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# Time-resolved Photoluminescence Spectroscopy of Thin Films for Controlled Synthesis of Functional Systems



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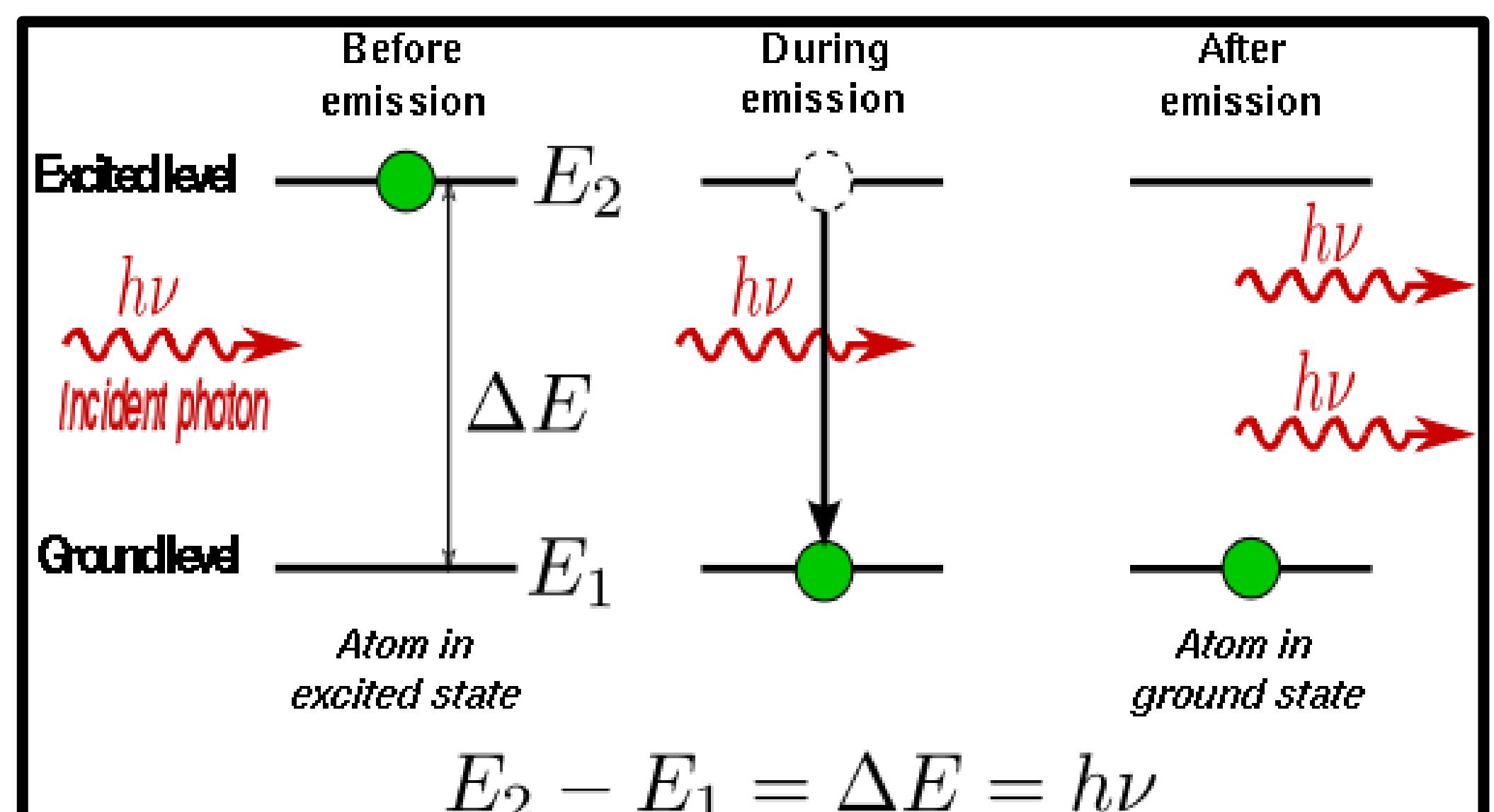
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## What is Photoluminescence

Photoluminescence (PL) is the emission of light from a substance after it absorbed light (photons). When light is absorbed into a substance, it is then excited to a higher energy level than its ground state. As that energy decays it is released as photons of lower energy (red-shifted) compared with the original absorbed photon.



