Overview of existing and past instruments around the world

Andreas Quirrenbach

Abstract

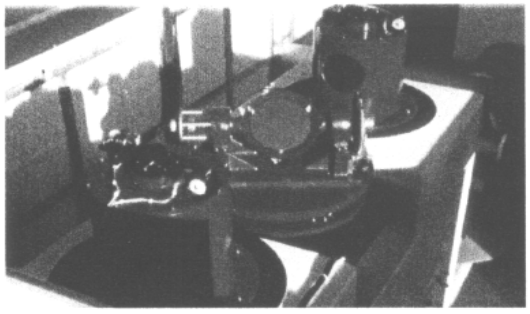
Brief descriptions and major achievements of: Michelson and Pease 20-foot and 50-foot, Hanbury Brown intensity interferometer, I2T, GI2T, MarkIII, CAOST, PTI, NPOI, IRMA, IOTA, CHARA, Mira, SUSI, ISI.

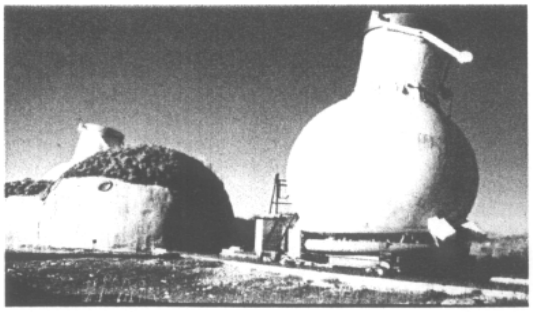
Overview of Existing Instruments around the World

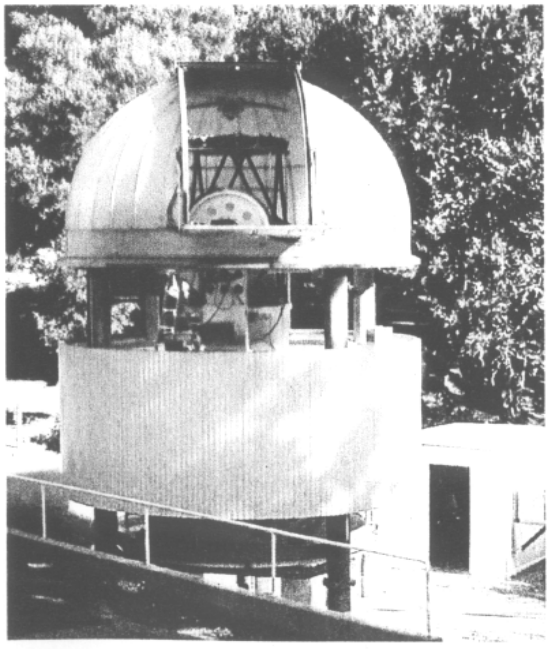
Andreas Quirrenbach

(University of California, San Diego)

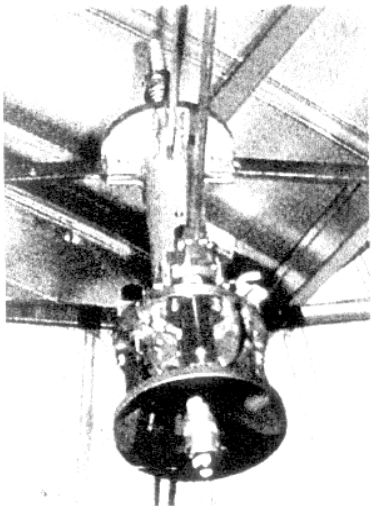
The light must get in ...

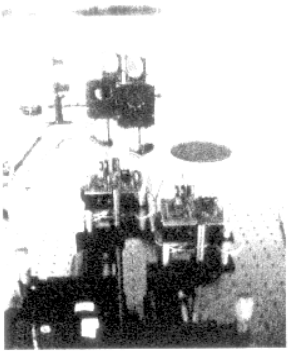


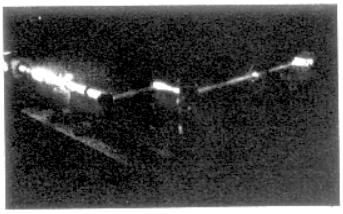


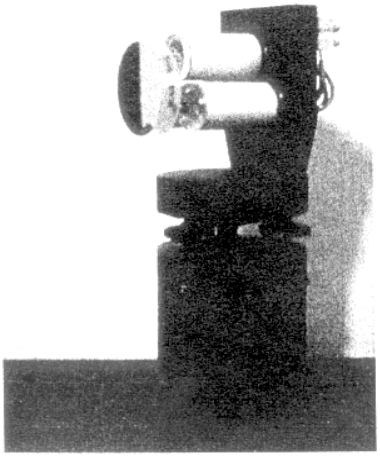


… be stable

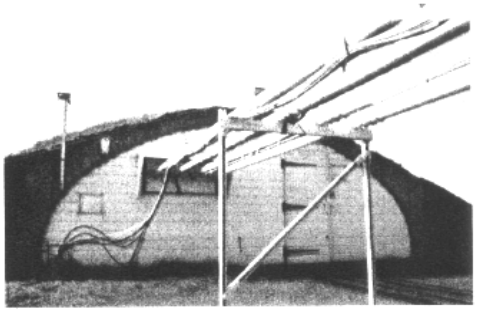


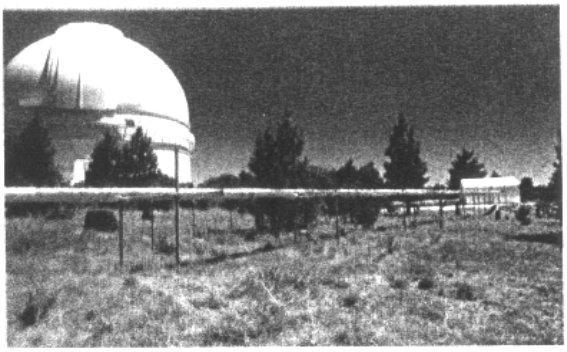


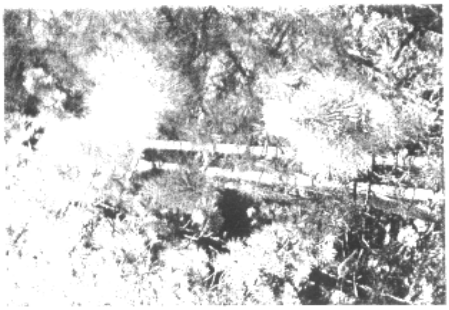




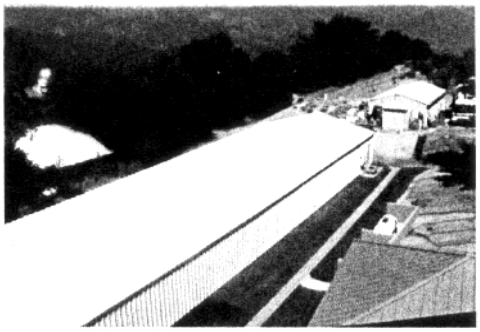
… and make it to the central facility

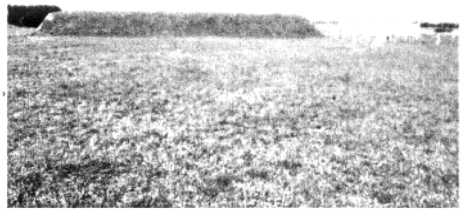




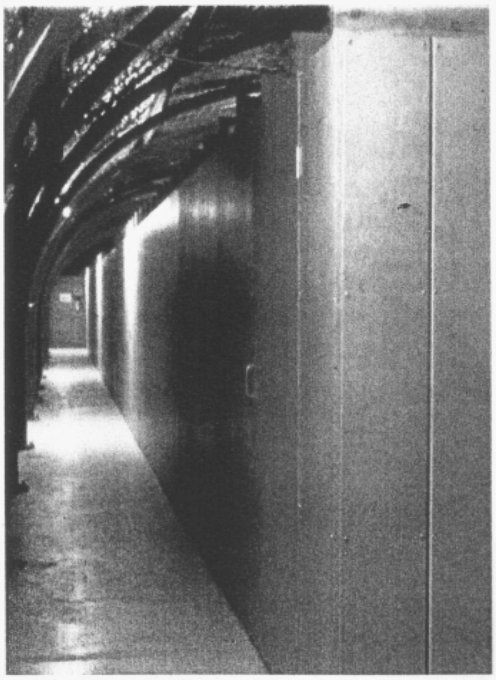


The instruments need enclosing … (not buildings)

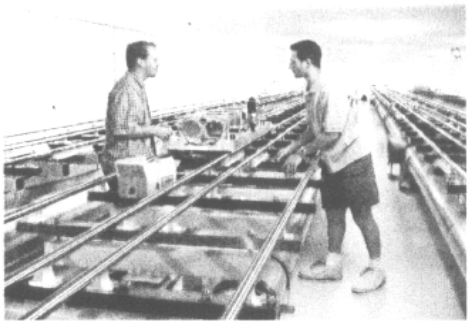


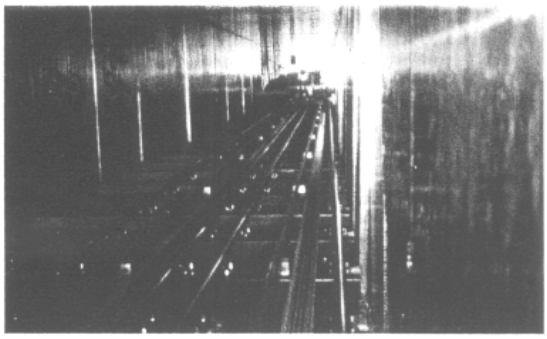
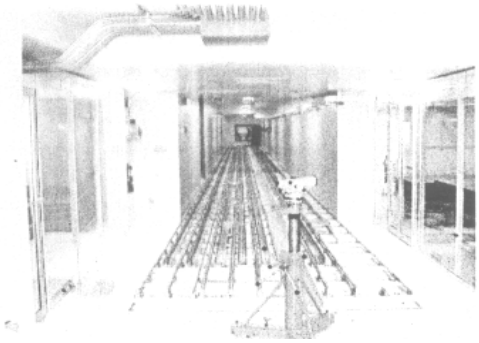


…and thermal stability.

