The Launch of Gorizont 45 on the First Proton K /Breeze M

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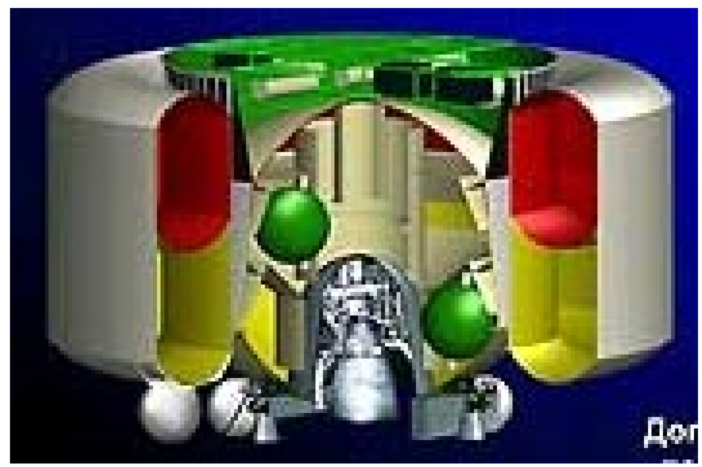

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Outline

- Introduction
- Breeze M
- Launch Scenarios and Pre-Launch Planning
- Mission Events
- Summary

Introduction

- On 6 June 2000 Russia launched Gorizont 45 using the newly developed Breeze M upper stage
- First non-historic deep space Russian launch in many years
- However, International Launch Services published detailed description of the booster capabilities and launch scenarios
- Pre-mission planning led to successful coverage of the rocket body and payload up to synchronous injection

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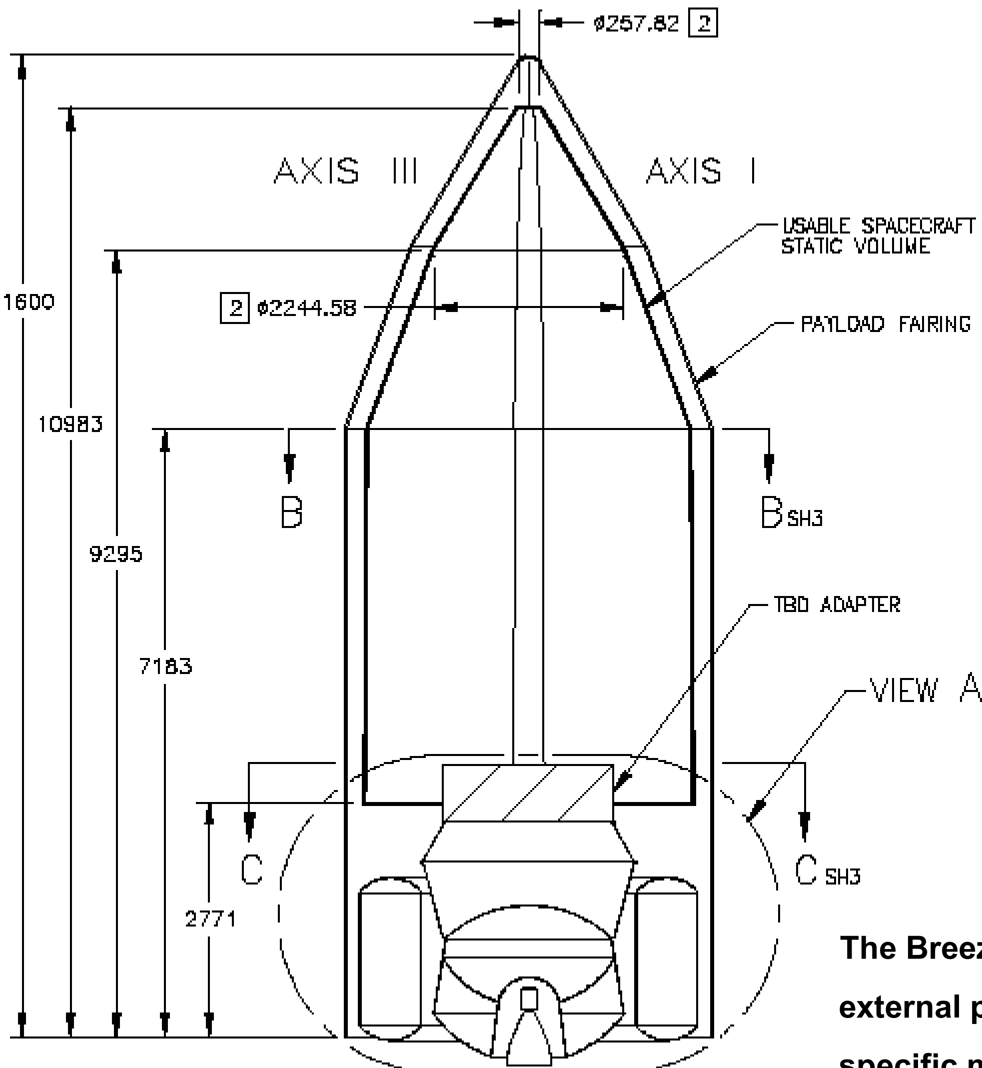
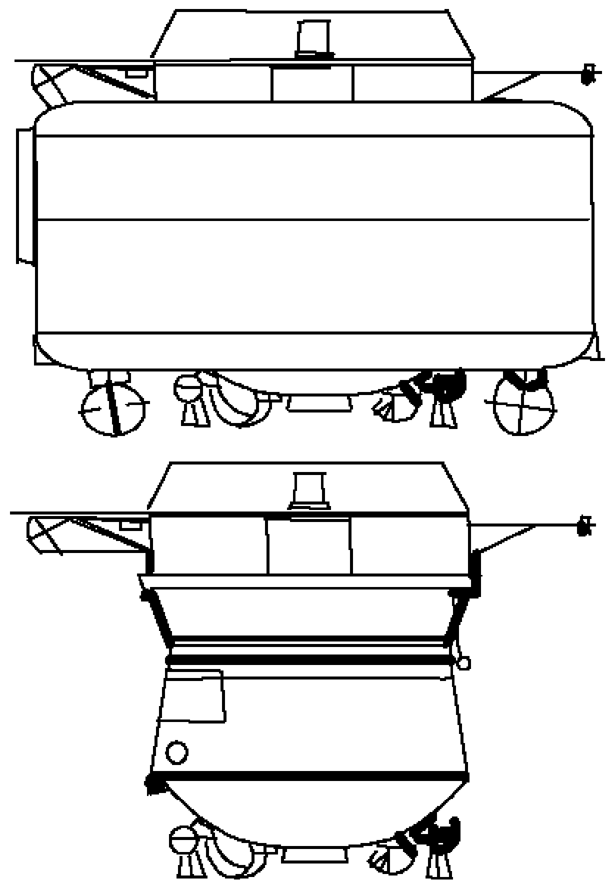
Breeze M with Auxiliary Propulsion Tank

