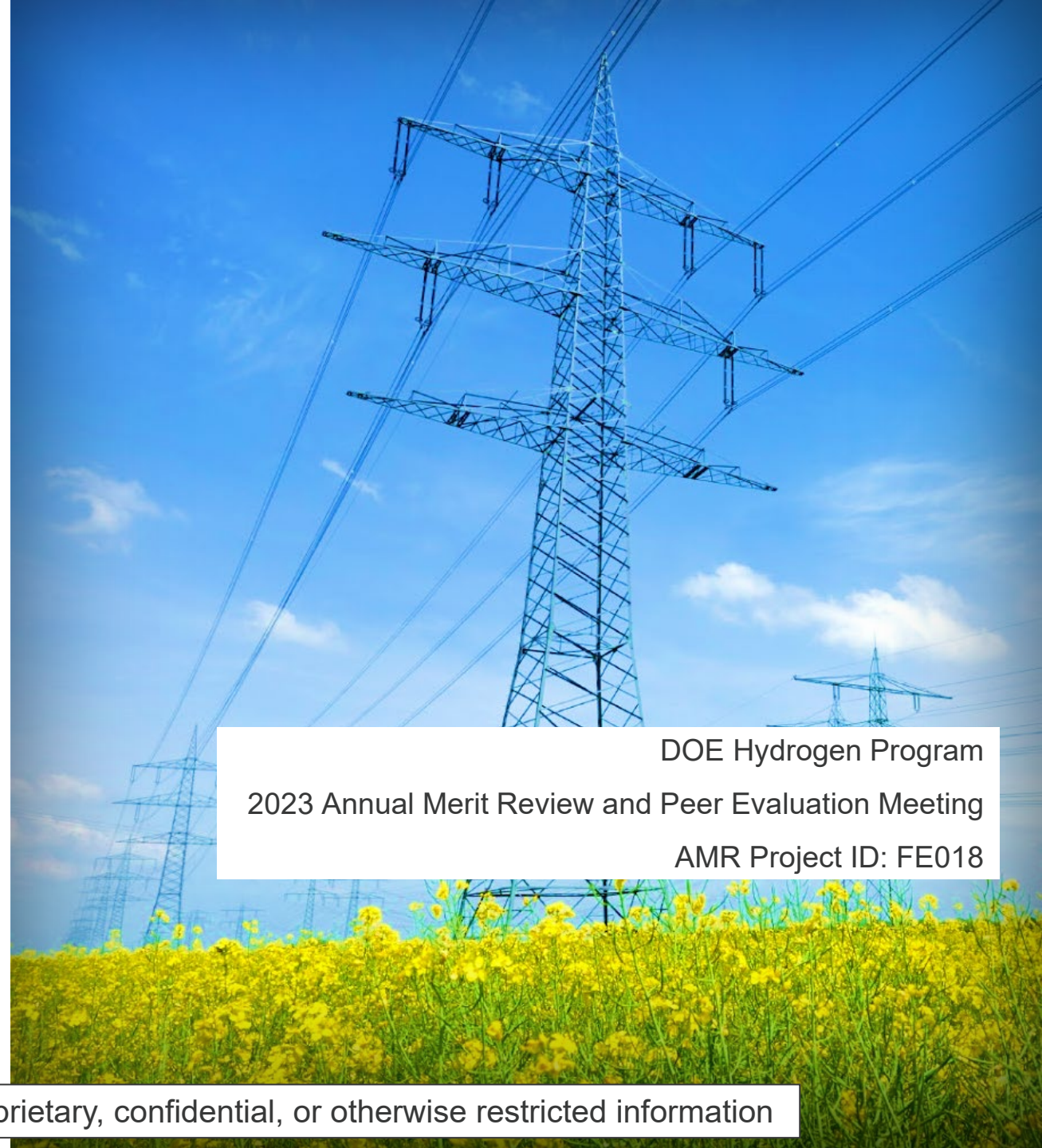


Raman Gas Analyzer for Real-time Gas Composition Monitoring

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FECM FWP 1022427, Task 41



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DOE Hydrogen Program
2023 Annual Merit Review and Peer Evaluation Meeting
AMR Project ID: FE018

Support the transition to the hydrogen economy through the technical development and field testing of the NETL Raman Gas Analyzer (RGA), to provide real-time (1 second) analysis of hydrogen fuel gas blends at system pressure (up to 1000 psi), to enable control of gas turbines, SOFCs, and industrial systems based on the fuel composition

Timeline and Budget

- DOE FECM annual FWP funding
- FY22 DOE Funding (if applicable): \$141k
- FY23 Planned DOE Funding (if applicable): \$160k

Barriers

- Existing prototype larger and heavier than needed for some applications
- Application testing for hydrogen blends to advance Technical Readiness Level

Targets

- New design for reduction of instrument size and weight to rack mount, and less than 70 lbs
- 1 second measurement time and composition measurement to 0.1% (vol) or better
- Software and interface updates

- Hydrogen fuel gas blends with natural gas, or syngas, are expected to be used in turbines, reciprocating engines, SOFCs, and industrial equipment during a transition period to hydrogen systems.
- Hydrogen content variation in a fuel gas affects the energy content and flame speed, which have a large impact on the operation of power turbines, reciprocating engines, SOFCs, and industrial equipment. Not adjusting for the fuel composition can result in poor system efficiency, increased emissions of NO_x, and expensive equipment damage.
- The NETL Raman Gas Analyzer (RGA) is much faster than a gas chromatograph, can detect hydrogen which is difficult for IR absorption technology, and can differentiate nitrogen from carbon monoxide which is difficult for mass spectrometers.

