

Gemini: Rendezvous and Docking

INST 154

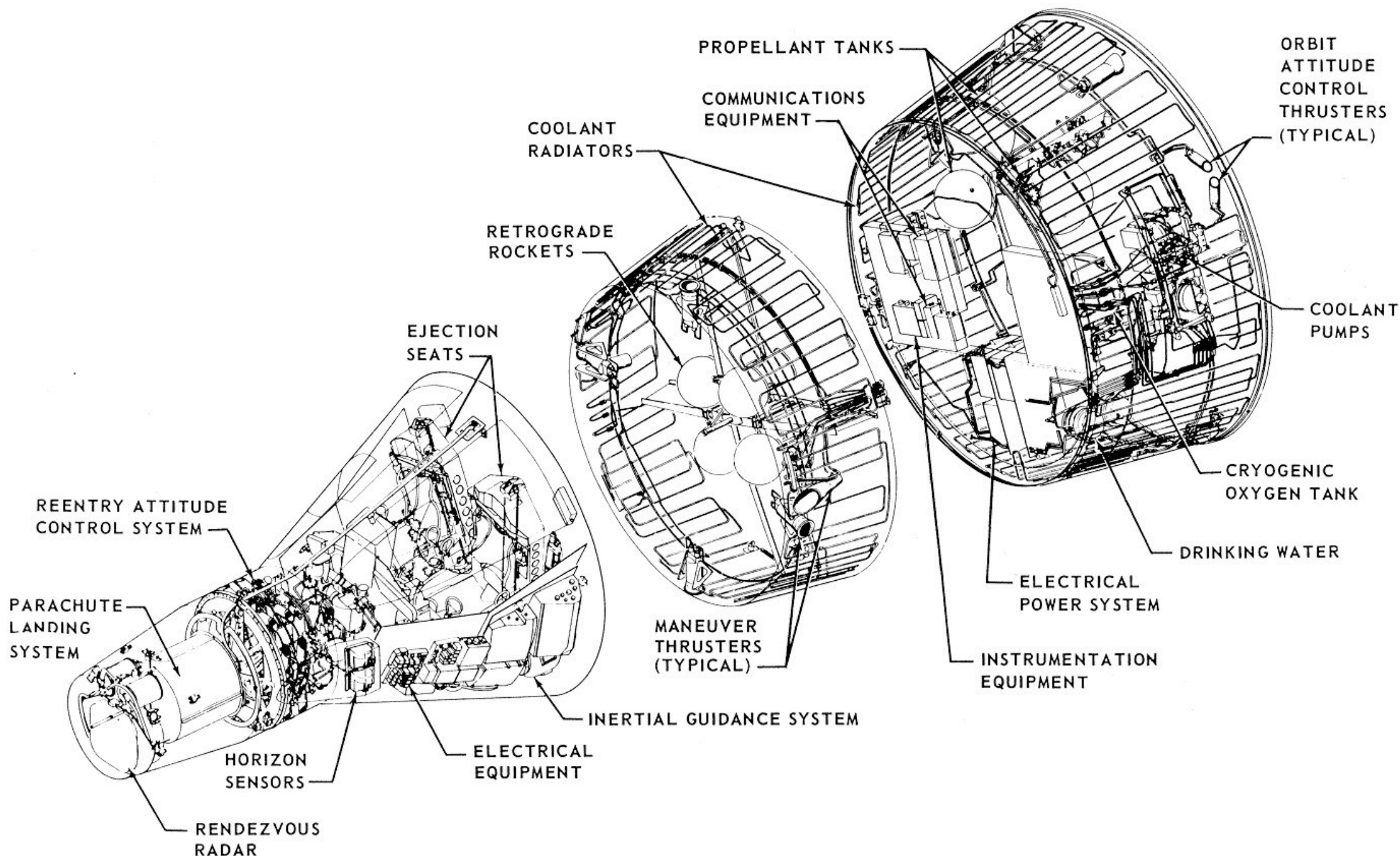
Apollo at 50

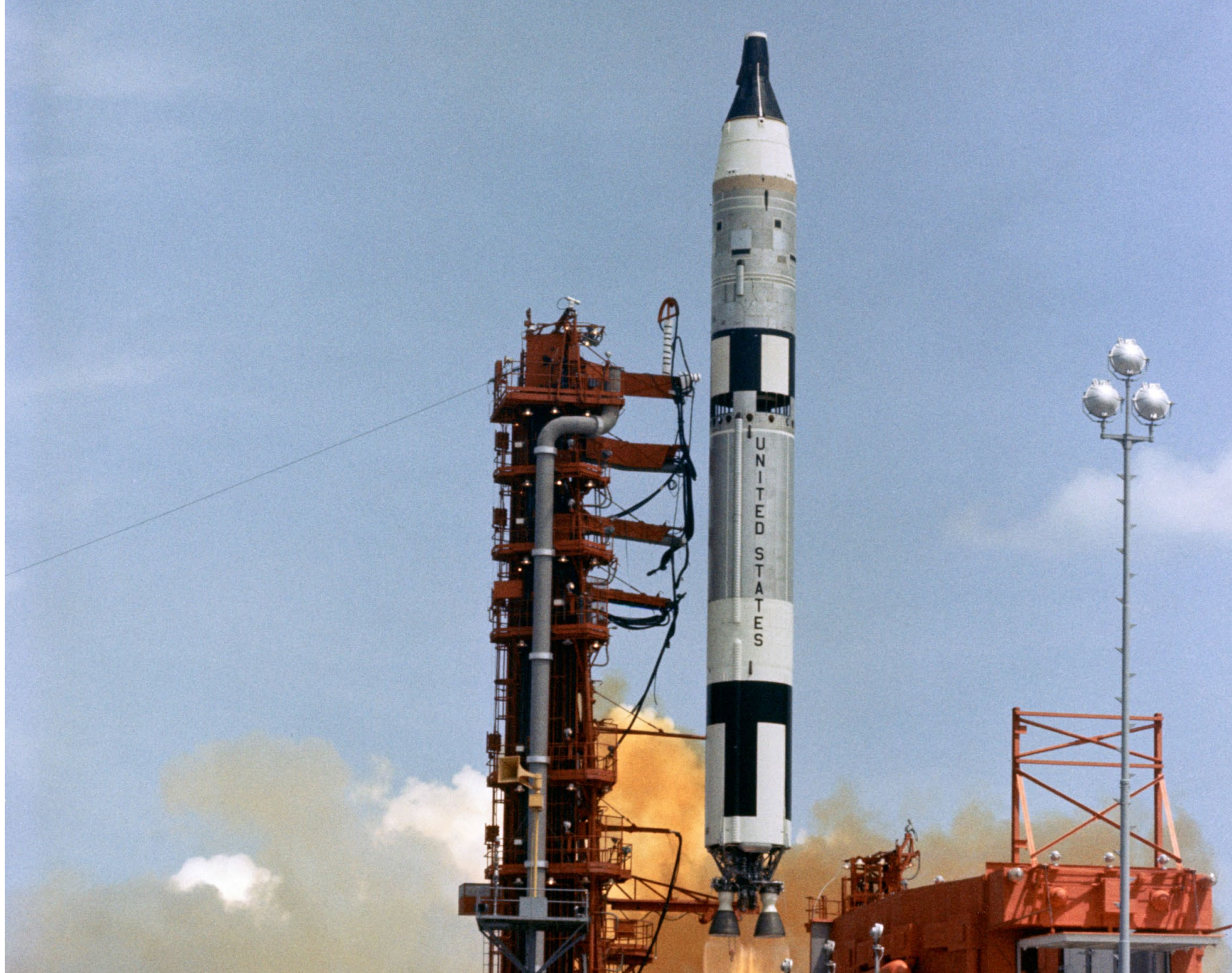
[Gemini Flight Controller Orientation](#)

Gemini Objectives

- To demonstrate endurance of humans and equipment in spaceflight for extended periods, at least eight days required for a Moon landing, to a maximum of two weeks **[succeeded]**
- To effect rendezvous and docking with another vehicle, and to maneuver the combined spacecraft using the propulsion system of the target vehicle **[succeeded]**
- To demonstrate Extra-Vehicular Activity (EVA), or space-"walks" outside the protection of the spacecraft, and to evaluate the astronauts' ability to perform tasks there **[succeeded]**
- To perfect techniques of atmospheric reentry and touchdown at a pre-selected location on land **[failed]**

