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**RPPR Final Report**  
as of 12-May-2021

Agency Code: 21XD

Proposal Number: 74312ELREP

**Agreement Number: W911NF-19-1-0497**

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**Report Date:** 09-Jun-2021

Date Received: 12-May-2021

**Final Report** for Period Beginning 10-Sep-2019 and Ending 09-Mar-2021

**Title:** Optical/Infrared Microscopy and Spectroscopy System for the Characterization of Point Defects and Carrier Dynamics in 2D and 3D Semiconductors

**Begin Performance Period:** 10-Sep-2019

**End Performance Period:** 09-Mar-2021

**Report Term:** 0-Other

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**Distribution Statement:** 1-Approved for public release; distribution is unlimited.

**STEM Degrees:** 2

**STEM Participants:** 6

**Major Goals:** The main goal in this project was to augment the research capabilities at CCNY through the acquisition of three complementary items, namely, a super-continuum laser, a superconducting infra-red (IR) photo-detector, and a streak camera. The plan was to incorporate these instruments into existing optical microscopes and/or to develop supporting systems that would allow their use.

**Accomplishments:** The list below highlights the key accomplishments of the project:

\* Prior to purchasing the requested instruments, we used funding from other sources to buy and install two optical tables along with surrounding canopies and light containing boxes. The attached file contains some photos of the completed system.

\* Leveraging this infrastructure, we purchased and installed all three proposed items, namely, a supercontinuum laser from NKT Photonics (SuperK EXTREME EXR-20), a streak camera from Hamamatsu (C10910), and a superconducting wire photo-detector from ID Quantique (ID281). Photos of each of these systems can be found in the attached pdf document.

\* We integrated the supercontinuum laser to one of our existing systems in the Menon Lab. The system is setup, however, with configurable fiber couplers, which allow us to use the laser beam for different applications in neighboring laboratories too (see attached photo)

\* We built a dedicated optical setup around the streak camera; remote access from other microscopes in our laboratories is also possible through the use of optical fibers. We refer the reader to the attached photograph for further details.

\* We integrated the superconducting wire photo-detector to our Montana microscope in a neighboring optical table (this system combines optical and atomic force microscopy along with magnetic resonance control at variable temperatures). In parallel, we are presently completing another microscope immediately adjacent to the photo-

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detector which is explicitly designed for measurements in the infra-red window around 1000 nm (where the detector is most sensitive).

\* Upon negotiating the final price with the vendors, we saved sufficient money (\$19,750) to buy a monochromator and a CCD camera from Princeton Instruments, which we have already integrated to one of our existing microscopes (see attached pdf file).

**Training Opportunities:** Installing and integrating the purchased instruments with existing instrumentation has served as a valuable training experience for several postdocs and graduates. One example is Richard Monge, a minority graduate student, whose thesis work centers on the development and application of an optical microscope for spin-probe-based scanning microscopy at variable temperatures. Richard has learned not only to operate the photo-detector but also developed the interface required to integrate it with his own microscopy system. Other examples are graduate students Gabriel Lopez-Morales, Rezlind Bushati, and Prathmeth Deshmukh as well as postdocs Artur Lozovoi and Sachin Sharma, who have learned how to leverage these instruments for their research work.

**Results Dissemination:** Both PIs presented their research activities - many of which explicitly benefitted from these instruments - in multiple conferences including the 2021 and 2020 APS March Meeting, the 2021 CLEO conference, the 2020 ISMAR conference, the 2021 ENC conference, the 2021 and 2020 OSA conferences, etc.

**Honors and Awards:** Vinod Menon was elected an Optical Society of America (OSA) fellow.

**Protocol Activity Status:**

**Technology Transfer:** Nothing to Report

### **PARTICIPANTS:**

**Participant Type:** PD/PI

**Participant:** Carlos Andres Meriles

**Person Months Worked:** 1.00

Project Contribution:

National Academy Member: N

**Funding Support:**

**Participant Type:** Co PD/PI

**Participant:** Vinod Menon

**Person Months Worked:** 1.00

Project Contribution:

National Academy Member: N

**Funding Support:**

**Participant Type:** Graduate Student (research assistant)

**Participant:** Richard Monge

**Person Months Worked:** 1.00

Project Contribution:

National Academy Member: N

**Funding Support:**

**Participant Type:** Graduate Student (research assistant)

**Participant:** Gabriel Lopez Morales

**Person Months Worked:** 1.00

Project Contribution:

National Academy Member: N

**Funding Support:**

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**Participant Type:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Participant:** Daniela Pagliero  
**Person Months Worked:** 1.00 **Funding Support:**  
Project Contribution:  
National Academy Member: N

**Participant Type:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Participant:** Artur Lozovoi  
**Person Months Worked:** 1.00 **Funding Support:**  
Project Contribution:  
National Academy Member: N

**Participant Type:** Postdoctoral (scholar, fellow or other postdoctoral position)  
**Participant:** Artur Lozovoi  
**Person Months Worked:** 1.00 **Funding Support:**  
Project Contribution:  
National Academy Member: N

**Participant Type:** Graduate Student (research assistant)  
**Participant:** Rezlind Bushati  
**Person Months Worked:** 1.00 **Funding Support:**  
Project Contribution:  
National Academy Member: N

