



中国科学技术大学

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

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Detection and Electronics

Content

- ❖ Introduction
- ❖ 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.

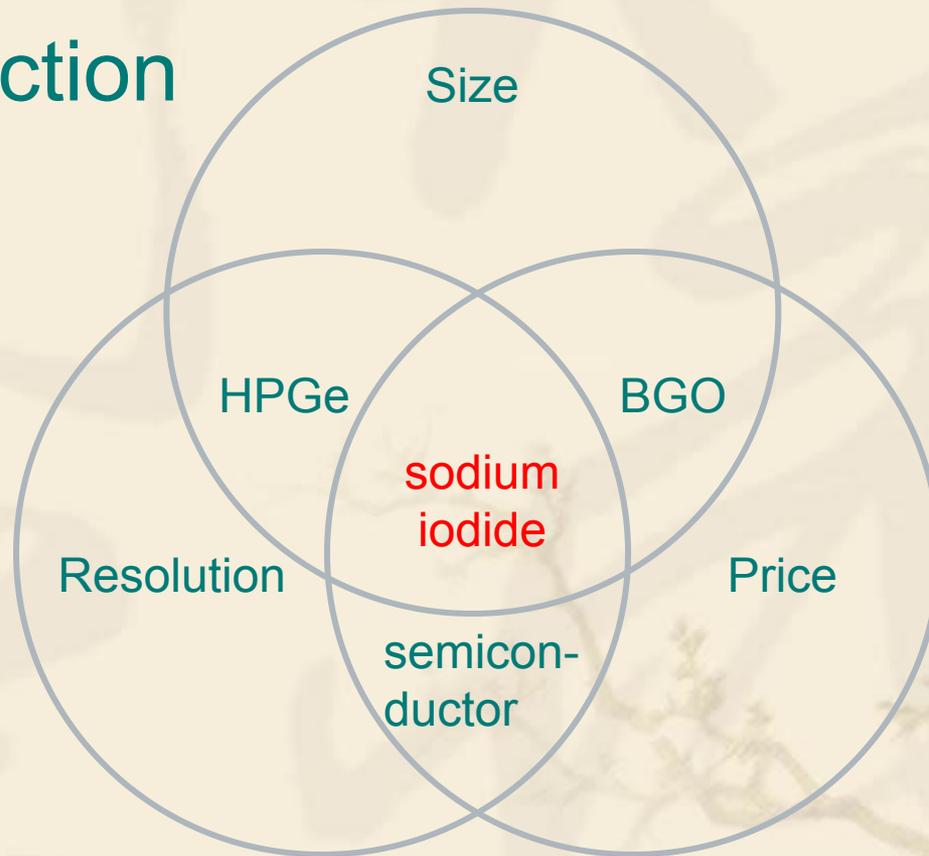
PGNAA

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



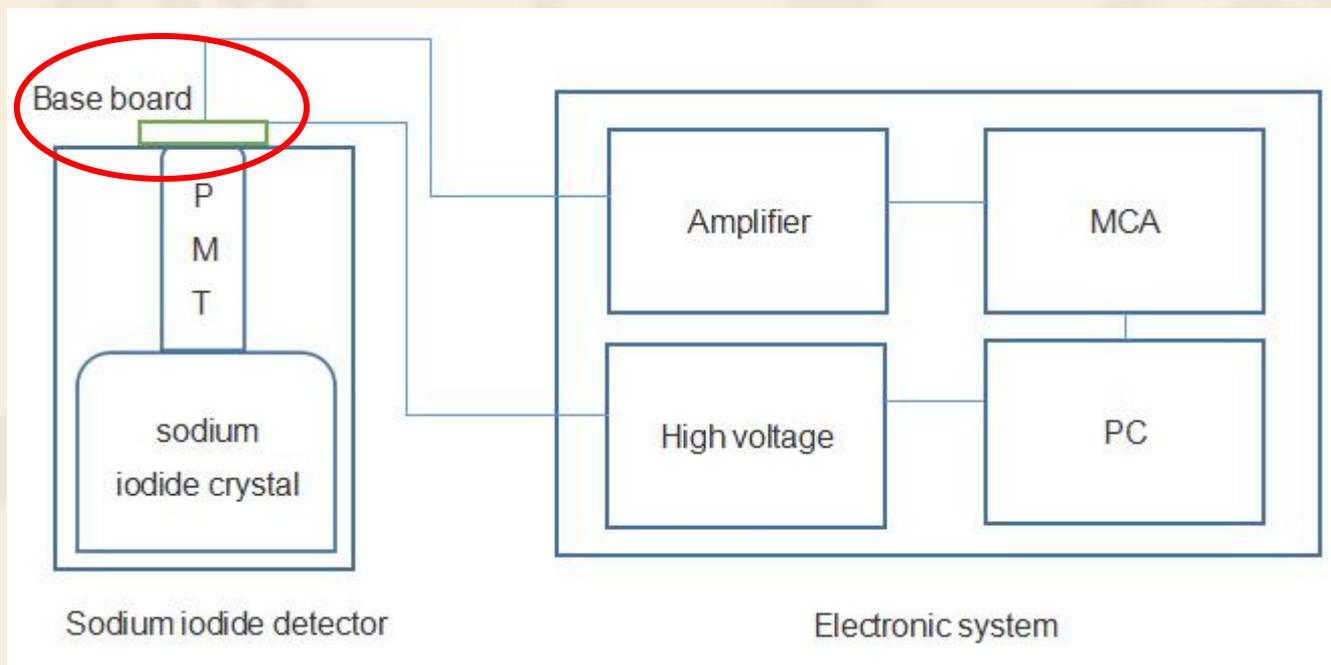
