MOBILE EDGE COMPUTING SENSORS AND MACHINE LEARNING ENABLE GRID PREDICTIVE MAINTENANCE

Think About:

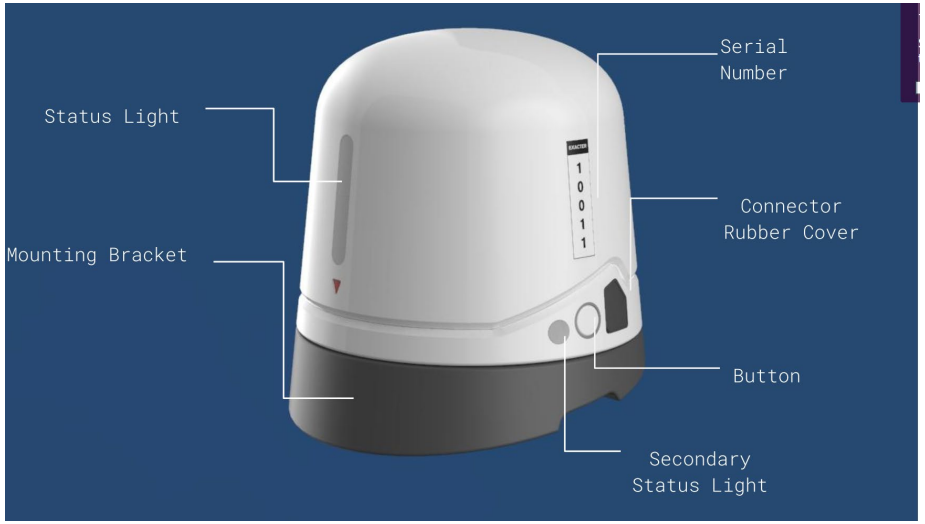
- New Grid Power Flow Requirements
- The Wireless Grid
- National Grid Condition Assessment

What New Grid Monitoring and Management Paradigms are Needed?

EXACTER TREKKER™ BIRD FOUNDATION GRANT AWARD

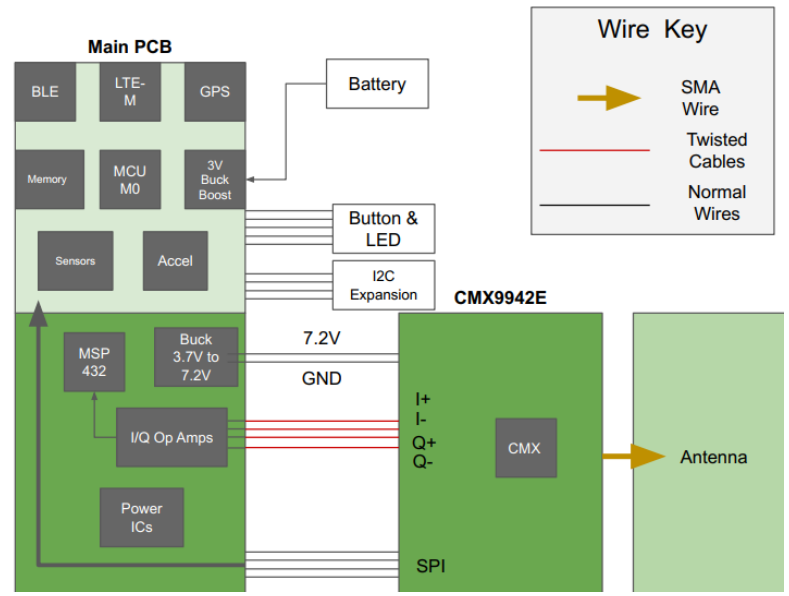
U.S. and Israel Collaborate for Power Grid Predictive Analytics

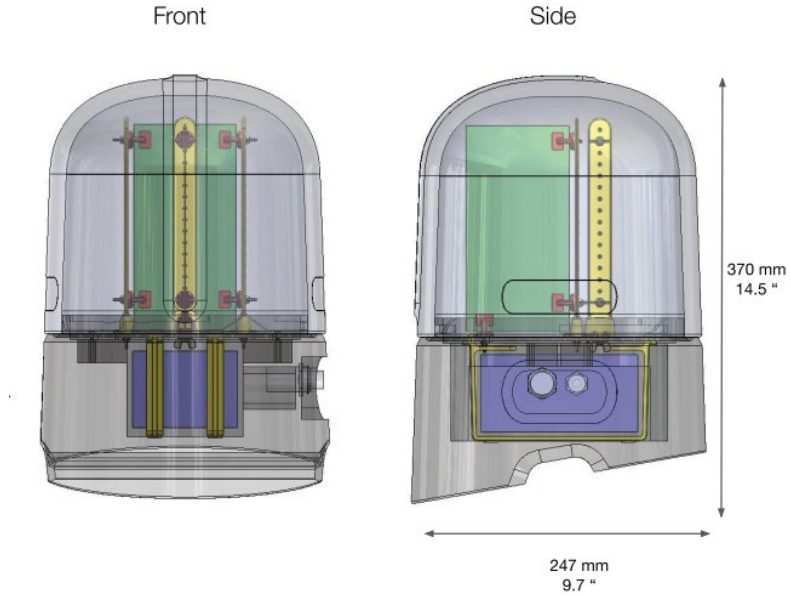
Exacter, Inc., of Columbus, Ohio, and Razor Labs of Tel Aviv, Israel, were awarded a $950,000 grant to fund collaborative research and development efforts. As part of a pilot project, these sensors will be installed on garbage trucks in Akron, Ohio, for continuous grid monitoring.

