THE STATE OF PLAY
US SPACE SYSTEMS COMPETITIVENESS

PRICES, PRODUCTIVITY, AND OTHER MEASURES OF LAUNCHERS & SPACECRAFT

EDGAR ZAPATA
MAY 11, 2026

Zapata Talks NASA

zapatatalksnasa.com

Where I translate NASA and the space industries techno-gibberish and happenings into almost English

Edgar Zapata on NASA

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What follows is NOT those blogs

Instead, this is…

DATA + CONTEXT

DATA

A. Awards, "Prime" contractor awards, *govtribe.com*, GAO, IG, etc.

- Only part of the total cost to NASA, DoD, government
- Closer to the "price" of piece parts to a buyer

B. NASA budget documents, congressional records, etc. – to draw out civil servant, personnel, government management costs

C. NASA budget documents, congressional records, etc. – to draw out other program and project procurement dollars, e.g., "support contractors"

- e.g., Total Budget = "The Cost" so "Total Budget" minus A minus B = Other Procurement Dollars
- e.g., A + B + C = ~ the total resources NASA spends on a project

- Flight rate, payload, and other public data
  - The result produced for that resource

Context

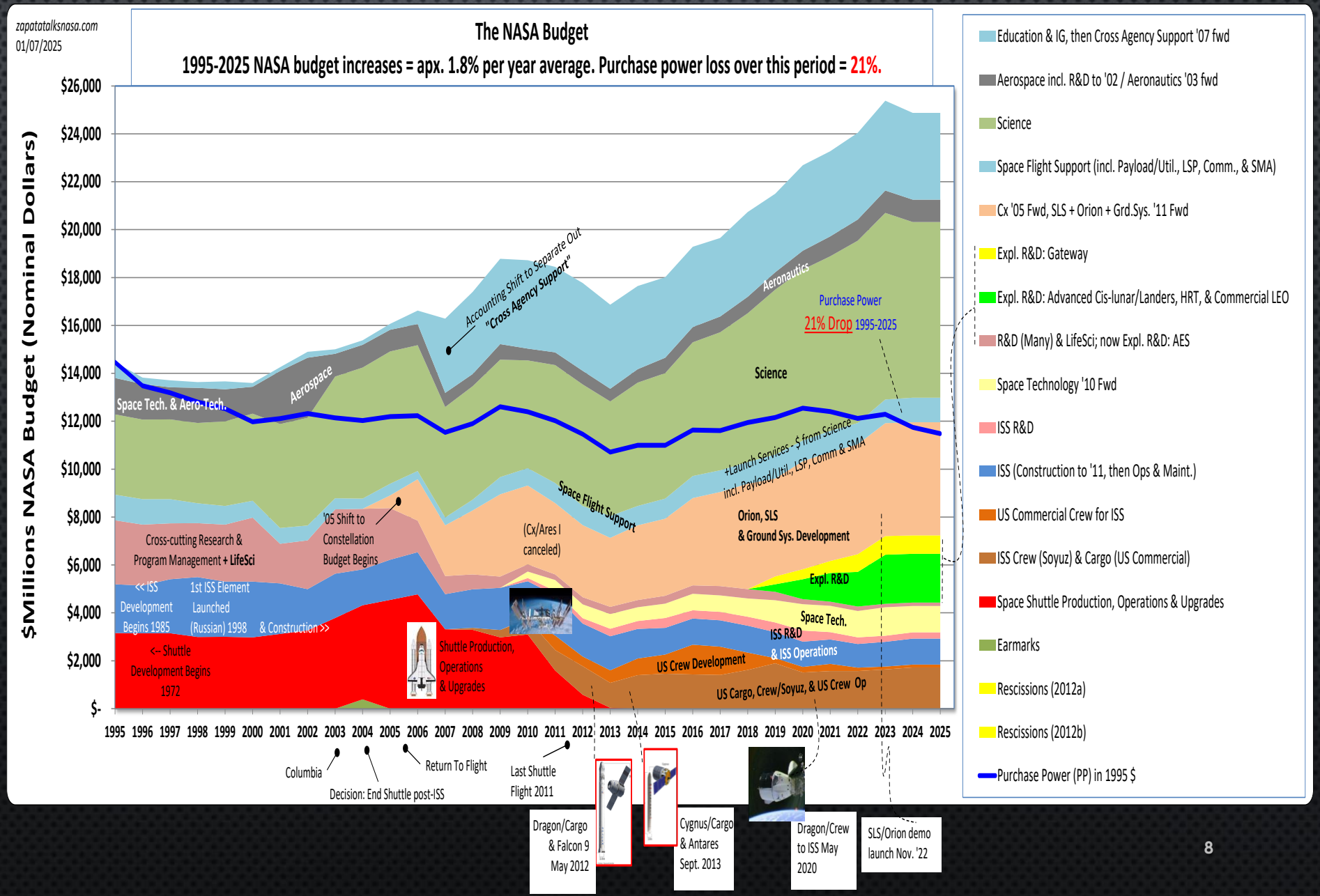
- Minimally processed data, but – distill for detail, consistency, apples-to-apples
  - Capability –same orbit
  - Dollars –same kind, nominal OR inflation adjusted
  - Costs –same "what," "when," and "who"
    - Prime only $ only, OR all procurement &, OR total $ (budget/spent)
    - Launch OR spacecraft
    - Up-front, NON-Recurring, development OR later/future Recurring, production, units, ops, flights/missions
    - Boeing, OR SpaceX, OR Aerojet, etc.

NASA BUDGET

NASA RESOURCES

Purchase Power Drop 1995 to **2025** = **21%**

Notes:
1. 2021 Bio/Phys. Sci. moved from ISS R&D to Sci. line. (Not one for one; ISS R&D drop 2X larger than new line)
2. Commercial LEO 2020 $15M, 2021 $17M
3. 11/1/2022 - Applies the latest 2022 NASA Inflation Tables. General US Inflation for 2021=7.0%, 2022=7.9% as of March 2022. But note that NASA's updated indices = 3.8% & 5.7% resp.

