



中国科学院高能物理研究所

Institute of High Energy Physics Chinese Academy of Sciences

# NDL LGAD sensor R & D in China

Zhijun Liang

Institute of High Energy Physics ,  
Chinese Academy of Science

HGTD 3 day meetings in upgrade week

# LGAD sensor R & D in China : Epitaxial layer wafer

## – LGAD sensor with Epitaxial layer

- NDL is foundry for SipM. They can provide LGAD as well.
- First batch LGAD sensor fabricated. (~100 2x2 sensors )
  - Thickness of epitaxial layer: 33um
  - epitaxial layer Resistivity: 300 Ohm.cm

<http://www.ndl-sipm.net/contacteng.html>

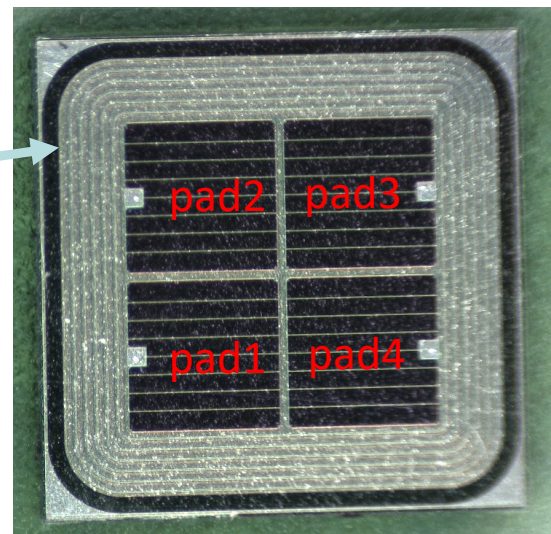
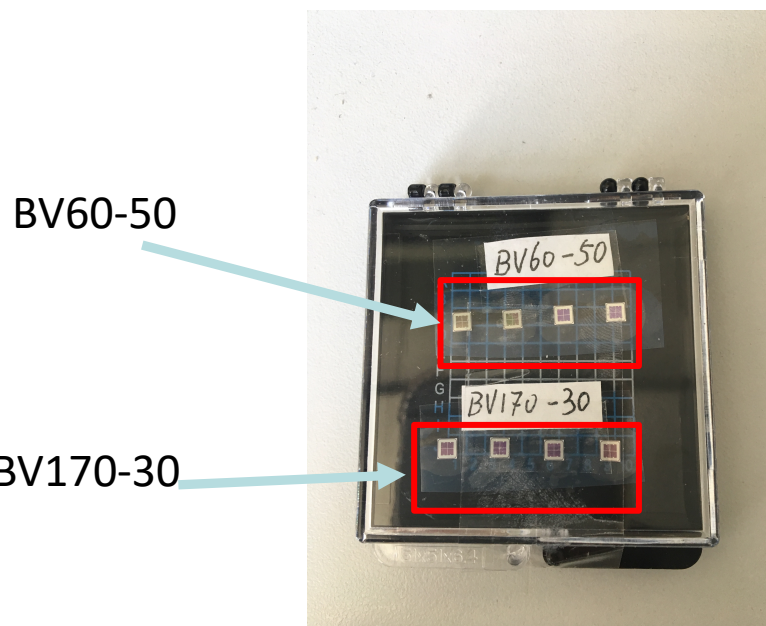
Two type of sensors BV170-30-B, BV60-50-B



NDL can provide reliable and cost effective SIPMs with typical delivery time from 1 week to 3 months.

