Thermoluminescent dosimetry at the IFJ Krakow

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INSTITUTE OF NUCLEAR PHYSICS (IFJ), KRAKÓW, POLAND

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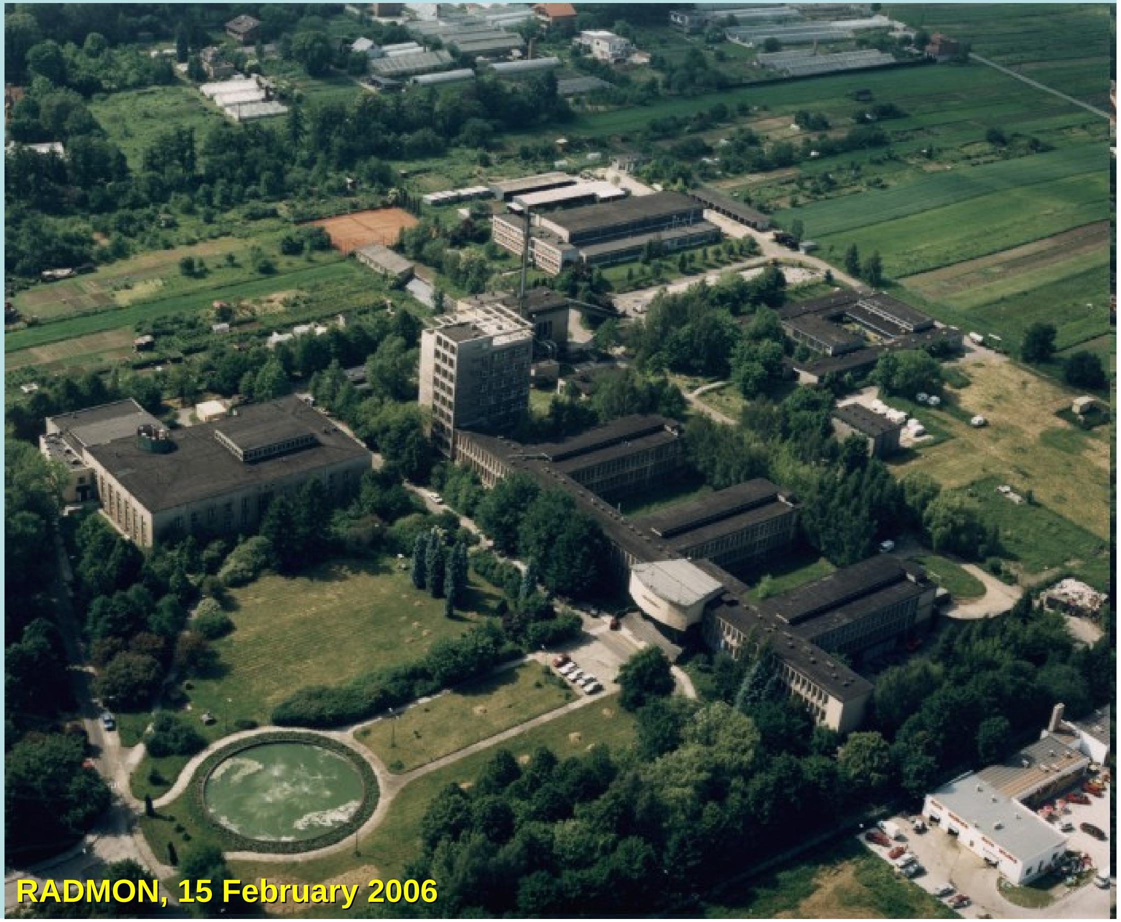
belongs to Polish Academy of Sciences

- **founded 1955**
- **450 personnel (180 with Ph.D.)**
- **main research interest**:
  - particle physics
  - nuclear physics
  - theoretical physics
  - solid state physics
  - interdisciplinary research
- **facilities:**
  - V-d Graaff (2.5 MeV proton)
  - cyclotron (60 MeV p, 30 MeV d)



Thermoluminescent dosimetry at the IFJ Krakow

40 years of experience in TL dosimetry:

first LiF crystals for dosimetry were developed in Krakow in 1960s

Our activities:

- **Research on thermoluminescence phenomena**
- **Development of new materials, detectors and methods**
- **Application of TLDs in various dosimetric measurements**
- **Dosimetric service**

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DOSIMETRIC SERVICE

Laboratory for Personal and Environmental Dosimetry (LADIS)

- Started in 2002
- Accredited according to the ISO/IEC 17025 standard
- 13000 monitored persons or environmental sites

    - including 1000 CERN dosimeters

Equipment:

- 3 Rados DOSACUS automatic readers
- 3 manual readers
- Rados dosimeter holders

Calibration: with gamma-rays in the accredited Secondary Standard Calibration Laboratory at the IFJ (LWPD)

