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APPENDIX I

INTRODUCTION

Over the last two decades a series of low orbiting spacecraft have been successfully launched and operated whose missions can be broadly grouped into the following categories:

- 1. General Search/Indications and Warning
- 2. Directed ELINT Search/Technical Intelligence
- 3. Directed COMINT Search
- 4. Special Purpose
- 5. General/Directed EHF Search
- 6. VHF Mainbeam Technical Intelligence

Table 1 gives a tabulation of the P989 missions from 1963 to 1982. The tabulation is complete with mission numbers and mission characterizations. As noted from the table that with the exception of some special purpose missions the emphasis tends to be in frequency ranges above 2 GHz.

While the lower RF collection band (.1 to 2 GHz) has received considerable attention in terms of studies and indeed a few missions have collected data and/or searched in that band, the results do not fulfill current needs.

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LAUNCH YEAR	SATELLITE	MISSION	FREQUENCY RANGE - GHz											
			0	5	10	15	20	25	30	35	40	45		
1963	4301 --	MAP INNER VAN ALLEN BELT	60-80 MHz											
	4001 PUNDIT I		60-80 MHz											
	4101 PUNDIT II		60-80 MHz											
1964	4301 NOAH'S ARC	GENERAL SEARCH (VHF) MAP INNER VAN ALLEN BELT ANTISATELLITE RADAR SEARCH	150-550 MHz											
	4202 --		150-230 MHz											
	4302 STEP 13		61-72 MHz											
1965	4401 PUNDIT IV	TELEMETRY	180-250 MHz											
	4402 FANION/TRIPOS		153-178 MHz											
	4403 MAGNUM		153-163 MHz											
1966	4404 LEIGE/PICAT	TALL KING/HEN HOUSE SEARCH	4900-5150 MHz											
	4405 SAMPAN/SOUSEA		101-240 MHz											
	4406 FANION/TRIPOS		[REDACTED]											
1967	4408 FANION/SLEWTO	TELEMETRY ABM SEARCH	[REDACTED]											
	4409 SAVANT		[REDACTED]											
	4410 FACADE		[REDACTED]											
1968	4412 TIVOLI	ABM/TI/SEARCH	[REDACTED]											
	4411 LAMPAN/SAMPAN		[REDACTED]											
	4420 TRIPOS/SOUSEA		[REDACTED]											
	4413 VAMPAN		[REDACTED]											
1969	4418 TIVOLI	ABM TI	[REDACTED]											
	4417 LAMPAN/SAMPAN		[REDACTED]											
	4419 SAVANT		61-76 MHz, 142-248 MHz											
	4407 WESTON		60-70 MHz, 360-420 MHz											
1970	4422 TIVOLI	ABM/TI/SEARCH	[REDACTED]											
	4421 TRIPOS/SOUSEA		[REDACTED]											
	4423 TOPHAT I		450-1000 MHz											
1971	4427 ARROYO	CW SEARCH	[REDACTED]											
	4424 MABELI		151-156, 387-526, 840-960, 1300-2500 MHz											
	4425 URSALA I		[REDACTED]											
1973	4426 URSALA II	OPERATIONAL ELINT/SEARCH	[REDACTED]											
	4428 TOPHAT II		450-1000 MHz											
1974	4429 RAQUEL I	TI/SEARCH	[REDACTED] 4-18 GHz											
1976	4430 URSALA III	OPERATIONAL ELINT/SEARCH	[REDACTED] 2-12 GHz											
1978	4432 RAQUEL IA	TI/SEARCH	[REDACTED] 4-18 GHz											
1979	4431 URSALA IV	OPERATIONAL ELINT/SEARCH	[REDACTED] 2-12 GHz											
1980	- LOREI	GS, DS, PULSE & CW	[REDACTED] 26 TO 42 GHz											
1982*	4433 FARRAH I	GS, DS, TI & EO	[REDACTED] 2-18 GHz											
1984	4434 FARRAH II	GS, DS, TI & EO	[REDACTED] 2-18 GHz											
1986	LORRI II	G/D EHF & UHF MBTI	[REDACTED] 26 TO 42 GHz											
1989/ 1992	LORRI III	G/D EHF SEARCH	[REDACTED] 26 TO 42 GHz											

GS = General Search
DS = Directed Search

Table 1. P89 Mission Summary

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SELECTED EARLY LOW ORBITING, LOW RF COLLECTORS

SAVANT I

SAVANT I was a vehicle directed at specified low RF bands to search for Soviet Telemetry Signals. Specifically this unit searched at: 61, 66, 71, 76, 165, 181, and 240 MHz with a frequency accuracy of ± 1 MHz. The mission used 1 MHz bandwidth tape recorders to permit predetection recording of Soviet telemetry signals. Automatic IF signal interference rejection networks were used for the first time.

