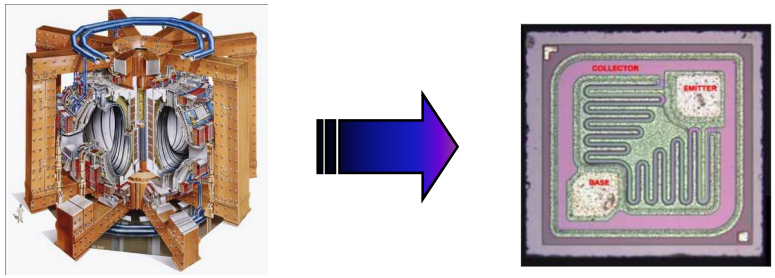
SAND2008-5041P

Transitions to Transistors



Tech Talk – University of Wisconsin Madison
GERS Meeting
July 30, 2008

Joseph Castro
Qualification/Requirements PRT Lead
Electrical & Microsystem Modeling, Org. 01437

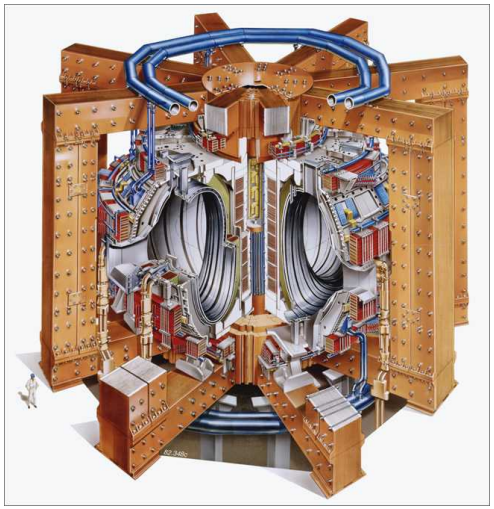
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Overview

- Sandia Recruiting DVD – 15 minute video
- Journey of Transitions
  - Academics –> Profession
  - Transitions Continue @ Sandia
  - Lessons Learned
- Current Work at Sandia (Tech Talk)
  - QASPR Project
- Wrap-Up and Q&A

Pre-College Years (pre 1984)

- Graduated from Junction City (Kansas) High School 1984
  - Ambition: develop fusion power
- Undergraduate schools: No Fusion Centered Programs
- Focused on Nuclear Engineering Programs
  - Kansas State University
  - UC – Berkeley
- Ultimate Decision Maker = $
- Although a campus visit to Berkeley with my parents probably didn't help….

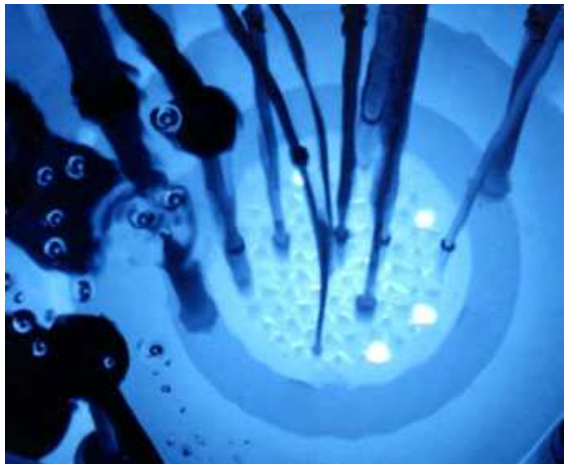


$$[Berkeley] \approx [Different]$$

$$[Berkeley] + [Grateful\ Dead\ Concert] \approx [Different]^2$$

Undergrad Years (1984-1989)

- Berkeley on the Brain
  - Planned to transfer after freshman year
  - 1st semester grades suffered
- Refocused – graduate school is the next goal
- K-State was a great school and a great experience
- Obtained B.S. in Nuclear Engineering – Dec. 1989
  - Emphasis on physics and math



Lesson Learned:

"High Profile" School was not a critical need for my academic goals

Graduate Years (1989-1995)

Lessons Learned:

- On-site visit is critical – if not offered a visit take the time and expense to do it yourself
- The school is not only important but also the location – you'll live there for 5-8 years of your life!
- Grad school choice is more critical than undergrad – make sure to do your homework
- Your academics are important but have a broader perspective about your future. Transition to next slide…

Desert Period (1995-1997)

Lessons Learned:

- Assumed Would Receive a Post-Doc position (no money) – communicate with advisor!
- Should have been pro-active on job search early! (saw it coming)
- Should have made more contacts – involvement in intern program, university organizations, etc.
- Job market tends to be cyclic – don't give up!

Being a part of GERS already puts you ahead of the game!

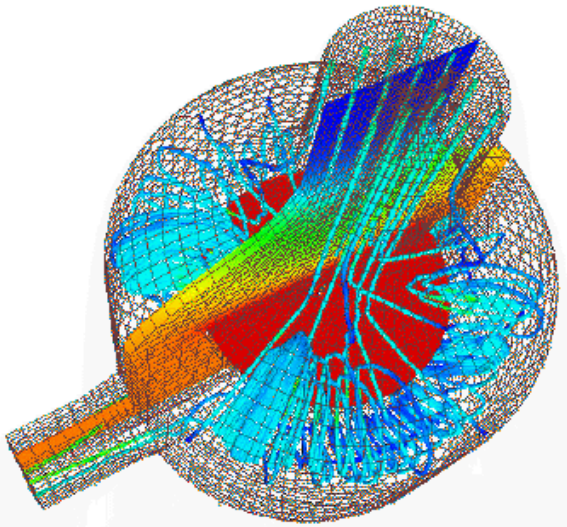
Sandia: Early Years (1997-2001)

Lessons Learned:

❖Always re-educate yourself when you have the opportunity (something I should have done more during grad years)

❖Be flexible and willing to transition into something new – you may find you like it!

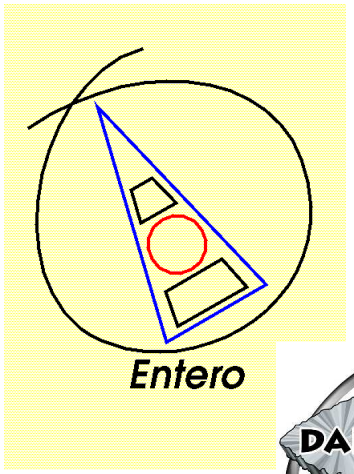
❖Be persistent and communicate with your management – was able to be hired during a very difficult time



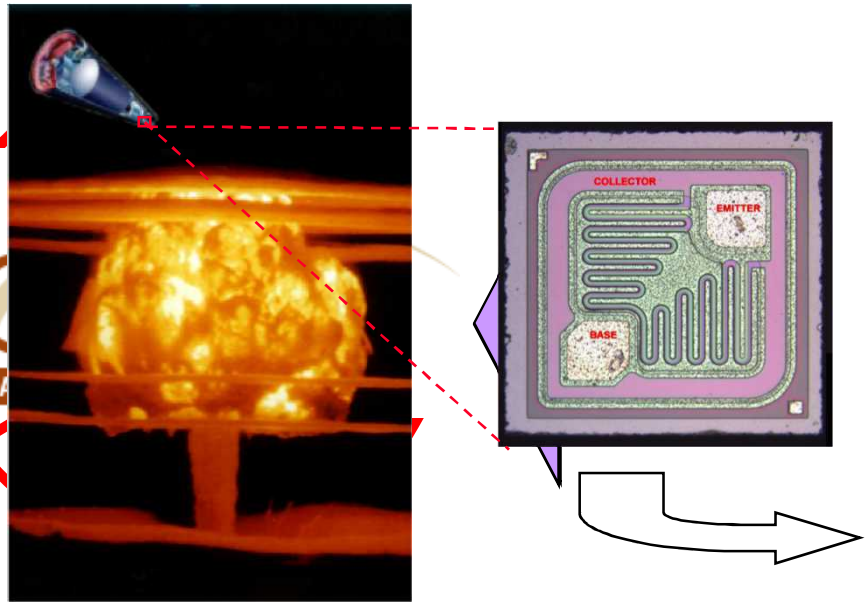
Sandia Years: Later Years (2001-Present)

