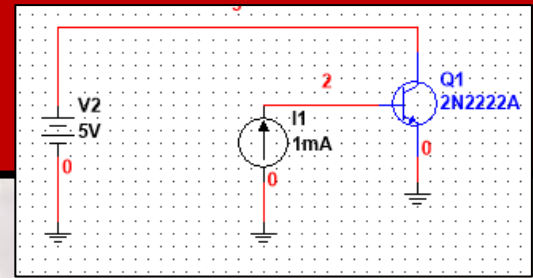


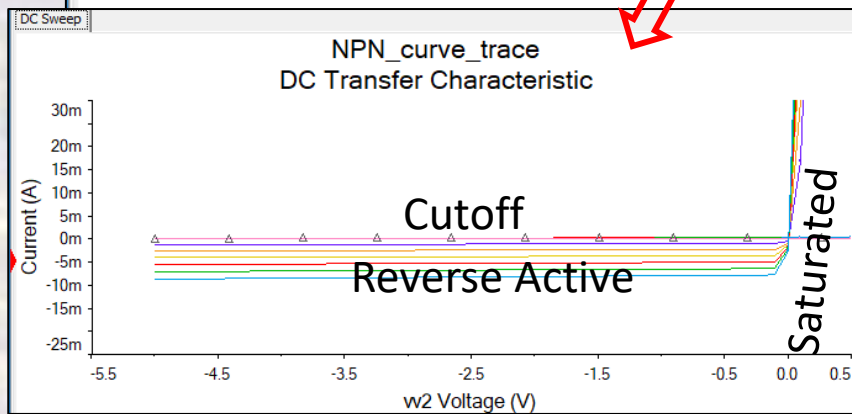
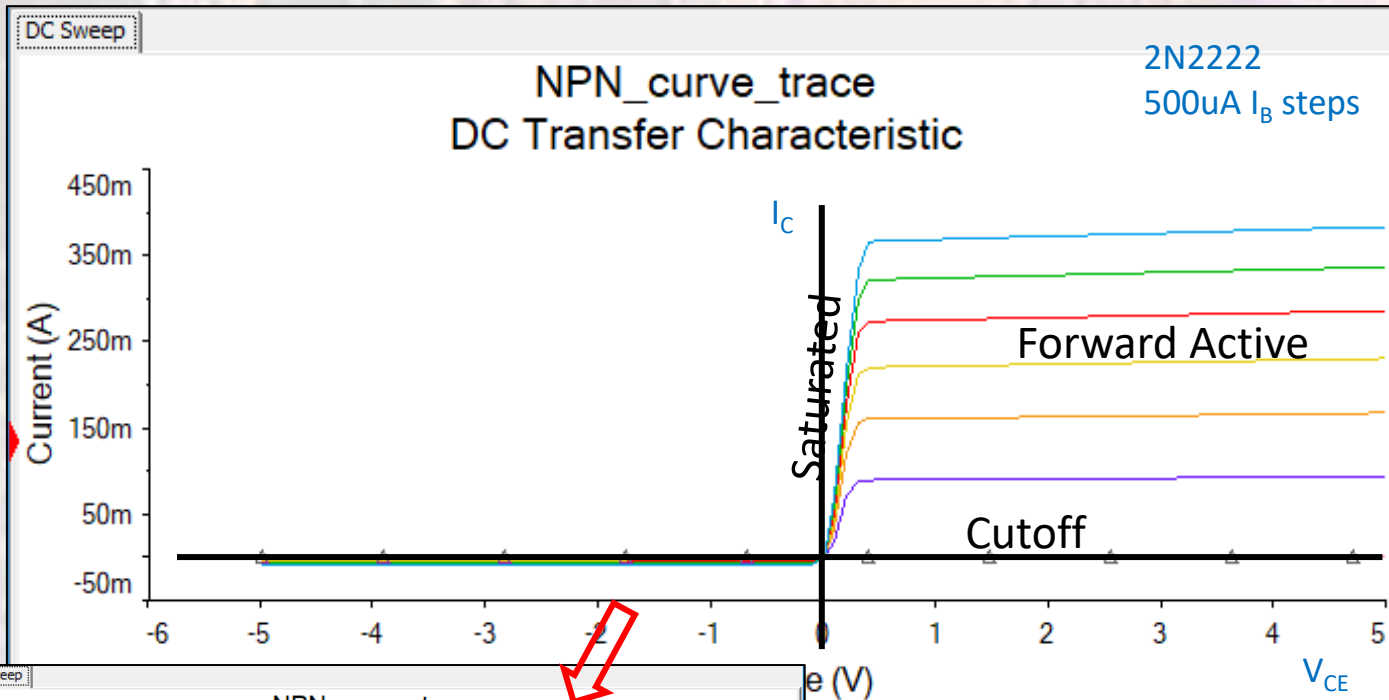
# BJT IV Characteristics

