2023年1-4月考核报告

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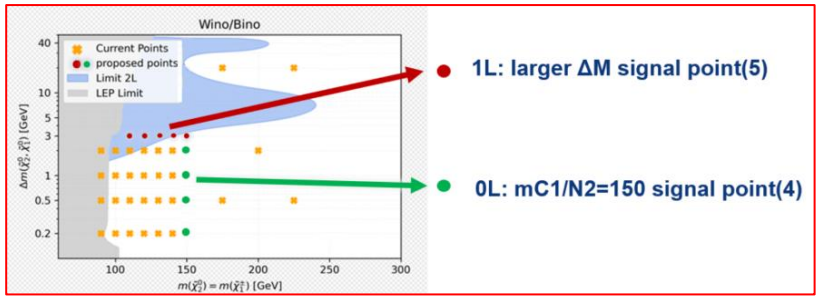
实验物理中心
2023年4月23日

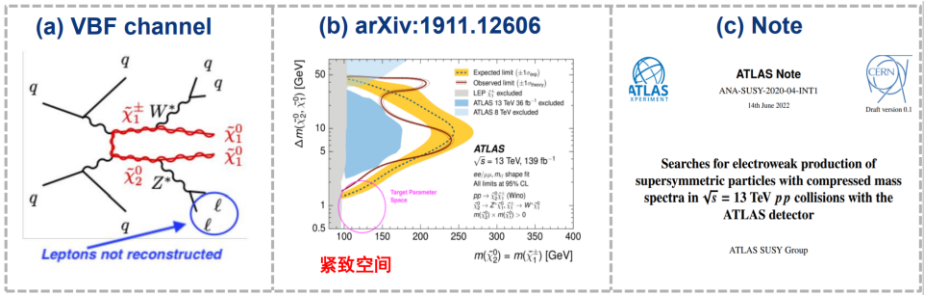
研究工作

- **ATLAS 实验物理分析**
  - 零轻子末态在紧致空间的超对称寻找
  - 单个软轻子末态在紧致空间的超对称寻找
- **ATLAS-ITk 硬件项目（本季度开始的新工作）**
  - 熟悉IHEP站点硅微条探测器项目的完整生产流程
  - 学习并掌握混合条的组装和光学测试
  - 承担光学测试的网页开发与维护工作
- **计划及报告链接**

ATLAS 实验物理分析--零轻子末态在紧致空间的超对称寻找

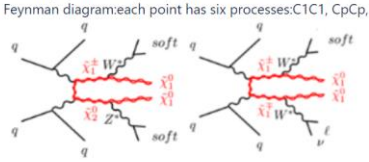
- **研究动机**：通过新“矢量玻色子聚合VBF过程”进一步拓展 low $\Delta M<1$ GeV空间；
- **研究进展**：本人完成现有信号点理论误差计算，也为该分析道成功申请了信号网格扩充，推动了包含所有系统误差的样本产生；
- **研究计划**：本人将基于新申请的信号点研究理论误差，截面误差等；基于最新版的Ntuple **(Run2)** 重新进行机器学习并微调信号区和使用HF/Pyhf 对所有的CR/SR进行联合拟合后**申请unblinding**。





General info:

- Physics process and explanation: Compressed VBF channel with 0L & 1L final states production. Red points of the 1L channel aim for future Run3 analysis and beyond based on Machine Learning method, while 4 green points account for the uncertainty band. There are 6 processes for Wino/Bino samples. Each point on the Wino/Bino grid with dm = 3 GeV has 30k events for 16a, 40k events for 16d, and 50k events for 16d per process so they can be used for Machine Learning studies, all other points have 20,000 events per process.
- Feynman diagram:each point has six processes:C1C1, CpCp, CmCm, N2C1p, N2C1m, N2N2



left: 0L right:1L

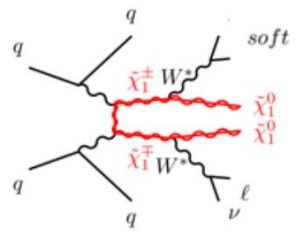
- Generators used: MadGraph
- Production type: AF2
- Extension of existing sample: https://its.cern.ch/jira/browse/ATLMCPROD-9665
- Link to validation plots or presentation: SUSY Electroweak Meeting(24/3/2023) https://indico.cern.ch/event/1269140/contributions/5330465/attachments/2617529/4524681/230324_Compressed%20VBF%20signal%20grid%20extension%20request.pdf (Minor modifications: remove (90,87),(100,97), and larger statistics for ML of 1L signals.
- Athena release: 21.6.80
- Priority and justification: 1

Production:*

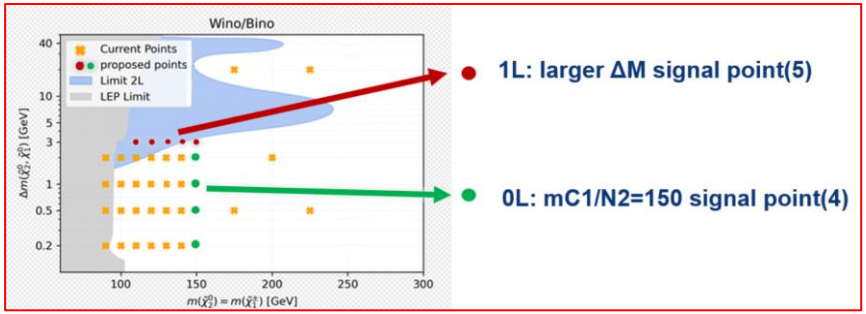
- mc16a:
  - evgen: https://prodtask-dev.cern.ch/prodtask/inputlist_with_request/48612/ **done**
  - sim/reco: https://prodtask-dev.cern.ch/prodtask/inputlist_with_request/48671/ **done**
- mc16c/d:
  - evgen: https://prodtask-dev.cern.ch/prodtask/inputlist_with_request/48613/ **done**
  - sim: https://prodtask-dev.cern.ch/prodtask/inputlist_with_request/48672/ **done**
  - reco: https://prodtask-dev.cern.ch/prodtask/inputlist_with_request/48675/ **done**
- mc16e:
  - evgen: https://prodtask-dev.cern.ch/prodtask/inputlist_with_request/48614/ **done**
  - sim/reco: https://prodtask-dev.cern.ch/prodtask/inputlist_with_request/48673/ **done**

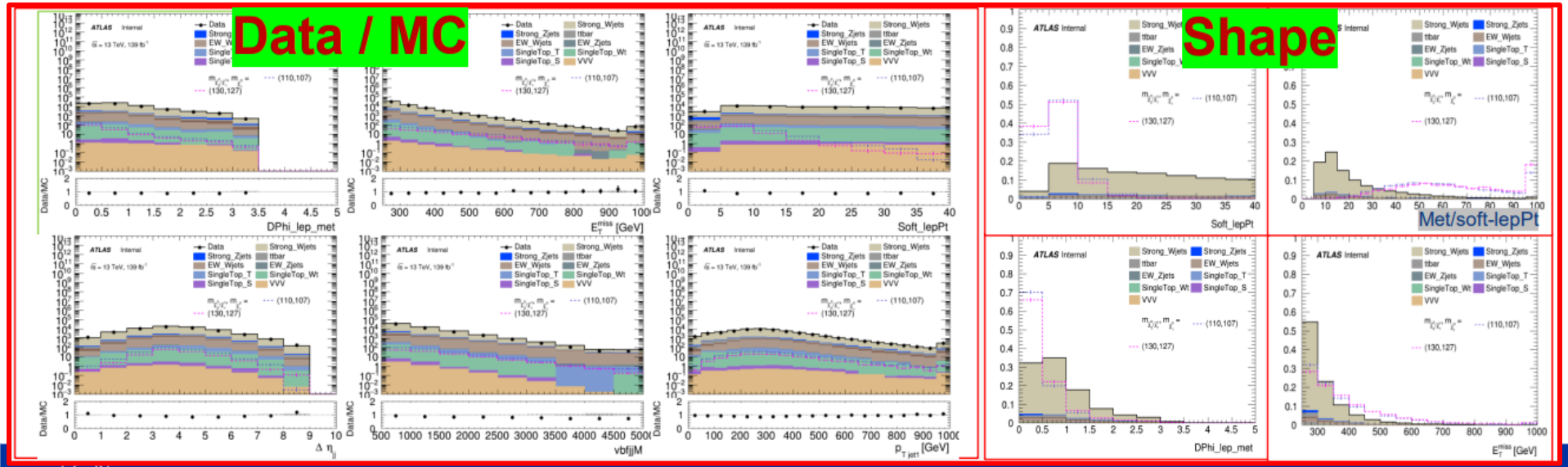
ATLAS 实验物理分析—单个软轻子末态在紧致空间的超对称寻找（一）

- **研究动机：**通过首次研究soft 1L提高信号显著性；现有分析是基于0L和2L进行，希望通过新的soft 1L提高信号显著性。
- **研究进展：**本人通过对多个不同的Truth smeared信号样本分别进行信号区优化，得到较好的排除限；本人成功通过SUSY-EWK组的批准申请了新的官方信号点。目前已产生好AOD样本，DAOD正在进行中。
- **研究计划：**首次使用N维扫描方法和神经网路框架两种方法进行信号区优化，该分析道将用于**Run2+Run3预研。**



