



中国科学技术大学

University of Science and Technology of China

# Design of a High-Count-Rate photomultiplier base board on PGNAA application

Wang Baochen

Department of Modern physics,USTC

State Key Laboratory of Particle

Detection and Electronics

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- ❖ Design and test
- ❖ Summary

# Introduction

- ❖ PGNAA
- ❖ Detector system
- ❖ PMT Base board

# PGNAA

## Prompt gamma neutron activation analysis (PGNAA)

is a measurement technique for  
nondestructive elemental analysis.



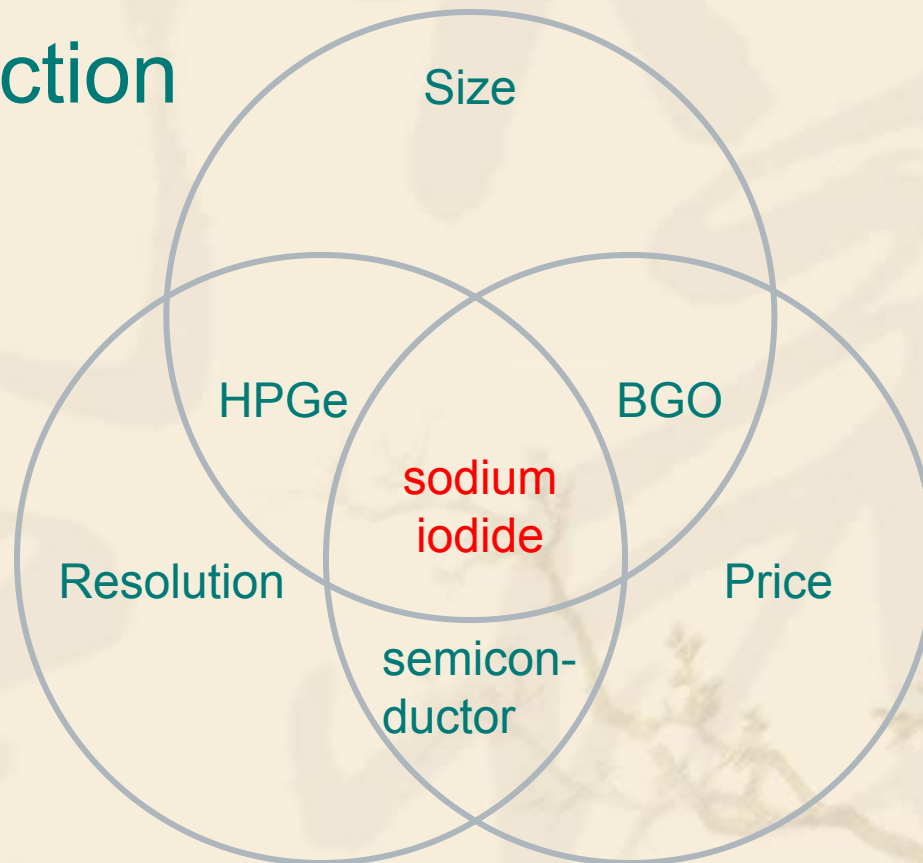
# PGNAA

- ❖ On-line industrial materials elemental analysis.
- ❖ High count rate. - Good statistics.



