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Space Launch Reliability History

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- A little bit of history





- Robert H. Goddard
 - Inspired Wernher Von Braun
- The V-2 rocket (1942)
- R-7 (1957)
- The Space Race
 - 1957
 - Sputnik 1 and Explorer 1
 - Apollo 11



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Past





- Learning
 - Mostly accidents such as: fires, new technology, vacuum of space, space suits, rocket failures
- Russia and USA



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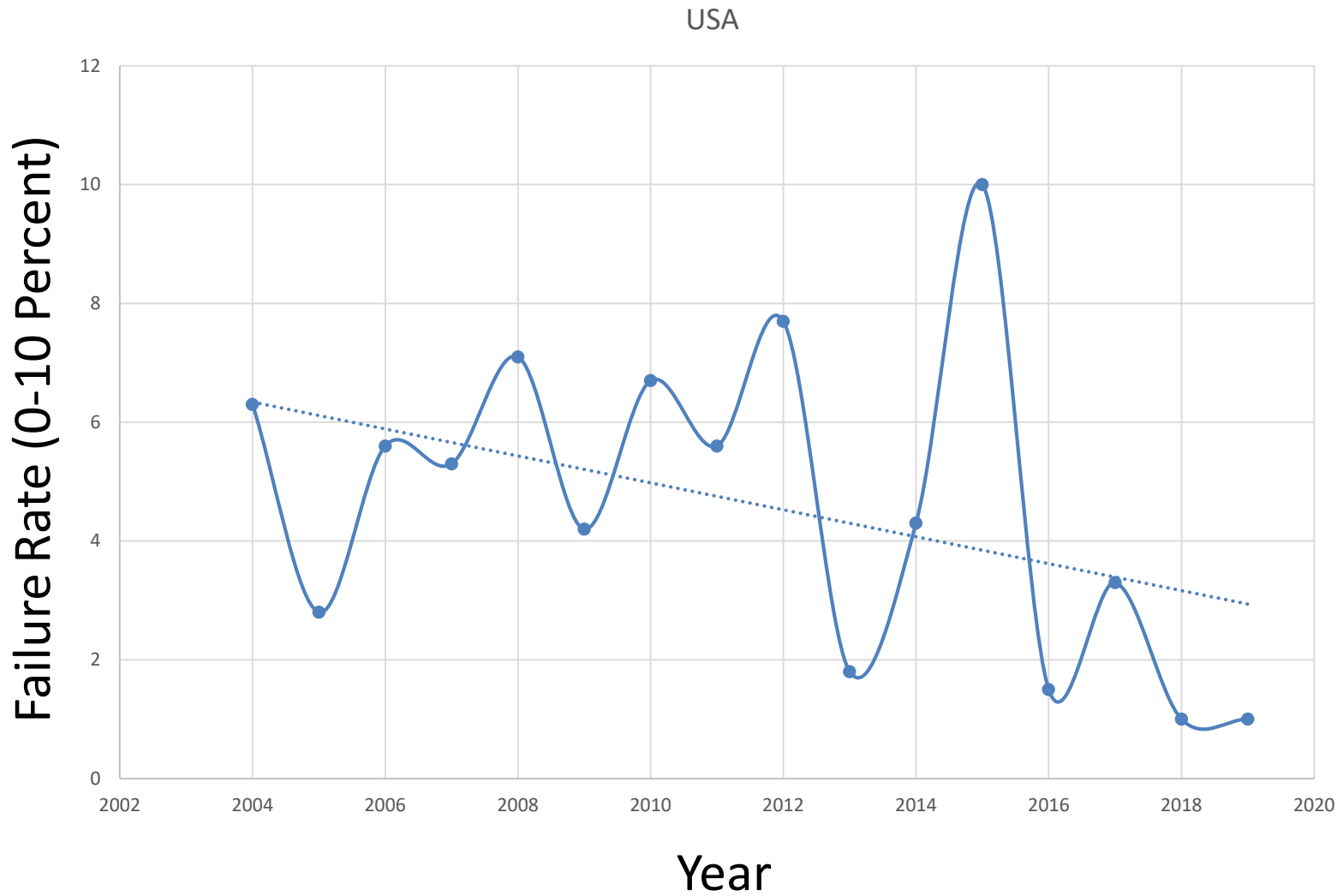
Present

