Preparation of a Vertical-Beam Facility

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The use of beams from particle accelerators for biophysical experiments has enjoyed growing interest during the last years [1]. The radiobiological effect of charged hadrons is of fundamental interest in biology and also for applications in radiotherapy with protons or heavy ions. The use of "living targets" like cultures of mammalian cells may give rise to biology-specific problems like the cells' exposure to environmental conditions during transport and irradiation. A vertical beam offers the advantage that the cells seeded in petri dishes can be irradiated through the thin–walled bottom without emptying the growth medium. The sensitive cells remain protected against effects of unregulated temperature and uncontrolled atmosphere.

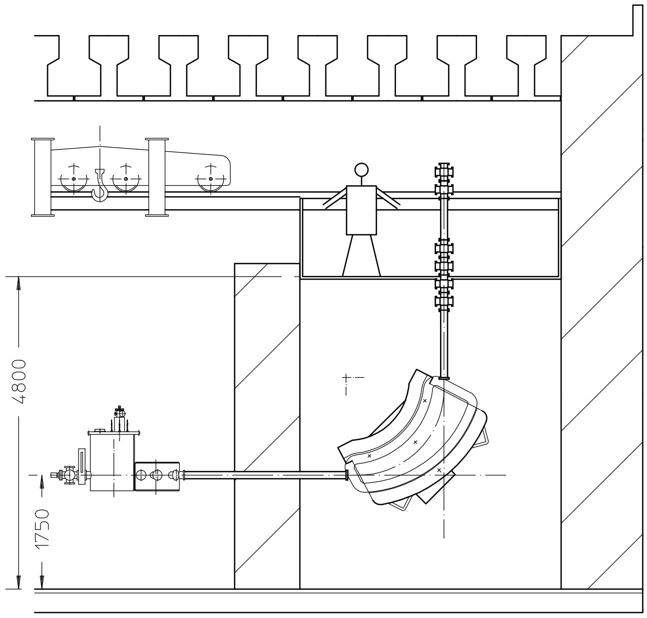

Fig. 1: Schematic view of the 90° magnet setup for the vertical–beam facility

In March 1996 the 90° analyzing magnet of the Tandem accelerator will be replaced by a new more efficient magnet. The old one will serve as the main component for a vertical beam line. The magnet will be installed downstream of the beamline for a microlense experiment in the 0° direction of the switching magnet. A platform at about 5 m height will be mounted below the ceiling of the experimental hall (Fig. 1).

In November 1995 an international meeting of potential users of such a vertical beam was held in Munich, at which radiobiologists and physicists discussed possible biophysical experiments and the specifications they impose on a vertical beamline. The requirements of the particle beam for irradiation are a well–defined energy and energy loss in the biological target and a homogeneity of the radiation field of less than 5 % variation over a diameter of several centimeters. The beam leaves the vacuum through a thin window to allow the cell probes to be irradiated at atmospheric pressure. An accurate beam monitor and dosimetry system is needed to control and measure the flux of particles and its homogeneity. During irradiation it must also provide an online measurement of the applied dose and of the stability of the radiation field. A device to stop the irradiation when the desired dose has been reached must be available.

The number of inactivated cells or other radiobiological effects like DNA–aberrations are measured as a function of dose, i.e. the energy deposited in the target. From fluence or dose effect curves RBE (Relative Biological Effectiveness)–values reflecting the ratio to γ–ray exposures can be determined. Experiments are planned to measure RBE at different energies with different ions. The dependence of the oxygen content of the growth medium on cell survival is another interesting question. For the preparation of samples a rudimentary cell–culture laboratory with a clean and sterile workspace will be made available.

Another kind of experiment envisaged is the microdosimetry of a proton beam in a tissue–equivalent water phantom. With the increasing use of particle beams in radiotherapy the accurate calibration and standardisation of dosimeters for clinical applications will be needed [2].

The preparation of an accurately known radiation field can also be used for other applications like the test of detectors at different counting rates as well as for investigations of radiation damage of electronic devices and detector components after exposure to different hadronic doses.

References

[1] Book of Abstracts of the Fifth Workshop on Heavy Charged Particles in Biology and Medicine, GSI Darmstadt, 1995, GSI Scientific Report **95–10**, 1995.

[2] J.F. Dicello, in *Ion Beams in Tumor Therapy*, Ed. U. Linz, (Chapmann, Weinheim, 1995), p. 35.