GAMMA IRRADIATION FACILITY

Institute of Isotopes Ltd., Budapest

DESCRIPTION

SELECTED PUBLICATIONS

FACILITY LAYOUT

FACILITY PHOTOS

DOSIMETRIC EQUIPMENT AND DOSIMETERS

IZOTOP

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QUALITY ASSURED FIRM ISO 9001 SGS

NATIONAL ACCREDITATION OF CERTIFICATION BODIES

SLL-01 TYPE PILOT SCALE GAMMA IRRADIATOR

The Pilot-scale gamma-irradiation facility is utilizing Co-60 radiation sources. The maximum amount of activity which can be loaded into the facility is **4.44 PBq (120 kCi**).

The **SLL-01 type** Co-60 gamma irradiator is a ***Category IV*** facility. It normally contains **20 Co-60 source capsules** (so called torpedoes) each of them can be loaded with 4 Hungarian made sealed **Co-60 sources** (type CoS-43 HH) of **dia 11 mm, height 451 mm**, or other sources of the same size.

The Co-60 sources are stored in an underground water pool when not in use. The inner lining of the pool is made of 5-mm thick stainless steel. In storage position the radiation sources are kept (in fully shielded condition) in the source-cage. In this case there is 4.2-m water over the upper level of the sources, which gives adequate radiation protection in the direction of the irradiation chamber.

In order to reach the irradiation position the torpedoes must be lifted from the storage position to the irradiation position. The sources in the **cage** are cylindrically arranged on a pitch-circle of **280-mm diameter**. The design of the tubes holding the sources allows after-loading of the sources. The torpedoes in the cage can be lifted up to irradiation position from the storage position by a hoist mechanism. In the irradiation position the symmetry level of the sources is 80 cm over the floor of the irradiation room.

The size of the irradiation chamber is **4 x 4 x 4 m**; it is surrounded by walls made of 1.7 m normal concrete. Safe entrance to the irradiation chamber is ensured by a shielded **maze** with several turnings (breaks). The entrance door of the maze is made of steel. Access of personnel and transport of products are controlled by safety rules and technology to prevent accidental exposure of personnel or visitors. The irradiation process can be monitored from the control desk in the control room adjacent to the irradiation chamber. The irradiator is operated fully automatically, controlled by an electronic control unit. Irradiation during daytime-operation is performed in the presence of operators by manual or automatic control.

The radiation sources can be lifted to the irradiation position as required by the experimental or pilot-plant radiation treatment. The number of sources appropriate for the program can be manually chosen; the time required for irradiation can automatically be ensured.

The goods, to be irradiated, can be placed either in the **cylinder of 215-mm dia located in the middle of the cage** irradiation position (inner irradiation field), or around the source-cage in the irradiation room (outer irradiation field).

The distance of the horizontal plane of symmetry of the **sources from the floor is 80 cm**. This height makes it possible for regular pilot-scale radiation treatment of products placed in 40 x 60 x 75-cm boxes and also at larger distances from the sources. The radiation treatment of various products placed in aluminium containers (80 x 60 x 130 cm) of 0.5 m^3 volume can be carried out as well. In the space near the cage radiation treatment can be performed in small size e.g. 40 x 40 x 35-cm boxes.

The **high dose intensity space** within the cage can be regularly used for the radiation treatment of **max. 9 litre** samples (∅180x360). Owing to the relatively large volume of the irradiation chamber, up to 1.6 m height of the useful radiation field, products can be irradiated at very wide dose rates.

Operation at night or at weekends is also possible at automatic power supply by battery, without supervision.

The irradiator is equipped with devices for water purification and exhaust air filters.

The goods to be irradiated - before and after treatment - are transported into and out of the irradiation chamber through the maze manually or with the help of carriages made for this purpose.

Dosimetry

Physical dosimetry:

Calorimetry using water, graphite and polystyrene

Chemical dosimetry:

Radiochromic films (films and pieces of polymers) exposed to radiation change their colour and the absorbance (e.g. at 656.5 nm) measured can be related to dose by calibration

The **ethanol-chlorobenzene dosimeter** uses the hydrochloric acid formation. Dose range: **0.1 kGy – 1 MGy**

The ethanol-chlorobenzene dosimeter (ECB) has got wide-spread application in gamma radiation processing and at (linear) electron accelerators. Its reliable performance was proved in a number of international and bilateral intercomparison programmes, including the IAEA and several National Institutes of Standards. The method is in routine use in more than twenty countries.

