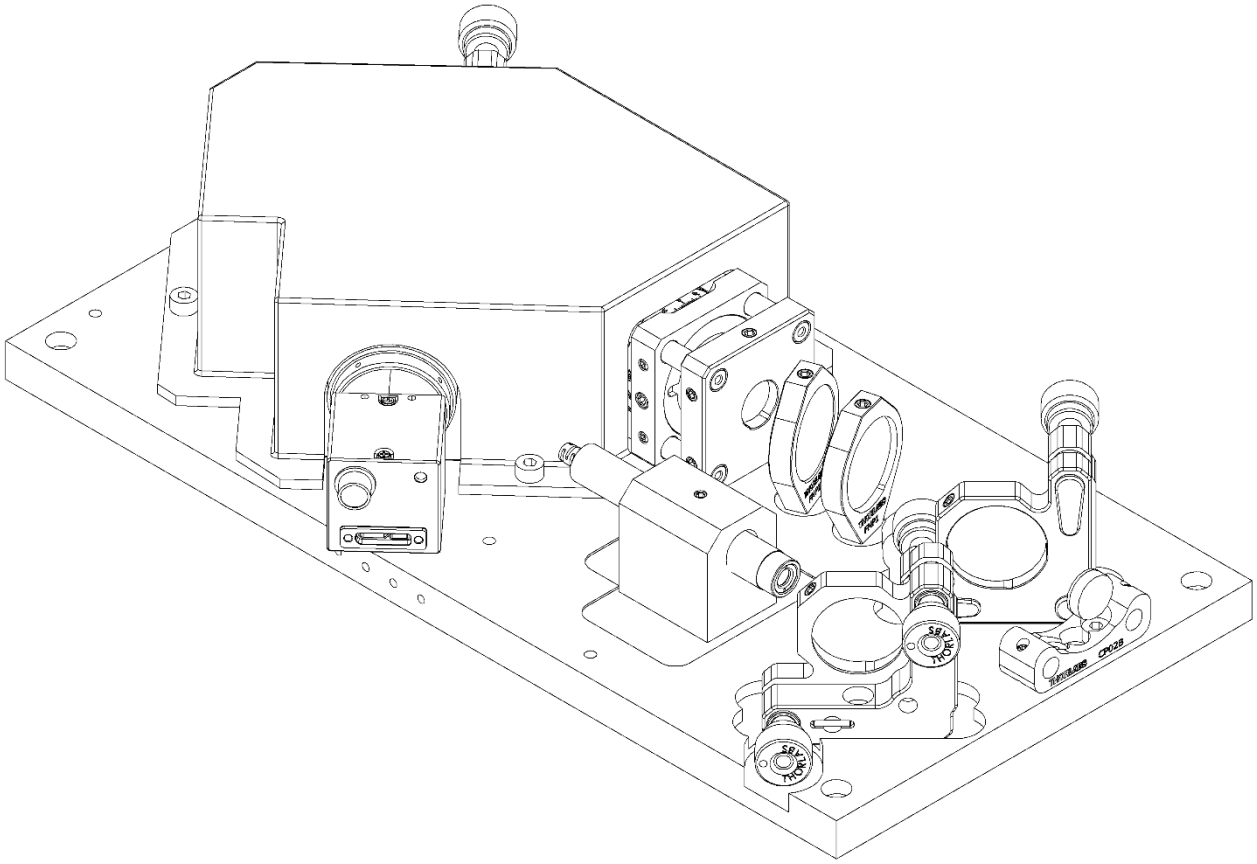
OpenRAMAN
Starter Edition Spectrometer



Product Datasheet

DESCRIPTION

The OpenRAMAN spectrometer is an open-source Raman spectrometer designed for educational purposes. It is a low-cost alternative to more expensive instruments and was designed such that students can disassemble and reassemble the spectrometer themselves.

The spectrometer exists in two versions which differ in performance and price. The Starter Edition is the entry level version and has limited resolution and laser power. The Performance Edition has better resolution and higher laser power but requires a more expensive laser. It is possible to convert the Starter Edition into a Performance Edition using one of the optional items listed in this document.

Due to its open-source approach, the user is also free to create add-ons or modify the software to best fit their needs. We strongly encourage users to share their work on our bulletin board (https://talk.thepulsar.be/) but it is by no means compulsory. Users creating derivatives work of the spectrometer will have to place their own work under the CERN OHL-W-V2 license.

