A low-cost 3D-printed spectrometer based on Raspberry Pi

Omar Ormachea[1], Alex Villazón[2], Adriana Orellana[2] and Ángel Zenteno[2]

[1]Centro de Investigaciones Ópticas y Energías, Universidad Privada Boliviana

[2]Centro de Investigaciones de Nuevas Tecnologías Informáticas, Universidad Privada Boliviana

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UPB UNIVERSIDAD PRIVADA BOLIVIANA

EUBBC Digital

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CIOE Centro de Investigaciones Ópticas y Energías

CINTI CENTRO DE INVESTIGACIONES DE NUEVAS TECNOLOGÍAS INFORMÁTICAS

Introduction

EUBBC-Digital Project

18 EUBBC-Digital partners: 8 from 3 Latin America countries, and 10 from 6 European countries, who join forces to develop globally available learning modules in the Energy area.

Introduction

What we do ?

EUBBC-Digital (Europe, Brazil, Bolivia and Cuba) project aims at enforcing Capacity Building to create globally available digital learning modules, to collaboratively implement postgraduate programs in Latin America

Accesibility

Learners can access the learning modules no matter where they are.

Create & Share

Teachers create or reuse existing learning material and get feedback from other teachers, through a Quality Assurance Process.

Introduction

What we do ?

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Remote Labs

Learners can use remote labs at their own location.

Introduction

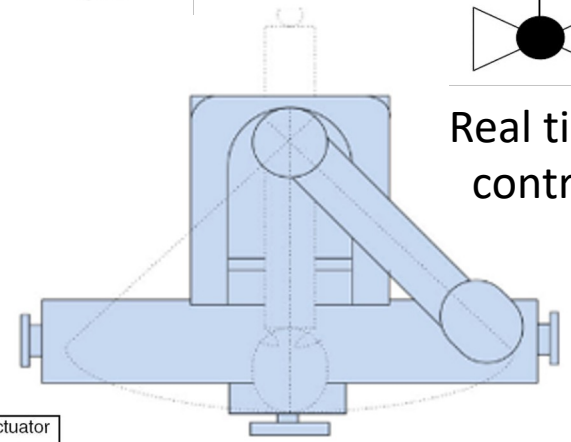
What is a remote Laboratory ?

Real time

Only one user !
A booking system is needed

Remote control

Streaming video



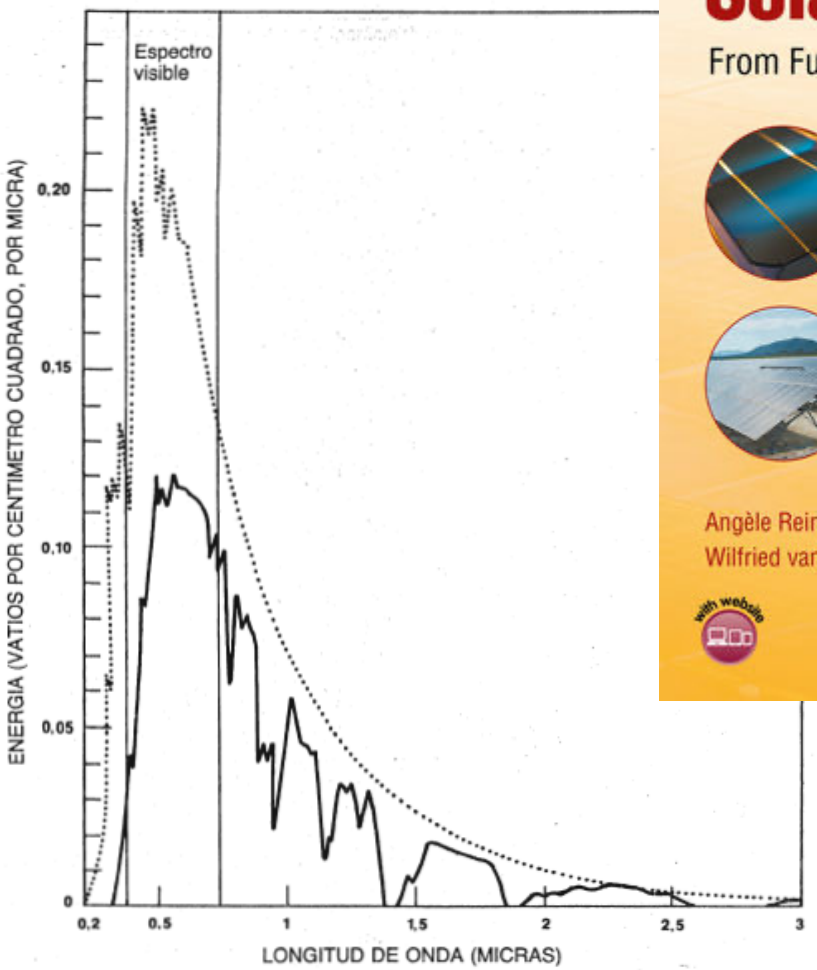
Real time
control

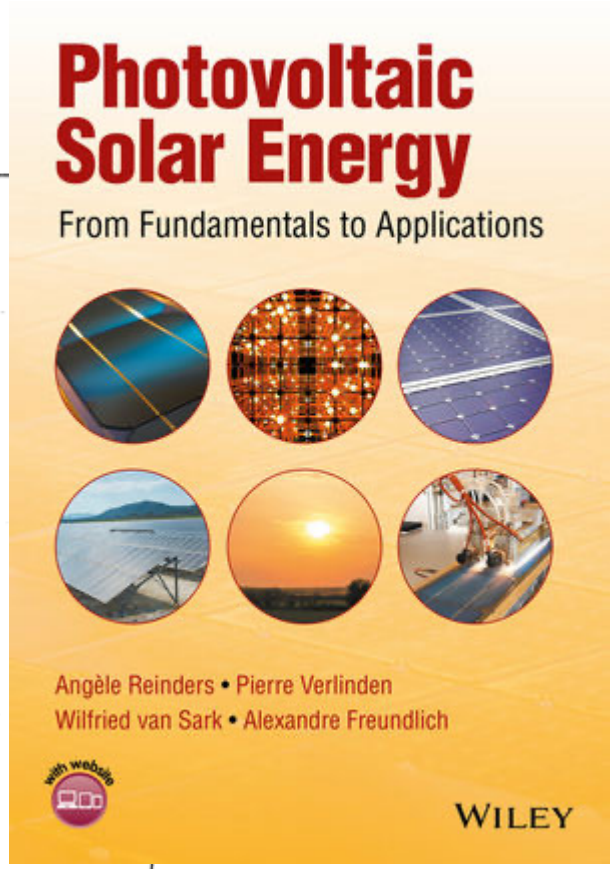
Real time
control

Motivation

Create several remote laboratories in the energy area

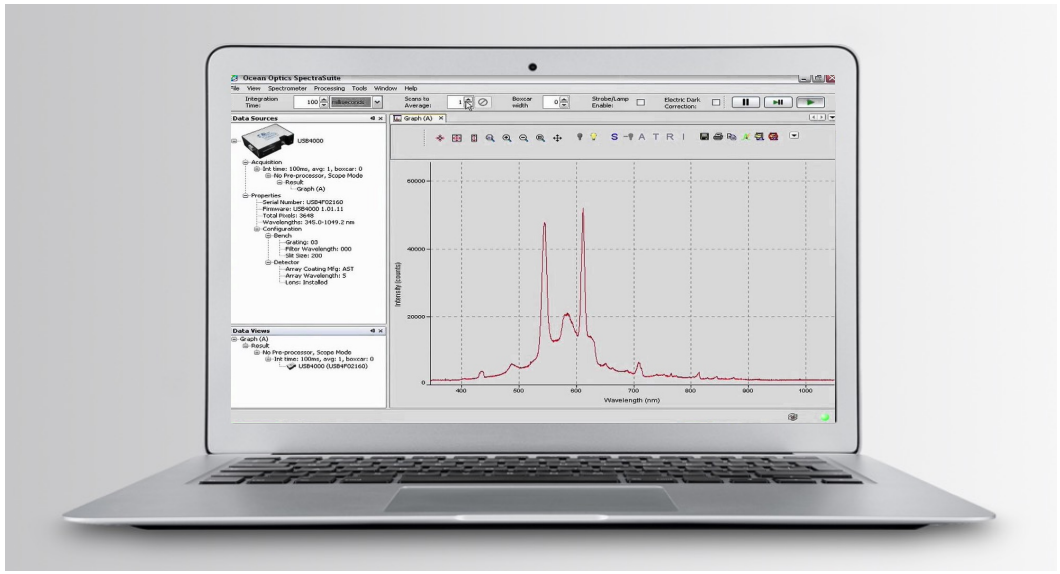
- Remote laboratory #1
- Remote laboratory #2
- Remote laboratory #3
- Spectroscopy Remote Laboratory



