



# SAVER: EVOLUTION AND PERFORMANCE OF MAXAR SPACE SYSTEMS GEO SOLAR ARRAYS

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*Prepared for:*

**The Aerospace Corporation**  
Space Power Workshop  
22-25 April 2024

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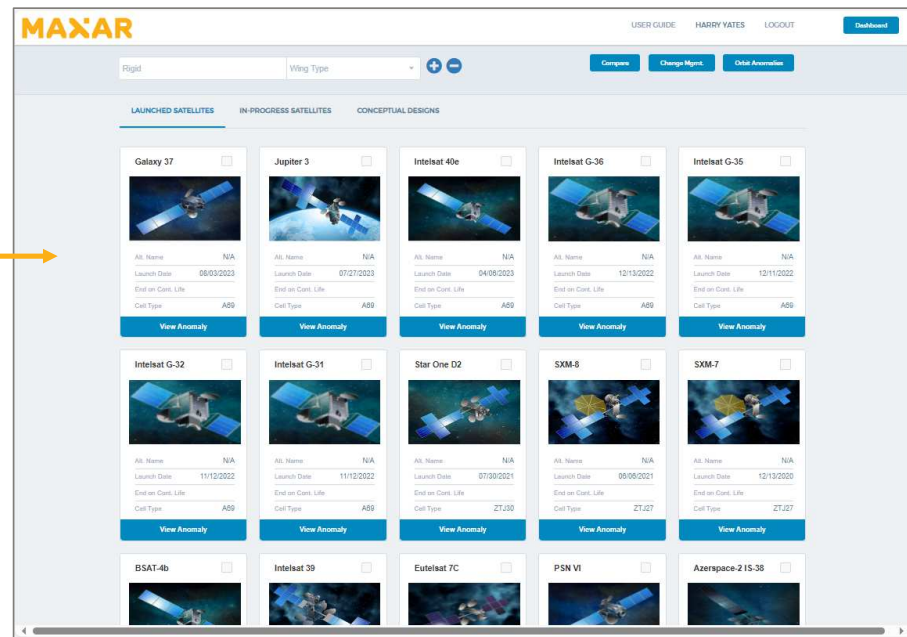
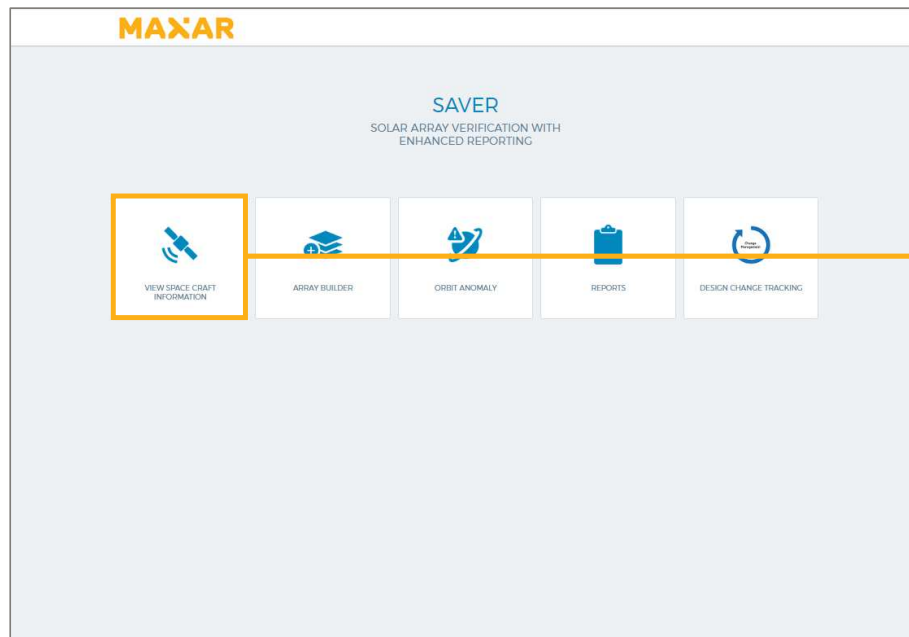


