

Expert Declaration of David Schaafsma

UNITED STATES PATENT AND TRADEMARK OFFICE

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**BEFORE THE PATENT TRIAL AND APPEAL BOARD**

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CYTEK BIOSCIENCES, INC.,  
Petitioner,

v.

BECKMAN COULTER, INC.,  
Patent Owner.

U.S. Patent No. 12,174,106

Case No. PGR2025-00084

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**EXPERT DECLARATION OF DAVID SCHAAFSMA**

CYTEK V. BECKMAN  
PGR2025-00084  
BECKMAN 2028

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## Expert Declaration of David Schaafsma

I, David Schaafsma, declare as follows:

### **I. INTRODUCTION AND BACKGROUND**

1. My name is David Schaafsma. I am the President of California Optical Engineering, Inc.

2. I have been retained by counsel for Plaintiff Beckman Coulter, Inc. (“Patent Owner” or “Beckman Coulter”) as an expert in *Cytek Biosciences, Inc. v. Beckman Coulter, Inc.*, No. PGR2025-00084, challenging claims 1, 2, 10, 11, 13, 14, and 17 of U.S. Patent No. 12,174,106 (the “’106 patent”).

#### **A. Qualifications And Professional Experience**

3. My qualifications are stated more fully in my curriculum vitae, which is attached as Appendix A. Below is a summary of my education, work experience, and other qualifications.

4. I have over thirty years of industry experience in optics. I am currently President and Principal at California Optical Engineering, Inc. which provides technology and product development consulting services primarily in the medical and industrial fields. The company specializes in software and hardware development for medical devices, communications systems, and sensing. Over the last 35 years, I have built a wide range of optical systems for research and product development, including free-space, fiber optic, and integrated optic systems for sensing and diagnostics. In the early 1990s, I built a confocal fluorescence

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microscope with very low noise and high spatial resolution which I used to study quantum effects in semiconductor structures. In the mid-1990s, I built the optical train for a near-field scanning optical microscope, used in conjunction with a free-electron laser to study the surface morphology of diamond films. I have designed, built, and tested numerous microscope and endoscope systems, as well as many fluorescence measurement systems including very low light level systems, for a wide array of applications.

5. I was an adjunct professor of applied physics at California State University, San Marcos from 2006 to 2022. I taught physics, electronics and optics courses, which I developed as new curriculum. I also mentored several undergraduate projects in the areas of lasers and optics. I taught courses and mentored projects in the area of embedded systems, including courses dealing with programming microcontrollers at a low level (e.g. in C or Assembly) and logic design in VHDL and schematic mode for field-programmable gate arrays (FPGAs). I have also used these embedded systems skills in numerous product development efforts.

6. I have a bachelor of arts in physics from Whitman College, a master of science in physics from Brown University, and a doctorate in physics from the University of Colorado, Boulder.

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7. I am a named inventor on two patents and have been a listed author on over thirty papers. I was for many years also an Executive Editor of *Fiber & Integrated Optics*, a peer-reviewed bi-monthly technical journal.

### **B. Compensation**

8. I am being compensated for my time at my ordinary hourly rate of \$675, which includes a fee paid to WIT Legal LLC for administrative services provided in connection with my retention in this matter. My compensation is not dependent on the outcome of these proceedings or the content of my opinions. To the best of my knowledge, I have no financial interest in either party or in the outcome of this proceeding.

### **C. Bases of Opinions**

9. In forming my opinions set forth in this Declaration, I have considered and relied on my education and experience in the fields of optics, engineering, medical devices, communications, and instrument development. I have also relied on the materials cited in this Declaration, the materials cited in the Petition for Post-Grant Review, and the material cited in the Patent Owner's Request for Discretionary Denial, and listed in **Appendix B**.

## **II. LEGAL PRINCIPLES**

10. The opinions I express in this Declaration involve the application of my technical knowledge and professional experience to the evaluation of certain art with

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respect to the '106 patent. Since I am not an attorney, I have applied the following legal principles explained to me by Patent Owners' legal counsel ("counsel").

### **A. Claim Construction**

11. For the purposes of this Declaration, I understand that certain principles of law are relevant to my analysis and opinions. For example, I understand that before a validity determination can be made, the claims must be construed by the Board.

12. I understand that in a Post-Grant Review, the Board construes claim terms in light of the specification of the patent in which they appear. I further understand that a claim construction analysis begins with the ordinary meaning of the disputed claim term, and there is a presumption that claim terms carry their accustomed meaning among a person of ordinary skill in the art ("POSA"). I have also been informed that the ordinary and customary meaning of a claim term may be determined by reviewing a variety of sources, including the claims themselves, the specification (or "written description") of a patent, its prosecution history, and dictionaries and treatises.

13. I understand that the patent specification is the single best guide to the meaning of a disputed term. I understand that the intrinsic evidence, namely the patent specification and the prosecution history, may clarify whether the patentee intended a claim term to have a meaning that is different than its ordinary and

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customary meaning, or clearly disavowed the ordinary meaning in favor of some special meaning. The specification may include a special definition given to a claim term by the patentee that differs from its ordinary meaning. In such cases, the inventor's lexicography governs.

14. I further understand that a patent is a fully integrated written instrument, and a skilled artisan is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification. Accordingly, it is my understanding that the specification is always highly relevant to the claim construction analysis and is the single best guide to the meaning of a disputed term.

15. I understand that extrinsic evidence, which includes expert and inventor testimony, dictionaries, and learned treatises, may also be considered during the claim construction process. However, extrinsic evidence is given less weight than the intrinsic record in determining the meaning of disputed claim terms. I understand that dictionary definitions may reflect or establish the plain and ordinary meaning of claim terms; however, when construing claim terms, reference should also be made to the intrinsic record to determine which dictionary definition(s) are most appropriate in light of the use of the claim terms by the inventor.

**B. Claim Differentiation**

16. I understand that the doctrine of claim differentiation is a principle that can be used in claim interpretation. It suggests that each claim in a patent is presumed to have a different scope, so dependent claims should not be interpreted to make independent claims redundant.

**C. Priority**

17. I have been informed and understand that patent applicants can claim the benefit of priority to the filing date of an earlier application if (a) the earlier application names one or more inventors in common with the later filed application, and (b) the earlier application discloses the invention claimed in the later application in a manner that satisfies the enablement and written description requirements.

**D. Obviousness**

18. I have been informed that a patent claim is unpatentable under 35 U.S.C. § 103 as obvious if the subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the invention was made. I understand that the obviousness analysis involves several factual inquiries: (1) the scope and content of the prior art; (2) the differences between the prior art and the claimed invention; (3) the level of ordinary skill in the art at the time of the invention; and (4) the existence of objective indicia of non-obviousness (“objective indicia”), such as a long-felt but unresolved need, the failure of others, unexpected results and

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commercial success. I understand that for objective indicia to be given weight, there must be a nexus between the evidence and the merits of the claimed invention.

19. I understand that a petitioner in Post-Grant Review bears the burden for showing the obviousness of the claimed invention. My understanding is that obviousness is not proven by mere conclusory statements or conclusory expert testimony. Instead, I understand there must be some articulated reasoning with rational underpinning to satisfy the legal standard of obviousness. I understand that, for a claim to have been obvious, there must have been some reason or motivation for a POSA to modify or combine the teachings of the prior art references to achieve the claimed invention, and the POSA must have had a reasonable expectation of success in doing so in view of the prior art. I have also been informed that it is improper to rely on hindsight reasoning or ex post reasoning in the obviousness analysis.

20. I understand that prior art references must qualify as “analogous art” to be considered in an obviousness analysis. I understand that, to be analogous art, the reference must (1) be from the same field of endeavor as the challenged claims; or (2) be reasonably pertinent to the particular problem with which the inventor is involved. I understand that a reference is reasonably pertinent if it, as a result of its subject matter, logically would have commended itself to an inventor’s attention in considering his problem.

**E. Written Description**

21. I have been informed that a patent is presumed to be sufficiently described under 35 U.S.C. § 112 unless a challenger proves that a person of ordinary skill in the art, after reading the specification and claims, would not be able to make and use the full scope of the invention without undue experimentation. I understand that the written description requirement may be satisfied by any combination of the words, structures, figures, diagrams, formulas, etc., contained in the patent application.

22. I understand that the full scope of a claim or any particular requirement in a claim need not be expressly disclosed in the patent application if it is well-known by a person of ordinary skill in the art at the time of the invention.

**III. LEVEL OF ORDINARY SKILL IN THE ART**

23. The analysis I provide in this Declaration is from the perspective of a person of ordinary skill in the art of the '106 patent at the time of invention. I have been asked to assume a priority date for the claimed inventions of the '106 patent of May 30, 2012, the date of the earliest provisional applications to which the '106 patent claims priority. EX1001 at (60).

24. Petitioner's expert, Dr. Fedor Ilkov, opines that a person of ordinary skill in the art ("POSA") would have had, as of December 2011, "at least a B.S. in physics, mechanical engineering, electrical engineering, or optical engineering (or

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equivalent degree) and at least two years of experience in designing optical and electro-optical systems, including for flow cytometer applications. A person could also have qualified as a POSA with a combination of (1) more formal education (such as a doctoral degree) and less technical experience, or (2) less formal educational and more technical or professional experience.” Pet. at 14; EX1002, ¶14. I qualify (and have qualified since before the priority dates of the patents) as a person having at least ordinary skill in the art under this definition by virtue of my education and experience in life sciences applications for optics. *See* Section I.

25. For purposes of this Declaration, I do not currently dispute Petitioner’s proposed definition of a POSA.

## **IV. OVERVIEW OF THE RELEVANT TECHNOLOGY**

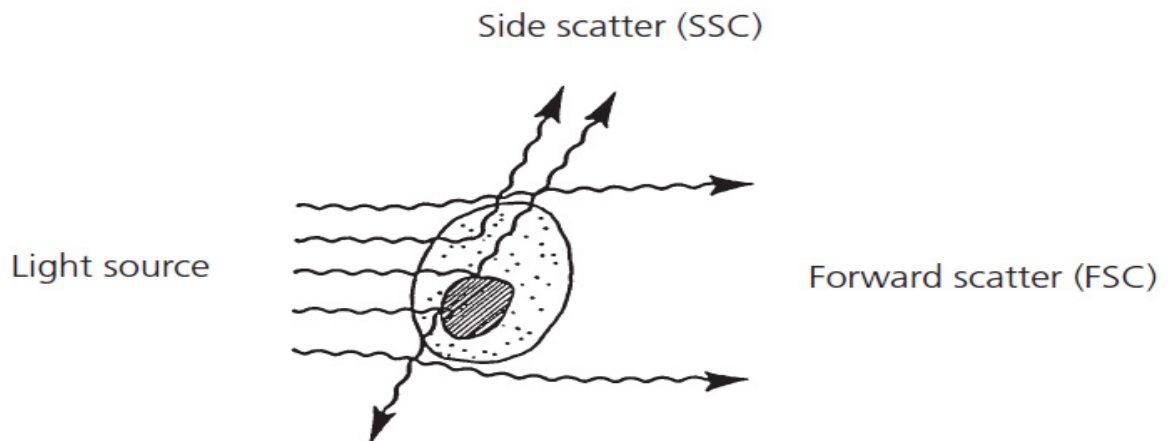
### **A. Basics of Flow Cytometers**

26. In a flow cytometer, cells move in a line through a flow channel where they are illuminated by light, typically from a laser from a direction essentially perpendicular to the direction of flow. EX1004 at 10, 17. Laser light incident on the cell scatters in multiple directions. *Id.* at 19-20; EX2023 at 100-01. Flow cytometers collect and analyze this light to measure multiple parameters of the cells, including “physical and/or chemical characteristics,” and they can perform this analysis on thousands of cells per second. EX1001 at 1:46-52. Flow cytometry has a number of

use-cases in research and medicine, including cell counting, cell sorting, rare cell detection, diagnostics, cancer therapy, and genetics. *Id.*; EX1004 at 10.

### 1. Scattered Light Detection

27. After the laser light incident on the cell scatters, flow cytometers typically measure this light scattered from two directions: forward (along the direction of the laser beam) and around 90 degrees to the side of the laser beam's direction (side scatter), shown below.



EX2023 at 100. Forward-scattered light provides information on the size of a cell: generally, larger cells produce wider scattering (often a longer interruption of the beam). The change in forward scattered intensity as a cell passes through the beam and scatters can also be used to count cells. This forward scattered light is also typically stronger in signal than side scattered light, and the component that detects this forward scattered light is called a forward scatter detector, or FSC. *Id.*

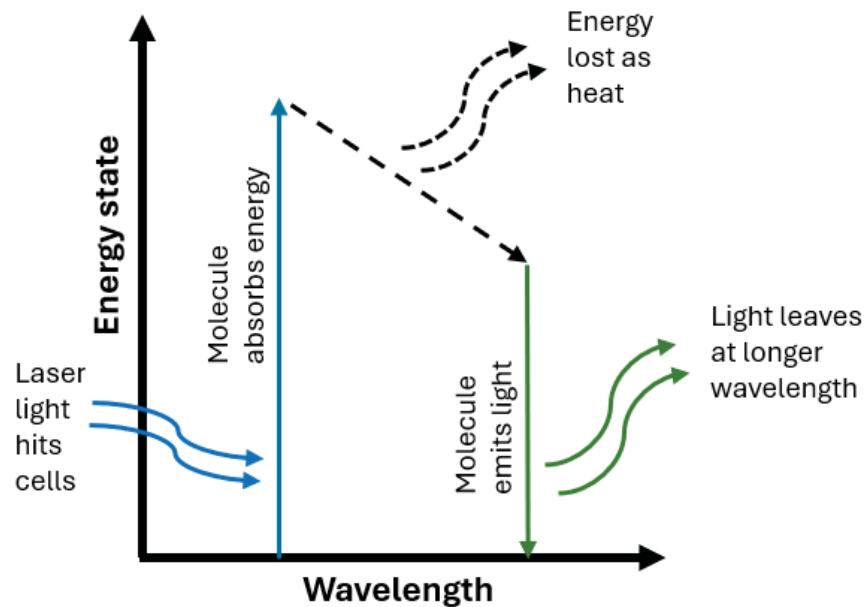
28. Side scattered light is used to measure and identify cells by their shape and internal structure, and is both weaker and physically more spread out in all directions than forward scattered light. *See id.* To capture as much of this scattered light as possible, flow cytometers typically use optical components having large openings (termed “apertures”) to collect light. EX1004 at 19-20. The amount of light an optical components collects can be quantified by its **étendue**, which is defined as the product of source size and angle (to the source) subtended by the collection optic. Thus, a large diameter source whose light is captured over a smaller angle can have the same étendue as a small diameter source captured over a larger angle. Étendue can also be thought of as the throughput (amount of light passed) of an optical component in a given configuration, and the overall optical system is limited by the throughput of its smallest component. Thus, to collect scattered light produced by cells in a flow cytometer, it is highly desirable for a flow cytometer’s optical systems to have a large étendue to collect scattered light. EX1001 at 45:10-23.

29. Side scatter signals are typically orders of magnitude lower than forward scatter signals, *see* EX1004 at 23-24, and fluorescent signals, discussed more below, are orders of magnitude below side scatter.

## 2. Fluorescence Detection

30. In addition to detecting and assessing forward and side scattered light, some flow cytometers also detect fluorescent light to assess additional properties of the cells. EX1004 at 10; EX1007 at 33.

31. When measuring fluorescence in flow cytometry, the most common strategy is to label cells with molecules called fluorophores, *id.*, though some cells fluoresce on their own. Fluorophores are typically attached to antibodies specific for certain cell surface proteins that a researcher wants to detect. *Id.* Atoms or molecules in these fluorophores absorb light at specific wavelengths, at which point they become “excited” and momentarily move to a higher energy level. When these atoms or molecules fall back to their original state, they can emit light of a lower energy (i.e., longer wavelength) than the light they initially absorbed, as I depict below (adapted from EX1007 at 103):



This emitted light, which varies in wavelength<sup>1</sup> depending on the fluorophore, and thus is indicative of a certain type of cell, is then analyzed by the flow cytometer using detectors.

32. Fluorescent light from tagged cells is often collected in the same direction as the side scattered light, but it is much weaker than either forward or side scatter. *See EX1004 at 23-24.*

33. As noted previously, the side scatter and fluorescent signals are very weak, so the first job of the optical system is to collect as much of the light as

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<sup>1</sup> Fluorophores used in flow cytometry emit various wavelengths across the visible spectrum. EX1007 at 68; EX1001 at 57:64-66.

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possible, typically using objective lenses or similar optics with high numerical aperture (meaning in this case, high étendue).

34. Flow cytometers such as those described in EX1005 (Oostman) used optical fibers (typically with large core diameters and correspondingly high numerical apertures), to transmit light toward a detection system that could separate wavelengths into different bands. *See, e.g.*, EX1007 at 148-49 (discussing how “[l]ight collection is limited by the N.A. of the fiber or waveguide” and discussing numerical apertures above 0.4).

35. Even with large étendue, the side scattered light is still very weak and the fluorescence even weaker. It is insufficient just to collect the emitted light over a very large angle, so detectors designed to amplify these weak signals with minimal degradation of signal-to-noise ratio—historically photomultiplier tubes (PMTs)—have been used in flow cytometers. EX1004, 23-24.

### **B. Basics of Optical Communications Detection**

36. Optical communications refers to the transmission of information—such as with internet traffic and voice or video communication—via optical fibers using light as the carrier signal. EX2036 at 1073. Certain telecommunications systems increase data transmission capacity by encoding different signals in different wavelengths of light, e.g., with wavelength division multiplexing (WDM). EX2036 at 1104-05; EX2039 at 50-51. This involves combining (or multiplexing)

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light from multiple lasers at various wavelengths into one narrow light beam at the signal source and transmitting the combined/multiplexed light signals through an optical fiber. EX2036 at 1104-05. Then at each destination, a device separates out (or demultiplexes) the light signals from those lasers according to wavelength. *Id.* This technique is typically designed to operate at infrared wavelengths ranging from around 1300 to 1600 nm. As of the '106 patent's priority date, the International Telecommunication Union (ITU) had two standard forms for WDM applications: Coarse WDM (CWDM), which separate wavelengths 20 nm apart, and Dense WDM (DWDM), which separates wavelengths at spacings less than 1 nm apart. EX2032 at 3; EX2033 at 4-5.

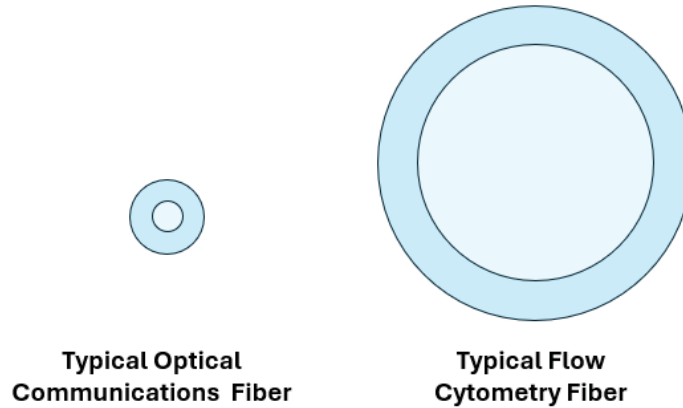
### **C. Flow Cytometry Fluorescence Detection and Optical Communications Signal Detection Have Multiple Key Differences**

37. The light transmitted and received in an optical communications system is notably different than that in flow cytometry: the former involves light in a small range of wavelengths that is typically transmitted directly from a laser into a fiber, often with some configuration of coupling optics. *See* EX2035 at 850, 861. The latter involves light scattered off cells and collected, resulting in a wide cone (i.e., high étendue) of weak light, as I discussed above in Section IV.A and incorporate here. Particularly, the fluorescent light comes from molecules attached to cells, being emitted in all directions relative to the cell and will vary based on different sets of fluorescent tags used. A collection optic can only gather a fraction of this, typically

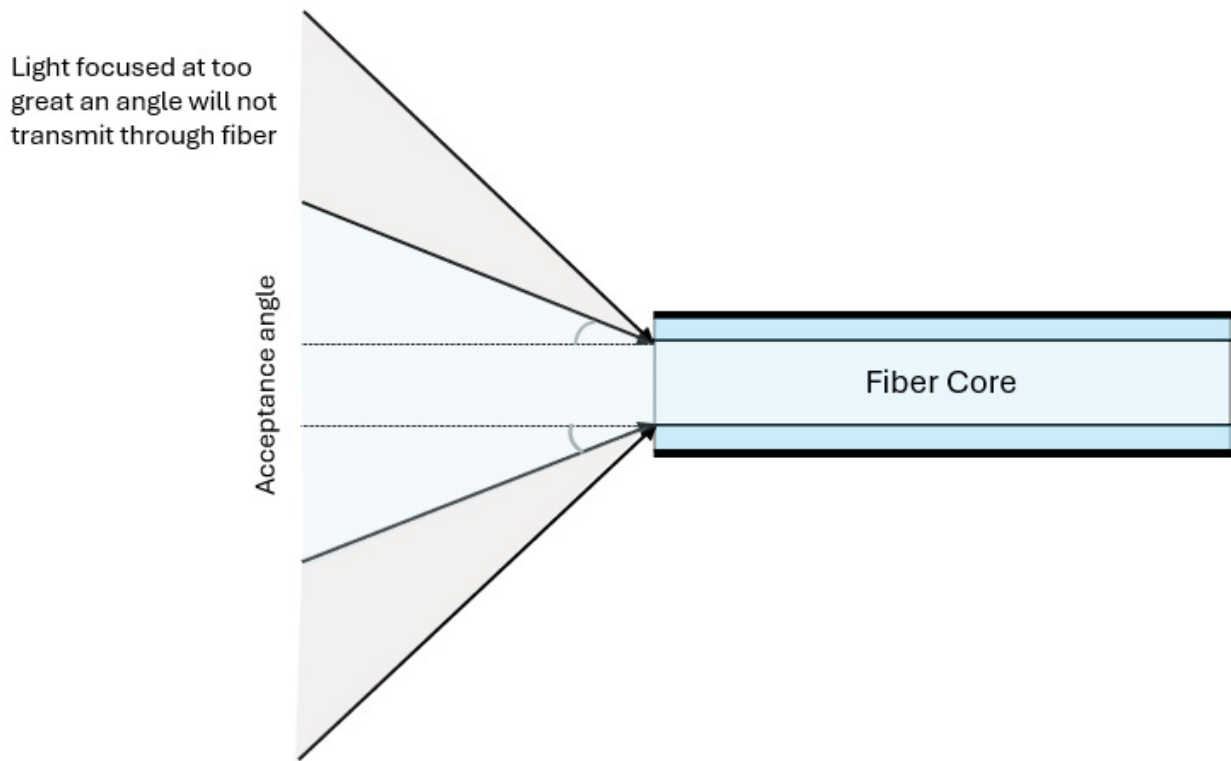
over a wide cone of weak light (i.e., high étendue). By contrast, in wavelength-multiplexed optical communications, each wavelength band is typically narrow, predefined, and has “blank wavelength space” between it and the next wavelength band. These fundamental differences are reflected in various design differences between optical communications systems and flow cytometry fluorescence detection systems.

