

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

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



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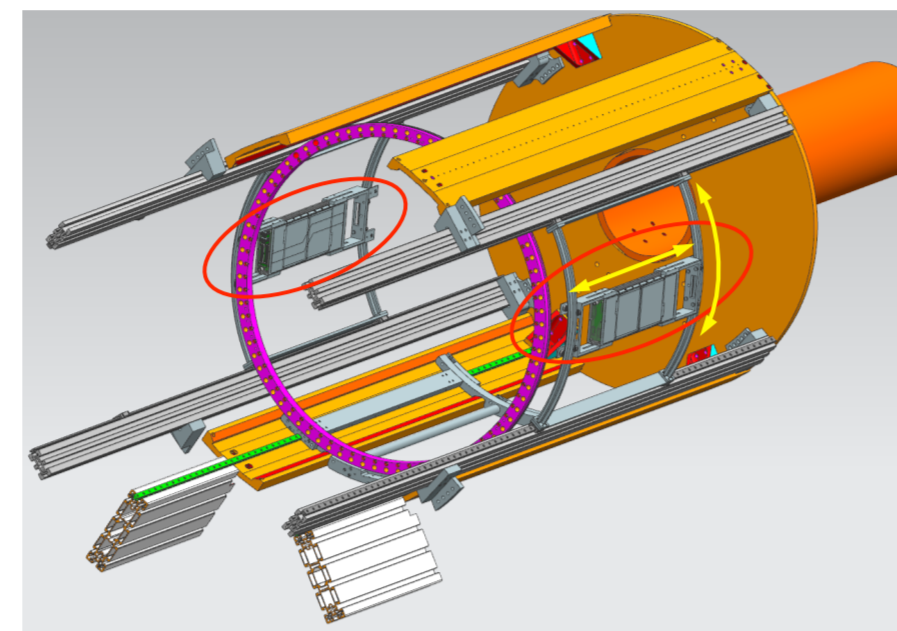


Introduction

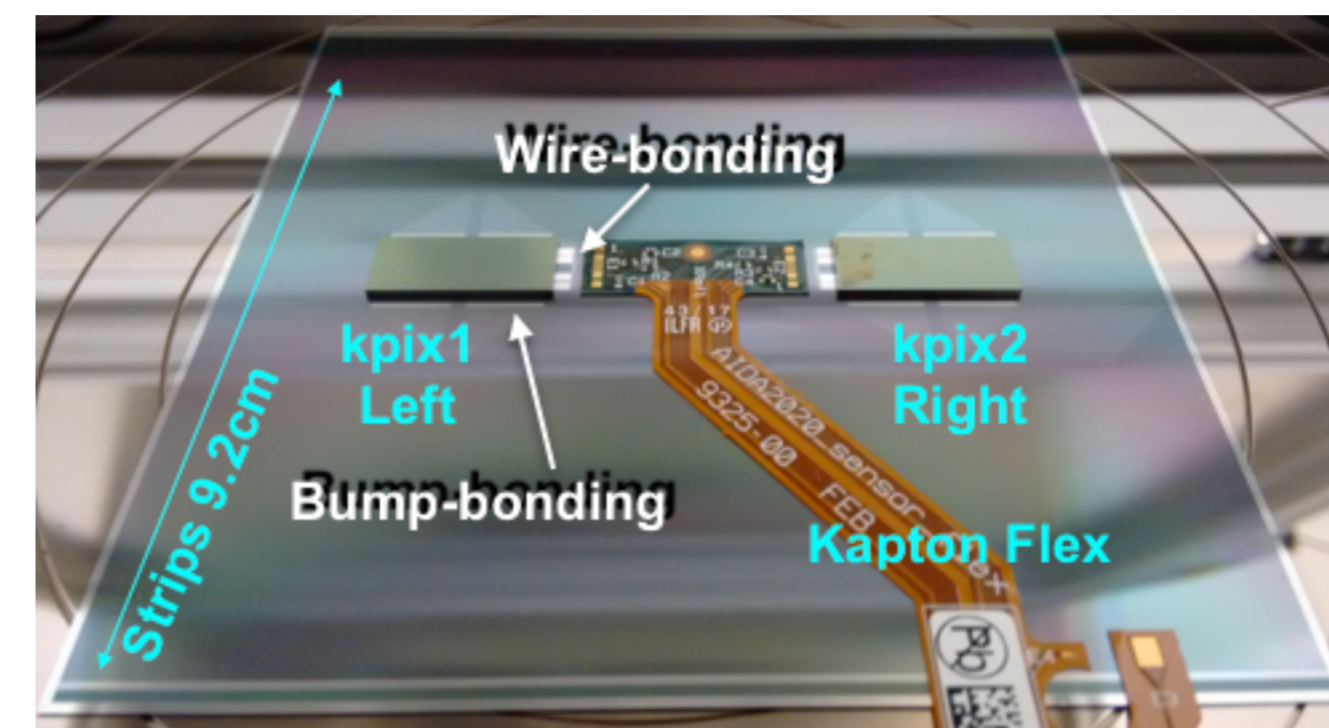
The DESY II test beam facility provides e+e- beams with energies 1-6 GeV. A new large area beam telescope is being built to address many user demands for momentum measurements in a 1T solenoid.

