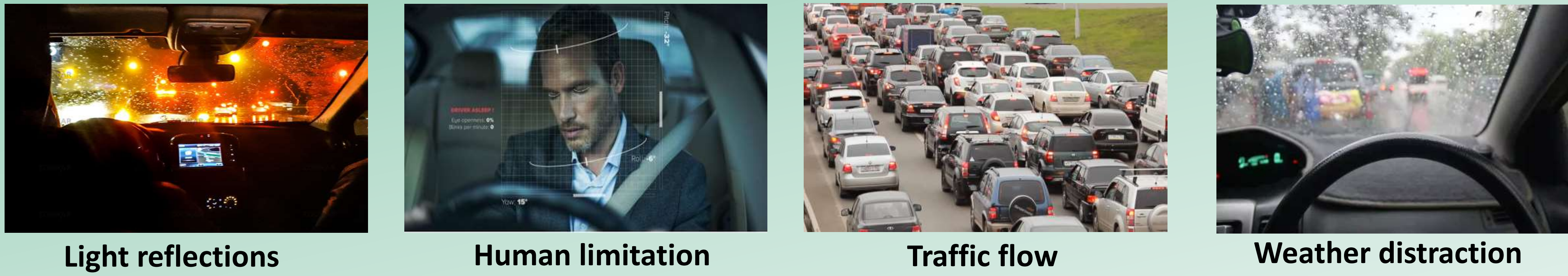


General entropy-based framework for a robust and fail-safe multi-sensor data fusion

