

Introduction to semiconductor for High Energy Physics using



EASY: Educational Alibava System

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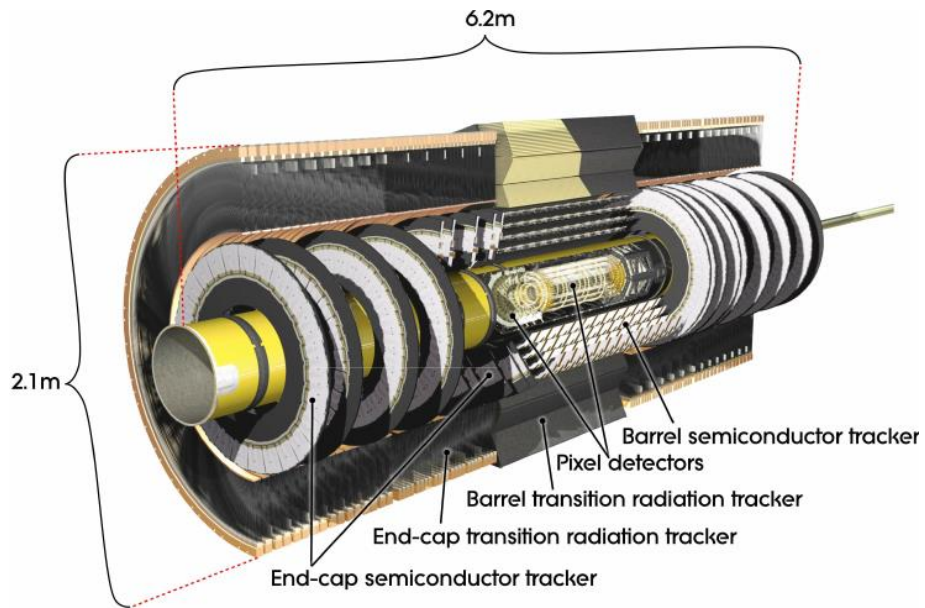
Alibava systems



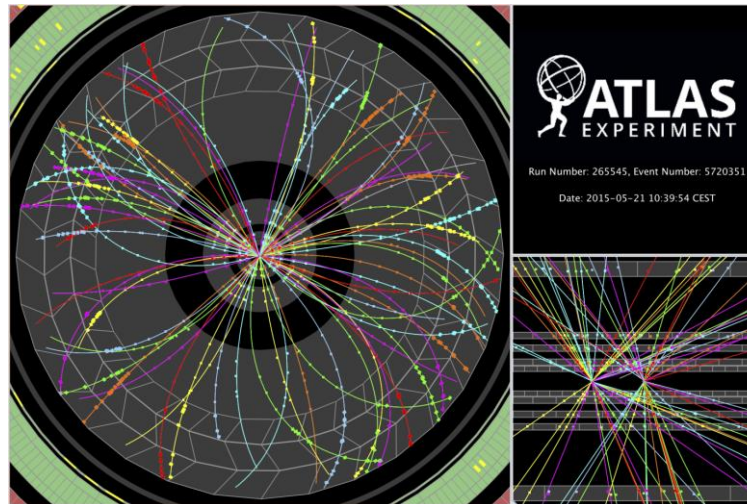
- Basic principles of silicon strips sensors
- The experimental setup (EASY system)
- Data acquisition and monitoring
- Data analysis:
 - **Exercise 1:** Charge collection and depletion voltage
 - **Exercise 2:** Strip structure and charge sharing
- For the exercises you need your **google drive account**
- **Two windows:** one for zoom and other for your google account

Silicon strip sensors are used to track the pass of charge particles in high energy physics detectors.

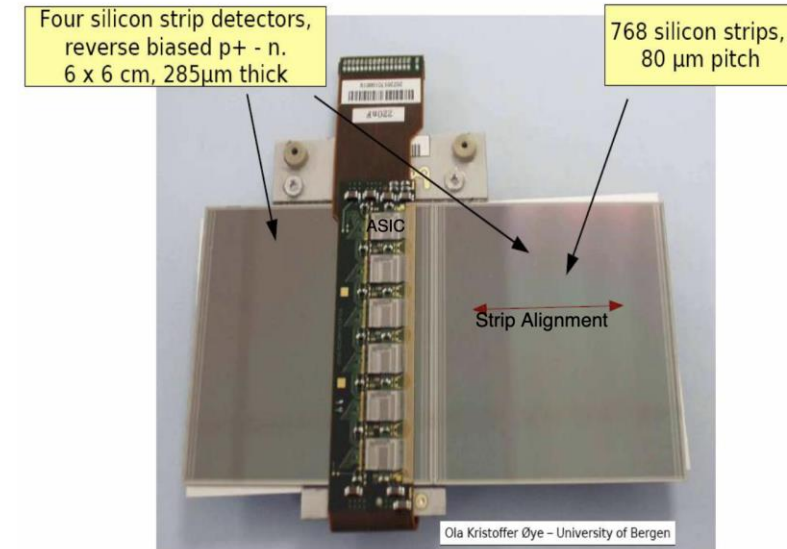
The ATLAS example



Inner Tracker ATLAS



Inner Tracker ATLAS event

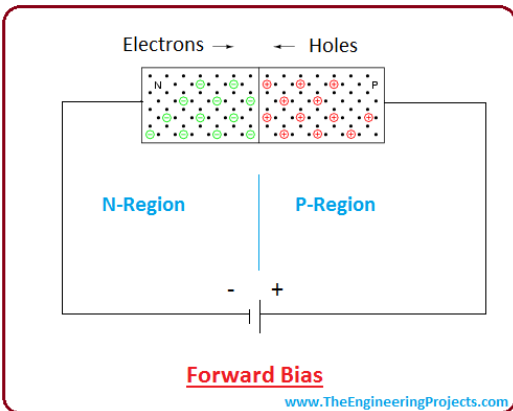
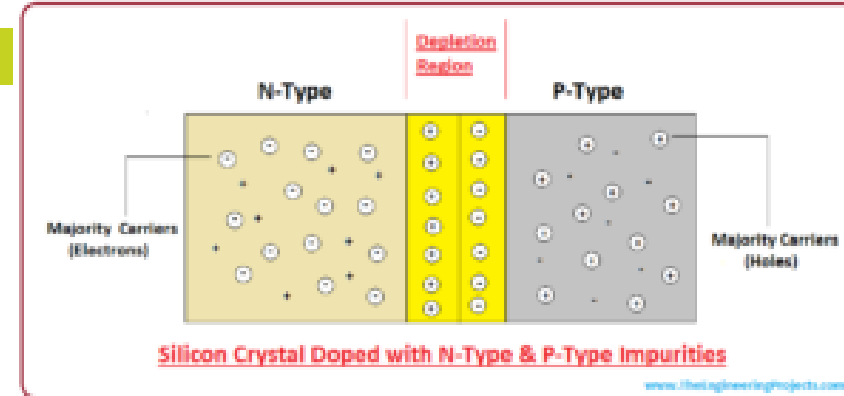


ATLAS SCT module

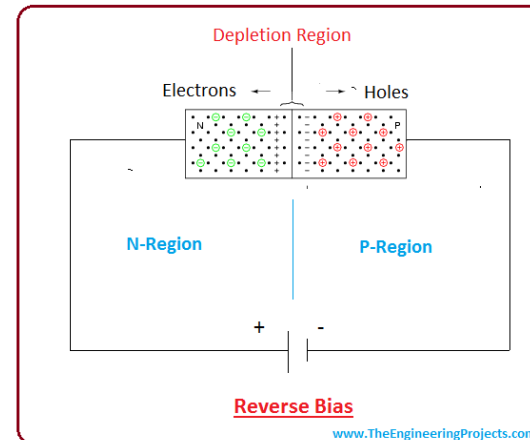
Basic principle: p-n junction

The holes present in the P region are diffuse into the N-region, leaving behind the negative charge in the P region. Electrons present at the N-region diffuse into the P-region leaving behind the positive.

