MAGDALENA RIDGE OBSERVATORY PRESENTS

# THE OPTIC

MROI MONTHLY INQUIRER

BIANNUAL SPECIAL EDITION

July 2020

# In Memory of

## Daniel Alexander Klinglesmith III

was born in St. Louis, Missouri, in 1939. Dan received his undergraduate degree, majoring in Physics, from the St. Louis University. After graduating from Indiana University with a Masters degree in Physics and PhD in Astrophysics, he joined the Goddard Space Flight Center in 1966 and worked there for the next 30 years.

Dan had spent a sabbatical at New Mexico Tech in Socorro, New Mexico, in 1987 working at the Joint Observatory for Cometary Research on Magdalena Ridge. When he retired from Goddard in 1996, he and his wife Gerry returned to Socorro with the intention of devoting his retirement to weaving tapestries. However, Dan became involved with the astronomy program at Tech and started teaching the astronomy lab for the Physics Department which led to his being hired by MRO in 2000.

Dan was a much loved member of MRO who was selfless in devoting his time to conducting star parties at the Etscorn Observatory on campus as well as on Magdalena Ridge and also to making presentations to schools. He was a great ambassador for astronomy in general and MRO in particular.

Dan Klinglesmith passed away after a brief bout with cancer on July 27, 2019.

# SPECIAL RECOGNITION

At the MRO and MROI, we have crossed many milestones over the decades. We would not be in our current position without the incredible generosity of those who have supported us throughout the years. We would like to express our gratitude and extend special recognition to a few members of Friends of the MRO.

Special thanks to the following Friends of the MRO members, who have given at the Galaxy Level or higher:

| | | |
|---|---|---|
| **Albert and Elizabeth Kidd** | **Ollie Eisman and Sharon Finn** | **Glenna and Mike Schmidt** |
| **Deborah Peacock and Nathan Korn** | **Brett Bachman and Elisbeth Challener** | **Raven and Samuel Goswick** |
| **Ted Kase** | **Ravi and Addy Bhasker** | **Len and Mary Beavis** |

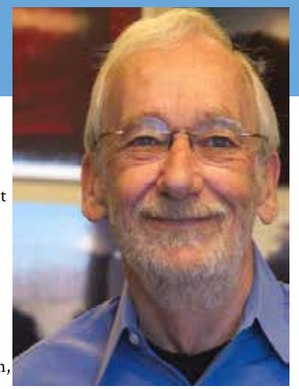
Two special individuals who have done so much not just for the MRO, but for NMT as a whole, are **Frank and Sheri Etscorn**. Their generosity and contributions to the MRO date back to 1993, when the Frank T. Etscorn Campus Observatory first came into existence. Their support for the MRO has been tremendous throughout the decades, and their generosity and compassion in the promotion of education and outreach for NMT cannot be put into words. We are truly grateful to have supporters like Frank and Sheri.

We would also like to thank **Dan Klinglesmith III** to whom this publication is dedicated. It was Dan's mission to make the joys of astronomy accessible to everyone, and the current members of the Outreach Department work hard to continue that mission. We will always be grateful for his driving spirit.

We also offer a warm thanks to **Van Romero**, Principal Investigator and Vice President of Research at NMT, for all of his past and present work for the MRO and MROI. Additional thanks are extended to the MRO and MROI team whose dedication, vision, and commitment make the Observatory what it is. Each employee of the MRO is a piece in a puzzle — every scientist, engineer, staff member, office and maintenance personnel, and student employee brings their own unique skill set, area of expertise, and perspective. We fit perfectly together to form something that is truly unique, working in-sync to do magnificent things in the name of science.

Fromt Cover Photo: Colleen Gino
Layout and Design: Shelbi Etscorn

# Letter from the Director



How quickly our lives can change!

Last year was surely the most successful and exciting year in the history of the project. We had successful engineering runs with the first telescope and succeeded in detecting First light from Unit Telescope#1/Fast Tip Tilt system #1 through the Beam Relay System, Delay Line System, and Beam Compressor optics, to the inner Beam Combining Area.

Those were heady days indeed!

And then the pandemic struck.

It has been a salutary experience to watch how such a small, almost invisible, microbe can cause world-wide disruption, even devastation. Our situation was made worse by the fact that the onset of Covid-19 coincided with the news that our project did not receive funding this year. This double blow resulted in MROI being reduced to a skeleton crew until our next infusion of funding.

The successes of last year now seem to be receding into a dim and distant past as though view though the wrong end of the telescope.

Fortunately, we have been able to retain most of our staff at New Mexico Tech by reassigning them to other projects for the interim, ready to ramp up again as soon as the new funding is in place. This is expected to be in the fall of this year.

As for me, the situation presents a different dilemma since I had already decided to retire from MROI. I have been with the project for 17 years and now I was not sure whether this was a good time or a bad time to retire but on balance I feel that it is an appropriate time for a new person to take over the leadership when the project enters a new phase later this year.

I have been fortunate in having the opportunity to contribute to the development of the MROI and am proud to have been a part of our dedicated team of engineers, scientists, and students. It has been a rewarding 17 years and I look forward eagerly to the exciting developments which are planned for the future of MROI, the most "powerful" telescope on earth.

Ifan Payne

Editorial

## ~~CELESTIAL~~ COORDIANTES





# Farewell from the Team

The whole team at the MROI, from Socorro to Cambridge, would like to send our director, Ifan Payne, a bitter-sweet congratulations on his well-earned retirement.

Ifan, since MROI's inception you have been there guiding the project along: first as Site Project Manager over an empty, flat ridge then as Program Director of an interferometer on the cusp of its very first fringes. Soon, the MRO Interferometer will take its first true look out into the universe; we hope your retirement acts as your own telescope and brings you as many wonderful new discoveries as the MRO Interferometer that you helped create will bring the world. We'll miss you, Boss.

Ifan,
First of all thank you so much for the opportunities you have given me. MRO was thus far the best department I have worked for hands down. I loved the family-like environment we had and how we all worked together. Just know that whoever takes your place has very large shoes to fill. I wish you the best in whatever your future holds. Thank you for letting us work side by side with you!
Danielle

Dear Ifan,
I am writing to you my sincerest, profound gratitude for taking me aboard this wonderful team and this amazing project. By virtue of this invigorating environment under your great leadership, I have been learning a lot from working with the outstanding people around me. You have been so much supportive of me and marked a significant point in the path of my career.
Thank you so much for everything and I wish you all the best on your next adventure!
Siavash

Ifan- Good luck with retirement! I hear that's when the real work begins! Thanks for everything and it was a pleasure working with/for you. Take care and hopefully we will see you around sometime.
Dylan

Ifan, it's been great working with you for all these years. You've been a great boss and I want to say thanks for everything you've done for the project and me. I wish you best for your future and hope you enjoy your retirement!
Chris S

Just want to say thank you for all of your help, I really appreciate. Best of luck and enjoy your retirement.
Juan

It has been a pleasure collaborating with you through the years.
Best wishes for your retirement!
Bodie Seneta

Dear Ifan
How we could forget those parties in your house, when we used to poured red margaritas in your carpet or when your house took people's shoes and made them disappear, good old days. It has been a long journey here and I am hoping that you have enjoyed the time at MROI. Thanks for all the support to the team and myself all these years, you made this project better.
I wish you the best.
Andres

Dear Ifan,
Greetings and fond farewells from the other side of the pond. I hope "release" from the MROI's chains, will leave time for other equally entertaining activities. Memories of my mom drinking very alcoholic New Years punch at your old place, bidding for beautiful woven tapestries at a reservation auction, and sipping beers at your new place watching the sun drop over the golf course at all come to mind. I do hope the coming years are equally memorable and fun (and that you'll continue to entertain your UK visitors from time to time).

