# Public Lab Desktop Spectrometry Kit 3.0



# Instructions 1.0

# Getting Started

### Calbration and setup

Once you've assembled your spectrometer and are ready to use it,

:tisiv bna ni ti Bulq

Android phones. the Chrome, Firefox and Opera browsers on most computers and SpectralWorkbench.org

### Peer Support

environmental science researchers which you have just joined! Public Lab is not a corporation; we're an open community of DIY

## The best place to get help is the spectrometry mailing list. The

publiclab.org/lists questions, look for help, and consider helping others too! building and improving open source spectrometry techniques. Ask spectrometry mailing list is made up of people like you, who are

photos or screenshots of what you're trying to do. You can also post a question on this site; it helps to share some

### Sontributing

current kit (as of 2015/02/10): program and our future kits. Public Lab users contributing to the cover), please join our community and make contributions to our this is Open Hardware released under the CERN OHL (see back

oitatic	gbathree	oggny	wədəiw	
v&zstc	Donglie	ngejeub	ļueynjd	
TiddsAstidN	borsacio6	opup	tlodbnetun	jeffreyjoy
ailstal	wagnerc4	straylight	jetson	nmittler
tsimedoemor	marlokeno	snueqejp	cpreuer	Adam-Griffith
nsmanida	uouueys	srossobi	snjda	dhaffner
teOtel	RTegelbeckers	PeterDavidowicz	ernestbolds	JoshMc
eitseta	Sreyanth	zyzəuej	BradDudenhoffer	Misterdeman
Zļ	Wleoseq	Bqqilihq	mkoistinen	ресктал
Jeguso	jyojwez	danbeavers	2wokey45	niətznəwuəəl
eykoskue	silverhammer	siniuZ	bµe-DOKE	Alex-McCarthy
akemartin	ipne§	dckim	Jean-Christo-	FoF
)eforme	yən/nw	owau	səjpoouuopnH	H_moT
ArBumper	chrisjob	RachelFinan23	pen.alley43	kosamari
wədtsn	ttoft	rigon	dɛsvoðɛmədɔ	emsilliW.B
5นายไปเปลี่ยง	nickha	Naljorpa	акјеЩ91	Livioguerrero
9iv9fa	Henryo815	oisgant	souotaquark	ckmurt
Narren	lionheadrex	ZybnA	zssysqilfi	ajtarnas

and credit those whose work bases even that from a the constraint operated for one application provides for one the same level of application of the preventiation provides for a first event for a force of the provident of the p changes and improvements so joug as you share your ute, or sell your own version, change, modify, redistribwhich means you can Ihis kit is open Hardware,

.270J up to date list of contribu-Check the instance cover for an army here applicable, a later version of this Licence or where applicable, a later version of this Licence and the formation of the set and th

### CERN Open Hardware Licence vi.2

of hardware designs under the CERN OHL does not constitute an endorsement of the licensor or its designs nor does it imply any involvement by CERN in the development of such designs. Instance designers. The CERN OHL is copyright CERN. Anyone is welcome to use the CERN OHL in unmodified form only, for the distribution of their own Open Hardware designs. Any other right is reserved. Release of hardware heisters under the CERN OHL does not constitute an Through this CERN Open Hardware Licence ("CERN OHL") version 1.s. CERN wishes to provide a tool to foster collaboration and sharing among perdemongations devised as tool to foster collaboration and sharing among the statement of the statemen 910mb974

board layouts mechanical drawings, flow charts and descriptive text and other explanatory material lay in the Licence. The Documentation may available under the conditions of this Licence. The Documentation may be in any mechanical put noil limited to computer files and experimentations on paper film or any index of the mechanic expressibility of the put noil limited to any other mechanic expressibility of the put of the put noil index of the mechanic expressibility of the put of the put of the mechanics. "Documentation" means schematic diagrams, designs, circuit or circuit n this Licence, the following terms have the following meanings: Licence" means this CERN OHL. r. Definitions