The SAVANT I was launched in June 1967 and had an operational life of 16.5 months.

The intercept antenna was a 60 x 84 inch flat planar log spiral. The vehicle and the antenna are depicted in Figure 1.

TIVOLI I

TIVOLI I was designed for directed search and TI of pulsed and CW signals of interest in the 0.1 to 4.0 GHz band. It was launched in January of 1968 and remained operational for 14.5 months.

The antenna design is well illustrated in Figure 2. The mission was primarily for mainbeam collection providing scan rate, beamwidth, and approximate power level

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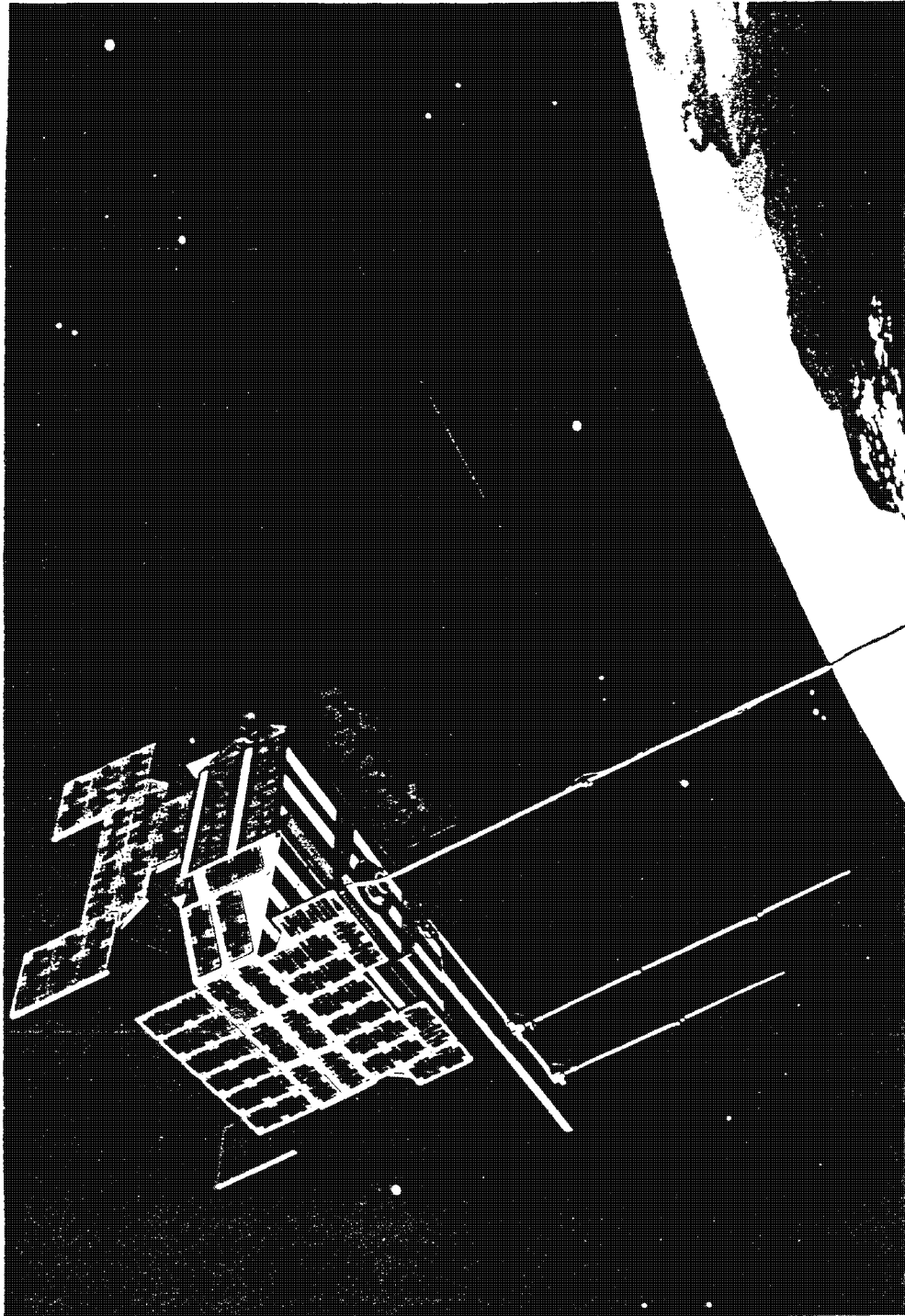
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SAVANT I

Figure 1.

