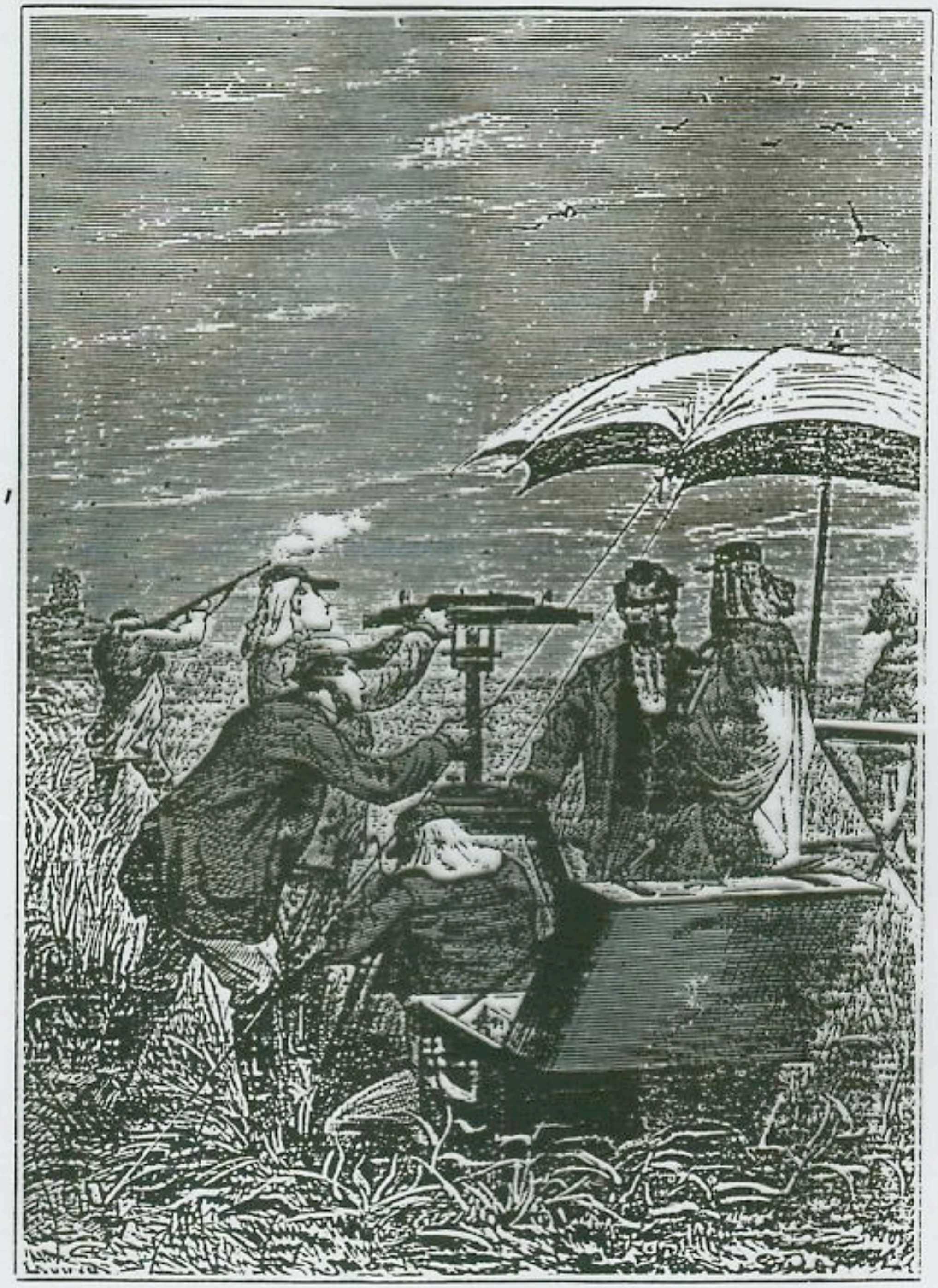


chambres photogoniométriques placées de manière qu'on puisse photogra-

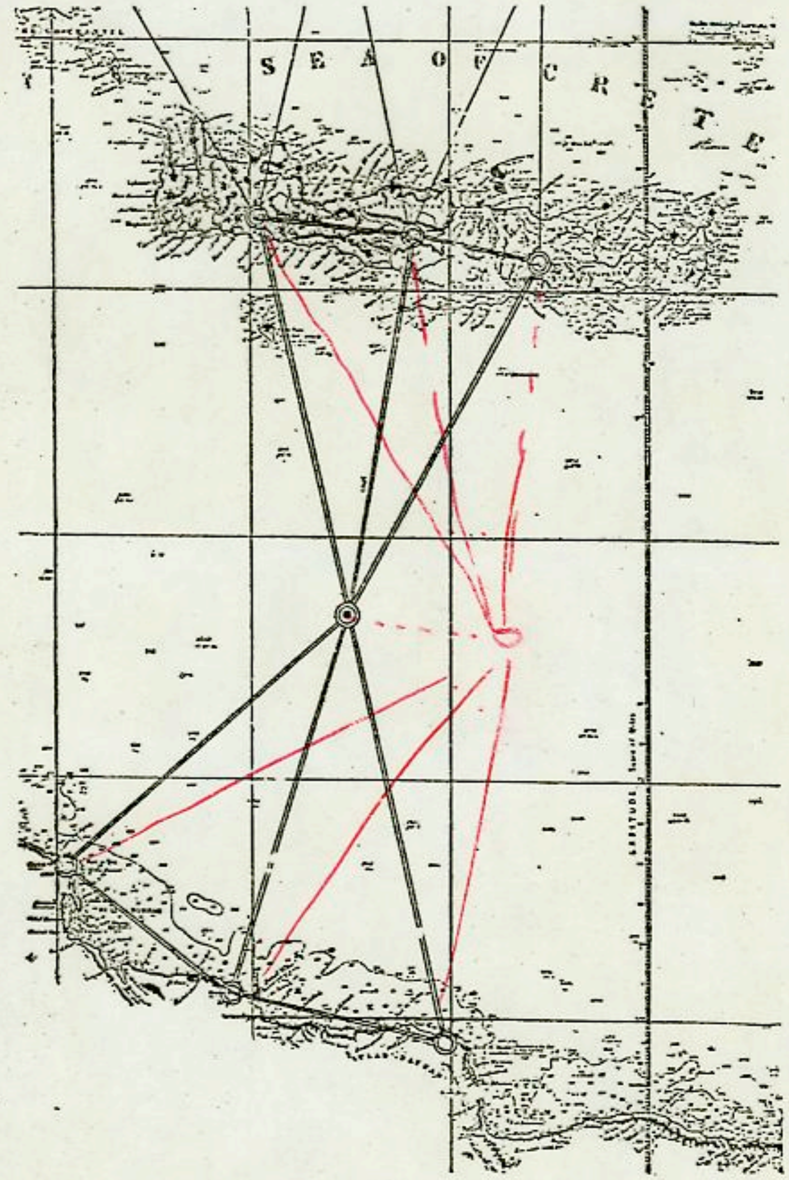
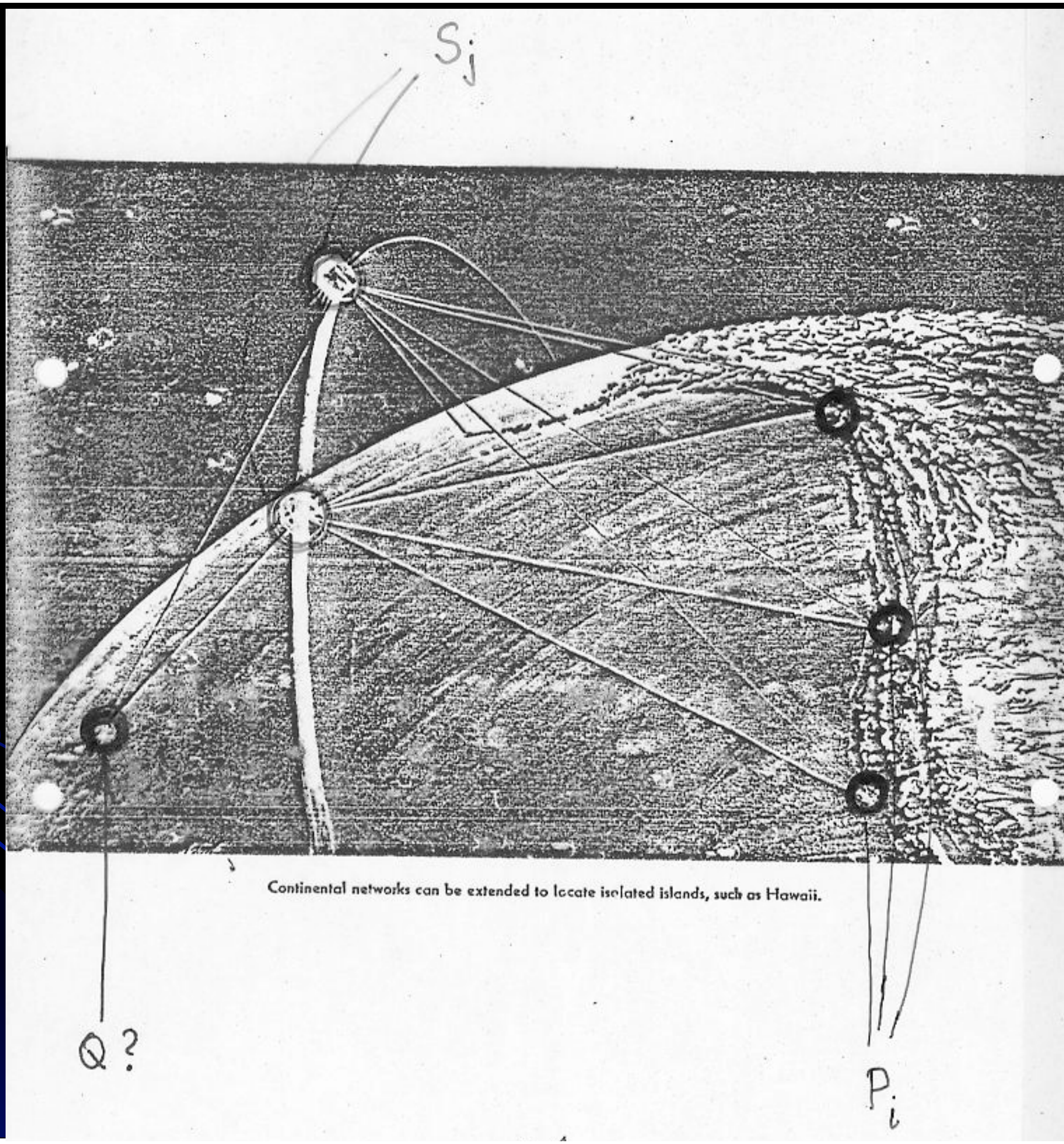
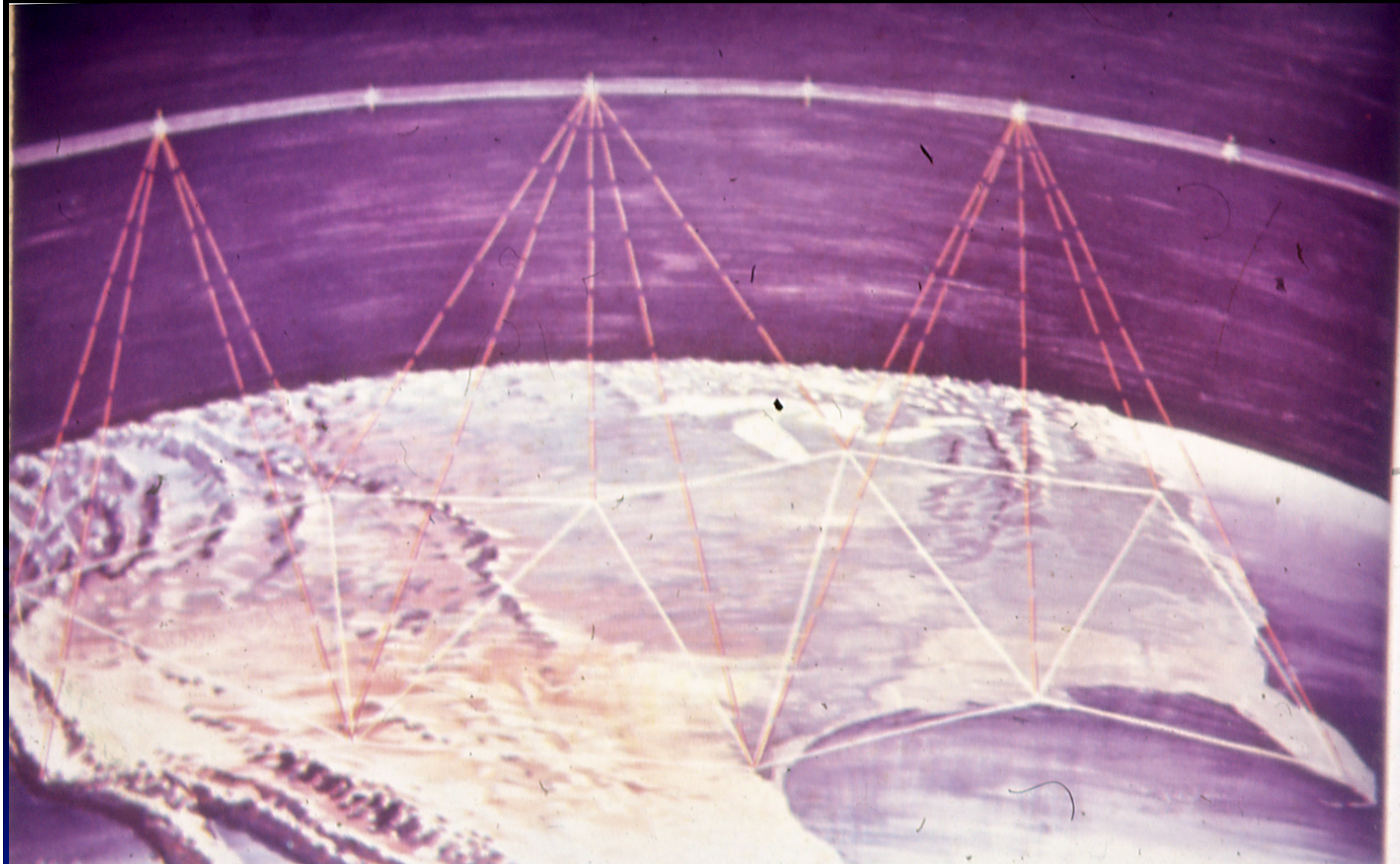


Fig. 2

phier simultanément sur la même plaque. Cette plaque aura une épaisseur



Continental networks can be extended to locate isolated islands, such as Hawaii.



By photographing the successive positions of a satellite in its orbit from strategically placed camera sites a network of relatively few triangles can be established covering a whole continent.

