核探测与核电子学国家重点实验室

STATE KEY LABORATORY OF PARTICLE DETECTION & ELECTRONICS

UNIVERSITY OF SCIENCE AND TECHNOLOGY OF CHINA

Measurement of HGTD Module Bonded with ACP technique

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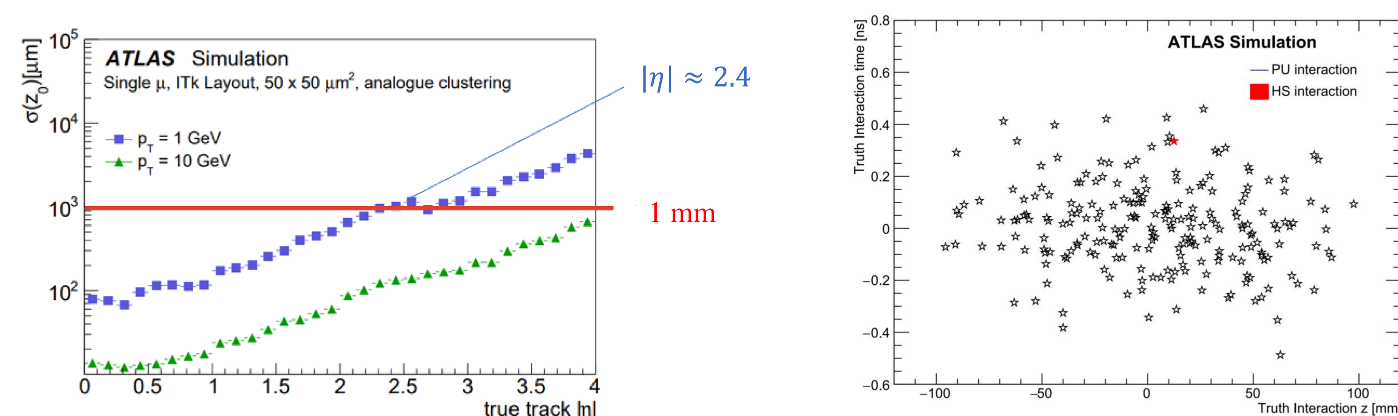
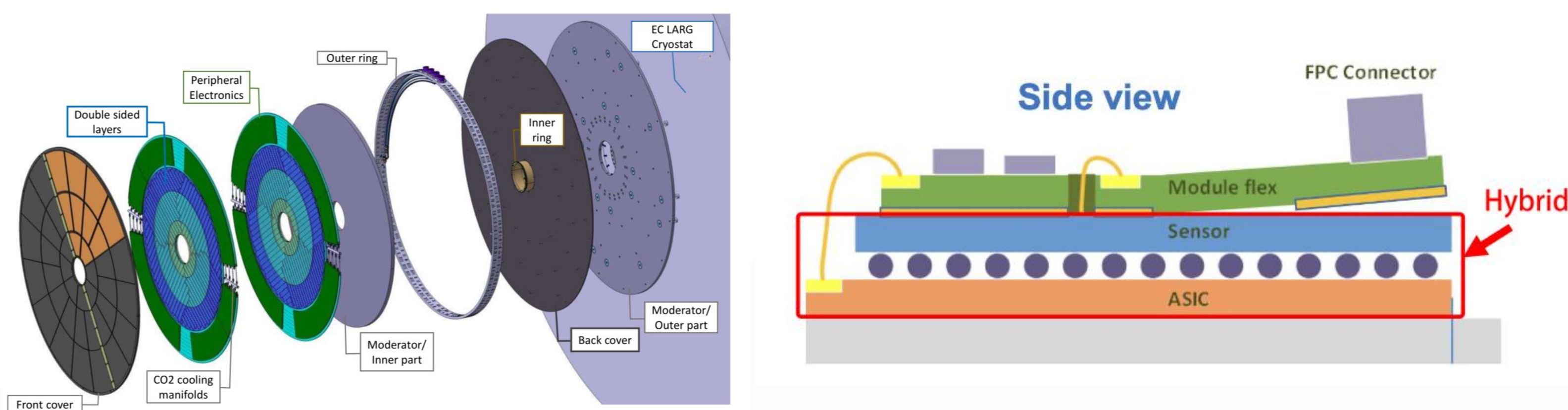
High Granularity Timing Detector (HGTD)

