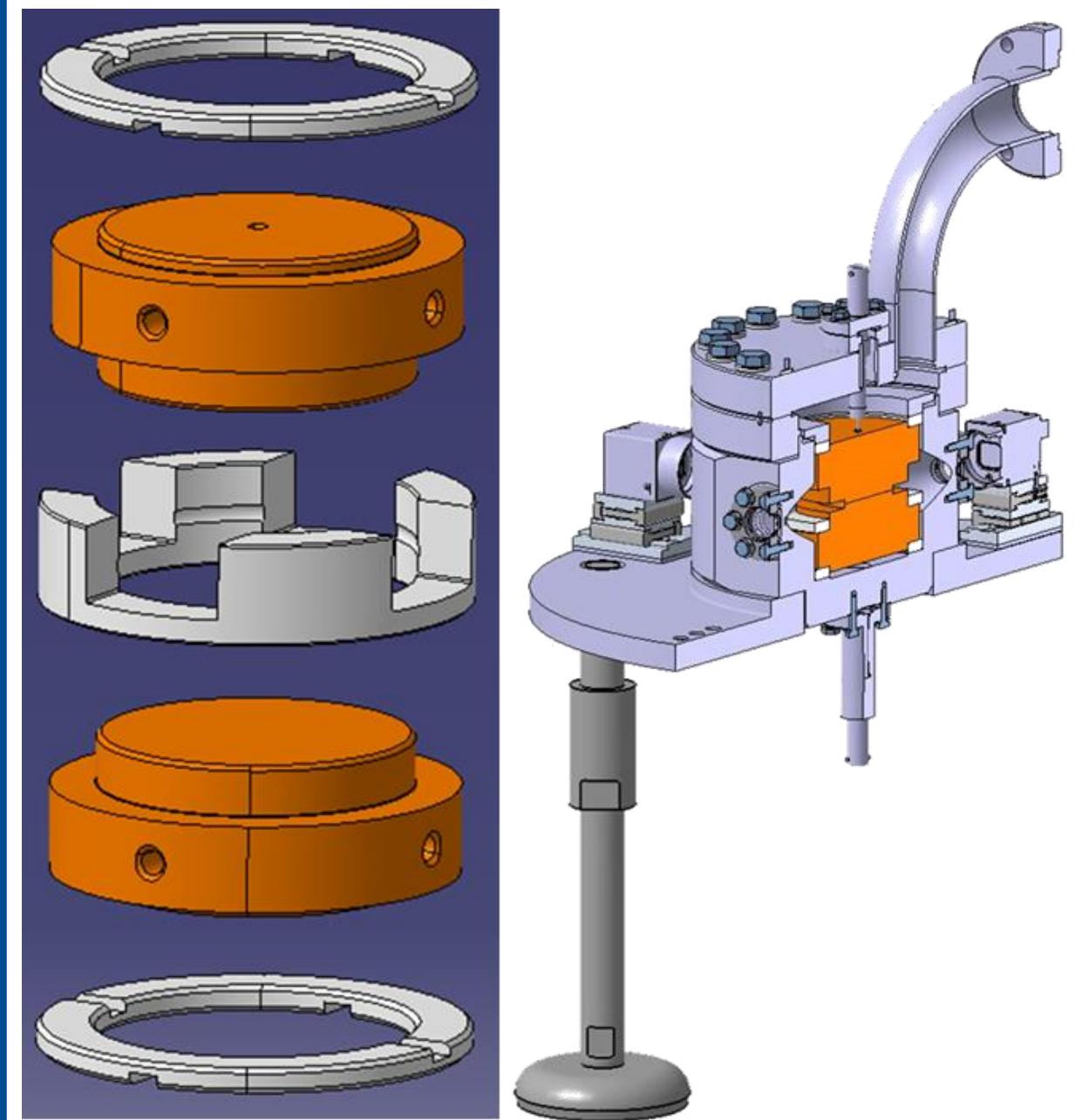
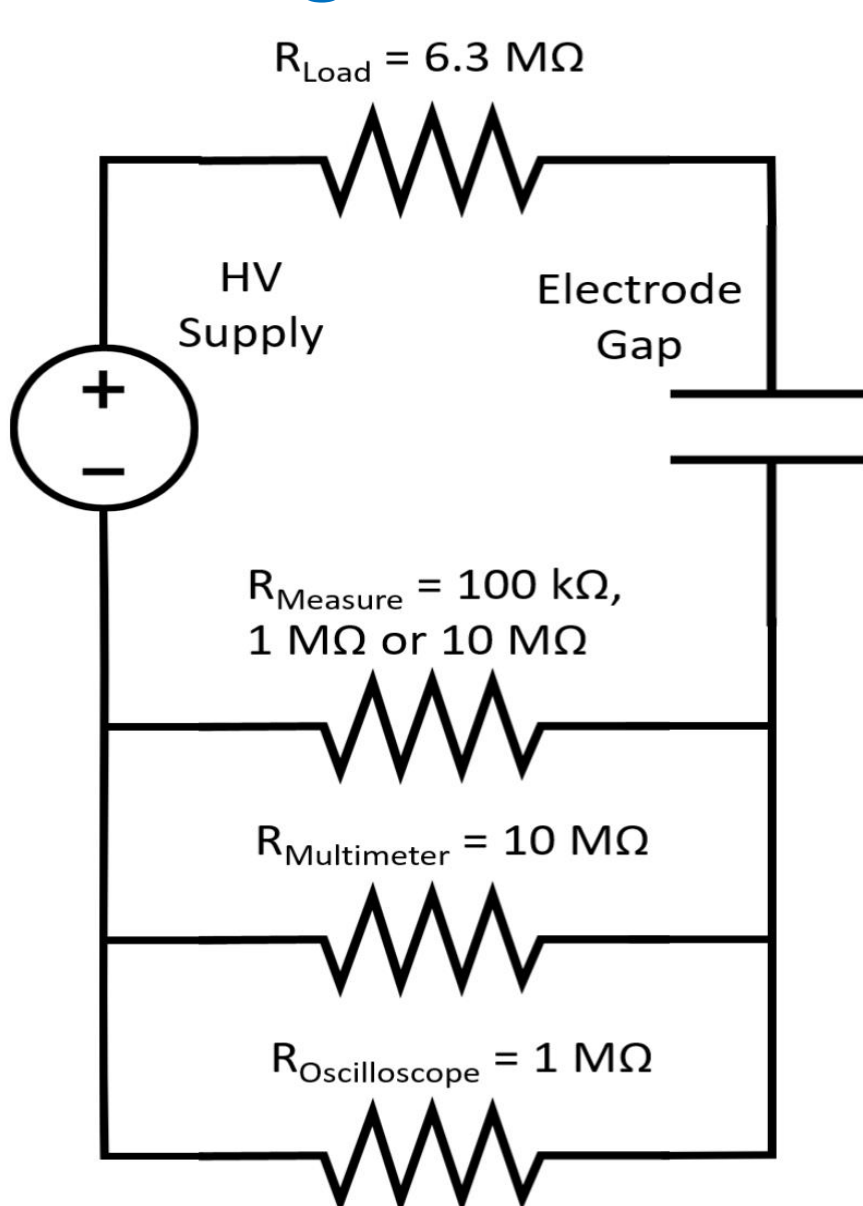


Introduction

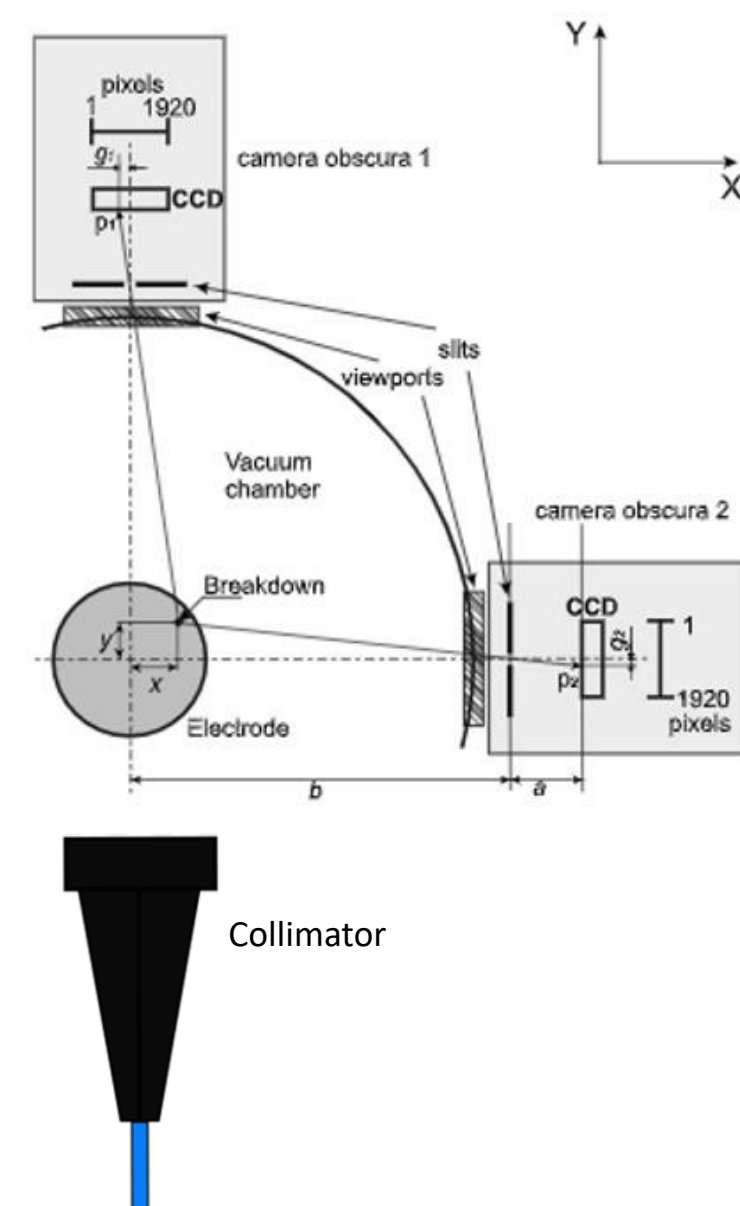
2 high-precision-machined electrodes placed parallel 60µm apart in a vacuum chamber with a constant DC supply.



