Systematic analysis of spectral mismatch between compensation particles and cell in conventional and spectral flow cytometry

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Abstract

Compensation particles are widely utilized support reagents that are simple to use and provide a clear and bright signal for setting compensation or unmixing for multi-color flow cytometry experiments. Formulations vary between vendors, but these products generally consist of both a positive, antibody-binding beads in conjunction with negative, non-binding beads. Despite the many advantages of using compensation particles for single-color reference controls, there are instances when fluorophore-conjugated antibodies bound to compensation particles produce slightly different spectral emission signatures compared with stained cells. These differences can result in incorrect compensation and spectral unmixing and have been observed anecdotally for specific combinations of fluorophores. Since differences in spectral signature occurs at specific wavelengths and their corresponding filter sets, it can be difficult to predict compatibility. The lack of understanding of these discrepancies has led to distrust in using compensation particles and a belief that some fluorophores are incompatible with compensation particles for some experiments, but not in others. This distrust is noted especially when using compensation particles for spectral flow cytometry, where an accurate assessment of each fluorophore's spectral emission signature is critical for unmixing and interpreting multi-color experiments.

We set out to systematically explore the spectral mismatch between cells and compensation particles for both conventional and spectral flow cytometry. We evaluated fluorophores from Thermo Fisher Scientific and selected fluorophores from other vendors using Ultra Comp eBeads™ Plus Compensation beads. For each fluorophore, unmixing errors were identified by applying an unmixing matrix created using compensation beads to single-stained cells. A compatibility matrix was created based on which fluorophore pairings had unmixing errors. Fluorophore pairings with unmixing errors were then run on a conventional cytometer to determine if spectral unmixing errors were translatable as compensation errors on a conventional cytometer. Finally, a multiparameter panel was run on both conventional and spectral cytometers to qualitatively compare and assess the impact of spectral unmixing and compensation errors caused by compensation particles on panel performance.

This information can serve as a valuable reference and provide clearer guidance for using compensation particles on both spectral and conventional flow cytometers.

Introduction

Invitrogen™ UltraComp eBeads™ Plus Compensation Beads are a useful tool for conventional compensation and spectral unmixing, when:

- Sample is limited
- Antibody stains a very small subset of cells
- Dim staining is expected
- Antibody does not stain a distinct population of cells
- Spectral characteristics of the dyes are not affected

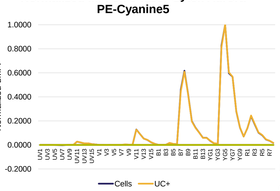
UltraComp eBeads Plus compensation beads, is the second generation of the UltraComp eBeads compensation beads, which have been optimized to be more compatible with violet-laser excited fluorophores compared to the first generation. However, even with the better optimized Ultracomp eBeads Plus compensation beads, there are spectral unmixing issues when used with certain fluorophore combinations. To further explore the unmixing and compensation issues when using compensation particles, Ultracomp eBeads Plus compensation beads and human peripheral blood cells were stained with CD4 (clones SK3 and RPA-T4).

Results

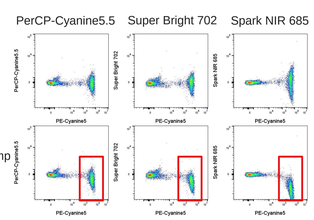
UltraComp eBeads Plus stained spectral signatures are similar to cell-stained samples but can still lead to unmixing issues.

Though the overlay of spectral emission signature of PE-Cyanine5 on Cells and UltraComp eBeads Plus has a similarity calculated to be 99.992%, noticeable unmixing issues can be identified. PE-Cyanine5 single-color cell-stained sample was analyzed using either a single-color stained cell sample or UltraComp eBeads plus for unmixing, other fluorophores were unmixed using cell-stained samples. Data shown are from 2-fluorophore unmixing matrix. Unmixing issues can be identified depending on fluorophores used together with PE-Cyanine5.

Normalized MFI on 5-laser Cytek Aurora PE-Cyanine5



Unmixed CD4 PE-Cy5

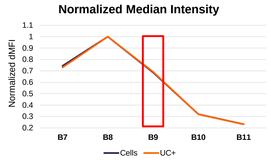


Subtle changes in the spectral signature of single-color controls can lead to unmixing issues.

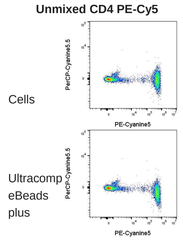
Unmixing issues may be more noticeable when the staining on the experimental sample is on a high density, bright population. The following experimental data was generated using CD4, to emphasize any unmixing issues. PE-Cyanine5 spectral signature difference between cells and UltraComp eBeads plus compensation beads in channel B9, the primary peak for PerCP-Cyanine5.5, is only 0.8%.

Theoretical example

Normalized Median Intensity



Unmixed CD4 PE-Cy5



Compatibility matrix created for spectral unmixing on the Cytek® Aurora using CD4.

CD4 in a variety of fluorophores from Thermo Fisher Scientific, Biolegend, and BD Biosciences were evaluated by staining with cells and UltraComp eBeads plus compensation beads. Multiple mock panels were created to enable evaluation of dye pairings in an experiment after spectral unmixing, denoted by numbers in the parenthesis, to explore a variety of fluorophore combinations. One compensation bead-stained fluorophore was used for unmixing at a time, with all other single-color controls in a mock panel used cell-stained single-color controls. After unmixing with beads, the unmixing matrix is applied to the cell-stained single-color control and evaluated.

Conventional cytometry compensation verbiage is used to categorize unmixing issues. This matrix evaluates how unmixing with beads stained with a specific fluorophore may cause unmixing issues when looking at bivariant plots against another fluorophore.

