2022.9-12研究生考核报告

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01/06/2023

Content

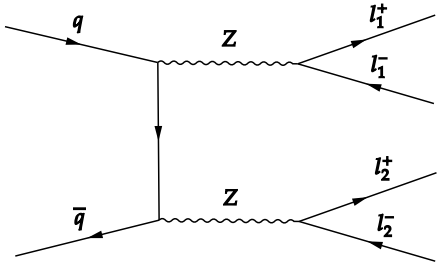
- Analysis:
  - Measurement of ZZ CP-violation and polarization in four-lepton dataset in 13 TeV proton-proton collisions with the ATLAS detector
    - Spin correlation analysis
    - Unfolding & systematic uncertainties check
    - 1st circulation and SM approval

- Module Assembly
  - ATLAS High-Granularity Timing Detector(HGTD) module assembly with gantry system (with Hao Zeng)
    - Digital module & full module assembly
    - Assembling accuracy improvement
  - ATLAS HGTD support unit planarity measurement & module loading (QT)
    - Gluing study
  - CEPC MOST2 vertex detector
    - Prototype loading
    - Testbeam

ZZ CP-violation and polarization

Introduction

- We have measured with Run-2 data, which have luminosity of $139 fb^{-1}$ and 13TeV. We focus on the qqZZ branch to measure the spin correlation of the ZZ pair and have already defined the spin correlation observable: decay angle $cos\theta_1$ and $cos\theta_3$.
- Already finish all 6 EB meeting
- SM approval meeting on 24th November.



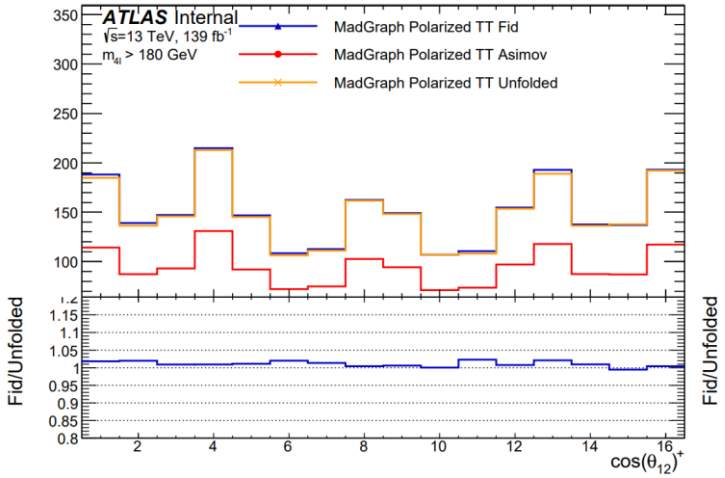
Spin correlation analysis unfolding check

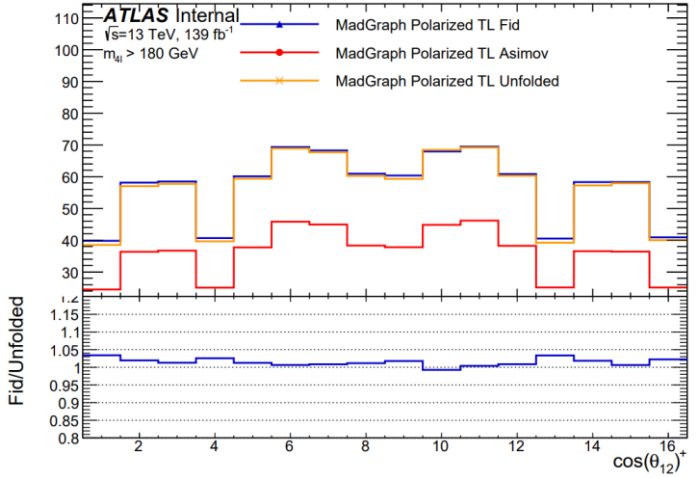
- We are try to do the unfolding for polarized samples with Migration matrix from sherpa qqZZ sample, to test unfolding bias with different hypothesis.

