TASK ORDER NUMBER: W81XWH-15-9-0001-7
MTEC RESEARCH PROJECT NUMBER: W81XWH-15-9-0001

EGS NUMBER: MT17008.034
TITLE: MTEC-17-08-MT-0340; The Effects of Complete and Partial Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) with Pharmacologic Treatment in Swine Models of Hemorrhagic Shock, Traumatic Brain Injury, and Complex Vascular Injuries.

PRINCIPAL INVESTIGATOR: Hasan B Alam, MD, Research Project Lead

PERFORMING ORGANIZATION: Northwestern University
676 North St. Clair Street, Suite 2320
Chicago, IL 60611
Phone Number: 312-926-4962

CONTRACTING ORGANIZATION: Medical Technology Enterprise Consortium (MTEC)

REPORT DATE: 09/24/2021

TYPE OF REPORT: Annual Report (with an Updated Statement of Work)

PREPARED FOR: U.S. Army Medical Research and Development Command
Fort Detrick, Maryland 21702-5012

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE 09/27/21	**2. REPORT TYPE** Annual	**3. DATES COVERED** 10/22/20 – 09/24/21

4. TITLE AND SUBTITLE MTEC-17-08-MT-0340; The Effects of Complete and Partial Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) with Pharmacologic Treatment in Swine Models of Hemorrhagic Shock, Traumatic Brain Injury, and Complex Vascular

5a. CONTRACT NUMBER
W81XWH-15-9-0001

5b. GRANT NUMBER
N/A

5c. PROGRAM ELEMENT NUMBER
(Can be blank if don't know)

6. AUTHOR(S); Hasan B Alam, MD; Rachel Russo, MD; Yongqing Li, MD, PhD; Michael Kemp, MD; Glenn Wakem, MD; Jessie Ho, MD, Toby Keeney-Bonthrone, MD

E-Mail:hasan.alam@nm.org

5d. PROJECT NUMBER
MT17008.034

5e. TASK NUMBER

5f. WORK UNIT NUMBER
N/A

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
AND ADDRESS(ES) Northwestern University, 676 North St. Clair Street, Suite 2320, Chicago, IL 60611

8. PERFORMING ORGANIZATION REPORT NUMBER 4

[Enter RPA#]

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Fort Detrick, Maryland 21702-5012

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
N/A

12. DISTRIBUTION / AVAILABILITY STATEMENT Distribution Unlimited

13. SUPPLEMENTARYNOTES

14. ABSTRACT

The goal of this project is to provide practical solutions for the control of non-compressible torso hemorrhage. We plan to achieve this objective by combining two innovative strategies to make REBOA more practical for the military and austere use, and by testing these approaches in clinically realistic large animal models.
Specific Aim 1: Determine the effects of c-and pREBOA, with and without VPA, on brain lesion size and edema, spinal cord injury, damage to organs distal to the aortic occlusion (e.g. kidney, liver, bowel, muscles), and global ischemia-reperfusion injury in swine models of combined controlled hemorrhagic shock (HS) and severe traumatic brain injury (TBI).
Specific Aim 2: Study the consequences of c- and pREBOA, with and without VPA treatment, on hemorrhage control, long-term survival, neurological outcomes, and multiple organ injury, in swine models of combined uncontrolled HS and TBI.
Specific Aim 3: Elucidate the underlying physiological and cellular mechanisms that are altered by the application of REBOA (cREBOA and pREBOA), as well as the administration of VPA.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified	Unclassified	23	

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MTEC-17-08-MT-0340; The Effects of Complete and Partial Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) with Pharmacologic Treatment in Swine Models of Hemorrhagic Shock, Traumatic Brain Injury, and Complex Vascular Injuries.
MT17008.034

Reporting Period: Effective Date – 10/21/2020-09/24/2021

University of Michigan (Awardee)
Hasan B Alam, MD, Research Project Lead
Co-Investigators: Yongqing Li, MD, PhD
Hasan B Alam, MD Research Project Technical POC

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Chicago, IL 60611
Phone Number: 312-926-4962
Email address: hasan.alam@nm.org

Michael Doran (Senior Research Admin): Michael.doran@northwestern.edu

Submitted: <09/27/2021>

1. Project Status

a. Accomplishments

1. Wrote and revised protocol. Obtained IACUC and ACRUO approval.
    a. First draft of protocol submitted for veterinary review 15-MAY-2019
    b. Revised in response to IACUC questions 31-MAY-2019
    c. Revised in response to IACUC questions 24- JUN-2019
    d. Revised in response to IACUC questions 18-JUL-2019
    e. Revised in response to IACUC questions 5-AUG-2019
    f. Revised in response to IACUC questions 22-AUG-2019
    g. Obtained IACUC approval 9-SEP-2019
    h. Submitted to ACRUO 10-SEP-2019
    i. Revised in response to ACRUO questions 03-JAN-2020
    j. Revised in response to ACRUO 07-JAN-2020
    k. Obtained ACRUO approval 27-JAN-2020
    l. Milestone 1 completed.
    m. Submitted approvals to MTEC.
    n. Received first allocation for funds
2. Began model development experiments
    a. Equipment ordered. Delivered. Personnel training updated.
    b. Animals ordered. Delivered. Acclimated. 27-JAN – 6-FEB-2020
    c. Completed in-service with Transonic Engineer, Cole McLarty
    d. Completed in-service with Prytime Engineer, Curtis Franklin. 5-FEB-2020
    e. Model development experiments
        i. 6-FEB-2020
        ii. 12-FEB-2020
        iii. 25-FEB-2020
        iv. 03-MAR-2020 – determined need for fluoroscopy to troubleshoot pREBOA-PRO
        v. Obtained access to fluoroscopy. Additional training. Arranged for Prytime Engineer, Curtis Franklin to be on site.
        vi. Lab shut down for COVID-19. Obtained special permission to complete planned experiment.
        vii. 20-MAR-2020 – Learned new insights about the pREBOA-PRO, novel device
        viii. Experiments on hold through JUL-2020 due to COVID-19 restrictions
        ix. Applied for and received approval to perform complex procedures during COVID-19 restrictions – July-2020
        x. Short-term survival model with 40% hemorrhage developed and tested in July 2020/August 2020: model compared complete occlusion with standard ER-REBOA catheter versus partial occlusion (without provider titration) using novel catheter pREBOA-PRO (see below)
3. Completed data analysis on previously performed animal model development experiments
    a. Last analyzed pre-COVID data 07-APR-2020
    b. Presented pre-COVID data at lab meeting 10-APR-2020
4. Fine-tuned the Standard Operating Procedures for future model development experiments to be carried out at Northwestern
    a. Last modified 21-JUN-2020
5. Established the preliminary plan for relocating the lab, including starting initial recruitment of personnel, inventory of equipment with moving plan, and submission of the animal protocols for this experiment to the IACUC at Northwestern

a. 15-JUN-2020

6. Published manuscript describing the performance characteristics of the pREBOA-PRO catheter as observed during the model development experiments completed thus far
    a. Russo RM, Franklin CJ, Davidson AJ, et al. A new, pressure-regulated balloon catheter for partial resuscitative endovascular balloon occlusion of the aorta (REBOA) [published online ahead of print, 2020 Apr 27]. J Trauma Acute Care Surg. 2020;10.1097/TA.0000000000002770. doi:10.1097/TA.0000000000002770
    b. Submitted for publication 10-APR-2020
    c. Accepted for publication 13-APR-2020
    d. Published online ahead of print 27-APR-2020
    e. Proofs revised for print 19-MAY-2020
    f. Published in hard copy AUG-2020
7. Accepted for presentation at 2020 Military Health System Research Symposium, initially planned for August 2020 in Florida, that was cancelled due to COVID with no plan to reschedule or replace with a virtual conference
    a. Submitted for presentation 04-APR-2020
    b. Accepted for presentation 03-JUN-2020
8. Published abstract relating to the design and the performance of the pREBOA-PRO catheter as observed during the model development experiments completed thus far
    a. Russo RM, Franklin CJ, Davidson AJ, et al. Technical Innovation in Partial Aortic Occlusion: A Brief Review of the pREBOA-PRO. [Abstract, published online ahead of print, 2020 July 8]. 2020 Military Health System Research Symposium. [conference cancelled for COVID]. Available at https://mhsrs.amedd.army.mil/. Accessed on July 16, 2020.
    b. Submitted 03-JUN-2020
    c. Accepted for publication 13-JUN-2020
    d. Published online 8-JUL-2020
9. Established the MTEC add-on project proposal to investigate the use of our Super-Continuum Infrared Spectroscopy of Cytochrome-C-Oxidase (SCISCCO) system [patent pending] to detect and monitor brain injury
    a. Submitted 22-APR-2020
    b. Approved 01-MAY-2020
10. Obtained approval for add-on proposal from U of M
    a. Executed 9/18/2020

11. Modified the statement of work and milestones to include the addition of the new add-on Project.
    a. Revised 22-JUN-2020

12. Analyzed short-term model data assessing resuscitation requirements and end levels of organ injury biomarkers
    a. Last analyzed 22-SEP-2020
    b. Demonstrated improvement in resuscitation requirements and lower end levels of organ injury biomarkers in partial occlusion cohort.

