



Irradiation tests on SiC Power Devices

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Outline

- ⊙ γ -ray irradiations (SiC power MOSFETs)
- ⊙ Heavy ion irradiations
 - SiC power Schottky diodes
 - SiC power MOSFETs
- ⊙ Future updates

γ -ray irradiations



Tested devices:

CREE CMF 10120D (1200V 24A)
Silicon Carbide Power MOSFET

25 samples

Dose	Samples	Exposure days	Total Dose [Gy]
5	D1-D5	19	10885,1
4	D6-D10	9	5156,1
3	D21-D25	3	1718,7
2	D11-D15	2	1145,8
1	D16-D20	1	572,9

Procedure

Measurements:

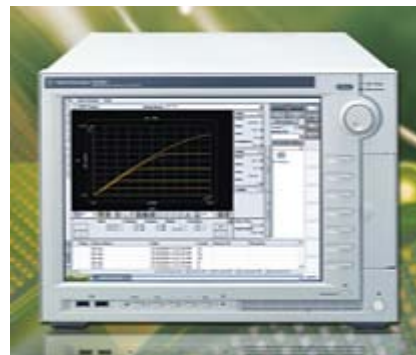
Gate Source Leakage Current
Transfer Characteristics
Output Characteristics

Test conditions:

Pre irradiation

Post irradiation

Post annealing: 1 weeks at 100°C @ $V_{GS}=16V$

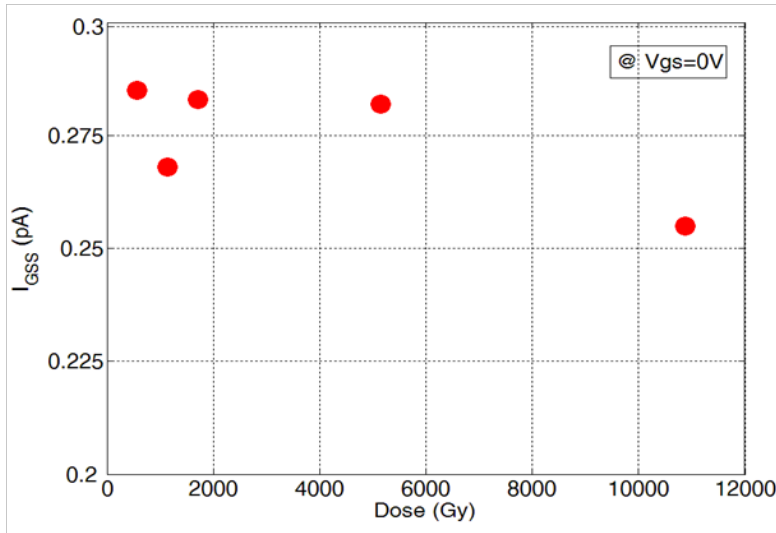


I_{GSS}
 $V_{GS(th)}$
 $R_{DS(on)}$

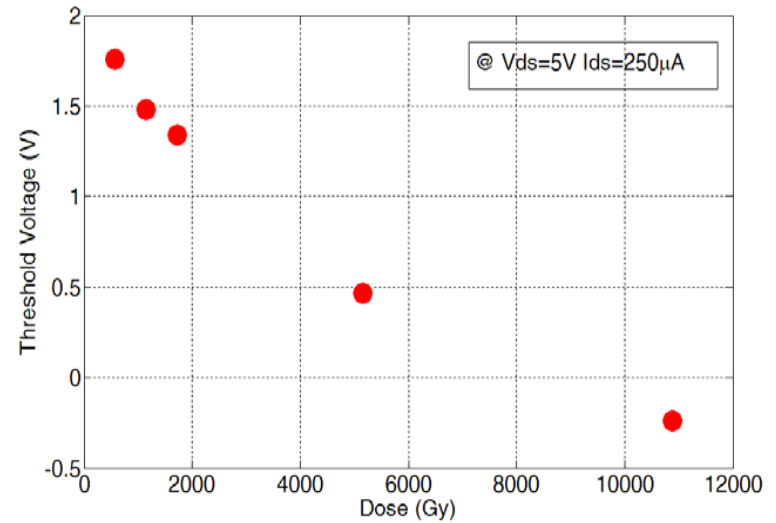
as a function of the dose

Results

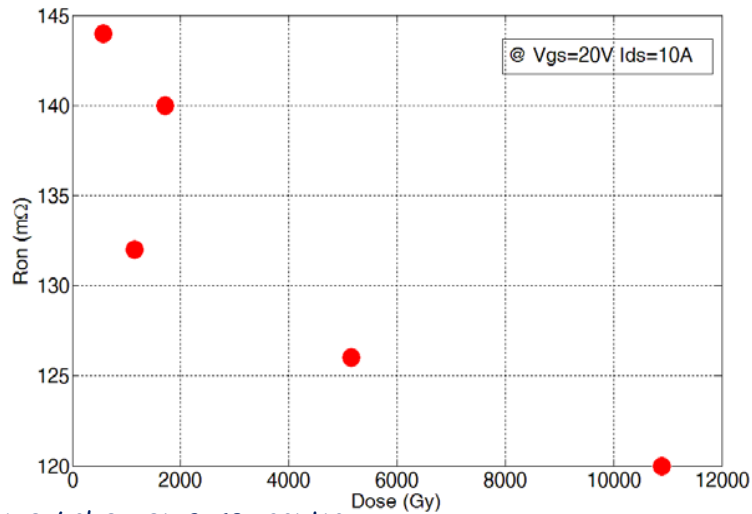
Gate-Source Leakage Current



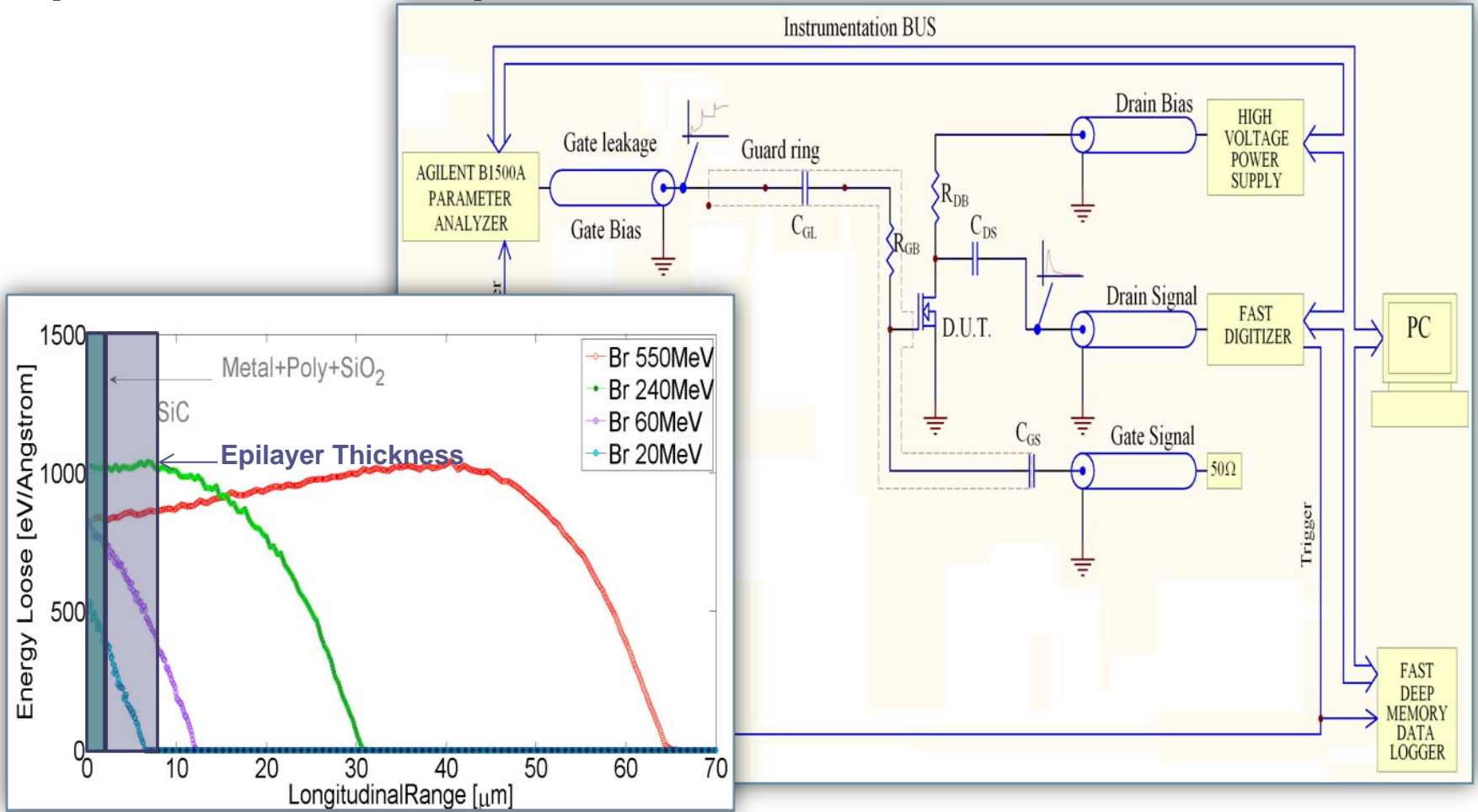
Gate Threshold Voltage



Drain-Source On-State Resistance

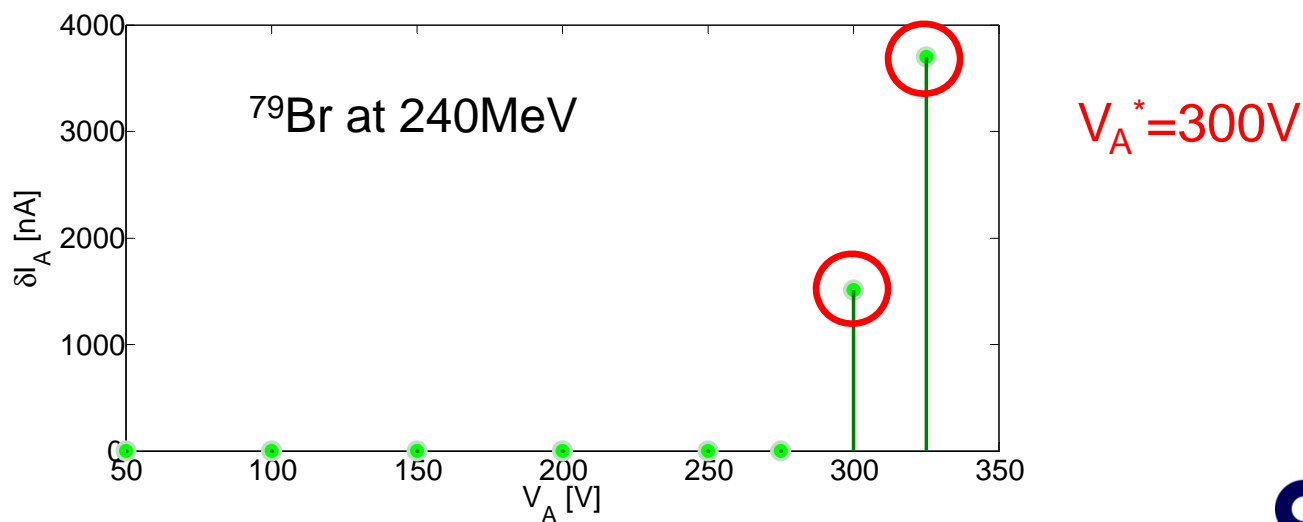
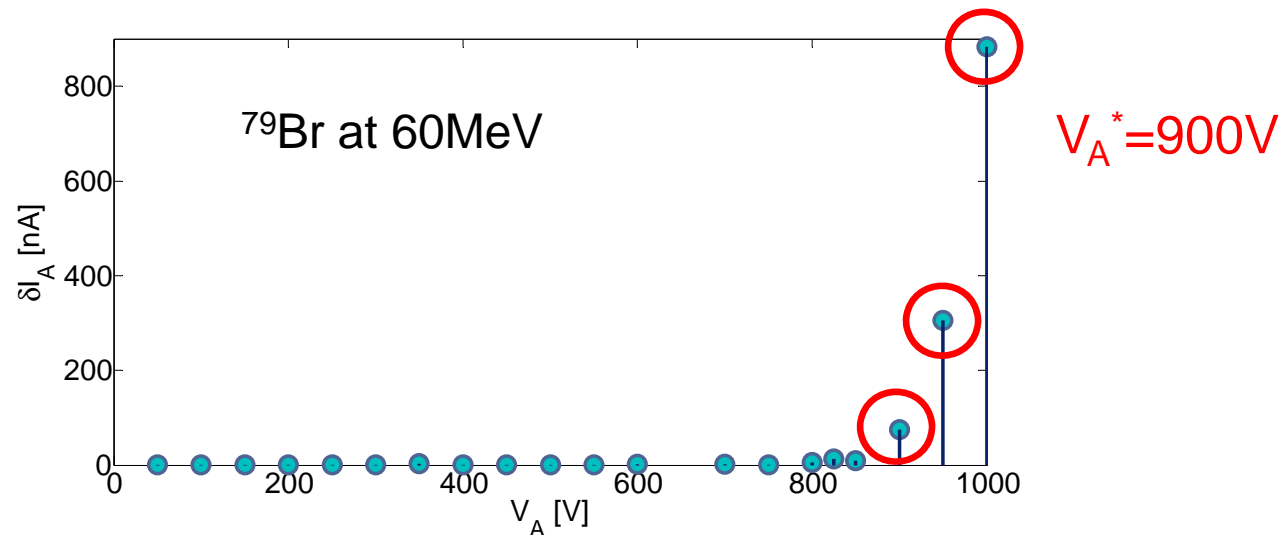
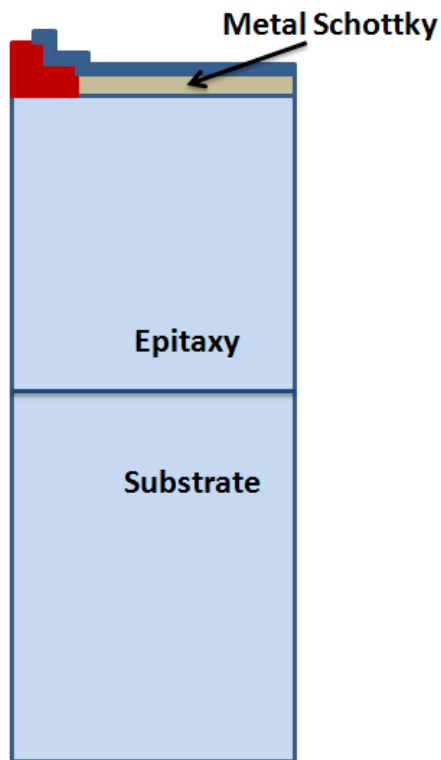


