University of Nevada, Reno

Nevada Center for Applied Research

Development of Spectroscopic Plasma Diagnostics for Measurement of Electromagnetic Fields

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Quarterly Progress Report

Reporting Period: July 1st to September 30th, 2015

October 2015

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Project Purpose

A time-resolved, multi-axis spectroscopic diagnostic is being developed for the simultaneous measurement of magnetic fields, electron densities and temperatures in dense magnetized plasmas. These plasmas are found in neutron generators such as NSTec's Dense Plasma Focus (DPF), the NTF Zebra Z-pinch and Sandia's Z machine. This major goal of this project will be the measurement and interpretation of emission spectra to more accurately understand plasma conditions in these machines. Spectral phenomena such as Zeeman splitting, Stark and Doppler broadening and polarization of emitted light will be used to characterize the plasmas. The experimental diagnostics and technique will be developed in parallel with more accurate computational models in order to gain a more complete picture of plasma conditions that lead to neutron production.

This project addresses many technology needs assessments identified by the National Nuclear Security Administration (NNSA) for Neutron Diagnosed Subcritical Experiments (NDSE) and would help NSTec's to maintain leadership in this arena. Currently, NSTec uses DPF technology for NDSE efforts, but neutron source performance improvements are limited by an incomplete understanding of the pinched-plasmas in the machine.

The project is important in that field diagnostics will help to create more accurate computational models of DPF physics that could lead to optimization of neutron yields and more reliable machine performance. Secondly, these diagnostics could provide expanded opportunities for NSTec on other high energy density plasma physics platforms such as the National Ignition Facility (NIF) or Z. Finally, the close interface between NSTec and UNR personnel will also help strengthen ties between industry and the academy and may lead to in state employment opportunities for UNR students.

Section I: Proposal Progress

Project activities for the July 1st- September 30th, 2015 reporting period are summarized below.

The NSTec project lead (Eric Dutra) has enrolled in the UNR Physics Department's PhD program and the company will support him (3/4 FTE) while he pursues an advanced degree. Eric has already started to help field experiments on Zebra Z-pinch in order to gain first hand experience of machine behavior and core diagnostics.

During the reporting quarter, significant progress has been made toward meeting proposed metrics. Major accomplishments for the current reporting period include:

1. **Major Accomplishment 1**

Mr. Dutra secured matching funds for this effort by submitting and winning a competitive proposal to NSTec's Site Directed Research and Development (SDRD) program. Eric's proposal will be funded for a three-year period and will start with the new federal fiscal year (Oct 1st).

2. **Major Accomplishment 2**

A task order was completed to bring all of Eric's spectroscopy equipment from Livermore to Reno. This includes high-resolution optical spectrometers, white light streak cameras, CCD cameras, electronics, calibration sources and optics. This equipment is being set up and calibrated in the NTF optical diagnostics laboratory and will be moved onto the main experimental floor during campaigns.

3. Major Accomplishment 3

Thomas Floyd (NSTec Sr. Safety Specialist) travelled to NTF in early September to survey the work environment and make sure it meets specific NSTec occupational safety requirements for employees working offsite. Fortunately, he was satisfied with the overall safety of the environment and the work order was processed and sent to OSPA.

4. Intellectual Property

N/A

5. Programmatic & Project Changes

A ½ time Postdoctoral Research Fellow (Post Doc) has been hired in place of a Graduate Research Assistants (GRA) to help with NSTec projects. This will replace one GRA and overload for a faculty member in the original budget. This was necessary given that the Physics Department and NTF have recently landed five separate competitive research grants and there were not enough uncommitted GRAs to cover all projects. In addition, Dr. Roberto Mancini, who will be helping with plasma modeling efforts, is already oversubscribed and no longer has any overload available. In this case, a dedicated post doc who has both modeling and experimental experience would be extremely beneficial to help get these projects moving in the short 2-year window we have to deliver on these systems.

6. Looking Forward

This project has been broken down into quarters on the federal fiscal year to help synchronize with the SDRD.

By Quarter, this years goals are:

Q1 (Oct-Dec 2015) Transfer all equipment needed to make 2-D spectroscopic measurements to UNR. Start to develop a working model of spectroscopic behavior of plasmas under investigation

Q2 (Jan-Mar 2016) Set up and characterize both spectroscopic systems (high resolution Zeeman and Broadband Optical) and improve models.

