

Flexible Printed Circuit Board for Positron Tracking Detector of J-PARC Muon g-2/EDM Experiment



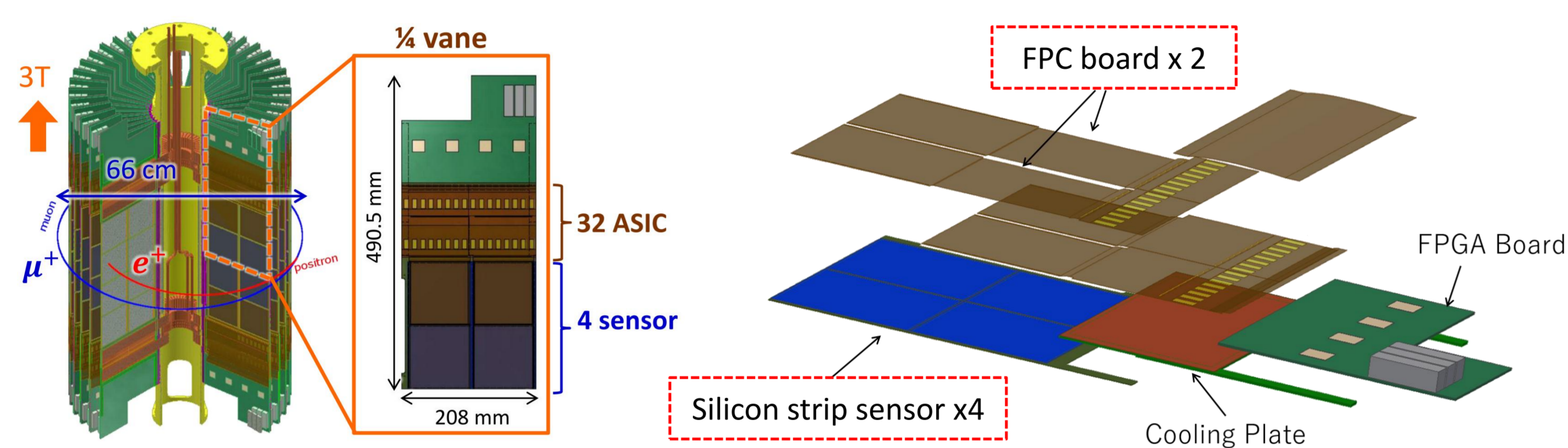
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in Collaboration with KEK & Kyushu University



1. Introduction

- J-PARC Muon g-2 / EDM experiment aims to measure muon g-2 and EDM values precisely and search for a new physics beyond the standard model.
- KEK and Kyushu University have been developing a decay e^+ tracking detector to measure the decay time, momentum and emission angle of positrons generated by the decay of muons with high accuracy.
- FPC (flexible printed circuit) board is one of the important parts of the detector to transmit signals from the silicon strip sensors to ASICs when positrons hit the silicon strip sensors in the detector.
- Fujikura has developed the FPC board for the detector.



Decay e^+ tracking detector FPC board in the detector

2. Requirements

- FPCs are usually so small and thin that they can be used in electronic devices such as cellphones.
- However, the FPC used in the silicon strip sensors are quite large (100 mm x 100 mm x 2 sensors). Nevertheless, since the sensors has many sensor units (1,024 channels each), the FPC needs to accommodate fine circuits.
- The amount of FPC board materials need to be minimized to reduce multiple scattering.

