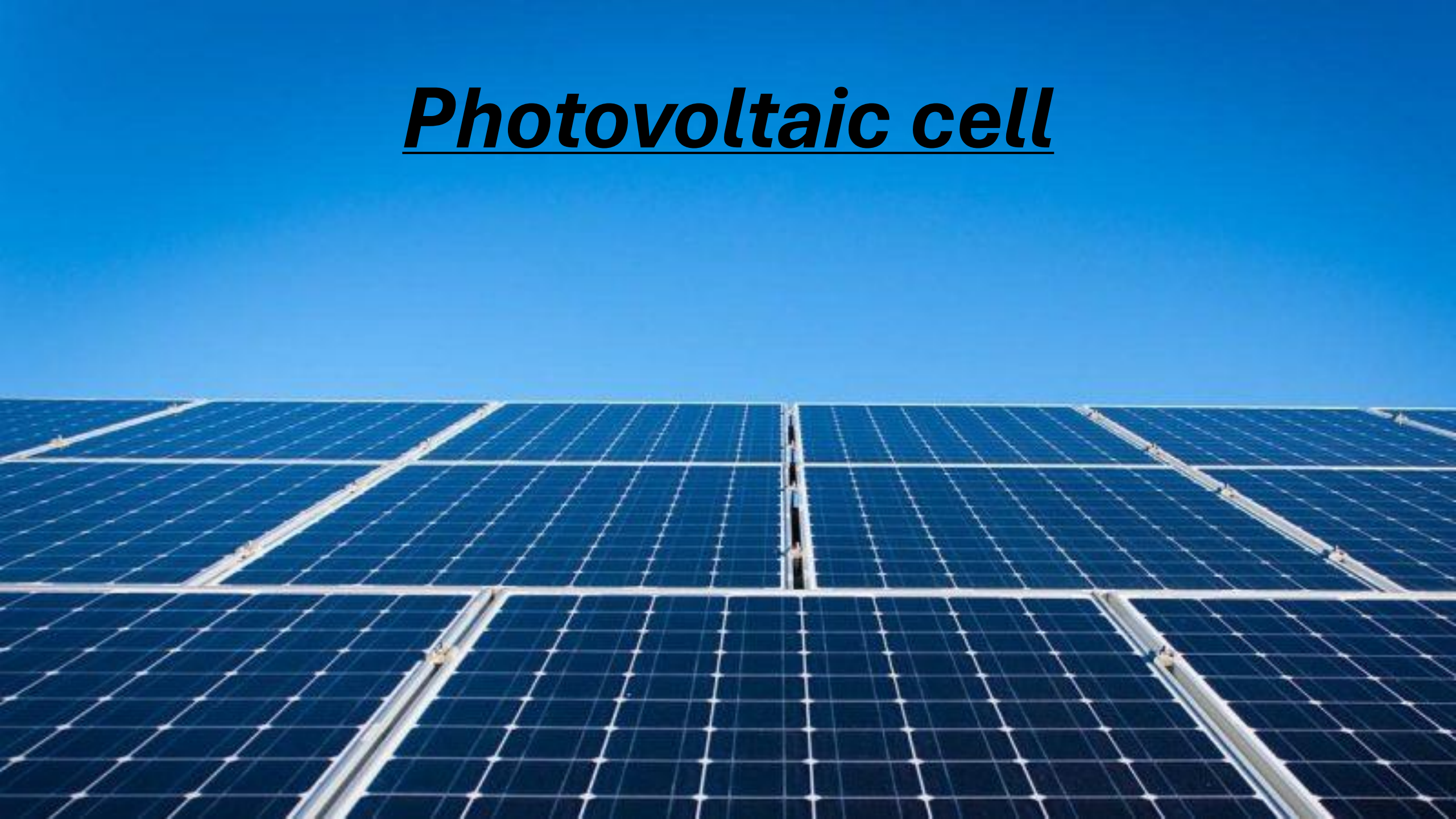
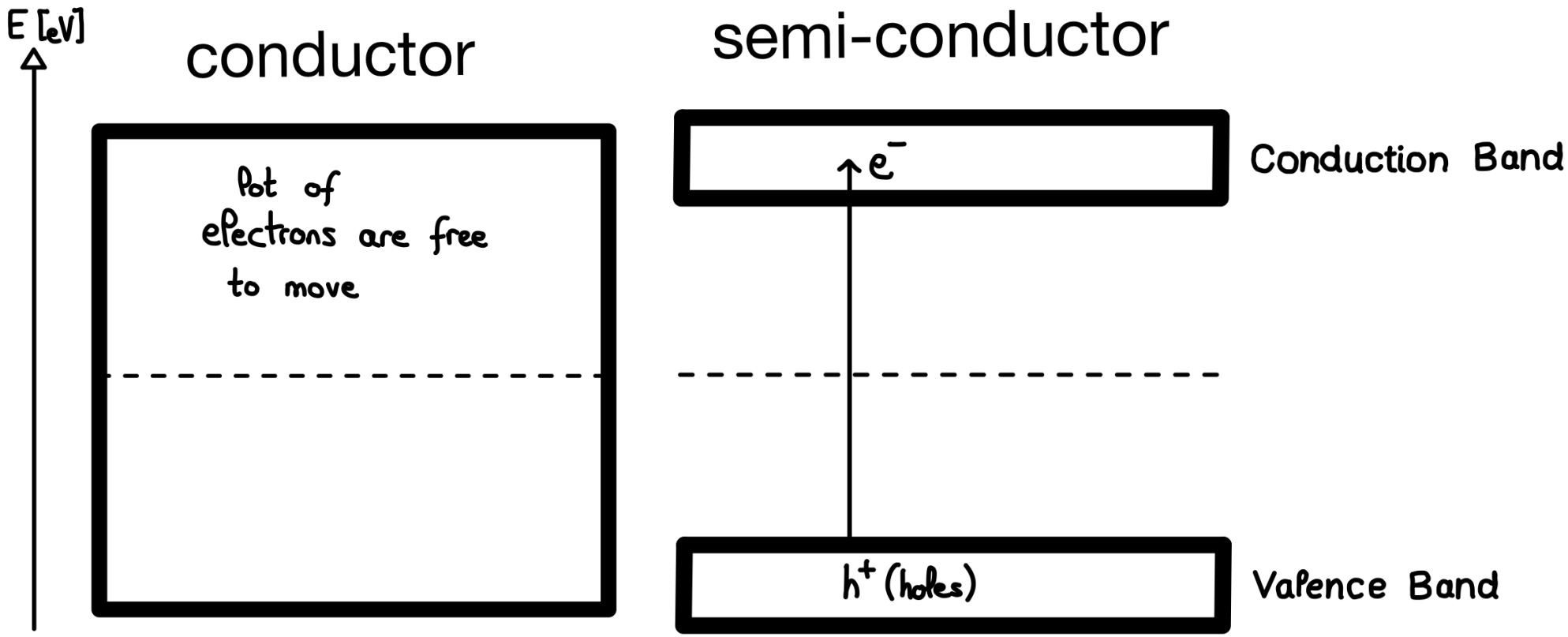
Photovoltaic cell

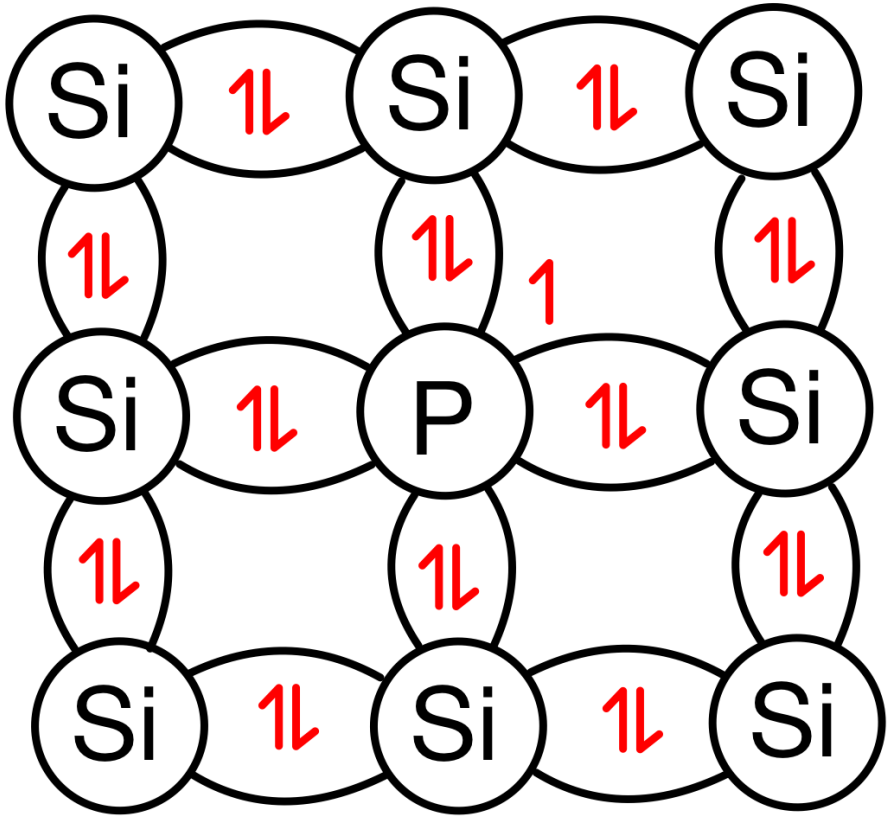



E [eV]
conductor
Lot of
electrons are free
to move
semi-conductor
e⁻
Conduction Band
h⁺ (holes)
Valence Band

