The Diné College Library and its Fruitful Relationship with Mathematics

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http://lib.dinecollege.edu/

http://mealab.dinecollege.edu/

Tribal College Librarians Institute (TCLI), June 8th, 2023

Introduction

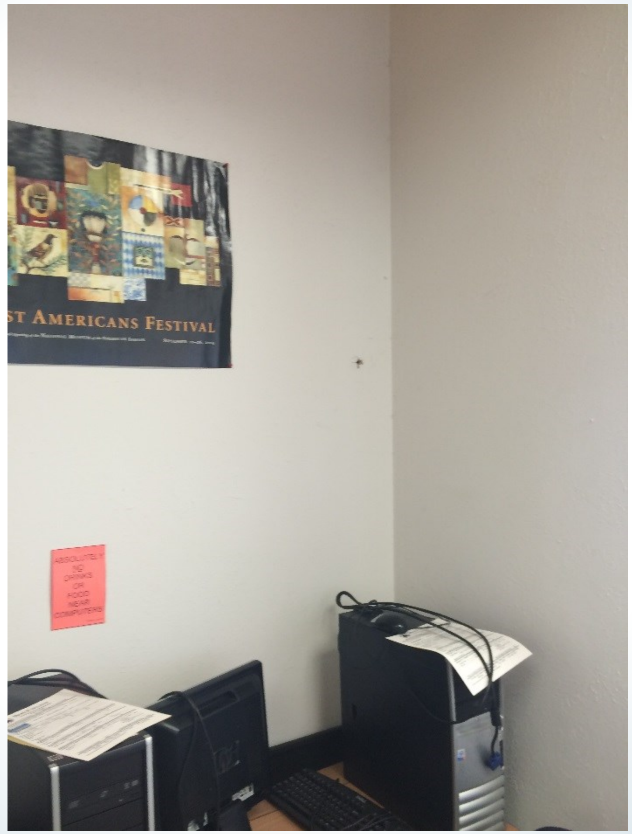
- A unique relationship between Diné College Libraries and School of STEM faculty which yielded results that could be replicated at other TCUs:
  - It began with NSF funded Mathematics for Engineering Applications (MEA) laboratory, with student research assistants and an attendant tutoring service, being located in the Tsaile Campus library.
  - It eventually blossomed into a Technology Transfer Center, the first of its kind at a TCU, with Congressional funding to be located in the Tsaile Campus library.
  - This presentation goes from the MEA lab to the Technology Transfer Center highlighting the vital role that library played in making them happen.

Award Abstract # 1622481

Seizure onset detection using tripolar Laplacian electroencephalography

NSF Org:	HRD Division Of Human Resource Development
Recipient:	NAVAJO NATION TRIBAL GOVERNMENT, THE
Initial Amendment Date:	September 9, 2016
Latest Amendment Date:	September 9, 2016
Award Number:	1622481
Award Instrument:	Standard Grant
Program Manager:	Lura Chase lchase@nsf.gov (703)292-5173 HRD Division Of Human Resource Development EHR Direct For Education and Human Resources
Start Date:	September 15, 2016
End Date:	August 31, 2020 (Estimated)
Total Intended Award Amount:	$200,000.00
Total Awarded Amount to Date:	$200,000.00
Funds Obligated to Date:	FY 2016 = $200,000.00
History of Investigator:	Oleksandr Makeyev (Principal Investigator) omakeyev@dinecollege.edu
Recipient Sponsored Research Office:	Dine College P O Box 126 tsaile AZ US 86556-0067 (928)724-6670

September 21, 2016



Old computer lab, equipment, peculiarities.

October 11, 2016

Networking equipment, more peculiarities.

November 14, 2016

All the old equipment gone.

