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### **Dissemination Level**

PU	Public	x
PP	Restricted to other programme participants (incl. Commission Services)	
RE	Restricted to a group specified by the consortium (incl. Commission Services)	
СО	Confidential, only for the members of the consortium (incl. Commission Services)	

### **Document Log**

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V3.0	23/06/2021	Final revision by WSFR, Innosieve and IZSVe			







### **Table of Contents**

1	Exec	utive Summary	. 4
2	Apta	mers for heavy metals	. 4
2	2.1	Selection of aptamers	4
2	2.2	Fundamental literature database for the selection of aptamers	6
-	2.3	Back-up strategy for heavy metal detection	. 7
3	Dete	ction of pesticides by immunoassays	. 8
4	Seleo	ction of microbial targets	10
5	Seleo	ction of fluorophores	11
6	Conc	clusion	14
7	Anne	ex 1: Complete list of fluorophores	16





### **1** Executive Summary

For the detection of relevant targets in the h-ALO project, bio-recognition elements are a crucial factor for success. In the h-ALO biosensor the selective bio-recognition elements, comprising DNA coding sequences, innovative aptamers and commercially available antibodies, are combined for the multiplexed detection of microbiological, pesticide/antiparasitic and heavy metals contaminations. The proposed multiplexing capability of the h-ALO sensor will enable early detection and monitoring of microbiological, pesticide/antiparasitic and heavy metal contaminations simultaneously in aquaponics water, raw milk, craft beer and organic honey. Therefore, the selected bio-recognition molecules need to be fit for purpose in every h-ALO defined matrix. The selection should focus on ease of applicability, sensitivity requirements (zero tolerance, MRL or industry set parameters), but most importantly, on availability. Additionally, fluorophore molecules suitable for incorporation and/or coupling to the aptamers and DNA probes are essential for operating the h-ALO sensor in the plasmonic-enhanced fluorescence (PEF) sensor mode.

For the selection of aptamers, suitable to detect heavy metals, a database with recent literature is compiled. Based on this literature, aptamers for the detection of mercury (Hg<sup>2+</sup>), methylmercury (CH<sub>3</sub>Hg<sup>+</sup>), lead (Pb<sup>2+</sup>) and cadmium (Cd<sup>2+</sup>) are directly implemented or redesigned by adaptation of the most logical approach closest to the h-ALO sensor format (for the direct detection, or for the indirect complementary strand approach). For the immunoassay-based detection of pesticides a high TRL multiplex assay is introduced in the h-ALO project. This assay will be further extended on the basis of end-user demands (please consider D1.2) for the application in the h-ALO target-matrices: aquaponics water (carbamate pesticides), beer (glyphosate herbicide), milk (levamisol, triclabendazole and moxidectin antiparasitic pesticides) and honey (azoxystrobin pesticide and tetracyclines antibiotics group). For the PEF detection a database containing over 300 different fluorochromes is compiled. Based on the expected specifications of the h-ALO sensor (especially the Optoplasmonic Module), an initial selection of fluorochromes is made based on optical features such as absorption and emission maximum wavelengths, Stokes shift, extinction coefficient and fluorescence quantum yield. Moreover, parameters such as Excitation coefficient, Emission coefficient and PEF factor related to the entire process of optical excitation and emission of the Fluorophores within the detection scheme based on the nanoplasmonic grating are considered (please refer to D1.3). Eventually this selection has been further narrowed down to a final list of 6 suitable fluorochromes based on the ability of conjugation to aptamers and DNA oligo's.

## 2 Aptamers for heavy metals

### **2.1 Selection of aptamers**

Aptamers are small, synthetic, single-stranded oligonucleotides (DNA) which can selectively bind chemical and biological targets. Aptamers form diverse, complex secondary structures, like multi-branched loops or G-quadruplexes. Most aptamers fold into their unique three-dimensional conformation upon binding their specific target. For the h-ALO project, aptamers for the detection of lead, cadmium and mercury are selected based on a literature study which focused on recent publications.

For the detection of  $Pb^{2+}$ , three different types of aptamers are described in literature: among these, the most common form is the G4-quadruplex. This type of aptamer consists of four G-rich sequences which form a G-quadruplex with  $Pb^{2+}$  ion due to a G-Pb-G interaction. For setting up the benchmark assays, and the implementation on the h-ALO sensor the G4-quadruplex format has been selected.





Aptamers directed against  $Hg^{2+}$  and  $CH_3Hg^+$  are rich in thymine (T) and readily form a T- $Hg^{2+}$ -T or T- $CH_3Hg^+$ -T configuration in the presence of  $Hg^{2+}$  or  $CH_3Hg^+$  respectively. The binding force of DNA sequences to  $Hg^{2+}$  or  $CH_3Hg^+$  is different,  $Hg^{2+} < CH_3Hg^+$ , and can be tuned by altering the number and locations of T-bases. Therefore, two different aptamers for the detection of  $Hg^{2+}$  and an aptamer optimised for detection of CH3Hg<sup>+</sup> will be implemented in the h-ALO project.

 $Cd^{2+}$  targeted aptamers are mainly based on one clone, Cd4. The Cd4 aptamer displays a high binding affinity to  $Cd^{2+}$  which is facilitated by a domain of 30 nucleotides that is rich in T and G nucleotides. This domain forms a secondary structure which consists of a stem-loop that is critical for binding the target. Different modifications of the CD4 aptamer are described for different sensing surfaces, but the aptamer that will be used in the h-ALO project consists of the critical domain of the original Cd4 aptamer which forms the stem-loop structure for binding of  $Cd^{2+}$ .

For the development of the benchmark aptamer-detection technology, the selected aptamers from literature have been optimized and ordered (Table 1). Each aptamer sequence is attached to a C-12 carbon spacer at the 5' end, to avoid sterical hindrance on the sensing surfaces. For the coupling to the sensing surfaces, the C-12 carbon spacer is coupled to an amino group (- $NH_2$ ). For an indirect heavy-metal detection approach, complementary sequences labeled with ATTO532 fluorochromes have been designed. For the future combination of aptamer- and antibody-based assays on the same h-ALO sensor surface, the complementary sequences have been designed for annealing temperatures lower than 60°C degrees. This to avoid the irreversible denaturation of antibodies.

Heavy	Adapted aptamer sequence	Complementary strand sequence	Annealing
metal			temp (°C)
Lead	5'-NH2-C12-GGGTGGGTGGGTGGGT-3'	5'-ATTO532-ACCCACCCACCCAC-3'	41
Mercury	5'-NH2-C12-TTCTTTCTTCCCCCTTCTTTCTT-3'	5'-ATTO532-AAGAAAGAAGGGGAAG-3'	51
Methyl-	5'-NH2-C12-GTTCTTTGTTAAAAATTCTTTGTTC-3'	5'-ATTO532-GAACAAAGAATTTTTAACA-3'	49.2
mercury			
Cadmium	5'-NH2-C12-	5'-ATTO532-CATACTGCACAACCAAA-3'	41.2
	ACTCTGGACTGTTGTGGGTATTATTTTTGGTTGTGCAGTATG-3'		
Random	5'-NH2-C12-AGACTAAGCTCAGACTCAGCTCAG-3'	5'-ATTO532-CTGAGCTGAGTCTGAGC-3'	54.1
strand			

Table 1. Selected and h-ALO adapted aptamer sequences and their complementary reporter strands





### **2.2 Fundamental literature database for the selection of aptamers**

#### Fundamental literature about aptamer-based lead detection

1. Li, T.; Dong, S.; Wang, E. A Lead(II)-Driven DNA Molecular Device for Turn-On Fluorescence Detection of Lead(II) Ion with High Selectivity and Sensitivity. Journal of the American Chemical Society 2010, 132, 13156-13157, doi:10.1021/ja105849m.

2. Li, F.; Feng, Y.; Zhao, C.; Tang, B. Crystal violet as a G-quadruplex-selective probe for sensitive amperometric sensing of lead. Chemical Communications 2011, 47, 11909-11911, doi:10.1039/C1CC15023E.

3. Shen, B.; Li, J.; Cheng, W.; Yan, Y.; Tang, R.; Li, Y.; Ju, H.; Ding, S. Electrochemical aptasensor for highly sensitive determination of cocaine using a supramolecular aptamer and rolling circle amplification. Microchimica Acta 2015, 182, 361-367, doi:10.1007/s00604-014-1333-3.

4. Gao, F.; Gao, C.; He, S.; Wang, Q.; Wu, A. Label-free electrochemical lead (II) aptasensor using thionine as the signaling molecule and graphene as signal-enhancing platform. Biosensors and Bioelectronics 2016, 81, 15-22, doi:https://doi.org/10.1016/j.bios.2016.01.096.

5. Yang, D.; Liu, X.; Zhou, Y.; Luo, L.; Zhang, J.; Huang, A.; Mao, Q.; Chen, X.; Tang, L. Aptamer-based biosensors for detection of lead(ii) ion: a review. Analytical Methods 2017, 9, 1976-1990, doi:10.1039/C7AY00477J.

6. Dolati, S.; Ramezani, M.; Abnous, K.; Taghdisi, S.M. Recent nucleic acid based biosensors for Pb2+ detection. Sensors and Actuators B: Chemical 2017, 246, 864-878, doi:https://doi.org/10.1016/j.snb.2017.02.118.

7. Abu-Ali, H.; Nabok, A.; Smith, T.J. Development of Novel and Highly Specific ssDNA-Aptamer-Based Electrochemical Biosensor for Rapid Detection of Mercury (II) and Lead (II) Ions in Water. Chemosensors 2019, 7, 27.

#### Fundamental literature about aptamer-based mercury detection

 Abu-Ali, H.; Nabok, A.; Smith, T.J. Development of Novel and Highly Specific ssDNA-Aptamer-Based Electrochemical Biosensor for Rapid Detection of Mercury (II) and Lead (II) Ions in Water. Chemosensors 2019, 7, 27.
 Li, L.; Li, B.; Qi, Y.; Jin, Y. Label-free aptamer-based colorimetric detection of mercury ions in aqueous media using unmodified gold nanoparticles as colorimetric probe. Analytical and Bioanalytical Chemistry 2009, 393, 2051-2057,

doi:10.1007/s00216-009-2640-0.
Yilin, L.; Zhong, J.; Yao, G.; Huang, Q. A label-free SERS approach to quantitative and selective detection of mercury (II) based on DNA aptamer-modified SiO2 @Au core/shell nanoparticles. Sensors and Actuators B: Chemical 2017, 258, doi:10.1016/j.snb.2017.11.110.

4. Sun, C.; Sun, R.; Chen, Y.; Tong, Y.; Zhu, J.; Bai, H.; Zhang, S.; Zheng, H.; Ye, H. Utilization of aptamerfunctionalized magnetic beads for highly accurate fluorescent detection of mercury (II) in environment and food. Sensors and Actuators B: Chemical 2018, 255, 775-780, doi:https://doi.org/10.1016/j.snb.2017.08.004.

5. Liu, C.-W.; Tsai, T.-C.; Osawa, M.; Chang, H.-C.; Yang, R.-J. Aptamer-based sensor for quantitative detection of mercury (II) ions by attenuated total reflection surface enhanced infrared absorption spectroscopy. Analytica Chimica Acta 2018, 1033, 137-147, doi:https://doi.org/10.1016/j.aca.2018.05.037.

6. Qi, Y.; Ma, J.; Chen, X.; Xiu, F.-R.; Chen, Y.; Lu, Y. Practical aptamer-based assay of heavy metal mercury ion in contaminated environmental samples: convenience and sensitivity. Analytical and Bioanalytical Chemistry 2020, 412, 439-448, doi:10.1007/s00216-019-02253-8.

#### Fundamental literature about aptamer-based cadmium detection

Wu, Y.; Zhan, S.; Wang, L.; Zhou, P. Selection of a DNA aptamer for cadmium detection based on cationic polymer mediated aggregation of gold nanoparticles. Analyst 2014, 139, 1550-1561, doi:10.1039/C3AN02117C.
 Luan, Y.; Lu, A.; Chen, J.; Fu, H.; Xu, L. A Label-Free Aptamer-Based Fluorescent Assay for Cadmium Detection.

Luan, Y.; Lu, A.; Chen, J.; Fu, H.; Xu, L. A Laber-ree Aplamer-Based Fluorescent Assay for Cadmium Detection.
 Applied Sciences 2016, 6, 432.
 Zhu, Y.-F.; Wang, Y.-S.; Zhou, B.; Yu, J.-H.; Peng, L.-L.; Huang, Y.-O.; Li, X.-J.; Chen, S.-H.; Tang, X.; Wang.