GEMINI EQUIPMENT ARRANGEMENT

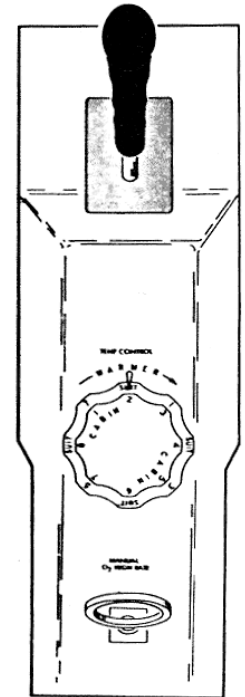
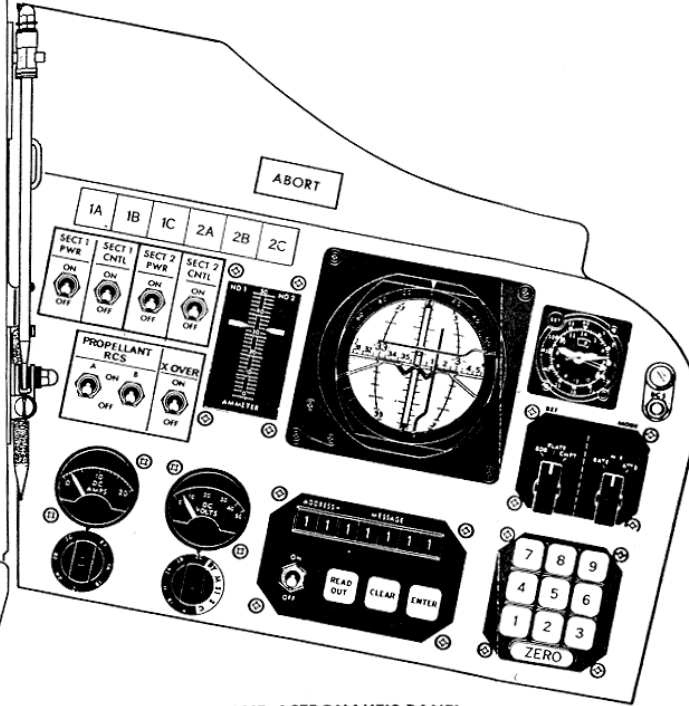
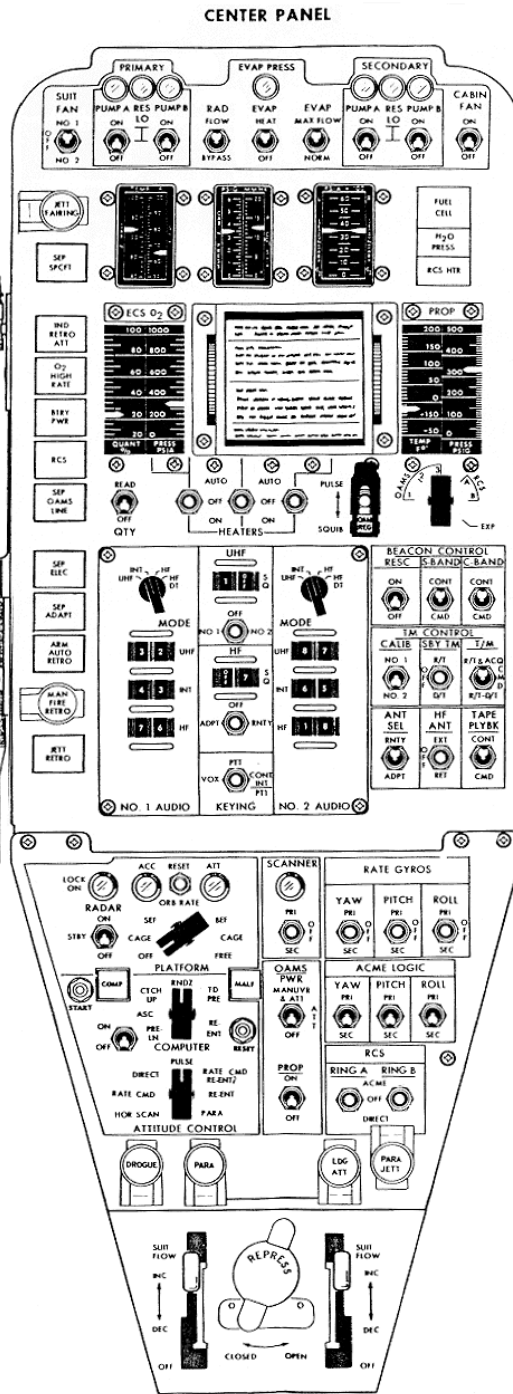
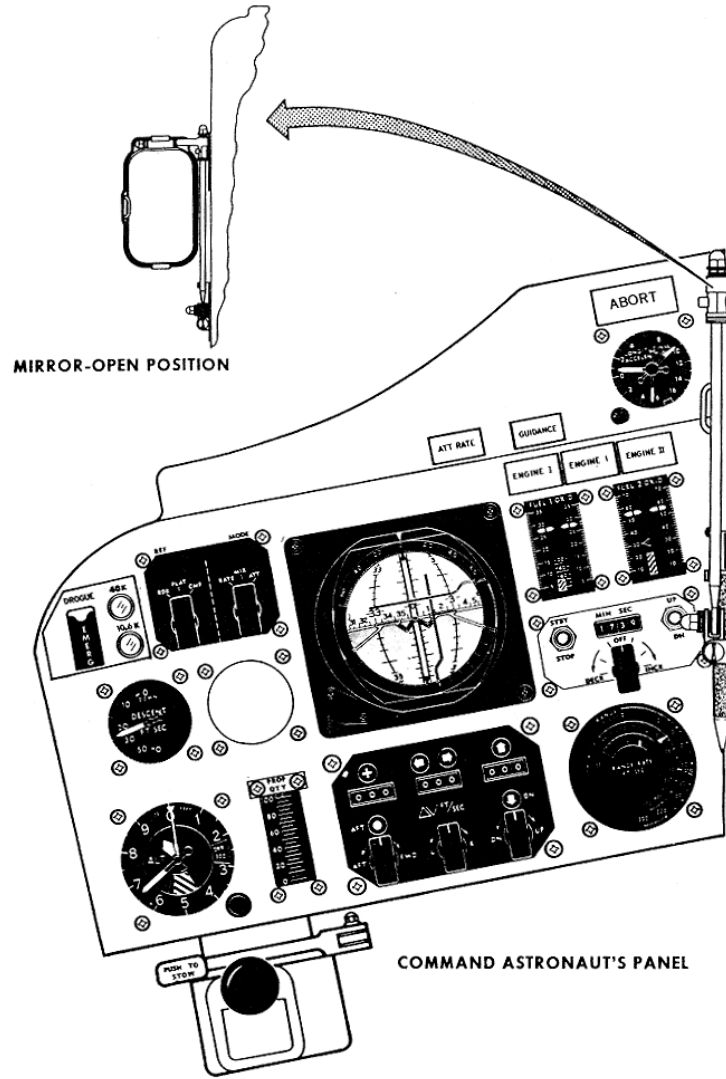




GEMINI INSTRUMENT PANELS AND CONTROLS

from Project Gemini Familiarization Manual

revised 31 December 1964



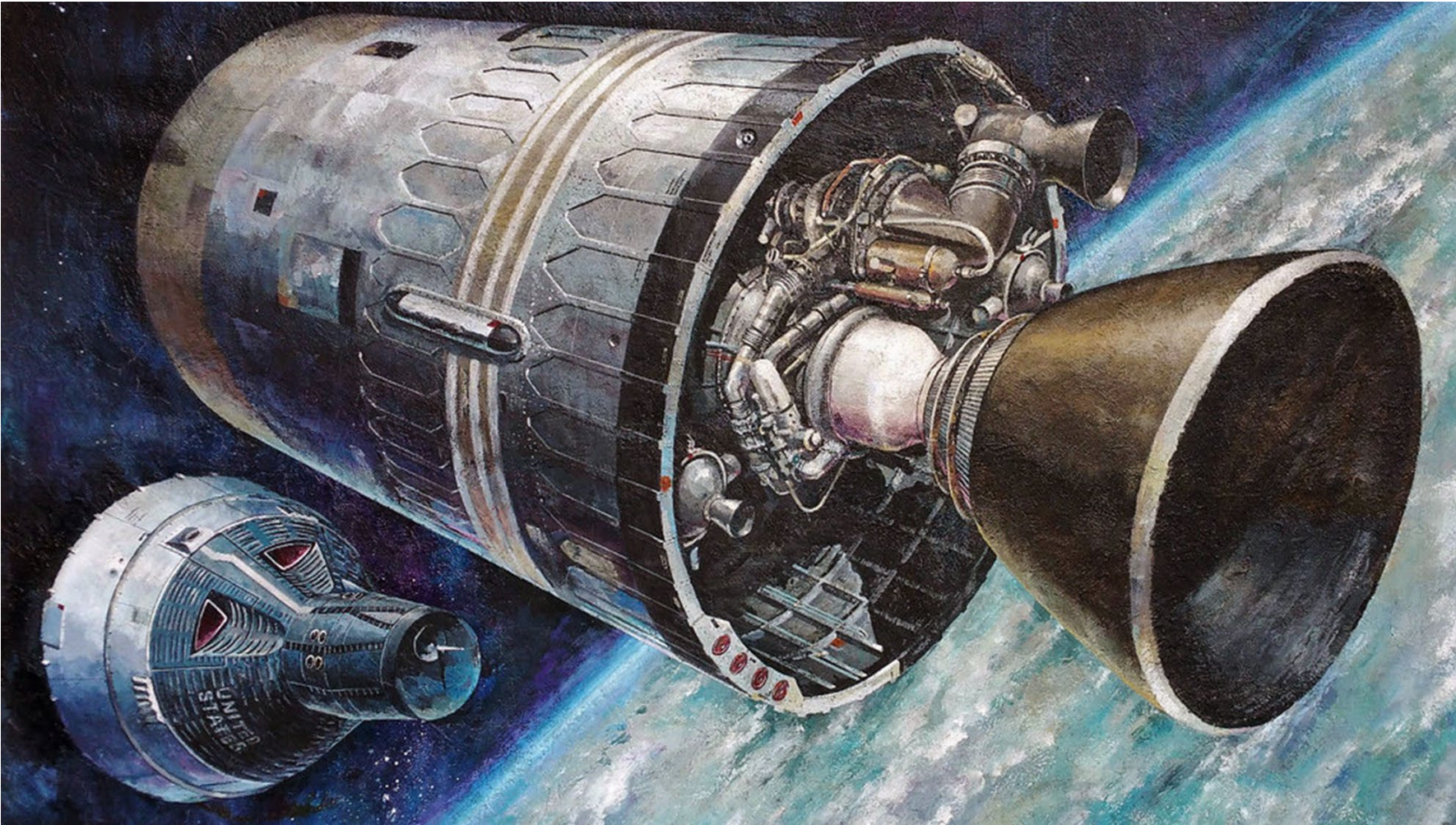
PEDESTAL PANEL

Timeline

- Mercury Mark II program approval
 - Last Mercury mission
 - First uncrewed Gemini mission
 - First crewed Gemini mission
 - First US Spacewalk
 - First Rendezvous
 - Last Gemini mission
 - Uncrewed Air Force Gemini B (MOL program) launch
 - Air Force Manned Orbiting Laboratory program cancelled
- December 1961
May 1963
- April 1964
- March 1965
June 1965
December 1965
November 1966
- November 1966
June 1969