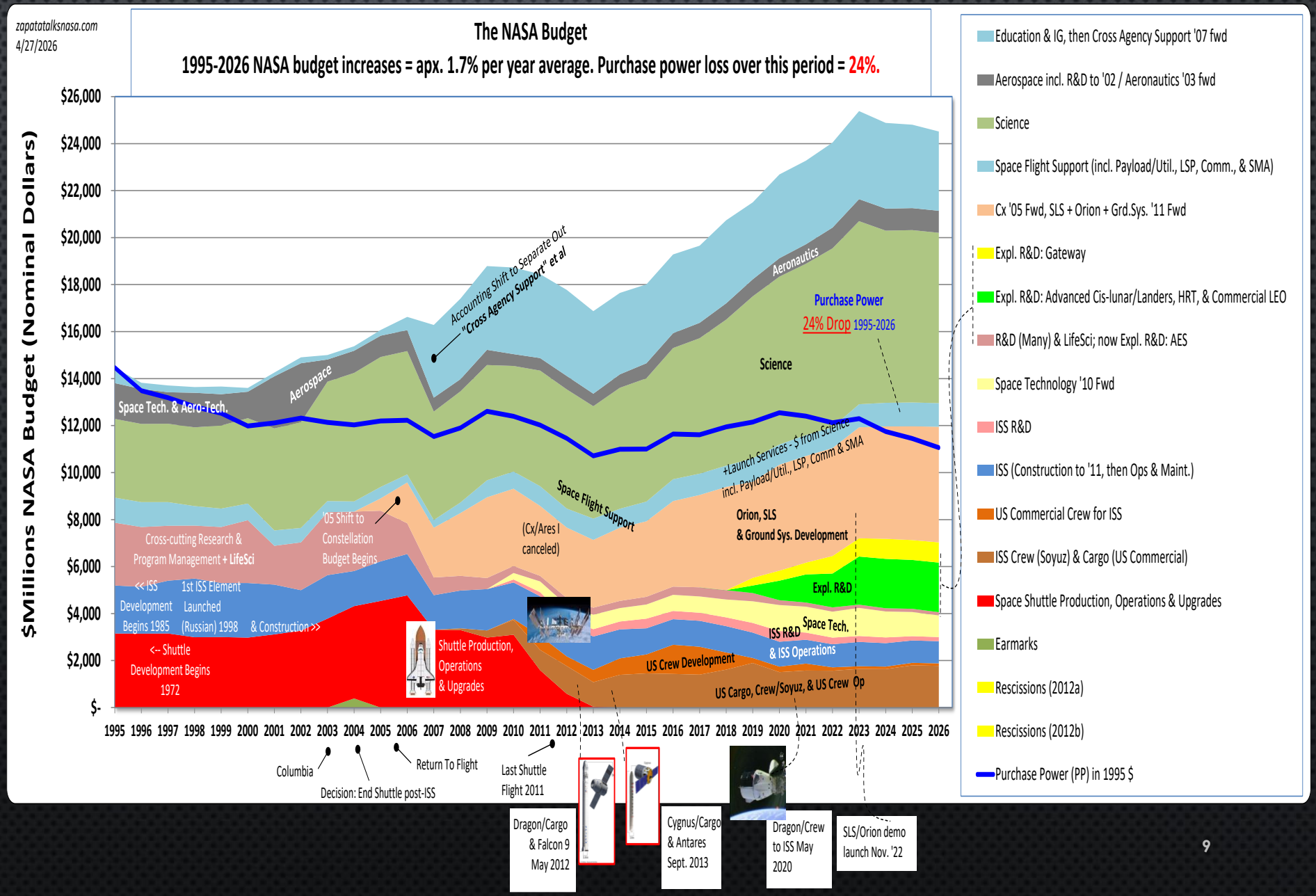


NASA RESOURCES

Purchase Power Drop 1995 to **2026** = **24%**

Notes:

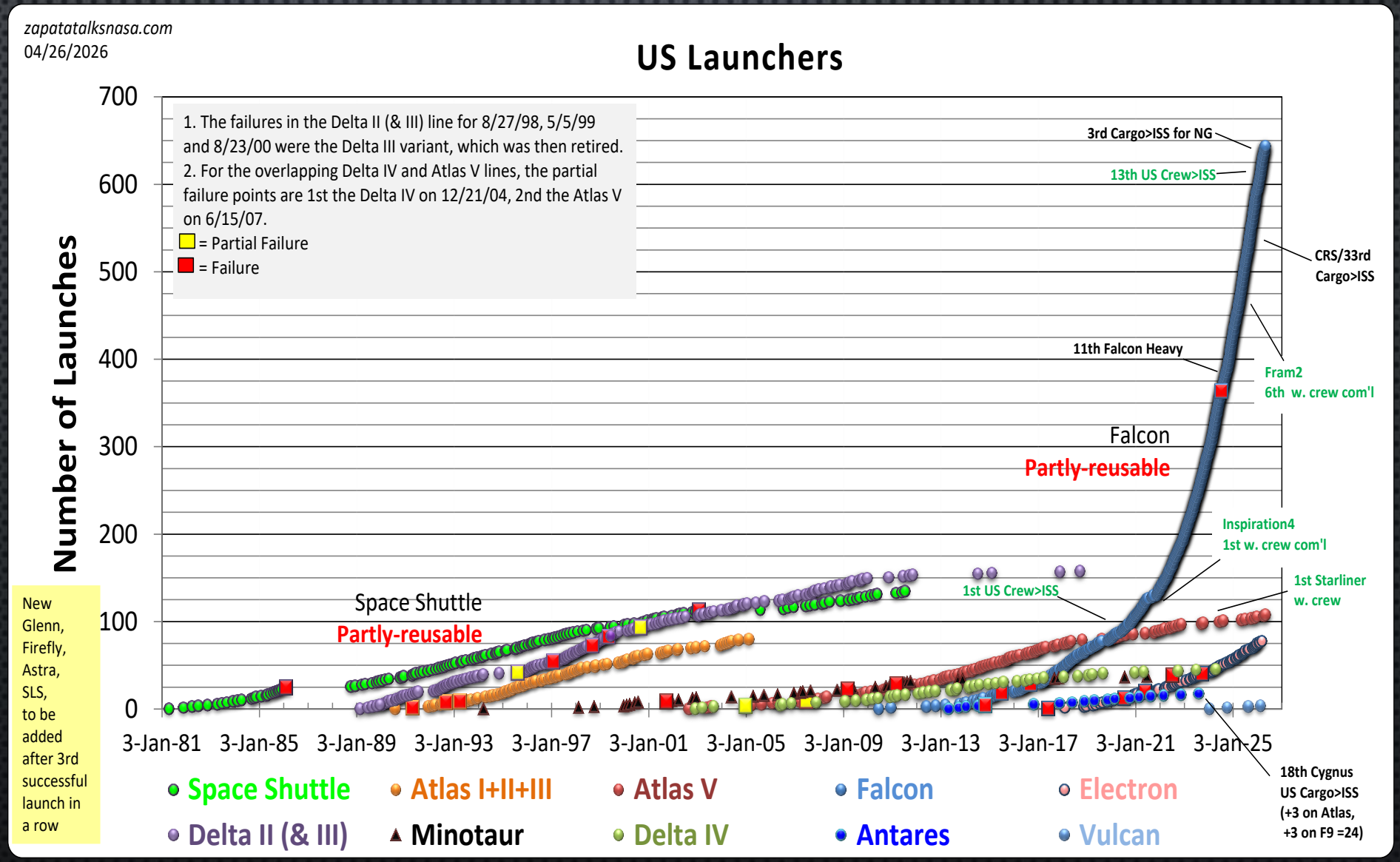
1. 2021 Bio/Phys. Sci. moved from ISS R&D to Sci. line. (Not one for one; ISS R&D drop 2X larger than new line)
2. Commercial LEO 2020 $15M, 2021 $17M
3. 11/1/2022 - Applies the latest 2022 NASA Inflation Tables. General US Inflation for 2021=7.0%, 2022=7.9% as of March 2022. But note that NASA's updated indices = 3.8% & 5.7% resp.



