VNIIA
ROSATOM

PHOTOELECTRONIC DEVICES
for Detecting Fast Processes

Photoelectronic Devices for Detecting Fast Processes

Dukhov Automatics Research Institute (VNIIA) develops and produces equipment for detecting fast processes while nuclear-physical research and for laser emission diagnostics. It includes gamma and neutron emission detectors of high sensitivity, high time resolution, and high linear current, subpicosecond time resolution streak cameras for optical emission, and X-ray streak cameras for studying X-ray image of plasma in laser nuclear fusion facilities.

Unique electrovacuum devices, such as photomultipliers and photocells of high time resolution, X-ray image-converter tubes and streak tubes are produced as the components for scintillation detectors and high speed streak cameras.

VNIIA is the only in the world developer and manufacturer of vacuum photocells and photomultipliers providing a unique combination of high time resolution and high linear output current, and compact subpicosecond resolution streak tubes with a dynamic range of up to 24,000.

The key features of the photomultipliers and photocells produced by VNIIA:

- high time resolution (from 0.1 ns for photocells, and from 0.16 ns for photomultipliers);
- high linear output current (up to 11 A for photocells, and up to 2.5 A for photomultipliers);
- spectral sensitivity range from 200 to 1100 nm;
- wide range of light sensitivity: from 30 μA/lm for photocells, and from 0.01 A/lm to 550 A/lm for photomultipliers.

The key features of the streak tubes produced by VNIIA:

- spectral range of recorded optical radiation 200 to 1300 nm;
- X-ray recording range 0.1 keV to 10 keV;
- time resolution 0.7 to 20 ps;
- spatial resolution 10 to 30 lp/mm;
- dynamic range to 24,000 (depending on the time resolution).

High-performance Vacuum Photocells

VD1500
Photocell

Designed for conversion of ultrashort optical pulses into electrical analogs.
Used within low-sensitive fast scintillation and Cherenkov detectors.

TECHNICAL CHARACTERISTICS		
Spectral sensitivity range, nm		300–650
Photocathode type		Sb-Cs
Photocathode diameter, mm		25
Photocathode light sensitivity, μA/lm		25–45
Output current linearity limit, A, not less than		11.0
Dark current at 100 V, nA, not more than		0.1
Pulse response FWHM, ps, not more than		500
Supply voltage, kV		1.8
Dimensions, mm	Diameter	40
	Height	40

VD2000
Photocell

Designed for measurement of pulsed luminous radiation fluxes.
Used within low-sensitive fast detectors using scintillators and Cherenkov detectors having visible luminescence spectrum.

TECHNICAL CHARACTERISTICS		
Spectral sensitivity range, nm		350–650
Photocathode type		Sb-Cs
Photocathode diameter, mm		50
Photocathode light sensitivity, μA/lm		20–45
Output current linearity limit, A, not less than		8.0
Dark current at 100 V, nA, not more than		1.0
Pulse response FWHM, ps, not more than		1000
Supply voltage, kV		1.8
Dimensions, mm	Diameter	92
	Height	85

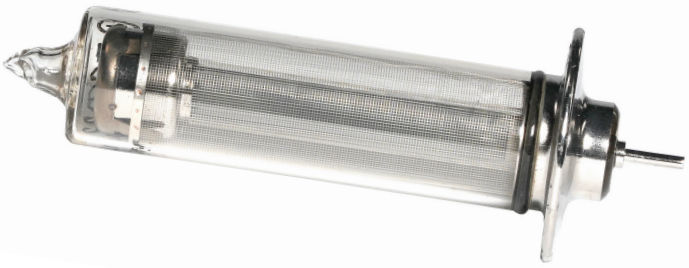
VD2100
Photocell

Designed to convert ultrashort optical pulses into electrical analogs.
Used within low-sensitive fast detectors using scintillators and Cherenkov radiators having luminescence spectrum in the near-ultraviolet and visible regions.