# Solar Array Verification with Enhanced Reporting – SAVER

- Maxar Space Systems' in-house database for documenting the on-orbit performance of our solar arrays
- Used for cataloging orbital anomalies and identifying any related trends or systemic issues
- Maxar Space Systems provides tailored reports to our customers for tracking the performance of their satellites

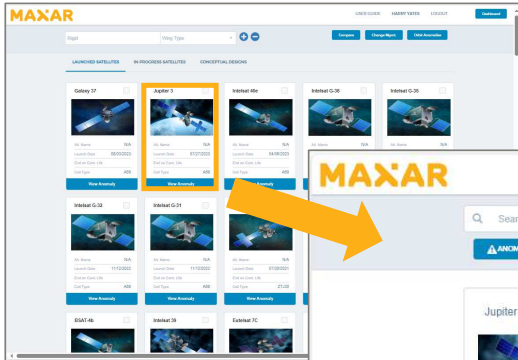
Dashboard

Launched Satellites



SAVER GUI includes clickable links to native specifications and CAD files

# SAVER Example Click through from “Launched Satellites” Page



## Program Info

MAXAR USER GUIDE HARRY YATES LOGOUT Dashboard

Search by Name

ANOMALIES DESIGN CHANGES

All Spacecraft Change Mgmt. Orbital Anomalies Compare

Jupiter 3

GENERAL INFO & LAUNCH DETAILS

Launch Date 07/28/2023	De-orbit Date	Launch Vehicle Falcon Heavy	Launch Location Cape Canaveral Air Force Station, Florida, USA
Wing Type Rigid	Program Category CAT 3	Hybrid Cell Panel No	End of Contract Life
Orbital Type GEO	Apogee	Perigee	Longitude 100° West
Number of PCU Dual	EPS	Noth South Station Keeping (NSSK) Bi-Propellant	Bus Type
Orbit Raising SPT	PCU Type 642	Holddown Number 8	Yoke Type I-Beam

Panel Details  
7 GaAs panels: 3 circuits\*4p + 1 circuit\*5p

## Solar Array Build Info

WING DETAILS

All program options and support documents are released in Teamcenter. Refer to Teamcenter for the revision or parts list for the specific program.

NORTH SOUTH

Wing Solar Array Related Documents

Panel Specification Document G060097	Wing Assembly G071800-01	Yoke Prep Assembly G071805
CIC Spec Document N/A	Panel Prep Assembly G071803-01-02-03-04-05-06-07	Yoke Harness G071806
Coverglass Spec Document E171735	Cell Drawing Doc E307506	Yoke Assembly G071806
CELL Spec Document G062258	3 Pack Assembly Document G071804	SADA Hinge
ICD Document G071801	Power Harness Document E112800-116-117-124-125	Power Harness Connector Doc
Integration-Final G071800-01	Holddown kit G013003-02	
Integration-Test G071800-02-102		

