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

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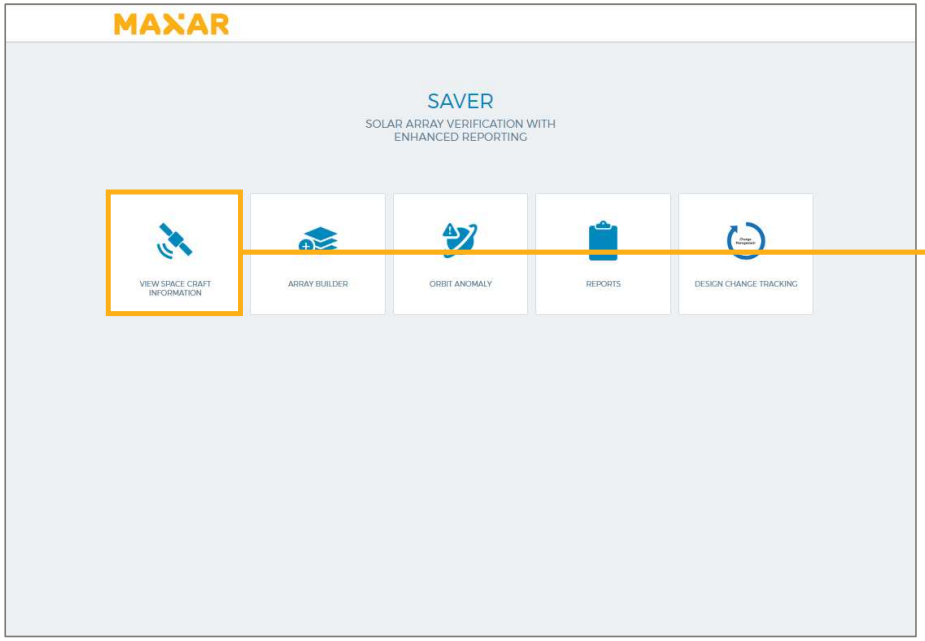
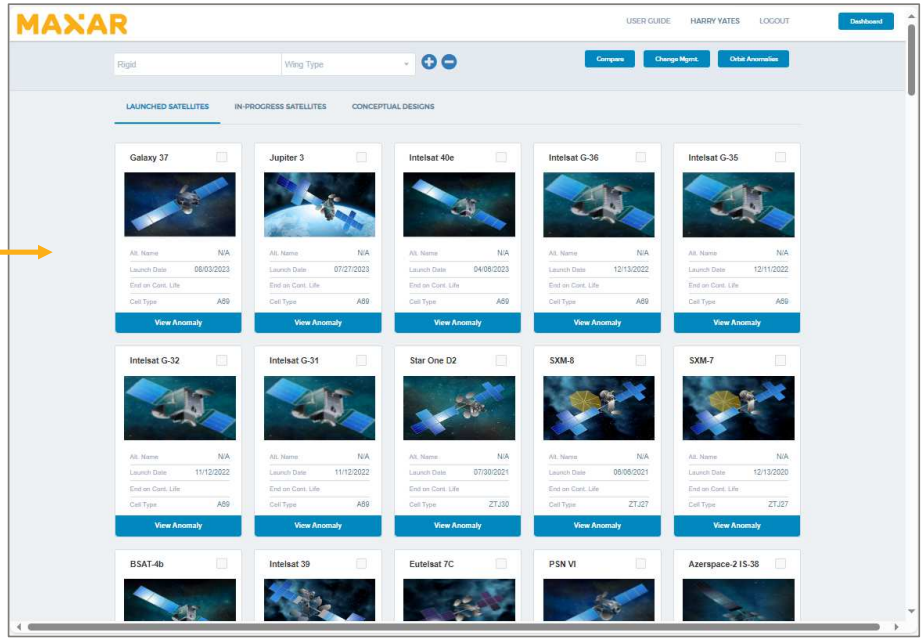
Solar Array Verification with Enhanced Reporting – SAVER