With all best wishes, ChrisH

Ifan, your dedication and devotion to this project will always be remembered and appreciated.
Enjoy your retirement,
Chuck

The pandemic has made life surreal in a way; I don't think I will feel the full effect of your retiring until we return to the office. It's been a pleasure working for you and hope to see you once the second telescope is in place!
Ligon

I consider myself lucky to have had the opportunity of being a part of your team and learning from you. They call retirement the world's longest coffee break and I hope you enjoy every single moment of this break. Thank you for bringing so much joy and dedication. You always listened and supported me. I'm going to miss your energy and positivity at the office.
Omid

Thank you, Ifan, for all the leadership you've given us these past several years. You and I both started at MRO in 2003 and have seen many exciting milestones with the project. You've helped us establish the Friends of MRO and we hope that you will continue to participate and visit us as we achieve new milestones for many years into the future. Take some much-deserved time off to celebrate all your hard work.
Michelle Creech-Eakman

During one of our weekly status update meetings you asked Chris (known Cowboys fan) if he had been watching football in the past week. It was not only during the beginning of the quarantine but also outside of football season, so he of course asked you "What football?" "Oh, right" you said as you pondered a minute, "well at least if quarantine lasts until football season, the Cowboys will see a tremendous improvement! Since they won't be playing and all..." I never told you that I'm a Cowboys fan too, and that's still the funniest thing I've ever heard.
Wish we had gotten more time to work together! I've enjoyed it immensely.
Shelbi

Dear Ifan,
It has been a pleasure and an honor to work with you these past three years! Although you will soon no longer be "Boss" to me, I will always consider you a dear friend. I thank my lucky stars (pun intended!) for having you as a student in my photography class. Had we not talked about your missing class due to a work visit to Mt. Wilson Observatory, which led to us talking about your job and my background in astronomy, which snowballed into me saying I'd love to get back into astronomy and literally begging you to hire me in any capacity, I would not have the fantastic job with MROI that I have today. And those rugby-tournament/F1-racing/whatever-excuse-to-get-the-team-together nights at your house -- priceless! It is a rare boss who opens their home to their staff to watch sports, share delicious food, and drink a few adult beverages...
While we have the best team EVER at MROI, your presence will be sorely missed for a long time to come. Enjoy your retirement! Come back and visit us!
Colleen

# What is Interferometry?

## An overview of the science behind the investigative technique and how it is used at the MROI

"...it will make images of unprecedented detail of the center of our galaxy, regions of star and planet formation, stellar accretion discs, active galactic nuclei...The MROI will be able to make accurate and detailed images of complex astronomical objects up to 1000 times faster than other previous or current interferometric arrays..."

**An interferometer combines** the captured light from two or more telescopes into a single image that an individual larger telescope may be incapable of producing. Astronomers use a process called aperture synthesis, a specialized type of interferometry, which arranges the light passed through many small-scale openings to resemble a large aperture. This process produces high resolution results and provides astronomers with images that appear as though objects are observed by mirrors measuring many hundreds of meters in diameter. Similar to aperture synthesis, the ten 1.4 meter telescopes utilized by the Magdalena Ridge Observatory Interferometer (MROI) will simulate a single telescope mirror. This simulation will have the capability of producing diameters ranging from 7.8 meters up to a remarkable 340 meters.

Not only do interferometers produce higher quality images than a single, smaller telescope, they also come with a far lower price tag. In addition to a higher cost of initial production, the light collected by the larger telescopes must undergo further atmospheric correction and error analysis. For reference the Giant Magellan Telescope, Thirty Meter Telescope, and the European Extremely Large Telescope (all measuring 30 meters) cost around $1 billion, $1.4 billion and $1.3 billion respectively. The higher production, operation, and maintenance costs associated with larger telescopes make the utilization of interferometry a much more economical choice. The MROI will come at a fraction of the cost of these telescopes, and will have the greater resolution than any of the 30 meter telescopes currently in existence.

Ifan Payne, the Program Director at the MRO, was interviewed in June 2018 by local Socorro County newspaper, El Defensor Chieftain. Ifan highlighted the innovation of the MROI, stating, "it will make images of unprecedented detail of the center of our galaxy, regions of star and planet formation, stellar accretion discs, active galactic nuclei, and… satellites in Geosynchronous orbit. The MROI will be able to make accurate and detailed images of complex astronomical objects up to 1000 times faster than other previous or current interferometric arrays."

### Did you know?

To protect the delicate (and expensive!) cargo , the first Unit Telescope was transported up the mountain with a carefully placed layer of pool noodles to cushion it!

*The first unit telescope was installed in 2018 (imaged to the right). The illustration to the left represents the layout of the completed array, with each circle representing one telescope.*

*Upon completion, the array will utilize ten movable telescopes and 28 separate foundation pads on which they can be placed.*

*The delay lines allow the light from different telescopes to be delayed to ensure all light arrives at the scientific instrumentatation at the exact same time.*

Artist impression of the completed MROI array.
Image of the array: Andres Olivares; Aeial image: Tyson Eakman

The primary objective of the MROI is to construct and develop an array of ten moveable 1.4 meter telescopes to be oriented in a "Y" configuration. The interferometer will consist of 28 stations onto which the Unit Telescope Enclosure (UTE) can be positioned, with nine stations on each arm of the "Y," and a central station at the center where the arms meet. Movement and placement of the UTEs on the array will be facilitated by a special crane built specifically for this purpose.

The design of each UTE is unique from any other telescope enclosure. The base and lower portion of the enclosure consists of a steel rectangular base, which must be capable of supporting the weight of the telescope's mount during the movement of the enclosure. The exterior is made up of specifically designed panels that protect the instruments from environmental conditions and thermal elements. The shutter and dome (the portion that actually rotates) are made up of composite materials, which guarantee adequate thermal and environmental protection and reduce the overall size of the dome. Additionally, these materials increase the stability of the entire structure and reduce overall cost by using less energy to operate the enclosure and the telescope.

The mission of the MROI consists of three main goals: conducting astrophysical research, increasing our situational awareness in space, and providing valuable educational and outreach opportunities. The situational awareness program will include observation and imaging of Geosynchronous Satellites, including commercial and military targets.

The main astrophsycial science behind the MROI will include formation of stars and planets, accumulation of stellar material and loss of mass of objects, and the study of active nuclei on the galactic scale.