Advantages of TLD

☑ Very small dimensions (standard ∅4.5x0.9 mm, but even < 1 mm^3 is possible)

☑ Passive - no cables, no power supply, etc

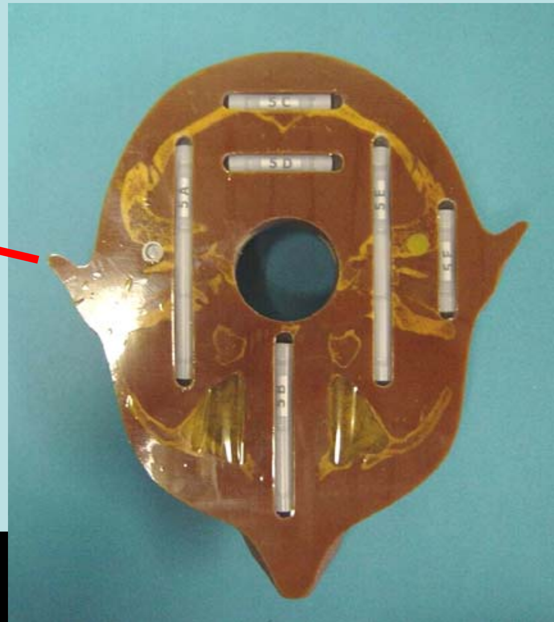
☑ Wide range of measured doses

☑ Relatively resistant to environmental factors (e.g. no influence of electric and magnetic field, vibrations; only elevated temperature is a limiting factor)

☑ Practically unlimited period of measurement (years)

