Siksika Nation – The future is looking up

For tens of thousands of years, the Siksika-itsitapi have studied and recorded the motions of celestial bodies. Today, this knowledge is emerging from the past to reveal a vision of the future — one that reaches the planets and beyond!

By **Tusha Sharma, Bruce Rout, David Garrett and Anis Ben Arfi**

Siksika Nation is a First Nations community situated an hour's drive east of Calgary in an optically-dark and radio-quiet zone. It is the second largest reservation in Canada, and is about 60 km in width.

The Siksika education department, in collaboration with other universities, is discussing building significant optical observatories on the reserve and providing telescopes for other schools in the Canadian province of Alberta. This would turn this isolated community into a major centre of astronomical research, and provide data and research projects for university-level and professional astronomers. Not only focusing on astronomy, our goal is to expand the horizons of education into various disciplines which can bring in more value to the community. After devastating floods in 2013, we now look forward to making a technically empowered sustainable community.

This will have a major impact on opportunities for community members of all ages. The project will benefit both those on the reserve and those in the surrounding community, building bridges between native and non-native people through the mutual exchange of educational outreach. Students will come to a greater understanding of their own history and the activities of their ancestors. They will become more connected to their Blackfoot, (or Niitsitapi – "that which is real") heritage. The motto of this project is simple: "You, the Sky, and the Land."

Basic Radio Astronomy - Hands on Equipment for School Kids

As a means of connecting the local people both with technology and the universe around us, radio astronomy is being explored as an activity on the reserve. Community events have shown a great interest from the local people in astronomy, especially given their rich history of storytelling about the stars. Community members will build half-wave dipole antennas to receive radio signals emitted from Jupiter and the Sun. Low-cost receivers will then be assembled by means of component soldering and tuning, allowing the signals to be recorded on a computer. This data will then be shared online in a growing community of radio astronomy enthusiasts.

Discovered accidentally in 1955 at the Carnegie Institute in Washington, DC., radio emissions from Jupiter are formed from the complex interaction between ionized gas and its moon Io.

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Background to Projects

In the year 2015, Dr. Deborah Scherrer, Director of Stanford Solar center, and Dr. Phil Scherrer, Professor, Stanford University visited the Siksika Nation to commence the International Year of Light initiative started by IEEE Southern Alberta Section (SAS) Young Professionals, under the leadership of Tushar Sharma. Bruce Rout, Co-Founder of Astronomy Teacher Training Institute (ATTI) arranged a meeting and session in Siksika. The Stanford Solar center was very interested in supporting this initiative, and provided its materials and courses for developing their community and improving academic achievement. A meeting was arranged with the Chief and Council at Siksika, and soon afterwards the needed approval was secured.

Tushar Sharma and Drs. Phillip and Debbie Scherrer of Stanford Solar Centre enjoy a brisk evening on an effigy mound east of Blackfoot Crossing.

A radio astronomy feedhorn adjacent to the Siksika Nation High School.

This is not the first foray into astronomy for the Blackfoot nation. They have been studying the stars and seeking their place in the universe for tens of thousands of years.

– Bruce Rout

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The Majorville Medicine Wheel was built before Stonehenge and is based on the position of the stars more than 5,000 years ago. Here, Elder Connie Crop Eared Wolf and her husband Andy examine a plaque at the entrance to the site.

Summer 2016 Program Highlights

IEEE Young Professionals and Special Interest Group on Humanitarian Technology (SIGHT) group in Southern Alberta had meetings with Chief Yellow Old Woman and Council, and the Siksika Board of Education, which kicked off a summer science program for local children in 2016. A small building behind Old Crowfoot School was secured, cleaned and prepared to use as a base for the upcoming summer project and as a hands-on training centre for future programmes.The graduate students team helped to clean and restore the building and develop the education program for the summer school.

Local teacher, Nadine Solway, volunteered as a programme assistant and adviser on Blackfoot culture and the summer program began. A field trip to the Majorville Medicine Wheel was organized for students and accompanying Elders, who had never before visited it; all were deeply moved by the rediscovery and witnessing of the activities of their own ancestors. The Medicine Wheel was built before Stonehenge, and is based on the positions of the stars more than 5,000 years ago. Although the site has been disturbed and vandalized by local and federal governments and tourists, the structural outlay and positions of major demarcations are intact.

