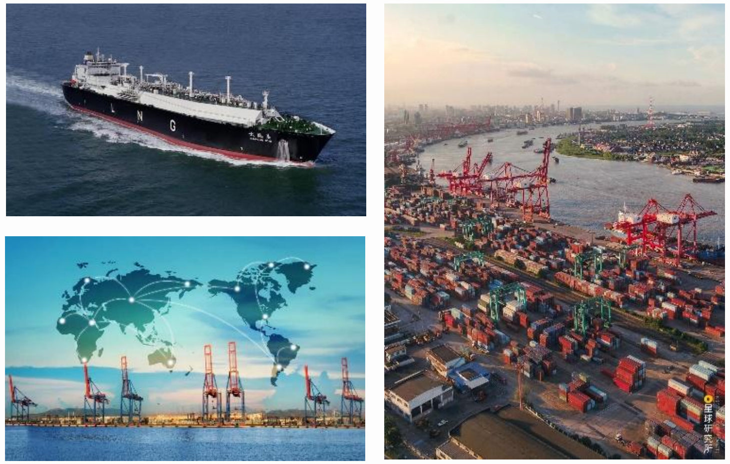
CONTENTS

01 Background

❑ Background and Significance

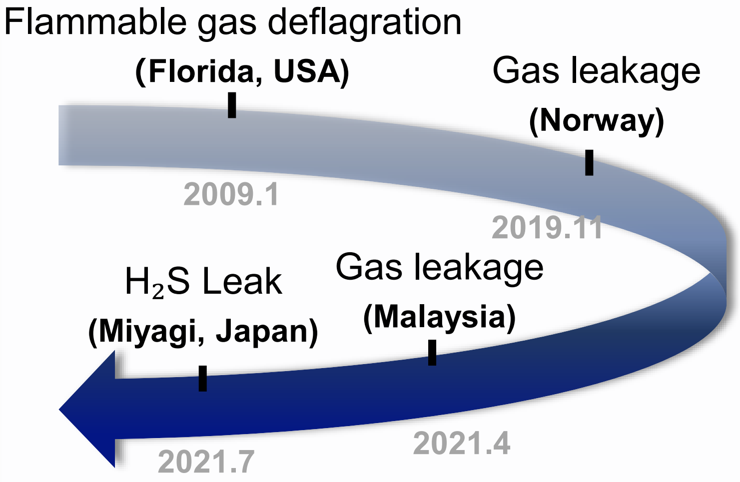
Maritime shipping connecting the global economy

Ports and Trade



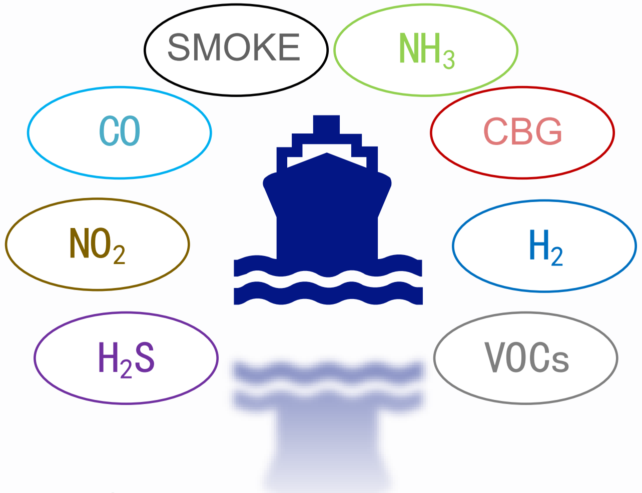
Maritime shipping • Global trade

Shipping Safety



Gas leakage • Incidents

Safety Monitoring in Ship Cabins



Common leaked gases

Gas leak detection is essential for ensuring the maritime shipping safety!

❑ Common Existing Gas Detection Devices

➢ **Fixed Gas Detector**

Advantages: 24H real-time monitoring

Disadvantages: Fixed location, poor mobility

➢ **Mobile Gas Detector**

Advantages: Portable gas detection

Disadvantages: Poor mobility, high power consumption

➢ **GCMS**

Advantages: Exceptional detection performance

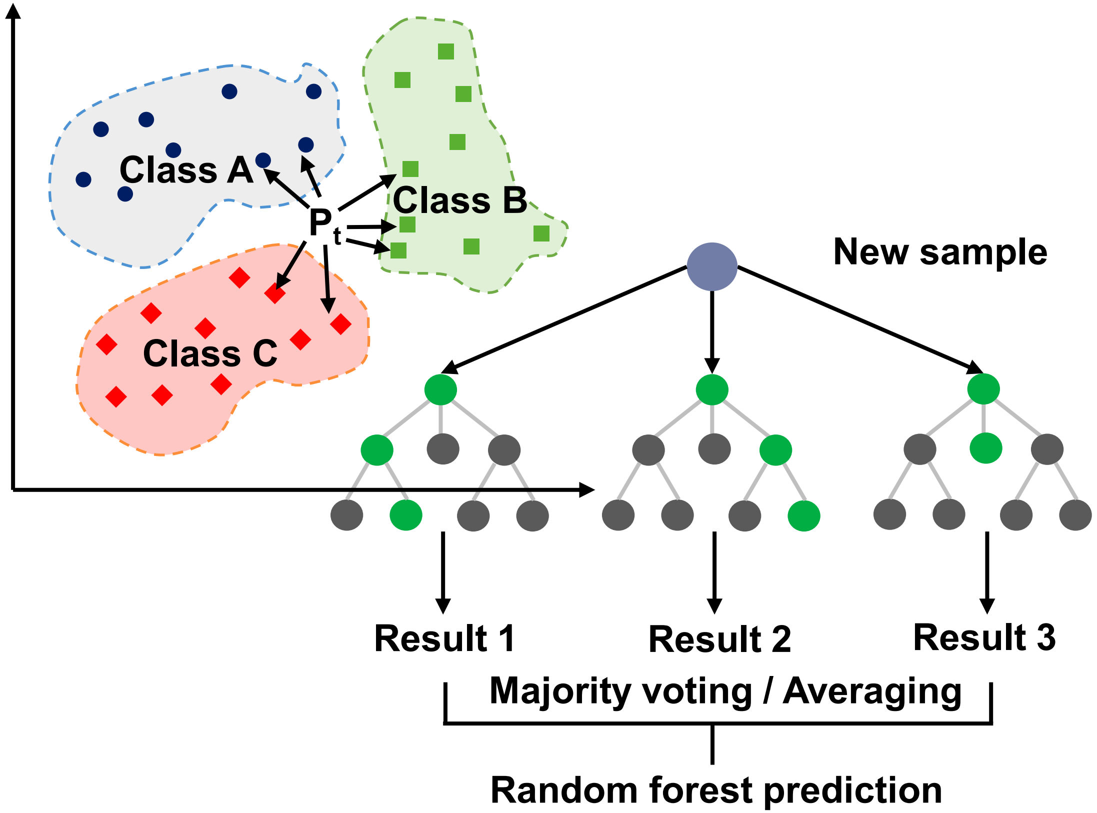
Disadvantages: Complex structure, lack of mobility

The portable electronic nose system has broad application prospects in ship gas detection !

