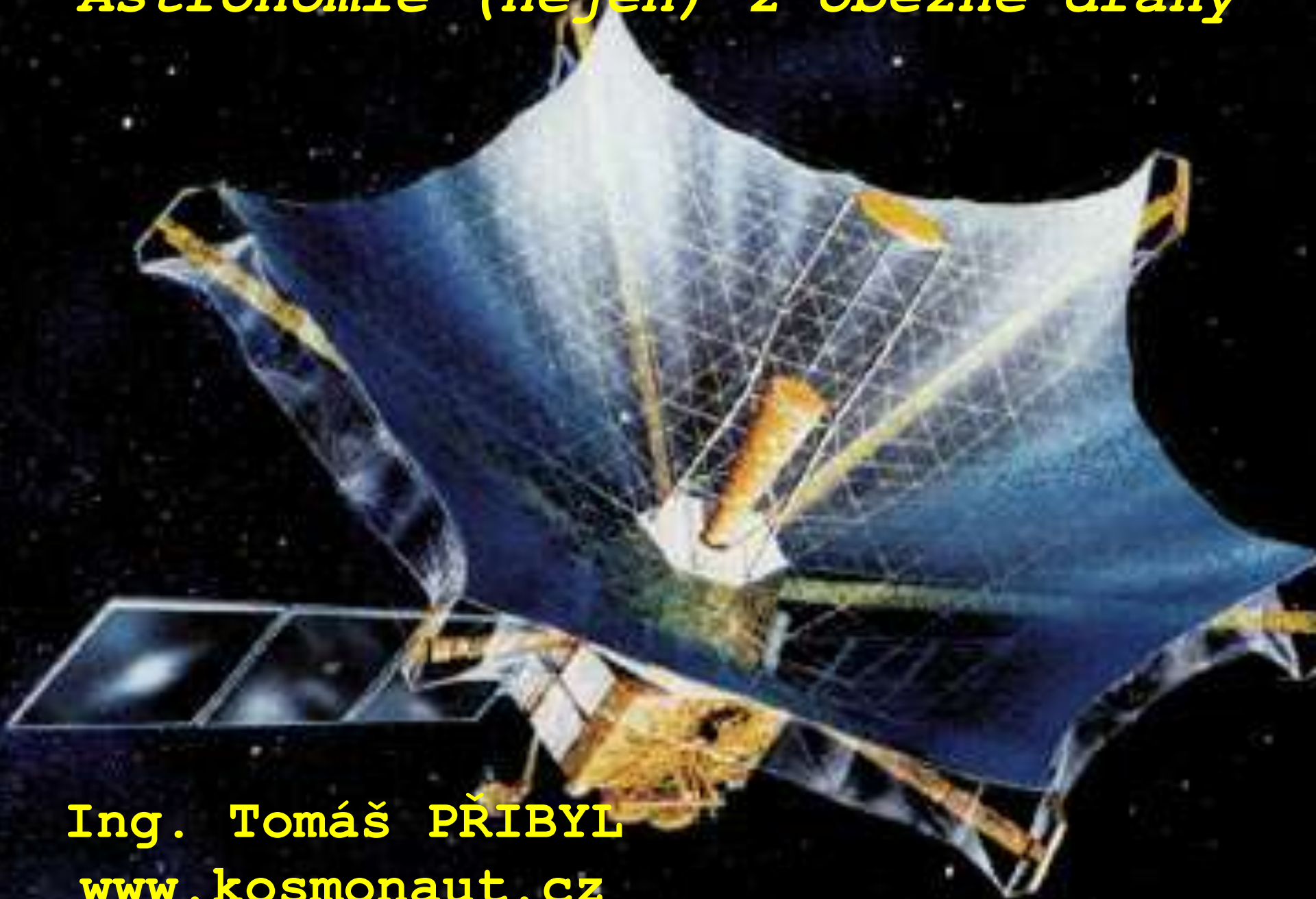


Astronomie (nejen) z oběžné dráhy



Ing. Tomáš PŘIBYL
www.kosmonaut.cz



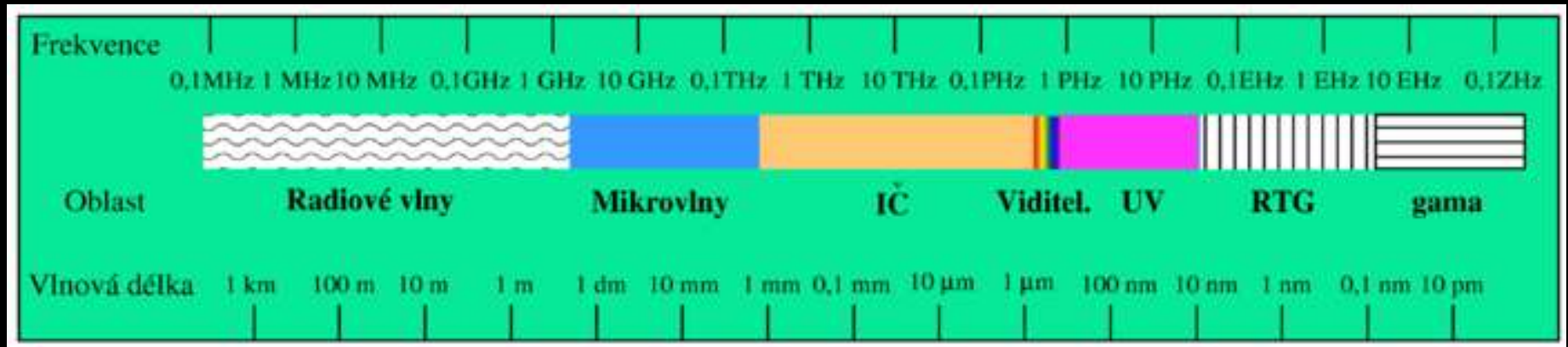
Astronomie

Astronomie v nejširším slova smyslu je věda, která se zabývá jevy za hranicemi zemské atmosféry.

Kosmická astronomie

Kosmická astronomie je její podskupina, která ke zkoumání jevů za hranicemi zemské atmosféry využívá detektory na družicích kolem Země nebo na sondách na meziplanetárních drahách.

Elektromagnetické spektrum



Emitují, odrážejí nebo absorbují.

Emisní spektroskopie.



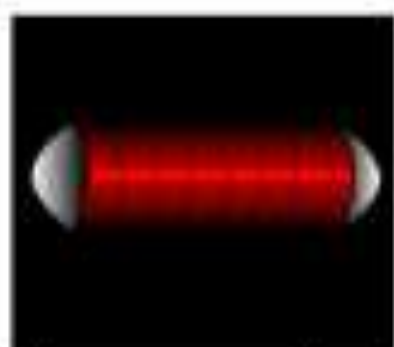
0.01nm



1nm



100nm



1mm

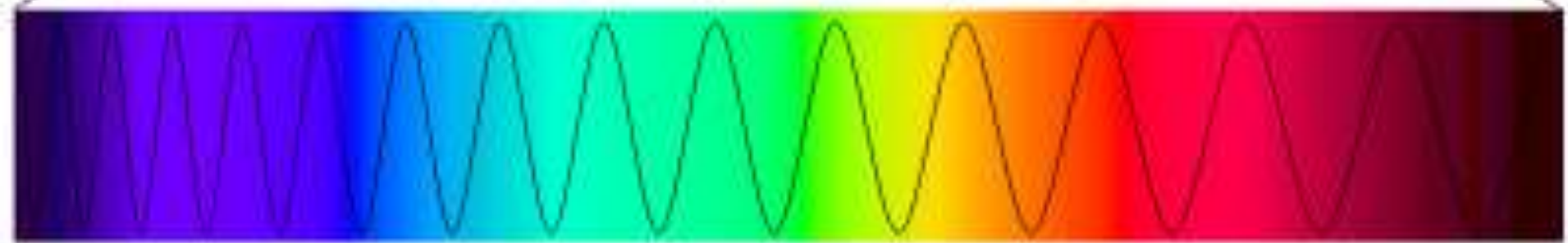


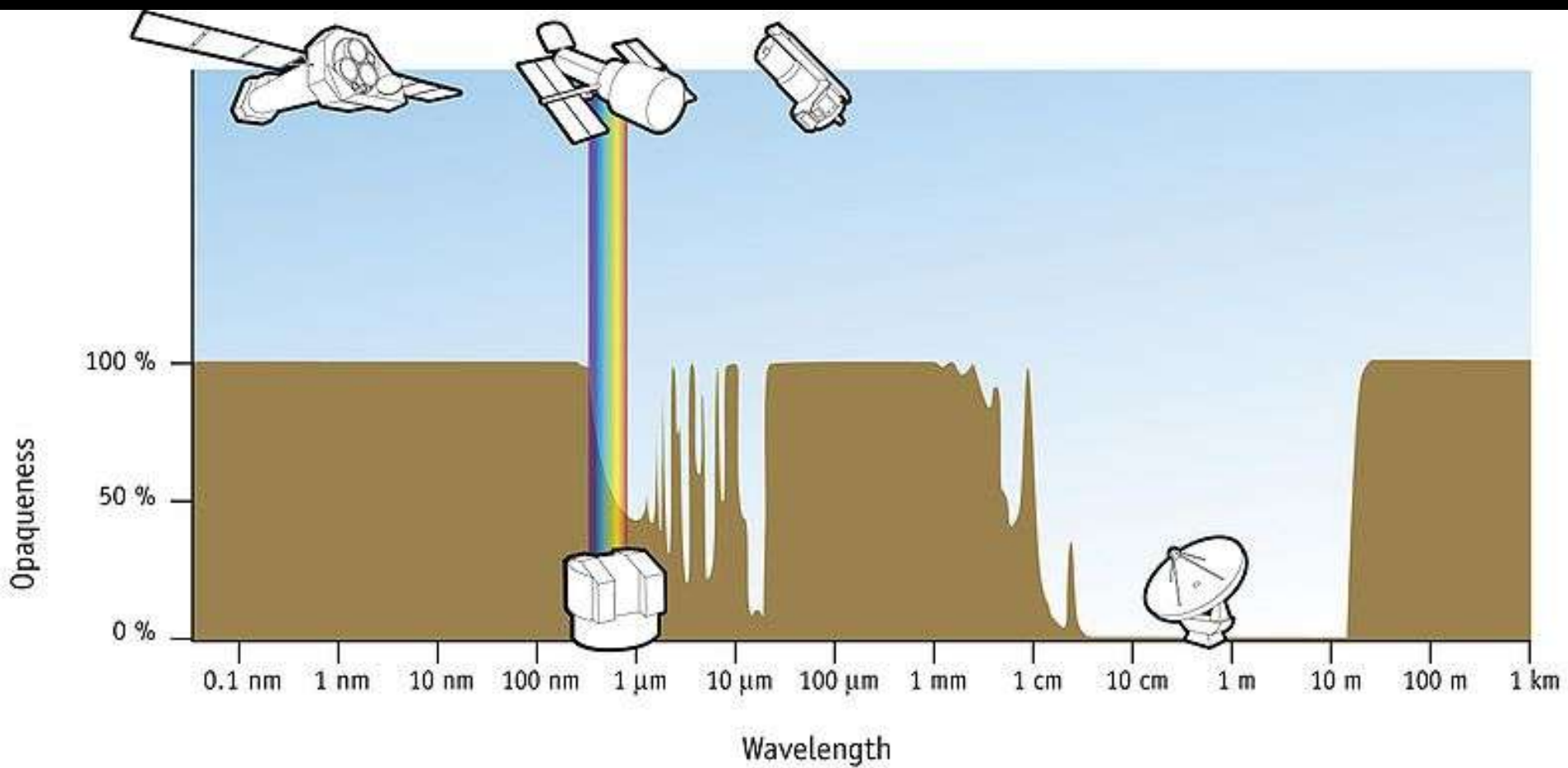
1m

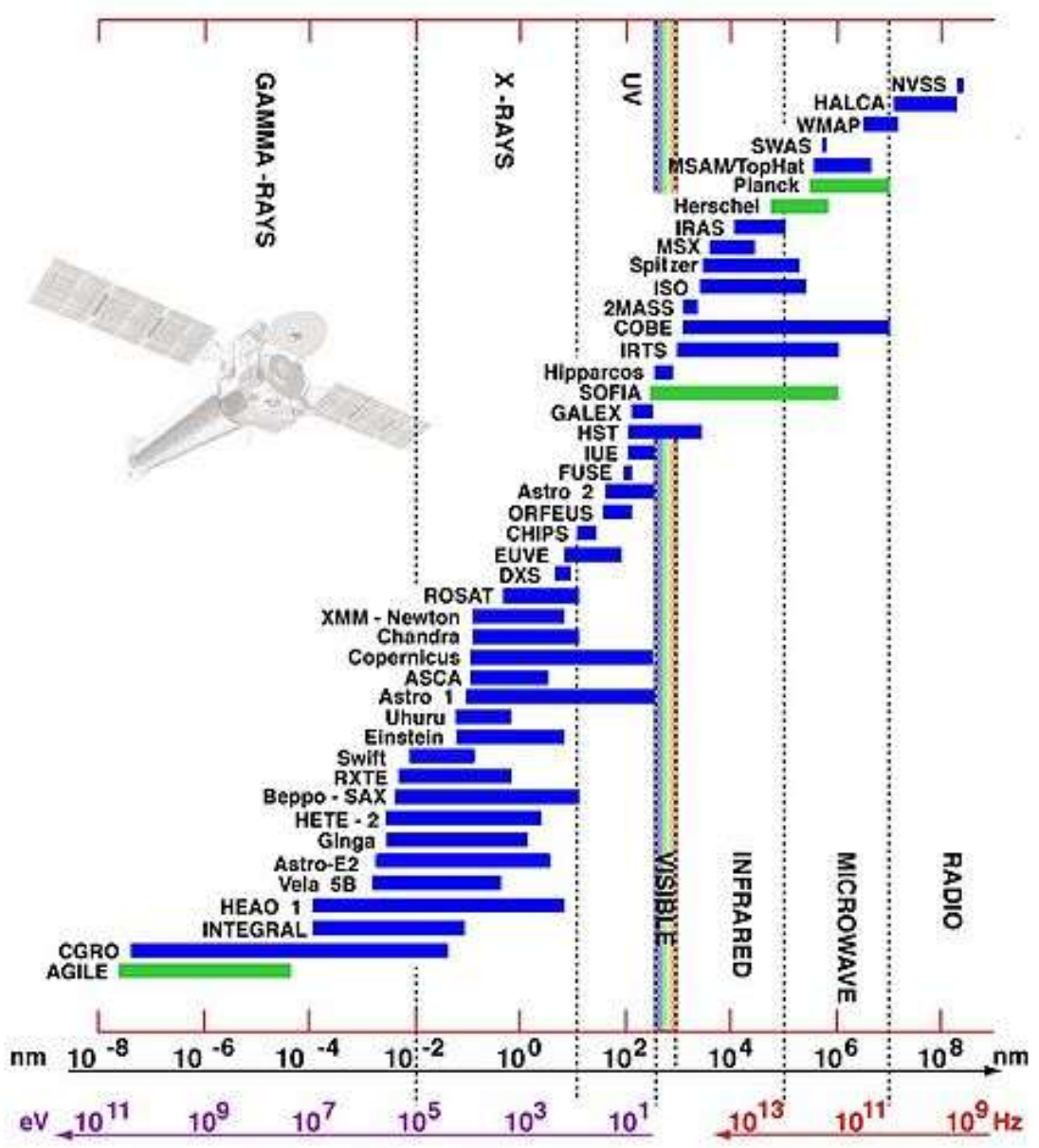
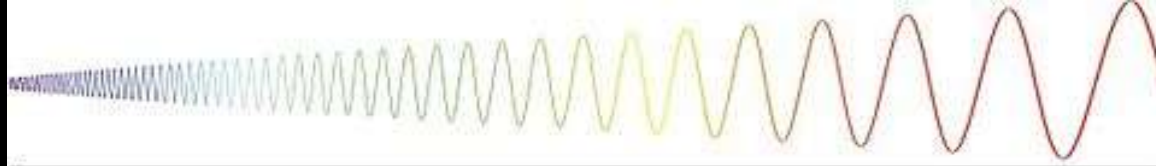
1km

400nm

700nm







K čemu je to dobré?

Kosmické mikrovlnné pozadí –
fosílie Velkého třesku.

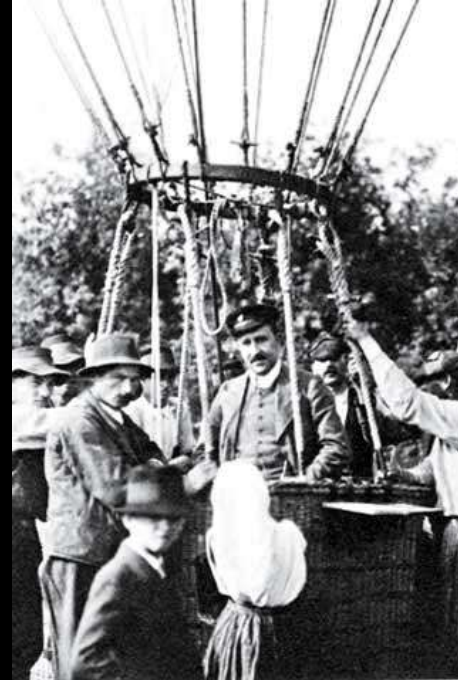
Infračervené spektrum – hnědí
trpaslíci.

Ultrafialové záření – velmi horké
objekty (extrémně žhavé hvězdy,
kvazary).

Rentgenové záření – supernovy nebo
černé díry.

Historická exkurze

Balóny



Objev kosmického záření a
neslunečních rentgenových zdrojů.

Victor Francis Hess (1883 – 1964).

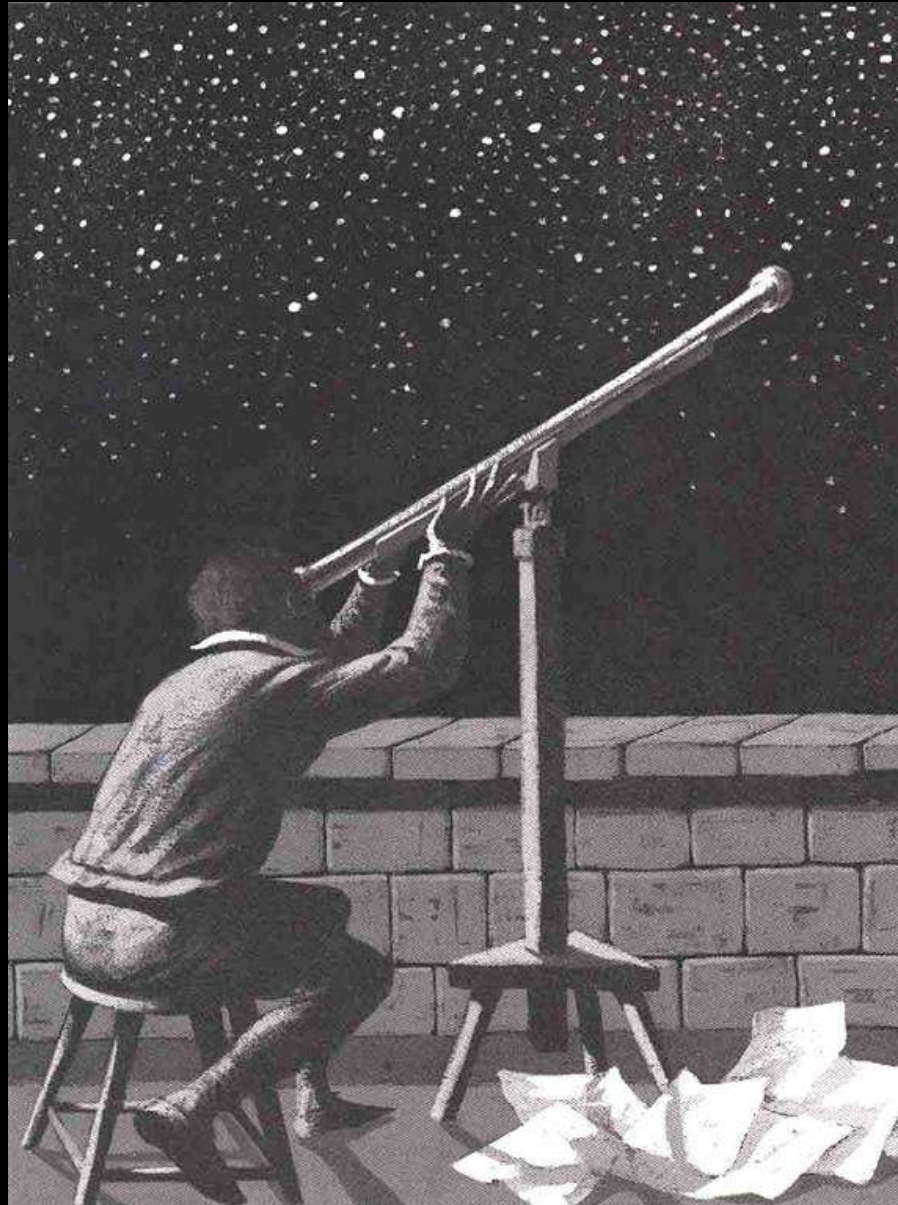
Sondážní rakety 1949 - 1962



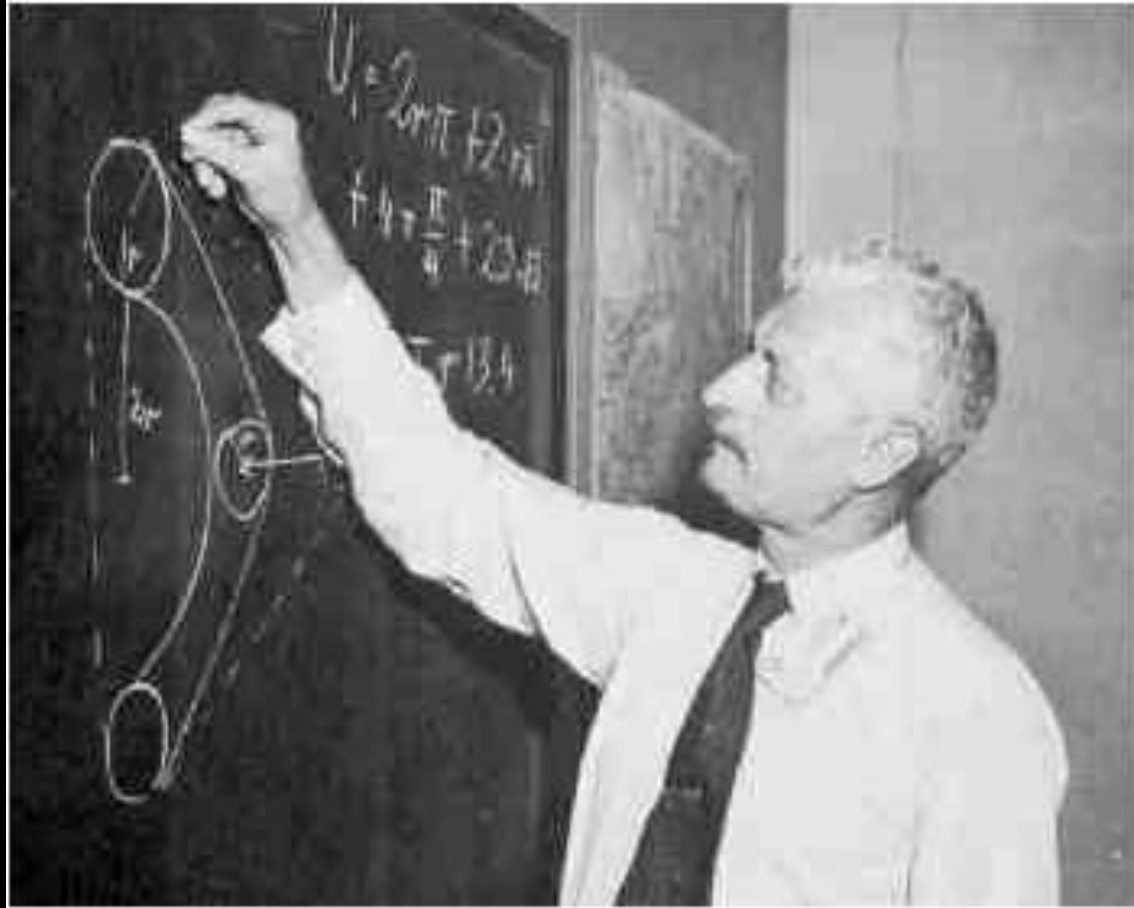
Scorpius X-1.

Ricardo Giacconi.

Stomiliónový skok



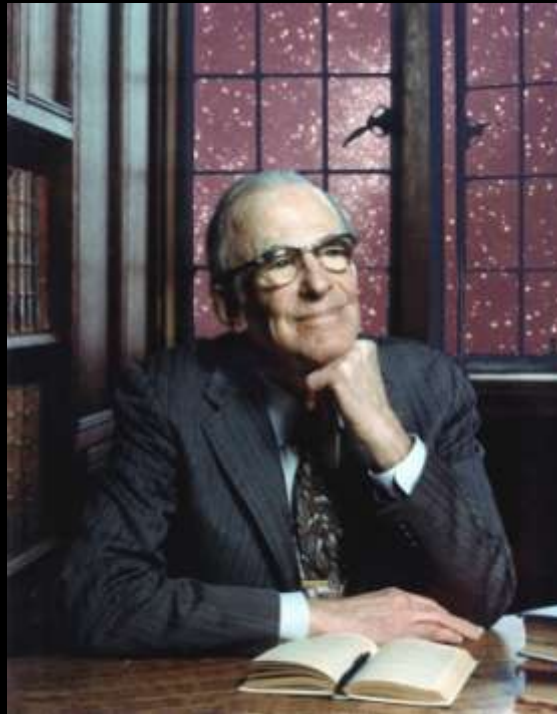
1923 – Hermann Oberth



Die Rakete zu den Planetenräumen

Made in USA

1946 – Lyman Spitzer



Atmosférické jevy, infračervená
a ultrafialová záření.

Kosmická vs. pozemní.