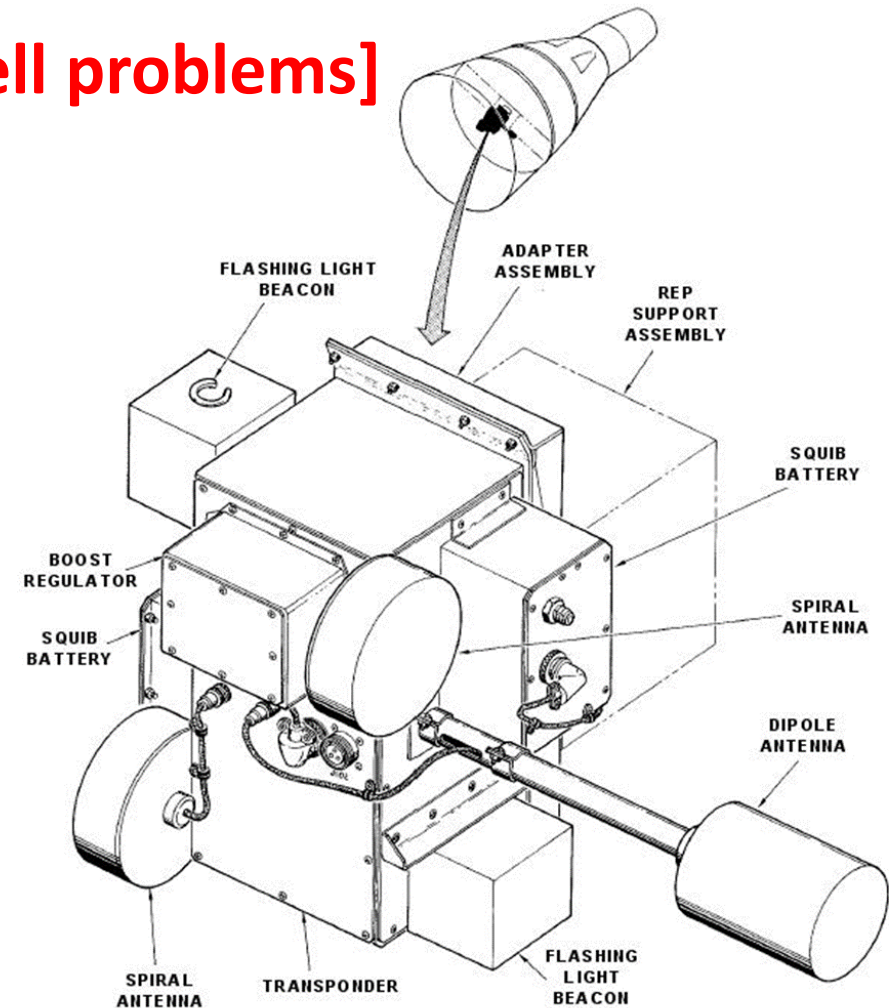
Rendezvous Missions (before Apollo 11)

- Gemini 4 (second stage re-rendezvous) **[venting, line of sight thrusting]**



Rendezvous Missions (before Apollo 11)

- Gemini 4 (second stage re-rendezvous) **[venting, line of sight thrusting]**
- Gemini 5 (Radar Evaluation Pod) **[fuel cell problems]**



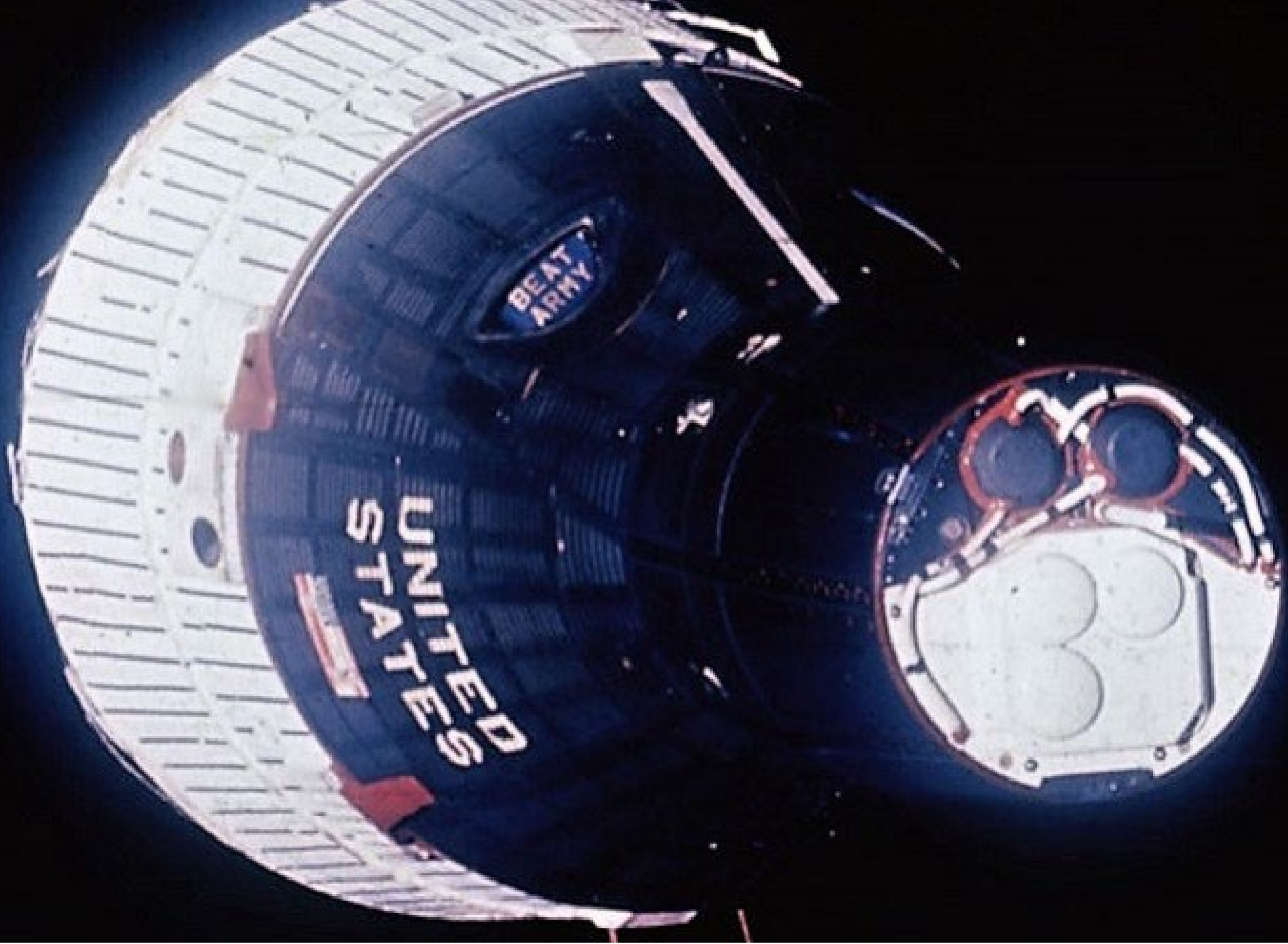
Rendezvous Missions (before Apollo 11)

- Gemini 4 (second stage re-rendezvous) **[venting, line of sight thrusting]**
- Gemini 5 (Radar Evaluation Pod) **[fuel cell problems]**
- Gemini 6A (first rendezvous – with Gemini 7) **[Agena fail, pad abort]**



