

# Laboratory of Individual and Environmental Dosimetry at IFJ PAN

Renata Kopec



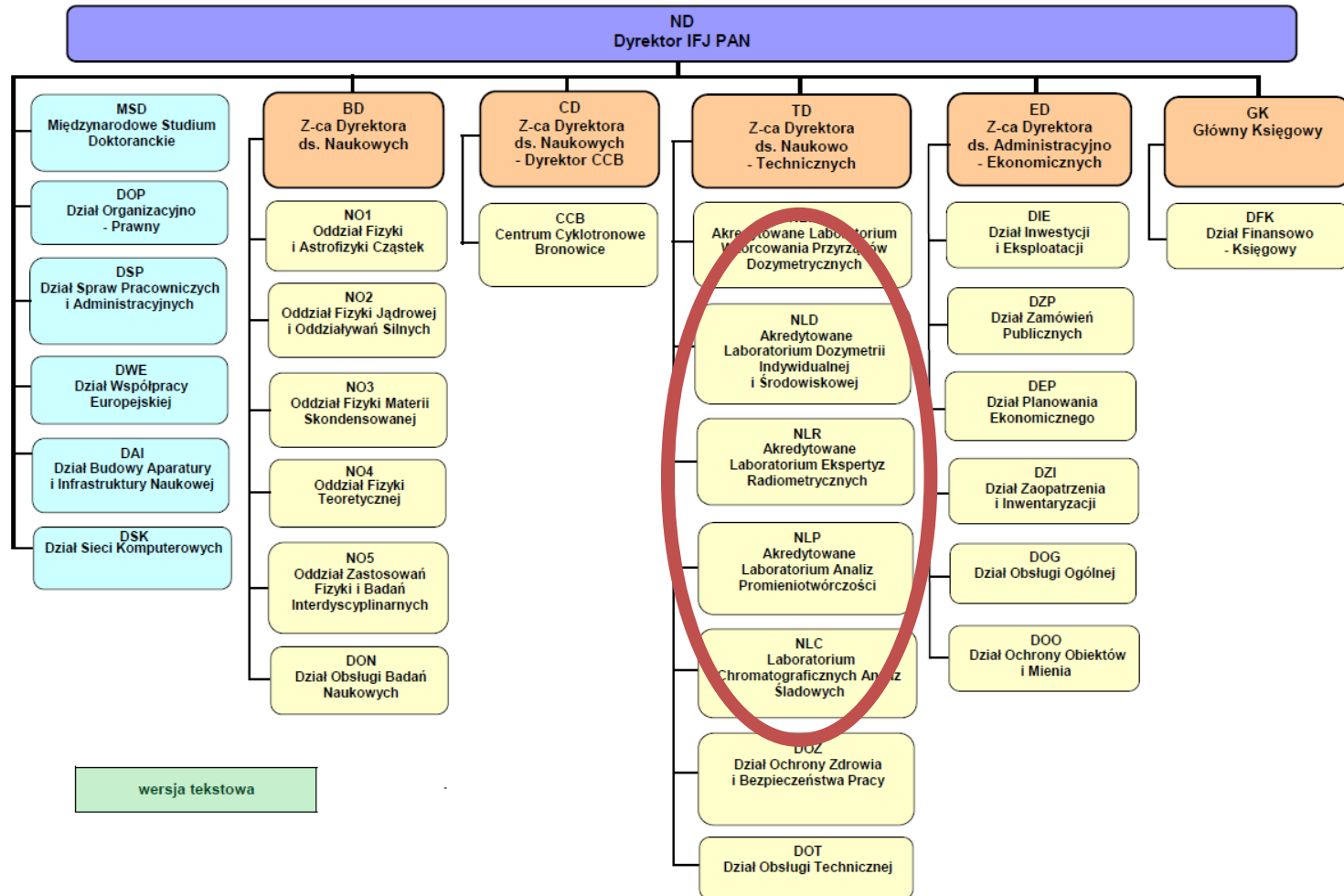
Institute of Nuclear Physics  
Polish Academy of Sciences Krakow, Poland



# Introduction



## Organization of the Institute of Nuclear Physics Polish Academy of Sciences



**Institute offers a special services in the field of radiation protection, dosimetry and spectroscopy.**

- **For some services accreditation is obligatory:** Atomic Law Polish Act 2000: only accredited dosimetry labs are able to perform individual dosimetry and calibration of radiation protection instruments
- Accreditation according to the ISO/IEC 17025 norm



