Kick Detection at the Bit: Early Detection using Borehole Geophysics

NATIONAL ENERGY TECHNOLOGY LABORATORY

Research & Innovation Center

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Background

Kick events are a persistent threat during the drilling process.

Ecosystem damage

Kicks can grow in intensity and become blowouts.

44 % drilling non productive time

The most-commonly used kick detection techniques (e.g. monitoring mud return) are inherently **imprecise and time-consuming**

8 billion/year losses

Our Solution

We propose using the real-time annular measurements from a suite of **geophysical tools** together with an algorithm to provide early kick detection and to identify kick fluids

Sensitive geophysical instrumentation is deployed on the drill string to make formation measurements - **logging-while-drilling**, measurement-while-drilling

Some instruments measure the fluid-filled annulus to correct formation measurements - annular measurements are usually unused beyond this purpose

Integrating Data Science

Kick events can be approximated as **sequential anomalies**.

Unsupervised sequence segmentation.

Raw borehole signals | Signal Filter & Enhancement Module | Kick Fingerprinting Module
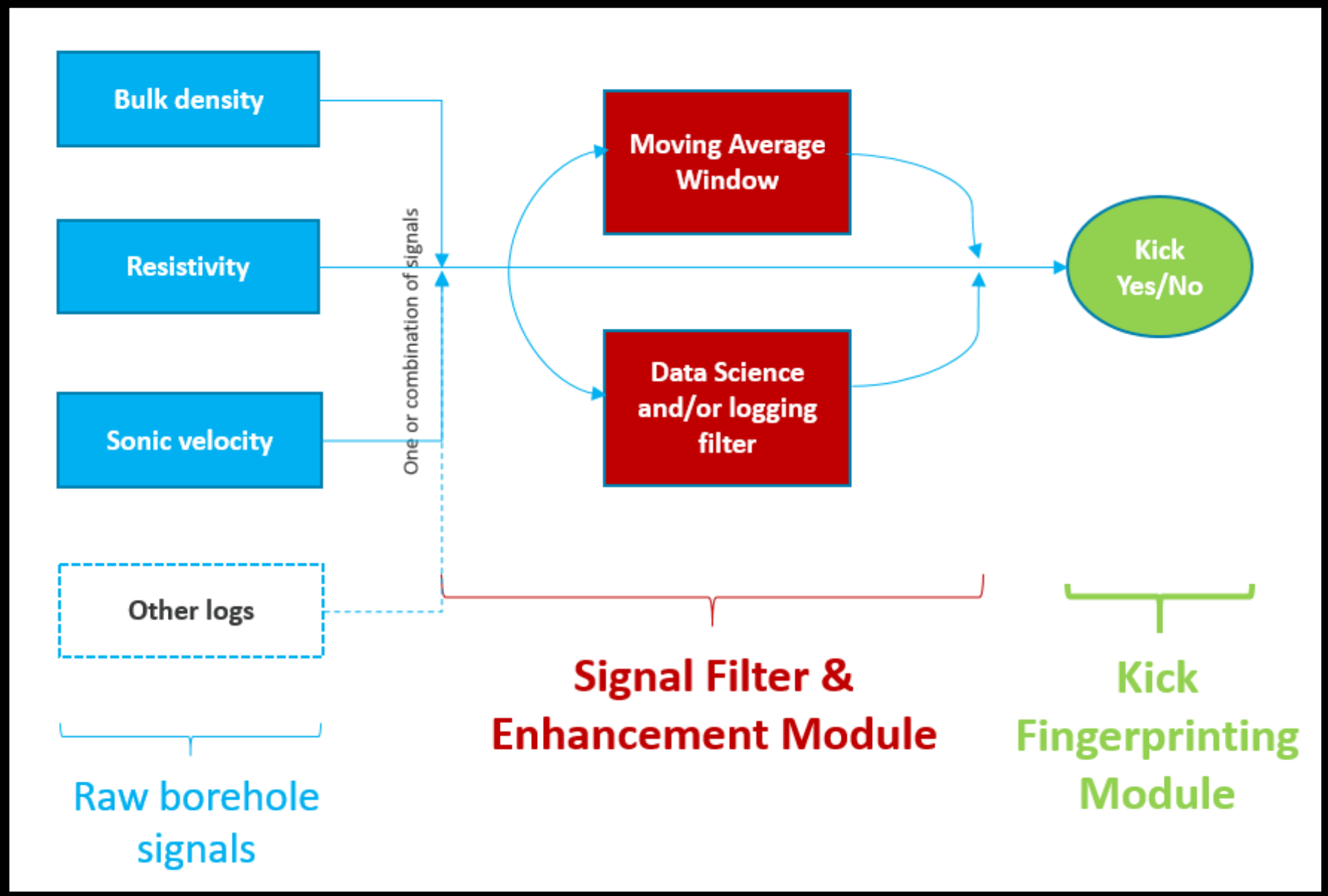
Signal Filter & Enhancement Module
Feature extraction
Noise reduction
Multi-dimensional motif identification

