

Tac-7C[®]



Tactical Bioaerosol Detector

UV-C based detection: High sensitivity, low false positives

Features

- True UV-C based "biological trigger"
- Photon counting: no analog drift
- Automated trigger/sampler protocols
- 40+ hours operation on swappable battery
- Wide operating temperature range
- Light weight/small size
- Long operating life
- RS-232 or wireless communications capable

Application Areas

- Indoor or outdoor use
- Sports stadiums and arenas
- Subways
- Military bases
- Airports

The TAC-7C[®] bioaerosol detector

measures and records the biofluorescence and diffractive scattering produced by aerosol particles as they pass through an intense UV-C ultraviolet beam. It classifies them as being of either biological or non-biological origin, and alarms if there is an abnormal change in bio-aerosol level. Applications range from homeland security to public health and military.

Low false alarms Certain aerosols, such as burning vegetation, contain aromatic hydrocarbons which fluoresce strongly under long wavelength UV light. But the Tac-7C's UV-C light source ignores these, minimizing false alarms.

Stable operation Sampled air is screened with a two-stage filtering process that rejects aerosols such as pollen and insects. Photon counting methods minimize the effects of temperature and electro-optic component aging. The rugged UV-C LED source has a center emission wavelength of 280nm, maximum use temperature of 85°C, and half-life of 10,000-20,000 hours.



Connectivity An RS-232 serial data connection is provided, allowing the Tac-7C to trigger sample collection by Research International air samplers. Signals may also be transmitted wirelessly between the Tac-7C and a monitoring PC or other equipment using BioLink[™] transmitters and receivers. Multiple units may be monitored remotely using the Tac-7C's included proprietary software for Windows[®] operating systems.

Low power use, long operating periods Electric power consumption is less than 6 watts, allowing operation from either a small solar panel or for more than 40 hours on a swappable, rechargeable UBI 2590 style battery.

Software controls & data storage The Tac-7C proprietary software allows the user to modify its operating characteristics and alarm levels as needed. All data is stored automatically on an onboard removable solid state memory chip with a five-year capacity.

U.S. Patent Nos.: 10267723, 10274410, 10444137, 10794815, 11340153.

Technical Discussion

The Tac-7C biodetector is a third-generation product based on photon-counting technology licensed from the U.S. Army in 2010. In this device, all aerosol particles in sampled air pass through a beam of UV-C excitation light and each particle is binned according to its light scattering, fluorescence emission intensity, and physical size. Since aerosol background levels often vary substantially in content over time, a 15 minute rolling average is maintained of key aerosol characteristics and every 15 seconds the latest recorded characteristics are compared to the rolling averages to determine whether a suspicious event has occurred.

Four-criterion testing minimizes false positives

The highly variable composition of environmental aerosols makes it difficult to maintain adequate threat sensitivity while keeping false positives to an acceptable level. The Tac-7C maintains a good balance by monitoring four aerosol characteristics. Two of these alarm parameters are well-known statistical measures sensitive to unusually large changes in bioaerosol concentration. A third measure is the percentage of particles that have significant fluorescent emission.