Soft 1L Pre-selection
Met>250
Vbfmjj>500
nAjets >=2
nSoft_lep(Pt<40) == 1
B-jet veto





ATLAS 实验物理分析—单个软轻子末态在紧致空间的超对称寻找（二）

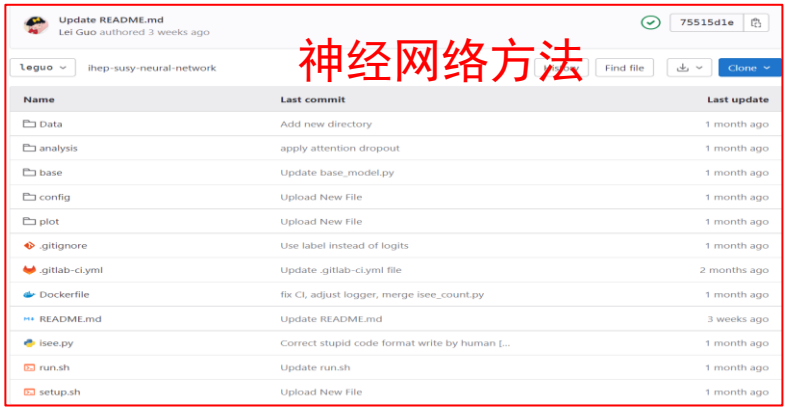
N维扫描方法

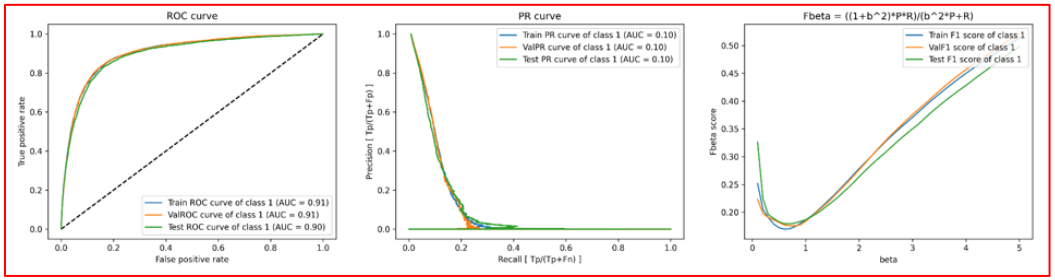
Soft 1L Pre-selection
Met>250
vbfmjj>500
nAjets>=2
B-jet veto
nlep_signal(lep1Pt<40) == 1

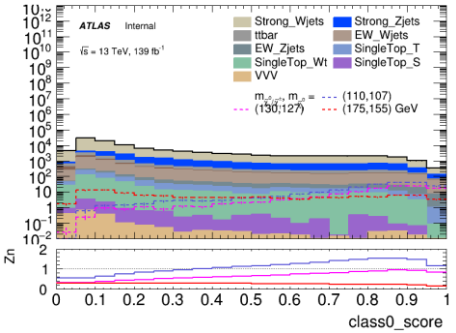
SR	requirement
met	>250
vbfjjM	>600
vbfTagJet1_Pt	>100
vbfTagJet2_Pt	>40
lep1Pt	<20
lep1MT_Met	<30
vbfdEtajj	<2.5
DPhi_lep_met	<1
MET_HTl	>50

CC-Zn	0.81(130,127)
bkg	3161.94+-44.92
signal	58.73+-1.17

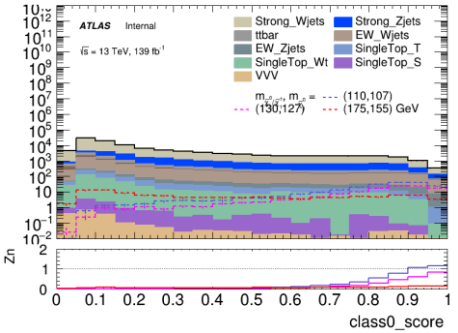
神经网络方法







(110,107) Zn=1.57
(130,127) Zn=1.00
(175,155) Zn=0.34

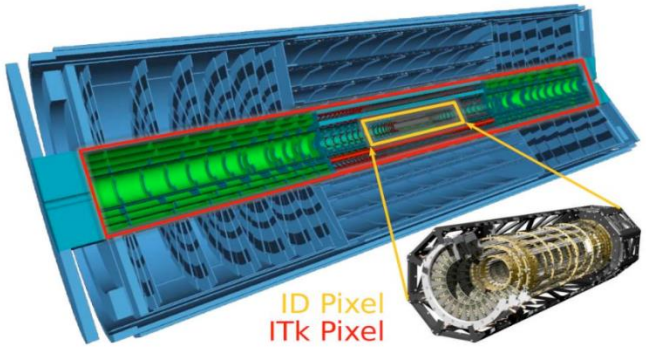


(110,107) Zn=1.32
(130,127) Zn=0.81
(175,155) Zn=0.28

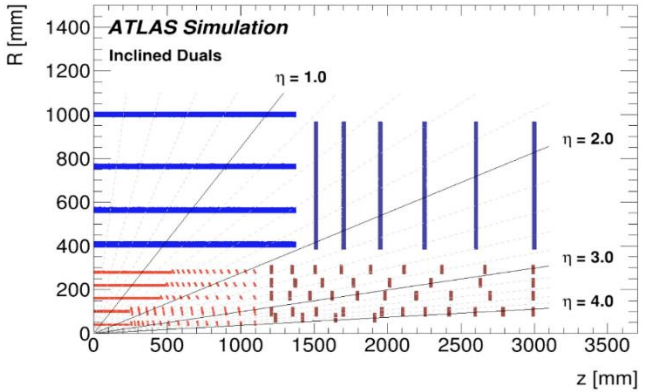
ATLAS-ITk 硬件项目（一）

- **研究动机：升级径迹探测器**
  - ✓ **“技多不压身”**
  - ✓ **想参加ITk国外合作项目(UK)**

ATLAS二期ITk径迹探测器



- 全硅径迹探测器（ITk）替代现有径迹探测器（ID）
  - 高亮度LHC升级
  - 硅像素探测器总覆盖面积：1.7m² → 13m² (5e9测量道)
  - 原始数据读出速度提高 O(100) 倍
  - 领域内最前沿的硅探测器和电子学技术
  - 直接影响几乎所有的物理研究：**不能失败！**