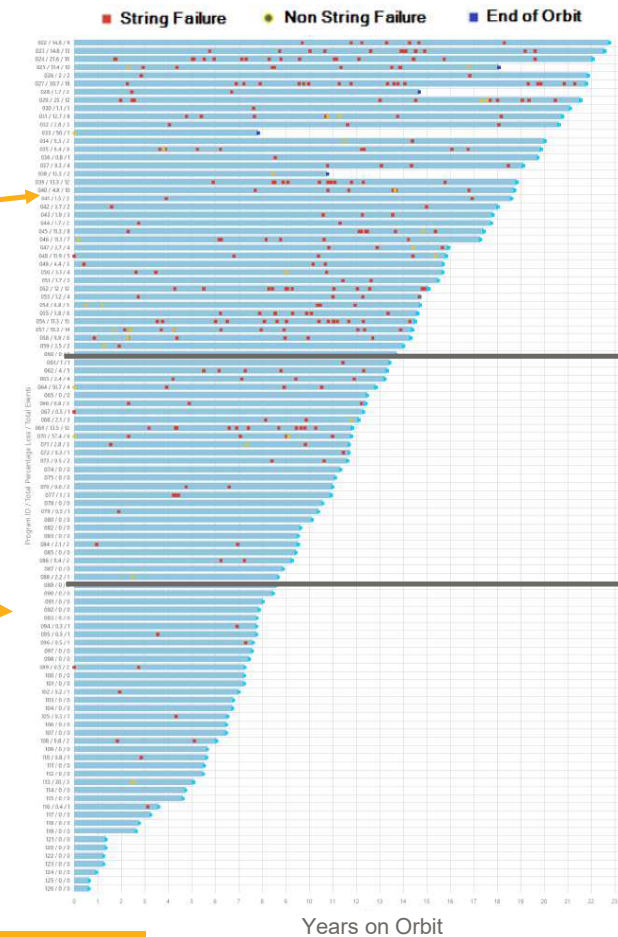
Vendor MELCO

SADA Hinge	Yoke Assy: G071805	Destination Inboard Center	Destination Inboard Center	Destination Center	Destination Outboard Center	Destination Outboard Center
Yoke Prep: G071805	Substrate: E342192-01	Substrate: E342193-01	Substrate: E342193-02	Substrate: E342193-01	Substrate: E342193-01	Substrate: E342193-01
Yoke Harness: G071806	Panel SCD: E342191-01	Panel SCD: E342191-02	Panel SCD: E342192-05	Panel SCD: E342191-03	Panel SCD: E342191-04	Panel SCD: E342191-04
	Full	Full	Full	Full	Full	Full

SAVER enables Maxar Space Systems to track the effectiveness of periodic design upgrades

# Five Categories of Solar Array Design Upgrades at Maxar Space Systems

- CAT 1 (1997-1998)
  - Early, simple ESD mitigation measures
- CAT 2 (2000)
  - Early, simple ESD mitigation measures
- CAT 3 (2001-2009)
  - Thorough electrical and structural insulation improvements
  - Up to 7.5% string failures by EOL (15 yrs)
- CAT 4 (2010-2015)
  - Wing harness, diode board, and structural improvements
  - Up to 2% string failures to date
- CAT DIA (2015)
  - “Dual Insulated Array” – enhanced insulation features
  - String failures observed only on non-DIA arrays post 2015
  - Zero string failures to date on CAT DIA arrays

