Damage Projections for Pixel Sensors

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New Standard Scenario:

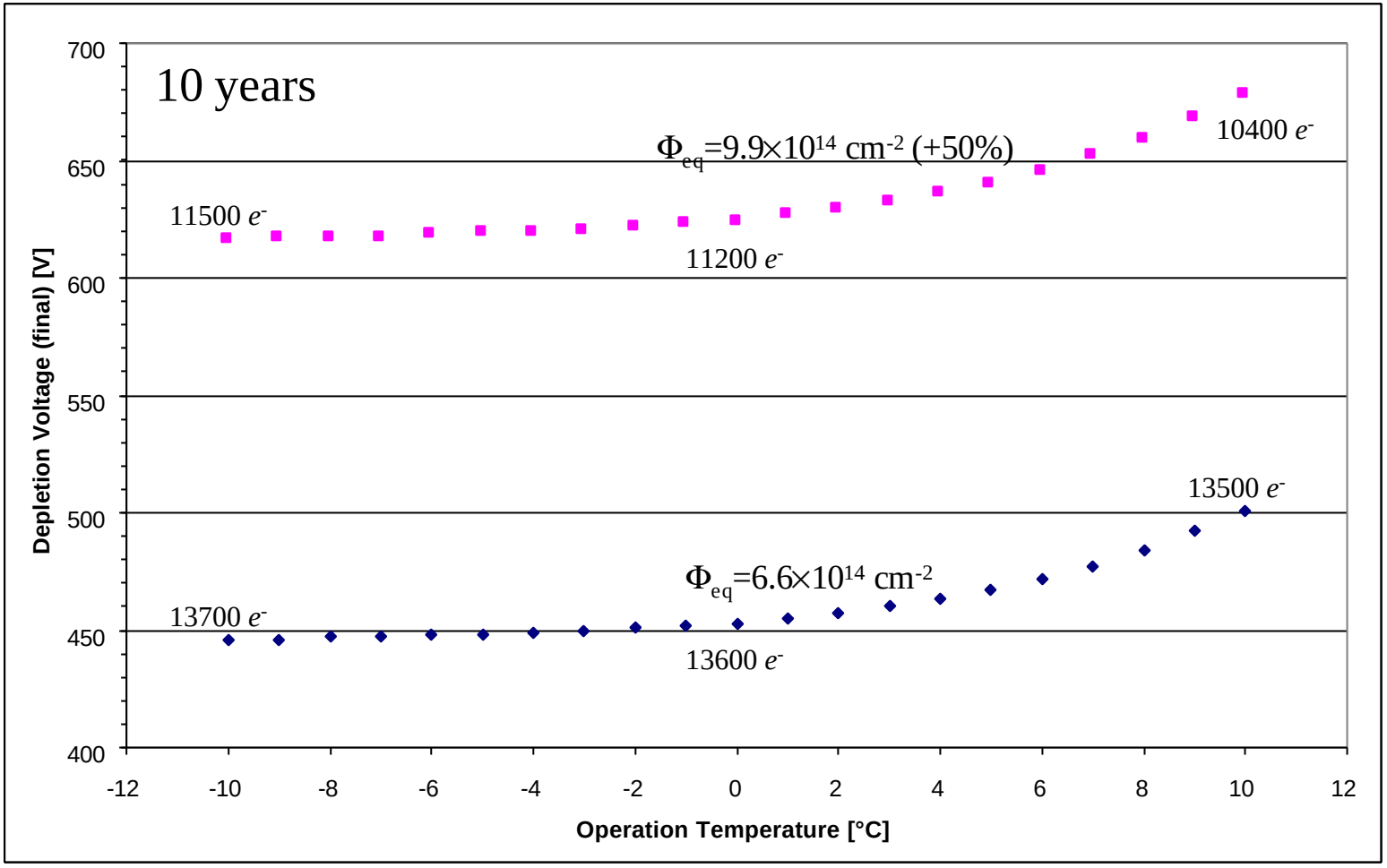
- 100 days beam at 0°C
- 30 days warm-up at 20°C
- 235 days storage at -10°C
- Layer 1:
  Φ_{eq}(10 years) = 6.6×10^{14} cm^{-2}, 70% ch.
  sensor thickness 250 µm
- B-Layer:
  Φ_{eq}(5 years) = 1.2×10^{15} cm^{-2}, 85% ch.
  sensor thickness 200 µm