Requirements

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



SiD Hybrid-less Micro-strip Sensor

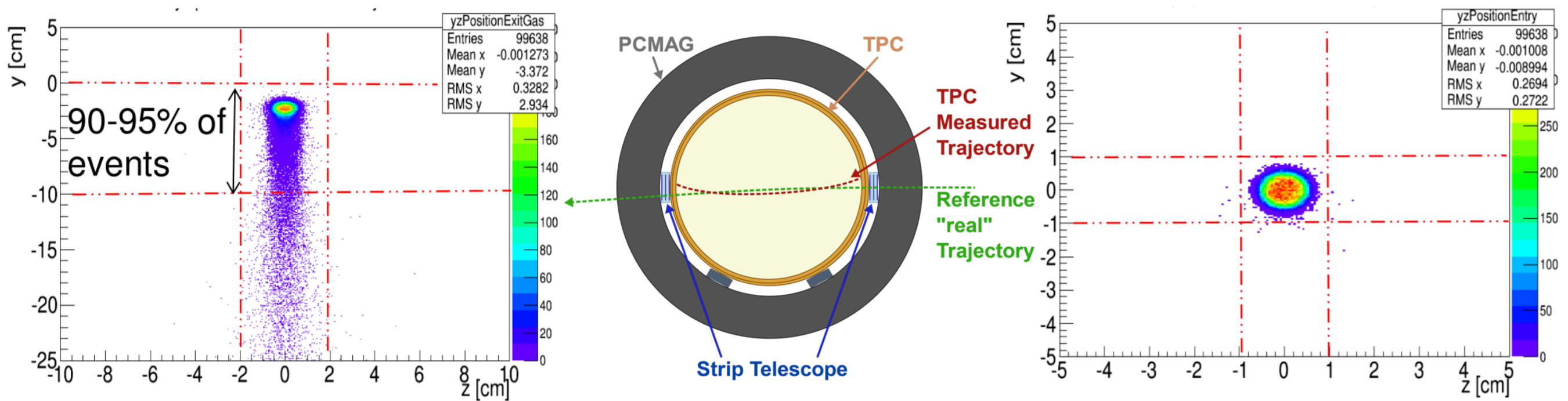
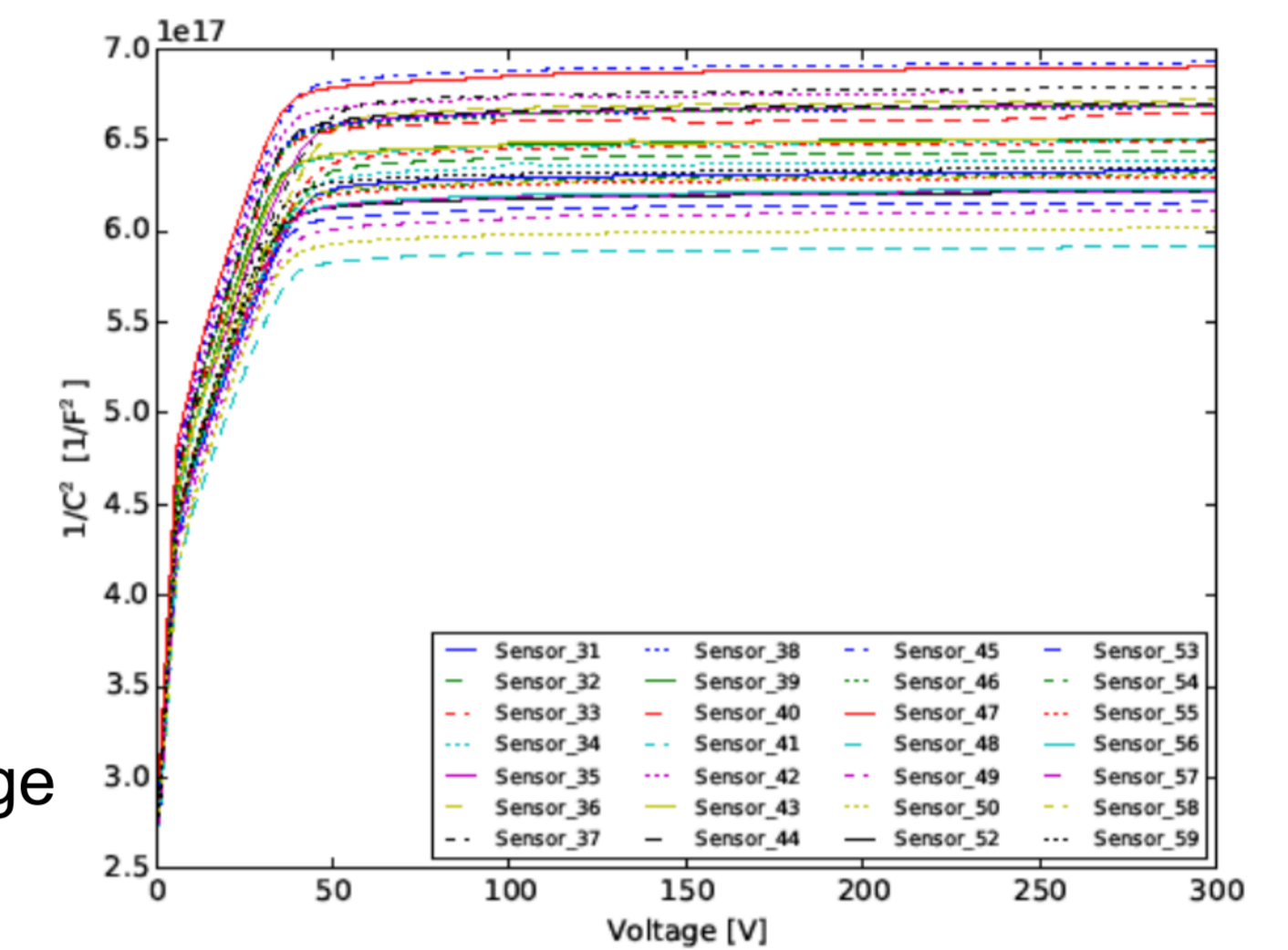