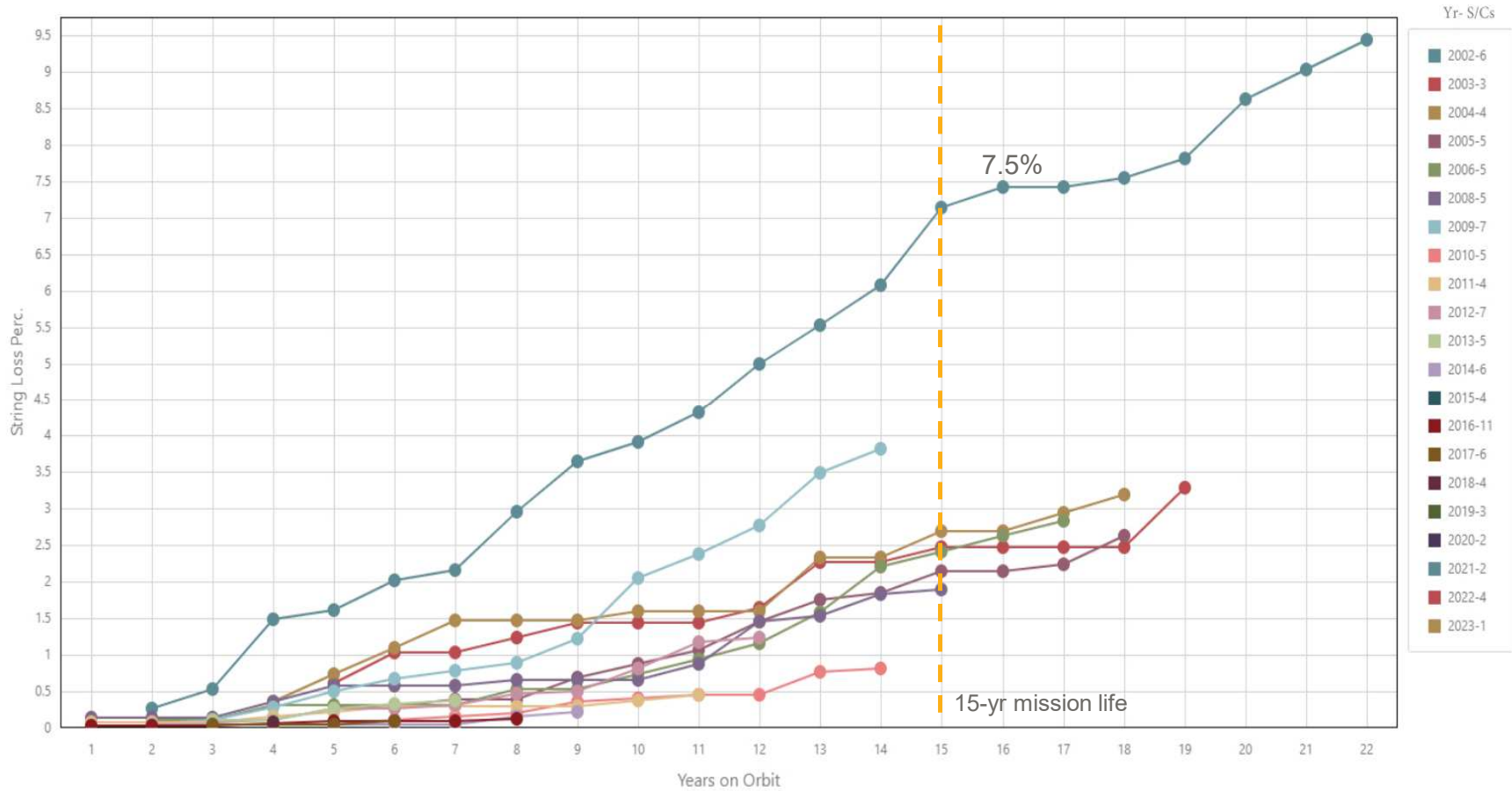


Solar array reliability has improved with each successive upgrade



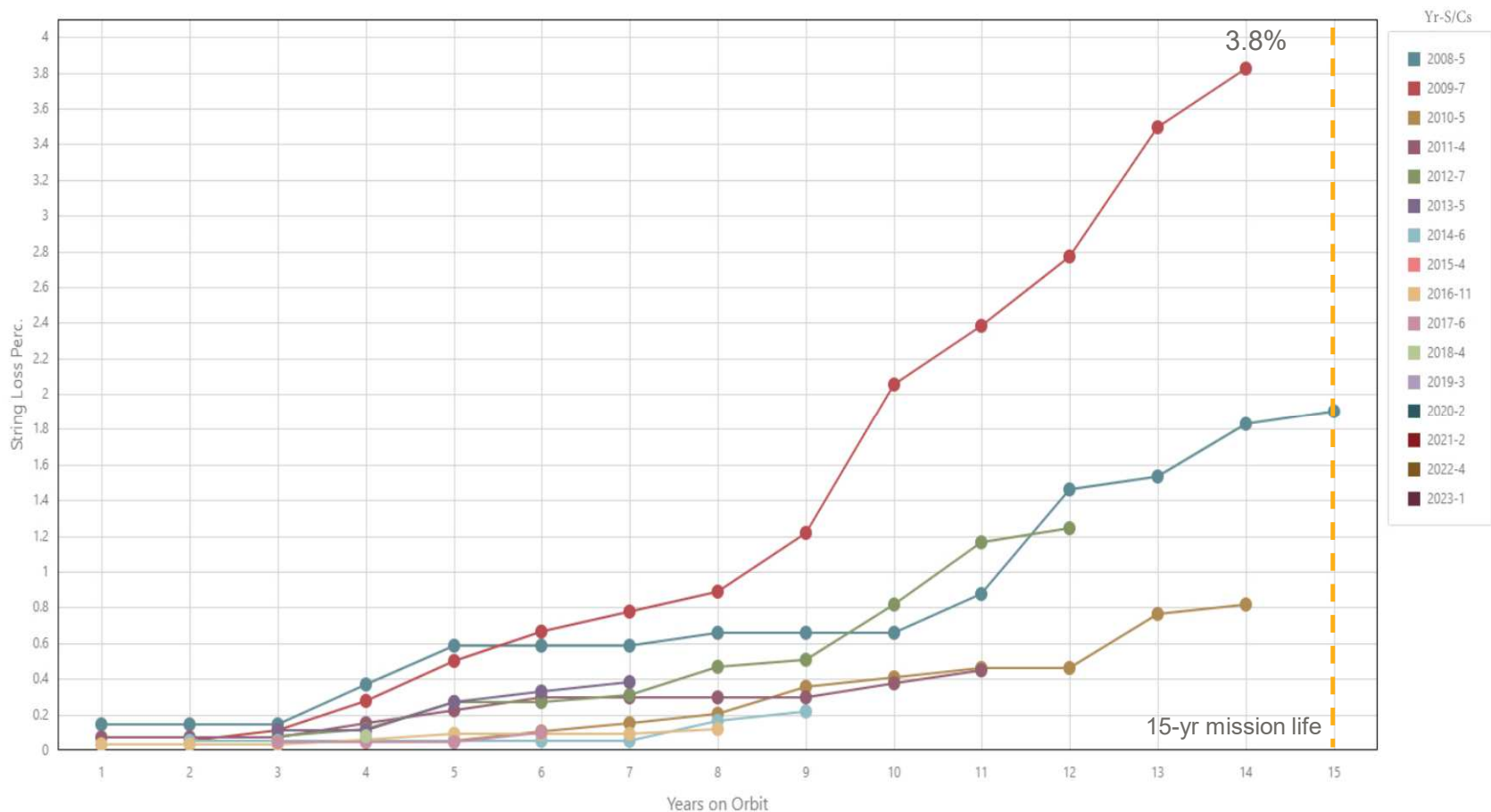
# Trends

# Solar Array String Loss % for Maxar Space Systems CAT 3 Spacecraft by Launch