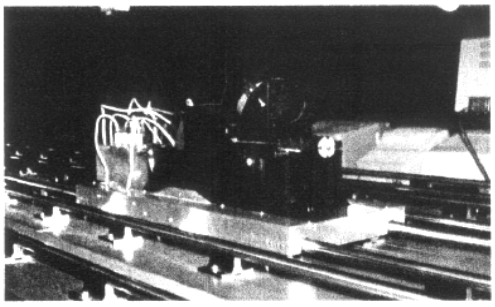
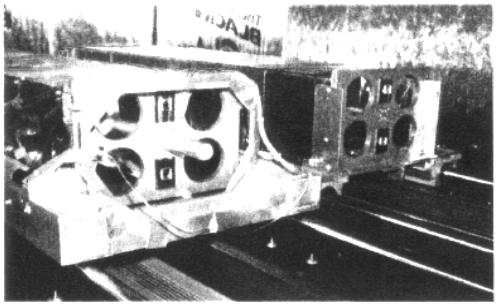
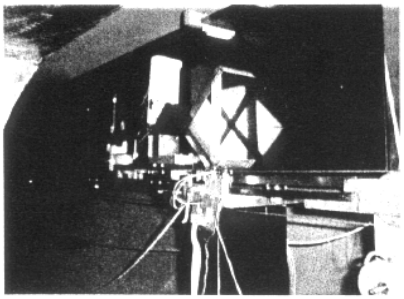
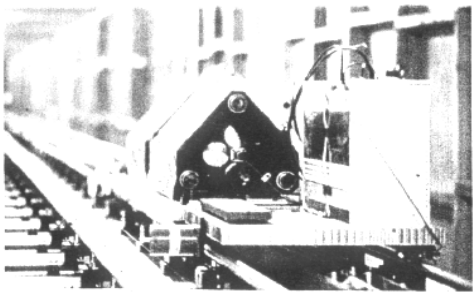


Delay lines sit on rails ...

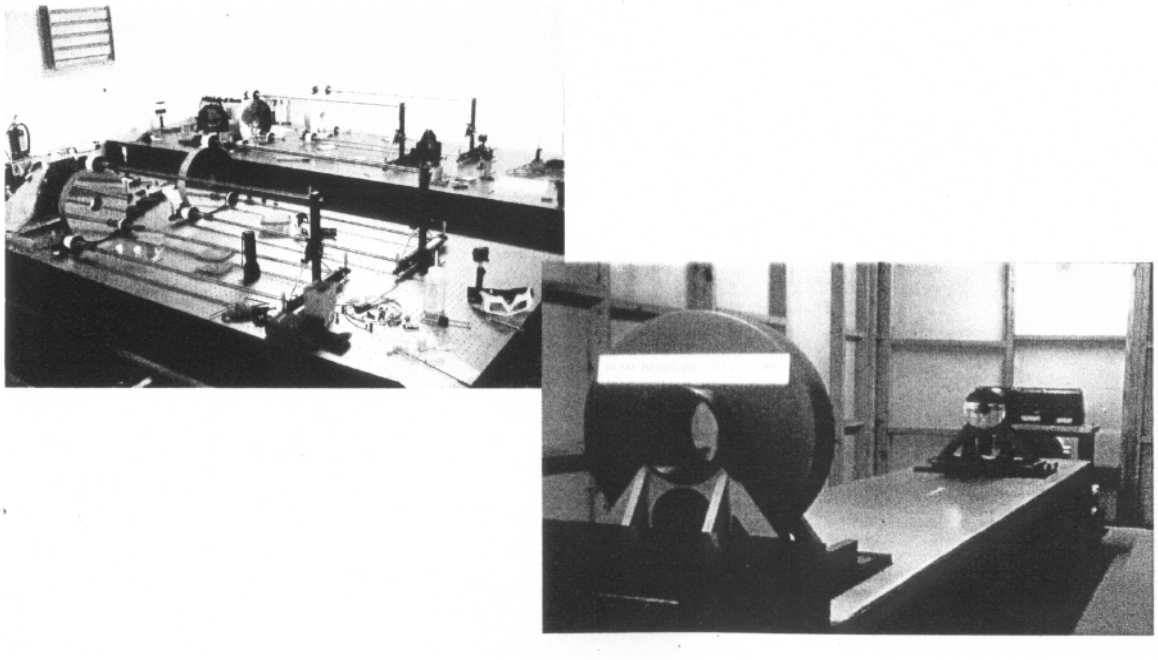


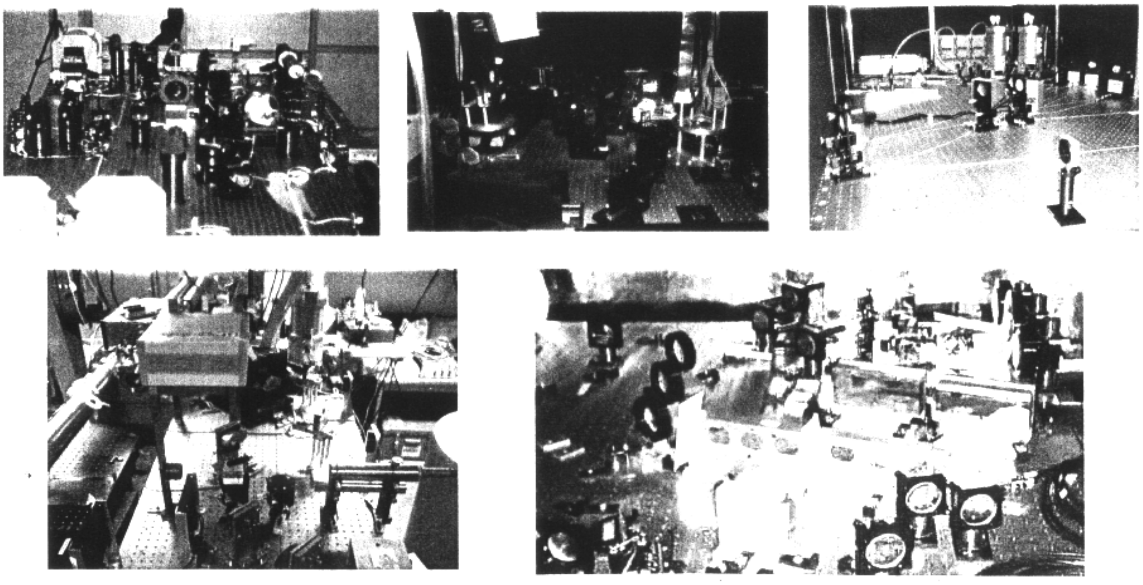
… and delay the light

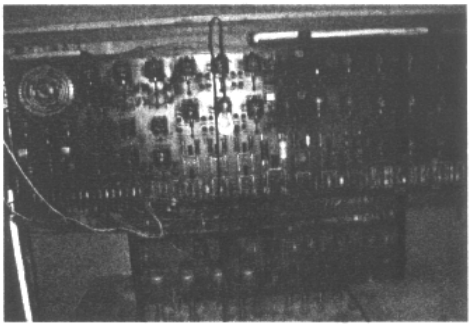
Beams need to be the right size ...

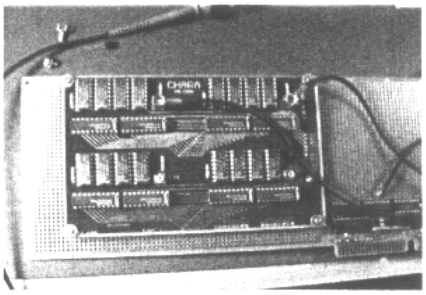


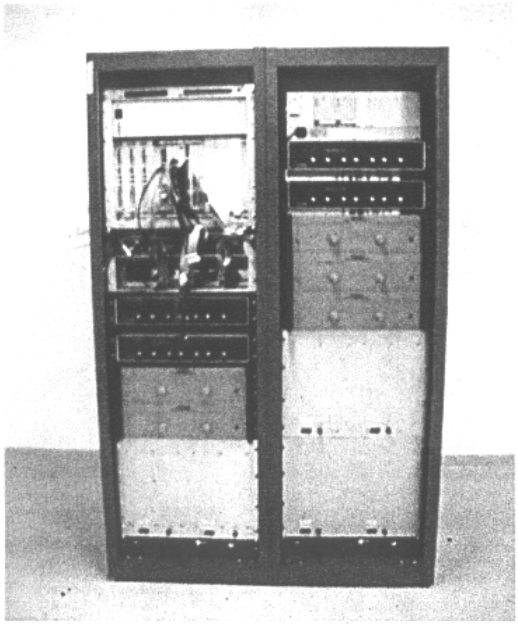
… and combined with other beams

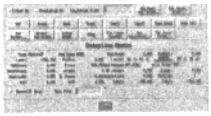


Controllers made by DIY Electronics, Inc.

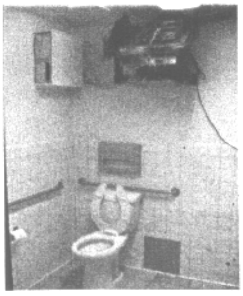


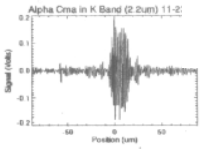






… with a well trained sequencer





All resulting in fringes … you hope

Current Ground-Based Interferometers

Name	Institution	Site	Number of Elements	Element Aperture (cm)	Max. Baseline (m)	Operating Wavelength (microns)	Operating Status
GI2T	CERGA	Calern	2	150	35	0.4 - 0.8 & >1.2	since 1985
COAST	Cambridge U	Cambridge	4	40	100	0.4 - 0.95 & 2.2	since 1991
SUSI	Sydney U	Narrabri	13	14	640	0.4 - 0.66	since 1991
IOTA	CfA	Mt. Hopkins	3	45	38	0.5 - 2.2	since 1993
ISI	Berkeley U	Mt. Wilson	3	165	30(+)	10	since 1990
NPOI	USNO/NRL	Anderson Mesa	6	60	435	0.45 - 0.85	since 1995
PTI	JPL/Caltech	Mt. Palomar	2	40	110	1.5 - 2.4	since 1995
CHARA	Georgia St. U	Mt. Wilson	6	100	350	0.45 - 2.4	initial 1999
Keck	CARA	Mauna Kea	2(4)	1,000(150)	165	2.2 - 10	initial 2001?
VLTI	ESO	Cerro Paranal	4(3)	800(180)	200	0.45-20	initial 2001?

