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Application of High Pressure Textile Inflatable Structures for Planetary Probes

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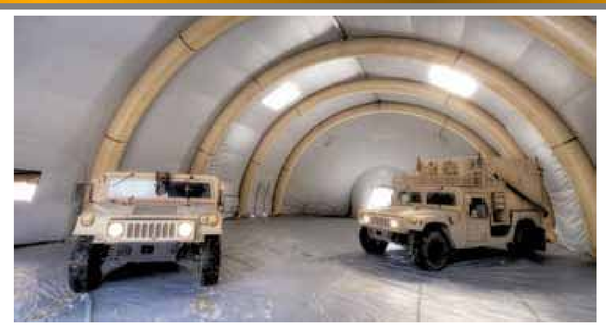
History of High Pressure AirBeams®

- **AirBeams® originally developed to rigidize parafoil type parachutes.**
- **Applicability to rapidly deployable large scale shelters was quickly discovered and a product line was successfully launched. Current shelter widths include 20, 32, and 40 ft. width shelters of varying lengths.**

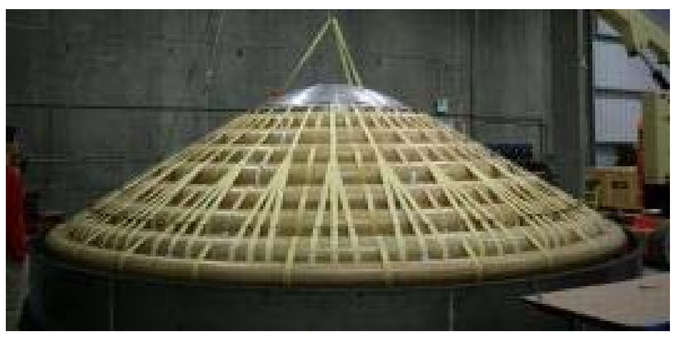


- **Large-scale aircraft maintenance structures have been developed to demonstrate the scalability of AirBeams® and have proven themselves in extreme environments.**
- **AirBeam® technology was also applied to Inflatable Aerodynamic Decelerators (IADs) and research was conducted on the feasibility in early trade studies and prototyping.**
- **Airbeams® were also applied and tested on deployable inflatable wing demonstrations, and they have been wind tunnel tested but have not yet been full-scale flight tested.**

Inflatable Aerodynamic Decelerators

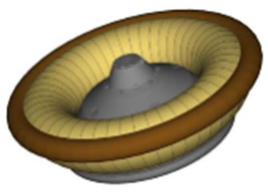
- **High pressure inflatables were selected as potential candidates for rigidizing deployable Tension-Cone decelerators and Stacked-Torus configurations capable of hypersonic re-entry.**

Tension Cone

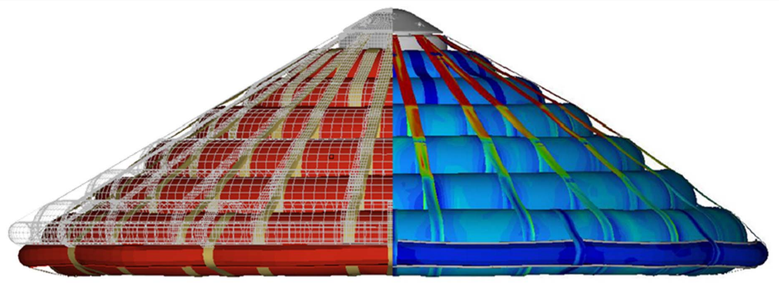


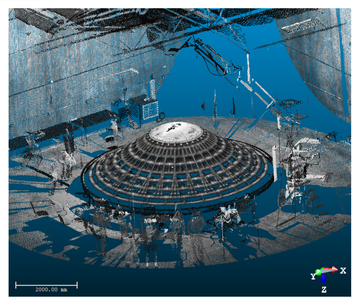
6m Stacked Torus

- **AirBeams were investigated for "Attached Torus" configuration and as a "Burble Fence" on other decelerators.**

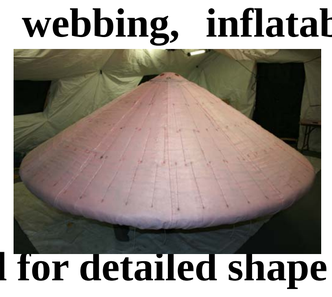


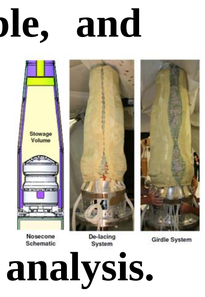
Attached Torus with Burble Fence





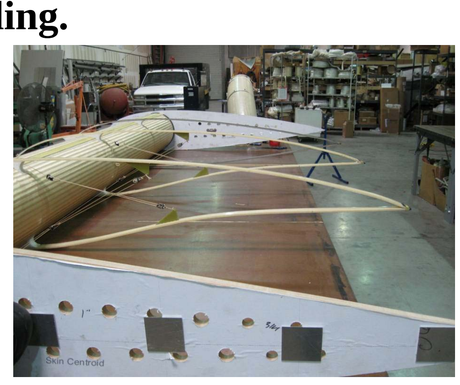
- **LS-Dyna FEA is used to model inflatable decelerators.**
  - **Models use non-orthogonal braided tori.**
  - **Complex interactions occur between webbing, inflatable, and bonds requiring specialized techniques.**
- **3m IRVE-3 model included flexible TPS.**
- **Additional 3m and 6m models were fabricated for wind tunnel testing.**
- **All models are load tested and laser scanned for detailed shape analysis.**
- **Most recent models have been instrumented to collect in-situ load data for model comparison and verification.**





Inflatable Wings

- **A 10 ft. wing specimen was fabricated to demonstrate adaptive wing camber through rib warping.**
- **The 10 inch spar inflates to provide the skin tension and support the aerodynamic loading.**



- **A 25 ft. span with integrated aileron and laminate textile skin was fabricated and used for packing and deployment testing.**

- **The 25 ft. model was successfully packed around a representative fuselage and deployed in multiple orientations (nose level, nose down, etc.).**

- **Deployable (inflatable) wing technology would allow for a new generation of planetary exploration similar to that researched for the ARES MARS SCOUT mission.**

- **AirBeam® spars have proven highly scalable and applicable to wing spans to suit any mission.**
- **On-going work is being conducted to reduce the mass of potential inflation systems.**

Conclusions

- **High pressure textile inflatable structures utilizing the AirBeam® technology have proven highly successful in the development of lightweight deployable aerodynamic structures that can be utilized on inter-planetary missions.**
- **Work is being conducted to increase the capabilities of the structures in high temperature and extreme environments in addition to high loading conditions.**
- **Ground verification testing has successfully proven validity of analytical estimates of structural performance, and the addition of in-situ measurements has proven invaluable to model verification.**