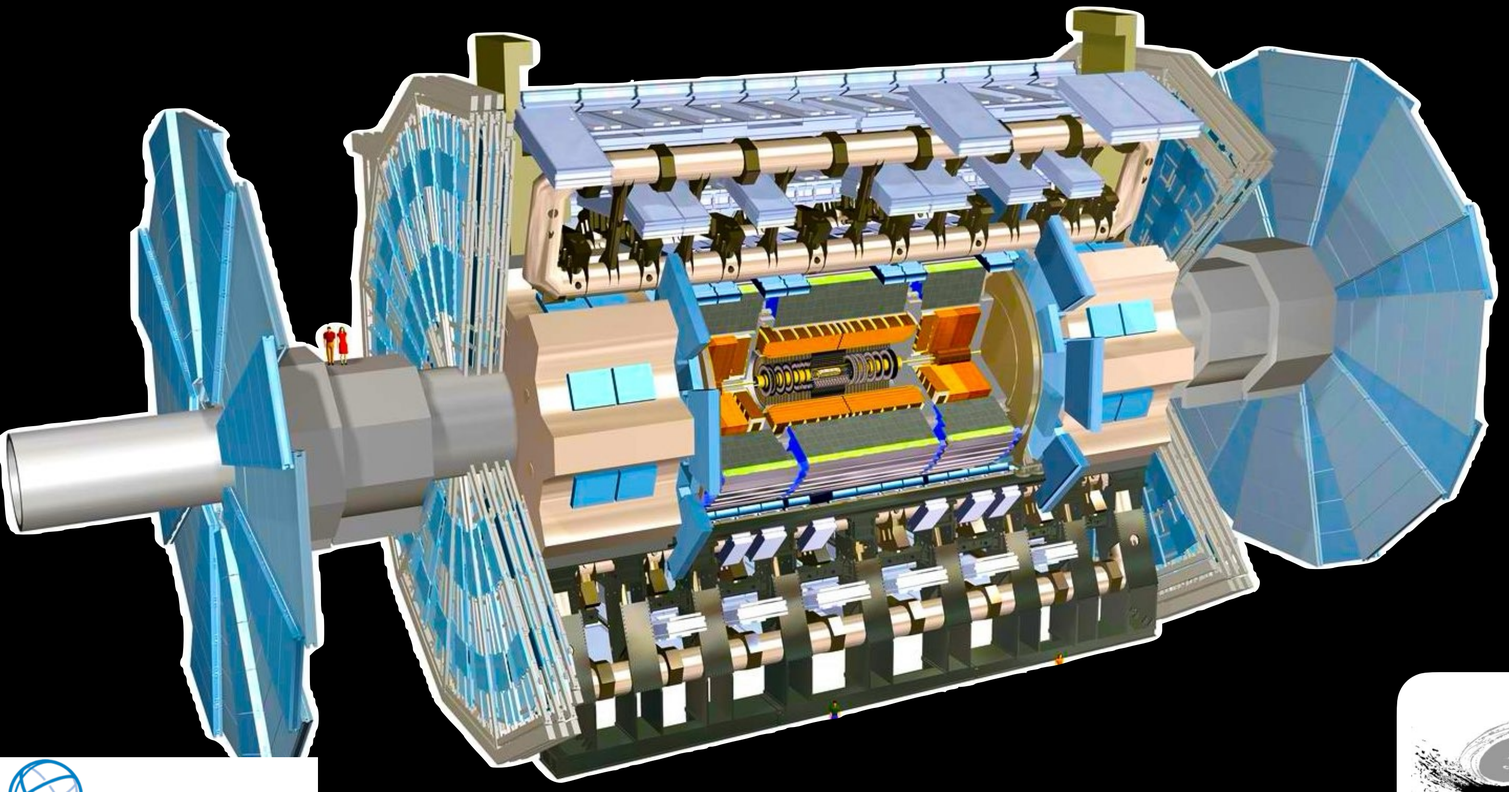
2023年国家重点研发计划“大科学装置前沿研究”

ATLAS 探测器升级

项目实施方案汇报



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2024年07月05日

Items for discussion

1. Review of Morning Meeting Outcome

2. Most Guidelines Regarding Usage of Funds and Organization Matters

3. Project Organizational Issues

Review of Morning Meeting Outcome

Review Comments

- 该项目研究目标明确、研究内容具体、项目任务（课题）分解合理、项目实施方案和年度计划可行、考核指标明确、研究团队具有相关研究背景和丰富的研究经验，预期能够按原计划完成任务。专家组建议：
  - 1. 细化项目完成的指标，包括测试条件，测试方法等；
  - 2. 进一步明确国内外合作单位参与人员的分工与协调。

- The research objectives of the project are clear, the research content is specific, the decomposition of project tasks (topics) is reasonable, the project implementation plan and annual plan are feasible, the assessment indicators are clear, the research team has relevant research background and rich research experience, and it is expected to complete the task according to the original plan. The expert group recommends:

  - 1. Refine the indicators of project completion, including test conditions, test methods, etc.;

  - 2. Further clarify the division of labor and coordination of participants in domestic and foreign cooperation units.

Achievement Presentation and Assessment Methods

	Assessment indicators				Assessment methods and evaluation methods
	Indicator	**Indicator at the time of project initiation**	**Midterm indicator**	**Final assessment indicator**	
Task 1: HGTD	**Time resolution**	Small-area prototype silicon sensors: better than 50 ps	Official silicon sensors for ATLAS upgrade: 30-50 ps	Final detector module: 30-50 ps	Test reports, project peer reviews.
Task 2: Inner tracker	**Spatial resolution of silicon microstrip track detectors**	Prototype module: 25 microns	Pre-production module: 25 microns	Full detector: 25 microns	Test reports, project peer reviews.
	Silicon pixel detector time resolution	Better than 10 ns	Better than 1 ns	Better than 100 ps	Simulation verification and laboratory testing, test reports

In addition: ATLAS organizes peer-reviews, with external reviewers, at each step of each upgrade project. Such reports, will provide an additional basis for each task progress and achievement assessment

Achievement Presentation and Assessment Methods

	Assessment indicators				Assessment methods and evaluation methods
	Indicator	**Indicator at the time of project initiation**	**Midterm indicator**	**Final assessment indicator**	
Task 3: **Muon Detector**	**Counting rate**	Prototype detector: 1 kHz/cm2	Pre-production detector: 1 kHz/cm2	RPC mounted to ATLAS: >1 kHz/cm2	Experimental test or acceptance by ATLAS
	Efficiency	RPC Prototype: > 95%	Pre-production detectors: >95%	RPC mounted to ATLAS: > 95%.	Experimental test or acceptance by ATLAS
	Time Resolution	Prototype detector: 1 ns	Pre-production detector: 1 ns	RPC installed into the ATLAS experiment < 1 ns	Experimental test or acceptance by ATLAS

In addition: ATLAS organizes peer-reviews, with external reviewers, at each step of each upgrade project. Such reports, will provide an additional basis for each task progress and achievement assessment

Most Guidelines Regarding Usage of Funds and Organization Matters

Project Organization Issues: Funding Issues

- Check slides from MOST on Indico page
  - https://indico.ihep.ac.cn/event/22764/timetable/#8-discussion-among-project-mem
- Funds received: 48.45%
  - Already allocated to institutes
- Need to spend the money
- Cannot use funds for other projects!

