Introduction and Overview

- COSMIAC is a Research Center under the School of Engineering at the University of New Mexico. UNM is a minority serving academic institution
- COSMIAC's Mission Statement - To provide a dynamic work environment where faculty and students find fulfillment and enjoyment in providing technical engineering solutions for our clients that correlate to ever-changing technologies
- COSMIAC's 30,000 square foot facility provides excellent design capabilities including laboratories, high bay, offices and cleanroom space
- All COSMIAC personnel in New Mexico are US citizens with active security clearances (up to TS or Q for DOE)
- COSMIAC consists of approximately 60 staff, students, consultants and faculty
- COSMIAC manages approximately $50M in contracts and holds approximately 95% of all of UNM's security clearances

THE UNIVERSITY OF
NEW MEXICO.

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Partners

- AFRL Space Vehicles and Directed Energy Directorates
- Defense Threat Reduction Agency through Peraton
- Millennium Engineering and Integration Company (RISE)
- KBRWyle Corporation (under FILMSS and DTRA)
- AEgis Technologies/BlueHalo (under D3I HSV and SCRA ABQ)
- New Space New Mexico
- Other Government Agencies
- A large collection of other small and medium sized businesses

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Why what COSMIAC is doing matters

- COVID accelerated retirement for Boomers
- Boomers didn't have as many children as their parents
- If New Mexico hopes to be competitive, there must be an aggressive activity to increase the pipeline
- A record 4.5M Americans left their jobs in November 2021 (ASEE Report)

Unlike birth rates, college enrollment rates tend to rise during recessions as people look for ways to increase their value in the job market. But 2020 was not a typical recession. New enrollment at 2-year colleges didn't just slump last year—it tumbled off a cliff. First-time student enrollment at community colleges fell a staggering 21%.

First-time enrollments are projected to decline sharply
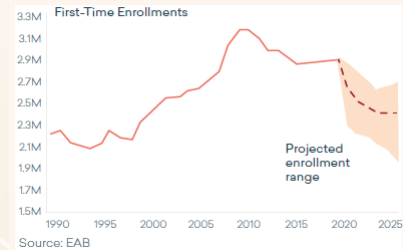
Student enrollment at US colleges down 11% since 2011
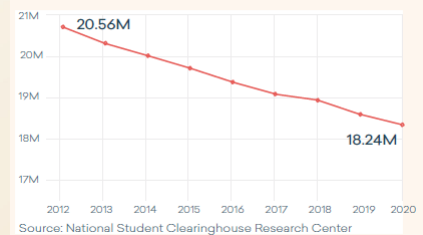
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Services and Focus Areas

- Telecommunications
- Positioning, Navigation and Timing
- Targeted Research and Development services to meet the needs of our customers
- Facilitation and oversight of technical collaborations
- Satellite development, demonstration and flight opportunities
- Rapid Prototyping with additive and subtractive manufacturing
- Services and support for radiation analysis and testing
- VR/AR, machine learning and GPU processing
- Signal Processing and Remote Sensing Artificial Intelligence
- C-sUAS Drone building and government testing

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Current Projects: Radiation

Radiation Testing – Government
- Perform Total Ionizing Dose and Single Event Effects testing and analysis
- Modeling and Simulation of space effects
- Working for DTRA to develop Mil-Std for radiation hardening of spacecraft and missiles

Radiation Testing – Private Industry
- Performed parts radiation testing for Blue Origin, SEAKR and other commercial and government organizations
- CRADA in place to support corporate testing at Kirtland Air Force Base

Travel to Test
- Capabilities for TID, FXR, LINAC and other sources within NM to avoid company complexities with COVID
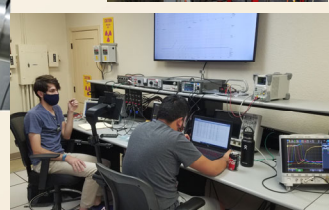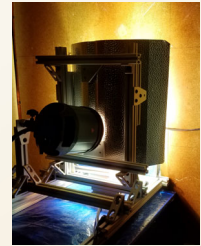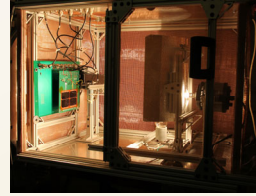
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Current Projects: SATCOM