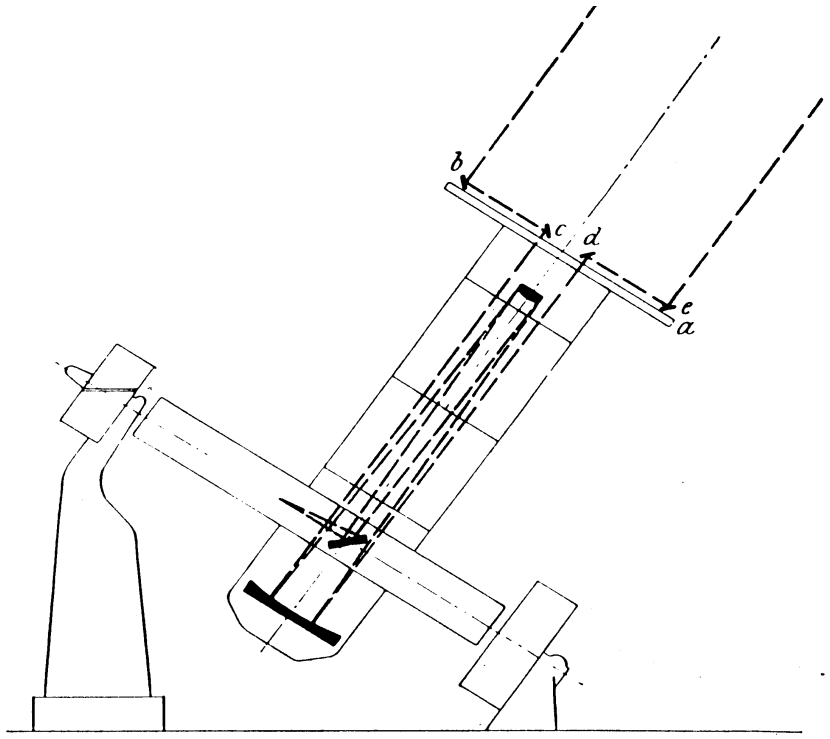
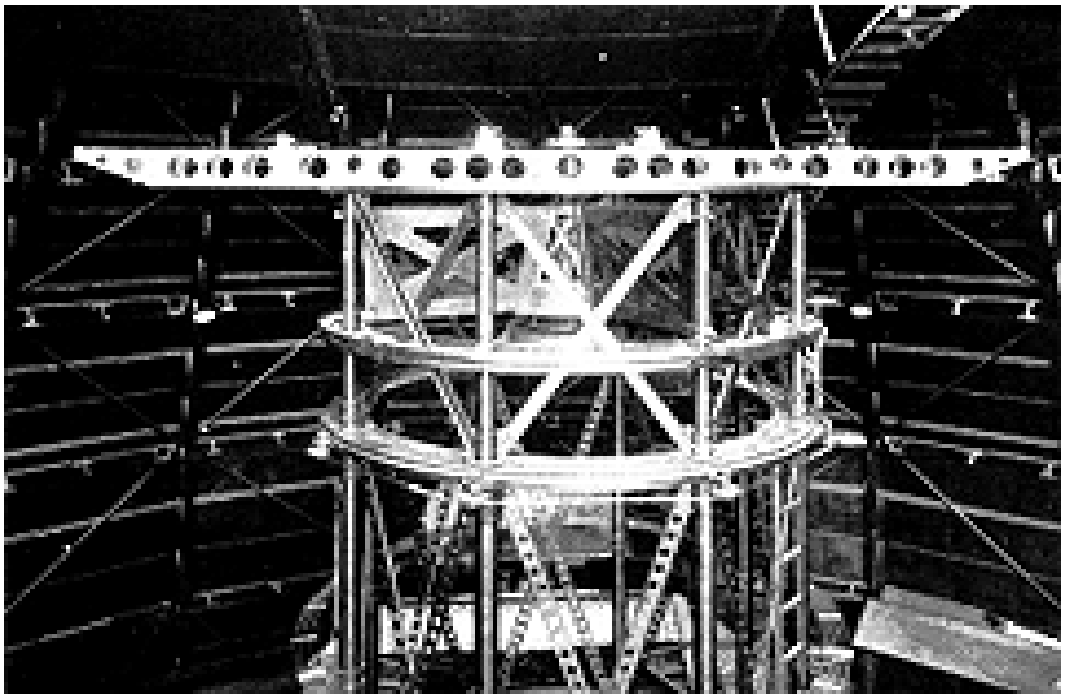
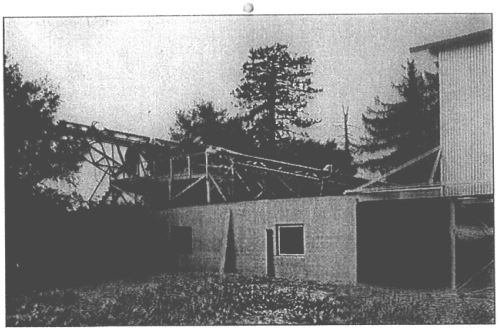


Abb. 2. Diagram of light path when using 20 ft. Interferometer with 100-inch Reflector.

Michelson's 20-foot Stellar Interferometer



The Mt. Wilson 50 foot interferometer



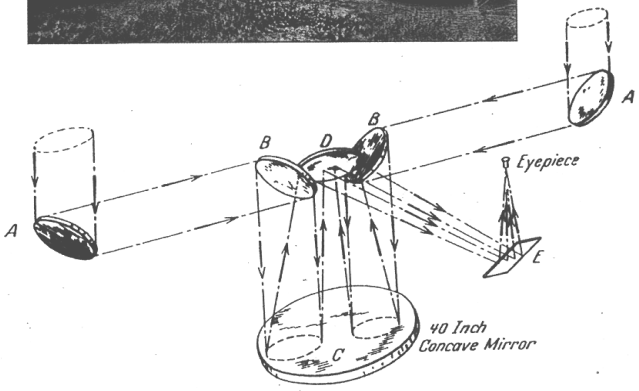


Abb. 8. Diagram of light path in 50 foot interferometer.

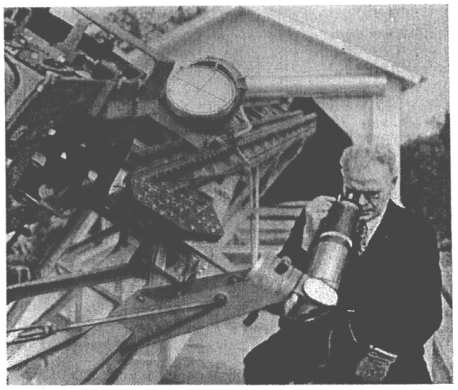
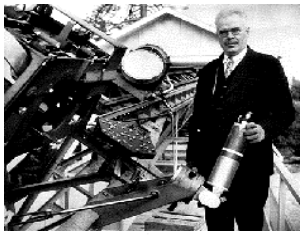
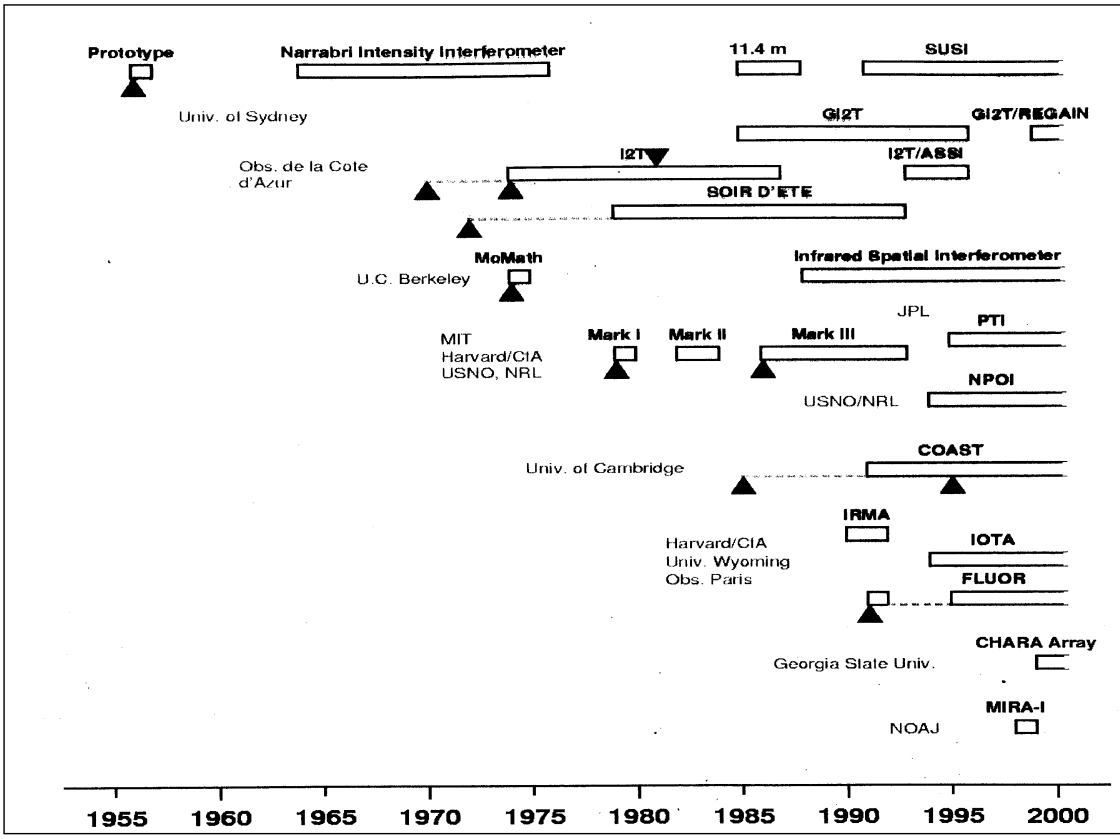
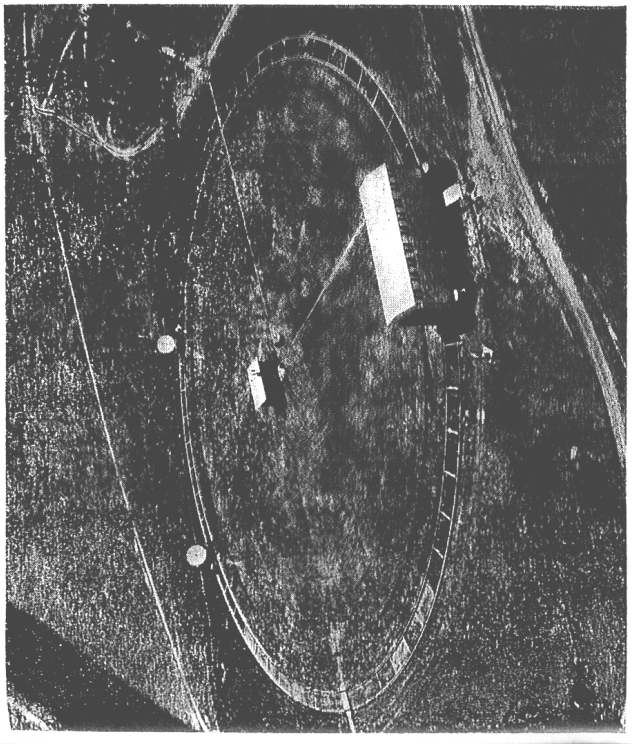


Abb. 9. Upper part of interferometer showing control board and observer at eyepiece.