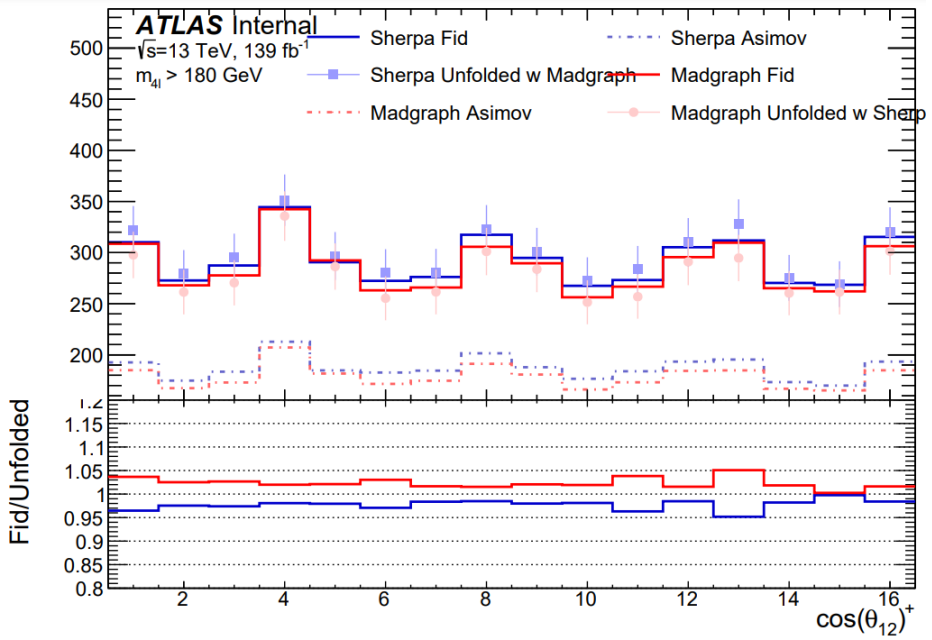
✓ Bias: < 5%

✓ Compatible with the unfolding in CP analysis

✓ Acceptable for spin correlation analysis



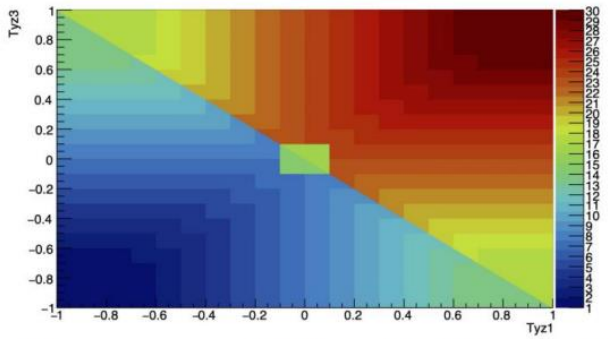




ZZ CP-violation and polarization

Unfolding & Systematic check

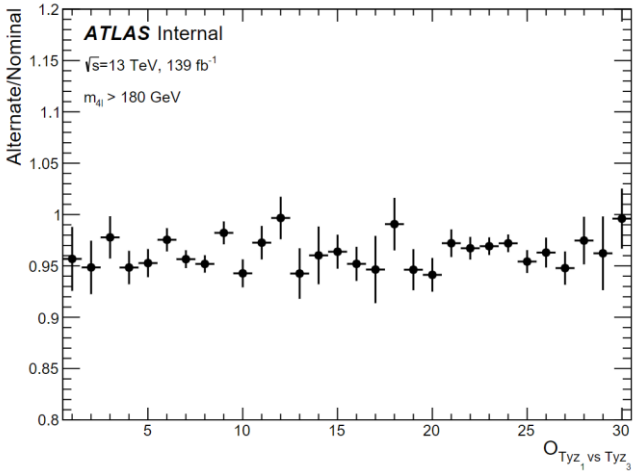
- ZZ CP observable:
  - $Tyz \equiv \cos\theta \sin\phi$ (arXiv:1604.06677) defined to increase the asymmetry structure of Interference term
- Unfolding Bias check
  - Reweighting and calculating generator bias.
  - Spin correlation observables give similar results.



