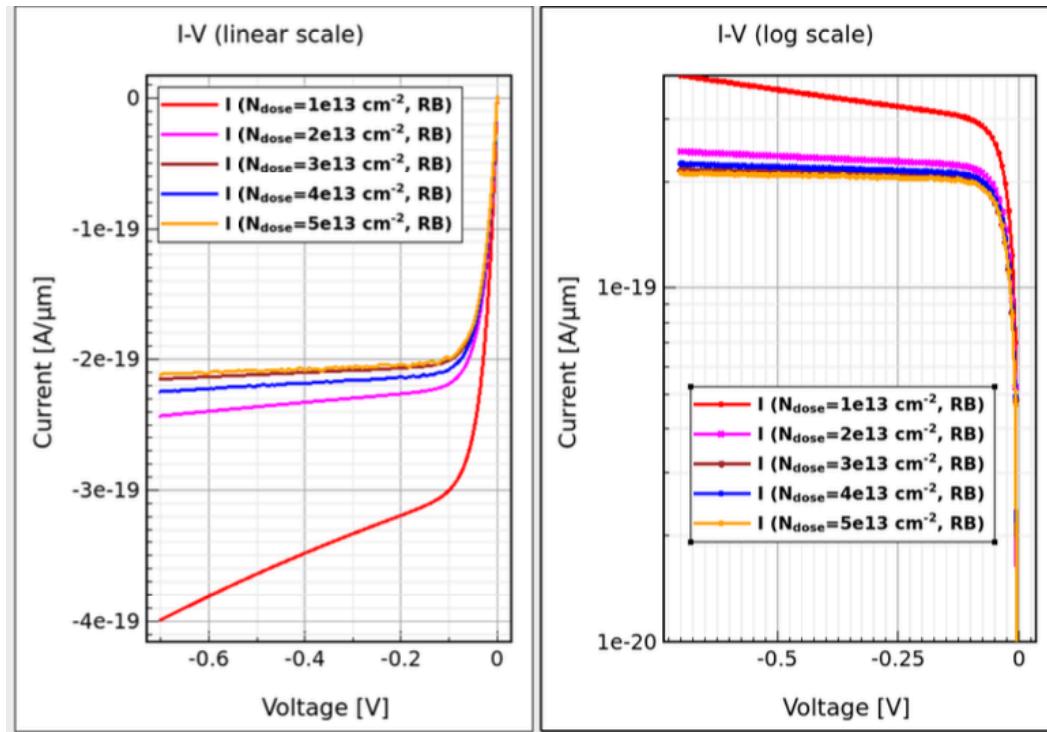


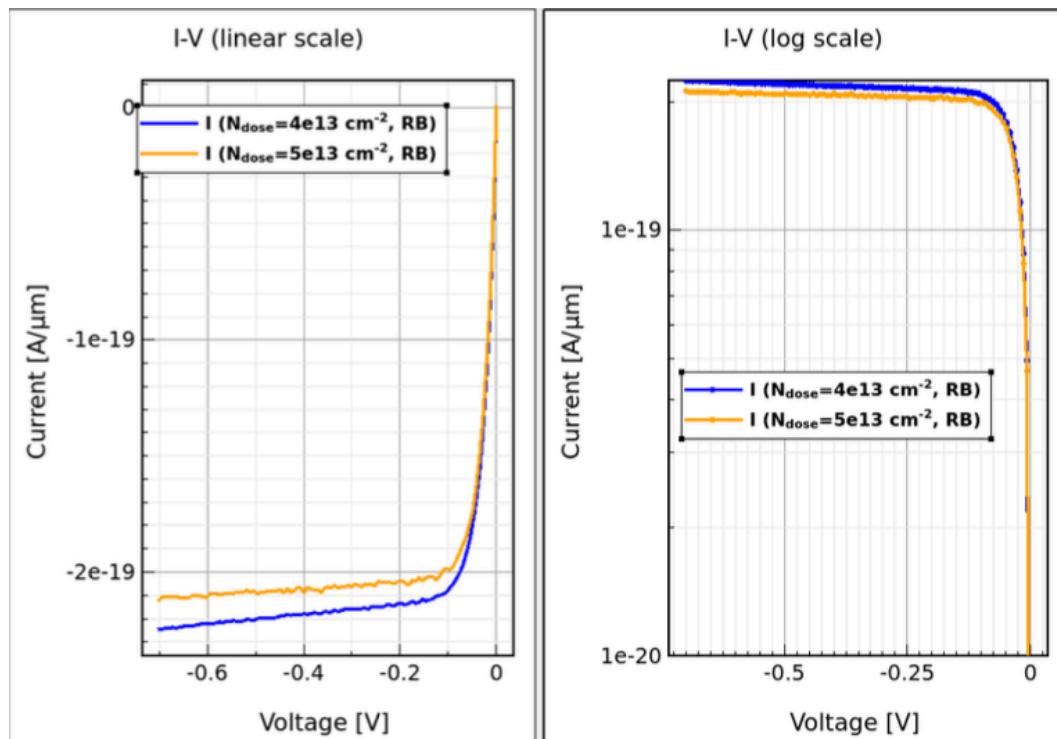
**Supriya Anand Mishra - 24b1312**  
**Semiconductor Fab 101**  
**PN Junction**

