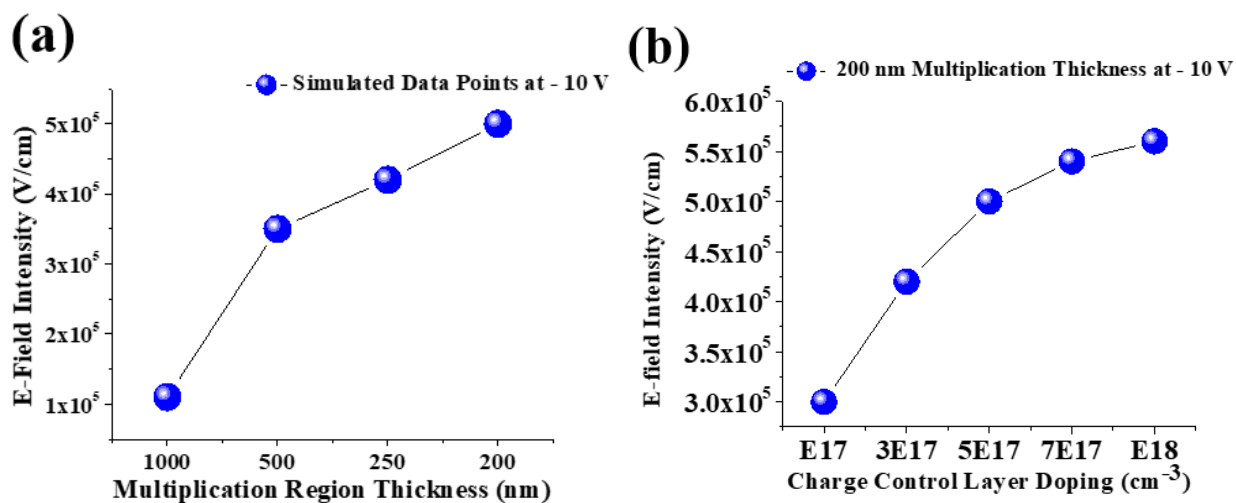


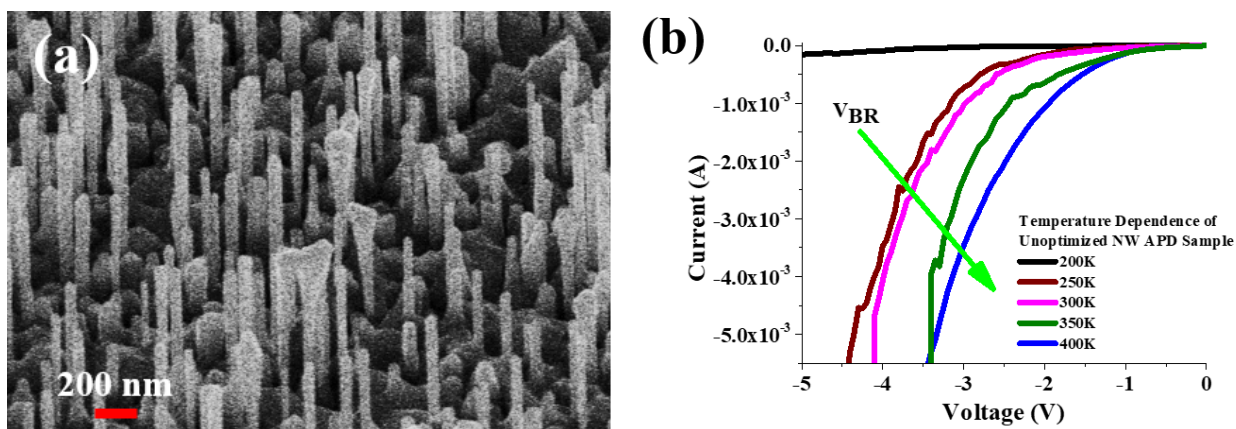
S1. Table I: Parameters used for E-field simulation of the single SACM axial NW APD structure at 300 K.

| Parameters | GaAs | GaAsSb _x (x = 7 %) |
|--|----------------------|-------------------------------|
| n-doping (cm ⁻³) | 10 ¹⁸ | - |
| p-doping (cm ⁻³) | 5 x 10 ¹⁷ | 10 ¹⁹ |
| i-doping (cm ⁻³) | 10 ¹⁵ | 10 ¹⁵ |
| Relative Permittivity | 12.9 | 13.1 |
| Electron Affinity (eV) | 4.07 | 4.05 |
| Electron Mobility (cm ² /V.s) | 8500 | 1370 |
| Hole Mobility (cm ² /V.s) | 400 | 105 |

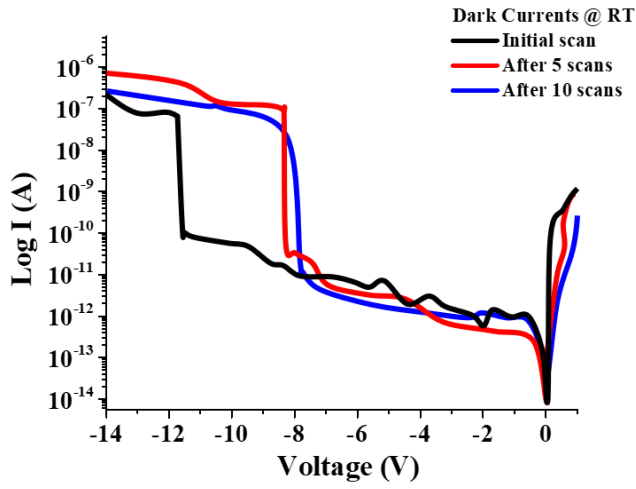
S2. E-field intensity variation throughout single SACM axial NW APD with change in charge control layer doping and multiplication segment thickness.