Year



Maxar Space Systems applies an additional 7.5% power loss factor to all GEO solar array designs

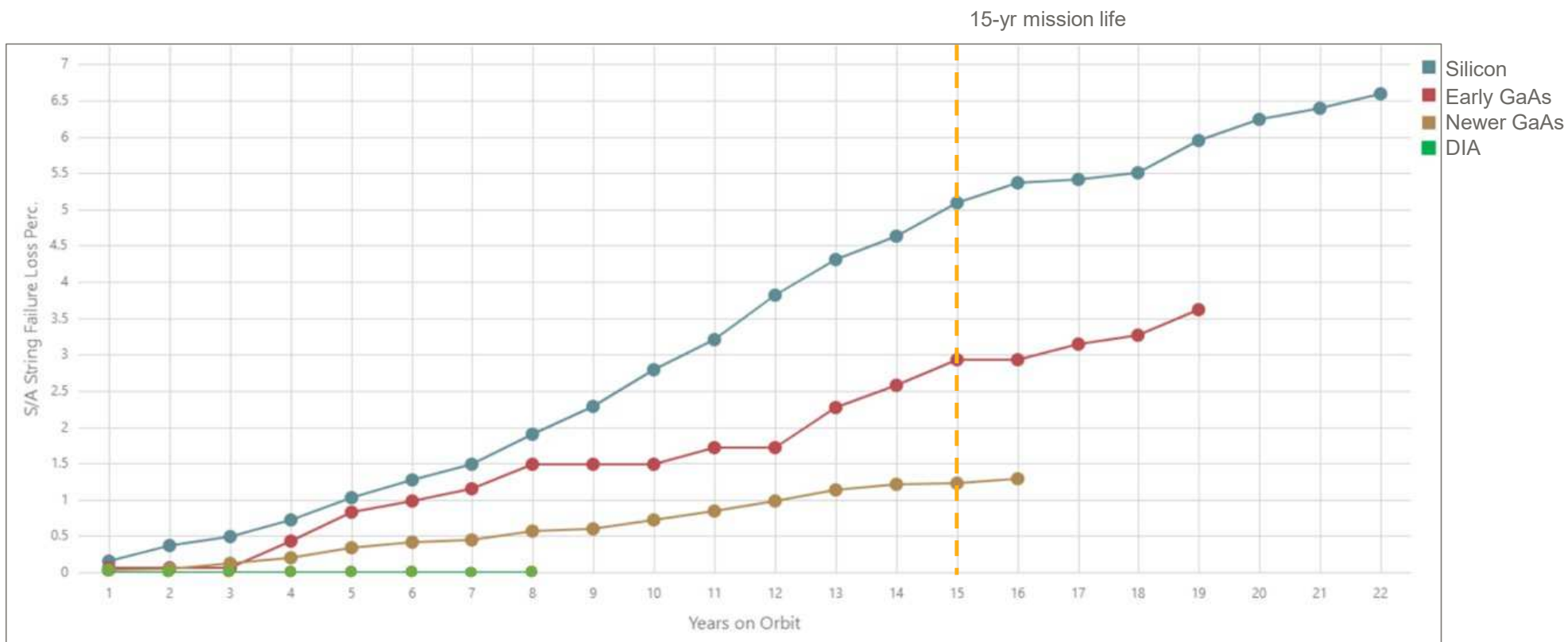
# Solar Array String Loss % for Maxar Space Systems CAT 3 Spacecraft Launched Since 2008



