

# 2022.5-8研究生考核报告

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9/2/2022



- **Analysis:**

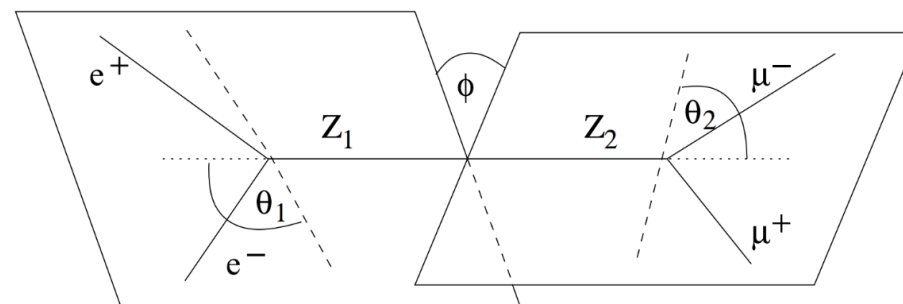
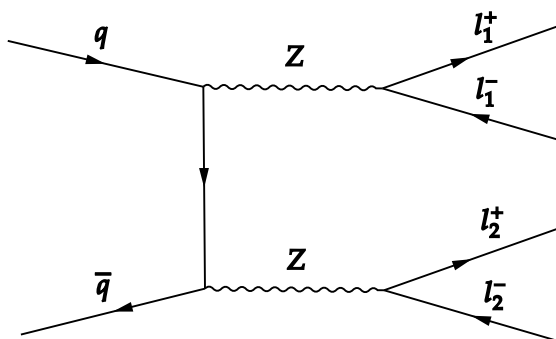
- Measurement of ZZ CP-violation and polarization in four-lepton dataset in 13 TeV proton-proton collisions with the ATLAS detector
  - Spin correlation analysis
    - Systematics Uncertainties & Smoothing
      - Add shower variation
    - Already sent the note to EB

- **Module Assembly**

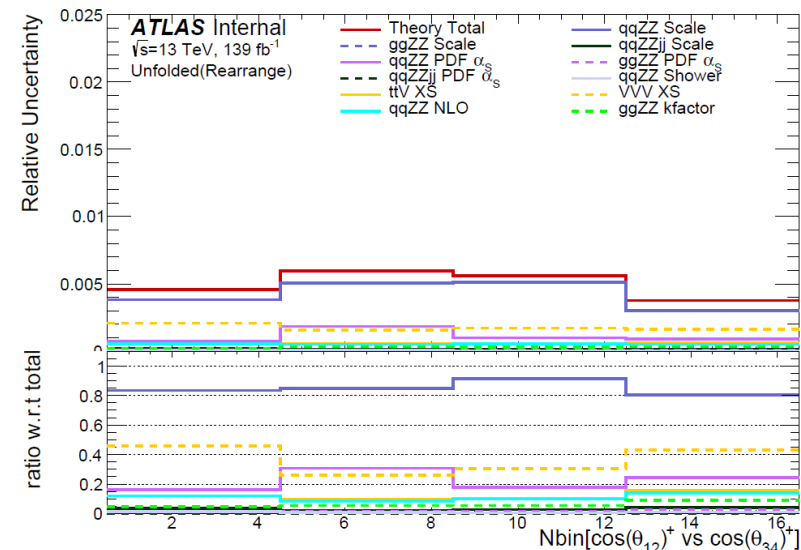
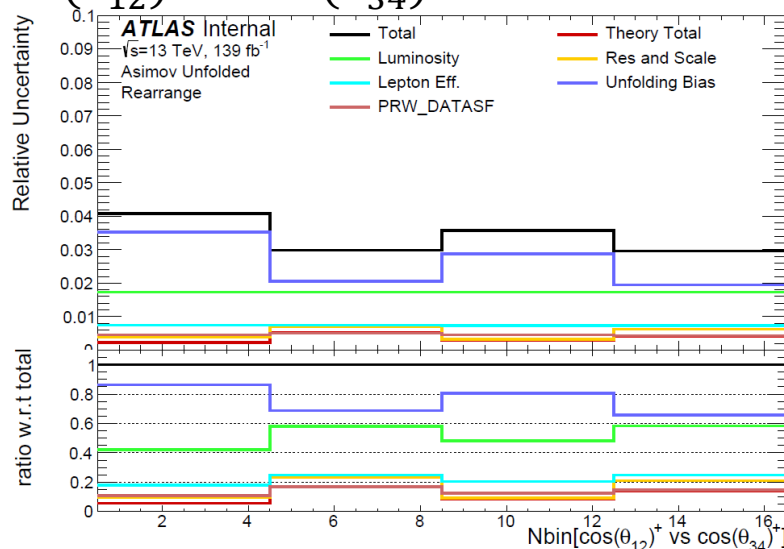
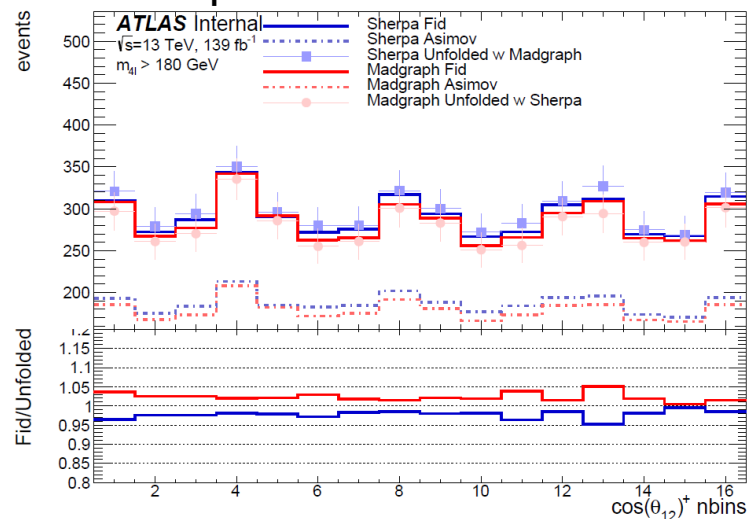
- ATLAS High-Granularity Timing Detector(HGTD) module assembly with gantry system (with Hao Zeng)
  - Digital module & full module assembly
  - Automatic assembly procedure design & code package
- ATLAS HGTD support unit planarity measurement & module loading (QT)
- CEPC MOST2 Vertex detector module assembly with gantry system
  - Dummy module assembly

