

50th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, 28 - 30 July 2014

# **MARS AERIAL-GROUND NUCLEAR GLOBAL EXPLORER (MANGLE): A Global Mobility and Multi-Mission Platform**

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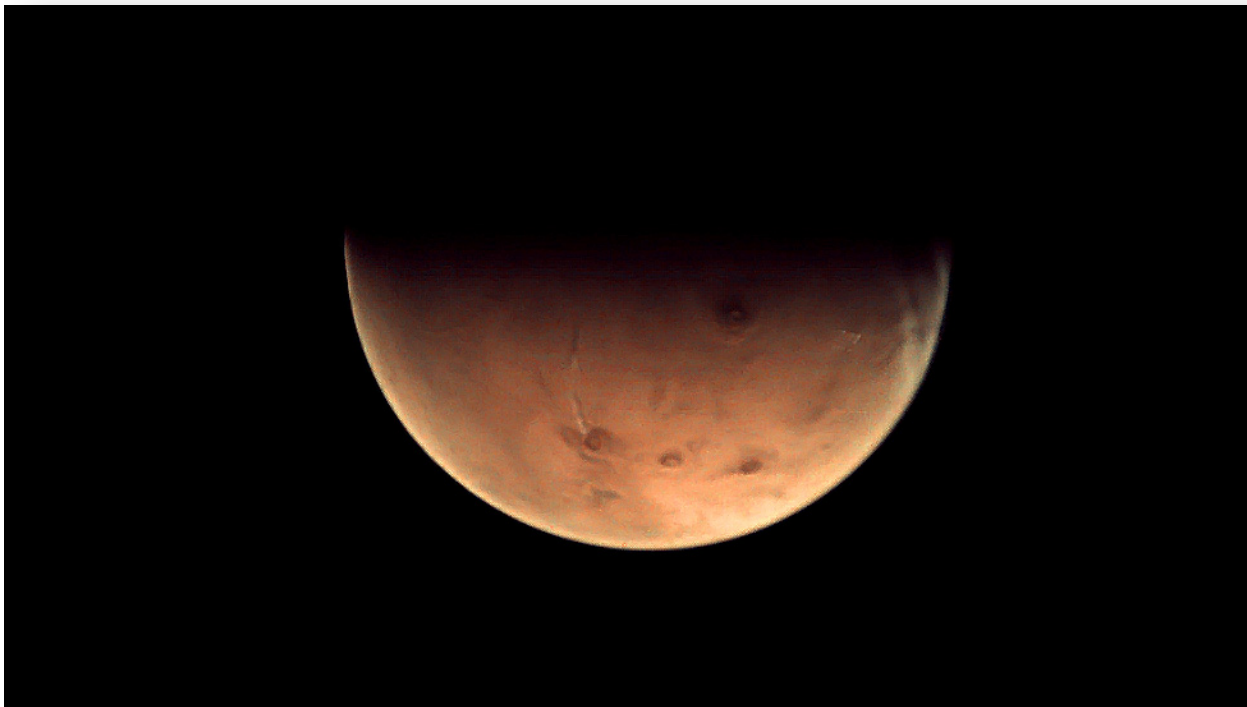
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# Introduction

## Is there life on Mars?



### Mars exploration:

- ◆ **Mobility is not just important –it is essential.**
- ◆ **Deep Drilling necessary**

**NRC 1999**

# Introduction

## Rovers



## Point Scale

- Soil examination
- Small range
- No capability for atmosphere
- Investigation
- No capability for soil drilling



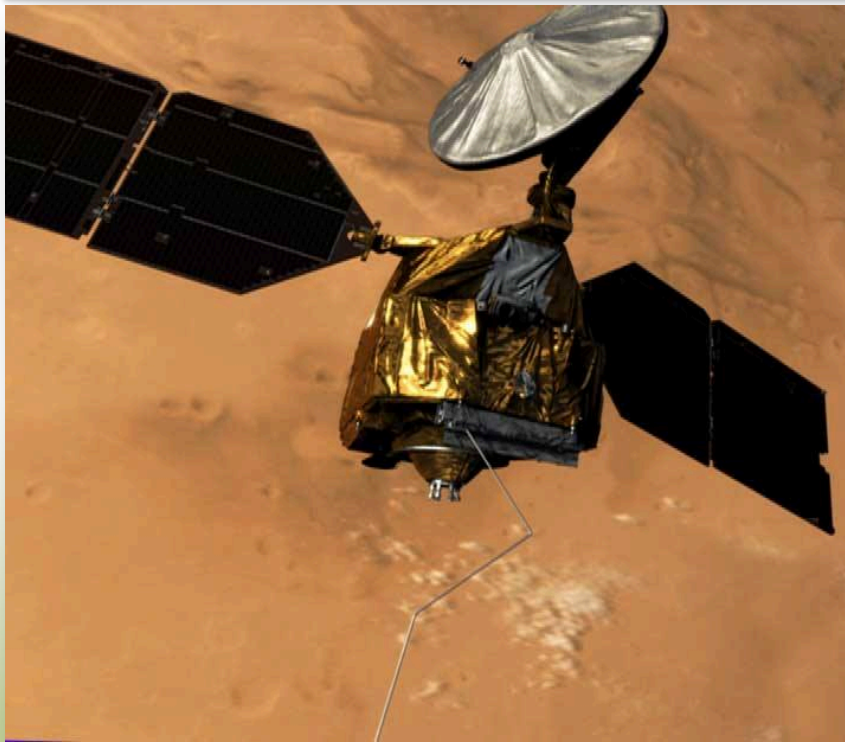
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# Introduction