Further summer activities included: the mathematics of tipis, rockets, observing the Moon, chemical reactions, making and flying kites and field trips to the Telus Spark Science Centre and the Blackfoot display at the Glenbow museum in Calgary. This provided students with a wide and balanced view of various sciences. Many of the students had not been off of the reserve before. The Summer science program ended with another field trip to the Medicine Wheel with Dr. Genevieve Fox, the Superintendent of the Siksika Board of Education.

Local teacher Nadine Solway studies one of the Okotoks (rocks) at the Medicine Wheel

Anis Ben Arfi and David Garrett prepare class.

Bruce Rout demonstrates chemical reactions

The summer science program was a discovery that Blackfoot culture and science are not only complementary, but are intertwined. There is no division between culture and science. Science, in studying the relationship between truth and reality, forms the social culture of Blackfoot people. ■

(Basic Radio Astronomy... continued from Page 14)

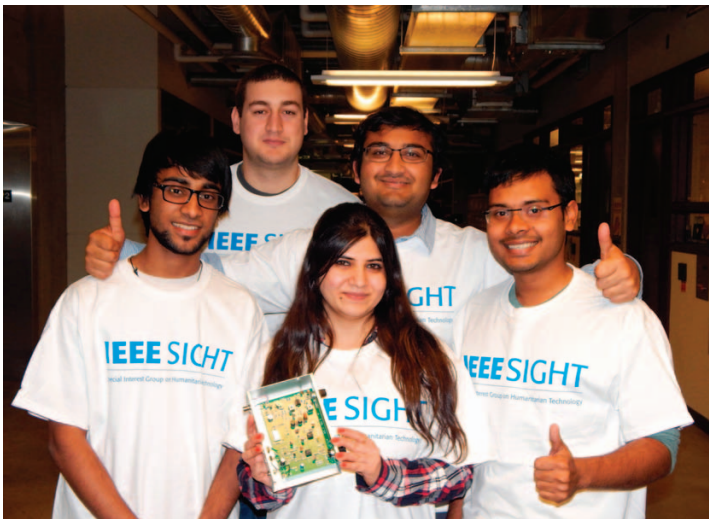
Traveling almost 600 million kilometers, these signals are so powerful that they can be easily received on Earth. Emissions are generally below 40 MHz, but the Earth's ionosphere reflects and absorbs much of the radiation below 15 MHz. The NASA Radio Jove project was initiated to provide a low-cost method of listening to these emissions. These receivers operate at 20.1 MHz, which is a relatively quiet portion of the radio spectrum. They use a direct-conversion architecture, whereby the 20.1 MHz radio signals are mixed down to audible frequencies. Audio is directly output from the receivers and input into a recording computer. Radio activity on Jupiter can then be directly heard, with the two common types being L-bursts, which sound like ocean waves, and S-bursts, which are more percussive and sound like popping popcorn. Signals are received using an array of two half-wave dipole antennas. By reconfiguring the height, orientation, and phase delay in the antennas, the primary radiation beam can be steered to follow Jupiter's optimal position during each season. Emissions from Jupiter are best heard at night when the Sun's emissions are less prominent, and the Earth's ionosphere is less ionized.

This project aligns with the vision of developing a world-class radio astronomy centre on the reserve, presenting a first step to developing the technical framework for future projects. Throughout this process, reserve members will develop practical skills such as soldering, web development, and antenna design. The location of the reserve is optimal for these measurements, where the radio-quiet zone will be useful in obtaining clean results. Prior to installing systems on the reserve, customized modules were developed and assembled by the Young Professionals team in the IEEE Southern Alberta Section at the University of Calgary. Using 20-foot-tall PVC masts, two dipole antennas were raised and connected to an assembled receiver, and preliminary measurements have been performed.