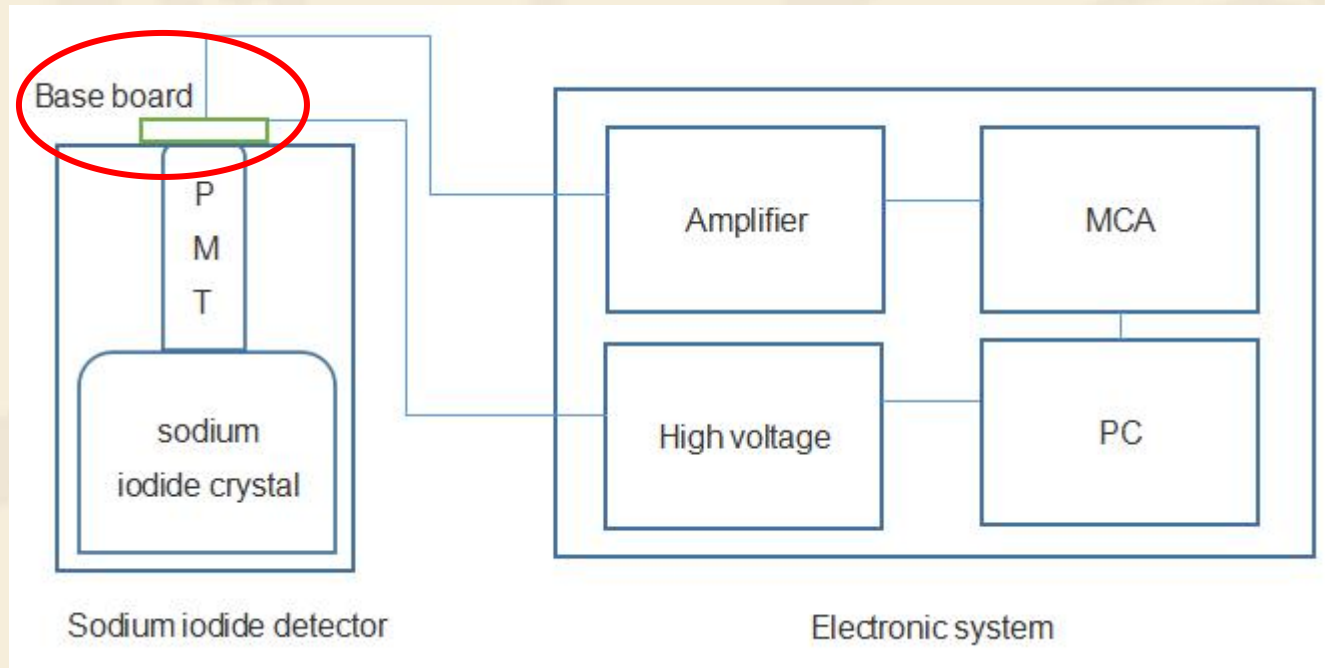
# Detector system

## ❖ Detector selection



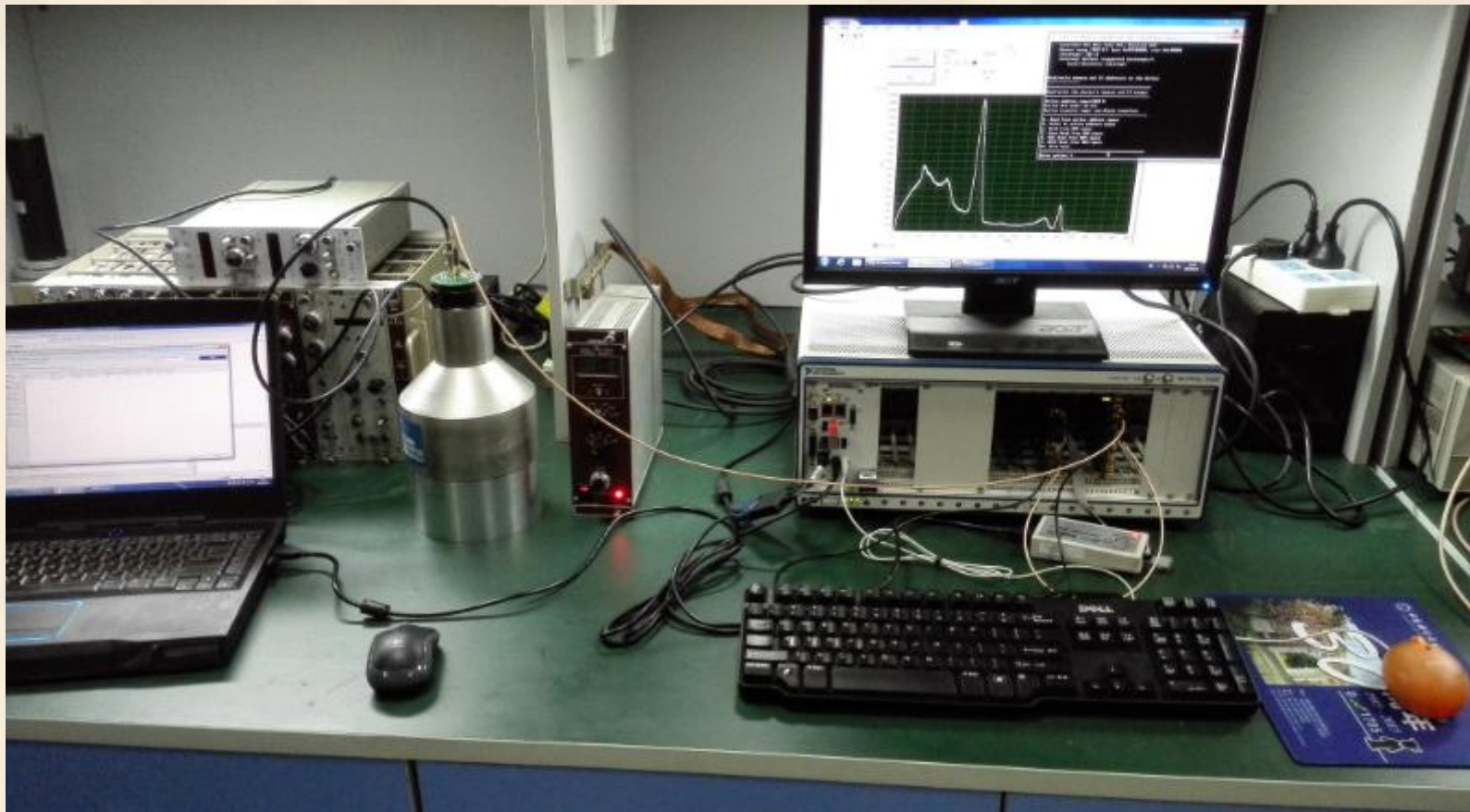
# Detector system

## ❖ Detector - Base board - Electronic system





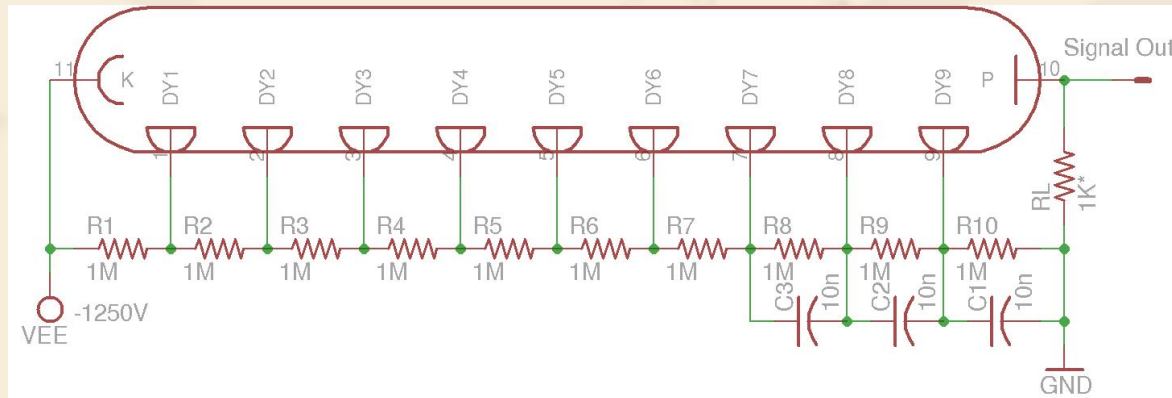
# Detector system





# PMT Base board

- ❖ PMT voltage divider
- ❖ Consists of a string of passive components: resistors and capacitors - connected in series across HV power supply