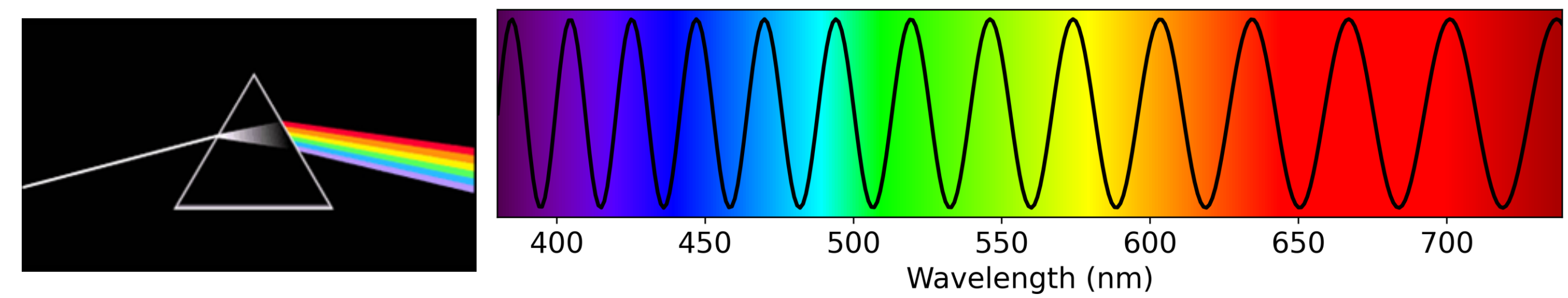
A 6.3 MΩ resistor is placed in series with the chamber to reduce the probability of breakdown, and a current sense resistor is placed between the chamber and ground



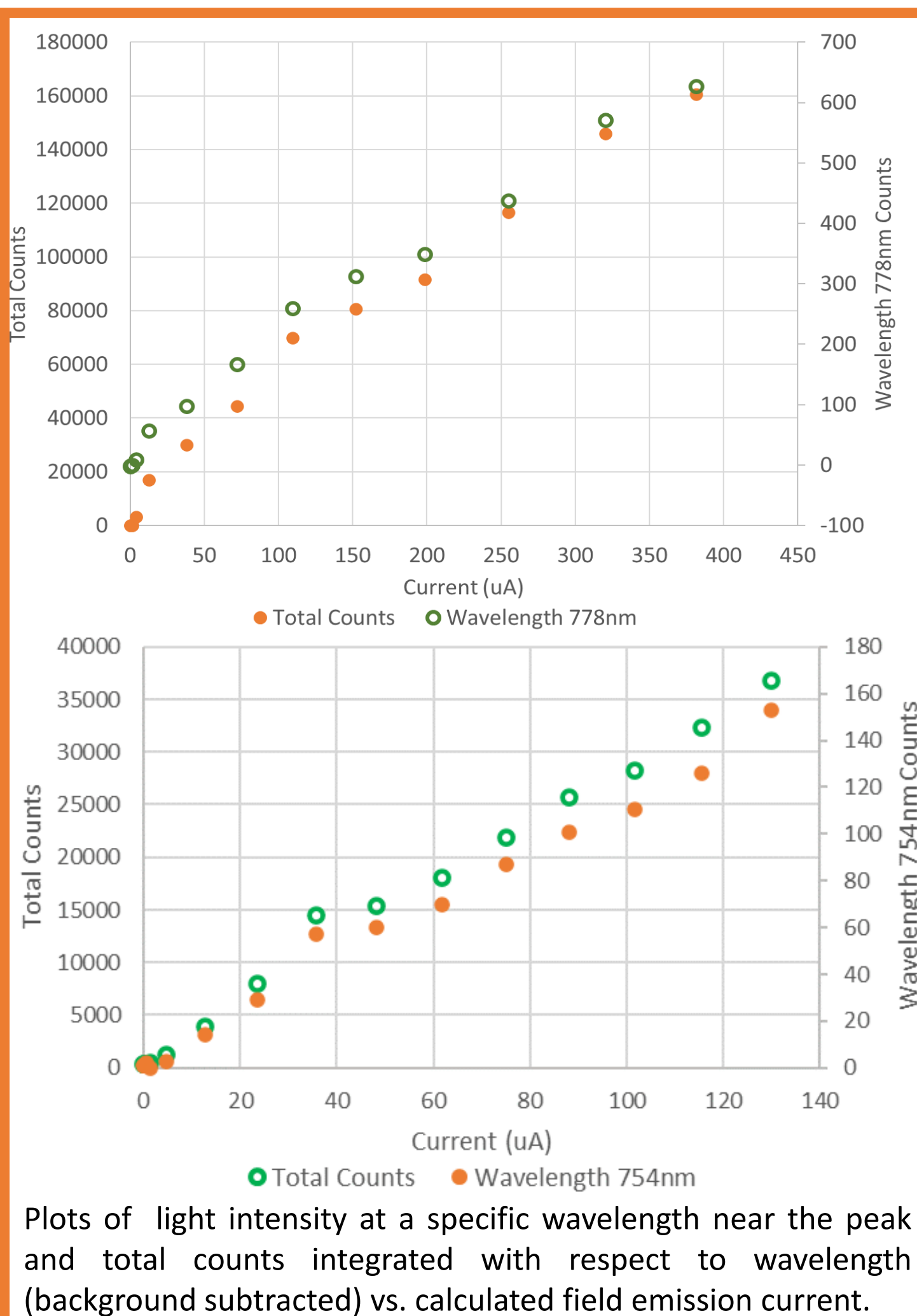
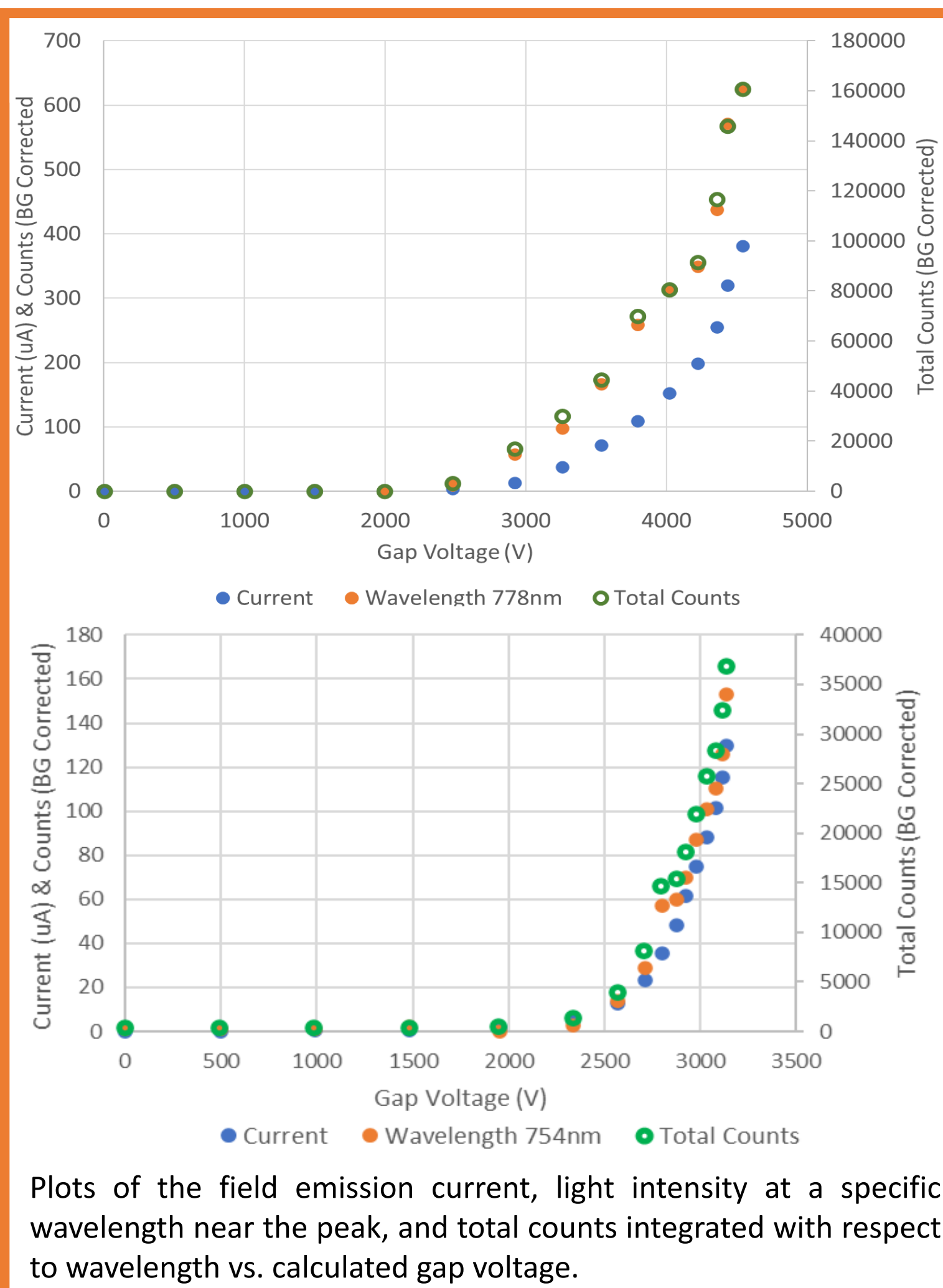
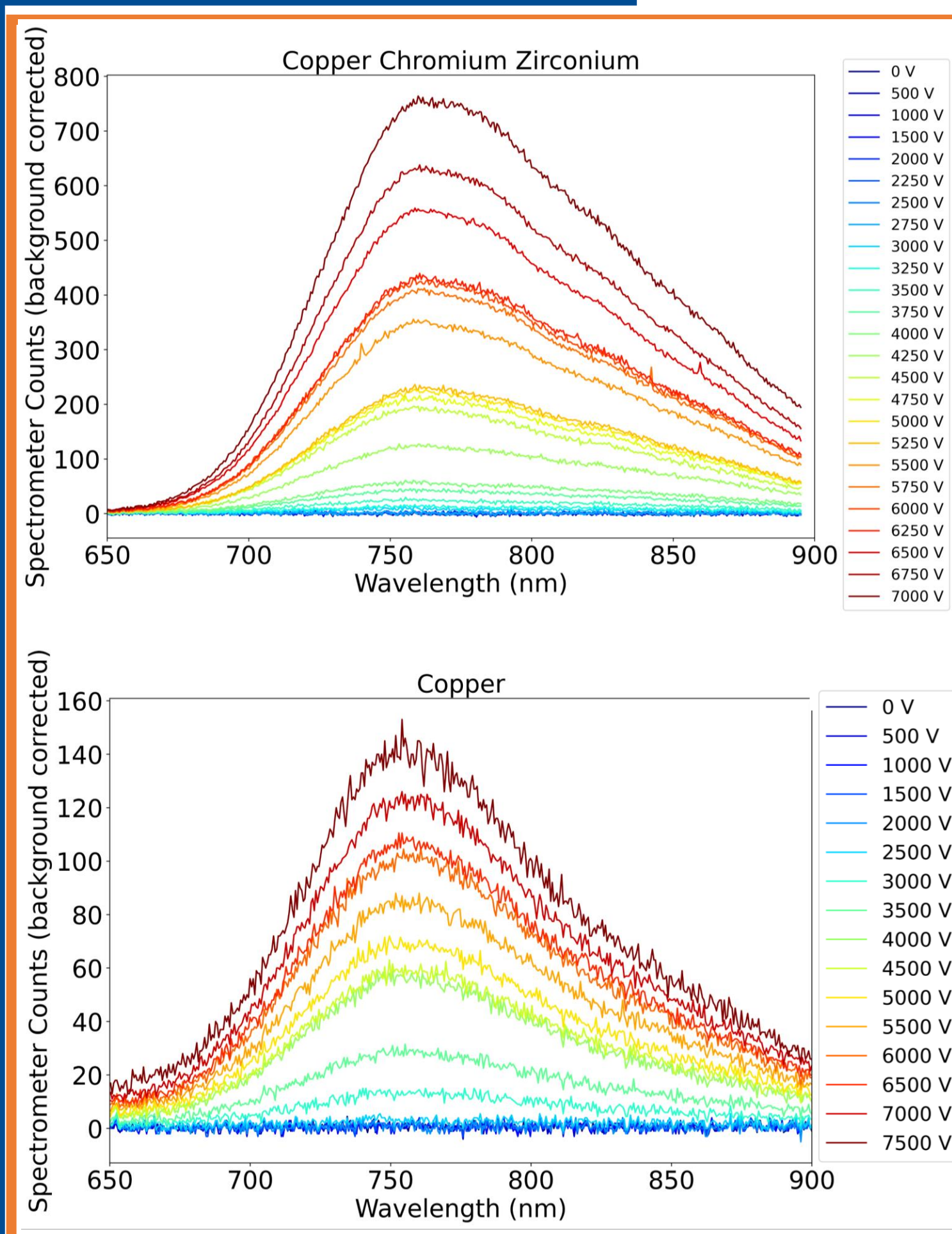
Perpendicular cameras to determine the location of the light sources and an optical fibre to transmit the light to the spectrometer



All measurements were taken during field emission and no breakdown spectra are shown below