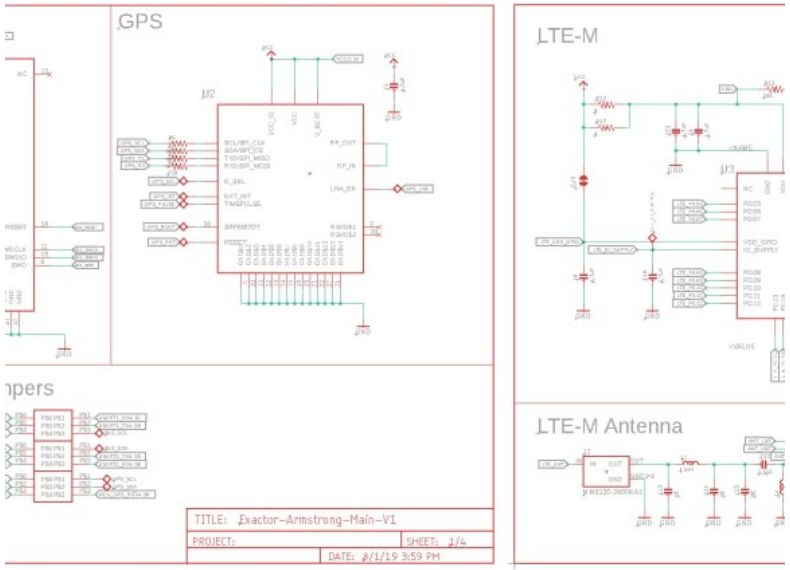


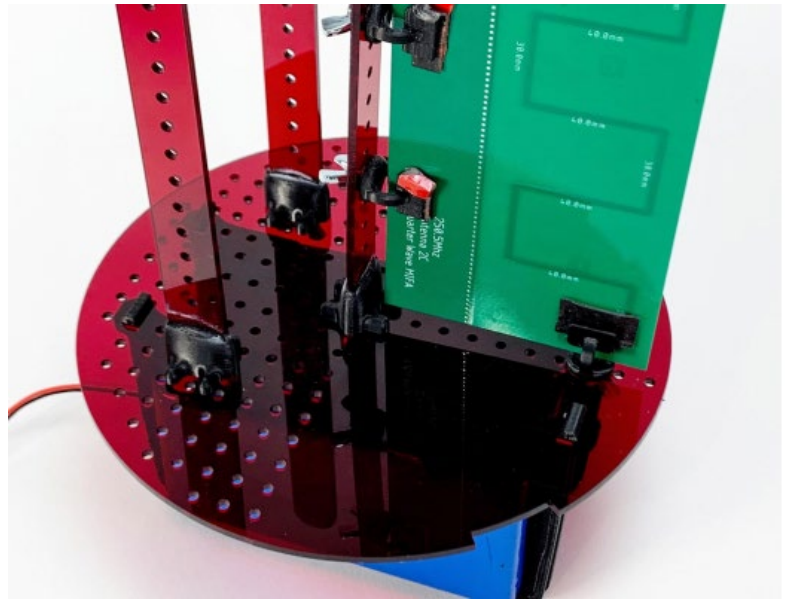
MOBILE EDGE-COMPUTING SENSOR PROTOTYPE TECHNOLOGY COMPLETE

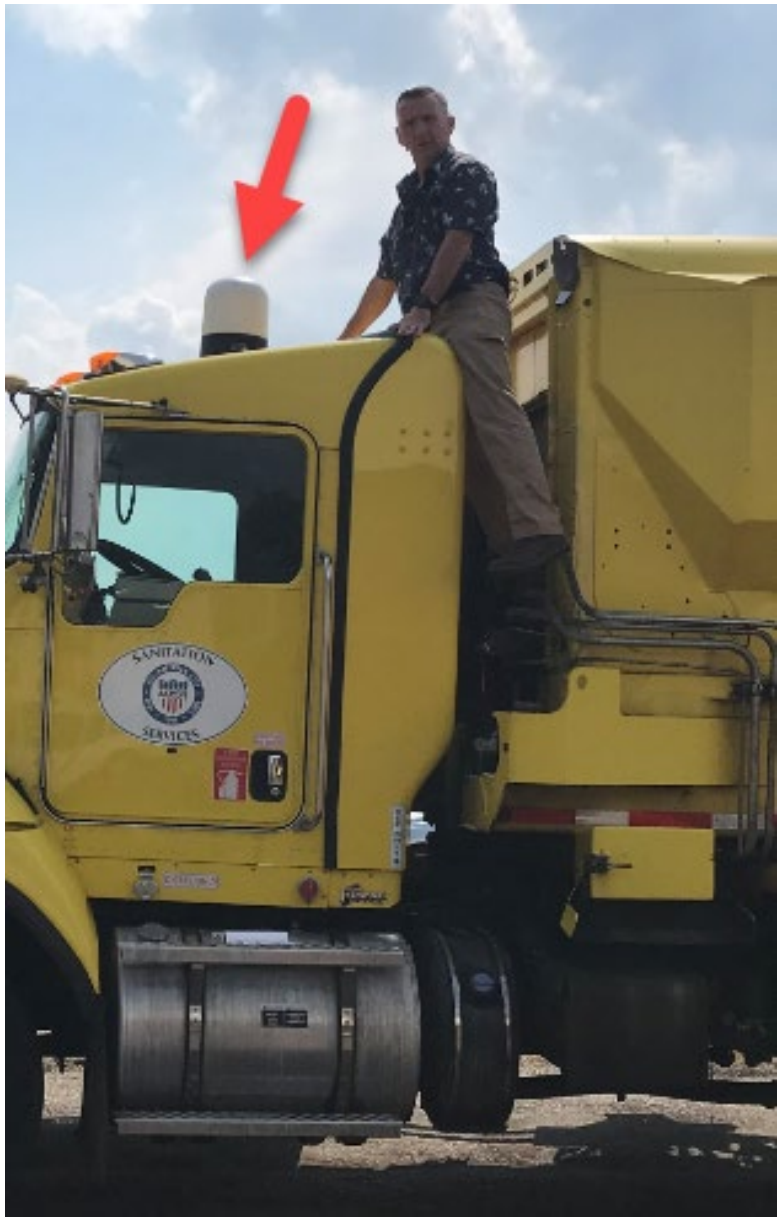
- Field Trials Complete
- AWS Cloud Connections Established
- Prototype Housing in Field Test
- Data Visualization Platform Complete
- Trial Field Deployments Scheduled Q1:2020











WHAT IF . . .