Kick Fingerprinting Module
Current focus on **offline algorithm** development

Algorithms currently under development are being trained and tested on data from **industrial partnership**. In-house well flow facility under development.

Drill String · Annulus · Kick Velocity · Kick Scenario
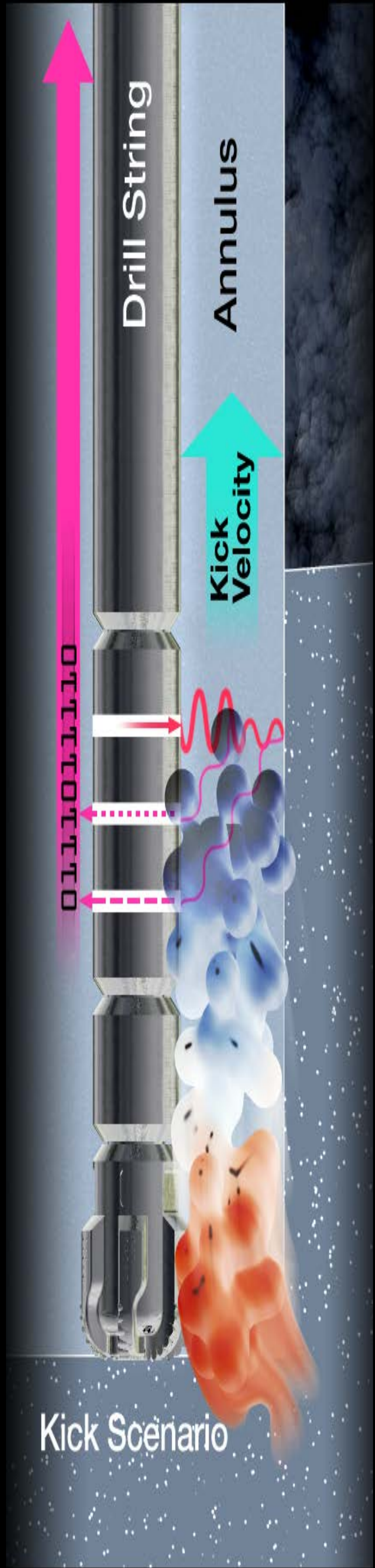
Method	Promising			Notes
	Yes	May be	No	
Threshold based segregation			X	Change in signal is more important than the absolute value.
Unsupervised clustering	X			Requires SME validation. Prove on LWD data.
threshold of (gradient of moving avg window)	X			Requires SME validation. Prove on LWD data.
threshold of (derivative of the gradient of the moving avg window)	X			Requires SME validation. Prove on LWD data.
Isolation Forest + unsupervised clustering		Postulated but untested		
Bayesian Network on expert made DAG				

