A Historical Review of
Inflatable Aerodynamic Decelerator Technology Development

Brandon P. Smith*, Christopher L. Tanner*, Milad Mahzari*, Ian G. Clark†, Robert D. Braun‡

Daniel Guggenheim School of Aerospace Engineering, Georgia Institute of Technology
Atlanta, GA, 30332-0150

F. McNeil Cheatwood§

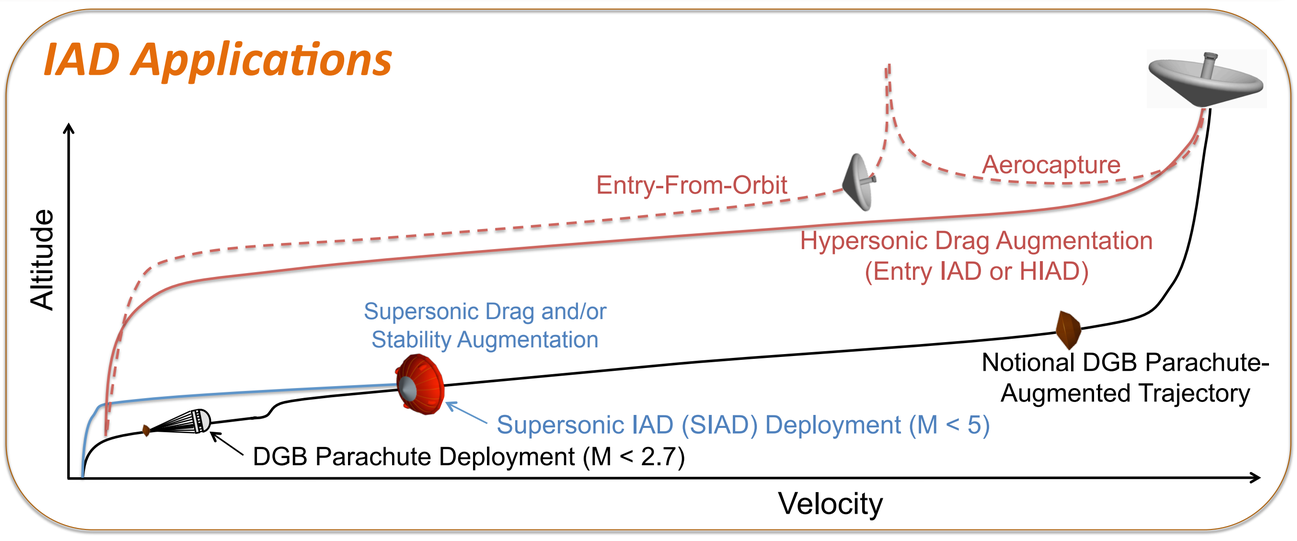
NASA Langley Research Center
Hampton, VA, 23681

* Graduate Research Assistant
† Visiting Assistant Professor
‡ Associate Professor
§ Senior Technologist

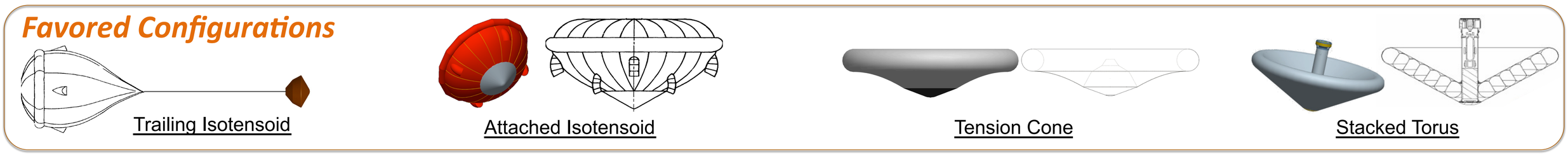
Overview

Numerous system studies in the past fifty years demonstrate the benefit of developing a new decelerator technology capable of operating at higher Mach numbers and higher dynamic pressures than existing decelerators allow. Inflatable aerodynamic decelerators (IADs) can provide increased landed mass and altitude, longer entry timeline, and improved mission flexibility. This poster describes the development history of the IAD from its conception in the 1960's to the present day. Performance of favored IAD configurations is discussed.