Removing 2002 from the data set drops the max failure rate by almost half



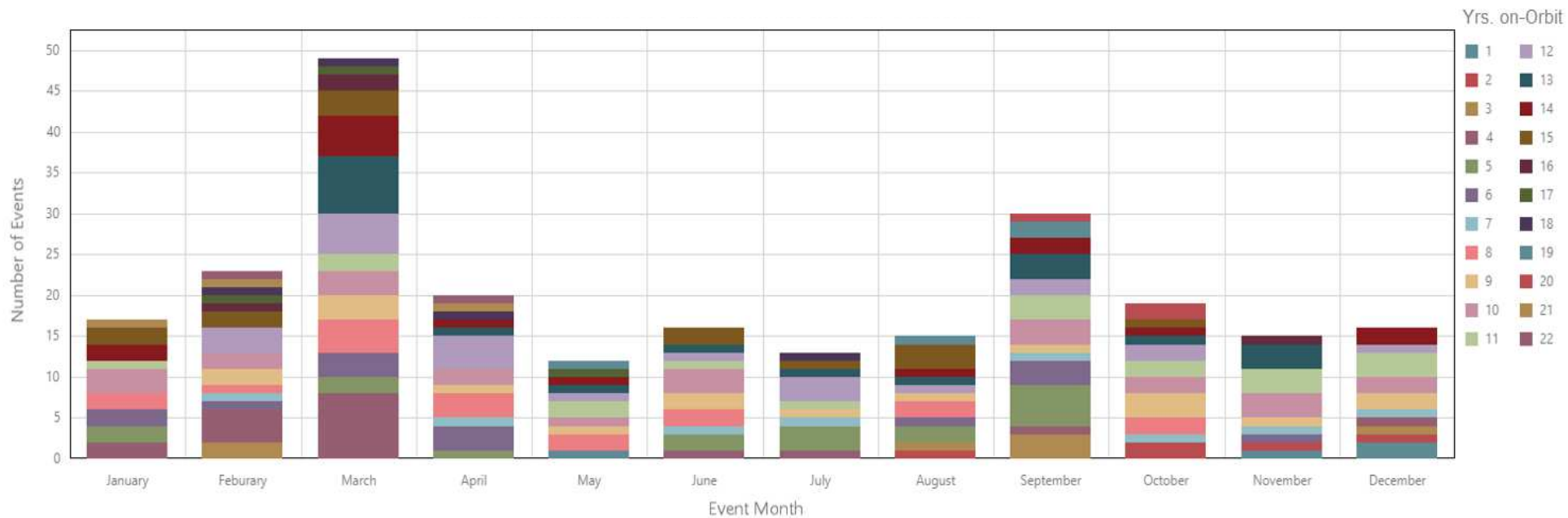
## Solar Array String Loss % by General Solar Cell Type



