Effective Small-Satellite Radiation Assurance for Non-Specialists

Rebekah A. Austin, B. D. Sierawski, A. F. Witulski, R. D. Schrimpf, R. A. Reed, G. Karsai, N. Mahadevan

Contact: Rebekah.a.Austin@vanderbilt.edu

This work supported by NEPP and NASA OSMA Grant and Cooperative Agreement Number 80NSSC18K0493

What is radiation hardness assurance (RHA)?

- Analysis of the expected ionizing radiation environment and its impact on the system
  - Effects cause part degradation and random events from energy deposition of the ionizing particles

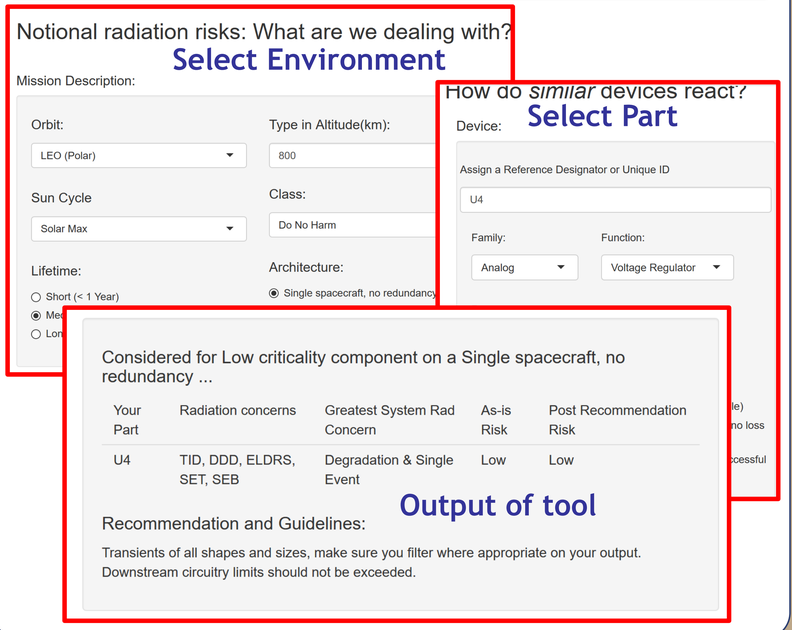
How do designers know the effect of radiation on parts?

- Use R-GENTIC
- Should be addressed early in design phase, before PDR
- Do not need to know specific part numbers, just general part types

R-GENTIC

- Select representative environment
  - Orbit, Altitude, Sun Cycle, Class, Lifetime, Architecture
- Select representative parts
  - Designator, Family, Function, Process, Criticality
- Outputs of tool
  - Description of radiation for similar environments
  - For each part: Typical line of questioning, Radiation concerns, Greatest system concern

https://vanguard.isde.vanderbilt.edu/RGentic/



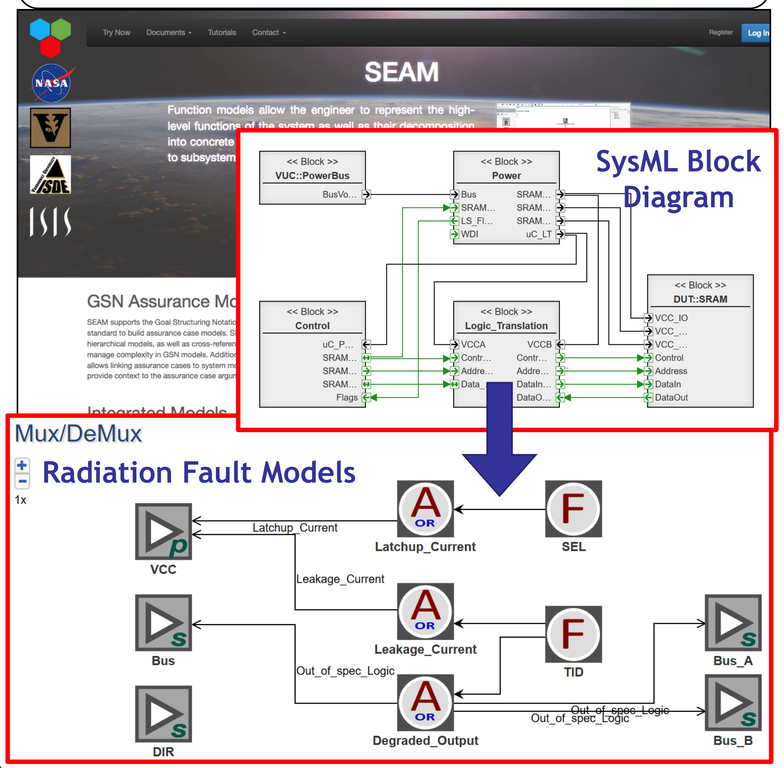
How do designers model how the radiation-induced faults propagate through the systems?

- Use SEAM
- Radiation fault models for different part types
- Analyze how faults in parts propagate through the system

SEAM

- Contains the following functionalities:
  - System Modeling Language (SysML)
    - Requirement Diagrams
    - Block Diagrams
  - Fault modeling (within SysML block diagrams)
  - Functional Decomposition
  - Graphical Argument Structure (GSN)
- Exports via XML
  - Bayes Nets
  - Fault Trees
- Radiation-related tools
  - CRÈME
  - R-GENTIC

https://modelbasedassurance.org



Why use a model-based approach for RHA?

- Captures a "digital copy"
  - Enables knowledge capture, sharing, and continuity
- Radiation effects and reliability ultimately need to analyzed at the system level
  - Knowledge about the system is needed
  - Complements and uses model-based system engineering processes and languages

How do designers capture and analyze radiation hardness assurance activities?

- Use graphical arguments like Goal Structuring Notation to link arguments with models of the system