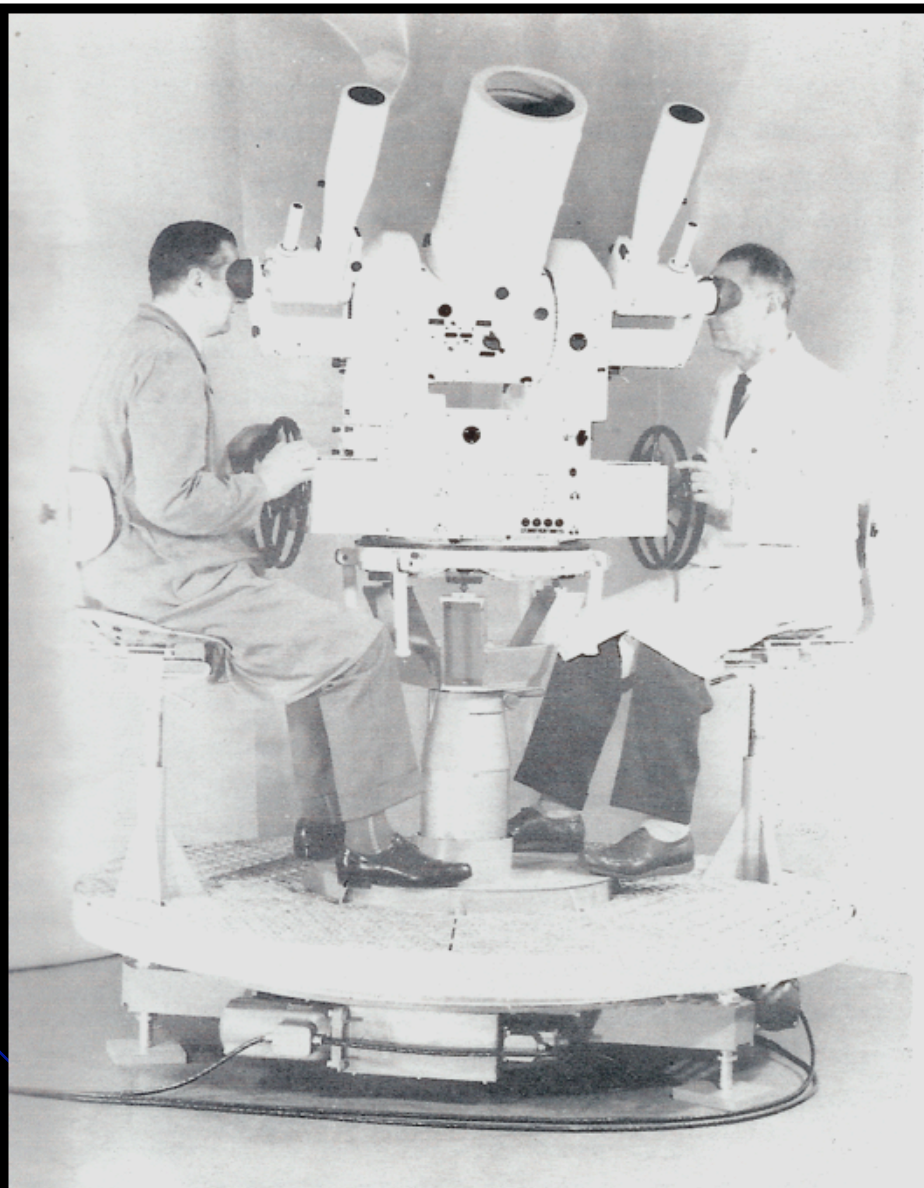
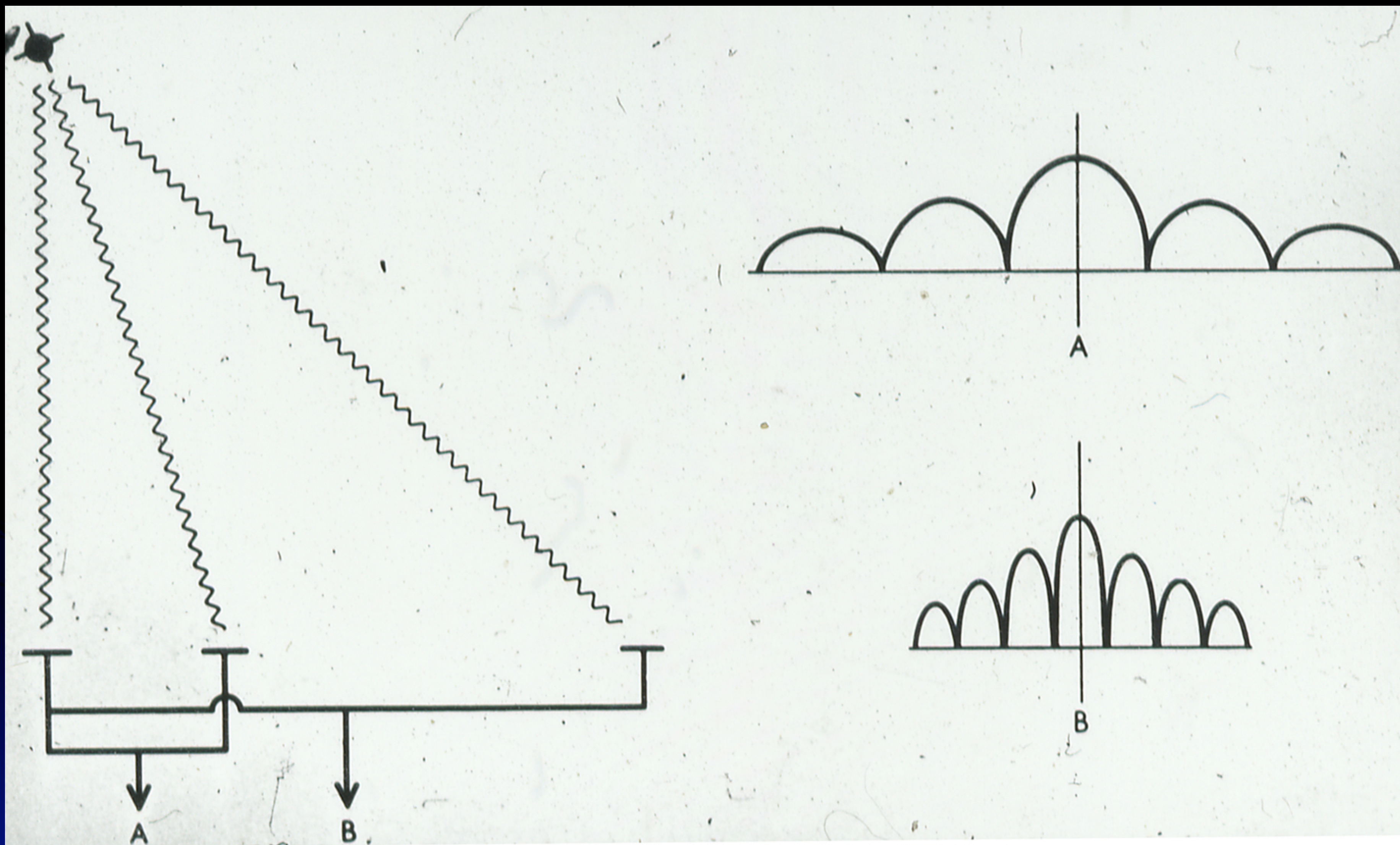
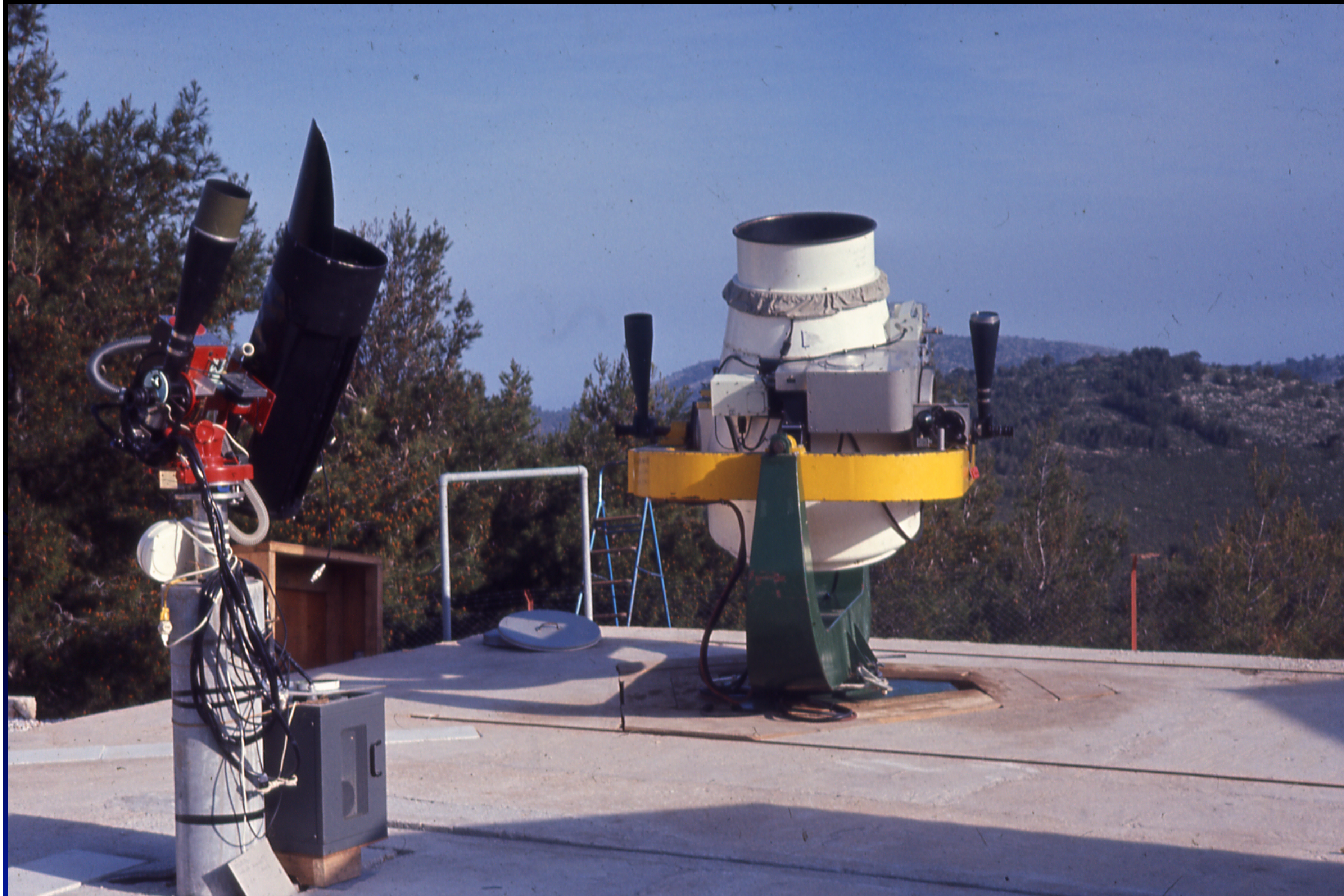
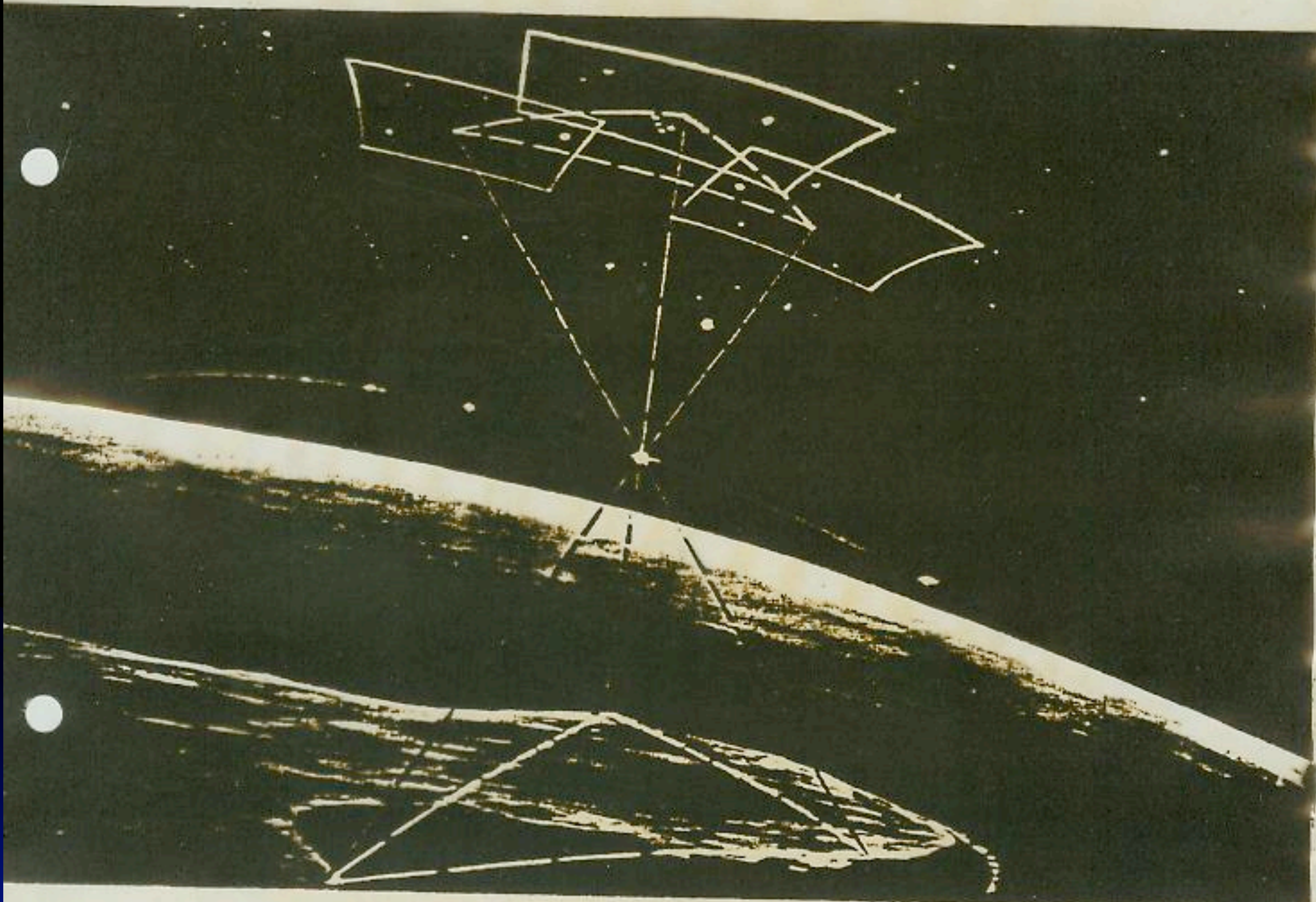


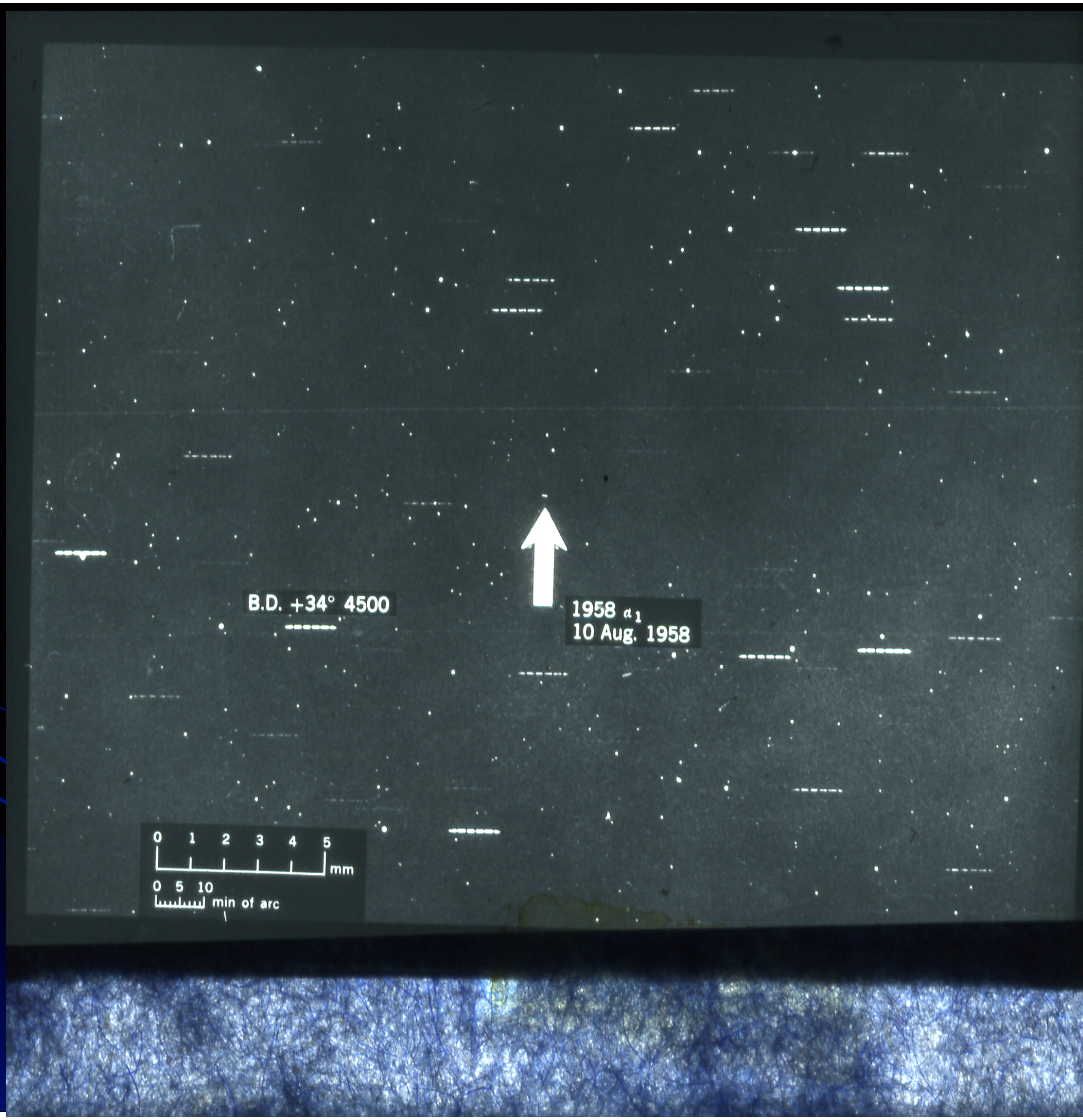
Fig. 9 Cinetheodolite. (Courtesy Askania Werke.)


