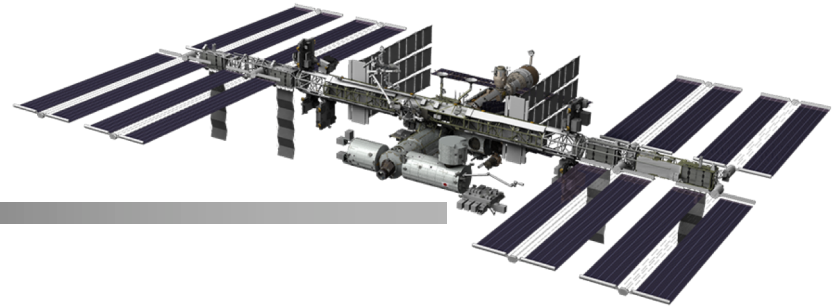


HEO NAC
International Space Station Maintenance Trending

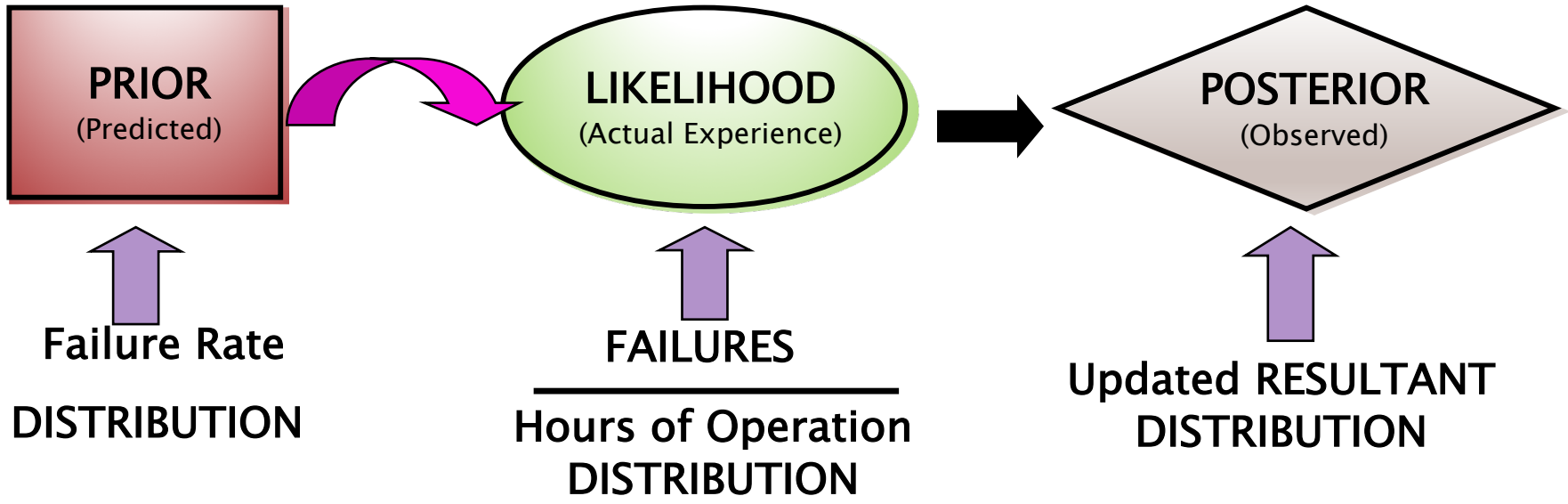
Sam Scimemi- ISS Director

December 2018

Analytical Process

Historically Total actual failures were much lower than predicted

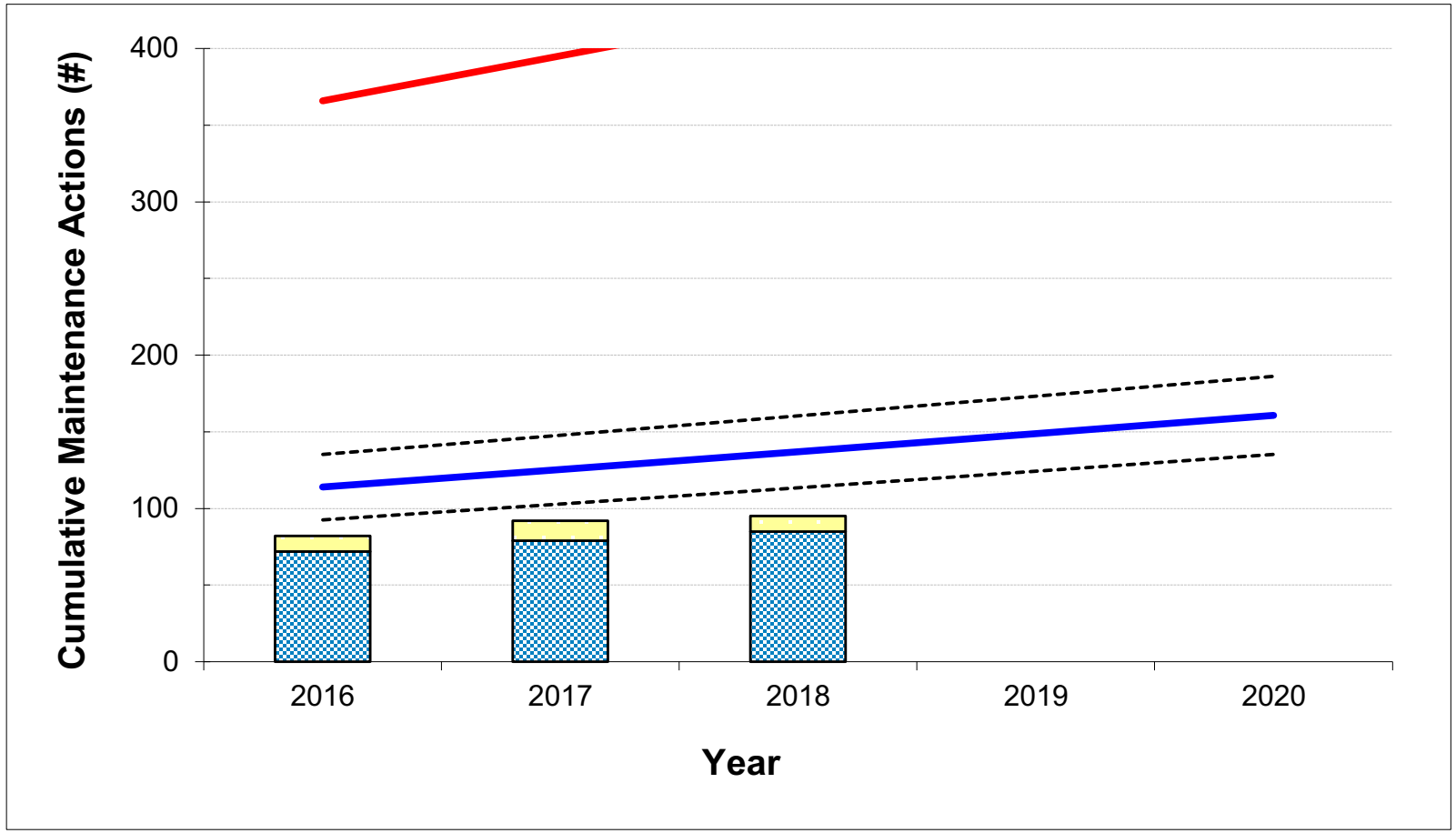
Process Improvement Incorporated BAYES THEOREM to COMBINE the PRIOR with the LIKELIHOOD to GET the POSTERIOR



The posterior is then compared to total actual failures

NOTE: Bayesian analysis is a method of statistical inference that allows one to combine prior information about a population parameter with evidence from information contained in a sample to guide the statistical inference process.