# FOURIER

**The designer of the MROI's Free-space Optical multi-aper-tUre combineR for IntERferometry on how the instrument got its mouthful of a name.**

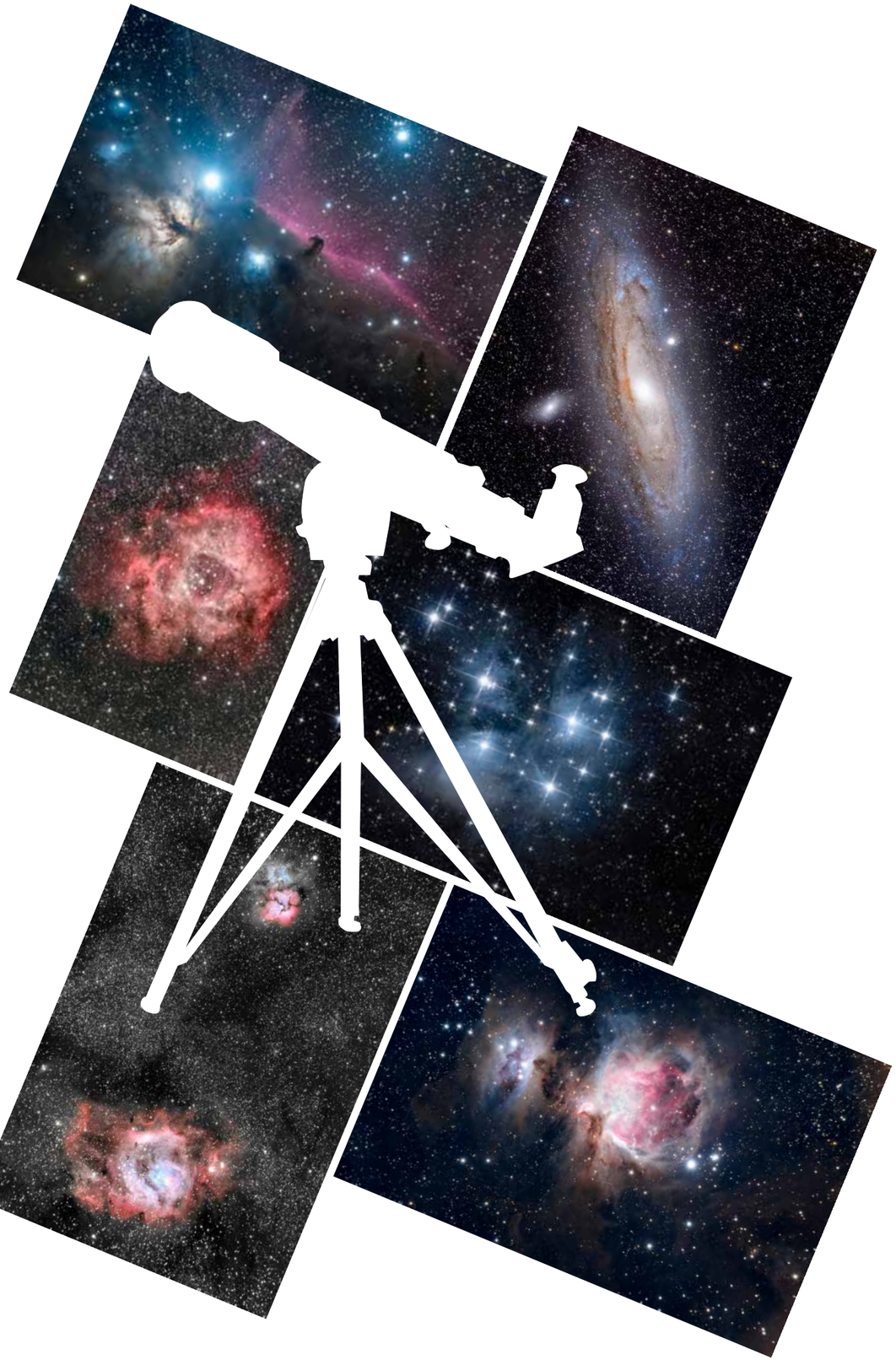
**By Daniel Mortiner**

Imagine you're sitting at a piano; what sound does it make when you press a key? How would you describe it? You'd probably describe it by the frequency (the pitch) and the amplitude (the volume) of the fundamental. With these two pieces of information, you would be able to describe the sound to anyone, and they would be able to "reconstruct" it. This idea can be extended to the sound produced when multiple piano keys are pressed, and so it is not entirely unexpected that it applies to any arbitrary sound. Every possible sound can be reconstructed simply by knowing the frequencies, and the amplitudes of those frequencies, the sound is comprised of. The mathematics that allows you to step from the frequencies and amplitudes to the sound itself is called a Fourier transform, named after the French mathematician and physicist Joseph Fourier.

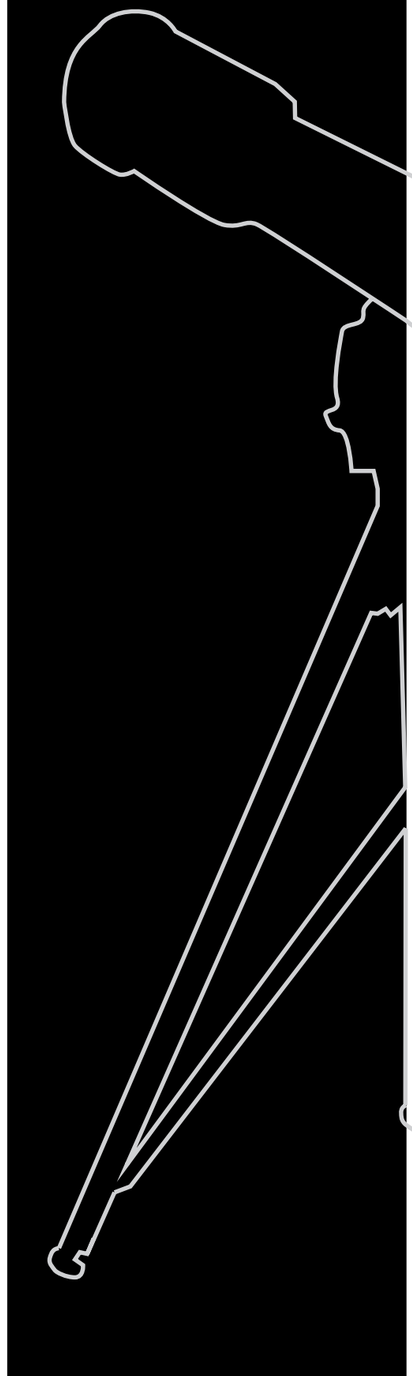
How does this relate to optical interferometry? In the same way that complex sounds can be broken down into frequecies, an image can be broken down into what we call spatial frequencies. As with the sounds described above, if we know the spatial frequencies present in an image, we can reconstruct the original image. This is where optical interferometry comes in. An optical interferometer does not take images of the night sky but can be thought of as an instrument which samples the spatial frequencies present in an image of the night sky. If enough of these spatial frequencies are measured, it is possible to reconstruct an image of the night sky using techniques based on the mathematics of a Fourier transform.

