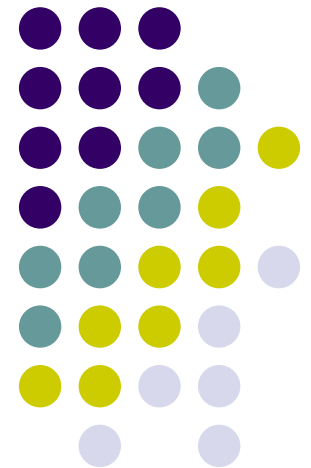
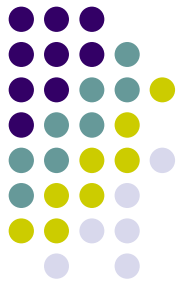


Introduction to Process and Layout

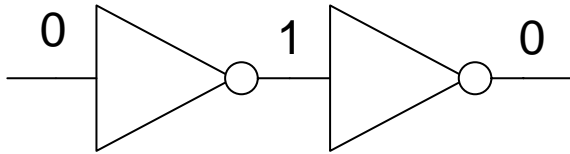
ECE 482 Lecture Notes



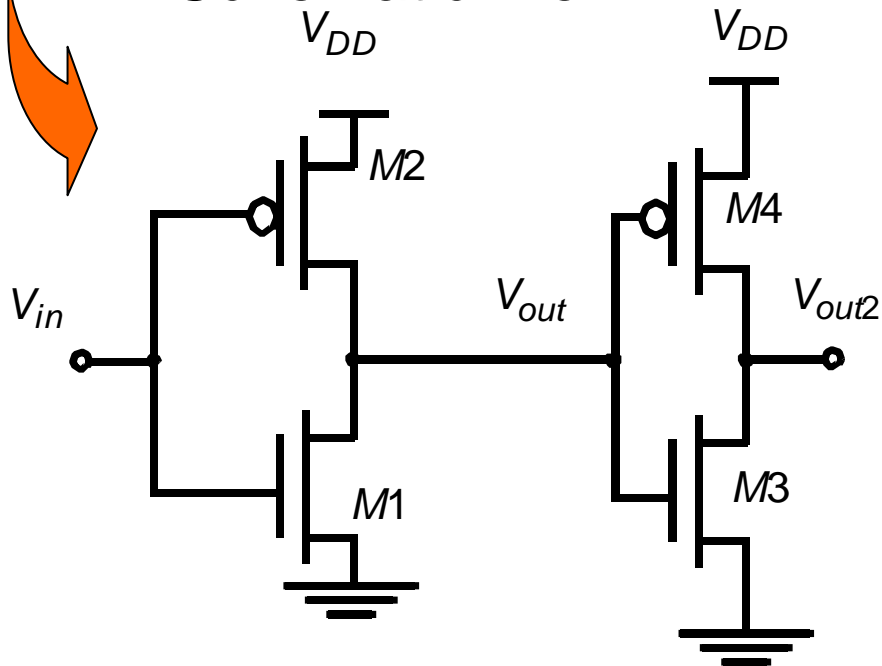


Circuit Design and Layout

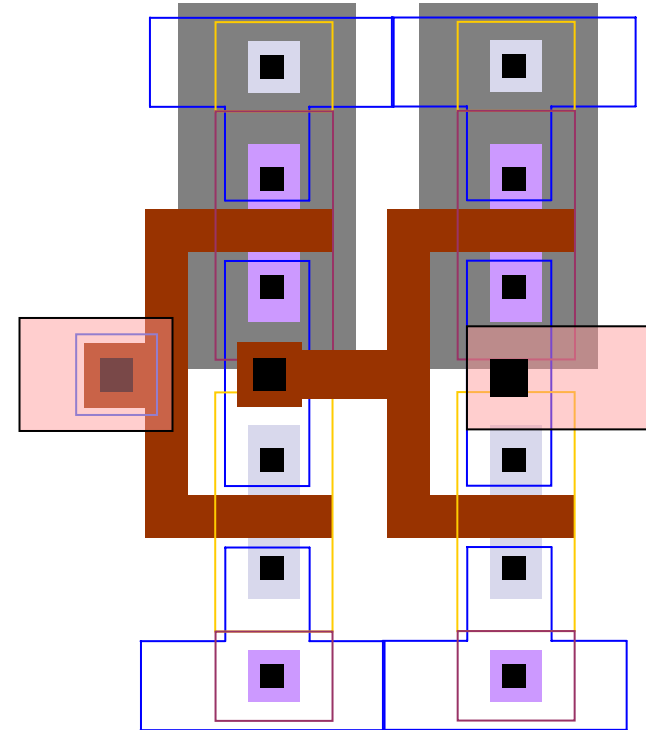
Logic Gate View:

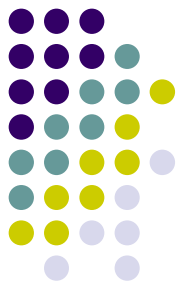


Schematic View:



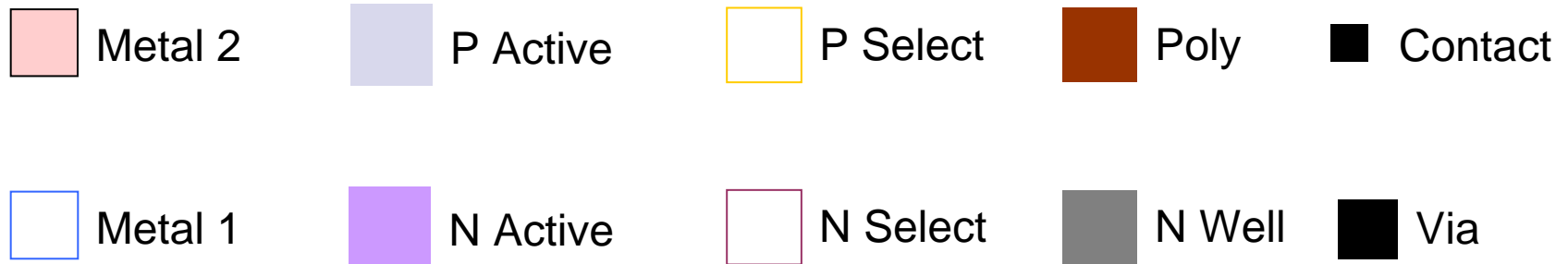
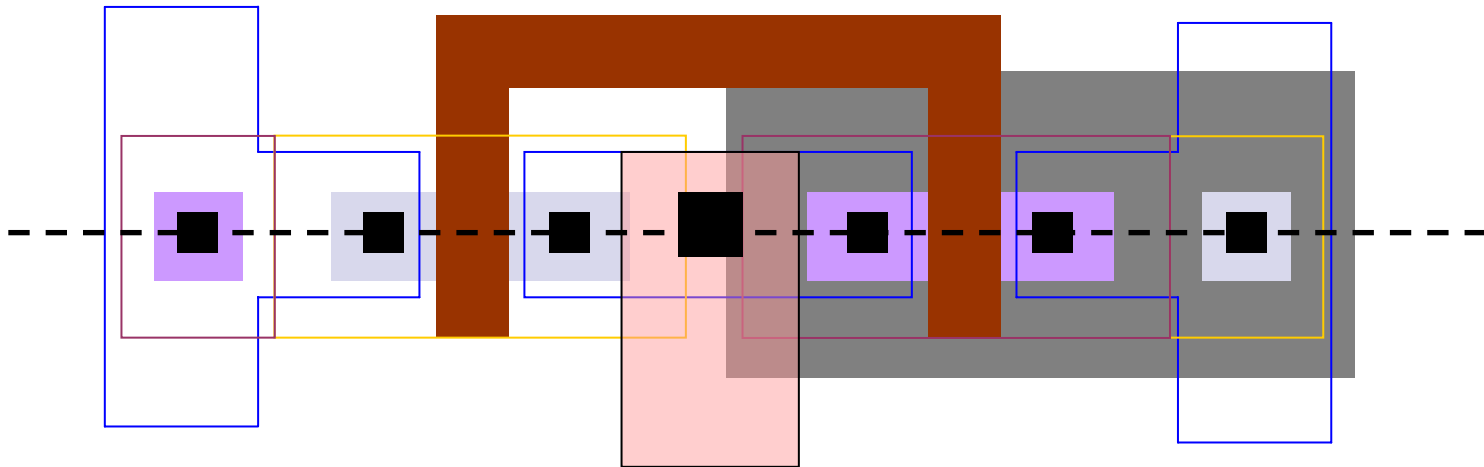
Layout View:





A Typical Inverter Layout

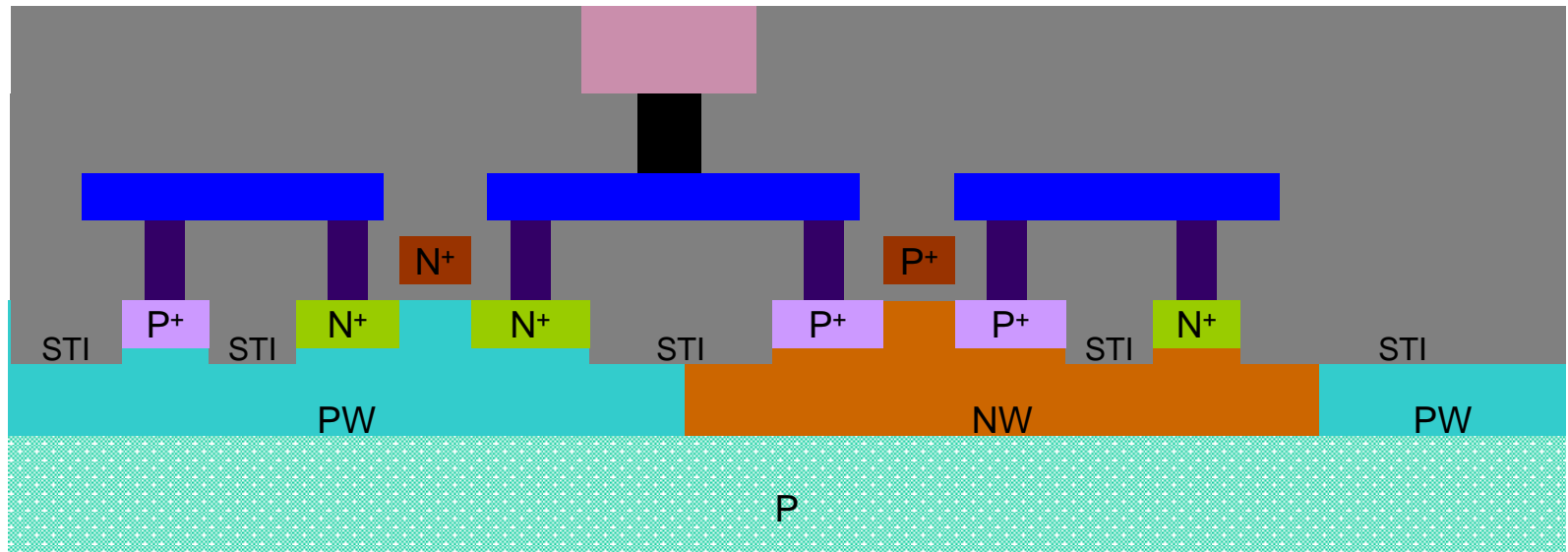
- Transistors and wires are defined by geometric patterns
- Cross-section taken along the dashed line





Process and Cross-section

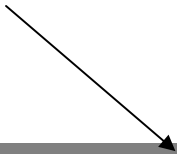
- Shallow Trench Isolation
- Dual-Well Process
- Dual-select Masks (n-sel and p-sel masks)