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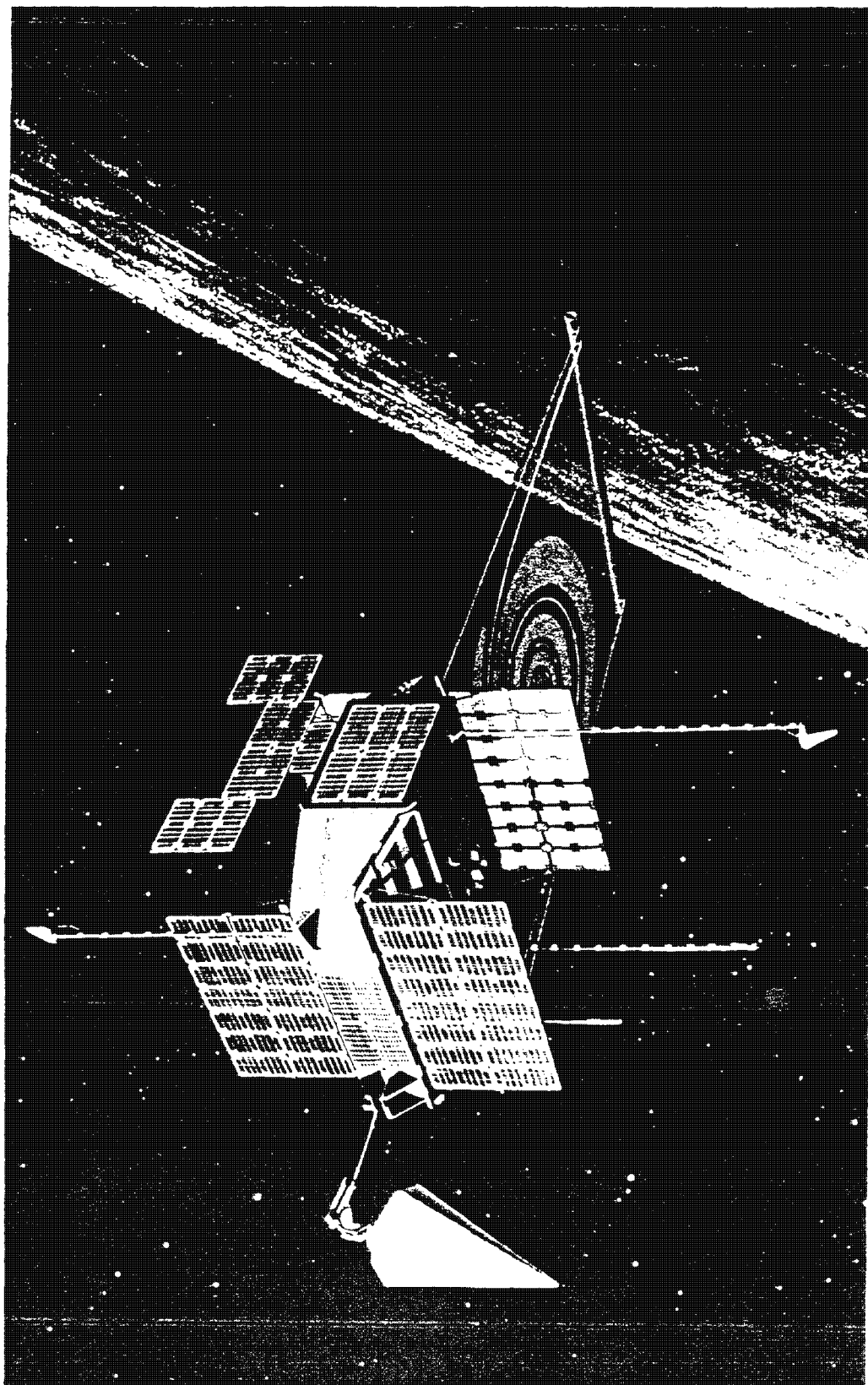


Figure 2. TIVOLI I

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of target emitters. Signal waveform PRE-D was recorded on a 1 MHz bandwidth tape recorder. The TIVOLI I series was an extremely valuable source of this type of data.

TIVOLI II

TIVOLI II, was the same, operationally, as TIVOLI I (see Figure 3).. However, the frequency range was extended 50 MHz. The total frequency range was 0.05 to 4.0 GHz in order to provide for the collection of certain low frequency communication signals.

This unit was launched in March of 69, it was operational for 18 months.

