Reason for the Request for an Additional STA for the REAL Spacecraft

An additional STA is requested to: 1) provide additional time to gather the science data needed to complete the investigation, and 2) take advantage of a unique flight opportunity to improve instrument performance for a future NASA mission. Each of these goals is described here.

1. **Complete the Science Investigation**

Several challenges were encountered early in the REAL mission which delayed the start of science operations. These included difficulty with commanding the spacecraft and performance issues with the instrument, that are still being addressed. The result of these challenges was a delay to the start of science operations and a reduction in the rate science data collection.

For the first few months of the mission, the UHF ground station at Montana State University struggled to command the spacecraft. The team worked diligently to identify and fix several issues that were cutting into the link margin. The Doppler correction algorithm was updated, and the antenna rotors were replaced. Although commanding has improved, the link margin is still suboptimal, impacted by a noisy Earth station environment. To address this, we built and licensed a second ground station at Dartmouth College in New Hampshire. That station is now routinely receiving spacecraft telemetry. We expect this station to be operational in the next couple of weeks.

Due to the challenges cited above, the REAL concept of operations was modified. This modified conops generates more total data than originally planned, but is less efficient at confining the data to the orbit segment of interest (the auroral regions at high latitudes). Additionally, less spacecraft health and other information is being downlinked than desired. Both the delays in start of operations, and reduction in science data volume per day, can be mitigated with an extension of the mission.

In addition to communications issues, commissioning of the instrument took longer than planned, delaying the start of science data collection.

Instrument performance is still being improved. The REAL instrument has three sensor heads, designed to measure electrons in three energy ranges:

- The medium energy sensor needed tuning early but has been collecting good science data.
- Commissioning of the low energy sensor was delayed until December , and the data was noisy, decreasing sensitivity. In February, work to find optimal threshold settings was completed and the low energy sensor is now operating well.
- The high energy sensor is still being adjusted to optimize its performance. Noise in the high-energy sensor reduces its efficiency. Additional time will enable better quality data from the high energy sensor to be collected, allowing the impact of energetic particles on Earth's upper atmosphere to be understood.

2. Improve Instrument for Future Missions

REAL provides a unique opportunity to test and improve an energetic particle instrument for future NASA and operational missions. The instrument used on REAL is a prototype of the primary instrument on NASA's Small Explorer mission, CINEMA, which was recently selected to move into the preliminary design phase (Phase B). It's very difficult to truly replicate the flight environment on the ground. Our continued ability to adjust instrument settings and test the performance of the instrument is invaluable..

Since CINEMA will fly in a similar orbit as REAL, it provides an important opportunity to gather and apply lessons learned. The additional time allowed by this STA will allow us to not only improve instrument performance but also test the instrument in new regimes. New voltage scan tables will also be uploaded to test the performance of the low energy sensor at energies below the current operating voltage of 1 kiloelectron volt. This will provide important input for CINEMA development.

In addition, the data gathered at lower energies will be highly complementary to the NASA TRACERS mission which suffered an anomaly with one of its spacecraft during commissioning, compromising access to some of the desired data. We have coordinated our experiment design to help fill the data gap created by the anomaly.

In summary, additional time to complete the instrument debugging and tuning will provide highly valuable science data, allowing the mission science goals to be achieved, and will inform the development of the energetic particle instrument for future missions.