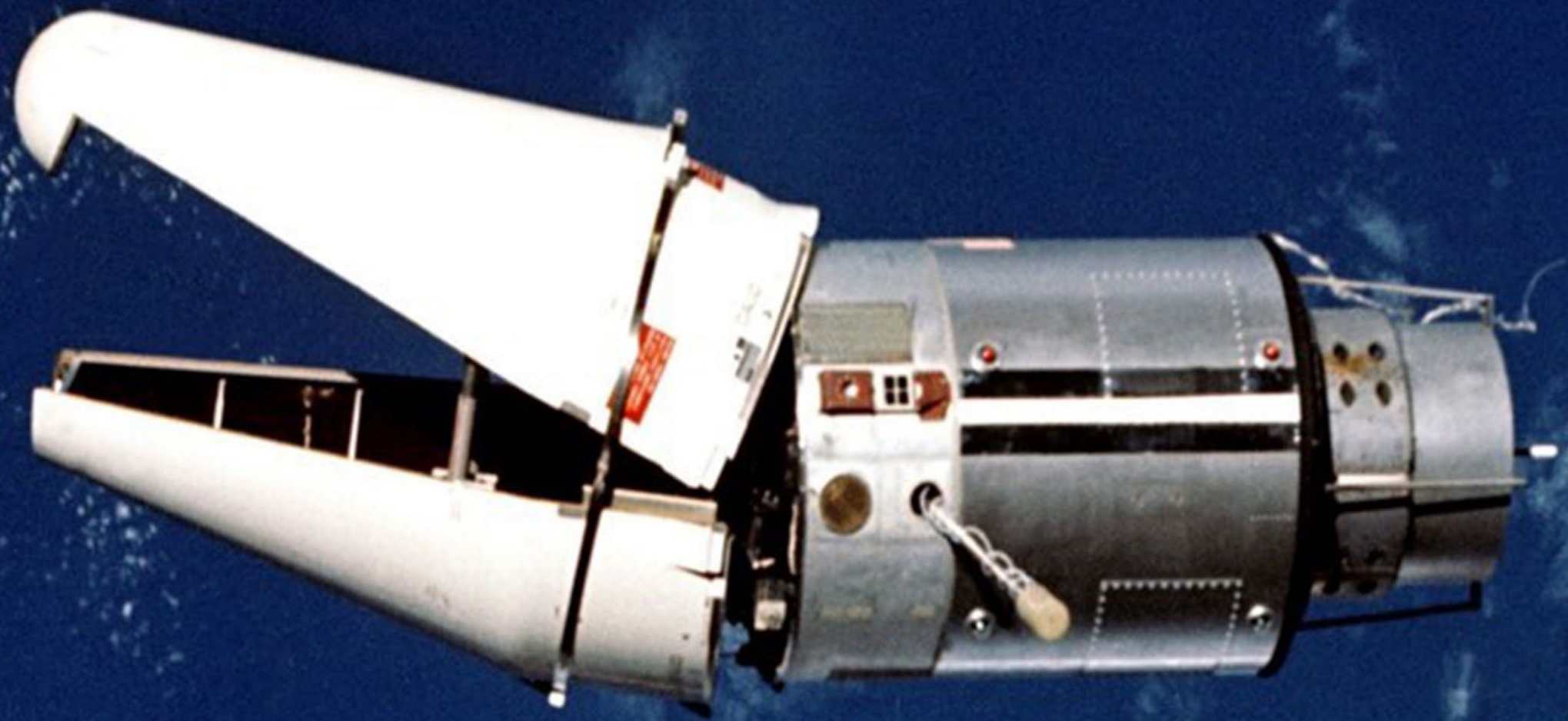
UNITED STATES

AS13



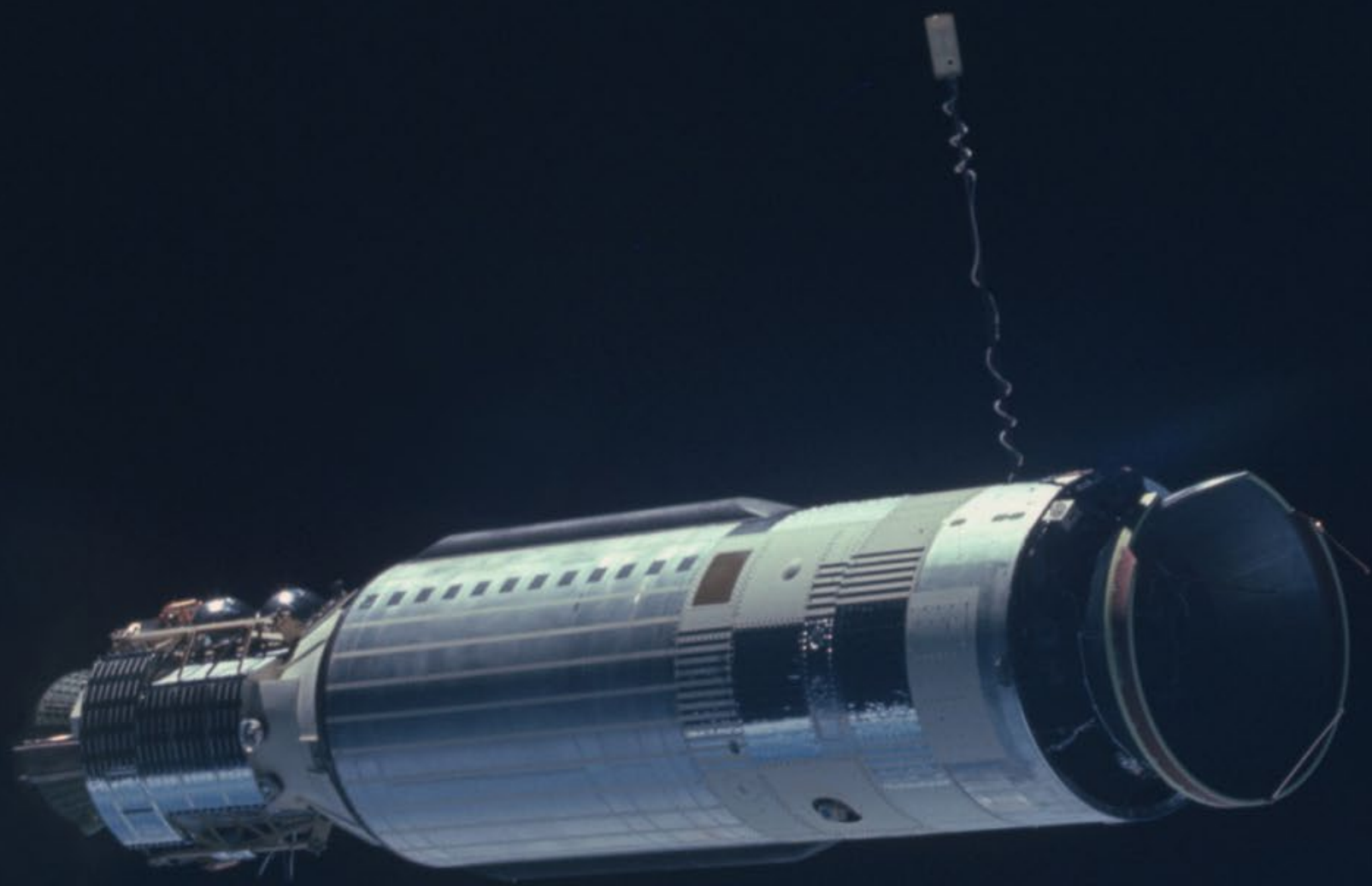
Rendezvous Missions (before Apollo 11)

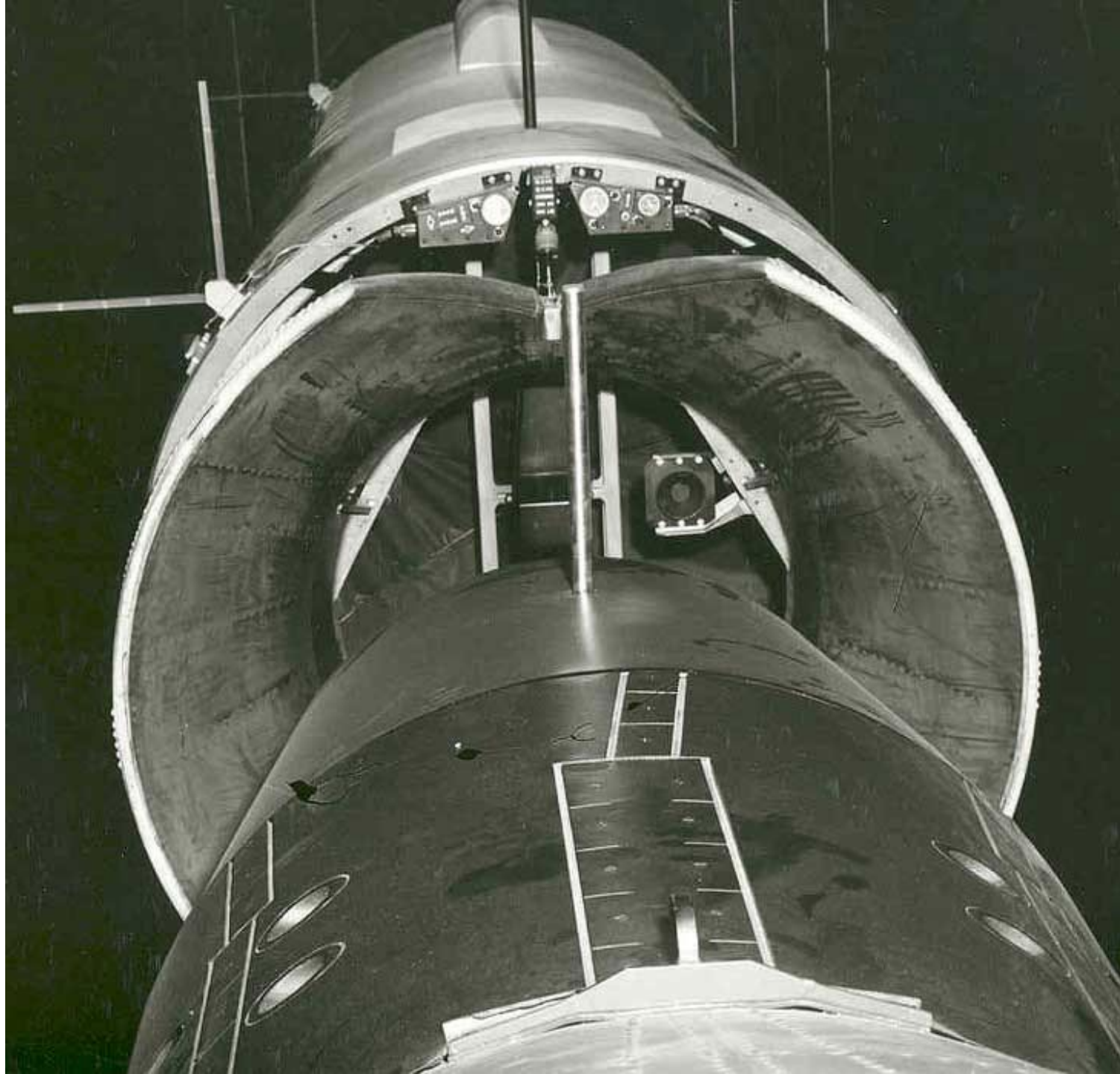
- Gemini 4 (second stage re-rendezvous) **[venting, line of sight thrusting]**
- Gemini 5 (Radar Evaluation Pod) **[fuel cell problems]**
- Gemini 6A (first rendezvous – with Gemini 7) **[Agena fail, pad abort]**
- Gemini 8 (first docking) **[emergency reentry]**
- Gemini 9A (rendezvous from above) **[backup crew, Atlas fail, ADTA fail]**