A
B
A
B





Cameras at three widely separated points in Florida photograph simultaneously an artificial satellite against their respective star backgrounds.


B.D. +34° 4500
1958 α1
10 Aug. 1958
0 1 2 3 4 5
mm
0 5 10
min of arc

tional radius $m = GM/c^2$, eqs. (37) to (40) become

$$y'_{\substack{11\\22}} = -\frac{4m}{r}\left(\frac{\Omega R}{c}\right)^2 \sum_{n=0}^{\infty}\left[\frac{I_n}{2}\left(\frac{R}{r}\right)^n P_n(\sin\phi) \mp \frac{(n-2)!}{(n+2)!}\frac{L_n}{2}\left(\frac{R}{r}\right)^n P_n^2(\sin\phi)\cos 2\theta\right], \tag{41}$$

$$y'_{44} = \frac{4m}{r}\left[1 - \sum_{n=2}^{\infty} J_n\left(\frac{R}{r}\right)^n P_n(\sin\phi)\right], \tag{42}$$

$$g_{12} = y'_{12} = \frac{4m}{r}\left(\frac{\Omega R}{c}\right)^2 \sum_{n=1}^{\infty}\left[\frac{(n-2)!}{(n+2)!}\frac{L_n}{2}\left(\frac{R}{r}\right)^n P_n^2(\sin\phi)\sin 2\theta\right], \tag{43}$$

$$g_{\substack{14\\24}} = y'_{\substack{14\\24}} = \pm i\frac{4m}{r}\left(\frac{\Omega R}{c}\right) \sum_{n=1}^{\infty}\left[\frac{(n-1)!}{(n+1)!} K_n\left(\frac{R}{r}\right)^n P_n^1(\sin\phi)\begin{matrix}\sin\theta\\ \cos\theta\end{matrix}\right], \tag{44}$$

and therefore

$$\sum_{a=1}^{4} y'_{\alpha\alpha} =$$

$$= \frac{4m}{r}\left[1 - \sum_{n=2}^{\infty} J_n\left(\frac{R}{r}\right)^n P_n(\sin\phi) - \left(\frac{\Omega R}{c}\right)^2 \sum_{n=0}^{\infty} I_n\left(\frac{R}{r}\right)^n P_n(\sin\phi)\right].$$

Because

$$g_{kk} = -1 + y'_{kk} - \tfrac{1}{2}\sum_{a=1}^{4} y'_{\alpha\alpha},$$

it follows that

$$g_{\substack{11\\22}} = -1 - \frac{2m}{r}\left[1 - \sum_{n=2}^{\infty} J_n\left(\frac{R}{r}\right)^n P_n(\sin\phi) \mp \right.$$
$$\left. \mp \left(\frac{\Omega R}{c}\right)^2 \frac{(n-2)!}{(n+2)!} L_n\left(\frac{R}{r}\right)^n P_n^2(\sin\phi)\cos 2\theta\right], \tag{45}$$

$$g_{33} = -1 - \frac{2m}{r}\left[1 - \sum_{n=2}^{\infty} J_n\left(\frac{R}{r}\right)^n P_n(\sin\phi) - \right.$$
$$\left. - \left(\frac{\Omega R}{c}\right)^2 \sum_{n=0}^{\infty} I_n\left(\frac{R}{r}\right)^n P_n(\sin\phi)\right], \tag{46}$$

$$g_{44} = -1 + \frac{2m}{r}\left[1 - \sum_{n=2}^{\infty} J_n\left(\frac{R}{r}\right)^n P_n(\sin\phi) + \right.$$
$$\left. + \left(\frac{\Omega R}{c}\right)^2 \sum_{n=0}^{\infty} I_n\left(\frac{R}{r}\right)^n P_n(\sin\phi)\right]. \tag{47}$$

Taking only the terms up to $n = 2$, the components of the fundamental tensor are

$$g_{\substack{11\\22}} = -1 - \frac{2m}{r}\left[1 - J_2\left(\frac{R}{r}\right)^2 P_2(\sin\phi) \mp \right.$$
$$\left. \mp \left(\frac{\Omega R}{c}\right)^2 \frac{L_2}{8}\left(\frac{R}{r}\right)^2 \cos^2\phi\cos 2\theta\right], \tag{48}$$

$$g_{33} = -1 - \frac{2m}{r}\left\{1 - J_2\left(\frac{R}{r}\right)^2 P_2(\sin\phi) - \right.$$
$$\left. - \left(\frac{\Omega R}{c}\right)^2\left[\Gamma + \Delta\left(\frac{R}{r}\right)^2 P_2(\sin\phi)\right]\right\}, \tag{49}$$

$$g_{44} = -1 + \frac{2m}{r}\left\{1 - J_2\left(\frac{R}{r}\right)^2 P_2(\sin\phi) + \right.$$
$$\left. + \left(\frac{\Omega R}{c}\right)^2\left[\Gamma + \Delta\left(\frac{R}{r}\right)^2 P_2(\sin\phi)\right]\right\}, \tag{50}$$

$$g_{12} = \frac{4m}{r}\left(\frac{\Omega R}{c}\right)^2 \frac{L_2}{16}\left(\frac{R}{r}\right)^2 \cos^2\phi\sin 2\theta, \tag{51}$$

$$g_{\substack{14\\24}} = \pm i\frac{2m}{r}\left(\frac{\Omega R}{c}\right)\Gamma\left(\frac{R}{r}\right)\cos\phi\begin{matrix}\sin\theta\\ \cos\theta\end{matrix}. \tag{52}$$

In order to have a spherically symmetric field the very small terms proportional to m/r and $(\Omega R/c)^2$ will be neglected. In g_{44} only, the term will be retained and the second-order term

$$2m^2/r^2 \cdot [1 - 2J_2(R/r)^2 P_2(\sin\phi)]$$

will be added according to de Sitter (eq. 20). The reason why g_{44} is required

Accordingly, a position referred to in the celestial system will be transformed into the terrestrial system by

$$x = SNPw \tag{12}$$

As the terrestrial system had to be replaced by a number of geodetic systems, the celestial system is also replaced in practice by a number of systems that

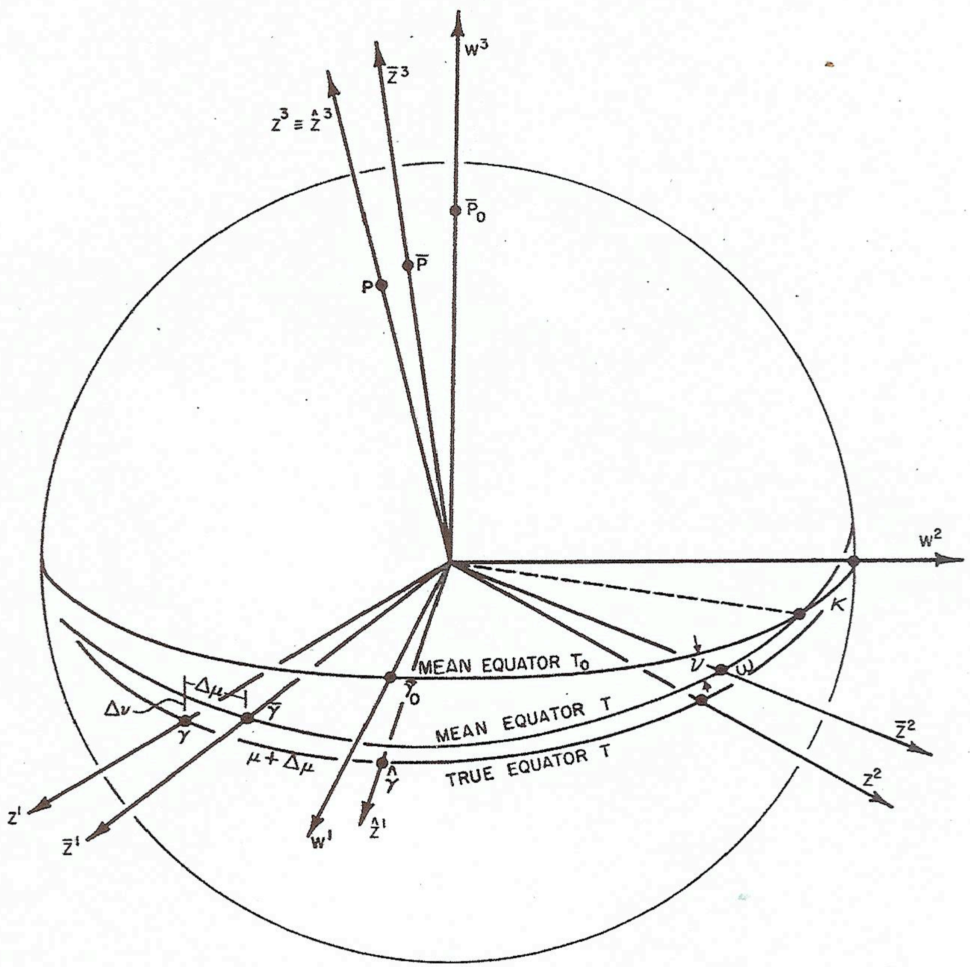


Fig. 3. Sidereal and celestial systems.

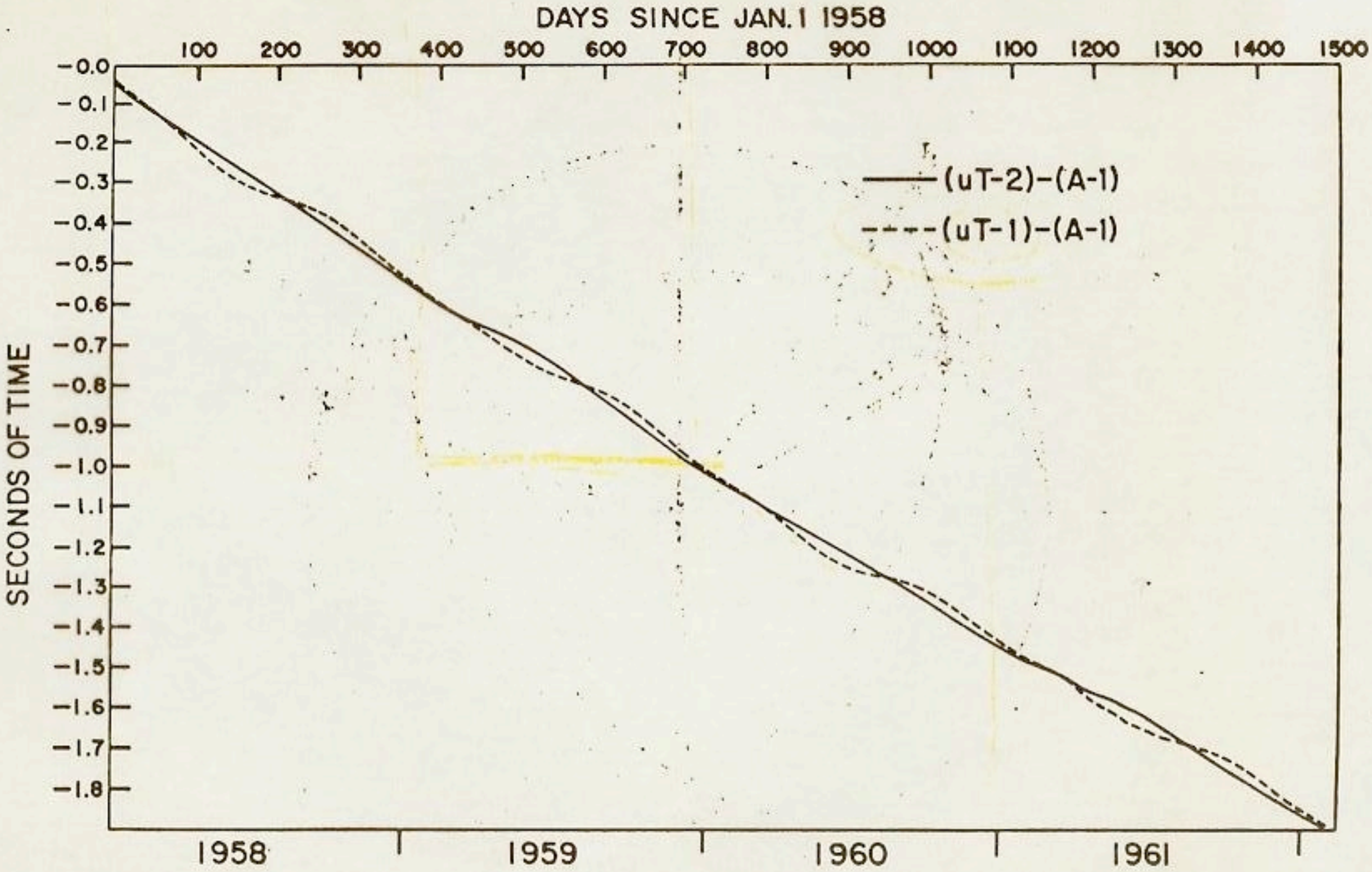


Fig. 2.--Relation between UT-1, UT-2, and A-1.