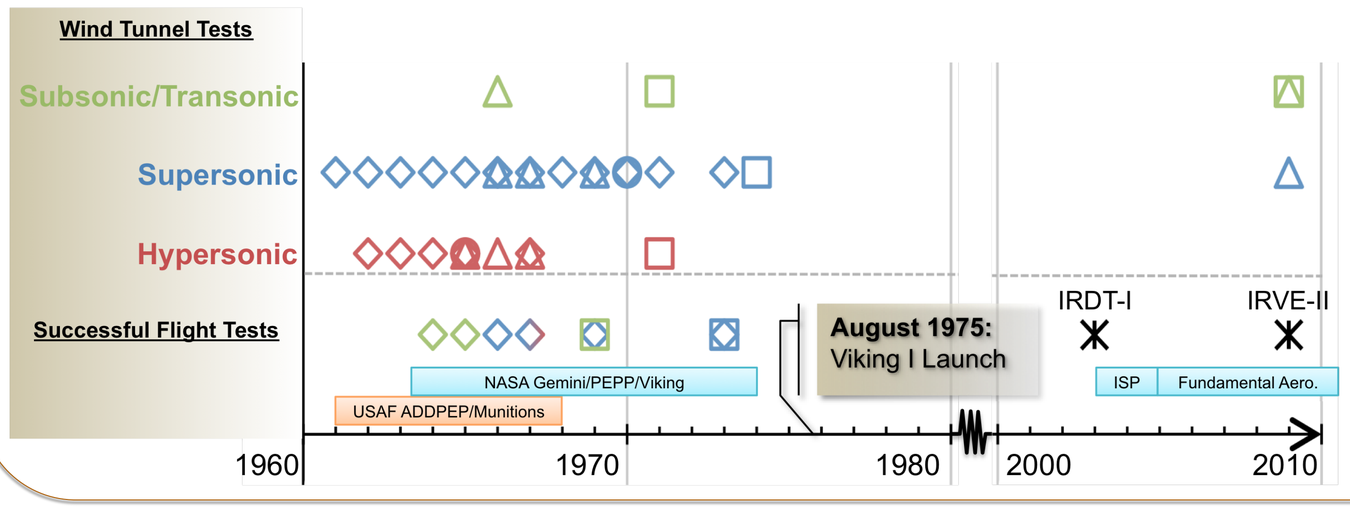
IAD Applications



Favored Configurations



IAD Test History



In the nearly fifty years since IAD development began, dozens of different IAD configurations have been analyzed and tested at a suite of flight conditions for numerous military and exploration-related applications. Probe missions being planned prior to the early seventies were enabled by the more mature supersonic disk-gap-band (DGB) parachute, so the immediate need for IAD technology dried up. Interest in the IAD has renewed in recent years from numerous atmospheric entry trajectory analyses at Earth, Mars, Titan, and Neptune calling for deployable decelerator operations outside of the demonstrated DGB performance envelope.