Grid Equipment Condition Sensors were installed on all 60,000 sanitation vehicles collecting the condition of the nation's grid every day?

Who could use this data?

What would be the use cases?

FirstEnergy®

FIRST DEPLOYMENT – THE CITY OF AKRON, OH

- SMART CITY INITIATIVE
- GRID MANAGEMENT
- SMART SENSOR DESIGN

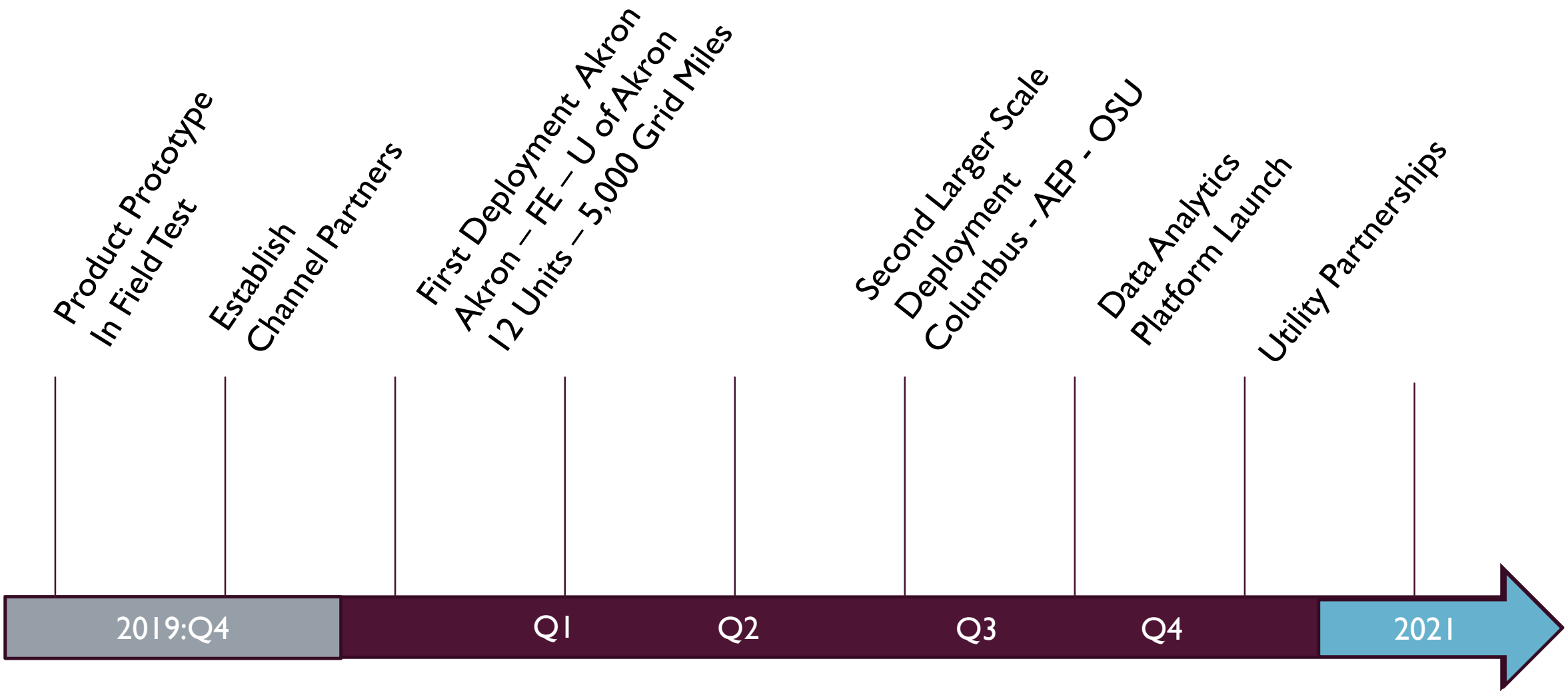
AKRON, OHIO
FLEET VEHICLE DEPLOYMENT STRATEGY

