



Welcome to the Caltech/IPAC CHARA Community Workshop

Douglas Gies

Director

**Center for High Angular Resolution Astronomy
Georgia State University**

www.chara.gsu.edu



Your hosts

- **Douglas Gies**, CHARA Director, Dept. of Physics and Astronomy, Georgia State University, Atlanta, Georgia
- **Jeremy Jones**, Data Scientist, GSU/CHARA
- **Gail Schaefer**, Visitor Support Scientist, GSU CHARA Array, MWO, California
- **Sergio Fajardo-Acosta**, Caltech/IPAC
- THANKS to Caltech/IPAC and NSF!

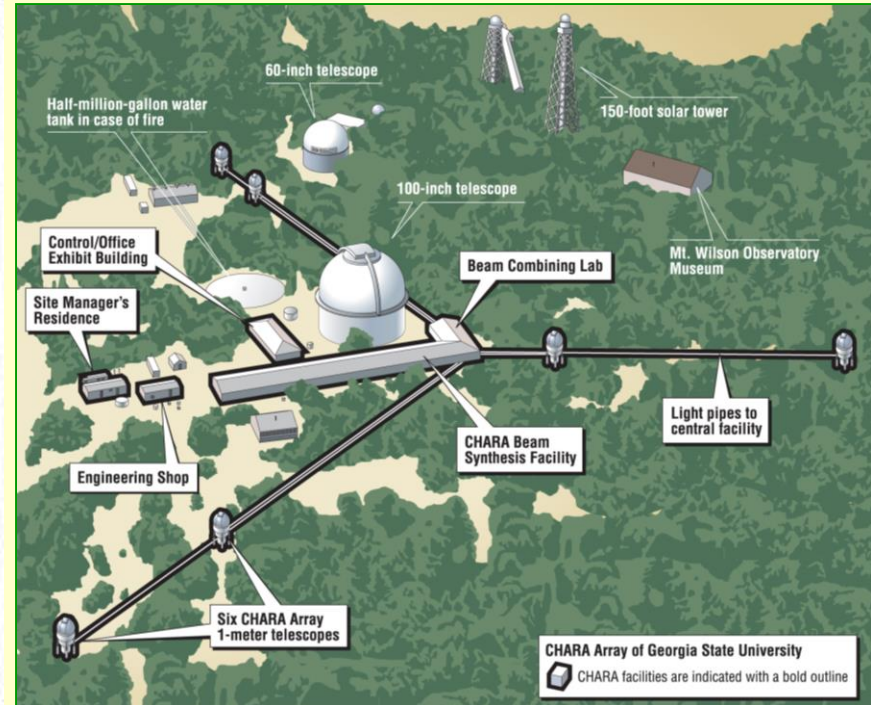
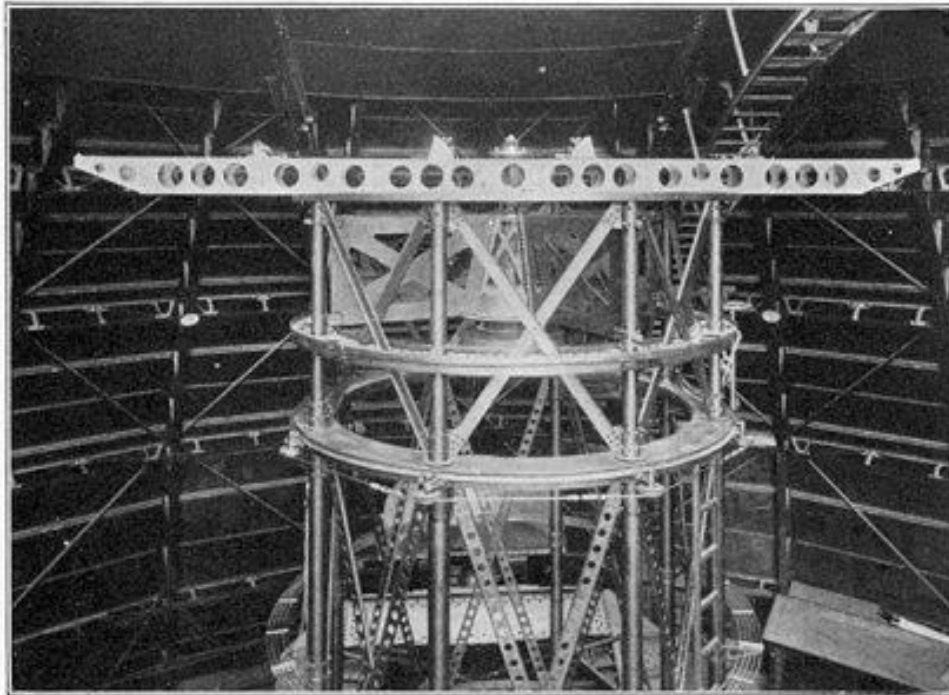


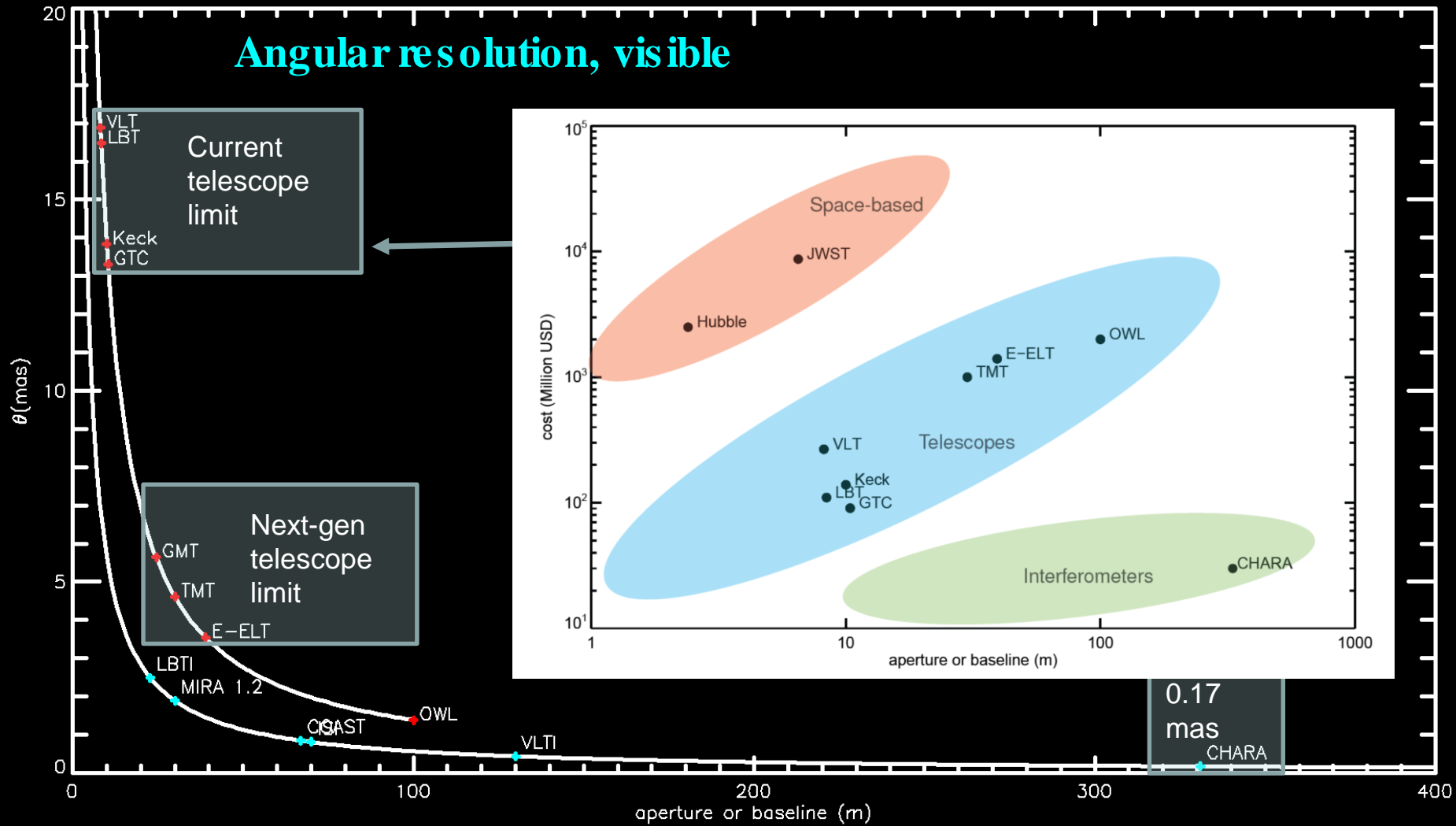
Outline

- CHARA at Mount Wilson Observatory
- Telescopes and beam paths
- Beam combiners
- CHARA and other long baseline interferometers
- Today's program