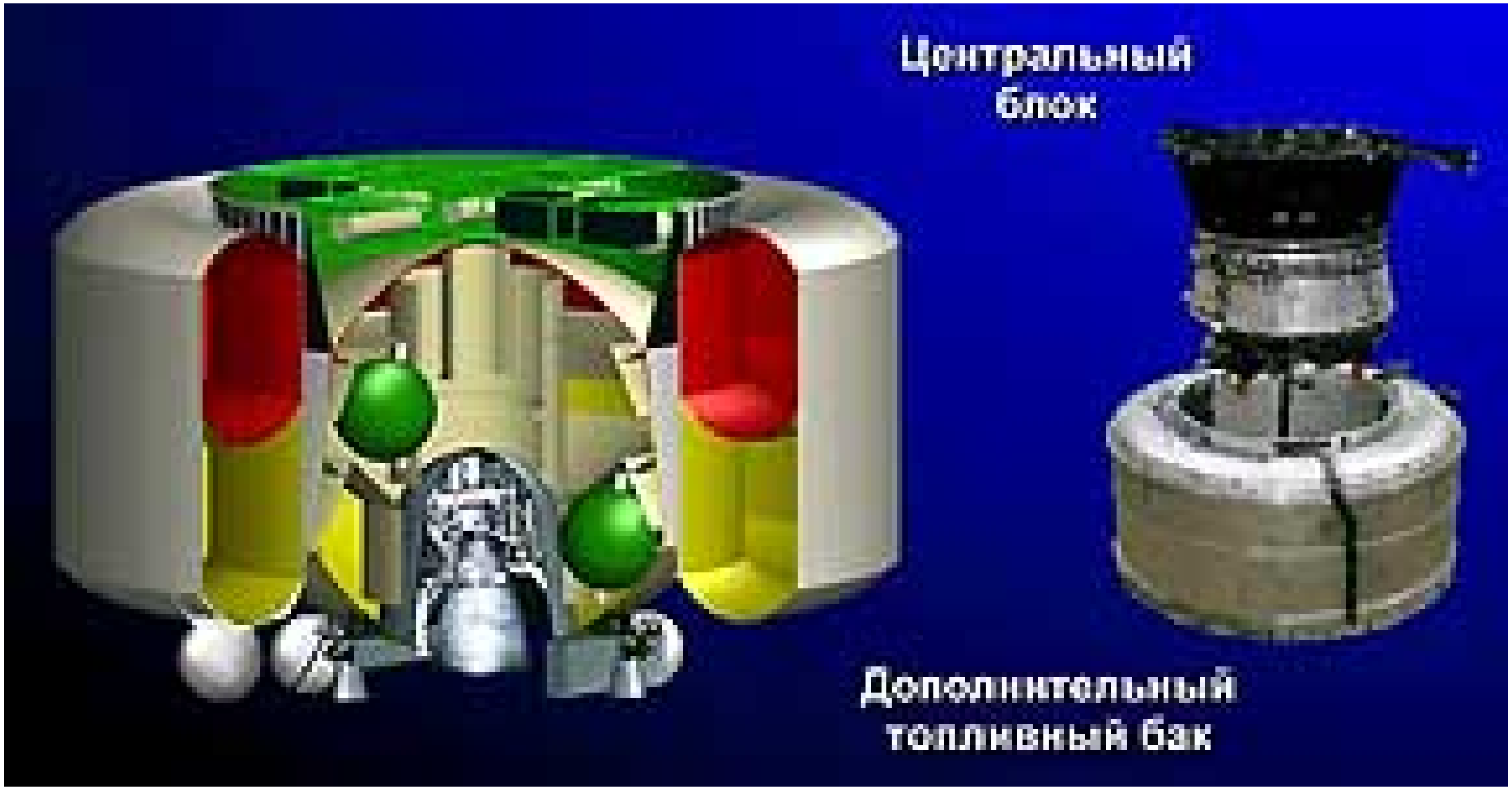




The Breeze M is comprised of a central cylinder and a jettisonable external propellant tank. Propellant carried is dependent on the specific mission requirements and is varied to maximize performance for the mission. Ref: ILSLaunch.com

Breeze M

Rocket Body and Surrounding External Fuel Tank



The Breeze M will be replacing the Block DM

- More lift capability
- Flexible launch profile
- 3rd stage not left in parking orbit

