Single-Event Upset Cross-Section Measurements on High-Speed Silicon-on-Sapphire Divide-by-2 Devices

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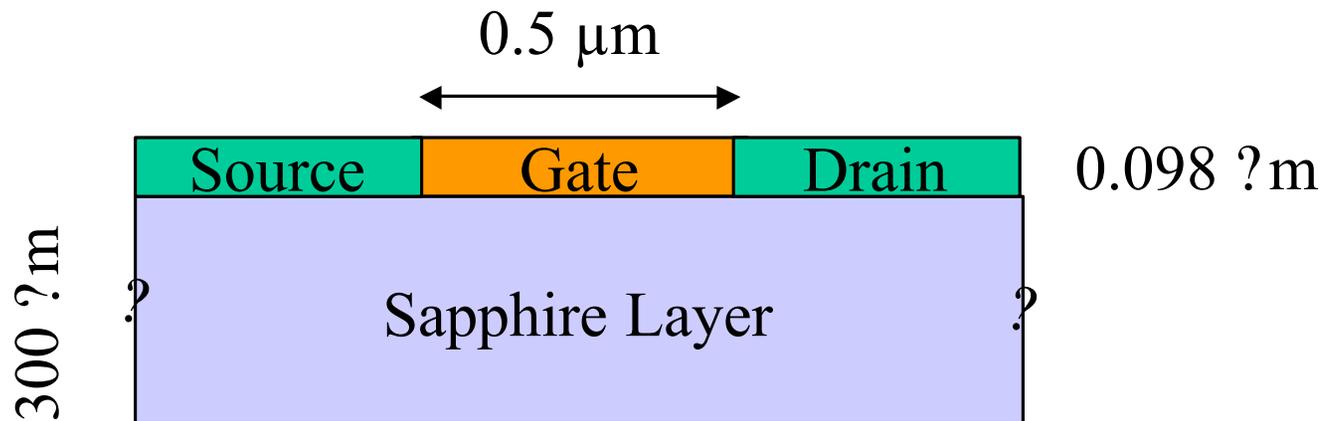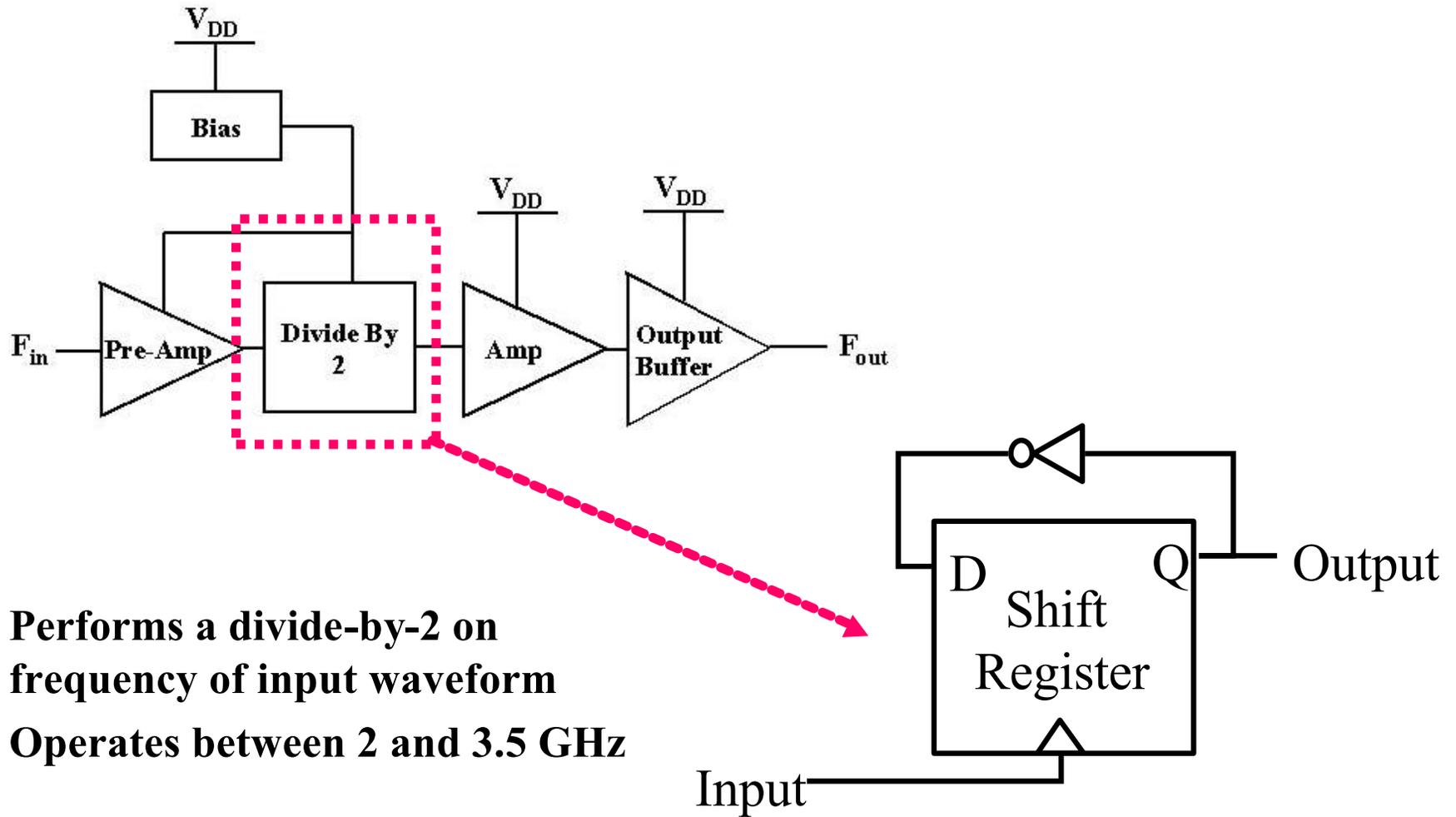
Talk Outline