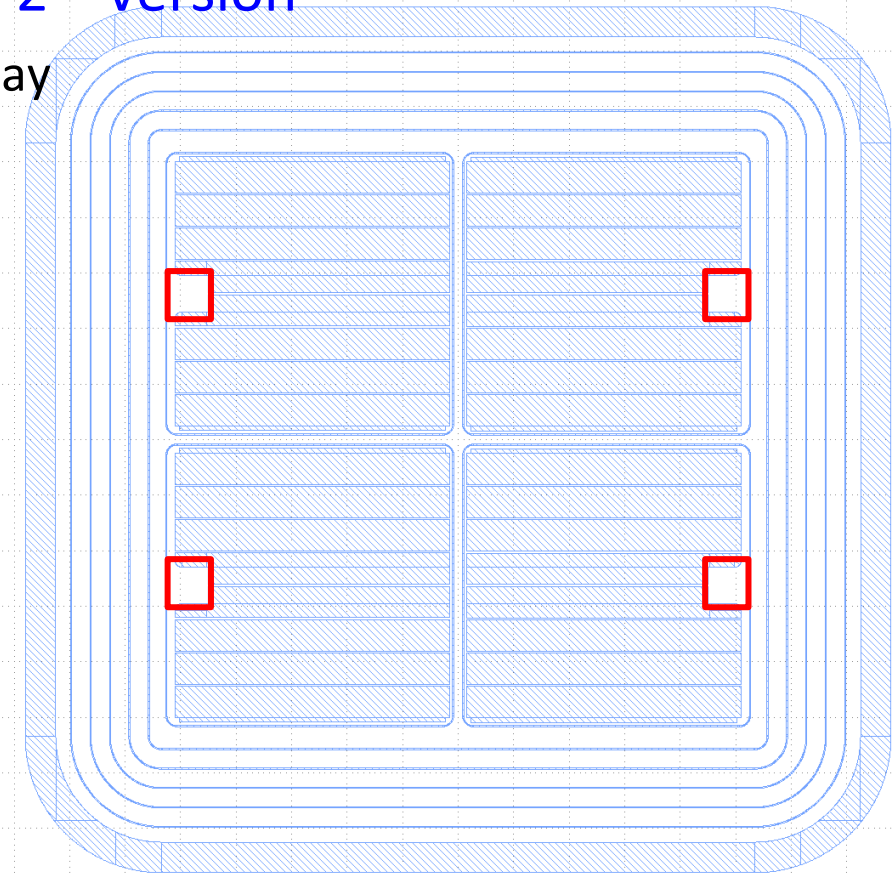
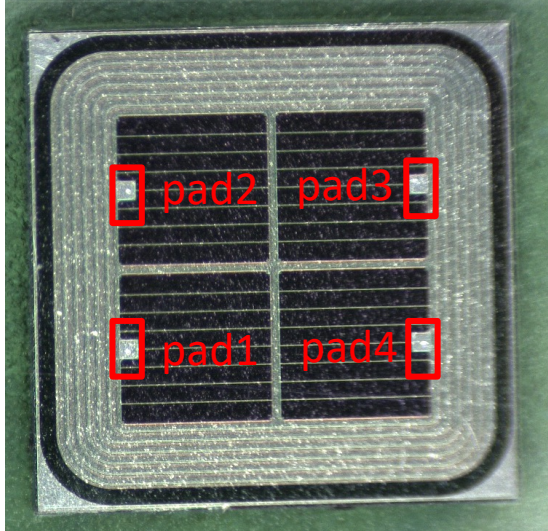
Novel Device Laboratory (NDL)  
Address: XueYuan Nan Lu No.12  
Hai Dian District, Beijing, China,100875  
Tel: +86-10-62207419, Fax: +86-10-62207419  
Email: info@ndl-sipm.net

Photoelectric Instrument Factory of Beijing Normal University  
Address: 1st floor in block B of Dormitory 4 Xin Wai Da Jie No.19, Hai Dian District, Beijing, China  
Tel: 010-58807630  
Email: 58807630@163.com  
Web: <http://www.peifbnu.com/plus/view.php?aid=72.html>



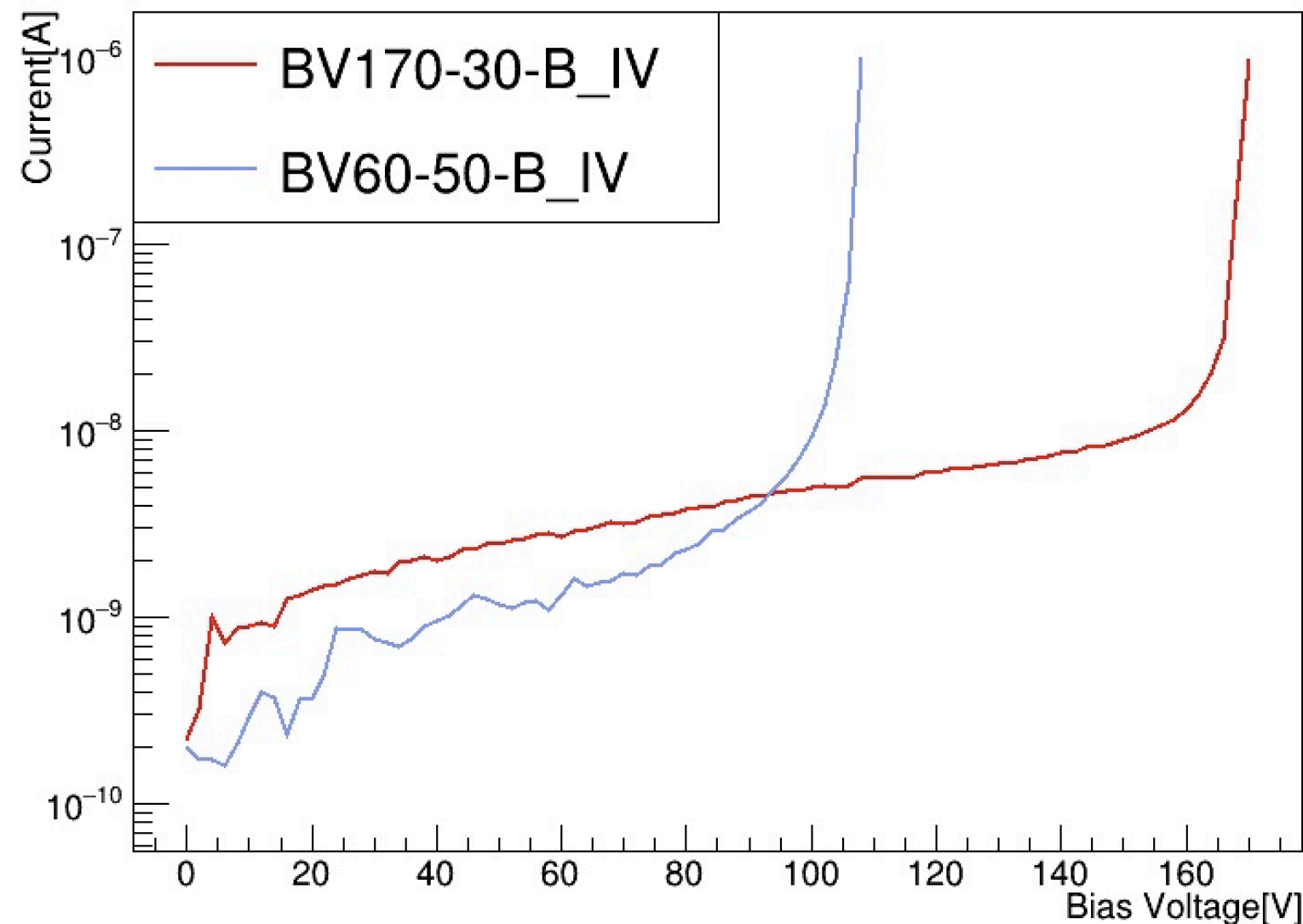
# schematic with the wire bond pads highlighted

