

SEPTEMBER 2026



EXAMINATION OF A CIRCUIT'S SLEW RATE DEGRADATION DURING IN-SITU IRRADIATION OF CIRCUIT SENSITIVE TRANSISTOR

TRTR 2026 Presentation

MICHAEL SHERIDAN*, WILLIAM CHARLTON*, ANDREW TONIGAN^

*The University of Texas at Austin, ^Sandia National Laboratories

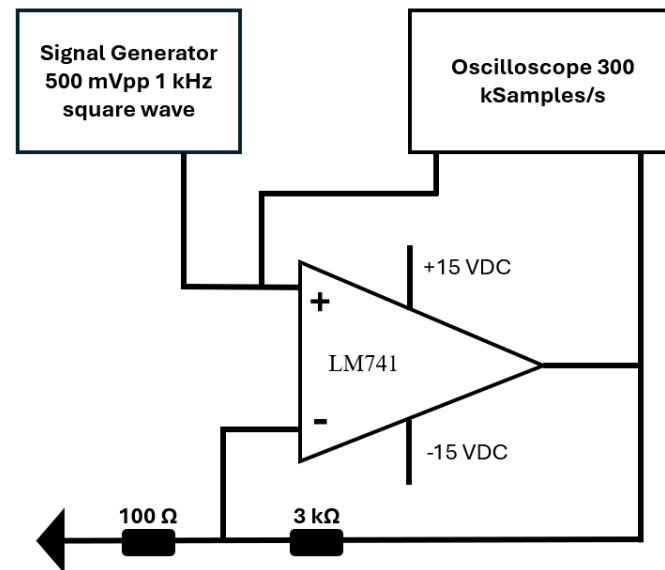
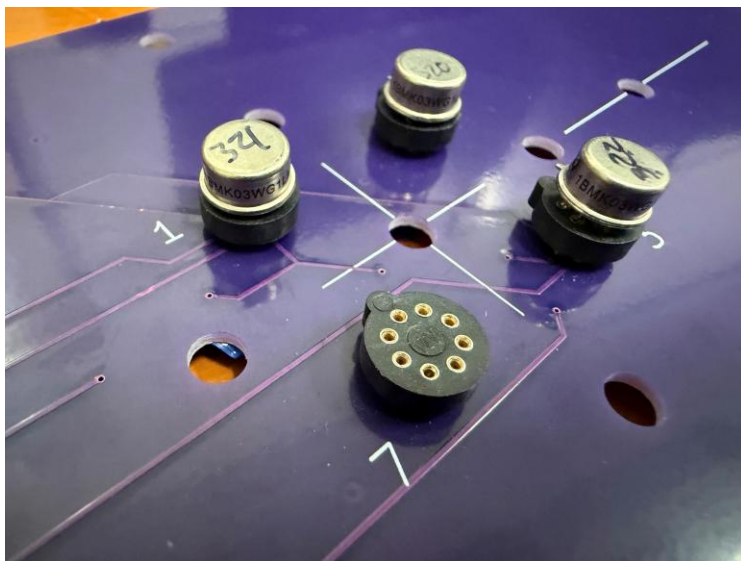
Objective

- Create a method for testing **weakest component** within an integrated circuit
- Examine integrated circuit performance with **irradiation of isolated component**
- Irradiate circuit component while **rest of circuit functions external to irradiation facility**



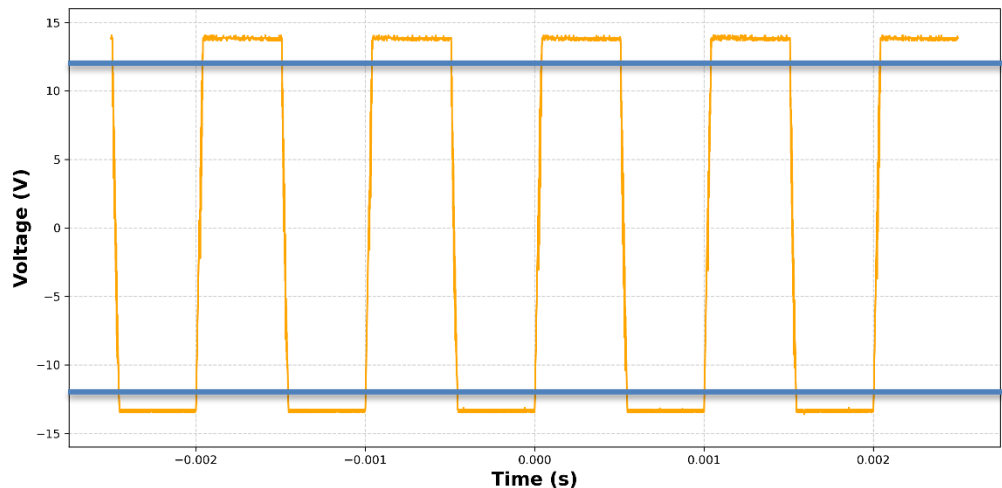
Texas Instruments *LM741-MIL Operational Amplifier Datasheet*
([ti.com/product/LM741-MIL](https://www.ti.com/product/LM741-MIL))