Project Organizational Issues

Project management organization

- **MOST Project Responsibility Expert**
  - **Ma Yugang** (Shanghai Institute of Applied Physics, CAS) (Excused today)

- **Expert Team (9 people)**
  - **Li Ji** (Institute of High Energy Physics, CAS) (Chair)
  - **Xiang Dao** (Shanghai Jiao Tong University) (MOST expert team)
  - **Li Qiang** (Peking University)
  - **Li Zhankui** (Institute of Modern Physics, CAS)
  - **Liu Jianbei** (University of Science and Technology of China)
  - **Sun Xiangming** (Central China Normal University)
  - **Zhou Daicui** (Central China Normal University)
  - **Heng Yuekun** (Institute of High Energy Physics, CAS)
  - **Ouyang Qun** (Institute of High Energy Physics, CAS)

Project leader — Management responsibilities

- Edit and sign project task book, review project task book;
- Establish a project management office and a project expert group based on the project leading institute;
- Formulate the project research plan, make sure the academic direction and research focus of the project;
- Carry out academic and technical communication and integration among tasks, and promote data sharing;
- Review the annual summary, technical report and other materials, compile and report project information, achievements and other progress reports;
- Develop project publicity plans and programs to enhance the impact of the project;
- Formulate the project (task) implementation management system, formulate the approval system of funding allocation process;
- Propose major adjustment suggestions for projects (tasks), including adjustment or change of research objectives, contents, personnel and funding;
- Compile the mid-term assessment and annual report of the project, and cooperate with the completion of the mid-term assessment and acceptance of the tasks;
- Cooperate with MOST to complete the project assessment and acceptance;
- Complete other tasks entrusted by MOST

Project management organization

- **Project office**
  - **Contact person：Zhaoru Zhang**
  - **Academic assistant：Zhijun Liang (Associate professor)**
  - **Financial assistant：Zhaoru Zhang**
  - **Contact person of Task 1：Zhijun Liang（task leader)**
    - **Financial assistant: Ran Lou**
  - **Contact person of Task 2：Xin Shi（task leader)**
    - **Financial assistant: Ran Lou**
  - **Contact person of Task 1：Yongjie Sun（task leader)**
    - **Financial assistant: Gongxiu Dong**

- **Project implementation scheme is finalized**

Project management organization

- **Communication and Inspection Mechanisms**
  - **Exchange mechanism:**
    - Strong integration in the ATLAS global activities, meetings and workshops
      - Regular international meetings being held weekly on diverse topics
    - Weekly internal task-level meetings to coordinate evolution of project
    - Quarterly meeting videoconference meetings on the global project
  - **Special meetings**
    - Conduct academic exchanges
      - ATLAS International HGTD Workshop at IHEP, next week
      - Should we plan for other events?
        - Workshops can easily be organized in January at Hong Kong
    - Annual meetings: including mid-term meeting and projection completion meeting

Project management organization

- **Communication and Inspection Mechanisms**

  - **Documentation archiving:**
    - ATLAS Collaboration provides excellent tools for documentation archiving:
      - Indico: Meetings and minutes
      - EDMS database: Specifications and long-term technical documentation archiving
      - CDS: Internal reports and technical working reports archiving

    - Establish a project shared web area in IHEP for sharing and archiving documentation locally

Assessment Indicators of Science and Technology Report

序号	Report type	数量	Submission time	公开类别及时限
1	Annual technical progress report of project	1	December 2024	公开
2	Mid-project technical progress report	1	Before the mid-term examination	公开
3	Annual technical progress report of project	1	December 2026	公开
4	Annual technical progress report of project	1	December 2027	公开
5	Final technical progress report of the project	1	December 2028	公开

Risk Analysis (风险分析)

The project is challenging and a key contribution to the ATLAS upgrade

- **The overall risk of the project is low**
  - The project team has rich experience in research and development
  - The research unit is supported by multiple detector research and development platforms
- **The two main risks (两个最主要的风险)**
  - 风险1: **Degradation of international relations** prevent access to some advanced technologies from abroad (e.g. ASICs)
    - **Mitigation**: Collaborate with international colleagues to execute some of the tasks abroad (e.g. tracker modules construction at RAL)
  - 风险2: **Delay of LHC Upgrade Project** — the ATLAS upgrade is organized in a large international collaboration involving many institutions with interconnected work with centralized overall planning, so delays can occur due to issues outside our control
    - **Mitigation**: Work with ATLAS management to minimize impact to the project. The large international team will ensure that the project is feasible even if delays occur.

Risk Analysis

- Delay of LHC Project
  - Type: policy
  - Risk Level: middle
  - Mitigation plan: keep communication with CERN and ATLAS, reduce the uncertainty of LHC to this project
- ASICs for ITk not able to import to China
  - Type: policy
  - Risk level: middle
  - Mitigation plan: send people to RAL in UK to complete the module assembly task
- Timing pixel front end electronics not able to import to China
  - Type: policy
  - Risk level: middle
  - Mitigation plan: send people to US or CERN to continue the study. Investigate technology based on China

Extra Slides

Guidance:“大科学装置前沿研究”重点专项2023年度项目申报指南

1. 粒子物理

1.3. ATLAS探测器升级 （共性关键技术）

研究内容:

按照与 ATLAS 合作协议规定，完成硅径迹探测 器、缪子谱仪和高颗粒度时间探测器相关研发、制造和安装等工 作。针对 LHC 高能量、高亮度的升级，改造 ATLAS 实验的粒子 探测器系统，开展相关探测器研制、建造和运行,提升 ATLAS 实 验对物理过程的灵敏度。

主要包括:

硅径迹探测器模块建造，径 迹探测器系统集成和运行;缪子谱仪阻性板探测器及相关电子学的研制和运行;高颗粒度时间探测器研发和建造;新一代有时间 信息的硅像素探测器的研发。

考核指标:硅微条径迹探测器空间分辨率达到 25 微米。阻性板室探测器:计数率达 1 kHz/cm2，探测效率高于 95%，时间分 辨率好于 1 ns。高颗粒度时间探测器:研发硅传感器、前端电子 学、探测器模块组装等，研制出高时间分辨率的探测器模块与前 端读出电路板，其时间分辨率好于 50 皮秒。新一代有时间信息 的硅像素探测器:研发时间分辨率在 100 皮秒以下的抗辐照传感 器及前端电子学。

Guidance: “Frontier Research of Large Scientific Devices" Key Special 2023 Project Application Guide

1. Particle Physics

1.3. ATLAS Detector upgrade (common key technology)

Research content:

In accordance with the provisions of the cooperation agreement with ATLAS, complete the research and development, manufacturing and installation of silicon track detectors, muon spectrometers and high-granularity time detectors. For the upgrade of LHC high energy and high luminosity, transform the particle detector system of ATLAS experiments, carry out the development, construction and operation of related detectors, and improve the sensitivity of ATLAS experiments to physical processes.