Assembled NASA Radio Jove antenna on the University of Calgary campus

Radio Astronomy Componentry

Since Siksika reserve is a radio quiet zone, the development of a scientific skill set among students is a goal introduced both in hands-on and classroom teaching. Single radio astronomy units have a limited spatial resolution at high frequencies. To enhance this spatial resolution, these single radio units are combined into multiple-element arrays that work as a single array. To start with, individual or groups of students can assemble a two-element array, which consists of a simple pair of dipole antennae, along with a direct convergent receiver that students can solder and assemble. The middle level and high schools students will focus on using dipole antennae and optimizing different antenna geometry to customize different shapes that can be used for radio astronomy observations. As part of an advanced module, students will simulate the receiver chair, advanced antenna geometries and build a standalone interferometry system

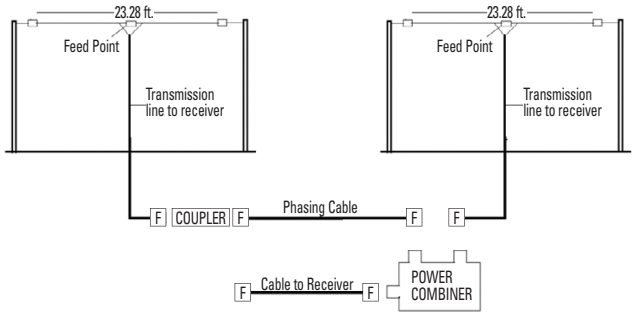


The IEEE Special Interest Group on Humanitarian Technology (SIGHT) at University of Calgary with Radio Jove circuit board

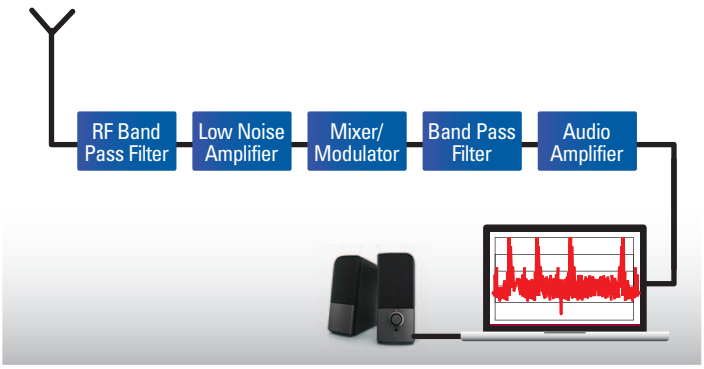
that can be used by amateur radio astronomers in and around Siksika for different experiments. The basic interferometer is a pair of radio telescopes whose voltage outputs are correlated (multiplied and averaged).

Amateur Radio

To continue technical development on the reserve, amateur radio courses are to be held through the winter of 2016/2017. Community members will work towards amateur radio certification through the successful completion of a 100-question multiple-choice exam. Throughout several weeks, members will participate in enjoyable activities which will gradually introduce the relevant topics, where the focus will be on hands-on learning. By highlighting practical applications of amateur radio such as emergency communication and local network deployment, members will be working simultaneously



Connection of two di-pole antennas to create a simple array



Block diagram of a simple radio receiver used for measurements

Amateur radio events held at the University of Calgary have attracted large attendance from students and the local amateur radio community

The architecturally unique Blackfoot Crossing Cultural Centre is proposed as the site for future astronomical conferences.

towards their certification and the betterment of the reserve. For instance, a radio link will be established between the reserve and the University of Calgary. With many of the reserve members without cell phones or internet access, this will provide a continued bond between Siksika Nation and university students, where experience and knowledge can be shared. Members of Calgary's local amateur radio community will also be assisting in preparing the community in case of future emergencies such as the 2013 floods that left the area in a state of disarray. Equipment and training will be provided. A high frequency (HF) and very high frequency (VHF) station will be assembled at the Siksika Nation high school, where students and other community members can get on the air and speak around the world.

Topics such as radio wave propagation, transceiver architecture, and modulation schemes will be explored. Many of the skills taught in this process are transferable to other areas of employment and study. The amateur radio license is a widely recognized achievement that would be an attractive asset in the search of employment. It is anticipated that through the emphasis of enjoyable and interesting aspects of science and engineering, members will gain the motivation to complete their high school education and pursue university or college studies.