13. Published manuscript entitled: “A Novel Partial Resuscitative Endovascular Balloon Aortic Occlusion (pREBOA) Device That Requires Minimal Provider Titration”
    a. Submitted OCT-2020 to Journal of Trauma and Acute Care Surgery. Published March 2021.
    b. Highlights the minimal return of distal femoral arterial wave form as the target for partial occlusion
    c. Highlights the ability to achieve partial occlusion without need for significant provider titration

   d. Emphasizes the improvement in resuscitation requirements and end levels of organ injury biomarkers in the partial occlusion (pREBOA-PRO) cohort
14. Executed the SCISCCO add-on project to detect and monitor brain injury
   a. Project Completed 29-MAR-2021

b. Reportable Outcomes:

1. Russo RM, Franklin CJ, Davidson AJ, et al. A new, pressure-regulated balloon catheter for partial resuscitative endovascular balloon occlusion of the aorta (REBOA) [published online ahead of print, 2020 Apr 27]. J Trauma Acute Care Surg. 2020 Aug;89(2S Suppl 2):S45-S49. doi: 10.1097/TA.0000000000002770. PMID: 32345889.

2. Russo RM, Franklin CJ, Davidson AJ, et al. Technical Innovation in Partial Aortic Occlusion: A Brief Review of the pREBOA-PRO. [Abstract, published online ahead of print, 2020 July 8]. 2020 Military Health System Research Symposium. [conference cancelled for COVID]. Available at https://mhsrs.amedd.army.mil/. Accessed on July 16, 2020.
Accepted for presentation at 2020 Military Health System Research Symposium, initially planned for August 2020 in Florida, that was ultimately cancelled due to COVID with no plan to reschedule or replace with a virtual conference.

3. Kemp MT, Wakam GK, Williams AM, Biesterveld BE, O'Connell RL, Vercruysse CA, Chtraklin K, Russo RM, Alam HB. A novel partial resuscitative endovascular balloon aortic occlusion device that can be deployed in zone 1 for more than 2 hours with minimal provider titration. J Trauma Acute Care Surg. 2021 Mar 1;90(3):426-433. doi: 10.1097/TA.0000000000003042. PMID: 33492106.

c. Progress Detail

Overview

In the first quarter, we continued to establish the model at the new site (Northwestern). We attempted to increase the duration of occlusion from 2.5 hours to 3.5 hours and then assess the effect of VPA. This was marred by lack of pREBOA catheter availability, as the contract transfer from U. Michigan to Northwestern had not been approved, and the funding stream for the catheters was therefore not available.

In the second quarter, we performed a single pREBOA experiment. During the experiment, we noted that the pig was reacting as if we were using a regular, complete-occlusion REBOA catheter. During necropsy, we determined that the size of the pig was smaller relative to the balloon size, with its smaller aorta being completely occluded by the pREBOA catheter. This will inform future pig size parameters. Three further experiments were conducted during Q2 to establish the model, two with pREBOA alone and one with pREBOA plus VPA. The SCISCCO add-on project was completed during the second quarter.

During the third quarter, a further two animal experiments were conducted. At this point, we had to pause experiments for the remainder of the year, as funding for further catheter purchases had not yet become available.

In the fourth quarter, experiments continued to be on hold pending funding transfer. Mike Kemp, MD, returned to the clinical portion of his general surgery residency and was replaced by Toby Keeney-Bonthrone, MD, who is expected to be in the lab until 2023.

Results summary

The results discussed in the previous year's results section were published in one article in the *Journal of Trauma and Acute Care Surgery* (see above Reportable Outcome 3). At this time, we are awaiting funding to continue re-

establishing the model at Northwestern University, and will be able to obtain further results once the model has been re-established and further experiments have been conducted. In particular, we expect to report on the results of extending occlusion time from 2.5 to 3.5 hours.

Dr. Islam's lab completed Task #2, entitled "Build SCISSCO prototype that can be transported to remote labs." The instrument name SCISSCO is an acronym for Super-Continuum Infrared Spectroscopy of Cytochrome-C-Oxidase. In particular, the deliverable for Task 2.1 is the tested performance metrics for the SCISCCO prototype.

The results for the built SCISSCO prototype and its performance metrics are summarized in the attached slide deck. The high-level system schematics are provided in Image 1.

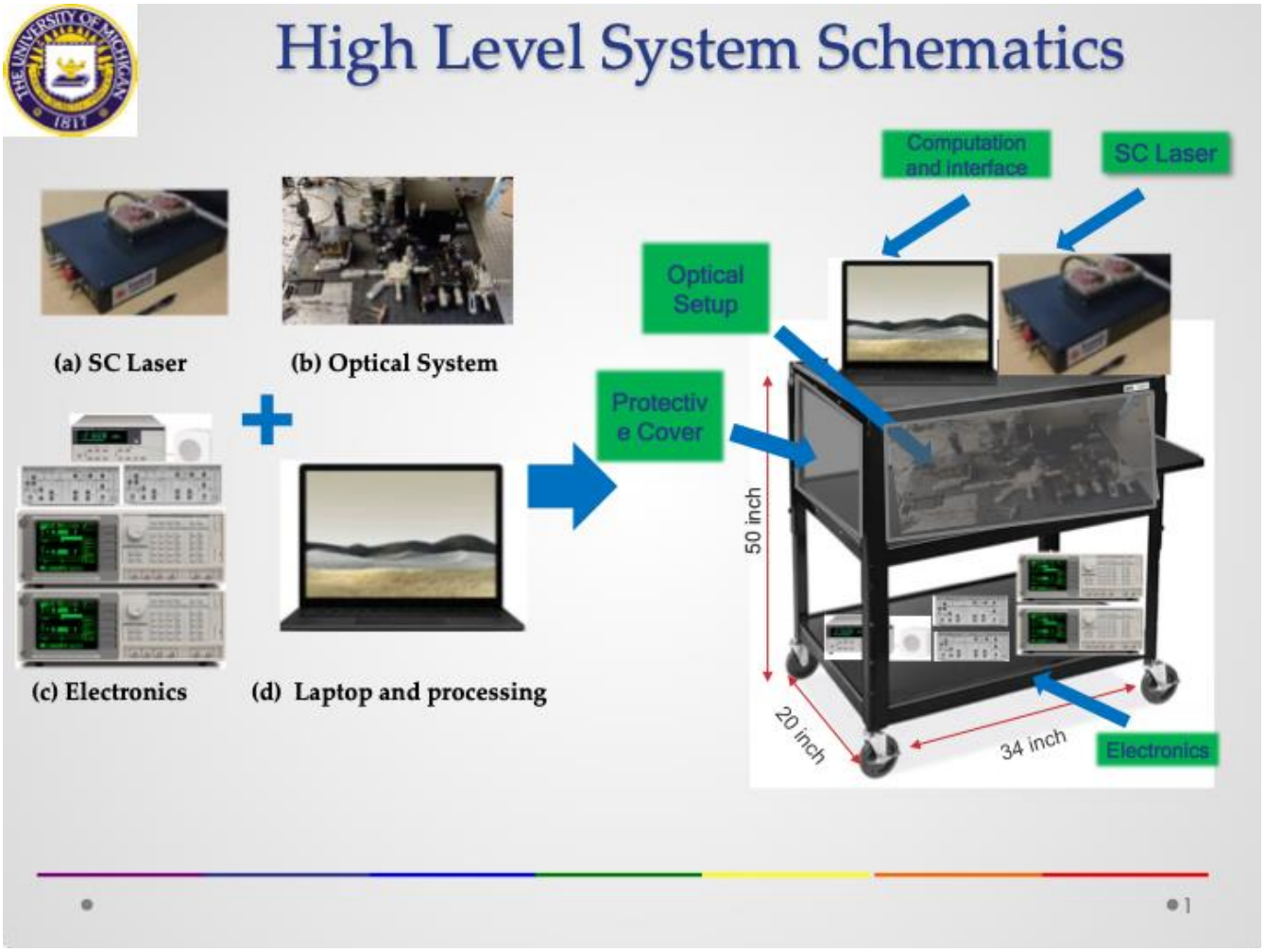

Image 1: high-level schematics.