### 1. Different Optical Fibers

38. Flow cytometers most commonly use optical fibers with significantly greater core diameters than those used in optical communications systems. *See, e.g.*, EX1007 at 148-49; EX2036 at 1076. For example, optical communications systems typically use fibers with core diameters ranging from less than 10 microns to around 50 or 62.5 microns. EX2035 at 851-53; EX2036 at 1076. In contrast, flow cytometers, as I discuss above, collect a wide cone of light scattered from cells, and as a result typically use optical fibers with large numerical apertures and correspondingly having core diameters at least *ten times larger* than those in optical communications. *See* EX1007 at 148-49 (discussing how “[l]ight collection is limited by the N.A. of the fiber or waveguide” and discussing numerical apertures above 0.4). I illustrate this difference below:



39. As the above figure indicates, fibers from optical communications typically cannot be switched at will with flow cytometry fluorescent detection optical fibers and vice versa. Since optical fibers will only guide light that enters the fiber at angles below the “acceptance angle” (the numerical aperture of the fiber), light that is focused at high angles will result in losses due to rejection from the fiber. Thus, light must be focused within the acceptance angle of the fiber, as I illustrate in the following figure (adapted from EX2036 at 16):



*See also* EX2037 at 282-83; EX2038 at 135-36.

40. The larger size of the fiber thus means that collected light (over a large angle) does not need to be focused to a very small spot, (historically a technical difficulty). Likewise, the large NA of the fiber means that light can be focused into it over a large angle without being rejected. Thus, the large core fiber more closely matches the designed étendue of the cytometry system and does not impose a smaller throughput limitation on it (as a communications fiber would). As I note above in paragraph 34, larger core fibers are very commonly used in most fluorescence and low-light applications, and were available from commercial vendors.

## 2. Different Detectors

41. Semiconductor detectors are photodetectors that detect light using semiconductor materials to convert the light into an electrical signal. *See* EX2039 at 157-60. Light hits the semiconductor material, and photons are absorbed and the semiconductor material creates a current or voltage that is proportional to the light intensity. *Id.* The output signal is then measured. *Id.*

42. Optical communication devices “almost exclusively” use diodes, either photodiodes or avalanche photodiodes (APDs) depending on the application. EX2039 at 173. Both photodiodes and APDs are types of semiconductor detectors that “provide very good responsivity in the wavelengths used in fiber optics,” meaning the communications wavelengths from 1.3-1.6  $\mu\text{m}$ . EX2039 at 173. The primary difference between these two detectors is that APDs have internal current gain. This feature is captured in what is termed the “responsivity” of the device, measured in Amps/Watt. This is effectively a measure of how many electrons result from the device when a photon hits it; a PIN diode might have a responsivity between 0.5 and 1 A/W, whereas APDs often have responsivities of 10,000 A/W or more. However, any solid-state device can only source a finite amount of current. So, while the APD generates more current per photon, it also has a lower upper bound on the number of photons it can detect (before it saturates). *See, e.g.,* EX2039 at 164; *see also* EX1001 at 44:9-33; EX1007 at 155.

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43. In contrast to optical communications systems, before the '106 patent, flow cytometers historically used PMTs for fluorescence detection along with side scatter, and photodiodes for measuring the comparatively stronger forward scattered light. PMTs are not semiconductor detectors. PMTs use the “photoelectric effect,” where photons strike a photocathode releasing electrons, which are then multiplied inside a vacuum tube to create a larger electron current (per incident photon).

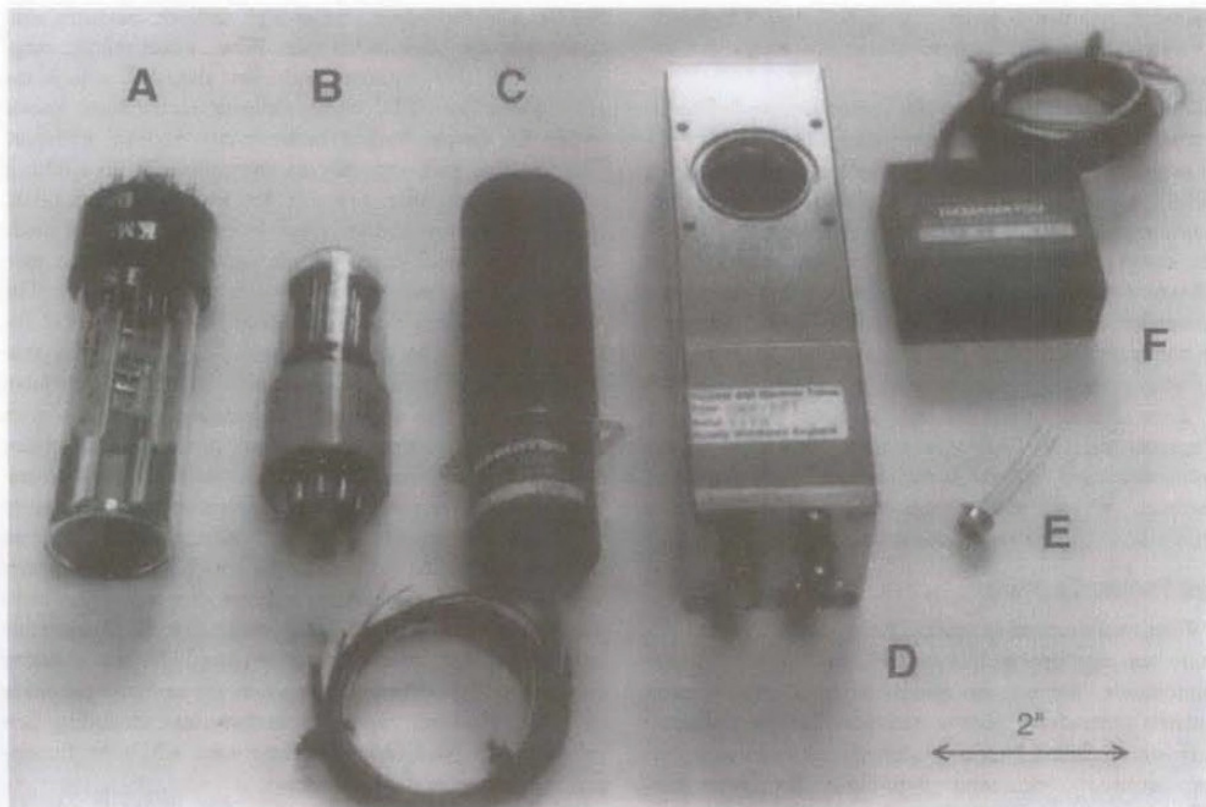


Figure 4-36. Detectors and housings. A: End-window PMT. B: 1 1/8" side-window PMT. C: 1 1/8" side-window PMT, with a magnetic shield, in a socket with a voltage multiplier. D: RF shielded housing for a side-window PMT, with a dynode chain. E: Silicon photodiode. F: Detector module with small side-window PMT and voltage multiplier power supply.

EX1007 at 154 (showing relative sizes of PMTs (Figure 4-36 A-C) and photodiodes (Figure 4-36 E)).

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44. Compared to signal in optical communications, the fluorescence intensity in applications like flow cytometry can be over 1,000,000 times weaker. To demonstrate, optical communications network signals are measured on a logarithmic scale proportional to milliwatts, with 1 mW as a reference level (0 dBm). EX2039 at 23-24. Milliwatts or microwatts at a given wavelength (e.g., 1300-1600 nm wavelengths in optical communications) can be straightforwardly correlated to photons per second (essentially, the power in watts divided by the energy of a single photon at a certain wavelength). Here, only a microwatt of power (1/1000 mW) at 1300 nm wavelength correlates to trillions of photons per second. In contrast, in flow cytometry fluorescent light detection, only “hundreds of photons are likely to be emitted from each fluorescent molecule in or on a cell during the cell’s traverse of an illuminating beam at a wavelength at or near the molecule’s excitation maximum.” EX2029 at 283. Even this is an overstatement, as “even the most efficient fluorescence collection optics collect no more than about 20% of the total emission from cells,” meaning many such photons would not even reach the detector. *Id.*

45. Cytometry often uses fluorescence to identify or characterize cells, with the fluorescence to be detected usually coming from a single cell at a time. EX2029 at 283. This means that typically only a few molecules (often just one) are emitting light, resulting in just hundreds of photons to be detected for any given cell (*id.*),

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which means the power to be measured is on a completely different scale than higher signal applications like telecommunications.

46. Photomultiplier tubes (PMTs) have high internal current gain due to the mechanism described above. PMTs have long been the industry standard for detection of fluorescence and other low-level signals. *See, e.g.*, EX1001 at 44:6-33.

47. Though they are bulky, fragile (they are very much like glass radio tubes), expensive, and typically require high voltage power supplies (often up to several hundred volts), PMTs can have large active areas (typically 10-20 mm or more diameter, and can be made with a range of very responsive materials across the visible and near infrared spectrum. *See* EX1004 at 24 (“Photomultipliers are photosensitive electron tubes with a more restricted spectral response [than diodes], but with high gain and good signal-to-noise characteristics suitable for the detection of weak fluorescence.”); EX1007 at 152-153. A consideration in low light fluorescence applications like flow cytometry is the collection of the emitted fluorescence, which is emitted in all directions from the fluorophore (attached to the cell). It is not feasible to capture all of this light, since some is emitted in directions occupied by other parts of the machine, EX2029 at 283, but it is highly desirable to collect as much as possible. As I’ve discussed, this generally mandates a high numerical aperture (NA) optical component, which can collect light over a large solid angle, and in turn this mandates a high throughput (étendue) for the system.

48. An APD with active area equivalent to the area of a PMT would produce a very high amount of background noise, so the active area must be kept small (typically 1 mm or less) to make the device practical. *See* EX1001 at 44:14-20. In a high étendue system, the small spot required to “fit” the light into the small active area of an APD places significant constraints on preserving the overall étendue of the system.

49. The large active area of a PMT, however, lends itself well to high throughput (étendue). Additionally, the noise figure for PMTs scales only weakly with increasing area, particularly when the detector is cooled below room temperature. Thus, PMTs have been the detector of choice for fluorescence detection in flow cytometry for decades. *See* EX1001 at 44:6-33.

50. These étendue considerations alone prevented the use of APDs in most flow cytometry systems before the inventions of the '106 patent. *See* EX1001 at 44:47-53, 45:10-14.

## **V. CLAIM CONSTRUCTION**

51. I understand that in the time since the Petition was filed, the district court has held two claim construction hearings. EX2012; EX2013. I understand that the judge has put forth the following constructions:

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<b>Term</b>	<b>'106 Patent Claim</b>	<b>Construction</b>
“first dichroic filter” and “second dichroic filter”	Claim 1	Plain and ordinary meaning. EX2013 at 5:21-22.
“first curved mirror” and “second curved mirror”	Claim 1	First curved mirror and second curved mirror are in sequence. EX2013 at 27:3-12.
“portion of the”	Claims 1	“subset of the spectrum of the wavelength of the.” EX2013 at 92:21-24.

I also understand that the judge did not construe any other claim limitations, and no further claim limitations in the '106 patent are before the court at this time.

52. I have applied the constructions provided by the district court judge in my analysis and throughout this declaration.

## **VI. OVERVIEW OF THE ASSERTED REFERENCES**

### **A. Goodman**

53. One of the patents Petitioner relies on is U.S. Patent No. 6,542,306, which I refer to as “Goodman” because that is the only named inventor. EX1016 Goodman is a patent that granted from an application filed March 16, 2001. Based on my review, Goodman only describes optical communications systems and the components used in such systems. EX1016 at 2:7-14, 3:47-50. Goodman describes a multiplexing/demultiplexing system for optical communications, and it proposes that this system would be primarily used in “wide wavelength division multiplexing (WDM) systems.” EX1016 at 5:41-47. The phrase “wide wavelength division

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multiplexing (WWDM)” was not an industry-defined term by the time Goodman issued in 2004; however, from the description in Goodman (wavelengths centered at 1310 nm and spaced 25 nm apart), it appears that the primary use case was for what is now standardized as coarse wavelength division multiplexing (CWDM). EX1016 at 2:21-29, EX2032 at 3.

54. Goodman describes demultiplexing devices designed for “low cost injection molding fabrication techniques, facilitating high volume production at lost cost.” EX1016 at 6:62-64. Goodman also states that certain objectives of its disclosure included describing a “multiplexer/demultiplexer device that is easy to mold and fabricate accurately,” “that is easily scalable or modified,” and “that is easy to incorporate into other optical systems.” EX1016 at 3:47-67. Goodman describes applications of its technology as ranging from “spacecraft and aircraft applications to closed circuit and cable television systems.” EX1016 at 2:10-13.

55. In one figure, Goodman discloses a zig-zag configuration for the path of the light beam travelling through its demultiplexing device (which it notes can also be used as a multiplexer if the optical path is reversed):

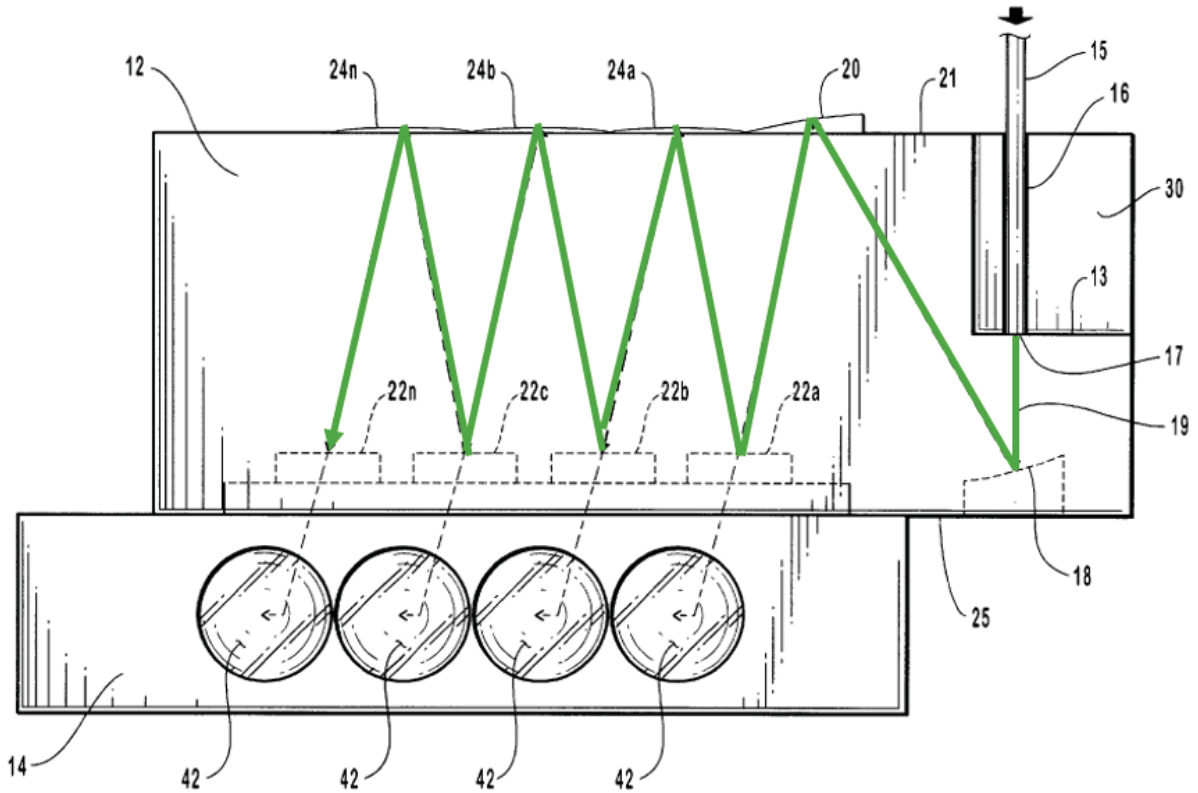


FIG. 1

EX1016 at FIG. 1 (annotated). Light coming into Goodman’s demultiplexing device from optical fiber 15 contacts two mirrors 18 and 20 before it is directed into a series of filters and reflectors (22a-n and 24a-n). EX1016 at 7:17-8:27. After light passes through the filters 22a-n, it goes to a beam-directing member 14, which includes components that reflect the light at a 90-degree angle. EX1016 at 11:8-16. The light then passes through focusing lenses toward detectors outside the demultiplexing device. EX1016 at 11:31-50, cl. 17. For the wavelength signal ranges preferred in Goodman (wavelengths centered at 1310 nm and spaced 25 nm apart, EX1016 at 2:21-29, 5:41-47), detector modules made from infrared-responsive semiconductor

materials (e.g., indium gallium arsenide (InGaAs)) were commonly used. EX2036 at 1082, 1086.

56. Goodman states that its optical block and beam-directing member are both preferably “formed of a moldable thermoplastic material” so as to “facilitat[e] high volume production at low cost.” EX1016 at 6:60-64. As Goodman’s device is not designed to be customized or adjusted after its manufacture, Goodman states that its filters are “affixed therein such as by an optical adhesive.” EX1016 at 8:44-47. Optical blocks and molded parts were very common in the telecommunications industry at the time; industry standards (then set by Bellcore/Telcordia, now iconectiv) defined mechanical tolerances and testing for optical devices used in communications as of the mid-1990s.

**B. Chandler**

57. The Petition also relies on U.S. Patent No. 6,139,800, which I refer to as “Chandler” because that is the first named inventor. EX1051. Chandler is a patent granted from an application filed by Luminex Corporation on June 22, 1998, and it describes a particle analyzer used to measure multiple fluorescence wavelengths. *See* EX1051 at 3:38-65. Chandler’s system detects fluorescent microspheres or particles coated with tags that bind to molecules of interest to be detected in a sample fluid, such as antigens, antibodies, cell receptors. EX1051 at 2:1-10.

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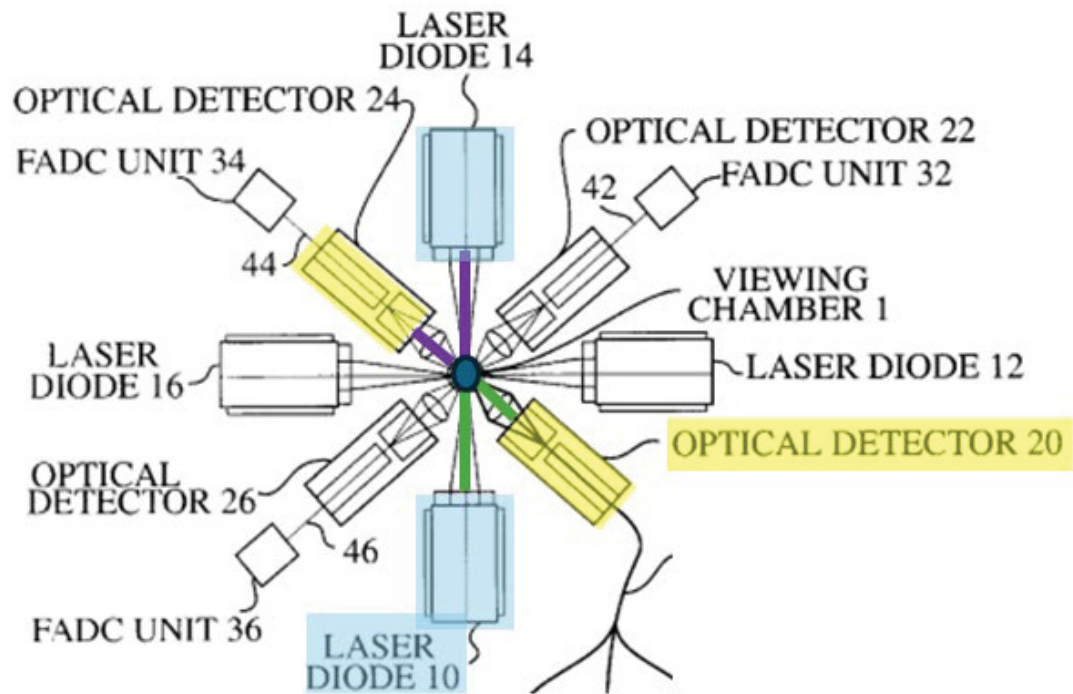
58. Chandler addresses specific limitations to fluorescence detection in conventional flow cytometers. I note that Chandler's system (using, e.g., microspheres) operates at higher levels of fluorescence than a continuous flow cytometer (such as Oostman), and thus the detector can be very different. EX1051 at 2:1-10, 3:38-65, 9:5-10, 10:1-5; EX1001 at 47:39-43.