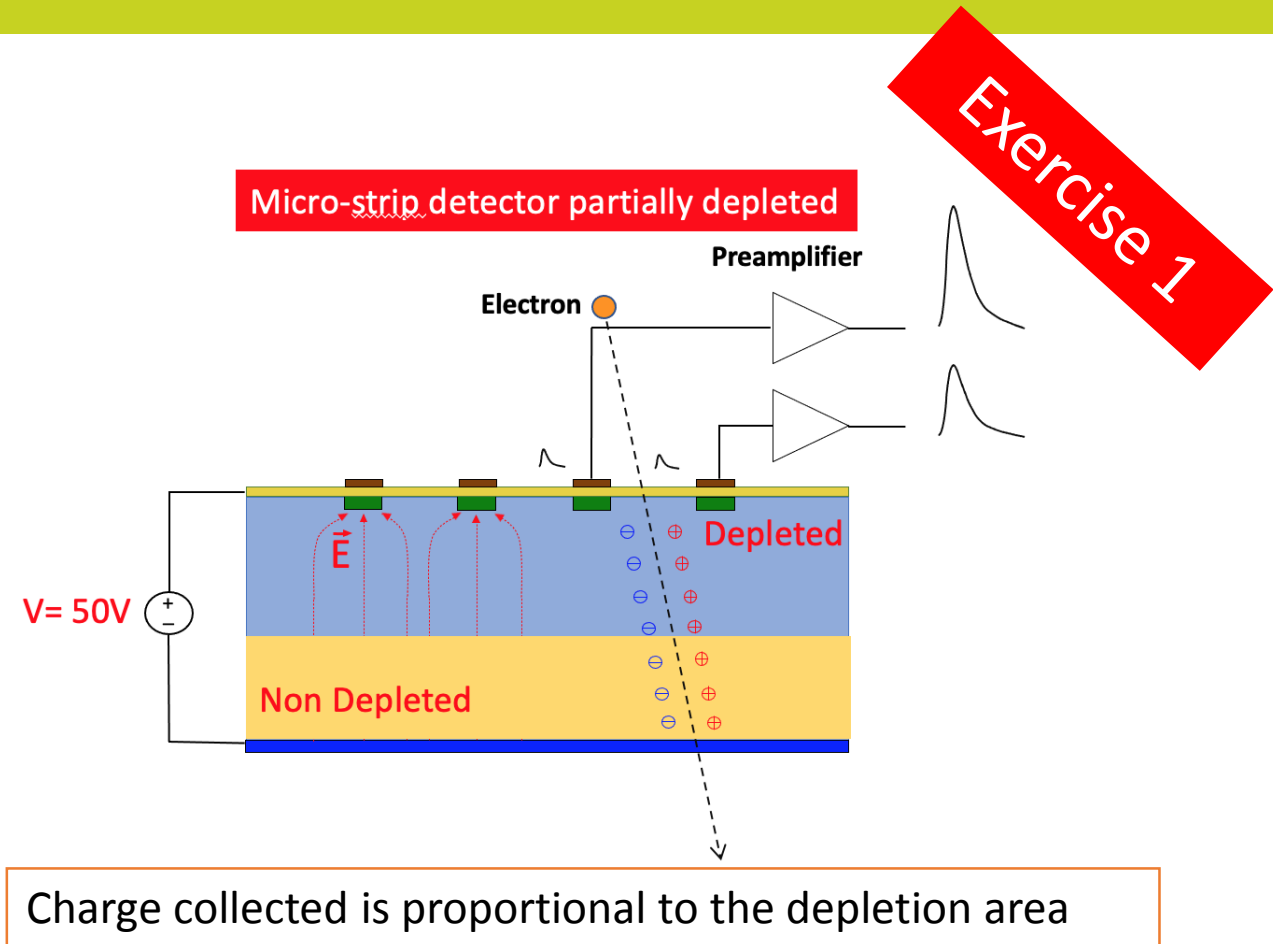
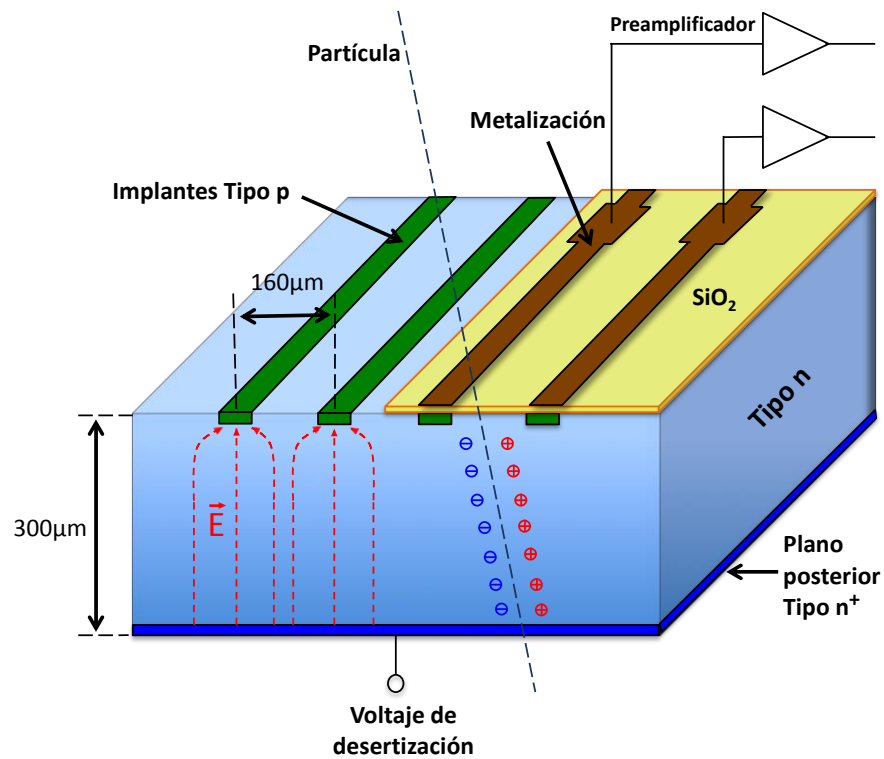
As the junction is formed, each region of silicon crystal becomes depleted from major charge carriers around the junction.