The Listons on paper filtro or any other meaks precommentations on paper filtro or any other meaks "Documentation control means a location where the Liernooth the public or distribution of Documentation "Product means any natural or legal person exercising rights under "Product means any natural or legal person exercising rights under the bouncementation or the modified Documentation (The Liernover and the product of the product of the public of the public or the modified Documentation (The Liernover and the product of the public) (The Liernover and the product of the public) (The public of the product of the product of the product of the public of the product of the public) (The product of the product

"Licensor" means any natural or legal person that creates or modifies "Licensor" means any natural or legal person that creates or the public and/ or distributes the resulting Documentation under the terms and conditions of this Licence acuestice and the second secon

COLORIZATION COLORIZATION

Use of the masculine gender includes the teminine and neuter genders and is employed solely to facilitate reading. A Licensee may at the same time be a Licensor, and vice versa.

2. Applicability

granted under this Licence, the Licensee irrevocably accepts these terms and conditions. 2.2. This Licence is granted by the Licensor directly to the Licensee.

loaded into programmable devices which may be used in conjunction with and shall apply worldwide and without limitation in time. The Licensee may assign his licence rights or grant sub-licences. 2.3. This Licence does not extend to software, firmware, or code

therwise subject to the applicable licence terms and conditions. The Documentation, the modified Documentation or with Products, unless such software, firmware, or code is explicitly expressed to be subject to this Learee. The use of such software, firmware, or code is obtained with the order size and is the income of and software and the software and the software and the software of the software or the software and the soft

3. Copying, modification, communication to the public and distribution

notices, all notices reterring to Documentation Location, and all 

notices that refer to this Licence and to the disclaimer of warranties. That are included in the Documentation. He shall include a copy thereof in every copy of the Documentation or as the case may be

ารอากตนารเต dified Documentation, that he communicates to the public

5.2. The Licensee may copy, communicate to the public and distribute entastim copies of the Documentation, in any medium, subject to the entastim copies of the Documentation.

3.3. The Licensee may modify the Documentation or any portion thereof r.c noitoez ni beñtoeq zinemeniupen

initiates legal action against Licensor in relation to this Licence. Section 5 shall continue to apply. notice and without involvement of a court if the Licensee fails to comply with any of its terms and conditions, or if the Licensee 6.4. This Licence shall terminate with immediate effect, upon written

the same general provisions as this version, but differ in detail so far this is required and reasonable. New versions will be published with anique version number.

kind of implication by the Licensor or its personnel in the preparation of the modified Documentation of Product 6.3. CERN may publish updated versions of this Licence which retain

shall in no event suggest any kind of endorsement by the Licensor or ts personnel of the modified Documentation or any Product, or any bring the state of the section 3. Any such permitted use or reterence shall be tactual and including acronyms and abbreviations), images, or logos under which the Licensor is known, save in so far as required to comply with

2.2. The Licensee shall not use or make reterence to any of the names

does not imply or represent any transfer or assignment of intellectual property lights to the Licensee. 5.1. Except for the rights explicitly granted hereunder, this Licence

General

damages, and the Licensee shall hold the Licensor(s) free and harmless from any liability. costs, damages, fees and expenses, including claims by third parties, in relation to such use. istribution of a Product, even it advised of the possibility of such theory of contract, warranty, tort (including negligence), product liability or otherwise, arising in any way in relation to the Documentation, modified Documentation and/or the use, manufacture or distribution of a Product weps if advised of the poscipiity of such punitive or other damages of any character including, without limitation, procurement of substitute goods or services, loss of use data or profits, or business interruption, however caused and on any theory of contrast warranty for finder neglegree production not act in a consumer capacity. 5.2. LMITATION OF LIABILITY – The Licensor shall have no liability for direct, indirect. Special, incidental, consequential, exemplary, uplitye or other damages of any character individual without uplitye or other damages of any character individual without

essential part of this Licence and a condition for the grant of any lights granted under this Licence. The Licensee warrants that it does

