MANUAL

SUMMARY

REGARDING THE DOSIMETER

The VanellusRad introduces a groundbreaking national technology to Brazil for the real-time measurement and management of radiation doses for occupationally exposed individuals (OEIs). This equipment provides exceptional precision in measurements taken every minute of use, exceeding both national standards and international technologies.

The device transmits captured information in real-time through wireless technology, enabling efficient usage and monitoring. In instances of radiation exposure, immediate and proactive action can be taken, thereby enhancing safety for professionals.

The technology developed by VanellusRad facilitates the generation of reports and automatic notifications when dose limits are exceeded. Equipped with movement sensors, the system also provides alerts in instances of improper dosimeter usage, thereby mitigating risks for OEIs and enhancing the legal safety of the organization.

The implementation of a login/logout function allows multiple users to share the same device across various work shifts, thereby minimizing the necessity for additional equipment. Within the online management platform, report visualization is conducted on a per-user basis. This facilitates the swift and straightforward identification of high doses, misuse, and emerging trends, enabling proactive adjustments to processes aimed at mitigating risks.

- Real-time monitoring of effective dose
- Electronic dosimeter for shared use among users
- Wireless communication for the intelligent management of radioactive doses.
- Cloud history documentation with automated and secure data backup
- User administration and dosage restrictions on a digital platform
- Automated dosage limit notifications with user customization.

WIRELESS COMMUNICATION

MOBILE APPLICATION

The VanellusRad dosimeter transmits data via Bluetooth (BLE) to the "Vanellus" mobile application on Android devices, which may include the tablet supplied in the VanellusRad kit or the user's personal Android smartphone.

In the "on and linked" state, the dosimeter transmits data to the paired device, which includes the following information: Date and Time of the data, dose value in µSv (Accumulated Dose) recorded during the accumulation period specified in the web application (ranging from 1 to 15 seconds, with a default of 5 seconds), dose rate in µSv/h for the interval (Instantaneous Dose), motion detection flag (a parameter adjustable in the web application), dosimeter serial number, currently linked user, battery level in percentage, and temperature in degrees Celsius.

The BLE communication is facilitated through a chip certified by Anatel (Nina-W102).

WEB APPLICATION

The web application is a platform accessible through a web browser for the monitoring and management of ionizing radiation dosage.

While the mobile application collects data from the dosimeters, it is subsequently integrated into the web application for display in the "Real Time" tab.

When the dosimeter is connected to the base, data is compiled in one-minute intervals and transmitted to the web application, making it accessible for the "Overview" and "Detailed View" tabs, which allow users to view aggregated information and analyze the time series of absorbed dose, respectively.

INDICATION LEDS AND OPERATIONAL CYCLE

Dosimeter at the Base

(1) GREEN LED[(b)] CONSTANT: battery fully charged, not in use.

Dosimeter removed from base

(2) YELLOW LED[(a)] CONSTANT: awaiting user connection.

(3) YELLOW LED[(a)] BLINKING: establishing connection with the app, not currently operational.

(4) GREEN LED[(b)] BLINKING: operational.

Dosimeter at the Base

(5) YELLOW LED[(a)] SLOWLY BLINKING: awaiting connection with the Login APP to download data.

(6) YELLOW LED[(a)] BLINKING: data download in progress.

(7) GREEN LED[(b)] BLINKING: battery is charging; the device is not in operation.

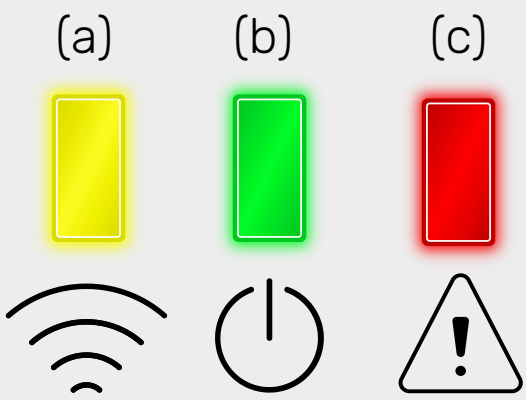
ADDITIONAL PERTINENT INFORMATION

RED LED[(c)] CONSTANT: ionizing radiation has been detected.