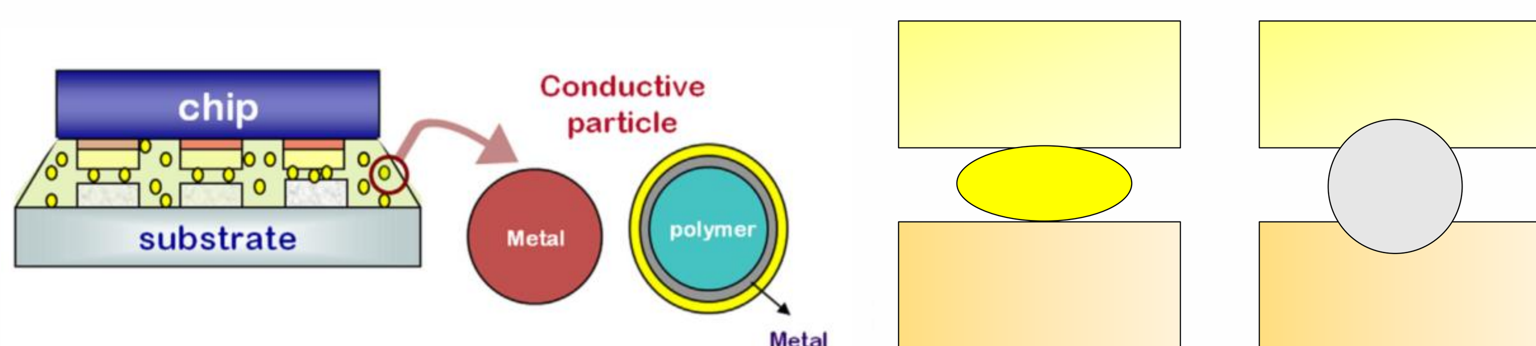
As LHC upgraded into HL-LHC, instantaneous luminosity will reach 7.5×10^{34} $cm^{-2}s^{-1}$, which means significant increase in pile-up. A novel timing detector, HGTD, will be installed in forward region. By utilizing timing information, hard scattering vertices can be distinguished in such situation.



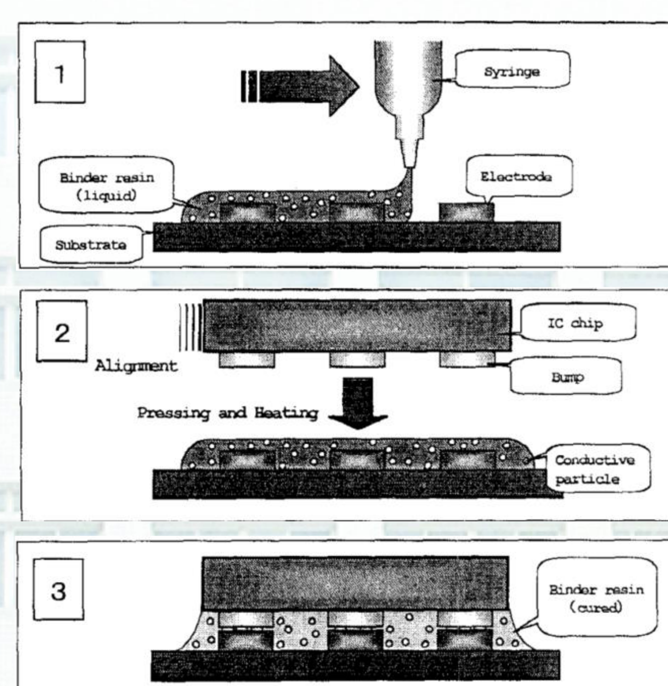
- The Low Gain Avalanche Detector (LGAD) is used as sensor for HGTD.
- Front-end Application Specific Integrated Circuit (ASIC) named ALTIROC.
- The sensor is flip-chip bonded to the ALTIROC to create a hybrid.
- Two hybrids are then glued to the Module flex PCB and wire bonded to it, forming a module.