Satellite Communications
- Two different ground stations operating 24/7 supporting government missions
- MC3 ground station supporting NPS/NRO distributed ground station architecture - decoding packets daily
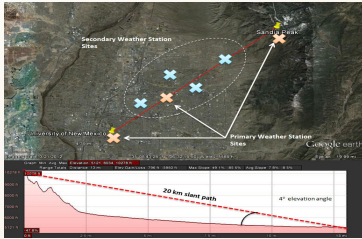- 3m dish for USB operations

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Current Projects: W/V Band

- W/V-Band Atmospheric Prorogation Research – joint activity with AFRL and NASA GRC. The W/V-band Terrestrial Link Experiment (WTLE) has been operational since October 2015 supporting AFRL flight experiment (WSCE-T)

- 24km link used to characterize rain attenuation, depolarization, scintillation, and gaseous absorption effects of the atmosphere in the W and V-bands
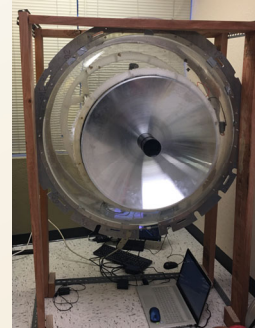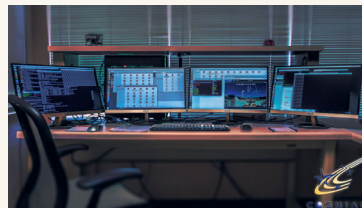
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COSMIAC RESINATE and RF Testbeds

- COSMIAC antenna portfolio. Shown from left to right (below): MC3 system, 4.5GHz system, laser communications testbed, W/V communications, three-meter S-band supporting the AFRL Center for Rapid Innovation

- RF and Laser Communications to Sandia Crest and KAFB

- RESINATE Control Room provides command and control for entire network
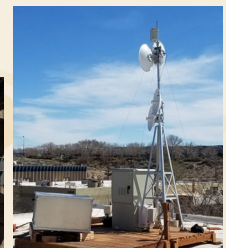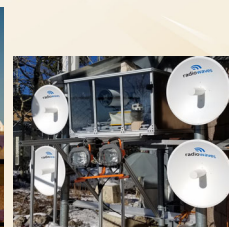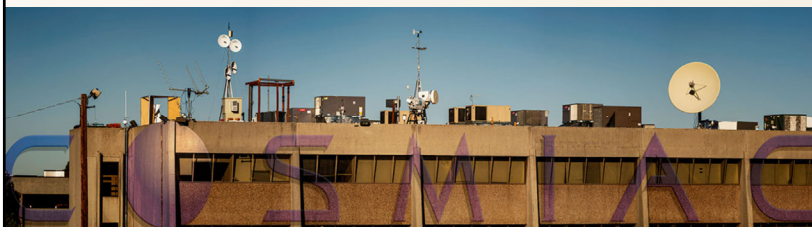
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Current Projects: RHEME

Rad-Hard Electronic Memory Experiment

RHEME: UNM's First ISS Experiment
- Working with NASA and AFRL to measure radiation in space and its effects over memory ICs.
- FPGA (Virtex 5) at the core of the system for control and communications with the ISS
- Testing SEU mitigation schemes at the architecture and system levels
- RHEME was launched on STP-H5 (Currently on the ISS), RHEME-II STPSat-5 (LEO-Polar – on orbit), and RHEME-III STP6-M18 (GEO – launched Dec 21)
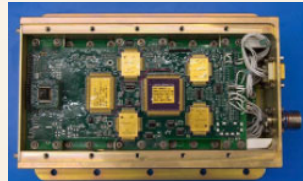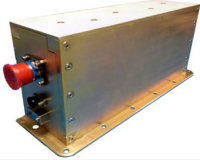
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Current Projects: Machine Learning

Machine learning improves software-based decision making

Nvidia GPUs accelerate development of neural networks
- COSMIAC has a dual NVidia Titan platform with a total of 9216 Cuda enabled cores and 48 GB of GPU RAM
- Amazon Web Services allows for on demand acceleration
- AWS.GOV provides pathway for secure processing/documentation