AP 029

Calibration



AP 049

Individual  
dosimetry



AB 788

K,U,Th + Rn-222



AB 979

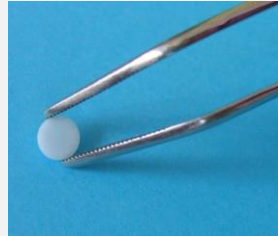
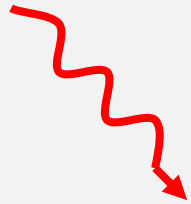
Cs-137 , Pu



- **Laboratory for Calibration of Dosimetric Instruments**
  - Calibration of radiation protection survey metres (gamma/Cs-137 irradiation facility and surface emission rate- alfa and beta sources)
- **Laboratory of Individual and Environmental Dosimetry**
  - Dosimetric Service (based on the thermoluminescent method)
  - QA tests of X-ray medical machines
- **Laboratory of Radiometric Expertise**
  - Radon in dwellings, soil, water
  - Natural radioactivity: K, U, Th
- **Laboratory of Radioactivity Analyses**
  - gamma spectrometric measurements of artificial radionuclides (Cs-137 and others); different kind samples (soils, minerals, bones...).
  - Whole body spectrometer
- **Laboratory of Chromatographic Trace Analyses**
  - physics of environmental
  - hydrogeology

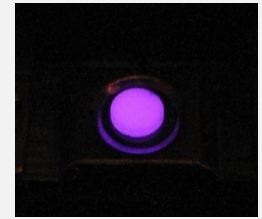
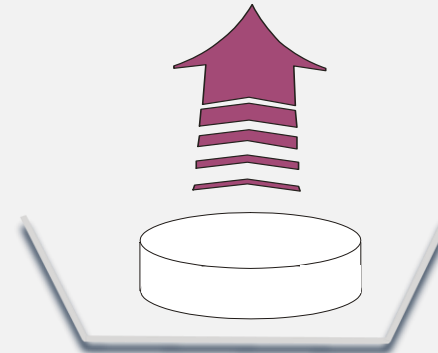
## Thermoluminescence (TL) – 2-stage process

### Exposure to ionizing radiation



**Ionization and electron trapping**

### Emission TL light after heating



**Heating and recombination  
with light emission**

**Dose ~ TL light**

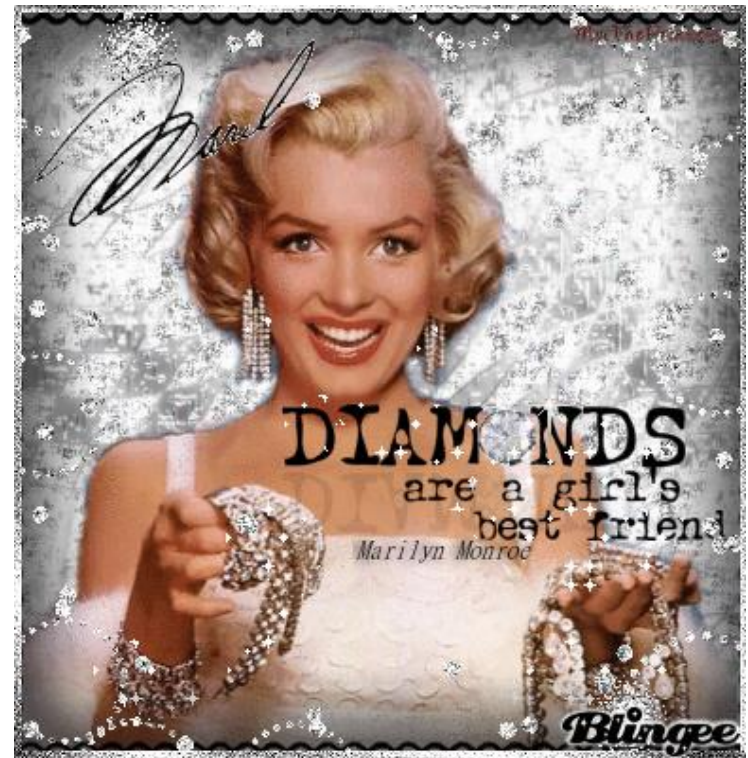
Thermally stimulated light emission following the removal of excitation by ionizing radiation

**The prevalence of the thermoluminescence phenomena in nature: diamond, fluorite, quartz, minerals meteoric calcium fluoride**

- Determining the excavations age in archaeological sites;
- Geology;
- The test structure of solid states.



