年度绩效考核报告
2023.12~2024.11

史欣

探测器一组

2024年 11月 20日

报告提纲

一、岗位职责

二、本年度工作情况

1、研究任务完成情况

2、本人研究成果与经费情况

3、学术交流、学术发展规划

4、公共服务

5、其它贡献

三、存在问题

四、下年度工作计划

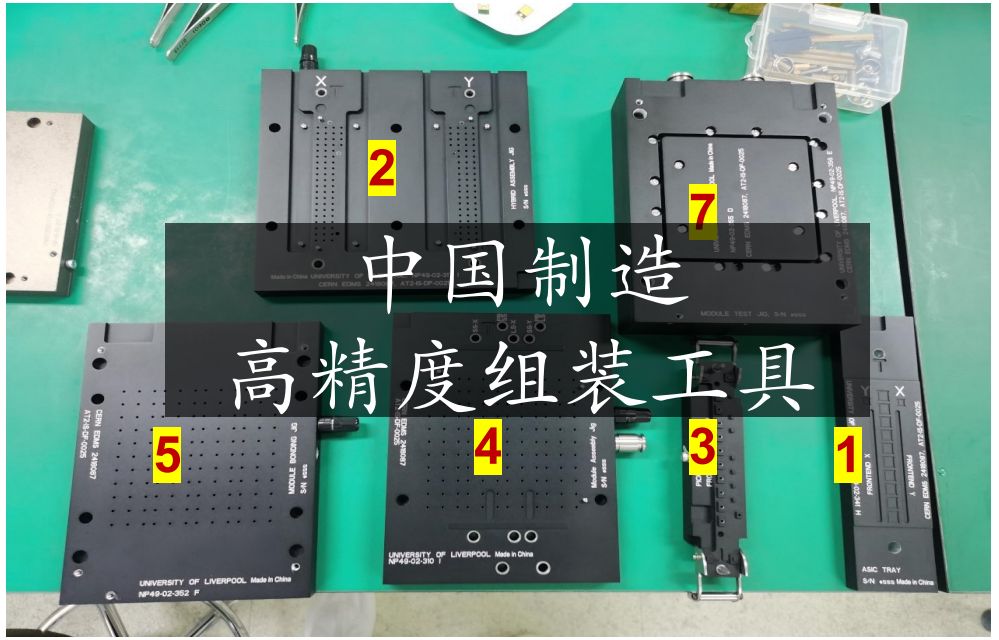
岗位职责

- ATLAS 硅微条内径迹探测器升级
- CEPC 硅径迹探测器设计
- 抗辐照半导体探测器研究

ATLAS 硅微条内径迹探测器升级

- 高能所站点已经通过**全部（29)**探测器模块生产步骤考核
  - 研制 10 个预生产模块并送到 CERN，国产厂家研制高精度组装工具
  - 高能所史欣作为中国-英国集群负责人，协调桶部径迹探测器50%的研制任务
- 开展读出电子学芯片和传感器的抗辐照性能研究
  - 推动散列中子源伴生质子束作为合作组认证的硅传感器和芯片抗辐照研究站点
- 开展硅内径迹探测器系统安装及联调测试
  - 外派博士后与学生常驻英国卢瑟福实验室，在探测器低温碎裂研究中发挥重要作用