Doping = introducing charge carriers

n-type

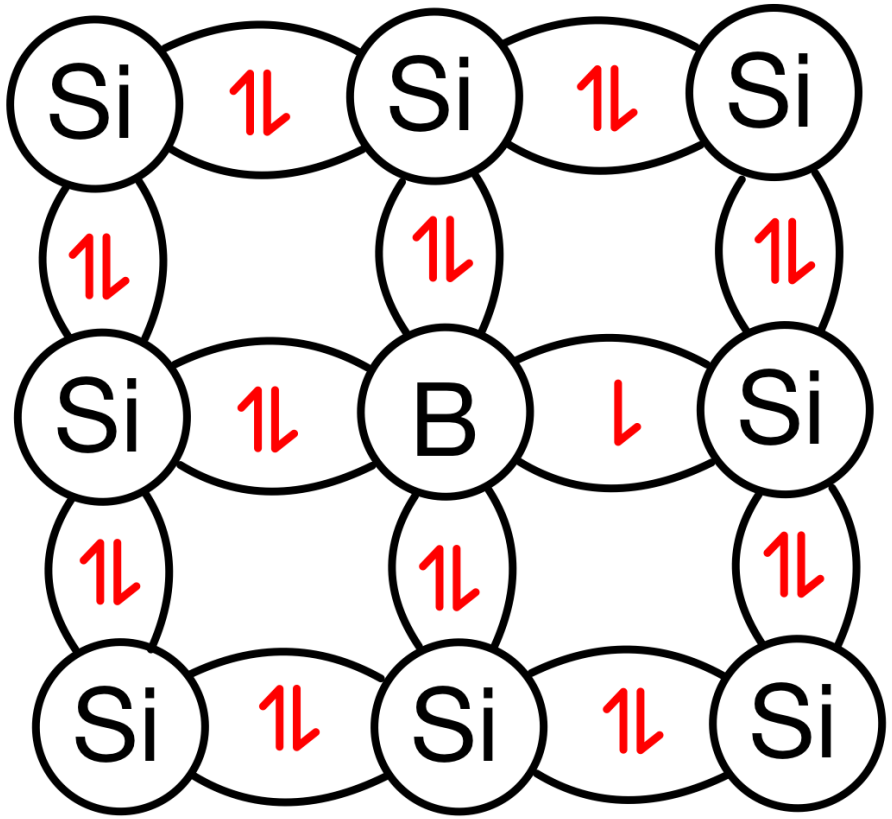
- Some silicons are replaced by phosphorus atoms.
- The excess of electron give rise to a free electron
- The Fermi level is above the middle of the band gap



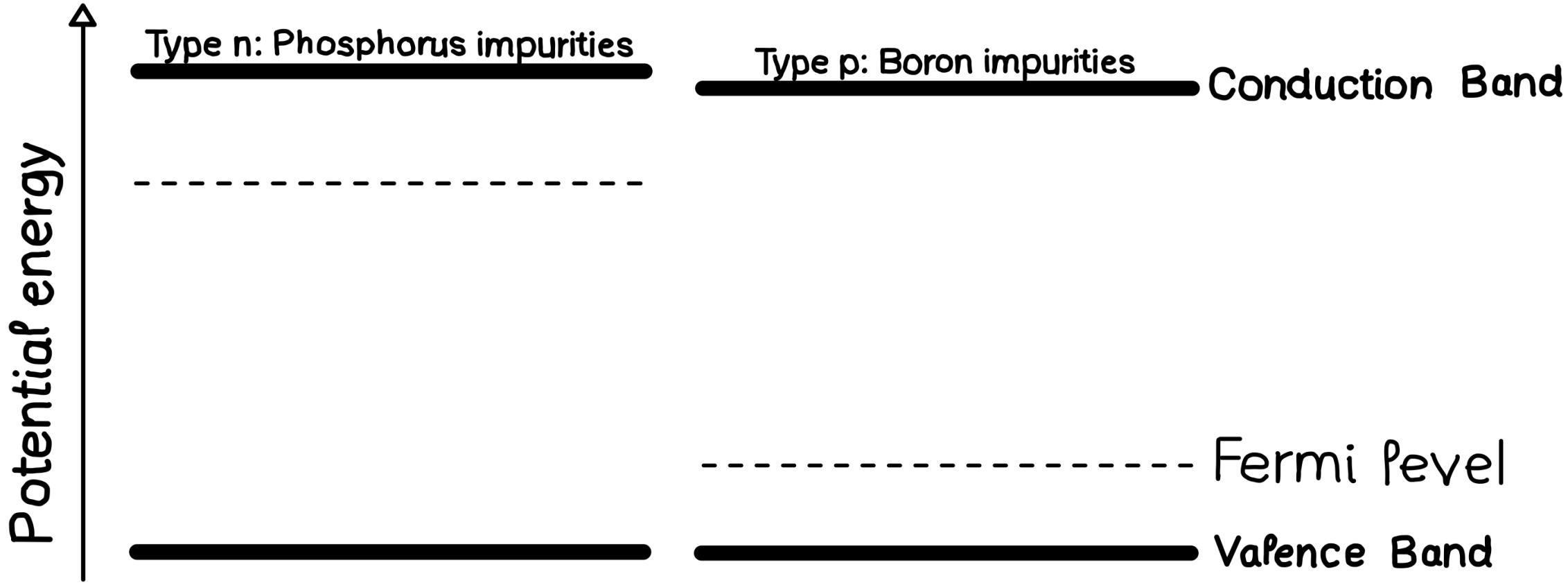
Doping = introducing charge carriers

p-type

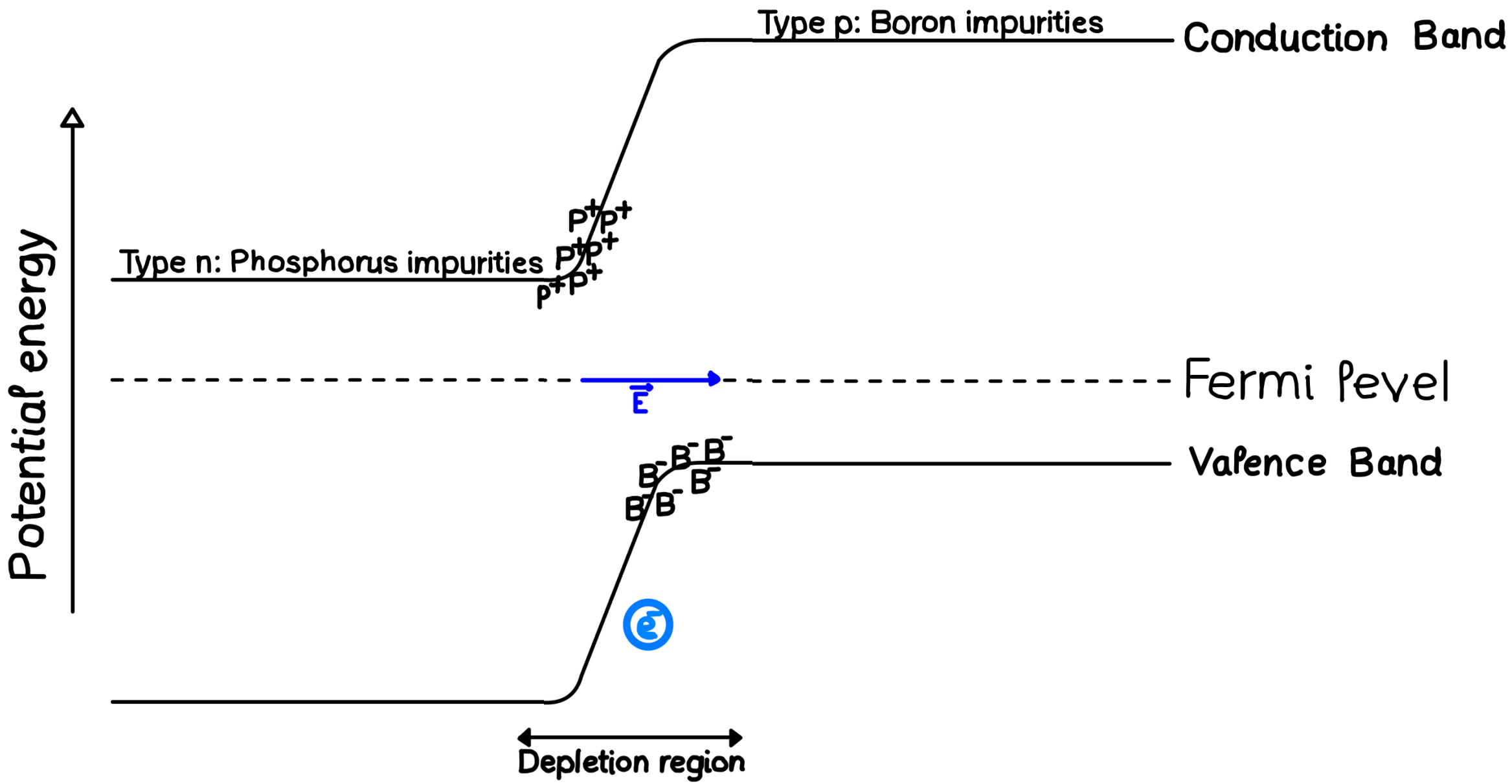
- Some silicons are replaced by boron atoms.
- A lack of electron is called hole
- The Fermi level is below the middle of the band gap



