

# Development of low-material power and data transmission technology for silicon pixel trackers

-- a proposal of Key Project submitted to NSFC

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CEPC Inner Tracker meeting, 17<sup>th</sup> Mar 2026

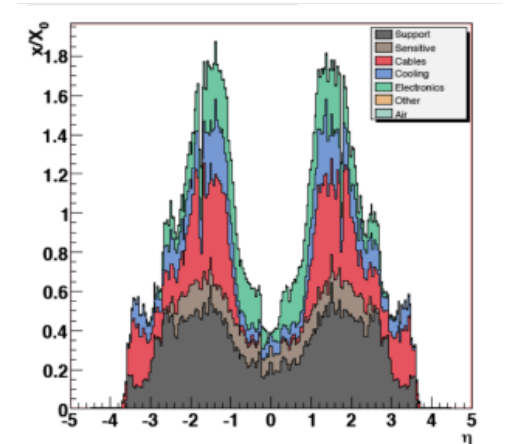
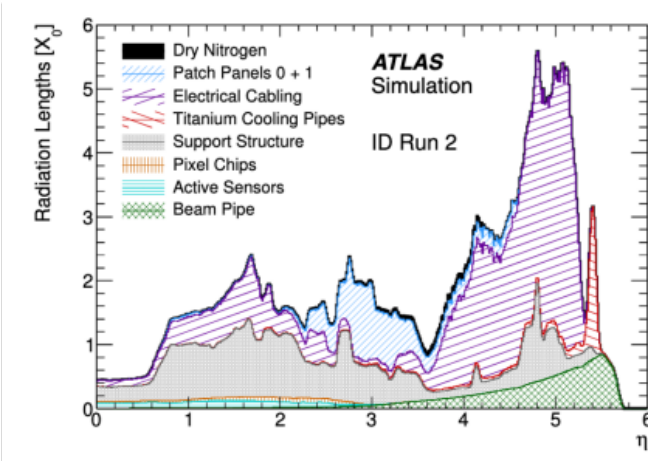
# Motivation

- Modern silicon pixel tracking detectors: complex system with high-density interconnections, with increasingly large area and high granularity

|              | 系统                           | 探测面积 [m <sup>2</sup> ] | 模块数量   | 芯片数量   | 芯片                     | 芯片像素数   |
|--------------|------------------------------|------------------------|--------|--------|------------------------|---------|
| operating    | ALICE ITS2                   | 10                     | 192    | 24,120 | ALPIDE<br>(1024 x 512) | 524,288 |
|              | ALICE MFT                    | 0.4                    | 228    | 936    | ALPIDE<br>(1024 x 512) | 524,288 |
|              | LHCb Upgrade I VELO          | 0.25                   | 52     | 624    | VELOPix<br>(256 x 256) | 65,536  |
| constructing | ATLAS Upgrade II ITk Pixel   | 13                     | 10,276 | 33,184 | ITKPix<br>(400 x 384)  | 153,600 |
|              | CMS Upgrade II Inner Tracker | 4.9                    | 4,352  | 13,488 | CROC<br>(432 x 336)    | 142,128 |
|              | CEPC Inner Tracker           | ~ 20                   | 3,612  | 47,024 |                        |         |

# Motivation

- Modern silicon pixel tracking detectors: complex system with high-density interconnections, with increasingly large area and high granularity
- Cables and services become challenge
  - Material budget! → deteriorating momentum resolution
  - Space, installation complexity, possibility to repair
  - Power consumption
  - ...
- Efforts to minimize material budget:
  - Sensor thinning
  - Low-material PCB
  - Mechanics: CF, truss, foam...
  - Cooling: water, bi-phase CO<sub>2</sub>,...
- Time to reduce cables!