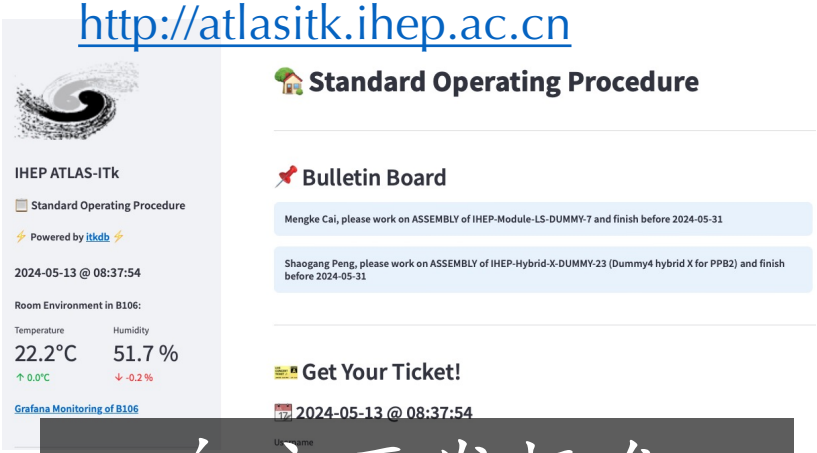
发表
NIMA 两篇



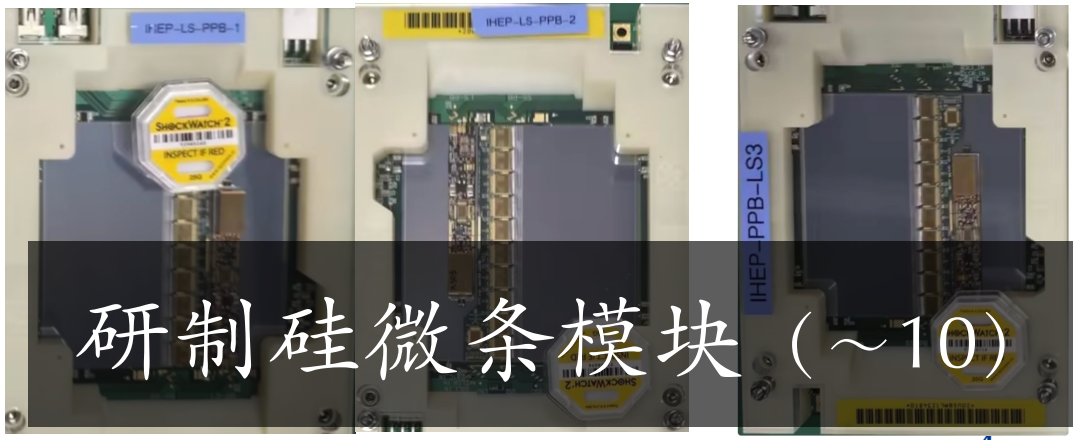
Step Number	Qualification Step	Review End Date
3.2	Sensor Storage	finished: 2021-06-17
6.1	PB Reception	finished: 2022-01-11
6.2	PB E tests	finished: 2022-07-14
6.3	PB Vis Insp	finished: 2021-12-16
6.4	PB Storage	finished: 2021-06-17
8.2	Storage + shipping of glue	finished: 2021-08-26
8.3	Assembling hybrids	finished: 2021-11-20
8.4	Glue weight measurements	finished: 2021-11-21
8.5	Bonding procedures: hybrids	finished: 2022-05-31
8.6	Metrology: hybrids	finished: 2023-03-07
8.7	Visu[illegible]spec[illegible] hybrids	finished: 2021-08-06
8.8	Hybrid [illegible]	finished: 2023-05-25
8.10	Hybrid Storage	finished: 2021-06-17
8.11	hybrid QC: single panel testing	finished: 2022-08-25
11.1	Storage of modules	finished: 2021-06-17
11.2	Cleaning [illegible] jigs	finished: 2021-06-16
11.4	Storage [illegible] of [illegible]	finished: 2021-11-29
11.5	Removing hybrids from [illegible]	finished: 2022-09-07
11.6	Module Assembly	finished: 2022-02-25
11.7	Metrology: modules	finished: 2023-07-10
11.8	Bonding procedures: modules	finished: 2022-05-25
11.9	Visual inspection: modules	finished: 2021-07-19
11.10	Module Thermal Cycling	finished: 2023-10-29
11.11	Single Module Electrical Test	finished: 2022-10-23
12.1	Shipping modules	finished: 2022-04-25
13.1	Cleanroom standards	finished: 2021-11-25
13.2	ASIC Compliance & Handling	finished: 2021-06-03
13.3	Bond Pulling Procedures	finished: 2021-12-03
14.1	Module Reception	Finished: 2022-01-25

29 步
生产流程

http://atlasitk.ihep.ac.cn

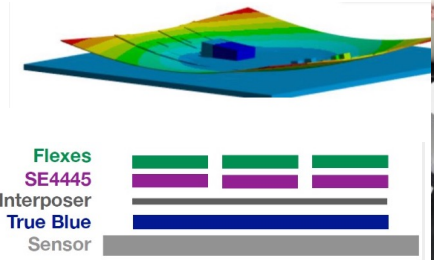


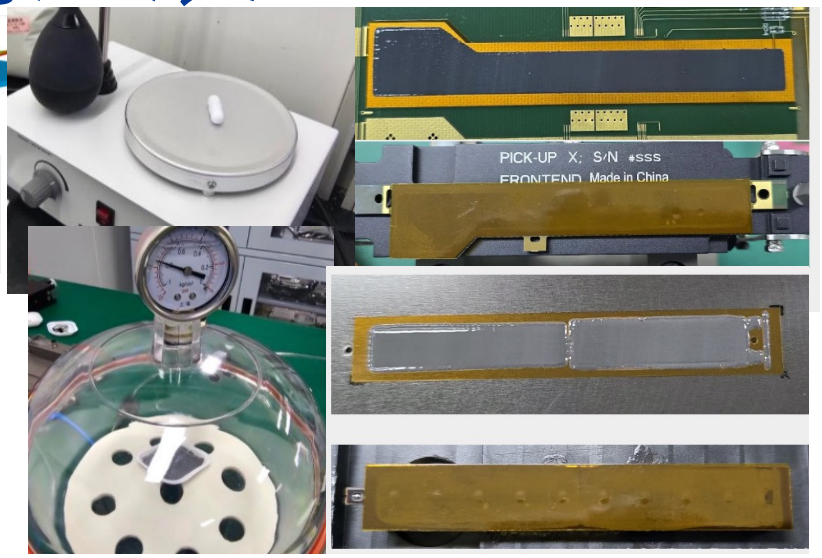
自主开发标准
操作流程动态网页



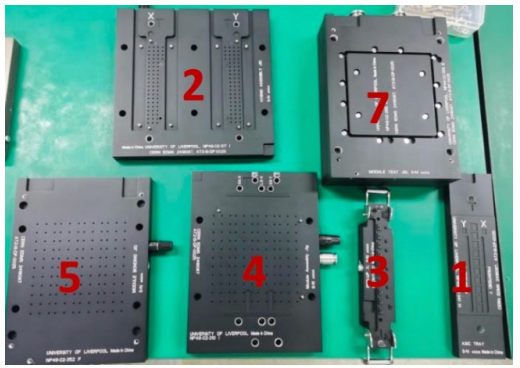
ATLAS 硅微条探测器模块研制进展

- 解决硅微条传感器低温碎裂问题
  - 自研工具增加垫层和胶水
  - 组装的模块**没有碎裂**





- 完成国产模块组装工装标定
  - 达到精度要求（0.02mm）

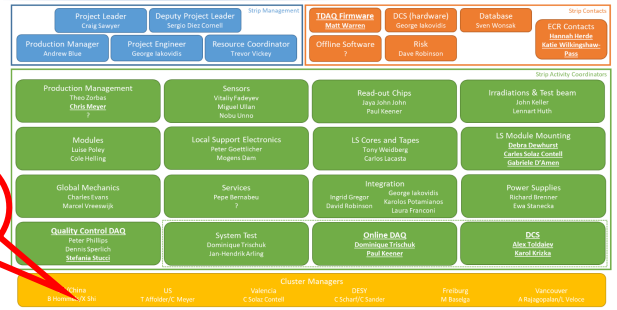


- 正式通过生产站点考核
  - 作为中英集群负责人推动桶部模块组装

Barrel
SQ status:
99 %
Production capacity

End-cap
SQ status:
92 %
(>75 % production capacity)