December 14-15, 2016

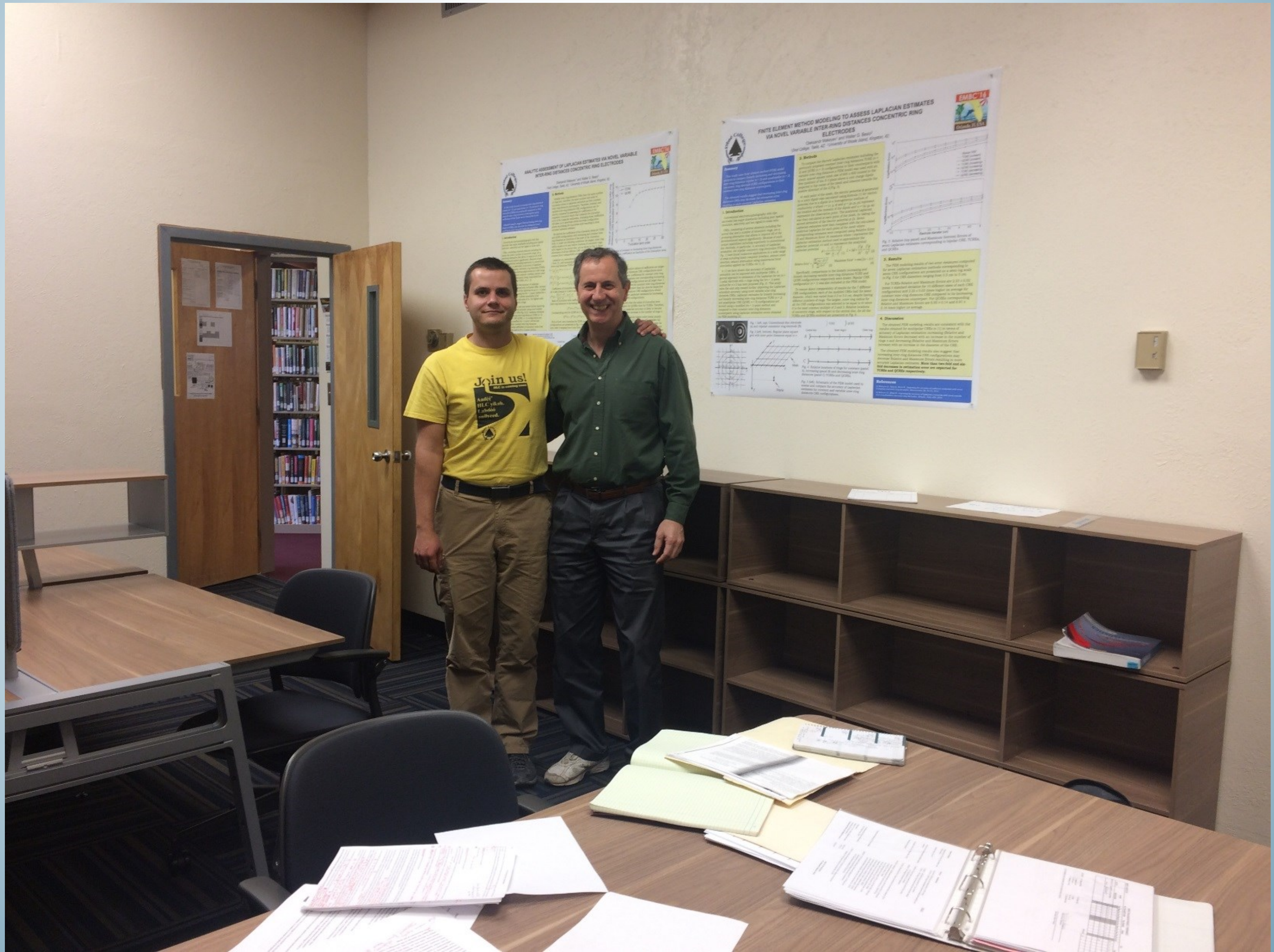
Putting in partition wall.

January 13-17, 2017

Paint, carpet, and furniture.

January 13-17, 2017

March 22, 2017



MEA lab's original equipment

- MEA lab's cluster has four Intel® Xeon® E5-1650 v4 3.6 GHz based machines with a total of 24 cores and 128 Gb of DRAM.
  - Still the fastest computer cluster at Diné College and is available to other faculty for their research projects.