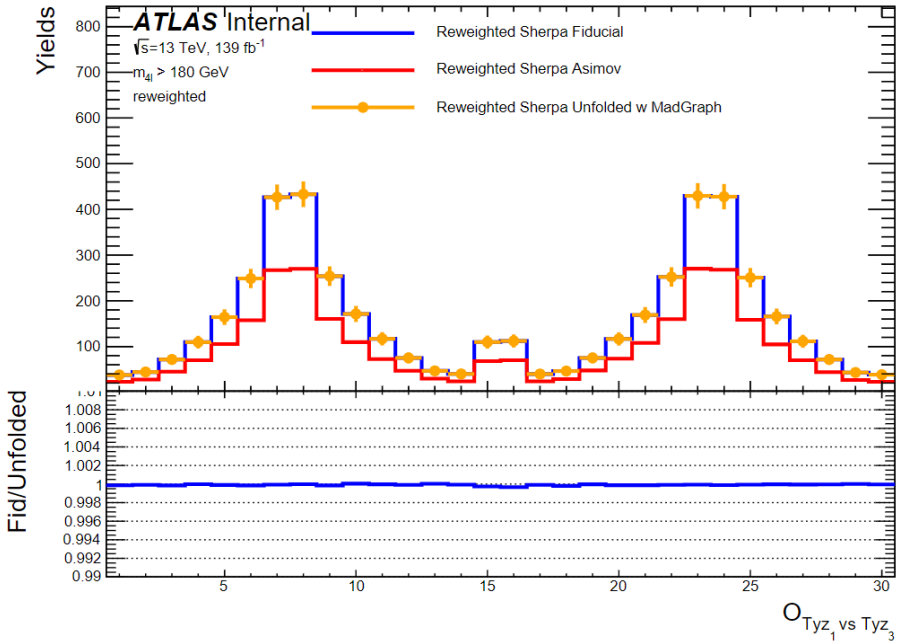
2D->1D mapping

$\mathcal{O}_{Tyz1,Tyz3}$ as final CP-sensitive observable

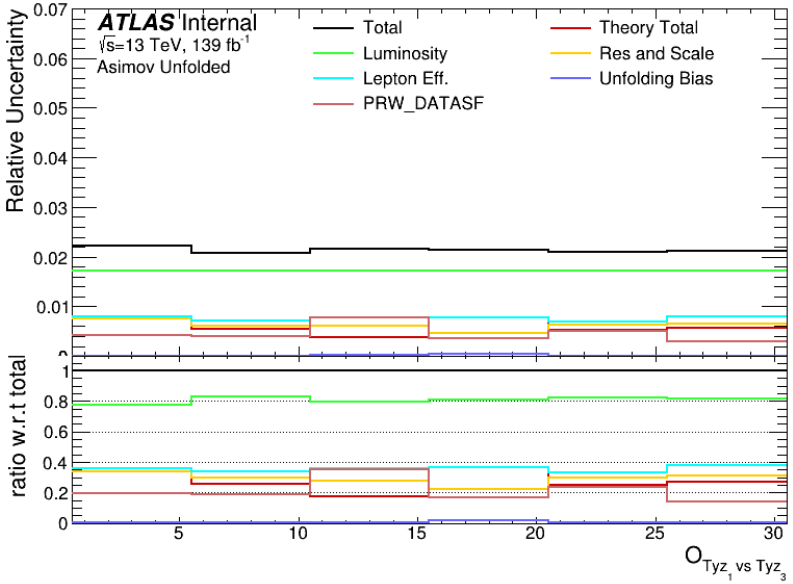
Reweighting function



Generator Bias



Systematic uncertainty

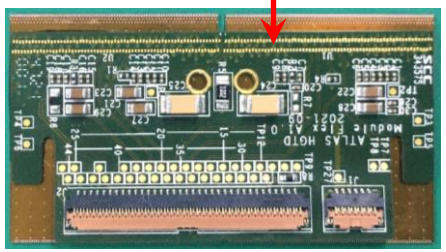


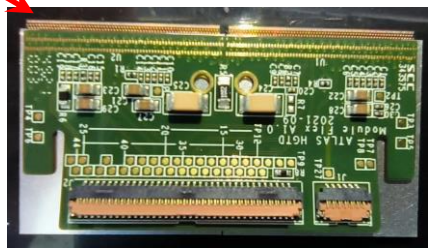
Smooth: Average 5 bins

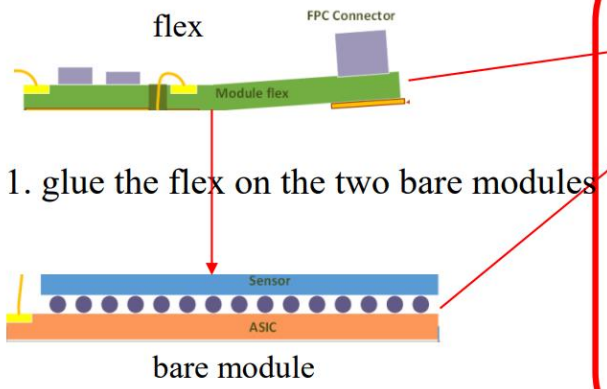
HGTD Module Assembly

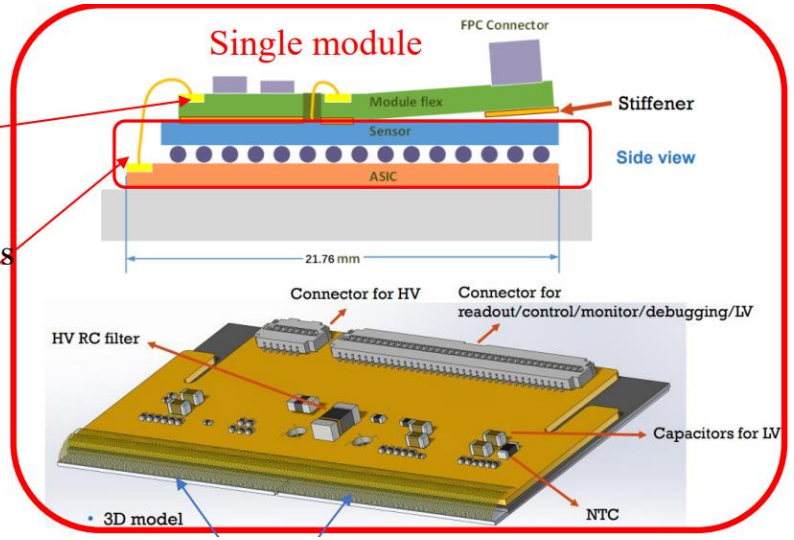
- IHEP is developing automatic assembling system for HGTD program.