- **Peregrine SOS process**

- **Peregrine PE9301 prescaler**

- **Test setup**

- **Heavy ion results**

- **Proton results**

- **Implications of angle of incidence effects**

- **Conclusions**

Peregrine Silicon-On-Sapphire (SOS) process

- **Ultra Thin Silicon (UTSi.)**
  - **Gate width of 0.5 μm**
  - **Gate thickness of 0.098 μm**
  - **Gate length of 1.5 to 10 μm**

0.5 μm

| Source | Gate | Drain |

0.098 ?m

300 ?m

? Sapphire Layer ?

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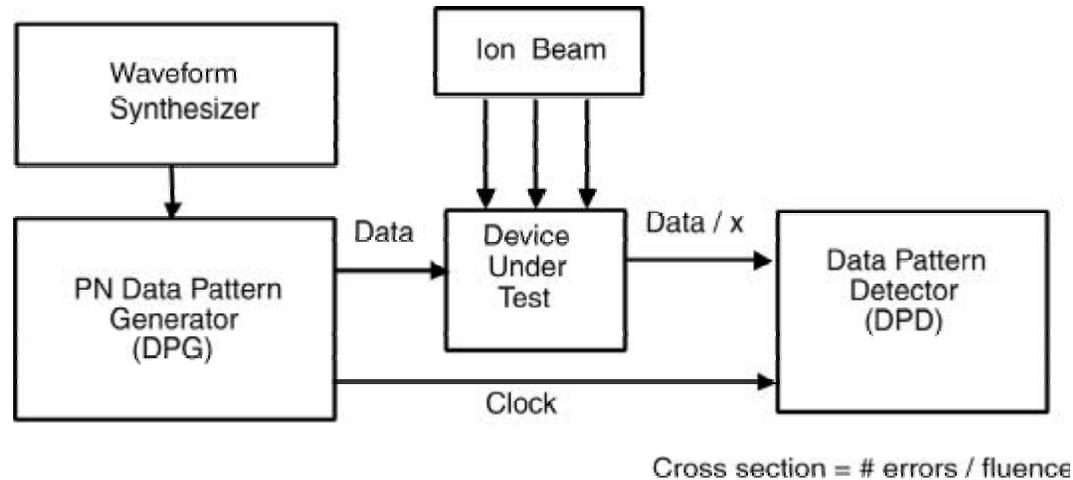**SEE symposium 04/23-25/02**

