The SCALE Radiation Effects Workforce Development Program

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Chip Shortages - Engineers Needed

- [In case you have not heard] ***there is a microelectronic chip shortage***
- **Lots of investment in expanding manufacturing capacity**
- ***Need more educated workers too!***

Samsung, TSMC lobby for inclusion in CHIPS for America Act - Electronics360, 21 March 2022

ST Microelectronics to double investments due to chip shortage - Reuters, 28 Jan 2022

U.S. Senate approves $52 bln chips bill in bid to reach compromise - Reuters, 28 March 2022

Global chip shortage gives US manufacturing a boost

A proposed $52 billion in US government subsidies would help Intel's planned $100 billion "megafab" in Ohio. Europe, Taiwan and Korea have subsidies of their own.

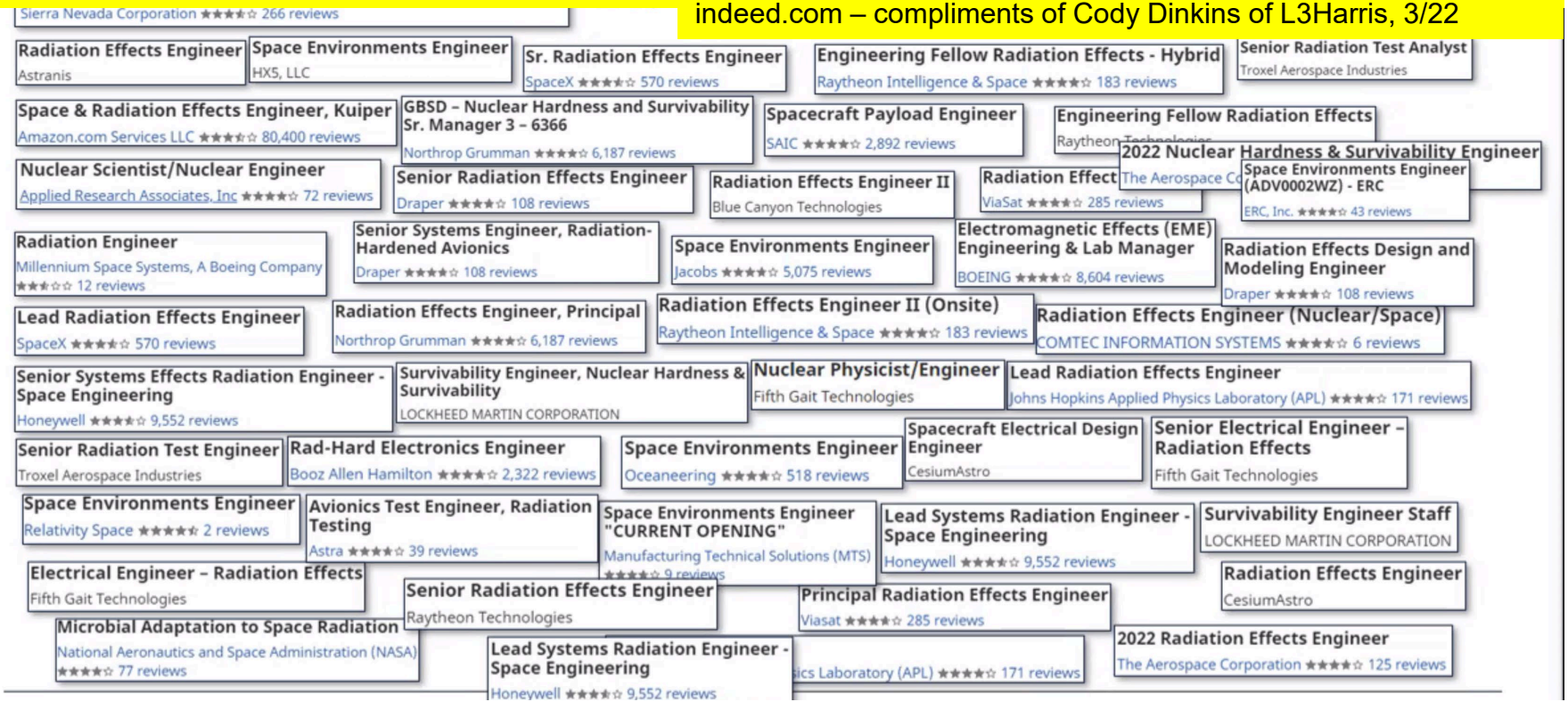
Intel's Fab 42 in Chandler, Arizona, cost $7 billion. The chipmaker has begun making fabs 52 and 62, which are scheduled to go online in 2024 and employ 3,000 more people.

