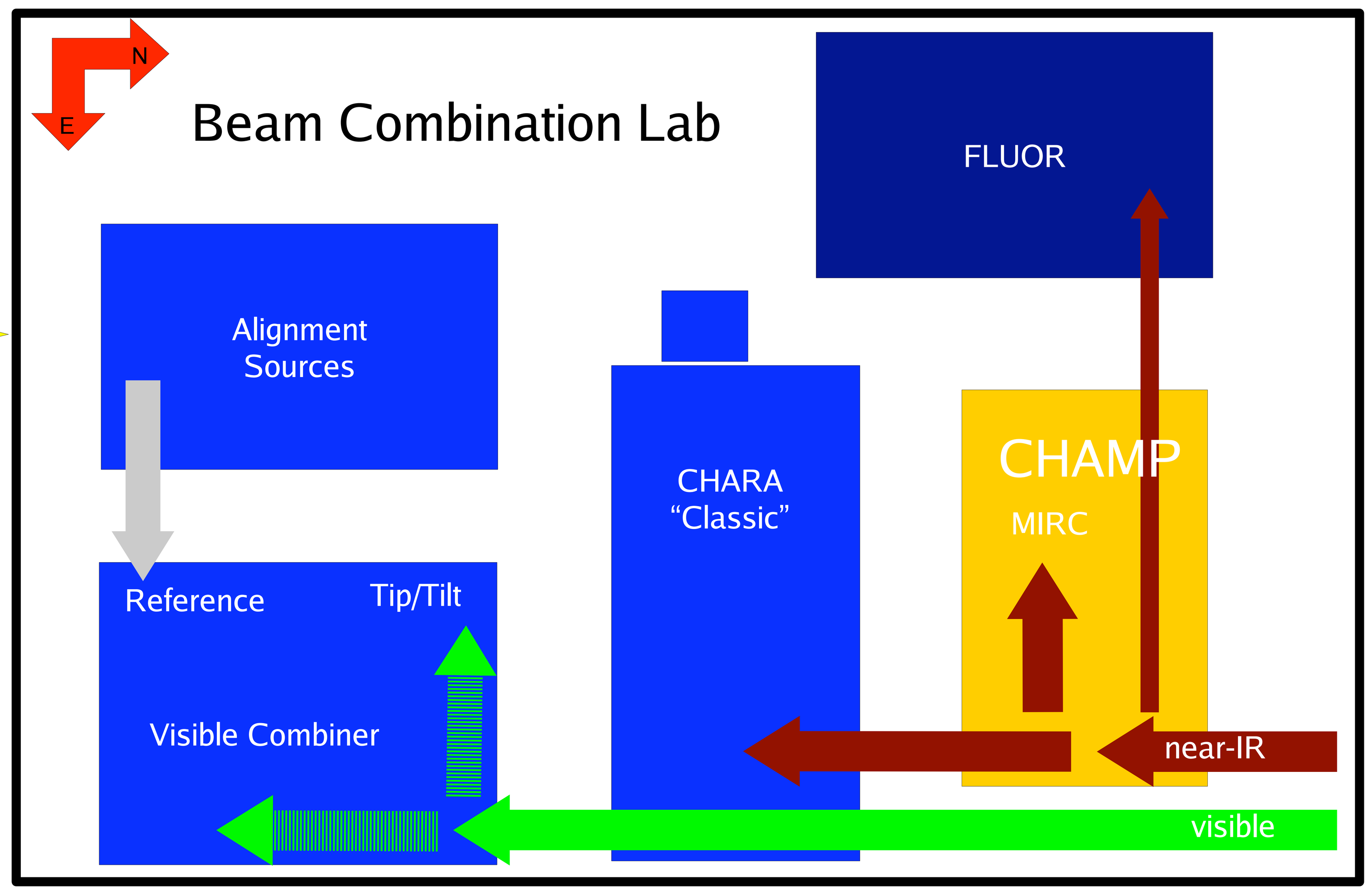
Abstract

We present the design for a near-infrared (JHK) fringe tracker to be used at the CHARA Array, a long baseline optical interferometer located at Mount Wilson Observatory. The CHARA Michigan Phase-tracker (CHAMP) is being fabricated and tested at the University of Michigan and then will be transported to the CHARA Array for general use. CHAMP is separate from the science combiners and can therefore be optimized for fringe tracking. It will modulate around fringe center by 1-2λ at up to 500 Hz and calculate phase offsets in real-time using a modified `ABCD' method . Six pair-wise Mach-Zehnder combiners will phase the entire Array. We give an overview of the optical layout and discuss our design strategy. Components such as the path-length modulators, low-OH fiber transport system, 1024x1024 HAWAII-1 detector, and control computer are discussed.