KPIX Readout Chip

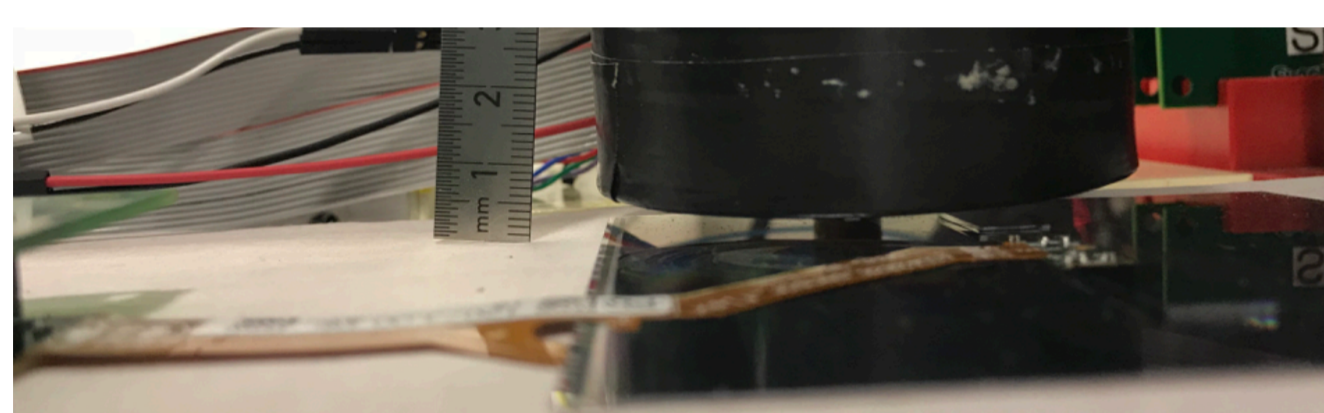
- 1024 channel, pitch adapter;
- Digitization: 13 bit ADC resolution
- Can accommodate input clock up to 100 MHz, 10 ns resolution;
- Two trigger modes: self- and external trigger;
- Power cycled.