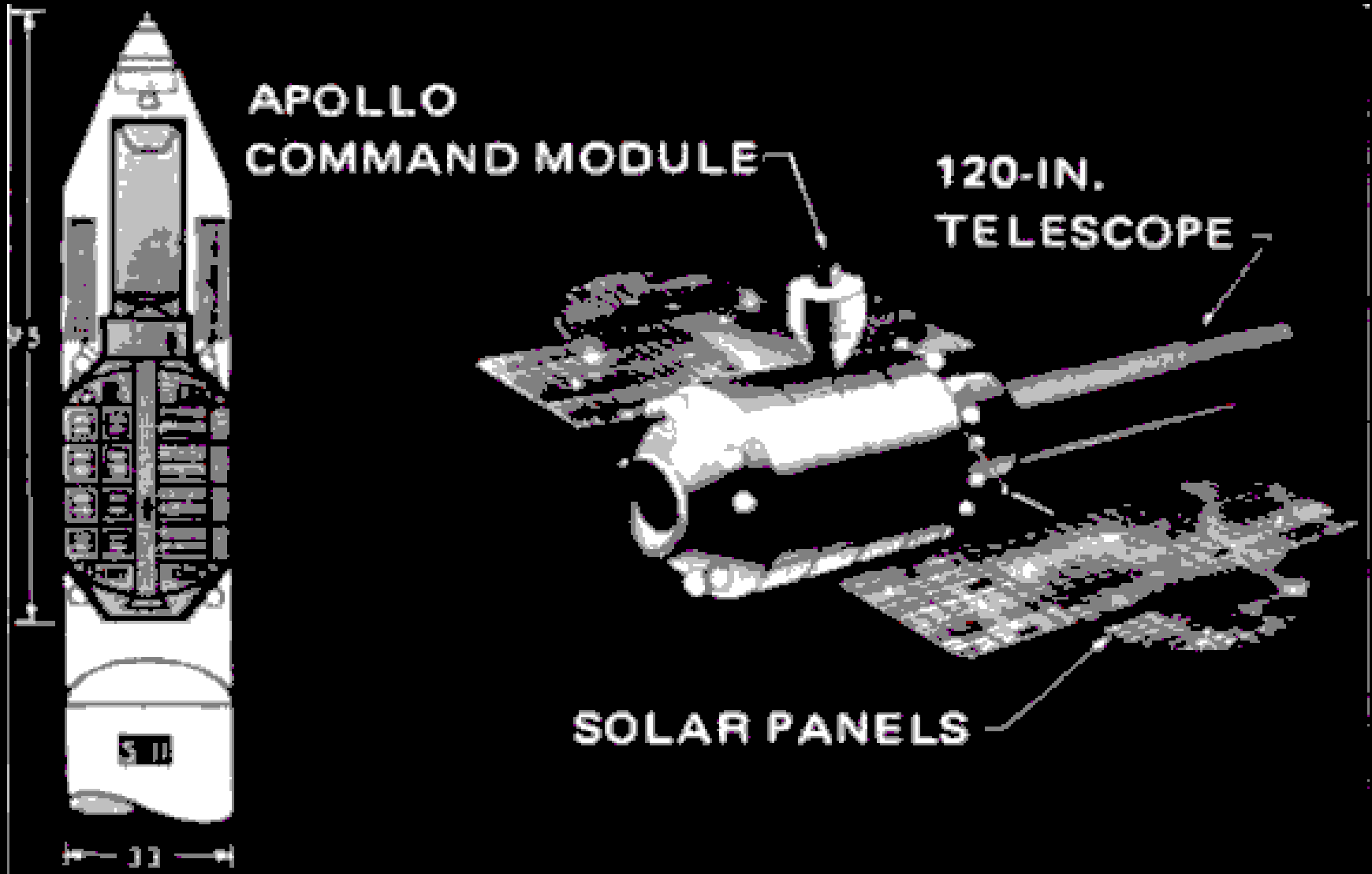
Orbiting Astronomical Observatory



1966 až 72.

OAO-2 ultrafialové (plus Nova Serpentis),
OAO-4/Copernicus – pulzary.

Large Orbiting/Space Telescope (1968)



Einstein (HEAO-2)



První rentgenový dalekohled pro celou oblohu.

Čtyři velké
observatoře



CGRO



HST

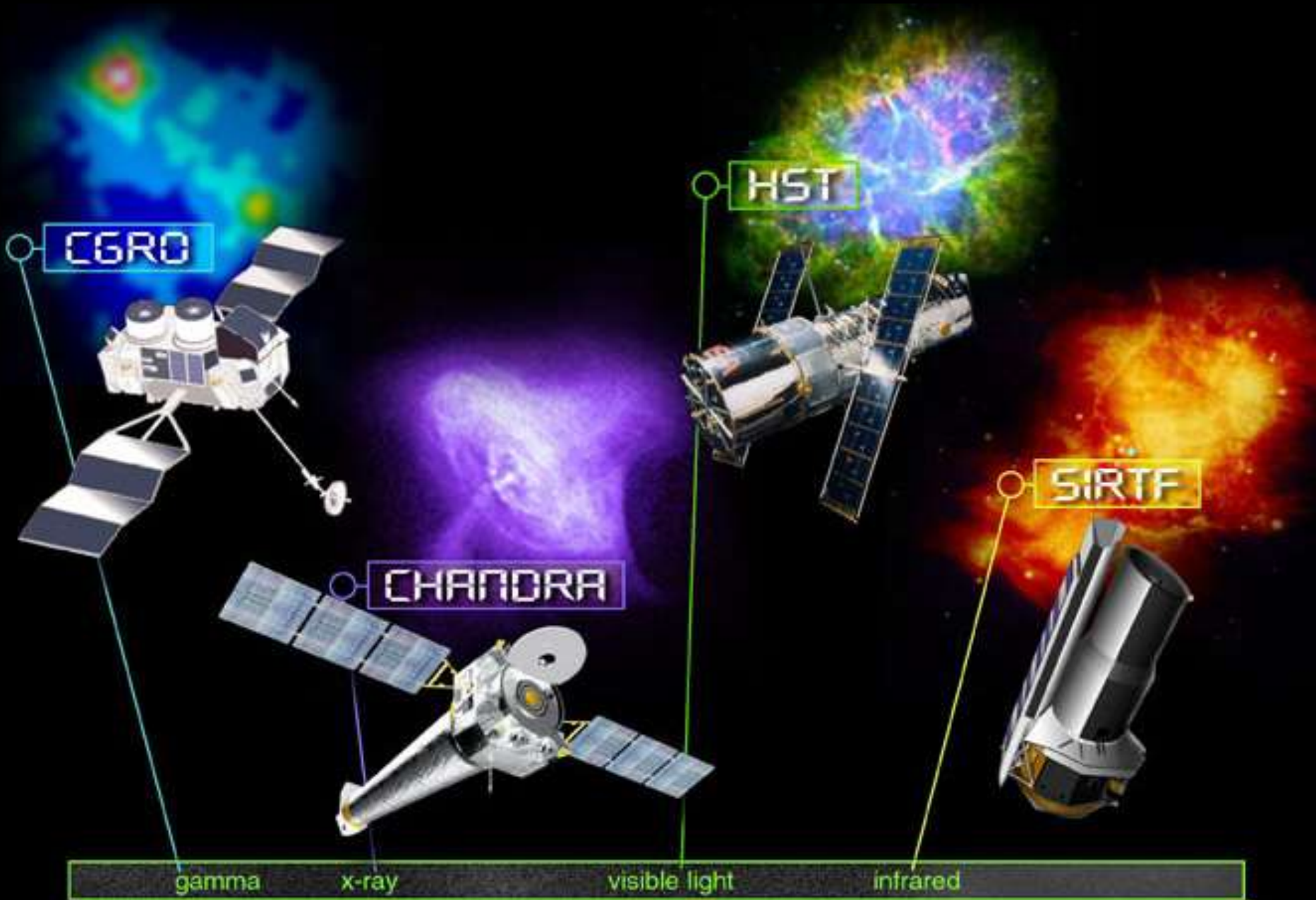


CHANDRA



SIRTF

gamma x-ray visible light infrared



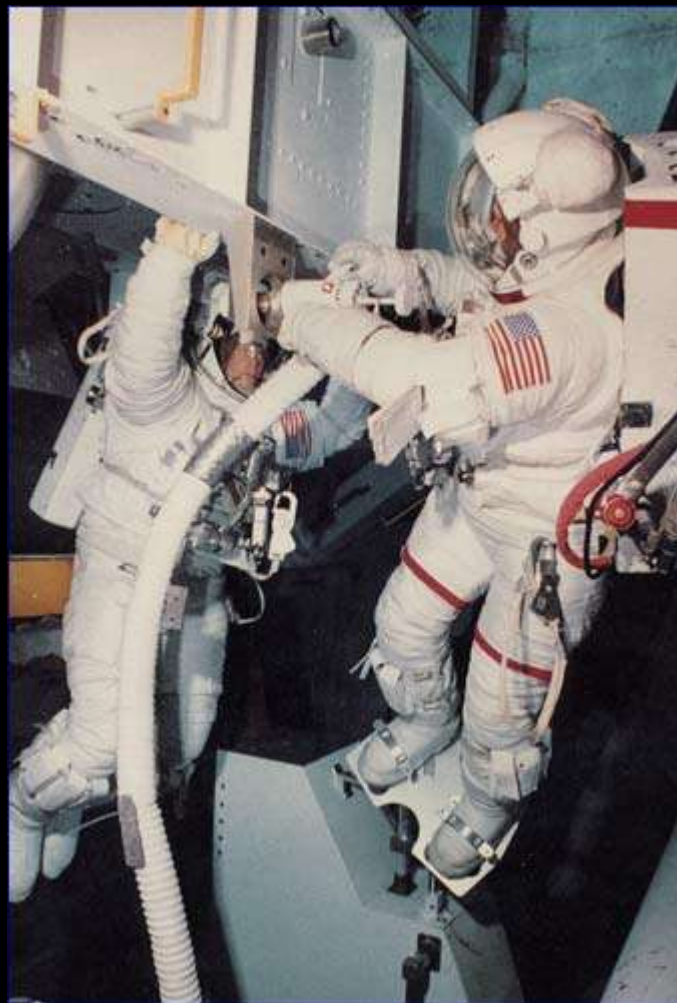
Compton Gamma Ray Observatory





Zmapování pulzarů a zbytků po
supernovách.

Objev zdrojů gama záření na Zemi.



16,5 t.

Tři gyroskopy.

Chandra X-Ray Observatory





1976 – první návrh.

**1992 – redukce (dva z šesti
přístrojů, čtyři z dvanácti
zrcadel, změna dráhy).**

1999 – start, životnost 5 let.

22753 kg (4600 kg) .



Space Infrared Telescope Facility



Spitzer Space Telescope.



Start srpen 2003.



Helioцентриká dráha.

1970: Large Space Telescope



Cassegrainův zrcadlový dalekohled
v Ritchey-Chrétienově uspořádání

Dva výbory ustanoveny (1970).

1974: škrtý, škrtý, škrtý



Na scénu přichází ESA



Menší zrcadlo, zrušení
testovací mise.

1978: práce začínají



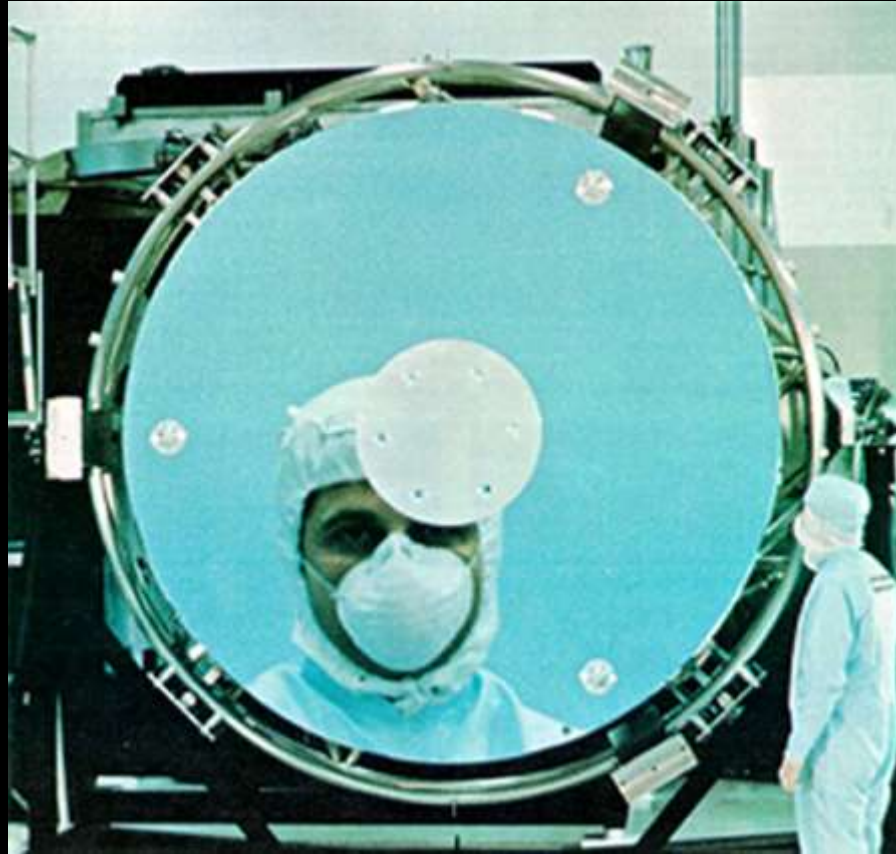
Není optimální pro infračervené –
15 stupňů.

Příběh tří zrcadel



Perkin-Elmer, Kodak, Itek.

Finální zrcadlo



Dvakrát 2,5 cm, plástev, odrazová vrstva hliníku 75 nm, fluorid hořčíku 25 nm (ochrana, ultrafialové spektrum).

Cena



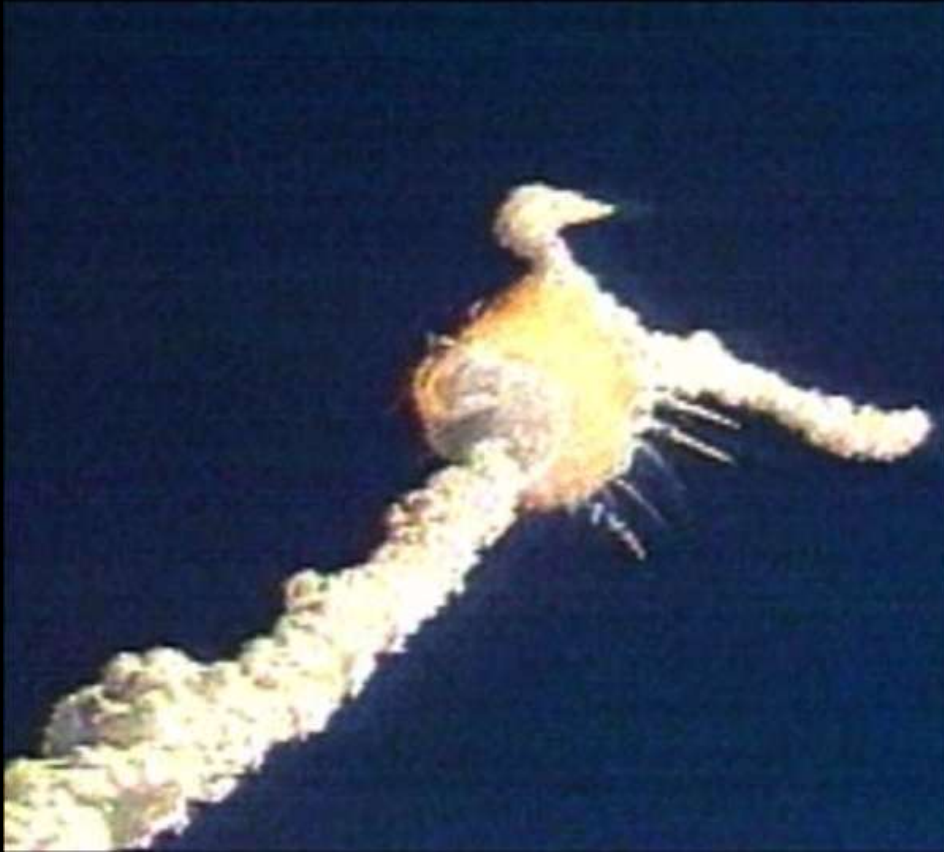
Plán 400 mil. USD.

Do roku 1986 1,175 mld. USD.

V roce 1990 uváděno 2,5 mld. USD.

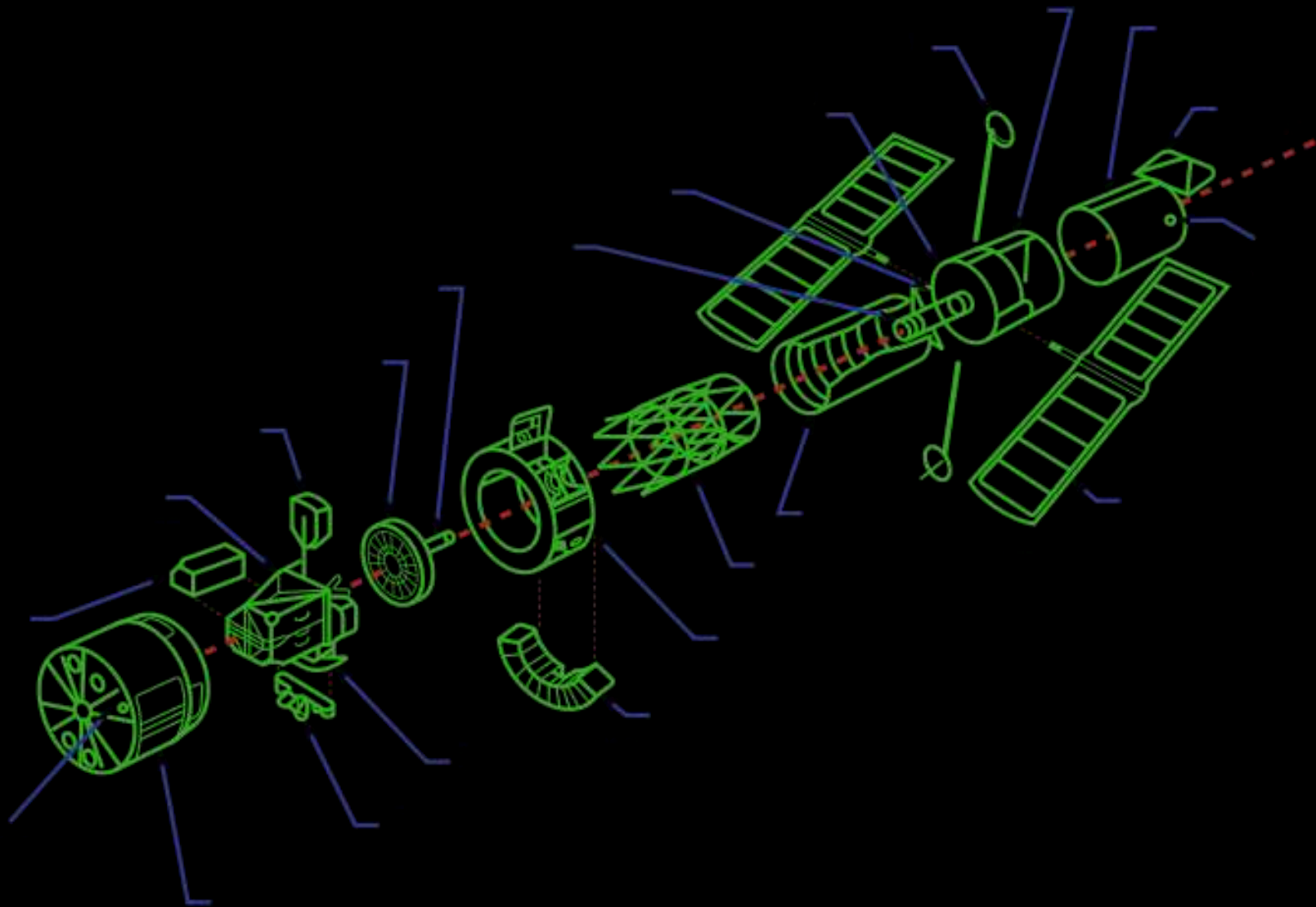
Dosud 6 až 8 mld. USD.

Plán startu srpen 1986



24. duben 1990





Omezení



Nestabilní oběžná dráha, nesmí se pozorovat blízko Slunce, Jihoatlantická anomálie.

Houston, máme problém



Sférická aberace – příliš ploché zrcadlo
(na krajích plošší o 2,2 mikronu).

Možnosti řešení



Corrective Optics Space Telescope Axial Replacement - COSTAR (obětován fotometr HSP).



Wide Field Planetary Camera 1

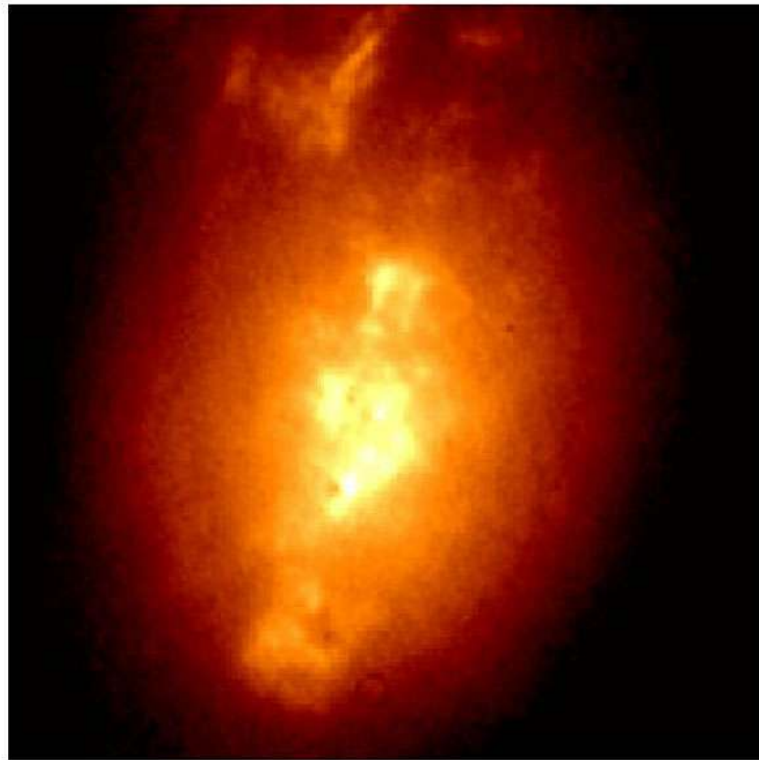


Wide Field Planetary Camera 2

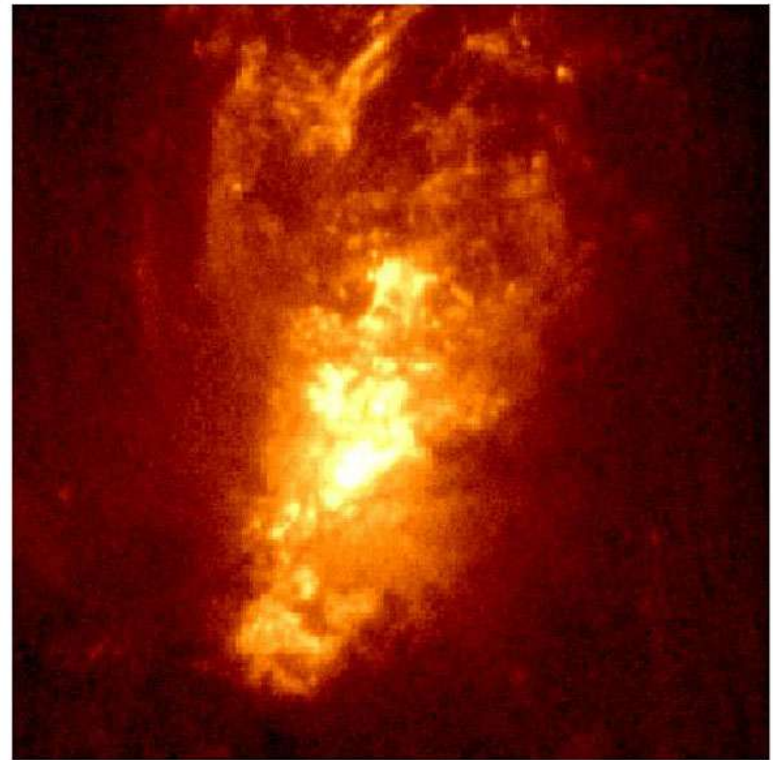
The Central Region of the Active Galaxy NGC 1068

Hubble Space Telescope

Faint Object Camera



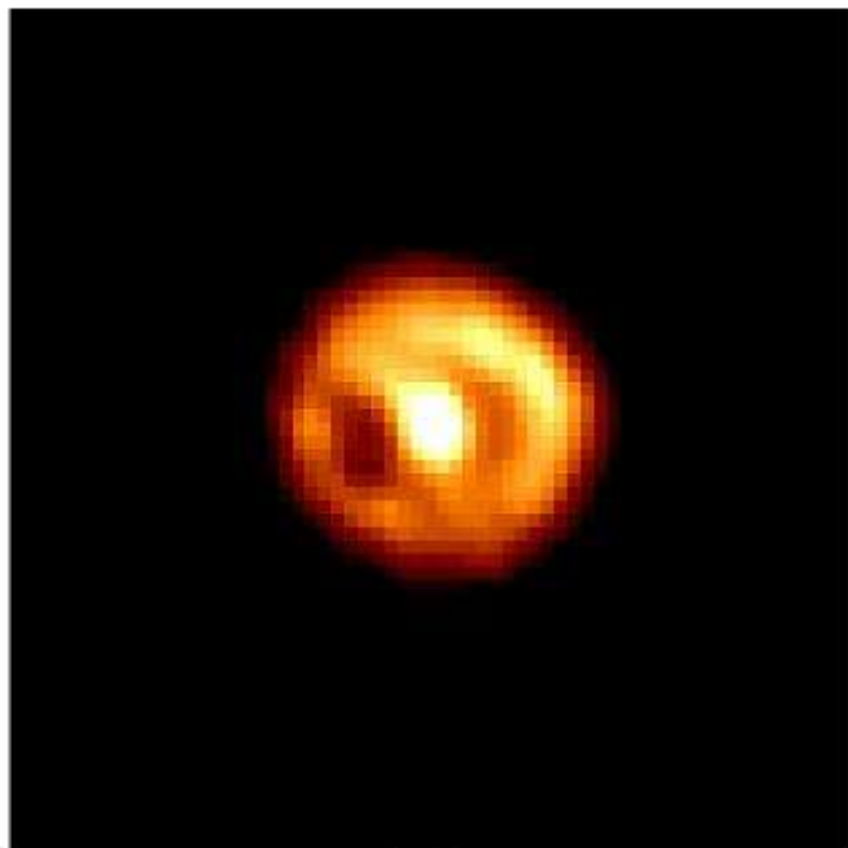
Pre-COSTAR



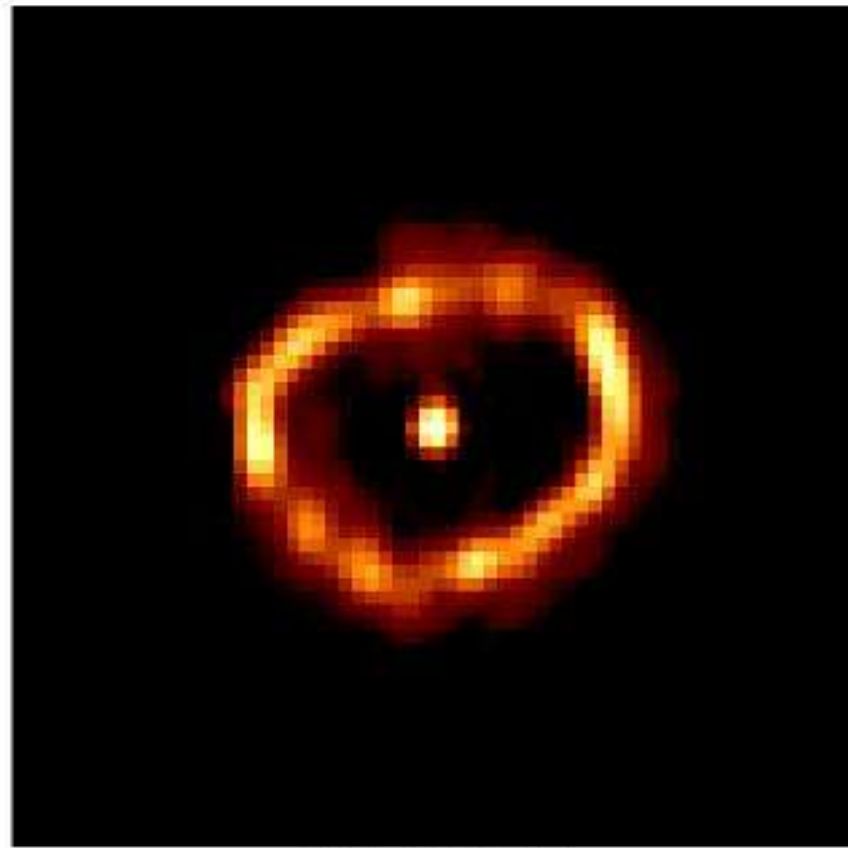
With COSTAR

Nova Cygni 1992

Hubble Space Telescope
Faint Object Camera



Pre-COSTAR
Raw Image



With COSTAR
Raw Image

Plány na SM-4 a návrat



Umíráček nad teleskopem

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GROUND TO MACHINE
SOUNDPOOL

DJ RICHARD HINGE

AND OTHER COSMIC SPINNERS

PLANETARIUM ON SITE

ACTUAL 10 FOOT DOME!