TIVOLI III

This spacecraft, a design duplicate of TIVOLI II is shown in Figure 4. This unit was launched in March of 1970 and remained operational for 20 months.

LAMPAN I/SAMPAN II

LAMPAN I/SAMPAN II were launched in March of 1968 and remained operational for one year. The spacecraft carried two operational payloads.

The task of LAMPAN was general search for new and unusual pulse and CW signals in the 1.0 to 2.0 GHz band.

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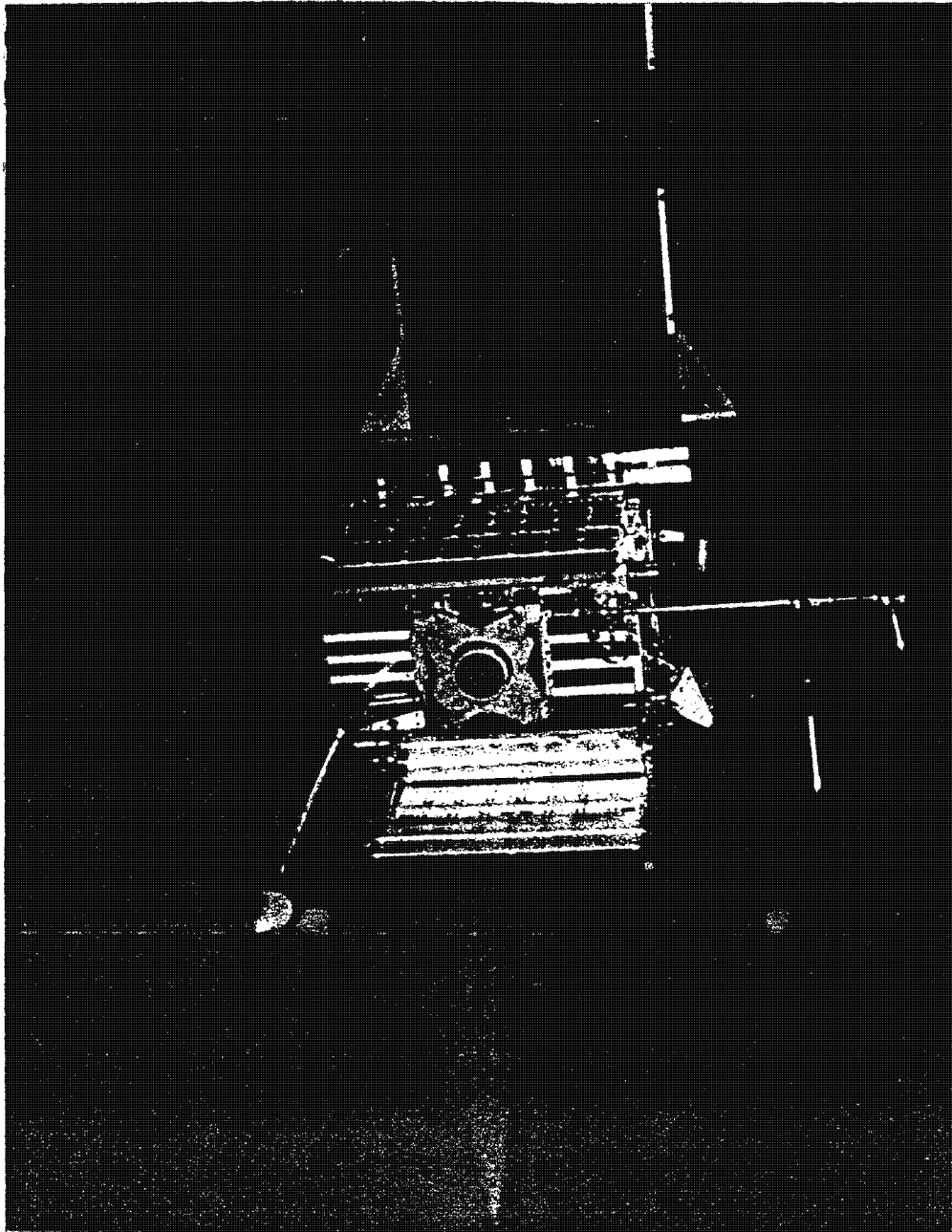