❑ Existing Issues with Electronic Noses

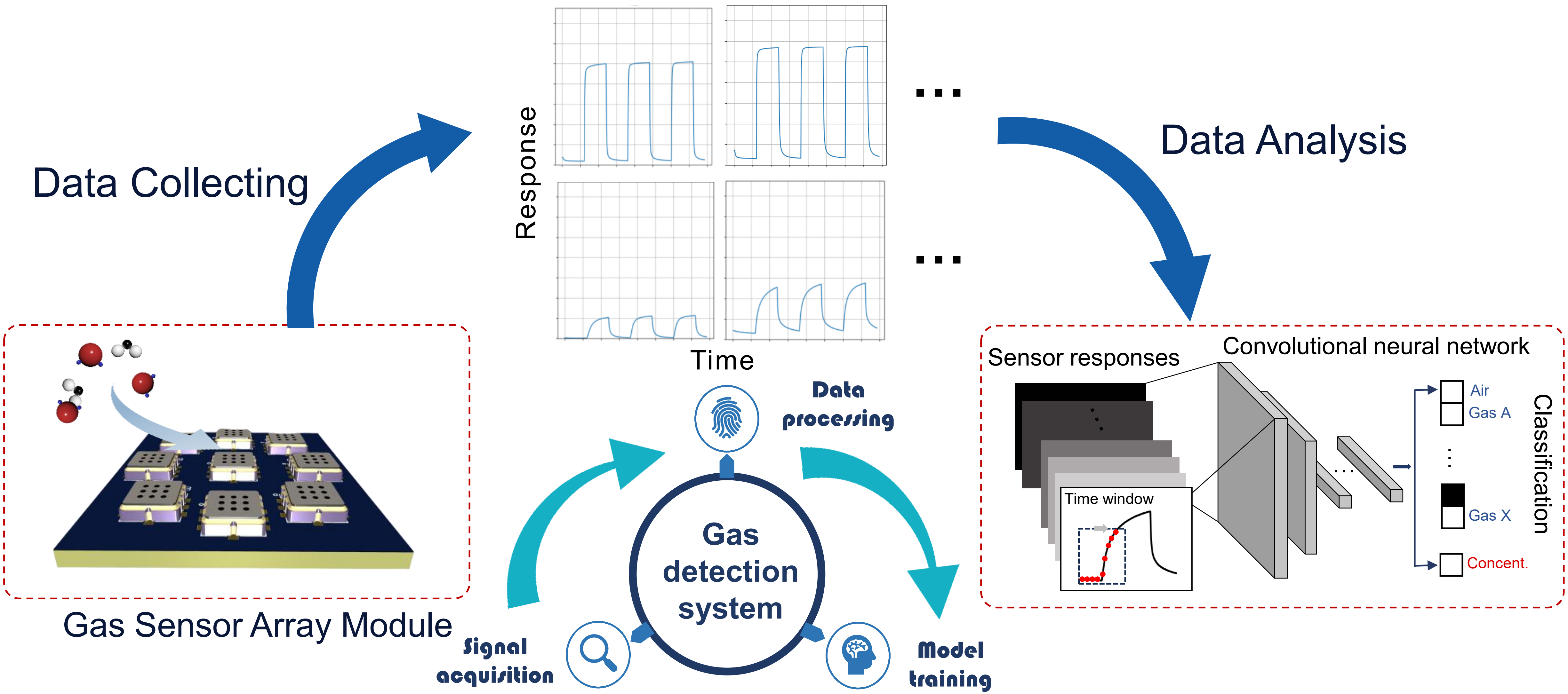
Poor selectivity for detecting multiple gases

Low accuracy in detecting single gases



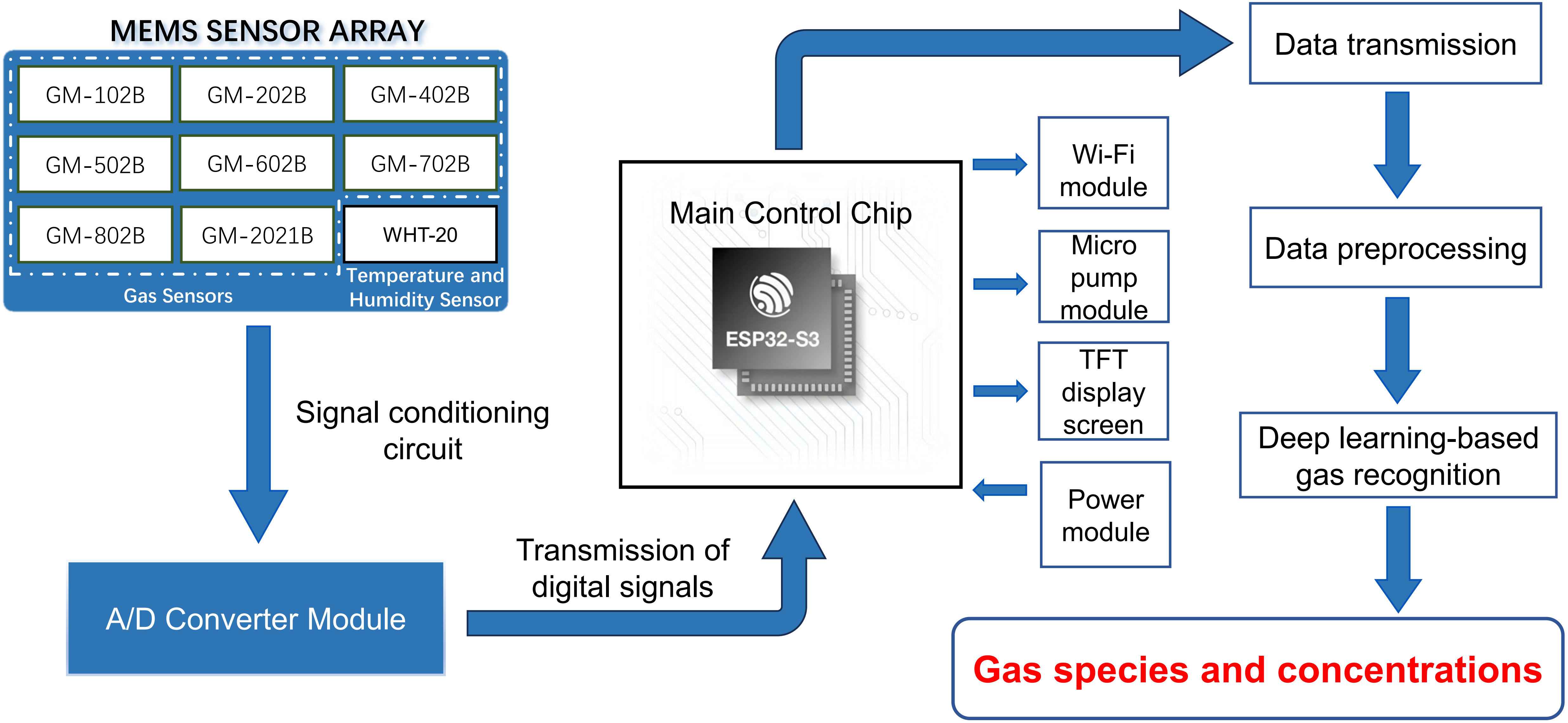
Current electronic nose systems generally suffer from poor selectivity and low accuracy !