Diamonds are a best TL detectors, although usually we use them differently ...

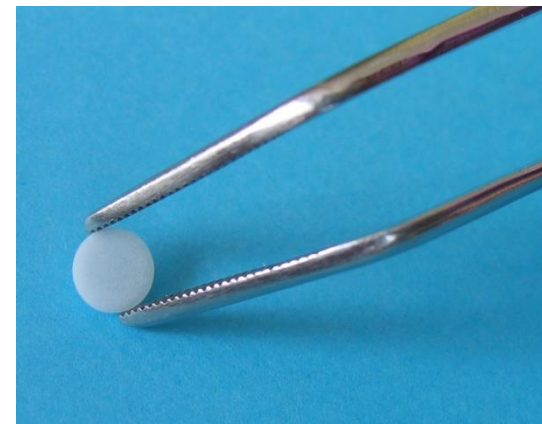


**The prevalence of the thermoluminescence phenomena in nature:  
diamond, fluorite, quartz,  
minerals meteoric calcium  
fluoride**

**Manufacture of  
synthetic luminescent  
materials  
LiF: Mg, Ti  
LiF: Mg, Cu, P**

- Determining the excavations age in archaeological sites;
- Geology;
- The test structure of solid states.

Individual, environmental and medical dosimetry





1663

R. Boyle described lighting of diamond in the bed



Sir Robert Boyle  
(1627 – 1691)

Eleventhly, I also brought it to some Glimmering Light, by taking it into Bed with me, and holding it a good while upon a warm part of my Naked Body.

Twelfthly, to satisfy my self, whether the Motion introduce`d into the Stone did generate the Light upon the account of its producing Heat there, I held it near the Flame of a candle, till it was qualified to shine pretty well in the dark.

**Sir Robert Boyle "Experiments and Considerations upon Colours with Observations on Diamond That Shines in the Dark". *Register of the Royal Society London*, 213, 1663**



**1904**

M. Skłodowska–Curie noticed and interpreted TL emission from natural  $\text{CaF}_2$  after exposure to radium source.



Maria Skłodowska-Curie  
(1867- 1934)

Certain bodies, such as fluorite, became luminous when heated; they are thermoluminescent.

Their luminosity disappears after some time, but the capacity of becoming luminous afresh through heat is restored to them by the action of radiation.

Radium can thus restore to these bodies their thermoluminescent properties.

**Marie Curie „Radioactive Substances (English translation of doctoral thesis presented to the Faculty of Science, Paris 1904)". Greenwood Press. Westpoint, 1961**

**1953**

TL detectors were used first time in practical dosimetry of ionizing radiation. Performed measurements of dose levels on ground from the first US atmospheric nuclear weapons tests



Farington Daniels  
(1889-1972);  
University of Wisconsin,  
USA



**1966**

Developed at Institute of Nuclear Physics (IFJ) thermoluminescent detectors (based on  $\text{LiF}:\text{Cu,Ag}$  and  $\text{CaF}_2:\text{Mn}$ ).

**1975**

Started routine individual dosimetry service at IFJ (based on self-developed thermoluminescence detectors).



Tadeusz Niewiadomski  
(1920 – 1996)



**2001**

Laboratory of Individual and Environmental Dosimetry (polish acronym LADIS) was established