Detector system

❖ Detector selection

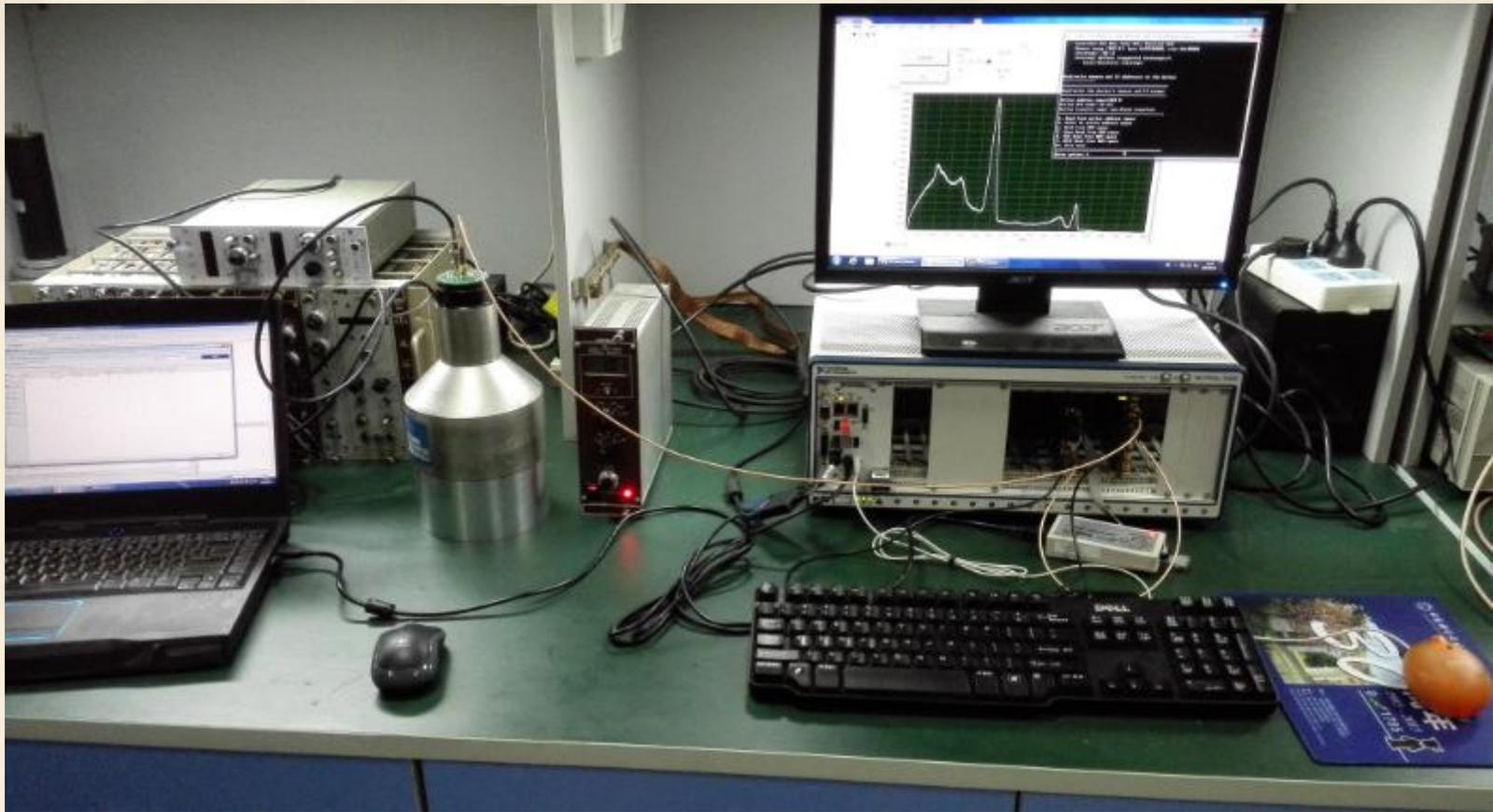


Detector system

❖ Detector - Base board - Electronic system

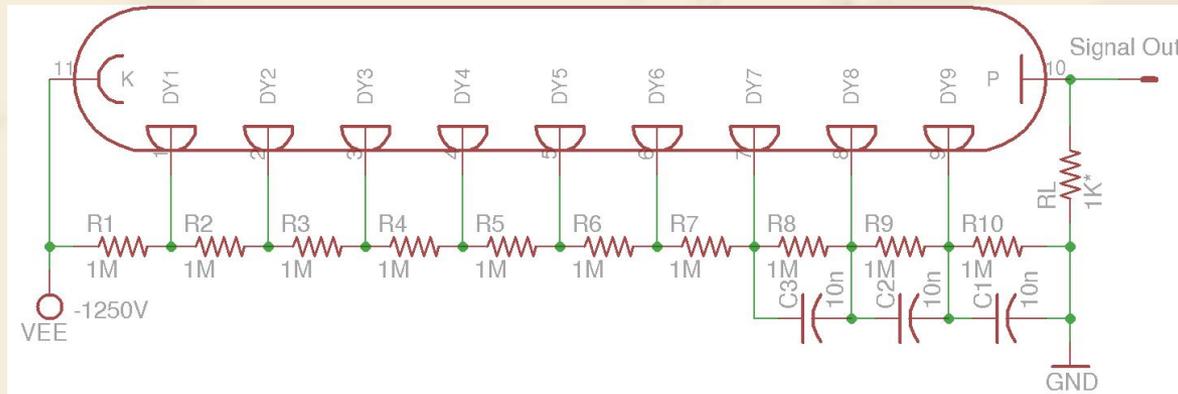


Detector system