❑ Design Strategies and Concepts



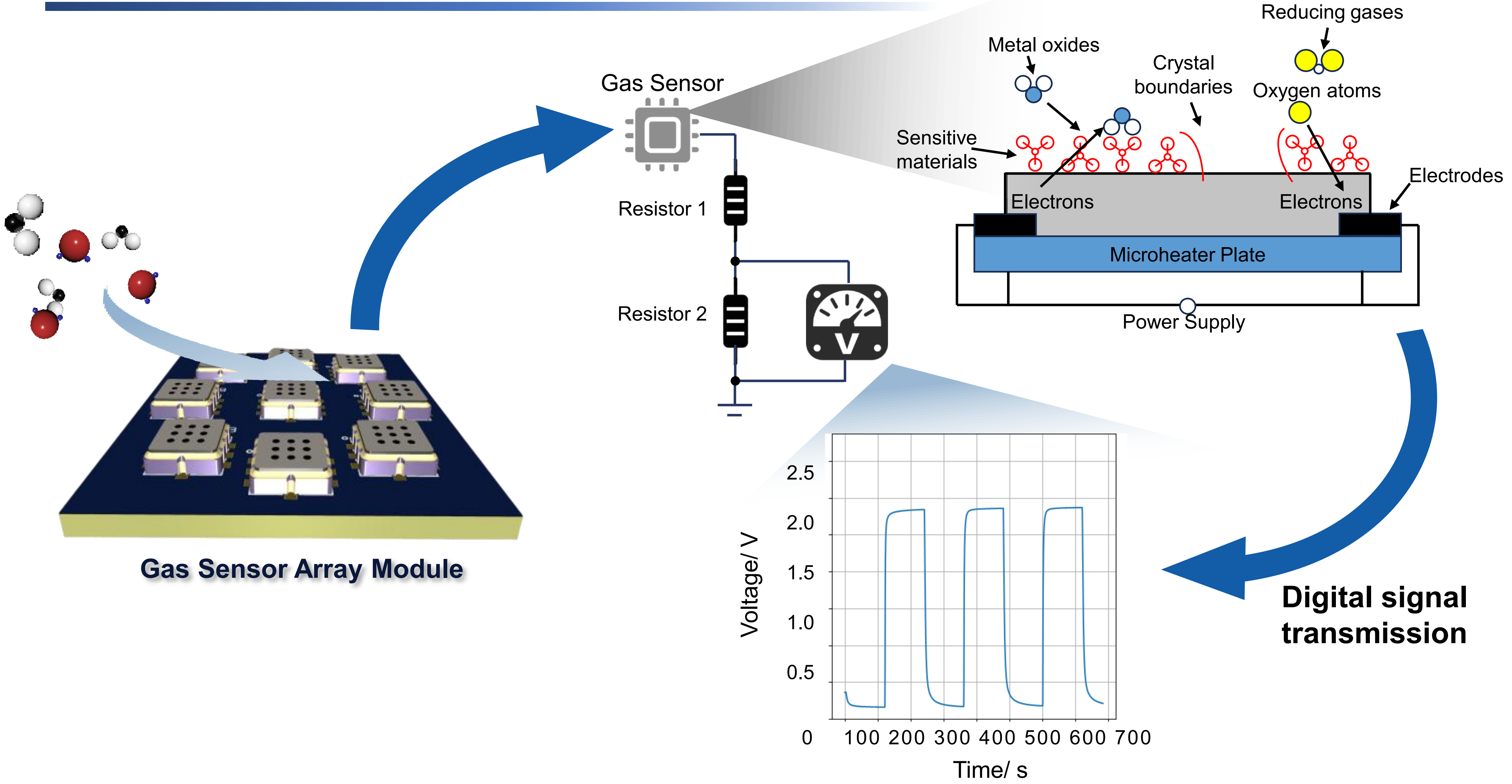
Design of a sensor array-based circuit and training of a deep learning model for precise identification of leaked gases