RED LED[(c)] CONSTANT AND BUZZER ACTIVATED: ionizing radiation has been detected exceeding the specified dose rate limit in the Web application.

RED LED[(c)] FLASHING: internal malfunction.

GREEN LED[(b)] SLOWLY FLASHING: battery is in critical condition (below 25%). Below 8%, no measurements are recorded.



THE UTILIZATION CYCLE

INITIAL STEP - ENGAGEMENT WITH THE USER

When the dosimeter is detached from the base, its yellow LED (a) will remain illuminated, signifying that it requires association with a user. If it is not in this condition, position it on the base and then remove it once more.

(2) YELLOW LED[a] CONSTANT: awaiting user connection.

Under these circumstances, the Vanellus Login APP will recognize that the dosimeter is ready for association with the user.

With the dosimeter at hand, simply click the "Initialize" button and present your linking QR Code to the camera.

Upon successfully scanning the QR Code, the app will connect the user to the dosimeter. At this time, the Yellow LED will flash.

(3) YELLOW LED[a] FLASHING: establishing connection with the app, not currently operational.

Once the connection is established, the dosimeter will display a blinking Green LED (b), and the app will confirm the dosimeter's connection in the “Connected Dosimeters” list.

(4) GREEN LED[b] FLASHING: operational.

THE UTILIZATION CYCLE

SECOND STEP - REAL-TIME OBSERVATION

With the connected dosimeter in operation, radiation dose levels can be monitored via the Vanellus Monitoring APP.

(4) GREEN LED[(b)] FLASHING: operational.

The Monitoring APP will automatically detect a nearby Vanellus dosimeter. It is possible to view the accumulated dose since the connection with the dosimeter was established.

"On and Linked Dosimeter" associated with the device.

Accumulated dose since the dosimeter was activated and connected.

Under these conditions, all information received by the Monitoring APP will be automatically transmitted to the Vanellus cloud for real-time access in the Web APP, specifically in the "Real Time" tab.

If the Monitoring APP is not in proximity to the dosimeter, there is no need for concern. All data recorded by the dosimeter throughout the day will be uploaded to the cloud upon reconnection.

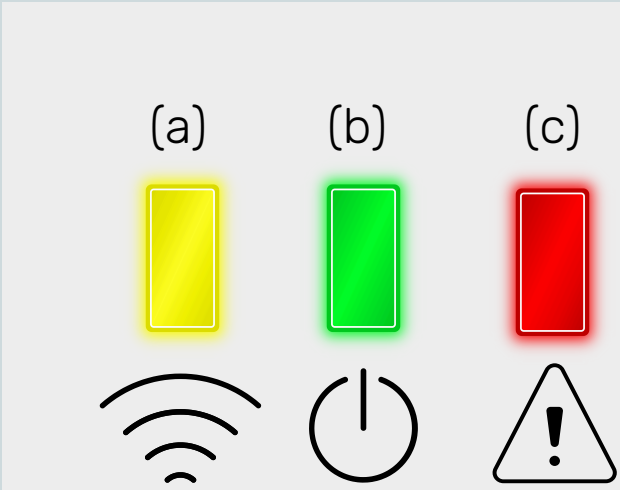
THE UTILIZATION CYCLE

SECOND STEP - REAL-TIME OBSERVATION

With the dosimeter fully operational, users can access additional information by clicking on the user icon. Consequently, the following tab will be displayed:

This tab provides details regarding the serial number associated with the user's dosimeter, which in this instance is 4000 (displayed next to the QR Code of the dosimeter), along with pertinent information for real-time monitoring, including:

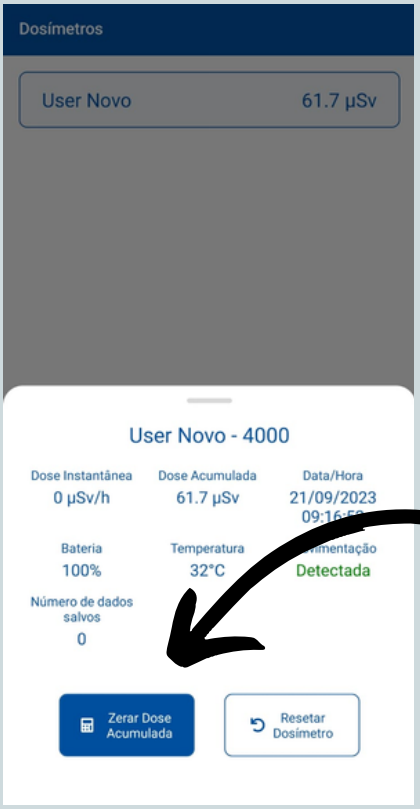
- Date and time of the most recent data reception.
- Accumulated Dose: the dose value in µSv documented during the accumulation period specified in the web application (ranging from 1 to 15 seconds, with a default of 5 seconds);
- Instantaneous Dose: average dose rate throughout the accumulation period, measured in µSv/h;
- Movement: Motion detection indicator via accelerometry (sensitivity parameter set in the web application);
- Battery percentage;
- Temperature in Celsius;
- Number of saved data: this figure indicates the total of 1-minute aggregations prepared for transmission.



THE UTILIZATION CYCLE

SECOND STEP - REAL-TIME OBSERVATION

The user has the option to view the accumulated dose during a specific procedure. This can be accomplished using the "Reset Accumulated Dose" feature to aid in comparison. The actual dose will remain unchanged; only the information displayed on the screen will be reset for comparison purposes.



- The most recent accumulated dose value is displayed in green, while the new primary value adjusts based on subsequent exposures.

In this instance, all information remains intact and accurately documented within the web application and database.

- This functionality is designed solely to enable the monitoring of a specific procedure, allowing the user to observe the accumulated dose over a designated time interval, as well as for dosimeter exposure tests, which provide a rapid reading of the data collected during exposure.

THE UTILIZATION CYCLE

THIRD STEP - DISCONNECTION FROM USER

After utilizing the dosimeter, the user must return it to the charging base.

With the Login APP open, the user will observe that the dosimeter will gradually flash the yellow LED (a), indicating the necessity for communication with the Login APP.

(5) YELLOW LED[(a)] SLOWLY BLINKING: awaiting connection with the login APP to download data.

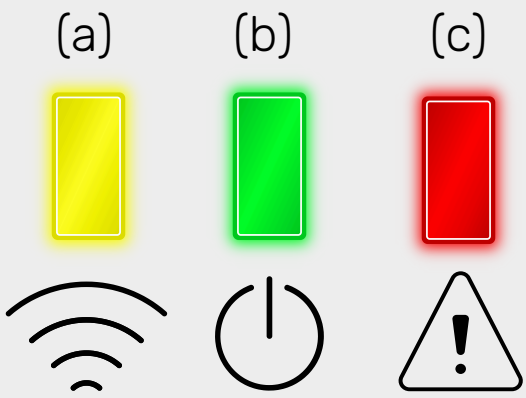
The connection may require a few seconds. If it persists for an extended period, it is advisable to restart the Login APP by closing and reopening it.

Once the connection is established, the dosimeter will begin to flash the Yellow LED (a) rapidly, signifying that the data is being downloaded. This process may take several minutes, depending on the duration of the dosimeter's usage throughout the cycle.

(6) YELLOW LED[(a)] BLINKING: data download in progress.

Upon completion of the data download, the dosimeter will begin to flash its green LED (b), signifying that the battery is charging. If the LEDs remain off, attempt to remove the dosimeter and reinsert it into the base, ensuring that the base is connected to a power outlet.