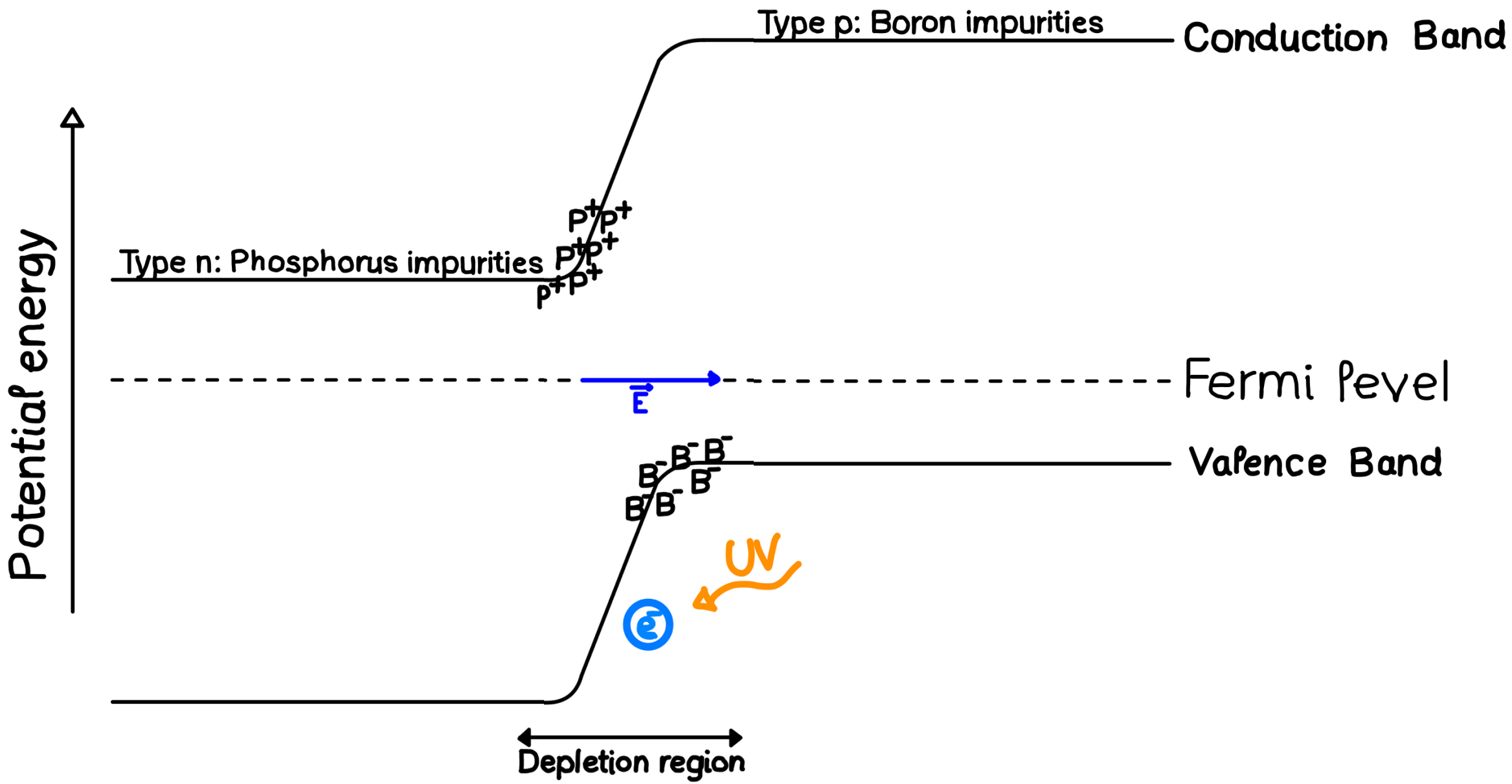
P & N type semi-conductors Fermi levels

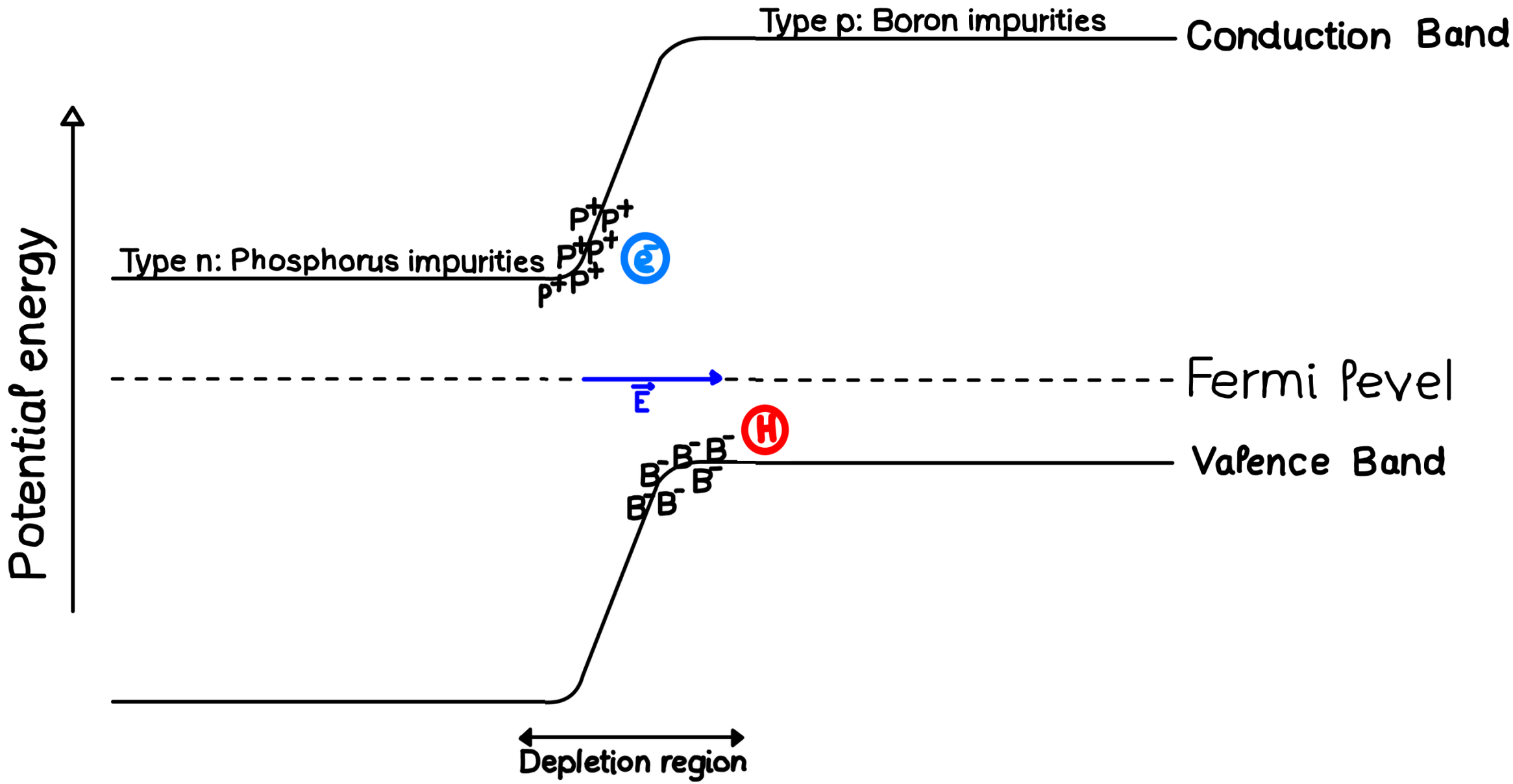


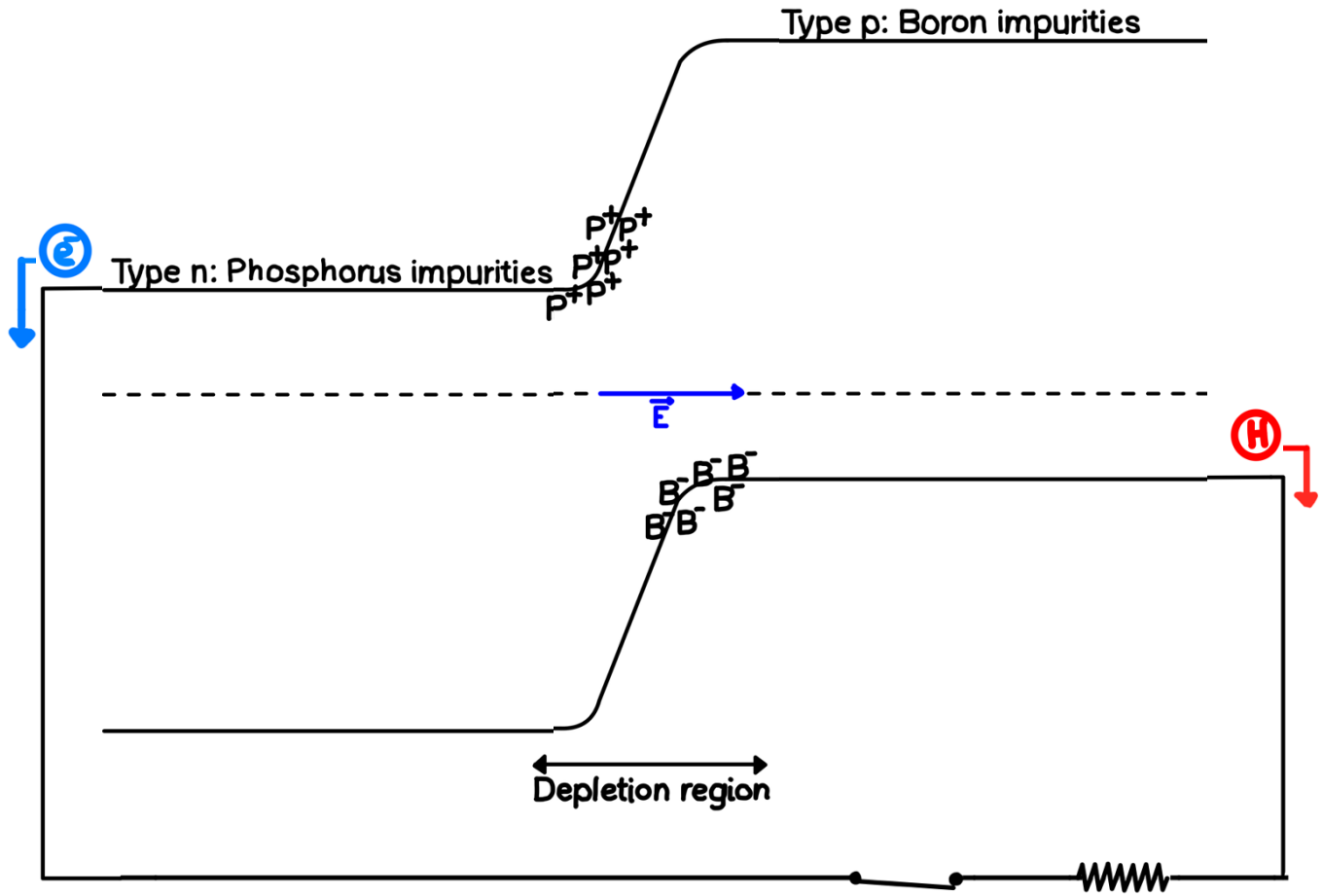
Pn junction


Type p: Boron impurities
Conduction Band
Type n: Phosphorus impurities
Potential energy
Fermi level
E
Valence Band
Depletion region

Pn junction


Type p: Boron impurities
Conduction Band
Potential energy
Type n: Phosphorus impurities
P+ P+ P+ P+ P+ P+
Fermi level
E
B- B- B- B- B- B-
Valence Band
UV
e
Depletion region


Type p: Boron impurities
Conduction Band
Potential energy
Type n: Phosphorus impurities
P+P+
P+P+
P+P+
e
Fermi level
E
H
B-B-B-
B-B-
B-B-
Valence Band
Depletion region


Type p: Boron impurities
Type n: Phosphorus impurities
P+ P+
P+ P+
P+ P+
e
E
H
B- B- B-
B- B-
B- B-
Depletion region

Introduction

Goal:

- characterize the performance under varying conditions
- determine the properties and the best operating conditions

Current-voltage curve shows:

- short-circuit current (Isc)
- Open-circuit voltage (Voc)
- Fill factor (FF)
- Overall efficiency (η)

How does temperature and brightness affect these parameters ?