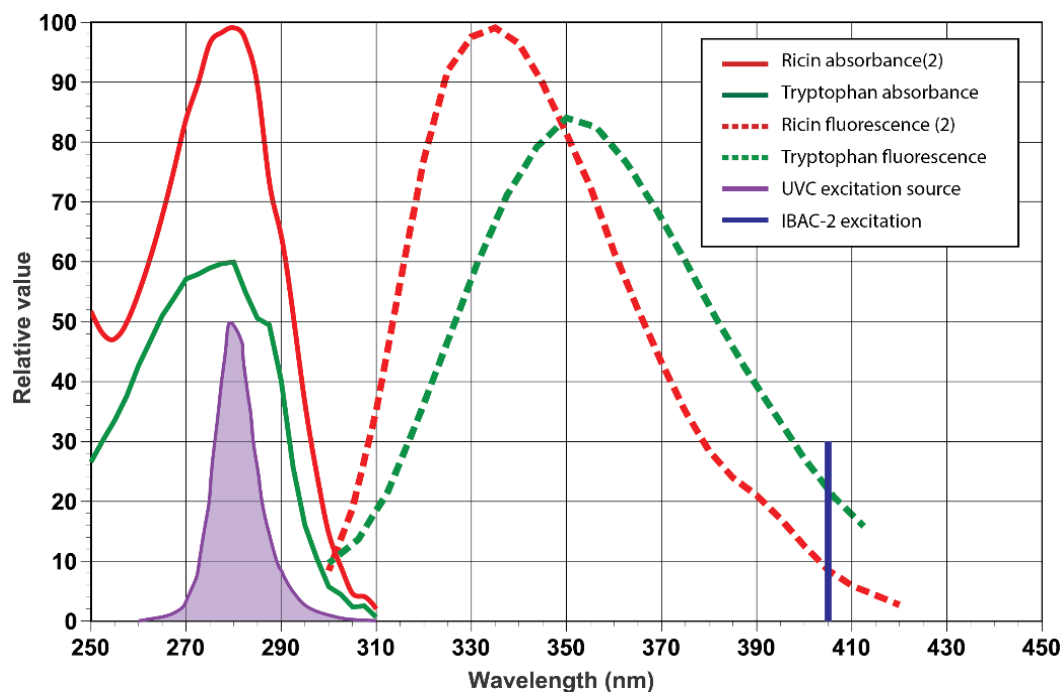


Figure 1. Absorbance and fluorescence spectra of ricin toxin and the protein tryptophan in relation to the Tac-7C's excitation spectrum. The Tac-7C is optimally designed to excite bio-fluorescence.

The fourth parameter is fluorescence emission intensity. The Tac-7C monitors both scattered light and fluorescent light emission levels, and it has been found that most aerosol targets in pure form produce a characteristic ratio of fluorescence photons to scattering photons that is independent of particle size. This parameter is called a material's "brightness." For example, if the brightness of the aerosolized protein tryptophan is given a brightness value of 100%, then interferences such as cement dust and sea salt spray have brightnesses less than 1%. This is clearly a useful parameter for excluding interferences that fluoresce weakly but may nevertheless be encountered at high concentration.

The 280 nm light source advantage

The brightness alarm parameter is strongly enhanced by using a light source with a center wavelength in the range of 280nm. As illustrated in Figure 1, many proteins found in toxins, viruses, and bacteria have peak absorbance and peak in fluorescence emission when excited at this wavelength: This excitation wavelength is optimum for the

detection of the full gamut of bio-threats, both because of the high intrinsic brightness and because the exterior surfaces of most threats have high levels of these fluorescing materials.

User control of alarm parameters

All four parameters must exceed specific alarm levels before the Tac-7C issues an alarm. Nominal alarm levels for the four parameters are loaded into the units at the factory, but Research International's Tac-Optimum™ software program allows users to set alarm parameters unique to their field environment based on collected historical data stored on the Tac-7C's internal SD card.

Applications and connectivity

The Tac-7C is a lightweight bioaerosol detector that may be operated as a hand-carry stand-alone field detector, as a low-maintenance vehicle-based or fixed-location monitor, or as a trigger to initiate the operation of other devices. As supplied, the Tac-7C can be used to trigger Research International's dry electret filter sampler, the SASS 3100, or the wetted wall cyclone product, the SASS 2300. In component form, the Tac-7C is the bioaerosol trigger used in Research International's combination biodetector/sampler the Tac-7SD, the BioHawk LF bioidentifier, and as the biothreat monitor in a high-speed mail sorting system running at a 10Hz reporting rate. A low-weight UAV version is slated for introduction in 2024.

Connection between the Tac-7C and Research International's stand-alone sampling systems or a remote PC may be by hard-wired RS-232 connection or by wireless link. The new BioLink™ LR encrypted wireless link from Research International is capable of connecting the Tac-7C to other hardware at ranges of 2km or more.