Lessons Learned:

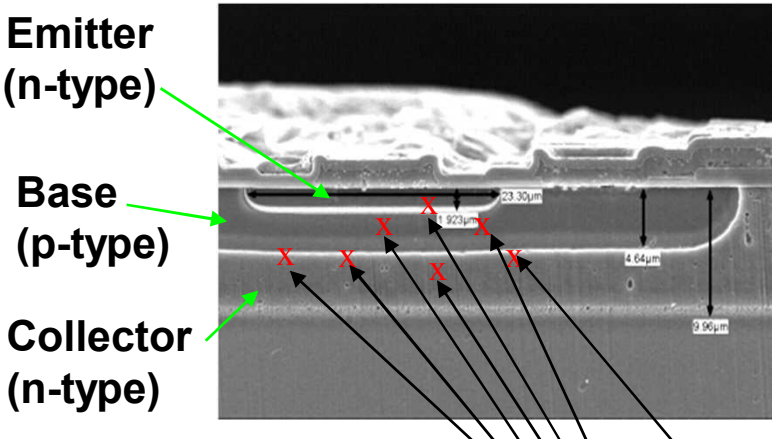
- Again, always be open to change:
  - Unforeseen change
    - ✓Budget
    - ✓Priority
  - New Opportunities
    - ✓Technical
    - ✓Programmatic
  - Good for growth!
- Sandia gives you the opportunity to transition to different things and wear different "hats"
  - If it doesn't work for you – have the ability to transition back



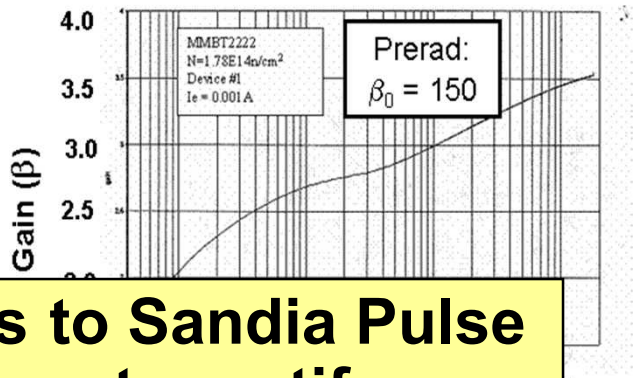
Issue – Weapon System Electronics Degrade When Exposed to Neutron Radiation



Neutrons create damage



Damage degrades gain



- Military requirement to certify to hostile environment
- SPR dismantled end of FY06 to improve SNL/NM security posture

QASPR (Qualification Alternatives to Sandia Pulse Reactor) will provide a methodology to certify qualification via quantified uncertainty