## What is Time Resolved Photoluminescence

Time resolved photoluminescence is measuring the how the PL decays after photoexcitation. Electrons in a sample will decay to its ground state and remit this light back into the beamline where we will capture it as photons.

Key Ideas:

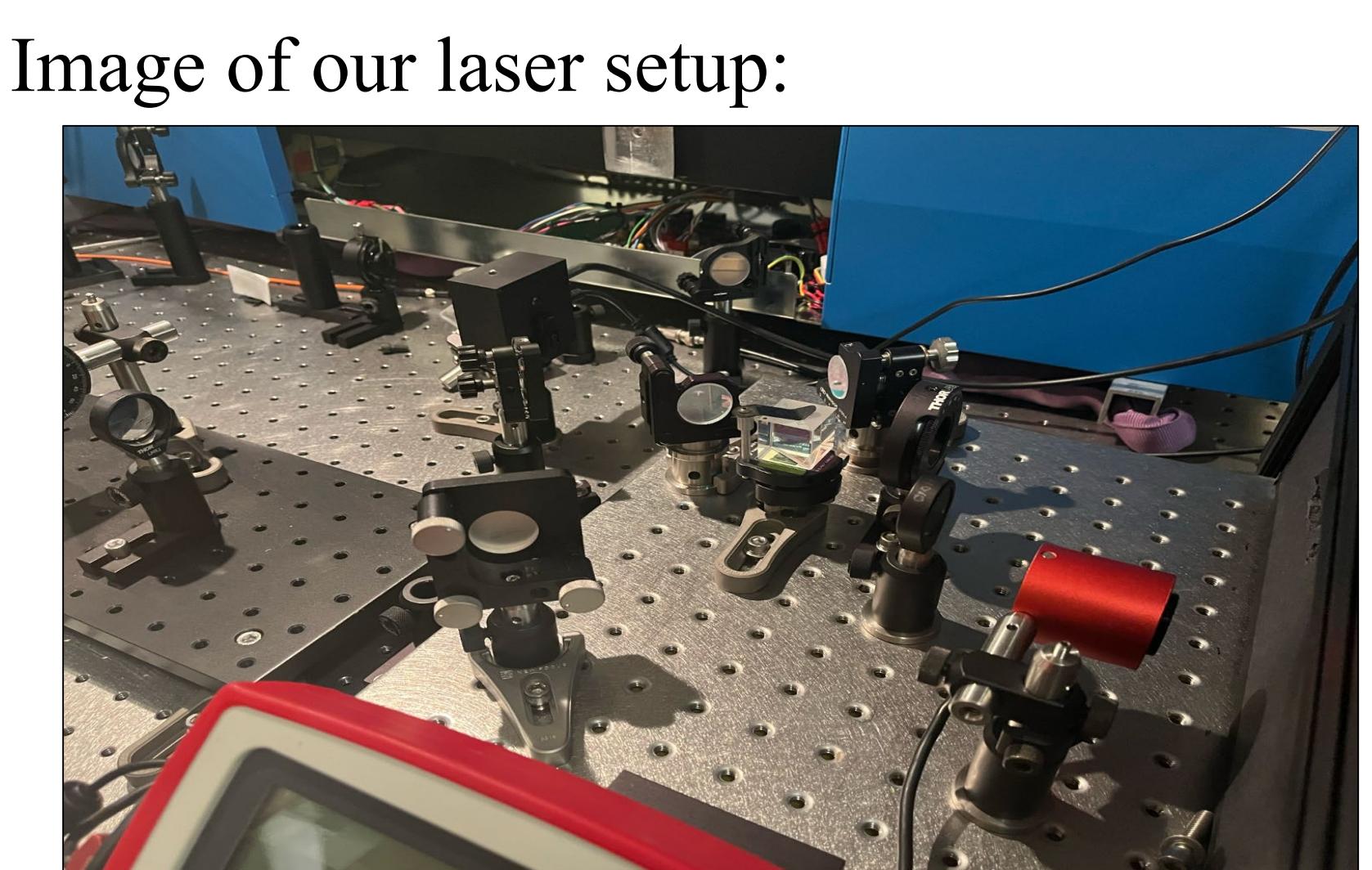
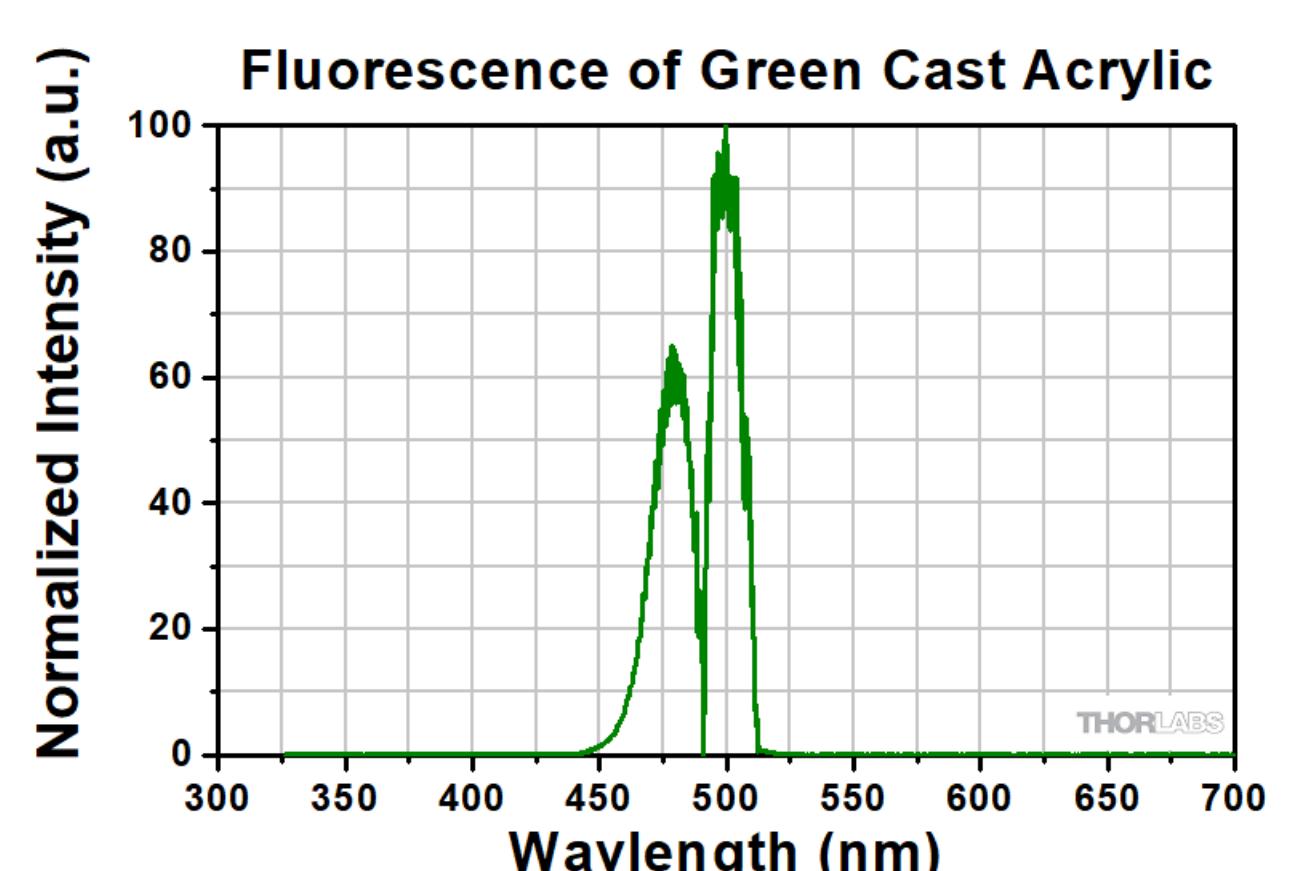
- 1) Hit Sample with Laser Light.
- 2) Capture Sample decay light
- 3) Analyze data.

