AUTONOMOUS PARAFOIL FOR SOFT AND PRECISE LANDING ON MARS

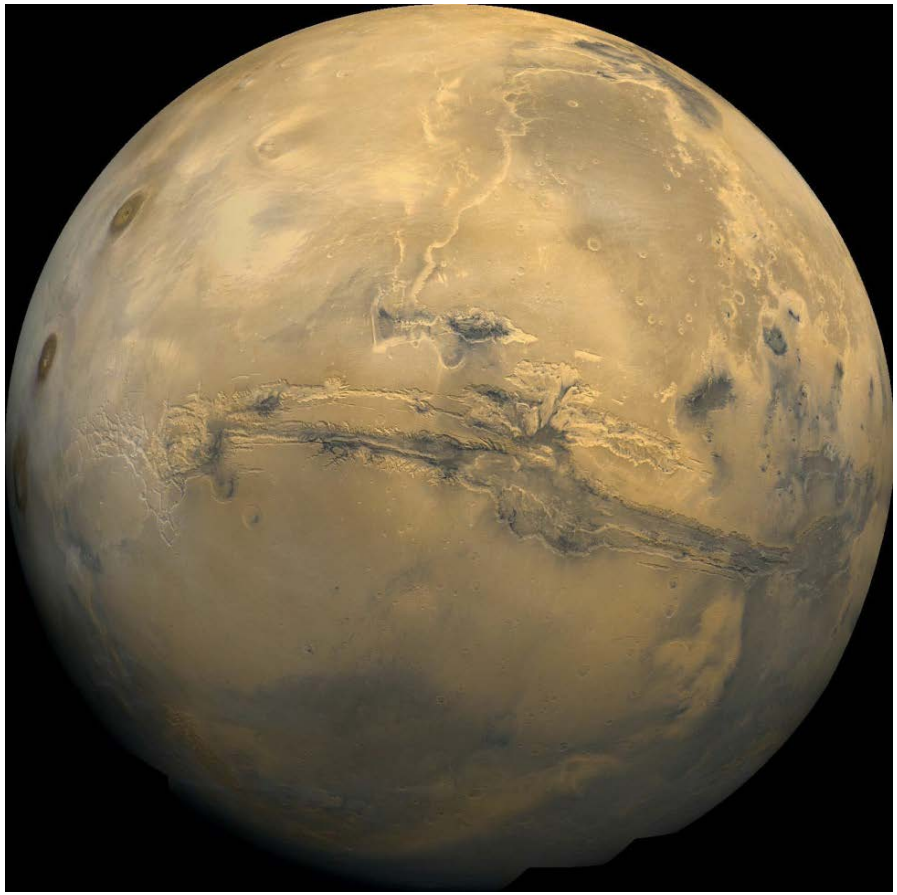
WU ZHUO

INDEX

1. BACKGROUND
2. SYSTEM
3. SIMULATION
4. CONCLUSION

BACKGROUND——OBJECTIVE

- Entry Weight: 650kg
- Dynamic pressure of parachute deployment: 700Pa
- Altitude of parachute deployment: 9km
- Velocity of parachute deployment: 1.6Ma
- Vertical landing speed:<15m/s
- Horizontal landing speed:<20m/s
- Landing: Airbags



Mars (Image Courtesy of: NASA/JPL/USGS)

BACKGROUND——PROBLEMS

- **Supersonic**

------- Hard to deploy
------- High strength requirement
------- Wakes impaction

- **Low density**

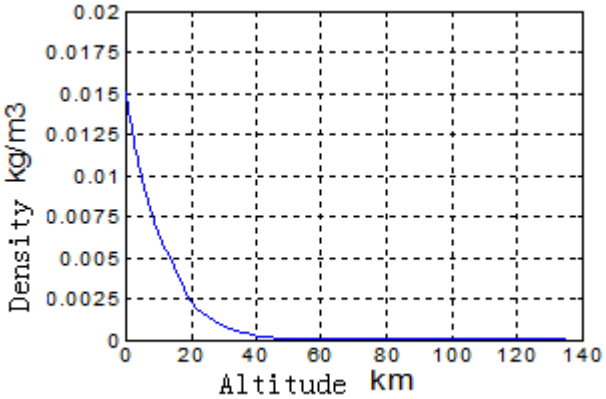
------- Reduction of stability
------- Reduction of drag