Experimental part

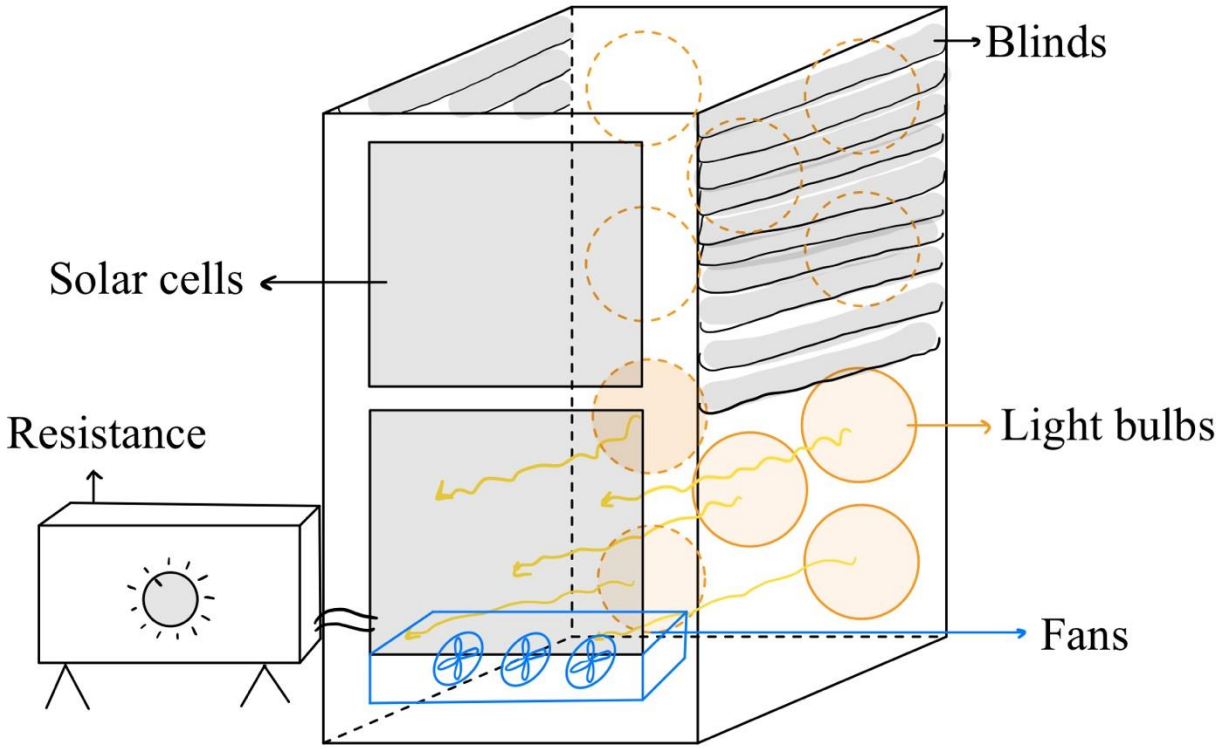
- Description of the apparatus

- Description of the manipupation

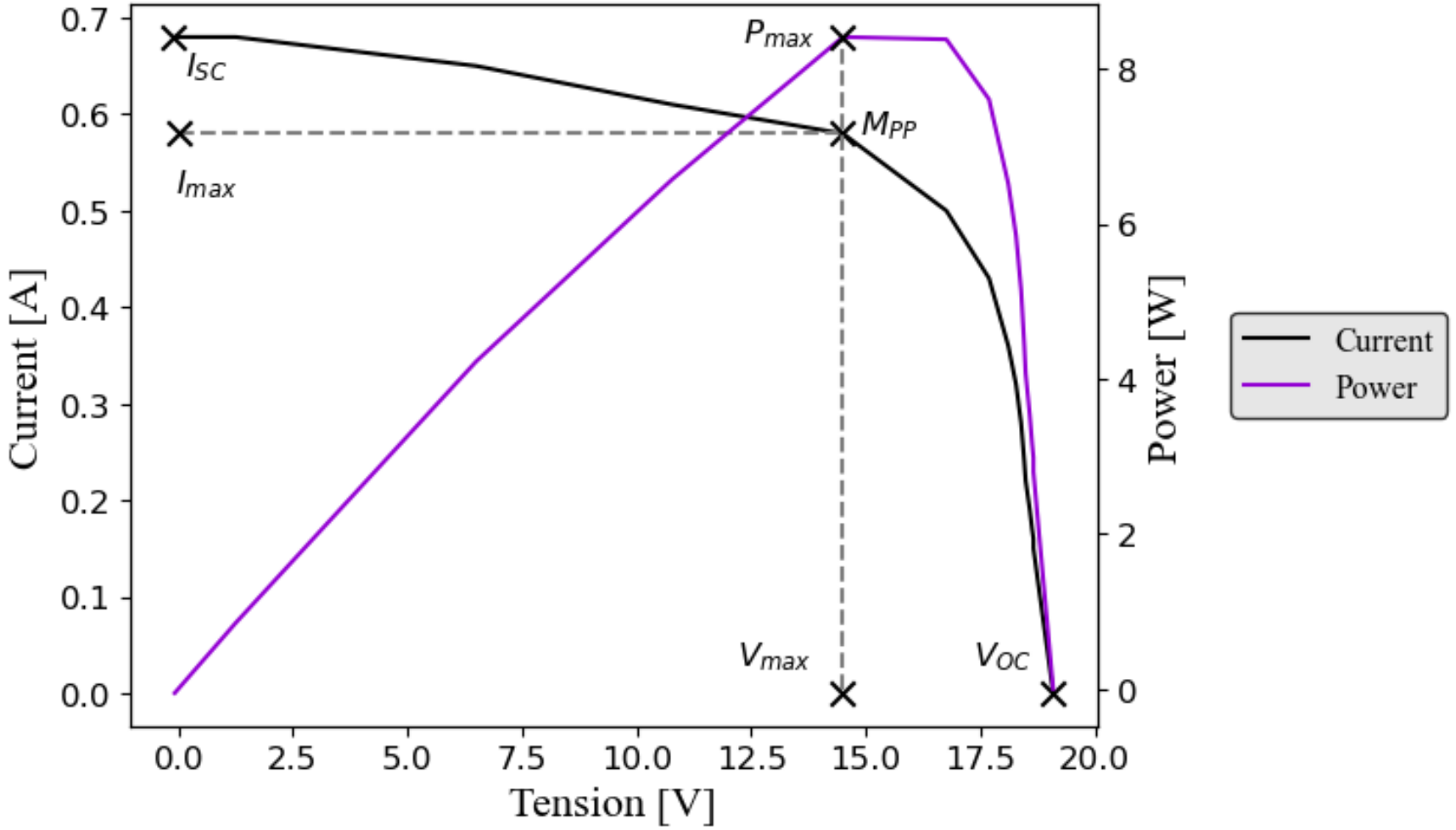
  - ➢ Constant intensity light = 100%,
    Temperature = 40, 45, 50 °C

  - ➢ Constant temperature = 35 °C,
    Intensity light = 75, 85, 100%

  - ➢ 6x 18 values taken



Results & Discussion



Temp: 35°C

I_{SC} = 0.68 A

V_{OC} = 19.1 V

I_{max} = 0.58 A

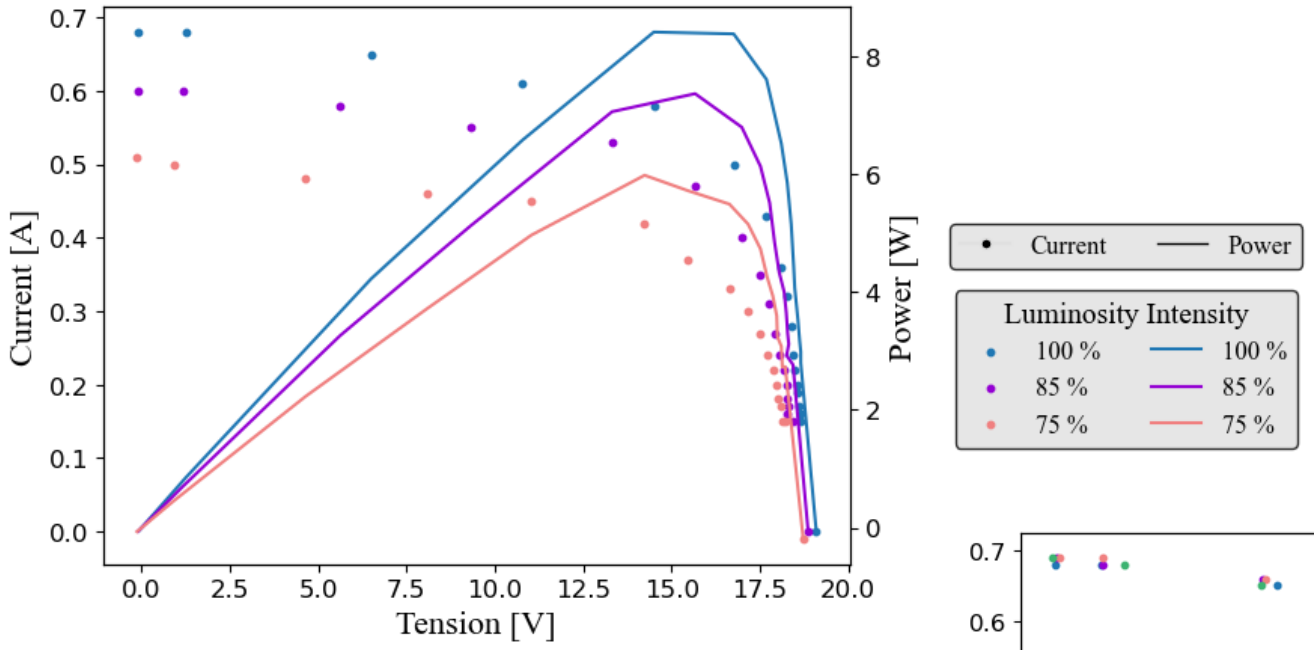
V_{max} = 14.5 V

P_{max} = 8.41 W

η = 3.09 %

FF = 0.65

Influence of the temperature and light intensity

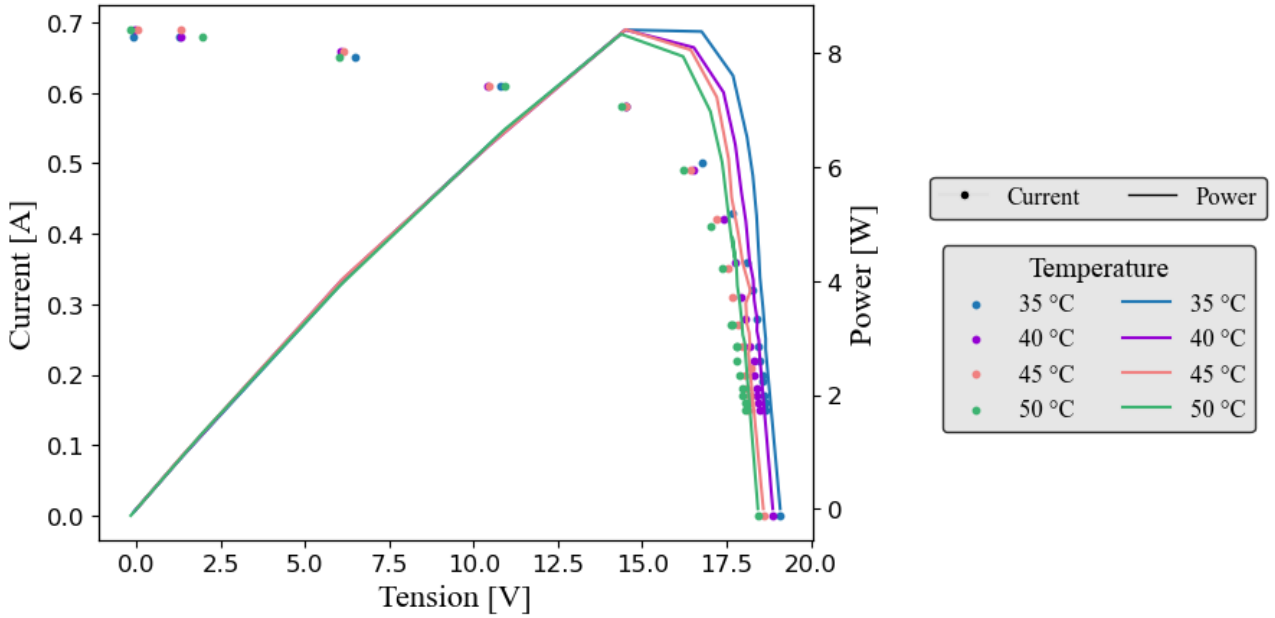


Tension:

$V = RI$

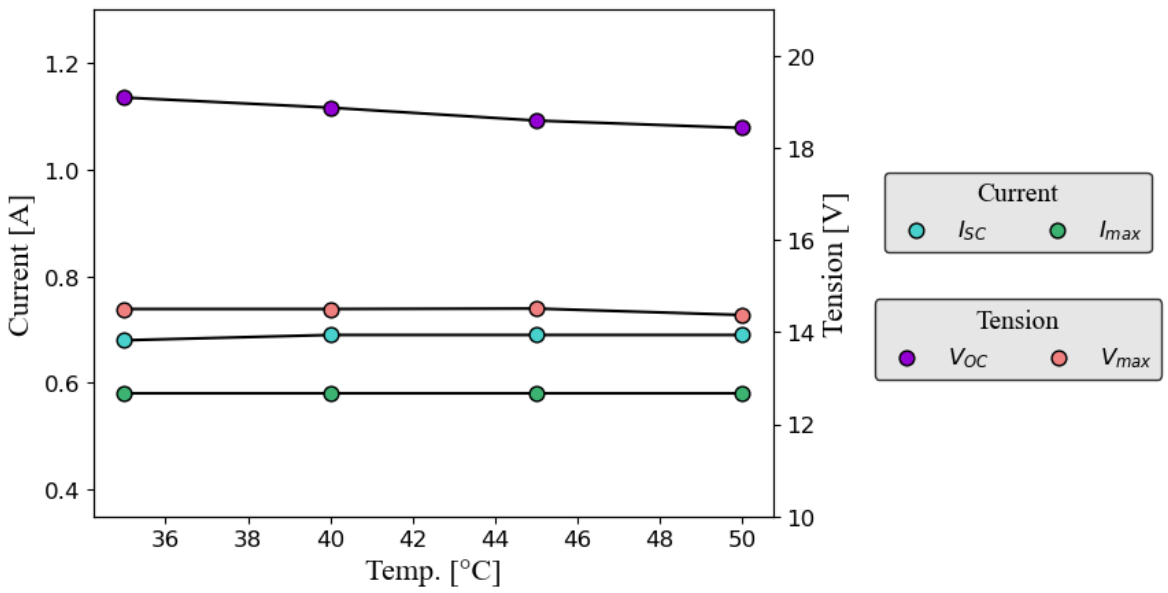
Power:

$P = VI$

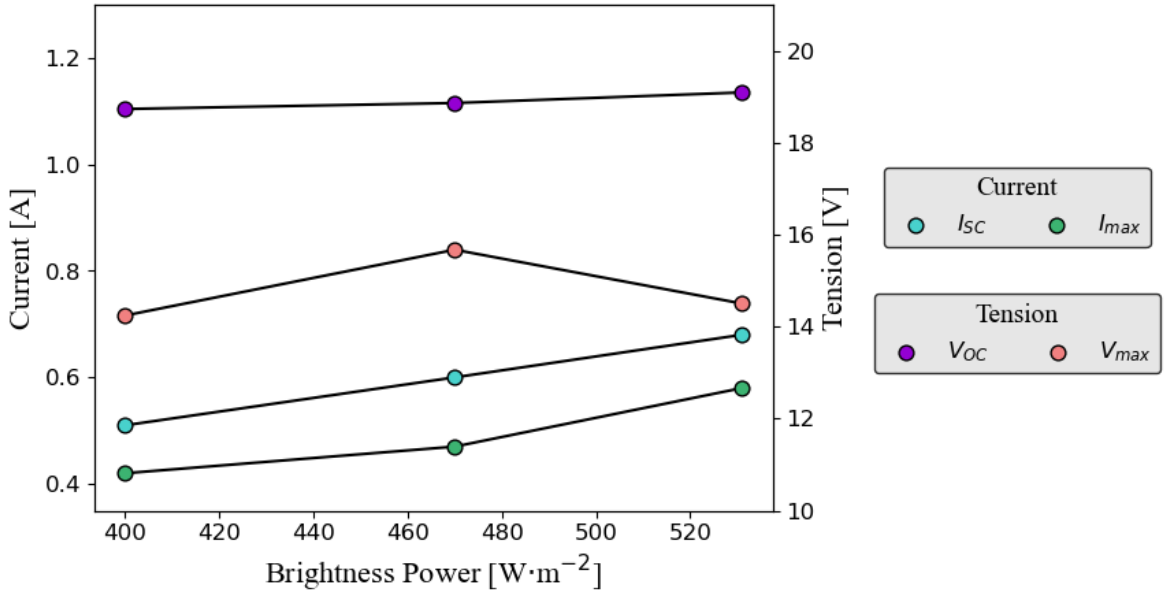


Interest parameters

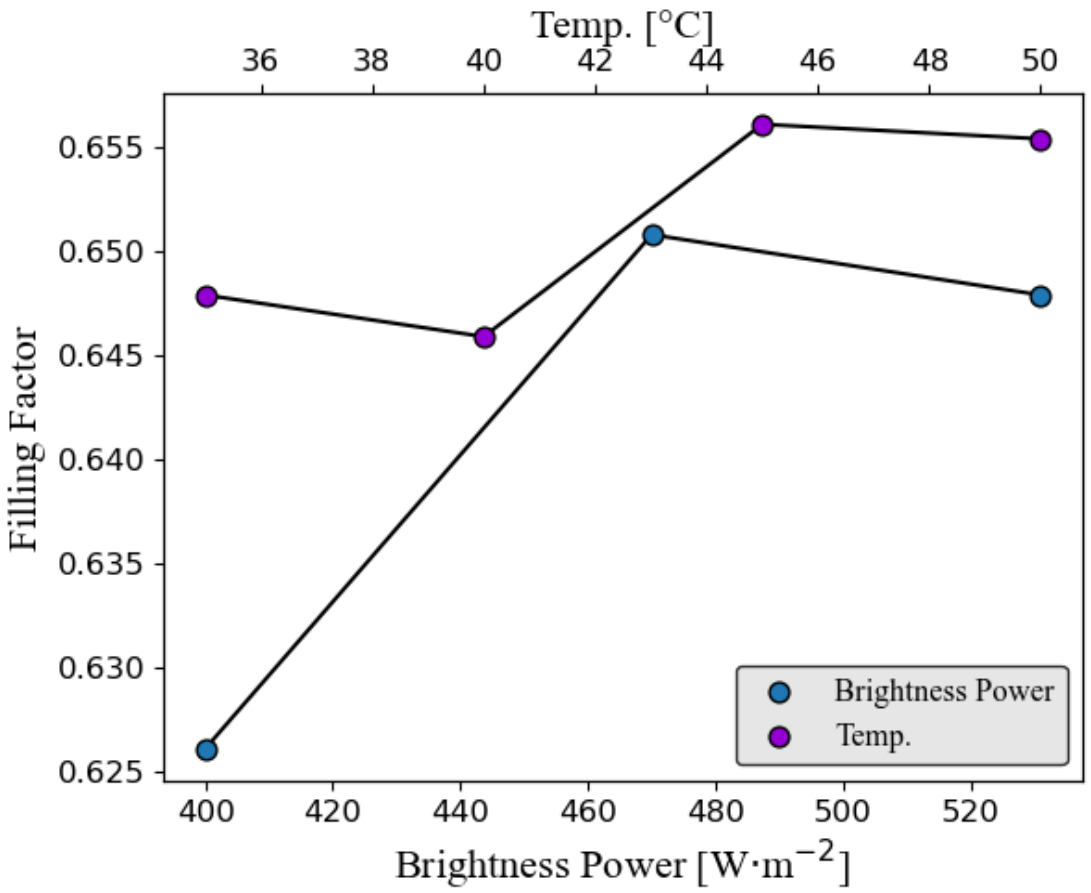
Temperature:



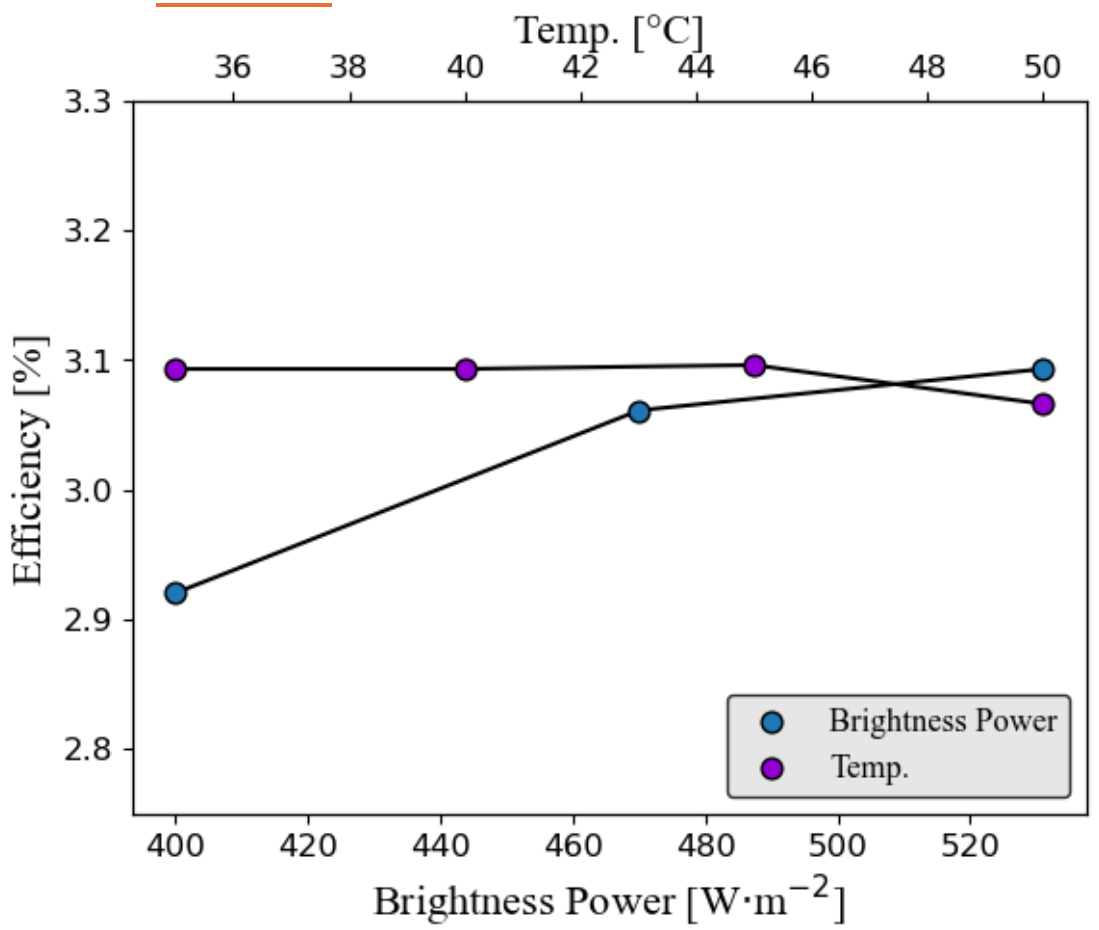
Luminosity intensity:

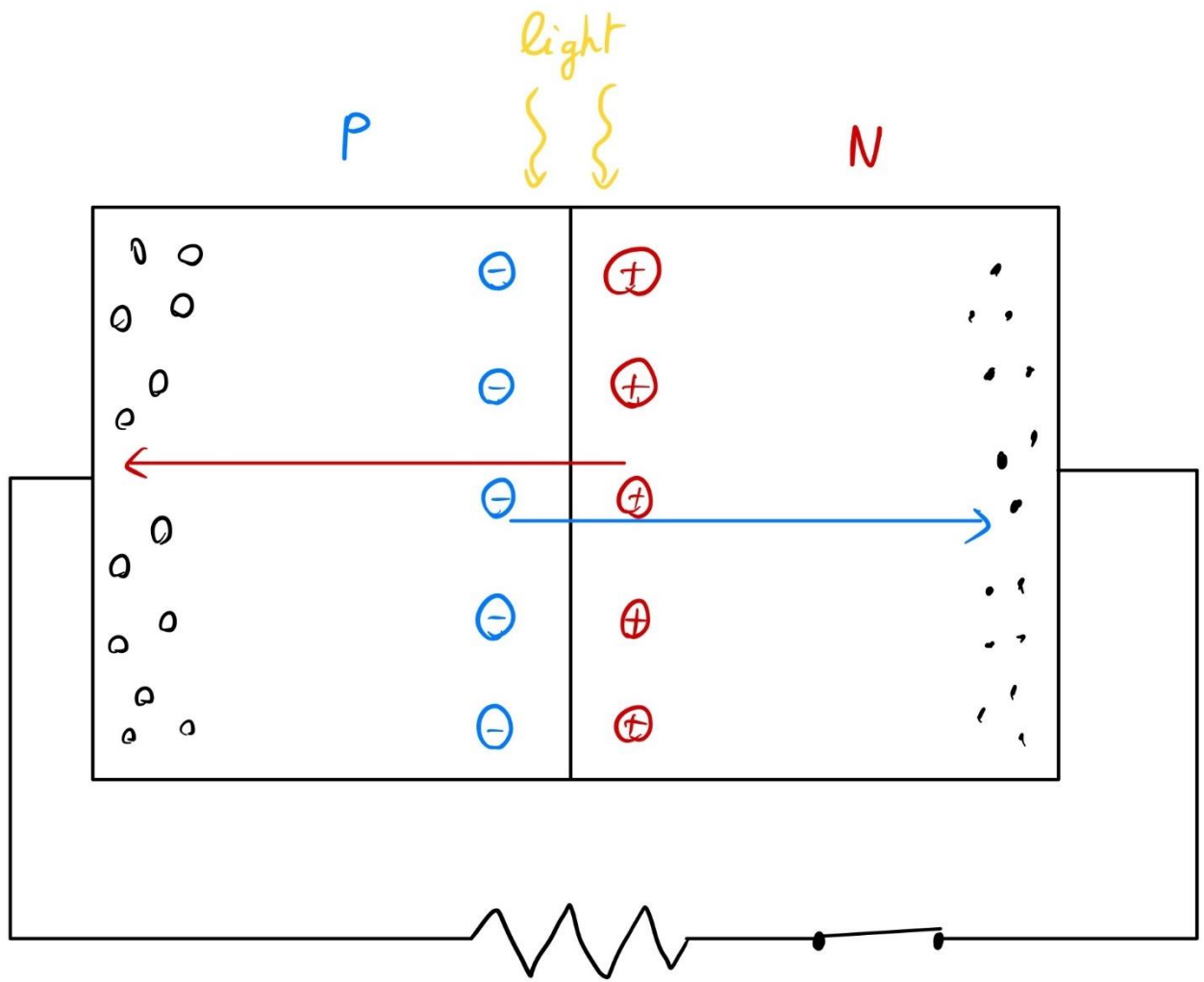


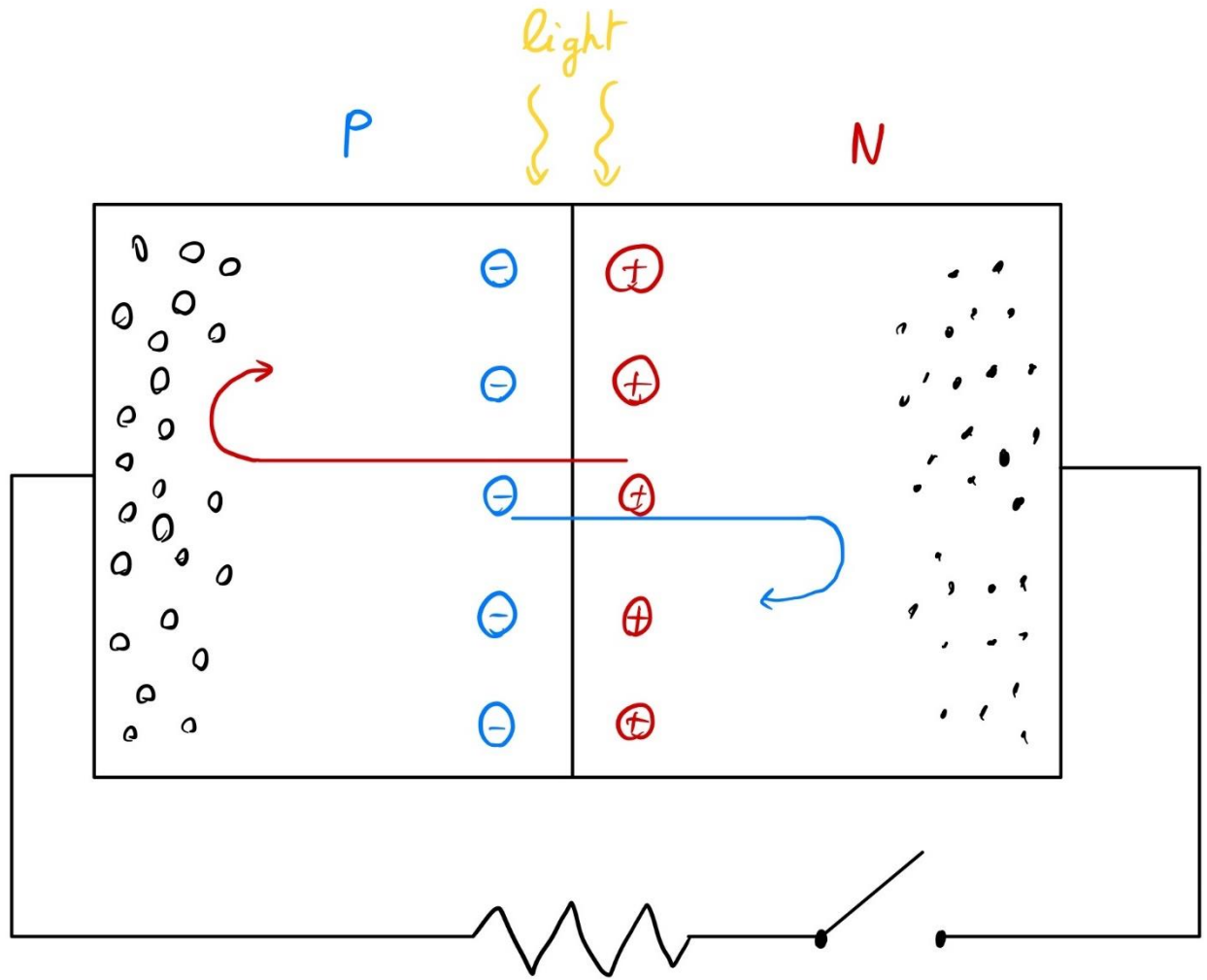
Filling Factor:



Efficiency:




light
P
N


light
P
N

Conclusion

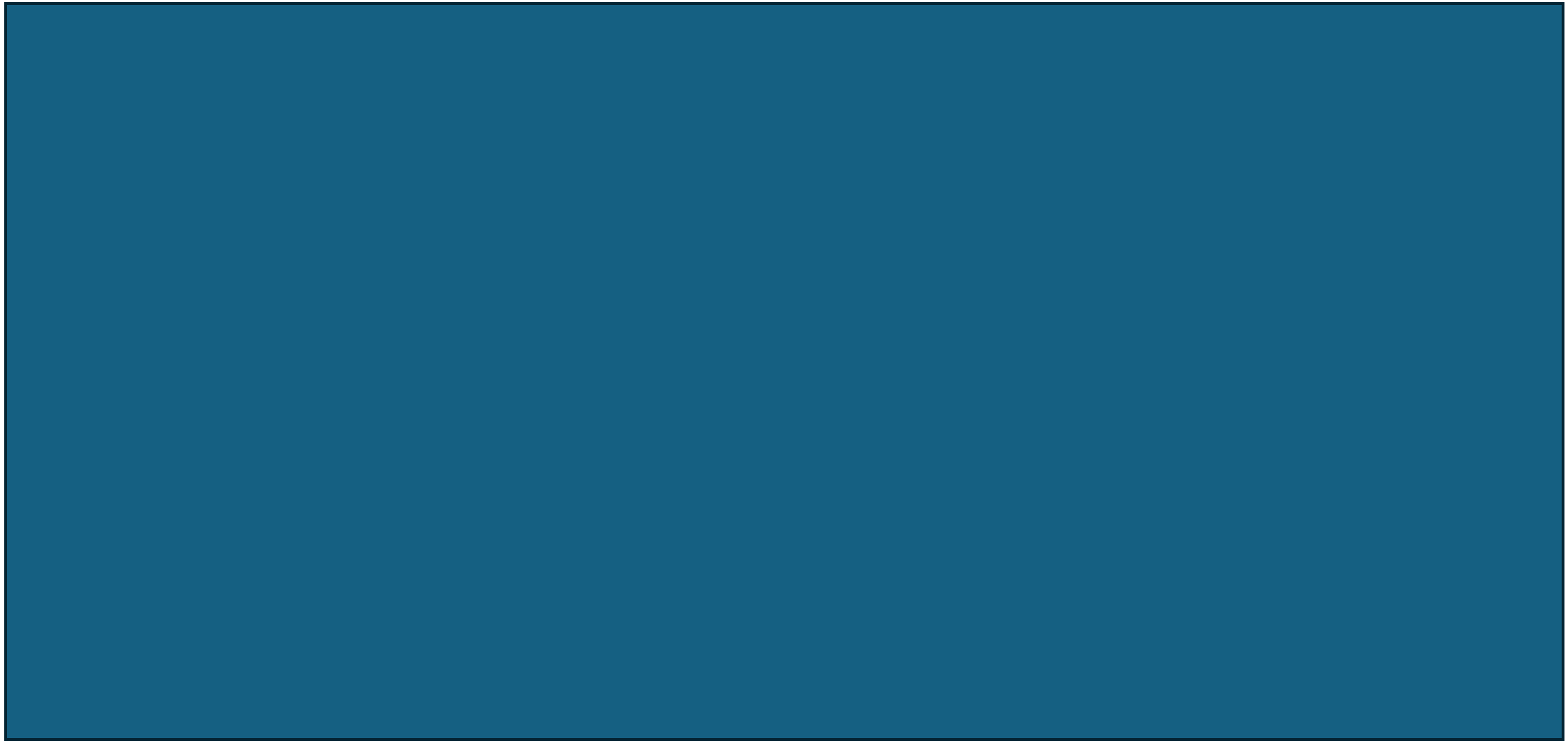
- The performance of the panel is affected by its age and usage.

- Optimal conditions: high intensity light and low temperature locations

- ↑ light intensity ➔ cst open circuit tension (Voc), ↑ short circuit current (Isc).

- ↑ temperature ➔ ↓ open circuit tension (Voc), cst short circuit current (Isc).

Recommendations



Attachements

- Literal formulas:
  - Power: $P = VI$
  - Efficiency: $\eta = \frac{P_{max}}{P_{light}S_{panel}} = \frac{I_{max}V_{max}}{P_{light}S_{panel}}$,
  - Filling factor: $\mathrm{FF} = \frac{P_{max}}{I_{sc}V_{oc}} = \frac{I_{max}V_{max}}{I_{sc}V_{oc}}$

$S_{panel} = 0.512\ m^2$

$P_{light} = 531\ \frac{W}{m^2}$

References