❑ Portable Electronic Nose System Design Route



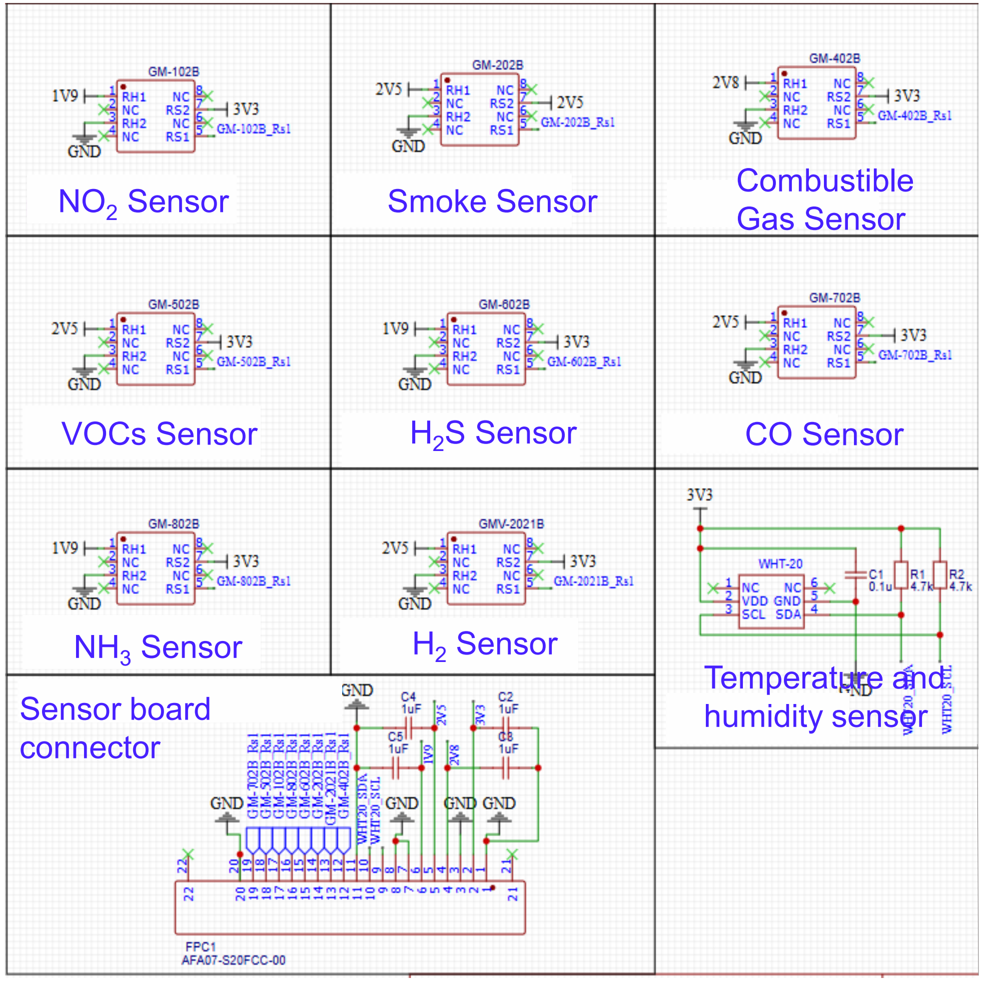
02 Hardware Implementation

❑ System Working Principle

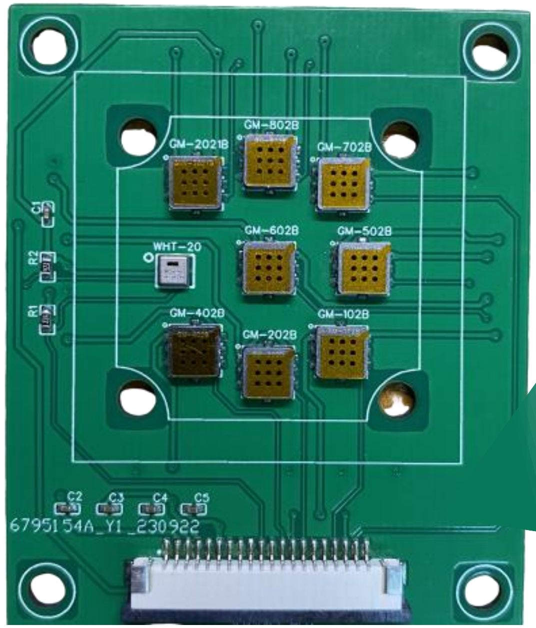


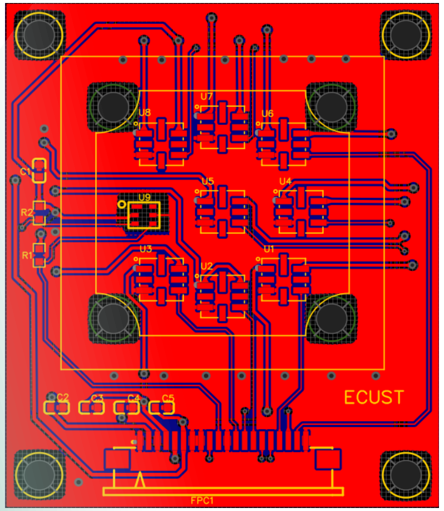
Sensor Array Board

Schematic diagram



Size of whole board
60mm*50mm

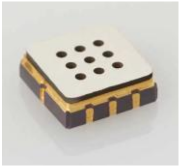




- PCB

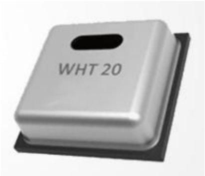
- Physical diagram

- Gas MEMS sensors:



Detecting gas types:
NO_2, VOCs, H_2, NH_3, etc.

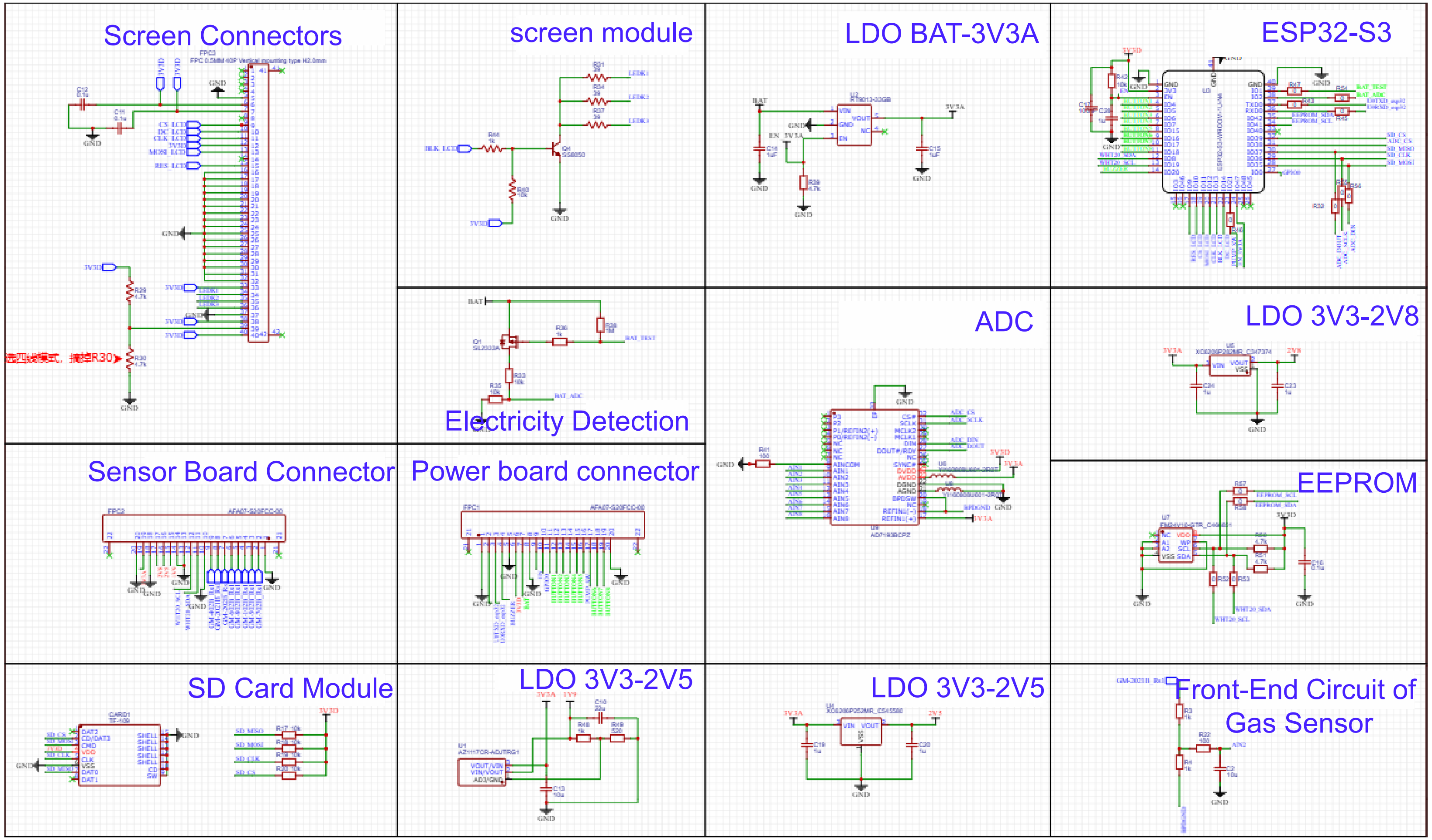
- Temperature and humidity MEMS sensors:



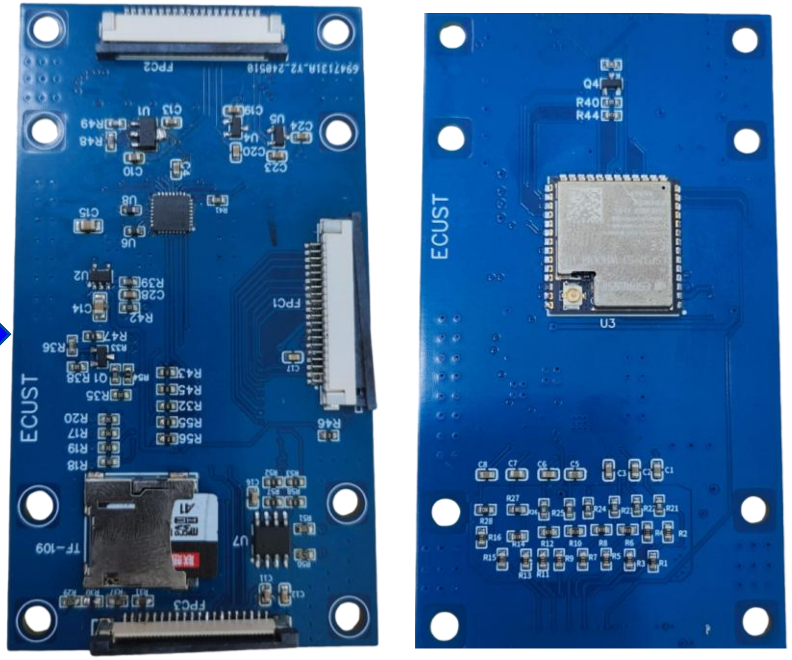
Detection range:
Temperature 5℃-60℃
Humidity 0%-80%