Experimental procedure



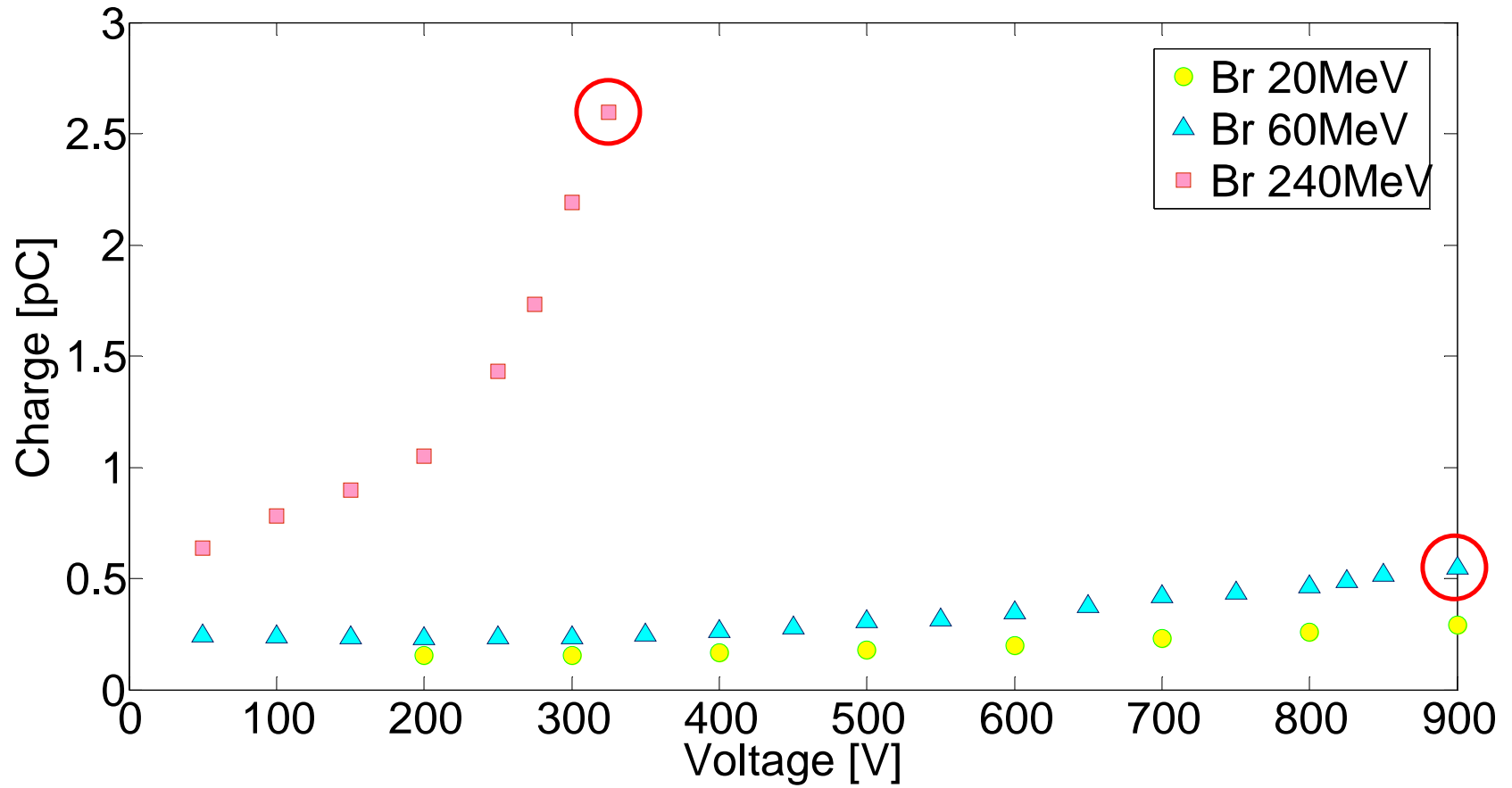
SiC power Schottky diodes rated at 1200V-6 A
SiC power MOSFETs rated at 1200V-24A