The rolling cart system has three levels: the top level comprises the super-continuum (SC) laser and laptop for processing, the middle level comprises the optical system hardware, and the bottom level comprise the electronics and lock-in amplifiers. Photographs of the SCISCCO prototype are provided in Images 2 and 3.

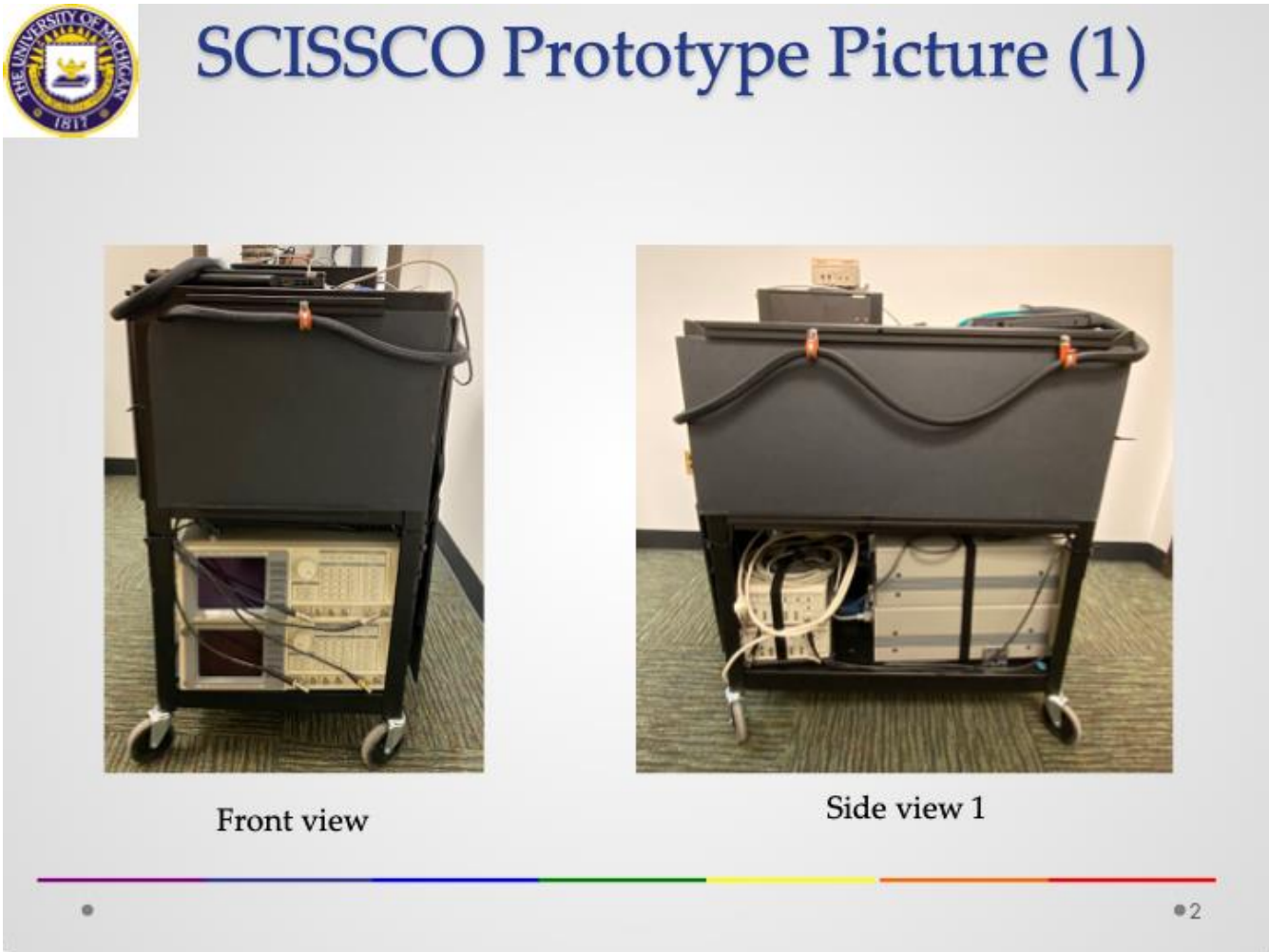

Image 2: front view (left) and side view (right) of the prototype.

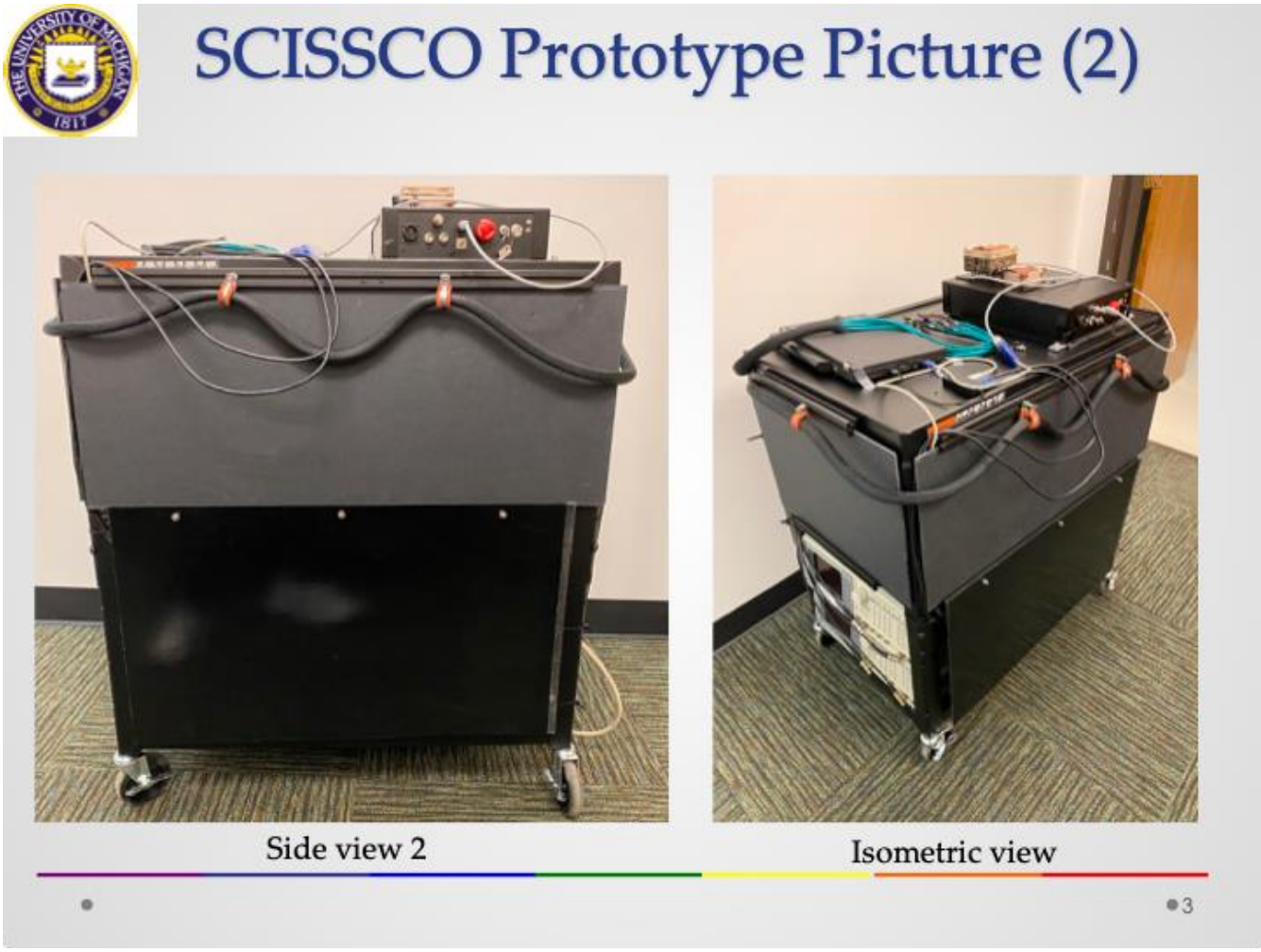

Image 3: another side view (left) and an isometric view of the SCISCCO prototype.