3. Zhu, Y.-F.; Wang, Y.-S.; Zhou, B.; Yu, J.-H.; Peng, L.-L.; Huang, Y.-Q.; Li, X.-J.; Chen, S.-H.; Tang, X.; Wang, X.-F. A multifunctional fluorescent aptamer probe for highly sensitive and selective detection of cadmium(II). Analytical and Bioanalytical Chemistry 2017, 409, 4951-4958, doi:10.1007/s00216-017-0436-1.

4. Zhou, B.; Chen, Y.-T.; Yang, X.-Y.; Wang, Y.-S.; Hu, X.-J.; Suo, Q.-L. An Ultrasensitive Colorimetric Strategy for Detection of Cadmium Based on the Peroxidase-like Activity of G-Quadruplex-Cd(II) Specific Aptamer. Analytical Sciences 2019, 35, 277-282, doi:10.2116/analsci.18P248.

5. Li, S.; Ma, X.; Pang, C.; Tian, H.; Xu, Z.; Yang, Y.; Lv, D.; Ge, H. Fluorometric aptasensor for cadmium(II) by using an aptamer-imprinted polymer as the recognition element. Microchimica Acta 2019, 186, 823, doi:10.1007/s00604-019-3886-7.

6. Gan, Y.; Liang, T.; Hu, Q.; Zhong, L.; Wang, X.; Wan, H.; Wang, P. In-situ detection of cadmium with aptamer functionalized gold nanoparticles based on smartphone-based colorimetric system. Talanta 2020, 208, 120231, doi:https://doi.org/10.1016/j.talanta.2019.120231.

7. Fakude, C.T.; Arotiba, O.A.; Mabuba, N. Electrochemical aptasensing of cadmium (II) on a carbon black-gold nano-platform. Journal of Electroanalytical Chemistry 2020, 858, 113796, doi:https://doi.org/10.1016/j.jelechem.2019.113796.







### 2.3 Back-up strategy for heavy metal detection

Aptamer assays are widely researched, but until now there are no commercial aptamer assays available. Aptamers surely have advantages (e.g. cheap to produce, animal-friendly and highly stable) over the classic antibody used in detection assays. However, aptamers are more difficult to work with and highly platform-dependent (Table 2). The classic antibody approach is still considered the golden standard, but is under the strong attention of the European Union, since it is based on animal experiments. Therefore, the aptamer approach is chosen for the heavy metals. However, due to the higher risk factor, a back-up approach using classical antibodies is studied in case the aptamer approach does not work in the benchmark sensor and/or h-ALO sensor.

Aspect	Antibodies	Aptamers
Sensitivity	High through affinity	Medium through avidity
Track record	Reliable golden standard approach for a wide range of bio-sensor immunoassays	Innovative approach for selected bio- sensor immunoassays
Size	160 - 15 Kd	12 – 30 Kd
Production/maintenance costs	High	Low
Animal welfare	Animal experiments necessary	No animal experiments necessary
Engineering for improving	Highly labour intensive	Low labour intensive
Development time	Several months	Several weeks
Stability at room temperature	Medium	High
Available market applications	High	Low
Surface density on chip	Low	High
Regeneration/temperature stability	Medium	High
Modification during synthesis	Not possible	Possible
Commercial benchmark assays	yes	No

Table 2. Antibodies versus aptamers: comparison of different aspects

For this back-up strategy, a database of antibodies for heavy metals that are commercially available and produced within scientific collaboration is compiled. The selected antibodies are listed in Table 3. WFSR has good experiences with Unibiotest from Wuhan, so their antibodies will be included in an initial selection for setting up the heavy-metal detection back-up strategy.





Supplier	Antibody directed	Supplier	Antibody directed
	against		against
Unibiotest	Cadmium	Creative Biolabs	Lead
Unibiotest	Lead	Creative Biolabs	Cadmium
Unibiotest	Mercury	Creative Biolabs	Cadmium (clone 1H9)
Unibiotest	Methyl Mercury Chloride	Creative Biolabs	Nickel
Unibiotest	Copper	Creative Biolabs	Arsenic
Unibiotest	Chromium	Jiangnan University	Mercury
Creative Diagnostics	Mercury	Jiangnan University	Methyl Mercury Chloride
Creative Diagnostics	Cadmium	Jiangnan University	Copper
Creative Diagnostics	Lead	Jiangnan University	Chromium
Creative Diagnostics	Copper	Jiangnan University	Cadmium
Creative Diagnostics	Chromium	Jiangnan University	Lead
Creative Diagnostics	Methyl Mercury Chloride	Jiangnan University	Mercury (clone 2)
Invitrogen/ThermoFisher	Lead	Jiangnan University	Aluminium
LSBio	Lead	Jiangnan University	Nickel

Table 3. Available antibodies for the detection of heavy metals

### **3** Detection of pesticides by immunoassays

As a key-enabling approach in the design of the h-ALO sensor, multiplex detection of different typologies of analytes and of different compounds within the same typology of analyte was introduced. Considering the pesticides class, even though high TRL benchmark assay multiplex method is already in place, this detection tool still allows the easy addition of target compounds that would meet the end-users' needs (please refer to D1.1).

The current pesticide immunoassay multiplex detects 29 pesticides from 6 different pesticide classes, which are all highly detrimental to bees and insects (Table 4).





Group	Microsphere- code	Pesticides	Detection range (ng/mL)
Neonicotinoids	#66 IMI	Acetamiprid	0.1-10
		Clothianidin	0.1-10
		Imidacloprid	<0.1
		Imidaclothiz	0.1-10
		Nitenpyram	0.1-10
		Thiacloprid	0.1-10
Avermectins	#38 AVRM	Abamectin	<0.1
		Doramectin	0.1-10
		Emamectin	<0.1
		Eprinomectin	<0.1
		Ivermectin	0.1-10
Pyrethroids	#27 PYRS	Cyfluthrin	10-1000
		Cyhalothrin	10-1000
		Cypermethrin	10-1000
		Deltamethrin	10-1000
		Fenpropathrin	0.1-10
Phenyl pyrazole	#73 FPIR	Fipronil	<0.1
		Fipronil-sulfone	<0.1
Carbamates	#55 CABF	Carbofuran	0.1-10
		Carbosulfan	10-1000
		Isoprocarb	0.1-10
		Propoxur	0.1-10
	#30 CABY	Carbaryl	0.1-10
Organophosphorus	#64 PARA	Fenitrothion	0.1-10
		Methyl-parathion	0.1-10
		Methyl-paraxon	10-1000
		Parathion	<0.1
	#26 CHLP	Chlorpyrifos	0.1-10
		Triazophos	10-1000

Table 4. High TRL benchmark assays for the detection of pesticides

The current multiplex covers most of the pesticides that were highlighted by the end-users and then reported in the h-ALO Grant Agreement. However, at the start of the project, a small desk study was undertaken in view of the Stakeholders Workshop at M5 in order to extend this multiplex with end-user-selected targets. Thus, an updated list of antibodies and antigen-conjugates has been drafted in order to meet end-users' needs. The extended list includes: levamisol, triclabendazole, moxidectin (additional antiparasitic targets for milk), but also the herbicide glyphosate (additional target for honey and craft beer), azoxystrobin and the antibiotics group tetracyclines (additional targets for honey).

After the round table between WSFR and the end-users committee (EUC) at the Stakeholders' Workshop (please refer to D1.1), additional targets are taken into consideration for addition to the pesticides list during the project.

The critical parameter for implementing new targets is strongly based on the availability of antibodies and their corresponding antigen-conjugates. These are crucial for developing new detection assays. Besides the availability of biorecognition molecules, the feasibility and







workload are parameters that seriously need to be considered in the progress of WP2 and WP3 in order to define the best trade-off between the feasible realization of detection assays according to the technology-provider partners and the expected fit for purpose at the end-users' side.

## **4** Selection of microbial targets

An extensive study for selecting the microbial targets has been performed in close contact with the EUC by starting from the information that was already present in the project Grant Agreement. On the basis of the bilateral interactions between Innosieve and selected end-users, and of the outputs of the Stakeholders Workshop, the microbial targets have been confirmed, and additional targets are added for further investigation and back-up strategies. For each food chain, at least one microbial target of interest is selected.

### <u>Aquaponics water</u>

Selected targets: *Escherichia coli* and *Salmonella enterica*. *Escherichia coli* is selected as the primary microbial target of interest. *Escherichia coli* is an indicator bacterium capable to estimate the level of faecal contamination in water systems. They are generally not very dangerous to human health, but since they are found in the intestinal tracts of warm-blooded animals, they are used to indicate the presence of a potential health risk. Additionally, *Salmonella enterica*, a bacterium dangerous to human health, is selected as a back-up target if no suitable antibody for *Escherichia coli* is available (if required).

### <u>Craft beer</u>

Selected group target: *Lactobacillus* species. *Lactobacillus* species are the most frequently occurring beer-spoiling micro-organisms in craft beer. Their presence may cause off-flavours, turbidity, elevated carbon dioxide levels and acidity. An additional target that was indicated by the end-users is *Saccharomyces cerevisiae* var. *diastaticus*. Unfortunately, due to a combination of the nature of the organism (very close to the brewing yeast), the samples of the end-users (unfiltered craft beer), the currently most promising sample preparation protocol (separation-based on size) and the possible protocol of use of the h-ALO sensor, the detection of *Saccharomyces cerevisiae* var. *diastaticus* proves to be out of reach for unfiltered beer samples with a high background flora of living brewing yeast cells in the h-ALO sensor.

### <u>Raw milk</u>

Selected targets: *Escherichia coli*, *Salmonella enterica* and *Listeria monocytogenes*. *Escherichia coli* is selected as the primary microbial target of interest. *Escherichia coli* is an indicator bacterium capable to estimate the level of faecal contamination. Therefore, it provides an excellent parameter to monitor milking hygiene and indicates the potential presence of human pathogens. *Salmonella enterica* and *Listeria monocytogenes* have been indicated as an additional target of interest by the end-users and are selected as possible other choices in case no effective antibody for *Escherichia coli* is available.

### <u>Honey</u>

Selected target: *Clostridium botulinum* and *Escherichia coli*. *Clostridium botulinum* are selected as the primary microbial target of interest. The presence of *Clostridium botulinum* spores can





lead to infant botulism. *Escherichia coli* and *B. cereus* are selected as a back-up targets in case spore-forming *Clostridium botulinum* bacteria are not specifically detectable by the h-ALO sensor or the benchmark technology.

# **5** Selection of fluorophores

An extensive desk study was undertaken by WFSR for the construction of a diversified initial database, containing the most commonly used fluorophores (Annex 1). From this initial list, CNR and PLASMORE selected a group of 14 fluorophores that meet the following optical/spectral requirements (please refer to D1.3):

- □ Absorption or excitation maximum should be at a wavelength >436 nm. This requirement is correlated to the stability/efficiency requirements for the light source (the Organic Light Emitting Diode, OLED). CNR has experience in the fabrication of OLEDs based on commercial deep blue emitters, also listed in D1.3. Such OLEDs would be suitable for excitation of fluorophores with absorption below 436 nm. However, both the efficiency and the stability of such OLEDs are practically low. For this reason, we decided to avoid deep blue OLEDs as light sources, and to discard consequently fluorophores absorbing in that spectral region (<436 nm).
- □ The Stokes Shift should be ≥60 nm. In the PEF detection mode, to improve the signalto-noise ratio, two spectral features should be simultaneously optimized: i) the spectral overlap between the electroluminescence spectrum of the OLED and the fluorescence spectrum of the fluorophore should be minimized, so that the optical filter can block the light from the OLED back-reflected by the nano-plasmonic grating (NPG), before reaching the light detector (organic phototransistor, OPT) while allowing the light emitted by the fluorophores to reach the OPT; ii) the overlap between the OLED electroluminescence spectrum and the fluorophore absorption spectrum should be maximized in order to guarantee high optical excitation of the fluorophore. These requirements are possibly fulfilled by narrowing the emission spectrum of the OLED (i.e. using an OLED with a small full width at half maximum -FWHM-). However, only a few OLEDs show such a low FWHM, while most OLEDs that emit light in the visible range have a typical FWHM of around 50-60 nm on average. Therefore, selecting fluorophores with a large Stokes shift (≥ 60 nm) is a preferred option.
- □ The emission quantum yield (QY) should be ≥0.3. This ensures maximized emission intensity from the fluorophore, at a fixed excitation intensity. For the same reason, the Molar Extinction Coefficient, which is the fraction of light absorbed per units of concentration and light path, should be as large as possible, at least above 10<sup>4</sup> mol<sup>-1</sup>·cm<sup>-1</sup> at the maximum-absorption wavelength.