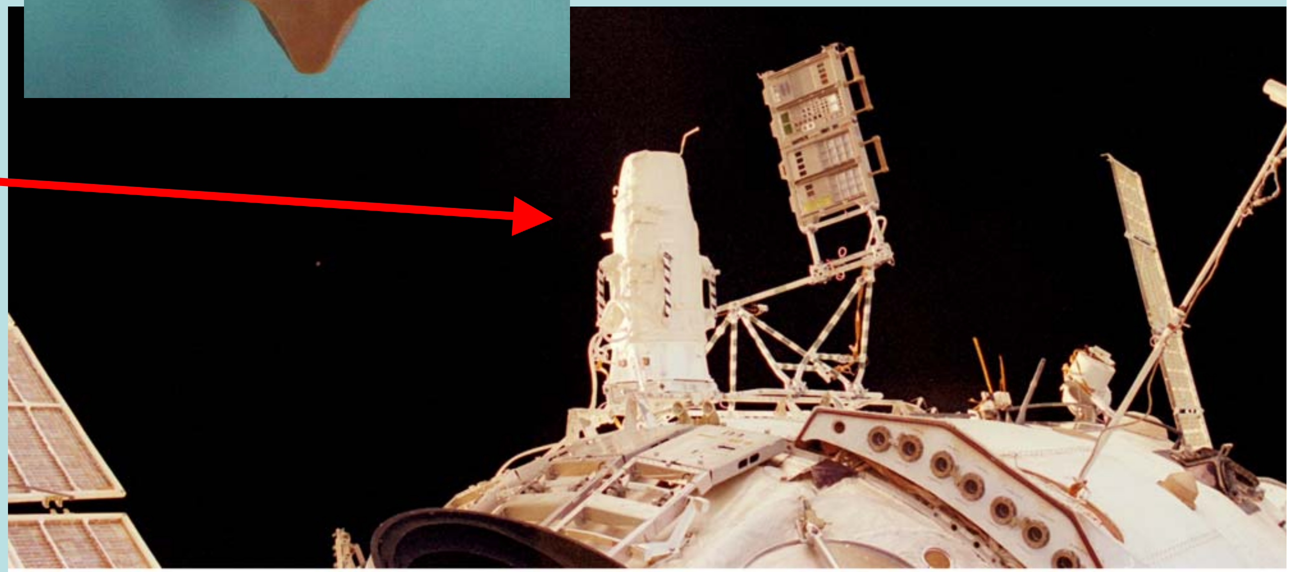
Space experiment MATROSHKA

2.4 years measuring period



A human phantom exposed outside of the International Space Station
2003-2006

Over 3000 TLDs from Krakow



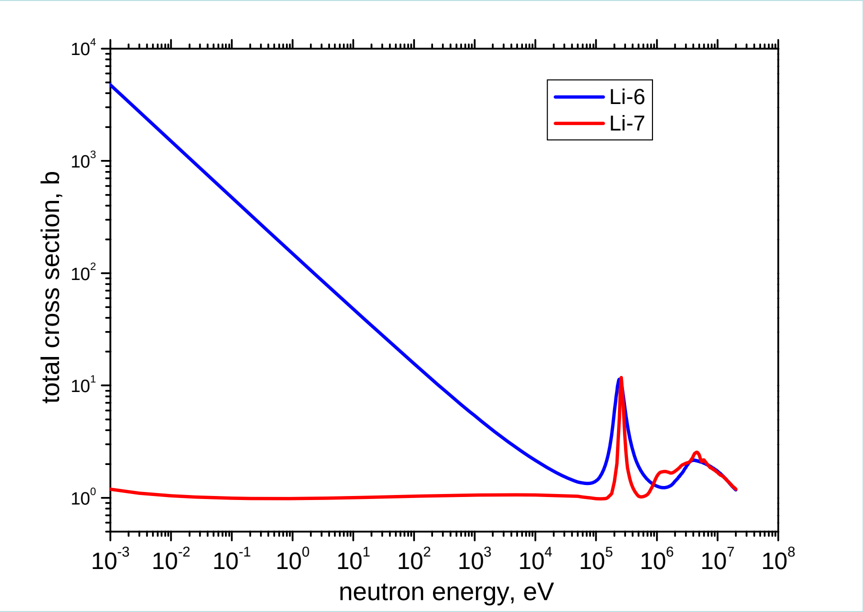
LITHIUM FLUORIDE

The most widely used TL detector

Two types:	**LiF:Mg,Ti**	("standard")	**MTS**
	LiF:Mg,Cu,P	("high-sensitive")	**MCP**

Tissue equivalent - atomic number close to tissue (important for X-rays)

Li-6 and Li-7 isotopes make it possible to measure a low-energy neutron signal



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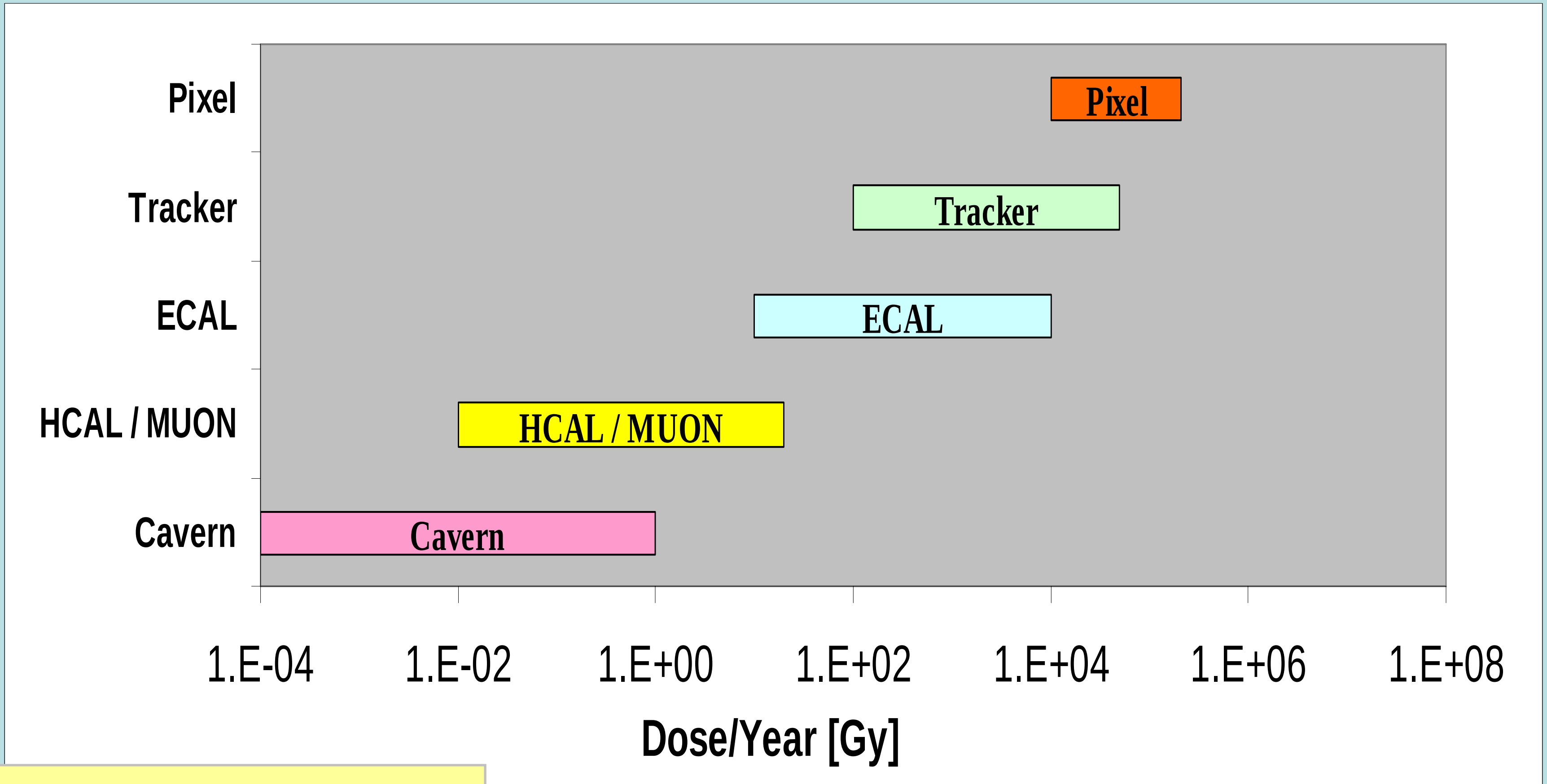
DOSE RESPONSE OF TLDs

