Choosing the Optimal Photodetection Technology for Your ATP Testing System

In food processing, you are forced to make the high risk decision to begin production, based on limited information and under tight schedules. With consumer safety, your company's brand and your personal reputation at stake, you must have a hygiene monitoring and management system that includes a luminometer that you can trust to quickly provide both accurate and precise results and give you peace of mind.

You also need a luminometer that is robust and tolerant to a wide range of environmental conditions that can be found in a food processing plant, including temperatures ranging from cold to hot, variations in humidity, vibration from equipment or the shock of being accidentally bumped or dropped.

In addition, the results a system produces must be accurate and precise even though delays can occur between swab activation and reading the swab. A system also has to be tolerant to use by various technicians who may have different techniques, or levels of experience.

Accuracy and precision of test results are different. With a precise ATP (adenosine triphosphate) testing system, if the same swab were measured twice, you would get nearly the same result both times. With an accurate system, the ATP test result would indicate the actual amount of ATP present on the swab. Having both accuracy and precision in your results is critical and you should not have to choose one or the other.

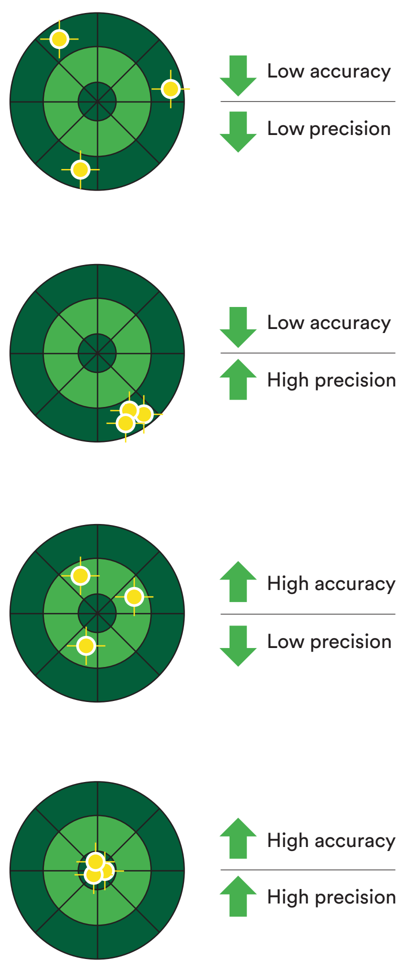
Detecting extremely low levels of light is critical

Hygiene monitoring systems test for the presence of ATP in food processing areas using bioluminescence. During testing, a system must detect and measure very low levels of light. The more light produced during testing, the greater the amount of ATP, indicating potential contamination and the need for re-cleaning before food processing can safely begin.

As food processing surfaces become cleaner, for instance after re-cleaning, less ATP would be present so less light would be generated for measurement. Also, beyond daily monitoring, as continuous improvement increases the cleanliness of your facility, even smaller levels of contamination and ATP would be available to measure. Therefore, your luminometer must have a technology capable of detecting extremely small amounts of light, sometimes only a few photons, to alert you to very low levels of contamination.

ATP testing results must be both accurate and precise

A dartboard shows the difference between accuracy and precision of results but proves both are critical.



Not all ATP testing systems are the same

It's easy to believe that all luminometers are the same and would provide the same accuracy and precision. But that's not true. It's also easy to get confused when comparing and evaluating different luminometers.

The most critical difference among hygiene systems is in the technology — called photodetection technology — that a luminometer uses to detect and measure photons. There are two general options in photodetection technology: photomultipliers and photodiodes. But they have very different capabilities, especially in their ability to detect the extremely low levels of light produced in ATP detection for hygiene monitoring and management.

Photomultipliers: The most sensitive photodetection systems commercially available

Considered to be "the gold standard" in photon detection technology, only photomultipliers have the critical properties that increase accuracy and precision in ATP testing results:

- Highly efficient in capturing photons
- Capability of counting individual photons
- More tolerant to temperature variations, providing the robustness needed in the challenging food processing environment
- Less susceptibility to noise (interference)
- A signal that can easily be increased (gained) for measurement

ATP testing results must be both accurate and precise

Photomultipliers are used in highly sophisticated, demanding applications within medicine including imaging, instrumentation and diagnostics as well as in radiation detection, genomics, aerospace, military/defense, radar jamming, motion picture film scanning (telecine), and high-end image scanners (drum scanners) and are the basis of night vision devices. They also have an essential place in nuclear and particle physics.

Photodiodes are used in consumer electronics devices such as smoke detectors, CD players and TV remote control devices. They may be used for camera light meters, switching on street lighting after dark and in various medical applications.

A photomultiplier can detect a single photon!

