

Automated Monitoring of Nuclear Weapon or Space Vehicle Health using Telemetry Data and Principle Component Analysis (PCA)

Rosalie Multari, Ph.D.

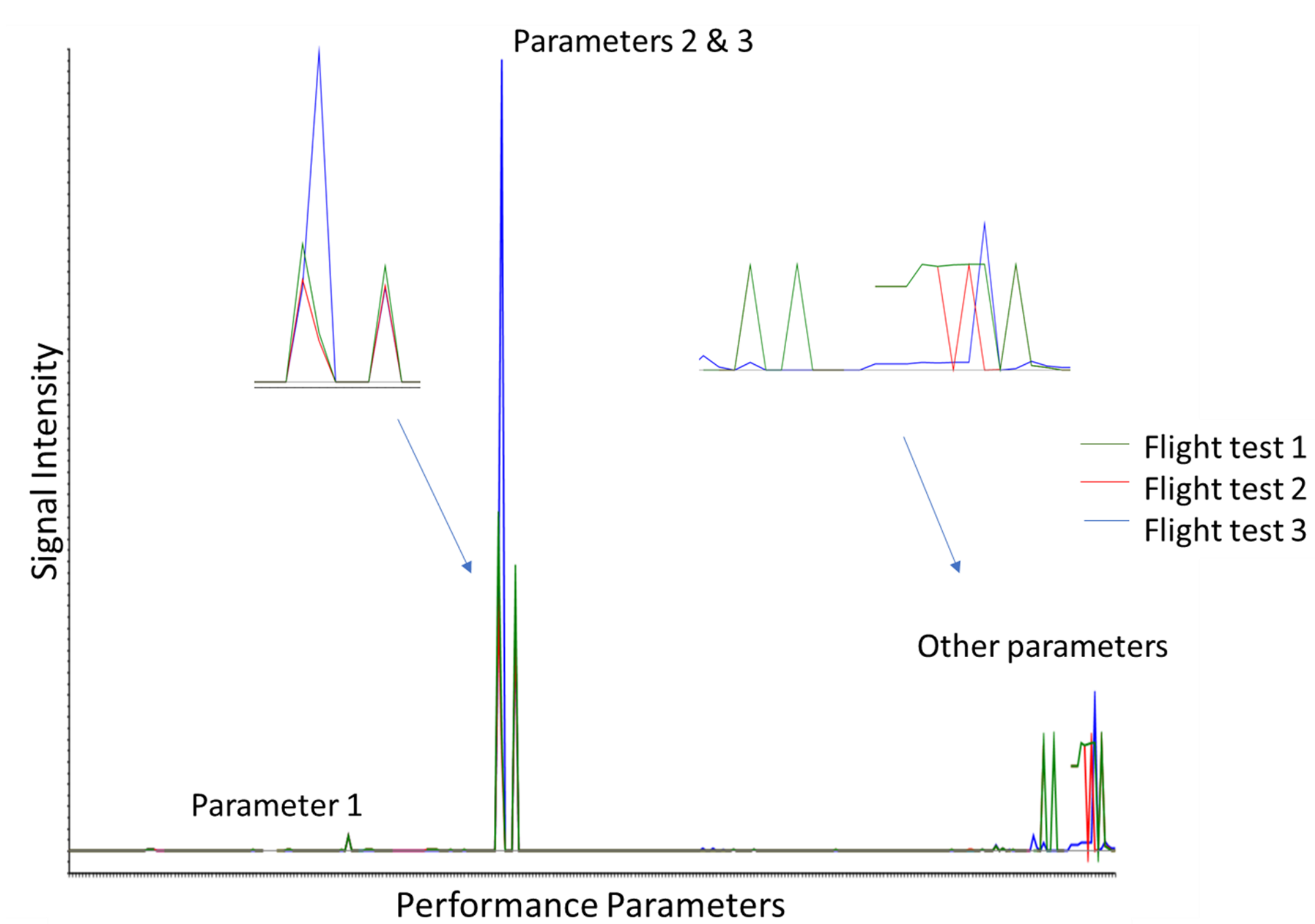
Sandia National Laboratories, 1515 Eubank Blvd. SE, Albuquerque, NM 87123

Method

- Unclassified raw telemetry data from three different nuclear weapon systems with different delivery methods were investigated
- Several different test flight time periods were selected for investigation and a data array consisting of telemetry major frame data in rows was created
- PCA was applied to each of the raw telemetry data arrays and the resulting score plots were compared to plots of parameters critical to performance obtained from a more complex and lengthy analysis made on the telemetry data after transformation to multi-channel time series data to determine if similar PCA score plots could be correlated to similar performance