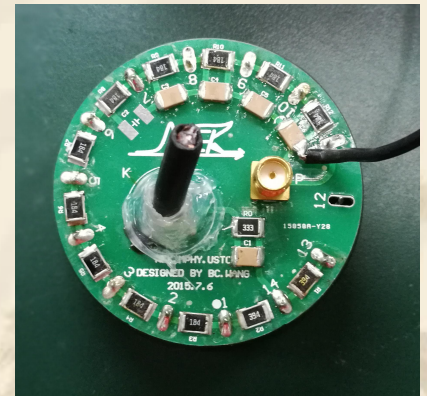
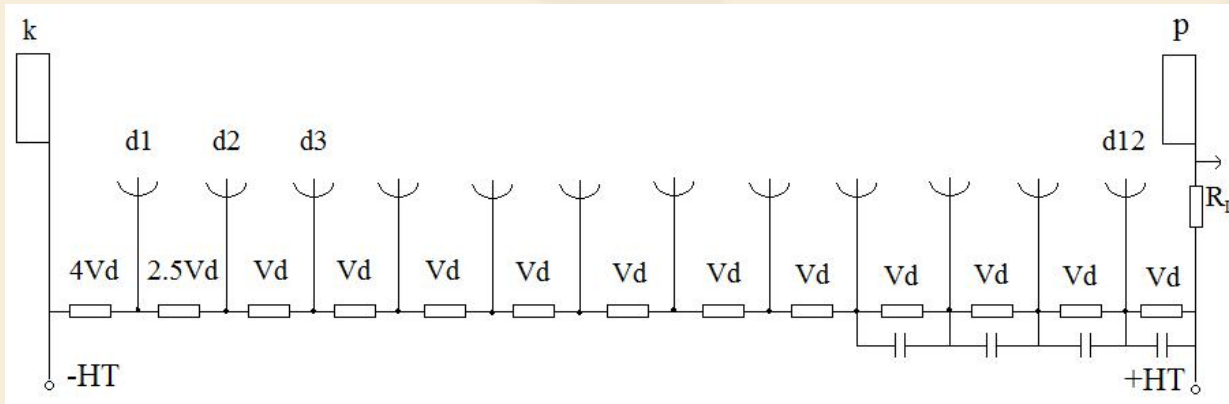


# Design and test

- ❖ "Simple" resistive voltage divider
- ❖ Limitation
- ❖ Development - Current driver design
- ❖ Test result

# "Simple" resistive voltage divider

- ❖ Voltage of dynodes
- ❖ Many applications can be achieved, except the high dynamic range applications



# Limitation


- ❖ PGNAA-high count rate application
- ❖ The electrode current depends on light intensity
- ❖ The upper limit of energy spectrum is only 5MeV at 100k count rate.





Limitation

It doesn't work!