LAUNCH

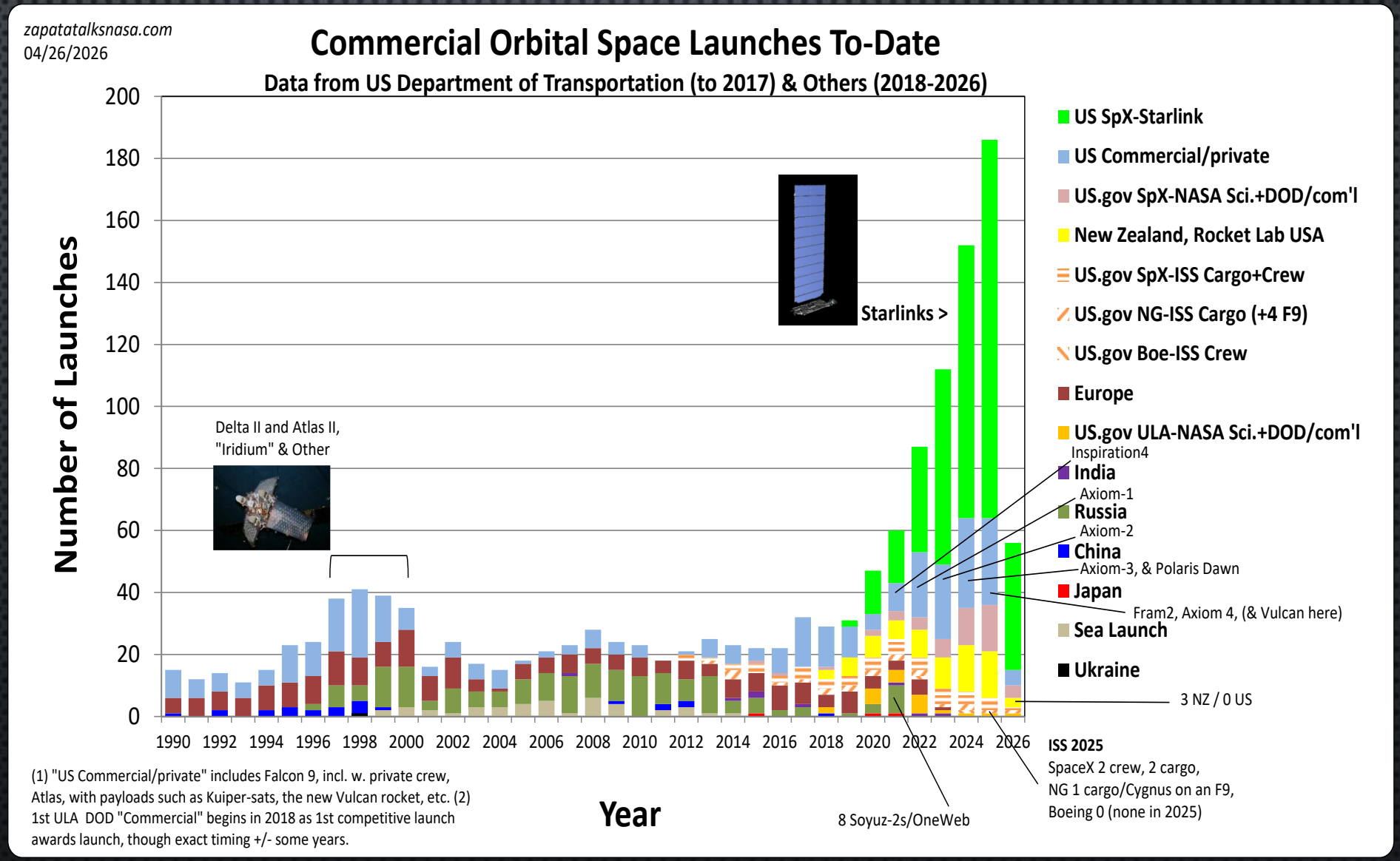
Total Launches

Growth Productivity



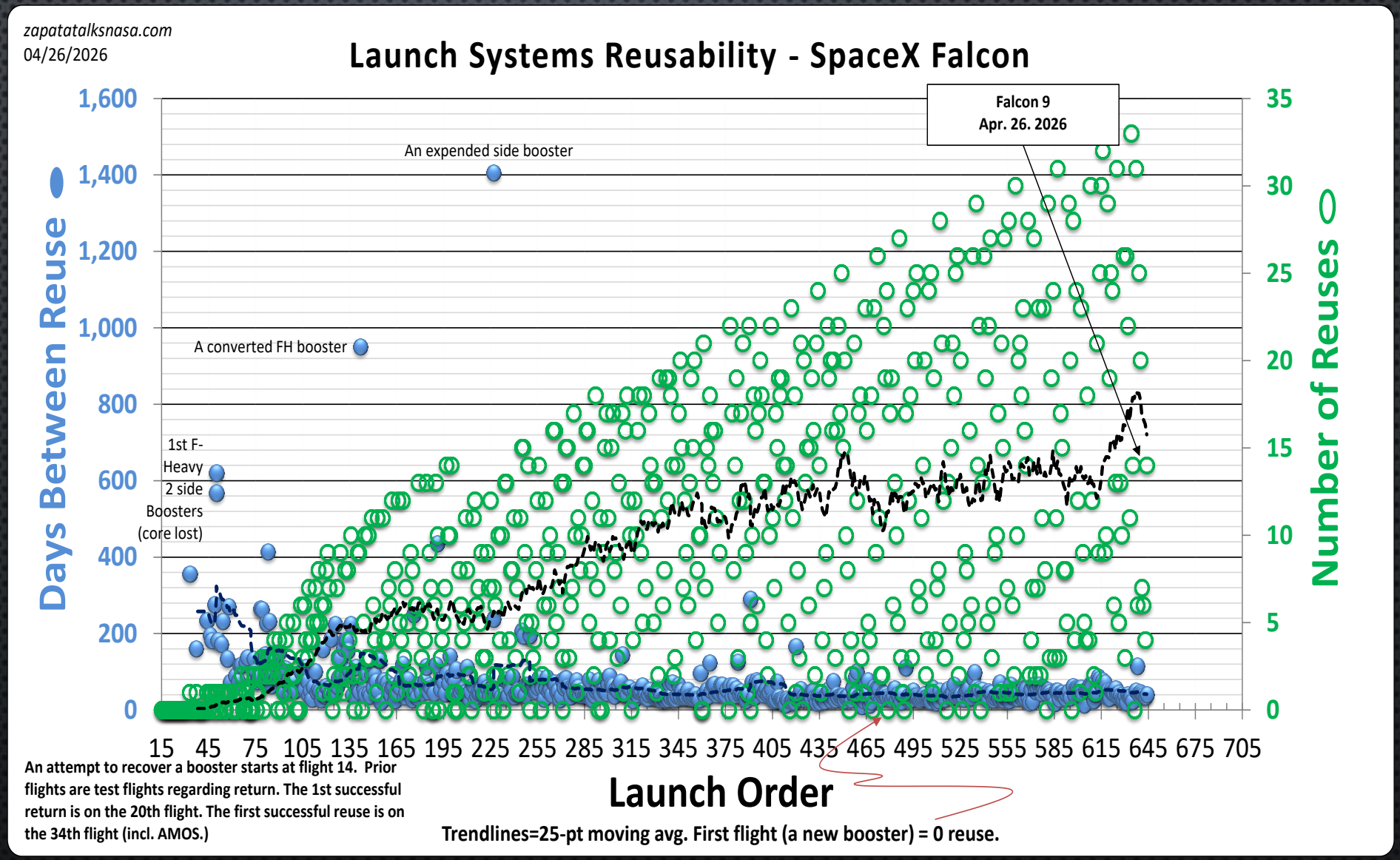
Competitiveness

- The DOT defines a commercial launch as a "*launch that is internationally competed (i.e., available in principle to international launch providers) or whose primary payload is commercial in nature*"; also FAA licensed launches. So, interpreting Starlink as "commercial in nature" it is included here. Cargo and crew to the ISS, and NASA science missions are competed and awarded on commercial terms as a service and licensed by the FAA, even if only competed nationally, so also included here.



Reusability

- The Falcon booster return success rate vs. attempts is:
  - 97.7% to drone ship
  - 99.0% to land
  - 97.9% overall
- For Falcon Heavy, 3-boosters are included. Points may overlap, e.g., 2 side boosters on flight 391, 5 reuses each, and each had a turnaround of 290 days. The core was new, and expended.



Reusability

- Falcon 9 1st stage/booster reuse appears to be topping out in the high-twenties.