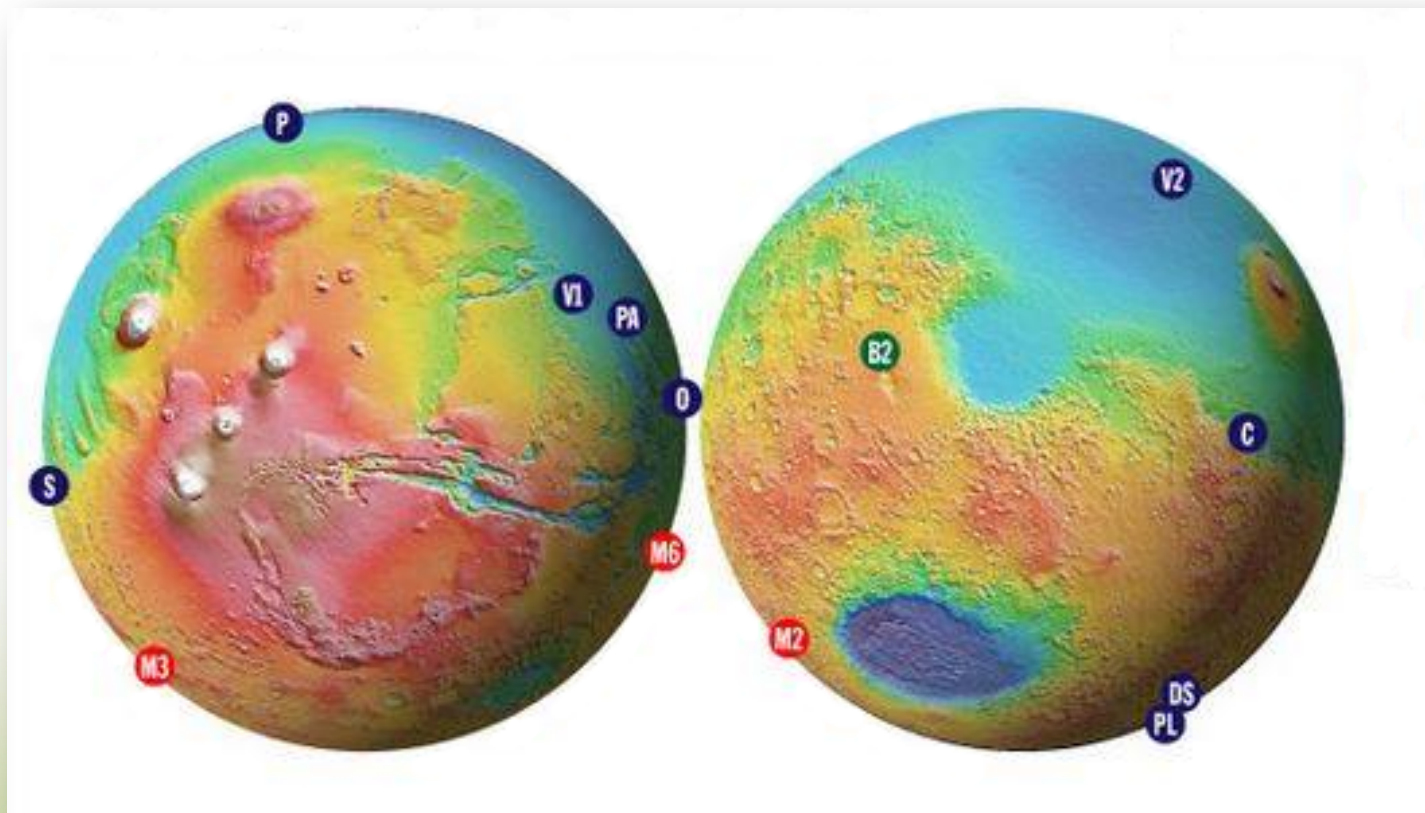
## Orbiters



## Global Scale:

- **Poor resolution**
- **No capability for atmosphere and soil investigation**

# Introduction



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# Introduction



**Regional Scale,  
One shot**

**Mach 0.65**

**Alt=1.5km**

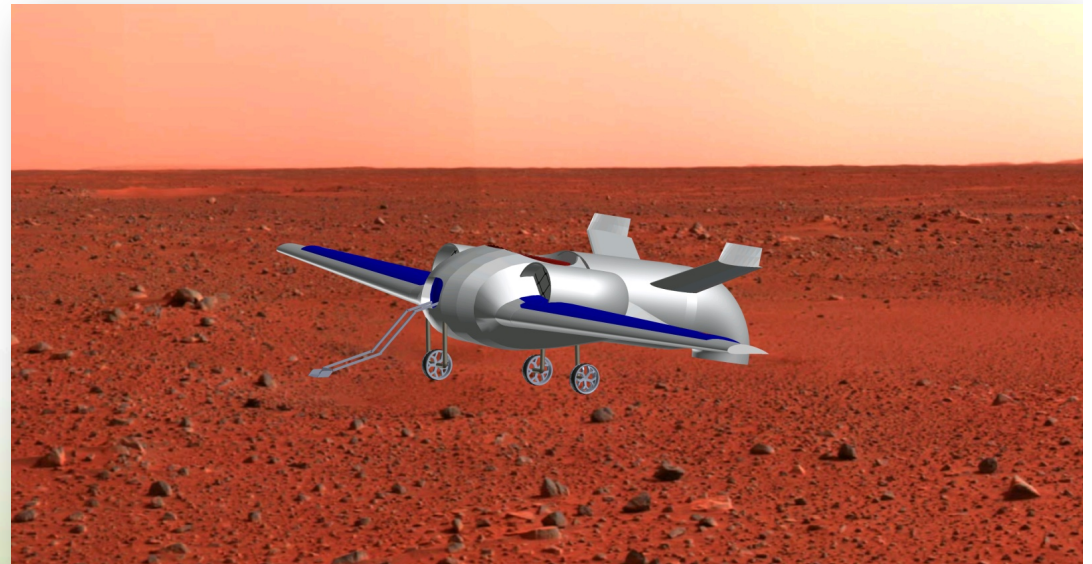
**Weight =175kg**

**Range=600km**

**T=4.2h**

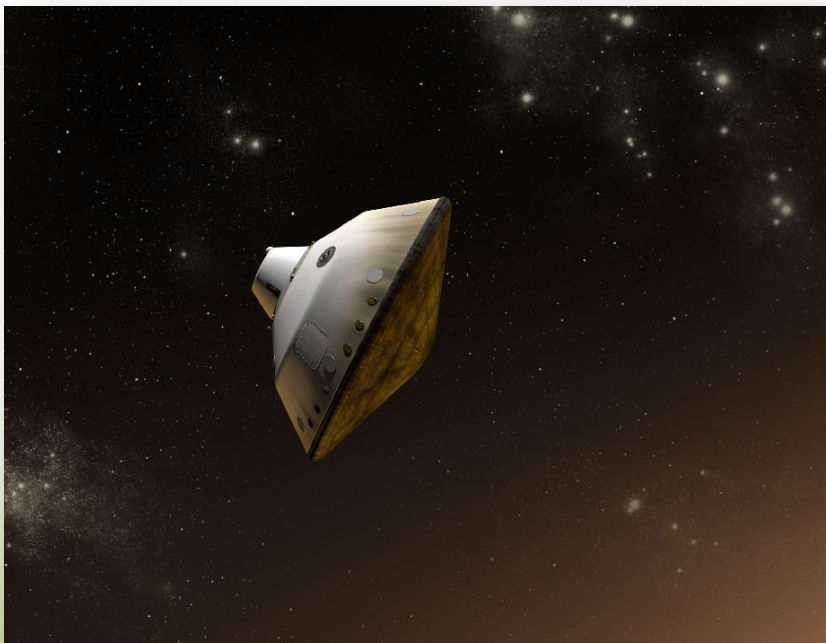
# MANGLE: Global Scale Mobility

- Multi-Scientific Missions
- Martian aircraft
- Land explorer
- Nuclear jet engine
- High lift Co-flow jet
- VTOL