Sensor

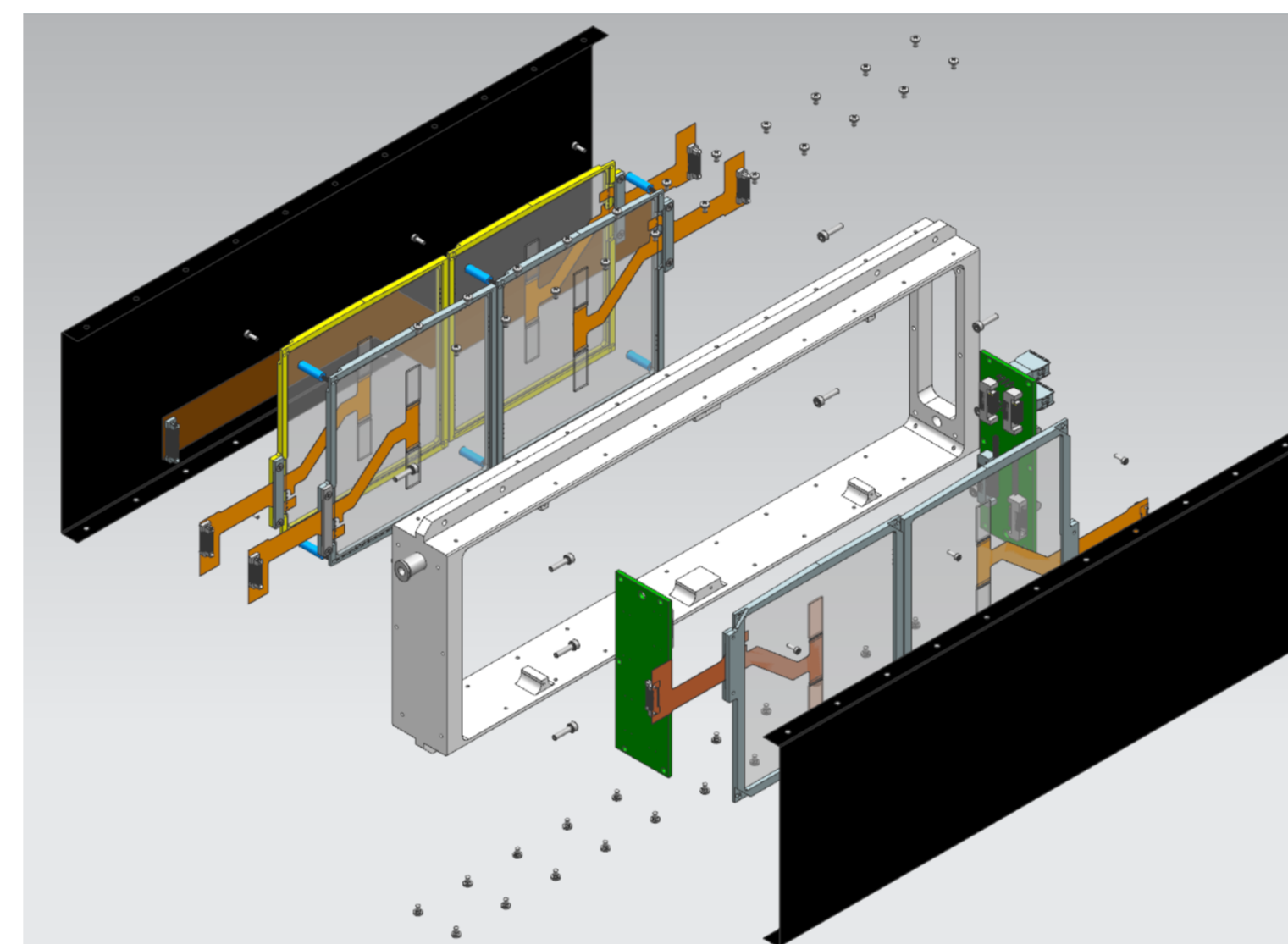
- 25/50 μm sense/readout pitch \rightarrow spatial resolution of $\sim 7 \mu\text{m}$;
- Thickness of 320 μm \rightarrow material budget of 0.3% X_0 ;
- $\sim 10 \times 10 \text{ cm}^2$ active area \rightarrow 1840 readout strips;
- Signal routing through a 2nd metallization layer;
- Good electric properties: quite leakage current, all depletes $\sim 50 \text{ V}$.