The basic radiation chemical process, used for dosimetry, is the formation of HCl upon irradiation. Its concentration is a linear function of the dose absorbed in the solution in a wide dose range of 0.1-100 kGy. At higher doses the reactions become more complicated.

The absorbed dose is determined by measuring the concentration of HCl(c_{HCl}) formed during irradiation. Oscillometric titration is the most frequently used method. The irradiated dosimeter can be re-evaluated many times.

Selected Publications

Zs. Horváth et al: The radiofrequency (oscillometric) alcoholic chlorobenzene dosimeter; radiochim. Acta 13 (1970), 150-152

A. Kovács et al: Evaluation of irradiated ethanol-monochlorobenzene dosimeters by conductivity method; Proc IAEA Symp. High-Dose Dosimetry, Vienna (1984) 143-156

A. Kovács et al.: Oscillometric and Conductometric Analysis of Aqueous and Organic Dosimeter Solutions; Radiat. Phys. Chem. 46/4-6, pp 1211-1215 (1995)

M. Osvay: Measurements on Shielding Experiments Using Al_2O_3:Mg.Y TL Detectors; Rad. Prot. Dosimetry, 66/1-4, pp 217-219 (1996)

See further relevant articles in the next chapter (Electron Accelerator)

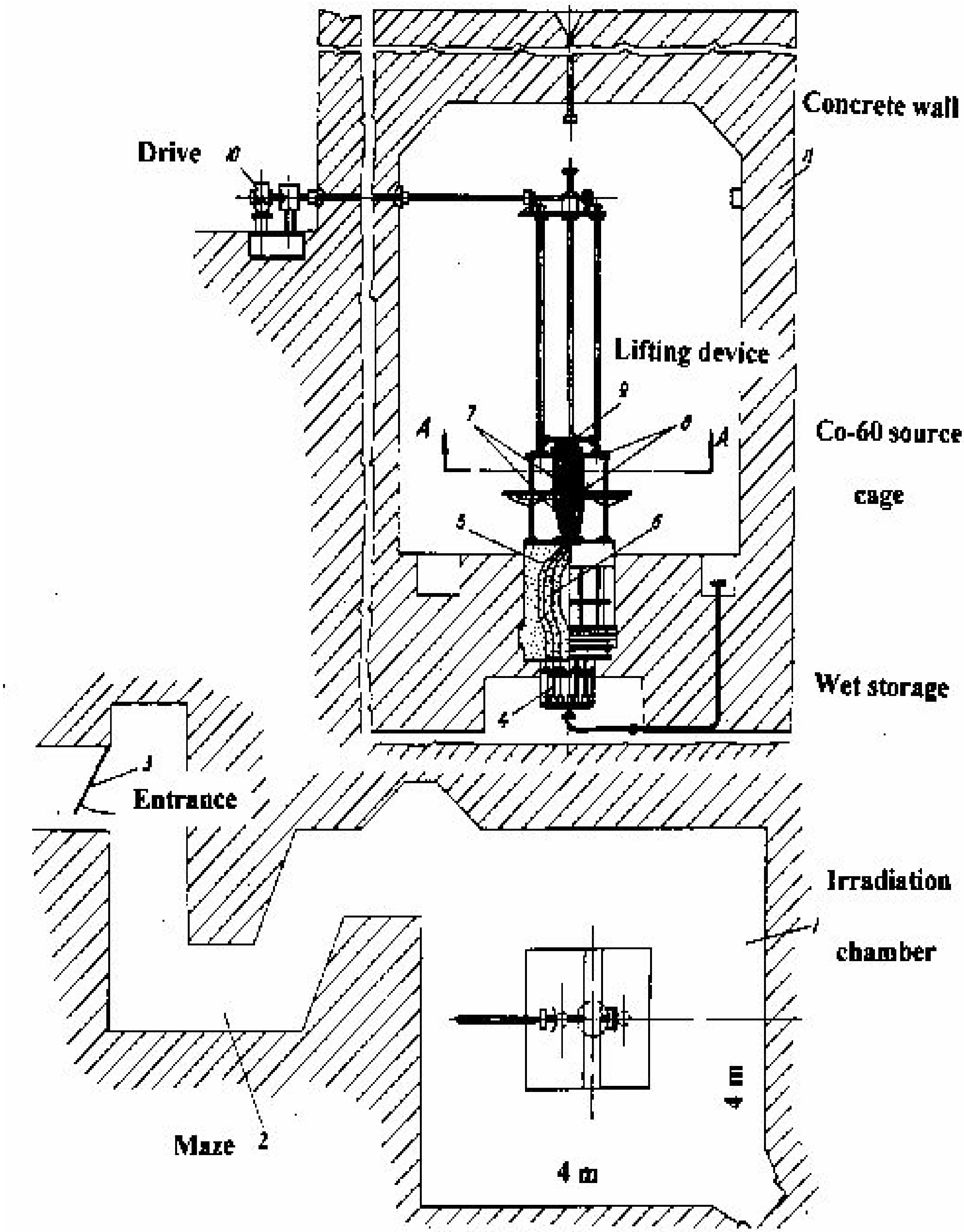


Fig. 1. Gamma (Co-60) Irradiation Facility

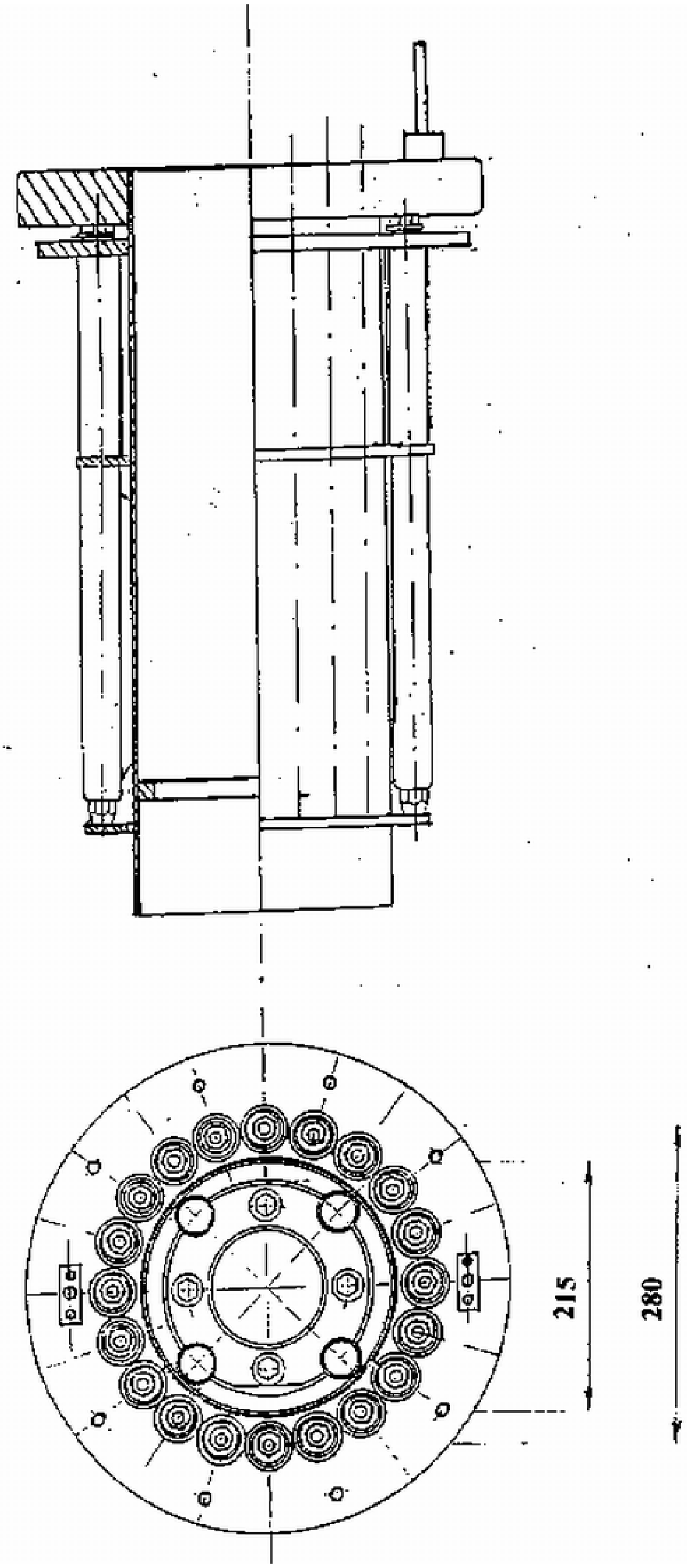
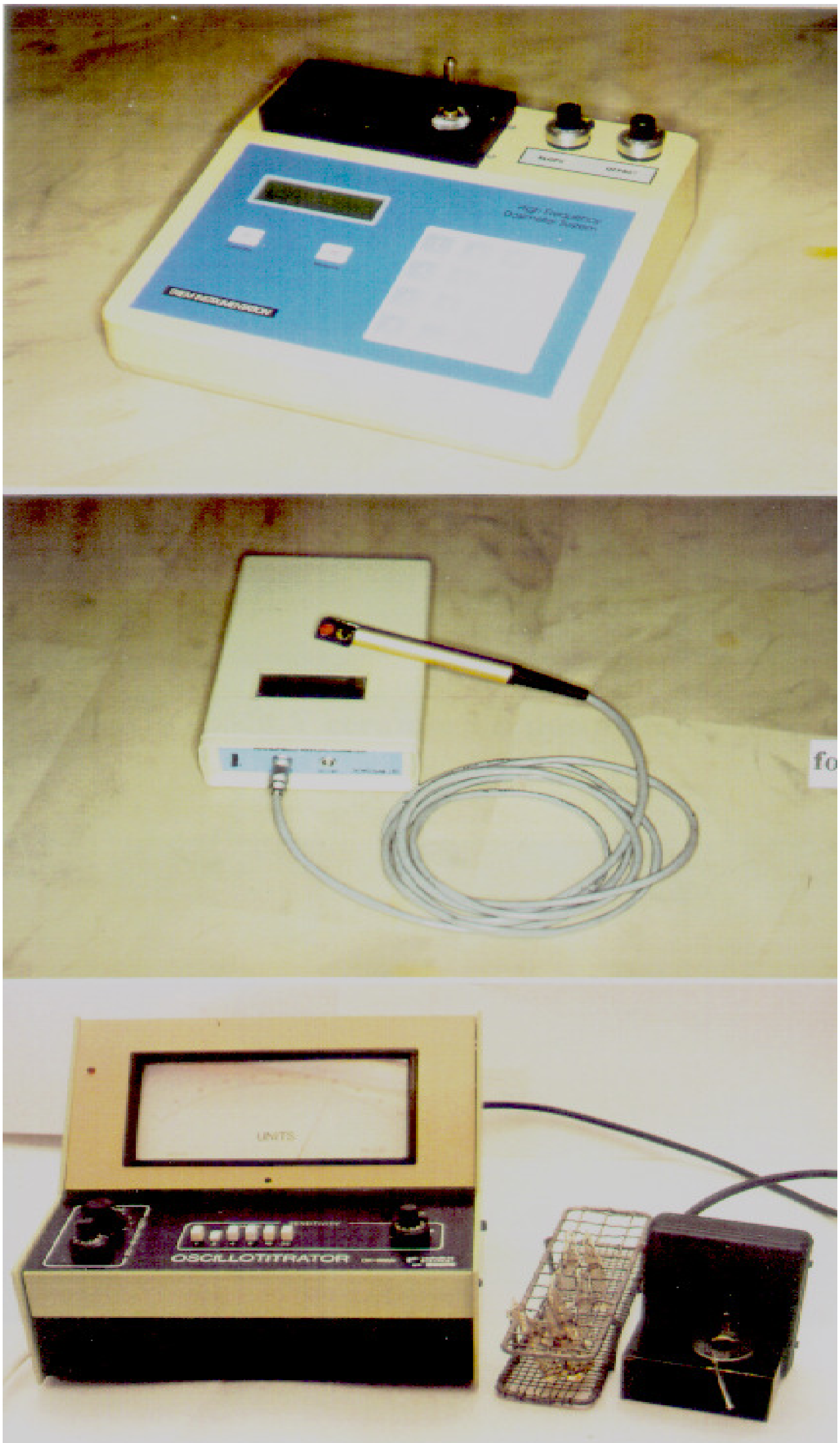