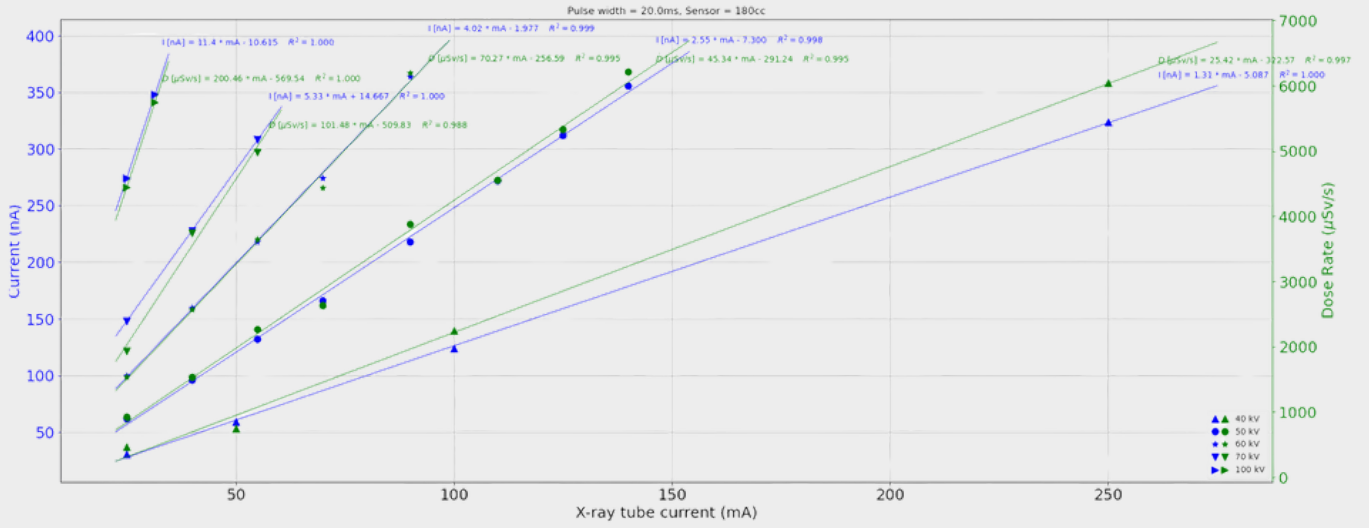
(7) GREEN LED[(b)] BLINKING: battery is charging, device is not in operation.