59. The number of fluorescent labels that could be simultaneously measured with one laser was restricted to two to three dyes because of dye properties and wavelength overlap. EX1051 at 2:1-10, 2:37-42, 2:30-32. The amount of analysis that could be performed on a single sample was thus limited because it required multiple runs of a large quantity of sample for meaningful analysis. EX1051 at 2:42-51. Chandler explains that the prior art solution to this problem was to use two lasers of different wavelengths that each focused on a different spot along the flow stream, but with that method, it was often hard to know if measurements are made on the same particle. EX1051 at 2:61-3:17. Even the slightest amount of flow turbulence could cause particle mixing and lead to errors in measurements. EX1051 at 3:8-17.

60. In an effort to resolve those issues, Chandler proposes using a system that would allow for excitation and detection of multiple fluorescence emissions at substantially the same time. EX1051 at 3:38-41. Specifically, multiple lasers (10, 12, 14, 16) of different excitation wavelengths are angled in different directions.

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EX1051 at 7:1-34. This way, the focal regions of the lasers are substantially overlapping and ensure that the same particle is excited by all lasers. EX1051 at 7:1-34. Each laser is positionally paired with a standard optical detector that detects emissions from excitation by its respective laser. EX1051 at 7:1-34. Figure 4 from Chandler is annotated below to show a positional relationship described by Chandler between the lasers (blue) and optical detectors (yellow) and their respective lights from the laser onto a particle and emissions into its paired optical detector (e.g. green and purple, respectively)



EX1051 at FIG. 4 (annotated).

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61. When the laser is on, Chandler's optical detector gathers emissions from the particles in the flow cell and transmits them into a multi-mode fiber optic cable that splits and directs each beam through multiple different band-pass filters in a filtering, amplification, and digital conversion (FADC) unit. EX1051 at FIG. 4. Once the fluorescence from a given laser has been collected, the next laser is turned on and its fluorescence collected, until all laser sources have been used to illuminate the particle in the viewing chamber.

62. The optical path of light discussed by Chandler is annotated in green below:

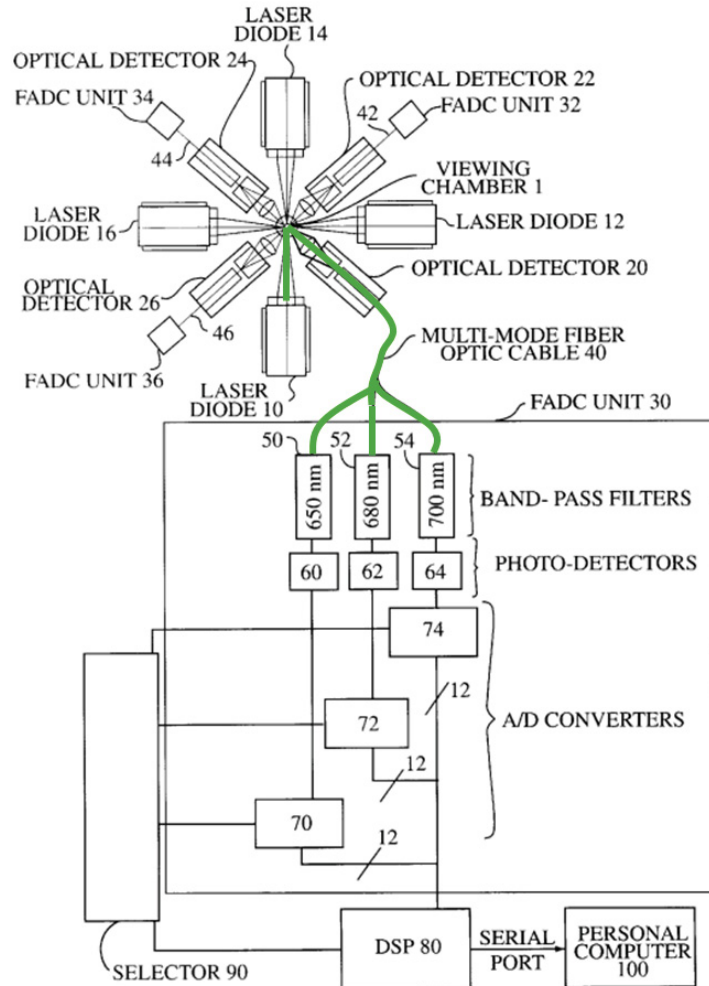


FIG. 4

EX1051, FIG. 4 (annotated).

63. Chandler's band-pass filters allow the emission wavelength of a fluorescent dye to be seen or measured. The scattered laser light can also be filtered out to improve the sensitivity of the device. The signals corresponding to specific wavelengths for each dye are then detected, amplified, digitized, and processed. EX1051 at 8:6-8. Each optical detector can thus be associated with a nearby laser to detect multiple wavelengths in each FADC unit. EX1051 at 7:24-34.

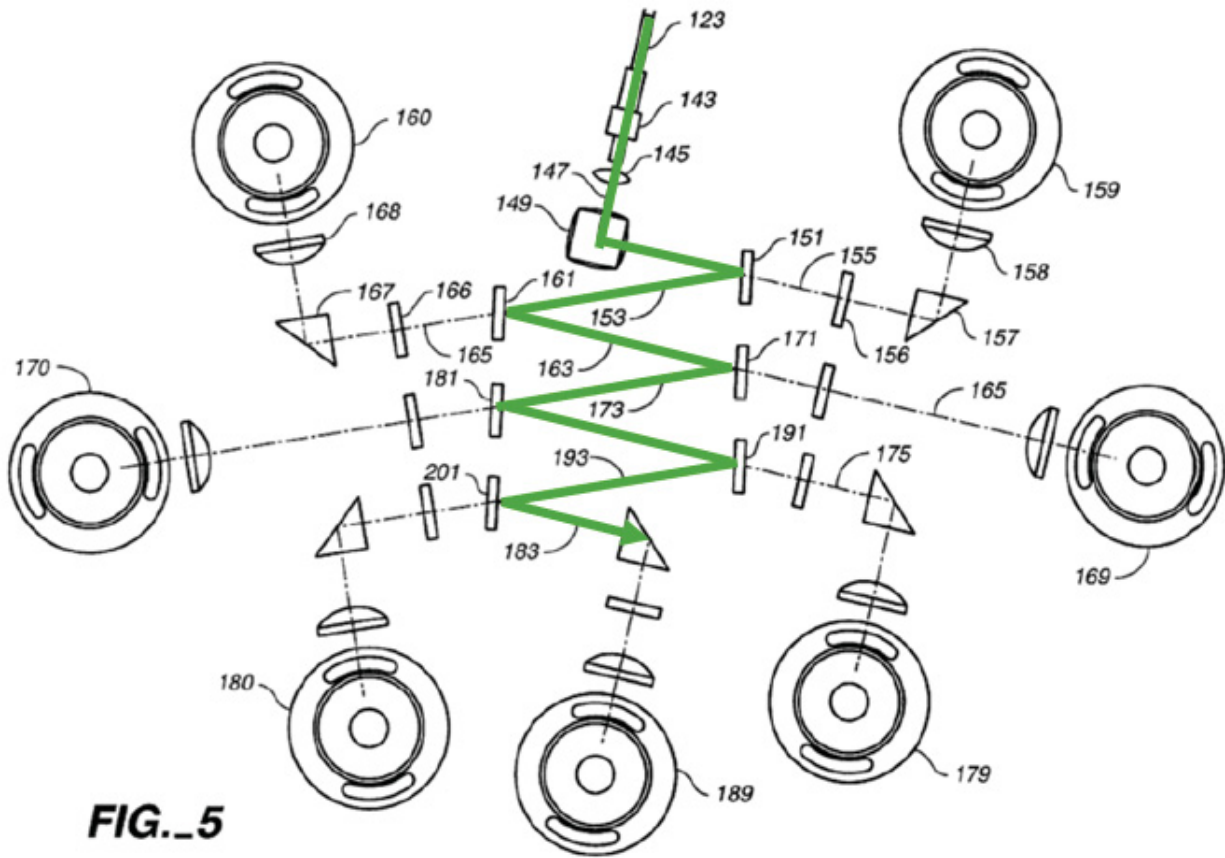
64. Chandler prefers using multi-mode optical fiber cables to split the beam of light over a beam-splitter approach, which generally increases the size and manufacturing complexity. EX1051 at 11:38-50. In contrast, the multi-mode optical fiber cable approach is simpler and/or more compact and/or less expensive, but both approaches suffer from losses due to dividing the signal for each channel (wavelength band) in the FADC. EX1051 at 11:38-50.

**C. Oostman**

65. The Petition also relies on U.S. Patent No. 6,683,314, which I refer to as “Oostman” because that is the first named inventor. EX1005. Oostman is a patent granted from an application filed August 28, 2001, and it describes fluorescence detection instruments used in a flow cytometer, and its stated improvement is being able to separate more fluorescent colors in a smaller overall size compared to prior art flow cytometers. *See* EX1005 at 4:10-13, 4:65-5:2.

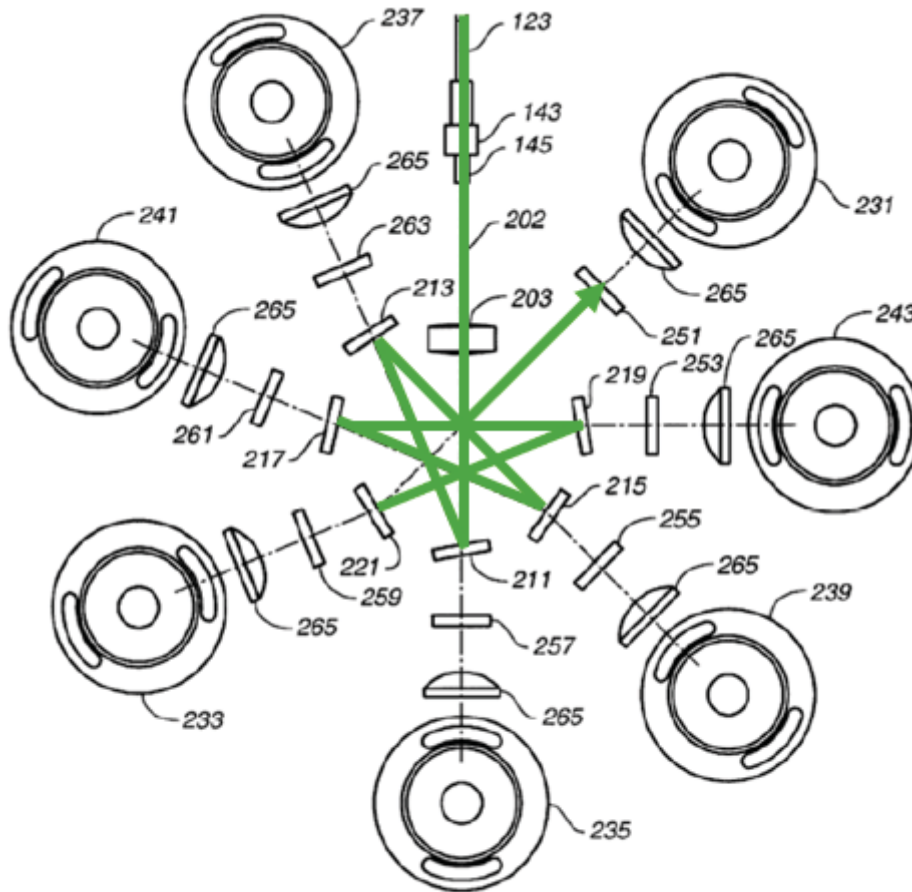
66. Oostman discloses two primary improvements over prior art flow cytometers. EX1005 at 3:44-57, 4:14-16, 6:40-7:36, 8:18-9:3. Oostman first discusses changing the path of the fluorescent light: in Oostman’s cited prior art, light from a flow cytometer would travel in a straight (rectilinear) optical path, and planar dichroic beam splitters in that path would reflect certain wavelengths of light to detectors. EX1005 at 1:54-2:16. The optical path of light in the prior art discussed by Oostman is annotated in green below:





EX1005 at FIG. 5 (annotated); *id.* at 3:44-57, 6:40-7:34.

67. Oostman’s second stated improvement is in developing an alternative optical path and PMT detector arrangement. Although FIG. 5 of Oostman describes the shortest optical path available for a zig-zag pattern (e.g., with every beam splitter being used to transmit at least one wavelength of light to a detector), the use of PMTs means the overall detector cluster size is relatively large. *See* EX1005 at 7:34-36. In view of these considerations, Oostman also discloses an alternative “star-shaped pattern yielding a more compact polygonal arrangement of detectors.” EX1005 at 7:34-36.



**FIG. 6**

EX1005 at FIG. 6 (annotated). Oostman also emphasizes its customizability, such as allowing for the addition of more detector clusters in a modular fashion, removing and replacing filters depending on the application, and adjusting the clusters to improve light detection for specific applications. EX1005 at 4:14-16, 8:18-9:3.

**D. Frazier**

68. The Petition also relies on U.S. Patent No. 8,284,402, which I refer to as “Frazier” because that is the first named inventor. EX1009. Frazier is a patent granted from an application filed February 26, 2010, and it describes fluorescence

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detection assemblies in flow cytometry using an optical alignment assembly to introduce an output beam into an array of filters. EX1009 at Abstract.

69. Frazier's seeks to improve prior art detector assemblies by providing assemblies that can be customizable, such that the number of dichroic filters and detectors associated with each light beam can be varied. EX1009 at 2:50-59.

70. Frazier's detector assembly (100) introduces light beams through a beam reflecting element (108), such as a prism, to a dichroic filter (102), which splits the beam so that a portion of the passes through the filter and then passes through a bandpass filter (104) in order to isolate a desired band to each detector (125, 126) for detection in its respective detector port (112), whereas another portion is reflected to the next dichroic filter which captures a band of different wavelengths, and the remaining bands are reflected onward. EX1009 at 4:55-5:11. The optical path of light in Frazier's central boulevard (122) to its final detector is annotated in green below:

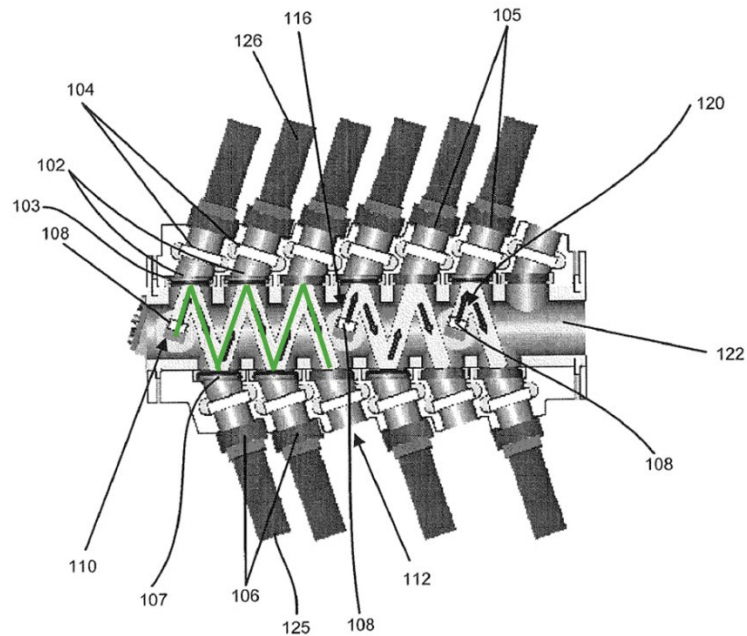


FIG. 1 (annotated).

71. In its background section, Frazier discusses a prior art reference from the optical communications field U.S. Patent No. 4,244,045. Frazier states that using such assemblies would not be beneficial for Frazier’s customization goals because those assemblies contained prefabricated blocks that were not customizable to accommodate multiple light beams, and could each require separation of a different amount of wavelengths. EX1009 at 2:9-46. Frazier does not describe any beam controlling (e.g. focusing or re-collimating) optics along the zig-zag “boulevard.”

## VII. OVERVIEW OF U.S. PATENT NO. 12,174,106

72. I have also reviewed the challenged ’106 patent, which is titled “Flow Cytometer,” and was filed on December 22, 2021. EX1001.

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73. The '106 patent states that its disclosure would enhance the performance of flow cytometers while making them more compact and easier to use. EX1001 at 2:18-23. The '106 patent describes a reconfigurable, compact wavelength division multiplexer (WDM) that permits the use of low noise, millimeter-sized detectors not previously used in flow cytometry, resulting in a smaller instrument footprint. *Id.* at 2:29-34, 45:49-46:21.

74. As I discuss in the Technology Background and throughout this declaration, the needs for optical signal detection in fluorescence detection systems, and particularly in flow cytometry are very different from other fluorescence applications, and even more different from optical communications. *See supra* Section IV. A stated innovation of the '106 patent was to allow the use of passive, parallel wavelength separation, via a WDM, while maintaining the high signal-to-noise and temporal response needed for flow cytometry. *See, e.g.*, 2:35-39.

75. Furthermore, the light entering a flow cytometer's fluorescence detection system enters via a large optical fiber—typically at least ten times larger—than in optical communications, producing a larger and more spread out light beam. EX1001, 45:3-23. This fact, necessitated by the nature of light collected by the flow cytometer's collecting optical element, (e.g., scattered light), presents challenges in controlling the light beam over an extended distance so as to focus the beam onto

the detectors, and the '106 patent identified its inventions as solving that problem. *Id.* at 44:47-67.

### **VIII. RELEVANT PROSECUTION HISTORY**

76. I understand that U.S. Patent Application No. 17/645,727 issued as the '106 patent on December 24, 2024. I also understand that the '106 patent is a continuation in a family of patents. I have reviewed the prosecution history of the '106 patent as well as the file histories of certain earlier-filed patents sharing the priority claim and specification with the '106 patent. These earlier patents overcame similar challenges during prosecution as the obviousness Grounds Petitioner puts forth here.

77. One such application I reviewed was U.S. Patent Application No. 14/555,102, which was filed November 26, 2014 and eventually issued as U.S. Patent No. 9,746,412 (the "'412 patent"). EX2015. During prosecution of this application, the Examiner initially rejected the pending claims—which, similar to the '106 patent, recited a “flow cytometer having a wavelength division multiplexer”, as obvious over the published application for Oostman combined with U.S. Patent Pub. No. 2004/0165828 (“Capewell”) (EX2014), a reference from the optical communications field. EX2015 at 1070-71. In support of this combination, the Examiner argued that the references were “[i]n a similar field of endeavor.” *Id.* Applicant did not amend the claims but instead explained to the examiner that “the

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fluorescence detection instrument, as taught by *Oostman*, and the optical communication system, as taught by *Capewell*, are actually different kinds of optical systems with different sizes of light sources,” and therefore obviousness had not been established. *Id.* at 1107-09. Following this response, the Examiner issued a notice of allowance, stating that they “fully considered” Applicant’s arguments and found them “persuasive.” *Id.* at 1132.

78. Another application I reviewed was U.S. Patent Application No. 15/638,461 which was filed June 30, 2017 and eventually issued as U.S. Patent No. 10,330,582 (the “’582 patent”). I understand that the ’582 patent is not part of the same chain of applications as the ’106 patent; however, the ’582 claims priority to the same provisional applications as the ’106 patent as well as the ’412 patent. Here as well, Examiner also rejected the claims based on *Oostman* in an office action dated July 30, 2017. EX2016 at 537-542. Applicant again overcame this rejection and received a notice of allowance. *Id.* at 599.

79. I have also reviewed the prosecution history for the ’106 patent itself. The ’106 patent was filed on December 22, 2021 as U.S. Patent Application No. 17/645,727. EX1003 at 2. To start, I note that on February 10, 2024, prior to any substantive action, the Examiner signed an Information Disclosure Statement filed March 9, 2022, stating that they “considered” *Oostman*, *Goodman*, and *Frazier*—three of Petitioner’s four references in its obviousness Grounds in this Petition:

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A72	6542306	4/1/03	Goodman
A73	6572255	6/3/03	Husher
A74	6608682	8/19/03	Ortyn et al.
A75	6618143	9/9/03	Roche et al.
A76	6638481	10/28/03	Sklar et al.
A77	6647175	11/11/03	LoRegio et al.
A78	6683314	1/27/04	Oostman Jr. et al.
A79	6713019	3/30/04	Ozasa et al.
A80	6748133	6/8/04	Liu et al.
A81	6767188	7/27/04	Vrane et al.
A82	6768593	7/27/04	Jutamulia
A83	6788409	9/7/04	Goodwin
A84	6794671	9/21/04	Nicoli et al.
A85	6813017	11/2/04	Hoffman et al.
A86	6839367	1/4/05	Nagamatsu et al.
A87	6870679	3/22/05	Randall et al.
A88	6870976	3/22/05	Chen et al.