$N_{dose} = 4 \times 10^{13}$  and  $5 \times 10^{13}$  to the existing default values of  $1 \times 10^{13}$ ,  $2 \times 10^{13}$ , and  $3 \times 10^{13}$   $\text{cm}^{-2}$

Structure	$N_{energy}$	$P_{dose}$	IV			Plot_IV	Eqtn_EBD	EBD_IV	profiles	lb	n	ss	xi	Rsh,top
			Vneg	Vpos	bias									
15	1e13	--	-0.7	0.9	FB	--	--	--	--	2.9e-19	1.01	60	0.071	3.31e+03
15	1e13	--	-0.7	0.9	RB	--	--	--	x	x	x	0.071	3.31e+03	
15	1e13	--	-0.7	0.9	FB	--	--	--	--	2.2e-19	1.00	59.69	0.085	1.63e+03
15	1e13	--	-0.7	0.9	RB	--	--	--	x	x	x	0.085	1.63e+03	
15	1e13	--	-0.7	0.9	FB	--	--	--	--	2e-19	1.00	59.62	0.095	1.14e+03
15	1e13	--	-0.7	0.9	RB	--	--	--	x	x	x	0.095	1.14e+03	
15	1e13	--	-0.7	0.9	FB	--	--	--	--	2.1e-19	1.00	59.65	0.101	8.97e+02
15	1e13	--	-0.7	0.9	RB	--	--	--	x	x	x	0.101	8.97e+02	
15	1e13	--	-0.7	0.9	FB	--	--	--	--	2e-19	1.00	59.61	0.107	7.39e+02
15	1e13	--	-0.7	0.9	RB	--	--	--	x	x	x	0.107	7.39e+02	