Matrix example

bead single-color controls → Cell-stained single-color controls

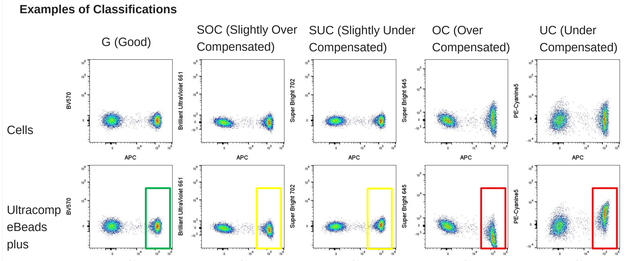
	BUV661	BV570	Super Bright 600	BV605	Super Bright 645	BV650	Super Bright 702	BV711	BV750	BV786	PE-Cy5
APC	SOC (1,2)	G (1,2)	G (2)	G(1)	OC (2)	OC (1)	SUC (2)	SUC (1)	G (1,2)		UC (1,2)

Scan for full matrix – +2500 pairs analyzed (78 Fluorophores tested)

Unmixing issues were subjectively categorized into the following classifications:

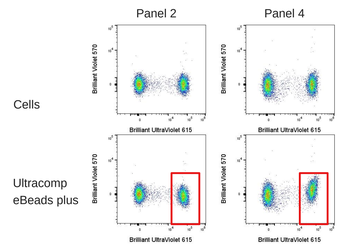
G (Good, no unmixing issue) – colored green; minor unmixing issues: SOC (slightly over-compensated), SUC (slightly under-compensated) – colored yellow; and OC (over-compensated), UC (under-compensated), - colored red. Some pairings had unmixing issues depending on the mock panel fluorophore combination and these were highlighted in orange. Pairs that have not been analyzed yet are blank, white cells, while pairs that cannot be analyzed are highlighted in blue and labeled N/A. Note, that other kinds of unmixing issues were not evaluated in these series of experiments, and not captured by this matrix.

Examples of Classifications



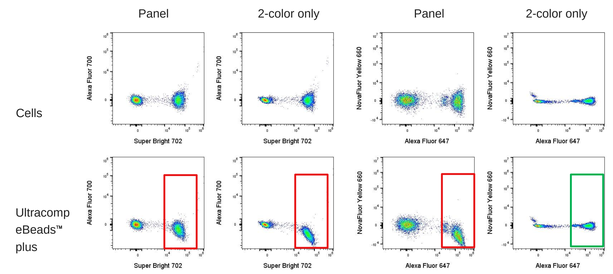
Unmixing issues can be dependent on fluorophore combinations that are being unmixed.

There were some unmixing issues that were identified in one mock panel and were different in another mock panel. This suggests that unmixing issues are not only isolated to a specific dye pair and based on the primary staining peaks of the fluorophores, but unmixing issues may come from influences of secondary peaks and other channels depending on the fluorophore combinations that are being used to unmix.



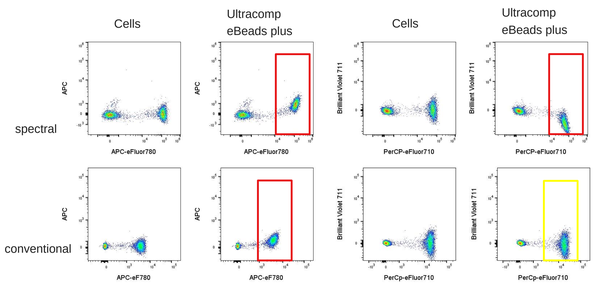
Select fluorophore pairings, with unmixing issues, were re-analyzed in experiments of just 2 fluorophores to confirm that unmixing issues were specifically due to that specific pairing.

Most unmixing issues were reproduced when only unmixing a pair of fluorophores using the UltraComp eBeads plus compensation beads. This suggests that difference in spectral signature of the compensation beads cause improper unmixing between the specific fluorophore pairing. However, there were also several instances where unmixing issues only occurred in multi-color mock panels, but not in fluorophore pairs. This suggests, that differences in the spectral signature of a single-color control, not directly related to unmixing of that specific fluorophore pair, can cause unmixing issues depending on the specific combinations of all the fluorophores being unmixed.



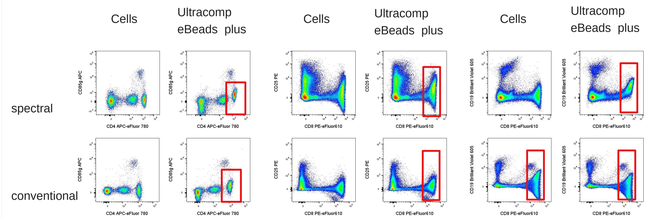
Fluorophore pairings with unmixing issues also had issues with conventional flow cytometer compensation.

Selected dye pairings compatible on a conventional cytometer, that had unmixing issues on a spectral cytometer, were further analyzed on a conventional flow cytometer. In 75% (n = 42) of the fluorophore pairings evaluated, incorrect compensation was also found when using compensation particles. However, there were also a few pairings where conventional compensation looked better with beads, which again suggest that non-primary peaks of a fluorophore can also cause unmixing issues.



Multiplexed samples using compensation beads to unmix or compensate will lead to incorrect unmixing and compensation issues.

Dye pairings with unmixing issues were specifically used to evaluate panel performance on both a spectral and a conventional instrument. In general, unmixing issues were reproducible on conventional instruments as compensation issues. It is possible that due to a conventional cytometry not being able to multiplex certain combinations of fluorophores, generally smaller panel sizes, and differences in spreading error, compensation issues with conventional flow cytometry when using compensation beads are not recognized as much as spectral flow cytometry.



Conclusions

- The generated compatibility matrix shows that majority (>82%) of fluorophore pairings evaluated will unmix correctly when using UltraComp eBeads plus compensation beads (see generated compatibility matrix).
- Unmixing and compensation issues using compensation beads are possible in both spectral and conventional flow cytometry.
- Compatibility matrix generated is specific for UltraComp eBeads plus compensation beads using CD4, a high abundant specificity. Other compensation tools are unique and will have unique results.
- Though unmixing and compensation issues are a possibility with use of compensation beads, they remain a valuable tool especially when we have a better understanding of when these issues may occur.

