
# Project Overview

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# CAESAR

The CAESAR (Comet Astrobiology Exploration SAmple Return) mission is one of two New Frontiers missions selected for Phase A. CAESAR will acquire a sample from the nucleus of comet Churyumov-Gerasimenko, returning it safely to Earth.

Comets are made up of materials from ancient stars, interstellar clouds, and the birth of our solar system.

The CAESAR sample will reveal how these materials contributed to the early Earth, including the origins of the Earth's oceans, and of life

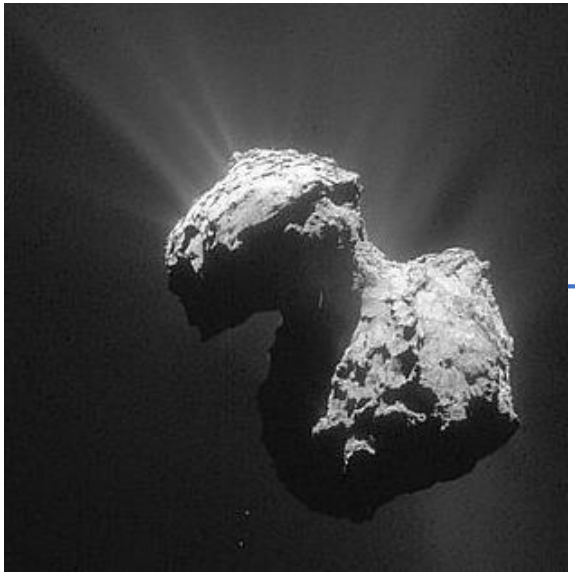
The CAESAR mission seeks to return this sample from 67P/Churyumov-Gerasimenko, a comet that was successfully explored by the European Space Agency's Rosetta spacecraft, to determine its origin and history.

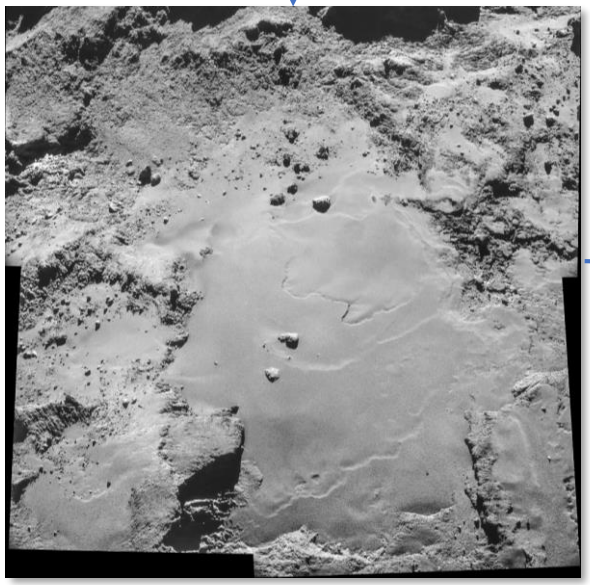
- PI Steve Squyres of Cornell University
- CAESAR would be managed by NASA's Goddard Space Flight Center

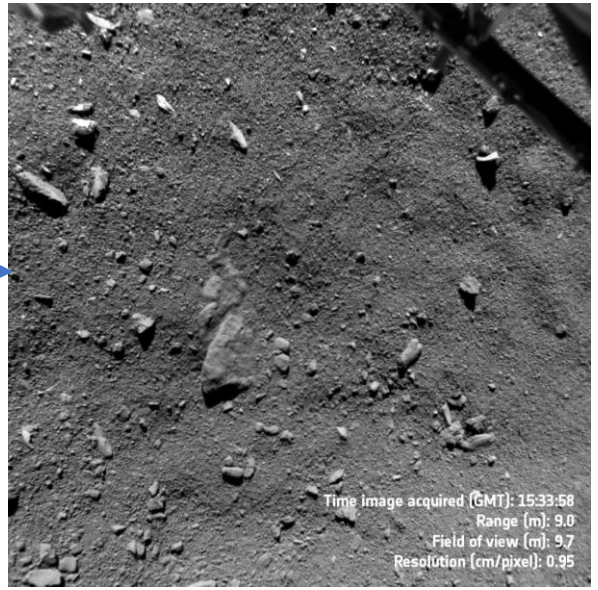
# CAESAR Sample Science

| Testable Hypotheses | Observables from Solid Sample in SCS and Volatile Sample in GCS | Observables from Solid Sample in SCS |
|---|---|---|
| **Interstellar Medium to Protoplanetary Disk Transition (D.2.1.3.2)** | | |
| 67P contains a greater abundance and diversity of circumstellar grains and molecules than asteroids sampled by meteorites. | Crystallography, elemental and isotopic compositions of mineral and organic grains; molecule-specific isotopic ratios; noble gases | |
| 67P contains volatile elements, ices and organic molecules that were trapped during formation of grain mantles in the ISM or outer protoplanetary disk. | Isotopic and chemical compositions of volatile elements, organics, and noble gases (GCS). Isotopic compositions of noble gases in non-volatile samples | |
| 67P contains refractory organic compounds that formed in cold molecular clouds and the outermost protosolar disk. | Isotopic and chemical compositions of refractory organic molecules & carbonaceous grains; Isotopic, chemical and structural properties of macromolecular material. | |
| $H_2O$ and CO in 67P retain evidence of O isotopic fractionation from photochemical self-shielding. | Oxygen isotopic compositions of $H_2O$ and CO | |
| **Protoplanetary Disk (D.2.1.3.3)** | | |
| 67P contains high-temperature materials, such as chondrules, CAIs, and silicates that formed across the Solar System. | Mineralogy, chemistry, and isotopic compositions of chondrules, CAIs, metals, sulfides, crystalline and amorphous silicates | |
| 67P contains complex refractory organics from the hot, inner regions of the protoplanetary disk. | Textures, chemistry, and isotopic compositions of refractory organics | |
| 67P is a primordial fossil that retains largely unaltered signatures from the protoplanetary disk epoch. | Textures, mineralogy, crystallography, and isotopic compositions of grains and organics. H and O isotopic ratios of hydrated minerals and $H_2O$ | |
| **Geological and Dynamical Evolution (D.2.1.3.4)** | | |
| 67P is a collisional remnant of a larger planetesimal that underwent internal heating, partial differentiation, sublimation and recondensation, outgassing, and hydrothermal alteration. | Crystallography, petrology, mineral textures, labile element abundances, mineralogy, trace element profiles, H and O isotopic measurements of hydrated minerals and $H_2O$ | |
| Jupiter family comets delivered a substantial fraction of water to Earth. | H and O isotopic measurements of $H_2O$, H isotopic measurements of organics | |
| 67P contains prebiotic organic compounds that may have contributed to the origin of life on Earth. | Volatile and non-volatile organic molecule abundances, isotopic ratios, and chirality, mineralogical constraints for aqueous alteration | |
| 67P surface materials record processes of tidal disruption and reaccumulation, resurfacing, and mass wasting. | Space weathering rims, mineral microstructures, IR spectra, noble gas abundances and isotopes | |