Rendezvous Missions (before Apollo 11)

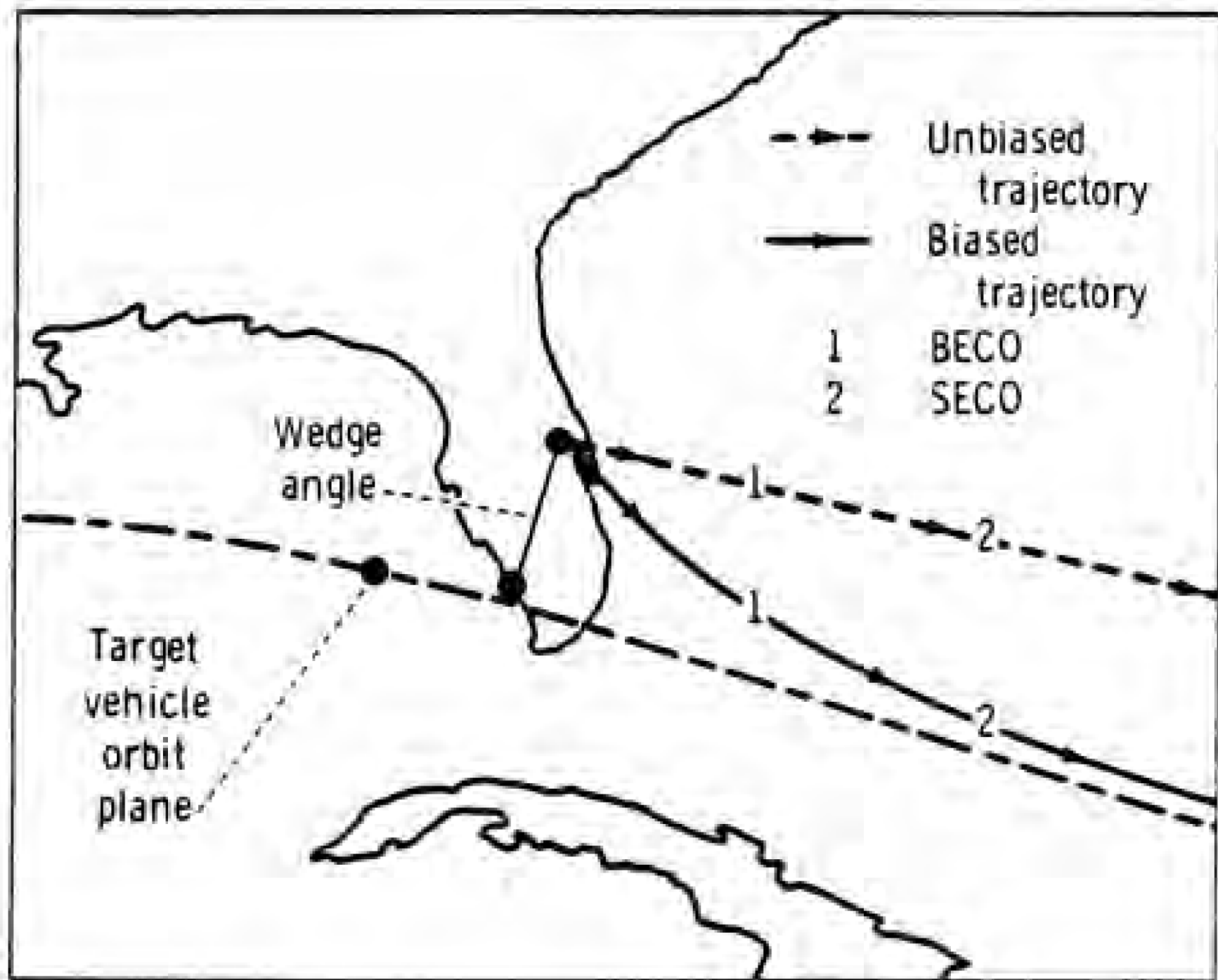
- Gemini 4 (second stage re-rendezvous) **[venting, line of sight thrusting]**
- Gemini 5 (Radar Evaluation Pod) **[fuel cell problems]**
- Gemini 6A (first rendezvous – with Gemini 7) **[Agena fail, pad abort]**
- Gemini 8 (first docking) **[emergency reentry]**
- Gemini 9A (rendezvous from above) **[backup crew, Atlas fail, ADTA fail]**
- Gemini 10 (rendezvous with an uncooperative target)
- Gemini 11 (rapid one-orbit rendezvous)
- Gemini 12 (unplanned rendezvous without radar)
- Apollo 9 (LM-active rendezvous)
- Apollo 10 (Lunar Orbit Rendezvous)





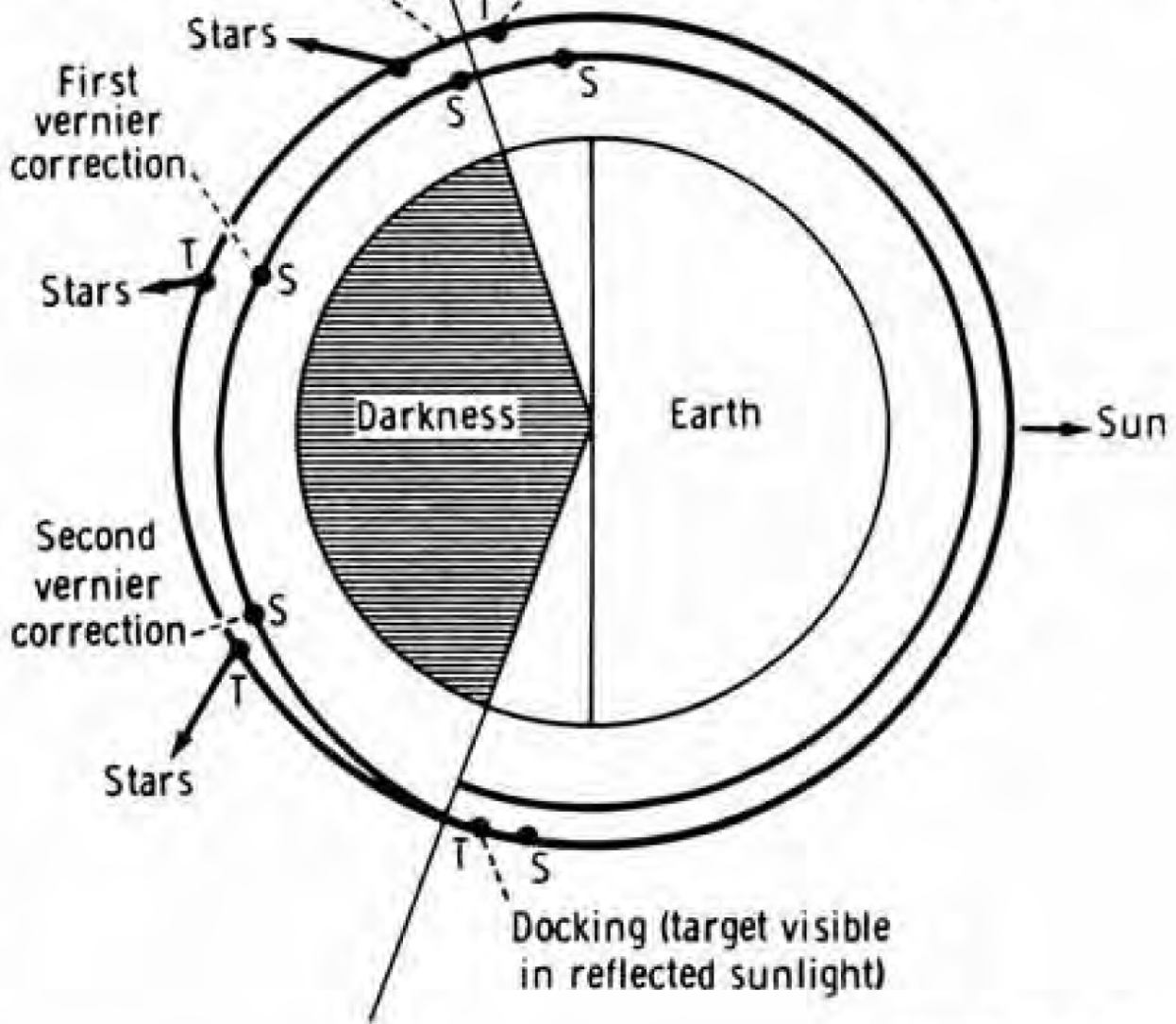
Rendezvous Missions (before Apollo 11)

- Gemini 4 (second stage re-rendezvous) **[venting, line of sight thrusting]**
- Gemini 5 (Radar Evaluation Pod) **[fuel cell problems]**
- Gemini 6A (first rendezvous – with Gemini 7) **[Agena fail, pad abort]**
- Gemini 8 (first docking) **[emergency reentry]**
- Gemini 9A (rendezvous from above) **[backup crew, Atlas fail, ADTA fail]**
- Gemini 10 (rendezvous with an uncooperative target)
- Gemini 11 (rapid one-orbit rendezvous)
- Gemini 12 (unplanned rendezvous without radar)
- Apollo 9 (LM-active rendezvous)
- Apollo 10 (Lunar Orbit Rendezvous)



