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# Polish standard: determination of soil particle size distribution by laser diffraction method (LDM)

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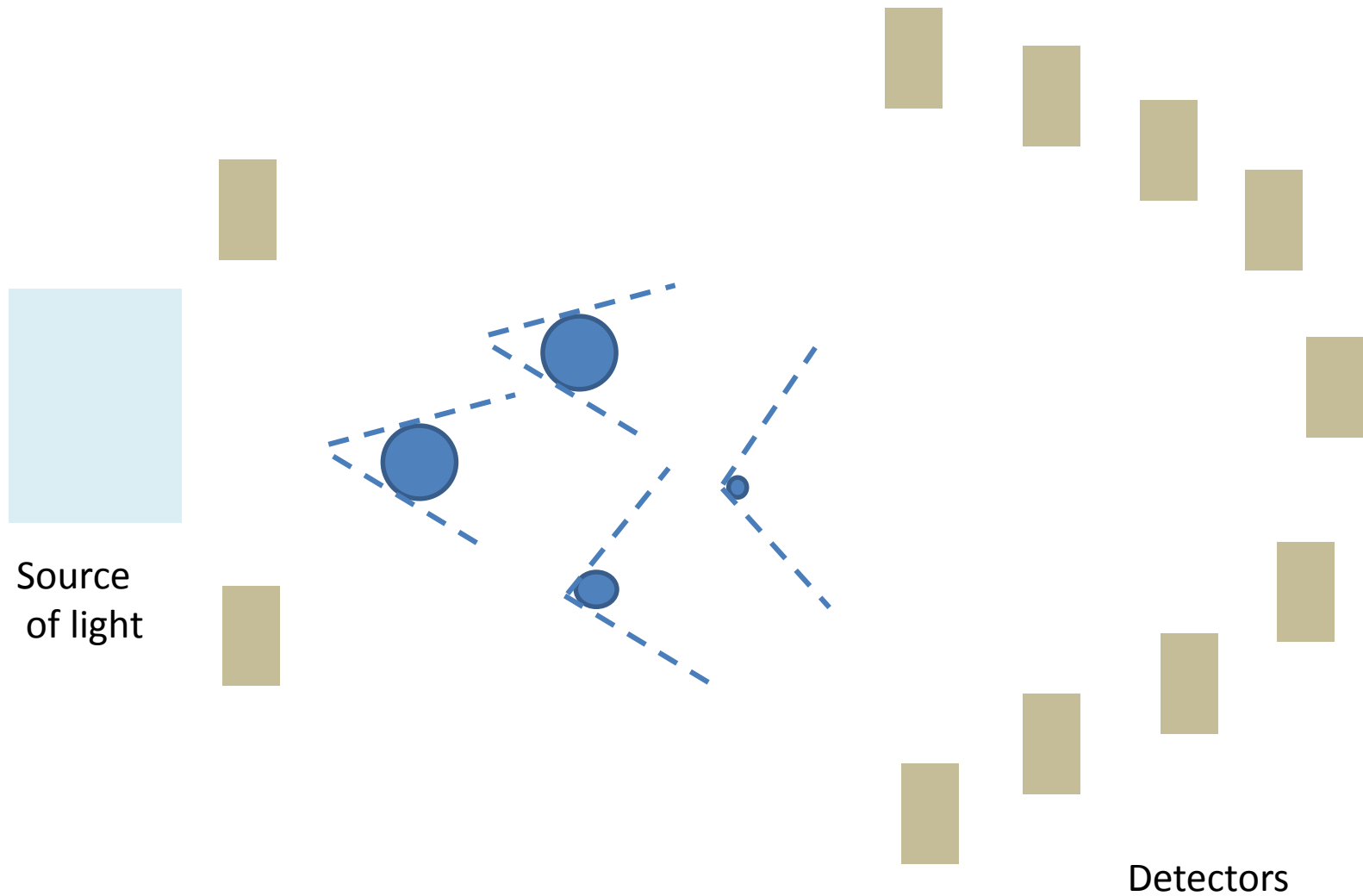
# Structure of presentation

1. Introduction
2. Laser diffraction method
3. PN-Z-19012 Soil quality. Determination of granulometric composition of mineral soil material. Laser diffraction method

# Introduction

Measurement method	Basic assumptions
sieve	<ul style="list-style-type: none"><li>• particles with a diameter smaller than the mesh of the sieve pass through the sieve</li></ul>
pipette / sedimentation method	<ul style="list-style-type: none"><li>• the particles fall to the bottom of the vessel in a uniform motion</li><li>• the particles to be analysed are spherical</li><li>• constant density value of solid phase (<math>2.65\text{g/cm}^3</math>)</li><li>• there are no interactions between the particles and the walls of the vessel</li></ul>
laser diffraction	<ul style="list-style-type: none"><li>• the particles to be analysed are spherical</li><li>• each particle as an independent object causes light scattering</li><li>• knowledge of refractive index and light absorption coefficients is required</li><li>• random orientation of particles in relation to the light beam</li></ul>