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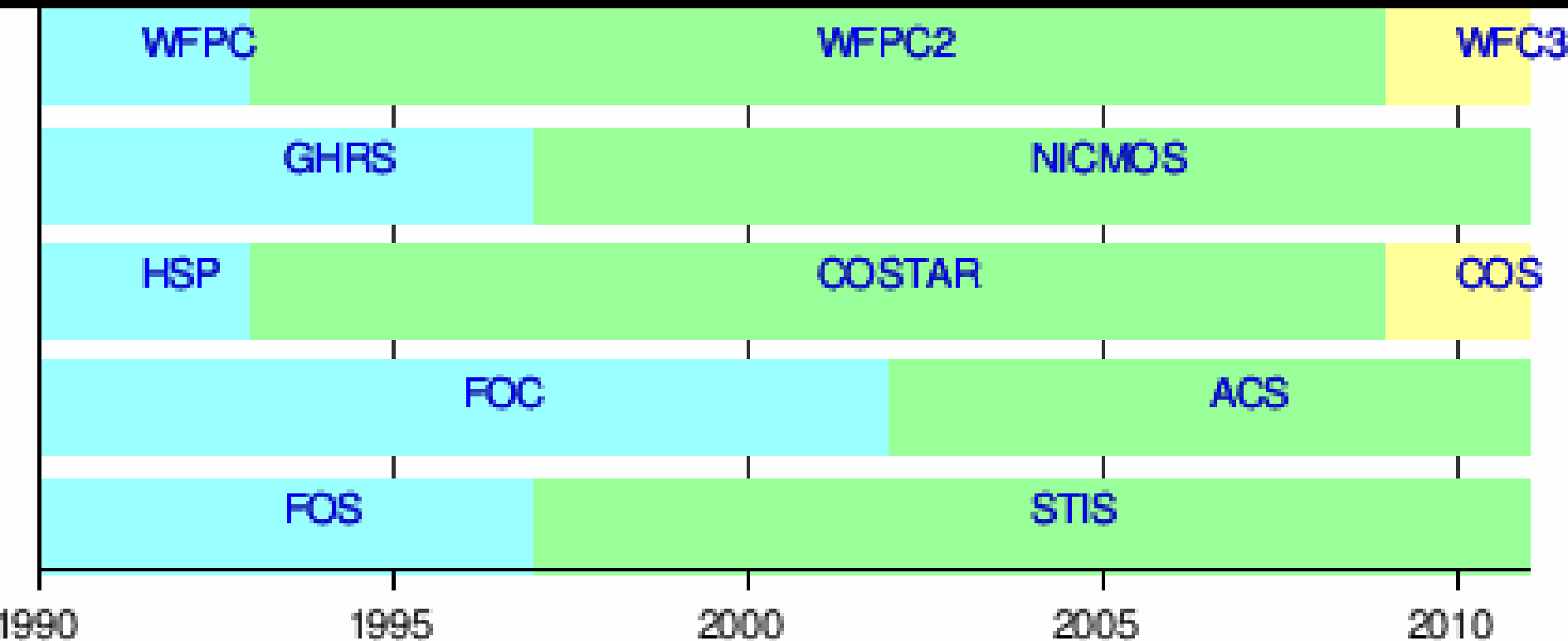
Robotická mise



Nové koště dobře mete



Jak šel čas...



Evropská astronomie

Hipparcos

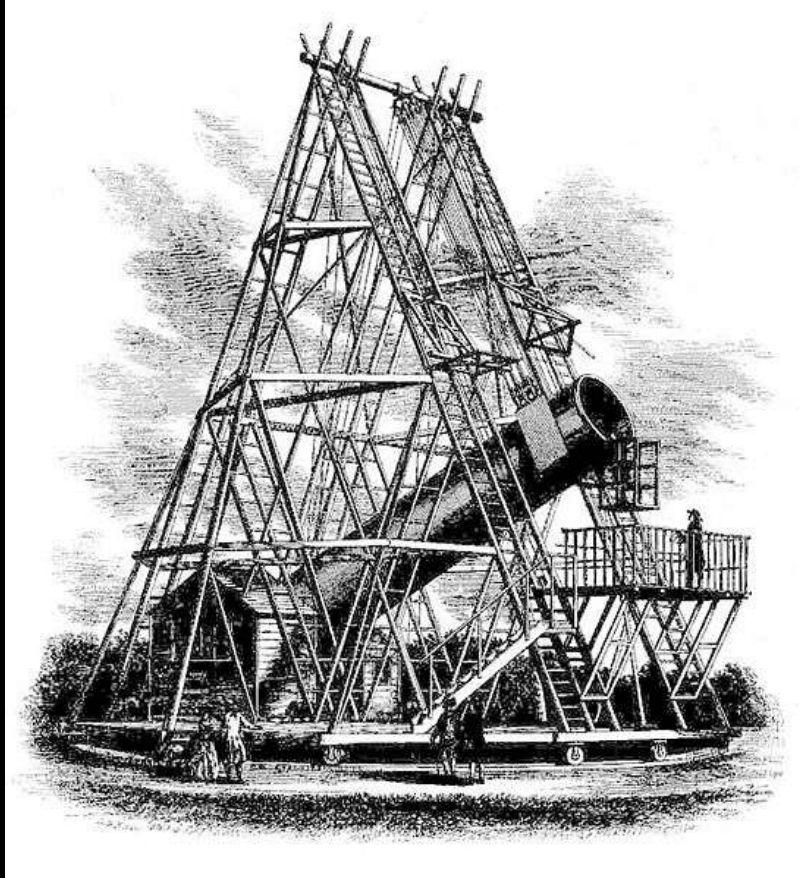


Astrometrie: určování paralaxy.

Herschel



14. května 2009 (3,5 m, infračervené).

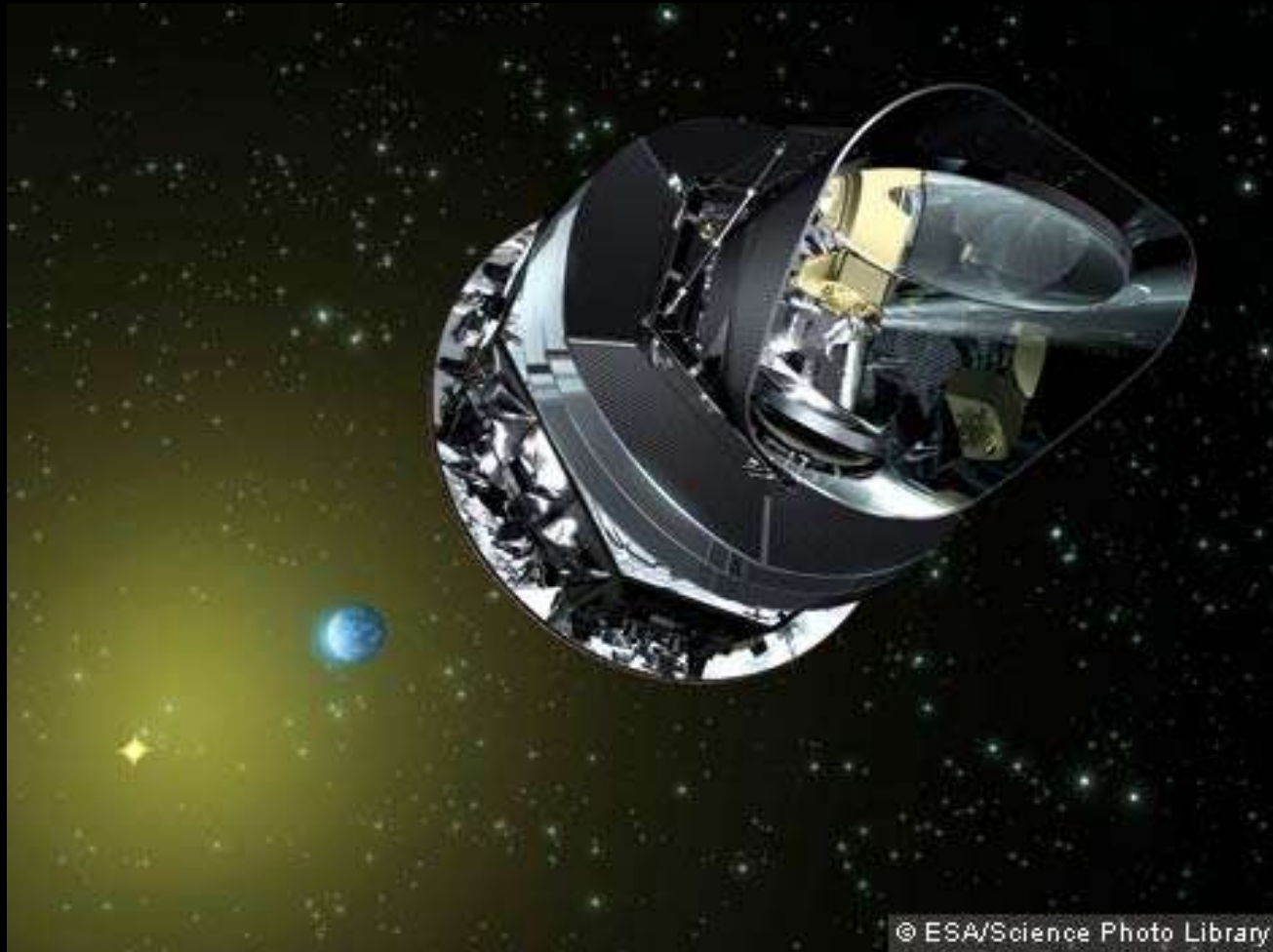


2000 litrů tekutého
hélia (0,3 K).

Studium tvorby
galaxií, chemické
složení blízkých
chladných objektů
(kometry, hnědí
trpaslíci), studium
atmosféry planet a
mezihvězdné hmoty.

Kolem L2.

Planck



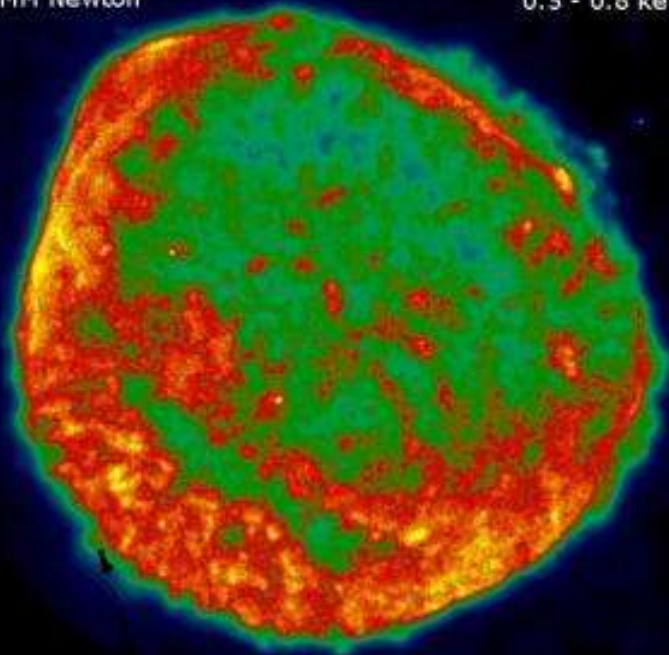
Ověření teorií raného vesmíru a původu kosmických struktur.

XMM Newton



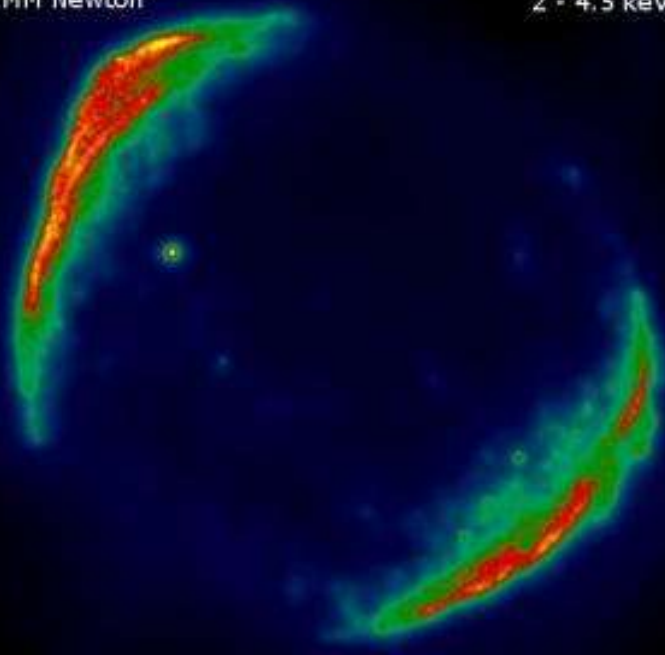
XMM Newton

0.5 - 0.8 keV



XMM Newton

2 - 4.5 keV



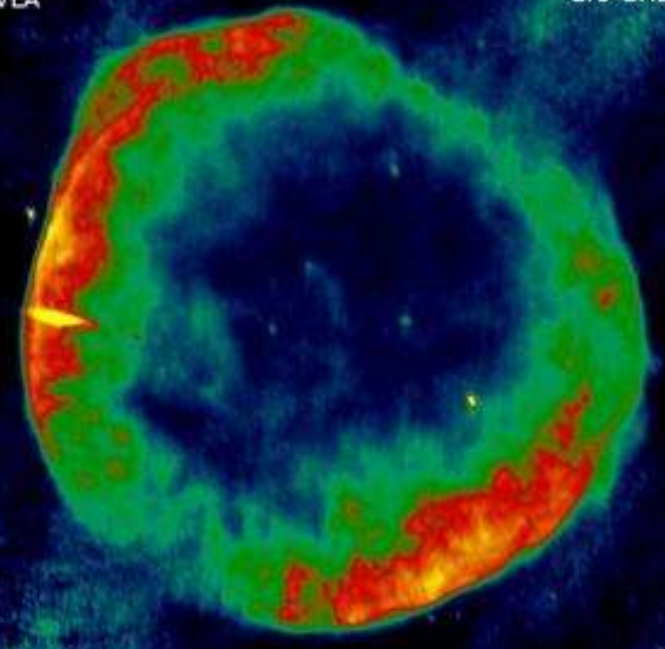
XMM Newton

SN 1006

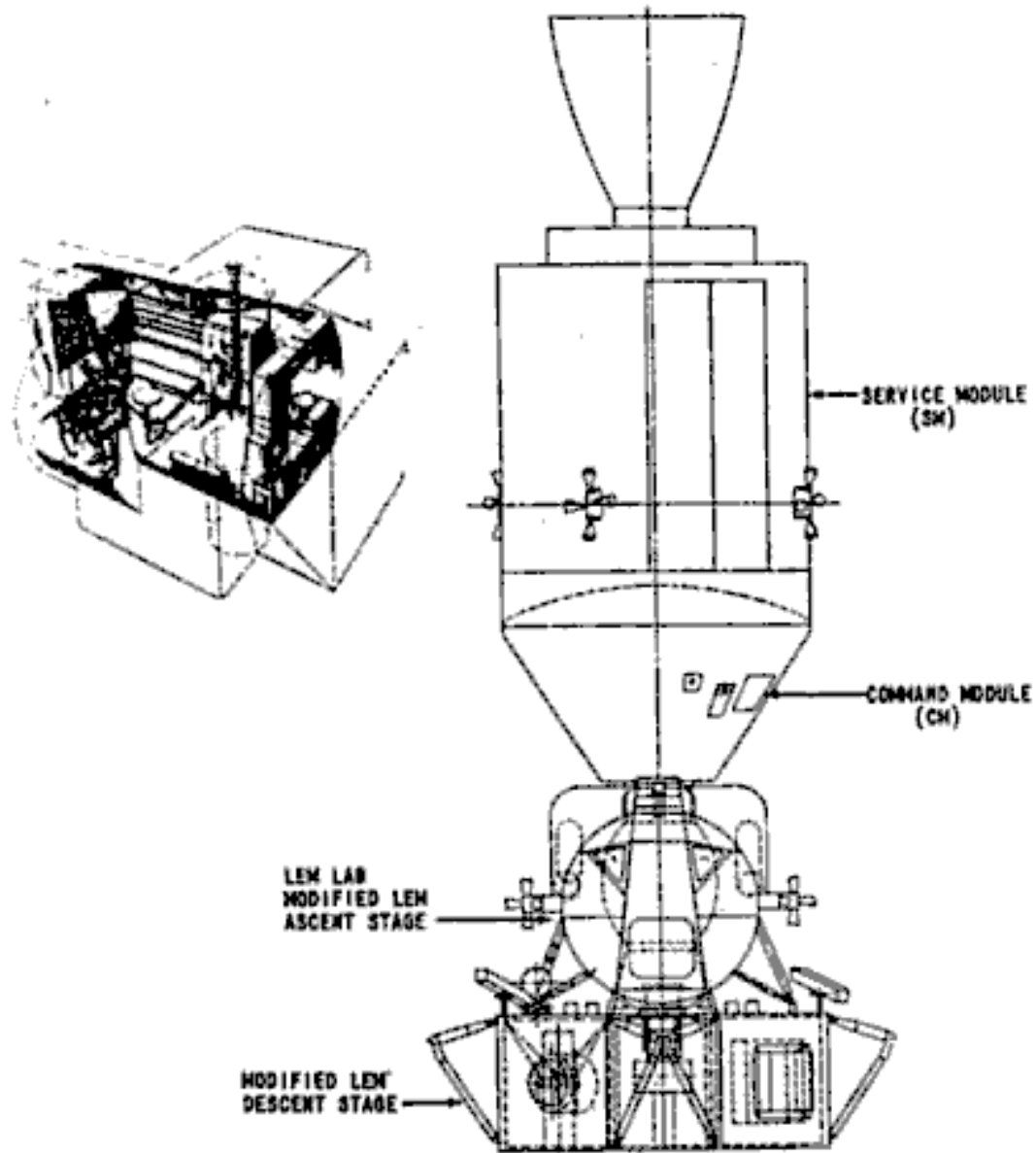


VLA

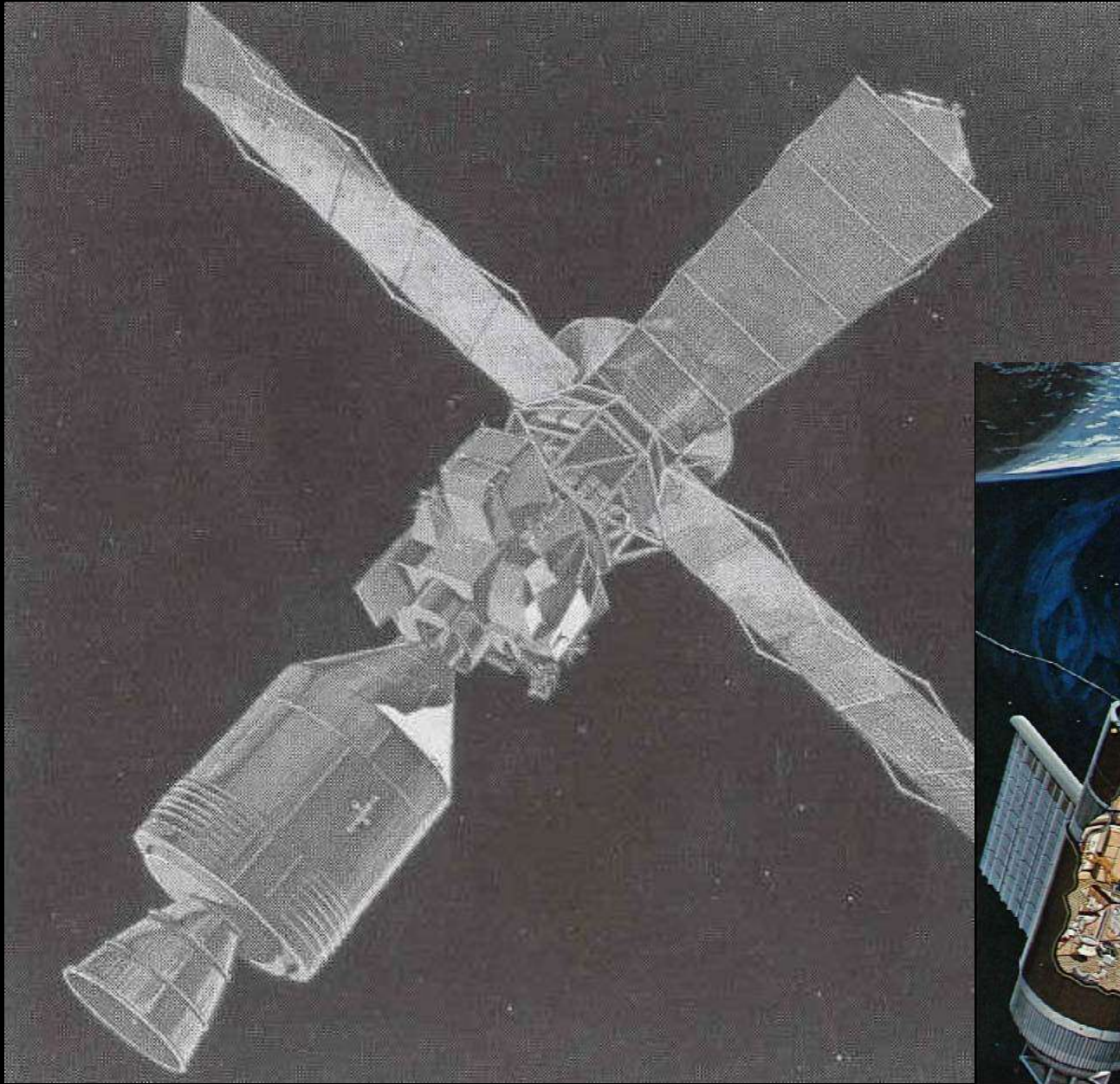
1.5 GHz



Kosmické stanice



APOLLO SPACECRAFT FOR ORBITAL MISSIONS



Skylab

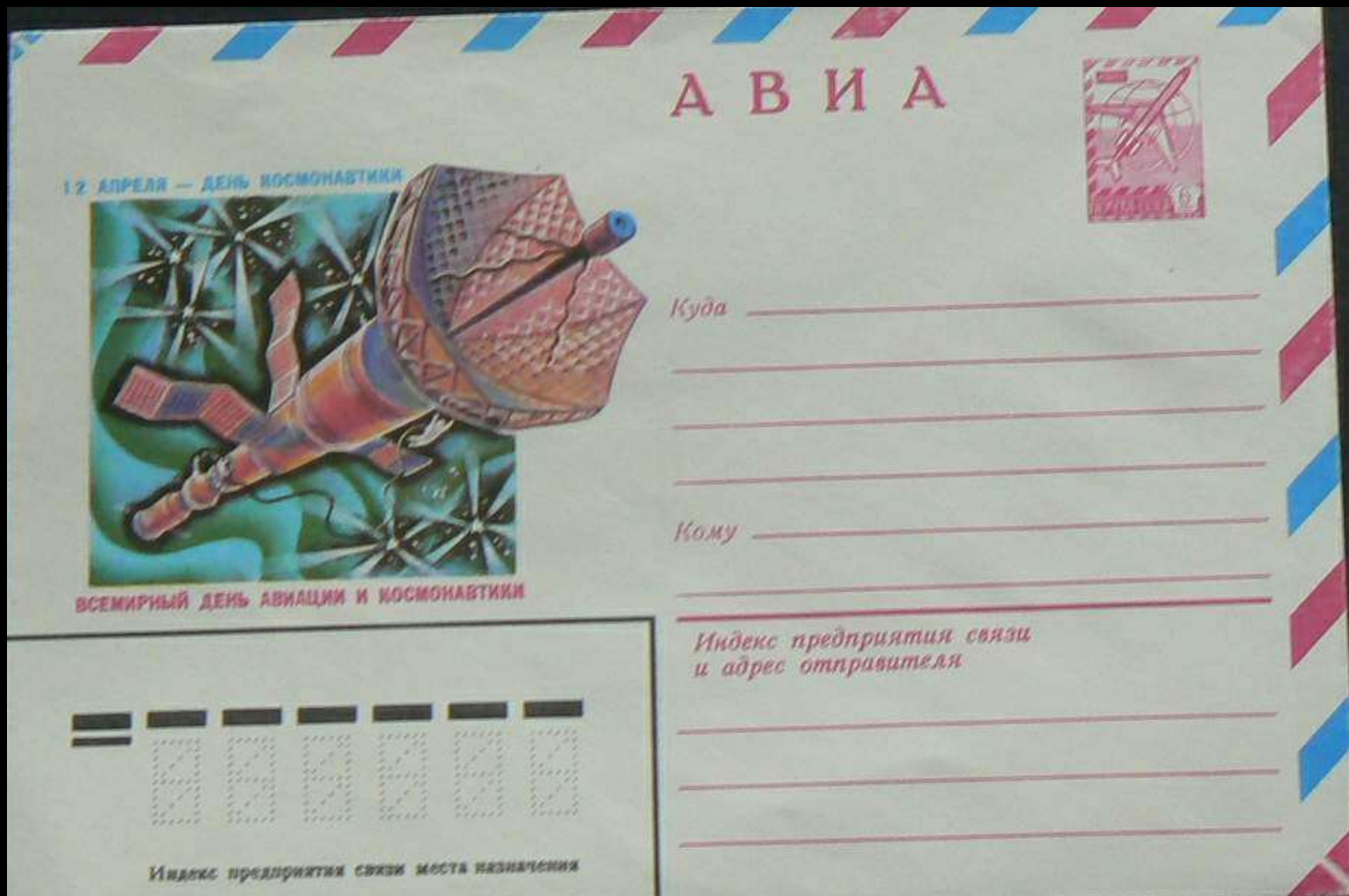


Saljut



1,5 m zrcadlo BST-1M.

