TRANSFER ORBITS THAT ACHIEVE HIGH RESOLUTION GRAVITY COVERAGE OF THE SOUTHERN HEMISPHERE

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INTRODUCTION

- Gravity data quality strongly depends on the spacecraft altitude.
- Gravity data cannot be collected during aerobraking because the High Gain Antenna cannot point at the Earth.
- The altitude during the Mapping orbit is pre-determined.
- The <u>only</u> opportunity to obtain gravity data which is better than that from the Mapping orbit is during the Transition from Aerobraking to Mapping, while periapsis drifts to the South Pole.
- A preliminary discussion of an Engineering Change Request to obtain the High Resolution Gravity data demonstrated the value of this option and resulted in an action item to determine the ΔV cost, which is discussed in this presentation ...

DESIGN CONSTRAINTS

- 10 Day Spacing between Designed Maneuvers.
- 3 Day Orbit Lifetime.
- Minimum Thruster Activity during Gravity Data Collection.

INITIAL CONDITIONS

- All Cases Start with The Same State.
- One Orbit before ABX (MOS CDR BASELINE)
- Integrating High Resolution Gravity Data Collection into the Plan could result in a modified Walkout phase.
- TWO TYPES:
  - ALL PROPULSIVE (3 Maneuvers, More than 70 m/s)
    - Split Periapsis Raise into Two Maneuvers.
    - Propulsively Lower Apoapsis.
  - CONTINUED DRAG (2 Maneuvers, Less than 60 m/s)
    - Split Periapsis Raise into Two Maneuvers
    - Use Drag to Lower Apoapsis to Mapping Orbit.

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BASELINE & SIX OPTIONS

Option	Total ΔV	Description
CDR	74 m/s	All Propulsive Transfer. Orbit Lifetime > 3 Days. First maneuver (58 m/s ABX) raises periapsis to "Final" value. Second maneuver (16 m/s TMO) lowers apoapsis to Mapping.
1	**70** m/s	**All Propulsive Transfer. Orbit Lifetime > 3 Days. Power OK. First Maneuver (20 m/s ABX) raises periapsis to 228 km. Second Maneuver (ABX + 10 days) lower apoapsis to 410 km. Third Maneuver (ABX + 20 Days) raise periapsis to 366 km when periapsis is at South Pole and apoapsis drifted to 414 km.**
2	58 m/s	Shrink apoapsis to 403 km by delaying ABX by 28 orbits (2 Days). Orbit Lifetime reaches 1.7 Days. Power needs 10° Panel Sweep. First Maneuver (20 m/s ABX) raises periapsis to 223 km. Second Maneuver raises periapsis to 366 km when periapsis is at the South Pole and Apoapsis drifted to 413 km.
3	57 m/s	First 6 m/s Maneuver raises periapsis to increase Orbit Lifetime while maintaining enough drag to reduce apoapsis to 414 km in 10 Days. Second Maneuver (14 m/s ABX) raises periapsis to 213 km. Third maneuver (37 m/s TMO) raises periapsis to 366 km. Orbit Lifetime > 4 Days. Needs Thrusters. Power is VERY POOR.

