

Planetary Probe Descent Control Requirements

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Top-Level Requirements

- Usually one of two types
 - limit impact speed to range acceptable to landing system
 - control descent duration to maximize scientific return in given altitude range
- Another requirement associated with second type is spin control

Landing

Mars is driver: Venus, Titan are 'easy' – high ρ/g .

Tradeoff exists between capability ($\sim SC_D$) of descent control system and energy absorption capability of landing system.

Delivered mass drives both systems

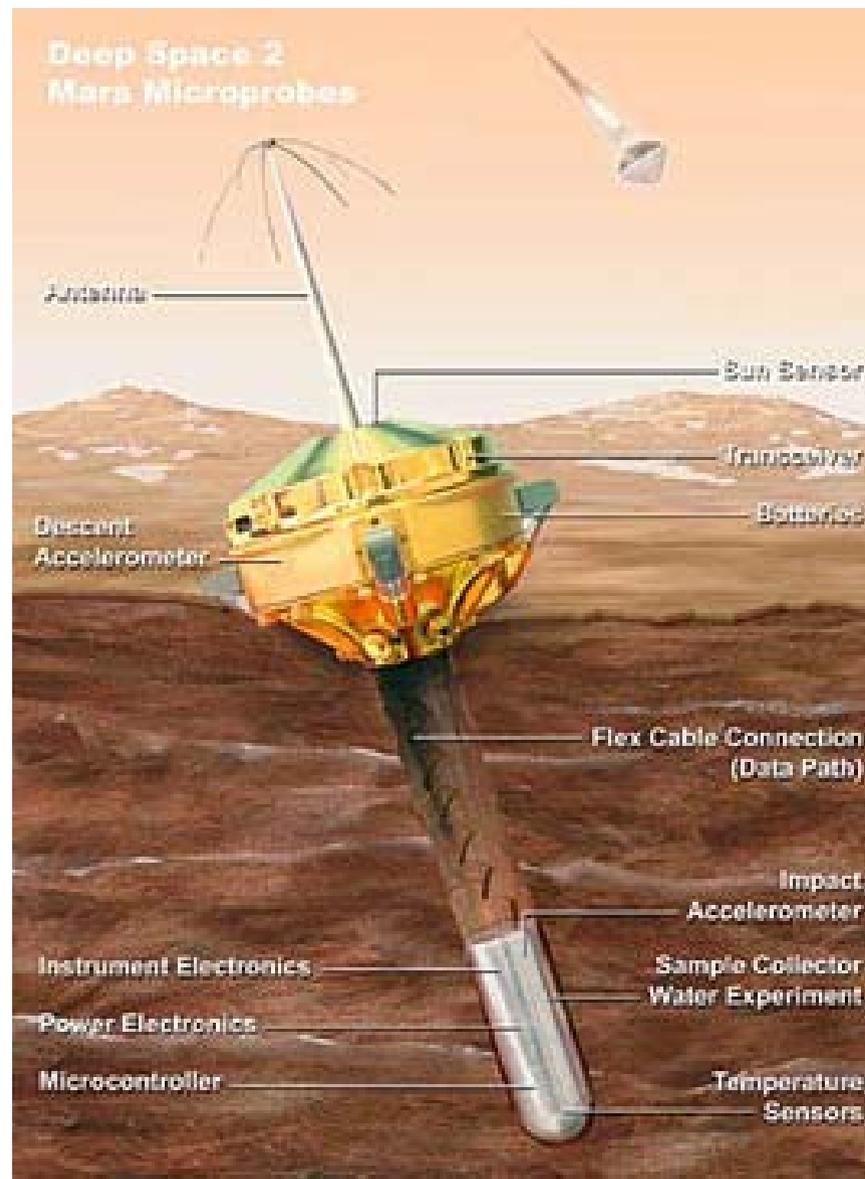
Usually, the range of horizontal velocities (wind, largely beyond engineering control) will bound this problem - low descent speed means large incidence angle range.



- Apollo 15 splashdown
- Large payload, but well-known environment.
- Water landing permits higher impact speed than for solid ground.