# Preliminary Considerations

Size



Endurance



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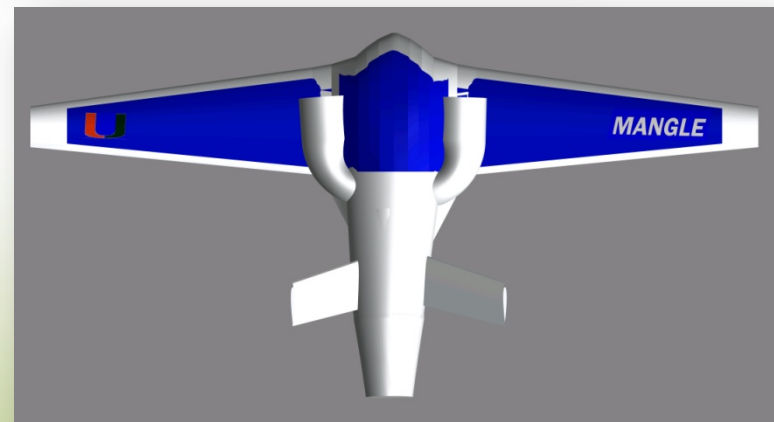
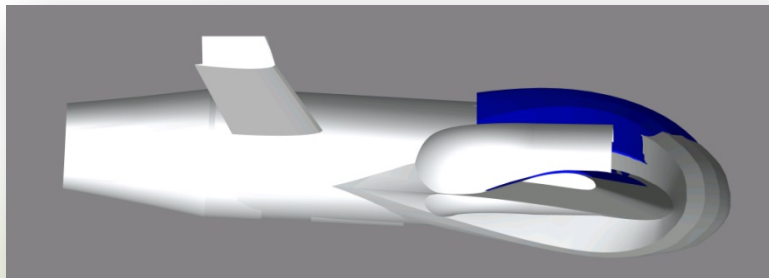
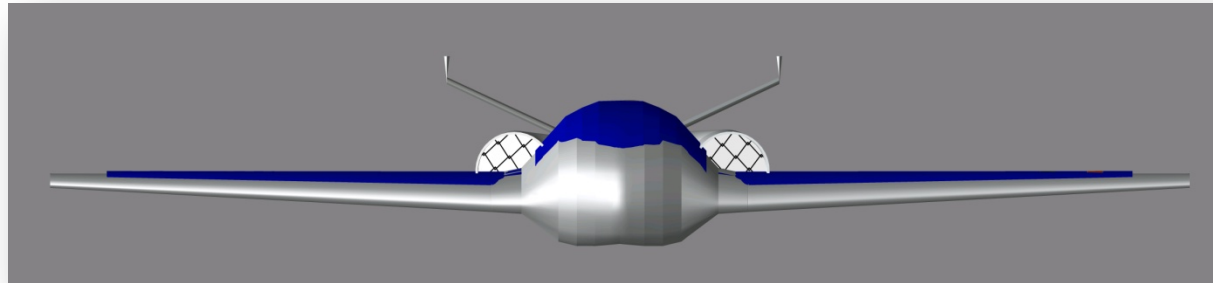
# MANGLE



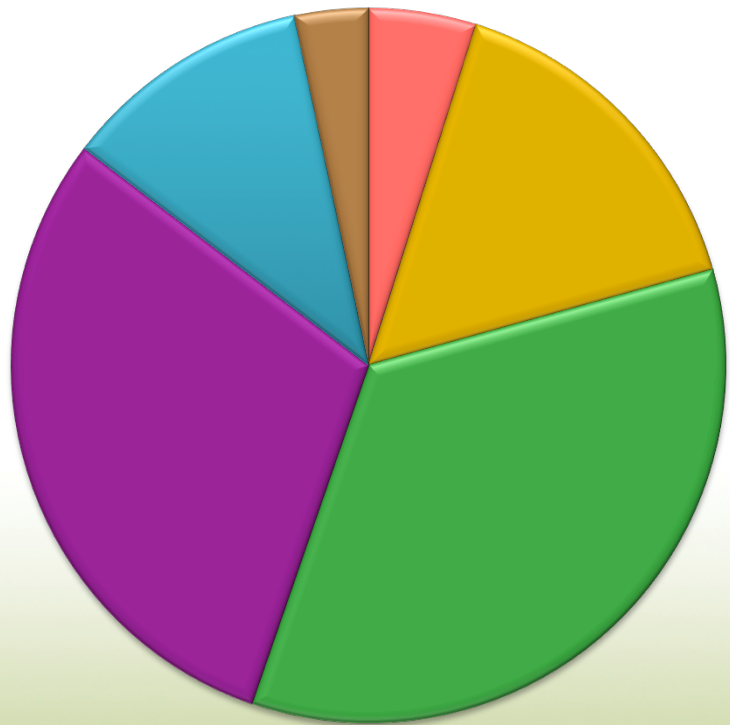
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# Airframe



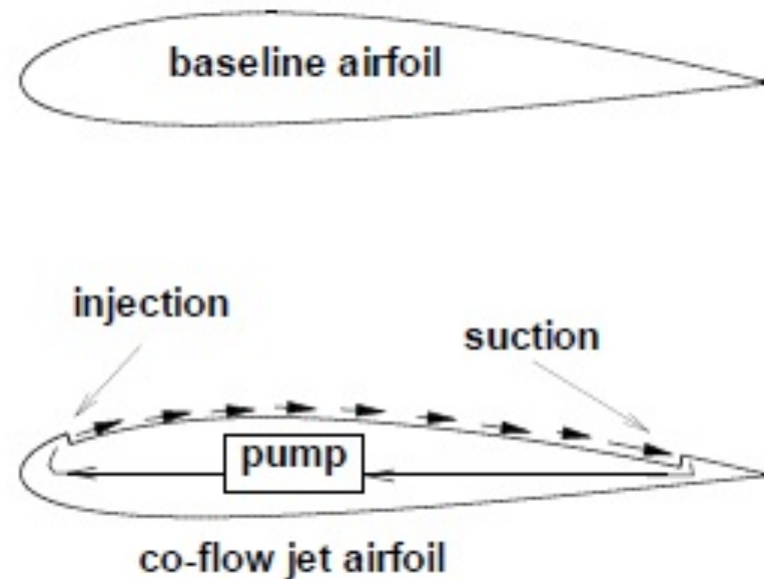
# Weight Analysis



- Electronics
- Structures
- Nuclear Reactor
- Shielding
- Propulsion Components
- Miscellaneous

# Co-Flow Jet High Lift System

- Zero-Net Mass Flux Flow Control
- Drastically Increase Lift and Stall Margin
- Ideal for Low Re Martian Flow
- Drastically Reduce Drag or Generate Thrust(negative Drag)
- Low Energy Expenditure



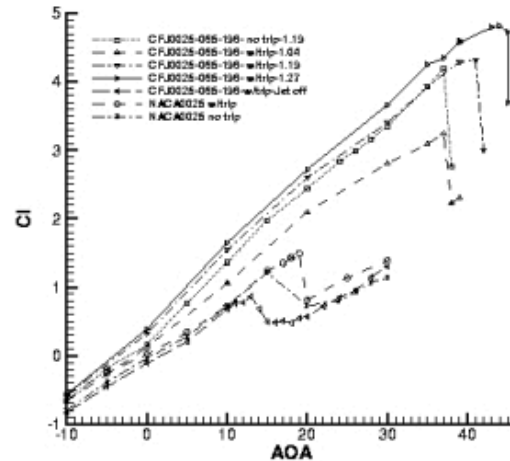
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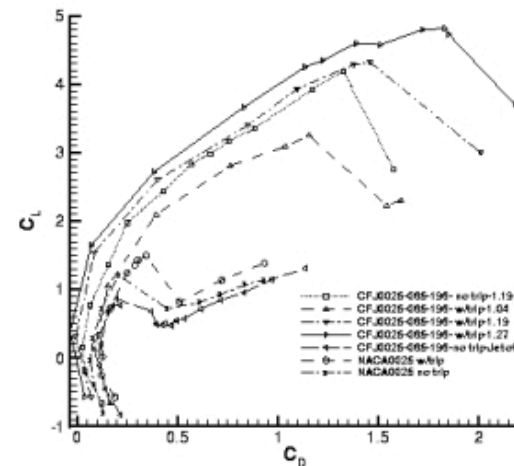
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# Co-Flow Jet High Lift System, open slot reduce energy expenditure

