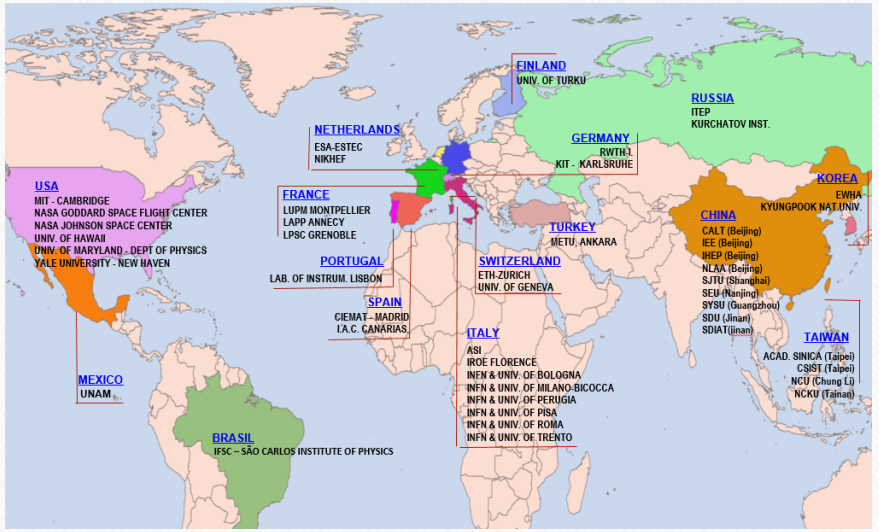
AMS L0硅径迹室升级

高能所 董静
代表项目组

大纲

1. 背景介绍
2. 进展
3. 小结与计划

1.国际空间站阿尔法磁谱仪（AMS）



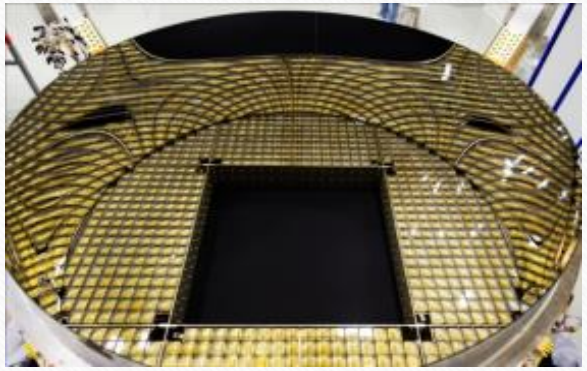
AMS实验是由诺贝尔奖获得者丁肇中教授领导的大型国际合作，由来自16个国家和地区的60多个研究所的科学家组成。

AMS从2011年5月19日开始稳定运行，至今已经收集了超过1700亿宇宙线事例。AMS将在ISS持续运行到2028年或更久，累计收集超过3000亿宇宙线。AMS具有统计量大、精度高和区分正负电荷的优势，在暗物质、反物质和宇宙线起源等研究中具有不可替代性。

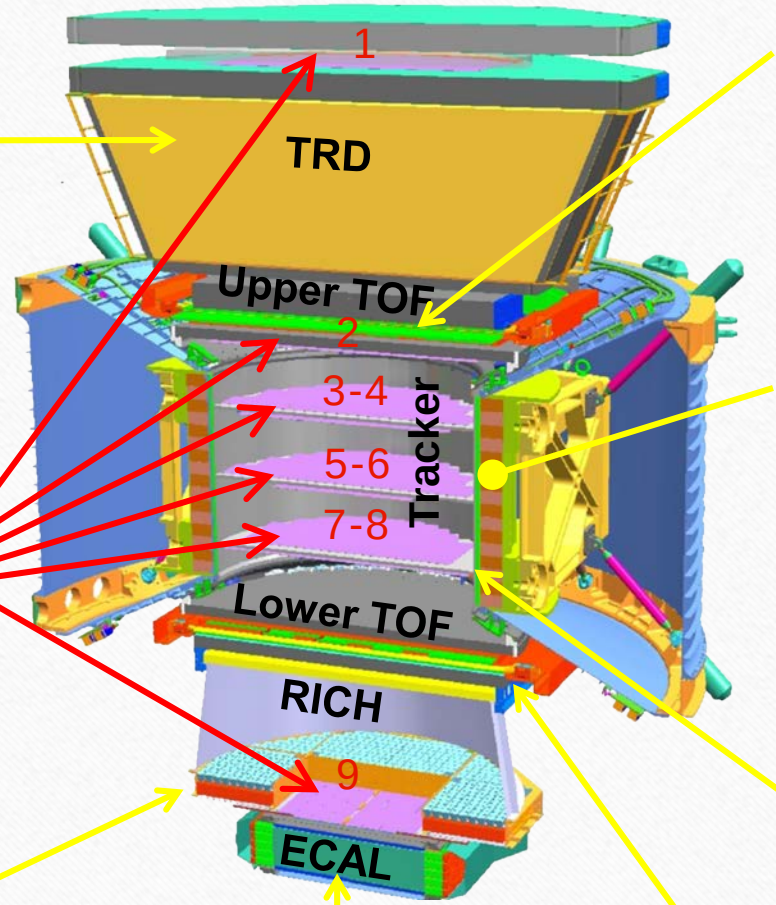
AMS is a space version of a precision detector used in accelerators

Transition Radiation Detector (TRD)

Silicon Tracker

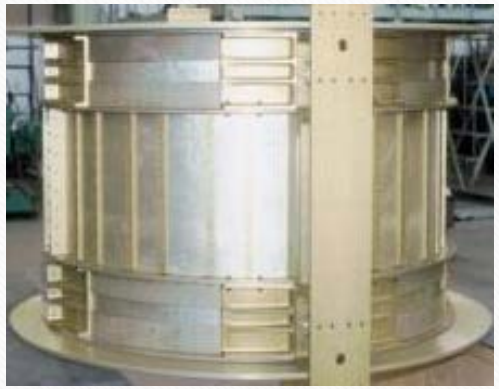


Ring Imaging Cerenkov (RICH)

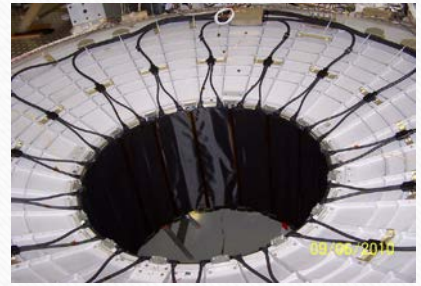


Electromagnetic Calorimeter (ECAL)