- 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

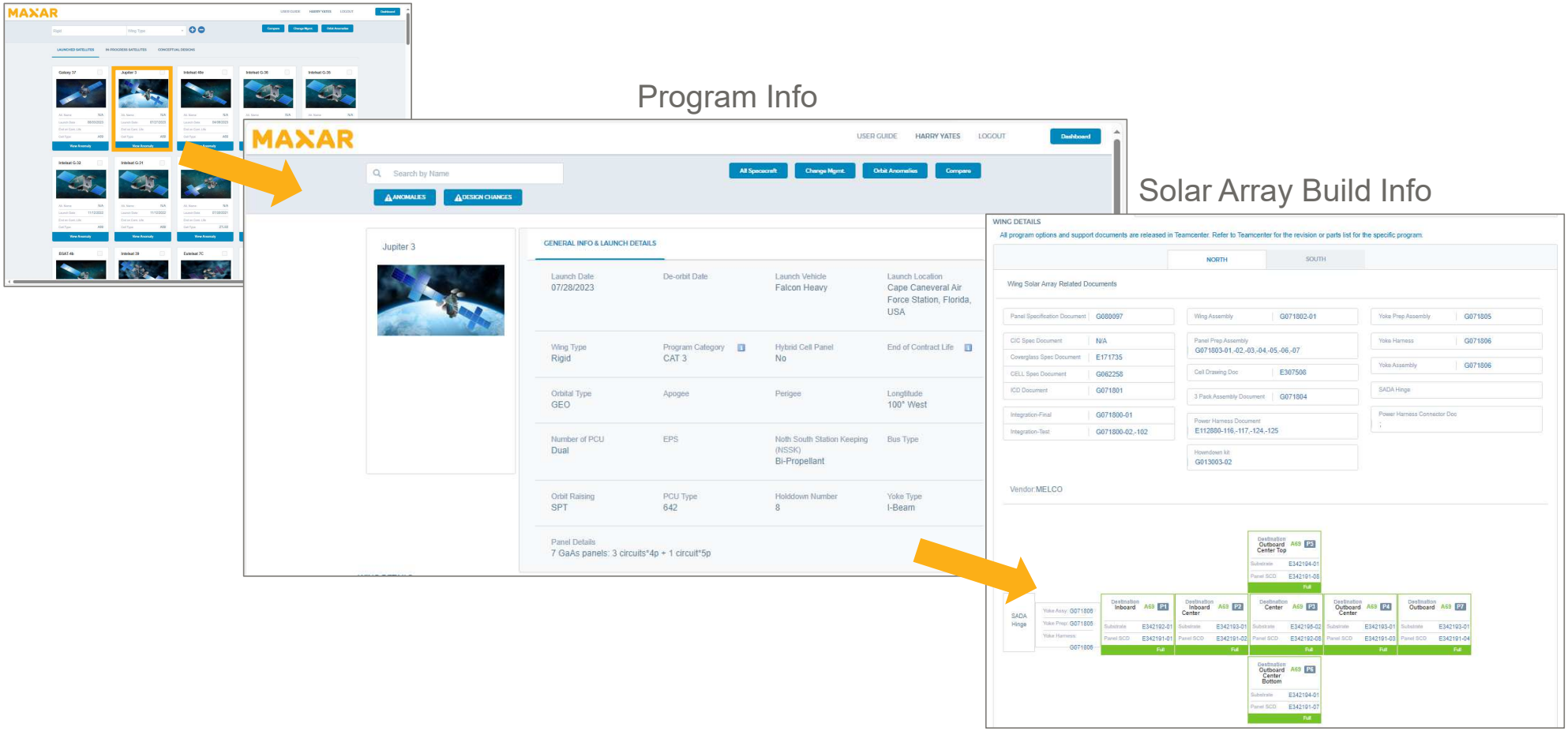


Launched Satellites



SAVER GUI includes clickable links to native specifications and CAD files

SAVER Example Click through from “Launched Satellites” Page