The CHARA Array

The CHARA Michigan Phase-tracker (CHAMP) is a near-infrared fringe tracker (FT) being designed and fabricated by our team at the University of Michigan for use at Georgia State University's (GSU) Center for High Angular Resolution Astronomy (CHARA) Array. The CHARA Array is a ``Y''-shaped long baseline interferometer at Mount Wilson Observatory operating in the visible and near-infrared. CHAMP will use the ABCD phase-tracking method (similar to Mark III, NPOI, and KI).



The future location of CHAMP within the Beam Combination Laboratory (BCL) is shown to the left. Before entering the BCL, the collimated beams from each telescope have been compressed to 20 mm and optionally corrected for longitudinal dispersion. Each beam is then split into visible and near-infrared components. The resulting twelve beams enter the BCL at the Northeast corner and have a 11.2" phase delay between adjacent beams. The visible beams pass eastward ofthe optical table and are untouched by the CHAMP optics.

Project Status

input optics
- CaF2 glass and coatings being ordered

path modulation
- piezos have been lab tested and ordered
- design for custom mirror mount finalized
- elliptical mirrors at UM
- amplifiers have been ordered
- analog signal generator card and breakout box at UM

beam combiner
- Infrasil glass being ordered
- off the shelf mounts specificied

camera
- dewar design finalized (delivery ~1 month)
- Hawaii chip and digital readout electronics at UM

computer
- computer at UM with RTOS installed

delay line control
- consultation with JPL engineers

Project Schedule

- Spring '06: finish optical and mechnical fabrication
- Summer '06: camera testing and dewar optics design
- Fall/Winter '06: integrate camera with combiner and close loop with artificial turbulence; upgrades to CHARA VME
- Summer '07: delivery to CHARA; sky testing

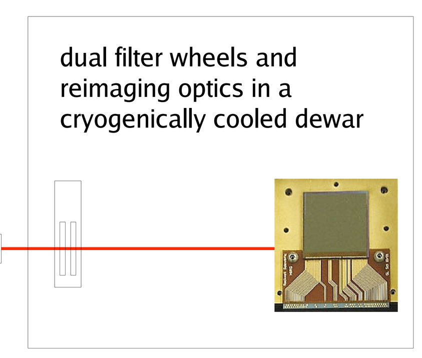
Fiber Transport

- coupled into low-OH multi-mode fibers: 50 micron core, NA=0.12
- configured in a 2-D fiber array
- short (~1-m) fibers minimize FRD attenuation

Input Optics

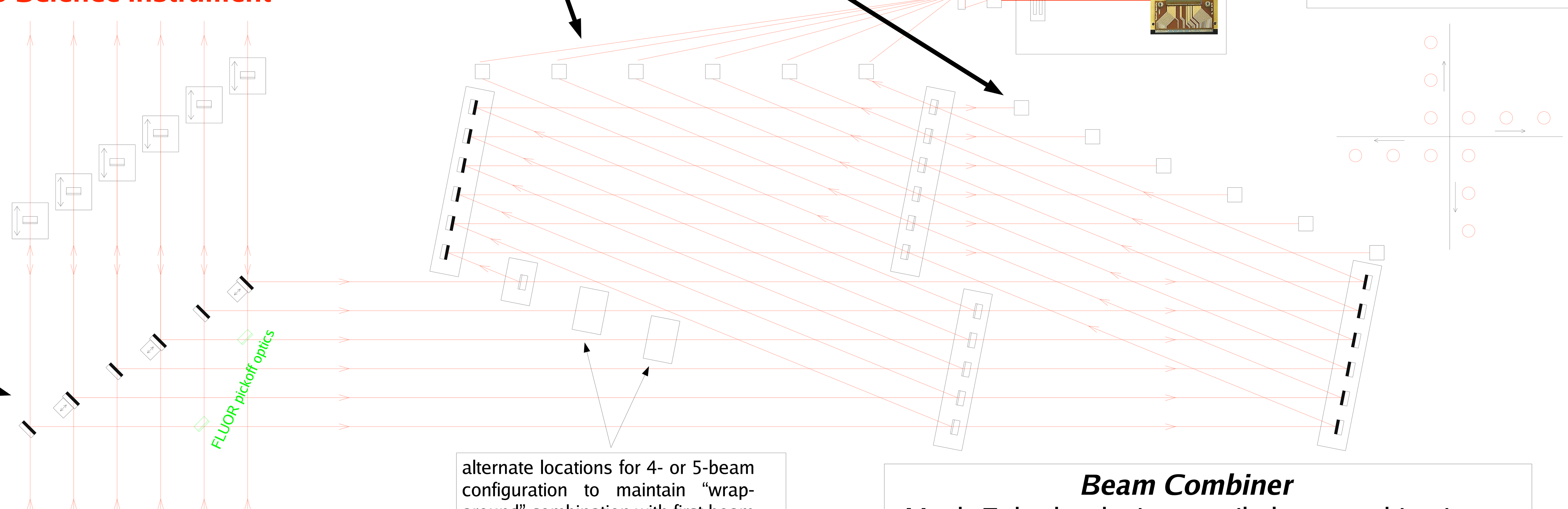
- encodes stages for internal and external phase matching
- reflects light into CHAMP using beam splitters: 50/50 gray, J+H, and K
- changes beam height from 6 to 4.5 inches (3° AOI)

