# SUPPLEMENTARY INFORMATION

# Ligand-Assisted Solid Phase Synthesis of Mixed-Halide Perovskite Nanocrystals for Color-Pure and Efficient Electroluminescence

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### **Experimental details**

#### **Synthetic protocol:**

**Chemicals:** Toluene (99.8%, Fisher Chemical), Oleic acid (OLA, 90%, technical grade), Oleylamine (OAM, approximate C18-content 80–90%, Acros Organics), Lead (II) bromide (PbBr<sub>2</sub>, 98+%, Acros Organics), *N*,*N*-Dimethylformamide (DMF, >99.8%, Aldrich), Ethanol (EtOH, absolute for analysis, Merck), Methylammonium iodide (MAI, 98%, Aldrich), Methylammonium bromide (MABr, Aldrich), Methylammonium chloride (MACl, for synthesis, Merck), Potassium iodide (KI, >99%, Aldrich), Methyl acetate (MeOAc, 99%, abcr), *n*-Butanol (99.5%, for analysis, Acros Organics), 3-Methyl-2-butanone (MIPK, 98%, Acros Organics), Ethyl acetate (EtOAc,  $\geq$ 99.5%, Honeywell), Dimethyl sulfoxide (DMSO, 99.7+%, Acros Organics), Propionitrile (99%, Acros Organics), Acetonitrile (ACN,  $\geq$ 99.5%, Aldrich), Chloroform ( $\geq$ 99.8%, Aldrich). All chemicals listed above were used as received without further purification.

**Synthesis of MAPbBr3 nanocrystals (NCs):** The synthetic protocol of the parent MAPbBr<sub>3</sub> NCs was adapted and slightly modified from our previous work.<sup>1</sup> Briefly, MABr (0.6 M) was dissolved in EtOH and PbBr<sub>2</sub> (0.6 M) was dissolved in DMF. OLA (1.25 mL) and OAM (100  $\mu$ L) were mixed with toluene (25 mL) in a 100 mL round-bottomed one-neck flask. Subsequently, the perovskite precursor solutions PbBr<sub>2</sub> (1.25 mL, 0.6 M, in DMF) and MABr (1.25 mL, 0.6 M, in EtOH) were added dropwisely under vigorous stirring. The reaction was stirred at room temperature and ambient conditions for 2 min to ensure the complete conversion of the precursors. A precipitate is formed and is separated from the reaction mixture by means of centrifugation (8000 rpm, 8 min). The supernatant was discarded. The precipitate was

redispersed in 6 mL of fresh toluene and centrifuged again. The resultant supernatant containing colloidally dispersed MAPbBr<sub>3</sub> NCs was filtered through a syringe filter (pore size =  $0.2 \mu m$ ). MeOAc (2.5 mL) was added to 5.5 mL of MAPbBr<sub>3</sub> colloidal dispersion for the purification. The clear green solution turns turbid upon addition of anti-solvent. The suspension was immediately centrifuged (8000 rpm, 8 min). The resultant precipitate was redispersed in 5 mL of toluene and centrifuged again. The supernatant was filtered through a syringe filter (pore size =  $0.2 \mu m$ ). The purified MAPbBr<sub>3</sub> solution was stored for further experiments.

**Synthesis of MAPbBr3 nanoplatelets** (**NPLs**): Colloidal MAPbBr3 NPLs were synthesized using a modified protocol from our previous reports.<sup>2, 3</sup> Specifically, a 100 mL round-bottomed one-neck flask was loaded with 12.5 mL of toluene, 2.5 mL of OLA, and 500  $\mu$ L of OAM. PbBr2 (625  $\mu$ L, 0.4 M, in DMF) and MABr (375  $\mu$ L, 0.53 M, in EtOH) were added dropwisely under vigorous stirring. Although all reactions could be carried out under ambient conditions, it has been observed that the yield varied with respect to air humidity. Therefore, the flask was connected to the Schlenk line, followed by purging with nitrogen for three times. In the meantime, the solution gradually turned yellowish. The reaction mixture was stirred at room temperature and under inert atmosphere for 4 h until enough precipitate was formed. The solid was separated by means of centrifugation (8000 rpm, 8 min). The resulting precipitate was redispersed in 3 mL of toluene containing small amounts of ligands (~15 mM OLA, ~3 mM OAM) and centrifuged again. The resultant supernatant was filtered through a syringe filter (pore size = 0.2 µm) yielding blue-emitting ( $\lambda_{PL}$  = 458 nm) MAPbBr3 NPLs. No further washing procedures were applied.