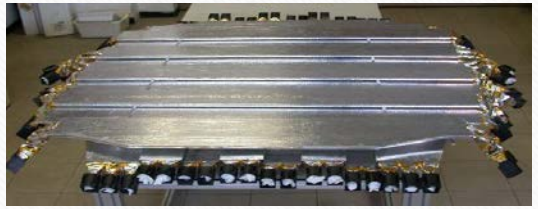
Upper TOF



Magnet

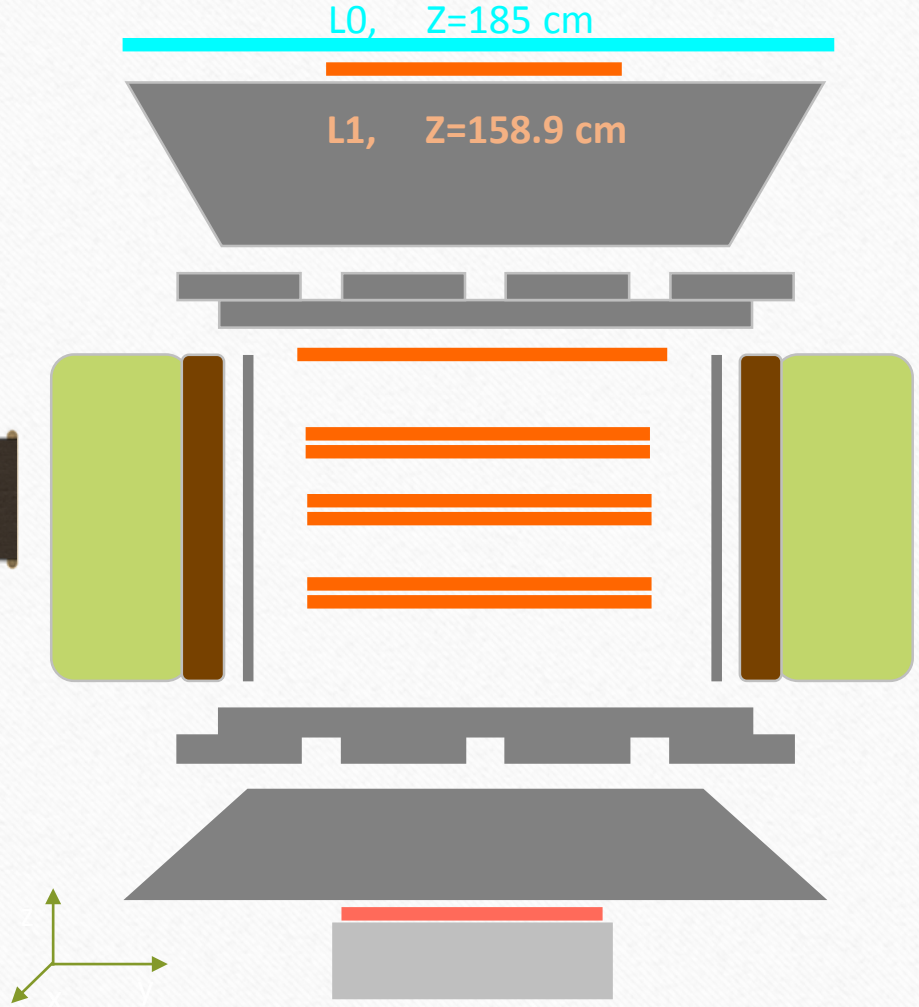


Anticoincidence Counters (ACC)

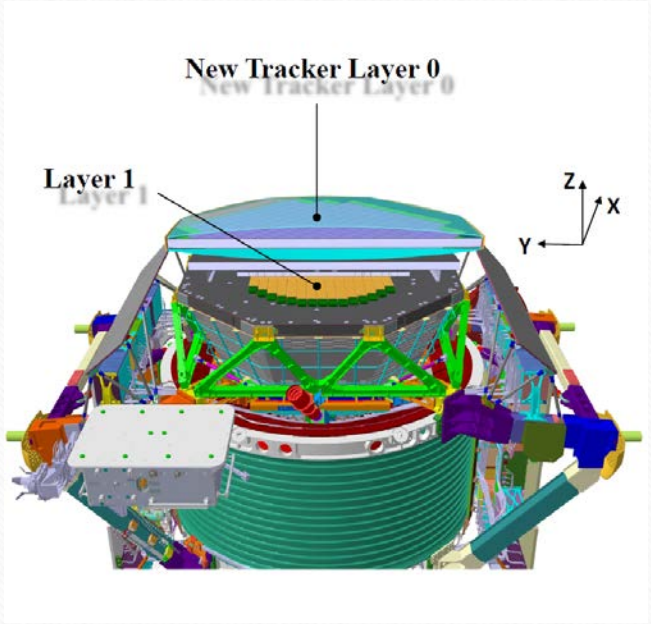


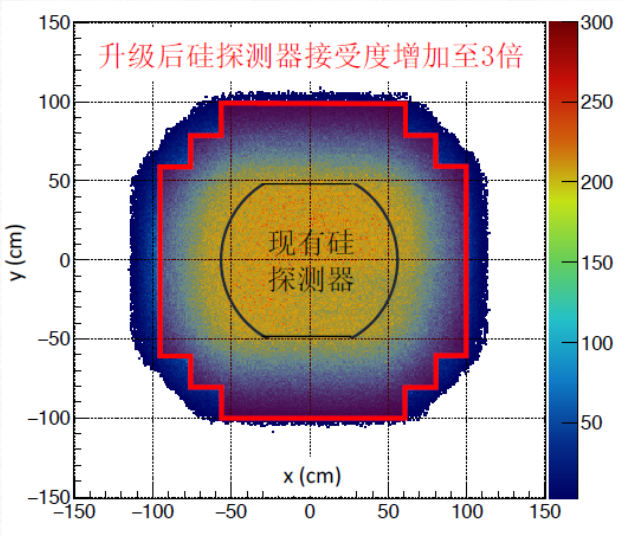
Lower TOF

硅径迹室及其升级Layer0



现有：9 层硅探测器, 200,000 路
平均位置分辨率 10 μm【1】.





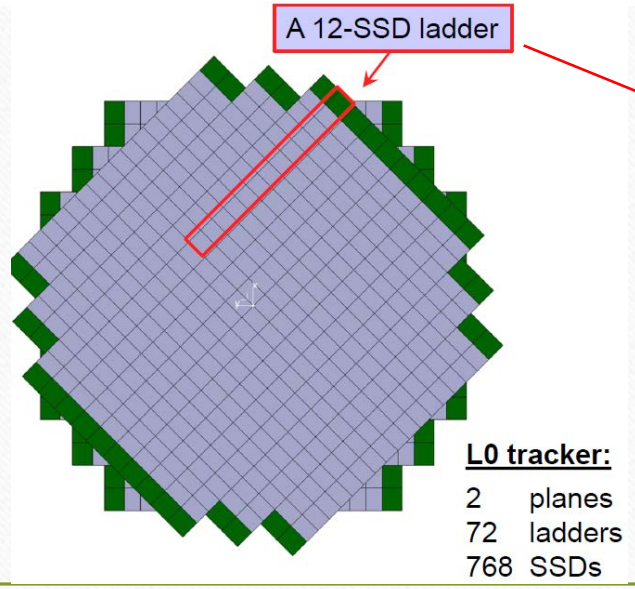
- 受限于统计量，现有AMS高能正电子误差还较大，不能区分暗物质和脉冲星来源【2,3】；【4】反质子测量在高能时的误差较大，本底的理论估计误差较大，还不能够确定高能反质子的来源。
- 需要增加探测器接受度-第零层。