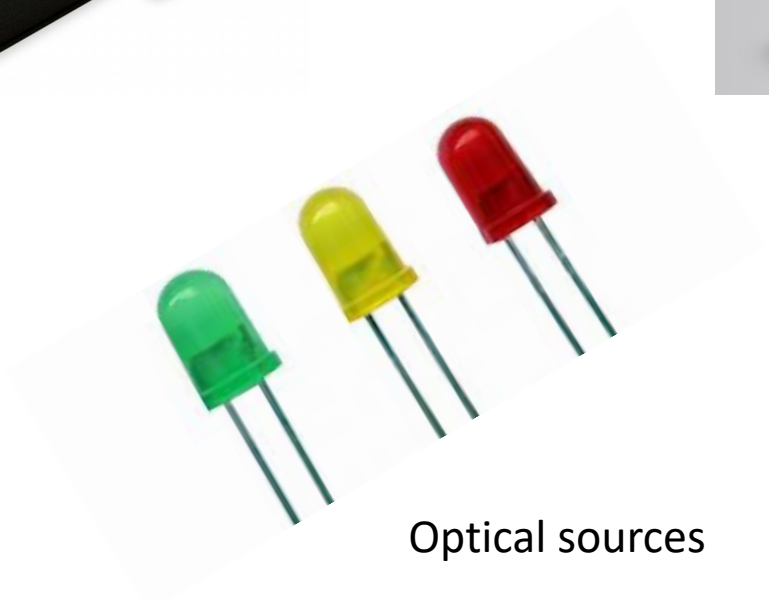


Spectrometry Remote Lab

Spectrometer



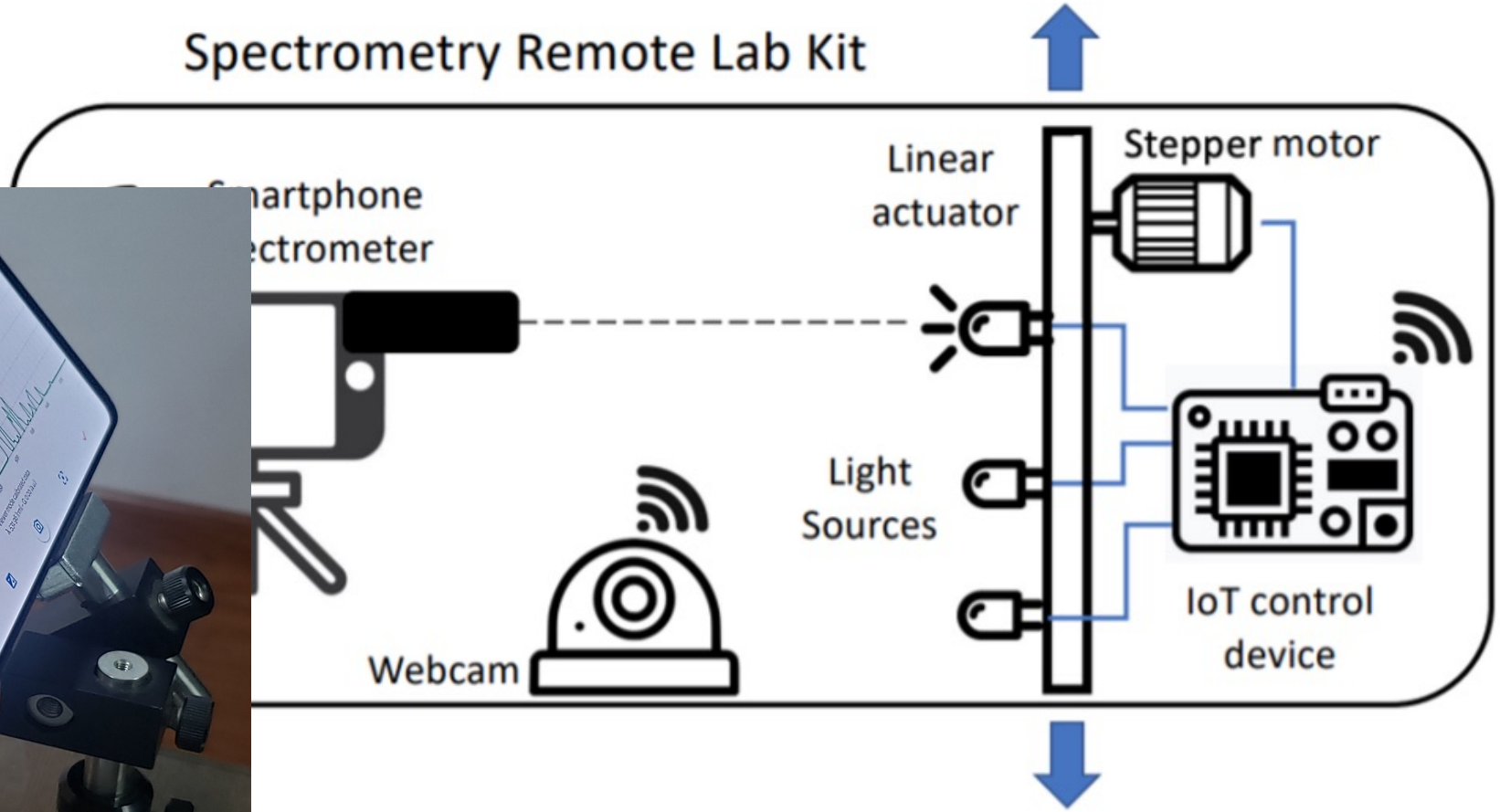
Software + Licence



Optical sources

How to turn this equipment into a remote laboratory ?

Spectrometry Remote Lab



ÓPTICA PURA Y APLICADA
REVISTA EN ESPAÑOL DE ÓPTICA Y FOTÓNICA

A spectrometer based on smartphones and a low-cost kit for transmittance and absorbance measurements in real-time
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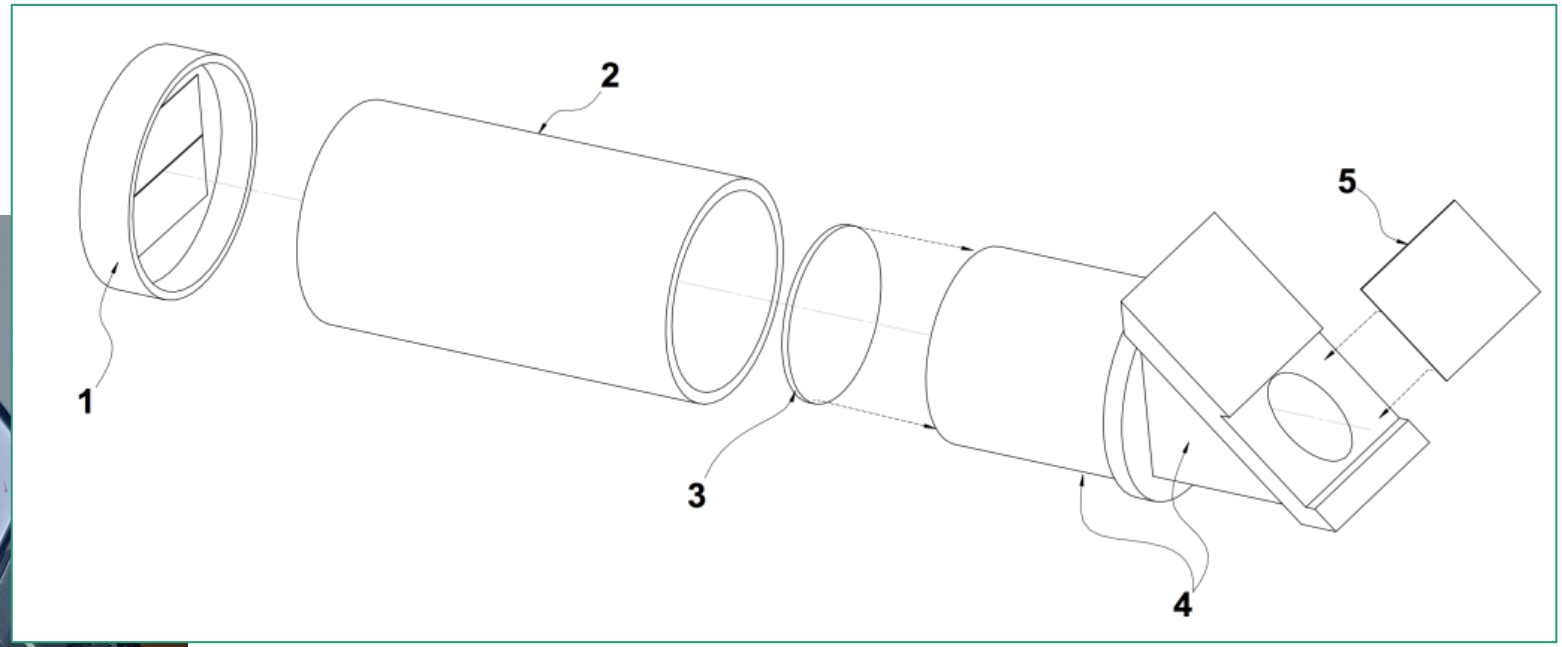
V50-N3/2017 Sección: Espectroscopía