Previous LM741 Experiment

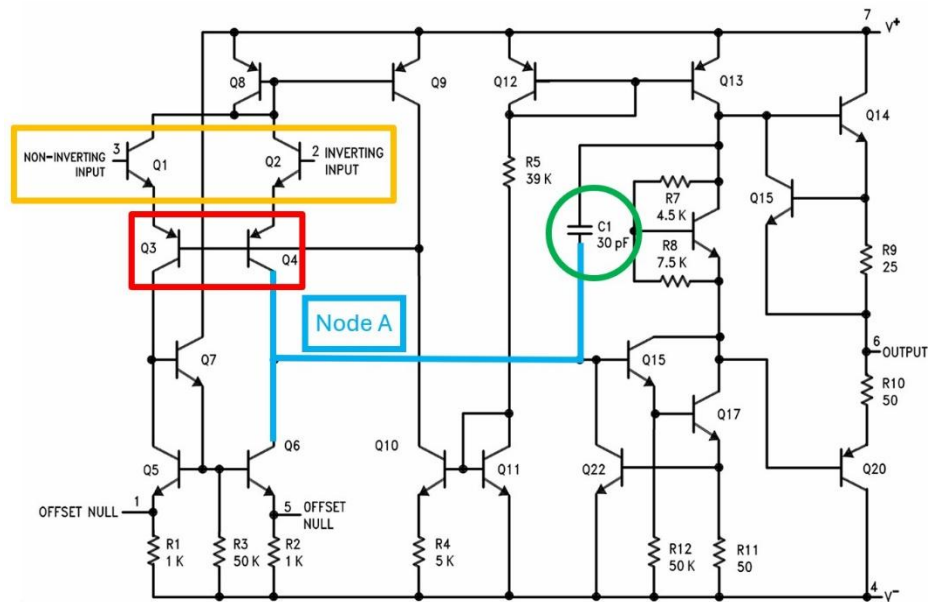
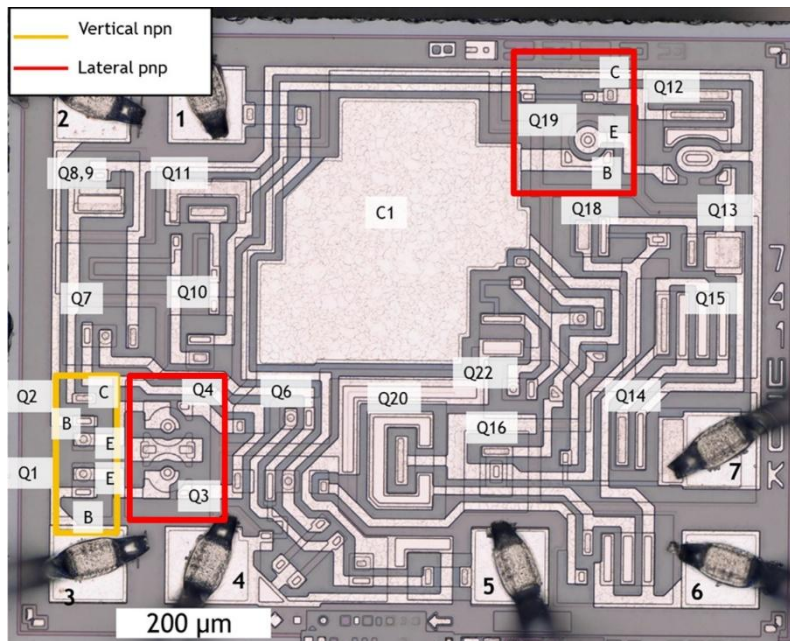


Slew Rate

- Slew rate is a measurement of **how quickly the device can switch signals**
- Analyzed by measuring the **positive and negative slope between cut off points 80% the max and min** of the square wave
- A **linear fit** is applied to the data to determine the slope
- Slew rate is divided by the unirradiated “virgin” slew rate to get slew rate ratio