Stephen Shankland/CNET

- CNET, 8 Feb 2022

Specifically: There is great (growing) demand, and limited supply, for students who are educated in the area of Radiation Effects in Microelectronics

Illustrating demand: “Radiation Effects Engineer” search for from indeed.com – compliments of Cody Dinkins of L3Harris, 3/22



Overview of SCALE Program

SCALE is a microelectronics focused research and workforce program funded by the Department of Defense

5 technical areas:

- Radiation hardening technology
- Heterogeneous integration and advanced packaging
- Supply chain awareness
- Embedded Systems Security
- System on Chip

SCALE is committed to getting students the technical skills and experiences they need to be competitive in the microelectronics workforce and research community.

SCalable Asymmetric Lifecycle Engagement Workforce Development

Opportunities in Radiation Effects Engineering

Multidisciplinary field: Opportunities for EE, CS, Physics, Math, Chemistry, Systems Engineering, etc.

Develop specific skills through Summer training se*participation in*

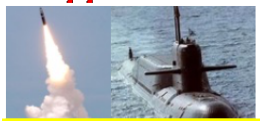
- Undergraduate/graduate mentored research projects
- Senior projects
- Internships
- Multi-university cohorts
- Conferences and publishing
- ssions
- Specialty courses

Strong and growing demand (>> supply)

https://www.purdue.edu/discoverypark/scale/

Develop a ready workforce to support the needs of U.S. radiation-hardened electronics industry

Applications of electronics technologies in radiation environments



Military/Weapons

Aerospace / Outer space

Nuclear Detection

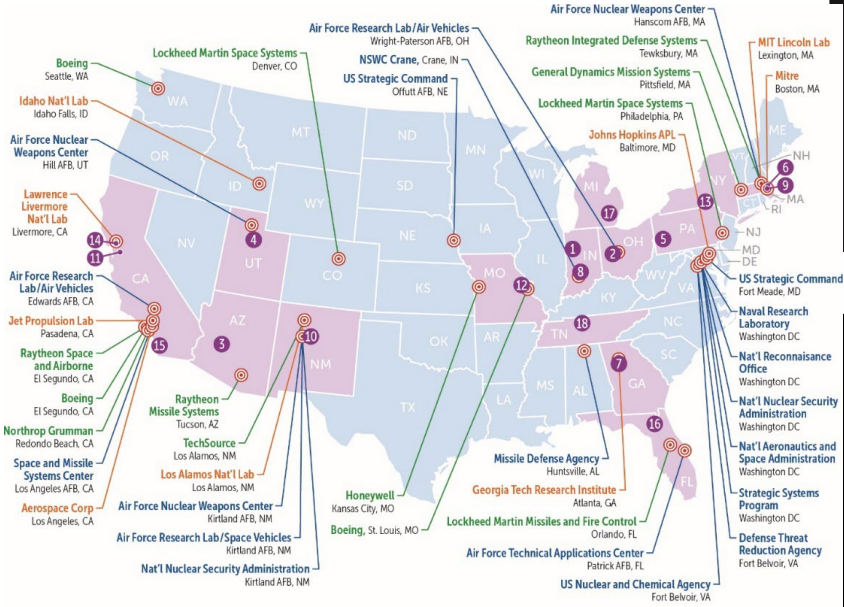
Networking, computing and communications

