

ExoMars Drop Test at Esrange Space Centre

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- Broad cooperation between ESA and Roscosmos.
- Rover & Surface Platform mission to be launched in September 2022
- ESA
 - Carrier Module
 - Rover Module
 - 300-kg class
 - 218 sols on Mars
 - Two-meter drill
 - Pasteur payload
 - Contribution to Descent Module
 - Parachute Assembly System
 - IMUs
 - On-Board Computer
 - Radar altimeter
 - UHF Transceiver and antenna
- Roscosmos
 - Launcher Proton
 - Descent Module
 - Surface Platform
 - 218 sols on Mars



- Mission objectives
 - Technology demonstration objectives:
 - Entry, Descent and Landing (EDL) of a payload on the surface of Mars;
 - Surface mobility with a Rover;
 - Access to the subsurface to acquire samples;
 - Sample acquisition, preparation, distribution, and analysis;
 - Qualification of Russian ground-based means for deep-space communication in cooperation with
 - ESA's ESTRACK;
 - Development and qualification of throttleable braking engines for prospective planetary landing missions.
 - Scientific objectives
 - Search for signs of past and present life on Mars;
 - Investigate the water/geochemical environment as a function of depth in the shallow subsurface;
 - Characterise the surface environment.

- Four parachute system
 - Most complex system flown outside Earth's atmosphere
- Two main parachutes
 - 15 m Supersonic Disk-Gap-Band
 - Decelerates lander from Mach 2.1 to subsonic
 - Based on Huygens heritage
 - Largest ESA parachute flown on planetary mission
 - Until second parachute deployed
 - 35 m Ringslot
 - Controls descent until powered descent system takes over
 - Largest parachute ever flown on planetary mission (by anyone)
- Two pilot chutes
 - Mortar deployed
 - Deploy main parachutes



- Bench deployments
- Dynamic deployments
- Low altitude drop test
- High altitude drop tests
 - Validate end to end sequence
 - Subject parachutes to qualification loads