## Wind Tunnel Test Results



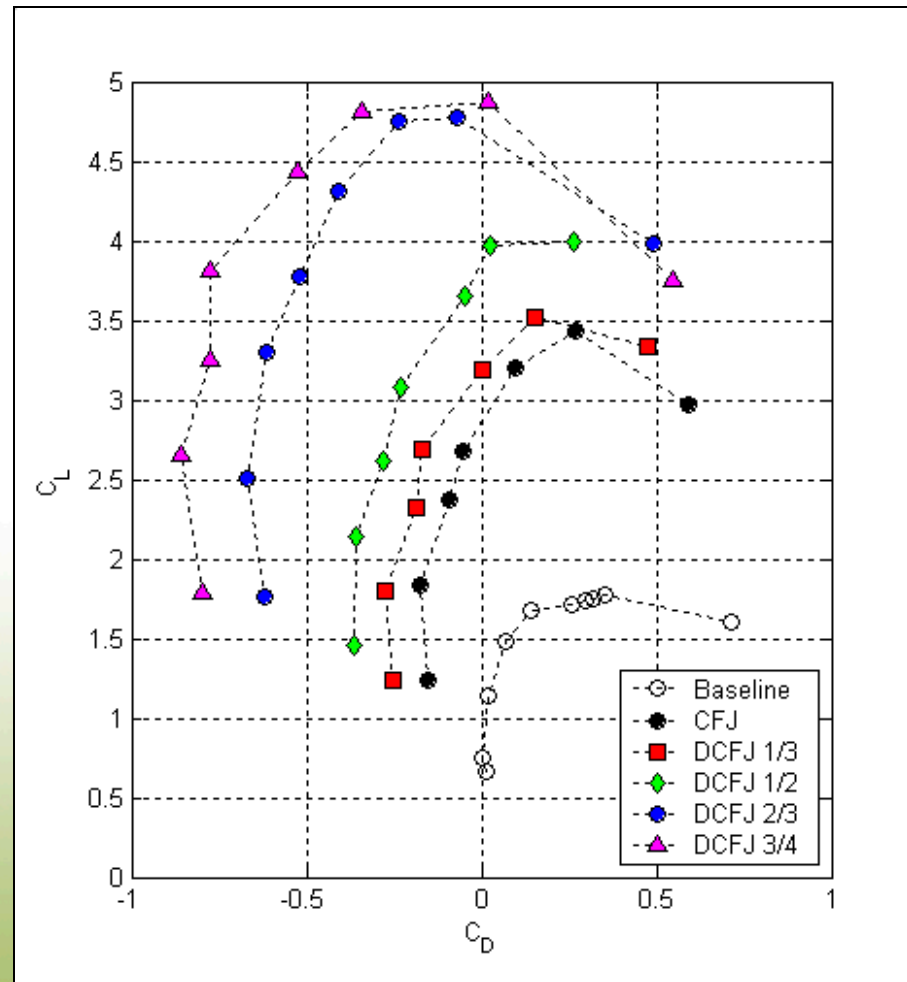
tested lift coefficient for baseline NACA0025 and CFJ0025-065-196 airfoil



Measured drag polar, CFJ0025-065-196 airfoil

# Discrete Co-Flow Jet High Lift System

## Reduce jet mass flow rate



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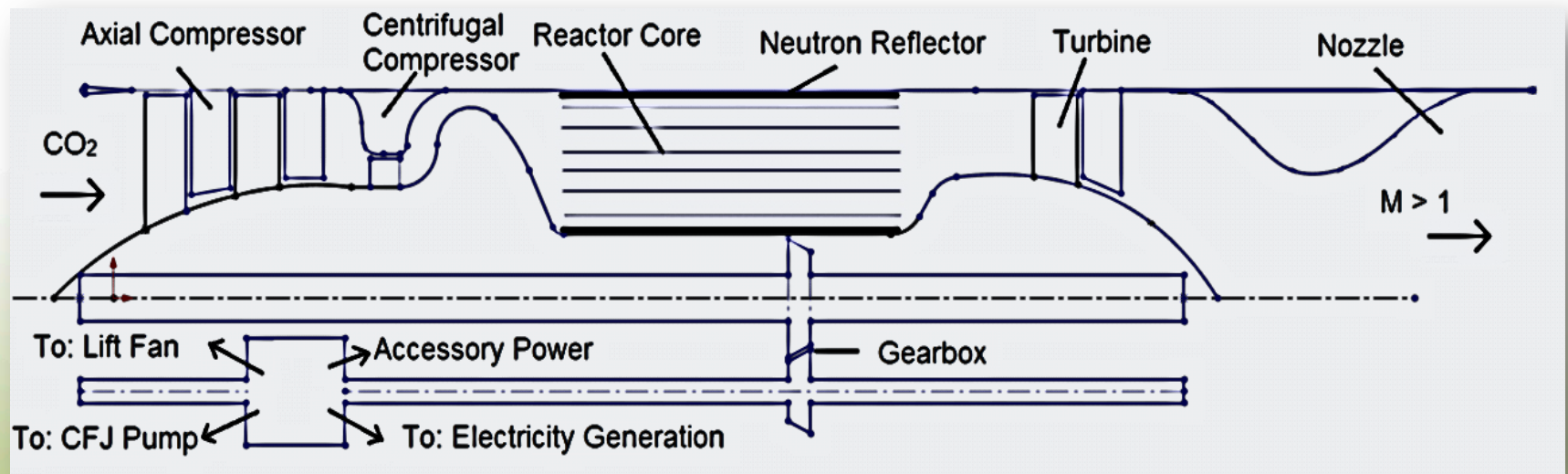
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# Propulsion System