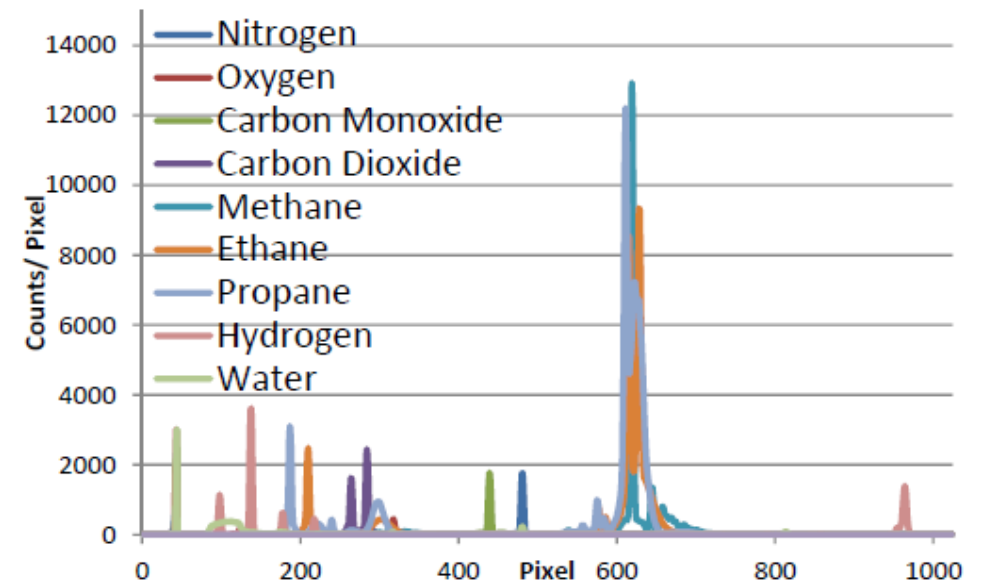
Fast Raman Gas Analyzer Prior Work

- Applications to **power generation** and **chemical process control**
- Prototype testing in pilot scale laboratory applications
- Fast - 1 second measurement time
- Species concentrations measured to 0.1%
- Optical waveguide technology boosts Raman signal more than 1000X
- Designed for Class 1 Division 2 electrical safety locations



No commercial technology has this combination of speed, accuracy, and multi-gas capability

US Patent 8,674,306, NETL and U. of Pittsburgh



Approach

- Software upgrades and maintenance of existing field prototype
- Smaller design has been constructed
 - Compact RGA is lighter (less than 100 lbs), existing prototype ~500 lbs
 - Design for rack mount format
 - Electrically unclassified locations
 - Final system integration and programming in progress
- Calibration will be with H₂, CO₂, CO, N₂, air, CH₄, C₂H₆, C₃H₈
- Initial testing will compare performance with the larger prototype
- Subsequent testing will support research activities at NETL and technology transfer activities

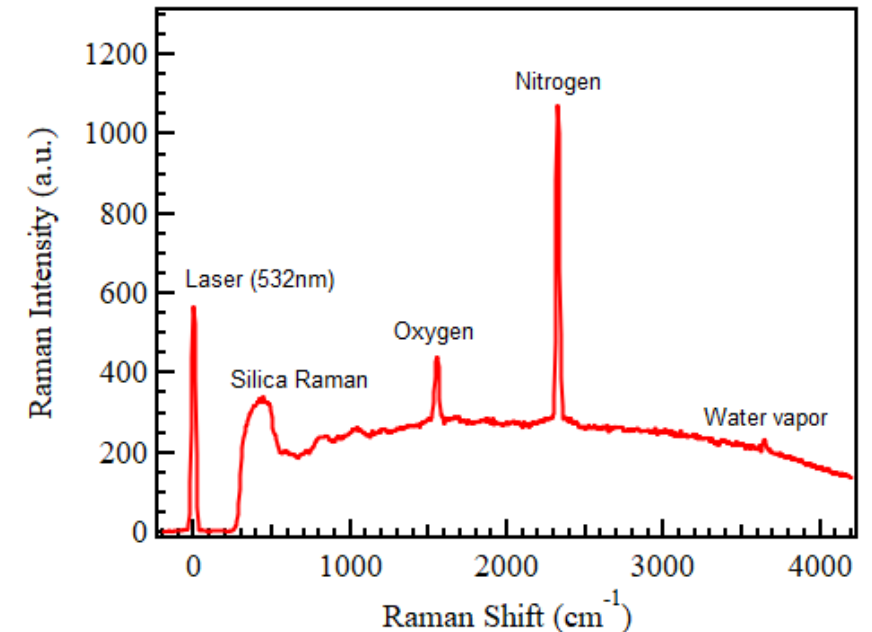
Accomplishments and Progress

EY22

- Completed the construction of the compact RGA (third prototype).
- Installed the short waveguide inside the compact RGA and demonstrated its capability of detecting the room air Raman signal in a folded optical configuration.
- Programming the compact RGA is underway and expected to be completed in mid EY23.



Compact RGA rack mount design



Room air Raman signals from initial checkout of the compact RGA

Future Work

FY23

- Complete the compact RGA programming
- Calibrate the compact RGA with various fuel gases in laboratory
- Initial testing of compact RGA in laboratory with bottled gas mixtures

FY24

- Compare the performance of compact RGA with larger RGA
- Support application testing for hydrogen blends with prototypes
- Improve prototypes based on test experience, support tech transfer

- **NETL Raman Gas Analyzer is a novel instrument for real-time composition measurement of hydrogen fuel blends, which will support transition to hydrogen power and industrial systems for carbon emissions reduction**
- **Optical waveguide technology greatly improves collection of Raman signal with low laser power (150mW)**
- **Smaller, lighter prototype in development**

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