4, 1967 *The stellar interferometer at Narrabri Observatory—I* 377

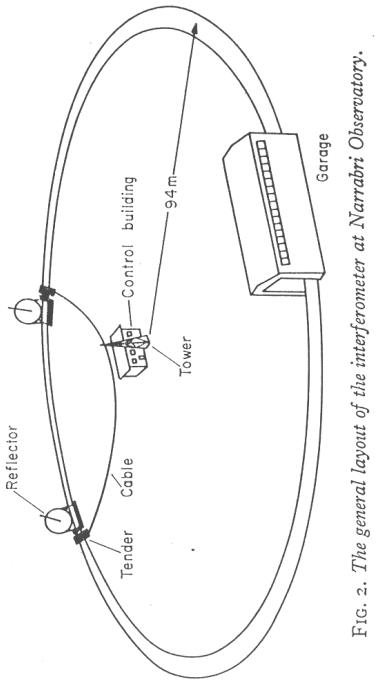
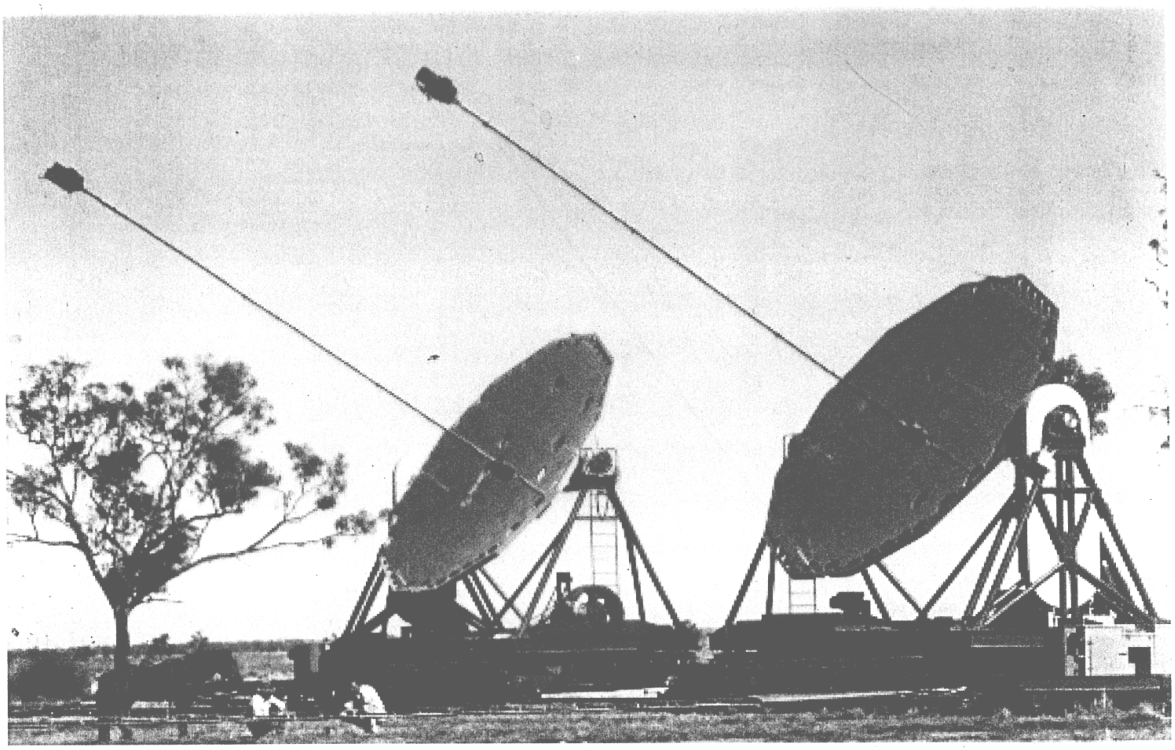
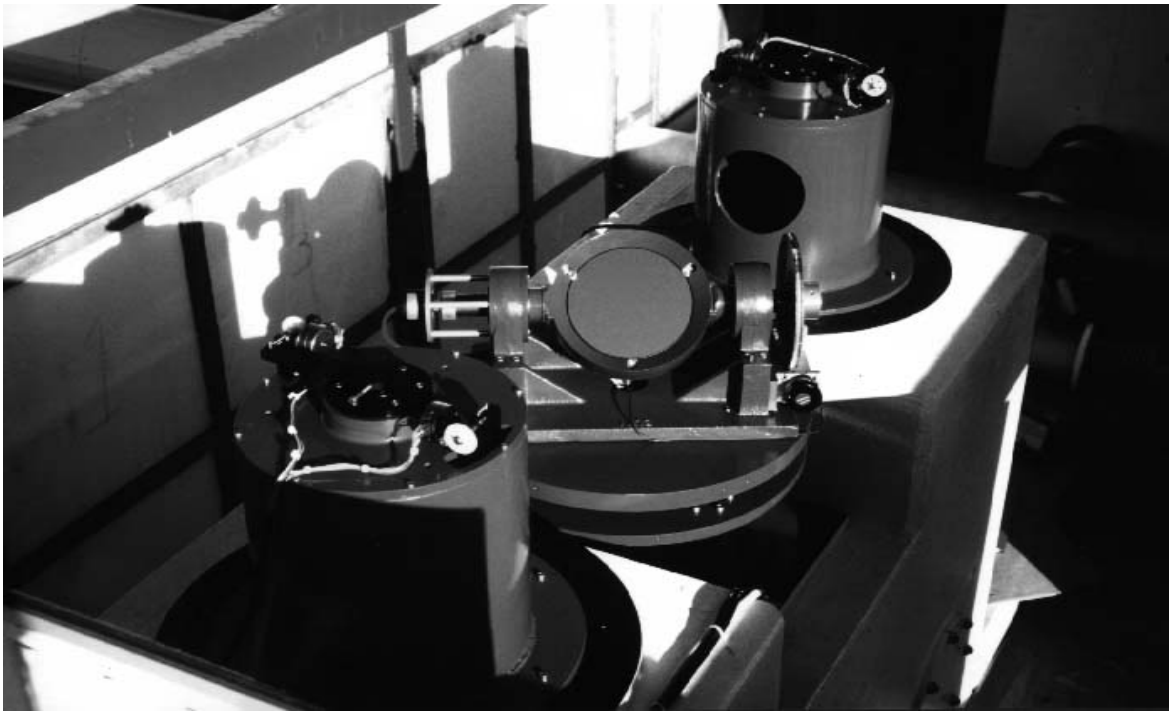


FIG. 2. *The general layout of the interferometer at Narrabri Observatory.*

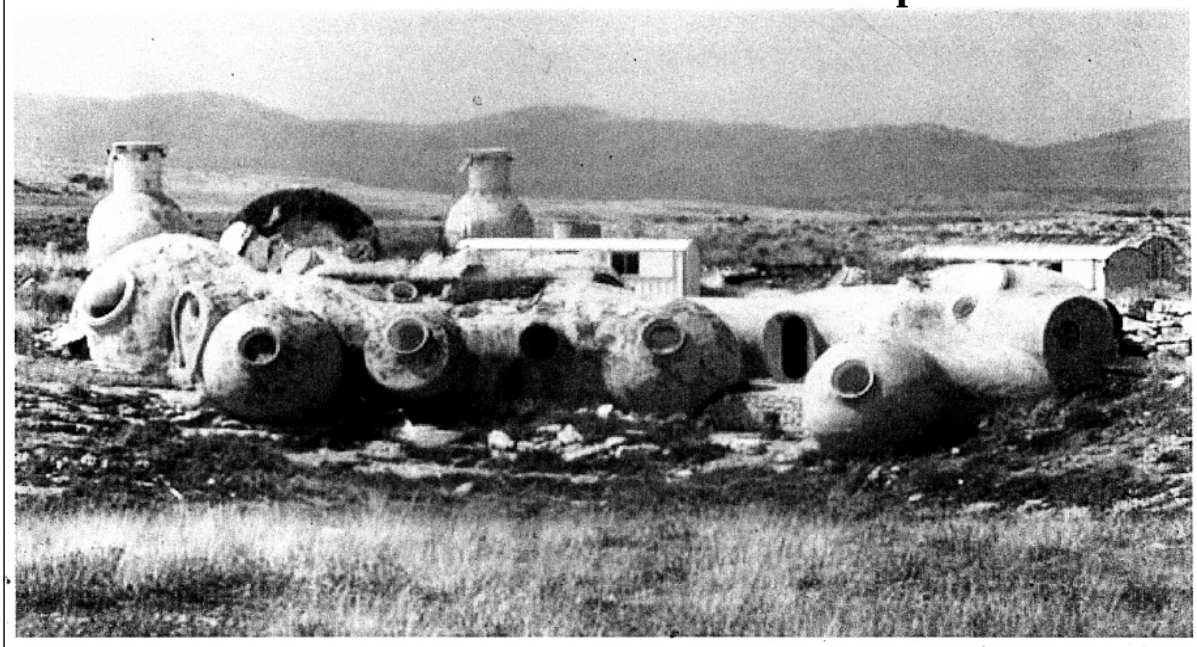


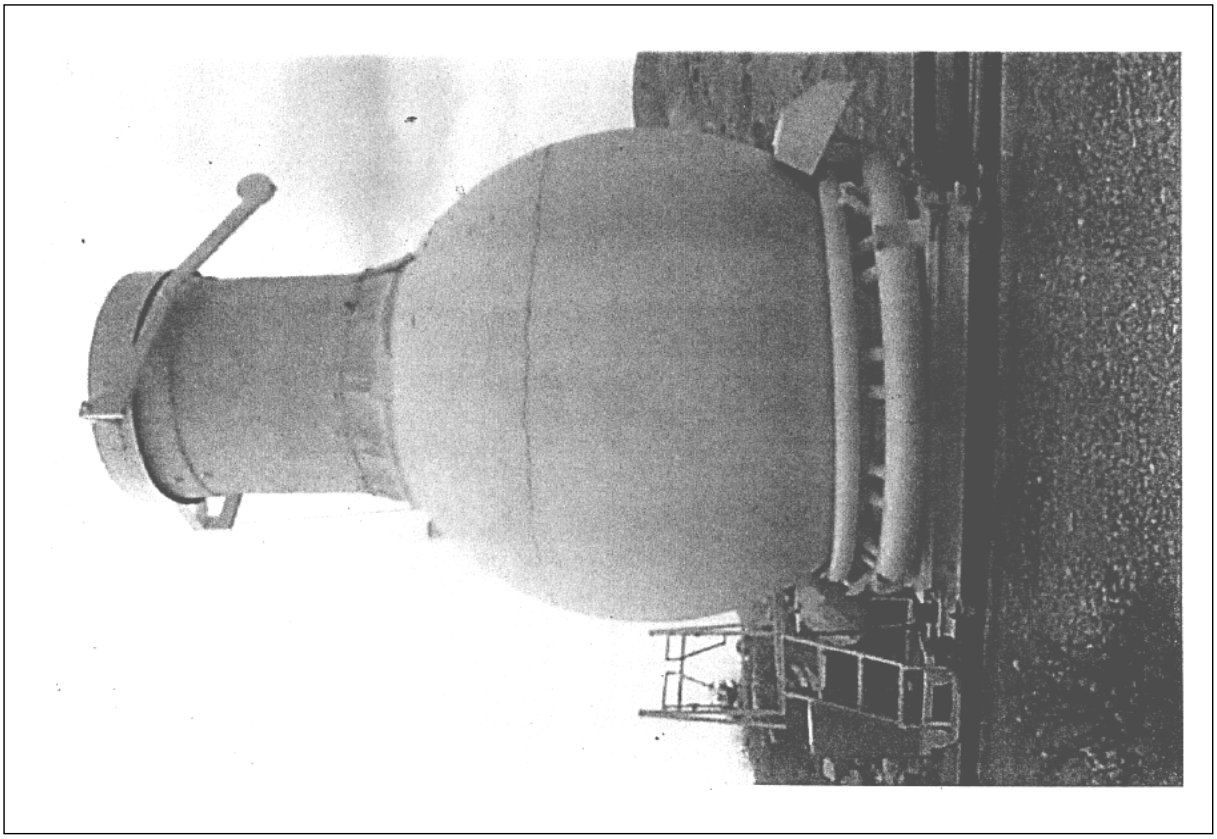
SUSI :
The Sydney University Interferometer



A siderostat station at SUSI, showing the 20cm mirror in its alt-az mounting, which feeds starlight into one of the north or south periscopes mounted on either side of it.