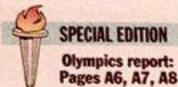
Stellar interferometry: measuring star size

- Michelson and Pease (1920): Betelgeuse
- Required technology (lasers, optics, computers)
- Culmination at Mount Wilson in CHARA Array: resolves most stars visible to human eye





The Atlanta Journal



Covers Dive Like the Dew

Copyright © 1996 The Atlanta Journal Vol. 108, No. 144 TUESDAY EVENING, SEPTEMBER 16, 1996 68 PAGES, 6 SECTIONS FINAL HOME 25 CENTS

The 1996 Olympics

Atlanta's Atlanta!

City explodes in thrill of victory



In '96 race, tortoise again beats the hare

TOKYO — You'd probably better take this sitting down. Find a chair. Take a cold drink of water. Race yourself. Clear your head.

Chilus, albus, fortius, Atlanta.

You have just become the parents of the Olympic Games. Not just any old Olympic games, but the 100th birthday Games, the 1996 Olympic Games, the centennial year of rebirth.

Senior Juan Antonio Samaranch, president of the International Olympic Committee, took his stance at the podium before a packed auditorium in the New Takanawa Prince Hotel, and a worldwide television audience, Tuesday night about 8:45 (Tokyo time) and let the world hear the news.

The IOC had made its choice. Not Athens, the most favored rival, for it was there the Games were revived in 1896, not Melbourne, the Australian city considered the best compromise choice; not Toronto, Atlanta's North American rival.

Not Manchester, England, not Budapest, Yugoslavia, but ATLANTA, capital seat of Georgia. After four ballots, it pulled down Atlanta and Athens — the one in Greece, not the one in Clarke County — and Atlanta took the Greek capital on the fifth ballot, 51-35.

So once again it was proved that it ain't over till it's over, and in this case, until the fat ladies sang. Eighty-seven delegates were advised, but one was winning for reasons unknown by this correspondent.

It had been a long, hard climb from zero to the top of the mountain for Billy Payne, the attorney and former Georgia football player who came up.

Please see BISHER, A6 ▶



Moment of victory: People at Underground Atlanta celebrate today upon hearing the IOC's decision, broadcast live from Tokyo on large TV screens.

'We finally won something!'

By Gary Pomerantz Staff writer

Some 126 years after Atlanta lay in smoking ruin, the city emerged today as an international superpower.

Soon after daybreak at the Peachtree Fountain Plaza of Underground Atlanta, an estimated crowd of 2,000 watched a

satellite television feed from Tokyo and learned that Atlanta had captured the 1996 Olympic Games.

The reaction was immediate: 2,500 balloons were released, confetti was shot from cannons, fireworks exploded in the morning sky, blacks hugged whites, and school kids playing hocky screamed at the top of their

lungs. A businessman in a gray suit squawked a construction worker holding a lunch pail. An elderly woman cried.

Call it a Greek tragedy and send a God-Well-Soon card to Athens, express mail.

For Atlanta, a city that long has been skeptical of great ex-

Please see UNDERGROUND, A6 ▶

Athens defeated on 5th vote

By Bert Roughton Jr. and Karen Rosen Staff writers

TOKYO — Atlanta's Olympic dream has come true. Promising to stage the best Olympics the world has known, Atlanta today won the right to play host to the 1996 Games, which will mark the beginning of the second century of the modern Olympics. Atlanta will be only the third U.S. city to host the Summer Games.

The nearly 400 Atlantans scattered around the enormous, ornate ballroom of the New Takanawa Prince Hotel exploded into cheers as International Olympic Committee (IOC) President Juan Antonio Samaranch made the simple announcement.

"The International Olympic Committee has awarded the 1996 Olympic Games to the city of Atlanta," Mr. Samaranch said.

Atlanta Organizing Committee (AOC) President Billy Payne embraced former Mayor Andrew Young and Mayor Maynard H. Jackson, who were sitting on the front row in front of a stage where the IOC members were standing.

Charlie Battle, an AOC member whose personal skills at lobbying IOC members were a key in Atlanta's win, said he was "stunned."

"I'm excited, I'm elated. I'm shell-shocked," he said. "I can't express it. I'm at a loss for words."

Martina Payne, Mr. Payne's wife, sat on the edge of her seat until the announcement and then hugged their daughter, Elizabeth, and son, Porter. Vince Doo-

Please see OLYMPICS, A10 ▶

Fireworks tonight, parade on Monday

By Ben Smith III Staff writer

Let the party begin. The citywide celebration kicked off by the announcement of Atlanta's acquisition of the 1996 Olympic Games continues tonight and into next week, culminating in a ticker-tape parade Monday for the Atlanta Organizing Committee (AOC) on Peachtree Street.

Thousands of metro Atlantans were expected at Underground to listen to Dr. Martin Luther King Jr. speak and rock bands, surf on screens. AOC T-shirts, and see a fireworks display at 8:45 p.m.

"It will be quite spectacular," said Laurie Gillen, an AOC volunteer. "According to the guy who is doing it, it's the biggest fireworks display that's ever been done in Atlanta."

The 7:49 a.m. announcement of Atlanta's victory will be replayed continuously on large television screens at Underground 15 minutes before the top of every hour. Ms. Gillen said 51 ticket

Workshop 2017-10-08

Resolving power of CHARA equivalent to seeing astronauts on the Moon ...

Exhibition open same scale (1900)



Observatory actor same scale (1893)



Hale (200") Mt Palomar, California (1948)



Hobby-Eberly Telescope (1999-) Davis Mountains, Texas, Arizona



Large Binocular Telescope (Large Binocular Telescope) (1995)



Large Synoptic Survey Telescope (Large Synoptic Survey Telescope) (2003)



Kepler Earth-trailing solar orbit (2009)



Hubble Space Telescope Low Earth Orbit (1990)



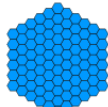
Magellan Telescopes Las Campanas, Chile (2000/2002)



Overwhelmingly Large Telescope (cancelled)



Large Sky Area Multi-Object Fiber Spectroscopic Telescope Hebei, China (2009)



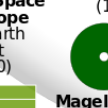
Southern African Large Telescope Sutherland, South Africa (2005)



Very Large Telescope Cerro Paranal, Chile (1998-2000)



Giant Magellan Telescope Las Campanas Observatory, Chile (planned 2020)



Gran Telescopio Canarias La Palma, Canary Islands, Spain (2009)



European Extremely Large Telescope Cerro Armazones, Chile (planned 2022)



Human at the same scale



Scale: 0 5 10 m / 0 10 20 30 ft



or reading the fine print in a newspaper from across the country



The CHARA Legacy of Prof. Hal McAlister



Founded in 1984 GSU Center for High Angular Resolution Astronomy with goal to build a world-class instrument.

Realized with the CHARA Array, the best of its kind in the world.

Ground breaking July 13, 1996.

First “fringe” November 1999.

Scientific observations since 2004.

Hal retired (Aug 2015), now emeritus professor at GSU.