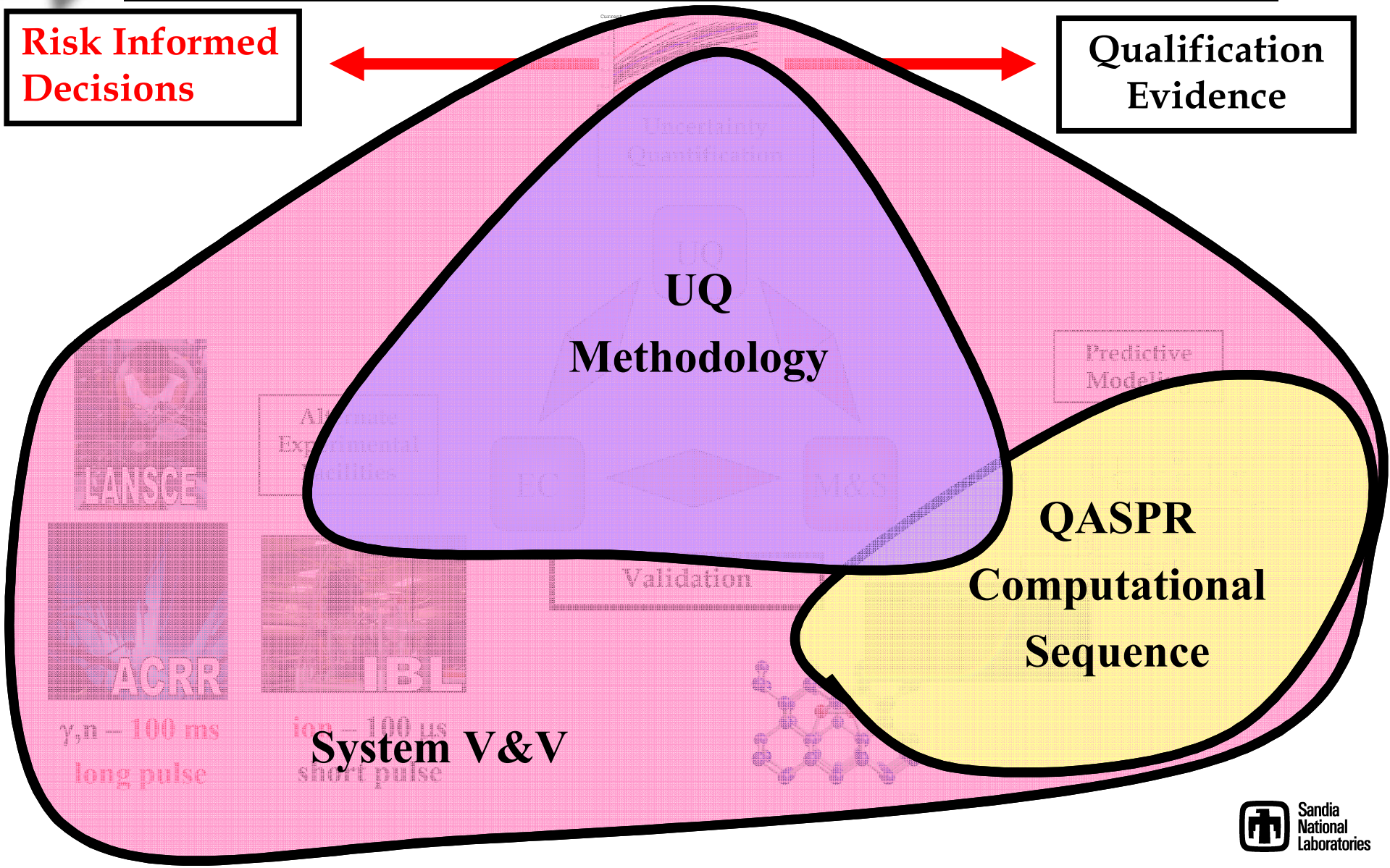
UQ-Relevant Terms

- **Calibration:**
  - **Use existing experimental data (model development) to improve physics model parameter settings in simulation code.**
- **Validation:**
  - **Assess agreement between simulation data and <u>new</u> experimental data (validation).**
    - ***Not using same test data from calibration*.**
- **Uncertainty quantification:**
  - **Estimate uncertainty in experimental data.**
  - **Propagate input parameter uncertainty through code(s), and estimate uncertainty in simulation data.**
- **Related topic – Verification:**
  - **Assess mathematical correctness of simulation code(s).**