External Corrective Maintenance Trends

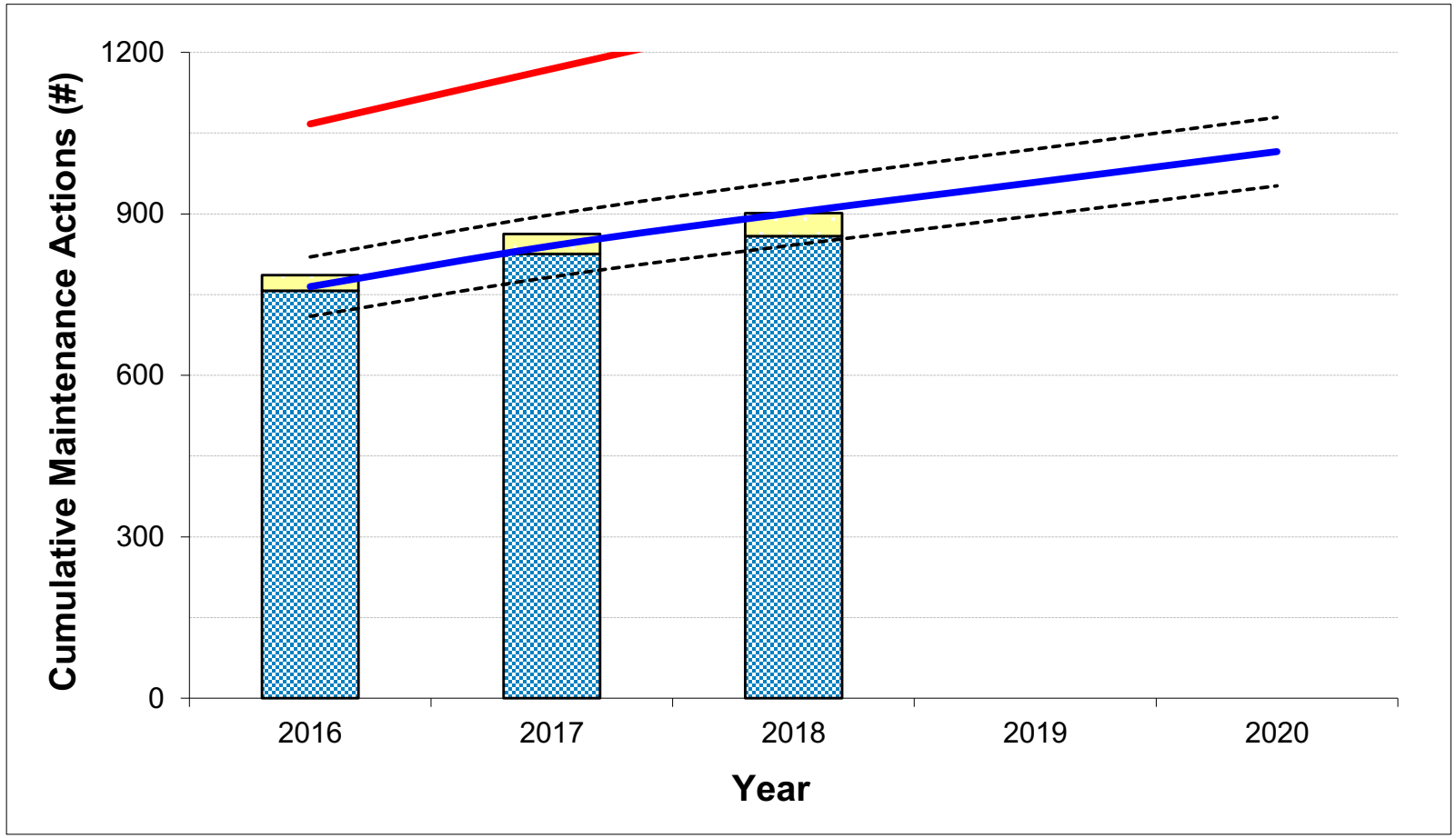


Legend

- Predicted Failures (PRIOR Baseline)
- Predicted Failures (POSTERIOR B/L 6/18)
- Predicted Confidence Limit
- Actual Maintenance Actions
- Maintenance Backlog (includes degraded hardware)