The measured performance metrics for the SCISSCO prototype are summarized in Image 4.

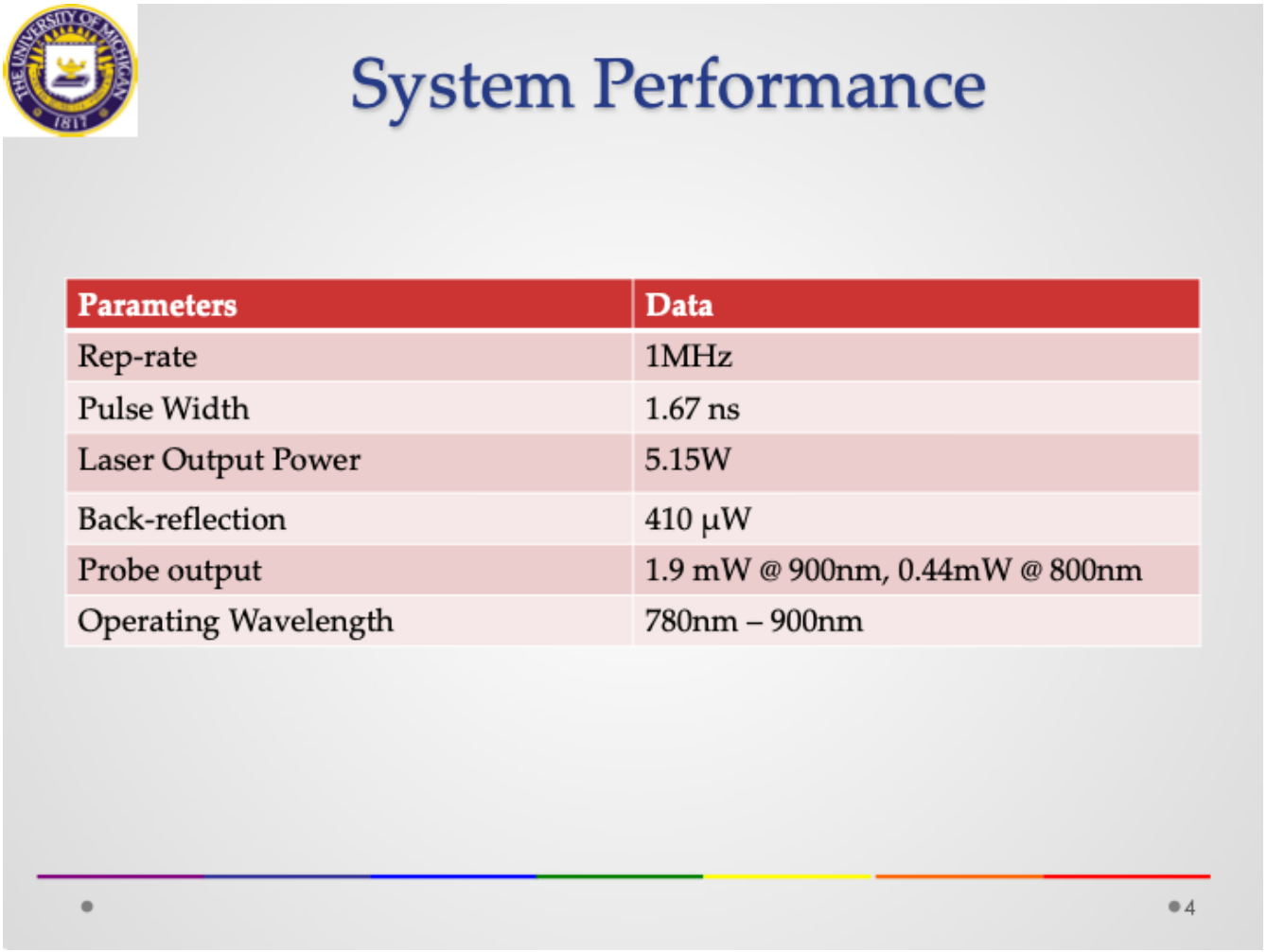

Image 4: SCISSCO performance metrics.

In preparation for transporting the SCISSCO system to Northwestern University and moving within the buildings, we also ruggedized the unit and have conducted shake-rattle-and-roll testing. In particular, the metric for stability is to look at the sample and reference arms of the set-up as a function of wavelength, and then checking how well they balance out after cancellation. We also provide a metric of signal-to-noise ratio (SNR), which should exceed about 700 for the clinical trials to be conducted unimpeded. For a more detailed look at the set-up, Image 5 shows a block diagram of the optical configuration, defining the reference and sample arm measurements.

