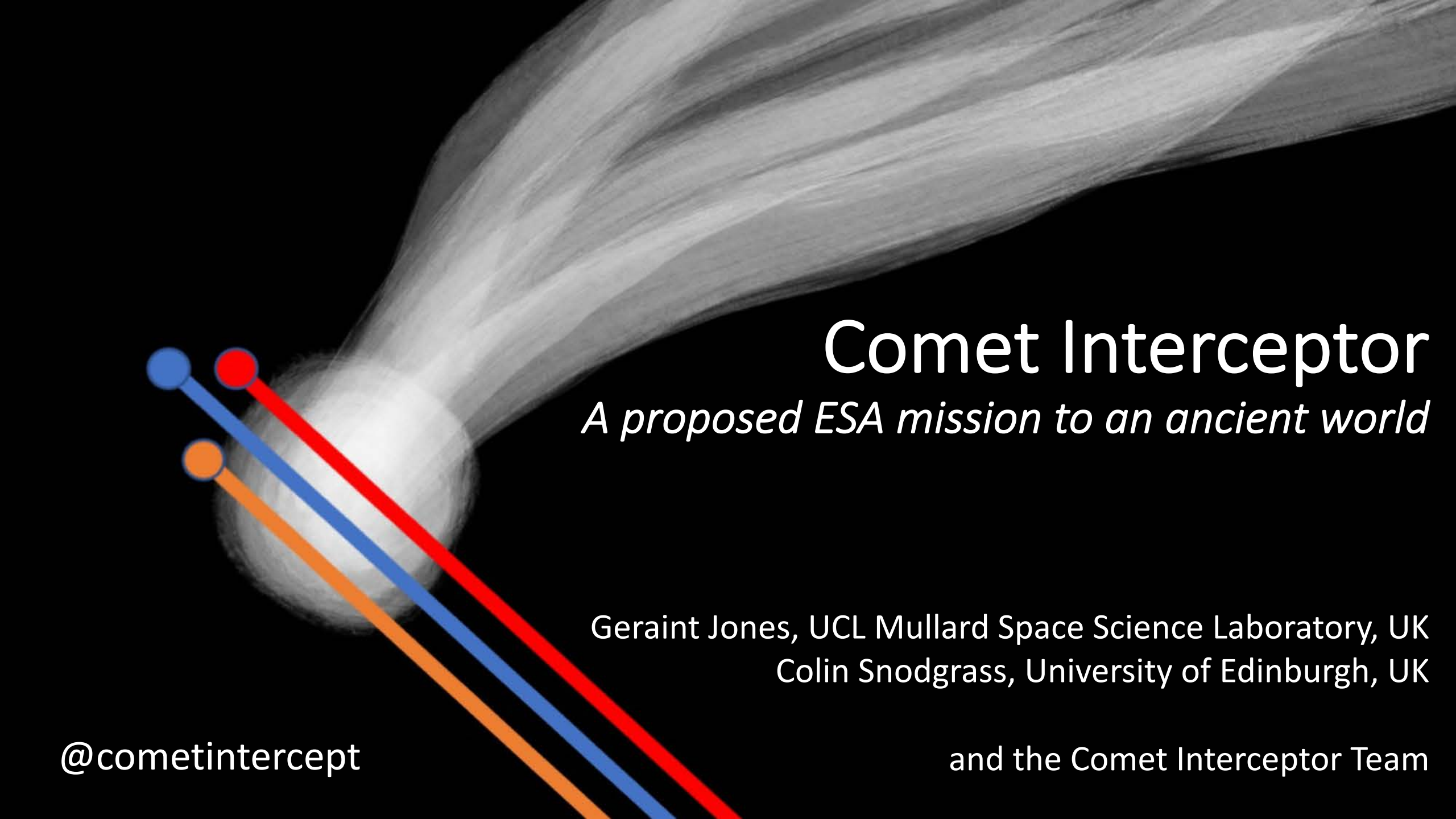


Comet Interceptor

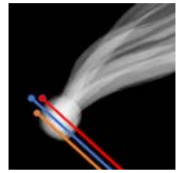
A proposed ESA mission to an ancient world