K. Mawkawi, N. Ait-Tmazirte, M. El Badaoui El Najar, N. Moubayed

General Overview

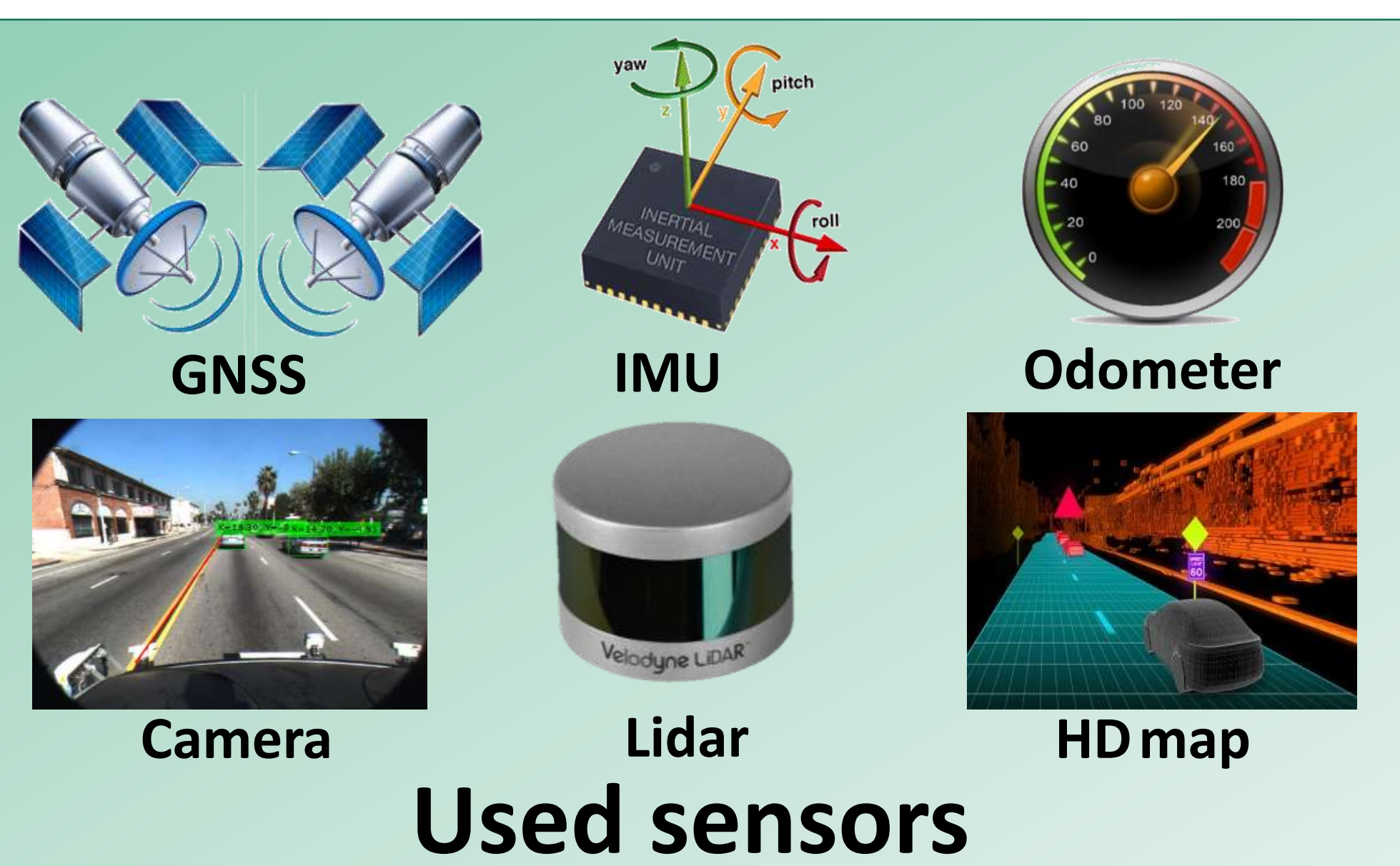
Challenges



Objectives

Localization

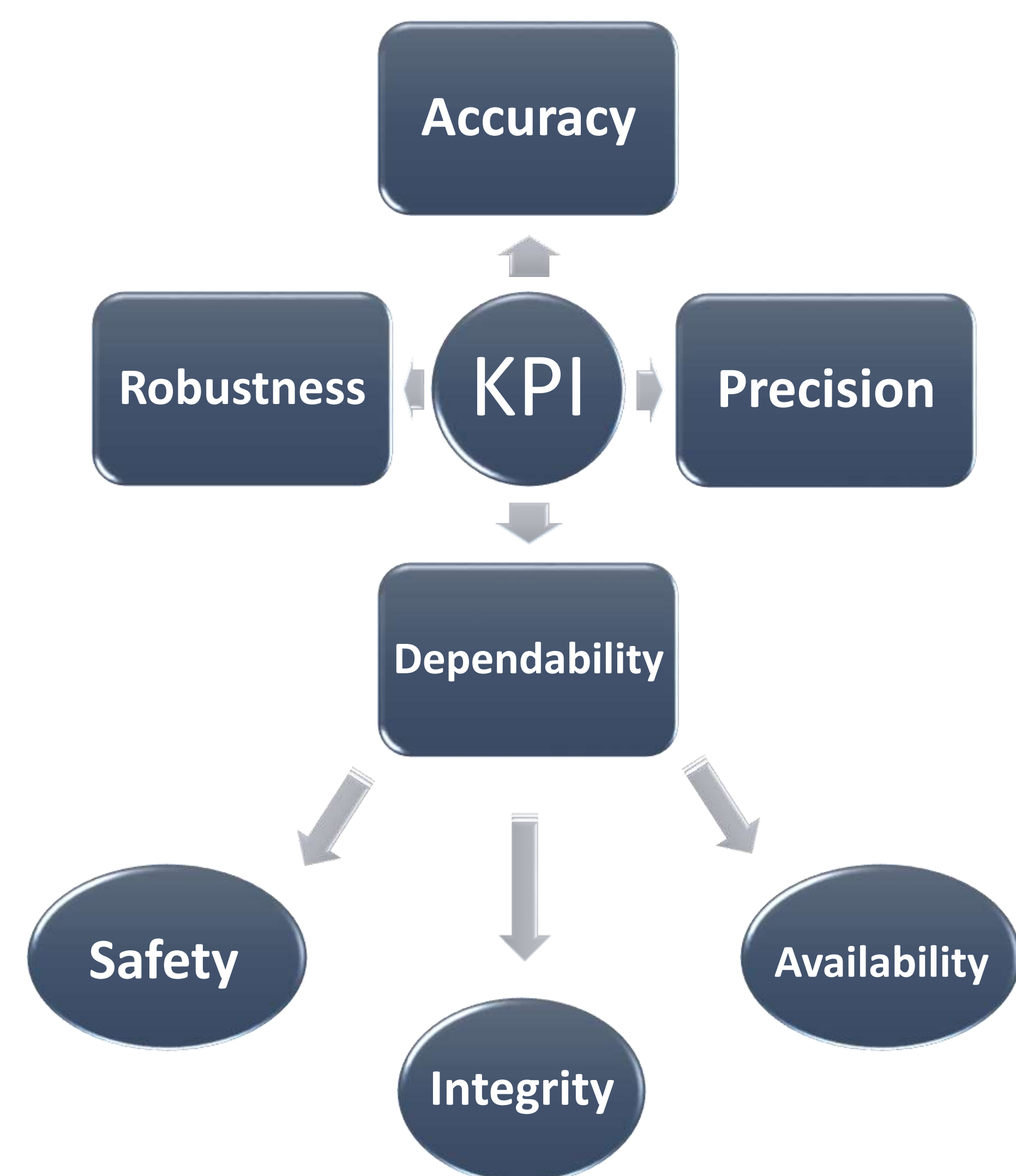
- Robust
- Accurate
- Precise
- Fail-Safe
- Continuous
- Available