- 4 pads for 2x2 LGAD arrays
- No pads for GR in 1<sup>st</sup> version of NDL LGAD sensor
  - GRs are supposed to be floating
- Pad for GR will be available in 2<sup>nd</sup> version
  - Will be available in middle of May



# I-V and gain for NDL LGAD sensor

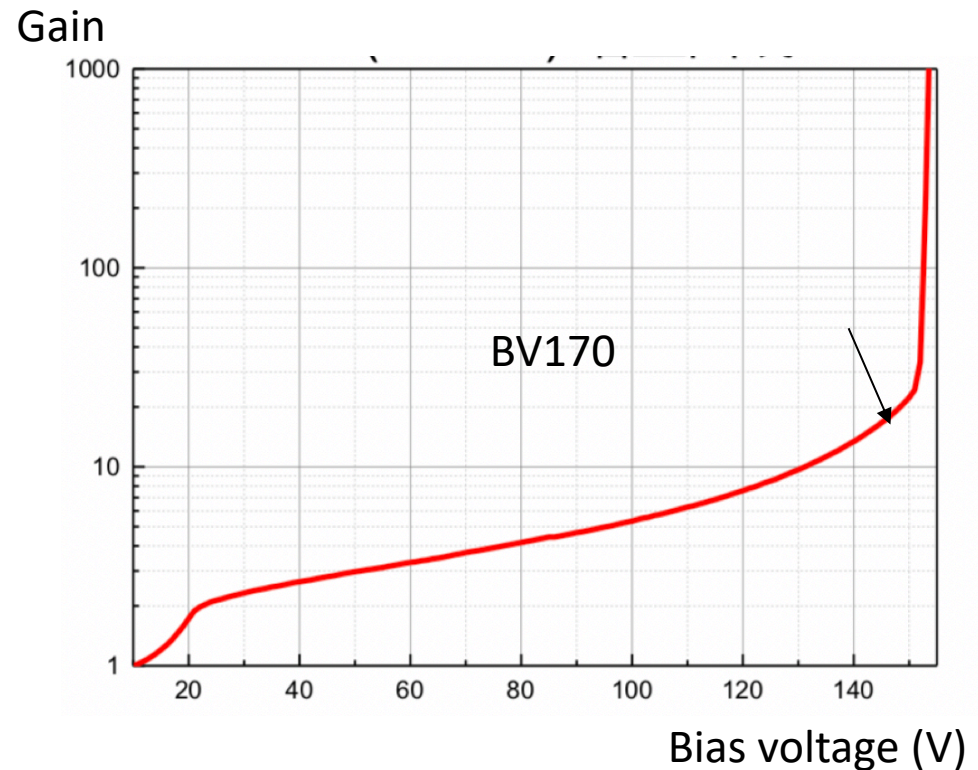
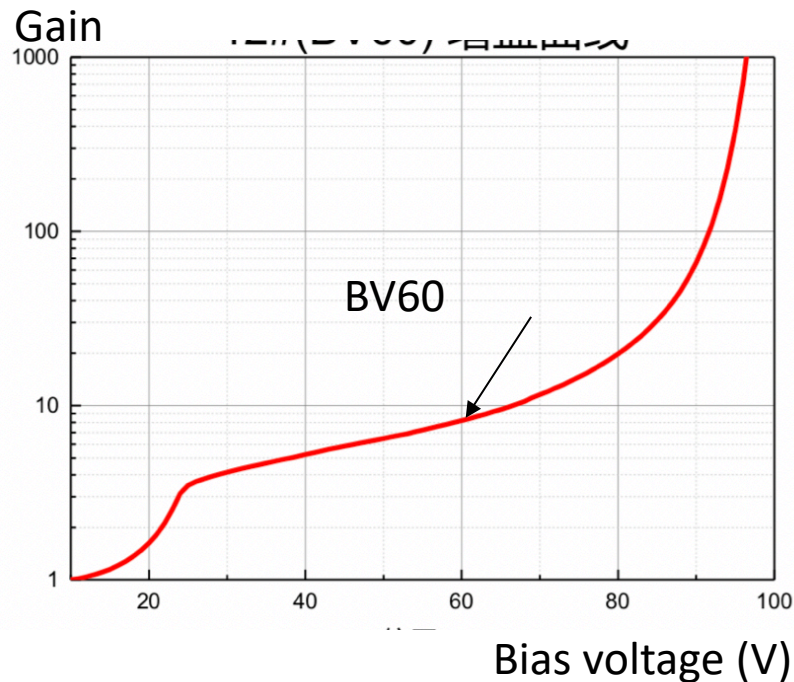
- Two type of NDL sensors ( BV170 and BV60)