Optical Telescope

Dark sites are becoming quite rare. Steward Own Chief, the Siksika council member for Education, has suggested the use of the Poor Eagle Camp site on Siksika as a dark site for a future optical observatory. The mirror-making laboratory at the University of Arizona has proposed providing assistance and large telescope mirrors for such an observatory. The University of Lethbridge and Mount Royal University have also expressed interest in a joint venture with Siksika to build a research-grade optical telescope.

Renewable energy solutions have been suggested to provide electrical power to this isolated site with the instructional assistance and guidance of IEEE SIGHT. The IEEE SAS already hosted a hands-on training on micro electrification using solar energy. This will provide more high tech educational opportunities for students in the program.

Benefits to SAS YP/SIGHT/IEEE MTT SA

This is not just a one-way benefit to the people of Siksika; SAS Young Professionals members stand to receive huge benefits from their involvement as well. These benefits include: enrichment in terms of circuit design and other technical skills, learning about a different culture, and perceiving the role that science plays in that culture. Students will develop adaptation and communication skills transferrable to future different workplace cultures, in potentially many different countries and regions of the world. Furthermore, the consultative aspect - working with those who will use the technology – is invaluable, as is the enhancement of presentation and interpersonal skills. This initiative is being led by IEEE student and graduate student members in a model for fostering sustainable community development through demand-driven projects that can be applied throughout the entire IEEE community.

Benefits to Siksika

For young and old members of the reserve alike, a renewed interest in technology and science will be developed, motivating them to pursue careers in those areas. Technical and professional skills will be acquired by members, while maintaining a deep connection with their history and culture. For the community as a whole, this will be empowering on multiple levels; the local people will be able to take charge and be self-sustaining, leading to a bright prosperous future. Siksika stands to be a model for other reservations in North America.

Professional Growth to Community

These continuing education projects on Siksika reserve will help the youth to get engaged, learn and share knowledge with the outside world. Starting with amateur radio astronomy projects which will help in nurturing basic science education, HAM Radio will equip the community to get connected with the outside world and prepare a task force for emergency response. Training the youth on solar electrification and deployment will also help enhance their professional and technical skillset which can help them to shape a career. The amateur radio site is expected to be a center wherein amateurs from nearby areas in Alberta can come for optical and radio night sky observations. The team envisions developing this as a hub for amateur education programs which will be run by the people, of the people and for the people.

Larger aspect of Community Empowerment

The community will be empowered through this program. Siksika people are to direct it. The program will evolve through the growing experience and skills of local participants. Progress will be achieved through short-term, easily achievable and easily accessible goals. As the project progresses,

Bobbi Running Rabbit

Kayci Breaker

it will involve identifying people of capacity and enabling them to be facilitators of various future projects which will arise organically. It is hoped students at Siksika will visit local non-native schools to teach astronomy and to help teachers.

True empowerment lies with knowledge. The source of knowledge lies with the individual. Through action and through responding to challenge, humanity progresses. We anticipate the people of Siksika as world leaders in education and community development. ■

Support for Siksika Nation Initiative by IEEE HAC

"The IEEE mission and vision is to apply our engineering profession to leverage technology in creating a better tomorrow. IEEE seeks to impact our world through technical solutions that empower people to achieve sustainable development while partnering with underserved communities and local organizations.

We as engineers should not be developing technology and then looking for problems to solve; instead we need to listen to the voices calling out the needs and creating together with local partners appropriate solutions.

The radio astronomy / amateur radio / optical telescope program led by YP/MTT-S IEEE Southern Alberta Section is truly an innovative platform for STEM education, scientific discovery, and potential economic benefit to the Siksika Nation. Its success points the way to how the IEEE can simultaneously serve the global community and provide empowerment for the local community."

Tim Lee IEEE Humanitarian Activities Committee, Partnerships IEEE MTT-S SIGHT Chair

"Local and indigenous capacity-building is a core value of IEEE SIGHT (Special Interest Group on Humanitarian Technology); we seek to support underserved communities in their development efforts by leveraging technology solutions. This is in alignment with the history of siksika-itsitapi because of the astronomical observations and studies done by the community since thousands of years ago. We are excited to learn about the positive outcomes from this community engagement."

