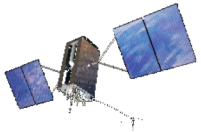


State-of-the-art Data Processing for Heliophysics:

Ionosphere/Space Weather Monitoring

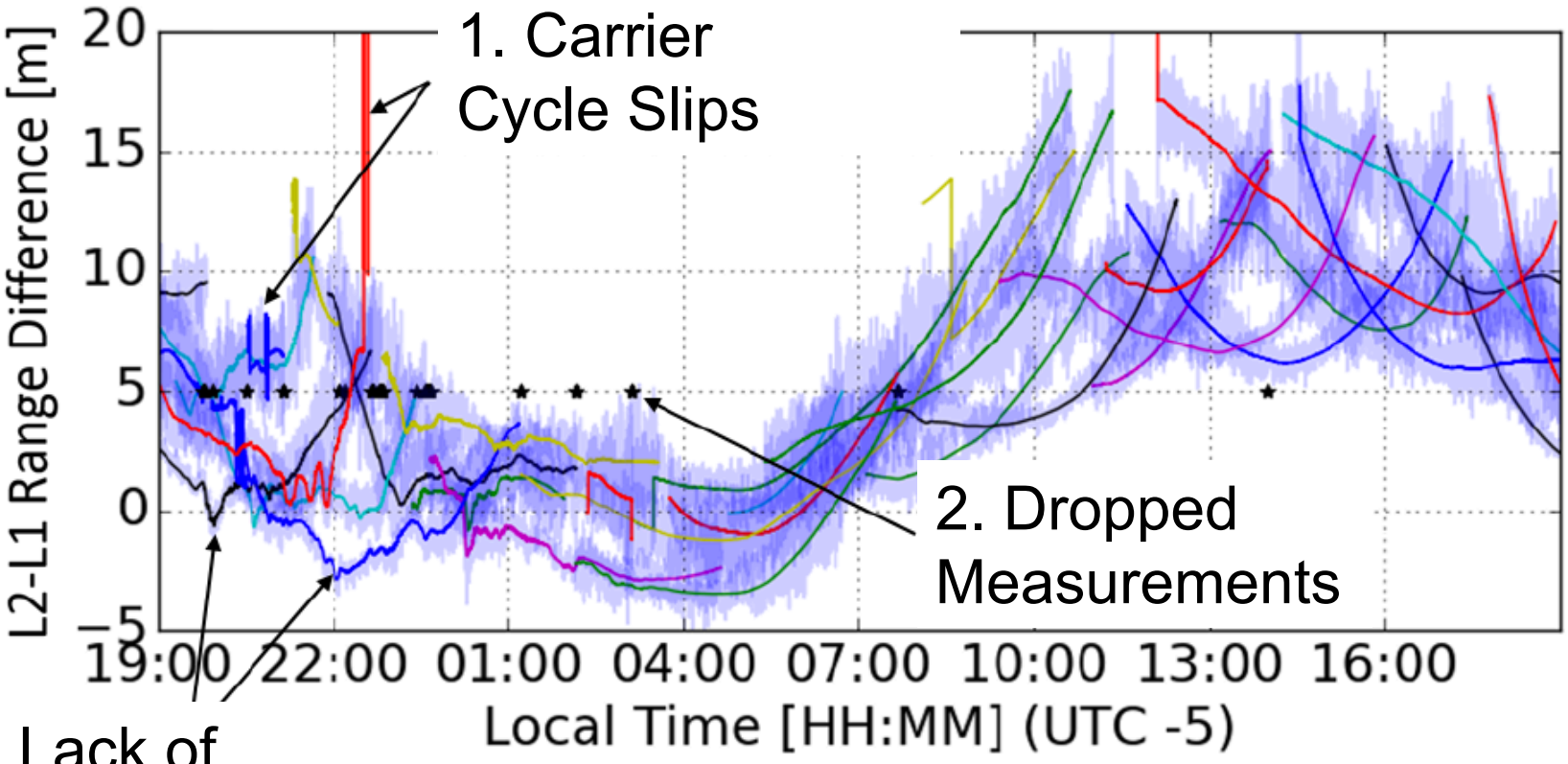
Jade Morton

University of Colorado, Boulder