By Liaoshan, Baohua, Zhijun

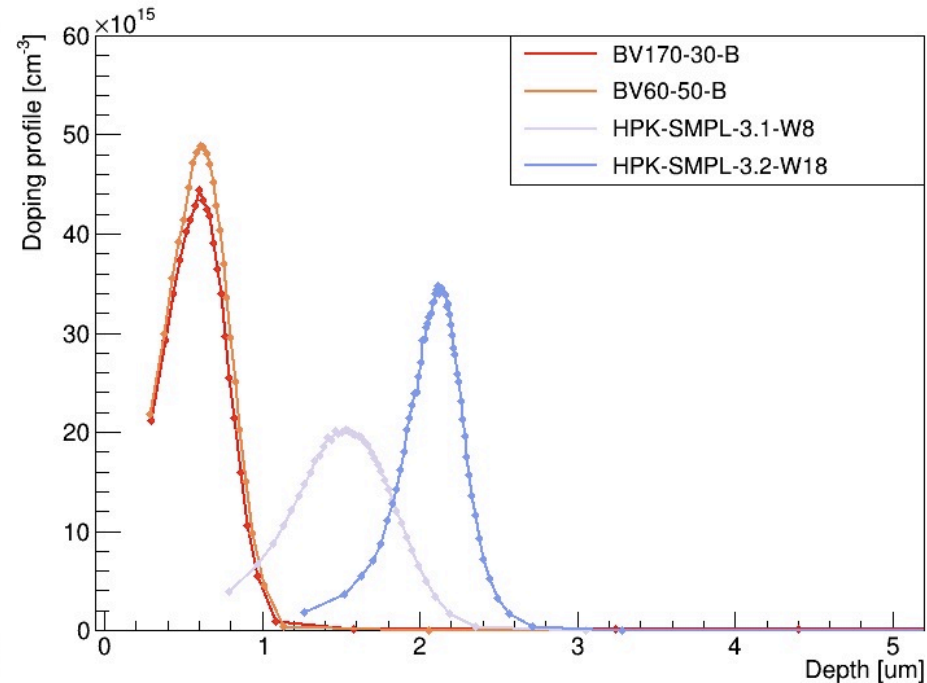
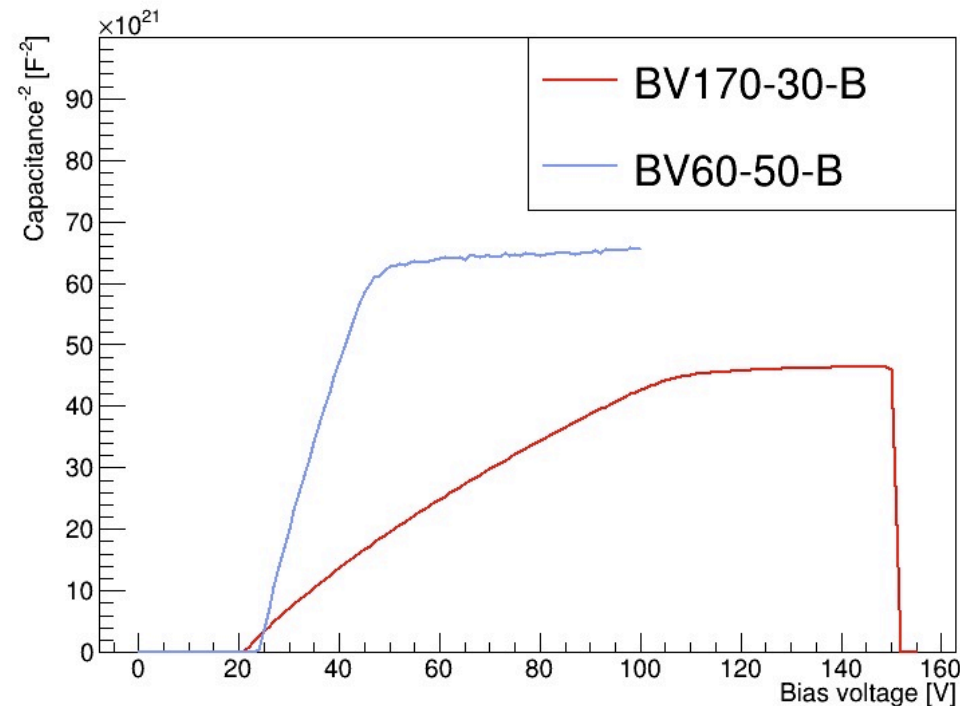
# Gain for NDL LGAD sensor

- Two type of NDL LGAD sensor (gain=10 for working voltage)