OUTLINE OF

GEODESY 861 AND 862

MODERN GEOMETRIC GEODESY

O.S.U.
Spring 1958

I. Introduction

a. Principle - History - Different methods and classification
b. Geocentric rectangular system of coordinates
c. The use of stars for determination of directions

II. Methods with the Moon

a. General
   Ephemerides - Ephemeris Time - Libration
b. Direct observations
   1. Theory
   2. Instruments
   3. Methods of low accuracy
c. Occultations
   1. Theory - Predictions
   2. Instruments
   3. Applications
d. Eclipses
   1. Theory - Predictions
   2. Instruments
   3. Applications

III. Methods with rockets

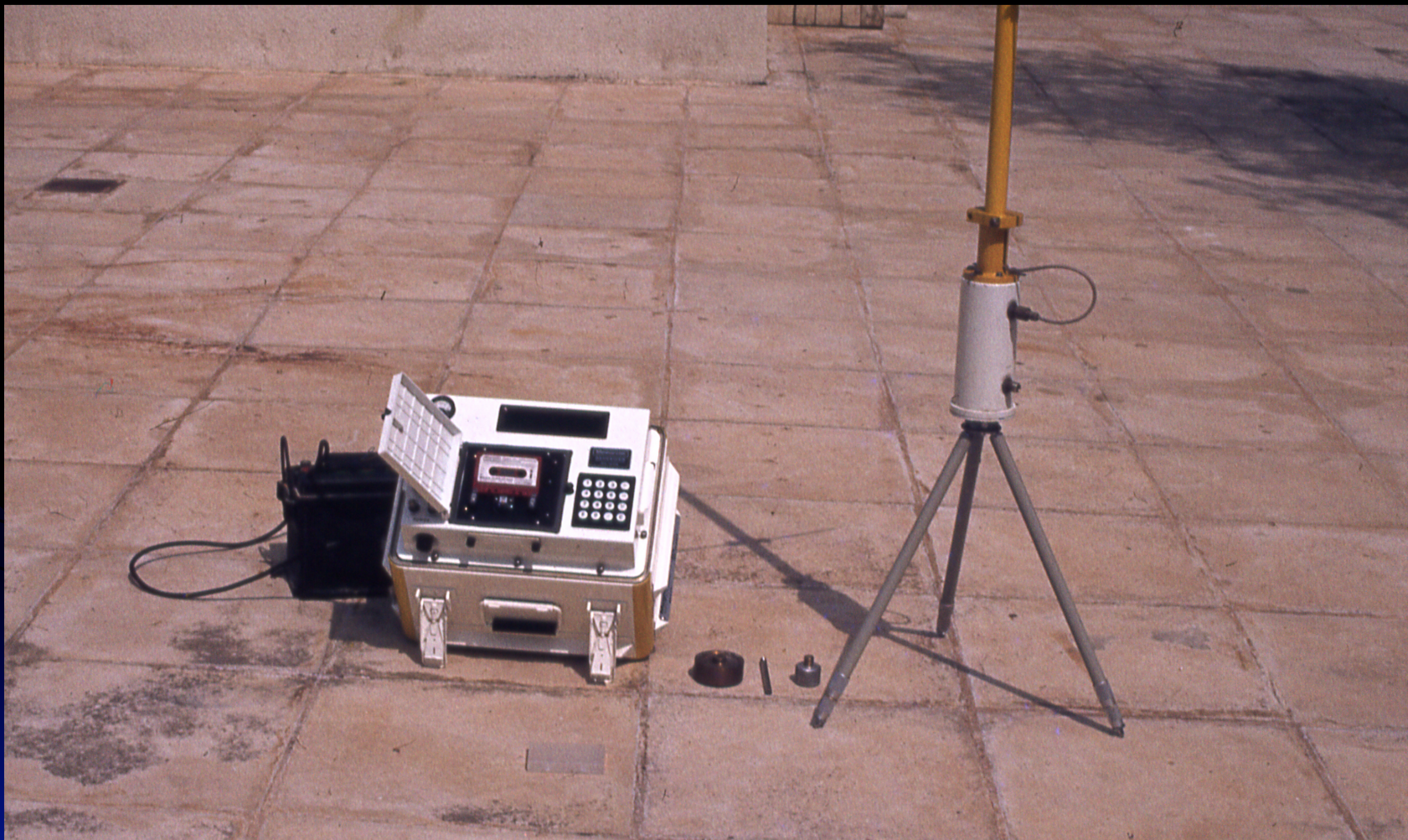
a. Theory
b. Instruments
c. Possible applications - accuracy

IV. Methods with artificial satellites

a. Theory - Orbits
b. Instruments
c. Possible applications - accuracy
d. Geometric and Dynamic Solutions.

V. The direct and indirect geodetic problem for super long distances


INSTRUMENTATION UNIT
NO. 314



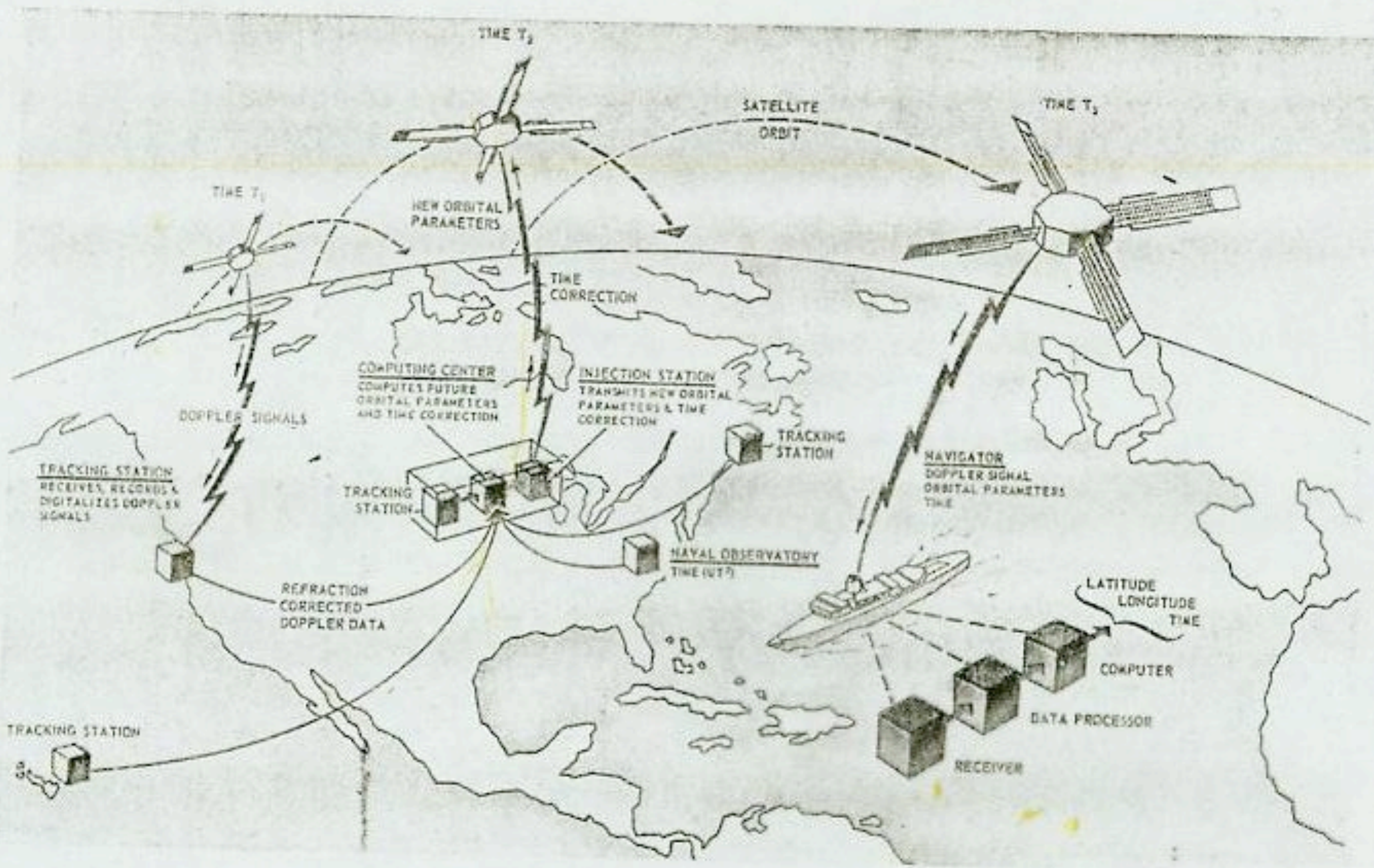
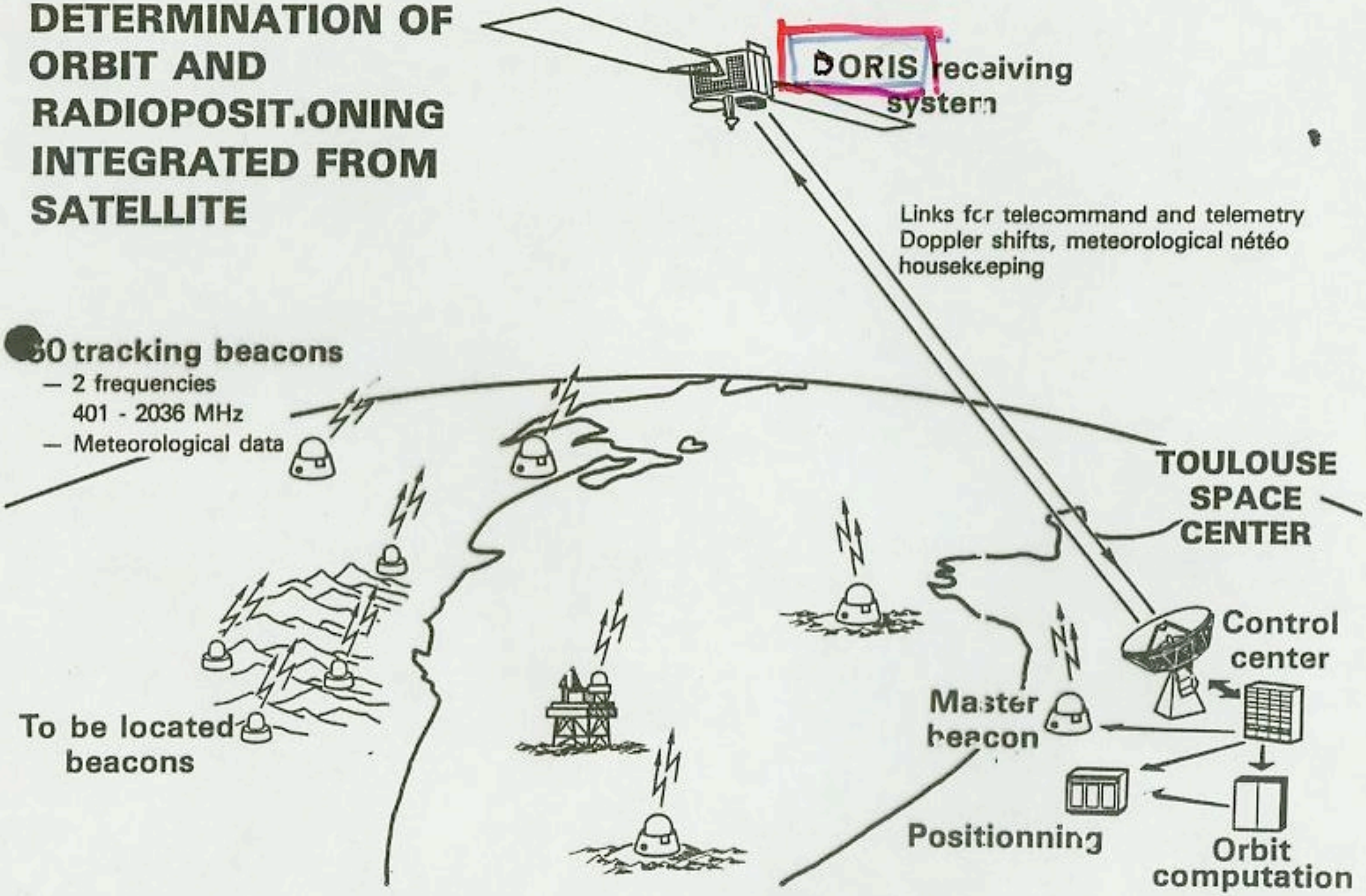


Fig. 2. Operational transit satellite navigation system (high accuracy). Project Transit. (Rev. May 1961).

DETERMINATION OF ORBIT AND RADIOPOSIT.ONING INTEGRATED FROM SATELLITE



P 1.2.3

FIGURE 2

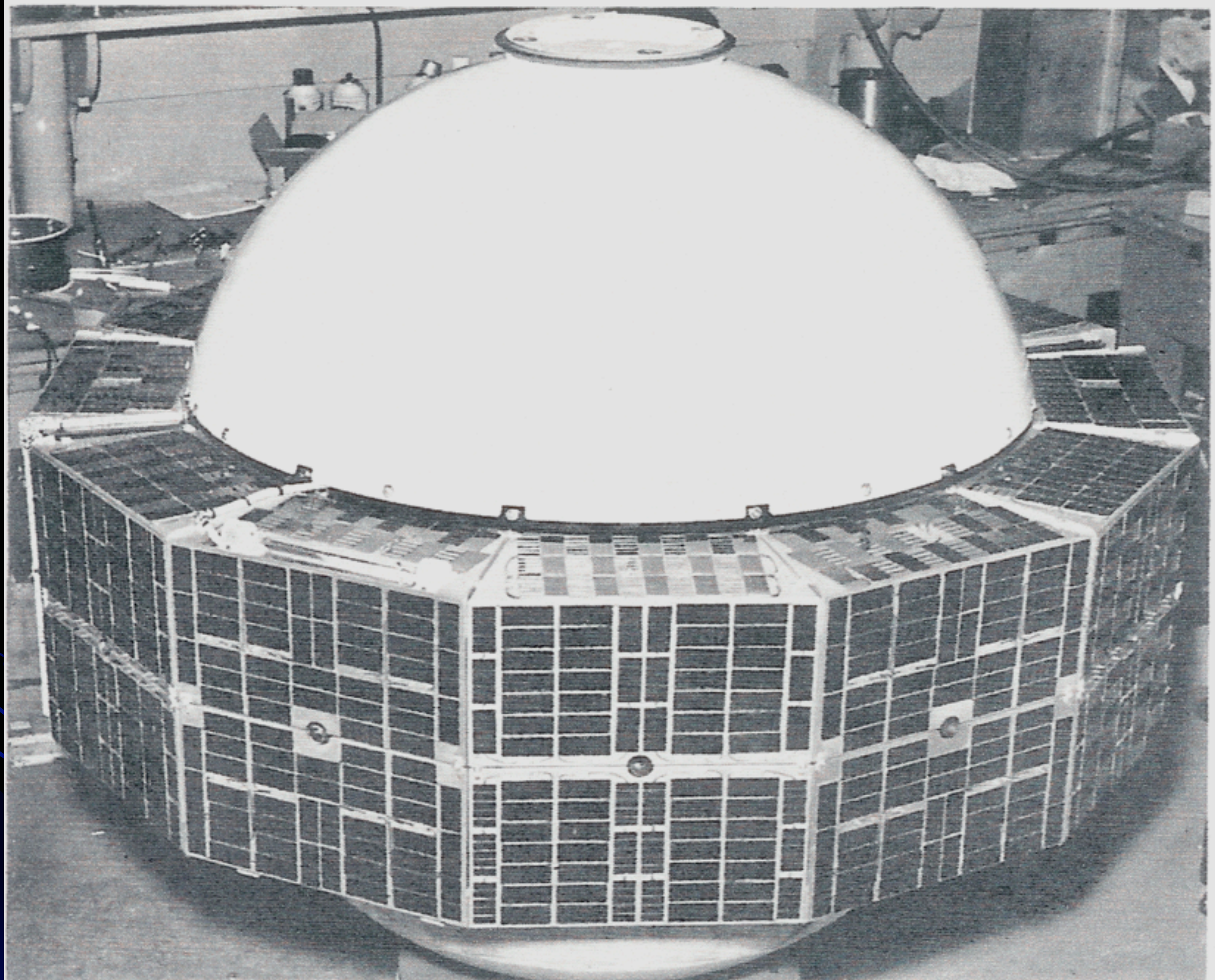


Fig. 1a. The ANNA 1A satellite when ready for launch.