TECHNICAL CHARACTERISTICS		
Spectral sensitivity range, nm		300–650
Photocathode type		Sb-Cs
Photocathode diameter, mm		12
Photocathode light sensitivity, μA/lm		20–45
Output current linearity limit, A, not less than		2.5
Dark current at 100 V, nA, not more than		0.05
Pulse response FWHM, ps, not more than		100
Supply voltage, kV		1.5
Dimensions, mm	Diameter	36
	Height	30

VD2200
Photocell

Designed to convert light emission with a duration of up to 10 μs into an electrical analog.
It is used as part of low-sensitive detectors to record X-ray, gamma and neutron emissions.



TECHNICAL CHARACTERISTICS		
Spectral response range, nm		300–650
Photocathode type		Sb-Cs
Photocathode luminous sensitivity, μA/lm, at least		20–45
Dark current at a voltage of 100 V, nA, at least		0.5
Linearity limit for output current, A, at least		10
Pulse response duration at half-height, ns, at least		2
Supply voltage, kV, at least		2.0
Dimensions, mm	Diameter	40
	Height	116

High-current Photomultipliers

PT3100
Photomultipliers

Designed to convert weak light pulses into electrical analogs with high time resolution.
Can be applied when measuring the parameters of light emission pulses, and as a part of scintillation detectors of ionizing radiation.
Ensure recording of not longer than 20 μs light pulses.
Photomultipliers have an end semitransparent photocathode and a discrete electron multiplication system.

TECHNICAL CHARACTERISTICS		PT3100	PT3101	PT3102
Spectral sensitivity range, nm		350–650	350–650	300–650
Photocathode type		Sb–Cs	Sb–Cs	Sb–Cs
Photocathode diameter, mm		50	50	50
Photocathode sensitivity, μA/lm		20–40	20–40	20–40
Anode light sensitivity, A/lm		50–400	30–400	50–300
Output current linearity limit when illuminated by light pulse of 0.5 μs width, A, not less than		2.5	1.5	2.5
Output current linearity limit when illuminated by light pulse of 20 μs width, A, not less than		0.7	—	0.7
Dark current, μA, not more than		0.7	0.7	0.15
Pulse response width, ns, not more than		5.0	5.0	5.0
Supply voltage, kV, not more than		4.0	4.0	4.0
Dimensions, mm	Diameter	91	91	91
	Height	177	177	177

PT5100
Photomultipliers

Designed to convert weak light pulses into electrical analogs with high time resolution.
Can be applied when measuring the parameters of light emission pulses, and as a part of scintillation detectors of ionizing radiation.
Ensure recording of not longer than 20 μs light pulses.
Photomultipliers have an end semitransparent photocathode and a discrete electron multiplication system.

TECHNICAL CHARACTERISTICS		PT5100	PT5101
Spectral sensitivity range, nm		350–650	300–650
Photocathode type		Sb–Cs	Sb–Cs
Photocathode diameter, mm		50	50
Photocathode sensitivity, μA/lm		20–40	20–40
Anode light sensitivity, A/lm		0.5–10	0.5–10
Output current linearity limit when illuminated by light pulse of 0.5 μs width, A, not less than		2.5	2.5
Output current linearity limit when illuminated by light pulse of 20 μs width, A, not less than		0.7	0.7
Dark current, μA, not more than		0.7	0.7
Pulse response width, ns, not more than		5.0	5.0
Supply voltage, kV, not more than		3.3	3.3
Dimensions, mm	Diameter	91	91
	Height	157	157

PT2200
Photomultiplier

Designed to convert weak light pulses into electrical analogs with high time resolution.
Can be applied when measuring the parameters of light emission pulses, and as a part of scintillation detectors of ionizing radiation.
Ensure recording of not longer than 20 μs light pulses.
Photomultiplier has an end semitransparent photocathode and a discrete electron multiplication system.