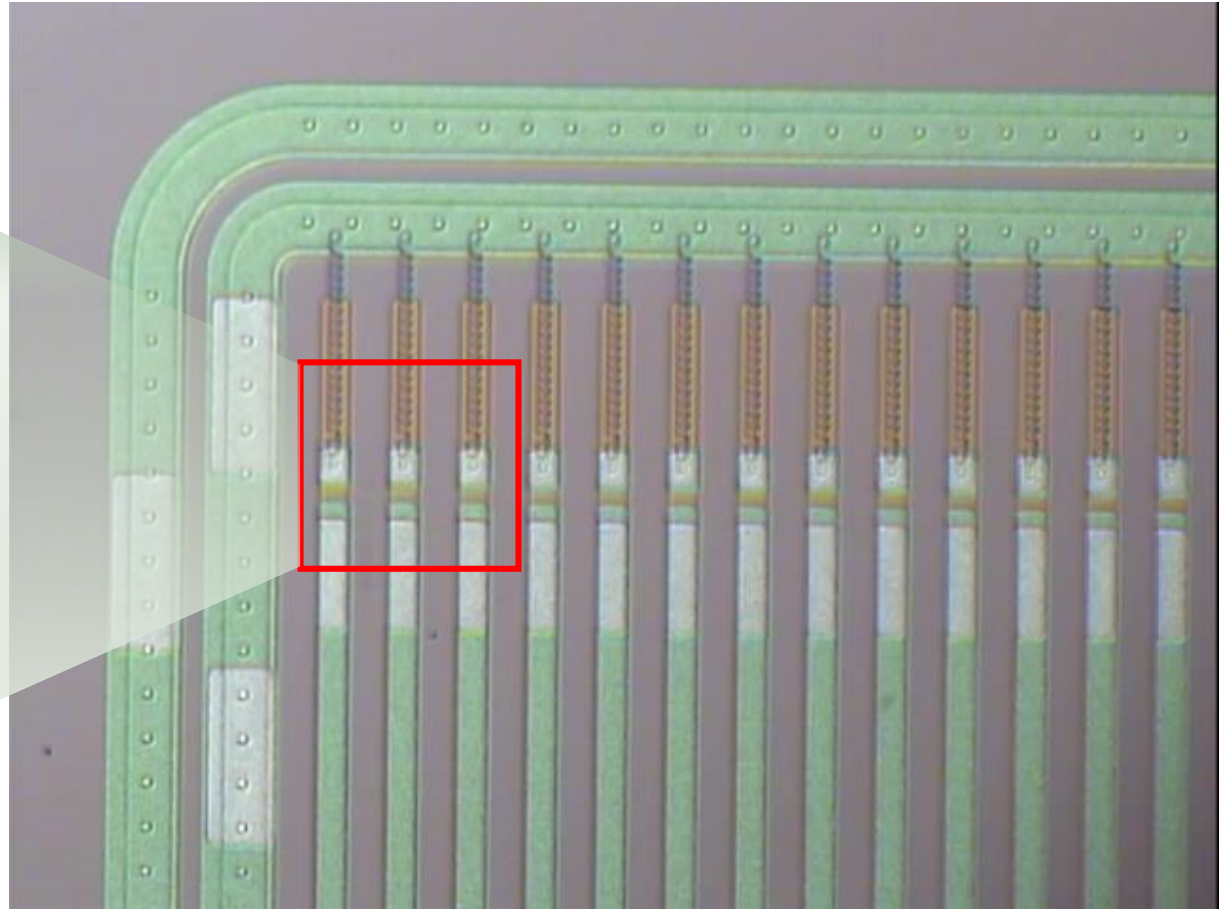
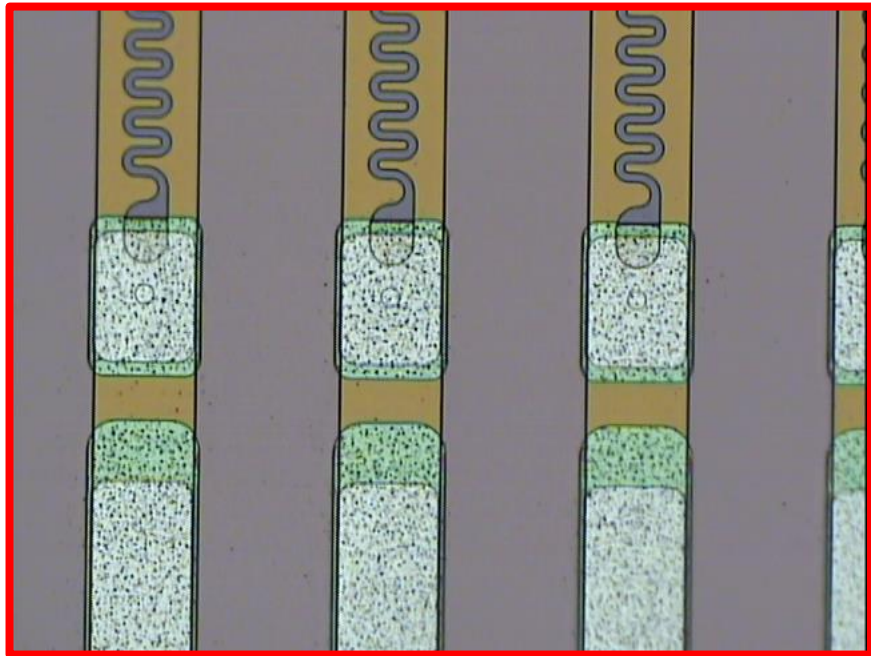
The electrons present in the N-region will push toward the P-region. Holes in the P-region will continue to diffuse into the N-region as long as the forward bias voltage is applied across the junction.



The width of depletion region behaves in proportion with the reverse bias voltage applied across the junction. Stops the current flow between the junction. In this condition, PN junction behaves as an insulator.