Autonomous Driving Vehicle

Proposed Approach

Key Performance Indicators



Tools and solutions

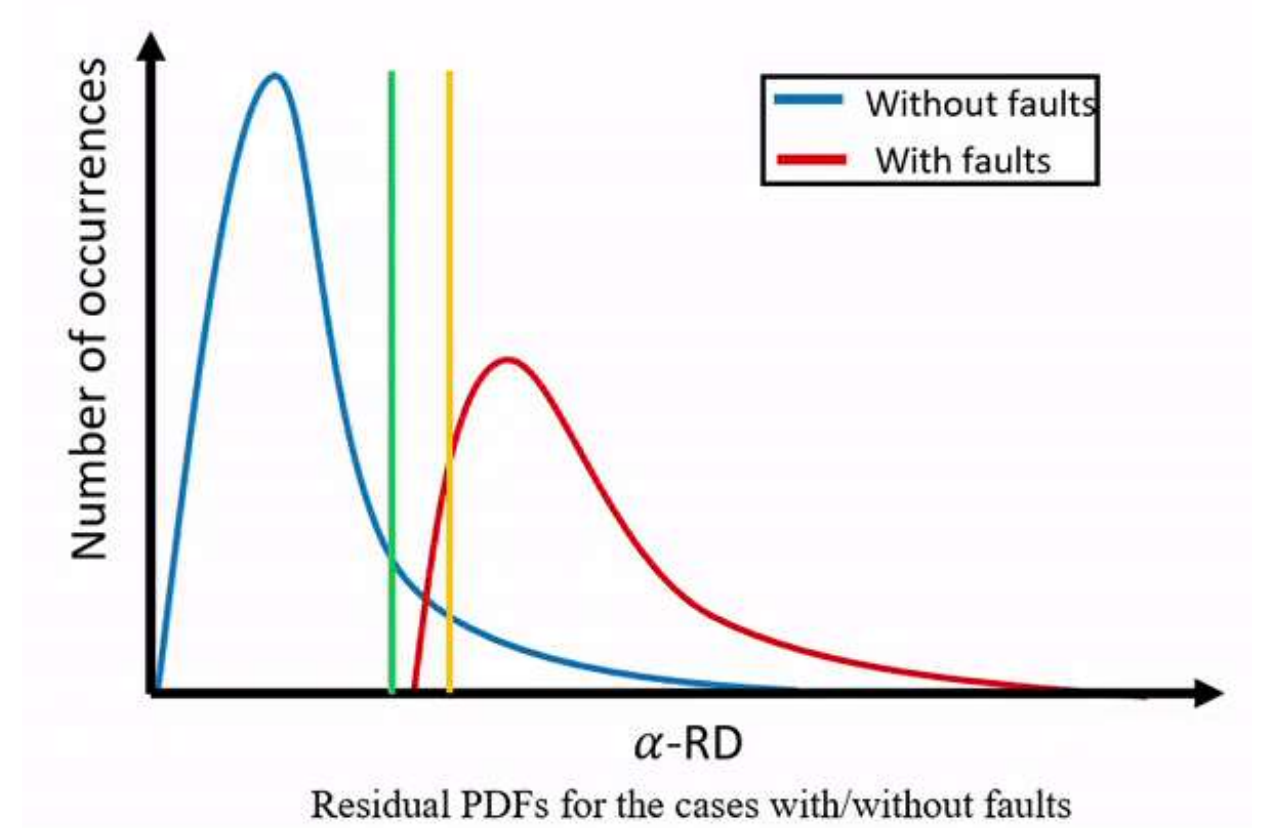
- System availability and accuracy: Multi-sensor data fusion
- Non-linearity state estimation problems: Nonlinear Kalman Filter in informational form, Unscented transformation for high non-linearity
- Non-Gaussian noises: Maximum Correntropy Criterion as criterion
- Changing in environment and KPI requirements: Adaptive diagnostic layer based α -Rényi Divergence
- safety issues, poor accuracy and availability problems: Fault Detection and Isolation (FDI) method
- Decision Making: Adaptive thresholding using α -Rényi criterion

