

Launch Windows

How is Matthias Maurer going to join Thomas Pesquet's Halloween party?

Adrien CHARDON

2021-11-03

PTS.space - *Lunch & Learn*



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1. Introduction

1 Introduction

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NASA's Crew-3 Mission



Source: [4]

Launch Date and Time

I'm not (too much) interested in science, but rather the engineering supporting the science

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Crew-3 Successive Launch Date And Time

- Sun Oct 31 06:21 UTC (02:21 local)
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Crew-3 Successive Launch Date And Time

- Sun Oct 31 06:21 UTC (02:21 local)
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Oddly specific date and time:

- During the night
- During the weekend
- Precision down to the minute

The Question

=> What factors drive a launch date and time?

2. Going to the ISS: Launch Windows Constraints

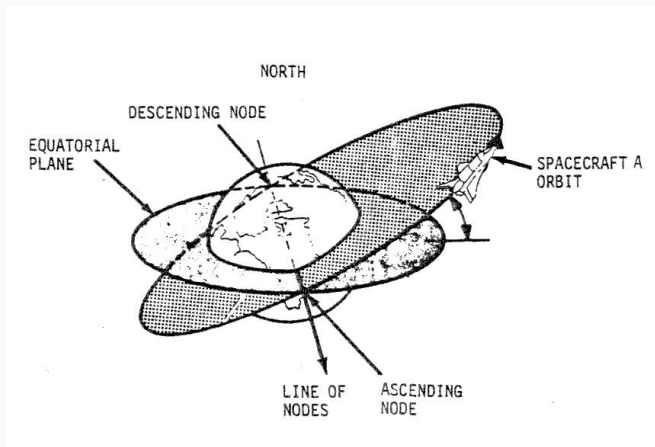
1 Introduction

2 Going to the ISS: Launch Windows Constraints

- Orbital Constraints
- Range and Safety Constraints
- More Constraints

3 Conclusion

Constraint 1: Inclination - Theory



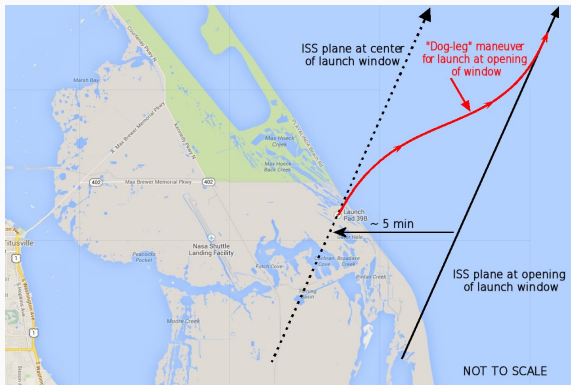
Source: [1]

Constraint 1: Inclination - Summary

- A given launch site crosses the orbital plane twice a day (instantaneous window)

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- A given launch site crosses the orbital plane twice a day (instantaneous window)
- Can afford some misalignment: dogleg maneuver



Source: [1]

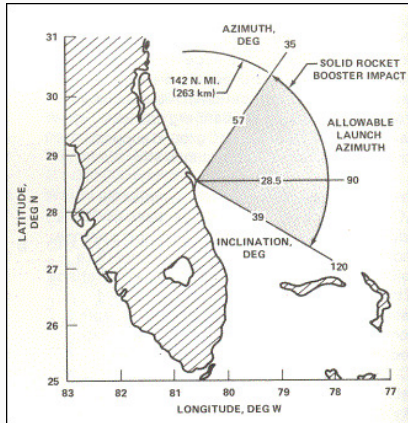
Constraint 2: Launch Azimuth - Launch Site

- Launch sites:
 - USA: Kennedy Space Center: 28.5°N
 - USSR/Russia: Baikonur Cosmodrome: 46.0°N
- Adjusting the inclination
 - In flight: super expensive
 - From launch:
 - Going lower: very expensive
 - Going higher: (relatively) easy

Constraint 2: Launch Azimuth - Launch Site

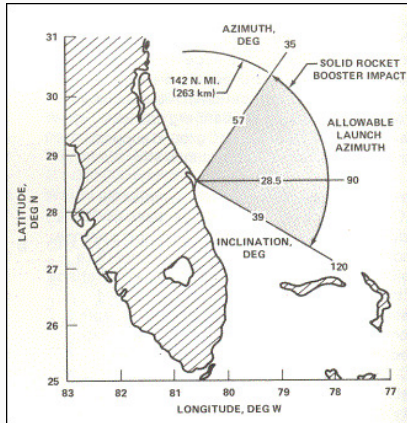
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- \rightarrow ISS is the lowest inclination without overflying China or dropping spent rocket stages in inhabited areas $\Rightarrow 51.6^{\circ}\text{N}$

Constraint 2: Launch Azimuth - ISS



Source: [3]

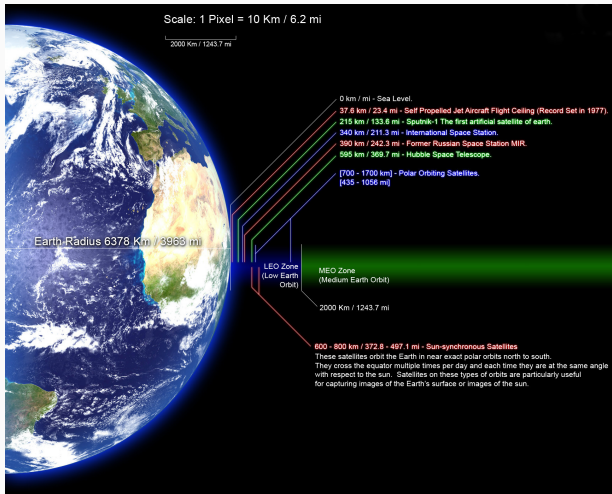
Constraint 2: Launch Azimuth - ISS



Source: [3]