As a further requirement, the size and molecular weight of the fluorophore should be sufficiently low (i.e. molecular weight below 100 kDa). This requirement is necessary for fluorophores to be effectively bio-functionalized by chemical coupling with small recognition elements (as in the case of aptamers or DNA small fragments). A fluorophore with large molecular weight and large spatial hindrance could inhibit recognition at the binding sites of the NPG, hampering the selective detection of analytes through PEF. For this reason, the quantum dots QD 605 and QD 655, and R-Phycoerythrin (R-PE) are removed from the selected fluorophores. Finally, also the Fluorophore 4-(Dicyanomethylene)-2-Methyl-6-(p-Dimethylaminostyryl)-4H-Pyran (DCM) is removed from the final selection, due to low stability issues experienced at CNR in past experiments when handling this dye in air.





Table 5. Selection of the best fluorophore options based on the optical/spectral requirements of; i) Maximum Absorption/Excitation Wavelength (Max Abs/Exc. WL); ii) Maximum Emission Wavelength (Max Em. WL), (iii) Stokes Shift; iv) Molar Extinction Coefficient; v) Quantum Yield.

Category	Fluorophore	Fluorophore short name	Max Abs/Exc. WL	Max Em. WL	Stokes Shift	Molar Extinction Coefficient	Quantum Yield
			(nm)	(nm)	(nm)	(mol <sup>-1</sup> ·cm <sup>-1</sup> )	
dye	4-(Dicyanomethylene)-2- Methyl-6-(p- Dimethylaminostyryl)- 4H-Pyran	DCM	458	624	166	44900	0,6
dye	7-Benzylamino-4- Nitrobenz-2-Oxa-1,3- Diazole	BBD	459	529	70	19700	0,36
dye	4-(Dicyanomethylene)-2- Methyl-6-(p- Dimethylaminostyryl)- 4H-Pyran	DCM	464	624	160	42000	0,43
dye	NBD-X (succinimidyl ester)	NBD-X	467	539	72	22000	
dye	FM 1-43	FM 1-43	479	598	119	40000	0,3
Phyco biliprotein	R-Phycoerythrin	R-PE	480	578	98	1960000	0,68
ATTO	ATTO 490LS	ATTO 490LS	496	661	165	40000	0,3
Chromeo	Chromeo P503 Py-Dye	Chromeo P503	503	600	97	24000	0,5
Chromeo	Chromeo P503 Dye BSA- conjugate	Chromeo P503 BSA	505	600	95	24000	0,5
dye	6-Carboxyrhodamine 6G, SE]	Dye 524	524	551	-	94000	-
quantum dot	eVolve 605	QD 605	605	-	-	-	-
ATTO	ATTO 611X	ATTO 611X	611	681	70	100000	0,35
quantum dot	eVolve 655	QD 655	655	-	-	-	-
dye	NIR820	NIR820	792	-	-	-	-

The final list which meets the above formulated requirements includes the following fluorophores:

- NIR 820
- ATTO611x
- Chromeo P503
- ATTO490LS
- FM1\_43
- BBD
- Dye524
- NBDx

This list of fluorophores, together with their spectral/optical features and figures of merit, has shared within WFSR, CNR and PLASMORE for calculations on the best spectral matching between





these fluorophores, the light source (OLED), and the NPG optical features for PEF detection, as reported in D1.3. In parallel, information on the possibility to chemically couple the selected fluorophores to the 5' or 3' end of DNA-aptamers and nucleotides has been collected from one of the main commercial providers of oligonucleotides, Eurogentec. The possibility for biofunctionalization is a further structural requirement which guides the final selection of fluorophores for their application to PEF detection. As a result, the list of selected fluorophores is reduced to ATTO490LS and Dye 524 because only these two fluorophores are suitable for modification of aptamers and oligo nucleotides. The list of fluorophores is further extended with ATTO620, ATTO700, ATT740 and ALEXA FLUOR 750. Although these fluorophores typically have a Stokes shift < 60 nm they do have the advantage that they can be coupled to aptamer/DNA fragments and therefore are also considered in the calculation for the PEF efficiency in D1.3.

Fluorophore	Max Abs/Exc. WL	Max Em. WL (nm)	Stokes Shift (nm)	Brightness Index (a.u.)	Molar Extinction Coefficient	Quantum Yield
	(nm)				(mol <sup>-1</sup> ·cm <sup>-1</sup> )	
ATTO 490LS	496	661	165	12	40000	0.3
5-CR6G, SE	522	550	28	n.s.	94000	n.s.
ATTO 620	618	642	24	60	120000	0.5
ATTO 700	699	719	20	30	120000	0.25
ATTO 740	740	764	24	n.s.	120000	0.1
Alexa Fluor 750	749	775	26	n.s.	290000	0.12

Table 6. Final selection of fluorophores that meet all requested characteristics

n.s. = not specified





# 6 Conclusion

In general, the preliminary final list of target detection assays covers the major interest brought forward by the end-users represented in the EUC. Besides that, the selection also shows that the majority of the assays cover multiple food matrices (Table 7). A final selection of aptamers, and their corresponding complementary reporter oligo, is defined for lead, mercury, methylmercury and cadmium heavy metals. These 4 heavy metals are considered very relevant by the end users and comply with at least 3 out of the 4 relevant matrices in the h-ALO project (Table 7). Since these assays are also new for a benchmark assay, we have chosen two novel approaches, which will be developed on two different platforms. As is shown in table 7, the selection of antibodies for the detection of pesticides is rather extensive. The main reason, on one hand, is to try and fulfil the demand of the end users, while on the other hand, the h-ALO project benefits from the high TRL assays that are the background of partners in the Consortium. This means that for 10, out of the 13 pesticides and pesticide groups, the immunoassays are already available in the benchmark technology and only need to be transferred to the h-ALO sensing surface.

Based on end-users specific needs, a herbicide (glyphosate) and antibiotics (tetracyclines) detection assay have been added to the preliminary final selection. While some immunoassays are relevant for 3 out of 4 matrices, others are really specific to 1 matrix.

Considering the selection of microbial targets, 1 to 3 targets are selected for each matrix. For craft beer, *Lactobacillus* species is chosen as the main target, for milk and aquaponics water, *Escherichia coli* and for honey *Clostridium botulinum*. The additional targets for each matrix are reserved for second-choice strategies. Specific probe sequences will be reported in D3.4 (M18).

The desk study for suitable fluorophores for the h-ALO sensor results in a final selection of 6 fluorophores. This selection takes into account, all the specifications and constraints brought forward by the technology-provider partners. They might be considered as a trade-off between the demands for optics, spectral properties as well sensor surface compatibility and the incorporation to aptamers and DNA reporter strands.

The chosen analytes represent important targets for the safety of products belonging to the food chains of interest. Not all of them has legislative criteria reporting limits of concentration, however their absence would guarantee product safety and quality, and in most cases, they are of interest for producers and/or consumers. The specific maximum residue levels and limits for all target in each matrix will be reported in D6.3 according not only to relevant legislation, but also to requirements from guidelines and from scientific literature.







 Table 7. Preliminary final selection of analyte targets revised according to end-users' needs (AQW: aquaponic water, B: craft beer; H: raw milk; H: organic honey)

	Target	Assay format	Matrix	Benchmark technology	Readiness level <sup>1</sup> (%)
	Lead	aptamer	AQW, B, M, H	Octet - Luminex	15
	Mercury	aptamer	AQW, B, H	Octet - Luminex	15
sl	Methyl-mercury	aptamer	AQW, B, H	Octet - Luminex	15
Meta	Cadmium	aptamer	AQW, B, H	Octet - Luminex	15
l vva	Lead	antibody	AQW, B, M, H	Luminex	5
Hea	Mercury	antibody	AQW, B, H	Luminex	5
	Methyl-mercury	antibody	AQW, B, H	Luminex	5
	Cadmium	antibody	AQW, B, H	Luminex	5
	Carbamates (group)	antibody	AQW	Luminex	80
	Carbamates (carbaryl)	antibody	AQW	Luminex	80
	Organophosphates (group)	antibody	B, M, H	Luminex	80
icides	Organophosphates (chlorpyrifos)	antibody	В, М, Н	Luminex	80
Pest	Neonicotinoids (group)	antibody	Н	Luminex	80
	Neonicotinoids (thiamethoxam)	antibody	Н	Luminex	80
	Fipronil	antibody	Н	Luminex	80
	Pyrethroids (group)	antibody	М, Н	Luminex	80
	Avermectins (group)	antibody	М, Н	Luminex	90
	Avermectins (moxidectin)	antibody	М, Н	Luminex	10
tics	Benzimidazoles (all)	antibody	Μ	Luminex	90
ticides iparasi	Benzimidazoles (triclabendazole)	antibody	Μ	Luminex	5
Pesanti	Levamisol	antibody	Μ	Luminex	5
Herbicide	Glyphosate	antibody	H, B	Luminex	10
Antibiotic	Tetracyclines	antibody	Н	Luminex	90
	Escherichia coli	SPC <sup>2</sup> or Antibody <sup>3</sup>	AQW, M4, H4	<i>Sieve-</i> ID <sup>®</sup> technology	80
	Lactobacillus spp.	SPC <sup>2</sup>	В	<i>Sieve-</i> ID <sup>®</sup> technology	15
sms	Listeria monocytogenes	SPC² or Antibody³	$M^4$	<i>Sieve-</i> ID <sup>®</sup> technology	25
-organi	Salmonella enterica	SPC² or Antibody³	AQW, M <sup>4</sup>	<i>Sieve-</i> ID <sup>®</sup> technology	80
Micro	Clostridium botulinum	SPC <sup>2</sup>	H4	<i>Sieve-</i> ID <sup>®</sup> technology	5
	Bacillus cereus	SPC <sup>2</sup>	H <sup>4</sup>	<i>Sieve-</i> ID <sup>®</sup> technology	0

<sup>1</sup> For the benchmark assay. <sup>2</sup> Solid Phase Cytometry only. <sup>3</sup> Solid Phase Cytometry with antibody coating. <sup>4</sup> Final selection of the bacterial target depends on the availability of suitable antibodies directed to structures on the outer bacterial membrane.