- Actual Maintenance Actions include Troubleshooting

Internal Corrective Maintenance Trends

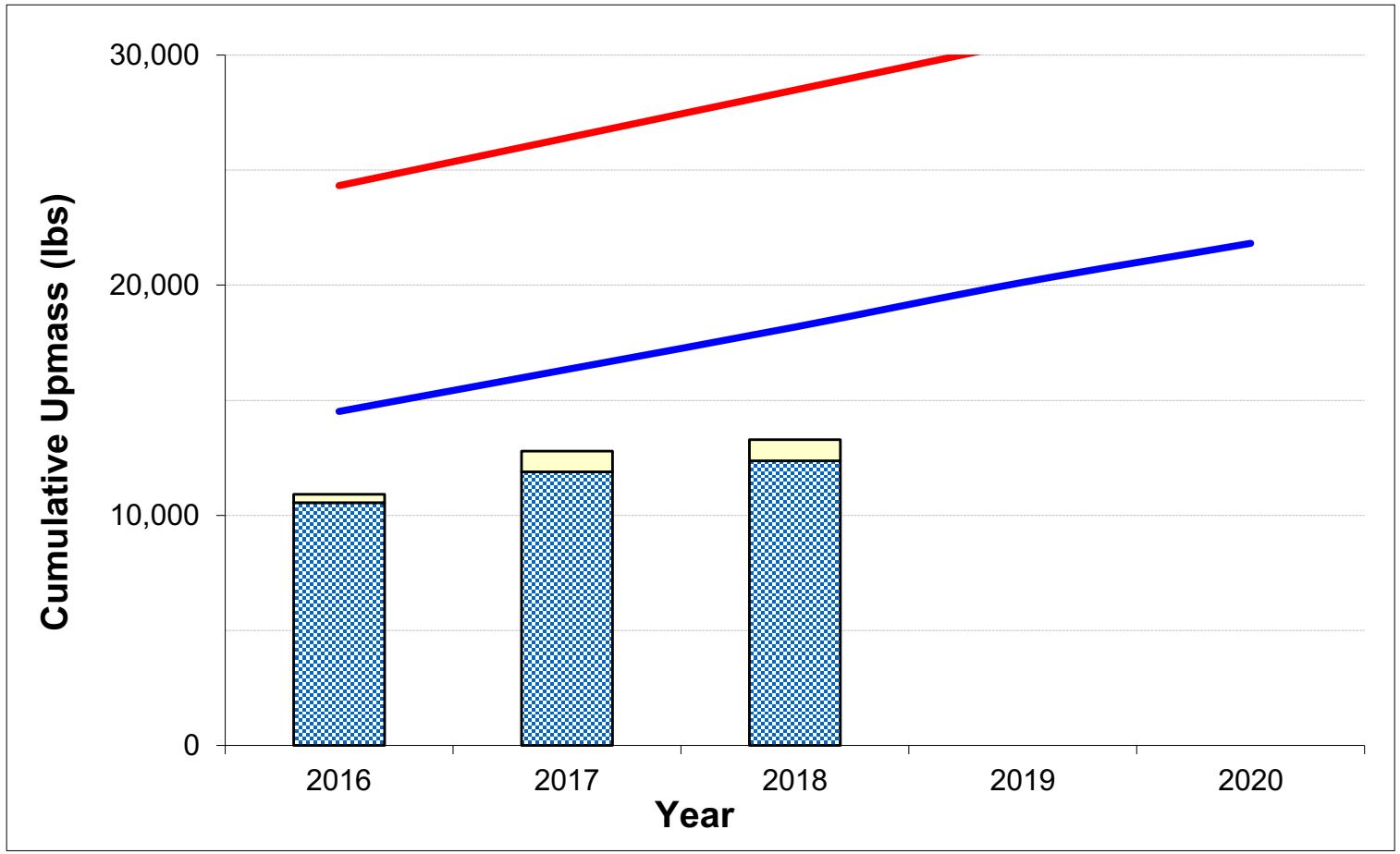


Legend

- Predicted Failures (PRIOR Baseline)
- Predicted Failures (POSTERIOR B/L 6/18)
- Predicted Confidence Limit
- Actual Maintenance Actions
- Maintenance Backlog (includes degraded hardware)