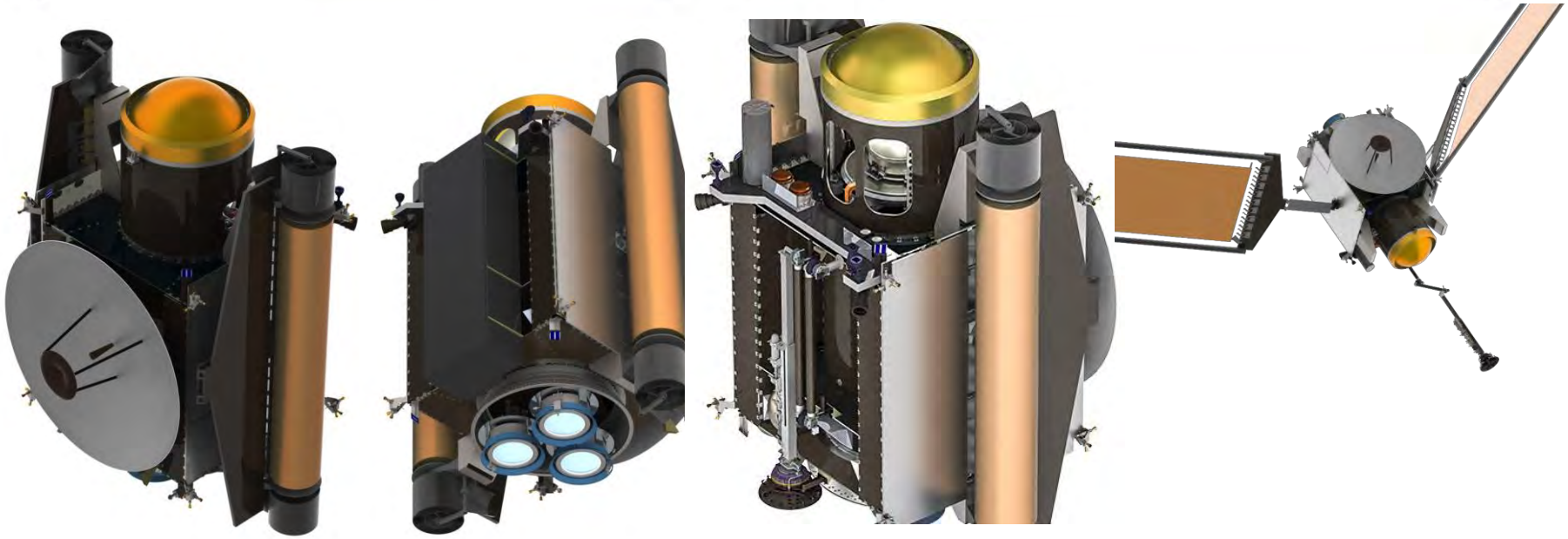
# Churyumov-Gerasimenko

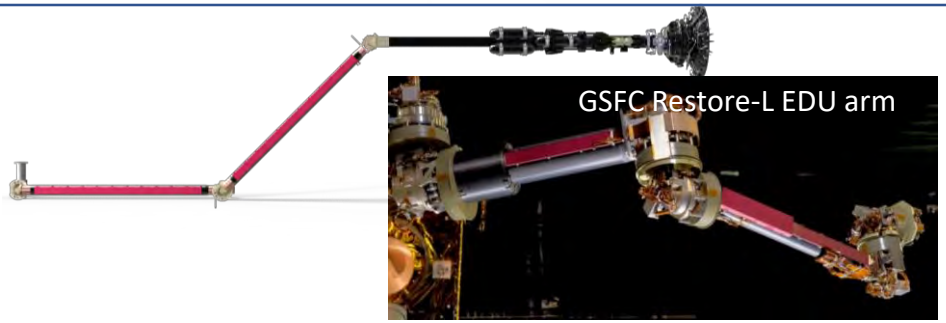


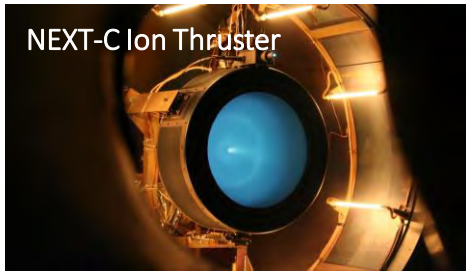




# The CAESAR Spacecraft





# Mission Timeline

2024 2026 2028 2030 2032 2034 2036 2038

Comet Ops