# 7 Annex 1: Complete list of fluorophores

Category	• Fluorophore •	Abs or Ex max (nm)		Em max (nm) 🔻 Sto	kes Shift 💌	Brightness Index 🔻	Extinction Coefficient	Quantum Yield 🔻
Alexa Fluor	Alexa Fluor 350		346	442	96		19000	
Alexa Fluor	Alexa Fluor 405		401	421	20		35000	
Alexa Fluor	Alexa Fluor 430		431	541	110	9	16000	0.55
Alexa Fluor	Alexa Fluor 500		493 502	525	24	07	/1000	0.54
Alexa Fluor	Alexa Fluor 514		517	542	25		80000	
Alexa Fluor	Alexa Fluor 532	1	532	553	21	65	81000	0.8
Alexa Fluor	Alexa Fluor 546		556	573	17	100	104000	0.96
Alexa Fluor	Alexa Fluor 555		555	565	25	60	155000	0.1
Alexa Fluor	Alexa Fluor 594		590	617	23	47	73000	0.64
Alexa Fluor	Alexa Fluor 610		612	628	16		144000	
Alexa Fluor	Alexa Fluor 633		632	647	15		159000	
Alexa Fluor	Alexa Fluor 635		633	647	14		140000	
Alexa Fluor	Alexa Fluor 647		650	665	15		270000	0.33
Alexa Fluor	Alexa Fluor 680		670	702	27		192000	0.37
Alexa Fluor	Alexa Fluor 700	÷	702	702	23		205000	0.25
Alexa Fluor	Alexa Fluor 750	:	749	775	26		290000	0.12
Alexa Fluor	Alexa Fluor 790		782	805	23		260000	
amino acid	Trp		287	348	61	2	6000	0.31
amino acid	Tryptophan		220	354	134	0.66948	5579	0.12
amino acid	Tyrosine		275	303	28	0.18265	1405	0.21
ATTO	ATTO 390	1	390	479	89	22	24000	0.9
ATTO	ATTO 425		436	484	48	40.5	45000	0.9
ATTO	ATTO 430LS		433	547	114	21	32000	0.65
ATTO	ATTO 465		465	507	42	41.25	75000	0.55
ATTO	ATTO 488		196	525	165	12	40000	0.82
ATTO	ATTO 495E5		495	527	32	36	80000	0.45
ATTO	ATTO 520		524	545	21	99	110000	0.9
ATTO	ATTO 532		532	553	21	103.5	115000	0.9
ATTO	ATTO 550	1	553	576	23	96	120000	0.8
ATTO	ATTO 565		563	592	29	110.4	120000	0.92
ATTO	ATTO 590 ATTO 594		594 601	624	30	96	120000	0.8
ATTO	ATTO 610		614	634	20	77	110000	0.03
ATTO	ATTO 611X		611	681	70		100000	0.35
ATTO	ATTO 620		618	642	24	60	120000	0.5
ATTO	ATTO 635		635	658	23	30	120000	0.25
ATTO	ATTO 647		644	670	26	24	120000	0.2
	ATTO 655		663	683	25	33	110000	0.3
ATTO	ATTO 680		680	700	20	36	120000	0.3
ATTO	ATTO 700		699	719	20	30	120000	0.25
ATTO	ATTO 725	-	729	752	23		120000	0.1
ATTO	ATTO 740	1	740	764	24	4.95	120000	0.1
Brilliant	Brilliant Blue BB515		490	531	41	125	1/9000	0.7
Brilliant	Brilliant Ultraviolet BUV395		348	395	47			
Brilliant	Brilliant Ultraviolet BUV496	1	348	496	148			
Brilliant	Brilliant Ultraviolet BUV563	3	348	563	215			
Brilliant	Brilliant Ultraviolet BUV661		348	661	313			
Brilliant	Brilliant Ultraviolet BUV/3/		348	737	389			
Brilliant	Brilliant Violet BV421		405	421	437	1625	2500000	0.65
Brilliant	Brilliant Violet BV510		405	510	105	254	577000	0.44
Brilliant	Brilliant Violet BV570		405	570	165	184	2300000	0.08
Brilliant	Brilliant Violet BV605		405	603	198	696	2400000	0.29
Brilliant	Brilliant Violet BV650		405	645	240	425	2500000	0.17
Brilliant	Brilliant Violet BV711 Brilliant Violet BV785		405	711	306	420	2800000	0.15
Chromeo	Chromeo 488		488	517	29	20	73000	0.27
Chromeo	Chromeo 494		494	628	134	8	55000	0.15
Chromeo	Chromeo 505		505	526	21	21	70000	0.3
Chromeo	Chromeo 546		545	561	16	15	98800	0.15
Chromeo	Chromeo 642 Chromeo 642		642	660	18	38	180000	0.21
Chromeo	Chromeo P429 Dye BSA-con Chromeo P429 Pv-Dve		430	536	106	7.5	75000	0.1
Chromeo	Chromeo P503 Dve BSA-con		505	600	95	12	24000	0.5
Chromeo	Chromeo P503 Py-Dye		503	600	97	12	24000	0.5
Chromeo	Chromeo P540 Dye BSA-con		533	627	94	10	50000	0.2
Chromeo	Chromeo P540 Py-Dye		533	627	94	10	50000	0.2
Chromeo	Chromeo P543 BSA-conjugat		279	590	311	8.55	57000	0.15
dve	1-ANS		243 271	370	47	9	57000	0.15
dye	1,1'-Diethyl-4,4'-Carbocyanir		710	717	7	1.50	210000	0.007
dye	1,2-Diphenylacetylene		271	404	133	0.0926016	27560	0.00336
dye	1,4-Diphenylbutadiene	1	330	373	43	13.86	33000	0.42
dye	1,4-Diphenylbutadiyne		305	330	25	0.044758	27800	0.00161
dye	1,6-Dipnenyinexatriene		353	425	72	bb.144	84800	0.78
dye	2,5-Diphenyloxazole		303	354	51	2.32	46400	0.05
dye	4-(Dicyanomethylene)-2-Me		458	624	166	26.94	44900	0.6
dye	4-(Dicyanomethylene)-2-Me		464	624	160	18.06	42000	0.43
dye	4-Dimethylamino-4'-Nitrosti	1 4	432	588	156	18.9	27000	0.7
aye	4'6-Diamidino-2-Phenylindol	(	353	465	112	15.66	27000	0.58
dye	5-FAM		544 492	487	143	1.161	27000	0.043
dye	6-FAM		494	520	26	,2.00	75000	0.9
dye	6-FAM dr		494	520	26		75000	0.9
dye	5-IAF		492	515	23			
dye	5-TAMRA		543	568	25	61.88	91000	0.68
dye	7-Benzylamino-4-Nitrobonz	1	347 450	5/3	26	7 003	10700	0.26
dye	7-Methoxycoumarin-4-Aceti		220	382	162	2.1276	13700	0.18
dye	9,10-Bis(Phenylethynyl)Anthr		271	467	196	35.4	35400	1
dye	9,10-Diphenylanthracene		279	302	23	14	14000	1





Category	<ul> <li>Fluorophore</li> </ul>	Abs or Ex max (nm)	Em max (nm)	Stokes Shift 👻	Brightness Index	Extinction Coefficient	Quantum Yield
dye	Acridine Orange	271	520	249		5 27000	0.1
dye	Acridine Orange	271	520	249	5.	4 27000	0.2
dye	Acridine Yellow	264	492	228	18.51	8 39400	0.47
dve	Auramine O	431	499	68	0.75	9 25300	0.03
dye	Benzene	255	303	48	0.0111	3 210	0.053
dye	Biphenyl	247	326	i 79	2.8	8 16000	0.18
dye	BO-PRO-1	280	481	201	9.2	8 58000	0.16
dye	BOBO-1	256	595	25	50.2	2 81000	0.62
dve	BOBO-3	570	483	34	57.7	2 148000	0.22
dye	BODIPY 507/545	513	549	36	6	0 82800	0.73
dye	BODIPY FL	504	510	6	6	3 70000	0.9
dye	BODIPY TR	588	616	28	5	7 68000	0.84
dye	C3-Indocyanine	544	557	13	9.3	1 133000	0.07
dye	C3-Thiacyanine Dye (EtOH)	559	571	. 12	6.	3 126000	0.05
dye	C3-Thiacyanine Dye (PrOH)	560	572	12	8.0	5 161000	0.05
dye	C5-Indocyanine	638	657	19	8	0 200000	0.4
dye	C5-Oxacyanine	582	603	21	116.6	2 238000	0.49
dye	C5-Thiacyanine	556	6/4	18	87.1	249000	0.35
dye	C7-Oxacvanine	687	712	25	107.	2 240000	0.49
dye	Calcein	494	516	22	6	3 81000	0.78
dye	Cascade Blue	378	423	45	1	4 26000	0.54
dye	CHOxAsH-CCXXCC	386	430	44	11.7	6 33600	0.35
dye	Coumarin 1	375	445	70	17.15	5 23500	0.73
dye	Coumarin 314	406	476	40	31.82	4 46800	0.67
dye	Coumarin 343	443	462	19	27.90	9 44300	0.63
dye	Coumarin 6	456	500	44	42.1	2 54000	0.78
dye	Cresyl Violet Perchlorate	603	622	19	44.8	2 83000	0.54
dye	Cresyl Violet Perchlorate	603	622	19	4	5 83000	0.54
dye	Crystal violet (Glycerol)	592	506	46	2.12	8 112000	0.019
dye	Су2	547	570	23	1	6 150000	0.04
dye	Cy3.5	576	596	20	22.	5 150000	0.15
dye	Cy3B	552	570	18	8	7 130000	0.67
dye	Cy5	649	670	21	7	0 250000	0.28
dve	Cy3.5	753	767	19	5	6 20000	0.23
dye	Labeling-detection	550	564	14	5	150000	0.20
dye	CyLyte Fluor 3, NHS ester	554	576	22			
dye	Dansyl Glycine (Dioxane)	262	492	230	2.83	8 4300	0.66
dye	Dansyl-X	333	518	185			
dye	DAPI (IN DIVISO)	353	465	112	1	6 27000 1 27000	0.58
dye	dichlorofluorescein	504	529	213	82.	8 90000	0.92
dye	Dragon fly orange	554	576	22			
dye	DY-681	691	708	17			
dye	DY-781	782	800	18	-	5 442000	0.65
dye	EOSIN Y Eosin Y	525	543	18	75.0	4 112000	0.6
dye	Ethyl-p-Dimethylaminobenzc	309	330	21	6.716	4 23160	0.29
dye	EYFP	514	527	13	5	1 84000	0.61
dye	FITC	495	514	19	80.9	6 88000	0.92
dye	FIAsH-CCXXCC	508	528	20	20.	5 41000 c 89000	0.5
dve	Fluorescein (EtOH)	500	540	40	89.53	1 92300	0.97
dye	Fluorescein F2- (pH >8)	490	515	25	7	1 76900	0.92
dye	Fluorescein FH- (pH 5.3)	472	515	43	1	1 29000	0.37
dye	Fluorescein-Dibase	225	514	289	72.91	7 92300	0.79
dye	fluoro-emerald	495	514	19	80.9	6 88000	0.92
dve	Fivi 1-45 Fura Red	479	590	220	0.53	2 40000	0.01
dye	Fura-2, Ca++ free	363	512	149	0.55	6 28000	0.23
dye	Fura-2, Ca++ saturated	335	505	170	1	7 34000	0.49
dye	Fura-2, Zn++ saturated	345	505	160	2	4 34000	0.69
dye	HEX Hillsto Eluor 405	535	556	21		90000	0.7
dve	Hil yte Fluor 488	404	526	24	70.9	8 78000	0.91
dye	HiLyte Fluor 532	545	565	29		171000	0.26
dye	HiLyte Fluor 555	550	566	16		6 150000	0.04
dye	HiLyte Fluor 594	593	616	23		80,000	0.9
dye	HiLyte Fluor 647	649	673	24	67.	5 250000	0.27
dye	HILyte Fluor 680 Hil yte Plus 555	552	702	24	1	9 190000 6 150000	0.04
dye	HiLyte Plus 647	649	668	19	67.	5 250000	0.27
	HiLyte™ Fluor 750	750	782	32		275,000	0.12
dye	Hoechst 33258 (in DMF)	354	486	132	1	6 46000	0.35
dye	Hoechst 33258 (in H2O)	345	507	162		2 46000	0.03
dve	Hoechst-33258 (H2O)	354	485	132	156	46000 4 46000	0.35
dye	Indo-1, Ca++ free	346	475	129	1.50	3 33000	0.38
dye	Indo-1, Ca++ saturated	330	401	. 71	1	8 33000	0.56
dye	IRDye38	778	806	28	6	2 179000	0.35
dye	IRDye40	768	788	20	5	3 140000	0.38
aye dve	IRDye700 IRDye78	681	712	31	8	170000 8 220000	0.48
dye	IRDye80	768	790	28	5	3 25000	0.2
dye	IRDye800	787	812	25	4	1 275000	0.15
dye	JOE	520	548	28	4	4 73000	0.6
dye	J0J0-1	530	545	15	75.2	4 171000	0.44
dve	LULU-1	568	580	12	43.	z 108000	0.4
dye	Lucifer Yellow CH	230	542	312	5.08	2 24200	0.21
dye	Merocyanine 540	559	579	20	53.8	2 138000	0.39
dye	Merocyanine 540	559	579	20	5	4 138000	0.39
dye	monobromobimane	301	490	189	1.	5 5000	0.3
aye	N,N <sup>-</sup> -Difluoroboryl-1,9-Dime	503	521	. 18	3.74	4 48000	0.078