- 1 Gbps network
  - At that time first network faster than 100 Mbps at Diné College which came in handy both during our first NSF project and the second one for which we still needed a fast network and a lot of computational power but did not depend on anyone in terms of datasets.

Award Abstract # 1914787

Optimizing concentric ring electrode design for noninvasive electrophysiological measurement

NSF Org:	EES Div. of Equity for Excellence in STEM
Recipient:	NAVAJO NATION TRIBAL GOVERNMENT, THE
Initial Amendment Date:	June 5, 2019
Latest Amendment Date:	June 5, 2019
Award Number:	1914787
Award Instrument:	Standard Grant
Program Manager:	Lura Chase lchase@nsf.gov (703)292-5173 EES Div. of Equity for Excellence in STEM EDU Directorate for STEM Education
Start Date:	September 1, 2019
End Date:	August 31, 2023 (Estimated)
Total Intended Award Amount:	$200,002.00
Total Awarded Amount to Date:	$200,002.00
Funds Obligated to Date:	FY 2019 = $200,002.00
History of Investigator:	Oleksandr Makeyev (Principal Investigator) omakeyev@dinecollege.edu
Recipient Sponsored Research Office:	Dine College 1 CIRCLE DR TSAILE AZ US 86556-9998 (928)724-6670

MEA lab products since 2016

- 3 NSF research awards total ($600,000+);
- 3 patents (one issued and two pending);
- 8 journal and 9 conference proceedings papers;
- 7 undergraduate Research Assistants published their research including journal papers;
- Awards, tutoring for Diné College students, running activities for local school students at STEM festivals, etc.

Papers

sensors MDPI
Article

Comprehensive Optimization of the Tripolar Concentric Ring Electrode Based on Its Finite Dimensions Model and Confirmed by Finite Element Method Modeling

Oleksandr Makeyev [1,*], Yiyao Ye-Lin [2], Gema Prats-Boluda [2] and Javier Garcia-Casado [2]

Sensors 2021, 21, 5881. https://doi.org/10.3390/s21175881

Measurement 80 (2016) 44–52
Contents lists available at ScienceDirect
Measurement
journal homepage: www.elsevier.com/locate/measurement

Improving the accuracy of Laplacian estimation with novel multipolar concentric ring electrodes

Oleksandr Makeyev [a,*], Quan Ding [b], Walter G. Besio [c]

Hindawi
Journal of Sensors
Volume 2020, Article ID 6269394, 9 pages
https://doi.org/10.1155/2020/6269394
Research Article

Improved Spatial Resolution of Electroencephalogram Using Tripolar Concentric Ring Electrode Sensors

Xiang Liu,[1] Oleksandr Makeyev,[2] and Walter Besio[1]

applied sciences MDPI
Article

Validating the Comparison Framework for the Finite Dimensions Model of Concentric Ring Electrodes Using Human Electrocardiogram Data

Oleksandr Makeyev [1,*], Mark Musngi [1], Larry Moore [1], Yiyao Ye-Lin [2], Gema Prats-Boluda [2] and Javier Garcia-Casado [2]