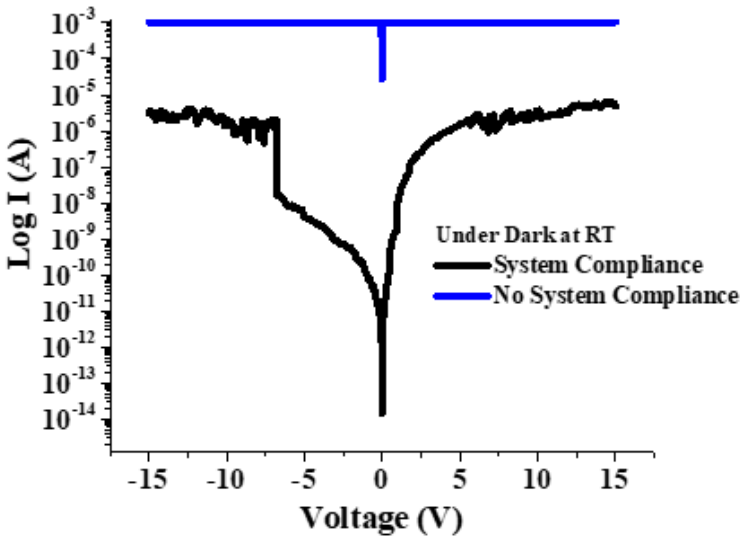
S3. Unoptimized NW APD growth: (a) SEM image showing inverse tapering of NWs with increased NW diameter and high parasitic growth. (b) Negative temperature dependence of V_{BR} in I-V-T analysis, characteristic of Zener breakdown.



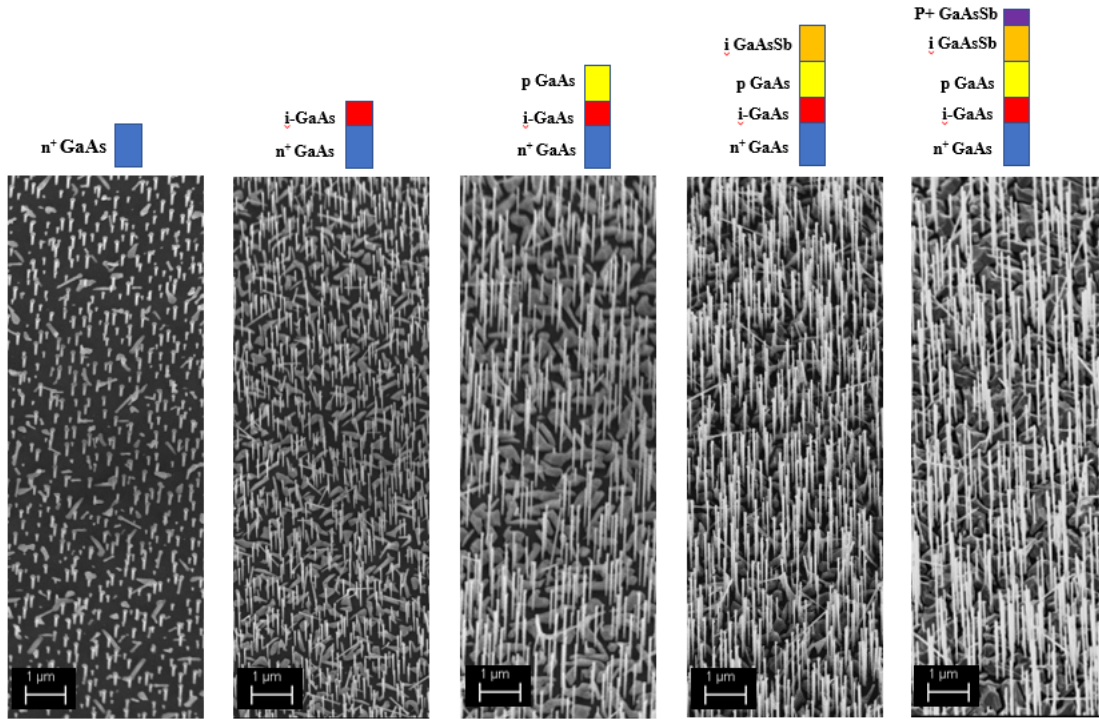
S4. Variation in V_{BR} for ensemble SACM axial NW APDs under dark at RT for initial I-V sweeps.



S5. Dark I-V at RT of ensemble SACM axial NW APDs showing ohmic characteristics without system compliance, indicative of NWs burning.



S6: Segment-wise axial APD structure growth.



The individual axial segment growth rates were calculated from SEM images performed on segment-wise axial APD structure growth as shown in the above Figure S6. The NW lengths were measured after each sequential growth for all segments individually and from the total growth length and the duration of the growth, the growth rates of each segment were then delineated. Sample size were typically ~ 20 NWs for average segment growth rate calculation. These growth rates were then used to calculate the length of each segment with varying segment growth duration. For example: growth rate of 40 nm/min was calculated for multiplication segment.