❑ Main Control Board

➢ Schematic diagram



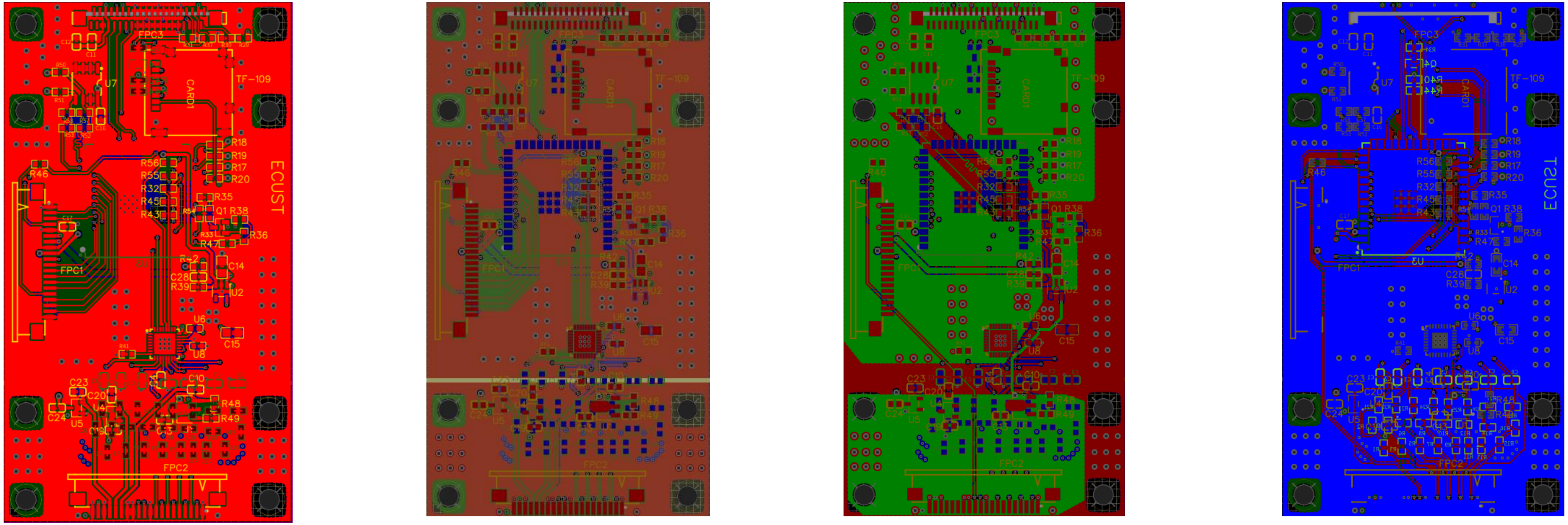
Size of the whole board
90cm*50cm



➢ Front and back physical diagram

❑ Main Control Board

Main control board PCB (4-layer board)

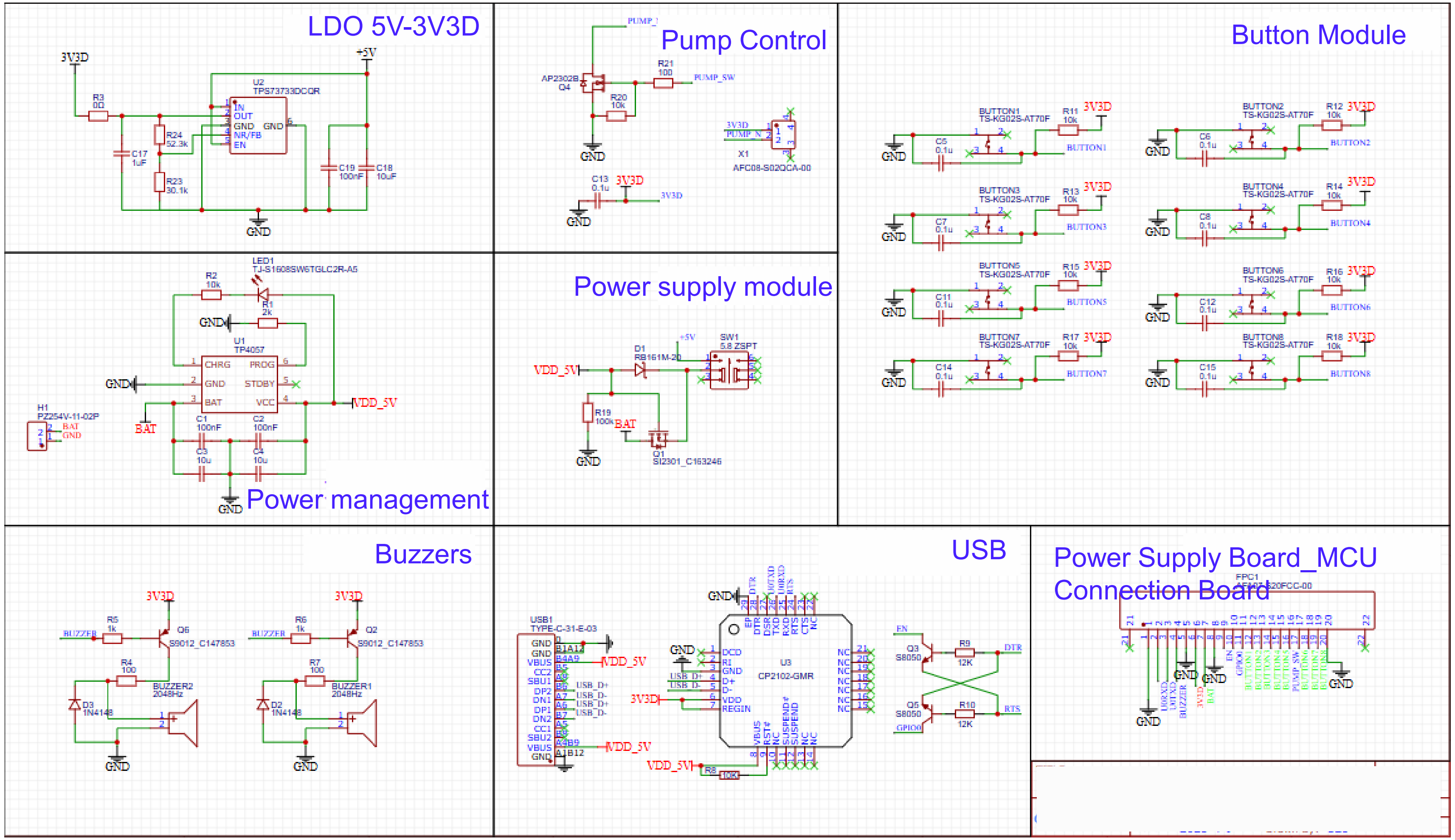


- Top layer
- GND layer
- VCC layer
- Baseboard

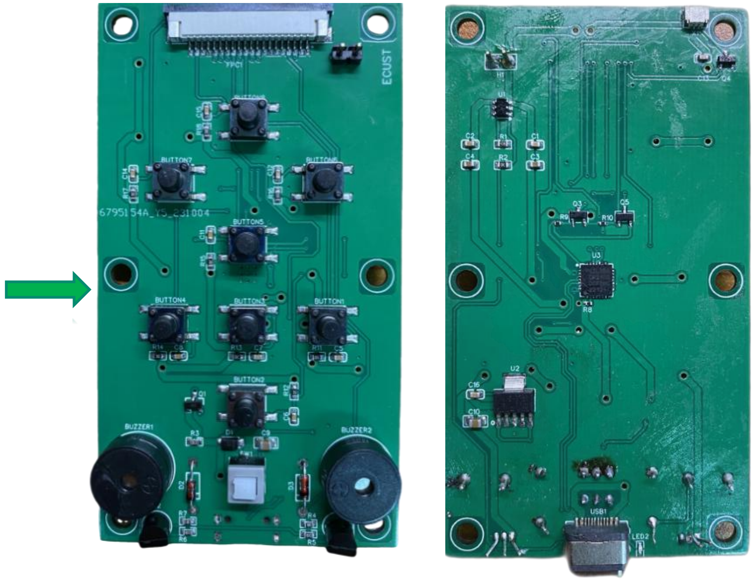
GND layer: Separate analog GND and digital GND | VCC layer: Isolate analog VCC and digital VCC