This sampling of spatial frequencies is the fundamental principle of how optical interferometers work and can reach unprecedented levels of spatial resolution in the optical. Therefore, it seemed only fitting to name the MROI's first science beam combiner after Joseph Fourier, whose work laid the mathematical groundwork for optical interferometry.

*Daniel Mortimer, University of Cambridge*



*A look at the tools that enable MROI staff to shoot more (and hotter) stars than the paparazzi!*





# Small Telescope Astrophotography

Among the benefits of the amazing work done at the MROI is the array of magnificent photographs made possible by the telescope and camera system shown below. Our photographers, Colleen Gino and Dylan Etscorn, are both well-versed in the field of astrophotography, and have taken an extensive number of spectacular photos over the years. The following images are only a small sample from the vast library of images that Colleen and Dylan have captured.

The MROI Bachman-Challener Outreach Telescope, pictured below, is a Takahashi FC-100 f/7.4 Fluorite APO Refractor designed for wide-field astrophotography, as well as visual use. It is coupled with a Sky-Watcher EQR-6 Equatorial GoTo Mount, which has pointing accuracy up to 1 arcminute and fine enough stability and tracking to allow for long-exposure imaging. The other aspect of our astrophotography setup involves using a Nikon D850 DSLR, the Orion Magnificent Mini Autoguider, and software programs Siril, Pixinsight, and Photoshop for processing.

Many of the wonderful images taken by MROI staff can be found as free downloadable wallpapers on our website at [http://www.mro.nmt.edu/multimedia/wallpaper/.](http://www.mro.nmt.edu/multimedia/wallpaper/)

# From the Clouds to the Stars

## A History of The Magdalana Ridge Observatory Interferometer

**At the 2019 meeting of the American Astronomical Society in St. Louis, MRO Program Director, Ifan Payne, presented a poster that detailed the history of the MROI and the events that led to its creation. Scientists and researchers in the field of astronomy from all over the globe were able to learn about all the milestones that were passed during the creation of the MROI. This material is based on research sponsored by Air Force Research Laboratory (AFRL) under agreement number FA9453-15-2-0086. The U.S. Government is authorized to reproduce and distribute reprints for Governmental purposes notwithstanding any copyright notation thereon.**

## Gazing at Clouds

**Dr. Everly John Workman**, Head of the University of New Mexico Physics Department from1933 to 1946 , pioneered the scientific study of Storm Behavior in central New Mexico. In 1946 he transferred to New Mexico Institute of Mining and Technology, now New Mexico Tech (NMT), where he continued to support research into storm behavior, cloud seeding and radar detection of electric storms.

Those who came to the desert near Socorro in 1948 included Nobel Laurlat Irving Langmuir, to study cloud seeding, and Bernard Vonnegut (brother of Kurt), to study the electrical process in storms.

Storm cloud over Magdalena Ridge

E. J Workman

Mobile weather laboratories in the desert near Socorro

Joint Observatory for Cometary Research

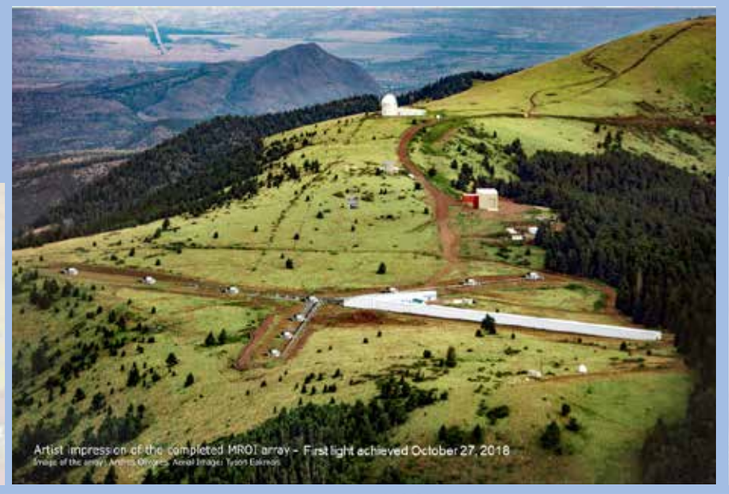
Stirling Colgate standing in front of the Digital Nova telescope.

**In 1963** the permanent Langmuir Atmospheric Research Laboratory was built on Magdalena Ridge.

**1965 Dr. Stirling A. Colgate** become president of NMT. He not only continued the development of the Langmuir Laboratory but, being an astrophysicist, oversaw the construction of the Joint Observatory for Cometary Research (JOCR), constructed in 1973, and the Digital Supernova Telescope in 1974.

Ifan Payne (right) Director of MROI with, from left to right, Chuck Dahl (Lead Electro-Mechanical), Andres Olivares (seated, Lead Opto-Mechanical), Rob Ligon (Project Instrument Scientist), Fernando Santoro (Project Engineer), Chris Salcido (Senior Opto-Mechanical).

Van Romero (right) PI of MRO with, from left to right, Chris Haniff, Repeesentative Heather Wilson and Dave Westpfahl at the formal signing of the MU with Cambridge in the House Office Building, , Washington, DC.



Artist impression of the completed MROI array – First light achieved October 27, 2018

Image of the array: Andres Olivares, Aerial Image: Tyson Eskmos

## Defending the Skies

**In 1974 Jess Granone and Osborne Milton** started working together at White Sands Missile Range (WSMR) with the Department of the Army, Office of Missile Electronic Warfare, which later became Office of the Test Director, Joint Services Electro Optical Guided Counter Measure Test Program (DRXDE-TD).

In 1981 Granone and Milton moved to Space Missile Defense Command (SMDC) in Huntsville where they continued to work on countering ballistic missile threats.

Nike Zeus, WSMR 1960

Perkin-Elmer Optical Technology Division, Danbury, 1956

Jess Granone

2.4 meter mirror polishing, Perkin-Elmer, 1969

Dick Newton

By the early 1990's Milton had conceived of a system for tracking ballistic missiles and was in search of a light-weighted primary mirror that could be used in a fast slewing telescope.

**Perkin–Elmer** fabricated 2.4-meter primary mirrors for space surveillance satellites. Because of that experience in fabricating light-weighted mirrors Perkin-Elmer mirrors were ideal for fast-slewing ground based telescopes for tracking ballistic missiles. At least one mirror was never installed in a telescope and was stored first in Danbury and then in Boston. Osborne Milton learned of this mirror.

Dick Newton worked at SMDC, WSMR, under Osborne Milton and had for many years looked for a site to place a fast tracking telescope with look down capability to track missiles being fired at White Sands.

Milton Osborne told Dick Newton about the 2.4-meter mirror in storage in Boston.

Newton then heard of an Observatory that had been developed by New Mexico Tech in the Magdalena Mountains. Dick Newton telephoned Dave Westpfahl, a Physics Professor at New Mexico Tech.