Automotive

Medical

Nuclear Power and Accelerators

SCALE provides DOD/GOV/DIB with an asymmetric microelectronics workforce advantage



KEY

Target Institutions

Government | Federally Funded Research and Development Centers | Industry

Partners (Institution Topic Areas*)

1. Purdue University, West Lafayette, IN (RH, HIAP, SC, ESS, SC)
2. Air Force Institute of Technology, Wright-Patterson Air Force Base, OH (RH)
3. Arizona State University, Tempe, AZ (RH, HIAP, SC)
4. Brigham Young University, Provo, UT (RH)
5. Carnegie Mellon University, Pittsburgh, PA (ESS, SoC)
6. Draper Laboratory, Campridge, MA (RH)
7. Georgia Institute of Technology, Atlanta, GA (RH, HIAP, SC, ESS, SoC)
8. Indiana University, Bloomington, IN (ESS, SoC)
9. Massachusetts Institute of Technology, Boston, MA (ESS, SoC)
10. Sandia National Laboratory, Albuquerque, NM (RH)
11. Sandia National Laboratory, Livermore, CA (RH)
12. St. Louis University (RH)
13. State University of New York at Binghamton, NY (HIAP)
14. University of California, Berkeley, CA (ESS, SoC)
15. University of California, San Diego, CA (ESS)
16. University of Florida, Gainesville, FL (SC)
17. University of Michigan, Ann Arbor, MI (RH)
18. Vanderbilt University, Nashville, TN (RH)

*RH = Radiation Hardened, HIAP = Heterogeneous Integration/Advanced Packaging, SC = Supply Chain, ESS = Embedded Systems Security, SoC = System on Chip)

SCALE Scalability Demonstrated by PPAP National Network

Technical Verticals

Radiation-hardened technology:
1. Vanderbilt
2. Air Force Institute of Technology
3. St. Louis University
4. Brigham Young University
5. Arizona State University
6. Georgia Tech
7. Purdue University
8. Indiana University
9. New Mexico State University
10. UT-Chattanooga

Supply Chain Awareness:
1. Purdue University
2. University of Florida

Heterogeneous integration and advanced packaging:
1. Purdue University
2. Georgia Tech
3. SUNY-Binghamton
4. Arizona State University

System on Chip:
1. Ohio State University
2. Georgia Tech
3. Purdue University
4. UC-Berkeley

Embedded Systems Security:
1. Indiana University
2. IUPUI
3. Notre Dame

Scope and Technical Objectives

Security. Train students and faculty in ITAR, EAR, CCL, and related regulations and to provide facilities to meet program requirements; security clearances for students.