Variation of

- operation temperature
- warm-up temperature
- warm-up time

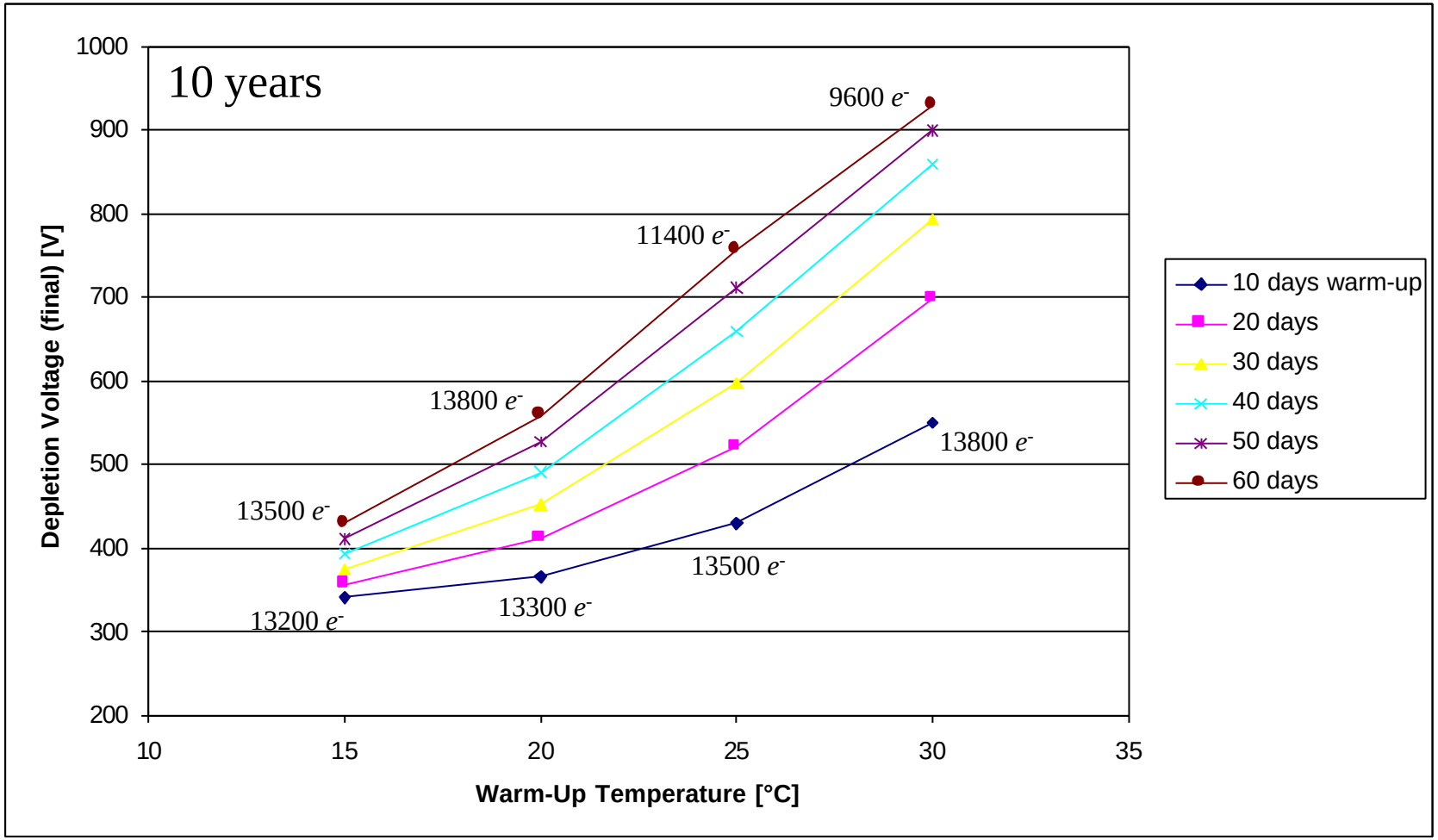
Depletion Voltage $V_{dep}(T_{op})$ - Layer 1 - 10 years