Adaptive Diagnosis Based on Parametric Residual

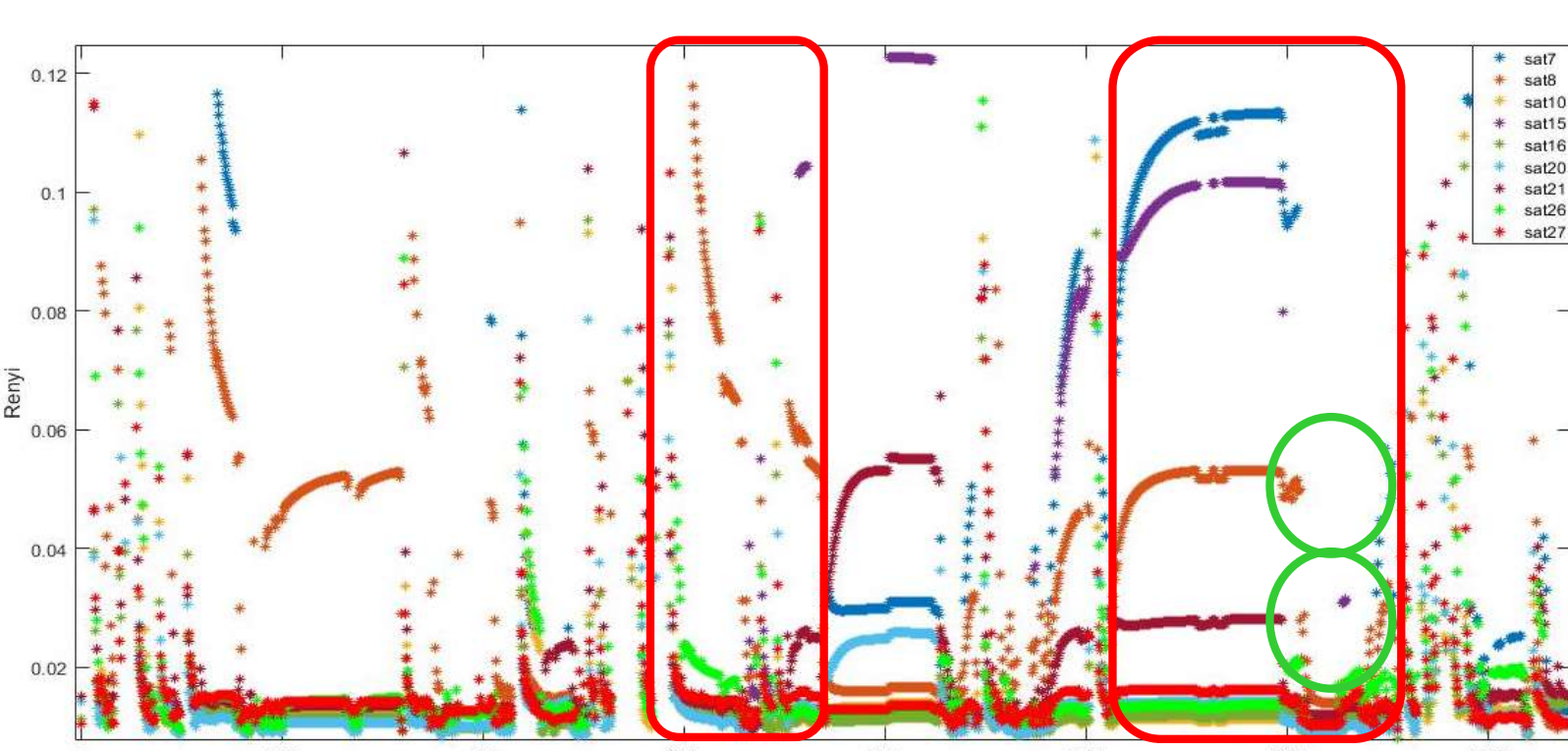
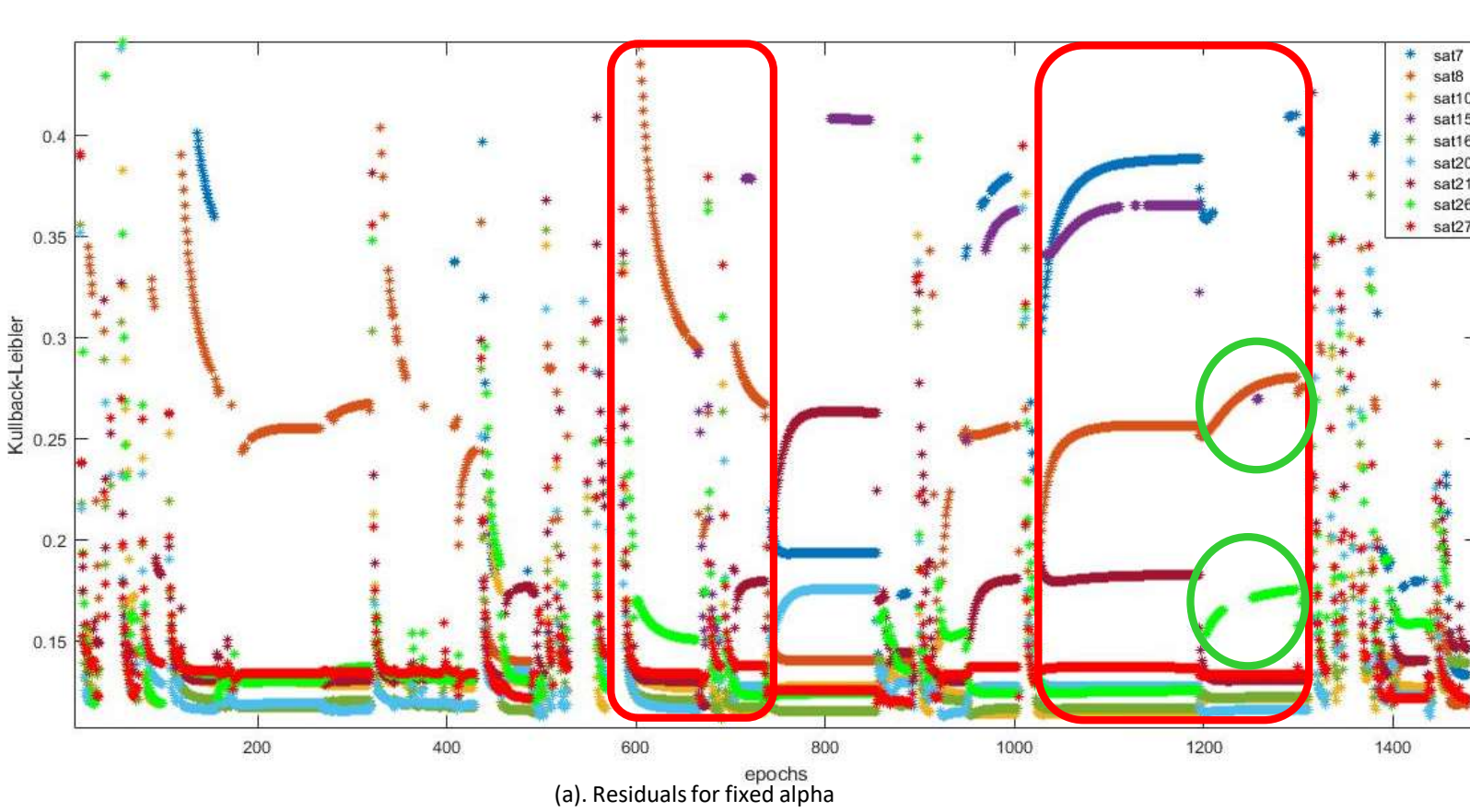
$$RD_{\alpha}(g(k/k-1)||g(k/k)) = \frac{\alpha}{2} (X_{k/k-1} - X_{k/k})^T \left(\frac{Y_{k/k-1} Y_{k/k}}{\alpha Y_{k/k-1} + (1-\alpha) Y_{k/k}} \right) (X_{k/k-1} - X_{k/k}) + \frac{1}{2(\alpha-1)} \log \left| \frac{Y_{k/k-1} Y_{k/k}}{\alpha Y_{k/k-1} + (1-\alpha) Y_{k/k}} \right| + \frac{1}{2(\alpha-1)} \log \frac{|Y_{k/k-1}|^{\alpha-1}}{|Y_{k/k}|^{\alpha}}$$