DS-2 : The other extreme

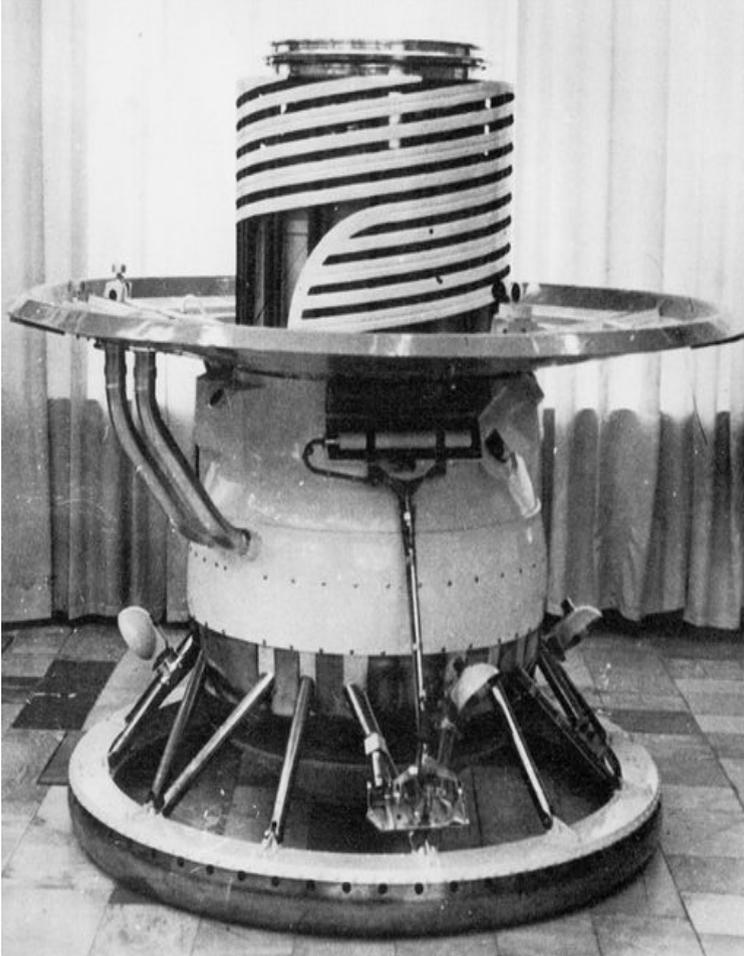
- **Penetrator design tolerates 200 m/s impact speed.**
- **No parachute required.**





Canaria (proceder?)