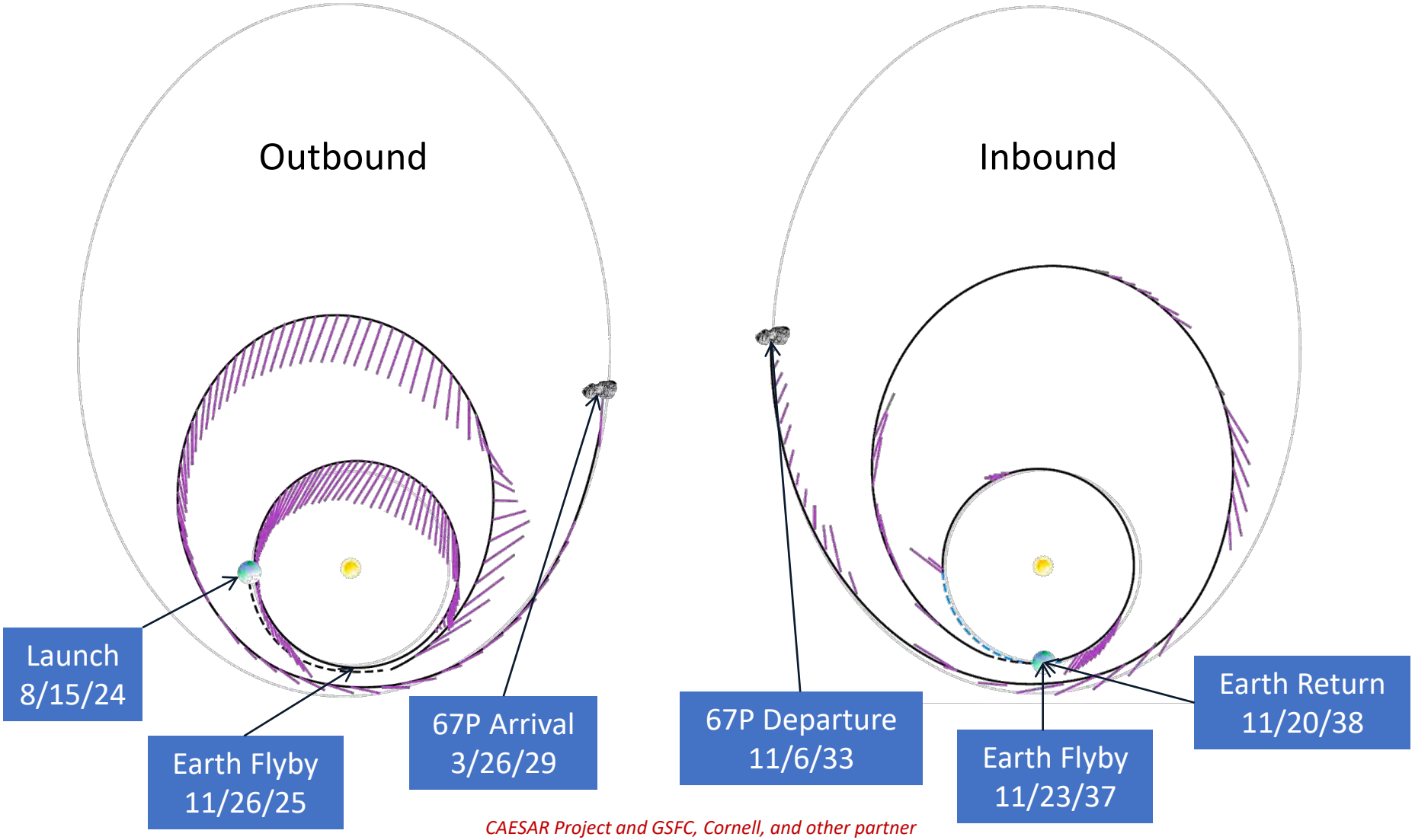
SEP Cruise to 67P

SEP Return to Earth

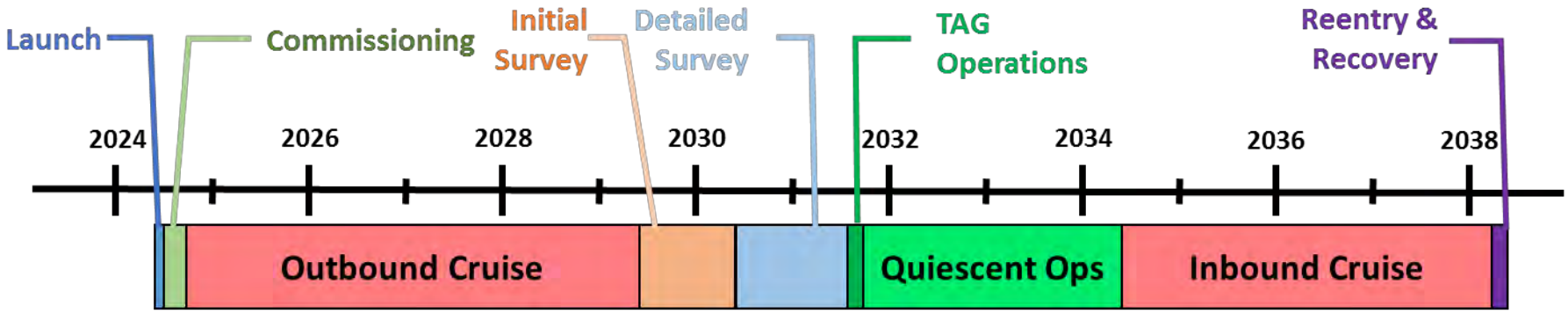
Launch

| | |
|---|---|
| Launch | August 2024 |
| Arrive at Comet | March 2029 |
| Depart Comet | November 2033 |
| Earth Return | November 2038 |