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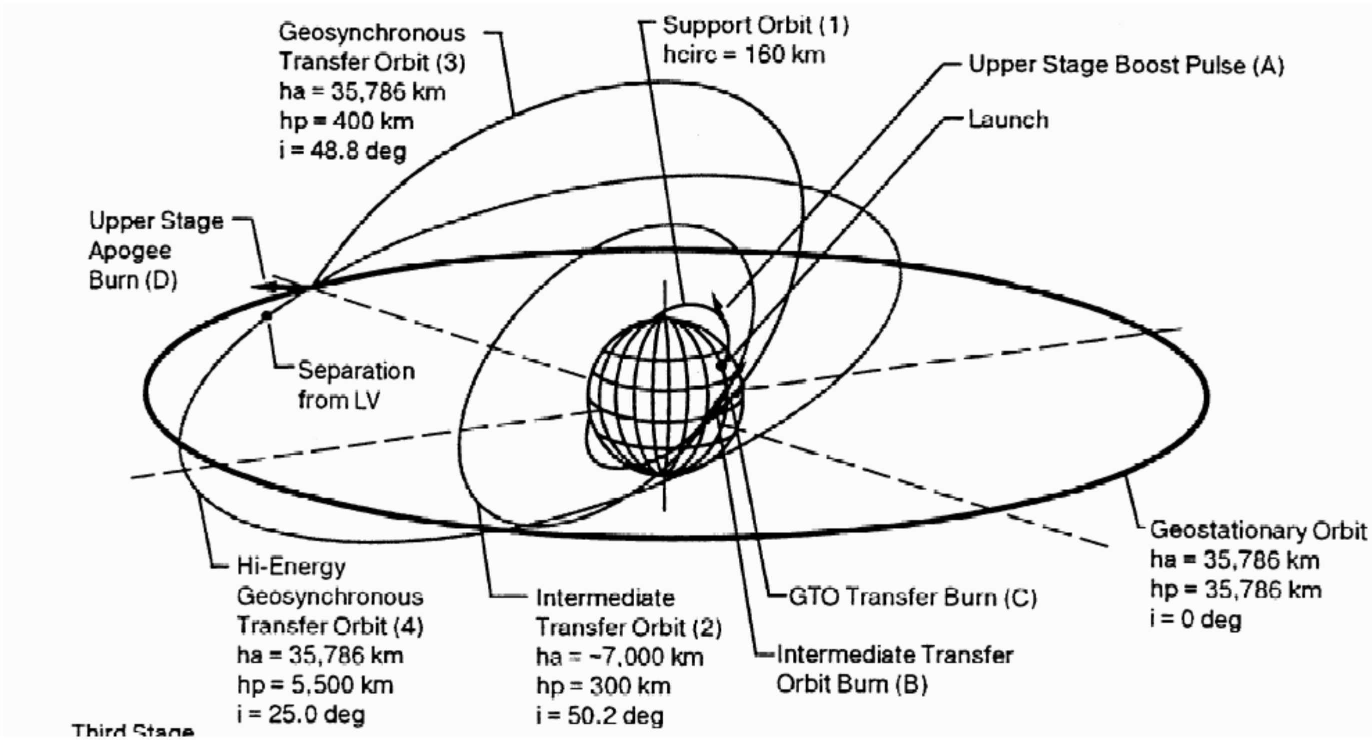
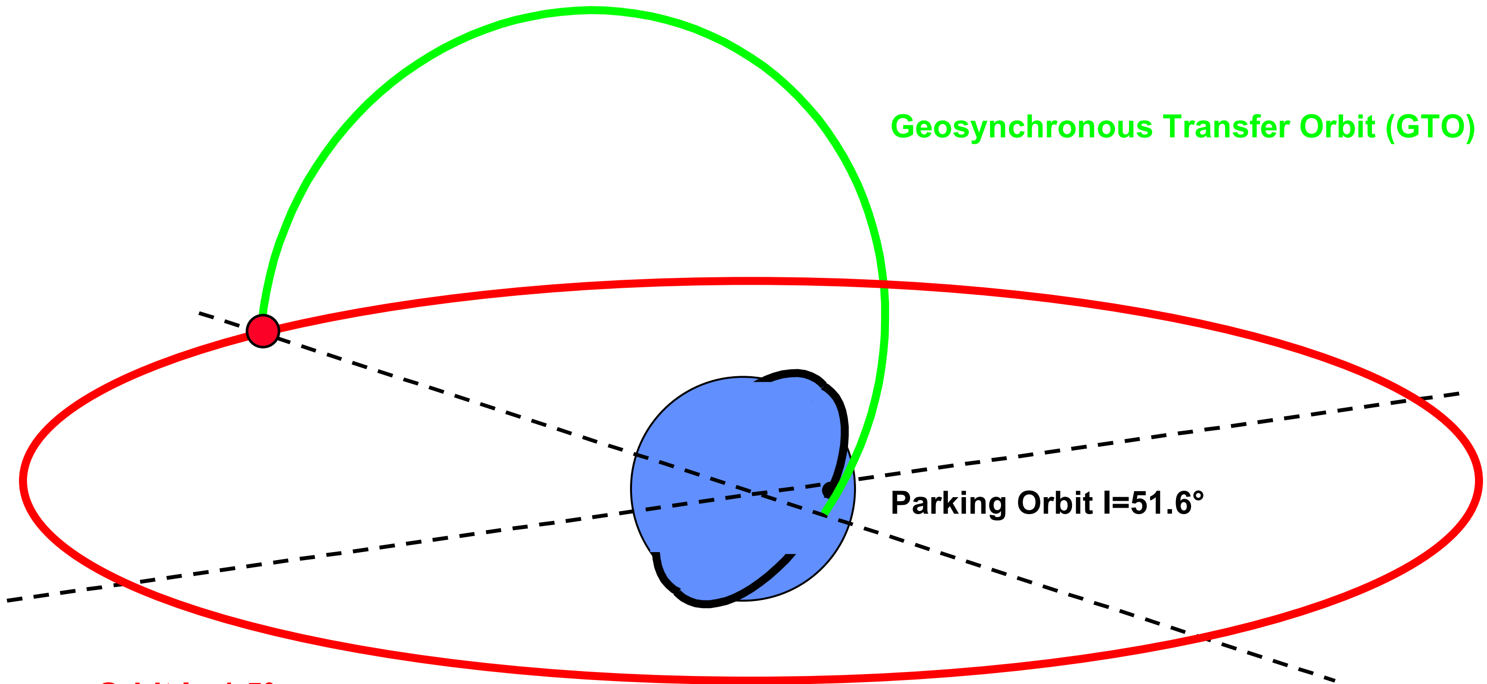
"Typical Breeze M Flight Profile to Geosynchronous Transfer Orbit"

