

# 2023.1-4研究生考核报告

导师：梁志均

学生：黄鑫辉

04/23/2023



- Analysis:
  - Measurement of ZZ CP-violation and polarization in four-lepton dataset in 13 TeV proton-proton collisions with the ATLAS detector
- Module Test
  - ATLAS High-Granularity Timing Detector(HGTD) module assembly with gantry system
    - Module Assembly
  - ATLAS HGTD support unit planarity measurement & module loading (QT)
    - Test proposal & preliminary test plan
  - CEPC MOST2 vertex detector
    - Ladder assembly & prototype loading
    - Test beam in DESY

## • Introduction

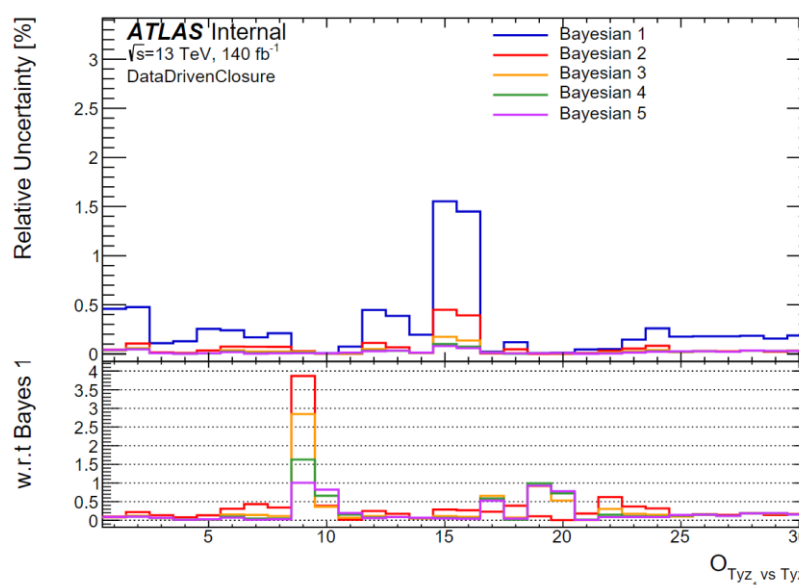
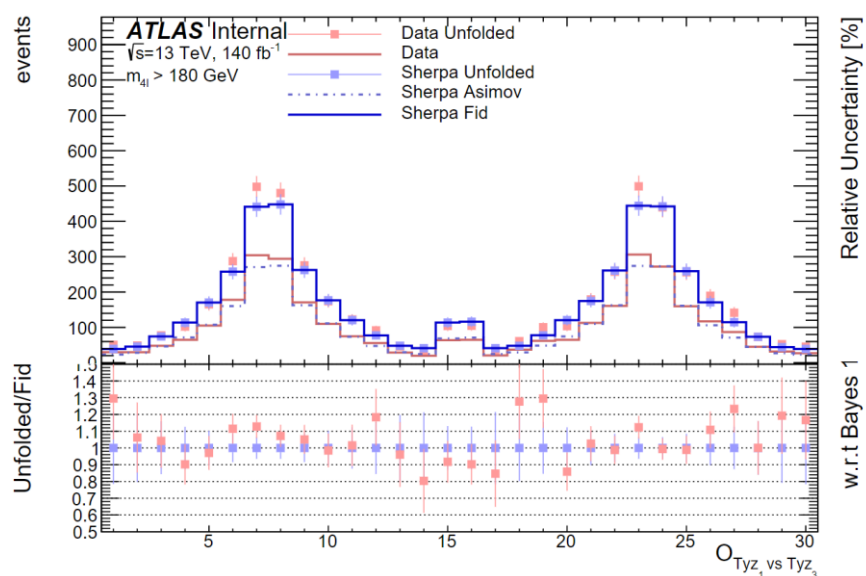
- We have measured with Run-2 data, which have luminosity of  $139\text{fb}^{-1}$  and 13TeV. We focus on the qqZZ branch to measure the spin correlation of the ZZ pair and have already defined the spin correlation observable: decay angle  $\cos\theta_1$  and  $\cos\theta_3$ .