Peregrine Prescaler

- **Performs a divide-by-2 on frequency of input waveform**
- **Operates between 2 and 3.5 GHz**

Bit Error Rate Tester (BERT) Setup for Testing Prescaler for Single Event Upsets Signatures
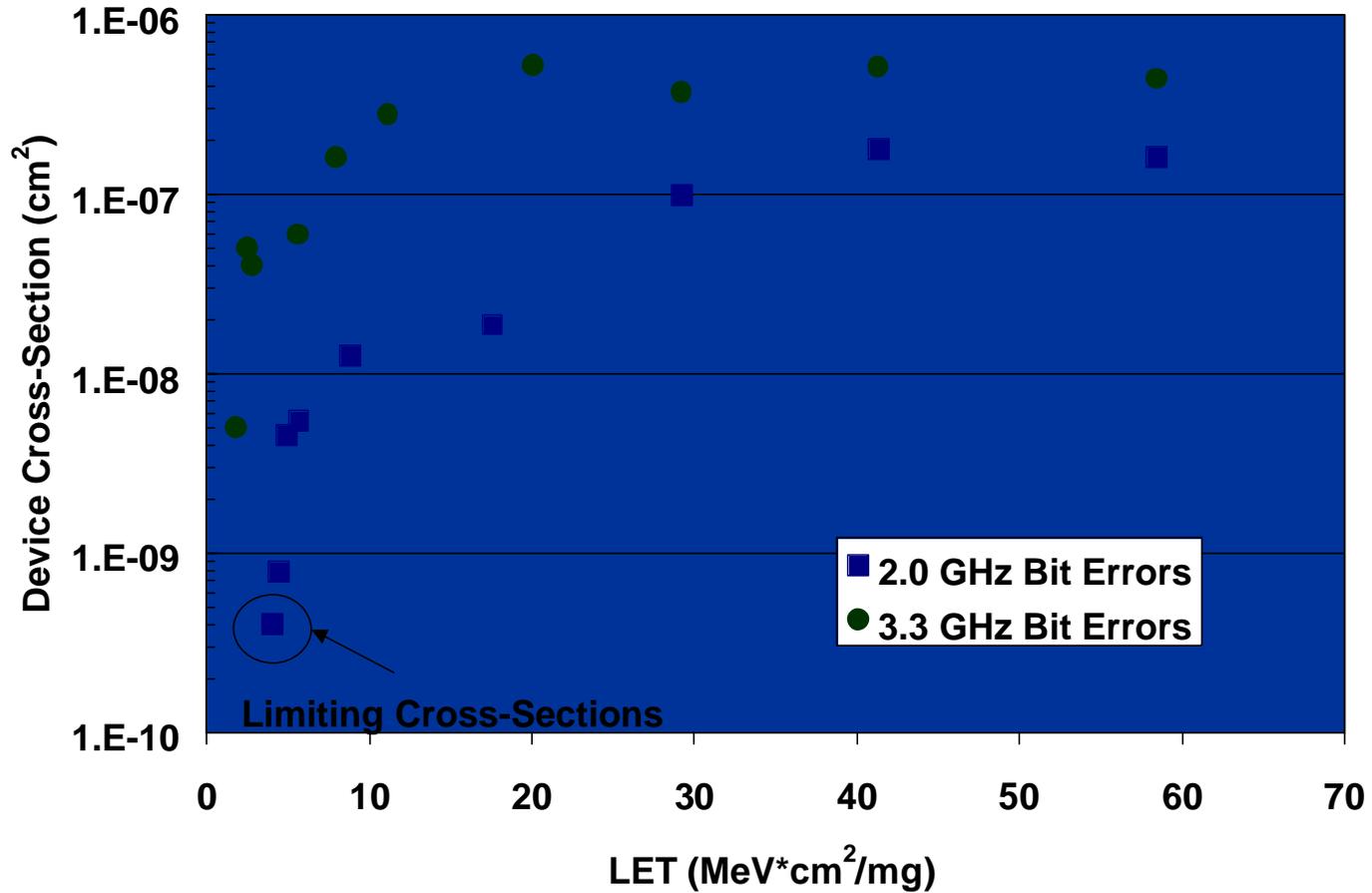