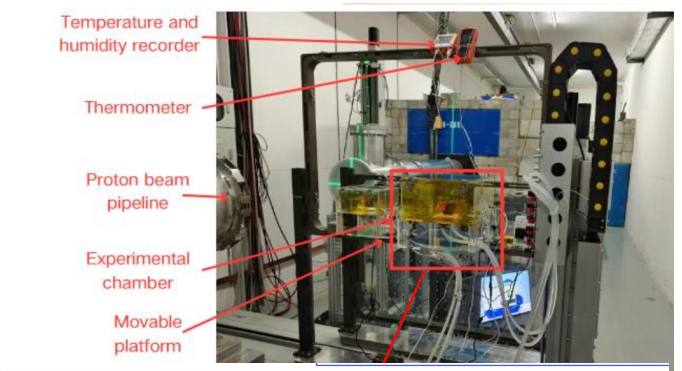
X. Shi

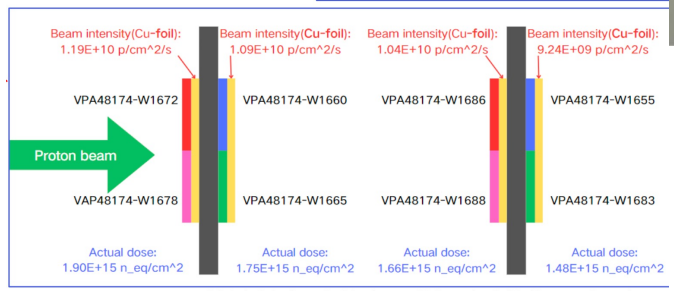


Cluster	Site	SQ status
UK+China	Birmingham	100 %
UK+China	Cambridge	100 %
UK+China	Glasgow	96 %
UK+China	IHEP	100 %
UK+China	Liverpool	100 %
UK+China	RAL	100 %
UK+China	Sheffield	100 %

ATLAS 硅微条传感器抗辐照性能研究

- 完成散列中子源伴生质子束三次辐照实验
  - 样品架采用石墨片
  - 温湿度控制 (-20C, 5% RH)
  - 辐照后电学测量符合预期，与国外站点样品一致
- 推动 CSNS 成为辐照站点，IHEP 为测试站点



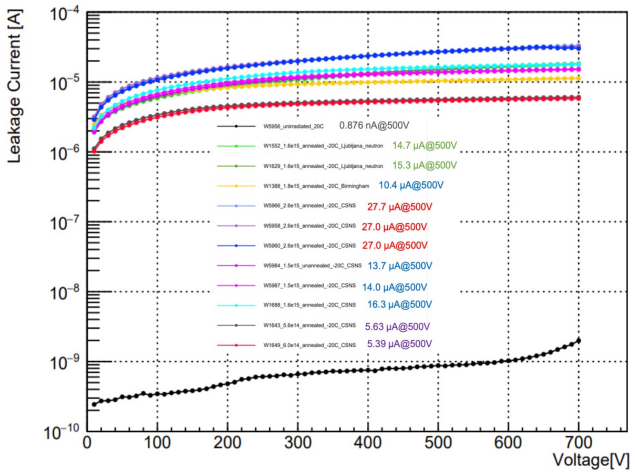


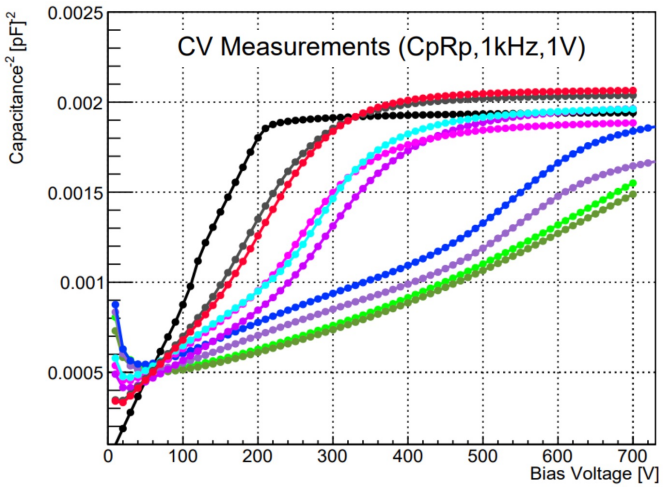
2024.06.17: 9.8h (small box), 31h(large box)