Figure 3. TIVOLI II

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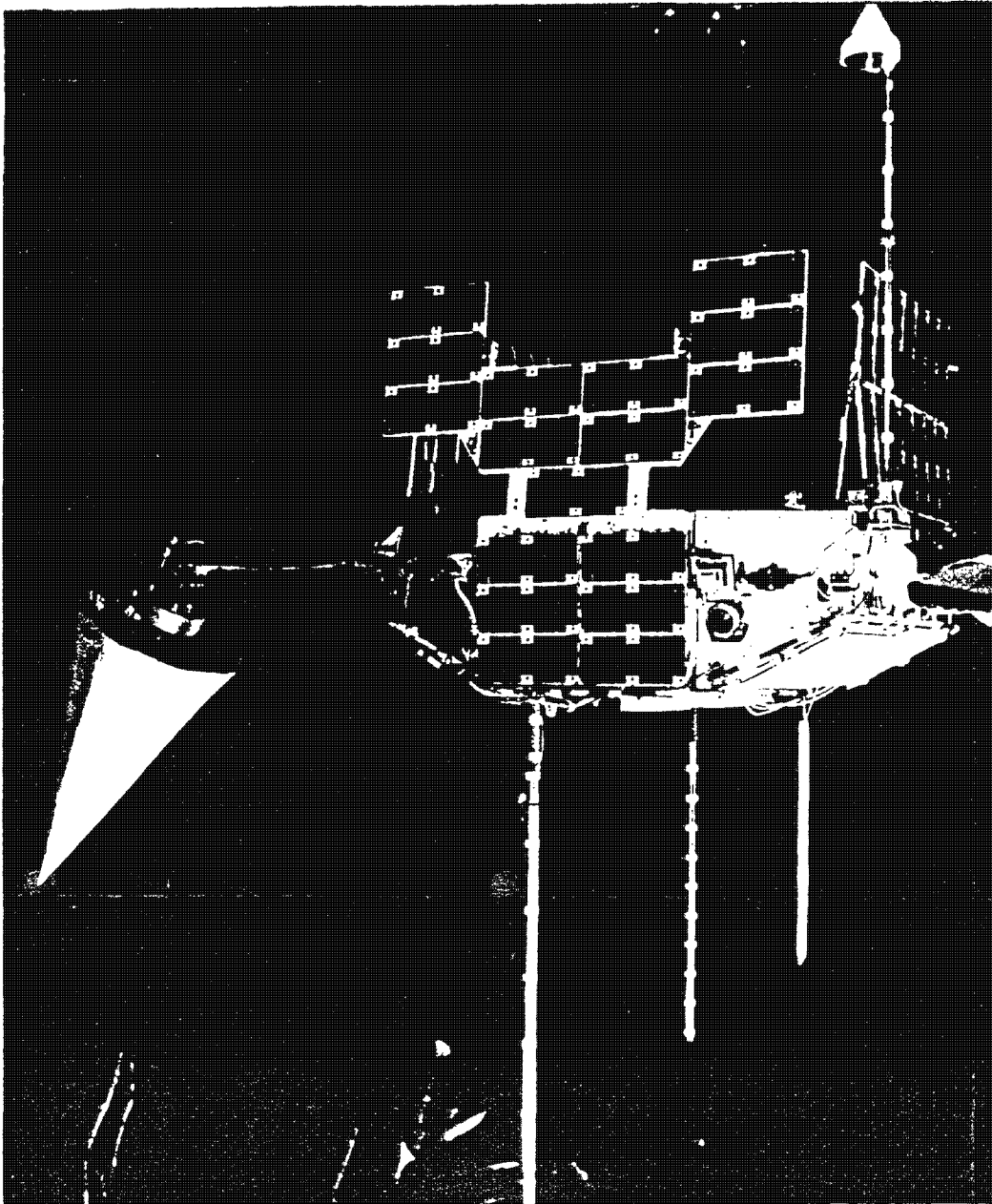


Figure 4. TIVOLI III

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SAMPAN was used in a general search mode for new and unusual pulsed signals in the 2.1 to 4.0 GHz band.

This spacecraft used a six foot diameter unfurlable flex rib parabola as the DF antenna. See Figure 5.

WESTON

Launched in September of 1969 Weston's mission was that of directed search for Soviet communication signals in the 60 to 70 MHz band and in the 360 to 420 Mhz band.

This satellite used an encrypted data link and voice and teletype recognizers. The intercept antenna was a 30 x 57 inch unfurlable planar log spiral (see Figure 6). A square wire wound conical log spiral was used in the 360 to 420 MHz band. WESTON was operational for 10.5 months.

VAMPAN

This spacecraft was launched in September of 1968 and remained operational for just over one year.

Its mission was EOB and a general search for new and unusual pulsed signals in the 0.1 to 1.0 GHz band.