## • Analysis Status

- Unblinded
- Update CP study results and systematics



**ATLAS Note**  
ANA-STDM-2021-05-INT1  
8th December 2022



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

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

<sup>a</sup>Michigan  
<sup>b</sup>University of science and technology of China  
<sup>c</sup>Brandeis  
<sup>d</sup>Manchester  
<sup>e</sup>Institute of High Energy Physics, Chinese Academy of Sciences  
<sup>f</sup>Shandong University

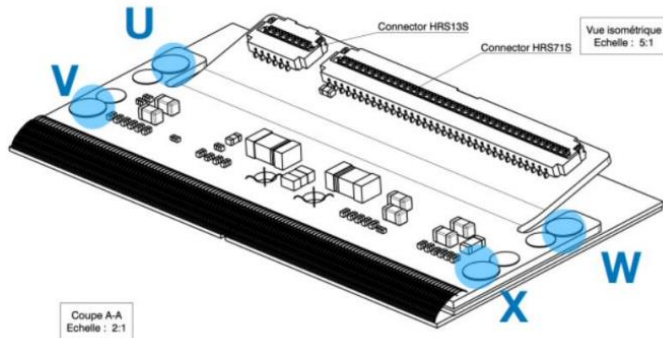
This note describes the measurement of CP-violation and polarisation in  $ZZ \rightarrow 4l$  dataset using the proton-proton collision data collected by the ATLAS detector from 2015 through 2018 at  $\sqrt{s} = 13$  TeV, corresponding to an integrated luminosity of  $139\text{fb}^{-1}$ . The polarization 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  $3.82\sigma$ . 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.

# HGTD Module Assembly

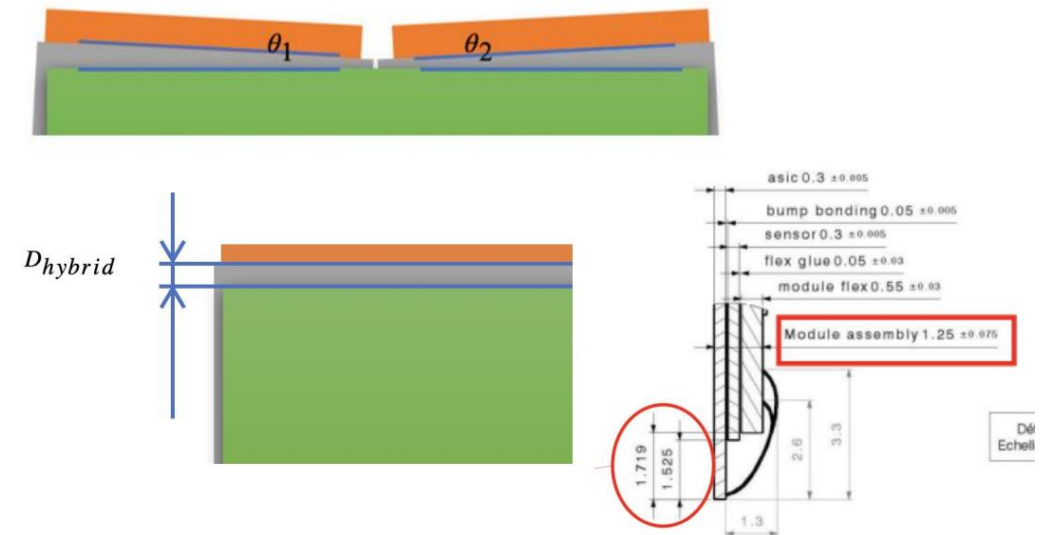
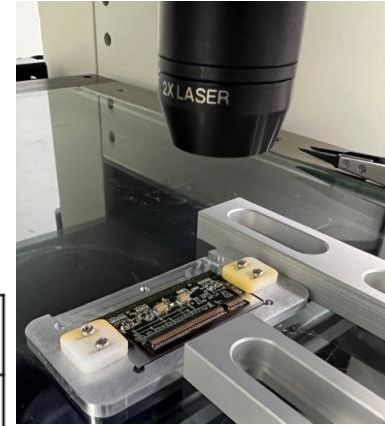
- IHEP is developing automatic assembling system for HGTD module assembly.
- Now we have assembled another 12 full modules(hybrids + modules).
  - 6 full modules were assembled for HGTD demonstrators (19 in total).
  - Perform metrology measurement on those modules.

