NASA TECHNICAL MEMORANDUM

NASA TM-77669

PROJECT VESTA - EXPLORATORY MISSION TO THE ASTEROIDS; SCIENTIFIC OBJECTIVES AND TECHNICAL SPECIFICATIONS

Centre National d'Etudes Spatiales (CNES)

Translation of "Projet VESTA - Interet Scientifique d'Une Mission d'Exploration vers les Petits Corps", Centre National d'Etudes Spatiales (CNES), Paris, France, 1985, pp. 1-14

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 SEPTEMBER 1985

STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TM-77669		

4. Title and Subtitle	5. Report Date
PROJECT VESTA-EXPLORATORY MISSION TO THE ASTEROIDS; SCIENTIFIC OBJECTIVES AND TECHNICAL SPECIFICATIONS	SEPTEMBER 1985
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Centre National d'Etudes Spatiales (CNES)	10. Work Unit No.

9. Performing Organization Name and Address	11. Contract or Grant No.
The Corporate Word, Inc. 1102 Arrott Bldg, Pittsburgh PA 15222	NASW-4006
	13. Type of Report and Period Covered
	TRANSLATION
12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION WASHINGTON, D.C. 20546	

15. Supplementary Notes

Translation of "Projet VESTA - Interet Scientifique d'Une Mission d'Exploration vers les Petits Corps", Centre National d'Etudes Spatiales (CNES), Paris, France, 1985, pp. 1-14

16. Abstract

A description of the VESTA project, a Franco-Soviet collaboration, is presented. The VESTA probe will be launched by the Soviet Union at the end of 1992, and will pass through the asteroid belts before encountering comets. The probe will be an autonomous vehicle under French control. The scientific objectives include obtaining information on asteroids, comets, solar system formation, meteorites and other sources of extraterrestrial material. The surface morphology, mineral composition and internal structure of asteroids are to be studied.

17. Key Words (Selected by Author(s))	18. Distribution Statement
	Unlimited - Unclassified

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	13	

PROJECT VESTA - EXPLORATORY MISSION TO THE ASTEROIDS; SCIENTIFIC OBJECTIVES AND TECHNICAL SPECIFICATIONS

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- To complete the information gathered on objects which make up the solar system (asteroids, comets).

- To obtain information on the first stages of formation of the solar system: very primitive bodies → processes of differentiation and of collision between planetoids.

- To define the relationship between meteorites and asteroids, micrometeorites and comets: scientific evaluation of the most important and diverse source of extraterrestrial material.

SPECIFIC SCIENTIFIC OBJECTIVES: FLIGHT OVER AN ASTEROID IN THE BELT /2

Overall characteristics: size, shape, rotation period and axis. Density → information on internal structure.

Surface morphology and characteristics: existence and thickness of a layer of debris (dust or chunks) → physics of collisions, origin of meteoritic flaws.

Mineral composition of the surface: relationship with the principal groups of meteorites. Existence of geochemical provinces (differentiation).

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*Numbers in the margin indicate pagination in the foreign text.

Environment of the asteroids: magnetic field (core)?
Satellites? Weak comet activity → dusts?

Characteristics of the interplanetary environment between 0.7 and 2.5 u.a.

PRINCIPAL SCIENTIFIC RESULTS OBTAINED DURING FLIGHT OVER AN ASTEROID /3

Target type: Asteroid 50 to 100 km in diameter
Minimum distance: < 1000 km
Relative velocity: 4 to 10 km/sec

- Complete cartography of the light hemisphere with a resolution of ~ 100 m + ~ 10 high-resolution (< 10 m) photographs.

- Cartography of the dark hemisphere resolution ~ 1 km with the high-resolution camera.

- Infrared cartography of the light hemisphere; pixel 3 to 5 km.
- Volume (in qq %), roughness, thermal and dielectric properties.

- Determination of mass → density Δ m/m ~ 3% ("test mass").

SPECIFIC SCIENTIFIC OBJECTIVES: FLIGHT OVER A COMET CORE /4

Overall characteristics: size, shape, rotation period and axis.

Surface morphology: Existence of a silicate crust, of active regions (ice), possible craterization.

