BEPICOLOMBO TRAJECTORY OPTIONS TO MERCURY IN 2016 AND 2017

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ABSTRACT

BepiColombo is a cornerstone mission of the ESA Science Programme, to be launched towards Mercury in 2016 with back-up launch opportunities in 2017. After a journey of more than 7 years two probes, the Magnetospheric Orbiter (JAXA) and the Planetary Orbiter (ESA) will be separated and injected into their target orbits. The baseline interplanetary trajectory includes flybys at the Earth, Venus (twice) and Mercury (five times), as well as several low-thrust arcs provided by the solar electric propulsion module. At the end of the transfer an orbit insertion burn will be performed. If it fails the spacecraft will still be gravitational captured in an orbit around Mercury.

Since a direct Hohmann transfer to Mercury requires excessive launch and arrival ΔVs of about 16 km/s in total, a more economic approach is the combination of low-thrust propulsion arcs with flybys. An Earth flyby is usually required to deflect the spacecraft into the right orbital plane to reach Venus and the two Venus flybys are required to reduce the perihelion distance by rotating the V_∞-vector at the Venus flybys from a radial direction to a retrograde direction.

In order to find transfer trajectories to Mercury, launch opportunities to Venus need to be investigated. Earth and Venus are roughly in a 8:13 resonance and therefore launch windows repeat every 8 years. Already in 2009 there was a 18-month gap in launch opportunities and the same geometry is encountered in 2017. However, this can be mitigated by extending the Earth-to-Earth arc from 1 to 2 years: The launch will take place in July 2016 and the Earth flyby in July 2018. The advantage of this scenario is that back-up launches can be determined 6 and 12 months later, reducing the Earth-to-Earth arc to 540 or 360 degrees (1.5 or 1 year), but following exactly the same trajectory after the Earth flyby. For each of three launch dates the options exist to launch radially inward or outward and thus be trailing or leading the Earth during the Earth-to-Earth arc. (The current baseline is a radially inward launch which leads to an Earth-leading trajectory.) The pros and cons of these options will be discussed.

Finally, there is a unique opportunity in January 2017 to launch directly to Venus with a low escape velocity of about 2.7 km/s and a low declination that favours a high Ariane 5 launcher performance. Three Venus flybys will be required before the classical Mercury flyby sequence will be started. Nominal arrival is also on 1 Jan 2024 like in the baseline option, but possibilities may exist in both scenarios to advance the arrival date. Again the pros and cons of all options will be investigated.