L0 硅径迹室的升级

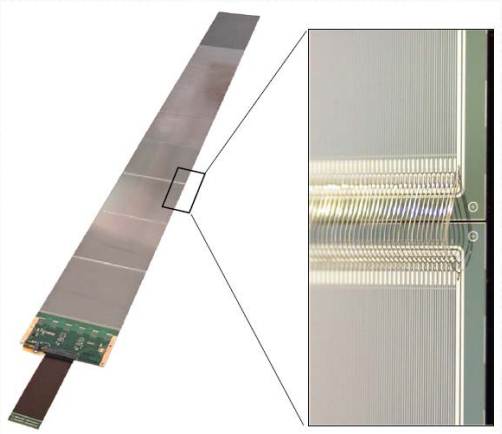
面向高能宇宙线的空间探测，需满足稳定、可靠和抗辐照等整体性能要求。

难点：传感器对齐。多个独立芯片上的读出条通过对齐键合的方式得到每一路的信号，精度要求10微米，对组装的难度提出了前所未有的挑战。

方案：版标对齐（中方） vs 边缘对齐（意方）

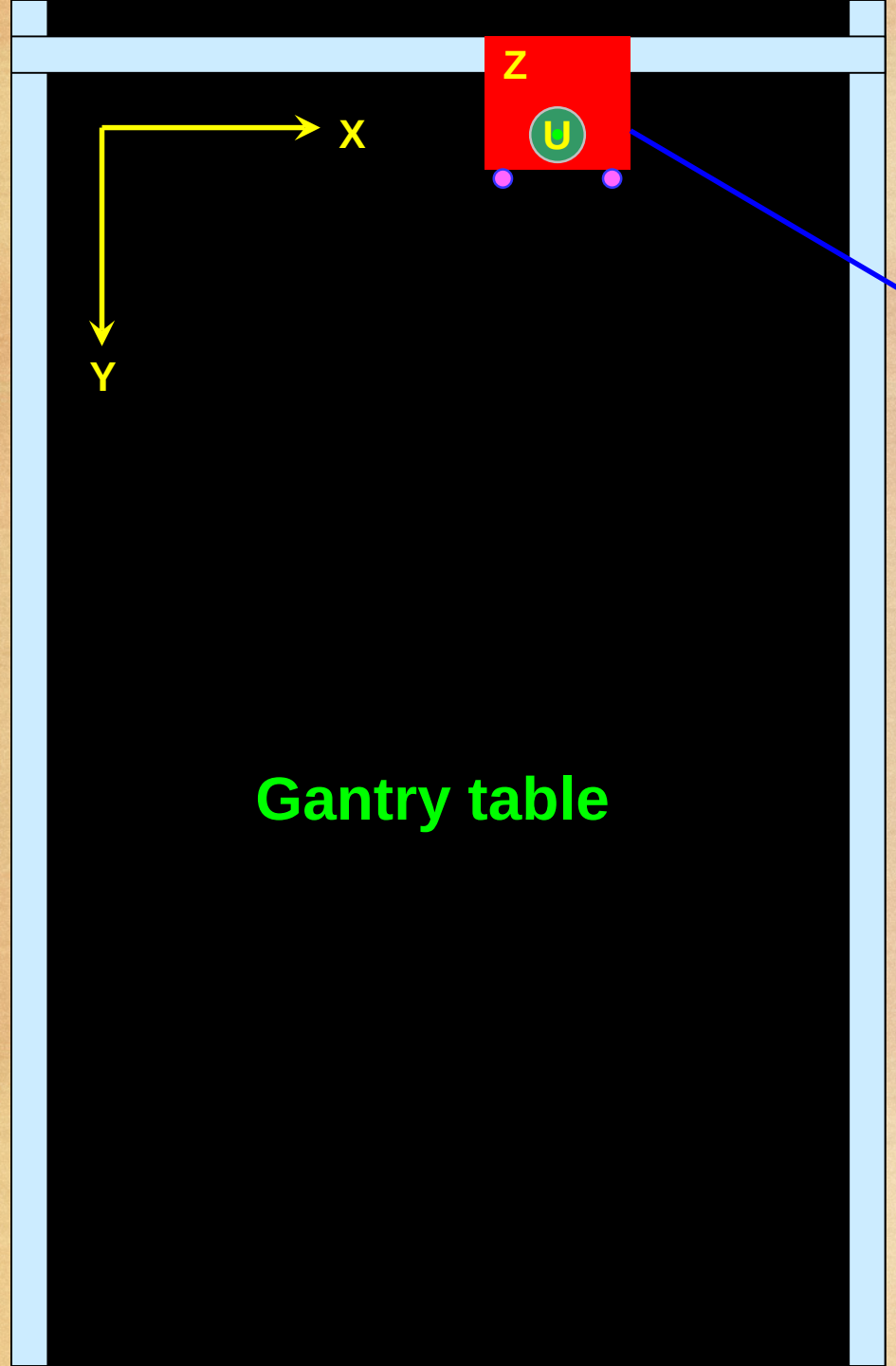


SSD Sensor: 8×11.3cm^2



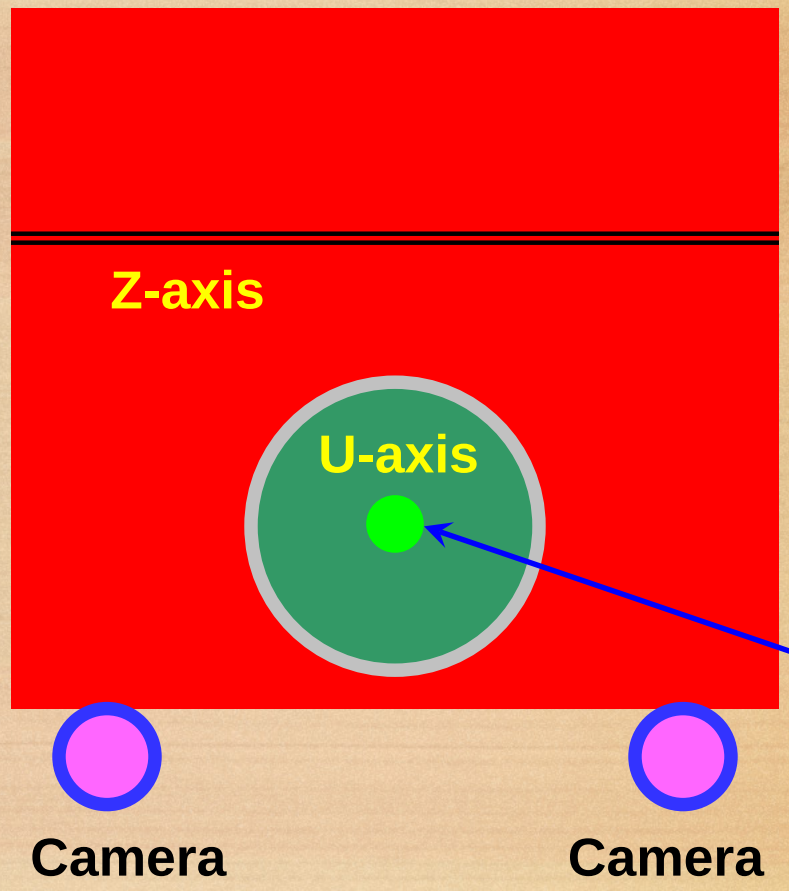
2. 进展

