This is a letter of recommendation for Antigoni Georgiadou to strongly support the application for the NSF Mathematical Sciences Graduate Internship (MSGI) Program. Antigoni worked in close collaboration with me for 5 months, during her visit as a trainee at ESA/ESOC. Therefore, I believe that I can verify her strong dedication to learn, and inclination to science. She also interacted well with all members of our team, so I can attest her ability to work successfully at an internship.

During Fall 2017 Antigoni spent dissertation hours abroad working at the European Space Agency (ESA) in Darmstadt, Germany in the area of Machine Learning Modelling Methods for Radiation Belts Profile Predictions. The project is related to the prediction of the space radiation environment and its effects on spacecraft operations and hardware, particularly the solar panels. While radiation monitoring instruments on-board, in general, provide for instrument safety, it is of vital importance to accurately predict the future radiation belts entry and exit times to allows precise planning of the deactivation and activation in a controlled manner. This not only optimizes scientific return but also protects the instrument, insofar as possible, against long term degradation and mitigates against possible failure of the on-board radiation monitor.

There were a number of tools already available partly based on regression analysis of data provided from a network of ground, balloon and space based space weather observatories, while others rely on either a completely theoretical model or a combination of the two approaches. Unfortunately, neither approach was particularly accurate for either XMM or Integral due to a variety of factors nor suitable for medium term predictions. This had implications for the optimization of the scientific program and also for the instrument payload safety.

During her visit in ESA/ESOC in Darmstadt Ms. Georgiadou spent time divided between the XMM- Integral Flight control team (FCT), the data analytics team (DA) and the Flight dynamics team (FD) in order to familiarize with operations, orbital mechanics and machine learning. Antigoni implemented and optimized the algorithm and validated against existing data with support from the FCT, FD & DA with Machine Learning Methods. She worked on unsupervised learning with Random Decision Forests, a method that uses as the training algorithm the technique of bootstrap aggregating or bagging where given a training set X with responses Y, bagging repeatedly selects a random sample with replacement of the training set and fits trees to these samples. Antigoni will communicate the final results via a formal technical note and presentation to the International Conference in Space Operations 2018 in Marseilles, France. Antigoni’s work in Germany was fully funded by the DAAD short-term research grant.

Antigoni played a critical role in all these activities, so she is certainly stronger than a typical graduate student. In summary, I think the proposed activities at an NSF Internship will enrich Antigoni’s knowledge and lead to new and important discoveries. So I strongly support Antigoni’s application.