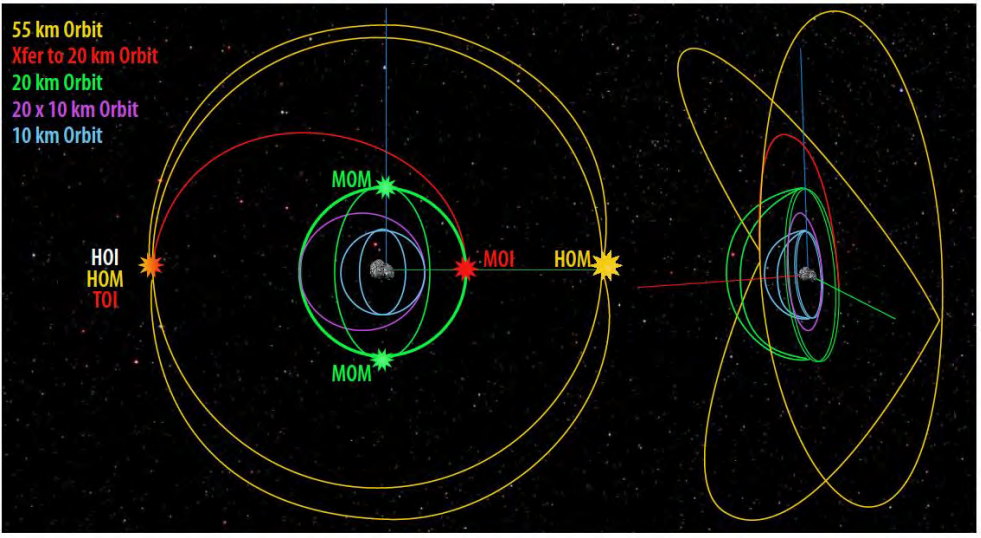
# CAESAR Trajectory



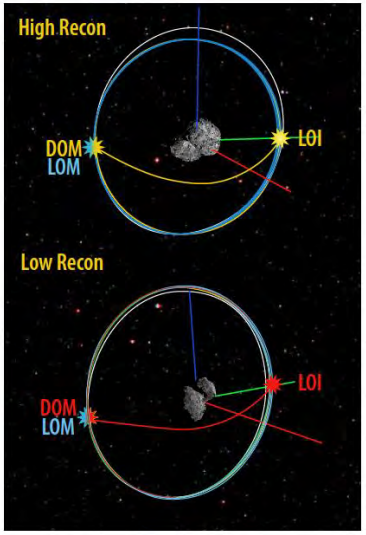
# CAESAR Mission Operations Phases



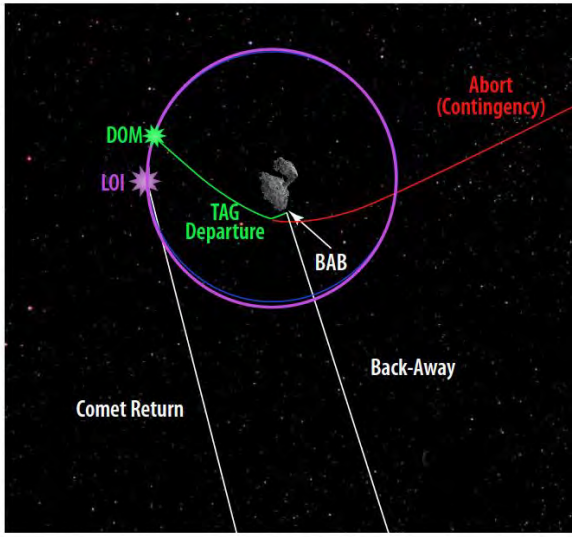

Initial Survey