# ZZ CP-violation and polarization

- The measurement of spin correlations provides an important test of the electroweak and gauge symmetries in the Standard Model (SM) and thus opens the door to the origin of the electroweak symmetry breaking.
  - During previous LHD data taking (Run-1), the results have very large uncertainty and dominated by statistical uncertainty (321 ZZ events). We have measured with Run-2 data, which have luminosity of  $139fb^{-1}$  and 13TeV.
  - The LL component of ZZ is extracted from a global fit and the expected significance is about  $4.10\sigma$ .
  - First for precise measurement and combine with theory work for boson pair spin correlation.
- 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 sent the note to EB and wait for their comment.



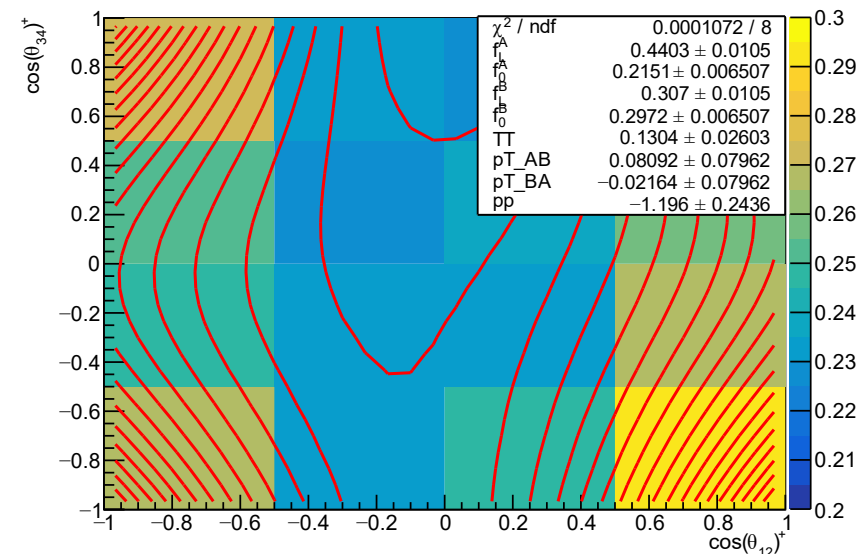
## Unfolding validation & Systematic uncertainties: spin correlation observable: $\cos(\theta_{12})^\dagger$ vs $\cos(\theta_{34})^\dagger$



(a) Unfolding Validation: Unfold Asimov data of Sherpa using the unfolding inputs from MadGraph