【Requirements for the FPC board】

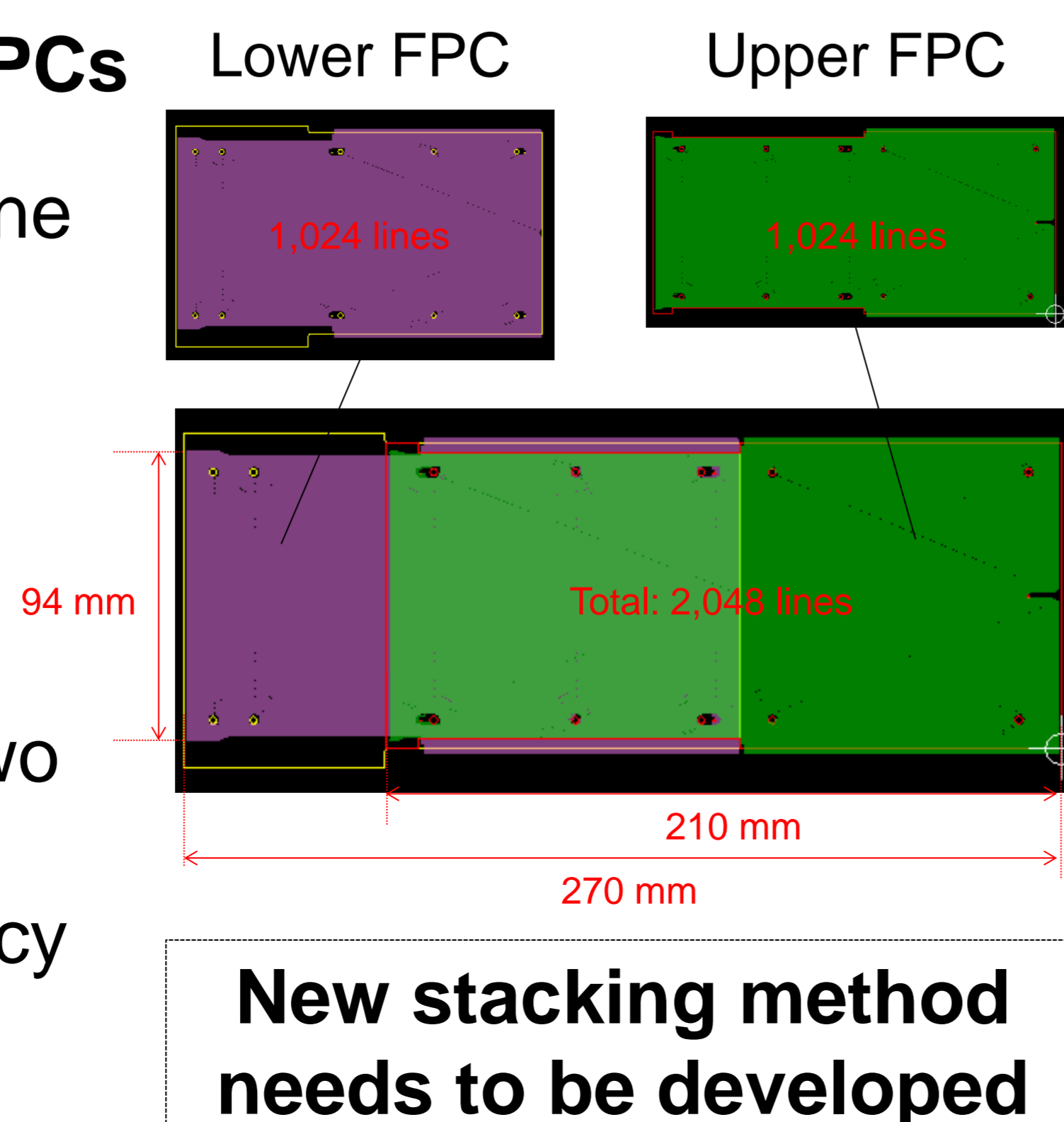
	Requirements
Circuit width	Min. Line/Space = 35 μ m/35 μ m
Number of circuit	2,048 (for two sensors)
Circuit length	Max. Length = 200 mm Line/Space = 25 μ m/58.5 μ m
Circuit thickness	Cu: 5 μ m
Pad size	ASIC side: 60 μ m x 200 μ m Sensor side: 140 μ m x 400 μ m
FPC size	210 mm x 94 mm

3. Challenges

- We had many challenges in production of the FPC board, and two of them were especially complicated.