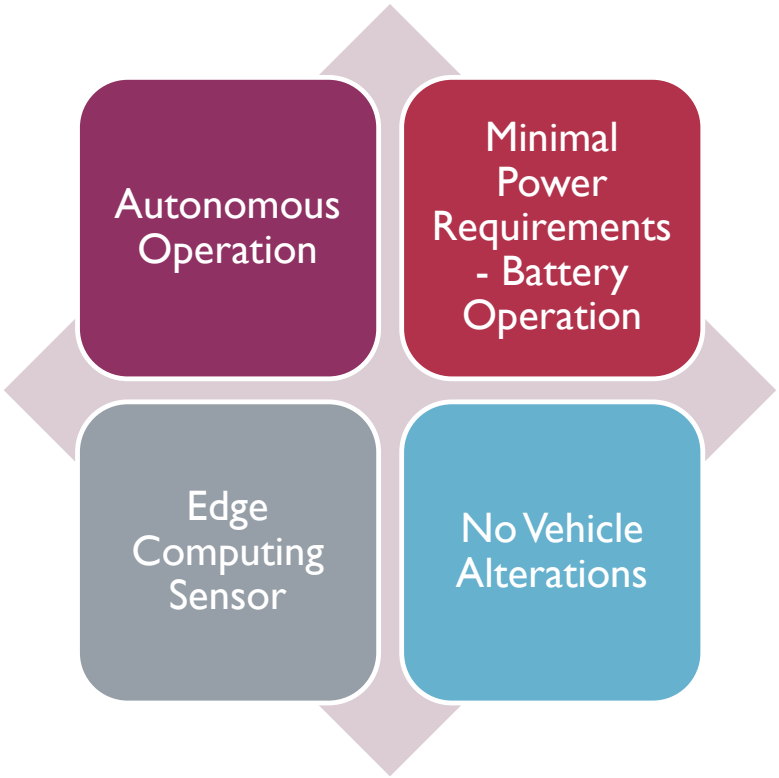
THE OHIO STATE UNIVERSITY

AMERICAN ELECTRIC POWER

SECOND DEPLOYMENT PLANNING UNDERWAY

LAUNCH TIMELINE



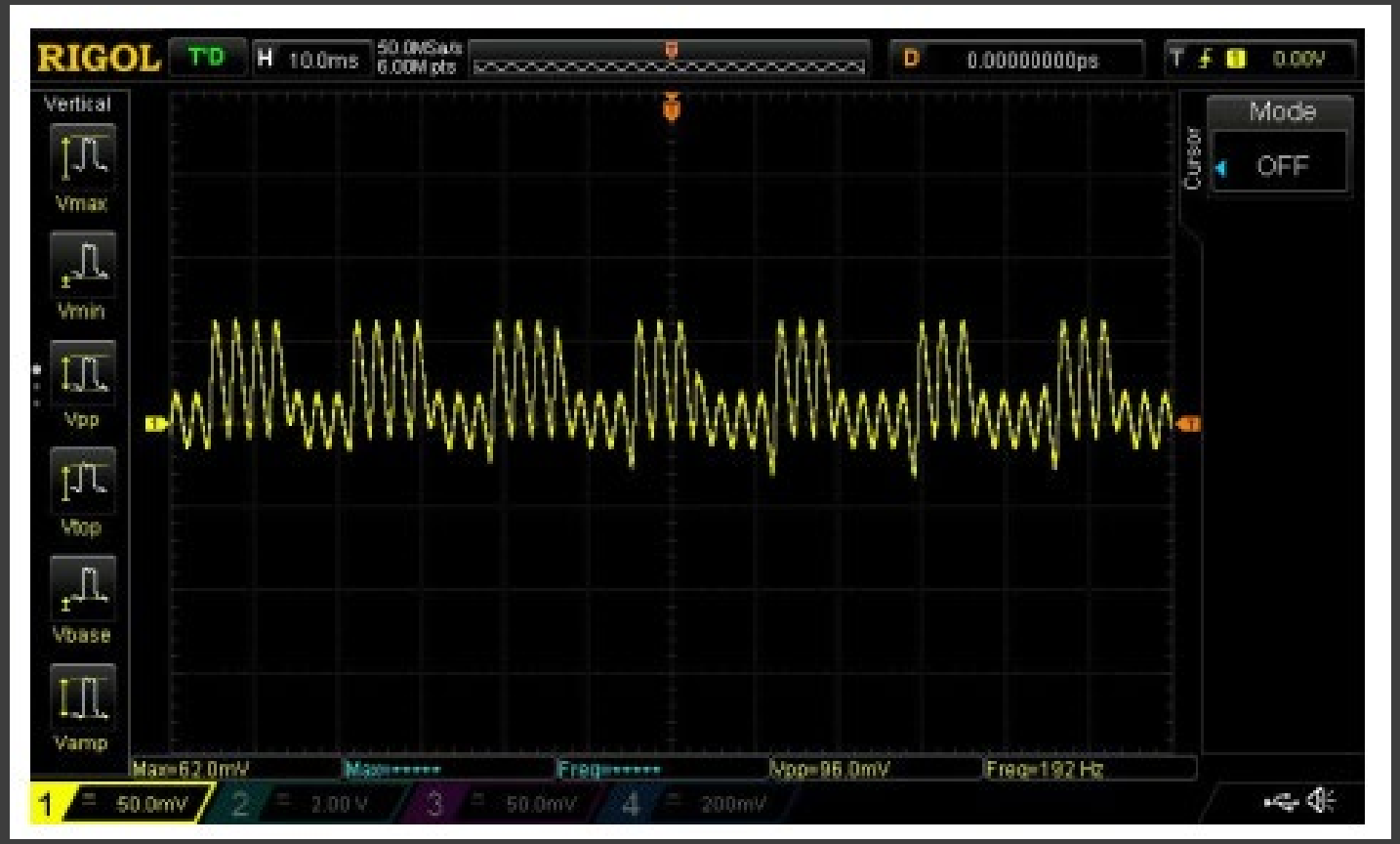