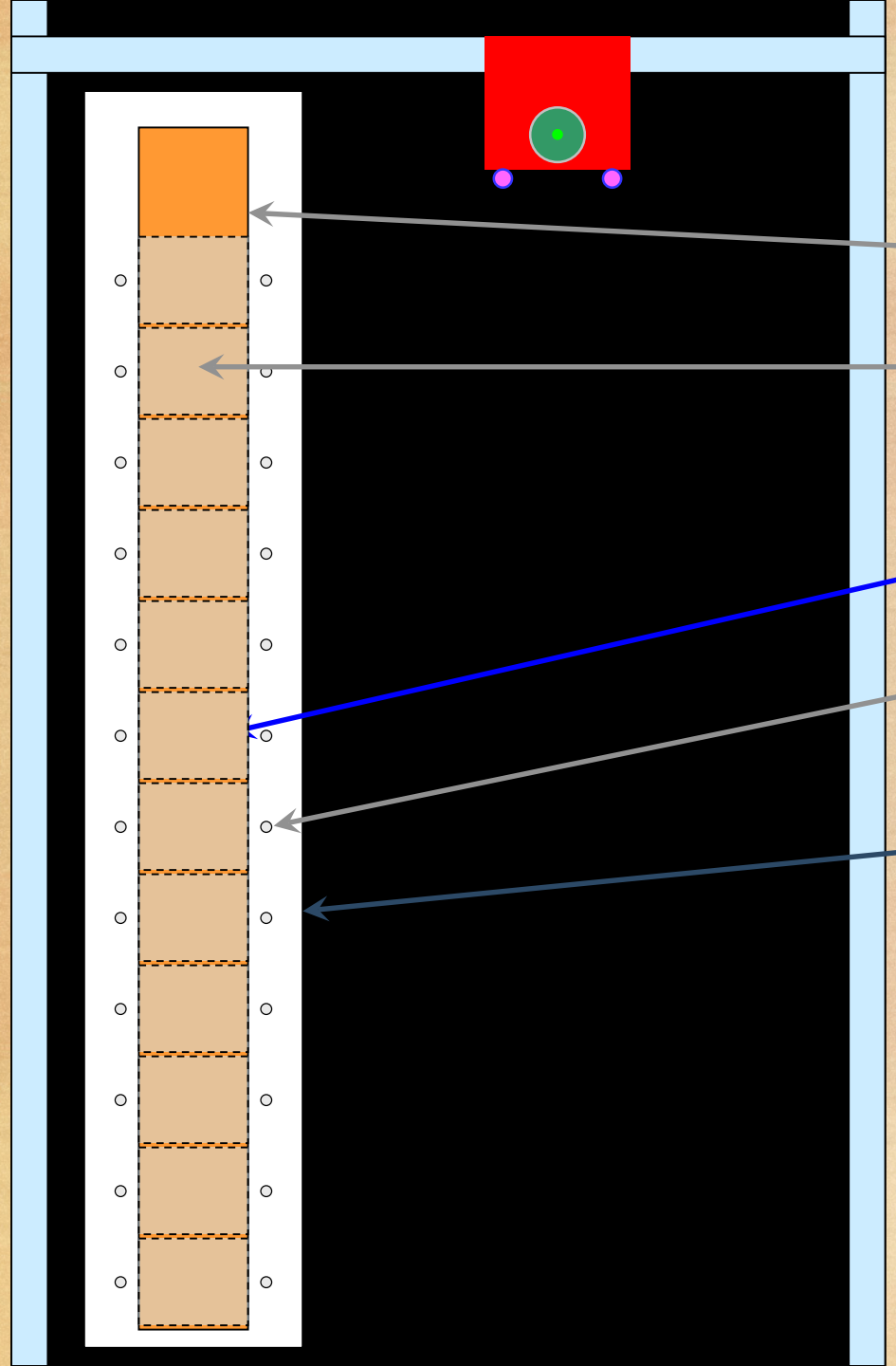
（1）传感器拼接方案



Not To Scale

Gantry Head





Ladder Flex Tape (LFT)

Target locations of the 12 SSDs

Vacuum holes for a ladder flex tape

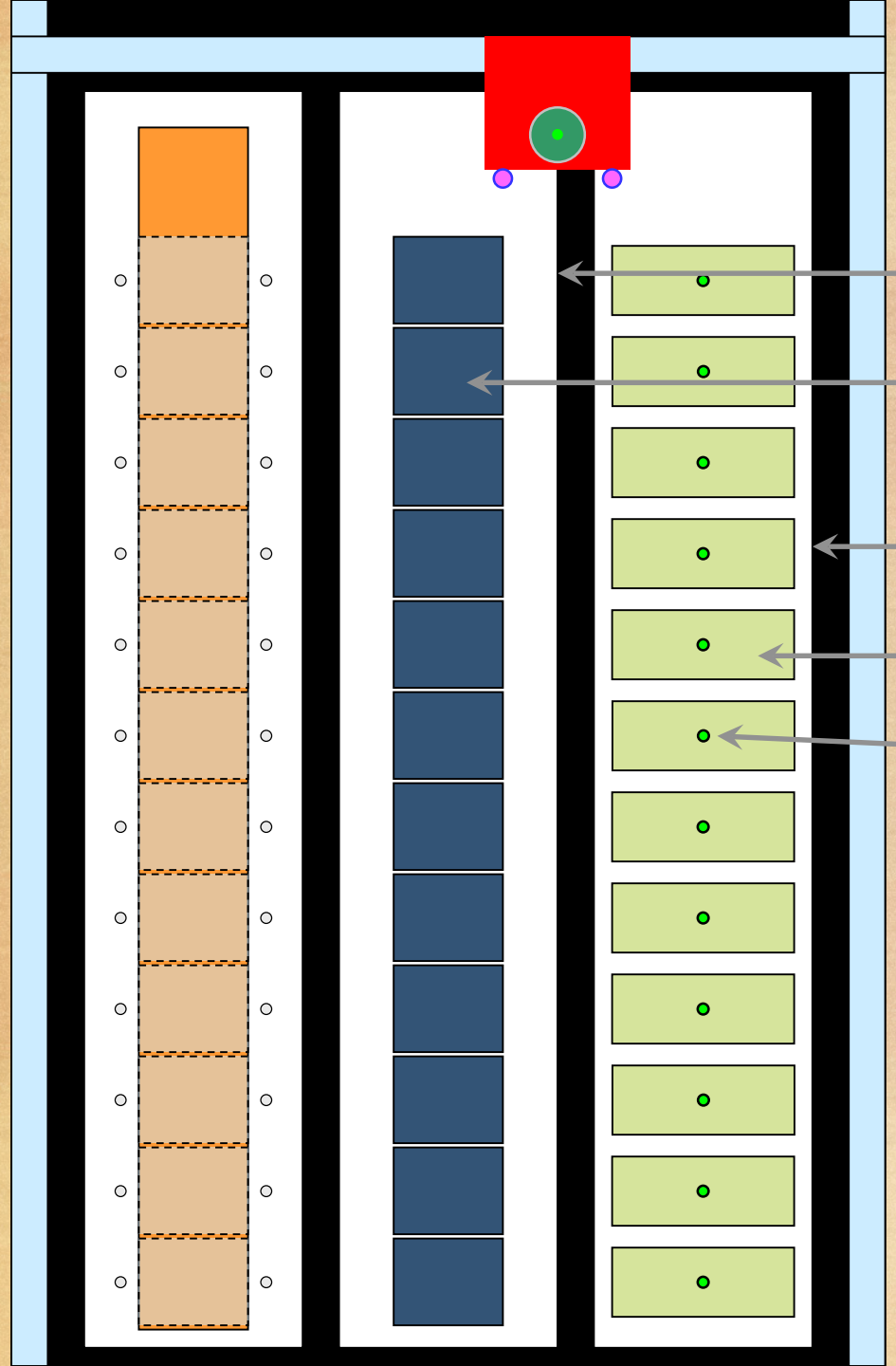
Vacuum holes for individual SSDs

(Number of holes are to be decided)