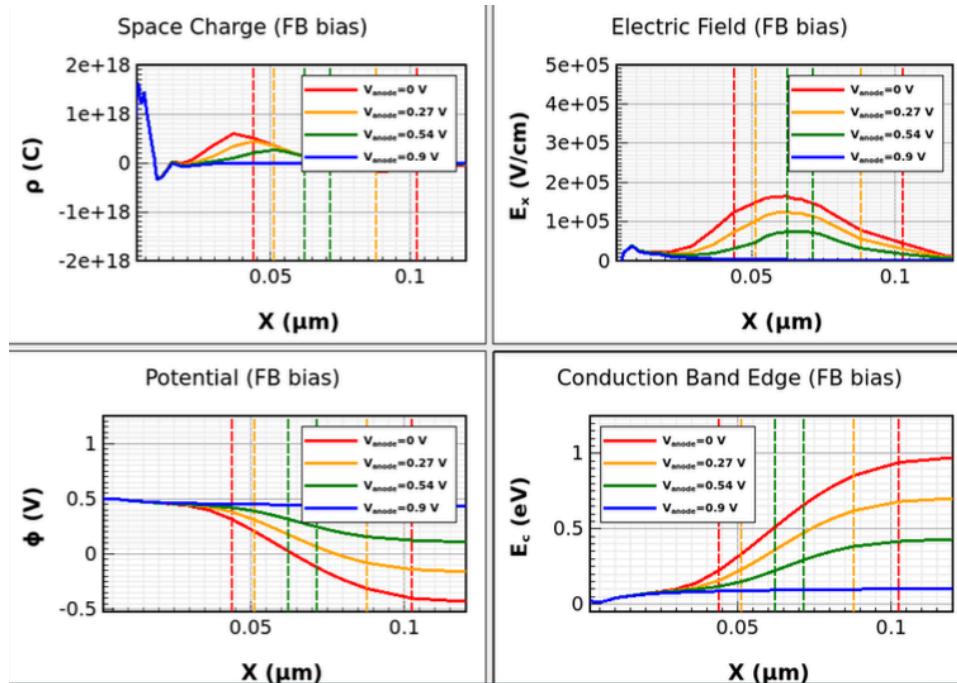
I-V plot of RB condition for different doping concentration



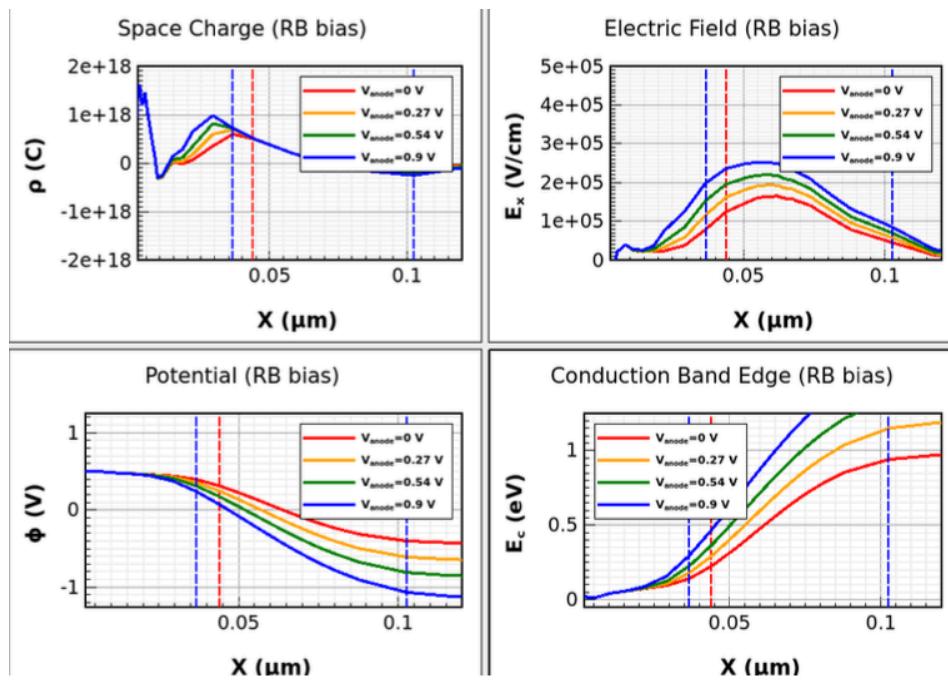
I-V plot of RB condition for  $4e13$  and  $5e13$  different doping concentration

The PN junction with lower doping ( $N_{dose} = 1 \times 10^{13} \text{ cm}^{-2}$ ) exhibits the highest reverse-bias current, whereas junctions with higher doping concentrations ( $4 \times 10^{13}$  and  $5 \times 10^{13} \text{ cm}^{-2}$ ) show reduced leakage current