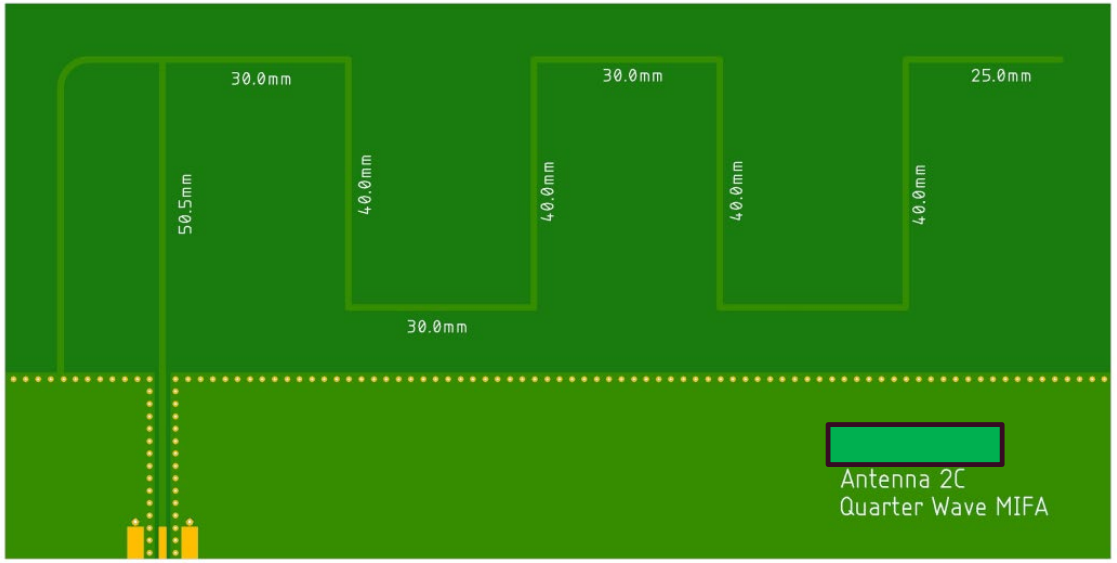
TECHNICAL CHALLENGES

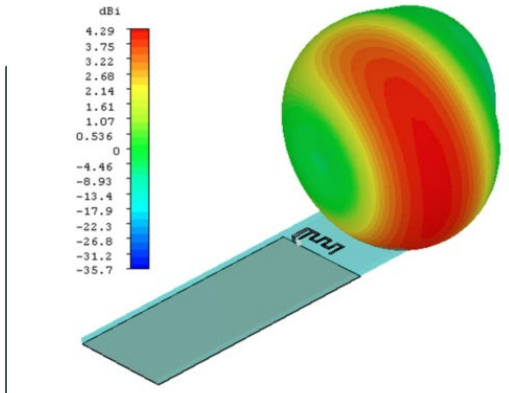
“PARTIAL DISCHARGE IS A KEY INDICATOR OF EQUIPMENT DETERIORATION.”