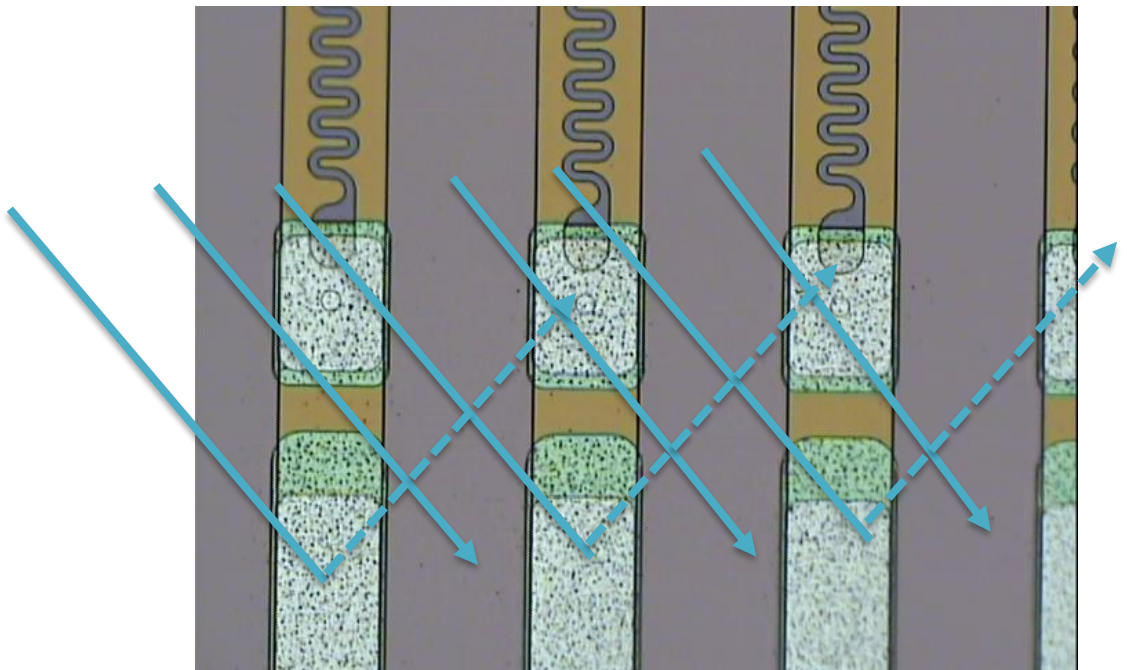


EASY sensor

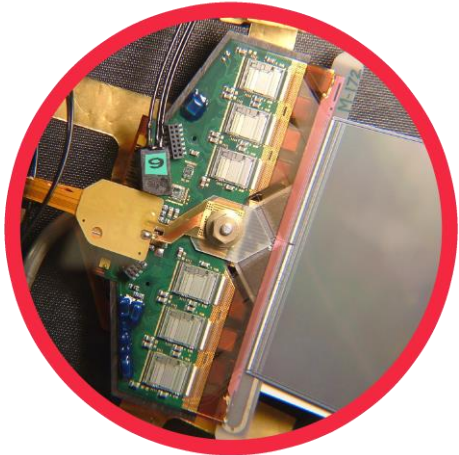


Exercise 2

Laser $\xrightarrow{\text{Steps of } 10\mu\text{m}}$



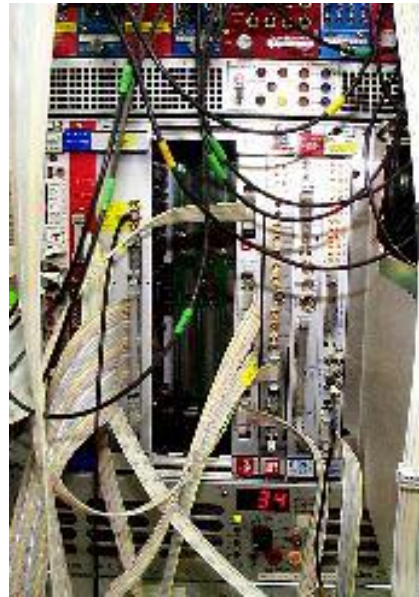
Components of a silicon microstrip detectors



Sensor + ASIC



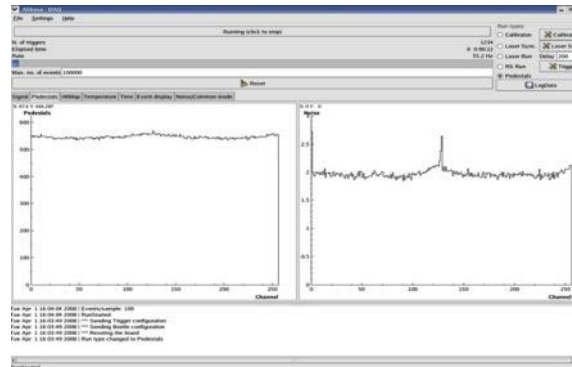
HV power supply



Control unit



Trigger



Data acquisition and monitoring

Source of particle



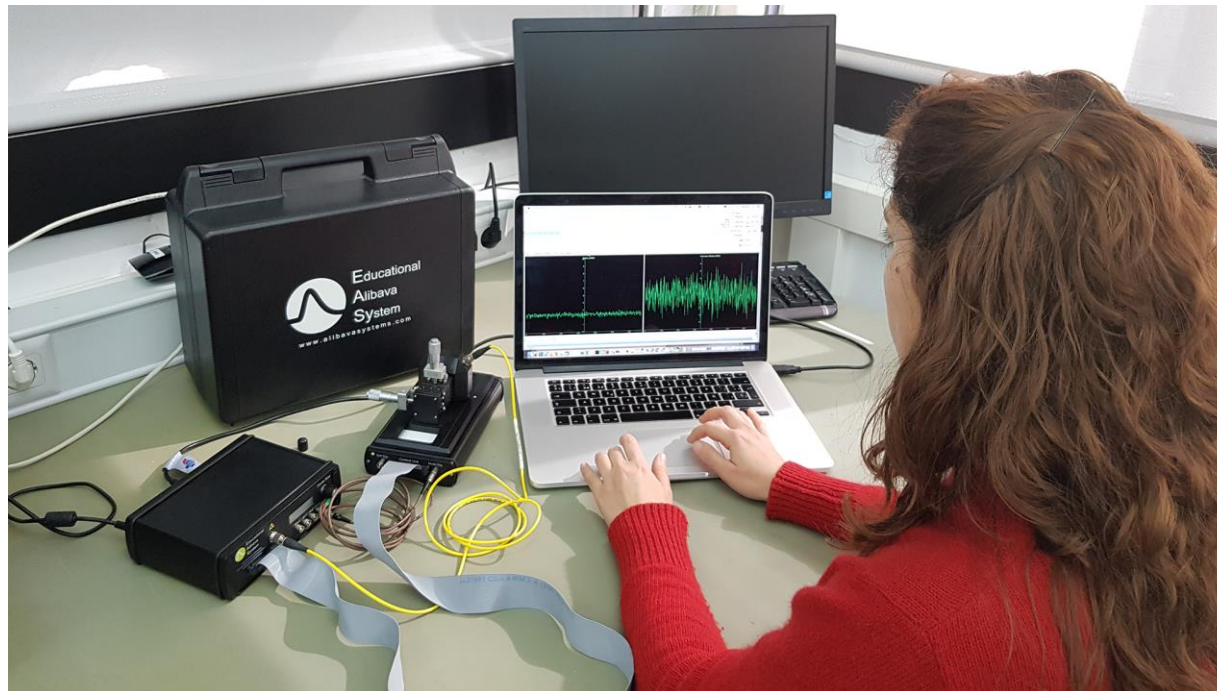
Laser



Radioactive source

EASY is a portable, compact and complete system for microstrip ideal complex experiments with silicon microstrip detectors.

EASY SYSTEM



Control unit

- Data Acquisition Control.
- Processing of the sensor and trigger data
- Adjustable HV unit for microstrip sensor bias, with voltage and current display.
- Include the laser source
- Communication with computer software via USB

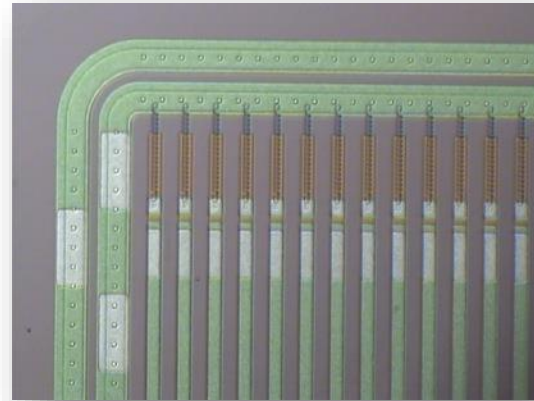


Sensor unit

- Silicon microstrip sensor and the Beetle chip.
- Opaque carbon fibre window to place radioactive source.
- Laser micropositioner and focus system.
- A diode placed under the detector provides a trigger signal.