Mineral composition of the surface: composition of silicates, trapped volatiles, ice.

Environment of a low-activity comet: chemical composition of dusts → direct information of the chemical composition of the core.

POSSIBLE USEFUL SCIENTIFIC PAYLOAD FOR FLIGHT OVER THE ASTEROIDS AND COMETS /5

Two Cameras	Field	Pixel Size	Other characteristics
Wide angle	8°	80 m	navigation
High resol.	0.6°	5 m	"
IR Spectrometer	6.5°	2 km	0.8 to 5 µm
Radar			
Altimeter	1.6°	15 km	±=20 m (alt.)
Radiometer	2.5 to 15°		±=0.5°K
Experiment "test mass"			+ 5% of density

Study of the environment and the interplanetary surroundings

Magnetometer	~ 1 nano Tesla of B
PUMA dust detector/analyzer	
Cosmic rays, Y jumps, etc.	

TOTAL MASS 100 kg

SCIENTIFIC OBJECTIVES CONCERNING VENUS /6

Study of the surface: chemical composition of the soil, of the atmosphere near the soil, of volatile components; geophysical data by passive seismology, electrical readings. Priority is given to the study of areas which might show volcanic activity.

The atmosphere: study of atmospheric circulation through several types of long lifespan balloons, at various altitudes (including a "flying deer" consisting of two balloons linked by a cable); chemical and isotopic composition of gases and condensed phases, possible evidence of products of volcanic activity.

THE VENERA 90/VESTA MISSION: INTERNATIONAL CONTEXT

Mission	Date	Type of Missior
Vega Giotto	1986	High-velocity flight over an active comet
Galileo?	1986	Distant and rapid flight over Amphitrite
Phobos	1988	Very slow and very close (~ 50 m) flight over Phobos
Vesta	1992-1993	Multiple flights over asteroids and comets
Craf	1997-1999	Rendezvous with a short-period comet
Agora	1997-2002?	Multiple rendezvous with the asteroids

