During external beam radiotherapy normal tissues are irradiated along with the tumour. Radiation therapists try to minimize the dose to normal tissues while delivering a high dose to the target volume. Often this is difficult and complications arise due to irradiation of normal tissues. These complication depend not only on the dose but also on volume of the organ irradiated. Experimental and clinical data have indicated that the probability of tumour control and normal tissue complications after radiation therapy are dose dependent, and that the corresponding dose-response relationships produce sigmoid-shaped curves. However, for many human cancers the observed tumor control curve represents a population average for clones of different sensitivities. This problem is further complicated by uncertainties in tumor delivery, organ motion, and in patients positioning from day by day. To compensate for these uncertainties, large safety margins have usually been added to the planning target volume (PTV), extending into surrounding normal tissue, to decrease the risk of marginal tumor miss.

In delivering high dose, the radiation oncologist pay attention every day not only to the target volume but, especially, to critical surrounding tissues. At high dose very small variations of percentage of volume of normal tissue included in the target can determine chronic and no-reversable damage. To compensate for these uncertainties, large safety margins have usually been added to the planning target volume (PTV), extending into surrounding normal tissue, to decrease the risk of marginal tumor miss.

In MAESTRO project, novel technologies in patient alignment, organ tracking, dose calculation and dose measurement will be developed, together with advanced software for radiotherapy image processing and merging for therapy planning using new conformal therapy modalities are investigated. Clinical environments will be provided for pre-clinical validation.

New tools will be available as prototypes before the end of this study, such as real-time imaging devices used with high energy photon beams and protons, and software using fast Monte Carlo codes, well-known for their high accuracy in any material and beam situation, and novel 2D surface and 3D volume dosimeters allowing better patient positioning and better beam and dose monitoring.

The aim of Maestro is to develop and validate in clinical conditions the advanced equipment need in using new techniques. The development of a clinical protocol is very important to evaluate the emerging results and to ensure that the new technologies will be clinically relevant and industrially viable.

The project is organised in 3 specific work packages on research and development activities and two blocks of training and management activities. The main field of interest of the MAESTRO project are sketched in Fig. 1, here below a brief description of the R&D work packages is reported.
The first one concerns the “Adaptive Radiation delivery, tracking and control for radiotherapy” (WP1). This package is important to evaluate the target and normal tissue motions to permit a safety dose escalation. During irradiation must be considered not only the normal tissue motions but also patient’s commodities and different motion in different segments due to physiological settings or for example due to previous surgical approach (bowel motion-synechia).

The second one is about the “Radiotherapy Software development” (WP2). An accurate dose evaluation using a Monte Carlo based TPS is very important to understand the effective dose distribution to the target and critical organs. High dose in very small volume in normal tissue can determine severe late complication.

“Sensors for dose evaluation in radiotherapy” is treated in the third work package (WP3). The special techniques are characterized by high dose delivered. Consequently clinicians pay attention also to small variation of dose on very small volume of critical organs to avoid chronic and no-reversible damage for these reasons strong requirements in the current dosimeters and techniques arise.

The three work programmes (WP1, WP2, WP3) have been constructed around research activities including recent advances in high technology development done in public research institutes and manufacturer’s laboratories.

Within work package WP4 the clinical requirements will be defined, the QA procedures and protocol studies developed, comprising risk assessment studies, and the new devices proposed in the consortium evaluated.

The work package WP5 will deal with training and dissemination activities for researchers and medical physicists applying new instruments developed in this project. Particular attention will be devoted to obtaining guidance and critical evaluation concerning newly developed products, by practicing clinicians and medical physicists, in their clinical environment.

References

2. Hendry JH, Moore JV. Is the steepness of dose-incidence curves for tumour control or complication due to variation before or as a result of irradiation? Br J Radiol 1984; 57: 1045-6.