- Setup capable to operate > 4 GHz

- DPD can store complete error signature

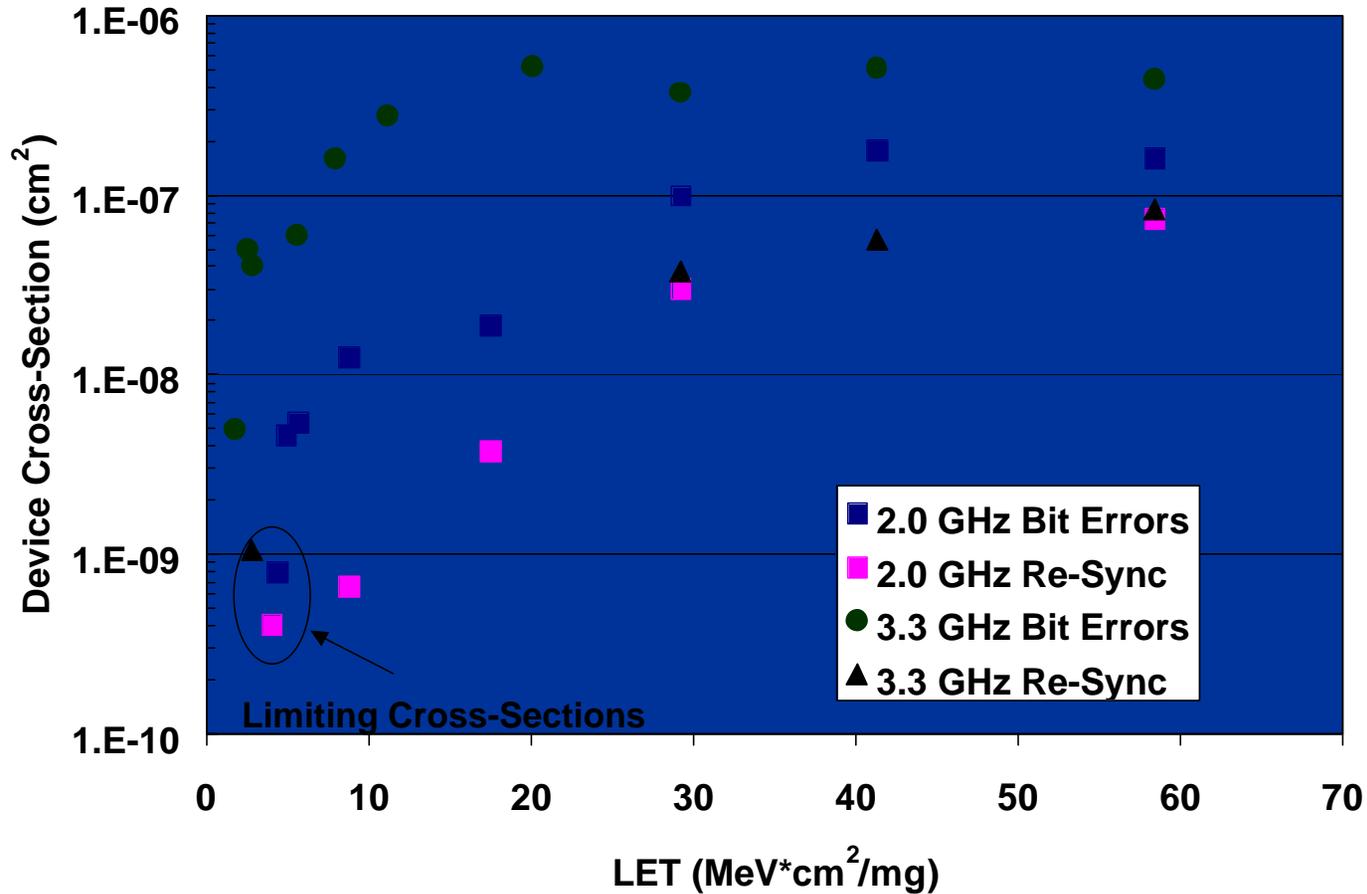- Auto re-synchronization when synchronization error occurs