Mainly including:

Construction of silicon track detector module, integration and operation of track detector system; development and operation of resistance plate detector and related electronics; research and development and construction of high granularity time detector; research and development of a new generation of silicon pixel detector with time information.

Assessment index: The spatial resolution of the silicon micro strip track detector reaches 25 microns. Resistive chamber detector: the counting rate is 1 kHz/cm2, the detection efficiency is higher than 95%, and the time resolution is better than 1 ns. High granularity time detector: develop silicon sensors, front-end electronics, detector module assembly, etc., and develop a high-time-resolution detector module and front-end readout circuit board, with a time resolution of more than 50 pics. A new generation of silicon pixel detectors with time information: develop anti-irradiation sensors and front-end electronics with a time resolution of less than 100 picoseconds.

Assessment Indicators (考核指标)

对应的课题	考核指标				考核方式（方法）及评价手段
	指标名称	立项时已有指标值/状态	中期指标值/状态	完成时指标值/状态	
课题 1：ATLAS 实验高粒度时间探测器升级 HGTD	时间分辨率	小面积原型硅传感器时间分辨率好于 50 皮秒	为 ATLAS 升级研制出正式的硅传感器，时间分辨率达到 30-50 皮秒	探测器模块时间分辨率达到 30-50 皮秒	测试报告、同行评审。
课题 2：ATLAS 实验内径迹探测器升级：Tracker	硅微条径迹探测器空间分辨率	原型模块 25 微米	预生产模块 25 微米	径迹探测器 25 微米	测试报告、同行评审。
	硅像素探测器时间分辨率	好于 10ns	好于 1ns	好于 100ps	仿真验证和实验室测试，测试报告

对应的课题	考核指标				考核方式（方法）及评价手段
	指标名称	立项时已有指标值/状态	中期指标值/状态	完成时指标值/状态	
课题 3：ATLAS 实验缪子探测器升级 Muons	计数率	原型探测器 1 kHz/cm2	预生产探测器 1 kHz/cm2	安装到 ATLAS 实验的 RPC：>1 kHz/cm2	实验测试或由 ATLAS 验收
	探测效率	RPC 样机>95%	预生产探测器>95%	安装到 ATLAS 实验的 RPC >95%	实验测试或由 ATLAS 验收
	时间分辨	原型探测器 1 ns	预生产探测器 1 ns	安装到 ATLAS 实验的 RPC <1 ns	实验测试或由 ATLAS 验收

Chinese CORE contribution to ATLAS Phase-II Detector Upgrade

ATLAS	ITk	HGTD	Muons	NSW (phase I)	Total (kCHF)
kCHF	2043	2100	1028	733	5904
%	3.4%	21%	3.6%	6.5%	2.3%

Focus on key projects to make a sizable contribution with limited resources

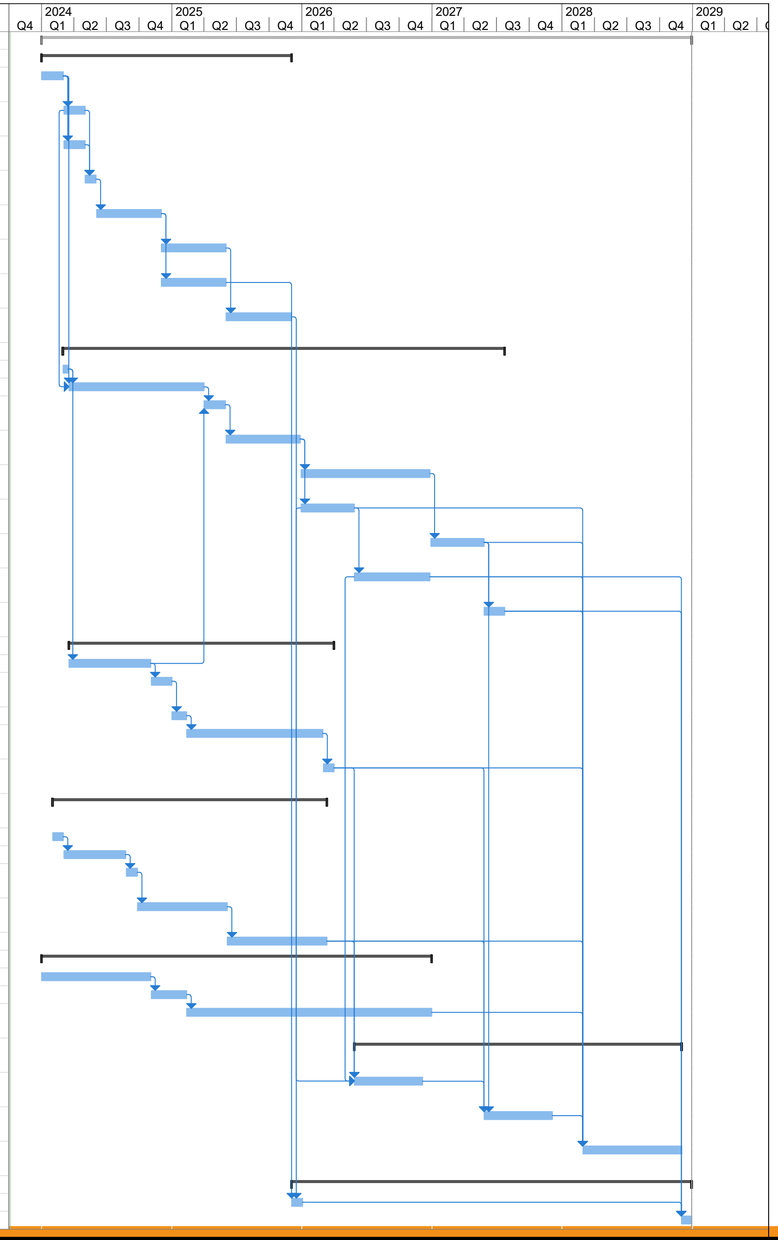
Chinese contribution to upgrades of the order of ~2.3% of total cost