Results of heavy Ion Irradiation SiC power Schottky diodes



Results of heavy Ion Irradiation

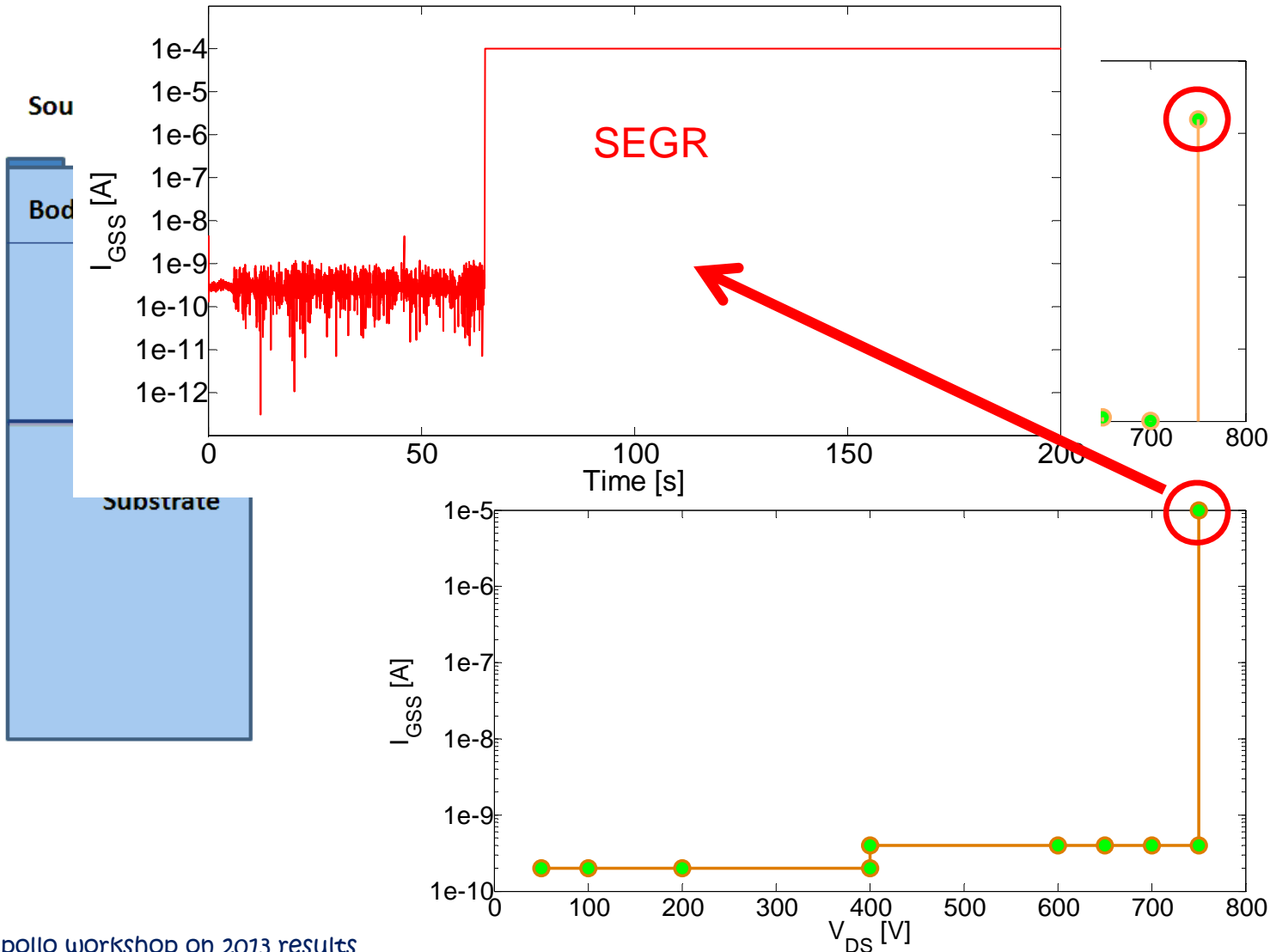
SiC power Schottky diodes



Results of heavy Ion Irradiation

SiC power MOSFETs

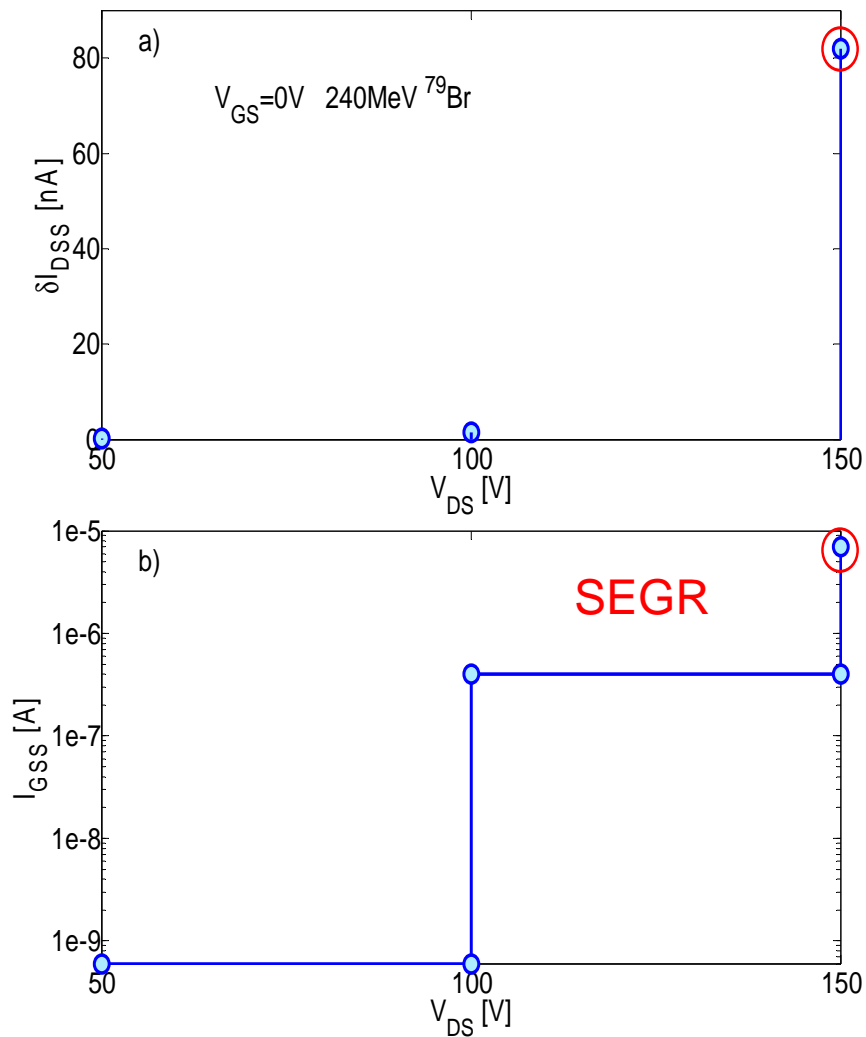
^{79}Br at 60MeV
 $V_{GS}=0\text{V}$