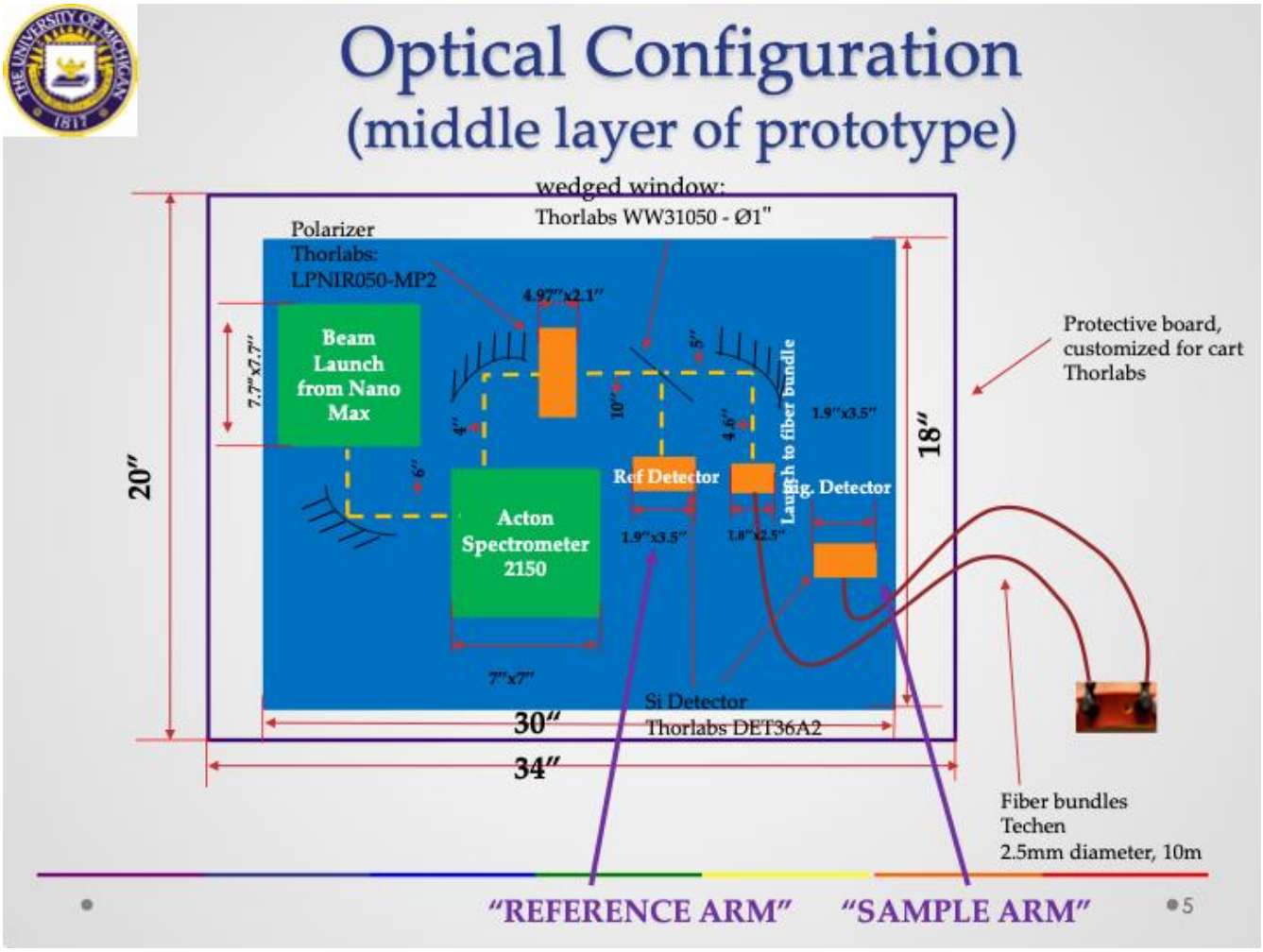

Image 5: optical configuration block diagram

For characterizing the movement tests, we use in the sample arm a polystyrene block as the scattering medium. The first set of tests are for moving the SCISSCO system within the building, including rolling the cart over the non-smooth brick atrium. Image 6 shows the spectrum of the sample and reference arms before and after the in-building movement, and the blue boxes provide the absolute power levels at two wavelengths.

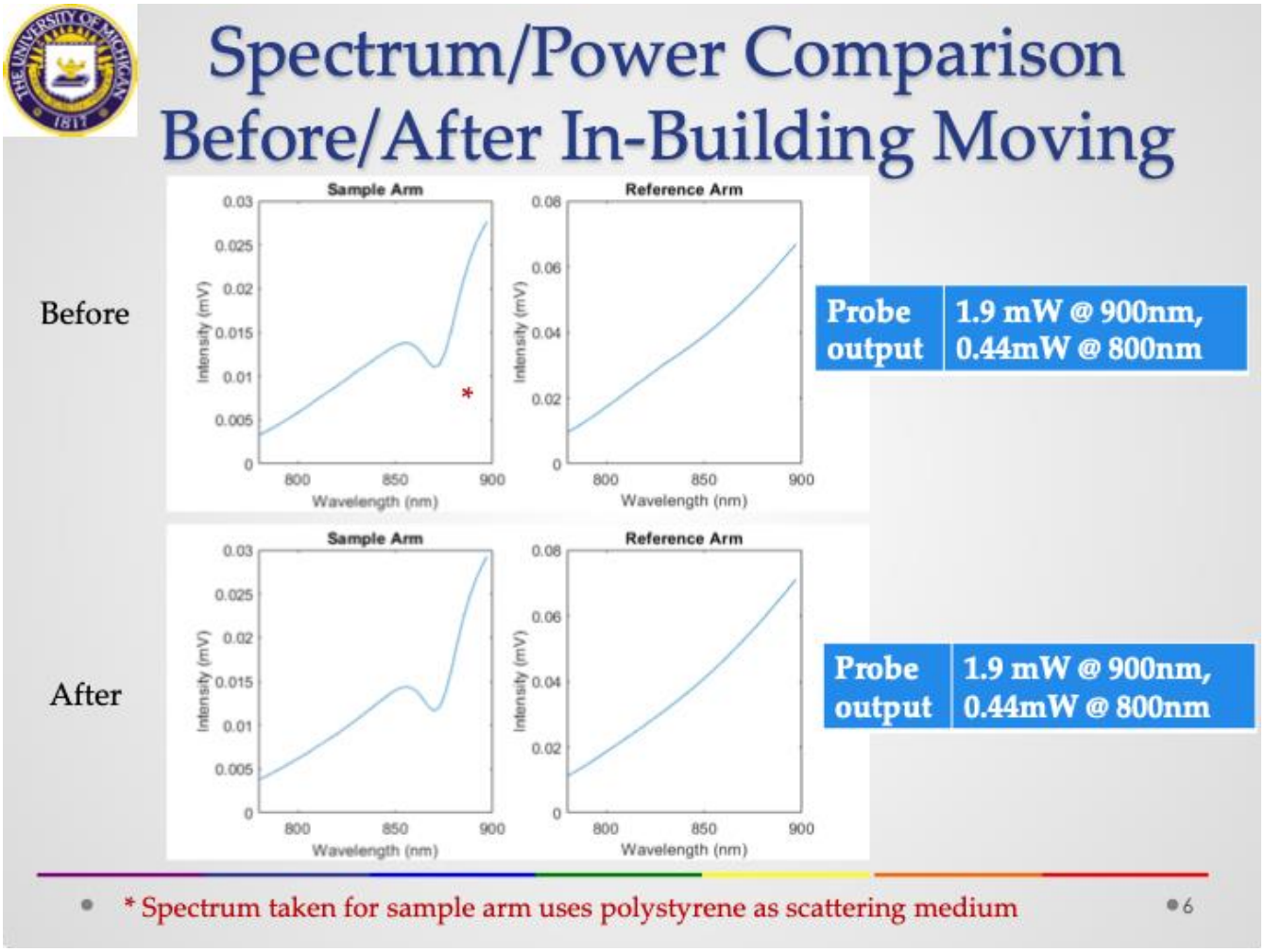

Image 6: Spectrum/Power Comparison Before/After In-Building Moving.

Image 7 illustrates the repeatability comparison before and after in-building moving, and the SNR is maintained above 700 with all the motion.