- Have already assembled 15 modules:
  - 5 full modules (flex PCB + hybrids)
  - 11 digital modules (flex PCB + ASICs)



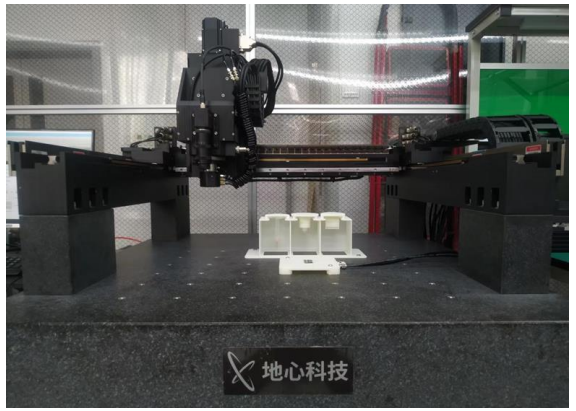


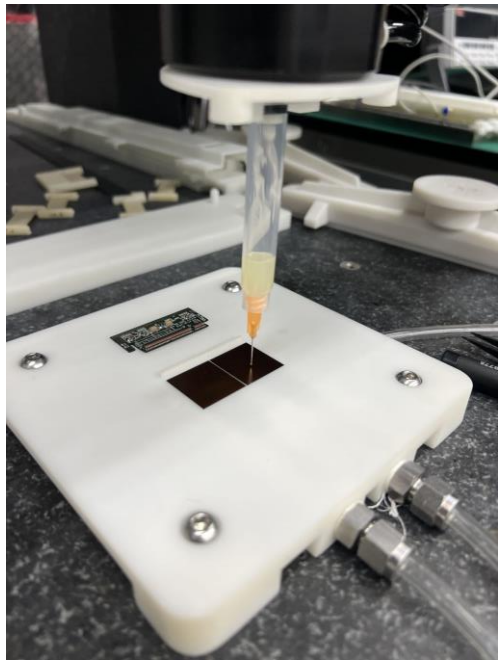




- The assembling accuracy has been improved to 30μm;
  - ✓ Add pattern recognition to the automatic assembly system;
  - ✓ Can recognize the sensor and flex with high precision;

- Some of our assembling method and tooling are shared with USTC;
- Now aim to assemble 19 modules for demonstrators before April.

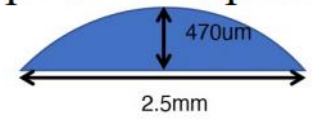




◆ Gluing study

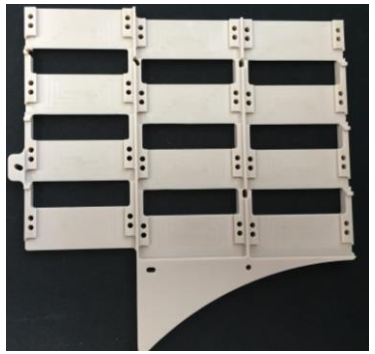
- Glue height on top of module flex to attach to the support unit is critical;
- Need glue to “absorb” variations of component thicknesses;
- Study on glue dots’ weight, height and diameter (Measure with microscope).

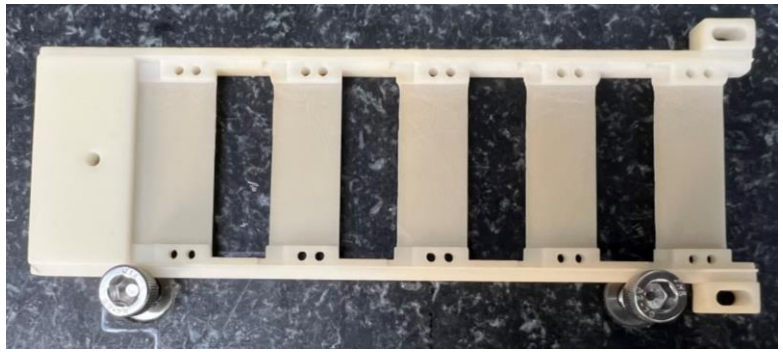
Shape of the deposited glue (dome)

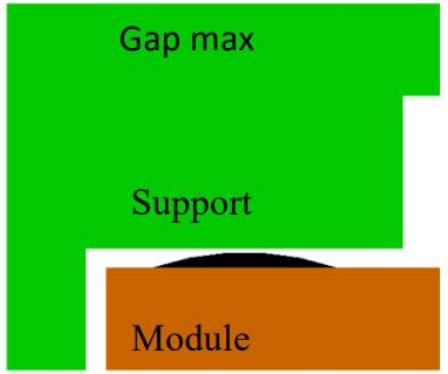


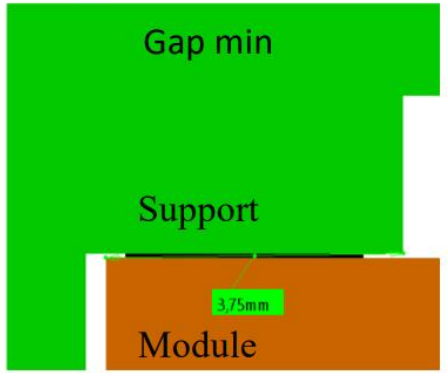
After placing the support (cylinder)