PMT Base board

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

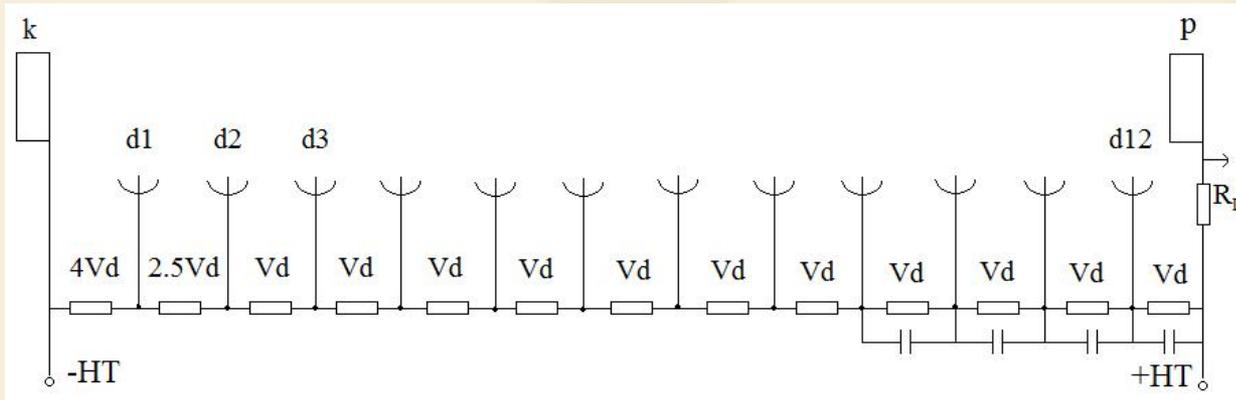


Design and test

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