❑ Power Management and Button Board

➢ Schematic diagram



Size of the whole board
90cm*50cm



➢ Front and back physical diagram

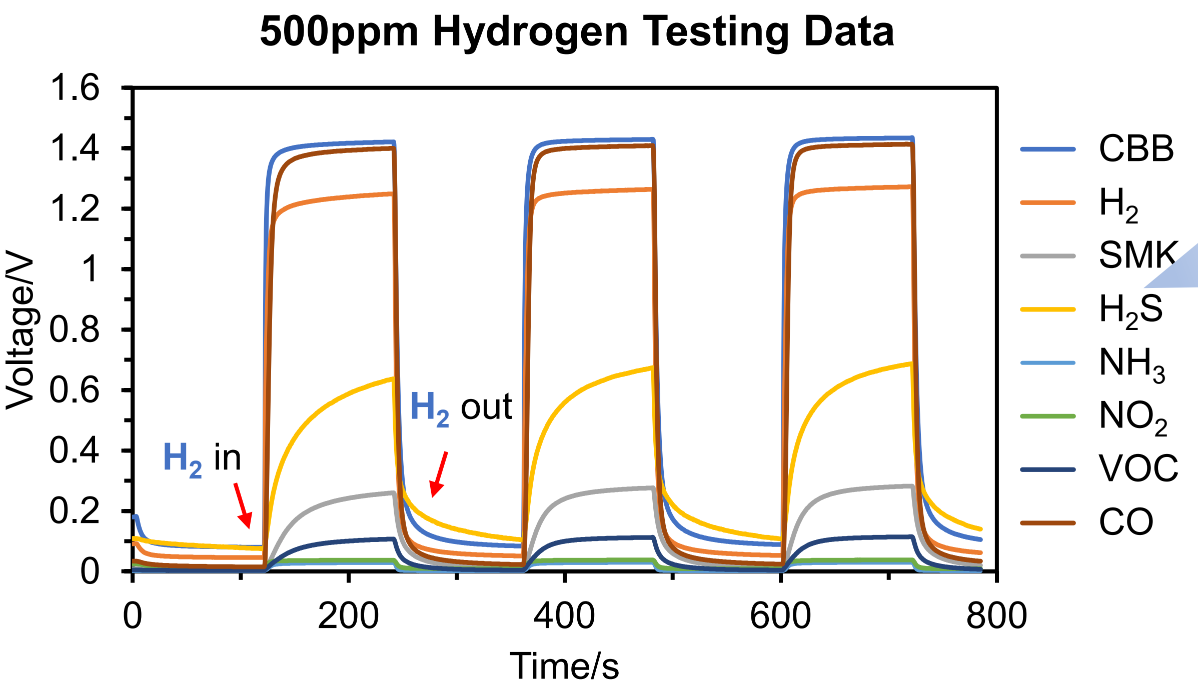
❑ Modeling and Physical Diagram of Shell and Internal Structure

➢ **Modeling Diagram**

➢ **Prototype Diagram**

03 Deep learning Algorithm

❑ Experimental Procedure



Sensor data

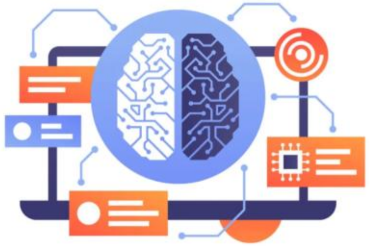
0.181	0.092	0.009
0.182	0.092	0.009
0.177	0.091	0.009