CMS expected dose range



Ch. Ilgner, RADMON, July 2006

What doses can be measured with LiF TLDs?

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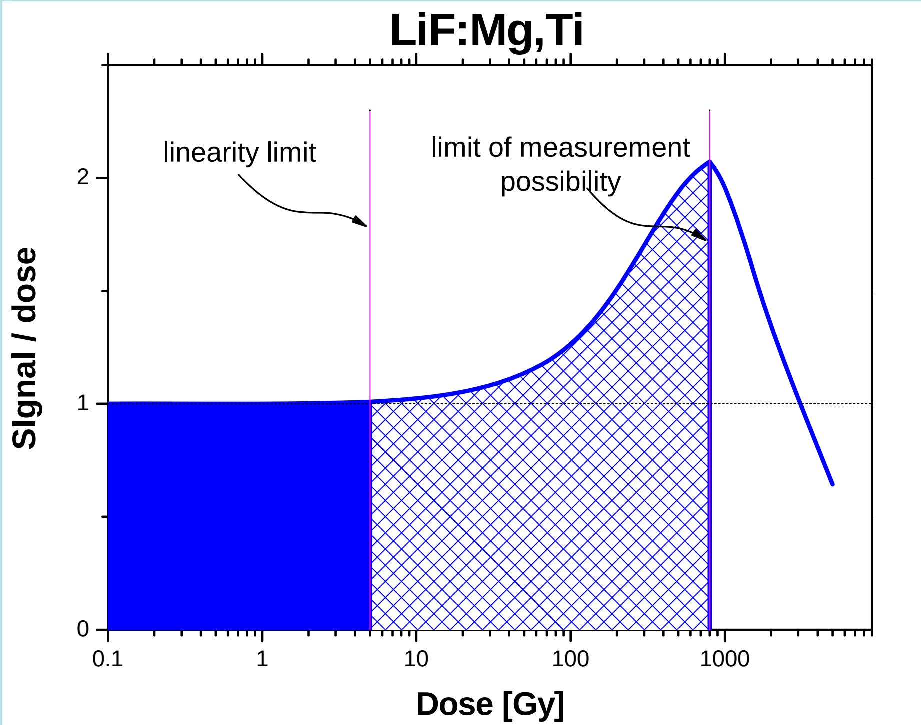
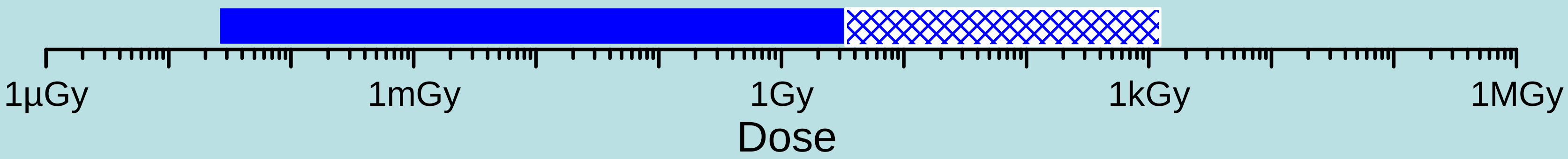
DOSE RESPONSE OF TLDs