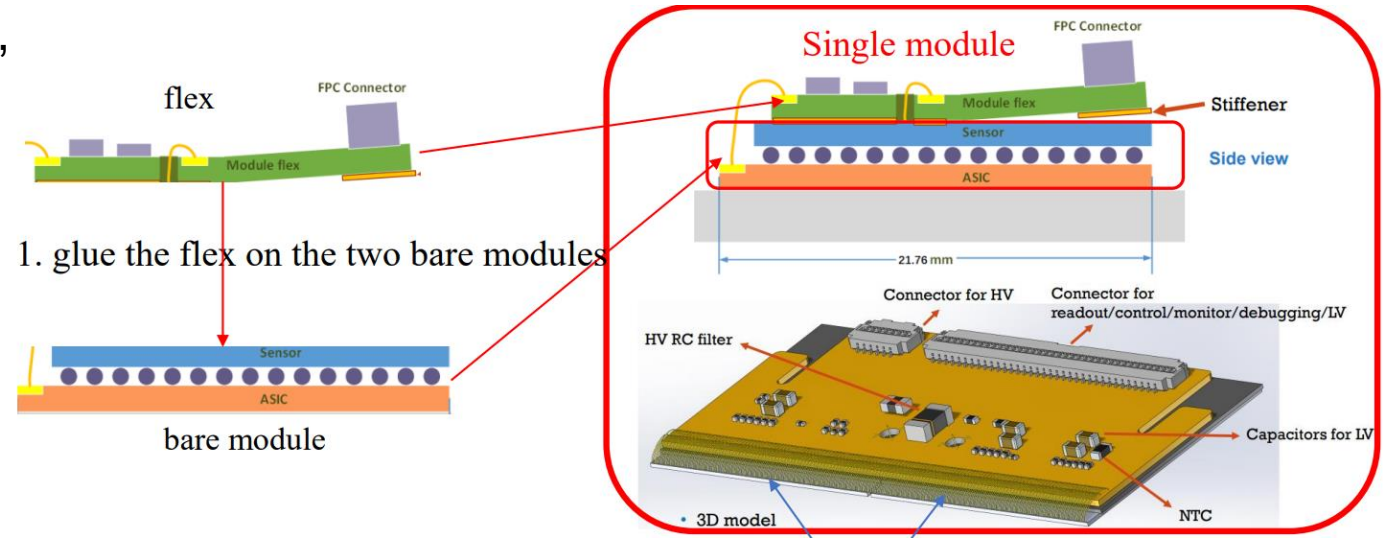
The total systematic uncertainty on the Asimov unfolded distribution is about 4% which is dominated by the unfolding bias.

We can extract spin correlation information with this 2D distribution.

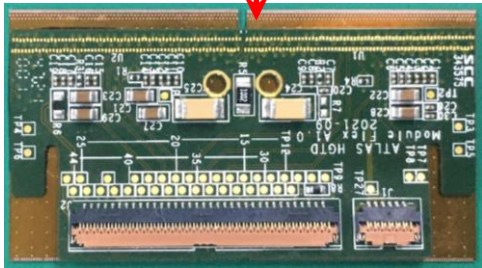


# HGTD Module Assembly

- HGTD program requires over 9k modules in total, automatic assembly is necessary ( ~4k in IHEP)
- IHEP is the **leading site** with automatic assembly. (Similar system is sent to USTC and applied)
  - Highly-Customized Tooling (most by 3D-Printed);
  - Multiple apply scene (HGTD, MOST2, ...);
  - Customized procedure design;
  - High-precision by pattern recognition(~10μm);



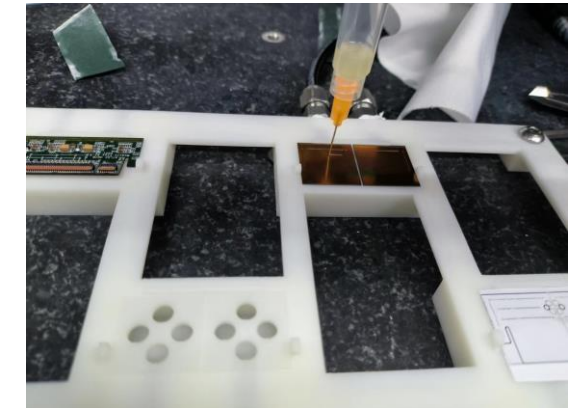
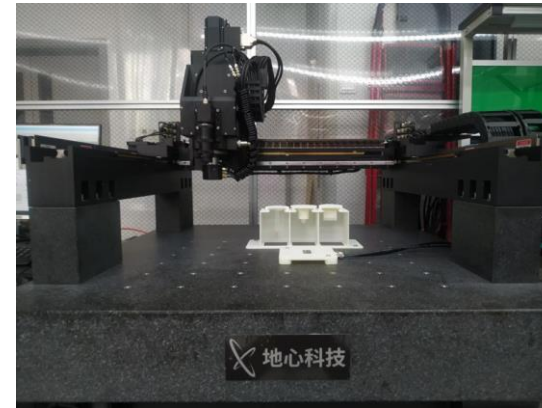
- ✓ The **first Full Module** within all the 6 production sites (CN, Fr, DE, ES...)
- ✓ Several **Digital Modules** were assembled and tested, already sent to HGTD demonstrator. (Other sites have assembled digital module manually for their own test)



