CHARA Futures

Douglas Gies
CHARA Director
Georgia State University, Atlanta, GA, USA
gies@chara.gsu.edu

CHARA Futures: Meeting 22 September 2017

- CHARA and NOAO
- Guidelines for Discussion
- Scientific Goals
- Stellar Samples
- Mt. Wilson Sites for Additional Telescopes
- Limitations: Telescopes, OPLE, BCL
- Organizational Challenges
- “Strawman” Concepts
- Discussion

CHARA and NOAO

- CHARA is providing open access to the Array for 25 nights/semester (50 nights/year) through competitive proposals collected and reviewed by the National Optical Astronomy Observatory (via Steve Ridgway)
- NOAO interested in continuing plan into future
- Invited representatives from CHARA (ten Brummelaar, Gies, Schaefer), NPOI (van Belle), MROI (Creech-Eakman) [+PFI paper by Monnier et al.] to a Decadal Planning workshop in Tucson (Feb. 20, 21)
- Plan to build science cases and develop specific plans for the U.S. Decadal Review for the 2020s
- Now is the time to consider future of CHARA

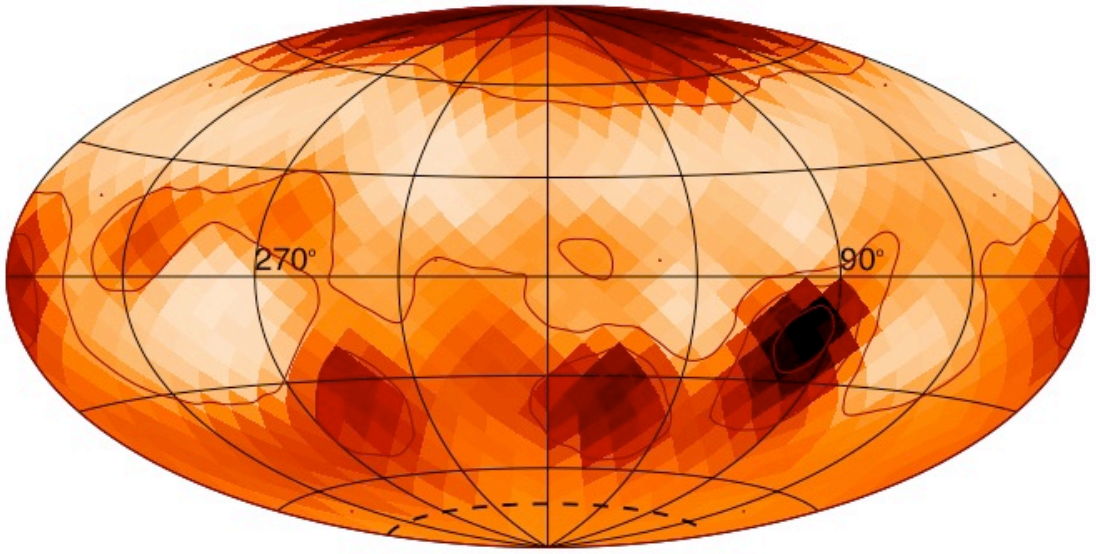

The CHARA Array
Georgia State University
CHARA Futures Meeting – 22 Sep 2017 – Mount Wilson, CA

CHARA Staff Meeting on Futures

- Now in 15th year of regular observing with AO coming
- Develop plans that build on our strengths
- Not building a new array
- Projects that can be completed in 5 – 10 years
- Scientific goals and physical limitations
- Report here on contributions from staff

Scientific Goals

- From stellar properties to stellar processes
- CHARA Array:
  many and varied baselines
  make it ideal for ***imaging***
- Need to define key science programs to guide designs



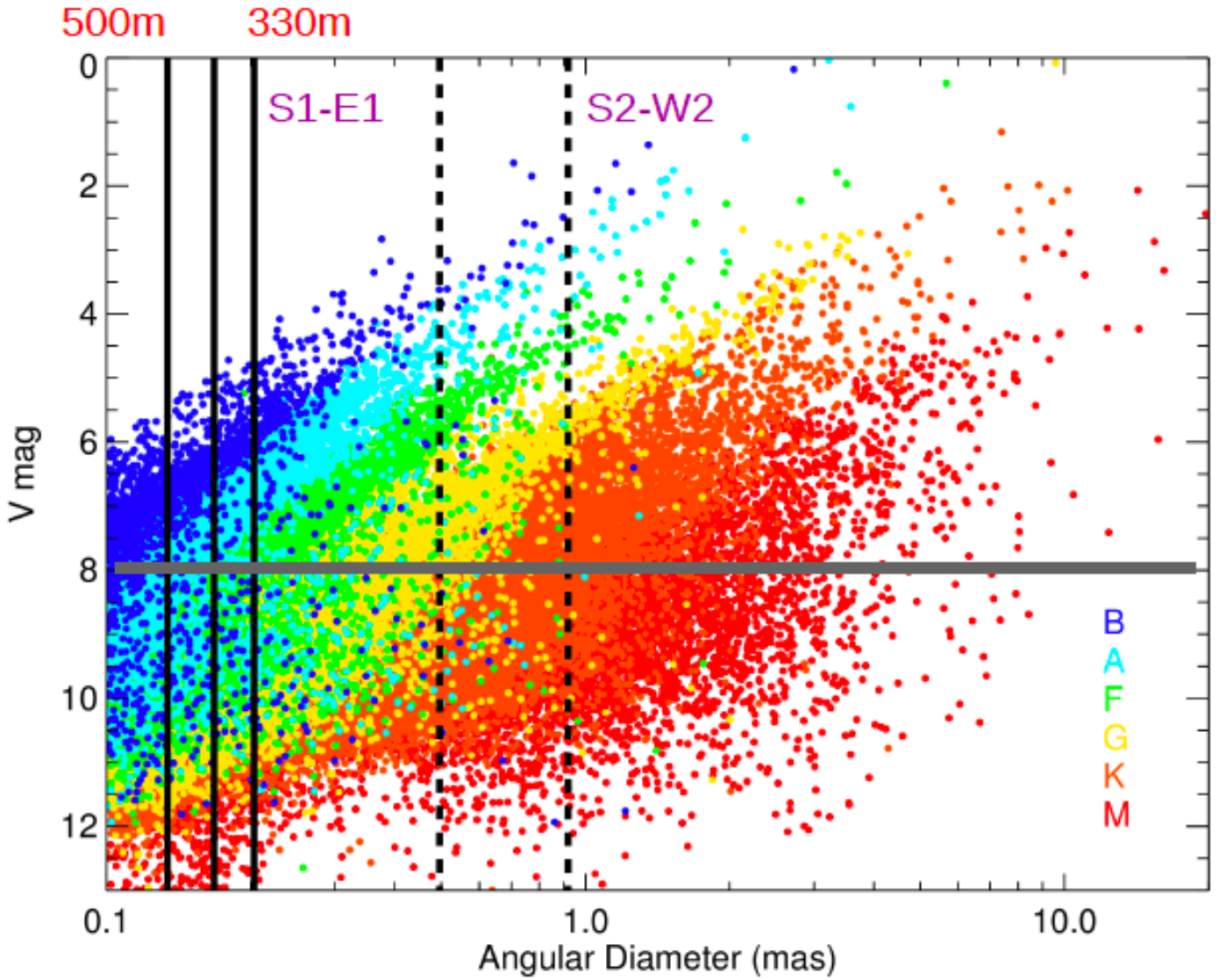
Zeta And (Roettenbacher et al. 2016)