Mass flow=0.5-2kg/s,  
PR=50  
T\_turbine=1400-1800K  
D=0.98m  
L=1.7m

Total power: 0.4-2.1MW

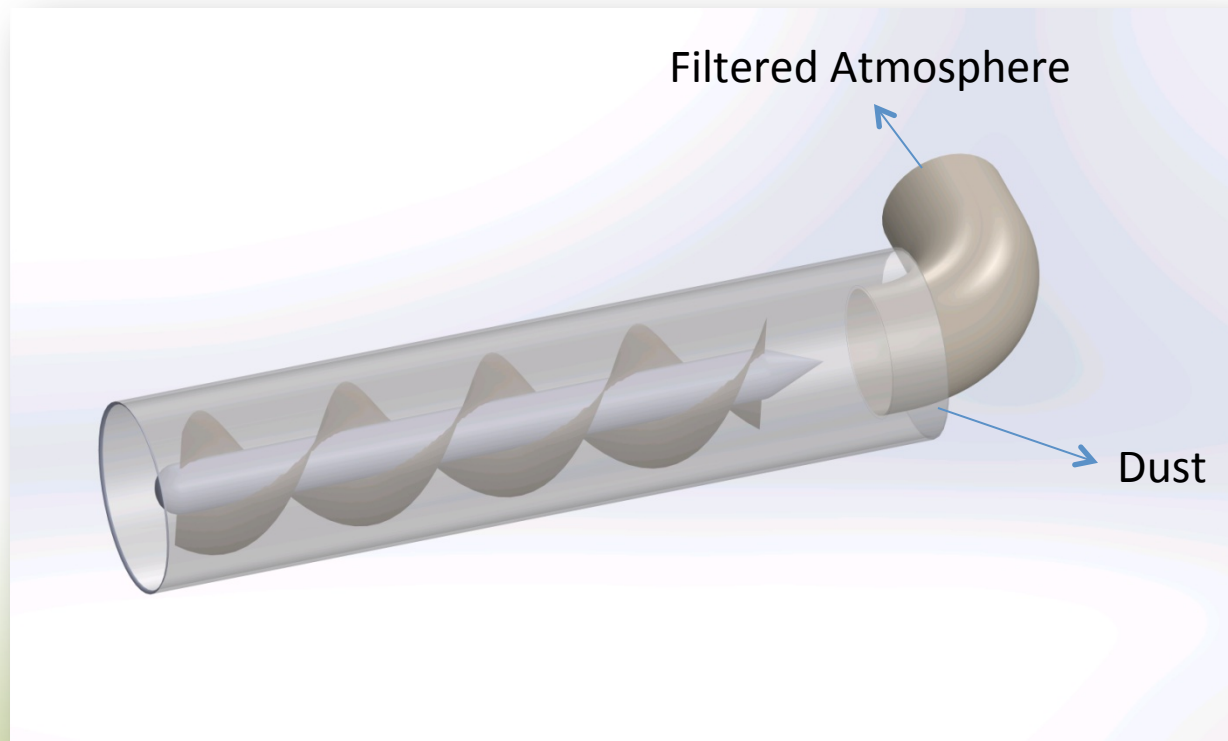


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# Dust Filtering



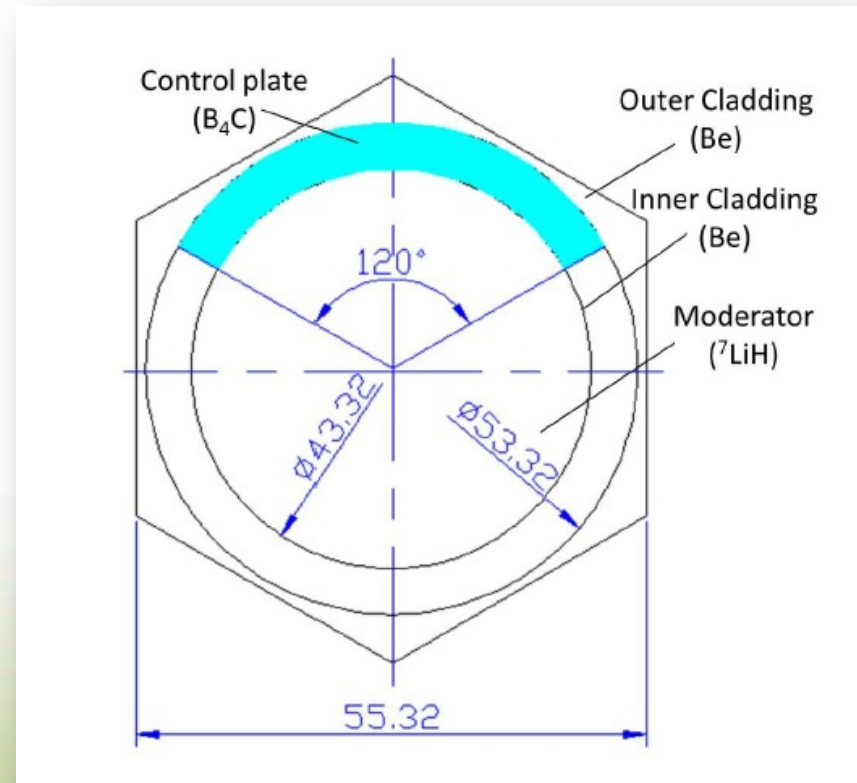
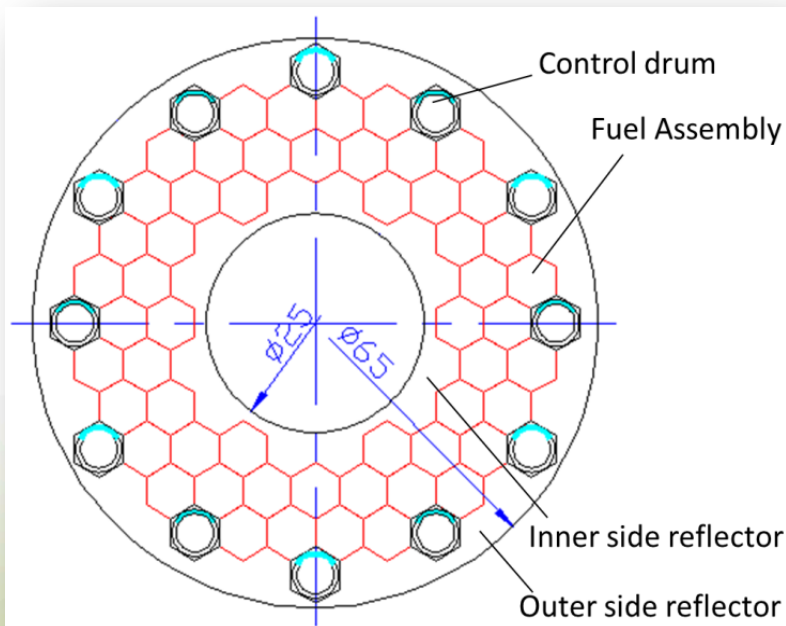
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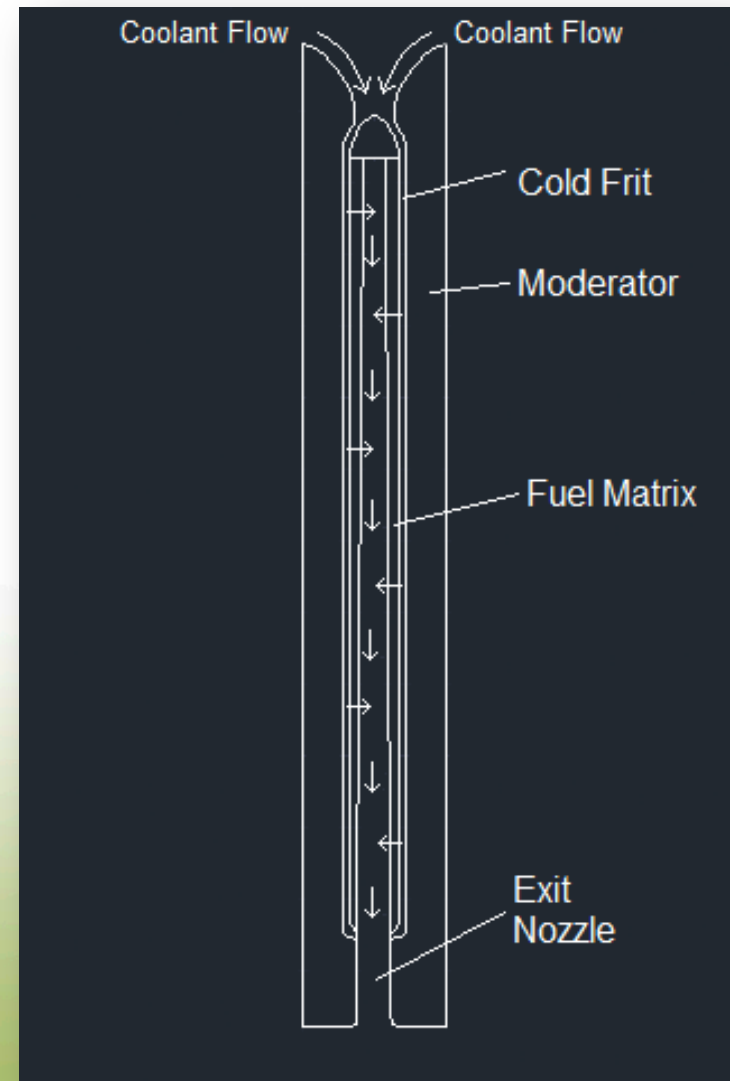
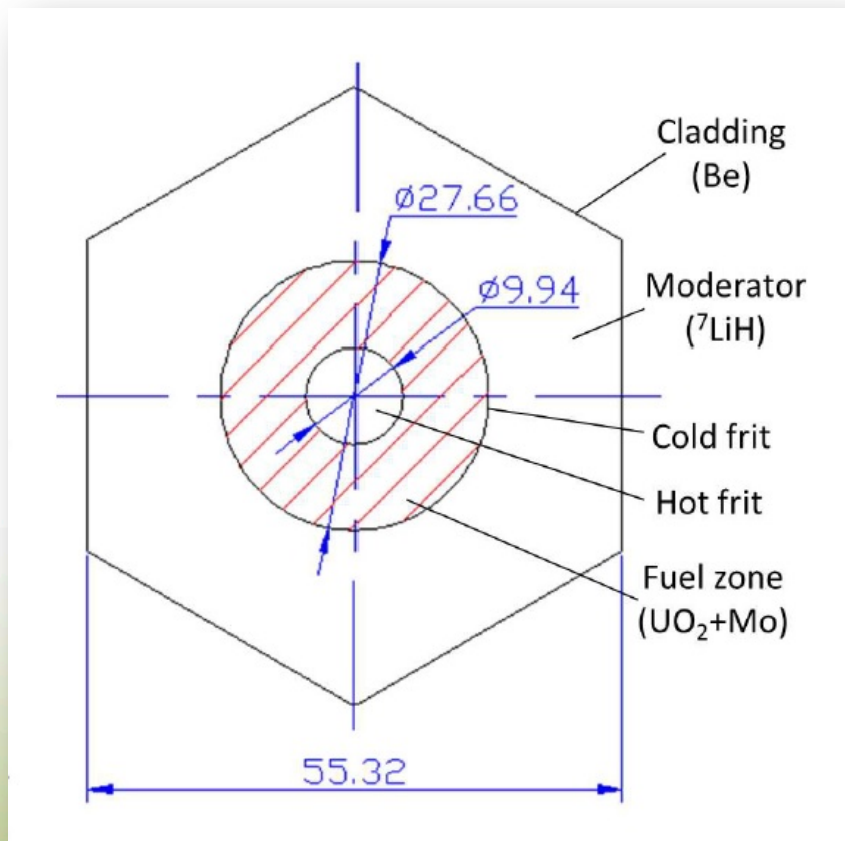
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# Nuclear Reactor