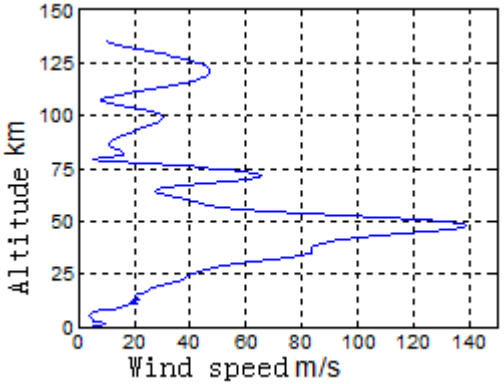
- **Low dynamic pressure**

------- Hard to deploy

- **Positioning and navigation**

------- Without GPS system





BACKGROUND——SOLUTION

- **Supersonic**

------- Hard to deploy ⇒ drag parachute + parafoil

------- High strength requirement ⇒ strengthen material and structure

------- Wakes impaction ⇒ long connecting strap

- **Low density**

------- Reduction of stability ⇒ disk-gap-band parachute

------- Reduction of drag ⇒ bigger parachute

- **Low dynamic pressure**

------- Hard to deploy ⇒ high ejection speed

- **Positioning and navigation**

------- Without GPS system ⇒ inertial navigation or signal probe

SYSTEM——COMPONENT

Drag Parachute

- Ejection Equipment
- Parachute Package
- Drag Parachute
- Connecting Strap

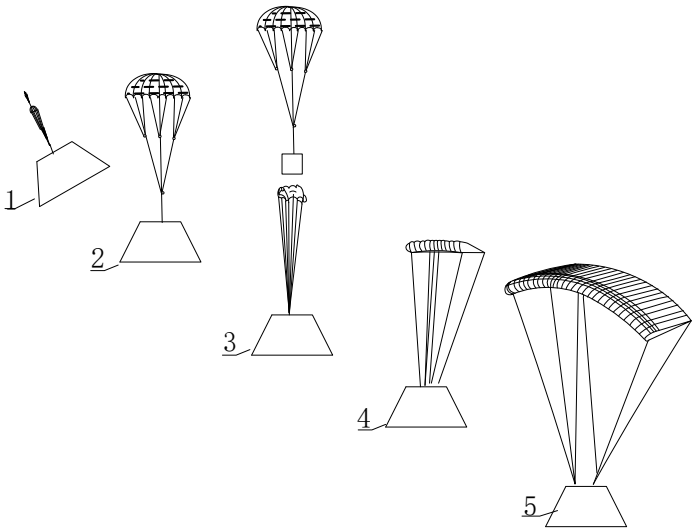
Parafoil

- Parachute Package
- Parafoil
- Control Equipment

Airbags

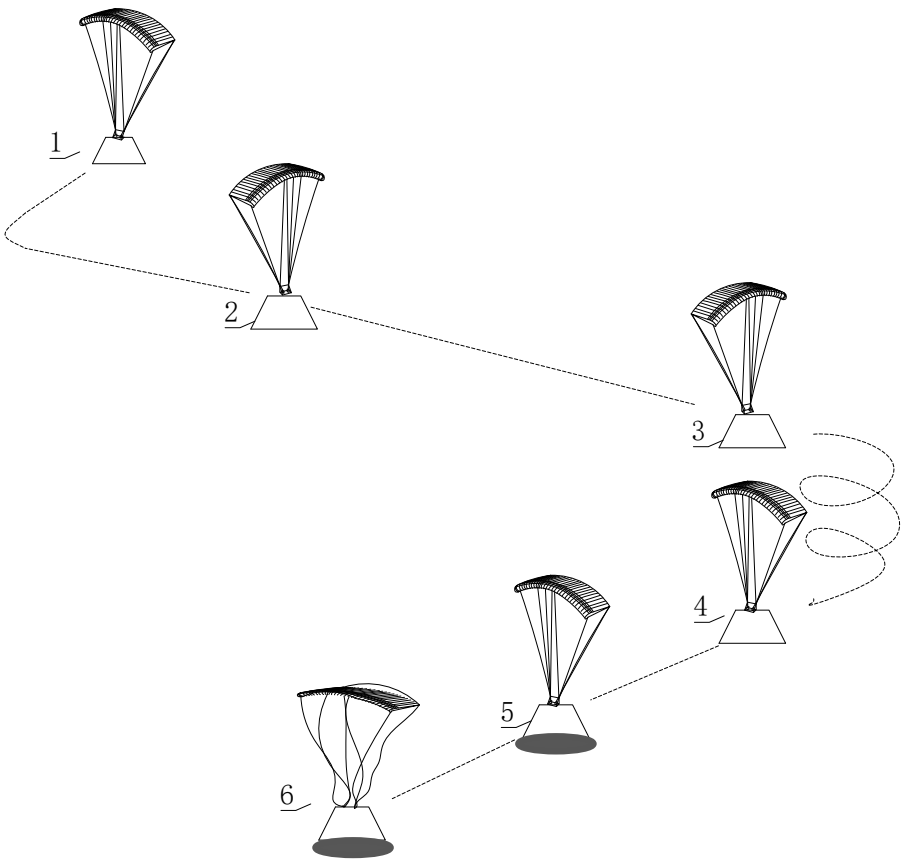
- Airbags
- Inflation Equipment

SYSTEM——PROCESS



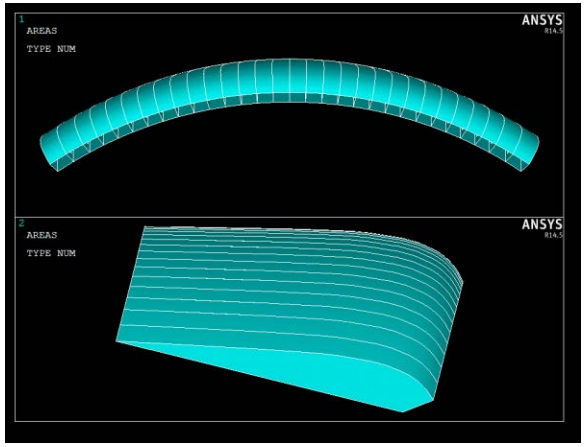
1. Drag parachute ejection
2. Drag parachute working
3. Pulling out parafoil
4. Parafoil inflation
5. Parafoil flying