The spacecraft used two large unfurlable "window shade" antennas. One was 48 x 96 inch and contained one large log spiral (0.1 to 0.4 GHz) and two smaller log

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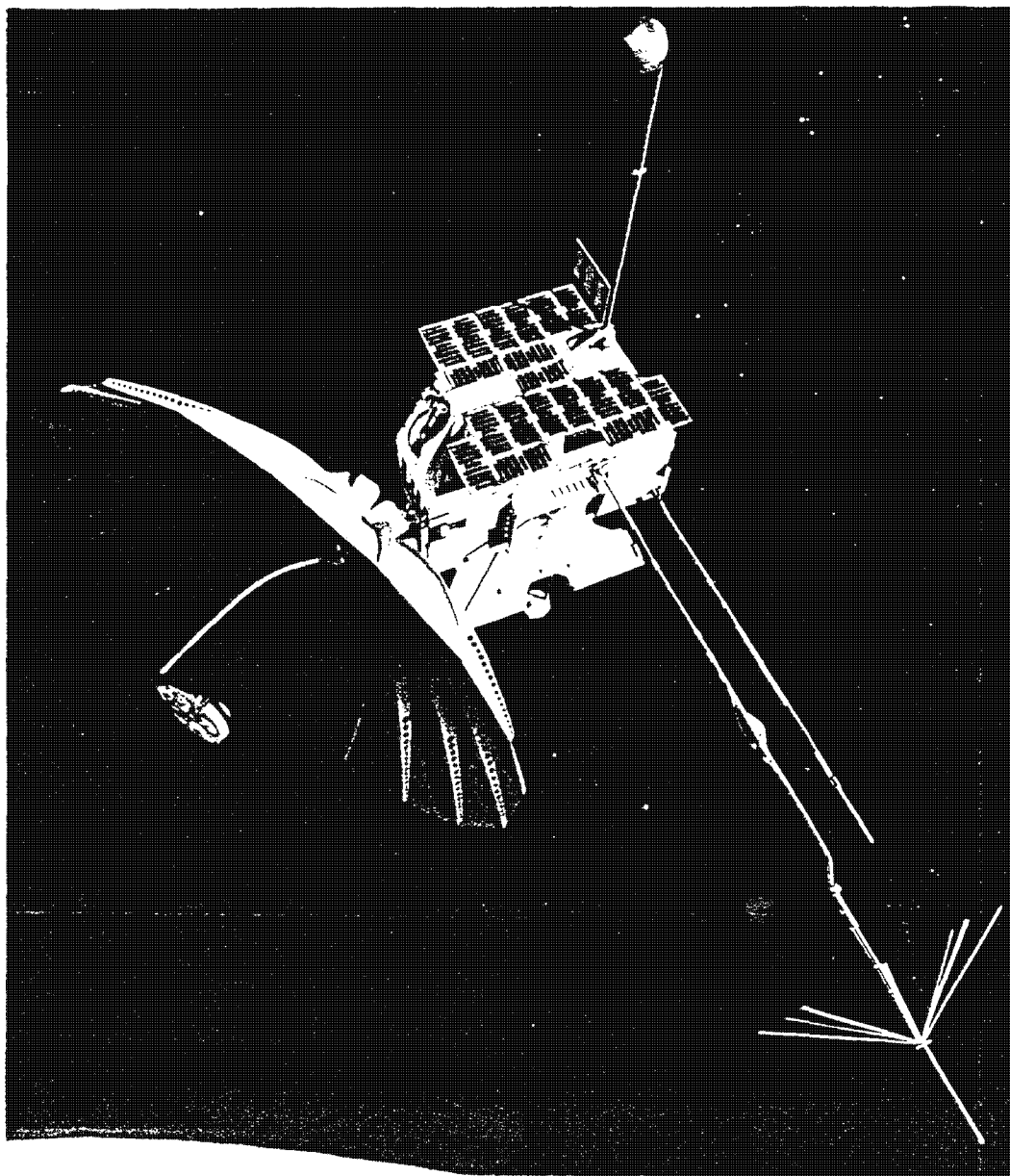


