



# The Future of Space Tourism and Space Weather

*Virgin*

*Virgin Galactic*  
*Spaceflight Safety Assurance Officer*  
*Jeff Peters*

*Space Weather Workshop*  
*April 24 2012*

April 2012



# Dawning of a New Space Age



April 2012



# Space Tourism is real

**Sub Orbital**



April 2012

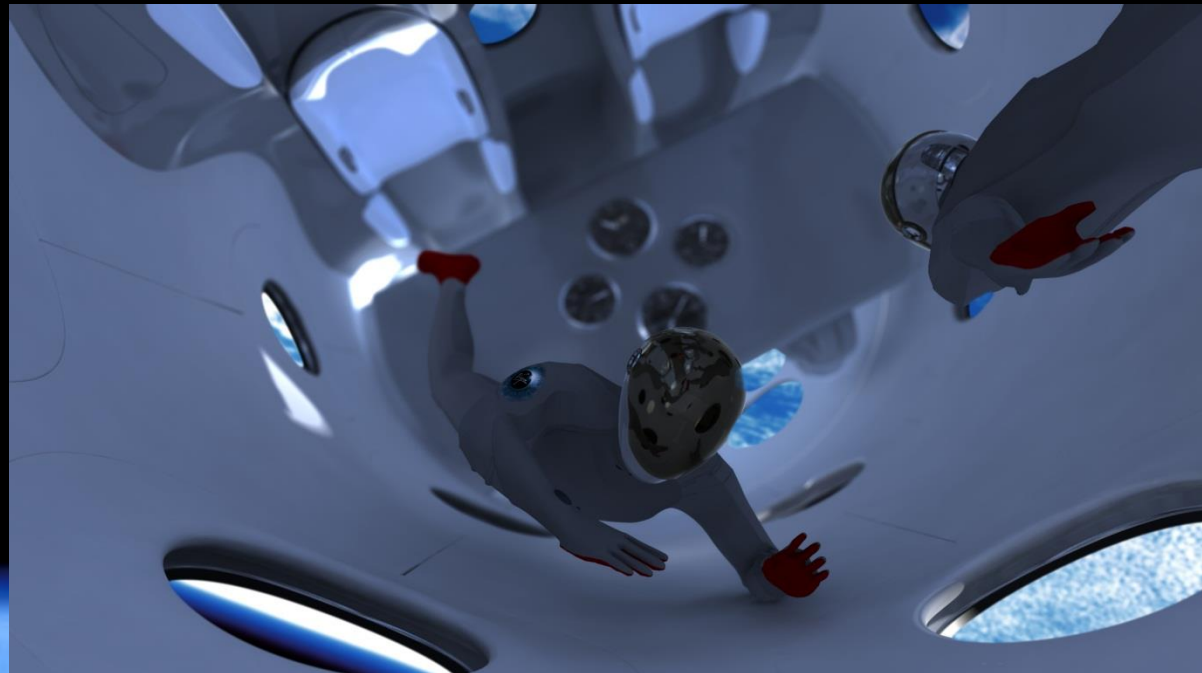
**Orbital**





# Point of Reference

- Virgin Galactic has almost as many people on the waiting list to fly to space (510) than the number of people who have already flown in space (approximately 523)







# Virgin Galactic LLC

- Mission to create **safe** and commercially viable access to space for people, science and potential for payload
- Space tourism early adopters provided vital proof of first available market and made project possible



April 2012



# Sub-Orbital Space Tourism Experience

- 3-4 days of preparation, medical checks, bonding & training
- Each sub-orbital flight will carry 6 passengers + 2 pilots & lasts about 2.5 hours
- Passengers will be able to leave their seats & float in zero G & enjoy views of the Earth's surface for about 1,000 miles in every direction & get a black sky view of space
- Experience cost is \$200K



# Virgin Galactic Today

April 2012



# Flight Test Update

- WhiteKnight Two mothership completed most flight testing
- SS2 completed 16 glide flights
- First rocket powered test of SS2 projected for later this year



April 2012





# Rocket Motor Development

Hot Fire Testing in Progress – started in 2009  
at Sierra Nevada Corp.



April 2012



# Spaceport America

- Major construction completed
- Virgin Galactic starting interior build-out
- Ready for Operations by late 2013







# Spaceport America

➡ In New Mexico: Lat  $107^{\circ}$  W Long  $33^{\circ}$  N



April 2012



# Space Weather implications for Virgin Galactic





# Culture of Safety

Virgin transportation companies transported over 50 million people safely each year