## Methods using Optics

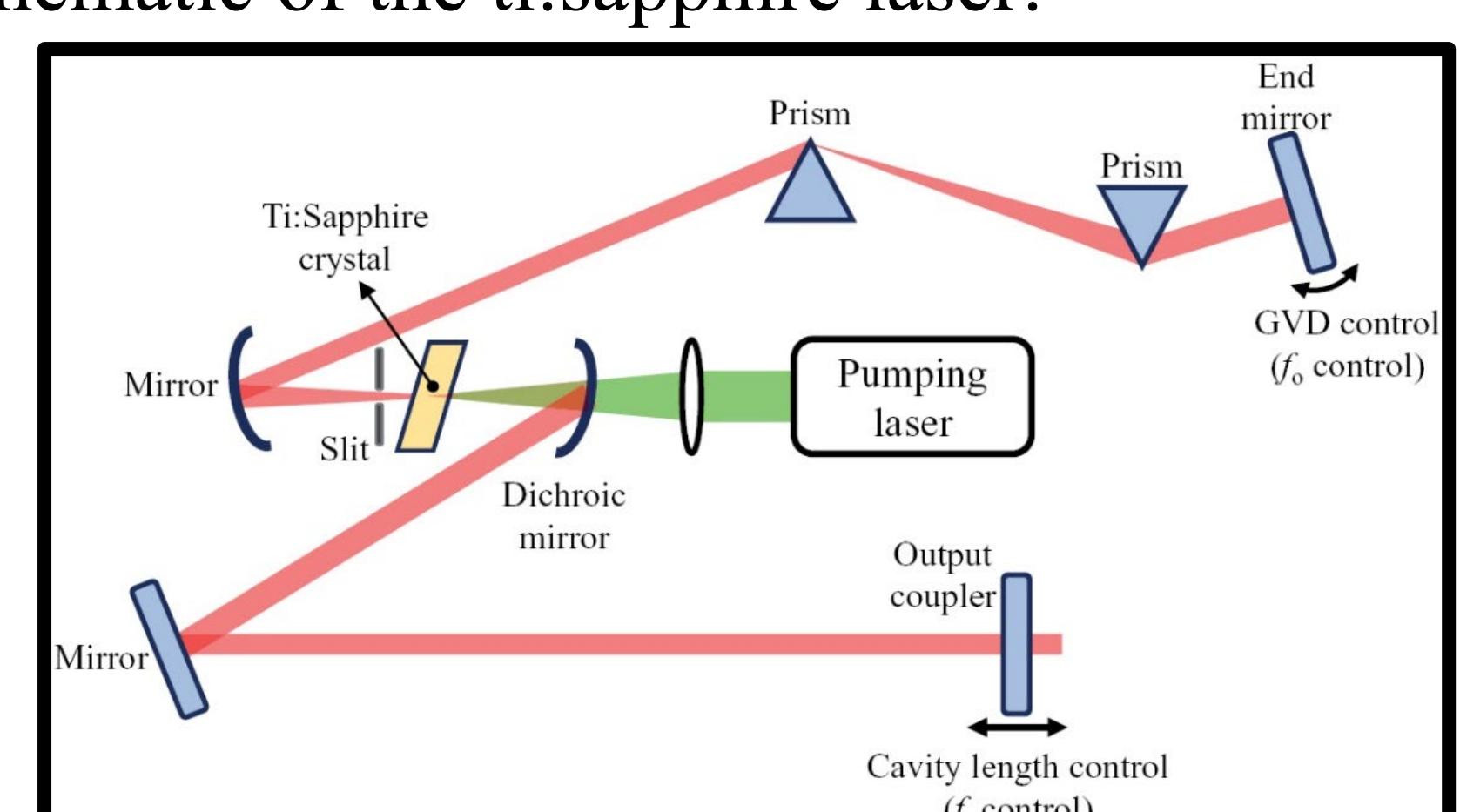
Our study is done through isolating specific wavelengths of light through using filters, lenses, and mirrors to control the beam path. The optics guide light pulses to the trigger detector to begin measurement, and then our single-photon detector stops the clock to record the timing between excitation and emission in our sample.

## Calibrating of our instrument

We use a green acrylic slide with a strong PL signal to calibrate our instrument. Next step is to resolve signals from perovskite thin film samples.