The spectrometer is best used with pure organic solvents such as isopropanol or acetone but has been shown to be effective on powder samples as well including benzoic acid, paracetamol, salicylic acid and urea. It is also possible to use the spectrometer to illustrate classical textbooks concepts of chemistry such as bisulfite addition to formaldehyde.

IMPORTANT INFORMATION

This spectrometer is intended as an educational tool and may require regular recalibration to maintain optimal performance. Despite our best efforts to ensure robustness, transportation can affect alignment. We therefore recommend performing a recalibration after shipping. This characteristic is a natural consequence of our open design, which is deliberately optimized to facilitate maintenance, adjustment, and re-assembly by users.

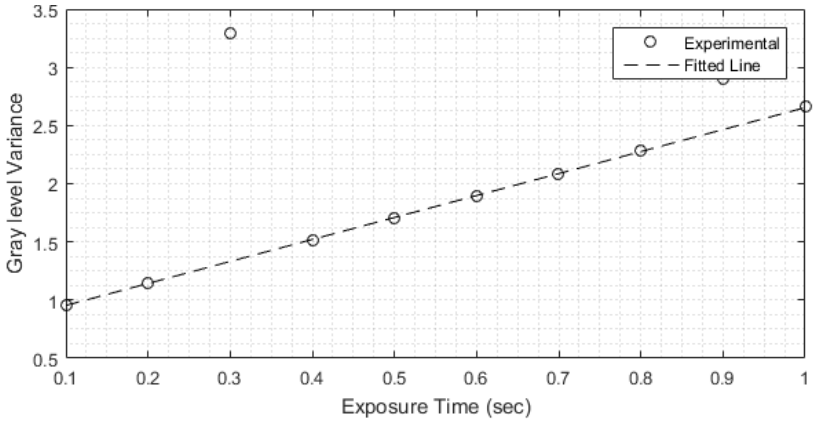
At the request of the user, additional measures can be applied to increase the mechanical stiffness of the spectrometer. These modifications may slightly reduce flexibility for adjustments but can improve robustness in environments where frequent handling or transportation is expected.

SPECIFICATIONS

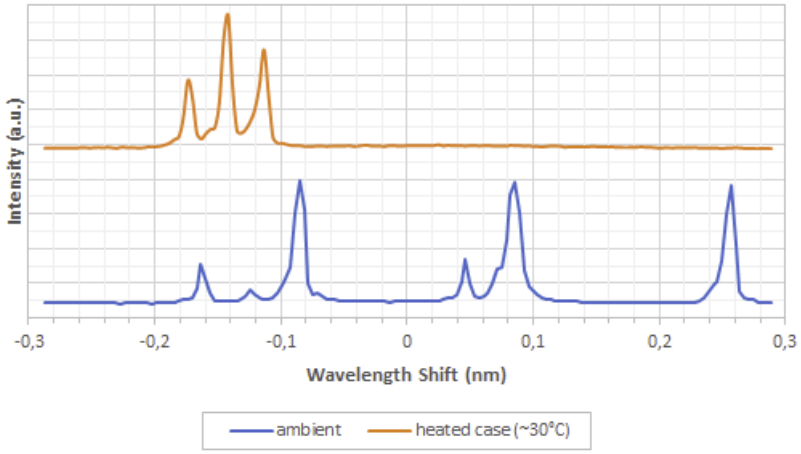
	STARTER EDITION	PERFORMANCE EDITION
REFERENCE	5430004310006	5430004310068
EXCITATION LASER	532 nm, 4.5 mW	532 nm, 50 mW
RANGE	500-3,500 cm^{-1}	
RESOLUTION	35 cm^{-1} typical	12 cm^{-1} typical
DYNAMIC RANGE	> 1,000:1 with proper exposure time on common organic solvents main peaks	

OPERATING CONDITIONS	10 to 40°C, non-condensing atmosphere	
LASER SAFETY CLASS	3R	3B
CONNECTIVITY	Ethernet[1]	

The camera used in the Starter Edition is a based on a Sony IMX273 sensor with temporal dark noise measured at 2.23 e-/px, dark current 5.11 e-/px (0.1-1 sec exposure) and absolute sensitivity threshold of 5.66 photons. Gain experimentally measured as 0.178 DN/photon. All properties evaluated at 625 nm.

