

# Theory and demonstration of plasma measurement using Langmuir probe

## 電漿量測之蘭摩爾探針原理與實作

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**2021 winter break**

**1/18(Mon.) – 1/22(Fri.) 14:00-17:40**

**<http://capst.ncku.edu.tw/PGS/index.php/teaching/>**

**Lecture 4**

# Course Outline



## 1. Introduction to plasma

- a. What is Plasma?
- b. How to generate plasma
- c. Applications of plasma

## 2. Theory of Langmuir probe

- a. Sheath
- b. Single Langmuir probe
- c. Double Langmuir probe
- d. Triple Langmuir probe

## 3. Demonstration of Langmuir probe

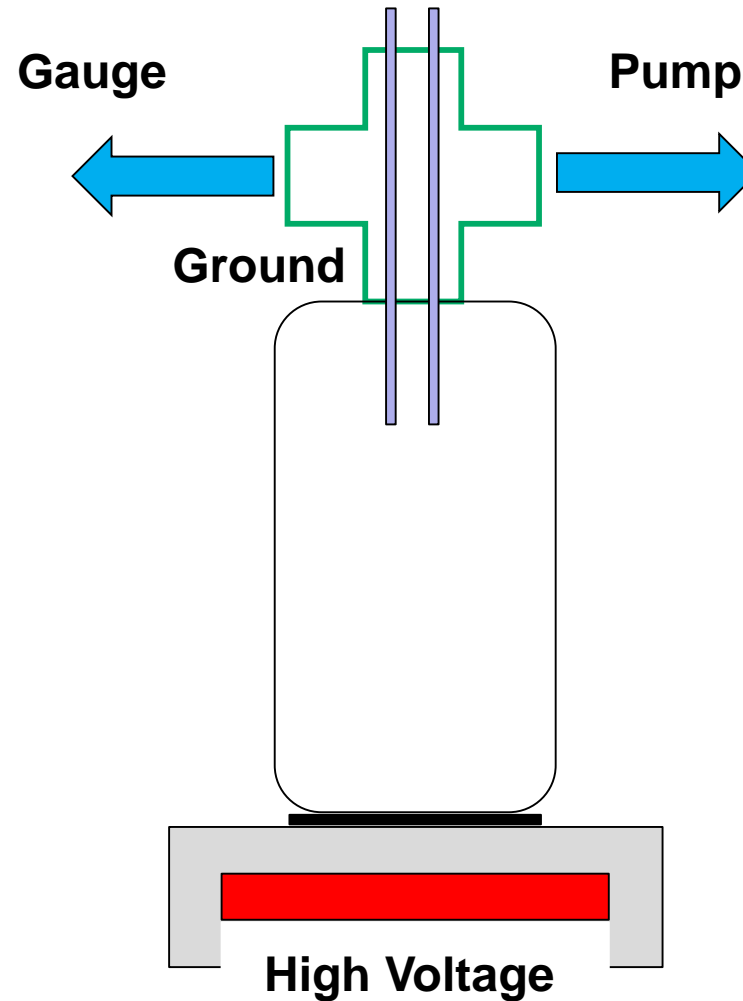
- a. Building vacuum systems
- b. Building Langmuir probes
- c. Measuring temperatures and densities of plasma