DR. S SEBO, THE OHIO STATE UNIVERSITY HIGH VOLTAGE LABORATORY

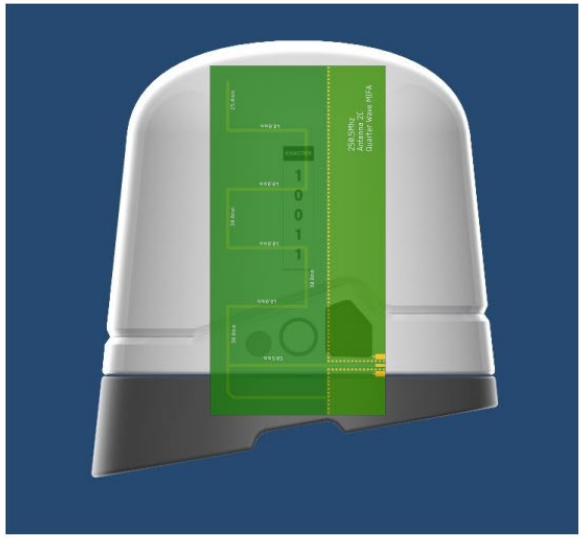
- Patented Partial Discharge Analysis Algorithms
- 99.7% Ground Truthing Achievement
- 14-year Experience







Meandering has some effect on making the radiation/gain pattern asymmetrical.

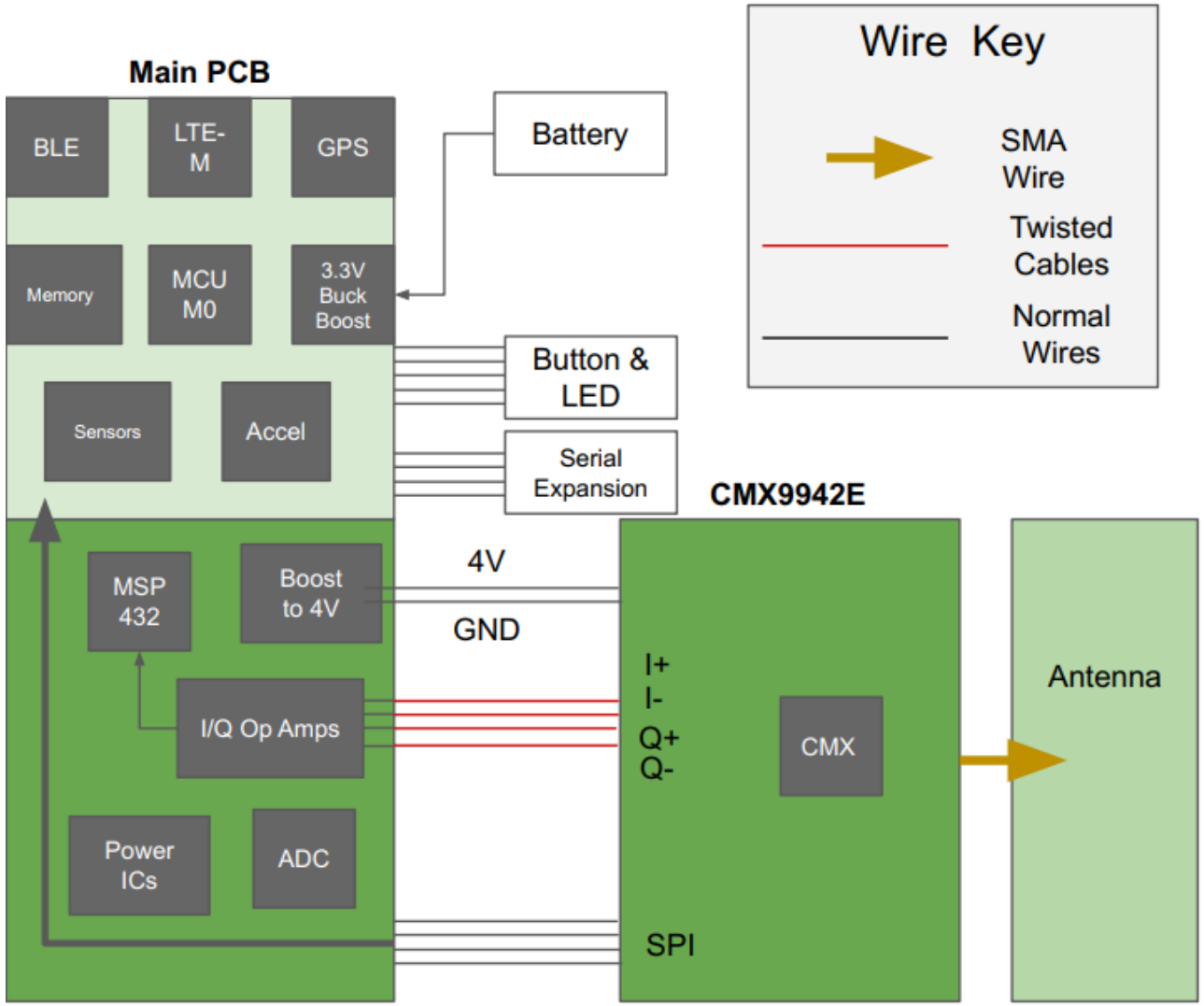


NO VEHICLE ALTERATIONS

- No External Wiring
- No External Antennae – Meandering Inverted F-Pole Antenna (MIFA)
- Simple Installation and Commissioning

EMISSION DETECTION AND ANALYSIS

- Vehicle Motion Detection
- Dynamic Sleep Mode
- Concealed Antenna
- Centralized Maintenance Web Portal