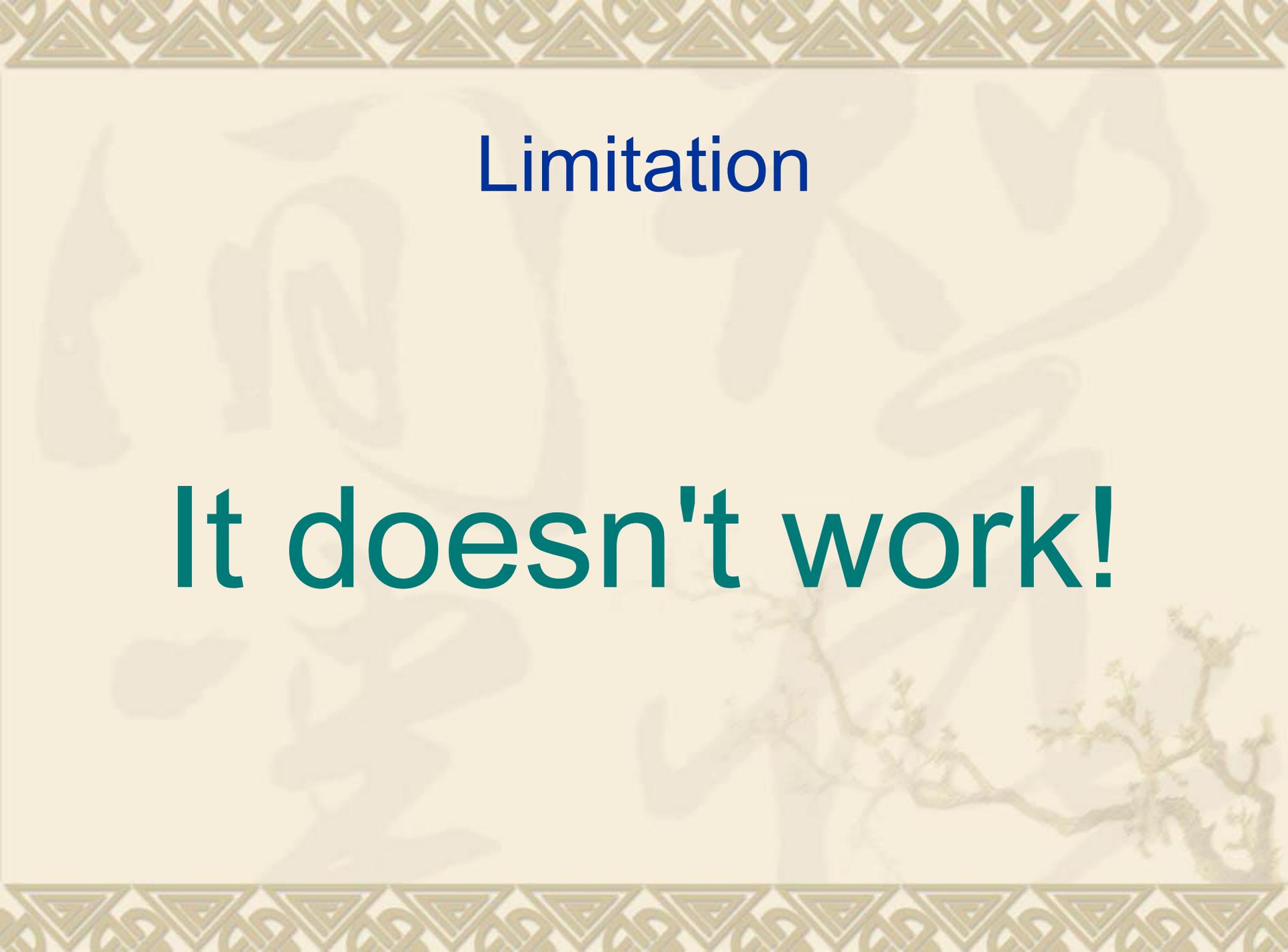
"Simple" resistive voltage divider

- ❖ 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

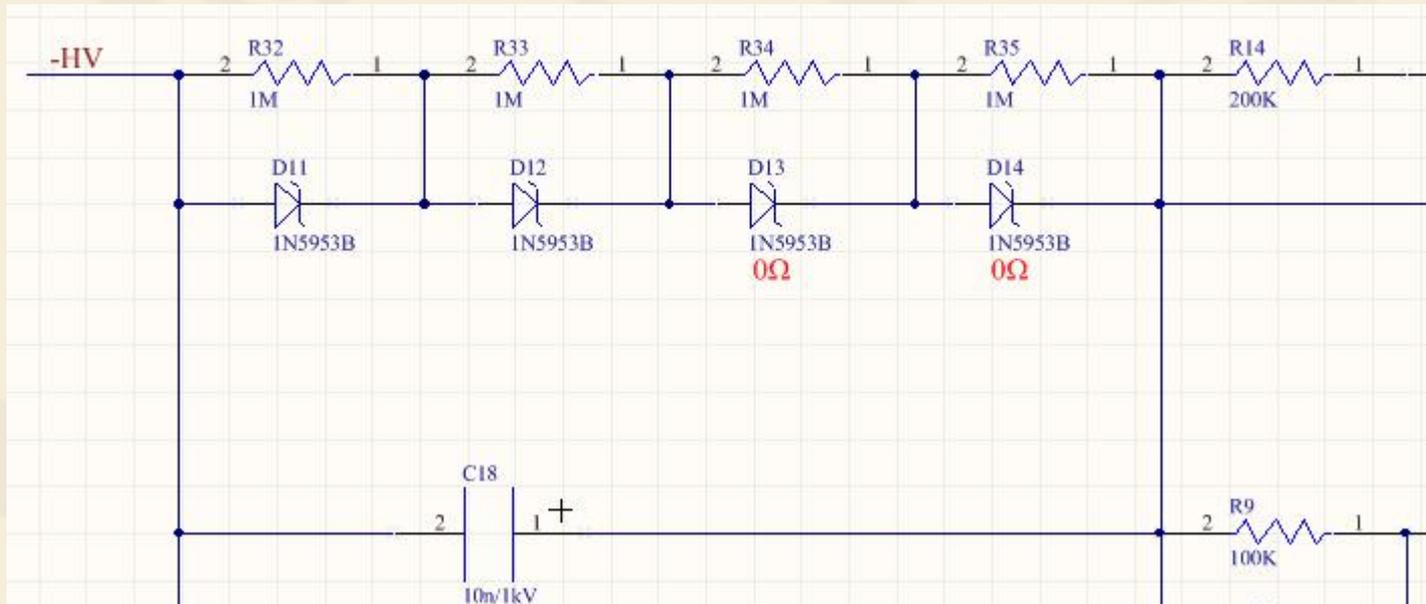
It doesn't work!