Percentage of Chinese authorship on physics analysis papers ~4.3%

Detailed schedule

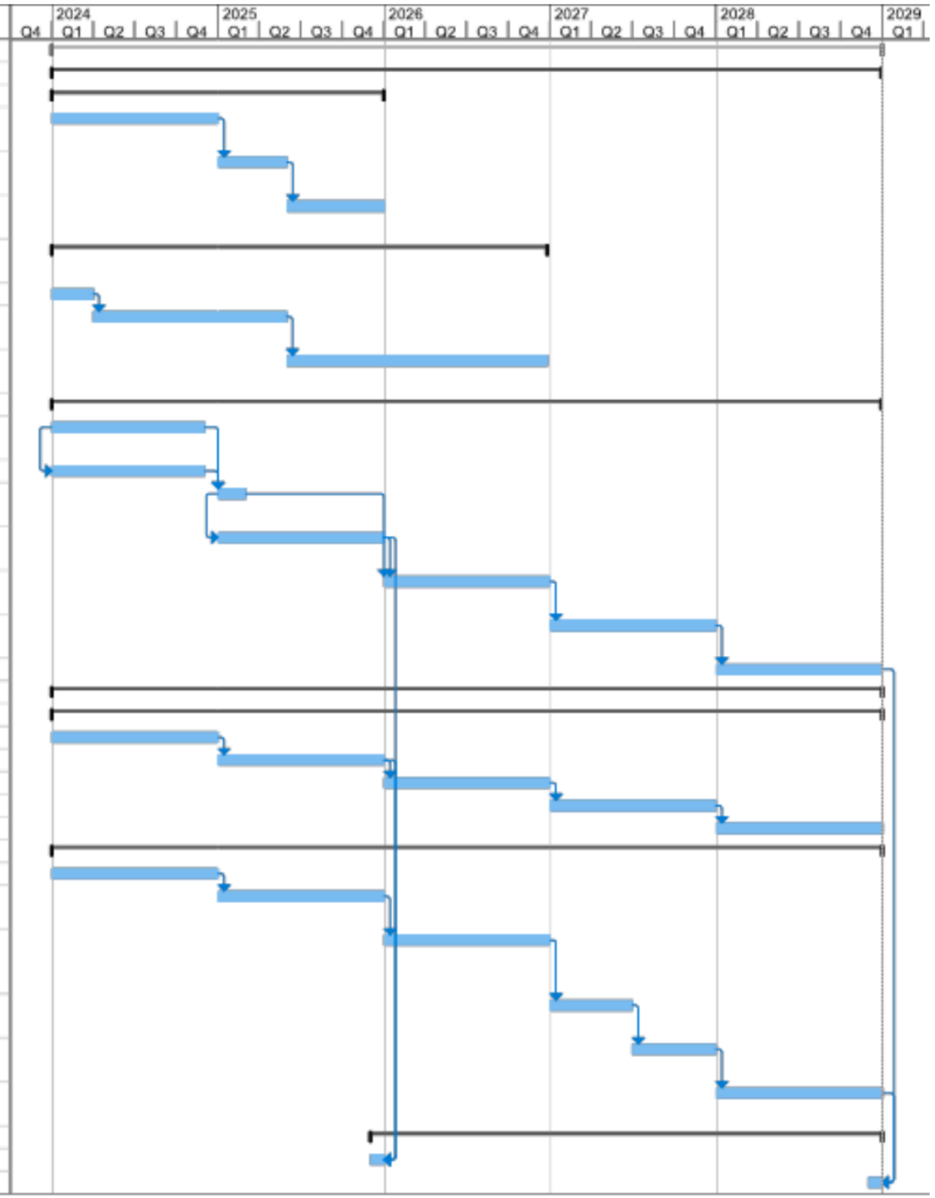
Timing Detector Detailed Schedule

ID	Task Name	Text1	Duration	Start	Finish
0	**1）高粒度时间探测器**	**1) High granularity time detector**	**1305 days**	**2024/1/1**	**2028/12/29**
1	**1.1）传感器**	**1.1) sensor**	**502 days**	**2024/1/1**	**2025/12/2**
2	1.1.1）预生产研制（第一批）	1.1.1) pre production development (the first batch)	45 days	2024/1/1	2024/3/1
3	1.1.2）预生产研制（第二批）	1.1.2) pre production development (the second batch)	43 days	2024/3/4	2024/5/1
4	1.1.3）预生产传感器性能测试	1.1.3) pre production sensor performance test	43 days	2024/3/4	2024/5/1
5	1.1.4）预生产传感器评审（PRR）	1.1.4) pre production sensor review (PRR)	22 days	2024/5/2	2024/6/1
6	1.1.5）正式生产研制（第一批）	1.1.5) formal production and development (the first batch)	130 days	2024/6/3	2024/12/1
7	1.1.6）正式生产研制（第二批）	1.1.6) formal production and development (the second batch)	130 days	2024/12/2	2025/6/1
8	1.1.7）正式生产传感器性能测试（第一批）	1.1.7) performance test of formally produced sensors (the	130 days	2024/12/2	2025/6/1
9	1.1.8）正式生产传感器性能测试（第二批）	1.1.8) performance test of formally produced sensors (the	132 days	2025/6/2	2025/12/2
10	**1.2）探测器模块**	**1.2) detector module**	**886 days**	**2024/3/1**	**2027/7/23**
11	1.2.1）原型模块评审（FDR）	1.2.1) prototype module review (FI	11 days	2024/3/1	2024/3/15
12	1.2.2）预生产研制	1.2.2) pre production development	271 days	2024/3/18	2025/3/31
13	1.2.3）预生产的模块评审（PRR）	1.2.3) pre production module review (PRR)	44 days	2025/4/1	2025/5/30
14	1.2.4）模块正式研制（第一批）	1.2.4) formal development of modules (the first batch)	150 days	2025/6/2	2025/12/26
15	1.2.5）模块正式研制（第二批）	1.2.5) formal development of modules (the second batch)	260 days	2025/12/29	2026/12/25
16	1.2.6）多模块探测器单元研制（第一批）	1.2.6) development of multi module detector unit (the first	108 days	2025/12/29	2026/5/27
17	1.2.7）多模块探测器单元研制（第二批）	1.2.7) development of multi module detector unit (the second	108 days	2026/12/28	2027/5/26
18	1.2.8）探测器模块性能测量（第一批）	1.2.8) performance measurement of detector module (the first	152 days	2026/5/28	2026/12/25
19	1.2.9）探测器模块性能测量（第二批）	1.2.9) performance measurement of detector module (the second	42 days	2027/5/27	2027/7/23
20	**1.3）柔性电路尾板**	**1.3) flexible circuit tail board**	**532 days**	**2024/3/18**	**2026/3/31**
21	1.3.1）预生产研制	1.3.1) pre production development	165 days	2024/3/18	2024/11/1
22	1.3.2）预生产柔性板测试	1.3.2) pre production flexible plate test	42 days	2024/11/4	2024/12/31
23	1.3.3）预生产的评审（PRR）	1.3.3) pre production review (PRR)	29 days	2025/1/1	2025/2/10
24	1.3.3）正式生产研制	1.3.3) formal production and development	274 days	2025/2/11	2026/2/27
25	1.3.4）正式生产柔性板测试	1.3.4) formal production flexible plate test	22 days	2026/3/2	2026/3/31
26	**1.4）外围电子学电路板**	**1.4) peripheral electronics circuit board**	**550 days**	**2024/2/1**	**2026/3/11**
27	1.4.1）原型模块评审（FDR）	1.4.1) prototype module review (FI	22 days	2024/2/1	2024/3/1
28	1.4.2）预生产研制	1.4.2) pre production development	125 days	2024/3/4	2024/8/23
29	1.4.3）预生产的模块评审（PRR）	1.4.3) pre production module review (PRR)	23 days	2024/8/26	2024/9/25
30	1.4.4）正式生产研制	1.4.4) formal production and development	180 days	2024/9/26	2025/6/4
31	1.4.5）电路板测试	1.4.5) circuit board test	200 days	2025/6/5	2026/3/11
32	**1.5）高压电源**	**1.5) high voltage power supply**	**783 days**	**2024/1/1**	**2026/12/30**
33	1.5.1）预生产研制	1.5.1) pre production development	220 days	2024/1/1	2024/11/1
34	1.5.2）预生产的评审（PRR）	1.5.2) pre production review (PRR)	71 days	2024/11/4	2025/2/10
35	1.5.3）正式生产研制	1.5.3) formal production and development	492 days	2025/2/11	2026/12/30
36	**1.6）探测器整体联调**	**1.6) overall joint commissioning of detector**	**657 days**	**2026/5/28**	**2028/12/1**
37	1.6.1）探测器单元安装（第一批）	1.6.2) installation of detector unit (the first batch)	137 days	2026/5/28	2026/12/4
38	1.6.2）探测器单元安装（第二批）	1.6.2) detector unit installation (the second batch)	137 days	2027/5/27	2027/12/3
39	1.6.3）探测器整体联调	1.6.3) overall joint commissioning of detector	200 days	2028/2/28	2028/12/1
40	**1.7）项目文档**	**1.7) project documents**	**803 days**	**2025/12/3**	**2028/12/29**
41	1.7.1）项目中期测试报告	1.7.1) Interim test report of the proje	22 days	2025/12/3	2026/1/1
42	1.7.1）项目结题报告	1.7.1) project conclusion report	21 days	2028/12/1	2028/12/29