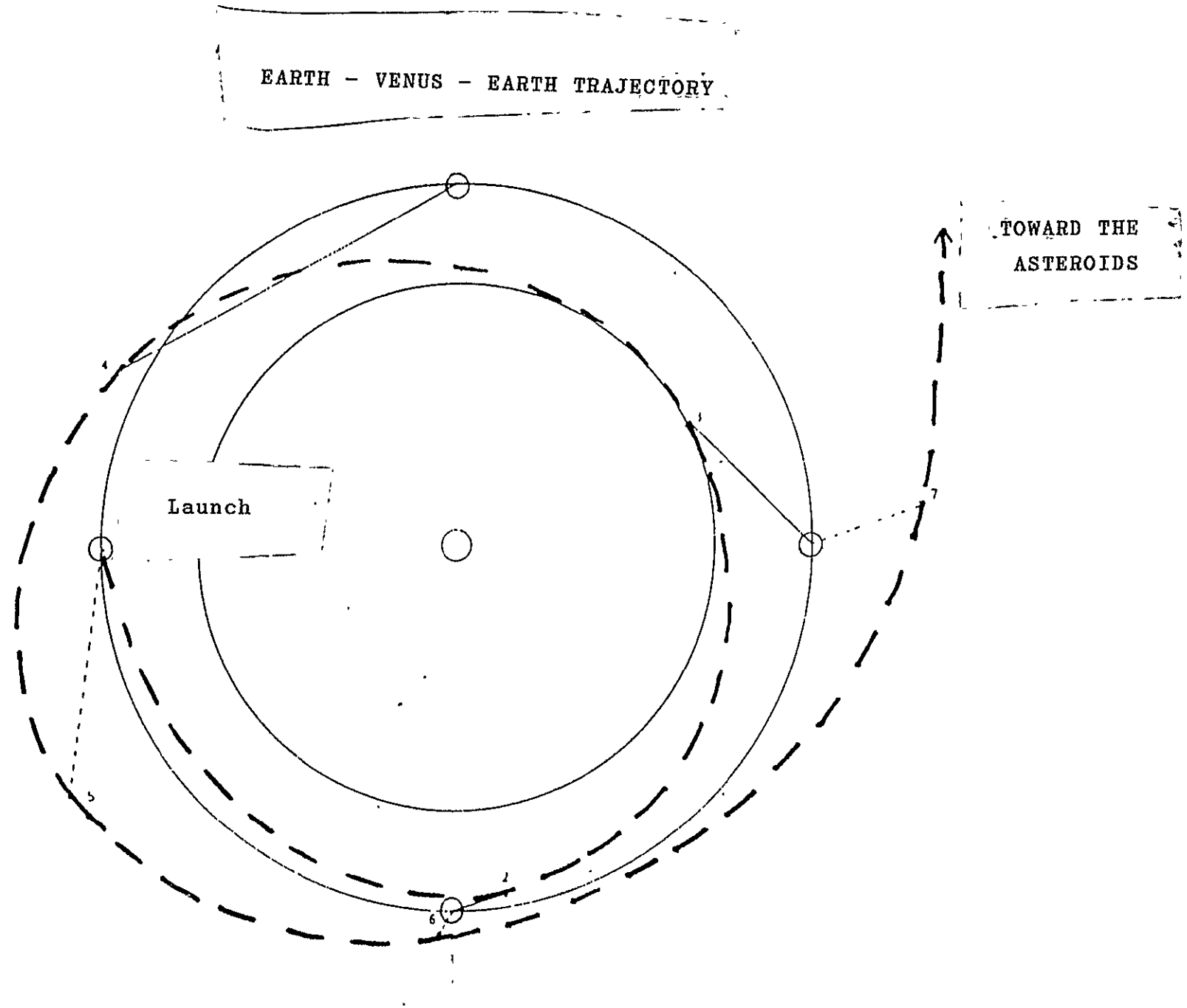
VESTA /8

STUDY OF VENUS AND THE ASTEROIDS AND COMETS IN THE SOLAR SYSTEM

GENERAL MISSION PLAN

Launch date:	End of 1992 Double mission: 2 proton launchers
2 different vehicles:	
- 1 Soviet vehicle	Directed toward Venus Launches a descent vehicle there Then flies over a small body within the orbit of Mars
- 1 independent vehicle built under the responsibility of the CNES	Independent from launch Uses double gravitational assistance Venus to Earth Fly over 3 small bodies in the principal asteroid belt

8 SMALL BODIES OVERFLOWN


EARTH - VENUS - EARTH TRAJECTORY
TOWARD THE ASTEROIDS
Launch

AN EXAMPLE OF TRAJECTORY INCLUDING FLIGHTS OVER COMETS

/10

EARTH	Depart 12/18/92	V = 3.2 km/sec
VENUS	Arrive 5/13/93	V = 5.05 km/sec
EARTH	Return 2/14/94	V = 8.35 km/sec
33 POLYMNIE	Fly over 7/18/95	Type S asteroid Diameter 62 km V = 11.9 km/sec
EARTH	Return 6/12/96	V = 8.7 km/sec
P/KOPFF	Fly over 7/30/96	Comet (28 days after perihelion) V = 10.5 km/sec
P/GEHRELS	Fly over 7/18/97	Comet (28 days before perihelion) V = 10.1 km/sec