Acknowledgements

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UltraComp eBeads Plus Compatibility matrix on human CD4

CD4 Dye evaluated (down)	BUV395	BUV496	BUV563	BUV615	BUV661	BUV737	BUV805	BV421	SB436	eF450	BV480	eF506	BV510	Pacific Orange	BV570	Super Bright 600	BV605	Super Bright 645	BV650	Super Bright 702	BV711	BV750	BV785	Super bright 780	BV786
BUV395	X	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
BUV496	G (1, 2, 4)	X	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
BUV563	G (1, 2, 4)	G (1, 2, 4)	X	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
BUV615	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	X	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	SOC (1,2), SUC (4)	G (2)	G(1), SOC (4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
BUV661	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	X	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
BUV737	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	X	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2), SOC (4)	G(1)	G (2)	SUC (4)
BUV805	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	X	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
BV421	SUC (1, 2, 4)	OC (1, 2, 4)	SOC (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	X	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
SB436	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	X	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
eF450	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	X	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
BV480	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	X	G (2)	G(1)	G (1, 2)	G (1, 2, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
eF506	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	OC (2)	X		SUC (2)	SOC (2)	G (2)		G (2)		G (2)		G (2)		G (2)	
BV510	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)		X	G(1)	G(1)		G(1)		G(1)		G(1)	G(1)	G(1)		
Pacific Orange	G (1, 2)	G (1, 2)	G (1, 2)	G (1, 2)	G (1, 2)	G (1, 2)	G (1, 2)	G (1, 2)	G (1, 2)	G (1, 2)	G (1, 2)	G (2)	G(1)	X	G (1, 2)	G (2)	G(1)	G (2)	G(1)	G (2)	G(1)	G (1,2)	G(1)	G (2)	
BV570	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)	G (2)	G(1)	G (1, 2)	X	G (2)	G (1, 4)	G (2)	G (1, 4)	G (2)	G (1, 4)	G (1,2,4)	G(1)	G (2)	G (4)
Super Bright 600	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	G (2)	X	N/A	G (2)		G (2)		G (2)		G (2)	
BV605	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)		G(1)	G(1)	G(1), SUC (4)	N/A	X		G (1, 4)		G (1, 4)	G (1, 4)	G(1)		G (4)
Super Bright 645	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	G (2)	OC (2)		X	N/A	G (2)		G (2)		G (2)	
BV650	G (1,4)	G (1,4)	G (1,4)	G (1,4)	SOC (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)		G(1)	G(1)	G (1,4)		G (1, 4)	N/A	X		G (1, 4)	G (1, 4)	G(1)		G (4)
Super Bright 702	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	G (2)	G (2)		G (2)		X		G (2)		G (2)	
BV711	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G(1), SOC (4)	OC (1, 4)	G (1,4)	SOC (1, 4)	G (1,4)	G (1,4)	G (1,4)		G(1)	G(1)	G (1,4)		G (1, 4)		G (1), SUC (4)		X	G (1, 4)	G(1)		G (4)
BV750	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	OC (1), SOC (2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (2)	G(1)	G (1,2)	G (1,2,4)	G (2)	G (1,4)	G (2)	G (1, 4)	G (2)	SUC (1,4)	X	G(1)	G (2)	G (4)
BV785	G(1)	G(1)	G(1)	G(1)	G(1)	SOC (1)	SOC (1)	SOC (1)	G(1)	G(1)	G(1)		G(1)	G(1)	G(1)		G(1)		G(1)		G(1)	G(1)	X	N/A	N/A
Super bright 780	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	G (2)	G (2)		G (2)		G (2)		G (2)	N/A	X	N/A
BV786	G (4)	G (4)	G (4)	G (4)	G (4)	SOC (4)	SOC (4)	SOC (4)	G (4)	G (4)	G (4)				G (4)		G (4)		G (4)		G (4)	G (4)	N/A	N/A	X
NFB510																									
BB515	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	G (2)	G(1)	G (2)	G(1)	G (2)	G(1)	G (1,2)	G(1)	G (2)	
AF488	SOC (4)	SOC (4)	SOC (4)	SUC (4)	SOC (4)	G (4)	G (4)	G (4)	G (4)	SOC (4)	G (4)				G (4)		G (4)		G (4)		G (4)	G (4)			G (4)
FITC	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	SOC (1,2)	G (1,2)	G (2)	G(1)	G (2)	G(1)	G (2)	G(1)	G (1,2)	G(1)	G (2)	
NFB530																									
Spark Blue™ 550	G(1), SUC (4)	SOC (1), SUC (4)	G(1), SUC (4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)		G(1)	G(1)	SUC(1), SOC (4)		G (1,4)		G (1,4)		G (1,4)	G (1,4)	G(1)		G (4)
NFB555	G(3)	G(3)	G(3)	G(3)	G(3)	G(3)	G(3)	G(3)		G(3)		G(3)					G(3)				G(3)	G(3)			G(3)
AF532	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	SUC (2)	G (2)		G (2)		G (2)		G (2)		G (2)	
