# Radiation Effects Boot Camp & MS Degree in Radiation Effects

at the Texas A&M University

## Cyclotron Institute


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Accelerator Physicist / Project Manager


http://cyclotron.tamu.edu/ref/

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# Outline of Today's Talk:

1. **Masters Degree in Radiation Effects at TAMU:**
   a. Overview of Program
   b. Coursework
   c. Skills Learned While Working at the Cyclotron Lab
   d. Masters Project

2. **Boot Camp in Radiation Effects**
   a. SEE testing  with Heavy ions at Medium / Low Energy
   b. 2021 Virtual Boot Camp
   c. 2022 Boot Camp (Virtual or In-Person??)

# Masters Degree in Radiation Effects at TAMU:

- **Two year program:**
  - Degree from TAMU Physics Department
  - 4 Semesters – 60% Coursework / 40% Laboratory
  - Coursework – Relevant Physics/EE/ME/Math topics
  - Lab Operations Knowledge – Cyclotrons, Ion Sources, Detectors, Dosimetry Systems, Beam Tuning/Transport
  - Masters Project – Collaborative Effort w/ NASA JPL/GSFC – Test Board Fabrication, In-Beam Data, Analysis/Write-Up

- **Masters Students would graduate with:**
  - General Knowledge in Radiation Effects
  - Hands-On Testing/Cyclotron Laboratory Experience

- **Application Deadline – July 16, 2021 for Fall 2021**
- **Financial Assistance for US citizens – Tuition, Fees & Stipend**

# Example Coursework (7 Classes):

1. **NUEN 604, Radiation Interactions and Shielding:**

Basic principles of radiation interactions and transport, especially as related to the design of radiation shields. Radiation sources, nuclear reactions, radiation transport, photon interactions, dosimetry, buildup factors and fast neutron shielding.

2. **PHYS 615, Methods of Theoretical Physics:**

Orthogonal eigenfunctions with operator and matrix methods applied to solutions of the differential and integral equations of mathematical physics; contour integration, asymptotic expansions of Fourier transforms, the method of stationary phase and generalized functions applied to problems in quantum mechanics.

# Required Coursework (7 Classes):

**3. PHYS 606, Quantum Mechanics:**

Schrodinger wave equation, bound states of simple systems, collision theory, representation and expansion theory, matrix formulation, perturbation theory.

**4. PHYS 603, Electromagnetic Theory:**

Boundary-value problems in electrostatics; basic magnetostatics; multipoles; elementary treatment of ponderable media; Maxwell's equations for time-varying fields; energy and momentum of electromagnetic field; Poynting's theorem; gauge transformations.

# Required Coursework (7 Classes):

**5. PHYS 607, Statistical Mechanics:**

Classical statistical mechanics, Maxwell-Boltzmann distribution, and equipartition theorem; quantum statistical mechanics, Bose-Einstein distribution and Fermi-Dirac distribution; applications such as polyatomic gases, blackbody radiation, free electron model for metals, Debye model of vibrations in solids, ideal quantum mechanical gases and Bose-Einstein condensation; if time permits, phase transitions and nonequilibrium statistical mechanics.