Digital Module  
ASIC+Flex PCB

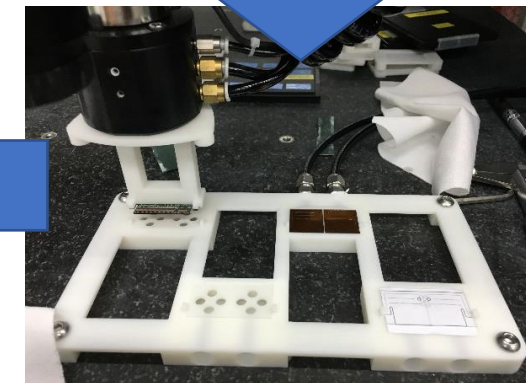
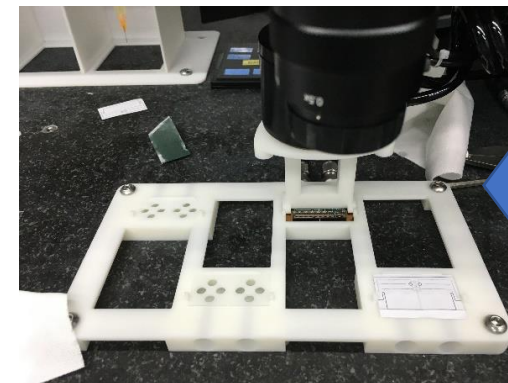
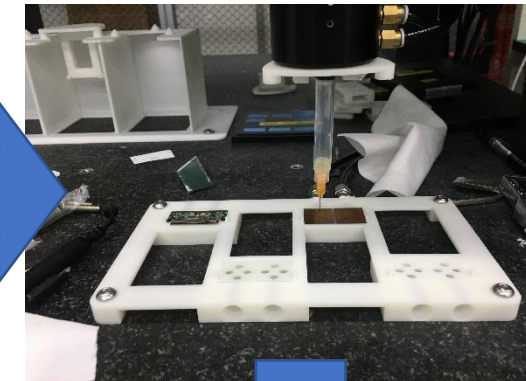
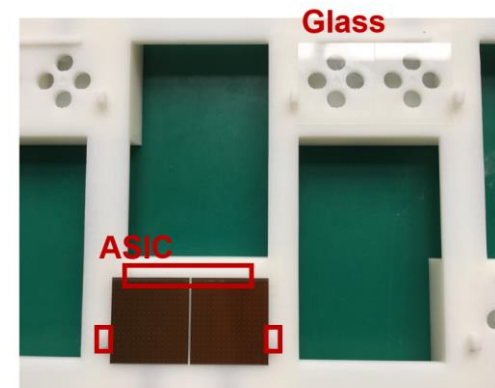
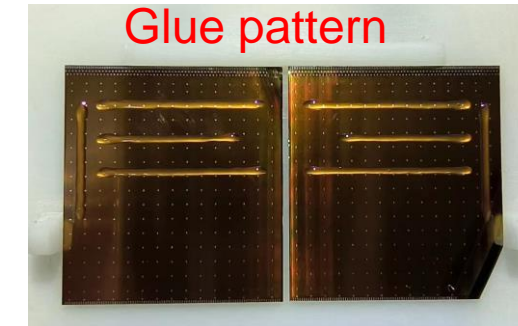


Full Module  
Hybrid+Flex PCB



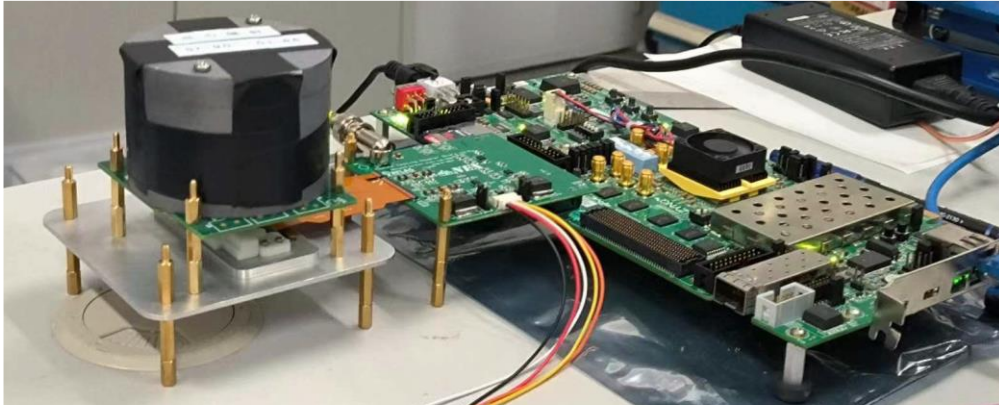
# HGTD Module Assembly

- ◆ Automatic assembly procedure design & run
  - Align two glasses on the vacuum chuck.
  - Prepare the flex.
  - Calibrate the glue needle.
  - Dispensing glue on the two glasses.
  - Pick and place the flex on the glass.
  - Keep the pressure on the flex until the glue is cured.
- ◆ Modules assembled:
  - 8 Digital Module & 5 Full Module were assembled;
  - 10 of them were wired-bonded and tested;