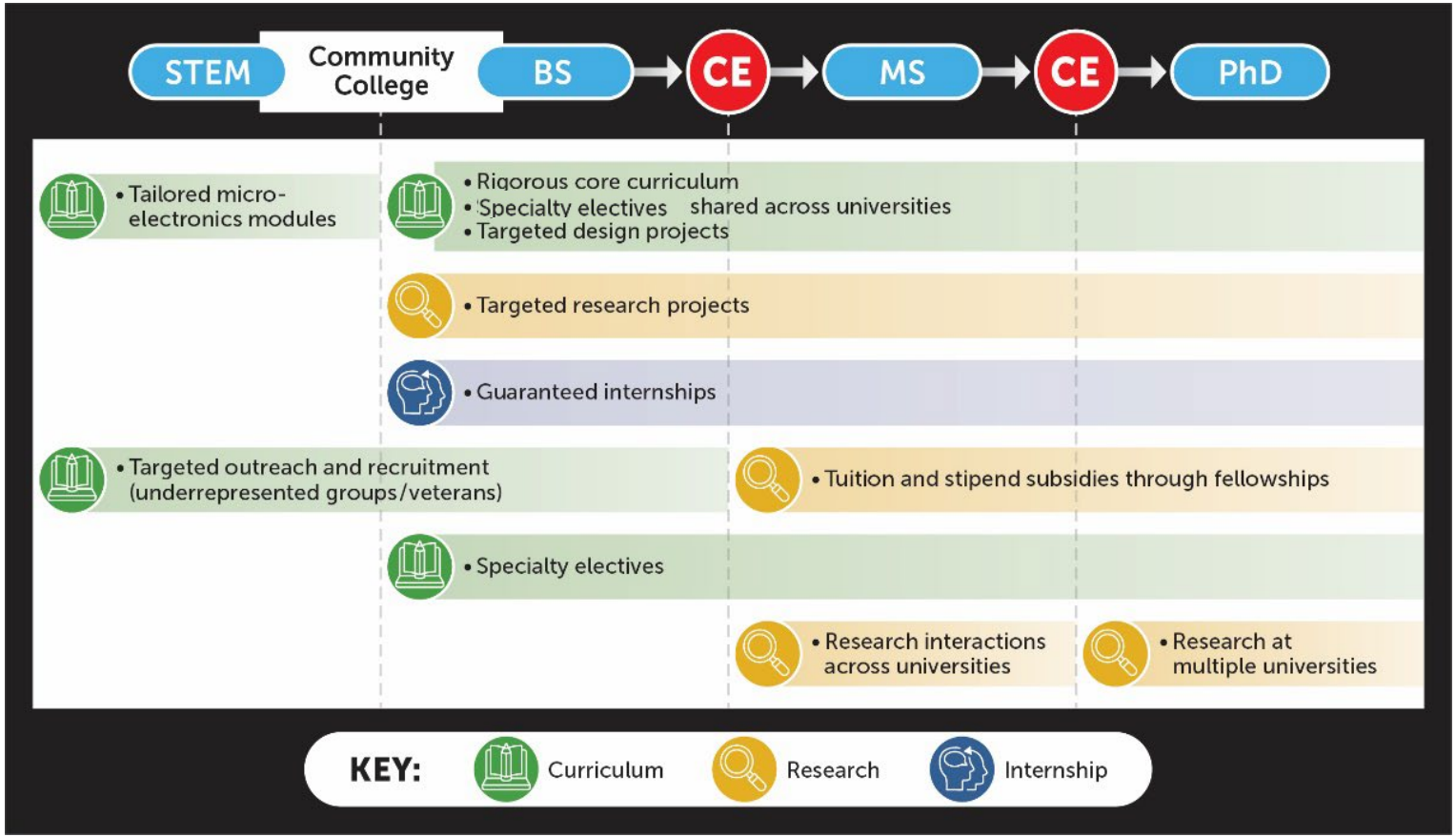
Curricular innovation. Tailored curriculum and targeted research experiences; designed based on DoD prioritized needs; collaboration between practitioners and educators.

Recruiting. Early exposure to the program including K-12 and community colleges; incentives; identity building through cohorts.

Projects, Research, and Internships. Mentored research experiences; near-peer mentoring; internships.

Metrics-driven, iterative model development. Model will be updated through an iterative, design-based method; metrics include both outcome evaluations and process assessments.

Overview of Key Program Elements for SCALE Students



Key Accomplishments to Date

- A PPAP board and working groups in career pathways, educational standards, and student recruitment and retention have been stood up across 5 technical areas.
- The full range of efforts resulted in the following:
  - the establishment of 18 subcontracts with universities
  - definition of career pathways in each of the 5 technical areas
  - corresponding national curriculum standards
  - new course content as well as new courses
  - the establishment of significant partnerships with 20 unique internship programs, with 65 total billets for Summer 2021, split fairly evenly between government and the defense industrial base, with an increase to between 141 to 243 expected in Summer 2022
  - recruitment of 202 total students to the program as of 1-FEB 2022
  - Surveys collected during the Summer 2020 & 2021 programs indicated that students are already experiencing a measurable increase in their positive response for career choice factors and knowledge.