Day 1~3

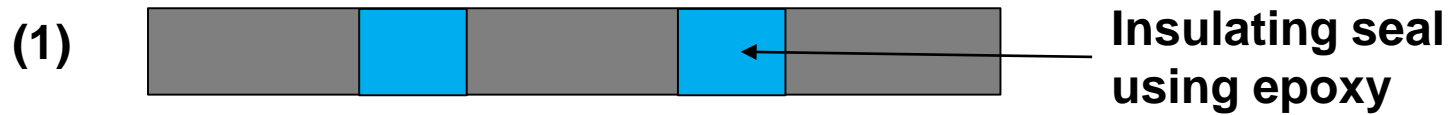
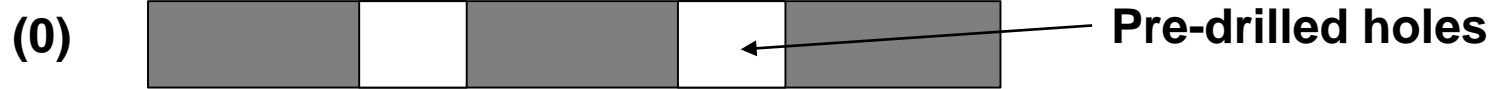
Day 4~5:  
Experiments

• **Wear shoes!**

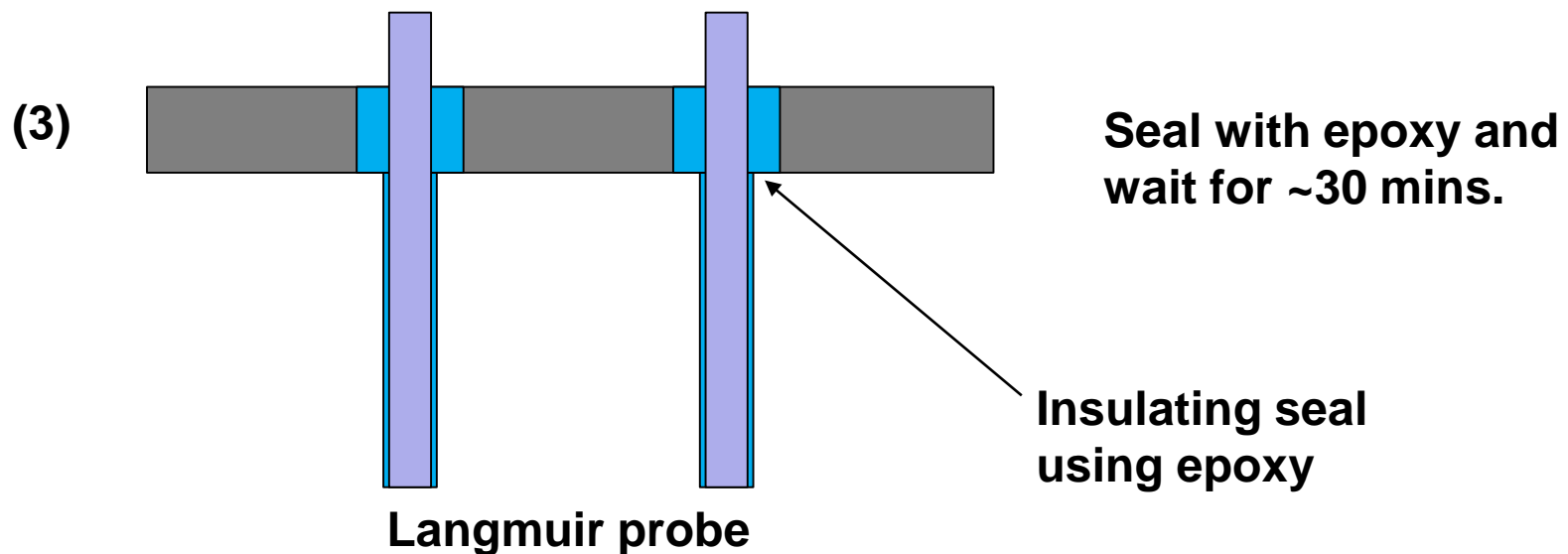
# $T_e$ and $N_0$ measurements of a glow discharge in a glass jar