- Actual Maintenance Actions include Troubleshooting

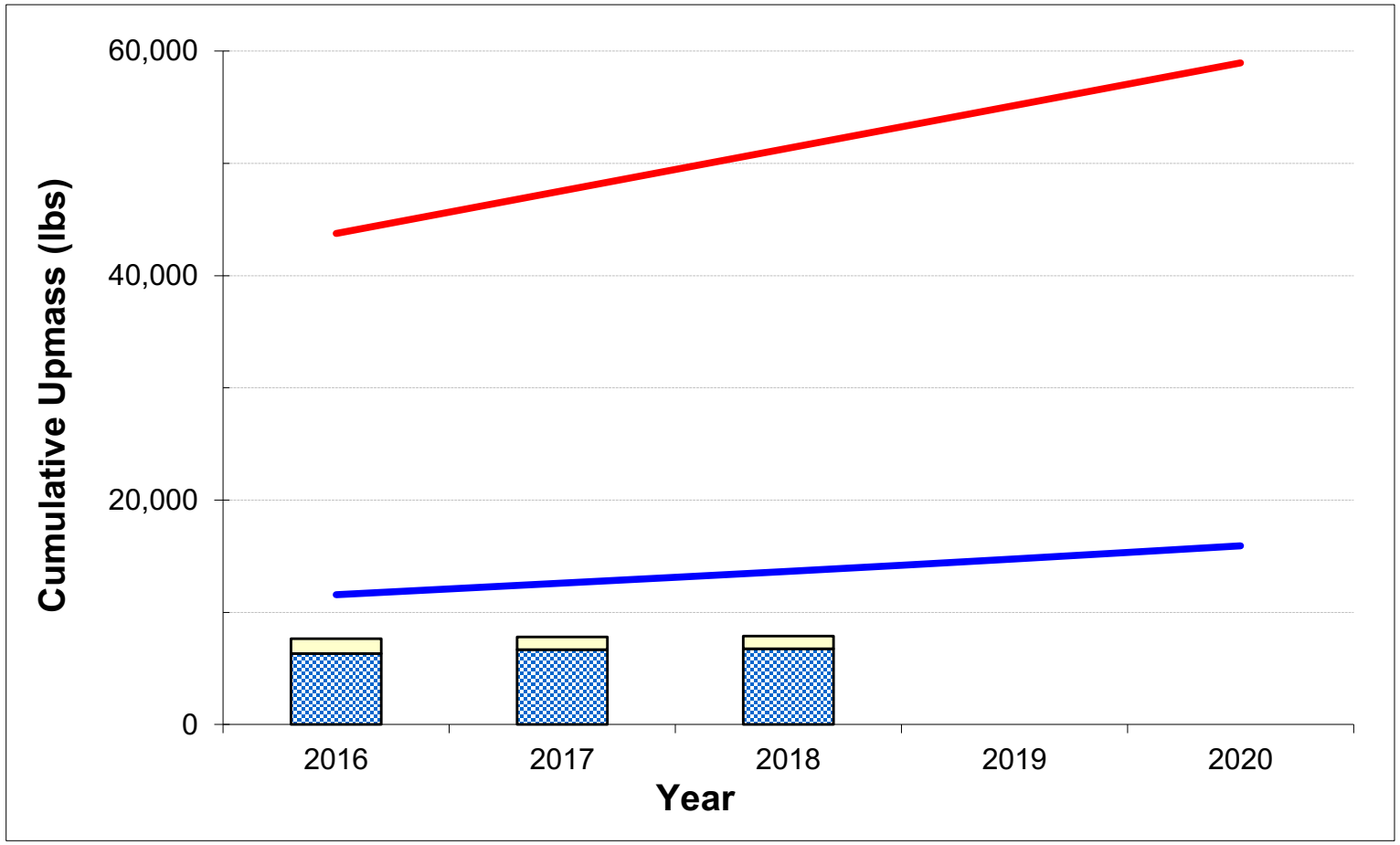
Pressurized Upmass Corrective Maintenance Trends



Legend

- Predicted Upmass (PRIOR Baseline)
- Predicted Upmass (POSTERIOR B/L 6/18)
- Actual Maintenance Upmass
- Maintenance Backlog Upmass (includes degraded hardware)