Anisotropic Conductive Paste (ACP) Technique



- The ACP is composed of conductive fine particles diffused in nonconductive resin.
- Two kinds of conductive particle can be used.
  - Metal coat resin particle and soft metal particle. Make contact through their deformation under pressure.
  - Hard metal particle (e.g. Ni) will be squeezeed into electrode and make contact with it.
- Bonding process including following steps:
  - Dispense paste.
  - Apply force in Z-axis, and trape conductive particles between the bump and the corresponding pad.
  - Cure the paste with heat or other energy.
- Potential reasons for an increase of contact resistance:
  - Thermal expansion mismatch.
  - Swelling of paste.

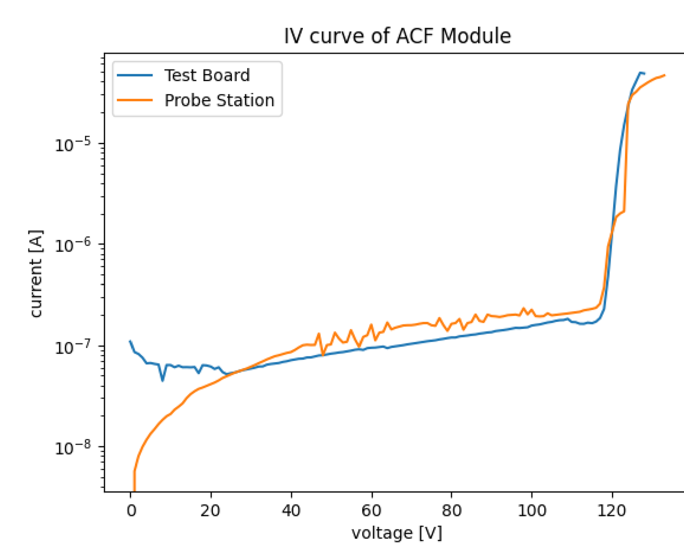


- Key factor for ACP bonding

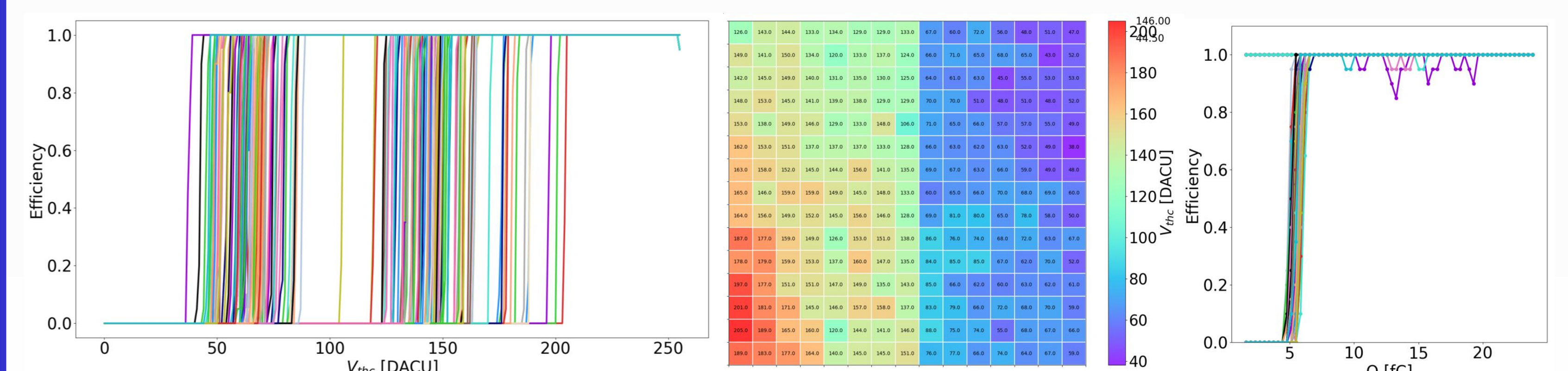
Curing Temperature	Pressure	Resin	Conductive particle	Bump Shape	Surface treatment