Motifs and Anomalies

Binary classification

Threshold based anomaly

Motifs analysis
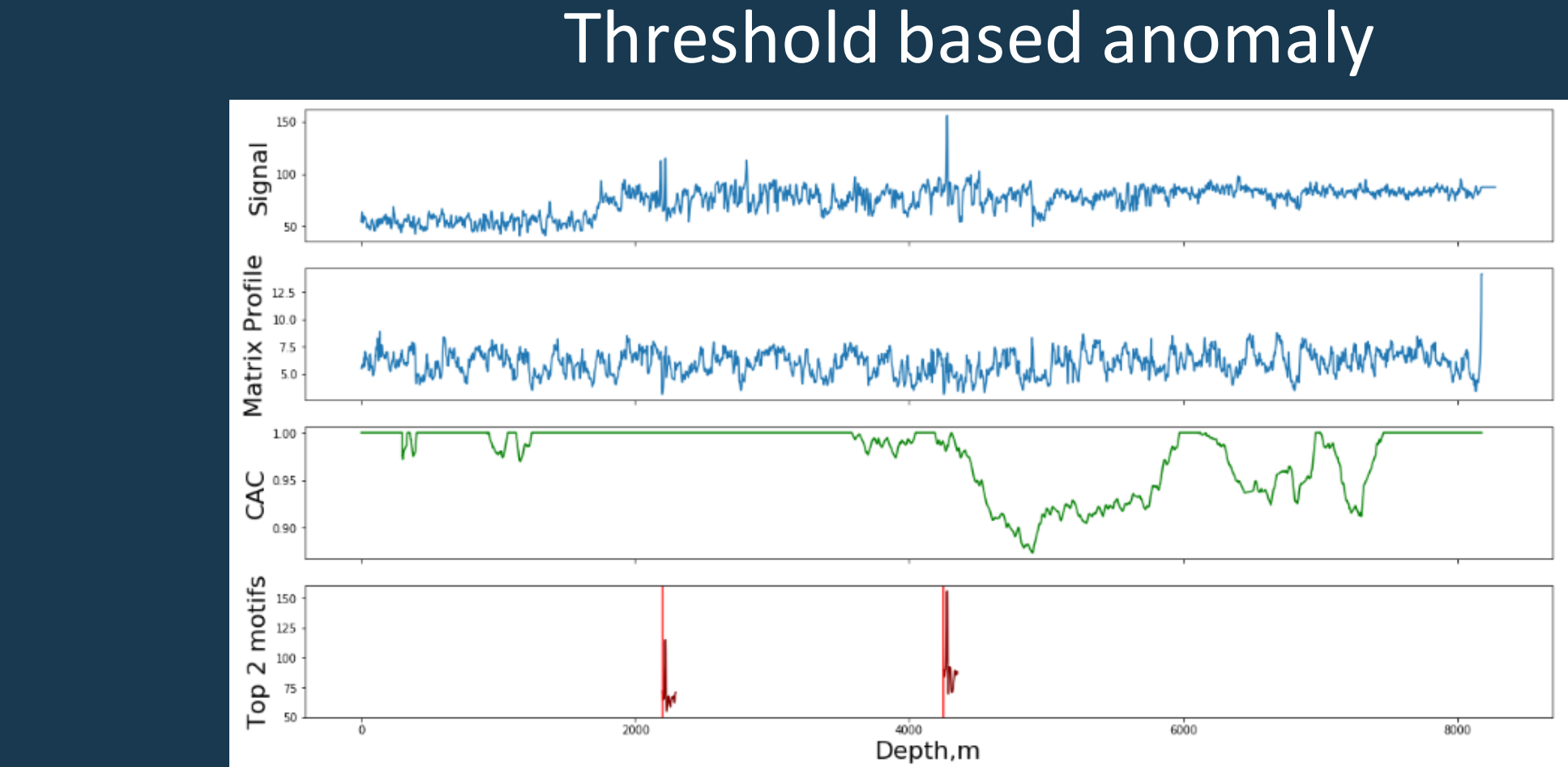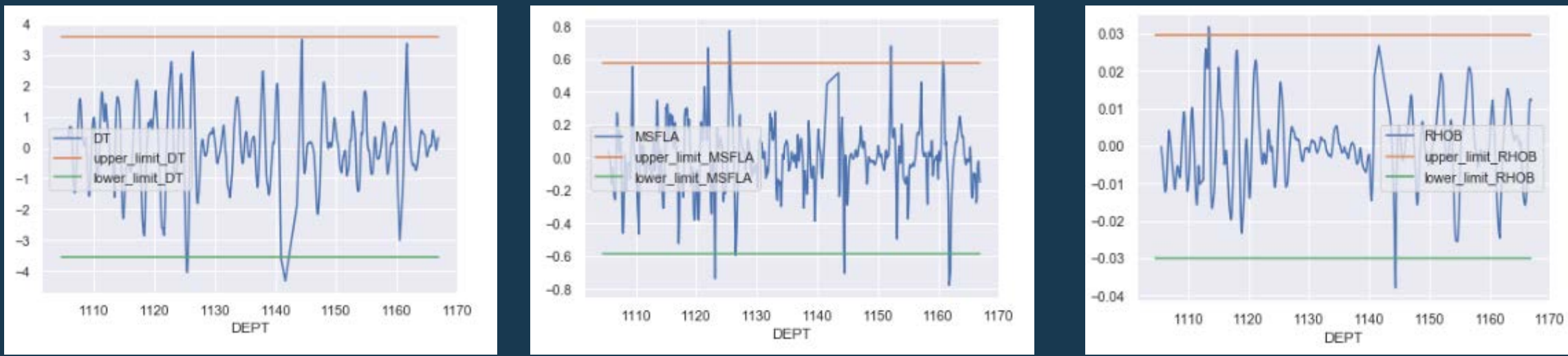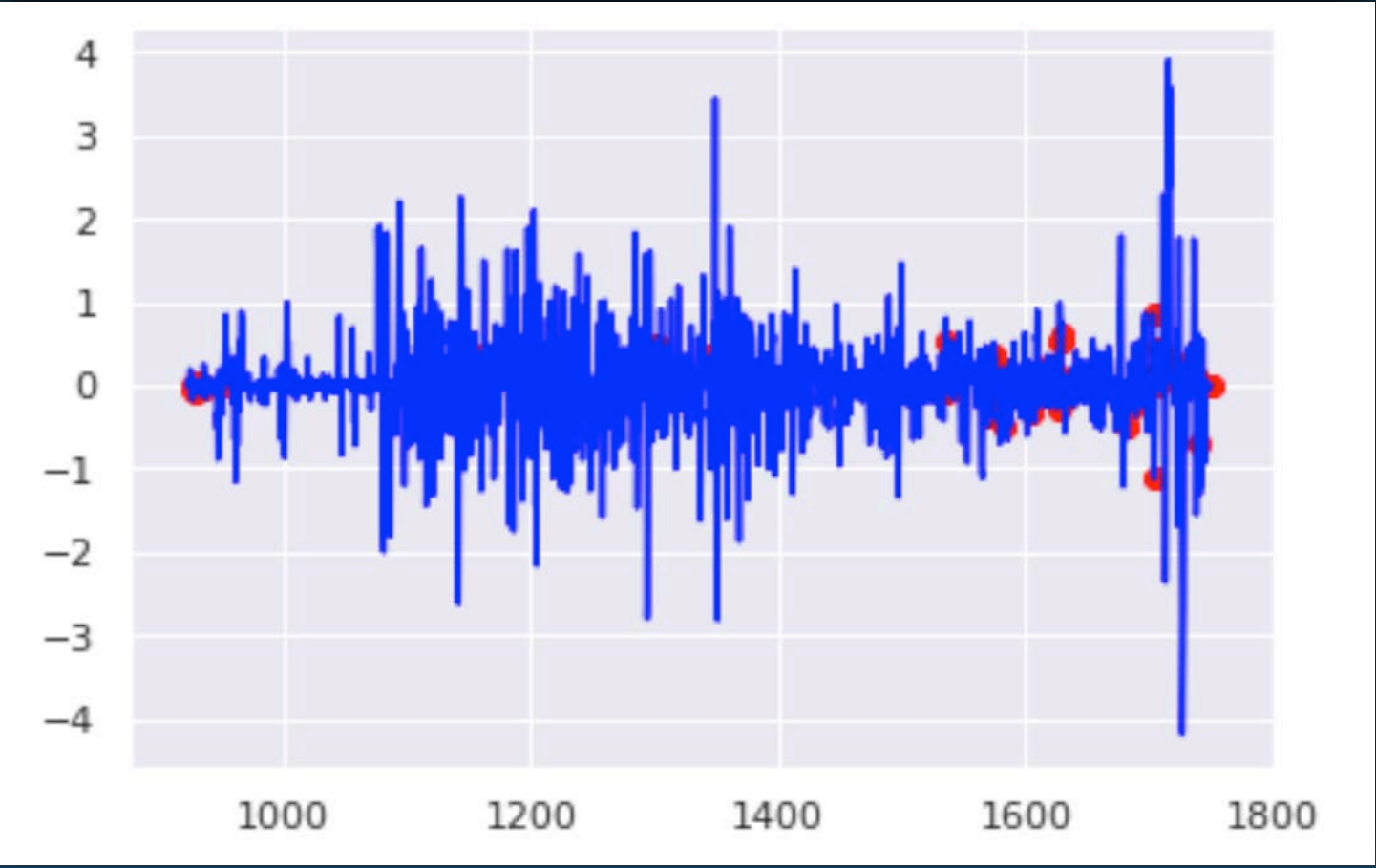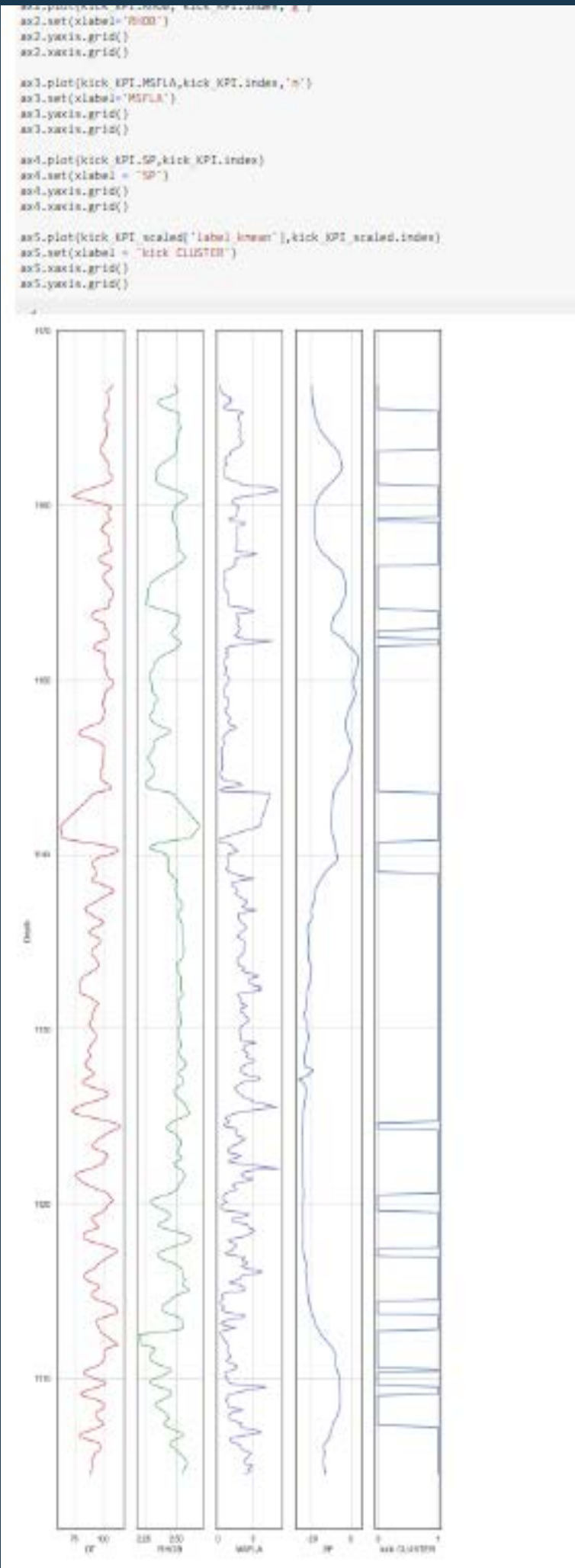
Achievements

Tost, B., Rose, K., Aminzadeh, F., Ante, M. A., & Huerta, N. (2016). *Kick Detection at the Bit: Early Detection via Low Cost Monitoring* (No. NETL-TRS-2-2016). National Energy Technology Lab.(NETL), Albany, OR (United States).

US Patent #10,253,620, granted April 2019.

External interest:

Chevron · pason · saudi aramco · TOTAL

U.S. DEPARTMENT OF ENERGY

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