Category	Fluorophore	Abs or Ex max (nm)	Em max (nm) 🔻	Stokes Shift 👻	Brightness Index 👻	Extinction Coefficient	Quantum Yield
dve	N.N'-Difluoroboryl-1.9-Dimethyl-5-Phenydipyr	515	526	11	2.862	54000	0.053
dye	N,N'-Difluoroboryl-1,9-Dimethyl-5-Phenydipyr	516	536	20	13.57	59000	0.23
dye	Naphthalene	220	322	102	1.38	6000	0.23
dye	NBD-X (succinimidyl ester)	467	539	72		22000	
dye	neo-Cy5 (DMSO)	656	675	19	49	195000	0.25
dye	Nile Blue (MeOH)	625	659	34	20.736	76800	0.27
dye	Nile Red	262	580	318	26.6	38000	0.7
dye	NIRI	/61	796	35	62	268000	0.23
dye	NIR1	703	684	20	61 64	250000	0.34
dye	NIR2	662	684	20	85	208000	0.23
dye	NIR3	750	777	27	77	275000	0.28
dye	NIR3	726	777	51	111.8	260000	0.43
dye	NIR4	629	671	42	77	275000	0.28
dye	NIR4	650	671	21	1112	260000	0.43
dye	NIR820	792			0		
dye	Oregon Green 488	496	516	20	68	76000	0.9
dye	Oregon Green 514	506	526	20	85	88000	0.96
dye	Oxazine 1	643	665	22	13.53	123000	0.11
dye	Ovazine 170 Ovator 645 (othapol)	614	641	2/	52.29	250000	0.63
dve	Oyster 656 (ethanol)	665	684	10	100	230000	0.4
dye	P-Quaterphenyl	293	363	70	36.49	41000	0.89
dye	P-Terphenyl	276	338	62	31.434	33800	0.93
dye	Pacific Blue	400	447	47	16	29500	0.55
dye	Perylene	253	435	182	36.19	38500	0.94
dye	Phenol	220	292	72	0.1755	2340	0.075
dye	Phenylalanine	222	279	57	0.00429	195	0.022
dye	Phthalocyanine	699	701	2	97.2	162000	0.6
dye	Pinacyanol-Iodide	604	621	17	0.128	128000	0.001
dye	Piroxicam	325	476	151	0.455	13000	0.035
dye	PO-PRO-1	437	455	18	19.5	50000	0.39
dvo	POPO 1	339	507	20	50.10	02000	0.57
dye	POPOP	256	400	151	44	47000	0.0
dye	Proflavin (pH 7)	261	511	250	13.226	38900	0.34
dye	Pyrene	241	381	140	17.28	54000	0.32
dye	Quinine Sulfate (0.05M H2SO4)	256	450	194	3.1122	5700	0.546
dye	Quinine Sulfate (0.5M H2SO4)	256	451	195	3.1122	5700	0.546
dye	Quinine sulfate (in 0.5M H2SO4)	256	451	195	3	5700	0.55
dye	Rhodamine 110	496	520	24	71	80000	0.89
dye	Rhodamine 123	512	531	19	76.68	85200	0.9
dye	Rhodamine 6G	530	552	22	110	116000	0.95
dvo	Rhodamine B	543	500	22	74 74 2	106000	0.7
dye	5(6)-CR110 [5-(and-6)-Carboxyrhodamine 110	498	521	22	74.2	76000	0.7
dve	5-CR6G, SE [5-Carboxyrhodamine 6G, SE]		550	28		94000	
dye	6-CR6G, SE [6-Carboxyrhodamine 6G, SE]	524	551			94000	
at us	Riboflavin	220					
aye	Riboriavin	220	531	311	9.9	33000	0.3
dye dye	Rose bengal	559	531 571	311	9.9	33000 90400	0.3
dye dye dye	Rose bengal 5(6)-ROX	559 568	531 571 591	311 12 27	9.9 10	33000 90400	0.3
dye dye dye	Rose bengal 5(6)-ROX SNIR1	559 568 666	531 571 591 695	311 12 27 29	9.9 10 52.32	33000 90400 218000	0.3
dye dye dye dye dye	Kose bengal 5(6)-ROX SNIR1 SNIR2	559 568 666 764	531 571 591 695 803	311 12 27 29 39	9.9 10 52.32 24.64	33000 90400 218000 224000	0.3 0.11 0.24 0.11
dye dye dye dye dye dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4	220 559 568 666 764 667 755	531 571 591 695 803 697 803	311 12 27 29 39 30 30	9.9 10 52.32 24.64 59 30.94	33000 90400 218000 224000 224000 245000 238000	0.3 0.11 0.24 0.11 0.24 0.11
dye	Rose bengal 5(6)-ROX SNIR1 SNIR2 SNIR3 SNIR4 SPERTURE REPORT	220 559 568 666 764 667 765 650	531 571 695 803 697 803 697 803	311 12 27 29 39 30 30 38	9.9 10 52.32 24.64 59 30.94 70	33000 90400 218000 224000 245000 238000 250000	0.3 0.11 0.24 0.11 0.24 0.13 0.28
dye dye dye dye dye dye dye dye	Rose bengal 5(6)-ROX SNIR1 SNIR2 SNIR3 SNIR4 Spectrum FRed Souarvium dve III	220 559 568 666 764 667 765 650 650 650	531 571 591 695 803 697 803 676 676	311 12 27 29 39 30 30 38 26 26	9.9 10 52.32 24.64 59 30.94 70 200.85	33000 90400 218000 224000 245000 238000 250000 309000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65
dye dye dye dye dye dye dye dye	Rose bengal 5(6)-ROX SNIR1 SNIR2 SNIR3 SNIR4 Spectrum FRed Squarylum dye III Squarylum dye III Star 440 SXP	220 559 666 764 667 765 650 628 436	531 571 591 695 803 697 803 676 646 515	311 12 27 29 39 30 30 38 26 6 18 79	9.9 10 52.32 24.64 59 30.94 70 200.85 15	33000 90400 218000 245000 238000 250000 309000 309000 22700	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.65
dye dye dye dye dye dye dye dye dye dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylum dye III           Star 440 SXP           Star 440 SXP	220 559 666 764 667 765 650 650 650 436 436	531 571 591 695 803 697 803 676 646 646 515 515 624	311 12 27 29 39 30 30 38 26 6 18 8 79 152	9.9.9 10 52.32 24.64 59 30.94 70 200.85 15 4	3300 90400 218000 2245000 238000 250000 309000 22700 22000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12
öye           dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 488	220 559 568 666 764 667 765 650 628 438 438 472 503	531 571 591 695 803 697 803 676 646 515 624 524	311 12 27 29 39 30 38 26 18 79 9 152 21	9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 4 57	33000 90400 218000 2245000 238000 250000 309000 22700 29000 29000	0.3 0.11 0.24 0.13 0.24 0.13 0.28 0.65 0.68 0.68 0.63 0.12 0.89
dye dye dye dye dye dye dye dye dye dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 440 SXP           Star 448           Star 512	220 559 566 666 764 667 765 650 650 628 436 473 503 511	531 571 591 695 803 697 803 697 803 676 646 515 624 552 530	311 12 27 29 39 30 30 38 26 6 18 79 152 21 19	9.9 10 52.32 24.64 59 30.94 70 0 200.85 15 4 57 6 9	33000 90400 218000 224000 245000 238000 25000 309000 22700 29000 64500 84000	0.33 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.68 0.68 0.82 0.89 0.82
oye           dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 470 SXP           Star 520 SXP	220 559 568 666 764 667 765 650 628 436 436 436 436 511 515	531 571 591 695 803 697 803 667 646 515 624 515 624 523 624 530 612	311 12 29 39 30 30 38 26 18 8 79 152 21 152 21 19 97	9.9.9 10 52.32 2.24.64 59 30.94 70 200.85 15 4 4 57 69 9 3 3	3300 90400 218000 245000 238000 250000 309000 22700 64500 64500 84000 66000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.82 0.82 0.82 0.05
öye           dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 430 SXP           Star 430 SXP           Star 438           Star 520SXP           Star 580	220 559 566 667 764 667 765 650 628 436 472 503 511 515 515 587	531 571 695 803 697 803 697 803 697 803 697 803 697 803 646 515 644 524 524 524 524 524 524 524 524 524 5	311 12 27 29 39 30 30 38 26 18 79 9 152 21 152 21 19 9 77 20	9.9 10 52.32 24.64 59 30.94 70 200.85 115 4 4 57 69 3 3 65	33000 90400 218000 2245000 238000 250000 309000 250000 309000 64500 64500 84000 64500 84000 72000	0.3 0.24 0.11 0.24 0.13 0.28 0.65 0.65 0.65 0.65 0.62 0.12 0.89 0.82 0.89 0.82 0.05 0.05 0.05 0.05
oye           dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 440 SXP           Star 448           Star 512           Star 530           Star 500	220 559 568 666 667 764 650 650 650 628 436 472 533 541 515 548 644	531 571 591 665 803 697 803 676 646 515 624 524 530 612 627 627	311 12 27 29 39 30 38 26 18 79 152 21 19 99 7 20 20 23	9.9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 57 69 3 3 65 32 2 2 2 2 2 4 5 5 4 5 5 4 5 5 5 5 5 5 5 5 5 5 5 5 5	33000 90400 218000 245000 245000 250000 250000 250000 229000 29000 66500 84000 60000 64500 84000 64500 84000 60000 720000	0.33 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.012 0.89 0.82 0.05 0.89 0.82 0.05 0.99 0.73
oye           dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylum dye III           Star 440 SXP           Star 440 SXP           Star 470 SXP           Star 520SXP           Star 520SXP           Star 635           Star 625	220 559 568 666 764 667 765 650 650 650 628 436 436 436 436 436 436 436 436 436 436	531 571 591 665 883 893 667 664 655 515 624 532 624 532 624 545 624 545 624 545 624 545 624 545 624 545 624 545 624 545 624 627 627 627 627 627 627 627 627 627 627	311 12 27 29 39 30 30 38 26 18 79 152 21 19 99 97 20 23 35 5 23 23 24 25 24 25 25 25 25 25 25 25 25 25 29 29 29 29 29 29 29 29 29 29 29 29 29	9.9 10 52.32 2.24.64 59 30.94 70 200.85 15 4 57 69 3 3 65 32 32 32 32 32 32 32 32 32 32	3300 99400 21800 224000 24500 238000 30900 30900 64500 64500 64500 60000 72000 63000 63000 63000 63000 63000 63000	0.33 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.088 0.12 0.88 0.05 0.93 0.05 0.93 0.73 0.51
öye           dye	No.6 bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 440 SXP           Star 470 SXP           Star 488           Star 520SXP           Star 600           Star 635           Star 64	220 559 568 666 764 667 765 650 628 436 436 436 437 503 511 537 604 436 633 633 633	531 571 591 695 8833 697 8833 676 646 515 644 544 544 544 544 544 544 544 544 54	311 12 27 29 39 30 30 38 26 56 18 79 9152 21 15 20 20 23 315 56 66 17	9.9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 57 69 3 3 65 32 20 32 15 10 10 10 10 10 10 10 10 10 10	33000 90400 218000 2245000 2238000 250000 309000 22000 64500 64500 64500 64500 72000 72000 43500 63000 125000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.68 0.68 0.68 0.68 0.68 0.68 0.69 0.65 0.99 0.73 0.51 0.92
öye           dye	Rose bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 430 SXP           Star 430 SXP           Star 520SXP           Star 600           Star 635           Star 635P           Star 64	220 2559 568 666 764 667 765 628 433 503 511 515 587 604 633 635 635 635 638 204	531 571 591 695 803 697 803 676 646 515 624 535 624 532 624 533 612 627 646 651 627 646 651 627 651 651 655 835 85 835 85 85 85 85 85 85 85 85 85 85 85 85 85	311 12 27 29 39 30 30 38 26 18 79 91 52 21 19 97 20 20 23 315 51 16 17 75	9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 57 69 3 3 65 32 2 32 32 115 191 145	33000 90400 218000 2245000 238000 250000 309000 309000 64500 64500 64500 64500 64500 64500 64500 64500 64500 64500 64500 229000 720000 720000 720000 7200000000	0.3 0.24 0.11 0.24 0.13 0.28 0.65 0.65 0.65 0.68 0.02 0.89 0.82 0.05 0.93 0.73 0.93 0.73 0.92 0.92 0.92 0.92