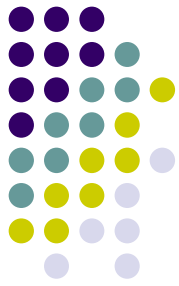
Process Step 1: SiO₂ Growth



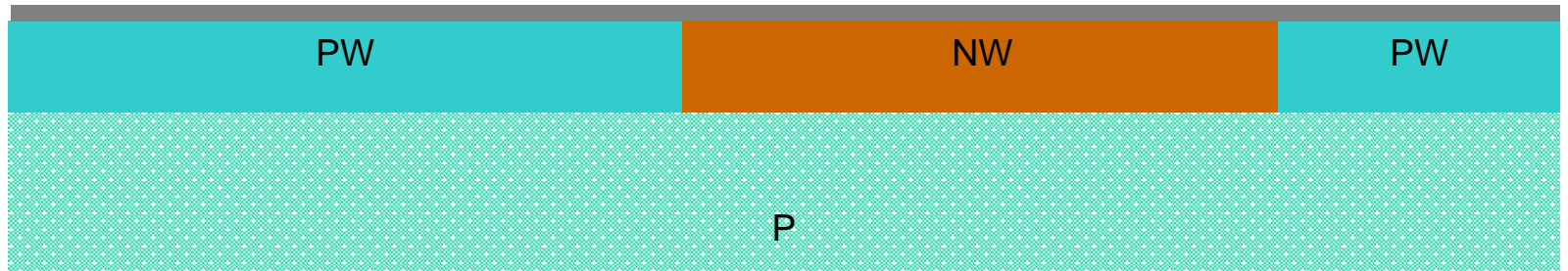
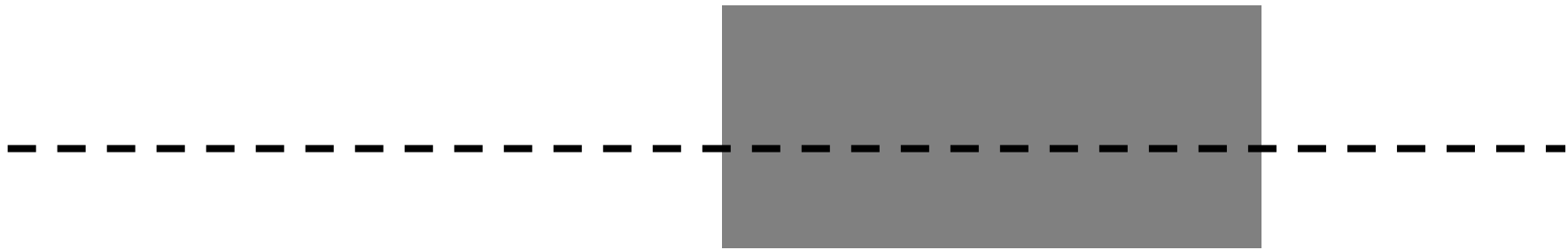
SiO₂



Step 2: N-Well & P-Well Implantation



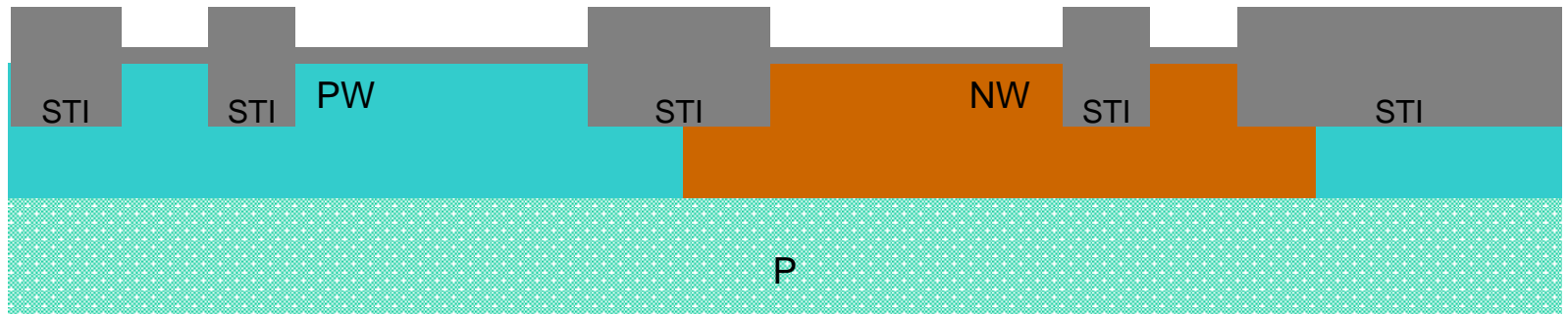
N-Well Mask:



Step 3: Etch STI & Generate Active Area

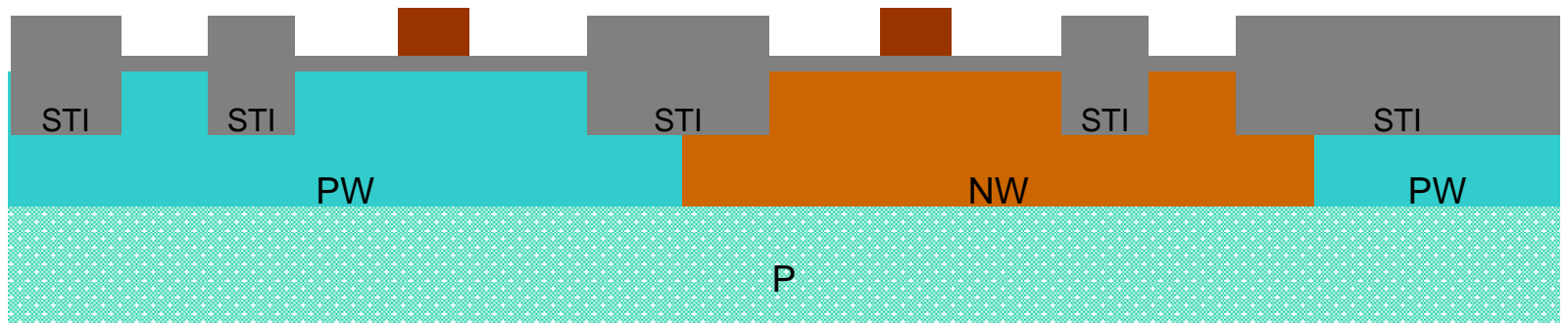
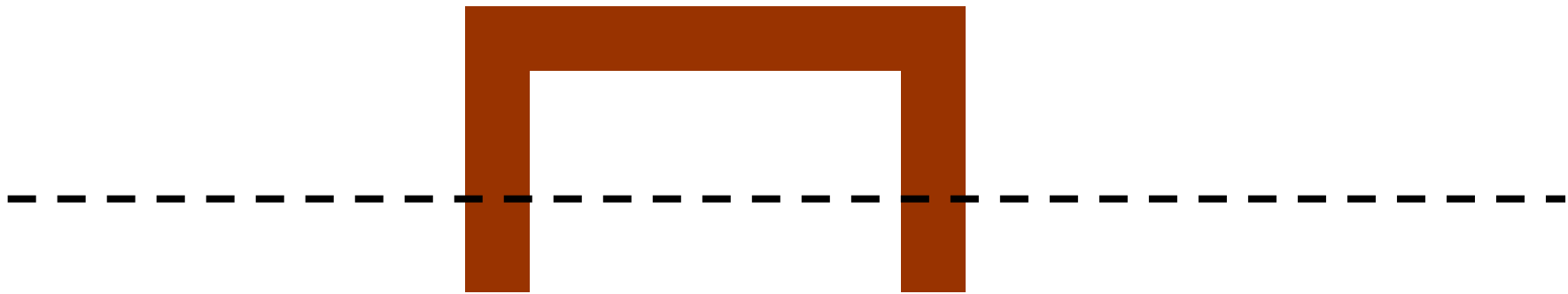


Active Area Mask:



Step 4: Poly

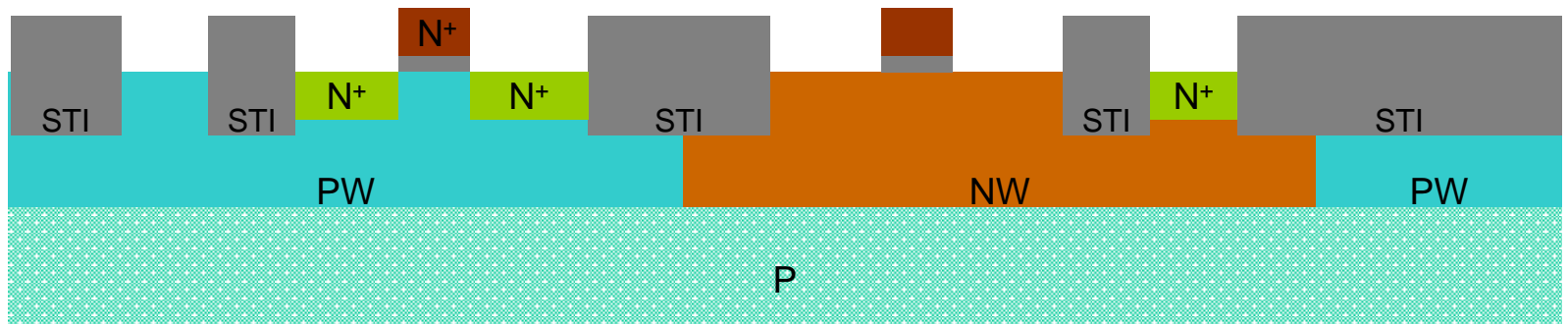
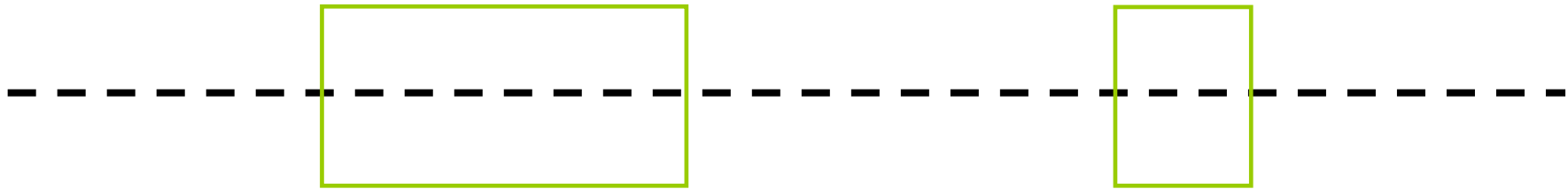
Poly Mask:



Step 5: N-Select & N⁺ Implantation



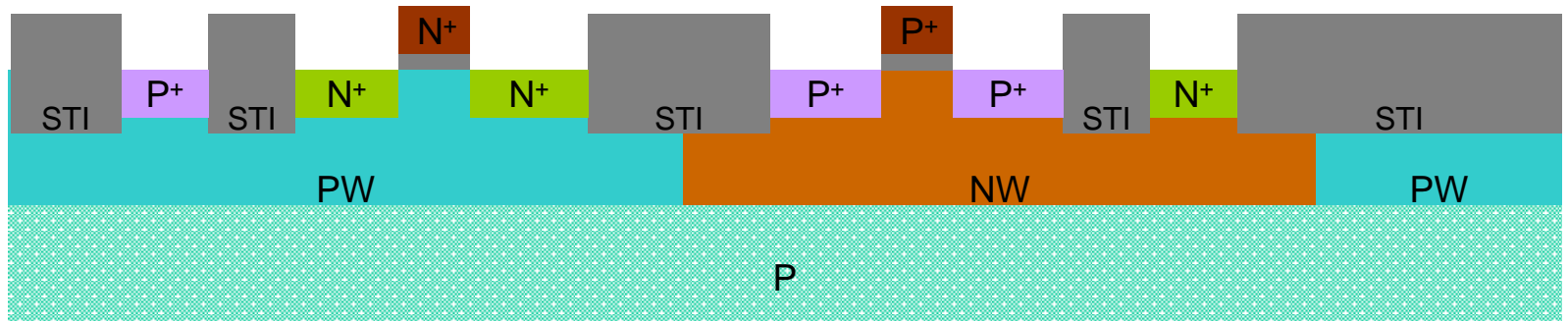
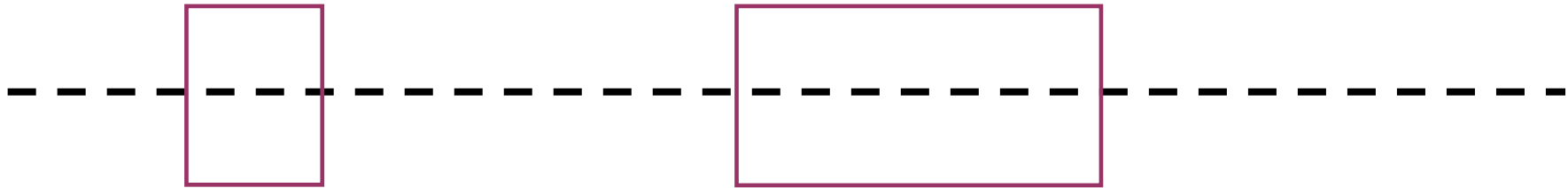
N-Select Mask:

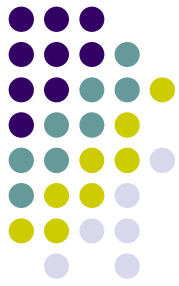


Step 6: P-Select & P⁺ Implantation



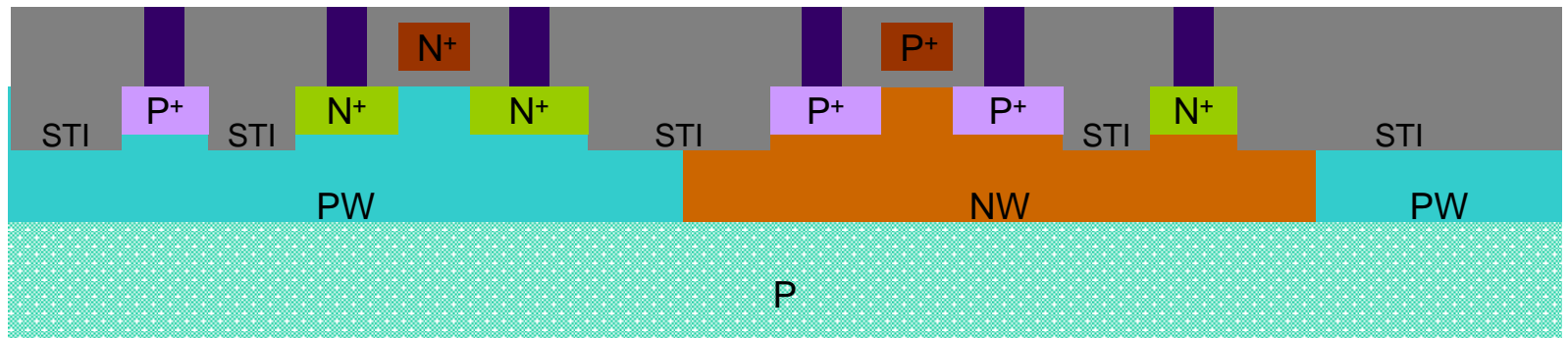
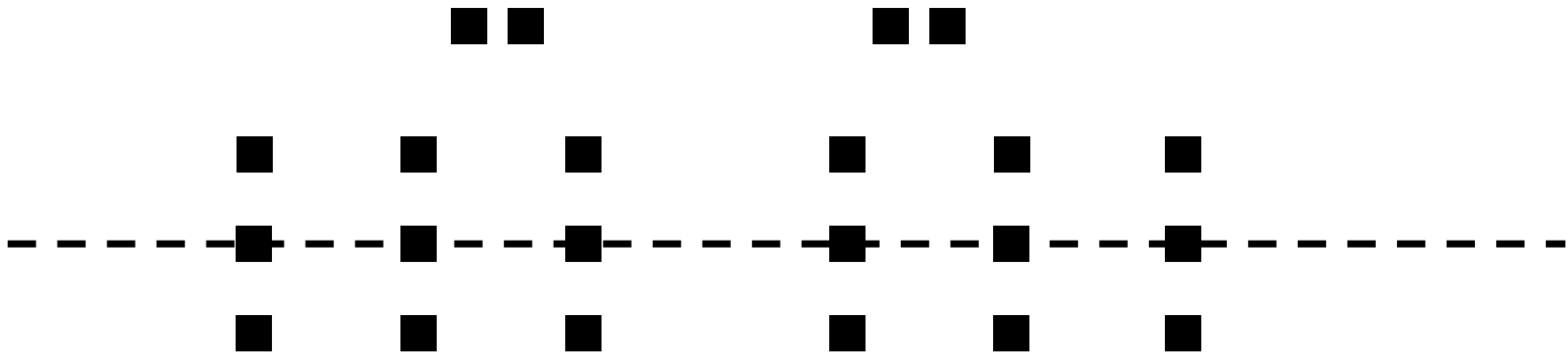
P-Select Mask:

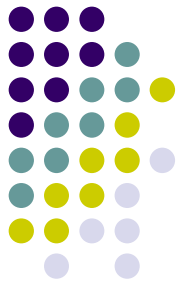




Step 7: Etch Contacts

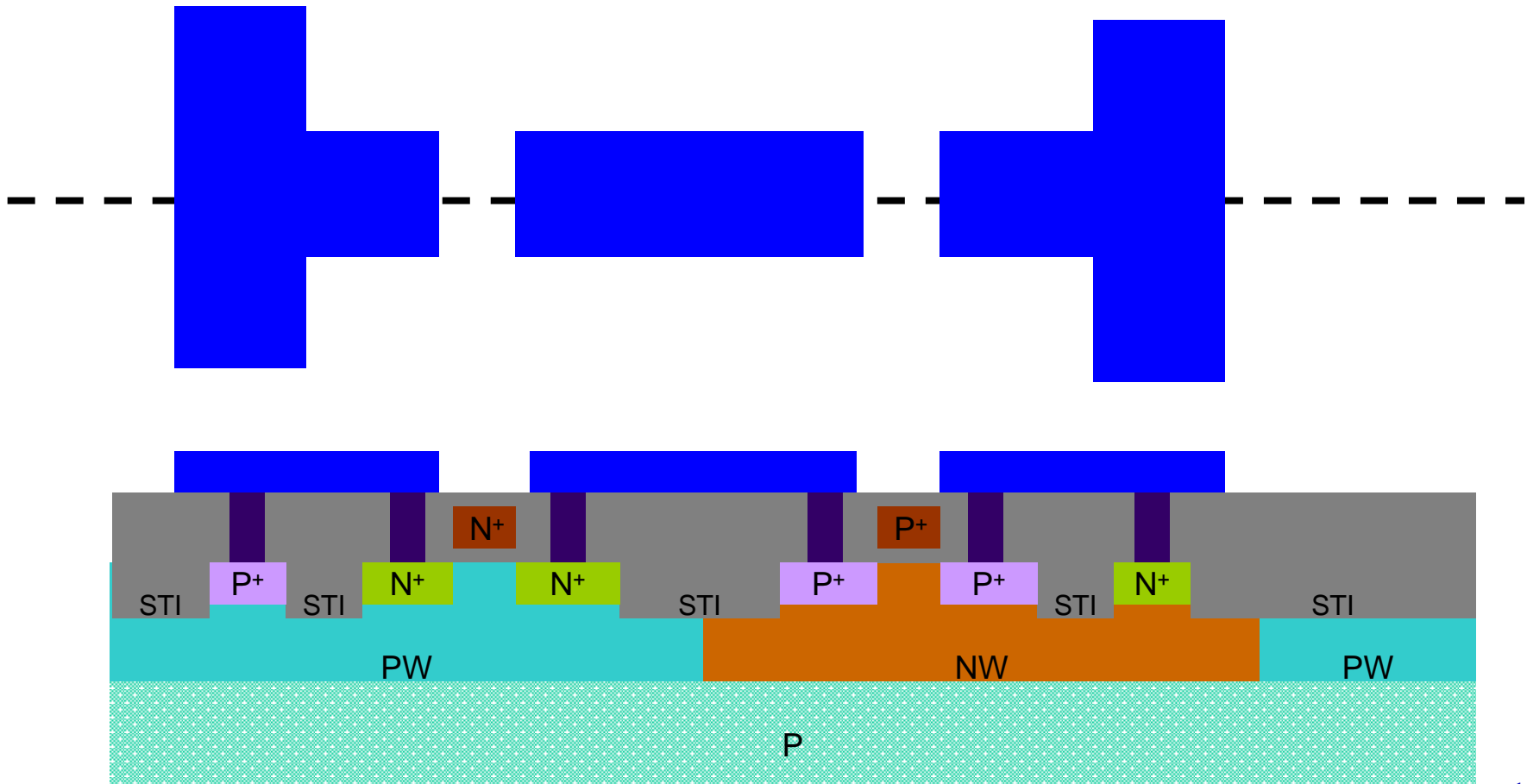
Contact Mask:

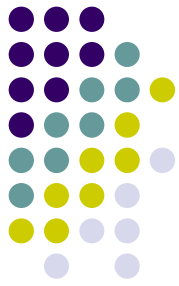




Step 8: Deposit Metal 1

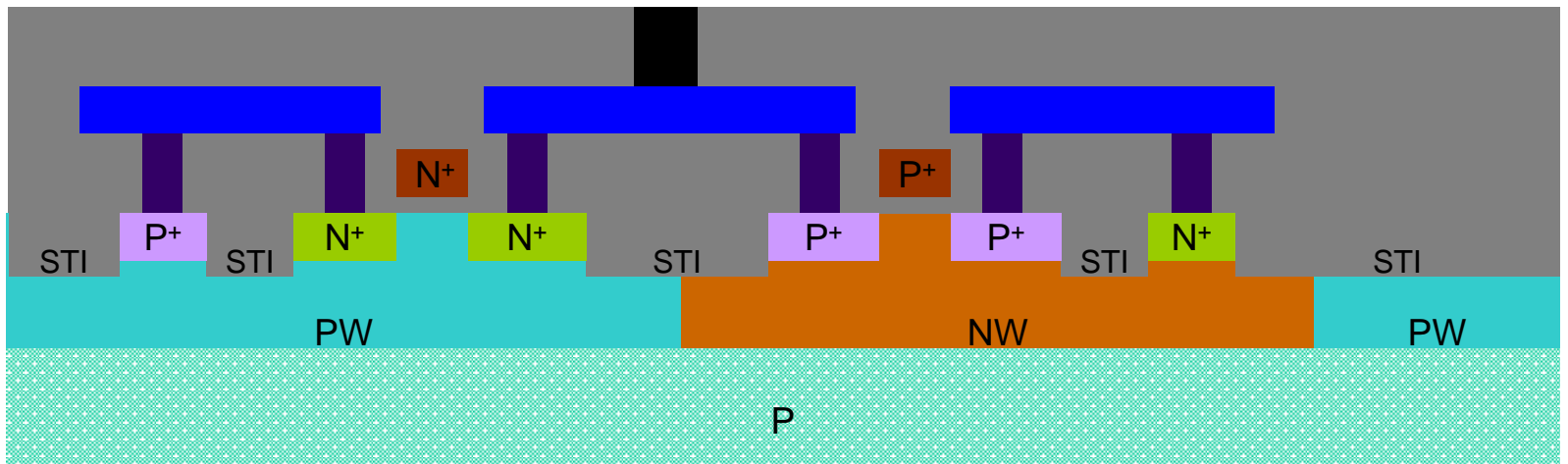
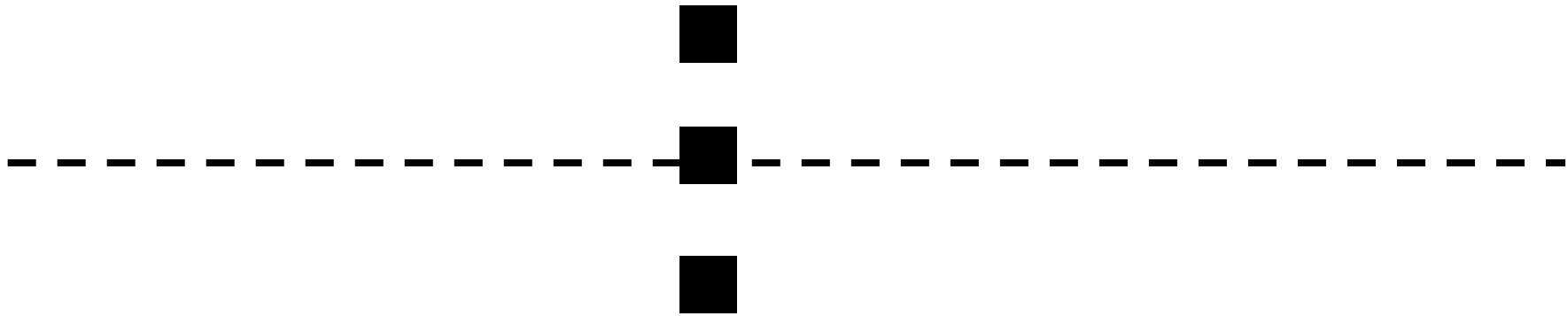
Metal 1 Mask:

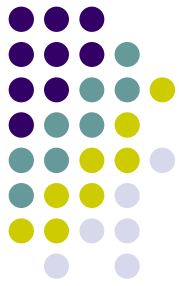




Step 9: Etch Via 1-2

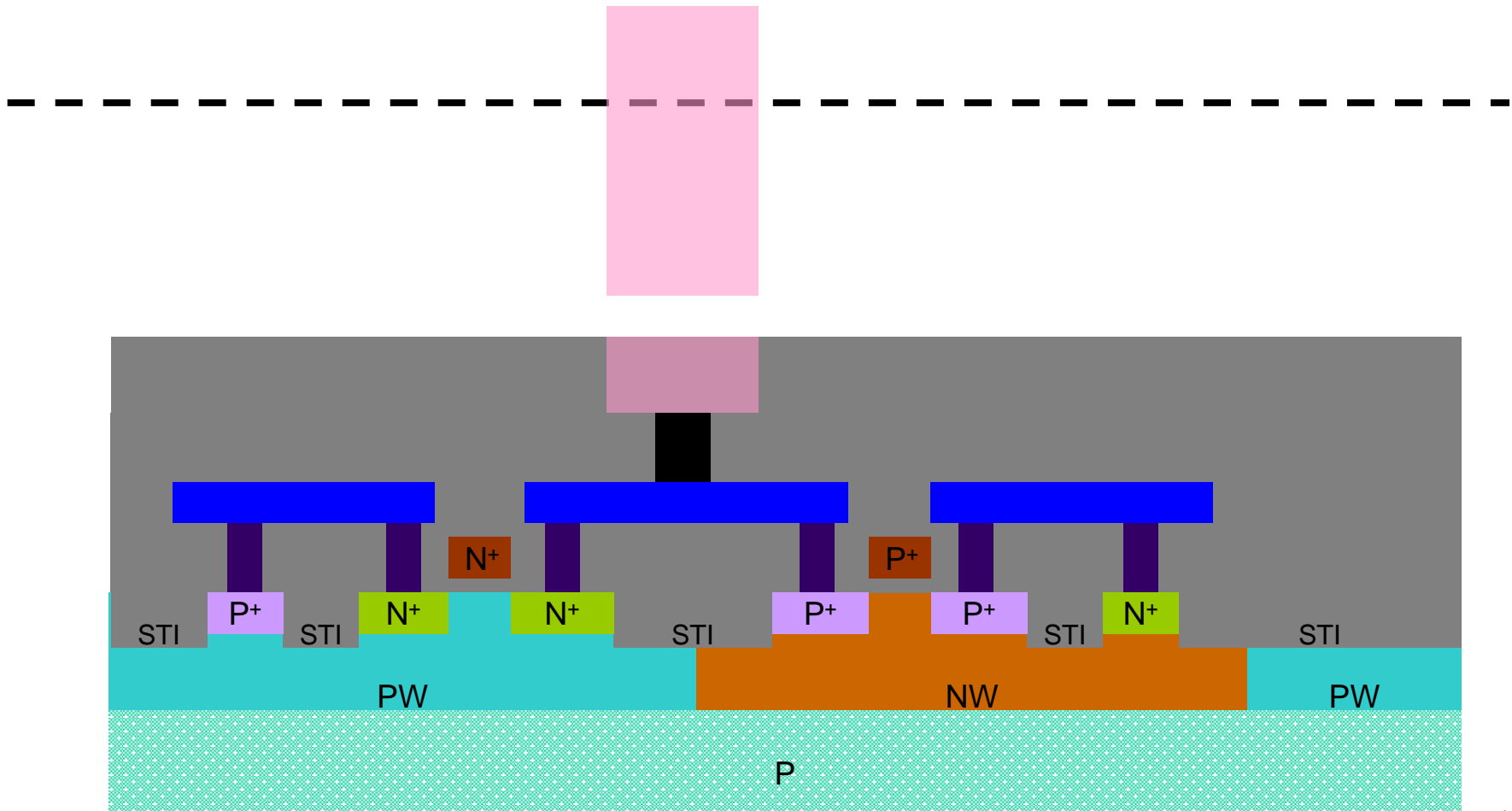
Via 1-2 Mask:





Step 10: Deposit Metal 2

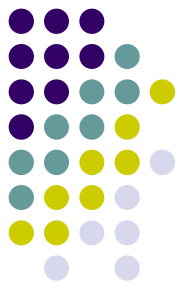
Metal 2 Mask:



Design Rules



- Interface between designer and process engineer
- Guidelines for constructing process masks
- Unit dimension: Minimum line width
 - scalable design rules: λ parameter (used in our lecture)
 - absolute dimensions (micron rules)

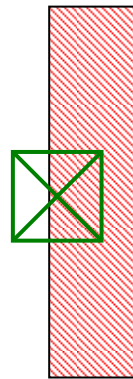


Why are Design Rules needed?

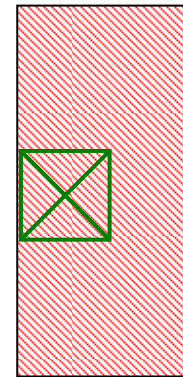
- E.g.: Metal must overlap contact by 1λ
 - *Because lithography process is not perfectly controlled*



$W_{M1} = W_{\text{contact}}$
Perfect alignment
Low contact resistance

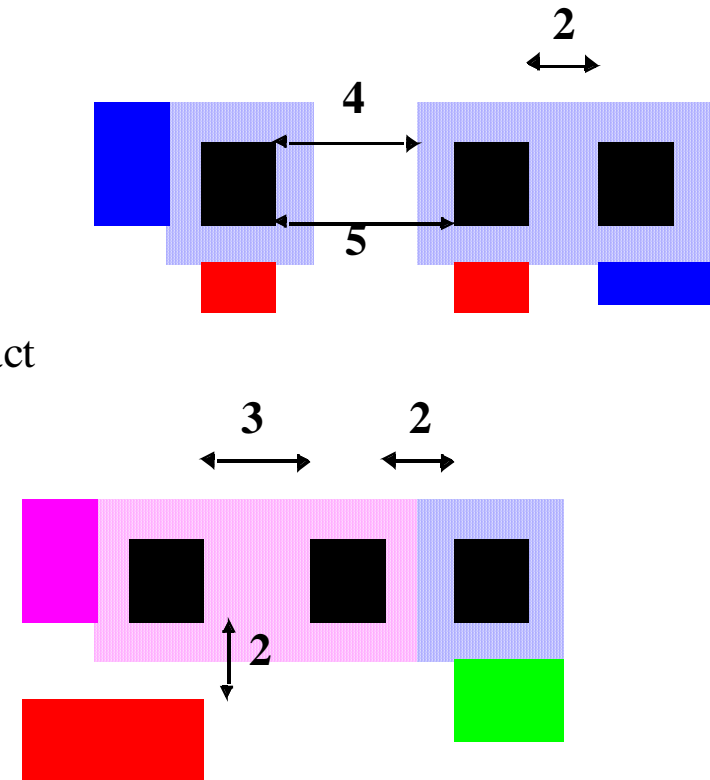
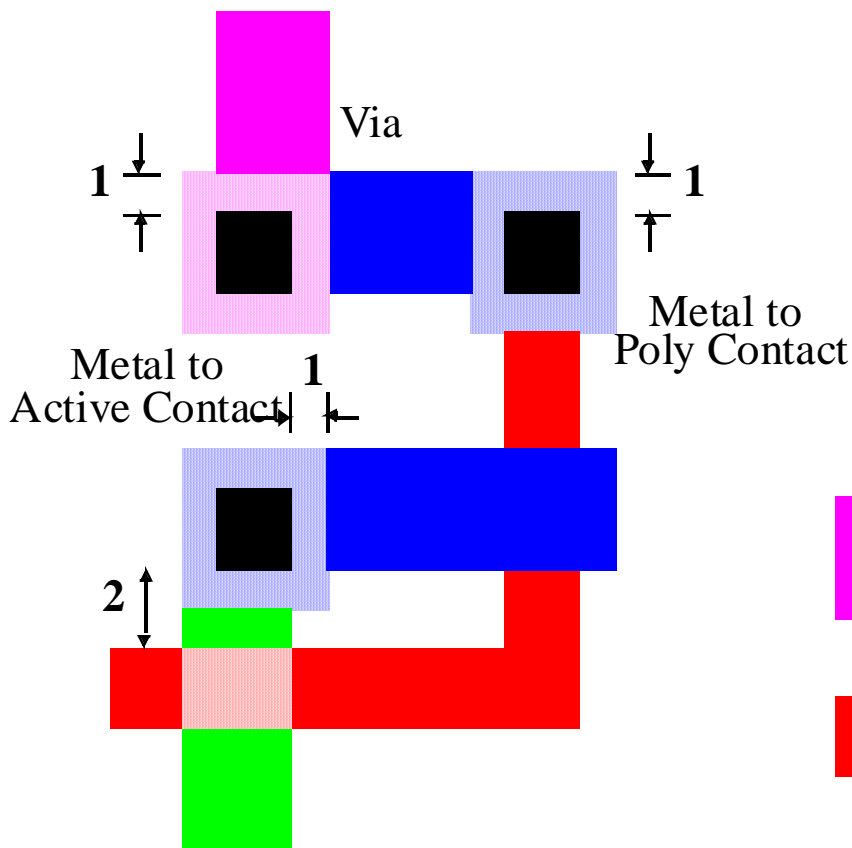