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

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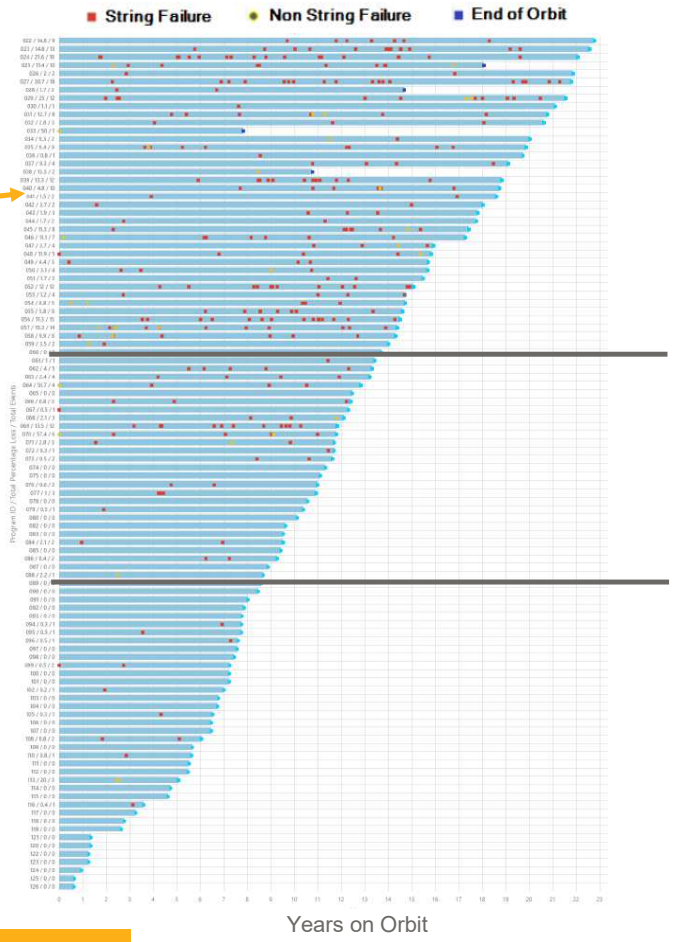
Five Categories of Solar Array Design Upgrades at Maxar Space Systems