TECHNICAL CHARACTERISTICS		
Spectral sensitivity range, nm		350–650
Photocathode type		Sb–Cs
Photocathode diameter, mm		50
Photocathode sensitivity, μA/lm		20–40
Anode light sensitivity, A/lm		0.005–0.020
Output current linearity limit when illuminated by light pulseof 1.2 μs width, A, not less than		1.5
Dark current, μA, not more than		0.05
Pulse response width, ns, not more than		5.0
Supply voltage, kV, not more than		4.5
Dimensions, mm	Diameter	91
	Height	140

PT2501, PT2502, PT2521, PT2522
Photomultipliers

Designed for recording of weak pulsed radiation fluxes in UV, visible, and near-IR region from 150 to 800 nm.
Can be used both in photometry and in scintillation detectors, in counting or spectrometric modes. Amplification varies from 10^3 to 10^6. The anode current linearity limit is at least 0.3 A. Time resolution is not more than 0.65 ns.
Photomultipliers have an end semitransparent photocathode and a microchannel electron multiplication system; they are enclosed in a housing fitted with a voltage divider.

TECHNICAL CHARACTERISTICS		PT2501	PT2502	PT2521	PT2522
Spectral sensitivity range, nm		200–800	200–800	200–650	200–650
Photocathode type		S25	S25	S20UV	S20UV
Photocathode diameter, mm		25	25	25	25
Photocathode sensitivity, μA/lm		250–550	250–550	20–100	20–100
Spectral sensitivity, mA/W, not less than		50 (430 nm)	50 (430 nm)	30 (265 nm) 70 (365 nm)	30 (265 nm) 70 (365 nm)
Amplification		$2{\cdot}10^3$	$0.7{\cdot}10^6$	$2{\cdot}10^3$	$0.7{\cdot}10^6$
Number of microchannel plates		1	2	1	2
Anode current linearity for 20 ns pulse width, A, not less than		0.3	0.3	0.3	0.3
Dark current, A, not more than		$1{\cdot}10^{-7}$	$1{\cdot}10^{-7}$	$1{\cdot}10^{-7}$	$1{\cdot}10^{-7}$
Time resolution, ns, not more than		0.5	0.65	0.5	0.65
Supply voltage, kV		5.0	5.0	5.0	5.0
Consumption current, μA		200	200	200	200
Dimensions, mm	Diameter	70	70	70	70
	Height	75	75	75	75

PT8500
Photomultiplier

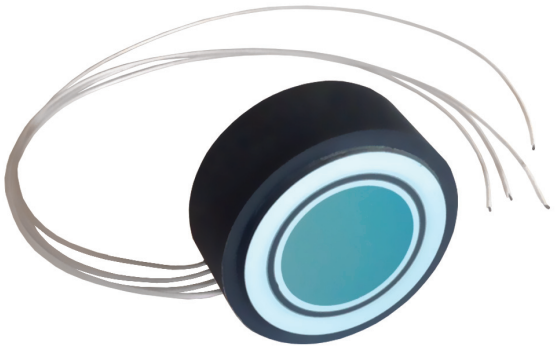
The TNFT85 photomultiplier is designed to convert light emission into an electrical analogue. It is used as part of advanced scintillation ionizing radiation detectors to record the number of signal pulses in a selected period of time as well as to analyze the distribution of pulse amplitudes. It can be used as part of portable radiometric and dosimetric equipment for operation in detection, spectrometric devices, and scintillation counters.

TECHNICAL CHARACTERISTICS		
Spectral response range, nm		320–650
Photocathode luminous sensitivity, μA/lm, at least		60
Photoelectric yield for a wavelength of 410 nm, mA/W, at least		60
Spectral anode response for emission wavelength of 410 nm, kA/W, at least		30
Energy resolution with a scintillation detector based on a NaI (Tl) crystal and a Cs^{137} gamma radiation source, %, less than		12
Self-noise energy equivalent with a scintillation detector based on a NaI (Tl) crystal and a Am^{241} gamma radiation source, keV, less than		10
Supply voltage relevant to the anode luminous sensitivity of 30 A/lm, V, max.		1250
Dark current at supply voltage relevant to the anode luminous sensitivity of 30 A/lm, nA, max.		15
Photocathode diameter, mm		25
Dimensions, mm	Diameter	30
	Height	114

Image Converters

IT2500
Image Converter (Luminance Amplifier)

Designed to be used as an intensity amplifier within streak camera configuration to study fast processes.
Sensitive in visible spectrum region.
Optional gating/shutter function with less than 10 ns actuation time can be provided.