Development

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

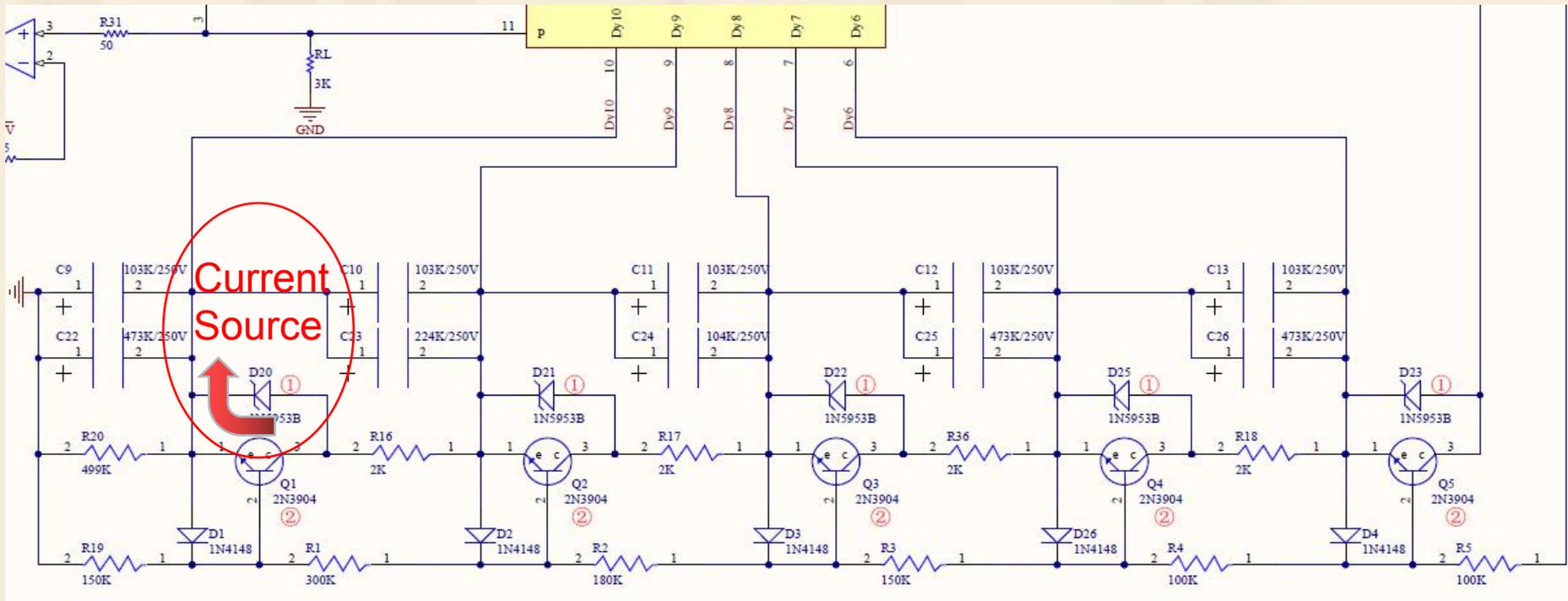
Development

- ❖ Dy1~5 with zener diodes to limit voltage