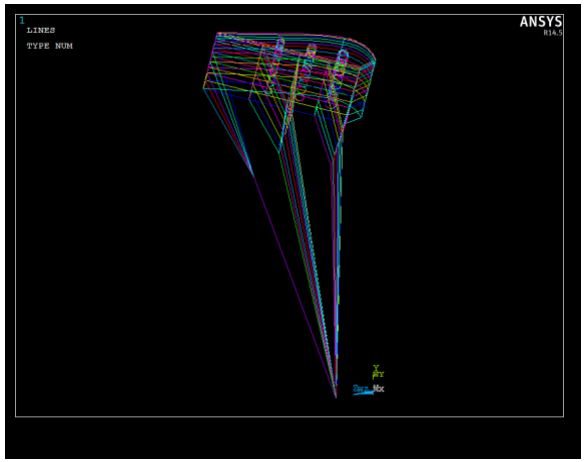
SYSTEM——PROCESS

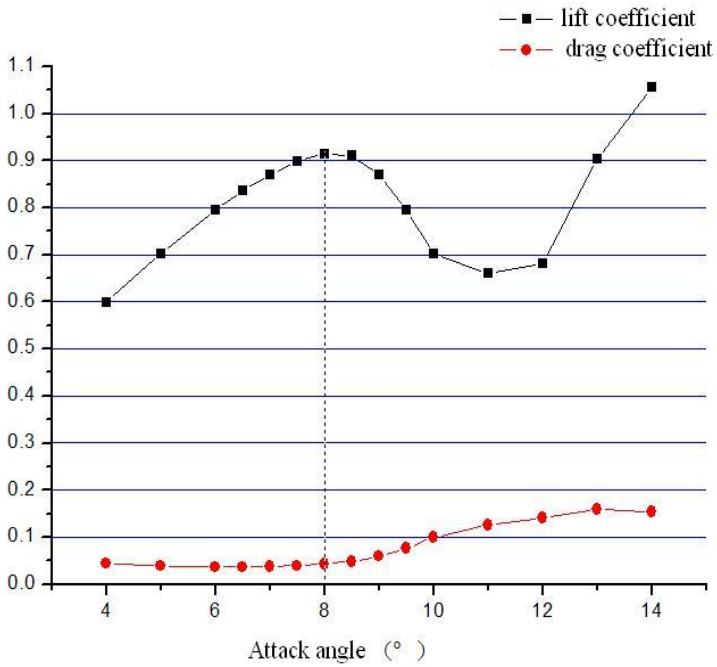


1. Control equipment working
2. Flying to target point
3. Circling flying
4. Upwind flying
5. Airbags inflation and flap
6. landing