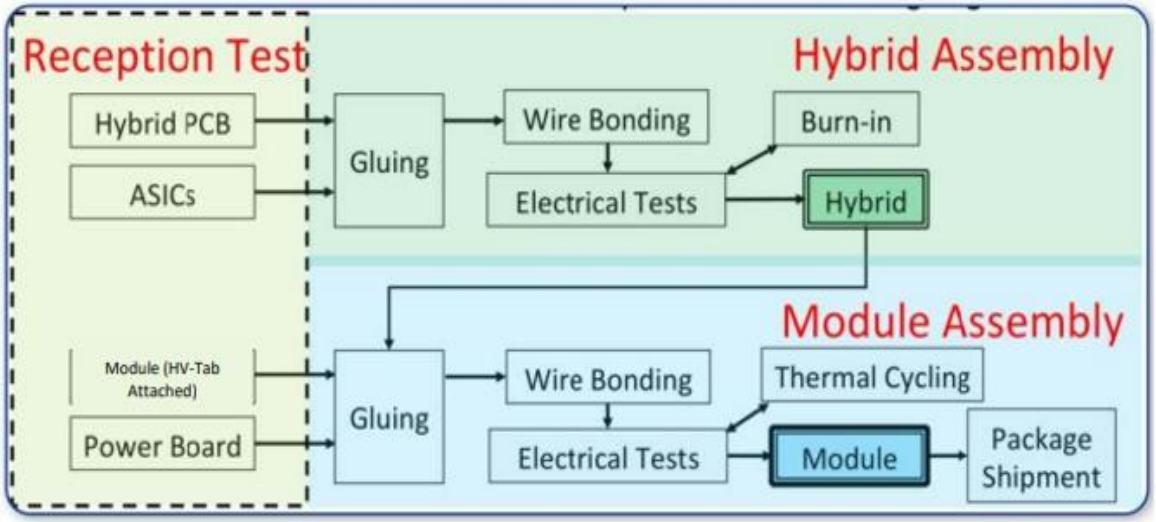


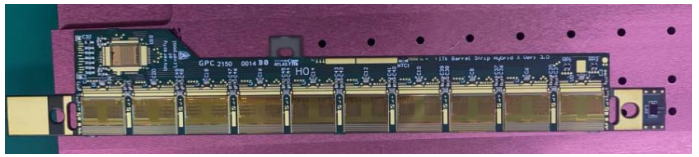
- 外层硅微条探测器
  - 硅覆盖面积约10平方米，约占桶部总面积10%，为国内首次承担此类大面积抗辐照硅径迹探测器项目

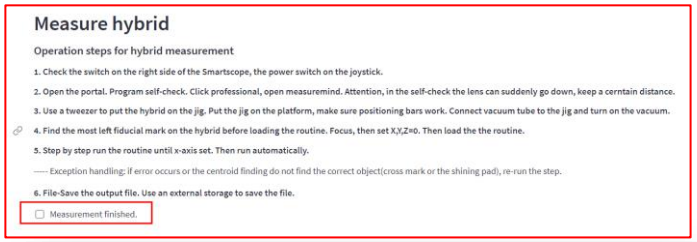
ATLAS-ITk 硬件项目（二）

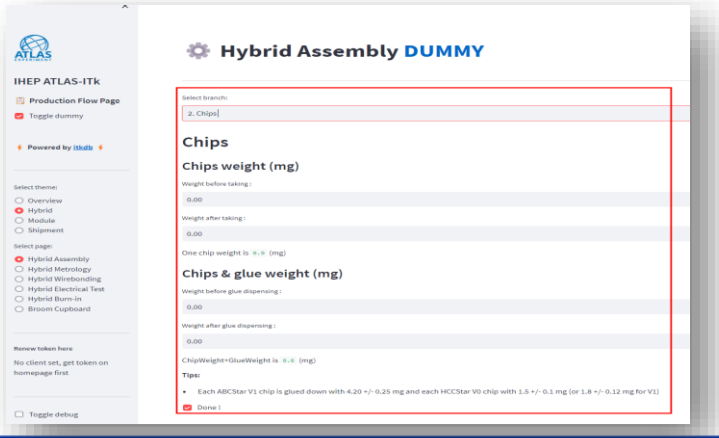
➢ 研究进展

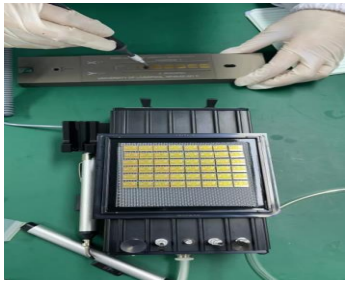
- 熟悉该项目生产的完整流程（如下流程图所示）。
- **承担**生产的Hybrid组装和Metrology光学测试以及Module Metrology测试。
- 在实验室中，学习了Hybrid组装以及metrology测试，并可以独立完成整个metrology测试。
- 在网页开发中，基于Streamlit包负责Hybrid metrology的开发与维护部分，正在尝试开发新功能。

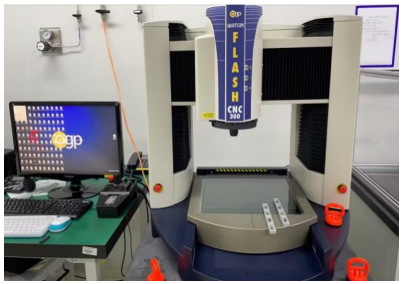






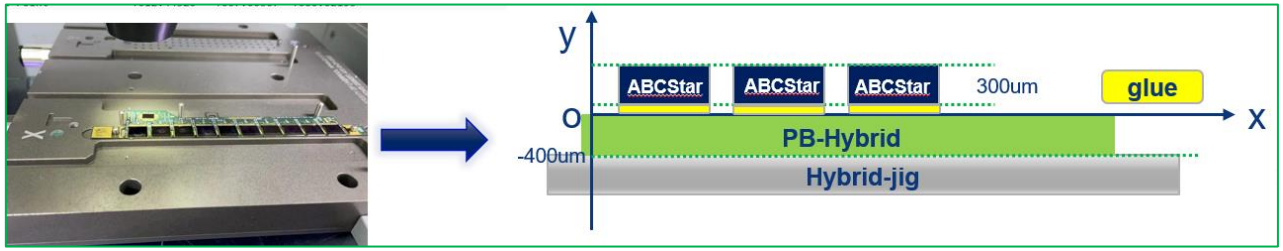


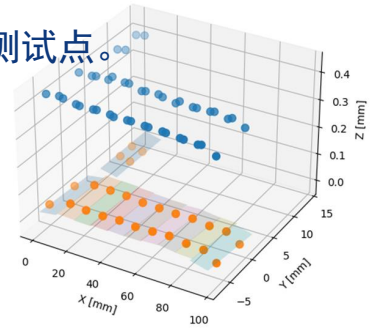


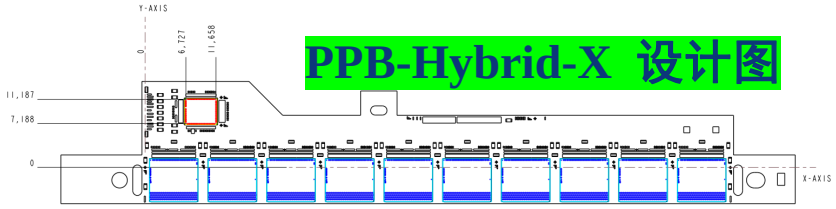


ATLAS-ITk 硬件项目（三）

- 承担生产的Hybrid组装任务和Metrology光学测试任务以及Module Metrology测试。
- 测试细节及亮点：采用**OGP CNC 300测试设备**和**自动化Python编程**实现定位测量198个测试点。



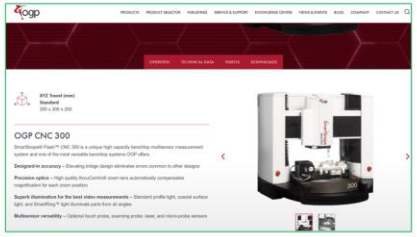




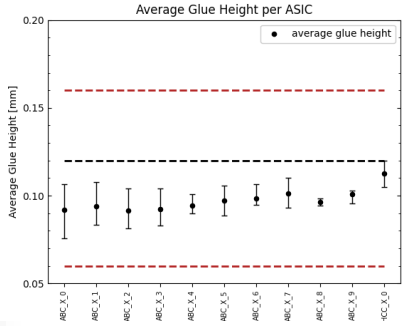
PPB-Hybrid-X 设计图

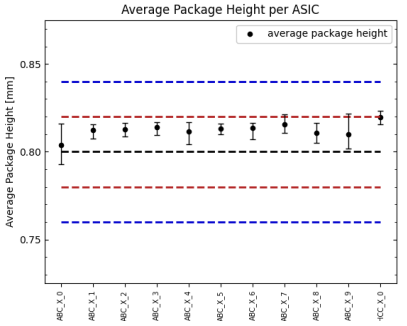
- Motivation
  - The first **check is whether the hybrid passes the QC requirements.** QC requirements see the documentation, as very loose, basically passable.
  - Second, **check if there are any problems with our workflow and equipment**. The previous assembly was installed incorrectly, and this step can be checked immediately.
  - Third, **provide information for subsequent bonding.** For example, if there is a large deviation, you need to tell the bonding staff to pay attention. (Not a particularly big deviation is not a big problem.)
- List of requirements to be shown for both an X and Y Hybrid
  - ASIC to hybrid glue heights - 120 ± 40μm
  - Total package height - 800 ± 40μm (0.8 ± 0.04mm)
  - ASIC positions - ± 200μm (0.20 mm) from nominal
  - ASIC Flatness/Tilt - 0.025
- Machine

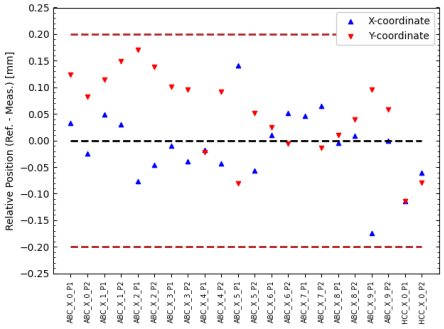
The smartscope that we have at IHEP is the OGP CNC 300. The specifications can be found here. The programs are written using the MEASUREMIND software that outputs plain text files that will be analyzed offline using Python scripts.