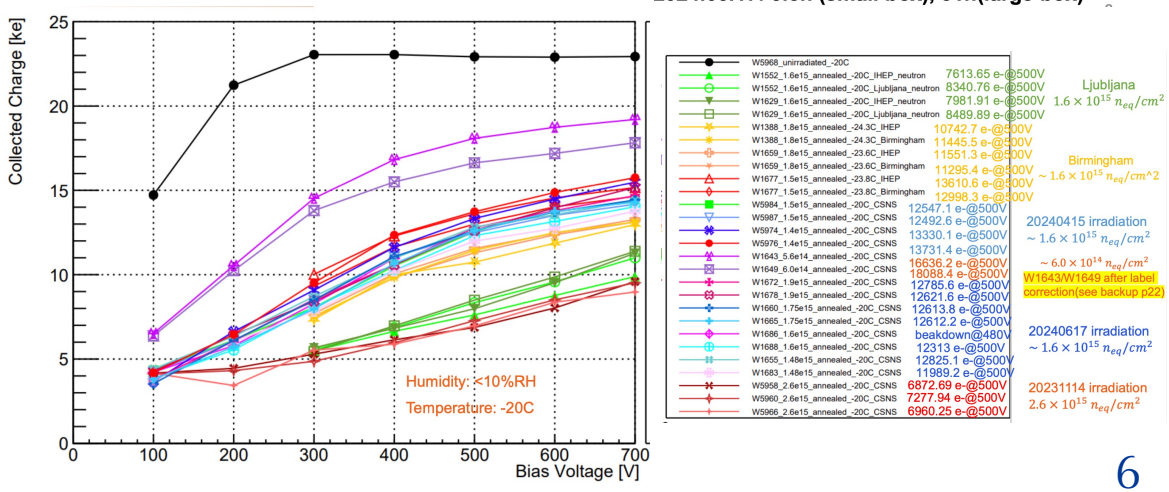
Feasibility study of CSNS as an ATLAS ITk sensor QA irradiation site

NIMA

Hui Li [a,b,*], Zhan Li [b], Shudong Wang [b], Zijun Xu [b], Xin Chen [a], Mingming Xia [a], Yingjun Huang [d], Yang Liu [d], Zhixin Tan [e,b], Hantao Jing [e,b], Suyu Xiao [f,g], Vitaliy Fadeyev [h], Miguel Ullan [i], Yoshinobu Unno [j], Xin Shi [b,c]

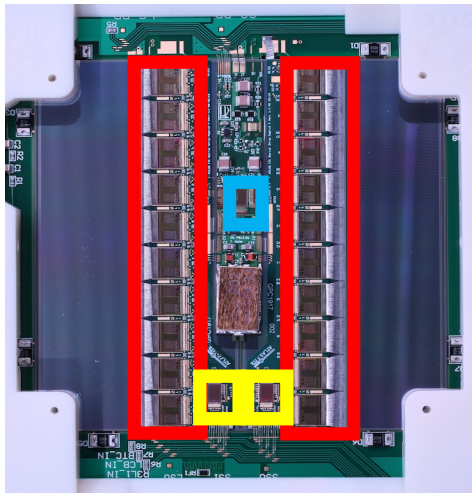


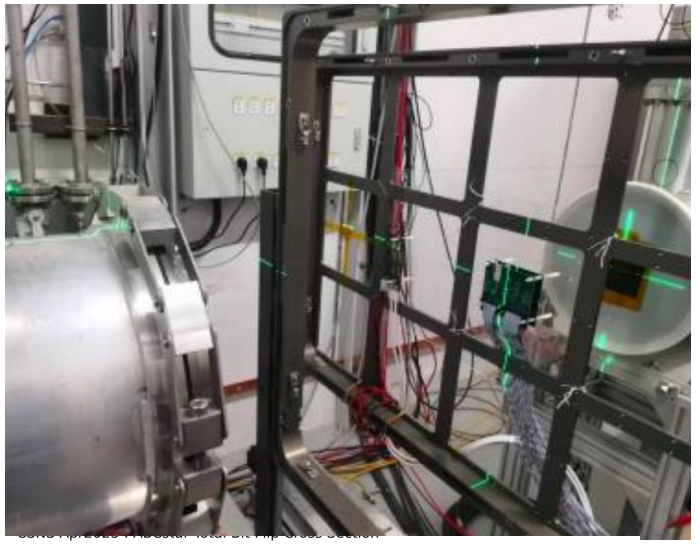


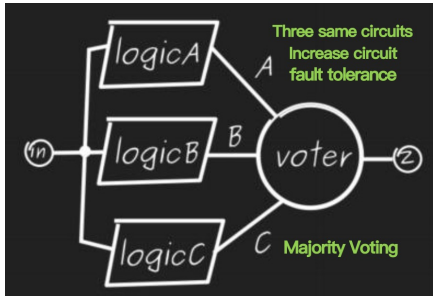


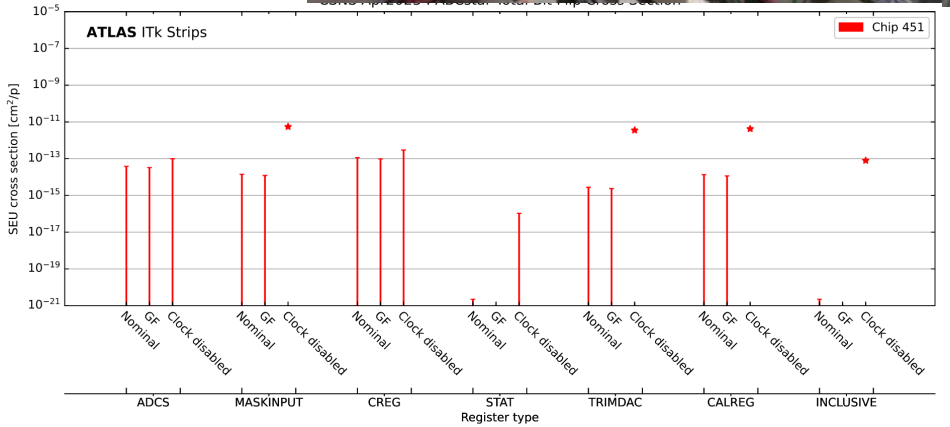
ATLAS 硅微条读出芯片辐照单粒子效应研究

- 利用伴生质子束开展硅微条读出芯片单粒子效应（SEE）研究
  - 测试得到80 MeV 质子辐照下ABC芯片SEU截面 3.6E-11 cm^2/p, 低于正常运行模式允许的出错率（1E-9）
  - 测得 ABC 芯片寄存器读数截面 1E-18 cm^2/p，验证三模冗余（TMR）工作正常







