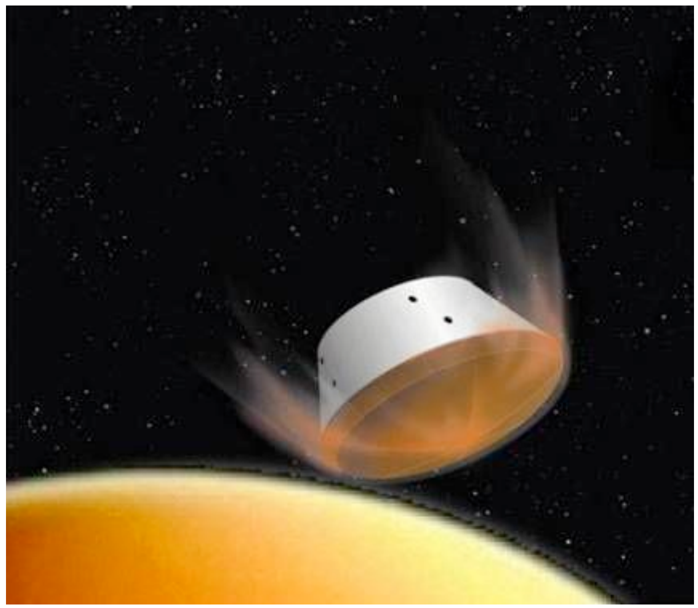
An Aerocapture Snapshot



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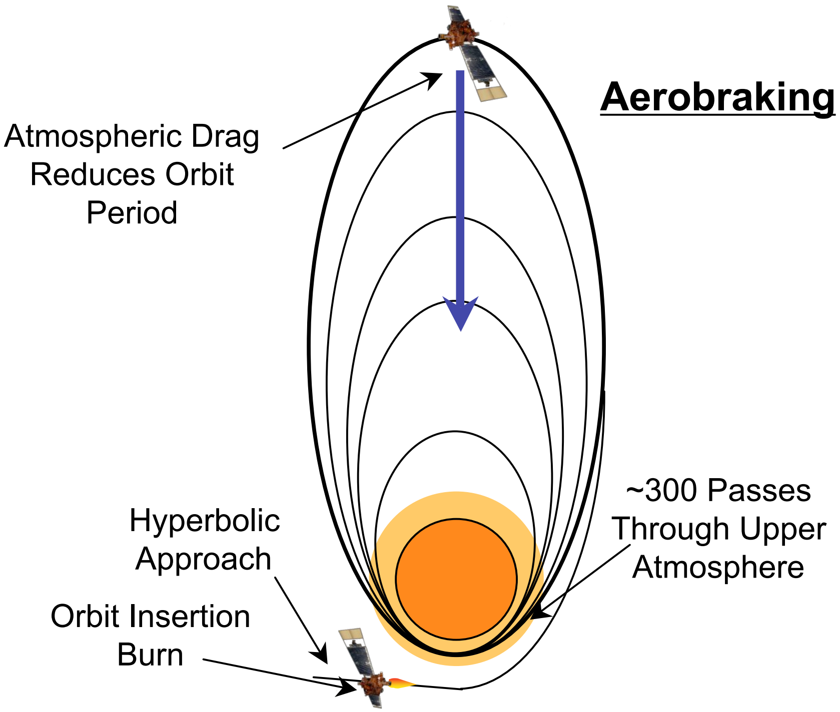
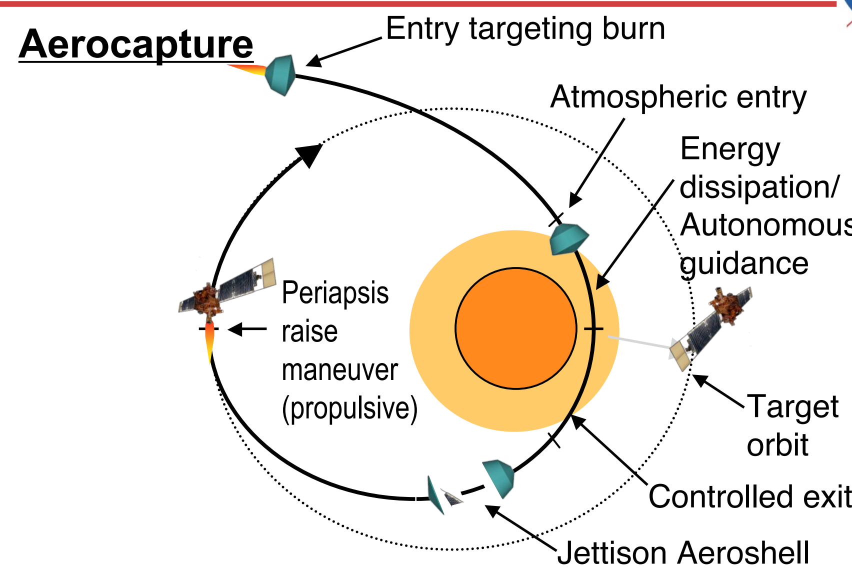
Aerocapture vs Aerobraking