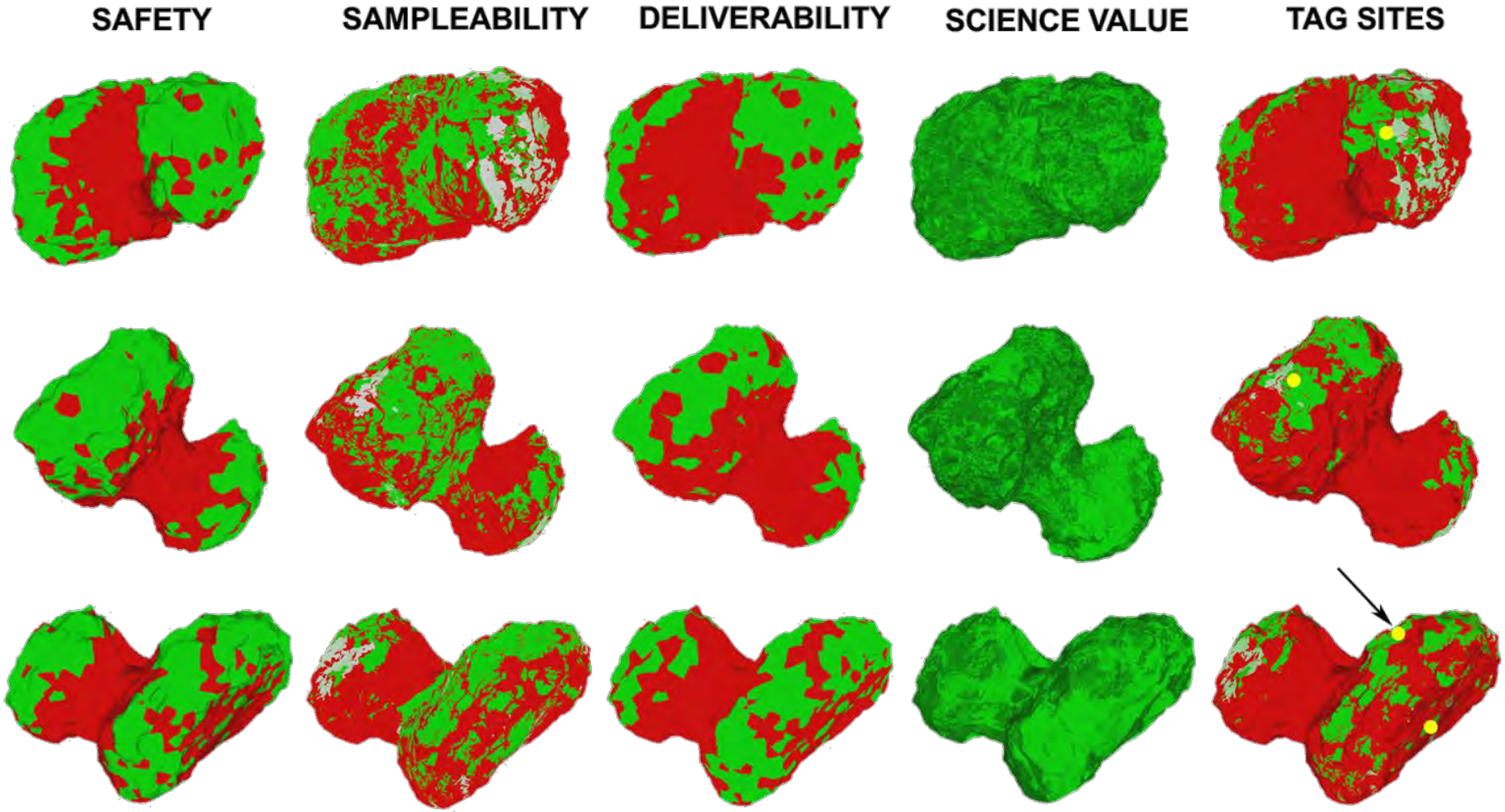

Detailed Survey



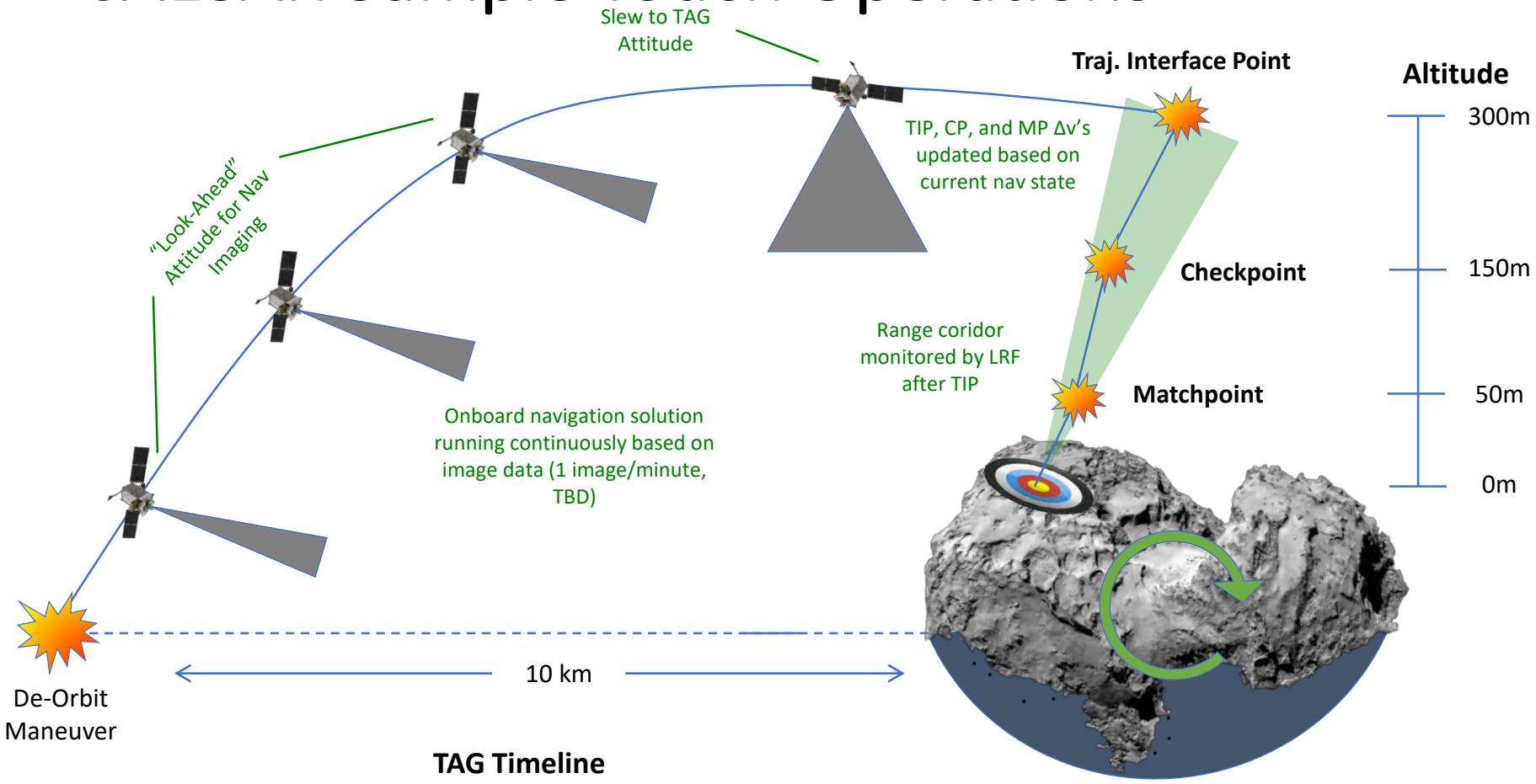

Light Touch Operations



# CAESAR Preliminary Touch Site Selection



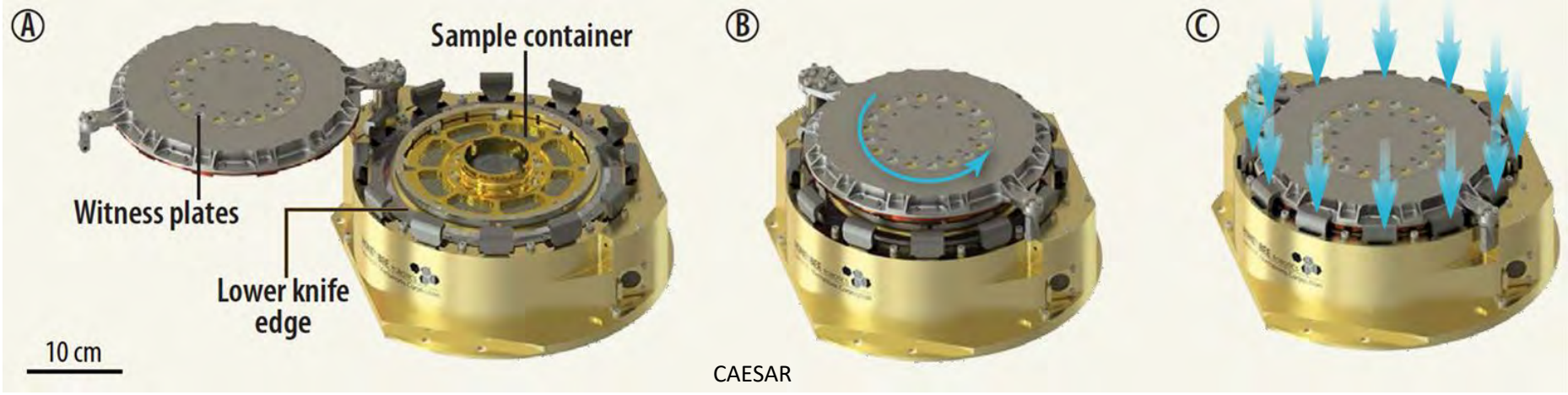