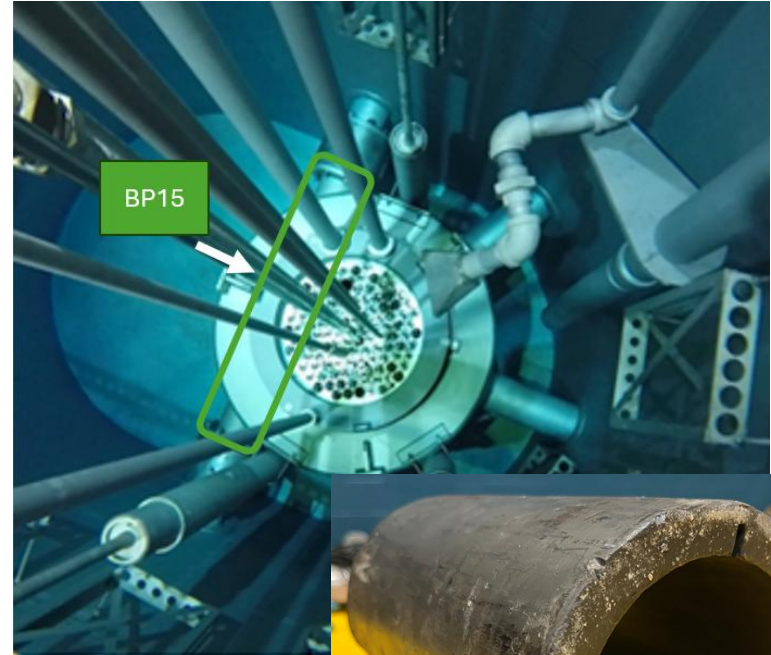


LM741 Circuit

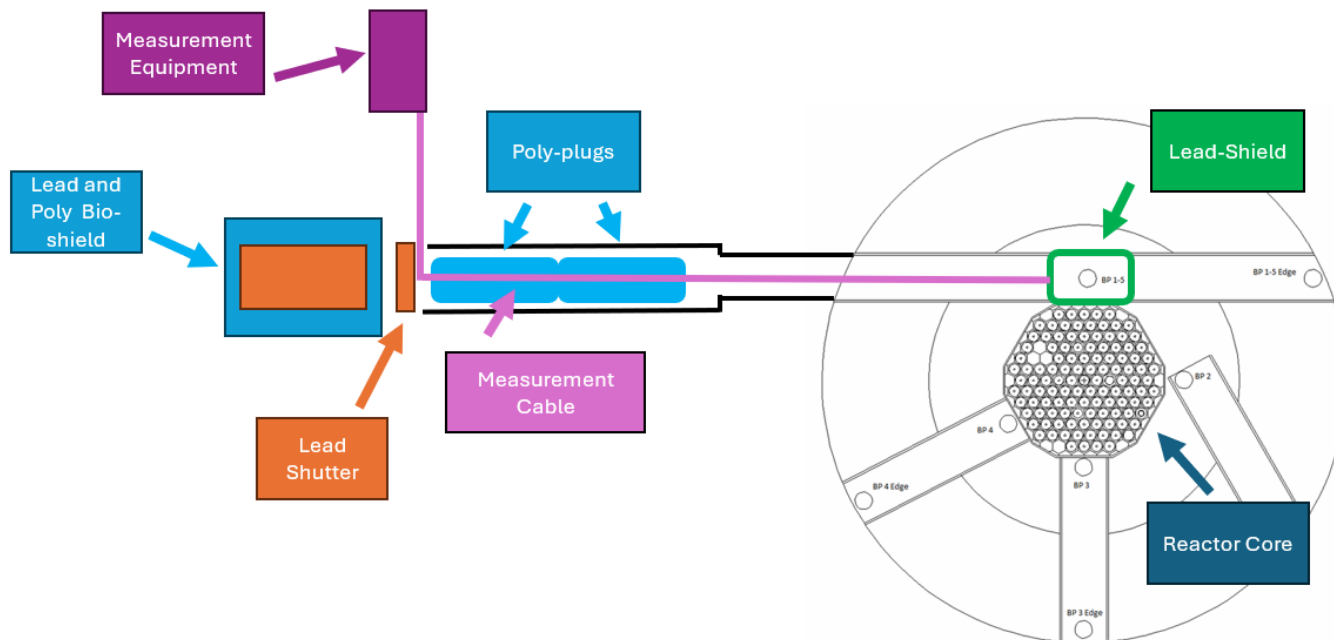


Beam Port 1-5

- 1.1 MW TRIGA Reactor
 - Ran at 10 kW in this work
- Location between beam ports 1 and 5
- $\frac{3}{4}$ in. lead shielding reduces TID by 50%