The Tac-7C is supplied with Windows® software for adjusting alarm parameters and storing data remotely on the PC. The Tac-7C instruction manual lists all interface control commands needed to query the unit and link the serial data output to another data monitoring program.

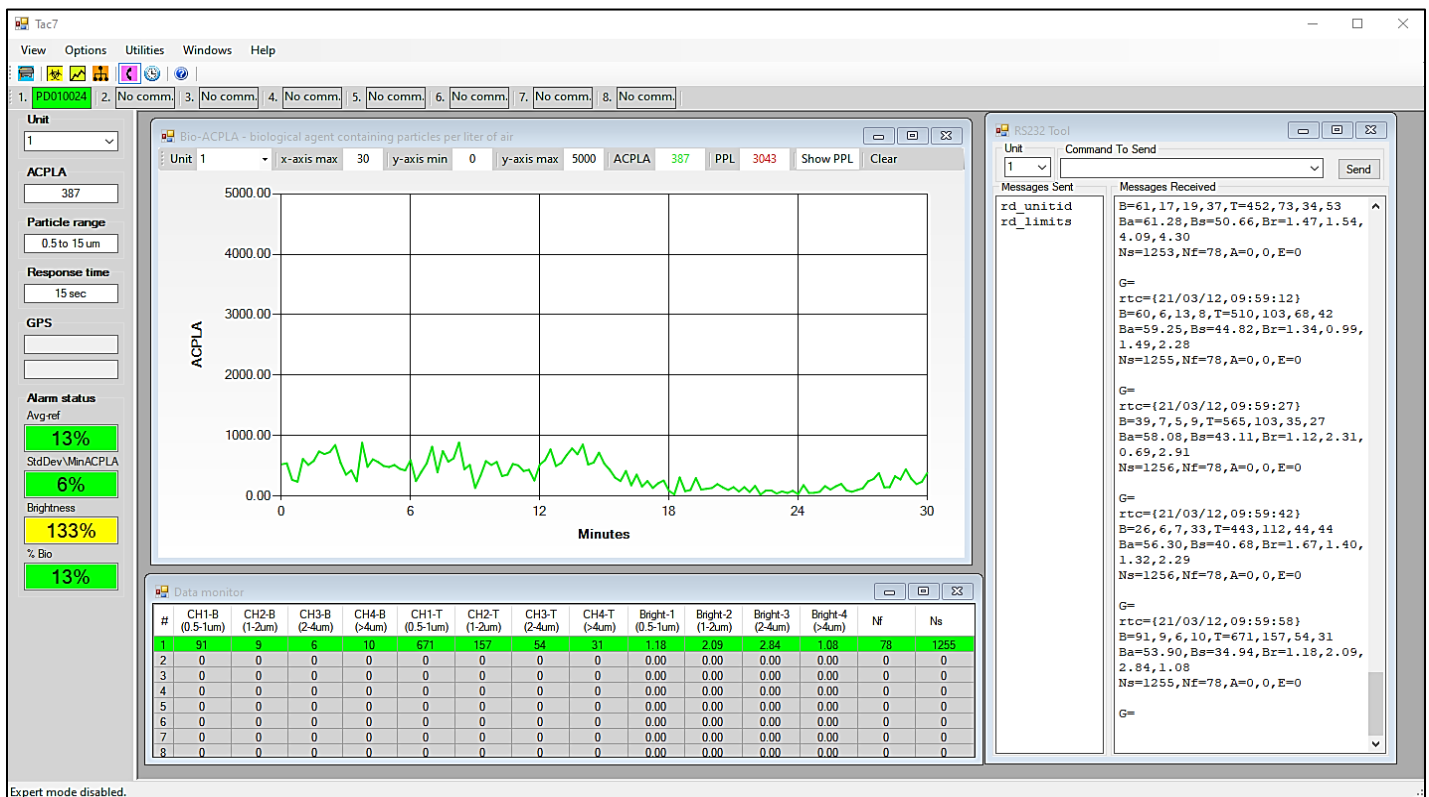


Figure 2. Typical main window on the Tac-7C PC control program.

