Institute for scintillation materials

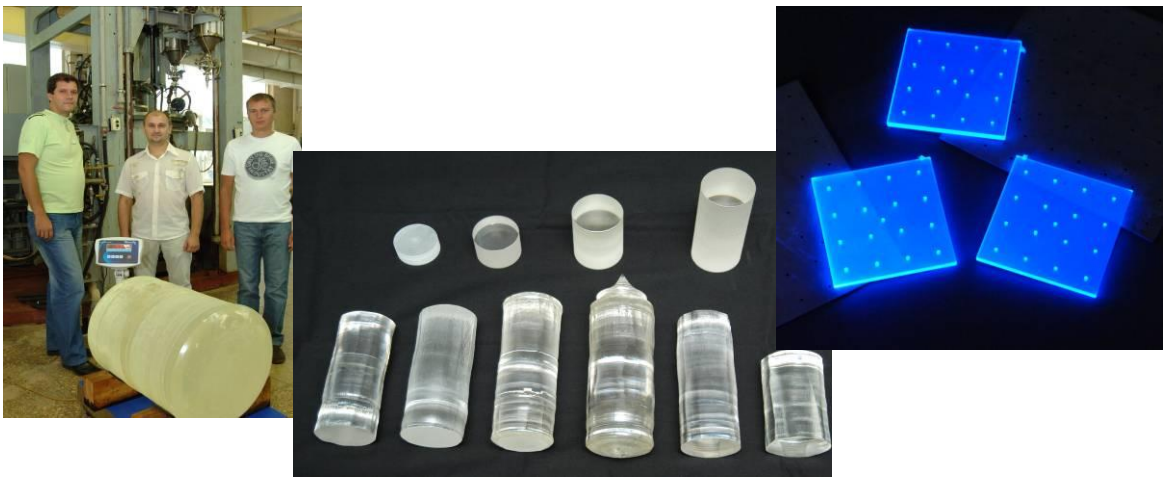
National Academy of Sciences of Ukraine

1.1. Overview

Institute for scintillation materials (ISMA) is a newly developed institute but it has a long history. ISMA was established in 2002 by extraction from the Institute for Single Crystals which has kept the leading position in dielectric material studies and radiation detection at the former USSR and later in Ukraine. Thus, the Institute history takes it place since the 60s of the last century, when scientists from research departments of Institute for Single Crystals began conducting research in the field of ionizing radiation scintillation materials and detectors.

Long history of Institute scientific departments includes a great number of large-scale developments on the creation, study and implementation of new scintillation materials, products made of them, as well as based on them modern equipment for different areas of human activity.

Among the key results of ISMA's departments should be mentioned the following achievements we are proud of. New scintillation materials such as CsI(Na), CsI(CsBr), CsI(CO_3), LiF(W), $KMgF_3$(Eu), ZnSe(Te), $PbWO_4$ (the main domain for LHC project) and other have been introduced. The theory of the dielectric crystals initial response to ionizing radiation and means of the scintillation process mathematical modelling have been developed.



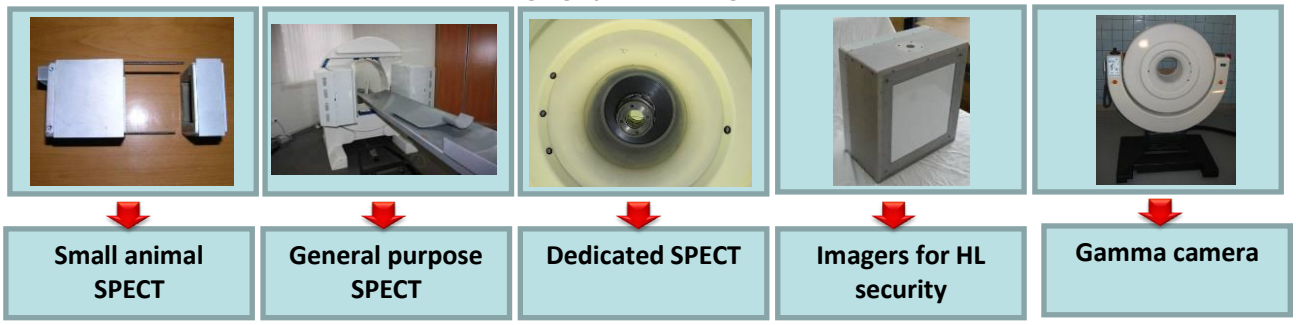
Unique technologies and equipment for automated growth and tooling of large single crystals of high structural perfection, which allow us to obtain alkali halide scintillation crystals with a diameter exceeding 500 mm and weight over 500 kg, have been introduced.

Genuine technology of polycrystalline samples production by single crystals plastic deformation at high temperatures makes it possible to obtain detectors with linear dimensions exceeding 700 mm.



Institute scientists' Research in the fields of plastic scintillators physics and production conditions have helped to create their special production technology with record specifications (weight of up to 1,000 kg, length of up to 7 meters, transparency over 4 meters).

Imaging systems designed in ISMA



A domestic medical tomography camera has been developed on the basis of the produced scintillation detectors. As for right now production of the second generation of modern diagnostic equipment has been launched. Development of portals and scanners used for the inspection control is now underway.