Q3 (Apr-Jun 2016) Start experimental series at NTF.

Q4 (Jul-Sep 2016) Analyze data and publish results

Section II: Performance

Table 2. Progress toward Metrics

[No narrative just insert Scorecard here.]

Project Scorecard Narrative

[Add supporting narrative here]

Section III: Budget

[Optional budget narrative related to project expenditures. This does not replace the need to report to the GOED Business Office.]

NTF/NSTec Spectroscopic Plasma Diagnostics- KF Expenditures July 1st – September 30th, 2015			
	Estimate (Year 1)	**Expenditures** Inception to Date July 1st – Sept 30, 2015	**Expenditures** Current Period July 1st –Sept 30th, 2015
Total Salary & Benefits	$ 65,000	$ 0,000	$ 0,000
Equipment	$ 20,000	$ 0,000	$ 0,000
Travel	$ 5,000	$ 0,000	$ 0,000
Other Direct Costs	$ 10,000	$ 0,000	$ 0,000
Graduate Tuition	$ 0,000	$ 0,000	$ 0,000
Total	**$ 100,000**	**$ 0,000**	**$ 0,000**

NTF/NSTec Spectroscopic Plasma Diagnostics- NSTec Expenditures July 1st – September 30th, 2015			
	Estimate (Year 1)	**Expenditures** Inception to Date July 1st – Sept 30, 2015	**Expenditures** Current Period July 1-Sept 30, 2015
Total Salary & Benefits	$ 43,000	$ 0	$ 0
Equipment	$ 20,000	$ 0	$ 0
Travel	$ 5,000	$ 0	$ 0
Other Direct Costs	$ 5,000	$ 0	$ 0
Graduate Tuition	$ 0,000	$ 0,000	$ 0,000
F&A	$ 19,050	$ 0,000	$ 0,000
Total	**$ 92,050**	**$ 0,000**	**$ 0,000**

Project Income in each category is as follows:

Grants/Contracts:

This project will provide grant/contract income from NSTec to help support a student or post doc.

Gifts: N/A.

Cont Ed/ Outreach: NSTec is supporting one of their scientists to continue his education at ¾ FTE. The unburdened equivalent of this salary is ~$85k/year for the duration of his studies at UNR.

Other contributions:

NSTec has provided Eric and this project with a tremendous number of extremely expensive streak cameras and spectroscopic equipment to help ensure programmatic success.

NTF/NSTec Spectroscopic Plasma Diagnostics Income

July 1st – September 30th, 2015

	Estimate (Year 1)	Income Inception to Date April 1, 2014 – Month 31, 2015	Income Current Period Month 1-Month 31, 2015
Grants / Contracts*	$ 92,050	$ 0,000	$ 0,000
Gifts	$	$ -	$ -
Cont. ED/ Outreach	$ (85,000)	$ -	$ -
Other Contributions*	$	$	$
Knowledge Fund	$ 100,000	$ 0,000	$ 0,000
Total	**$ 192,050**	**$ 0,000**	**$ 0,000**

Section IV: Weekly/Monthly Logs of [Project] Activities for Reporting Quarter

Section V: Appendices

Appendix 1 – Sales Pipeline

[Only include opportunities that are new or have progressed in the sales pipeline. List multiple opportunities with the same company separately. Include the TOTAL previous and current number (#) of opportunities in each stage of the sales pipeline. Company names may be anonymized with unique identifiers only if required by confidentiality agreements. Attach spreadsheet if needed]

Company Name	Company Type	Opportunity Type	Notes (Progression and Next Step)
Leads - Awareness (346 - 432)			
Bayer	Life Science	Collaboration	Follow-up discussion at a conference
Prospects - Interest (56 - 79)			
MGM Resorts	Hotels and Gaming	Option	Expressed interest in licensing a game - Setup Demo
Qualified - Desire (19 - 26)			
Sams Software	Startup	License	Experienced entrepreneur wants to use IP for a startup - conduct background check
Negotiation - Action (7 - 5)			
Outotec	Water Solution Provider	Membership	Membership proposal submitted, awaiting response - follow-up next week
Won or Lost (2 - 4)			
VA Hospital	Hospital	Product Sales	2 year supply of widgets - make more widgets

Appendix 2 – Scorecard Supporting Documentation