Tac-7C Sampling Specifications

Operating principle	Monitoring of 280nm UV-stimulated particle scattering and biofluorescence using photon counting electro-optics. Alarm decisions are based on algorithms that consider bioaerosol statistical behavior, bio-fluorescence intensity, and aerosol composition.
Particle size and type	1 to 15 microns in four size ranges. Respirable aerosolized bacteria, spores, viruses, and toxins. Biofluorescence intensity in each size range is monitored and reported.
Interferents	Interferent resistant to burning vegetation, diesel smoke, pollen, silica dust.
Detection limit	100 ACPLA in most natural environments, 20-30 ACPLA under laboratory test conditions.
Sampling rate	1.2 liter per min of ambient air nominal.
Time to alarm	15 second average, 30 seconds maximum. 15-minute trailing history is used in alarm protocols.
Alarms	Red LED and >100dB piezoacoustic alarm, plus serial link digital alarm output.
Operating time	Essentially unlimited if powered externally or 40 hours on UBI 2590 rechargeable battery.
Operating life	Air pump: 30,000 - 40,000 hours. UV light source: greater than 10,000 hours.
Start-up time	1 minute.
Consumables	None.

Power & Communications

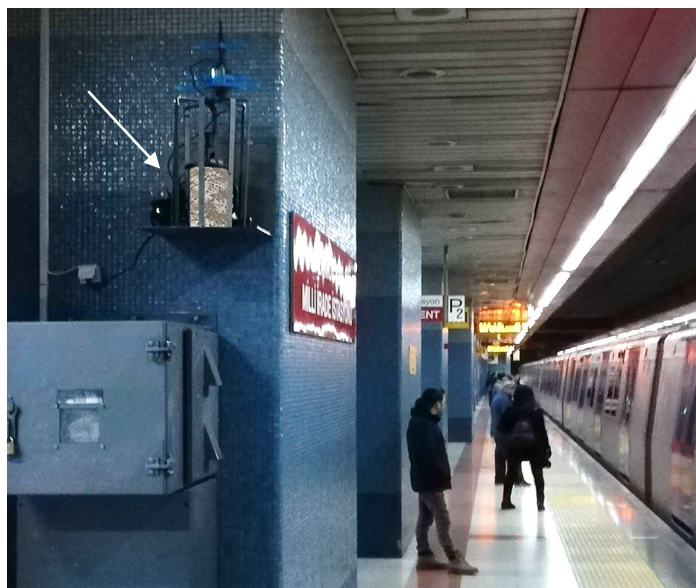
Communication	RS-232 or wireless BioLink; pre-programmed for use with sampler.
Serial data output	Alarm, particles per liter of air in each size bin; percentage of particles that are biological; relative biofluorescence compared to scattering intensity for each size bin.
Power source	100–240 VAC/50–60 Hz lump-in-cord 28 VDC power supply. Optional BA-5590/U primary battery or UBI-2590 rechargeable battery.
Power consumption	Less than 6 watts at 18 VDC to 36 VDC.
Data storage	Onboard removable SD-type data card. Stores more than 5 years of aerosol data.

Physical Specifications

Dimensions	16 x 18 x 28 cm with no inlet air stack. 16 x 18 x 39 cm with inlet stack attached. 16 x 15 x 39 cm without side handle.
Weight	3.5 kg without battery / 4.5 kg with battery.
Operating temp.	-40° C to 50° C. Operation to 60° C is permitted up to a total time of 1,000 hours.
Storage temp.	-40° C to 50° C
Humidity	0 to 95% non-condensing.
Sound level	Sampling: <10 dBA Alarm: >100 dBA
Package	EMI-resistant aluminum shell construction.

Software and Accessories

PC software requirements	OS: Windows; processor: 400 MHz Pentium or equivalent (min.); RAM: 96 MB (min.), 256 MB (recommended); hard disk: 1.2 MB available space; USB port or CD-ROM.
Optional Accessories	Transport case, rechargeable UBI 2590 battery, battery charger, tripod,



A Tac-7C biodetector monitoring air quality in a Turkish subway



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