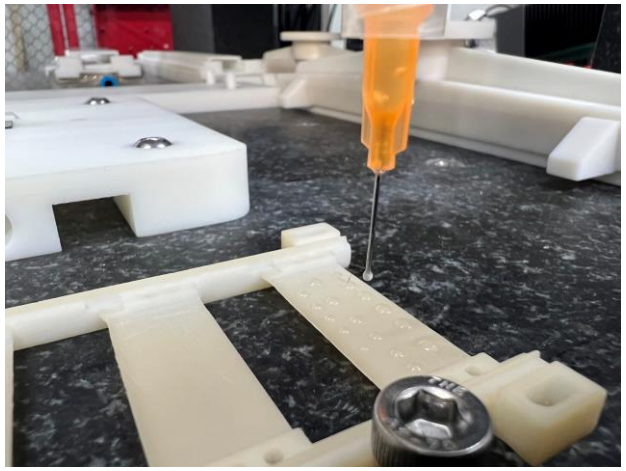
Support Unit

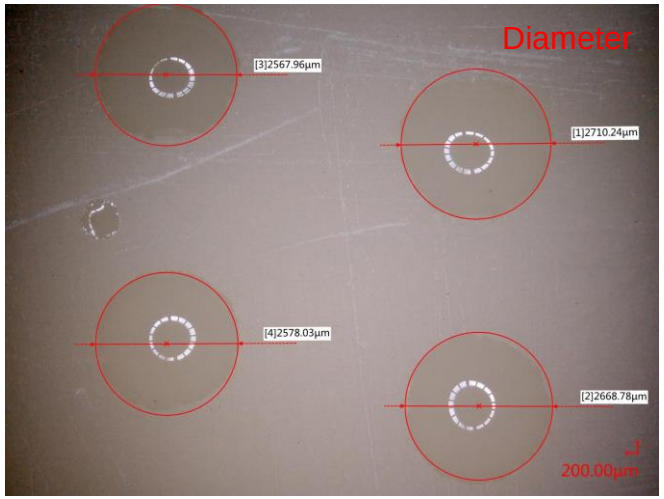


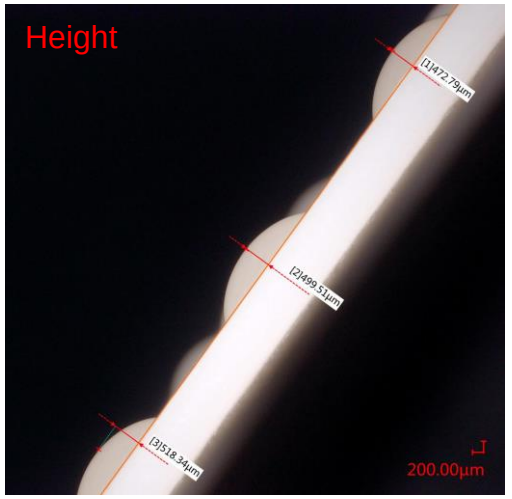


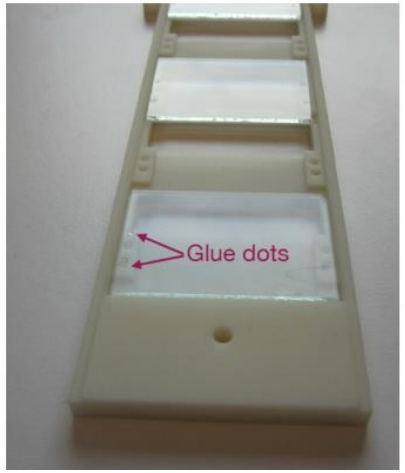




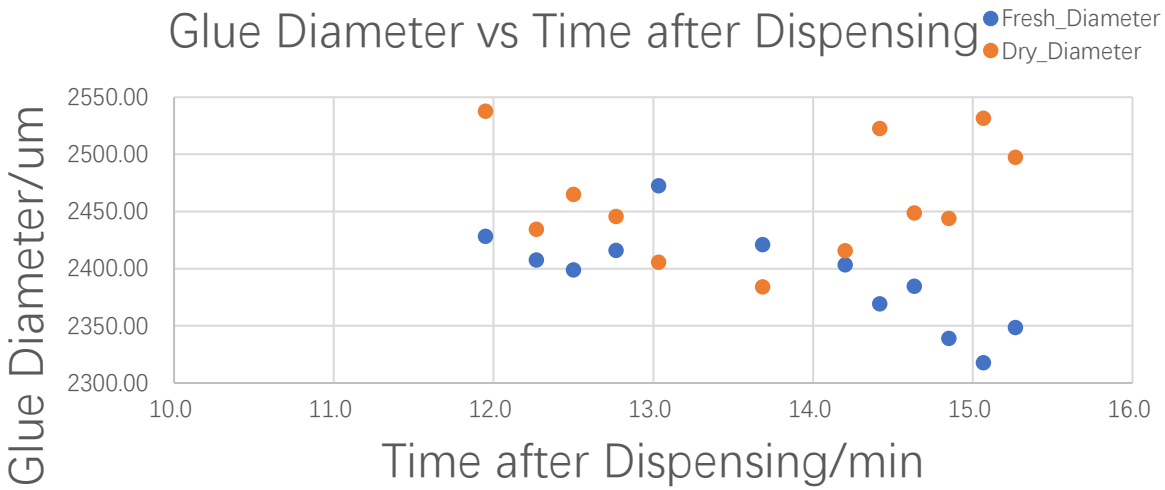


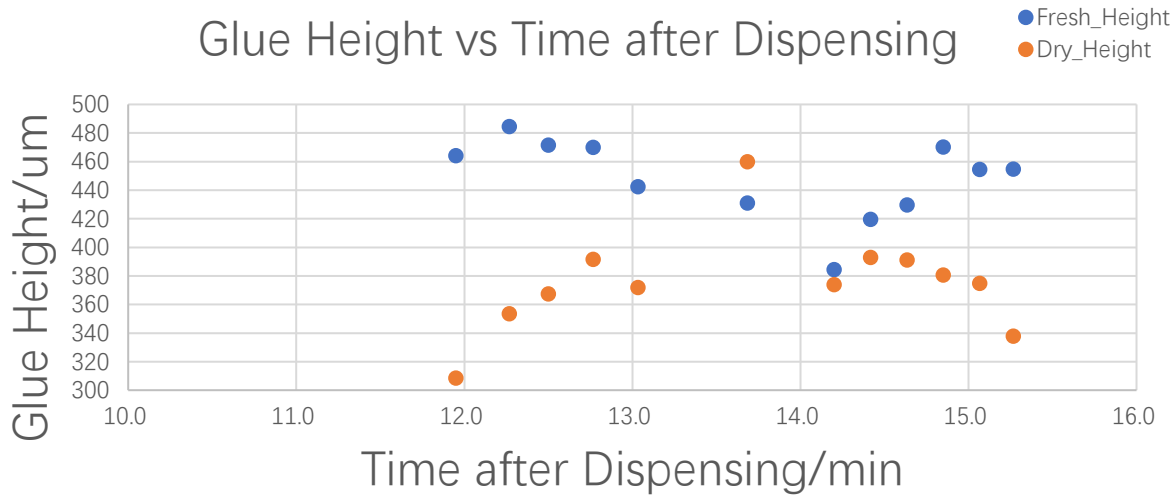




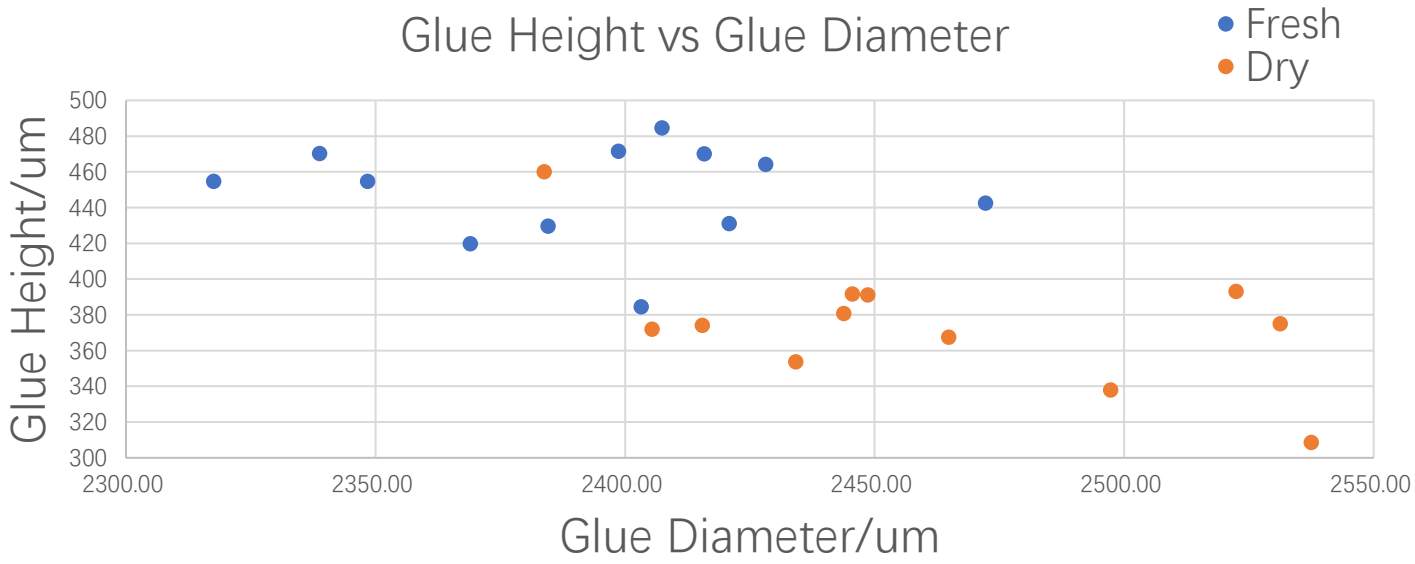


◆ Gluing study





- Dispensing height: 0.9 mm
- Dispensing time: 6 s
- Dispensing pressure: 5 bar

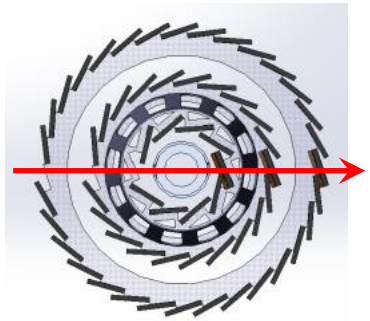


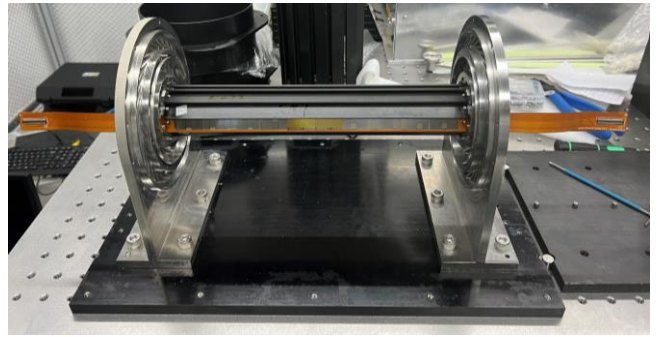