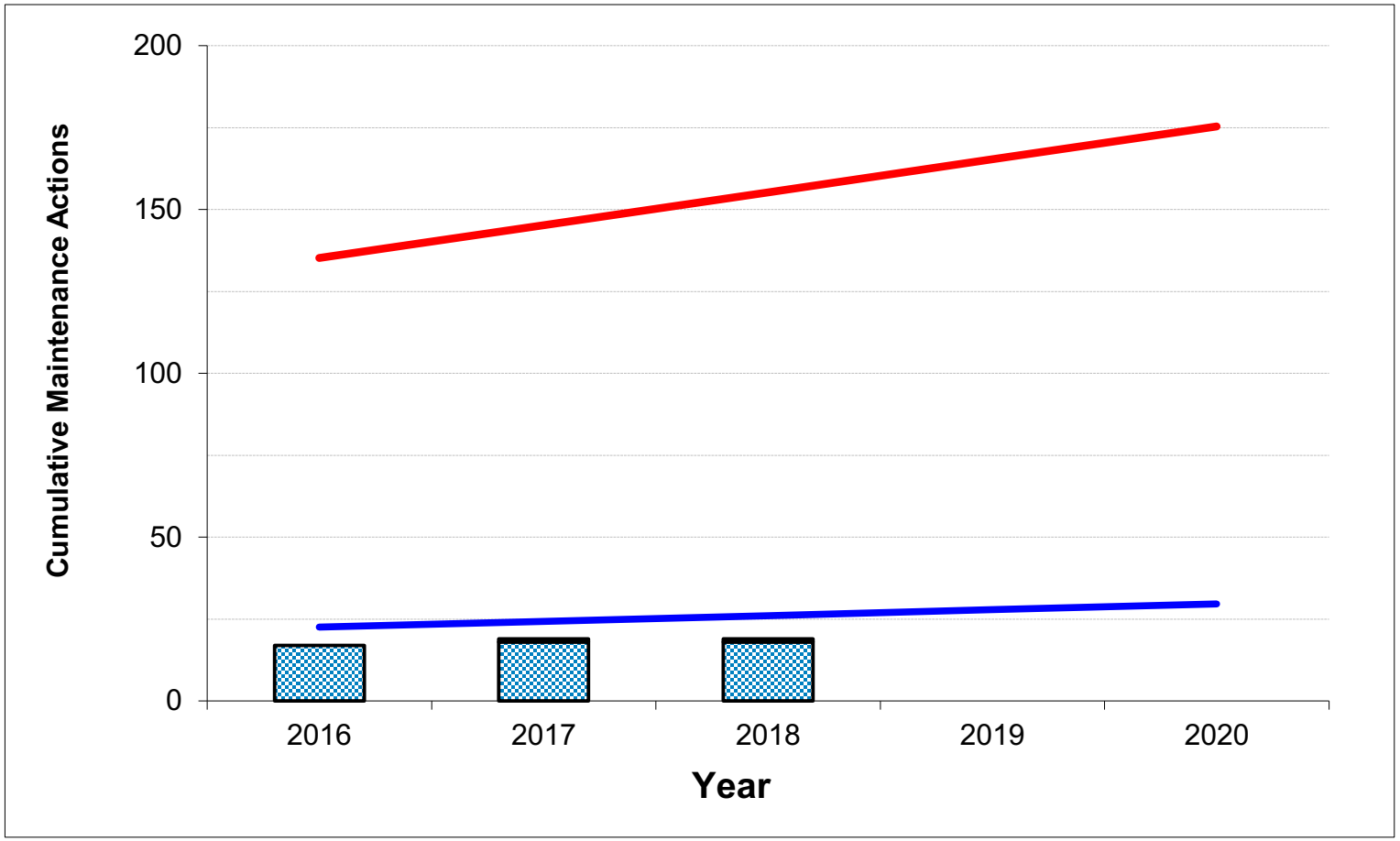
Unpressurized Upmass Corrective Maintenance Trends



Legend

- Predicted Upmass (PRIOR Baseline)
- Predicted Upmass (POSTERIOR B/L 6/18)
- Actual Maintenance Upmass
- Maintenance Backlog Upmass (includes degraded hardware)