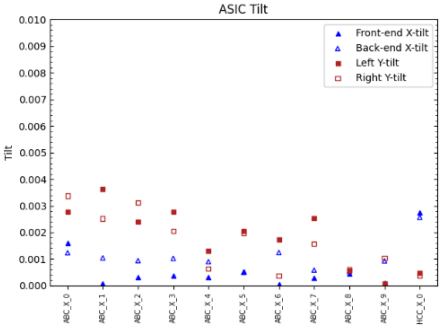


PPB-Hybrid-X-03测试结果









测试结果：满足要求

未来计划

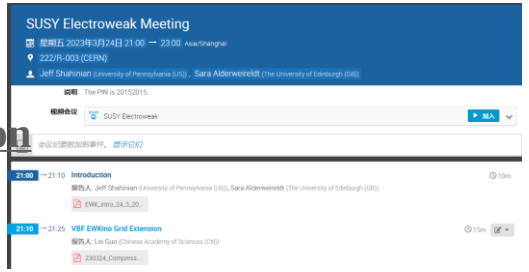
➢ ATLAS 实验物理分析

- **零轻子末态在紧致空间的超对称寻找：**
  - 研究新申请的信号点，推动该分析，预计明年发表一篇文章；
- **单个软轻子末态在紧致空间的超对称寻找：**
  - 作为最主力分析人员开展新分析道研究，基于新产生的信号点使用多种方法进行信号显著度研究；
  - 进行**Run2+Run3**的预研。

➢ ATLAS-ITk 硬件项目（本季度开始的新工作）

- 深入学习IHEP站点硅微条探测器项目的完整生产流程
- 熟练掌握混合条的组装和光学测试
- 承担光学测试的网页开发与维护工作，继续开发该部分

相关链接



- **SUSY Electroweak Meeting(24/3/2023)**

  https://indico.cern.ch/event/1269140/#11-vbf-ewkino-grid-extension

- **Grid extension request**

  https://its.cern.ch/jira/projects/HIGGSINO/issues/HIGGSINO-255?filter=allissues

  https://its.cern.ch/jira/browse/ATLMCPROD-10539

- **Compressed EWK Meeting**

  20230418 https://indico.cern.ch/event/1277875/contributions/5367603/note/

  20230411 https://indico.cern.ch/event/1275547/

  20230404 https://indico.cern.ch/event/1273222/contributions/5346533/

  20230321 https://indico.cern.ch/event/1268337/#28-round-table-discussion

  20230316 https://indico.cern.ch/event/1270314/contributions/5335622/note/

  20230314 https://indico.cern.ch/event/1265318/#28-round-table-discussion

  20230307 https://indico.cern.ch/event/1260951/#28-round-table-discussion

  20230221 https://indico.cern.ch/event/1254745/#27-vbf-soft-1l-study-signal-sa

- **China ATLAS ITk Weekly Meeting**

  20230317 https://indico.cern.ch/event/1264657/contributions/5311226/attachments/2613446/4516126/Atlas%20ITk%20report_20230317.pdf
  20230407 https://indico.cern.ch/event/1274446/contributions/5352270/attachments/2626481/4542252/Atlas%20ITk%20report_20230407.pdf
  20230421 https://indico.cern.ch/event/1275000/contributions/5354577/attachments/2632901/4554096/Atlas%20ITk%20report_20230421.pdf

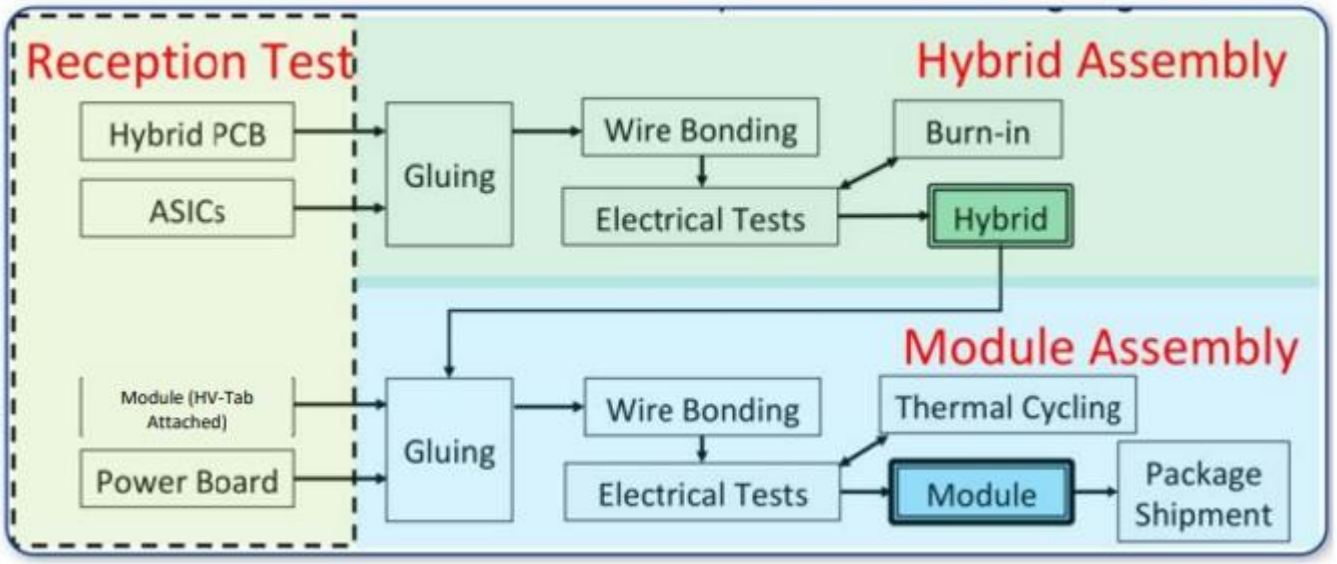
谢谢！

Soft 1L 新分析道的初步研究

1. 使用CMS-SR查看现有信号的信号显著度
2. 用现有的信号点使用Cut-Count方法和HF框架进行信号区优化(175,155)（90，88），并和已有的0L研究进行合并。
   ① One-bin
   ② Multi-bin
   ③ 2D-bin
3. 产生新的信号点使用Cut-Count方法和HF框架做信号区优化(150,147)(200,196)，并和已有的0L研究进行合并。
   ① One-bin
   ② Multi-bin
   ③ 2D-bin
4. 本地产生新的信号点dM=3使用Cut-Count方法和HF框架做信号区优化并得到0L和1L合并后的排除限，代表整个compressed EWK组在SUSY EWK小组上得到批准后申请官方信号点，现在已完成MC样本产生。
5. 学习机器学习的相关知识，并使用ML的方法研究1L的信号显著度，并得到初步结果。
6. 新分析道Soft 1L将是HL-LHC的预研，接下来将继续推进该研究。

ITk 进展

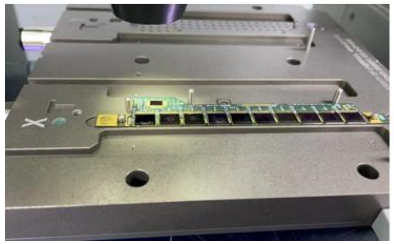
1. 熟悉ITk生产的完整流程。
2. 承担ITk生产的Hybrid组装任务和Metrology光学测试任务以及module metrology测试。
3. 在实验室中，学习了Hybrid组装以及metrology测试，并可以独立完成整个metrology测试。
4. 在网页开发中，负责Hybrid metrology的开发部分，正在尝试开发新功能。