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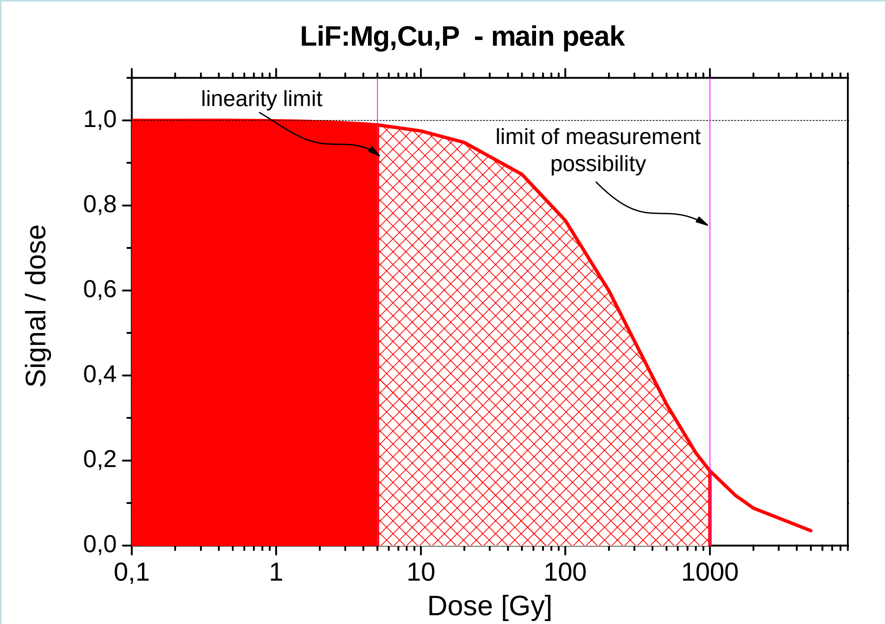
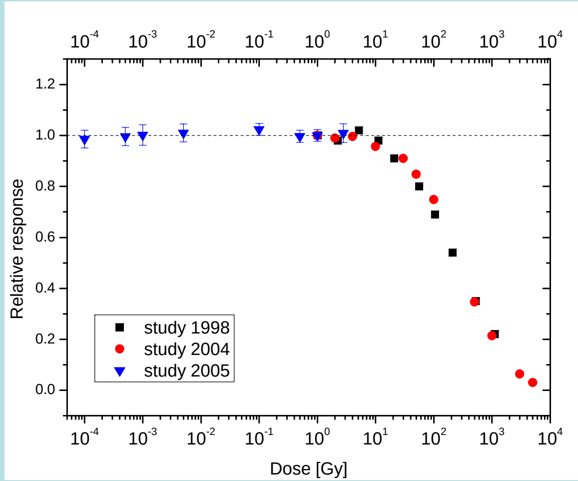
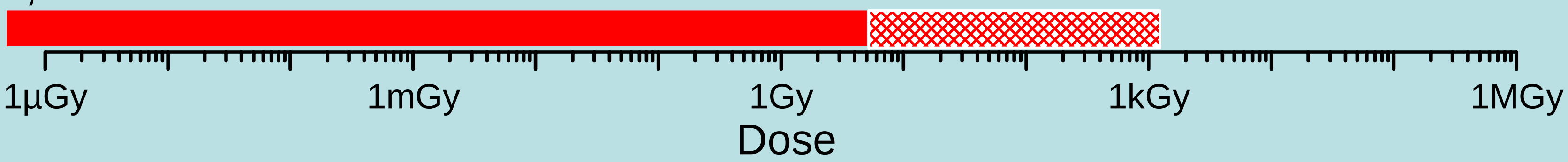
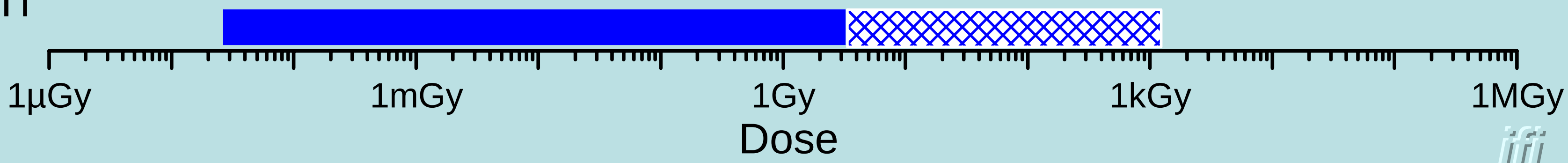