- Radiation level for 1st layer: Φ_{eq}(10 years) = 6.6×10^{14} cm^{-2} resp. 9.9×10^{14} cm^{-2} (+50%)
- Scenario: 100 days beam at *T*, 30 days at 20°C, 235 days at -10°C per year
- Sensor thickness 250µm, oxygenated silicon, $V_{bias}=V_{depl}$+50 V, max. 600 V



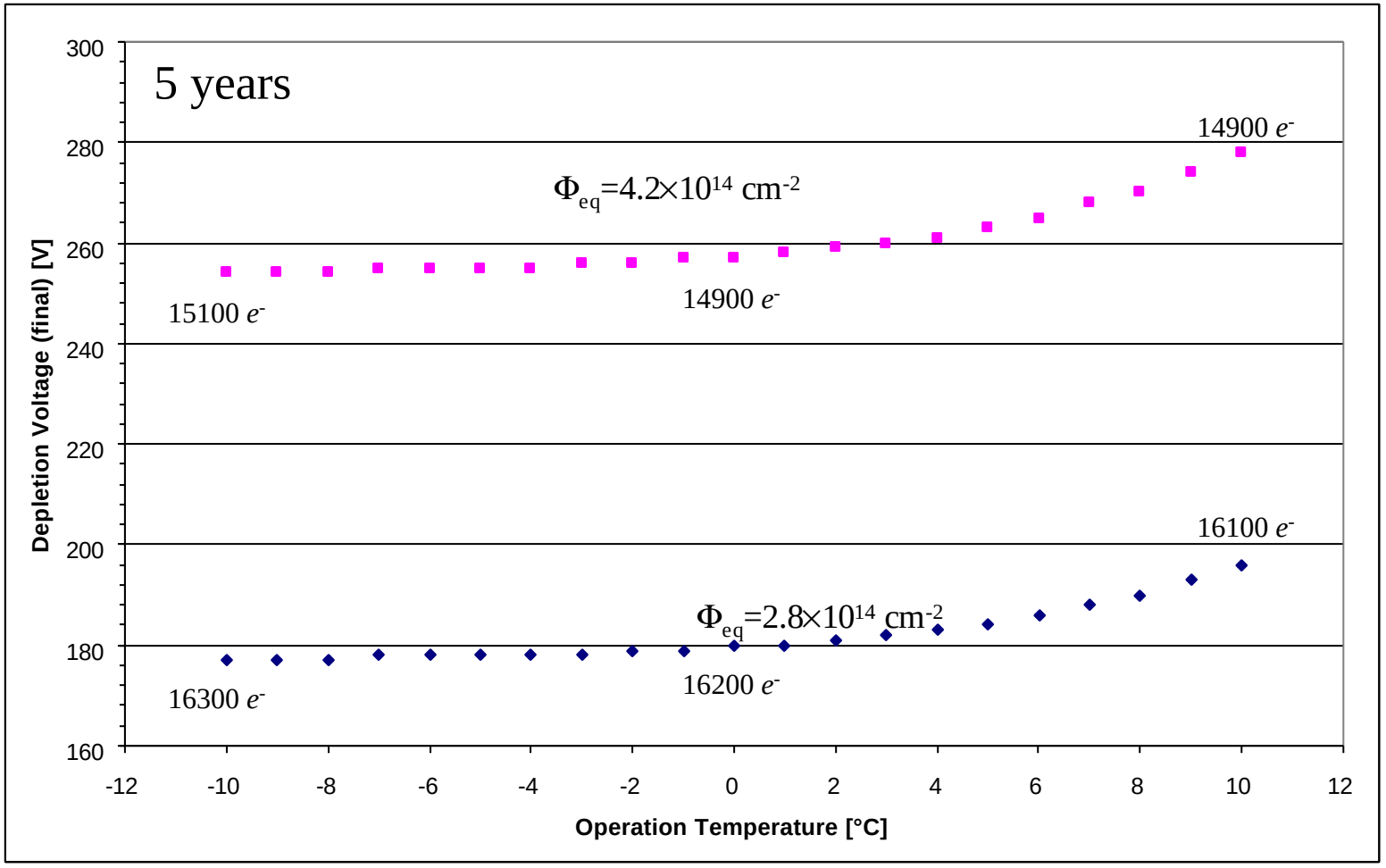
Depletion Voltage $V_{dep}(T_{warm\text{-}up})$ - Layer 1 - 10 years