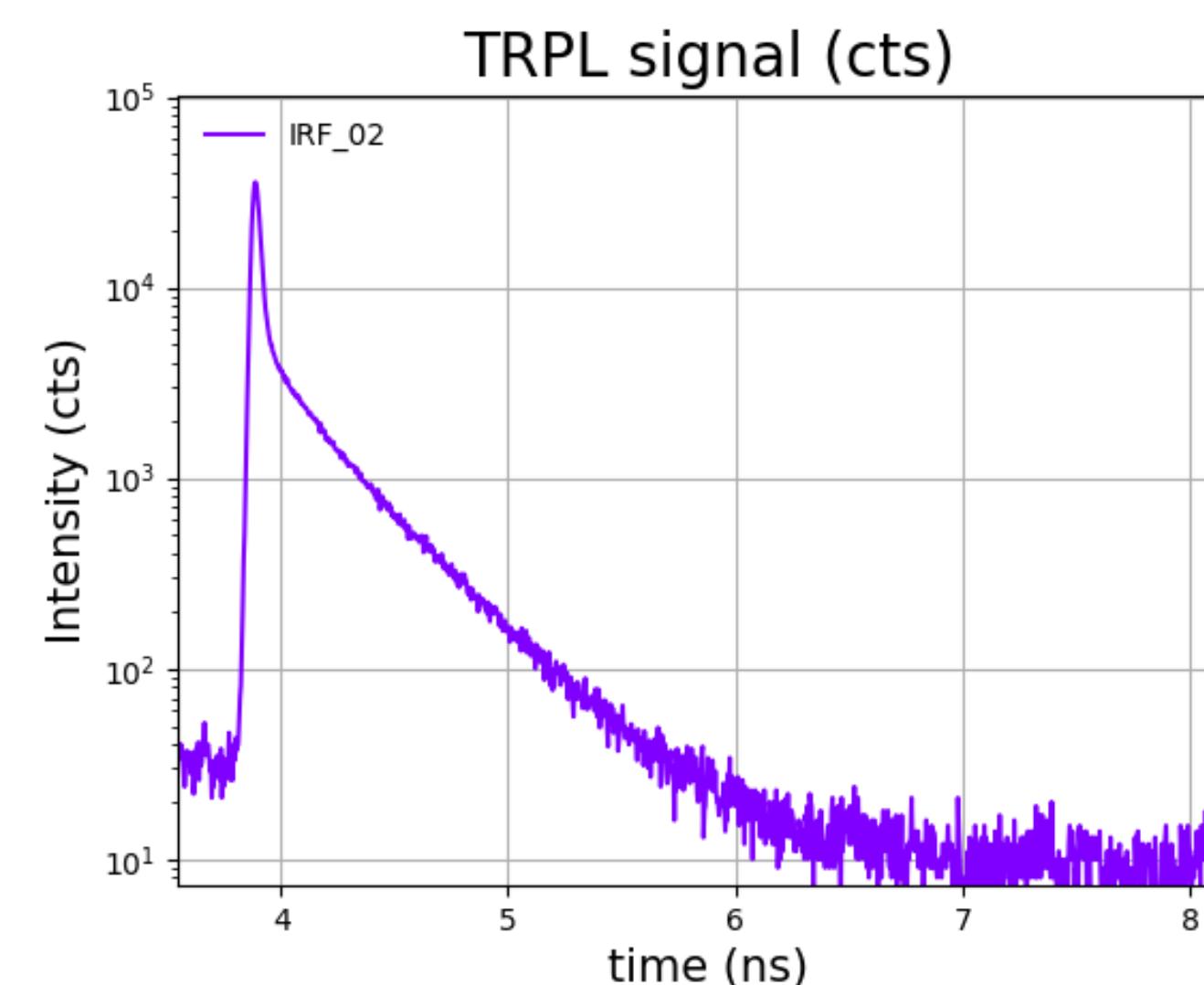


Schematic of the Ti:Sapphire laser:



## Instrument response function (IRF)

Our laser delivers light to our sample in pulses – the simplest characterization of how well the system performs is to send the laser pulse directly to the single-photon detector