Silicon Tracker Detailed Schedule

ID	Task Name	Text1	Duration	Start	Finish
0	硅径迹探测器	**Silicon track detector**	**1305 days**	**2024/1/1**	**2028/12/31**
1	**1**）硅微条探测器	**1) Silicon micro strip detector**	**1305 days**	**2024/1/1**	**2028/12/29**
2	**1.1**）传感器与读出芯片	**1.1) sensor and readout chip**	**523 days**	**2024/1/1**	**2025/12/31**
3	1.1.1）传感器与读出芯片关键性能测试	1.1.1) key performance test of sensor and readout chip	262 days	2024/1/1	2024/12/31
4	1.1.2）传感器、芯片在不同辐照条件下的性能表现	1.1.2) performance of sensors and chips under different irradiation conditions	108 days	2025/1/1	2025/5/31
5	1.1.3）参与批量生产阶段可靠性测试	1.1.3) participate in reliability test in batch production stage	153 days	2025/6/2	2025/12/31
6	**1.2**）硅微条探测器研制	**1.2) development of silicon micro strip detector**	**780 days**	**2024/1/1**	**2026/12/25**
7	1.2.1) 模块站点考核	1.2.1) module site assessment	65 days	2024/1/1	2024/3/31
8	1.2.2) 制备长硅微条模块	1.2.2) preparation of long silicon micro strip module	305 days	2024/4/1	2025/5/30
9	1.2.3) 制备短硅微条模块	1.2.3) preparation of short silicon micro strip module	410 days	2025/6/2	2026/12/25
10	**1.3**）系统集成	**1.3) system integration**	**1305 days**	**2024/1/1**	**2028/12/29**
11	1.3.1) 多桶板小系统联调测试	1.3.1) joint commissioning test of multi barrel small system	240 days	2024/1/1	2024/12/1
12	1.3.2) 搭建桶板接收测试系统	1.3.2) build a barrel receiving test system	240 days	2024/1/1	2024/12/1
13	1.3.3) 接收、测试运往 CERN 的首批桶板	1.3.3) receive and test the first batch of barrels shipped to CERN	43 days	2025/1/1	2025/3/1
14	1.3.4) 中国生产的硅探测器模块加载到 RAL 的桶板上	1.3.4) the silicon detector module made in China is loaded on the barrel of ral	261 days	2025/1/1	2025/12/31
15	1.3.5) 完成测试后运往 CERN 安装点	1.3.5) transport to CERN installation site after testing	261 days	2026/1/1	2026/12/31
16	1.3.6) 封闭桶部探测器，联调测试	1.3.6) closed barrel detector, joint commissioning test	261 days	2027/1/1	2027/12/31
17	1.3.7) 早期运行	1.3.7) early operation	260 days	2028/1/3	2028/12/29
18	**2**）时间像素探测器	**2) Time pixel detector**	**1305 days**	**2024/1/1**	**2028/12/31**
19	**2.1**）传感器	**2.1) sensor**	**1305 days**	**2024/1/1**	**2028/12/31**
20	2.1.1）整体架构设计	2.1.1) overall architecture design	262 days	2024/1/1	2024/12/31
21	2.1.2）第一版设计	2.1.2) first edition design	261 days	2025/1/1	2025/12/31
22	2.1.3）第一版测试	2.1.3) first version test	261 days	2026/1/1	2026/12/31
23	2.1.4）第二版设计	2.1.4) second edition design	261 days	2027/1/1	2027/12/31
24	2.1.5）性能评估	2.1.5) performance evaluation	260 days	2028/1/3	2028/12/31
25	**2.2**）电子学	**2.2) Electronics**	**1305 days**	**2024/1/1**	**2028/12/31**
26	2.2.1）整体架构设计	2.2.1) overall architecture design	262 days	2024/1/1	2024/12/31
27	2.2.2）第一版原型验证电路设计	2.2.2) design of the first version prototype verification circuit	261 days	2025/1/1	2025/12/31
28	2.2.3) 第一版原型验证电路性能的仿真验证	2.2.3) simulation verification of circuit performance in the first version of prototype verification	261 days	2026/1/1	2026/12/31
29	2.2.4）第一版性能评估测试	2.2.4) first edition performance evaluation test	129 days	2027/1/1	2027/6/30
30	2.2.5) 第二版电路设计和仿真	2.2.5) circuit design and Simulation of the second edition	132 days	2027/7/1	2027/12/31
31	2.2.6）完成电子学性能评估测试	2.2.6) complete the electronic performance evaluation test	260 days	2028/1/3	2028/12/31
32	**3**）项目文档	**3) Project documentation**	**804 days**	**2025/12/2**	**2028/12/31**
33	3.1）项目中期测试报告	3.1) Interim test report of the project	22 days	2025/12/2	2025/12/31
34	3.2）项目结题报告	3.2) project conclusion report	21 days	2028/12/1	2028/12/31