G.I.2T. :
Grand Interferometre a 2 Telescopes





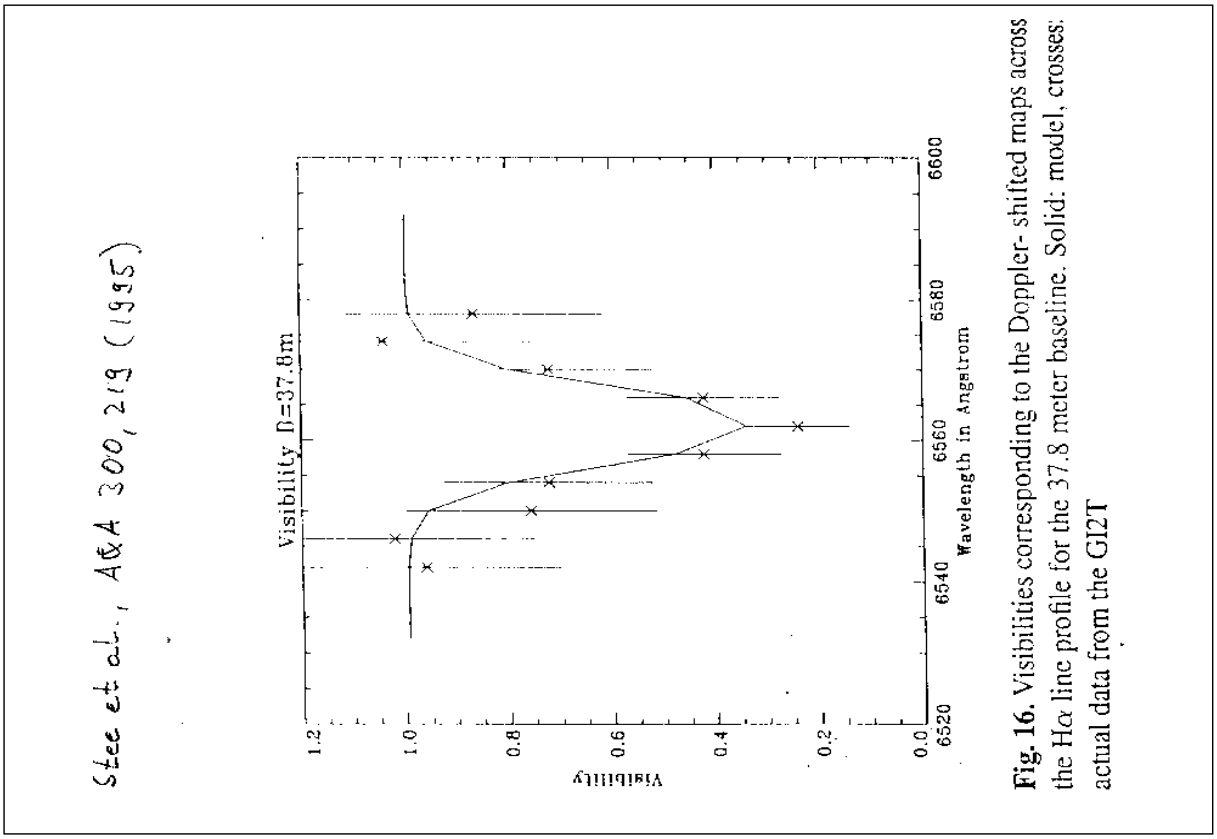
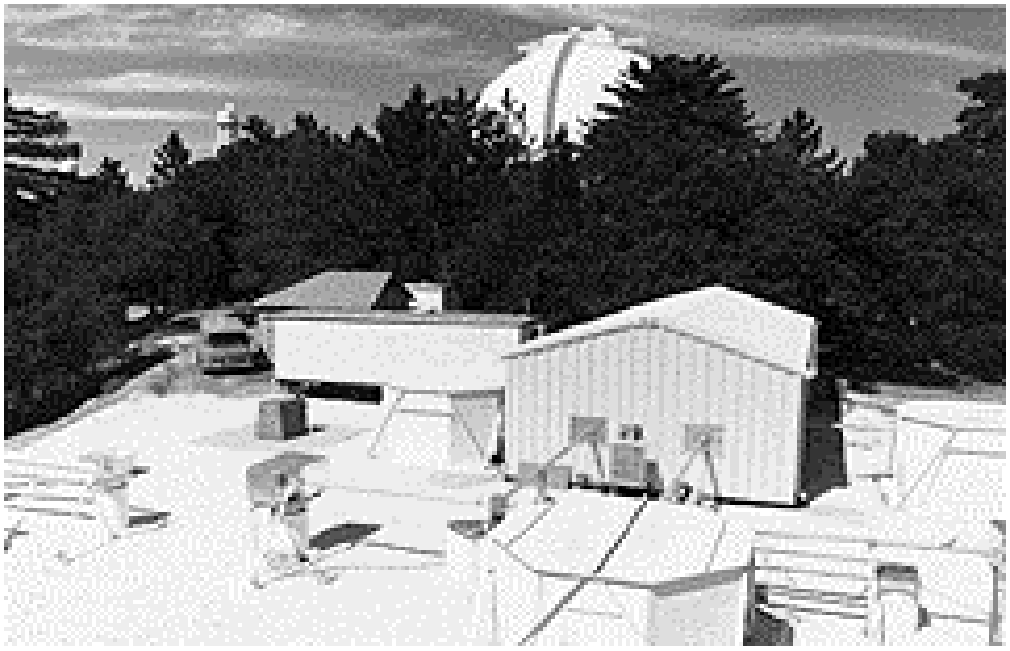
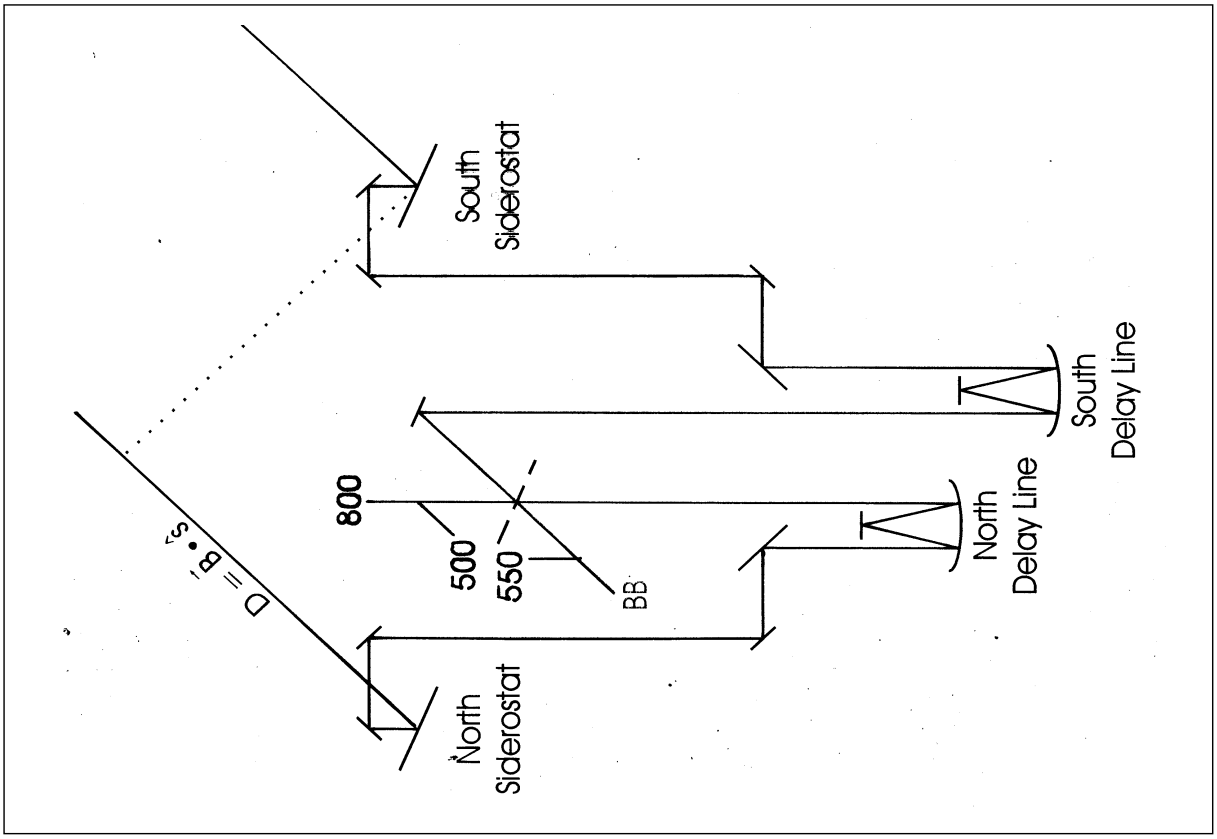


Fig. 16. Visibilities corresponding to the Doppler- shifted maps across the Hα line profile for the 37.8 meter baseline. Solid: model, crosses: actual data from the GI2T