Venera



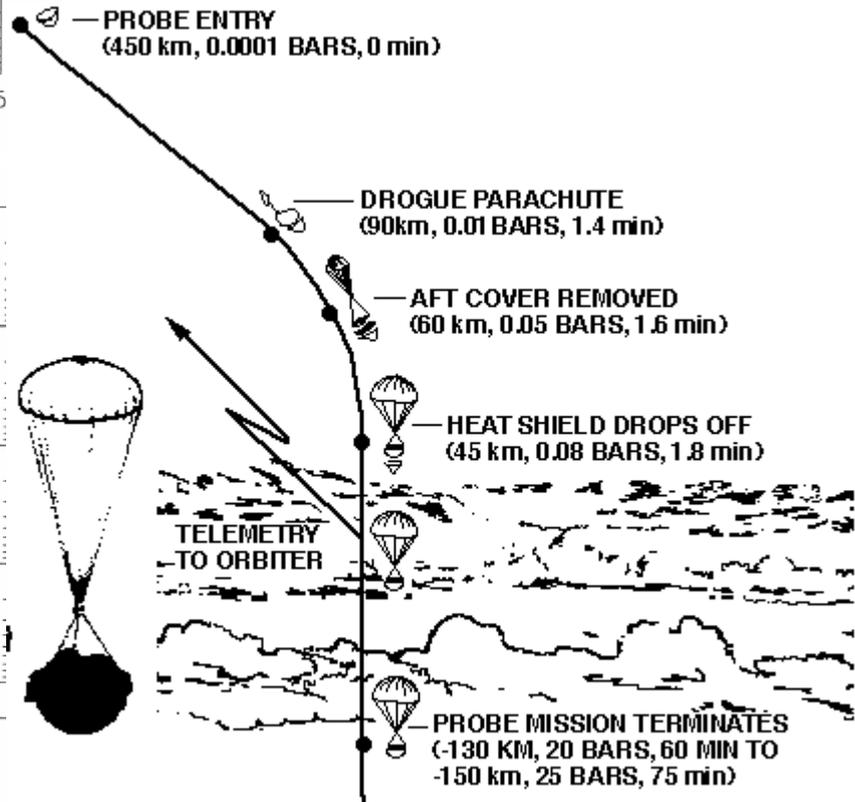
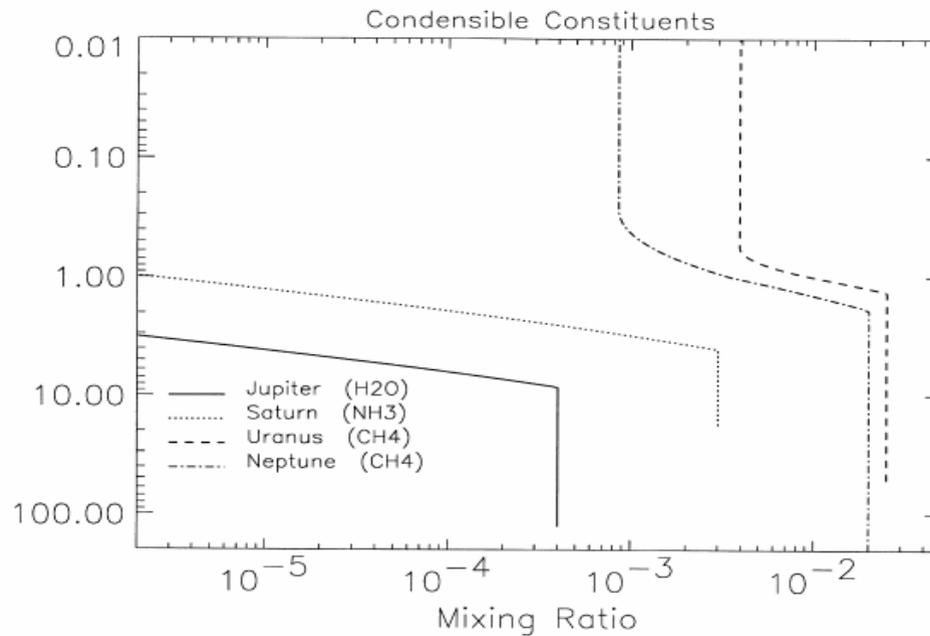
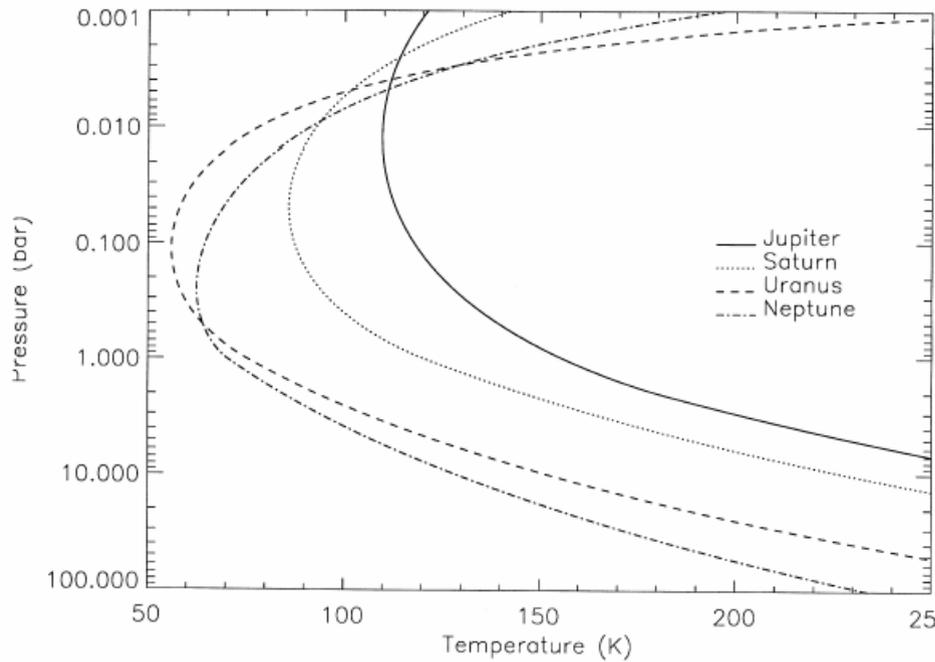
Venera probes descended to surface without parachutes.