105007106.1

<b>EXAMINER:</b> /ISIARA O AKANBI/	<b>DATE CONSIDERED:</b> 02/10/2024
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A139	8284402	10/9/12	Frazier et al.
A140	8337096	12/25/12	Shen et al.
A141	8345237	1/1/13	Tsukii et al.
A142	8405048	3/26/13	Hayashi
A143	8432541	4/30/13	Rich
A144	8436371	5/7/13	Medendorp Jr., et al.
A145	8436993	5/7/13	Kaduchak et al.
A146	8488244	7/16/13	Li et al.
A147	8507279	8/13/13	Ball et al.
A148	20020081744	06/27/02	Chan et al.
A149	20020067895	06/06/02	Flanders
A150	20020141902	10/3/02	Ozasa et al.
A151	20030142720	7/31/03	Bradburn et al.
A152	20040031521	02/19/04	Vrane et al.
A153	20040218184	11/4/04	Joregenson et al.
A154	2004165828	08/26/04	Capewell et al.

105007106.1

<b>EXAMINER:</b> /ISIARA O AKANBI/	<b>DATE CONSIDERED:</b> 02/10/2024
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EX1003 at 231, 234 (annotated).

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80. The Examiner also noted that it considered U.S. Patent No. 7,505,131 (EX1045), a patent that was assigned to Luminex Corporation, just like Chandler, Petitioner's fourth reference. EX1003 at 233.

81. Based on my review of the file history it is clear that the Examiner issued several rejections over Oostman throughout prosecution and in response Applicant explained how Oostman differs from the claimed invention.

82. After thorough examination and consideration of the issues, the Examiner issued a Notice of Allowance on September 11, 2024. EX1003 at 527. In the Notice of Allowance, the Examiner stated:

The closest prior art reference of Oostman, JR. et al. (2003/0048539 A 1) discloses a flow cytometer.

However, Oostman, JR. fail to disclose, teach or suggest a collimating optical element that is separate from the collecting optical element and is arranged to receive the fluorescent light collected by the collecting optical element, the collimating optical element configured to collimate the fluorescent light, as claimed and as specified in the present application specification. This argument is persuasive. Therefore, the rejections are withdrawn.

EX1003 at 527. Thus, the innovation was upheld in the face of obviousness arguments over Oostman.

83. The '106 patent issued on December 24, 2024. EX1003 at 565.

**IX. IT IS MY OPINION THAT THE PETITION AND DR. ILKOV'S OPINIONS DO NOT DEMONSTRATE THAT THE CHALLENGED CLAIMS LACK WRITTEN DESCRIPTION FOR A "CURVED MIRROR" AND "SEMICONDUCTOR DETECTOR"**

**A. Curved Mirror**

84. I have reviewed the written description for U.S. Patent No. 11,255,772 (the "'772 patent") (EX1078), U.S. Patent No. 9,746,412 (the "'412 patent") (EX1070), and PCT/US2013/043463 (the "PCT Application") (EX1071). I have also reviewed the written description for provisional application 61/715,819 filed on October 18, 2012 (the "'5819 Provisional") (EX2043).

85. Petitioner challenges priority before December 22, 2021 because of the recited limitation of a "curved mirror." Pet. at 14-23. Petitioner and Dr. Ilkov note that the '772 patent, '412 patent, and PCT Application did not use the exact words "curved mirror." Pet. at 16-17; EX1002, ¶81.

86. Having reviewed these patents and applications, it is my opinion that the written description supports a "curved mirror" and that the '106 patent is entitled to the benefit of priority to those earlier applications.

87. Petitioner and Dr. Ilkov acknowledge that the '772 patent, '412 patent, and PCT Application all teach a "concave mirror." Pet. at 16-17; EX1002, ¶81. They contend that the term "curved mirror" must also include mirrors of convex curvature

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in the scope of the patent. While this generality may be true in isolation, it is clearly not correct in the context of the specification of the '106 Patent.

88. In my view, a POSA would understand that the curved mirror of the invention must have positive optical power to achieve the goals of the stated inventions. This in turn means that the curvature of the mirror must be concave by the standard optics definition. In particular, claim 1 requires a curved mirror that is “configured to reflect the portion of the fluorescent light towards the first semiconductor detector.” EX1001, cl. 1. Claim 13 requires a curved mirror that is “configured to sequentially reflect different color bands of the fluorescent light collected by the collecting optical element after the fluorescent light has passed through the collimating optical element.” EX1001, cl. 13. Moreover, claims 1 and 13 recite a “collimating optical element” and curved mirrors that receive fluorescent light after it has passed through the collimating optical element. EX1001, cls. 1, 13. These limitations would not be achievable with an element of negative optical power, e.g. a convex mirror. Thus, the “curved mirror” limitation in independent claims 1 and 13 of the '106 patent can only mean a concave mirror when read in the context of the full claim language and the specification.

89. The specification also explains that the WDM separates light from an extended light source without expanding the beam diameter, using an image relay architecture. EX1001, 57:49-59:26. Again, this requires positive optical power, or a

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concave mirror. Petitioner seemingly recognizes this concept too, admitting that: “Because concave mirrors lessen the divergence of light rays within an incident beam of light, the written descriptions teach that they are useful to ‘extend the collimated distance’ of a collimated beam within the WDM.” Pet. at 20. Dr. Ilkov also concedes that “a POSA would have recognized that concave mirrors are well-suited for causing light rays to converge and/or become less divergent.” EX1002, ¶89. A POSA would have thus understood the reference to “concave mirror” in the specification as referring to a mirror that has a concave curvature and positive optical power to achieve these functions.

90. In my opinion, a POSA would have understood the inventors to have been in possession of a “curved mirror” as of at least the ’5819 Provisional’s October 18, 2012 filing date. The ’5819 Provisional explains that “[t]he device consists of a collimating optical element that produces an image of the light source and at least one imaging relay optical element.” EX2043 at Abstract; *see also id.* [0007] (“The said second optical element is positioned near the said image, and relates the said first optical element with unit magnification down the optical path, therefore effectively doubles the collimated light path length.”); FIGs. 1, 3-4, Claims 1-12. The ’5819 Provisional states that this optical element can be a “concave mirror.” *Id.* at [0008]; *see also id.* [0009]-[00013], [0016]-[0020], Claims 1-12, Figs. 1, 3-4.

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91. I note that the language that appears in the '5819 Provisional is nearly identical to the language in the '106 patent specification:

<b>EX1001 ('106 patent)</b>	<b>EX2043 ('5819 provisional)</b>
“In one embodiment of a WDM, the first optical element is a lens and the second element is a concave mirror, although it is apparent to those skilled in the art that other types of refractive and/or reflective optical components may also be used to achieve the same design goal.” EX1001 at 5:1-5.	“In one exemplary embodiment of the present invention, the said first optical element is a lens and the said second element is a concave mirror, although it is apparent to those skilled in the art that other types of refractive and/or reflective optical components may also be used to achieve the same design goal.” EX2043 at [0008].

92. I further note that Figure 1 of the '5819 Provisional depicts mirrors similar to Figure 25 of the '106 patent. *See* EX1001, FIG. 25; EX2043, FIG. 1.

93. Petitioner and Dr. Ilkov rely on a principle in patent law called claim differentiation, as described above. Pet. at 21; EX1002, ¶83. First, I understand this doctrine is not absolute and cannot overcome the clear teachings from the specification I explain above. I also understand that claim differentiation would not apply from the claims of U.S. Patent No. 11,703,443, which is a child application. Additionally, claim 6 of the '443 patent is narrowing in other ways outside of the “curved mirror” limitation because it includes at least one dichroic filter, and thus would not mean that a curved mirror must include convex mirrors due to claim differentiation.

**B. Semiconductor Detector**

94. It is also my opinion that the written description supports a “semiconductor detector” and that the ’106 patent is entitled to the benefit of priority from at least as early as the ’5819 Provisional. The language “semiconductor detectors” is express in both the ’106 patent and the ’5819 Provisional. *See* EX1001 at 4:62-67; EX2043 at [0007]. I note that the language that appears in the ’5819 Provisional is nearly identical to the language in the ’106 patent specification:

EX1001 (’106 patent)	EX2043 (’5819 provisional)
“In particular, multiple colored bands present in the beam of light can be separated using dichroic filters located among the optical path with the separated light being tightly focused into small spots compatible with low noise semiconductor photodetectors.” EX1001 at 4:62-67.	“In particular, multiple colored bands can be separated using dichroic filters along the optical path and tightly focused into small spots compatible with low noise semiconductor detectors.” EX2043 at [0007].

95. I further note that Figure 1 of the ’5819 Provisional depicts detectors similar to Figure 25 of the ’106 patent. *See* EX1001, FIG. 25; EX2043, FIG. 1. *See* also Section XI.B, incorporated here by reference.

**X. IT IS MY OPINION THAT THE PETITION AND DR. ILKOV’S OPINIONS DO NOT DEMONSTRATE A REASONABLE LIKELIHOOD THAT THE CHALLENGED CLAIMS ARE INVALID**

96. As I discuss in more detail below, it is my opinion that the Petition and the accompanying opinions from Dr. Ilkov fail to demonstrate that the challenged claims invalid for the reasons I discuss below. *First*, it is my opinion that the Petition

and accompanying opinions from Dr. Ilkov fails to demonstrate disclosure or obviousness of a wavelength division multiplexer for a flow cytometer. **Second**, it is my opinion that the Petition and the accompanying opinions from Dr. Ilkov fail to demonstrate that Goodman was analogous art to the inventions in the '106 patent or that a POSA would have any reason to combine Goodman with Chandler or Oostman. **Third**, it is my opinion that Petitioner and the accompanying opinions from Dr. Ilkov fail to demonstrate that a POSA would have had a reasonable expectation of success in combining Oostman or Chandler and Goodman. **Fourth**, it is my opinion that Petitioner and the accompanying opinions from Dr. Ilkov fail to demonstrate a lack of written description support for “curved mirror” or “semiconductor detector.”

**A. It Is My Opinion that Petitioner and Dr. Ilkov Fail to Demonstrate Obviousness In Grounds 1 and 2**

**1. Petitioner and Dr. Ilkov fail to demonstrate disclosure of all of the challenged claim limitations**

- i. Petitioner and Dr. Ilkov do not show disclosure in Chandler and Goodman of “a wavelength division multiplexer (WDM)” for “[a] flow cytometer” (Ground 1)*

97. All of the challenged claims require a “wavelength division multiplexer” for use in “a flow cytometer.” EX1001, cls. 13, 14, 17. Independent claim 13 recites “A flow cytometer comprising ... a wavelength division multiplexer (WDM) configured to separate into color bands the fluorescent light collected by the

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collecting optical element.” EX1001, cl. 13. It is my opinion that Petitioner and Dr. Ilkov do not show that a WDM as described by the claims is obvious in view of Chandler and Goodman.

98. Petitioner and Dr. Ilkov rely on Chandler as disclosing a WDM by way of its FADC unit. Pet. at 39-40; EX1002, ¶127. Petitioner states elsewhere in its Petition, however, that “A POSA would have known that a ‘wavelength division [de]multiplexer’ or ‘WDM’ refers to the optical components that demultiplex light into [] color bands. [] WDMs accomplish spectral separation through the use of filters, mirrors, and lenses to separate light into color bands and focus those color bands into photodetectors.” Pet. at 7-8.

99. In contrast to a WDM, Chandler’s system splits the collected fluorescence into multiple fibers and then directs the output of each fiber through a single band-pass filter. EX1051 at 11:38-50; FIG. 4. Due to the dwell time and brighter fluorescence discussed above, a POSA would not have considered this approach inadequate for Chandler’s device, even with the optical division losses, particularly since Chandler describes it as an improvement over prior art.

100. In fact, Chandler teaches against using a “beam splitter approach,” noting that this approach “generally increases the size and manufacturing complexity,” while the optical detector/multi-mode fiber optic cable approach is

“simpler and/or more compact and/or less expensive.” EX1051 at 11:38-50. Thus, a POSA would not understand Chandler’s relied upon disclosures to teach a WDM.

101. Further, a POSA would not look to combine Chandler and Goodman as Petitioner proposes for several reasons.

102. Petitioner relies on Dr. Ilkov’s opinion that the claims are invalid by incorporating Goodman’s demultiplexing configuration (for example, as depicted in Figure 1 of Goodman) into Chandler’s particle analyzer by “replac[ing] the branched configuration from Chandler’s FADC unit(s),” and summarily concluding that a POSA would have found the combination obvious. Pet. at 39-40; EX1002, ¶109.

103. I disagree. As I discuss in more detail below, fundamental differences in the optical constraints between flow cytometry and optical communications would prevent a POSA from considering an optical communications reference. Dr. Ilkov’s statements that such combinations would have been obvious are not supported by any contemporaneous evidence presented by Dr. Ilkov or Petitioner and are, in my opinion, hindsight-based reasoning.

*ii. Petitioner and Dr. Ilkov do not show disclosure in Oostman, Goodman, and Frazier of “a wavelength division multiplexer (WDM)” for “[a] flow cytometer” (Ground 2)*

104. Petitioner relies on Dr. Ilkov’s opinion that the claims are invalid by incorporating Goodman’s demultiplexing configuration (for example, as depicted in Figure 1 of Goodman) into Oostman’s flow cytometer. Pet. at 60-61; EX1002, ¶160.

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I disagree. As I discuss in more detail below, fundamental differences in the optical constraints between flow cytometry and optical communications would prevent a POSA from considering an optical communications reference. Dr. Ilkov's statements that such combinations would have been obvious are not supported by any contemporaneous evidence presented by Dr. Ilkov or Petitioner and are, in my opinion, hindsight-based reasoning.

*iii. Petitioner and Dr. Ilkov do not show disclosure in Oostman, Goodman, and Frazier of "a collimating optical element that is separate from the collecting optical element" (Ground 2)*

105. All of the challenged claims require a collimating optical element that is separate from the collecting optical element." EX1001, cl. 13. Petitioner and Dr. Ilkov assert that the proposed combination would have predictably resulted in the placement of Oostman's collimating lens 203 in Goodman's WDM device after optical fiber 15 but before imaging element 18. Pet. at 68-69; EX1002, ¶182. I disagree. Goodman's optical block is monolithic and made from plastic or glass. EX1016 at 6:56-67. A POSA would have understood that it would be extremely impractical to incorporate a lens inside of a monolithic plastic or glass optical block. Molding an optical block while also incorporating a lens in the middle of the glass would also completely negate any benefits of cost or ease of manufacture. Thus, a POSA would not understand the combination to disclose a collimating optical element that is separate from the collecting optical element.

**2. A POSA Would Not Have Looked to a Reference From Optical Communications to Solve Problems in Flow Cytometry**

106. Dr. Ilkov opines that “A POSA seeking to reduce the footprint of Chandler’s FADC units, while also ensuring efficient, accurate, and (if possible) expanded color separation and detection, would naturally have consulted alternate WDM arrangements, including Goodman.” EX1002, ¶112; Pet. 29. Dr. Ilkov also opines that “[a] POSA seeking to improve color band separation, modularity, scalability, miniaturization, ease of alignment, and portability in Oostman’s flow cytometer would naturally have consulted alternate WDM arrangements, including Goodman.” EX1002, ¶163; Pet. at 60.

107. However, as I discuss in the Technology Background and below, the fields of optical communications and flow cytometry faced different problems at the time of the ’106 patent. Goodman’s demultiplexing device was designed to address problems and design considerations that are fundamentally different than Chandler’s and Oostman’s light detection systems. Dr. Ilkov does not acknowledge these differences, which I discuss above in the Overview of the Relevant Technology and incorporate here.

108. Goodman discloses a demultiplexing device for use in optical communications, for relatively high signal levels, in infrared wavelengths, with relatively small etendue or NA, EX1016 at 5:42-47, 2:20-29; EX2036 at 1080

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(discussing how “narrow spectral widths” are “critical for the efficient operation of 1.3 and 1.55  $\mu\text{m}$  wavelength-division-multiplexed (WDM) optical communications systems”).

109. In an optical communications device for demultiplexing, laser light propagates through an optical fiber ranging from less than 10 microns to around 50 or 62.5 microns as a series of encoded pulses at specified wavelengths (where each wavelength is a sequence of digital data). *See supra* Section IV.B-IV.C; *see also* EX2036 at 1084-85. The laser light enters the optical fiber at relatively high power levels (see above – typically in the milliwatt range), and it has very low loss through the fiber (in certain circumstances, it is also amplified while in the fiber, *see, e.g.*, EX2036 at 1080-81). And because optical communications WDM systems most commonly deal in light as encoded pulses (i.e., “digital”), noise considerations (though still present) are reduced because an “on” pulse has a defined intensity distinct from an “off” pulse (i.e., no light). *See, e.g.*, EX2036 at 1084-85; EX2039 at 21-22. This in turn means that the absolute intensity (signal level) of the “on” pulse is not as important as distinguishing it from the “off” state. The specific wavelength ranges are also typically narrow: wavelength ranges for each detector range from 20 nm (with a wavelength centered around 1310 nm for coarse WDMs) and even 1 nm (with a wavelength centered around 1500 nm for dense WDMs) and the lasers themselves have spectral widths typically much less than 1 nm. *See*

EX2032 at 3; EX2033 at 4-5. Finally, by virtue of using a small optical fiber with low NA, the light leaving the fiber (i.e., entering the demultiplexing device) is a narrow beam with low étendue. *See supra* Section IV.B-IV.C.

110. Fluorescence detection systems, such as those disclosed in Chandler and Oostman deal with an altogether different optical regimen. Although flow cytometers and particle analyzers often include laser light as a starting point, that light is scattered once it hits cells or particles, and the presence, absence, amount, or wavelength of fluorescent light is not a given. Flow cytometers and particle analyzers must therefore be able to detect a wide range of visible wavelengths at extremely low levels with very high etendue. *See* EX1016 at 2:20-64; EX1007 at 67, 151.

111. In flow cytometry, signal strength is of paramount importance, since each cell will only emit a total of perhaps 100-1000 photons (many millions fewer than the “on” state of a digital optical signal) during its time in the flow channel active area. This signal level is then comparable with the “dark noise” of many detectors (as discussed above), which is not even a consideration in most communications links (where “shot noise” dominates). Overall, this means that the detection of signals in flow cytometry lies in a completely different noise regime than communications with completely different detector and optical collection considerations.

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112. While the particle analyzer of Chandler has higher fluorescence intensity than a continuous flow cytometer (such as Oostman), the levels are still much lower than side scatter or forward scattered laser light or optical communications signals.

113. And as I discuss in the Overview of the Relevant Technology and incorporate here, the necessity of collecting as much of the fluorescent light as possible means that the system, and in turn the light leaving the fiber has an etendue of up to hundreds of times greater than in optical communications. EX1001 at 44:47-54. This means that the optical design will be much different than a low-NA, small spot size communications system.

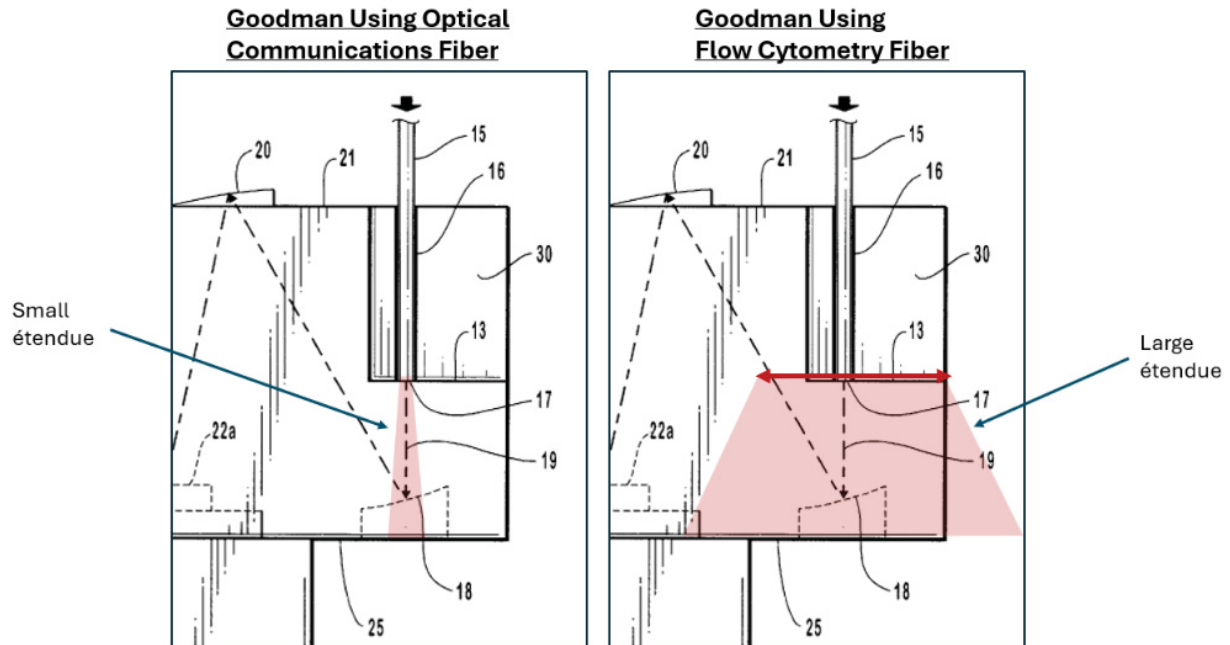
114. Further, the wavelength ranges and constraints are very distinct. Fluorophores used in flow cytometry typically emit visible light at varying center wavelengths, with bandwidths 20-50 nm or greater, *see, e.g.*, EX1007 at 68; EX1001 at 57:64-66. Detectors for the 1300-1600 nm range are different than those which are optimal for visible wavelengths. Thus, even if a POSA were motivated to improve or modify Chandler or Oostman, they would not consider doing so by integrating Goodman's demultiplexing device due to these significant differences in light propagation between the two systems.

