# **Electrical characterization of ATLAS ITk-Strip modules**

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CLHCP2020

#### Introduction: ITk project



IHEP/THU will contribute 500 Strip Barrel Modules

#### Introduction: building electrical module



#### • Wire bondings:

- ABCStar to PCB
- HCC to PCB
- Hybrid to PowerBoard
- ABCStar to Sensor

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# **Quality control**

- Quality control(QC) tests performed on every production item
- Include but not limited to:
  - assembled structure (metrology surveys)
  - electrical functionality
  - thermo mechanical properties
    - ASIC burn in
    - thermal cycling
    - long term cold tests
- Electrical tests are one of the most important QC test

# **Electrical test procedures**

Checks the functionality and performance

#### • Hybrid testing

- Chip Communication
- Strobe Delay:
- Response Curve
- Noise Occupancy

#### Sensor testing

• I-V scan

- Module testing
  - Chip Communication
  - Strobe Delay:
  - Response Curve
  - Noise Occupancy
  - I-V scan

### **Electrical test setup at IHEP**



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### Hybrid testing: chip communication

#### To verify the communication to the chips by capturing:

- HCC(Hybrid-Controller-Chip) ID
- ABC(ATLAS Binary Chip) Chip IDs



# Hybrid testing: Strobe delay

Ensures that the discriminators,

- always firing at the clock frequency,
- will be synchronous with the calibration signal.



# Hybrid testing: Vt50 in threshold scan

- Performed by injecting a constant charge and varying the threshold value of the discriminator from zero to its maximum.
- At each threshold level several charge injections are performed.
- **S-curve** : the measured average hit rate versus threshold.
- Vt50 : the value with a 50% hit rate corresponds to the median of the injected charge



# Hybrid testing: response curve

- Threshold scans for three different injected charges(0.5 fC, 1 fC & 1.5 fC).
- The resulting response curve is fitted linearly to obtain values for its estimated discriminator offset (mV at 0 fC) and the channel gain (slope, mV/fC).
- Also determines input noise for each channel.





### Hybrid testing: noise occupancy

- Measures the noise occupancy as a function of threshold
- Noise occupancy is extracted from performing S-curve measurements of efficiency vs. threshold with no charge injection
- channel noise occupancy should below  $10^{-3}$



#### Sensor test: I-V scan

- Environment requirement
  - Light-shielding test-box
  - Humidity control: dry air
  - Temperature control: chiller



### Module tests

The first electrically functional STAR module at IHEP as an example



### **Milestones since Nov. 2019**

- From the perspective of the electrical tests
  - What we did since previous CLHCP



# **Summary and Plan**

- Summary
  - Electrical test platform have been built
  - Electrical modules built at IHEP, and passed the electrical tests
- Plan
  - Prepare for the pre-production
  - Prepare hybrid burn-in set-ups