α -Rényi criterion for decision making

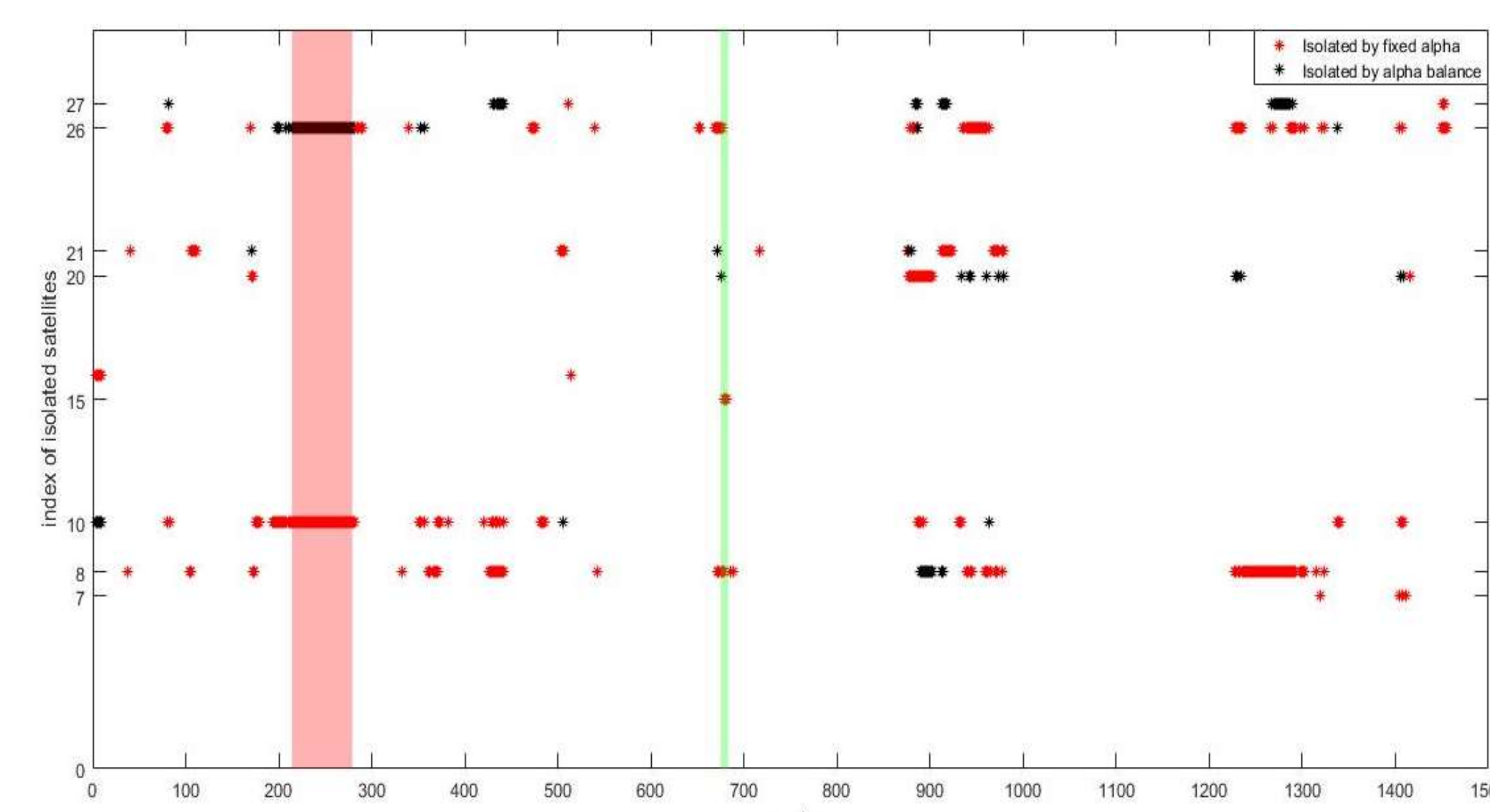
$$Rc_{\alpha} = \frac{1}{1-\alpha} \sum_{i \in \{0,1\}} \log \sum_{j \in \{0,1\}} \left(\frac{p(u_j/H_i)}{p(u_j)} \right)^{\alpha} p(H_i)$$