Silicon microstrip

- P-on-N Detector
- Size: 20x20 mm²
- Thickness: 300 μm
- Channels: 128
- Interstrip pitch: 160 μm

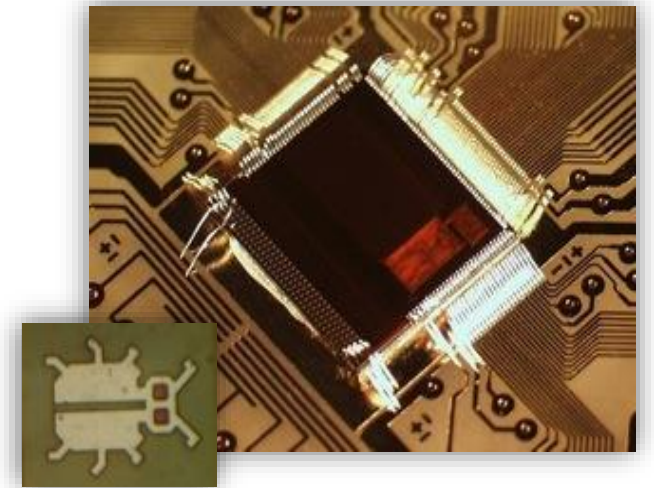


Laser source

- Wavelength: 980nm
- Pulse width: 5 ns
- Laser Spot: 20 μm
- Micropositioner resolution: 10 μm

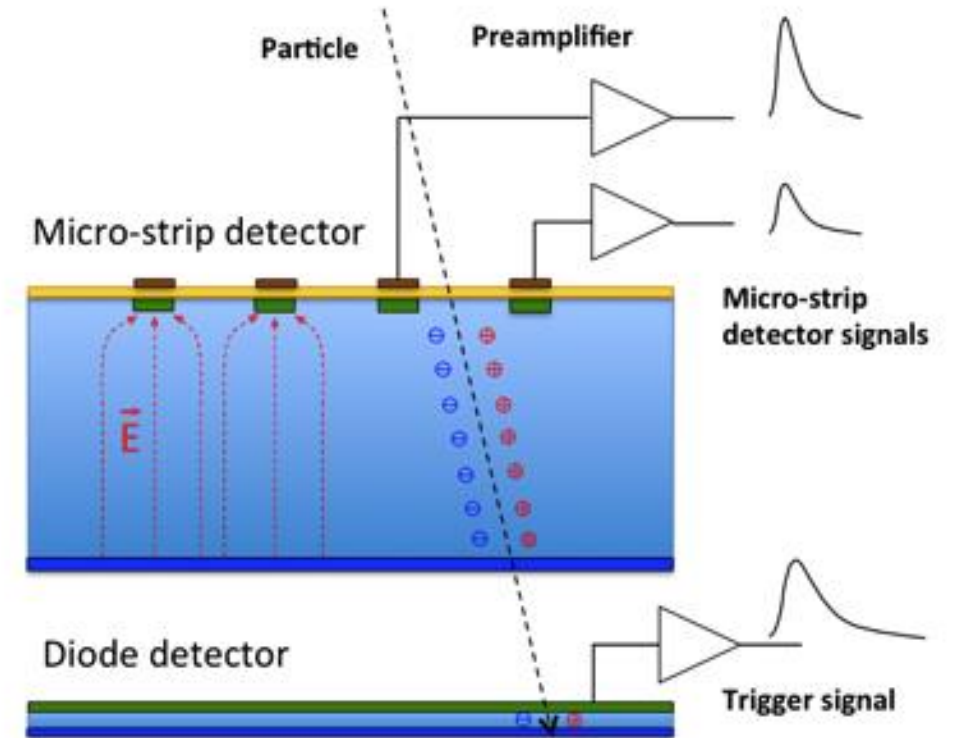
Beetle Characteristics

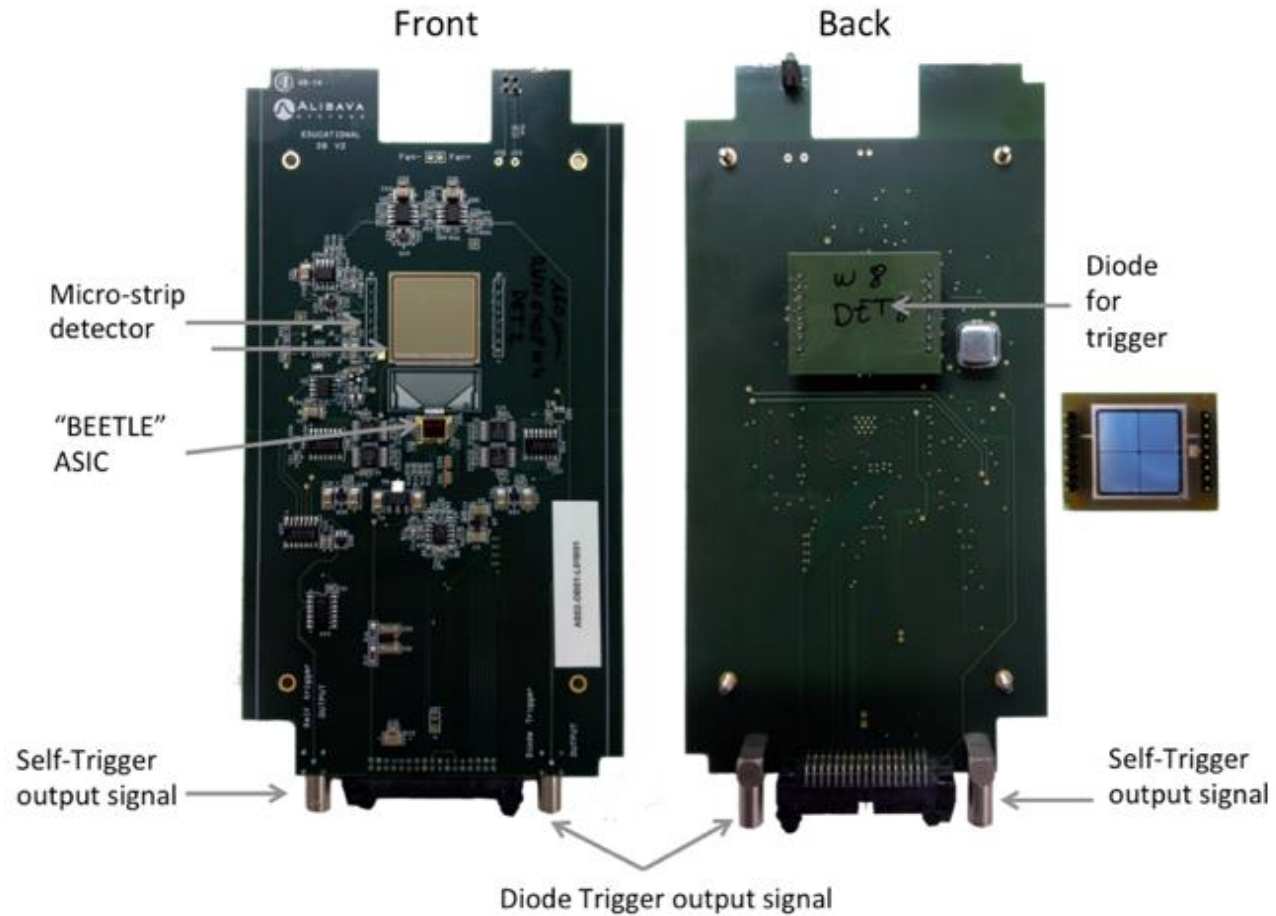
- Low noise ASIC developed for CERN/LHC experiments
- 128 channels