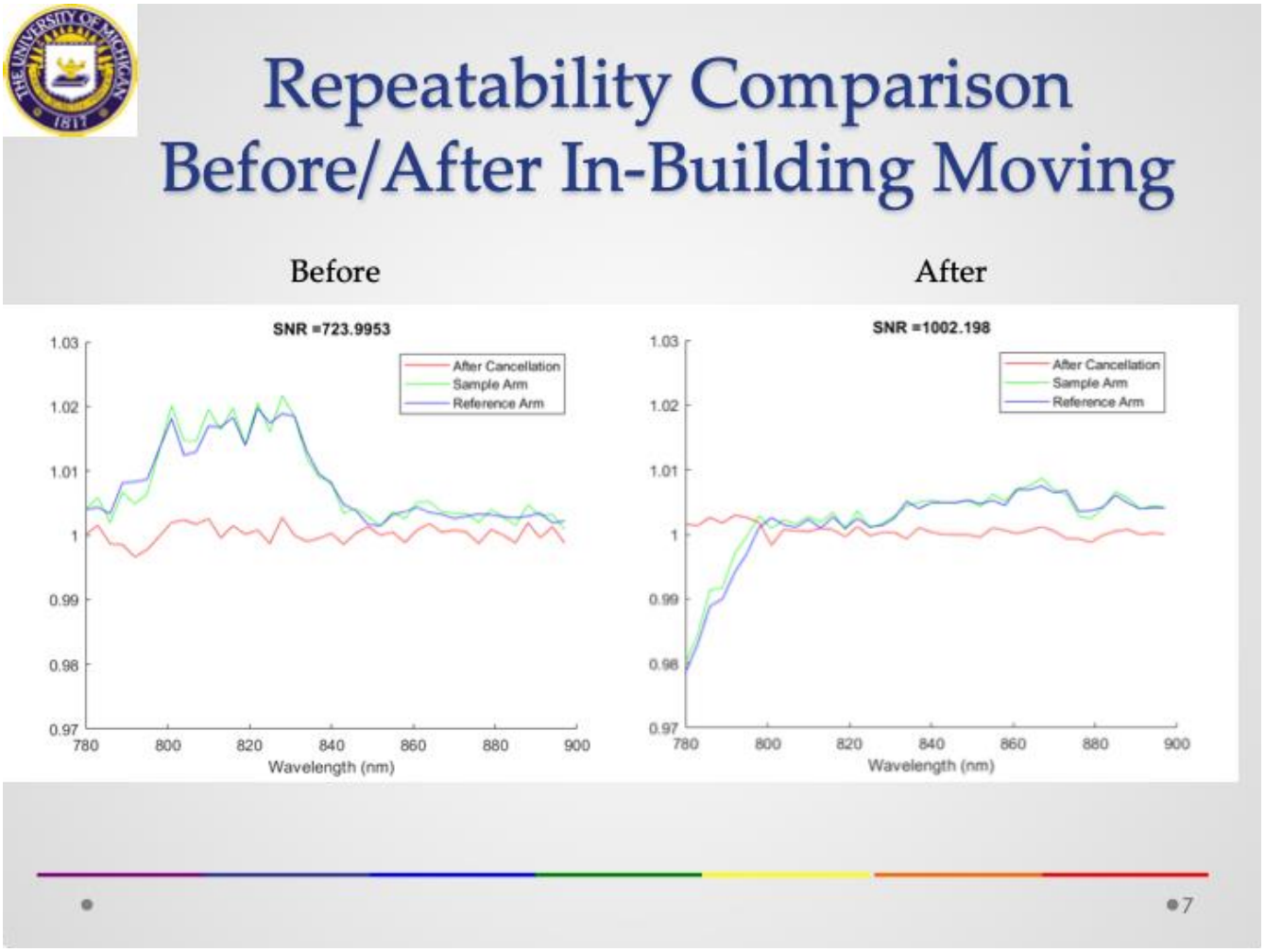

Image 7: Repeatability Comparison Before/After In-Building Moving.

The next set of tests were for moving the SCISCCO system in a van over Michigan roadways, which are notoriously bumpy. The system was held up on wood blocks to avoid rolling around in the vehicle, and the unit was strapped within the vehicle to avoid relative motion during transportation. Image 8 shows the spectrum of the sample and reference arms before and after the road driving tests, and the blue boxes provide the absolute power levels at two wavelengths.

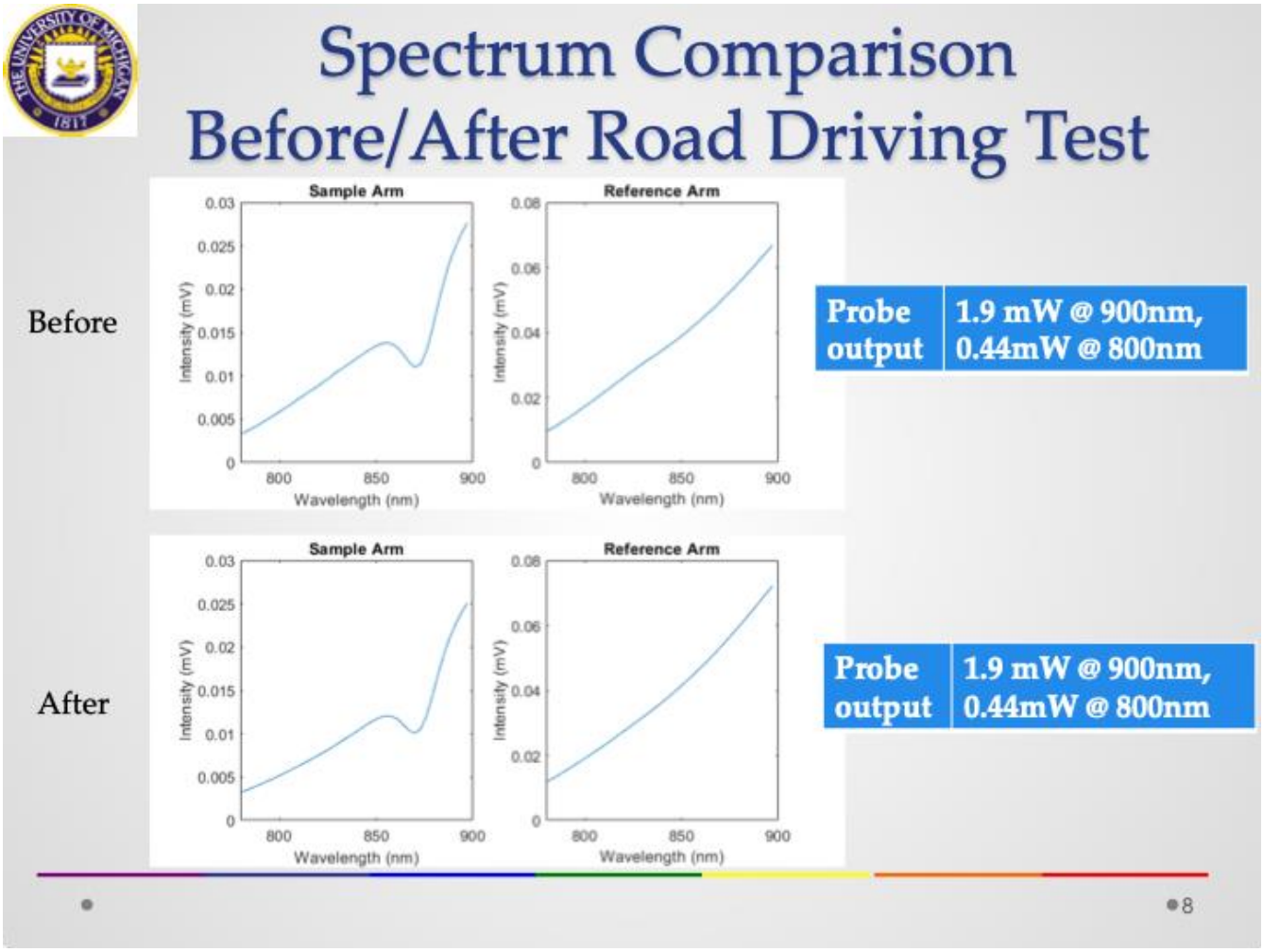

Image 8: Spectrum Comparison Before/After Road Driving Test.

Image 9 illustrates the repeatability comparison before and after road driving tests, and the SNR is maintained above 700 throughout the tests.