Scientific Goals

- *Surfaces of stars*: starspots, NRP, granulation, differential rotation, intensity
- *Exoplanet host stars*: parameters, hot Jupiters, astrometric perturbations
- *Circumstellar disks and outflows*: young, evolved, interacting binaries
- *Massive stars*: parameters, binary evolution to GW source
- *Active Galactic Nuclei*: environment of supermassive black hole

- Need
  - *larger spatial range* (shorter and longer baselines)
  - *increased (u,v) coverage* (more baselines)
  - *better sensitivity* (larger apertures, high efficiency coatings)

Stellar Samples: optical region

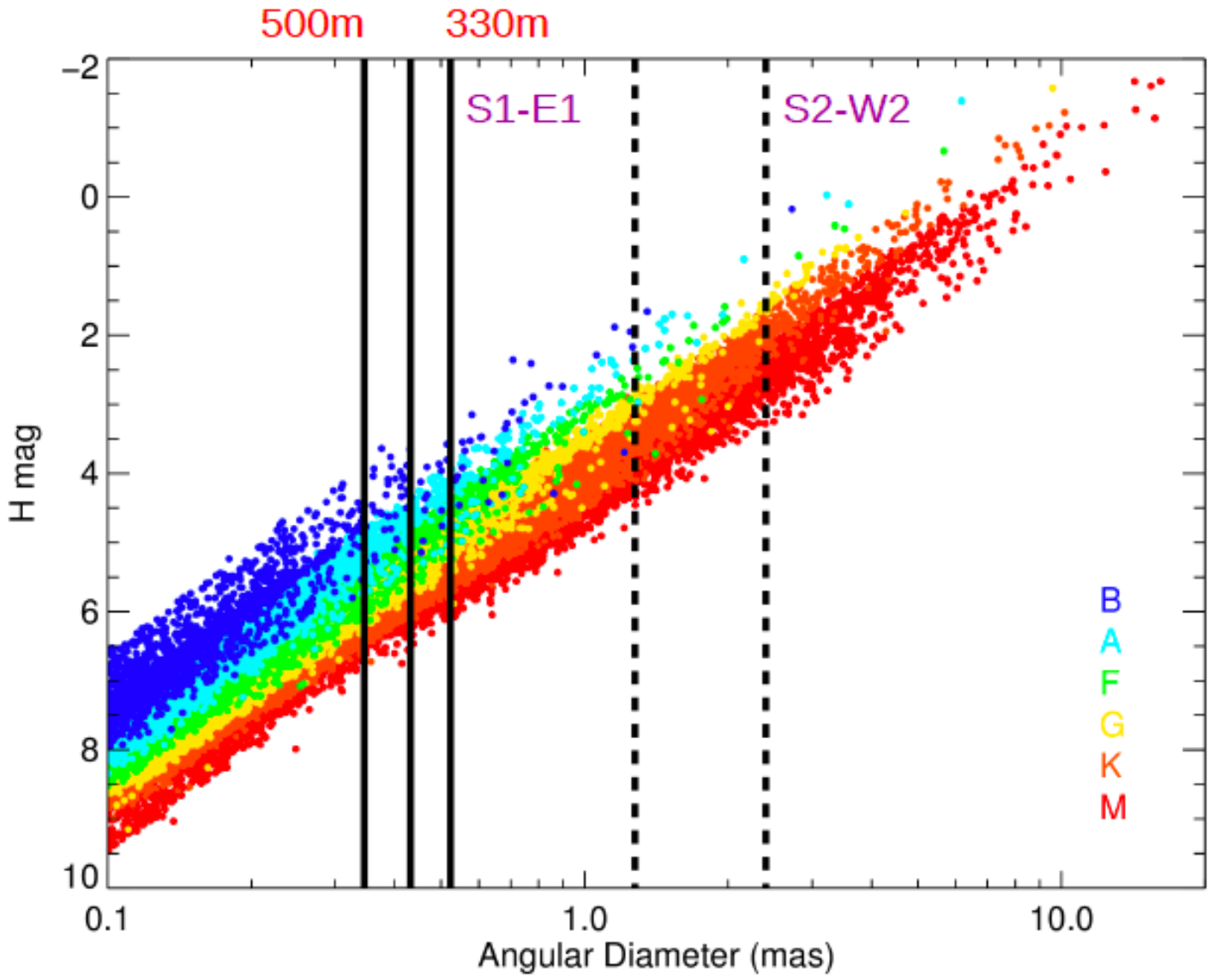


JMMC Stellar Diameter Catalog

DEC > -20°
V < 8 mag
θ > 0.1 mas

Nstar = 20,713

Stellar Samples: near-infrared region



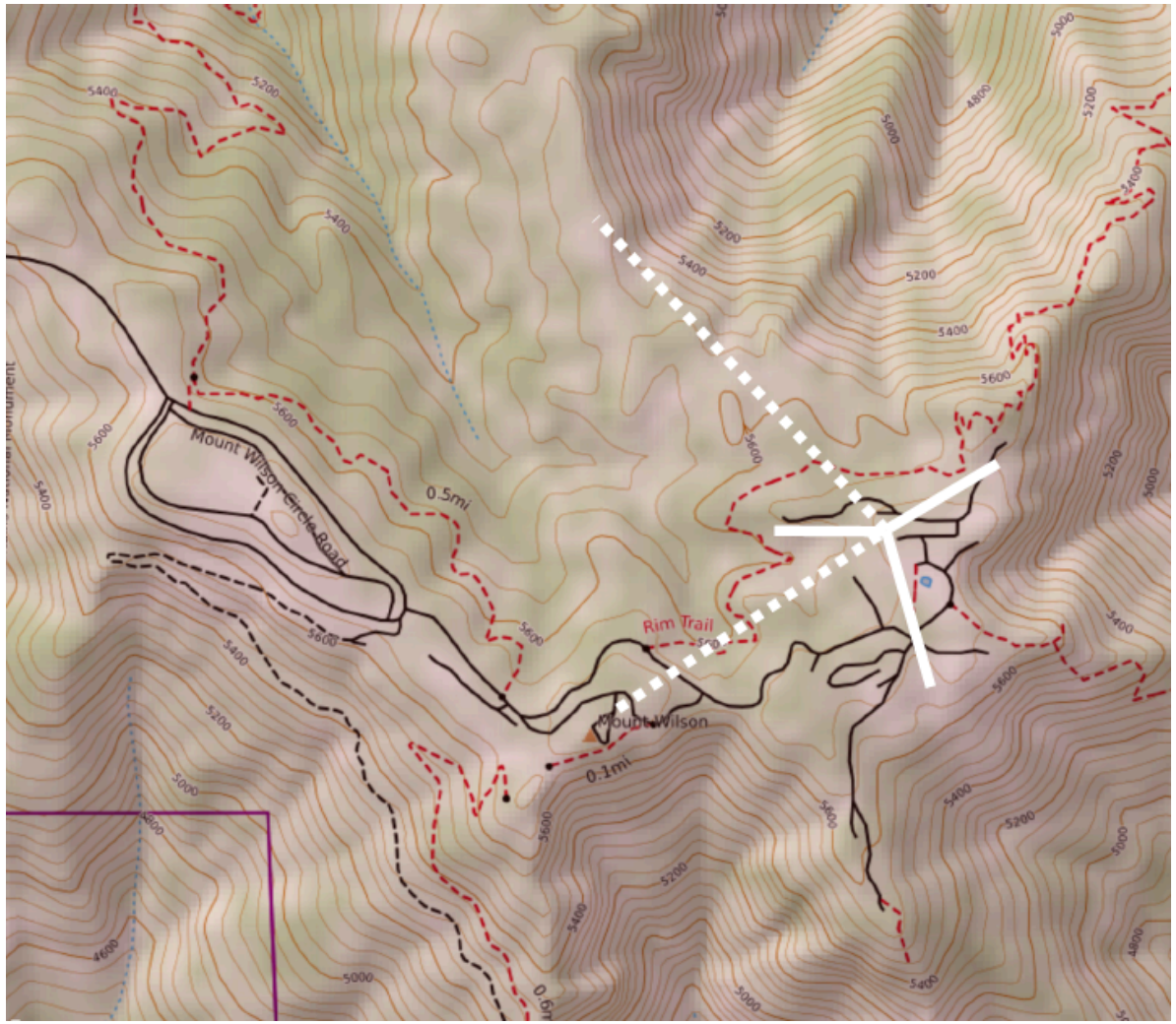
JMMC Stellar Diameter Catalog

DEC > -20°
V < 15 mag
H < 10 mag
θ > 0.1 mas

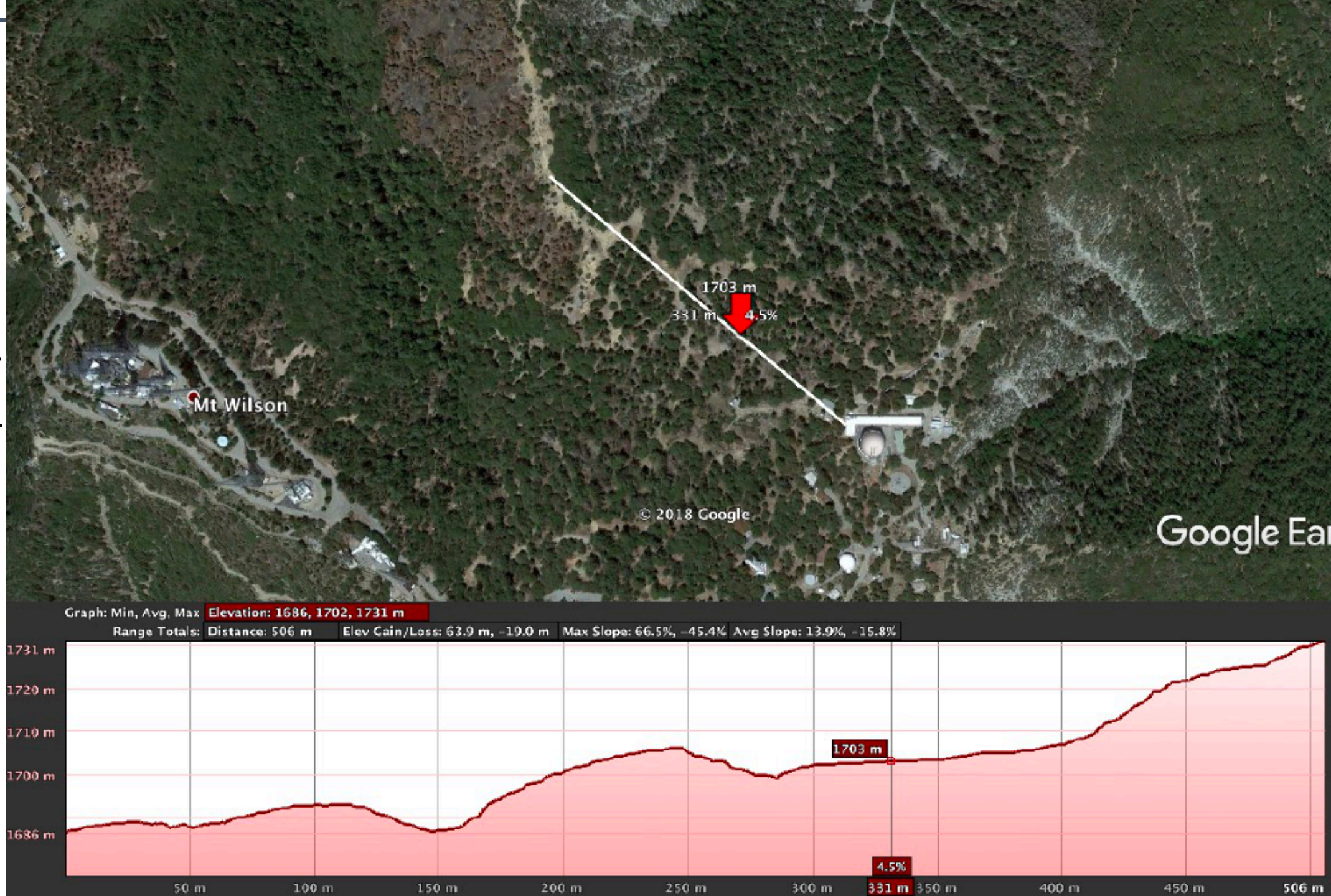
Nstar = 98,872

Mount Wilson sites for Additional Telescopes