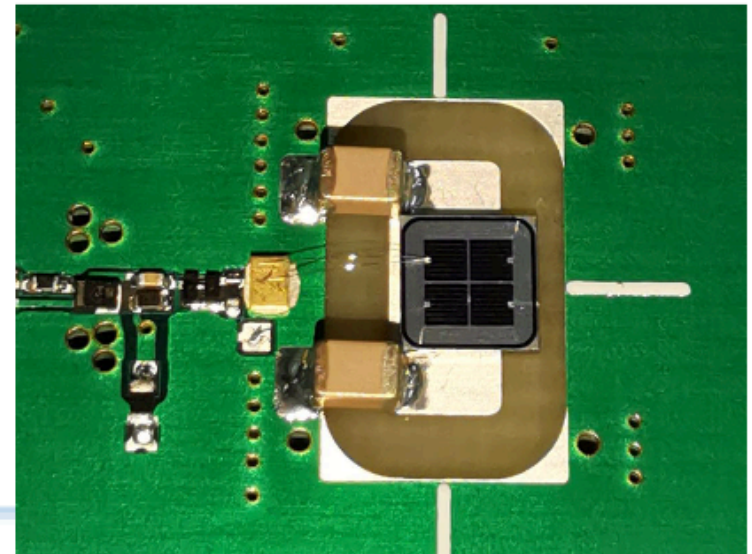
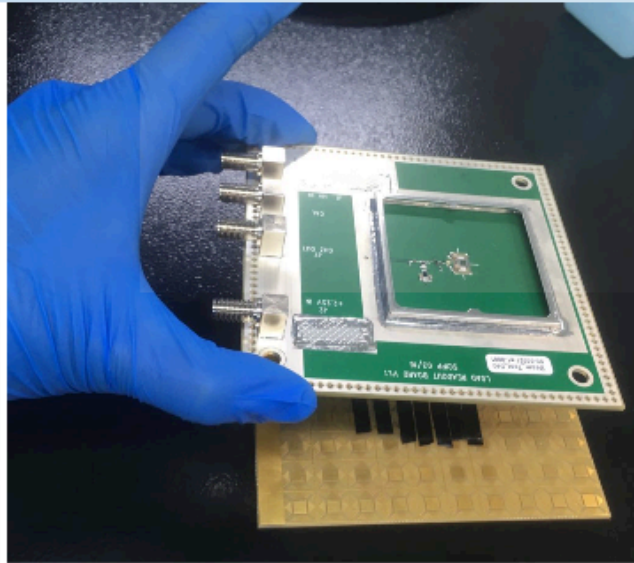
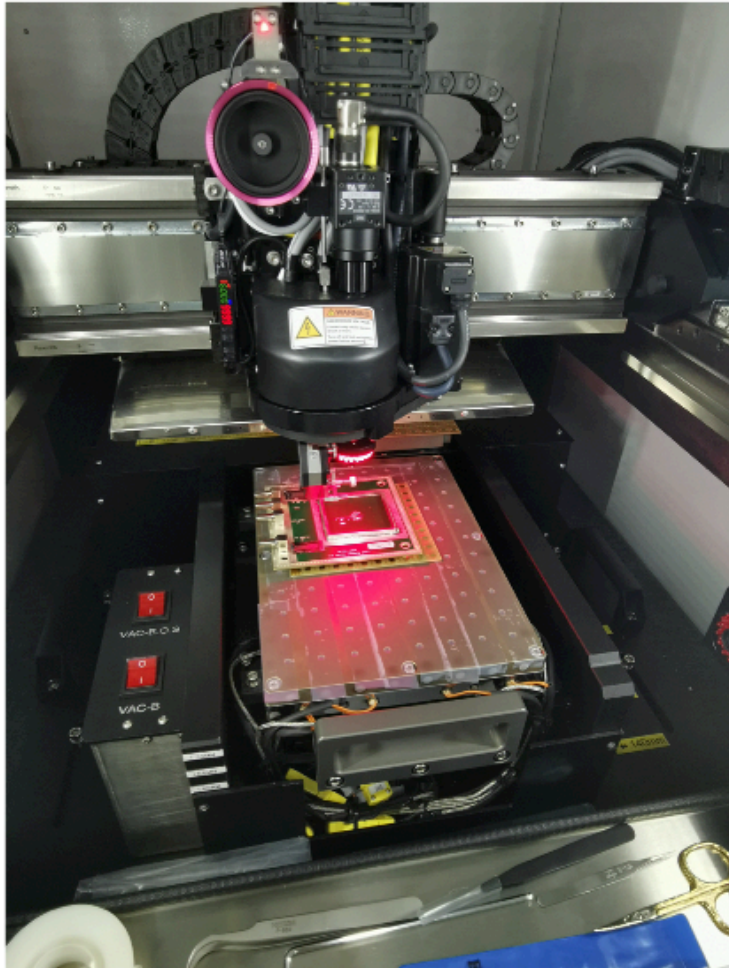
# C-V and doping profile

- BV60 depleted at 50V , BV170 depleted at 110V
- Doping depth for p+ layer is lower compared to HPK
  - Will ask foundry to try deeper p doping