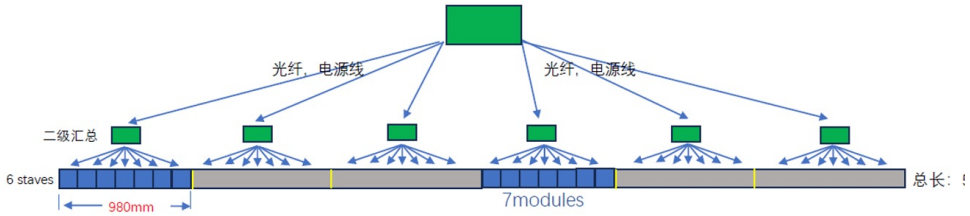


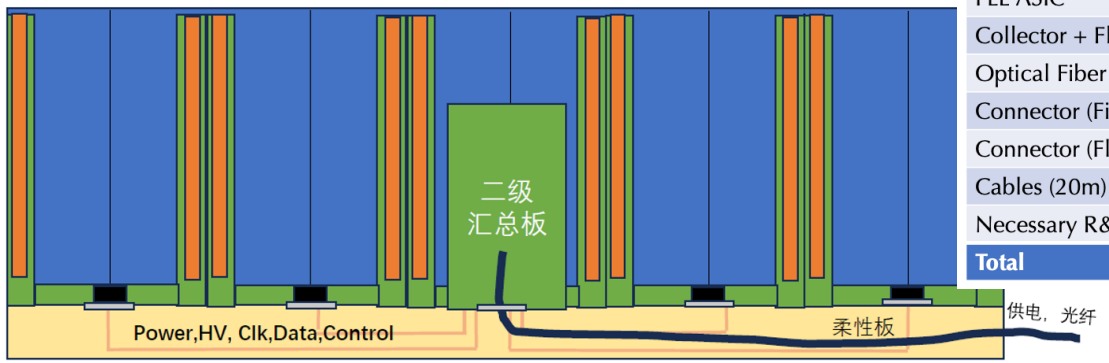
Single event effect in ABC ASICs for ITk strip upgrade NIMA

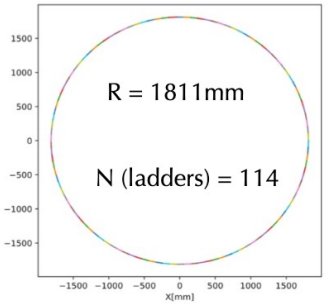
Shaogang Peng [a,b], Matthew Basso [c,d], Xin Chen [a], Jeff Dandoy [e], Bruce Gallop [f], Jaya John John [g], Hantao Jing [h], Paul Keener [i], Pedro Leitao [j], Weiguo Lu [b,k,*], Peilian Liu [b,k], Qiang Li [h], Yang Liu [l], Hui Li [a], Godwin Mayers [m], Mitchell Newcomer [m], Peter Phillips [f], Xin Shi [b,k], Zhixin Tan [h], Matt Warren [n], Chengwei Wang [b], Mingming Xia [a], Yan Zhou [a]

CEPC 外径迹探测器方案设计

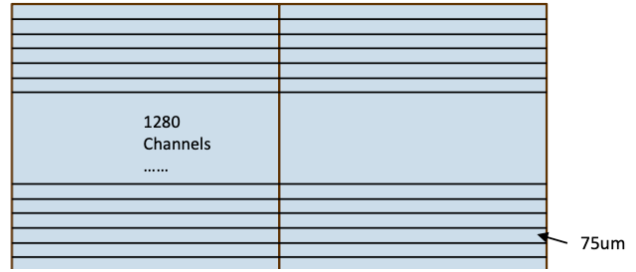
- 开展基于传统硅微条的 CEPC 径迹探测器设计
  - 设计桶部硅微条模块与板条分布方案
  - 估算传感器+电子学系统造价

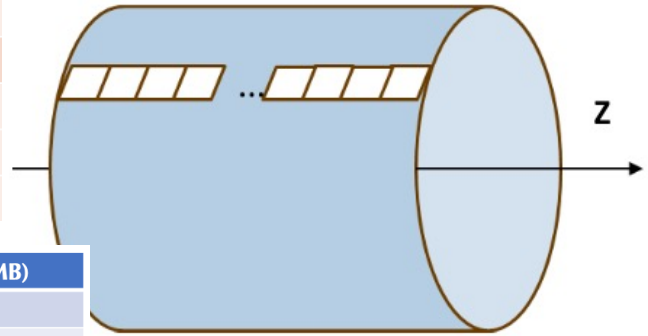






SET	
Radius	1811mm
+/- z	2904mm
Ladders	114
Staves	684
Modules	3306
Channels	~ 4.2 M