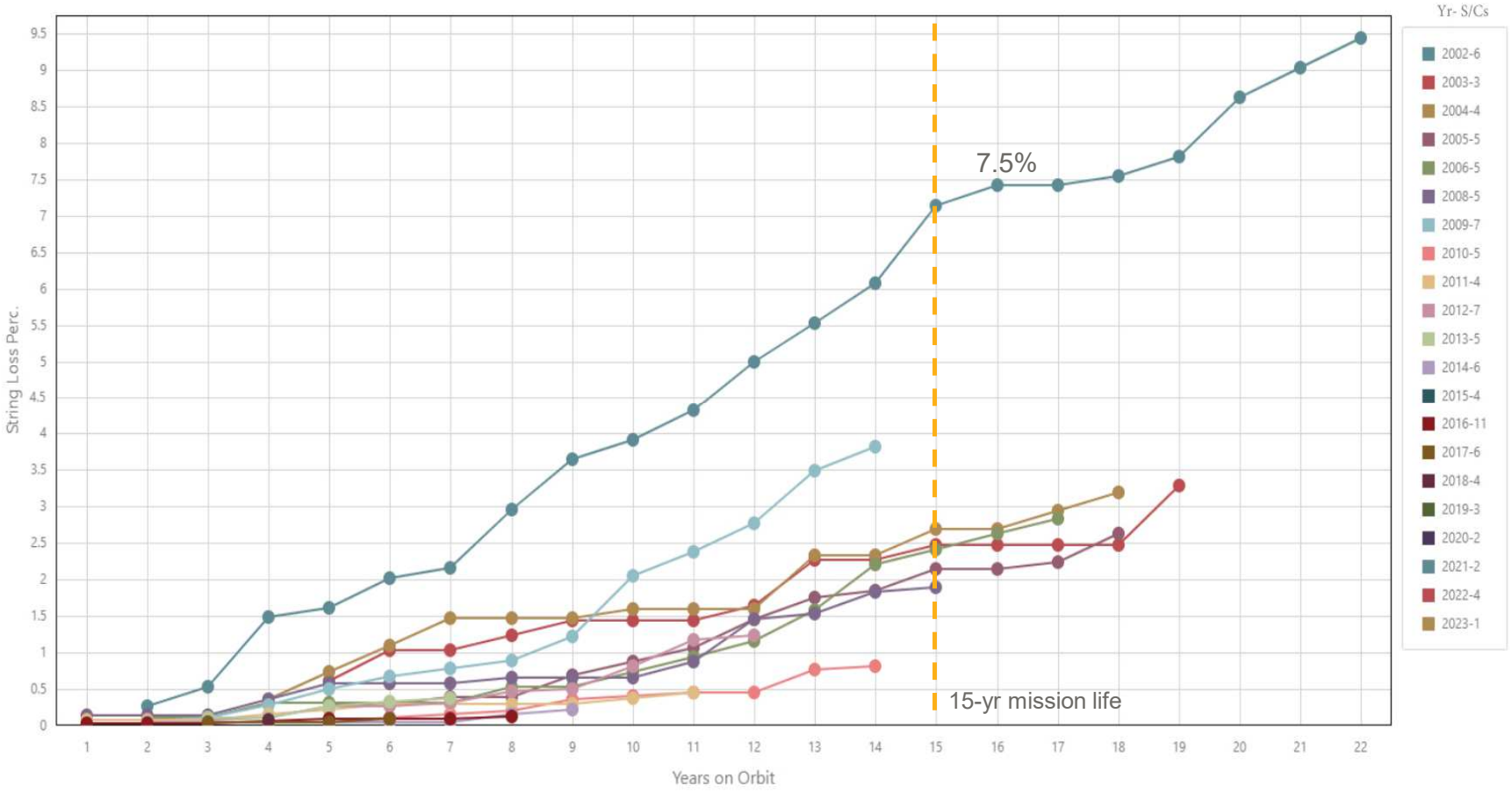
- CAT 1 (1997-1998)
  - Early, simple ESD mitigation measures
- CAT 2 (2000)
  - Early, simple ESD mitigation measures
- CAT 3 (2001-2009)
  - Thorough electrical and structural insulation improvements
  - Up to 7.5% string failures by EOL (15 yrs)
- CAT 4 (2010-2015)
  - Wing harness, diode board, and 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