IAD Ground Tests

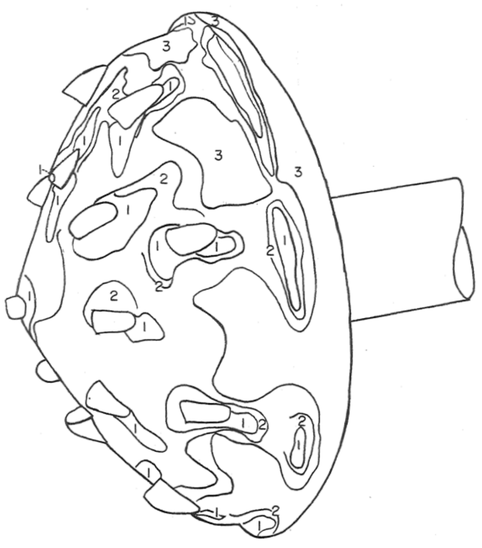


Image Credit: Creel 1971

Isotensoid Mach 8 aerothermal environment characterization

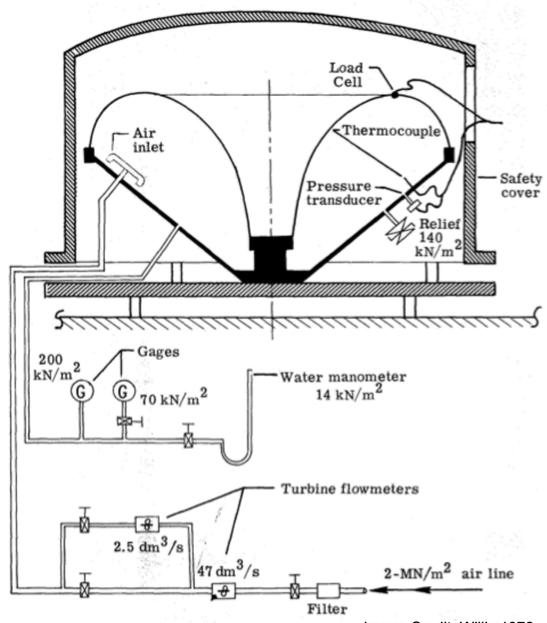
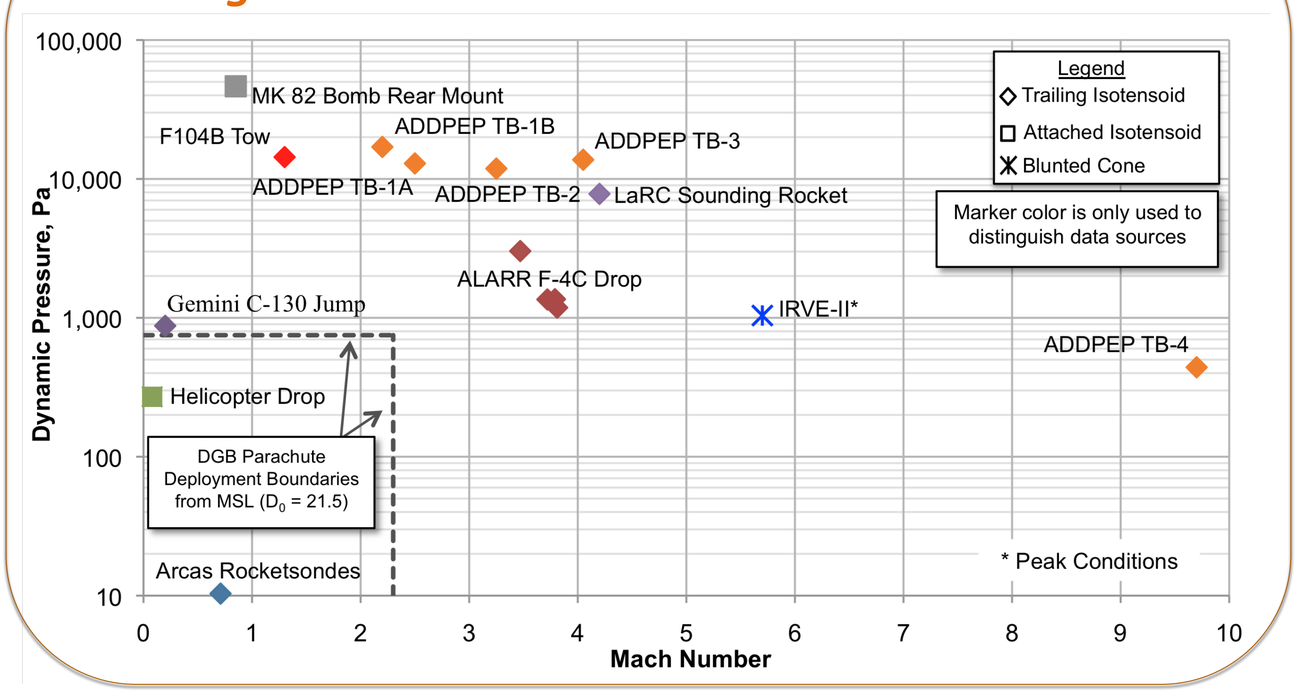