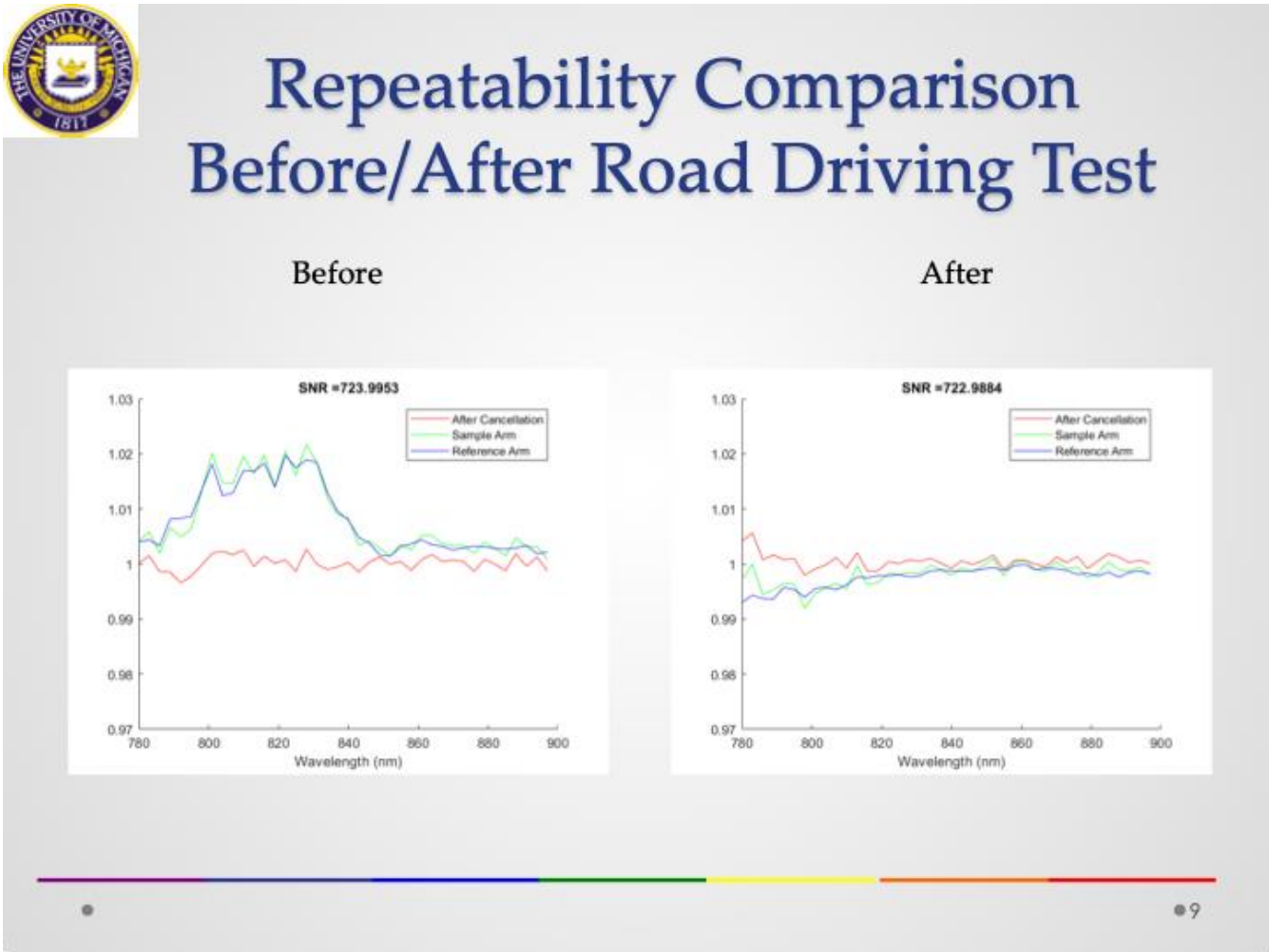

Image 9: Repeatability Comparison Before/After Road Driving Test.

Therefore, we are confident that the SCISCCO system is sufficiently rugged to be transported to Northwestern University or other locations for animal testing studies.

2. Future Plans

Due to the delay in funding transfer and establishment of a contract between MTEC and Northwestern, our plans remain essentially unchanged from the previous year. Our group is ready to proceed as soon as the funds are made available, and intends to continue to evaluate extending occlusion time with the novel catheter pREBOA-PRO from 2.5 to 3.5 hours, and longer. We also intend to assess how the addition of valproic acid dosing alters the tolerated duration of REBOA aortic occlusion, with the anticipation that VPA will enable us to extend the tolerated duration of occlusion.

3. Problems / Issues

SOW was updated for the transfer and covid 19 delays when we modified for MOD 1 addendum.

a. Current Problems / Issues

Awaiting transfer of funding to Northwestern University.

b. Anticipated Problems / Issues

Regulatory and COVID-19-induced delays will necessitate extension of the experimental portion of the project into 2022-23 (no cost extension).

4. Financial Health

We have utilized all funds from our first milestone payment and have exceeded those funds by $7,700. We are currently using Principal Investigator's discretionary funds to do the work. With the project transferring to Northwestern and our next milestone payment will be issued to that institution we will need to work together so these funds are made available as soon as possible to restart the project.

5. Personnel Effort

Personnel for the first year of the project.

Personnel	Role	Percent Effort
Hasan B. Alam	Project Leader	20% Until 8/31/20
Rachel Russo	Co-Investigator/Team Leader	50% Until 7/31/20
Jonathan Eliason	Co-Investigator	5% Until 7/31/20
Yongqing Li	Co-Investigator	25% Until 8/31/20
Baoling Liu	Research Specialist	30% Until 8/31/20
Kiril Chtraklin	Research Specialist	33.3% Until 8/31/20
Maggie McLaughlin	Research Associate	50% until July 6, 2020
Zoe Vanella	Project Manager	30% Until 8/31/20

6. Protocol and Activity Status

a. **Human Use Regulatory Protocols:** None
b. **Use of Human Cadavers for RDT&E, Education or Training:** Not Applicable
c. **Animal Use Regulatory Protocols:**

Protocol [ACURO Assigned Number]: PRO00009167
Title:"MTEC-17-08 Multi-Topic-0340: The Effects of Complete and Partial Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) with Pharmacologic Treatment in Swine Models of Hemorrhagic Shock, Traumatic Brain Injury, and Complex Vascular Injuries"
Target required for statistical significance:
Target approved for statistical significance:
Submitted to and Approved by: IACUC and ACURO

Hasan Alam General
Surgery 2920B TC
Ann Arbor 48109-5331
Dear Dr. Alam:
The Institutional Animal Care & Use Committee (IACUC) has reviewed the animal use application referenced below. The proposed animal use procedures are in compliance with University guidelines, State and Federal regulations and the standards of the "Guide for the

Care and Use of Laboratory Animals. This project has been approved. There may be additional issues that need to be addressed prior to initiation of the associated research. It is your responsibility, as Principal Investigator, to secure all the necessary requirements and recommendations and Notify funding agencies of changes made to the study. Committee approval must be obtained prior to making changes from what is originally stated in the protocol. An amendment must be approved prior to the implementation of the change.

Contact the ACU
Office for further information.
The United States Department of Agriculture (USDA), Department of Defense (DOD), and University policy require an annual administrative review of any animal use protocols funded by the DOD or approved to use USDA-covered species. Your continued animal use approval is contingent upon the completion of this online form. Additionally, your renewal application must be submitted, reviewed and approved in a timely manner prior to the expiration date of the current protocol. You will receive notification prior to the deadlines for both the annual review and protocol expiration.

The University's Animal Welfare Assurance Number on file with the NIH Office of Laboratory Animal Welfare (OLAW) is A3114-01, and most recent date of accreditation by the Association for the Assessment and Accreditation of Laboratory Animal Care International (AAALAC, Intl.) is November 22, 2017. If you receive news media inquiries concerning any aspect of animal use or care in this project, please contact James Erickson, News and Information Services, (734) 647-1842. If you have a security concern regarding the animals or animal facilities, or if you need emergency veterinary medical care, contact Joseph Piersante, Chief Operations Officer, at (734) 763-3434. UMPD will contact the appropriate veterinarian.

Sincerely,
Dr. Daniel Myers, D.V.M., MPH Professor of
Surgery
Chairperson, Institutional Animal Care and Use Committee

STATUS: Approved
IACUC approved 09/09/2019, reapproved 09/01/2021
ACURO Approved 01/09/2020

Annual Business Status Report for

MTEC-17-08-MT-0340; The Effects of Complete and Partial Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) with Pharmacologic Treatment in Swine Models of Hemorrhagic Shock, Traumatic Brain Injury, and Complex Vascular Injuries.
MT17008.034

Reporting Period: Effective Date – 10/22/2020 - 09/24/2021

University of Michigan (Awardee)
Hasan B Alam, MD, Research Project Lead
Co-Investigators Rachel Russo, MD; Yongqing Li, MD, PhD
Hasan B Alam, MD Research Project Technical POC

Northwestern University
676 North St. Clair Street, Suite 2320
Chicago, IL 60611
Phone Number: 312-926-4962
Email address: hasan.alam@nm.org

Michael Doran (Senior Research Admin): Michael.doran@northwestern.edu

Submitted: <09/27/2021>

1. CURRENT STAFF

Personnel	*% of Effort on project*
Project Leader	20%
Co-Investigator/Team Leader	50%
Co-Investigator	5%
Co-Investigator	25%
Research Specialist	30%
Research Specialist	33.3%
Research Associate	50%
Project Manager	30%

2. CURRENT EXPENDITURES

A. Fixed Priced Contracts:

.

MTEC Milestone Number	Milestone Description	Due Date	Government Funds
MTEC Milestone Number	**Milestone Description**	**Due Date**	**Government Funds**
1	Obtain IACUC and ACURO Approvals	10/15/2019 Completed 01/09/2020	$269,367
2		2/15/20	$1.00
	Total Expenditures		$269,368

B. In Kind Contributions:

2) In-Kind: Prytime Medical Device Inc. In-Kind Contribution
No new In-Kind Contributions since previous Annual Report.

3. STATUS OF MILESTONES All project milestones from the Milestone Payment Schedule, in the project award, should be accounted for below.