NFB585	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)				SOC (4)		G (4)		G (4)		G (4)	G (4)			G (4)
NFB610-30s																									
NFB610-70s																									
NFB660-40s																									
NFB660-120S																									
PerCP	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (2), SUC (1,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (2)	G(1)	G (1,2)	G (1,2,4)	G (2)	G (1,4)	G (2)	G (1,4)	G (2)	G (1,4)	G (1,2,4)	G(1)	G (2)	G (4)
NFB690																									
BB700	G (4)	G (4)	G (4)	G (4)	SOC (4)	SOC (4)	G (4)	G (4)	G (4)	G (4)	G (4)				G (4)		G (4)		UC (4)		UC (4)	G (4)			G (4)
PerCP-Cy5.5	G(1)	G(1)	G(1)	G(1)	SUC (1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)		G(1)	G(1)	G(1)		G(1)		G(1)		UC (1)	SOC (1)	G(1)		
PerCP-eF710	G (1,2)	G (1,2)	G (1,2)	G(1), SUC (2)	SUC (1), SOC (2)	G(1), SUC (2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	G (2)	G(1)	OC (2)	G(1)	UC (2)	UC (1)	OC (1,2)	G(1)	G (2)	
NFY570	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)	G (4)				SOC (4)		SUC (4)		G (4)		G (4)	G (4)			G (4)
AF561	G (1,2)	G (1,2)	G (1,2)	G(1)/ SUC (2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	SOC (1,2)	SOC (2)	SOC (2)	SUC (2)	SUC(1)	G (2)	G(1)	G (1,2)	G(1)	G (2)	
PE	G (1,2,4)	G (1,2,4)	SUC (1,2,4)	SUC (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	SOC (1,2,4)	G (1,2,4)	G (1,2,4)	G (1,2,4)	G (2)	G(1)	G (1,2)	UC (1,2,4)	OC (2)	OC (1,4)	SUC (2)	G (1,4)	G (2)	G (1,4)	G (1,2,4)	G(1)	G (2)	G (4)
NFY590																									
PE-Dazzle 594	G (1), SUC (4)	G (1,4)	G (1,4)	SUC (1,4)	SOC (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)	G (1,4)		G(1)	G(1)	G(1), SUC (4)		UC (1,4)		SOC (1,4)		G(1), SUC (4)	G(1,4)	G(1)		G (4)
PE-eF610	G (2)	SOC (2)	SUC (2)	SOC (2)	SUC (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	SOC (2)	UC (2)		SOC (2)		G (2)		G (2)		G (2)	
NFY610																									
AF594																									
NFY660	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	SUC (2)	G(1)	OC (2)	G(1)	SUC (2)	G(1)	G(1), SUC (2)	G(1)	G (2)	
PE-Cy5	SOC (1,2,4)	OC (1) SOC (2,4)	SOC (1), G (2,4)	SOC (1,2,4)	SUC (1), UC (2,4)	SUC (1,2,4)	SUC (1), SOC (2,4)	SOC (1,2,4)	G (1,2,4)	SOC (1,2,4)	SOC (1,2,4)	G (2)	SOC (1)	SOC (1,2)	G (2), UC (4), SUC (1)	G (2)	SUC(1), SOC (4)	SUC (2)	SOC (1), SUC (4)	UC (2)	SUC (1), OC (4)	SUC (4), SOC (1,2)	SUC (1)	SOC (2)	SOC (4)
NFY690																									
PE-Cy5.5																									
NFY700																									
PE-AF700	G (1,2)	G (1,2)	G (1,2)	G (1,2)	SUC (1), G (2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	G (2)	G(1)	G (2)	SUC (1)	SOC (2)	SOC (1)	G(1), SOC (2)	G(1)	SUC (2)	
NFY730																									
NFY755																									
PE-Cy7	G (1,2)	SOC (1,2)	G (1,2)	G (1,2)	SOC (1,2)	SUC (1,2)	G (1,2)	G (1,2)	G(1), SUC (2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	G (2)	G(1)	G (2)	G(1)	SOC (2)	SOC (1)	SUC (1), G (2)	SOC (1)	SOC (2)	
PE-Fire 810	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	G (2)	G(1)	G (2)	G(1)	SOC (2)	SOC (1)	SUC (1), G (2)	SOC (1)	SOC (2)	
APC	G (1,2)	G (1,2)	G (1,2)	G (1,2)	SOC (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	G (2)	G(1)	OC (2)	OC (1)	SUC (2)	SUC (1)	G (1,2)	G(1)	G (2)	
NFR660																									
AF647	G (1,2)	G (1,2)	G (1,2)	G (1), SUC (2)	SOC (1,2)	SOC (1,2)	SUC (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	SUC (2)	SUC (1)	OC (2)	OC (1)	SUC (2)	SUC (1)	SOC (1,2)	G(1)	G (2)	
NFR685																									
Spark NIR 685	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)	G(1)		G(1)	G(1)	G(1)		G(1)		OC (1)		G(1)	G(1)	G(1)		
AF660	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	G (2)	G (2)		G (2)		G (2)		G (2)		G (2)	
NFR700																									
APC-R700	G(1)	G(1)	G(1)	G(1)	G(1)	SOC (1)	G(1)	G(1)	G(1)	G(1)	G(1)		G(1)	G(1)	G(1)		G(1)		SUC (1)		G(1)	G(1)	G(1)		
NFR710																									
R718																									
AF700	G (2)	G (2)	G (2)	G (2)	SUC (2)	SOC (2)	SUC (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	G (2)	G (2)		SOC (2)		G (2)		OC (2)		SUC (2)	
NFR725																									
NFR755																									
APC-H7	G(1)	G(1)	G(1)	G(1)	G(1)	SUC (1)	G(1)	G(1)	G(1)	G(1)	G(1)		G(1)	G(1)	G(1)		G(1)		G(1)		SOC (1)	SUC (1)	SOC (1)		
APC-Fire750																									
APC-eF780	G (2)	G (2)	G (2)	G (2)	G (2)	SUC (2)	SOC (2)	G (2)	G (2)	G (2)	G (2)	G (2)		G (2)	G (2)	G (2)		G (2)		SOC (2)		SUC (2)		SOC (2)	
APC-Fire810	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (1,2)	G (2)	G(1)	G (1,2)	G (1,2)	G (2)	G(1)	G (2)	G(1)	G (2)	G(1)	G (1,2)	SOC (1)	SOC (2)	

