Rene Michelsen, Copenhagen University.
Anja Andersen, Nordita.
Henning Haack, Geological Museum.
John Leif Jørgensen, Technical university of Denmark.
Maurizio Betto, Technical university of Denmark.
Peter Siegbjørn Jørgensen, Technical university of Denmark.

The “Bering” small vehicle Asteroid mission concept.

The study of the Asteroids is traditionally performed by means of large earth based telescopes, by which orbital elements and spectral properties are acquired. Space borne research, has so far been limited to a few occasional flybys and a couple of dedicated flights to a single selected target.

The keen interest in Asteroids stem from the fact, that these object carry information on solar system and planetary genesis, solar system evolution and history, and, since Asteroids form the source for near earth objects, also for the study of NEO’s. The properties sought for are therefore both statistical, i.e. such as flux and orbital, size and taxonomic distribution, and, morphological, i.e. erosion state, surface composition etc..

While the telescope based research offers precise orbital information, it is limited to the brighter, larger objects, and taxonomy as well as morphology resolution is limited. Conversely, dedicated missions offers detailed surface mapping in radar, visual and prompt gamma, but only for a few selected targets. The dilemma obviously being the resolution vs. distance and the statistics vs. delta-V requirements.

Using advanced instrumentation and onboard autonomy, researchers from Copenhagen University, Denmark and the Technical University of Denmark, has developed a space mission concept whose goal is to map the flux, size and taxonomy distributions of the Asteroids. The main focus is on main belt objects, but the mission profile will enable mapping of objects inside the Earth orbit as well. This mission has been given the name “Bering” after the famous navigator and explorer.

The mission consist of two identical space probes that will fly in a loose formation. Each probe will carry a suite of advanced yet robust instruments that will allow for fully autonomous detection, tracking, mapping and ephemerid estimation of Asteroids. The autonomous instrumentation suite also enable automatic linkup with Earth and inter spacecraft communication.

The autonomous operations of the instruments are centred on the Advanced Stellar Compass (ASC). The ASC is a miniature star tracker, that was developed to generate accurate attitude information, but it may deliver spacecraft velocity and position information. Furthermore, since the ASC autonomously detect any luminous object in its field of view, any Asteroid there will be detected and tracked. Each space probe will carry eight ASC’s to giver full sky coverage. The main instrument of the probe is a precision tracking telescope fitted with a multi-spectral imager. When one of the ASC’s has detected an object of interest, the tracking telescope is pointed to the target field via guidance from dedicated ASC mounted on the secondary of the telescope.

The proposed mission profile encompass a swing-by manoeuvre at Venus. To allow for a comprehensive mapping of NEO's, the swing-by will take place on the second perihel passage, after which the probes will leave for the main asteroid belt. A subsequent kick burn at aphelion will ensure a proper scanning of the Asteroid belts and ensure a mapping of all Asteroid classes.

The loose formation flying has two objectives. Firstly, it allow for generation of distance information to the target, which otherwise would be constrained only. Secondly, the miniature probe concept will conflict with the need for redundancy of the main telescope. Because of the autonomous inter spacecraft link, made possible by the ASC's, only the possibility of stereo imaging of a target is lost should one of the telescopes fail.

This paper describes the scientific scope and expected level of goal achievement, rationale for mission profile, mission stages and the operation of the key technologies. The autonomous operations and estimated performance level of the probes are discussed, based on measured accuracies of the ASC instrument already inflight, the ASCFIT telescope guider and the ASCANT link-up algorithm.