Maciej Budzanowski  
head of LADIS 2001 -2013

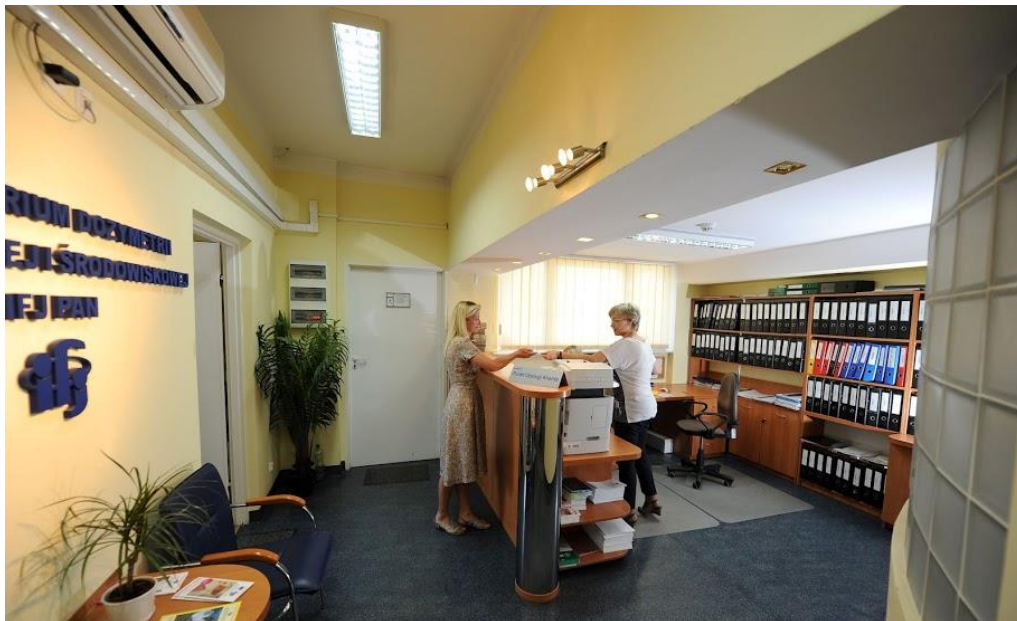
**Atomic Polish Law Act 2000** (national legislation of Radiation Protection- implementation Council Directive 96/29/EURATOM):  
**only accredited dosimetry labs are able to perform individual dosimetry**



**2002**

LADIS got accreditation PCA (AP-049)

- Accreditation valid for 4 years
- External audit every year



**2006**

Quality control of X-ray medical diagnostic machines  
(got accreditation PCA in 2012: AB-1317)

Phantoms and equipment dedicated  
for QA test of X- rays machines in:

- Interventional Radiology;
- Fluoroscopy and Angiography;
- Dental Radiology;
- Mammography;
- Computed Tomography



## **Dose control:**

- 3 administration
- 11 physicists
- 8 technicians

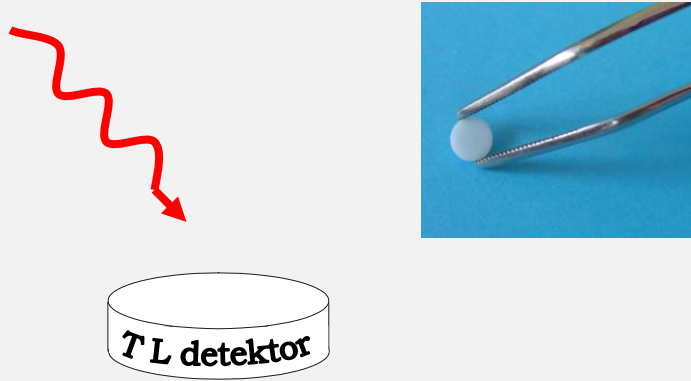
## **Quality control of X-ray medical diagnostic machines**

- 1 administration
- 5 physicists

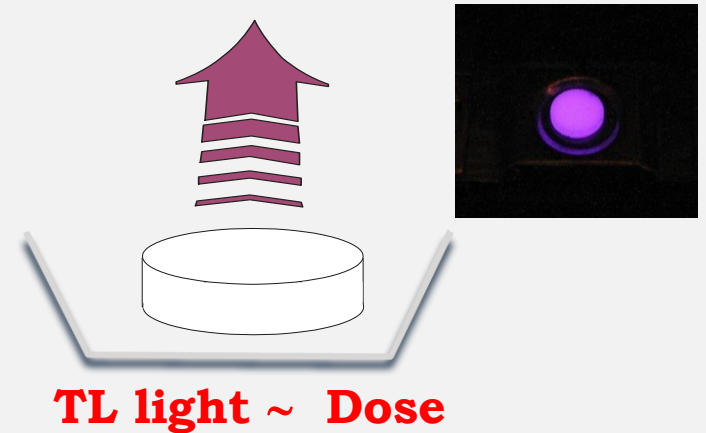




## Exposure to ionizing radiation



## Emission TL light after heating



## Detectors used in LADIS:

- LiF:Mg,Ti (MTS-N)
  - LiF:Mg,Cu,P (MCP-N)
- (diameter 4.5 mm  
Thickness 0.9 mm).