Increases in solar cell reliability and continuous improvements in wing design and manufacturing have driven improved on-orbit performance

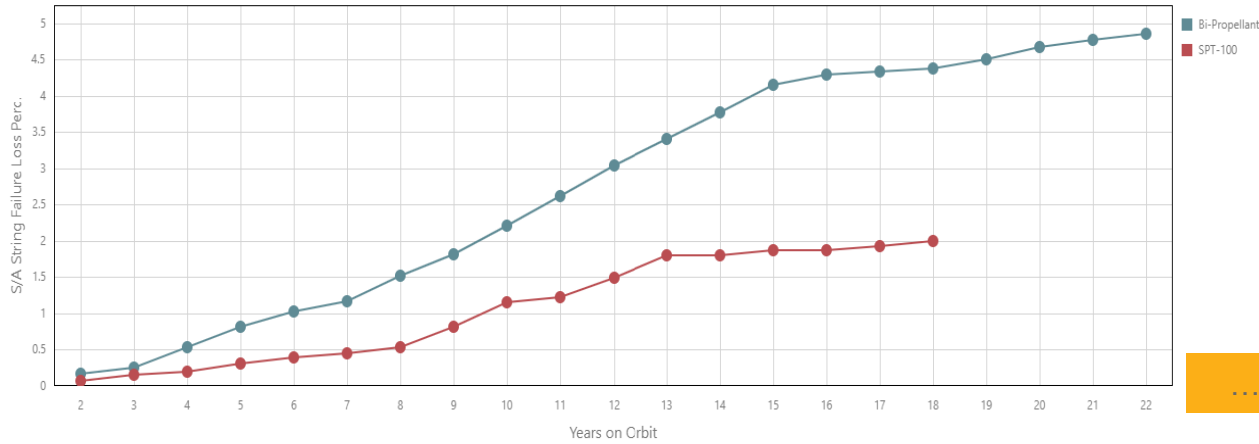


## Solar Array String Loss Events by Month



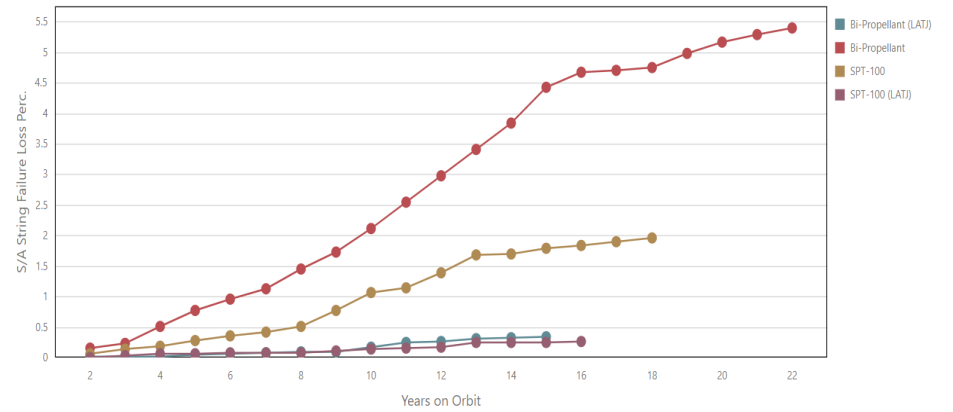
Failure rates peak during equinoxes: more eclipses, higher sun intensity (higher temperature, more array current)