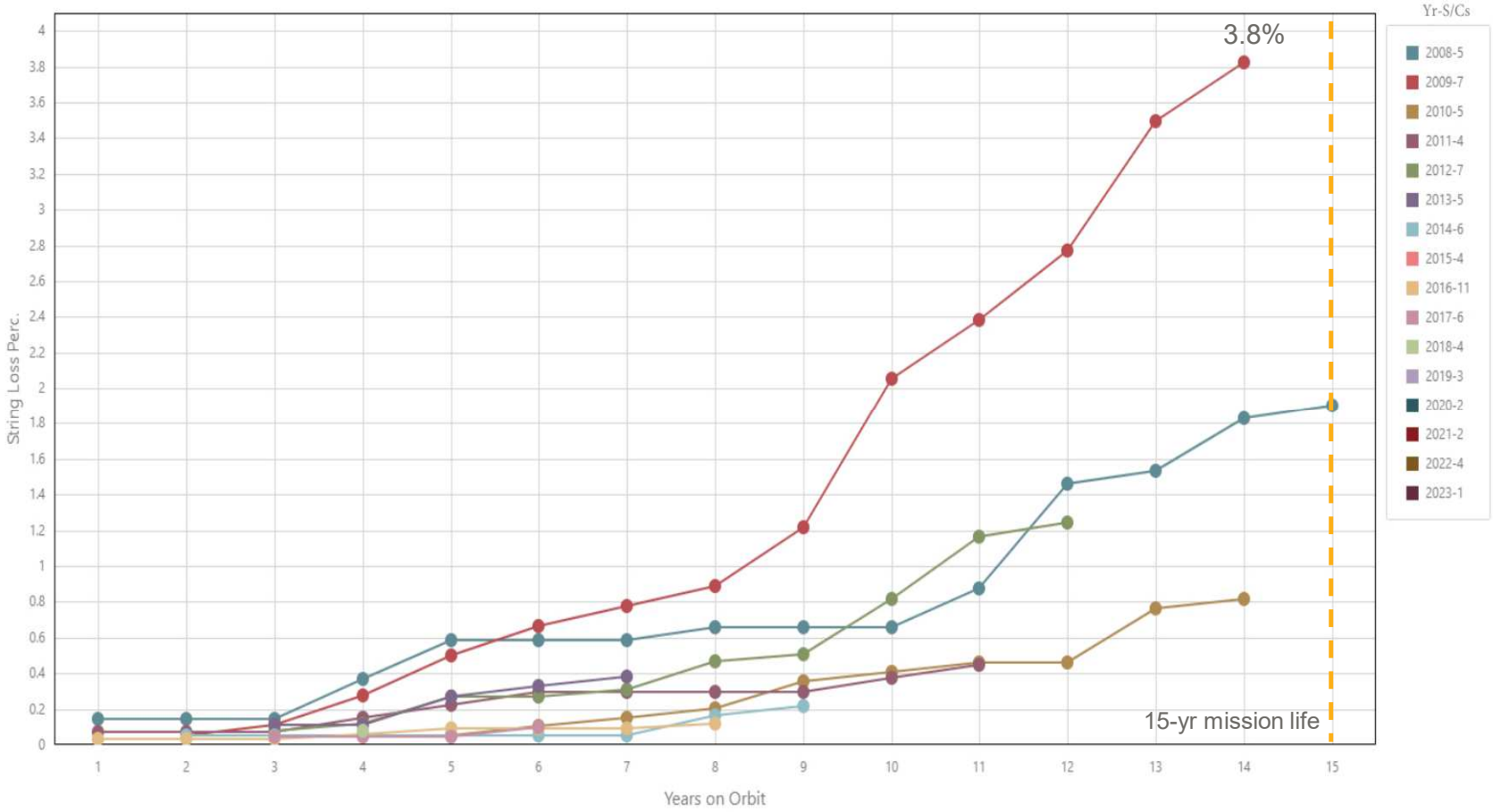
Trends

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

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