Ligand-assisted solid phase synthesis (LASPS) of MAPbX<sub>3</sub> NCs: 1 mmol of MAI powder was added to a 10 mL round-bottomed one-neck flask. Subsequently, toluene (1 mL), OLA (100 µL), OAM (25 µL), and 3.6 mL of the parent MAPbBr<sub>3</sub> dispersion were added to the MAI powder. The flask was sealed with a septum and the reaction was vigorously stirred for 90 min. Afterwards, the contents of the flask were separated by means of centrifugation (8000 rpm, 8 min). The resulting supernatant containing colloidally dispersed MAPb(Br/I)<sub>3</sub> NCs was filtered through a syringe filter (pore size =  $0.2 \mu m$ ). Several anti-solvents such as MeOAc, EtOAc, DMSO, propionitrile, ACN, acetone, *n*-Butanol, chloroform, and mixtures were tested for the purification. We found that using a mixture of the anti-solvents *n*-Butanol and MeOAc (volume ratio of 1:1) is the most effective way to purify the NCs regarding the enhancement of the photoluminescence (PL) quantum yield ( $\eta_{PL}$ ) and decreasing of the PL full width at half maximum (fwhm). This anti-solvent mixture (3.5 mL) was added to 3.8 mL of colloidally dispersed MAPb(Br/I)<sub>3</sub> and centrifuged (8000 rpm, 8 min). After the first centrifugation round 1.75 mL of the anti-solvent mixture were added and the contents were centrifuged again. Afterwards, the resultant residue was redispersed in 2 mL of fresh toluene yielding a colloidal dispersion of fully exchanged MAPb(Br/I)<sub>3</sub> NCs. The near-infrared (NIR)-emitting NCs were stored for further experiments. The intermediate yellow- and red-emitting species were synthesized by mixing parent MAPbBr<sub>3</sub> NCs with fully exchanged MAPb(Br/I)<sub>3</sub> NCs due to the sensitivity of the reaction and the washing difficulties of mixed-halide perovskite NCs with anti-solvents.<sup>4</sup> For that purpose, 200  $\mu$ L (50  $\mu$ L) of the parent MAPbBr<sub>3</sub> dispersion (~8 g L<sup>-1</sup>) were mixed with 400  $\mu$ L (450  $\mu$ L) of fully exchanged MAPb(Br/I)<sub>3</sub> NCs. The reaction was vigorously stirred for 30 min. The reaction mixture was stored in a glass vial for further use.

1.5 mmol of MACl powder were added to a 10 mL round-bottomed one-neck flask. Subsequently, toluene (0.5 mL), OLA (150  $\mu$ L), OAM (37.6  $\mu$ L), MIPK (250  $\mu$ L), and 3.6 mL of the parent MAPbBr<sub>3</sub> dispersion were added to the MACl powder. MACl exhibits a poor solubility in toluene. However, it was found that an addition of MIPK slightly accelerates the chloride exchange rate. Furthermore, the addition of MIPK had no big influence on the colloidal stability of the NCs. The flask was sealed with a septum. The final emission wavelength of the MAPb(Br/Cl)<sub>3</sub> NCs was controlled by the reaction time. The reaction was stopped after 55 min, 2 h, or 22 h for cyan-, blue-, and violet-emitting NCs, respectively. Afterwards, the halide exchanged NCs were separated from the unreacted MACl by means of centrifugation (8000 rpm, 8 min). The resulting supernatant containing colloidally dispersed MAPb(Br/Cl)<sub>3</sub> NCs was filtered through a syringe filter (pore size = 0.2  $\mu$ m). 2 mL of MeOAc was added to 3.5 mL of colloidally dispersed MAPb(Br/Cl)<sub>3</sub> and centrifuged (8000 rpm, 8 min). The resultant precipitate was redispersed in 2 mL of fresh toluene yielding a colloidal dispersion of MAPb(Br/Cl)<sub>3</sub> NCs.