$$X_i{}' = \frac{X_i - \mu}{\sigma} = \frac{X_i - Xmean}{X_{std}}$$

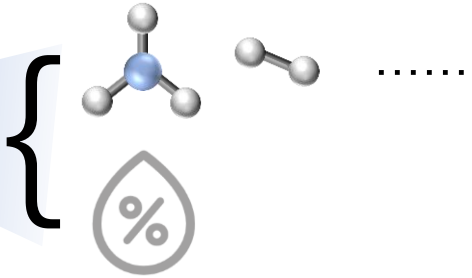
Standardization

Pre-processed data

CSV

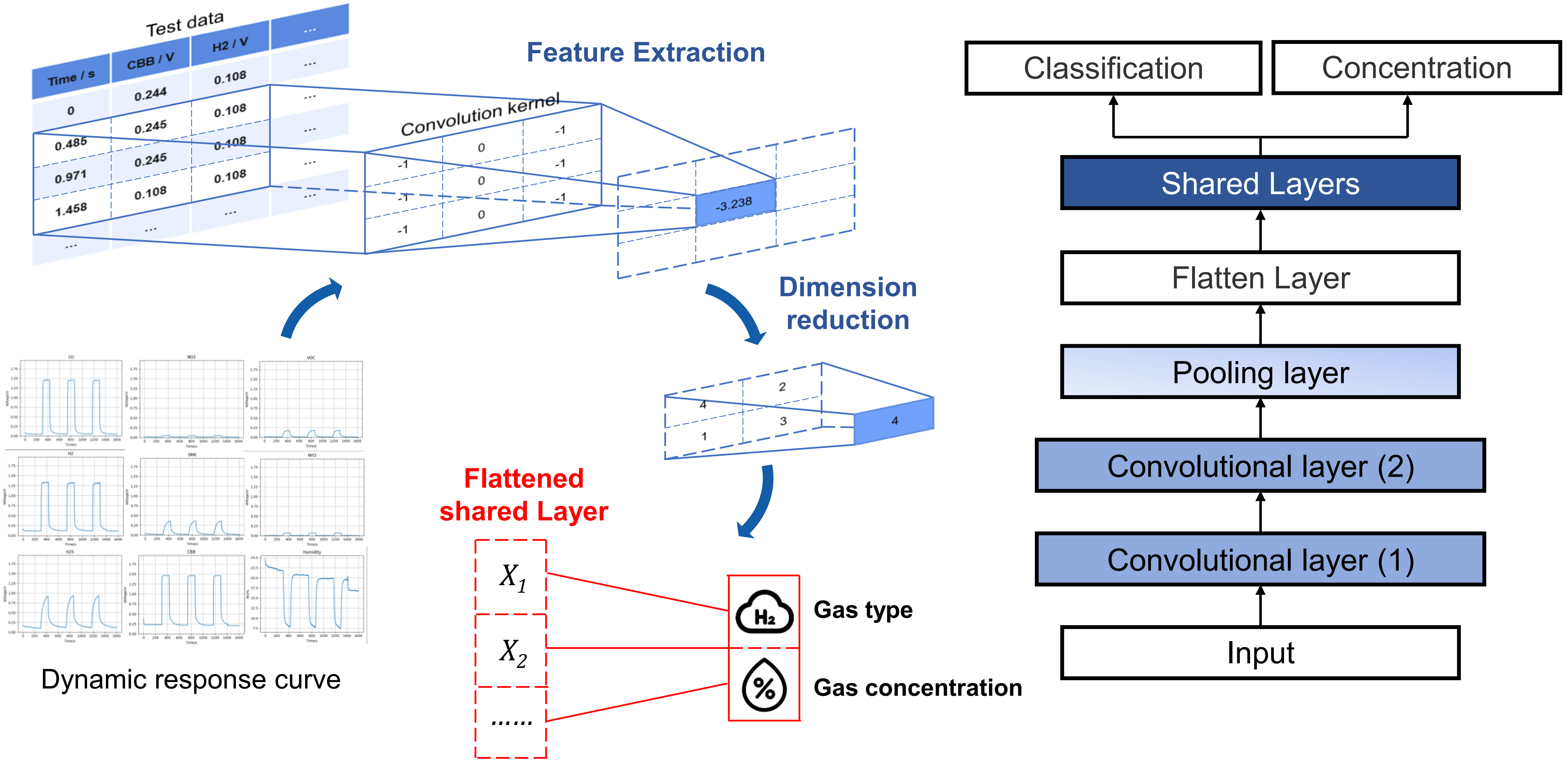


Deep learning model

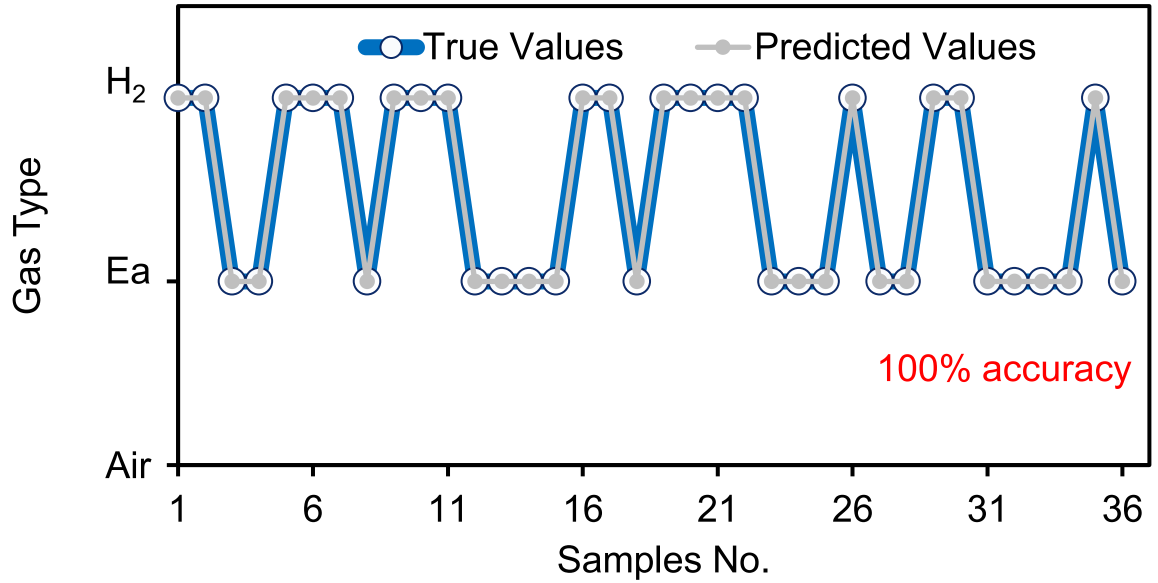


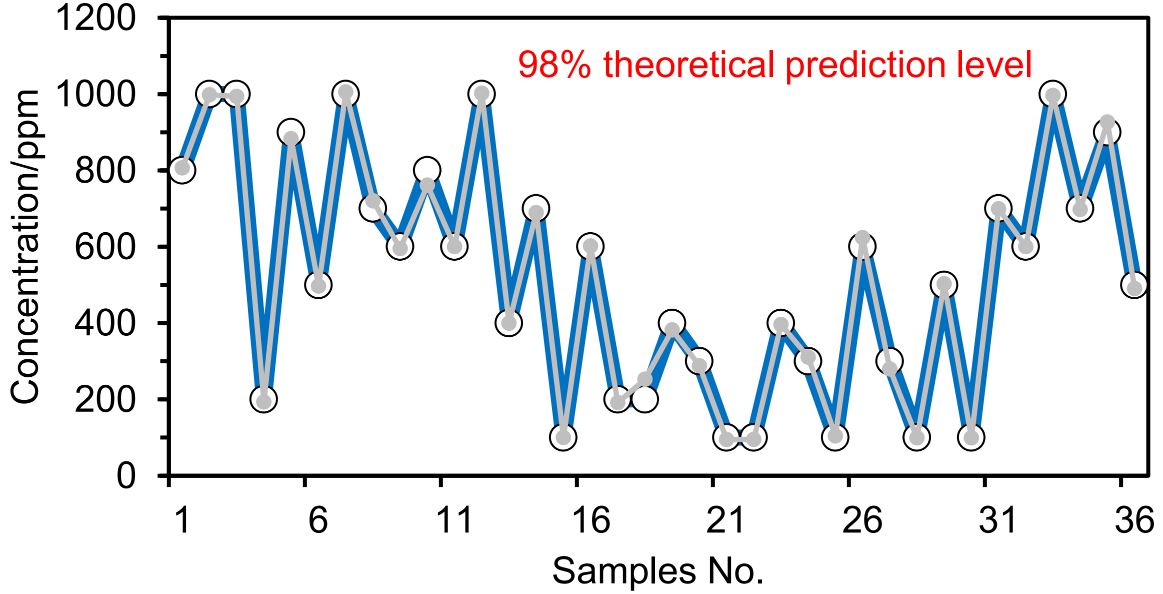
Achieve high accuracy detection by combining deep learning!