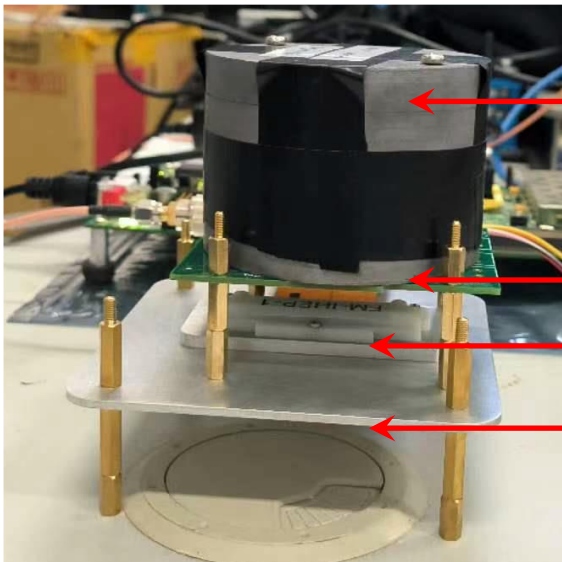


## ◆ Module test

- Beta source test on Full Module 02



temporary setup



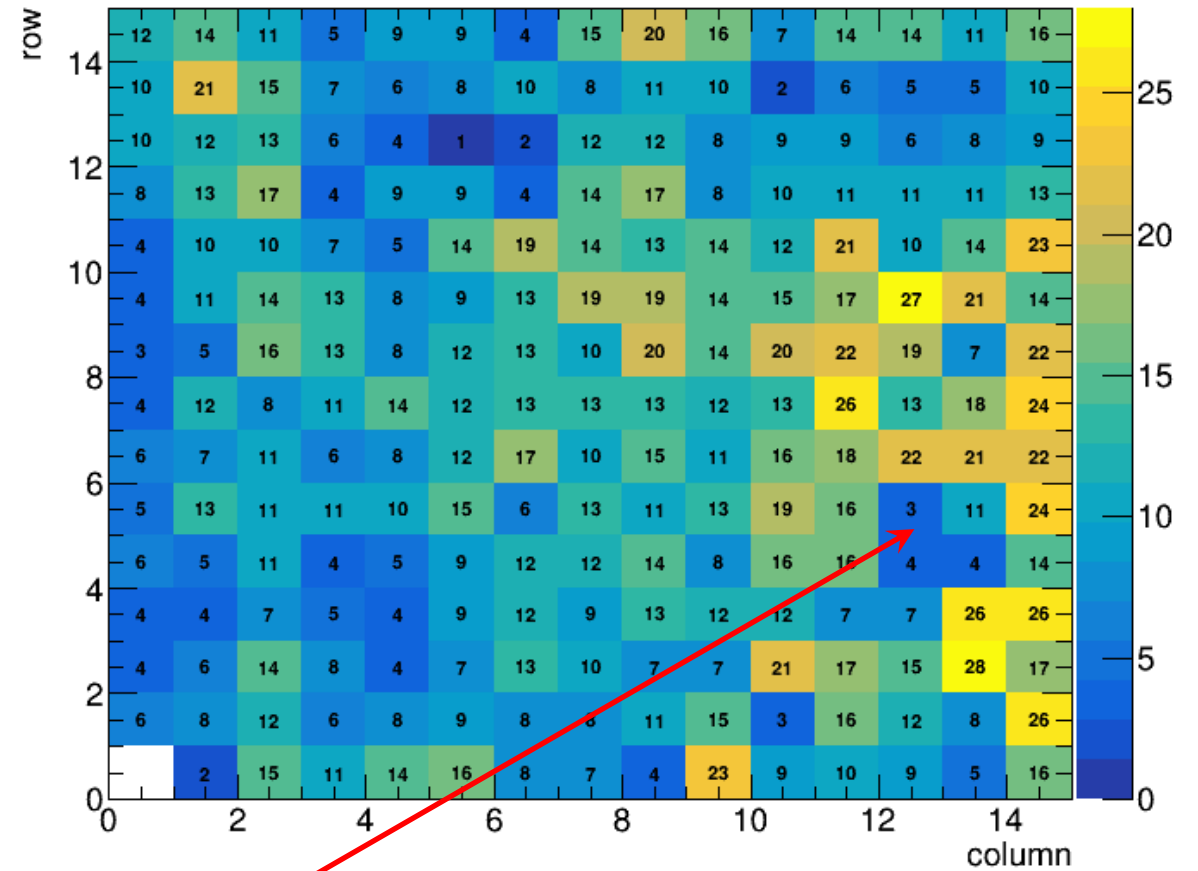
Sr90

Holding Plate

FM02

Cooling Plate

### Occupancy

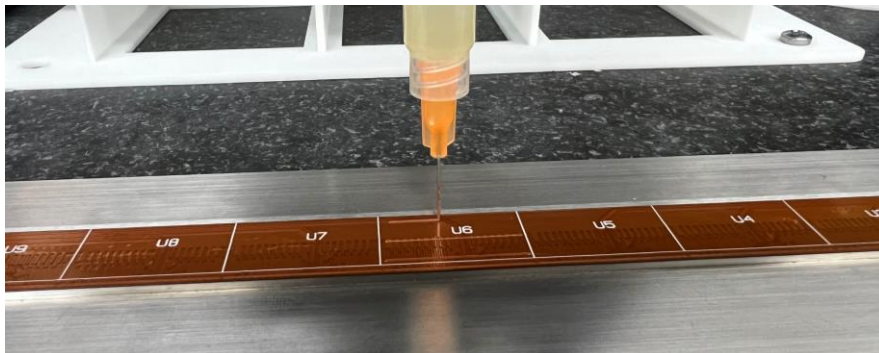
