New Mexico NASA EPSCoR
Year 3 Progress Report
Contract NNX09AP69A

1. **Project Title**: New Mexico Exoplanet Spectroscopic Survey Instrument (NESSI)

2. **Grant number**: NNX09AP69A

3. **PI name & contact information**:

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5. **Award Institution**: New Mexico State University (NMSU)

6. **Award date**: 8/1/2009

7. **Date of report**: May 18, 2012

8. **Research accomplishments measured against the proposed goals and objectives**.

Instrumentation: Since May, 2011 (the previous update) the NESSI project has completed its Final Design Review with our JPL Collaborators (July, 2011) and purchased the majority of the NESSI optical components due to a restoration of most of the NESSI hardware funds from NMT. NESSI mechanical assemblies are under construction using several firms in the New Mexico and Arizona areas, and the intentions are to have the NESSI subassemblies completed and assembled later this fall. The specifications, contracting and assembly work are being undertaken by the NESSI team at NMT: Dr. Michelle Creech-Eakman (science PI), Dr. Michael Hrynevych (postdoc/assembly-integration-verification planning), Mr. Luke Schmidt (PhD candidate), Ms. Heather Bloemhard (PhD student), Ms. Genevieve Vaive (undergraduate), Mr. Matt Napolitano (undergraduate) and unpaid engineers working with

the NESSI project from the Magdalena Ridge Observatory: Dr. Colby Jurgenson (optical engineer), Dr. Fernando Santoro (mechanical engineer), Mr. Andrea Olivares (mechanical engineer), Mr. Rob Selina (assembly-integration with the 2.4m observatory planning), and the assistance of a junior mechanical engineer at MRO: Mr. Chris Salcido. Occasional telecons to discuss design goals and tradeoffs were held with the NASA-JPL collaborators, principally: Dr. Mark Swain, Dr. Gautam Vasisht, and a new member of the JPL Exospec Team, Dr. Pieter Deroo. Contracts were let for NESSI components with: ISP Optics for the cold optics, Rainbow Research Optics Incorporated for the light-weighted k-mirrors, Optical Surfaces Ltd. for the infrared/optical dichroic, Rocky Mountain Instruments for the autoguider optics, Finger Lakes Instruments and E2V for the autoguider camera and detector, Optical Surfaces Ltd. for the NESSI filters, Newport Richardson Grating Labs for the grisms, and Newport Opto-mechnical Subdivision for the derotator stage. Ongoing telecons on a bi-weekly basis with Universal Cryogenics for the NESSI cryostat continue and we expect to conduct factory acceptance testing and receive the cryostat in June, 2012. The NESSI mounting structure is being fabricated in two machine shops in the Albuquerque area: JW Industries and Pro-Fab Incorporated. Ongoing discussions with Richard Blank at Teledyne and Bob Leach at ARC Software on the specifications for detector and the off-the-shelf electronics continue. Three students over the past year have been involved in the design work for the NESSI software, and they are currently prototyping software in the lab using motors, the k-mirror derotator stage and the autoguider camera to build interfaces to all the NESSI components. Personnel issues continue to affect progress, in particular, our second postdoc, Michael Hrynevych, decided to return to Austrailia and take over his parent's home after the death of both of his parents two years ago. He has decided to leave the field of astronomy and take up a new career in Australia. We are presently using the assistance of an engineer at MRO to take up the assembly planning and integration activities Dr. Hrynevych was conducting before he left. Second, while most of the pledged funding (separate from the EPSCoR matching funds) from MRO PI Dr. Van Romero's office was restored to pay for the NESSI hardware in October 2011, there is not enough funding to cover the cost of the H2RG detector array (a $250,000 item for an engineering grade detector, and $350,000 for a science grade device). Thus, an NSF Major Research Instrumentation proposal was submitted in Jan, 2012 to cover the cost of a science-grade detector. Additionally, two other faculty in the NMT Physics Dept. (Dr. Dave Meier and Dr. Raul Morales-Jubieras) participated as Co-I's on the NSF proposal to support the purchase of a set of narrow-band filters for NESSI to be used for imaging galaxies and solar system objects – principally Jupiter and Saturn. Finally, funding was secured from LANL's New Mexico Consortium ($10,000) in support of 3-day exoplanet workshop (*Making New Worlds: Atmospheric, Thermal and Astrobiological Interpretation of Exoplanets*), held in May 2012 at the Sevilleta Conference Center. Fifteen scientists from across several disciplines (astronomy, physics, planetary sciences, biology, geology and vulcanology) and another ten scientists and students from NMT participated in the workshop and plans have been formulated to produce a white paper about our discussions, to be published later in 2012 in the journal *Astrobiology*.

We are presently behind on spending, which has resulted in our request to NASA one month ago for a no-cost extension. The principal reasons for being behind include: 1) NESSI is not yet complete and so the funds to support telescope observations ($3100/night plus overheads) have not been used for either commissioning or to support student science, and 2) the continued inability to maintain a full complement of staff on the project. We will attempt to internally advertise for a postdoc at NMT, if the no-cost extension is successful, for the final year of the project. We are also going to try to find another undergraduate student to participate on the project. Finally, discussions have started with Dr. William Andersen at ENMU to find students at his institution to conduct science observations with NESSI. Another faculty member at a small institution in NM without telescope access is trying to be identified. Both faculty members and their students can be supported for travel to MRO when the NESSI observations for their science projects are undertaken.