**LASPS of MAPbX3 NPLs:** 5 mL of parent MAPbBr<sub>3</sub> NPLs dispersed in toluene containing ~15 mM OLA and ~3 mM OAM were mixed with MAI powder in a 10 mL round-bottomed one-neck flask and set under vigorous stirring. The final emission wavelength was controlled by the MAI amount and the reaction time. For 517 nm and 544 nm emission 0.5 mmol and for 574 nm emission 1 mmol of MAI were used. The flask was sealed with a septum. In the case of emission at 517 nm the reaction was stirred for 10 min. The reaction was stirred for 30 min for 544 nm emission and for 75 min for NPLs emitting at 574 nm, respectively. Afterwards, the

contents of the reaction were centrifuged (8000 rpm, 8 min) and the supernatant containing colloidally dispersed MAPb(Br/I)<sub>3</sub> NPLs was filtered through a syringe filter (pore size = 0.2  $\mu$ m). MeOAc (3.5 mL) was added to 4 mL of colloidally dispersed MAPb(Br/I)<sub>3</sub> NPLs and centrifuged (8000 rpm, 8 min). The resultant precipitate was redispersed in 3 mL of toluene containing ~15 mM OLA and ~3 mM OAM.

2 mmol of MACl were added to a 10 mL round-bottomed one-neck flask. Subsequently, toluene (1 mL), OLA (150  $\mu$ L), OAM (37.6  $\mu$ L), MIPK (200  $\mu$ L), and 4 mL of the parent MAPbBr<sub>3</sub> NPLs dispersed in toluene containing additional ligands (~15 mM OLA, ~3 mM OAM) were added to the MACl powder. The flask was sealed with a septum. The reaction mixture was stirred for 21 h. Afterwards, the reaction mixture was centrifuged (8000 rpm, 8 min) and the resulting supernatant was filtered through a syringe filter (pore size = 0.2  $\mu$ m) yielding colloidally dispersed MAPb(Br/Cl)<sub>3</sub> NPLs emitting at 428 nm. No further washing procedures were applied.

Halide exchange of MAPbBr<sub>3</sub> NCs with KI: OLA (625  $\mu$ L) and OAM (50  $\mu$ L) were mixed with toluene (12.5 mL) in a 100 mL round-bottomed one-neck flask. Subsequently, the perovskite precursor solutions PbBr<sub>2</sub> (625  $\mu$ L, 0.6 M, in DMF) and MABr (625  $\mu$ L, 0.6 M, in EtOH) were added under vigorous stirring. After the addition of all perovskite precursors KI powder (186.8 mg, 1.125 mmol) was added to the reaction flask. This mixture was stirred for 2.5 h. The solid was separated by means of centrifugation (8000 rpm, 8 min). The resulting precipitate was redispersed in 3 mL of toluene. These NCs were washed by mixing 2.5 mL of the NC dispersion together with MeOAc (1 mL) and centrifuging (8000 rpm, 8 min). After centrifugation MeOAc (300  $\mu$ L) was added and the centrifugation process was repeated. The resultant precipitate was redispersed in 2.5 mL of toluene and centrifuged again. The supernatant was filtered through a syringe filter (pore size = 0.2  $\mu$ m). The purified NC dispersion was stored for further experiments.

#### **Characterization:**

**Absorption spectroscopy:** UV-visible absorption of the colloidal NCs was measured using a Jasco V670 spectrophotometer. Liquid samples were diluted up to 200 times with toluene. In some cases toluene containing OLA (~1.5 mM) and OAM (~0.3 mM) was used.

**Photoluminescence (PL) spectroscopy:** PL characterization of the liquid samples was carried out using a Hamamatsu Quantaurus QY absolute  $\eta_{PL}$  spectrometer (C11347-11) equipped with a 150 W xenon lamp and a 3.3 inch integrating sphere, which is coated with highly reflective

Spectralon. Liquid samples were diluted up to 200 times with toluene. In some cases toluene containing OLA (~1.5 mM) and OAM (~0.3 mM) was used.

**Time-resolved photoluminescence (TRPL) spectroscopy:** TRPL spectra of the NC dispersions were acquired using a Hamamatsu Quantaurus-Tau Fluorescence Lifetime Spectrometer (C11367-31), which is equipped with a photon counting measurement system. The excitation wavelength was set at 365 nm and the measurements were recorded using a pulse repetition rate of 500 kHz. Liquid samples were diluted up to 100 times with toluene.

**X-ray diffraction (XRD):** XRD patterns of the perovskite films deposited on Si wafers were measured using a PANalytical X'Pert PRO-MPD diffractometer with Cu-Kα radiation.