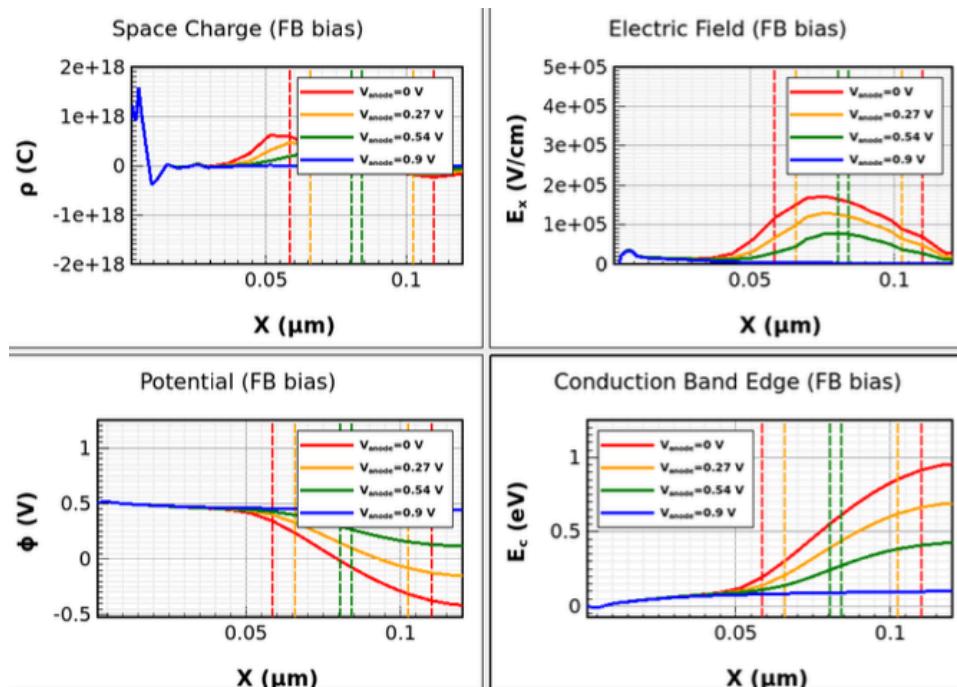
## Task2



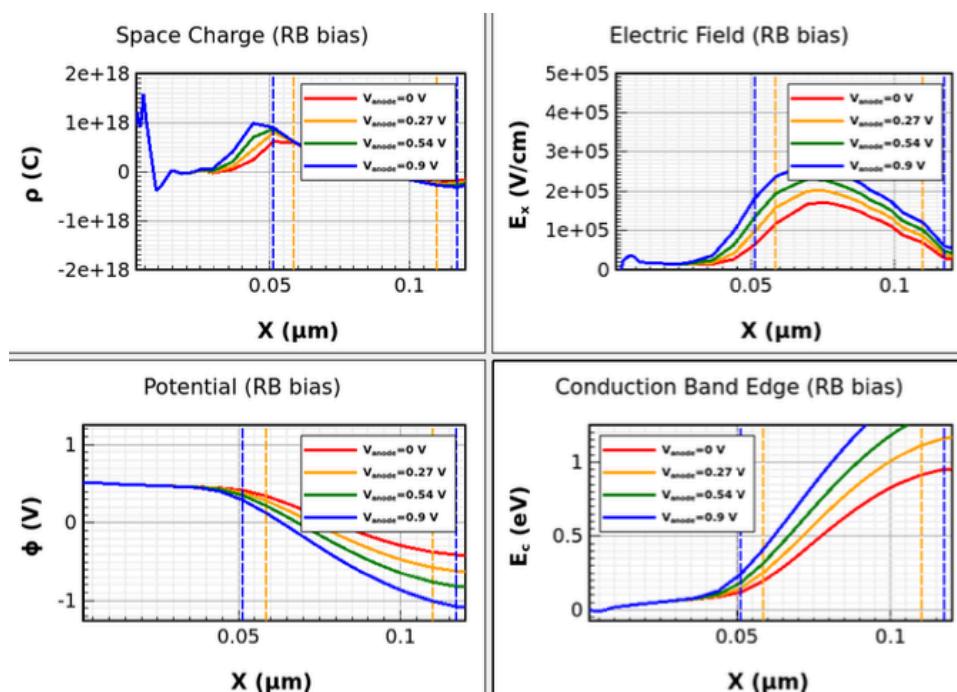
Depletion width modulation with doping concentration (FB) for  $1\text{e}13$