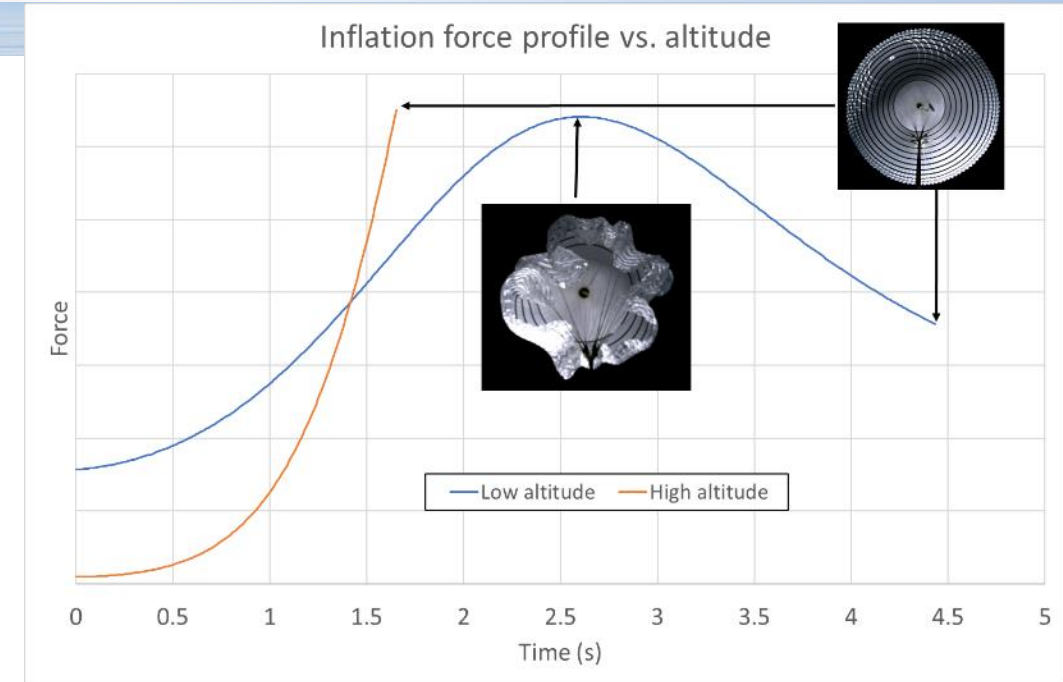
High altitude drop test requirements

■ Technical

- Deploy parachutes in sequence
 - Achieve qualification loads
 - First parachute: 180 kN
 - Second parachute: 140 kN
- Match flight stress profile
 - Peak force must occur at end of inflation
 - Test vehicle must not decelerate significantly during inflation
 - High velocity / low dynamic pressure required
 - Low density
 - High altitude

■ Practical

- Safety
 - 2 Tonne test vehicle
 - Nominal rate of descent: 8 m/s
 - Ballistic rate of descent: 110 m/s



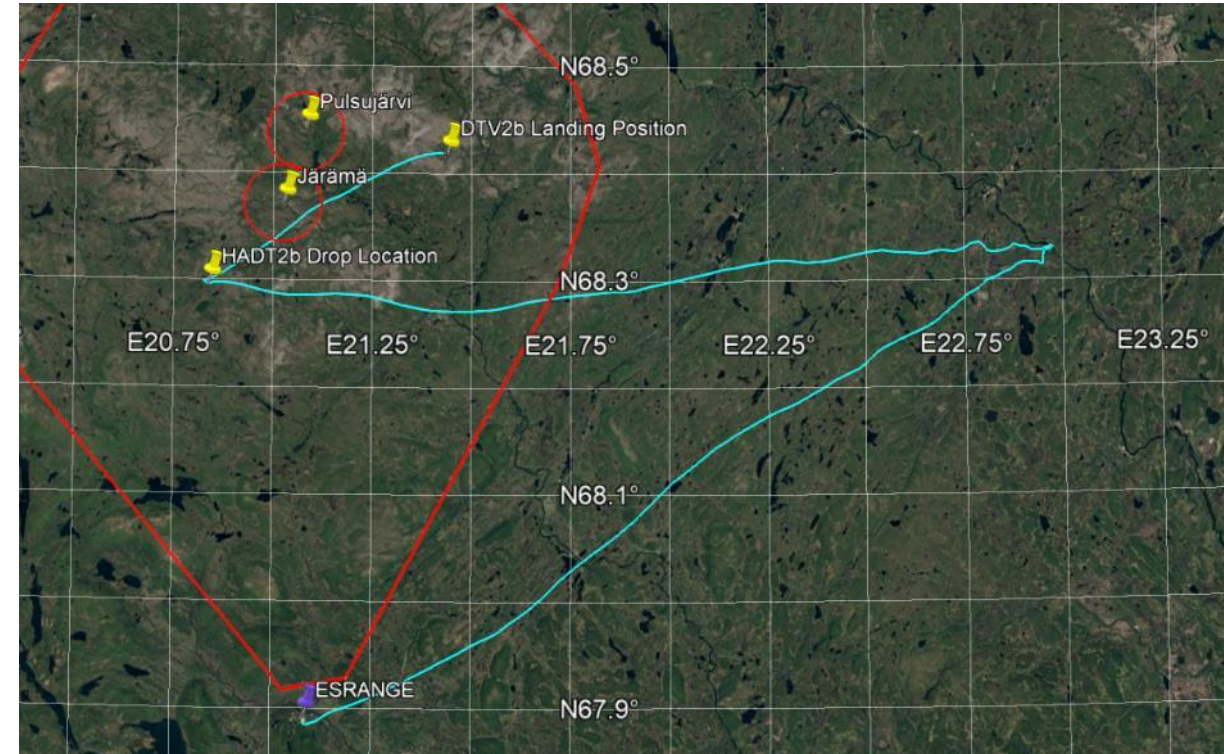
- Two test types
 - HADT1
 - First main parachute or full parachute sequence
 - Two parachutes or all four parachutes
 - Qualification load for first main parachute
 - 800 kg test vehicle
 - Drop from 29 km
 - HADT2
 - Second main parachute only
 - Two parachutes
 - Qualification load for second main parachute
 - 2000 kg test vehicle
 - Drop from 29 km