**Scanning transmission electron microscopy (STEM):** STEM images were acquired with a high-angle annular dark field detector at cryogenic conditions using liquid-nitrogen-cooled holders either on a Hitachi HD 2700 CS or a FEI Tecnai F30 microscope.

Scanning electron microscopy (SEM): SEM images were captured on a Quanta 200F microscope (Thermo Fisher Scientific) operated at an acceleration voltage  $V_{acc} = 20 \text{ kV}$  or 30 kV.

**Energy dispersive X-ray spectroscopy (EDXS):** EDXS was performed with an Octane SDD detector (EDAX (Ametec)) attached to the microscope column. For spectra recording and quantification (ZAF correction), the software Gemini (EDAX) was used.

### Materials for perovskite LED device fabrication:

The indium tin oxide (ITO) coated glass substrates with a sheet resistance of 15  $\Omega/\Box$  were purchased from Lumtech Corp. The hole injection material poly(3,4-ethylene-dioxythiophene)-poly(styrene sulfonate) (PEDOT: PSS) was procured from Heraeus (Clevios AI 4083). High quality 99.9% pure hole transporting material poly[*N*,*N*'-bis(4-butylphenyl)-*N*,*N*'-bis(phenyl)-benzidine] (Poly-TPD) and electron transporting material 2,2',2"-(1,3,5-benzinetriyl)-*tris*(1-phenyl-1-*H*-benzimidazole) (TPBi) were purchased from Lumtech Corp. The electron injection material lithium fluoride (LiF) with a purity of 99.98% was purchased from Acros Organics. Aluminum (Al) pellets (99.999%) were purchased from Kurt J. Lesker Co. Ltd. All the materials were used without any further purification.

#### **Device fabrication:**

Firstly, patterned ITO-coated glass substrates were rinsed with Extran MA02 neutral detergent and deionized (DI) water mixture (1:3). Subsequently, substrates were sonicated in DI water, acetone, and isopropanol, respectively, each for 20 min. Then the substrates were treated with oxygen plasma for 10 min. The aqueous solution of PEDOT: PSS was spin-casted on the precleaned ITO glass at a spin rate of 4000 rpm for 50 s and then annealed at 120 °C for 30 min in the ambient atmosphere. All the annealed substrates were transferred into a nitrogen atmosphere glove box for the deposition of successive layers. A Poly-TPD solution (1 mg mL<sup>-1</sup> in chlorobenzene) was then spin-coated at 2500 rpm for 40 s. Subsequently, the colloidal suspension of MAPbX<sub>3</sub>NCs in toluene, where X = Br, Br/Cl, and Br/I, was spin-coated at 2500 rpm for 40 s in a nitrogen filled glove box. Then the ETL was deposited by the sequential thermal evaporation of TPBi in a vacuum chamber at  $7.5 \times 10^{-8}$  Torr. Finally, 1 nm LiF electron injection layer and a 100 nm Al cathode layer were also deposited in a high vacuum chamber using a shadow mask. The active area of LED was 25 mm<sup>2</sup>, which is defined by the overlapping of ITO anode and Al cathode layers. Before measurement, all the devices were stored in the glove box and tested in the ambient atmosphere without encapsulation.

#### **Device measurement:**

The electroluminescence (EL) spectrum and current density-voltage-luminance (*J-V-L*) characteristics of the perovskite LED were measured by using a Photo Research Spectrascan PR 655 spectrometer and a Keithley 2400 source meter. All the measurements were performed under the atmospheric conditions. The  $\eta_{ext}$  was calculated from current density, luminance, and EL spectrum by assuming a Lambertian-like pattern due to the surface light source. The EL spectra of perovskite LEDs were also characterized by the Phelos (Fluxim Inc.) measurement system.

# **Additional figures**



**Figure S1.** Time evolution of the anion exchange (AE) reactions through LASPS of colloidal MAPbBr<sub>3</sub> NCs with either iodide (left side) or chloride (right side).





**Figure S2.** SEM image and EDXS results including quantitative analysis of the composition of purified, violet-emitting MAPb(Br/Cl)<sub>3</sub> NCs. The area in the red rectangle of the SEM image is investigated.



**Figure S3.** SEM image and EDXS results including quantitative analysis of the composition of purified, blue-emitting MAPb(Br/Cl)<sub>3</sub> NCs. The area in the red rectangle of the SEM image is investigated.