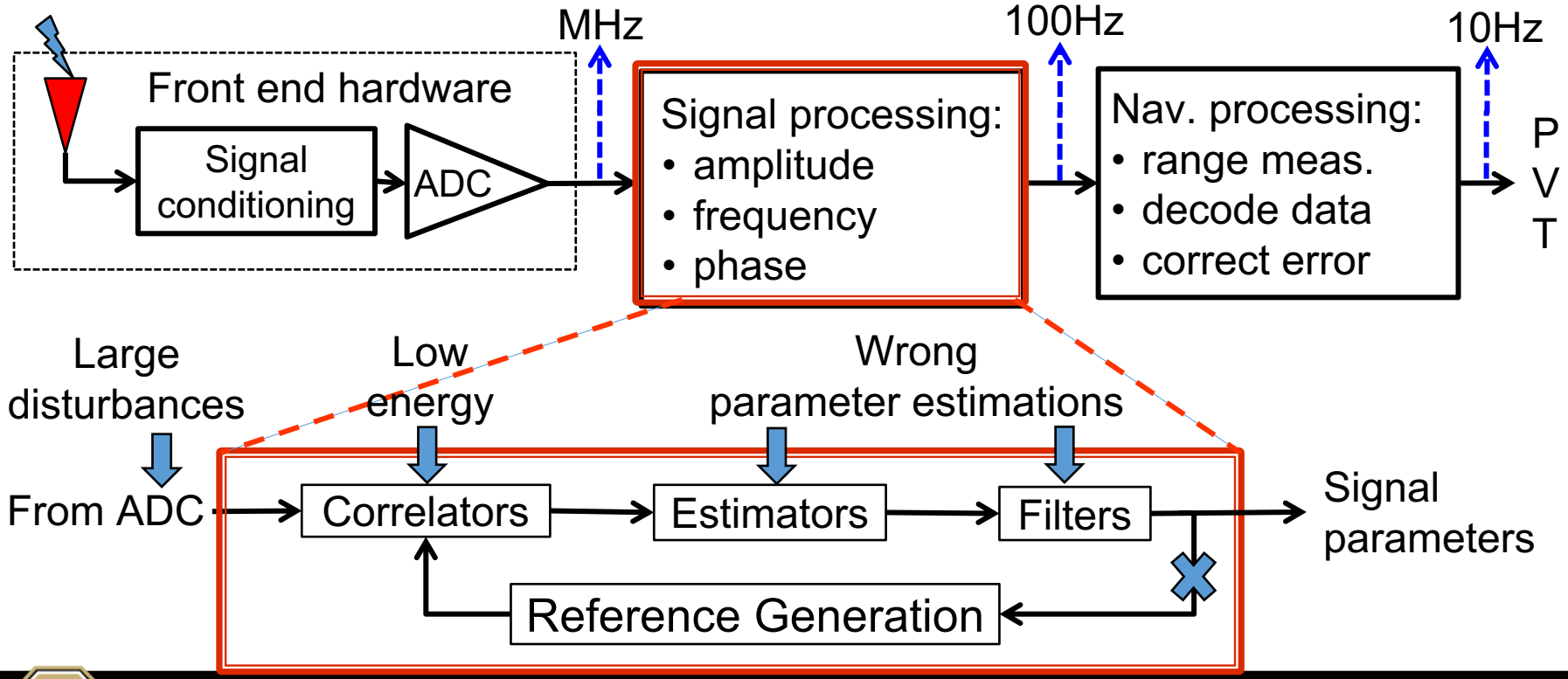
Discussion Topics

- Challenges in Using GNSS for Ionosphere Monitoring
- Advances in GNSS Data Collection Systems
- Advances in GNSS Signal Processing for Ionosphere Monitoring