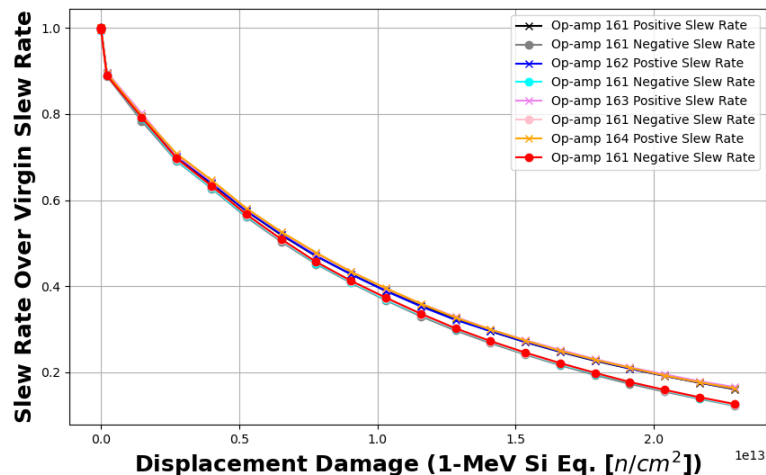


Beam Port 1-5

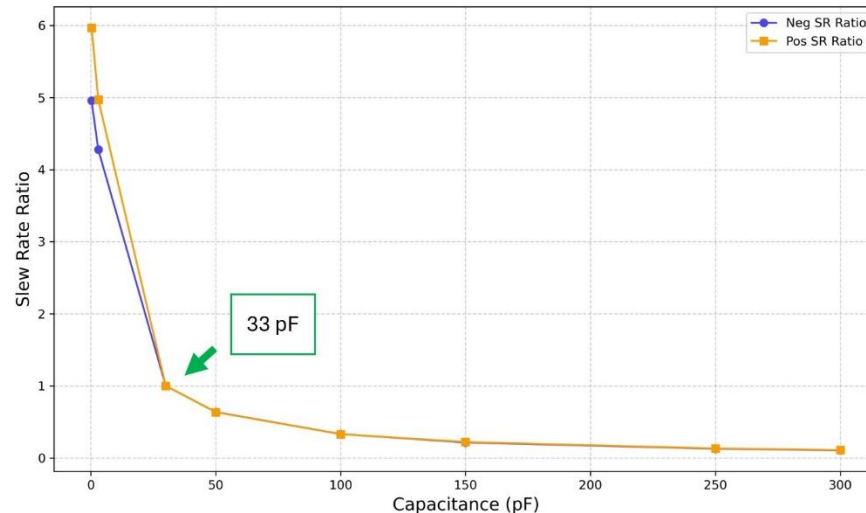
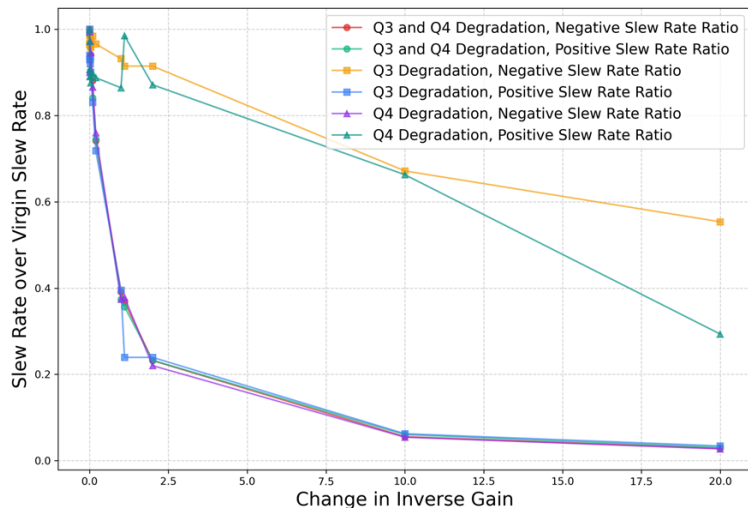