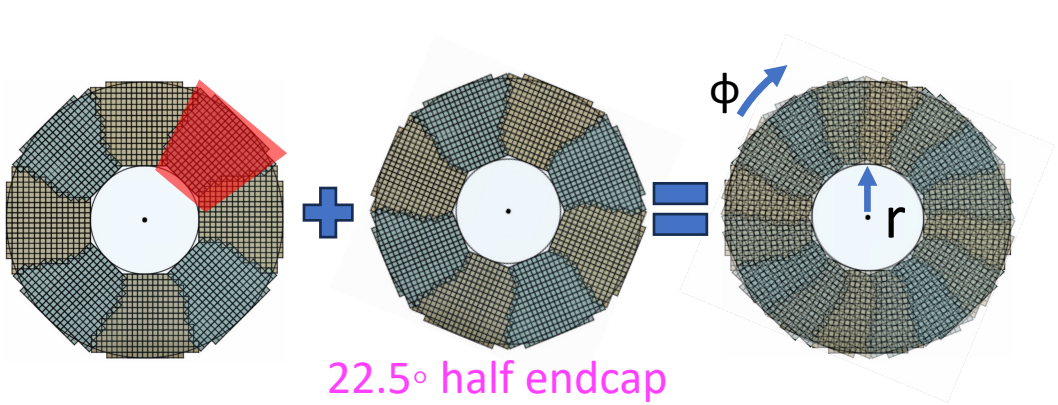


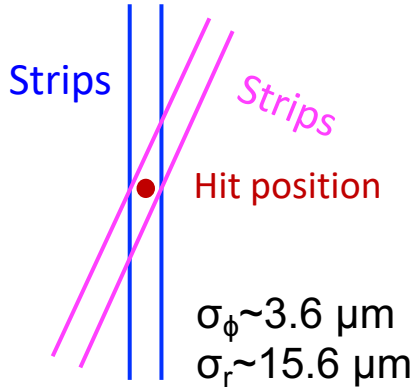
Items	Unit Cost (RMB)	Quality	Total (10k RMB)
FEE PCB	200	3306	67
FEE ASIC	0.09	4231680	38
Collector + Flex Board	700	684	48
Optical Fiber	200	684	14
Connector (Fiber)	2000	684	137
Connector (Flex)	100	3306	33
Cables (20m)	400	684	28
Necessary R&D			1460
Total			**1825**

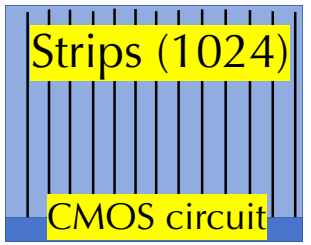
Items	Unit Cost (RMB)	Quality	Total (10k RMB)
Sensors	5500	6612	3637
Electronics			1825
Total			**5462**

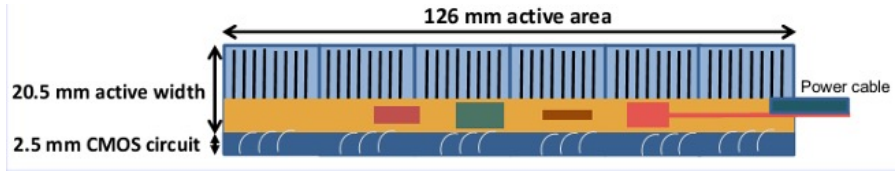
CEPC 内径迹探测器CMOS 微条方案设计

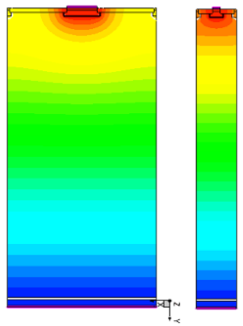
- 提出 CMOS Strip Chip (CSC) 一体式芯片设计方案
- 主导设计双层夹角端盖设计方案
  - 实现极致空间分辨率 (<4μm)

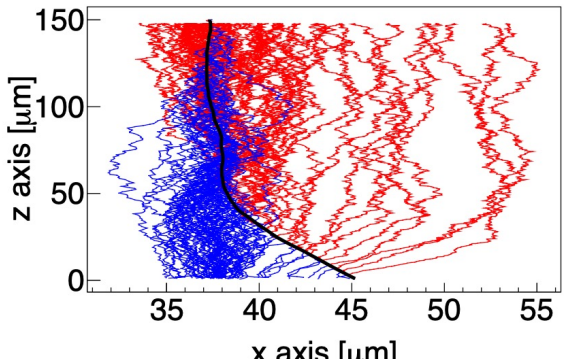




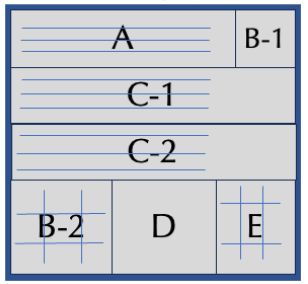


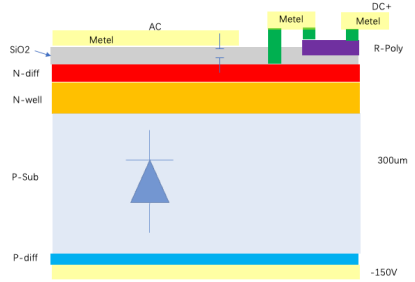






- 组织成立 CSC 芯片开发合作组 (12 个单位)
  - 完成传感器、电子学、信号响应初步仿真
  - 选用国产高阻晶圆 （2k Ω) 和国内CMOS工艺





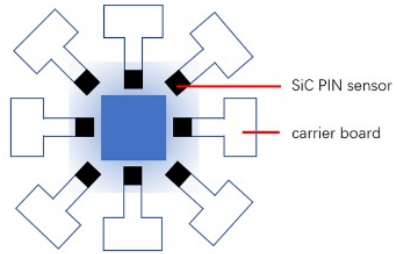
新型抗辐照半导体探测器研制

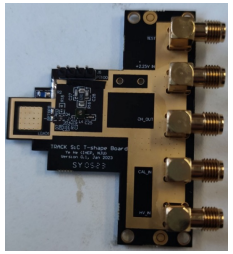
Electrical Properties and Gain Performance of 4H-SiC LGAD (SICAR)