SCALE Rad Hard Microelectronics Approach

Desired KSAs defined by stakeholders

Students gain experience through:

- Formal academic curriculum
- Internships
- Senior capstone projects
- Research projects
- Custom programming
- Engagement with stakeholders

KSA experience documented in a portfolio (supplement to a resume)

General: Device Physics, Circuits, Semiconductor Technologies Fabrication Process, Design Process, Systems, Project Management, Data Analyses Circuit Simulation, Physical Design and Verification, Laboratory Skills, Technical Communications, Computer Programming

Specialty: Interaction of Radiation with Materials, Radiation Environments, Device and Circuit Manifestations of Radiation Exposure, Modeling and Experimental Characterization Methods for Rad Effects, Mitigation Approaches, Compliance Application of simulation tools to rad-effects analyses and RHBD, performing radiation testing, analyses and reporting of of radiation test data, specialized presentations to different audience types

Current focus on early (undergrad) engagement

SCALE RHM Programming

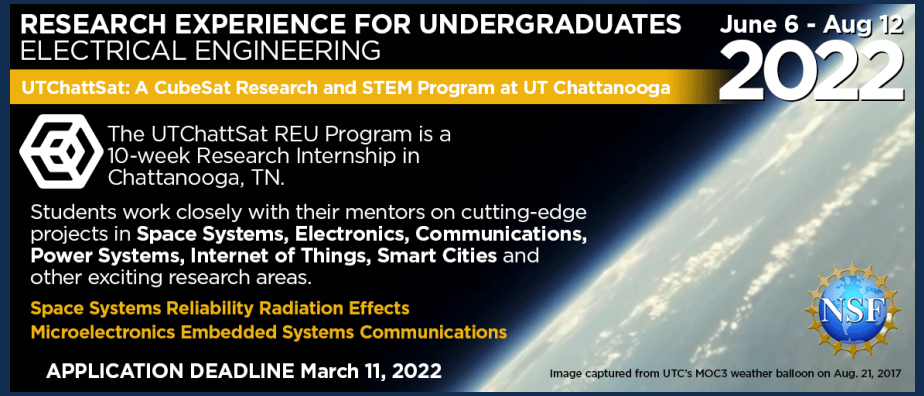
(1) STEM:
- Pre-collegiate and community college programs
- Certificates and learning modules
- Apprenticeships

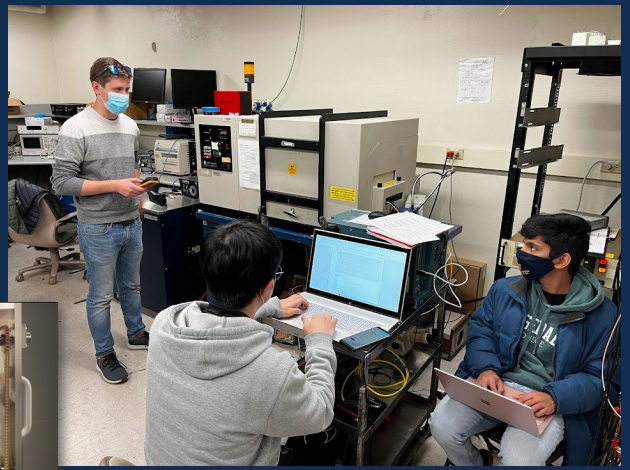
(2) Undergraduate Coursework:
- New courses on Extreme Engineering, Creative Design, Semiconductor Devices, Intro to Radiation Effects, and Systems Engineering

(3) Graduate Coursework:
- Courses in radiation effects (Radiation Effects and Reliability, Embedded Systems for Space Applications)
- Opportunities for specialty electives

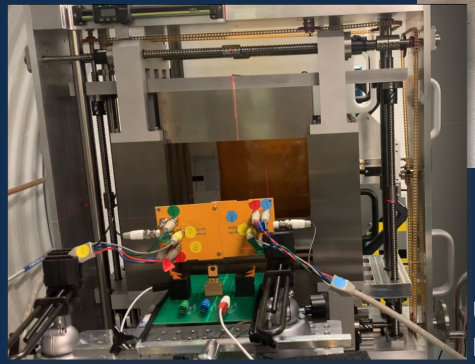
(4) University-Sponsored Projects:
- Experiential learning credited coursework
- UG/GA research
- Sponsored capstone design
- Community engagement