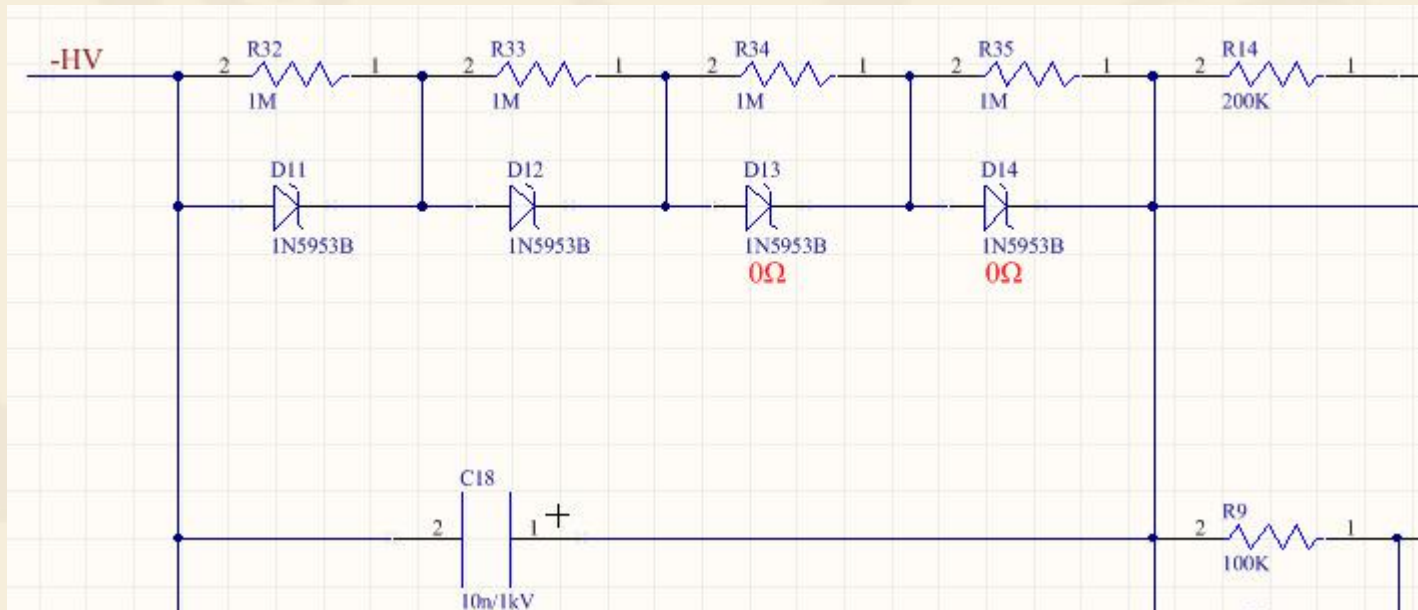


# Development

- ❖ Provide enough current, make the electrode current does NOT depend on light intensity
- ❖ Current driver design, using transistors
- ❖ Limit voltages, using zener diodes