TABLE 5

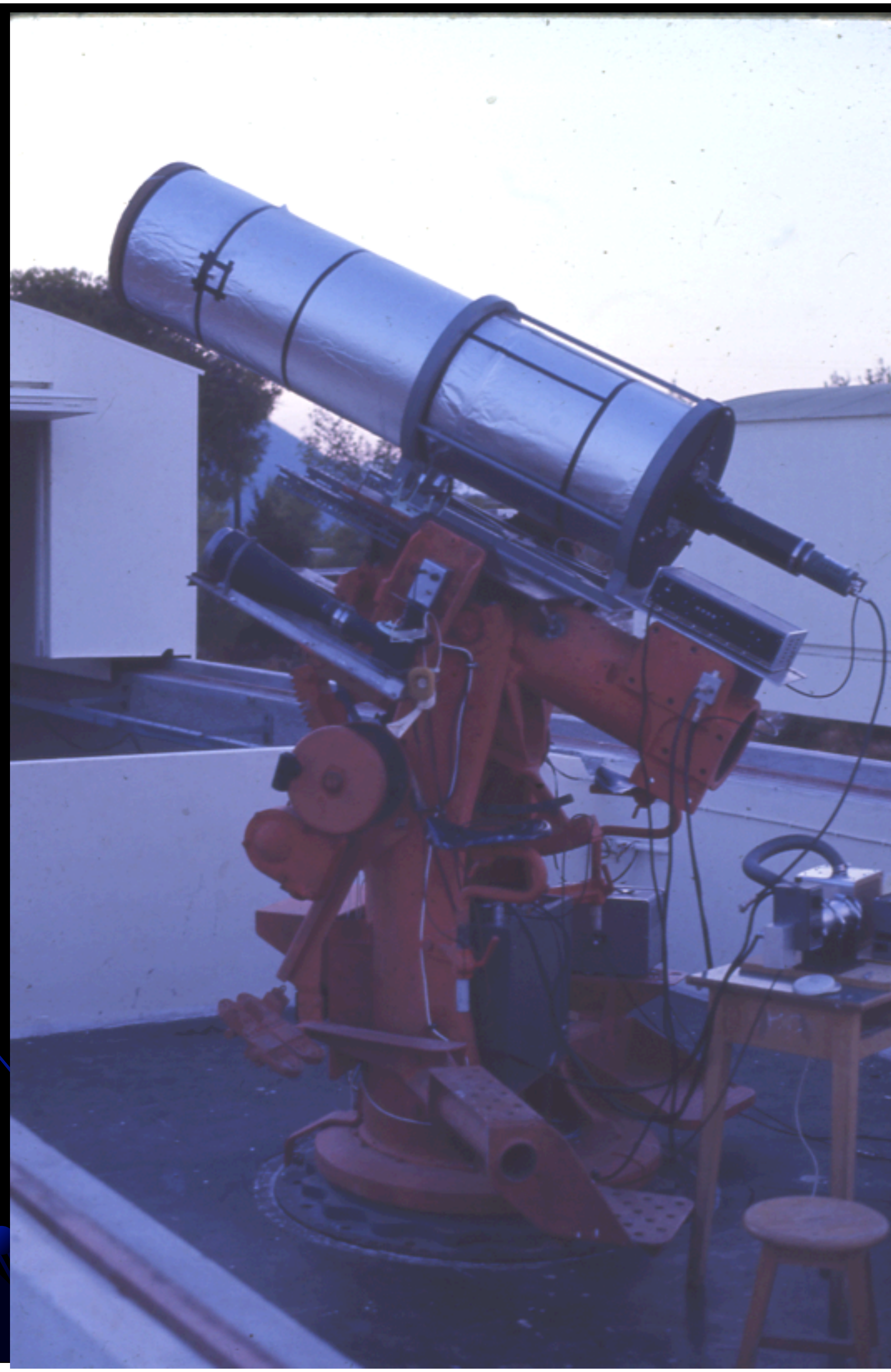
Numerical results for Jn

Source	$J_2 \times 10^6$	$J_3 \times 10^6$	$J_4 \times 10^6$	$J_5 \times 10^6$	$J_6 \times 10^6$	$J_7 \times 10^6$	$J_9 \times 10^6$
[6]	1082.79 ±0.15		−1.4 ±0.2		0.9 ±0.8		
[4]	1082.21 ±0.04	−2.29 ±0.03	−2.10 ±0.06	−0.23 ±0.03			
[15]	1082.48 ±0.04	−2.56 ±0.01	−1.84 ±0.09	−0.06 ±0.01	0.39 ±0.09	−0.47 ±0.01	0.12 ±0.01
[17]		−2.42 ±0.10		−0.22 ±0.07		−0.27 ±0.07	
[5]	1082.49 ±0.06	−2.39 ±0.26	−1.70 ±0.06	−0.30 ±0.53			
[11]	1082.61 ±0.05		−1.52 ±0.08		0.73 ±0.10		
[14.18]	1083.15 ±0.20	−2.37 ±0.18	−1.4 ±0.3	−0.05 ±0.15	0.7 ±0.6		
[13]	1083.3 ±0.7	−2 ±3	−4.1 ±0.7				

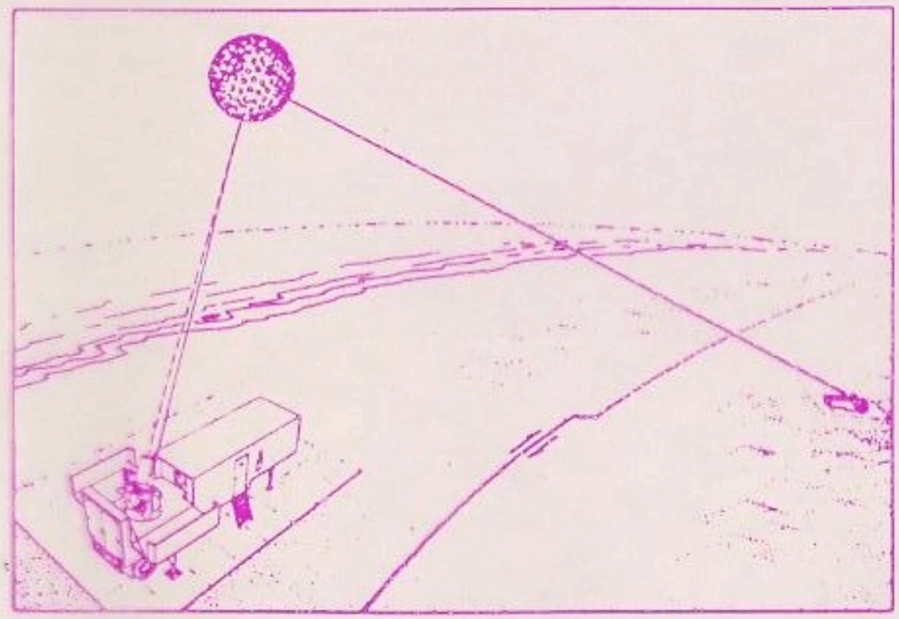
Y.K. 1962

	Station	x^1	x^2	x^3		Number of observations
9001	Organ Pass	-1.535713	-5.167030	+3.401099	±15	5 131
9002	Olifantsfontein	+5.056137	+2.716534	-2.775806	10	5 922
9003	Woomera	-3.983618	+3.743212	-3.275642	7	7 257
9004	San Fernando	+5.105602	-0.555230	+3.769708	20	2 715
9005	Tokyo	-3.946563	+3.366400	+3.698878	18	2 459
9006	Naini Tal	+1.018190	+5.471170	+3.109601	30	1 799
9007	Arequipa	+1.942755	-5.804100	-1.796895	15	2 976
9008	Shiraz	+3.376916	+4.404028	+3.136311	20	2 733
9009	Curaçao	+2.251790	-5.816950	+1.327212	10	3 092
9010	Jupiter	+0.976314	-5.601416	+2.880301	12	3 607
9011	Villa Dolores	+2.280624	-4.914540	-3.355451	12	4 514
9012	Maui	-5.466100	-2.404157	+2.242353	22	4 330

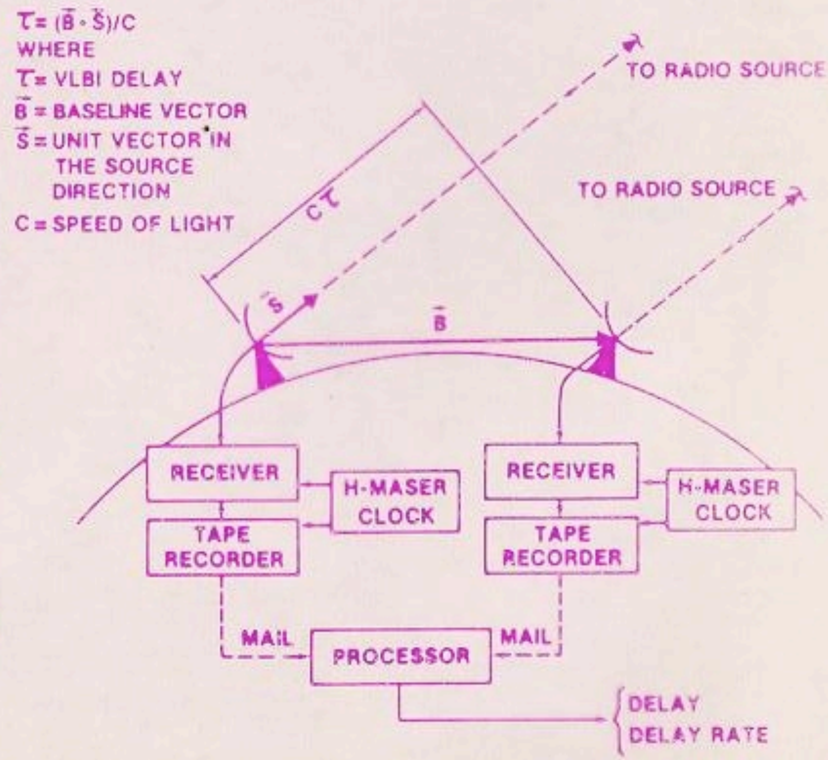
G.V. 1964



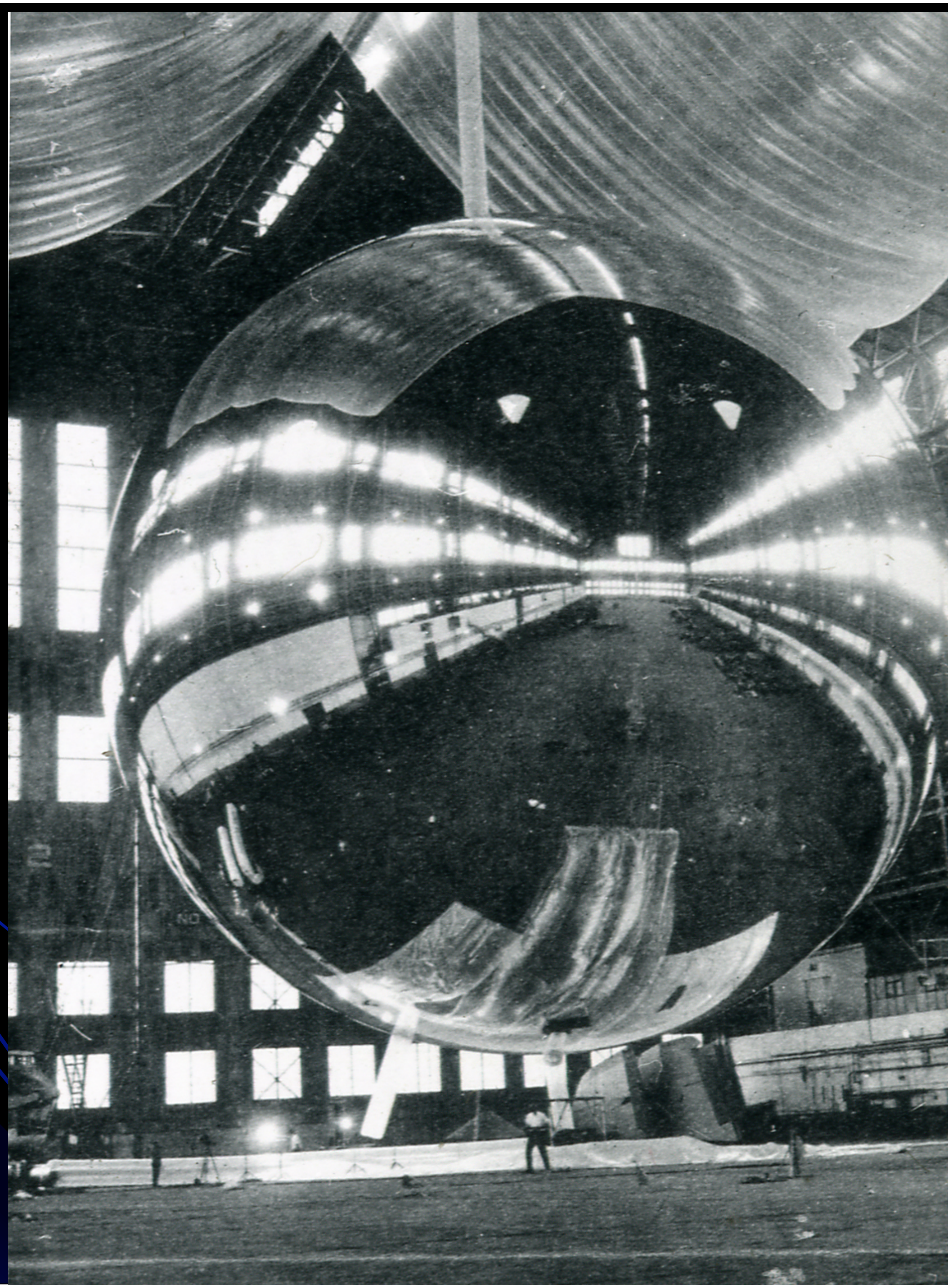
BASELINES BETWEEN LASER TRACKING STATIONS AND BETWEEN VLBI STATIONS ARE TO BE MEASURED TO A PRECISION OF A FEW CENTIMETERS