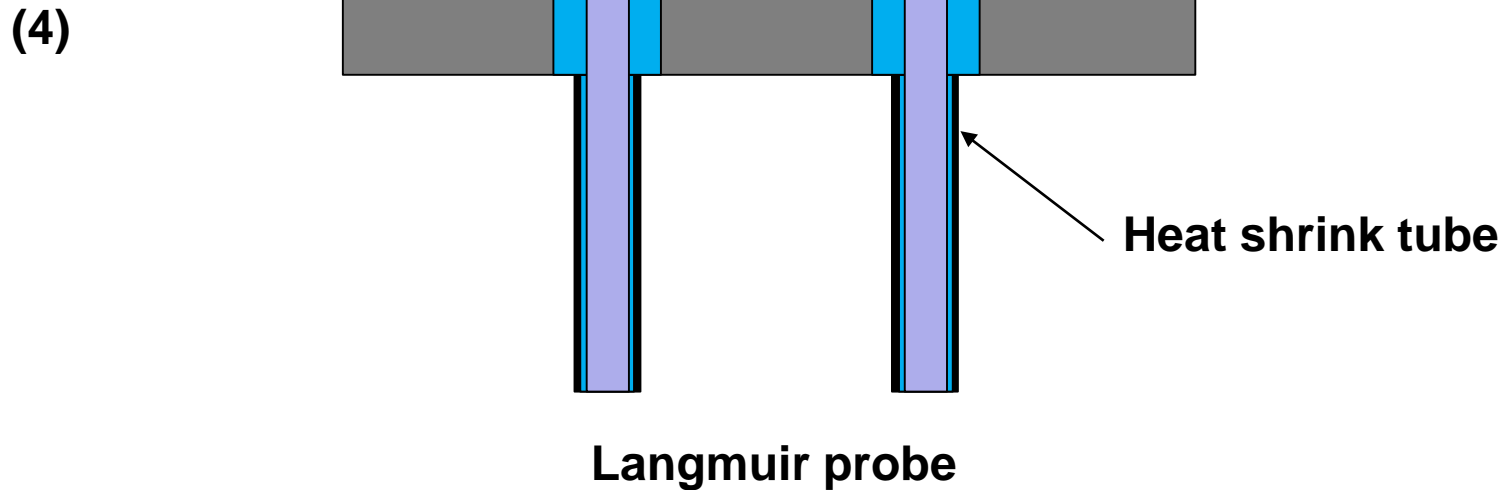
# feedthrough



Wait for ~30 mins.