KRT-10



Mapování pulsaru PSR 0329 + 24

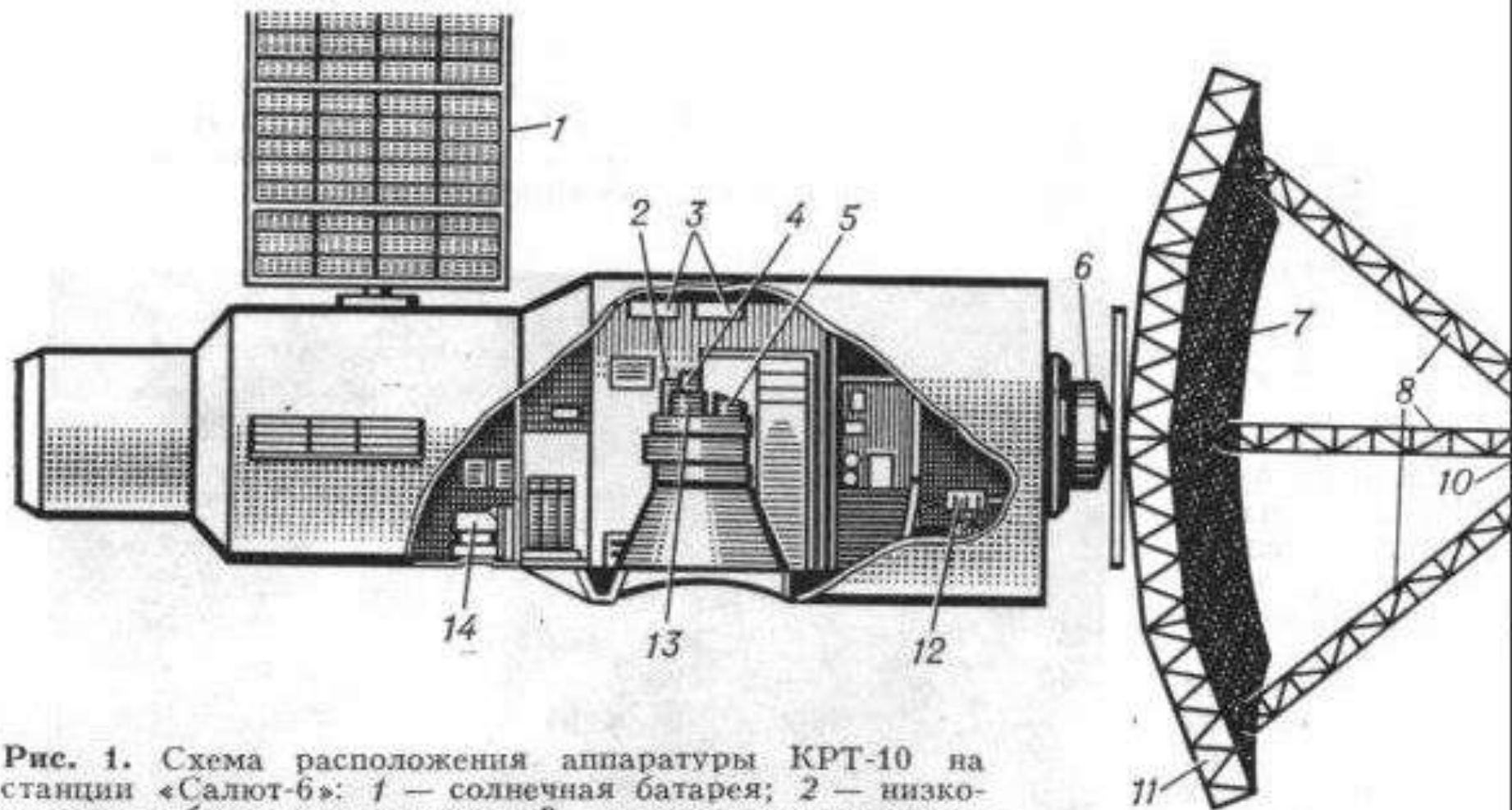
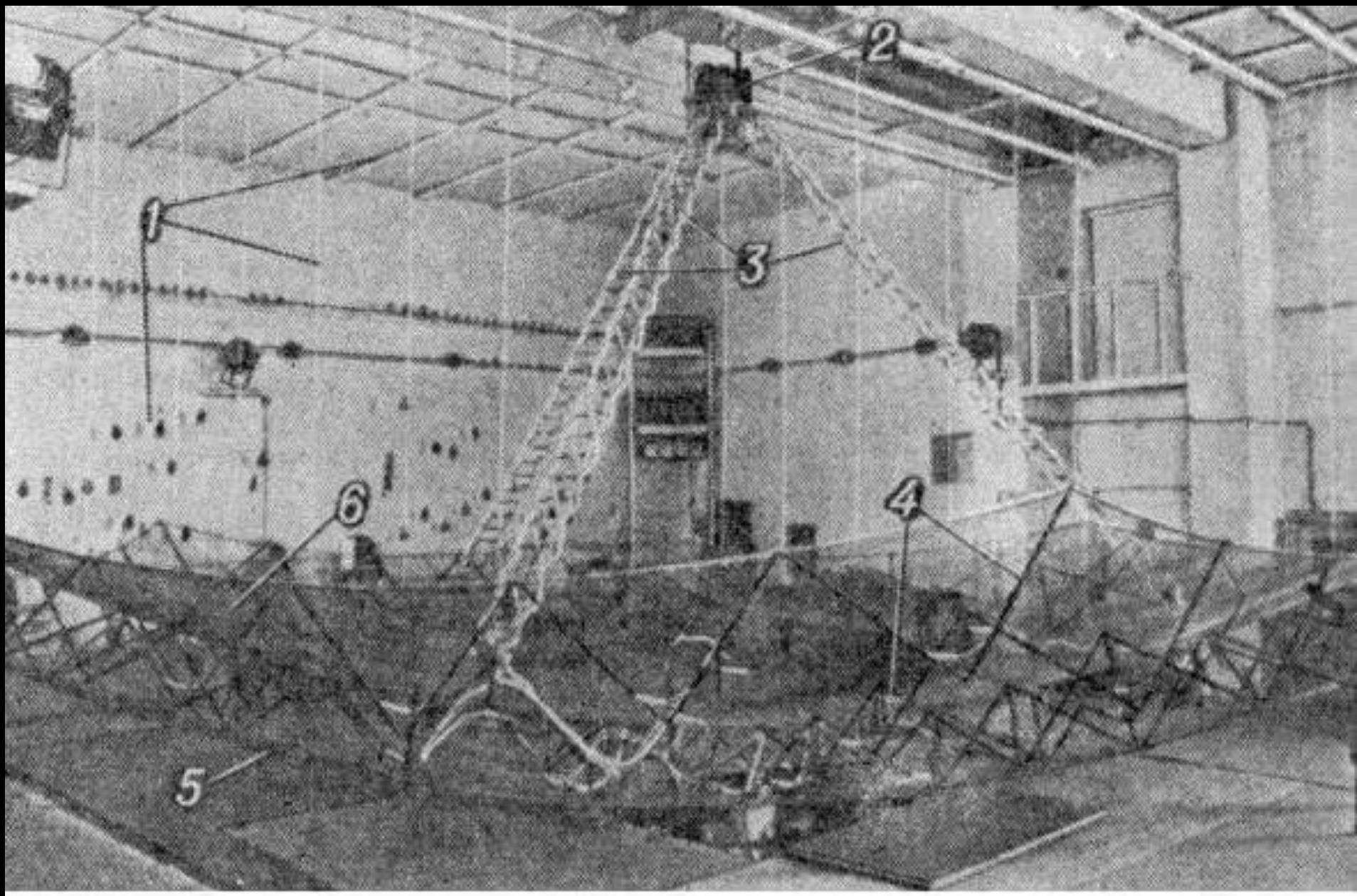
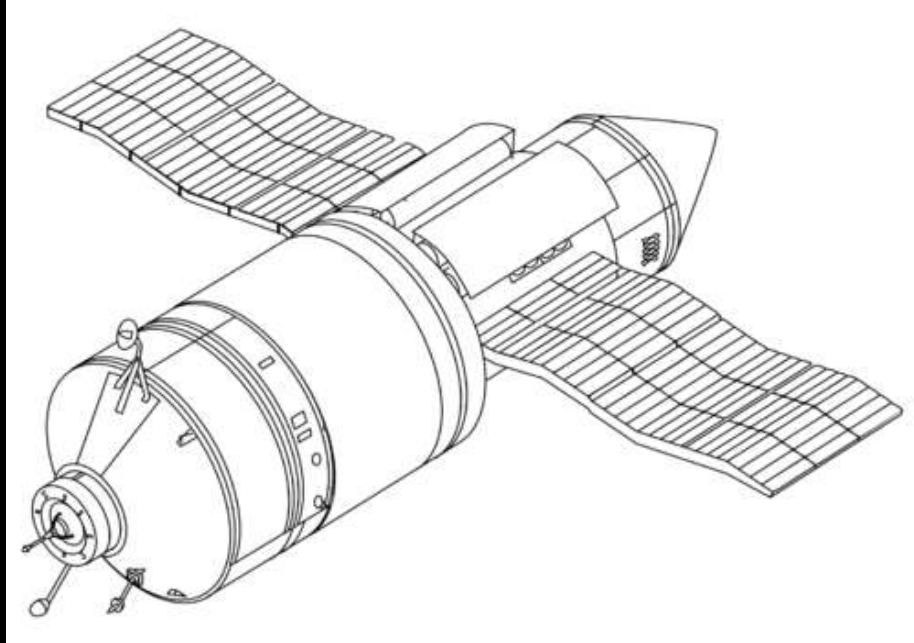


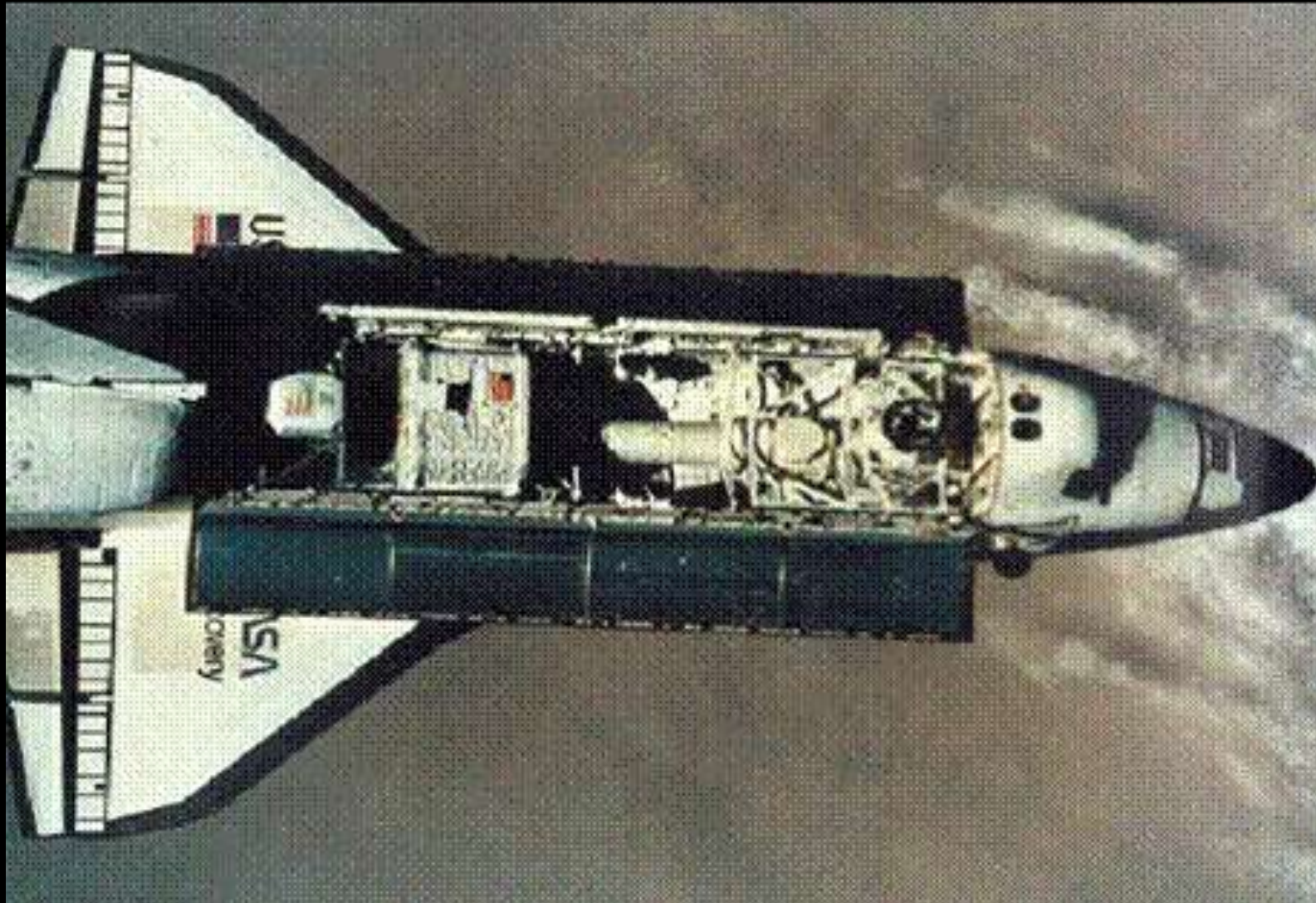
Рис. 1. Схема расположения аппаратуры КРТ-10 на станции «Салют-6»: 1 — солнечная батарея; 2 — низкочастотные блоки радиометров; 3 — аппаратура регистрации; 4 — пульт управления отделением антенны; 5 — пульт управления КРТ-10; 6 — механизм крепления антенны к станции; 7 — отражающее трикотажное сетеполотно; 8 — оры с кабелями; 9 — фокальный контейнер; 10 — облучатели; 11 — каркас зеркала; 12 — механизм отвода кабелей; 13 — блок времени; 14 — астроориентатор.