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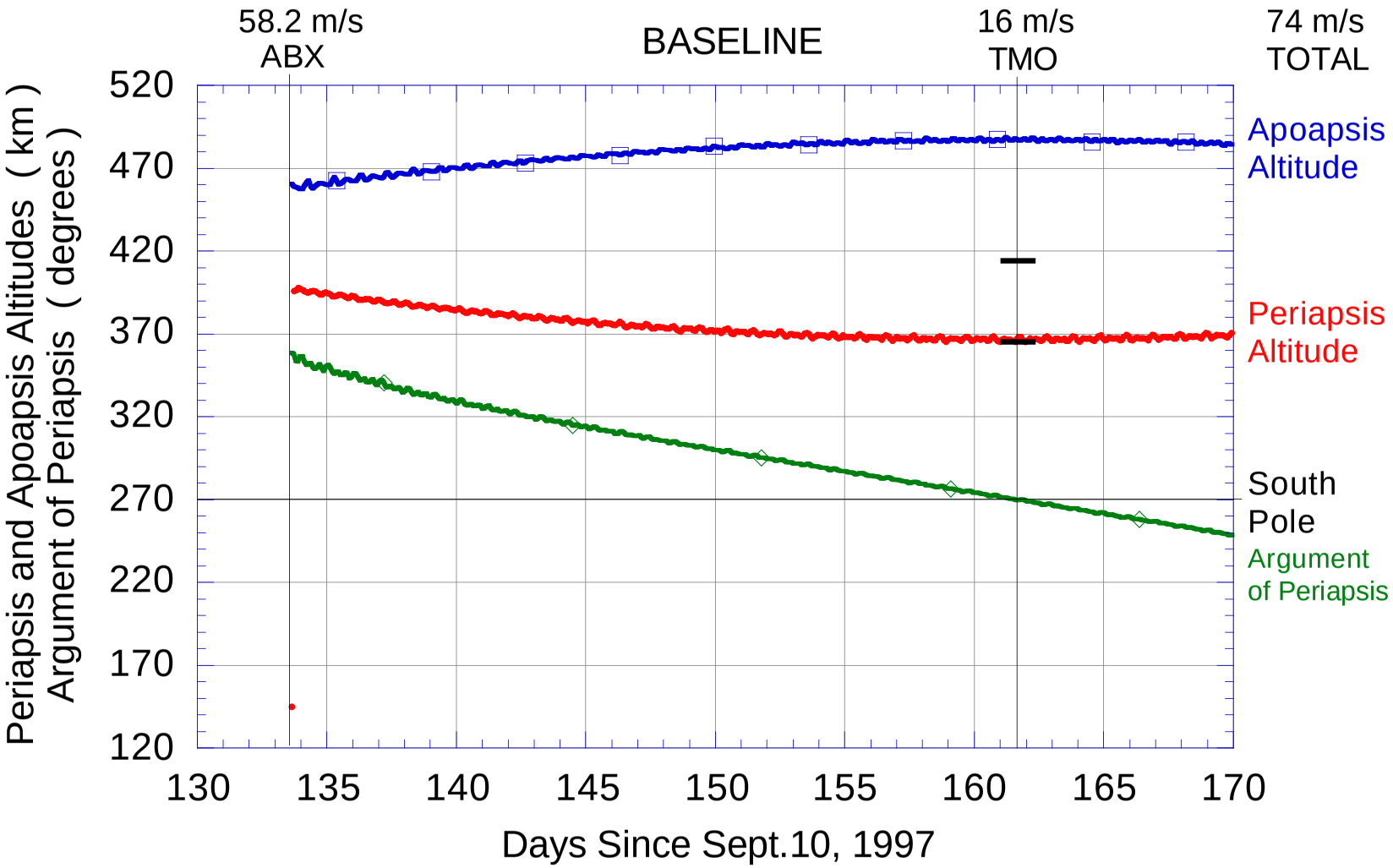
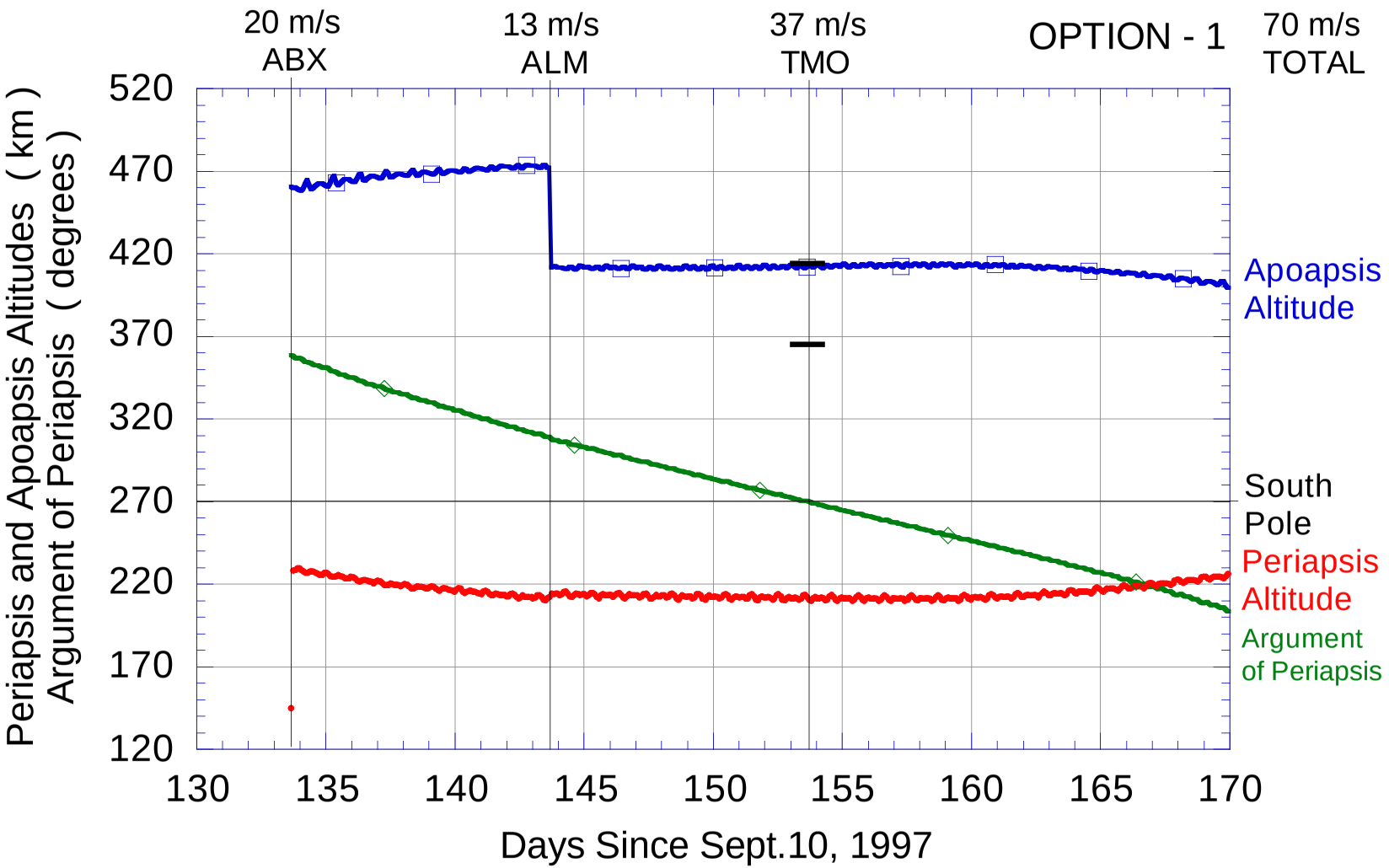
OPTIONS - continued