1.2. Structure of the Institute

Currently, structure of ISMA consists of 9 departments and 2 laboratories:

- Department of Scintillation Materials Synthesis;
- Department of Plastic Scintillators;
- Department of Materials Luminescence Study;
- Department of Radiation Controlling and Defectoscopy Systems;
- Department of Growth and Treatment Technologies of high-melting Scintillation Materials;
- Department of Molecular and Heterostructure Materials;
- Department of Nanocrystalline Materials;
- Department of Scintillation Radiometry and Radiochemical Research Methods;
- Department of Scientific-Technical Developments Implementation;
- Laboratory of Ionizing Radiation Visualization;
- Laboratory of Oxide scintillation crystals.

The staff of the institute is over 400 employees. There are about 240 scientists and researchers including 73 Professors and PhD. About 112 young specialists are involved in research and development as well as management activity.

1.3. International activity

Now, Institute for Scintillation Materials (ISMA) is **Ukrainian leading research centre** specializing on luminescent and scintillation materials research and development and can be ranked in the top of the European and international research organizations working in the area of radiation detection. At the latest time **ISMA is one of the world leaders** in the manufacturing of scintillation products for various branches of the science and industry. Within the last decade ISMA has been an active participant in all large scale International projects in high energy physics in the USA, Japan, Europe, such as LHC (CERN, Switzerland), BELLE (KEK, Japan), BaBar (SLAC, USA), PiBeta (PSI, Switzerland) etc, neutrino search, such as OPERA, NEMA (France) etc., astrophysics, such as GLAST, BepiColombo (international, NASA mission), AGILE (EC), current colliders such as PANDA, FAIR (Germany) and many other.

Our capacity and achievements create a background for continual developing and establishing a brilliant future for our Institute.

1.4. ISMA's research direction

The Field of Institute scientific and technological activities is interdisciplinary and formed from the great number of different sciences focused on one aim – radiation detection (fig. 1).

ISMA has extensive experience in applied research, solid state physics and fundamental studies of radiation and matter interaction, research and development of materials used for radiation detection, alkali halide single crystal growth, advanced technology development, engineering and scintillation detectors production

Technology development

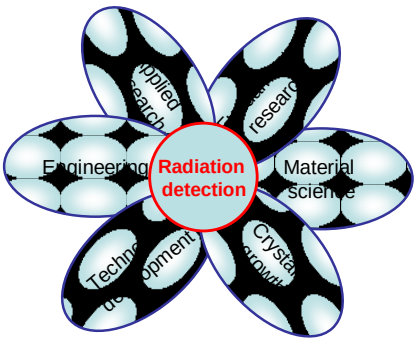
- development of technology for growing large scintillation single crystals.
- development of technologies for obtaining and tooling of plastic scintillators.
- production of polycrystalline by the high-temperature extrusion method.
- working out and deploying technologies into industrial production.
- development of technical documentation concerning the pilot production release.
- synthesis of organic phosphors and dyes.
- Development of technologies for obtaining fluorescent and scintillation nanomaterials.

Engineering

- development of scintillation detectors for various applications;
- creation of new and improvement of existing types of medical equipment, production of experimental samples;
- development of dosimetric and radiometric monitoring instruments, introscopic systems and complexes;
- development of equipment for growing large scintillation and optical single crystals.

MAJOR RESEARCH OBJECTS :

- Alkali halide, oxide, and chalcogenide scintillation mono-and polycrystalline materials;
- Organic, plastic and liquid scintillators;
- scintillation detectors and position-sensitive detection units;
- scintillation films and nanosized materials;
- organic phosphors and dyes of multifunctional purpose.



Crystals Growth

- Growth of halide, chalcogenide and oxide single crystal by the following techniques:
  - Czochralski
  - Bridgman-Stockbarger
  - Kyropoulos
  - solution growth
  - skull melting
- Obtaining scintillation thin layers and nanomaterials

Material science

- search for new fluorescent environments for registering different types of radiation;
- synthesis and physicochemical study of new inorganic scintillation materials (crystals, powders, films, nanomaterials, etc.);
- study of the scintillation characteristics of materials and detectors;
- study of structural and luminescent properties of single crystals, thin films and nanoscale materials for scintillation applications.

Fundamental research

- The processes of interaction of ionizing radiation with different environments;
- Energy transfer from the matrix to the luminescence centers
- Luminescence in Solids
- Radiation-induced defects

Applied research

- improvement of scintillation detectors based on alkali halide materials.
- development of special ionizing radiation detectors.
- improvement of plastic scintillators performance.
- studies on the effect of crystallization conditions and annealing on mechanical and functional characteristics of single crystals;
- study of thermal processes during the polymerization of scintillation compositions;
- radio spectroscopy of the condensed environment;

Fig. 1 Scientific and technological focus of ISMA

Conception of radiation detection and progress in scintillation materials research are the sources of innovation in many industrial sectors including nuclear power plants, geology, environment monitoring, embedded systems for transport (air, earth, sea), military equipment, radiography imaging methods in healthcare, large-scale scientific projects (Colliders physics, dark matter search, astrophysics research) etc. Moreover, radiation detection is at the forefront of global challenges. Recent March catastrophe in Fokusima-1 (Japan) showed that the topic concerns every citizen.

So, developments in the field of nuclear instruments, radiation detection methods and scintillation material carried out in ISMA is largely related to demands of society and we are proud of the ways in which we create positive impact on the world. We are an Institute committed to being an innovative contributor and productive partner in the vitality of our regional, national and global communities.