(5) Networking Outreach:
- Wide community-based network and technology ecosystem
- Future-ready institutes, Velocity2040
- Industry involvement, training and workshops
- Mentorship programs
- Career and networking fairs





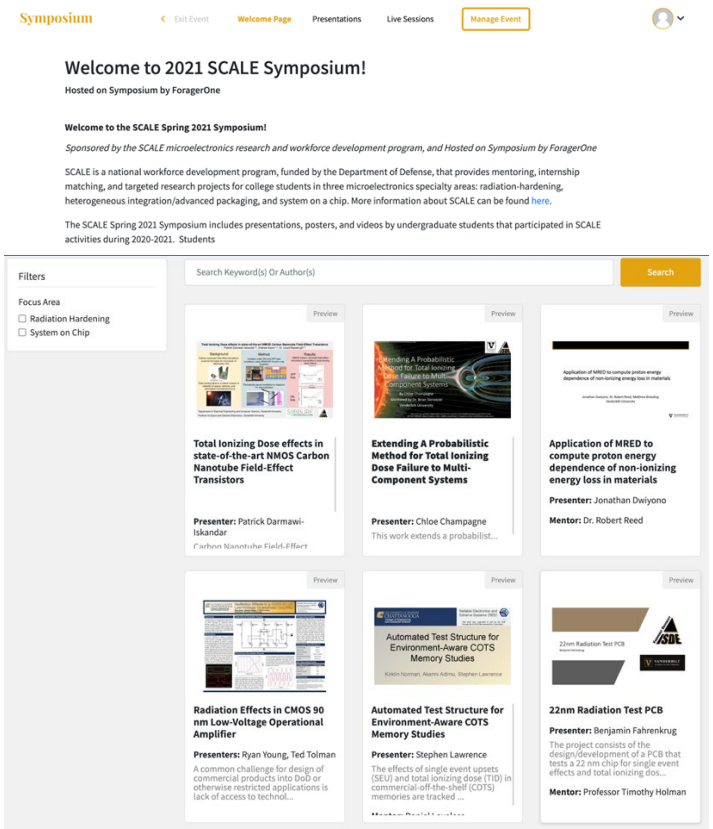
UTC SCALE students conducting TID experiments at Vanderbilt



