

University of Ljubljana  
Faculty of Health Sciences



**Naslov:**

Univerza v Ljubljani  
Zdravstvena fakulteta

**Oddelek za radiološko tehnologijo**

Poljanska 26a  
1000 Ljubljana  
Slovenija

**Address:**

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Faculty of Health Sciences

**Medical imaging and radiotherapy  
department**

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## **Student accommodation**

Accommodation for foreign students will be provided in the University dormitories in the city centre (20 meters to 5 kilometres from College of Health Studies). The rent varies from 56 EUR to 125 EUR per month, with a deposit of 2 monthly payments.

## **Travel information**

Ljubljana's airport is 20 km north of Ljubljana and there are shuttles to the city centre available every hour (5-9 Euros). Slovenian airline is called Adria airways <http://www.adria.si/en/index.cp2> - it flies to most European cities. Easy Jet flies from Ljubljana - London Stanstead.

## **Administration**

Help regarding all necessary administration will be offered to all students upon arrival.

## **Writing home, e-mail, mobile SIM card**

Internet access is available from the College and students' dormitories (approximately 2 EUR per month). Slovenian mobile SIM card is available for 1 Euro.

## **Uniforms**

Students **must** have a white uniform (trousers/skirt + tunic) and shoes (for indoor use only). You will have to launder yourself.

Personal name badge is obliged in the hospitals – it should be brought by the students.

## **Winter clothes**

Temperatures can vary from -10 to 15°C in winter time. There can be some snow therefore we recommend warm clothes and boots.

## **Meals**

Foreign students are entitled to approximately 20 student's meal ticket per month. One ticket can be used at lunch or supper time and it costs from 1.20 – 6 Euros.

## **Practical placement – 12 ECTS (95% attendance is required)**

Clinical placements are offered in two Ljubljana's hospitals;

1. University medical centre is a public health care institution providing medical services at the secondary and tertiary level with 7500 employees and 2,390 patient beds. Radiology departments are in the main building, in neurology, trauma, paediatrics and in three smaller departments. There is also a nuclear medicine department.
2. Institute of Oncology with Oncology centre with 840 employees. There is a diagnostic ward, radiotherapy department and nuclear medicine department with PET/CT.

Clinical placements can be granted in diagnostic, radiotherapy or veterinary field. Please let us know well in advance where you would like to rotate, in order to allow us enough time to organize the placements.

Students are expected to work from 8 am – 3 pm.

### **Radiation monitoring**

TLD dosimeters will be provided.

### **Insurance**

Health insurance is free for all EU citizens with a European health insurance card. This should be arranged prior to your arrival to Slovenia.

### **Medical examination**

There is no need for extra medical examination but please bring a card with a record which proves evidence of immunity to: hepatitis B, BCG, rubella (for ladies).

**More information can be found on the following sites:**

**University of Ljubljana**

Kongresni trg 12  
SI-1000 Ljubljana  
International Relations Office  
Telephone: +386 1 24 18 592  
Fax: +386 1 24 18 593  
e-mail: [intern.office@uni-lj.si](mailto:intern.office@uni-lj.si)  
Web: [www.uni-lj.si/en/](http://www.uni-lj.si/en/)

**Student Organization (ŠOU)**

International Office  
Kersnikova 4  
SI-1000 Ljubljana  
Telephone: +386 1 43 17 010  
Fax: +386 1 23 19 448  
e-mail: [student.exchange@uni-lj.si](mailto:student.exchange@uni-lj.si)  
Web: [www.sou-lj.si/novo/index.php?option=com\\_content&task=view&id=16&Itemid=39](http://www.sou-lj.si/novo/index.php?option=com_content&task=view&id=16&Itemid=39)

More information also on <http://www.esn-ljubljana.org/> and [http://www.esn-ljubljana.org/pdf/ESN\\_FAQ.pdf](http://www.esn-ljubljana.org/pdf/ESN_FAQ.pdf)

Information about Slovenia in English <http://www.slovenia.info/?lng=2>, and facts / statistics <http://www.stat.si/eng/index.asp> and [Slovenia in figures](#)

Information about Ljubljana in English <http://www.visitljubljana.si/en/> and <http://www.ljubljana.si/en/municipality/>

**We wish you a pleasant stay in Ljubljana, Slovenia.  
Dobrodošli!**

# EXCHANGE MODUL – QUALITY ASSURANCE / QUALITY CONTROL – 6 ECTS

Lectures for all Erasmus students will be provided in English language, separately from the Slovenian students. Erasmus exchange module is composed of quality assurance and quality control in general radiography, CT, MR, nuclear medicine and radiotherapy. Students may choose between topics; diagnostic or therapeutic or a combination of both.