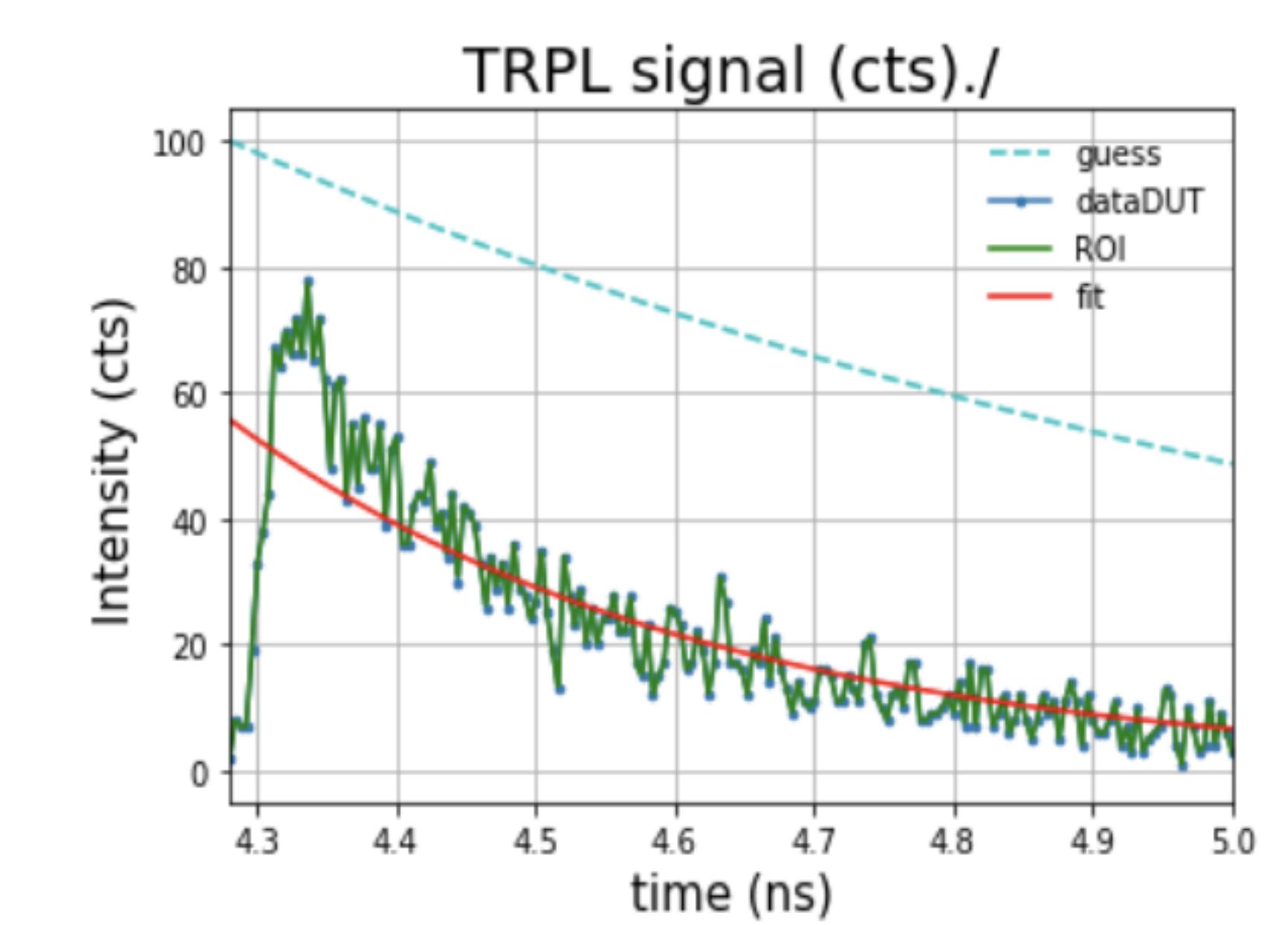


Our analysis shows a 26 ps response of the system – quite good for measuring any timescales of decay longer than this.