Ladder support

Step 1

- Place a LFT on top of the ladder support, and align using alignment marks
- Switch on vacuum to hold it down flat



SSD holder for pre-alignment

12 SSDs to be mounted

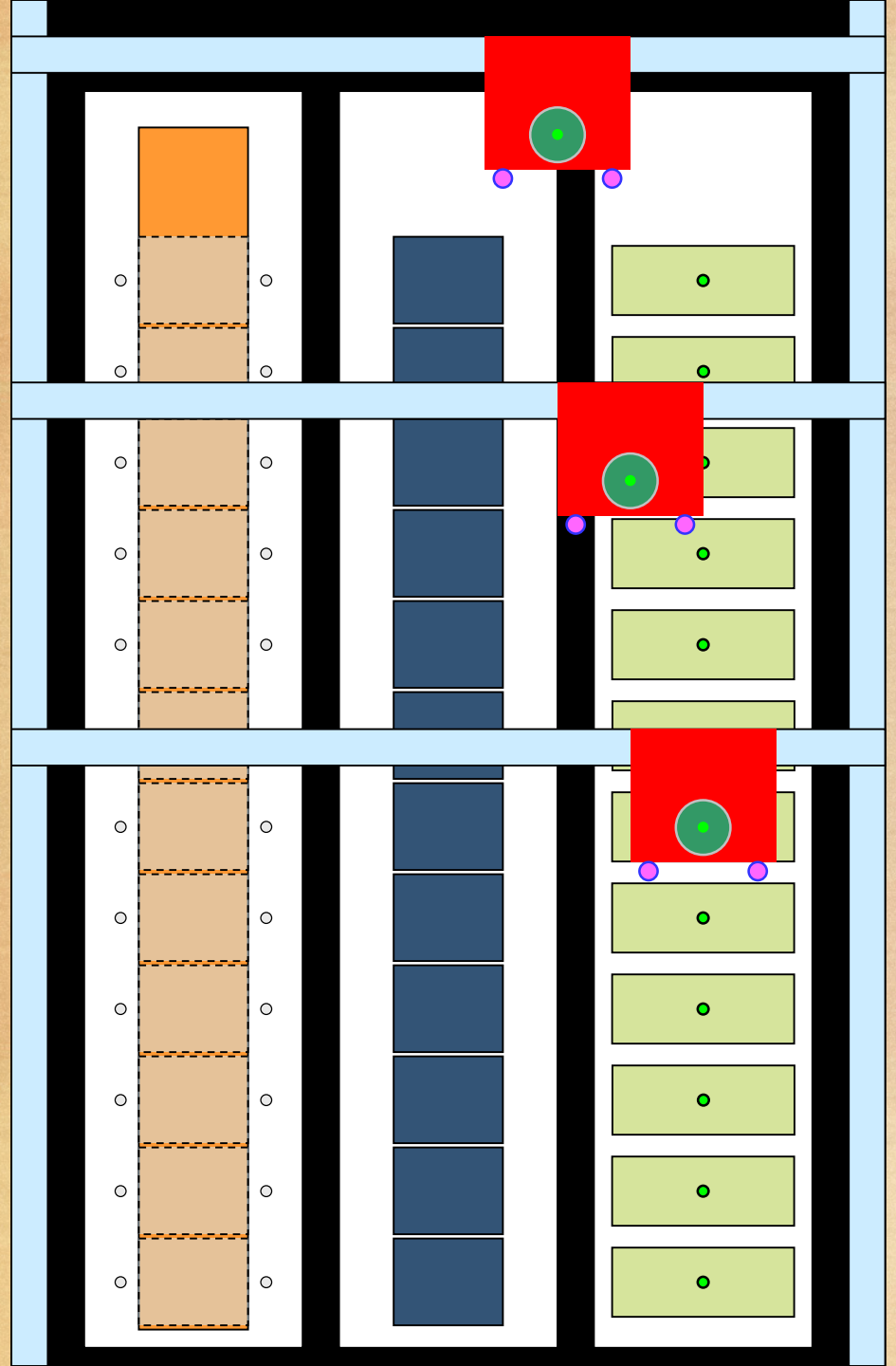
Pickup tool holder for pre-alignment

12 SSD pickup tools (SPTs)

Vacuum holes at the bottom

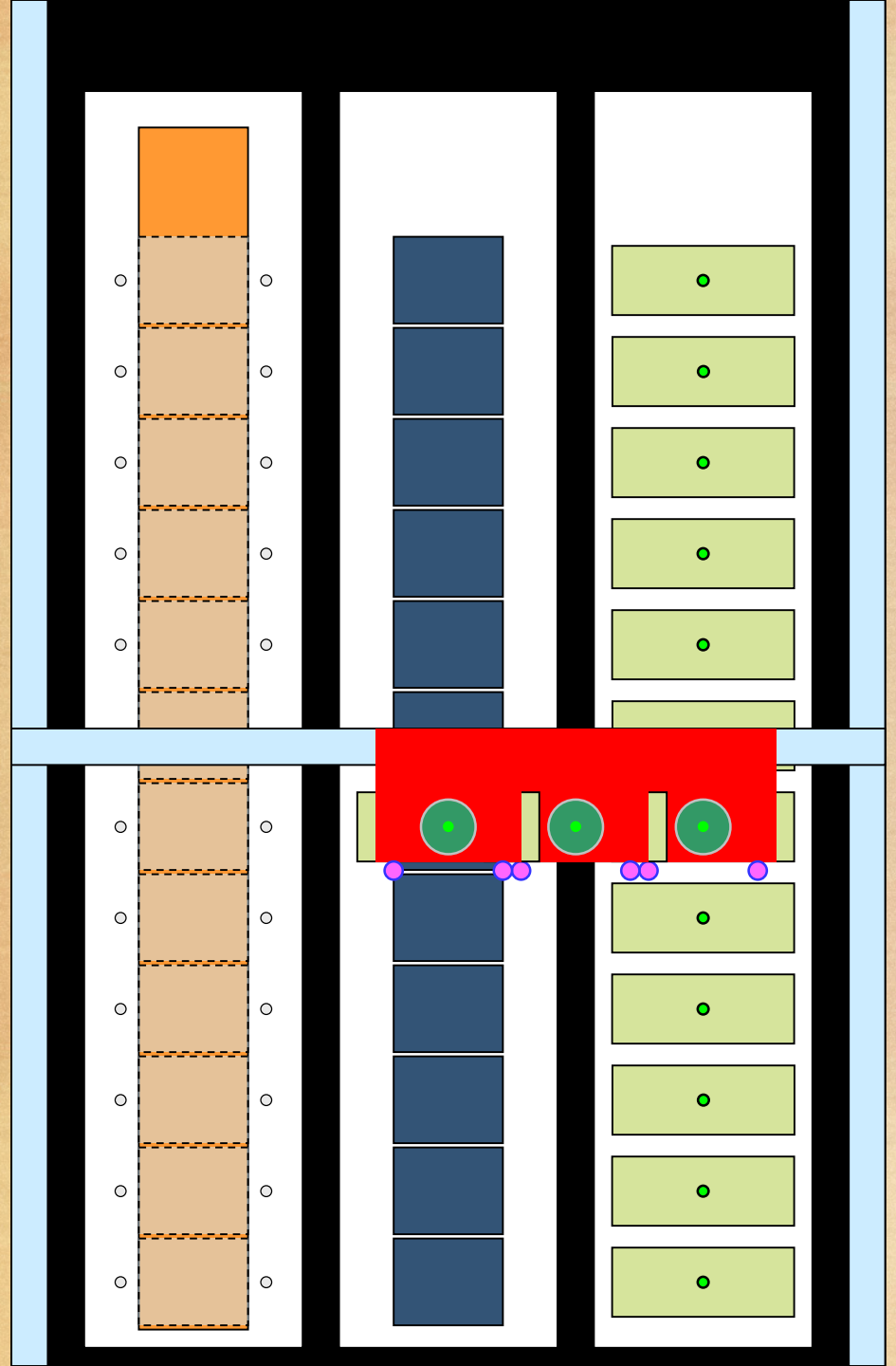
Step 2

- Place SSDs on their holder and pre-align
- Place SPTs on their holder and pre-align