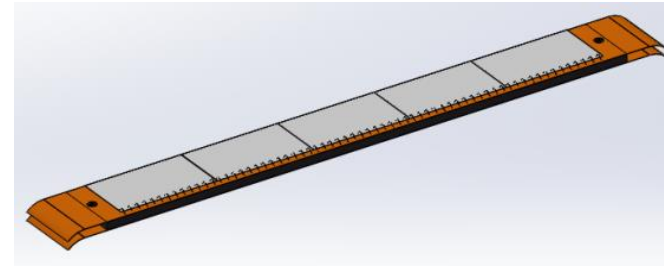
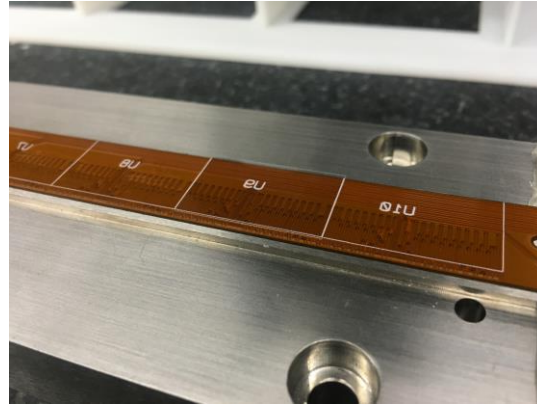
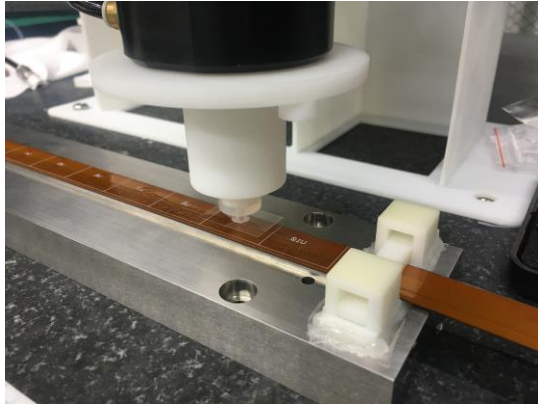
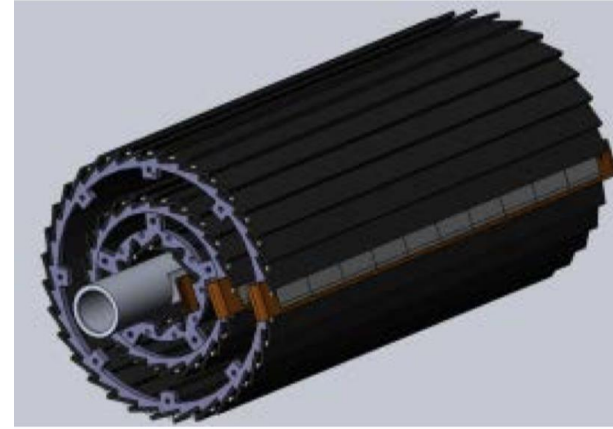


Offset between beta source and FM

Though statistic is quite low, but all pixels get hits  
-> all of them are connected!