CD4 Dye evaluated (down)	NFB510	BB515	AF488	FITC	NFB530	Spark Blue™ 550	NFB555	AF532	NFB585	NFB610-30s	NFB610-70s	NFB660-40s	NFB660-120S	PerCP	NFB690	BB700	PerCP-Cy5.5	PerCP-eF710	NFY570	AF561	PE	NFY590	PE-Dazzle 594	PE-eF610	NFY610	AF594	NFY660	PE-Cy5
BUV395		G (1,2)	G (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3,4)		G(3)		G(3)	G (1,2,4)	G(3)	G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			G (1, 2)	G (1, 2,4)
BUV496		G (1,2)	G (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3,4)		G(3)		G(3)	G (1,2,4)	G(3)	G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			G (1, 2)	G (1, 2,4)
BUV563		G (1,2)	G (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3,4)		G(3)		G(3)	G (1,2,4)	G(3)	G (4)	G(1)	G (1,2)	SOC (4)	SOC (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			G (1, 2)	G (1, 2,4)
BUV615		G (1,2)	SOC (4)	G (1,2)		G (1,4)	G(3)	G (2)	G(3), UC (4)		G(3)		G(3)	G (1,2), SUC (4)	G(3)	G (4)	G(1)	G (1,2)	SUC (4)	SOC (1,2)	SUC (1, 2), SOC (4)	G(3)	OC (1, 4)	OC (2)			SOC (1,2)	SUC (1, 2), SOC (4)
BUV661		G (1,2)	SUC (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3,4)		G(3)		G(3)	G (1,2), SUC (4)	G(3)	G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			G (1, 2)	G (1, 2), SOC (4)
BUV737		G (1,2)	G (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3, 4)		G(3)		G(3)	G (1,2,4)	G(3)	SOC (4)	UC (1)	OC (1), SOC (2)	G (4)	G (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			SUC (1) SOC (2)	G(1, 4), SUC (2)
BUV805		G (1,2)	G (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3, 4)		G(3)		G(3)	G (1,2,4)	G(3)	G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			G (1, 2)	G (1, 2,4)
BV421		G (1,2)	G (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3, 4)		G(3)		G(3)	G (1,2,4)	G(3)	G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			G (1, 2)	G (1, 2,4)
SB436		G (1,2)	G (4)	G (1,2)		G (1,4)		G (2)	G (4)					G (1,2,4)		G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)		G (1,4)	G (2)			G (1, 2)	G (1, 2,4)
eF450		G (1,2)	G (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3, 4)		G(3)		G(3)	G (1,2,4)	G(3)	G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			G (1, 2)	G (1, 2,4)
BV480		G (1,2)	G (4)	G (1,2)		G (1,4)		G (2)	G (4)					G (1,2,4)		G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)		G (1,4)	G (2)			G (1, 2)	G (1, 2,4)
eF506		OC (2)		SUC (2)			G(3)	SOC (2)	G(3)		G(3)		SOC (3)	G(2)	G(3)			G(2)		G(2)	G(2)	G(3)		G(2)			G(2)	G(2)
BV510		G(1)		G(1)		G(1)								G(1)			G(1)	G(1)		G(1)	G(1)		G(1)				G(1)	G(1)
Pacific Orange		G (1,2)		G (1,2)		G(1)		G(2)						G (1,2)			G(1)	G (1,2)		G (1,2)	G (1,2)		G(1)	G(2)			G (1, 2)	G (1, 2)
BV570		G (1,2)	G (4)	G (1,2)		G (1,4)		G(2)	G (4)					G (1,2,4)		G (4)	G(1)	G (1,2)	SOC (4)	G (1,2)	G (1,2,4)		G (1,4)	G(2)			G (1, 2)	G (1, 2,4)
Super Bright 600		G (2)		G (2)				G (2)						G (2)				G (2)		SOC (2)	SUC (2)			OC (2)			G (2)	G (2)
BV605		G(1)	G (4)	G(1)		G (1,4)	G(3)		G (3, 4)		G(3)		G(3)	G(1), SUC (4)	G(3)	G (4)	G(1)	G(1)	SOC (4)	SOC (1)	SUC (1), G (4)	G(3)	OC (1,4)				G(1)	SUC(1), SOC (4)
Super Bright 645		G (2)		G (2)				G (2)						G (2)				G (2)		G (2)	G (2)			G (2)			G (2)	G (2)
BV650		G(1)	SUC (4)	G(1)		SUC (1, 4)	G(3)		G (3, 4)		G(3)		G(3)	G (1,4)	G(3)	G (4)	G(1)	G(1)	G (4)	G(1)	G (1,4)	G(3)	G (1,4)				G(1)	G (1,4)
Super Bright 702		G (2)		G (2)				G (2)						G (2)				G (2)		G (2)	G (2)			G (2)			G (2)	G (2)
BV711		G(1)	G (4)	G(1)		G (1,4)	G(3)		G (3, 4)		G(3)		G(3)	G (1), SUC (4)	UC (3)	OC (4)	SUC (1)	SOC (1)	G (4)	G(1)	G (1,4)	G(3)	G (1,4)				G(1)	G (1,4)
BV750		G (1,2)	G (4)	G (1,2)		G (1,4)	G(3)	G (2)	G (3,4)		G(3)		G(3)	G (1,2,4)	G(3)	G (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2,4)	G(3)	G (1,4)	G (2)			G (1,2)	G (1,2,4)
BV785		G(1)		G(1)		G(1)								G(1)			G(1)	G(1)		G(1)	G(1)		G(1)				G(1)	G(1)
Super bright 780		G (2)		G (2)				G (2)						G (2)				G (2)		G (2)	G (2)			G (2)			G (2)	G (2)
BV786			G (4)			G (4)	G(3)		G (3,4)		G(3)		G(3)	G (4)	G(3)	G (4)			G (4)		G (4)	G(3)	G (4)					G (4)
NFB510	X	N/A																										
BB515	N/A	X		G (1,2)		G(1)	UC (3)	G (2)	G(3)		SUC (3)		G(3)	G (1,2)	SUC (3)		G(1)	G (1,2)		G (1,2)	G (1,2)	G(3)	G(1)	G (2)			G (1,2)	G (1,2)
AF488			X	N/A		OC (4)			UC (4)					SUC (4)		SOC (4)			SUC (4)		SOC (4)		SOC (4)					G (4)