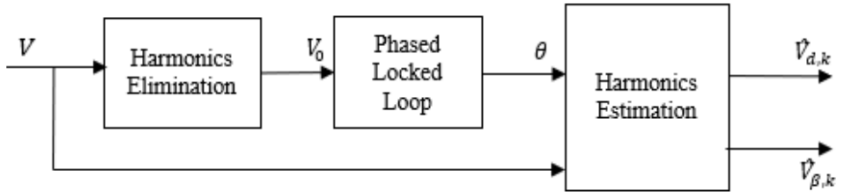


Fig. 1. Proposed PLL based approach

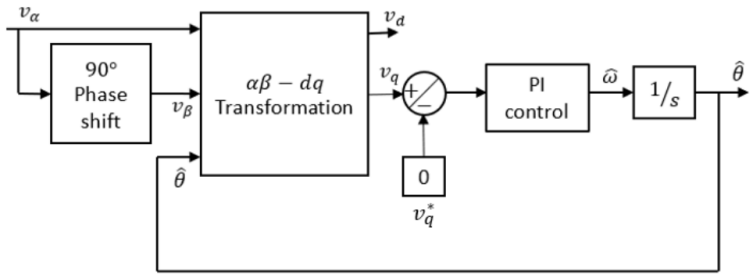


Fig. 2. Single phase dq0-PLL

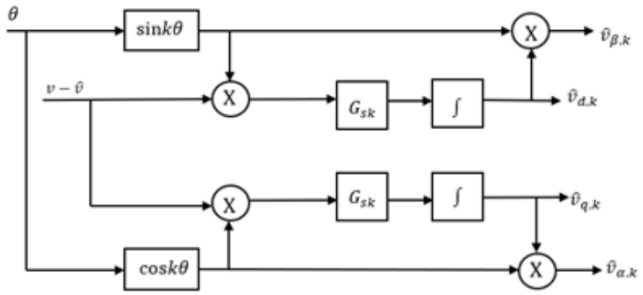


Fig.3. MEEI for sine and cosine harmonic components

MIXED ERROR ESTIMATION INTEGRAL

MEEI ALGORITHM MODEL[1]

- Fast
- Low Power
- Integrated on One Mixed Mode Microcontroller

1. Dasari, R.S., Phase Locked Loop Based Signal Processing Approach for the Health Monitoring of Power Systems through their Emissions, Master Degree Thesis, May 2019, ECE Department, University of Akron

Table I. Comparison of the Harmonic Component Values Estimated with Simulated Signals

Method	First Harmonic Component Magnitude	Second Harmonic Component Magnitude	Third Harmonic Component Magnitude
FFT	212.12	40.91	71.61
Simulated results with the proposed PLL approach	212.2	39.43	71.3
Embedded controller implementation with the proposed PLL approach	204-213	35-40	60-70

TABLE II. COMPARISON OF THE HARMONIC COMPONENT VALUES ESTIMATED WITH PROPOSED APPROACH AND FFT FOR THE NOISY SIGNAL

Method	First Harmonic Component Magnitude	Second Harmonic Component Magnitude	Third Harmonic Component Magnitude
FFT	0.03525	0.01782	0.0055
Simulated result with the proposed PLL approach	0.031-0.042	0.012-0.0326	0.003-0.00505
Embedded control implementation with the proposed PLL approach	0.0354	0.014	0.005-0.0055