Last updated 2/21/22

# BJT IV Characteristics



- NPN – 4 regions of operation



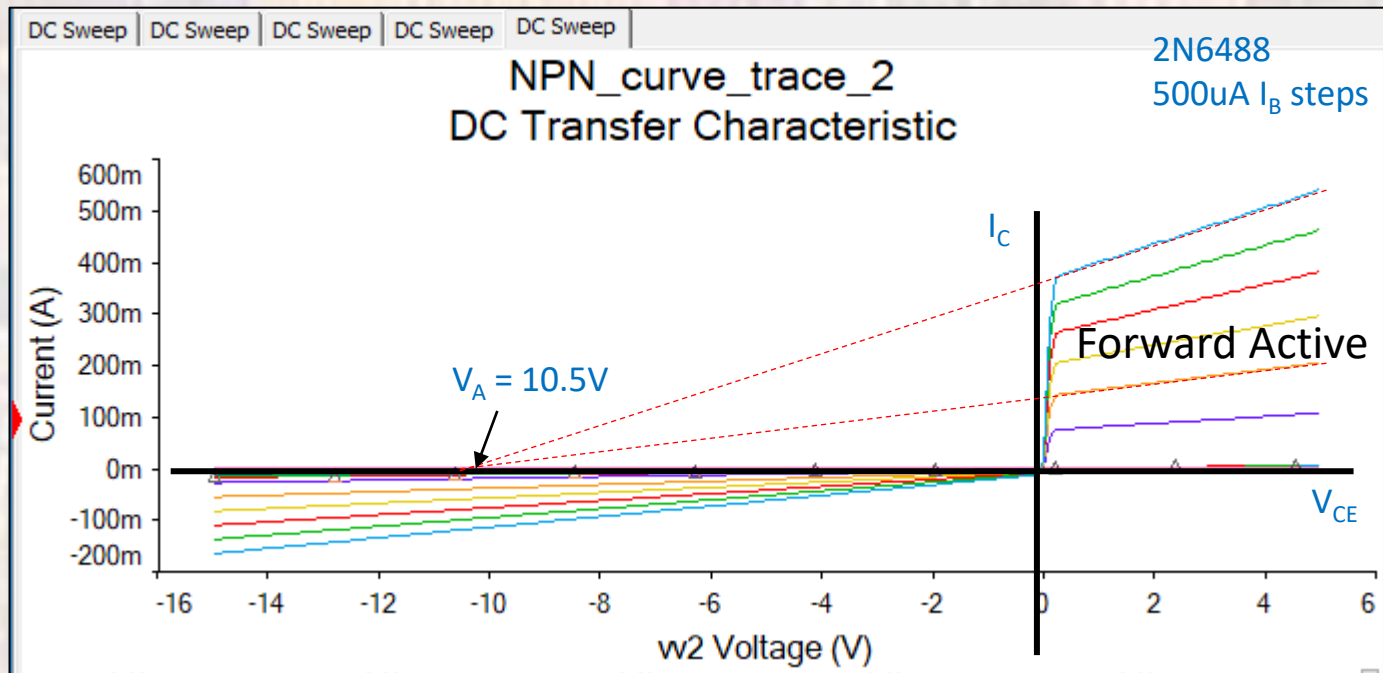
$$I_C = \beta I_B$$

Note: not exact, small slope to the  $I_C$  vs  $V_{CE}$  curve

Note: not constant for large  $I_C$