Geraint Jones, UCL Mullard Space Science Laboratory, UK
Colin Snodgrass, University of Edinburgh, UK

and the Comet Interceptor Team

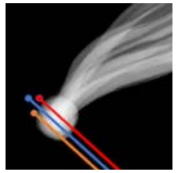
@cometintercept

Overview


Comet Interceptor

- **Comet Interceptor** is a mission proposed to ESA in response to its July 2018 F-class call for modest-sized missions. http://bit.ly/fclasscall
- Maximum cost to ESA at completion: €150M, but launch cost and science instruments not included in this sum.
- ESA member states and other collaborating agencies generally fund instruments and the science teams.
- Constraints: 850kg maximum wet mass; launch in 2028 with the Ariel exoplanet observatory mission; delivery to Sun-Earth L2.
- 23 proposals submitted to ESA in October 2018.
- Shortlist of 6 proposals, invited to submit Phase-2 proposal by March 20, 2019.
- **Comet Interceptor** is one of the 6 shortlisted proposals.

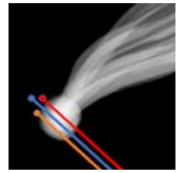
Comet Interceptor is a mission targeting a dynamically-new comet, or an interstellar object.



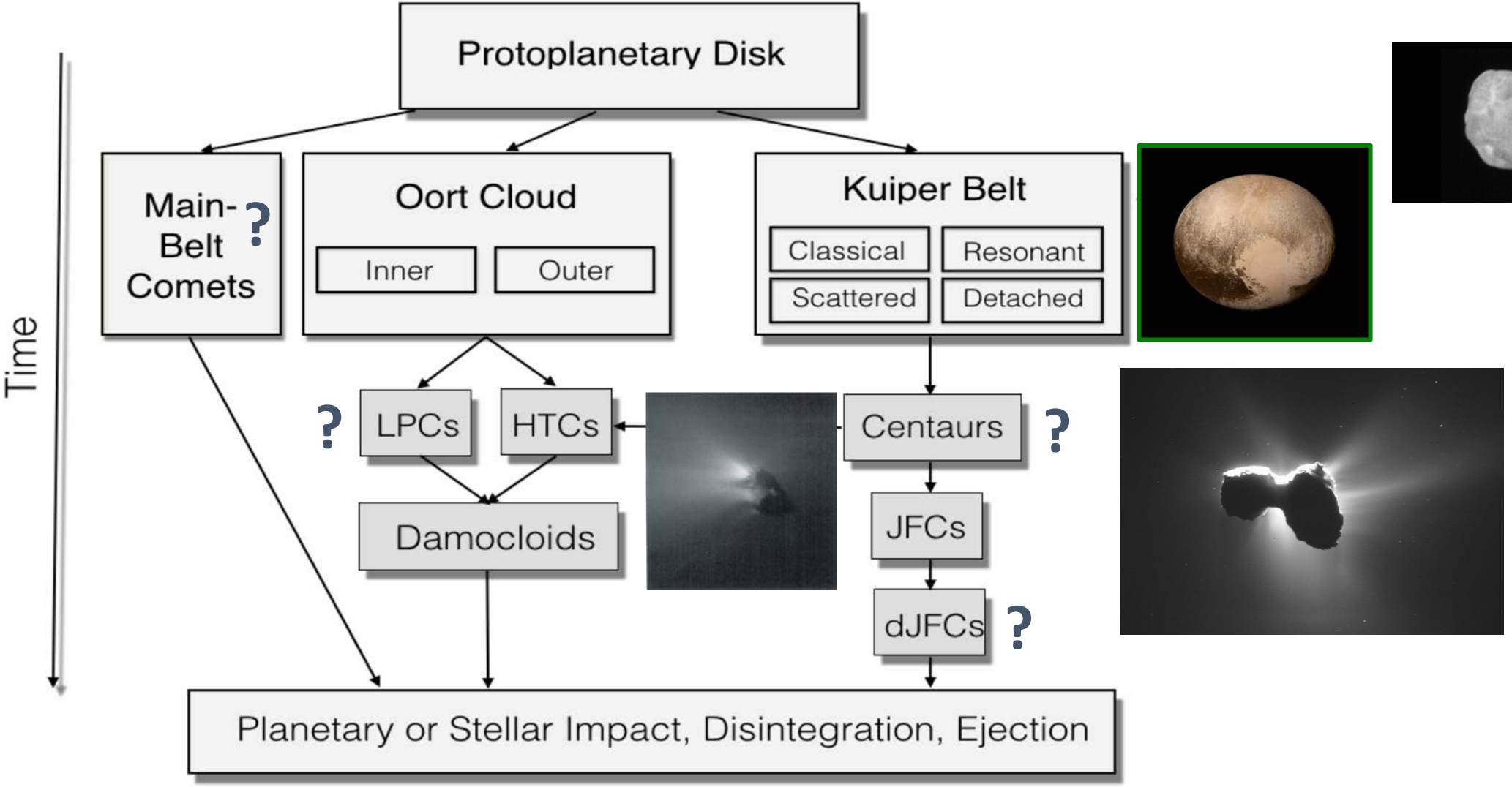
Why?