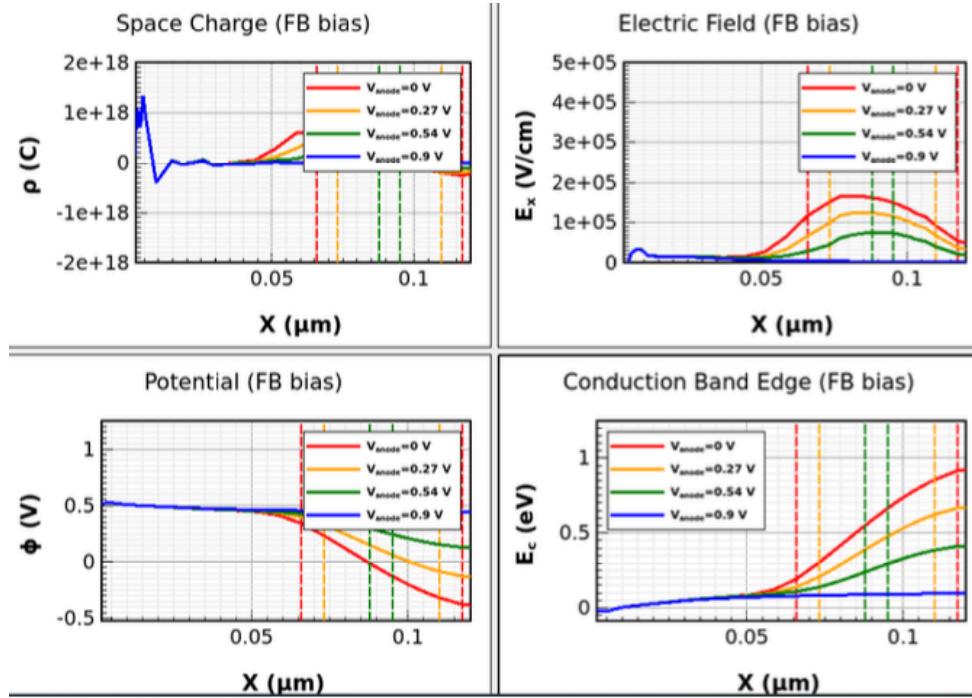
Depletion width modulation with doping concentration (RB) for  $1\text{e}13$



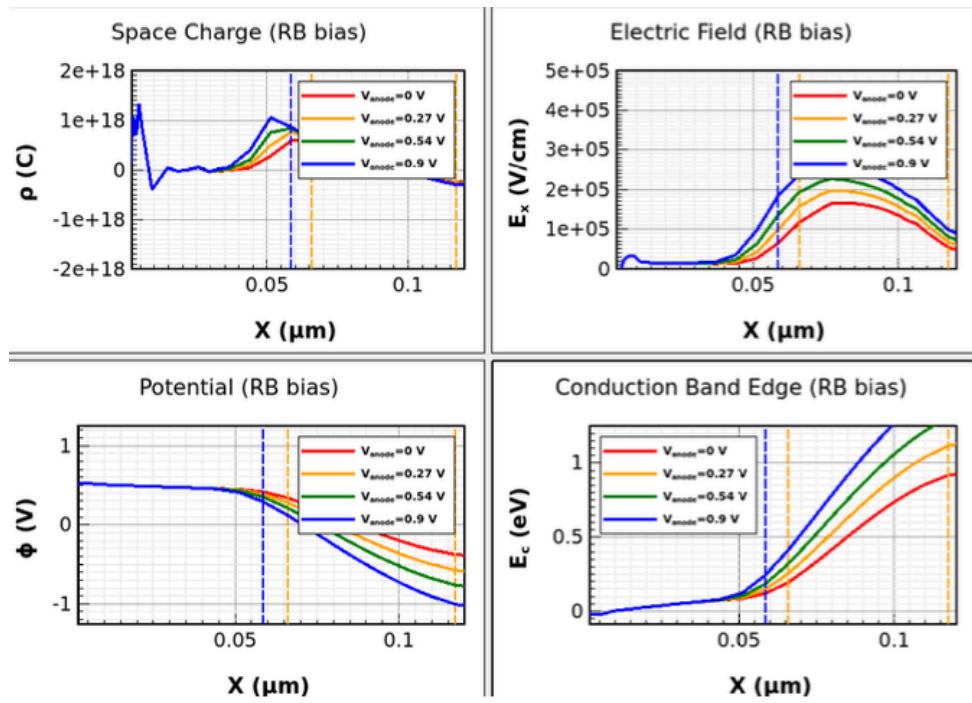
Depletion width modulation with doping concentration (FB) for  $2\text{e}13$