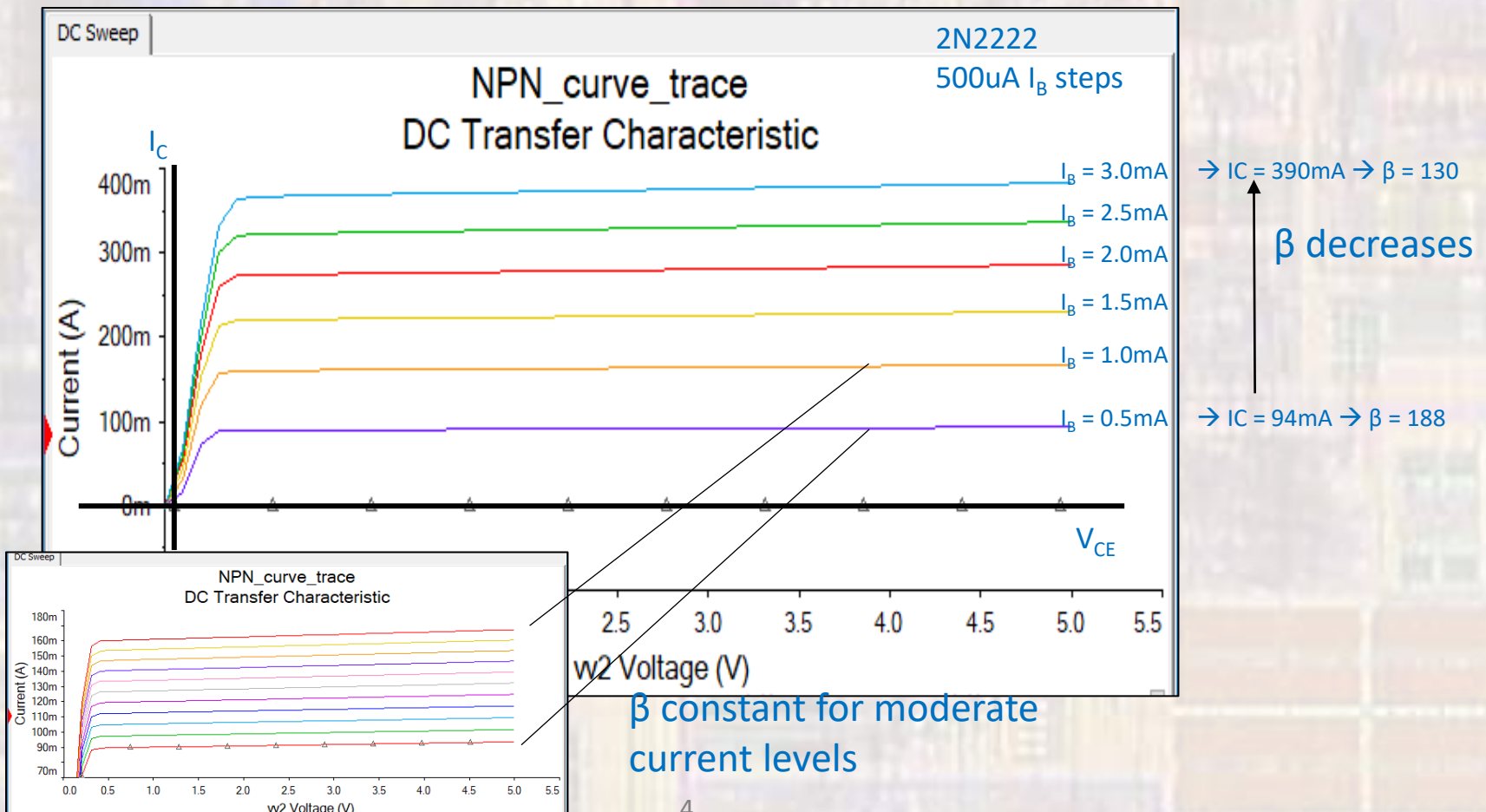
# BJT IV Characteristics

- NPN – Early Voltage
  - Increasing  $V_{CE}$  → wider depletion region and greater electric field
  - → increasing  $I_C$
  - The curves converge on the **Early Voltage**,  $-V_A$



