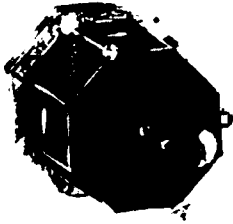


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Mission Overview

- **Target Selection: Emphasis on diversity and unique objects**
- **Baseline Mission: Flybys of three comets—
Encke, SW3, d'Arrest**
- **Launch Dates: June 26 → July 31, 2002 (36-day window)**
- **Backup Launch Opportunity: June–July 2003**
- **Launch Vehicle: Delta-7425 (Med-Lite)**
- **Indirect Launch Concept: Enabling technique**
- **Comet Encounters:**
 - **Near maximum comet activity**
 - **Very small Earth distances (0.27, 0.33, and 0.36 AU)**
 - **Excellent viewing geometry for Earth-based observations**
- **Mission Flexibility: Adaptive mission plan**
- **Minimal Operations and DSN Support: “Hibernation” strategy**

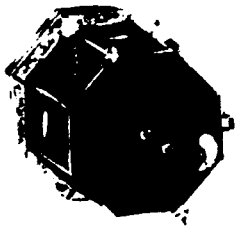


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Baseline Mission Profile



Encounter date	Sun distance (AU)	Earth distance (AU)	Phase angle (deg)	Flyby speed (km/s)
Encke: 11-12-03	1.07	0.27	12	28.2
SW3: 6-18-06	0.95	0.33	100	14.0
d'Arrest: 8-16-08	1.35	0.36	68	11.8