Kvant

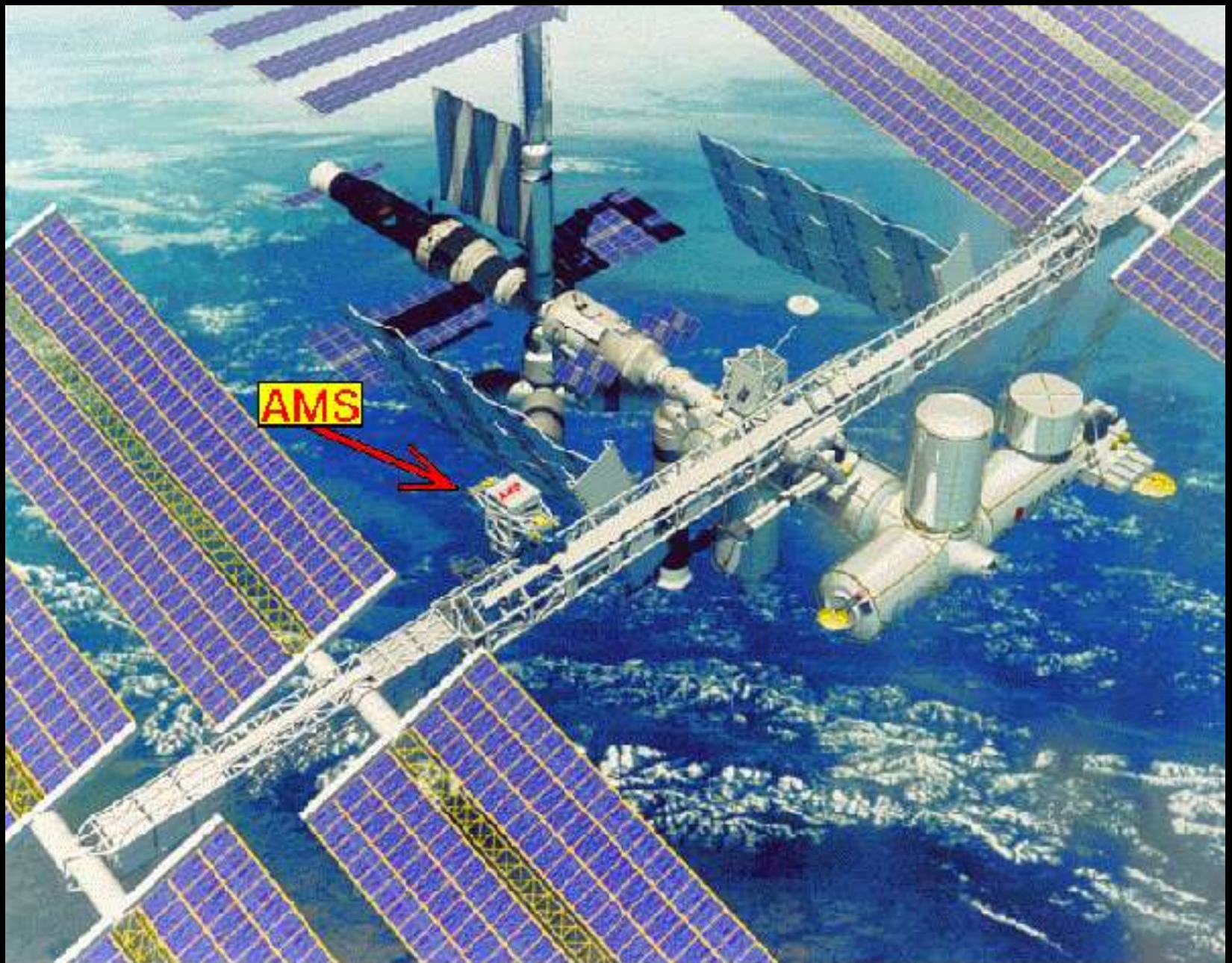


AMS-01 (Alpha Mass Spectrometer); Samuel Ting



AMS-02



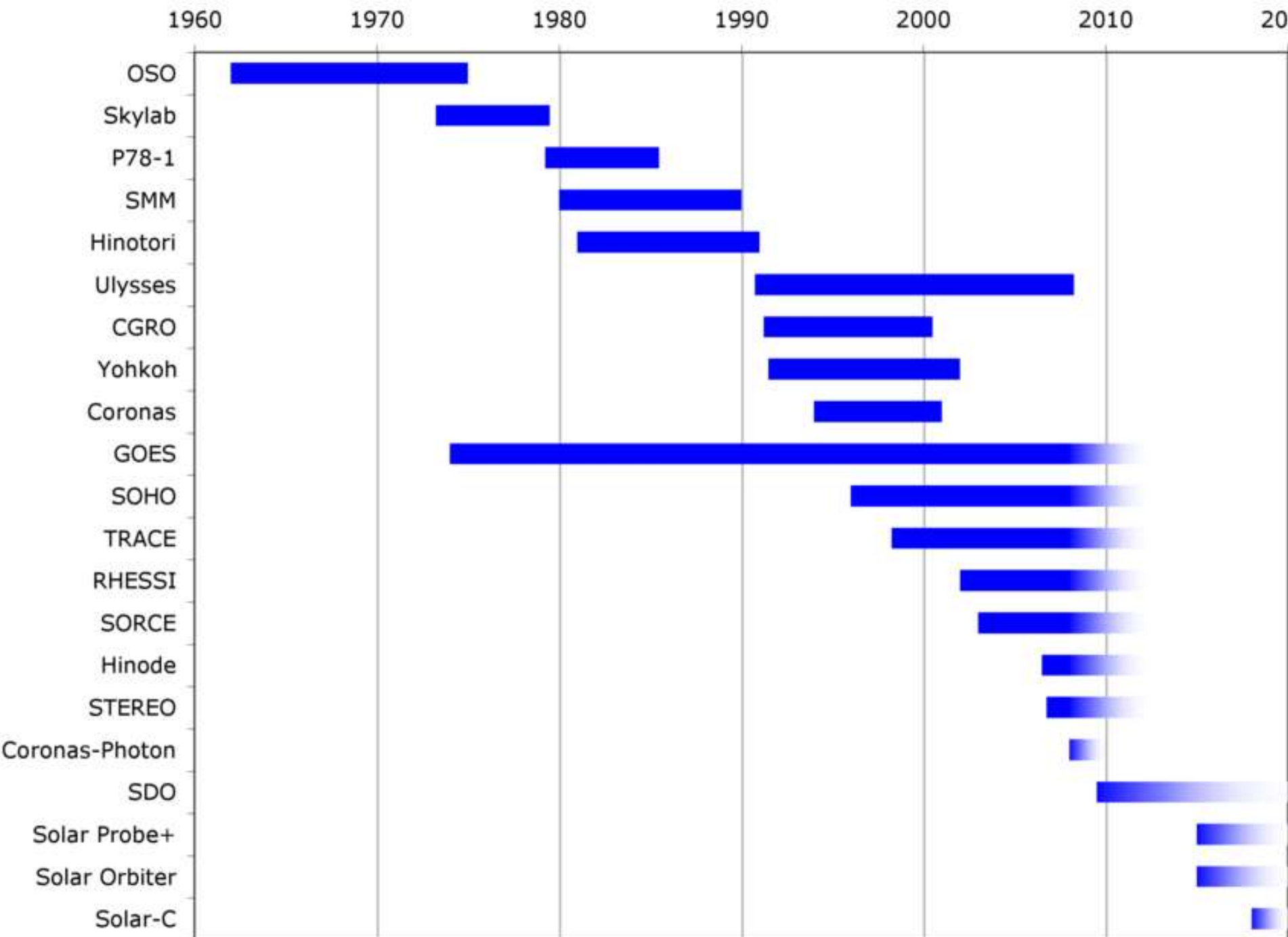


A views of AMS mounted on the International Space Station

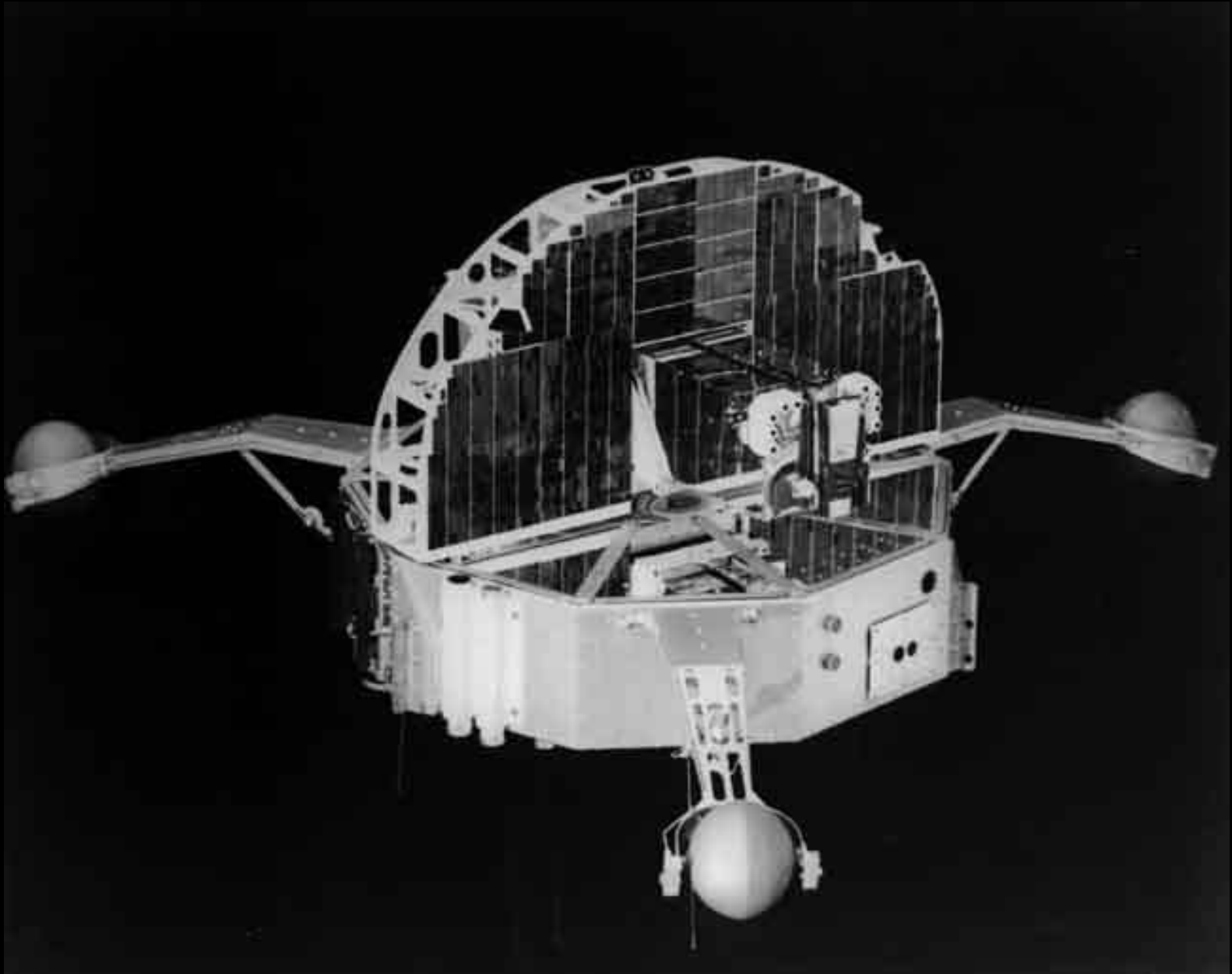




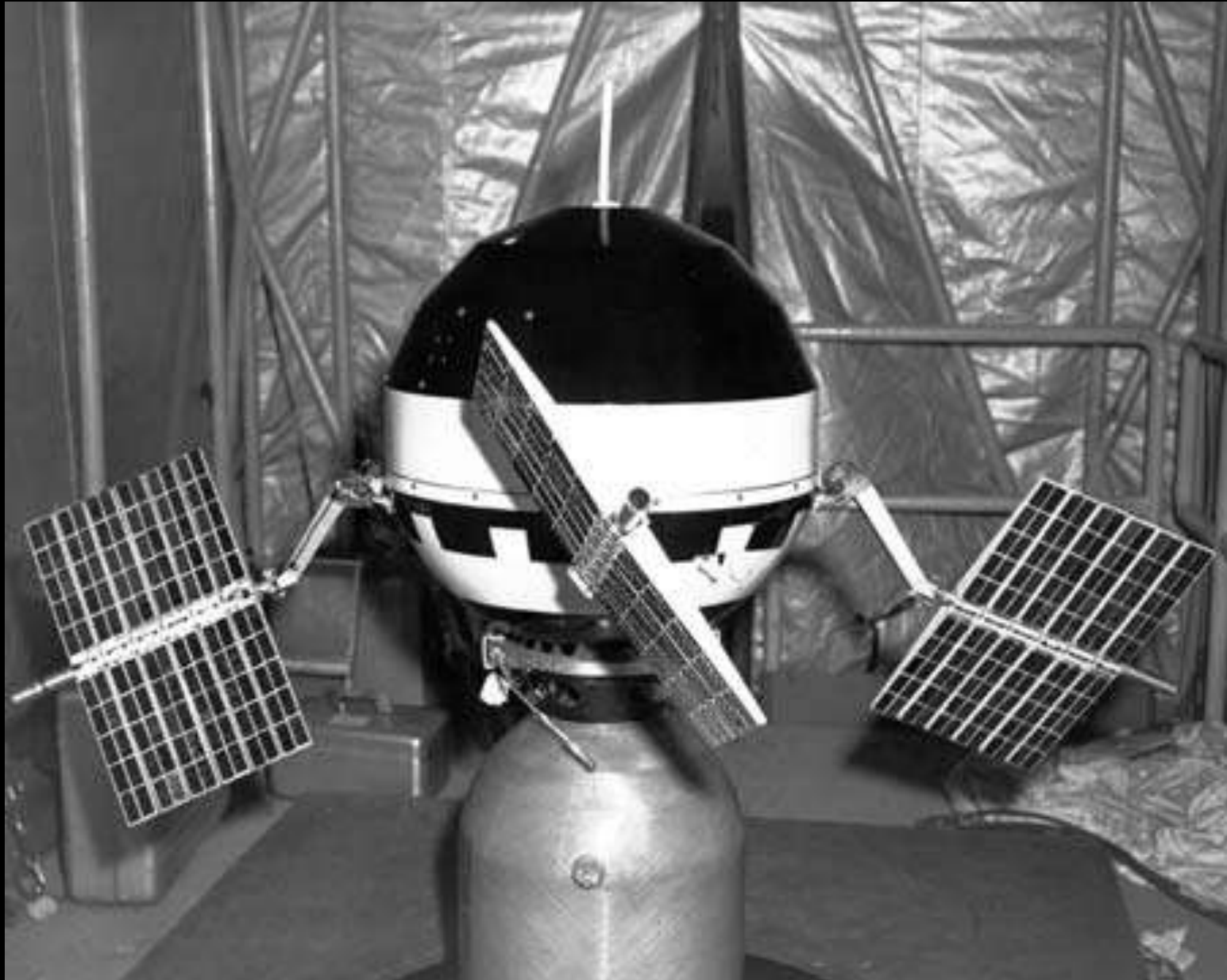
Sluneční sondy



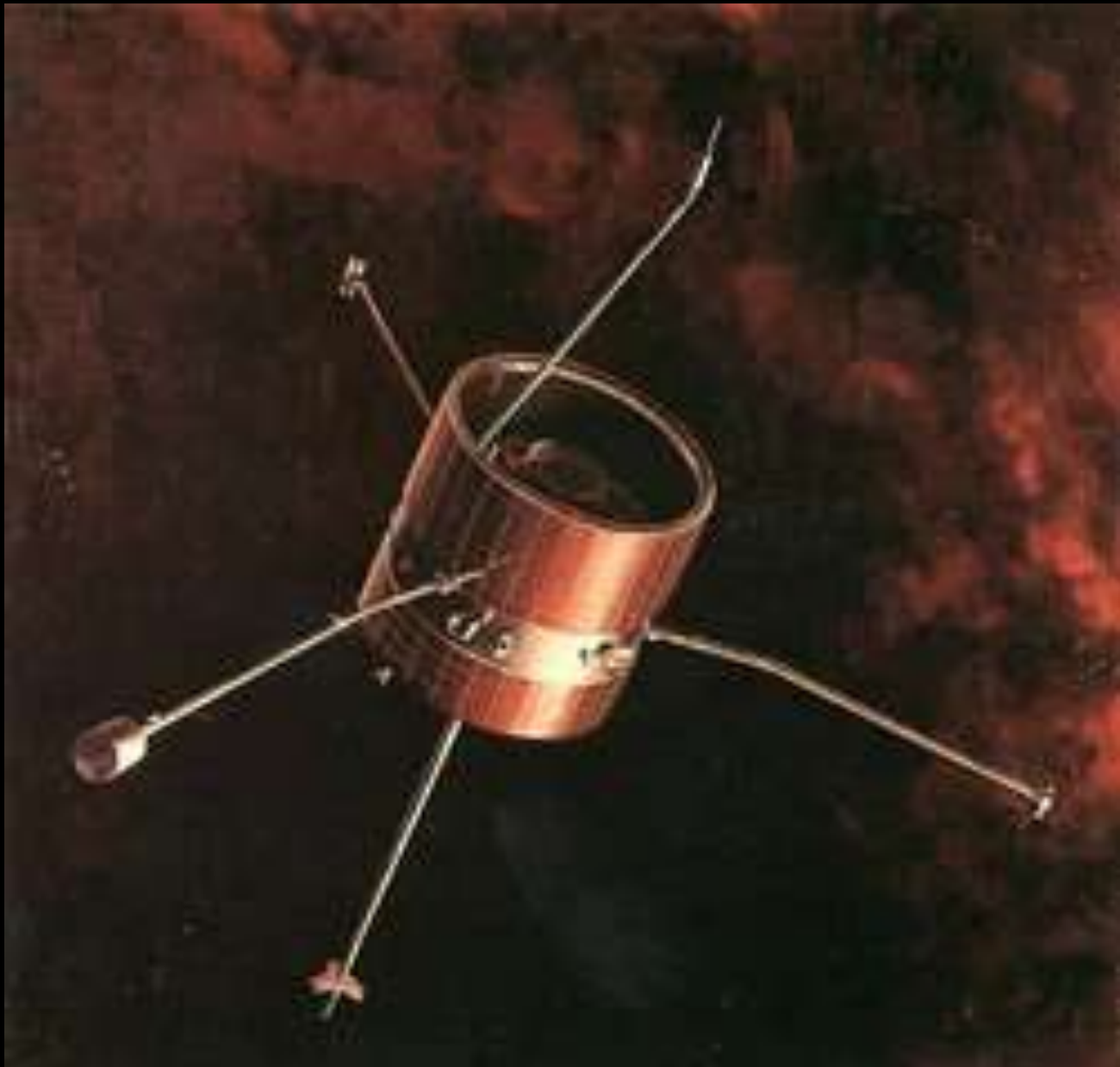
OSO - Orbiting Solar Observatory



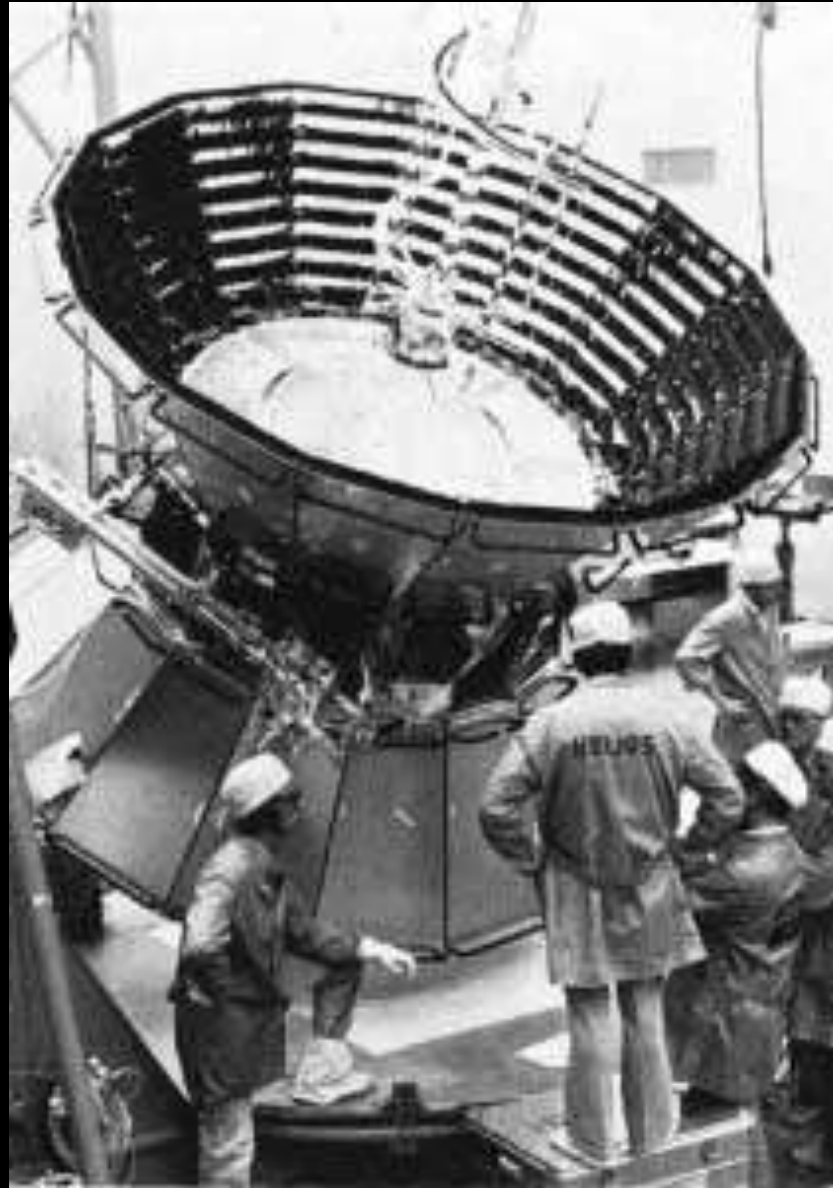
Pioneer-5



Pioneer-6 až -9



Helios-A a -B



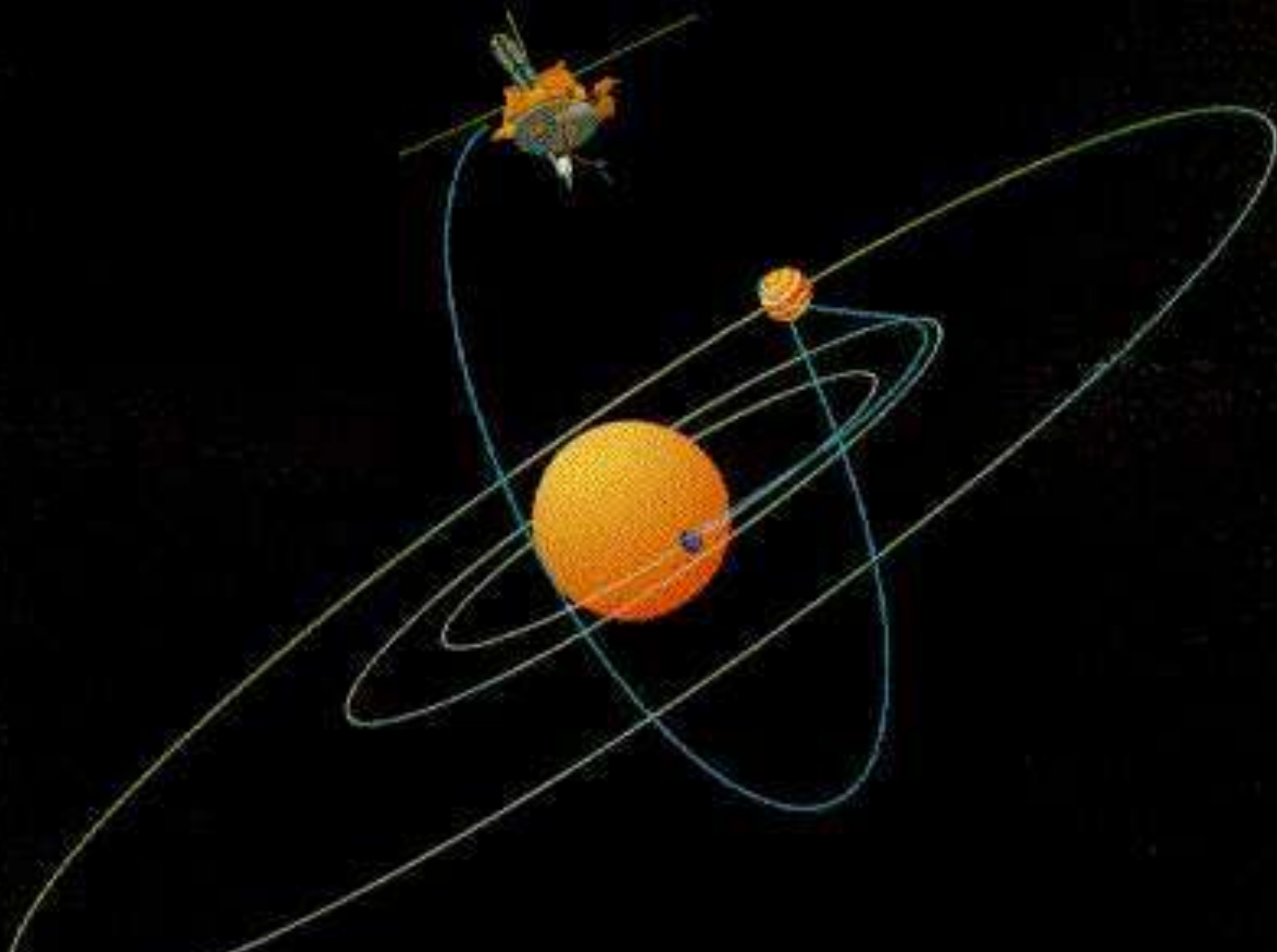
Sluneční odysea







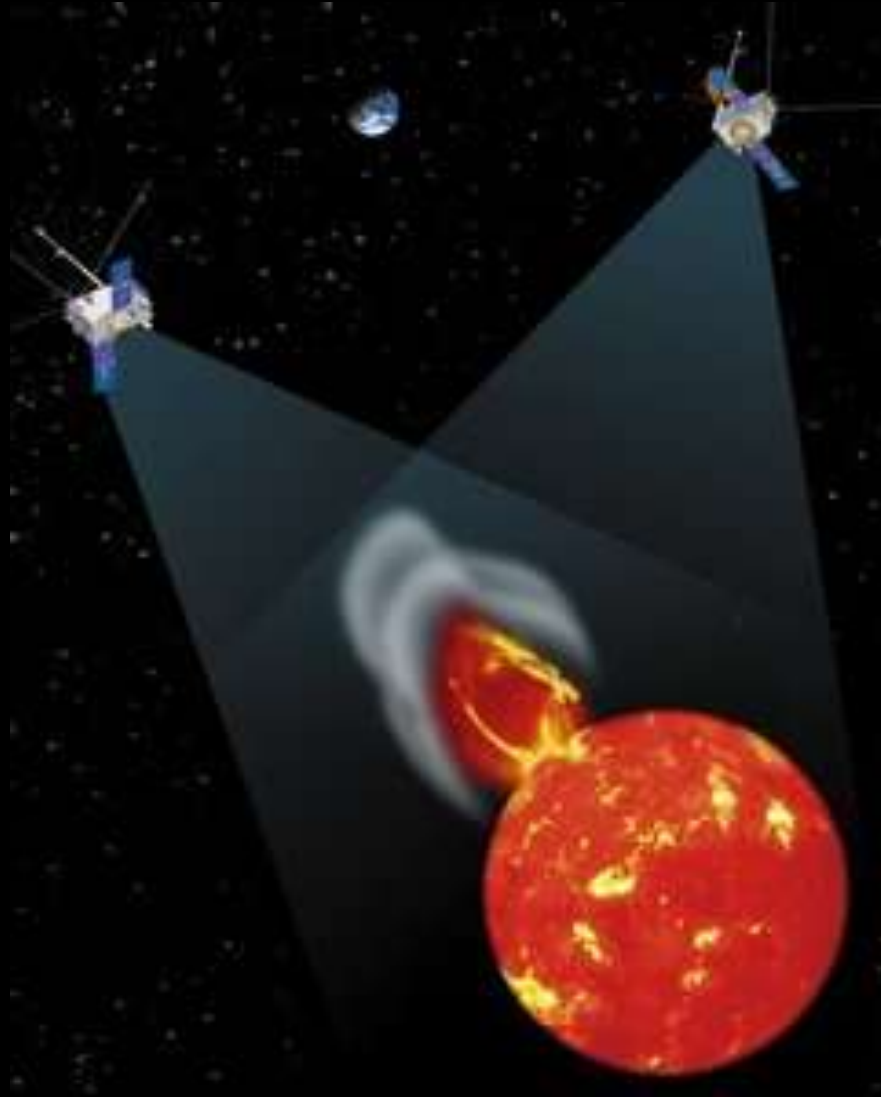




Genesis



STEREO-A a -B



Lovci exoplanet

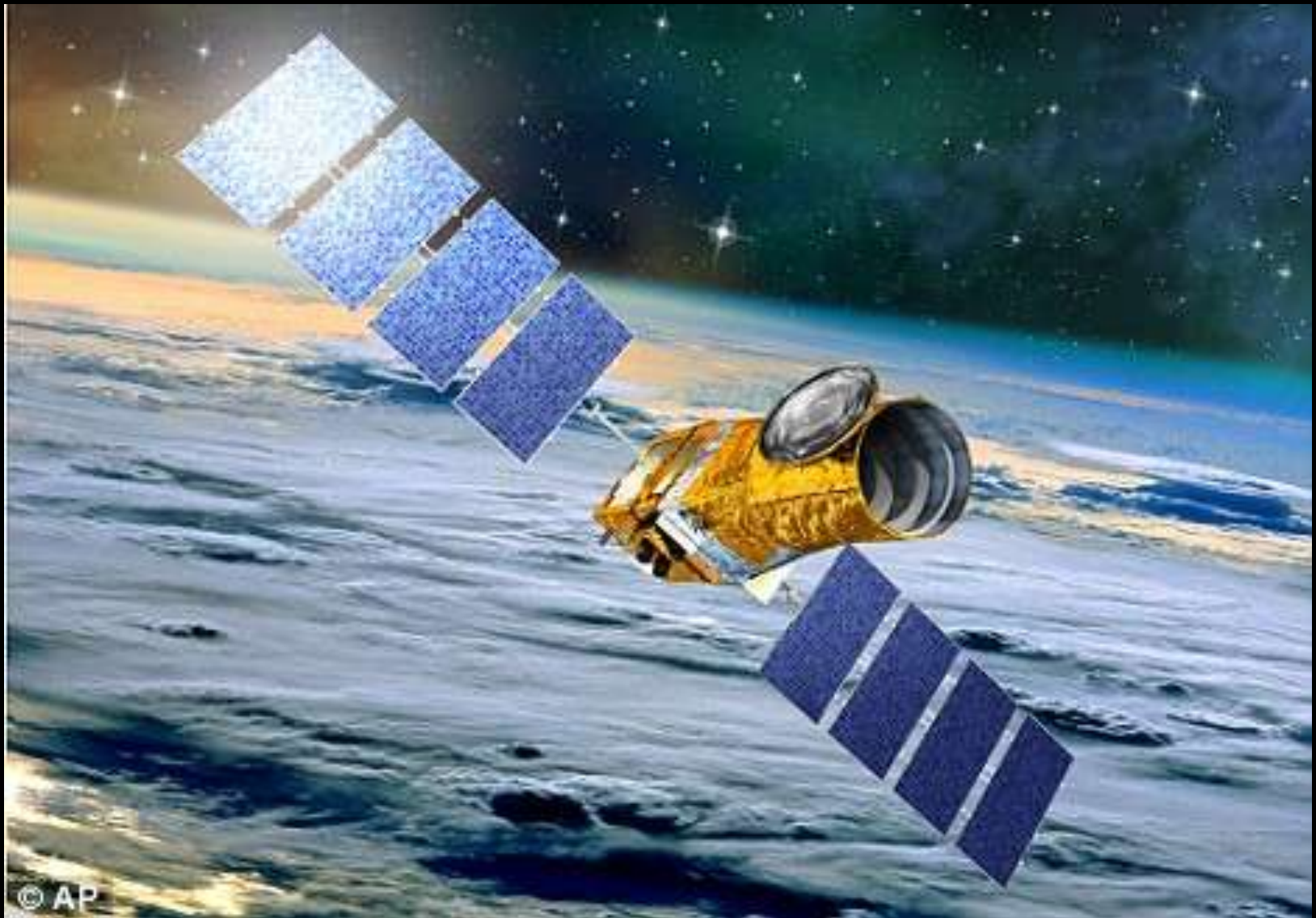
Hubble (2001 sodík)