Note large drag skirt - provides enough drag area in dense Venus atmosphere.

Sharp edge of drag plate leads to stable flow separation, minimizing attitude excursions.

Altitude Driver

Typically to resolve temperature and composition where these properties change, across the tropopause. Almost invariably this is ~ 0.1 bar since infrared opacity of gases at these pressures ~ 1 . Usually want measurement a scale height or two above that point.



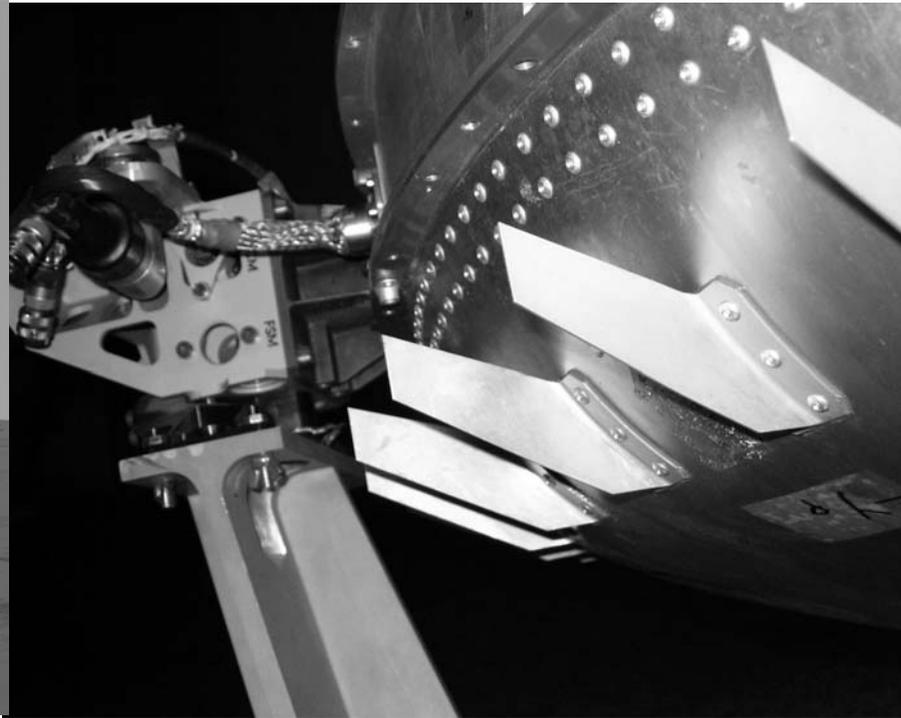
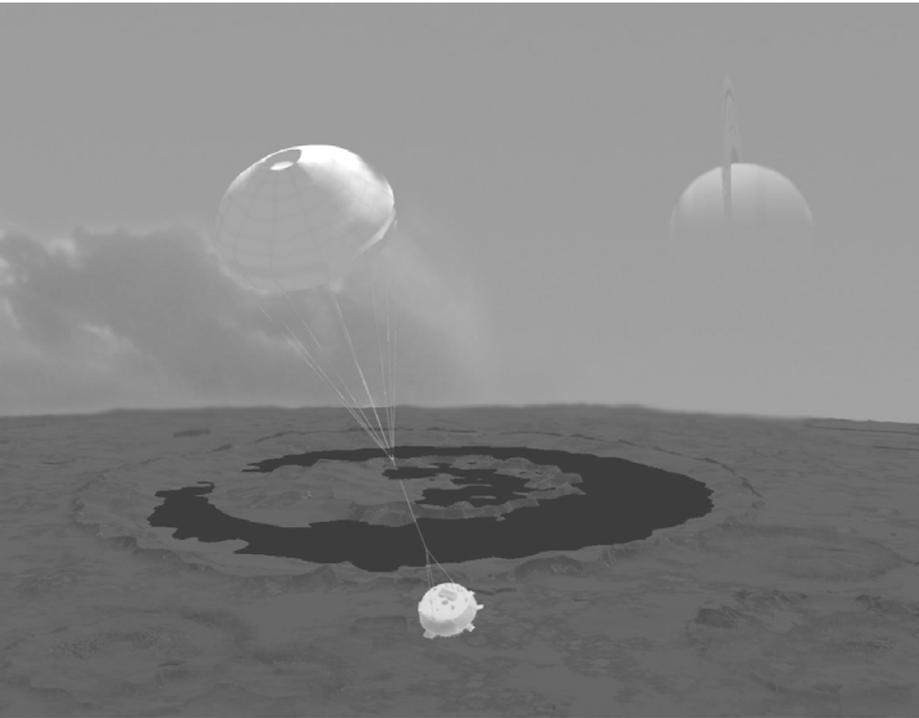
‘Requirements’ you may not have thought of