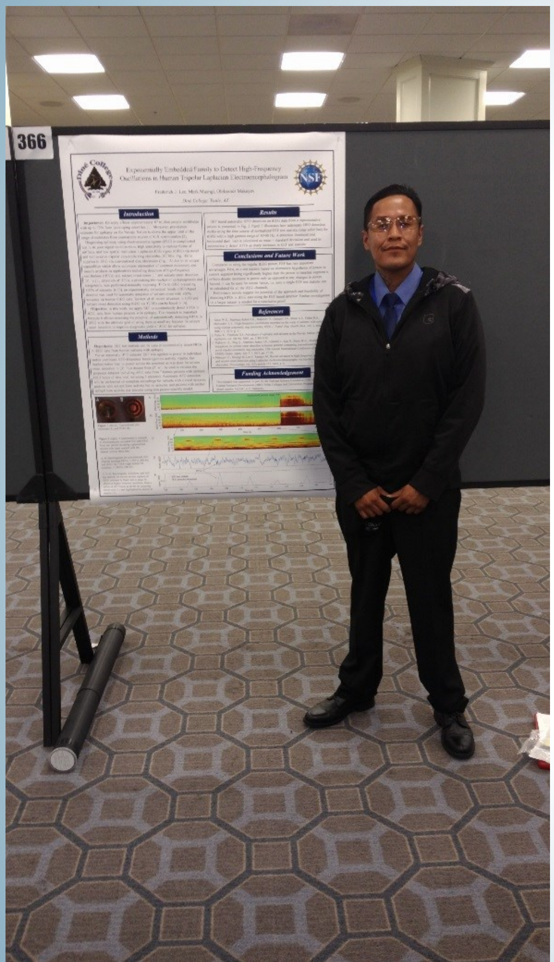
Appl. Sci. 2019, 9, 4279; doi:10.3390/app9204279

Makeyev BioMed Eng OnLine (2018) 17:117
https://doi.org/10.1186/s12938-018-0549-6
BioMedical Engineering OnLine
RESEARCH Open Access

Solving the general inter-ring distances optimization problem for concentric ring electrodes to improve Laplacian estimation

Oleksandr Makeyev*

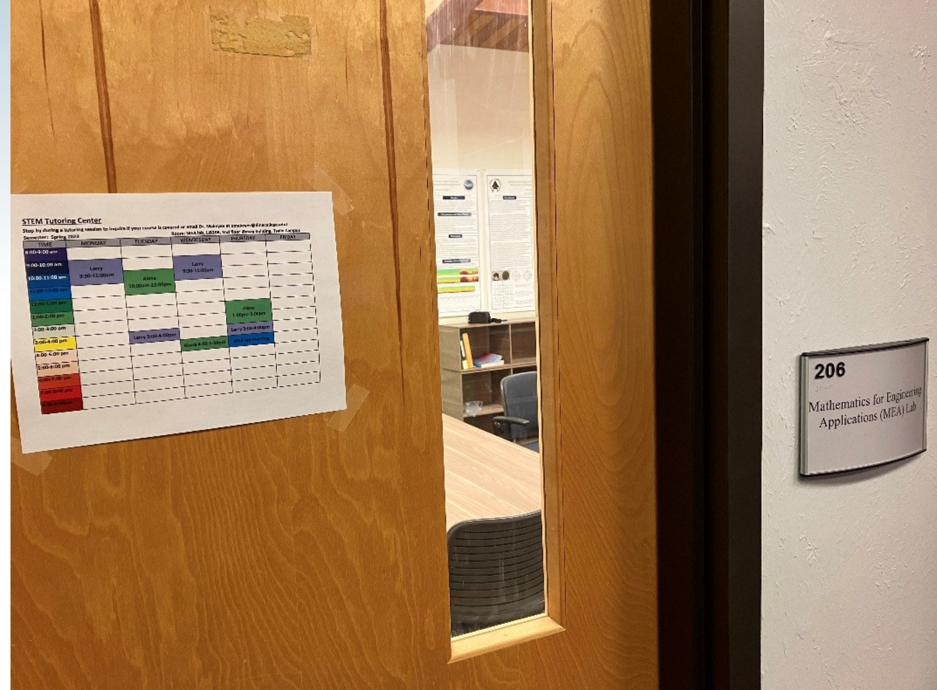
Awards



Competitive travel awards.