A Science-Based Engineering Methodology Is Being Developed For Qualification

Risk Informed Decisions

Qualification Evidence



Sandia National Laboratories

The QASPR Methodology Requires a Wide Range of Disciplinary Expertise

Applied Nuclear Technologies
Pat Griffin

S&T Lead

NM Stockpile Issues & Planning
Bob Paulsen

Project Manager

Weapon Engineering Program Center
Charles Barbour

Program Manager Engineering Campaign

Core Team

Don King

EC PRT Lead

Advanced Nuclear Concepts

Joseph Castro

Qual./Req. PRT Lead

Elect'l & Microsystem Modeling

Sam Myers

M&S PRT Lead

Rad, Nano & Interface Sciences

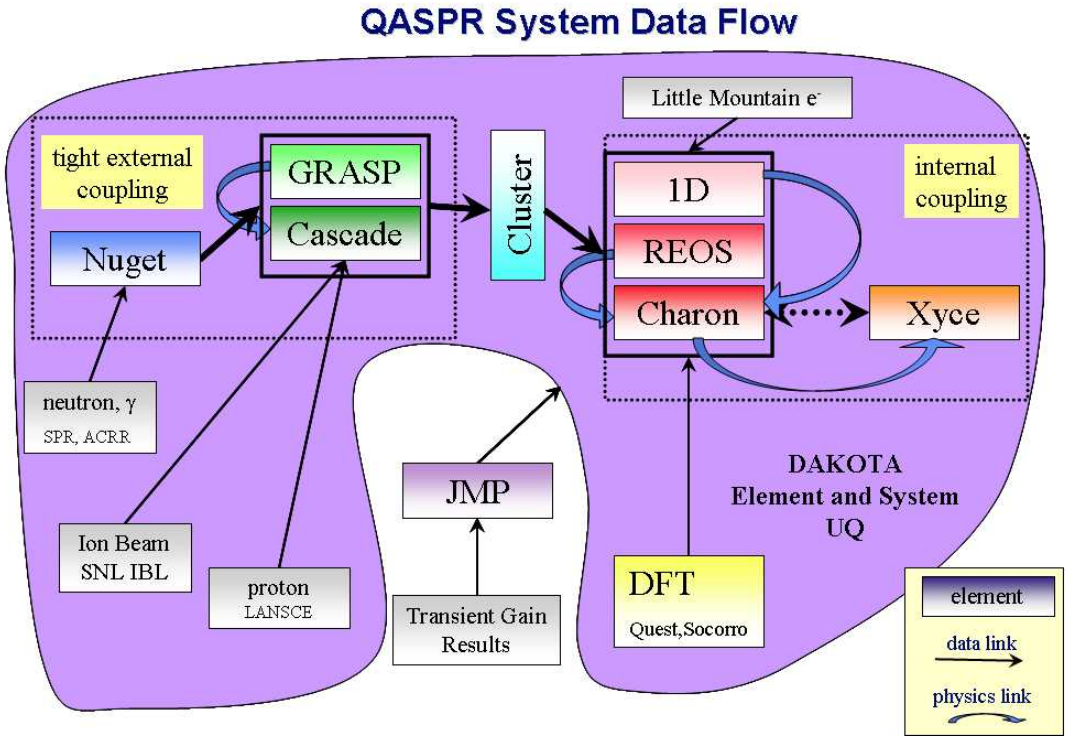
- **Key Technical Challenges:**
  - Damage relationship between facilities
  - Multi-scale, multi-fidelity physics
  - Uncertainty quantification process
- **Key Programmatic Challenges**
  - Integration across lab
  - Change culture!

QASPR success –> integrated, multi-program, multi-disciplinary team that spans the laboratory!