Transmitted beams to Science Instrument



dual filter wheels and reimaging optics in a cryogenically cooled dewar

left: Rockwell 1k x 1k Hawaii-1 HgCdTe FPA with 18 micron pixels and 4 readout amplifiers
Below: reimaged fiber array requires only one readout line

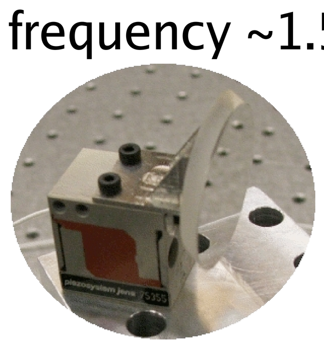


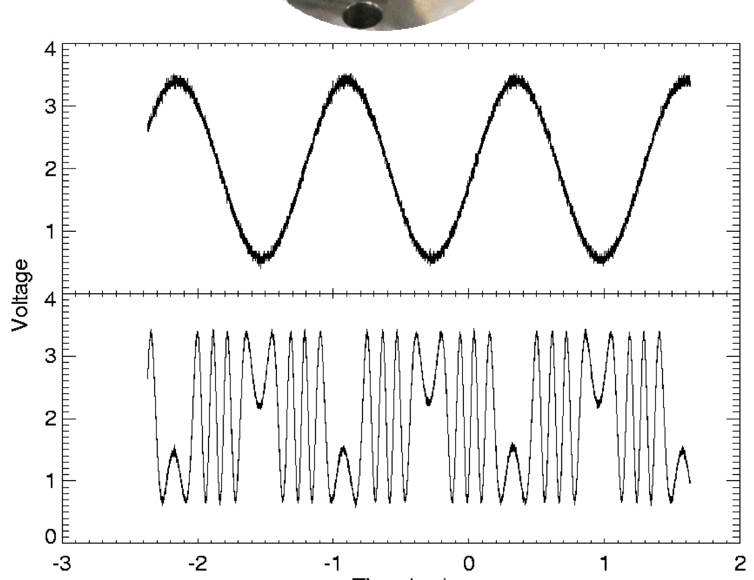
Infrared Light from Delay Lines (20-mm diameter collimated beam)

alternate locations for 4- or 5-beam configuration to maintain "wrap-around" combination with first beam

Path-Length Modulation

- every other beam at the same frequency
- 1-2 wavelength stroke at <500 Hz
- dithering via elliptical mirrors mounted on a piezo actuators
- resonant frequency ~1.5 kHz





Beam Combiner

- Mach-Zehnder design, pupil plane combination
- combines 1+2, 2+3, ... , 5+6, 6+1
- 11.09° AOI
- 25.4 x 4 mm low-OH fused silica (30 arcmin wedge) substrate with 50/50 gray coating
- individual mounts share a monolithic base

Computer and Hardware

- two 3.0 Ghz Xeon processors
- real-time Linux OS (Xenomai) – see Pedretti et al. (poster 6268-118)
- analog signal generator for piezo modulation and camera sync
- camera readout electronics
- dedicated fiber-link with delay line computer

Acknowledgments
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