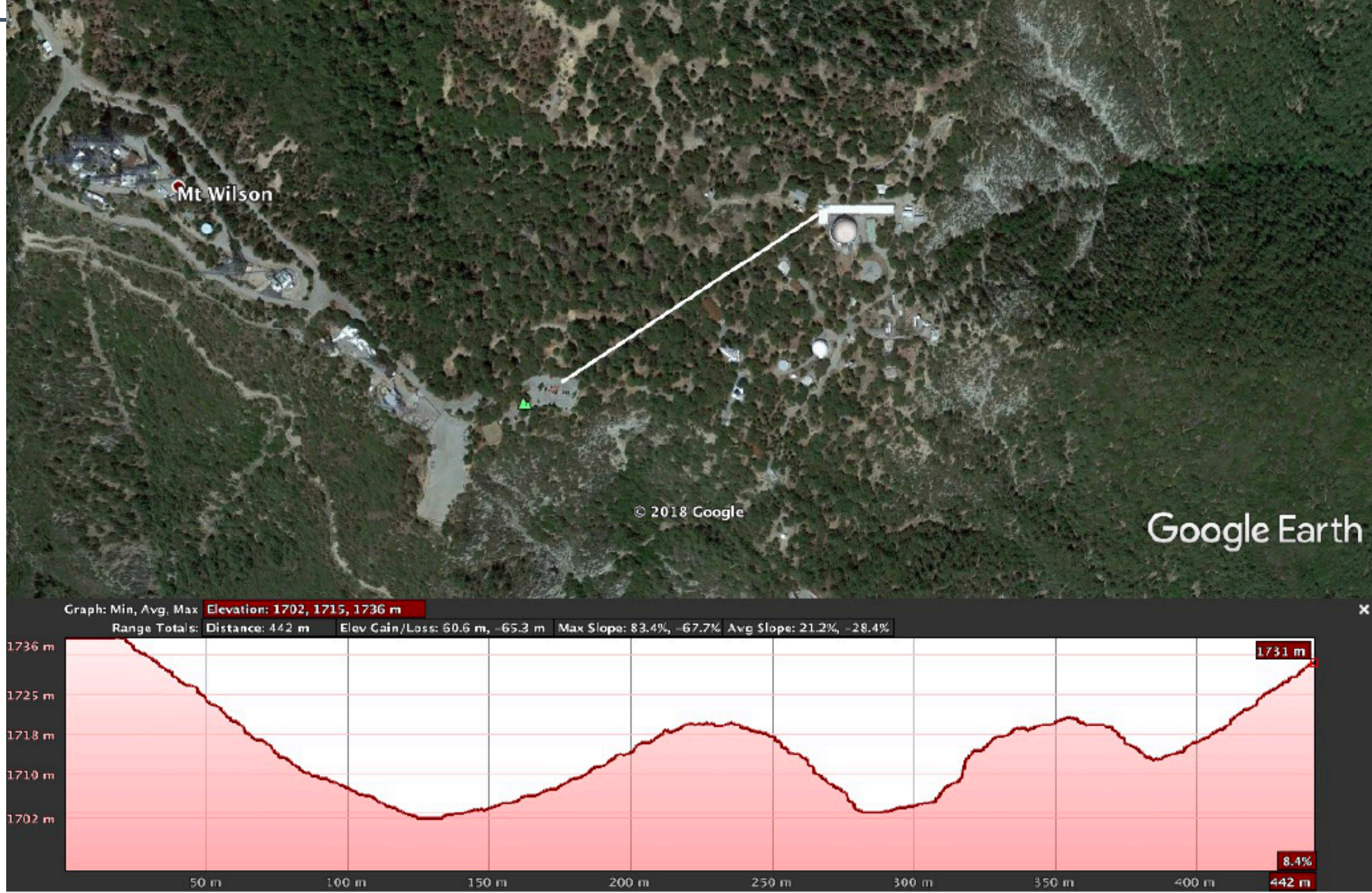
- For light pipes, need direct line of sight to OPLE
- More options for fiber optics relay
- Explore limits from local topography



- **500 m NW arm**
- 660 m to S1
- 590 m to E1



- **385 m SW arm** to upper parking lot
- 590 m to E1
- 550 m to NW
- Requires bridge (tree-top walk)

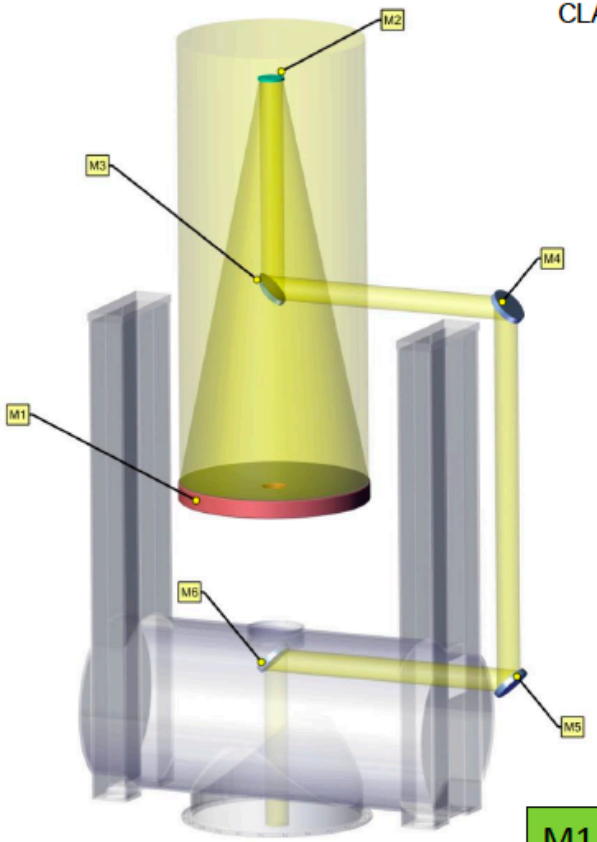


- **OPLE east end**
- Shorter baselines with E2, W2, S2
- Behind CRO (FS approved)
- North of Cadman and shops