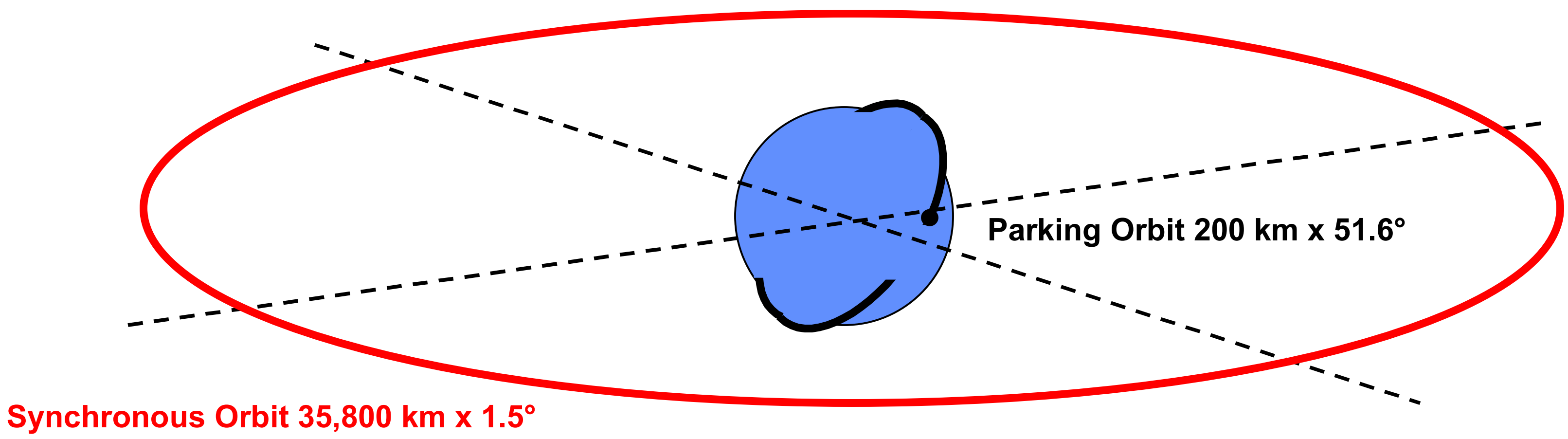


"For typical Proton M/Breeze M missions, the first three stages inject the elements above the third stage into a sub-orbital ballistic trajectory. Approximately 2 minutes after separation, the Breeze M fourth stage performs a main engine burn to reach a low earth "support" orbit inclined 51.6 degrees to the equator. The second burn of the Breeze M engine occurs approximately 55 minutes after lift-off as the vehicle crosses the first ascending node, and lasts nearly 12 minutes. After one revolution in an intermediate transfer orbit, a third Breeze M burn occurs to complete the raising of apogee to geosynchronous altitude. The fourth Breeze M burn, which places the spacecraft into its final orbit, occurs approximately 5.5 hours later at geosynchronous altitude, and lasts ten minutes. Total launch mission duration is approximately 10 hours."

Typical Launch Scenario Using the Block DM



Gorizont 45 Launch Scenario



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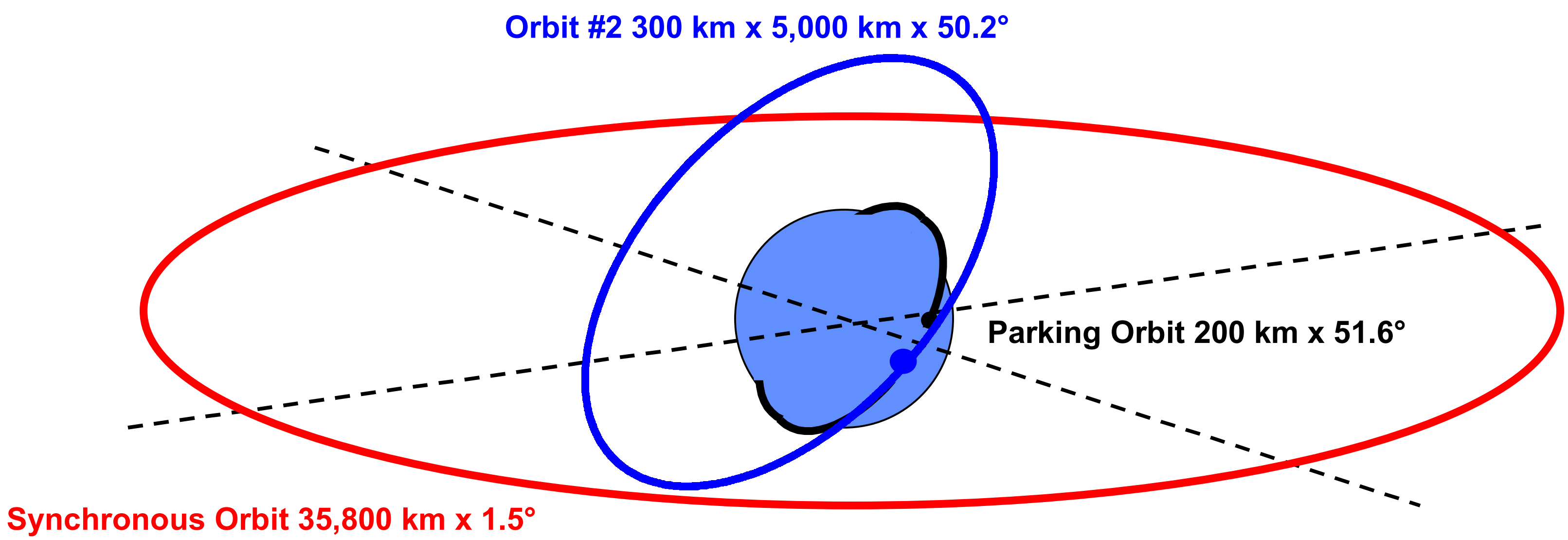