# Nuclear Reactor

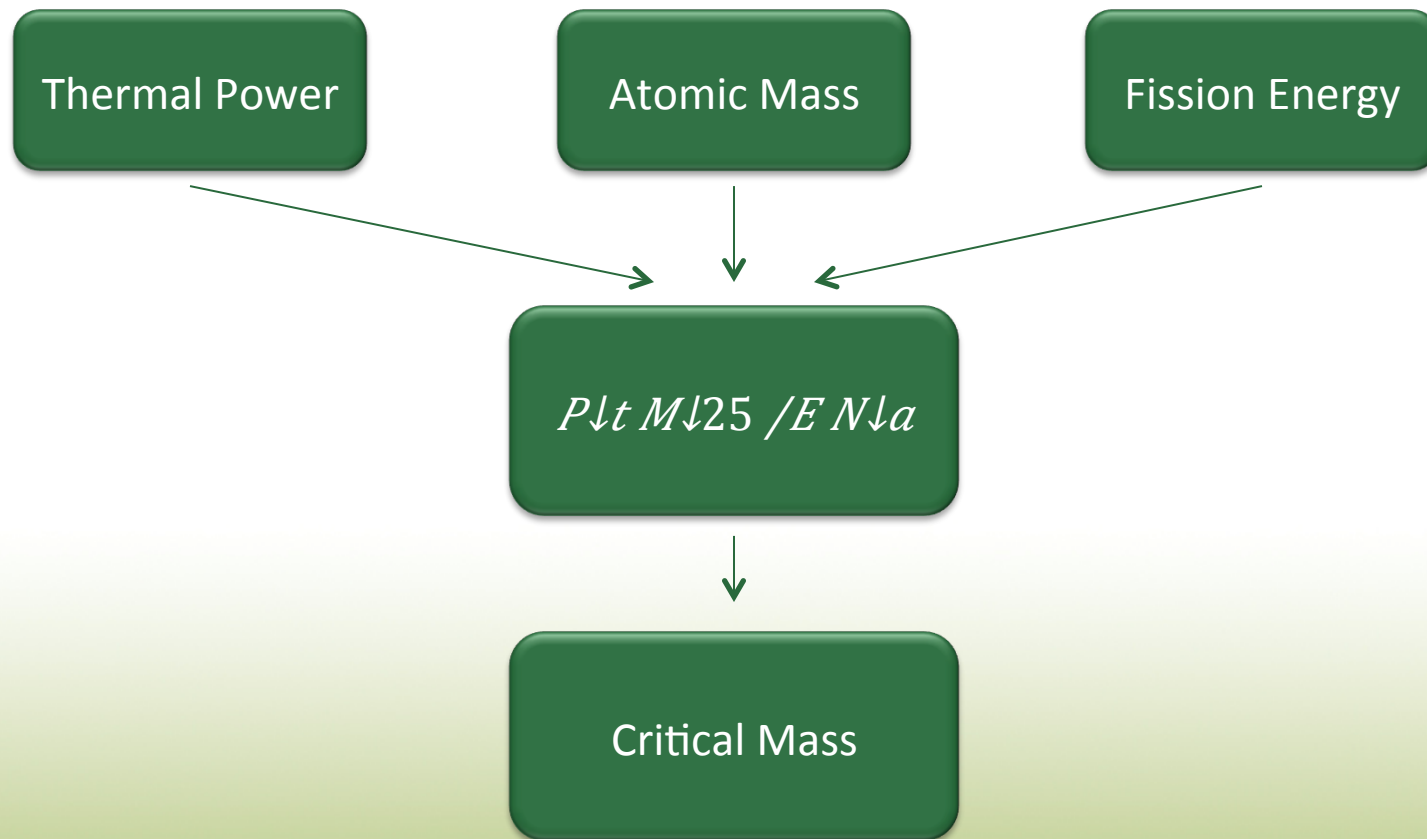


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# Reactor Criticality

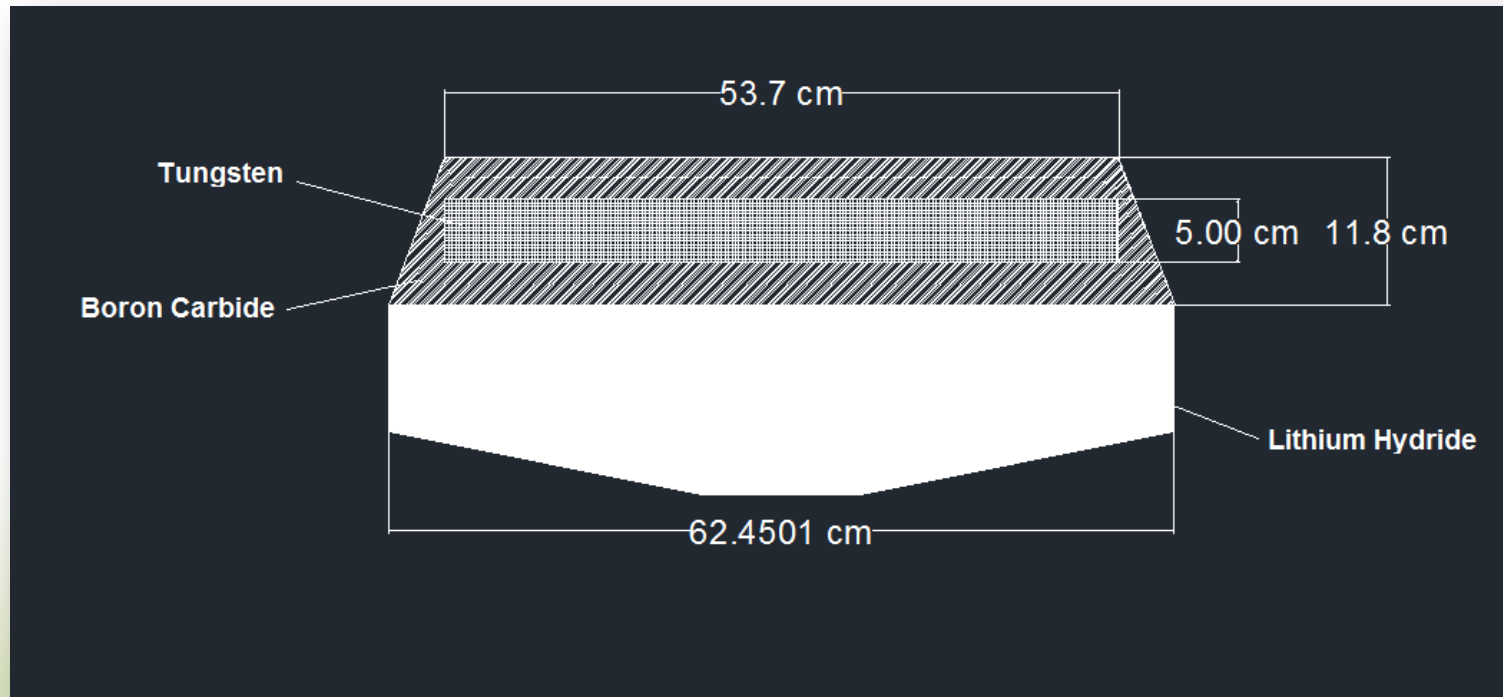


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# Shadow Shielding