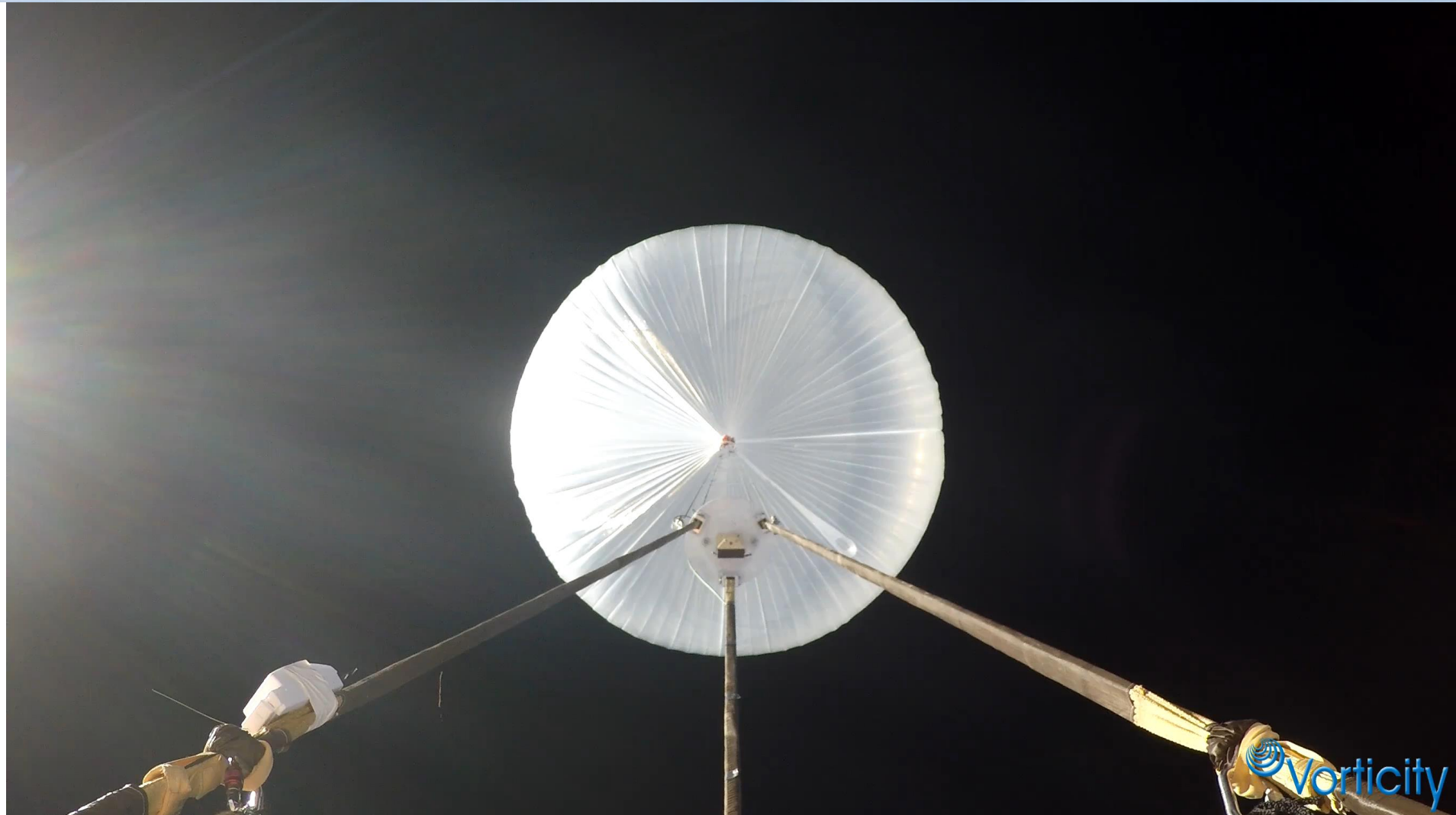
- Large, fragile balloons
 - HADT1: 113,000 m³
 - HADT2: 335,000 m³
- Balloon lay-out 2 hours before launch
 - >1 hour to inflate
 - Predictable weather
 - Low wind, constant wind direction, no precipitation