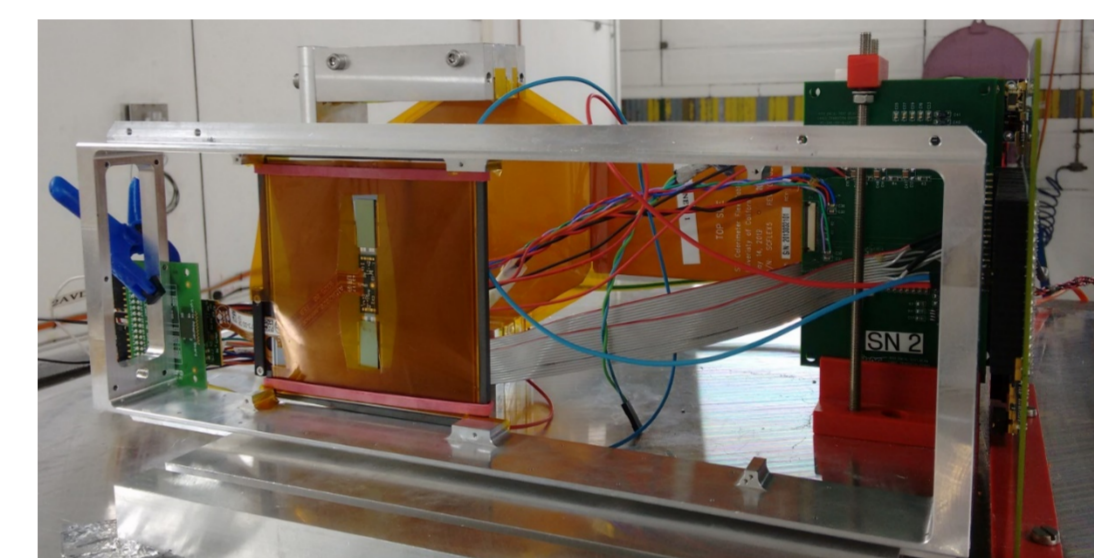
Lab Test



Conditions:
 Light tight, holding structure grounded but inside many cables laying around the sensor.