oye           dye	Nocional Sigh Rose bengal Sigh Rox SNIR1 SNIR2 SNIR3 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 448 Star 540 Star 540 Star 530 Star 635 Star 635 Star 635 Star 635 Star 635 Star 635 Star 64 Stilbene Stilfond damine 101	220 2559 568 666 764 667 765 650 652 436 436 436 436 437 511 511 515 587 644 633 638 638 638 638 638 638 638	531 571 591 665 803 669 803 676 646 515 624 533 612 624 533 612 607 627 655 635 655 345 531	311 12 27 29 33 30 38 26 18 79 152 21 19 97 20 23 15 16 17 15	9.9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 57 69 3 3 65 32 32 32 32 115 191 1.45 125	33000 90400 218000 245000 245000 238000 250000 250000 22700 29000 64500 84000 660000 43500 63000 63000 63000 212000 212000 239000	0.3 0.11 0.24 0.24 0.11 0.28 0.65 0.28 0.05 0.02 0.02 0.02 0.02 0.03 0.03 0.03 0.05 0.99 0.05 0.99 0.05 0.99
oye           dye	Nosional Sigh Rose bengal Sigh Rose SinR2 SinR2 SinR3 SinR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 4520 Star 520 Star 520 Star 520 Star 530 Star 635 Star 6	220 2559 568 666 764 667 765 650 628 436 436 436 436 436 436 436 436 436 436	531 571 591 695 8833 697 803 676 646 515 624 532 624 533 612 624 533 612 627 627 655 634 612 655 635 635 635 635 635 635 635 635 635	311 12 27 29 39 30 30 38 26 18 79 152 21 152 21 19 97 20 23 31 55 16 6 17 75 152 270	9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 57 69 33 65 32 32 32 32 115 14 57 69 32 32 32 32 32 32 32 32 32 32	3300 99400 21800 224500 24500 23800 25000 30900 64500 64500 64500 64500 64500 63000 63000 125000 22200 125000 212000 239000 139000	0.33 0.11 0.24 0.24 0.11 0.24 0.13 0.28 0.65 0.92 0.05 0.93 0.05 0.93 0.05 0.93 0.05 0.93 0.05 0.93 0.93 0.93 0.93 0.93 0.93 0.93 0.93
öye           dye	No.5000           Stop bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 440 SXP           Star 438           Star 438           Star 520SXP           Star 600           Star 600           Star 635           Star 600           Star 635           Star 600           Star 600           Star 600           Star 600           Star 600           Star 600           Star 601           Star 602           Star 603           Star 603           Star 601           Star 602           Star 603           Star 603           Star 604           Stilbene           Stilbene           Str0 13	220 2559 566 666 764 667 765 650 628 436 630 511 557 587 604 472 503 511 558 603 603 603 603 603 603 603 603 603 603	531 571 591 695 803 697 803 667 646 646 515 644 524 530 642 524 530 612 607 627 655 655 345 535 535 591 527 509	311 12 27 29 39 30 30 38 26 18 79 91 15 21 21 19 97 20 20 23 315 16 17 51 55 16 270 252	9.9.9 10 52.32 24.64 59 30.94 (70 200.85 15 4 4 57 69 33 65 32 23 23 115 191 1.45 125 36.75 29.6	33000 99400 218000 2245000 2245000 238000 309000 309000 250000 64500 64500 64500 64500 64500 64500 64500 64500 212000 212000 212000 212000 2139000 75000 75000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.89 0.82 0.05 0.99 0.73 0.51 0.99 0.99 0.05 0.99 0.4
öye	Nosition           Sigh Rose bengal           Sigh Rox           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylum dye III           Star 440 SXP           Star 470 SXP           Star 470 SXP           Star 512           Star 580           Star 600           Star 635           Star 635           Star 635           Star 630           Star 600           Star 635           Star 600           Star 600           Star 630           Star 631           Star 632           Star 633           Star 635           Star 635           Star 631           Star 632           Star 633           Star 635           Star 635           Star 635           Star 637           Star 638           Star 639           Star 780           Star 780           Star 780           Star 780           Star 780           Star 780           Star 780 <td>220 2559 568 666 764 667 765 650 628 433 503 511 515 515 515 515 515 515 515 515 51</td> <td>531 571 591 695 803 697 803 676 646 515 624 535 624 532 624 533 612 627 644 631 627 644 631 644 535 644 535 644 535 647 535 651 535 535 535 535 535 535 535 535 535 5</td> <td>311 12 27 29 39 30 30 38 26 18 79 91 152 21 19 97 20 20 23 51 16 17 15 15 5270 252 376</td> <td>9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 57 69 33 65 32 23 31 15 191 11.15 191 1.45 1.25 36.75 2.9.6 1.8.48</td> <td>33000 99400 218000 2245000 238000 238000 309000 309000 64500 64500 64500 64500 64500 64500 64500 229000 125000 125000 125000 125000 139000 75000 75000 75000 75000 75000 74000 88000</td> <td>0.3 0.24 0.24 0.11 0.24 0.3 0.28 0.65 0.65 0.65 0.65 0.65 0.65 0.65 0.65</td>	220 2559 568 666 764 667 765 650 628 433 503 511 515 515 515 515 515 515 515 515 51	531 571 591 695 803 697 803 676 646 515 624 535 624 532 624 533 612 627 644 631 627 644 631 644 535 644 535 644 535 647 535 651 535 535 535 535 535 535 535 535 535 5	311 12 27 29 39 30 30 38 26 18 79 91 152 21 19 97 20 20 23 51 16 17 15 15 5270 252 376	9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 57 69 33 65 32 23 31 15 191 11.15 191 1.45 1.25 36.75 2.9.6 1.8.48	33000 99400 218000 2245000 238000 238000 309000 309000 64500 64500 64500 64500 64500 64500 64500 229000 125000 125000 125000 125000 139000 75000 75000 75000 75000 75000 74000 88000	0.3 0.24 0.24 0.11 0.24 0.3 0.28 0.65 0.65 0.65 0.65 0.65 0.65 0.65 0.65
öye           dye	No.500           Stop-bengal           Stop-bengal           Stop-bengal           SNIR1           SNIR2           SNIR2           SNIR4           Spectrum FRed           Squarylum dye III           Star 440 SXP           Star 440 SXP           Star 470 SXP           Star 512           Star 520SXP           Star 635           Star 63           Star 64           Strop 70 13           Strop 70	220 2559 568 666 764 667 765 650 650 650 652 436 436 436 436 433 436 433 511 515 587 644 633 635 635 635 635 635 635 635 635 635	531 571 591 665 883 697 803 666 515 664 515 664 515 664 515 662 453 612 607 662 655 534 655 534 655 535 591 527 509 6634 523	311 122 27 29 339 300 38 26 18 8 79 152 21 152 21 19 99 70 20 23 31 55 16 61 17 51 52 270 270 2270 2376 51 51 51 51 51 51 51 51 51 51 51 51 51	9.9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 4 57 69 3 3 65 32 32 32 115 191 1.45 125 36.75 29.66 18.88 35.51	33000 99400 218000 224000 245000 238000 309000 309000 64500 64500 64500 64500 64500 63000 72000 227000 237000 63000 73000 125000 239000 1399000 73000 740000 7400000000	0.33 0.11 0.24 0.11 0.24 0.33 0.28 0.65 0.28 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.49 0.49 0.49 0.49
öye           dye	No.5000           Sig. Rose bengal           Star 440 SXP           Star 470 SXP           Star 470 SXP           Star 470 SXP           Star 520SXP           Star 530           Star 635           Star 635           Star 635           Star 64           Stilbene           Sulforhodamine 101           SYTO 11           SYTO 13           SYTO X Green           SYTOX Grange	220 2559 566 666 764 667 765 650 628 436 436 436 436 436 436 633 633 643 633 644 633 644 633 644 633 644 633 645 638 644 657 7257 257 257 2557 2554	531 571 591 695 883 697 883 667 646 646 515 664 535 644 544 544 544 544 544 544 655 655 65	311 12 27 29 39 30 30 38 26 18 79 9152 21 15 15 15 15 15 15 15 15 15 15 15 270 2252 376 91 313	9.9.9 10 52.32 24.64 59 30.94 (70 200.85 15 4 4 57 69 3 3 65 32 20 3 20 3 3 5 3 20 4 57 69 9 3 3 20 20 8 5 20 20 8 5 20 20 8 5 20 20 20 20 20 20 20 20 20 20	33000 99400 218000 2245000 238000 250000 309000 227000 64500 64500 64500 64500 72000 72000 738000 125000 239000 125000 239000 739000 740000 74000 74000 74000 74000 74000 740000 740000 740000 7	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.68 0.02 0.99 0.05 0.99 0.99 0.05 0.99 0.05 0.99
öye	Nosi bengal           5(6)-ROX           SNIR1           SNIR2           SNIR3           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 512           Star 520 SXP           Star 600           Star 630           Star 600           Star 635           Star 637           Star 638           Star 639           Star 631           Star 632           Star 633           Star 633           Star 635           Star 635           Star 637           Strop 7011           SYTO 13           SYTO 17           SYTO X0 range           6-TET	220 2559 5666 6667 764 667 650 628 436 630 511 515 587 604 472 503 511 515 587 604 472 503 511 515 587 604 472 503 633 633 633 633 633 633 633 633 633 6	531 571 591 695 803 697 803 664 515 664 551 664 524 524 524 533 662 524 524 524 524 524 525 655 655 655 655 655 655 655 655 655	311 12 27 29 39 30 30 38 26 18 79 9 152 21 19 9 97 20 20 23 315 16 16 17 15 15 200 22 22 376 19 9 313	9.9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 4 57 69 3 3 65 32 2 32 15 191 1.45 125 36.75 29.66 18.48 35.52 36.75 19 10 10 10 10 10 10 10 10 10 10	33000 99400 218000 2245000 238000 309000 309000 227000 64500 64500 64500 384000 64500 384000 72000 125000 125000 125000 139000 75000 75000 75000 75000 75000 75000 75000 75000	0.3 0.11 0.24 0.11 0.24 0.3 0.28 0.65 0.68 0.12 0.38 0.82 0.05 0.93 0.
oye       dye	Noordina Soce bengal SiGP ADX SNIR1 SNIR2 SNIR3 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 470 SXP Star 488 Star 488 Star 512 Star 520 SXP Star 580 Star 580 Star 635 Star 64 Star 64 Sta	220 2559 568 666 764 667 765 650 650 650 628 436 436 436 436 433 435 435 435 635 635 635 635 635 635 635 635 635 6	531 571 591 665 883 667 664 655 515 624 534 532 624 532 624 533 624 533 624 533 655 533 655 5334 533 622 523 500 634 533 500 533 500 533 500 533 500 533 500 533 500 533 500 533 500 533 500 533 500 533 500 533 500 533 500 500	311 12 27 29 39 30 38 26 18 8 9 9 152 21 19 97 20 23 15 16 15 15 26 37 9 97 20 97 97 20 97 97 20 97 97 20 97 97 20 97 97 20 97 97 20 97 97 20 97 97 20 97 97 20 97 97 20 97 20 97 97 20 20 21 21 21 21 21 21 21 21 21 21	9.9.9 10 52.32 2.4.64 59 30.94 70 220.85 15 4 4 57 69 33 65 32 32 32 115 51 191 1.45 125 36.75 29.66 18.48 35.51 71.1 0.67 2.02 0.67 0.02	33000 99400 218000 2245000 238000 238000 309000 64500 64500 64500 660000 72000 63000 63000 125000 232000 139000 739000 74000 739000 7300000 730000000 7300000000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.08 0.05 0.9 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.9 0.05 0.5 0.9 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5