Figure 5. LAMPAN I/SAMPAN II

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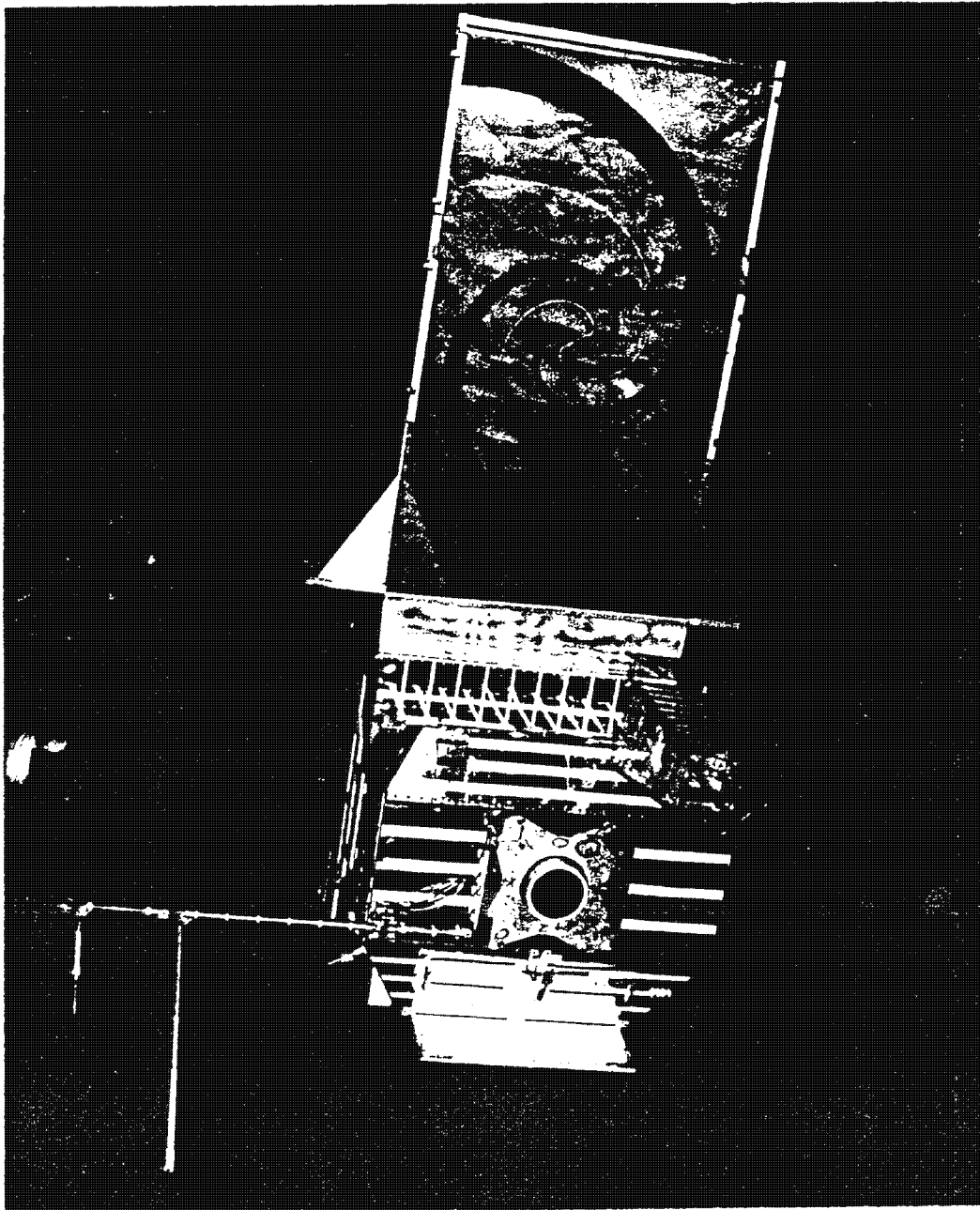


Figure 6. WESTON

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spirals (0.4 to 1.0 GHz). The second was 48 x 48 inch and contained one large log spiral (0.4 to 1.0 GHz).

The outputs of these antennas were delivered to a dual channel phase measurement receiver to provide emitter geolocation.

TOPHAT I

TOPHAT I was launched in November of 1970 and remained operational for 44 months. The unit was used for directed search with copy and DF of troposcatter communication signals in the 450 to 1000 MHz band.

The unit is illustrated in Figure 7. The four conical spiral antennas are used in pairs as phase interferometers. [redacted]



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TOPHAT II

This mission was identical to TOPHAT I. However added intercept capability was included to permit detection



signals.

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The unit was launched in April 1974 and had a long operational life, 70 months.

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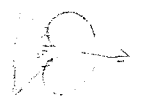
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Figure 7. TOPHAT I



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MABELI

MABELI was launched in January of 1972 and was operational for 87 months. It was designed for directed search and TI against the following radars:

	151 to 165 MHz
DOG HOUSE	387 to 426 MHz
BIG SCREEN	860 to 960 MHz
TRY ADD	1.5 to 2.5 GHz

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The spacecraft (Figure 8) used dual polarized antennas to permit the measurement of total received power, polarization and tilt angle.