President Ronald Regan with Senator Pete Dominici signing the law establishing the Langmuir Research Site Dec 19, 1980.

On 27th July, 2004, a Memorandum of Understanding was signed between the University of Cambridge, UK, and New Mexico Tech. Chris Haniff and David Buscher became the System Architects for the 10-element Magdalena Ridge Observatory Interferometer.

Dave Westpfahl (right) and Chris Haniff

2000 At the Summer School on Space and Ground Based Optical and InfraRed Interferometry held in Leiden, Germany, from September 18th to 22nd, Gary Loos and David Westpfahl presented a comprehensive overview of the MRO 3-element Interferometer concept. It was there that Loos met Chris Haniff from the Cavendish Laboratory at the University of Cambridge who, with his colleague David Buscher, was presenting a poster on a proposed 10-element Large Optical Array (LOA) based on their experience with the COAST interferometer in the UK.

Spring 1997 – In a conversation during a car journey from Socorro to Las Cruces, New Mexico, Gary Loos proposed, by adding 2 more telescopes, a design for a three-element, 2.4-meter, interferometer.

1997 Van Romero becomes VP for Research and Economic Development. As PI for MRO he successfully guides the project forward

October 4th, 1995, Dick Newton telephoned Dave Westpfahl, a Physics Professor at New Mexico Tech, to offer a light-weighted 2.4-meter primary mirror for a fast slewing telescope.

Gary Loos (right) in 2002.

The Navel Prototype Optical Interferometer (NPOI), above, now the Navel Precision Optical Interferometer , was eventually built on Anderson Mesa outside Flagstaff

On 4th May, 1987, Kenneth J Johnson, Head of the Radio and Infrared, Astronomy Branch, of the Navel research Laboratory, approached New Mexico Tech to propose evaluating Magdalena Ridge as a site for the Naval interferometric array as a follow-up to CHARA.

December 14, 1987, Dr. Mel Dyke from the University of Wyoming and Dr Nat Carelton Smithsonian Astrophysical Observatory/Harvard College Observatory proposed to Langmuir Laboratory Affiliates that a second generation, enlarged, Infrared Optical Telescope Array be constructed on Magdalena Ridge. This was to be a development of the prototype which would be constructed at the Fred Whipple Observatory in Mt. Hopkins in southern Arizona.

IOTA, which started in 1988, was decommission and dismantled due to lack of funding in the summer of 2006

ALMA

1982 NRAO developed the concept of a Millimeter Array of radio telescopes. In 1988 a study of sites which fulfilled requirements for the millimeter array favored the Magdalena Ridge but in 1996 ALMA was sited in the Atacma desert in Chile.

On December the 19th, 1980, the 96th US Congress established the Langmuir Research Site dedicated to atmospheric and astronomical research. NMT administration then embarked on a quest to find a telescope for their new observatory site.

## Searching for stars

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MRO Magdalena Ridge Observatory

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# MROI on the Road

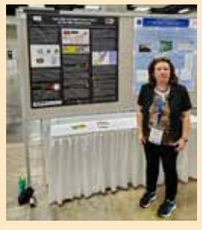
Members of the Outreach and other departments of the MROI team had a busy year in 2019 when it came to attending events and meetings both here in Socorro and out of town (and in some cases out of state!). We even managed to put in plenty of travel hours this year before the implementation of stay-at-home orders due to COVID-19. At every event, MROI staff were able to spread awareness of the MROI and its mission and delight members of different communities with the science, images, and aspirations that everyone on our team works so hard on. Taking part in these events and being able to share the MROI with people from around the world is an honor and a privelege that is possible in part with the support and donations given by our Friends, for which we offer another sincere Thank You! Because of our supporters, this year alone the MROI team was able to travel to Hawaii, our state's capitol in Santa Fe, and our nation's capitol in Washington, D.C.

By Shelbi Etscorn

The 235th meeting of the American Astronomical Society met January 4-8, 2020 in Honolulu, Hawaii, a destination and event MRO staff eagerly attended. The MROI team showed off their characteristic bright display in the exhibit hall as well as took part in the poster and oral presentations.

Colleen Gino and Shelbi Etscorn sitting at the MRO booth next to the AMOS and EIE booths.

Michelle Creech-Eakman, the MROI's Project S cientist, presented her poster titled "First Light and Initial Science Plans for the MRO Interferometer" which discussed possible science ideas for the MROI's early-days science as the facility looks forward to getting its second and third telescope on site. It also provided a status update of the current facility.



Dr. Michelle Creech-Eakman and her poster she presented at the AAS meeting.

Program director for the MROI, Ifan Payne, gave a talk titled "The History of Optical Interferometers: from the laboratory to the stars", in which he spoke of the development of optical interferometry for those without an optical science background. In his talk, he grouped interferometers into three distinct generations, with facilities like the MROI representing the third and newest generation.

Along with their respective presentations, both Michelle and Ifan helped Colleen Gino and Shelbi Etscorn of the Outreach Department at the MROI's booth in the Exhibit Hall. This year, the MROI was happy to have a table near AMOS and EIE, the brilliant teams behind our telescope mount and enclosure respectively.

On Monday February 4, MRO staff traveled to our state's capital to take part in NMT/Earth Sciences Day at the Roundhouse. As the legislative session was being held, tables representing different departments and research branches of Tech sprang up in the halls around the rotunda. Colleen Gino and Shelbi Etscorn with the help of Ifan Payne manned the MRO's booth and spoke with politicians, New Mexico Tech staff and students, Santa Fe school children, and members of the public who stopped by our vibrant display.


In a first for the MROI team, three staff journeyed to Washington D.C. to attend the Satellite 2020 conference this past March.

While attendees may have initially been confused by the presence of an observatory at a satellite convention, their confusion quickly abated after members from the outreach department, Colleen Gino and Shelbi Etscorn, explained the potential the MROI has in aiding satellite companies in forensic anomaly resolution (finding out what went wrong when things go wrong).

John Young of the University of Cambridge, created the images to the left to show what the MROI is cabable of. The top row of images are simulated images of an intact 17m-sized satellite, a satellite missing its antenna, and one missing 1/2 of its solar panel. The images below them are simulations of what the MROI will be capable of seeing upon its completion. Any satellite malfunctions could be visually identified by the MROI within 25 minutes.

The images were simulated using the BSMEM Maximum Entropy algorithm from simulated measurements at 1.25 and 2.2 microns wavelength, along with realistic noise for a satellite of 9.5 magnitudes. Further details of the simulation methods can be read at: J. S. Young, et al., 2016, Proc. of SPIE, 9907, 99073I.