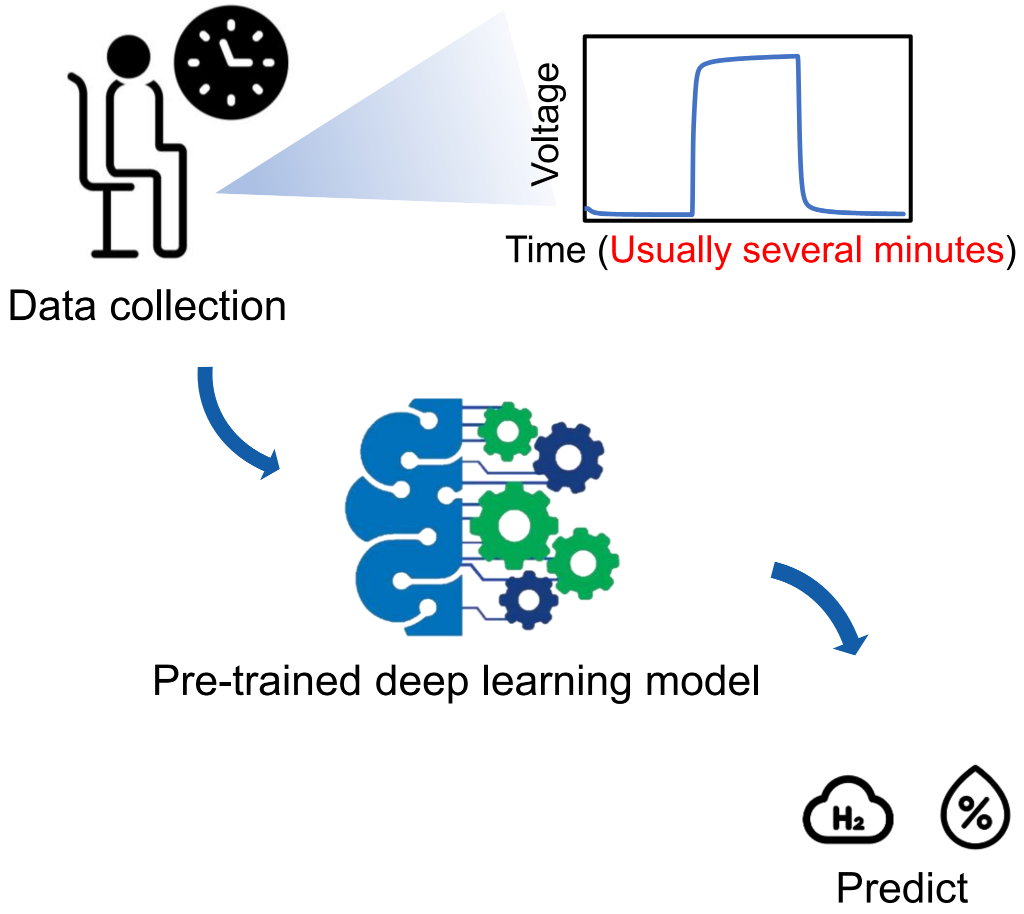
❑ Algorithmic Model



❑ Experimental Results



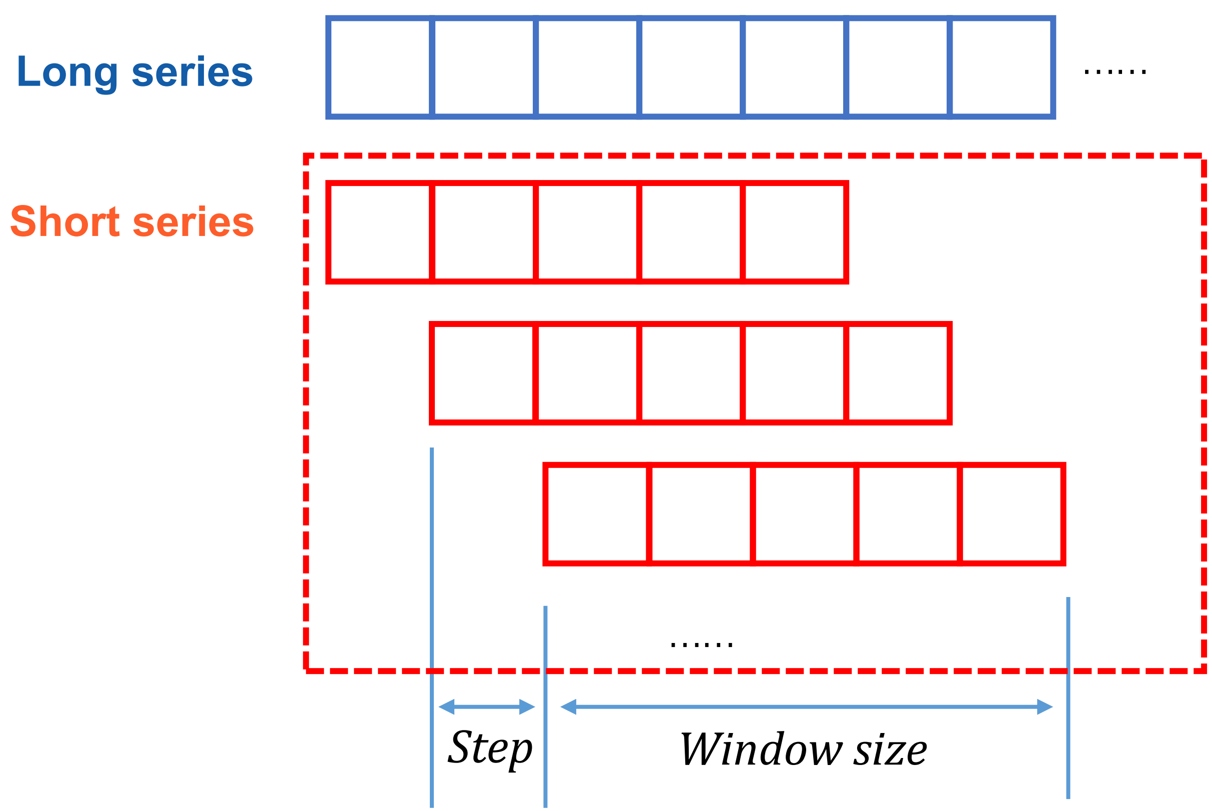




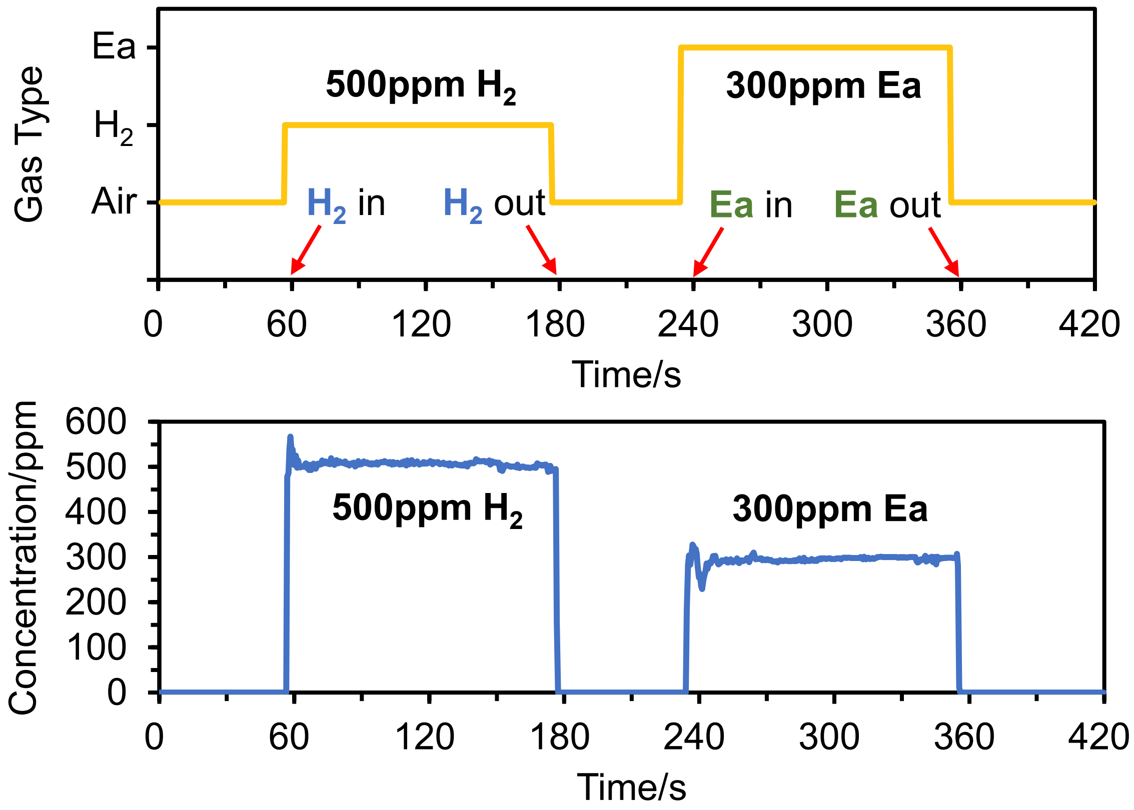
How to achieve real-time detection?

❑ Sliding Window

● **Sampling diagram**



● **Continuous Prediction of hydrogen and ethanol**



Sliding window sampling enables real-time detection!

❑ Summary of this work

- Designed and developed a portable electronic nose system capable of real-time detection.
- The combination of gas sensor arrays and deep learning algorithms can improve selectivity and accuracy.