- Diameter: $2.389 \pm 0.044\ mm$ (Fresh) , $2.454 \pm 0.047\ mm$ (Dry)
- Height: $446 \pm 47\ \mu m$ (Fresh) , $381 \pm 31\ \mu m$ (Dry)

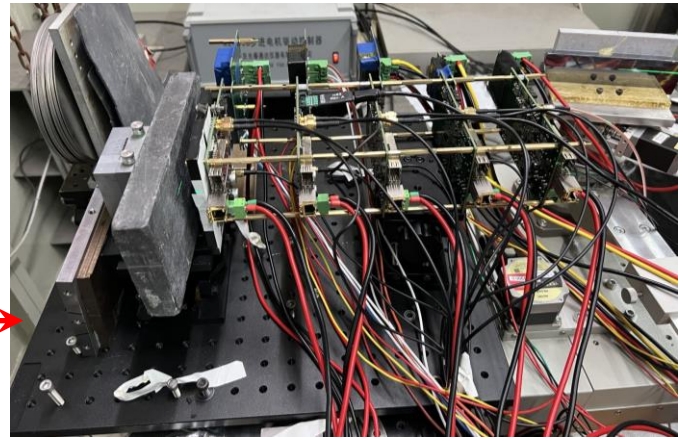
CEPC MOST2 vertex detector

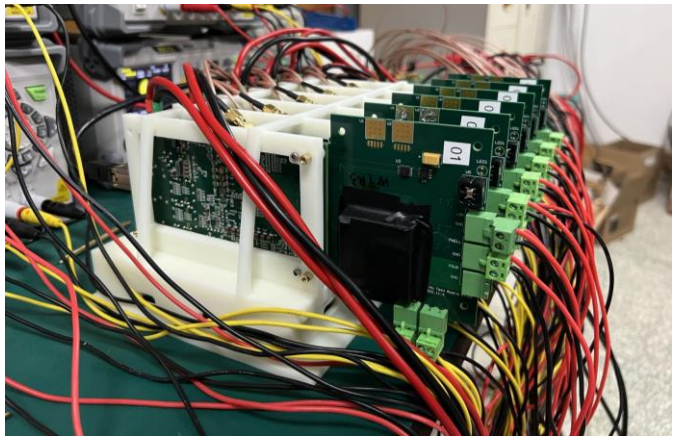
- Prototype loading
  - Assemble the MOST2 sensor and flex for prototype
    - Long flex cable (>20cm)
    - Very thin sensor (0.15mm)
    - High alignment (1 flex with 10 sensors)
    - Large amount (60 sensors in total)