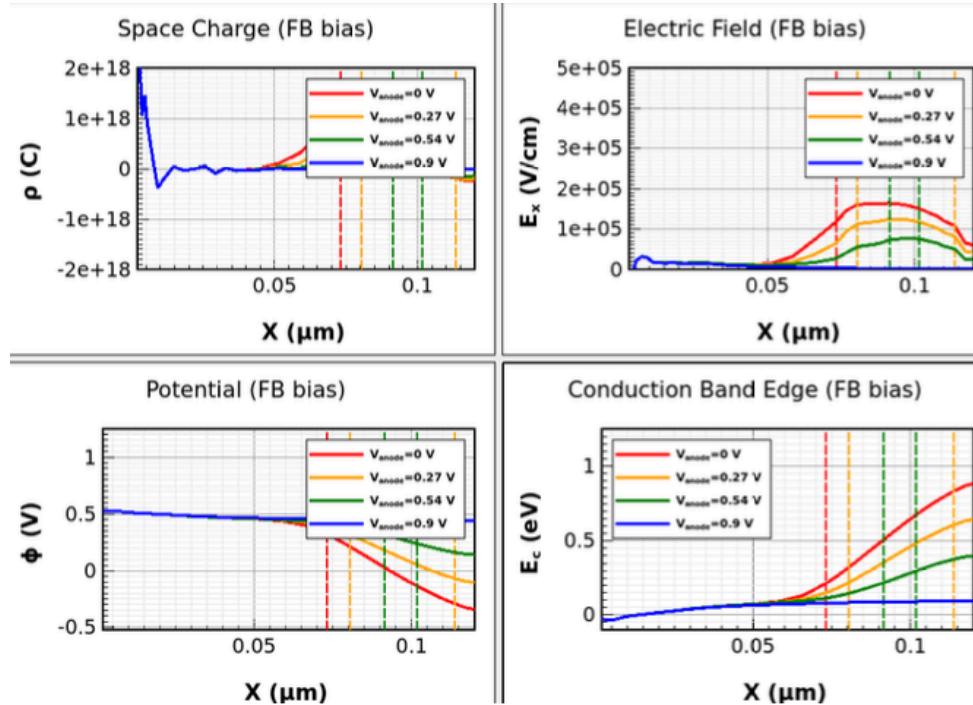
Depletion width modulation with doping concentration (RB) for  $2\text{e}13$



