Pixel Vertex Detector Prototype
MOST 2018

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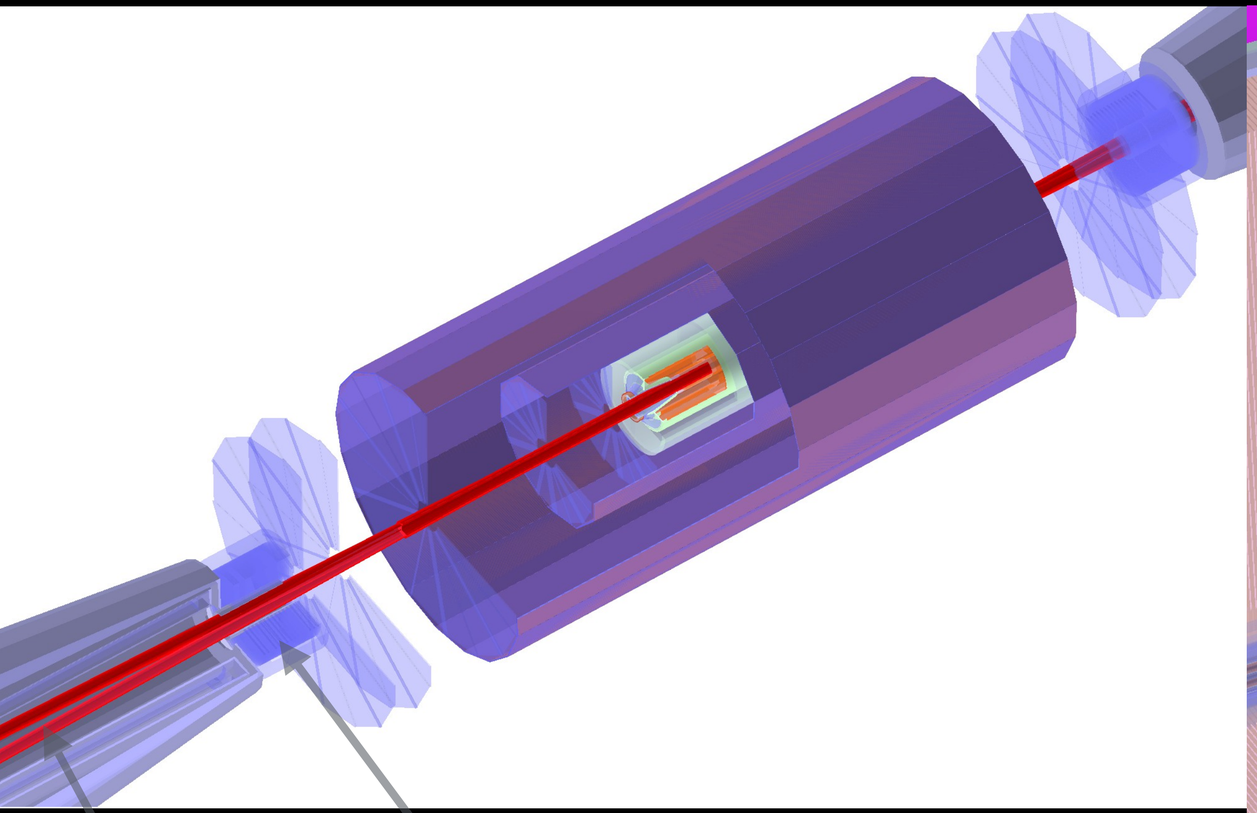
CEPC CDR baseline conceptual detector