- Radiation level for 1st layer: Φ_{eq} (10 years) = 6.6×10^{14} cm^{-2}
- Scenario: 100 days beam at 0°C, *n* days warm-up at *T* per year, rest at -10°C
- Sensor thickness 250µm, oxygenated silicon, $V_{bias}=V_{depl}+50$ V, max. 600 V



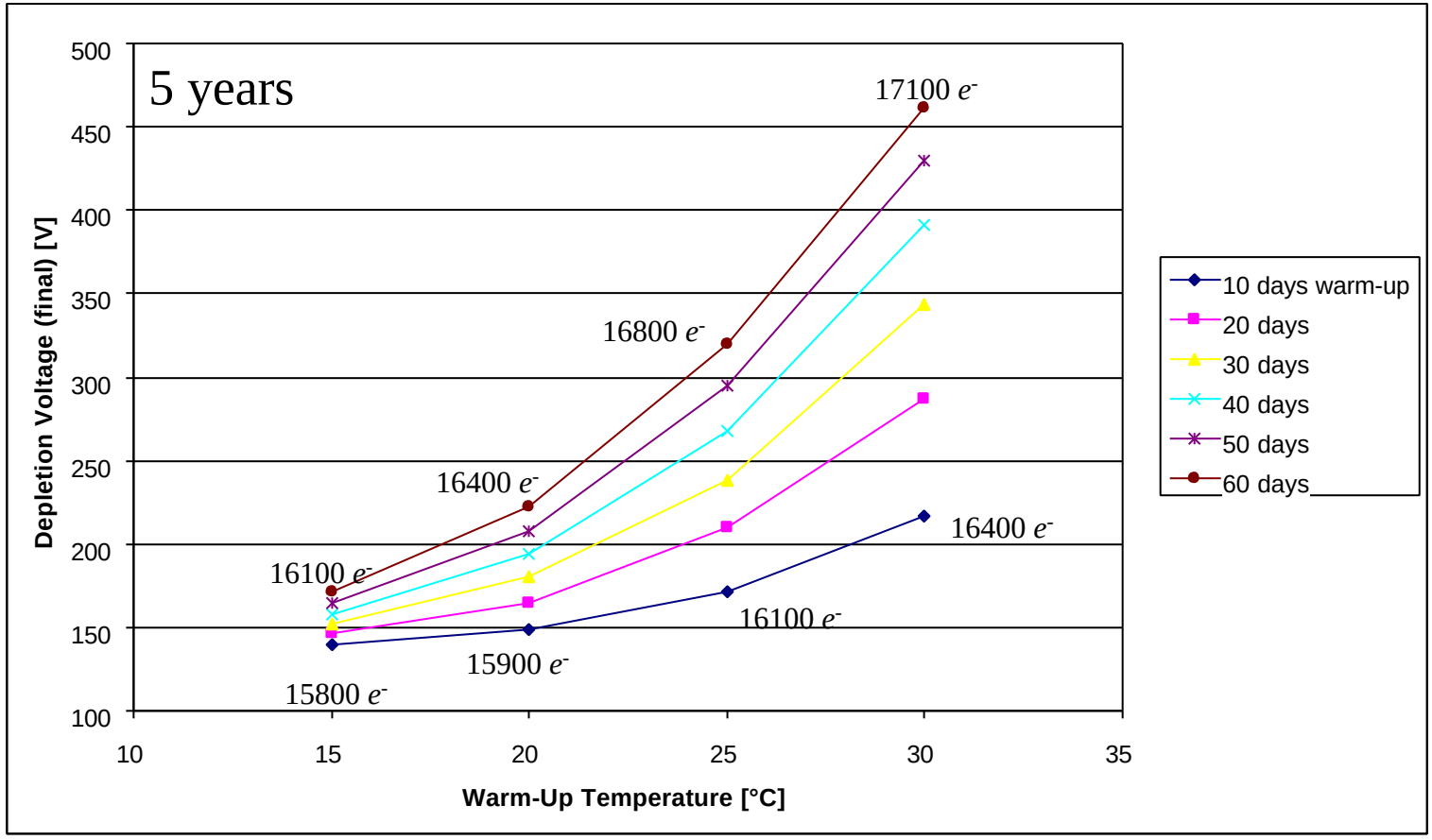
Depletion Voltage $V_{dep}(T_{op})$ - Layer 1 - 5 years

