# CLEVELAND ELECTRIC LABORATORIES

## Fiber Optic Sensing Solutions

FiberStrike™ by Cleveland Electric Labs

LIGHT CAPTURING MOTION

# Active Surge Control

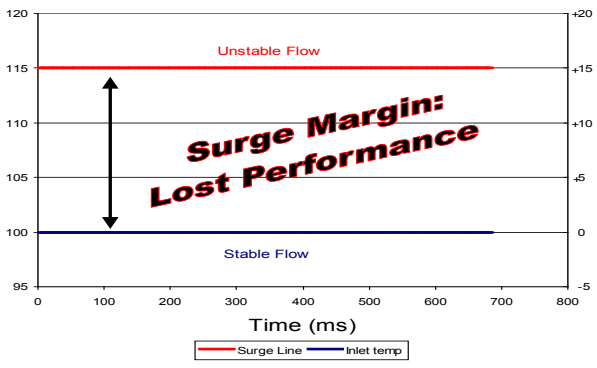
THE BIG CHALLENGE for all turbine engine manufacturers is finding that extra performance and efficiency required to stay competitive in today's demanding marketplace. Millions of dollars are being invested in the push for higher power to weight ratios, lower SFC and tighter emissions requirements. Engine and airframe manufacturers are looking for new technologies to advance their designs, and their compressor design engineers know that SURGE is a critical issue. The key to optimum engine performance is to maximize power while staying away from the dreaded "Surge Line".

We know that Surge is influenced by a number of constantly varying environmental conditions, which is exactly why Cleveland Electric Labs has developed and patented a method of continuously monitoring compressor characteristics to determine adverse flow conditions into the compressor, i.e. compressor instability. During compressor instability, small temperature fluctuations occur as one of the stages “back flows”. Trying to measure these events requires a sensing device that is both reliable and sensitive to millisecond temperature fluctuations. Until now conventional temperature sensing technologies were just too “slow” to indicate these millisecond transients. However, advancements in fiber optic technologies have allowed for sensing temperature transients as fast as 0.1 milliseconds. This is fast enough to pick up the initial onset of instability and testing has shown that as a compressor starts to cross into instability, the frequency and amplitude of the temperature fluctuations increase.

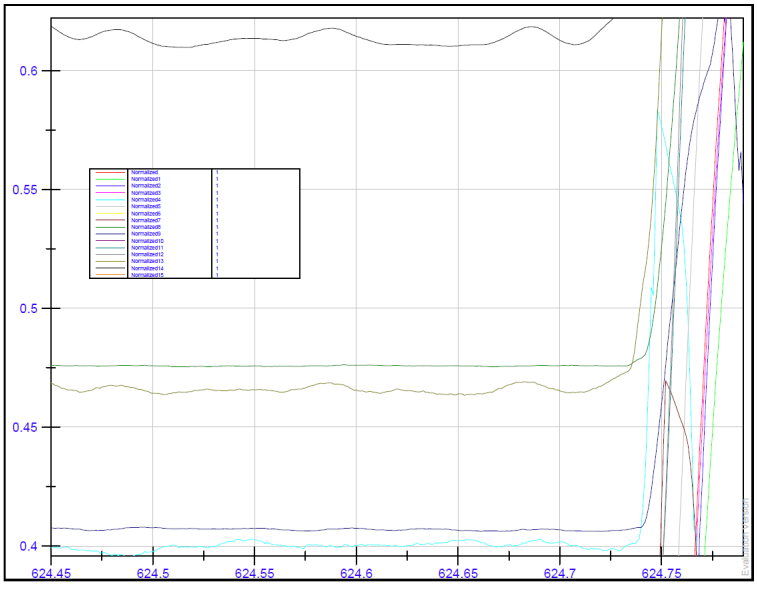
By mapping these temperature characteristics through instability and into surge, it is possible to create flow signature. By comparing real time compressor data to the stored compressor data map, the “engine controls” could determine the exact operating proximity to absolute surge. This would allow the engine control to effectively and safely operate above the conventional surge line by monitoring the temperature fluctuations along with frequency and amplitude. The benefits for this capability are increased efficiencies and lower emissions.

While technology is currently available for high speed temperature sensing, the need to develop and optimize an effective control system is required. As technology continues to advance, only those companies that choose to embrace it will thrive. Leading edge technologies will continue to propel turbine engine development. Cleveland Electric Labs Advanced Technologies Group is anxious to share this exciting new technology with your organization.

### Potential Performance Gain




### Actual Test Data





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