115. I have not identified any section of Dr. Ilkov's declaration which addresses any of these differences in the light traveling through Chandler or

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Oostman's and Goodman's separate systems. In my opinion, these differences and natural results of these differences demonstrate how Petitioner's combinations of Goodman and Chandler, or Goodman and Oostman are incompatible.

116. As just one notable example, Goodman's demultiplexing device's imaging optical element 18 (e.g., an imaging mirror as stated in Goodman), EX1016 at 7:17-30, would be configured to receive light from a typical optical communications optical fiber. As I discuss in the Overview of the Relevant Technology and incorporate here, optical communications optical fibers are typically at least ten times smaller (and likely a hundred times smaller) in diameter than the large core optical fibers used in Chandler and Oostman. The angle of light emitted by the large-core fibers used in Chandler and Oostman would mean that Goodman's imaging optical element 18, as designed for optical communications, would fail to reflect most of the light and thus would result in very large collection losses, severely limiting the ability to detect fluorescent light with this substitution. *See supra* Section IV.C.1. I illustrate the differences in the light path below:



EX1016 at FIG. 1 (annotated). One could attempt to reduce the distance from Goodman’s optical fiber 15 to its imaging optical element 18. However, in order for this to work, the fiber would have to be extremely close to the imaging optical element 18. Although this might result in most of the light actually hitting the mirror, the majority of light reflected by the mirror would not clear the fiber coupling 30 to reach mirror 20. And doing the converse—using a typical optical communications fiber—would fail to transmit much of the fluorescent light initially collected because much of the light would have to be focused down beyond the acceptance angle of the fiber. *See supra* Section IV.C.1.

117. Coming back to Dr. Ilkov’s statements that a POSA would have identified various deficiencies in Chandler and Oostman (which I dispute below) and

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“would naturally have consulted alternate WDM arrangements, including Goodman’s WDM,” EX1002, ¶¶112, 163; Pet. at 29, 60, I note that Dr. Ilkov identifies no references supporting this statement.

118. In fact, Dr. Ilkov’s first evidence for combining these disclosures or suggesting to do so is in the disclosure within the ’106 patent from around ten years after Chandler, Oostman, and Goodman. Dr. Ilkov also notes that Frazier in a background section “refers in its specification to [a zig-zag] detector array configuration by pointing to U.S. Patent No. 4,244,045 to Nosu (EX1010, “Nosu”), a demultiplexer device used in the optical communications industry.” EX1002, ¶49 (citing EX1010 at 2:9-24); Pet. at 9. However, Dr. Ilkov does not discuss the very next passage of Frazier, which discusses how it views the “prefabricated blocks” in that disclosure among others as not optimal compared to more “customizable” options. EX1009 at 2:25-46. Customizability, as I discuss below, was also of importance to both Chandler and Oostman.

119. Dr. Ilkov next states that Goodman “is in the same fields as the alleged invention related to optical fibers and, more particularly, modular optical instruments for color separation and detection.” EX1002, ¶¶112, 163; Pet. at 29, 60. In my view, this characterization overgeneralizes and mischaracterizes the field and would sweep in numerous fields beyond even optical communications and flow cytometry.

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120. In reviewing Goodman, I identified no discussion or evidence suggesting relevance of its disclosure to flow cytometry or any life sciences application. Goodman states its devices “are particularly suited for use in wide wavelength division multiplexing (WDM) systems,” which Goodman states utilizes wavelengths centered at 1310 nm with channel spacing 25 nm apart, rather than flow cytometry’s typical visible light wavelength ranges. EX1016 at 5:42-47, 2:20-29, EX1001 at 57:64-66. Dr. Ilkov notes Goodman’s statement that its invention “is easy to incorporate into other optical systems,” EX1002, ¶¶113, 168; Pet. at 30, 61; *see also* EX1016 at 3:65-67. However, this is a generic statement that does not work to explain how or why it is easy to incorporate into other optical systems. Regardless, a POSA would understand this statement to mean that Goodman’s demultiplexing device could be incorporated into other optical communications systems or similar technologies, not flow cytometers or particle analyzers. In fact, Goodman elsewhere describes its envisioned scope: “The scope of applications for WDM devices ranges from spacecraft and aircraft applications to closed circuit and cable television systems.” EX1016 at 2:10-13.

121. I similarly have not identified any statement in Chandler or Oostman that might direct a POSA to consider optical communications art as within the same field or particularly relevant to problems in flow cytometry, nor have I seen any statement from Dr. Ilkov suggesting as much.

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122. Of the life sciences references discussed by Dr. Ilkov, the only one Dr. Ilkov identifies as even mentioning art from optical communications is Frazier. EX1002, ¶41 (citing EX1010 at 2:9-24); Pet. at 11-12. As I previously noted, Frazier in turn cites to U.S. Patent No. 4,244,045 to Nosu, which was filed in 1979. Frazier's discussion of Nosu is limited to one paragraph describing "[a] second type of detector array configuration." EX1009 at 2:9-24. Frazier then states that this reference and another have detector assemblies that "are generally prefabricated blocks," and goes on to discuss Frazier's "problems" with these blocks including regarding customizability. EX1009 at 2:9-46. Thus, Frazier in fact discourages the direct adaptation of communications references for flow cytometry. A single mention and subsequent dismissal of a 30-year old optical communications reference in a flow cytometry reference does not in my view constitute any kind of encouragement for a POSA to look at optical communications art to solve a flow cytometry problem. Quite the contrary, it is a discouragement.

123. Aside from prior art references, Dr. Ilkov also states that he had, in his pre-2011 work experience, "extensively reviewed demultiplexing technologies from the field of optical communications in the design of a next-generation mini flow cytometer." EX1002, ¶166. To the extent Dr. Ilkov had personally reviewed any such references, I do not see that reflected in any cited references or my understanding of the state of the art prior to the inventions in the '106 patent. Nor

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do I think this constitutes motivation for a POSA to do the same based on the cited references such as Chandler and Oostman.

124. Dr. Ilkov also cites several phrases from the '106 patent specification to discuss how the inventor would have considered communications devices. EX1002, ¶¶116, 168; Pet. at 31, 61-62. In my opinion, none of these statements indicate that Goodman, or any optical communications reference, would have been considered by a POSA for addressing problems the inventor was seeking to solve.

125. First, Dr. Ilkov's first excerpted quote ignores the context of the specification: "[As a result], WDM techniques well-established in the optical communication industry can be readily adapted for fluorescence light detection" does *not* say that telecom WDMs can simply be used for fluorescence applications, but at most states that the inventor identified how they can be *adapted* to do so. The '106 specification in fact spells out the adaptations (innovations) that allowed their use. The notable omission of the adjunct clause "as a result" disconnects the sentence from the preceding description of how to adapt the WDM for these purposes (such as, e.g., "extend[ing] the collimated optical path length without large beam expansion). EX1001 at 4:57-67. The fact that techniques from a different field can be adapted "[a]s a result" of the claimed invention simply demonstrates that the adaptation of a WDM concept from a different field is in fact one of the claimed inventions.

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126. Second, Dr. Ilkov additionally recites a quote from the '106 patent that certain fluorescent detection systems “are almost identical in function and architecture to the wavelength division multiplexers (WDM) widely used in optical communication.” EX1002, ¶¶116, 168 (citing EX1001 at 44:39-47); Pet. at 31, 61-62. However, this omits the following discussion of why telecom demultiplexing devices could not previously be used for fluorescence detection, EX1001 at 45:3-23 (noting, e.g., how light in flow cytometry enters a detection system from a large optical fiber, producing a larger light beam compared to optical communications). *See also supra* Section IV.C. The '106 patent discusses how these differences in flow cytometry fluorescence detection create challenges in controlling the light beam entering the detection system over an extended distance and focusing the beam onto the detectors, as is needed for effective detection. *Id.* at 44:47-67. The '106 patent also explains that these fundamental differences “prevent[ed] the use of small area APD in fluorescence detection instrumentation,” despite APDs having “wide acceptance [] in optical communication.” EX1001 at 44:34-67.

127. In sum, Dr. Ilkov’s statements that a POSA would combine a demultiplexing device from optical communications to improve a flow cytometer is, in my opinion, based on pure hindsight. The fields of optical communications and flow cytometry fluorescence detection were markedly different, and Dr. Ilkov does not provide support in the literature to demonstrate that a POSA would have turned

to the optical communications field despite these differences. Dr. Ilkov also does not explain how Goodman's demultiplexing device would work with light emitted from a flow cytometry fiber optic, nor how Goodman's fiber optic would work in a flow cytometer, and he does not propose any modifications to Goodman that would allow it to function as a flow cytometry WDM as recited in the '106 patent's independent claims. Thus, in my opinion, Petitioner's combination fails to render obvious a "wavelength division multiplexer (WDM)" for use in "a flow cytometer," as required by all claims.

**3. Petitioner Fails to Show that Goodman Is Analogous Art to the Claimed Inventions**

128. As I explained above in Section II.D, I understand and have been informed by counsel that prior art references must qualify as "analogous art" to be considered in an obviousness analysis. I understand that, to be analogous art, the reference must (1) be from the same field of endeavor as the challenged claims; or (2) be reasonably pertinent to the particular problem with which the inventor is involved. I understand that a reference is reasonably pertinent if it, as a result of its subject matter, logically would have commended itself to an inventor's attention in considering his problem.

129. For similar reasons as I discuss in the preceding section and incorporate here, it is my opinion that Goodman is not analogous art that can be afforded any weight in the obviousness analysis.

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130. First, it is my opinion that Goodman is not from the same field of endeavor as the challenged claims. As I discuss in the preceding section and incorporate here, Dr. Ilkov characterizes Goodman and the '106 patent far too broadly to meaningfully group technologies into the same “field.” To best understand the field of the '106 patent's inventions, I would look to the '106 patent itself.

131. Second, it is my opinion that Goodman is not reasonably pertinent to the particular problem with which the inventor is involved. Dr. Ilkov's statement that Chandler, Oostman, and Goodman “are directed to the same problems faced by the inventor of efficiently demultiplexing and detecting light,” EX1002, ¶¶112, 163; Pet. at 29, 60, is misleading. As I have noted, the problem of “efficiently detecting” in optical communications would have been interpreted as having low insertion loss, measured at the level of tenths of milliwatt, whereas in a fluorescence system, efficiency would have been recognized as more a matter of millionths of milliwatts. *See supra* Section IV.C.2. The '106 patent specifically describes the problems that its inventor was able to solve: to create “an improved flow cytometer” that is “reliable, compact and easy to manufacture,” and “provide[] a Wavelength Division Multiplexing (WDM) system to separate a light beam into multiple colored bands” that “may be compatible with low noise semiconductor detectors” and “may be reconfigurable.” EX1001 at 2:1-40.

132. Thus, in my opinion, a POSA faced with the problems of trying to control and focus a large, diffuse beam diameter over an extended distance, would not have found optical communications references dealing with narrow, intense beam diameters reasonably pertinent to that particular problem.

**4. Chandler and Oostman Would Not Be Improved By Goodman**

133. In my opinion, Petitioner also has not demonstrated that a POSA would have looked to Goodman to modify Chandler or Oostman. Petitioner relies on Dr. Ilkov to argue that a POSA reviewing Chandler or Oostman “would have recognized” various issues in its respective fluorescence detection design, and that a POSA would have found solutions in Goodman’s disclosure. EX1002, ¶¶111-115, 161-165; Pet. at 28-31, 60-61. I disagree with these assertions, and in fact, Oostman’s disclosure expressly contradicts these assertions, as I discuss below.

*i. The proposed combinations would remove Chandler and Oostman’s features that improve the prior art*

134. Petitioner relies on Dr. Ilkov to argue that a POSA would have to sought to “provide an improvement in harmony with Chandler’s design goals” and “to improve Oostman’s design” with Goodman. EX1002, ¶¶113, 161; Pet. at 24-26. Dr. Ilkov does not cite any evidence to support this contention. Also, as I discuss below, Chandler and Oostman expressly described the very same features Petitioner and Dr. Ilkov would remove as a *feature* of the respective invention and an *improvement*

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over the prior art. Therefore, it is my opinion that a POSA would not seek to change Chandler or Oostman in the way proposed.

135. Dr. Ilkov states that a “POSA seeking to reduce the footprint of Chandler’s FADC units, while also ensuring efficient, accurate, and (if possible) expanded color separation and detection, would naturally have consulted alternate WDM arrangements, including Goodman.” EX1002, ¶112; Pet. at 29. Dr. Ilkov also states that a “POSA would have recognized that the ability to perform color separation for additional spatially separate lasers in Oostman’s system comes at the cost of overall footprint and scalability.” EX1002, ¶161; Pet. at 62. However, Dr. Ilkov provides no reason why Goodman would reduce the size of Chandler or Oostman and cites no supporting evidence.

136. Dr. Ilkov states that “Oostman’s polygonal WDM clusters ... only permits ‘between five and ten light detectors in a common plane,’ a potential design constraint that limits how finely grained light fed into a detector cluster from an optical fiber can be separated.” EX1002, ¶161 (citing EX1005 at 3:53-55).

137. In contrast to Dr. Ilkov’s statements, Oostman states that its number of detectors (as well as its “modular design that feeds a ‘greater number of fibers’ that can ‘feed a greater number of [detector] clusters’”, EX1002, ¶161 (citing EX1005 at 4:14-16) as one of its key features improving upon the prior art, rather than a “potential design constraint” of its device. EX1005 at 3:42-55 (noting differences

over the prior art and concluding that “[b]y using reflective transfer legs for most detectors, the detectors may be clustered in a polygonal arrangement of between five and ten light detectors in a common plane”); 4:14-16 (“Moreover, the apparatus is modular because a greater number of fibers can feed a greater number of clusters.”).

138. I have seen no evidence suggesting that “between five and ten detectors in a common plane” is “a potential design constraint that limits how finely grained light fed into a detector cluster from an optical fiber can be separated.” EX1002, ¶181 (citing EX1005 at 3:53-55); Pet. at 24. In fact, Oostman itself states that its detector clusters are such that “the instrument of the present invention has a wide spectral response.” EX1005 at 6:36-39. I also note that, as Dr. Ilkov acknowledges, Oostman’s device was expressly designed to “provide an improved system for detecting fluorescent light having multiple colors emitted from a target using a greater number of detectors than has been achieved in the prior art.” EX1002, ¶161; (quoting EX1005 at 2:60-64); Pet. at 26; *see also* EX1002, ¶161 (quoting EX1005 at 4:14-16).

139. I have also not seen any evidence, other than the inclusion of high-level statements from Goodman that its design “is easily scalable” (EX1002, ¶113 (citing EX1016 at 3:48-68); Pet. at 30), that indicates that Goodman would even provide an improvement over Chandler or Oostman. For example, Goodman discloses that its demultiplexing device preferably has four “wavelength selective elements [e.g.,

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filters] 22a-22n,” i.e., four channels for wavelength separation, and therefore four detectors that would receive light from those filters. EX1016 at 8:28-29.

140. Although Goodman contemplates that more channels may be added, it also states that the number of channels is limited by “the attenuation of the beam of light that will occur and the number of wavelength channels that can be multiplexed.” EX1016 at 8:27-35. In other words, Goodman describes functional limits in terms of how many channels its device can maintain a strong beam of light for demultiplexing different wavelengths of light. Indeed, CWDM was commonly used for between 2-4 channels, either as 1310/1550 nm or 4 channels in the 1310 nm or 1550 nm band. *See, e.g.*, EX2031 at 4, 8-9.

141. A POSA would understand that this practical challenge of maintaining signal strength across an optical path through multiple optical elements is similarly present in flow cytometry—indeed, this is even more of a concern in fluorescence detection systems where the starting signal is orders of magnitude lower than in optical communications—and a POSA would therefore not expect for Goodman to provide for an improvement over Chandler or Oostman. *See, e.g.*, EX1005 at 3:42-57, 4:16-24.

142. Although Dr. Ilkov opines that that “the combination of Chandler and Goodman replaces the star configuration from Chandler’s FADC unit(s) with an alternative, known zig-zag demultiplexing configuration described in Goodman”

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(EX1002, ¶128; Pet. at 40, suggesting Petitioner seeks to only modify Chandler to a “zig-zag demultiplexing configuration”), Petitioner relies solely on Goodman for disclosure of most components within the claimed WDM. *See, e.g.*, Pet. at 41-52, 55-59; EX1002, ¶¶129-147, 154-159 (relying only on Goodman’s disclosure for claims 13[d]-[g], 14, and 17).

143. Petitioner also relies on Dr. Ilkov to state that a POSA would not view adding further detector clusters, as described in Oostman, as preferable compared to increasing the number of detectors per cluster because, according to Dr. Ilkov, adding additional clusters would “increase complexity in the geometry of the optical fibers” feeding to each separate detector cluster and “does not reduce but merely redistributes the flow cytometer’s overall footprint.” EX1002, ¶161. I disagree with these assertions for the reasons discussed below.

144. First, as I discussed in the preceding paragraph, I have seen no literature or explanation cited by Dr. Ilkov or Petitioner demonstrating that Goodman’s demultiplexing device would allow an increased number of detectors than one of Oostman’s detector clusters. In my opinion, even if a POSA were to incorporate Goodman’s demultiplexing device into Oostman’s flow cytometer, they would need to use multiple copies of Goodman’s demultiplexing devices, thereby again mandating division of the fluorescence signal into multiple fibers (and a zero-sum proposition over Chandler).

145. Second, Dr. Ilkov’s statement that Oostman’s use of multiple clusters “does not reduce but merely redistributes the flow cytometer’s overall footprint,” EX1002, ¶161, is strange. If Goodman did in fact allow for more filters and detectors in one device compared to Oostman’s clusters, Goodman would also simply “redistribute[]” the footprint, but this time in a vertical or horizontal direction depending on which way it is placed on a bench (i.e., one long row of filters and detectors).<sup>2</sup> I do not see any evidence how, for example, one long device with twenty channels necessarily has a reduced footprint compared to Oostman’s disclosed footprint (and even if it did, what effect that might have on Oostman’s functionality). Third, Oostman illustrates that more channels can be easily accommodated via a number of means including the multi-spot laser configuration of Fig. 4. Fourth, the footprint of the cytometer of Oostman is limited by the size of the PMTs, which are required for the system to operate, and Dr. Ilkov has not shown any motivation for a POSA to adapt, nor any method by which a POSA would adapt, the WDM of Goodman to use PMTs, let alone that such an adaptation would have a reduced

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<sup>2</sup> As I discuss in a later section, Oostman discloses that its specific configuration is actually more compact than Goodman’s when accounting for the size of PMTs. *See infra* Section X.A.

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footprint over Oostman. Given that Oostman already describes a zig-zag topology using PMTs, this “advantage” of the combination is unsupportable.

146. Thus, it is my opinion that Petitioner’s rationale for combining Goodman and Oostman is not supported by Goodman and Oostman, but is instead based on hindsight.

*ii. Chandler’s FADC units and Oostman’s detector clusters are design choices that would be negated by Goodman’s optical block and Frazier teaches against using an optical block*

147. Petitioner and Dr. Ilkov fail to acknowledge that Chandler and Oostman were both designed for problems specific to fluorescent detection, and that incorporating Goodman’s design would not benefit either system.

148. Chandler states that “[a]t any given excitation wavelength, I have determined that there are often only about two or three commercially available dyes that emit a spectrum of wavelengths narrow enough and sufficiently separated enough that they are individually measurable simultaneously.” EX1051 at 2:37-42, 2:30-32 (“I have determined that the properties of the fluorescent dyes themselves limit this flow cytometric technique to about three different wavelengths.”). Chandler’s solution is to use multiple lasers of different emission wavelengths and angled in different directions, so that some light scattered from every laser will hit the different collecting elements, but each of the four FADC units has its *own* set of bandpass filters to filter the wavelengths emitted from each laser. EX1051 at 7:1-

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8:8, FIG. 4 7:24-34 (“Each optical detector can be associated with an adjacent, near, or operationally responsive laser diode. Optical detector 20 detects emissions resulting from excitation by, for example, laser diode 10; optical detector 22 detects emissions resulting from excitation by, for example, laser diode 12, and the like.”). Incorporating Goodman’s configuration into each one of Chandler’s FADC units—even if Goodman’s configuration can detect more than three channels—would not provide any benefit to Chandler because of Chandler’s self-described limitations on the number of channels that would be useful in each branch.

149. Another feature of Goodman that Petitioner, relying on Dr. Ilkov, cites heavily upon for motivation to combine is Goodman’s “optical block with integrated filters and reflectors.” Pet. at 60-61; EX1002, ¶165. According to Dr. Ilkov, Goodman’s optical block “reduces optical alignment challenges with thermoplastic molded integrated componentry, reducing the time, labor, and costs associated with optical component calibration that would have been more prevalent in the Oostman detector arrays.” EX1002, ¶165; Pet. at 60-61. I disagree with these assertions.