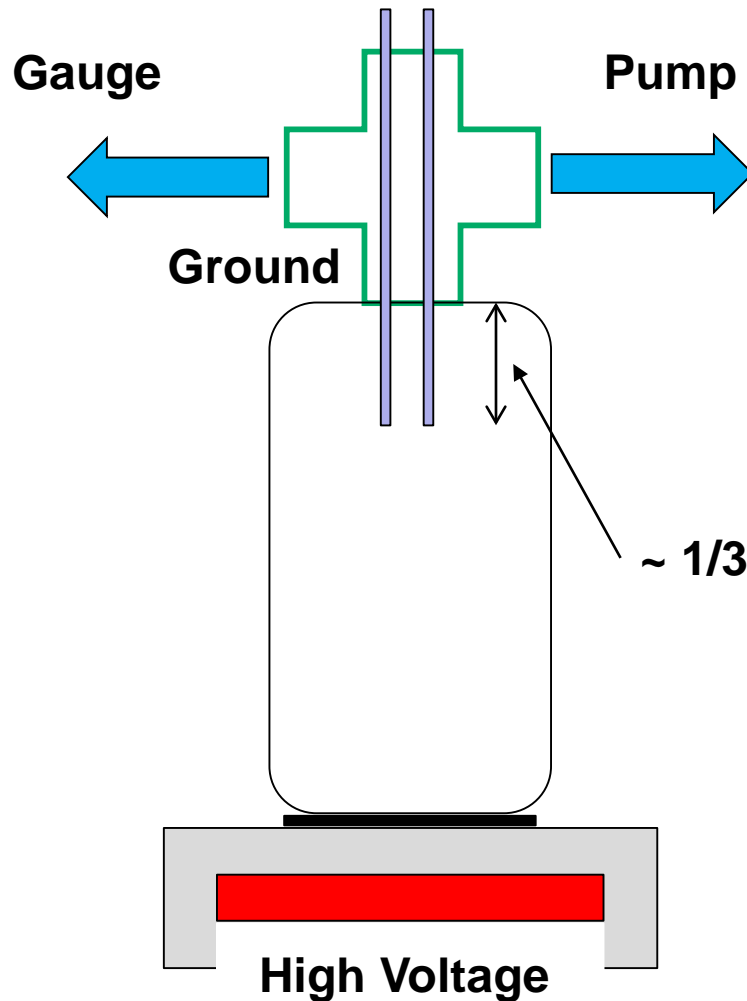


# feedthrough



- Each group need to finish two probes on a single flange. Need to pass the vacuum test where  $P \leq 9 \times 10^{-2}$  Torr (12 Pa).
- 1 Pa=0.0075 Torr.