SATELLITE LASER RANGING



VERY LONG BASELINE INTERFEROMETRY



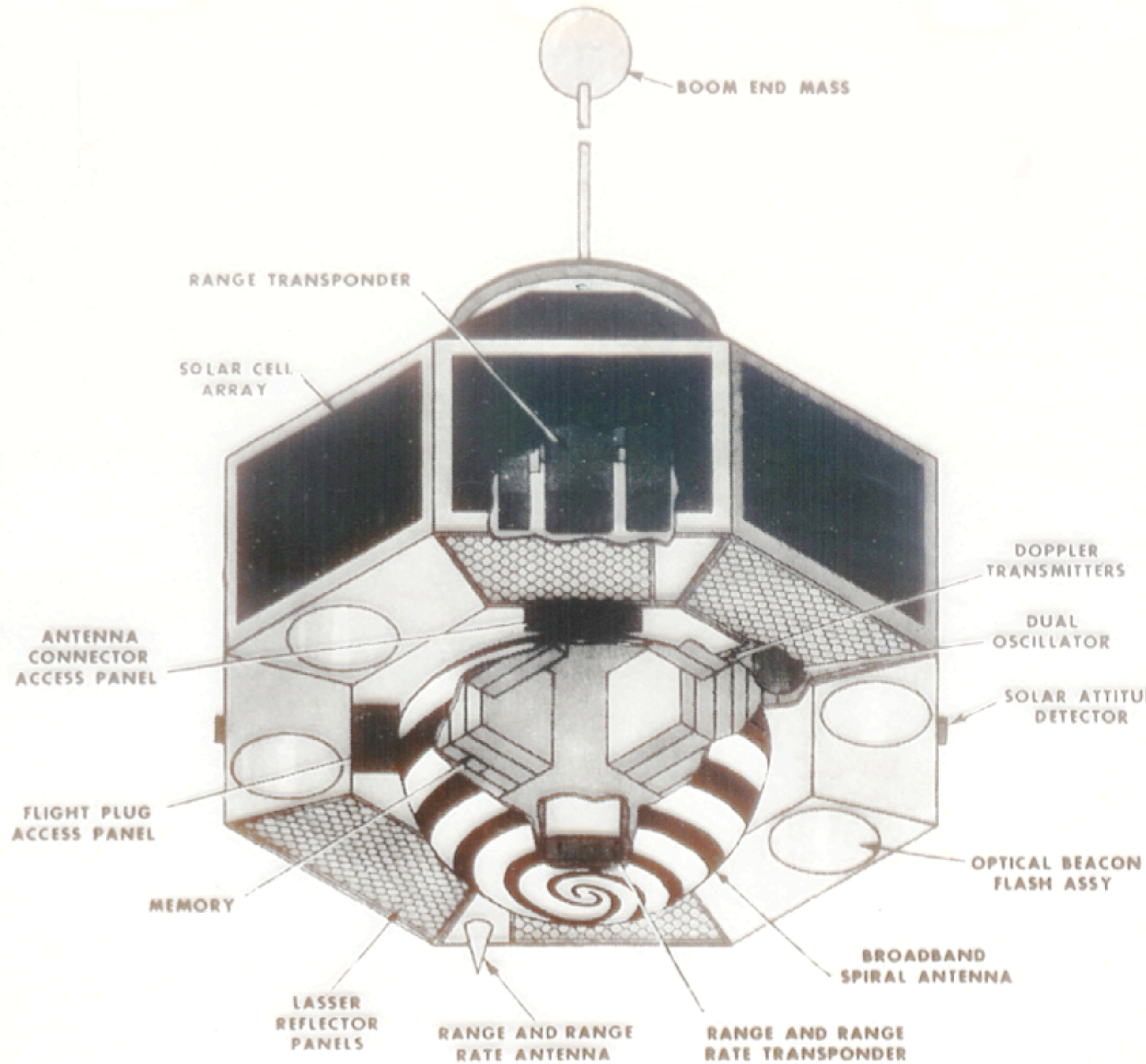
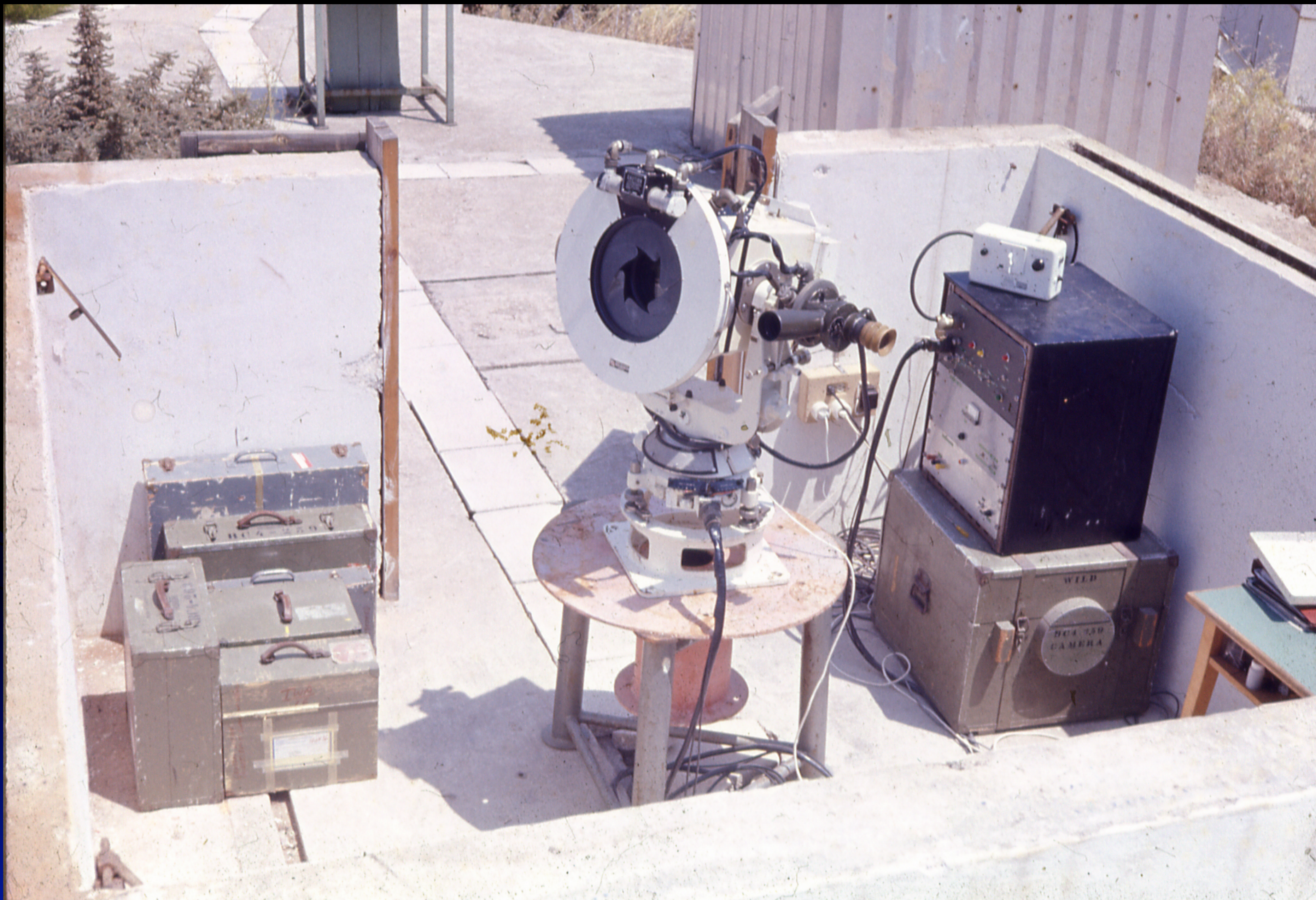
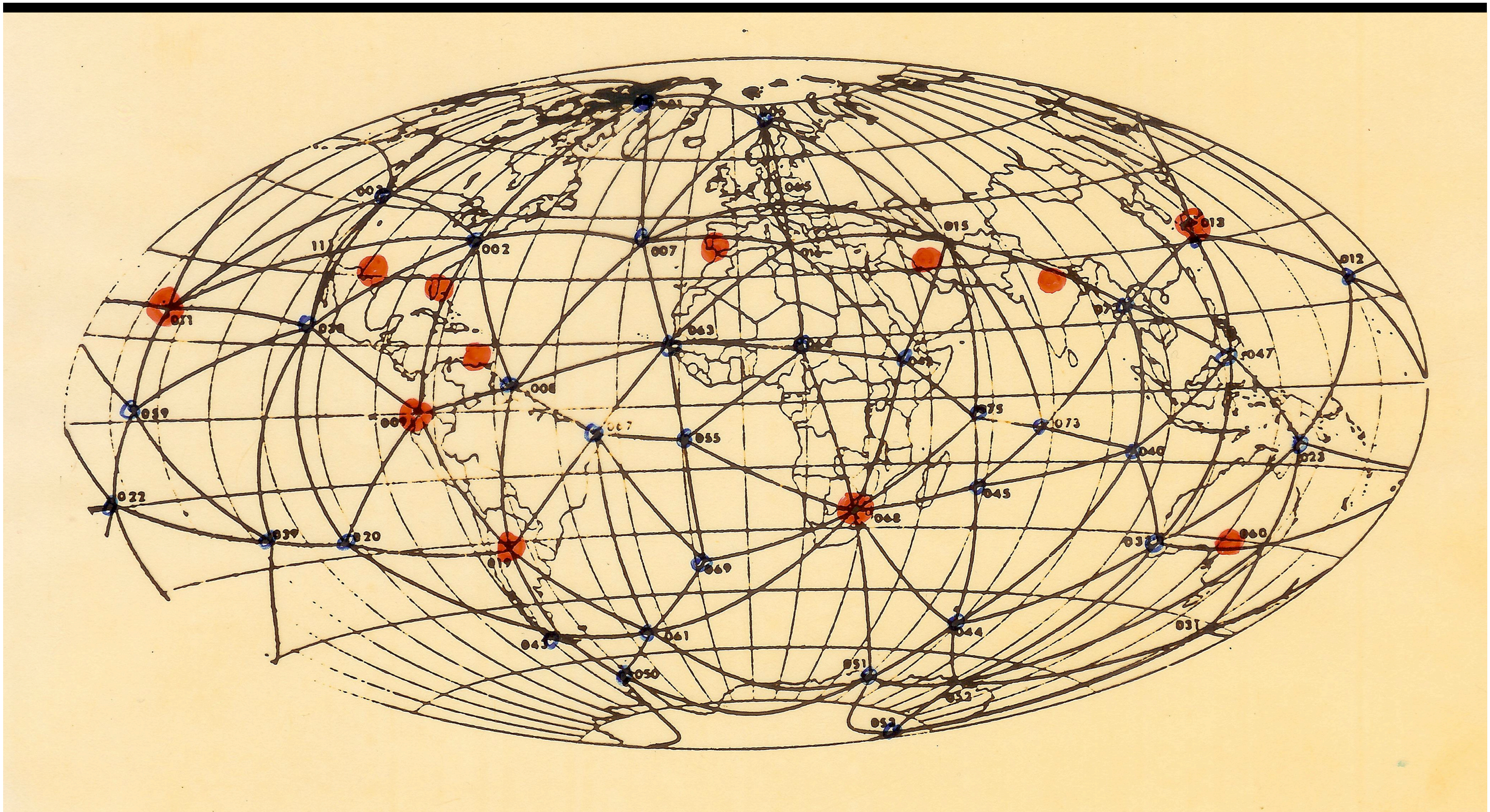
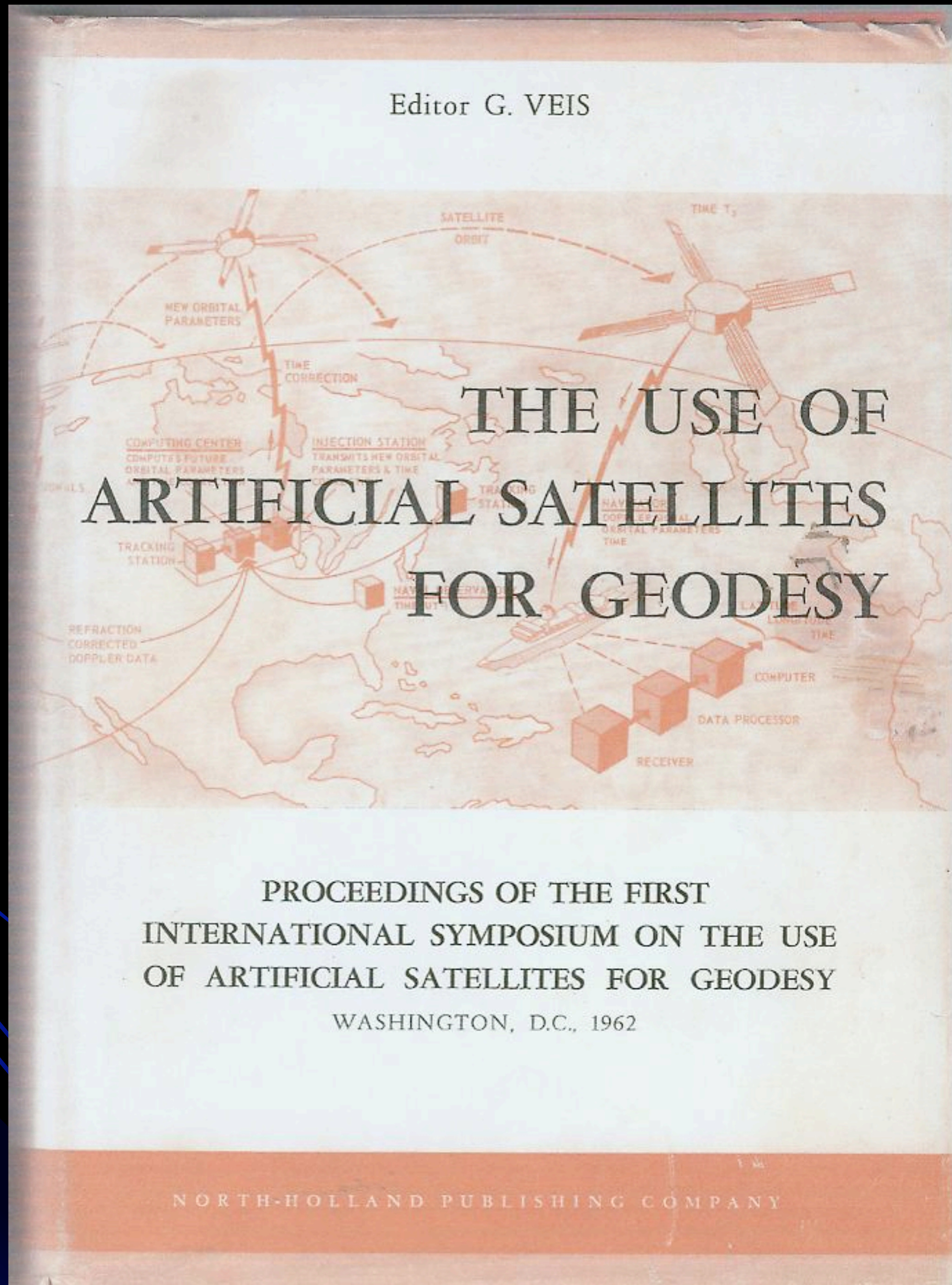

BOOM END MASS
RANGE TRANSPONDER
SOLAR CELL
ARRAY
DOPPLER
TRANSMITTERS
DUAL
OSCILLATOR
ANTENNA
CONNECTOR
ACCESS PANEL
SOLAR ATTITUDE
DETECTOR
FLIGHT PLUG
ACCESS PANEL
OPTICAL BEACON
FLASH ASSY
MEMORY
BROADBAND
SPIRAL ANTENNA
LASSER
REFLECTOR
PANELS
RANGE AND RANGE
RATE ANTENNA
RANGE AND RANGE
RATE TRANSPONDER

Figure 2.


WILD
CAMERA



- BC 4
- B/N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THE USE OF
ARTIFICIAL SATELLITES
FOR GEODESY
PROCEEDINGS OF THE FIRST
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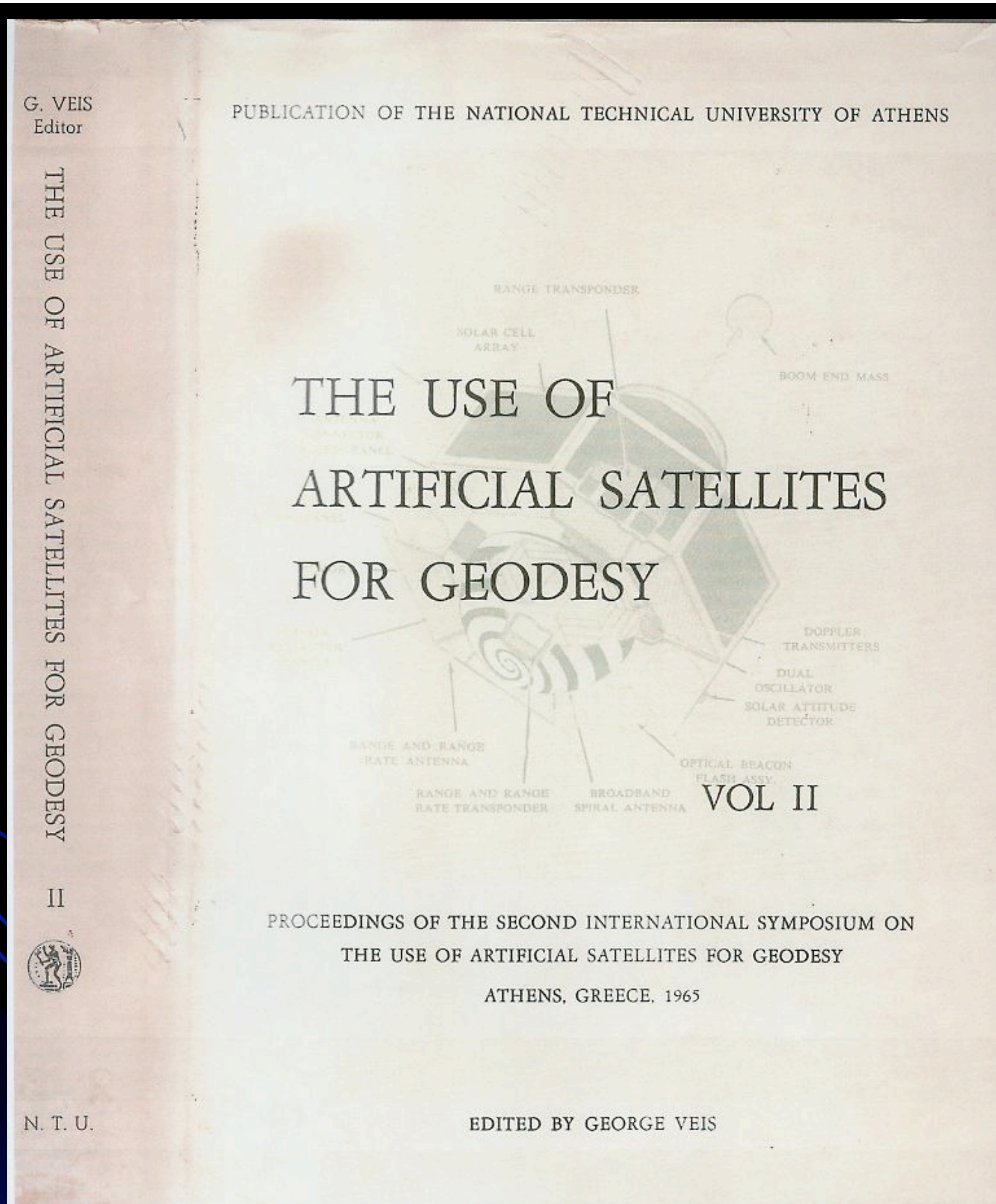
OF ARTIFICIAL SATELLITES FOR GEODESY
WASHINGTON, D.C., 1962
NORTH-HOLLAND PUBLISHING COMPANY