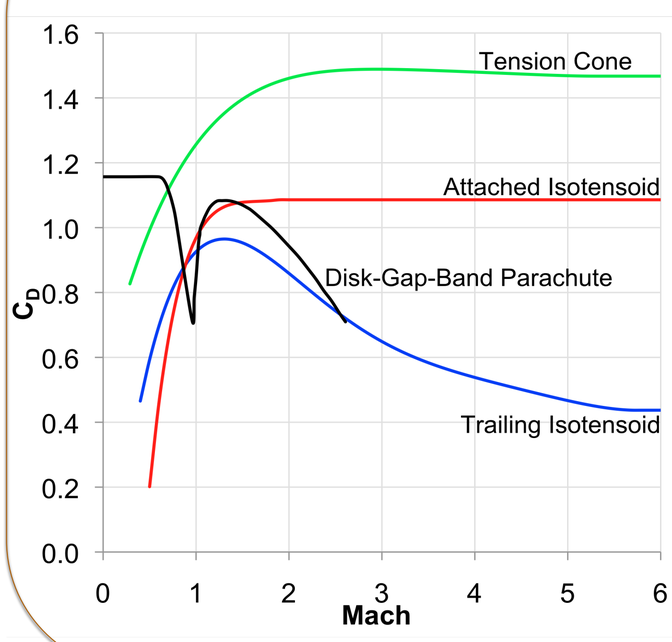
Image Credit: Willis 1972

Isotensoid static structural test

IAD Flight Tests



Aerodynamic Trends



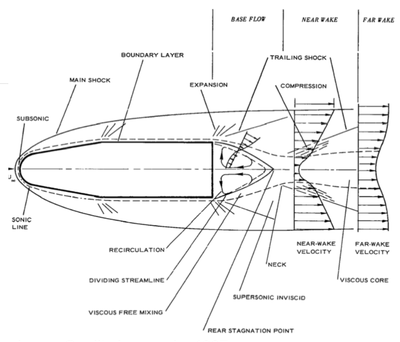
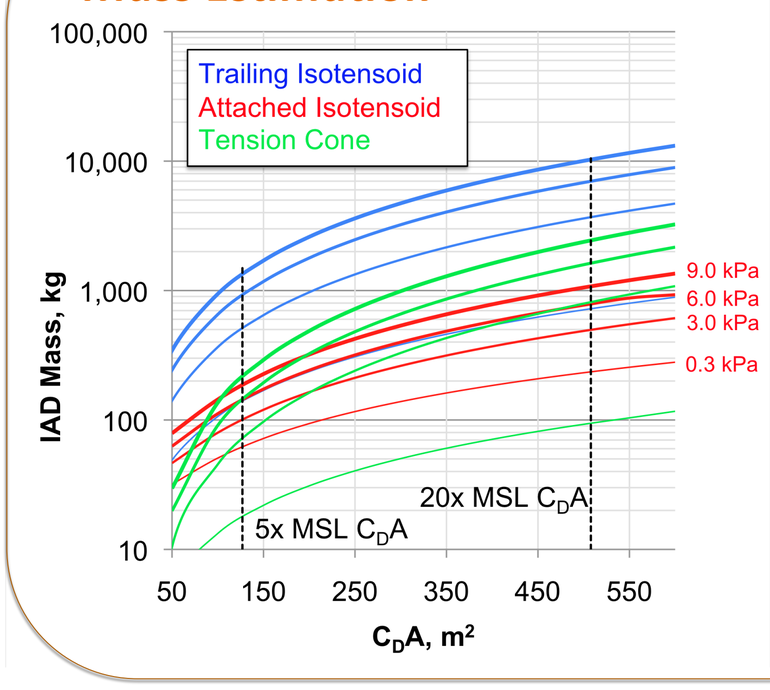