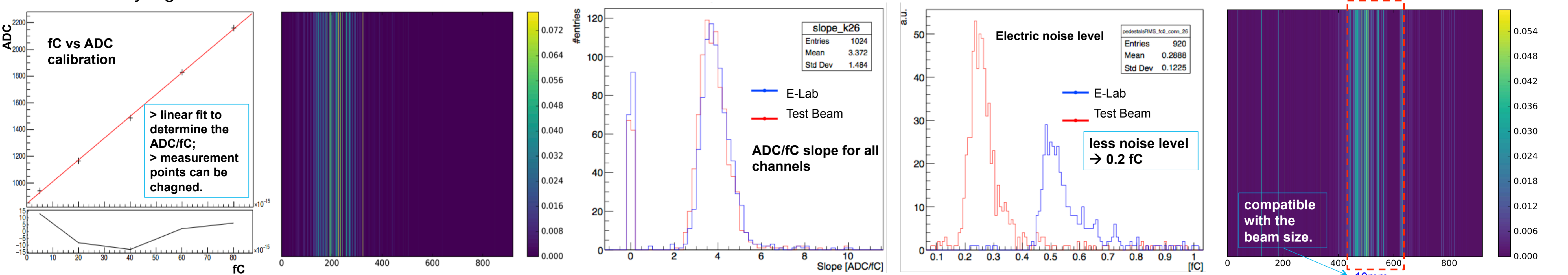
Test Beam



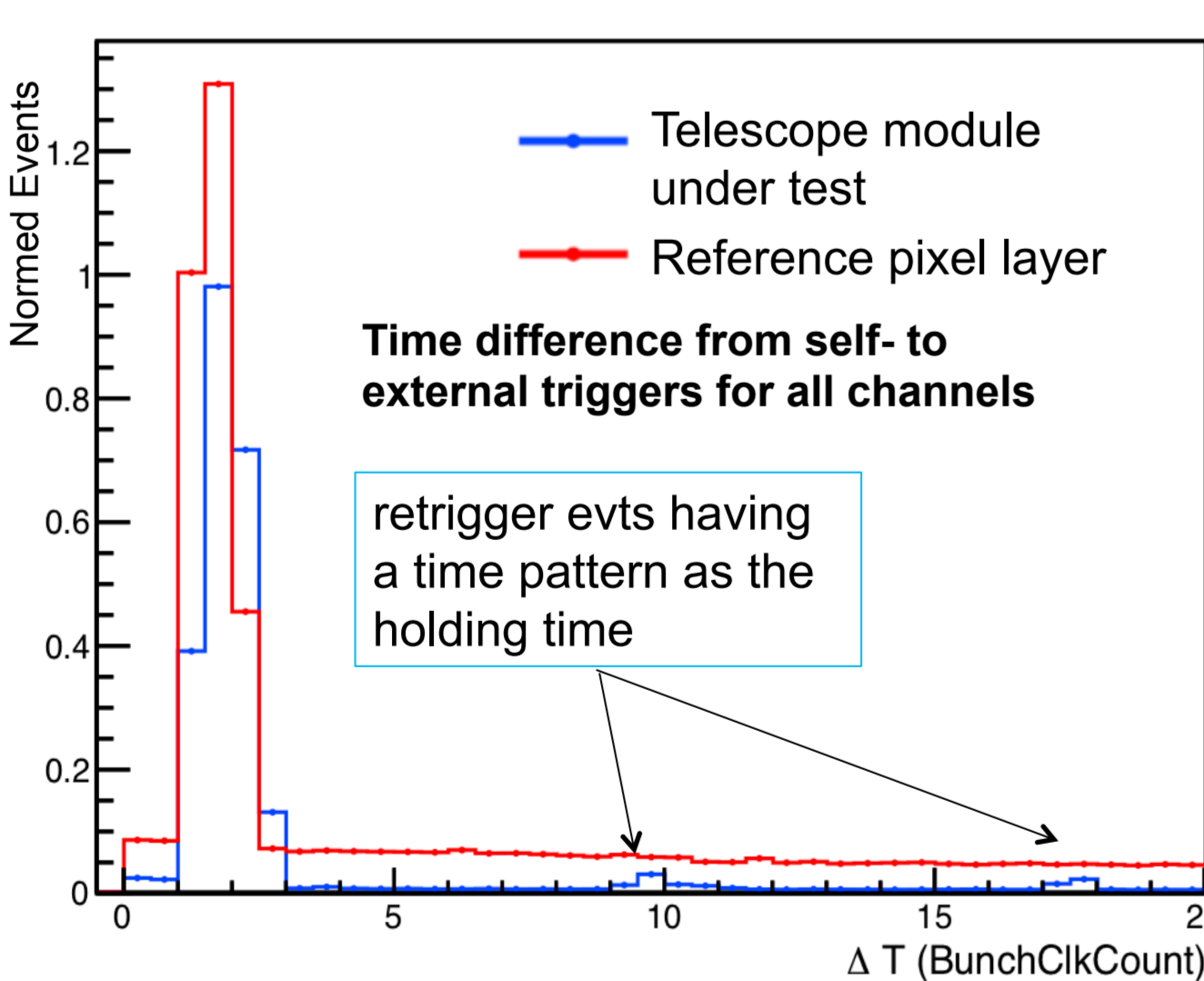
Beam Profile
 3 GeV, 5 kHz trigger rate
 Collimator 9x9 mm²
 Reference Device
 Hexagonal pixel sensor (~6mm pitch), same readout.