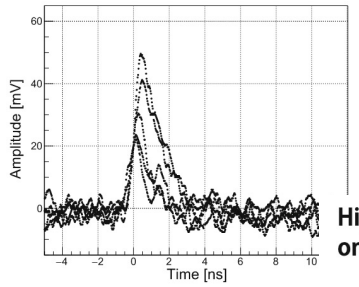
IEEE

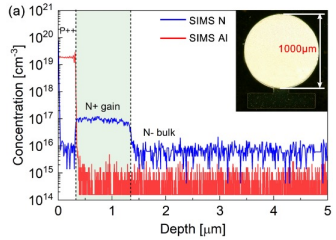
Sen Zhao, Keqi Wang, Kaibo Xie, Chenxi Fu, Chengwei Wang, Suyu Xiao, Xiyuan Zhang, Xin Shi, and Congcong Wang

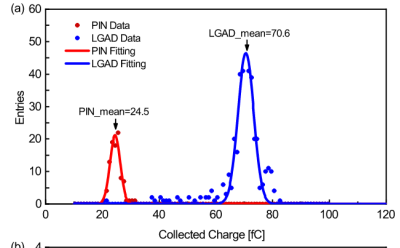
- 研制碳化硅低增益（SiC-LGAD）探测器SICAR
  - 第一版测试结果增益结构明显 ~ 3@350V
- 完成 CSNS-II项目束流监控探测器物理设计及评审

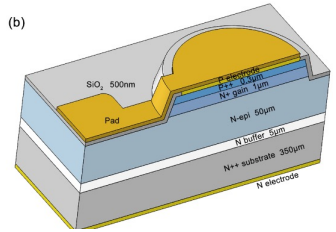


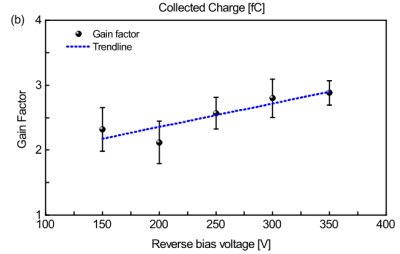










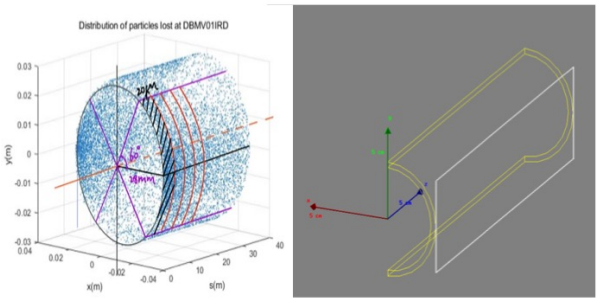


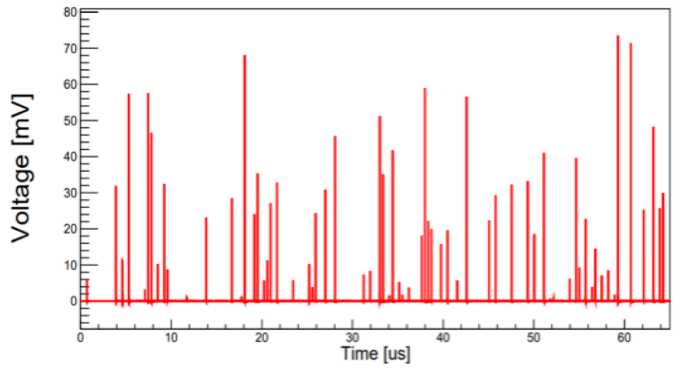
- CEPC快速亮度监控探测器
  - 开展基于 Bhabha 事例的 SiC 探测器仿真研究

High-precision CSNS beam monitor system conceptual design based on SiC

RDTM

Ye He[1,2] · Xingchen Li[2] · Zijun Xu[2] · Ming Qi[1] · Congcong Wang[2] · Chengwei Wang[2] · Hai Lu[1] · Xiaojun Nie[4] · Ruirui Fan[4] · Hantao Jing[4] · Weiming Song[3] · Keqi Wang[2,5] · Kai Liu[6,7] · Peilian Liu[2] · Hui Li[2,8] · Zaiyi Li[2] · Chenxi Fu[2] · Xiyuan Zhang[2] · Xiaoshen Kang[5] · Zhan Li[2] · Weiguo Lu[2] · Suyu Xiao[9] · Xin Shi[2]





Workshop

CEPC Fast Luminosity Detector design using SiC

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研究成果

通讯作者

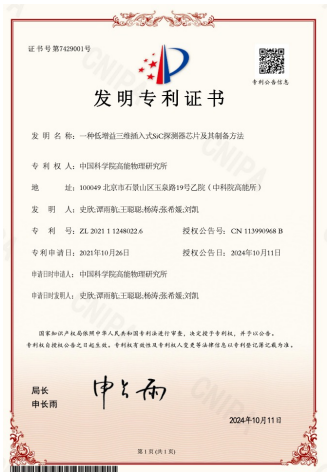
1. Feasibility study of CSNS as an ATLAS ITk sensor QA irradiation site, NIMA **1063** (2024) 169288
2. High-precision CSNS beam monitor system conceptual design based on SiC, RDTM (2024)
3. Electrical Properties and Gain Performance of 4H-SiC LGAD (SICAR), IEEE TNS VOL 71, NO. 11, 2024

非第一作者

1. Effect of irradiation and annealing performed with bias voltage applied across the coupling capacitors on the interstrip resistance of ATLAS ITk silicon strip sensors, NIMA **1047** (2023) 167726
2. Electric field measurement by edge transient current technique on silicon low gain avalanche detector, NIMA **1065** (2024) 169479
3. Single event effect in ABC ASICs for ITk strip upgrade, NIMA **1065** (2024) 169531

发明专利

1. 一种低增益三维插入式SiC探测器及其制备方法，ZL 2021 1 1248022.6 （授权） （第一发明人）
2. 一种低增益雪崩探测器仿真方法即系统 2023113001502690 （第一发明人）