10000 km



VLBA spans the Earth and has the highest angular resolution of any observatory



Image © 2005 EarthSat

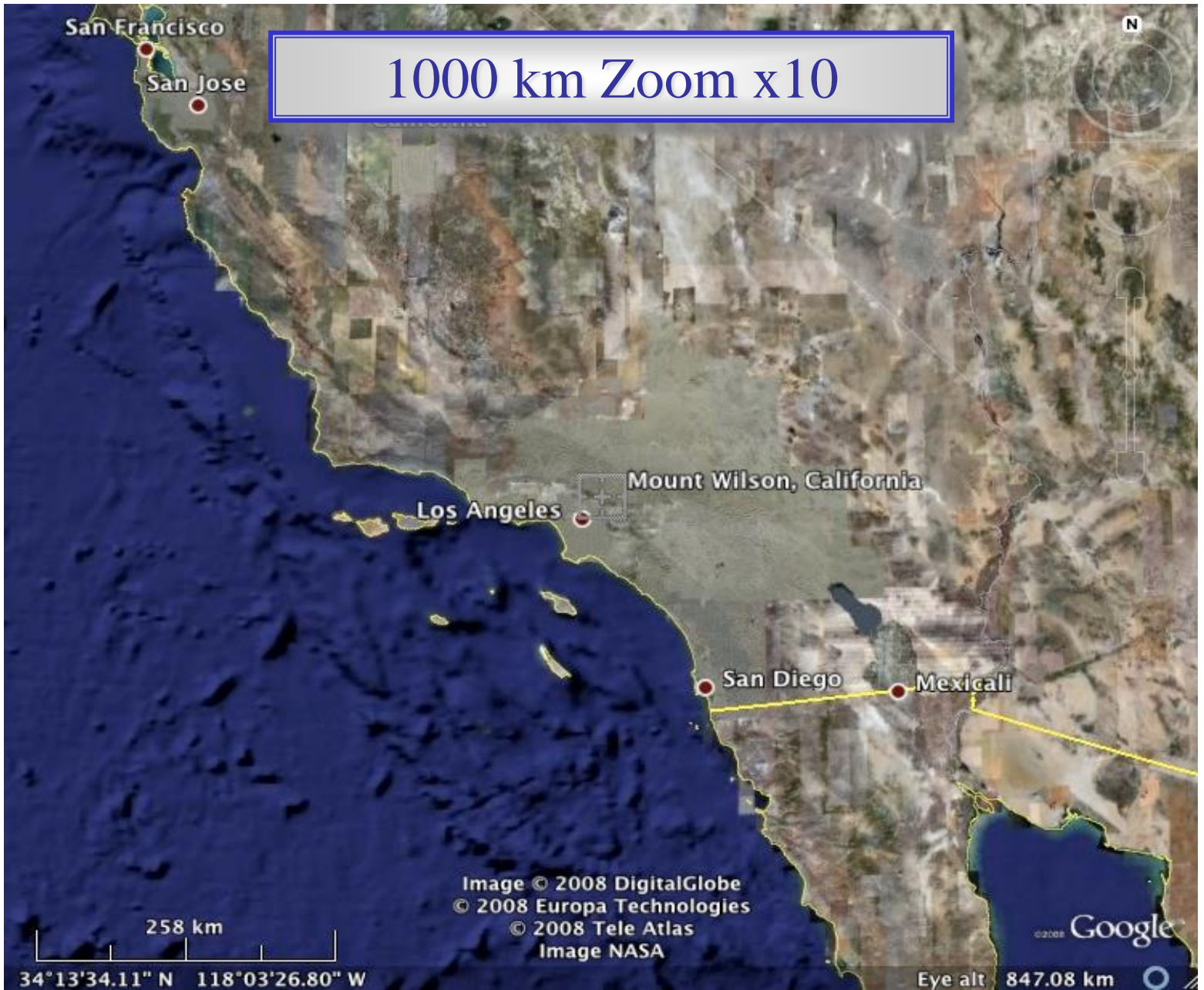
© 2005 Google

Pointer: 33°08'16.94" N 108°28'03.21" W

Streaming ||||| 100%

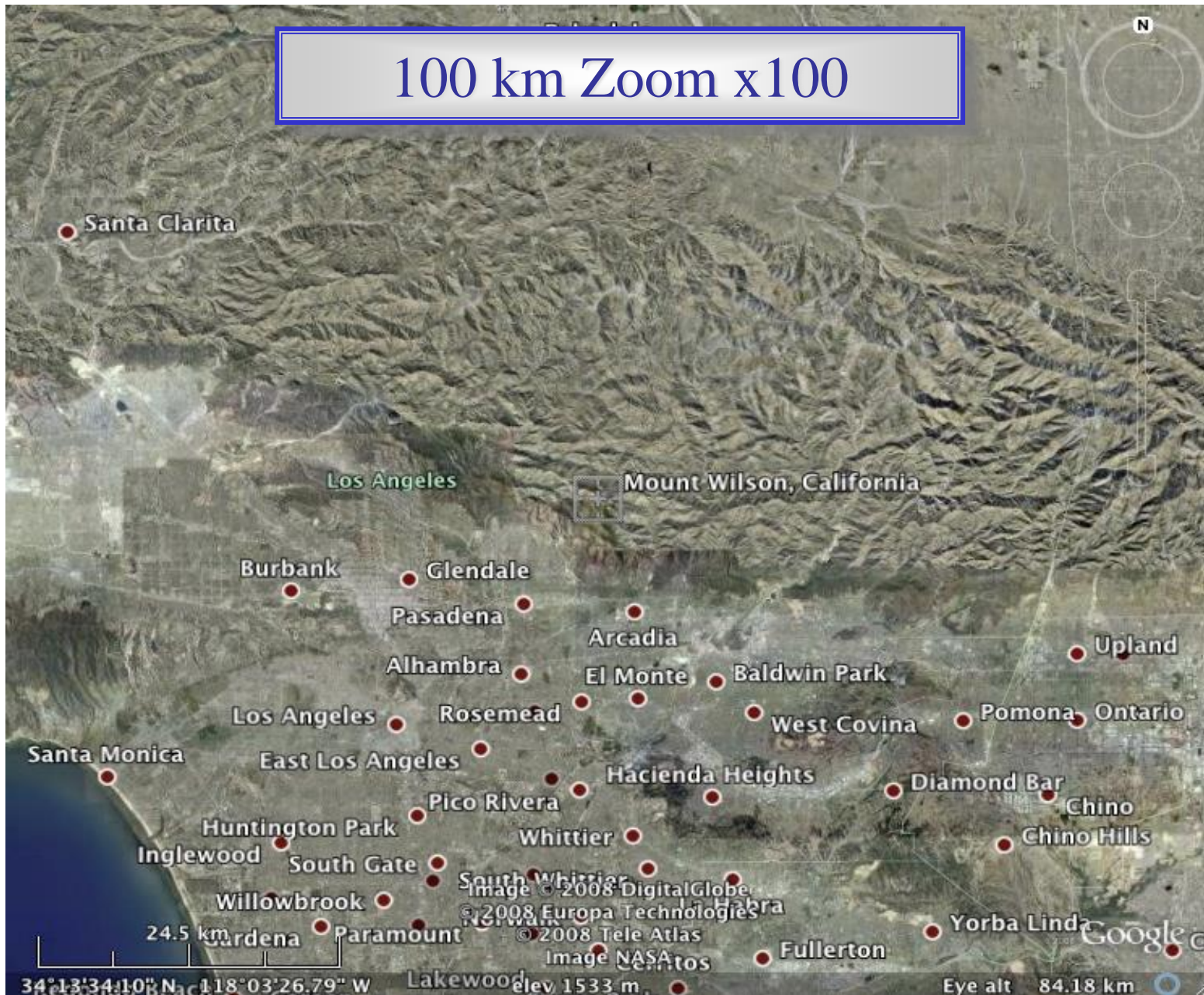