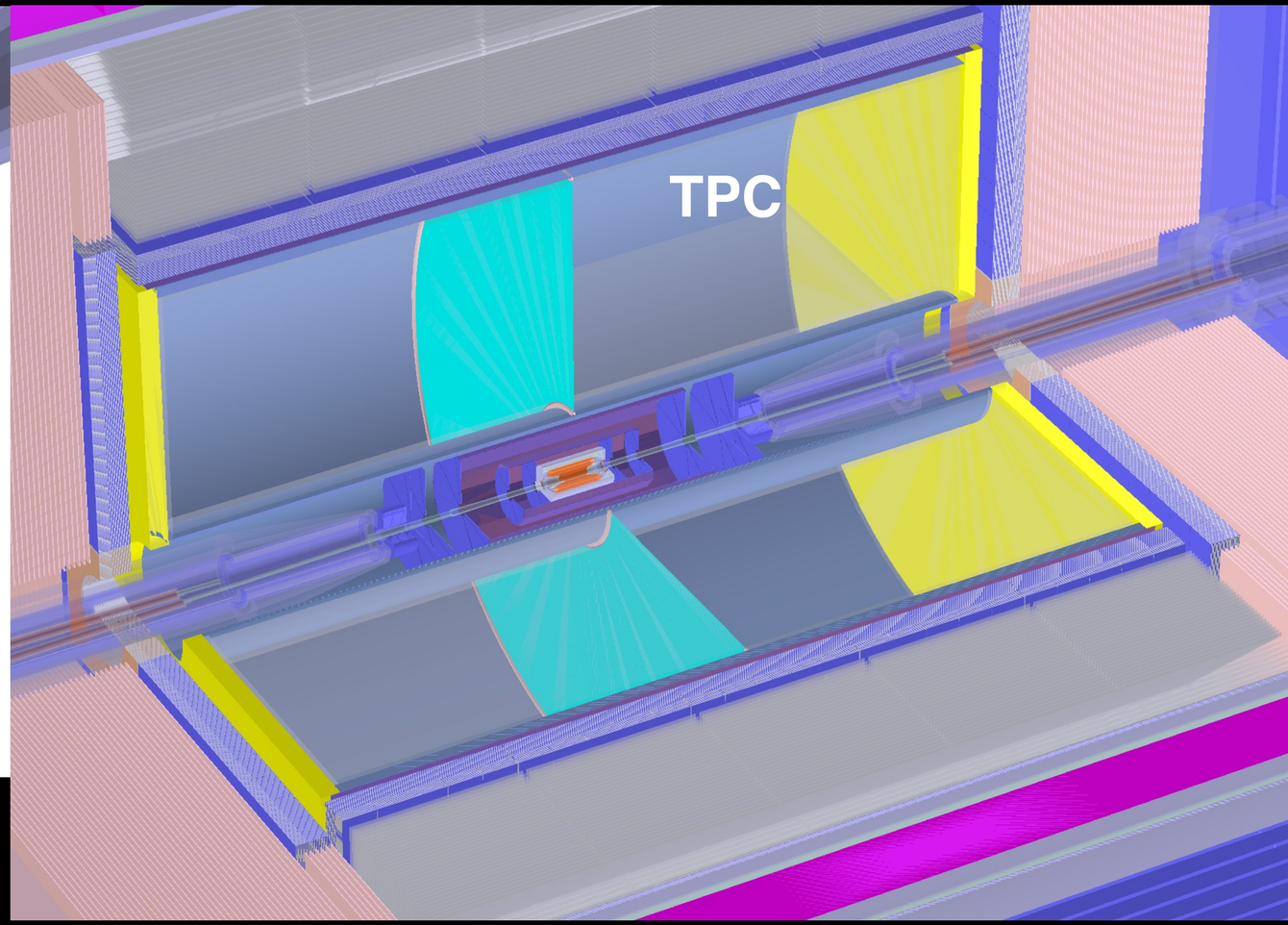


MDI

Lumical

Beam pipes

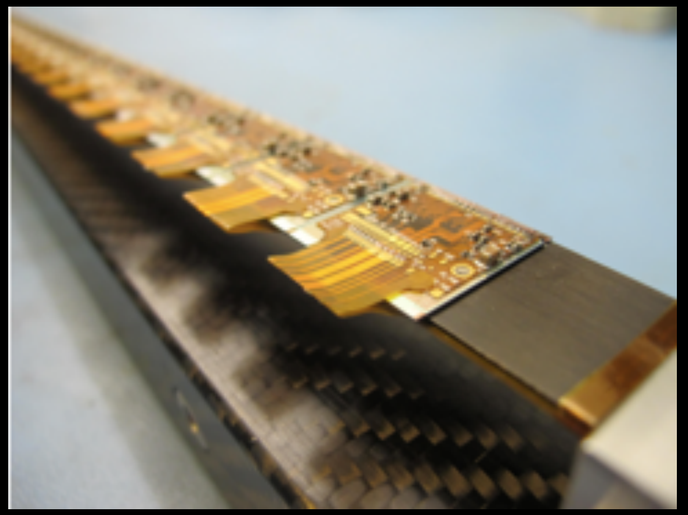
L* = 2.2 m
Cross angle = 33 mrad



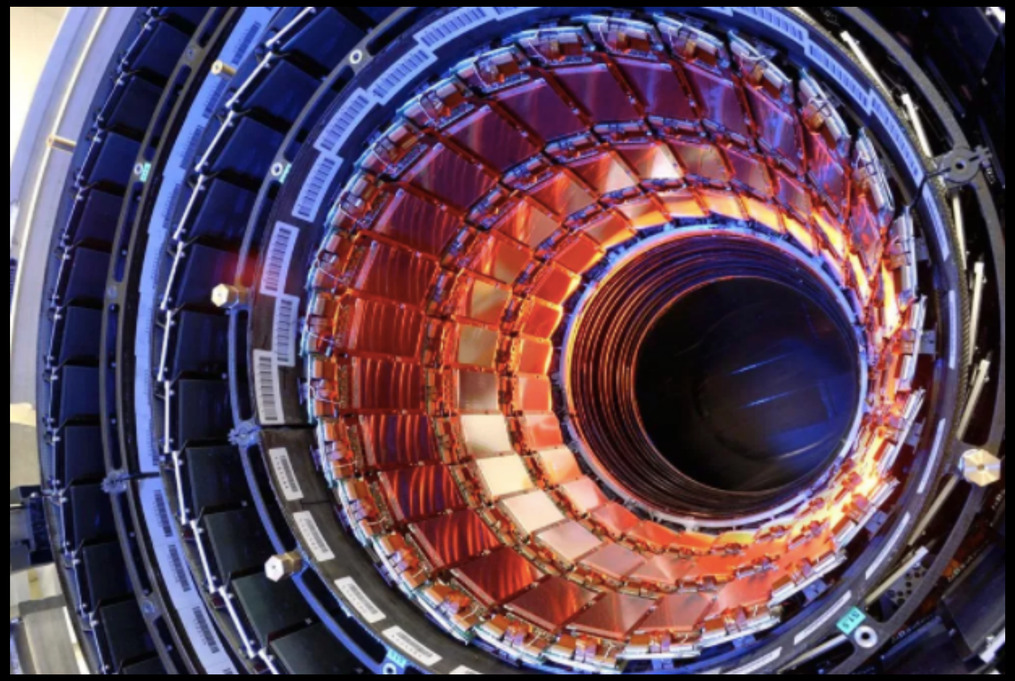
Task 2: Research Goal

- **Produce a world class vertex detector prototype**
  - Spatial resolution 3~5 μm (pixel detector)
  - Radiation hard (>1 MRad)
- **Preliminary design of prototype**
  - Three layer, module ~1 cm × 6-12 cm²

Typical module



Typical tracker



Resolution