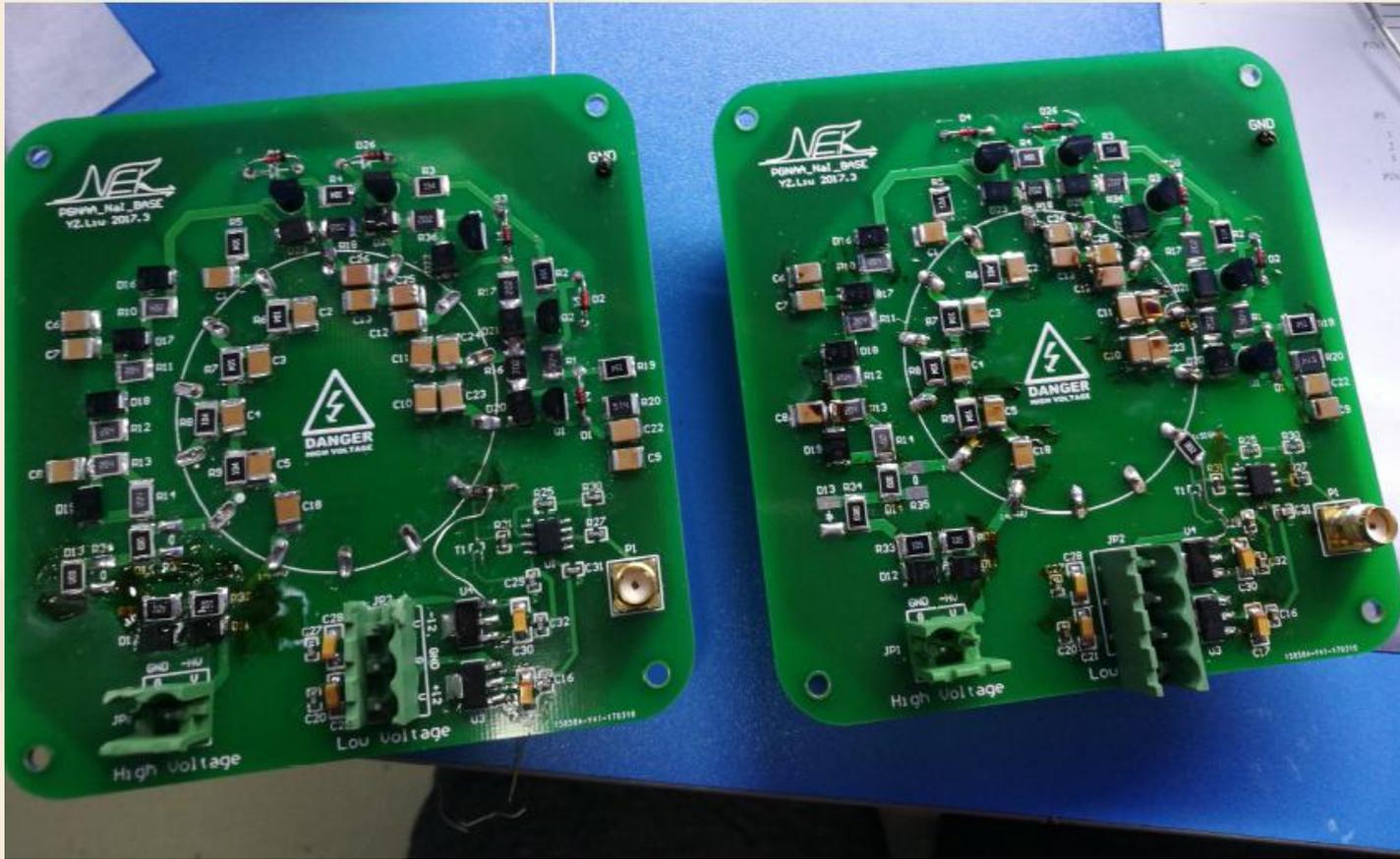


Development

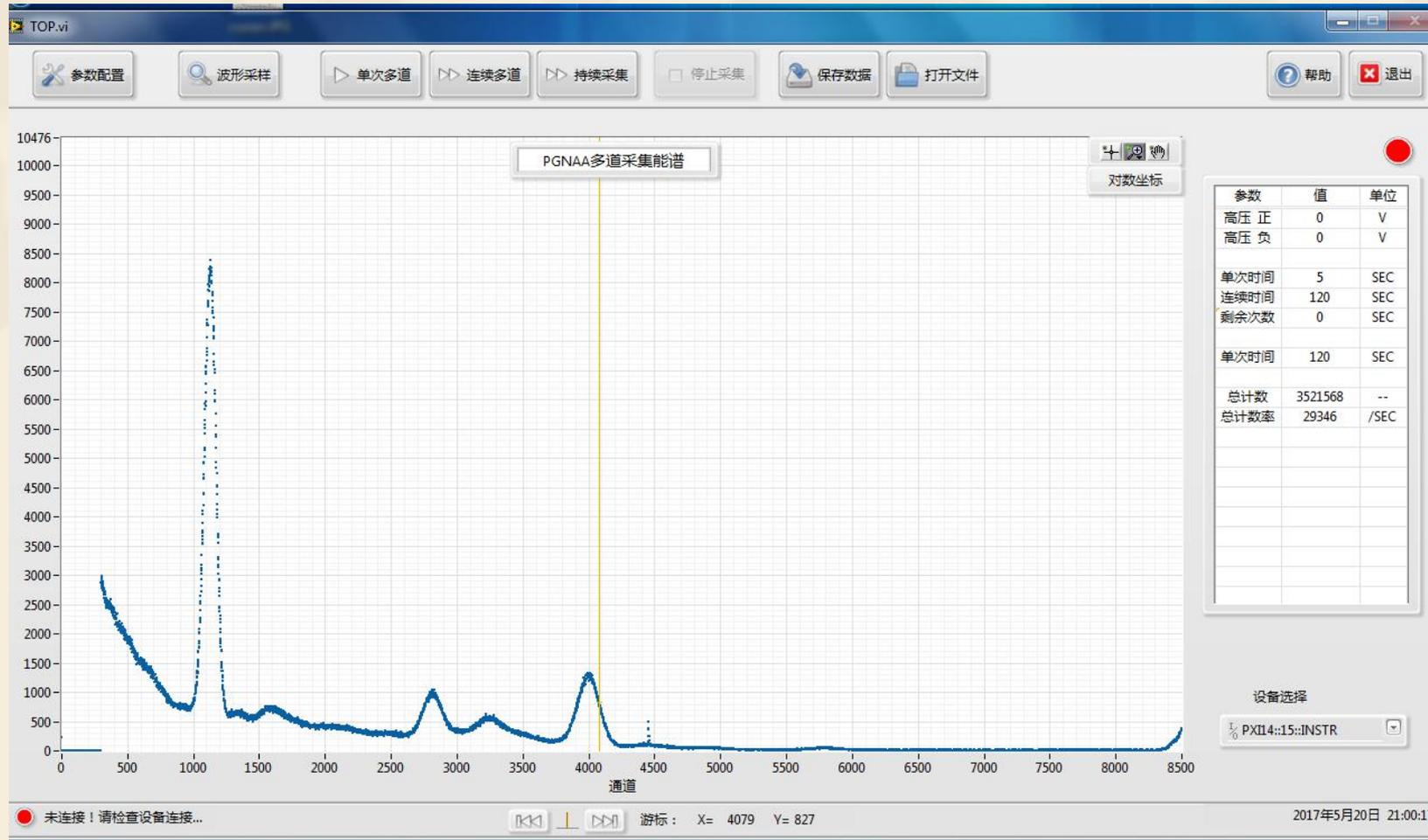
❖ Dy6~10 with current driver, i.e. transistors