# Glow discharge test

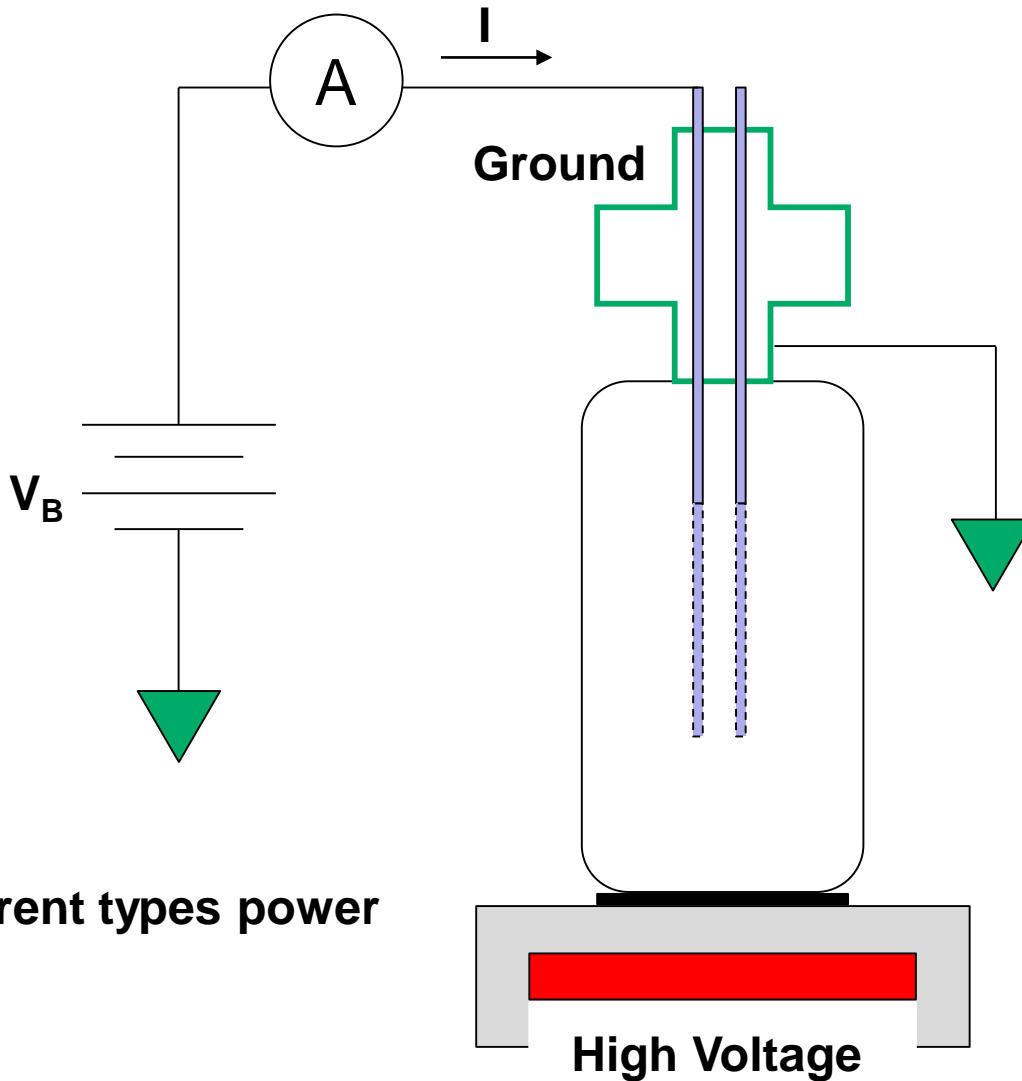


- Once the vacuum meet the requirements, connect the bottom plate to high voltage power supply for glow discharge test.