G. VEIS
Editor

THE USE OF ARTIFICIAL SATELLITES FOR GEODESY

II

N. T. U.

PUBLICATION OF THE NATIONAL TECHNICAL UNIVERSITY OF ATHENS

THE USE OF ARTIFICIAL SATELLITES FOR GEODESY

VOL II

PROCEEDINGS OF THE SECOND INTERNATIONAL SYMPOSIUM ON THE USE OF ARTIFICIAL SATELLITES FOR GEODESY

ATHENS, GREECE, 1965

EDITED BY GEORGE VEIS

Research in Space Science

SAO Special Report No. 200

GEODETIC PARAMETERS FOR A 1966 SMITHSONIAN INSTITUTION STANDARD EARTH

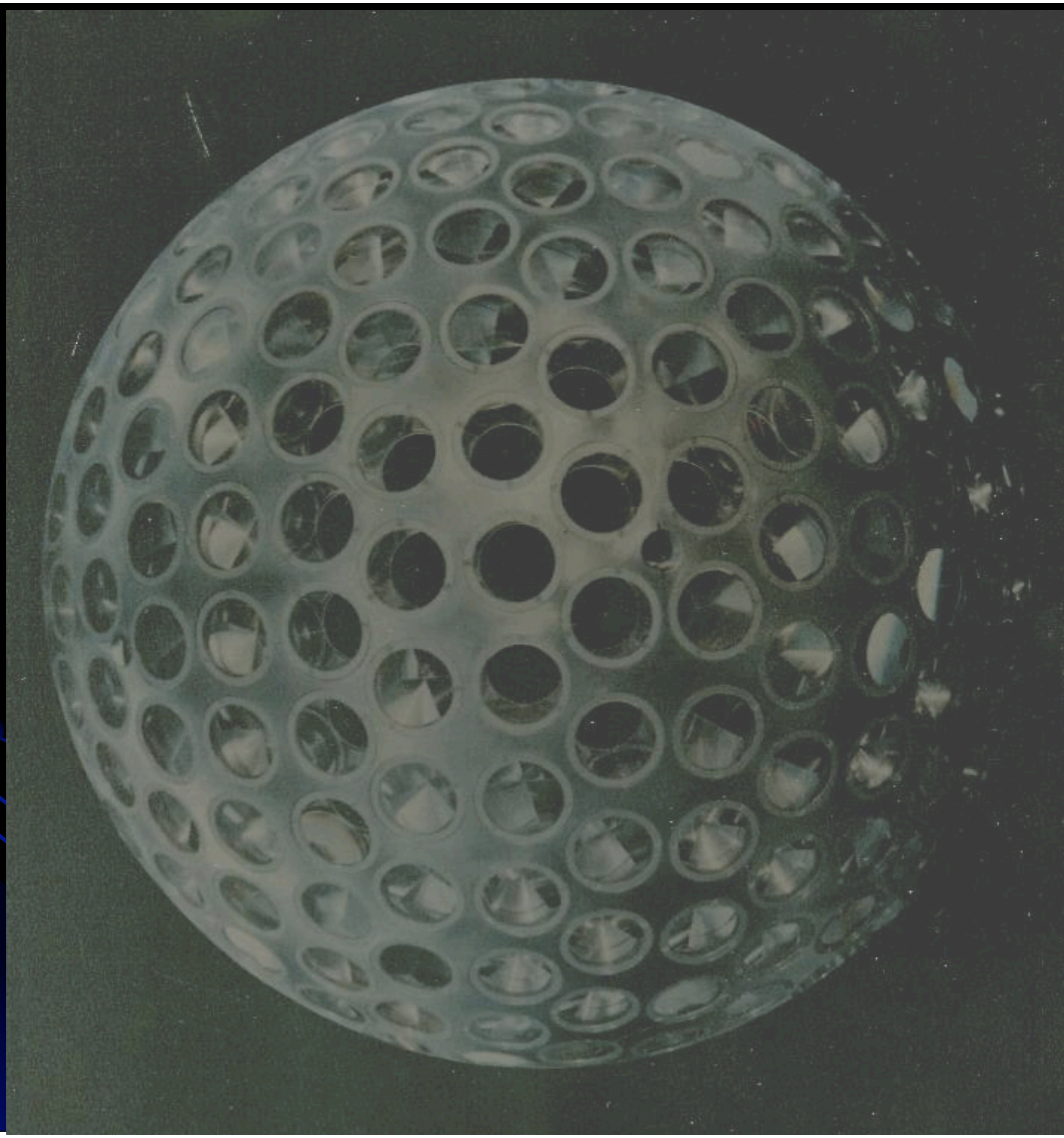
Volume 1

edited by

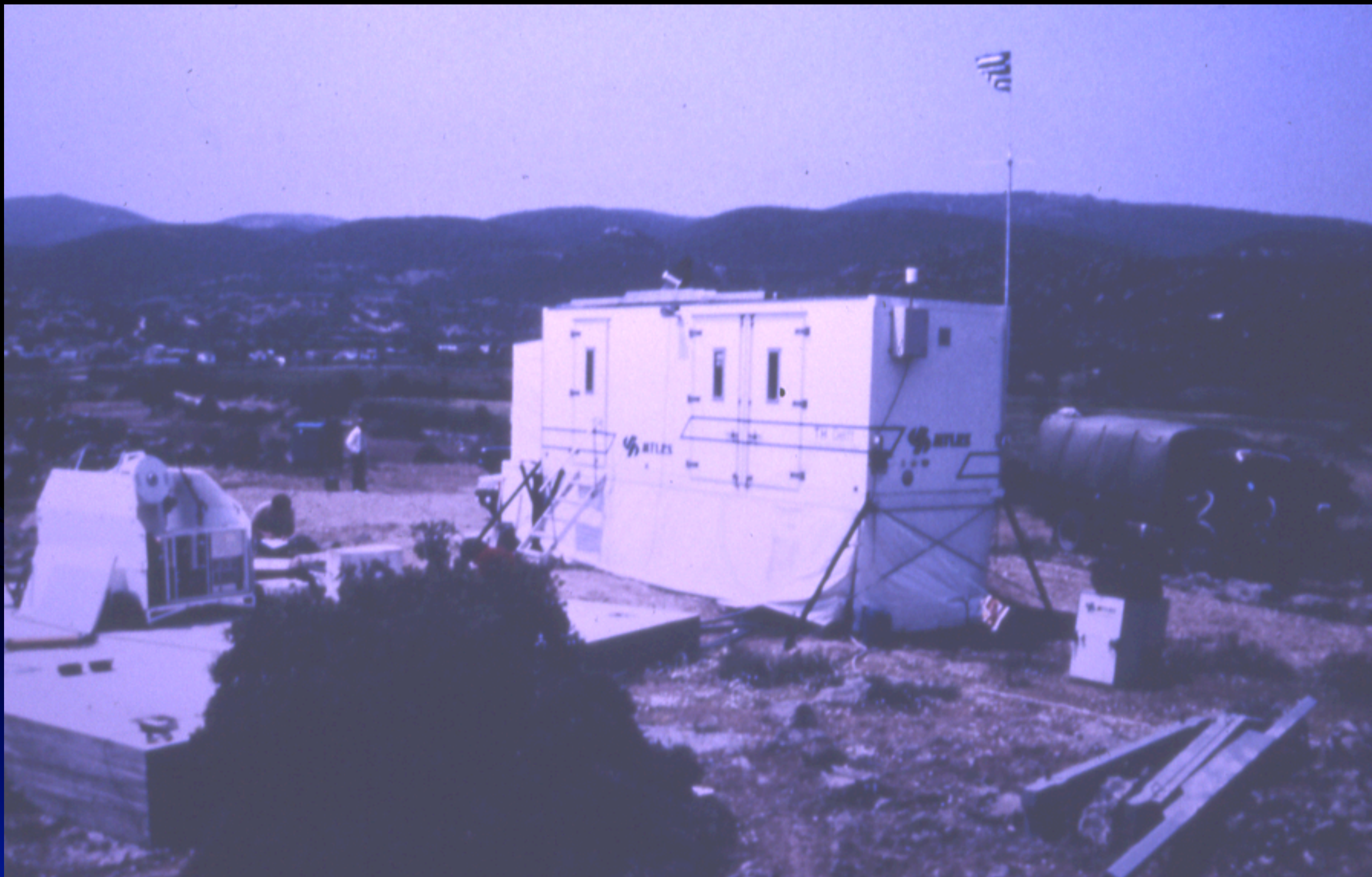
Charles A. Lundquist and George Veis

1966

Smithsonian Institution
Astrophysical Observatory
Cambridge, Massachusetts, 02138