Thank you to the NM Senate Democrats for visiting our booth and featuring us on their page. Their post can be found here: https://www.facebook.com/NMSenateDemocrats/

## A Look at Events from 2019

- Jan 6-10 233rd Meeting of the American Astronomical Society, Seattle WA
- Feb 19 MRO Exhibit at NMT Day at Roundhouse
- Mar 30 University of Arizona Astronomy Club tour MRO
- Apr 11-12 MRO Exhibit at Las Cruces Space Festival
- May 18 MRO Spring Open House
- June 9-13 234th Meeting of the American Astronomical Society, St. Louis MO
- Jul 19 - Sep 16 Macey Center Astrophotography Exhibit
- Oct 16 MROI Exhibit at NMT Research Colloquium
- Oct 23 & 24 MRO/MROI tour and star party for Enchanted Skies Star Party
- Nov 9 MRO Fall Open House
- Dec 11 Instituto nacional de Astrofisica, Optica y Electonica (INAOE) tour MROI

Ifan Payne gives a presentation to tour guests in the Visitor Center during the Spring Open House (above), and Socorro residents are treated to the spectacular images taken by MROI staff Colleen Gino and Dylan Etscorn at the Macey Center Astrophotography Exhibit (right).

Ifan Payne presented a talk at the Space Festival (left) while Danielle Ochoa manned the MROI booth (above).

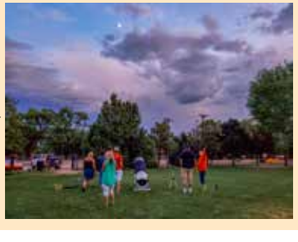
Ifan Payne with his poster, "From the Clouds to the Stars", at the 234th Meeting of the American Astronomical Society (far left). Ifan Payne, Danielle Ochoa, and Jeanette Wolfram at the MROI booth at the same event (left).

## Etscorn Campus Observatory (ECO) and MROI Events

- Feb 18 John Shipman Memorial Presentation at ECO
- Sep 4 Private Star Party at ECO
- Sep 7 MROI/ECO hosted star party in Corrales NM
- Dec 6 ECO Star Party at San Antonio School
- Nov 22 ECO Star Party for Festival of the Cranes

A student uses on the the telescopes at the Etscorn Campus Observatory (above).

Tour guests see the first telescope of the MROI during the Fall Open House (above).



Corrales community members gaze through ECO telescopes at the a ECO/MROI star party organized by Dr. Frank Etscorn (right).

# Instrumentation Station:

## Why does MROI need movable telescopes?

M. J. Creech-Eakman, MROI Project Scientist

When giving tours of MROI, I spend several minutes outside with the tour group discussing the telescopes and enclosures. As an astronomer, telescopes are a fundamental tool required to gather the data one wishes to study. In an interferometer, however, telescopes are merely one part of a much bigger system. Having separate telescopes that are combined is what allows what we call "aperture synthesis" which transforms a bunch of single telescopes into a much more powerful interferometric array capable of seeing much finer details on your astronomical target. I have had many a clever and curious visitor ask me: "Why do you spend so much money and effort making telescopes that can be moved around?" It is a fair question with a very interesting answer.

If you read my last installment about delay lines you will recall my discussion of the pieces of "light paper" being gathered at each telescope that are brought together using the delay lines to form the final image. With any interferometer the first "step" we must address with these delay lines is associated with the geometric positions of the telescopes on the array. The relative positions of the telescopes to each other actually behaves like an inverse zoom lens of a camera. If the telescopes are close together (in what we call the "tight-packed configuration") then they sample larger scale features on the object we are looking at. For telescopes that are very far apart, they are sampling smaller scale features of that object. A common astronomical example here would be looking at a nearby supergiant star with star spots on it. The close-packed telescopes would be sampling the overall size and shape of the star. Move all the telescopes as far apart as you can, and now they are doing a good job studying the spots on the star itself, but the size/shape are washed out. Both sets of data would be required to make a complete image of the supergiant star with details of its star spots.

Unfortunately, it's not as easy as adjusting a zoom lens on a camera to move the telescopes at MROI. As you can rightly imagine, telescopes are very precise types of equipment that generally do not get moved once they are installed. So why risk moving them at MROI? This is a tradeoff associated with the specific scientific goals of any array facility. In order to look at a variety of spatial scales and the many different types of astronomical objects that exist – from binary stars transferring mass, to star with spots, to pulsating stars, to the torus of gas and dust around supermassive black-holes – we need a variety of sampling configurations for the interferometer. This can really only be achieved one of two ways: either you have many, many telescopes all spread over a large area (much like some recent radio interferometers like the Allen Telescope Array), or you have a more limited number of movable telescopes (like the Very Large Array just down the road from us at MROI) which you re-locate periodically. At MROI we have chosen to pursue this second option.

So our ability to move the telescopes between different telescope pads (eventually 28 pads for our 10 MROI telescopes) depends on having telescopes and domes (which we refer to as enclosures) that can be picked up and readily moved. We designed it this way from the beginning: each telescope and enclosure has a "hand-in-glove" relationship to each other, with all clearances carefully tracked, and using metal pylons between the pair during relocation that are able to support the 33 metric ton mass of the combined system. The telescope relocations are accomplished using a lifting fixture (see photo XXX), which ideally is handled using a reach stacker. This is the same type of specialized articulated crane used to move shipping containers onto ships at ports. (Incidentally, Friends of MRO, we are still looking to purchase a reach stacker today, so if you happen to have an extra one, please let us know!) Using the reach stacker, an appropriately trained driver can relocate a telescope in about four hours with a precision of a few centimeters. We hope someday in the near future to be able to rapidly re-deploy our telescopes in this way in order to study exciting astrophysical phenomena like supernovae explosions or large coronal mass ejections from other stars. And now you know why we need 10 movable telescopes for MROI.



# MROI Vehicles Volunteered to Aid in Relief Effort for Navajo Nation

By: Shelbi Etscorn

Now, more than ever, it is vital that we as a community support one another. In this regard, the MROI proudly stepped up to aid the Alamo community by helping to deliver water, an undertaking that took combined efforts of local government, community members, and the quick thinking and driving spirit of Tara Jaramillo, owner of Positive Outcomes, Inc.

On May 1st, a water truck was loaned by the MROI to be filled with water from the nearby community of Magdalena. Socorro County employees then drove the precious cargo to Alamo, a rural community and the largest found in the Alamo Navajo Indian Reservation.

"They have approximately 3000 people living in the area. Many areas must haul water for daily use. Electricity is not always available nor is cell phone service. Food insufficiency is often an issue as well," Tara Jaramillo said of the issues currently faced by the people living in Alamo.

These issues were compounded by the spread of CoVid-19, but Jaramillo, Positive Outcomes, Inc., and countless others rose to the challenge to help our fellow New Mexicans. "We began a food distribution for the families whom we serve and quickly had more requests. Two weeks later we participated in an even larger food distribution campaign with donations from the City of Deming and [the] NM Wild Life association. We were able to distribute 3000 pounds of food and water. Verizon also hoped [sic] on board and brought a satellite hot spot tower and distributed 25 phones to the area. In the weeks that followed, we received donations of gallons of hand sanitizer, water and face masks from Sen. Heinrich and Rep. Torres Small and we began to share stories of homes without water."