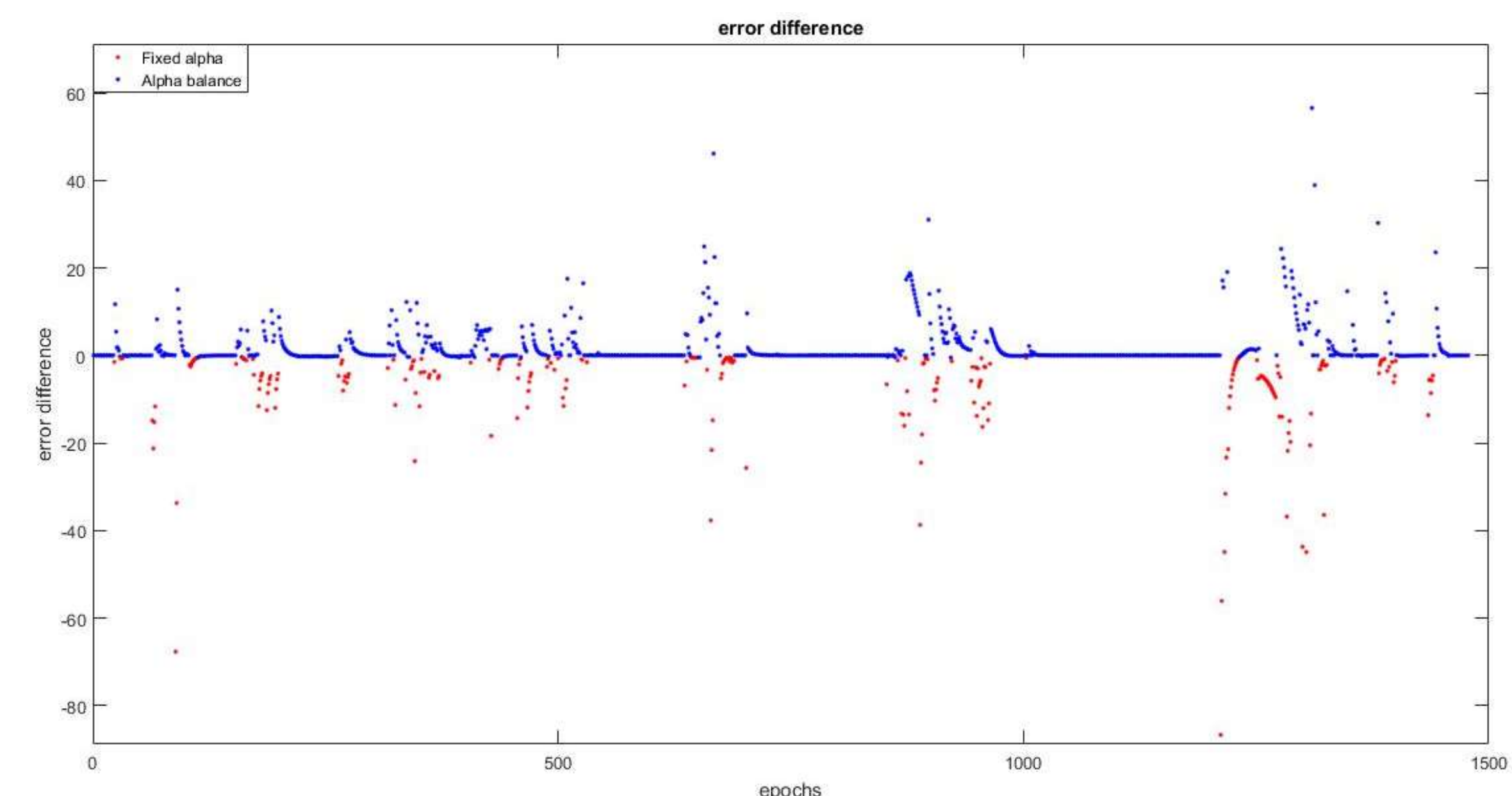
Results and Conclusions



Partials Rényi observation for identification



The difference in decisions between fixed and balance α



Difference in error between fixed and balanced α

Error type in meters	Error removed by α balance	Error removed by fixed α	Difference
Median error	5.8883	4.4228	1.4655
Mean error	5.6866	4.6615	1.0251
Max error	61.7337	55.0582	6.6755