- There will be a desire to minimize the number of requirements, especially those that may require expensive testing.
- Nonetheless, the interaction of the probe+parachute with the planetary environment may generate signatures in scientific instrumentation that are significant.
- The more advanced the instrumentation, the more subtle these effects can be

'Requirements' you may not have thought of

- Outgassing
- Dynamic behaviours - oscillations, spin etc.
- Aeroacoustic noise
- Electrostatic effects / triboelectric charging.

Huygens

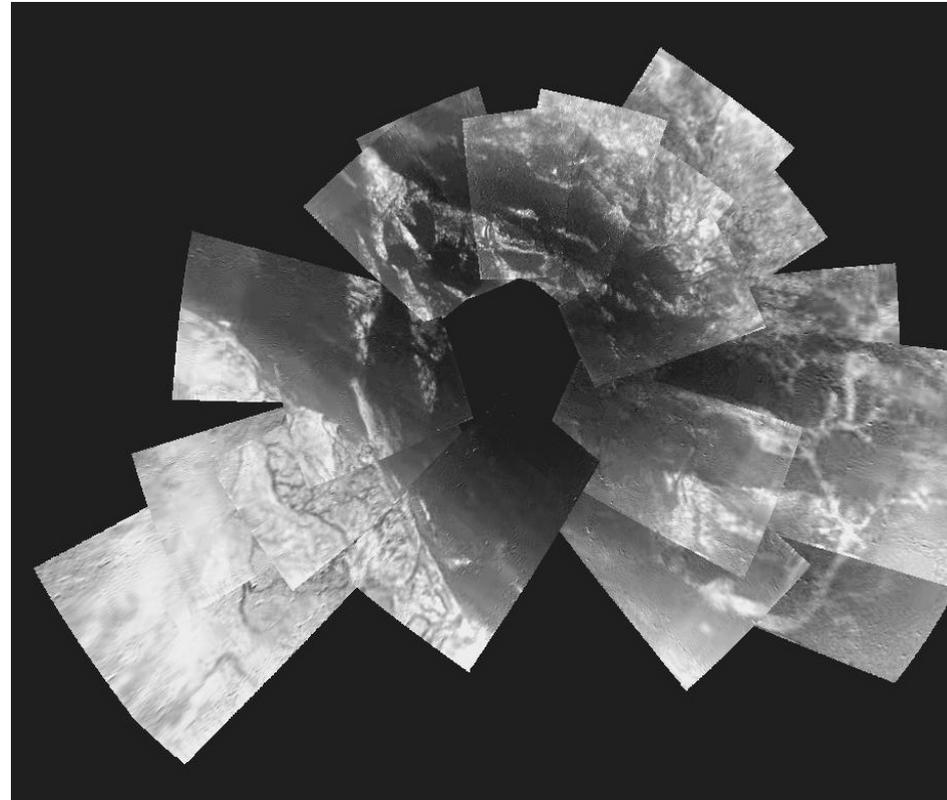
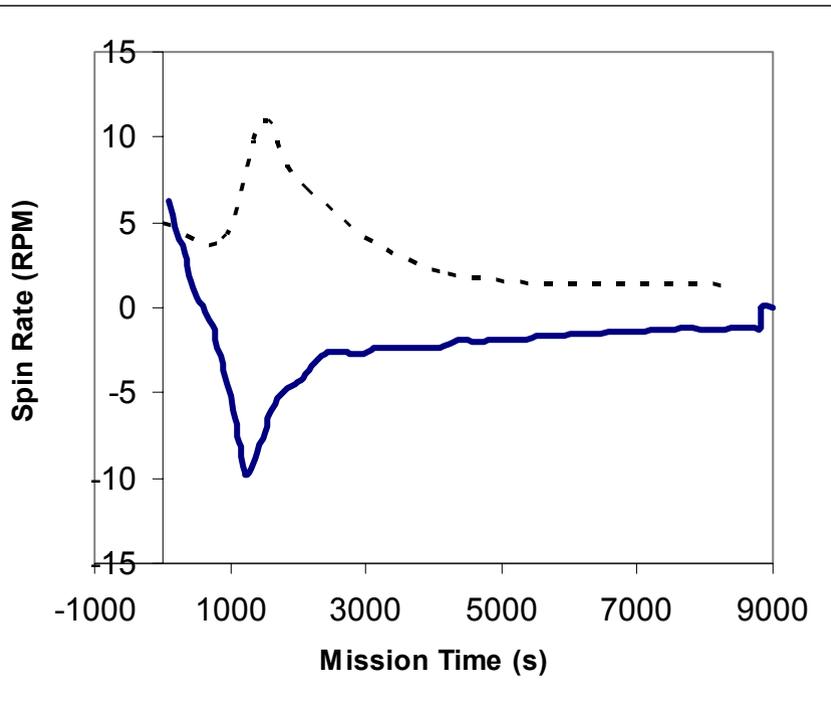