***"Water is the only vaccine we know that will stop this. We need it to sanitize and we need it to live."***

One evening, Jaramillo received a phone call from a community member requesting help in getting water to the area. "Harold Peralto shared that the shelter-in-place and 57 hour curfews were making it almost impossible for people to collect and store water that was gathered at a local windmill. He asked that I come out and see the area. Harold's words, 'Water is the only vaccine we know that will stop this. We need it to sanitize and we need it to live.'"

Jaramillo reached out to Socorro mayor Ravi Bhasker and together they began to formulate a plan that would bring water to the people most in need. Eight 500 gallon water tanks were purchased and calls for help were sent out to New Mexico Tech and Magdalena. It was at this time that the MROI water truck was offered as a means of transport.


*Photo credit to Tara Jaramillo. Her facebook post regarding the incident can be found here https://www.facebook.com/photo.php?fbid=655563975001406&set=a.172011100023365&type=3&theater*

Normally, the MROI uses the truck to bring water up to the observatory. "There is no infrastructure that pipes water up to the top of the mountain, so we have to fill up the water truck here in Socorro and drive it up all the way to the top of the mountain and fill the tank up there one truck load of water at a time," says MROI's Lead Engineer of Operations, Isaac Salayandia. "We occasionally will use the water truck for maintaining the road but that is a bit more of a rare occurrence for us."

"Many wonderful people from the community came together to solve a problem for this area," says Jaramillo. "However, the fight is not over. Alamo still requires assistance through this pandemic. This community of 3000 has had 32 cases and lost 2 members. The needs are vast and the fear immense and they are now within the "hot spot" of New Mexico's fight of Covid-19. Positive Outcomes continues with distribution of masks and gloves to the clinic and EMS, toilet paper, bleach and food throughout this pandemic and hope to support Alamo to better days in the future."

A link to a donation page and information on how to help were provided by Jaramillo and can be found below.

**Donation site for tribal communities:**
Native American Relief Fund - New Mexico Community Foundation

**Localized donations can be made directly by contacting the Alamo Navajo Tribal Council representative Inez Herrera:**
Administration:
575.854.2543
Clinic:
575.854.2626
Address:
PO Box 5907

# Students on Staff

The Magdalena Ridge Observatory and New Mexico Tech provide both graduate and undergraduate students with opportunities in practical research and development during their academic careers. From 1997 through early 2020, over 100 students in the fields of physics, mathematics, computer science, engineering, and technical communication have worked at MRO in a variety of capacities.

Student Projects at MRO span multiple areas of study, including: optical design and instrumentation, software engineering and information technology, mechanical and electrical engineering, and atrophysics and astronomical data reduction. Among the specific student projects for the 2.4-meter telescope and the MROI are sub-system monitoring of infrastructure, automated alignment system design and alignment algorithm development, environmental monitoring systems, and aperture masking instrumentation.

The MRO attracts a diverse group of highly motivated students who gain valuable, practical experience that provides a foundation for advanced degrees or careers in a variety of scientific applications. These students hold a graduation rate of 90 percent, and many remain with the observatory and develop their professional careers after graduation.

## Former and Current Student Employees

**Siavash Norouzi**
**Computer Science**

"This project is something I really love and have always wanted to do: something that is multidisciplinary. It has to do with software, engineering, mechanics, optics, high performance computing, whatever you can think of. I've learned a lot from it, and I take so much pride in it. It's something I work on throughout the night and after office hours. It's been an amazing experience."

**Jeanette Wolfram**
**Physics**

"This opportunity has also allowed me to build upon my undergraduate teachings and helped grow my interest in astronomy, astrophysics and science in general. The people I have met here are brilliant people who enjoy sharing their knowledge and helping each other grow as a community."

**Isaac Alejandro Salayandia**
**Mechanical Engineering**

"My favorite part of working at the MROI are the people I work with, many whom I can say have become good friends of mine. It may seem a bit cliché, but the working environment and the culture at the MROI is very welcoming and accepting of new ideas. This, in my opinion, is due to all of the diverse and outstanding individuals we have employed here."

Two highly valuable opportunities available to MRO and MROI students and employees include the allowance to present their research and the ability to attend global scientific conferences. Recently, NMT graduate student Jonathan Dooley, who is pursuing a PhD in physics and instrumentation, was in attendance at the Society of Photo-Optical Instrumentation Engineers (SPIE) conference. So far in 2020, there are eight New Mexico Tech students employed at MRO, and two of our full time staff were formerly student workers.



# Spargo's Sky Report

July Skies

This month the evening sky will allow easy visibility of two giants. Both Jupiter and Saturn reach opposition from the Sun this month. Jupiter on the 14th and Saturn on the 20th. Both spend the month separated by 6 to 7 degrees and both rise well before midnight. Jupiter's magnitude grows to -2.7 while Saturn's improves to +0.1. Starting around 10 p.m., both gas giants are well placed for viewing with small telescopes with a wealth of atmospheric features being quite visible. Saturn's rings are still wide open at around 20 degrees from horizontal which just adds to the telescopic delights of the ringed planet.

Not to be outdone, Mars rises around 12:30 a.m. with its magnitude improving to -1.1.
The red planet also appears to grow in diameter as the distance between it and Earth grows smaller. (Earth is overtaking Mars) During the month its position in the sky crosses north of the celestial equator. (imagine the Earth's equator projected onto the sky) This means that Mars will be well placed for telescopic viewing as it rises higher in the southern sky.

Venus spends this month rocketing up into the early morning sky rising 3.75 hours before the Sun by the end of the month. While doing so, its magnitude also increases to a stunning -4.7 which should make it pretty easy to find by naked eye in the early morning sky. Through a telescope you can watch as its crescent waxes to 43% illumination by month's end.

Mercury, having passed inferior conjunction with the Sun, climbs into the early morning eastern sky beginning around the 17th. The tiny planet reaches maximum elongation from the Sun on the 22nd and should be visible for another week to 10 days as it slowly sinks toward the eastern horizon.

The Moon will be full on the 5th, last quarter on the 12th, new on the 20th and first quarter on the 27th. Looking southeast on July 5th, between 10 and 11 p.m., the full Moon will be just below and about halfway between Jupiter and Saturn. Looking east on the 17th, about 30 minutes before sunrise, the waning crescent Moon will be just to the left of brilliant Venus. Two days later on the 19th, looking east at the same time, a very thin crescent Moon will be to the left of the tiny planet Mercury.

Due to the closure of New Mexico Tech because of COVID-19 virus concerns, there WILL NOT be a first Saturday of the month star party at the Etscorn Campus Observatory.

Stay safe and Clear Skies!

Jon Spargo
New Mexico Tech Astronomy Club
July 2020

# The Road to The Ridge

By Shelbi Etscorn

Photo Credit: Shelbi Etscorn

Driving up the long and winding road to the Ridge that serves as home to the MRO, it's hard to keep one's nose a respectable distance away from any windows that look down over the rolling hills and plummeting cliff faces. Nestled within the strikingly wild and untamed face of the Magdalena Mountains is the well maintained road made of winding switchbacks and light dirt that contrast the dark trees nearly as much as its manufactured appearance contrasts the untamed landscape that surrounds it.