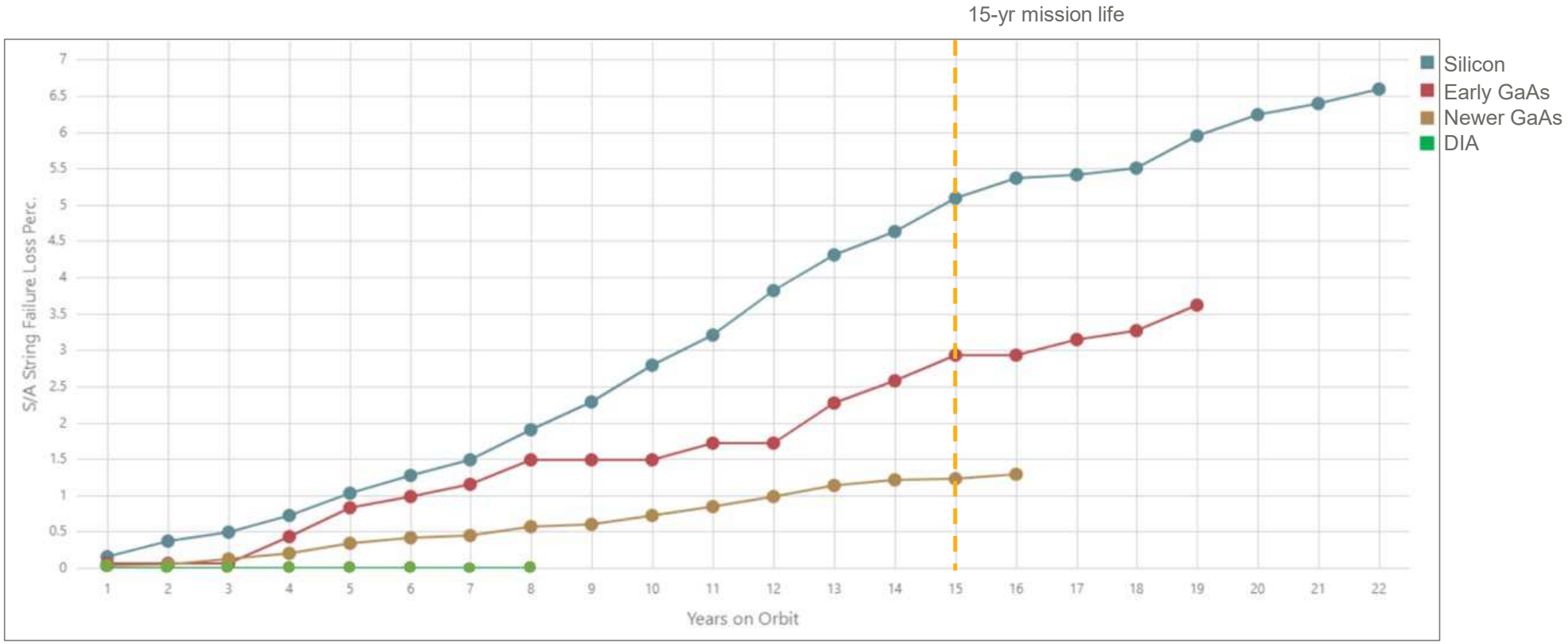
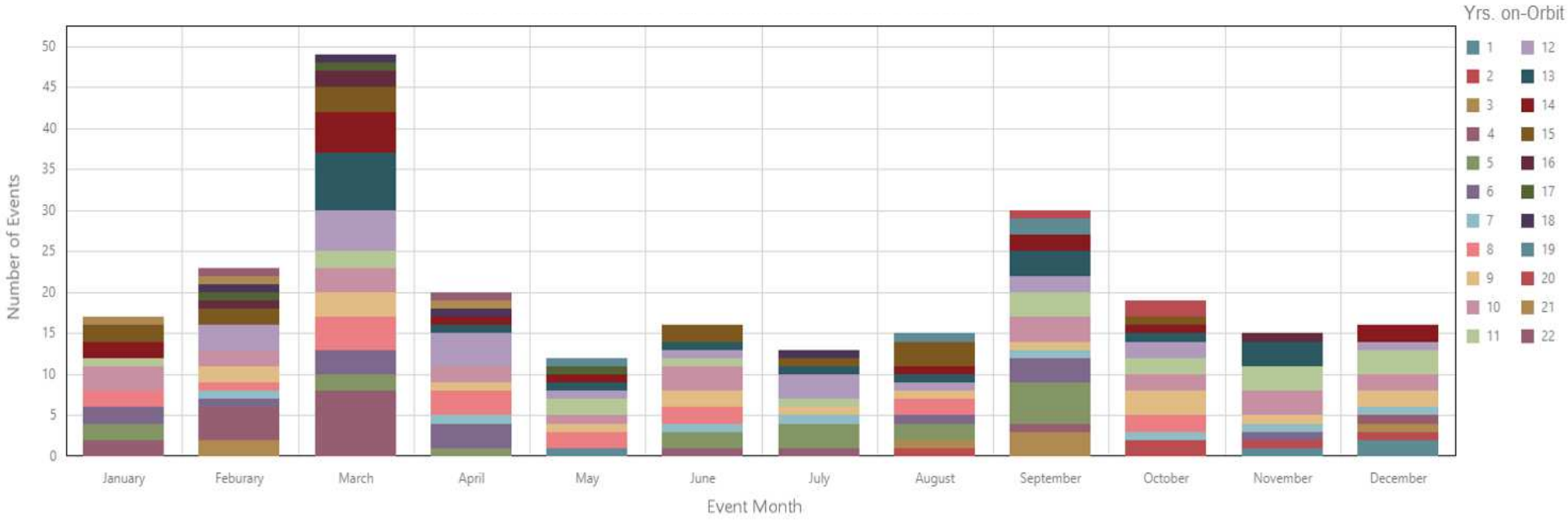
Solar Array String Loss % by General Solar Cell Type