TOTAL DURATION OF MISSION ~ 4.6 years

Δ TOTAL V 400 m/sec

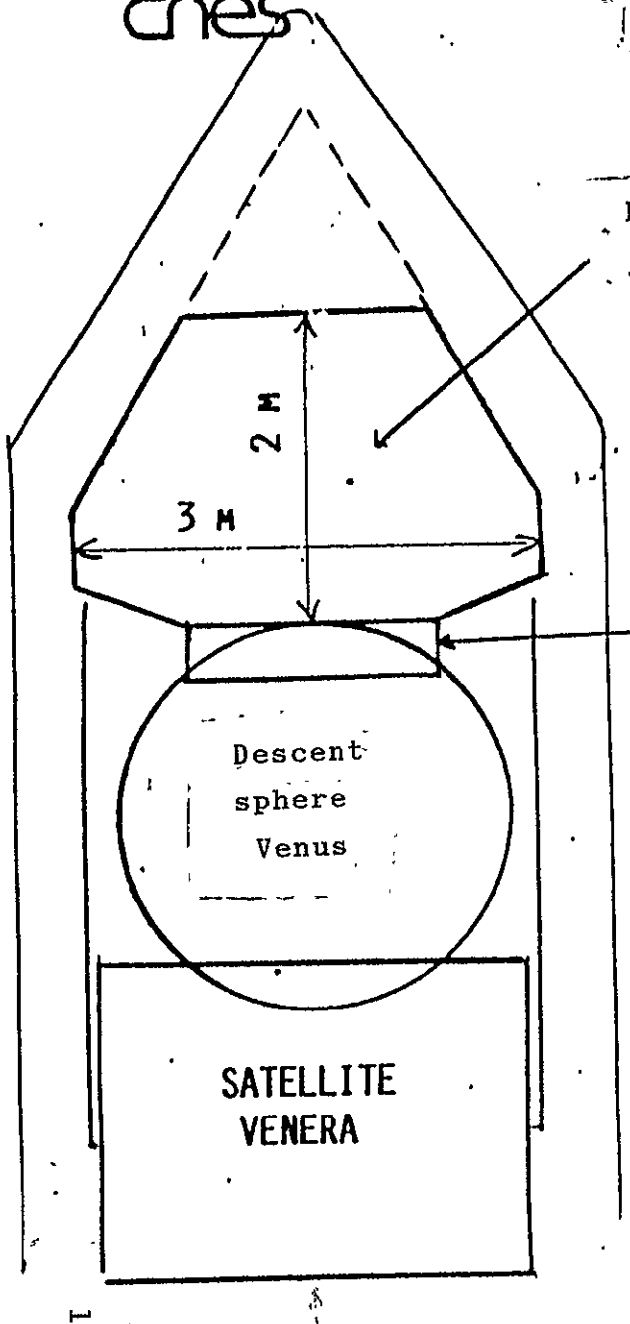
AN EXAMPLE OF TRAJECTORY INCLUDING FLIGHTS OVER ASTEROIDS

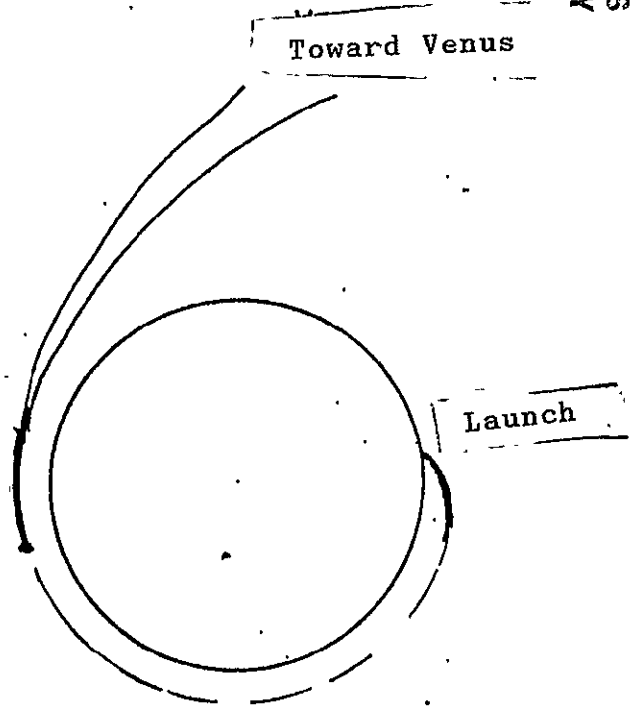
/11

EARTH	Depart 12/27/92	V = 3.1 km/sec
VENUS	Arrive 5/1/93	V = 4.7 km/sec
EARTH	Return 1/22/94	V = 7.9 km/sec
7 IRIS	Fly over 8/7/95	Type S asteroid Diameter 208 km V = 7.8 km/sec
EARTH	Return 1/20/96	V = 8.15 km/sec
4 VESTA	Fly over 8/4/96	Type V asteroid Diameter 576 km V = 12.2 km/sec
286 ICLEA	Fly over 4/27/98	Type CX asteroid Diameter 92 km V = 8 km/sec
TOTAL DURATION	5.3 years	
Δ TOTAL V	230 m/sec	