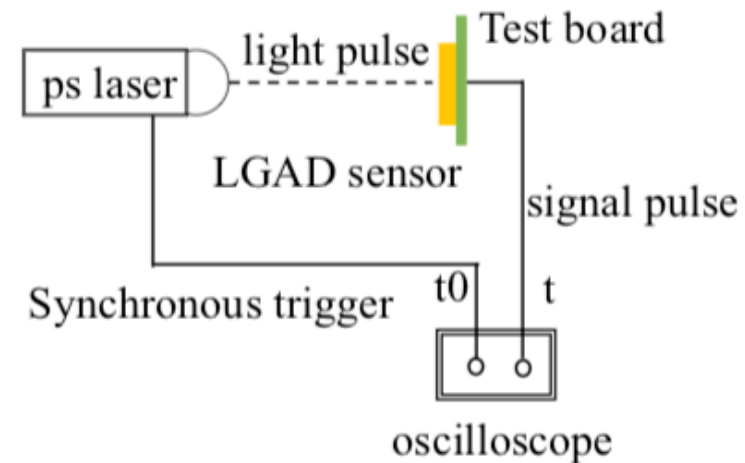
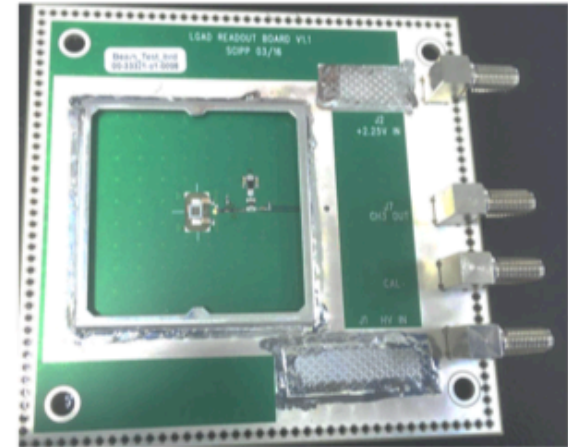
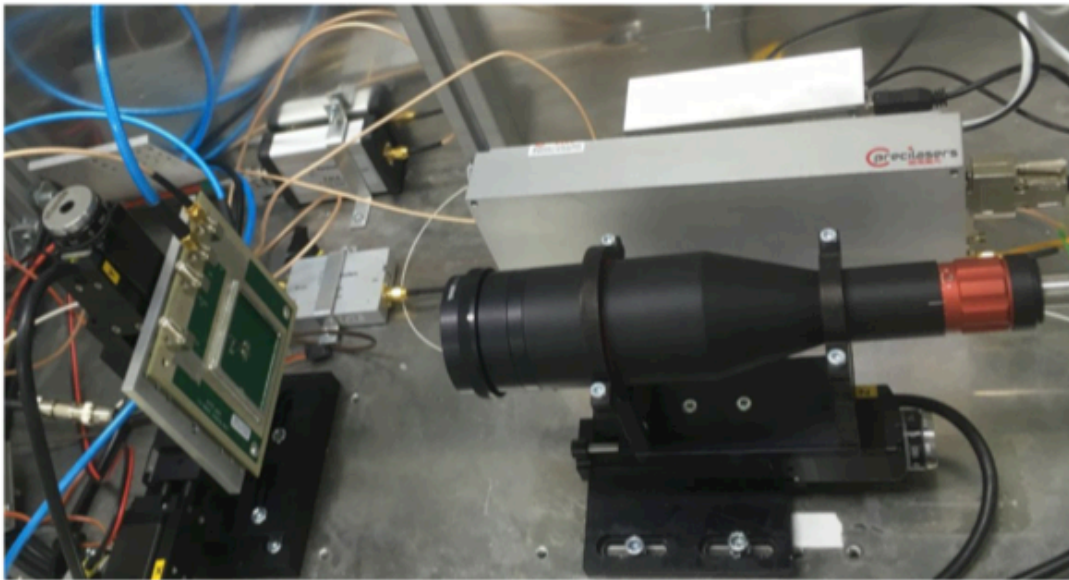
# Assembly and Wire bonding