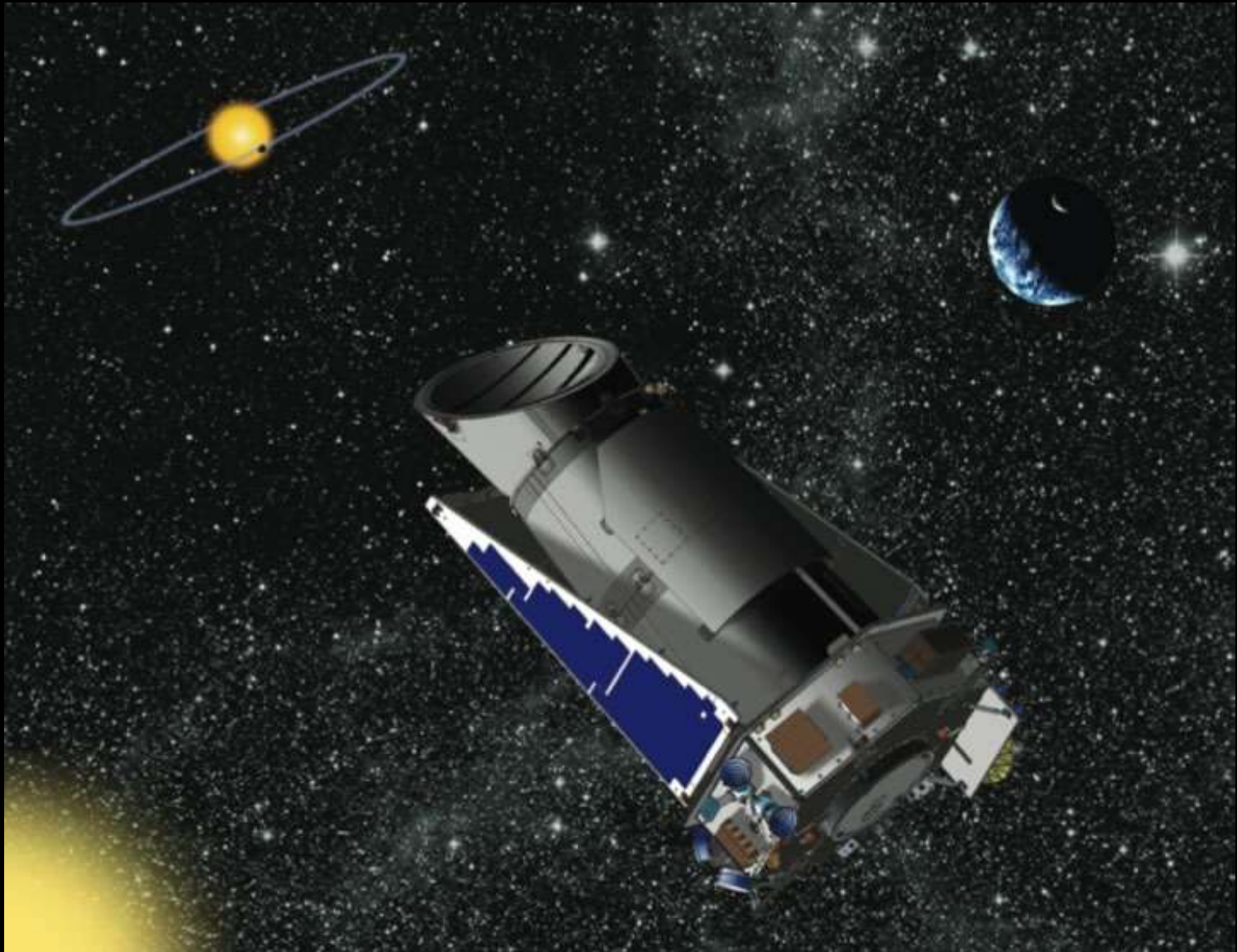
Spitzer



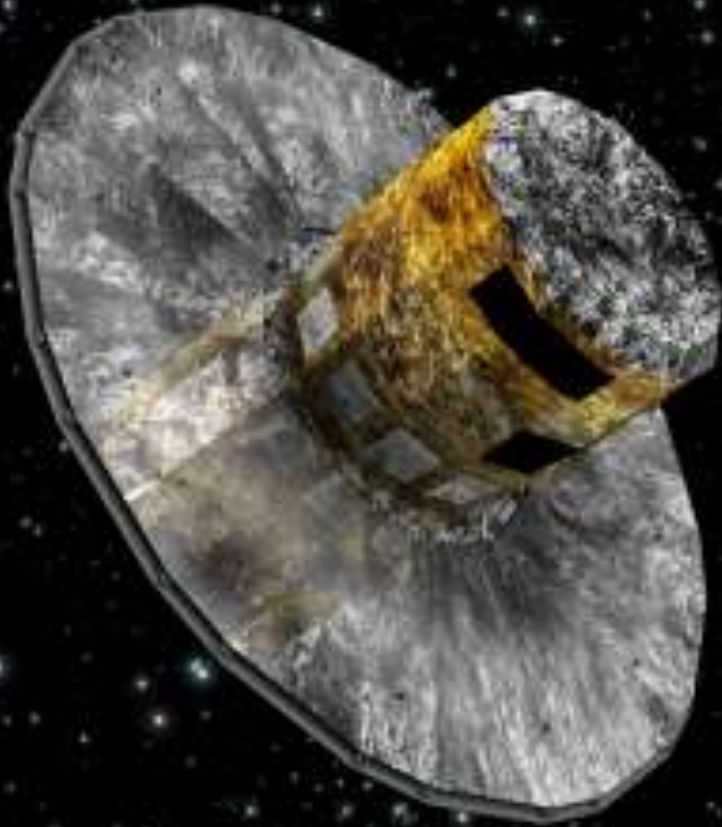
CoRoT



Kepler



Gaia (2012)



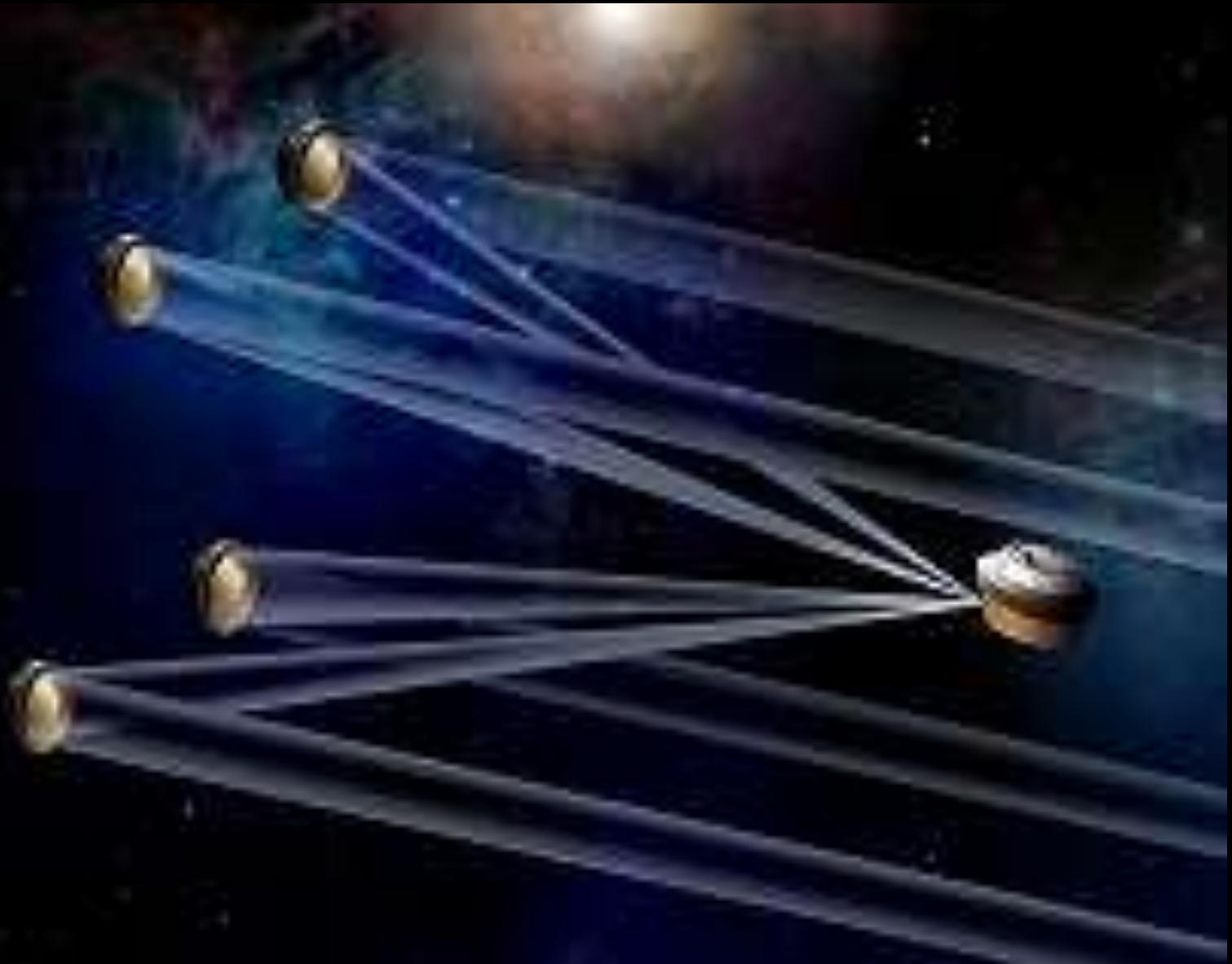
PEGASE



Space Interferometry Mission



Darwin



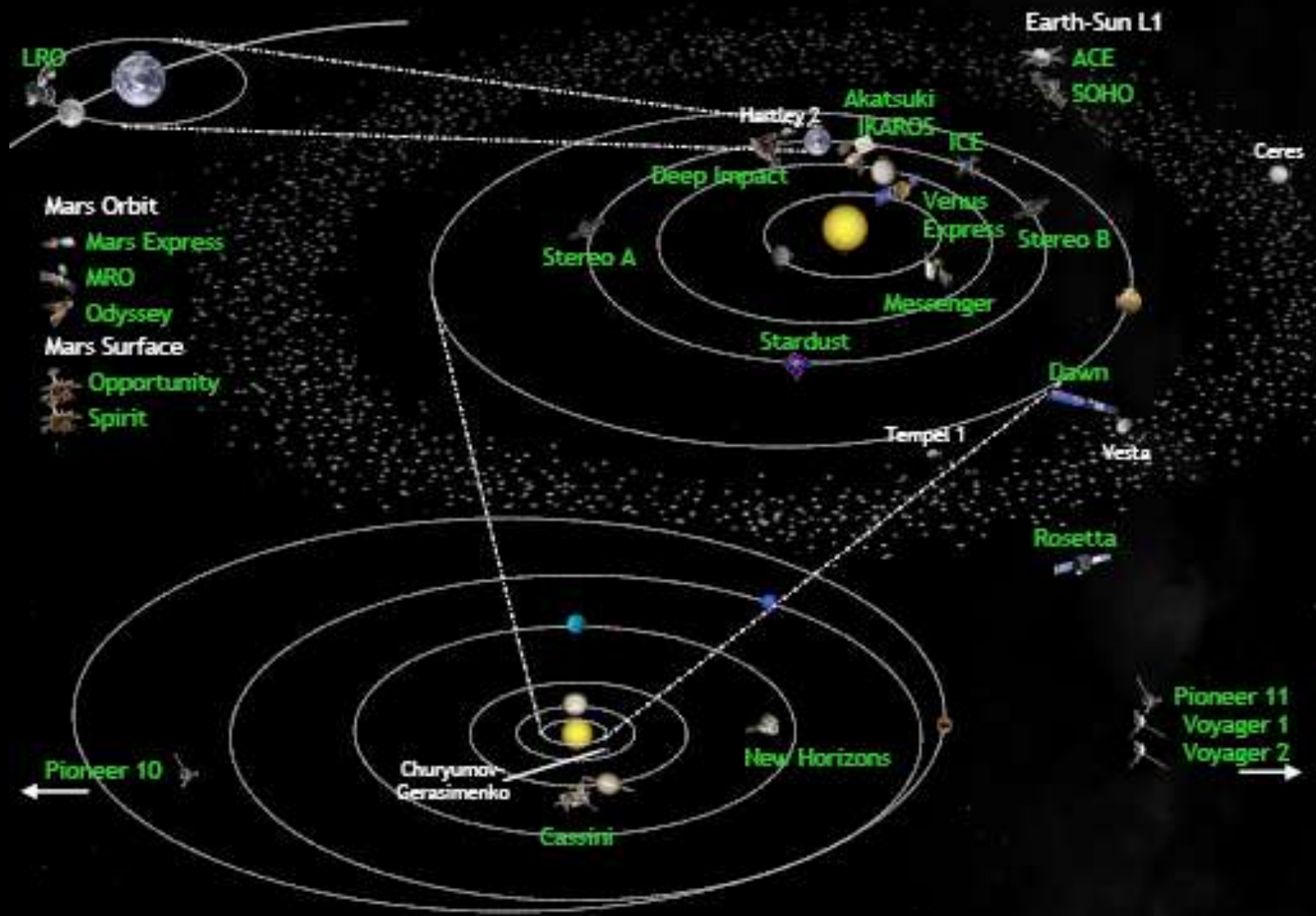
Nejen z oběžné dráhy







Meziplanetární sondy



Future Missions

2010

Chang'e 2 (Moon)

2011

GRAIL (Moon)

Juno (Jupiter)

Phobos-Grunt (Mars/Phobos)

Yinghuo 1 (Mars)

2012

LADEE (Moon)

Luna-Glob (Moon)

Curiosity (Mars Rover)

2013

Chandrayaan 2 (Moon)

MAVEN (Mars)

2014

Bepi-Colombo (Mercury)

2016

Venera D (Venus)

Exomars/TGM (Mars Orbiter / Lander)

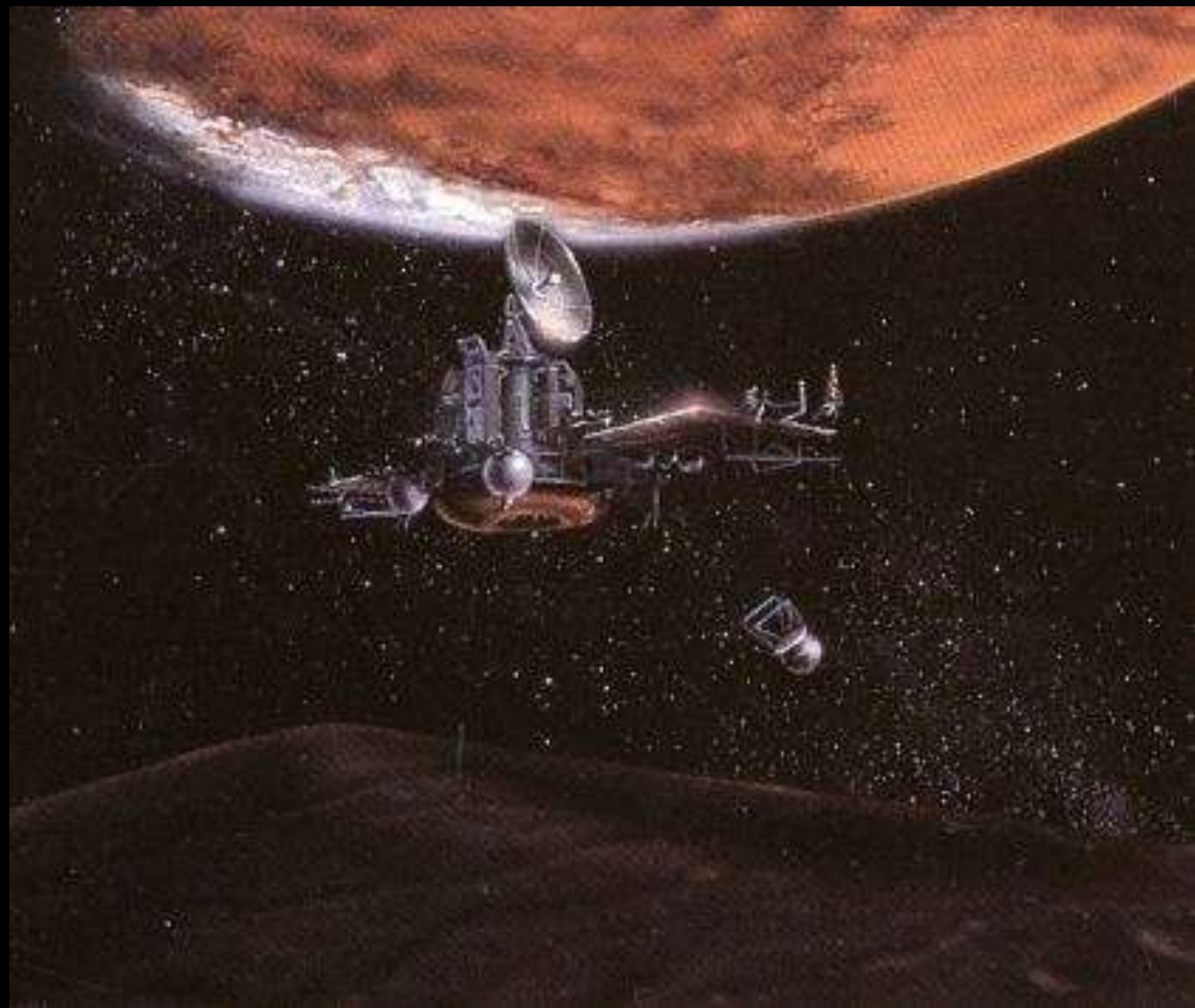
2018

Solar Probe Plus (Sun)

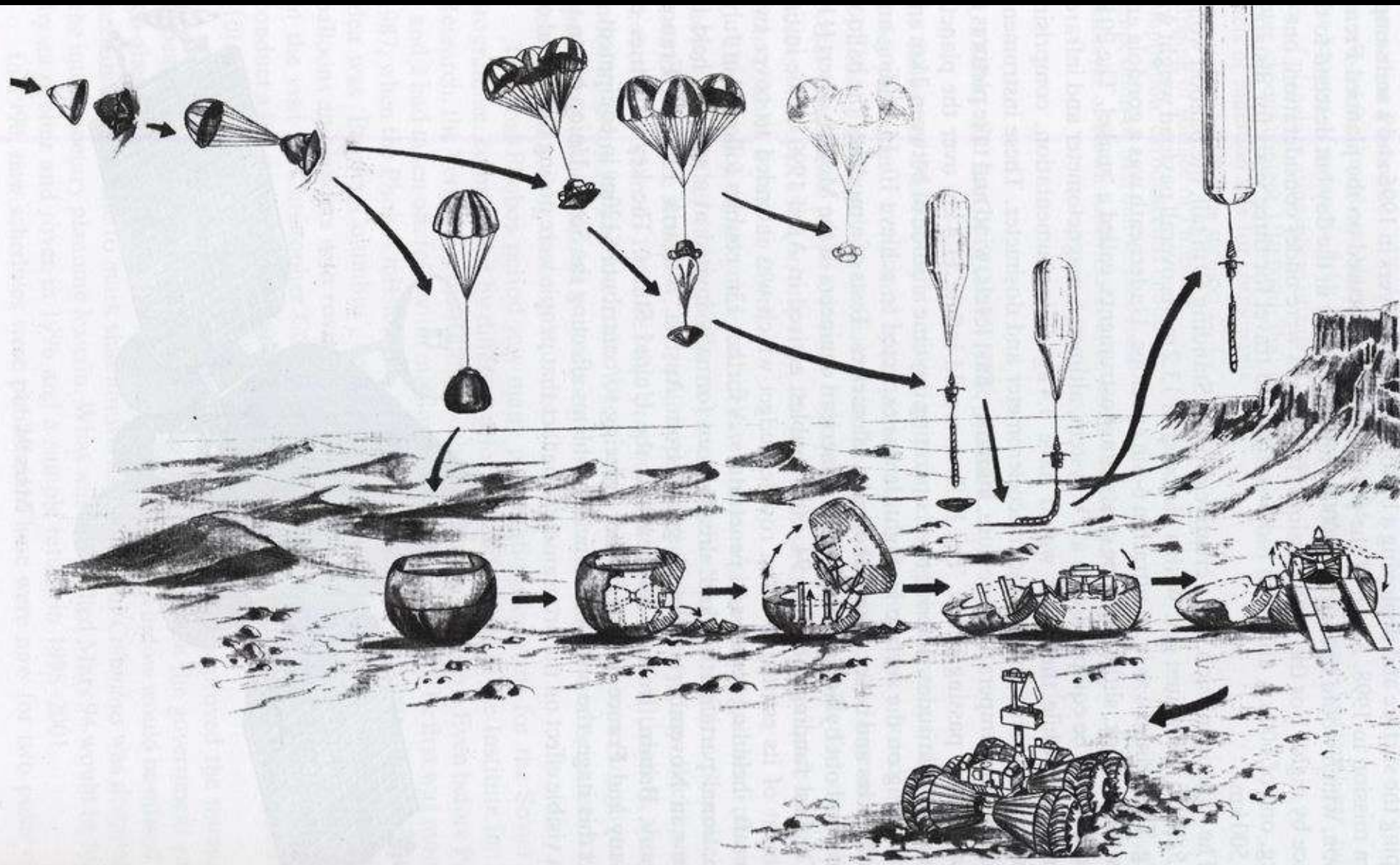
Exomars/MAK-C (Mars Rovers)

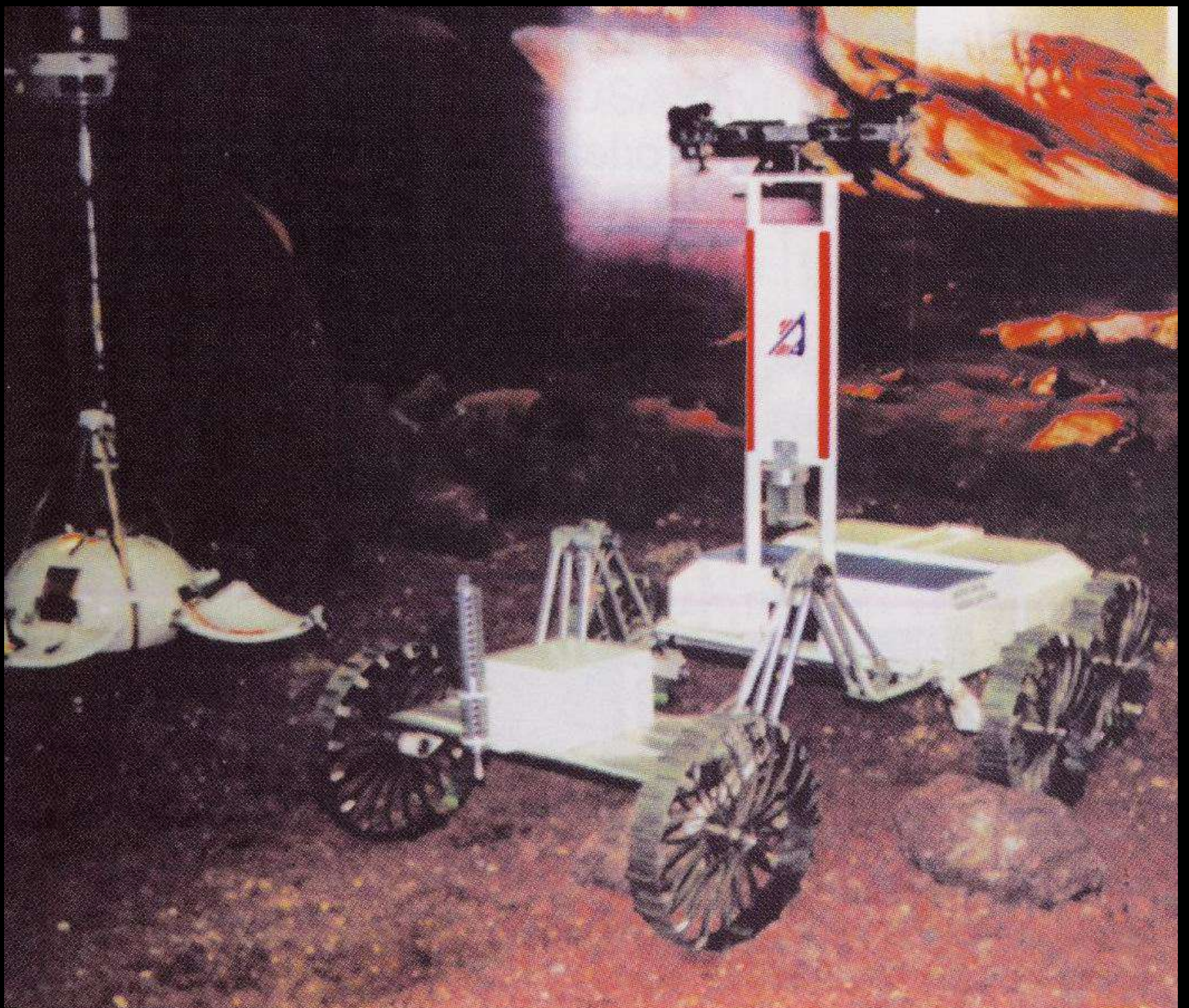
2020

EJSM (Jupiter)












LAVOCHKIN
Association

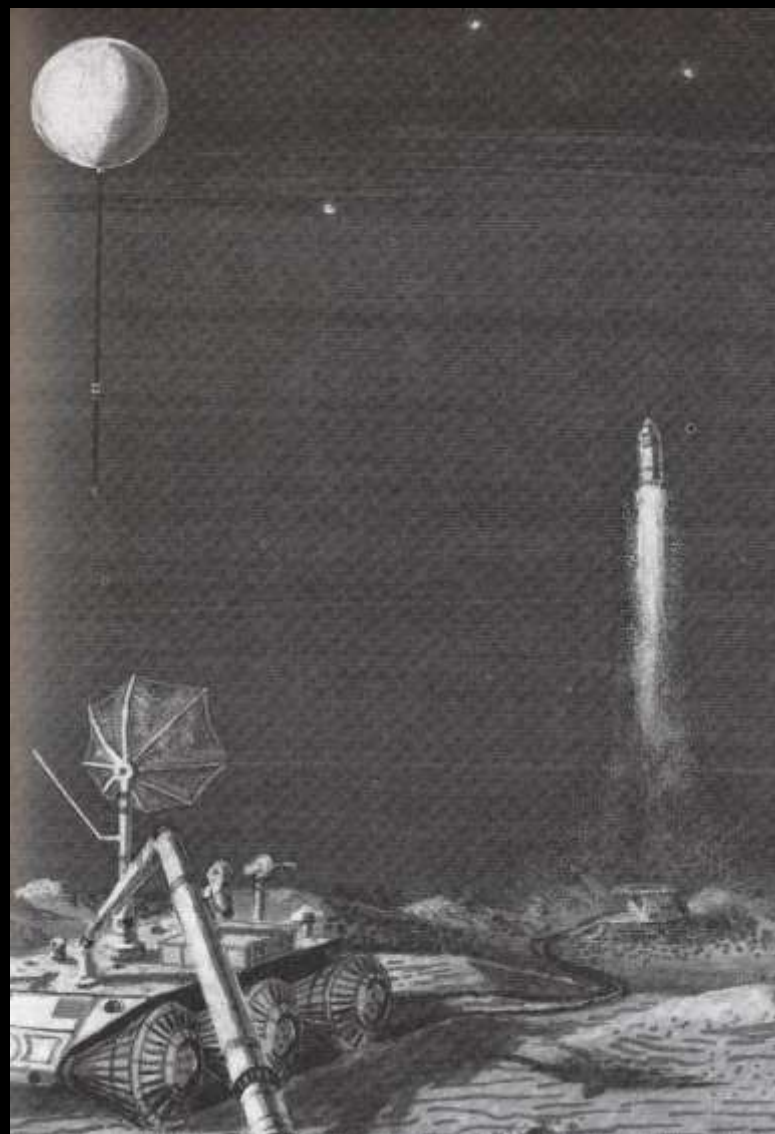
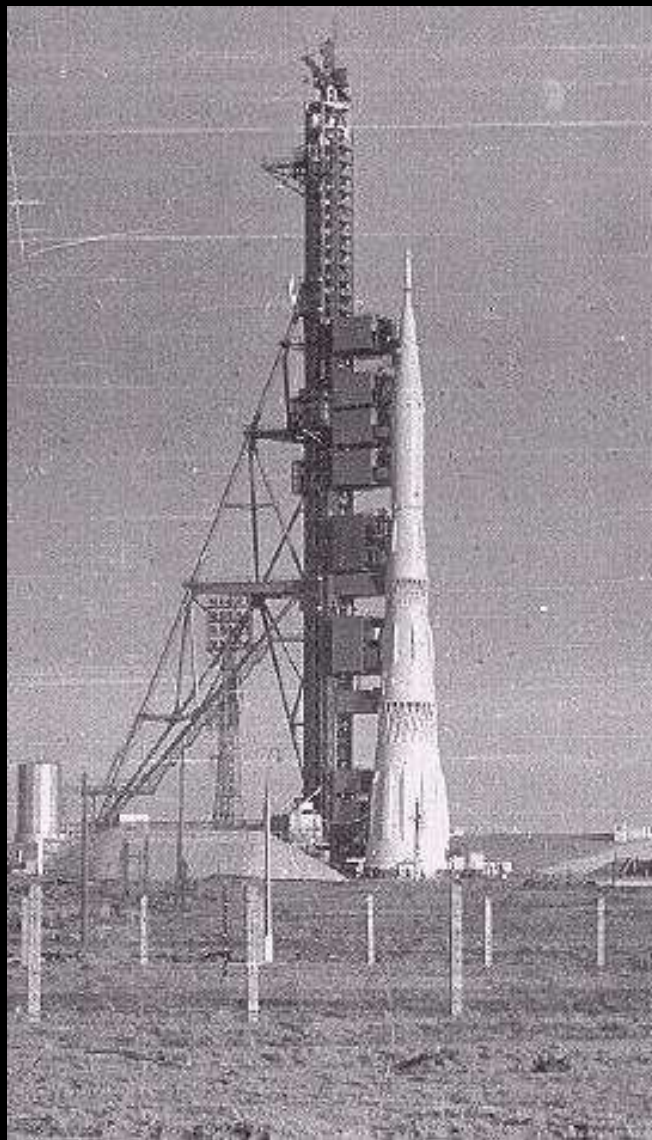
Na Mars za svitu petrolejek