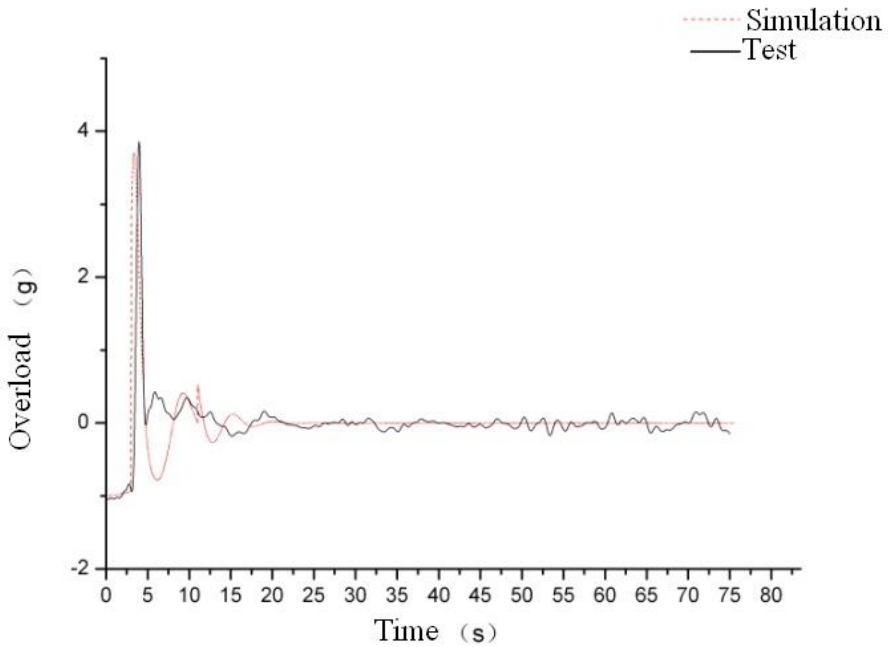
SIMULATION——METHOD



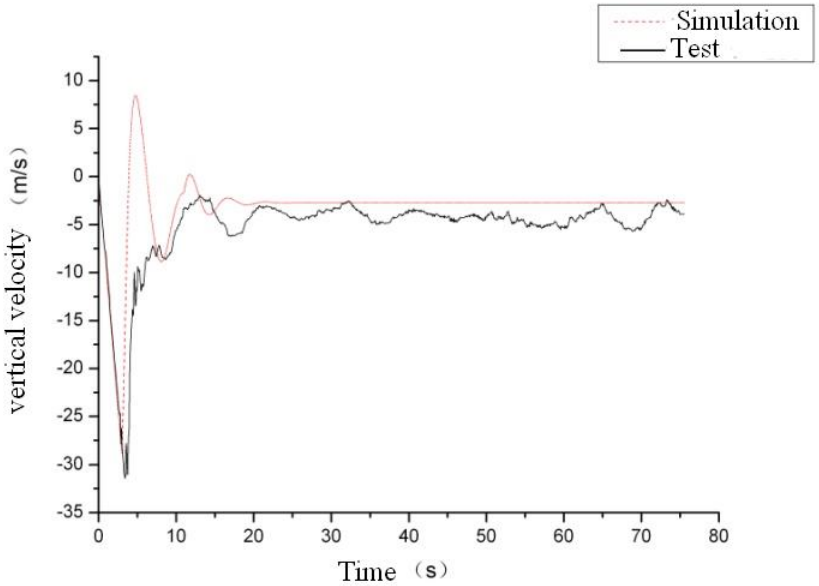




SIMULATION——TEST

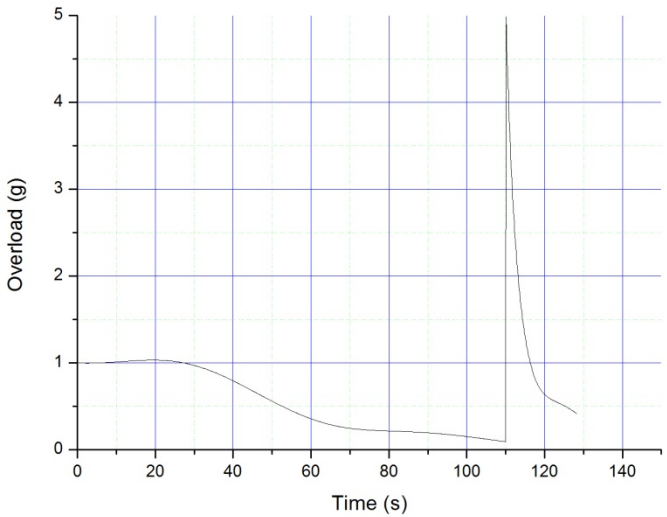


Overload coefficient of numerical simulation and flight test vs. time

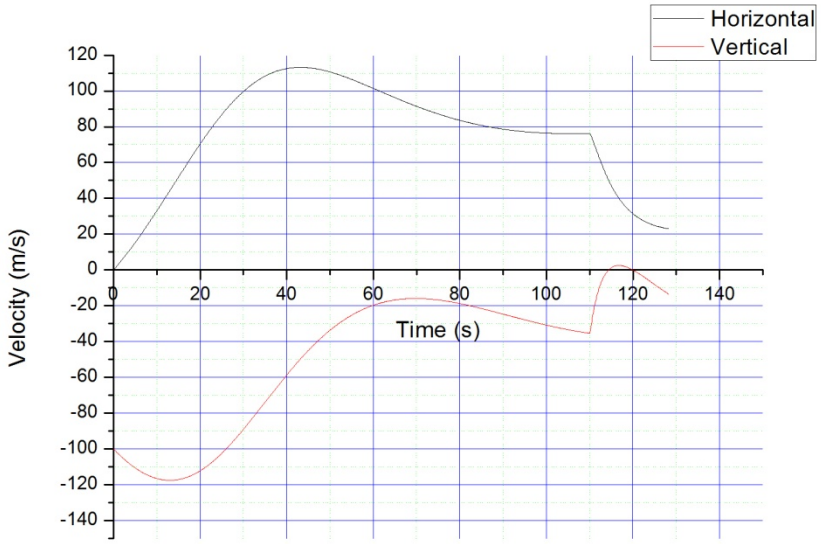


Vertical velocity of numerical simulation and flight test vs. time

SIMULATION——MARS



Overload of Mars lander vs. time



Velocity of Mars lander vs. time

CONCLUSION

Special performance of parafoil has become a unique advantage in planetary exploration missions, and made the independently precision landing possible, and greatly reduced the landing impact with flap.

Landing on Mars with parafoil is very complex project which need many tests and simulations to perfect the whole system. We will continue to do more work.

THANK YOU!