Error Modes

- ## Resynchronization
  - **Requires BERT re-initial bit sequence**
  - **Errors in divide-by-2, pre-amp and bias**

- ## Bit Errors
  - **Self recovery of data sequence**
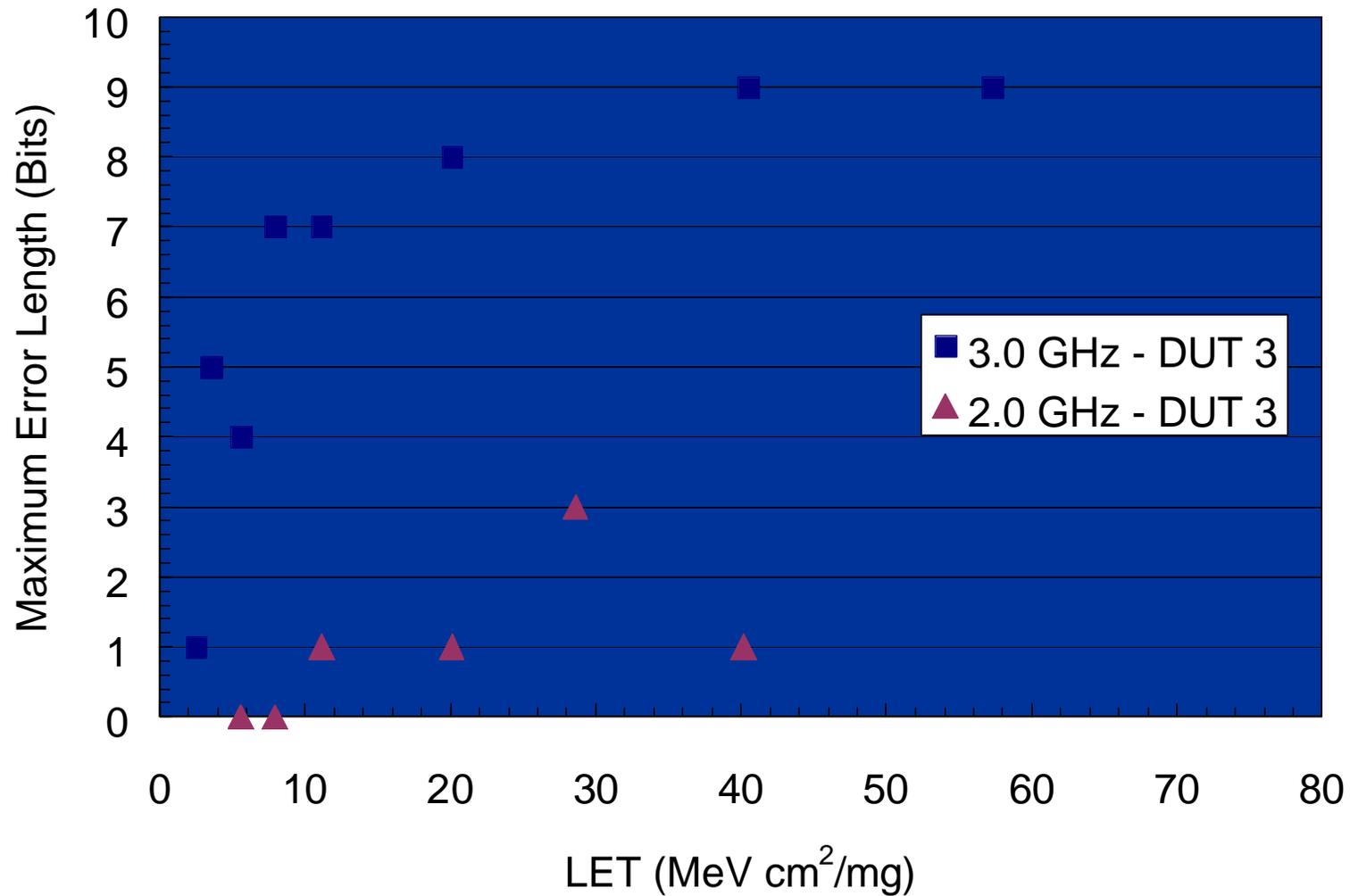 - **BERT records complete error signature**
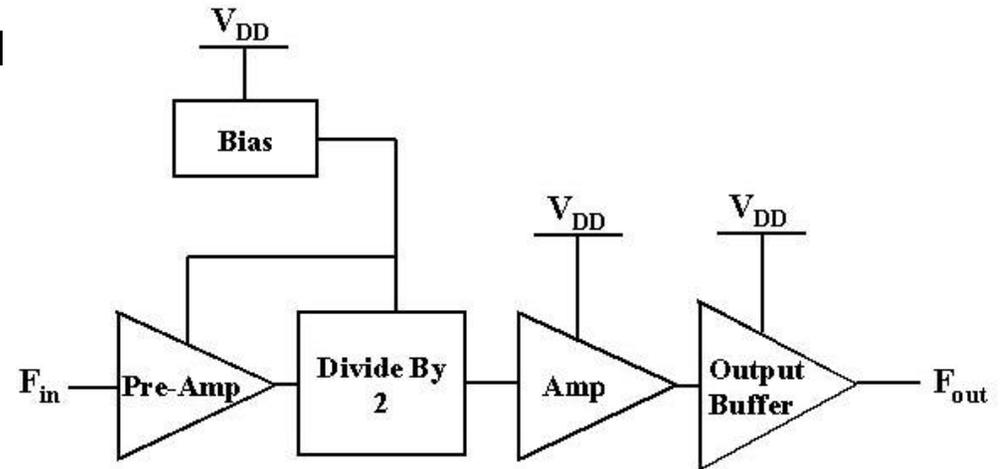
Heavy Ion Induced Bit Errors