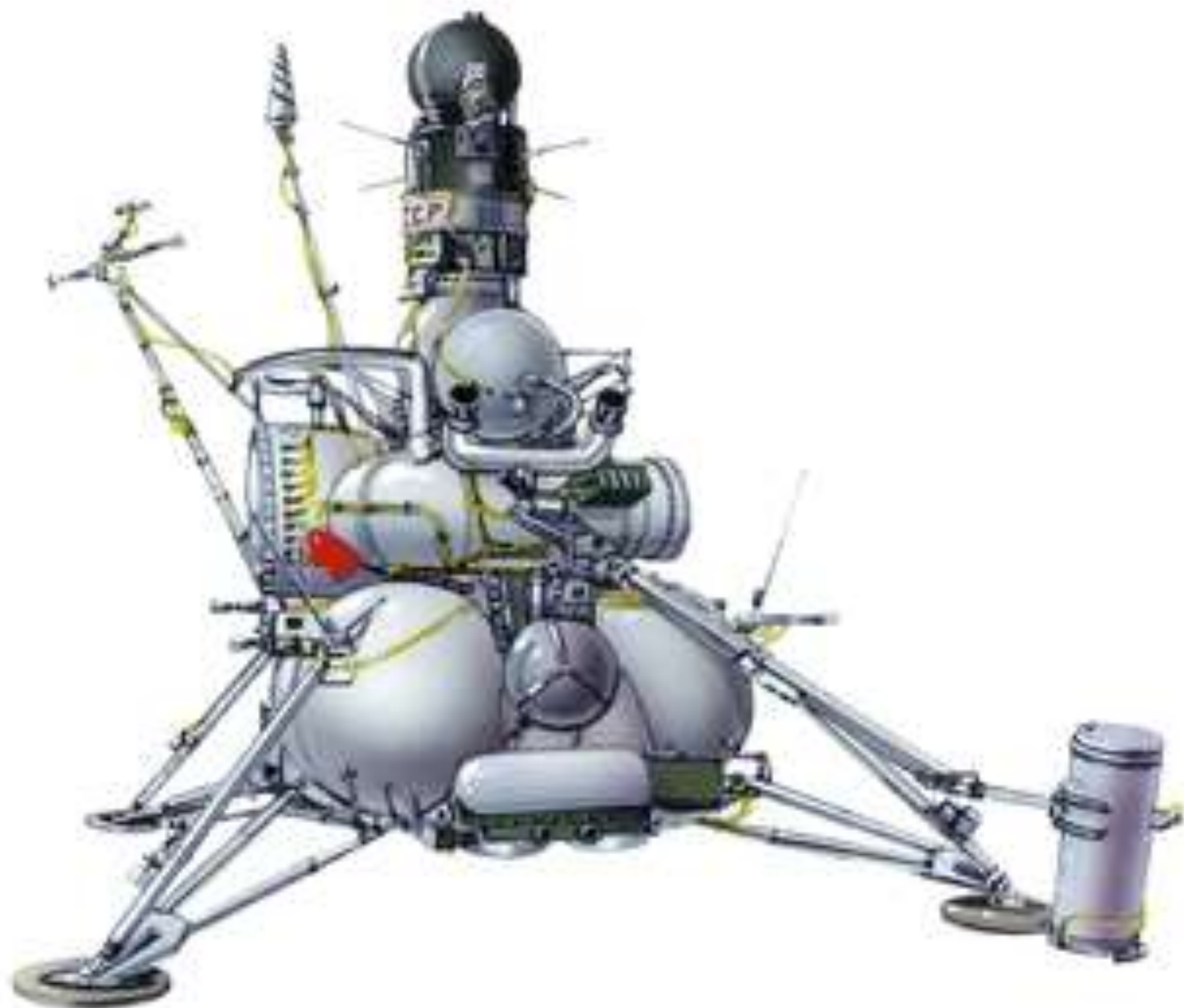


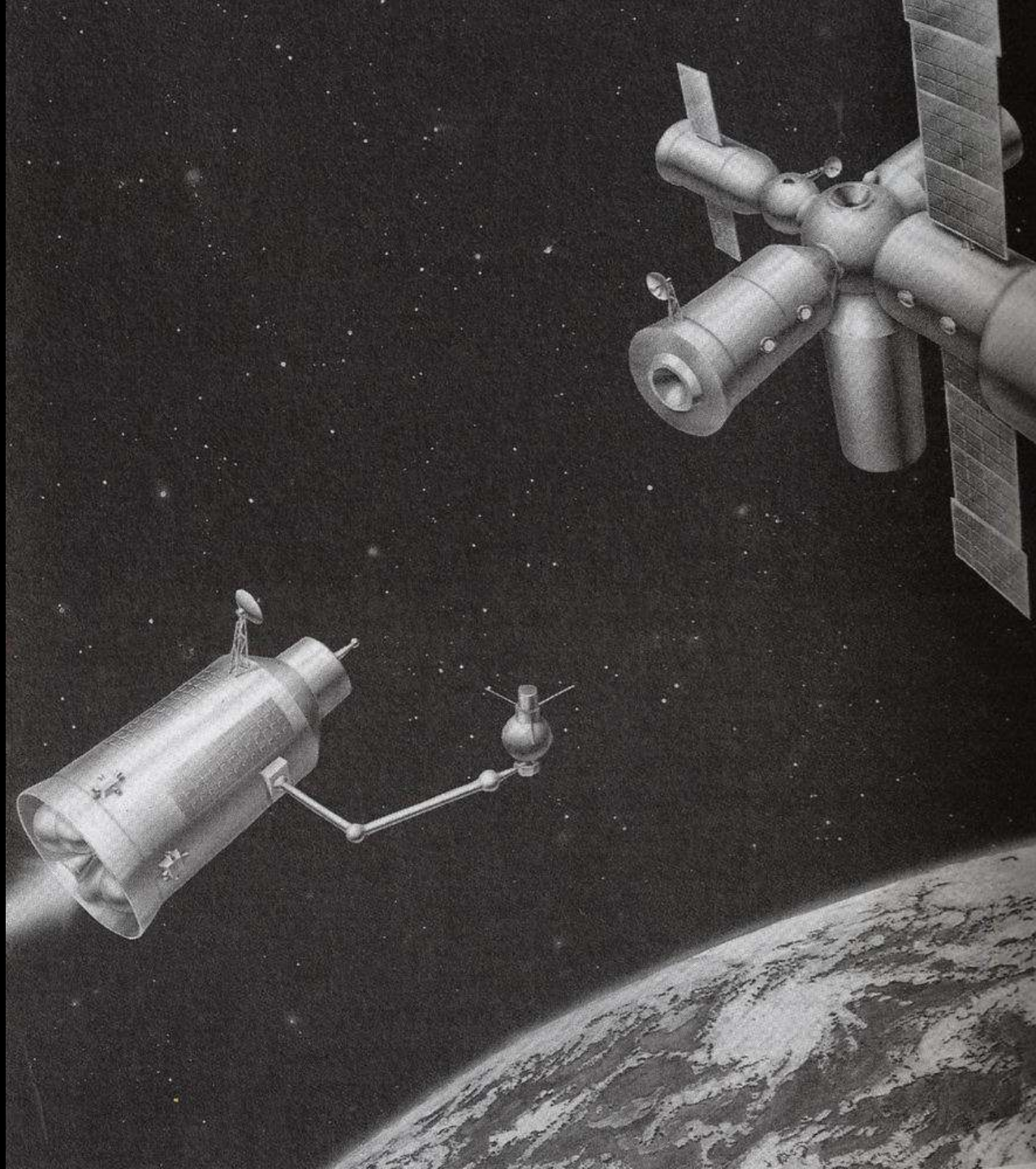
Francouzský balón

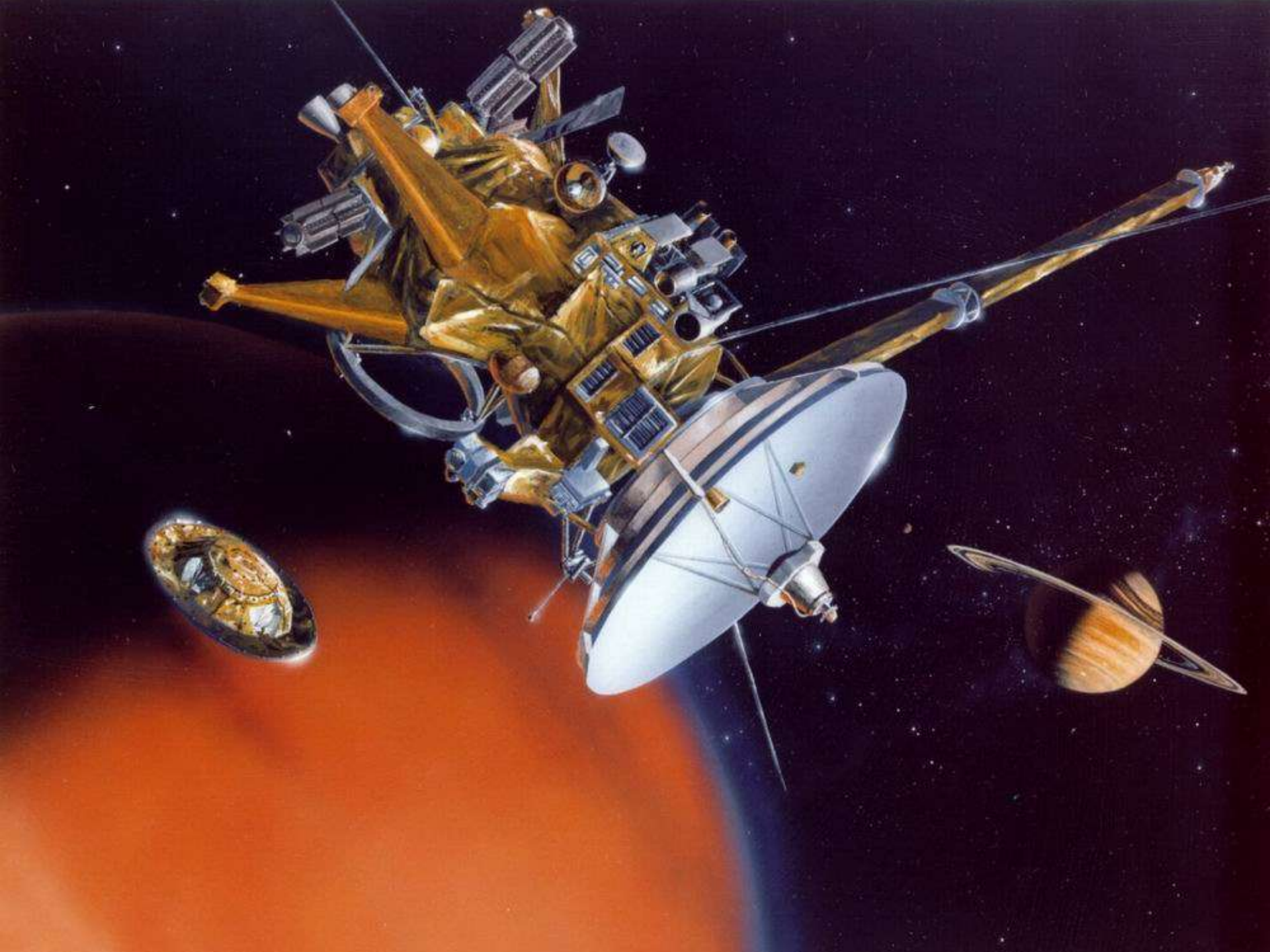


17. září 1975: mise (pro) Mars









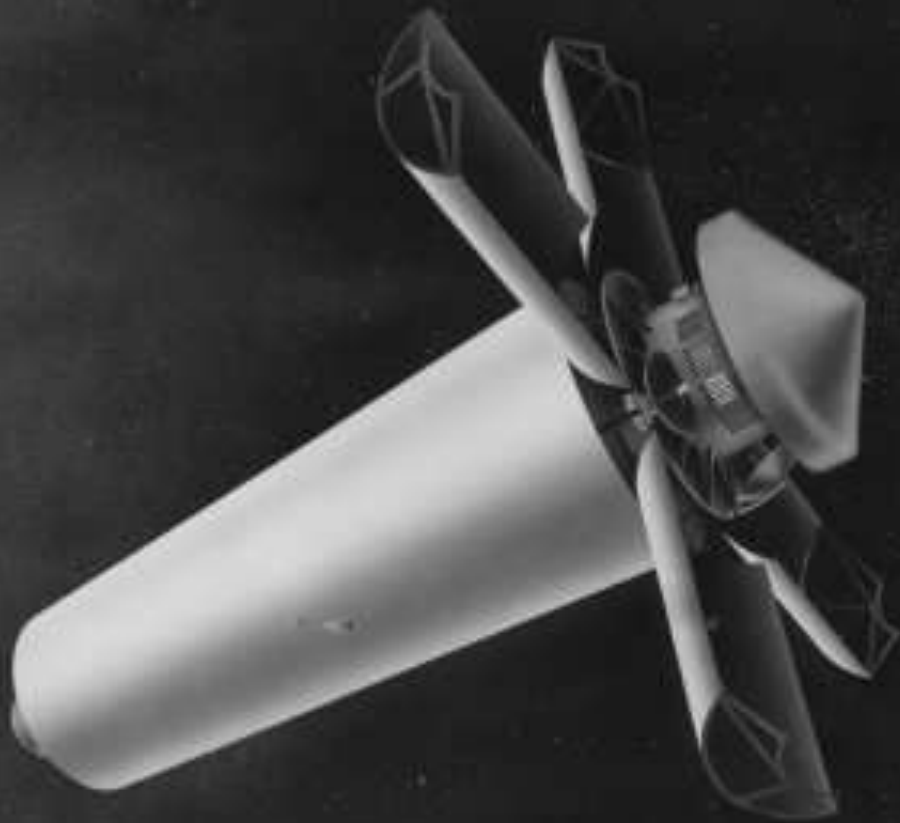
Supersonda ke hvězdám



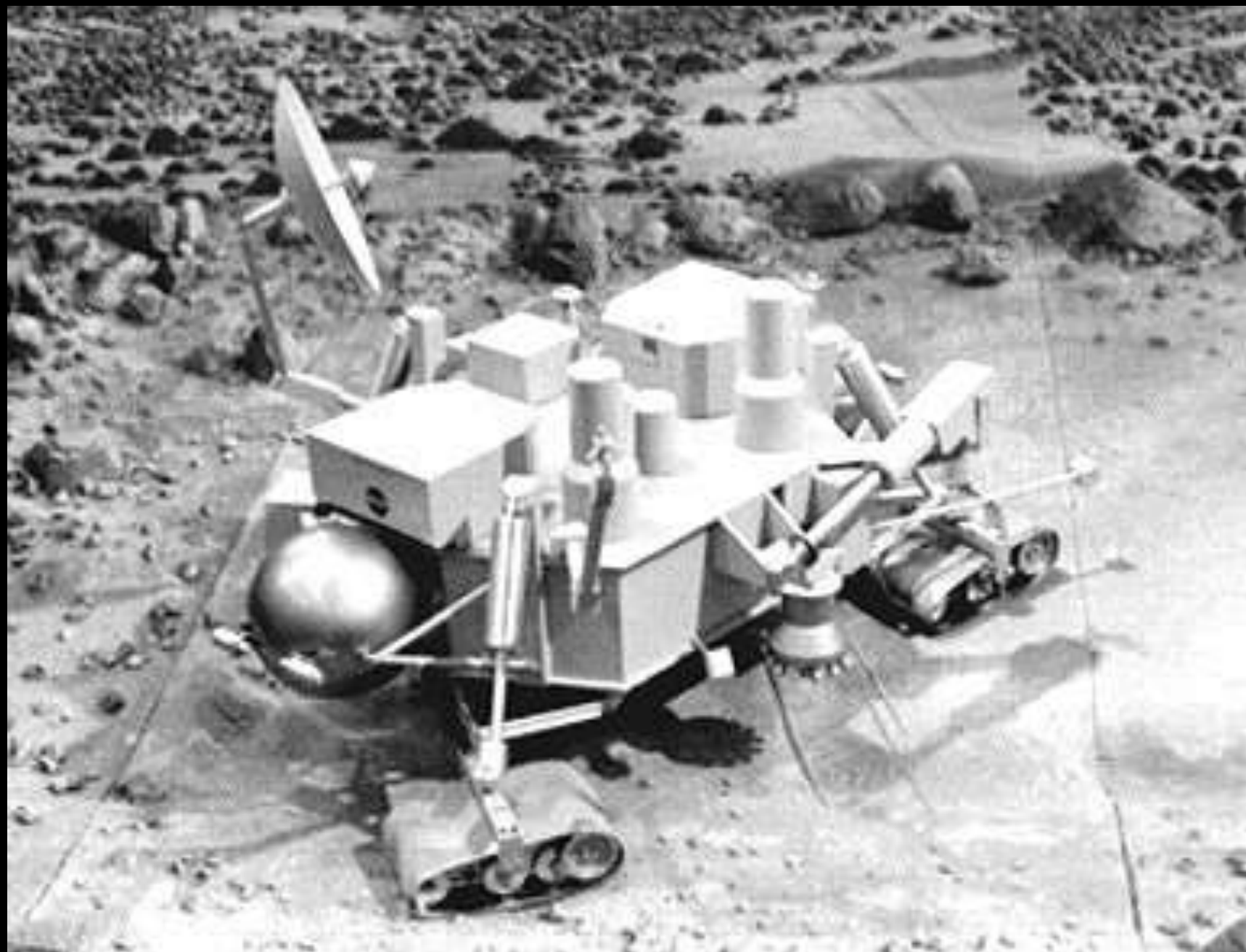
Rychleji, lépe, levněji



Vábení Rudé planety



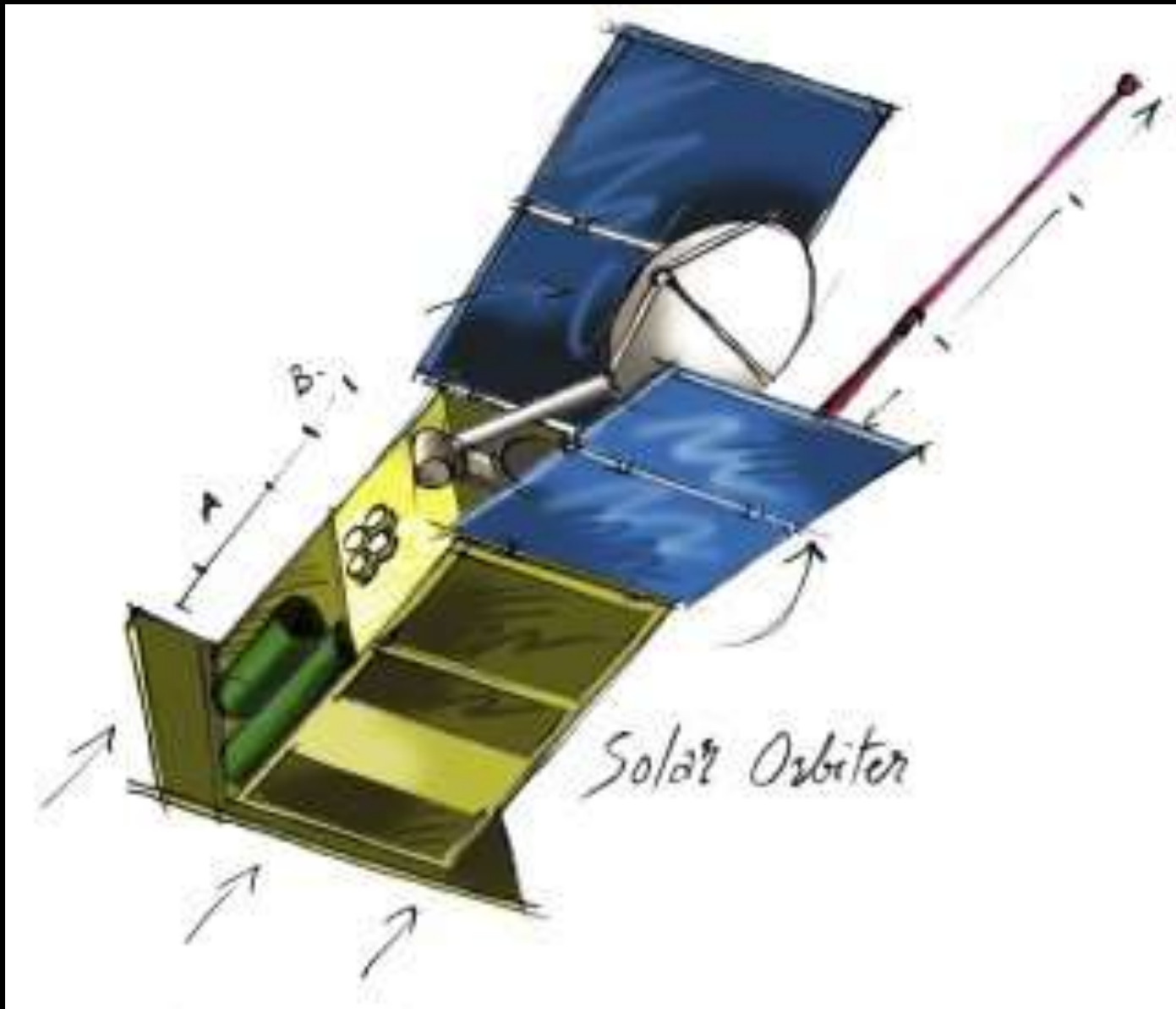




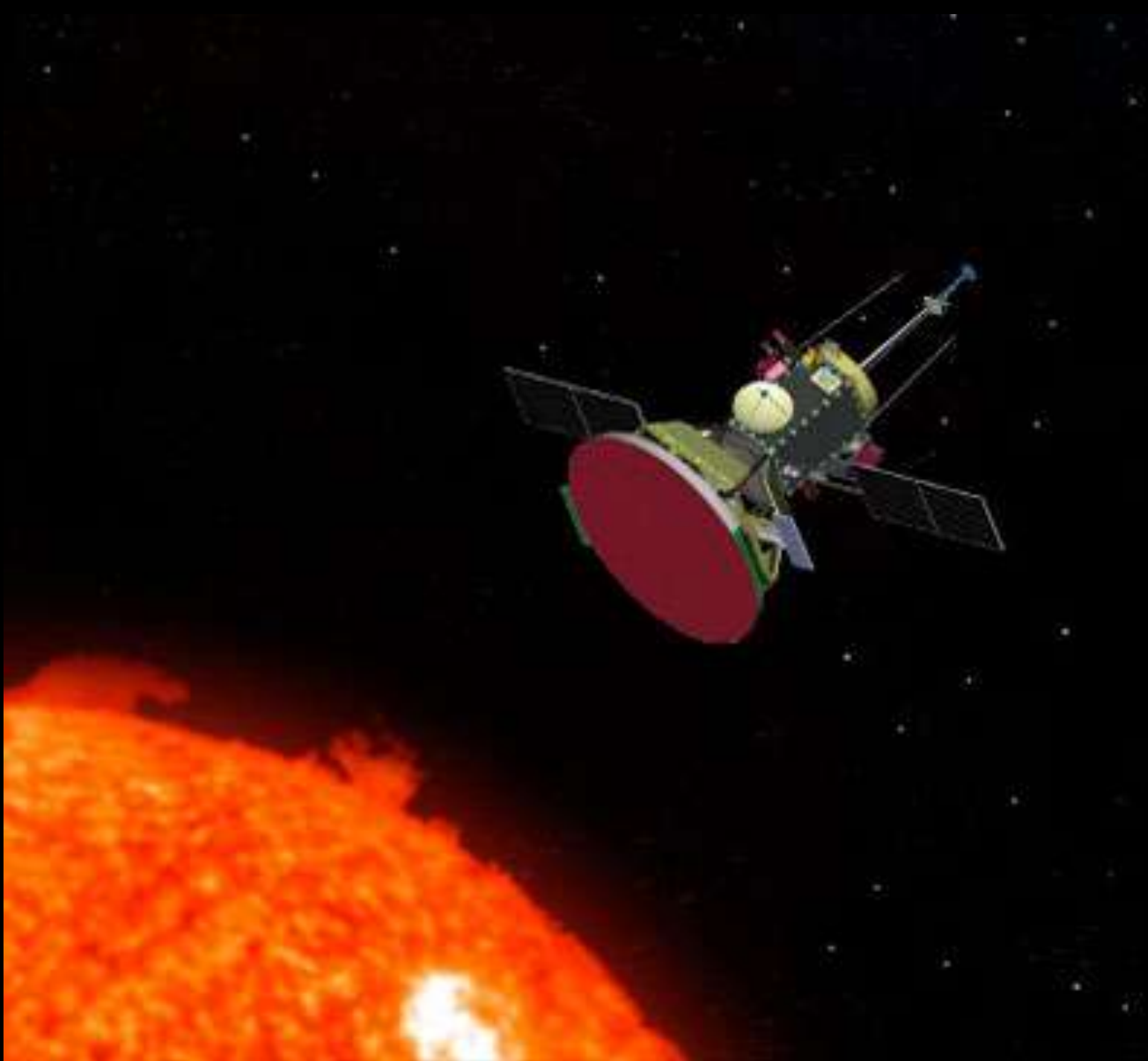


Budoucnost

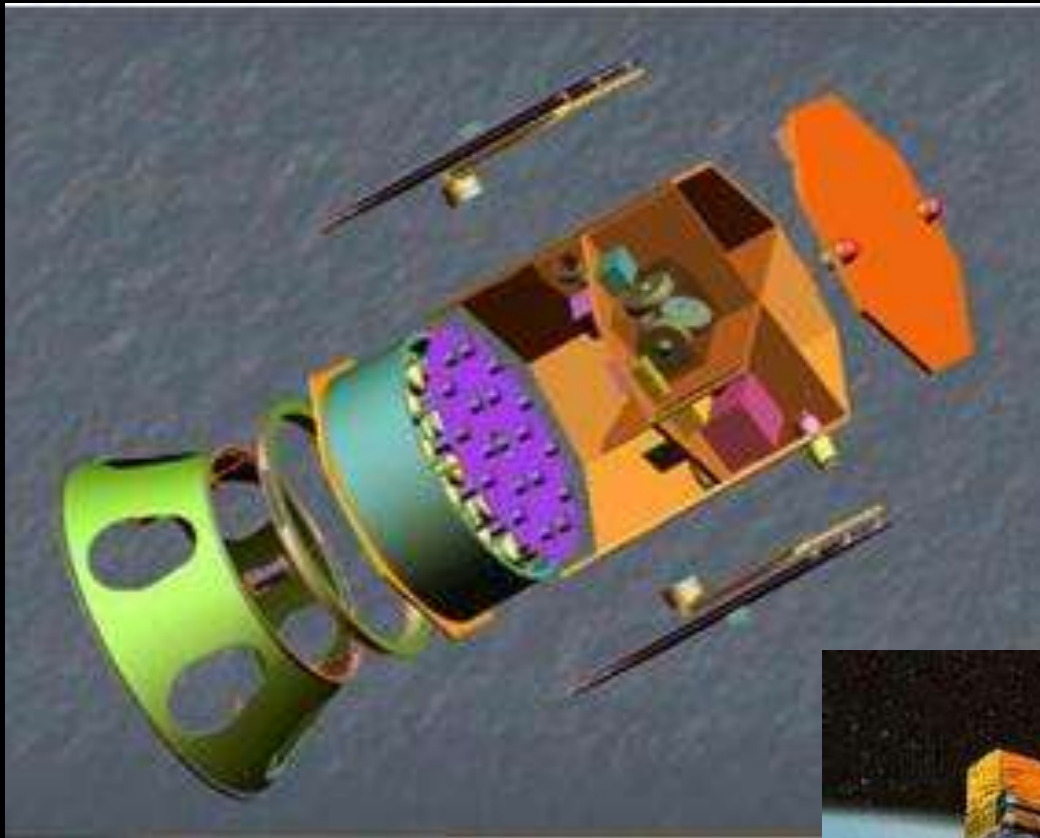
Solar Orbiter



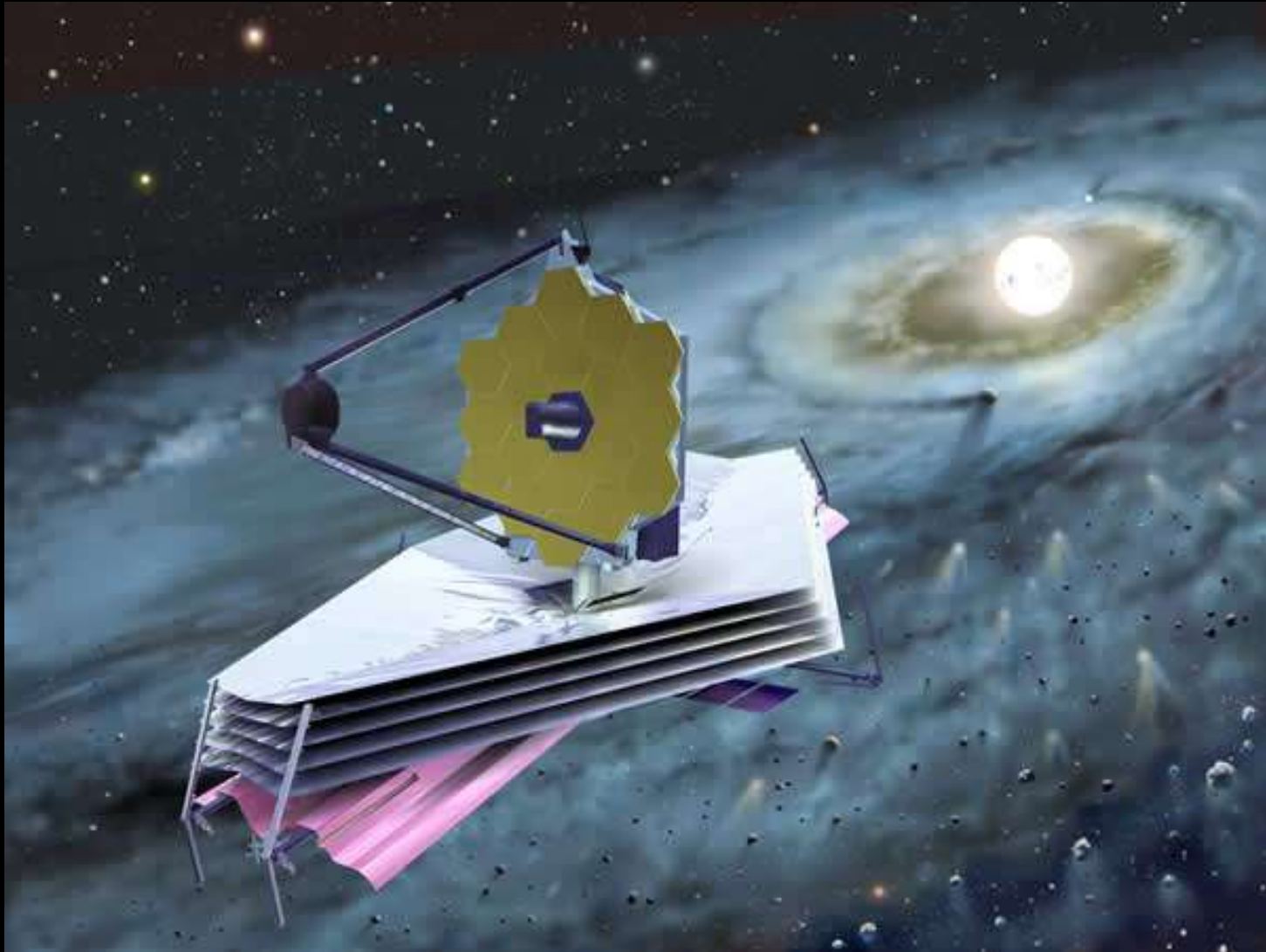
Solar Probe Plus



Čínský kosmický teleskop



James Webb Space Telescope