发明专利证书

经费情况

获得经费

- CEPC 半导体径迹探测器， 主持CMOS微条课题，2024-2027，河南省科学院，550 万元 新
- ATLAS 探测器升级，负责 ITk 课题，2024-2028，科技部重点项目，600 万元 新
- SiC-LGAD-TPIX，主持，2024-2027，CERN-RD50，50k CHF 新
- 碳化硅低增益雪崩探测器研究，主持，2024.1-2027.12，面上项目，52 万元
- ATLAS 实验探测器Phase 2 升级，子课题负责，2020.1-2024.12，NSFC，1178 万元

申请经费

- ATLAS 实验内径迹探测器升级，NSFC-CERN ， 主持 750 万，2025-2028 ， 评审中
- 抗辐照半导体探测器研究，杰青项目，2025-2030，未获批

学术交流

会议名称	会议时间	会议地点	会议类型	报告名称
IAS Program on High Energy Physics	2024.01.08	香港	国际	CEPC Silicon Strip Outer Tracker
半导体探测器特殊芯片开发与应用科技前沿国际高峰论坛	2024.03.28	山东烟台	国际	抗辐照半导体探测器研发
中国科学技术大学 见微学术沙龙	2024.06.07	安徽合肥	国内	抗辐照碳化硅高时间分辨探测器
1st DRD3 week on Solid State Detectors R&D	2024.06.17	瑞士日内瓦	国际	SiC AC-LGAD Timing Pixel Detector
2024 International Workshop on the High Energy Circular Electron Positron Collider	2024.10.22	浙江杭州	国际	CMOS Strip Development for CEPC ITK
DRD3 WG1/WP1 Meeting	2024.10.28	在线	国际	CMOS Strip Chip for Future Tracking Detector

- 国际会议报告 5 次
- 国内会议报告 1 次
- 组织 2024 抗辐照半导体探测器（RASER）工作组会议（三日在线）

公共服务

- NIMA 、原子核物理评论、RDTM 审稿人
- 公众开放日参观志愿者
- 实验物理中心实验品考核评委
- 研究生、联培生面试评委
- Sensors 特刊 Radiation Sensors and Detectors: Materials, Principles and Applications”客座主编
  - 主持特刊 “Radiation Sensors and Detectors: Materials, Principles and Applications” 第一卷，共发表 19 篇文章

https://www.mdpi.com/journal/sensors/special_issues/RSDMPA

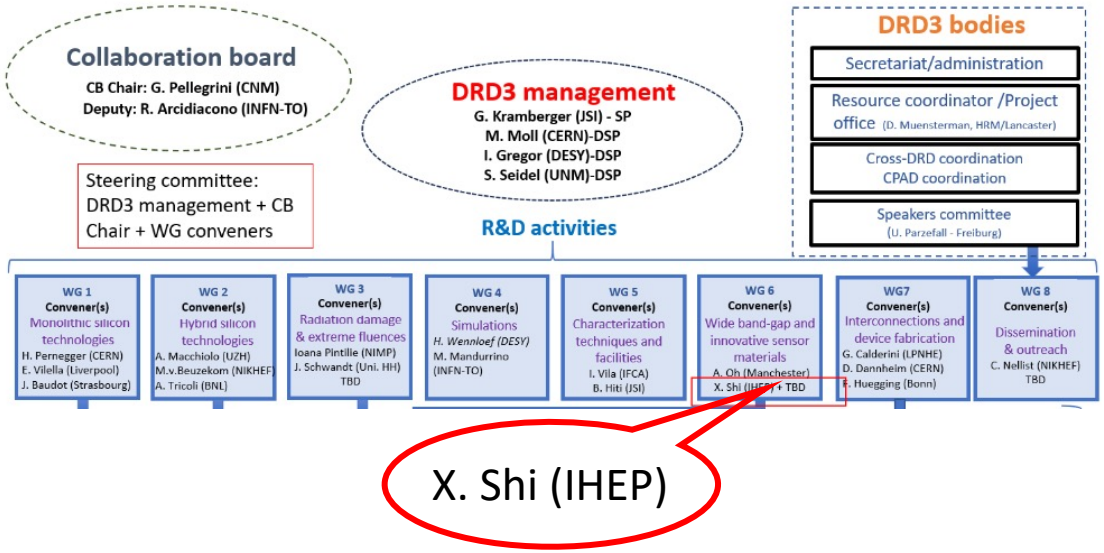
Published Papers (19 papers)

Special Issue Editors

Dr. Xin Shi **E-Mail** **Website**
Guest Editor
Institute of High Energy Physics, Cl
100049, China

职业素质

- 管理能力
  - ATLAS 微条径迹探测器项目中国组负责人、中英集群桶部探测器负责人
  - DRD3 国际抗辐照半导体研究合作组 WG6 “宽禁带半导体与新型传感器材料”分组协调人
    - SiC-LGAD 项目负责人，项目成员 24 个国家与机构
- 科研水平
  - 组织国内抗辐照半导体探测器研究团队 RASER，构建自主软件平台
- 合作精神
  - 与国际国内的单位开展积极的合作



存在问题及解决方法

- 项目组人员流动性大，缺少固定职工

- 拟解决方法：培训学生参与项目，通过联合培养、“科创计划”等扩展生源

下年度工作计划

- ATLAS：启动硅微条探测器模块正式生产；在散裂中子源伴生质子束开展硅传感器质量检验
- CEPC：完成硅微条方案 TDR设计，提交第一版 CSC 芯片流片
- 抗辐照半导体：推进碳化硅快时间探测器研制
- 在培养学生、公共服务等方面继续努力

感谢中心领导与同事们的支持，欢迎指正！