# Laser diffraction method



# Laser diffraction method

The angular distribution of the intensity of light scattered on the particles depends on the size, shape and optical properties of the particles. It results from four types of interactions between the electromagnetic wave (incident light) and the particle:

- diffraction on the contours of the particle, the so-called Fraunhofer diffraction,
- reflection from the external and internal surface of the particles,
- reflection from the border scattering phase - particle and particle - scattering phase,
- absorption within the particle.

Obtaining information on particle size distribution based on the intensity of scattered light falling on the detectors requires two steps:

- choosing a mathematical model describing the scattering of light by homogeneous particles,
- the translation of information from the angular distribution of the intensity of scattered light into the size of the particles under analysis.

# PN-Z-19012 Soil quality. Determination of granulometric composition of mineral soil material. Laser diffraction method

- 1 Scope of the standard
- 2 Normative references
- 3 Terms and definitions
- 4 Principle of method
- 5 Reagents and solutions
  - 5.1 Water
  - 5.2 Sodium hexametaphosphate ( $\text{Na}_6\text{P}_6\text{O}_{18} \cdot 6\text{H}_2\text{O}$ )
  - 5.3 Anhydrous sodium carbonate ( $\text{Na}_2\text{CO}_3$ )
  - 5.4 Dispersing solution
  - 5.5 Surfactant
- 6 Laboratory equipment and apparatus
  - 6.1 General
  - 6.2 Laser diffractometer
  - 6.3 Ultrasaund probe
- 7 Initial sample preparation
- 8 Theory selection
- 9 Dispersion phase
  - 9.1 General
  - 9.2 Preparation of the dispersion phase
  - 9.3 Setting the parameters for the dispersion phase

# PN-Z-19012 Soil quality. Determination of granulometric composition of mineral soil material. Laser diffraction method

- 10 Preparation of the apparatus for work
    - 10.1 General
    - 10.2 Venting the entire system and alignment of the optical system
    - 10.3 Setting the measurement parameters
      - 10.3.1 Additional settings available in the software
      - 10.3.2 Wavelength
      - 10.3.3 Stirrer speed
      - 10.3.4 Pump speed
      - 10.3.5 Duration of a single measurement
  - 11 Background measurement
  - 12 Adding the soil sample into the laser diffractometer
    - 12.1 Preparation of the soil sample
    - 12.2 Determination of soil sample amount
    - 12.3 Addition of surfactant
    - 12.4 Soil sample dispersion
  - 13 Verification of measurement parameters
  - 14 Measurement
  - 15 Presentation of results
  - 16 Test protocol
- Annex A (informative) Schema illustrating the procedure

# PN-Z-19012 Soil quality. Determination of granulometric composition of mineral soil material. Laser diffraction method

1 Scope of the standard

2 Normative references

ISO 13320 Particle size analysis - Laser diffraction methods

PN-EN ISO 3696 Water for analytical laboratory use — Specification and test methods

PN-ISO 11277 Soil quality — Determination of particle size distribution in mineral soil material — Method by sieving and sedimentation

PN-ISO 11464 Soil quality — Pretreatment of samples for physico-chemical analysis

PN-R-04032 Soils and mineral compositions - Sampling and determination of granulometric composition

3 Terms and definitions

4 Principle of method



# PN-Z-19012 Soil quality. Determination of granulometric composition of mineral soil material. Laser diffraction method

## 5 Reagents and solutions

**Water** of at least class 2 according to the PN-EN ISO 3696 Water for analytical laboratory use — Specification and test methods

## 6 Laboratory equipment and apparatus

## 7 Initial sample preparation

## 8 Theory selection

Use for the calculation of results:

- Mie theory,
- Mie or Fraunhofer theory

See ISO 13320 for additional information.

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## 9 Dispersion phase

Measurements of soil particle size distribution should be made in water. The water should be air bubble free.

## 10 Preparation of the apparatus for work

When preparing the apparatus for measurement, follow the recommendations of the apparatus manufacturer.

After each filling of the apparatus with water - and before starting to check the measurement parameters or measurements - make sure that the measuring system is free of air bubbles.