Infračervené záření.

MIRRORS WAVELENGTHS



HUBBLE
MIRROR



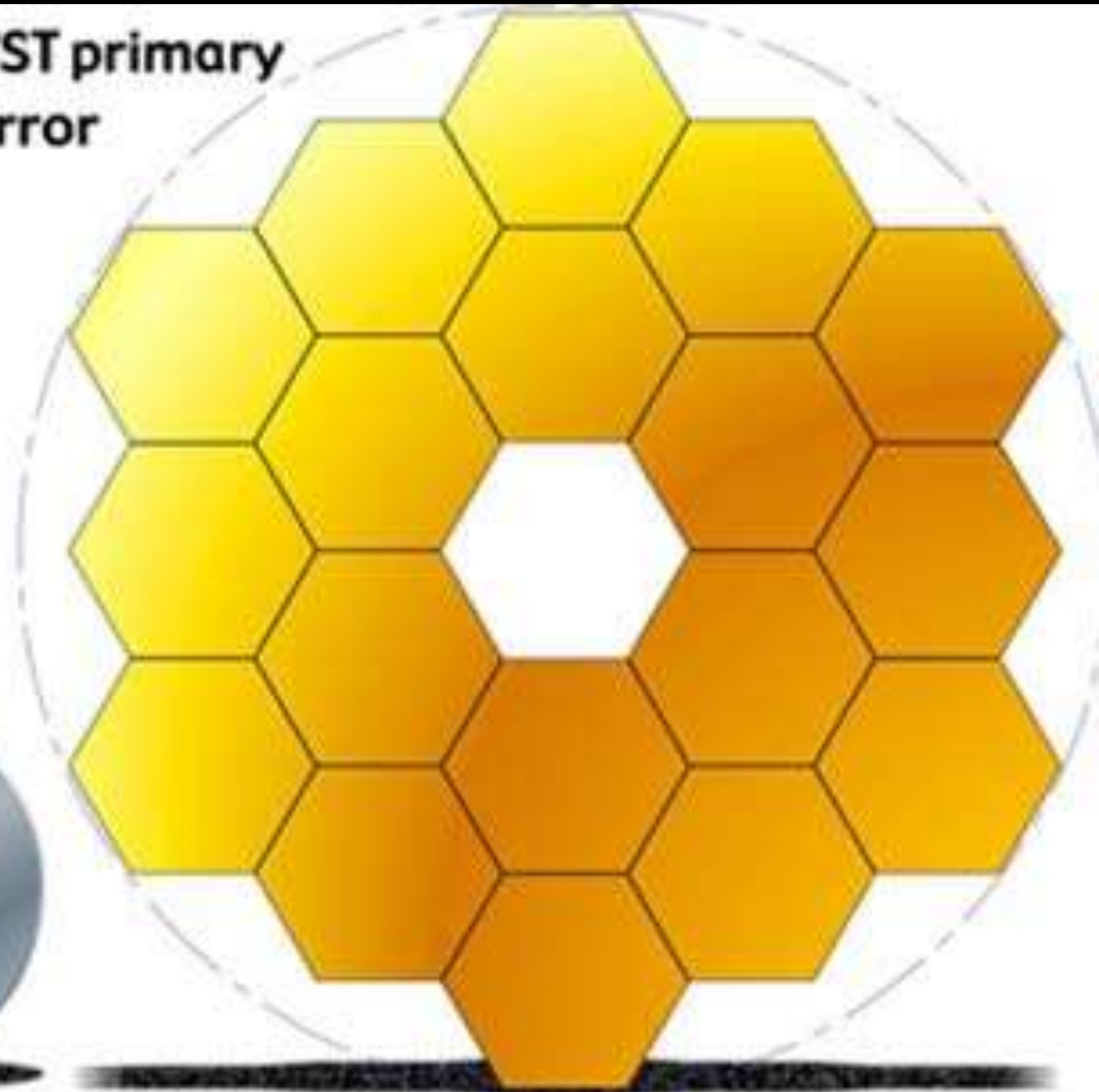
WEBB
MIRROR



SPITZER
MIRROR

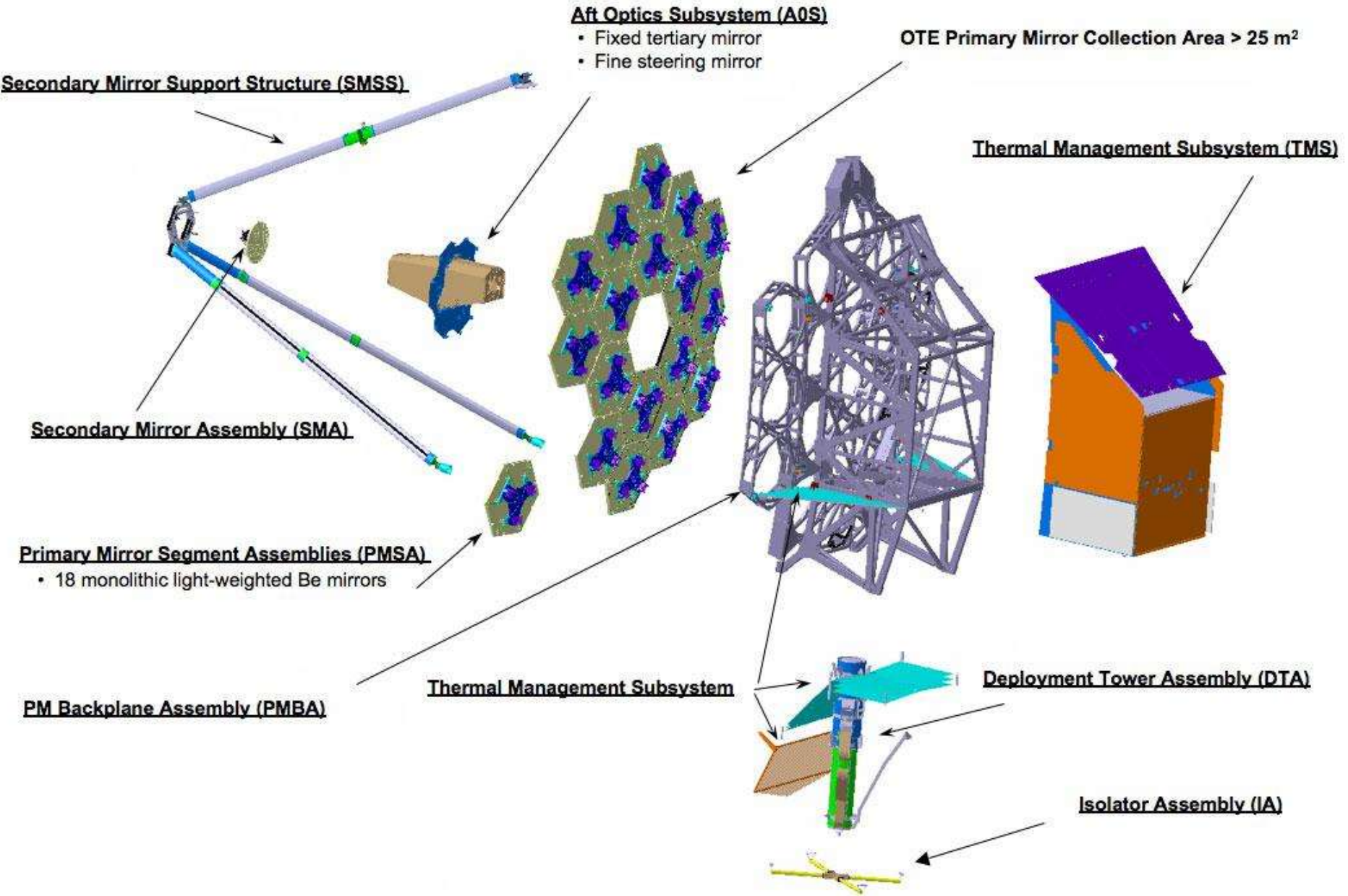


JWST primary mirror

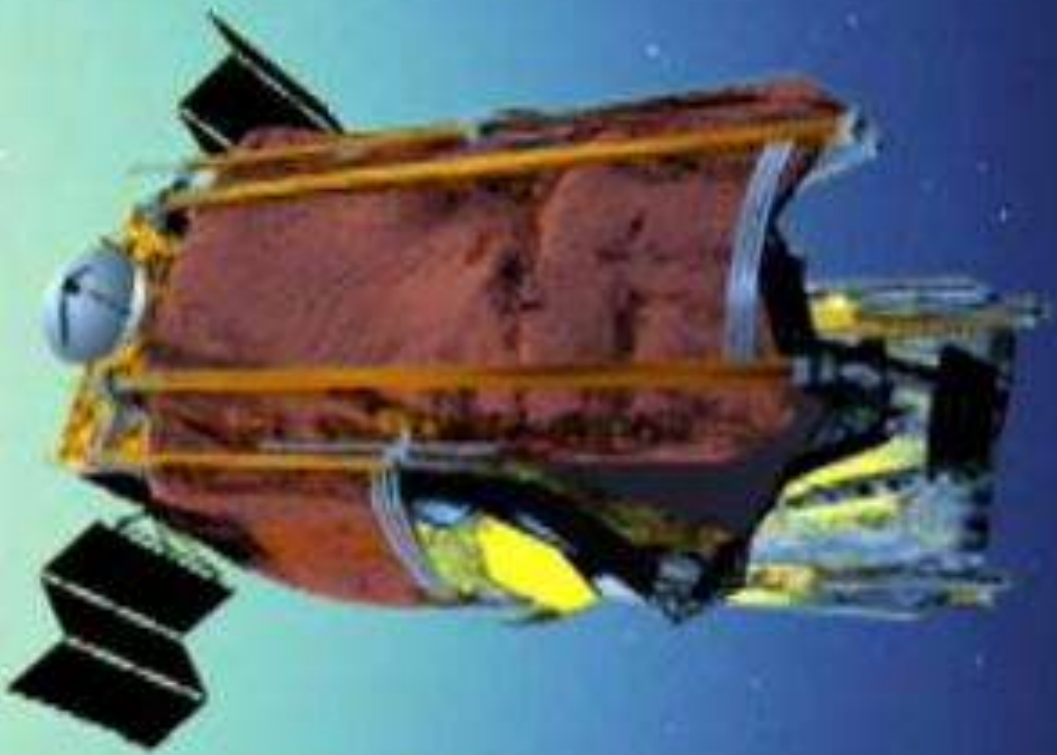


Hubble primary mirror







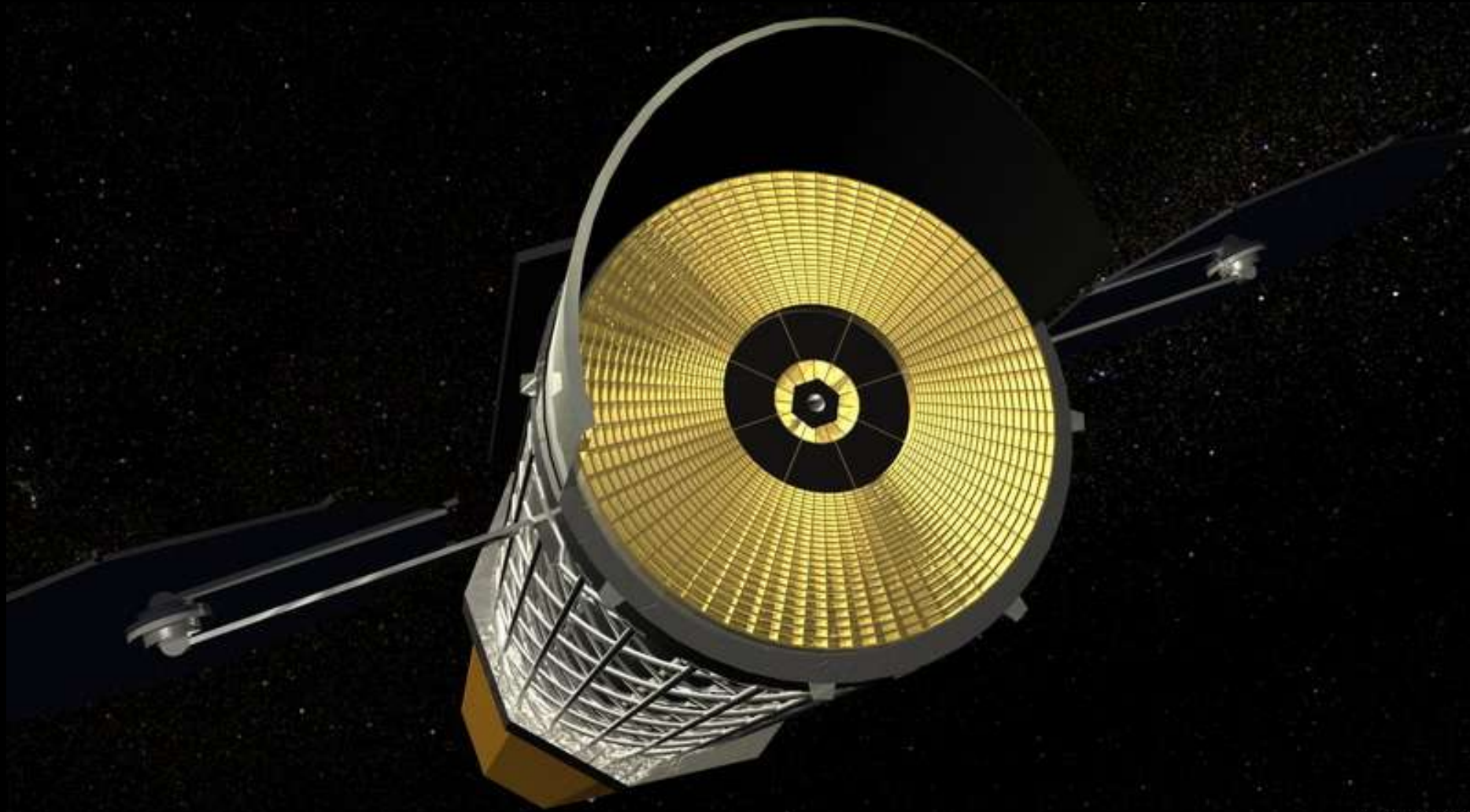








International X-ray Observatory



Chris Murray / NASA 2009

2021 - NASA, ESA, JAXA

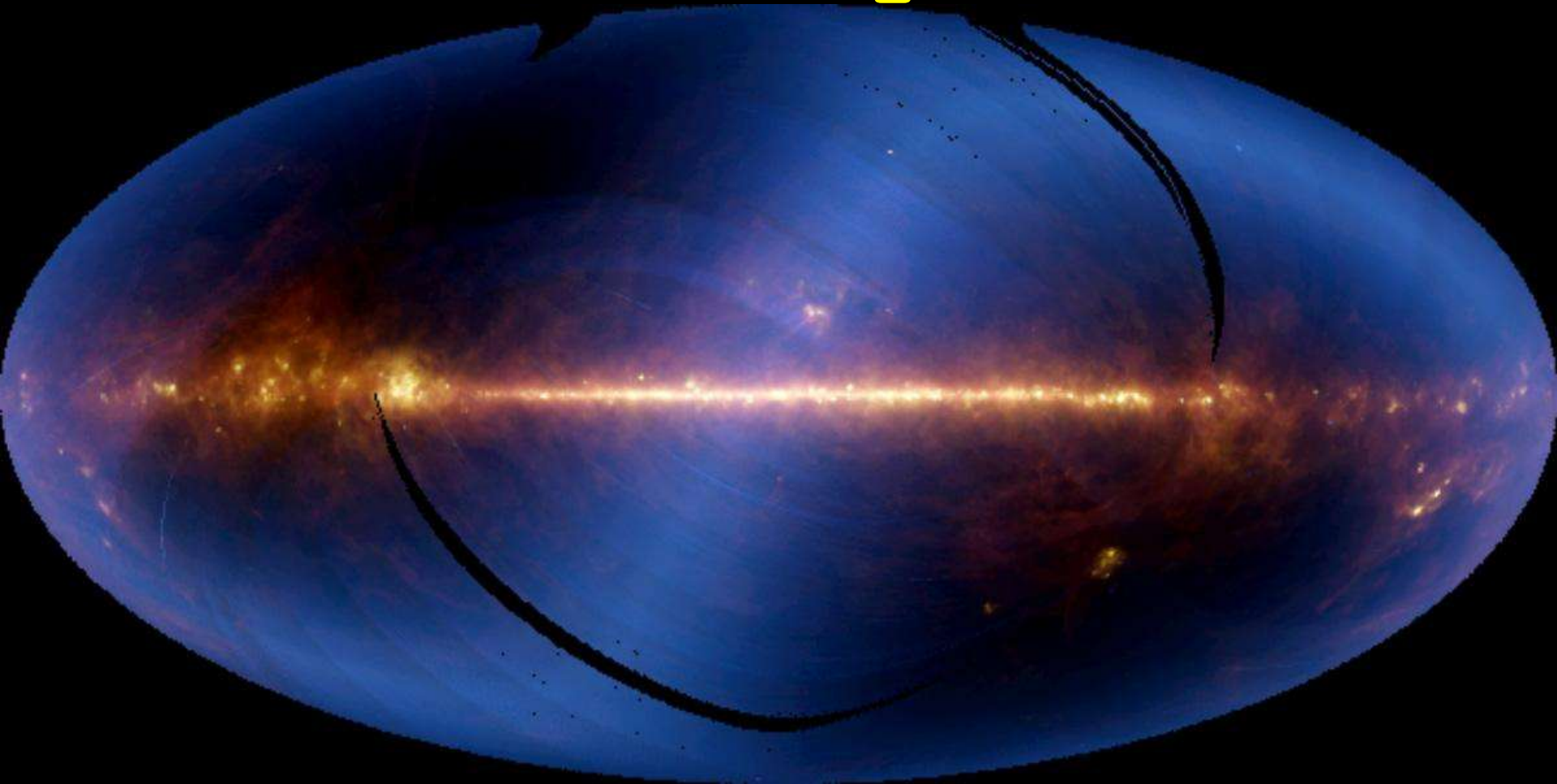


ATLAST



Advanced Technology Large-Aperture Space Telescope

Dotazy?



Ing. Tomáš Přibyl

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