Image Credit: Jaremenko 1967

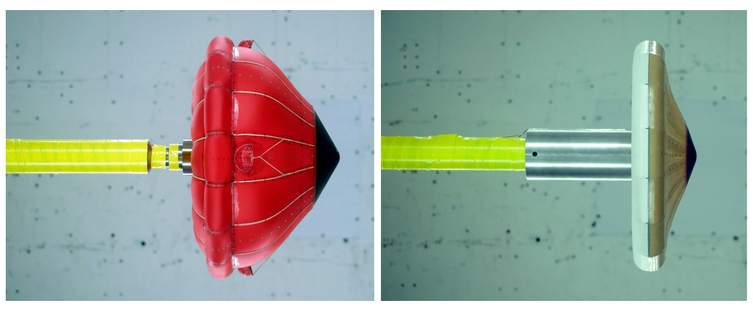
IADs lower ballistic coefficient by augmenting drag area. Trailing IAD configurations have lower drag than attached IADs but may have hypersonic applications as a result of decreased heating in the wake.

Mass Estimation



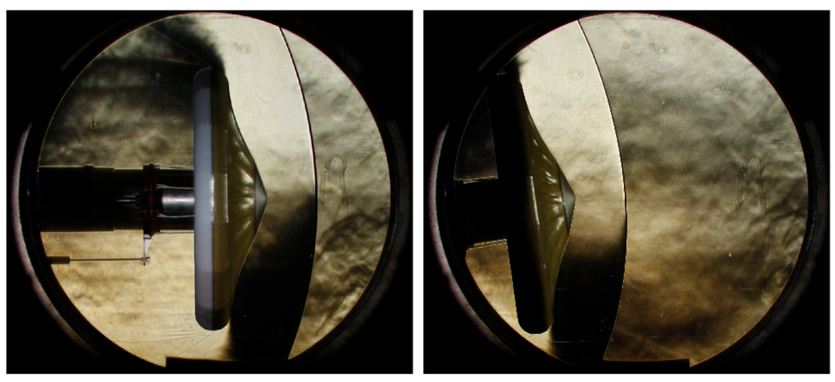
Mass estimation of IADs remains an immature field in large part due to the lack of historical precedence for constructing full-scale flight articles. Trailing SIAD configurations suffer a large mass penalty for the extra towline, which must be sized to carry the entire aerodynamic force. The tension cone and attached isotensoid likely represent the lowest mass solutions. Future HIAD mass estimation methods must account for thermal effects and accommodate non-uniform material properties.

Recent Testing



Isotensoid and tension cone at NASA Langley Transonic Dynamics Tunnel (TDT)

Subsonic / Transonic



Tension cone at angle of attack in supersonic flow at NASA Glenn 10x10 Facility

Supersonic

Image Credit: NASA

Inflatable Reentry Vehicle Experiment

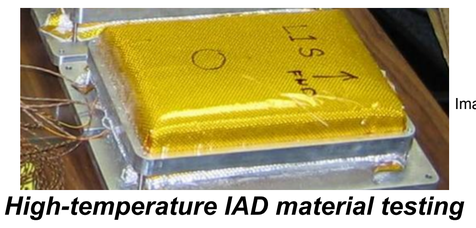


Image Credit: Hughes 2009

High-temperature IAD material testing

Hypersonic