- Radiation level for 1st layer: Φ_{eq}(5 years) = 2.8×10^{14} cm^{-2} resp. 4.2×10^{14} cm^{-2} (+50%)
- Scenario: 100 days beam at *T*, 30 days at 20°C, 235 days at -10°C per year
- Sensor thickness 250µm, oxygenated silicon, $V_{bias}=V_{depl}+50$ V, max. 600 V



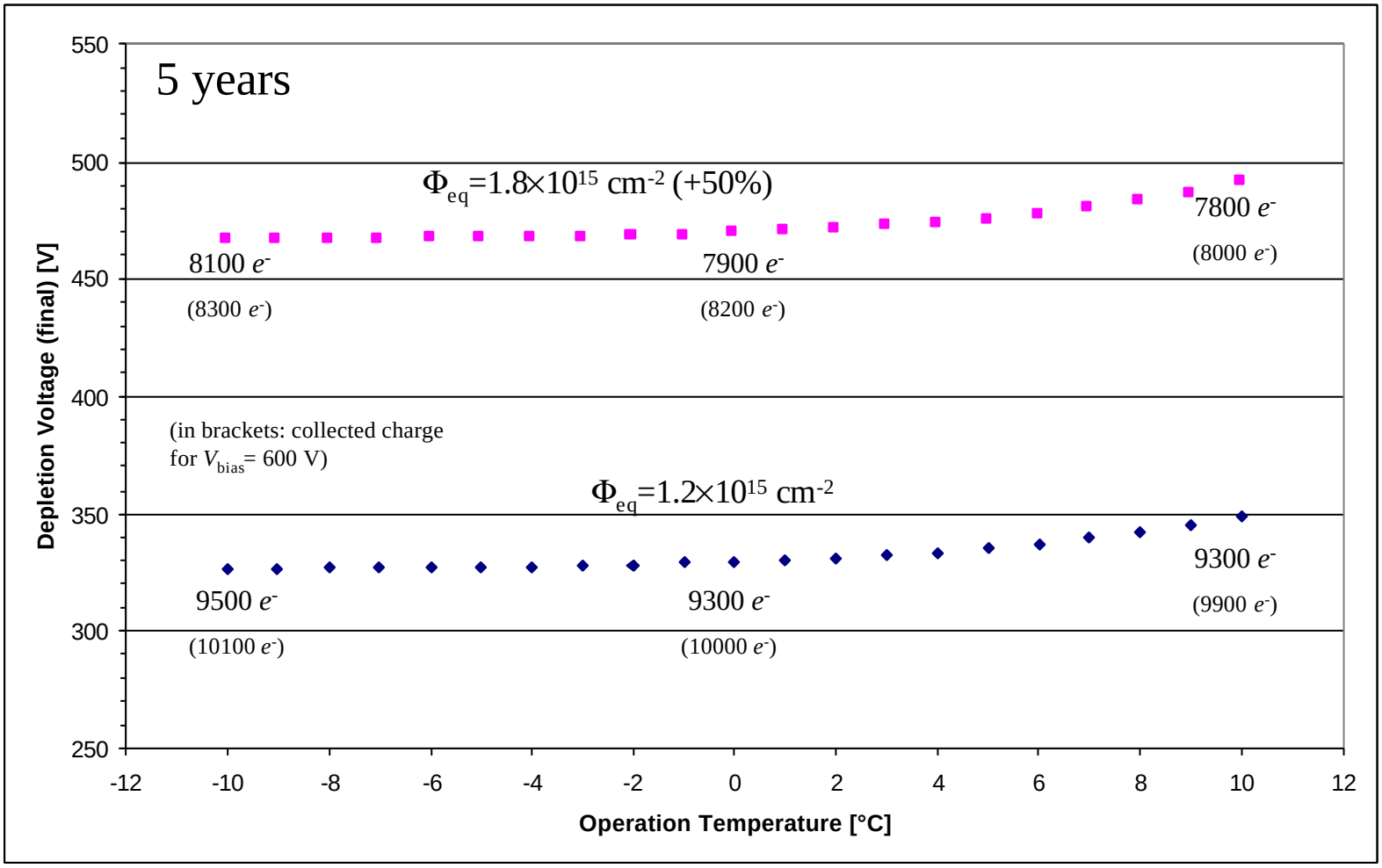
Depletion Voltage $V_{dep}(T_{warm\text{-}up})$ - Layer 1 - 5 years

- Radiation level for 1st layer: Φ_{eq} (5 years) = 2.8×10^{14} cm^{-2}
- Scenario: 100 days beam at 0°C, *n* days warm-up at *T* per year, rest at -10°C
- Sensor thickness 250µm, oxygenated silicon, $V_{bias}=V_{depl}+50$ V, max. 600 V