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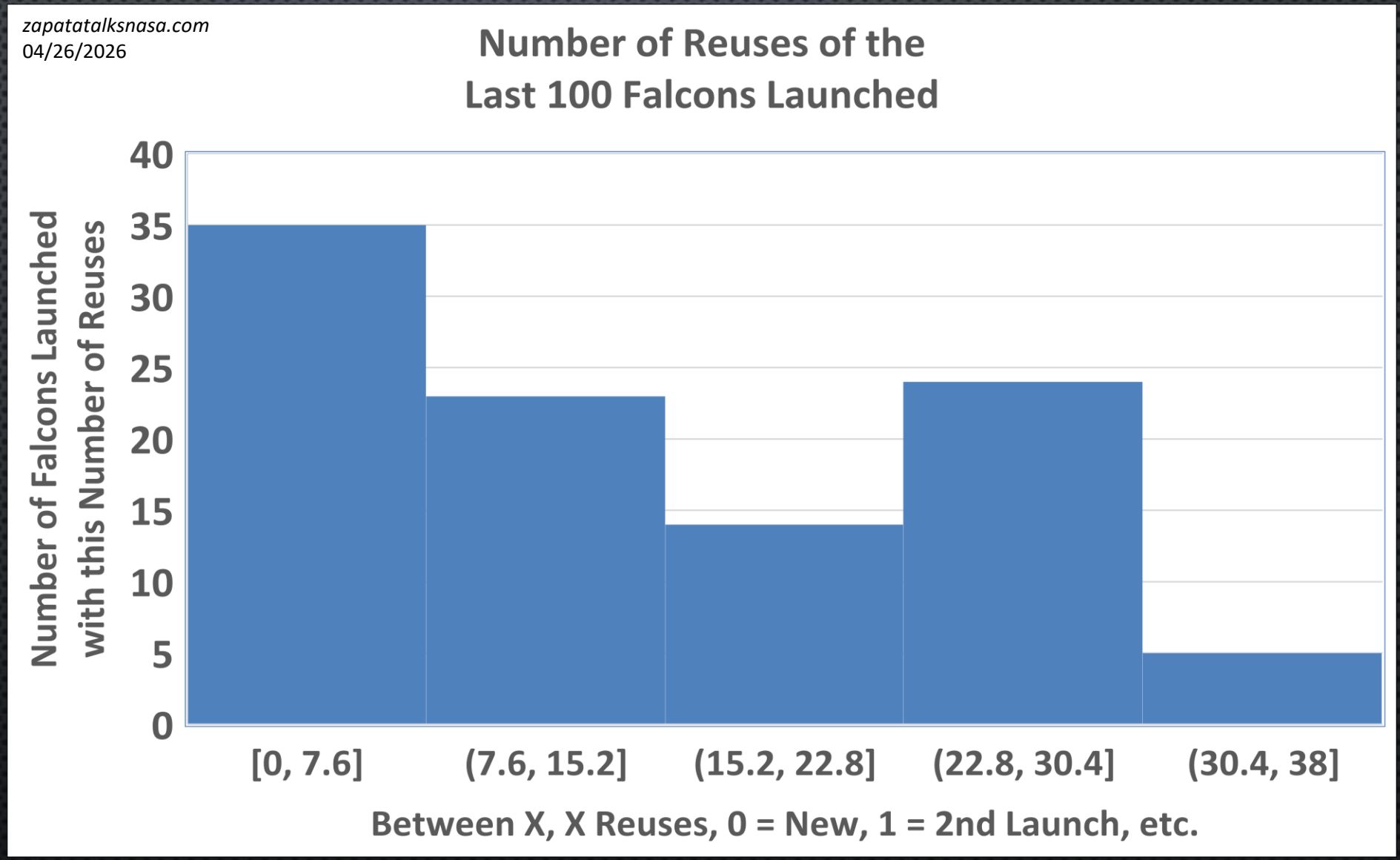
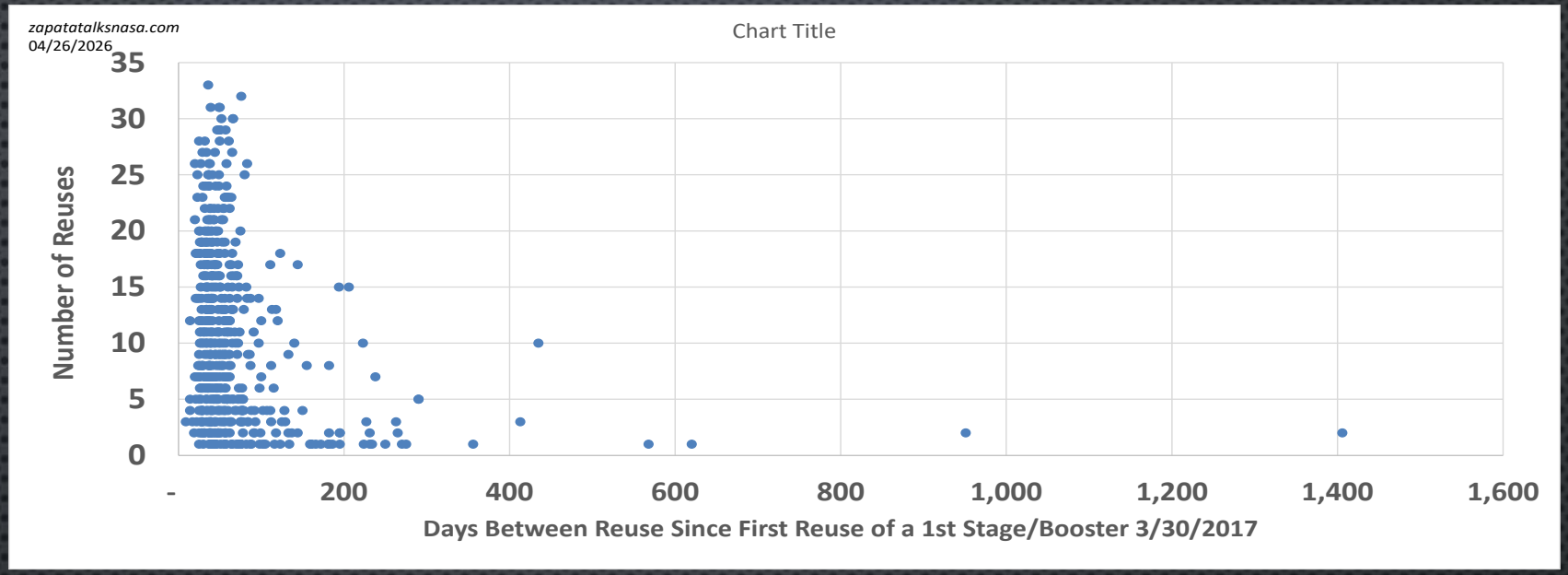
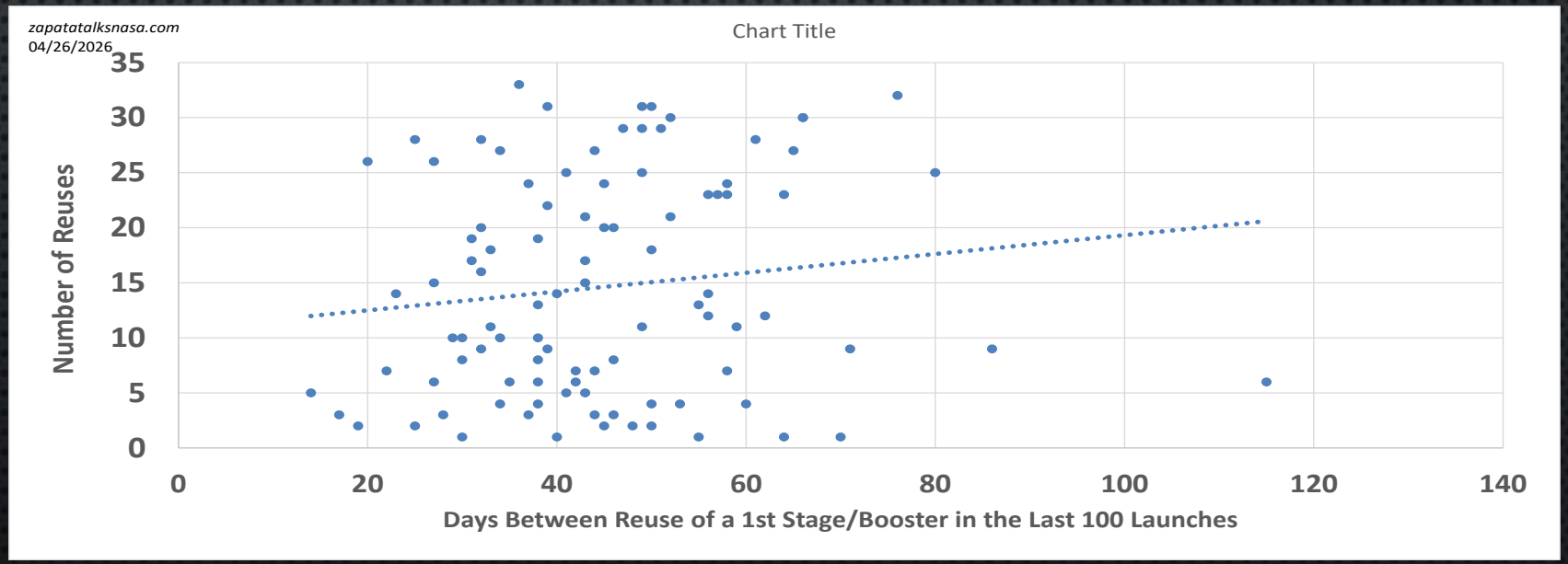


Reusability

- Curiously and counterintuitively, long-term data since the first reuse of a Falcon 9 1st stage/booster tends to a wider range of turnaround times as the booster is newer. More wear and tear does not imply more work next time.
- **BUT -** In the last 100 launches, there is a slight leaning to more days between turnaround as a booster is reused more often. Only slight.