Development

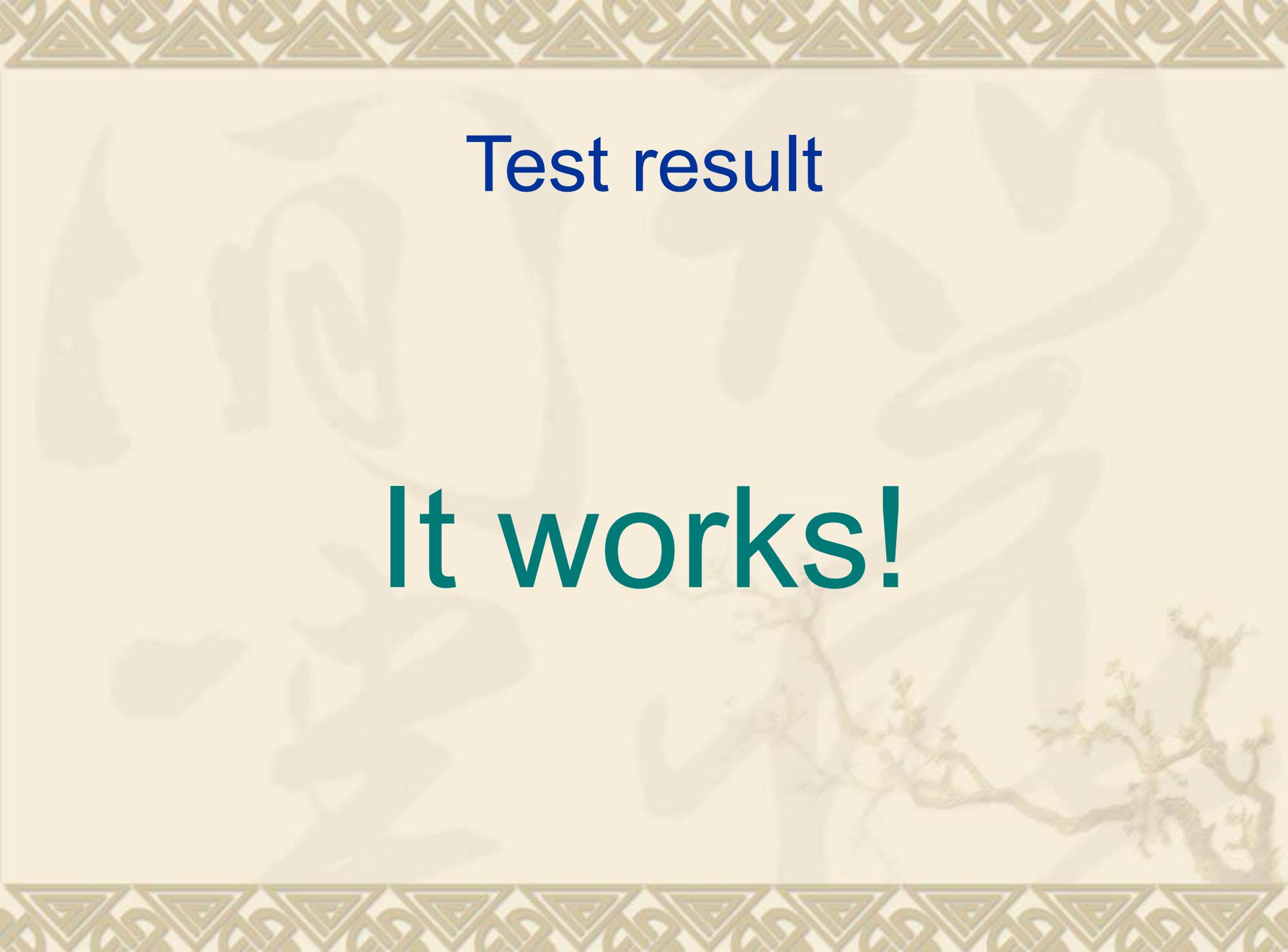


Test result of ^{22}Na source



Test result

- ❖ The design increases the upper limit of energy spectrum to 10MeV at 300k count rate.
- ❖ The resolution of ^{22}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!