Test result for the ACP module

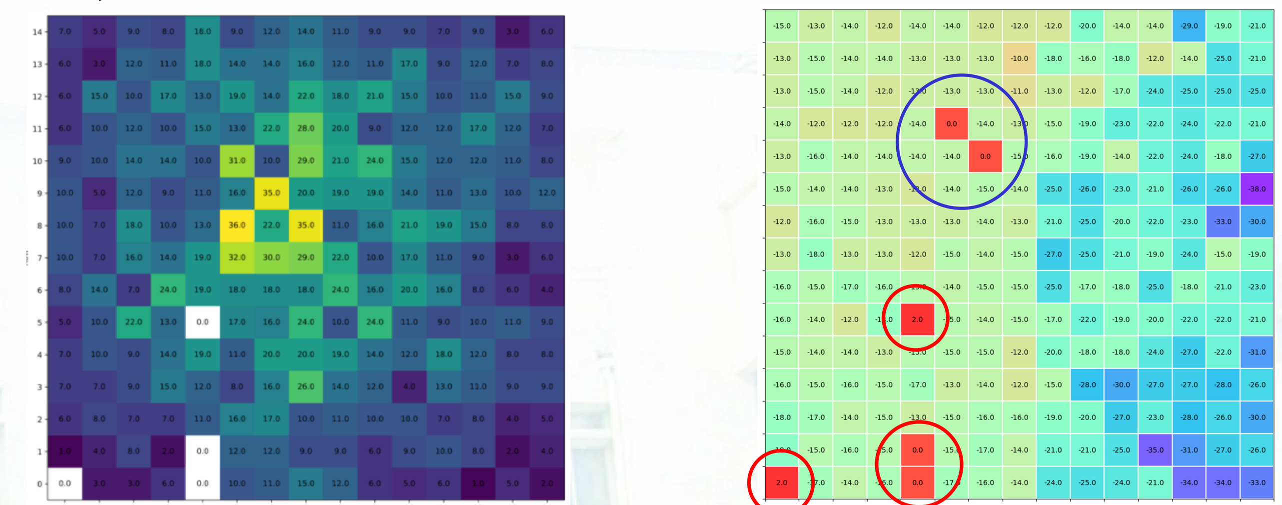
- We have received the first ACP module from UNIGE, and attach it to the test board developed by IJCLAB and perform wire bonding on it.
- For the readout, we use Interface board provided by IJCLAB and ZC706. The firmware and software in use are FADA.
- We also make a frame to support Sr-90 radioactive source for the connection between ASIC and LGAD check.



- First, we check the current (I) vs voltage (V) relationship with system set in the climate chamber, and found it is comparable with the result got on probe station.
- We tune threshold voltage per channel and use charge scan to validate obtained threshold voltage value.
- The efficiency of some channels is always one due to the failure of charge injection in two channel of ASIC .



- Electron from Sr-90 induce signal in the sensor, connected channel will output hits.
- Using different capacitance before and after bias voltage turns on, with same injected charge, the threshold of connected channel will vary with bias.
- Radioactive source shows four channels are not connected.
- A detailed investigation revealed failures in the charge injection system of two channels, and found four channels were not connected.



Summary

- ACP technique provided a new method for sensor ASIC flip-chip bonding, besides the solder bump bonding.
- First HGTD ACP module has been produced by UNIGE, and wire bonded to test board at USTC.
- We have setup a test system for module to measure performance of ACP module.
- Preliminary measurement results show good reliability of ACP technique in module production.

Reference

Kim, S.-C. and Y.-H. Kim (2013). "Review paper: Flip chip bonding with anisotropic conductive film (ACF) and nonconductive adhesive (NCA)." Current Applied Physics **13: S14-S25.**

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