150. First, Goodman’s prefabricated optical block configuration with integrated filters, *see* EX1016 at 8:37-50, 10:45-59, cl. 9, runs contrary to express teachings discussed in Oostman’s flow cytometer, which emphasizes providing an adjustable flow cytometer and thus rejects a prefabricated configuration for wavelength detection. EX1005 at 8:35-40 (“The dichroic mirror holders and the

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filter holders are mounted in vertically removable housings so that dichroic mirrors and associated filters may be interchanged or replaced.”); *see also, e.g.*, EX1009 at 2:27-38.

151. Optical communications demultiplexing devices have industry-standard channels that rarely, if ever, need to be changed due to predictable inputs of wavelength and intensity entering the devices. *See, e.g.*, EX2032; EX2033. In contrast, Oostman recites interchangeability of its detector clusters as a feature of its invention. *See, e.g.*, EX1005 at 8:19-20 (“Each lens 265 is movable for adjusting the focal spot during calibration of the instrument.”); *id.* at 8:35-40; *see also id.* at 5:62-6:5; 8:48-9:3.

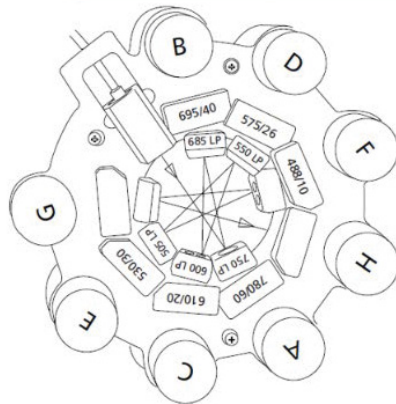
152. Goodman’s injection-molded design, with optical elements adhesively bonded in place (which is common in telecom devices), runs contrary to Oostman’s teachings regarding ease of changing filters. Goodman’s optical block would not (and would not need to) allow changing filters to adapt to different wavelength bands as Oostman describes. EX1016 at 8:44-47. In fact, Frazier cited similar considerations in rejecting the applicability of an optical communications device to its life sciences fluorescence detection instruments. *See* EX1009 at 2:27-38. As one real-world example, the BD LSR Fortessa (which is marked with Oostman, EX2023 at 2) provides various mirror and bandpass filter options depending on fluorophores are to be measured:

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Five-color blue laser configuration

The following map shows the five-color configuration for the 488-nm blue laser.

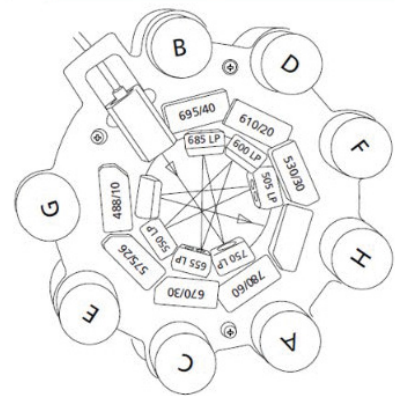
PMT	LP mirror	BP filter	Fluorochromes
A	750	780/60	PE-Cy7
B	685	695/40	PerCP-Cy5.5
C	600	610/20	PE-Texas Red®
D	550	575/26	PE
E	505	530/30	FITC, Alexa Fluor® 488
F	Blank	488/10	SSC



Six-color blue laser configuration

The following map shows the six-color configuration for the 488-nm blue laser.

PMT	LP mirror	BP filter	Fluorochromes
A	750	780/60	PE-Cy7
B	685	695/40	PerCP-Cy5.5
C	655	670/30	PE-Cy5
D	600	610/20	PE-Texas Red®
E	550	575/26	PE
F	505	530/30	FITC, Alexa Fluor® 488
G	Blank	488/10	SSC



EX2023 at 140-141 (annotated).

153. Dr. Ilkov also cites alignment challenges as a reason a POSA might prefer Goodman’s “block with integrated filters and reflectors.” EX1002, ¶165; Pet. at 60-61. I disagree with this argument as well because Oostman emphasizes features for adjusting alignment. Oostman teaches that the option of adjusting alignment is an important feature for the customization of wavelength bands. *E.g.*, EX1005 at 8:49-50 (“The beam splitter mirror 321 is held in a mirror holder frame *at a desired angle.*”), 8:61-65 (emphasizing ability to adjust focusing lenses to focus light at more sensitive spots on PMTs).

## Expert Declaration of David Schaafsma

154. Further, Oostman describes in Figure 7 its detector clusters with mechanically-stabilized mounts which was often accomplished with small (e.g. set screw) adjustments for critical components, that allow for easy alignment adjustments. *See* EX2023 at 140-141; *see also* EX1005 at 5:63-6:23, cl. 32. In my opinion, a POSA would thus understand that adhesively bonding optics inside a molded thermoplastic was not the only, nor indeed the best, route to achieving ease of alignment and mechanical stability.

*iii. In my opinion, Petitioner fails to adequately explain why a POSA would select Goodman's zig-zag pattern*

155. Petitioner relies on Dr. Ilkov to state that it would have been obvious to try Goodman's WDM in Chandler or Oostman to reach the limitations of all challenged claims because Goodman's zig-zag pattern "is an alternate, known option to the polygonal arrangements in Oostman's detector arrays, and one of several options available to a POSA at the time of the invention. EX1002, ¶¶ 115, 167; Pet. at 30-31, 62. Dr. Ilkov and Petitioner states that "[t]he Goodman demultiplexers are also smaller, more scalable, and more portable than Oostman's configuration," though Dr. Ilkov and Petitioner do not cite anything to support this statement. EX1002, ¶165; Pet. at 60-61. In my opinion, Petitioner and Dr. Ilkov have not provided sufficient evidence to establish that incorporating Goodman's demultiplexer would result in a smaller system. Indeed, Oostman's star-shaped pattern is described as a more compact detector module. EX1005 at 7:32-36.

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156. The only evidence cited in the Petition or Dr. Ilkov's declaration for the respective sizes of the devices is a single figure from Oostman with no means of comparing the size with Goodman's device. EX1002, ¶161; Pet. at 60-61. I have not identified any discussion or evidence demonstrating that a POSA could adapt Goodman for Oostman's flow cytometer, or whether, if Goodman was in fact adapted, Goodman's device would actually be smaller than Oostman's detector module. A POSA would understand that the limiting factor in Oostman's footprint is the PMT cluster and that Goodman offers no solution to this problem.

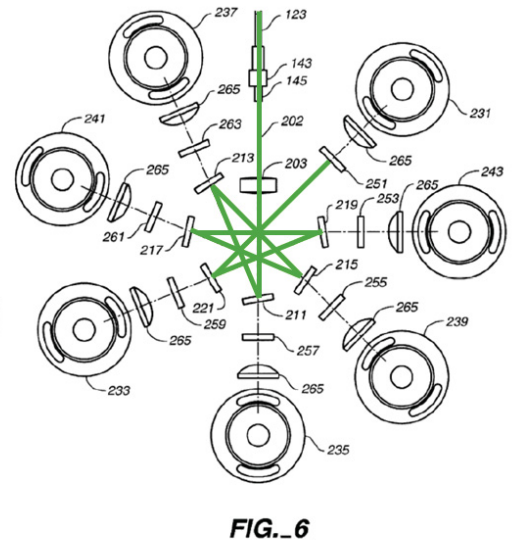
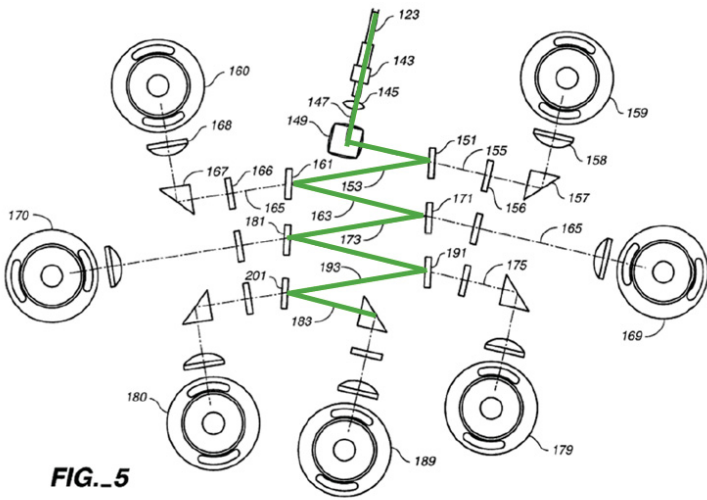
157. Oostman actually discloses that its star-shaped configuration is *more compact* than a zig-zag configuration:

In FIG. 5, the transfer leg forwarded upstream from one beam Splitter to the next follows a zigzag pattern. In FIG. 6, the transfer legs intersect in a star-shaped pattern yielding a *more compact* polygonal arrangement of detectors.

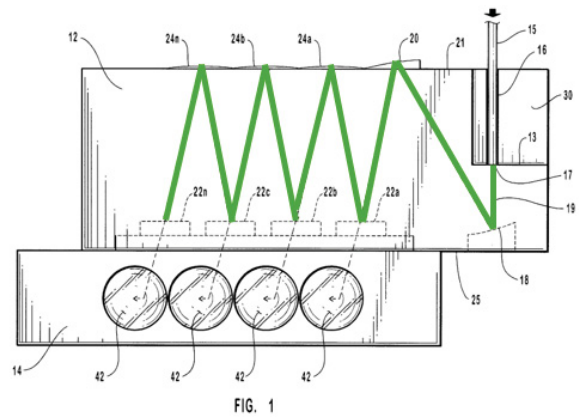
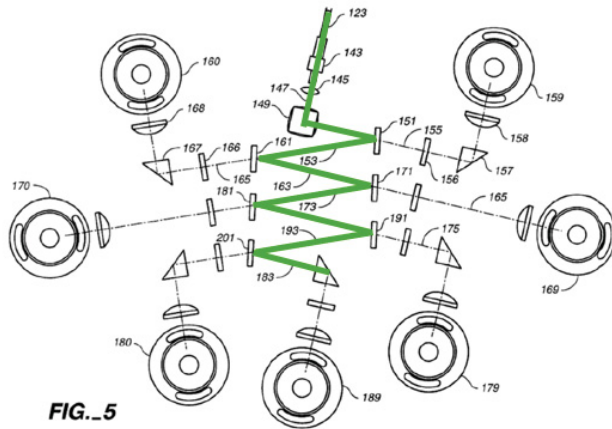
EX1005 at 7:23-36.<sup>3</sup> I have annotated Figures 5 and 6 of Oostman below to illustrate the relative optical paths between Figure 5 (zig-zag) and Figure 6 (star):

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<sup>3</sup> All emphasis added unless otherwise stated.



## Expert Declaration of David Schaafsma



EX1005 at FIGS. 5 (annotated); EX1016 at FIG. 1 (annotated); Pet. at 29 (“Goodman provides a zig-zag pattern in an optical block that was widely accepted in optical communications and had long found adoption within flow cytometry applications.”). Dr. Ilkov’s analysis does not take into account why a POSA would replace Oostman’s preferred star-shaped configuration with Goodman’s zig-zag demultiplexing configuration when Oostman already discloses that a zig-zag configuration is less compact than its star-shaped configuration in FIG. 6.

159. Finally, if a POSA were to hypothetically consider replacing Oostman’s star-shaped configuration Goodman’s zig-zag demultiplexing device, Petitioner fails to establish that the combination would have a more “simple geometric design.” For example, Oostman’s FIG. 5 shows beam turning elements directing light into the PMT detectors, but a closer review of Goodman reveals these types of components would also be present upon combining Goodman and Oostman. Particularly, Goodman states that its configuration includes a “beam folding mirror” that “bends

the wavelength beams and redirects them toward the series of focusing lenses,” including bending light at angles of 90 degrees. EX1016 at 12:26-32.

160. Thus, in my opinion, there is nothing in Goodman that a POSA would look to in order to reduce “complexity.”

**5. Petitioner and Dr. Ilkov Fail to Explain How Goodman Would Improve Chandler or Oostman Specifically**

161. Dr. Ilkov and Petitioner rely on a series of quotes taken from Goodman’s summary section in order to support the motivation themes discussed above. EX1002, ¶78; Pet. at 30. In my opinion, these quotes do not demonstrate how Goodman would improve Oostman or supply a motivation to combine the two references.

162. The first four quotes cited by Dr. Ilkov, directed towards ease of fabrication, have no context for which to compare the simplicity or complexity of Goodman’s manufacturing method compared to Oostman’s holder (indeed, the holders disclosed in Oostman Figures 7 and 8 are eminently injection-moldable

## Expert Declaration of David Schaafsma

pieces), nor is there any explanation of why any theoretical benefits would outweigh Oostman's stated benefits of customizability and reduced size.<sup>4</sup>

163. The fifth quote cited by Dr. Ilkov, that Goodman's WDM is "easy to incorporate into other optical systems," Pet. at 30, is a generic statement as I have previously discussed, and a POSA would not, in my opinion, take this quote as a suggestion to try to incorporate Goodman's device into a flow cytometers. And further, Goodman never mentions any life sciences application, including flow cytometry, such instead describes relevant applications for its technology was "spacecraft and aircraft applications" and "closed circuit and cable television systems." EX1016 at 2:10-13. Finally, Goodman's statement that its demultiplexing device "is easily scalable or modified," ignores that Chandler's and Oostman's

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<sup>4</sup> Dr. Ilkov also argues that Goodman's design is smaller and would allow for "reducing the bill of material (BOM) costs by using less materials." EX1002 at ¶¶114, 165. But as I have discussed above, Goodman's design is *not* necessarily smaller, and if a POSA were to implement Goodman's design, they would likely end up with a topology similar to Oostman's Figure 5. Nor is smaller necessarily cheaper. I have not seen any evidence, whether in the form of exemplary BOM costs or otherwise, to assess costs of manufacturing between Oostman and Goodman.

## Expert Declaration of David Schaafsma

systems are similarly, or more, easily scalable as I have discussed above. *See* Section X.A.4.

164. I have addressed in detail why Goodman's zig-zag pattern and optical block would not improve Oostman's design based on Oostman's express disclosures. But even if either feature did result in some improvement, I see no reason why (and Dr. Ilkov does not discuss why) a POSA would further change every other aspect of Oostman's design (e.g., its dichroic filters, bandpass filters, etc.), in favor of Goodman, or even simply remove Oostman's detector clusters completely and slot in Goodman's demultiplexing device without further adjustments. This is particularly the case here, where Oostman already provides a zig-zag pattern utilizing Oostman's optical elements.

165. I disagree with Dr. Ilkov's underlying assumption that a POSA would, without thought, change Oostman's entire arrangement or view each additional difference between Oostman and Goodman as irrelevant.

166. Thus, it is my opinion that Goodman would not offer a POSA any advantage in compactness, reduced complexity, stability, or scalability. There is not one single element in Dr. Ilkov's or Petitioner's arguments for motivation to combine that clears even the lowest bar to compel a POSA to seek Goodman for remedy. In my opinion, the Petition's motivation to combine analysis is in fact

completely based on hindsight, devoid of substantive arguments in this respect, and should be rejected for these reasons.

**B. It Is My Opinion that Petitioner Fails to Demonstrate a Reasonable Expectation of Success**

167. I have reviewed Petitioner's single paragraph in its Petition, and Dr. Ilkov's similar paragraph in his declaration, stating that a POSA would have had a reasonable expectation of success in implementing Goodman's WDM into Chandler or Oostman. Pet. at 31, 61; EX1002, ¶¶116, 172. Dr. Ilkov (and Petitioner) cites to the following evidence supporting this assertion: 1) two statements from Goodman stating its WDM could be incorporated into other generic optical systems; and 2) statements from the '106 patent itself; and (cited only in the Petition). I disagree that any of these pieces of evidence provide such support. Further, Dr. Ilkov does not discuss the practical considerations in how Chandler or Oostman and Goodman could be combined.

168. First, as I discussed above, a POSA would not simply take Goodman's generalized statement about ease of incorporating into "other optical systems" at face value, and Goodman does not explain how its optical communications demultiplexing device could be incorporated into a flow cytometer fluorescent detection system or any fluorescence measurement system. *See supra* Section X.A.1.

169. Further, as I have previously discussed, Goodman itself states that relevant applications for its technology range from "spacecraft and aircraft

applications to closed circuit and cable television systems.” EX1016 at 2:10-14; *see supra* Section X.A.1. These applications do not have any connection to life science fluorescent light detection systems, and I thus do not view Goodman’s statements as supporting a reasonable expectation of success.

170. For point 2, as I have discussed above, the statements cited from the ’106 specification, actually highlight the *challenges* in translating WDMs from optical communications to flow cytometry prior to the inventions disclosed in the ’106 patent. EX1001 at 45:10-27. *See supra* Section X.A.1. I have not seen any evidence provided from Cytek that a POSA would have, in view of any prior art, had a reasonable expectation of success in combining Goodman with Oostman.

171. Finally, though Petitioner proposes incorporating Goodman’s entire WDM into Chandler’s or Oostman’s flow cytometer, Petitioner does not explain how Goodman’s entire system would work in a flow cytometer, nor how a POSA would reasonably expect it to work.

172. Other issues are similarly left to the imagination by Petitioner’s lack of explanation. The imaging elements and general optical architecture in Goodman, for example, are designed to receive light from a small-core, low numerical aperture fiber (emitted over a small angle) such as those used in optical communications. For example, and as I have discussed, Dr. Ilkov does not consider whether Goodman’s imaging elements 18 and 20 would function when receiving light from a large

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diameter flow cytometry fiber optic which produces light at an etendue hundreds of times greater than what they were designed for, nor does he consider whether Goodman's optical communications fiber optic would receive sufficient fluorescent light to allow for meaningful detection, nor whether Goodman's detectors designed for optical communications would be operable in a flow cytometer.

173. A large fiber with a large numerical aperture, as used for fluorescence, would emit light over a much larger angle, necessitating at least larger and/or closer optics in Goodman's design, which in turn introduces the potential for other problems such as mechanical interference (blocking collected light, such as elements 18 and 30 in Fig. 1). Larger diameter optics alone would necessitate a full reconsideration of Goodman's design, and this again raises the question of why a POSA would go to such lengths when presented with the result of such a design exercise by Chandler or Oostman. Finally, the adaptation of Goodman's design to use PMTs, as required in the flow cytometer of Chandler or Oostman, (or vice versa) is not straightforward and no description of this design alteration is provided by Goodman, Oostman, Chandler, or Dr. Ilkov.

**XI. IT IS MY OPINION THAT THE PETITION AND DR. ILKOV’S OPINIONS DO NOT DEMONSTRATE A REASONABLE LIKELIHOOD THAT THE CHALLENGED CLAIMS ARE INVALID AS LACKING WRITTEN DESCRIPTION SUPPORT**

**A. It is My Opinion that Petitioner and Dr. Ilkov Fails to Demonstrate Lack of Written Description for a “Curved Mirror”**

174. As I discuss above in Section X, which I incorporate here by reference, both the ’106 Patent and its earlier priority applications have written description support for the claimed “curved mirror.” Dr. Ilkov repeats his assertion that the challenged claims lack written description support for this element, EX1002, ¶201, and I disagree for the reasons I describe above. *See* Section .A.

**B. It is My Opinion that Petitioner and Dr. Ilkov Fails to Demonstrate Lack of Written Description for “Semiconductor Detector”**

175. As I explained above in Section IV.C, which I incorporate here by reference, a POSA would understand that semiconductor detectors are simply photodetectors that detect light using semiconductor materials to convert light received at their active area into an electrical signal. Photodiodes, avalanche photodiodes, and carbon nanotubes each fit within this categorization, and the description of semiconductor detectors in the ’106 Patent provides more than sufficient direction to a POSA on the structural and functional properties of semiconductor detectors the inventor possessed as of the provisional application.

## Expert Declaration of David Schaafsma

176. Dr. Ilkov opines that “the written description provides no teaching to guide a POSA toward the design of a carbon nanotube detector or its implementation within the claimed WDM.” EX1002, ¶¶212. As an initial point, the requirement in the specification is not for the design of such a detector, but simply its use in a flow cytometer.

177. Second, the implementation with the WDM would be well understood by a POSA to be a substitution for other types of semiconductor detectors like APDs. Publications had described the use of CNT detectors by the priority date of the ‘106 Patent, and detectors based on a familiar type of semiconductor junction (Schottky contact) were being made, many with small active areas similar to APDs.

178. Dr. Ilkov provides no technical rationale that would prevent a POSA from implementing carbon nanotube detectors into a flow cytometer of the ‘106 Patent, and instead cites to a purported absence of evidence that carbon nanotube detectors are viable for detecting fluorescent light such as in a flow cytometry system. *See, e.g.*, EX1002, ¶207. But this purported absence of evidence is false: carbon nanotube detectors had already been demonstrated as viable for life sciences fluorescence detection long before 2021, and even before 2012. For example, a 2008 article by Zhou et al. demonstrated nanoscale color detection using a single-walled carbon nanotube functionalized with azobenzene chromophores, stating that its

## Expert Declaration of David Schaafsma

carbon nanotube detector provided for “controlled detection of visible light of low intensity in narrow ranges of wavelengths.” EX2047.

179. Dr. Ilkov’s assertion that a POSA could not have made use of these carbon nanotube detectors using the inventions described in the ’106 Patent is thus demonstrably wrong.