Sandia National Laboratories

QASPR Must Sustain Expert Knowledge and Qualification Evidence within a System Framework

- **Minimize knowledge attrition**
  - **Capture expertise within technology not people**
  - **Reproducibility –> proof of qualification**
- **Maximize confidence in product**
  - **Component V&V (M&S)**
  - **System Level V&V (Qual)**

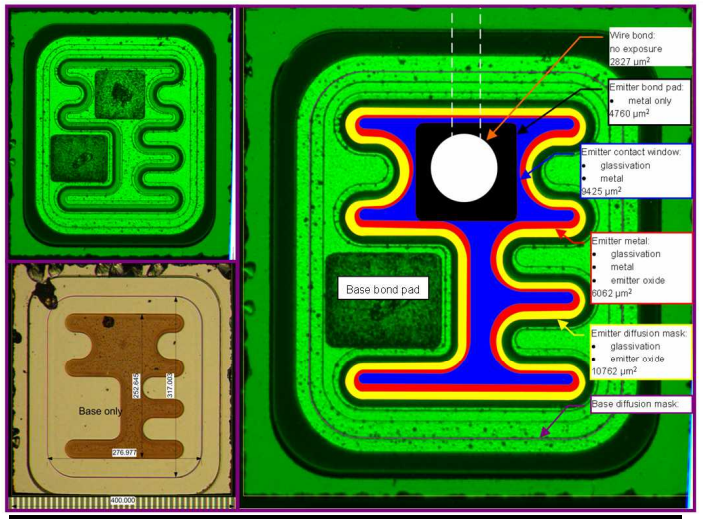


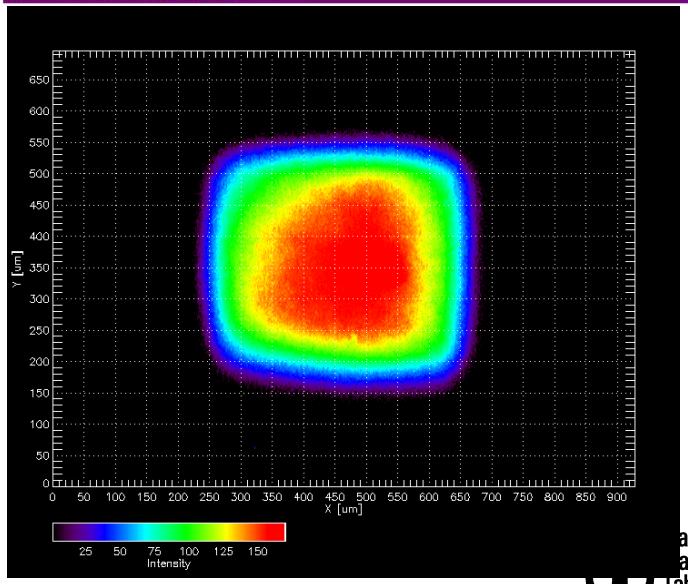
QASPR methodology will evolve into a product for qualification, V&V critical!