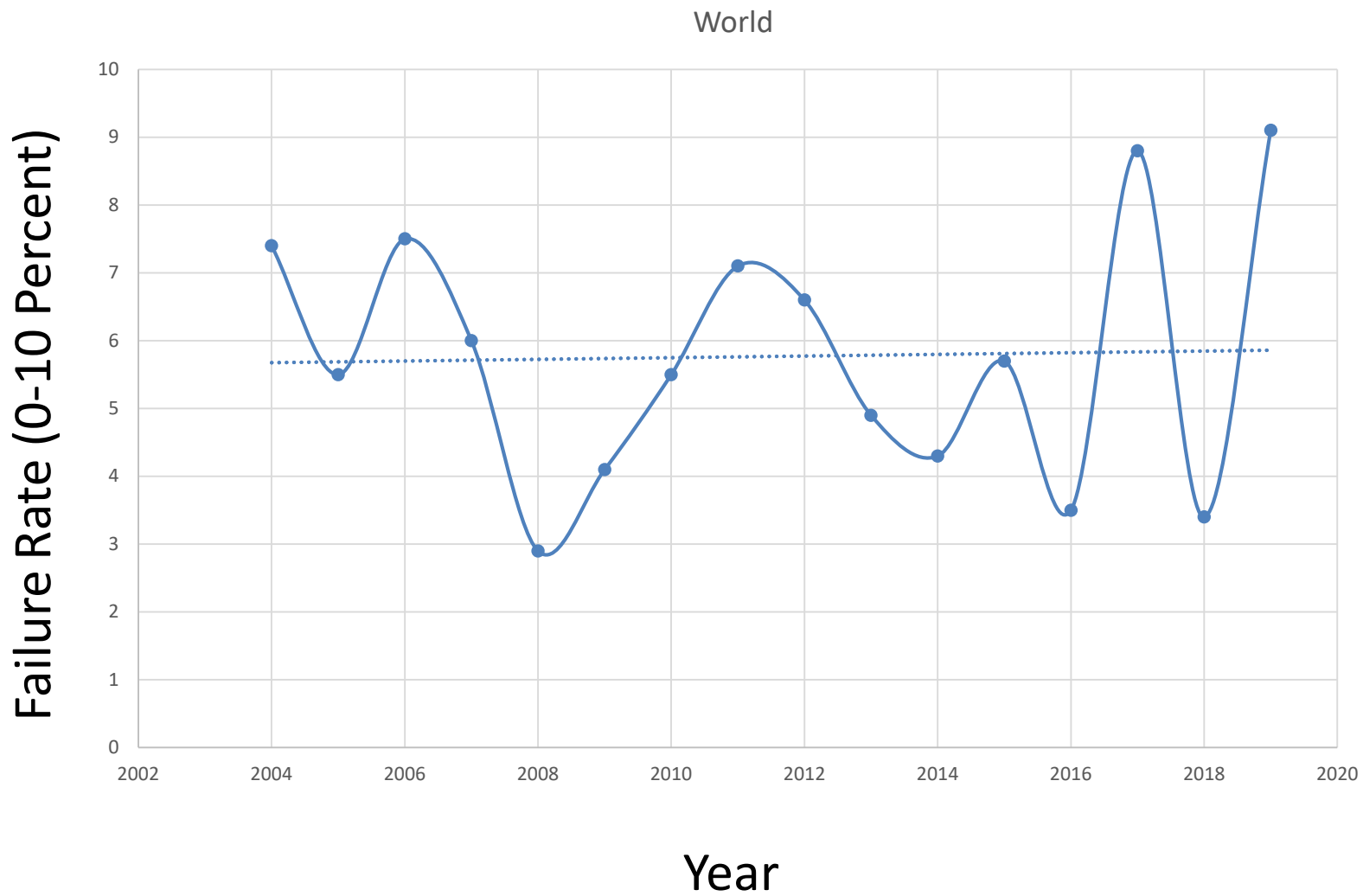




- Space flight is becoming increasingly popular
 - The first 8 months of 2019 had more launches than 2004 had in a year
- Worldwide safety has remained constant
 - Iran and China
 - USA at <1% failure rate since 2017
- 2018 was the busiest in history and 2019 is set up to take the lead

All data is open source







- As time progresses, things become more controlled
 - Consistent downward trend for most countries
- Facing different troubles in spaceflight
 - Separation and attitude



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Future





- Downward trend in failures for countries that institute safety and reliability tactics
- 2019 and 2018 both have zero failures thus far and the US is averaging about 1 in 102 failure rate using the 1/3 rule



- Interplanetary travel
 - New and unknown hazards
- New unknown unknowns



- Next challenge in Reliability and Maintainability
 - New environmental hazards
 - Extended periods of time in space
 - Predictability
 - The corona of the sun
 - Parker waves
 - Parker Solar Probe



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Conclusion



- Reliability over the past 6 decades
 - Launch rate is increasing
 - Commercialization and space exploration
 - Reliability has remained relatively constant
 - Recent data indicates possible improvement in reliability
- Reliability in the new era of spaceflight
 - Key to safe spaceflight as we return to unknowns



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QUESTIONS?





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Thank You!

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