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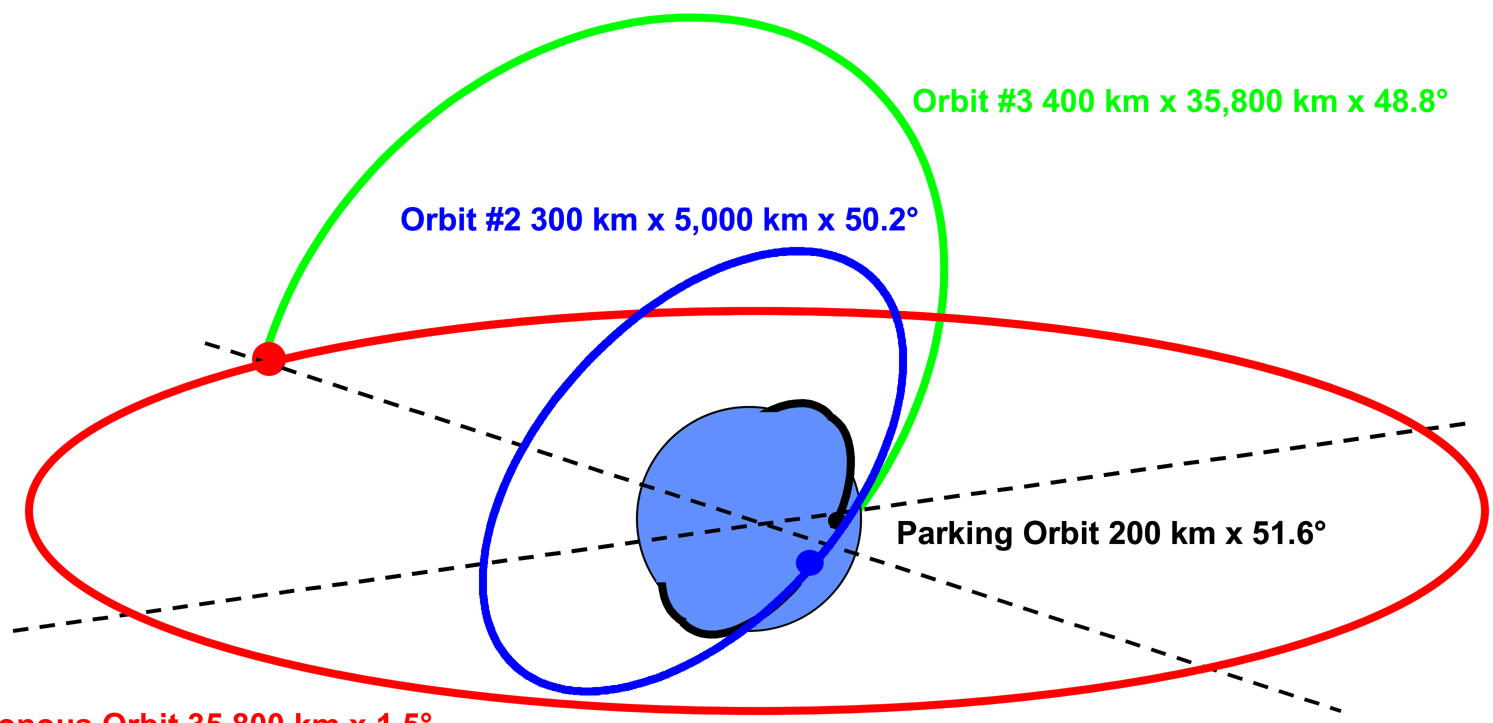
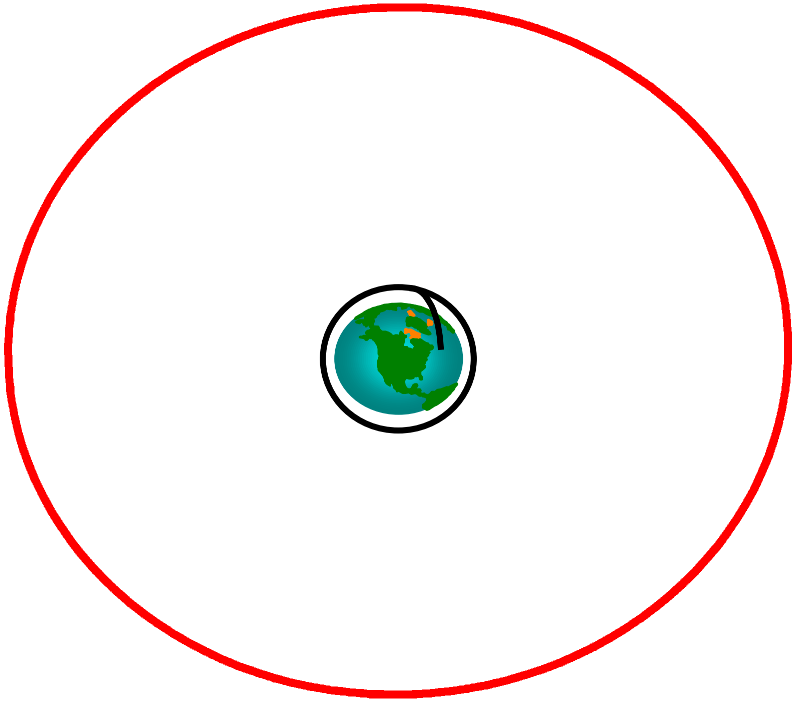