Kartik Kulkarni IEEE Humanitarian Activities Committee

Acknowledgements

This is a joint initiative by IEEE Young Professionals Southern Alberta, SIGHT, Siksika Board of Education, MTTS ,Astronomical Teacher Training Institute, NASA Radio Jove, Stanford Solar Center, IEEE Antenna and Propagation Society and the IEEE PES. The authors wish to acknowledge and thank their partners for their support and assistance in this onging project.

(Background to Projects... continued from Page 14)

Mr. Rout has been visiting and engaging the Siksika Nation for the past six years. The project is overseen by ATTI, which was founded in 2014 by Bruce Rout and Tushar Sharma. Other founding members of ATTI included Dr. Martha Manygreyhorses of the University of Lethbridge, and Cameron Rout, a Yale Business School graduate. Dr. Rob Cardinal, who is from Siksika (and has a comet named after him), lent support and assistance in initiating this project. Mr. Sharma, through his membership with IEEE, is leveraging volunteer expertise and enthusiasm from University of Calgary students to teach and instruct Siksika students and community members as the project unfolds. With the support of a great team of graduate students from the University of Calgary including the chair of IEEE SIGHT Southern Alberta Section, Mr. Anis Ben Arfi, vice chair Mr. Martin Berka, and the founder of Amateur RadioClub at the University of Calgary, Mr. David Garett, this group is helping to execute the sessions and building a great program for the community.

In preparation for the Siksika Astronomy project, Mr. Rout attended the 2016 summer conference of the American Astronomical Society (AAS) in San Diego to present a paper on galactic structure, and to promote the Siksika program. While there, Mr. Rout met with past and present presidents of AAS as well as professional astronomers from major universities throughout the US. From this, the use of Siksika as a future astronomy facility was discussed. This would provide data for American university students who are hard-pressed for professional optical and radio observation time. Also, as a result of this conference, the AAS educational chairman is looking to provide raw data from the Chandra X-Ray observation satellite for Siksika students to analyze. Through Mr. Rout, ATTI is now an educational affiliate of AAS opening access to resources from NASA, JPL and other major astronomical facilities throughout the world. ■

Bios

Tushar Sharma received his Bachelors of Technology in Electronics and Communications engineering from GGSIPU, Delhi and currently he is pursuing his doctoral studies at University of Calgary. His research interests focus on RF/ Microwave Power Amplifiers, System Level Design, RF Circuit Design, High-Efficiency Broadband Power Amplifiers, Waveform Engineering, active and passive load-pull techniques, etc. He is currently working as a Research and Development design intern at NXP Semiconductors. Tushar has been an avid IEEE volunteer for the past eight years and is leading the community development initiative at Siksika.

Bruce Rout currently works at Siksika Nation as an Educational Consultant using astronomy to further community development. Mr. Rout graduated with a Masters degree in Mathematics from SFU in 2002 after obtaining a Bachelors degree in Astrophysics at U of A. Mr. Rout has done scientific research with AOSTRA on Alberta oil sands, developed automated brokerage systems for the New Zealand Stock Exchange and was a member of the national task force for RCMP resourcing as a mathematical consultant. Mr. Rout has been a high school teacher for 20 years and has recently presented a paper to the American Astronomical Association on galactic structure.

(Bios... continued from Page 18)

David Garrett completed his B.Sc. in Electrical Engineering at the University of Calgary in 2016, where he is currently working towards his M.Sc. in Electrical Engineering. During his B.Sc., he spent one year in an internship with ABB Corporate Research in Baden, Switzerland, working on dielectric testing and characterization. His current research focus is on radio frequency systems for biomedical sensing applications. He is the current chair of the IEEE Microwave Theory and Techniques Society (MTT-S) Student Chapter at the University of Calgary.

Anis Ben Arfi completed his B.Sc with Honours from SUP'COM Tunis, then joined the Schulich School of Engineering, University of Calgary as a graduate student after showing promising research skills and being awarded with a scholarship to carry out his research activities with the iRadio Lab team. His research interests centre on the performance of low-power transceivers, mainly through the application of new types of modulation schemes, software defined devices, digital predistortion techniques, and wireless sensors networks. Anis is currently the president of the Graduate Engineering Students Consortium at the University of Calgary and the chair of the IEEE Special Interest Group on Humanitarian Technology (SIGHT) Southern Alberta Section.

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