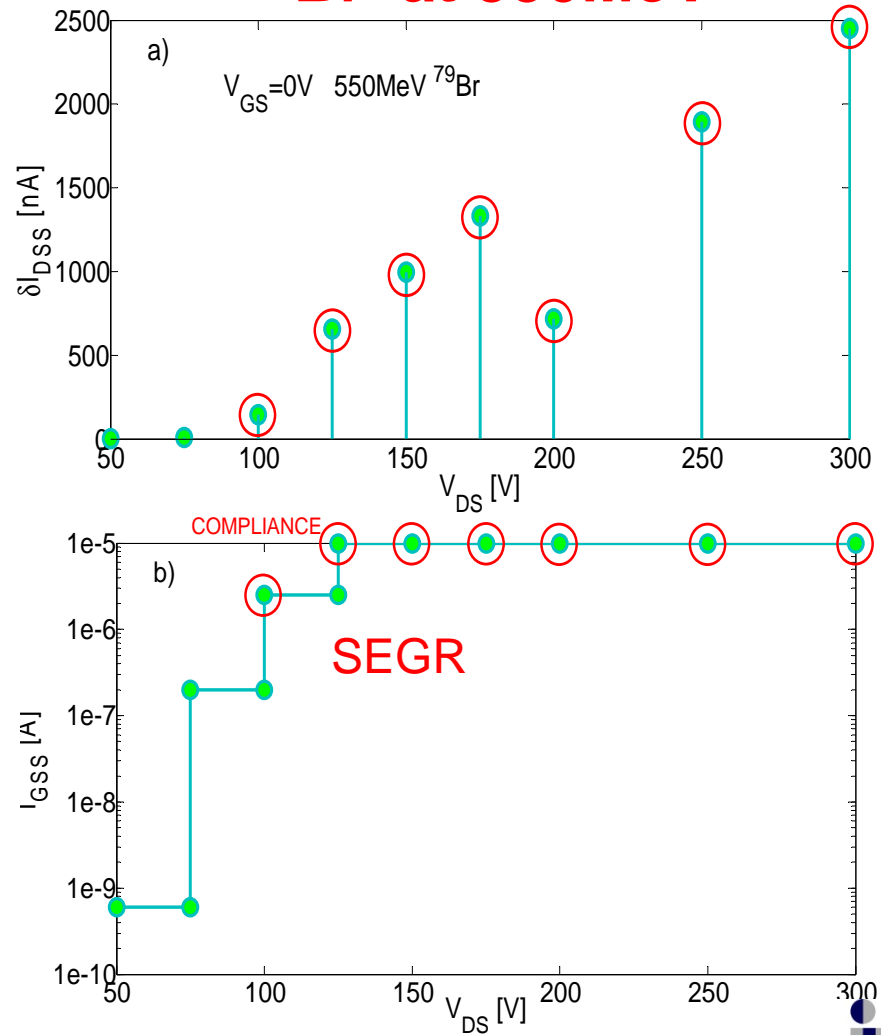
Results of heavy Ion Irradiation

SiC power MOSFETs

^{79}Br at 240MeV

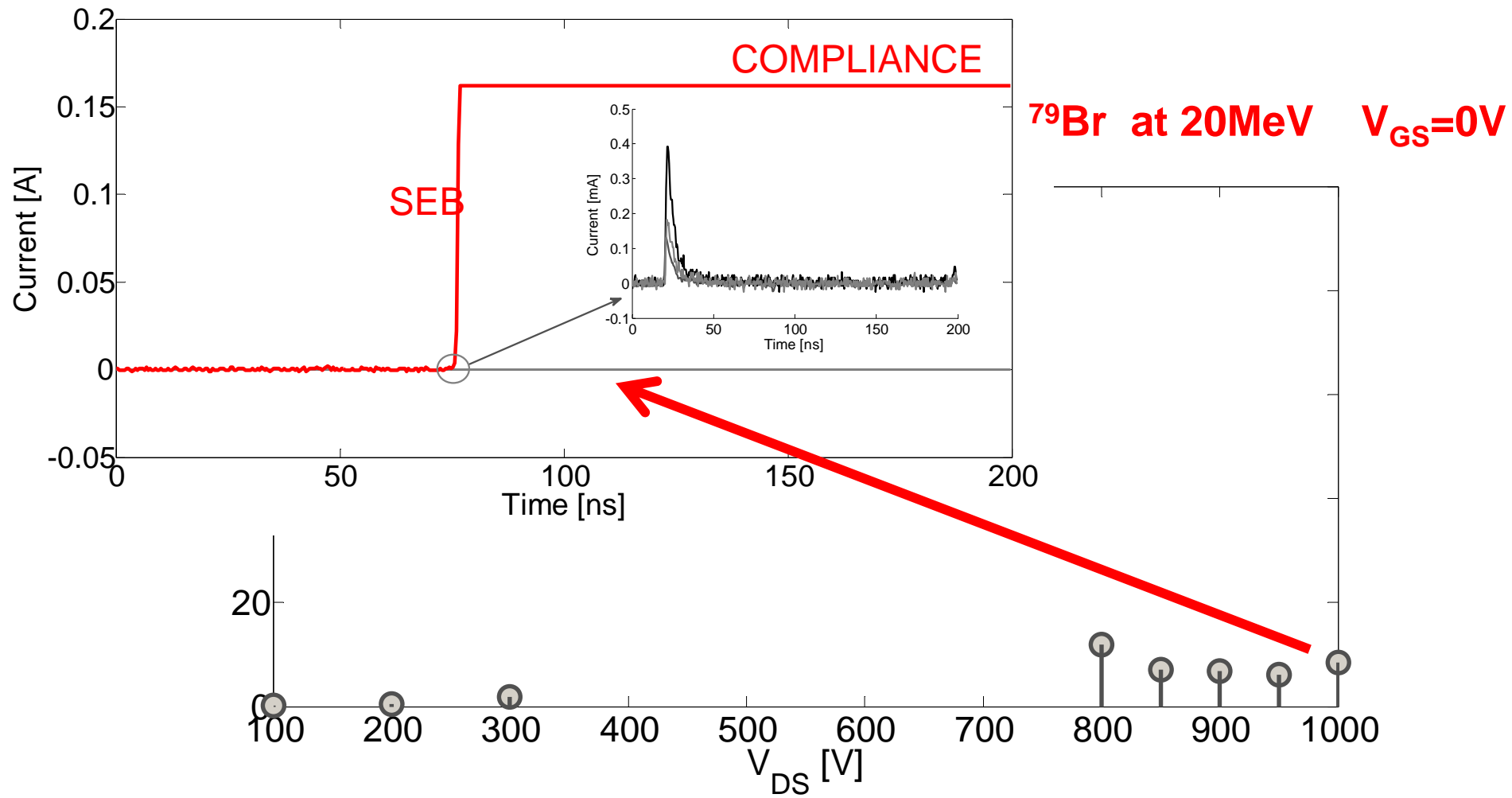


^{79}Br at 550MeV



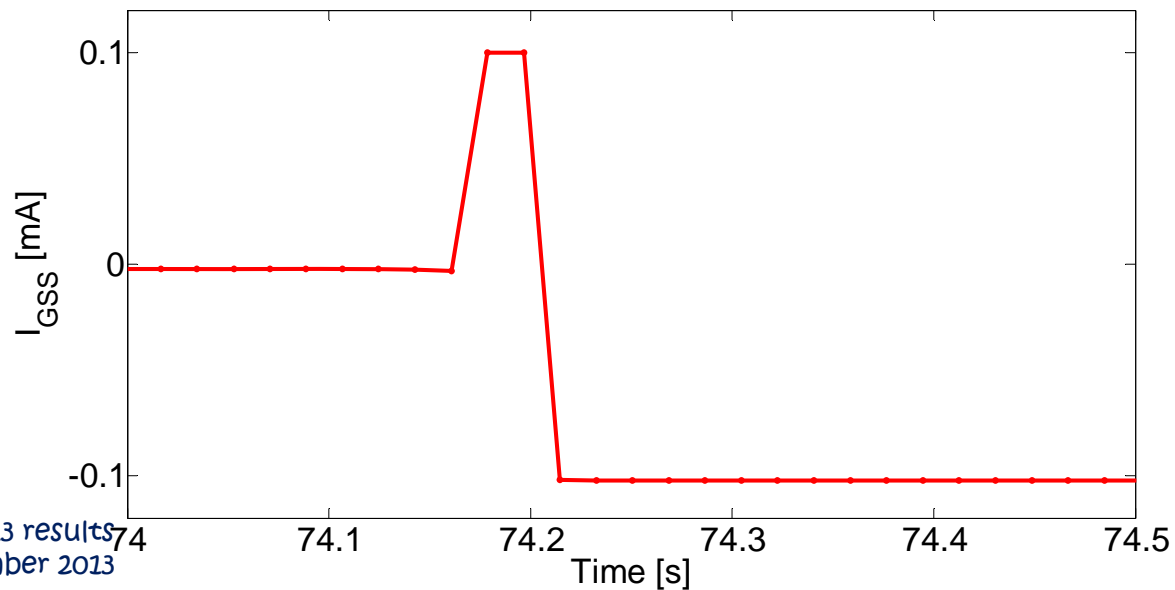
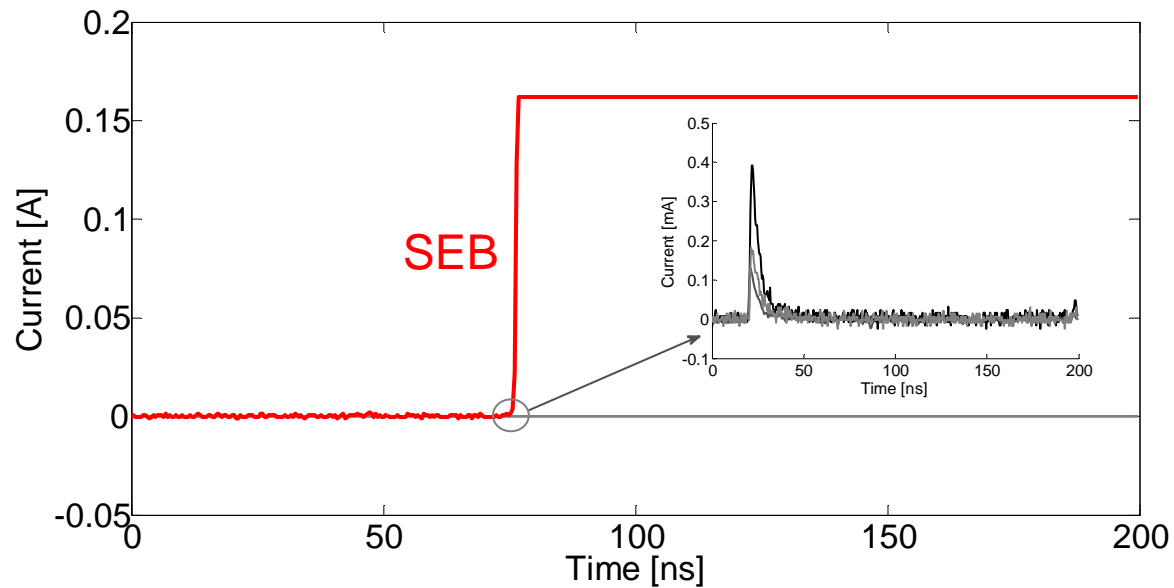
Results of heavy Ion Irradiation