Schedule – Strip Detector

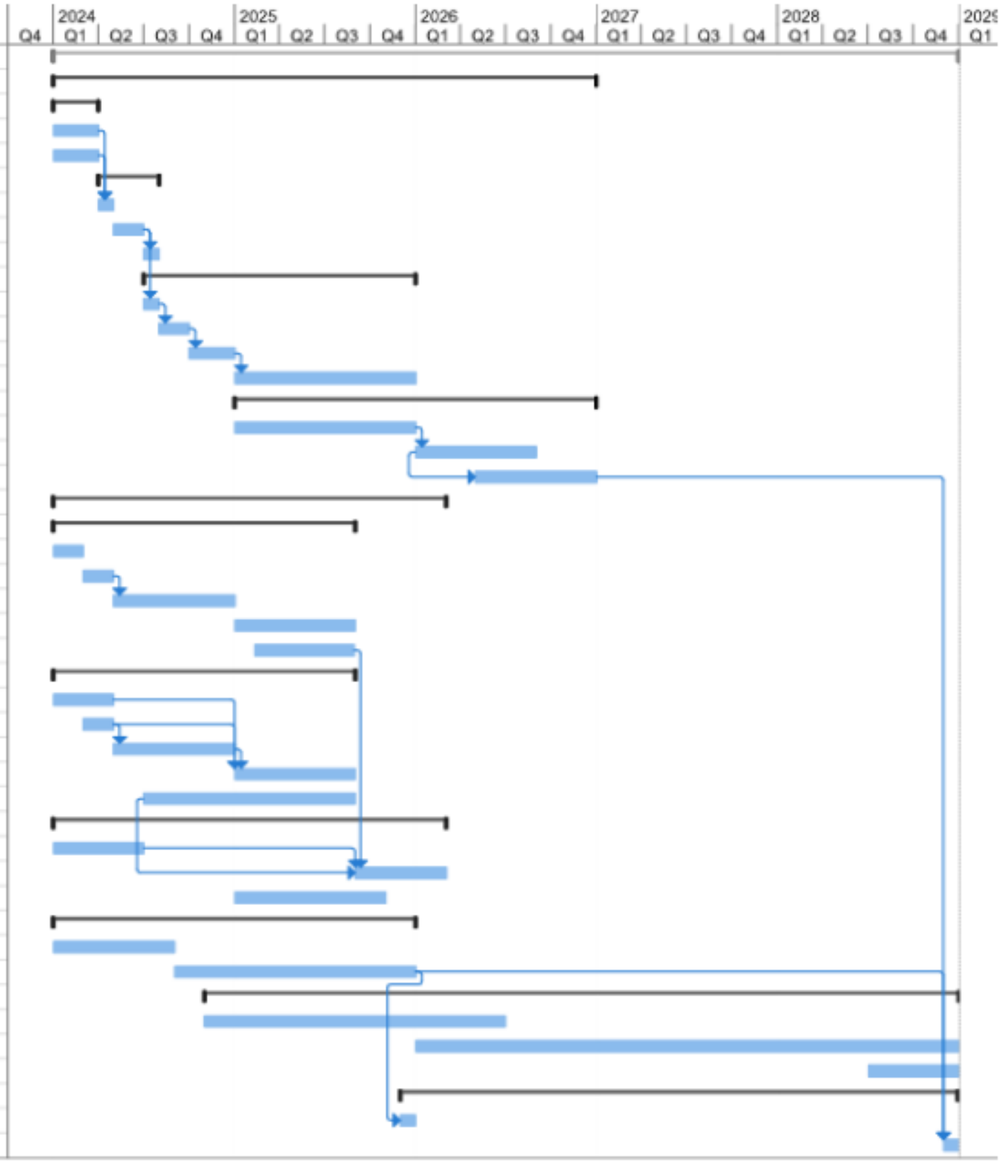
- 2024: Finish the sensor and ASICs key evaluation test; pass the site qualification, start producing long strip module; complete multi-stave small system test at RAL, start system integration such as stave reception at CERN
- 2025: Evaluate the performance of strip sensor and ASICs after irradiation, participate in the reliability test during production; produce long strip module; receive, test and ship the barrel stave to CERN, complete the workflow.
- 2026: Complete the long strip module production, start the short strip module production; modules make in China will be loaded on stave at RAL and send to CERN to integrate onto barrel strip tracker
- 2027: Complete the short strip module production; barrel strip tracker test with different stage.
- 2028: Complete the strip tracker system test, participate the early run.

Schedule – Timing Pixel Detector

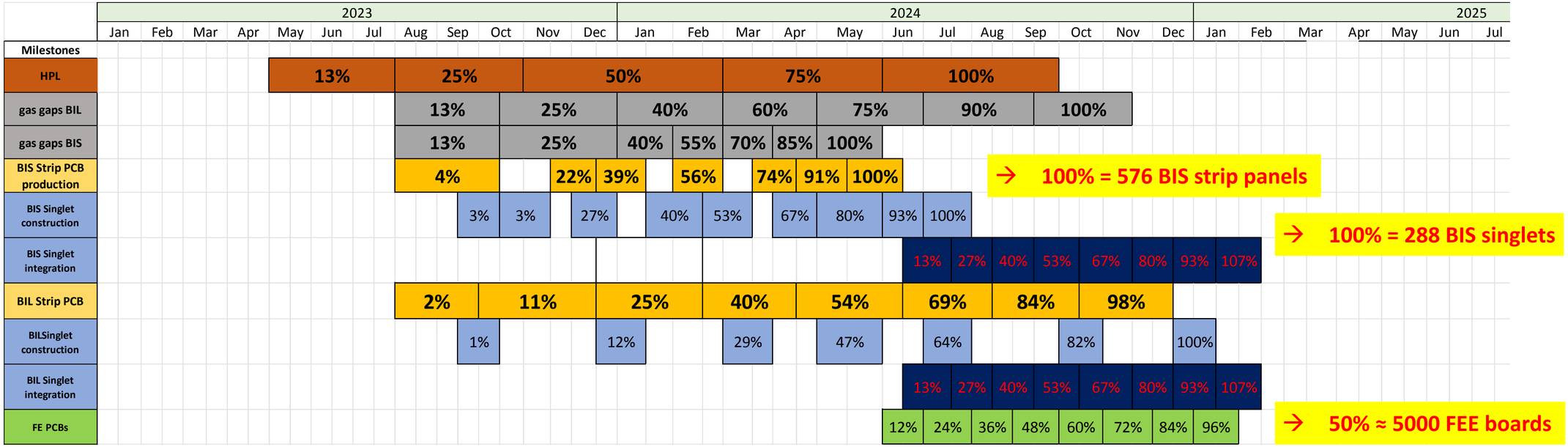
- 2024: Complete literature survey, clarify the design specifications and technical path, finish the framework and functional module design of sensor and front-end electronics.
- 2025: Complete design of the first sensor, finish the prototype design of the first front-end electronics.
- 2026: Complete the first sensor test, validate the simulation of the first front-end electronics
- 2027: Complete the second sensor design, evaluate the first front-end electronics, improve the circuit structure and parameters, design the second version of electronics.
- 2028: Complete the sensor and front-end electronics evaluation, release document.