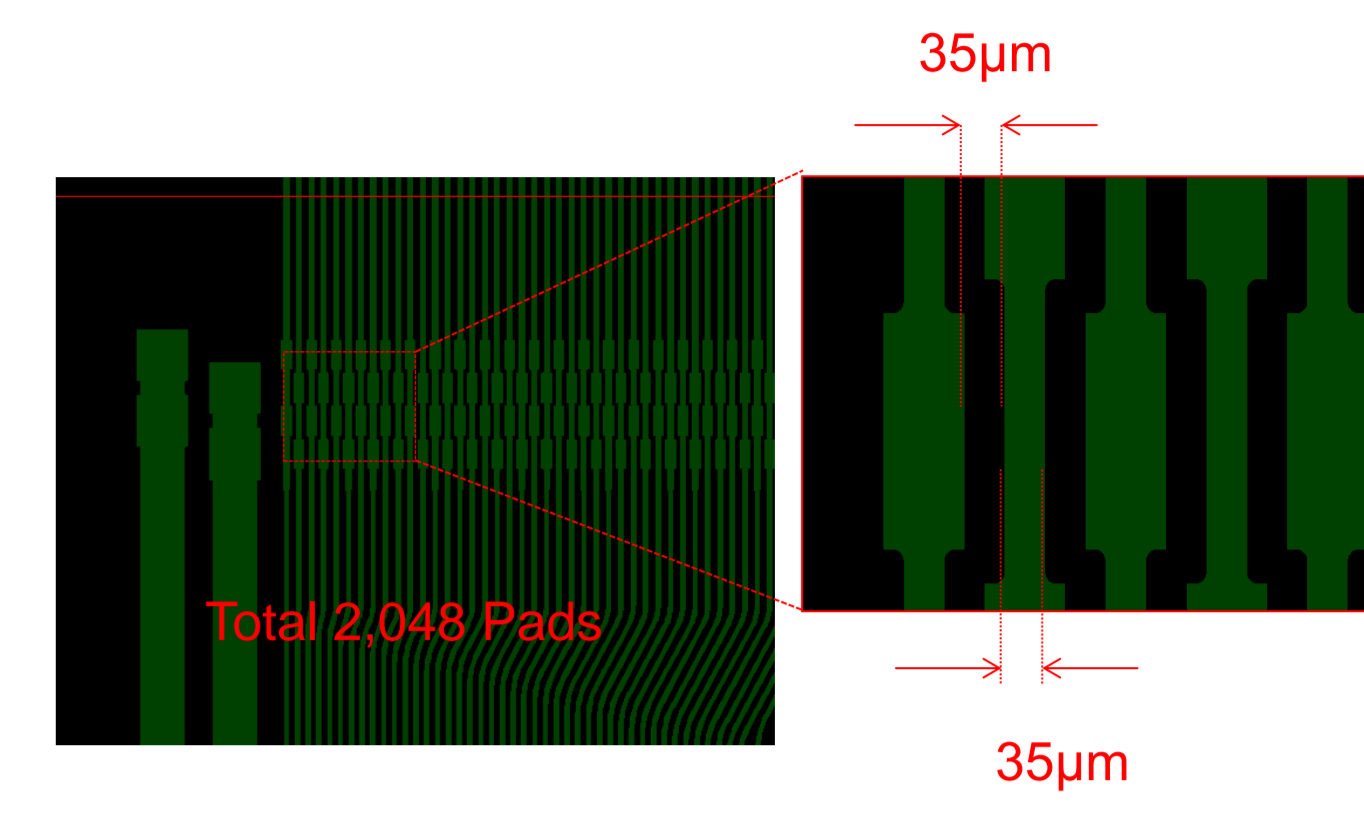
(1) Partial Lamination of two FPCs

- If 2,048 circuits are put into one FPC, the pitch between the 2,048 traces (line/space = 10 μ m/15 μ m) is too narrow and exceeds our design limits.
- Thus we made two FPCs separately and stacked the two FPCs together.
- The required stacking accuracy shall be within $\pm 100 \mu$ m.



(2) Formation of very fine circuits in large area

- We need to make 1,024 circuits of which pitch is our design limit (Line/Space = 35 μ m/35 μ m) in the large area.
- Just one foreign matter larger than 10 μ m can cause critical problems in circuit formation.