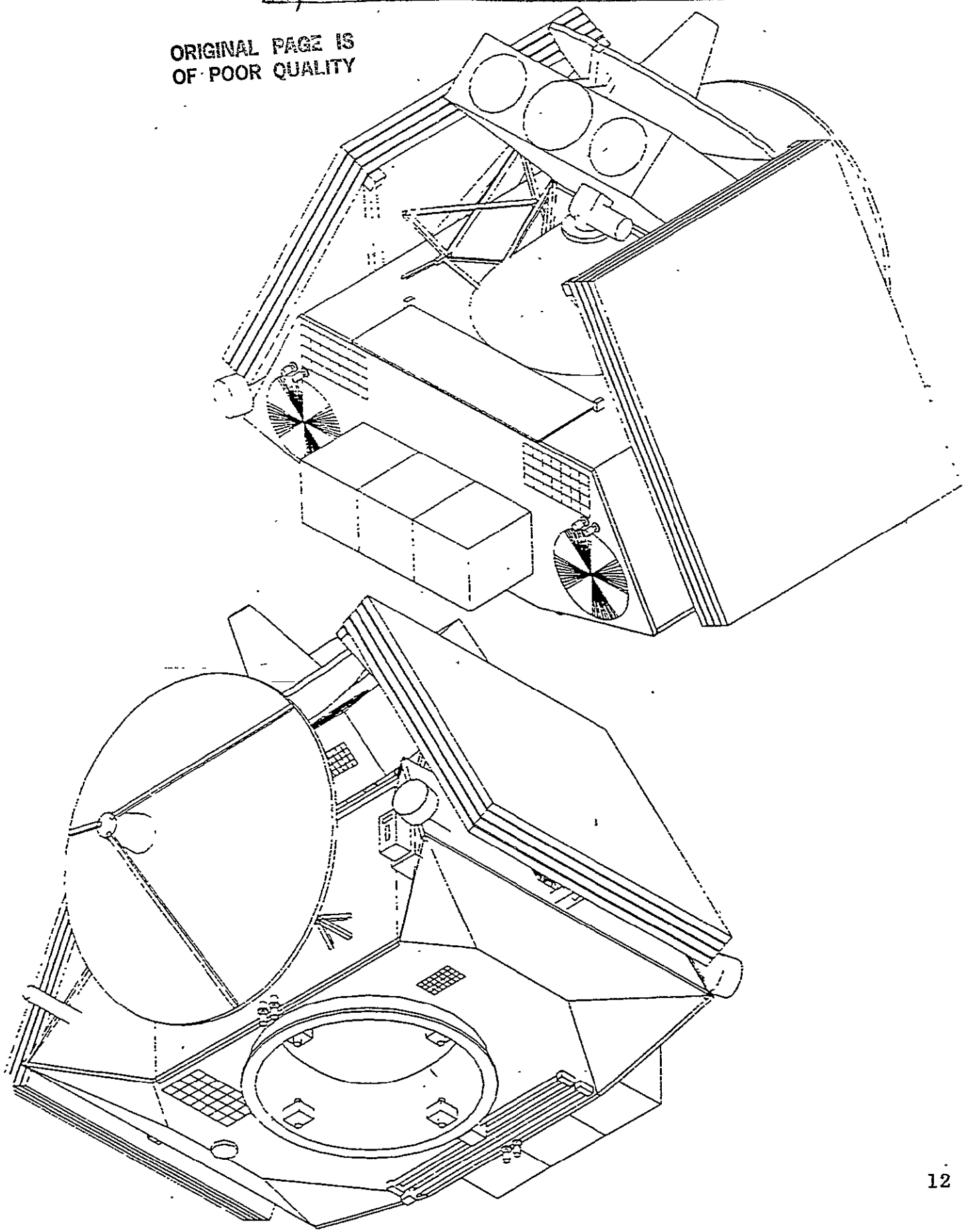
cnes

LAUNCH CONFIGURATION





VEHICLE FOR ASTEROIDS AND COMETS



CONFIGURATION IN OBSERVATION PHASE