Spectrometry Remote Lab



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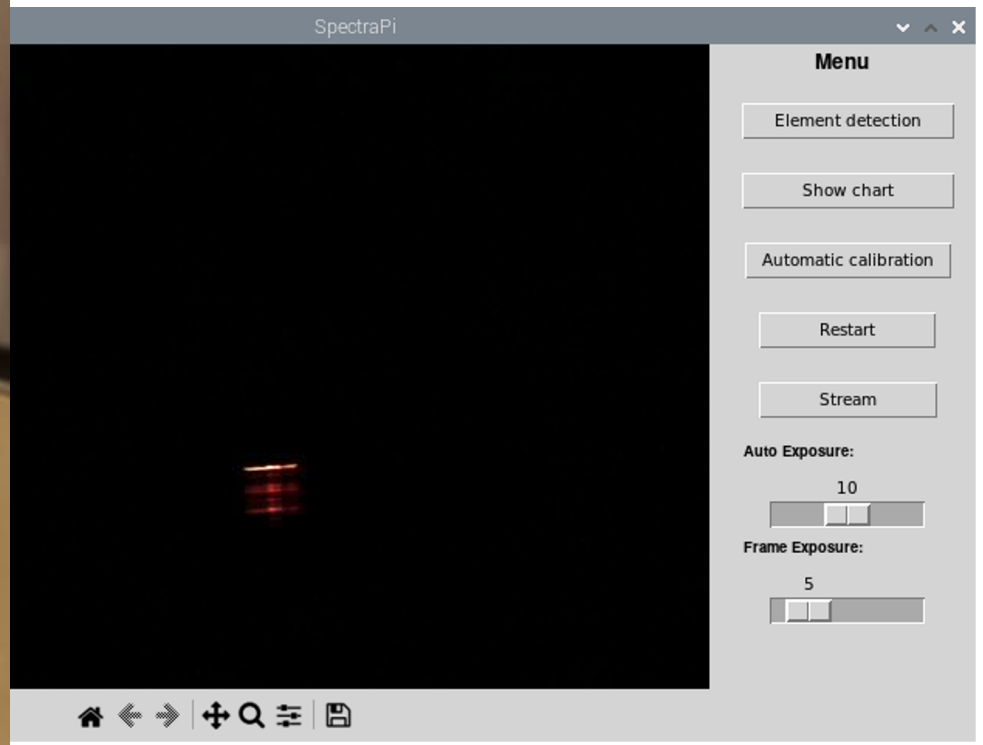
Spectrometer based on Raspberry Pi



SpectraPI: Python program

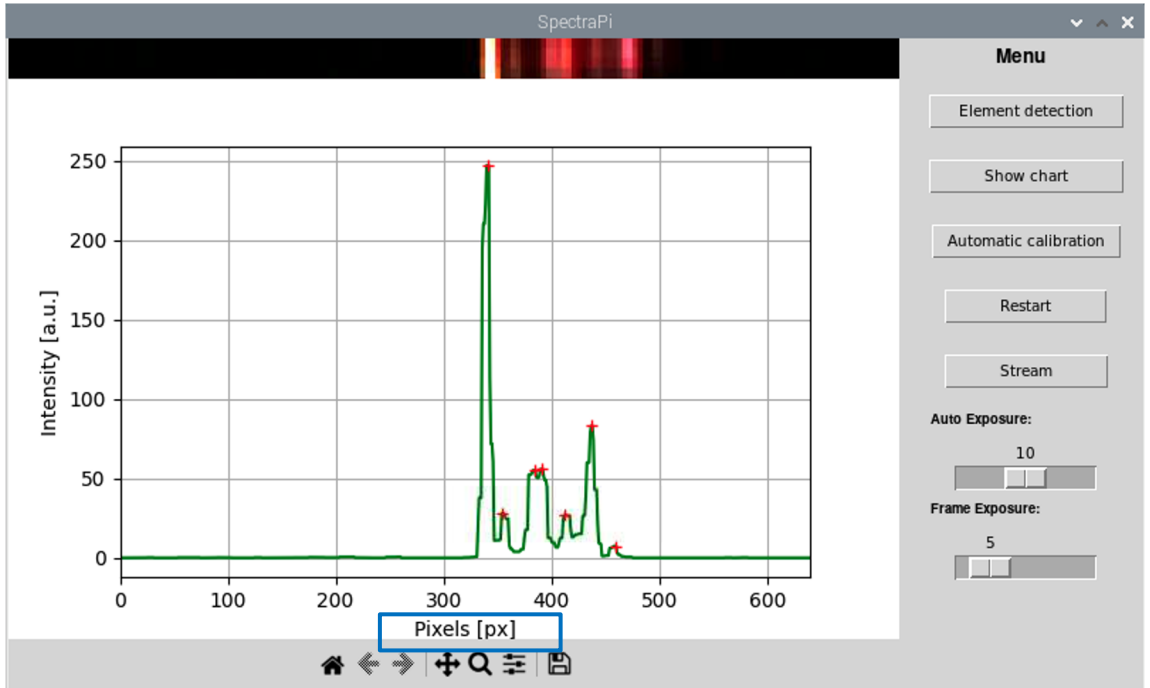
Spectrometer based on Raspberry Pi: Calibration process