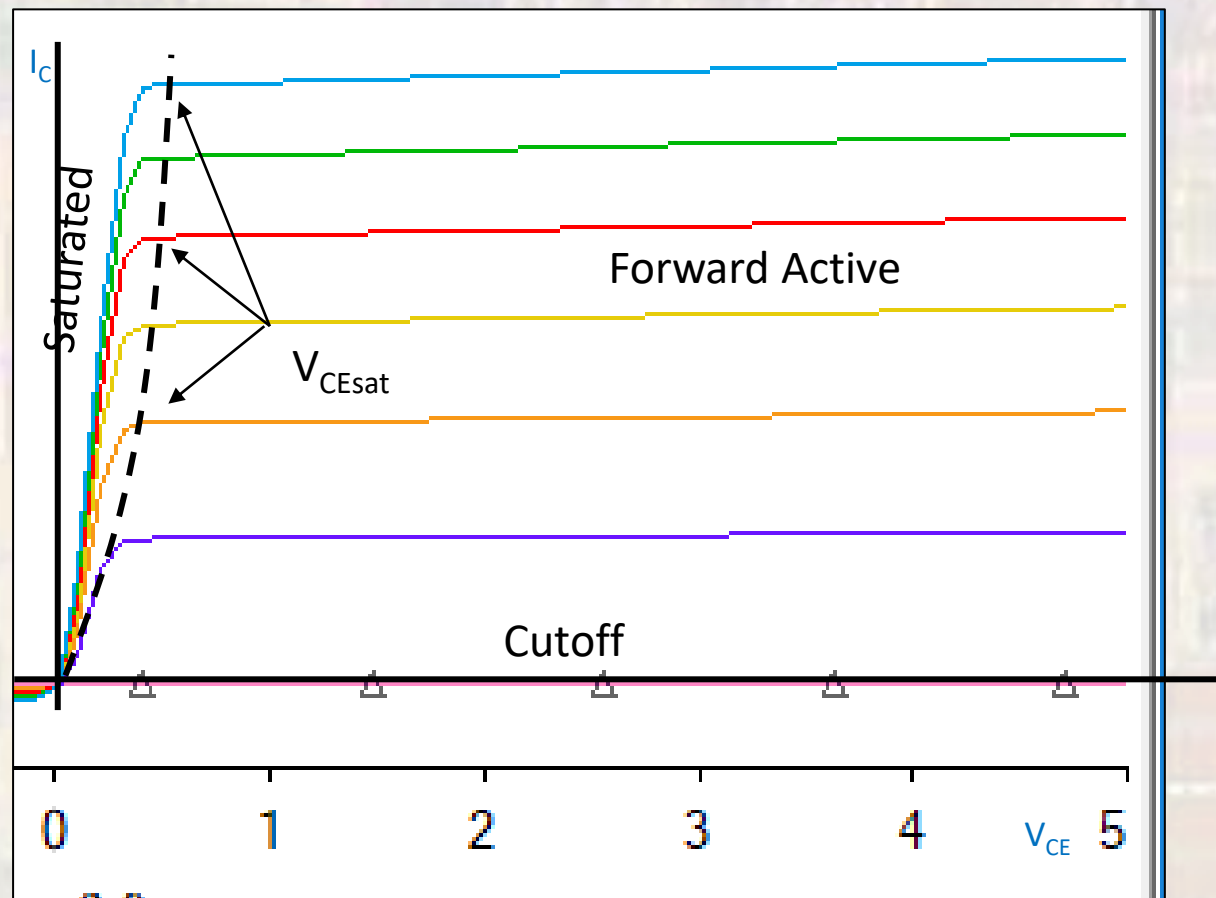
# BJT IV Characteristics

- NPN – Beta variation
  - Excess carriers in the base cause  $\uparrow$  base current  $\rightarrow \downarrow \beta$