LiF:Mg,Cu,P

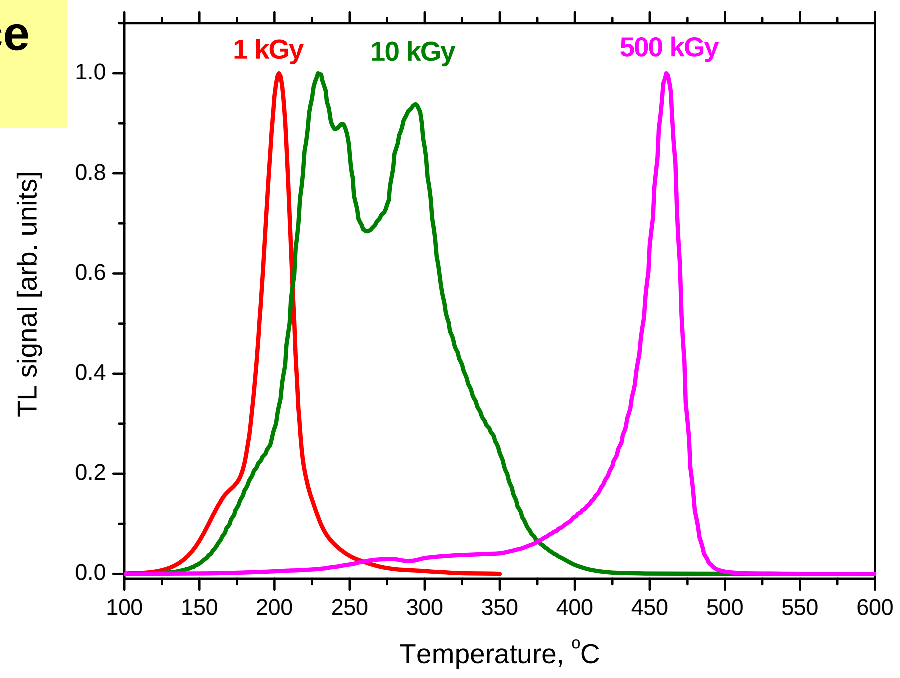


LiF:Mg,Ti



DOSE RESPONSE OF TLDs

LiF:Mg,Cu,P thermoluminescence glow-curves

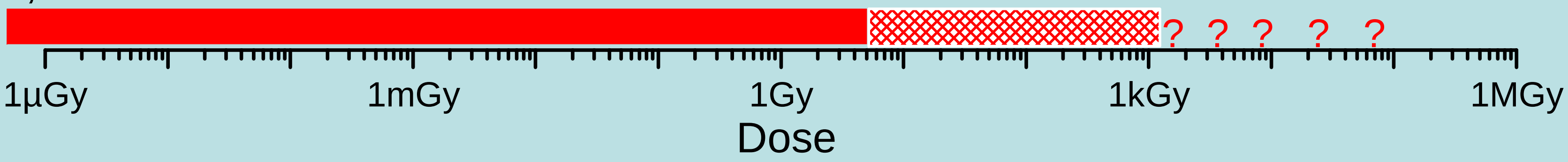


0 – 1 kGy

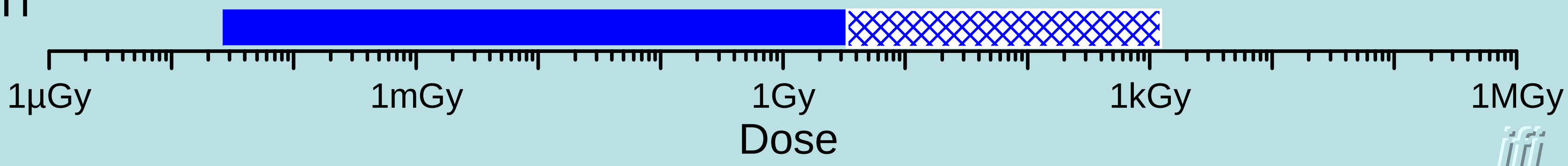
1 - 50 kGy

50 – 500 kGy

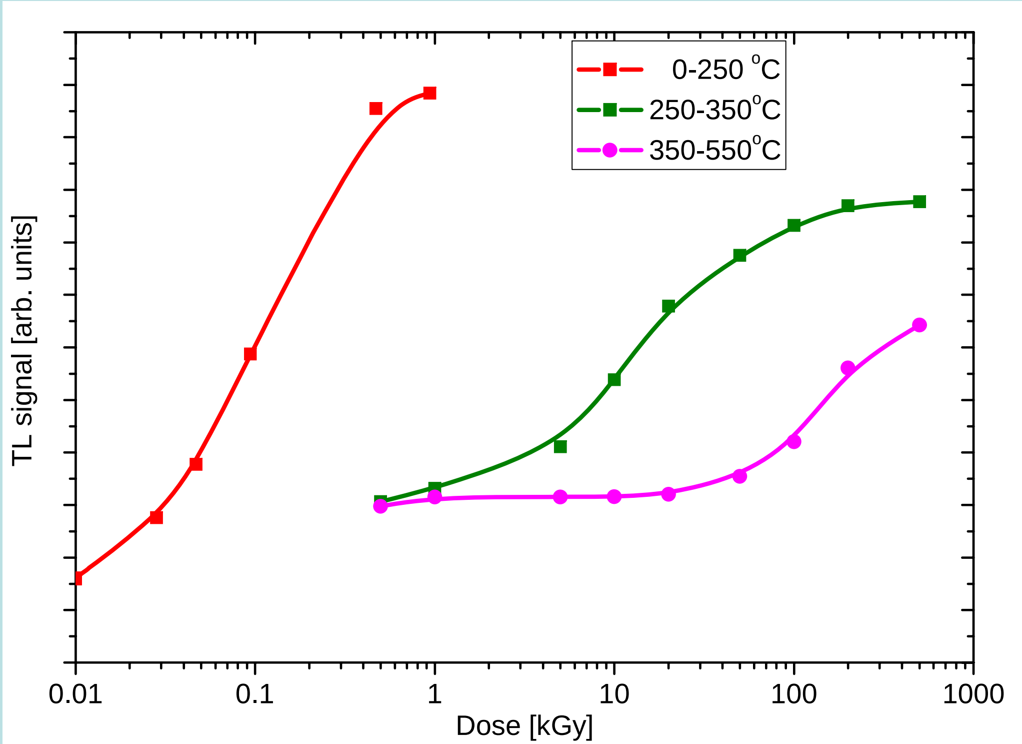