Credits theory:	Practice:			Other credits: (Slovenian language course- optional)
	Credits	Weeks with patients	Total hours of practice,	
6 (+2 optional- seminar work)	12	8	210	2

## Assessment

A written report of 1550 words regarding chosen topic at the end of the modul.

## 1. QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) IN GENERAL RADIOLOGY AND COMPUTED TOMOGRAPHY

Basic radiography knowledge appropriate to a third year student in conventional and CT equipment and techniques is required. No previous knowledge in QA/QC is required.

A module will be separated in theoretical and practical part, depending on modality and radiological procedures.

Students will participate with radiographers-dosimetrist and medical physicists who are entitled to perform all tasks in QA/QC programme at the Institute of Radiology at the University Medical Centre in Ljubljana.

Depending on QA programme we perform:

- daily QA test
- monthly QA tests
- annually QA tests

### 1.1 General radiology QA:

- tube output measurements
- repeatability
- linearity
- automatic exposure control
- image quality (IQ)
- Radiation Protection and optimization of radiological procedures

## 1.2 CT QA

- Scan plane lights
- Gantry tilt
- Couche travel accuracy
- Slice thickness
- Image Contrast
- HU values
- CTDI measurements
- Image Quality (IQ)
  - spatial resolution (MTF)
  - low contrast resolution
  - homogeneity
  - noise
  - artefacts
  - monitors
- Radiation Protection and optimization of radiological procedures

At the end of the course the students will be able to understand basic principles of QA procedures and will be able to perform them.

Students will be able to implement the optimization principles of radiological procedures in daily workflow. They will be able to perform all QA test under supervision and will understand the purpose of QA measurements.

## 1.3 References:

IPEM 91, Recommended Standards for the Routine Performance Testing of Diagnostic X-Ray Imaging Systems, 2005, ISBN 1 903613 24 8

Adrienne Finch et.all, Assurance of Quality in the diagnostic imaging department, British Institute of Radiology,2001

Peter J Loyd, QA workbook for radiographers and radiological technologists, WHO, 2001

## **2. QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) IN MAGNETIC RESONANCE IMAGING**

QA/QC in MRI consists of various tests which are performed periodically and can be divided in:

- Daily and weekly tests with the equipment supplied by vendor
- Service check up
- QA/QC performed with a computer programs

Service check up and QA/QC performed with computer programmes are made by service engineers. The most important for routine work are daily and weekly tests performed by radiographers.

### **2.1 Daily tests consist of:**

- Field homogeneity check up
- Spatial linearity check up

### **2.2 Weekly tests consist of:**

- Calculation of signal to noise ratio
- Field homogeneity check up
- Spatial linearity check up

### **2.3 Protocols of daily and weekly tests are composed of:**

- Choosing the right phantom and its regular placing
- Choosing the pulse sequence
- Run the measurement
- Assessment of the image
- Calculation of signal to noise ratio
- Save the results

At the end of the QA/QC in Magnetic Resonance Imaging the students will understand the basic of QA/QC and will be able to perform daily and weekly QA/QC tests on different MR tomographs (GE USA, Siemens Germany, Philips Nederland).

## 2.4 References:

Firbank MJ, Harrison RM, Williams ED, FIPEM, Coulthard A, Quality assurance for MRI: practical experience, *The British Journal of Radiology*, 73, 2000, 376-383

Koller CJ, Eatough JP, Mountford PJ, Frain G. A survey of MRI quality assurance programmes, *The British Journal of Radiology*, 79, 2006, 592-596

Di Nallo AM, Ortenzia O, Arienzo MD, Coniglio D, Benassi M. MRI qualità control tools for procedurea and analyses. *J.Exp.Clin.Cancer Res.*, 25,1, 2006

### **3. QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) IN RADIOTHERAPY**

Students, who will take program QA at the Radiotherapy department in Ljubljana, Slovenia, will learn about QA/QC procedures under the supervision of the radiophysics and dosimetrists. They will also follow the instructions of RTT-s, which are working on the simulators, linear accelerators and mould room. All of the team workers have very specific obligations regarding the QA/QC procedures.

QA/QC in Radiotherapy consists of various tests concerning both mechanical as well as dosimetrical properties of photon and electron beams. All tests are performed periodically, the frequency depends on the procedure and may vary from one centre to another.