Option	Total ΔV	Description
4	71 m/s	All Propulsive Transfer. Orbit Lifetime > 3 Days. Power OK. 20 m/s ABX to stop Aerobraking at same time as CDR Baseline. Raise Periapsis and Lower Apoapsis on "Consecutive" orbits when periapsis reaches the South Pole. (Violates requirement for 10 Days between maneuvers.)
5	**58** m/s	**Continue Normal (3 Day Orbit Lifetime) Walkout for 3 Days to shrink Apoapsis to 407 km.** **(Adds 2 more 1.1 m/s maneuvers)** **17.8 m/s ABX to Raise Periapsis to 220 km.** **37.5 m/s TMO to Raise Periapsis to 366 km when periapsis is at the South Pole,** **(Apoapsis has drifted back up to 414 km.)** **Power needs 10° Solar Panel Sweep.**
6	60 m/s	First 9.5 m/s Maneuver raises periapsis to 184 km such that apoapsis decays to 415 km when periapsis reaches the South Pole. 50.4 m/s TMO raises periapsis to 366 km. Needs Thrusters. Power is VERY POOR, needs more analysis.

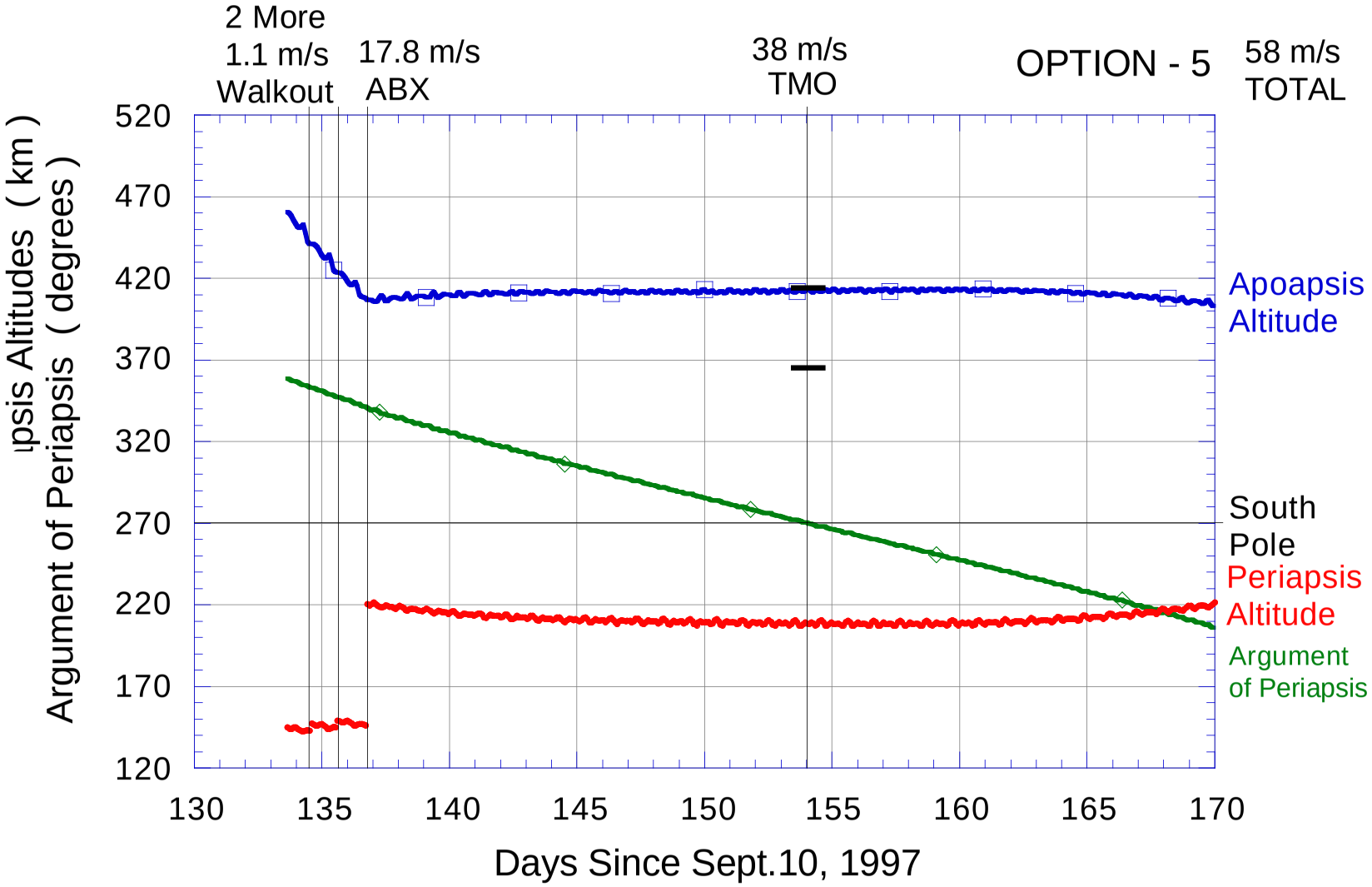
BASELINE: All Propulsive (74 m/s)



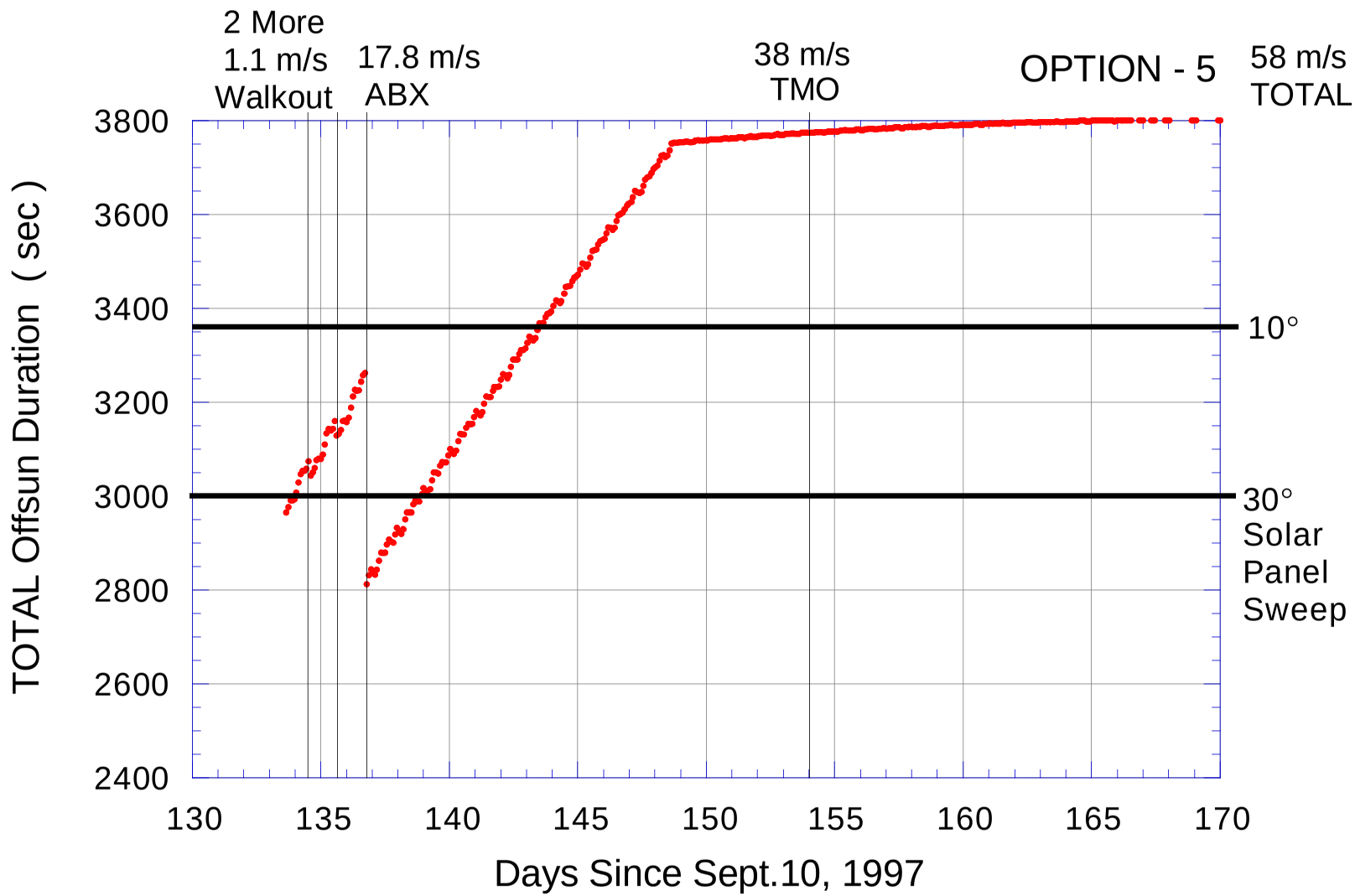
OPTION-1: All Propulsive (70 m/s)