Breeze M Scenario to Geo-Synchronous Orbit



- Breeze M scenario uses multiple transfer orbits
  - lower thrust 4th stage cannot insert directly into GTO
- Inclination changes selected to minimize Δvelocity requirement
  - Δvelocity same as for Proton/Block DM scenario
- Intermediate transfer orbit apogee height dependent upon payload mass

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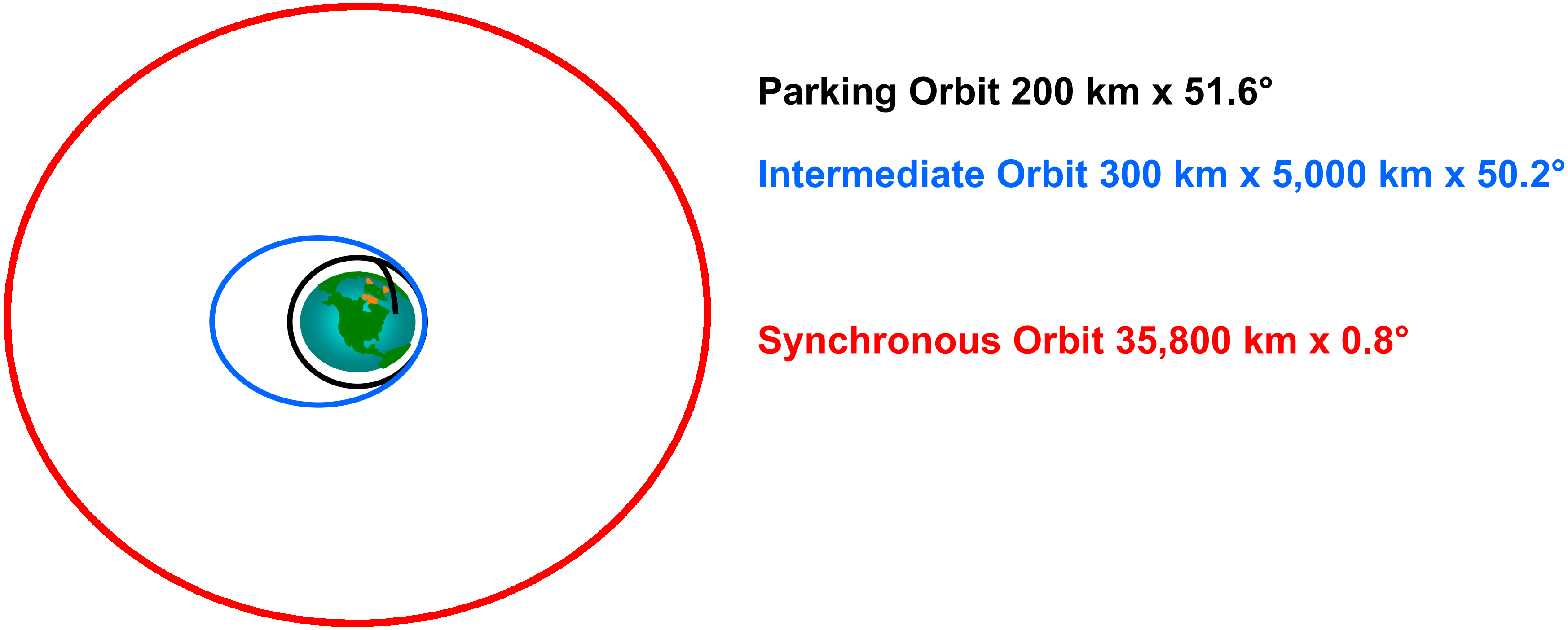

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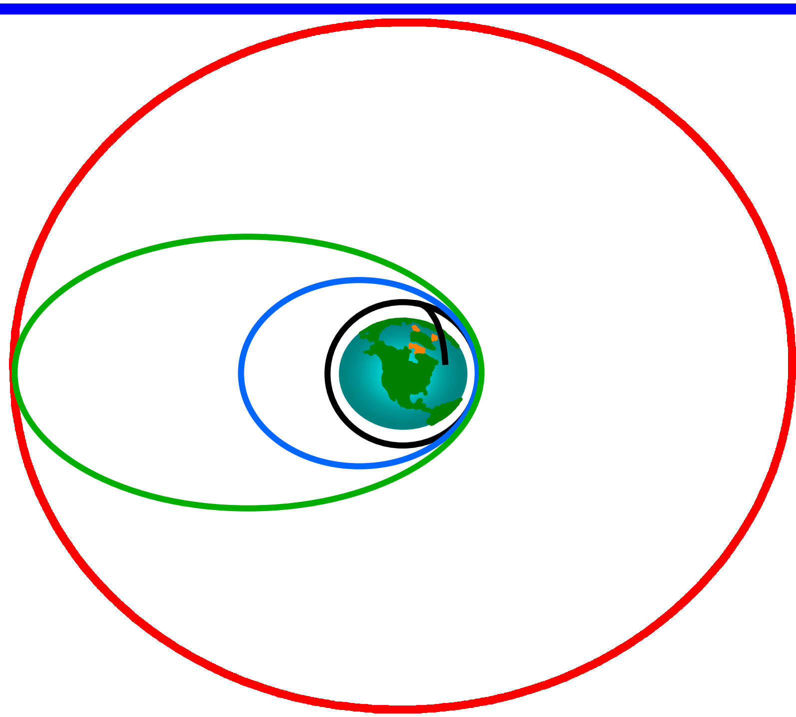