ATLAS/CMS upgrade
(15 μm)

Alice upgrade
(8~10 μm)

World leading

This project (3~5 μm)

Task 2: Technical route and schedule

Use CMOS image sensor technology

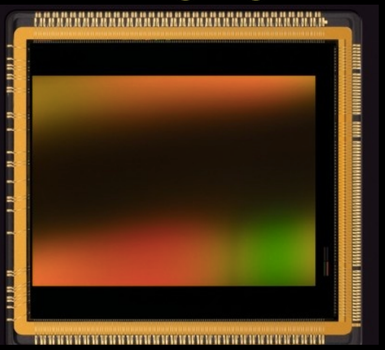
Optimize pixel circuitry, reduce size → High resolution

Special design and latest technology → Radiation hard

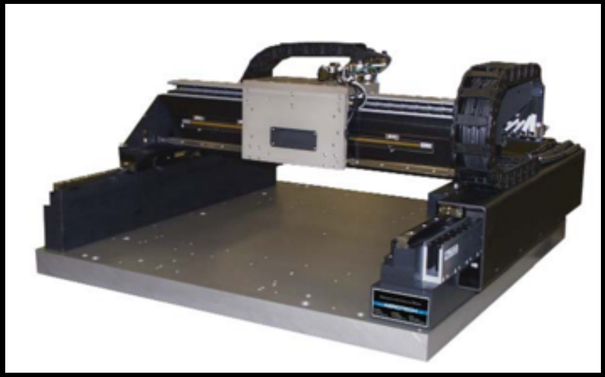
Use carbon fiber, polyamide, graphene, and other light materials for mechanical structure → Low mass