$W_{M1} = W_{\text{contact}}$
Imperfect alignment
High contact resistance

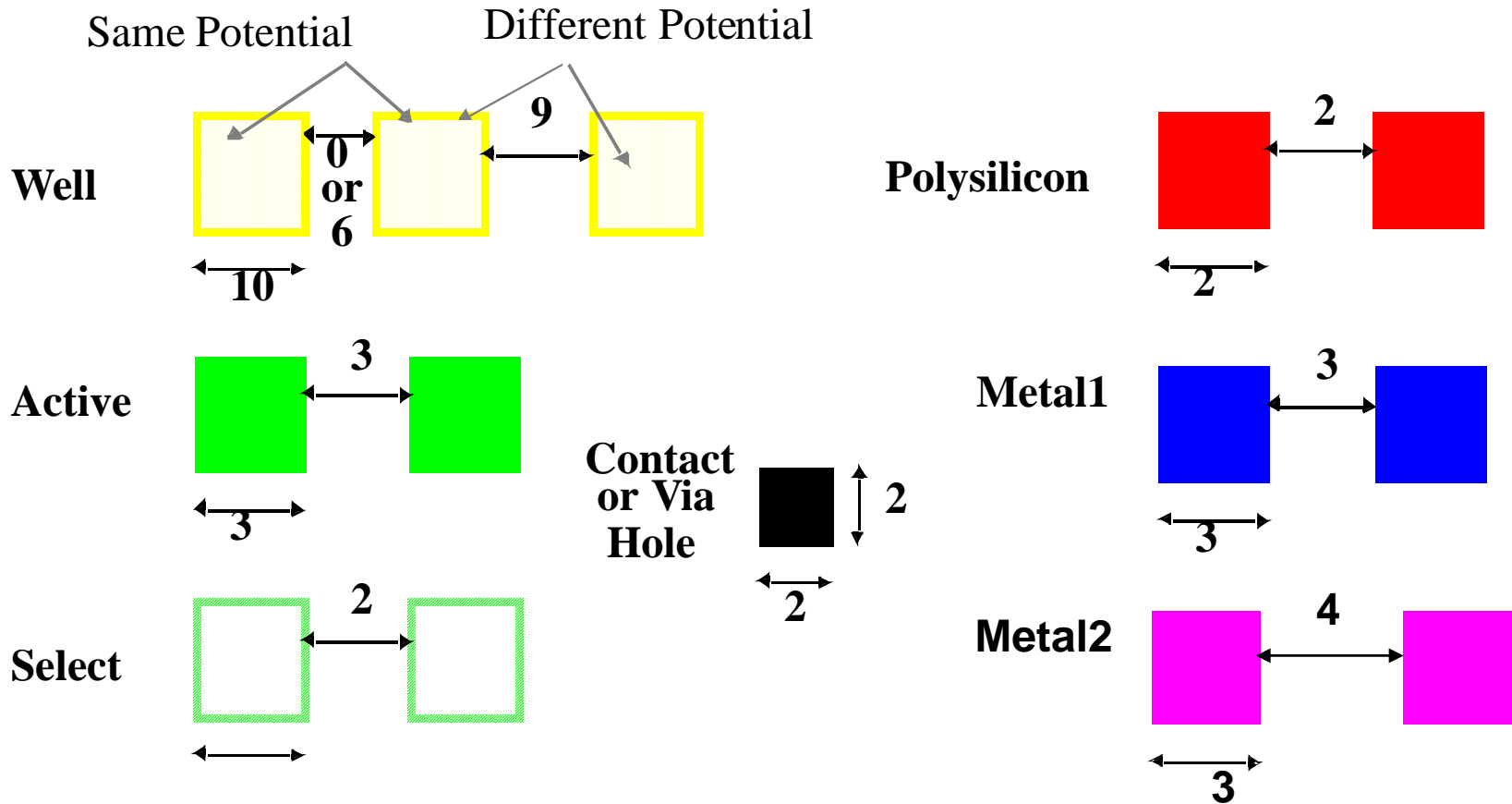


$W_{M1} > W_{\text{contact}}$
Imperfect alignment
Low contact resistance

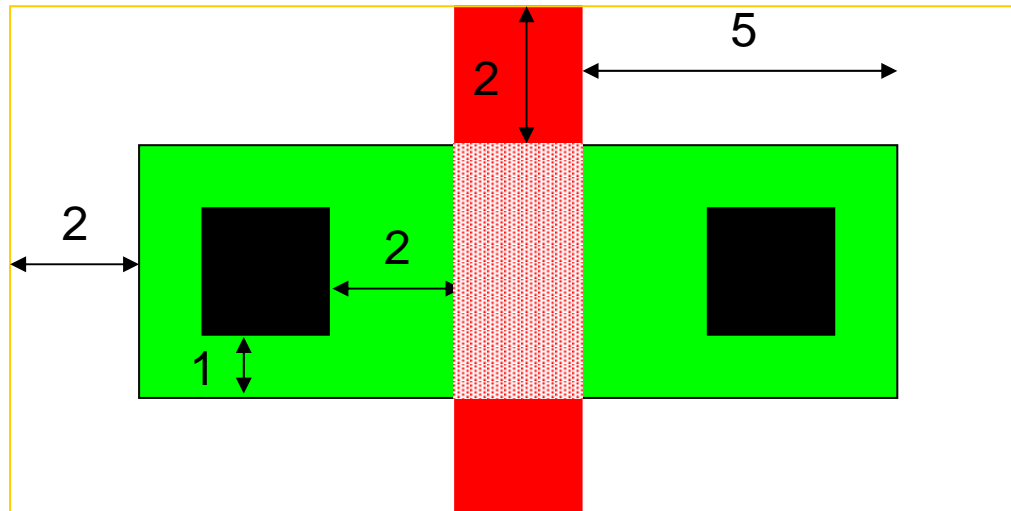
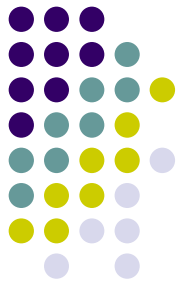
Examples of Via and Contact Design Rules



Examples of Spacing Design Rules



Examples of Extension Design Rules



Examples of Overlap Design Rules