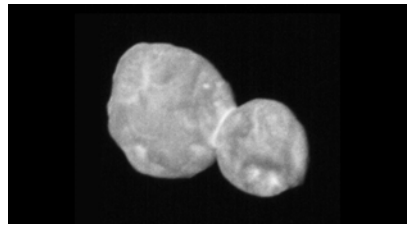
- All previous comet missions have been to objects that have passed the Sun many times
- Targets were relatively evolved, with thick dust mantles
- A dynamically-new comet (DNC) is one that is probably nearing the Sun for the first time
- A mission to a DNC would encounter a pristine comet, with surface ices as first laid down at the Solar System's formation

Evolution of different comet types



Pathways for icy bodies from planet forming disc





Jewitt 2018, arXiv:1808.04885

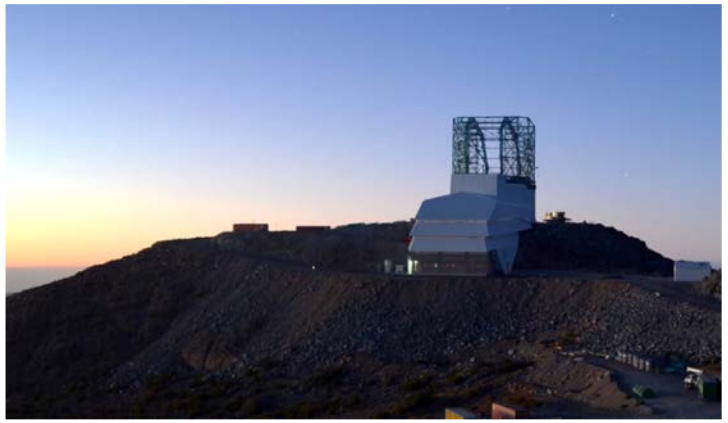
How?

- The only way to encounter a DNC is to discover it inbound with enough warning to direct a spacecraft to it

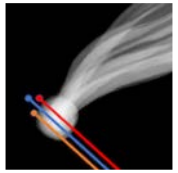
- The likelihood of this happening will soon be greatly increased by LSST

  - LSST probably won't increase the number of DNCs found every year, but will increase the distance at which they're discovered inbound