	Glue[mg]	Weight[g]	Gap[ $\mu\text{m}$ ]	D,left[ $\mu\text{m}$ ]	D,right[ $\mu\text{m}$ ]	$\theta_1$ [deg]	$\theta_2$ [deg]
FM007	14.8	3.4533	99.97	160.52	157.03	0.00	0.03
FM008	13.0	3.4094	152.87	208.37	254.44	0.07	-0.02

	U[mm]	V[mm]	X[mm]	W[mm]	Mean[mm]	$\delta$ [ $\mu\text{m}$ ]
FM007	1.712	1.728	1.710	1.689	1.710	16
FM008	1.755	1.750	1.779	1.806	1.773	25



- Glue thickness:
- FM007: 75.92  $\mu\text{m}$
- FM008: 58.02  $\mu\text{m}$

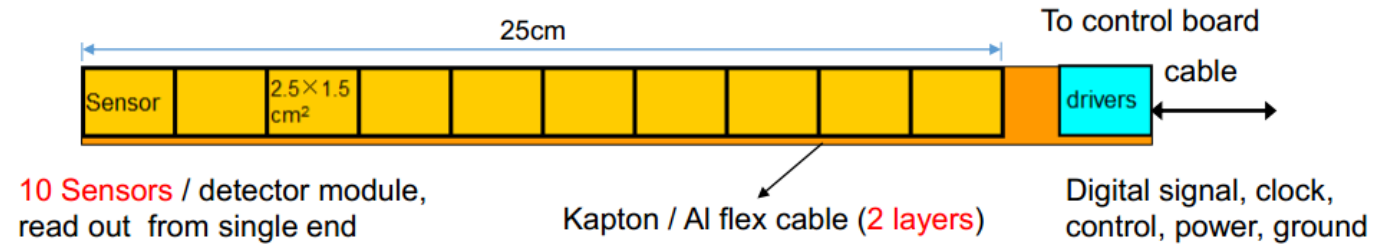


Distance between hybrid and flex  $D_{\text{hybrid}} = 125\mu\text{m}$ .