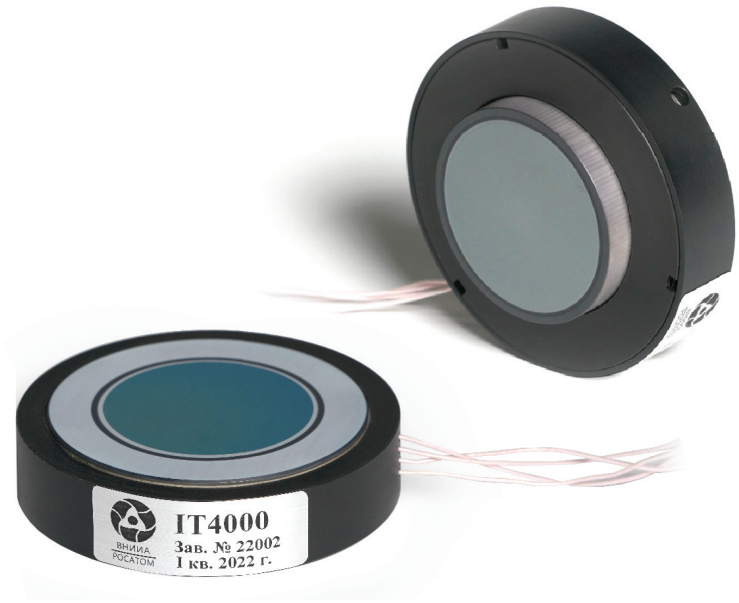


TECHNICAL CHARACTERISTICS		
Spectral sensitivity range*, nm		400–800
Photocathode light sensitivity, μA/lm		350 (std. 400–500)
Photocathode spectral sensitivity for 530 nm* wavelength radiation, mA/W, not less than		35 (std. 60)
Spatial resolution in screen working area, lp/mm, not less than		30 (std. 40–45)
Conversion factor for 530 nm* wavelength, rel. units, not less than		10,000
Electron-optical magnification ratio, rel. units, not less than		1
Dark background intensity, cd/m^2, not more than		$2 \cdot 10^{-3}$
Photocathode working area diameter, mm		25
Screen working area diameter, mm		25
Material of input and output window*		fiber-optical plate
Power supply (optionally)	Input voltage, V	12±3
	Control voltage of microchannel plate, V	0–5
	Current consumption, mA, not more than	30
Dimensions, mm	Diameter (with power supply)	75
	Diameter (without power supply)	45
	Height	24

* parameters can be varied according to customer's project.

IT4000, IT4001, IT4002, IT4003
Image Intensifier Tubes (IIT) (Image Intensifiers)

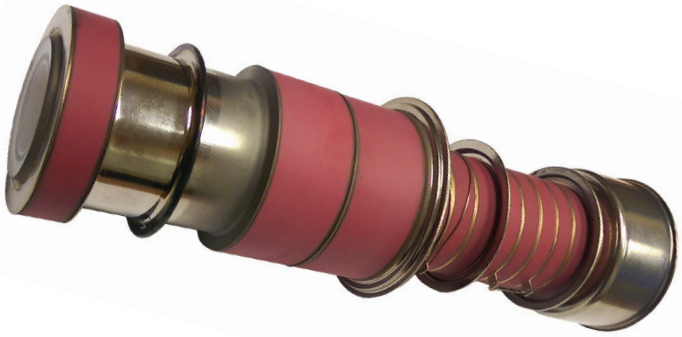
Frame-based Image Intensifier Tubes (IIT) with an increased information capacity and a photocathode diameter of 40 mm are used as an image intensifier tubes as part of chronographic electron-optical recorders to study high-speed processes, as well as, as part of framing electron-optical streak cameras (EOCs) for instant photography of high-speed process with an exposure time from 100 ns to units of milliseconds.