Eye alt: 4014.55 mi







100 km Zoom x100





10 km Zoom x1000





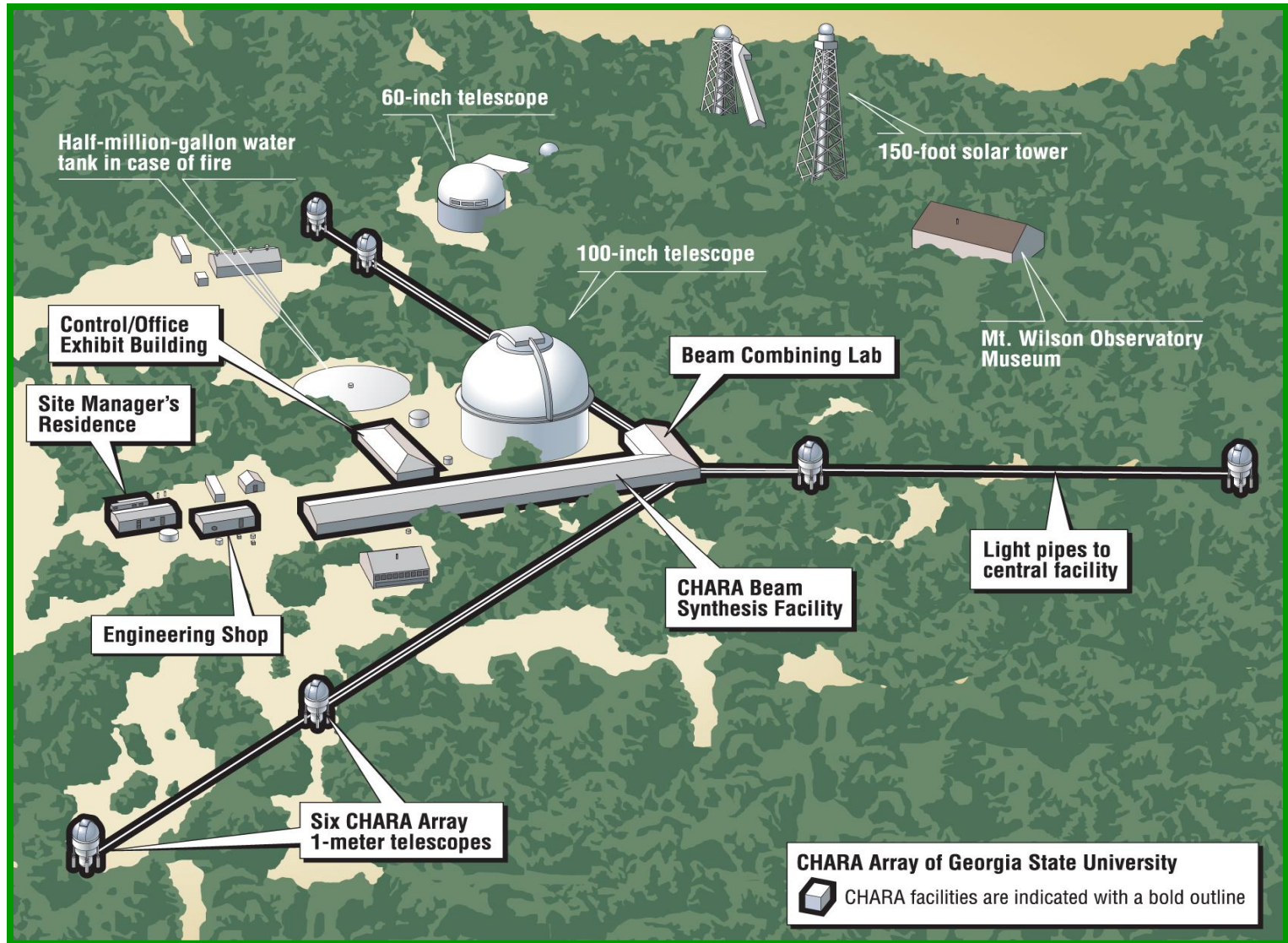
1 km Zoom x10000

By using NIR and Visible light instead of radio waves, we can achieve the same angular resolution as VLBA but with a much smaller interferometer