# CEPC MOST2 Module Assembly

- 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)
- Dummy sensor (glass) assembly





- ZZ spin correlation measurement :
  - Finish systematic uncertainties smoothing and qqZZ shower variation calculation and update in the note.
    - <https://cds.cern.ch/record/2801395/>
    - Note already was sent to EB (EB formed at Aug.8).
- Module Assembly Test (HGTD & MOST2):
  - Several HGTD module assembled and finish test. We have several reports in *HGTD module assembly and loading* meeting.
    - The glue thickness basically satisfy the TDR requirement.
    - The assembly can hardly influence the performance of the module.
    - Have sent digital modules to demonstrator.
  - MOST2 Dummy module was assembled and in loading test.
- Next steps:
  - ZZ spin correlation measurement :
    - Check the note & wait for the EB comments.
  - Module Assembly:
    - Finish pattern recognition part and package the code.
    - Calibrate the camera & Adjust the parameters for higher precision.
    - New tooling design.



ATLAS Note  
ANA-STDM-2021-05-INT1  
10th August 2022



Draft version 0.1.2

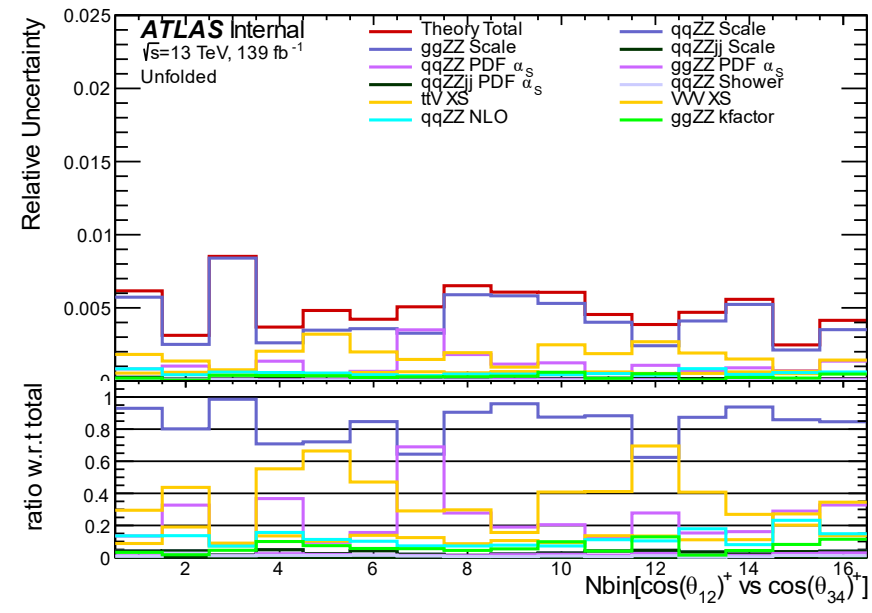
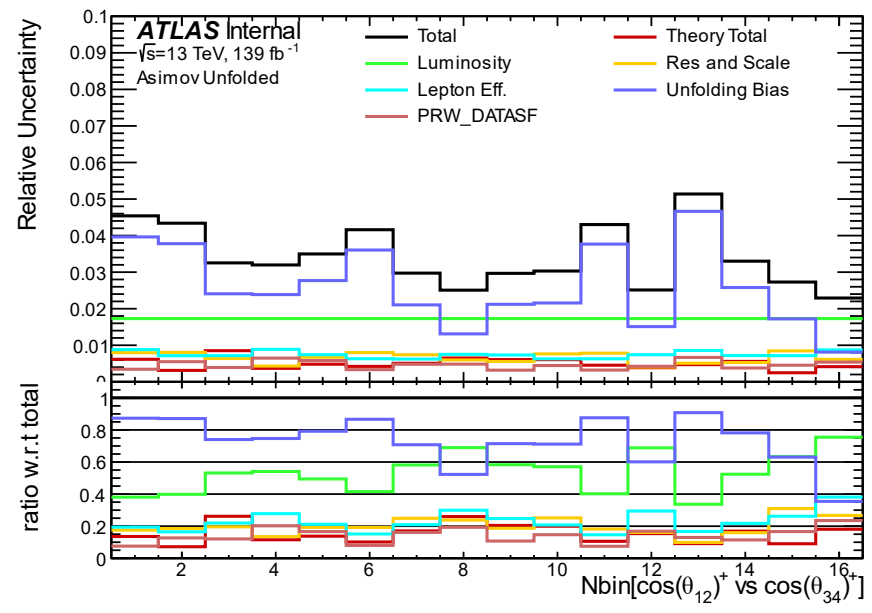
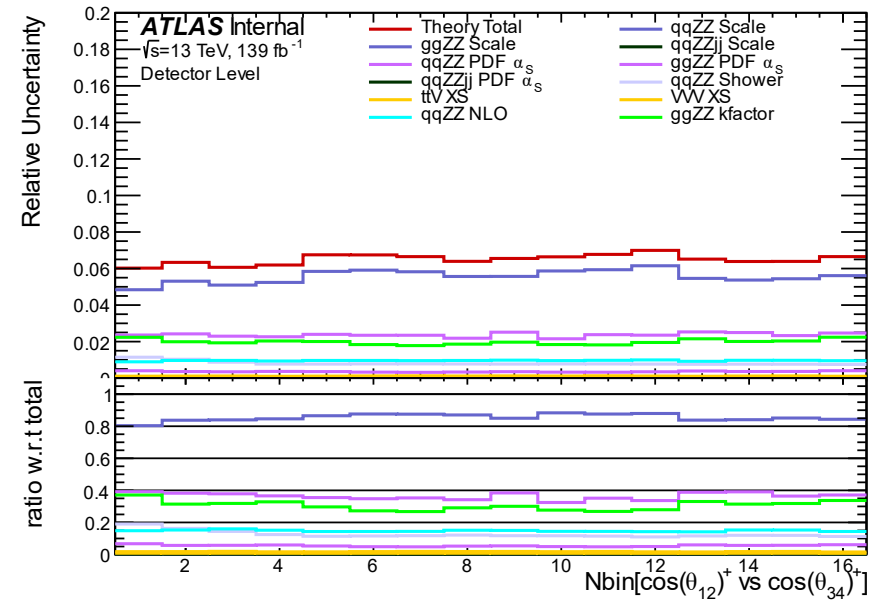
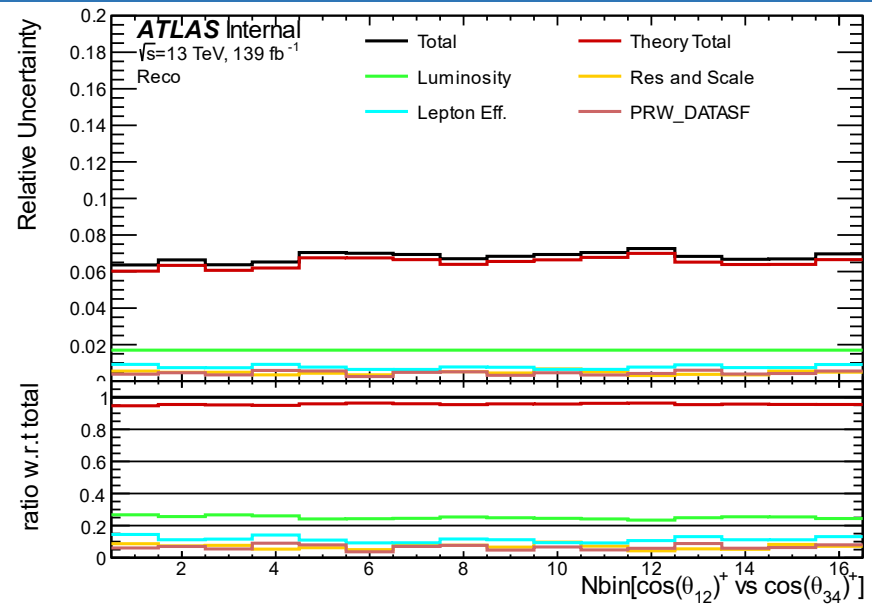
1  
2 **Measurement of ZZ CP-violation and polarization**  
3 **in four-lepton dataset in 13 TeV proton-proton**  
4 **collisions with the ATLAS detector**



# Backup

# ZZ Spin correlation systematics

Systematic update:  
qqZZ shower Variation added



# Module Assembled

	module type	assembled time	assembly method	glue weight(mg)	hybrid/ASIC	flex	wire-bonding
#1	digital module	2022-7-6	gantry		ALTIROC2	A1.0	√
#2	digital module	2022-7-6	gantry		ALTIROC2	A1.0	√
#3	digital module	2022-7-6	gantry		ALTIROC2	A1.0	√
#4	full module	2022-7-7	gantry		ALTIROC2 +IHEP-IMEv2	A1.0	√
#5	full module	2022-7-8	gantry		ALTIROC2 +IHEP-IMEv2	A1.0	√
#6	full module	2022-7-12	gantry	13.6	ALTIROC2 +IHEP-IMEv2	A1.0	√
#7	full module	2022-7-13	gantry	8.9	ALTIROC2 +IHEP-IMEv2	B1.0	√
#8	full module	2022-7-13	gantry	9.9	ALTIROC2 +IHEP-IMEv2	C1.0	√
#9	digital module	2022-7-13	manually		ALTIROC2	B1.0	
#10	digital module	2022-7-13	manually		ALTIROC2	C1.0	√



#0M1: Manually assembled for early test