C&DH Corrective Maintenance Trends

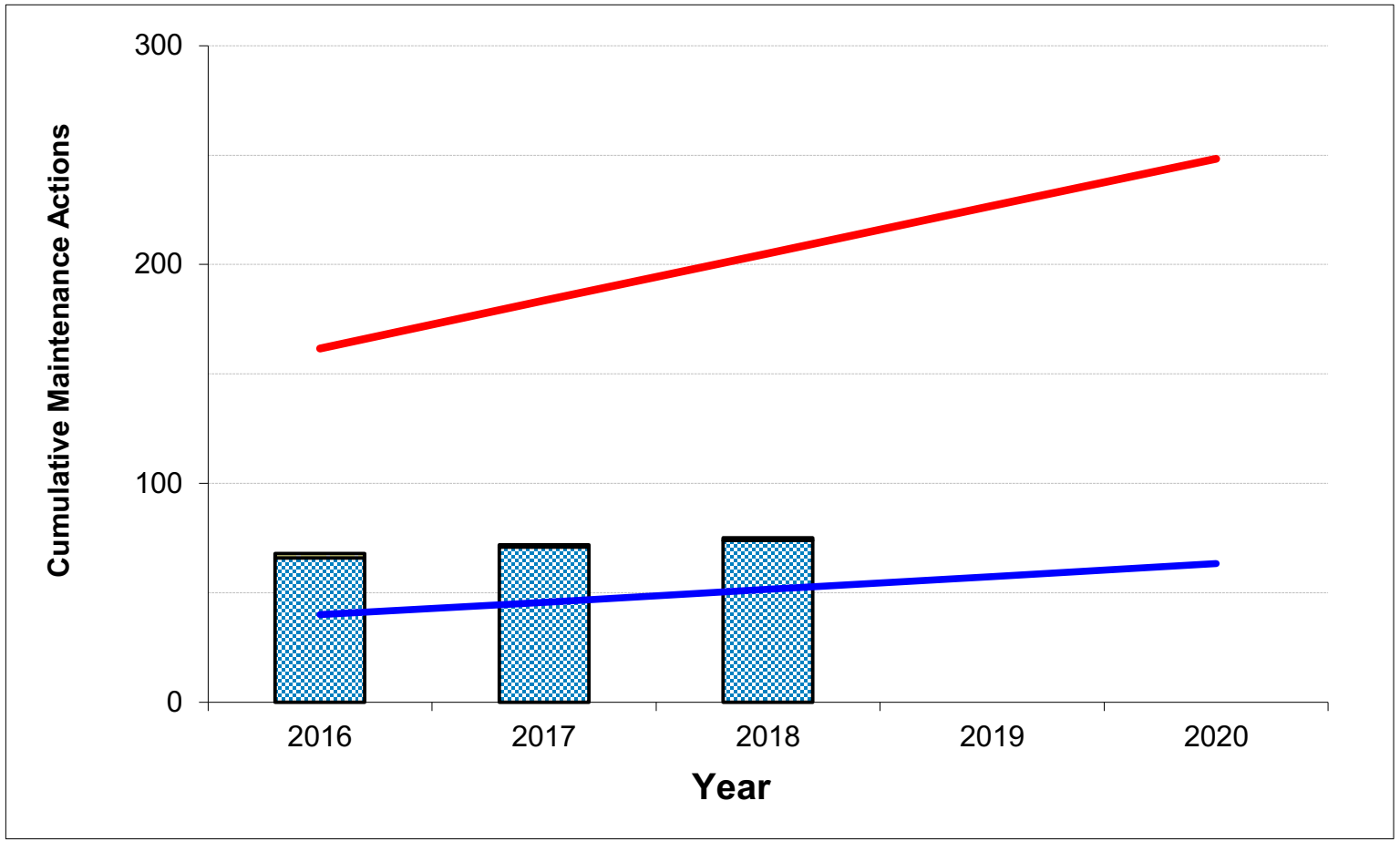


Legend

- Predicted Failures (PRIOR Baseline)
- Predicted Failures (POSTERIOR B/L 6/18)
- Actual Maintenance Actions
- Maintenance Backlog (includes degraded hardware)

- All C&DH ORUs have performed better than predicted
  - Multiplexer/Demultiplexer (MDM) ORUs have performed between 3 and 10 times better than predicted
- Actual Maintenance Actions include Troubleshooting

Regenerative – Environmental Control & Life Support System (Regen-ECLSS) Corrective Maintenance Trends