C.O.A.S.T. :
Cambridge Optical Aperture Synthesis Telescope

The N.R.L. (Naval Research Laboratory) Mark III Interferometer





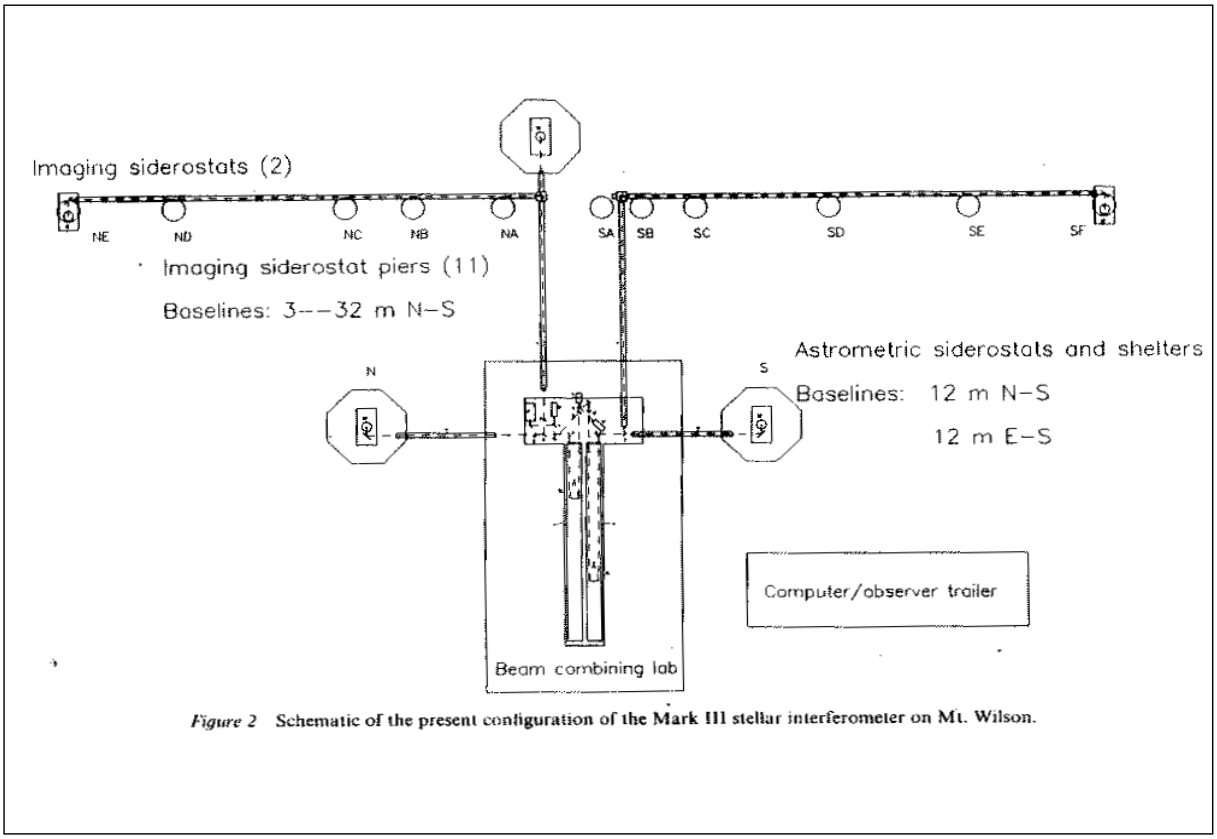
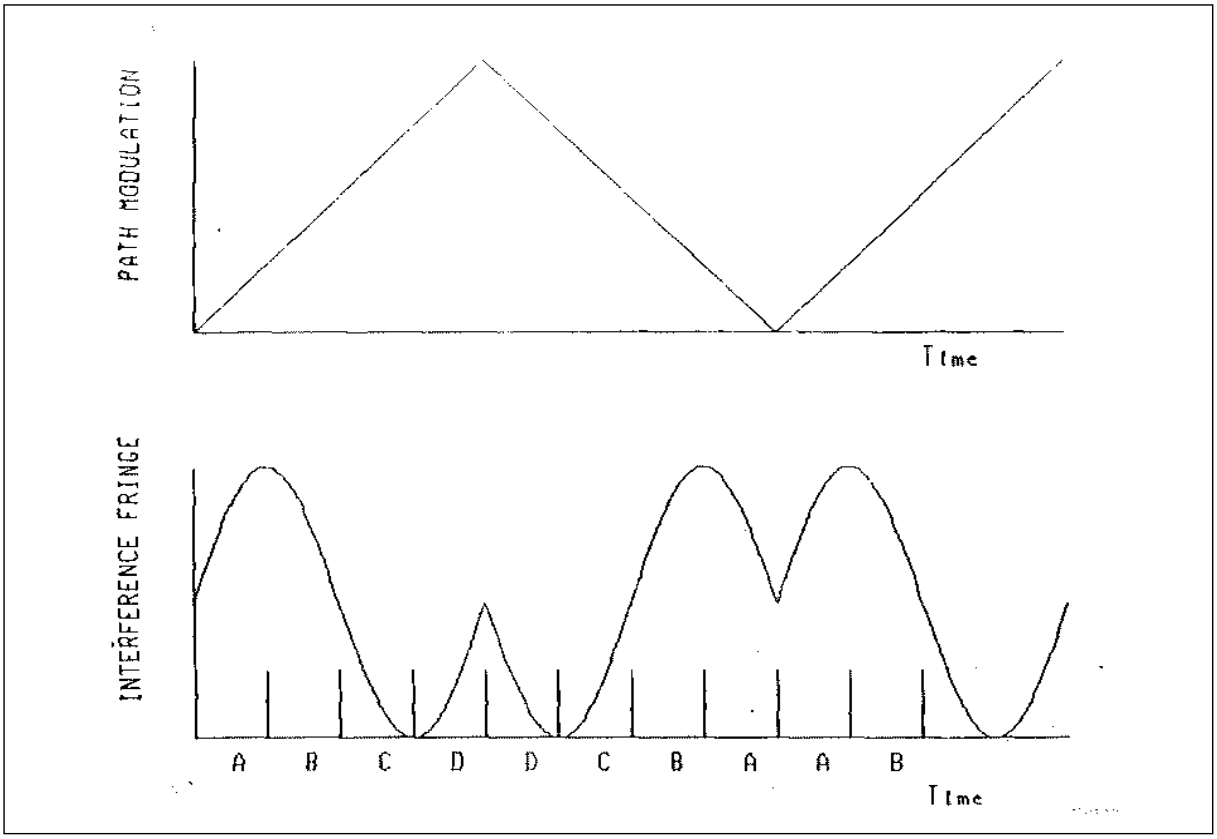
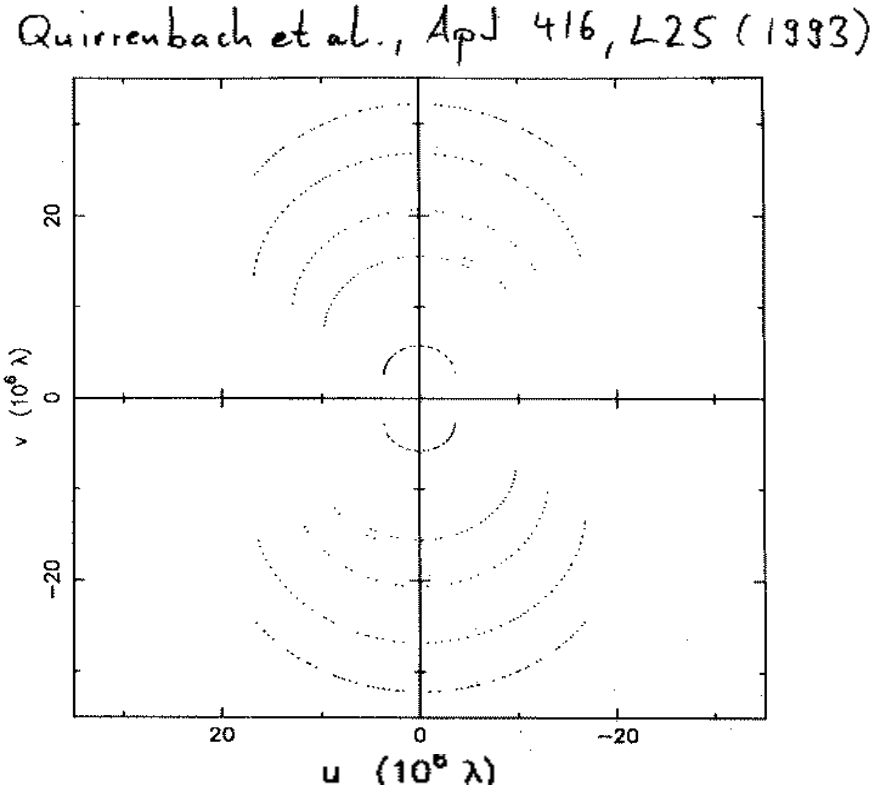


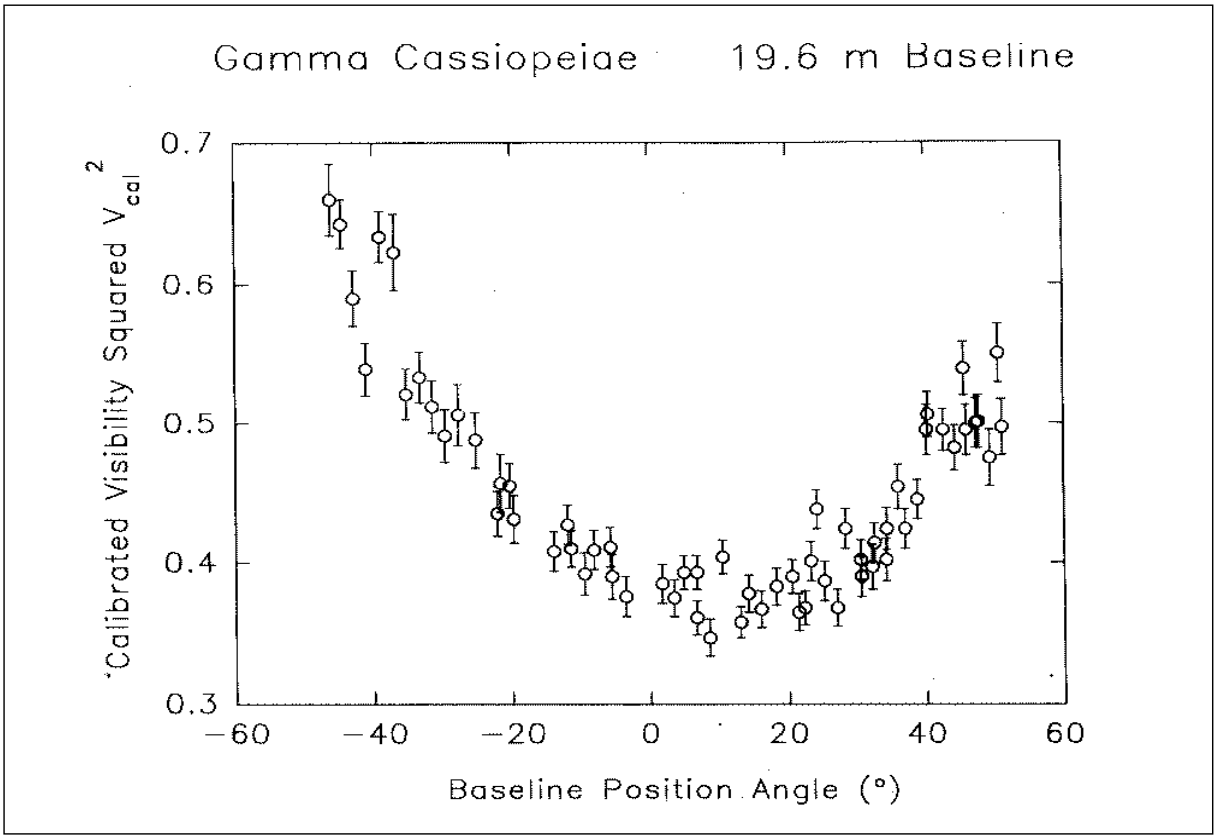
Figure 2 Schematic of the present configuration of the Mark III stellar interferometer on Mt. Wilson.