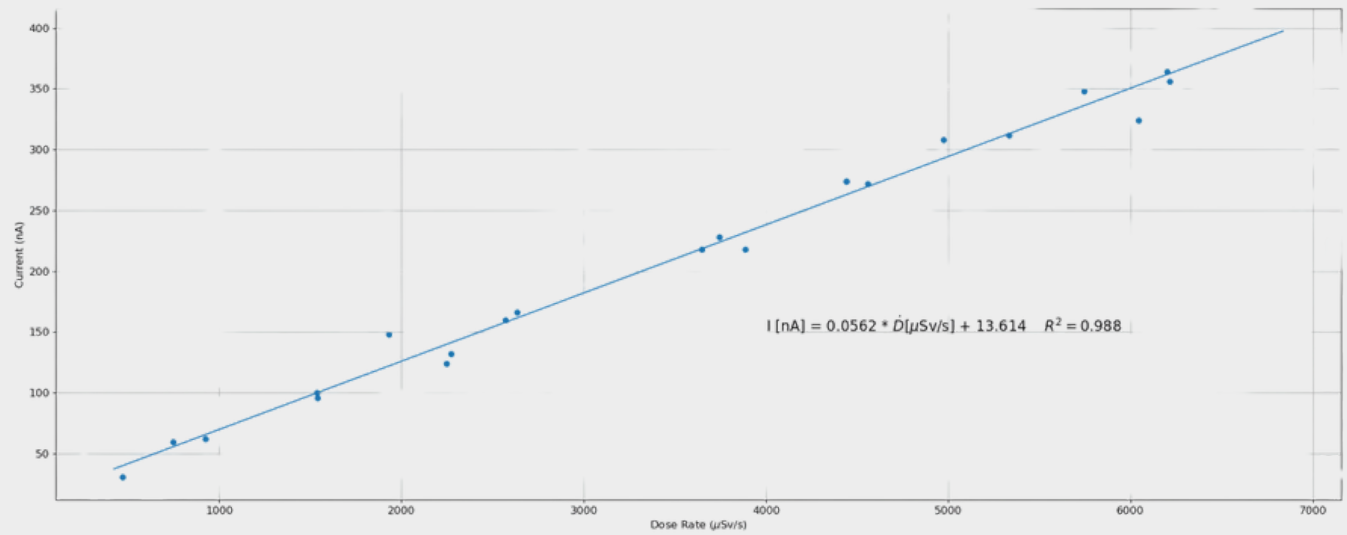
THE VANELLUSRAD TECHNOLOGY

The specifications outlined herein are based on tests performed by the company.

The quality of a radiation dosimeter is intrinsically linked to the technology of its sensor.
The sensor employed by Vanellus in the development of its device exhibits exceptional linear dependence concerning the incident X-ray flux (which correlates with the current supplied to the X-ray tube), as illustrated in the figure below:



The linear relationship between the current measured by the sensor and the dose rate indicated by the reference device is evident, as anticipated and illustrated in the figure below:



THE VANELLUSRAD TECHNOLOGY

The dosimeters were exposed to X-ray and gamma radiation beams, analogous to the reference radiations specified in ISO 4037-1:1996, as detailed in the following table:

Reference radiation code	X-ray tube voltage (kV)	Total filtration (mm)	Semi-reducing layer (mm)	Energy media (keV)
ISO N40	40	0.21 Cu + 4.0 Al	0.084 Cu	33
ISO N150	150	2.5 Sn + 4.0 Al	2.36 Cu	118
ISO S-Cs (137Cs)	-	-	-	662

Variation of dosimeter response with Hp(10) at low rates
The analysis of the test results conducted on the dosimeter was based on the IEC BS EN 61526:2013 standard, which pertains to radiation protection instrumentation and the measurement of personal dose equivalents Hp(10) and Hp(0.07) for X, gamma, neutron, and beta radiations, specifically for direct reading personal dose equivalent meters.

Table 1 - Response of the VanellusRad dosimeter for Hp(10) values in 137Cs gamma radiation beams at a low rate of 14.4 mSv.h^{-1}

Conventional true value Hp(10) (µSv)	100	1000	10000
Average value of the dosimeter measurement ("µSv")	105,2	1006,7	10010,9
Coefficient of Variation (%)	8,59	1,90	0,38
Response variation relative to 10,000 µSv (%)	11	-2	-

THE VANELLUSRAD TECHNOLOGY

Variation in dosimeter response with radiation energy

The analysis of the test results conducted on the dosimeter was based on the IEC BS EN 61526:2013 standard, which pertains to radiation protection instrumentation and the measurement of personal dose equivalents Hp(10) and Hp(0.07) for X, gamma, neutron, and beta radiations, specifically for direct reading personal dose equivalent meters.

Table 2 - Response of the VanellusRad dosimeter to 10,000 µSv in ISO reference X radiation with a low Hp rate (10).

Reference radiation code	ISO N40	ISO N150
Conventional true value of Hp(10) rate ($mSv \cdot h^{-1}$)	45,3	105,8
Conventional true value of Hp(10) (µSv)	10.000	10.000
Average value of the dosimeter measurement ("µSv")	9962,3	10055,2
Coefficient of Variation (%)	1,96	0,10
Response deviation relative to 10,000 µSv at 137Cs (%)	-4	5

THE VANELLUSRAD TECHNOLOGY

Variation of dosimeter response with the angle of radiation incidence
The analysis of the test results conducted on the dosimeter was based on the IEC BS EN 61526:2013 standard, which pertains to radiation protection instrumentation and the measurement of personal dose equivalents Hp(10) and Hp(0.07) for X, gamma, neutron, and beta radiations, specifically for direct reading personal dose equivalent meters.