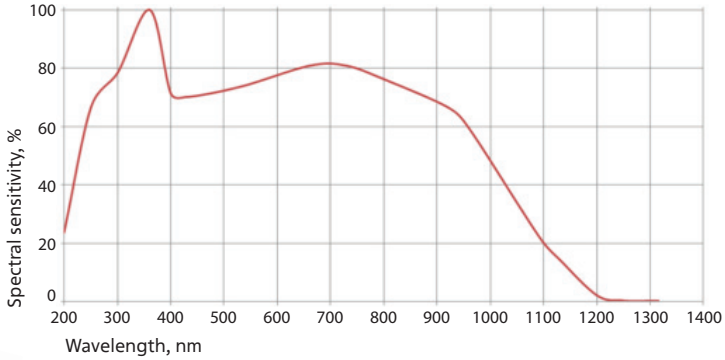
TECHNICAL SPECIFICATIONS					
Indicator name, unit of measurement		Indicator value			
		IT4000	IT4001	IT4002	IT4003
Input window type		Glass	FOP	Glass	FOP
Photoelectric yield for emission wavelength of 410 nm, mA/W, at least		40	–	40	–
Spectral transformation ratio for emission wavelength of 410 nm, pu, at least		10000	–	10	–
Photoelectric yield for emission wavelength of 530 nm, mA/W, at least		–	40	–	40
Spectral transformation ratio for emission wavelength of 530 nm, pu, at least		–	10000	–	10
Dynamic range, p. u., at least		$1{\cdot}10^{3}$		$1{\cdot}10^{5}$	
Photocathode operational area, mm		Ø 40–2.0			
Screen operational area, mm		Ø 40–2.0			
Resolution limit by photocathode, grooves/mm, at least		35		45	
Glow color of the FOP screen		green			
Uneven brightness of the screen glow, %		25			
Brightness of the dark background, cd/m2, at least		$2{\cdot}10^{-3}$		$5{\cdot}10^{-5}$	
Gate mode control by photocathode		available			
The minimum exposure duration at which the IIT provides image registration in a single power-on mode, ns, at least		100			
Overall dimensions (with a power source), mm:	Diameter	117			
	Length	24			

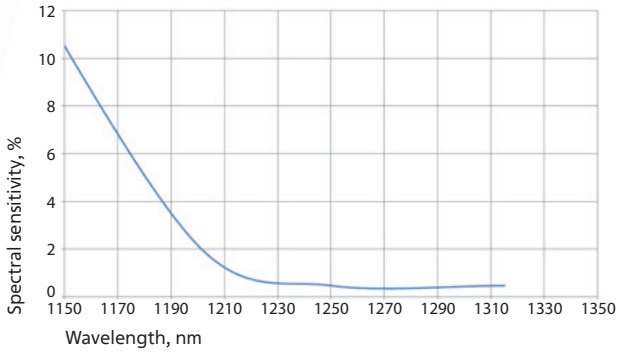
ST3001
Streak Tube

ST3001 are the new generation of streak tubes. Designed for spatial-temporal conversion of pulsed radiant fluxes within wavelength range from 200 to 1300 nm with up to 0.7 ps time resolution.