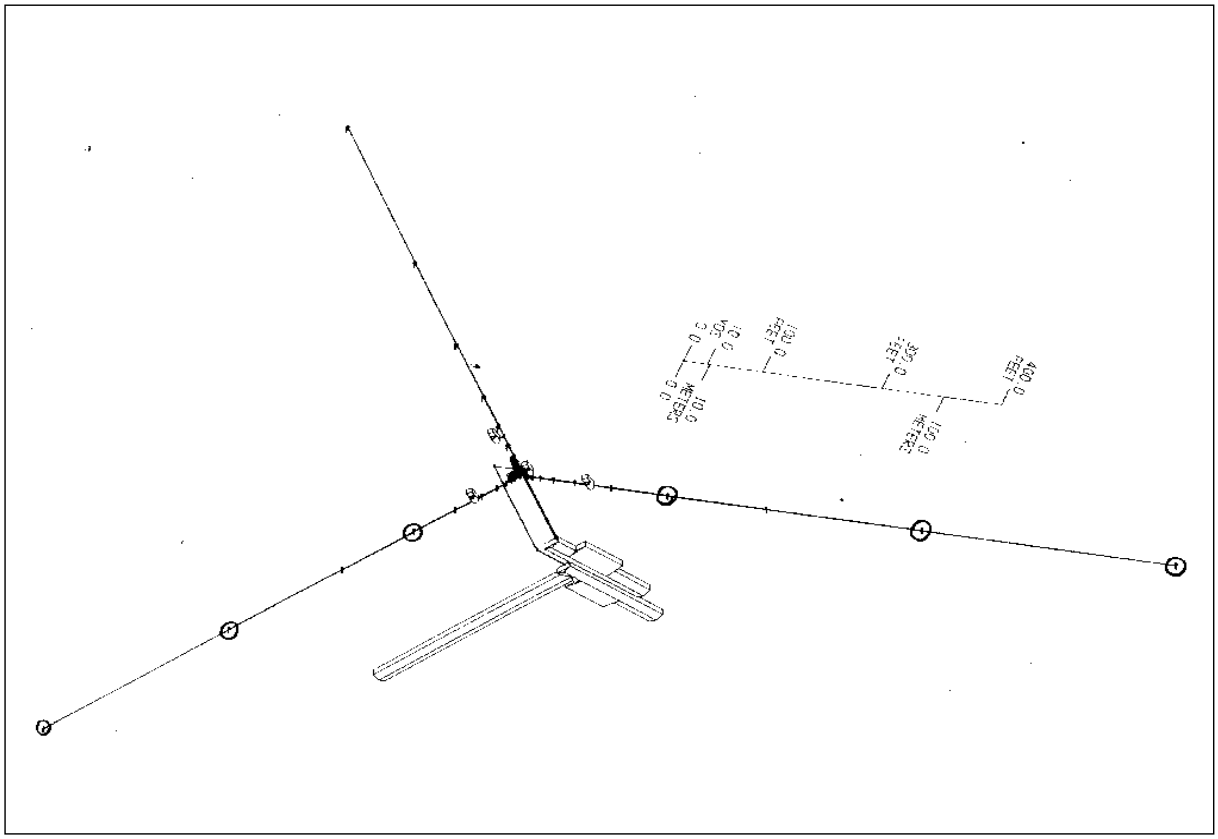
The MkIII Stellar Interferometer on Mt. Wilson, CA

- three fixed astrometric siderostats
- variable baseline, length from 3 to 31.5 m
- 5 cm apertures, limiting magnitude ~ 5
- four wavelength channels
- vacuum feed system and vacuum delay lines
- laser metrology system
- on-line fringe tracking
- fully computer-controlled operation





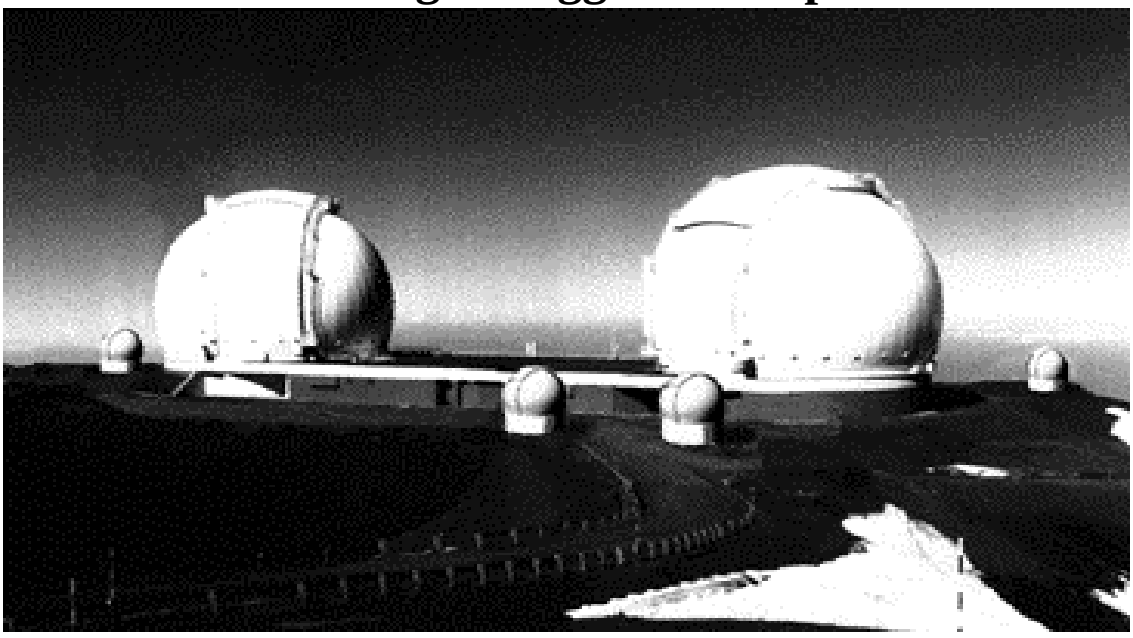
NPOI :
Navy Prototype Optical Interferometer



P.T.I. :
Palomar Testbed Interferometer

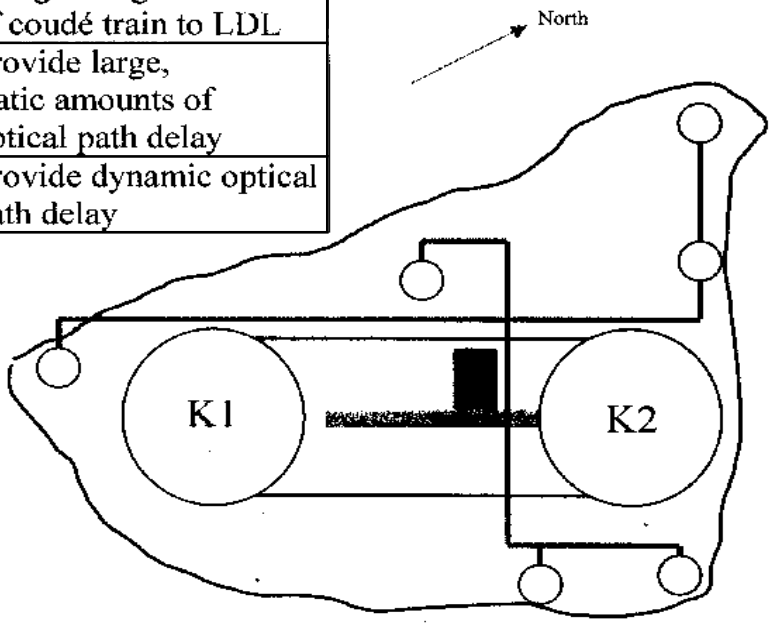
JPL CARA

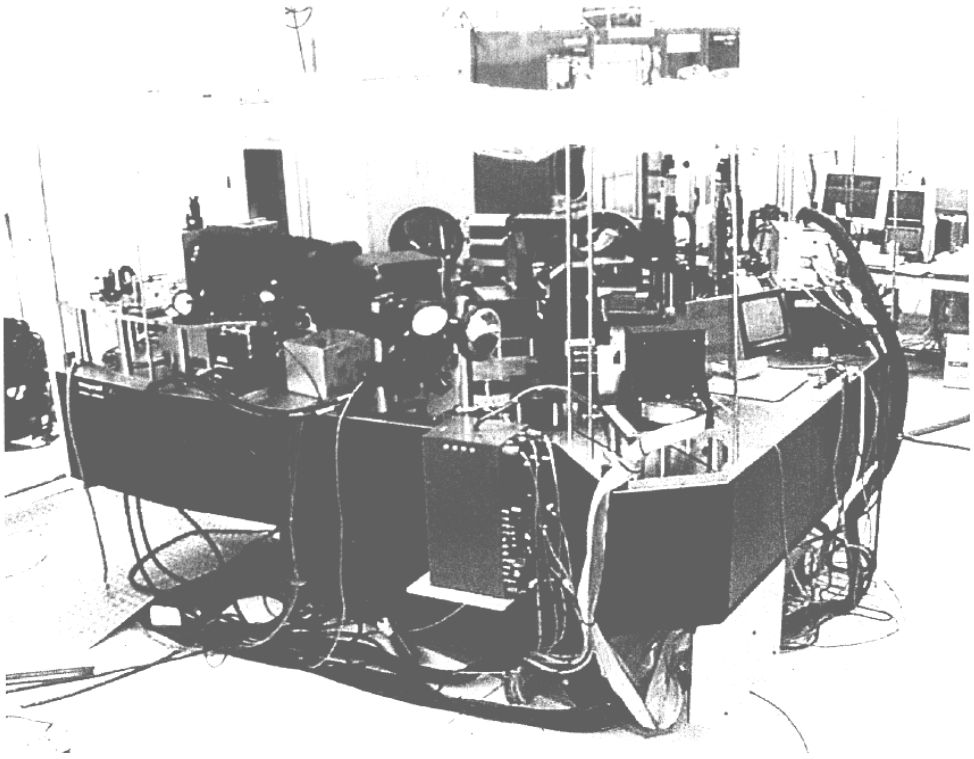
Artist's conception of Keck Interferometric Array showing outrigger telescopes



Basic Functions of Subsystems

Transport Optics	Bring starlight from end of coudé train to LDL
Long Delay Lines	Provide large, static amounts of optical path delay
Fast Delay Lines	Provide dynamic optical path delay