Light collected is diffracted using a Shamrock spectrometer and captured using an IDus CCD camera
Several 5-second exposures with a slit opening of 2500 µm to maximise light captured, were taken at each voltage step
For the Nb and Ta electrode pairs, spectra were recorded when light became visible, rather than from 0 V as with Cu and CuCrZr
Each spectrum was recorded with reference to the supply voltage and is compared to the gap voltage and field emission current
The plot below shows the colours associated with the wavelengths for reference in the following plots

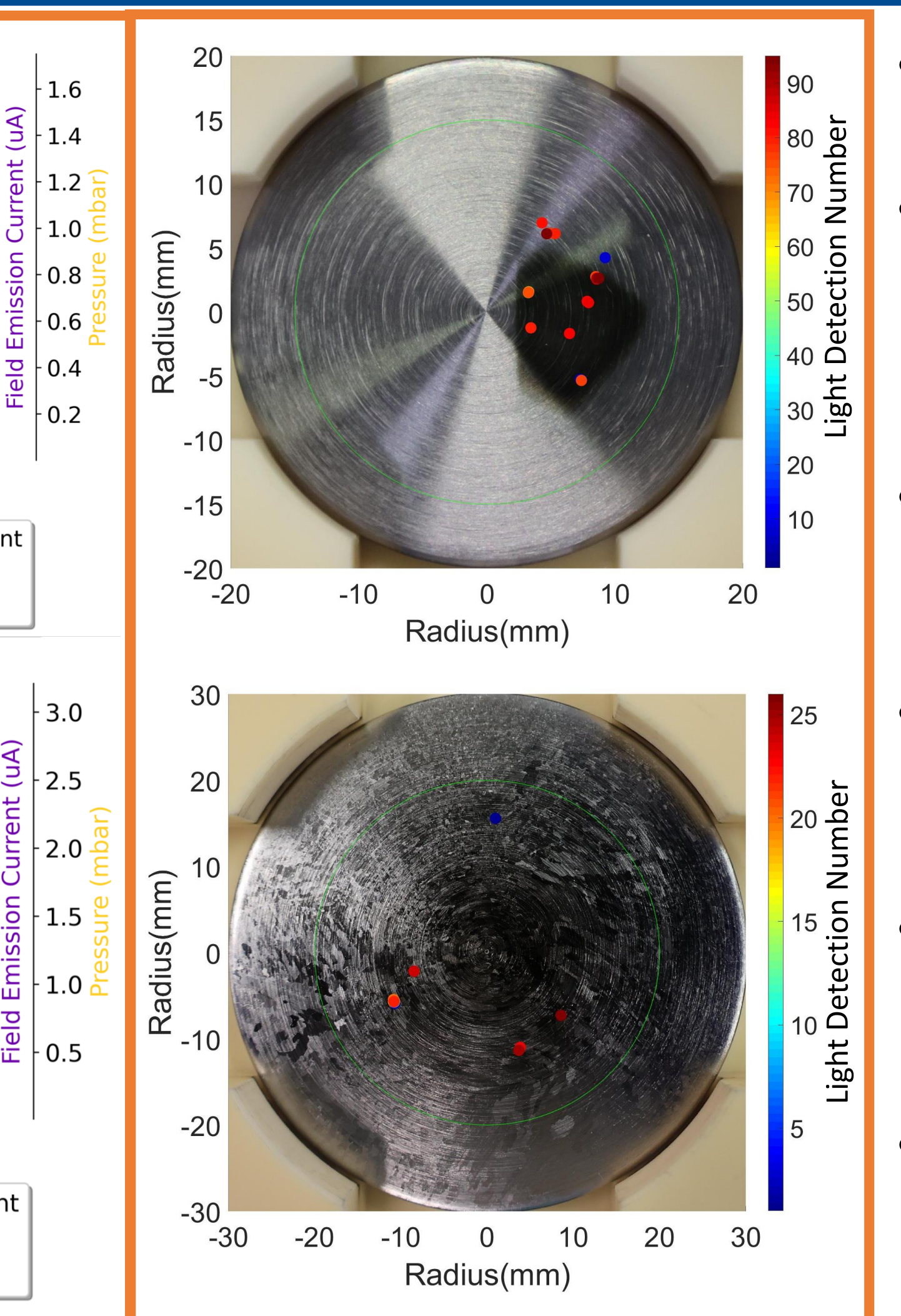
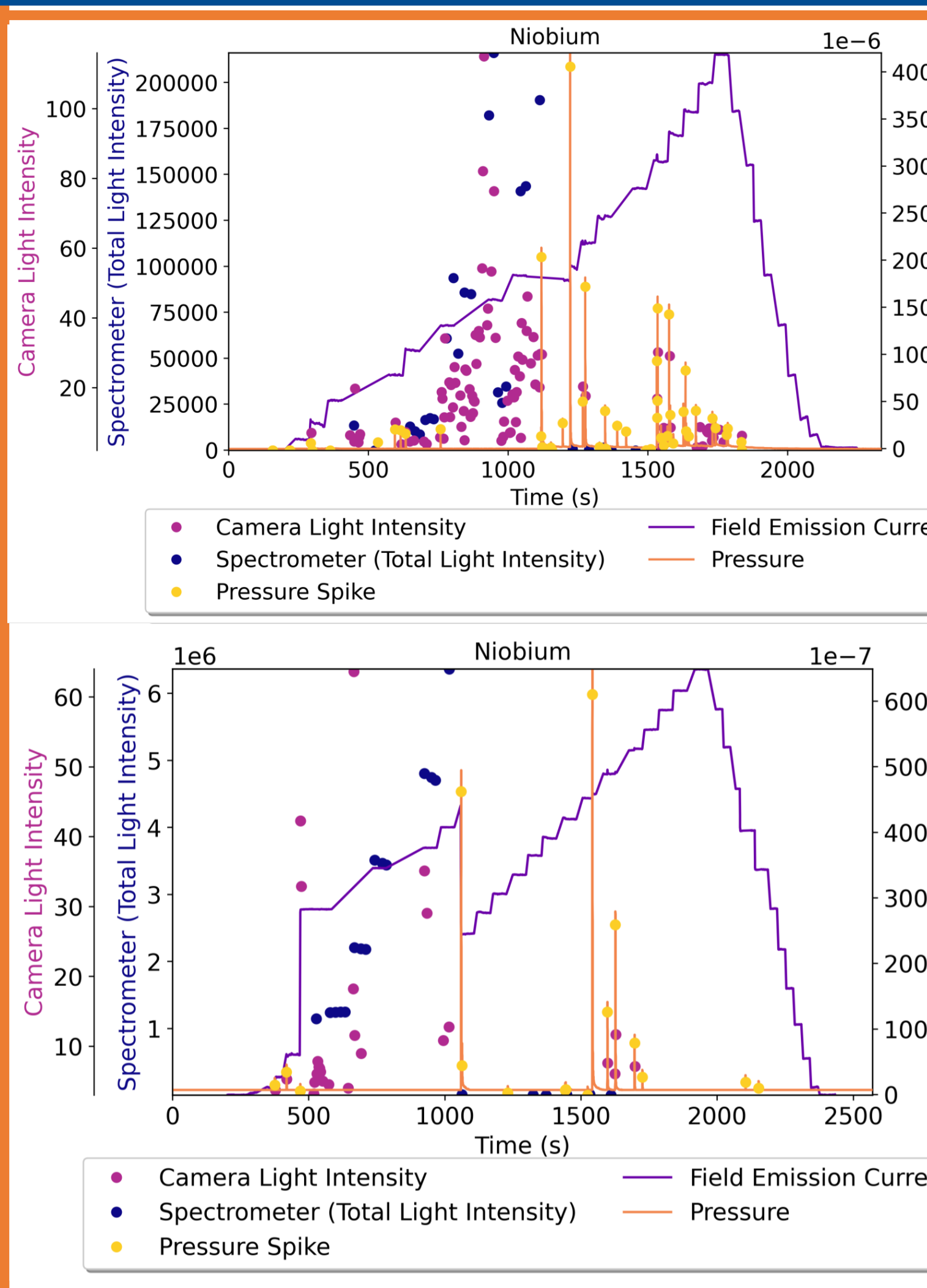
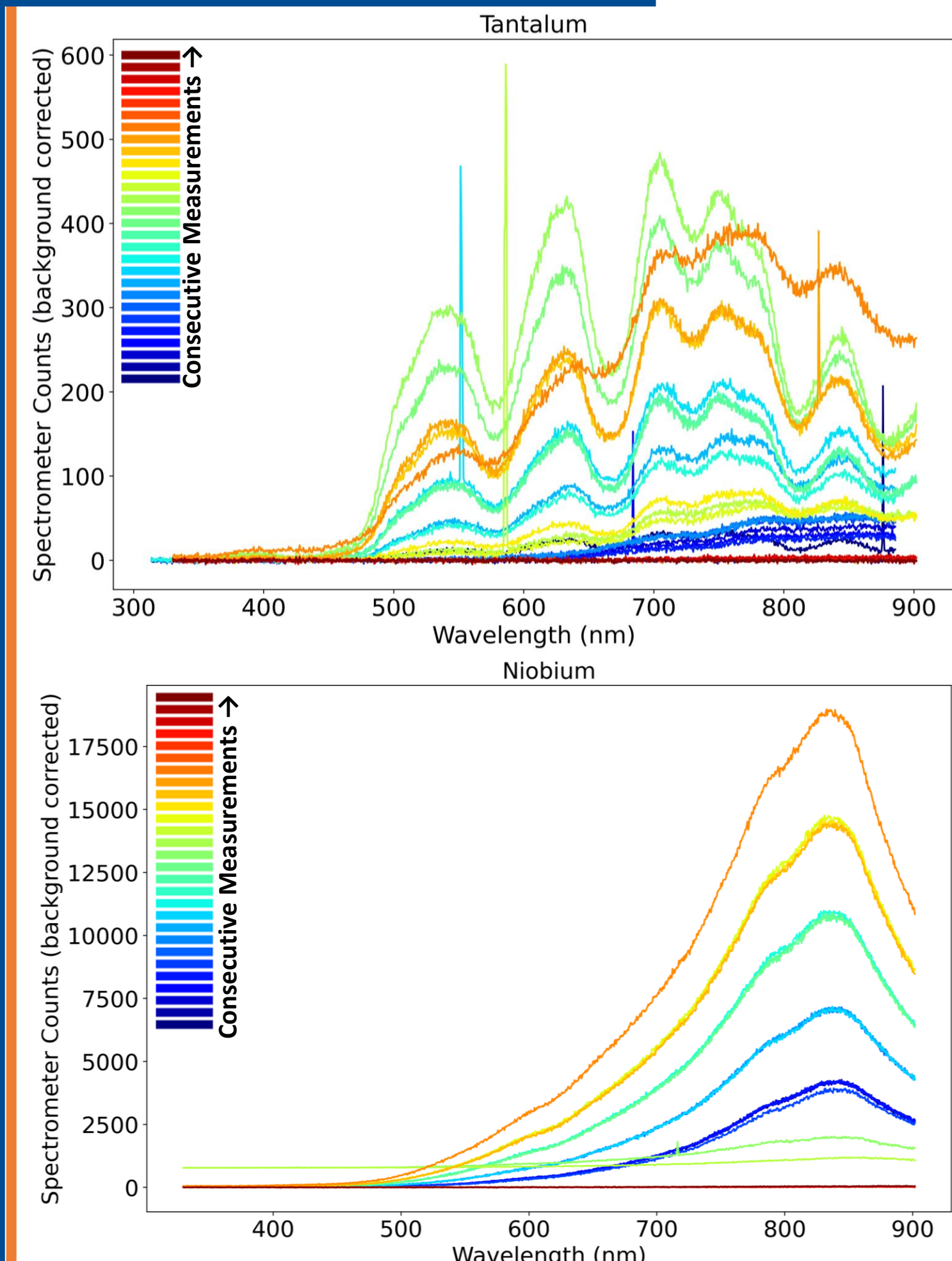


Cu based Spectra



- Spectra for both Cu and CuCrZr look very similar and span the same wavelengths - this is most likely due to the light reflecting off the Cu-coloured surface several times to escape the gap
- The spectra from these materials are stable and light intensity is clearly correlated with supply voltage
- Plots of gap voltage vs. both the current and light intensity show a Fowler-Nordheim-shaped curve
- Plots of current vs. light intensity show a linear correlation suggesting that they may be strongly related

Ta and Nb Spectra



- Ta and Nb are similar in physical colour but show different spectra
- Both only showed spectra for a relatively short period of time and went away after a breakdown (shown by the spike in pressure)
- Light was detected by the cameras at the same time as the spectra were observed
- Light intensity seen by both the spectrometer and cameras increased with supply voltage
- Nb displayed an increase in field emitted current during the increase in light seen
- Earlier light detection locations are covered with later ones suggesting that all areas of field-emitted light experienced breakdowns

Summary

- Light has been seen during field emission for Cu, CuCrZr, Nb and Ta but is more consistent in the Cu based materials
- Optical emission appears to be correlated with field-emitted current and therefore is more likely directly related
- Cu-based optical emission spectra seen show the colour of Cu and therefore it would be useful to measure the same phenomenon without filtering
- Light was detected by the cameras only for Ta and Nb and was no longer seen after a breakdown. This could mean either no more light being emitted or that the next source of light was less intense in relatively low reflectivity gap due to the worse surface finish
- The most likely explanation for the light emitted is optical transition radiation but this does not explain the differences between materials