Layout of the CHARA Array





A short visit to Mount Wilson





Telescopes



~6
ft

CAD by Laszlo

Photo by Steve
Golden



LESIA



Observatoire
de la COTE d'AZUR

UNIVERSITY OF
EXETER



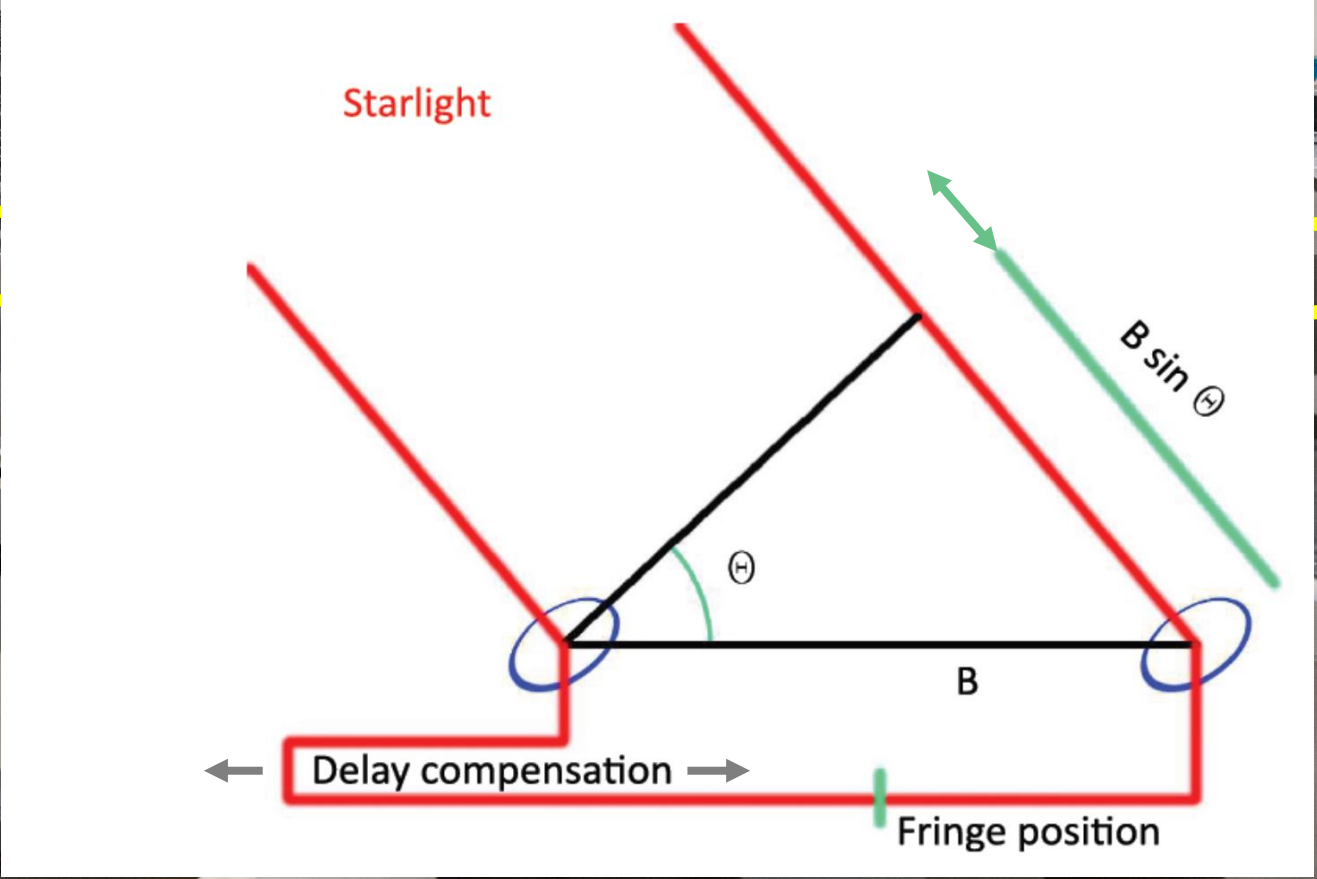
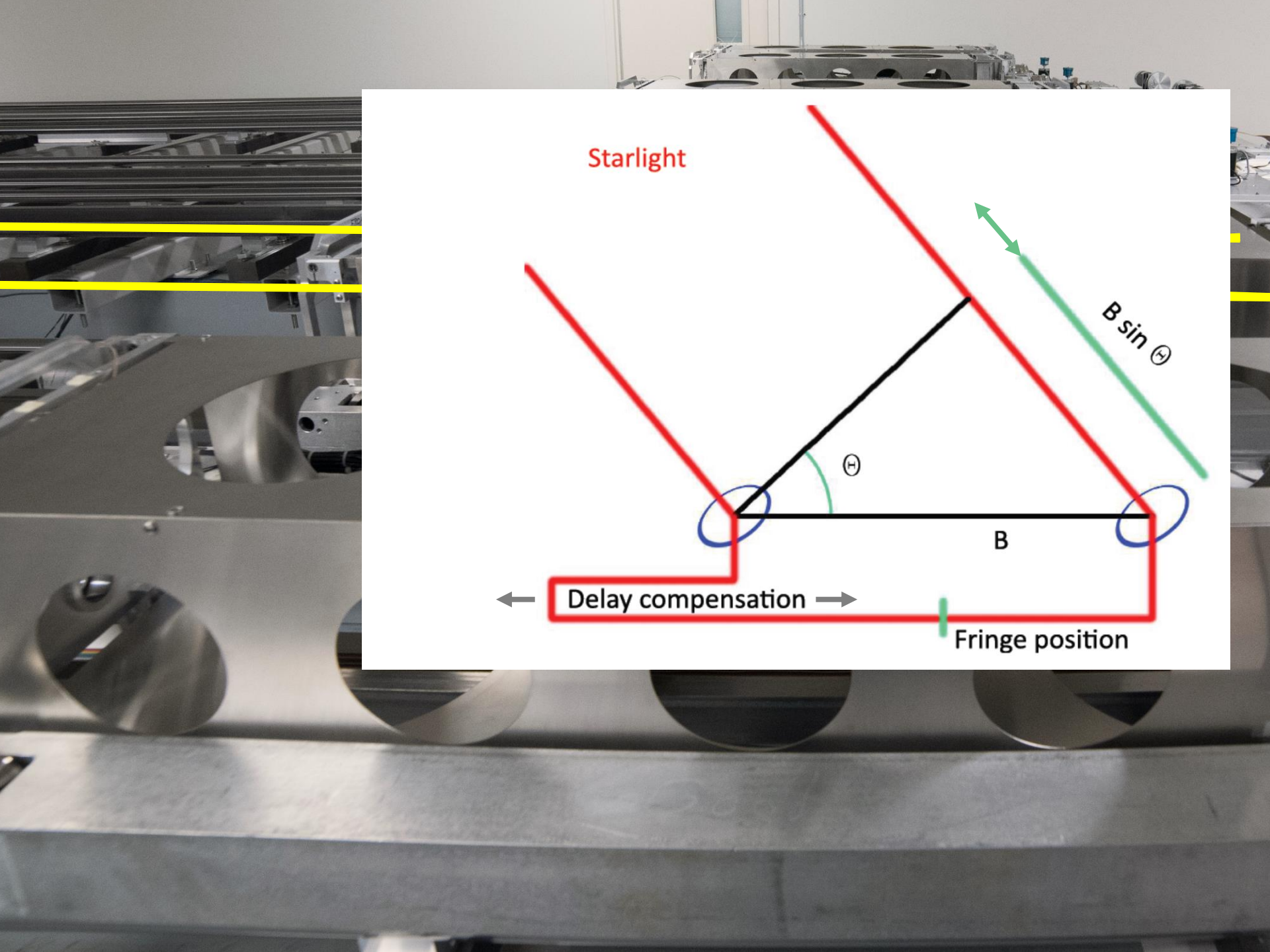