## Automatic thermoluminescent readers RE-2000 (4 pcs)



## Individual monitoring:

The doses to occupational staff are measured in terms of the personal dose equivalent:

- $H_p(10)$ : for whole body (dosemeters worn on the chest);
- $H_p(3)$ : for eye lens (dosemeters worn close to the eye);
- $H_p(0.07)$ : for hands/skin (dosemeters worn on fingers);

## Workplace monitoring:

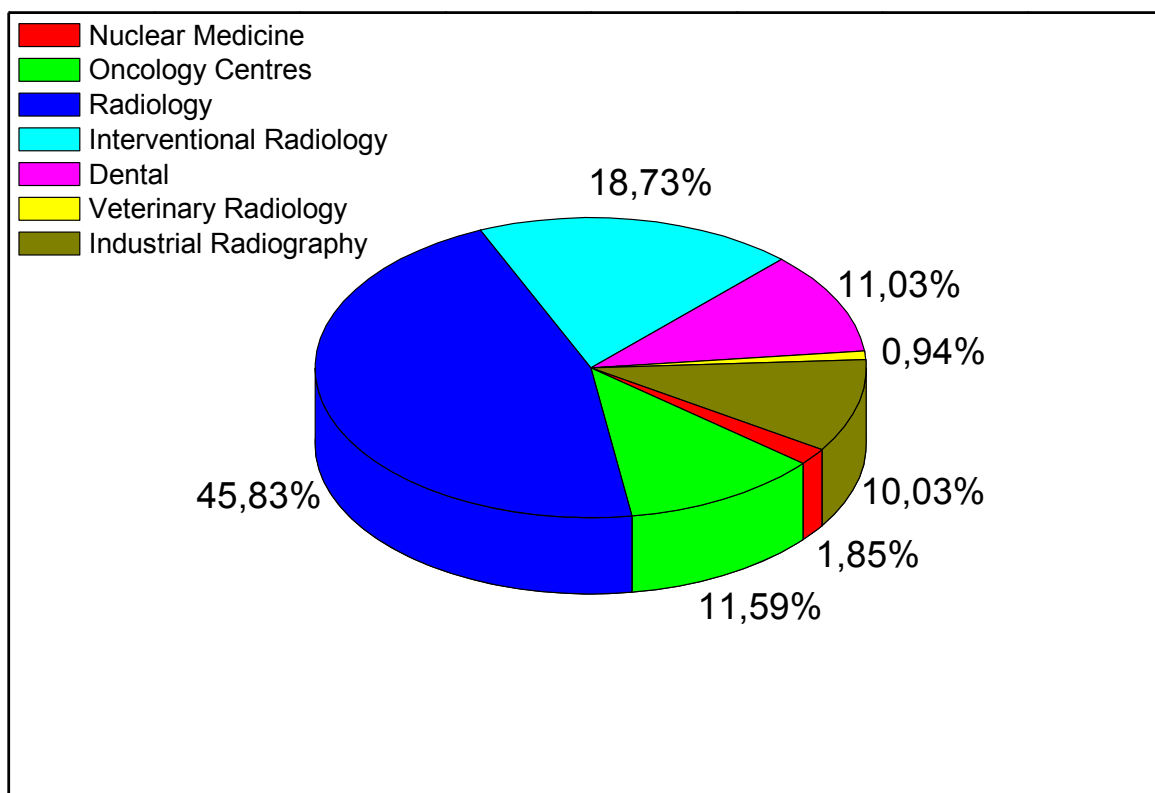
Environmental dosemeter integrated with the workplace