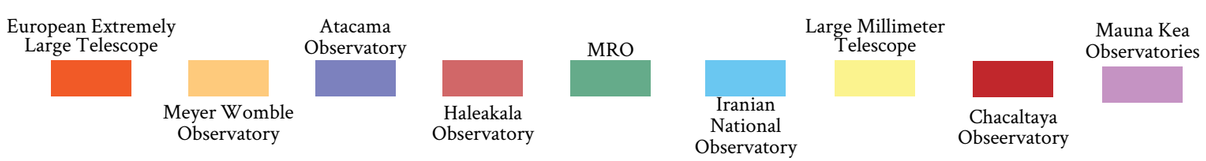
It may be easy to not give much thought to those switchbacks when preoccupied with the natural beauty of the mountains, but maintaining the road to keep its treacherousness at a manageable level is no small feat.

MROI staff drive the road every single day to make sure it's in the best condition for anyone venturing to the mountain's peak. In the winter, many hours are spent clearing the road of snow and ice. This task isn't only necessary from a practical standpoint, it's a contractual obligation of the MRO.

Photo Credit: Colleen Gino

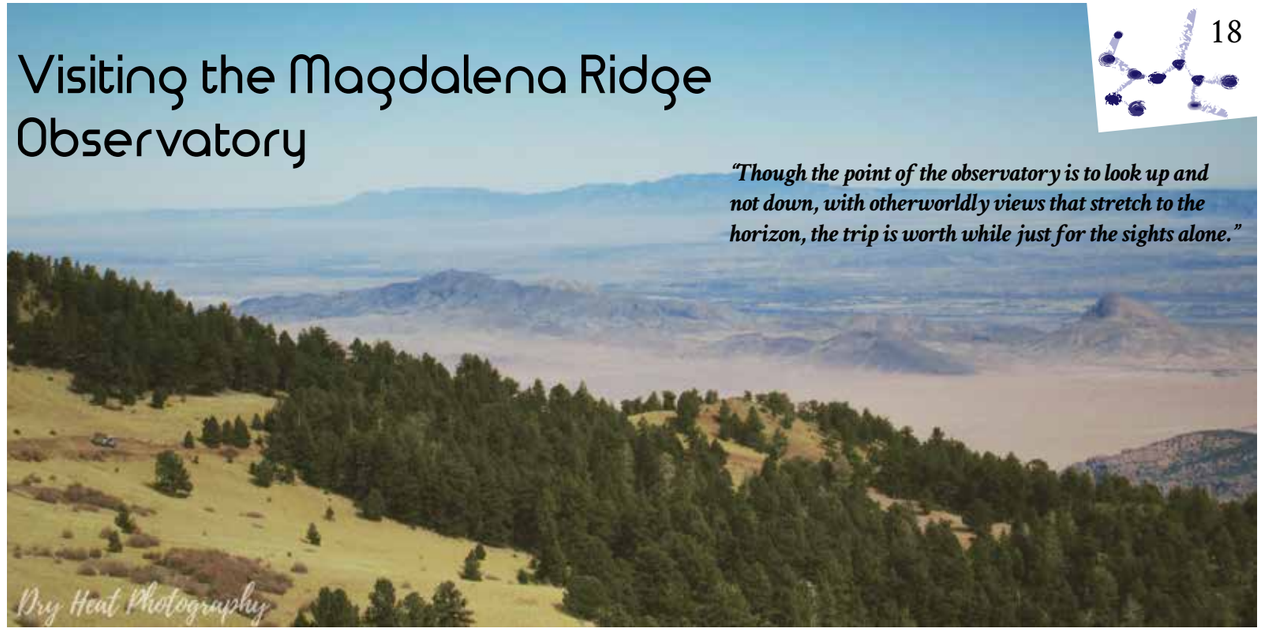
The site on which all of the MRO's telescopes are built sits right in the middle of the Cibola National Forest. In exchange for the use of the public land, it was agreed the road would always be maintained by MRO staff. Keeping its promise, part of the Observatory's staff includes team members who bear the responsibility of keeping our road safe and accessible for as many days of the year as possible. A job that they have grown incredibly adept at!

No one could argue the beauty of the mountain, but an equal share of praise and awe is owed to the road and the men and women who work hard to keep it a functioning part of our Observatory! If you're still having trouble believing roads can be beautiful, take a second look at the mountain image at the top of the page. Each colored line is actually a bird's eye view of the road that leads up to observatories around the world. A key can be found at the bottom of this page.






# Visiting the Magdalena Ridge Observatory




*"Though the point of the observatory is to look up and not down, with otherworldly views that stretch to the horizon, the trip is worth while just for the sights alone."*

The Magdalena Ridge Observatory is located atop a towering mountain overlooking the San Agustin Plains of New Mexico. Though the point of the observatory is to look up and not down, with otherworldly views that stretch to the horizon, the trip is worthwhile just for the sights alone.

***"... this journey is not for the faint of heart."***

Speaking of the trip, this journey is not for the faint of heart. While the Magdalena Ridge Observatory sits on a National Forest and is therefore public property, the buildings are not open to the public so the only time that nosy photographers like myself can visit is when they host their open house events. Attendees of the open house event are instructed to park at a camp site at the bottom of the mountain. From there, we all load into a shuttle bus and begin the 30 minute, ten mile journey up the treacherous one lane dirt road with no guardrail. There is literally not room for two cars to pass each other going opposite directions on this road. As a passenger on the shuttle, it is safe to assume that the driver doesn't want to die in such a horrific manner as driving a bus full of screaming visitors off a cliff, so if you stay calm and busy eyes with your Twitter feed, all will be well and you'll be there in a jiffy.

The most interactive part of the open house is the tour of the 2.4 meter telescope. This telescope scans the skies looking for anything that may be a threat to the earth (like asteroids that could be on a collision course) or present a threat to national security like satellite remote sensing, space surveillance, and missile tracking.

During this part of the tour, guests are able to go up inside the dome and see the telescope up close. You can even have your photo taken in the telescope if you like.
One of the special features of the 2.4 meter telescope is its rapid tracking capability of ten degrees per second. Being able to move at a high speed allows the telescope to track things such as fast-moving asteroids, comets, and resident space objects in low Earth orbit. To facilitate the rapid movement of the telescope, the dome also has to open and rotate rapidly. The tour of the 2.4 meter telescope culminates in an excellent demonstration of the rotating dome. Everyone gathers around the telescope and the operators rotate the dome. This creates a crazy optical illusion where it looks and feels like the floor you're standing on is turning instead of the dome. It's a very convincing illusion!

Read this article in it's entirety at: https://www.dryheatphotography.com/dry-heat-blog/visiting-the-magdalena-ridge-observatory

About the author: DeAnna Vincent is the author of the Dry Heat Blog featuring New Mexico's ghost towns, Route 66 and interesting attractions across the desert southwest. www.dryheatphotography.com She is also a professional portrait photographer with over 20 years experience working in New Mexico.

Stay up to date with all of MROI's monthly newsletters at http://www.mro.nmt.edu/news/newsletter/.
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