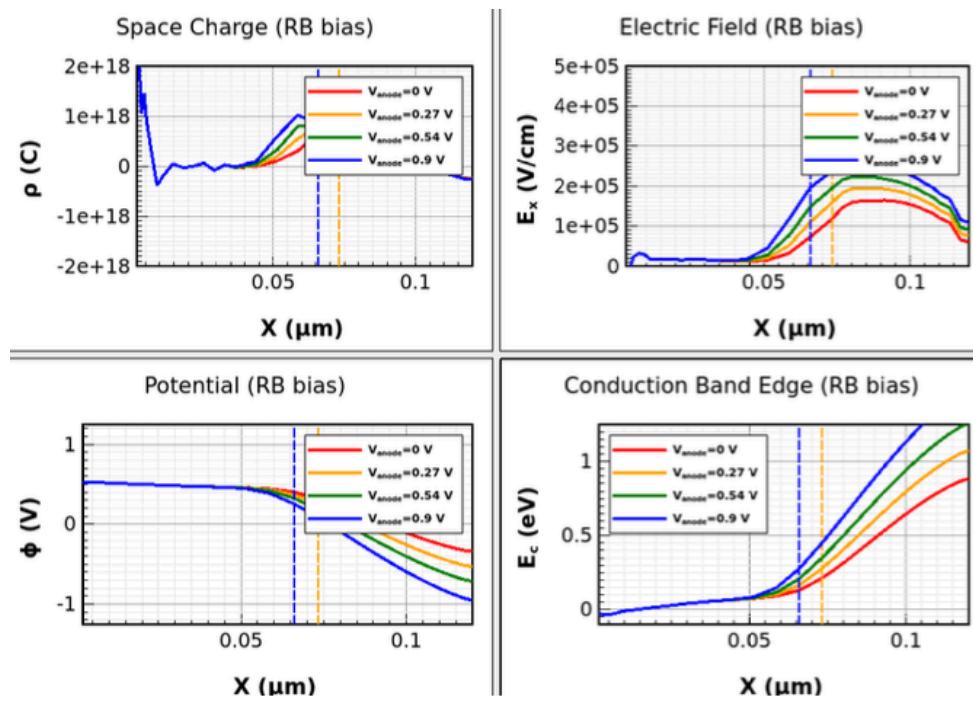
Depletion width modulation with doping concentration (FB) for 3e13



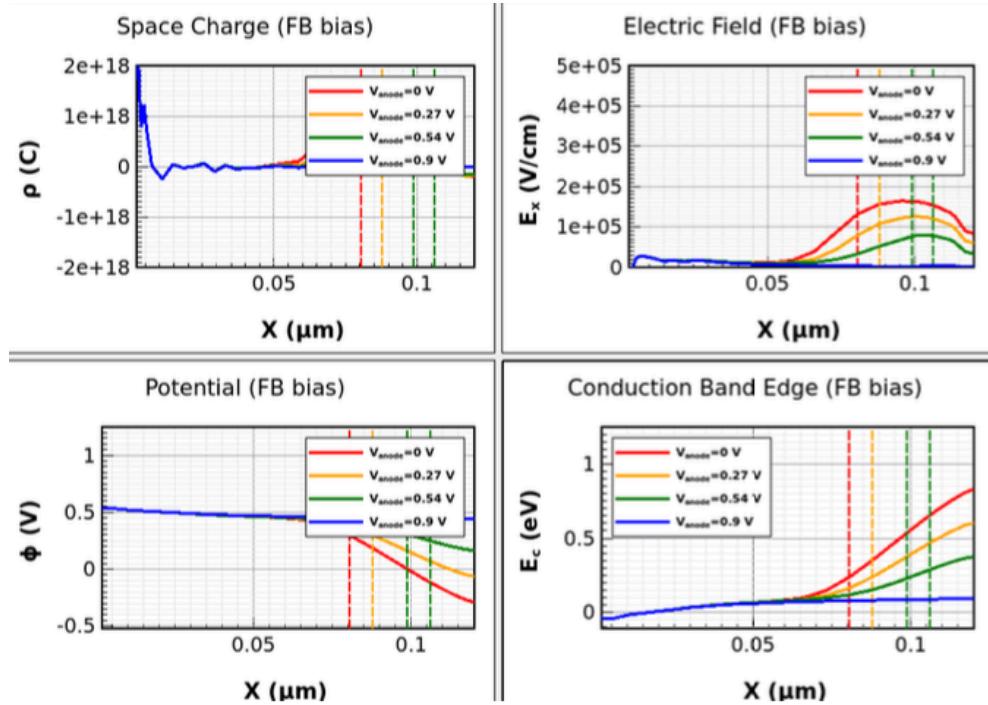
Depletion width modulation with doping concentration (RB) for 3e13