Muon Detector Detailed Schedule

ID	Task Name	Text1	Duration	Start	Finish
0	缪子探测器	**Muon detector**	**1305 days**	**2024/1/1**	**2028/12/31**
1	**1）气隙制作和工艺控制**	**1) Air gap fabrication and process control**	**784 days**	**2024/1/1**	**2026/12/31**
2	**1.1）气室边框垫片等机械结构加工和测试**	**1.1) machining and testing of mechanical structi**	**65 days**	**2024/1/1**	**2024/3/31**
3	1.1.1）边框加工和测试	1.1.1) frame processing and testing	65 days	2024/1/1	2024/3/31
4	1.1.2）垫片加工和测试	1.1.2) gasket processing and testing	65 days	2024/1/1	2024/3/31
5	**1.2）小面积气隙制作和测试**	**1.2) fabrication and test of small air gap**	**88 days**	**2024/4/1**	**2024/7/31**
6	1.2.1）自动垫片点胶装置调试	1.2.1) commissioning of automatic gasket dispen	22 days	2024/4/1	2024/4/30
7	1.2.2）小面积气隙制作和工艺优化	1.2.2) small area air gap fabrication and process	43 days	2024/5/1	2024/6/30
8	1.2.3）小面积气隙性能测试	1.2.3) small area air gap performance test	23 days	2024/7/1	2024/7/31
9	**1.3）大面积气隙制作和测试**	**1.3) large area air gap fabrication and testing**	**393 days**	**2024/7/1**	**2025/12/31**
10	1.3.1）大面积气隙制作程序优化	1.3.1) optimization of large area air gap fabricati	23 days	2024/7/1	2024/7/31
11	1.3.2）大面积气隙制作	1.3.2) large area air gap fabrication	43 days	2024/8/1	2024/9/30
12	1.3.3）大面积气隙测试	1.3.3) large area air gap test	66 days	2024/10/1	2024/12/31
13	1.3.4）大面积气隙老化锻炼	1.3.4) large area air gap aging exercise	261 days	2025/1/1	2025/12/31
14	**1.4）BIM/BIR位置气隙设计和制作**	**1.4) bim/bir position air gap design and fabricat**	**522 days**	**2025/1/1**	**2026/12/31**
15	1.4.1）BIM/BIR气隙设计	1.4.1) bim/bir air gap design	261 days	2025/1/1	2025/12/31
16	1.4.2）BIM/BIR气隙制作	1.4.2) bim/bir air gap fabrication	173 days	2026/1/1	2026/8/31
17	1.4.3）BIM/BIR气隙测试	1.4.3) bim/bir air gap test	175 days	2026/5/1	2026/12/31
18	**2）单层RPC探测器的设计、制作和性能测试**	**2) Design, fabrication and performance test of s**	**567 days**	**2024/1/1**	**2026/3/3**
19	**2.1）大面积蜂窝板设计、制作和测试**	**2.1) design, fabrication and testing of large area**	**435 days**	**2024/1/1**	**2025/8/31**
20	2.1.1）大面积蜂窝板设计和工程确认	2.1.1) large area honeycomb panel design and en	44 days	2024/1/1	2024/2/29
21	2.1.2）大面积蜂窝板材料采购	2.1.2) procurement of large area honeycomb par	43 days	2024/3/1	2024/4/30
22	2.1.3）大面积蜂窝板制作（前50%）	2.1.3) large area honeycomb panel production (t	175 days	2024/5/1	2024/12/31
23	2.1.4）大面积蜂窝板制作（后50%）	2.1.4) large area honeycomb panel production (t	173 days	2025/1/1	2025/8/31
24	2.1.5）大面积蜂窝板质量检测	2.1.5) quality inspection of large area honeycom	145 days	2025/2/10	2025/8/29
25	**2.2）前端电子学制作和测试**	**2.2) front end electronics fabrication and testing**	**435 days**	**2024/1/1**	**2025/8/31**
26	2.2.1）批量测试方法研究	2.2.1) research on batch test method	87 days	2024/1/1	2024/4/30
27	2.2.2）前放板材料订货	2.2.2) material ordering for front placing plate	43 days	2024/3/1	2024/4/30
28	2.2.3）前放板制作（前50%）	2.2.3) production of front plate (top 50%)	175 days	2024/5/1	2024/12/31
29	2.2.4）前放板制作（后50%）	2.2.4) fabrication of front plate (rear 50%)	173 days	2025/1/1	2025/8/31
30	2.2.5）前放板性能测试	2.2.5) performance test of front plate	305 days	2024/7/1	2025/8/31
31	**2.3）单层探测器设计、制作**	**2.3) design and fabrication of single-layer detec**	**567 days**	**2024/1/1**	**2026/3/3**
32	2.3.1）单层探测器设计工程确认	2.3.1) single layer detector design engineering co	130 days	2024/1/1	2024/6/30
33	2.3.2）单层探测器制作（前150个）	2.3.2) fabrication of single-layer detectors (top 1	132 days	2025/9/1	2026/3/3
34	2.3.3）单层探测器制作（后150个）	2.3.3) fabrication of single-layer detectors (the la	218 days	2025/1/1	2025/10/31
35	**2.4）单层探测器性能测试**	**2.4) single layer detector performance test**	**523 days**	**2024/1/1**	**2025/12/31**
36	2.4.1）大规模RPC测试平台搭建	2.4.1) construction of large-scale RPC test platfor	175 days	2024/1/1	2024/8/31
37	2.4.2）单层探测器性能测试	2.4.2) single layer detector performance test	348 days	2024/9/2	2025/12/31
38	**3）探测器组装、调试、试运行**	**3) Detector assembly, commissioning and trial o**	**1086 days**	**2024/11/1**	**2028/12/31**
39	3.1）三层探测器的测试、故障排除（@MPI）	3.1) test and troubleshooting of three-layer dete	433 days	2024/11/1	2026/6/30
40	3.2）现场组装和调试（CERN）	3.2) site assembly and commissioning (CERN)	782 days	2026/1/1	2028/12/31
41	3.3）无束流状态试运行（CERN）	3.3) no beam test run (CERN)	130 days	2028/7/3	2028/12/31
42	**4）项目文档**	**4) Project documentation**	**805 days**	**2025/12/1**	**2028/12/29**
43	4.1）项目中期测试报告	4.1) Interim test report of the project	22 days	2025/12/1	2025/12/30
44	4.2）项目结题报告	4.2) project conclusion report	21 days	2028/12/1	2028/12/29