FITC		OC (1,2)	N/A	X		G(1)		SUC (2)						G (1,2)			G(1)	G (1,2)		SOC (1,2)	SUC (1) G (2)		SUC (1)	G (2)			G (1,2)	G (1,2)
NFB530					X																							
Spark Blue™ 550		OC (1)	UC (4)	UC (1)		X			G (4)					G (1,4)		SUC (4)	SOC (1)	G(1)	G (4)	G(1)	G (1,4)		G (1,4)				G(1)	SUC (1,4)
NFB555		UC (3)					X		G(3)		G(3)		G(3)	G(3)	SUC (3)						G(3)	G(3)						G(3)
AF532		G (2)		G (2)				X						G (2)				G (2)		UC (2)	OC (2)			SOC (2)			G (2)	G (2)
NFB585			OC (4)			SUC (4)	G(3)		X		G(3)		G(3)	G (4)	SUC (3)	SOC (4)			OC (4)		UC (4)	G(3)	SUC (4)					SOC (4)
NFB610-30s										X																		
NFB610-70s							G(3)		G(3)		X		G(3)		G(3)							SOC (3)						
NFB660-40s												X																
NFB660-120S							G(3)		SUC (3)		SUC (3)		X		G(3)							G(3)						
PerCP		G (1,2)	SUC (4)	G (1,2)		G (1,4)	G(3)	G (2)	SOC (3), G (4)		G(3)		G(3)	X	G(3)	SOC (4)	G(1)	G (1,2)	G (4)	G (1,2)	G (1,2), SUC (4)	G(3)	G (1,4)	G (2)			G (1,2)	G (1,2,4)
NFB690							G(3)		G(3)		G(3)		G(3)		X							G(3)						
BB700			G (4)			G (4)			SUC (4)					SUC (4)		X			G (4)		G (4)		G (4)					SOC (4)
PerCP-Cy5.5		G(1)		G(1)		G(1)								G(1)			X	OC (1)		G(1)	G(1)		G(1)				G(1)	G(1)
PerCP-eF710		G (1,2)		G (1,2)		G(1)								OC (1), UC (2)			UC (1)	X		G(1), UC (2)	G(1), SOC (2)		G(1)	G (2)			SUC(1), OC (2)	G(1), UC (2)
NFY570			G (4)			SUC (4)			SUC (4)					G (4)		G (4)			X	N/A	UC (4)		SUC (4)					G (4)
AF561		G (1,2)		G (1,2)		G(1)								G (1,2)			G(1)	G (1,2)	N/A	X	UC (2)		UC (1)	G (2)			G (1,2)	G (1,2)
PE		G (1,2)	SUC (4)	G (1,2)		G(1), SUC (4)	G(3)	G (2)	G(3); SOC (4)		G(3)		G(3)	G (1,2,4)	G(3)	G (4)	G(1)	G (1,2)	OC (4)	OC (1,2)	X	SOC (3)	UC (1,4)	UC (2)			SUC(1,2)	SOC (1,2), SUC (4)
NFY590							G(3)		G(3)				G(3)		G(3)							X						
PE-Dazzle 594		SUC (4)	SOC (4)	SOC (4)		SUC (1), G (4)			SUC (4)					G (1,4)		G (4)	SOC (1)	SUC (1)	UC (4)	G(1)	UC (1), SOC (4)		X				G(1)	G (1,4)
PE-eF610		G (2)		G (2)				SUC (2)						SOC (2)				G (2)		OC (2)	UC (2)			X			OC (2)	UC (2)
NFY610																									X			
AF594							G(3)		G(3)		SUC (3)		G(3)		G(3)							SOC (3)				X		
NFY660		G (1,2)		G (1,2)		G(1)		G (2)						G (1,2)			G(1)	G(1), SOC (2)		OC (1,2)	G (1,2)		G(1)	G (2)			X	UC (1,2)
PE-Cy5		SUC (1) SOC (2)	OC (4)	SOC (1), SUC (2)		SUC (1), OC (4)	G(3)	SOC (2)	G(3), UC (4)		G(3)		G(3)	OC (1,2,4)	SUC (3)	UC (4)	OC (1)	UC (1), SOC (2)	UC (4)	SUC (1,2)	OC (4), SOC (1,2)	G(3)	UC (1), OC (4)	UC (2)			OC (1,2)	X
NFY690																												
PE-Cy5.5																												
NFY700																												
PE-AF700		G (1,2)		G (1,2)		G(1)		G (2)						SOC (1,2)			SUC (1)	G(1), UC (2)		G (1,2)	SUC (1,2)		G(1)	G (2)			SUC (1), G (2)	SOC (1), G (2)
NFY730							G(3)		G(3)		G(3)		G(3)		G(3)							G(3)						
NFY755							G(3)		G(3)		G(3)		G(3)		G(3)							G(3)						
PE-Cy7		G (1,2)		G (1,2)		G(1)		G (2)						UC (1) SUC (2)			SOC (1)	SUC (1), G (2)		G (1,2)	SUC (1,2)		G(1)	G (2)			SUC (1,2)	SOC (1,2)
PE-Fire 810		G (1,2)		G (1,2)		G(1)	G(3)	G (2)	G(3)		G(3)		G(3)	G (1,2)	G(3)		OC (1)	UC (1), SUC (2)		SOC (1,2)	G(1), SOC (2)	G(3)	G(1)	G (2)			SUC (1,2)	G(1), SOC (2)
APC		G (1,2)		G (1,2)		G(1)	G(3)	G (2)	SOC (3)		G(3)		G(3)	G (1,2)	G(3)		G(1)	G (1,2)		SUC (1,2)	G (1,2)	G(3)	G(1)	G (2)			OC (1,2)	UC (1,2)
NFR660																												
AF647		G (1,2)		G (1,2)		G(1)		G (2)						G (1,2)			G(1)	G (1,2)		G (1,2)	G (1,2)		G(1)	G (2)			OC (1,2)	UC (1,2)
NFR685																												
Spark NIR 685		G(1)		G(1)		G(1)								G(1)			G(1)	G(1)		G(1)	G(1)		G(1)				SOC (1)	G(1)
AF660		G (2)		G (2)				G (2)						G (2)				G (2)		G (2)	G (2)			G (2)			SUC (2)	G (2)
NFR700																												
APC-R700		G(1)		G(1)		G(1)								G(1)			G(1)	G(1)		G(1)	G(1)		G(1)				G(1)	G(1)
NFR710																												
R718																												
AF700		G (2)		G (2)				G (2)						G (2)				UC (2)		G (2)	G (2)			G (2)			G (2)	G (2)
NFR725							G(3)		G(3)		G(3)		G(3)		G(3)							G(3)						
NFR755							G(3)		G(3)		G(3)		G(3)		G(3)							G(3)						
APC-H7		G(1)		G(1)		G(1)								G(1)			G(1)	G(1)		G(1)	G(1)		G(1)				G(1)	G(1)
APC-Fire750																												
APC-eF780		G (2)		G (2)			G(3)	G (2)	G(3)		G(3)		G(3)	G (2)	G(3)			G (2)		G (2)	G (2)	G(3)		G (2)			G (2)	G (2)
APC-Fire810		G (1,2)		G (1,2)		G(1)	G(3)	G (2)	G(3)		G(3)		G(3)	G (1,2)	G(3)		G(1)	G(1), SUC (2)		G (1,2)	G (1,2)	G(3)	G(1)	G (2)			G (1,2)	G (1,2)

