IDENTIFICATION OF TARGETS FOR ESA'S COMET INTERCEPTOR MISSION. C. Snodgrass[1], Joan-Pau Sánchez[2], Matthew M. Knight[3], Marco Micheli[4], Meg Schwamb[5], Aurelie Guilbert-Lepoutre[6], Carrie Holt[7], Nicolas Biver[8], Laura Inno[9], Rosita Kokotanekova[10], Fiorangela La Forgia[11], Elena Mazzotta Epifani[12], Takafumi Ootsubo[13], Geraint H. Jones[14], Cecilia Tubiana[15], Carlos Corral Van Damme[4], and Michael Kueppers[4], [1]University of Edinburgh, (csn@roe.ac.uk),[2]Institut Supérieur de l'Aéronautique et de l'Espace (ISAE-SUPAERO), France, [3]United States Naval Academy, USA, [4]European Space Agency, [5]Queen's University Belfast, UK, [6]CNRS/Université de Lyon, France, [7]University of Maryland, USA, [8]LESIA, Observatoire de Paris, France, [9]Parthenope University of Naples, Italy, [10]National Astronomical Observatory, Bulgaria, [11]University of Padova, Italy, [12]INAF-Osservatorio Astronomico di Roma, Italy, [13]National Astronomical Observatory of Japan, Japan, [14]Mullard Space Science Laboratory, University College London, UK, [15]INAF- Istituto di Astrofisica e Planetologia Spaziali, Rome, Italy.

Introduction: Comet Interceptor was selected by ESA in 2019 and is due to launch in 2029, to perform a fly-by of a yet-to-be-discovered comet in the 2030s [1]. It will do this to perform a first encounter with a relatively pristine Long Period Comet entering the inner Solar System for the first time – in contrast with previous missions to Short Period Comets that have evolved after many close perihelion passages. The mission is unique in that it will be designed, built, and possibly even launched before its target is known. The spacecraft will wait in space, in a halo orbit around the Sun-Earth L2 point, between launch and the date it needs to depart to reach its interception point with its target comet. During the fly-by the main spacecraft will perform remote sensing and in situ measurements from a relatively safe distance, with a closest approach of about 1000 km, while two deployable small-sat probes will venture closer. The probes are supplied by JAXA and ESA and are designed to be expendable and short-lived, transmitting the data they collect back to the main spacecraft for storage and subsequent downlink to Earth over a period of months after the fly-by.

Target requirements: To enable spacecraft design within the mission budget and schedule constraints, a series of requirements are imposed on the choice of comet. For thermal design and energy / Δv reasons the spacecraft can only encounter its comet within a range between 0.9 and 1.2 au from the Sun, and close to the ecliptic plane, which defines a flattened torus of possible comet encounter locations. The target comet must therefore have an orbit with perihelion distance below 1.2 au and a node within 0.9 – 1.2 au. We further require the relative velocity between the spacecraft and comet at the fly-by to be < 70 km/s and at an angle towards/away from the Sun of > 45 degrees, for safety against dust impacts, and for thermal and power reasons and remote sensing instruments Sun avoidance, respectively. Slower encounters, i.e. avoiding retrograde orbits that give the highest velocities, and encounters at the pre-perihelion node are strongly preferred, but the limits are based on the Giotto encounter with comet Halley as a 'worst case'. We also therefore require a target with total activity at a similar level, or less, than Halley, but have to trade safety of the spacecraft with expected signal levels for in situ instruments when considering the expected activity level of the comet. A comet encounter that is relatively close to Earth is much better than one on the far side of the Sun, for both data transfer and complementary ground-based observations.

The mission will launch as a secondary payload with the ESA Ariel space telescope and is therefore highly constrained in the available mass. As the launch will be on the as-yet untested Ariane 6-2 rocket, there is also considerable uncertainty on what the final available mass for Comet Interceptor will be – plans currently have to assume a 'worst case' on launcher performance. This translates directly into a strong limit on the possible fuel mass, and therefore Δv available for departure from L2 and any deep space maneuvers. For budget reasons, the mission is also limited to a total duration, including waiting at L2, cruise, fly-by, and post-encounter data downlink, of 6 years. The available Δv and the length of the cruise place constraints on where can be reached, within the torus of possible encounter locations [2].

Choice of possible comets: We find a high probability that there should be reachable comets within these constraints. This depends on exactly how much warning time we have between discovery of the comet and needing to depart L2, as longer cruise times give a wider range of possible encounter locations. This in turn depends on the size and intrinsic activity level of the comet, how its brightness evolves with distance from the Sun, and the sensitivity and cadence of the survey that detects the comet (which will probably be the Vera C. Rubin observatory's LSST). In this presentation we will describe our studies of distant cometary activity, simulations of future comet discovery, and how we plan to characterize and prioritize potential targets for Comet Interceptor in the coming years.

References: [1] C. Snodgrass, et al. (2019) Nature Communications 10:5418 [2] J. P. Sánchez, et al. (2021) Acta Astronautica 188:265