KECK INTERFEROMETER

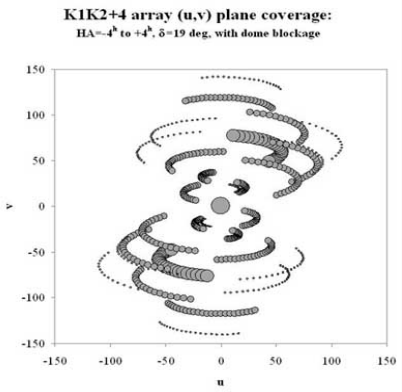
Science Program

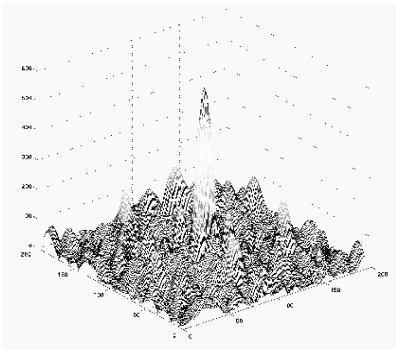
Program	Telescopes	Starting	Duration
Hot Jupiters	Kecks	2001	2-3yrs
Exo-zodiacal dust	Kecks	2001	2-3yrs
Astrometry	Outriggers	2003	>5yrs
Imaging	Full array	2003	Ongoing
Guest investigator	Any	2003	Ramping up

KECK INTERFEROMETER

Imaging - performance

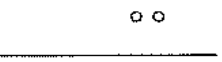
- Baselines 30m-140m
- Wavelengths 1.5µm-5µm
- Dynamic range ~100
- Resolution ~3mas at K
- Less than ~50^2 pixels
- Sensitivities:
  - phase reference k~14
  - point source k~18 (S/N=10 in 1000s)





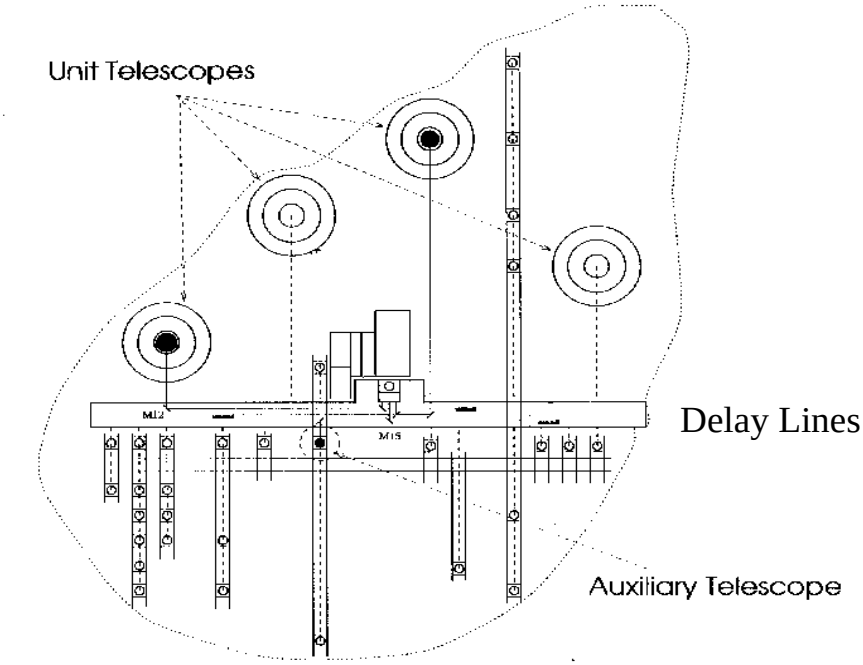
18

Operating Modes

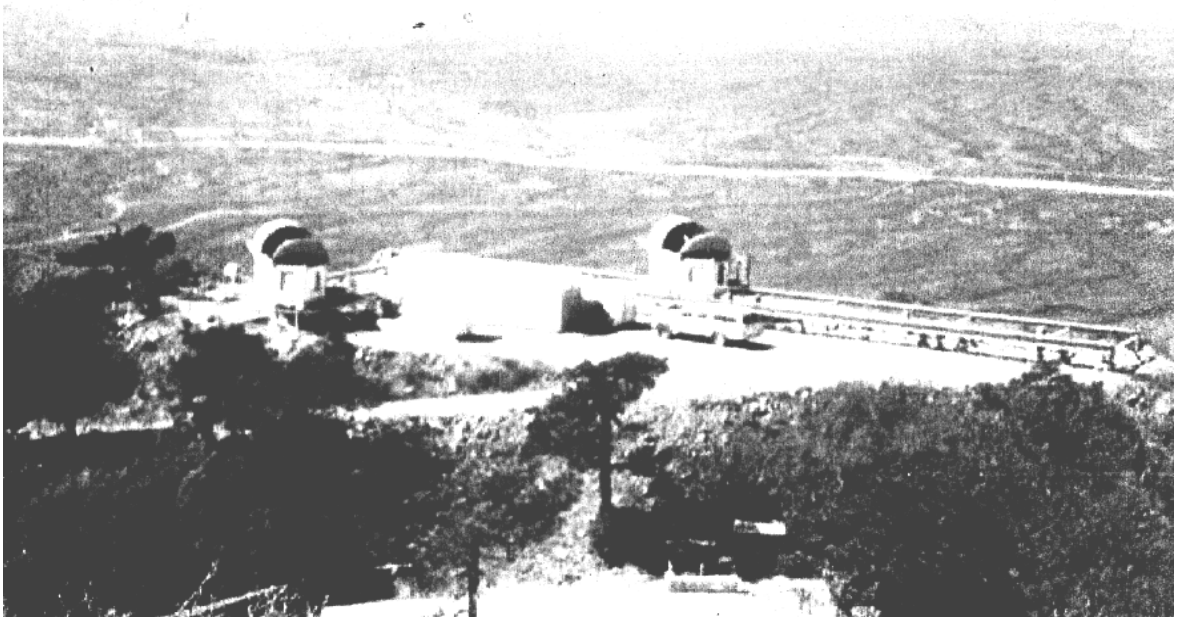
Configuration	Use	Science	Plan view
siderostats only	Interferometer subsystem testing	Testing only	
Two Keck Interferometer	Initial operation as interferometer	Exo-zodiacal emission Hot-Jupiters	
Single Keck + Outriggers	High resolution and high sensitivity Imaging mode	General imaging: YSOs	
Complete Imaging Array	Highest resolution imaging, highest sensitivity	General imaging: Planetary formation	
Outriggers alone	Astrometry, Imaging	Planet detection by measuring the movement of stars, General imaging	

The VLT Array on the Paranal Mountain (24 May 2000)

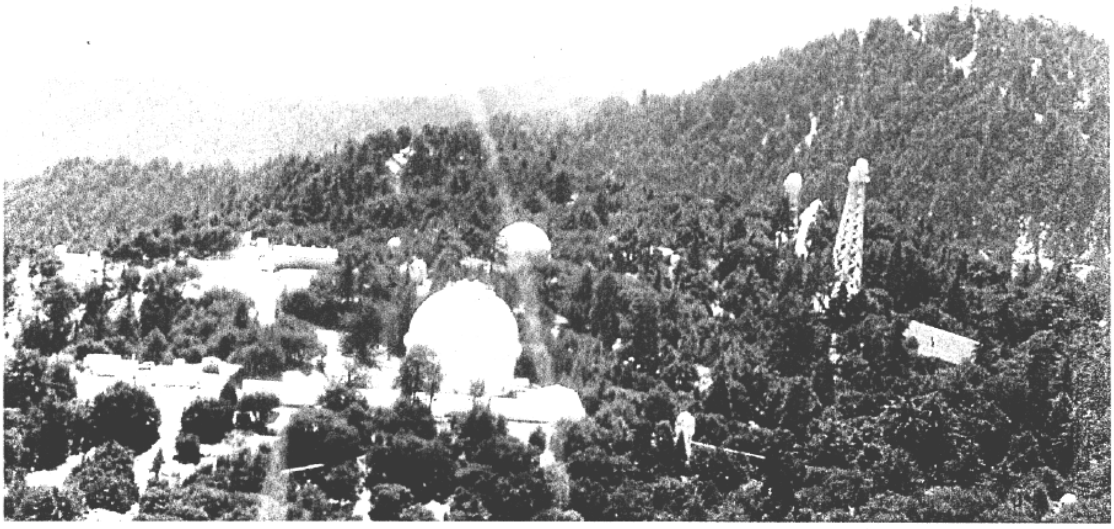
Elements of the VLT Interferometer



I.S.I. : Infrared Spatial Interferometer



View of Mount Wilson Observatory



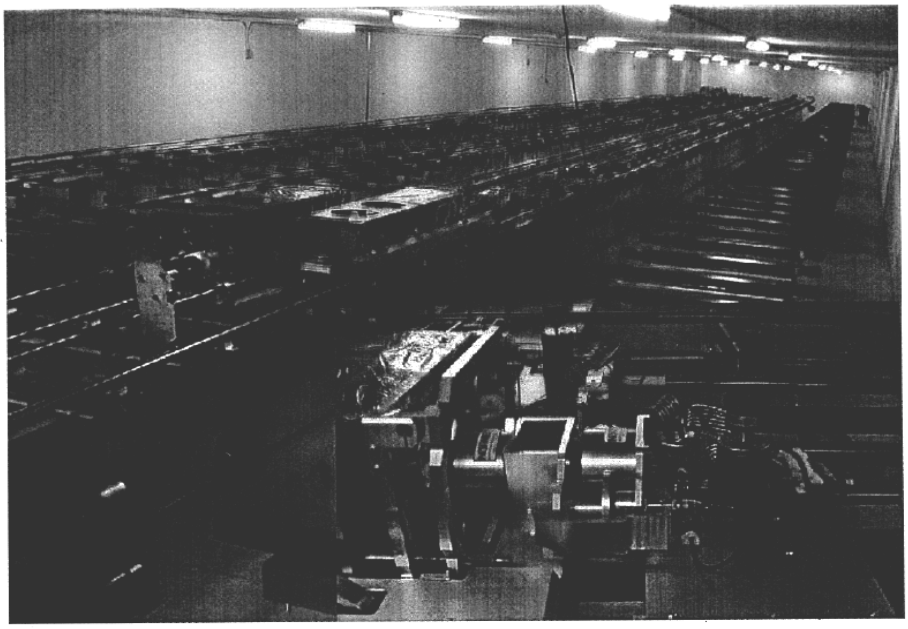


Figure 3. The Optical Path Length Equalizer area. The two fully functional carts can be seen close to the front of the rails. Three other carts are parked at the far end of the delay lines. A set of spare supports for a possible expansion to eight telescopes can be seen on the right. *Insert:* A closeup of the cart drives showing the two voice coils and the stepper motor drive cart.

NPOI siderostats with cover rolled back

I.S.I. :
Infrared Spatial Interferometer