# 2004 Director's Discretionary Fund Proposal

**Principal Investigator:** John Bolton/420
**Co-Investigators:** Mike Richardson/RIT, Stephen Reichenbach/UNL
**Proposal Title:** A Full-Spectral Imaging Feasibility Study

## Background:

Current optical remote sensing instrument technology allows the acquisition and digitization of all of the reflected energy (light) across the full-spectral range of interest. The current method for acquiring, transmitting, and processing this data is still based on the "multi-band" approach that has been used for the past thirty years.

This proposal seeks to investigate the feasibility of using entirely new methods for pre-processing, transmitting, and extracting information from full-spectral, remotely sensed data. The goal of the project will be to convert from the current "bytes-per-band" approach to the "spectral curve" approach. This approach has the possibility to greatly simplify instrument characterization and to significantly reduce data transmission and storage requirements.

The tools currently available for handling and processing full-spectral data will be evaluated. Techniques for handling the data in the form of spectral curves will be proposed and developed. The tools of information theory will be used to minimize the number of bytes required while at the same time losing none of the information content. We will see how the information obtained from an orbiting instrument can be most efficiently transmitted to the ground and utilized to most effectively produce the standard remote sensing data products.

We expect that a basic application of the Full Spectral Imaging (FSI) principle will reduce data transmission and storage requirements by an order of magnitude. Refinement of the principle and supplementing FSI using spectro-spatial compression could produce another order of magnitude reduction.

## Objectives:

1) Catalog and benchmark existing multi-band and hyperspectral capabilities
2) Evaluate existing full-spectral data acquisition, transmission, and processing systems
3) Investigate currently available alternative data handling and processing systems
4) Explore and develop new full-spectral concepts
5) Evaluate capabilities of full spectral systems and spectro-spatial compression
6) Assess advantages of new and alternative systems

## Research and Development Plan:

1) Define current multi-band state-of-the-art and data products (1 month)
2) Define current full-spectral systems state-of-the-art (1 month)
3) Research alternative pre-processing, transmission, and processing systems (5 months)
4) Develop "strawman" full-spectral evaluation systems (2 months)

5) Compare and evaluate new technology systems (2 months)
6) Compile information and prepare report on findings (1 month)

**Context:**

This proposed project is definitely innovative and also high risk. The risk is not primarily in the availability of technology and applications, but in the acceptance of this approach by the remote sensing community and NASA in particular. This DDF would allow the PI to demonstrate the feasibility and utility of full spectral imaging, and prepare for further investigations and development of the principle. This research would allow a follow-up to the well-received paper I presented at the 10th international Symposium on Remote Sensing sponsored by the SPIE entitled, "Full Spectral Imaging; A Revisited Approach to Remote Sensing".

The project fits perfectly with Goddard's Mission as it seeks to develop an innovative technology for Earth science measurements from space that will help "develop and maintain advanced information systems for the display, analysis, archiving and distribution of space and Earth science data". In addition this research could lead to technologies that could help to "develop National Oceanic and Atmospheric Administration (NOAA) satellite systems that provide environmental data for forecasting and research".

**Innovation Summary:**

Full Spectral Imaging is the next step beyond Hyperspectral Imaging. It can open the doors to major advances in passive optical remote sensing technology, in which significant advances have not been made in more then ten years. Developing FSI would put Goddard at the forefront of the development of the most widely used type of remote sensing. The technology to build a FSI system is currently available "off-the-shelf". This project will be successful if the remote sensing community sees and accepts the value of FSI. The major risk is that the community will not be willing to give up, much less change, the approach to remote sensing that it has used for the past 30 years.

**Budget:**

- Analytical Software $6,500
- Supplemental Hardware and associated Software $9,000
- Travel 5,500
- Total $21,000

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| PI Time | 0.25 man-years |
| Co-I Time | 0.10 man-years |

**Summer Interns**

This is an ideal project for Summer Interns with little experience in the established remote sensing practices. It would give them the opportunity to freely explore any approaches that might come to their minds.