1. Get the intensity of each pixel by pre-processing spectra image:

   [RGB] => **[Y'UV]** where **Y'**= (0.257×R) + (0.504×G) + (0.098×B) + 16

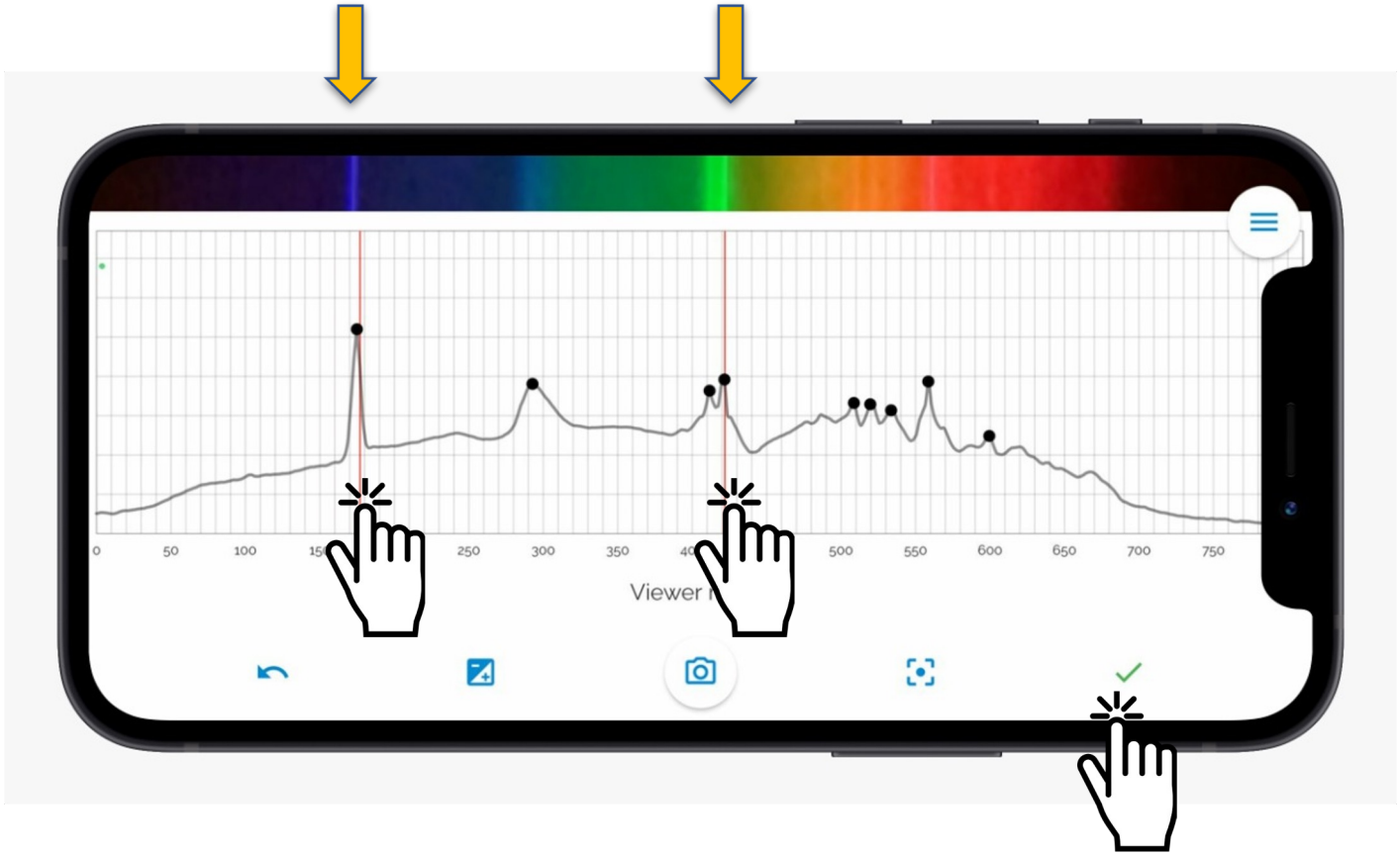
$$intensity_j = \sum_{i=1}^{n} Y'_{i,j}$$

2. Peaks detection



Spectrometer based on Raspberry Pi: Manual calibration process

3. Selection of reference lines



Reference lines - mercury:

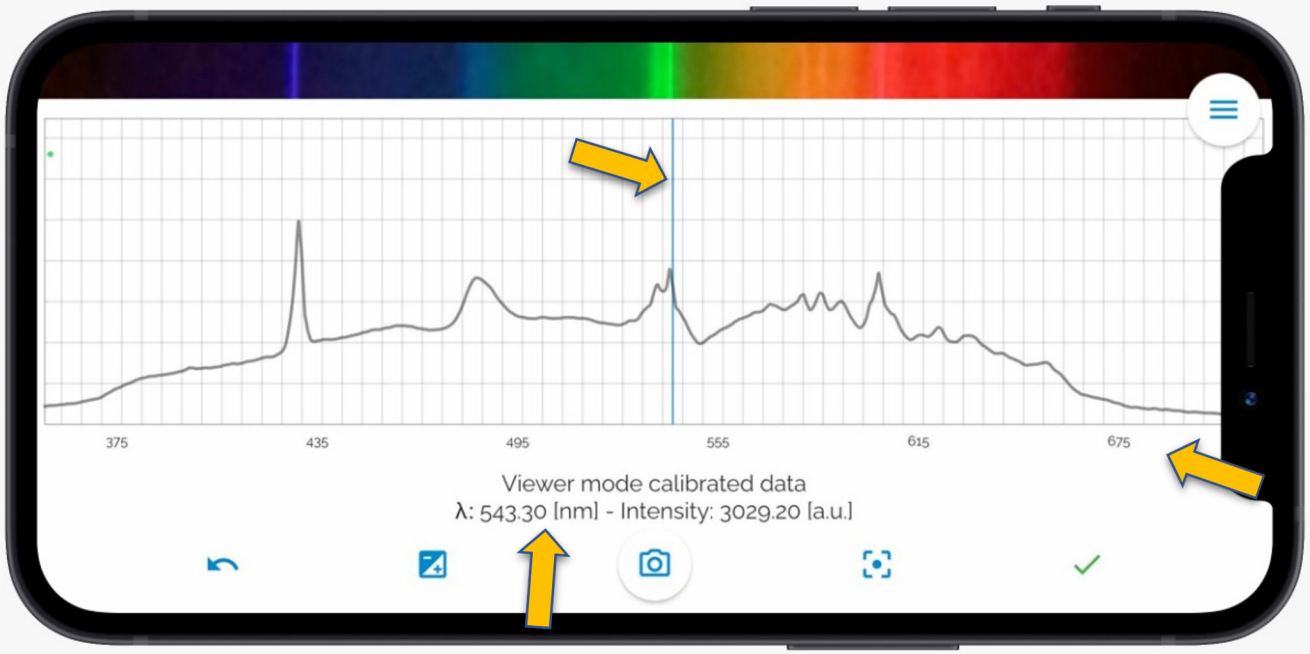
- 435.83 nm
- 546.07 nm

Calibration

Spectrometer based on Raspberry Pi: Manual calibration process

4. Calibration by fitting a first-order polynomial

$$y = y_1 + (y_2 - y_1) \times \frac{x - x_1}{x_2 - x_1}$$

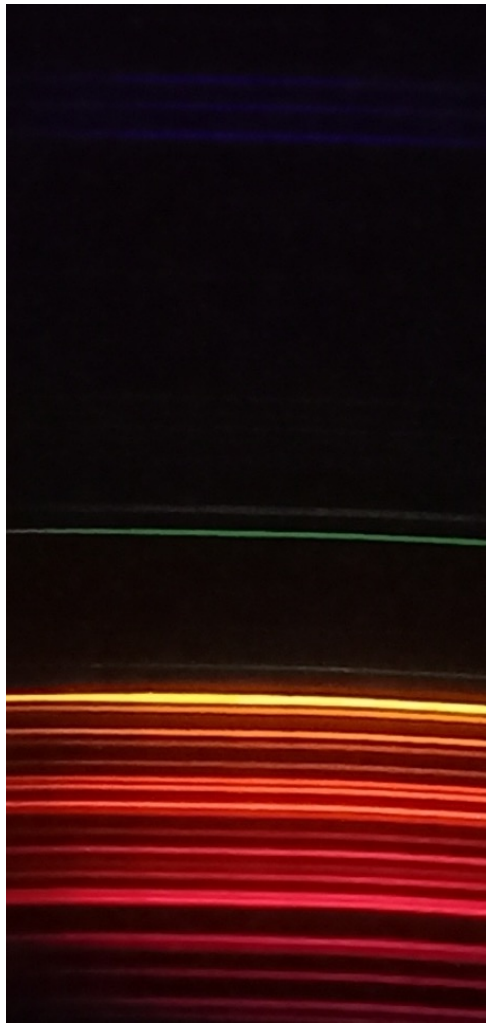


Reference lines - mercury:

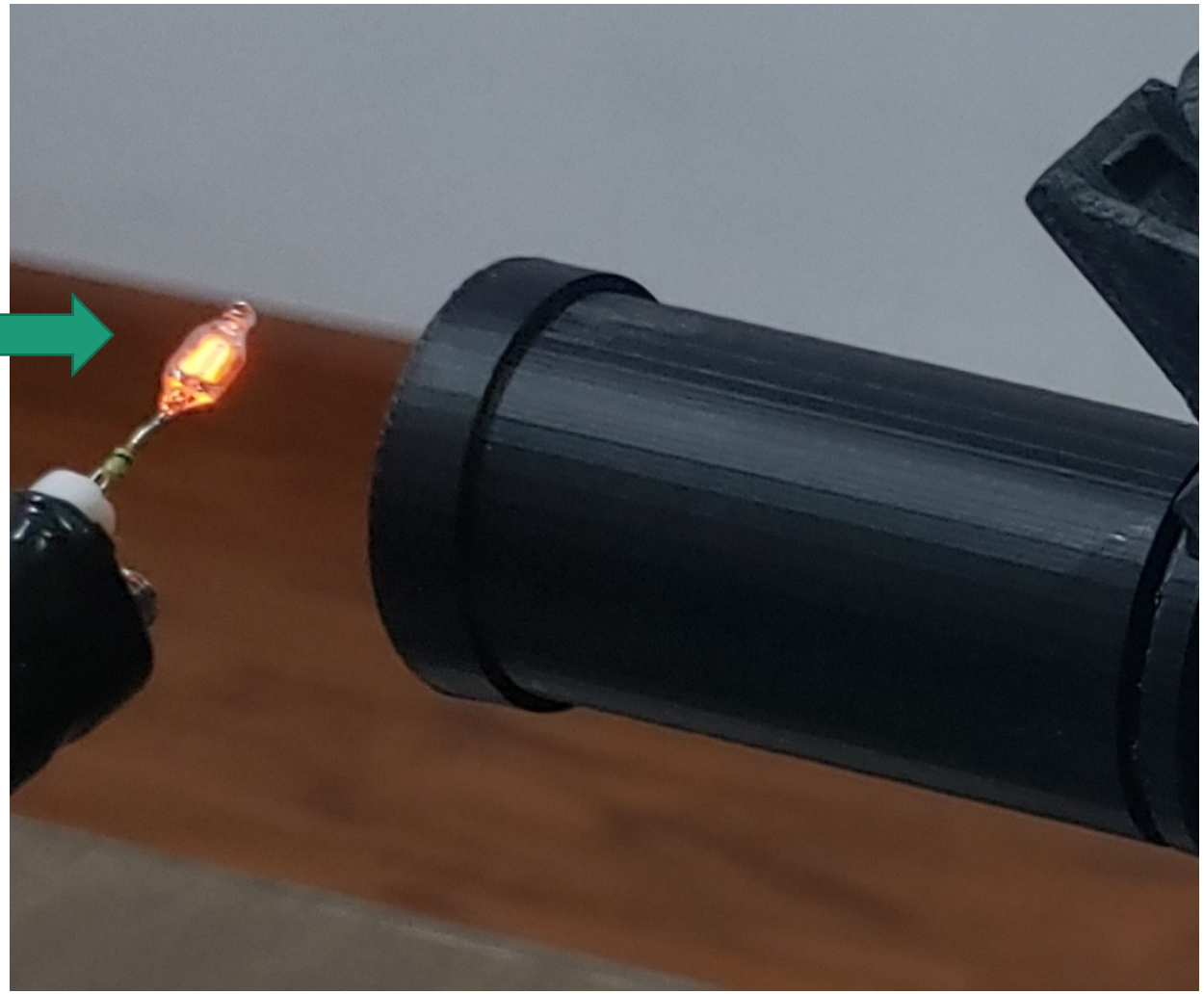
- 435.83 nm
- 546.07 nm

Wavelength [nm]