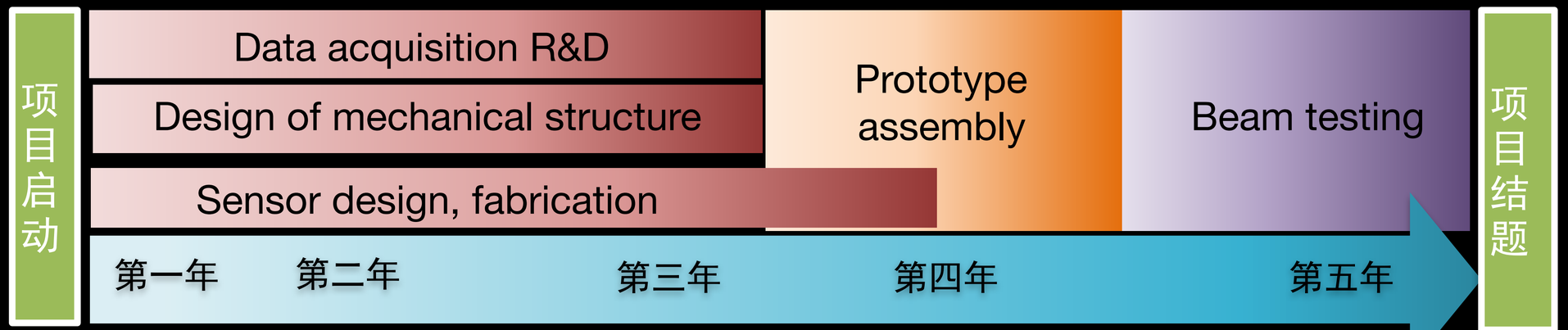
Robot automatic mechanical assembly → High accuracy