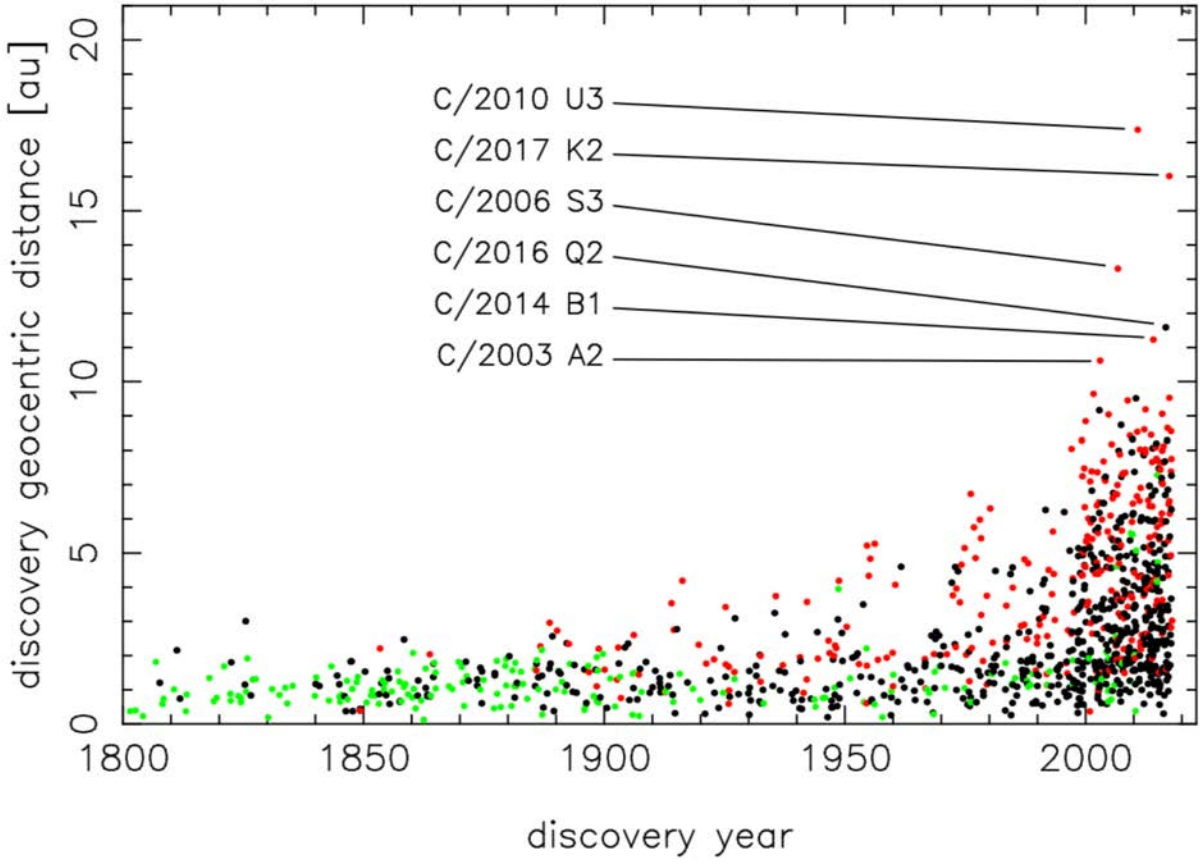
  - Comet Interceptor spacecraft can wait in dynamically-stable location L2 until the target is found



LSST Project/NSF/AURA

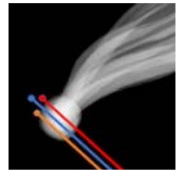


Comet Interceptor



M. Królikowska & P. A. Dybczynski 2019, arXiv 1901.01722

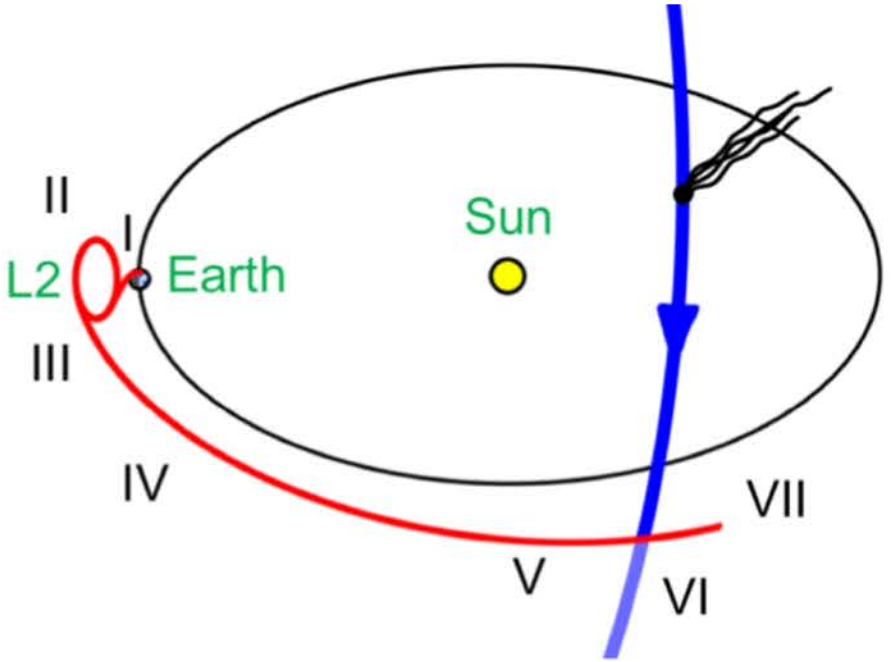
Mission Profile


Comet Interceptor

- Mission ‘parked’ at L2 after launch, waits for new target discovery by LSST or other ground-based survey (2-3 years)
- Short cruise and fast flyby near 1 AU
- Mothership with remote sensing payload, distant ‘safe’ flyby (few 1000km)
- Released subspacecraft take instruments on different trajectories through coma, including much closer to nucleus