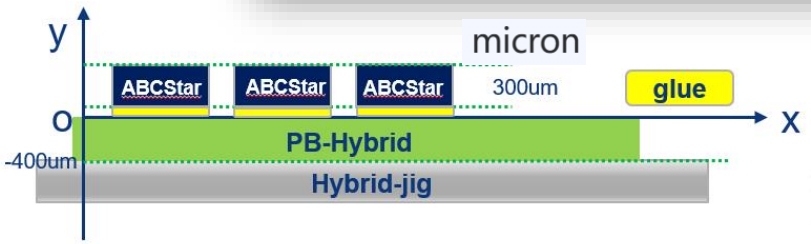


ITk update—PPB-03

```
# For points on ASICs, get glue height and package height relative to jig plane
if row.type==2:
    glueHeight = height - asicThickness
    packageHeight = jigPlane.distance_point_signed(point)
```

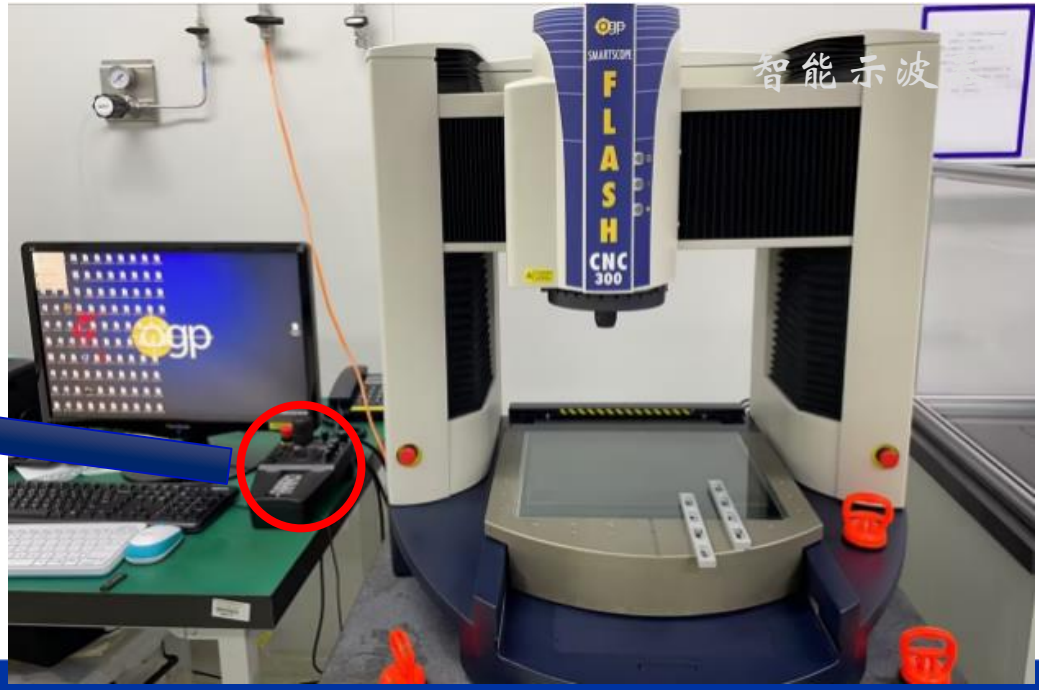
asic-thickness is known





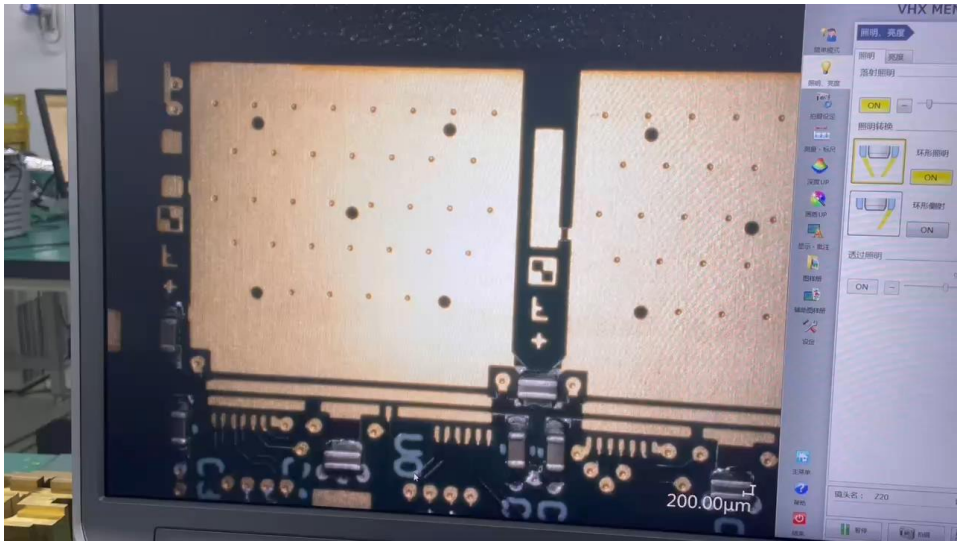
smartscope

it is controlled by a joystick



Hybrid Assembly(Yuqing Wang, Lei)

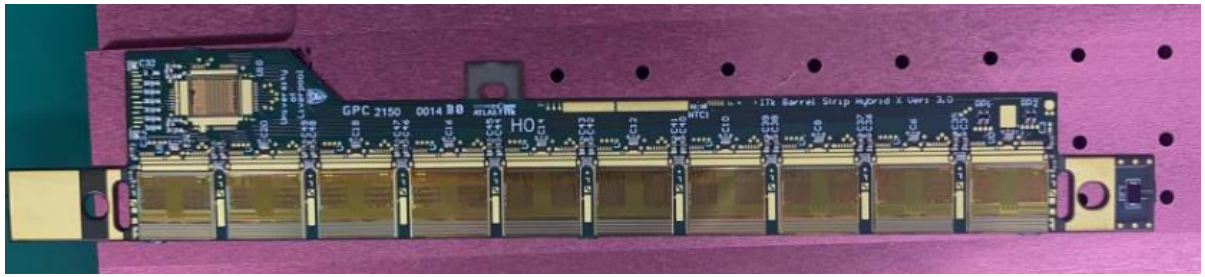
1. Before assembly, we need to use a microscope to check the surface for scratches or damage



2. More details will not be repeated. This image can more intuitively feel the size of each ASIC

3. Once done, we need to weigh the mass of the hybrid again

4. This drawing is the sample drawing of assembly completion, and the next step is metrology



Hybrid Metrology

➢ Motivation

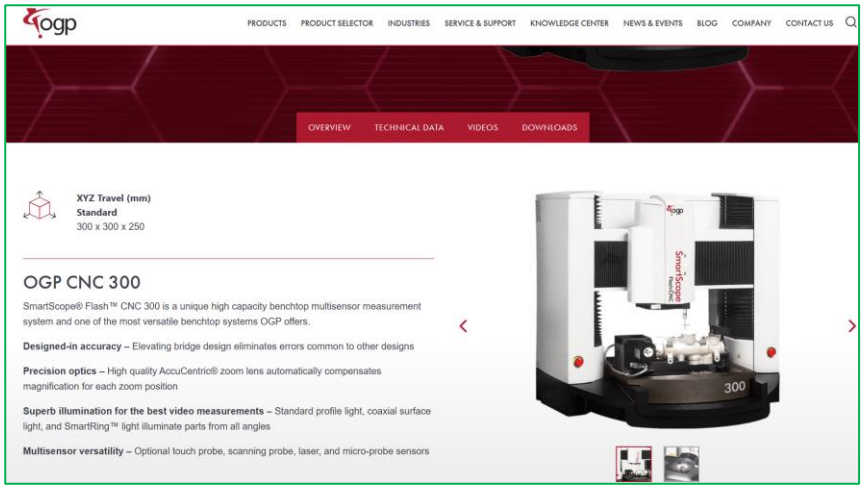
- The first **check is whether the hybrid passes the QC requirements.** QC requirements see the documentation, as very loose, basically passable.
- Second, **check if there are any problems with our workflow and equipment**. The previous assembly was installed incorrectly, and this step can be checked immediately.
- Third, **provide information for subsequent bonding**. For example, if there is a large deviation, you need to tell the bonding staff to pay attention. (Not a particularly big deviation is not a big problem.)