UTC SCALE student test card for NSRL Bootcamp

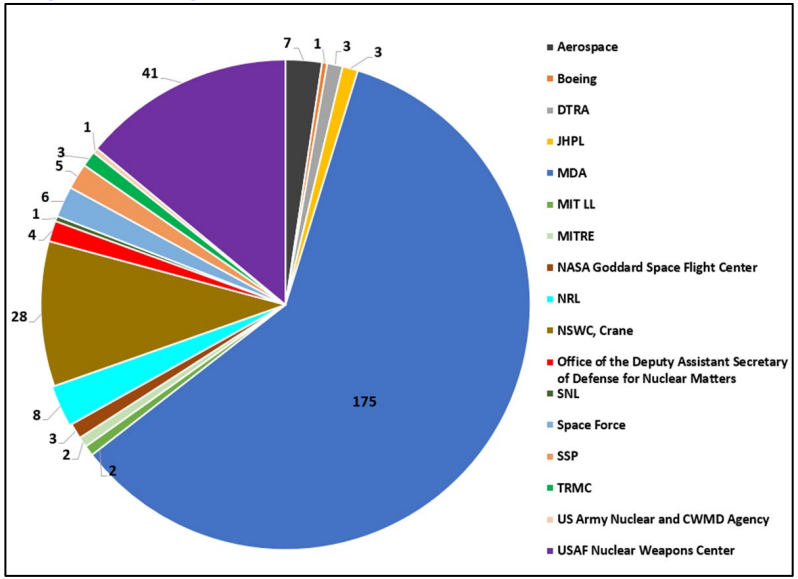
SCALE RHM Programming

- Collaborative multi-university "course" (VU, UTC, ASU, GT, Purdue)
  - Introduction to transistors and basic circuit elements
  - Electronics technologies and scaling
  - Radiation environments
  - Mechanisms of radiation interactions with materials used in electronics
  - Manifestations of radiation effects: TID, transient, displacement damage
  - Experimental radiation response characterization
  - Simulation of radiation effects
  - Event-rate calculations
  - Mitigation strategies at the process, technology, circuit design, system levels
  - Career paths in radiation-effect engineering: Industry government, academia
- Radiation Effects course at Lipscomb
- Students presented their research projects at the end of the Spring 2021 semester in a (trial-run) virtual symposium



Current Continuing Education Initiative - Survivability Seminar Series -

- **In November 2020, MDA began hosting a biweekly seminar series to provide content on radiation effects topics as they relate to systems engineering and acquisition**
  - **Aerospace Corporation will have delivered 22, one hour seminars by the end of the FY (all recorded and stored for future use)**
  - **MDA QSR currently funds the series (~$100k)**
- **Other DoD partners have been invited with the recognition that specialized radiation effects training at a regular battle rhythm is limited**



Planned Continuing Education Initiative - Radiation Test Workshops -

- In December 2021, MDA hosted a hands on radiation test workshop at the NASA Space Radiation Lab
  - This is a proof of concept to determine viability
  - The Survivability Seminar Series modules preceding will cover test planning, execution, and data analysis to maximize time available for hands on testing at the facility
- MDA has partnered with other entities to share the cost of executing this workshop
  - MDA has leveraged Defense Acquisition Workforce Development Account (DAWDA) funding ($190k) to secure test time at NSRL for workshop
  - Instructors are providing their time pro bono to teach the concepts
    - Includes NASA JPL, NASA Goddard, University of Tennessee Chattanooga, and Aerospace Corporation
- In addition to the continuing education aspect, MDA and partners benefit from the data that comes from testing to inform various program needs

Retention

- One on one meetings with students (UTC and Lipscomb so far) provides the opportunity to talk casually about topics that will impact their future:
  - Where a candidate wants to live
  - Job sector interests
  - Common questions about the work landscape
- Provides opportunity to show students opportunities that exist throughout my network
  - Gives students the opportunity to connect with professionals who have worked at an employer of interest to provide further perspective/advice
  - Introduce students and employers that have mutual interest in connecting
- Goal is simply to assist in removing the black box that currently exists between students applying for jobs and MDA seeking candidates
  - Helps MDA prioritize which candidates to target

Other Workforce Initiatives

- **Lunch and Learns – replenish the pipeline by educating those who don't know of it's existence**
  - **Gather industry to talk to students about the field of radiation effects and why we chose to get involved in the field**
  - **Past events have been widely attended (last event at UTC was the largest attendance the engineering school has ever had at similar events)**
    - **Several students signed up for SCALE and switched majors after the last event**
- **Meaningful capstone projects – provide problems to students to assist in understanding, solving, and deploying solutions that affect the stakeholder community**
  - **Leverage National Security Innovation Network, Hacking for Defense, and internal methods for engagement**
  - **Exposes students to the field of radiation effects through targeted projects while addressing community problems**
    - **ISEEU Scheduling Tool, Test facility access case study, testing parts tied to program needs**

Summary/Observations

- It takes a village: Partnerships and collaborations are critical in addressing workforce development woes
- The main issue with workforce development is a lack of expert time to pass on knowledge
  - Radiation effects SMEs time is highly sought after
  - Need to share any learning efforts widely
- Students and employers are in transparency between future workforce and opportunities
- Giving students ownership of problems that affect the community is an easy way to get them excited about the field
  - Students produce valuable high-quality products when they can see how their contribution is affecting the community