- Don't want to fly over Cuba
- ISS is at 51.6°N
- Fun fact: Israel launches toward west

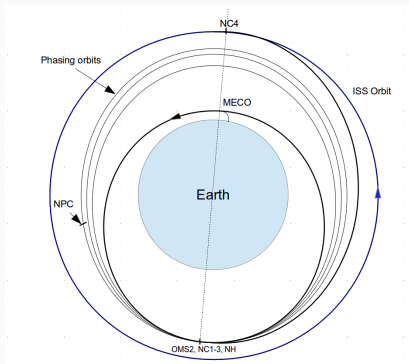
Constraint 3: Orbit Phasing - Altitude



Source: [7]

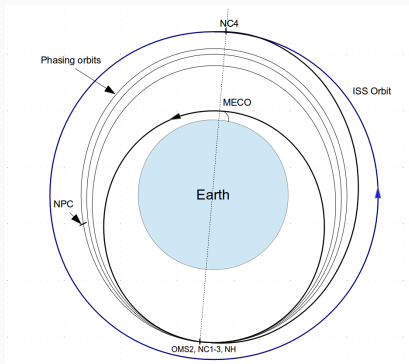
- ISS: 370-460 km -> 93 minutes per orbit

Constraint 3: Orbit Phasing - ISS



Source: [1]

Constraint 3: Orbit Phasing - ISS

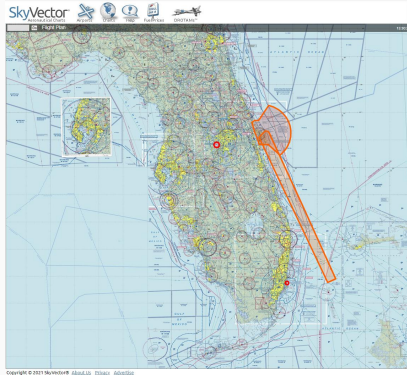


Source: [1]

- Launch when ISS is (approximately) overhead, to reduce phasing time as much as possible
- Inclination is still more important
- Soyuz's fast rendezvous: from 24-48h to 6h to 3h

Constraint 4: Range Safety (Exclusion Zones)

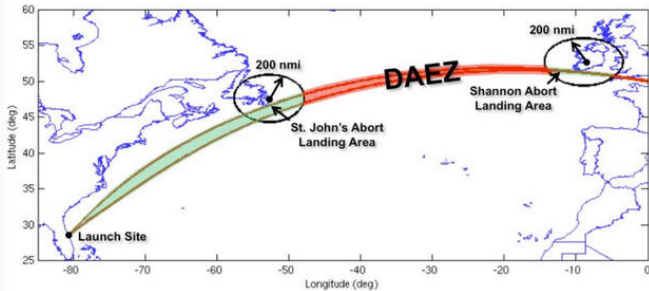
NOTAM/NOTMAR:



Source: [6]

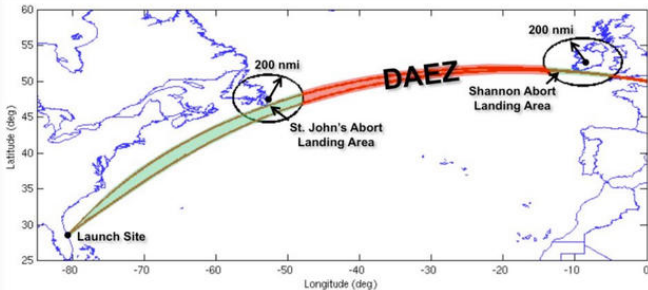
- There could be constraints (military exercise, visit of the president, a 10 billions \$ telescope traveling, ...)

Constraint 5: Abort Scenarios



Source: [2]

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Source: [2]

- Constraints in the abort zones
 - Weather
 - Support available - ex: Space Shuttle's TAL abort mode
 - ...

Constraint 6: Flight Path and Target Conditions

- Sun: visibility, temperature, power
 - Apollo: visibility required the Sun to be very low on the horizon
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- Communication: visibility, antenna handover

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- Weather
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 - Falcon 9 Crew Dragon Launch Weather Criteria: [link](#)

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3. Conclusion

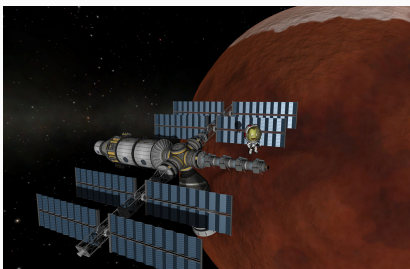
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Conclusion

- Launch notifications: <https://nextspaceflight.com/>
 - Don't forget to watch Crew-3's launch next Saturday evening
- Try to dock to the ISS: <https://iss-sim.spacex.com/>
- Learn orbital mechanics: Kerbal Space Program (KSP)



Source: [5]

- Slides: <https://github.com/Nodraak/PTS-lunch-and-learn> 14/14

References i

- [1] BAEN, *Rendezvous and Docking*.

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- [2] CBSNEWS, *Abort Exclusion Zones*.

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<https://forum.nasaspaceflight.com/index.php?topic=37558.0>, accessed 2021-10-27.

- [4] NASA/SPACEX, *Crew-3*.

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[6] STACKEXCHANGE/SKYVECTOR, *Exclusion Zones*.

<https://space.stackexchange.com/questions/53927/just-how-unreasonably-gigantic-was-the-exclusion-zone-for-the-scrubbed-spacex>, accessed 2021-10-27.

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Questions?