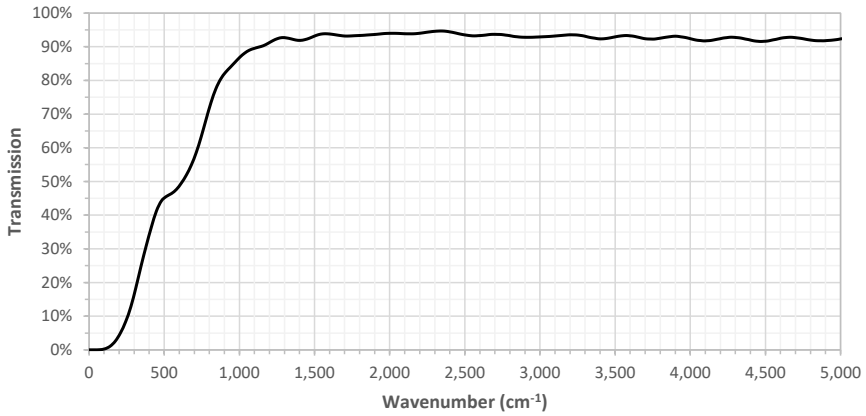


The Laser used in the Starter Edition is a Thorlabs CPS532 laser with a typical mode distribution of 0.5 nm at 20°C ambience[2].

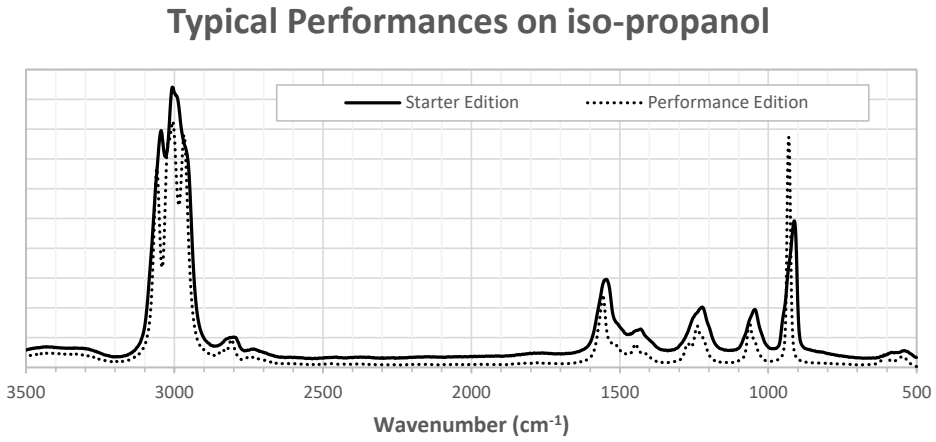


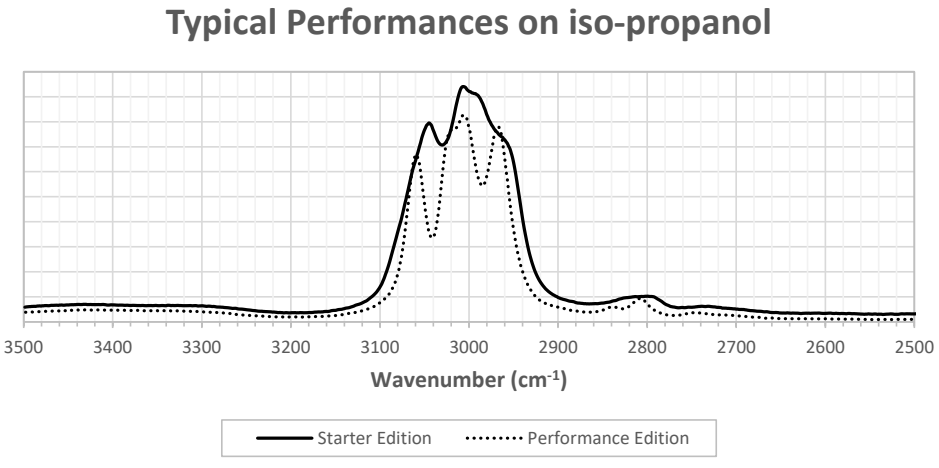
The typical transmission of the rejection filter is >50% near 500 cm^{-1}.

[1] Requires a free GiGe port on the computer
[2] Laser performances may vary from batch to batch.