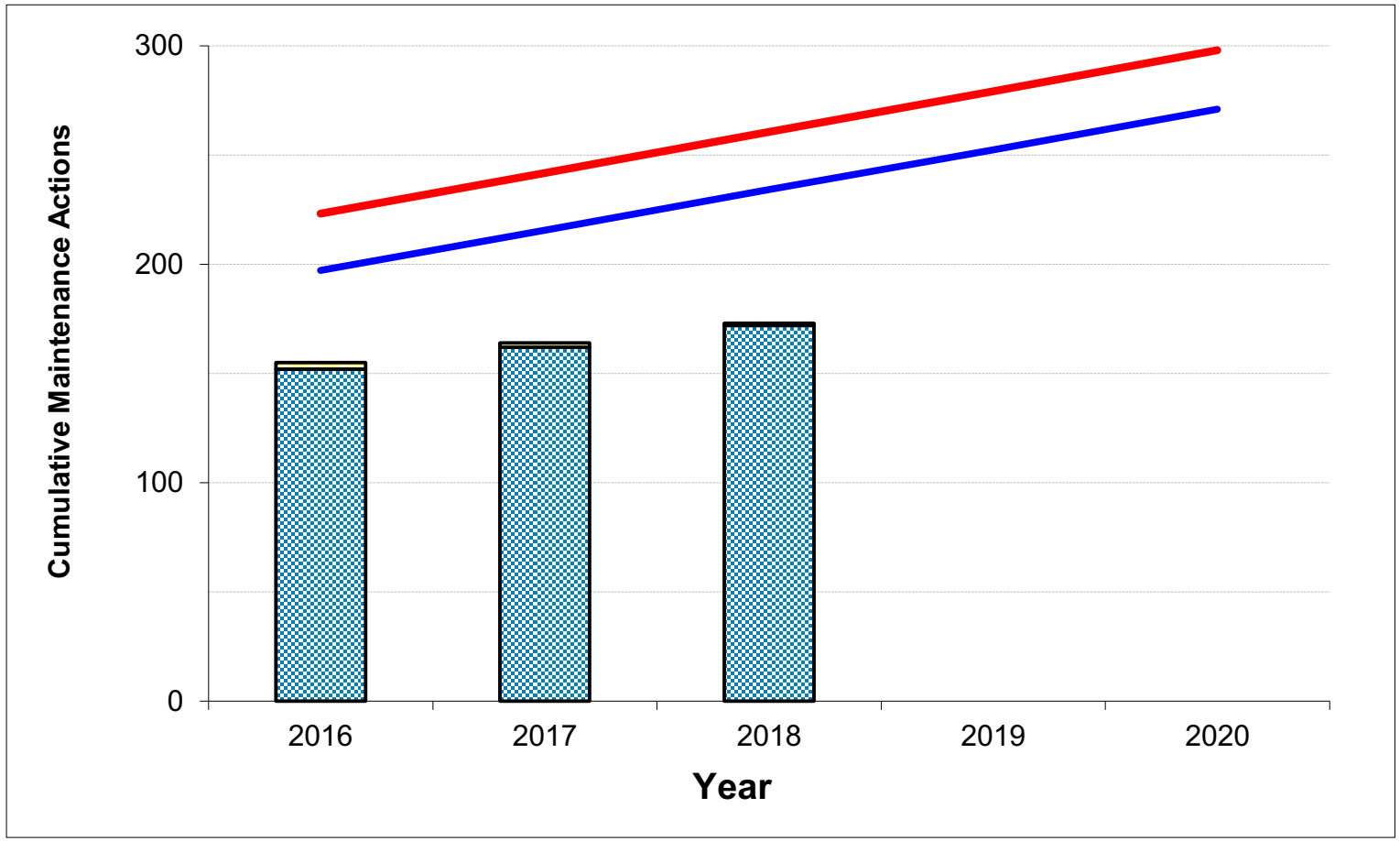
Legend

- Predicted Failures (PRIOR Baseline)
- Predicted Failures (POSTERIOR B/L 6/18)
- Actual Maintenance Actions
- Maintenance Backlog (includes degraded hardware)

- **Overall Regen ECLSS ORUs have performed much better than predicted – Exceptions are:**
  - UPA Distillation Assembly ORU (Predicted MTBF 19,000, Operational 9,000) which is undergoing redesign
  - UPA Fluids Pump and Control Assembly (Predicted MTBF 22,759, Operational 2,919). A new FCPA design has been implemented with an improved MTBF (16,800) and further improvements are being assessed as well.

Actual Maintenance Actions include Troubleshooting

Non Regen-ECLSS Corrective Maintenance Trends



Legend

- Predicted Failures (PRIOR Baseline)
- Predicted Failures (POSTERIOR B/L 6/18)
- Actual Maintenance Actions
- Maintenance Backlog (includes degraded hardware)

- Overall Non-Regen ECLSS ORUs have performed better than predicted.
  - Exceptions are:
    - CO2 Removal Dessicant/Absorbent ORU (Predicted MTBF 77,000, Operational 19,000) which is being redesigned as part of Exploration ECLSS CO2 removal upgrades
    - CO2 Removal Air Selector Valves (Predicted 117,000, Operational 29,410). Upgraded DTO valve was installed in Dec 2016 and has been performing well.

Actual Maintenance Actions include Troubleshooting

Summary

- The vehicle continues to perform better than predicted.
- Bayesian analysis has significantly closed the gap between actual and predicted maintenance demands.
  - NASA has implemented a semi-annual Bayesian update process.
  - Improving the accuracy of maintenance projections.
  - Continuing to refine the correlation of the Logistics & Maintenance predicted corrective maintenance with actual on-orbit experience.
- As operational experience is established, actual and projected demand will converge.