- Discover Tandem PV's Innovative Perovskite Solar Technology. https://www.tandempv.com/technology.
- Buonsanti, R. ChE-203 TP-4, Conversion photovolta¨ique de l'´energie solaire; EPFL, Printemps 2022.
- unea, G.; Wilson, K.; Meydbray, Y.; Campbell, M.; Ceuster, D. D. Low Light Performance of Mono-Crystalline Silicon Solar Cells. 2006; Pages: 1312–1314 Place: Waikoloa, HI.
- Best Research-Cell Efficiency Chart. https://www.nrel.gov/pv/cell-efficiency.html.

Interest parameters as a function of the light intensity and the temperature.

	Intensity [W/m^2] (T=35 °C)			Temperature [°C] (I=100%)		
	531 (100%)	470 (85%)	400 (75%)	40 °C	45 °C	50 °C
I_{sc}	0.68	0.6	0.51	0.69	0.69	0.69
V_{oc}	19.1	18.9	18.7	18.9	18.6	18.4
I_{max}	0.58	0.47	0.42	0.58	0.58	0.58
V_{max}	14.5	15.67	14.24	14.5	14.51	14.37
FF	0.65	0.65	0.63	0.65	0.66	0.66
η	0.0309	0.0306	0.0292	0.0309	0.031	0.0081