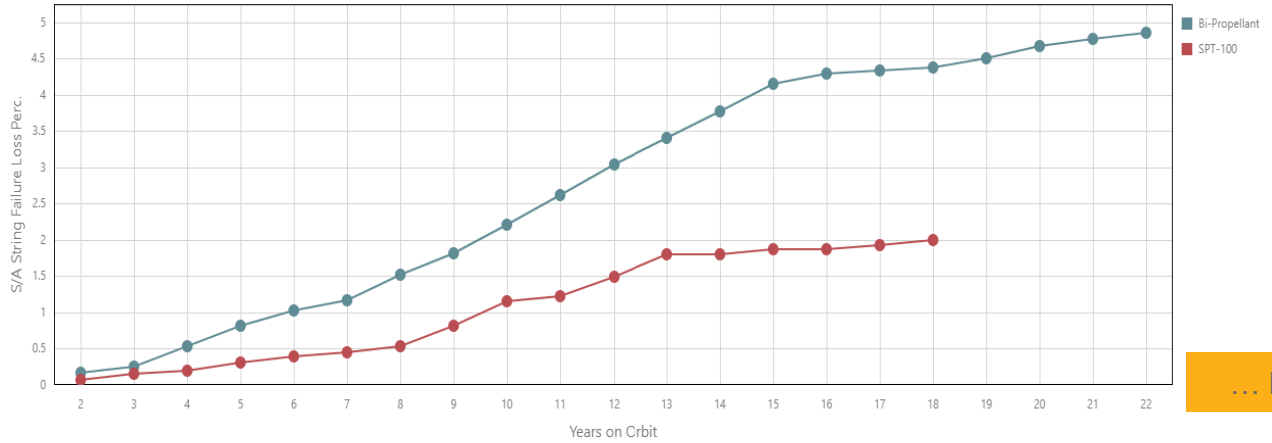
Increases in solar cell reliability and continuous improvements in wing design and manufacturing have driven improved on-orbit performance

Solar Array String Loss Events by Month



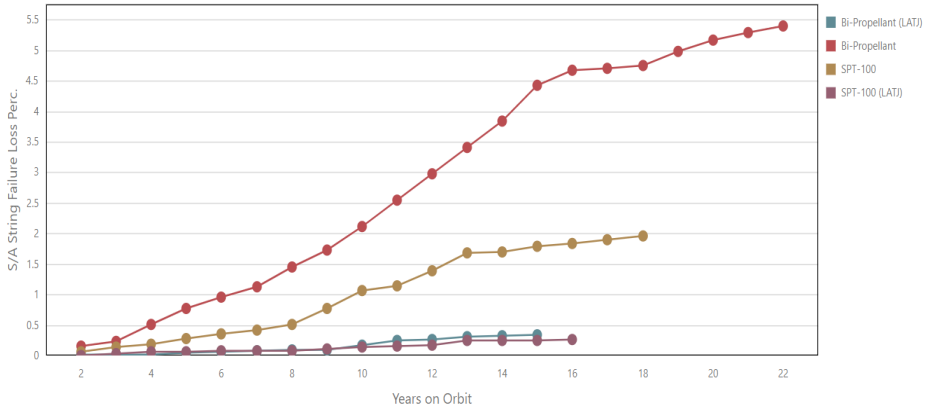
Failure rates peak during equinoxes: more eclipses, higher sun intensity (higher temperature, more array current)