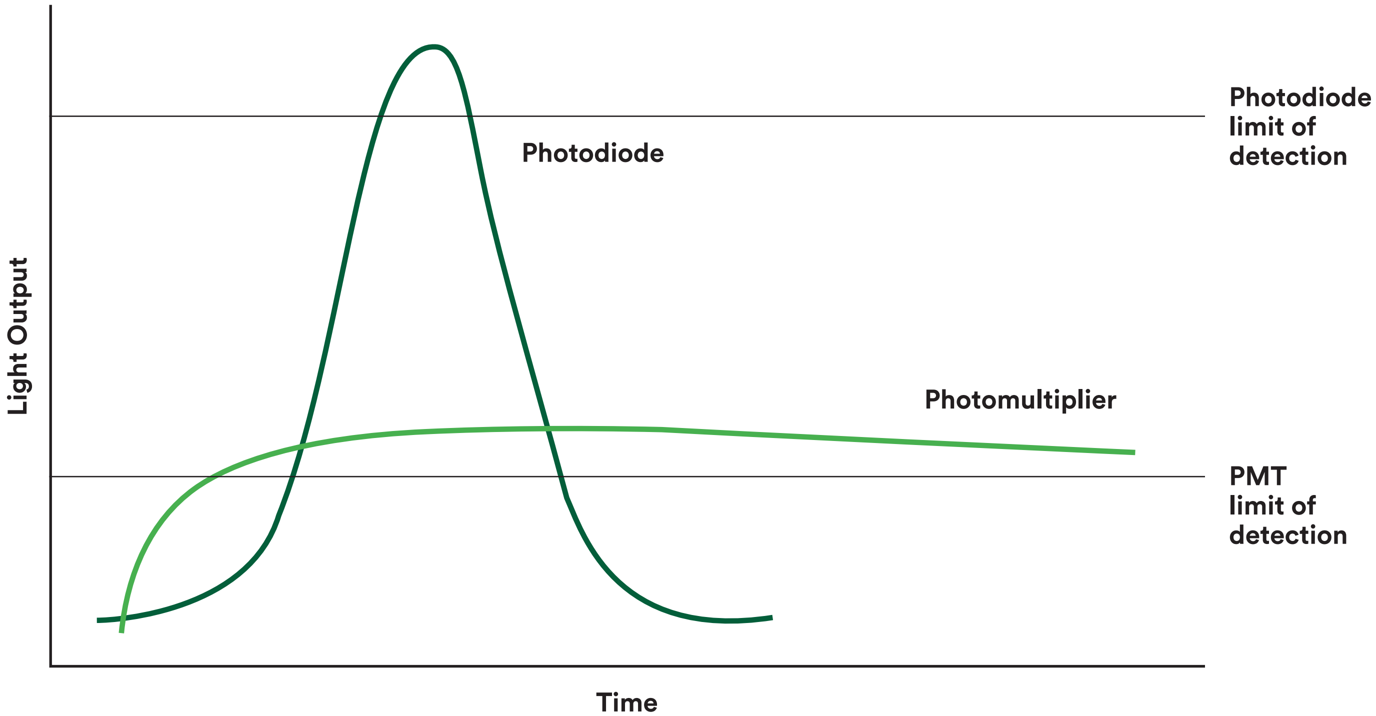
The smallest unit of light is called a photon and is too small for the eye to see. Normal room light is made up of trillions of photons per second and the human eye can see a minimum of about 100,000 photons per second. A photodiode can only detect as few as 10,000 photons per second. But photomultiplier technology is so technologically capable, it can detect one photon per second!

Light and Detection	Photons per Second
Normal room light	1,000,000,000,000
Human eye perception	100,000
Photodiode lower limit of detection	10,000
Photomultiplier lower limit of detection	1

Photomultiplier technology as part of a matched component ATP testing system can give more accurate and precise results

Photomultipliers specialize in detecting extremely low levels of light so they are ideally suited for ATP testing. In addition, swab chemistry can be optimized to produce long-lasting light with lower peak light output that can easily be read by photomultiplier technology and is tolerant to the temperature variations and time delays between activating the swab and measuring swab results that can occur in the demanding food processing environment.

In contrast, photodiodes have limited abilities to detect extremely low levels of light, like those from ATP testing. Therefore, light must be amplified by ATP swab bioluminescence chemistry to become detectable in the range that a photodiode can detect. This amplification process generates a higher peak output of light but it lasts only a very short period of time, during which ATP test results must be read. If a delay occurs between activating the swab and measuring swab results (as can frequently happen during routine testing) and a swab is not read within the short timeframe, the accuracy and precision of results from photodiodes can be unreliable.



> There is no doubt that photo multiplier technologies are more sensitive and detect lower levels of light...
>
> – Griffith, What makes a good ATP hygiene monitoring system?[1]

To deliver optimal results, photomultiplier technology must be properly engineered for the food manufacturing environment

Using any photomultiplier technology does not automatically ensure accurate and precise results. Obtaining optimal performance depends on how the system is designed and engineered — in its luminometer, swab chemistry and data management system — and the ways they work together.

The system also must be properly engineered to work in the demanding conditions of the food manufacturing environment. For instance, a robust luminometer design keeps light out when the system is being used because poor "light-tightness" can negatively affect a system's performance.

So even though photomultipliers are the optimal technology in ATP testing systems, be sure to investigate the accuracy and precision of the results each system delivers.

Choosing an ATP testing system with optimized photomultiplier technology can support high risk manufacturing decisions

Making the high risk decision to begin food processing should be based on data generated from the best commercially available photodetection technology. Photomultiplier technology that has been engineered within a complete hygiene monitoring and management system can deliver accurate and precise results and optimal performance in a challenging manufacturing environment.

Please note: The information provided in this piece is educational only and not directed towards any one ATP luminometer.

Learn more about hygiene monitoring at **info.neogen.com/Clean-Trace**

[1] Griffith, Chris, "What makes a good ATP hygiene monitoring system?", International Food Hygiene, Volume 22, Number 8, Pages 21–23.

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