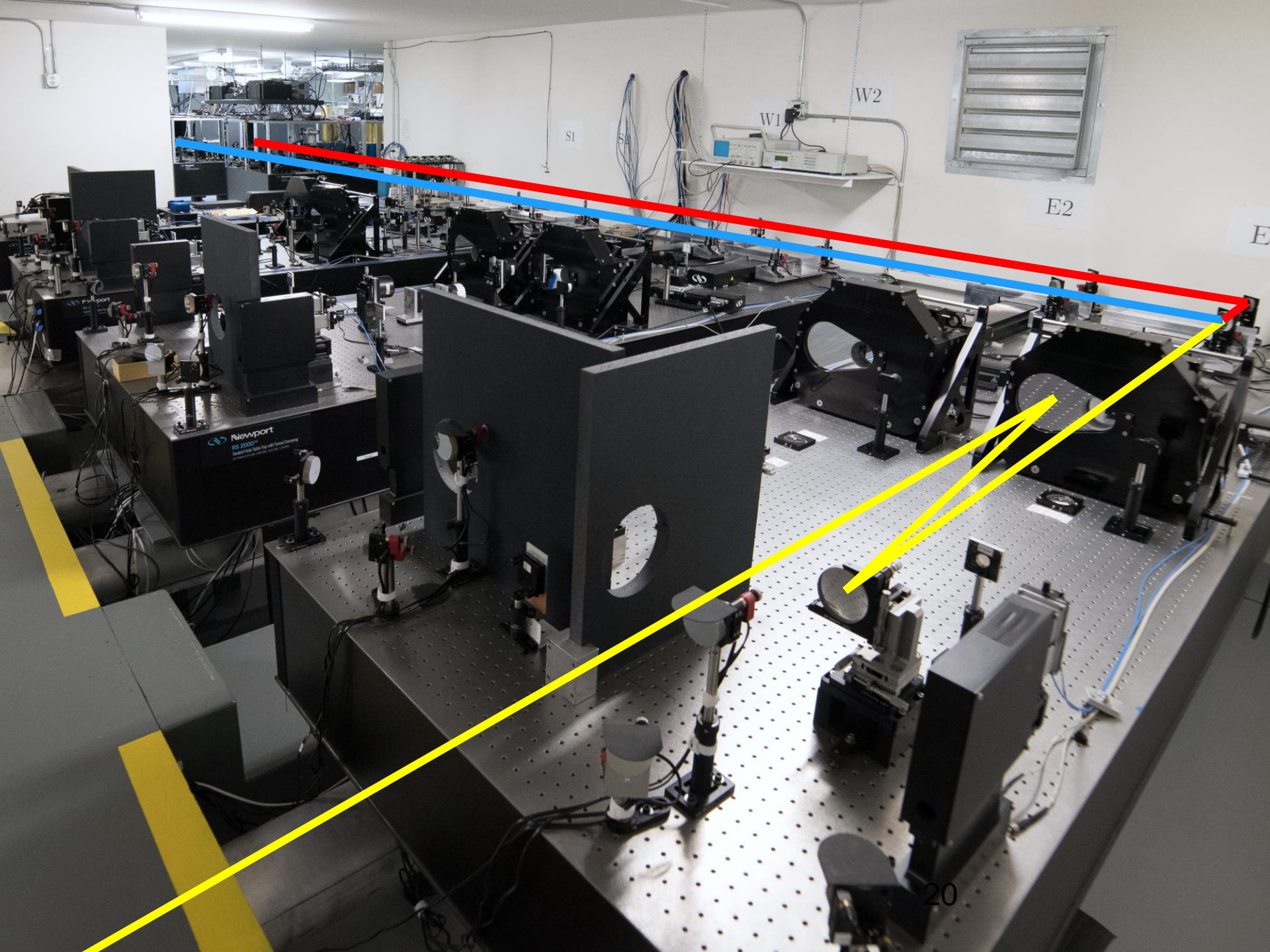
Vacuum Light Tubes

Feed Light from Each Telescope to the Central Lab









SI

SA

W1

W2

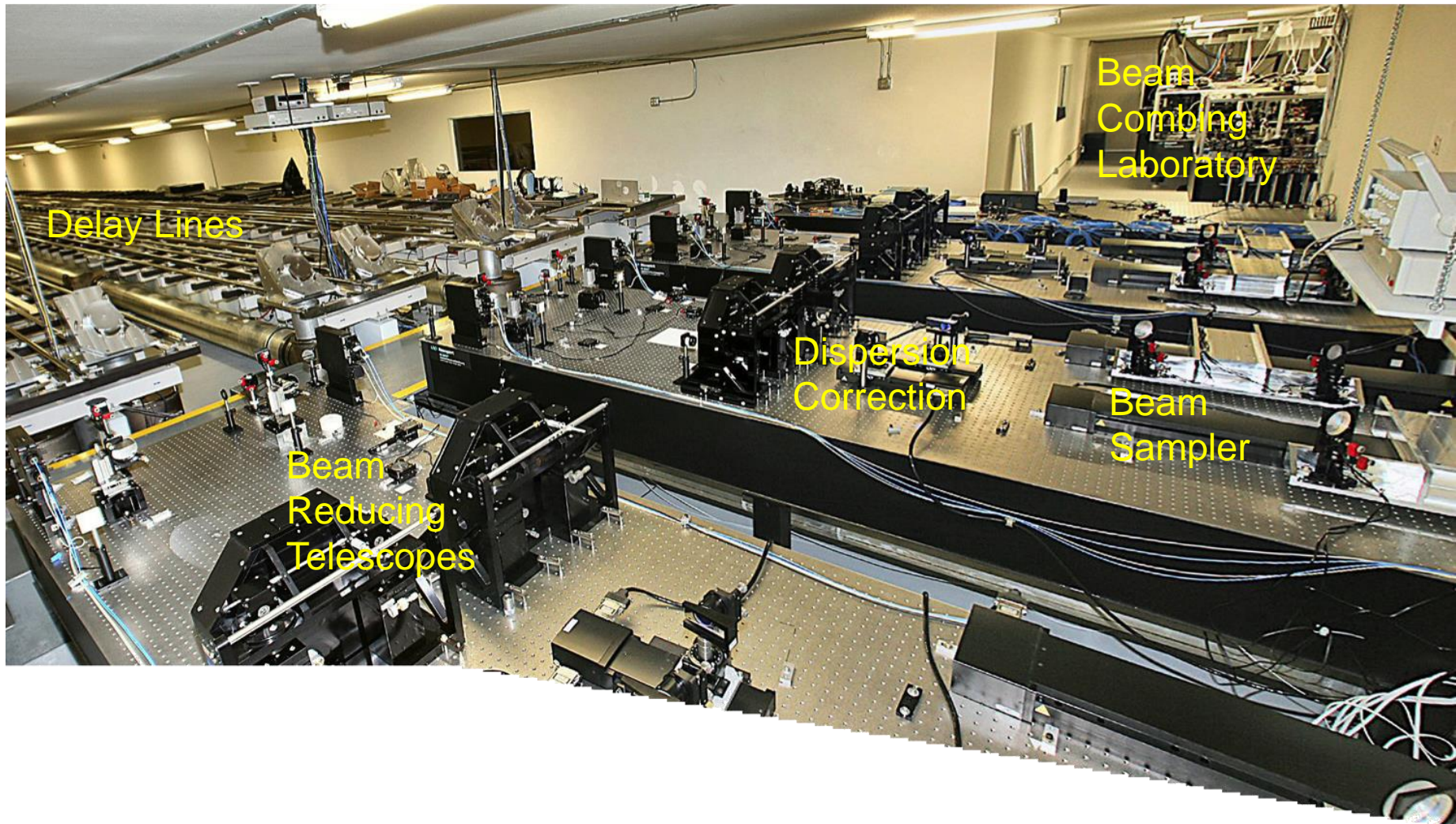
E2

E

Newport
RS 2000P
Motorized Table Top with Speed Control



Optics Laboratory



Delay Lines

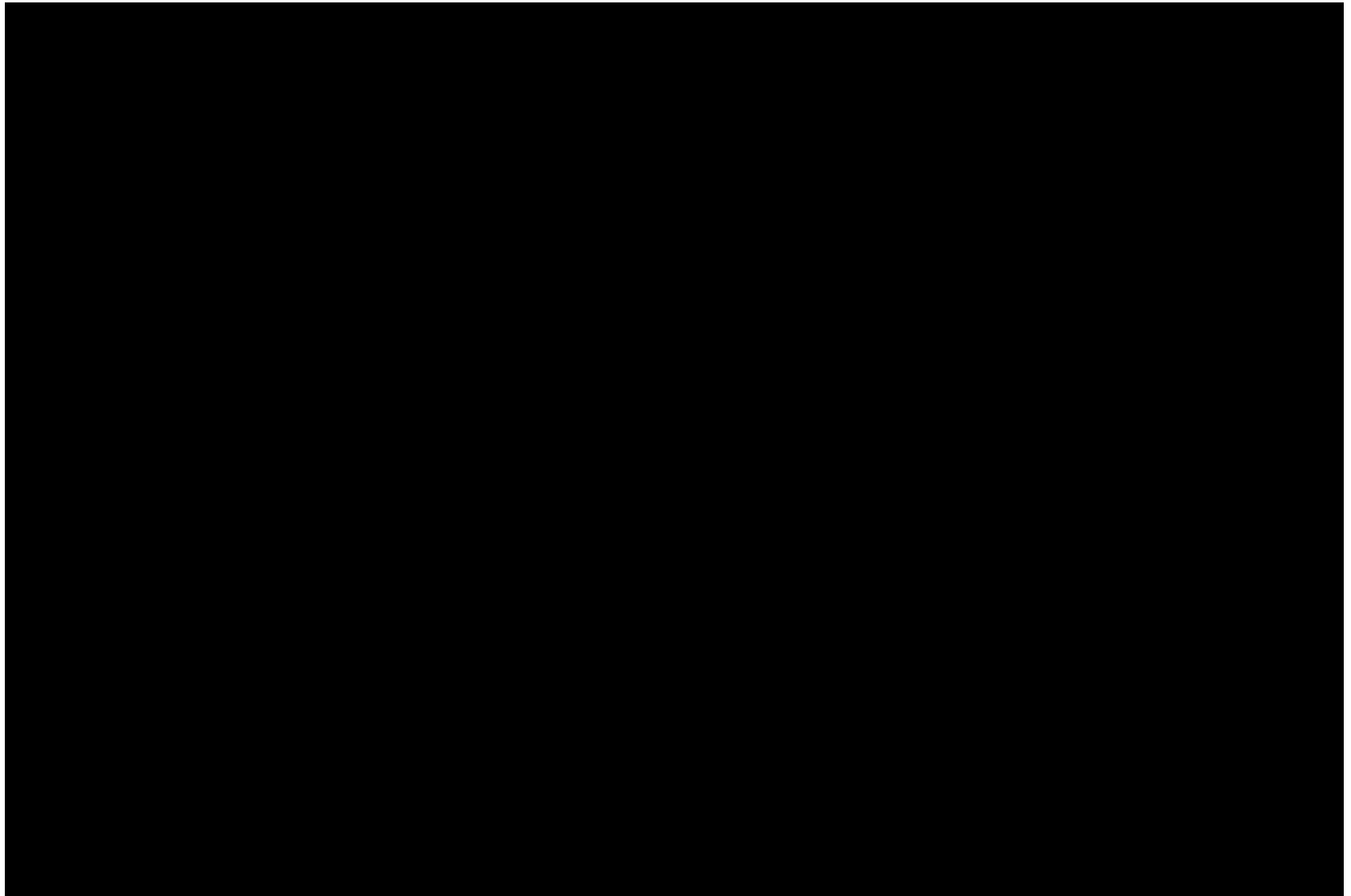
Beam
Combing
Laboratory

Dispersion
Correction

Beam
Sampler

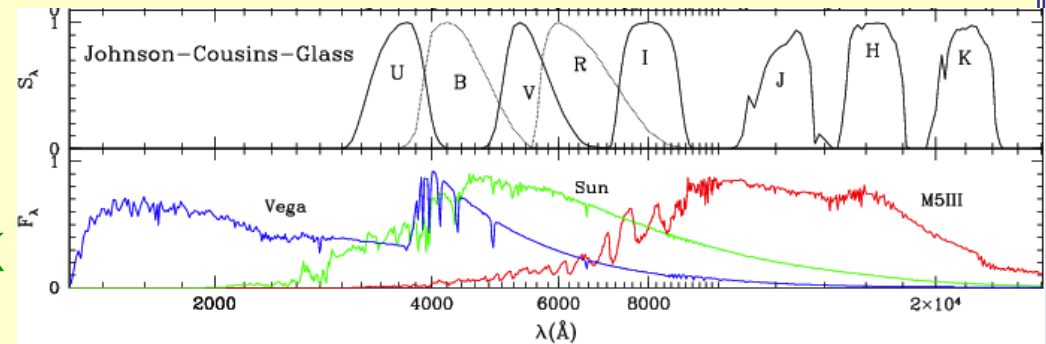
Beam
Reducing
Telescopes

The 30 second CHARA tour.



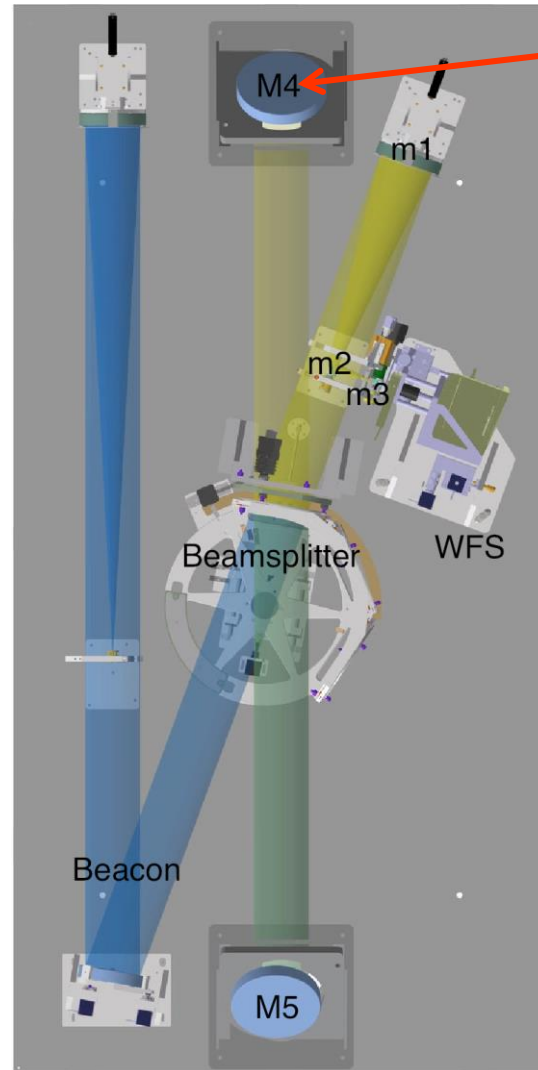
Beam Combiners: 0.5 - 2.2 microns