SpaceX Launch Rate

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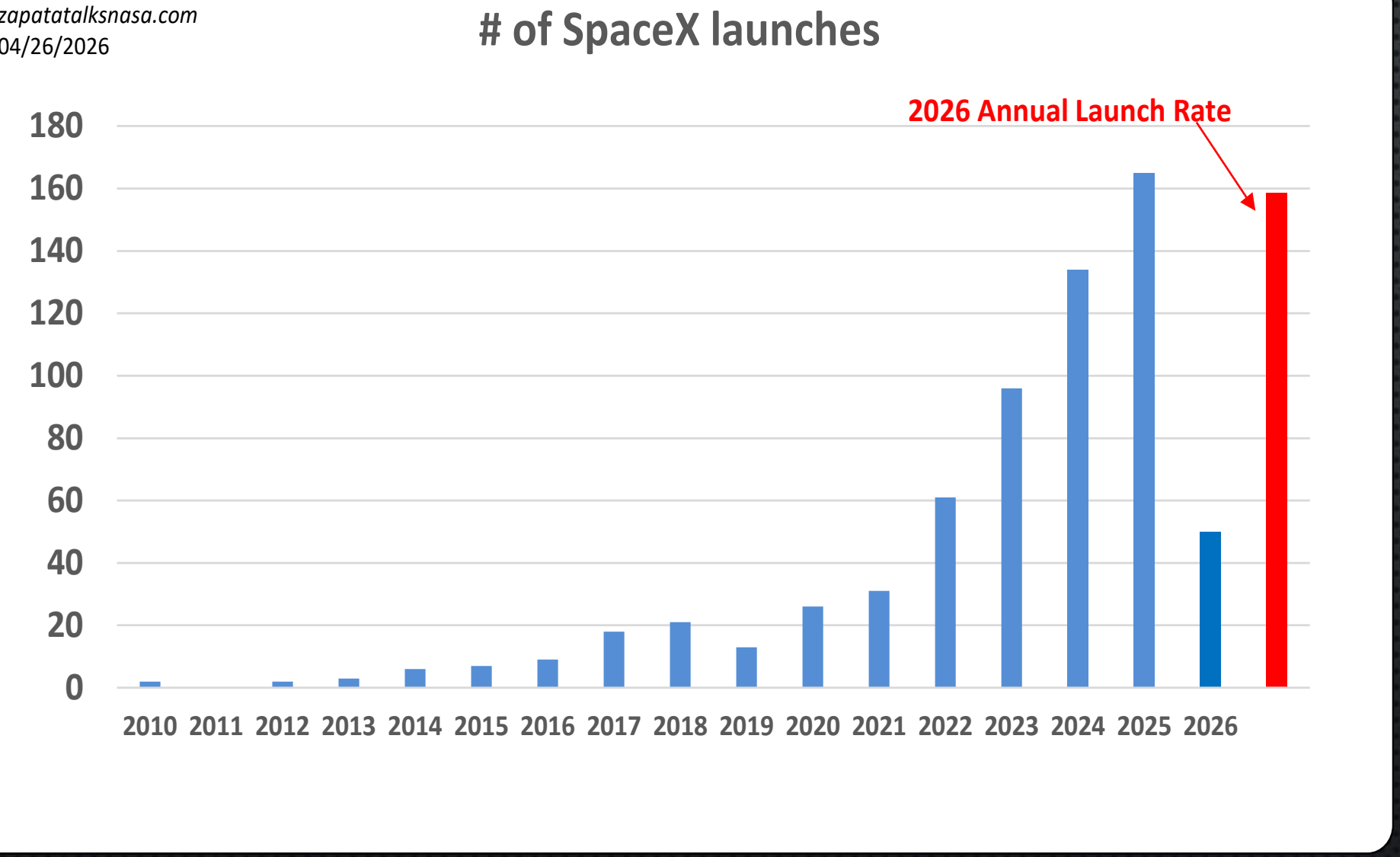

NASA SLS / ORION

- If you go looking after the big "prime" contractor awards and added up what NASA spent there at any time on SLS/Orion, you will still be missing about half the SLS/Orion dollars NASA spent.
- **Note!** This does not include mission / flight operations (JSC).
- **Note!** Space Flight Support (SFS) not included (mostly JSC).
- Note. Some funds 2019 forward would start to apply to "recurring" flight costs (Starting at Artemis III?), not development, but only minimally.

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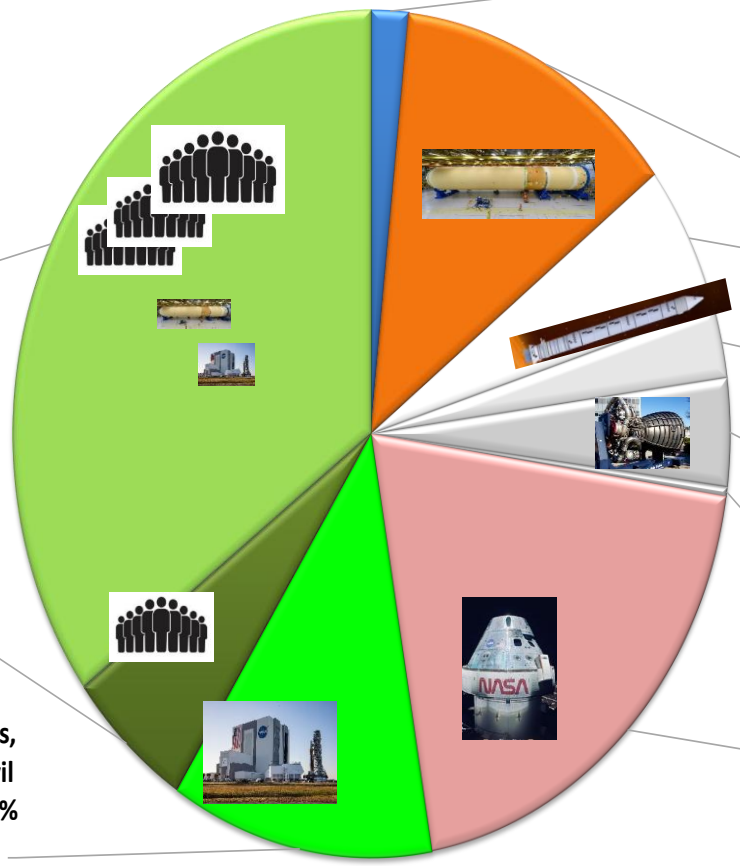
SLS/Orion Prime Contracts & Related Costs Obligated (~Spent) Through Early 2026 (billions, nominal $)



Other = ~$40.9B

*REMAINDER-Other SLS/Orion/Grd procurement $, support contractors, program integ. & ops @MSFC, SSC, JSC (and other TBD $), $27.385 , 35%

ESTIMATE-SLS/Orion Government mang'mt/civil Service @JSC, MSFC & SSC, (excludes KSC, below), $4.429 , 6%

SLS/Orion Ground/Launch Operations, procurement $ and gov. mang'mt/civil service @KSC since 2011, $9.194 , 12%

Prime Contracts = ~$36.8B

Boeing ICPS since 2012 -Contract data, $1.300 , 2%

Boeing Ares I, V & SLS since 2007 -Contract data, $10.000 , 13%

Orbital ATK since 2007 -Contract data, $4.400 , 5%

Aerojet Rocketdyne Contract #1 since 2006 -Contract data, $2.100 , 3%

Aerojet Rocketdyne Contract #2 since 2015 -Contract data, $3.200 , 4%

Aerojet SLS EUS Engines -Contract data, $0.285 , 0%

Lockheed-Martin Orion since 2006 -Contract data, $15.500 , 20%

*Prime contract data from govtribe.com reconciled with public budget data (budgets minus ground ops, typical % for government management, and prime contracts = the "REMAINDER").