➢ List of requirements to be shown for both an X and Y Hybrid

- ASIC to hybrid glue heights - 120 ± 40μm
- Total package height - 800 ± 40μm (0.8 ± 0.04mm)
- ASIC positions - ± 200μm (0.20 mm) from nominal
- ASIC Flatness/Tilt - 0.025

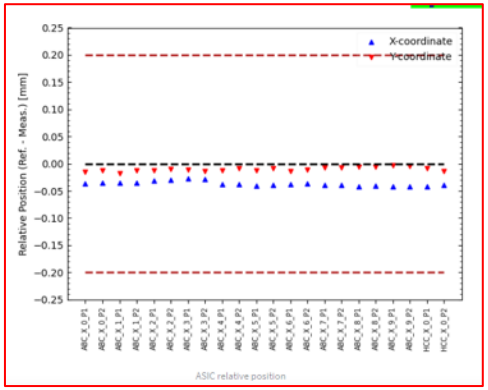
➢ Machine

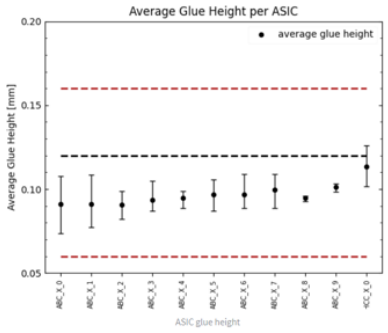
The smartscope that we have at IHEP is the OGP CNC 300. The specifications can be found here. The programs are written using the MEASUREMIND software that outputs plain text files that will be analyzed offline using Python scripts.

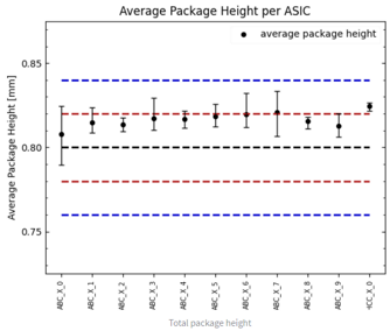


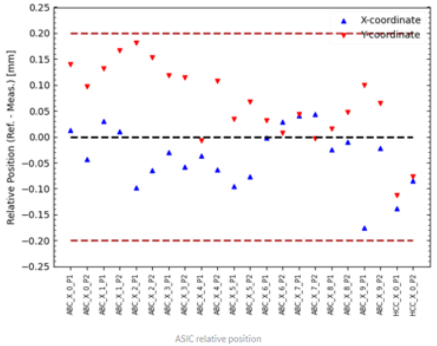
“PPB_Hybrid_X_03” Metrology results

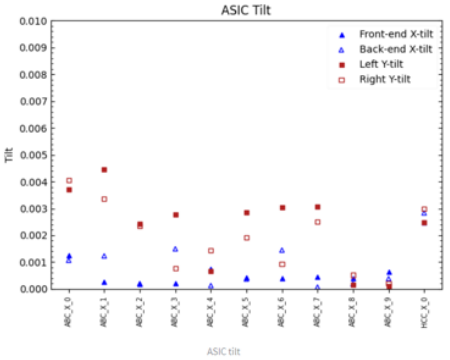
- The first row plots from Kaili’s test on Wednesday.
- The second row plots from Lei’s test on Tuesday.
- The results meet the official SQ requirement.
- Then some issues in ASIC relative position, which means hybrid assembly can be improved.



