

TO: 114/Career Development & Employee Worklife Office
THRU: Code 420/George Morrow, Code 400/Dorothy Perkins
FROM: Code 420/John Bolton
SUBJECT: Research Fellowship Proposal

1. Instrument Systems Engineer, GS-14, annual salary \$102,210
2. Resume of education background:
 - a. University of Chicago, University of Illinois; MSc, Physics (1973), MSc Chemistry (1975)
 - b. Multiple Goddard Achievement and Monetary Awards
3. Professional activities:
 - SPIE Lens Design Conference (1985)
 - Breault Research Corporation, stray light analysis, optical design course (1985)
 - SPIE Large Telescope Conference (1986)
 - SPIE Lens Design Conference (1986)
 - CORM Conference (1987)
 - SPIE Optics Conference (1987)
 - SPIE Remote Sensing Conference (1988)
 - SPIE Optical Design Conference (1988)
 - SPIE Optical Science & Engineering Conference (1989)
 - Next Generation Space Telescope Workshop (1989)
 - ASAP (Breault Research Organization) course (1989)
 - IGARSS Conference (1990)
 - SPIE Space Astronomical Telescopes and Instruments Conference (1991)
 - IGARSS Conference (1991)
 - Spacecraft engineering short course (1992)
 - SPIE Optical Science & Engineering Conference (1993)
 - ERIM Airborne Remote Sensing Conference (1996)
 - ERIM GIS and Remote Sensing Conference (1998)
 - Establish CARSTAD web site (1998)
 - ENVI remote sensing software course (with hyperspectral emphasis) (1999)
 - CLEO'99 Conference (1999)
 - ERIM Airborne Remote Sensing Conference (1999)
 - ASPRS meeting and ENVI Workshop (2000)
 - Space Mission Analysis and Design (SMAD) course (2000)
 - Joint development of Education and Outreach and CARSTAD web sites (2001)
 - Mid-Atlantic Land Use / Land Cover Workshop (2001)
 - Establish Remote Sensing Education and Outreach Laboratory (RSEOL) (2001)
 - Initiate development of the RSOL project (2001)

- Fig2002 conference in Washington, D.C. (2002)
- Fifth International Airborne Remote Sensing Conference (2002)

4. Description of present duties and responsibilities:

Since December 2001 I have been assigned to the EOS Program Office. As an Instrument Systems Engineer, in my previous assignments in STAAC (Code 730/740) I served the EOS Project since EOS started at Goddard, and thus I am familiar with all of the EOS instruments and technologies.

I am working to investigate new, state-of-the-art instrument technologies. The technologies of particular interest are high spectral and spatial resolution passive optical imagers. This would be an extension of technologies employed on the EOS MODIS and ASTER instruments, as well as technologies that were not utilized for the EOS Missions. These technologies are particularly applicable to the EO-1 mission and follow-on activities.

In addition to technology development, I am also engaged in several education and outreach efforts directly related to the activities of the EOS Program Office. One of these is the Remote Sensing Education and Outreach Laboratory (RSEOL), established in collaboration with the Education Office (Code 130) and the Earth Sciences Education and outreach Office (Code 900). Also I have set up, in collaboration with industry, the Remote Sensing On-Line web server (RSOL) which provides user-friendly access to remotely sensed data, MODIS direct broadcast data in particular.

5. Nature of the proposed research, time schedule, name and location of the proposed program facility, and the proposed program's value to the GSFC and to career objectives:

The proposed research is the development of the Full Spectral Imaging (FSI) and Spectro-Spatial Compression (SSC) concepts. These concepts were formulated as a result of my many years of experience with remote sensing instruments, and with the development of hyperspectral imaging instruments in particular. The primary benefit of FSI and SSC would be a dramatic reduction in data volume, facilitating the full exploitation of high spectral and spatial resolution remote sensing systems.

I have discussed these concepts with many colleagues inside and outside NASA, and have received enthusiastic encouragement to pursue the development of their principles. I have submitted an abstract for a paper on FSI and SSC at the SPIE "Sensors, Systems, and Next Generation Satellites IX", in Barcelona, Spain in September, 2003.