Previous LM741 Experiment

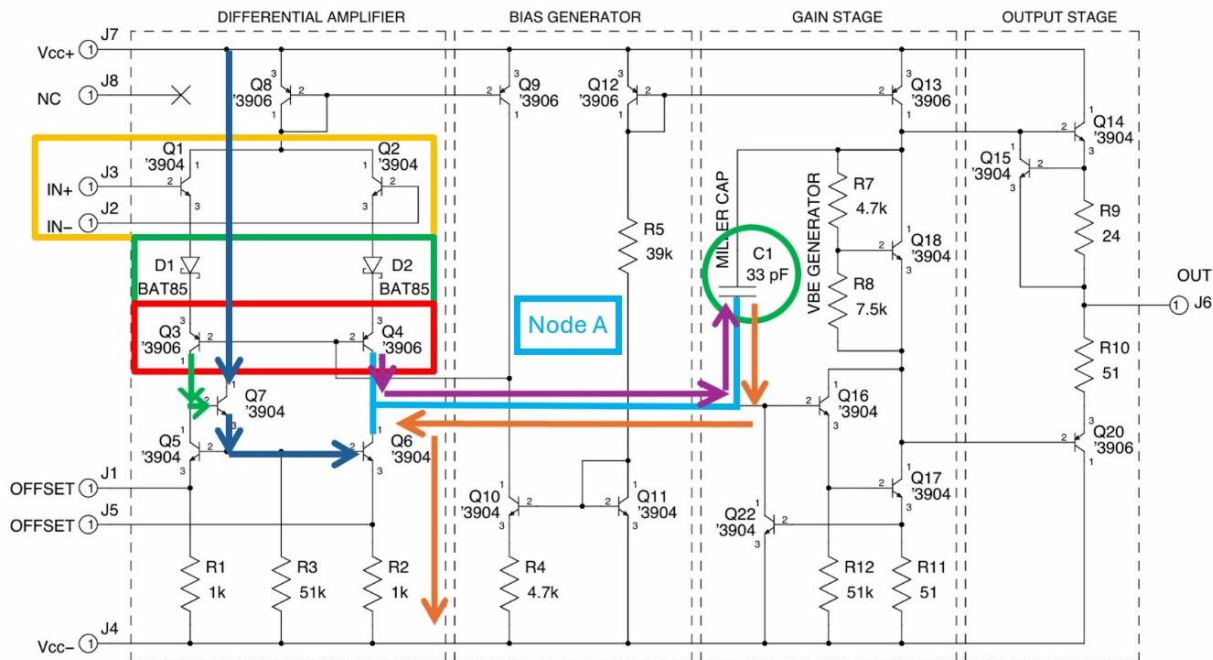
- Measurement made under bias and measured **in-situ**
- Positive and negative slew rate **degrade symmetrically**



