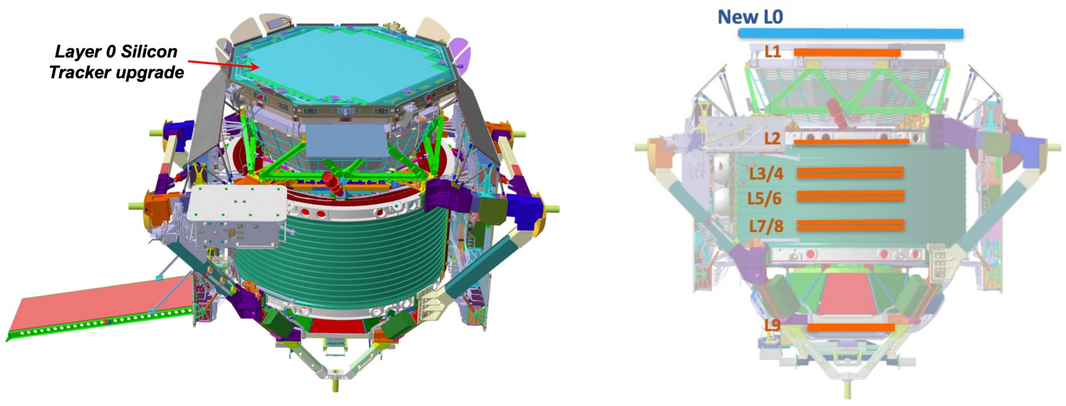
AMS-02 L0 Ladder Assembly Using a Robotic Gantry

Baasansuren Batsukh[1] on behalf of the AMS-02 upgrade team

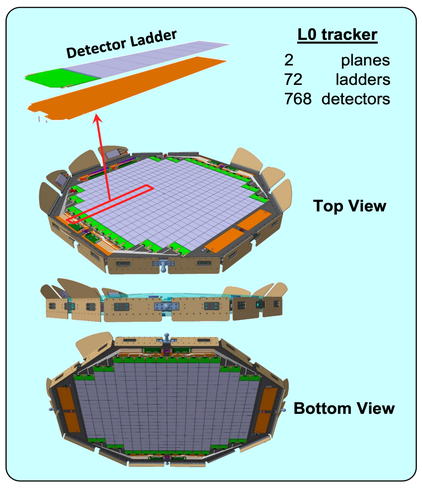
Institute of High Energy Physics[1], CAS