SiC power MOSFETs



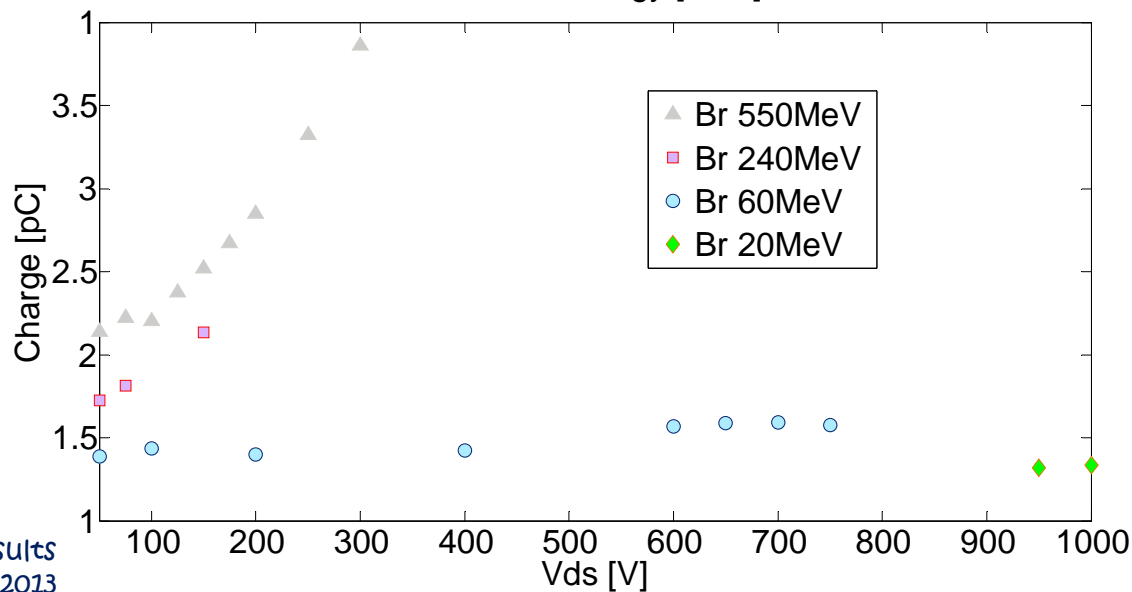
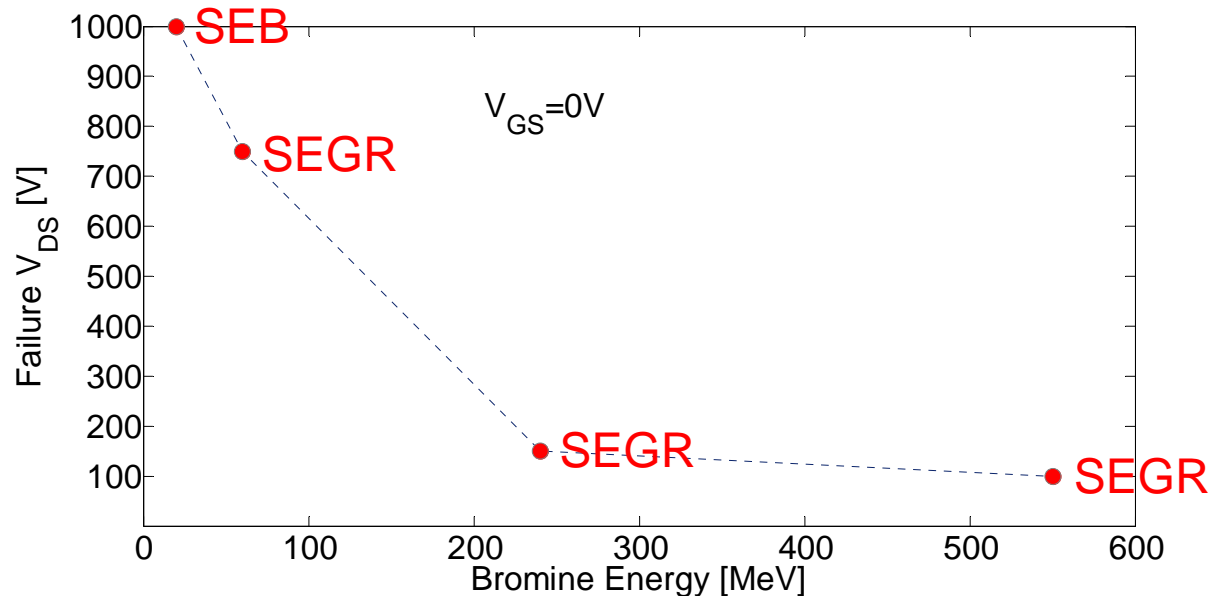
Results of heavy Ion Irradiation