- *Classic (GSU)*
2-tel open-air J,H,K
- *CLIMB (GSU)*
Dual 3-tel open-air J,H,K
- *JouFLUOR (Paris)*
2-tel fiber-based K band
- *MIRC (Michigan)*
6-tel fiber-based imager H
- *VEGA (Nice)*
4-tel open-air V,R,I R=6000, 30000
- *PAVO (Sydney)*
2-tel aperture-plane V,R,I
- *In progress: AO plus MIRCX, MYSTIC, SPICA*





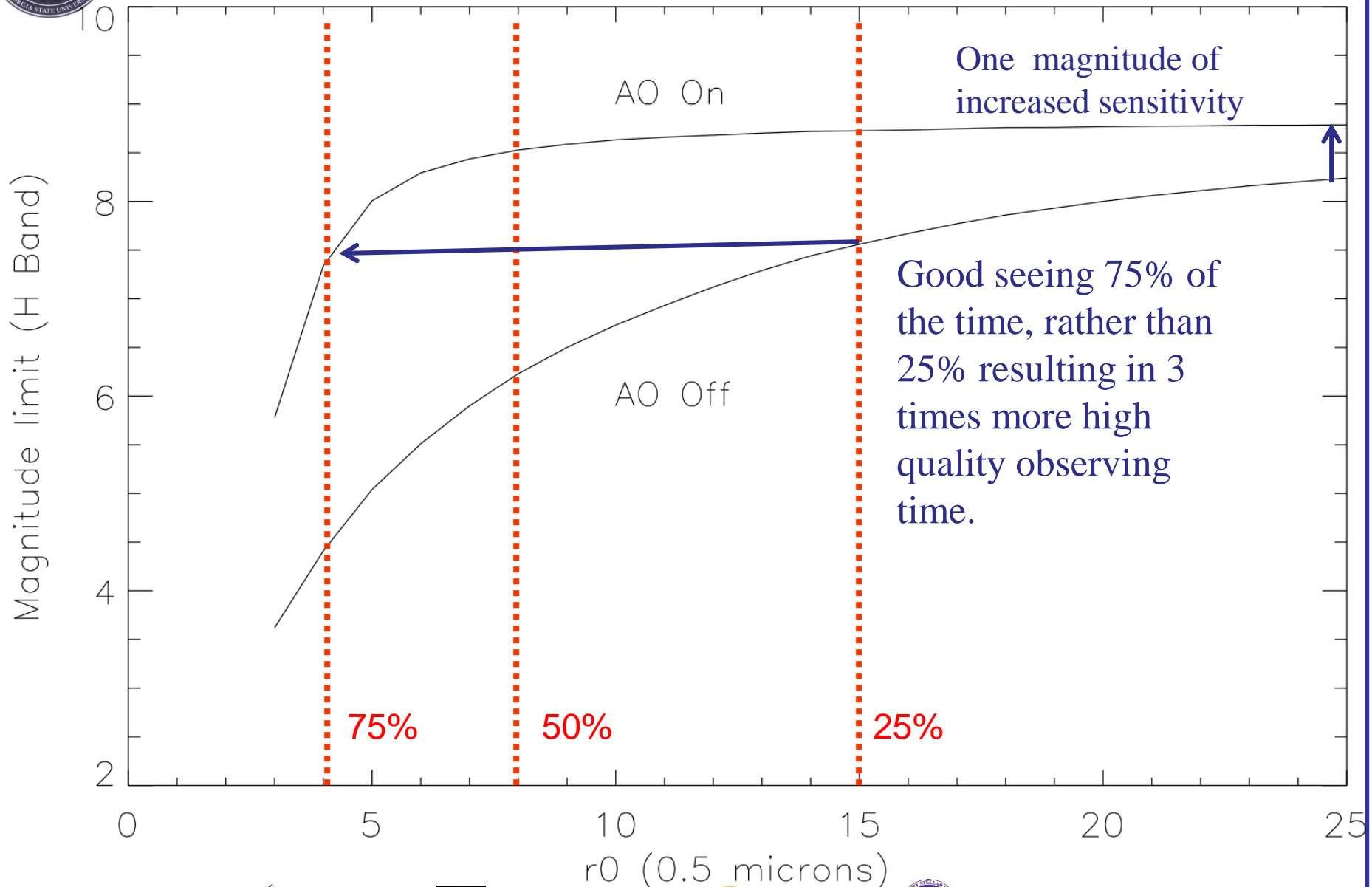
CHARA-AO: Telescopes and Lab



We will replace M4 with a deformable mirror at each telescope. This will enable us to correct for atmospheric seeing and increase scientific throughput.