- DC
- AC

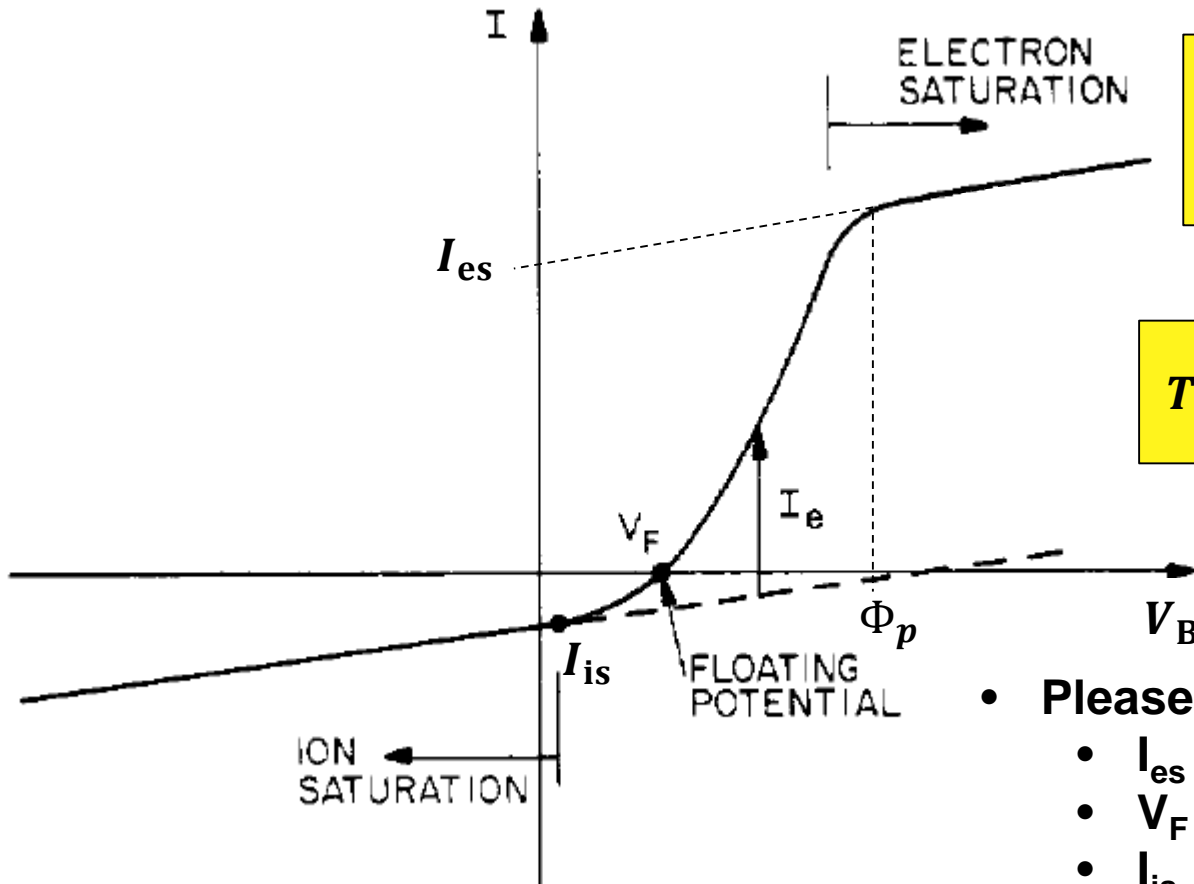
# Single Langmuir probe measurements

## - Vary $V$ and measure $I$



- Two different types power supply

# Expected I-V curve of single Langmuir probe



$$n_0 = \frac{I_{es}}{eA} \sqrt{\frac{2\pi m}{kT_e}}$$

$$T_e = \frac{e(V_B - \Phi_p)}{k(\ln I_e - \ln I_{es})}$$

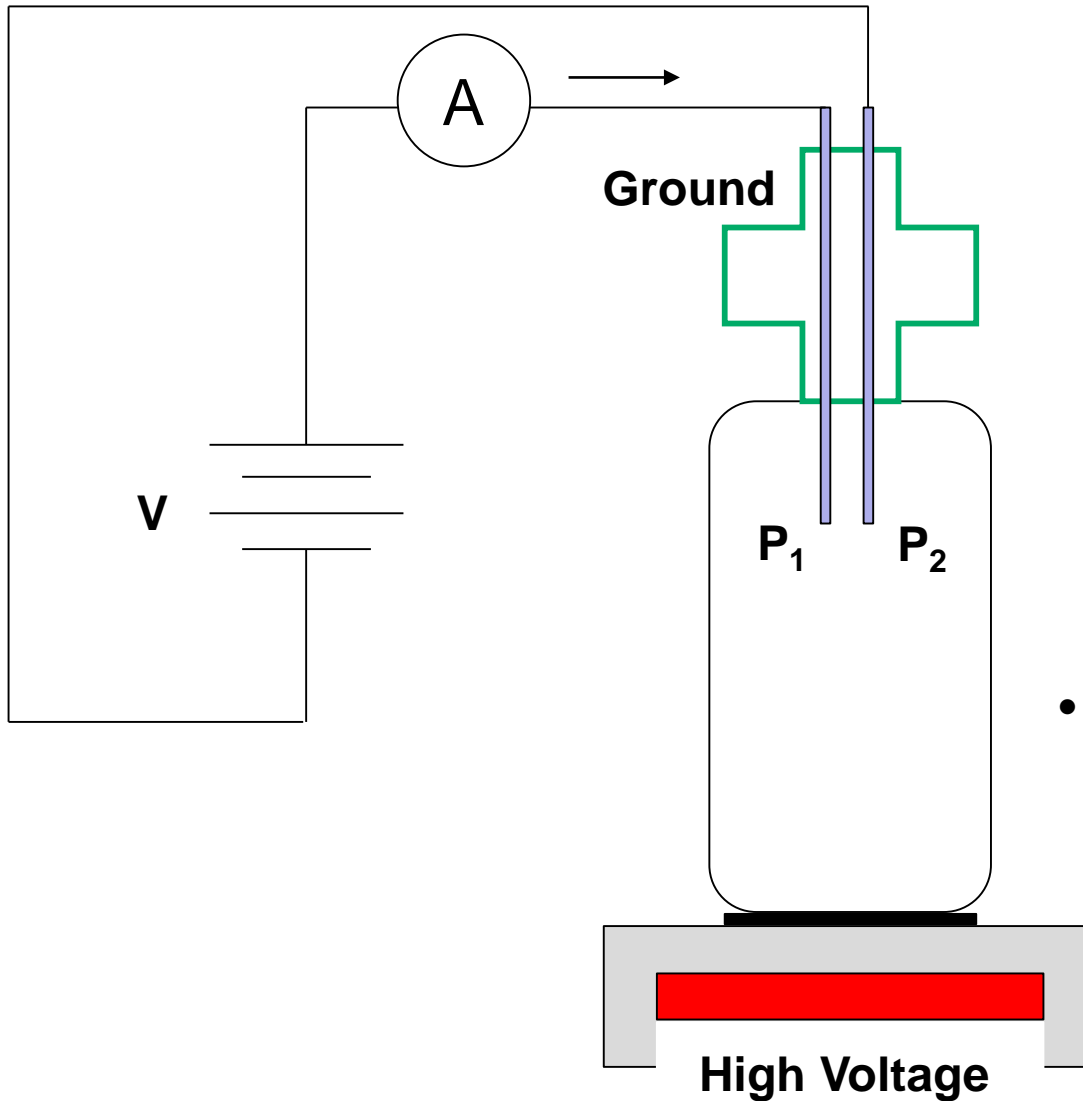
$$n_0 = \frac{1}{0.61} \frac{I_{is}}{eA} \sqrt{\frac{M}{kT_e}}$$