Table 3 - Response of the VanellusRad dosimeter to 10,000 µSv at various incidence angles of the ISO N80 reference radiation.

Angle of incidence of radiation	**0°**	**-45°**	**-60°**
Average value of the dosimeter measurement ("µSv")	10015,7	10079,6	10100,5
Coefficient of Variation (%)	1,83	1,25	2,75
Response deviation relative to 0° (%)	-	9	20

SUMMARY OF TECHNICAL SPECIFICATIONS

The specifications outlined herein are derived from tests conducted by the company itself.

Calibration	Hp(10)
Technology	Solid-state sensor (photodiode)
Resolution	1.3 pSv in cumulative dose
Minimum detectable dose	350 pSv
Minimum detectable dose rate	Background radiation dose rate
Sampling frequency	5 kHz
Measurement uncertainty	10% for X-ray tubes at 100 kV 10% for Cs-137 radioactive sources
Dose information supplied	Accumulated dosage over the specified period
Protection Index	IP42
Type of Communication	Bluetooth Low Energy (Wireless)
Communication Parameters	Up to 100 meters in an open field
Present consumption	110 mA under full utilization
Battery lifespan	20 hours of continuous use
Data storage	Sufficient for 24 hours without connection to a device.
Communication device	Android tablet and/or smartphone
Movement assessment	Accelerometry
Food	5V, up to 1A (through charging dock)
Charging station	For five units, each with a 5V – 400 mA power supply.
Operating conditions	Temperature ranging from 0 °C to 50 °C

The VanellusRad dosimeter functions dynamically between "Geiger counter" and "ionization chamber" modes, facilitating the measurement of ionizing radiation doses in relation to exposure to radioactive elements via gamma emission and exposure to x/gamma beams in both primary and secondary contexts.

ADDITIONAL TECHNICAL SPECIFICATIONS

The specifications outlined herein are derived from tests conducted by the company itself.

Cabinet	Blue Polylactic Acid
Visual Cues	Green LED - Indicates operational status. Yellow LED - Signifies communication with the gadget. Red LED - Denotes an internal error or dose alert.
Audio Signal	Buzzer - Dose rate exceeds the threshold established in the web application.
User engagement	Log in using a QR code and log out by connecting to the charging station.
Data Visualization	Mobile application and web application (site vanellus)

FURTHER INFORMATION REGARDING THE VANELLUSRAD DOSIMETER.

