Silicon detector module quality control demonstrator in Lebedev Physical Institute Moscow



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SPD at NICA — 7 June 2019



Group experience since 1999 in pixel detector assembly and tests

- Assembly and tests of currently working silicon pixel modules of ATLAS detector (LHC CERN).
- Assembly and tests of pixel module prototypes for ATLAS upgrade phase II



ATLAS Pixel modules (LHC CERN) 150 \times 50 μm pixel size







Members of our group were taking part in assembly, testing and tuning of currently operating ATLAS Pixel modules in collaboration with INFN Genova colleagues including

- Flex to bare module attachment
- Optical inspections
- X-ray microscope inspection
- Digital, analog and source pixel by pixel inspection
- Threshold tuning
- Module mounting on the mechanical supports
- Thermal tests of separate modules and assemblies of 13 modules on stave (C-C)
- Pixel detector production database creation and support

ATLAS pixel module prototypes for upgrade phase II (2026 HL-LHC CERN) $50 \times 50 \ \mu m$ pixel size

Nowadays we do the similar work for ATLAS upgrade phase II Pixel module prototypes. Our group perform now:

- Flip chip operation •
- **Optical inspections** •
- X-ray microscope inspection

We plan:

- Digital, analog tests
- Threshold tuning •

07.06.2019

- Source / X-ray tube pixel by pixel inspection •
- Thermal tests (stress test, thermal cycling)





Typical module quality control demonstrator components



Clean room



Cooling system



PC + programmable power supply for automatic module scan



Module specific adapter card



Radioactive source / X-ray tube

System for module quality control in LPI

- Clean room: under construction (to be completed in 2019 2020)
- Cooling system: under construction (to be completed this year, 2019)
- PC + programmable power supply is installed, working with ATLAS pixel module adapter card, tested on prototypes
- Radioactive source: to be ready in 2019 2020
- X-ray tube + positioning system are ready, waiting for X-ray tube power supply, to be installed in 2019



Clean room

The project of our clean room is ready, the main parameters are:

- 8.5 m²
- Ceiling height 2.9 m
- ISO8 standard
- Humidity 35 ÷ 70 %
- T 16 ÷ 28 °C
- ΔT = 2 °C /hour
- Antistatic floor



X-ray tube system

X-ray tube characteristics

- 10^{13} photons/s $\times 4\pi$
- 3 \times 10⁵ photons/s @10 mm distance \times 5 mm² spot with 20 μ m collimator
- $< E_{\gamma} > = 20 \text{ keV} = > 5 \times 10^3 \text{ MeV/s} / \text{pixel}$
- Changing tube current, the collimator diameter and distance, the flux can be reduced to 1 photon / pixel

Precise positioning system Cutmaster CM-D323S

- Operating field 325x230x100 mm
- Position precision 10 μ m
- Shift velocity 2000 mm/min





Possible radioactive sources

In ATLAS Pixel modules tests we used ${}^{90}_{38}{
m Sr}$; ${}^{241}_{95}{
m Am}$

- 37 MBq; 370 MBq
- Active diameter: 4.2 mm
- Stainless steel window 0.2 0.25 mm
- Photon output 60 keV
- Activity tolerance +/- 10 %

Thermal tests

2 kinds of test are proposed

- "Failure Range" -55°C to 40°C to be performed on the selected modules
- "Operation Range" -40°C to 20°C to be performed on all the modules

We plan to equip our lab with a climate chamber (Binder MKT 115 is put here as an example)





225 200 175 150 125 100 750 500 **MKT 115**

Conclusions and plans

The group experience and our laboratory equipment can be used for SPD NICA future silicon detector construction and tests

Spare slides

First flip chip with SET FC-300 in 2016

X-ray microscope and electronic microscope investigations



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