LICENSEE and not the LICENSOF. I his discipliner of warranty is an

Documentation, or any Product, does or will not infringe any patent, copyright, trade secret or other proprietary right. The entire risk as to the use, quality, and performance of a Product shall be with the infrared and only the infrared. This disclamer of warrany is an

Devolded "as is" and any express or implied warranties, including, but provided "as is" and any express or implied warranties, for astisfactory quality, non-infiningement of third party rights, and fitness for a statinger unseen or use are disclaimed in respect of the

his wish to receive this information about the type, quantity and dates of production of Products the Licensee has (had) manufactured

such Products an easy means of accessing a copy of the Documentation or modified Documentation, as a spliciable, as set out in section 3, 19.4 Leaves is invited to inform any Leaver who have indicated

iceuce nuger this Licence the Licensee provides to each recipient of

Construction of the extent necessary to make use of the rights granted under this Licence. The scope of this section 3.5 shall be strictly limited to the parts of the Documentation or constilled Documentation section of build by the pro-tion of the part of the parts of the Documentation or the part of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the section of the parts of the parts of the parts of the parts of the section of the parts of the parts of the parts of the parts of the section of the parts of the parts of the parts of the parts of the section of the parts of the section of the parts of the parts of the parts of the parts of the section of the parts of the parts of the parts of the parts of the section of the parts of the section of the parts of the

proprietary tool can create it; and sillcense the modified Documentation under the terms and conditions viewable with a tool licensed under an USI-approved license it the

b) cause the modified Documentation to carry prominent notices stating description of the modified documentation to carry prominent indications. (a cause the modified documentation to carry an ewy documentation (a cause the modified documentation to carry an ewy documentation (a cause the modified documentation to carry provided (for one-tion)).

modified Documentation (thereby in addition to being a Licensee also becoming a Licensor), always provided that he shall. a) comply with section 3.1.

3.4. The Licensee may communicate to the public and distribute the

not assert his rights under the foregoing proviso unless or until a Product is distributed.

modified Documentation under section 3.4, and, where required by section 4.1, by a recipient of a Product. However, the Licensor shall

shall make the modified Documentation available from a Documentation Location such that it can be easily located by an original Licensor once the Licensee communicates to the public or distributes the

second that upon modification of the Documentation, the Licensee

registered designs that are held by, under the control of, or

4.r. The Licensee may manufacture or distribute Products always provided that, where such manufacture or distribution requires a

4. Manufacture and distribution of Products nodified Documentation created by the Licensor.

4.2. The Licensee is invited to inform any Licensor who has indicated

5. Warranty and liability

particular purpose or use are disclaimed in respect of the Documentation, the modified Bocumentation or any Product. The Licensor makes no representation that the Documentation, modified Anomorphation or any Broduct does or will not infinite any ratent

sis noisetnemoto befilibom vna bna noisetnemutod ert – PAMIAJ22I0.1.

Slide the slit card in the front of the box. The printing is slightly off, unfortunately. level the slit card's line just above the box's line. the card should wedge in place on its bottom edge.





Push the camera cable through the cable hole in the back of the box:





Plug it into the camera-- it only fits one way, don't force it.

Slide the bench in at an angle, placing it down by the cable hole, and then pushing it down to the bottom.



Close the lid and you're done! Your computer should recognize your spectrometer as a webcam. go to Spectralworkbench.org to calibrate.

## Parts List:





tape



with USB Cable

45 degree ash camera block. 3 cm x 4 x 4cm









a 65-degree

grating

camera angle.

ash bench 1/4" (6mm) x 40mm x 235mm

DVD-R & 0.2mm collimation slit



45-degree fold-up

### not pictured: extra paper

50cm of loop fastener tape

25cm of hook fastener tape

fuzzy sid

# Assembly

Your spectrometer is composed of three functional elements:



- a collimation slit that works as a lens, only allowing parallel light
- a diffraction grating that deflects light more the lower the light's wavelength, creating a rainbow diffraction pattern.
- a camera to capture the diffraction pattern, focused on the collimation slit.