Introduction of Adaptive Optics Underway

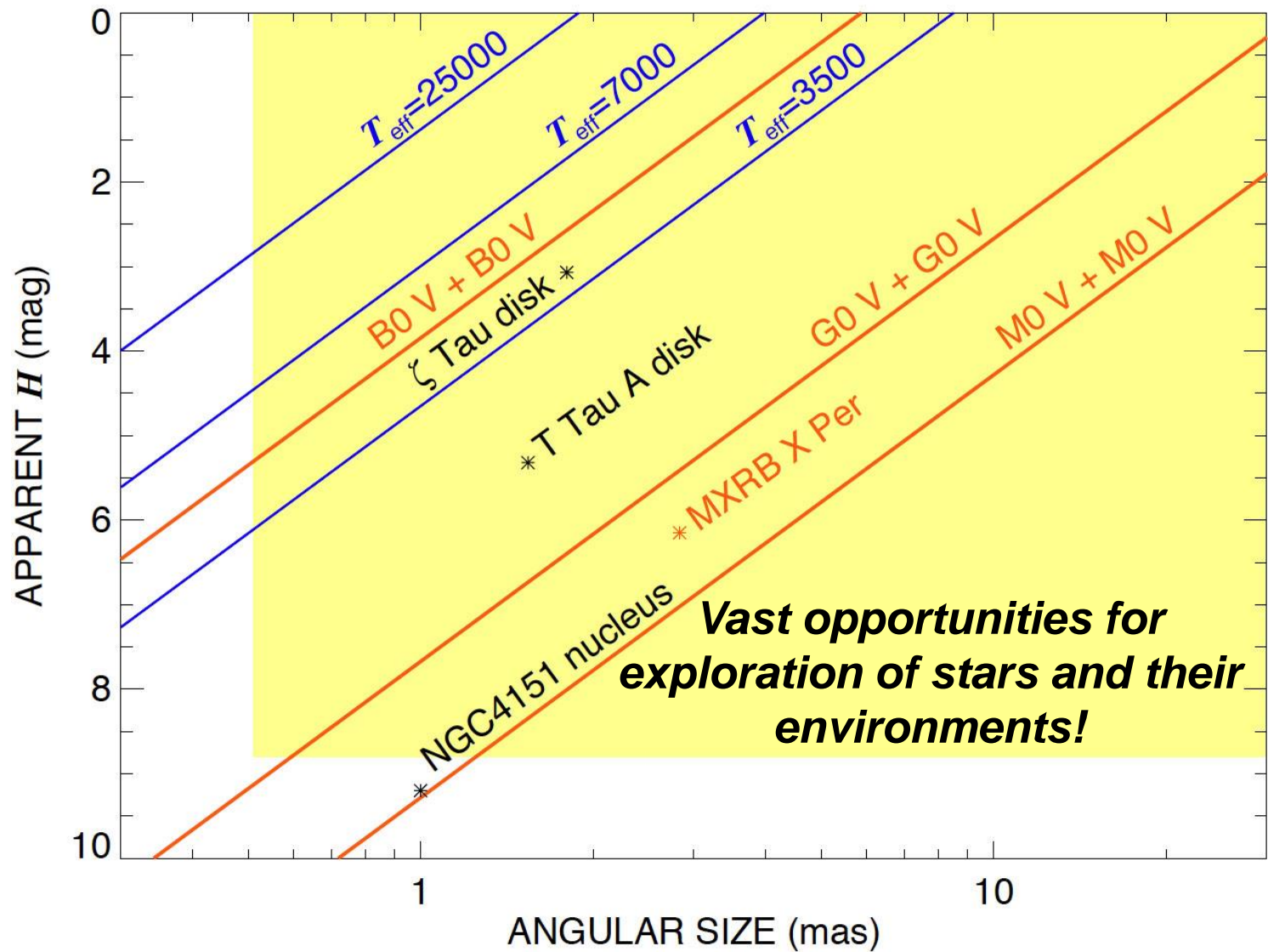


One magnitude of increased sensitivity

Good seeing 75% of the time, rather than 25% resulting in 3 times more high quality observing time.

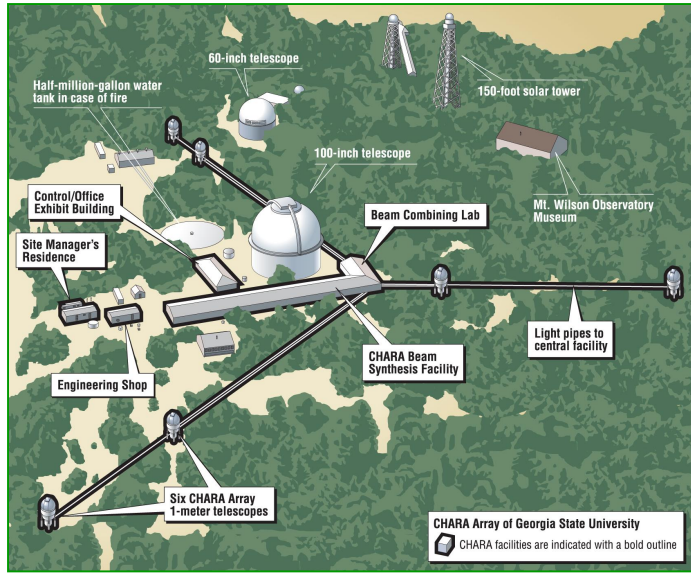


Working limits for Classic BC: stellar diameters, disk diameters, binary star separations (P=10d)

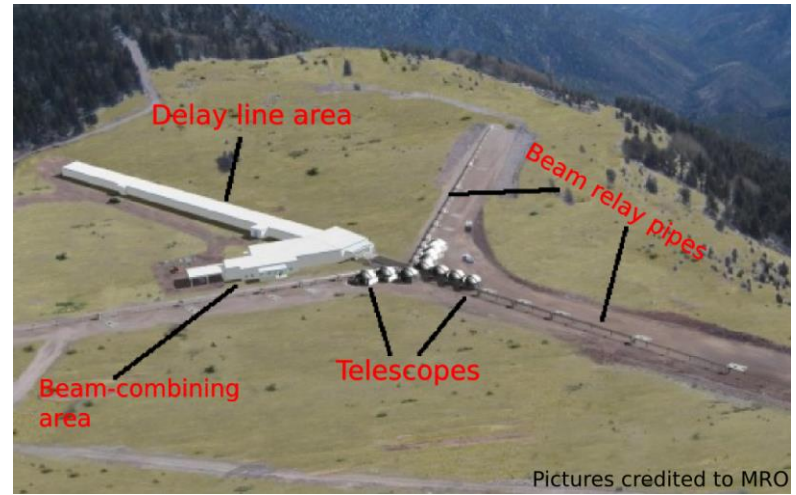




Other Long Baseline Interferometers



CHARA



MROI (under construction)



NPOI



VLTI



Goal: provide background for you to propose observations with the CHARA Array. *Morning Program*

Time	Topic	Speaker
11:10	Overview of the CHARA Array	Douglas Gies
11:40	Interferometry & Science Review	Gail Schaefer
12:10	Applying for time at CHARA	Douglas Gies
12:50	Lunch	



Afternoon Program

Time	Topic	Speaker
1:50	Observing strategies and planning software	Gail Schaefer
2:10	Data format and modeling/imaging software	Jeremy Jones
2:40	<i>Science topic:</i> Stellar Diameters & CHARA	Kaspar von Braun
3:00	<i>Science topic:</i> Science with PAVO	Dan Huber
3:20	<i>Science topic:</i> Ages of Stars	Jeremy Jones
3:40	Open discussion	All
4:00	End of program	



*CHARA Research
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National Science Foundation
GSU College of Arts & Sciences
plus resources obtained
by the
CHARA Collaboration Members



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