Deep Learning:
- Taking advantage of the above platforms, COSMIAC can create large neural networks that can be deployed to embedded platforms
- Enable remote platforms to decide what to do with big data
- To transmit or not to transmit – efficient use of bandwidth
- Publications at various conferences

We study machine learning to provide intelligent solutions to engineering challenges
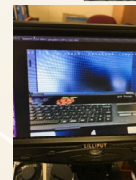
Frame Segmentation (Tramway/ Montgomery)

Image Recognition
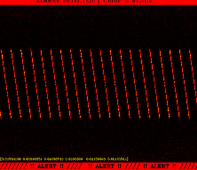
Object Detection (NanoRacks ISS)

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Current Projects: SatNavTA

Current activities for SatNav Technology Area (SatNavTA) involve:

- Specializing in Software Defined Transmitter (e.g. ORDWG) and Software Define Receiver embedded systems and software
- Developing SDR technology to receive and measure the effectiveness of advanced signals
- Drone countermeasures
- Developing, training, testing, and deploying Machine Learning Algorithms for threat detection, prediction, and mitigation
- Developing a distributable machine learning toolset with a diverse set of model deployment options (FPGA, GPU, ARM, TPU, VPU, etc)
  - Custom Ubuntu Linux build called MLTos
- Creating a standard database of GNSS signals to serve as a benchmark for future machine learning development

Supporting the AFRL SatNav Technology area (SatNavTA) Program and the Joint Navigation Warfare Center (JNWC)

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Current Projects: Rapid Manufacturing and Testing

24-Hour Manufacturing Facility

- Went from Authorization to Proceed to full production in eight days producing 500+ face masks and 500+ face shields per week for COVID relief
- Full array of additive and subtractive manufacturing capability to include 3D Printing of high temperature materials for aerospace and defense applications
- Class 1000 cleanroom
- Designed to support field testing at a moments notice
- US only facility
- Creating prototypes for Other Government Agencies

Launchpad High Bay

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Current Projects: Advanced Space Power Prototyping
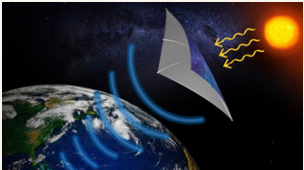
Program created in May 2021

- Wide Band Gap Semiconductors for improved power density and efficiency
  - more power for less heat and weight
- Digital control for versatility and reusability
  - same control board can be used in different converters, just change the code to add MPPT or your favorite battery charge algorithm
  - software can be ported to different CPUs and FPGAs for Rad-hardening or to alleviate supply issues
- Modular Design for reliability and reconfigurability
  - N+1 redundancy, and the ability to configure several different power systems from a few modules/building blocks

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Current Projects: SSPIDR

Space Solar Power Incremental Demonstrations and Research

- Creating prototypes to allow for testing and academic outreach
  - 1000+ middle and high school students attended outreach
- Supporting bus development
- Providing administrative support for team operations

- A LEctenna is a rectifying antenna (rectenna) with a light emitting diode (LED)

- Space Solar Power, also known as Space-Based Solar Power, moves the solar panels from the Earth's surface to orbit. In space, there is less atmosphere and clouds to get in the way of the sun's rays. This means that the solar panels can collect much more energy than on Earth's surface

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COSMIAC Workforce Development

Bridging the gap between academia, government and industry by having student interns work on projects driven by local organizations and COSMIAC engineers

- Projects directly related to the work of the sponsoring organization
- Removes necessary day-to-day supervision, hiring process, security clearance acquisition, etc.
- Utilizes COSMIAC laboratories, software, hardware and high bay space
- Builds the talent of people who are interested in staying in the local area

Student's Assembling 3m Dish System
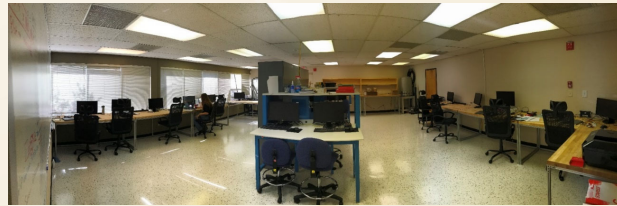
Student Incubator

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COSMIAC Technology Consortium

A major portion of the COSMIAC's UNM charter is the acceleration of business in New Mexico.