CD4 Dye evaluated (down)	NFY690	PE-Cy5.5	NFY700	PE-AF700	NFY730	NFY755	PE-Cy7	PE-Fire 810	APC	NFR660	AF647	NFR685	Spark NIR 685	AF660	NFR700	APC-R700	NFR710	R718	AF700	NFR725	NFR755	APC-H7	APC-Fire750	APC-eF780	APC-Fire810
BUV395		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
BUV496		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
BUV563		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
BUV615		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		SUC (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
BUV661		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	SOC (1,2), OC (4)		G (1, 2, 4)		G(1), SOC (2)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
BUV737		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2), SOC (4)		SUC (1, 4)	SUC (2)		OC (1)		OC (4)	OC (2)			OC (1)	G (4)	OC (2)	G (1,2,4)
BUV805		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			SOC (1)	SOC (4)	SOC (2)	SOC (1,2,4)
BV421		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
SB436		G (4)		G (1, 2)			G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
eF450		G (4)		G (1, 2)	G(3)		G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
BV480		G (4)		G (1, 2)			G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
eF506				G (2)	G(3)		G (2)	G (2)	G (2)		G (2)			G (2)					G (2)					G (2)	G (2)
BV510				G(1)			G(1)	G(1)	G(1)		G(1)		G(1)			G(1)						G(1)			G(1)
Pacific Orange				G (1, 2)			G (1, 2)	G (1, 2)	G (1, 2)		G (1, 2)		G(1)	G (2)		G(1)			G (2)			G(1)		G (2)	G (1,2)
BV570		G (4)		G (1, 2)			G (1, 2, 4)	G (1, 2, 4)	G (1, 2, 4)		G (1, 2, 4)		G (1, 4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
Super Bright 600				G (2)			G (2)	G (2)	G (2)		G (2)			G (2)					G (2)					G (2)	G (2)
BV605		G (4)		G(1)	G(3)		G (1,4)	G (1,4)	G (1,4)		G (1,4)		G (1, 4)			G(1)		G (4)				G(1)	G (4)		G (1,4)
Super Bright 645				G (2)			G (2)	G (2)	SOC (2)		G (2)			G (2)					G (2)					G (2)	G (2)
BV650		G (4)		G(1)	G(3)		G (1,4)	G (1,4)	SOC (1, 4)		G (1,4)		G (1, 4)			G(1)		G (4)				G(1)	G (4)		G (1,4)
Super Bright 702				SUC (2)			G (2)	G (2)	G (2)		G (2)			OC (2)					OC (2)					G (2)	G (2)
BV711		SOC (4)		UC (1)	SUC (3)		G (1,4)	G (1,4)	G (1,4)		G (1,4)		G (1), SOC (4)			OC (1)		OC (4)				SOC (1)	G (4)		G (1,4)
BV750		G (4)		G (1,2)	G(3)		G (1,2,4)	G (1,2,4)	G (1,2,4)		G (1, 2, 4)		G (1,4)	G (2)		G(1)		SOC (4)	SOC (2)			OC (1)	OC (4)	OC (2)	SUC (1,2,4)
BV785				G(1)			G(1)	G(1)	G(1)		G(1)		G(1)			G(1)						OC (1)			SUC (1)
Super bright 780				G (2)			G (2)	G (2)	G (2)		G (2)			G (2)					G (2)					SOC (2)	G (2)
BV786		G (4)			G(3)		G (4)	G (4)	G (4)		G (4)		G (4)					G (4)					OC (4)		G (4)
NFB510																									
BB515				G (1,2)	G(3)		G (1,2)	G (1,2)	G (1,2)		G (1,2)		G(1)	G (2)		G(1)			G (2)			G(1)		G (2)	G (1,2)
AF488		G (4)					G (4)	G (4)	SUC (4)		SOC (4)		SUC (4)					G (4)					G (4)		G (4)
FITC				G (1,2)			G (1,2)	G (1,2)	G (1,2)		G (1,2)		G(1)	G (2)		G(1)			G (2)			G(1)		G (2)	G (1,2)
NFB530																									
Spark Blue™ 550		G (4)		SOC (1)			G (1,4)	G (1,4)	G (1,4)		G (1,4)		G(1), SOC (4)			G(1)		G (4)				G(1)	G (4)		G (1,4)
NFB555					G(3)																				
AF532				G (2)			G (2)	G (2)	G (2)		G (2)			G (2)					G (2)					G (2)	G (2)
NFB585		G (4)			G(3)		G (4)	G (4)	SUC (4)		G (4)		SUC (4)					G (4)					G (4)		G (4)