Heavy Ion Induced Bit Errors

Maximum Error Length over Frequency and LET

Legend:
- 3.0 GHz - DUT 3
- 2.0 GHz - DUT 3

X-axis: LET (MeV cm^2/mg)
Y-axis: Maximum Error Length (Bits)
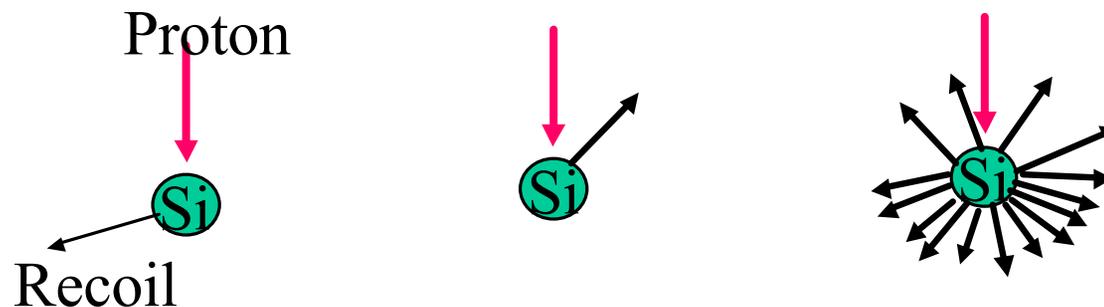
Presented by: Robert Reed NASA/GSFC