## Measuring TRPL signals

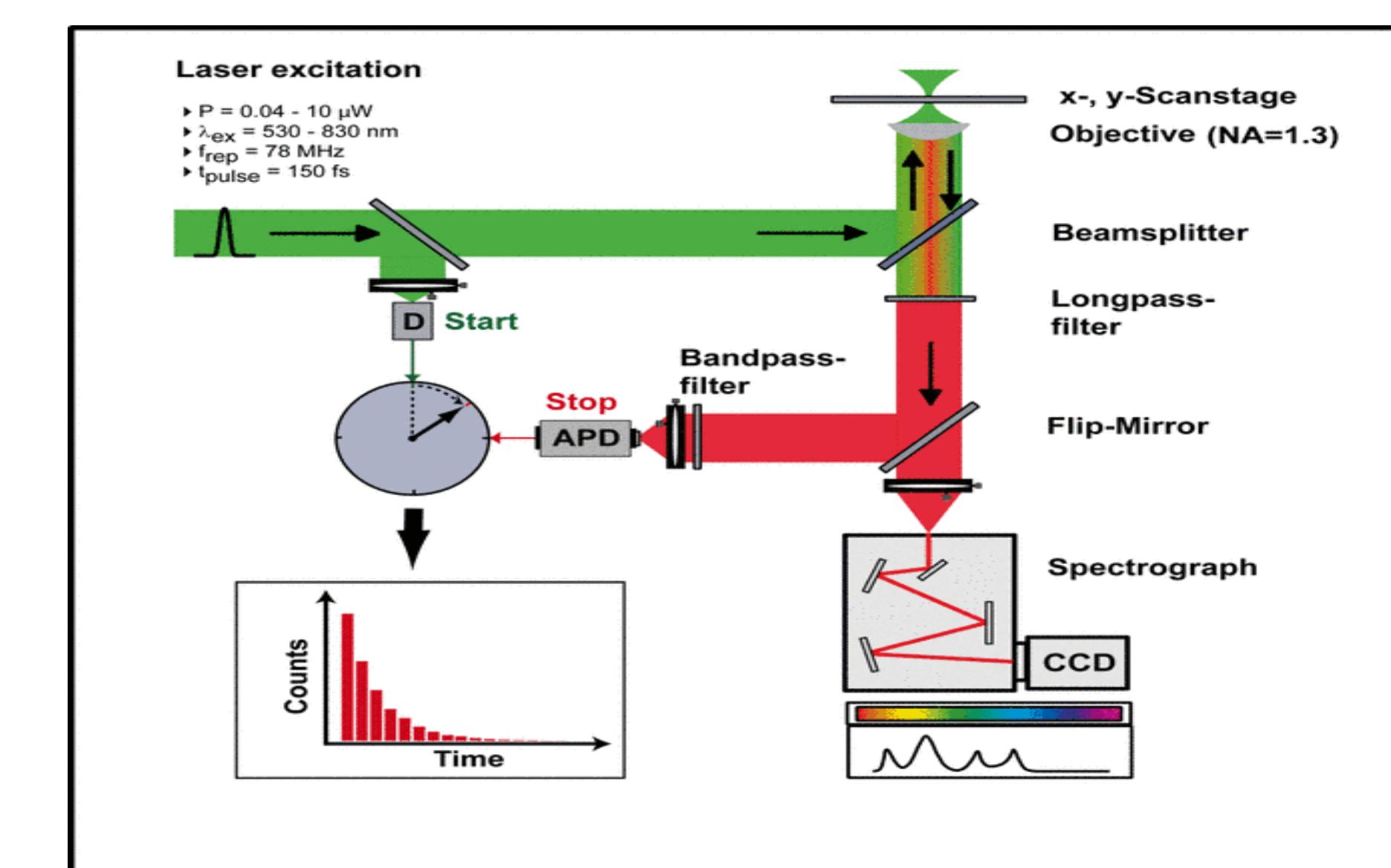
We measured the acrylic slide TRPL signal, and used python's scipy curve fitting, finding our decay time to be 0.3380 nanoseconds (338 ps).

Our fitted values:  
time start: 4.2800 ns  
amplitude : 55.7402 counts  
decay time: 0.3380 ns



## Recording the timing of photons

We build a histogram of counts on our single-photon detector by starting and stopping a clock.



## Progress, future outlook

Looking ahead, refinements we may prioritize in the experiment will be reducing ambient lighting to help get a more accurate depiction of the wavelength of light hitting our sample. Future work will also focus on optimizing beam paths, using better-aligned and more efficient optical components to reduce loss and or stray reflections. We plan to investigate perovskite thin film samples now that our setup has been established. Such samples have application for solar energy conversion.

## Literature Referenced

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