## **XII. RIGHT TO SUPPLEMENT**

180. I reserve the right to supplement my opinions in the future to respond to any arguments that Patentee raises and to take into account new information as it becomes available to me.

**XIII. JURAT**

181. I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: December 20, 2025



David Schaafsma, PhD

# APPENDIX A

# CV for David Schaafsma

dschaafsma@calopten.com

## Selected Expertise

- Medical product design / development
- Optics - geometric, diffractive, waveguide, optical technology, optical materials, optical systems design
- Networks, data links, protocols
- Fiber optics, optical sensors
- Lasers & light systems, illumination
- Infrared materials & technology
- Imaging & microscopy (SEM & optical), spectroscopy
- Signal and image processing, spectroscopic identification & pattern recognition
- Spectroscopy, optical materials analysis
- Embedded computer systems, microcontrollers
- Software & programming, Embedded & high level languages
- Electronics, embedded design
- Sensors, data acquisition
- Semiconductor metrology, photovoltaics, renewables
- Project planning, management
- ISO 9000, SPC, GMP
- Tooling, process development
- Market, patent research
- Grant writing
- Expert witness

## Employment History

From: 2004      **California Optical Engineering, Inc.**  
To:     Present    Escondido, CA  
Position:         *President & Principal*

Consulting in technology & product development (primarily medical and industrial), over 40 associates. Specialized in software and hardware (electronics, sensors, optics) development for medical devices, communications systems, and sensing. Recent projects have included:

- ophthalmic optical therapy devices
- fundus camera systems
- optical bilirubinemia measurements for neonates
- image-based and sequential (point) genetic assays (fluorescent)
- smartphone-compatible optical assay systems
- pulse oximetry and optical blood pressure monitoring
- optical blood glucose monitoring
- optical flow cytometry
- confocal fluorescence microscopy
- optical markers of glucose concentration in the eye (lens and aqueous humor)
- optical pattern recognition for anti-counterfeit systems, development of optically-functional coatings
- ophthalmic thermal therapy devices
- design and validation of endoscopes/laryngoscopes
- design and construction of microscope systems for fluorescent assays
- laminar flow and lab-on-a-chip systems, colorimetric and fluorescent
- embedded systems for dosimetry & flow measurement
- in-vivo flow measurement for insulin dosimetry
- ECG/MCT monitors
- machine-vision flow control systems
- monitoring of optical ablation of arterial plaque
- design and experimentation for in-vivo optical probes
- machine vision for computer aided surgery
- colorimetric measurement of fluid concentration
- design of ophthalmic instruments for early detection of eye disease
- image processing for hyperthermia
- robotic automated animal marking systems
- polymer materials analysis & evaluation for angiography and angioplasty
- high-speed hybrid optical-electronic data networks
- materials for optical data storage media
- optical semiconductor metrology
- optical systems for packaging and tracking
- infrared optical imaging for cancer detection

## CV for David Schaafsma

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Core specialty areas include electronics (sensors, embedded systems, optical data transport, eCAD, programmable logic/VHDL, ARM, AVR, FPGA, DSP), software (Linux/Windows, C/C++, Java, assembly, Python), and optics (systems level design to ray trace/non-sequential modeling using Zemax, Matlab).

From: 2006      **Computer Aided Surgery Associates**  
To: 2009      La Mesa, CA  
Position:      *Vice President of Engineering*

Developed and demonstrated non-contact alignment system for prosthesis placement (navigation) during total knee arthroplasty (TKA). Image-guided system used dual-band stereoscopic camera system with image processing to analyze alignment and provide feedback to surgeons. Early sponsorship from leading orthopedic companies.

From: 2006      **California State University**  
To: 2022      San Marcos, CA  
Position:      *Adjunct Professor of Applied Physics*

Teach and develop curriculum in electronics, optics, and physics. Oversee student research projects, initiate industry collaboration with university. Lead academician in embedded systems/electronics focus of Applied Physics program, and nascent Electrical Engineering program.

From: 1999      **Ipitek/Tetra Tech Data Systems**  
To: 2004      Carlsbad, CA  
Position      *Director of Sensor Products*

Responsible for overall management and technical leadership of fiber optic sensor group (scientists, engineers, salespeople, and technicians):

- R&D, product management, engineering, business development, sales & marketing.
- Instrument electronic design: photoreceivers (e.g. low noise, high linearity and high speed), embedded processing (uC/PGA, DSP), interfacing (serial, Ethernet, some USB, displays, keypad, etc.), CPLD & FPGA (Xilinx) design.
- Redesigned temperature sensor product, improving performance & cost.
- Initiated supplier relationships with semiconductor, medical, automotive, aerospace customers.
- Designed, built, tested and sold instrumentation for semiconductor metrology, particularly wafer processing machinery, some deposition equipment.
- Designed, built, tested, and sold instrumentation for medical thermal therapy equipment, particularly hyper- and hypo-thermic methods.

## CV for David Schaafsma

dschaafsma@calopten.com

- Software development: embedded processing (ARM, 8051, x86, eZ80), DSP (Analog/TI), scientific computing, numerical modeling.
- Conceived, initiated, & directed R&D and product development in thermal, acoustic, pressure, biological, chemical, and e-field sensors, as well as communications devices & systems.
- Other R&D projects: millimeter-wave links, DWDM/UDWDM networks, wavelength cross-connects, fiber optic switches, avionics networks, free space optical communications, laser tracking systems, optical beam steering, and secure communications. Over 30 patent disclosures & 2 patent applications.

From: 1996      **U.S. Naval Research Laboratory**  
To: 1998      Washington, DC  
Position:      *Senior Scientist*

Developed devices & applications for chalcogenide (CG) fibers and integrated optics. Authored three patents, several publications resulting from research. R&D accomplishments: first chalcogenide SM fused coupler, first IR singlemode near-field optical microscope probe, first model of 1.3 um CG fiber amplifiers, made CG fiber Bragg gratings. Built electro-mechanical system for fiber tapering. Wrote optical amplifier modeling code in C using open source compiler (Windows platform). Other R&D areas: IR scene simulation, Raman amplifiers in CG, chemical sensors, microlensed fibers, photosensitive waveguides & photo-doping.

From: 1992      **National Institutes of Standards and Technology**  
To: 1996      Boulder, CO  
Position:      *Research Associate*

R&D in quantum optics of vertical-cavity surface-emitting semiconductor lasers. Set up, instrumented, wrote code for, and maintained optical characterization laboratory. Provided primary optical characterization support for all structures grown in NIST MBE machine. Designed, modeled, characterized laser structures for MBE growth. Wrote code for multilayer dielectric modeling with complex index using Borland C++. Designed instrumentation and wrote instrument control software (in Borland C) for photon counting spectroscopy system (noise floor 4 photons). Other measurements: reflectance, photoluminescence, DCXRD, SEM, and X-ray. Other R&D accomplishments: quantum well interdiffusion, crosstalk in VCSEL arrays, angular and spectral dispersion of and spectral drift of the fundamental lasing mode in VCSELs.

**CV for David Schaafsma**  
dschaafsma@calopten.com

From: 1989      **Bandgap Technology Corporation**  
To: 1992      Broomfield, CO  
Position:      *Senior Characterization Engineer*

Primary quality control officer for a start-up compound semiconductor manufacturing company. Designed & supervised construction of characterization laboratory with budget over \$2M. Developed and maintained characterization facilities (hardware, software, training, calibration, etc). Wrote numerous GUI instrument control & data acquisition applications for HP Unix workstations using XWidget & Athena toolkits. Primary technical interface to customers. Responsible for analysis and interpretation of all wafer test data. Set up and administered HP 9000 Unix cluster network for characterization and manufacturing. Trained and supervised technicians and engineers, implemented SPC. One of 4 lead engineers responsible for design and equipping of 2000 sq-ft Class 10 clean room. Techniques used: PL, photoreflectance, parametric testing, C-V profiling, Hall effect, resistivity/particulate screening, Nomarski microscopy, DCXRD, and RF device characterization.

## Patents

<u>Patent</u> <u>Number</u>	<u>Date</u> <u>Issued</u>	<u>Title</u>
6,285,811	2001	Near-field optical microscope with infrared fiber probe
5,949,935	1999	Infrared optical fiber coupler

<u>Application</u> <u>Number</u>	<u>Date</u>	<u>Title</u>
US20060191566A1	2006	Solar concentrator system using photonic engineered materials
US20070246040A1	2006	Wide angle solar concentrator
US20060174867A1	2004	Nonimaging solar collector/concentrator
US20060233492A1	2006	Optical beam combiner/concentrator
US20080170826A1	2007	Misalignment-tolerant optical coupler/connector
WO2001027961A2	1998	Coated cathodoluminescent phosphors

## CV for David Schaafsma

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### Education

<u>College/University</u>	<u>Degree</u>
University of Colorado, Boulder, CO	Ph.D., Physics
Brown University, Providence, RI	M.S., Physics
Whitman College, Walla Walla, WA	B.A., Physics

### Publications / Presentations

1. "Comparison of analysis methods for fluorescence lifetime imaging," T. Hall, D.A. Dorroh, S.E. Robertson, and D.T. Schaafsma, SPIE BIOS/Photonics West, Paper #8227 (2012).
2. "Fiber pressure sensors based on periodical mode coupling effects," Haim Lotem, Wen C. Wang, Michael Wang, David Schaafsma, Bob Skolnick, and Haim Grebel, *Proc. SPIE* **5758**, 239 (2005).
3. "All-dielectric miniature wide-band RF receive antenna," Wen Wang, Weiping Lin, Hank Marshall, Bob Skolnick, and David Schaafsma, *Opt. Eng.* **43**, (2004).
4. "Electro-optic RF receive antenna," Wen C. Wang, Weiping Lin, Hank Marshall, David Schaafsma, and Richard Chaung, *SPIE Digital Wireless Communication V* **5100**, 149 - 156 (2003).
5. "Fiberoptic temperature sensors for medical applications," David Schaafsma, Gail Palmer, and James Bechtel, *Proc. SPIE*, (2003).
6. "Efficacy and Performance of Emissivity Cancellation Probes for Pyrometric Systems," M. Fisher and D. Schaafsma, *RTP 2000*, Baltimore, MD, Sept. 2000.
7. "Aircraft Fail-Safe Self-Monitoring System," Anthony C. Jackson and David T. Schaafsma, presented at *the 4<sup>th</sup> Joint DoD/FAA/NASA Conference on Aging Aircraft*, St. Louis, MO, May 2000.
8. "Chalcogenide fibers: an overview of applications," J.A. Moon and D.T. Schaafsma, *Fiber & Integrated Optics* **19**, June 2000.
9. "Comparison of conventional and gain-clamped semiconductor optical amplifiers for wavelength division multiplexed transmission systems," D.T. Schaafsma, E. Miles, and E.M. Bradley, *J. Lightwave Tech.* (July 2000).
10. "Fabrication of Singlemode Chalcogenide Fiber Probes for Scanning Near-Field Infrared Optical Microscopy," D.T. Schaafsma et al, *Opt. Eng.*, (August 1999).
11. "Cross-Gain Modulation and Frequency Conversion Crosstalk Effects in 1550-nm Gain-Clamped Semiconductor Optical Amplifiers," D.T. Schaafsma and E.M. Bradley, *Photon. Tech. Lett.* **11**, 727 (1999).
12. "Singlemode chalcogenide fiber infrared SNOM probes," D.T. Schaafsma, R. Mossadegh, J.S. Sanghera, I.D. Aggarwal, J.M. Gilligan, N.H. Tolk, M.

## CV for David Schaafsma

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- Luce, R. Generosi, P. Perfetti, A. Cricenti, and G. Margaritondo, *Ultramicroscopy* **77**, 77 (1999).
13. "First Experimental Results with the Free Electron Laser Coupled to a Scanning Near-Field Optical Microscope," A. Cricenti, R. Generosi, C. Barchesi, M. Luce, M. Rinaldi, C. Coluzza, P. Perfetti, G. Margaritondo, D.T. Schaafsma, I.D. Aggarwal, J.M. Gilligan, and N.H. Tolk, *Phys. Stat. Sol. A* **170**, 241 (1998).
  14. "Cation vacancy formation and migration in the AlGaAs heterostructure system," P. Mitev, S. Seshadri, L. J. Guido, D. T. Schaafsma, and D. H. Christensen, *Appl. Phys. Lett.* **73**, 3718 (1998).
  15. "Modeling of Dy<sup>3+</sup>-doped GeAsSe glass 1.3  $\mu$ m optical fiber amplifiers," D.T. Schaafsma, L.B. Shaw, B. Cole, J.S. Sanghera, and I.D. Aggarwal, *Photon. Tech. Lett.* **10**, 1548 (1998).
  16. "Chalcogenide optical fiber couplers for chemical sensing, telecommunications, and infrared lasers," D.T. Schaafsma, L.B. Shaw, L.E. Busse, J.S. Sanghera, and I.D. Aggarwal, CLEO 98, paper CThP4 (1998).
  17. "Dy<sup>3+</sup>-doped GeAsSe 1.3  $\mu$ m optical fiber amplifiers," L.B. Shaw, D.T. Schaafsma, B.J. Cole, P. Pureza, R. Mossadegh, V.Q. Nguyen, J.S. Sanghera, and I.D. Aggarwal, presented at CLEO '98.
  18. "Rare earth doped selenide glass optical sources," L.B. Shaw, B. Cole, D.T. Schaafsma, B.B. Harbison, J.S. Sanghera, and I.D. Aggarwal, presented at OFC '98.
  19. "Rare earth doped glass fibers as sources for IRSS," L.B. Shaw, D.T. Schaafsma, B.J. Cole, B.B. Harbison, J.S. Sanghera, and I.D. Aggarwal, presented at AeroSense '98.
  20. "Dy-doped selenide glass for 1.3 mm optical fiber amplifiers," L.B. Shaw, B.J. Cole, J.S. Sanghera, I.D. Aggarwal, and D.T. Schaafsma, presented at OFC '98.
  21. "Fabrication of Singlemode Chalcogenide Optical Fiber," R. Mossadegh, D.T. Schaafsma, J.S. Sanghera, V.Q. Nguyen, R.A. Miklos, and I.D. Aggarwal, *J. Lightwave Technol.* **16**, 214 (1997).
  22. "Fused taper infrared optical fiber couplers in chalcogenide glass," D.T. Schaafsma, J.A. Moon, J.S. Sanghera, and I.D. Aggarwal, *J. Lightwave Technol.* **15**, 214 (1997).
  23. "Mode splitting in vertical-cavity microlasers from side-emission measurements," D.T. Schaafsma and D.H. Christensen, CLEO 97, paper CWG4 (1997).
  24. "Evaluation of the IR transitions in rare-earth doped chalcogenide glasses," L.B. Shaw, D.T. Schaafsma, J.A. Moon, J.S. Sanghera, B.B. Harbison, and I.D. Aggarwal, CLEO 97, paper CWF48 (1997).
  25. "Cavity coupling in vertical-cavity semiconductor lasers," D.T. Schaafsma and D.H. Christensen, NIST Technical Note #5047 (1997).
  26. "Mode splitting in side emission from vertical-cavity surface-emitting lasers," D.T. Schaafsma and D.H. Christensen, *Phys. Rev.* **B 54**, 14618 (1996).

## CV for David Schaafsma

dschaafsma@calopten.com

27. "Cross-sectional microphotoluminescence and buried layer structures," D.H. Christensen and D.T. Schaafsma, 1995 OSA Annual Meeting, p.124, Portland, OR, Sept 10-15 (1995).
28. "Cross-sectional photoluminescence and its application to buried-layer semiconductor structures," D.T. Schaafsma and D.H. Christensen, *J. Appl. Phys.* **78**, 694 (1995).
29. "Vacancy diffusion and Al-Ga interdiffusion in quantum well heterostructures," S. Seshadri, P. Mitev, L.J. Guido, S. Smith, R.D. Burnham, D.T. Schaafsma, and D.H. Christensen, Proc. 21<sup>st</sup> Intl. Symp. On Compound Semiconductors, San Diego, CA (1994).
30. "Correlation of optical, X-ray, and electron microscopy measurements on semiconductor multilayer structures," D.H. Christensen, R.K. Hickernell, D.T. Schaafsma, J.G. Pellegrino, M.J. McCollum, and R.S. Rai, in *Spectroscopic Characterization Techniques for Semiconductor Technology V*, SPIE Proc. **2141**, 177 (1994).
31. "A self-consistent investigation of coupled vacancy and host-atom diffusion in AlGaAs:GaAs quantum well heterostructures," S. Seshadri, P. Mitev, L.J. Guido, D.T. Schaafsma, D.H. Christensen, M.J. McCollum, S. Smith, and R.D. Burnham, Electronic Materials Conference (1994).
32. "Measurement and simulation of photoluminescence spectra from vertical-cavity surface-emitting laser structures," D.T. Schaafsma, R.K. Hickernell, and D.H. Christensen, in *Quantum Well and Superlattice Physics V*, SPIE Proc. **2139**, 93 (1994).
33. "Comparative photoluminescence measurement and simulation of vertical-cavity semiconductor laser structures," D.T. Schaafsma, R.K. Hickernell, and D.H. Christensen, in *Growth, Processing, and Characterization of Semiconductor Heterostructures*, MRS Symp. Proc. **326**, 483 (1994).
34. "Rapid growth of thick, IC quality GaAs from a flowing solution," E.E. Crisman, C.B. Roberts, D.T. Schaafsma, and H.J. Gerritsen, Fall MRS Meeting, Boston, MA (1989).

## Organizations/Affiliations

- Past Executive Editor, *Fiber & Integrated Optics* (peer-reviewed bi-monthly technical journal published by Taylor & Francis)
- Past Member of American Physical Society, Institute of Electrical & Electronics Engineers, Materials Research Society

## Litigation/Expert Witness Experience

**Depositions:** 13

**Testimony in Court:** 5 (3 ITC, 1 District, 1 Superior)

CV for David Schaafsma  
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Start Date	Client/Case
2024-present	Quinn Emmanuel Urquhart & Sullivan <i>[confidential - not disclosed]</i> Code scanner case.
2024-present	Wilmer Hale <i>[confidential - not disclosed]</i> Flow cytometry case.
2024-present	Davis Grass Goldstein & Finlay <i>San Antonio Regional Hospital</i> Personal injury involving cardiac monitors.
2024	Alston & Bird <i>[confidential - not disclosed]</i> Fiberoptics case. Settled Aug. 2024
2023-present	Troutman-Pepper-Hamilton, LLP <i>3Shape v Medit</i> Dental scanners. Consulting and preparation for district court trial, 2 declarations filed. Deposed (2x) May 23-24, 2024.
2023-present	Stoel Rives <i>Cimbria v. 3U Vision</i> IR scanner PGR matter.
2023-present	Stearns & Kessler <i>[confidential - not disclosed]</i> Nitric oxide therapy IP case.
2023	Riman Law <i>[confidential - not disclosed]</i> Optical filters. Settled April 2023.
2022-2023	Ropes & Gray <i>[confidential - not disclosed]</i> Orthopedic surgery matter. Settled April 2023.
2022-2023	Latham & Watkins <i>[confidential - not disclosed]</i>

## CV for David Schaafsma

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Ophthalmic surgery IPR matter.

- 2022 Daniels & Tredennick PLLC  
*[confidential]*  
Patent prosecution malpractice case.
- 2022 Skiermont Derby, LLP  
*[confidential - not disclosed]*  
Ingestible camera infringement case. Settled 2022.
- 2022-2023 Perkins Coie, LLP  
*Sartorius v. Gator Bio*  
Biosensor infringement case. 3 declarations filed.  
Deposed May 2023. Testified at ITC Nov. 2023.
- 2020-2022 Troutman-Pepper-Hamilton, LLP  
*Align v. 3Shape*  
Consulting and preparation for district court trial  
Filed declaration in support of Markman hearing, IPR hearing,  
and 3 declarations in District Court. Settled Feb. 2022.
- 2018-2020 Buchanan, Ingersoll, & Rooney PC  
*Align v. 3Shape*  
Dental technology intellectual property case.  
IPR report consulting and preparation.  
Deposed Feb. 2020.
- 2018-2023 Crites Law Group  
*Morris v. Leica Biosystems*  
Consulting on personal injury case involving automated biopsy  
equipment.  
Deposed April 2023. Settled May 2023
- 2019 Walkup, Melodia, Kelly & Schoenberger  
*Melville v. Boston Scientific*  
Consulting on personal injury case involving laser-based  
bronchoscopy.
- 2018-19 Pepper-Hamilton, LLP  
Buchanan, Ingersoll, & Rooney PC  
*Align v. 3Shape*  
Dental technology intellectual property case.  
Prepared expert validity report for ITC  
Deposed July 2018.