oye           dye           dye <td>Noordina Soe bengal SIG-ROX SNIR1 SNIR2 SNIR2 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 520 SXP Star 520 SXP Star 530 Star 635 Star 64 Stilbene Star 64 Stilbene StrO 11 SYTO 13 SYTO 13 SYTO 35 SYTO Koreen SYTOX Korean SYTOX Korean SYTOX</td> <td>2 201 2 205 2 559 5 666 5 666 5 765 5 622 4 36 4 36</td> <td>531 571 591 665 880 697 803 667 646 515 664 524 534 534 677 627 655 345 534 535 535 537 537 537 537 537 537 537 537</td> <td>311 122 27 29 39 30 30 38 26 18 79 91 52 21 19 97 20 20 23 31 55 16 61 17 51 55 270 252 376 91 99 313 315 287 88 88 88</td> <td>9.9 10 52.32 24.64 59 30.94 (200.85 15 4 57 69 33 65 32 32 115 145 125 6 1848 35.51 71.1 67.2 0.26915</td> <td>33000 99400 218000 2245000 238000 3309000 2250000 3309000 64500 64500 64500 64500 64500 63000 72000 72000 125000 29000 139000 745000 29000 74000 88000 67000 79000 79000</td> <td>0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.88 0.65 0.99 0.05 0.99 0.21 0.05 0.05 0.99 0.21 0.05 0.05 0.99 0.21 0.05 0</td>	Noordina Soe bengal SIG-ROX SNIR1 SNIR2 SNIR2 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 520 SXP Star 520 SXP Star 530 Star 635 Star 64 Stilbene Star 64 Stilbene StrO 11 SYTO 13 SYTO 13 SYTO 35 SYTO Koreen SYTOX Korean SYTOX	2 201 2 205 2 559 5 666 5 666 5 765 5 622 4 36 4 36	531 571 591 665 880 697 803 667 646 515 664 524 534 534 677 627 655 345 534 535 535 537 537 537 537 537 537 537 537	311 122 27 29 39 30 30 38 26 18 79 91 52 21 19 97 20 20 23 31 55 16 61 17 51 55 270 252 376 91 99 313 315 287 88 88 88	9.9 10 52.32 24.64 59 30.94 (200.85 15 4 57 69 33 65 32 32 115 145 125 6 1848 35.51 71.1 67.2 0.26915	33000 99400 218000 2245000 238000 3309000 2250000 3309000 64500 64500 64500 64500 64500 63000 72000 72000 125000 29000 139000 745000 29000 74000 88000 67000 79000 79000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.88 0.65 0.99 0.05 0.99 0.21 0.05 0.05 0.99 0.21 0.05 0.05 0.99 0.21 0.05 0
öye	Noordina Soce bengal 5(6)-ROX SNIR1 SNIR2 SNIR2 SNIR3 SNIR4 Squarylium dye III Star 440 SXP Star 440 Star 40 SXP Star 488 Star 512 Star 520 Star 520 Star 520 Star 520 Star 520 Star 530 Star 600 Star 600 Star 630 Star 600 Star 635 Star 635 Star 635 Star 635 Star 64 Stilbene Sulforhodamine 101 SYTO 17 SYTO 17 SYTO 17 SYTO X SYTO X	220 2559 568 666 764 667 765 650 628 436 436 437 503 511 558 603 603 603 603 603 603 603 603 603 603	531 571 591 695 803 697 803 667 646 646 515 664 544 530 644 530 644 530 644 530 644 531 644 530 644 651 655 635 5335 534 535 535 535 535 535 535 535	311 12 27 29 39 30 38 26 18 79 9 15 21 19 97 20 23 15 16 17 51 5270 252 376 19 313 528 78 8 8 28 28 28 29 20 20 20 20 20 20 20 20 20 20	9.9 10 52.32 24.64 59 30.94 4 70 200.85 15 4 4 57 69 3 3 65 32 2 32 115 5 3.65 32 2 32 115 191 1.45 125 3.6.75 2.9.6 18.48 3.55 1	33000 99400 218000 2245000 238000 255000 309000 250000 64500 64500 64500 64500 64500 72000 72000 72000 125000 212000 212000 212000 339000 750000 750000 7500000000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.89 0.82 0.05 0.99 0.73 0.51 0.99 0.05 0.99 0.49 0.49 0.49 0.41 0.53 0.99 0.49 0.41 0.53 0.99 0.49 0.41 0.53 0.99 0.42 0.55 0.99 0.42 0.55 0.99 0.42 0.55 0.99 0.42 0.55 0.99 0.42 0.55 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.05 0.99 0.99 0.05 0.05 0
oye       dye       dye </td <td>Noordina Sobe bengal SIGF-ROX SNIR1 SNIR2 SNIR3 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 580 Star 580 Star 635 Star 635 Star 635 Star 635 Star 64 Stilbene Sulforhodamine 101 SYTO 11 SYTO 11 SYTO 11 SYTO 13 SYTO 17 SYTOX Green SYTO X Green SYTOX SY SC X G X G X G X G X G X G X G X G X G X</td> <td>2 201 2 205 2 559 5 666 6 666 7 64 6 667 7 65 6 50 6 50</td> <td>531 571 591 665 883 667 664 655 515 662 453 662 453 662 453 662 453 662 453 662 453 662 662 662 662 663 663 665 533 665 533 665 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 676 653 653 653 653 653 653 653 653 653 65</td> <td>311 12 27 29 39 30 38 26 18 8 79 152 21 19 97 20 02 23 155 166 17 51 155 270 227 23 155 26 17 27 20 20 20 20 20 20 20 20 20 20</td> <td>9.9 9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 4 57 69 33 65 32 32 32 32 32 32 32 32 32 32</td> <td>33000 99400 218000 2245000 238000 238000 309000 64500 64500 64500 64500 64500 64500 64500 64500 64500 64500 64500 72000 72000 735000 735000 744500 75000 75000 75000 74000 75000 75000 74000 75000 75000 74000 75000 75000 74000 75000 75000 74000 750000 750000 7500000000</td> <td>0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.08 0.12 0.82 0.05 0.93 0.73 0.53 0.93 0</td>	Noordina Sobe bengal SIGF-ROX SNIR1 SNIR2 SNIR3 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 580 Star 580 Star 635 Star 635 Star 635 Star 635 Star 64 Stilbene Sulforhodamine 101 SYTO 11 SYTO 11 SYTO 11 SYTO 13 SYTO 17 SYTOX Green SYTO X Green SYTOX SY SC X G X G X G X G X G X G X G X G X G X	2 201 2 205 2 559 5 666 6 666 7 64 6 667 7 65 6 50 6 50	531 571 591 665 883 667 664 655 515 662 453 662 453 662 453 662 453 662 453 662 453 662 662 662 662 663 663 665 533 665 533 665 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 653 533 663 676 653 653 653 653 653 653 653 653 653 65	311 12 27 29 39 30 38 26 18 8 79 152 21 19 97 20 02 23 155 166 17 51 155 270 227 23 155 26 17 27 20 20 20 20 20 20 20 20 20 20	9.9 9.9 10 52.32 24.64 59 30.94 70 200.85 15 4 4 57 69 33 65 32 32 32 32 32 32 32 32 32 32	33000 99400 218000 2245000 238000 238000 309000 64500 64500 64500 64500 64500 64500 64500 64500 64500 64500 64500 72000 72000 735000 735000 744500 75000 75000 75000 74000 75000 75000 74000 75000 75000 74000 75000 75000 74000 75000 75000 74000 750000 750000 7500000000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.08 0.12 0.82 0.05 0.93 0.73 0.53 0.93 0
öye	Noordina Sigh Rose bengal Sigh Rose SinR1 SNIR2 SNIR3 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 450 Star 520 Star 520 Star 530 Star 530 Star 635 Star 63 Star 64 Star 64 S	2 20 2 20 2 559 5 66 6 66 6 76 6 650 6 620 6 22 4 36 4 4 4 4 4 1 4 4 4 1 4 5 4 5 4 5 4 5 4 5 4 5 4 5 4 5	531 571 591 665 8833 667 864 515 664 515 664 515 664 515 664 515 664 533 6612 662 662 655 345 533 655 345 591 527 509 634 523 572 505 677 517 507 507 507 507 507 507 507 507 507 50	311 122 27 29 39 30 38 26 18 79 152 21 19 97 20 23 155 155 270 233 155 252 376 19 933 313 155 277 8 282 287 8 287 287 297 207 207 207 207 207 207 207 20	9.9 3.0 3.2 2.4.64 5.9 3.0.94 4.7 5.7 2.00.85 1.5 3.3 5.5 3.3 3.5 3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2	3300 99400 221800 224500 224500 23800 23800 225000 330900 64500 64500 64500 64500 64500 64500 64500 63000 63000 125000 229000 139000 740000 740000 740000 7400000000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.05 0.9 0.9 0.05 0.9 0.9 0.05 0.9 0.21 0.05 0.21 0.05 0.21 0.05 0.21 0.05 0.21 0.05 0.21 0.05 0.21 0.05 0.21 0.05
oye           dye	Noordina Soce bengal SIG-ROX SNIR1 SNIR2 SNIR2 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 488 Star 520 SXP Star 520 SXP Star 520 SXP Star 530 Star 635 Star 64 Stilbene StrO 11 SYTO 13 SYTO 13 SYTO 13 SYTO 3 SYTO X Orange 6-TET Tetra-1-Butylnaphthalocyanine Tetra-1-Butylnaphthalocyanine S-TMRIA, [Tetramethylrhodamine-5-iodoaceta Tetraks[2,6-Dichlorophenyl]Porphyrin Texas Red X	2,21,22,25,25,25,25,25,25,25,25,25,25,25,25,	531 571 591 665 880 803 667 664 646 515 664 564 564 564 564 564 564 564 564 56	311 122 277 29 39 30 30 38 26 18 79 97 20 21 21 19 97 20 23 15 16 17 20 23 15 15 20 23 15 24 27 20 20 20 20 20 20 20 20 20 20	9.9 0.0 52.32 24.64 59 30.94 4 700 200.85 15 4 4 57 69 3 3 65 32 32 115 5 32 32 135 145 125 36.75 29.6 18.48 35.51 71.1 67.2 0.26915 0.56811 83 104 104 105 105 105 105 105 105 105 105	33000 99400 218000 224000 238000 238000 309000 225000 309000 64500 64500 64500 64500 72000 72000 72000 72000 72000 125000 125000 125000 739000 73000 7300000 7300000 7300000000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.89 0.32 0.51 0.99 0.05 0.99 0.07 0.97 0.21 0.01 0
oye	Noordina Sobe bengal Sigh Rox SNIR1 SNIR2 SNIR3 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 440 SXP Star 448 Star 512 Star 530 Star 530 Star 600 Star 635 Star 600 Star 635 Star 635 Star 640 Star 635 Star 640 Star 635 Star 840 Star 635 Star 840 Star 635 Star 840 Star 635 Star 750 Star 75	2,21,22,25,25,25,25,25,25,25,25,25,25,25,25,	531 571 665 803 667 803 667 664 646 515 664 646 515 664 524 534 662 662 662 662 662 662 662 662 662 66	311 122 27 29 39 30 38 26 18 79 9 152 21 19 97 20 20 23 15 16 17 51 15 270 252 376 19 313 15 288 288 288 288 288 288 288 28	9.9 10 52.32 24.64 59 30.94 4 70 200.85 15 4 4 57 69 3 3 65 32 2 32 115 191 1.45 125 3.675 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 2.956 18.48 3.57 3.57 2.956 18.48 3.57 5.57 5.	33000 99400 218000 2245000 238000 238000 309000 2250000 64500 64500 64500 64500 64500 72000 64500 72000 72000 125000 2125000 2125000 139000 7550000 7550000 75500000000	0.3 0.11 0.24 0.11 0.24 0.31 0.28 0.65 0.22 0.89 0.42 0.05 0.9 0.73 0.51 0.99 0.49 0.55 0.99 0.99 0.49 0.51 0.99 0.99 0.01 0.99
aye dye dye dye dye dye dye dye dye dye d	Noordina Sobe bengal SIGP-ROX SNIR1 SNIR2 SNIR2 SNIR4 Spectrum FRed Squarylum dye III Star 440 SVP Star 440 SVP Star 470 SXP Star 480 Star 470 SXP Star 580 Star 580 Star 580 Star 580 Star 635 Star 64 Stilbene Stilfordoamine 101 SYTO 13 SYTO 17 SYTOX Green SYTOX Green SYTOX Orange G-TET Tetra-t-Butylazaporphine Tetra-t-Butylazaporphine S-TMRIA [Tetra methylrhodamine-5-iodoaceta Tetrakts/2,6-Dicholrophenyl)Porphyrin Texas Red-X TMR To-PRO-1	2 20 2 20 2 559 5 66 6 66 6 76 6 50 6 50 6 50 6 50 6 50 6 52 4 36 4 36 4 36 4 36 4 36 4 36 4 36 6 35 8 7 6 64 6 33 6 35 6 35	531 571 591 665 883 667 666 515 662 531 662 532 662 653 662 655 335 655 335 655 335 655 335 655 335 655 335 655 533 626 633 633 627 793 633 627 793 633 627 793 633 627 793 634 635 533 626 773 635 636 636 636 636 636 636 636 636 63	311 122 27 29 39 30 38 26 18 79 152 21 19 97 20 223 155 16 155 16 155 287 376 376 376 376 287 8 287 8 287 297 997 200 201 201 201 201 201 201 201	9.9 9.9 3.0 52.32 2.2.4.64 5.9 3.0.94 7.0 2.00.85 1.5 3.3 4.5 7.0 6.9 3.3 3.5 3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2	33000 99400 21800 224500 23800 23800 23800 23900 64500 64500 64500 64500 63000 72000 72000 125000 125000 125000 125000 739000 73000 73000 7300000 730000 730000 730000 730000 730000 730000 730000 730000 7300000 730000 7300000 7300000000	0.3 0.11 0.24 0.11 0.24 0.33 0.38 0.65 0.68 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.49 0.51 0.51 0.51 0.53 0.99 0.49 0.49 0.49 0.49 0.49 0.49 0.53 0.51 0.53 0.59 0