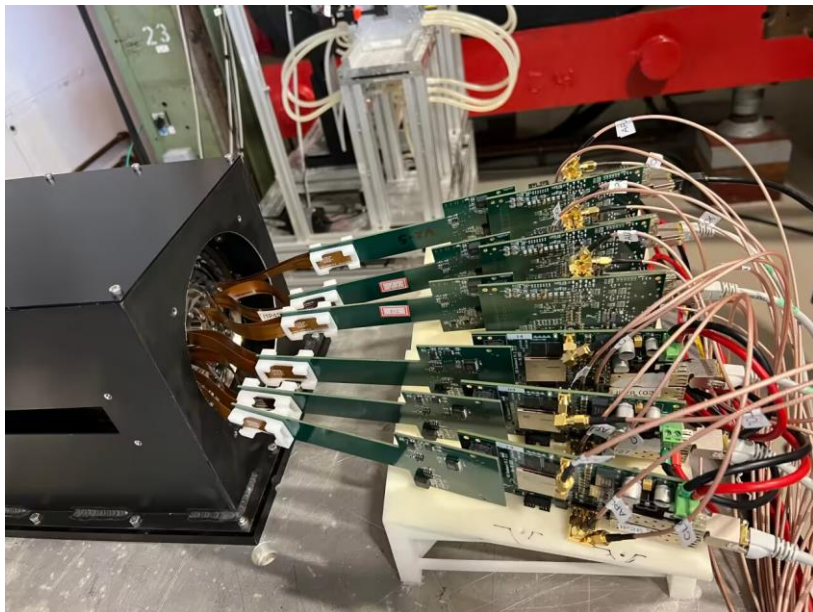


- Prototype loading

- Assemble ladders( 2 flex + 1 support)
  - 2 Sensor on each side.
  - Two flex on a support.
- Ladder mounting
  - Load the ladders on the 3-layer barrel structure.
- Test read-out board support structure.
- Test thermal cooling system: 38°C -> 29°C.