Yuzhen, Zhijun



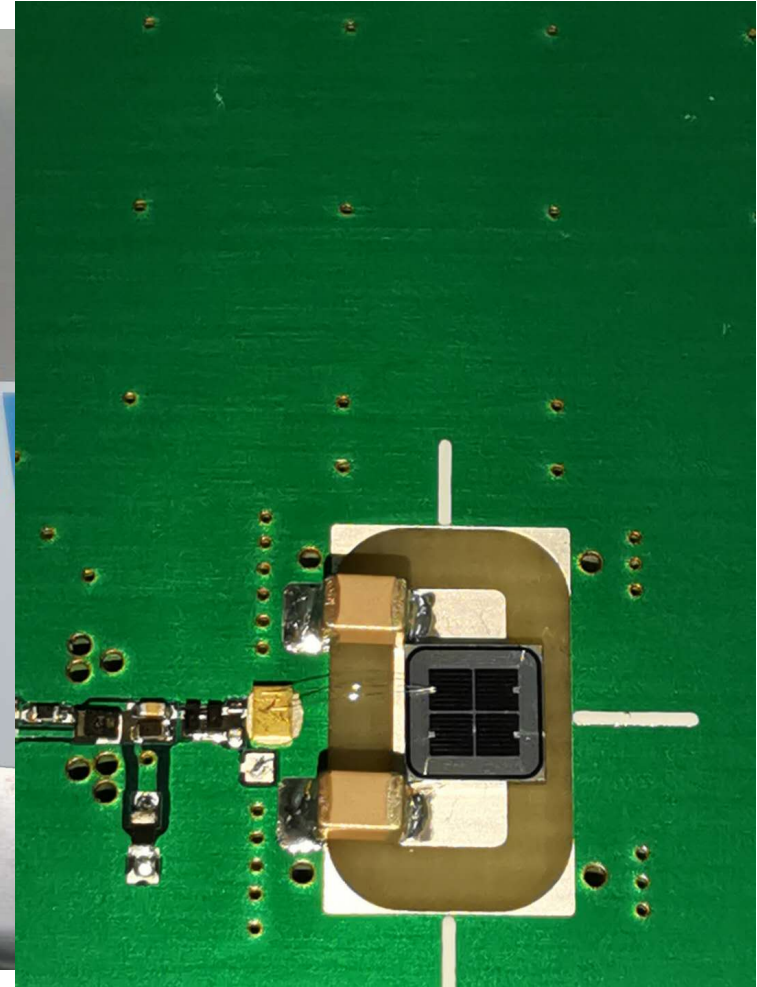
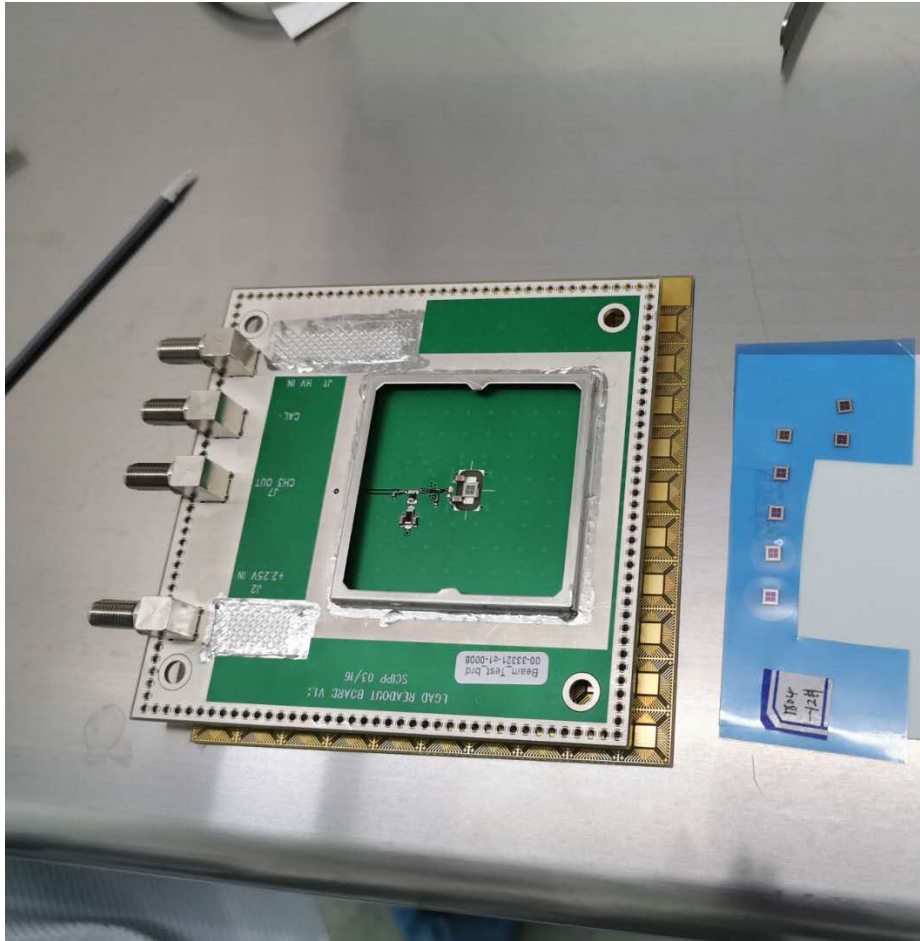
# Time resolution test system

- Pico second laser: 1064nm wave length, 7.5 ps pulse width, 20.97MHz frequency
- Oscilloscope: Lecroy 8254M, 2.5 GHz bandwidth, 40GS/s sample rate
- High voltage power supply: Keithley 2410
- Low voltage power supply: 1.4V for amplify