CMOS imaging sensor

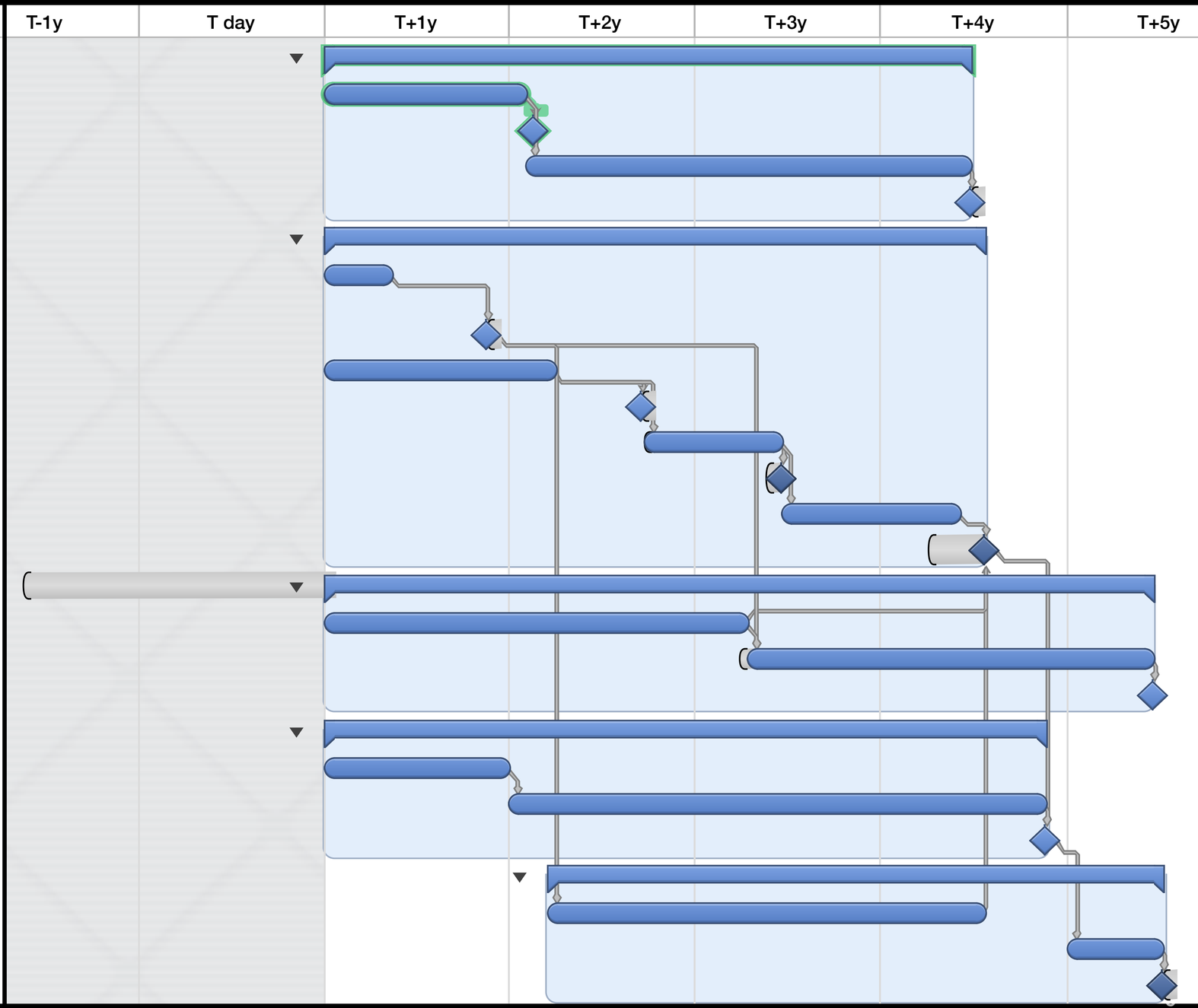


Gantry





Title	Effort
1) Mechanics design	182w
• 1.1) Module structure design	57w
◆ 1.2) Fabricated Module support structure	
• 1.3) Finish the design for pixel detector prototype	125w
◆ 1.4) Manufacture support structure for detector prototype	
2) CMOS sensor	172w 2d
• 2.1) sensor and frontend electronics functional block design	19w
◆ 2.2) First MPW run	
• 2.3) Integrate all functional block	65w
◆ 2.4) Second MPW	
• 2.5) Debug and optimize frontend electronics	38w 2d
◆ 2.6) The third MPW	
• 2.7) Fiinsh design for full area, fully functionality chip	50w
◆ 2.8) First engineering run	
3) DAQ	233w
• 3.1) readout board for MPW runs	119w
• 3.2) the design of DAQ for pixel detector prototype	114w
◆ 3.3) Implement the DAQ design for prototype	
4) Module	203w
• 4.1) Electronics design for module	52w
• 4.2) Assembly procedure	151w
◆ 4.3) Produce the modules	
5) Test beam and irradiation	150w
• 5.1) Testing for MPW runs	123w
• 5.2) beam test and data analysis	27w
◆ 5.3) Publish paper and finish the final report	



第一年（2018.5-2019.4）

Main Milestones

- Task 1:
  - Low-field dipoles: physical and structural design of various small prototypes
  - Preliminary design of vacuum box and bellows, and electrostatic separator
  - Parameter selection of polarization working mode
- Task 2:
  - Preliminary designs of mechanics, readout electronics and ASIC
  - First ASIC MPW submitted
- Task 3:
  - Design of calorimeter prototype, and parameters optimized
  - Batch production of scintillator unit studied and started
  - Design front-end electronics

Outcome

- Annual report

第二年（2019.5-2020.4）

Main Milestones

- Task 1:
  - Manufacture the high-precision low field dipole magnet small experimental prototype
  - Finish engineering design of vacuum box and bellows, and electrostatic separator
  - Simulation program for storage ring polarization is developed
- Task 2:
  - Engineering designs of mechanics structure
  - Second ASIC MPW submitted
- Task 3:
  - Simulate whole HCAL prototype and develop software framework
  - Carry out production of scintillator units
  - Prototype absorber and supporting structure are designed.

Outcome

- Mid-term report

第三年（2020.5-2021.4）

Main Milestones

- Task 1:
  - Smal prototype of magnet fully tested
  - Design of magnet complete
  - Processing of the vacuum tube, the coating experiment device and the shielding bellows are completed
- Task 2:
  - Mechanical structure completed
  - Second ASIC MPW tested
  - ASIC design optimized and completed
- Task 3:
  - Batch production of readout electronics, development of data acquisition system
  - Development of beam test platform and cosmic ray test platform

Outcome

- Annual report

第四年（2021.5-2022.4）

Main Milestones

- Task 1:
  - Completed the formal prototype of the dipole magnet and measurement system
  - Prototypes of vacuum tube and RF bellows completed
  - High pressure experiment was carried out on the electrostatic separator
- Task 2:
  - Silicon wafer processing of large area sensor submitted
  - Assembling and installing the prototype
- Task 3:
  - Integrated calorimeter prototype.
  - Carry out the cosmic ray test of the prototype

Outcome

- Annual report

第五年（2022.5-2023.4）

Main Milestones

- Task 1:
  - Complete the performance test of dipole prototype
  - Complete tests of prototypes of vacuum tube, RF bellows and electrostatic separator
  - High pressure experiment was carried out on the electrostatic separator
- Task 2:
  - Test beam and data analysis
  - Finish assembling of prototype
- Task 3:
  - Test beam and data analysis
  - Finish assembling of prototype

Outcome

- Final report, paper and experimental equipment