Various data taking mode tested:

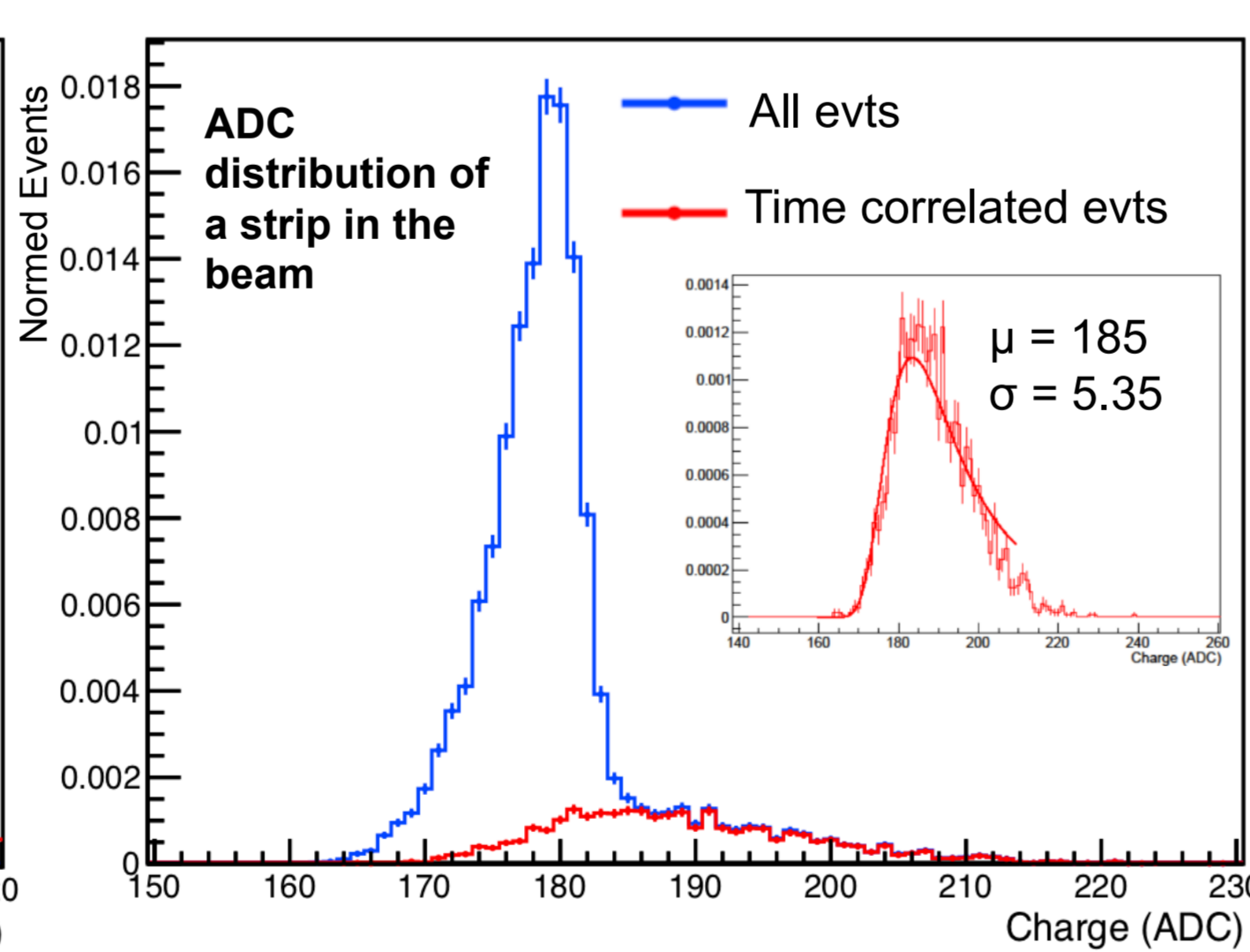
- Calibration** -- ADC/Charge response derived;
- Pedestal** measurement -- noise level determined;
 - Relative low noise level determined $\sim 0.5 \text{ fC}$
- Only **Self-trigger** mode tested:
 - Noise Run with various setup, e.g. threshold scan
 - Signal Run with ⁹⁰Sr : Able to locate signal spot with relatively high threshold.