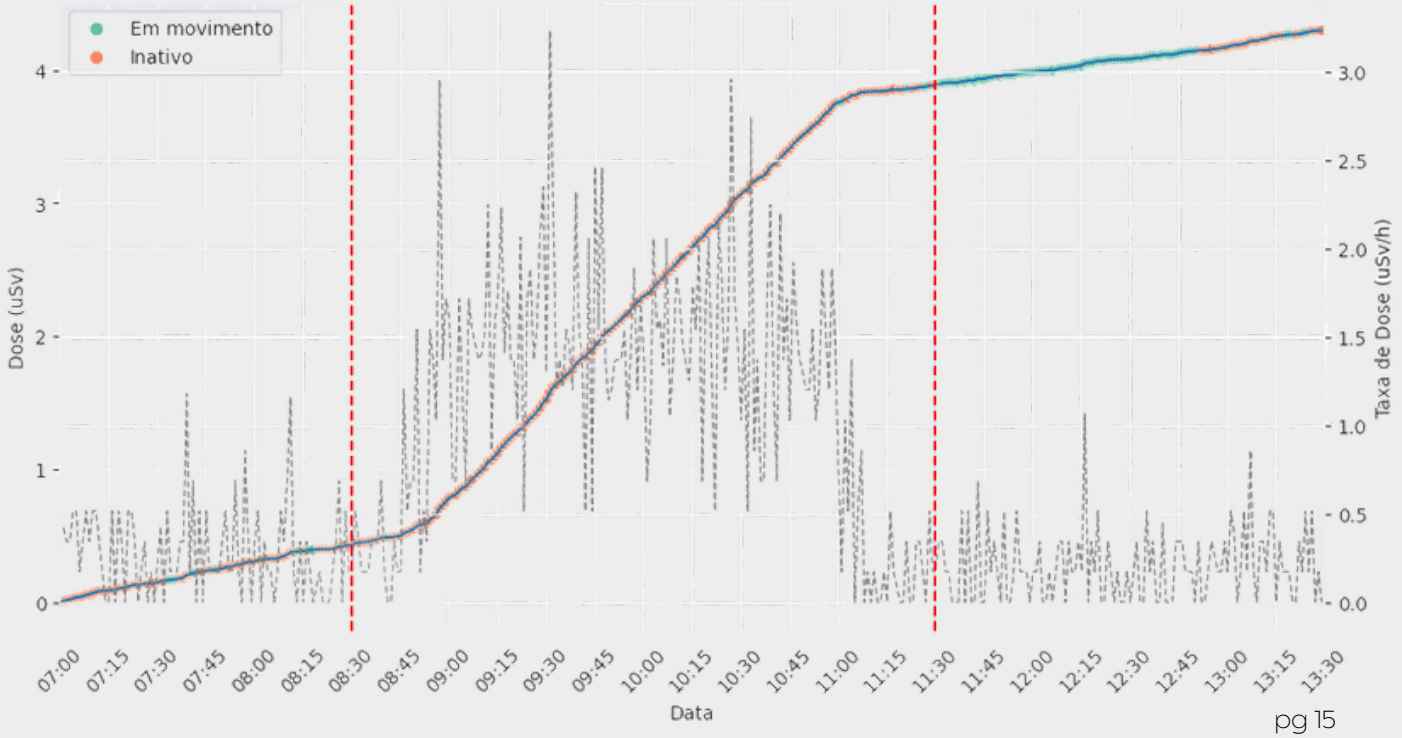
VanellusRad technology represents a state-of-the-art solution for the monitoring and assessment of diverse forms of exposure to ionizing radiation. Whether it involves primary and secondary X-ray apparatus, CT scanners, C-Arm devices, or Nuclear Medicine, the extensive functionality of the VanellusRad dosimeter offers a thorough, real-time perspective on these essential exposures.

Through its precise and immediate recording capabilities, the VanellusRad dosimeter technology emerges as a nimble and efficient instrument for the detection and analysis of radiation-related incidents, including contaminations that arise in Nuclear Medicine.

VanellusRad's versatility further encompasses the execution of procedural exposure studies. Specifically engineered to monitor the dose accumulated during particular procedures, the technology seamlessly integrates with communication tablets, facilitating precise real-time tracking.

The validity and accuracy of the VanellusRad dosimeter are evidenced by its performance in practical applications. The accompanying real-time graphs (A and B) depict exposure to background ionizing radiation during domestic flights (Graph A - São Paulo to Recife, Graph B - Florianópolis to São Paulo and São Paulo to Recife, marked by the sectors delineated by the red dashed vertical line), underscoring the dosimeter's capacity to capture nuances that may otherwise remain undetected. This same sensitivity is employed in identifying subtle variations in the background radiation dose to which we are inherently exposed.

Graph A: Representation of the variation in absorbed dose rate with increasing altitude.