System 1

Complex Analysis Results (Lengthy Data Processing)

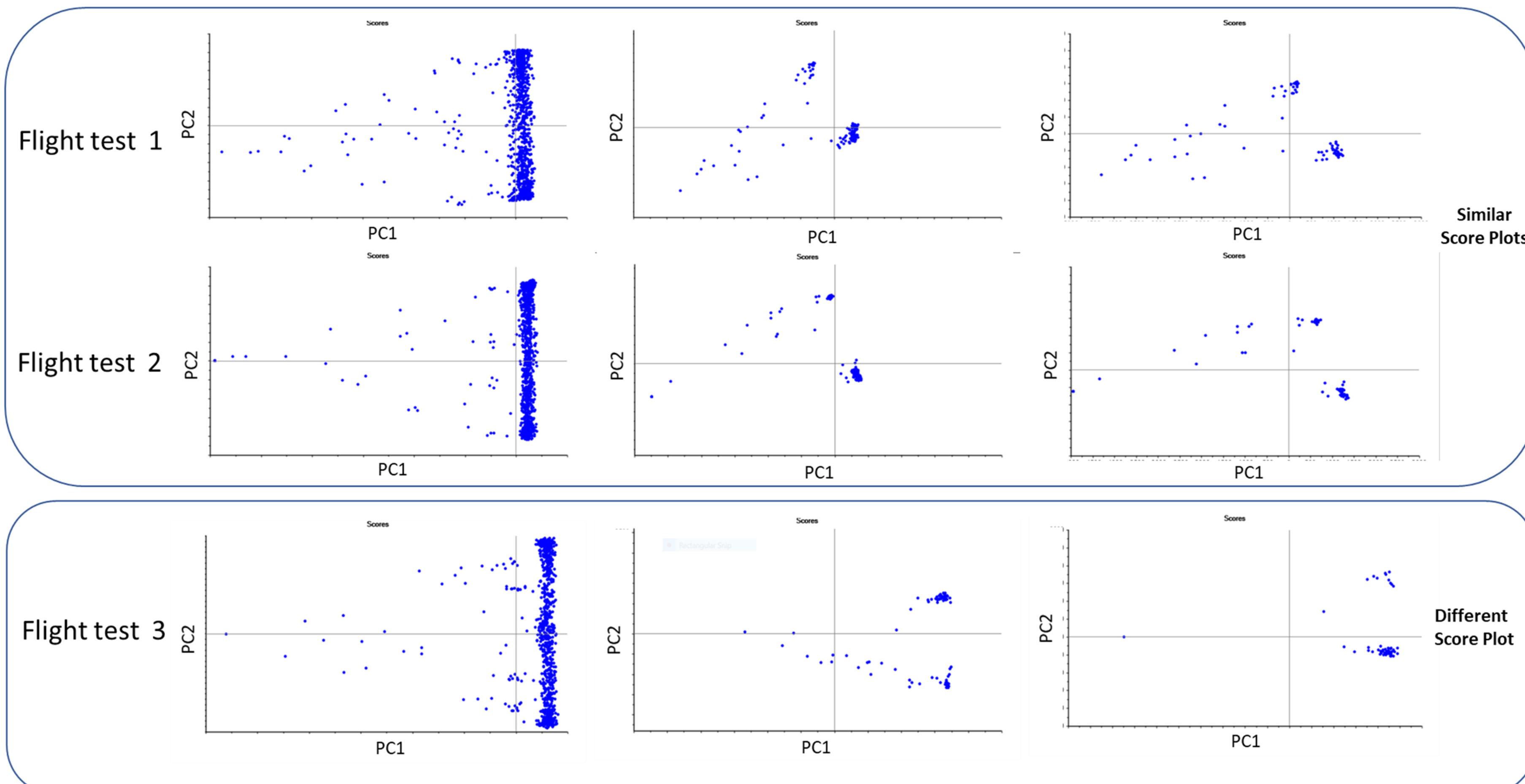


PCA Analysis Results

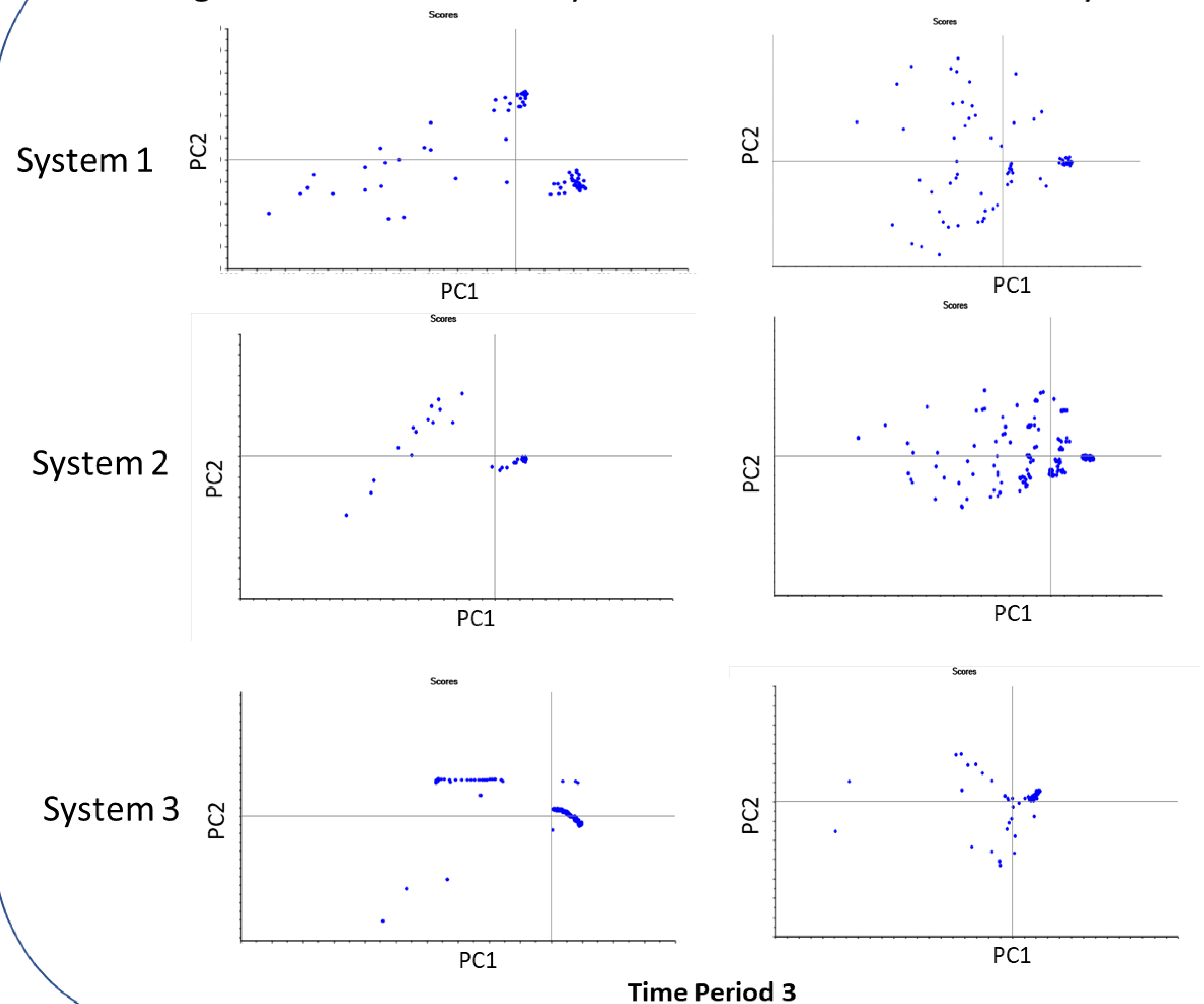
Time Period 1

Time Period 2

Time Period 3



Test flight data from different systems can have similar PCA Analysis Results



Summary

- Telemetry data is key to monitoring nuclear weapon and spacecraft performance
- Complex processing is often required to extract information from telemetry data
- The ability to infer performance from telemetry data without complex processing would be useful for nuclear weapons or space vehicle performance assessments
- Principle Component Analysis (PCA) shows promise as a tool for this purpose

Acknowledgements

Many thanks to Randall Wells and James Michael Bridges for help with data preparation

References

- Inui et al., *Adaptive Limit Checking for Spacecraft Telemetry Data Using Kernel Principal Component Analysis*, Trans. JSASS Space Tech. Japan Vol. 7, No. ists26, pp. Pf_11-Pf_16, 2009
- Li et al., *Kernel Self-adaptive Learning-based Satellite Telemetry Data Classification*, 2016 Third International Conference on Computing Measurement Control and Sensor Network
- Peng et al., *Telemetry Fault Detection for Meteorological Satellite based on PCA*, IEEE Xplore, 24 November 2016, ieeexplore.ieee.org/document/7751650/