Questions that arise in measurements of the peak power and time parameters of optical pulses in the subnano- and picosecond range are discussed. Methods of development and problems that arise in this area of photometry are considered.

Measurements of the time response (dynamic parameters) of optical pulses are, together with measurements of the energy parameters and characteristics, very common in the course of creating and applying systems and devices that are based on laser technology of pulsed or modulated radiation modes in different fields of science, technology, and industry and encompass all spheres of man's practical activity.

The most intensive development of these types of measurements is seen in those fields in which application of pulsed laser systems leads to high-quality measurements, for example, fiber-optic transmission systems, distance measurement, computer technology, biotechnology, medicine, and a number of other fields. With the practical mastery of micro- and nanosecond ranges in the 1970s and 1980s, successive development of the range of shorter optical pulses became necessary in the 1980s and 1990s. The transition to application of laser signals of subnano- and picosecond length has led to the appearance of essentially new capabilities or to a very substantial expansion of already existing capabilities. Thus, in the area of fiber-optic transmission systems it has become possible to create super-wideband transmission systems, including systems with spectral multiplexing and coherent communications systems. In distance measurement it is likely that measurement systems with super-high resolution will be created. In the area of biotechnology it is likely that controlled actions will become possible at the cellular and gene levels. In computer technology there is the likelihood that super-high-speed and high-capacity fourth and fifth generation computers will be created. Fundamentally new capabilities have become apparent in the area of medicine, including both surgical as well as therapeutic methods for the treatment of a large number of diseases, including oncological diseases. The list may be substantially lengthened.

However, practical application of the different types of laser technology in these fields inevitably entails determining the basic parameters and characteristics of radiation (both the energy and the time parameters and characteristics). In turn, the reliability and effectiveness of these measurements is determined by whether they are supported by metrological supervision and the theoretical capabilities of methods and techniques of measurement.

Since questions of metrological supervision in the area of micro- and nanosecond ranges have been virtually resolved in recent years, in the coming years these questions will arise exclusively for the case of subnano- and picosecond ranges, and, subsequently, in the femtosecond range with further advances in theoretical developments in this field.

The development and improvement of metrological support for measurements of dynamic parameters is indissolubly connected with the evolution and investigation of new physical elements (lasers, detectors, crystals, etc.) as well as new methods and techniques, including both purely mathematical (e.g., algorithmic) as well as indirect (e.g., correlation) methods of measurement and processing of measurement information.

From the economic point of view the most useful approach is one that involves the gradual (step-by-step) transition of the metrological support for measurements of dynamic parameters from one range to the next, a transition that should be correlated with practical advances and the demands of science and technology. It is natural for metrological supervision to outstrip...
somewhat those fields of science, technology, and industry (i.e., the demands of society) for which the particular form of metro-
logical supervision is intended.

The development of a system of metrological supervision must proceed in three general directions:
creation of radiation sources in the picosecond (and, thereafter, in the femtosecond) range with controlled (regulated) and normalized shape parameters;
creation of devices and systems for transformation and measurement of the waveform of optical pulses with normalized metrological characteristics;
improvement of existing measurement methods for transmission of the size of physical units between components of a metrological circuit along with the development of new methods, as well as practical application of these methods.

These trends must evolve in interdependent fashion, as a unified whole. Today, however, each of these trends exhibits the traditions and means of operations typical of those scientific groups where studies in the particular field have been basically concentrated. From an analysis of the results of these studies it is possible to predict in general outline the future development of the metrological support for measurements of dynamic parameters and, correspondingly, to coordinate the course of future studies.

Gas lasers, in conjunction with highly recommended electro- and acousto-optical crystal modulators, devices designed to normalize the optical signal, are rather commonly employed as a way of maintaining metrological support for measurements of dynamic parameters in the micro- and nanosecond range. Together with semiconductor injection lasers, they are the basic equipment used for metrological supervision. Other types of lasers have not become widely used for these purposes [1]. With the transition into the subnano- and picosecond regions, semiconductor lasers have proven to be virtually the only source with extensive control capabilities [2]. In the picosecond range, however, it becomes significantly more complicated to control the signal waveform and the capabilities available for this purpose are substantially limited. In all likelihood, these types of lasers will be used only as adequately stable sources of optical signals, i.e., as analogs of the delta function, in the range of several or dozens of picoseconds. Thus, the range of applicability of these types of lasers for the purpose of metrological support for measurement of dynamic parameters may be given as $10 \cdot 10^{-12}$–$30 \cdot 10^{-12}$ s.

There have been well-known efforts to create sources of radiation possessing square-topped optical pulses on the basis of a solid-state laser with nonlinear wavelength converter [3]. This type of special radiator, i.e., a source of square-topped optical pulses with normalized length of the front and cut-off frequency in the range 0.4–1.6 $\mu$m may be used as an initial source in the construction of a metrological system of measurement of the transient response of radiation detectors in the range $50 \cdot 10^{-12}$–$70 \cdot 10^{-12}$ s.

Studies aimed at designing sources using mode synchronization and compression in a monofilament and related topics are also of some interest. However, it is difficult to apply these types of radiators due to the substantial instability of their parameters and other physical constraints.

In reviewing the outlook for the development of devices and systems for transformation and measurement of the waveform of optical pulses possessing normalized metrological characteristics for purposes of metrological support in measurement of dynamic parameters in the subnano- and picosecond ranges, it should be kept in mind that, in all likelihood, methods for direct conversion using different types of photoconverters (mainly semiconductor photodetectors) and electron-optical converters, will become quite widespread in coming years.

Photoelectric diodes possessing a variety of different structures (p-i-n, avalanche, heterostructure diodes, etc.) that generally maintain a high-speed response up to $150 \cdot 10^{12}$–$300 \cdot 10^{12}$ s in the range 0.4–1.6 $\mu$m are currently in widespread use, and a number of different types of photoelectric diodes possessing higher rates of response have been introduced into use. For example, note that the best models of foreign radiation detectors exhibit a response threshold (certified values of the range of applicability) of $20 \cdot 10^{-12}$ s, whereas the analogous parameter of domestically produced radiation detectors is somewhat worse ($40 \cdot 10^{-12}$ s). At the same time, it should be noted that the theoretical threshold is on the order of $10 \cdot 10^{-12}$ s, and, in view of the technological and design capabilities of modern industry, this threshold will not, in all likelihood, surpass the above value of around $20 \cdot 10^{-12}$ s. These parameters derive mainly from studies from the middle 1980s that were made use of in industry in the second half of the 1980s. The conclusion concerning the limiting response of photoelectric diodes is, however, confirmed by the fact that there have been no major changes over the past decade.

Considerable experience has also been gained in this country from the development of Agat-type photoelectric chronographs and corresponding electron-optical converters and from the application of these devices in practical measurement of the waveform and length parameters of picosecond pulses. These types of photoelectric chronographs have a resolution threshold