# CAESAR Sample Touch Operations



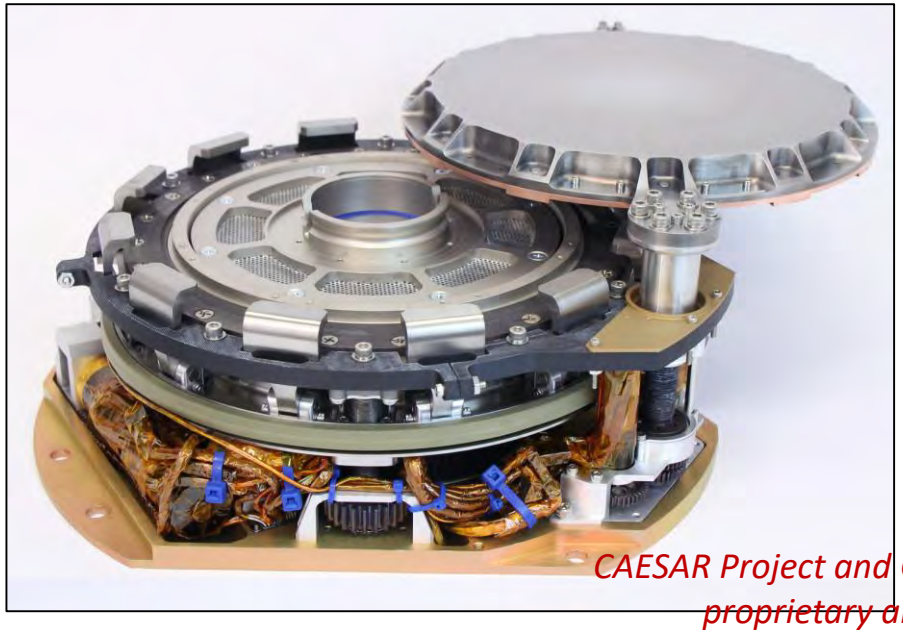

## TAG Timeline


# CAESAR Sample Acquisition System

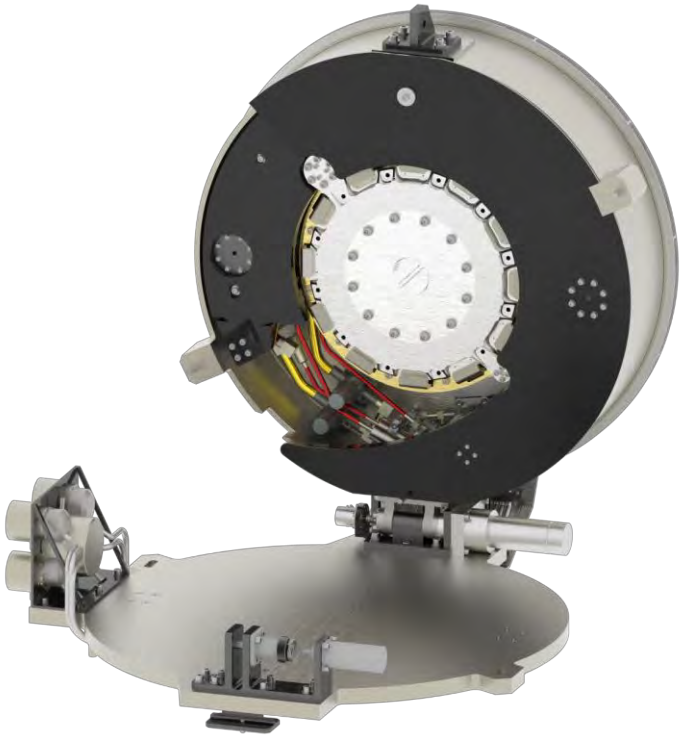
# CAESAR Sample Containment System

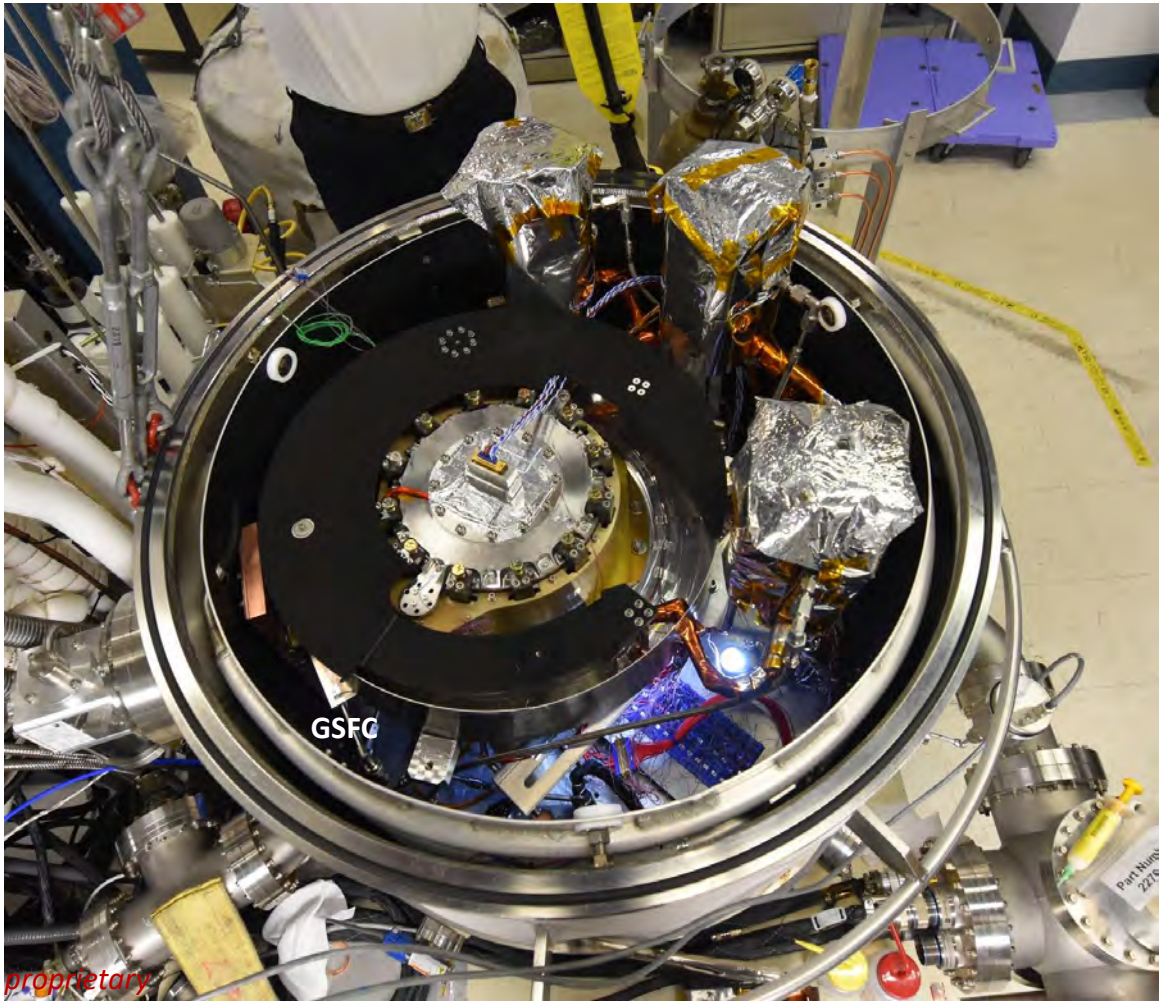