Presentations/Publications: Dr. Creech-Eakman has given presentations/briefings at the following venues: Dr. Mario Perez, NASA Contract Monitor on EPSCoR project, briefing, Albuquerque, NM, June, 2011; NESSI Final Design Review, NMT with Dr. Mark Swain, Dr. Gautam Vasisht, Dr. Pieter Deroo and Dr. David Buscher present, July, 2011; Astronomy Seminar, Dept. of Physics, University of Missouri, "NESSI, Exoplanet Atmospheres, and IR Spectroscopy at NMT", Oct, 2011; Physics Dept. Colloquium, NMT, "NESSI, Exoplanet Atmospheres, and IR Spectroscopy at NMT", Nov, 2011; private visitors to MRO in Nov 2011 and March, 2012 regarding NESSI and exoplanet science; "NESSI and Exoplanet Spectroscopy at NMT" keynote talk at *Making New Worlds* exoplanet meeting, Sevilleta Field Station, May, 2012. Dr. Michael Hrynevych presented a poster on "NESSI Design Progress and Exoplanets Spectroscopy" at the NM Symposium, NRAO, Socorro, Oct, 2011, and a talk "NESSI and Exoplanet Observations" at Columbia University astronomy lunch talk series, Jan, 2012. Ms. Heather Bloemhard presented a poster at the American Astronomical Society 219th Meeting, Jan, 2012 in Austin, TX "Characterizing the Atmospheres of Highly-Irradiated Hot-Jupiters". Additionally, two papers have been submitted and accepted for poster presentations at the SPIE Meeting in the Netherlands, July, 2012. Dr. Creech-Eakman will additionally be a moderator at a special session on Exoplanets at the American Astronomical Society Meeting in Anchorage, AK, June, 2012. Finally, Dr. Creech-Eakman will be speaking at the NM Museum of Natural History evening lecture series in Aug, 2012 about NESSI and the MRO Interferometer.

Proposals: Dr. Creech-Eakman submitted an NSF MRI proposal in Jan, 2012 to support the NESSI detector and narrow-band filters to support other science at NMT using the instrument. (Anticipated response from NSF is Aug, 2012). Dr. Boston submitted a second proposal (the first one last year was redacted due to LANL funding issues associated with the Los Conchos fire) to Dr. Steve Buelow at Los Alamos National Labs to support a May 2012 workshop on Exoplanets (NT2 Workshop in original proposal, in anticipation of NESSI first light in fall 2012.) The proposal was funded at the level of $10,000 and the workshop conducted earlier this month (May 13-16). Ms. Heather Bloemhard submitted 3 observing

proposals to NASA IRTF to undertake observations of 3 exoplanets. She has been awarded 10 -- ½ nights to observe eclipses of the three planets, and is waiting to hear on her final request for a final ½ night on one system to replace an earlier one with bad weather. Additionally, Dr. Creech-Eakman intends to submit a NASA Origins proposal in late May, 2012 for support of science observations with NESSI at MRO for 2013-2015.

9. Systemic Change as Evidenced by:

a) improvements in jurisdiction research and development infrastructure;

These improvements include:

1. development of a competent design team of engineers, postdocs and students for the NESSI instrument at MRO/NM Tech
2. outreach to other scientists in NM, AZ, CA, CO, PA, UK, and at NASA Centers as part of the NT2 workshop
3. interactions with vendors throughout the US and in the UK for components that are included in NESSI instrument

b) increased financial commitment from the jurisdiction, industry, and participating institutions;

In particular NM Tech MRO Management and NM Tech Administration is strongly behind the development of NESSI and has released professional engineers for several months of initially unanticipated design assistance on the project of approximately 30 months of FTE over the past year from principally 3 professional engineers. Pledged money was received via the NM Consortium after initial conversations with LANL and in support of scientists and students to attend the NT_2 workshop. The institutions include: NASA JPL, NASA Goddard, Lowell observatory, Queen Mary, Univeristy of London, College of William and Mary and University of Penn.

c) response of activities to NASA and jurisdiction priorities :

in particular the submission of an NSF instrumentation proposal in Jan 2012, and an anticipated NASA Origins proposal to support NESSI activities to be submitted at the end of May 2012.

10. Examples of successful technology transfer to the private sector.

The principal technology transfer at this time is in the design of NESSI instrument as evidenced via conference papers and discussions and purchasing of components from our vendors.

11. Extent to which collaborations with jurisdiction agencies, industry, research and academic institutions, and NASA have evolved.

The principal evolution in relationships associated with NESSI are with: 1) industry partners to whom contracts for the NESSI instrumentation was released (e.g. Universal Cryogenics, JW Industries, ISP Optics, Rainbow Research, Optical Surfaces Ltd, Rocky Mountain Instruments, Finger Lakes Instruments, E2V, Teledyne Imaging, Newport, ARC Instrumentation) and 2) community persons, university researchers, and national lab and NASA center individuals interested in the NT_2 workshop. These relationships have been developed via ongoing telephone discussions, requests for information and quotes (from the vendors), presentations, and discussions associated with and holding of the NT_2 workshop. Continued affects will be felt via our white paper resulting from the workshop.

12. Discussion of interaction between and cooperation with the jurisdiction's Space Grant Consortium.

The NM Space Grant Consortium helps identify colleagues at institutions within the district that have similar research goals to those of the project. They hold a yearly meeting at which EPSCoR groups report project results and seek additional contacts. They also provide technical support on the expenditure of project funds. Finally, they provide administrative support on the submission of project reports. Graduate students on the NESSI project at NMT (Mr. Luke Schmidt and Ms. Heather Bloemhard) have submitted to NMSGC calls for supplementary funding to support the research they are undertaking as part their work on the NESSI and related astronomical projects. To date these proposals have not been funded.

13. **Research success of individual investigators as measured by**: See attached Spreadsheet

14. **Demographic (ethnicity/race and gender through self identification) information on participants:** See attached Spreadsheet