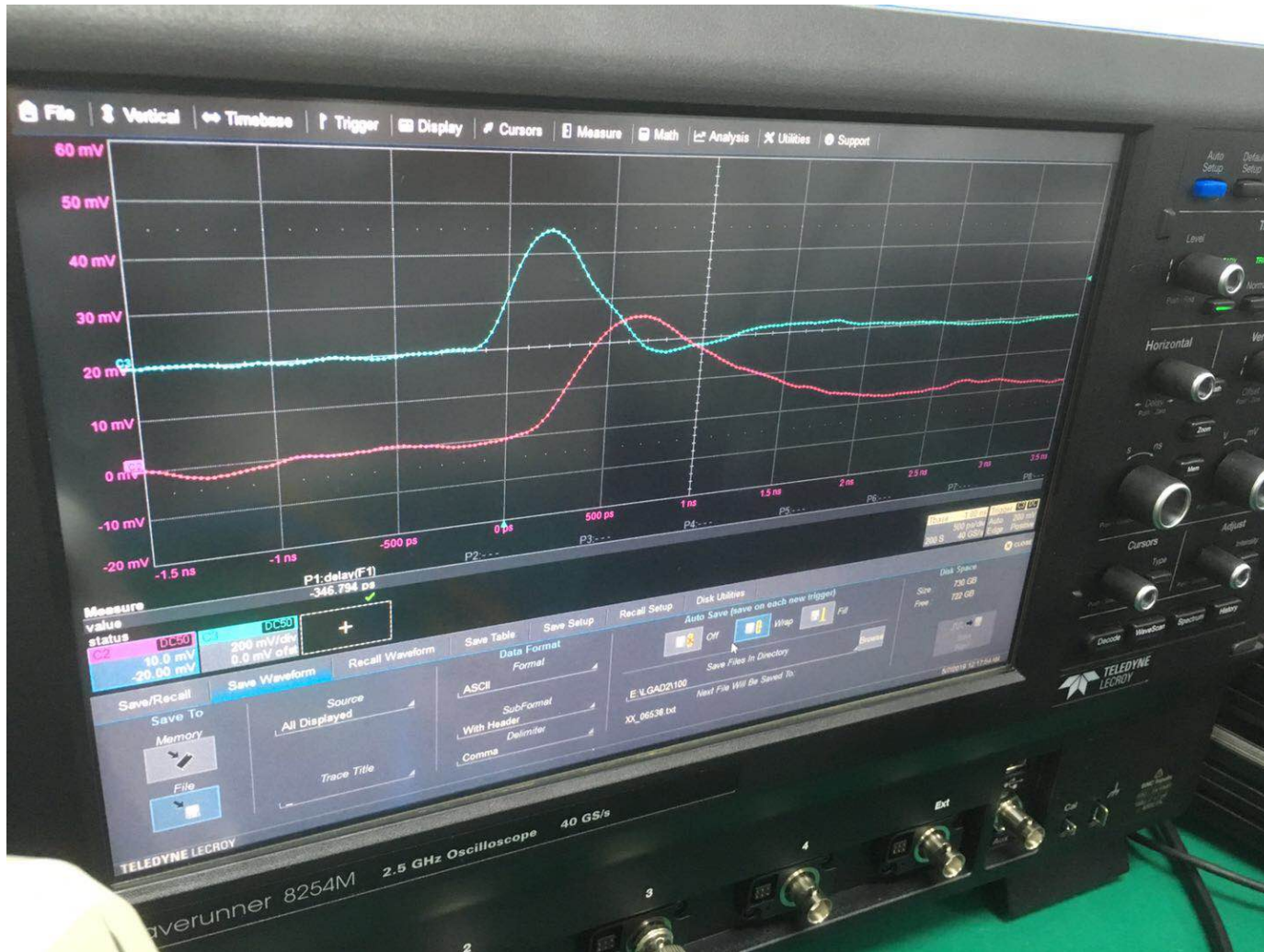
# Wire bonding

- Wire bonding NDL sensor to NDL single channel board.



# Laser test for NDL LGAD sensor

- Red is LGAD sensor signal
- blue is trigger signal for pico second laser.



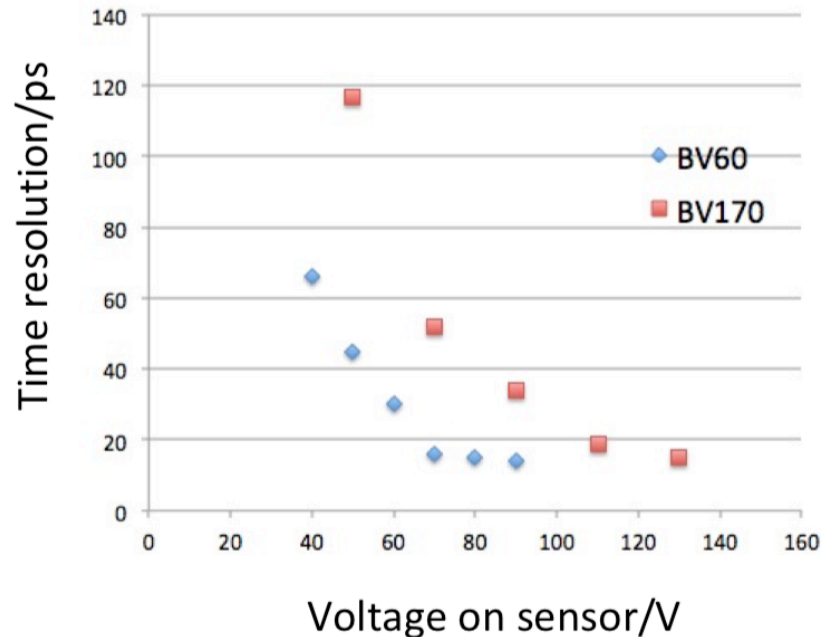
# Time resolution of NDL sensor in laser test

NDL BV60 LGAD sensor

V_bias	Time Resolution (ps)
90V	14
80V	15
70V	16
60V	30
50V	45
40V	66

NDL BV170 LGAD sensor

V_bias	Time Resolution (ps)
130V	12
110V	19
90V	34
70V	52
50V	117



# To do:

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- I-V in low temperature (-30 )
- Analysis of timing resolution
  - `/afs/ihep.ac.cn/users/l/liangzj/work2/LGAD`