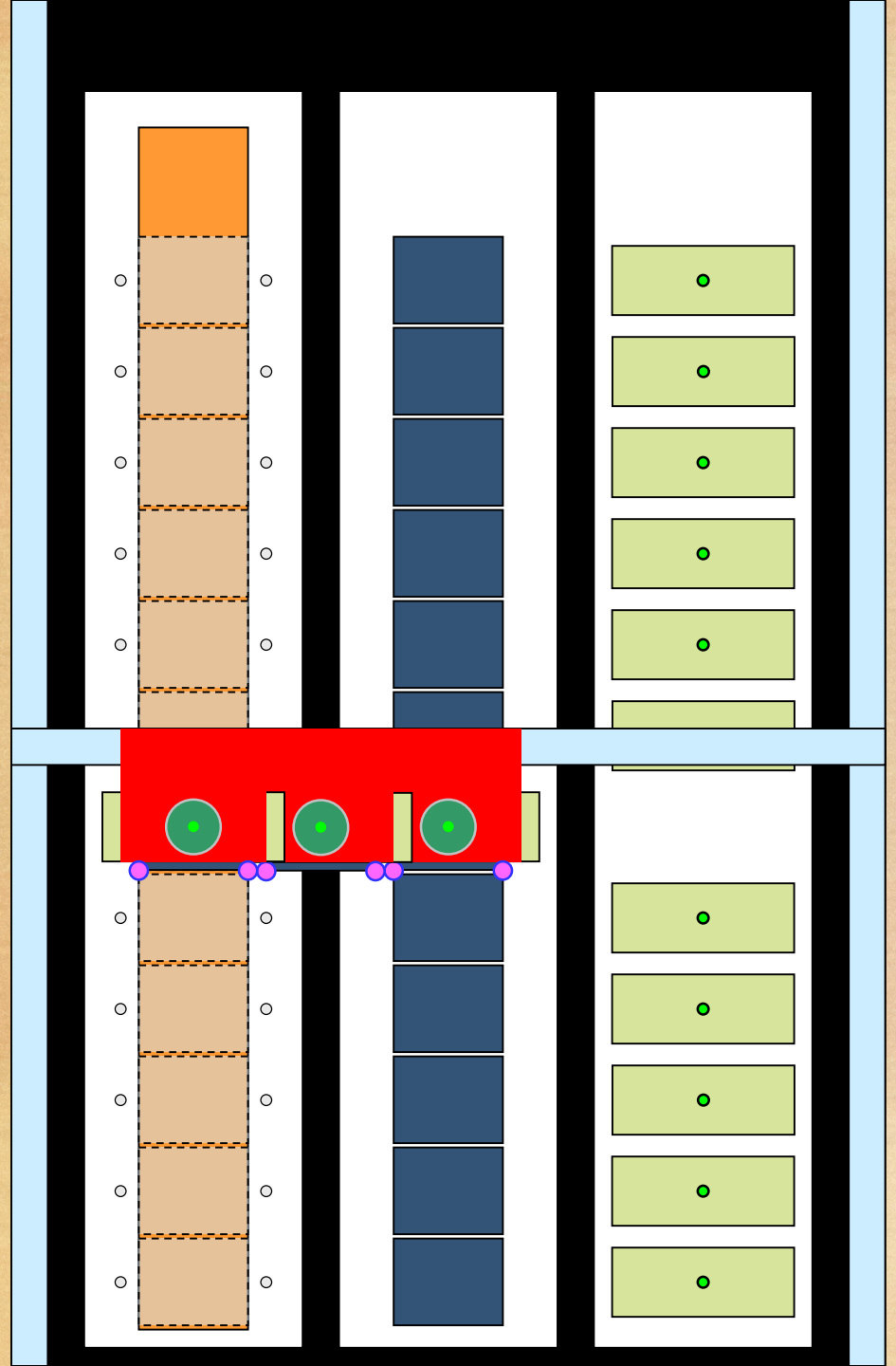
Step 3

- Move gantry head on top of a SPT
- Take the SPT by switching on vacuum



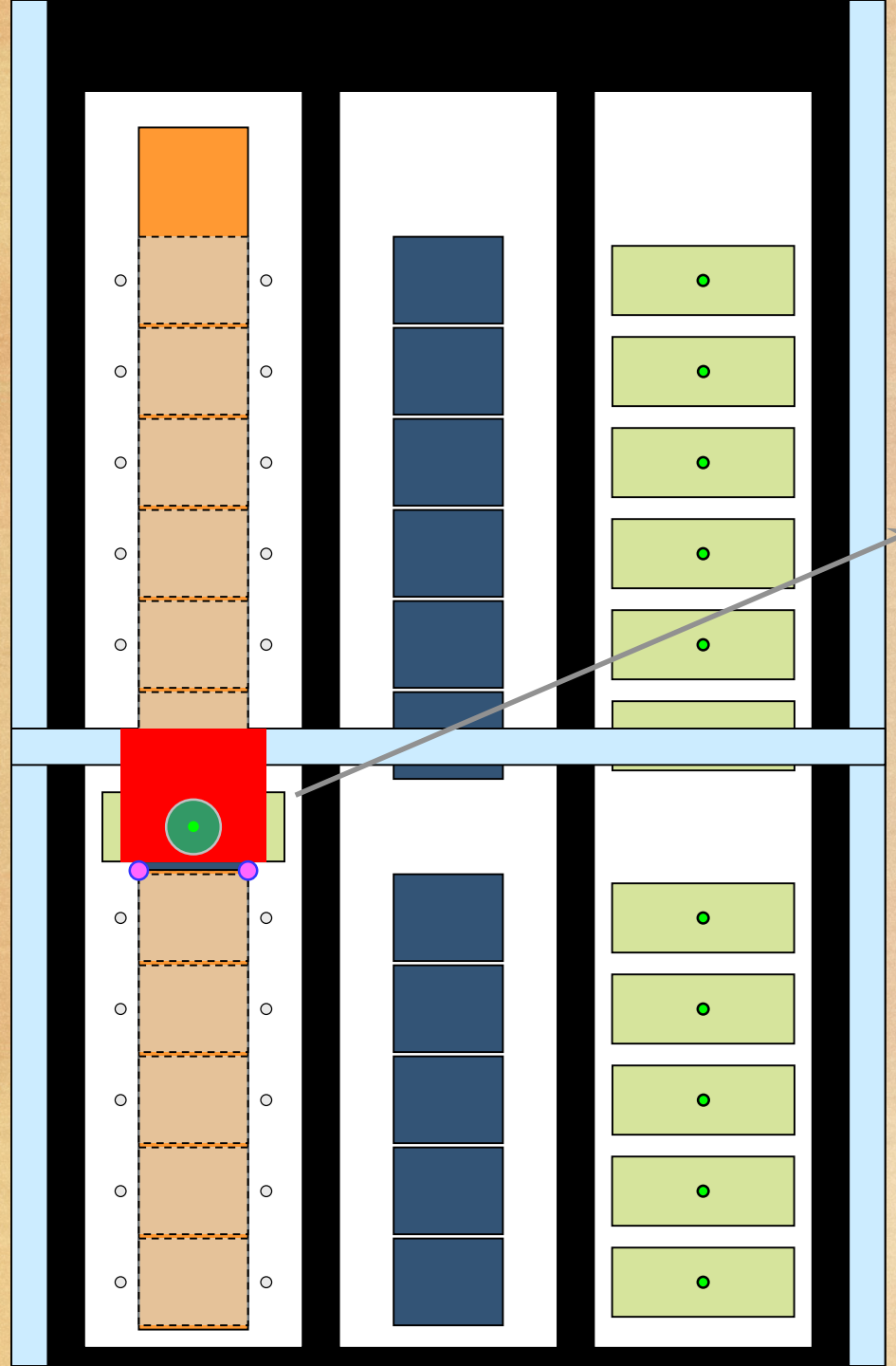