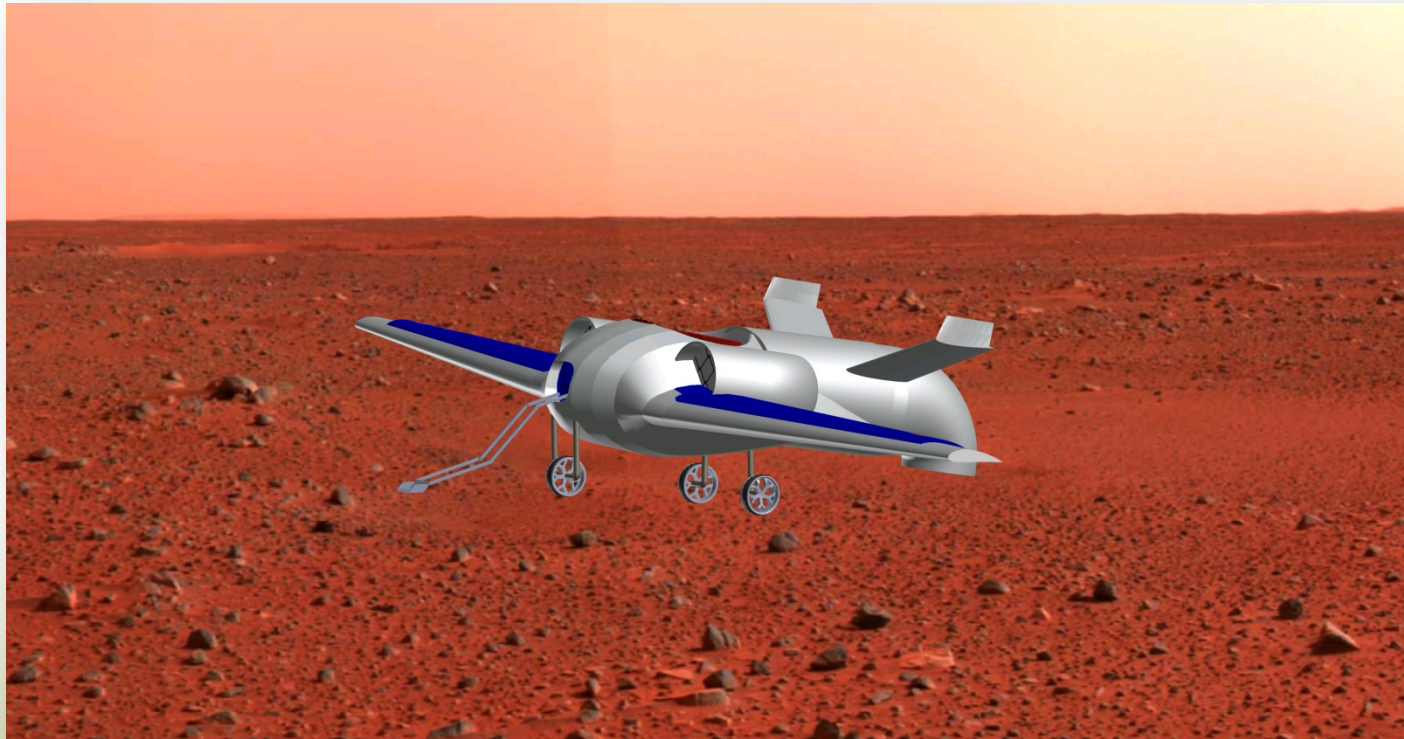


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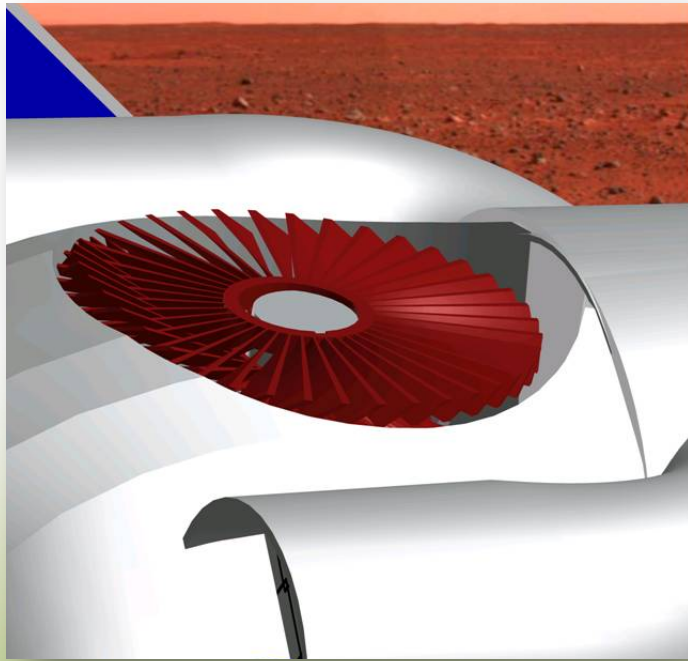
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# Sample Collection