LiF:Mg,Cu,P



LiF:Mg,Ti



DOSE RESPONSE OF TLDs



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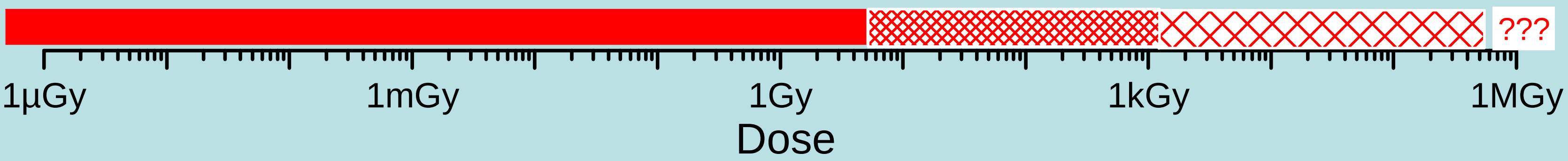
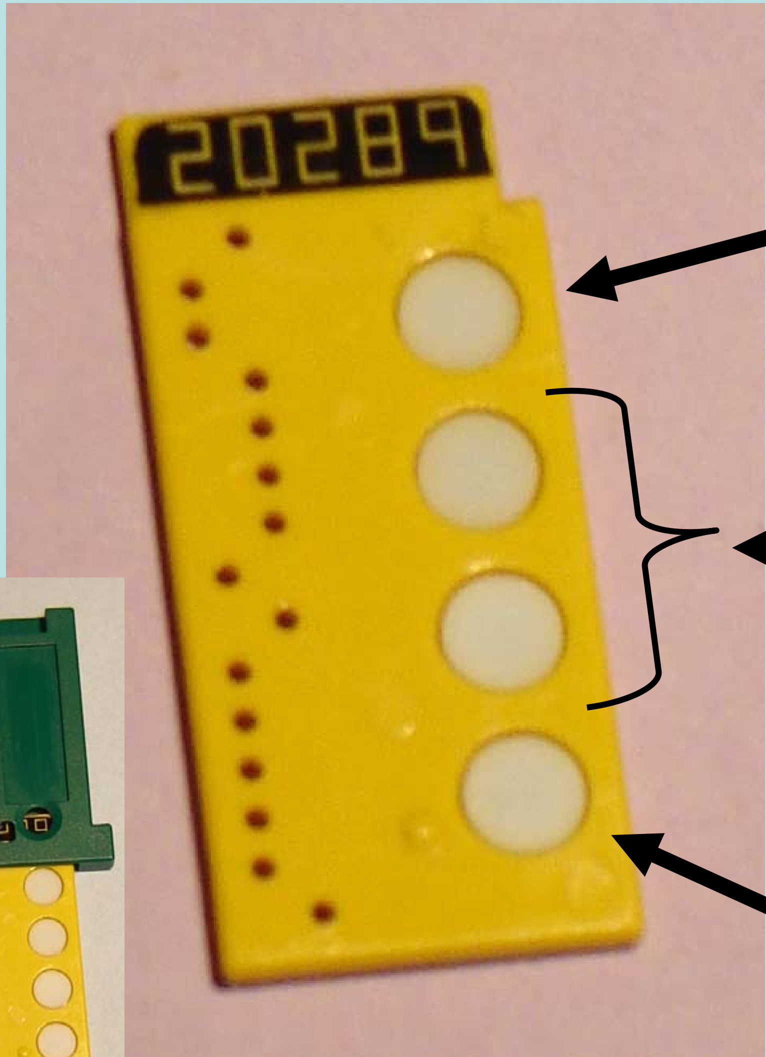
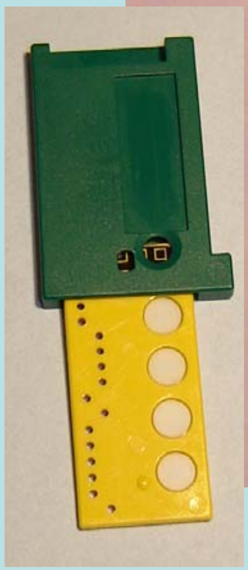
LiF:Mg,Cu,P



from µGy to MGy => 12 orders of magnitude!