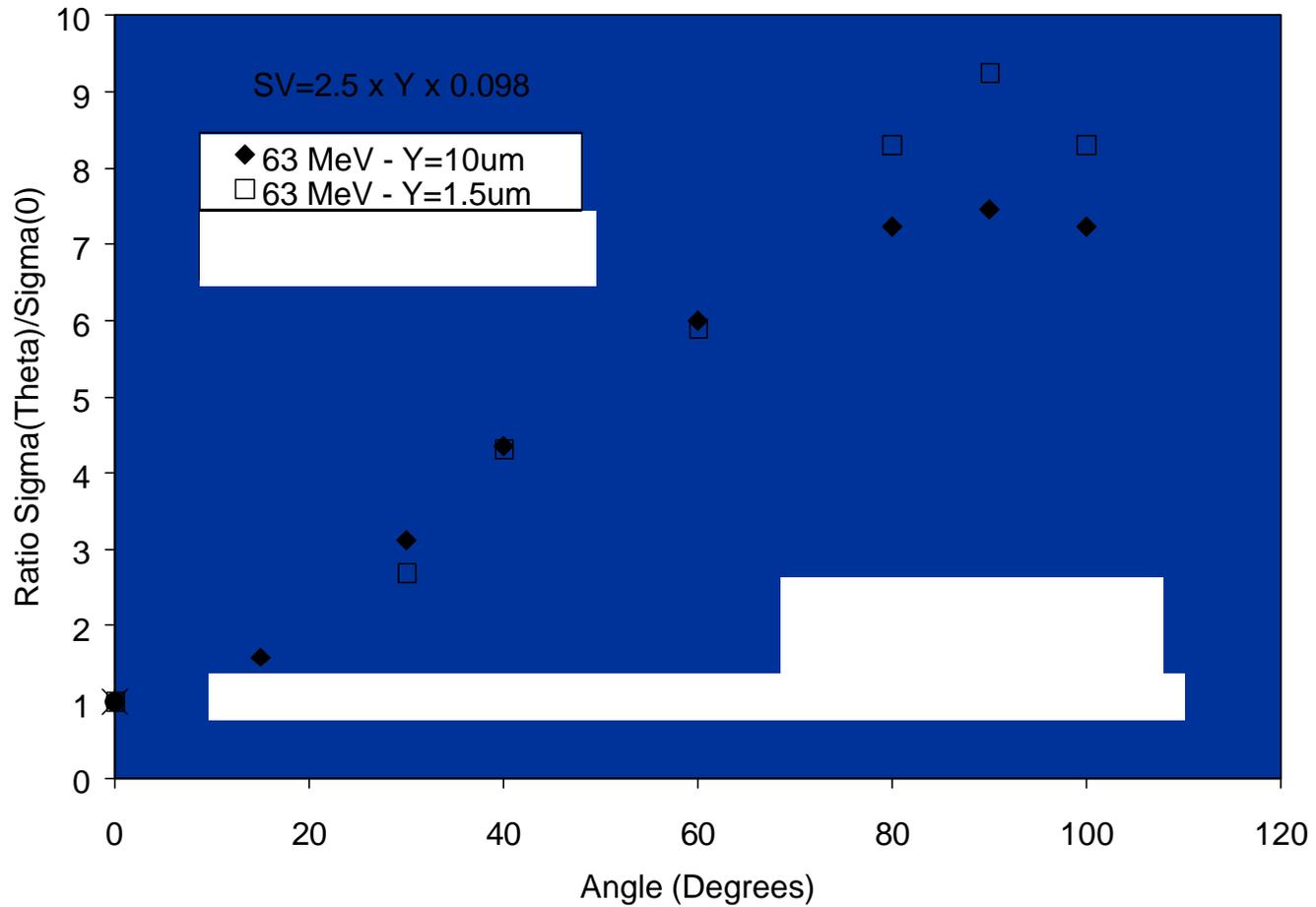# Proton Results for Peregrine Prescaler
(63 MeV)
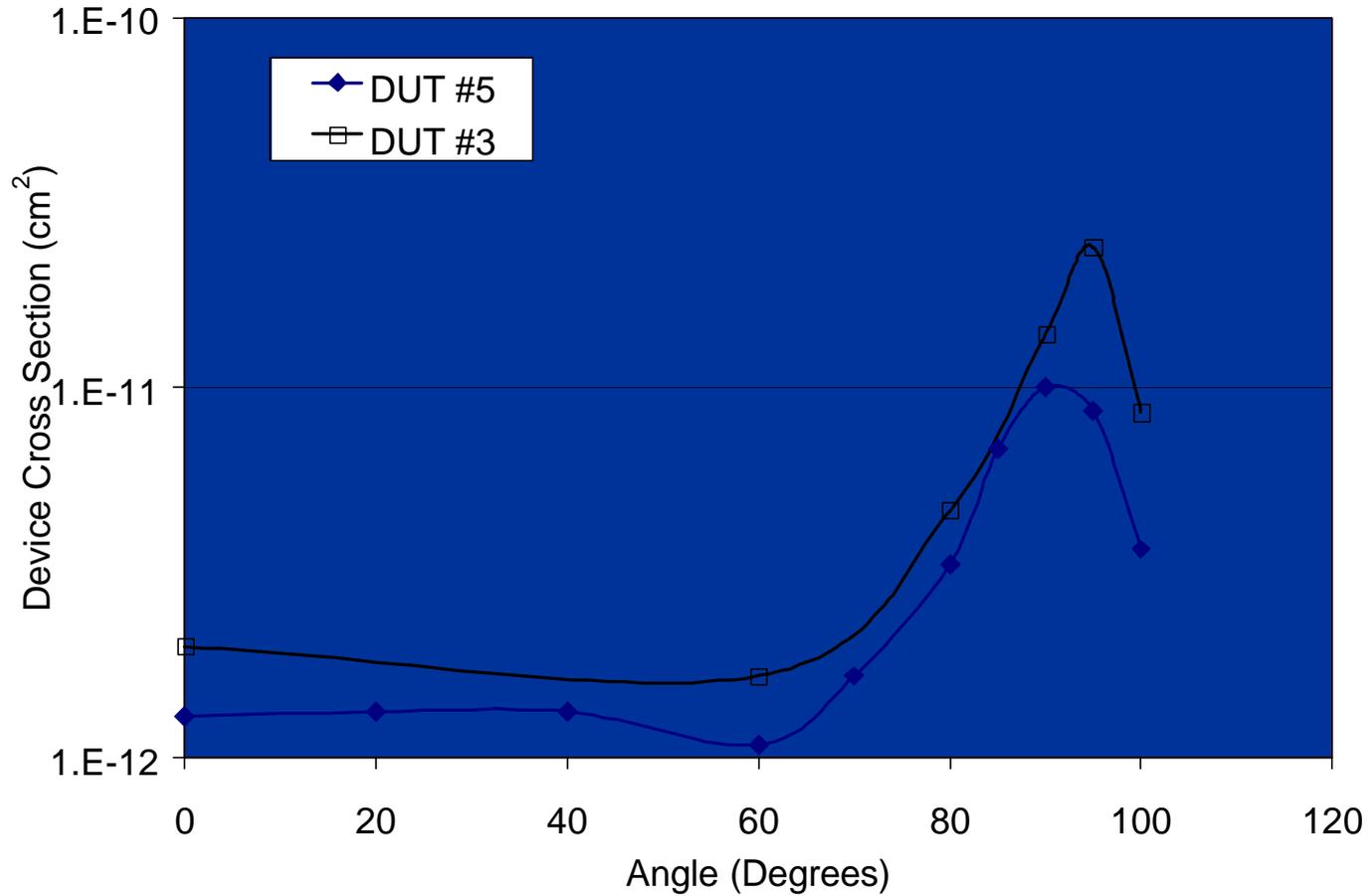
Background on Proton-Induced Angular Effect

- **Clemson University Proton Interactions in Device (CUPID)**
  - **Simulates the nuclear spallation reaction and**
  - **Predicts the energy deposition in a RPP by evaporation, cascade, and recoiling particles.**
- **In 1994 we published simulations showing that the proton-induced SEU cross-section could depend on the angle**
  - **Sensitive volume with at least one thin dimension**
  - **Sufficiently high critical charge**

Simulated Angular Effects

SV=2.5 x Y x 0.098

- ◆ 63 MeV - Y=10um
- □ 63 MeV - Y=1.5um

Ratio Sigma(Theta)/Sigma(0)

Angle (Degrees)

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Conclusions

- **SEU sensitivity demonstrated for SOS operating at frequencies > 2GHz**

- **Testing must be done at various angles of incidence when sensitive volume has at least one thin side and critical charge is "high"**
  - **SOI and SOS devices should be suspect**
  - **Simulation tools like CUPID, NOVICE, MCNPX, GEANT4 can help guide energy and angle selection during testing**

- **Rate prediction approach must be developed to handle this type of effect**
  - **CUPID has this capability but has never been validated**
  - **NOVICE, GEANT4 and MCNPX are a likely candidates**