Step 4

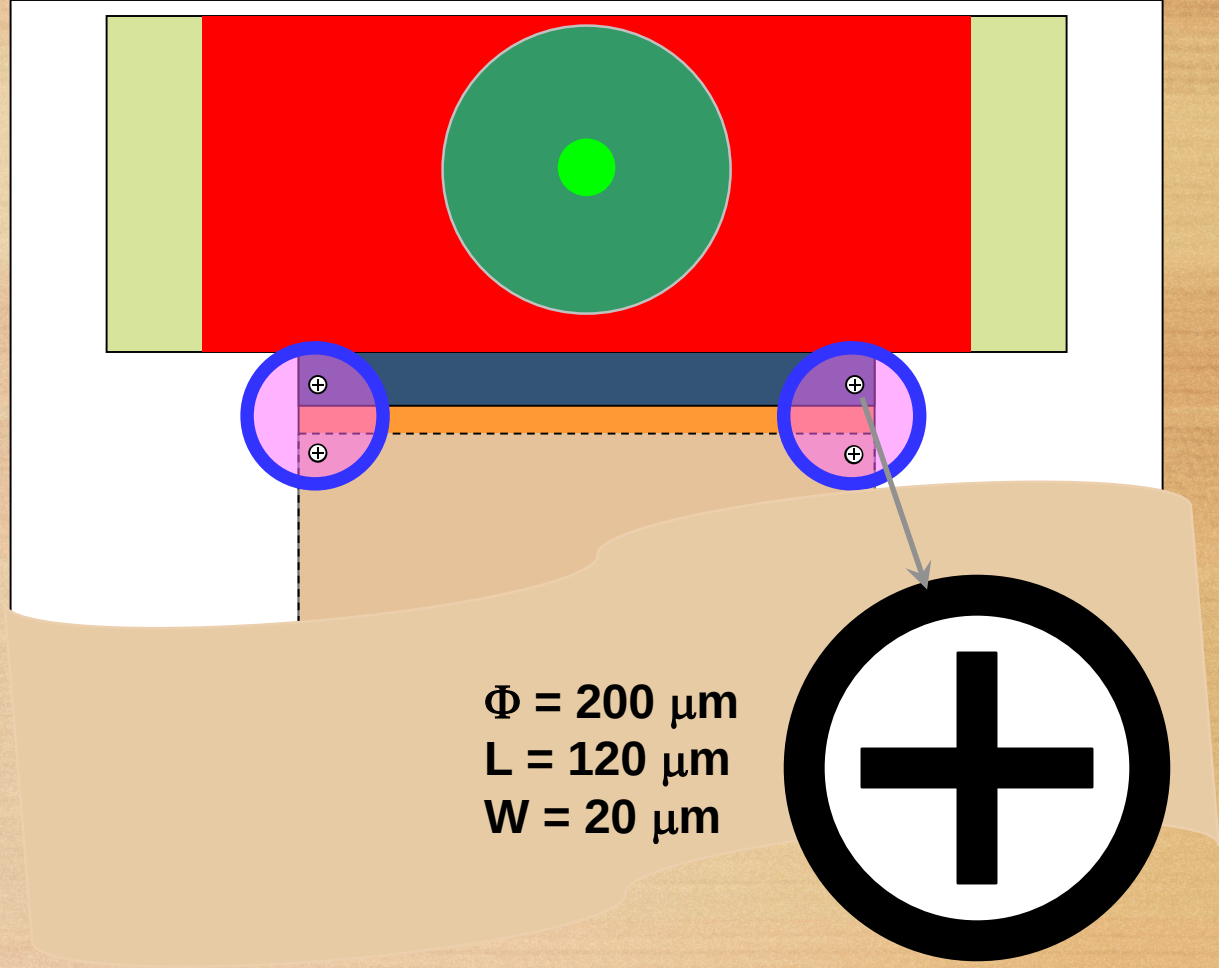
- Move gantry head with a SPT on top of a SSD
- Take the SSD by switching on vacuum on SPT