Outreach

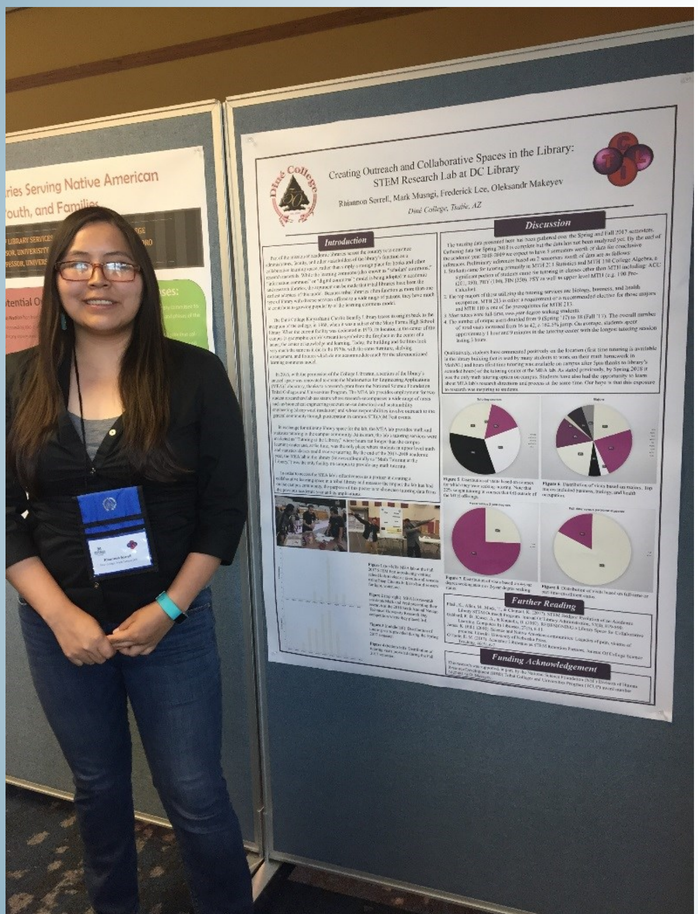
Fall 2019 STEM festiva



tutoring schedule.

2019 NSF TCUP TRS.

Tutoring



2018 TCLI.

Creating Outreach and Collaborative Spaces in the Library: STEM Research Lab at DC Library

Rhiannon Sorrell, Mark Musngi, Frederick Lee, Oleksandr Makeyev

Diné College, Tsaile, AZ

Introduction

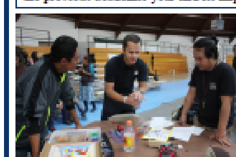
Part of the mission of academic libraries across the country is to convince administrators, faculty, and other stakeholders of the library's function as a collaborative learning space, rather than simply a storage place for books and other research materials. While the learning commons (also known as "scholars' commons," "information commons" or "digital commons") model is being adopted in academic and research libraries, the argument can be made that tribal libraries have been the earliest adopters of this model. Because tribal libraries often function as more than one type of library with diverse services offered to a wide range of patrons, they have much to contribute to growing popularity of the learning commons model.

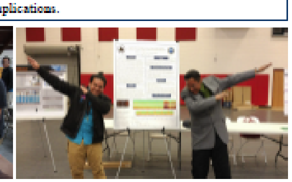
The Diné College Kinyaa'áanii Charlie Benally Library traces its origins back to the inception of the college, in 1968, when it was a subset of the Many Farms High School library. When the current facility was dedicated in 1973, its location in the center of the campus (a geographic circle) is meant to symbolize the fireplace in the center of a home; the center of knowledge and learning. Today, the building and facilities look very much the same as it did in the 1970s, with the same furniture, shelving arrangement, and fixtures which do not accommodate much for the aforementioned learning commons model.

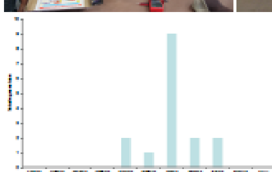
In 2016, with the permission of the College Librarian, a section of the library's unused space was renovated to create the Mathematics for Engineering Applications (MEA) Laboratory, thanks to a research grant from the National Science Foundation Tribal Colleges and Universities Program. The MEA lab provides employment for two student researchers/lab assistants whose research encompasses a wide range of areas such as biomedical engineering (seizure on-set detection) and sustainability engineering (sheep wool insulation) and whose responsibilities involve outreach to the general community through participation in campus STE(A)M Fest events.