- Exposure in terms of:  $K_{\text{air}}$ ,  $H^*(10)$



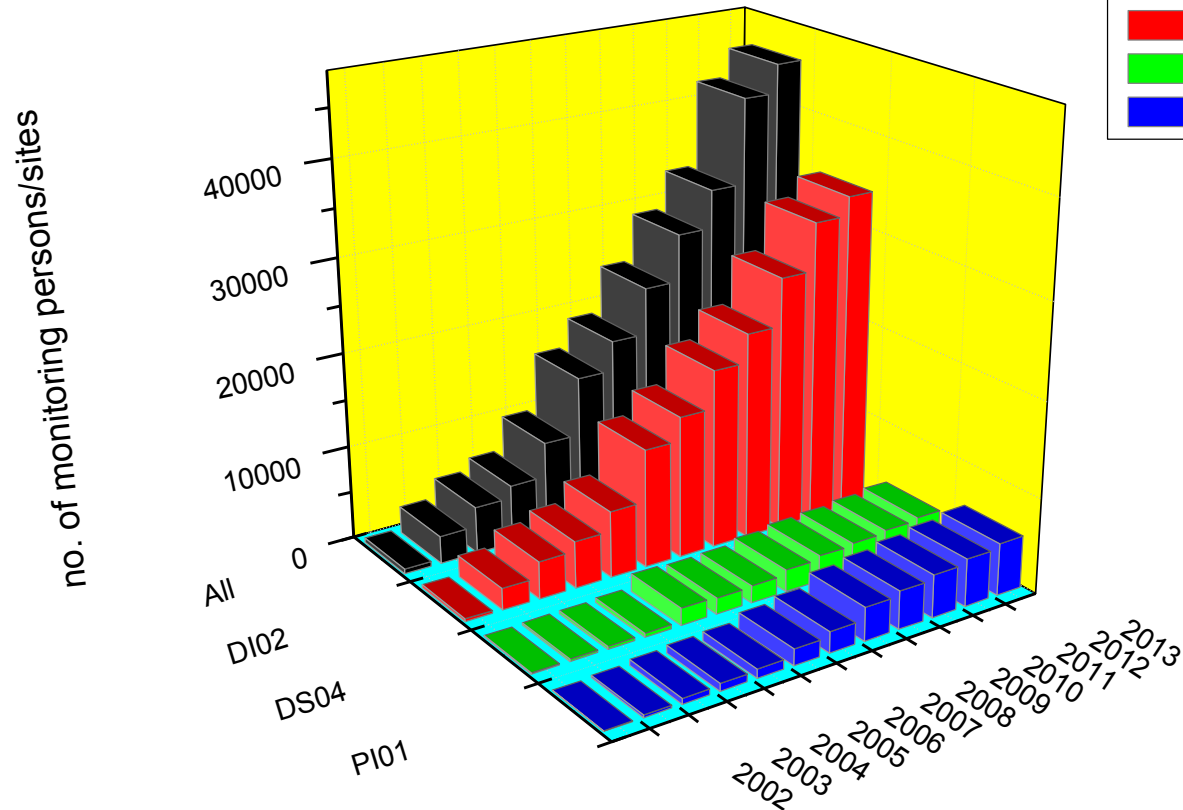
## Institutions:

6500 institutions: individual medical practices (mainly in dentistry), hospitals, oncology centres, research and university laboratories, heavy industry, food industry, car and fuel industry, geology, museums, state border inspectors and customs offices, where X- ray or gamma radiation is used for inspection or imaging