SiC power MOSFETs

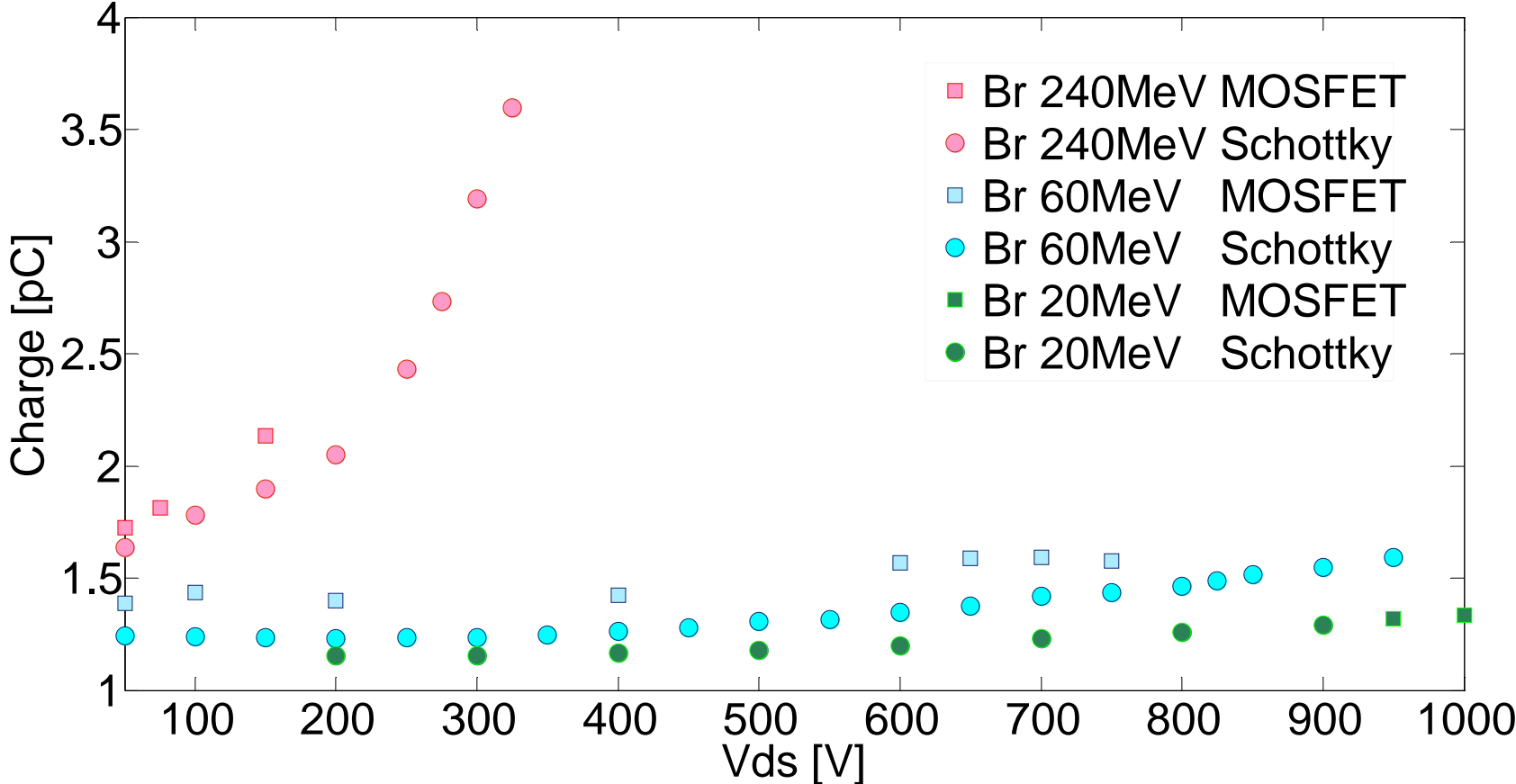


Results of heavy Ion Irradiation

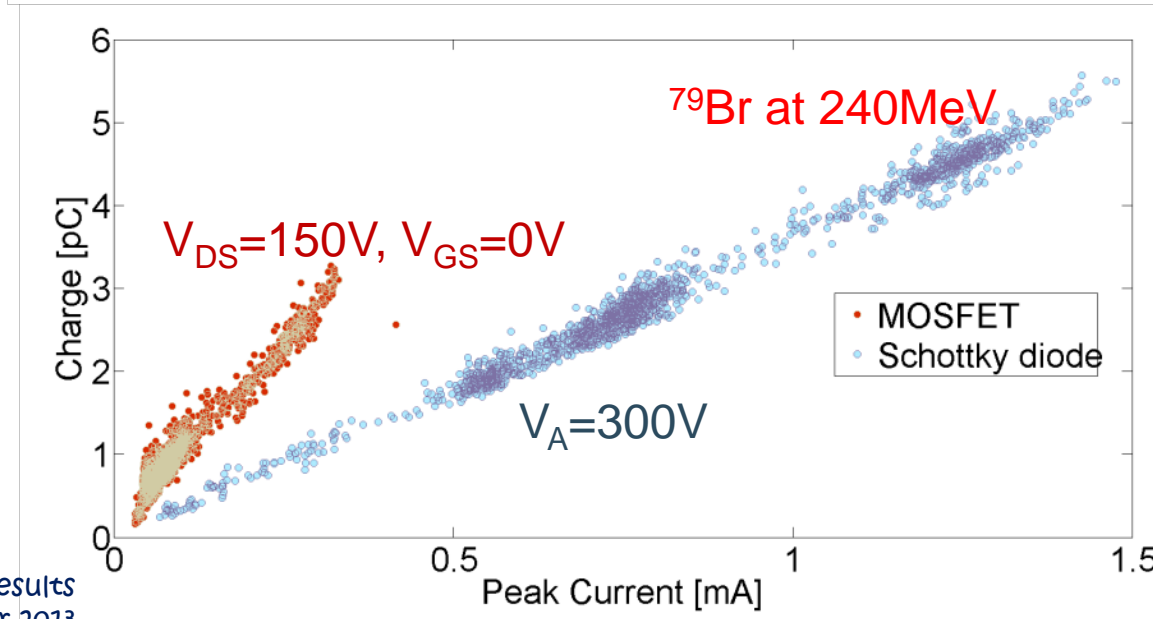
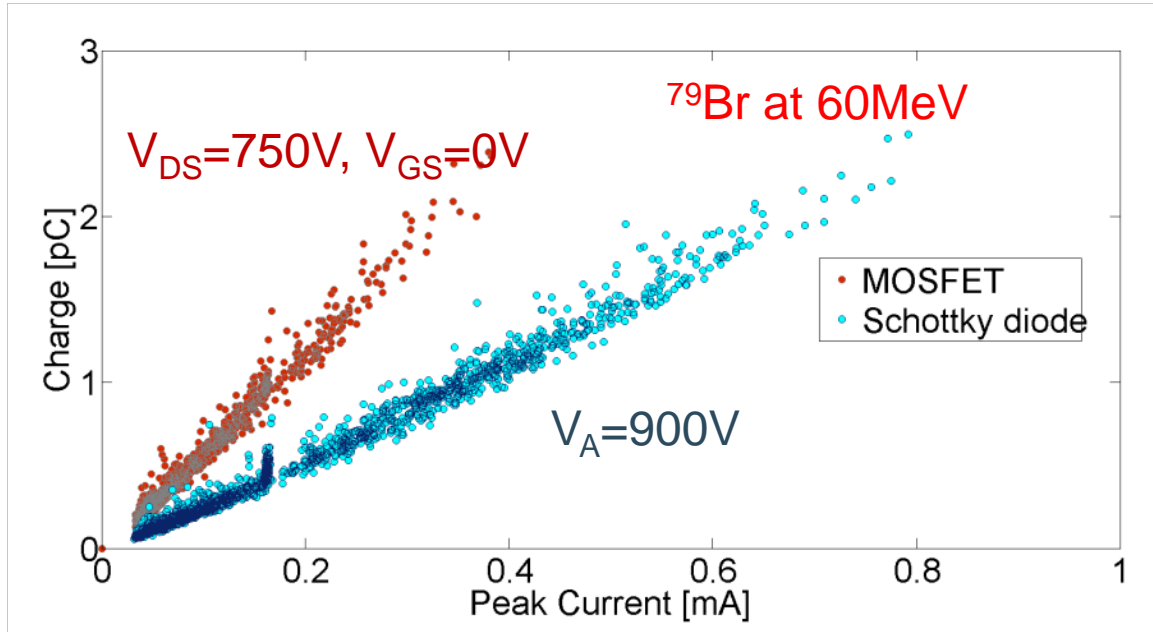
SiC power MOSFETs



Discussion

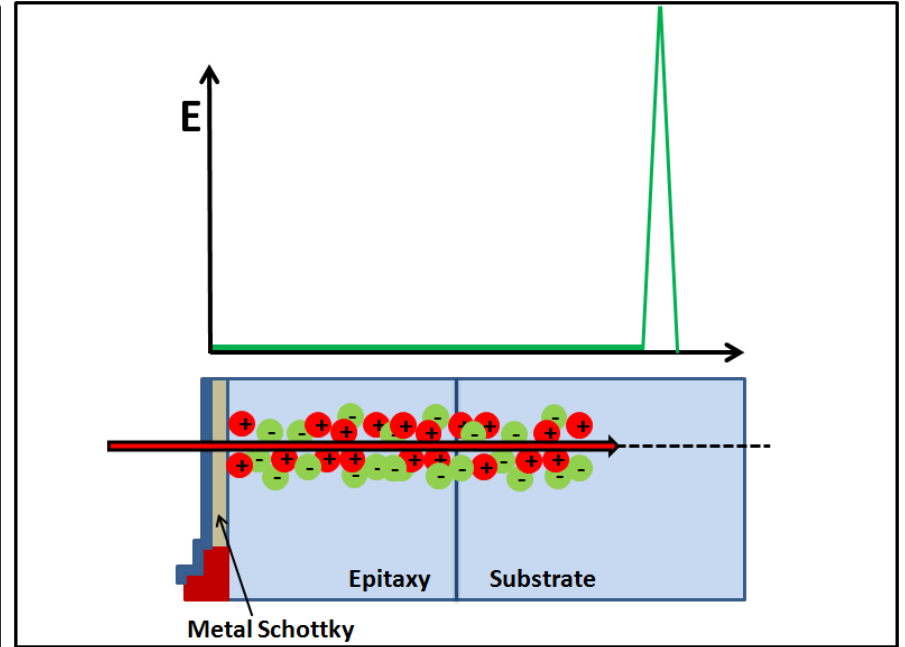
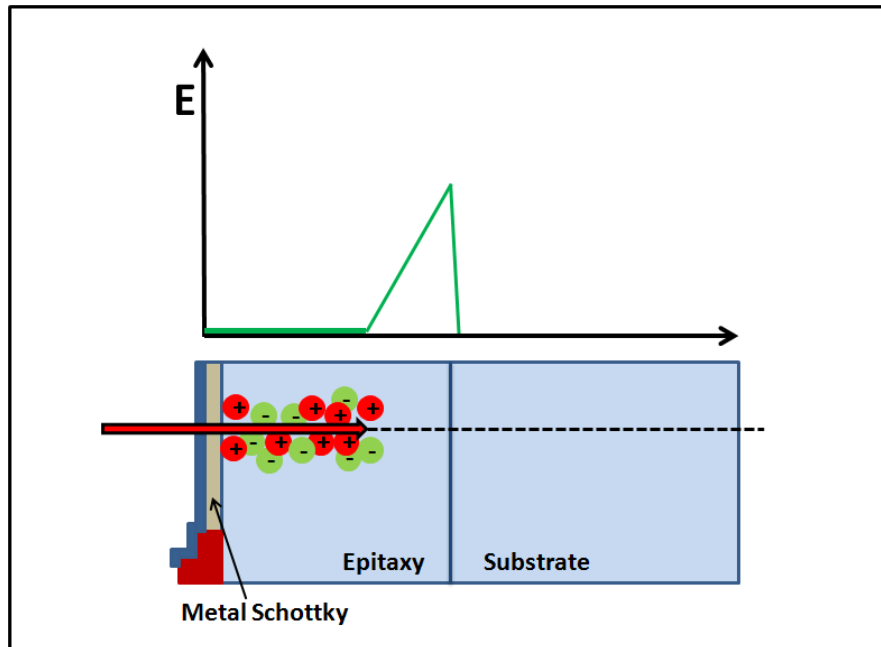