Sandia National Laboratories

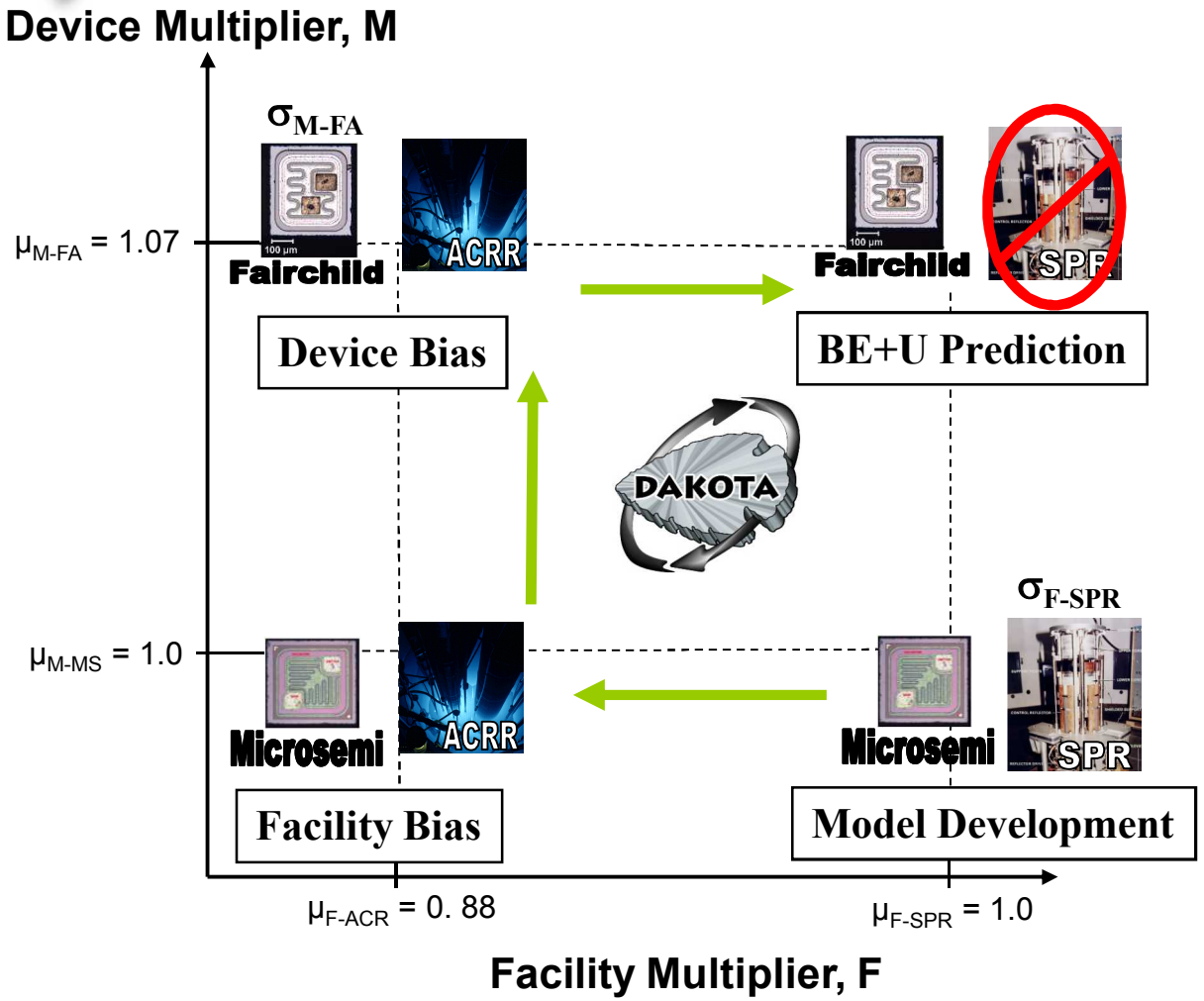
A Wide Range of Potential Model Parameters May Characterize the Observed Experimental Variability

- Device model
  - Doping characteristics
  - Device geometry
  - Material properties (physics parameters)
- Device operating conditions and performance measurements
  - Temperature
  - Electrical operating conditions
  - Current measurements
- Radiation environment measurements
  - Ni activity measurement
  - Si calorimeter integral data
- Shot-to-shot setup variability
  - Facility characterization
  - Scope measurements
  - Cabling
- ….





Development of a UQ Methodology Would Not Be Possible Without a Complete Integration of Efforts



- Process development and execution across all disciplines
- Uncertainty & Bias characterized by 2 degrees of freedom within model
  - Facility Multiplier
  - Device Multiplier
- Uncertainty quantified with D.O.E + statistical approach