After terminal-phase initiation (target lights visible)

Prior to and at terminal-phase initiation (target visible in reflected sunlight)



First vernier correction

Second vernier correction

Stars

Stars

Stars

Stars

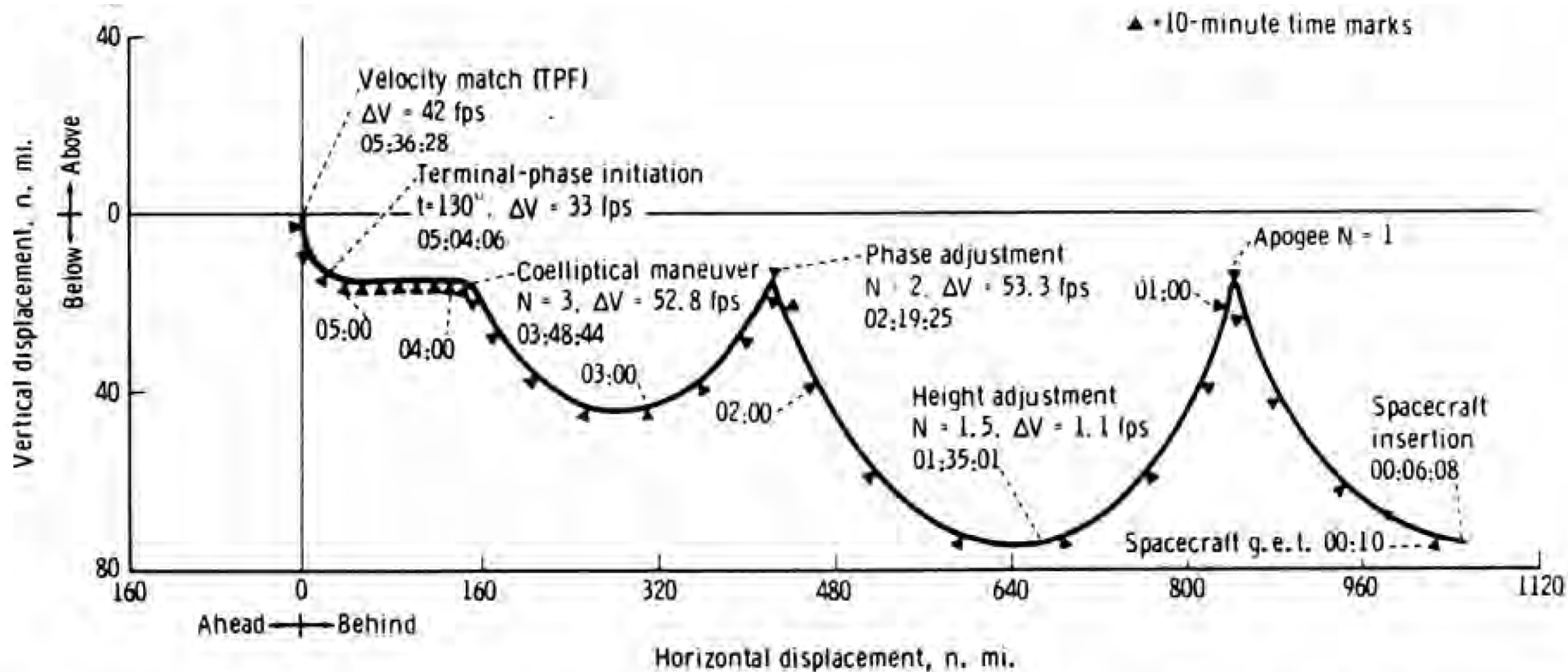
Stars

Docking (target visible in reflected sunlight)

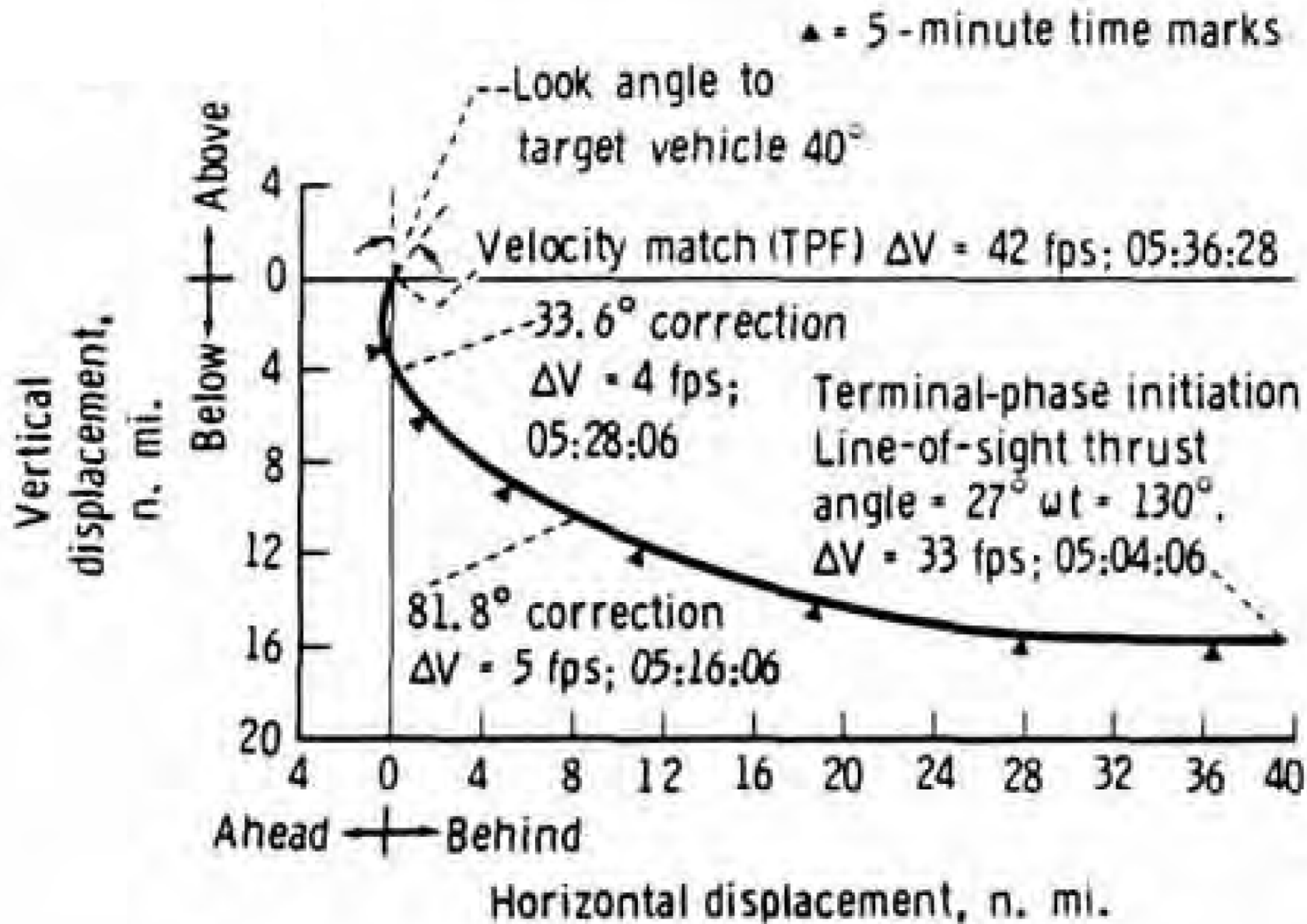
Sun

T - Target vehicle
S - Spacecraft

M=4 Rendezvous (Gemini 6A)



Terminal Phase



Braking Schedule

Apollo LOR:

- 6000 feet: -30 fps
- 3000 feet: -20 fps
- 1500 feet: -10 fps
- 600 feet: - 5 fps

Gemini 12 Pilot Report:

Braking was accomplished in increments, starting with a 3 ft/sec decrease to a closing rate of 45 ft/sec at the fourth midcourse correction. At a range of about 1.5 nautical miles, the closing rate had been decreased to about 17 ft/sec. The inertial indicators were used for an inertial reference during this period. The line-of-sight rates were very small throughout this portion of the braking sequence, requiring only one input correction, according to the inertial indicators. At a range of approximately one nautical mile, inertial reference was shifted to the stars.

From approximately one mile range, braking was accomplished in small increments. The analog range and range-rate indicators did not function during the braking phase. Position and closing rates were maintained by monitoring computer information and by visual observations of the target. At the completion of the rendezvous, the propellant-quantity-remaining indicator read 69 percent.