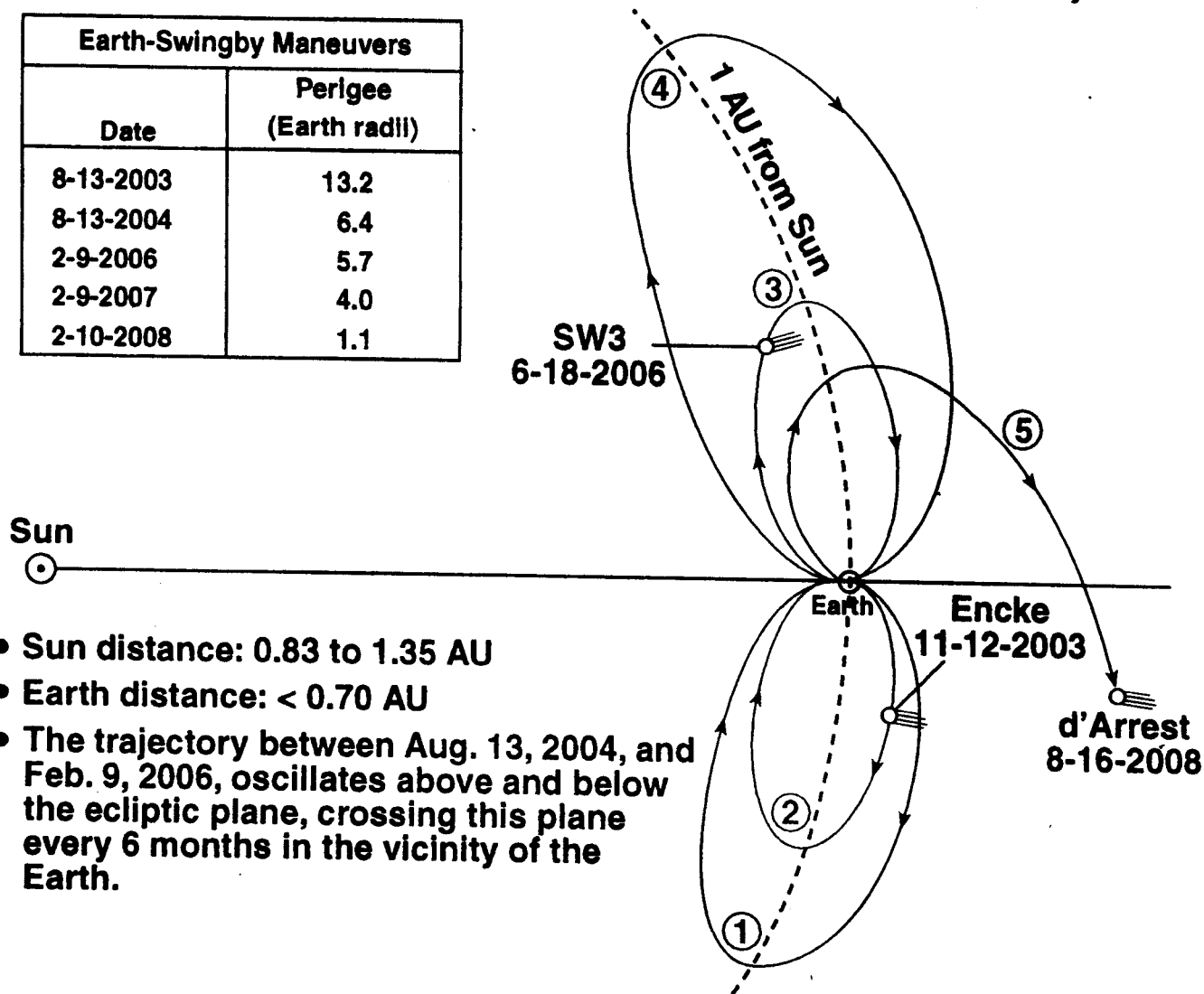


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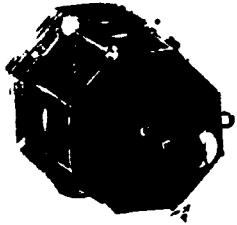


Trajectory Sequence (Bipolar Plot)

Earth-Swingby Maneuvers	
Date	Perigee (Earth radii)
8-13-2003	13.2
8-13-2004	6.4
2-9-2006	5.7
2-9-2007	4.0
2-10-2008	1.1



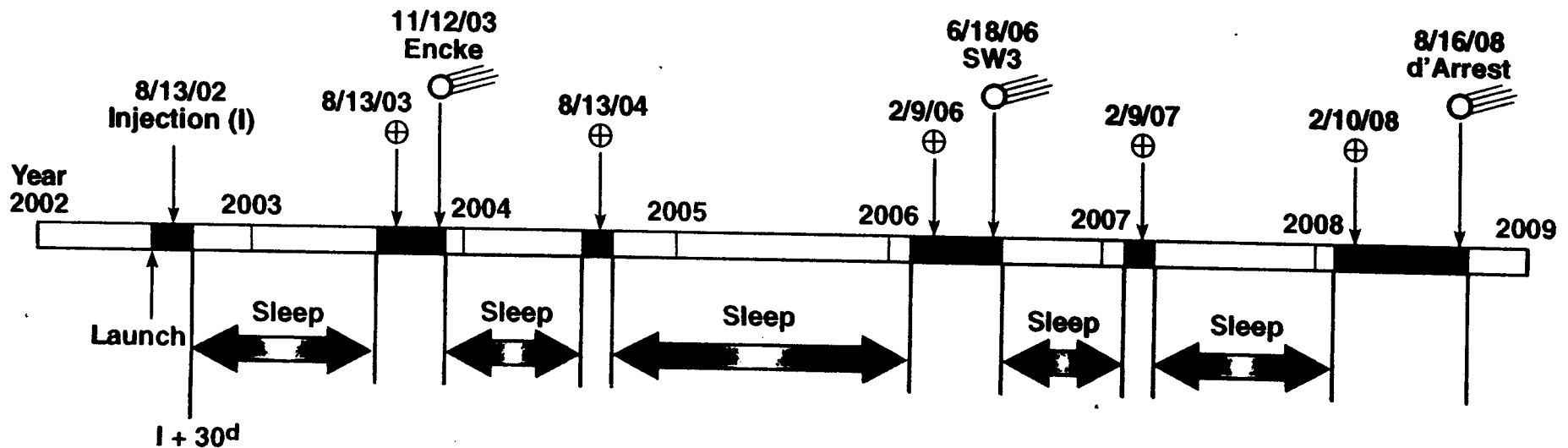
- Sun distance: 0.83 to 1.35 AU
- Earth distance: < 0.70 AU
- The trajectory between Aug. 13, 2004, and Feb. 9, 2006, oscillates above and below the ecliptic plane, crossing this plane every 6 months in the vicinity of the Earth.