**Figure S4.** SEM image and EDXS results including quantitative analysis of the composition of purified, cyan-emitting MAPb(Br/Cl)<sub>3</sub> NCs. The area in the red rectangle of the SEM image is investigated.

7.00

8.00

9.00

6.00

1.00

2.00

3.00

4.00

5.00

Br

12.00

keV

Pb

11.00

10.00



**Figure S5.** SEM image and EDXS results including quantitative analysis of the composition of purified, green-emitting MAPbBr<sub>3</sub> NCs. The area in the red rectangle of the SEM image is investigated.

8.00

Br

12.00

14.00

keV

Pb

10.00

2k

С

Si

2.00

4.00

6.00





**Figure S6.** SEM image and EDXS results including quantitative analysis of the composition of purified, yellow-emitting MAPb(Br/I)<sub>3</sub> NCs. The area in the red rectangle of the SEM image is investigated.





**Figure S7.** SEM image and EDXS results including quantitative analysis of the composition of purified, red-emitting MAPb(Br/I)<sub>3</sub> NCs. The area in the red rectangle of the SEM image is investigated. The Na peak at 1.04 keV probably arises from impurities.





**Figure S8.** SEM image and EDXS results including quantitative analysis of the composition of purified, near-infrared (NIR)-emitting MAPb(Br/I)<sub>3</sub> NCs. The area in the red rectangle of the SEM image is investigated.



**Figure S9.** Variation of the MAI amount for the AE with iodide. Five different amounts of MAI powder (0.1 mmol, 0.25 mmol, 0.5 mmol, 1 mmol, and 2 mmol) were investigated. The emission wavelengths of the five samples are shown in black ( $\lambda_{PL}$ ). The  $\eta_{PL}$  is shown in red. The  $\eta_{PL}$  increases with increasing emission wavelength. The other reaction parameters were kept constant for all these experiments. The reaction time is 90 min. The maximum emission wavelength is reached when 1 mmol of MAI is used for the reaction. Therefore, it was decided to use 1 mmol of MAI for the LASPS.



**Figure S10.** Variation of the MACl amount for the AE with chloride. Four different amounts of MACl powder (0.5 mmol, 1 mmol, 2 mmol, 4 mmol) were investigated. The emission wavelengths of the four samples are shown in black ( $\lambda_{PL}$ ). The  $\eta_{PL}$  is shown in blue. The  $\eta_{PL}$  decreases with decreasing emission wavelength. The other reaction parameters were kept constant. The reaction time is 90 min. There is a plateau of the emission wavelength between

the reaction with 1 mmol and 2 mmol of MACl. Although the emission wavelength with 4 mmol of MACl seems to be more pronounced, it was decided to use 1.5 mmol of MACl for the LASPS.



**Figure S11.** Variation of the reaction time of the AE with iodide. The influence on the emission wavelength ( $\lambda_{PL}$ ) of two different reaction times (90 min red, 17 h black) for samples prepared with either 1 mmol or 0.1 mmol of MAI are compared with each other. All the other reaction parameters were kept constant. The emission wavelength still increases after 90 min with 0.1 mmol. Hence, the reaction does not reach equilibrium after 90 min, whereas the equilibrium is reached after 90 min when 1 mmol of MAI is used.



Figure S12. PL evolution through the whole visible spectra of parent MAPbBr<sub>3</sub> and mixedhalide perovskite NCs.



**Figure S13.** PL spectra of unwashed and washed iodide exchanged MAPb(Br/I)<sub>3</sub> NCs including the excitation ( $\lambda_{ex} = 370$  nm). A reduction of the fwhm of the PL peak of the purified sample is shown as compared to the unwashed sample.



**Figure S14.** Normalized PL spectra of unwashed and washed MAPb(Br/I)<sub>3</sub> NCs. A blueshift of the emission occurs when these species are washed with anti-solvents.<sup>4</sup> A mixture of MeOAc and *n*-Butanol was used for the purification.



**Figure S15.** (a) Photographs of 25 mm<sup>2</sup> perovskite LEDs, based on parent MAPbBr<sub>3</sub> and anion exchanged MAPb(Br/I)<sub>3</sub> and MAPb(Br/Cl)<sub>3</sub> NCs, operating at 4V (top). CIEx,y 1931 color space with Rec. 2020 and perovskite LEDs gamuts. (b) Comparisons of NTSC and PeLEDs gamut areas.