TABLE 2-IV.—Rendezvous Propellant Usage

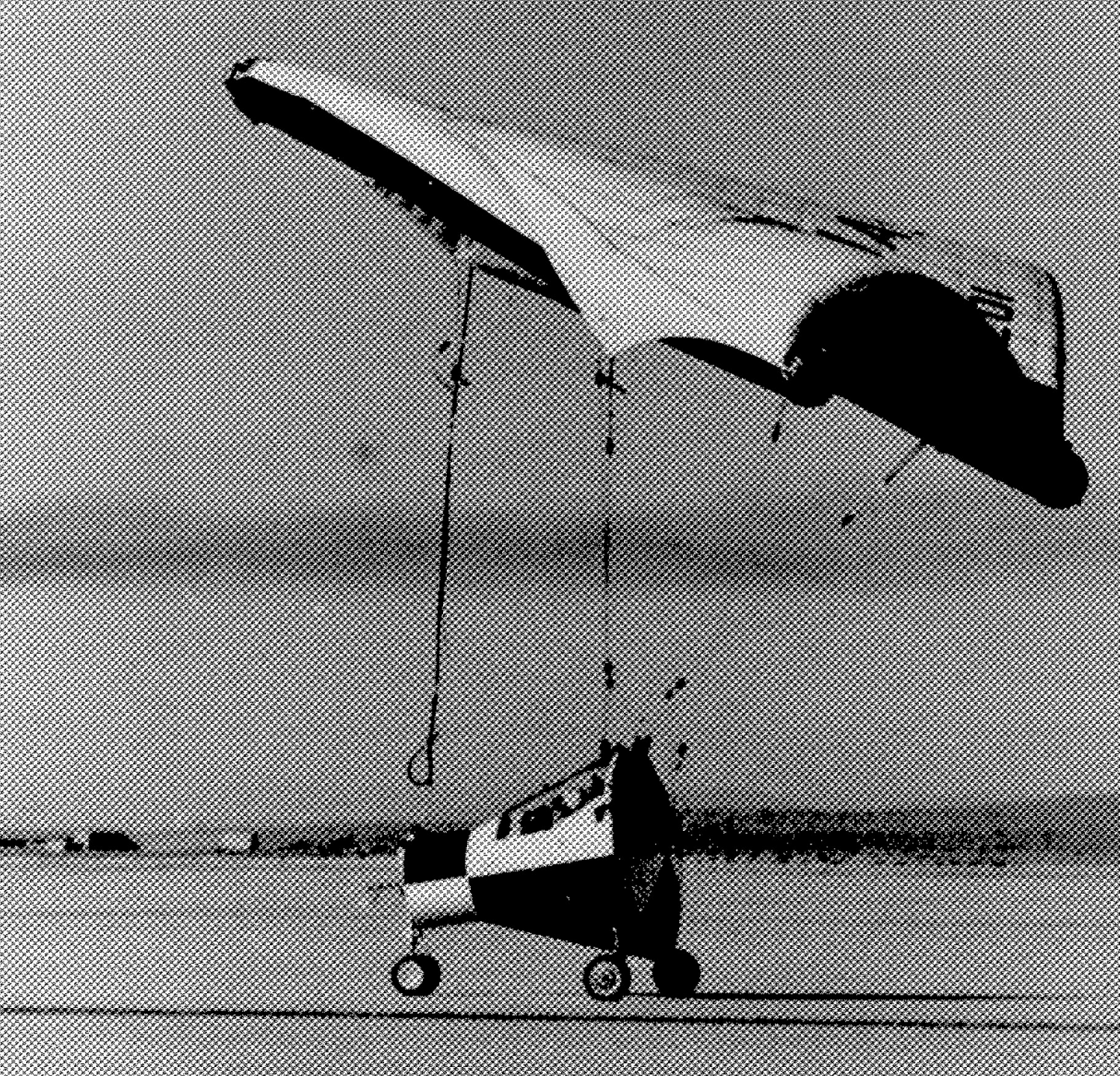
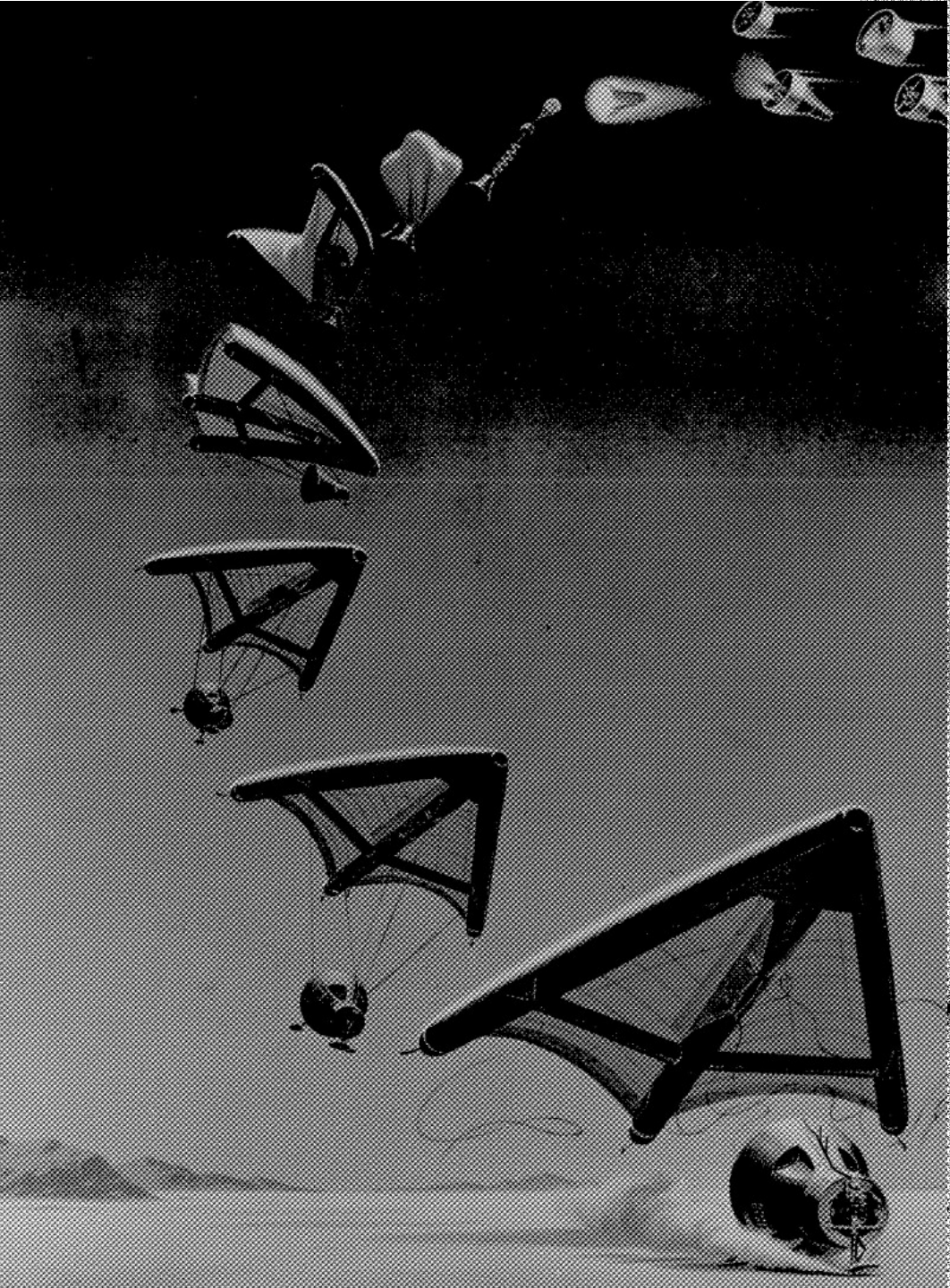
Gemini mission	Type of rendezvous	Conditions at start of terminal phase	Propellant usage, lb		
			Actual	Minimum	Ratio
VI-A	$M = 4$	Coelliptic: $\Delta h = 15$ n. mi. $\Delta X = 25$ n. mi.	130	81	1.60
VIII	$M = 4$	Coelliptic: $\Delta h = 15$ n. mi. $\Delta X = 25$ n. mi.	160	79	2.02
IX-A	$M = 3$	Coelliptic: $\Delta h = 12$ n. mi. $\Delta X = 22$ n. mi.	113	68	1.66
IX-A	Optical	$\Delta h = 2.5$ n. mi. $\Delta X = 3.5$ n. mi.	61	20	3.05
IX-A	From above	$\Delta h = -7.5$ n. mi. $\Delta X = -10$ n. mi.	137	39	3.51
X	$M = 4$	Coelliptic: $\Delta h = 15$ n. mi. $\Delta X = 30$ n. mi.	360	84	4.28
X	Optical dual	Coelliptic: $\Delta h = 7$ n. mi. $\Delta X = 12$ n. mi.	180	73	2.46
XI	$M = 1$	Spacecraft at apogee of 87/151 orbit: $\Delta h = 10$ n. mi. $\Delta X = 15$ n. mi.	290	191	1.52
XI	Stable orbit	$\Delta h = 0$ n. mi. $\Delta X = 25$ n. mi.	87	31	2.81
XII	$M = 3$	Coelliptic: $\Delta h = 10$ n. mi. $\Delta X = 20$ n. mi.	112	55	2.04

Discussion Groups

- Hacker chapter 12 (“Spirit of 76”)
 - The story of the first rendezvous
- FETM video episode 1 (“Can We Do This?”)
 - NASA from the lunar landing decision through the end of Project Gemini
- Summary Conference chapter 2 (“Summary of Rendezvous Operations”)
 - A detailed review of Gemini rendezvous