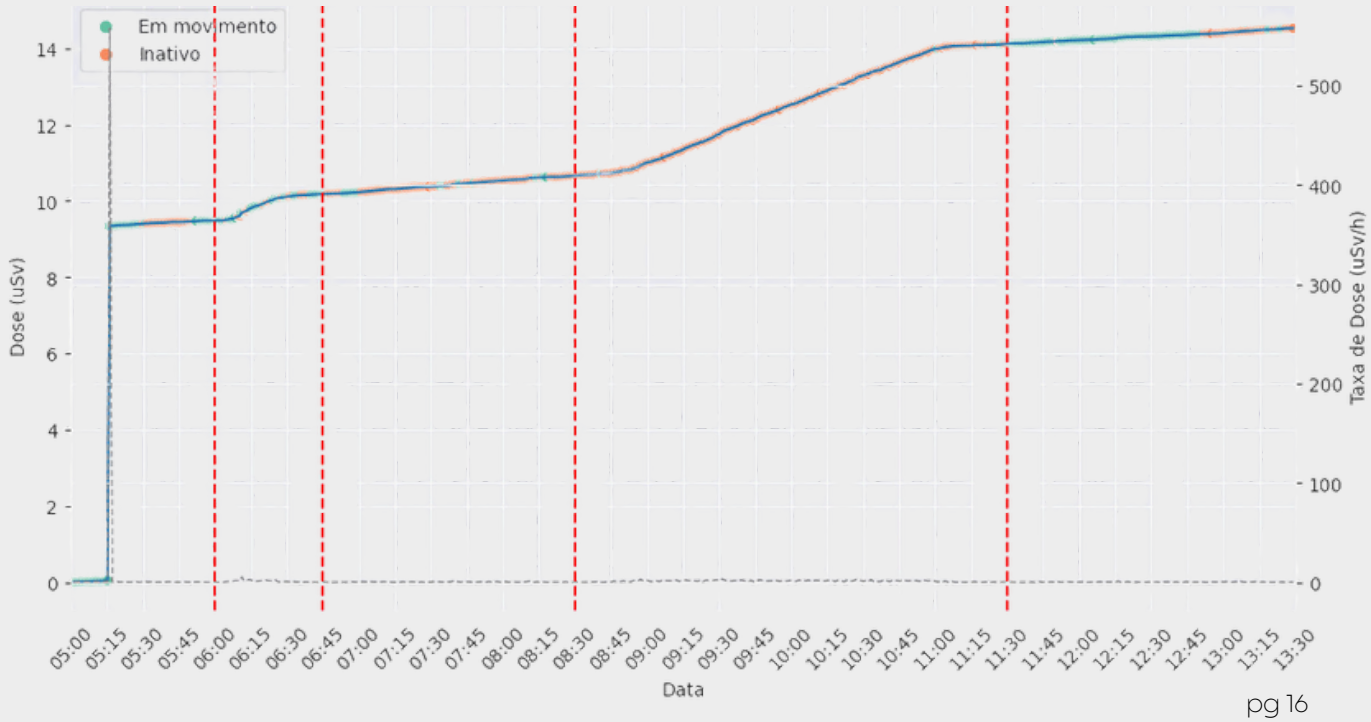
FURTHER INFORMATION REGARDING THE VANELLUSRAD DOSIMETER.

Observe the disparity in scale between graphs A and B.

The data presented in Chart B encompasses measurements obtained during an airport X-ray inspection. This further underscores the effectiveness and versatility of the VanellusRad dosimeter. With a dose of approximately 9 µSv noted during this inspection, it is evident that the technology can deliver valuable and detailed information even in dynamic environments. The disparity in scale between the charts emphasizes this point; we must zoom in on Chart B to identify the background radiation measurements recorded in Chart A.

Primary beam in X-ray examination

Graph B: Recorded absorbed dose from airport X-ray inspections and the variation in dose rate with increasing altitude.



A VANELLUS.

MISSION

DEVELOP SOLUTIONS THAT SAFEGUARD INDIVIDUALS THROUGH ADVANCED TECHNOLOGY, CONNECTIVITY, AND PRECISION.

VISION

TO BECOME A NATIONAL COMPANY RECOGNIZED IN THE MARKET FOR INNOVATIVE SOLUTIONS GROUNDED IN THE SENSING OF PHYSICAL QUANTITIES PERTINENT TO HUMAN AND ENVIRONMENTAL HEALTH.

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