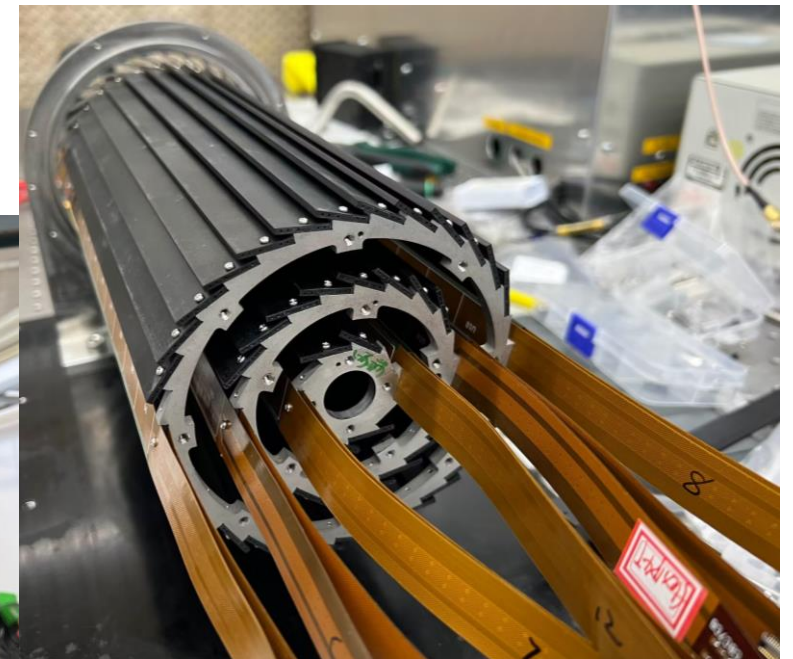
read-out board support



cooling system



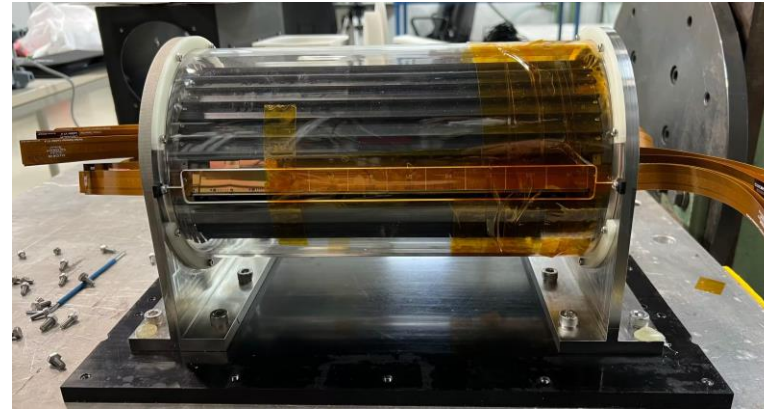
3-layer barrel



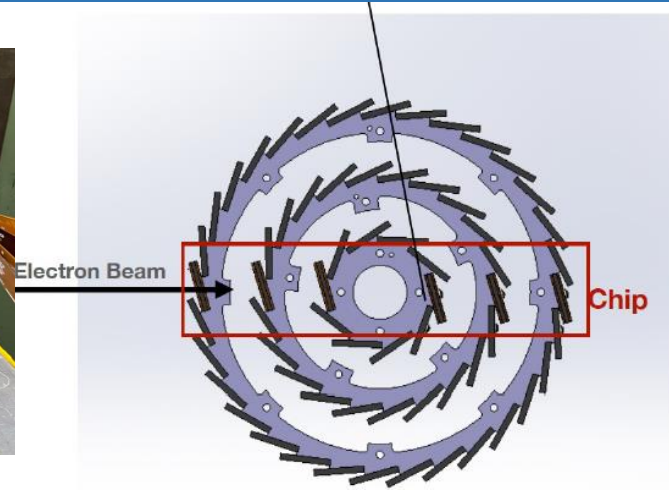


# CEPC MOST2 vertex detector

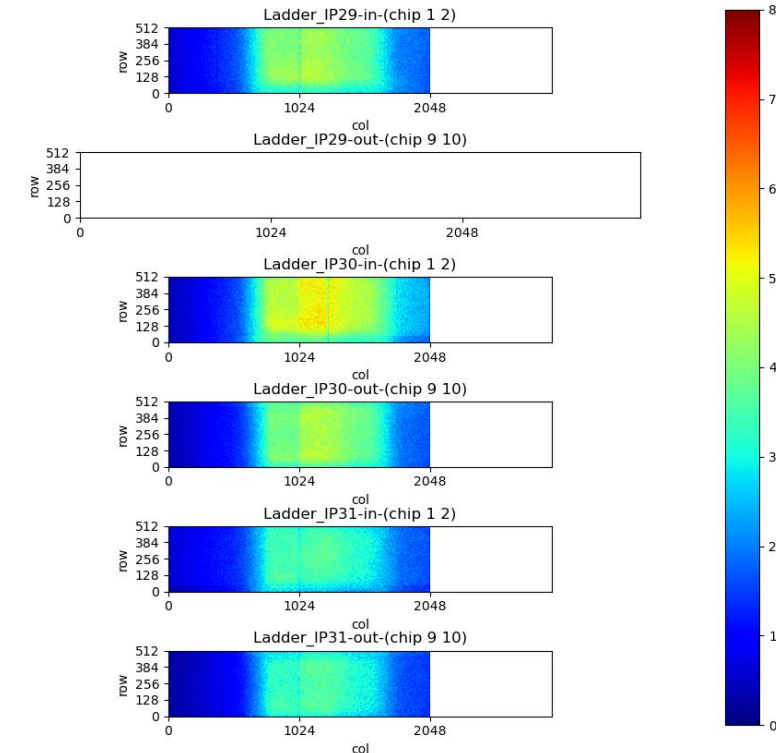
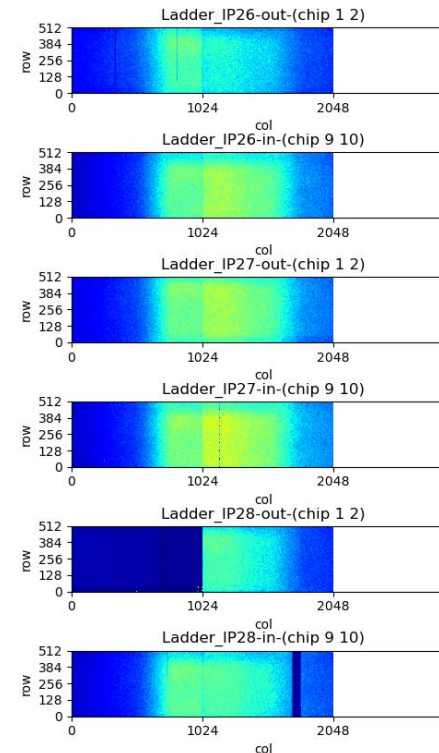
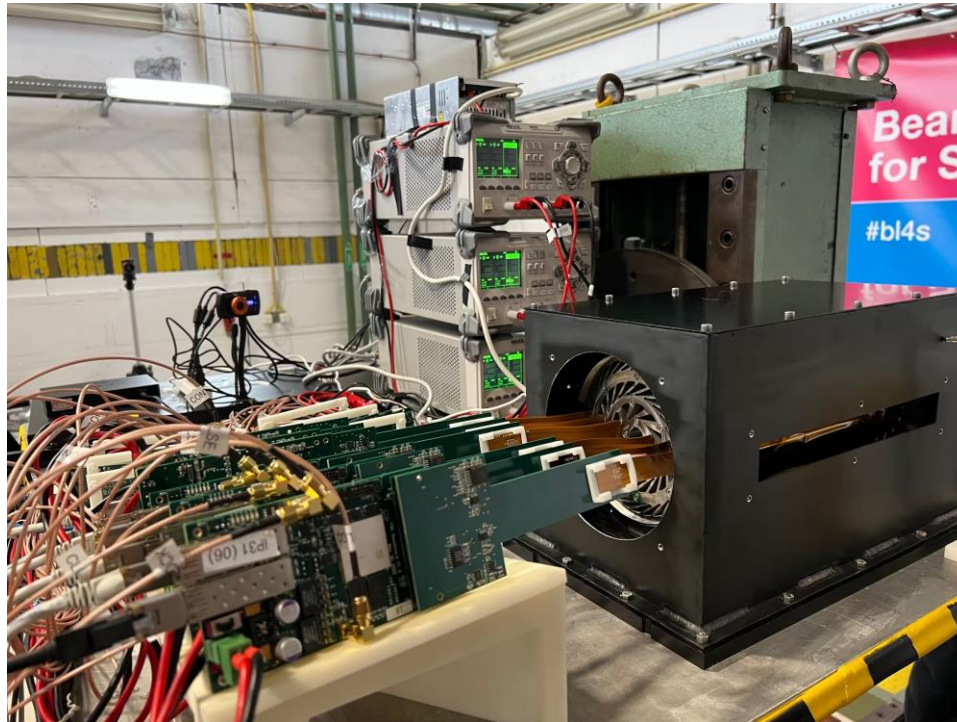
- Test beam in DESY
  - Set up the system
  - Monitoring
  - Data analysis.