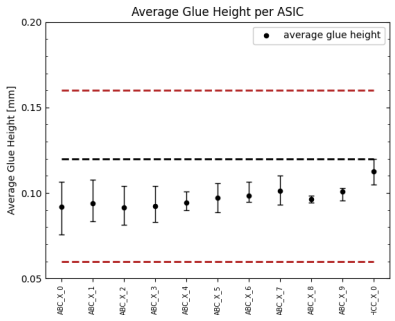


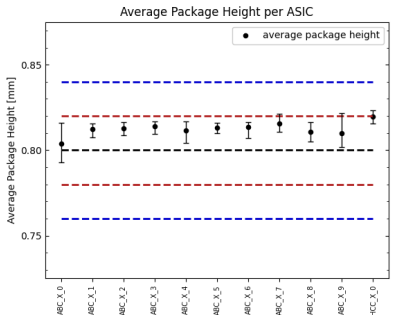


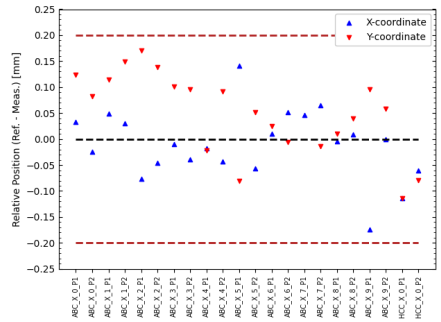


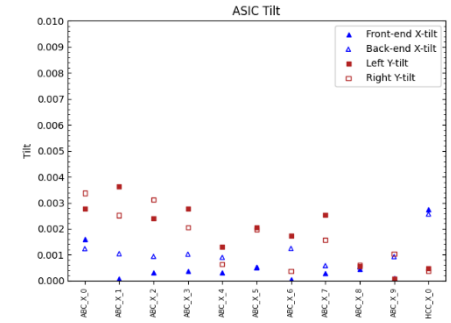


kaili





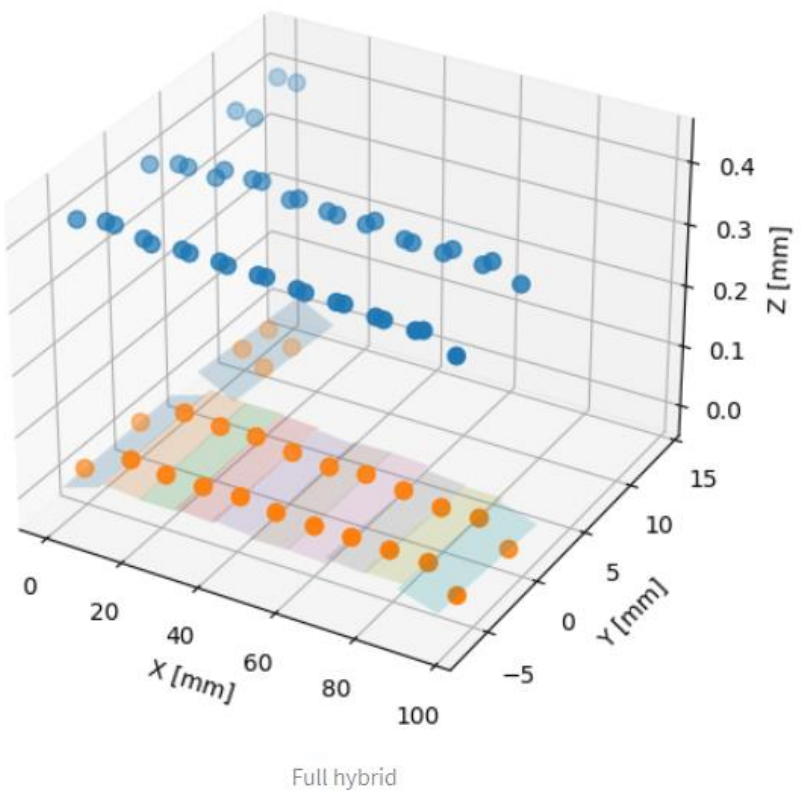




Lei

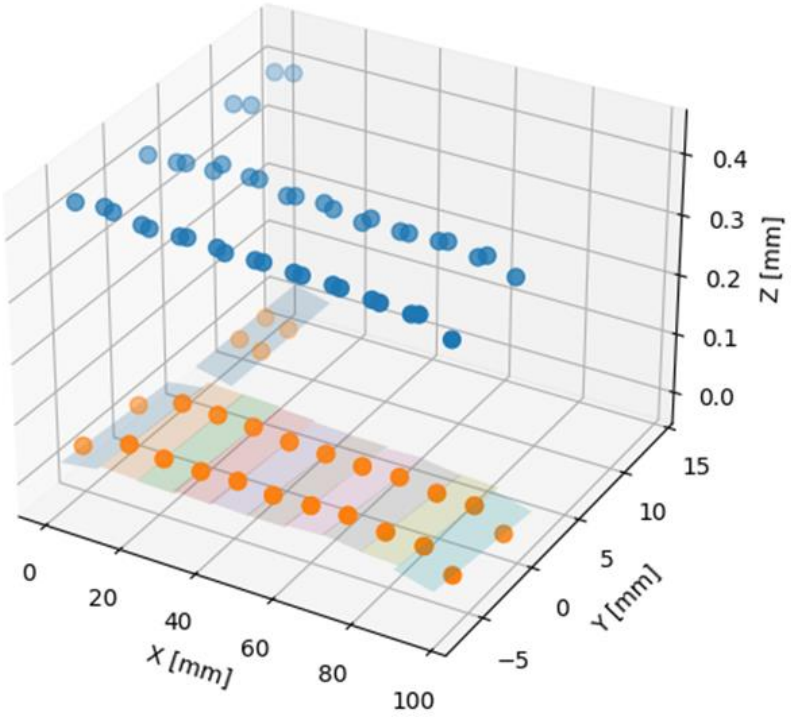
3D plot

Kaili



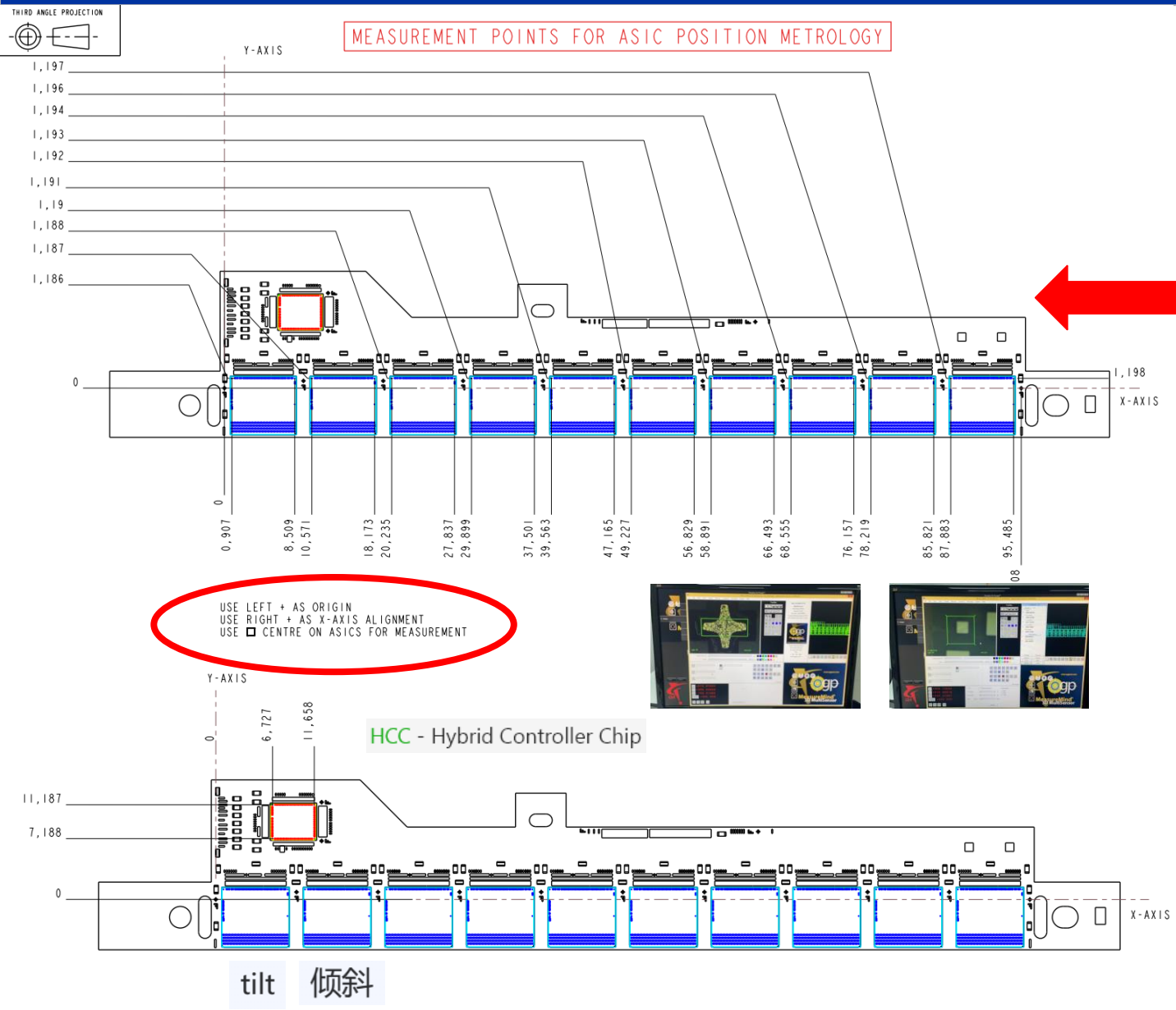
Full hybrid

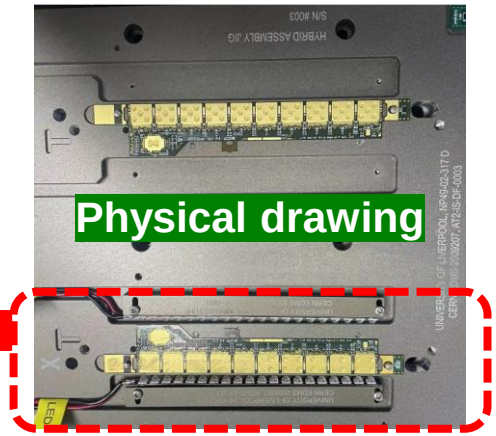
Lei



Full hybrid

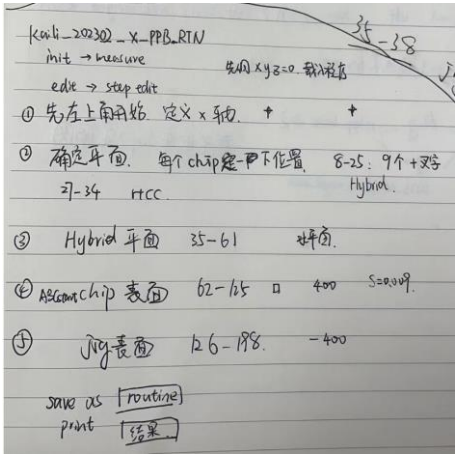
Design



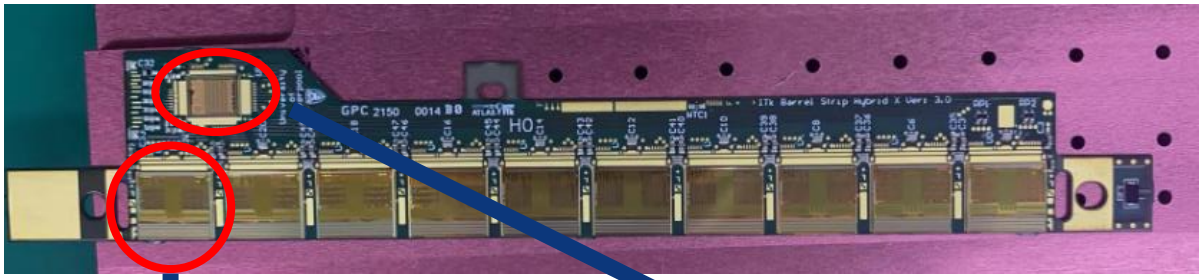


PPB-Hybrid-X

Process of test

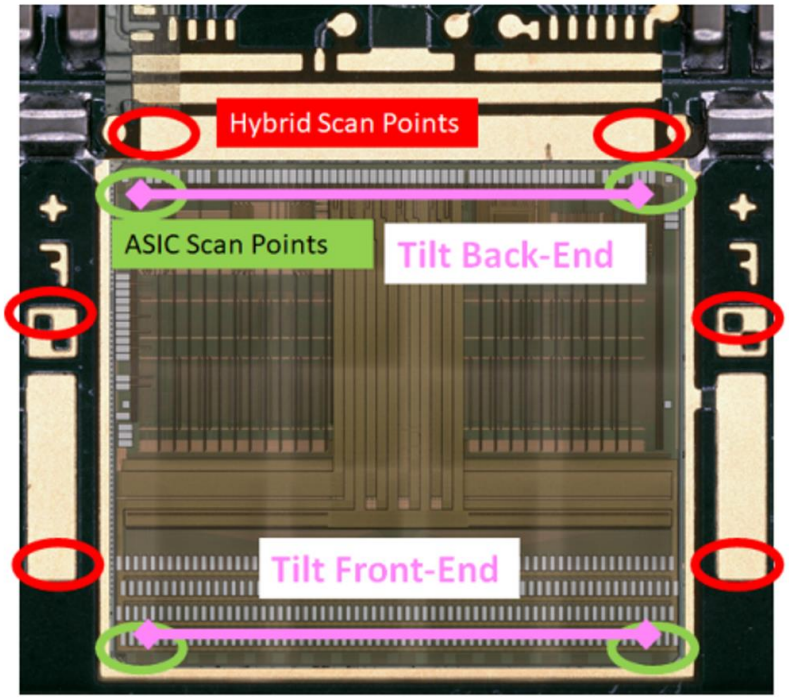


Tilt measurement

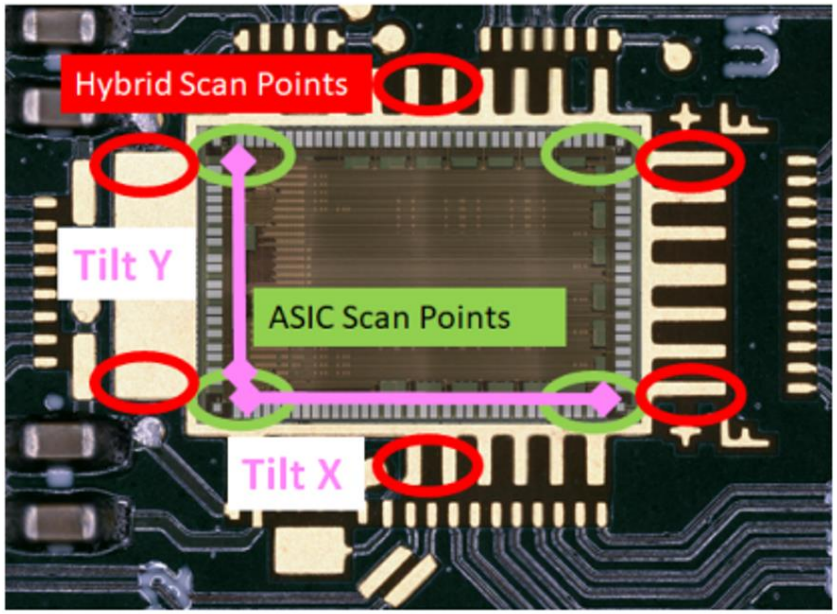