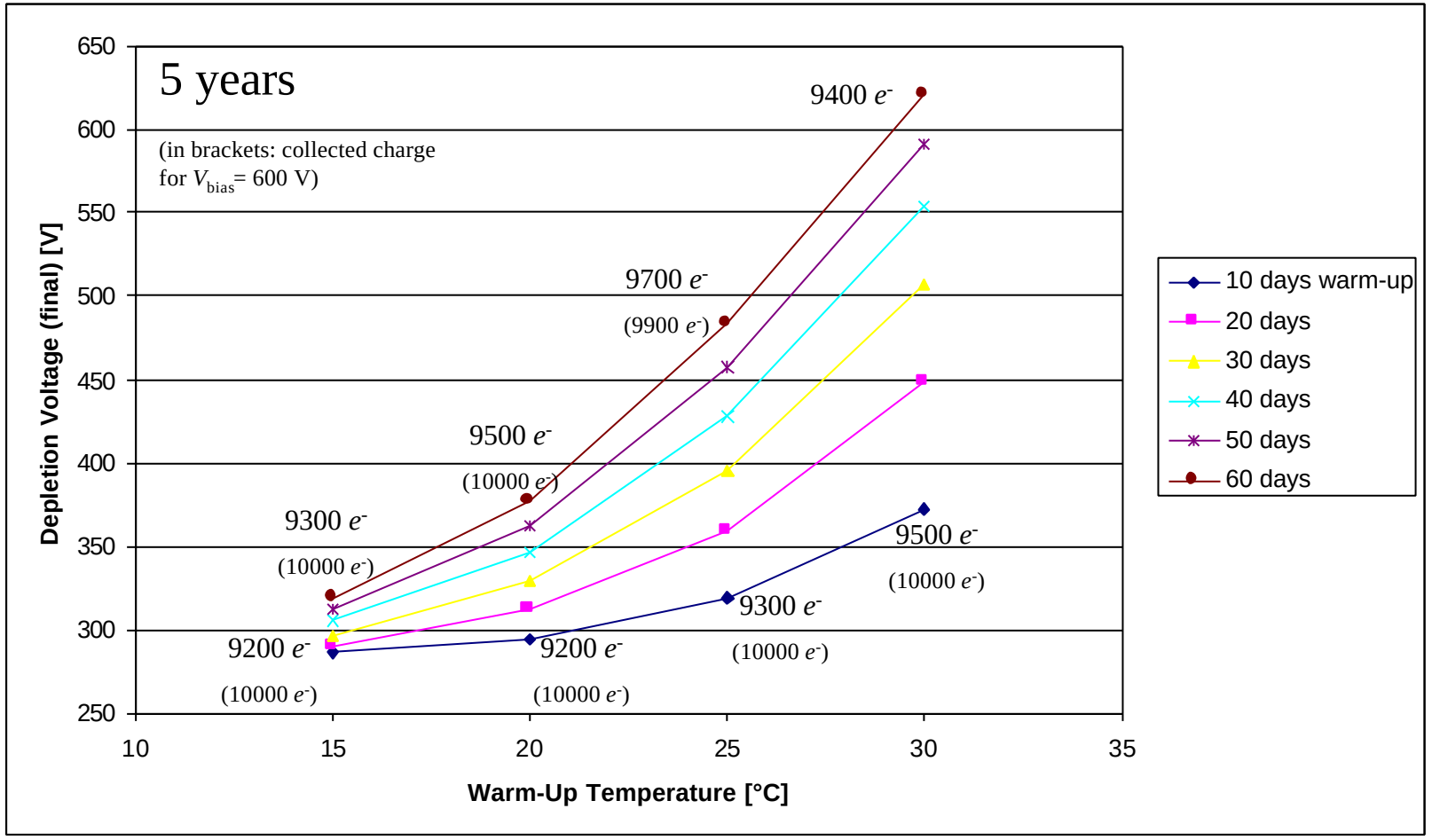
Depletion Voltage $V_{dep}(T_{op})$ - B-Layer - 5 years

- Radiation level for B-layer: Φ_{eq}(5 years) = 1.2×10^{15} cm^{-2} resp. 1.8×10^{15} cm^{-2} (+50%)
- Scenario: 100 days beam at T, 30 days at 20°C, 235 days at -10°C per year
- Sensor thickness 200µm, oxygenated silicon, $V_{bias}=V_{depl}$+50 V, max. 600 V