The specific objective of the Goddard Research Fellowship would be to demonstrate the feasibility of FSI and SSC. The first year of the work would be devoted to a theoretical analysis of the problem, and to attempt to apply the principles to real remotely sensed data. In parallel with this work, plans for the modification of remote sensing instrumentation that would fully utilize FSI and SSC would be developed.

An FSI and SSC feasibility study would require approximately one year, starting in the Spring of 2004. The work would be done at, and in collaboration with the Department of Earth Observation Science (EOS) at the International Institute for Geo-Information Science and Earth Observation (ITC in Enschede, Holland. I have had extensive discussions regarding FSI and SSC with members of the newly formed EOS Department at the ITC. The following is some background information about the ITC and the EOS Department extracted from their web site, and through contacts with the staff.

The International Institute for Geo-Information Science and Earth Observation, established in 1950 under the name International Training Centre for Aerial Survey (hence ITC), is an autonomous organisation operating under the aegis of the Ministry of Education, Culture and Science and the Minister for Development Cooperation of the Netherlands and closely linked to Twente University. It is the oldest and largest international higher education institute in the Netherlands, and seeks to promote the sound application of geo-information technology through programmes of research, education and project services.

ITC is an internationally recognized centre of excellence aiming at capacity building and institutional development specifically in countries that are economically and/or technologically less developed.

The Department of Earth Observation Science (EOS) deals with earth observation technology for problem solving. Problem solving means primarily identification of solutions for large-volume producers of geo-information and identification of solutions for application domains.

The staff at the ITC includes many people with expertise in the areas required for this study. Prof Freek van der Meer is a full professor of imaging spectrometry (in Delft), working at ITC. Prof Andrew Skidmore has published many articles on the application of hyperspectral images. Prof Alfred Stein, head of the EOS Department, is a mathematician and a statistician. Several PhD students are researching hyperspectral topics. ITC has worked closely together with people from DLR (German Aerospace Center) in their HySens DAIS / ROSIS Imaging Spectrometer campaigns. The ITC has more than 50 years of experience in earth observation and remote sensing applications. The ITC has a Remote Sensing and a Geographic Information Systems (GIS) Laboratory.

The Chairman of the EOS Department, Prof. Dr. Alfred Stein, has agreed to host me and to provide a collaborative environment at the ITC for the duration of the Goddard Fellowship. I have been in regular contact with Dr. Norman Kerle, Assistant Professor in the EOS Department, discussing the details of the work that I would do and with whom I would work. For several years I have maintained a close professional relationship with Wim Bakker, Lecturer in the Department of Geo-information Processing. Wim has provided information about the ITC which has convinced me that the ITC would be an ideal location for this research, and he has helped me to get in contact with the appropriate people.

Prior to determining that the ITC would be the best institution with which to collaborate on this research, I discussed the matter with several governmental organizations and educational institutions in the US, most notably the Center for Imaging Science at the Rochester institute of Technology. After two visits and many phone and e-mail contacts, we agreed that even though there was a good possibility for collaboration, Rochester would not be the best option at this time.

The Fellowship would be of great benefit to both Goddard and me. Examination of the FSI and SSC concepts, and possible development of the concepts, if they prove viable, would revolutionize the way in which passive optical remote sensing is done.

FSI and SSC could be applied to advanced MODIS and ASTER-type instruments, follow-on EO-1 type instruments, as well as to commercial instruments such as LANDSAT and SPOT. These activities fit in with both NASA's and Goddard's strategic plans to advance and augment methods for Earth observation.

Development of the FSI and SSC concepts, in combination with my other areas of expertise in the development of low cost, high performance airborne remote sensing systems would be of great benefit to the remote sensing community, particularly to the part of the community that has limited resources. As the ITC specializes in working with countries that are "economically and/or technologically less developed", this would be a particularly appropriate activity.