In exchange for utilizing library space for the lab, the MEA lab provides math and statistics tutoring to the campus community. At its start, the lab's tutoring services were marketed as "Tutoring at the Library," where hours ran longer than the campus learning center and, at the time, was the only place where students in upper level math and statistics classes could receive tutoring. By the end of the 2017-2018 academic year, the MEA lab in the library (known colloquially as "Math Tutoring at the Library,") was the only facility on campus to provide any math tutoring.

In order to access the MEA lab's effectiveness as a partner in creating a collaborative learning space in a tribal library and measure the impact the lab has had on the campus community, the purpose of this poster is to showcase tutoring data from the previous academic year and its implications.







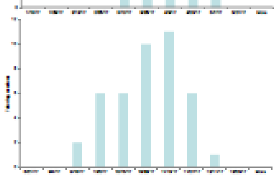


Figure 1 (top left). MEA lab at the Fall 2017 STEM Fest introducing visiting school kids to electric circuits and sensors using Snap Circuits Jr. kit to build sensors for light, water, etc.

Figure 2 (top right). MEA lab research assistants Mark and Fred presenting their research at the 2018 Sixth Annual Navajo Technical University Research Day competition where they placed 3rd.

Figure 3 (middle left). Distribution of tutoring visits provided during the Spring 2017 semester.

Figure 4 (bottom left). Distribution of tutoring visits provided during the Fall 2017 semester.

Discussion

The tutoring data presented here has been gathered over the Spring and Fall 2017 semesters. Gathering data for Spring 2018 is complete but the data has not been analyzed yet. By the end of the academic year 2018-2019 we expect to have 5 semesters worth of data for conclusive inferences. Preliminary inferences based on 2 semesters worth of data are as follows:

1. Students came for tutoring primarily in MTH 213 Statistics and MTH 110 College Algebra, a significant portion of students came for tutoring in classes other than MTH including: ACC (201, 330), PHY (110), FIN (330), PSY as well as upper level MTH (e.g. 190 Pre-Calculus).
2. The top majors of those utilizing the tutoring services are biology, business, and health occupation. MTH 213 is either a requirement or a recommended elective for those majors and MTH 110 is one of the prerequisites for MTH 213.
3. Most tutees were full-time, two-year degree seeking students.
4. The number of unique users doubled from 9 (Spring '17) to 18 (Fall '17). The overall number of total visits increased from 16 to 42, a 162.5% jump. On average, students spent approximately 1 hour and 9 minutes in the tutoring center with the longest tutoring session lasting 3 hours.

Qualitatively, students have commented positively on the location (first time tutoring is available in the library building that is used by many students to work on their math homework in MathXL) and hours (first time tutoring was available on campus after 5pm thanks to library's extended hours) of the tutoring center at the MEA lab. As stated previously, by Spring 2018 it was the only math tutoring option on campus. Students have also had the opportunity to learn about MEA lab's research directions and process at the same time. Our hope is that this exposure to research was inspiring to students.

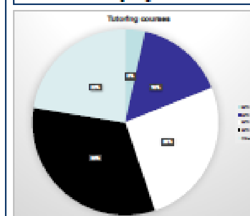


Figure 5. Distribution of visits based on courses for which they were seeking tutoring. Note that 22% sought tutoring in courses that fell outside of the MTH offerings.

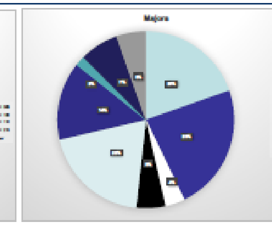


Figure 6. Distribution of visits based on majors. Top majors included business, biology, and health occupation.

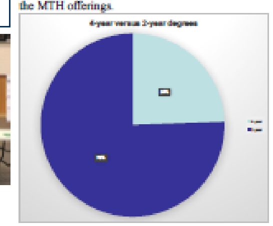


Figure 7. Distribution of visits based on 4-year degree seeking status or 2-year degree seeking status.

