

# Flex-PCB Pitch-Adapters for Silicon Micro-Strip Detectors\*

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## Introduction

Silicon micro-strip sensors for tracking detectors with high spacial resolution feature a vast number of channels. A single detector can have up to one thousand channels per side to be read out. With a strip pitch in the order of tens of micrometers, a high interconnection density between the detector and the front-end chip is required. In most cases the read-out pitch of the sensor and the input pitch of the front-end chip do not match. Thus, an interconnection device between sensor and front-end is required to adapt for this. These pitch-adapters are often made by thin film technology on a glass or ceramic substrate. This report demonstrates the effort to use advanced flex-PCB technology as pitch-adaptor. This development was carried out for the Micro-Vertex-Detector (MVD) of  $\overline{\text{P}}\text{ANDA}$  [1].

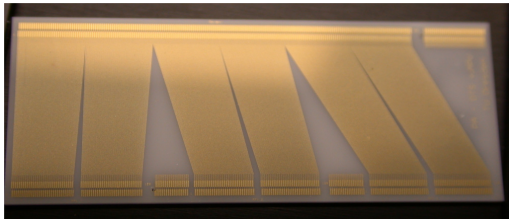


Figure 1: Photograph of the pitch-adaptor design based on thin film technology [2].

## Pitch-Adapter Design

Prototyping for silicon strip sensors was done with a pitch-adaptor made by thin film technology with a wire structure of  $2.0\ \mu\text{m}$  thickness made from TiW with gold plating for wire bonding. The pitch is  $44.0\ \mu\text{m}$  on the front-end input side and  $50.0\ \mu\text{m}$  on the sensor side using two staggered rows of bond pads. A change of the sensor or the front-end would need a redesign with a new set of production masks. Therefore, the possibility to reach the same interconnection density employing standard PCB-technology was explored. In order to reach this aim, a two-layer design of flex-PCB was chosen. This was necessary since the trace width of  $35\ \mu\text{m}$  is larger than using thin film technology. The traces on the bottom layer are connected to the top bonding pads using laser-drilled microvias of  $50\ \mu\text{m}$  diameter [3].

The production with standard industrial methods will allow the pitch-adaptor to be seamlessly integrated into the

front-end hybrid circuit. In addition, the flexible material permits the realization of detector geometries not possible using rigid hybrid carriers.

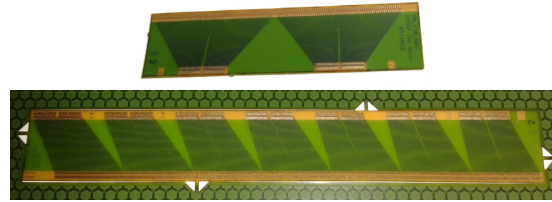


Figure 2: Photographs of two out of ten designs of flex-PCB pitch-adapters. Top: Design for two front-ends and  $130\ \mu\text{m}$  sensor strip pitch. Bottom: Design for seven front-ends and  $65\ \mu\text{m}$  sensor strip pitch.

## Results

A double-sided prototype module based on  $\overline{\text{P}}\text{ANDA}$  geometry sensors and flex-PCB pitch-adapters was produced and employed in a CERN test-beam. No changes in performance compared to thin film technology pitch-adapters were observed.

An electrical characterization measurement using an LCR-meter was performed to investigate the influence of the additional capacitance and resistivity introduced by the pitch-adaptor. The results indicate an additional crosstalk up to 2% and an increase in noise of less than 0.5% [4]. Advantages in terms of material budget arise from the small thickness and the material composition of flex-PCB. The radiation length of polyimide is  $28.6\ \text{cm}$  compared to  $7.4\ \text{cm}$  for aluminum oxide [5]. Therefore, a pitch-adaptor based on thin film technology made from aluminum oxide with a thickness of  $0.38\ \text{mm}$  yields 0.51 % of one radiation length. Whereas a pitch-adaptor based on polyimide films with a total thickness of  $50\ \mu\text{m}$  ( $25\ \mu\text{m}$  for core layer and coverlay respectively) exhibits 0.017 % of one radiation length.

## References

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- [2] RHe Microsystems GmbH
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- [4] S. Krah: “Entwicklung von Testsystemen zur Charakterisierung von Silizium-Streifen-Detektoren”, Diploma Thesis, Bonn, November 2012
- [5] PDG, Atomic and Nuclear Properties of Materials

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