Parking Orbit 200 km x 51.6°

Intermediate Orbit 300 km x 5,000 km x 50.2°

Transfer Orbit 400 km x 35,800 km x 48.8°

Synchronous Orbit 35,800 km x 0.8°

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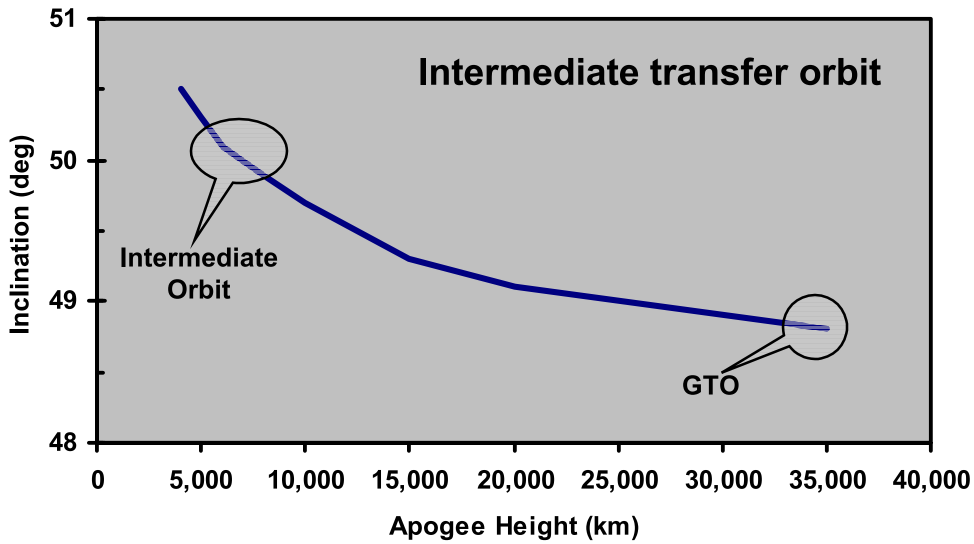
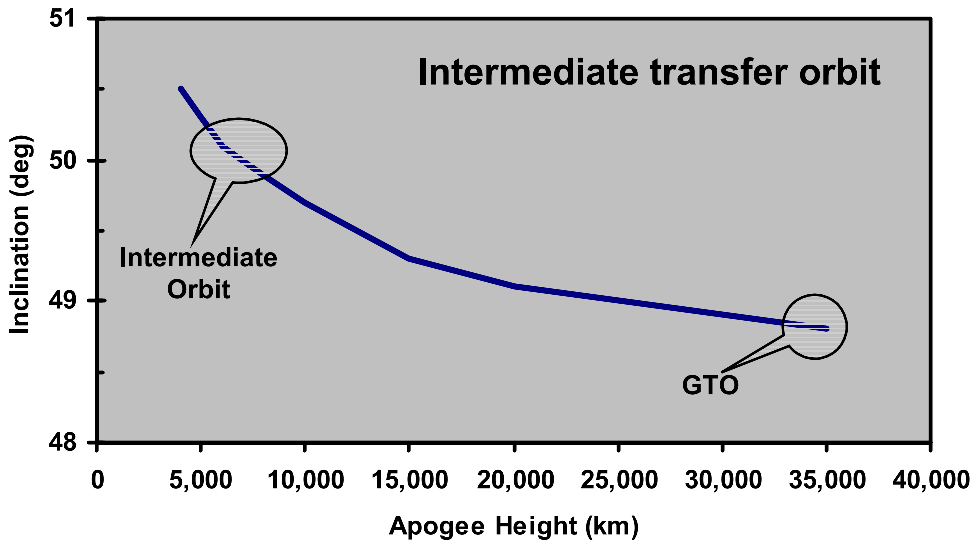
Apogee Height – Inclination Relationship



- A two-dimensional apogee height-inclination search of the intermediate transfer orbit would be very stressing
- However we can use a simple impulse burn model to limit the search to one-dimension

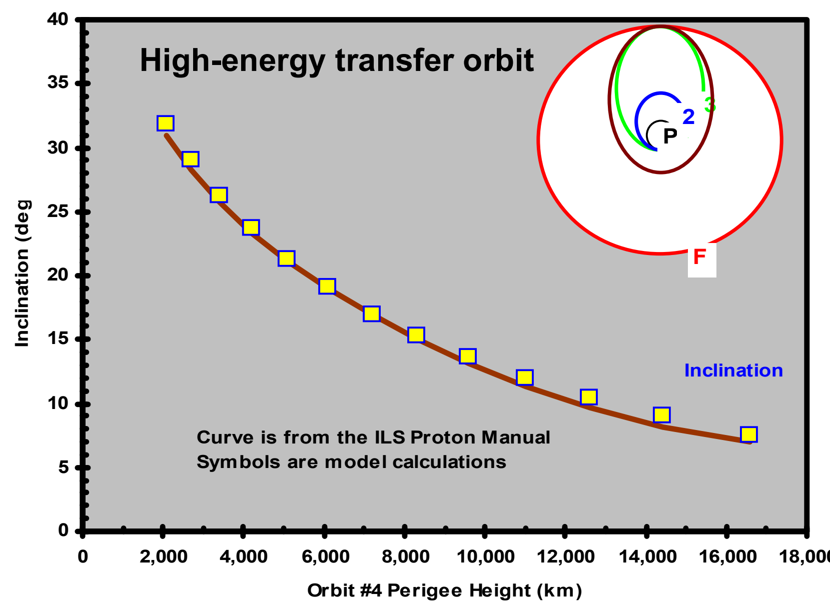
Apogee Height – Inclination Relationship



- A two-dimensional apogee height-inclination search of the intermediate transfer orbit would be very stressing

- However we can use a simple impulse burn model to limit the search to one-dimension

- This model has been tested against the Block DM scenario, as well as for the "high-energy transfer orbit" scenario published in the ILS Proton Manual.