Spectrometer based on Raspberry Pi: Calibration process with Ne lamp

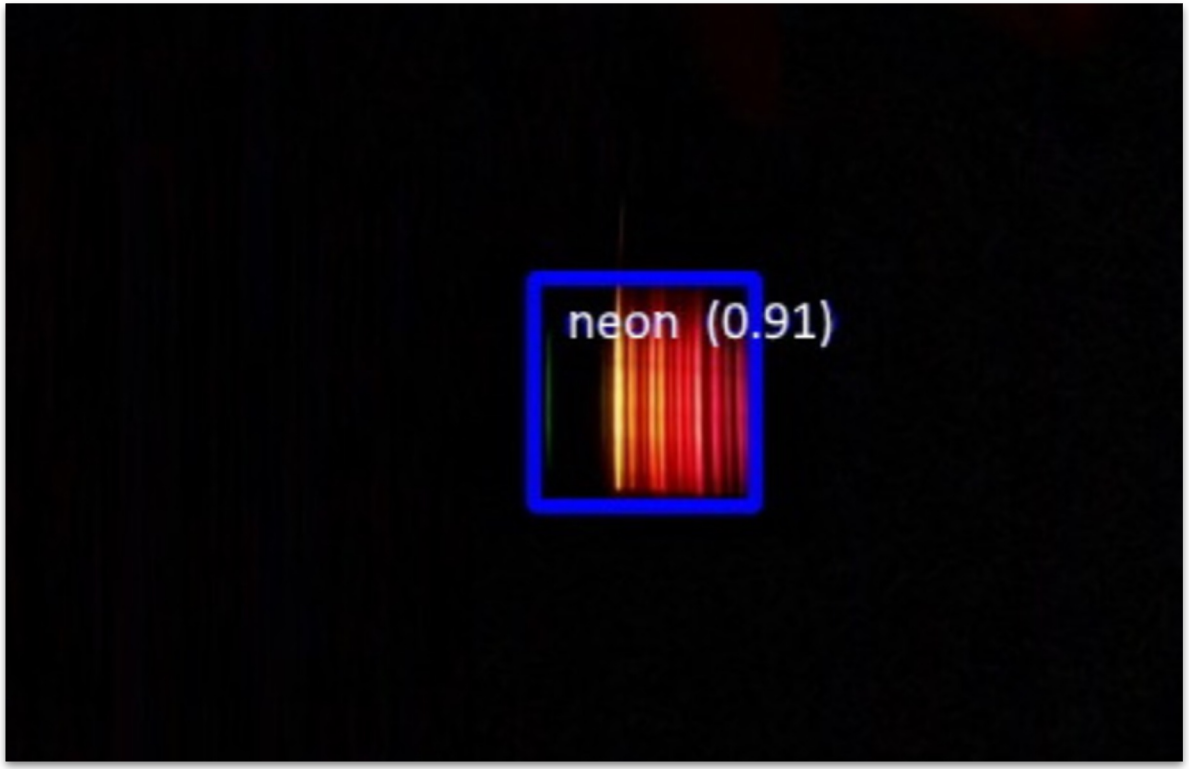


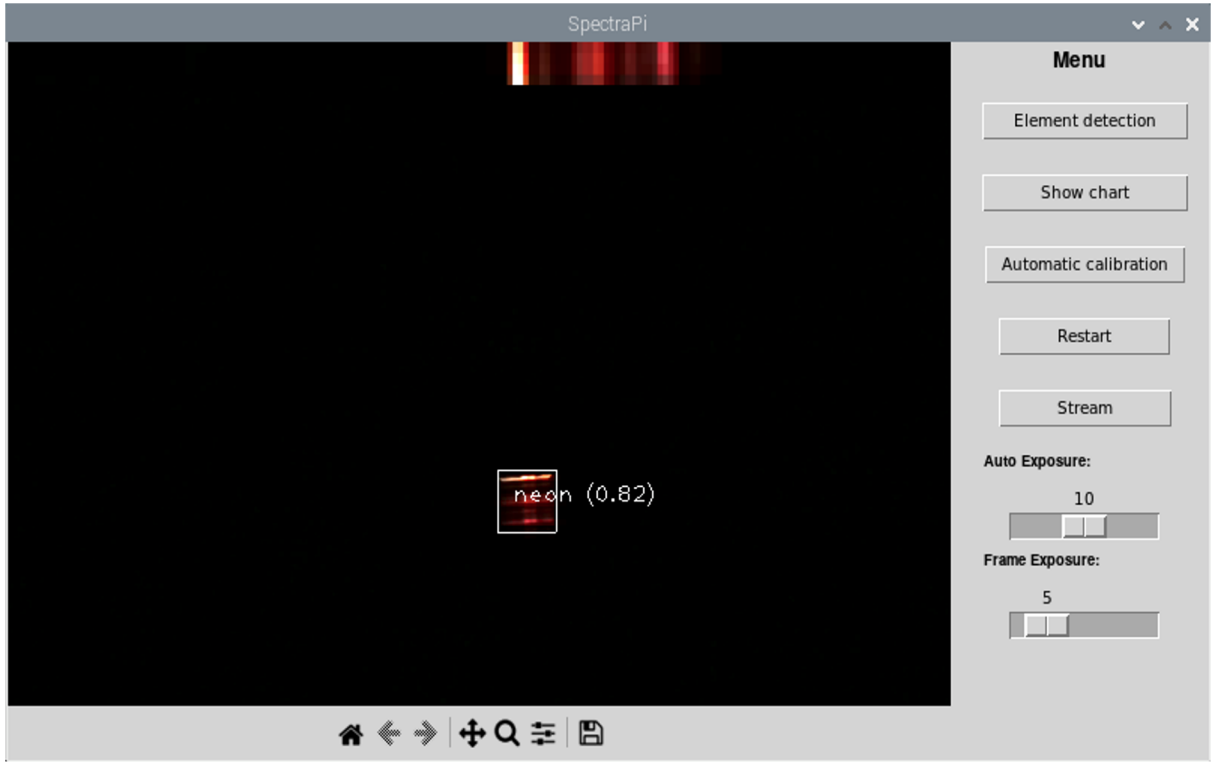
Ne lamp



Spectrometer based on Raspberry Pi: Calibration process with Ne lamp

Object detection

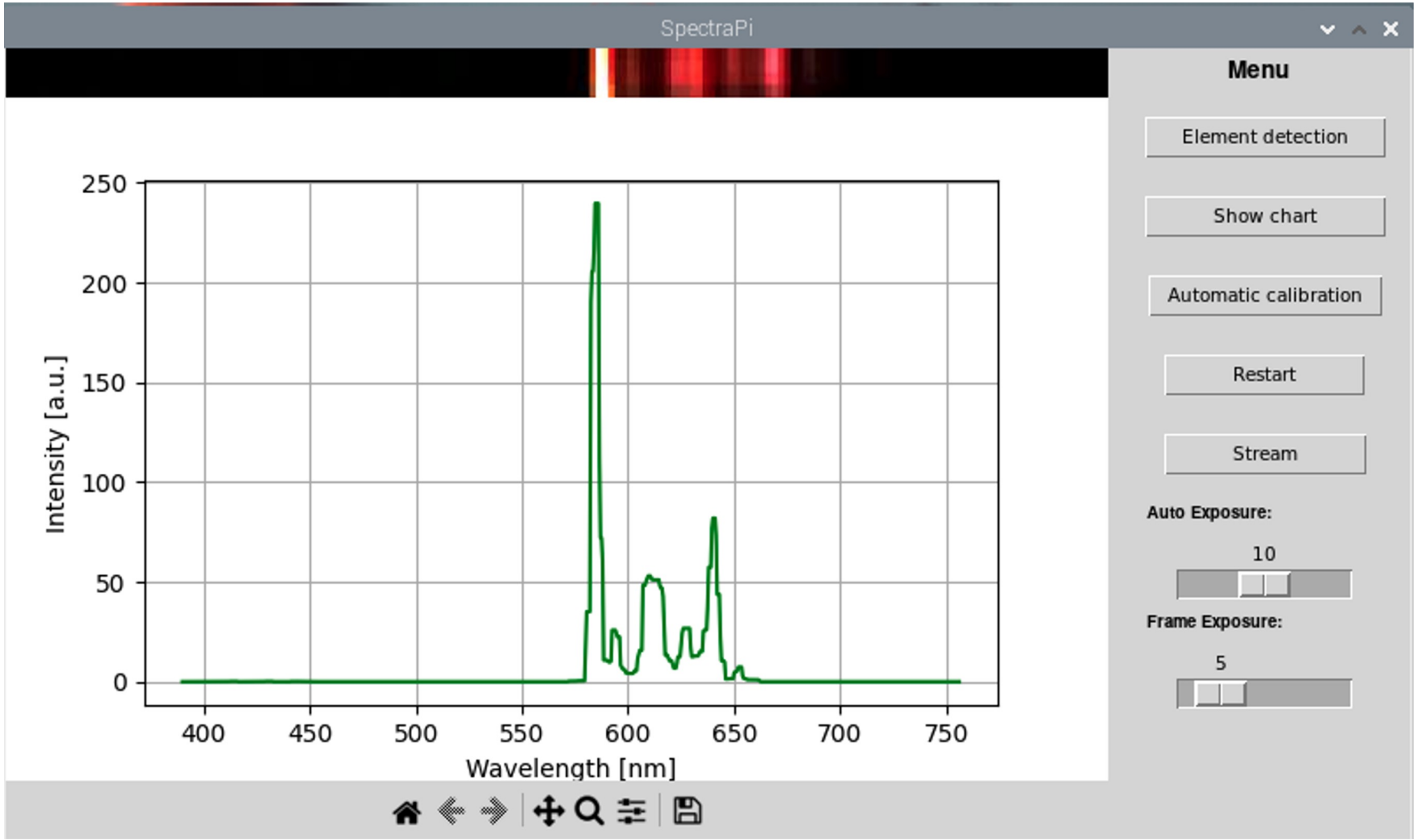




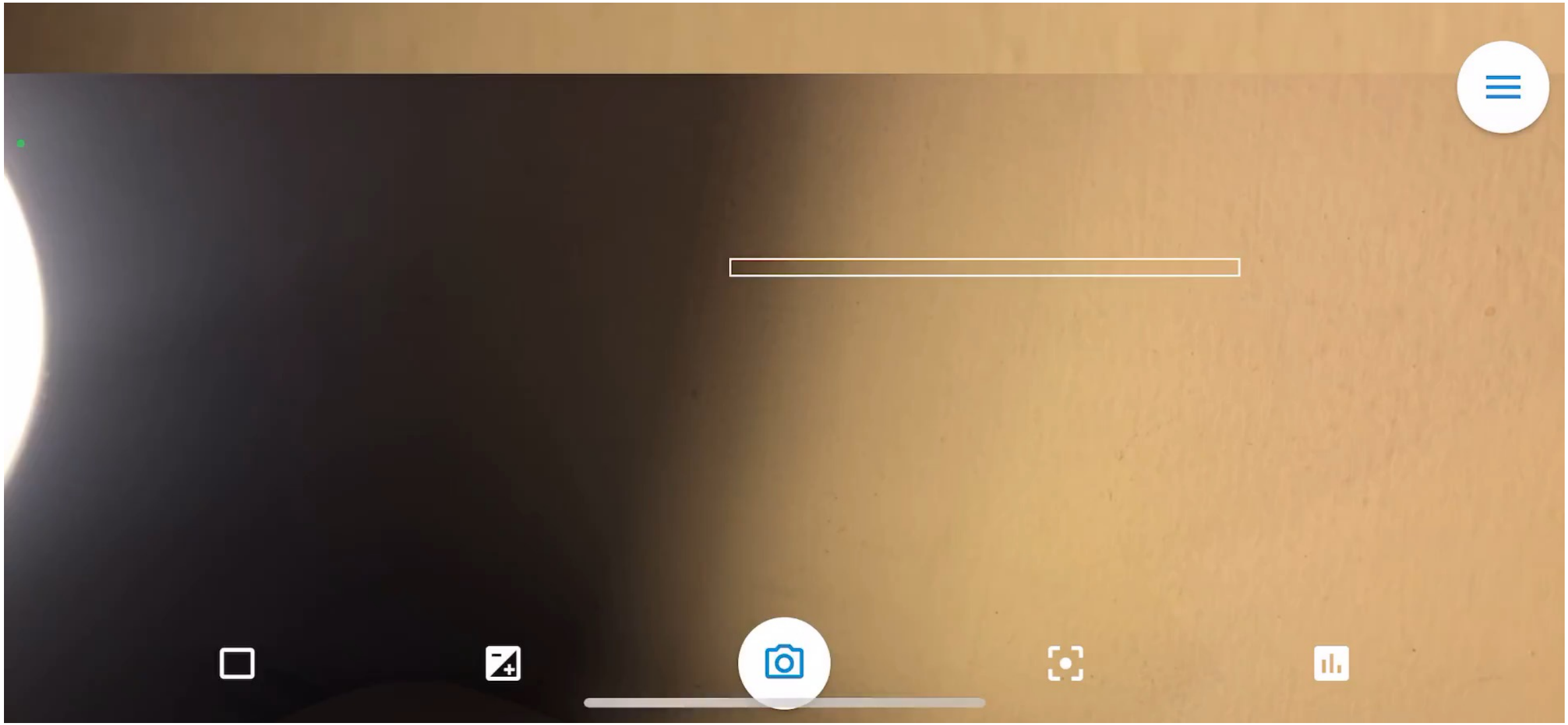
Spectrometer based on Raspberry Pi: Calibration process with Ne lamp