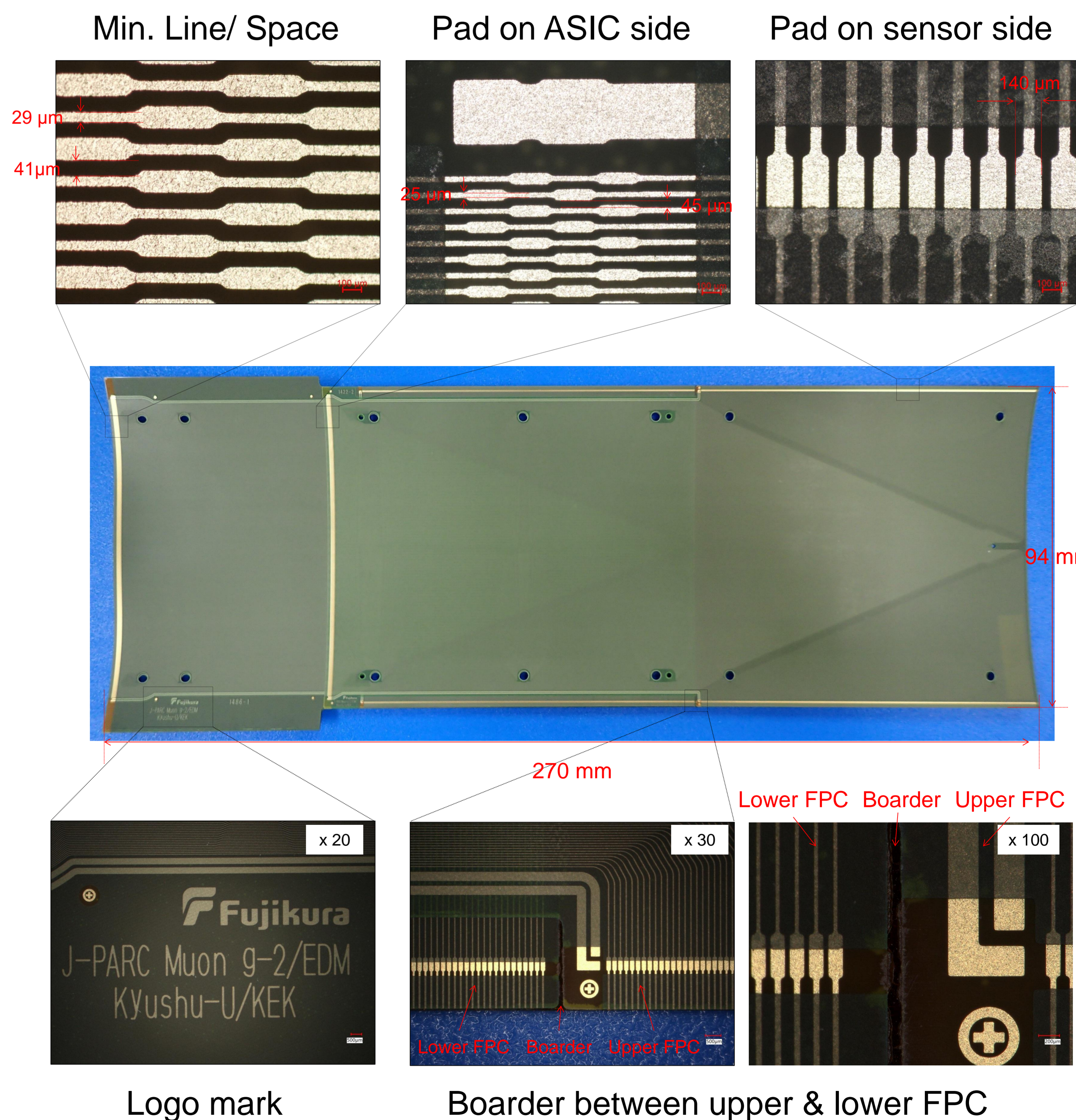
Minimum Line/Space

In forming the 1,024 circuits (Min. Line/Space = 35 μ m/35 μ m) in a 94 mm x 210 mm area, the cleanliness of our production environment must be kept severely.

4. Results

- We formed the fine circuit by using a direct imaging exposure machine, which is less affected by contamination than a typical mask-type exposure machine and by improving the cleanliness of our production environment.
- By developing a special stacking fixture and adjusting the stacking press condition, we succeeded in stacking 2 FPCs together within $\pm 100 \mu$ m.
- After many trials, we finally succeed in making the FPC board that satisfies all the requirements.

【FPC board for the positron tracking detectors】



5. Conclusion

- The large-size FPC board with high-density circuits is required for the positron tracking detector of J-PARC Muon g-2/EDM experiment.
- We succeeded in developing the FPC board by improving our production conditions and environment after many trials.
- The FPC board has already been delivered for the experiment.