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Mission Timeline



- Hibernation (sleep mode): 68% of time
- Active periods
 - Launch and early heliocentric phase: 72 days
 - Earth swingbys (5): 50 days each time
 - Comet encounters (3): 75 days each time



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Scientific Objectives

Concentrate on improving knowledge of key characteristics and on assessing the diversity of comet nuclei:

- Image parts of the nucleus at effective resolutions as high as 4 m/pxl, 25 times better than Giotto.
- Image and spectrally map the nucleus globally to determine large-scale characteristics.
- Obtain detailed compositional measurements of both gas and dust in the near-nucleus environment at precisions comparable to those of Giotto or better.

Coordination with remote-sensing observations from Earth:

- Can link high spatial resolution, near-nucleus observations by CONTOUR with spectroscopic, imaging, and thermal data obtained at broader scales by groundbased and Earth orbital telescopes.

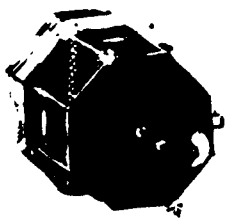


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Science Payload

Instrument	Mass (kg)	Power (W)	Supplier
Contour Remote Imager/ Spectrograph (CRISP)	12.0	36.1	JHU/APL
Contour Forward Imager (CFI)	3.9	1.9	JHU/APL
Dust Analyzer (CIDA)	12.0	13.0	von Hoerner & Sulger, GMBH
Neutral Gas Ion Mass Spectrometer (NGIMS)	8.8	22.6	GSFC
	36.7	73.6	



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Typical Encounter Scenario

E – 60 to E – 10 days: Determine spacecraft orbit. Spacecraft and instrument checkout. TCM-1 @ E – 25 days.

E – 10 to E – 0.5 days: Imaging and spectral observation of coma, OpNav observations (once per day from E – 10 to E – 5 days, twice per day thereafter). TCM-2 @ E – 7 days, TCM-3 @ E – 1 day.

E ± 0.5 days: Encounter mode, all instruments turned on. Sequence designed to fill data recorders. (Nominal miss distance ~ 100 km)

E + 0.5 to E + 15 days: Data playback. TCM-4 at E + 5 days. Determine spacecraft orbit.



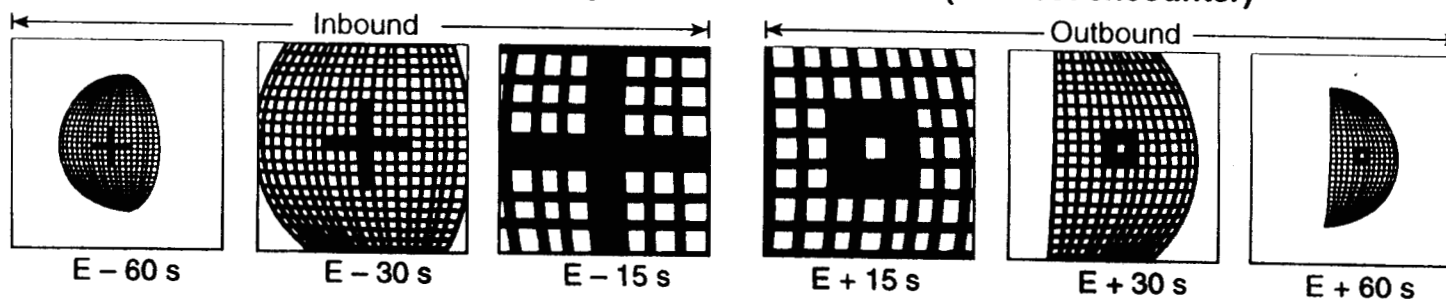
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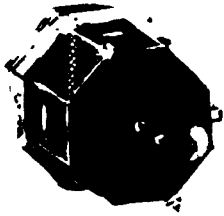


Science Scenario: Summary of d'Arrest Flyby

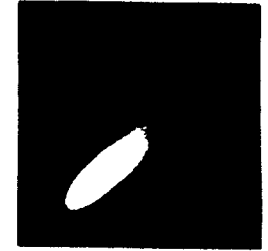
	Time	Range (km)	Resolution
Begin OpNav and coma monitoring	-10 days	10×10^6	200 km/pxl
End OpNav and coma monitoring	-1 day	1×10^6	20 km/pxl
Begin Encounter Phase (all instruments ON)	-0.5 days	0.5×10^6	10 km/pxl
Continuous CIDA/NGIMS observations	-30 min	2.1×10^4	0.4 km/pxl
High resolution CRISP visibility	-80 s	956	19 m/pxl
Closest CRISP inbound	-15 s	200	4 m/pxl
Closest CRISP outbound	+15 s	200	4 m/pxl
End Encounter Phase	+0.5 days	0.5×10^6	10 km/pxl