COSMIAC's hosts small businesses throughout the 30,000 square foot facility

- Acme – Expertise in Precision Acquisition, Tracking, and Pointing; Environmental emulation; Rapid prototyping; Product design; Emergent optimization algorithms; Laser and RF Communications
- Opticslah – Expertise in optical spectroscopy, femtosecond and nanosecond laser development, laser machining – tOSC and Opticlah now have joint contract together – synergism happens…
- Counter Drone – Cleared UAV capabilities
- Raven Defense – Experts in advanced RF systems and integration supporting satellite communications, directed energy, telemetry, command and control, and flight test activities
- AEgis Technologies/BlueHalo – Expertise in Modeling and Simulation
- Canyon Consulting – GNSS Systems expertise
- Prewitt Ridge – Develops engineering collaboration tools that eases inter- and intra-team friction when designing or assessing complex systems
- Sceye – High altitude persistent earth observation and communications
- emTruth – Provides secure immutable data tracking with Blockchain technology

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COSMIAC Students

- Clarizza Chacon (EE – BS May 22) – Machine Learning MLT
- Brandyn Solano (CompE – BS Dec 22) – Radiation Effects for ARHEME
- Annette Cortes (CS/WS – BS Dec22) – Machine Learning ORBS
- Jonathan "Zack" Daniels (EE Grad Student – MS Aug 22) – OGA working SPICE modeling
- Tyler Mitchell (ME/RAST – BS May 22) – Structures Support
- Jason Alberto (ME/COMPNT – BS May 23) – working RF on RESINATE
- Micco Estrada (CS/EPIC – BS Dec 22) – working structures under EPIC then Structures
- Ricardo Quintana (ME/COMPNT – BS May 23) – working Launchpad AFSIM
- Ralph Gesner (EE Grad Student – PhD May 23) – RF systems for SCAT
- Richard Briggs (CompE Grad Student – MS May 24) - Radiation Effects under SET
- Joshua Cooper (Electromag Grad Student – MS Dec 24) – WSCE Program

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Students (Cont.)

- Jacob Parsons (EE – BS May 24) – RF systems for SSPIDR
- Priya Bhakta (CompE – BS May 22) – Prewitt Ridge
- Andrew MacKenzie (ME – BS May 22) – SSPIDR/NSNM
- Dylan DeRaad (CS – BS May 25) – Radiation Effects for ARHEME
- Chad Rathbun (ME/RAST – BS May 22) – Thermal Chamber/RAST
- Leilani Baker (ME – BS Dec 22) – SSPIDR working Modeling and Simulation on OGA
- Emily Maethner (Arch – BS May 24) – NSNM working BD activities
- McKenna Collins – (EE/ME – BS May 25) – Working COMPNT testing
- Francisco "Frankie" Viramontes (CompE Grad Student – PhD May 25) – working SET
- Samantha Lambrecht (Bio –BS Dec 22) – Hoffman (AFRL/APECS) Structures Laboratory
- Mari Aoki (CS – BS May 22) – Working OGA

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Students (Cont.)

- Juampablo Heras Rivera (ME – BS May 22 – LANL Jun to Aug) – Working structures on RAST
- Adam Cover (AstroPhysics – BS Dec 23) – Working radiation analysis with Triad/SET
- Jeremy Holder (ME Grad Student – MS May 23) – Mechanical support in lab on RAST/APECS
- Dante Orona Yang (EE Grad Student – MS Dec 22) – Space Solar on SSPIDR
- William "Will" Hamel (EE – BS May 24) – Space Power on SSPIDR
- Lasair Servilla (CS – BS Dec 23) – Working KBR DTRA
- Meghan Schroeder (ME – BS May 23) – Working SSPIDR program
- Matthew Savik (ME – BS May 26) – Working 3D printer upgrades
- Jamie Holmes (ME – BS May 23) – Working agile manufacturing NSNM
- Austin McOwiti (EE – BS May 25) – Working COMPNT Power Systems

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