**Figure S16.** EL spectra of perovskite LED devices, at various operation voltages, based on (a) anion exchanged MAPb(Br/I)<sub>3</sub> deep-red perovskite NCs. (b) Parent MAPbBr<sub>3</sub> green perovskite NCs. (c) Anion exchanged MAPb(Br/Cl)<sub>3</sub> blue perovskite NCs.



Figure S17. Operational stability of the fabricated perovskite nanocrystal LEDs based on MAPbBr<sub>3</sub>, MAPb(Br/Cl)<sub>3</sub>, and MAPb(Br/I)<sub>3</sub> NCs.

## **Additional tables**

**Table S1.** Reaction parameters, resulting PL peak positions, and their  $\eta_{PL}$ . For the  $\eta_{PL}$  trend over the entire visible spectra presented in Figure 3a, parent MAPbBr<sub>3</sub> NCs (~8 g L<sup>-1</sup>) were mixed in an internanocrystal AE with fully exchanged MAPb(Br/Cl)<sub>3</sub> NCs (~6 g L<sup>-1</sup>) or MAPb(Br/I)<sub>3</sub> NCs (~2 g L<sup>-1</sup>) in different volume ratios. All internanocrystal halide exchange reactions were performed in 2 mL of toluene, at room temperature, and under ambient conditions for 30 min.

MAPbBr <sub>3</sub>	MAPb(Br/Cl) <sub>3</sub>	MAPb(Br/I) <sub>3</sub>	$\lambda_{PL}$	$\eta_{PL}$
(µL)	(µL)	(µL)	(nm)	(%)
-	pure	-	415	35
10	90	-	427	44
20	80	-	439	57
30	70	-	451	69
40	60	-	463	76
50	50	-	475	85
60	40	-	486	87
70	30	-	497	89
80	20	-	506	90
90	10	-	515	91
pure	-	-	524	91
90	-	10	527	16
70	-	30	539	5
60	-	40	551	6
50	-	50	565	8
45	-	55	576	11
40	-	60	583	15
35	-	65	595	18
30	-	70	605	24
25	-	75	615	29
20	-	80	627	36
18	-	82	640	42
15	-	85	650	51
12	-	88	661	58
10	-	90	670	64
7	-	93	679	68
5	-	95	686	74
5	-	120	694	76
5	-	150	699	78
5	-	250	704	80
5	-	500	709	81
-	-	pure	724	89

**Table S2.** Emission wavelength,  $\eta_{PL}$ , and fwhm values of mixed-halide perovskite NC dispersions measured on July 2019, after three months on October 2019, and after six months on January 2020 demonstrating the colloidal stability of these compound over a longer time period. The optical properties are preserved in the most cases for several months. The NC dispersions were stored in a glass vial and sealed with tape.

	July 2019			October 2019			January 2020		
Sample	$\lambda_{PL}$	$\eta_{PL}$ (%)	fwhm	$\lambda_{PL}$	$\eta_{PL}$ (%)	fwhm	$\lambda_{PL}$	$\eta_{PL}(\%)$	fwhm
	(nm)		(nm)	(nm)		(nm)	(nm)		(nm)
violet	415	35	14	415	24	15	417	23	16
blue	469	85	19	470	79	19	470	78	19
cyan	486	92	20	487	85	20	487	82	19
green	524	91	22	524	82	22	524	85	22
yellow	573	11	29	570	12	28	570	15	27
red	652	51	38	650	61	37	648	58	39
NIR	724	89	41	724	88	41	724	89	41

Table S3. Carrier lifetimes of MAPbBr3 and mixed-halide perovskite NCs.<sup>5</sup>

Sample	$\tau_{avg}$	$\tau_1$	$\tau_2$	$\tau_3$	Amplitude 1	Amplitude 2	Amplitude 3
	(ns)	(ns)	(ns)	(ns)			
violet	12.4	2.6	9.5	23.9	3042.9	1744.3	455.1
blue	27.4	7.8	22.2	88.1	3391.1	1581.7	131.4
cyan	24.5	7.0	17.8	73.9	3272.6	2265.4	183.9
green	30.7	8.7	22.6	76.9	3207.0	1808.4	267.0
yellow	23.5	3.8	15.9	37.2	2304.8	2368.8	895.1
red	36.5	7.4	24.3	49.8	834.0	3044.2	1622.0
NIR	40.4	15.7	33.3	69.8	816.0	3861.1	604.0

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