**Participant Type:** Graduate Student (research assistant)  
**Participant:** Prathmesh Deshmukh  
**Person Months Worked:** 1.00 **Funding Support:**  
Project Contribution:  
National Academy Member: N

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**Partners**

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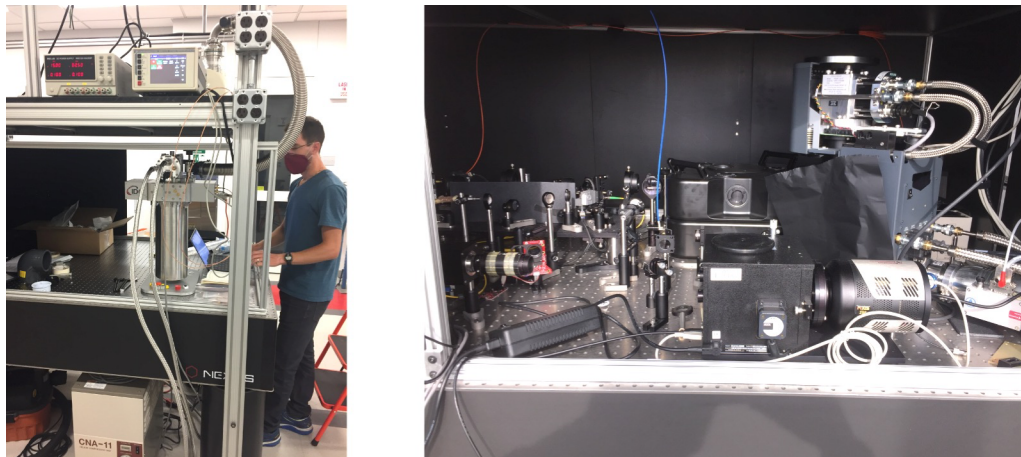
I certify that the information in the report is complete and accurate:

Signature: Carlos A. Meriles

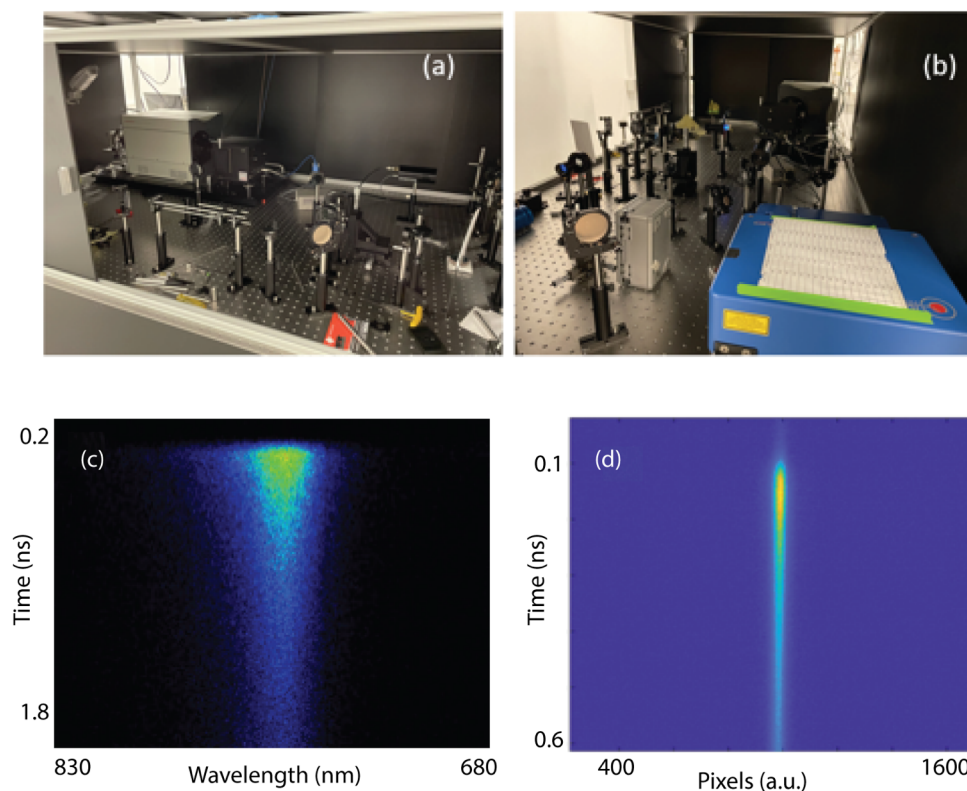
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**Figure 1:** Prior to installing the requested items, we erected the physical infrastructure required to operate the instruments in the form of two optical tables and accompanying canopies and light enclosure boxes. The photo series summarizes our work, starting from an empty room (upper left) to the completed system (lower right).



**Figure 2:** (Left) Image of the ID Quantique superconducting wire photodetector. (Right) Image of the Princeton Instruments monochromator.



**Figure 3:** (a). Image of the Hamamatsu streak camera. (b). Image of the optical system built around the streak camera. (c) Wavelength resolved photoluminescence lifetime from a monolayer WSe2 flake, showing a lifetime of about 100 ps. (d) Space resolved lifetime from CdSe quantum dots, showing reduced in-plane diffusion and a lifetime of about 200 ps.



**Figure 4:** Image of the NKT Photonics supercontinuum laser.