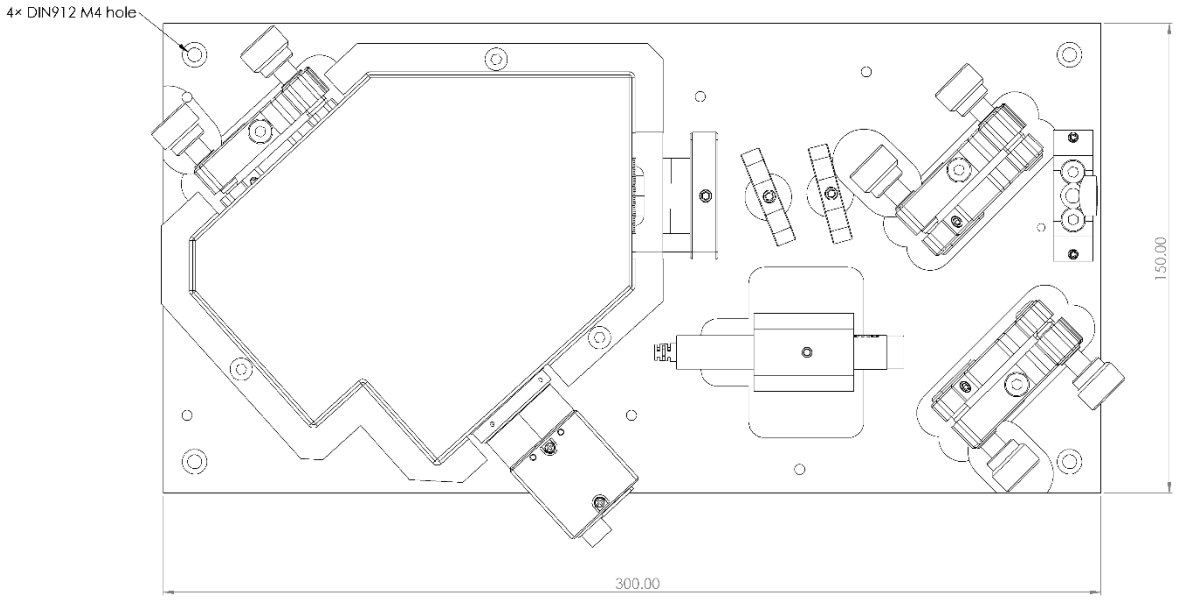


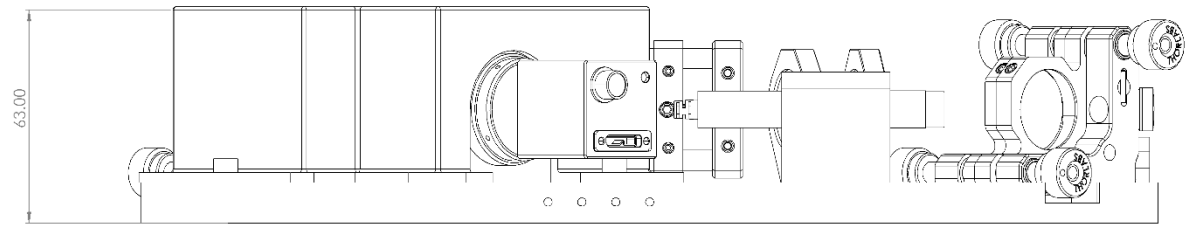
TYPICAL PERFORMANCES PLOT

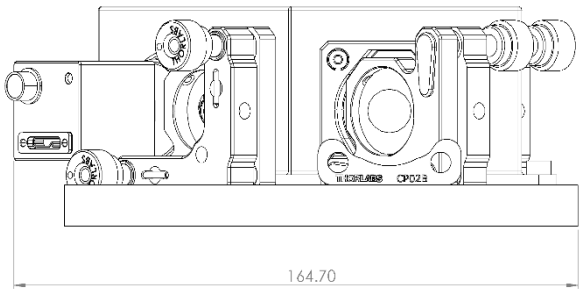




MECHANICAL DRAWING





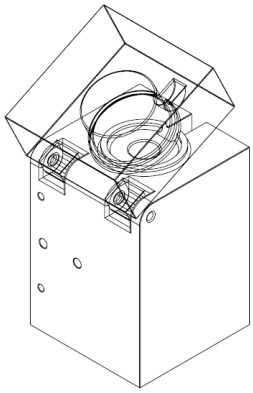


OPTIONAL ITEMS

Several optional items are available in addition to the spectrometer. Contact our sales for more information on them. We recommend starting with the Liquid cuvette system when purchasing an OpenRAMAN spectrometer.

CUVETTES SYSTEM

To study samples, the user needs to add to the OpenRAMAN spectrometer a “cuvette system”. Currently, we provide systems for the analysis of liquids and solids (powder form).