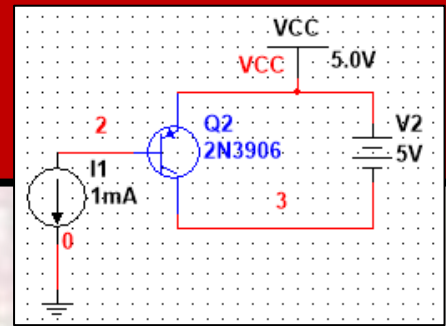


# BJT IV Characteristics

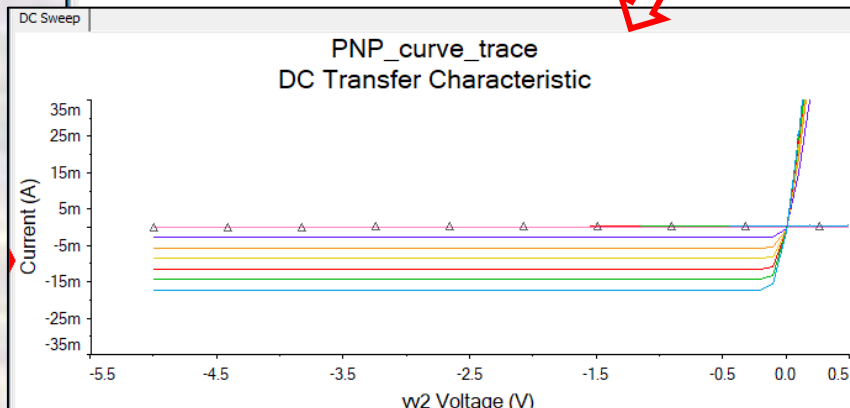
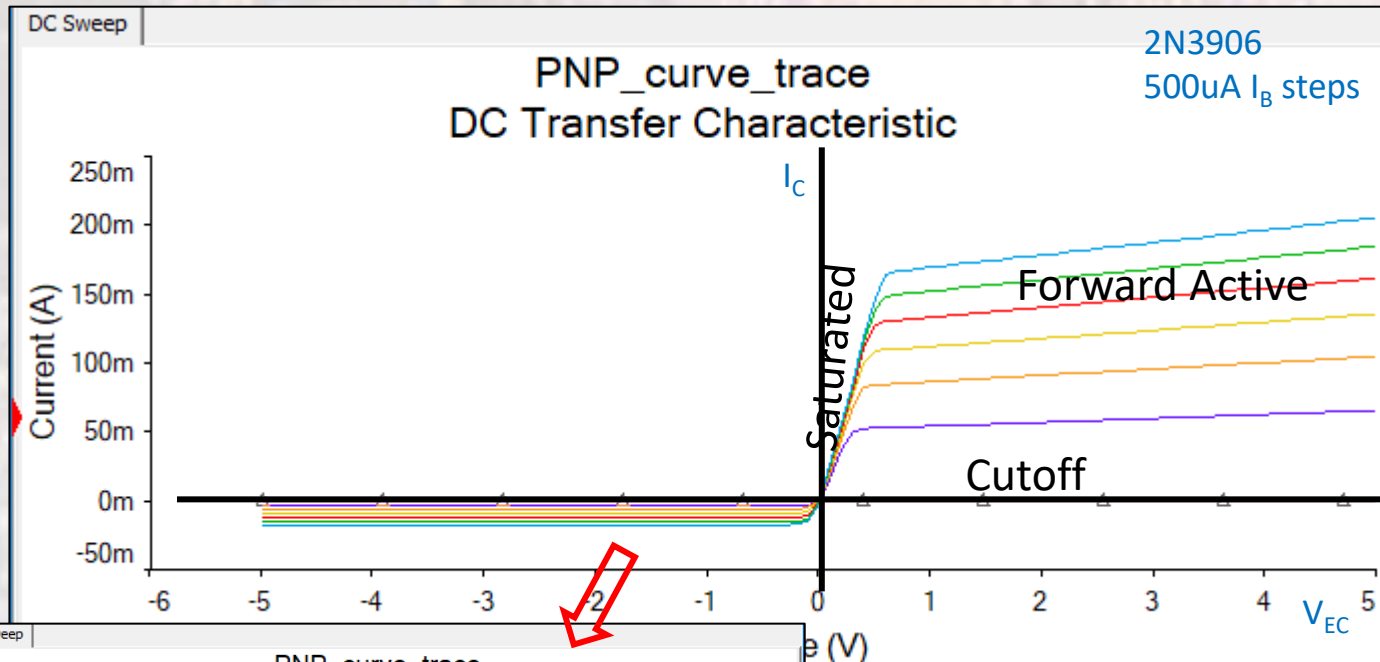
- NPN -  $V_{CEsat}$ 
  - Saturation voltage
  - Lowest the collector will “pull down” while still providing current