Automatic calibration

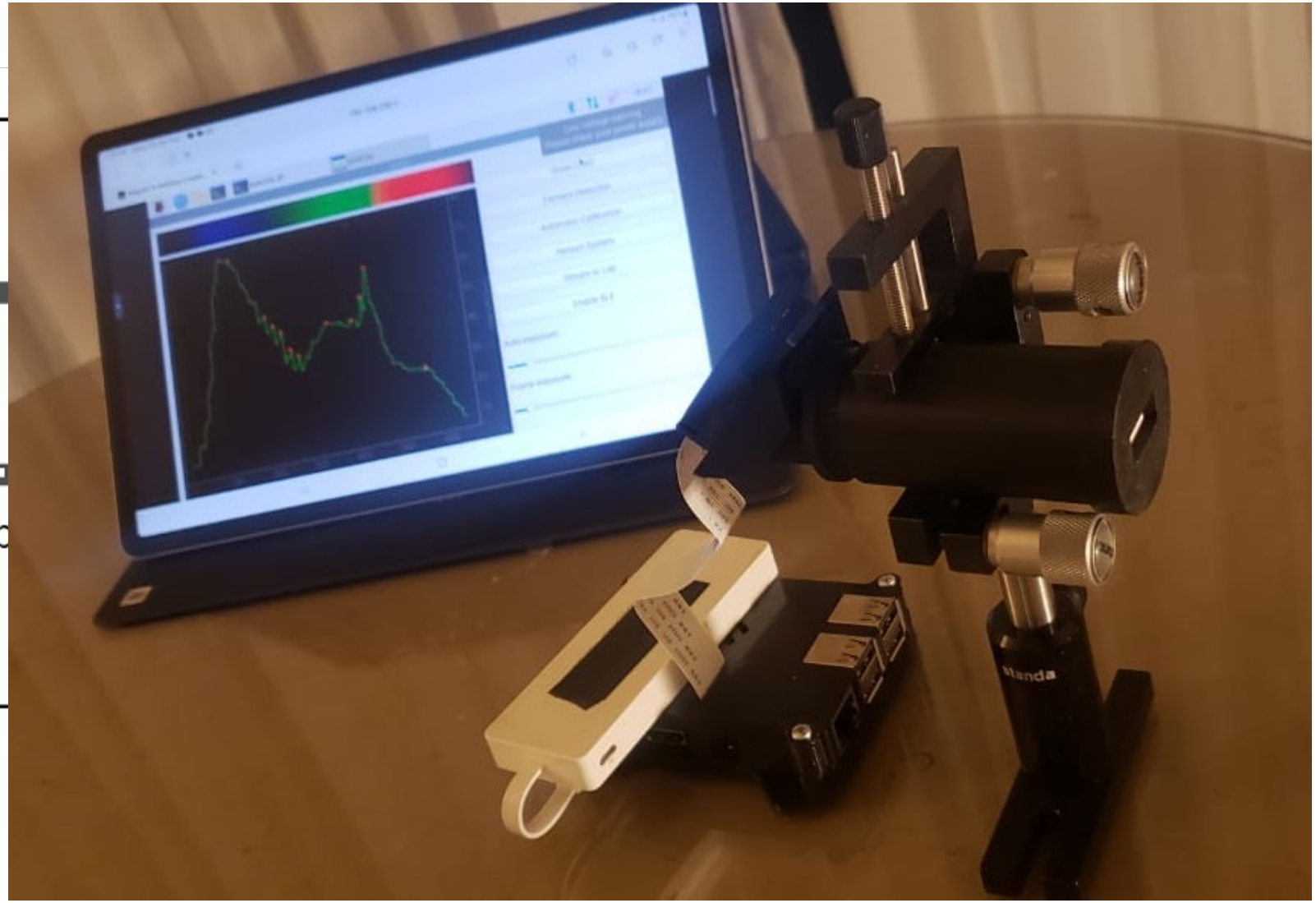
Automatic selection of reference lines



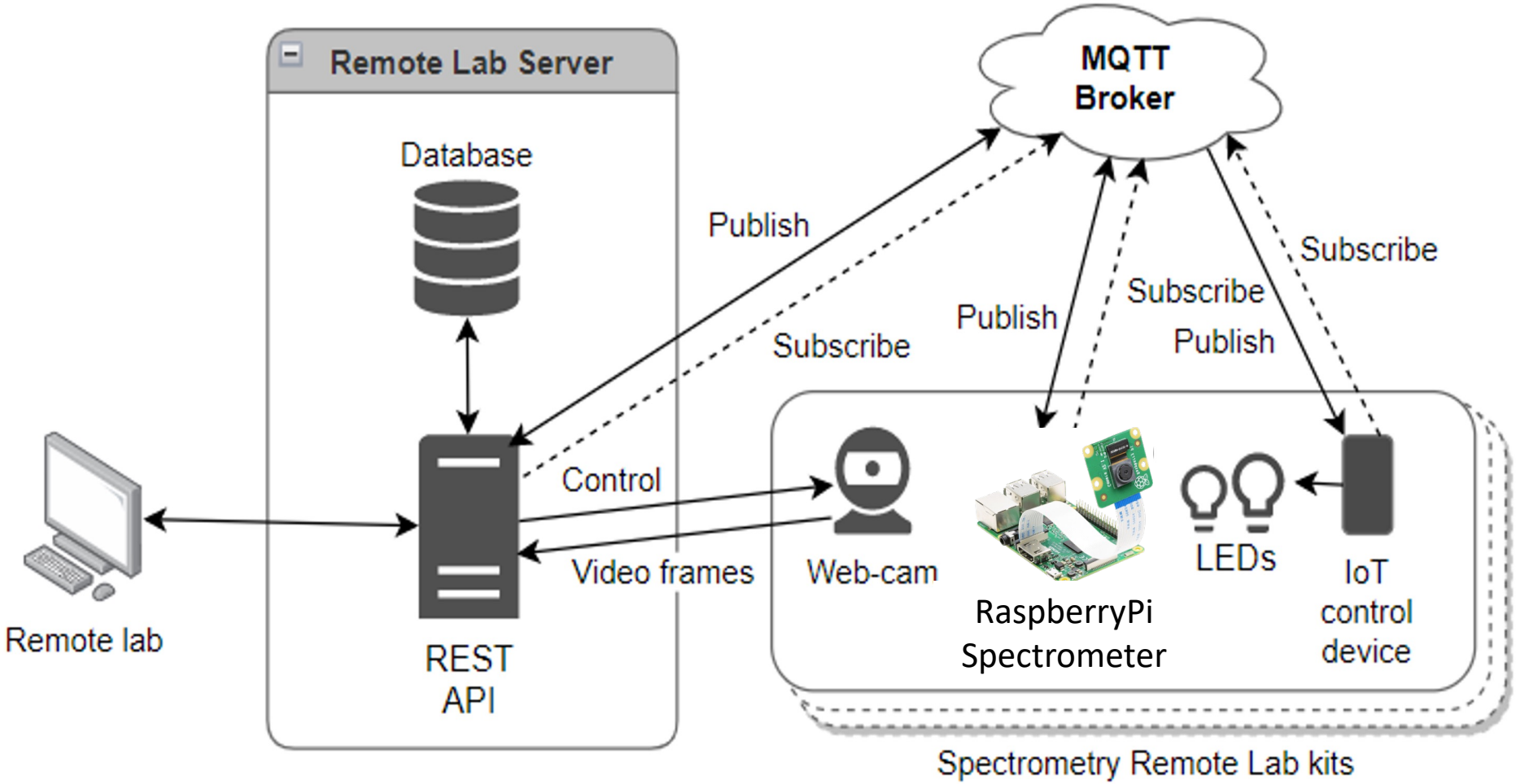
Spectrometer based on Raspberry Pi: Automatic Calibration