The more recent spacecraft sets; URSALA, RAQUEL, and FARRAH tend to cover the higher end of the spectrum. Specifically,

- URSALA I, II, III, and IV; 2.0 to 12 GHz
- RAQUEL I, and II; 4.0 to 18 GHz
- FARRAH I, II, III, and IV;

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For the P989 program the most recent mission which collected radiation below 1 GHz was TOPHAT II, launch in 1974. TOPHAT II became inoperative in early 1980. It's collection band extended from 450 to 1000 MHz.

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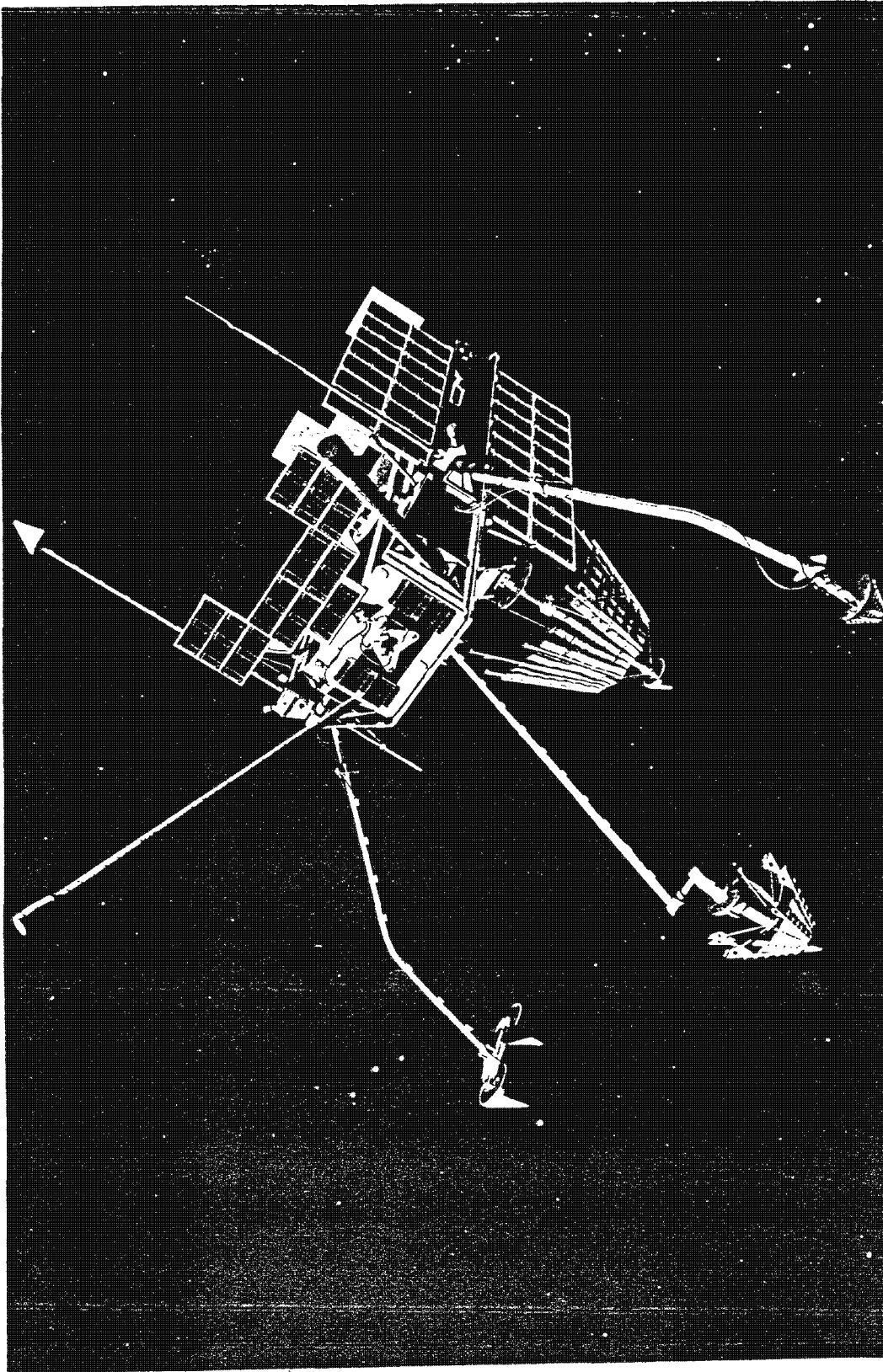


Figure 8. MABELI

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