## CV for David Schaafsma

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Testified at ITC court, Washington, DC, Sept. 2018

Deposed August 2019

Testified at ITC court, Washington, DC, Oct. 2019

- 2018-19 Perkins Coie, LLP  
*Fontem v. RJ Reynolds*  
Nathan Kassebaum, Atty. Joe Hamilton, Ptr.  
Prepared expert declaration for IPR (new filing).  
Deposed March 2018.
- 2017 Stradley, Ronon, Stevens & Young, LLP  
*[confidential]*  
Prepared expert declaration for trade secret case, interviewed  
by arbitrating judge. Initial judgment for defendant.
- 2017 Perkins Coie, LLP  
*Fontem v. RJ Reynolds*  
Prepared expert declaration for IPR. Deposed June 2017.
- 2016/7 Latham & Watkins, LLP  
*Ikaria-Mallinckrodt v. Praxair*  
IP litigation for nitric oxide therapy. Prepared expert report.  
Deposed Dec. 2016  
Testified in federal court, Delaware, Mar. 2017
- 2015 Goodwin-Procter, LLP  
*Alere v. Family Health*  
Intellectual Property – Review of IPR filing for lateral flow  
assays and flow measurement.
- 2015 Perkins-Coie, LLP  
Lara Dueppen, Atty.  
*Fontem v. RJ Reynolds*  
Intellectual Property - Patent infringement analysis & report  
for e-cigarettes.
- 2012-2013 Molever-Conelly, LLP  
*Kim v. Zeiss*  
Product Liability – negligent product service resulting in loss of  
business.  
Performed product testing, provided expert opinion (reports).  
Deposed Jun. 2013,  
Testified at trial Aug. 2013 (judgment for plaintiff).

## CV for David Schaafsma

dschaafsma@calopten.com

- 2012 James R. Rogers  
*Bicknell v. West Hills Hospital*  
Personal Injury – product liability, testing of external pacemaker  
Performed data analysis, product testing.
- 2012 Weiss & Moy, LLP  
*Pacific Bioscience Laboratories v. Nutraluxe*  
Intellectual Property – skin brushes  
Performed data analysis, product testing, provided expert opinion.
- 2011 DLA Piper  
*CareFusion 303, Inc. v. Sigma International*  
Intellectual Property – infusion pump technology.  
Performed product analysis and provided part of expert opinion.
- 2011-2013 Hogan-Lovells, LLP  
*Alere/Inverness v. Church & Dwight*  
Intellectual Property – pregnancy test device.  
Performed product analysis and interpretation. Settled 2013.
- 2010 Scheuring, Zimmerman & Doyle, LLP  
*Fonti v. Wilmarth*  
Personal Injury – product liability, electrosurgical device  
Performed data analysis, product testing, provided expert opinion.
- 2009 Peach-Weathers  
*Franklin v. Ladies' Workout and Omron, Inc.*  
Personal Injury – body fat analyzer  
Performed product analysis, testing, expert declaration.
- 2007-8 McKool-Smith  
*Medtronic USA, Inc. v. Boston Scientific, Scimed Life Systems Inc., and Boston Scientific Scimed, Inc.*  
Patent Infringement – angioplasty balloon/stent catheters  
Performed patent analysis, product testing, claim construction analysis, expert declaration and reports.

## IP Development/Analysis

Date	Client
2021-2022	[Confidential] Technology development for neonatal jaundice assay.
2019	[Confidential] IP development for pediatric audio company.
2015	[Confidential] Due diligence for acquisition of vascular therapy company.
2014	Convergent Dental, Inc. IP review and analysis of possible renewed application of US20060233492 A1.
2014	Pacific Science & Engineering, Inc. Patent/IP development for closed-loop spirometer.
2012-2014	Tearfilm, Inc. Patent/IP development for dry-eye (keratoconjunctivitis sicca) therapy device.
2008	Karasic Law Group Patent Issues - Personal biomonitor device (pulse, respiration) Performed patent analysis, product viability analysis, product design.
2006-12	Freedom MediTech, LLC Patent, IP validation, technology development Developed optical technology for ophthalmic glucose measurement
2006-9	Helixis, Inc. (now Illumina, Inc.) Patent & IP development Assisted with IP development for genetic assay system
2007-9	Therafuse, Inc. IP development Developed IP & prototypes for optical flow measurement device for drug delivery

**CV for David Schaafsma**  
dschaafsma@calopten.com

- 2003            L-3 Communications  
Due diligence – technology/IP analysis for corporate  
acquisition
- 2002            Boston Scientific, Inc.  
Patent & IP development  
Analyzed (customer) patent for thermal therapy system

# **APPENDIX B**

**APPENDIX B – LIST OF MATERIALS CONSIDERED**

<b>Exhibit</b>	<b>Description</b>
<b>EX1001</b>	U.S. Patent No. 12,174,106 B2 to Yong Qin Chen (filed December 22, 2021, issued December 24, 2024) (“106 patent”)
<b>EX1002</b>	Declaration of Fedor A. Ilkov, Ph.D.
<b>EX1003</b>	Prosecution History of U.S. Patent No. 12,174,106 B2
<b>EX1004</b>	Nigel P. Carter and Michael G. Ormerod, <i>Chapter 1, Introduction to the Principles of flow cytometry</i> , Flow Cytometry, pp. 1-22 (3rd ed. 2000)
<b>EX1005</b>	U.S. Patent No. 6,683,314 B2 to Clifford A. Oostman, Jr. et al. (filed August 28, 2001; published January 27, 2004) (“ <b>Oostman</b> ”)
<b>EX1006</b>	U.S. Patent No. 5,317,162 to Bertram G. Pinsky et al. (filed September 9, 1992; published May 31, 1994) (“ <b>Pinsky</b> ”)
<b>EX1007</b>	Excerpts of Howard M. Shapiro, Practical Flow Cytometry (4th ed. 2003) (“ <b>Shapiro</b> ”)
<b>EX1008</b>	World Patent No. WO 2010/101623 A1 to Michael Thomas (filed March 2, 2010; published September 10, 2010) (“ <b>Thomas</b> ”)
<b>EX1009</b>	U.S. Patent No. 8,284,402 B2 to Erich Frazier et al. (filed February 26, 2010; published October 9, 2012) (“ <b>Frazier</b> ”)
<b>EX1010</b>	U.S. Patent No. 4,244,045 to Kiyoshi Nosu et al. (filed January 31, 1979; published January 6, 1981) (“ <b>Nosu</b> ”)
<b>EX1011</b>	U.S. Patent No. 8,537,468 B1 to Xuan Wang et al. (filed June 10, 2011; published September 17, 2013) (“ <b>Wang</b> ”)
<b>EX1012</b>	U.S. Patent No. 6,198,864 B1 to Brian E. Lemoff et al. (filed November 24, 1998; published March 6, 2001) (“ <b>Lemoff</b> ”)
<b>EX1013</b>	U.S. Patent No. 7,212,343 B1 to Chun He et al. (filed July 11, 2003;

Schaafsma Declaration: Appendix B (Materials Considered)

	published May 1, 2007) (“He”)
<b>EX1014</b>	U.S. Patent No. 5,835,517 to Vijaysekhar Jayaraman et al. (filed October 4, 1996; published November 10, 1998) (“Jayaraman”)
<b>EX1015</b>	U.S. Patent No. 6,201,908 B1 to Eric B. Grann (filed July 2, 1999; published March 13, 2001) (“Grann”)
<b>EX1016</b>	U.S. Patent No. 6,542,306 B2 to Timothy D. Goodman (filed March 16, 2001; published April 1, 2003) (“Goodman”)
<b>EX1017</b>	Listing of Challenged Claims
<b>EX1018</b>	Joint Claim Construction Chart including Exhibit A Parties Agreed and Proposed Constructions filed in <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 24-945 (D. Del. May 28, 2025), D.I. 89 & 89-1
<b>EX1019</b>	Plaintiff’s Disclosure of Asserted Claims and Infringement Contentions [Redacted Version], served in <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 24-945 (D. Del. Feb. 14, 2025)
<b>EX1023</b>	Steve Wasserman, <i>Geometrical optics and ray tracing</i> , Course Wiki (August 27, 2019)
<b>EX1025</b>	Complaint filed in <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 1:24-cv-00945 (D. Del. Aug. 14, 2024), D.I. 1
<b>EX1026</b>	Summons in a Civil Action to Cytek Biosciences, Inc. c/o Cogency Global, Inc. served on August 15, 2024, filed in <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 1:24-cv-00945 (D. Del. Aug. 16, 2024), D.I. 5
<b>EX1027</b>	Stipulation and Order Amending Scheduling Order filed in <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 1:24-cv-00945 (D. Del. March 4, 2025), D.I. 55
<b>EX1030</b>	Rochelle A. Diamond, <i>Chapter 8: Quality Control Guidelines for Research Flow Cytometry</i> , In <i>Living Color</i> , pp. 98-105 (2000)

Schaafsma Declaration: Appendix B (Materials Considered)

<b>EX1031</b>	R.M.P. Doornbos et al., White Blood Cell Differentiation Using a Solid State Flow Cytometer, <i>Cytometry</i> 14:589-594 (1993) (“Doornbos”)
<b>EX1032</b>	SensL SPMMini High Gain APD (Oct. 2007)
<b>EX1033</b>	Menlo Systems APD210/310 High Sensitivity Detector Unit (Apr. 2021)
<b>EX1034</b>	Thorlabs.com – High-Sensitivity Avalanche Photodetectors website Overview, Specs and Documents & Drawings, (Aug. 31, 2011), <a href="https://web.archive.org/web/20110831115024/http://www.thorlabs.com/NewGroupPage9.cfm?ObjectGroup_ID=947">https://web.archive.org/web/20110831115024/http://www.thorlabs.com/NewGroupPage9.cfm?ObjectGroup_ID=947</a>
<b>EX1035</b>	World Patent No. WO 94/29695 to Oddbjørn Gjelsnes (filed June 8, 1993; published December 22, 1994) (“Gjelsnes”)
<b>EX1036</b>	Carleton C. Stewart et al., Flow Cytometer in the Infrared: Inexpensive Modifications to a Commercial Instrument, <i>Cytometry Part A</i> , 67A:104-111 (2005) (“Stewart”)
<b>EX1037</b>	William G. Lawrence et al., A 16-channel avalanche photodiode detector array for visible and near-infrared flow cytometry, <i>Imaging, Manipulation, and Analysis of Biomolecules, Cells, and Tissues IV</i> , Proc. of SPIE, Vol. 6088, 60880T, (2006) (“Lawrence”)
<b>EX1038</b>	William G. Lawrence et al., A Comparison of Avalanche Photodiode and Photomultiplier Tube Detectors for Flow Cytometry, <i>Imaging, Manipulation, and Analysis of Biomolecules, Cells, and Tissues VI</i> , Proc. of SPIE Vol. 6859, 68590M, (2008) (“Lawrence 2008”)
<b>EX1039</b>	Shutao Zhao et al., High gain avalanche photodiode (APD) arrays in flow cytometer optical [sic] system, <i>IEEE</i> (2011) (“Zhao”)
<b>EX1040</b>	U.S. Patent No. 8,188,438 B2 to Dongqing Li (filed Mar. 8, 2010; published May 29, 2012) (“Li-438”)
<b>EX1041</b>	Canadian Patent No. 2 771 324 to Paul Patt (filed Aug. 20, 2010; published June 21, 2016) (“Patt-324”)
<b>EX1042</b>	U.S. Patent No. 7,580,120 B2 to Yuichi Hamada et al. (filed Apr. 6,

Schaafsma Declaration: Appendix B (Materials Considered)

	2006; published Aug. 25, 2009) (“Hamada”)
<b>EX1043</b>	World Patent No. 98/59233 to Van S. Chandler (filed June 22, 1998; published Dec. 30, 1998) (“Chandler-233”)
<b>EX1044</b>	U.S. Patent No. 7,523,637 B2 to Wayne D. Roth et al. (filed Nov. 29, 2007; published Apr. 28, 2009) (“Roth-637”)
<b>EX1045</b>	U.S. Patent No. 7,505,131 B2 to Wayne D. Roth (filed Mar. 6, 2008; published Mar. 17, 2009) (“Roth-131”)
<b>EX1046</b>	U.S. Patent Application Publication No. 2008/0305481 A1 to Douglas F. Whitman et al. (filed Dec. 13, 2007; published Dec. 11, 2008) (“Whitman”)
<b>EX1047</b>	U.S. Patent Application Publication No. 2007/0269345 A1 to Adam Richard Schilffarth et al. (filed May 17, 2007; published Nov. 22, 2007) (“Schilffarth-345”)
<b>EX1048</b>	U.S. Patent Application Publication No. 2007/0207513 A1 to Keld Sorensen et al. (filed Mar. 5, 2007; published Sept. 6, 2007) (“Sorensen”)
<b>EX1049</b>	U.S. Patent Application Publication No. 2009/0071225 A1 to Adam Richard Schilffarth (filed Sept. 17, 2008; published Mar. 19, 2009) (“Schilffarth-225”)
<b>EX1050</b>	U.S. Patent Application Publication No. 2009/0237658 A1 to Edward Calvin et al. (filed Apr. 9, 2009; published Sept. 24, 2009) (“Calvin”)
<b>EX1051</b>	U.S. Patent No. 6,139,800 to Van S. Chandler (filed June 22, 1998; published October 31, 2000) (“Chandler”)
<b>EX1052</b>	Luminex 100™ IS User Manual Version 2.3 (Oct. 2005)
<b>EX1053</b>	Luminex FlexMap 3D® User Manual (Jan. 2019)
<b>EX1054</b>	BD Biosciences Immunocytometry Systems Technical Specifications BD FACSAArray (Oct. 2003)

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<b>EX1060</b>	Hamamatsu Si APD S5343 to S5345, S9073 to S9075, Short wavelength type APD (Apr. 2004)
<b>EX1061</b>	Hamamatsu Si APD S8890 series, Long wavelength type APD (June 2010)
<b>EX1062</b>	Hamamatsu Si APD S2381 to S2385, S5139, S8611, S3884, S4315 series, Low bias operation, for 800 nm band (May 2010)
<b>EX1069</b>	Joint Claim Construction Brief filed in <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 1:24-cv-00945 (D. Del. July 27, 2025), D.I. 114
<b>EX1070</b>	U.S. Patent No. 9,746,412 B2 to Yong Qin Chen (filed Nov. 26, 2014; published Aug. 29, 2017) (“412”)
<b>EX1071</b>	Prosecution History of PCT/US2013/043453 (the “PCT App.”)
<b>EX1072</b>	2.3: Spherical Mirrors, Bowdoin College, Phys1140: Introductory Physics II: Part 2, <a href="https://phys.libretexts.org/Courses/Bowdoin_College/Phys1140:_Introductory_Physics_II:_Part_2/02:_Geometric_Optics_and_Image_Formation/2.03:_Spherical_Mirrors">https://phys.libretexts.org/Courses/Bowdoin_College/Phys1140:_Introductory_Physics_II:_Part_2/02:_Geometric_Optics_and_Image_Formation/2.03:_Spherical_Mirrors</a>
<b>EX1073</b>	Michael W. Davidson, Molecular Expressions, Optical Microscopy Primer, Physics of Light and Color, Florida State University (Nov. 13, 2015), <a href="https://micro.magnet.fsu.edu/primer/lightandcolor/mirrorsintro.html">https://micro.magnet.fsu.edu/primer/lightandcolor/mirrorsintro.html</a>
<b>EX1075</b>	U.S. Patent No. 11,703,443 B2 to Yong Qin Chen (filed Nov. 4, 2022; published July 18, 2023) (“443”)
<b>EX1076</b>	Prosecution history of EP24151670
<b>EX1077</b>	Optics: Concave and Convex Mirrors and Lenses, ScienceReady (2025), <a href="https://scienceready.com.au/pages/mirrors-and-lenses">https://scienceready.com.au/pages/mirrors-and-lenses</a>
<b>EX1078</b>	U.S. Patent No. 11,255,772 B2 to Yong Qin Chen (filed June 30, 2017; published Feb. 22, 2022) (“772”)

Schaafsma Declaration: Appendix B (Materials Considered)

<b>EX1079</b>	Definition of quantitate from Concise Oxford English Dictionary (12th ed. 2011)
<b>EX1080</b>	M. Salvato et al., Time response in carbon nanotube/Si based photodetectors, <i>Sensors and Actuators A292</i> : 71-76 (2019)
<b>EX1081</b>	Declaration of Dr. David Schaafsma, Ph.D. in Support of Beckman Coulter's Opening Claim Construction Brief, dated June 5, 2025, filed in Beckman Coulter, Inc. v. Cytek Biosciences, Inc., C.A. No. 1:24-cv-00945 (D. Del. July 27, 2025)
<b>EX1082</b>	Xiaolu Xia et al., Emerging optoelectronic architectures in carbon nanotube photodetector technologies, <i>Fundamental Research</i> , 5:1153-1168 (available online in 2023, in print in 2025)
<b>EX1083</b>	Xiang Cai et al., Recent progress of photodetector based on carbon nanotube film and application in optoelectronic integration, <i>Nano Research Energy</i> 2:e9120058:1-18 (2023)
<b>EX1084</b>	Yue Wang et al., Advancement in Carbon Nanotubes Optoelectronic Devices for Terahertz and Infrared Applications, <i>Advanced Electronic Materials</i> , 10:2400124:1-31 (2024)
<b>EX1103</b>	Markman Hearing Transcript from <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 24-945 (D. Del. August 21, 2025)
<b>EX2001</b>	About Beckman Coulter ( <a href="https://www.beckmancoulter.com/about-beckman-coulter/history-and-innovation">https://www.beckmancoulter.com/about-beckman-coulter/history-and-innovation</a> )
<b>EX2002</b>	CytoFLEX Flow Cytometer ( <a href="https://www.beckman.com/flow-cytometry/research-flow-cytometers/cytoflex">https://www.beckman.com/flow-cytometry/research-flow-cytometers/cytoflex</a> )
<b>EX2003</b>	Beckman Coulter Patents ( <a href="https://www.beckman.com/patents">https://www.beckman.com/patents</a> )
<b>EX2004</b>	Cytek Form S-1 Registration Statement (2021)

Schaafsma Declaration: Appendix B (Materials Considered)

<b>EX2005</b>	Information Disclosure Statement for Application No. 15/817,237 to U.S. Patent No. 10,436,697 (May 7, 2019)
<b>EX2006</b>	Information Disclosure Statement for Application No. 15/942,430 to U.S. Patent No. 11,333,597 (June 17, 2021)
<b>EX2013</b>	Transcript of <i>Markman</i> Hearing of September 17, 2025, <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 24-945, D.I. 173 (D. Del. Sept. 17, 2025)
<b>EX2014</b>	U.S. Patent Pub. No. 2004/0165828 (“Capewell”)
<b>EX2015</b>	File History for U.S. Patent No. 9,746,412
<b>EX2016</b>	File History for U.S. Patent No. 10,330,582
<b>EX2017</b>	DocketNavigator, Time-to-Trial Statistics for District of Delaware (Sept. 2025)
<b>EX2021</b>	Assignment for U.S. Patent No. 8,922,778
<b>EX2022</b>	Assignment for U.S. Patent No. 8,605,283
<b>EX2024</b>	Request for <i>Ex Parte</i> Reexamination of U.S. Patent No. 10,330,582 B2 Under 35 U.S.C. §§ 302-307 and 37 C.F.R. § 1.510 <i>et seq.</i>
<b>EX2029</b>	Excerpts from Shapiro, Practical Flow Cytometry (2003)
<b>EX2030</b>	U.S. Patent No. 10,330,582
<b>EX2031</b>	Marcus Nebeling, CWDM: Lower Cost for More Capacity in the Short-Haul, Fiber Network Engineering (July 3, 2002)
<b>EX2032</b>	Telecommunication Standardization Sector of ITU, Recommendation G.694.2, Spectral Grids for WDM Applications: CWDM Wavelength Grid (Dec. 2003)

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<b>EX2033</b>	Telecommunication Standardization Sector of ITU, Recommendation G.694.1, Spectral Grids for WDM Applications: DWDM Frequency Grid (June 2002)
<b>EX2034</b>	Order Denying Request for <i>Ex Parte</i> Reexamination, Application/Control Number: 90/015,441 (Oct. 6, 2025)
<b>EX2035</b>	M. Arumugam, <i>Optical Fiber Communication—An Overview</i> , 57 Pramana J. Physics 849 (2001)
<b>EX2036</b>	B.E.A. Saleh and M.C. Teich, <i>Fundamentals of Photonics</i> , 2d. Ed. 2007, Chapters 1, 24 (“Saleh”)
<b>EX2037</b>	Warren J. Smith, <i>Modern Optical Engineering</i> (3d ed. 2000, Chapter 9 (“Smith”)
<b>EX2038</b>	W.T. Welford, <i>Optics</i> (3d ed. 1990), Chapter 8 (“Welford”)
<b>EX2039</b>	Mohammad Azadeh, <i>Fiber Optics Engineering</i> (2009), Chapters 1, 2, 6 (“Azadeh”)
<b>EX2040</b>	Cytek’s 35 U.S.C. § 112 Contentions – Exhibit A U.S. Patent No. 10,330,582, <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 24-945, (D. Del. October 22, 2025)
<b>EX2041</b>	Cytek’s Election of Asserted Prior Art Grounds, C.A. No. 24-945 (D. Del. Oct. 22, 2025)
<b>EX2042</b>	Amended Scheduling Order, <i>Beckman Coulter, Inc. v. Cytek Biosciences, Inc.</i> , C.A. No. 24-945, D.I. 198 (D. Del. Nov. 5, 2025)
<b>EX2043</b>	U.S. Provisional Patent Application No. 61/715,819 (“5819 Prov.”)
<b>EX2047</b>	Xinjian Zhou et al., <i>Color Detection Using Chromophore-Nanotube Hybrid Devices</i> , 9 Nano Letters 1028 (2009)

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<b>Paper</b>	<b>Description</b>
2	Petition for <i>Inter Partes</i> Review of U.S. Patent No. 12,174,106
6	Patent Owner's Request for Discretionary Denial