LTSpice Circuit Model

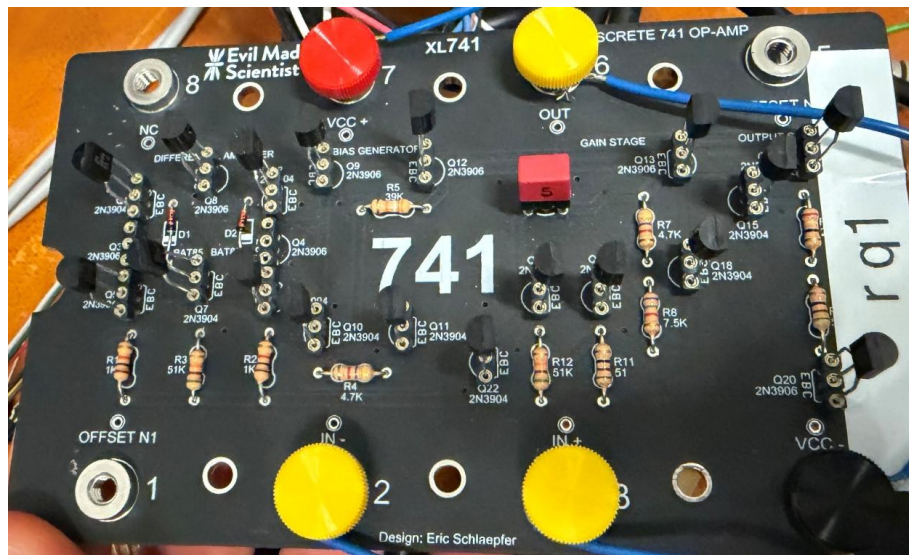


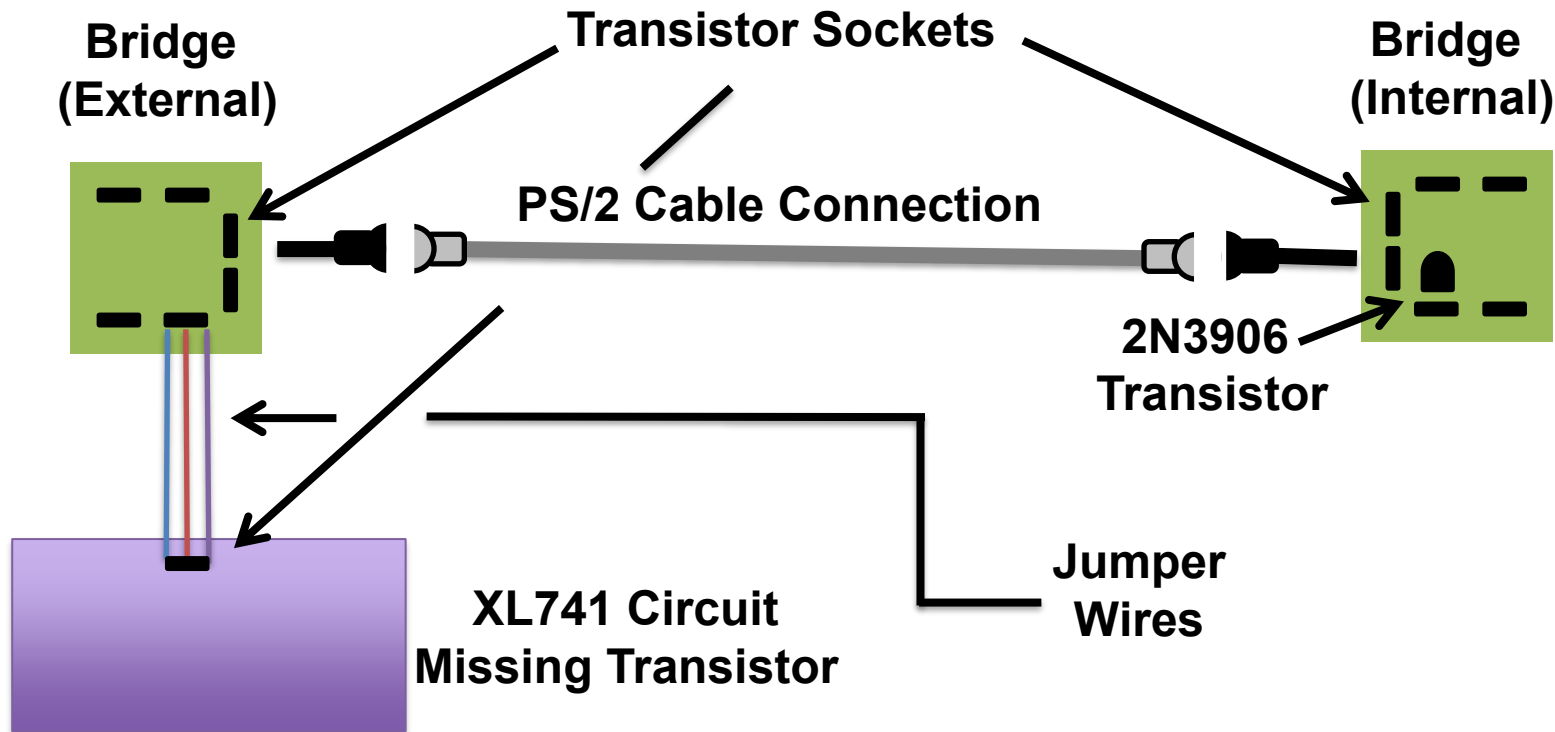
Discrete Circuit Diagram

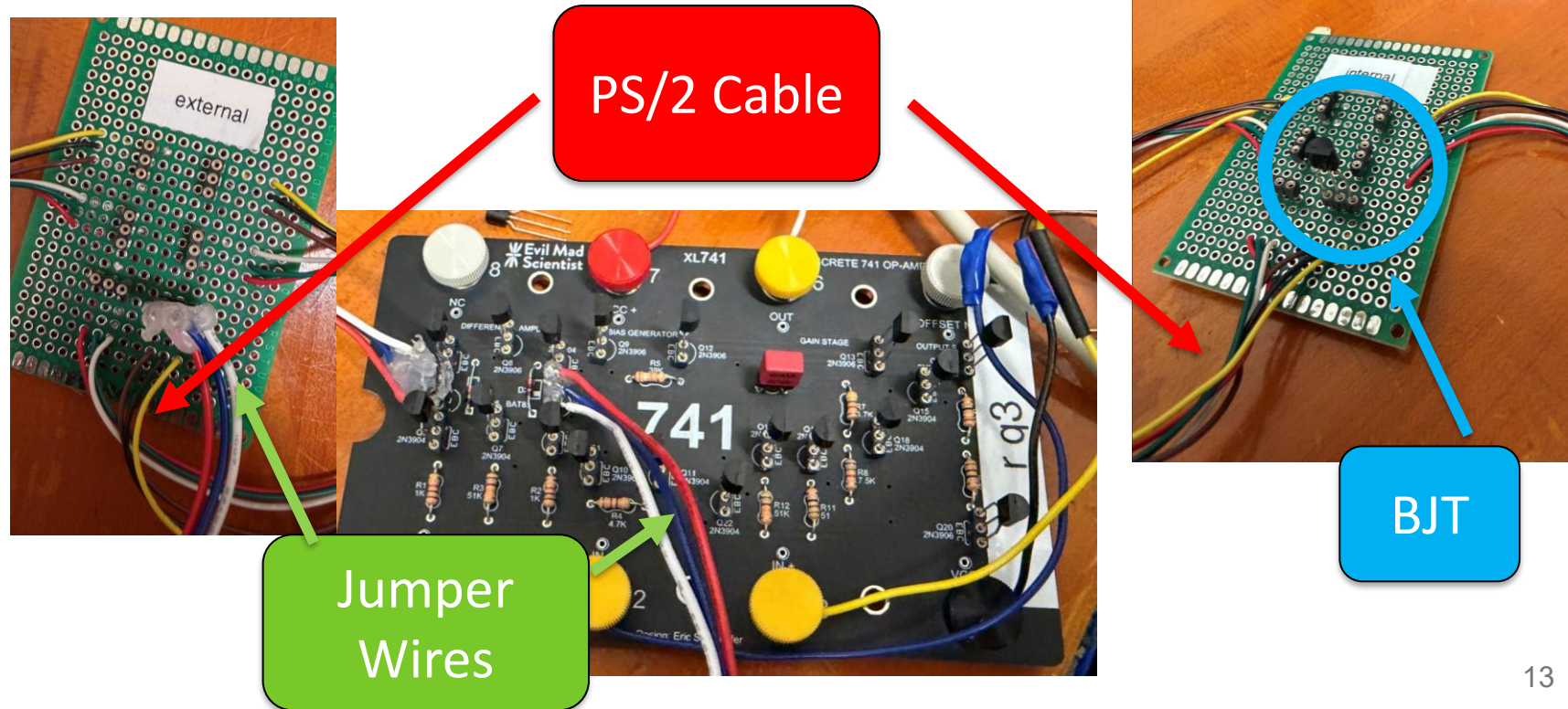


Construction of XL741

- Constructed from **2N3904 (NPN)** and **2N3906 (PNP)**
 - Both Vertical BJTs
- Sockets soldered to board for **easy replacement**
 - Easy connection to in-situ test set up