Phese elements are mounted on an adjustable velcro bench in a black paper box.



# Putting it all on the bench





Line up the the bench with the side of the box, and align the camera's lens with the zoomm marker on the side of the box. Press the camera block down firmly.



Place the diffraction grating angle directly in front of the camera block and press it down firmly. The inner walls hook together:



Fold the outer walls up and over the inner walls. Use the two circular holes in the outer walls to position the inner walls while folding the outer wall over.



Flip the box upside down and make sure the tabs have all popped out of the bottom of the box. Walk your fingers along the inside of the box and make sure all the tabs are popped out of the bottom.



### **Bench Assembly**

Everything is built up from the bench, an ash board 4cm (1.5 inches) wide. We will cover it with the loop tape (fuzzy side of the velcro).





The velcro loop tape is slightly wider than half the width of the bench, two strips will hang over each edge a bit.

### Camera block assembly

You will need the camera, double-sided tape, the block, and the hook side of the velcro tape. Try to hold the camera by its edges, as it can be sensitive to electrical shorts.



:619m67 Start by putting a strip of double-sided tape on the back side of the



from the double-sided tape and Remove the pink protective film

45-degree angled side, with the white cable port on top: attach to the center of the block's

hook tape (the velcro's scratchy side). attach two short strips of the On the underside of the block,





:JANOITqO

# Make a Diffraction Grating From a DVD

fingerprints will blur this important optical component. Do not touch the surface of the DVD, always hold it by the edges,

material to help. diffraction grating will take some tweaking. We've given you extra rigidity and consistency make it a very good grating. Aligningy your create a straight rainbow. A DVD produces a curved rainbow, but its separating light by frequency. An ideal diffraction grating would We are going to turn a DVD-R into a diffraction grating, a device for







right side Lay the box top so its tabs line up with the slots in the box bottom's

cable through that hole later. bottom of the box line up. We will put the webcam Make sure the small rectangular holes on the top and

don't worry- that is extra space for folding. Insert the tabs together. The box top will not lay flat--













We will attach the slit using the tape as single sided tape-tape it on top and DO NOT remove the backing film.

on the slit card and tape down.

Line up the collimation slit with the line



# Assemble the box

We strongly recommend watching the box assembly video, which is here:

publiclab.org/n/11533

For the purposes of this instructional I've highlighted the edges of the box in white and used an unprinted box. your box will have a printed and unprinted sides and no white edges.

Place the box with the printing facing down. Pre-crease all the creases towards you. crease the box top as well.





Fold the left side of the box (to the left of the narrow spot) over on itself, and insert the hold tab in place.



there are three steps, cutting a quarter of the DVD out, peeling off the reflective aluminum side, and triming to a small piece.

OPTIONAL: Wash the purple ink off of the DVD fragment for greater light transmission. see note /n/11515.

Peeling apart a quarter of the DVD: Cut out a quarter of the DVD with scissors. It may take more than one try to get a good diffraction grating, so save the rest too.



Use a knife or a fingernail to dig under the corner of the DVD quarter and peel the two layers apart.



You will get two layers. We are trying to get a transparent purple piece without aluminum stuck to it. If you can't find a good piece you may want to try another quarter DVD. You only need a 2cm (.75")

square cut from the outer edge. Trim down to a small square with roughly 2cm of the DVD 's outer edge.



# Assemble the diffraction grating angle

'non'





:weivnev0



rogether. and stick the bottom flaps under side of the center flap, ent no equat bebia-elduob eau

and pre-fold all folds towards punch out the center hole



the top of the angle. the DVD diffraction grating to use the binder clip to attach





put the outer edge of the DVD at the mid-point of the



.elon





attach veloro hook tape to bottom

















remove the handles from the binder clip. Put the outer edge of the dvd at the mid-point of the hole, and then

When taping the three flaps together, make sure the bottom flaps are