DOD

INCREASINGLY OPAQUE

OLDER PUBLIC DATA WEBSITES SHUTTERED

THE LAST SYSTEM ACQUISITION REPORT (SAR) WITH DETAILED DATA WAS IN 2019

2022/2021 SAR AVAILABLE BUT ELIMINATED DETAILED DATA

DOD NSSL

- As of Dec. 2019 SAR
- **Note!** The NRO also contributes funds to the NSSL program. These additional $ are NOT included here.
  - NRO covers 25% of the fixed yearly payment to ULA.
  - This NRO amount is likely in the range of an additional $300M a year.
- For comparison on unit costs, also see GAO-18-360-SP, pp.128, a unit cost of **$342.54M** in 2018 dollars.
- **Note!** The apx. $1B a year to ULA apart from services for a launch continues, even though at times thought to be phased out by 2020. There is now Launch Vehicle Production Services (LVPS) and Launch Operations Services (LOPS).
- Pending – further documentation and traceability on the fixed amount to ULA not included when announcing launch contract awards (but awards to SpaceX appear to be total amounts.)

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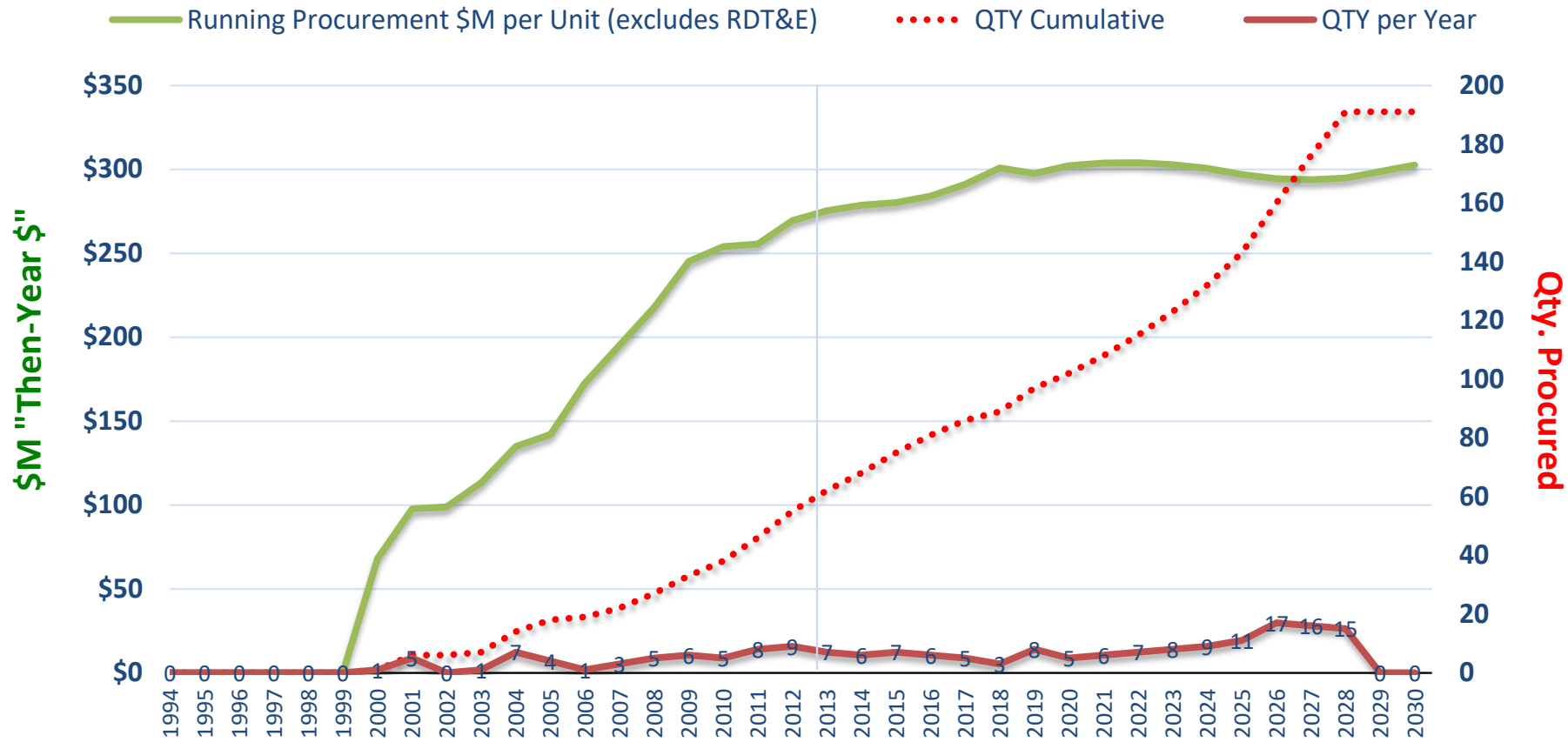
National Security Space Launch (was EELV) Program Annual Funding vs. Quantity Procured



Data from Dec. 2019
Selected Acquisition Reports
NOTE! Qty Procured are NOT Qty Launched

Dec. 2012 DoD opens EELV program to competition

SpaceX (14) 2017=2, '18=1, '19=1, '20=3 '21=1 '22=3 '23=3
ULA (24) 2017=5, '18=4, '19=4, '20=4 '21=3 '22=4 '23= 0

DOD NSSL

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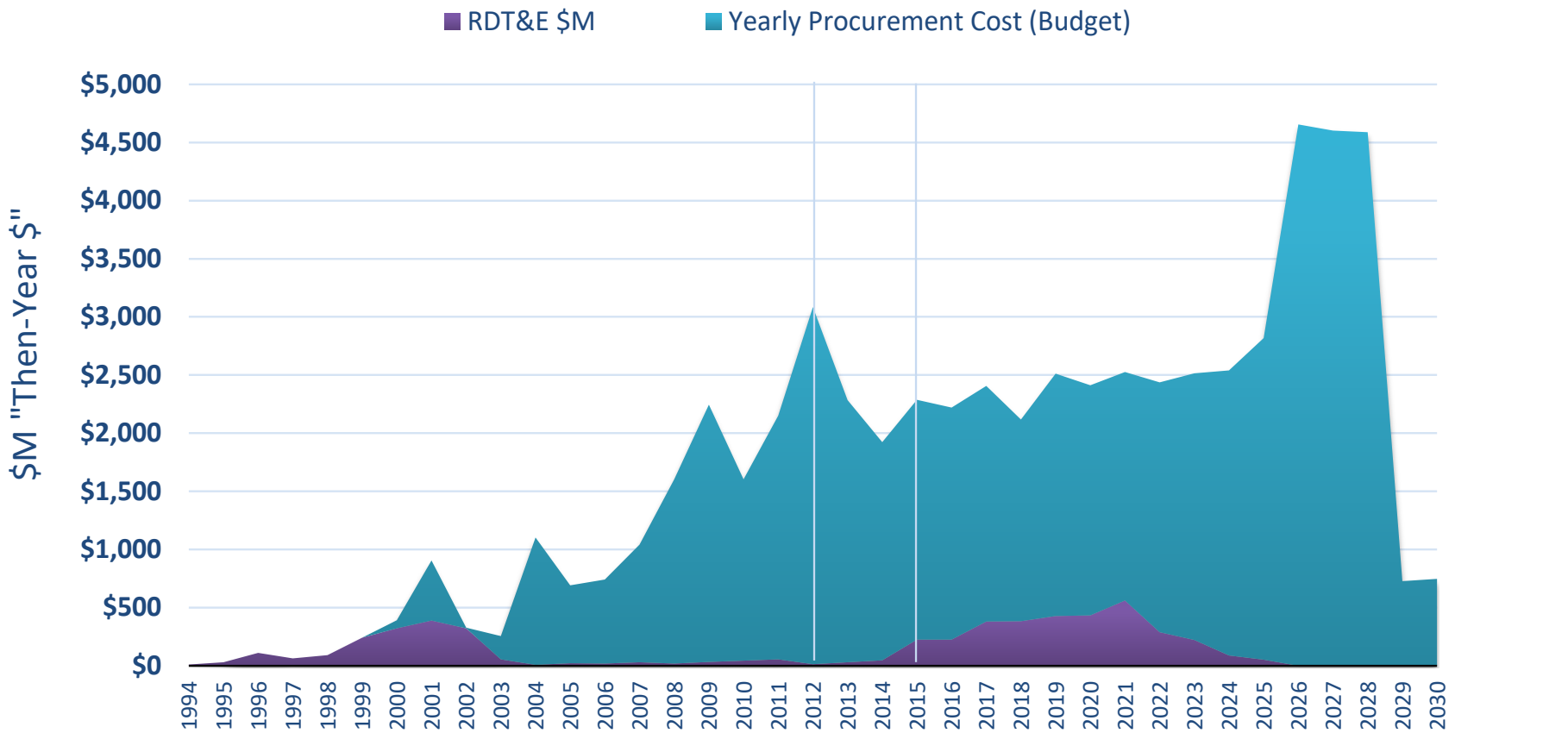
National Security Space Launch (was EELV) Program Annual Funding