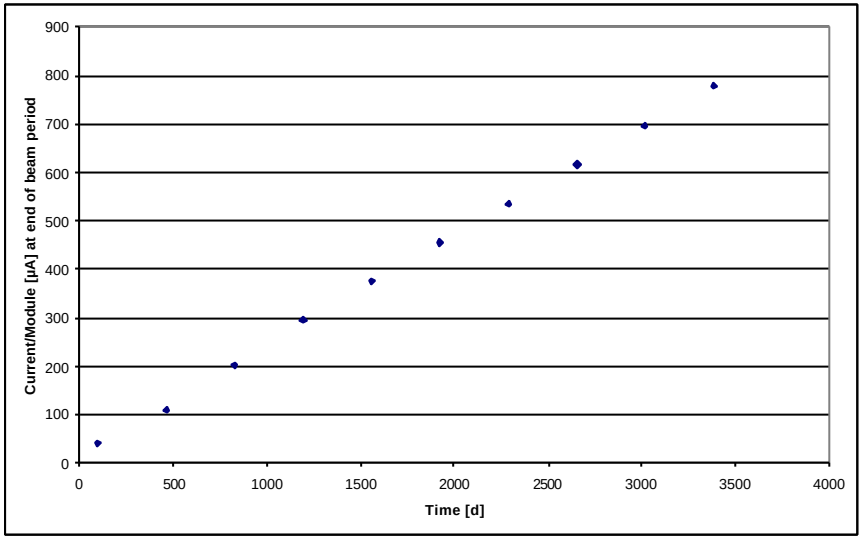
Depletion Voltage $V_{dep}(T_{warm\text{-}up})$ - B-Layer - 5 years

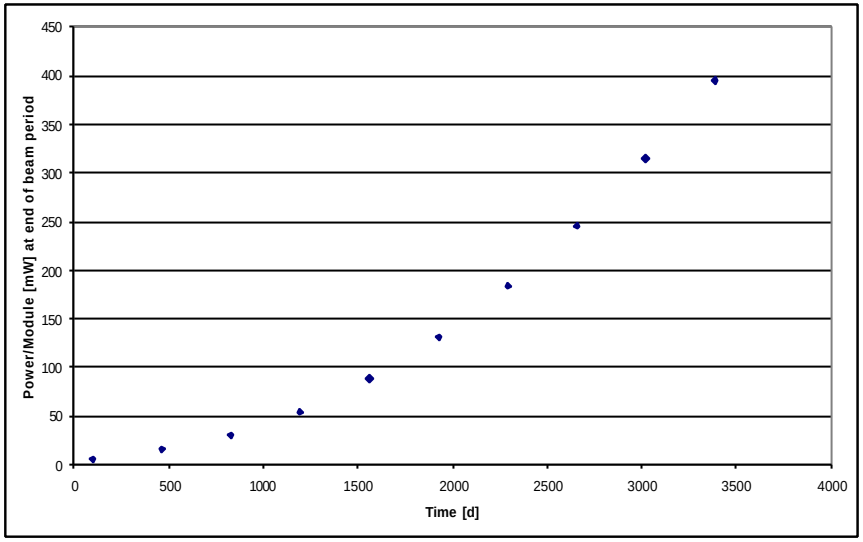
- Radiation level for B-layer: Φ_{eq} (5 years) = 1.2×10^{15} cm^{-2}
- Scenario: 100 days beam at 0°C, *n* days warm-up at *T* per year, rest at -10°C
- Sensor thickness 200µm, oxygenated silicon, $V_{bias}=V_{depl}+50$ V, max. 600 V



Leakage Current and Power Consumption

PRELIMINARY RESULTS!





	Operation at –7°C	**Operation at 0°C**
Layer 1 (10 years)	*I* = 380 µA/Modul *I* = 8 nA/Pixel *P* = 200 mW/Modul	*I* = 780 µA/Modul *I* = 17 nA/Pixel *P* = 400 mW/Modul
B-Layer (5 years)	*I* = 630 µA/Modul *I* = 14 nA/Pixel *P* = 300 mW/Modul	*I* = 1270 µA/Modul *I* = 28 nA/Pixel *P* = 540 mW/Modul

Conclusions

- Layer 1: V_{dep} and charge collection allow operation at 0°C
- B-Layer: 5 years at nominal fluence with
  0°C operation temperature,
  30 days warm-up to 20°C,
  200 µm,
  600 *V* bias voltage
  will result in 10000 electrons
- leakage currents stay within limits (<50 nA per pixel)
- Higher power consumption due to higher leakage current (about factor 2 per 8°C higher temperature)