Hitmap



Prototype setup



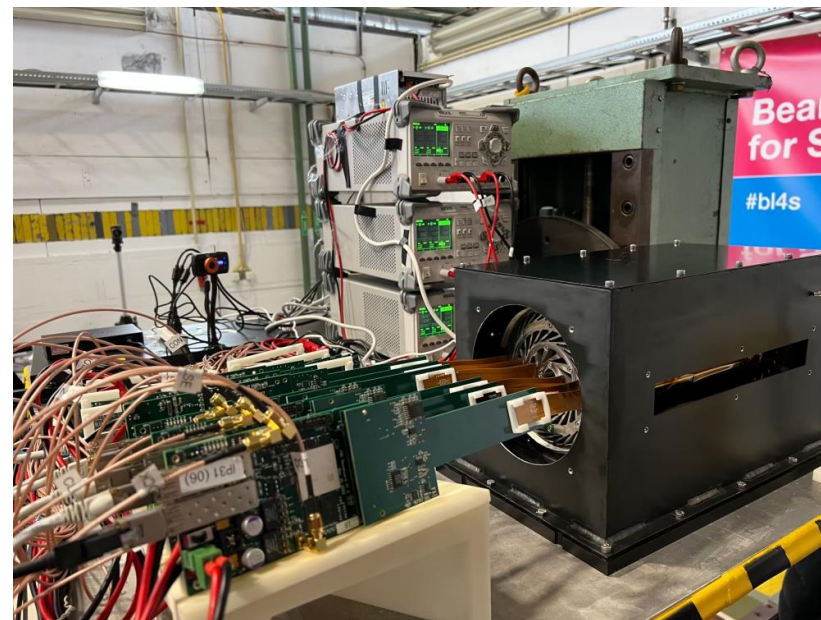
- ZZ CP & Polarization analysis :
  - Unblinded since April 6<sup>th</sup>;
  - The note is already updated, expect to call EB and report our result next week.
- HGTD Module Assembly :
  - 8 modules were assembled, wire-bonded and tested.
  - New protection of the module were designed and produced.
  - The modules for demonstrator are waiting for shipping to CERN.
- CEPC MOST2 vertex detector
  - Complete ladder assembly and prototype loading.
  - Now in test beam at DESY(till 23th).
- Next steps:
  - Deliver the unblinding results next in SM group.
  - New ATLAS analysis: Dark Photon Combination.
    - Kick-off in February
    - Study on uncertainty correlation and  $ZH, H \rightarrow \gamma\gamma_d$  channel.
  - More HGTD modules production.
  - Offline analysis with test beam data of CEPC MOST2 vertex detector.