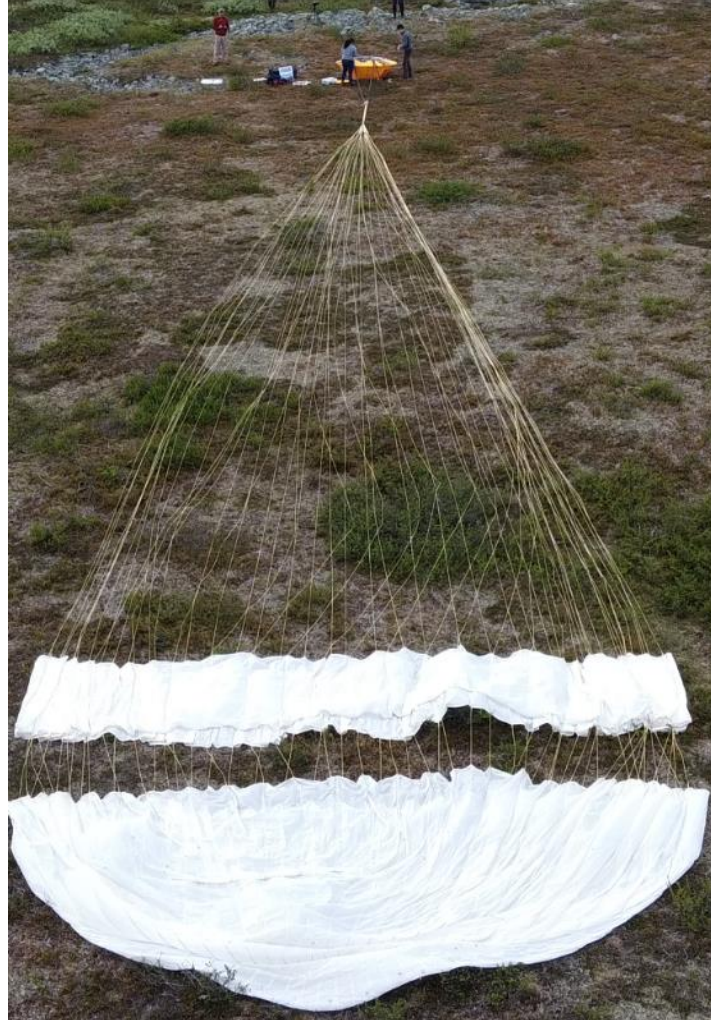
- Ascent to 29 km
 - About 2 hours
 - May be outside safety zone
 - Wind direction varies with altitude
- Float into (or within) safety zone
- Release point
 - Ballistic descent within safety zone
 - Nominal landing positions within safety zone



- Free-fall
 - HADT1
 - ~20 seconds
 - Mach 0.7
 - HADT2
 - ~10 seconds
 - Mach 0.3
- Parachute sequence
 - Complete at 25km
- Descent to ground
- Recovery



- Data recovery
 - IMU
 - Accelerations
 - 4 cameras
 - Up to 1000 fps @ 4k
 - Temperatures
 - Parachute
- Parachute inspection
 - ~1,000 m² of broadloom material
 - ~4 km of rigging line



- Six high altitude drop tests
- Eight main parachutes flown
- Successful qualification of both parachutes
- ExoMars launch from Baikonur in 2022