Step 5

- Move gantry head + SPT + SSD on top of the corresponding target location



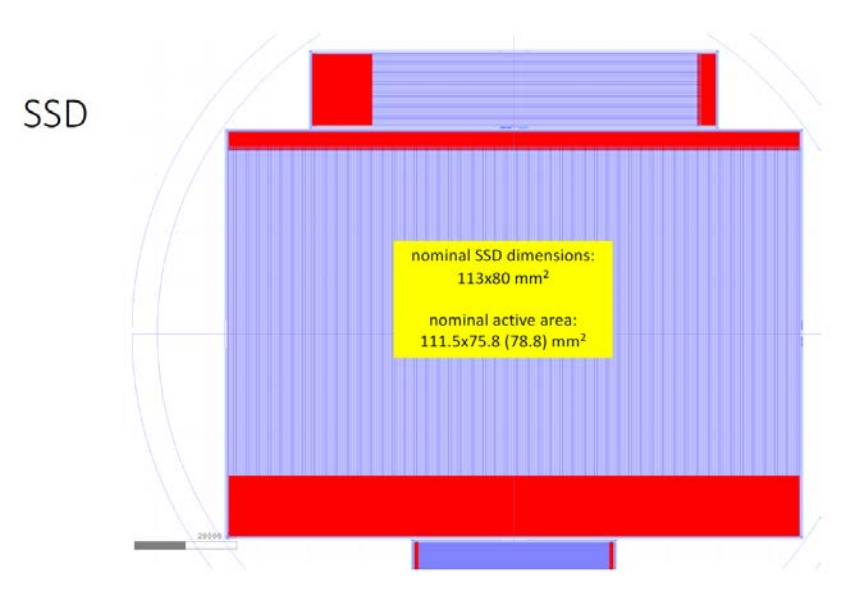


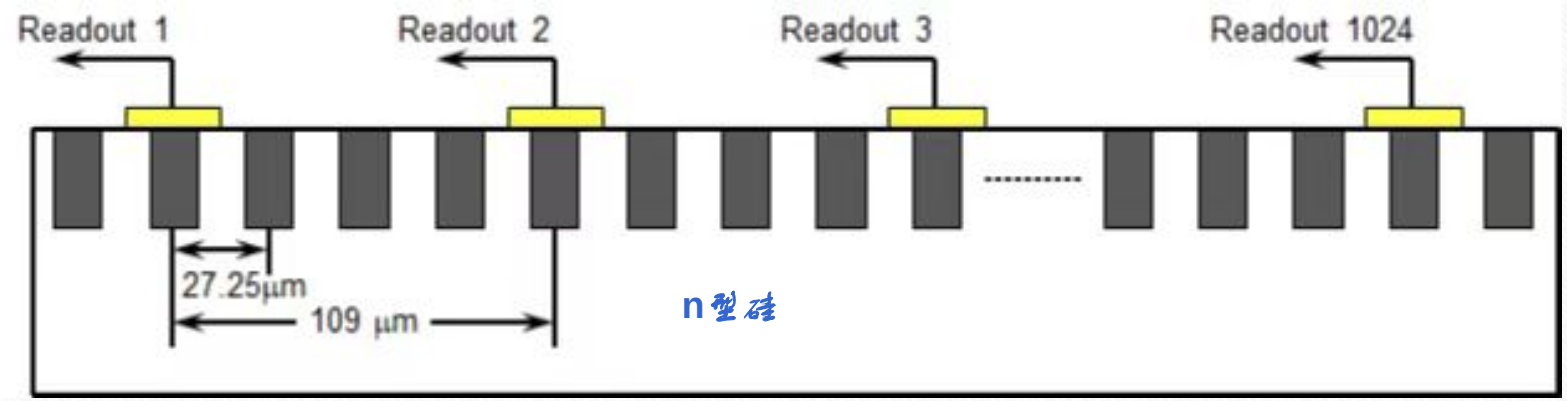
Step 6

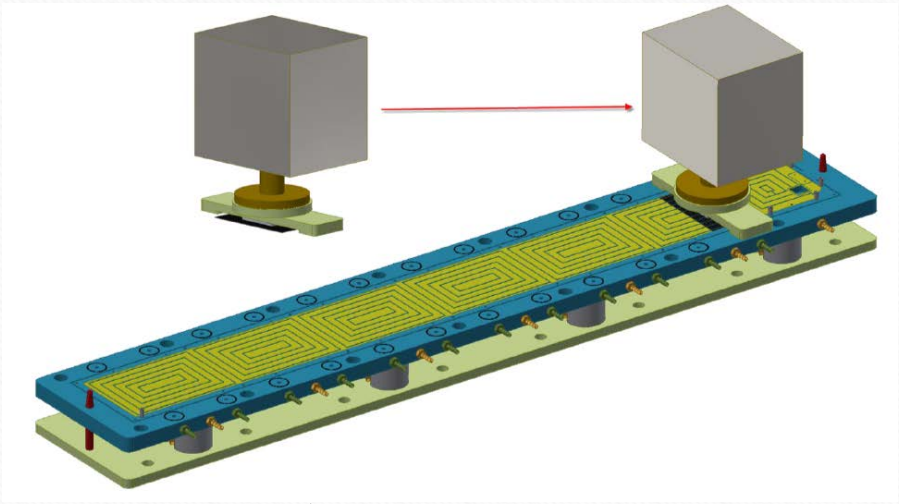
1) Further adjust the SSD wrt to its target location, using alignment marks via the cameras
2) Park the SSD and the SPT

2. 进展 -（2）Layer0 Customized SSD for AMS02 SiTrk

- 芯片尺寸：113mm×80mm
- 厚度：320μm
- 读出条间距：109μm
- 读出条个数：1024路
- 每个单元4条，条间距为27.25μm
- 条宽：10微米
- 读出方式：单端 AC
- Full depletion voltage：50V

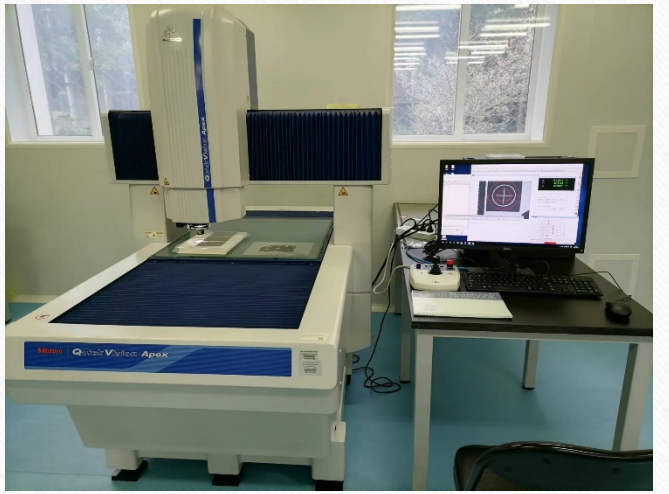


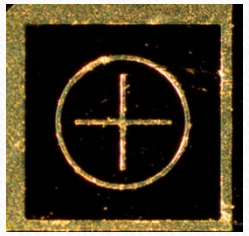




组装的某一环节

影像仪检查 试验版　Dummy sensor





目前，亟待组装的验证。

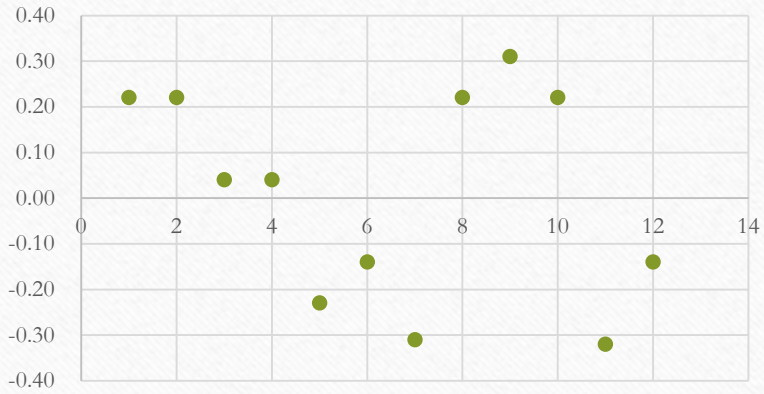
自主设计的全套工装：预计8月11号全部到实验室；

原型机传感器芯片：预计8月17号；

Dummy sensor：已到20片

Ladder PCB：已到12片

位置精度



3.小结和计划

① 研发了一套依赖版标对齐的组装方案；
② 完成了传感器的设计；
③ 未来半年将全面开展模拟组装、实现目标精度，年底完成预生产；
④ 要求2023年底完成L0径迹室所需的全部硅探测器模块。

谢谢大家！

Reference

[1] W.J.Buiger et al, Nuclear Instruments and Methods in Physics Research A 593 376 (2008)
[2] M. Aguilar et al, (AMS Collaboration), Phys. Rev. Lett. 122, 041102 (2019)
[3] M. Aguilar et al, (AMS Collaboration), Phys. Rev. Lett. 122,101101 (2019)
[4] M. Aguilar et al, (AMS Collaboration), Physics Reports 894 (2021)