

5.00 credits

30.0 h + 30.0 h

Q2

Teacher(s)	Janssens Guillaume ;Lee John ;Sterpin Edmond ;
Language :	English
Place of the course	Louvain-la-Neuve
Main themes	<p>Protontherapy gains more and more importance as an alternative treatment modality to radiotherapy with photons for specific types of patients and cancers.</p> <p>Compared to photons, protons deposit their energy in a much more localized area, which allows for both more focused tumor targeting and reduced side effects, mainly regrading healthy tissues.</p> <p>The course builds upon 4 pillars:</p> <p>Pillar 1: radiation oncology.</p> <ul style="list-style-type: none"> - Basis of cancer and carcinogenesis - Treating cancer with radiations: principles and elements of radiobiology - Main steps of a radiotherapy workflow - Introduction to particle therapy: principles and current status - Radioprotection: treatment facility shielding, personnel and patient protection - Health economics: treatment options and patient referral, reimbursement and impact on social security services <p>Pillar 2: technologies for protontherapy. This pillar provides a specific focus on the proton beam delivery process, i.e. from proton generation and acceleration (synchrotron/cyclotron) to energy deposition into a well-defined location in the patient, including magnetic beam steering.</p> <ul style="list-style-type: none"> - Producing and accelerating protons: cyclotrons and synchrotrons - Detailed design of cyclotrons (and synchro-cyclotrons) - Beamlines, magneto-optics - Robotics: rotating structures, positioning systems - Therapeutic beam: pencil beam scanning - Safety and quality assurance in medical technologies : safety automats, interlocks, redundancies, beam measurement devices (monitor ion chambers) and beam data analysis <p>Pillar 3: ancillary technologies for proton therapy. This pillar covers the devices and data flows associated with treatment preparation, execution, and verification, with all their specificities, compared to conventional radiotherapy treatment (X-rays).</p> <ul style="list-style-type: none"> - Treatment planning system (TPS), oncology information system (OIS), imaging; the role of software integration - Dose calculation including analytical and Monte Carlo dose engines, treatment optimization, treatment robustness against uncertainties, and robust optimization - Imaging in or out of the room (computed tomography (CT), on-board cone-beam CT (CBCT), magnetic resonance imaging (MRI)). Image reconstruction and analyses. - Range verification: prompt gamma camera, proton radiography, positron emission tomography (PET)) <p>Pillar 4: treatments of the future.</p> <ul style="list-style-type: none"> - Image guidance: status and perspectives, and the way towards adaptive treatments - Overcoming challenges of PT: innovation tracks (range uncertainties, proton imaging, etc.) - Emerging treatments: introduction to ion beam therapy - Emerging treatments: combining radiations and medication
Learning outcomes	
Evaluation methods	Oral Exam. Exact modalities depend on sanitary conditions (presential/distancial).

Teaching methods	<p>The course combines a series of ex-cathedra lectures - giving a strong emphasis on the system aspects of the proton therapy facility - and group projects (Problem-Based Learning, PBL) conducted by the students. Groups are made of X students (to be determined). Practical modalities depend on the sanitary conditions (presential/comodal/distancial).</p> <p>Possible topics for group projects (PBL):</p> <ul style="list-style-type: none"> - Main equipment pre-design (accelerator, beam line magnets, global energy/power/mass ratios, ...) - Basic CT/CBCT reconstruction - Basic dose calculation engine - Strategies to manage uncertainties (e.g. with margins and/or robust planning) - Last but not least, some practical activities could be envisaged within the Leuven/Louvain protontherapy center in the horizon 2019-2020. <p>An on-site visit of a protontherapy facility in the neighborhood (max. 3 hours by car) might be planned.</p>
Content	<p>Protontherapy gains more and more importance as an alternative treatment modality to radiotherapy with photons for specific types of patients and cancers. Compared to photons, protons deposit their energy in a much more localized area, which allows for both more focused tumor targeting and reduced side effects.</p> <p>The course builds upon 4 pillars:</p> <p>Pillar 1: radiation oncology.</p> <ul style="list-style-type: none"> • Basis of cancer and carcinogenesis • Treating cancer with radiations: principles and elements of radiobiology • Main steps of a radiotherapy workflow • Introduction to particle therapy: principles and current status • Radioprotection: treatment facility shielding, personnel and patient protection • Health economics: treatment options and patient referral, reimbursement and impact on social security service. <p>Pillar 2: technologies for protontherapy. This pillar provides a specific focus on the proton beam delivery process, i.e. from proton generation and acceleration (synchrotron/cyclotron) to energy deposition into a well-defined location in the patient, including magnetic beam steering.</p> <ul style="list-style-type: none"> • Producing and accelerating protons: cyclotrons and synchrotrons • Detailed design of cyclotrons (and synchro-cyclotrons) • Beamlines, magneto-optics • Robotics: rotating structures, positioning systems • Therapeutic beam: pencil beam scanning • Safety and quality assurance in medical technologies : safety automats, interlocks, redundancies, beam measurement devices (monitor ion chambers) and beam data analysis <p>Pillar 3: ancillary technologies for proton therapy. This pillar covers the devices and data flows associated with treatment preparation, execution, and verification, with all their specificities, compared to conventional radiotherapy treatment (X-rays).</p> <ul style="list-style-type: none"> • Treatment planning system (TPS), oncology information system (OIS), imaging; the role of software integration • Dose calculation including analytical and Monte Carlo dose engines, treatment optimization, treatment robustness against uncertainties, and robust optimization • Imaging in or out of the room (computed tomography (CT), on-board cone-beam CT (CBCT), magnetic resonance imaging (MRI)). Image reconstruction and analyses. • Range verification: prompt gamma camera, proton radiography, positron emission tomography (PET)) <p>Pillar 4: treatments of the future.</p> <ul style="list-style-type: none"> • Image guidance: status and perspectives, and the way towards adaptive treatments • Overcoming challenges of PT: innovation tracks (range uncertainties, proton imaging, etc.) • Emerging treatments: introduction to ion beam therapy • Emerging treatments: combining radiations and medication
Inline resources	See the Moodle website: https://moodleucl.uclouvain.be/course/view.php?id=11642
Bibliography	Haral Paganetti "Proton Therapy Physics" CRC Press
Faculty or entity in charge	GBIO

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Biomedical Engineering	GBIO2M	5		