NFB610-30s																									
NFB610-70s					G(3)																				
NFB660-40s																									
NFB660-120S					G(3)																				
PerCP		G (4)		G (1,2)	SOC (3)		G (1,2,4)	G (1,2,4)	G (1,2,4)		G (1,2,4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
NFB690					G(3)																				
BB700		OC (4)					G (4)	G (4)	G (4)		G (4)		OC (4)					OC (4)					G (4)		SUC (4)
PerCP-Cy5.5				UC (1)			SOC (1)	G(1)	OC (1)		SUC (1)		OC (1)			OC (1)						SOC (1)			G(1)
PerCP-eF710				UC (1,2)			SOC (1), G(2)	G (1,2)	G(1), UC (2)		G(1), SOC (2)		G(1)	G (2)		OC (1)			OC (2)			SOC (1)		SOC (2)	SOC (1,2)
NFY570		G (4)					G (4)	G (4)	G (4)		G (4)		G (4)					G (4)					G (4)		G (4)
AF561				G (1,2)			G (1,2)	G (1,2)	G (1,2)		G(1), SUC (2)		G(1)	G (2)		G(1)			G (2)			G(1)		G (2)	G (1,2)
PE		SOC (4)		G (1,2)	G(3)		G (1,2,4)	G (1,2,4)	G (1,2,4)		SOC (1,2,4)		G (1,4)	G (2)		G(1)		G (4)	G (2)			G(1)	G (4)	G (2)	G (1,2,4)
NFY590					UC (3)																				
PE-Dazzle 594		G (4)		G(1)			G (1,4)	G (1,4)	G(1), SUC (4)		SOC (1,4)		SUC (1,4)			G(1)		G (4)				G(1)	G (4)		G (1,4)
PE-eF610				G (2)			G (2)	G (2)	G (2)		SUC (2)			G (2)					G (2)					G (2)	G (2)
NFY610																									
AF594					SUC (3)																				
NFY660				G(1), SOC (2)			G (1,2)	G (1,2)	OC (1) SOC (2)		G(1), SUC (2)		G(1)	SUC (2)		G(1)			SOC (2)			G(1)		G (2)	G (1,2)
PE-Cy5		OC (4)		SOC (1,2)	G(3)		SUC (4), SOC (1,2)	G (1,2,4)	UC (1), SOC (2,4)		OC (1), UC (2), SOC (4)		UC (1), OC (4)	OC (2)		OC (1)		SUC (4)	UC (2)			SOC (1)	SOC (4)	SOC (2)	G (1,2,4)
NFY690	X																								
PE-Cy5.5		X																							
NFY700			X																						
PE-AF700				X			SOC (1,2)	G (1,2)	SOC (1), SUC (2)		G(1), OC (2)		G(1)	UC (2)		OC (1)			OC (2)			SOC (1)		G (2)	G (1,2)
NFY730					X																				
NFY755					G(3)	X																			
PE-Cy7				G (1,2)			X	OC (1,2)	SUC (1), SOC (2)		SOC (1), SUC (2)		UC (1)	SOC (2)		SOC (1)			SUC (2)			OC (1)		OC (2)	G(1)
PE-Fire 810				SOC (1,2)	G(3)		G (1,2)	X	G (1,2)		G (1,2)		G(1)	G (2)		G(1)			G (2)			G(1)		G (2)	SOC (1,2)
APC				G (1,2)	G(3)		G (1,2)	G (1,2)	X		UC (1,2)		G(1)	G (2)		SOC (1)			SOC (2)			G(1)		G (2)	G (1,2)
NFR660										X															
AF647				SOC (1), G(2)			G(1)	G(1)	UC (1,2)		X		OC (1)	OC (2)		G(1)			G (2)			G(1)		G (2)	G(1)
NFR685												X	N/A												
Spark NIR 685				G(1)			G(1)	G(1)	UC (1)		OC (1)	N/A	X			OC (1)						SOC (1)			G(1)
AF660				SOC (2)			G (2)	G (2)	SOC (2)		UC (2)			X					OC (2)					G (2)	G (2)
NFR700															X										
APC-R700				SOC (1)			G(1)	G(1)	SUC (1)		OC (1)		UC (1)			X						SOC (1)			G(1)
NFR710																	X								
R718																		X							
AF700				OC (2)			G (2)	G (2)	UC (2)		OC (2)			UC (2)					X					SOC (2)	SUC (2)
NFR725					G(3)															X					
NFR755					G(3)																X				
APC-H7				G(1)			SOC (1)	G(1)	SUC (1)		SOC (1)		G(1)			G(1)						X	N/A	N/A	OC (1)
APC-Fire750																						N/A	X	N/A	
APC-eF780				G (2)	G(3)		SOC (2)	G (2)	UC (2)		SUC (2)			G (2)					UC (2)			N/A	N/A	X	OC (2)
APC-Fire810				G (1,2)	G(3)		G (1,2)	SOC (1,2)	SOC (1,2)		G (1,2)		G(1)	G (2)		G(1)			G (2)			SUC (1)		SUC (2)	X

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