öye	Noordina Sign Poor Sign Poor S	2 20 2 20	531 571 591 665 880 697 803 667 664 646 515 562 524 530 612 664 531 662 677 627 655 345 531 532 532 532 532 532 532 532 532 533 626 533 634 555 567 7716 605 567 772 567 773 663 603 5655 563 5635 660 5531 661 661 661	311 122 277 29 39 30 30 38 26 18 79 97 20 21 19 97 20 23 31 51 51 51 52 270 252 376 19 313 15 287 88 288 288 287 97 19 313 15 277 15 277 20 20 20 20 20 20 20 20 20 20	9.9 10 52.32 24.64 59 30.94 4 70 200.85 115 77 69 33 65 32 32 115 5 125 325 131 1.45 125 3.6.75 2.9.6 1.8.48 3.5.51 7.1.1 6.7.2 0.26915 0.5681 88 88 104 65 15.75 1.1.22 1.5.75 1.1.22 1.5.75 1.1.22 1.2.2 1.2.2 1.5.75 1.2.2 1.5.75 1.2.2 1.5.75 1.5.	33000 99400 218000 2245000 238000 238000 309000 2250000 309000 64500 64500 64500 64500 63000 72000 72000 29000 125000 29000 139000 74500 29000 735000 74000 735000 735000 29000 139000 74000 759000 759000 139000 750000 750000 750000 750000 750000 750000 750000 750000 750000 750000 750000 7500000000	0.33 0.11 0.24 0.11 0.24 0.32 0.65 0.68 0.12 0.88 0.65 0.99 0.05 0.99 0.21 0.00 0.00 0.01 0.01 0.01 0.02 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.99 0.05 0.01 0.01 0.01 0.01 0.01 0.025 0.99 0.68 0.99 0.05 0.99 0.55 0.99 0.55 0.99 0.55 0.99 0.55 0.99 0.55 0.99 0.55 0.99 0.11 0.99 0.11
oye dye dye dye dye dye dye dye dye dye d	Noording           Sobe bengal           S(6) FOX           SNIR1           SNIR2           SNIR1           SNIR2           SNIR2           SNIR4           Spectrum FRed           Squarylium dye III           Star 440 SXP           Star 440 SXP           Star 440 SXP           Star 440 SXP           Star 488           Star 512           Star 520 SXP           Star 600           Star 630           Star 630           Star 633           Star 635           Star 636           Star 637           Stron 10           SYTO 11           SYTO 13           SYTO 13           SYTO 17           SYTO Xorage           6-TET           Tetar-18utylazaporphine           Tetarabily/hodamine           S-TMRIA (Tetramethylrhodamine-5-iodoaceta           Tetarabil(2, 6-bichorophenyl)Porphyrin           Texas Red	220 220 568 666 764 667 765 650 628 436 436 436 436 433 633 633 633 633 633	531 571 591 695 883 697 883 667 646 515 644 524 534 642 524 533 662 677 627 655 635 5335 5335 5335 5335 5335 5335	311 12 27 29 39 30 38 26 18 79 9152 21 19 97 20 23 15 16 17 51 5270 252 3766 19 313 5277 287 88 288 288 287 297 19 937 200 202 203 203 205 207 207 207 207 207 207 207 207	9.9.9 10 52.32 24.64 59 30.94 4 70 200.85 15 4 4 57 69 3 3 65 32 2 32 115 5 36,75 29.6 18.48 35.51 71.1 71.1 0.26915 0.5681 83 104 65 15.75 0.26915 0.5681 104 104 11.22 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.486888 0.4868888 0.4868888 0.4868888 0.4868888 0.4868888 0.4868888 0.48688888 0.4868888 0.4868888 0.48688888 0.486888888 0.48688888888888888888888888888888888888	33000 99400 218000 2245000 2245000 238000 309000 309000 220000 64500 64500 64500 64500 72000 72000 738000 2212000 3330000 212000 212000 3330000 750000 750000 7500000000	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.12 0.89 0.82 0.05 0.9 0.05 0.011 0.01
oye dye dye dye dye dye dye dye dye dye d	Noordina Sigh Pox Sigh Pox Sight Pox Sig	2 202 2 202 2 202 2 202 2 202 2 202 2 202 2 202 2 202 2 2 202 2 2 202 2 2 2 202 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	531 571 591 665 883 667 664 651 664 515 662 453 662 674 533 662 674 653 662 674 655 663 663 655 533 662 655 533 662 655 533 662 655 533 662 655 533 662 679 335 565 663 663 663 663 572 572 572 575 663 663 663 663 573 663 663 663 663 573 663 663 676 676 676 676 676 676 676 6	311 122 272 29 339 300 388 266 188 799 152 211 199 977 200 223 155 166 177 151 270 262 3766 3767 388 288 288 288 288 287 399 200 255 267 199 200 255 267 277 200 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 275 277 200 202 276 277 200 202 276 277 200 202 277 200 202 276 277 200 202 277 200 202 207 207	9.9.9 100 52.32 24.64 59 30.94 700 200.85 15 4 4 57 699 33 65 322 32 32 32 32 32 32 32 32 3	33000 99400 218000 2245000 2245000 238000 309000 309000 64500 64500 64500 64500 64500 64500 64500 64500 64500 72000 72000 72000 73000 75000 74000 75000 75000 74000 657000 75000 74000 667000 75000 75000 74000 75000 75000 74000 75000 75000 75000 74000 75000 70000 75000 70000 75000 700000 700000 7000000	0.3 0.11 0.24 0.11 0.24 0.33 0.28 0.65 0.028 0.05 0.9 0.33 0.51 0.92 0.9 0.05 0.9 0.49 0.51 0.99 0.01 0.0
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oye dye dye dye dye dye dye dye dye dye d	Noordina Soe bengal S(6)-ROX SNIR1 SNIR2 SNIR2 SNIR4 Spectrum FRed Squarylum dye III Star 440 SXP Star 530 Star 530 Star 530 Star 635 Star 64 Stilbene StTO 10 SYTO 11 SYTO 13 SYTO 13 SYTO 33 SYTO 33 SYTO 34 SYTO 40 range G-TET Tetra-t-Butylazaporphine Tetra-t-Butylapotrphine Tetra-t-Butylapotrphine Tetra-t-Butylapotrphine Tetra-t-Butylapotrphine Tetra-t-Butylapotrphine Tetra-t-Butylapotrphine Tetra-t-Butylapotrphine Tetra-t-Butylapotrphine Tetra-tSuff. (Tetra methylrhodamine-5-iodoaceta Tetrakis(2,6-Dichlorophenyl)Porphyrin Texas Red-X TMR TO-PRO-1 TO-PRO-3 Toluene TOTO-1 TOTO-3 Tris(2,2-Bipyridyl)Ruthenium(II) Yakima yellow YO-PRO-3	2 20 2 20 2 559 5 66 6 66 6 76 6 650 6 622 4 36 4 3	531 571 591 665 883 667 664 515 664 515 664 515 664 515 664 533 6612 664 533 6612 662 663 533 665 533 665 533 662 662 673 502 503 663 663 663 663 663 663 663 663 663 6	311 122 27 29 39 30 38 26 152 21 19 97 20 23 155 155 155 270 233 155 26 177 51 155 270 262 376 19 93 313 155 277 8 8 282 267 19 97 200 202 252 277 8 202 277 202 202 203 205 207 207 207 207 207 207 207 207	9.9 9.9 3.0 3.2 2.4.64 5.9 3.0 9 3.0 9 3.0 9 3.0 4 4.5 7 9 3.3 65 3.2 3.2 3.2 3.2 3.2 3.2 3.2 3.2	33000 99400 221800 224500 224500 23800 23800 23800 30900 64500 64500 64500 64500 64500 63000 63000 125000 22900 125000 239000 125000 775000 735000 735000 7390000 739000 7	0.3 0.11 0.24 0.11 0.24 0.13 0.28 0.65 0.68 0.05 0.99 0.05 0
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Category	Fluorophore	Abs or Fx max (nm)	Em max (nm) 💌 Sto	kes Shift 🔻	Brightness Index 🔻	Extinction Coefficient	Quantum Yield 🔻
fluorescent protein	KikGB Green	507	517	10	37 59	53700	0.7
fluorescent protein	KikGR Bed	359	593	234	22 815	35100	0.65
fluorescent protein	mAnnle	567	592	254	36.75	75000	0.03
fluorescent protein	mBanana	540	552	13	4.2	6000	0.7
fluorescent protein	mCherry	540	610	23	15.84	72000	0.7
fluorescent protein	mHoneyDew	478	562	84	2.04	17000	0.22
fluorescent protein	mKate?	589	633	44	2:04	62500	0.12
fluorescent protein	mOrange	546	562	16	18 00	71000	0.4
fluorescent protein	mOrange?	540	565	10	48.55	58000	0.05
fluorescent protein	mBlum	590	649	60	4.1	41000	0.0
fluoroscent protein	mPacabora	503	624	27	4.1	41000	0.1
fluorescent protein	mREP1 (Campbell Tsien 2003)	595	607	27	12.5	44000	0.15
fluoroscent protein	mtrawborn	505	505	22	26.1	44000	0.25
fluorescent protein	mTangarina	574	590	17	20.1	30000	0.29
fluorescent protein	D4.2 (Triop1008)	200	365	17	11.4 6.60	30000	0.3
fluorescent protein	PA-CED (nest estimation)	500	5440 517	15	12 740	22300	0.3
fluorescent protein		502	517	15	13.740	1/400	0.79
fluorescent protein	K14H4 KFP	589	648	59	4	40000	0.1
fluorescent protein	TagKFP-T	557	584	27	33.21	81000	0.41
fluorescent protein	to i omato	554	581	27	47.61	69000	0.69
fluorescent protein	Topaz (Tsien1998)	514	527	13	19.5	32500	0.6
fluorescent protein	W1B ECFP (Isien1998)	431	476	45	13	32500	0.4
fluorescent protein	WEGFP (post-activation)	482	505	23	13.88	34700	0.4
fluorescent protein	WTGFP (Tsien1998)	395	511	116	19.75	25000	0.79
phycobiliprotein	Allophycocyanin (APC)	650	660	10	476	700000	0.68
phycobiliprotein	APC	651	660	9	476	700000	0.68
phycobiliprotein	B-phycoerythrin (B-PE)	545	575	30	2362	2410000	0.98
phycobiliprotein	R-Phycoerythrin (R-PE)	480	578	98	1333	1960000	0.68
porphyrin	Magnesium Octaethylporphyrin (CH2Cl2)	407	581	174	61.245	408300	0.15
porphyrin	Magnesium Octaethylporphyrin (Toluene)	410	582	172	61.245	408300	0.15
porphyrin	Magnesium Phthalocyanine (PrOH)	668	671	3	66.196	87100	0.76
porphyrin	Magnesium Phthalocyanine (Pyridine)	674	678	4	41.808	87100	0.48
porphyrin	Magnesium Tetramesitylporphyrin	427	664	237	75.939	446700	0.17
porphyrin	Magnesium Tetraphenylporphyrin	426	663	237	85.5	570000	0.15
porphyrin	Octaethylporphyrin	400	623	223	20.67	159000	0.13
porphyrin	Porphin	396	683	287	11.223	261000	0.043
porphyrin	Tetrakis(o-Aminophenyl)Porphyrin	406	654	248	15.106	166000	0.091
porphyrin	Tetramesitylporphyrin	427	721	294	37.576	427000	0.088
porphyrin	Tetraphenylporphyrin	419	649	230	44	400000	0.11
porphyrin	Tetraphenylporphyrin (Diprotonated)	240	687	447	60.34	431000	0.14
porphyrin	Zinc Octaethylporphyrin	404	571	167	18.765	417000	0.045
porphyrin	Zinc Tetramesitylporphyrin	421	643	222	11.935	385000	0.031
porphyrin	Zinc Tetraphenylporphyrin	423	645	222	18.942	574000	0.033
qdot	QD525	300	525	225	284	710000	0.4
qdot	QD565	300	565	265	760	1900000	0.4
qdot	QD585	300	585	285	1400	3500000	0.4
qdot	QD605	300	605	305	1760	4400000	0.4
qdot	QD655	250	655	405	5460	9100000	0.6
quantum dot	eVolve 605	605					
quantum dot	eVolve 655	655					
quantum dot	QD525	348	525	177	192	320000	0.6
quantum dot	QD565	348	565	217	440	1100000	0.4
quantum dot	QD585	348	585	237	880	2200000	0.4
quantum dot	QD605	348	605	257	960	2400000	0.4
quantum dot	QD655	348	655	307	2280	5700000	0.4
quantum dot	QD705	348	705	357			