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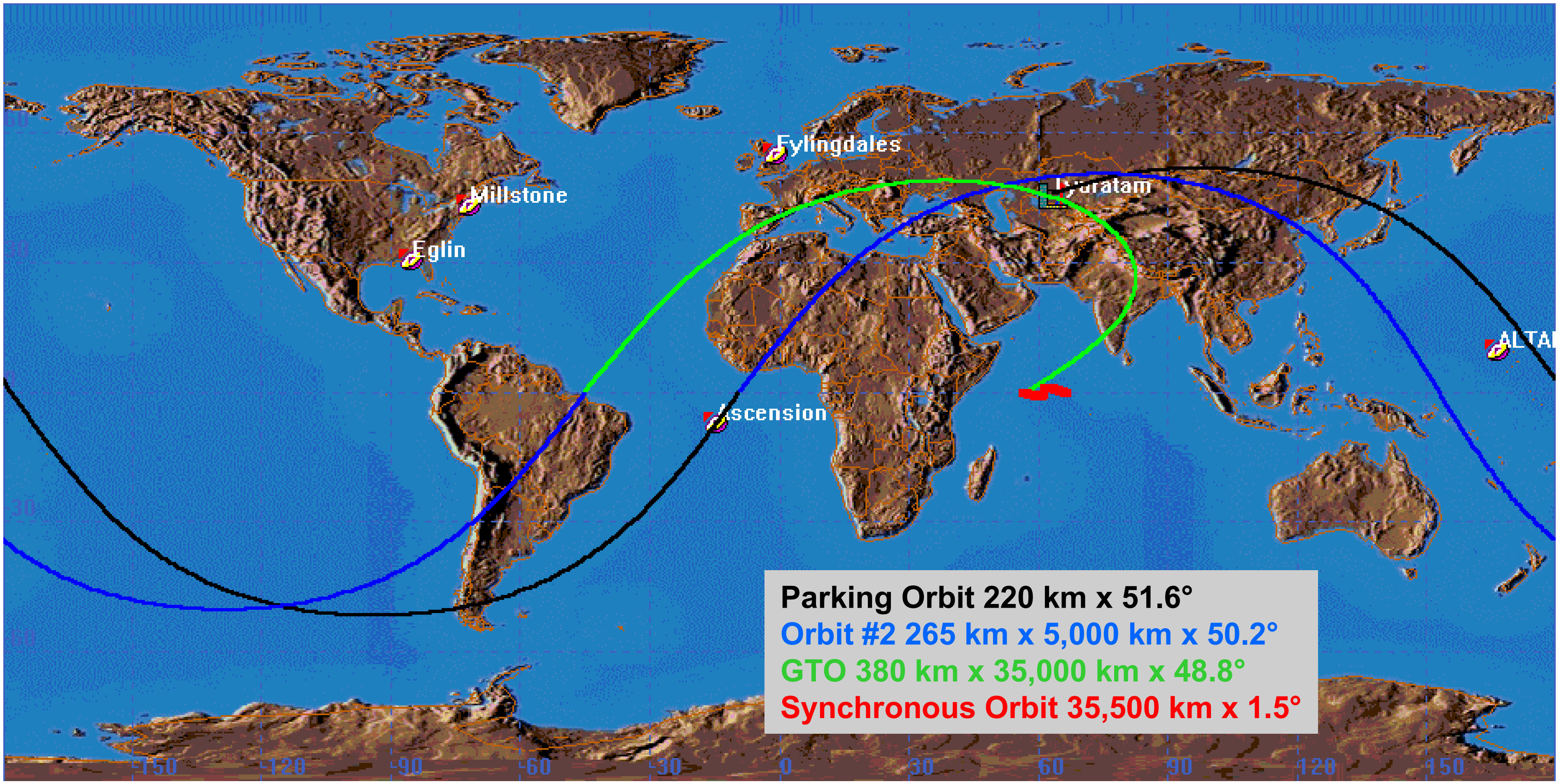
Gorizont 45 Launch Scenario



Gorizont 45 Chronology

Parking Orbit 220 km X 51.6º

02:59	Launch
	Tasked Gorizont folder by SCC
03:36	ALTAIR elset 95099
	piece count of 1
	Ascension acquisition/elset?

Intermediate Transfer Orbit 265 X 5,000 km X 50.2º

04:11	Ascending node injection into transfer orbit
04:45	Fylingsdale elset 90042 (acquisition from ???)
05:17	ALTAIR elset 95101; acquisition from FYL elset
06:00	*Faxed launch memo and briefing to SCC*

Geo Transfer Orbit 380 X 35,000 km X 48.8º

06:37	Perigee, ascending node injection into GTO
	Fylingsdale track to SCC
09:09	SCC elset from Fylingdale data

GEO drift orbit 56º drifting 10º/day toward 145º

11:48	Apogee, descending node injection into GEO drift orbit
17:04	ALTAIR elset on tank in GTO
17:32	MHR elset on tank in GTO
	ALTAIR acquired payload based upon postulated drift elset

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Summary

- Successful coverage of non-historic launch
  - Public information on the Web
  - Pre-mission planning at Millstone
  - SSN coordination through the SCC
  - Excellent sensor performance, particularly Fylingsdale
- Future success depends upon
  - Same attributes that lead to previous success
  - Use of optical and passive sensors if possible