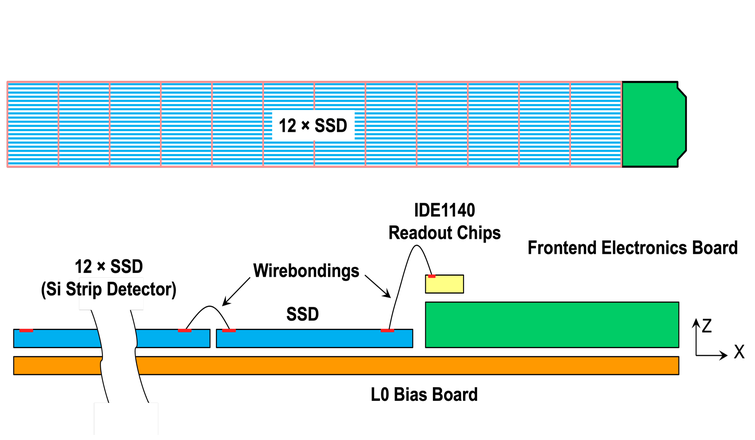
AMS-02 and L0 upgrade

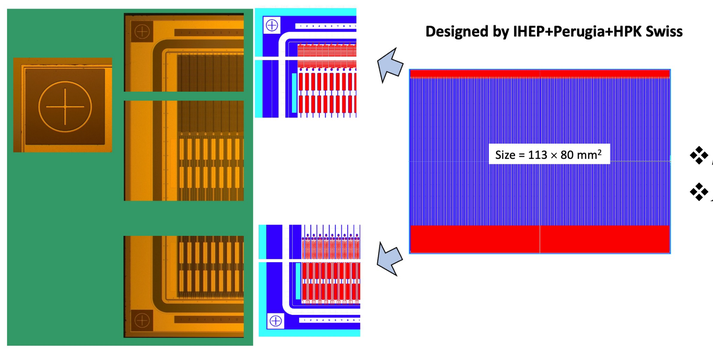
AMS is a multipurpose particle physics detector that was installed onboard the International Space Station(ISS) in 2011. The objective of the experiment include indirect searches for dark matter, the primordial anti-matter, and the origin and propagation of the cosmic ray. The AMS-02 detector has a large acceptance of $0.5\,m^2 sr$ and designed to carry out precise measurements of charged cosmic rays. The detector includes: a silicon tracker, the four planes of time-of-flight scintillation counter, transition radiation detector TRD, a ring imaging Cherenkov detector, an electromagnetic calorimeter, and the permanent magnet.



The L0 layer consists of two planes. Each plane is made up of 36 ladders and there are three types of ladders (with 8, 10 and 12 SSDs). The main responsibility of the Chinese team is to build ladders with silicon strip detectors (SSDs) using robotic gantry. Alignment precision is to be $5\mu m$. Each SSD bears four fiducial marks and with a pattern recognition, alignment accuracy can be controlled. SSDs are glued on top of L0 Bias Board(LBB from now on) using conductive and structural glues. With this upgrade, the acceptance of the current detector will increase by 300% and the heavy ion identification will improve to the nickel.





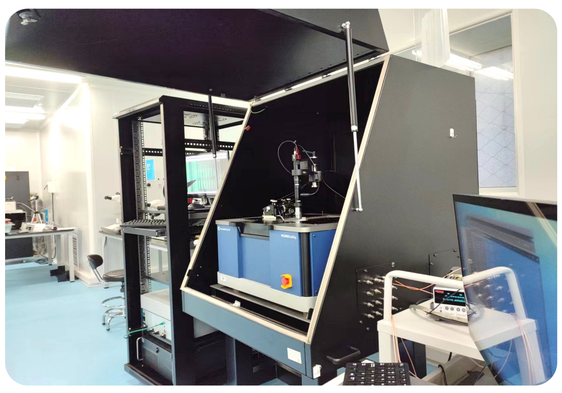


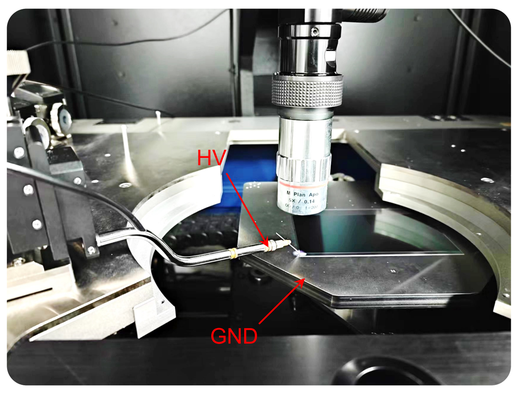
Highlights:

- ❖ *Special design of readout pads / bias resistors*
- ❖ *Alignment marks for precise placement*

Characterization and Quality Assurance of SSD

To select good SSDs for ladder production: visual inspection, IV, CV measurements are required.