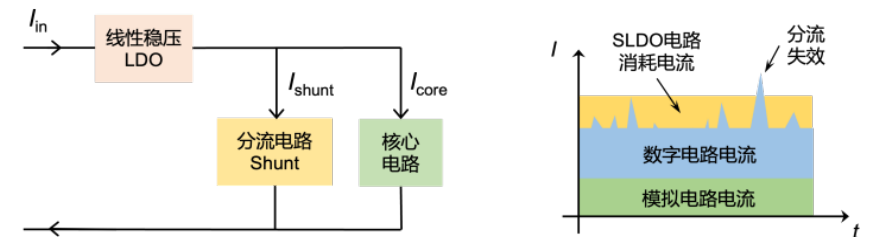
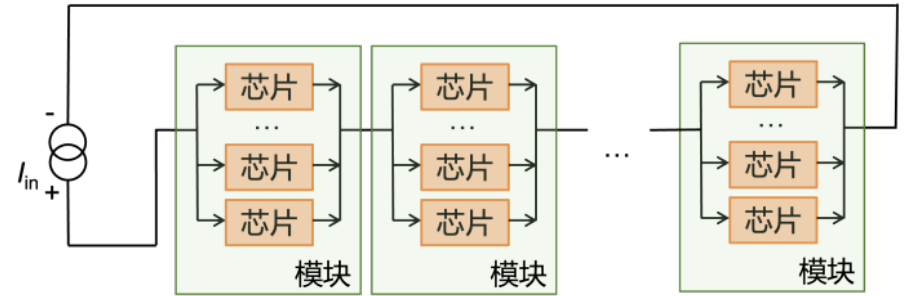
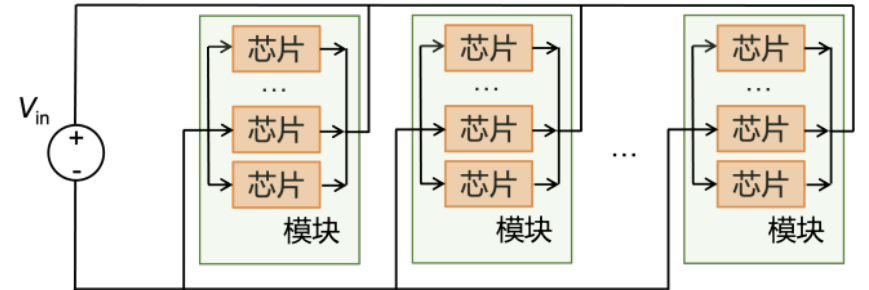


# Goal

- Development of multi-module prototype for CEPC ITK (-like) system with **minimum cables**
- What are cables for? What are the **new technology** could help?
  - Power supply → **Serial powering**
  - Data transmission → **mmWave wireless transmission**

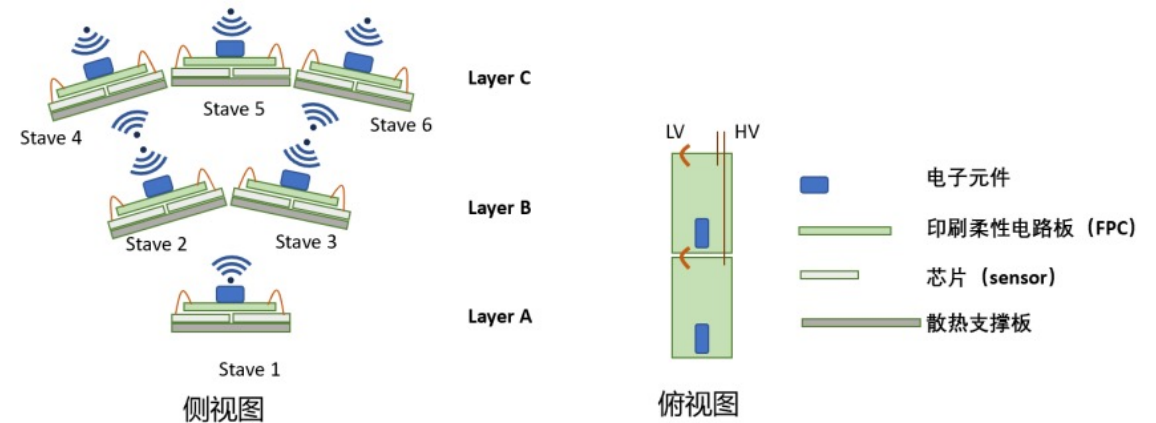
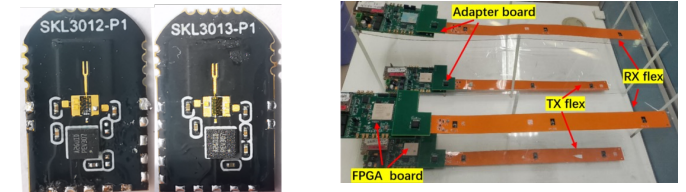
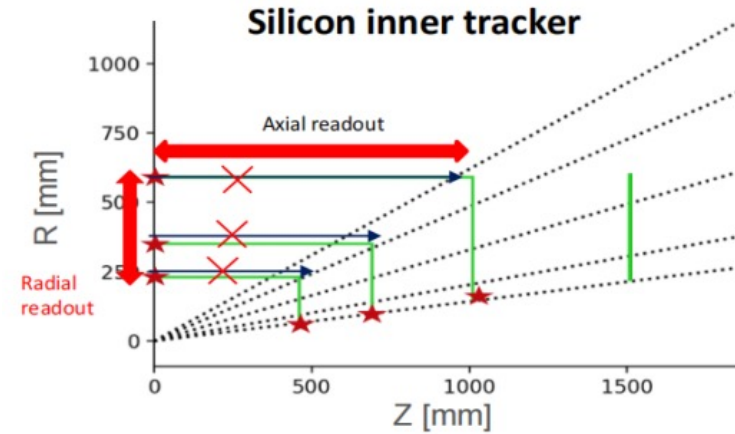
# Serial powering