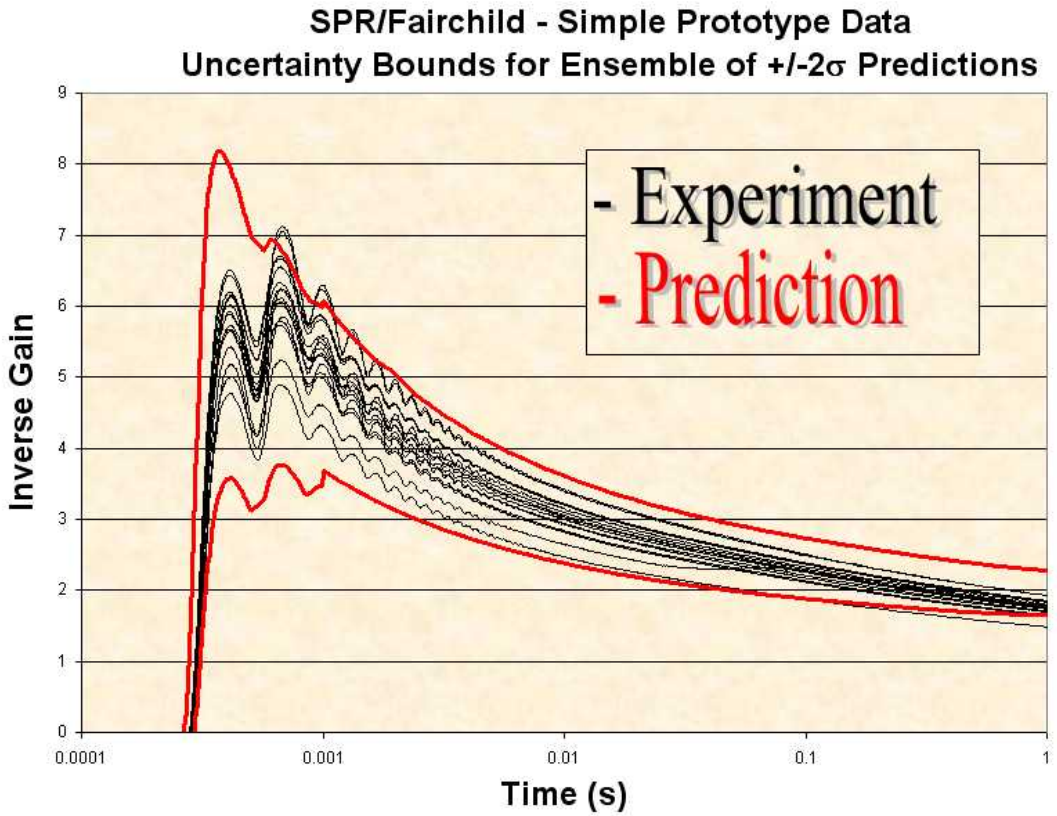
A Best Estimate + Uncertainty Prediction is the end game of the UQ Methodology

Sandia National Laboratories

Blind Prediction to Validate The Model

- Fairchild response data within SPR hidden
- First *prototype* of the QASPR methodology
  - First real validation of QASPR system
- Prediction + Uncertainty (+/-2σ device and facility uncertainty)
- Success!

Transient Device Damage Response



BE+U Prediction

The Device Prototype was a critical test for QASPR, but much more work to do…

Sandia National Laboratories

Concluding Thoughts

- QASPR integrates a wide range of modeling and experiments with UQ to provide a quantitative best estimate + uncertainty of electrical device/circuit response within a radiation environment
- QASPR spans eight Sandia centers and exemplifies one of it's unique strengths; integrate inter-organizational multidisciplinary teams to work problems of national importance
- Nuclear Weapons only encompasses ~50% of the work done at Sandia
  - Energy, Resources, Nonproliferation
  - Homeland Security and Defense
  - Information Systems
  - Next Slide…

Recruiting Resources & Upcoming Events

- DVD – "Change the World"
  - Overview of Sandia
  - Information on applying for a job
- Handouts
  - Student Internship Programs
  - Employee Benefits From Technology Transfer
  - PhD Research Positions
  - Laboratory Directed Research and Development (LDRD)
  - Computer Science & Computer Engineering
  - Electrical Engineering
  - Mechanical Engineering
  - Employee Benefits
  - Career Opportunities
  - Opportunities for Business Professionals
  - SNL-Livermore, California
  - SNL-Albuquerque, New Mexico
- Upcoming Recruiting Events
  - Get info from Drew…