ТПО30-01 Spectral Response Curves





TECHNICAL CHARACTERISTICS		
Spectral sensitivity range*, nm		200–1300
Photocathode spectral sensitivity for 1060 nm* wavelength radiation, μA/W, not less than		100 (std. 500–700)
Photocathode spectral sensitivity for 920 nm* wavelength radiation, μA/W, not less than		250 (std. 800–1000)
Photocathode spacial resolution, lp/mm, min.		30
Gate number, rel. units, not less than		$1 \cdot 10^5$
Photocathode active area height (normal to the sweep direction), mm		10
Screen active arrea width and height, mm		18×15
Dynamic range when recording process duration of ≥300 ps, rel. units, not less than		8 000
Estimated limit time resolution, ps		0.7
Error-free running time, h, not less than		2 000
Material of input window		quartz
Housing material		ceramet
Dimensions	Diameter	55
	Length	217

* parameters can be varied according to customer's project.

ST4100
Chronographic Image Intensifier Tube (IIT) with A3B5 Photocathode

ST4100 is an Image Intensifier Tube (IIT) with a photocathode based on GaAs epitaxial heterostructures, which has increased values of light and spectral sensitivity in the near-infrared region and an extended dynamic range of registration, has no analogues in Russia. ST4100 IIT is used as part of chronographic electron-optical streak cameras (EOCs) to study parameters of pulsed laser radiation in the wavelength range from 450 to 900 nm.

TECHNICAL SPECIFICATIONS		
Spectral response range, nm		450–900
Photocathode luminous sensitivity, μA/lm, at least		800
Spectral transformation ratio for emission wavelength of 800 nm, W/W, at least		0.5 (typ. 2)
Photoelectric yield for emission wavelength of 800 nm, mA/W, at least		50 (typ. 100)
Dynamic range of registration with a process duration of 500 ps, pu, at least		12,000 (typ. 20,000)
Photocathode operational area by height (perpendicular to the sweep direction), mm, at least		6
Screen operational area by width and height, mm, at least		18 × 6
Spatial resolution by photocathode, grooves/mm, at least		30
Estimated time limit resolution, ps, at least		20
Brightness of the dark background, cd/m^2, at least		$1 \cdot 10^{-5}$
Gate value, pu, at least		$1 \cdot 10^{5}$
Overall dimensions, mm	Diameter	54
	Length	215

UniStreak-2
Streak Camera

The UniStreak-2 streak camera based on a metal-ceramic streak tube can be used to investigate plasma, evaluate characteristics of the laser radiation, in LIDAR systems, in gas-dynamics researches, in MegaScience complexes.

The main features of the streak camera include a wide range of sweep time (from ps units to tens of μs), a modular design (for a flexible configuration), a remote control of the input optical system, an adjustable delay of the start-up time.

TECHNICAL CHARACTERISTICS		
Spectral response characteristics, nm	410–870	
Spatial resolution, Lp/mm, min.	20	
Quantity of possible elements along the sweep (20 ns), min.	200	
Sweep time (±10 %)	500 ps; 1; 2; 5; 10; 20; 50; 100; 200; 500 ns; 1; 2; 5; 10; 20; 50; 100 μs	
Error in setting the sweep length, less	±10%	
Sweep nonlinearity, max.	±20 %	
Spectral response characteristics for an optical trigger, nm	400–1100	
Defined thresholds of electric starting signal, V	5; 10; 20	
Tolerable pulse overload at the electric starting input signal	±500 V, 1 μs	
Trigger delay, ns, max.	35 (at the fasted range)	
Power supply and power consumption	~220 V; =24 V	60 W
Jitter, ps, max.	60 (at the fasted range, measured 30 ps)	
Dynamic range (sweep time 10 ns, laser pulse FWHM (450±150) ps), min.	2000	
Temporal resolution, ps	2	
Input optics	1. Zoom lens 1:1; 2. Motorized slit 0–10 mm long with a space of 1 μm; 3. 16-channel fiber-optic cable (core fibers 50 μm)	
Range of measured time intervals, ns	0.05 – 90 000	
Remote control of the camera from a package laptop with Client-Server software, including power supply control		
Interface	100BASE-Tx (twisted pair, RJ45-connector), up to 50 m 100BASE-Fx (singlemode optical fiber, SC-connector), up to 500 m	

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