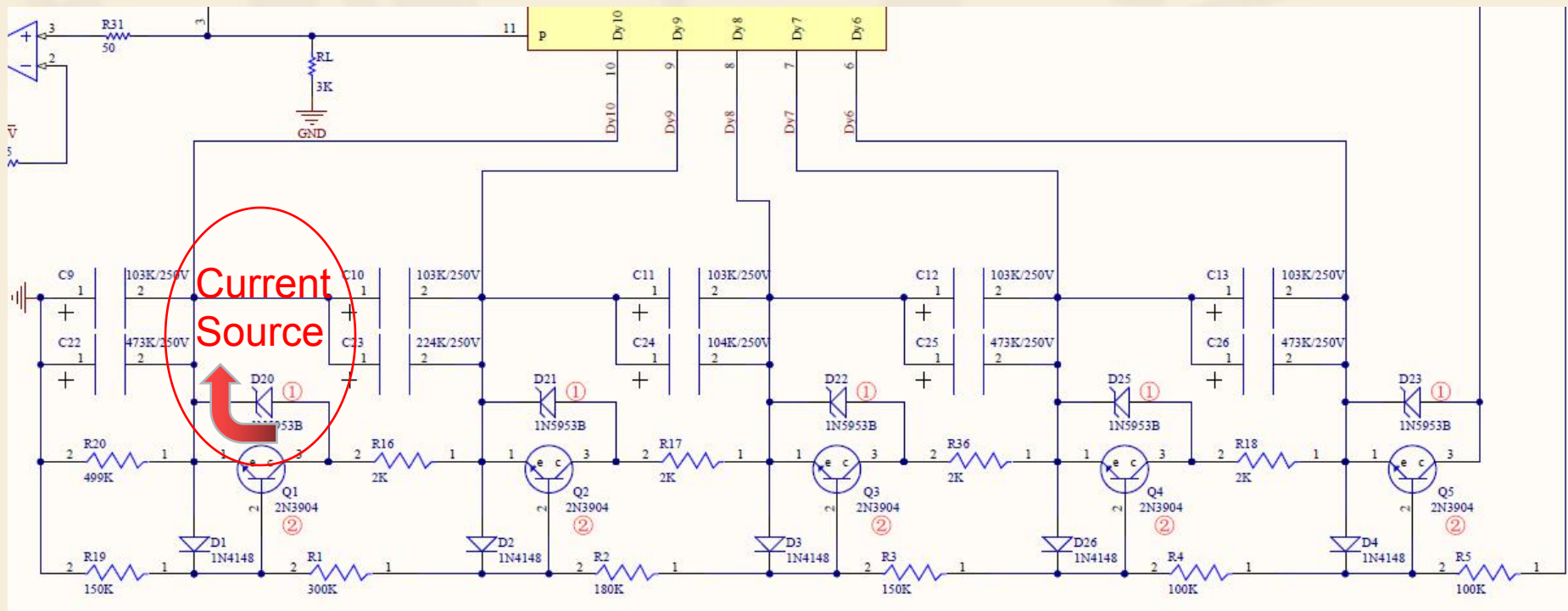
# Development

- ❖ Dy1~5 with zener diodes to limit voltage



# Development

❖ Dy6~10 with current driver, i.e. transistors

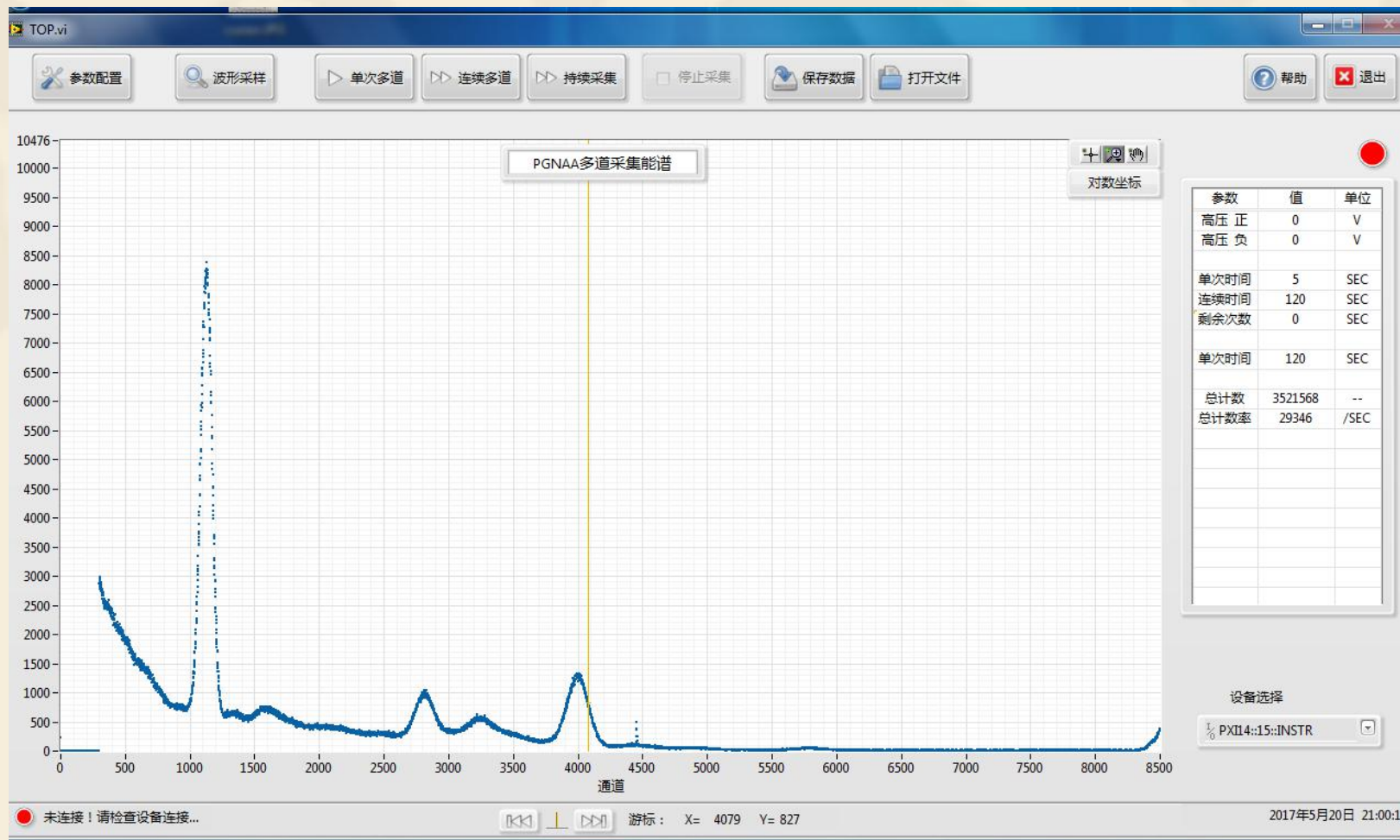




# Development



# Test result of $^{22}\text{Na}$ source



# Test result

- ❖ The design increases the upper limit of energy spectrum to 10MeV at 300k count rate.
- ❖ The resolution of  $^{22}\text{Na}$ (1.74MeV peak) is 4.8%. The resolution of hydrogen(2.2MeV) is 7.8%.





Test result

It works!





# Summary

- ❖ “Simple” resistive voltage divider design PMT base board doesn't work.
- ❖ The developed design adds current driver design, and has got good test result.
- ❖ It increased the upper limit of energy spectrum and counting rate.

Thanks for your attention!