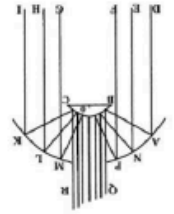
Limitations:

- Need to reproduce current telescopes and light paths for polarization matching
- Mixed apertures allowed
- Aperture size limited by aluminizing chamber (2.5 m) and transport over roads (1.5 to 2 m)

CHARA TELESCOPE



CLASSICAL TWO MIRROR TELESCOPE
(MERSENNE 1636)



M1: D = 1m
F = 2.5 m
CONCAVE PARABOLOID

M2: D = 0.14 m
F = - 0.312 m
CONVEX PARABOLOID

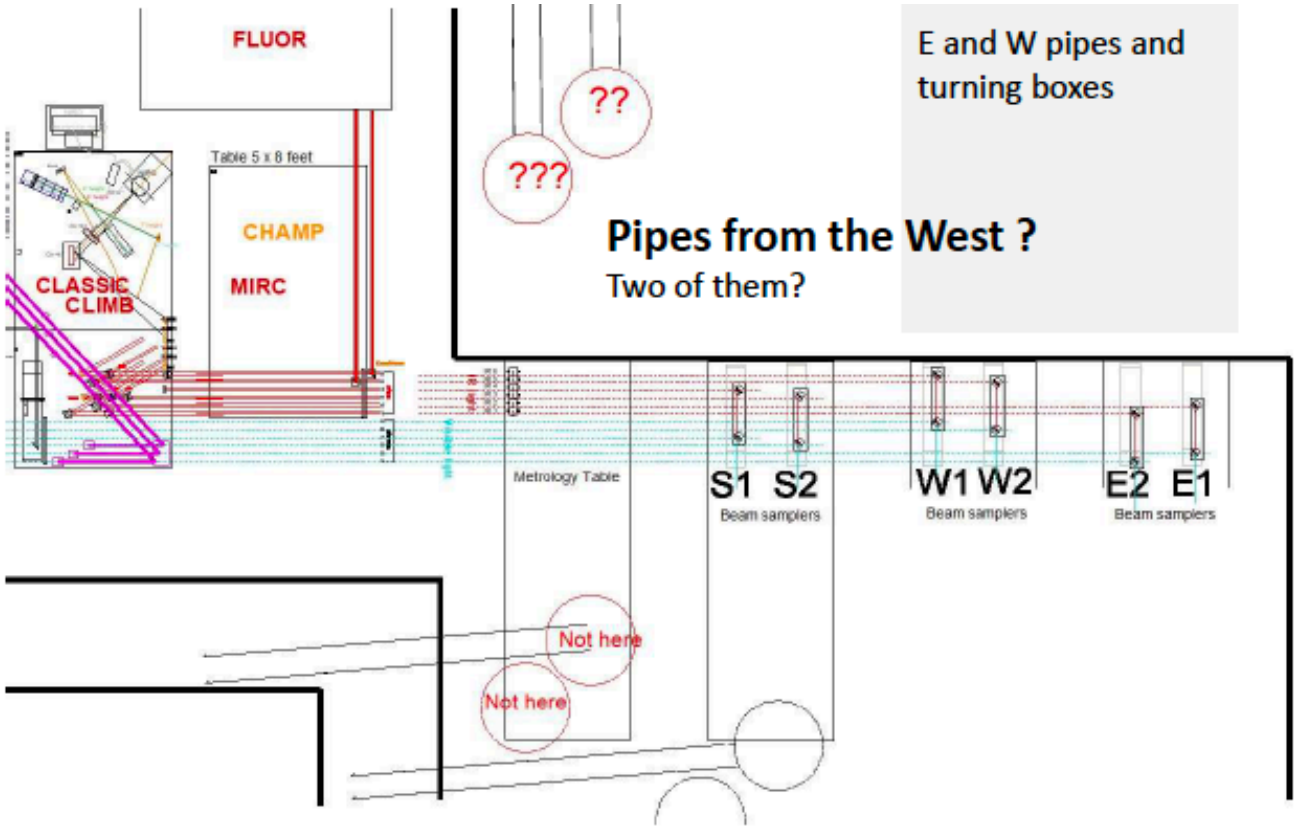
M1 AND M2 CONFOCAL
1:8 BEAM COMPRESSION

M3,M4,M5,M6… FLATS

OUTPUT BEAM ∅ 0.125 m

M1 AND M2 FOR THE 7-TH TELESCOPE ARE IN HAND

Limitations: light pipes



- Two pipes from the West (repeat of existing design all along), but why 4 in the West.
- One West + one South (with new type turning box) possible.
- One West + one East (turning box outside!) possible.
- One South (new type turning box) one East (turning box outside!) possible.

Limitations: OPLE, BCL

- OPLE building has space for two additional variable delay rails and carts; adding more than two more beams would require independent OPLE
- Additional fixed delay possible below new tracks
- Long baseline work will require fast moving carts and hence shorter times before running out of variable delay; consider extending tracks into storage area at east end of OPLE and/or double pass OPLE carts
- Space is very restricted in OPLE and BCL for new beams; would need to reposition optical benches
- MIRC designed for only 6 beams; use beam combiners with subsets of available telescopes and beams until next generation available