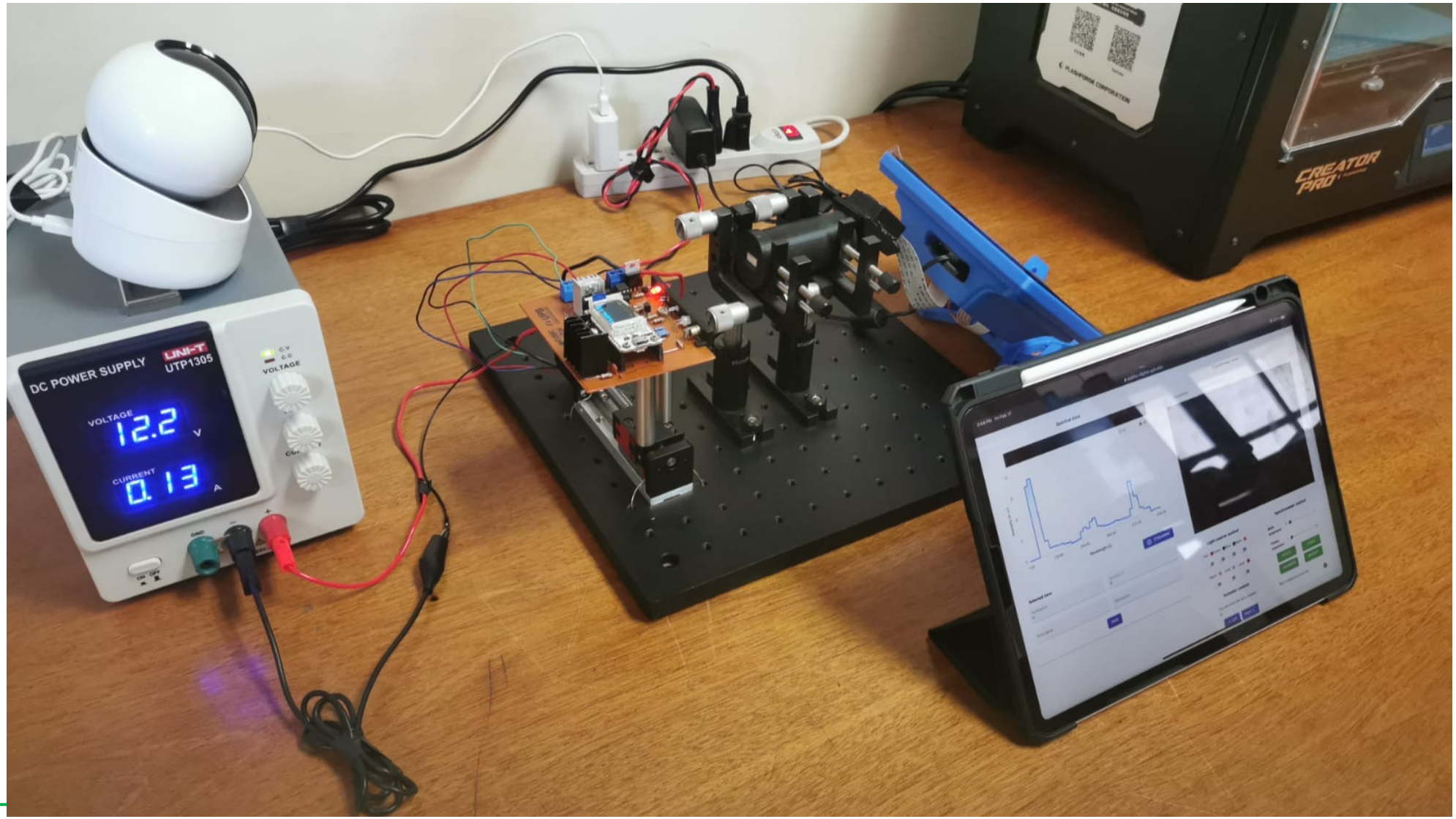
Spectrometer based on Raspberry Pi: Wireless transmission



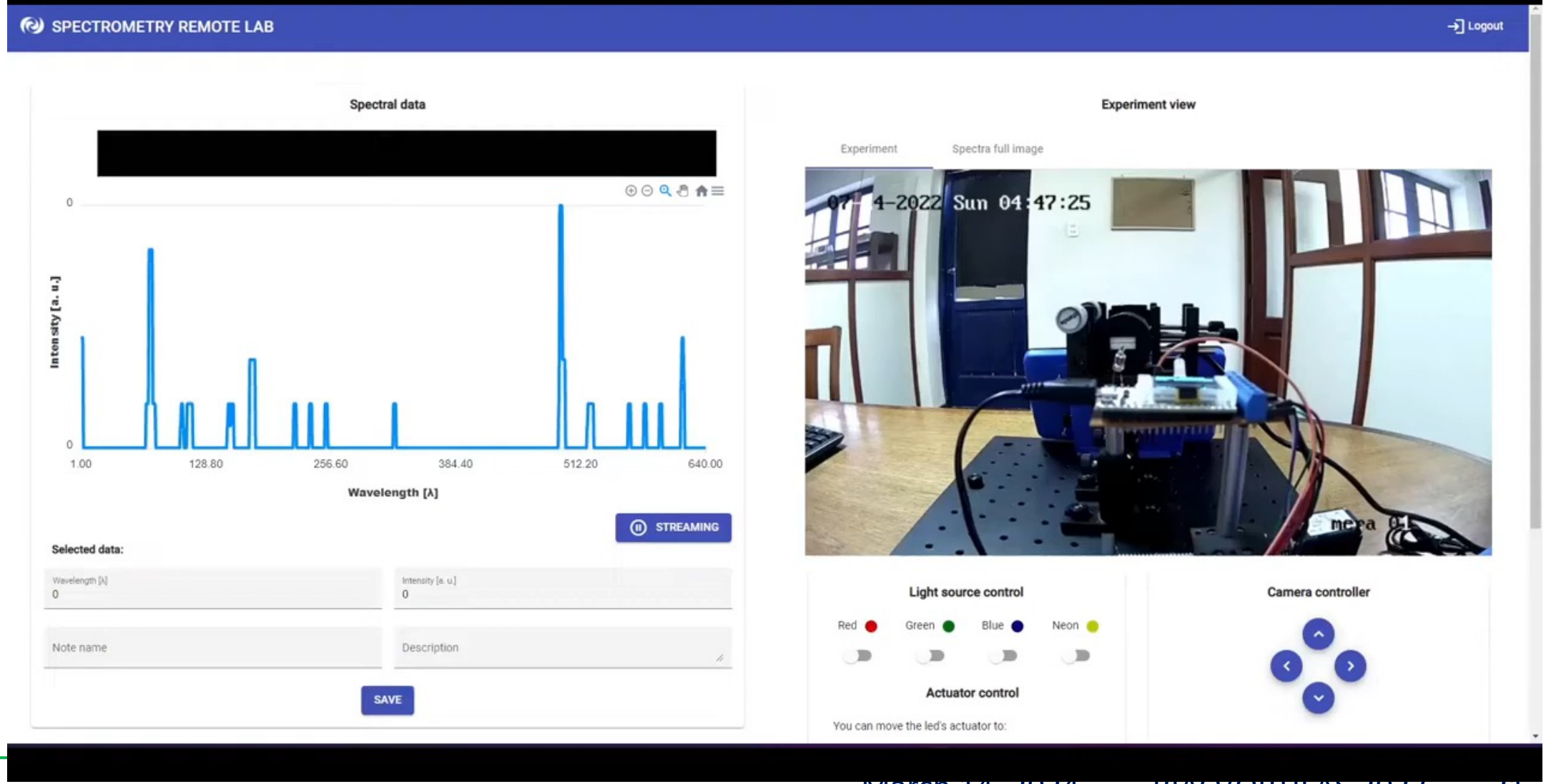
Spectrometry Remote Laboratory based on Raspberry Pi



Spectrometry Remote Laboratory based on Raspberry Pi



Spectrometr[redacted]



Thank You so much !!!