Liquid Cuvette System
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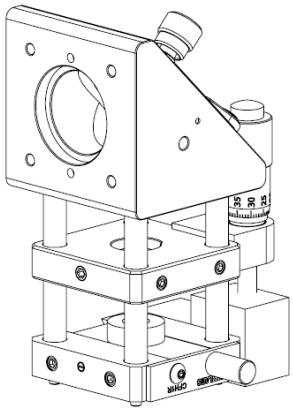
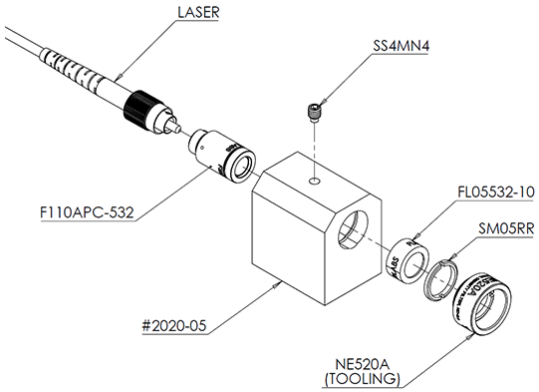


Solid Cuvette System
5430004310037

PERFORMANCE UPGRADES

It is possible to upgrade the performances of the Starter Edition using two different optional items: (a) an external fiber-coupled laser, or, (b) a TEC-cooling system for the Starter Edition laser.



External Laser
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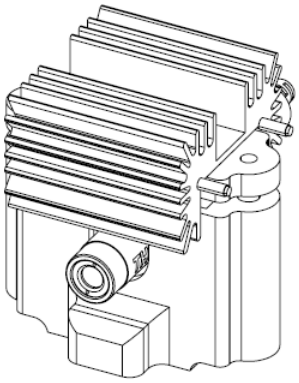

TEC cooling
5430004310051

TOOLING KIT

The alignment & calibration tooling kit (5430004310013) includes all items and tools required to perform a complete disassembly and reassembly of the spectrometer. The calibration kit also includes a Neon spectral lamp for the wavelength calibration of the spectrometer through our SpectrumAnalyzer software, a manual on how to assemble and align the spectrometer and a teaching support manual containing experiments to perform with the spectrometer.

RECOMMENDED CONFIGURATION

To use the spectrometer, you will need a computer with at least Windows 10 and a free 1,000 MBps ethernet port.

The spectrometer is designed to operate with a wide range of modern computers. While we provide general guidance on a typical configuration to ensure smooth operation, the responsibility for selecting and maintaining a suitable computer rests with the user. Our team will be happy to share recommendations and best practices, but we cannot guarantee compatibility with every system.

As an indication, we use the following configuration for our test computers:

Operating System	Windows 11
CPU	Intel i3-14100
Motherboard	MSI PRO B760M-P
RAM	Kingston FURY Beast 32 Gb DDR5 5600 MHz CL40
HDD	Samsung SSD 990 PRO M.2 PCIe NVMe 1 To w/ heatsink
Power Supply	MSI MAG A650GL
Ethernet	TP-LINK TG-3468
Case	Aerocool CS-106

APPLICATIONS

The spectrometer can be used to measure the spectra of liquid or solid compounds in either pure form, diluted form or in mixture. When using the spectrometer on diluted samples, we recommend keeping the concentration above 10,000 ppm for clarity. Similarly, when using the spectrometer on mixtures, we recommend keeping the fraction above 10%.

Several applications are developed into our experimental portfolio included with the tooling kit[3] such as

- differentiating similar organic compounds such as ethanol vs. methanol;
- quantify mixture of compounds such as finding the fraction of methanol in an ethanol/methanol mixture;
- showing evidence of chemical reactions such as bisulfite addition to aldehydes;
- validating experimental synthesis by comparing the product with a pure sample and detecting trace impurities in the synthesized product;
- experimenting with factors affecting resolution in spectroscopy (slit size, laser modes, imaging lens aperture etc.);

[3] See *optional items*.

- experimenting with factors affecting the dynamic range and signal to noise ratio in spectroscopy.

More applications are constantly being developed by our team such as to provide the best experience possible in discovering Raman spectroscopy.

SOFTWARE

The spectrometer can be operated from any software that can control a camera using GenICAM protocols, including Matlab and LabView.

We ship our spectrometers with our own, open-source, software which provides basic functionalities such as blank cancelation, exposure and gain control, filtering, calibration and delayed acquisition.