MEEI ALGORITHM VS. FFT

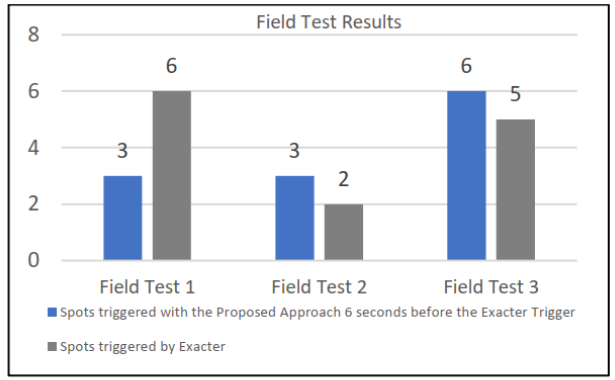
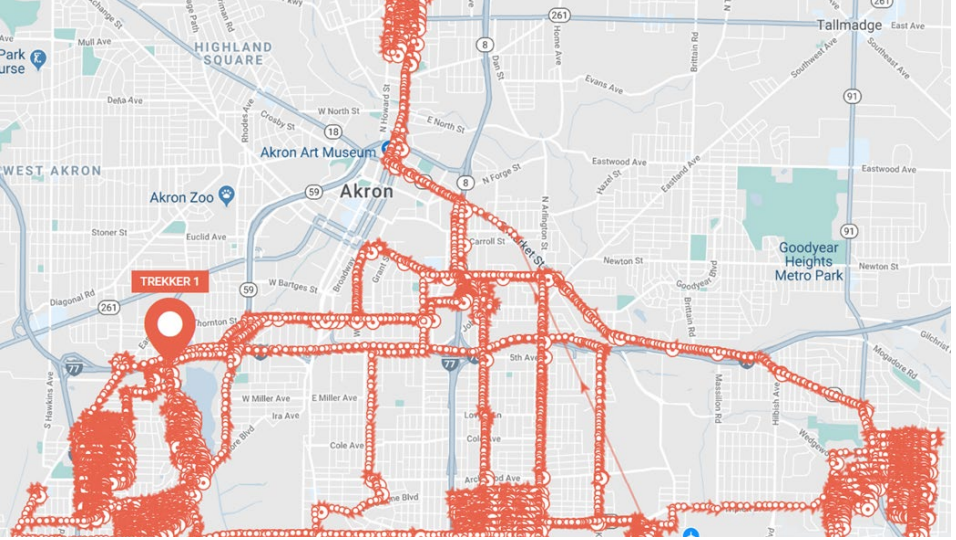
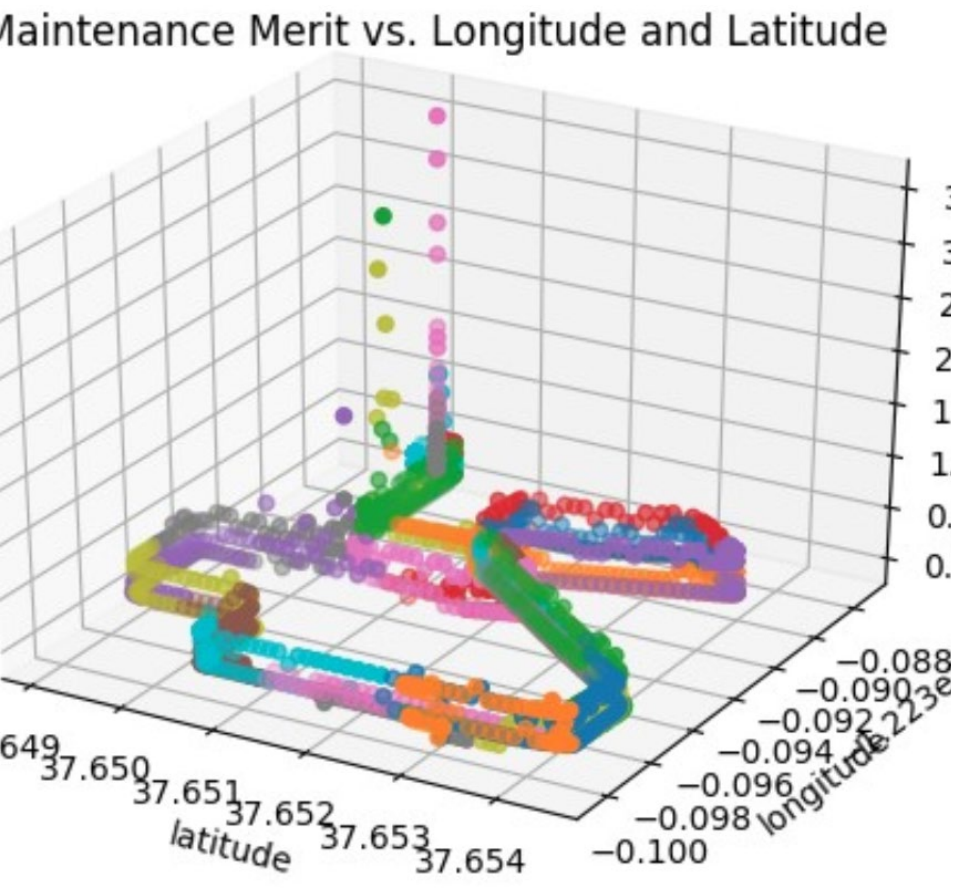


Fig.18. Comparison of proposed approach with FFT based on the field test triggering

TABLE III. COMPARISON OF THE HARMONIC COMPONENTS ESTIMATED WITH PROPOSED APPROACH AND FFT FOR THE NOISE RECORDED IN REAL-TIME

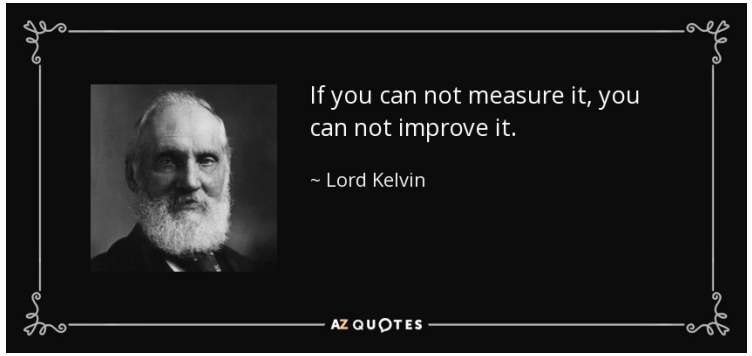
Method	First Harmonic Component Magnitude	Second Harmonic Component Magnitude	Third Harmonic Component Magnitude
FFT	0.017	0.017	0.1074
Embedded control implementation with the proposed PLL approach	0.11-0.18	0.015-0.018	0.07-0.11





DEPLOYMENT MODEL: 1-SECOND DATA ACQUISITION

- Partial Discharge Emissions
- GPS Location
- Date and Time
- Temperature, Barometric Pressure, Relative Humidity
- Air Particulate Contamination
- Neural Network Correlations
  - Grid Load
  - Weather Events
  - Air Quality



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