**ATLAS Note**  
ANA-STDM-2021-05-INT1  
8th December 2022



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



# Backup



## Module List:

FM – Full Module

DM – Digital Module

FMxxxd: FM for demonstrator  
d-Demonstrator

	Type	Hybrid	ASICs	Sensors	Tool	Glue [mg]	Spillage	WB issues
#1	Digital	Type A1	ALTIROC2	-	Gantry	Not Meas.	OK	OK
#2	Digital	Type A1	ALTIROC2	-	Gantry	Not Meas.	OK	OK
#3	Digital	Type A1	ALTIROC2	-	Gantry	Not Meas.	OK	OK
#4	Full	Type A1	ALTIROC2	IMEv2	Gantry	Not Meas.	OK	Not done
Full 1	Full	Type A1	ALTIROC2	IMEv2	Gantry	Not Meas.	OK	OK
Full 4	Full	Type A1	ALTIROC2	IMEv2	Gantry	13.6	OK	OK
Full 3	Full	Type B1	ALTIROC2	IMEv2	Gantry	8.9	OK	OK
Full 2	Full	Type C1	ALTIROC2	IMEv2	Gantry	9.9	OK	OK
#9	Digital	Type B1	ALTIROC2	-	Gantry	Not Meas.	OK	Problems in the flex pads
#10	Digital	Type C1	ALTIROC2	-	Gantry	Not Meas.	OK	OK
#11	Digital	Type B1	ALTIROC2	-	Gantry	Not Meas.	OK	OK

	Flex	ASICs	Sensors	Tool	Glue[mg]	Spillage	WB
FM001	Type A1	ALTIROC2	IMEv2	Gantry	Not Mess.	OK	OK
FM002	Type C1	ALTIROC2	IMEv2	Gantry	9.9	OK	OK
FM003	Type B1	ALTIROC2	IMEv2	Gantry	8.9	OK	OK
FM004	Type A1	ALTIROC2	IMEv2	Gantry	13.6	OK	OK
FM005	Type C1	ALTIROC2	IMEv2(ab)	Gantry	22.8	OK	OK
FM006	Type A1	ALTIROC2	IMEv2(ab)	Gantry	15.0	OK	OK
FM007d	Type C1	ALTIROC2	IMEv2(W24 15+16) 500 um y		14.8	OK	OK
FM008d	Type C1	ALTIROC2	IMEv2(W24-18, W23-20) 300 um y		13.0	OK	Broken
FM009d	Type C1	ALTIROC2	IMEv2(W24 8+9) 500 um y		16.0	OK	OK
FM010d	Type C1	ALTIROC2	IMEv2(W24-14, W23-20) 500 um y		13.2	OK	OK