# Required Coursework (7 Classes):

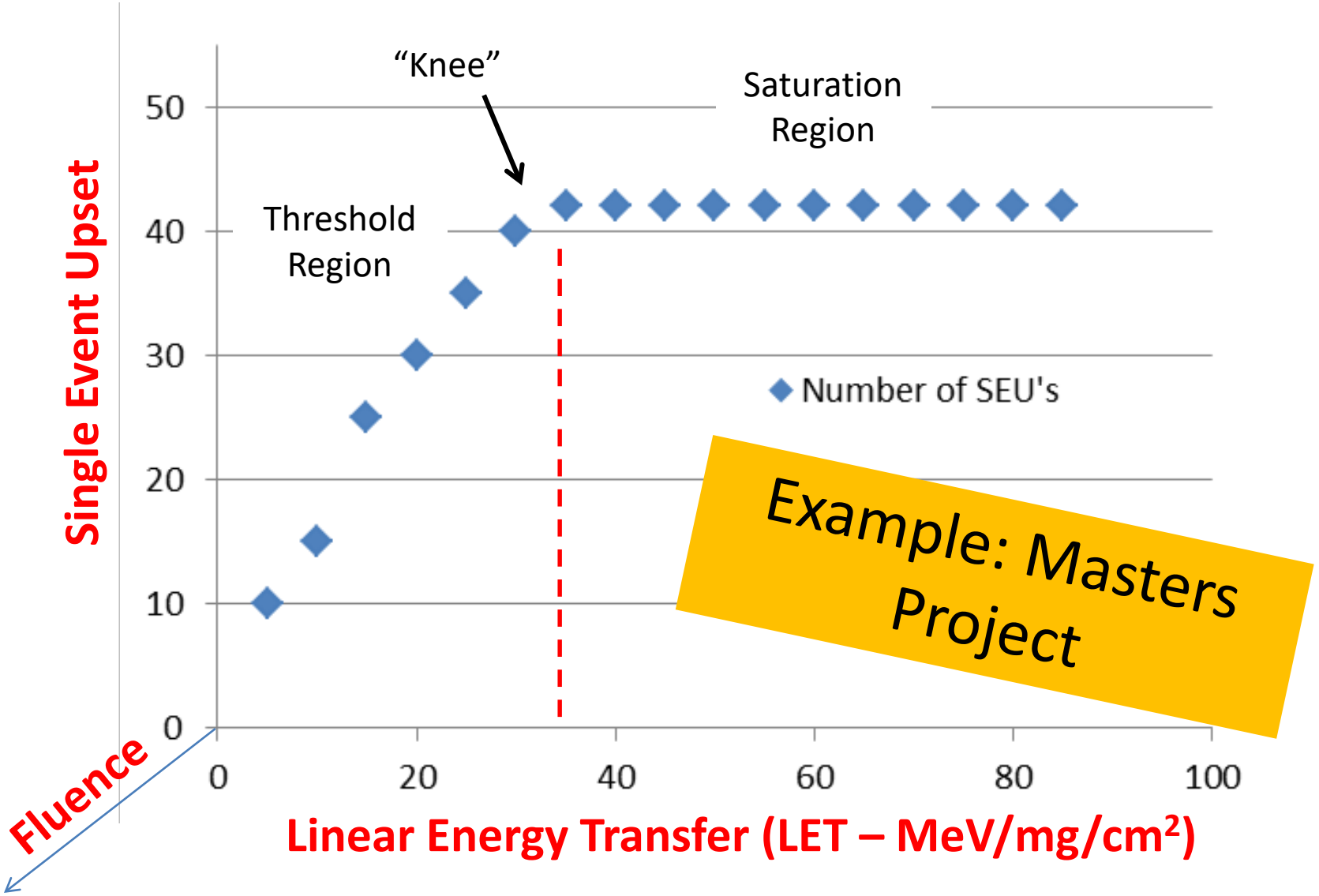
**6. PHYS 617, Physics of the Solid State:**

Crystalline structure and symmetry operations; electronic properties in the free electron model with band effects included; lattice vibrations and phonons; thermal properties; additional topics selected by the instructor from: scattering of X-rays, electrons, and neutrons, electrical and thermal transport, magnetism, superconductivity, defects, semiconductor devices, dielectrics, optical properties.

**7. ECEN 704, VLSI Circuit Design:**

Analysis and design of monolithic analog and digital integrated circuits using NMOS, CMOS and bipolar technologies; device modeling; CAD tools and computer-aided design; design methodologies for LSI and VLSI scale circuits; yield and economics; test and evaluation of integrated circuits.

# SEU Response of SRAM for Dosimetry




Example: Masters Project

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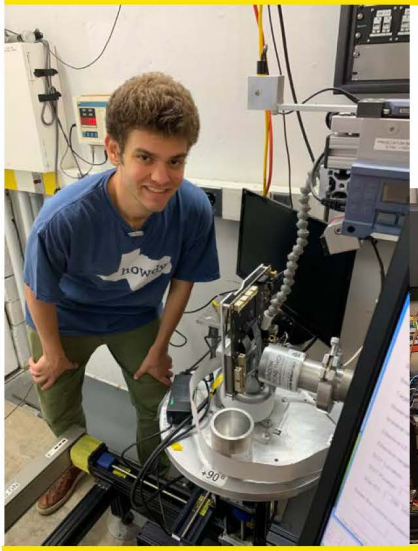
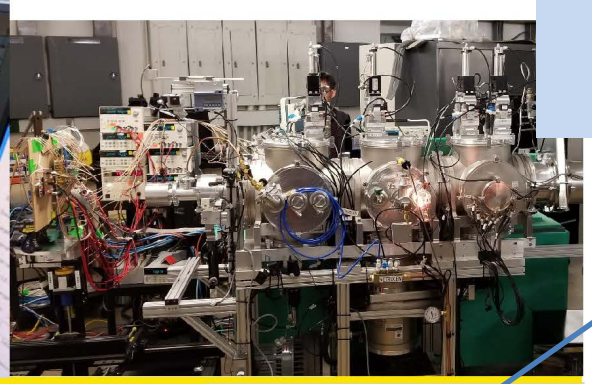
Science