MTEC Milestone Number	Milestone Description	Due Date	% Completed this Reporting Period	Cumulative % Complete
1	Obtain IACUC and ACURO Approvals	10/15/2019	**100%**	**100%**
2	Deliverable for task 1: Submit IACUC approval to funding agency			
3	Quarterly Report Y1Q1	10/25/2019	**Proj not started – no report**	
4	Quarterly Report Y1Q2	1/25/2020	**100%**	**100%**

	March - July COVID-19 Pandemic Shuts down all Large Animal Experiments			
5	Quarterly Report Y1Q3	4/25/2020	**100%**	**100%**
6	Annual Report Y1	7/25/2020	**100%**	**100%**
7	Task 1:Complete model Optimization Experiments	8/30/2020	**60%**	**60%**
	8/31/20 Alam Lab Moves to Northwestern University	8/31/2020	**100%**	**100%**
	Task 1b: At Northwestern obtain IACUC and ACURO Approval	12/30/20	**100%**	**100%**
8	Task 2 and 2.1: Islam Team - Improve and optimize SCISCCO breadboard design Blueprint for design and operating parameters	9/30/2020 (3 months after funding)	**100%**	**100%**
9	Quarterly Report Y2Q1	10/25/2020	**100%**	**100%**
10	Task 3 and 3.1 Islam Team - Build SCISCCO prototype that can be transported to remote labs. Tested performance metric for SCISCCO prototype	12/31/2020 (6 months after funded)	**100%**	**100%**
14	Quarterly Report Y2Q3	4/25/2021	**100%**	**100%**
15	Sub task 3.2 Islam Team - Deliver SCISCCO Operation with software and algorithms for display of relevant information for user:	4/30/2021	**100%**	**100%**
16	University of Michigan finalizes transfer of award to Northwestern University with MTEC	5/31/2021	**75%**	**75%**
17	Annual Report Y2	7/25/21	**100%**	**100%**
18	Quarterly Report Y3Q1	10/25/2021	**Not Started**	**Not Started**
19	Task 6: Complete 50% Experiment 1: Randomized 8 NS groups	11/15/2021	**Not Started**	**Not Started**
	Subtask 6.1 Complete 50% Animal Experiment		**Not Started**	**Not Started**
	Subtask 6.2 Deliverable for task 5: Analysis Report of Experimental Data		**Not Started**	**Not Started**
20	Quarterly Report Y3Q2	1/25/2022	**Not Started**	**Not Started**
21	Task 7: Complete remaining 50% Experiment 1	3/15/2022	**Not Started**	**Not Started**
	Subtask 7.1 Complete remaining 50% Animal Experiment 1		**Not Started**	**Not Started**
	Subtask 7.2 Deliverable for task 6: Analysis Report of Experimental Data		**Not Started**	**Not Started**
22	Quarterly Report Y3Q3	4/25/2022	**Not Started**	**Not Started**
23	Annual Report Y2	7/25/22	**Not Started**	**Not Started**
24	Task 8: 50% Experiment 2: Randomized 8 NS Groups	8/15/2022	**Not Started**	**Not Started**
	Sub task 8.1 Complete 50% Experiment 2		**Not Started**	**Not Started**
	Sub task 8.2 Deliverable for task 7: Analysis Report of Experimental Data		**Not Started**	**Not Started**
25	Quarterly Report Y4Q1	10/25/2022	**Not Started**	**Not Started**
26	Task 9: Complete remaining 50% Experiment 2	11/30/2022	**Not Started**	**Not Started**
	Sub task 9.1Complete Experiment 2		**Not Started**	**Not Started**
	Sub task 9.2 Deliverable for task 4: Analysis Report of Experimental Data		**Not Started**	**Not Started**
27	Task 10 Final Analysis of all Physiological Data	12/25/2022	**Not Started**	**Not Started**

28	Task 11 Publish findings in Peer Reviewed Journal	12/25/2022	**Not Started**	**Not Started**
29	Final Report	12/25/2022	**Not Started**	**Not Started**

4. DEVIATION FROM PROJECT PLAN

Covid 19 Pandemic shut down all operations and we were under a "Stay Home, Stay Safe" order from our Governor. University of Michigan restarted research, clinical, administrative activities through June 2020. We were allowed to restart large animal experiments in July. We submitted a revised SOW with add-on project and the transition of the lab to Northwestern University, which was approved. Additional delays caused by the transition to Northwestern University have caused a further right-shift in project completion. We therefore request to change the Due Dates for several milestones as follows (date changes underlined), which would extend project completion to 25 July 2023:

MTEC Milestone Number	Milestone Description	Due Date	% Completed this Reporting Period	Cumulative % Complete
1	Obtain IACUC and ACURO Approvals	10/15/2019	**100%**	**100%**
2	Deliverable for task 1: Submit IACUC approval to funding agency			
3	Quarterly Report Y1Q1	10/25/2019	**Proj not started – no report**	
4	Quarterly Report Y1Q2	1/25/2020	**100%**	**100%**
	March - July COVID-19 Pandemic Shuts down all Large Animal Experiments			
5	Quarterly Report Y1Q3	4/25/2020	**100%**	**100%**
6	Annual Report Y1	7/25/2020	**100%**	**100%**
	8/31/20 Alam Lab Moves to Northwestern University	8/31/2020	**100%**	**100%**
7	Task 2 and 2.1: Islam Team - Improve and optimize SCISCCO breadboard design Blueprint for design and operating parameters	9/30/2020 (3 months after funding)	**100%**	**100%**
8	Quarterly Report Y2Q1	10/25/2020	**100%**	**100%**
9	Task 3 and 3.1 Islam Team - Build SCISCCO prototype that can be transported to remote labs. Tested performance metric for SCISCCO prototype	12/31/2020 (6 months after funded)	**100%**	**100%**
10	Quarterly Report Y2Q3	4/25/2021	**100%**	**100%**
11	Sub task 3.2 Islam Team - Deliver SCISCCO Operation with software and algorithms for display of relevant information for user:	4/30/2021	**100%**	**100%**
12	University of Michigan finalizes transfer of award to Northwestern University with MTEC	5/31/2021	**75%**	**75%**
13	Annual Report Y2	7/25/21	**100%**	**100%**
14	Quarterly Report Y3Q1	10/25/2021	**Not Started**	**Not Started**
15	Quarterly Report Y3Q2	1/25/2022	**Not Started**	**Not Started**
16	Task 1:Complete model Optimization Experiments	2/15/2022	**60%**	**60%**
17	Quarterly Report Y3Q3	4/25/2022	**Not Started**	**Not Started**
18	Task 6: Complete 50% Experiment 1: Randomized 8 NS groups	6/15/2021	**Not Started**	**Not Started**

	Subtask 6.1 Complete 50% Animal Experiment		**Not Started**	**Not Started**
	Subtask 6.2 Deliverable for task 5: Analysis Report of Experimental Data		**Not Started**	**Not Started**
19	Annual Report Y2	7/25/22	**Not Started**	**Not Started**
20	Task 7: Complete remaining 50% Experiment 1: Randomized 8 NS groups	10/15/2022	**Not Started**	**Not Started**
	Subtask 7.1 Complete remaining 50% Animal Experiment 1		**Not Started**	**Not Started**
	Subtask 7.2 Deliverable for task 6: Analysis Report of Experimental Data		**Not Started**	**Not Started**
21	Quarterly Report Y4Q1	10/25/2022	**Not Started**	**Not Started**
22	Quarterly Report Y4Q2	1/25/2023	**Not Started**	**Not Started**
23	Task 8: 50% Experiment 2: Randomized 8 NS Groups	3/15/2023	**Not Started**	**Not Started**
	Sub task 8.1 Complete 50% Experiment 2:		**Not Started**	**Not Started**
	Sub task 8.2 Deliverable for task 7: Analysis Report of Experimental Data		**Not Started**	**Not Started**
24	Quarterly Report Y4Q3	4/25/2023	**Not Started**	**Not Started**
25	Task 9: Complete remaining 50% Experiment 2	6/30/2023	**Not Started**	**Not Started**
	Sub task 9.1Complete Experiment 2		**Not Started**	**Not Started**
	Sub task 9.2 Deliverable for task 4: Analysis Report of Experimental Data		**Not Started**	**Not Started**
26	Task 10 Final Analysis of all Physiological Data	7/25/2023	**Not Started**	**Not Started**
27	Task 11 Publish findings in Peer Reviewed Journal	7/25/2023	**Not Started**	**Not Started**
28	Final Report	7/25/2023	**Not Started**	**Not Started**