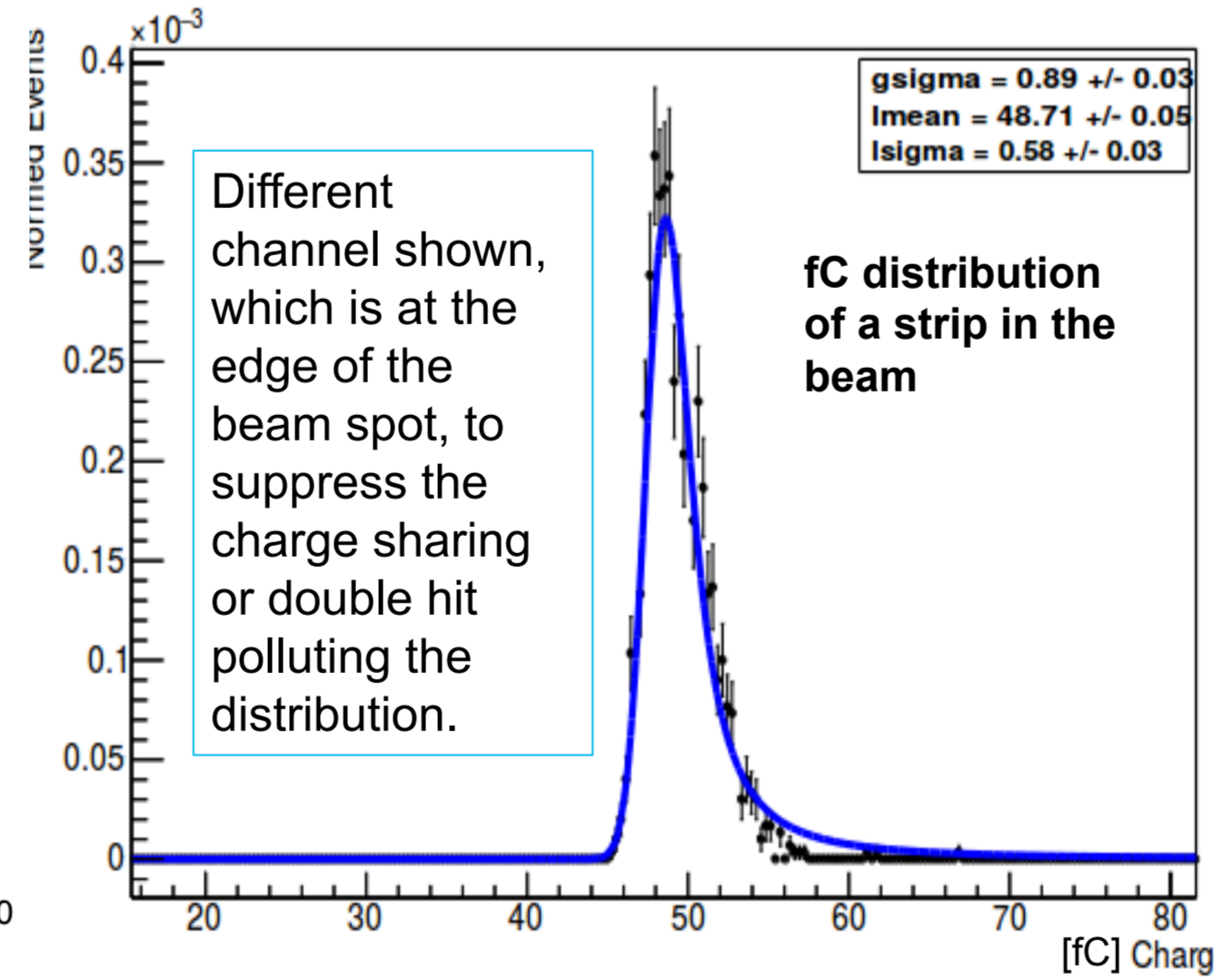
Results and Discussions



- 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;
 - S/N looks promising, but threshold dependent \rightarrow room for improvement;
 - Signal is $\sim 2\sigma$ far from the background only distribution.



- Self-trigger with a higher threshold, long run with more statistics
- A good landau convoluted Gauss fit can be performed;
 - Pedestal subtraction not yet applied due to known issue of pedestal shifting.

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.