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## 10.3 Setting the measurement parameters

10.3.1 Additional settings available in the software

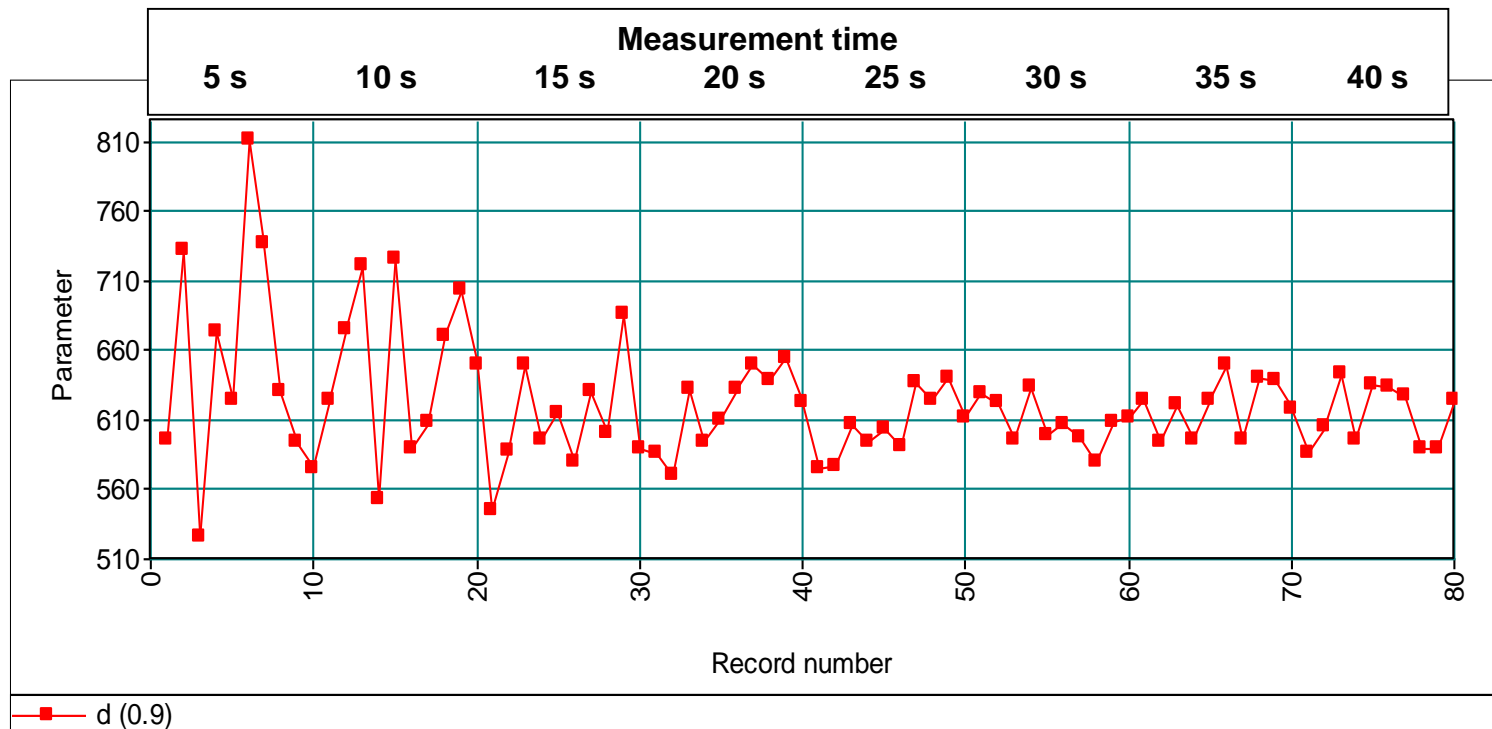
10.3.2 Wavelength **red 633 nm**, **blue 466 nm**

10.3.3 Stirrer speed

10.3.4 Pomp speed

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## 10.3.5 Duration of a single measurement



The duration of a single measurement should be selected experimentally, depending on the apparatus used and the size of the particles to be measured.

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## 11 Background measurement

## 12 Adding the soil sample into the laser diffractometer

The soil sample should be added to the measurement in the form of paste, which reduces the possibility of its segregation in the container and pre-disperse the soil aggregates.

## 13 Verification of measurement parameters

If the medians do not differ significantly in several consecutive measurements, the sample is dispersed properly and the measurement parameters are set correctly.

## 14 Measurement

Immediately before starting the measurements, make sure that all preliminary steps have been taken correctly.

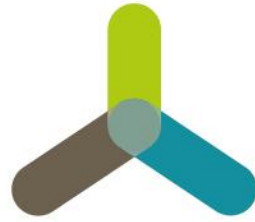
The measurement should be made in at least three repetitions.

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## 15 Presentation of results

The measurement results can be presented in a table (with the content of individual fractions) or in a graphic form, showing the cumulative curve.

## 16 Test protocol



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**Thank you for your attention**