CAESAR

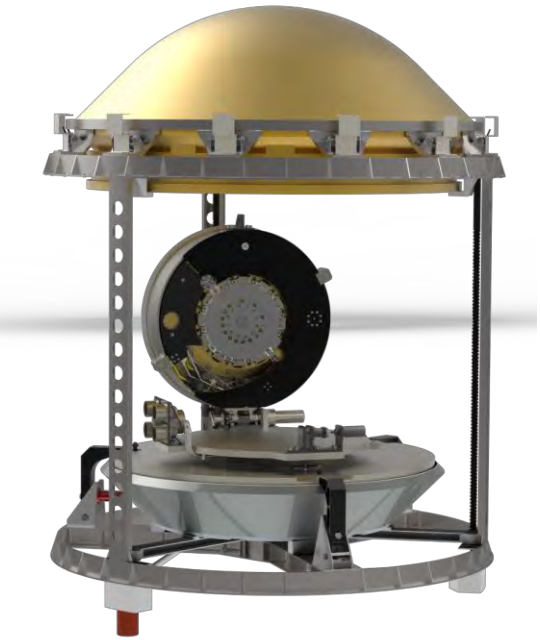


# CAESAR Gas Containment System

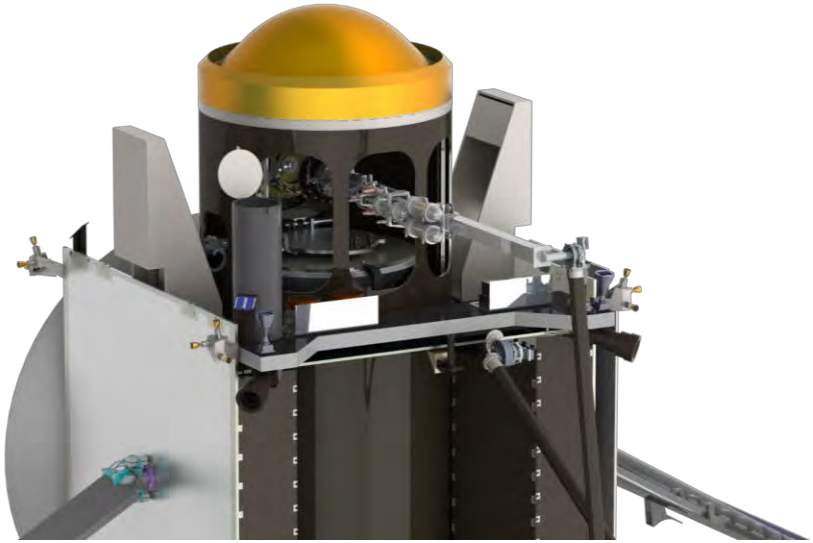




# CAESAR Sample Return Capsule



Stowed Sample Container