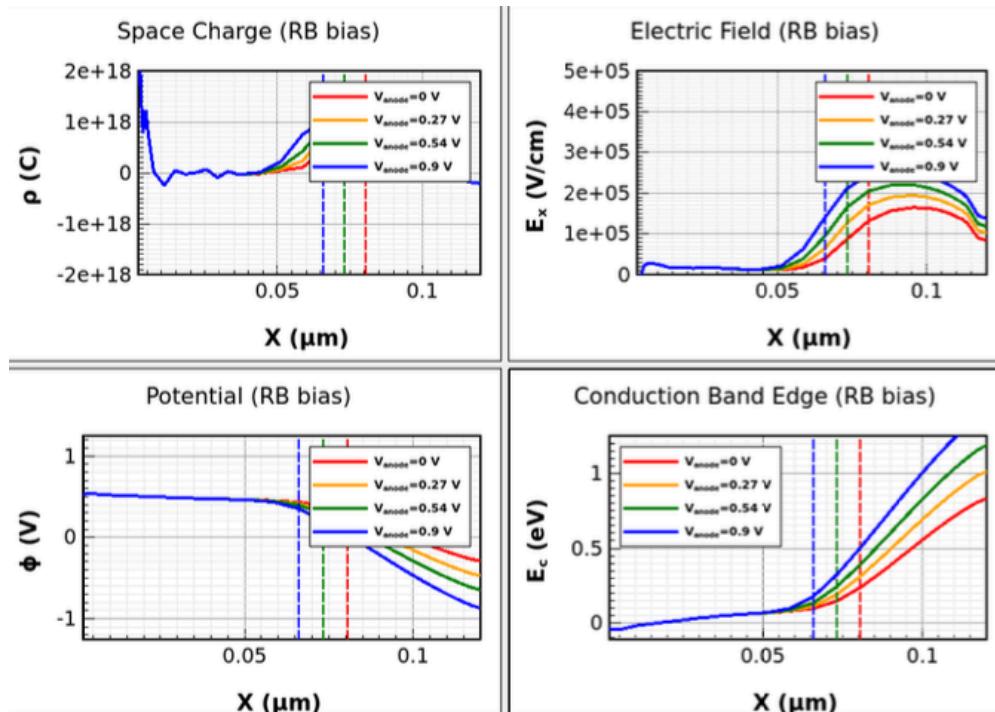
Depletion width modulation with doping concentration (FB) for 4e13



Depletion width modulation with doping concentration (RB) for 4e13



Depletion width modulation with doping concentration (FB) for  $5\text{e}13$



Depletion width modulation with doping concentration (RB) for  $5\text{e}13$

## **Forward Bias: Depletion Width Behavior**

When a PN junction is forward biased, the depletion region progressively shrinks as the applied voltage increases. This occurs because the built-in potential barrier is reduced, allowing space charge to remain confined closer to the junction interface. The electric field spans a smaller region, and the band diagrams show reduced curvature near the junction. As a result, charge carriers cross the junction more easily, leading to enhanced carrier injection.

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## **Reverse Bias: Depletion Width Behavior**

Under reverse bias conditions, the depletion region expands into both the p- and n-sides of the junction due to a stronger electric field and reduced mobile carrier density. At a fixed reverse voltage, increasing the implant dose ( $N_{dose}$ ) compresses the depletion region since higher doping raises the space-charge density near the junction. Space-charge and electric-field profiles clearly indicate that the depletion boundaries move inward with increasing  $N_{dose}$ . Hence, even in reverse bias, depletion width decreases with increasing doping concentration.

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## **Influence of Process and Bias Parameters**

- **N Energy:**

Higher N implantation energy pushes the junction deeper into the substrate, resulting in a wider physical spread of the depletion region. Lower N energy forms a shallower junction, causing the depletion region to remain more localized.

- **P Dose:**

Increasing the P dose strengthens the space-charge density, which in turn narrows the depletion region by enhancing the electric field near the junction.

- **V<sub>pos</sub> / V<sub>neg</sub>:**

An increase in forward bias voltage compresses the depletion region, whereas an increase in reverse bias voltage causes the depletion region to widen. In essence, voltage polarity directly controls depletion width expansion or contraction.