Organizational Challenges

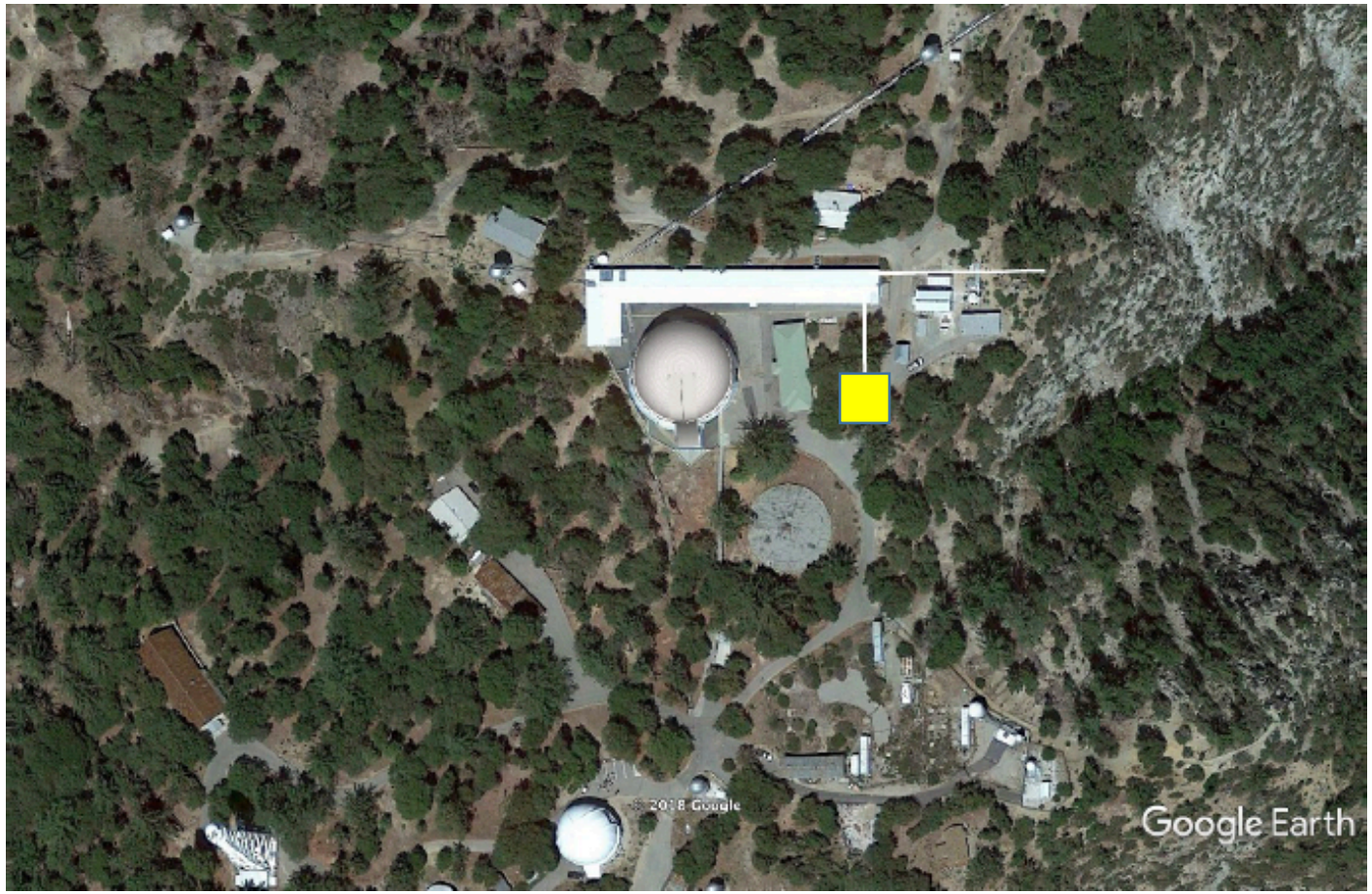
- Staff over-worked currently supporting AO and NOAO access programs
- Long lead time required to coordinate with Mount Wilson Institute, Carnegie Observatories, Carnegie Institute, US Forest Service, LA County
- Will require significant effort to find funding from a variety of sources (US federal, Georgia, private foundations, donors)

Concepts: *Need your opinions!*

- Here are five strawman concepts for expansion
- Please indicate on the page your level of enthusiasm
- Indicate any major positive features
- Indicate any major negative features
- Your name is optional

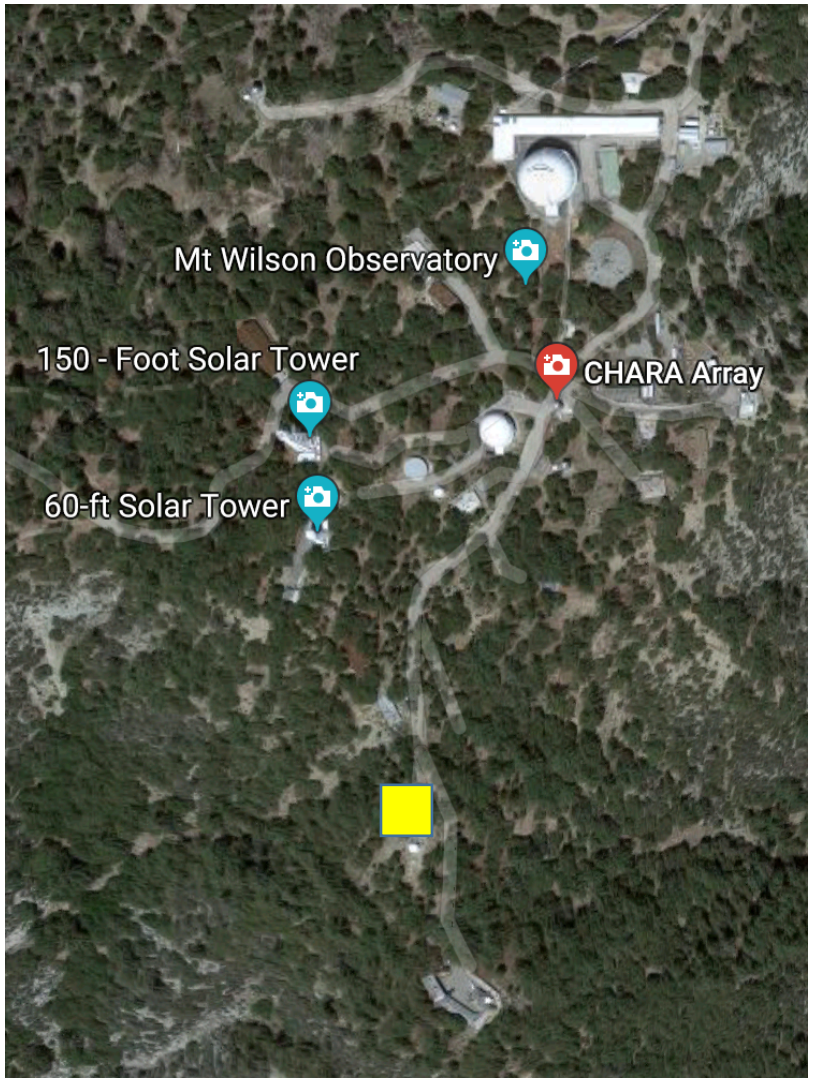
(1) Add central telescope behind CRO

- Use extra M1, M2 and build 1 m telescope of same design
- Place near the center of Array
- Increased short baseline coverage for baseline bootstrapping