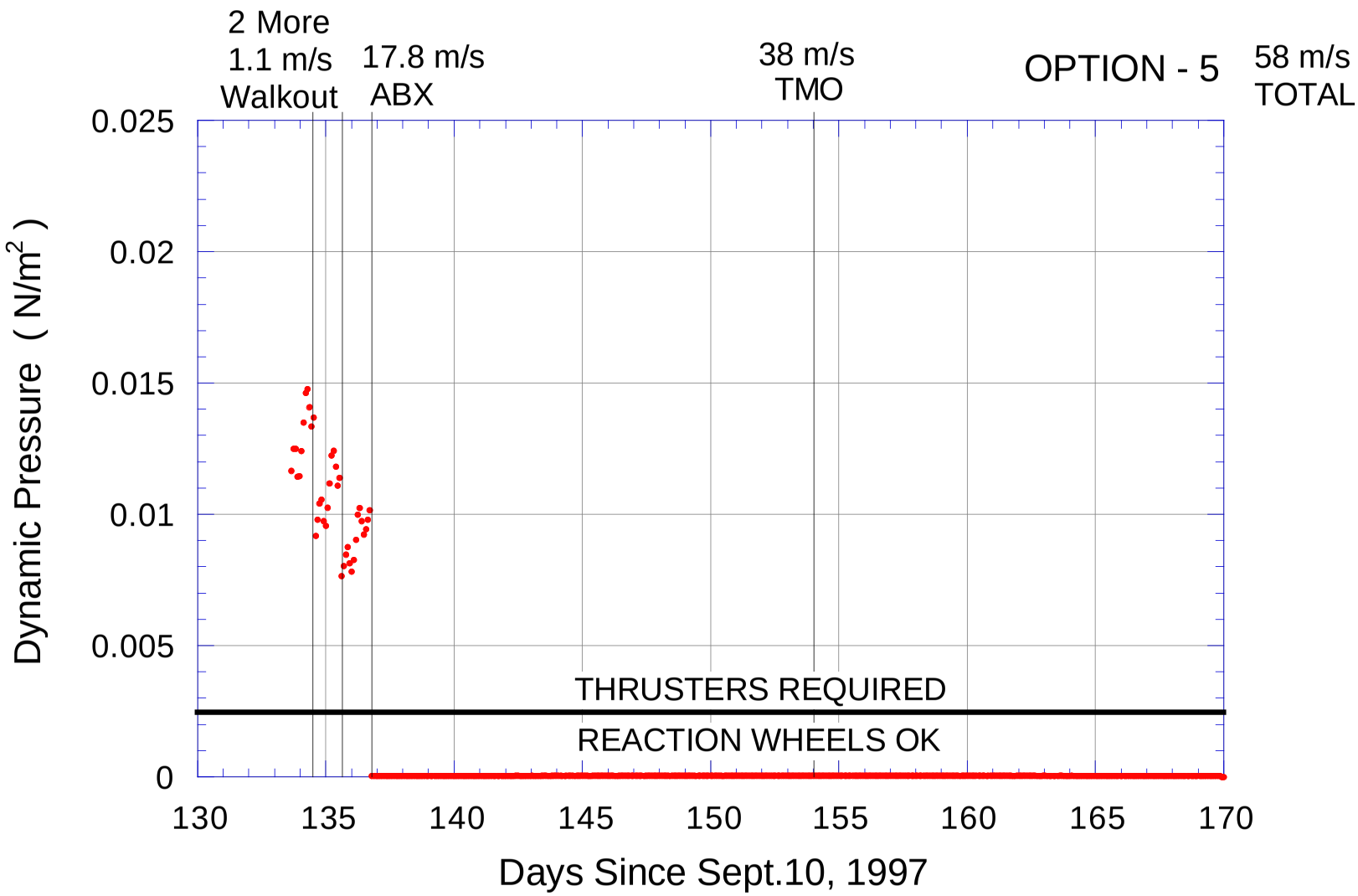
OPTION-5: Continue Walkout, (58 m/s)