Illustration of 3 Classes of Problems

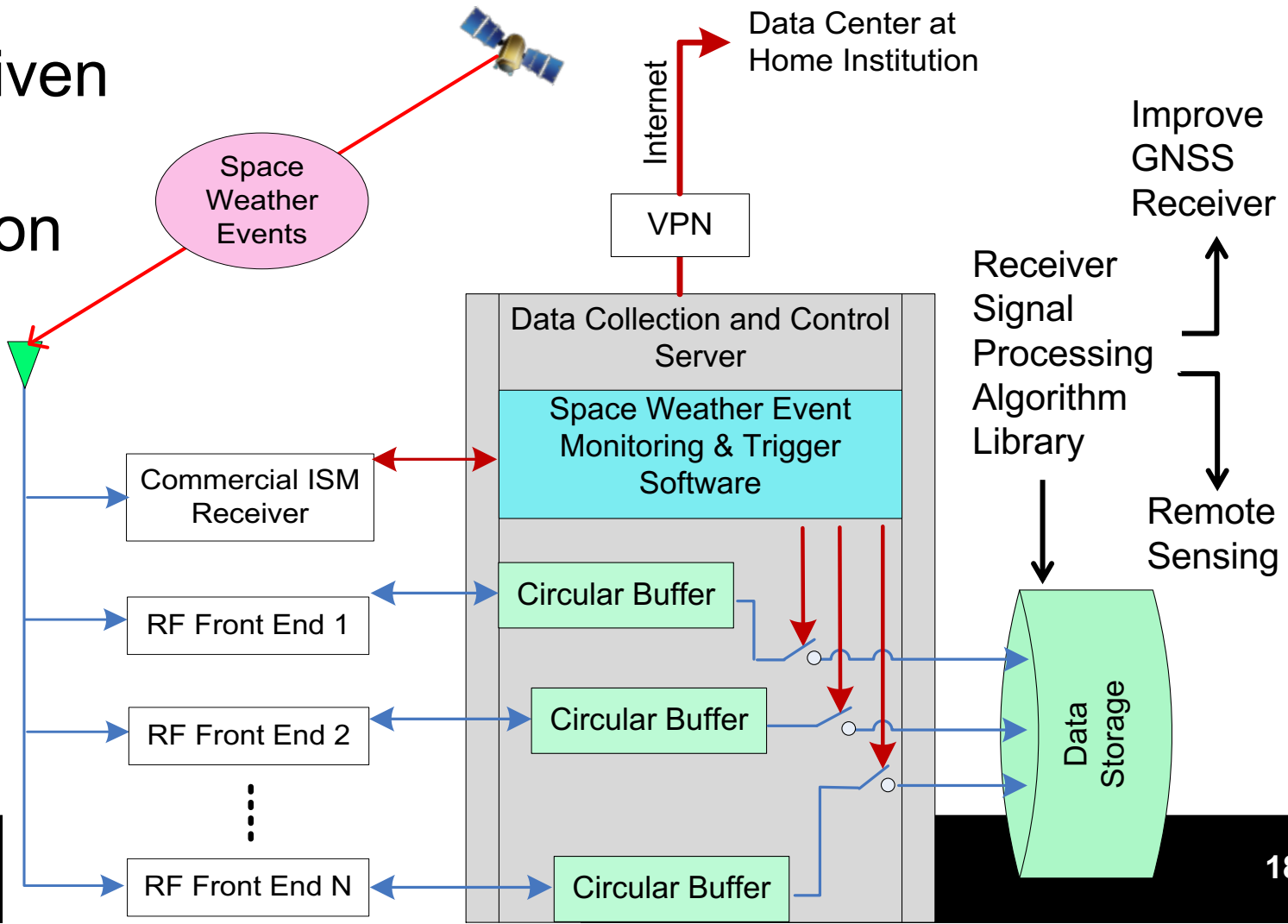


Why Do GNSS Receivers Have These Problems?