Pros	Cons
Little spacecraft design impact	Still need ~1/2 propulsive fuel load
Gradual adjustments; can pause and resume as needed (with fuel)	Hundreds of passes = more chance of failure
Operators make decisions	Months to start science
	Operational distance limited by light time (lag)
	At mercy of highly variable upper atmosphere



Aerocapture: A vehicle uses bank angle control to autonomously guide itself to an atmospheric exit target, establishing a final, low orbit about a body in a single atmospheric pass.

Pros	Cons
Uses very little fuel--significant mass savings for larger vehicles	Needs protective aeroshell
Establishes orbit quickly (single pass)	One-shot maneuver; no turning back, much like a lander
Has high heritage in prior hypersonic entry vehicles	Fully dependent on flight software
Flies in mid-atmosphere where dispersions are lower	
Adaptive guidance adjusts to day-of-entry conditions	
Fully autonomous so not distance-limited	

Aerocapture Summary

Aerocapture has Heritage

- Aerocapture can be accomplished at Mars, Titan, Venus and Earth with a high-heritage blunt cone shape like that of existing planetary entry vehicles
- Aerocapture guidance is fully analytic, less than 400 lines of code, derived from Apollo and Shuttle entry guidance (and works at every destination)
- Hypersonic guided entry has been accomplished many times; the only part of aerocapture that has **not** been proven is the atmospheric exit, but skip entry is similar
  - Apollo human-rated a skip entry mode for weather divert but it was never executed
  - Orion will fly skip entry for anytime Lunar return to the US Pacific coast (flight test scheduled for ~2015)--using a numerical guidance of 1000's of lines

Aerocapture is Robust

- An aerocapture system is designed with performance margin to handle worst-case nav, aero, and atmospheric uncertainties. Conservative estimates of variations are used in Monte Carlos.
- Thousands of simulations are run with validated tools to verify performance; *guidance works even with worst-on-worst uncertainties*.
- Guidance allows vehicle to "fly out" density dispersions, which are modeled based on all available data for each planet/moon
- **Aerocapture is much simpler (and easier) than a planetary lander (single flight regime)**

Aerocapture is Not High Risk

- PRA Conducted by SAIC in 2005
- Compared propulsive capture, aerobraking, and aerocapture at Mars
- Results* showed that if the system reliability is normalized so that the reliability of propulsive capture = 1.0, then
  - Aerobraking reliability = 0.9841
  - Aerocapture reliability = 0.9941
- **Aerocapture has HIGHER RELIABILITY than aerobraking, to which we routinely entrust high-dollar missions.**

* Reference: T. Percy, E. Bright, A. Torres, "Assessing the Relative Risk of Aerocapture Using Probabilistic Risk Assessment," AIAA-2005-4107

Aerocapture Status/Next Steps

- ISPT will complete ground-based development to TRL6 by end of 2009
- Technically, a flight test of Aerocapture is not necessary before use at Titan, Mars, or Venus
- However, a flight validation would mitigate risk perception and immediately prove Aerocapture for multiple mission customers, for a relatively small up-front investment
- Continue to seek a near-term mission infusion or flight validation opportunity.
- Seek to infuse ISPT-developed thermal protection systems to fill gaps in current Agency choices.
- Advocate that heatshield sensors, some developed by ISPT to fly on MSL, be used on every entry vehicle to improve tools and future performance