  - Load module on three-layer barrel prototype.

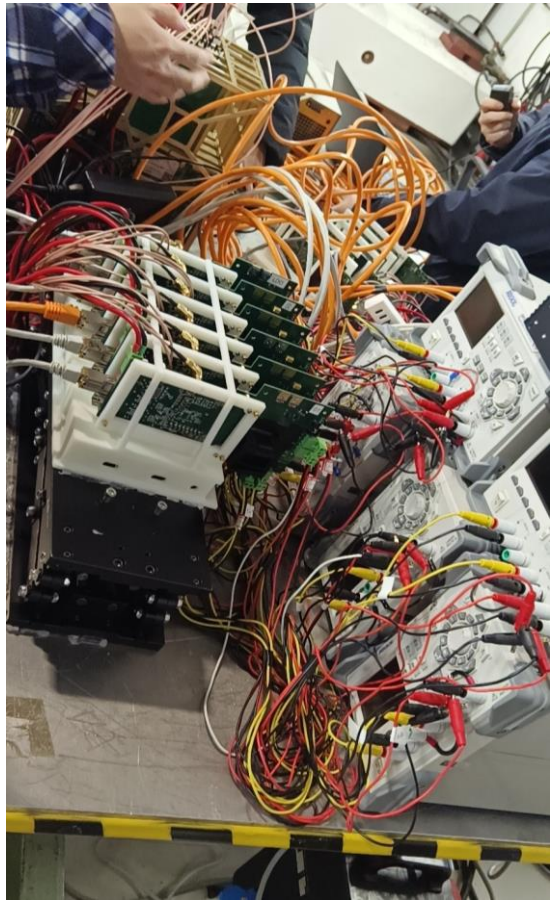
- Testbeam
  - Building support structure of telescope.
  - Shift and monitoring during testbeam.
  - Testbeam in BSRF
    - Early test for telescope and sensor
    - Prepare for beamtest in DESY
  - Testbeam in DESY
    - Formal test for telescope
      - Copper column→Resin shell
        - More stable and better alignment
    - Offline analysis for resolution
    - Prepare for prototype beamtest