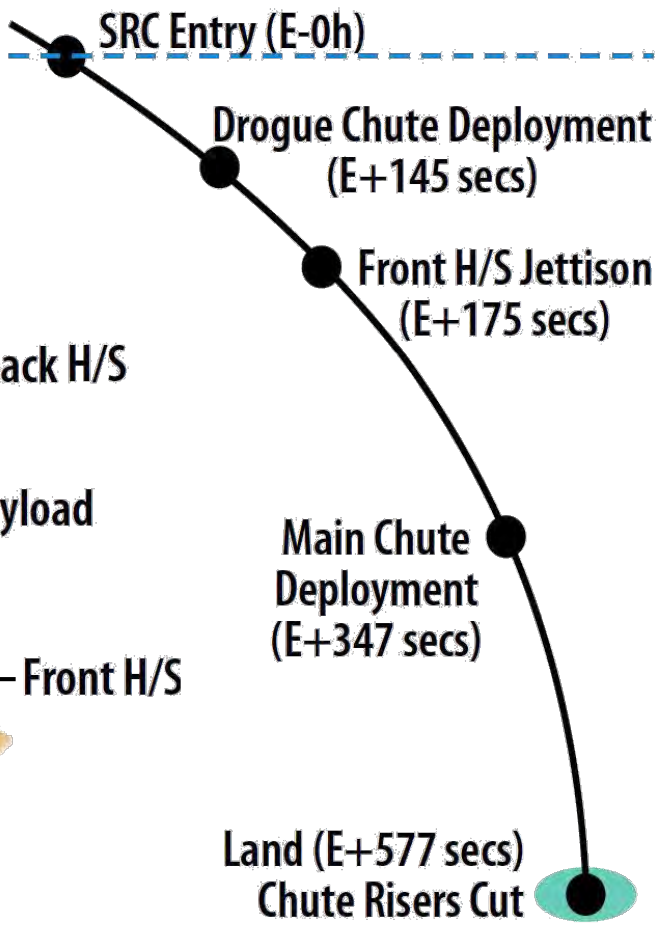


# CAESAR Sample Return Capsule

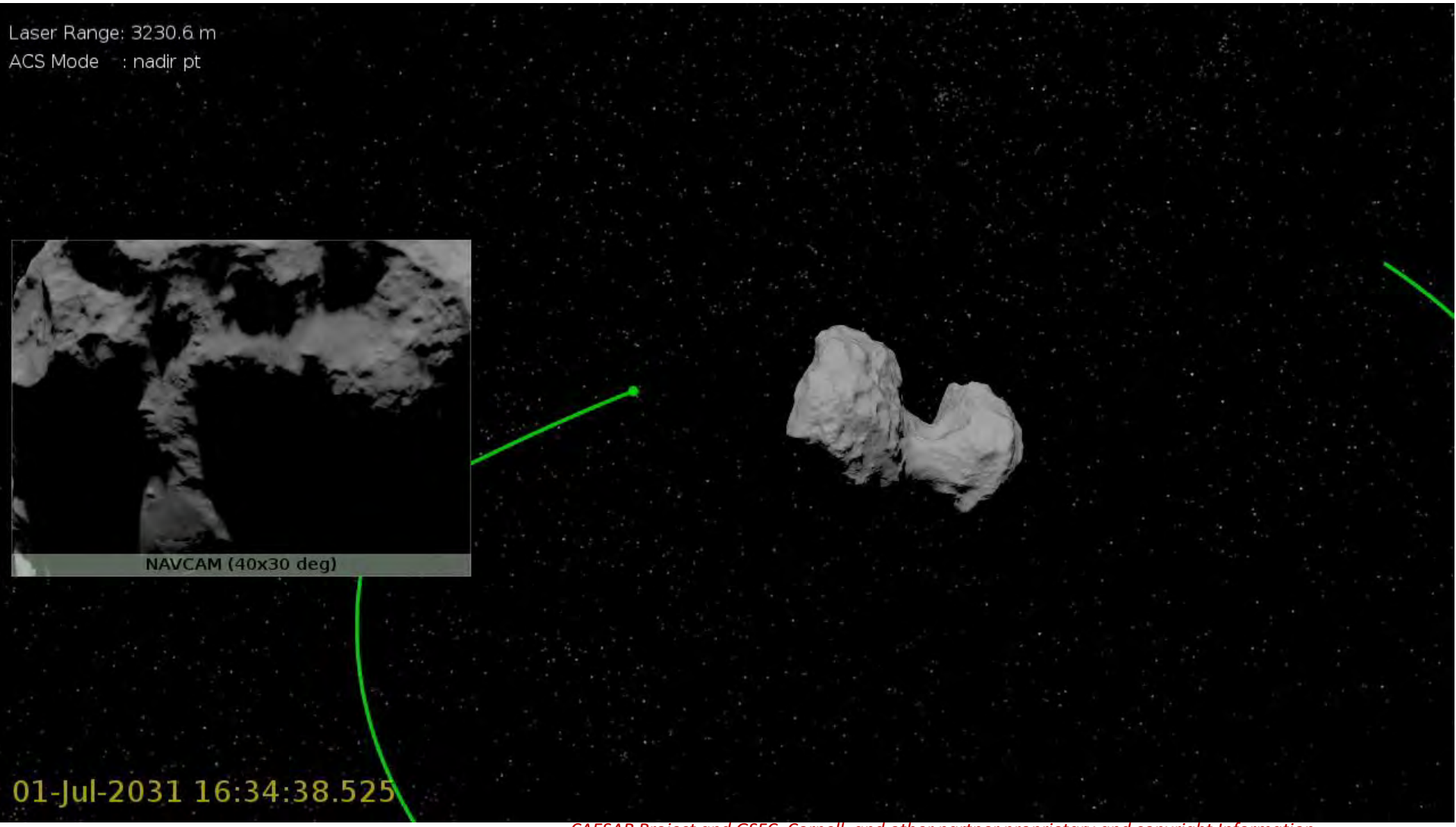
Drogue-chute Box H/S

Main-chute Box H/S






# CAESAR Sample Touch Operations



# BACK Up

# SRC Recovery