The up-to-date RPC production time line



- This table shows the up-to-date RPC production time line with the first priority, which contains the core part of the production.
- The main task for China-cluster is the BIS part (which covers all of 8 small sectors), including the strip PCB production, the honeycomb readout panel production, (half of) the FEE board production, the singlet construction and integration, and the QA&QC of all the products.
- In total, the work related to 288 BIS singlets.
- (From the time line, we can also find the “singlet integration” time is very limited. This is due to the fact that the delivery of the FEE ASIC is delayed again. This also makes the time for the QA&QC on the singlets very tight.)
- The table doesn’t contain the QA&QC on the chambers, which needs also manpower contributions from China.
- From 2026 to 2028, the main work will be the installation and commissioning at CERN.

Detailed Budget

课题1: High Granularity Timing Detector Budget

Content	Budget (10k RMB)	Description
1. Equipment	70	Work stations, LCR meters, HV/LV power supply ...
2 Operation	**734**	
2.1 LGAD	267	150 LGAD sensors wafers
2.2 flexible cable	105	7500 flexible cable
2.3 high voltage	70	750 channels of HV modules
2.4 PEB boards	200	160 PEB boards with components and testing
2.5 modules	68	Wire-bonding, 1000 hybrids
2.3 Travel, meeting, collaboration	24	Travels , meeting
3 Labor	**128**	Postdocs, graduate students
Indirect	**203**	
Total	**1135**	

课题2: Silicon Inner Tracker Budget

Content	Budget (10k RMB)	Description
1. Equipment	0	No equipment
2 Operation	**415**	
2.1 Material	356	
2.1.1 Strip Barrel Detector	286	Material for making 200 strip modules, including sensors, ASICs, hybrid readout flexes, glues
2.1.2 Timing Pixel Detector	70	One readout electronics prototype, two sensors prototypes
2.2 Test and machining	39	Tooling for strip detector module, Al bonding wires, testing material for timing pixel sensor and readout
2.3 Travel, meeting, collaboration	15	Support research activities
2.4 Publication, Patents	5	Publications, patents, etc.
3 Labor	**60**	Postdocs, graduate students, financial service
Indirect	**125**	
Total	**600**	

课题3: Muon Detector (RPC) Budget

Content	Budget (10k RMB)	Description
1. Equipment	0	No equipment
2 Operation	**328**	
2.1 Material	209	
2.1.1 RPC gas gaps	67.5	Material for making 90m^2 RPC gas gap
2.1.2 BIS readout panel	112	Material for making 160 readout panels
2.1.3 Cosmic test station and DAQ	17	Support structure, DCT boards and cables for the test station
2.1.4 RPC working gas	12.5	Gases for RPC test: Freon, iso-butane, SF_6, Ar
2.2 Test and machining	22	Test of the impedance, surface characters, electronics with the instruments in commom pool
2.3 Detector shipment	48	Shipment of the detectors to MPI, 8 x 6 times
2.4 Travel, meeting, collaboration	9	Support research activities
2.5 ATLAS M&O	40	Support the ATLAS Common Fund for 1 key member
3 Labor	**30**	Postdocs, graduate students
Indirect	**107**	
Total	**465**	

Muon Detector Detailed Information

Work sharing (under discussion)

PRIORITY			Number	GTE	INFN	MPI	USTC	HK	TK
1	BIL (excluding s7)	gas gap	312	100%					
		strip panel	624		100%				
		singlet	312		100%				
		triplet	**104**		100%				
1	BIL s7	gas gap 5-9 S7	30	backup			100%		
		gas gap(1-4+10)S7	30	100%					
		strip panel	120		50%		50%		
		singlet	60		50%		50%		
		triplet	**20**		50%		50%		
2	S9 @ Eta=0	gas gap S9@E=0	18	backup			100%		
		strip panel	36				100%		
		singlet	18				100%		
		triplet	**6**				100%		
1	BIS1-6	gas gap	288	100%					
		strip panel	576				100%		
		singlet	288				100%		
		triplet	**96**			100%			
2	BOR/BOM	gas gap	240	backup		100%			
		strip panel	480		50%		50%		
		singlet	240		25%	25%		25%	25%
		triplet	**80**		25%	25%		25%	25%
3	BIS7C	gas gap	24	100%					
		strip panel	48						
		singlet	24		100%			100%	
		triplet	**8**		100%			100%	
3	BIS8C	gas gap	24	backup			100%		
		strip panel	48						
		singlet	24				100%		
		triplet	**8**				100%		
3	BIS78A	electronics replaceme	48		50%			50%	
		triplet	**16**		50%			50%	
			Number	GTE	INFN	MPI	USTC	HK	TK
	Total Singlets assigned to be built		942	624	402	60	360	60	60
	Total Chambers assigned to be built		314		134	116	24	20	20
	Total Singlets unassigned		24		24			24	
	Total Chambers unassigned		8		8			8	
	Total refurbishing unassigned		16		16			16	

The core part! →

- ➢ Stations 5-9@S7 are not critical in installation sequence
- ➢ 30 gas gaps to be assigned to USTC-cluster.
- ➢ (very likely,) ½ of the strip panel production, single assembly and triplet assembly

- ➢ Eta=0@S9 has priority-2 in installation sequence
- ➢ 18 gas gaps to be assigned to USTC-cluster.
- ➢ And also the strip panel production, single assembly and triplet assembly

- ➢ BIS8C has priority-3 in installation sequence
- ➢ 24 gas gaps to be assigned to USTC-cluster.
- ➢ And also the single assembly and triplet assembly

Risk

- The ATLAS upgrade is organized in a large collaboration. The plan and the scheme of the upgrade are decided by the collaboration.

➔Take in-depth cooperation with the collaboration and other institutes.

➔Be aware of the plan and scheme at all the time.

➔Take responsive actions in case of new situation.

➔Keep the responsible work in healthy condition.