6. List of publications, reports, or other appropriate material.

- Paper on MODIS calibration system design at Conference on Optical Radiation Measurements (CORM), Gaithersburg, MD
- Paper as a representative of Code 725 in collaboration with the Space Telescope Science Institute (STScI) on the conceptual design of an advanced space telescope containing many of the concepts currently being considered for the Next Generation Space Telescope
- Developed conceptual design and performed end-to-end analysis of MODIS-T instrument (*Hyperspectral Transfer Radiometer*) as a joint project for the Engineering Directorate and the EOS Instruments Project
- Presented a paper on *imaging spectrometer technology*, directly related to development of the proposed MODIS-T instrument, at International Geophysics and Remote Sensing Society (IGARSS), Houston
- Filed a disclosure for a patent on a *hyperspectral* imaging instrument system, based on work done for MODIS-T and the EOS Instruments Project
- Awarded a DDF on Image Correlation Tracker (ICT) stabilized pointing system in collaboration with the Guidance, Navigation, and Control (GN&C) Branch
- Developed the *Instrument Geolocation and Pointing Stabilization System* (IGPSS) concept for airborne imaging instruments
- Filed a disclosure for a patent on the *IGPSS* and initiated commercialization activity
- Filed a disclosure for a patent on a digital terrain mapping system based on the concepts developed for the *IGPSS* and in support of Code 900 and commercial efforts to develop topographic mapping systems
- Organized and managed the EOS instrument proposal (original AO) technical review team (consisting of civil servants and contractors), which provided technical evaluations of all 81 EOS instrument proposals
- Organized an in-house seminar on CCD detectors in collaboration with the Goddard Detector Branch and JPL
- Established and managed PRA (Photon Research Associates) contract for Code 900 in support of scene simulation activities for Code 900 and the EOS Project
- Organized and chaired a panel discussion on *commercial airborne remote sensing* for ERIM'99 Airborne Remote Sensing Conference

- Proposed to establish the *Chesapeake Bay Remote Sensing Consortium* (CBRSC)
- Goddard Research and Study Fellowship Program to further knowledge of remote sensing instrument technology with the Remote Sensing Group at the Technical Research Center of Finland (VTT), Otaniemi, Finland. This work led to the development of a *commercial airborne imaging spectrometer*
- Served as instrument systems engineer for the EOS-PM Project reviewing and providing critical instrument systems support for the Atmospheric InfraRed Sounder (AIRS) instrument development by JPL at Loral InfaRed Imaging Systems (LIRIS) (currently BAE Systems), Lexington, MA
- Proposed establishment of the *Center for Airborne Remote Sensing and Technology Development* (CARSTAD) in conjunction with Code 900 at Wallops. CARSTAD follow-on activities (primarily the development of the CARSTAD web site) were done in support of remote sensing technology development and education and outreach for the EOS Program Office, and in support of Goddard's Technology Commercialization Office
- As a result of imaging spectrometer development and commercial activities, collaborated with Code 935 and regional Maryland authorities and politicians in the preparation for establishment of *Regional Application Center* (RAC) in Easton, MD
- Collaborated with the Applied Information Sciences Branch (Code 935) and industry to develop *hyperspectral applications* utilizing expertise obtained from EOS experience and Goddard Research and Study Fellowship
- Developed innovative (not requiring sophisticated calibration laboratory equipment) *hyperspectral imager calibration* procedures in collaboration with Code 935 and industry
- Assumed responsibility for maintaining the *Remote Sensing Tutorial* (RST) at the web site (<http://rst.gsfc.nasa.gov>) in collaboration with its author, Dr. Nicholas Short (formerly Code 935).
- Initiated development and secured funding from the Technology Commercialization Office (TCO) for commercialization of the *IGPSS* project
- Develop working relationship with the Center for Imaging Science (CIS) at the Rochester Institute of Technology (RIT) to develop *advanced remote sensing instrument technology*
- Developed the basic concepts for *Full Spectral Imaging (FSI) and Spectro-Spatial Compression (SSC)*, a revolutionary approach to remote sensing

Enclosure 1.

**Research Fellowship Program
Financial Requirements**

All reimbursable costs associated with a Fellowship must be reflected in this part of the application. Costs will need to be identified with the fiscal year in which they are received.

Research Fellowship

Travel From: Columbia, MD

To: ITC, Enschede, Holland

Date: April 2004

Cost: \$1950

From: ITC, Enschede, Holland

To: Columbia, MD

Date: April 2005

Cost: \$2350

Any additional travel requirements:

From: _____

To: _____

Date: _____

Cost: _____

Purpose of travel: _____

Total Travel Cost: \$4300

Per diem: Start Date: April 2004

End Date: April2005