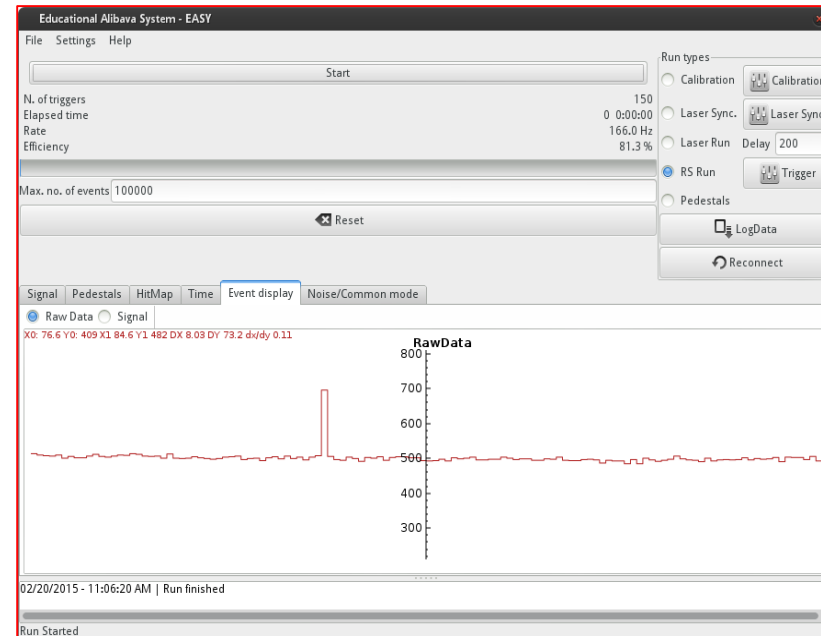
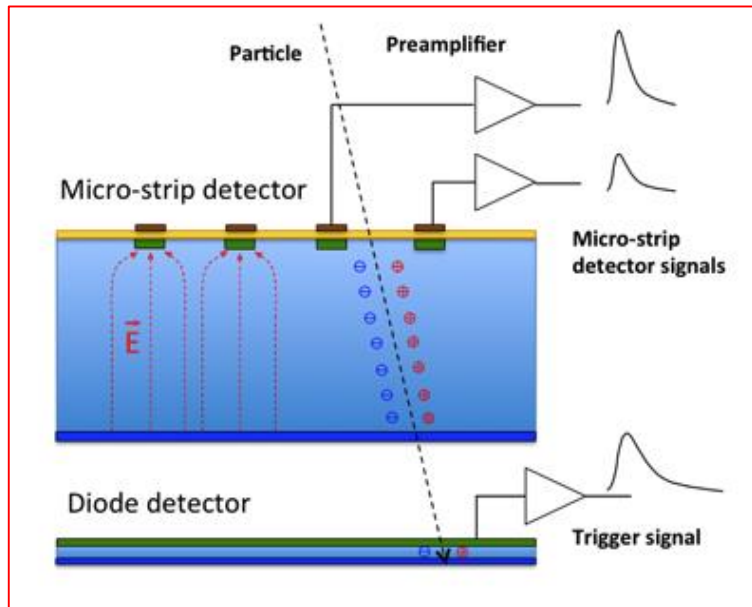
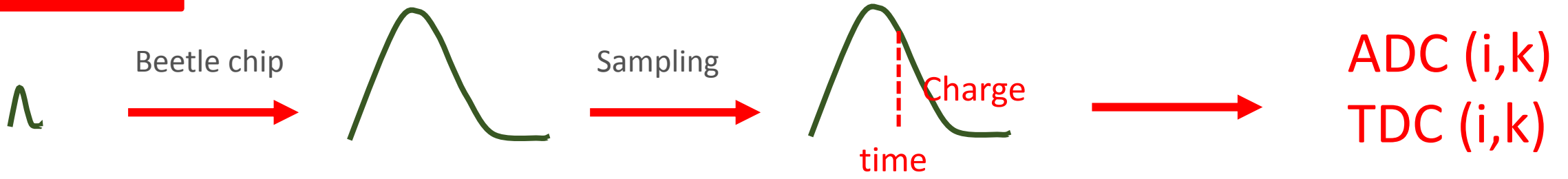
Trigger modes:

- **External:** provided by the diode, for particles crossing the sensor.
- **Synchronised trigger:** to trigger the laser source.





Strip i , Event k



Strip i , Event k

$$ADC(i,k) = \text{Offset } (i) + \text{Common Noise } (k) + \text{Electronic Noise } (i) + \text{Charge } (i,k)$$