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



Curves suggest more string failures with chemical propulsion…

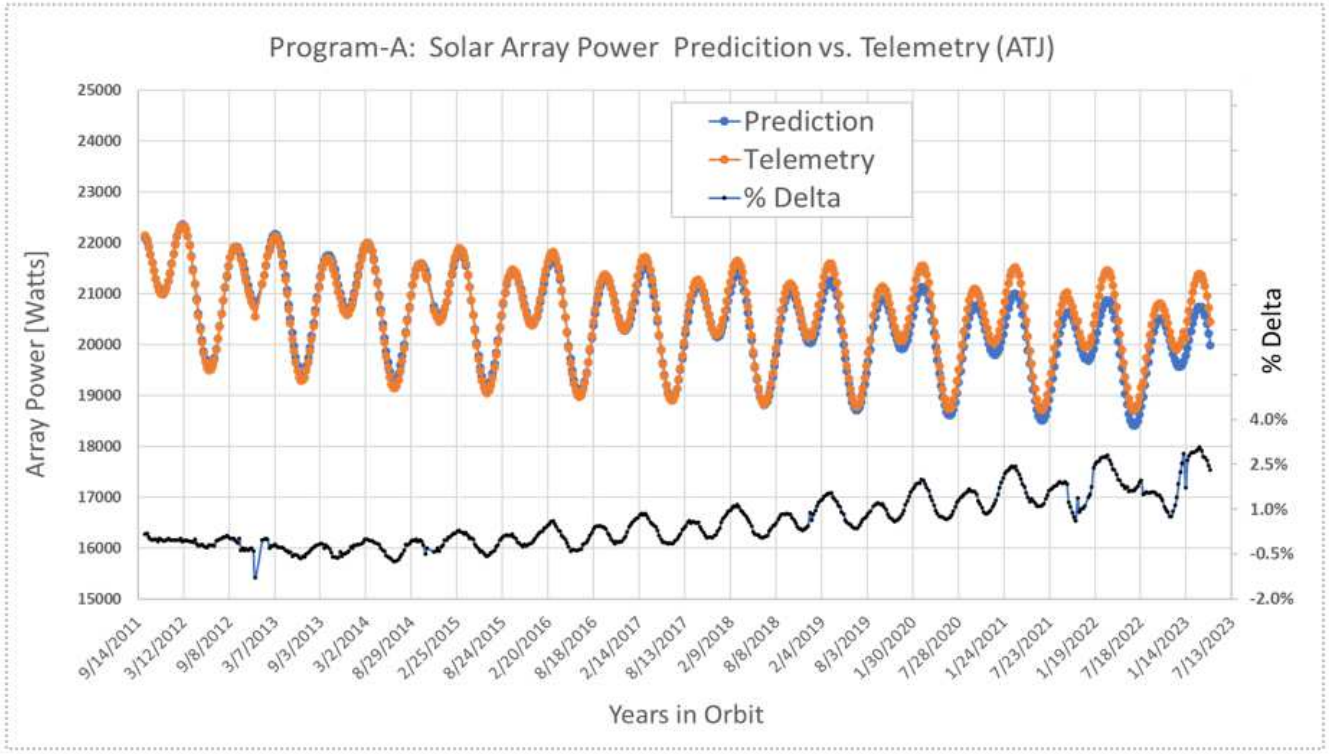
… but design CAT and/or cell type are also factors



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!

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