# Fast Fiber-Coupled Imaging of X-rays Events, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

## ABSTRACT

HyperV Technologies Corp. proposes to construct a long-record-length, fiber-coupled, fast imaging diagnostic for recording X-ray back-lit material flows and X-ray emission events. X-ray imaging of material flows in detonation fronts and combustion through protective housings has many important aerospace, industrial and defense implications. First HyperV will design, construct and test, in conjunction with UAH, a single fiber coupled X-ray scintillator pixel. Silicon Photo-multipliers will be investigated to maximize channel properties for the accepted cost and desired scalability. Next we will develope an X-ray imager of at least 16 pixels for observing X-ray backlit material flows based off of the single channel experiments. A camera performance of at least 2500 frames at 10 Megaframes per second with at least 12-16 bits per pixel will be targeted. X-ray emission from backlighter will be shone through a rocket motor and projected onto a scintillator. The optical emission from the scintillator is then observed by a fiber imaging grid. The imaging grid would then couple light to a bank of amplified SiPM pixels with integrated analog gain and data acquisition. HyperV has already demonstrated as part of previous work a two clock domain technique for using slow cheap micro-controllers to manage high time resolution data acquisition over long record-length with a low cost digital backend. HyperV has also demonstrated that this back end can be used to observe SiPM as well as photodiode detectors. We propose now to extend these techniques observe X-ray induced emission of scintillator materials for performing time resolved imaging of X-rays. This small scale imager would then be used to observe material flows in rocket motors in the UAH X-ray laboratory as a demonstration of the diagnostics capability.

## ANTICIPATED BENEFITS

### To NASA funded missions:

Potential NASA Commercial Applications: Rocket Motor


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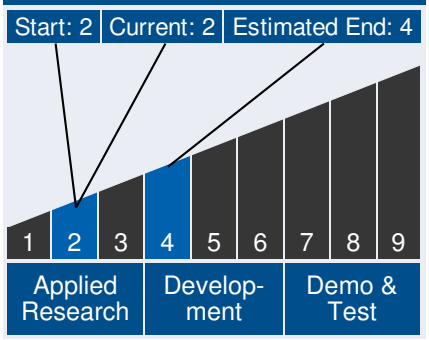
### Technology Maturity




### Management Team

**Program Executives:**

- Joseph Grant
- Laguduva Kubendran

**Program Manager:**

- Carlos Torrez

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Design:X-ray imaging can penitrate smoke and protective casings, allowing the combustion of propellants and exhaust plumes inside a rocket-motor to be imaged. High time resolution imaging of X-ray back-lit events can provide critical insight into the rocket motor dynamics. Investigation of Turbulence: For stochastic events, or dynamic events in devices too large to accumulate event evolution over many shots, the development of a deep record length imaging system for X-ray collection would be a huge advantage over single shot and burst shot imaging systems presently employed. Harsh Environment Testing: By minimizing the complexity of the imaging head, a replaceable, irradiateable imager head could be constructed for deployment in harsh environments. Filtered X-ray Imaging: Adding energy bandpass filtering only increases the flexibility and power of this diagnostic. Time Resolved X-ray Spectroscopy: By observing the output of an X-ray spectrometer it may be possible to record time resolved X-ray spectroscopy

**To the commercial space industry:**

Potential Non-NASA Commercial Applications: Combustion: X-ray information on the evolution of fast material flows that previously had to be aggregated over many shots, will now be recorded in a single shot. This allows shot-to-shot variant dynamics like turbulence and turbulent mixing to be resolved, and reduces the resources required, especially in large devices where shots are at a premium. Plasma Physics: X-ray imaging is important to plasma physics. Imaging of fast events in Z-pinches and implosions is absolutely vital to achieving the goals of Inertial Confinement Fusion (ICF). Tomography: A low cost high time resolution camera allows 4-D X-ray tomography, which would be an advance in observing complex flow evolutions in nozzles, manifolds, and detonation fronts. Fast Material Augmentation: This is a general tool for time resolved X-ray imaging of fast material augmentation or displacement. Laser sintering, deformation, and detonation flows could be resolved, allowing for optimization of these industrial applications.