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Restart RDT&E: ATK, AR, SpaceX, Vulcan

"Appropriators in a report accompanying the bill point out what industry and government officials have been saying for years: ***that the development of commercial launch systems has substantially reduced the cost of launching satellites to orbit. The price of launches under the National Security Space Launch (NSSL) program, meanwhile, do not appear to be coming down.*** *The 2020 budget funded four launches for $1.2 billion. The 2019 budget funded $1.7 billion for five NSSL launches."*

spacenews.com July 16, 2020

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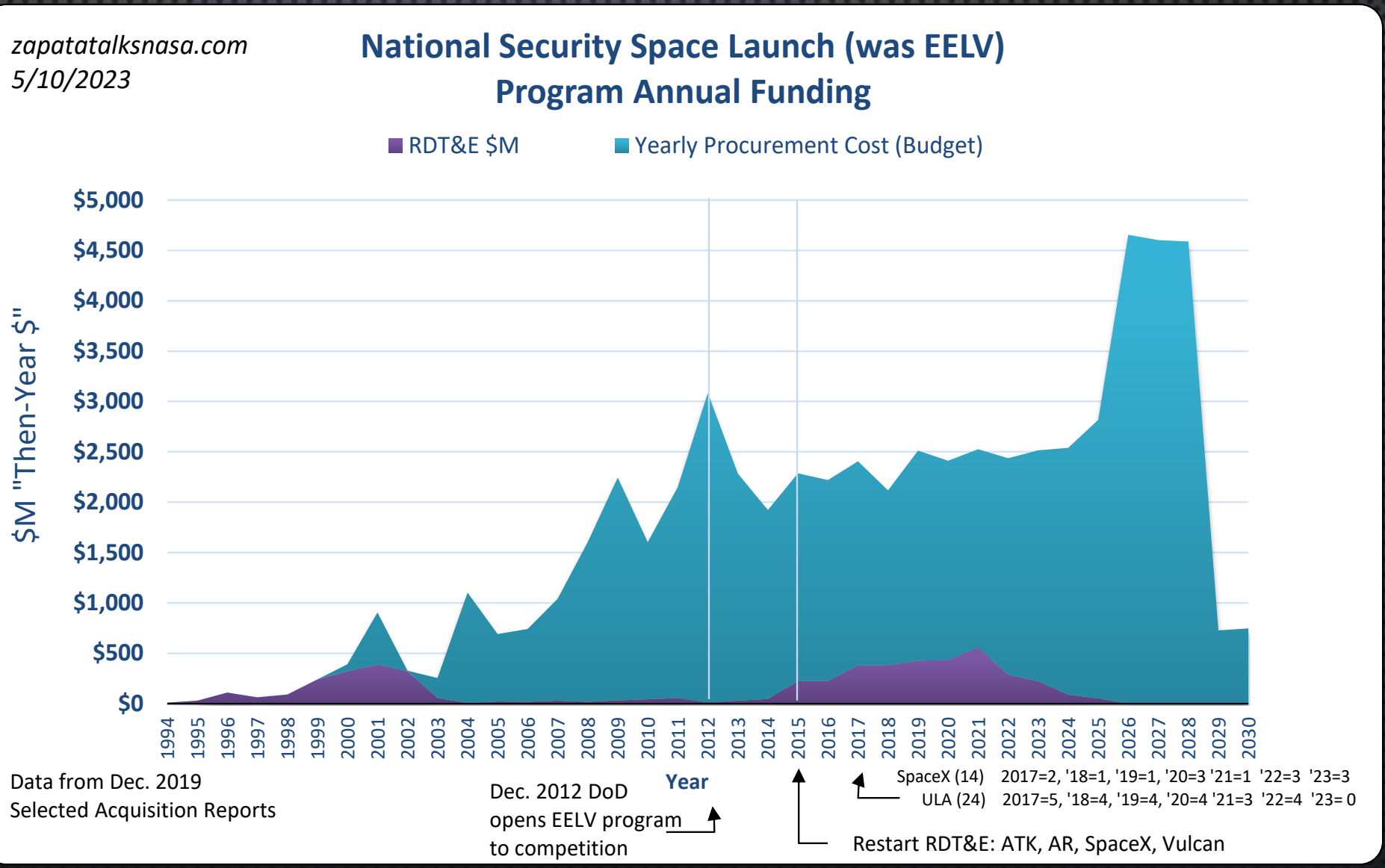

SPACECRAFT

Spacecraft Development Costs

Costs = Procurement Price to NASA (includes Prime and non-Prime)

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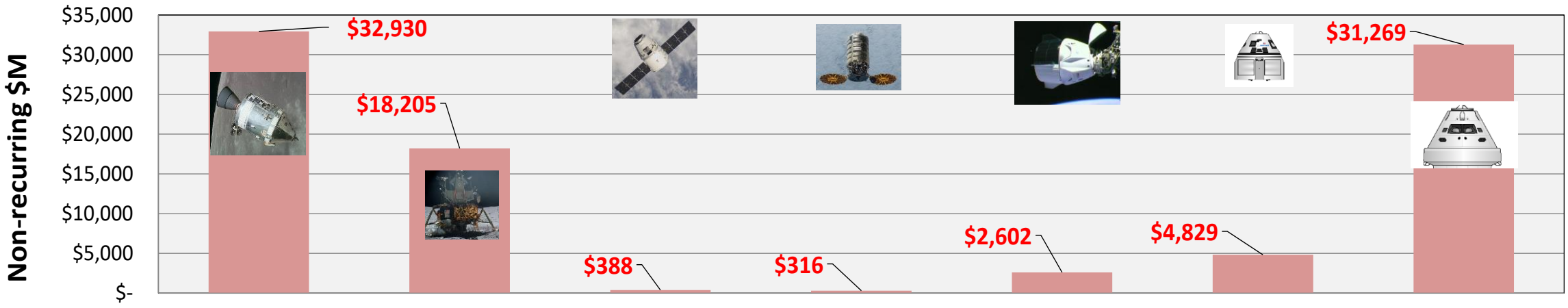
Spacecraft Non-recurring Development, NASA Procurement $ Only, $M 2026$