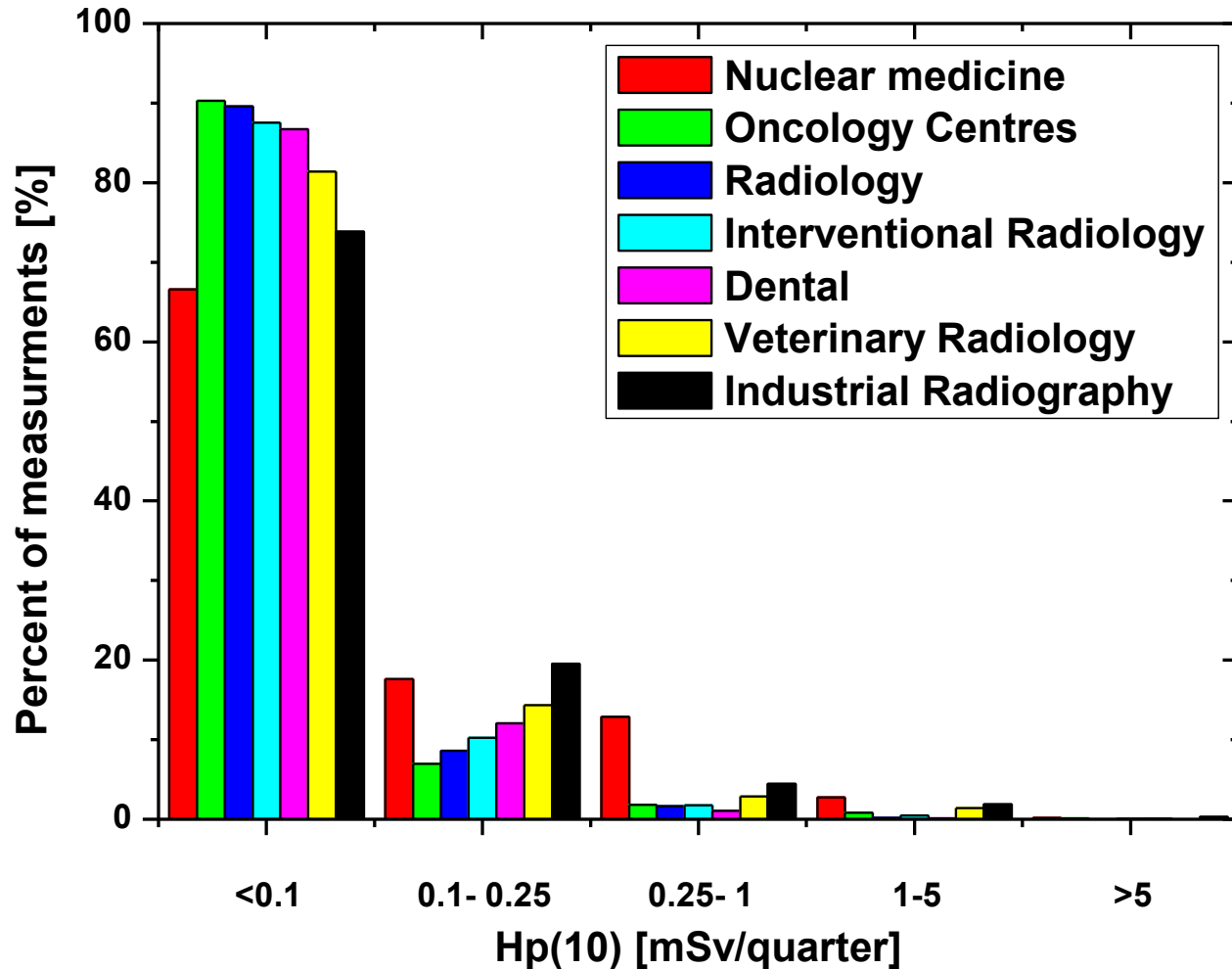
## 2013:

- Individually monitored persons): Hp(10): **37 000**
- Environmental sites (with CERN sites); Kair: **3500**
- Extremity dosimetry; Hp(0,07): **5500**
- Eye lens dosimetry Hp(3): **120**
- total monitored persons/sites: **> 45 500;**



Nowadays the second largest TLD dosimetry service in Europe.