Operating the world's first spaceline has new challenges, like Space Weather

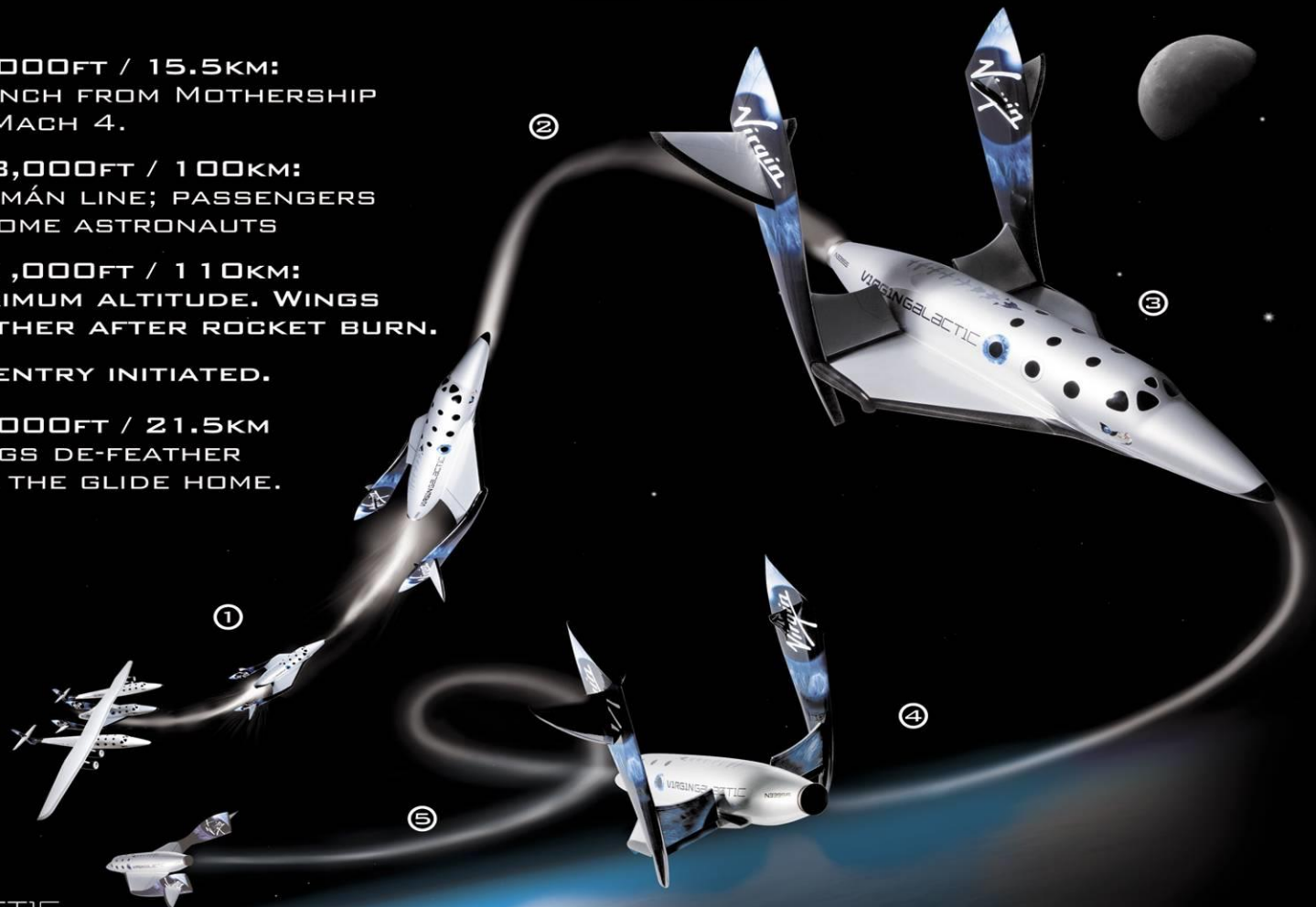




# Sub-Orbital Mission Profile



- ① 50,000FT / 15.5KM:  
LAUNCH FROM MOTHERSHIP  
TO MACH 4.
- ② 328,000FT / 100KM:  
KÁRMÁN LINE; PASSENGERS  
BECOME ASTRONAUTS
- ③ 361,000FT / 110KM:  
MAXIMUM ALTITUDE. WINGS  
FEATHER AFTER ROCKET BURN.
- ④ RE-ENTRY INITIATED.
- ⑤ 70,000FT / 21.5KM  
WINGS DE-FEATHER  
FOR THE GLIDE HOME.





# Minimal Risks

- Very limited exposure due to limited time and altitude
- Time frames
  - 1 hour take-off to 50,000 feet
  - 5 minutes boost to apogee
  - 25 minutes apogee to landing
- Altitude
  - Nominal flight - 100 KM



# Risk Management to date

## ➤ Reviewing SS1 flight data

- Radiation measured
- Winds in “upper middle atmosphere”

## ➤ Enrolled in Space Weather Prediction Center email service

- Daily forecasts & warnings
- Gaining familiarity with the system & terminology
- Observing trends with solar maximum





# Risk Management future plans

- Developing Space Weather policies & procedures
- Identifying Go & No-go criteria
  - For each phase of flight profile
  - Evaluating actions for the various warning levels
  - Determining acceptable level of risks for
    - Solar Radiation Storms – people at altitude
    - Geomagnetic Storms – spaceship & ground support
    - Radio Blackouts – spaceship & ground support



# Risk Management future plans

- Developing a radiation monitoring program for Virgin Galactic pilots
- Identifying best sources for correlating solar events to New Mexico
- Working with the Space Weather community to handle spaceline daily flights



# Risk Management future plans

- Sub-Orbital “Space” Weather interests beyond radiation
- Identifying best sources for pinpointing New Mexico high altitude data
  - Higher altitude wind shears
  - Sprites (extremely high altitude lightning)
  - Notilucent Clouds (extremely high altitude ice clouds)



# Pathfinder for the future



April 2012





Space is *Virgin* territory