Polish Space Agency

Training Opportunity for Polish National Trainees

Reference	Title	Duty Station
PL-2023-OPS-GF	**Flight Dynamics Division Support**	**ESOC, Darmstadt**

Overview of the mission:

The Flight Dynamics Division is responsible for providing mission analysis and flight dynamics operations support to ESA missions in the fields of orbit determination, manoeuvre optimisation, GNC monitoring and commanding. This includes several interplanetary missions (e.g. BepiColombo), astronomy missions at the Sun Earth Lagrangian points (e.g. Euclid) and Earth orbit missions (Sentinels fleet). The support covers the entire mission life cycle, comprising design, development, implementation and validation of Software tools, mission preparation and critical and routine operational activities.

Overview of the field of activity proposed:

As a Polish National Trainee in the Flight Dynamics Division, you will have the choice of the following topics:

Topic 1: Future improvements in new generation Flight Dynamics software (GENEOS)
The successful candidate would evaluate and eventually implement novel features in the new Flight Dynamics (FD) software for Earth Observation (EO) missions (GENEOS) that may improve its footprint as the European reference for Flight Dynamics Systems; taking into account potential future ESA missions as well as commercial/private missions. GENEOS is currently used in satellite operations and is a mixture of C++ and python. The successful candidate can also be involved in routine operations as part of their duties to provide a more complete training experience.

You will be based in the Earth Observation Mission Support Section of the Flight Dynamics Division. The division provides a comprehensive end-to-end, multi-project service covering all Flight Dynamics functions for the missions ESOC operates, including the provision of the necessary tools and systems and the relevant mission support from the mission analysis phase through the operation phase and up to the decommissioning phase. In addition, the division is the coordinator for mission analysis activities in ESA and undertakes innovative studies in related fields in order to prepare for future mission requirements.

Topic 2: Earth swing-by anomaly

During Rosetta's first Earth swing-by, what is referred to as the "Earth swing-by anomaly" was observed. The anomaly is that – in contrast to the theory - the incoming asymptotic velocity did not match the outgoing asymptotic velocity by a small, but detectable difference. The anomaly has also been observed by NASA operated spacecraft in the past. I has only been observed at some Earth swing-bys, but not at all, and it has never been observed at swing-bys at other solar system bodies. There have been quite a few attempts within the science and engineering community to find an explanation for that anomaly but to date without success. One candidate explanation for the anomaly is a shortcoming of the

underlying algorithms that are used in deep space navigation software. All Earth swing-bys of ESA spacecraft (namely Rosetta, BepiColombo and Solo) have been navigated using ESA deep space orbit determination system which was developed around the year 2000 in preparation for Mars Express and Rosetta. For new missions today, a new deep-space navigation software is being used which is based on the GODOT astrodynamics common infrastructure. It is worth to check whether the observed Rosetta anomaly can be reproduced by using the new software. It is also worth to check whether the anomaly occurs at one of the later Earth swing-bys of Rosetta, BepiColombo and Solar Orbiter when using the new software, since none was observed using the old operational navigation software at the time. The task of the national trainee would be to restore all relevant historic data of past Earth swing-bys of ESA missions (5 to date), configure the new navigation software such that it is able to process the data and to verify whether the observed results in flight could be reproduced. If yes, then various more tests could be performed using different models. If no, then the underlying algorithm is suspected and could be inspected closer. Either way does attempt to find a possible explanation for the anomaly.

Topic 3: Hera Observation Scheduling

The Hera spacecraft is planned to rendezvous with the binary asteroid Didymos after Nasa's DART spacecraft impacted in Didymos' moon. Hera's ateroid phase is planned to last 6 months and it is expected to fulfil an ambitious list of science requirements using a suit of payload instruments on-board Hera.

Hera operations are conducted by ESOC and includes the scheduling and commanding of Hera's payload instruments. Based on a list of observations that is being compiled by a team of scientists, it will be one of the tasks of Flight Dynamics Team to define the schedule of these observations.

The scheduling of these observations is a complex task, because certain parameters of the Didymos system, such as the moon's orbital phase and attitude motion, cannot be predicted today and it is not clear whether the science requirements can be fulfilled for the full range of possible system parameters in the presence of existing SC constraints (e.g. contact during station passes, wheel off loading etc). Aim of the proposed traineeship is to define the process for scheduling Hera observations including definition of its input from the science team and output to the Flight Control Team. The process is validated by assessing to which extend science requirements are met considering variation of relevant system parameters. If requirements are not met alternatives are explored in collaboration with the Flight Control Team and scientists with the aim to maximise the science return of the Hera mission.

Required education and skills:

- You should have recently completed or be in the final year of your master' s degree in a technical or scientific discipline
- Good interpersonal and communication skills
- Ability to work in a multi-cultural environment, both independently and as part of a team
- Fluency in English and/or French, the working languages of the Agency