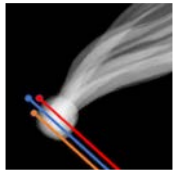
Mission Phases

I	Launch & delivery to L2
II	Station-keeping at L2
III	Departure from L2
IV	Cruise and instrument commissioning
V	Separation of spacecraft elements
VI	Target Encounter
VII	Data playback and solar wind studies, if possible



Not to scale

Challenges


Comet Interceptor

- Mission has to be designed to encounter comets on a wide range of possible trajectories: wide range of encounter speeds and geometries
- Retrograde orbits could mean flyby speeds >70km/s in worst case – have to design for this scenario
- Cost means that entire mission should be <5 years
- Wait at L2 therefore limited to ~3 years

Solutions

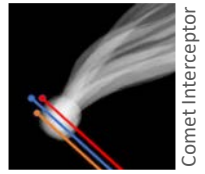
- If no suitable target found, backup short period comets identified
- Mission to a short period comet will also carry out new science: not a repeat of previous missions

New Science

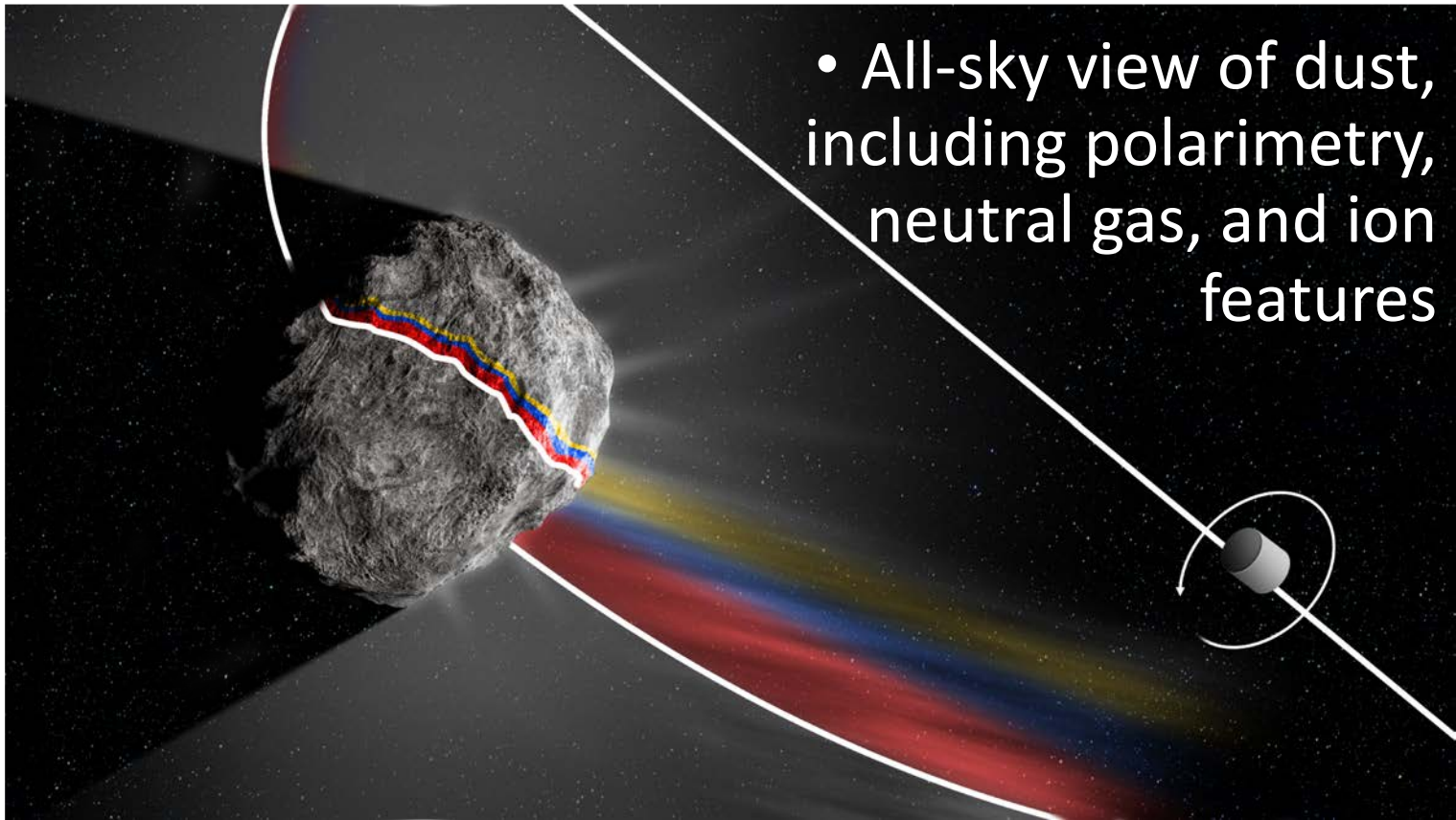
- **Multi-point measurements** of cometary environment, including plasma: separation of spatial and temporal effects.