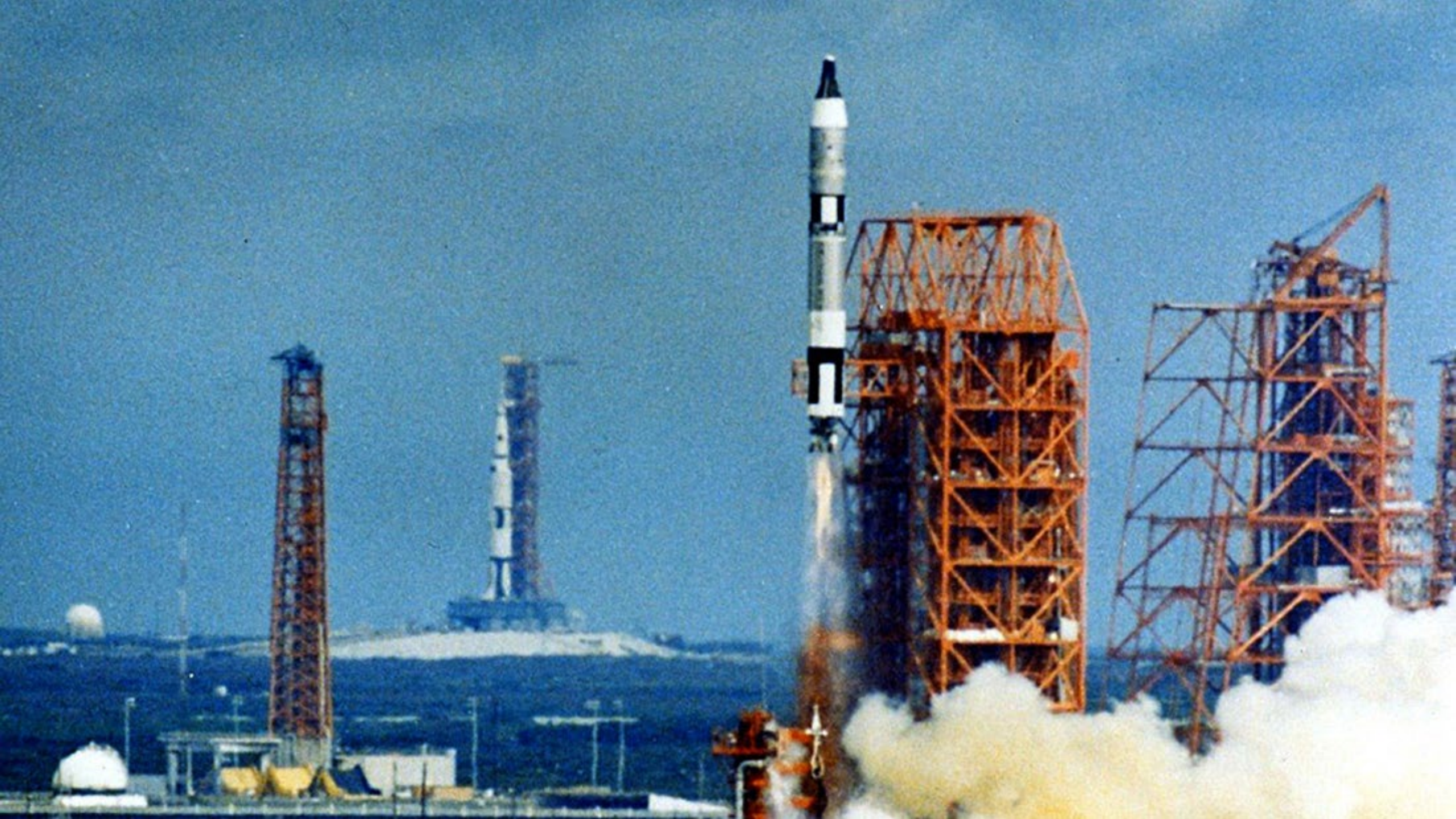
Long Duration Missions (before Shuttle/Mir)

Mercury-Atlas 9	1.4 days
Gemini 4	4.1 days
Gemini 5	7.9 days
Gemini 7	13.8 days
Skylab 2	28.0 days
Skylab 3	59.5 days
Skylab 4	84.1 days









LINE-OF-SIGHT GUIDANCE
TECHNIQUES FOR MANNED
ORBITAL RENDEZVOUS

by

Edwin Eugene Aldrin, Jr.


January 1963

degree of Doctor of Science

Team Project Status Reports

- Due on ELMS before class this Thursday
 - And a second one the Tuesday following Spring Break
- Paragraph 1: What you have done so far
- Paragraph 2: Problems you have encountered
 - Only needed if you have had problems
 - If you need help with problems, also send us an email!

https://apolloinrealtime.org/11



The First Landing on the Moon
Apollo 11
Real-Time Mission Experience
Sat Jul 19 1969 | 11:41:15 PM
Mission Elapsed Time: 086:09:15

Countdown | Earth On the Way to the Moon | In Lunar Orbit | On the Surface | Luna Docked w/ Returning to Earth | Re-entry

In Lunar Orbit | Begin lunar orbit 6/75 | 086:09:15 | Music: Bettye Swann - Angel Of The Morning

In Lunar Orbit 5/75 | Music: Frank Sinatra - It's Nice To Go Trav'ling

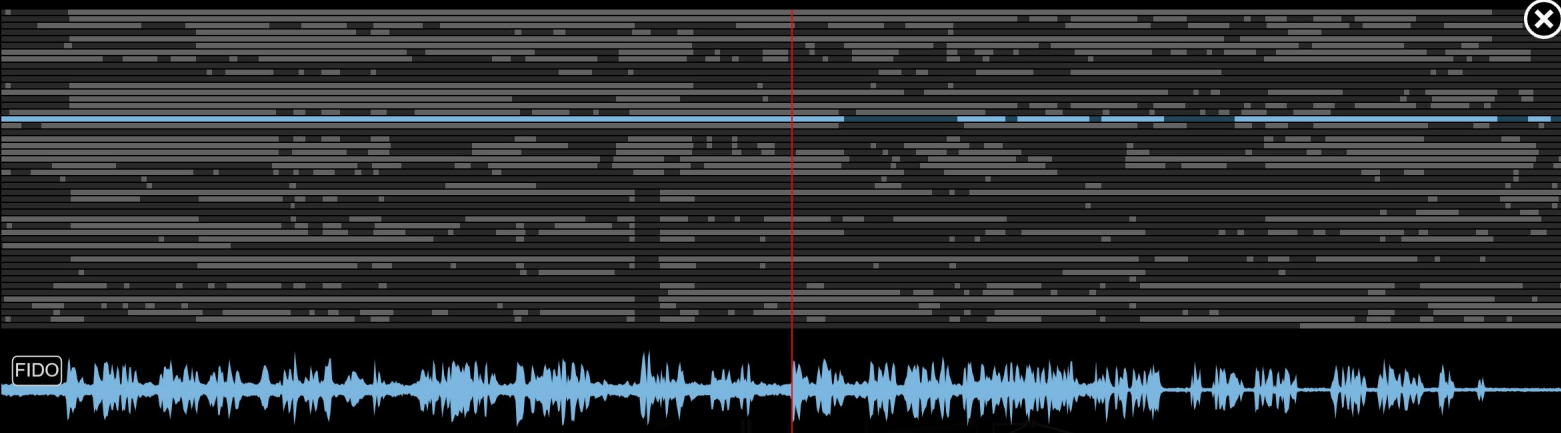
Mission Status

Mission Day: 4/9
Mission Phase:
In lunar orbit
Crew Status:
In Command Module, docked with the Lunar Module
Command Module:
In lunar orbit. Orbit: 6/31
Distance from Earth:
207,559 nautical miles (384,399.2 km) average

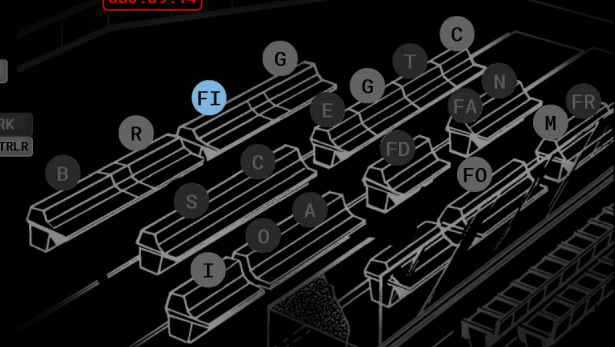
Mission Control Channels

PHOTOGRAPHY | MISSION CONTROL AUDIO | ASTROMATERIAL SAMPLES

FOD
MSN DIR
FLIGHT
FLIGHT-L
FLIGHT-R
CAPCOM
CAPCOM-R
BOOSTER
BOOSTER-C
BOOSTER-R
RETRO
FIDO
GUIDO
GUIDO-R
SURGEON
SURGEON-R
EECOM
GNC
TELCOM
CONTROL
INCO



086:09:14



086:09:15:07

TRANSCRIPT | MISSION MILESTONES | COMMENTARY

Q | PAUSE | REWIND | STOP | PLAY | F1

086:08:47 Aldrin Oops! ...
086:12:16 (Music - Bettye Swann - Angel Of The Morning)
086:13:39 Collins What time is it, Neil, 88 hours, something like that?
086:13:42 Armstrong 86:13.
086:15:54 Armstrong Doesn't it look like some of these crater walls had scallops inside like a design in a fan - like feathers.
086:16:05 Aldrin Seashells.
086:16:06 Armstrong Yes.
086:16:07 Aldrin Like seashells - very pretty, very symmetrical.
086:17:37 Armstrong Take along one of those craters.
086:17:57 Aldrin I took overlapping pictures of all that ... as well.
086:18:02 Collins I want to take the - we're going to have to carry a lot

INCO O&P AFD
FLIGHT FAO NETWORK
FOD M DIR
SPACE ENV COMP SUP SPAN EXPMT AO EASEP
TRACK RECOVERY CCATS LOAD CONF LOOP
GOSS 2
EASEP
MOCR DYN
GOSS CONF
GOSS 4
CCATS LD

FIDO: Flight Dynamics Officer - Responsible for the flight path of the space vehicle, both atmospheric and orbital. During lunar missions the FIDO was also responsible for the lunar trajectory. The FIDO monitored vehicle performance during the powered flight phase and assessed abort modes, calculated orbital maneuvers and resulting trajectories, and monitored vehicle flight profile and energy levels during re-entry.