Fig. 2. The Cage and Co-60 Source Positions

Photo 1. Co-60 Gamma Irradiation Chamber

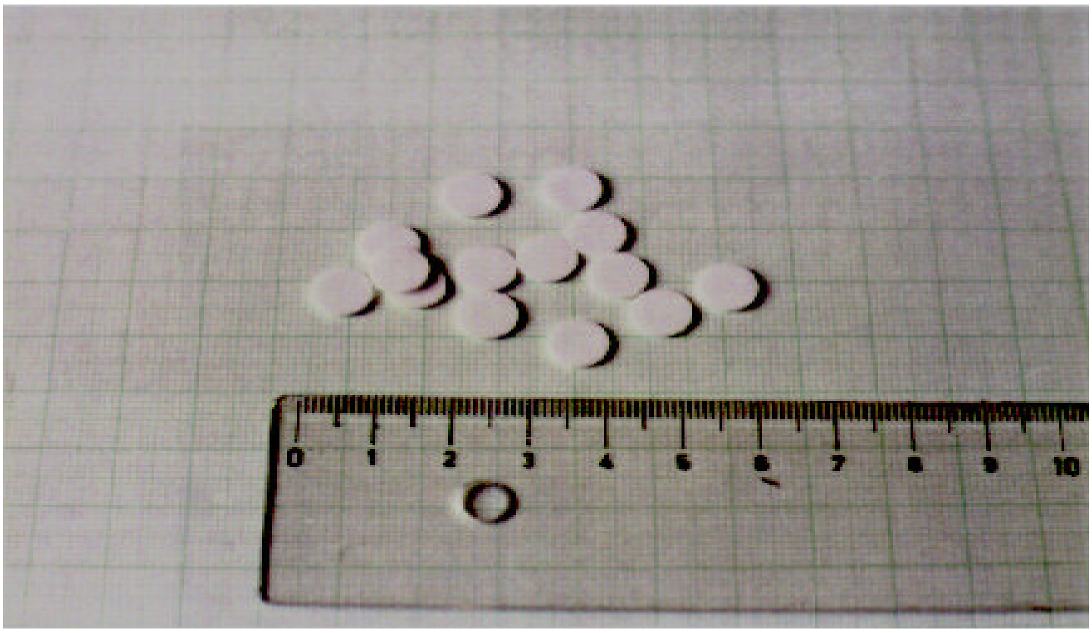


Digital oscillotitrator

Reflectometer for film dosimetry

Analogue oscillotitrator

Photo 2. Instrumentation for chemical dosimetry

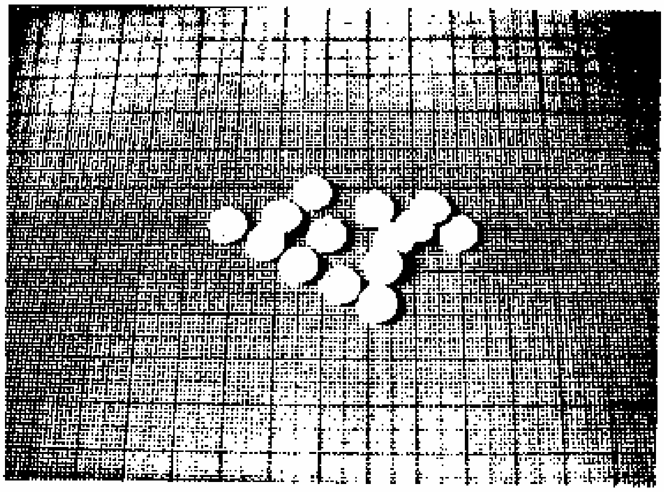


Al_2O_3:Mg,Y ceramic TL dosimeters

And TL Reader (Harshaw 2000 AB)

Photo 3.

Al_2O_3: Mg,Y THERMOLUMINESCENT DOSIMETER



APPLICATIONS

- Industrial high-dose dosimetry
- Dose distribution measurement
- Accidental dosimetry

CHARACTERISTICS

Density	3.5 g/cm^3
Effective atomic number (Z_{eff})	10.2
Temperature of the main TL glow peak	appr. 250°C
Measuring range Type D-2	10^{-1} - $5 \cdot 10^3$ Gy
Measuring range Type D-3	10^{-3} - 10^2 Gy
Standard deviation (sample to sample)	±10 per cent
Fading	15 per cent in the first 24 hours 25 per cent after 21 days
TL response ratio 80 keV/^{60}Co	appr. 2.5
Re-use	unlimited
Dimensions	Ø8x1 mm
Weight	appr. 150 mg