- **Energetic Neutral Atoms**: first observations of solar wind-neutral charge exchange processes at a comet

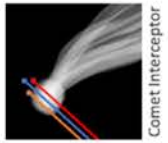
- **Multiple views of cometary nucleus:** views from three spacecraft reveal 3D structure of nucleus and coma from a single flyby



- **Entire Visible Sky**: EnVisS
- Multispectral and polarimetric mapper
- All-sky view of dust, including polarimetry, neutral gas, and ion features



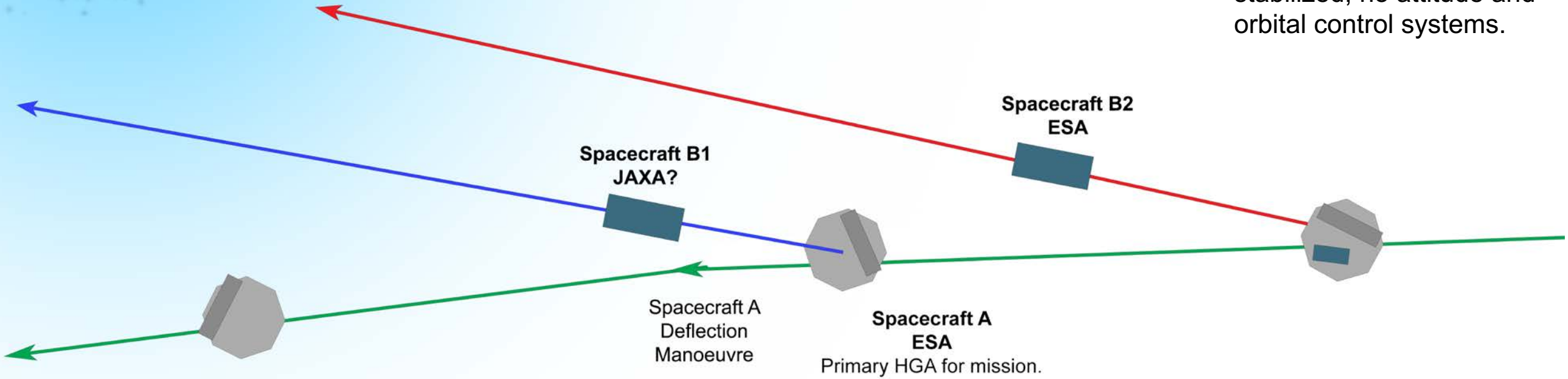
Nucleus

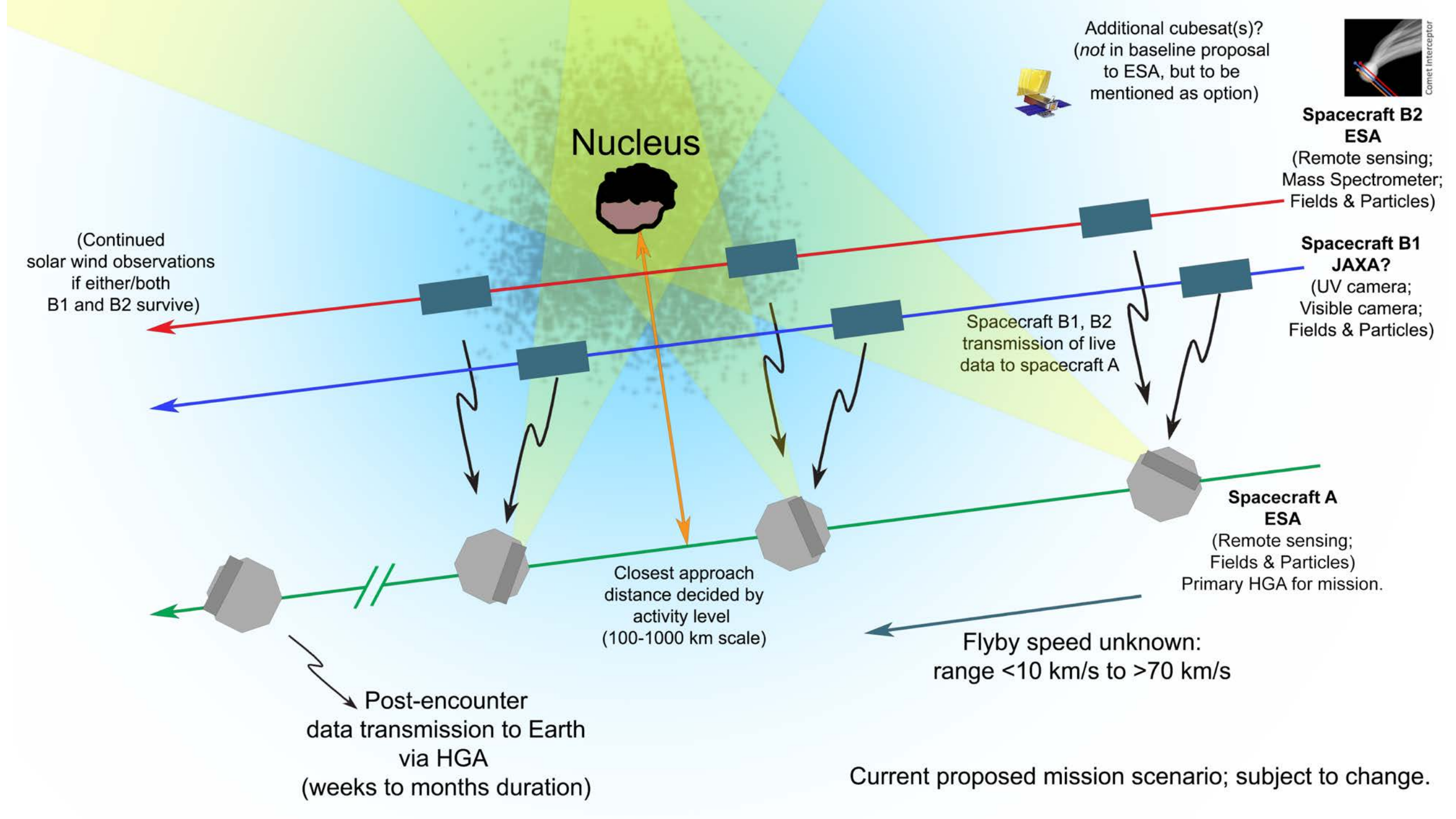


Current proposed mission scenario; subject to change.

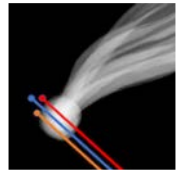
Sub-spacecraft separations 1 day - 3 weeks pre-encounter
(depending on desired miss distances)

For simplicity and to minimize cost, sub-spacecraft B2 will be spin-stabilized, no attitude and orbital control systems.




Additional cubesat(s)?
(*not* in baseline proposal to ESA, but to be mentioned as option)
Comet Interceptor
Spacecraft B2
ESA
(Remote sensing;
Mass Spectrometer;
Fields & Particles)
Nucleus
(Continued
solar wind observations
if either/both
B1 and B2 survive)
Spacecraft B1
JAXA?
(UV camera;
Visible camera;
Fields & Particles)
Spacecraft B1, B2
transmission of live
data to spacecraft A
Spacecraft A
ESA
(Remote sensing;
Fields & Particles)
Primary HGA for mission.
Closest approach
distance decided by
activity level
(100-1000 km scale)
Flyby speed unknown:
range <10 km/s to >70 km/s
Post-encounter
data transmission to Earth
via HGA
(weeks to months duration)
Current proposed mission scenario; subject to change.