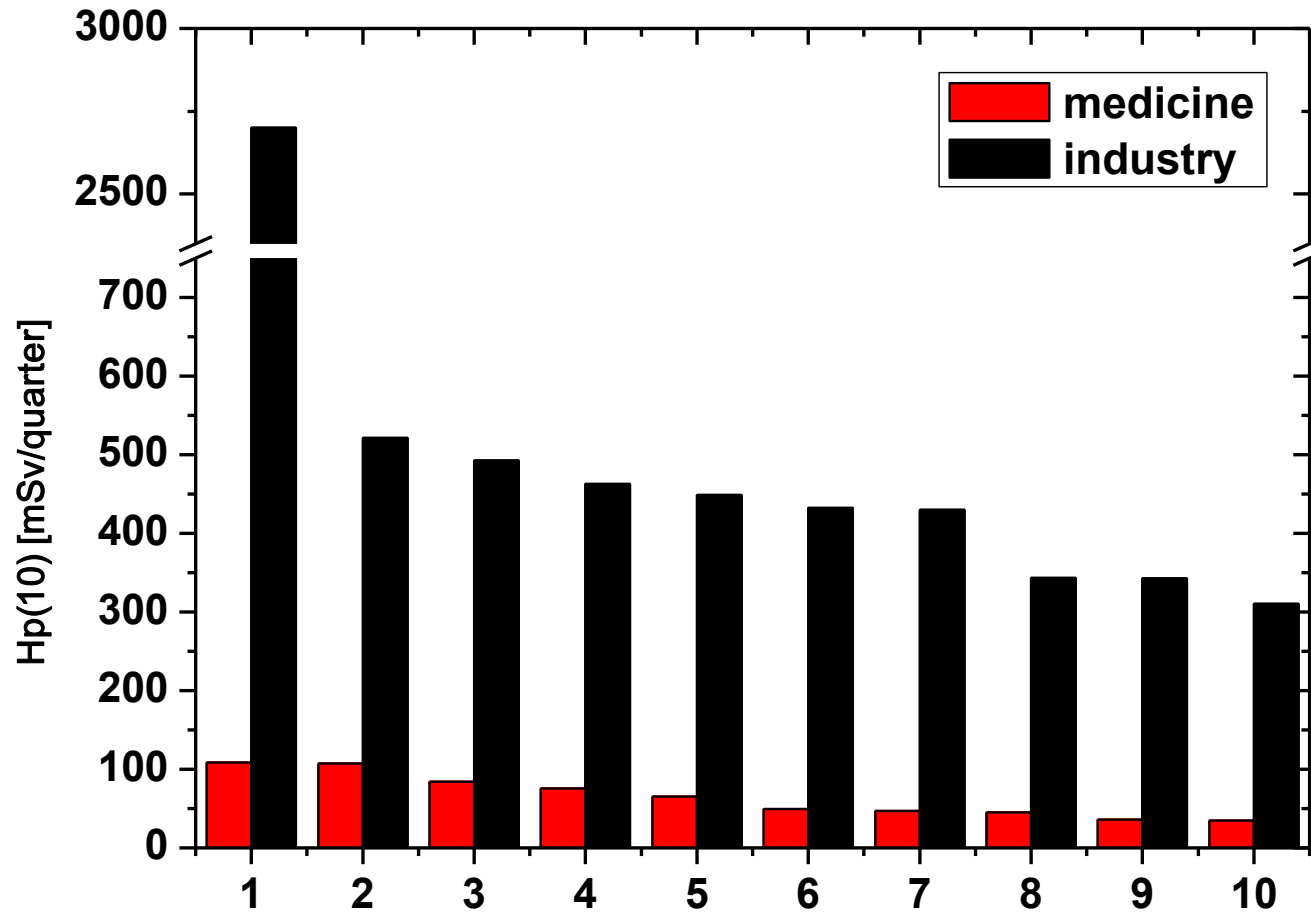
# Results of Hp(10) measurements



Results 2002-2009 published:

M. Budzanowski, R. Kopeć, B. Obyrk and P. Oiko *DOSE LEVELS OF THE OCCUPATIONAL RADIATION EXPOSURES IN POLAND BASED ON RESULTS FROM THE ACCREDITED DOSIMETRY SERVICE AT THE IFJ PAN, KRAKOW Radiation Protection Dosimetry (2011), Vol. 144*

# Results – 10 highest doses reported



- Development of individual TL dosimetry with identification of static and dynamic exposure
- Investigation of 2D dose distribution using TL foils in radiology and radiotherapy
- Development of techniques and methods for eye lens dosimetry
- Modelling of radiation exposure





- Laboratory of Individual and Environmental Dosimetry at IFJ PAN is accredited since 2001 and now is one of the most important supplier of dosimetric services in Poland.
- Using TL detectors we offer dosimetric service for more than 45 000 occupational staff in Poland. It still grows 10-15% per year.
- Still evaluating and developing of operating procedures
- Laboratory is actively involved in research & development.



# LABORATORIUM DOZYMETRII INDYWIDUALNEJ I ŚRODOWISKOWEJ

## O NAS

*Dowiedz się więcej o  
naszym laboratorium*

ZOBACZ

## ZAKRES BADAŃ

*Zobacz jakie badania  
oferujemy*

ZOBACZ

## KONTROLA DAWEK



**TLD**  
Nowoczesna kontrola  
dawek RTG  
<http://dawki.ifj.edu.pl>

WEJDŹ

## TESTY RTG



WEJDŹ

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