# Mesmerized by space exploration?



## Earn your MS in Physics in Radiation Effects!



### Why Study Radiation Effects at Texas A&M University?

With a Physics Masters degree from Texas A&M University specializing in Radiation Effects, you can expect to line up a rewarding job – well before graduation day. Federal government aerospace organizations such as NASA and the Jet Propulsion Laboratory, contractors such as Boeing, Honeywell, Lockheed Martin, and SpaceX, and military services such as the Air Force, Navy, and Space Force are all looking for people with experience and education in Radiation Effects. In addition to space, the autonomous vehicle industry needs people able to build robust terrestrial systems that can tolerate these effects to navigate the millions of vehicles that will soon be in operation across the globe. With their growing workforce needs, organizations like these provide opportunities for Masters students to do internships as an integral component of their career development. Collectively, government agencies and independent companies conduct hundreds of Radiation Effects experiments annually at the Cyclotron Institute. You'll get to rub shoulders with the very people that you may eventually work for!

**For Enrollment Information Contact:**
Prof. Carl Gagliardi
cggroup@comp.tamu.edu
979-845-1411

**Gain in class and hands on experience, from studying topics such as:**

PHYS 603 Electromagnetic Theory I
ECEN 714 Digital Integrated Circuit Design
NUEN 604 Radiation Interactions and Shielding

**Intern with companies and agencies such as:**
Boeing, Space X and NASA

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Contact & Enrollment Information:

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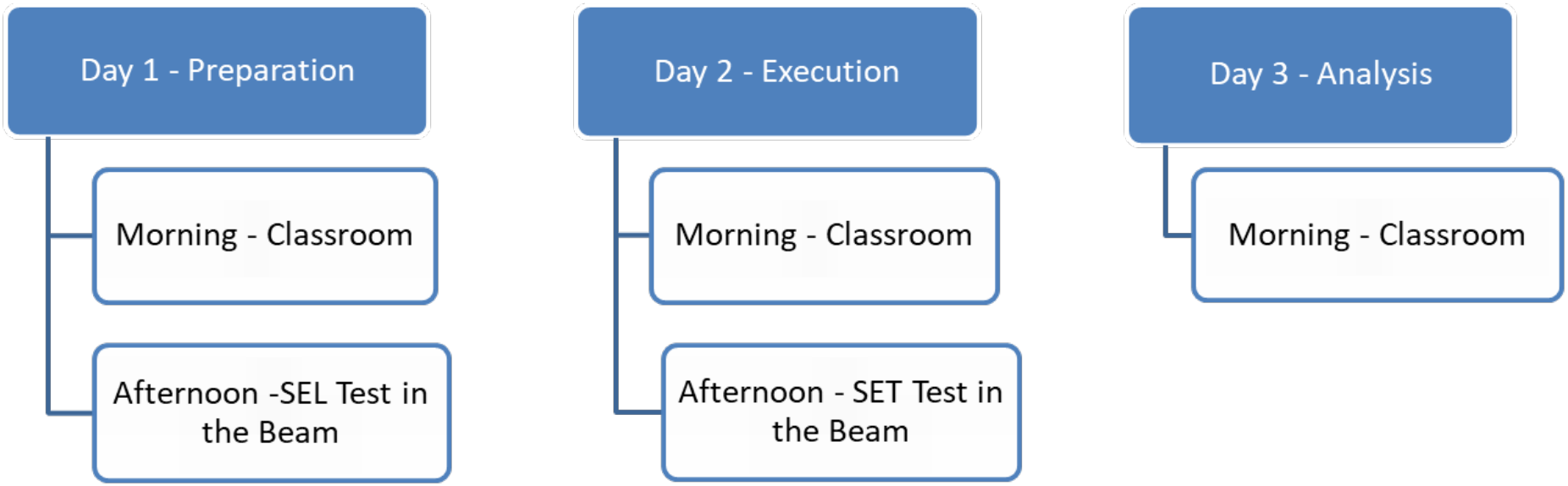
# Radiation Effects Bootcamp at TAMU in Collaboration with NASA JPL, GSFC:

1. **Overview of SEE testing:**
   - Environments, Terminology/Acronyms, Medium/Low Energy Testing Facilities, TAMU Cyclotron REF Overview
2. **Test Planning & Preparation:**
   - Formulating a Test Plan, Choosing Support Test Equipment
3. **Test Execution:**
   - Data taking, Efficiency & Common Mistakes
4. **Test Results:**
   - Data Analysis (Both In-Beam & Post Beam), Examples of Project Saves, Reporting

# Radiation Effects Bootcamp at TAMU in Collaboration with NASA JPL, GSFC:




**** Utilizing Beams from the K150 Cyclotron**

# Virtual Bootcamp – March 15 – 17, 2021

| Monday, 15 Mar 2021 | Tuesday, 16 Mar 2021 | Wednesday, 17 Mar 2021 |
|---|---|---|
| Module 1:<br>(10:00AM-11:00AM CDT)<br>Introduction to Bootcamp:<br>Why We Do This -<br>*Jonny Pellish* | Module 5:<br>(10:00AM-11:00AM CDT)<br>Requirements & Goals -<br>*Michael Campola* | Module 9A:<br>(10:00AM-10:45AM CDT)<br>Data Analysis & Interpretation -<br>*Ray Ladbury* |
| Module 2:<br>(11:00AM-11:30AM CDT)<br>Environments & SEE -<br>*Mike Xapsos* | Module 6A:<br>(11:00AM-11:45AM CDT)<br>Test Planning & Preparation -<br>*Ted Wilcox* | Module 9B:<br>(10:45-11:30AM CDT)<br>Data Put to Use:<br>Likelihood & Rate Calculations -<br>*Ray Ladbury* |
| **Break (30min)** | **Break (30min)** | **Break (30min)** |
| Module 3:<br>(12:00PM-2:00pm CDT)<br>SEE Basics &<br>Test Execution Definitions -<br>*Rob Davies / Megan Casey* | Module 6B:<br>(12:15PM-1:15PM CDT)<br>Test Planning & Preparation -<br>*Ted Wilcox* | Module 10:<br>(12:00PM -1:00PM CDT)<br>The Shape of Things to Come -<br>*Ken LaBel* |
| | Module 7:<br>(1:15-2:30PM CDT)<br>Test Execution Refined -<br>*Greg Allen* | Module 11:<br>(1:00-2:00 CDT)<br>SoC Testing -<br>*Steve Guertin* |
| Module 4:<br>(2:00PM-3:00PM CDT)<br>Cyclotron Overview -<br>*Henry Clark* | | Module 12:<br>(2:00-2:30 CDT)<br>Common Mistakes:<br>"Tales from the Cave" -<br>*Greg Allen* |
| | Module 8:<br>(2:30-3:00PM CDT)<br>Facility Considerations &<br>Differences -<br>*Jonny Pellish* | Module 13:<br>(2:30PM-3:00PM CDT)<br>Project Saves -<br>*Leif Scheick* |
| **Wrap up (30min)** | **Wrap up (30min)** | **Bootcamp Wrap up (30min)** |

# Virtual Bootcamp in Radiation Effects:

- **Overview of Bootcamp:**
  - March 15 – 17, 2021
  - 12 Presenters & 13 Presentations
  - Focused on Classroom Material Only
  - 15 – 20 Invited Viewers – University Faculty, Staff, Students and SEE Testing Professionals
  - Invited Viewers Provided Feedback Daily & at Conclusion

- **Takeaways from Invited Viewers:**
  - Well Done and Greatly Needed for the Community
  - Presentations Covered a Wide Range Material
    - Expand Bootcamp Material over 4 days?
    - Bootcamps at Student/Entry and Professional Levels

# Bootcamp in Radiation Effects – What's Next?

- **Proceedings from 2021 Bootcamp:**
  - Edits to Presentations Nearly Finished
  - Released Shortly

- **2022 Bootcamp:**
  - Planned for March – April 2022
  - In-Person at the TAMU Cyclotron Institute
  - To Be Finalized…
    - In-Person Class Size?
    - 4 - 6 Classroom Sessions?
    - 2 – 3 Data Taking Sessions In The Beam?
    - Provide Live Feed or Virtual Options?
  - Formal Announcement Coming Soon!

**Visit our website at**

http://cyclotron.tamu.edu/ref/

Questions, contracting, scheduling contact Henry Clark at

clark@comp.tamu.edu

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