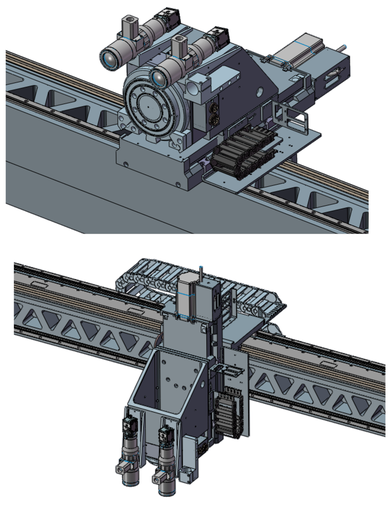


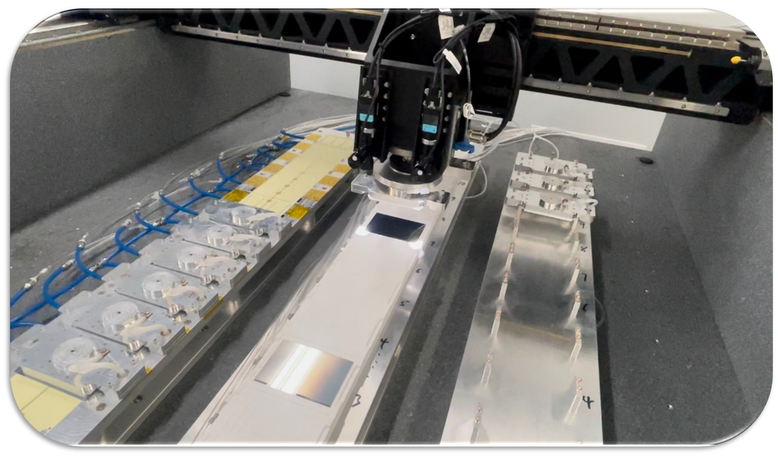
Pull Tester for Q/A of wire-bonding

Probe Station for Silicon Strip Detector Q/A

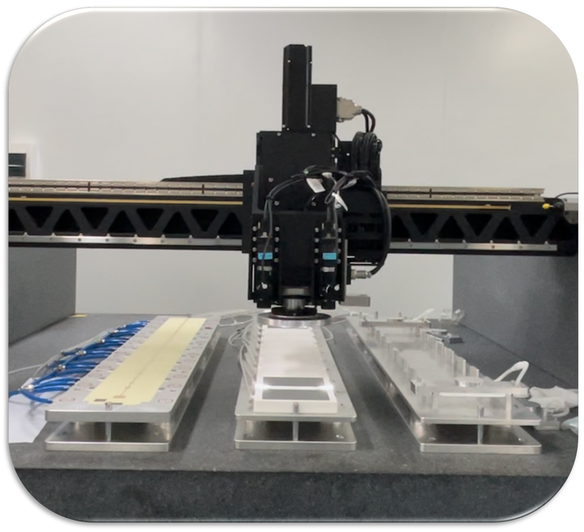
L0 Ladders and Assembly Procedure

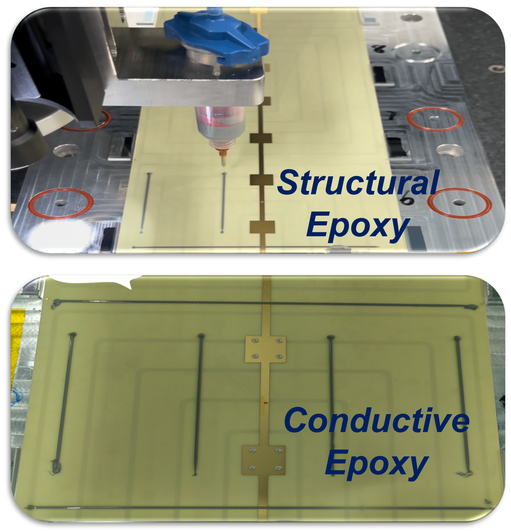
Robotic gantry consists of two cameras and can move in x, y, z and θ. Two camera will recognize two fiducial marks at the same time. This will provide the real-time coordinate information of SSD position that will be used for alignment.





Specific vacuum pick-up tools are made by a company. These tools will be picked up by the gantry head using vacuum pump. After this, vacuum pick-up tool will suck the SSD and bring it to the desirable location on top of LBB. Before these procedures, glues will be dispensed.





Once the ladder is assembled, alignment precision is assessed using an optical metrology system. The coordinates of all four fiducial marks on the SSDs are measured, and these measurements determine the alignment. We fit the X and Y coordinates to assess deviations along the vertical axis, as well as the vertical distances between two SSDs. The optimal vertical gap between two SSDs should be around 150μm. Thus far, we have achieved our goal of 5μm precision along the horizontal axis.