Marshall Problem Statement / Senior Design Topic

Problem Title: ***Design of a tether deployer for spacecraft applications that will enhance the MSFC Phase II Electric Sail NIAC work***

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Indicate which discipline/s is/are most appropriate to work on this problem, e.g., aerospace, mechanical, electrical, chemical, industrial, civil, computer, physics, materials, test, nuclear, earth science, other
Mechanical, electrical, aerospace, materials

Marshall Problem Statement

Background: The big picture with references to previous work (Why would a senior design student be excited about this work?)
The Electric Sail (E-Sail) propulsion system investigations on-going at the MSFC all require successful deployment of a multi km length, sub mm diameter conductive tether for the E-Sail to be a viable propulsion option in the near future. Over the past 20 years there has only been one successful deployment of a space tether greater then 1 km in length and that was done by European college students. They actually deployed 32 km length of tether. All space tether missions since 1997 from both the USA and Japan have all failed to deploy successfully.

Recent/on-going research on the problem (What resources, if any, are available to the senior design team, such as equipment, software, facility utilization)
Members of our E-Sail team include Tethers Unlimited Inc. which may be able to provide design advice relating to their past tether deployers. No additional resources (equipment or software) will be made available, but if a tether deployer prototype can be fabricated and tested at the university, it is envisioned that this deployer will come to the MSFC Flat Floor facility for additional testing in the summer of 2017.

Details of the problem; design constraints, requirements (if any), outcome expected (one semester Senior Design course lasts 15 weeks; two semester course lasts 30 weeks.) (What do you expect the senior design team to accomplish?)
Students will design, fabricate, and test a mechanical deployer for a long space tether. This deployer as designed must be capable of housing at least 8 (TBR) kilometers of the commercial off the shelf material Amberstrand 66 (current reference) or other AmberStrand material. However, testing may be performed on a significantly smaller length. The Amberstrand 66 or other tether material will be provided by NASA as a cost savings measure.

Students will design and build a mechanism capable of feeding out the tether at a rates from 1 m/s to 5 m/s. Also the measurement of tether deployed must be designed to measure accurately to within 1.0%.
The full designed system shall meet the following requirements:

- *Fit into a volume of 15 cm x 10 cm x 10 cm*
- *Have a mass of no more than 2 kg (Goal)*
- *Consume no more than 5 W of electrical power (Goal)*

This prototype may feature parts not suited for the space environment, but students should note in their various reports potential deployer changes that would be required to bring the design to a space ready unit.