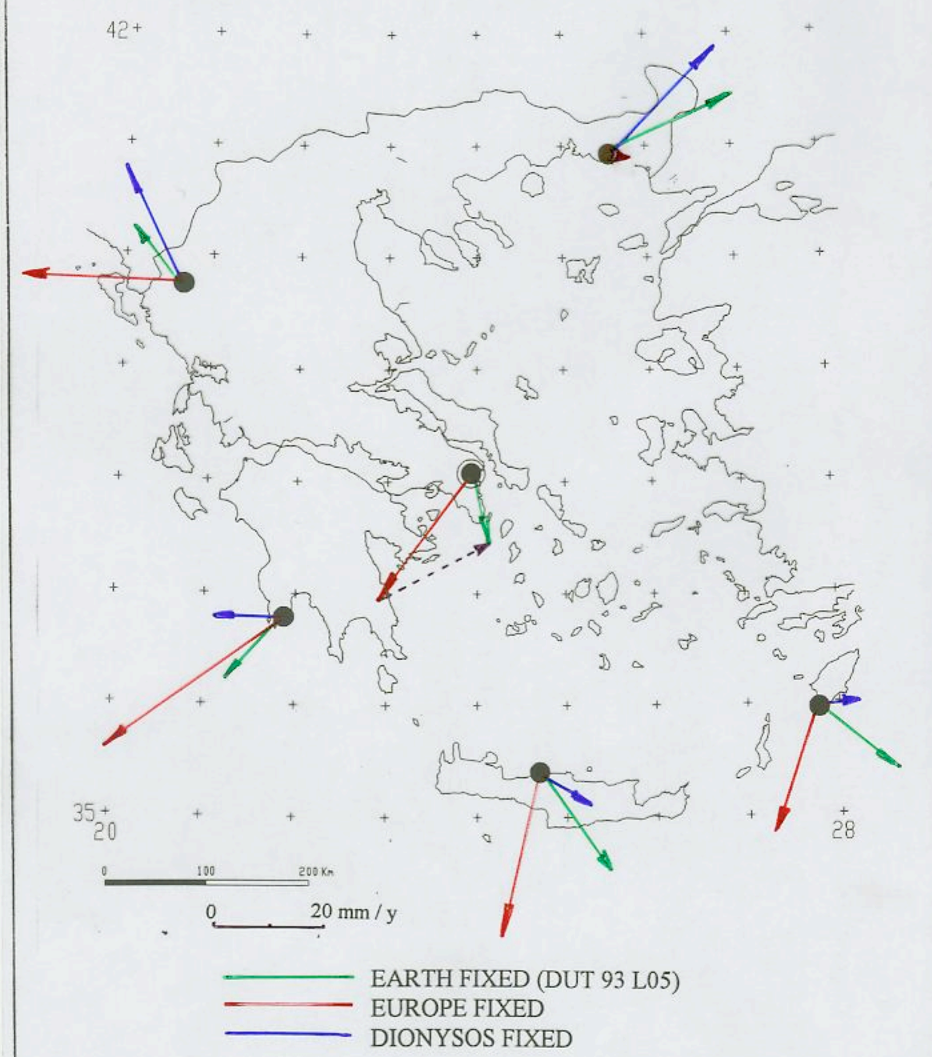


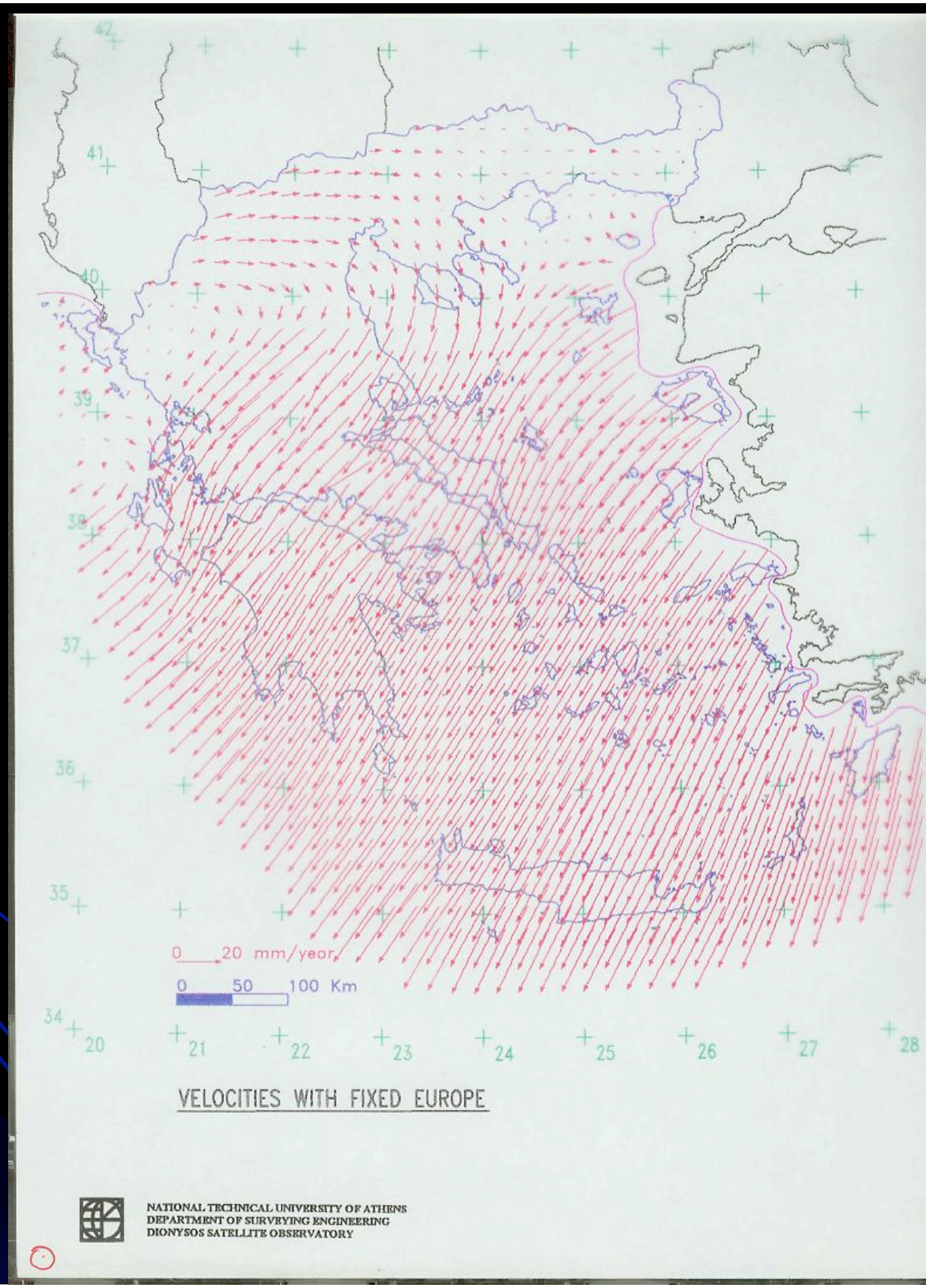

TU Delft

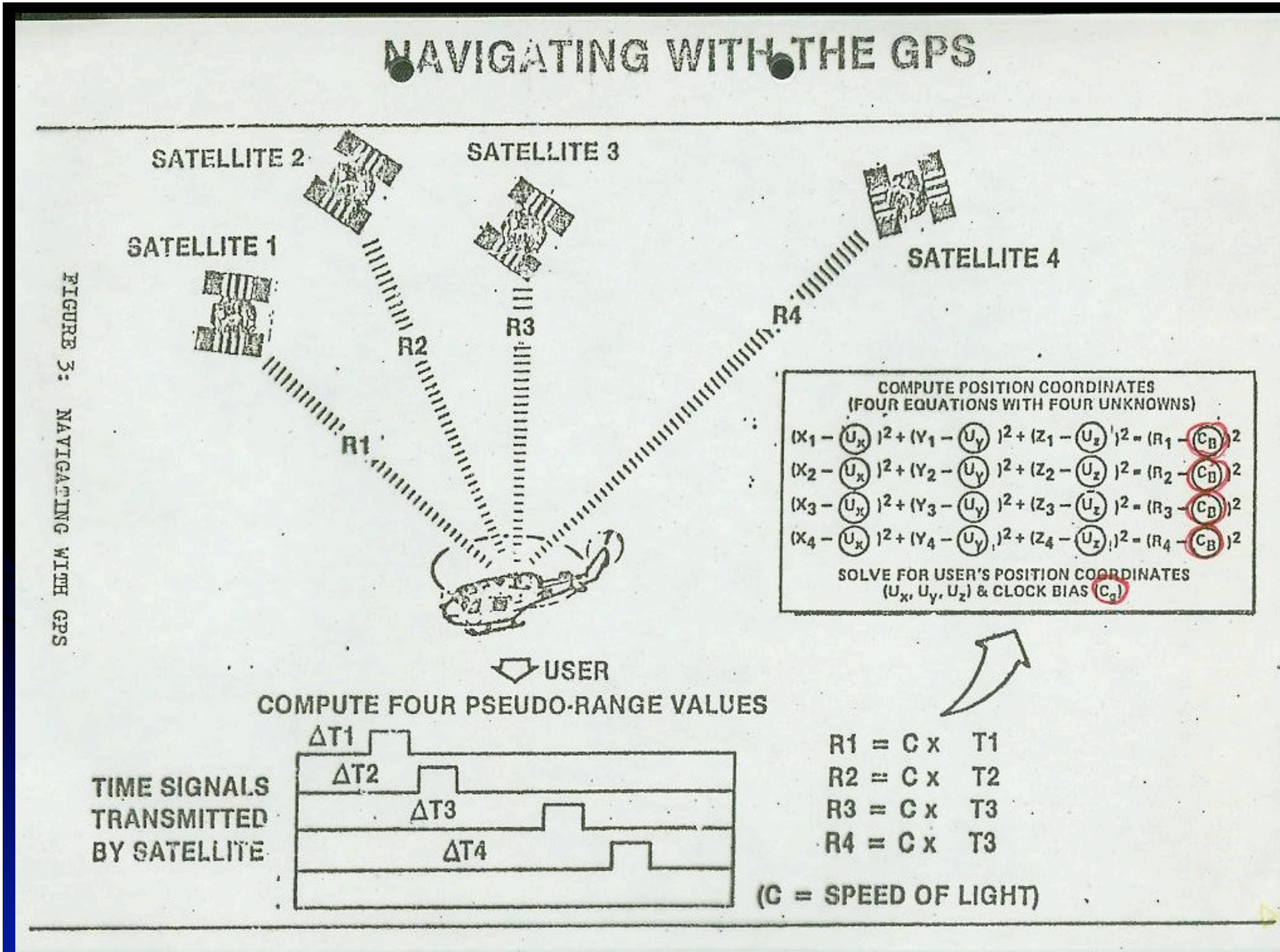


DIONYSOS SATELLITE OBSERVATORY
NATIONAL TECHNICAL UNIVERSITY OF ATHENS

SLR STATION VELOCITIES




0 20 mm/year
0 50 100 Km
VELOCITIES WITH FIXED EUROPE
NATIONAL TECHNICAL UNIVERSITY OF ATHENS
DEPARTMENT OF SURVEYING ENGINEERING
DIONYSOS SATELLITE OBSERVATORY


NAVIGATING WITH THE GPS
FIGURE 3: NAVIGATING WITH GPS
SATELLITE 1
SATELLITE 2
SATELLITE 3
SATELLITE 4
R1
R2
R3
R4
COMPUTE POSITION COORDINATES
(FOUR EQUATIONS WITH FOUR UNKNOWNS)
$(X_1 - U_x)^2 + (Y_1 - U_y)^2 + (Z_1 - U_z)^2 = (R_1 - C_B)^2$
$(X_2 - U_x)^2 + (Y_2 - U_y)^2 + (Z_2 - U_z)^2 = (R_2 - C_B)^2$
$(X_3 - U_x)^2 + (Y_3 - U_y)^2 + (Z_3 - U_z)^2 = (R_3 - C_B)^2$
$(X_4 - U_x)^2 + (Y_4 - U_y)^2 + (Z_4 - U_z)^2 = (R_4 - C_B)^2$
SOLVE FOR USER'S POSITION COORDINATES
(U_x, U_y, U_z) & CLOCK BIAS (C_B)
USER
COMPUTE FOUR PSEUDO-RANGE VALUES
TIME SIGNALS TRANSMITTED BY SATELLITE
ΔT1
ΔT2
ΔT3
ΔT4
R1 = C x T1
R2 = C x T2
R3 = C x T3
R4 = C x T3
(C = SPEED OF LIGHT)

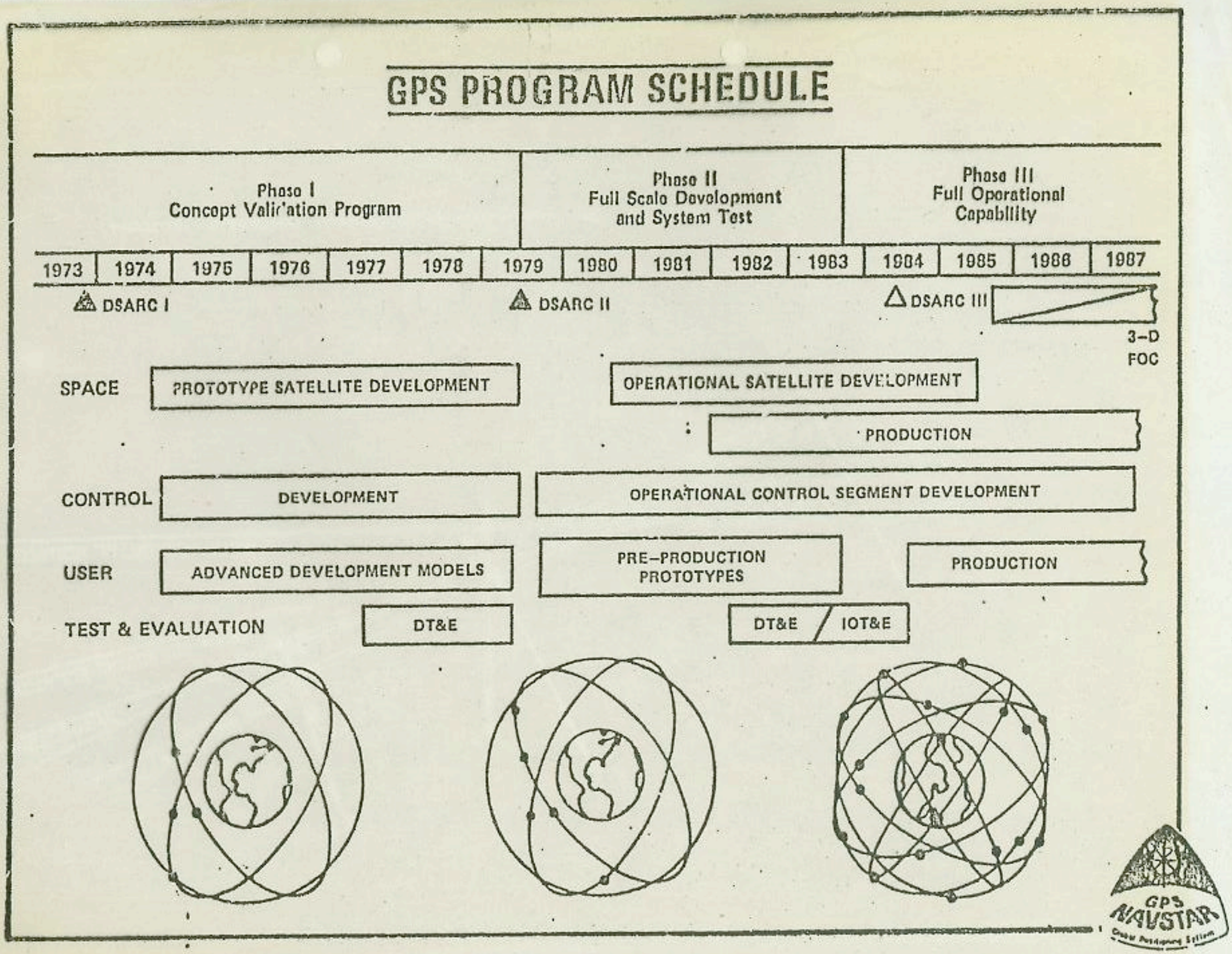
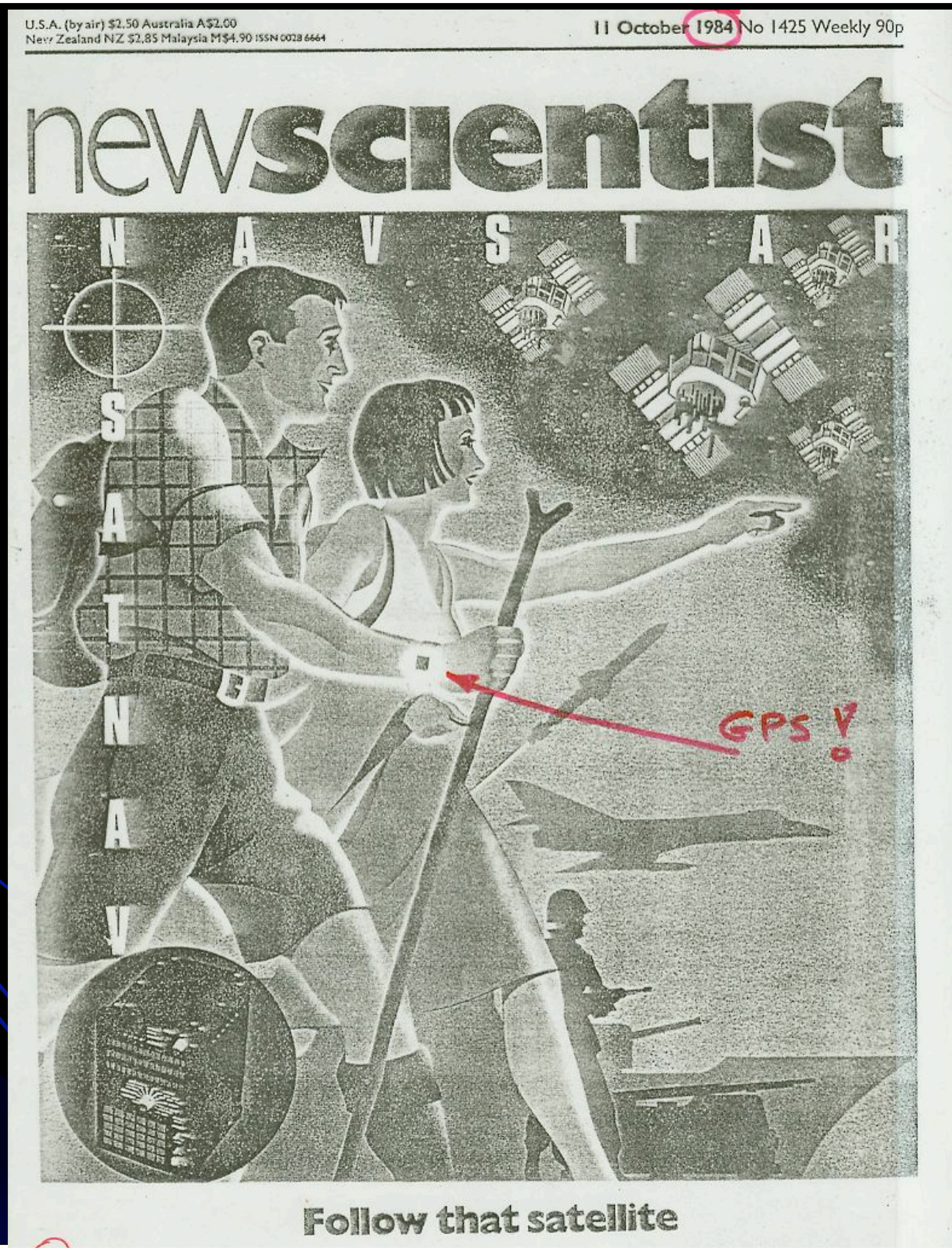


FIGURE 5: GPS PROGRAM SCHEDULE


U.S.A. (by air) $2.50 Australia A$2.00
New Zealand NZ $2.85 Malaysia M$4.90 ISSN 0028 6664
11 October 1984 No 1425 Weekly 90p
newscientist
NAVSTAR
SATNAV
GPS !
Follow that satellite

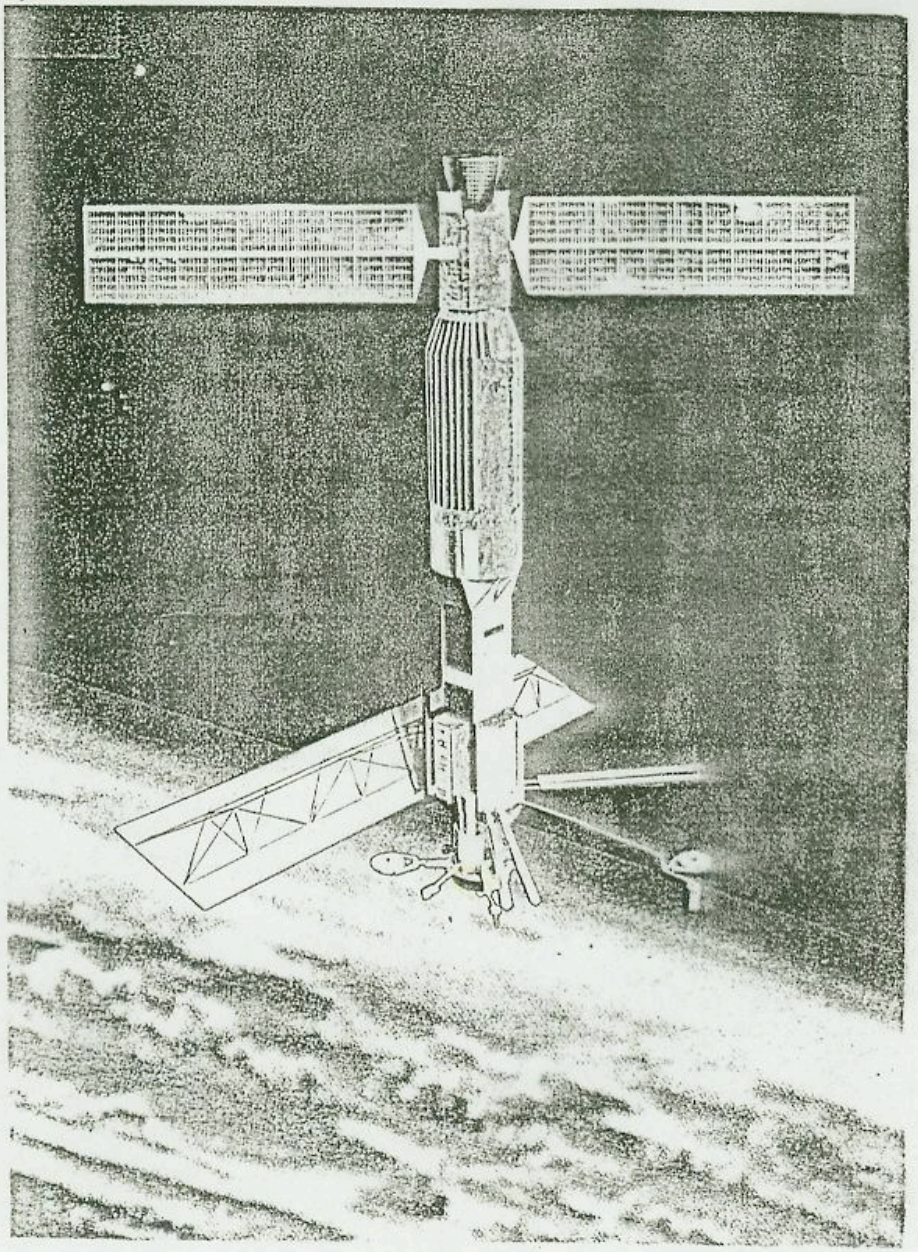


Figure 3. The first dedicated oceanographic satellite, Seasat, operated for three months in 1978 and demonstrated the feasibility of measuring surface winds, waves, sea level changes, and the marine geoid.