Simulated CRISP images of comet's nucleus (d'Arrest encounter)





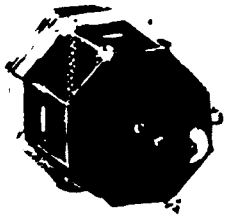
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Launch Summary

Launch window	June 26 → July 31, 2002 (36 days)
Launch-energy requirement	$C_3 \leq -9.8 \text{ km}^2/\text{sec}^2$
Launch vehicle	Delta-7425-9.5 (99% PCS, 3712C PAF)
Allowable launch mass	$M_0 = 1005 \text{ kg}$
<ul style="list-style-type: none">• Spacecraft placed into high-apogee (~11.7 Earth radii) phasing orbit (period ~0.95 days)• STAR-30 solid rocket motor used to place spacecraft into one-year Earth-return trajectory on August 13, 2002.• An Earth gravity-assist maneuver in August 2003 targets the spacecraft toward an encounter with comet Encke in November 2003.	

PCS = probability of commanded shutdown
PAF = payload attach fitting

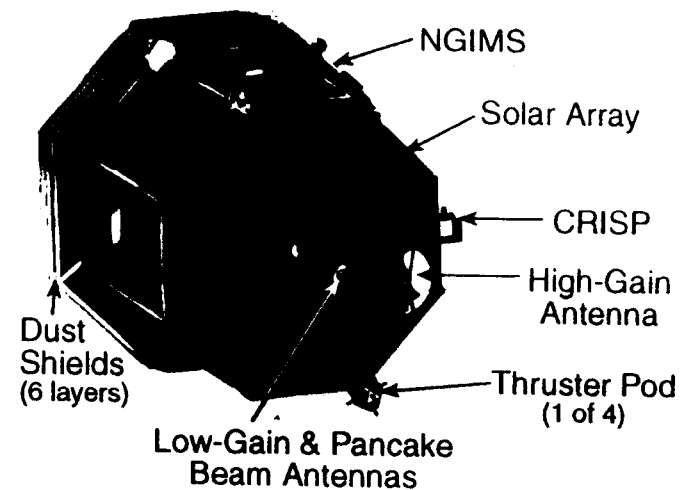


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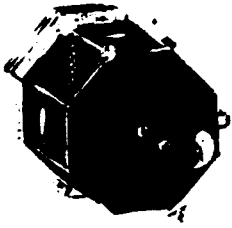


Spacecraft

- **Total Weight** 1005 kg
 - Dry spacecraft 371 kg
 - STAR -30BP SRM 544 kg
($\Delta V \sim 2057$ m/sec)
 - Hydrazine fuel 90 kg
($\Delta V \sim 400$ m/sec)



- Simple compact design
- Body-mounted solar array
- Unattended spin-stabilized cruise mode
- Precision three-axis stabilized encounter mode
- Designed for 0.75 to 1.5 AU solar distance
- Two 5-Gbit solid-state recorders
- Data rates at all comet encounters >100 kbit/sec



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Possible Encounter with "New" Comet

- New comet assumptions
 - Absolute magnitude ≤ 10
 - Perihelion distance ≤ 1.5 AU (an average of 10 new comets per year satisfy these criteria)
 - Comet should be discovered at least 1 year before perihelion and at least 6 months before retargeting maneuver
- Encounter constraints
 - Heliocentric distance between 0.8 and 1.4 AU
 - Earth distance less than 2.4 AU
 - Approach phase angle less than 140 deg

Successive Combinatorial Probabilities for an Encounter with a New Comet	
Earth gravity-assist divert opportunity	Probability of at least one successful encounter
1. Aug. 13, 2004	0.443
2. Feb. 9, 2005 (S)	0.671
3. Aug. 13, 2005 (S)	0.820
4. Feb. 9, 2006	0.905
5. Feb. 9, 2007	0.947
6. Feb. 9, 2008	0.969