# Solar Array String Loss % by Propulsion Type (Chemical vs. Electric)



... but design CAT and/or cell type are also factors

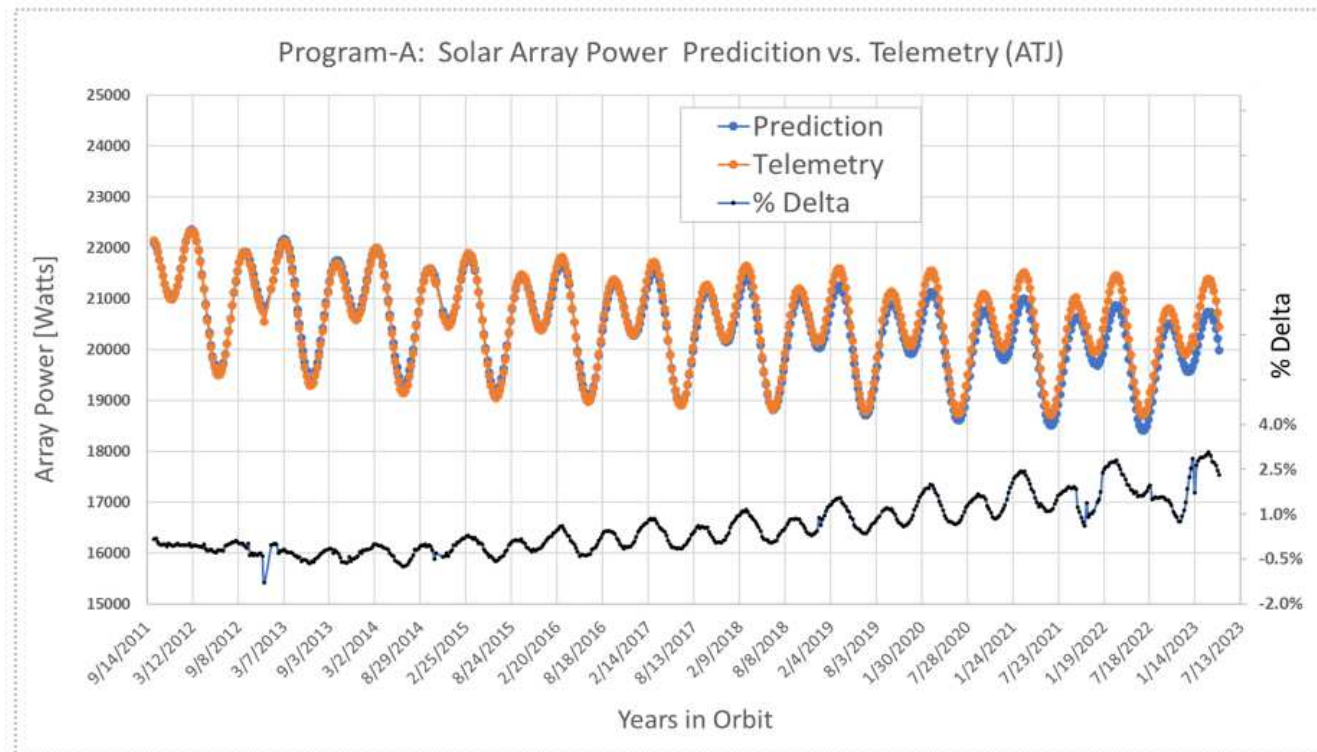
Curves suggest more string failures with chemical propulsion...



The SAVER tool allows Maxar Space Systems to parse data and better understand apparent trends

# Maxar Space Systems Solar Array On-Orbit Performance Actual vs. Predicted

- Prediction based on composite Worst Case Solar Flare radiation model (accounting for the 89 and 72 flares, JPL-91 Model with 95% percentile, and the old NASA X-600-85-12 model)



Divergence starting 2019/2020 coincides with reduced solar cycle activity

## Summary

- Solar array reliability has improved at Maxar Space Systems over the last two decades
- Advances in solar cell technology seem to be a major contributor
- Wing design upgrades focused mainly on improved electrical insulation have also helped
- Potential to reduce historical 7.5% knock-down factor based on performance since 2015

SAVER has helped Maxar Space Systems better understand our solar arrays and how to improve their reliability



# Thank You!



Jupiter-3



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