THE PROPOSED LHC DOSIMETER





^{nat}LiF:Mg,Ti

One test detector to check the dose level - read out automatically

Its results will decide about choice of readout method for the rest of detectors

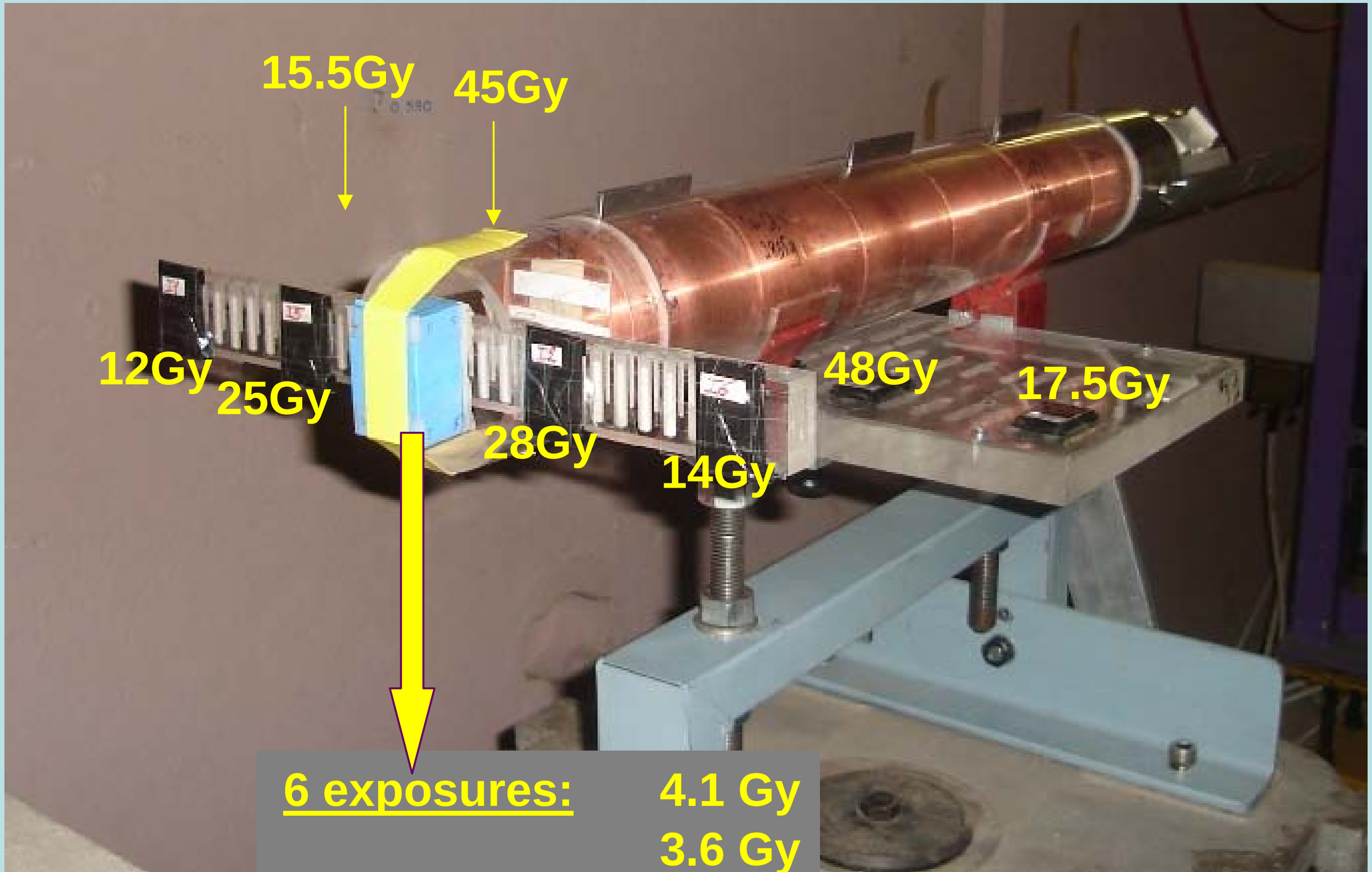
Two detectors for lower/intermediate doses: e.g. ^{6}LiF/^{7}LiF pair

One „high-dose detector”, to be read out by special procedure

^{7}LiF:Mg,Cu,P or ^{nat}LiF:Mg,Cu,P

CERF October 2006 RUN

Preliminary results



6 exposures:

4.1 Gy
3.6 Gy
3.7 Gy
3.7 Gy
110 Gy
55 Gy

CONCLUSIONS

- **IFJ Krakow is technically well prepared for dosimetric measurements for LHC**

- **The newly developed method using LiF:Mg,Cu,P detectors enables measurements far above 1kGy, i.e. the present TLDs' dose limit**

- **Further calibrations at the highest doses are planned**

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