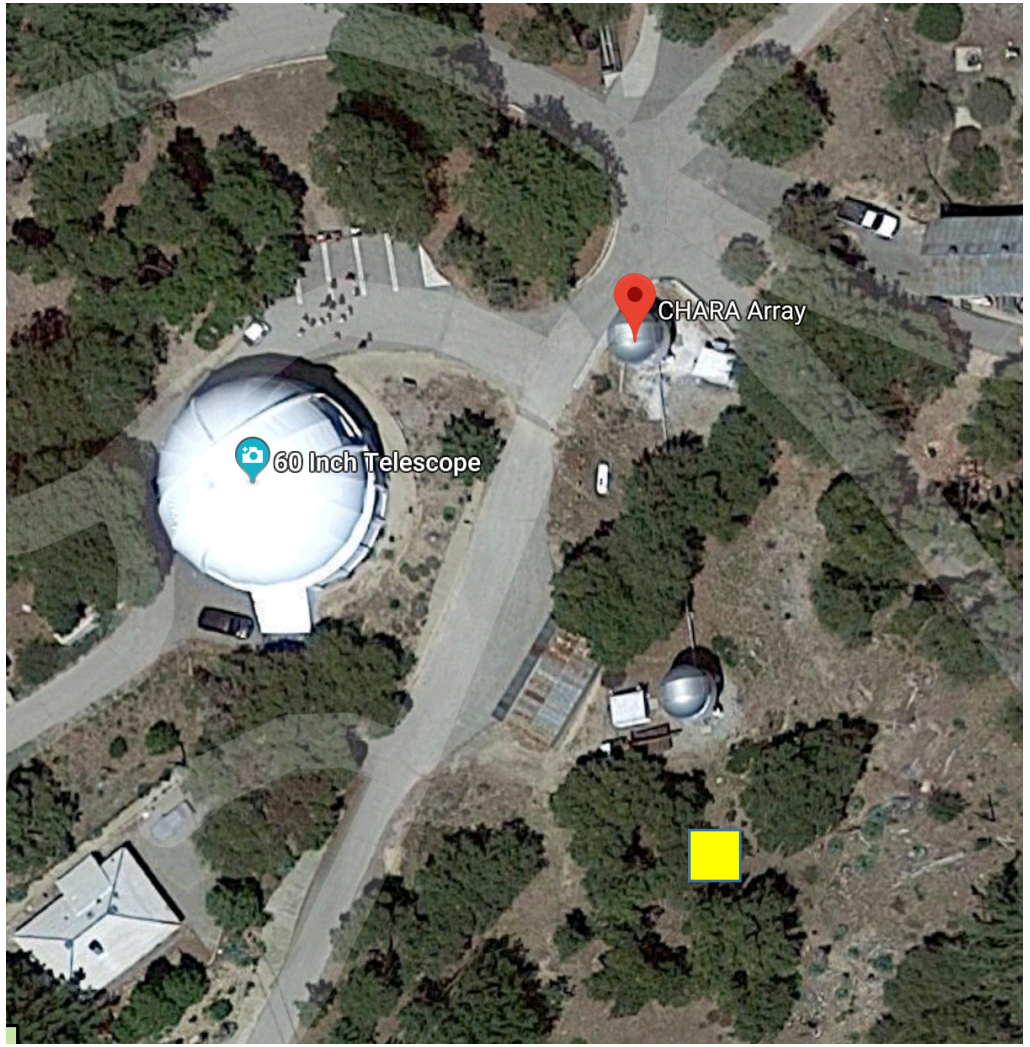
(2) Add 2 m telescope to the far south

- Connect to S1 by fiber
- Use as pathfinder for PFI technology



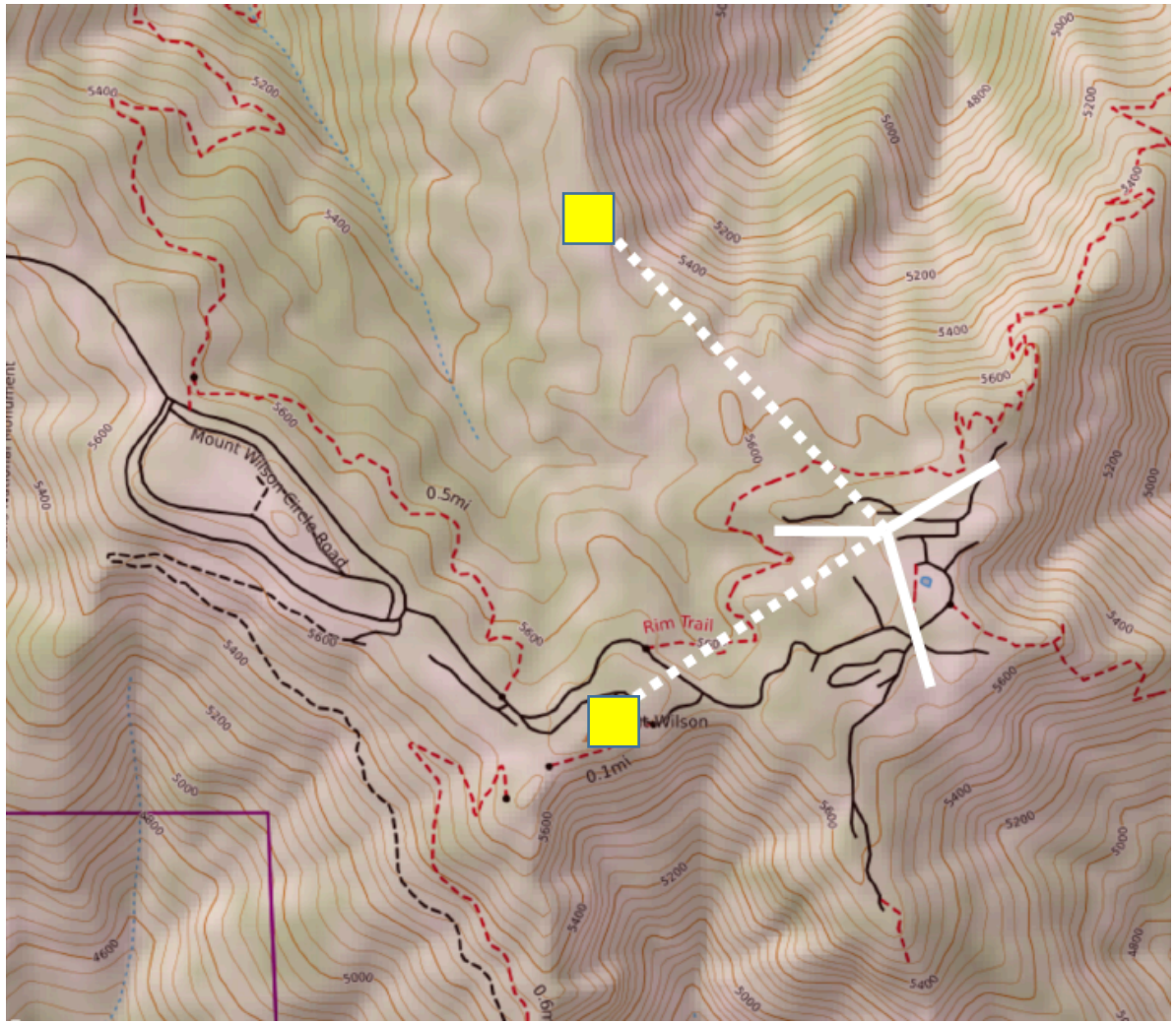
(3) Add 2 m telescope close to S1

- Helpful for large objects like supergiants and exozodiacal disks
- Role in baseline bootstrapping
- Might share light pipe with S1 or S2



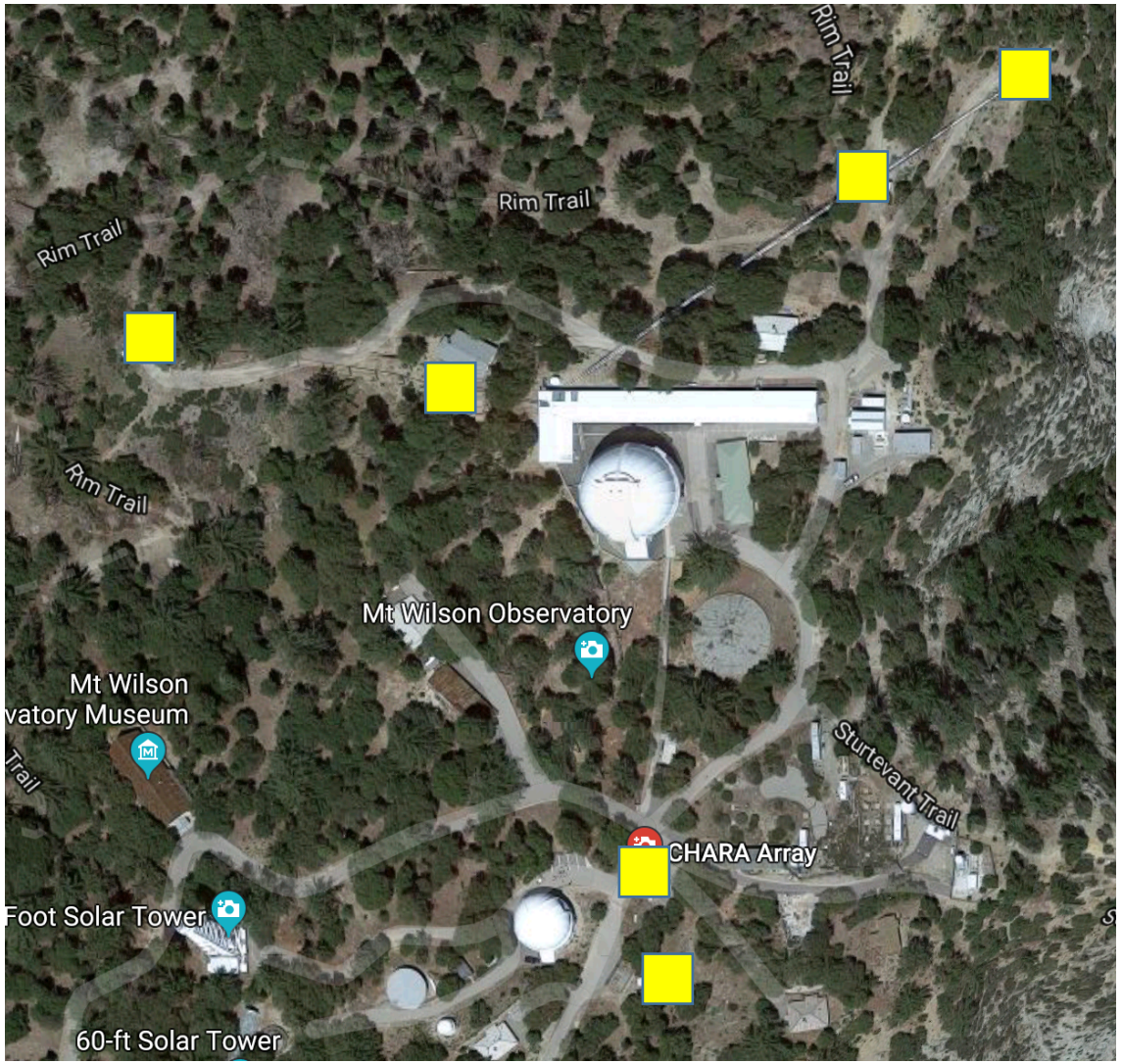
(4) Add two 2 m telescopes to NW and SW

- Very long baselines for highest resolution
- Requires strong bridge for SW light pipe
- Stepping stone to km baseline arrays



(5) Replace all six telescopes with 2 m scopes

- Increase sensitivity using existing light pipes
- Invest in high reflectivity optics



Combinations of these? Other ideas?

- Example: new telescope near S1 (#3) plus NW, SW pair (#4) to create a large triangle for closure phase measurements
- Fiber optics to remote locations (limited bandwidth in near-IR)

Please join the dialogue about future concepts!