# BJT IV Characteristics



- PNP – 4 regions of operation



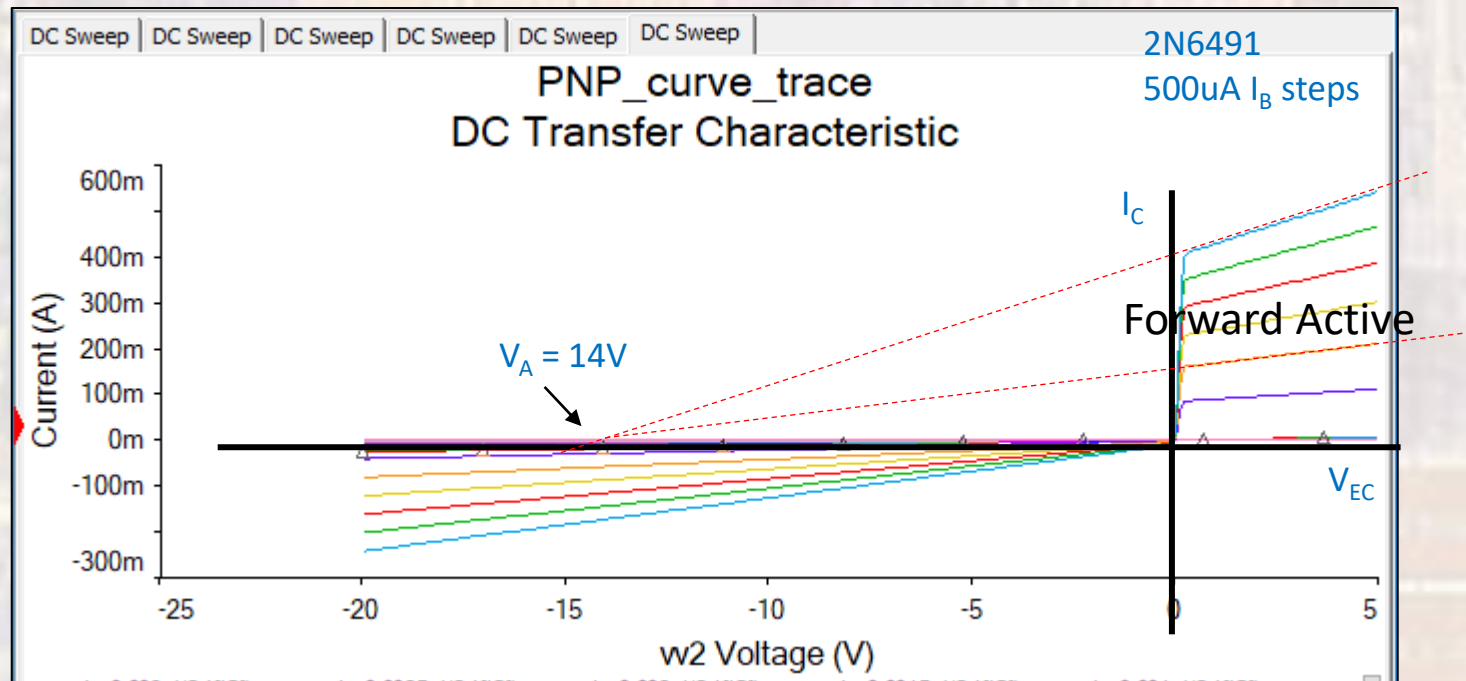
$I_C = \beta I_B$

Note: not exact, small slope to the  $I_C$  vs  $V_{CE}$  curve

Note: not constant for large  $I_C$

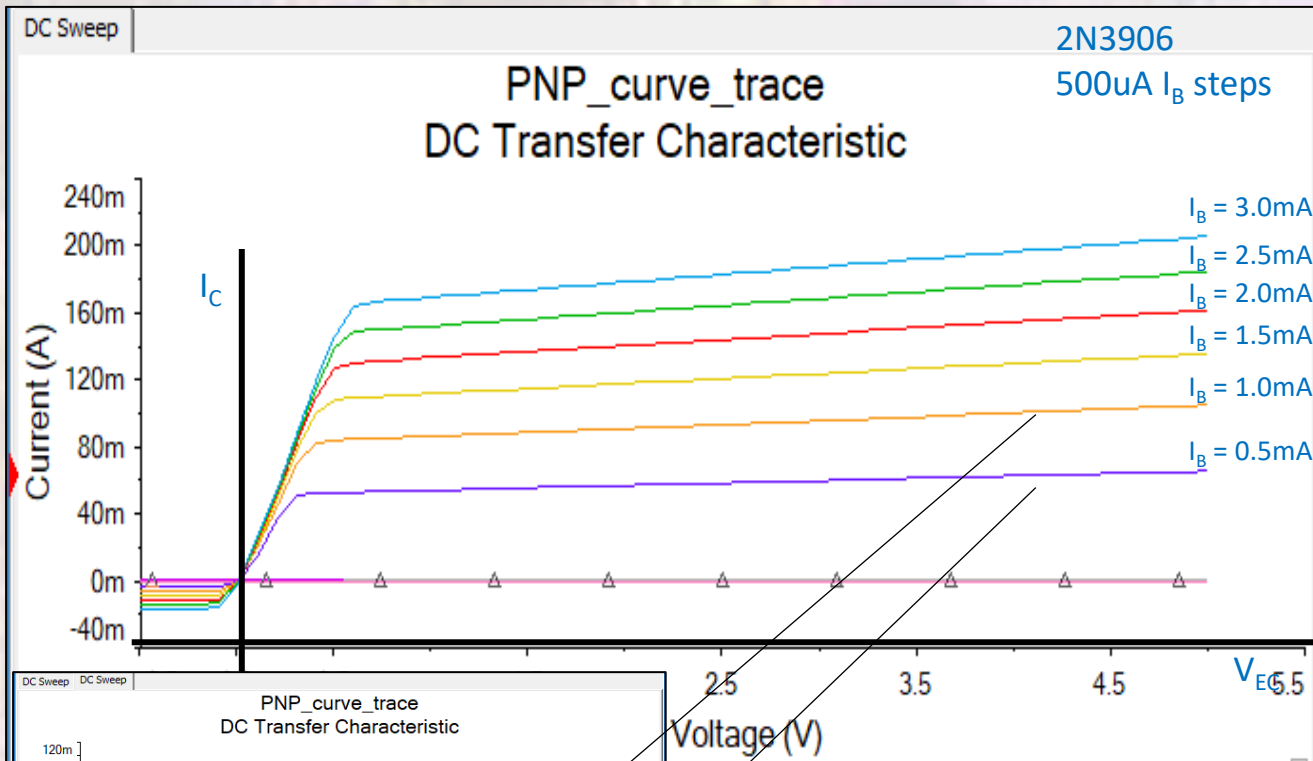
# BJT IV Characteristics

- PNP – Early Voltage
  - Increasing  $V_{EC}$  → wider depletion region and greater electric field
  - → increasing  $I_C$
  - The curves converge on the **Early Voltage**,  $-V_A$



# BJT IV Characteristics

- PNP – Beta variation
  - Excess carriers in the base cause  $\uparrow$  base current  $\rightarrow \downarrow \beta$

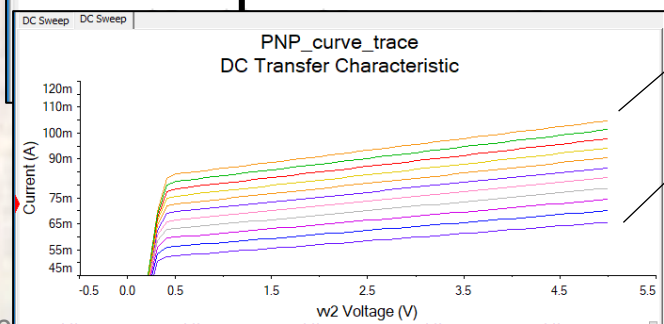


$\rightarrow I_C = 203\text{mA} \rightarrow \beta = 68$

$\uparrow$

$\beta$  decreases

$\rightarrow I_C = 65\text{mA} \rightarrow \beta = 130$



$\beta$  constant for moderate current levels



# BJT IV Characteristics

- PNP -  $V_{CEsat}$ 
  - Saturation voltage
  - Highest the collector will “pull up” while still providing current