OPTION-5: Marginal Power



OPTION-5: Three More Days of Walkout



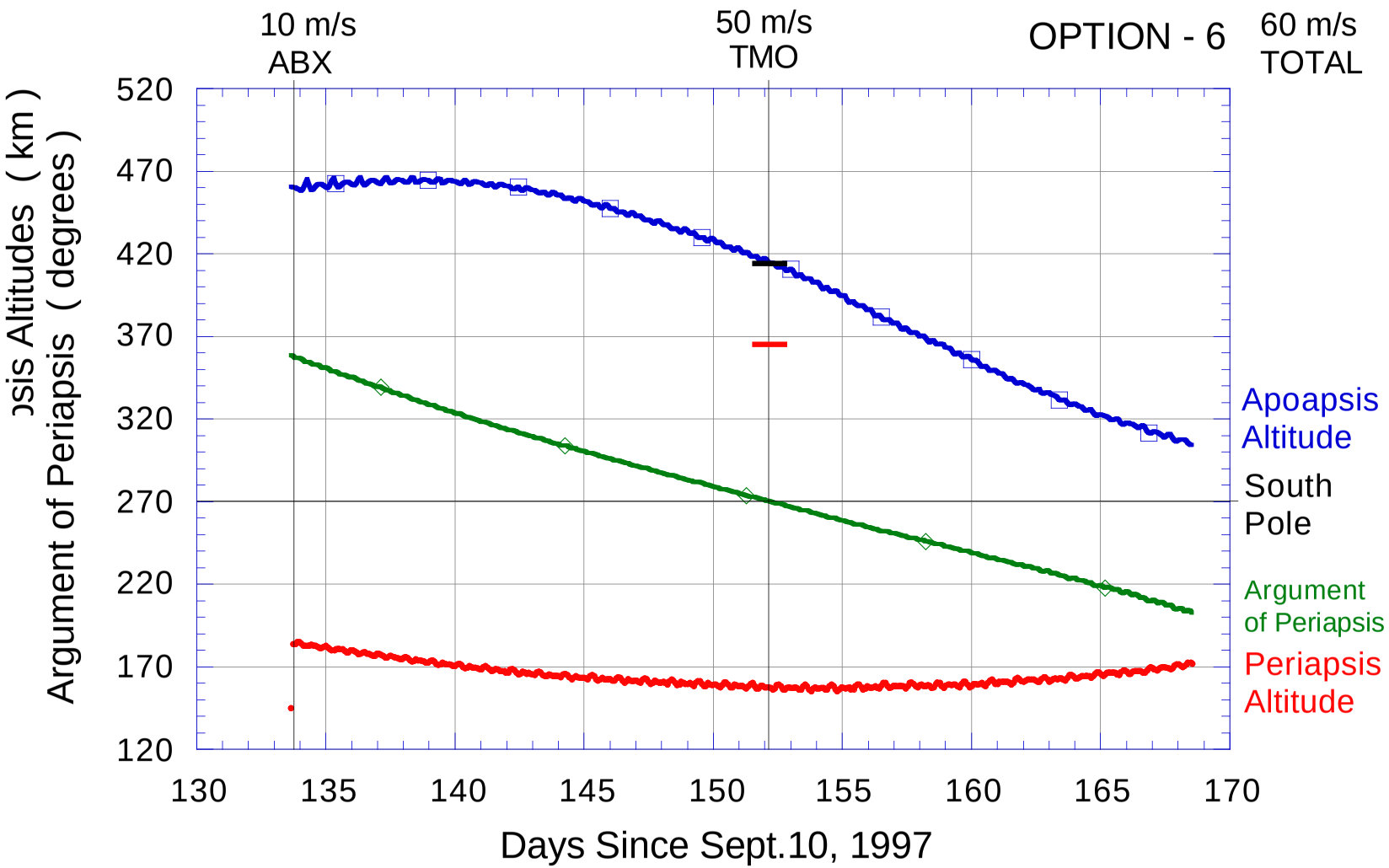
CONCLUSIONS

- High Resolution Gravity Data CAN BE COLLECTED.
  - Both Option-1 or Option-5 are feasible.
- All Propulsive Approach (Option-1)
  - Smaller ABX for Lower Periapsis Altitude during Transition.
  - ABX at Same Time as ABX for Baseline.
  - Lower Apoapsis Halfway through Transition Phase.
    - To Satisfy the 10 Day Maneuver Spacing Requirement.
  - Total ΔV is 4 m/s LESS than Baseline,
  - Reaches Mapping Orbit 8 Days Earlier than Baseline.
  - Power Margins are as Good as Baseline.