- As pixel size decrease by  $N$ , cables increase:
  - Parallel power (or +DCDC) by  $N^2$
  - Serial power by  $N$
- Adopted by ATLAS/CMS Phase II trackers
  - Hybrid pixel
- Nicely align with ongoing DRD3 project to develop demonstrator for MAPS-based tracker
- Tasks:
  - Design of SLDO for 55nm process aiming IP for integration into final chip
  - Demonstrator of multi-module tests

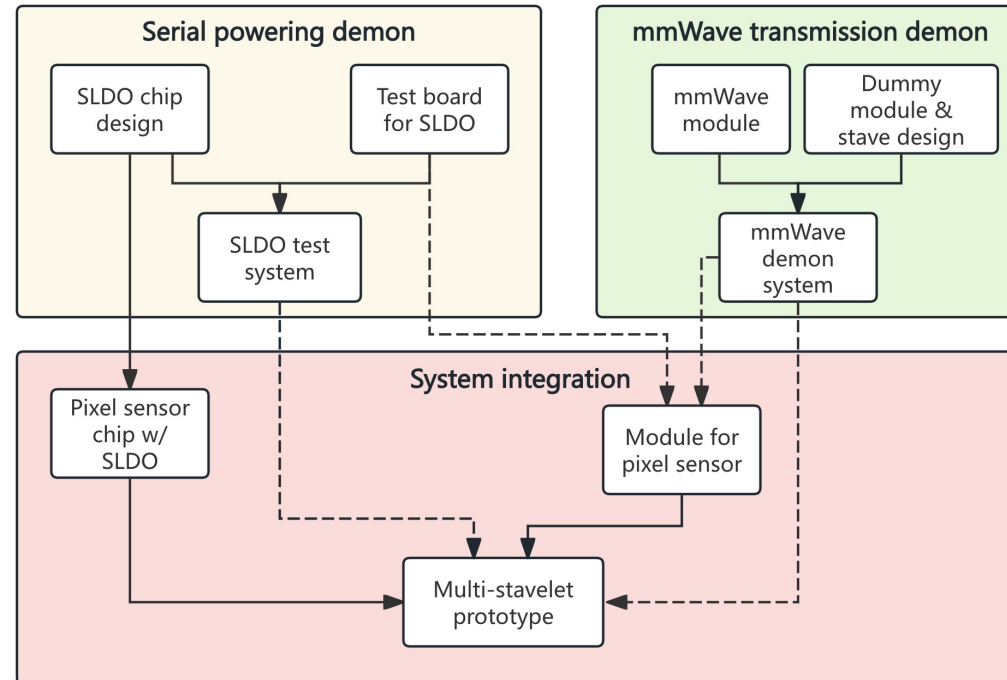


# Wireless transmission

- From axial to radial readout
- Single transmission and receiving modules working for transmission ~10cm
  - See Jun's report at 3<sup>rd</sup> Feb CEPC ITK meeting
- Tasks:
  - Optimization of the antenna module
  - Multi-module demonstration
  - → to show it works in real material, with operation EM environment!



# Project plan



# Project plan ... in bigger picture