Descent profile - total duration determined at system level (battery energy ; communications window) Altitude of 150-170km desired for stratospheric measurements

Two-chute design needed (primarily to assure front shield separation).

Requirement on spin rate to sample illumination directions and pan camera

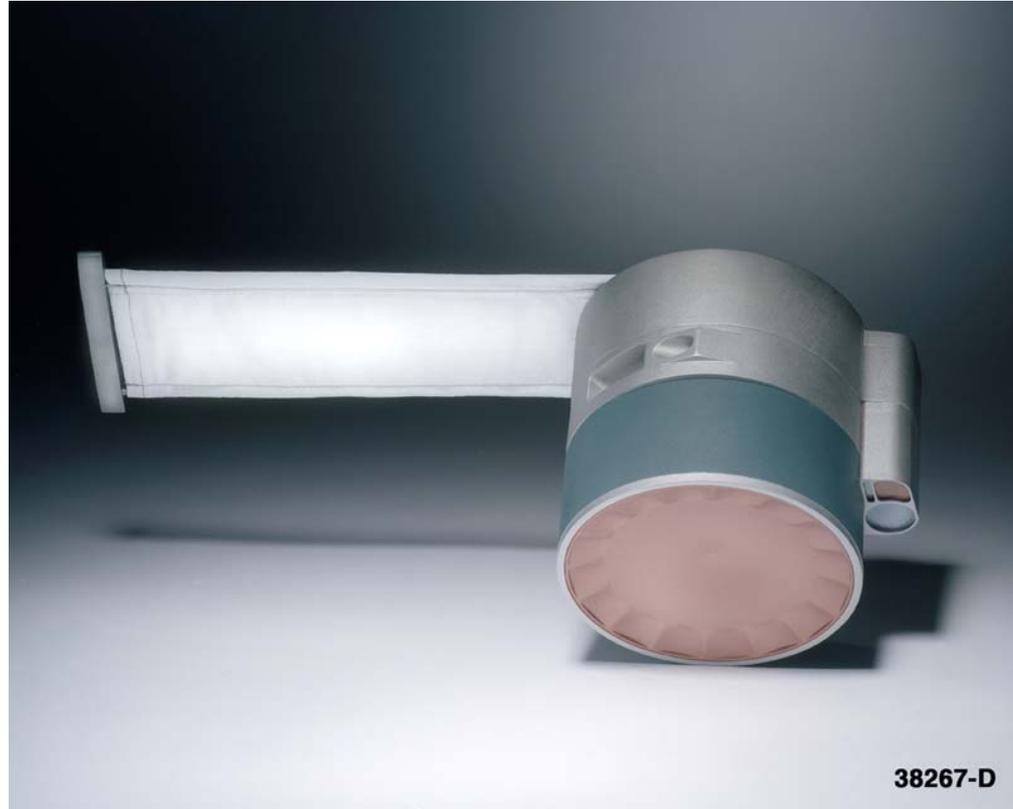
Huygens Spin



Spin and attitude Performance affects scientific return!

(actually more a problem for solar aureole, spectral measurements than for image mosaicing...)

A parachute alternative? - Samara-wing Decelerator



Selectively-Targeted Skeet - Textron Systems

Inflatables : Airbags ---> ballutes, blimps,
tumbleweed : new capabilities,
new challenges in integration..