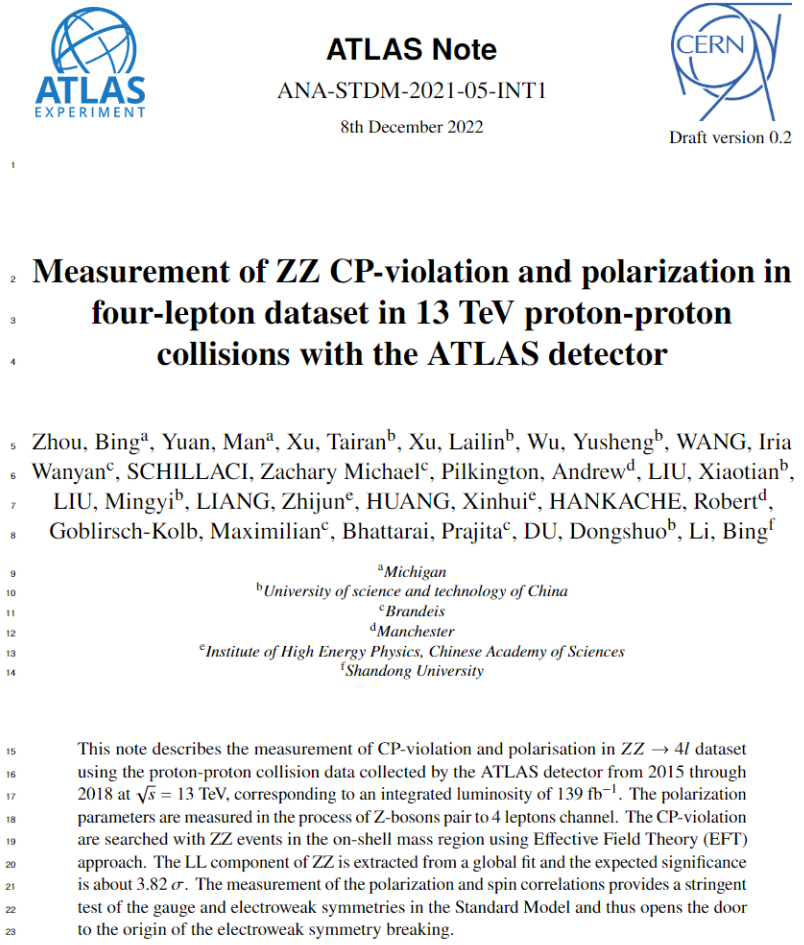


Summary

- ZZ CP & Polarization analysis :
  - Have 6 EB meetings and 1 SM approval meeting.
  - Fix the reweighting function problem and reduce generator bias.
  - Test the unfolding method with different hypothesis.
  - Update the unfolding & systematic uncertainty plots in the note.

- HGTD Module Assembly :
  - Automatic assembling system:
    - Have improved the assembling accuracy to 30μm.
    - More modules were assembled and waited for test.
  - Glue dots study
    - The glue dots' shape(diameter and height) can be well controlled in IHEP with gantry system.
- CEPC MOST2 vertex detector
  - Successful testbeam in DESY.

- Next steps:
  - ZZ CP & Polarization analysis:
    - Working on unfolding, systematic uncertainties & spin correlation with latest MC samples and reply the comments.
  - Module Assembly:
    - Assemble 19 modules for HGTD demonstrator before April.
    - Try to load the modules on the support units.



ATLAS EXPERIMENT

ATLAS Note

ANA-STDM-2021-05-INT1

8th December 2022

CERN

Draft version 0.2

Measurement of ZZ CP-violation and polarization in four-lepton dataset in 13 TeV proton-proton collisions with the ATLAS detector

Zhou, Bing[a], Yuan, Man[a], Xu, Tairan[b], Xu, Lailin[b], Wu, Yusheng[b], WANG, Iria Wanyan[c], SCHILLACI, Zachary Michael[c], Pilkington, Andrew[d], LIU, Xiaotian[b], LIU, Mingyi[b], LIANG, Zhijun[e], HUANG, Xinhui[e], HANKACHE, Robert[d], Goblirsch-Kolb, Maximilian[c], Bhattarai, Prajita[c], DU, Dongshuo[b], Li, Bing[f]

[a]*Michigan*
[b]*University of science and technology of China*
[c]*Brandeis*
[d]*Manchester*
[e]*Institute of High Energy Physics, Chinese Academy of Sciences*
[f]*Shandong University*

This note describes the measurement of CP-violation and polarisation in $ZZ \to 4l$ dataset using the proton-proton collision data collected by the ATLAS detector from 2015 through 2018 at $\sqrt{s} = 13$ TeV, corresponding to an integrated luminosity of 139 fb^{-1}. The polarization parameters are measured in the process of Z-bosons pair to 4 leptons channel. The CP-violation are searched with ZZ events in the on-shell mass region using Effective Field Theory (EFT) approach. The LL component of ZZ is extracted from a global fit and the expected significance is about 3.82 σ. The measurement of the polarization and spin correlations provides a stringent test of the gauge and electroweak symmetries in the Standard Model and thus opens the door to the origin of the electroweak symmetry breaking.