- Please measure if possible:
  - $I_{es}$
  - $V_F$
  - $I_{is}$
- Please calculate if possible:
  - $T_e$
  - $n_0$
  - Ionization fraction



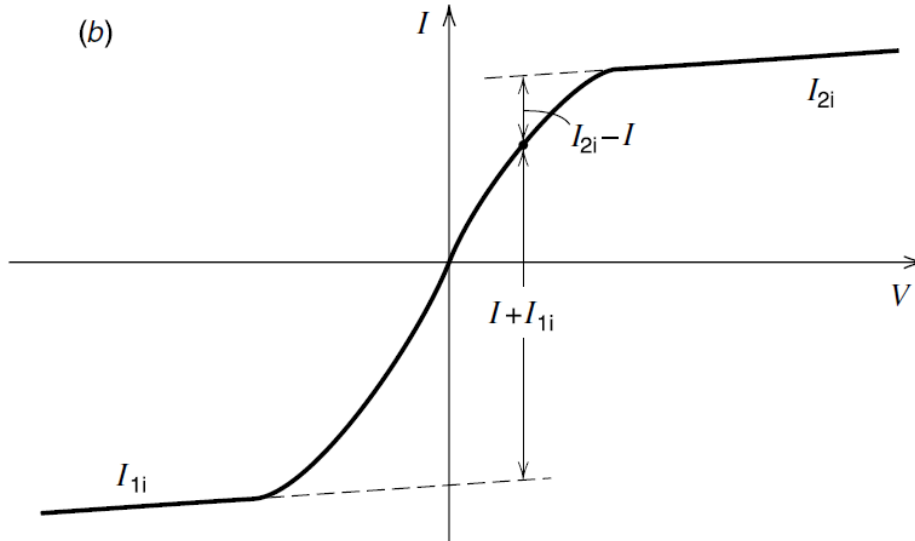
# Double Langmuir probe measurements

- Vary  $V$  and measure  $I$



- DC HV power supply

# Expected I-V curve of double Langmuir probe



$$I = I_{is} \operatorname{Tanh}\left(\frac{eV}{2kT_e}\right)$$

$$\frac{dI}{dV}_{V=0} = \frac{e}{2kT_e} I_{is}$$

- Please calculate if possible:
  - $T_e$
  - $n_0$
  - Ionization fraction

$$n_0 = \frac{1}{0.61} \frac{I_{is}}{eA} \sqrt{\frac{M}{kT_e}}$$

# Experiments

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- **DC glow discharge (do not change the voltage setting)**
  - **Single Langmuir probe**
  - **Double Langmuir probe**
- **AC glow discharge ( $V=20$  V)**
  - **Single Langmuir probe**
  
- **DC HV power supply: x3 – one for each group.**
- **AC HV power supply: x1 – shared between all groups.**