Apollo Command & Service Module	Apollo Lunar Module / Lander	Dragon 1.0, cargo	Cygnus enhanced, cargo	Dragon 2.0, crew & cargo	Starliner, crew & cargo	Orion
		Development Complete			2011-2026 $	2006-2026 $
					Crewed Demo Flt 2024	TBD 1st Crew flight 2026
Uncertainty. Lo $26B, Hi $40B	Uncertainty. Lo $15B, Hi $21B	NASA $ Only Shown	NASA $ Only Shown	2011-2020 Crewed Demo Flt 2020	Boeing "charges" =	Crew module $ mostly
		Private $ add $444M	Private $ add $435M	Private $ unknown.	Private $ add $1.5B+	Service modules by ESA
Cargo Commercial LEO		Cargo Commercial LEO		Crew Commercial LEO	Crew Commercial LEO	Crew Cost+ Cis-lunar

See backup

Spacecraft Per Unit Costs – $ Thru Cost Phase as Indicated

Costs = Procurement Price to NASA (includes Prime and non-Prime)

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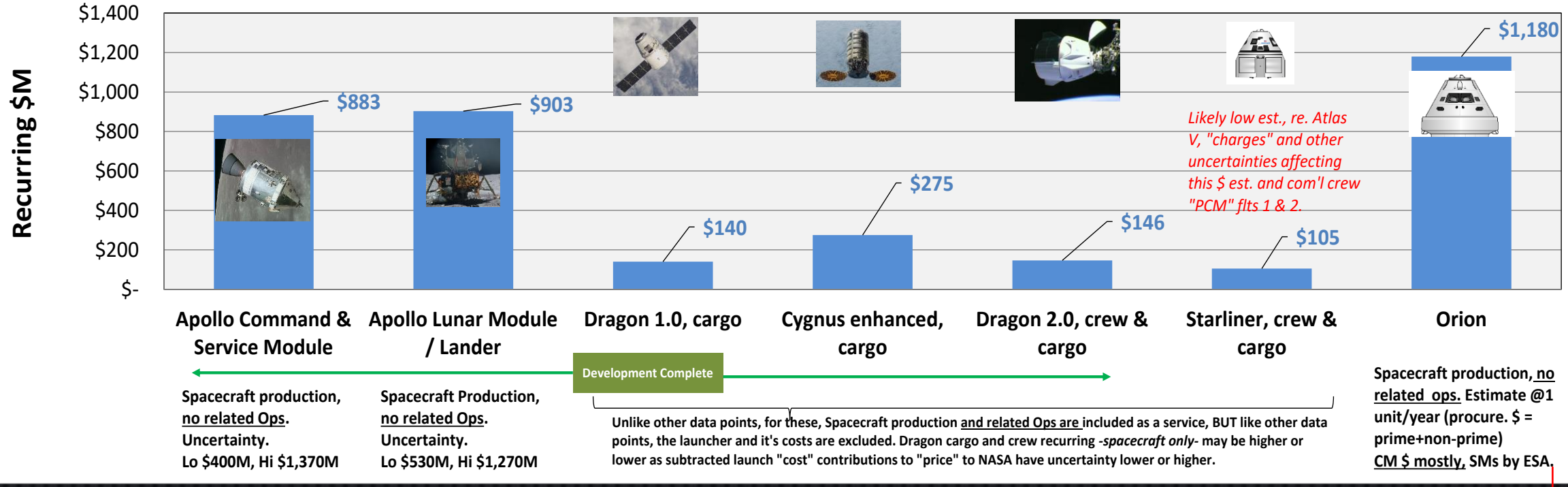

Manuf. $ Only | Manuf. $ Only | Cargo Commercial | Cargo Commercial | Crew Commercial | Crew Commercial | Crew Cost+ | Manuf. $ Only

Manuf. and Launch Ops Process $

See backup

More data soon?

- Commercial Crew
- Commercial Starship
- NASA Starship lunar lander
- Blue Origin lunar lander
- Commercial Lunar Payload Services (CLPS)

About the Author

- NASA Kennedy Space Center, Engineer 32+Yrs, Retired 2021
  - Space Shuttle Operations 1988-2000
  - Advanced Programs, Projects & Technology 2000-2021
- Publishing the annual "The State of Play - Prices, Productivity, and Other Measures of Launchers & Spacecraft" (at zapatatalksnasa.com)
- NASA Innovative Advanced Concepts (NIAC) External Council 2021-2027
- Blogging since 2021 at zapatatalksnasa.com
- 2022 New Space Journal – "A checklist for commercial space and NASA"
- 2023 Academia.edu – "Understanding aerospace market shifts by fusing technology and practices via genetic algorithm"
- 2024 Published the book "An engineer's journey in NASA: Space technology and policy on the final frontier" (Available on Amazon)
- Substack "Edgar Zapata on NASA" → https://edgarzapata.substack.com/

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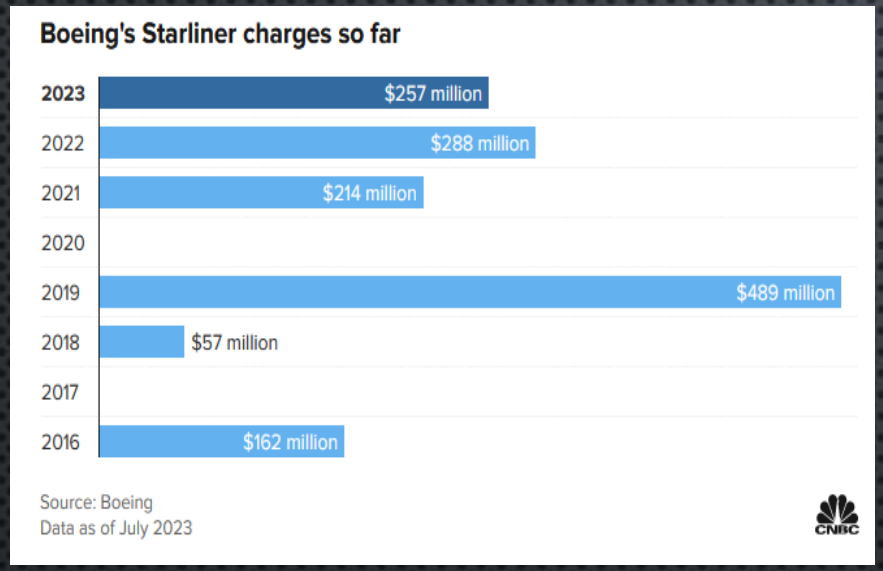
Backup

BOEING STARLINER



July 2023
Total = $1,467M

- 1/30/2020 Boeing takes $410 million charge to cover potential additional commercial crew test flight
- 10/27/2021 Boeing takes $185 million charge because of Starliner delays
- 07/27/2022 Boeing Takes Another Charge Against Earnings for Starliner ($93M)
- 07/26/2023 Boeing has now lost $1.1 billion on Starliner, with no crew flight in sight
  - …that the Starliner program had taken a loss of $257 million
- 07/26/2023 Boeing's Starliner losses total $1.5 billion with NASA astronauts still waiting to fly
  - …a $257 million charge in the second quarter for its Starliner
- 10/24/2024 More "charges" (?$250M, also see here) andthen 01/23/2025 Boeing projects additional Starliner losses in fourth quarter

CONTEXT, private sector partners contributed as much as 50% of development funds in the commercial *cargo* programs. These partnering approaches depend on the private sector partners investing, creating an incentive to later recover that investment from non-NASA customers.

ORION

- 2/4/2021 AIRBUS AWARDED €650 MILLION CONTRACT TO BUILD THREE MORE ORION SERVICE MODULES

Inflation

•A dollar in 1995, using the general US inflation indexes, would require **$2.06** today for the same purchasing power, or using the NASA inflation indexes, **$2.11**. Over time there is not much difference between the indices.

•NASA would need a little over $2 in 2024 to purchase what $1 purchased in 1995. That is, the NASA budget that kept up with inflation today would be just over twice the 1995 budget of $14.5 billion.

•But, NASA's 2024 budget is less than this equivalent purchasing power. NASA's budget, to have the same purchasing power in 2024 as in 1995 should be about $30.6 billion, but instead it is $24.9 billion, or **19% less.**

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4/1/2024