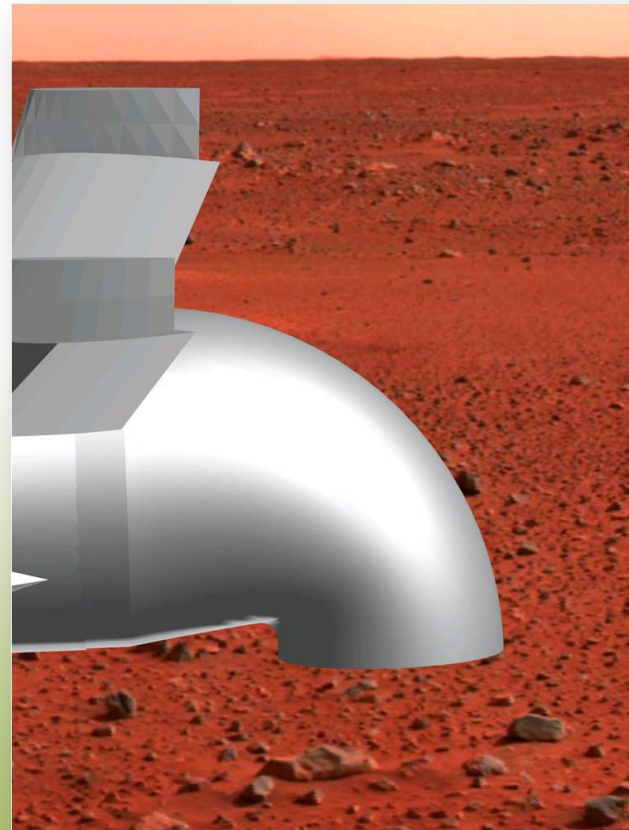


# Takeoff and Landing

Lifting Fan



Nozzle

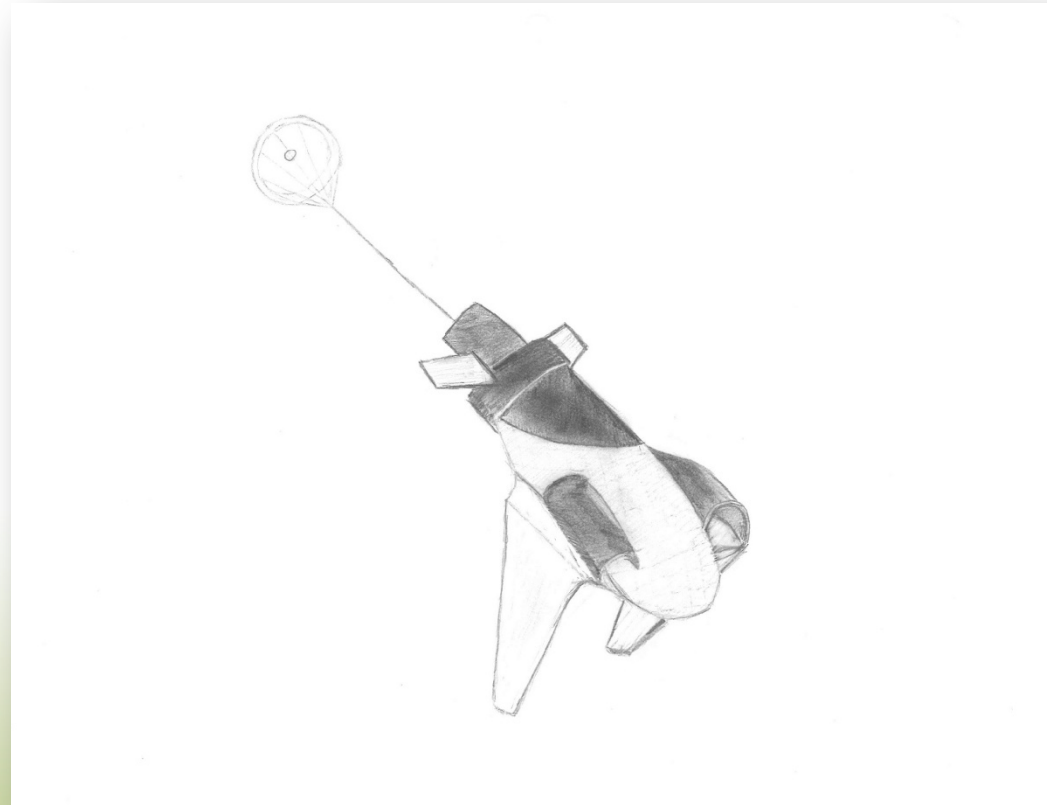


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# Entry, Descent, and Deployment

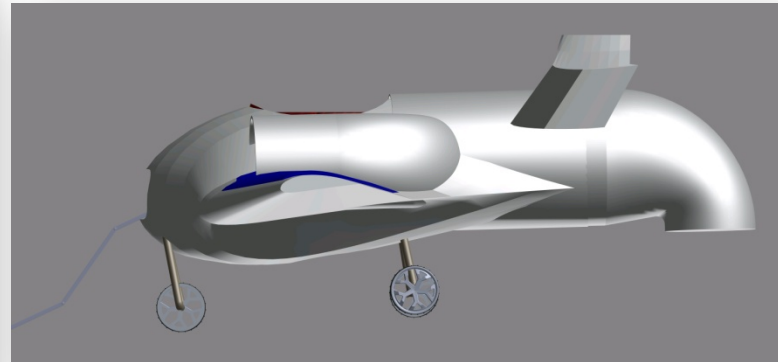
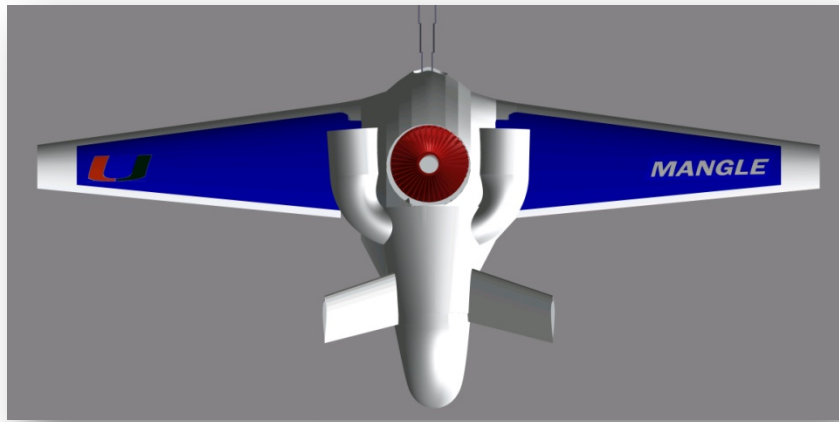


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# Conclusion



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# Conclusion

- MANGLE: A global mobility system for Mars Exploration in Atmosphere and on Ground
- Nuclear Jet Engine Feasible to Use CO<sub>2</sub> to reduce weight, Power 0.4-2.1MW
- High Lift Co-Flow Jet To Minimize the Size and Weight and overcome Low Reynolds number Flow
- Compact Nuclear reactor feasible to integrate to the engine system



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# Conclusion

- 1 Martian Year Operating Time
- Can Land any place of interest on Mars
- 2/3 time fly and 1/3 on ground,
- Range: 160 circles around Mars
- Power available for deep drilling



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# References

- Slide 2
  - [http://solarsystem.nasa.gov/multimedia/gallery/First\\_data\\_via\\_Malarguee\\_station\\_Mars\\_as\\_seen\\_by\\_VMC.jpg](http://solarsystem.nasa.gov/multimedia/gallery/First_data_via_Malarguee_station_Mars_as_seen_by_VMC.jpg)
- Slide 3
  - [http://www.nasa.gov/mission\\_pages/msl/multimedia/gallery/msl20100713-i.html](http://www.nasa.gov/mission_pages/msl/multimedia/gallery/msl20100713-i.html)
  - <http://www.jpl.nasa.gov/news/news.php?release=2006-109>
- Slide 4
  - <http://www.space.com/12404-mars-explored-landers-rovers-1971.html>
- Slide 5
  - <http://marsairplane.larc.nasa.gov/multimedia.html>
- Slide 7
  - [http://www.nasa.gov/mission\\_pages/msl/multimedia/gallery/pia14833.html](http://www.nasa.gov/mission_pages/msl/multimedia/gallery/pia14833.html)
  - <http://www.everystockphoto.com/photo.php?imageId=7749599>