$$P(i) = \frac{1}{N} \sum_{k=1}^N ADC(i,k)$$

$$D(k) = \frac{1}{128} \sum_{i=1}^{128} (ADC(i,k) - P(i))$$

$$Noise(i) = \sqrt{\frac{1}{N-1} \sum_{k=1}^N (P_c(i) - \bar{P}_c(i))^2}$$

N events
128 channels

<https://www.alibavasystems.com/>

Alibava System youtube

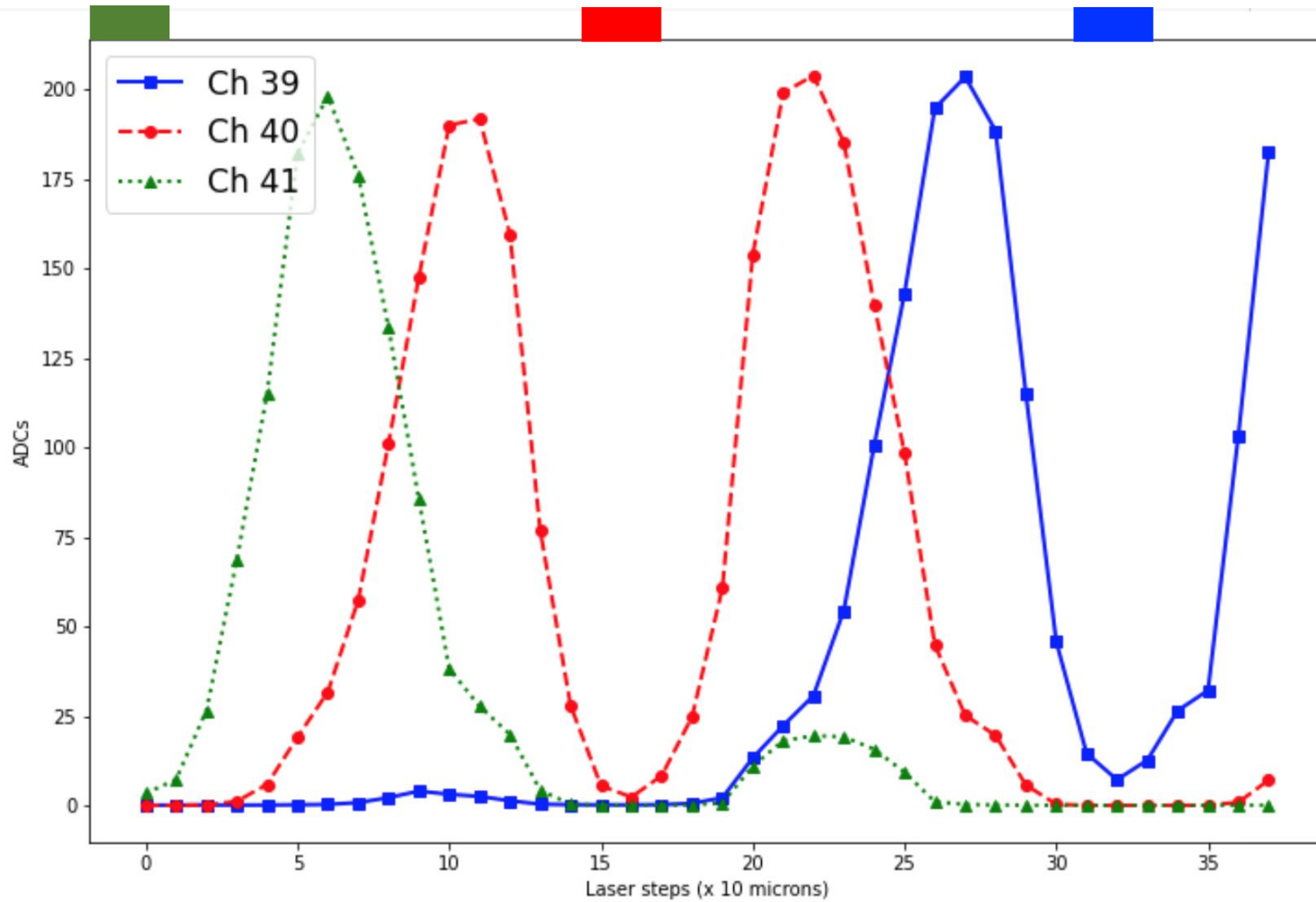


Exercise 1

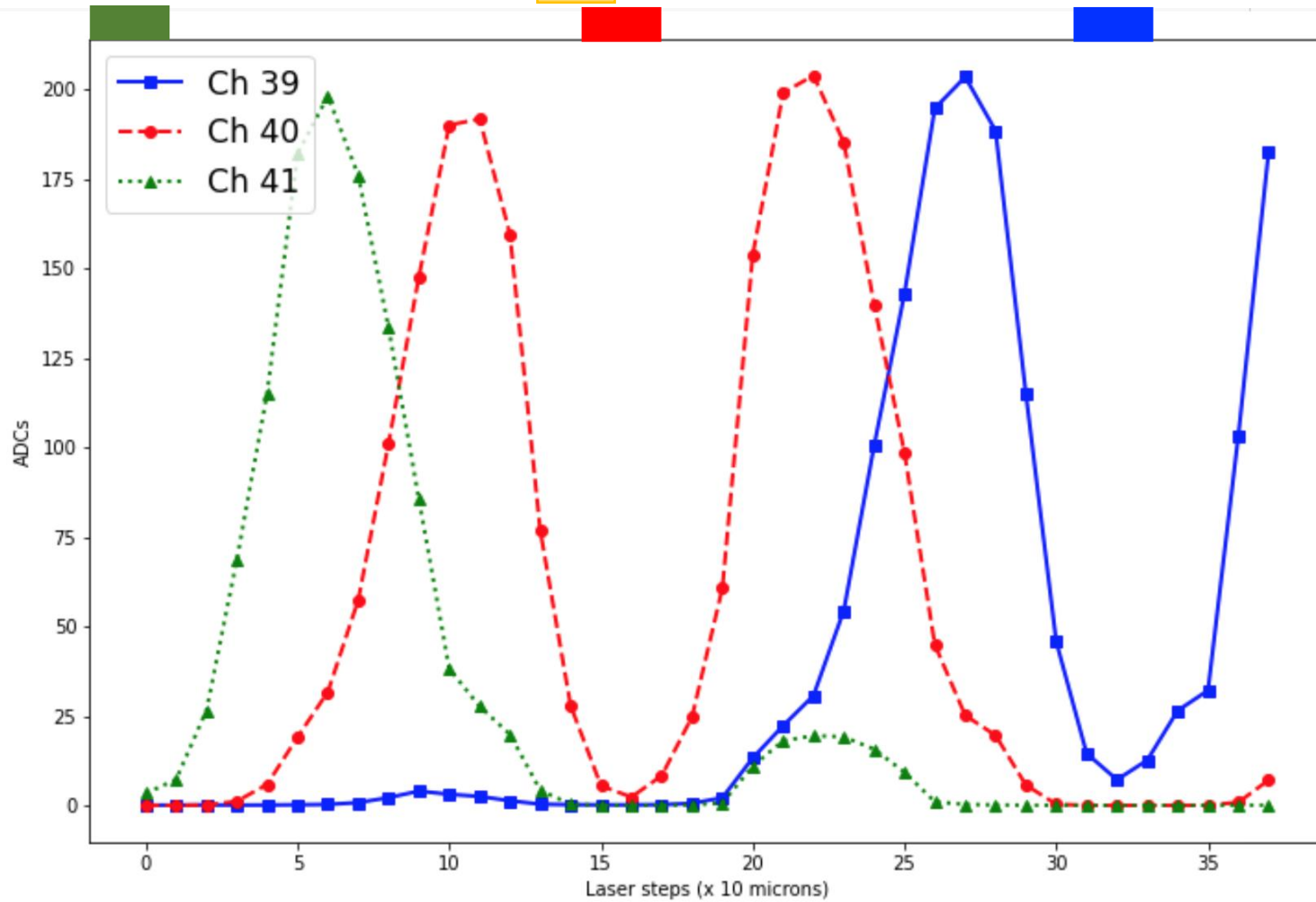


Exercise 2

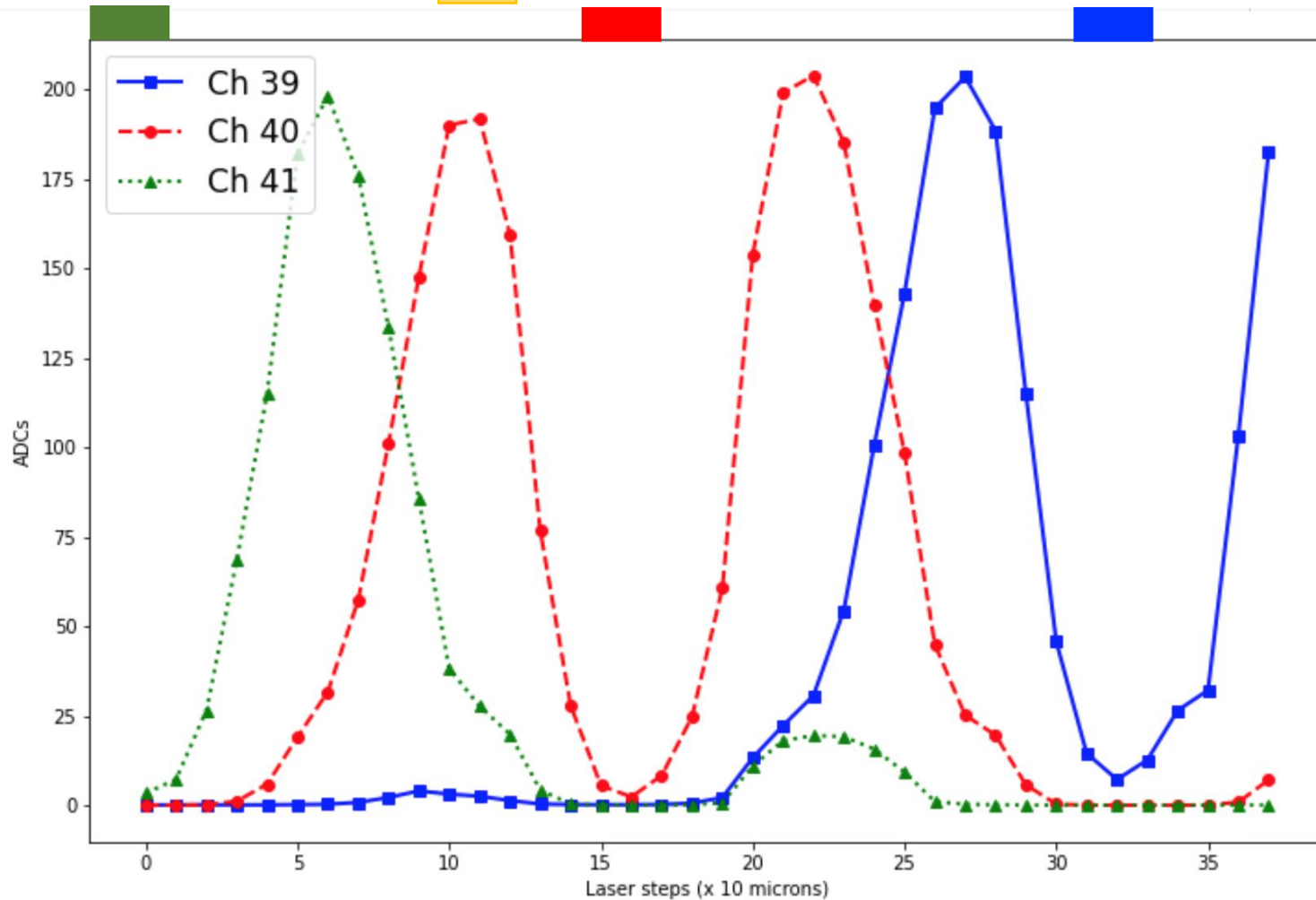
LASER



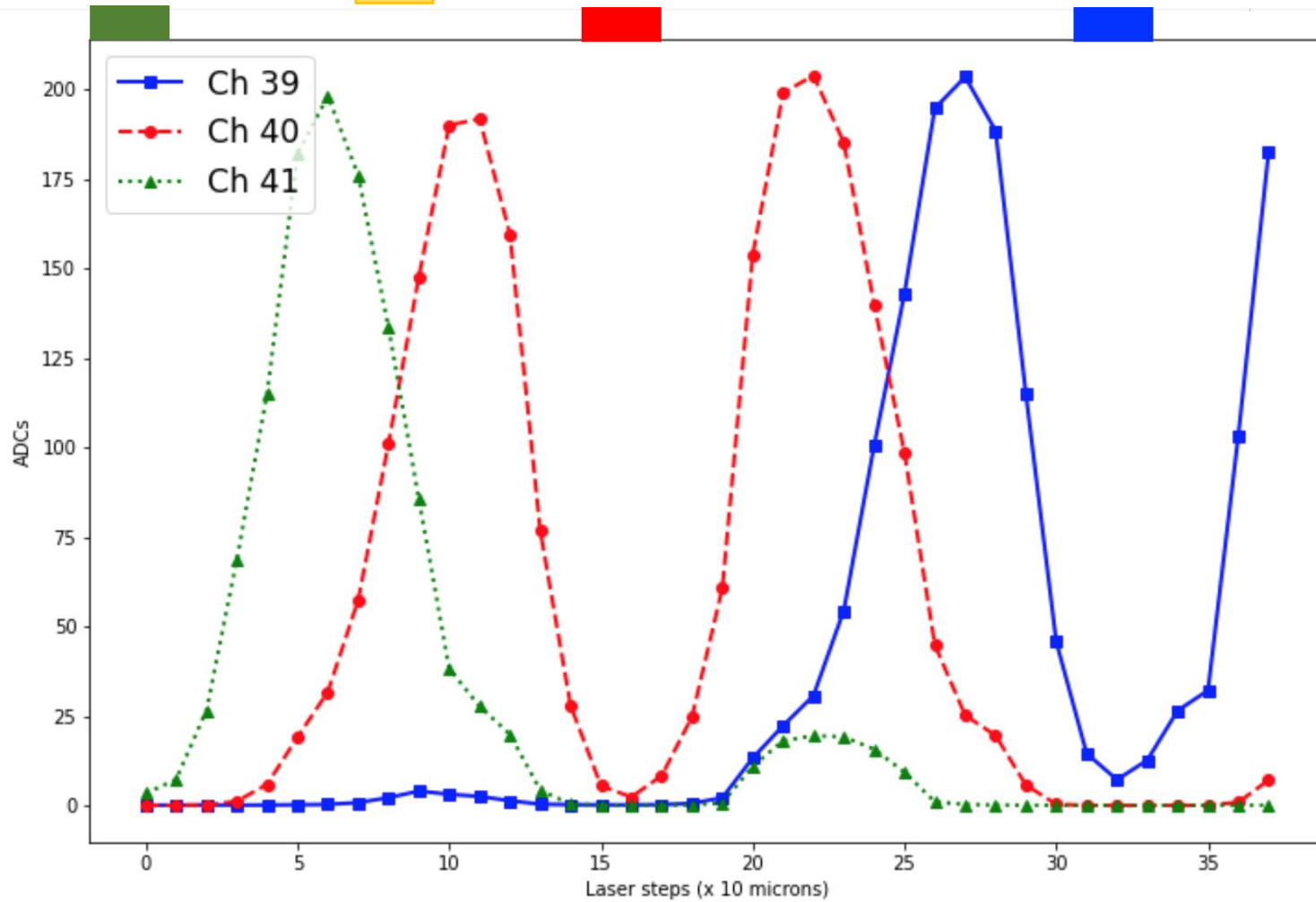
LASER



LASER



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LASER

