Lycoris: A large area beam telescope based on hybrid-less silicon sensors

Wu, Mengqing (DESY) et al

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**Summary**

First application of the SiD hybrid-less micro-strip sensor:
- sensor with its readout characterized;
- Lab test with first module
- various run conditions tested/verified, able to see signal;
- First beam test with first module with a reference device
  - Signal response verified in terms of beam spot location and a landau shape;
  - First study on external trigger;
  - retrigger events solution found;
  - Signal efficiency determined with various run conditions;

**Outlook**
- Pedestal shifting issue under study;
- Module characterizing method verified/controlled;
- Project delivery due in Jan 2019.

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**Introduction**

The DESY II test beam facility provides e+e- beams with energies 1-6 GeV. A new large area beam telescope is being built to address many user demands for momentum measurements in a 1T solenoid.

**Requirements**
- At least 10cm along bending direction (y-axis);
- Limited space for upstream/downstream sensors to accommodate large Device Under Test: <= 3.5 cm (y-axis);
- Spatial point resolution minimum requirements:
  - \( \sigma_z = 10 \mu m \)
  - \( \sigma_y = 1 \) mm

**Lab Test**

Various data taking mode tested:
- **Calibration** – ADC/Charge response derived;
- **Pedestal** measurement – noise level determined;
  - Relative low noise level determined ~ 0.5 IC
  - Only Self-trigger mode tested:
- Noise Run with various setup, e.g. threshold scan
- Signal Run with 90Sr: Able to locate signal spot with relatively high threshold.

**Results and Discussions**

Using the self-trigger mode, external trigger are saved as time stamps:
- looping all channels with all events, one can get a time difference between self- and external triggers;
  - a timing cut can be determined for event selection;
  - a signal efficiency can be derived.

Self-trigger mode, with a lower threshold:
- events in correspondence with external triggers show a good landau behavior;
- SiN looks promising, but threshold dependent – room for improvement;
- Signal is ~2σ farther from the background only distribution.

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**SID Hybrid-less Micro-strip Sensor**

**KPIX Readout Chip**
- 1024 channel, pitch adapter;
- Digitization: 13 bit ADC resolution
- Can accommodate input clock up to 100 MHz, 10 ns resolution;
- Two trigger modes: self- and external trigger;
- Power cycled.

**Beam Profile**
- 5 GeV, 5 MHz trigger rate
- Collimator 9x9 mm

**Reference Device**
- Hexagonal pixel sensor (~6mm pitch), same readout.

**Test Beam**

- Both self- and external trigger mode tested;
- In total ~2M Events accumulated;
- Calibration shows same ADC response as lab results
- Pedestal RMS shows lower noise level, because:
  - sensor held by the grounded cassette;
- Final production component: Cassette verified.

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**Paulo Breidenbach, D. R. Freytag, B. A. Reese (SLAC, CA, USA)**

**M. Wu (DESY, Hamburg, Germany)**

**U. Kraemer, M. Stanitzki, M. Wu (DESY, Hamburg, Germany)**

**M. Breidenbach, D. R. Freytag, B. A. Reese (SLAC, CA, USA)**

**S. Roelofs (La Hague, AL Delft, The Netherlands)**