Discussion



Discussion

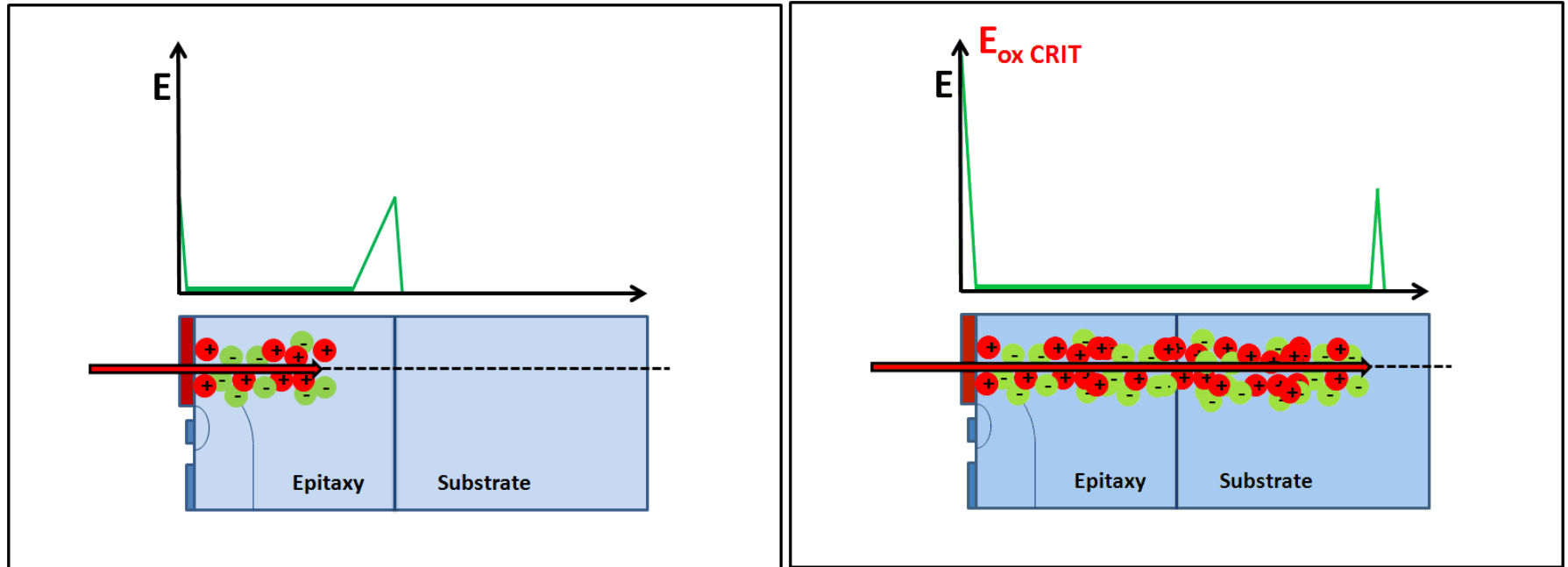
SiC power Schottky diodes



Damages at the Schottky diode during the irradiation

Discussion

SiC power MOSFETs



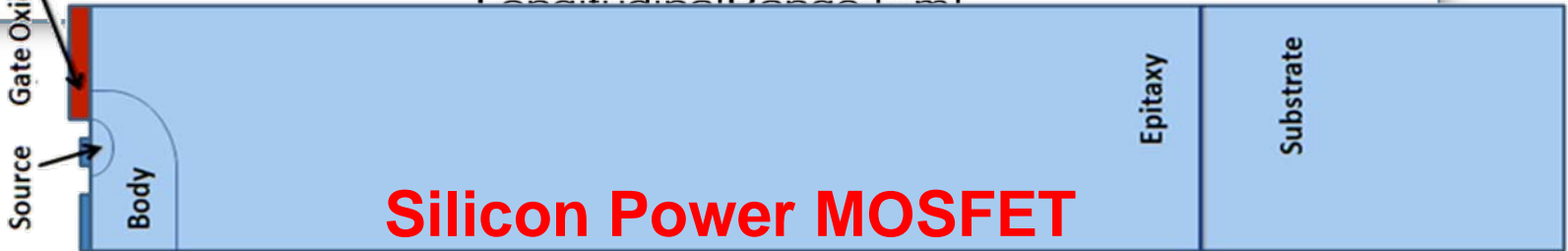
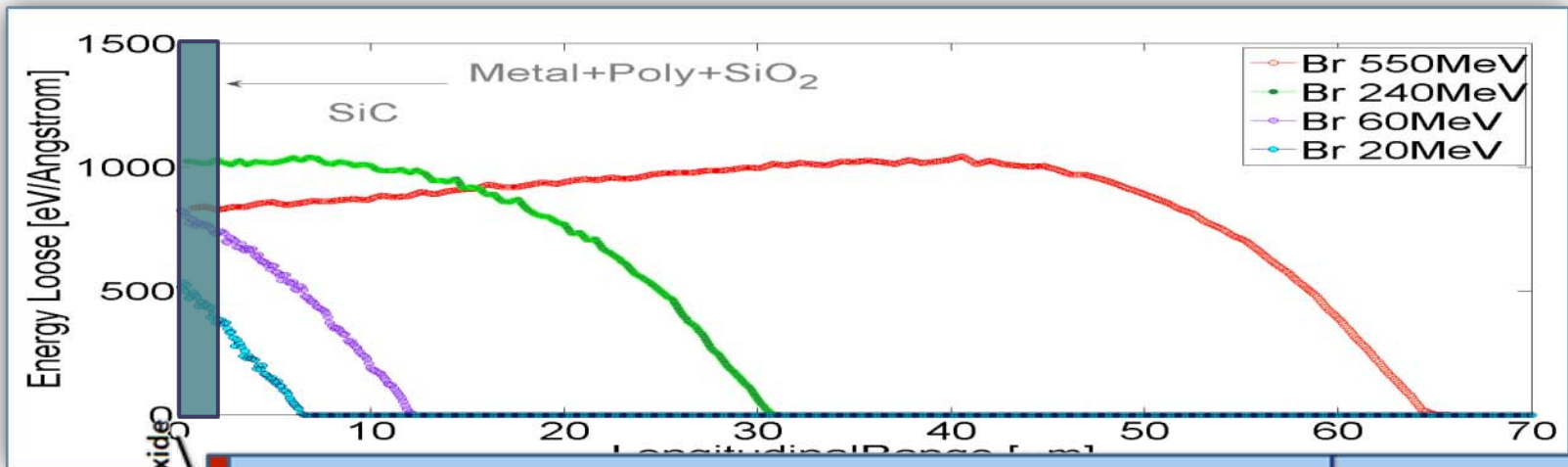
Damages at the Power MOSFET during the irradiation

Discussion

SiC vs Silicon power MOSFETs



SiC Power MOSFET



Silicon Power MOSFET

Conclusions

- ⦿ The main effect of γ -ray irradiation on the characteristics of SiC MOSFETs was observed on the threshold voltage. Small changes were observed in R_{ON} and I_{GSS} up to the highest dose.
- ⦿ SiC power MOSFETs and power Schottky diodes presented a quite poor tolerance to heavy ion induced SEE (SEB and SEGR).

Thank you for your attention!

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