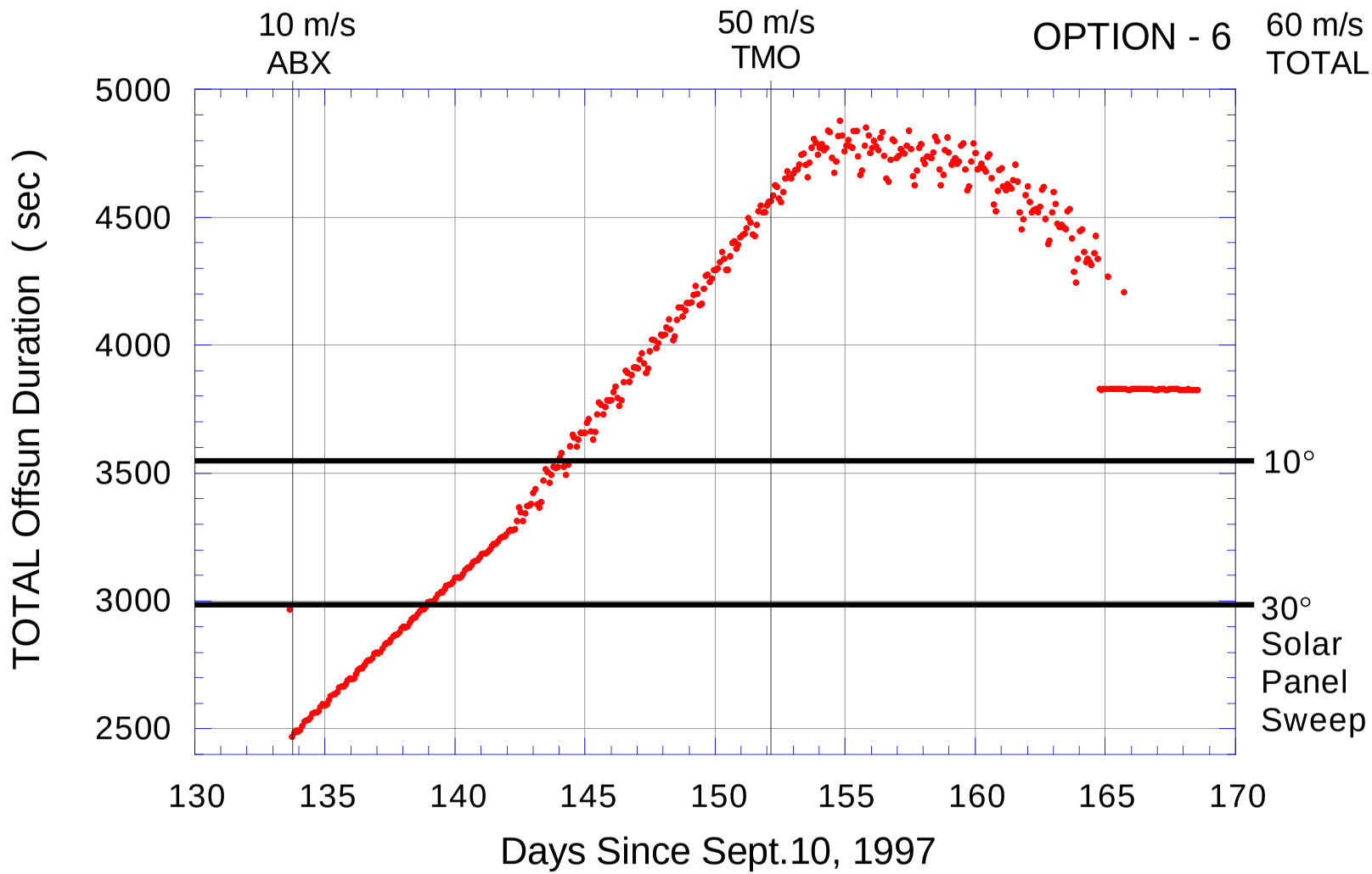
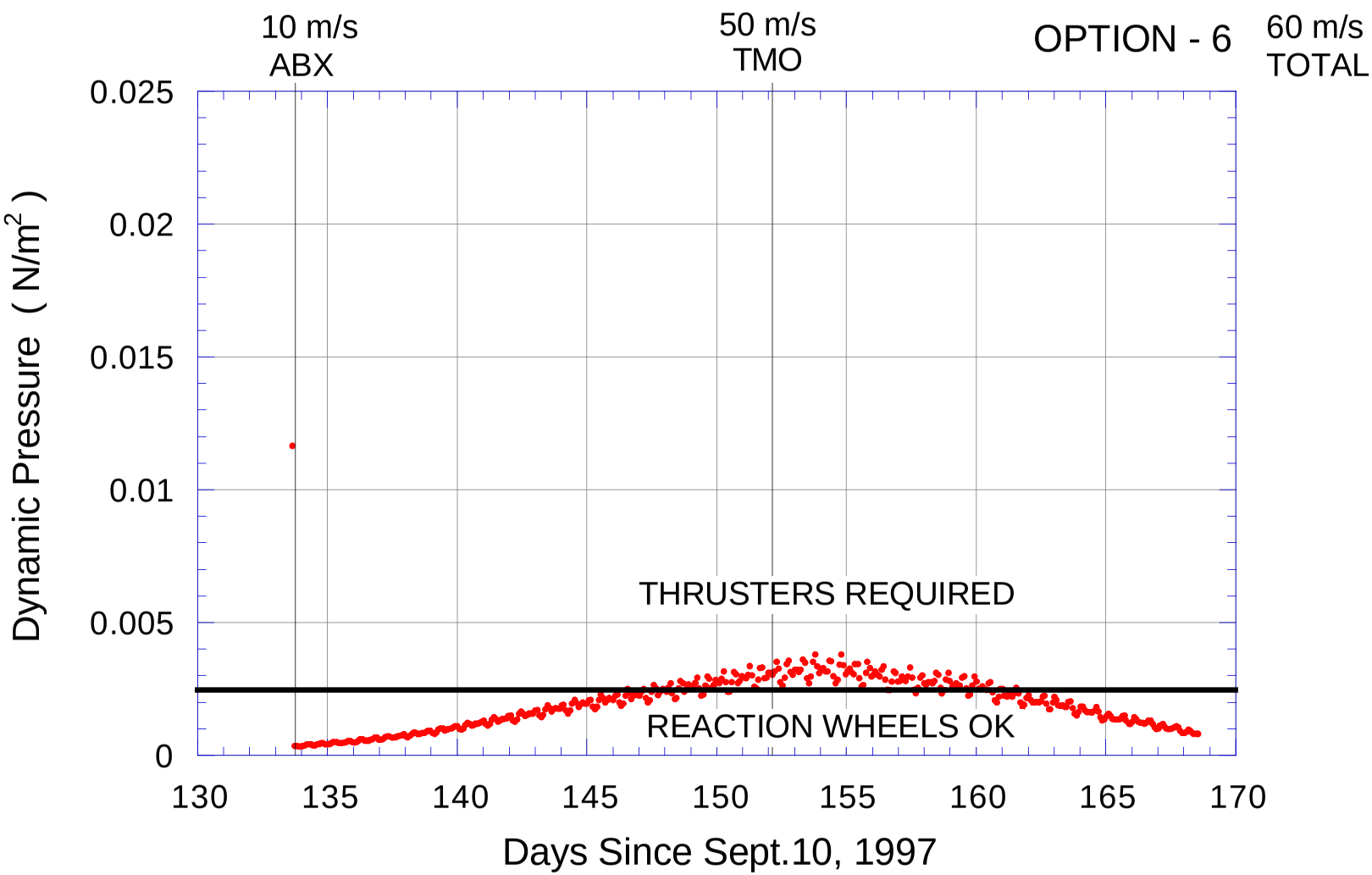
CONCLUSIONS - continued

- Use Drag to Lower Apoapsis to Mapping Orbit
  - Continue Walkout for 3 More Days (2 more Walkout Maneuvers)
  - Satisfies 3 Day Orbit Lifetime Requirement.
  - Total ΔV is **16 m/s LESS** than Baseline
  - Smaller ABX for Lower Periapsis Altitude during Transition.
  - Reaches Mapping Orbit 8 Days Earlier than Baseline.
  - Requires Something to Improve Power Margins ...
    - Less Sweep on the Solar Panels (One Time Change) or
    - Less Periapsis Timing Margins (More Frequent Uploads), or
    - Point the HGA toward the Sun (Lose Telecom), or
    - Reduce the Orbit Lifetime Requirement
      - Justify by Building an Anti-Sun Maneuver Capability.

OPTION-6: Too Much Drag, Not Enough Power



OPTION-6: Too Much Drag, Not Enough Power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