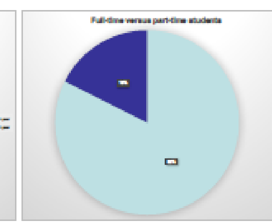


Figure 8. Distribution of visits based on full-time or part-time enrollment status.

Further Reading

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Funding Acknowledgement

This research was supported, in part, by the National Science Foundation (NSF) Division of Human Resource Development (HRD) Tribal Colleges and Universities Program (TCUP) award number 1622481 to O. Makeyev.

Nowadays

Newest toys.

Award Abstract # 2212707

SGR: Validating the Optimal Design of Concentric Ring Electrodes on Phantom Data

NSF Org:	EES Div. of Equity for Excellence in STEM
Recipient:	NAVAJO NATION TRIBAL GOVERNMENT, THE
Initial Amendment Date:	May 15, 2022
Latest Amendment Date:	May 15, 2022
Award Number:	2212707
Award Instrument:	Standard Grant
Program Manager:	Jeremy Guinn jguinn@nsf.gov (703)292-8193 EES Div. of Equity for Excellence in STEM EDU Directorate for STEM Education
Start Date:	June 1, 2022
End Date:	May 31, 2024 (Estimated)
Total Intended Award Amount:	$200,000.00
Total Awarded Amount to Date:	$200,000.00
Funds Obligated to Date:	FY 2022 = $200,000.00
History of Investigator:	Oleksandr Makeyev (Principal Investigator) omakeyev@dinecollege.edu
Recipient Sponsored Research Office:	Dine College 1 CIRCLE DR TSAILE AZ US 86556-9998 (928)724-6670

Some other firsts along the way

- Pursuing intellectual property required a respective set of policies and procedures which had to be created (mostly) from scratch first;
- Same goes for getting legal counsel on board, funding patent related costs and fees with soft money, dealing with USPTO, Bayh–Dole Act reporting, etc;
- MEA lab's web page showcased at http://mealab.dinecollege.edu/
- Certain aspects of international collaborations;
- Patents and the most important first yet…

Patents

- First patent issued to a Tribal College or University.
- Two more patents are currently pending.
- Other STEM faculty are ready to apply for patents but current process is not easy and how about other inventors?

US011045132B1

(12) **United States Patent**
Makeyev

(10) **Patent No.: US 11,045,132 B1**
(45) **Date of Patent: Jun. 29, 2021**

(54) **CONCENTRIC RING ELECTRODES FOR IMPROVED ACCURACY OF LAPLACIAN ESTIMATION**

(71) Applicant: **Diné College**, Tsaile, AZ (US)

(72) Inventor: **Oleksandr Makeyev**, Tsaile, AZ (US)

(73) Assignee: **Diné College**, Tsaile, AZ (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/067,480**

(22) Filed: **Oct. 9, 2020**

(51) **Int. Cl.**
A61B 5/291 (2021.01)

(52) **U.S. Cl.**
CPC *A61B 5/291* (2021.01); *A61B 2562/0209* (2013.01); *A61B 2562/0215* (2017.08); *A61B 2562/04* (2013.01)

(58) **Field of Classification Search**
CPC A61B 5/291; A61B 2562/0215; A61B 2562/0209; A61B 2562/04
See application file for complete search history.

(56) **References Cited**

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2012/0150011	A1*	6/2012	Besio	A61N 1/0502 600/388

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ES	2425692	* 10/2013		A61B 5/04
WO	2013135931	A1	9/2013	

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Oleksandr Makeyev et. al., "Proof of concept Laplacian estimate derived for noninvasive tripolar concentric ring electrode with incorporated radius of the central disc and the widths of the concentric rings", retreived: Jan. 7, 2021., (Year: 2017).*

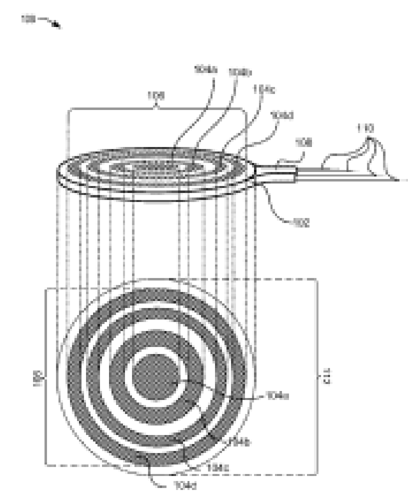
(Continued)