Team

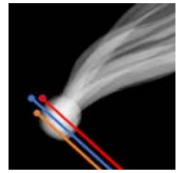


MIssion Proposal Lead: Prof. Geraint Jones, UCL Mullard Space Science Laboratory, UK
Mission Proposal Deputy Lead: Dr. Colin Snodgrass, University of Edinburgh, UK

The Comet Interceptor team comprises an international group of scientists and engineers at the following institutions, listed in no particular order:

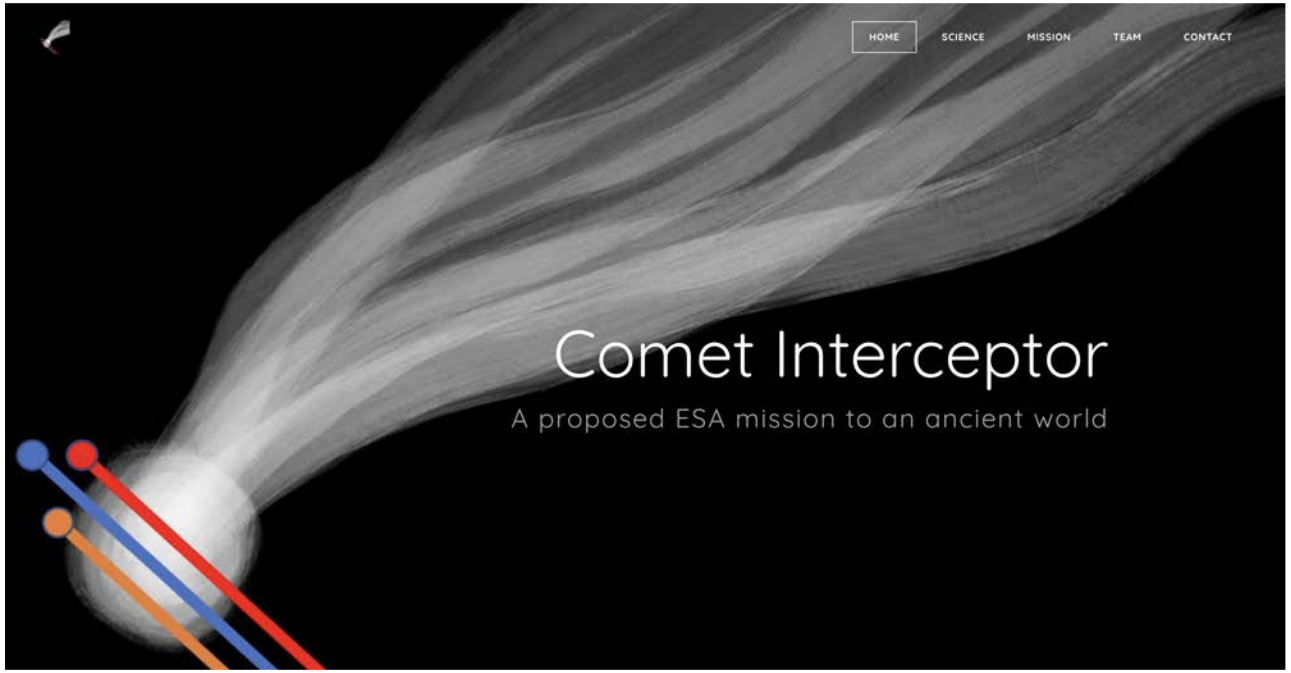
HAS, HU
IAP-CAS, CZ
U. Leuven, BE
U. Kent, UK
OEAW, AT
LASP, U. Colorado, USA
VTT, FI
U. Karlova, CZ
Wigner RCP, HU
ESO
U. Aalto, FI
U. Bern, CH
U. Cranfield, UK
U. Tartu, EE
CAS, CZ
NASA, USA
RAL, UK
IRF-U, SE
Birkbeck, UK
TU Braunschweig, DE
U. Helsinki, FI
LTU, SE
UTINAM, FR
BIRA-IASB, BE
IAA, ES
LPC2E, CNRS, FR
Obs. Paris, FR
U. Maryland, USA
KTH, SE
PPPL, USA
Rikkyo U., JP
MPS, DE
IRAP, FR
TU Braunschweig, DE
QUB, UK
IRF-K, SE
OU, UK
U. Padova, IT
SSI, USA
U. Oxford, UK
INAF, IT
Imperial, UK
U. Glasgow, UK
QMUL, UK
MSSL-UCL, UK
CNR-IFN, IT
U. Tokyo, JP
U. Hawai'i, USA

US involvement



- Several US-based scientists already involved in the proposal.
- Possibility of a NASA-funded cubesat not part of the baseline mission, but proposal will make it clear that such a contribution is possible if mass allows.

Interested?



@cometintercept

http://www.cometinterceptor.space/

Expression of support can be noted via the website

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