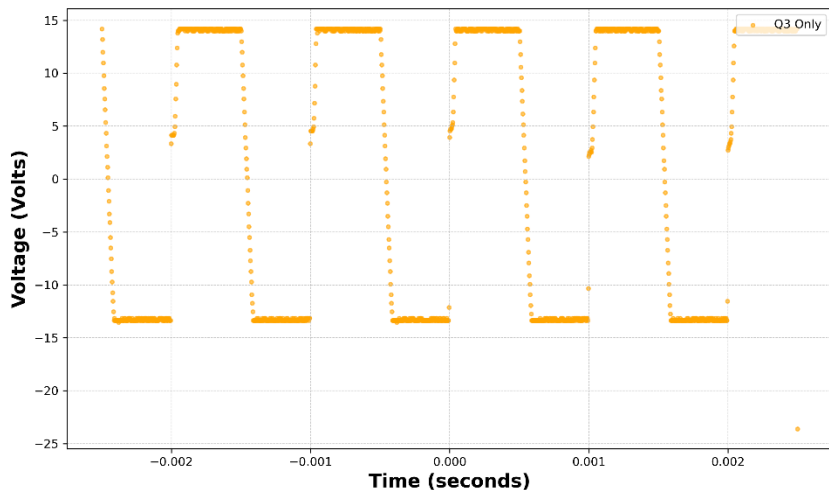




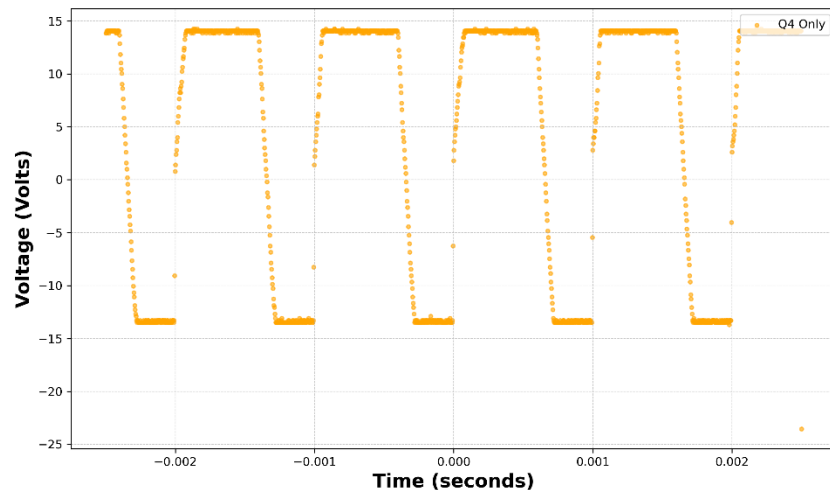


Unirradiated Q3 and Q4

Q3 30-Foot Cable

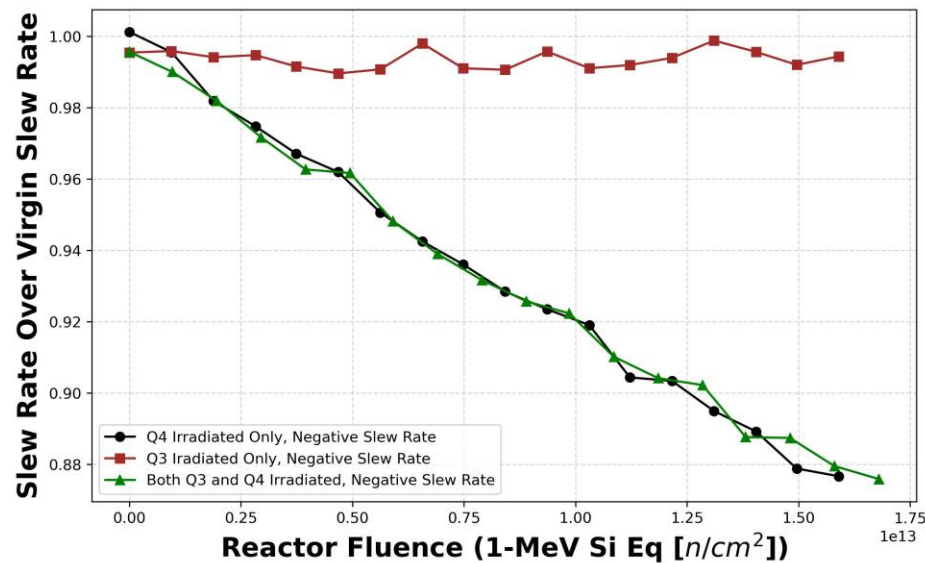


Q4 30-Foot Cable



Slew Rate Degradation

- Q3 and Q4 independent circuits; irradiated during same reactor run
- Q3 and Q4 shared circuit; irradiated in second reactor run
- **Negative slew rate degraded when Q4 was irradiated independently and when Q3 and Q4 irradiated together**
- **No meaningful degradation for Q3 irradiated alone**

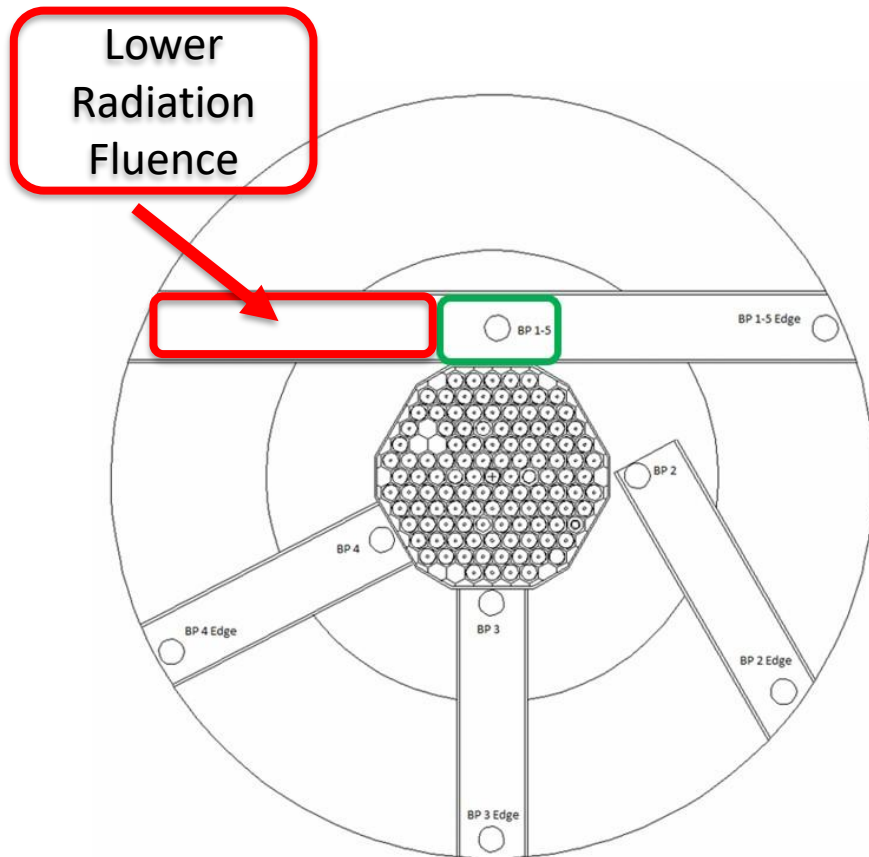


Lack of Positive Slew Rate Data

- Extended cabling makes positive slew rate data not useful for analysis
- Simulation suggests positive slew rate is degraded with Q3 degradation

Future Work

- Characterize BP1-5 radiation environment further down the beam line
- Move external circuit inside beam port 1 external high radiation areas



Thank You

Sandia National Laboratories is a multi-mission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC (NTESS), a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration (DOE/NNSA) under contract DE-NA0003525.