Primary Examiner — Eun Hwa Kim
Assistant Examiner — Adam Z Minchella
(74) *Attorney, Agent, or Firm* — Kilpatrick Townsend & Stockton LLP

(57) **ABSTRACT**

An electrode device for electrophysiological measurement may include an electrode substrate having a surface area. The electrode device may include a central electrode disposed on the electrode substrate around a central portion of the surface area. The electrode device may include a plurality of electrodes disposed on the electrode substrate concentric with the central electrode. The plurality of electrodes may include a first electrode covering a first portion of the surface area of the electrode substrate and a second electrode covering a second portion of the surface area of the electrode substrate. The second portion may be greater than a combined surface area of the first portion and the central portion.

20 Claims, 10 Drawing Sheets



Technology transfer center

- Current state of the art: who has them and why?
- What services are usually provided?
  - Protecting IP;
  - Licensing IP;
  - Creating small businesses around IP.

Diné College journey so far

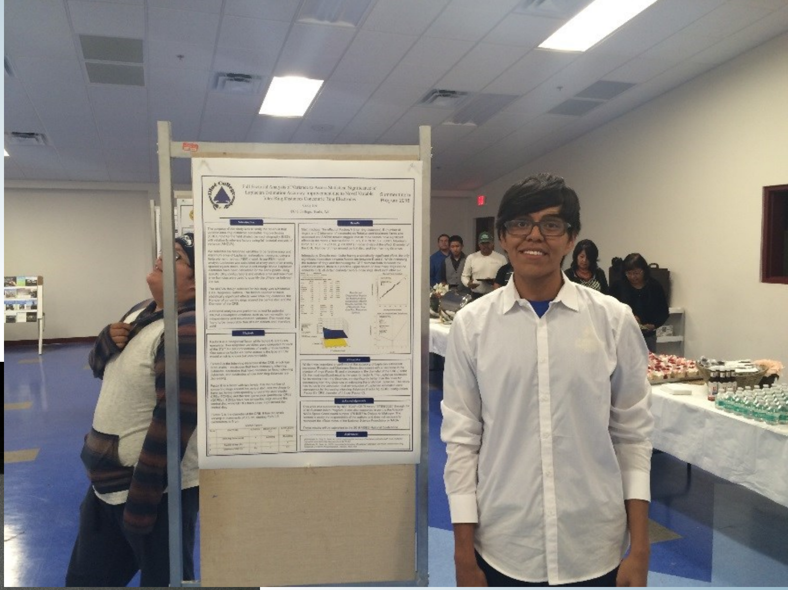
- Several funding proposals were prepared and submitted with varying degrees of success:
  - NSF TCUP TEA Center proposal was not funded but revision was invited;
  - That revision has been resubmitted on June 1st, 2023.
  - SBA earmark for over $1M was funded thanks to the Senator Mark Kelly.
- Technology Transfer Center as well as its computer lab and maker space will be located in the Tsaile Campus library.

What has been funded already

- Already funded via the SBA earmark:
  - Setting up and operations (including legal costs and fees) of the center during its first year;
  - Renovations (center and computer lab/maker space);
  - Computer lab/maker space hardware and software;
- Not funded yet:
  - Comprehensive suite of database subscriptions;
  - Years two through six of operations (crucial to its self-sustainability plan).

Conclusions

- It’s doable.
  - More of our research labs are now located elsewhere.
- Not spending hard money is possible:
  - NSF TCUP SGR awards are great for setting up research labs;
  - NSF TCUP TEA Center awards may be a fit for technology transfer centers;
  - Do as much as possible in house and don’t forget about the earmarks.
- Please, consider collaborating with a research laboratory at your Tribal College or University library.



Thanks You!

Questions?