## Management Team *(cont.)*

**Principal Investigator:**

- Samuel Brockington

## Technology Areas

**Primary Technology Area:**
Ground and Launch Systems (TA 13)
└ Operational Life-Cycle (TA 13.1)
└ Logistics (TA 13.1.4)

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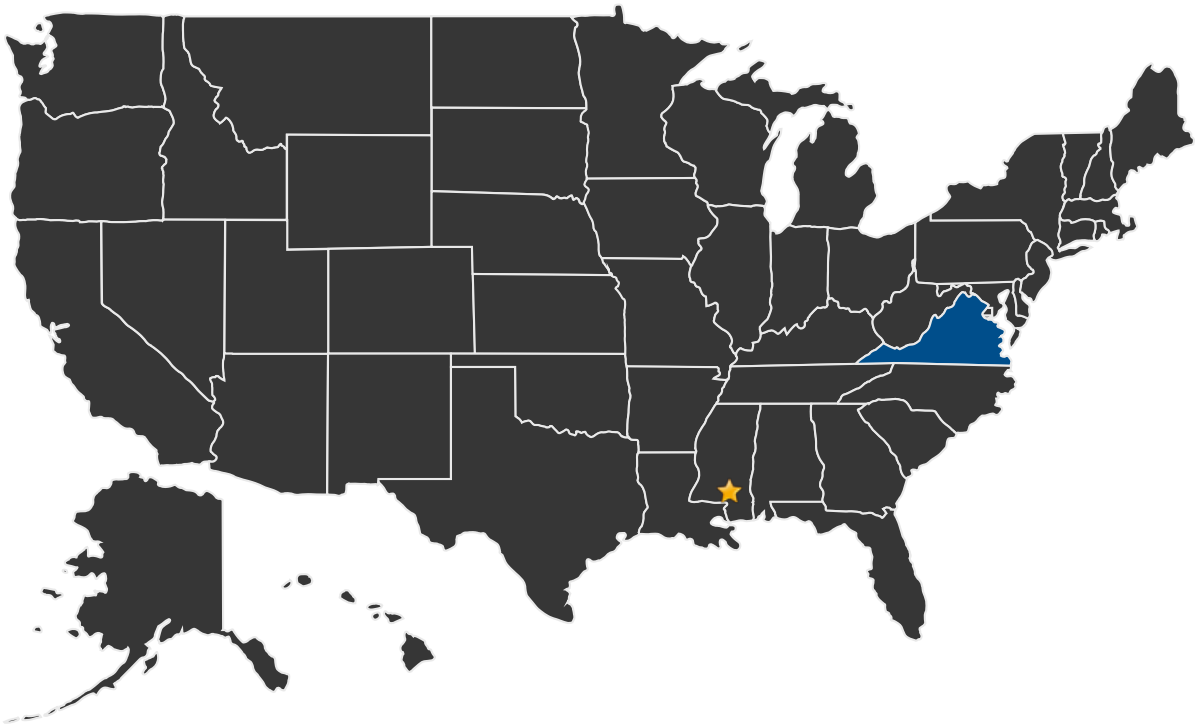
## U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

**Lead Center:**
Stennis Space Center

**Other Organizations Performing Work:**

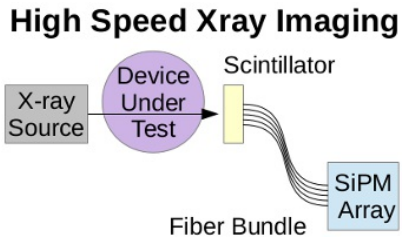
- HyperV Technologies Corporation (Chantilly, VA)

## PROJECT LIBRARY

**Presentations**

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23615)

## IMAGE GALLERY




*Fast Fiber-Coupled Imaging of X-rays Events, Phase I*

## DETAILS FOR TECHNOLOGY 1

### Technology Title

Fast Fiber-Coupled Imaging of X-rays Events, Phase I

### Potential Applications

Rocket Motor Design:X-ray imaging can penitrate smoke and protective casings, allowing the combustion of propellants and exhaust plumes inside a rocket-motor to be imaged. High time resolution imaging of X-ray back-lit events can provide critical insight into the rocket motor dynamics. Investigation of Turbulence: For stochastic events, or dynamic events in devices too large to accumulate event evolution over many shots, the development of a deep record length imaging system for X-ray collection would be a huge advantage over single shot and burst shot imaging systems presently employed. Harsh Environment Testing: By minimizing the complexity of the imaging head, a replaceable, irradiateable imager head could be constructed for deployment in harsh environments. Filtered X-ray Imaging: Adding energy bandpass filtering only increases the flexibility and power of this diagnostic. Time Resolved X-ray Spectroscopy: By observing the output of an X-ray spectrometer it may be possible to record time resolved X-ray spectroscopy