$$\frac{|\Delta z|}{\sqrt{\Delta x^2 + \Delta y^2}}$$

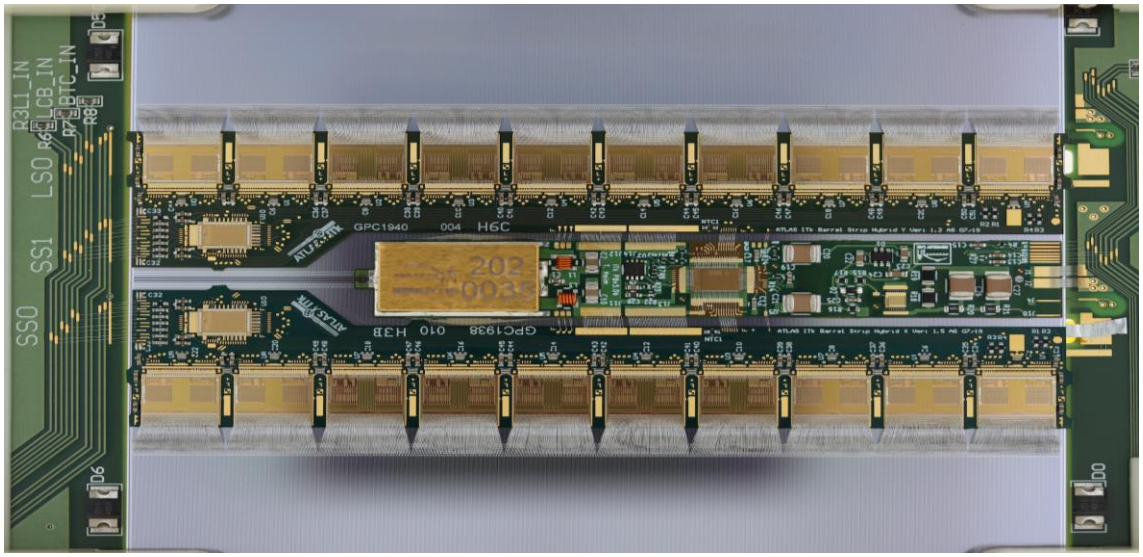
For ABC star chips, the tilt front-end and tilt back end is calculated.

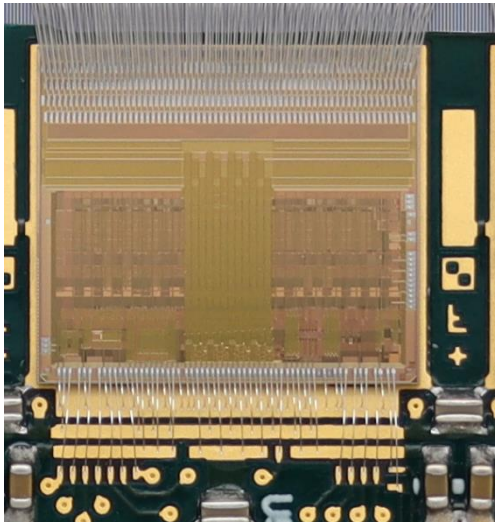


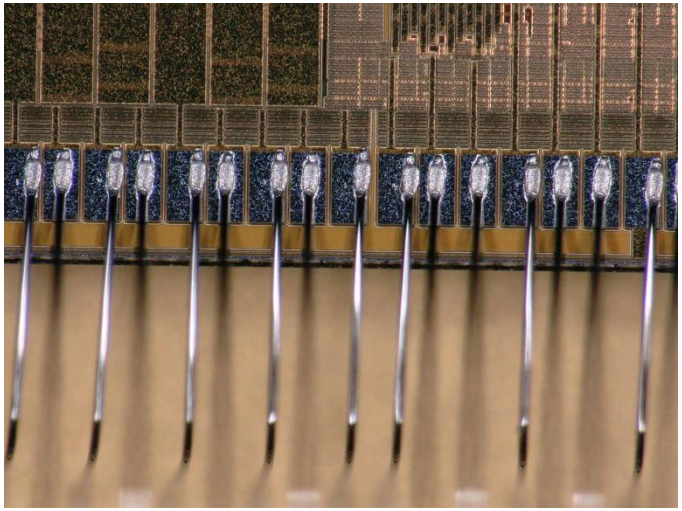
And for HCC star chips, the Tilt X and Tilt Y are calculated.

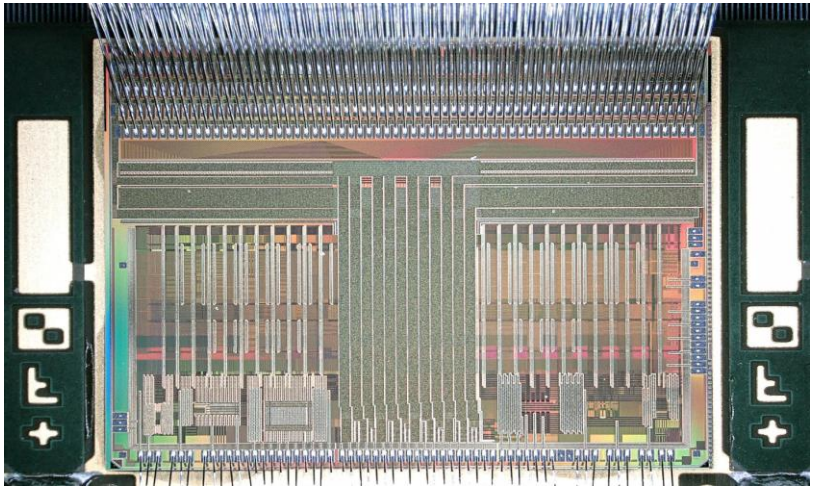


Next step→Wire bonding绑定(Ye)→ E-test(fabio) → burn-in(Yue)…









Cut-and-Count R&D

	1L(Zn=1.52)
vbfjet1Pt	>100
vbfjet2Pt	>40
lep1Pt	<15
lep1MT_Met	<40
vbfdEtajj	>2.5
DPhi_lep_met	<1
MET_HTl	>70

	2L(Zn=1.87)
vbfjet1Pt	>100
vbfjet2Pt	>40
lep1Pt	<20
lep2Pt	<12
lep1MT_Met	<40
vbfdEtajj	>2
DPhi_lep_met	<2
MET_HTl	>50