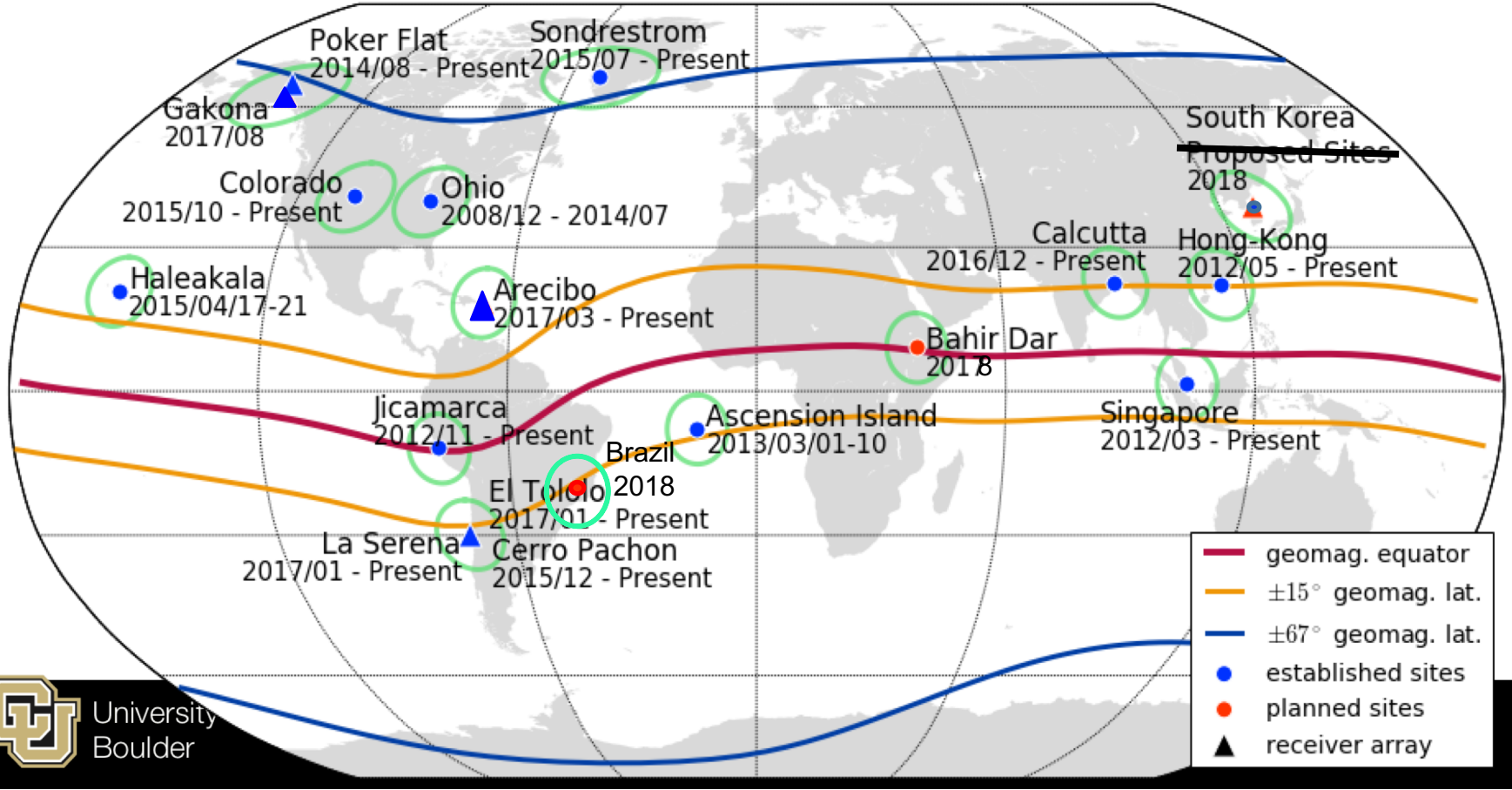


Event-driven Data Acquisition System

E-DAS



SDR GNSS Monitoring Network



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Event Detection: Machine Learning

Performance:

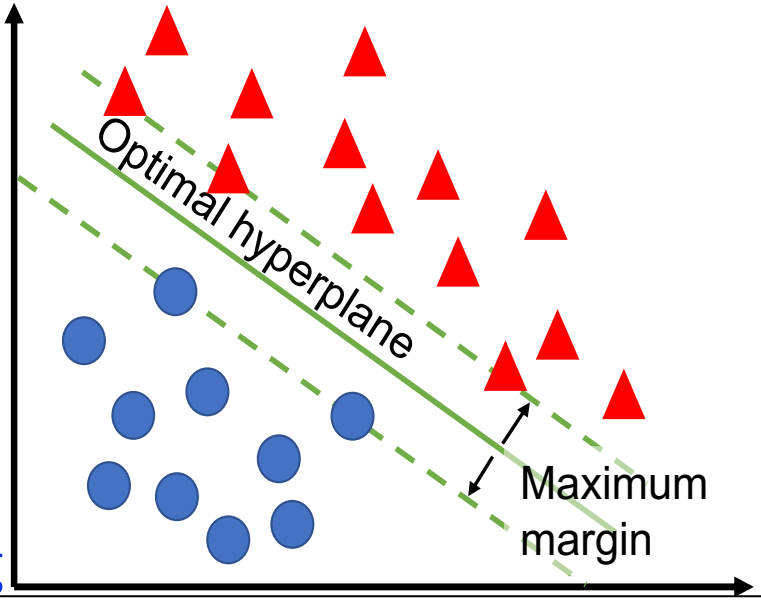
- Detection Rate 96%

Applications:

- Real Time Monitoring
- Big Data Post-Processing

Next:

- **Event Classification**
- **Event Association -> Forecasting**



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2. Jiao, Y., J. Hall, Y. Morton, "Automatic equatorial GPS amplitude scintillation detection using a machine learning algorithm," IEEE Trans. Aero. Elec. Sys., 53(1): 405-418, 2017.
3. Liu, Y., Y. Morton, Y. Jiao, "Application of machine learning to the characterization of GPS L1 ionospheric amplitude scintillation," Proc. IEEE/ION PLANS, Monterey, CA, April 2018.

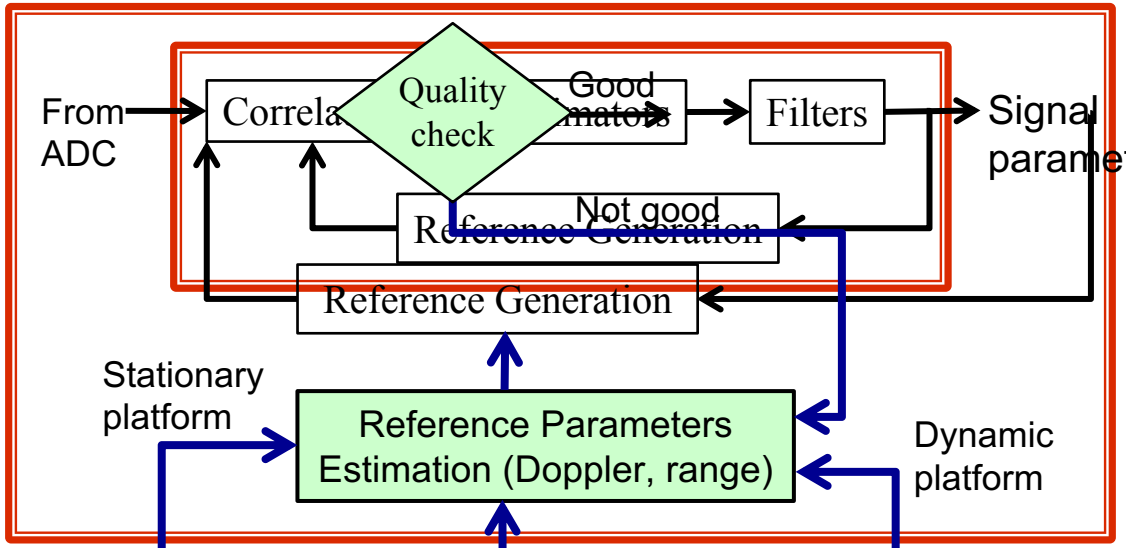
GNSS Receiver Signal Processing: Different Application Objectives

Minimize	**Disturbance signatures**	Maximize
Maximize	**Range accuracy**	Don't Care
Maximize	**Robustness**	Maximize

Navigation Applications

Ionosphere Monitoring

Advanced Receiver Designs: Multi-Domain Processing



Temporal Diversity: Semi-open loop

Stationary & dynamic platform

Vector tracking: Spatial Diversity

- Inter-frequency aiding: Frequency Diversity
- Open loop tracking: Environmental Models

Multi-Domain GNSS Receiver Processing

- Adaptive tracking → Parameter optimization
- Inter-frequency aiding → Frequency diversity
- Vector processing → Signal spatial diversity
- Semi-open loop → Temporal diversity
- Open loop → Environment information
- Array processing → Receiver diversity

Questions?