At the end of the course the students will be able to understand and in some points perform the following fields of the QA/QC procedures:

#### **At the Institute of Oncology in Ljubljana QA / QC the programme consists of:**

- daily tests of isocenter stability, optical field check and laser alignment of a single linear accelerator
- weekly tests of dosimetrical stability of every linear accelerator
- monthly tests of mechanical stability of:
  - § Isocenter
  - § X-ray field versus optical field
  - § collimator

There are also other tests performed in some cases, the frequency is not defined and depends on the circumstances (f.i. after major break down repairs...).

All tests mentioned above are performed additionally to measurements of relative parameters of every single machine before the start of clinical work. Those are much longer and more demanding and are performed only once.

At the end of the course the students will also be able to understand and explain the meaning of the QA procedures in connection with simulator, mould room and linear accelerator (RTT-s).

### **3.1 Localization and simulation**

- principles and functioning of conventional simulators
- laser alignment system
- contour acquisition devices
- patient immobilization and fixation equipment
- principles of accuracy in patient set up procedures
- patient positioning and fixation for various treatments
- simulation techniques for broad range of indications
- contour acquisition and reference marking
- Acquisition of radiographs for planning (use of markings and contrast media)
- Data recording and transfer
- QA-QC of equipment and procedures

### **3.2 Mould room**

- cutters for shielding blocks (hot wire and drill)
- block verification unit
- alloy melters
- materials (polystyrene cellular foam, low melting alloy...)
- fabrication of individual shielding blocks according to prescribed beam data
- documentation and labelling
- mould room safety
- QA-QC of equipment and procedures

### **3.3 External beam treatment delivery**

- single photon beam linear accelerator and R&V system
- QA-QC system, daily check
- Patient positioning and fixation
- Interpretation of the treatment prescription and plan
- Setting up prescribed beam parameters and check against reference marks
- Registration of delivered beam parameters on daily basis
- Portal verification and approval

### 3.4 References

Khan F., The Physics of Radiation Therapy, 3rd edn, Baltimore, MD: Williams and Wilkins, 2003

Perez C.A., Brady L.W., Halperin E.C., Schmidt – Ullrich R.K. Principles and Practise of Radiation Oncology. Fourth Edition. Lippincott Williams&Wilkins. Philadelphia, 2004.

Protokols IAEA: - Technical Reports Series 398

Walter and Miller's (2003).Textbook of Radiotherapy: Radiation physics, therapy and oncology.

Williams J.R., Thwaites D.I. Radiotherapy Physics in Practice. Oxford Medical Publication, 1993.  
6th ed. UK: Churchill livingstone.

## **4. QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) IN NUCLEAR MEDICINE**

Student, who will take program QA at the Nuclear medicine department in Ljubljana, Slovenia, will learn about QA/QC procedures under the supervision of the radiophysicist, radiopharmacist and nuclear medicine technologists. They will also follow the instructions of nuclear medicine technologists, which are working on the planar gamma camera, SPECT, and SPECT/CT. All of the team workers have very specific obligations about QA/QC procedures.

QA/QC in Nuclear medicine consists of various tests of the gamma camera, dose calibrator and the quality control of prepared radiopharmaceuticals. All tests are performed periodically; the frequency depends on the procedure and may vary from one centre to another.

At the end of the course the students will be able to understand and in some points perform the following fields of the QA/QC procedures.

### **4.1 The quality control of the gamma camera should include tests of parameters such as:**

- Uniformity.
- Energy window setting and spectrum display.
- Energy resolution.
- Sensitivity.
- Pixel size.
- Centre of rotation.
- Linearity.
- Geometric resolution.
- Count losses at high count-rates.
- Multiple window positioning.
- Background.
- Total performance.

Some of the parameters should be checked daily, such as the uniformity, background and energy window settings, while others should be checked less frequently but never less than once a year.

A set of phantoms and sources are necessary in order to perform the regular quality control. These include flood source, line source, bar phantom and a total performance phantom (planar or tomographic).

## 4.2 QC of dose calibrator and radionuclide:

- Identification of radionuclide and quality control of radionuclide.
- Activity of radionuclide of reference time.
- High voltage.
- Zero setting.
- Background.
- Check source response.
- Accuracy.
- Linearity.

At the end of the course the students will be able to understand and in some points perform the following fields of the QA/QC procedures.

- Make the calculation of administered activity to a child according to the local rules;
- Verify the administered radiopharmaceutical and its activity;
- Elution of sterile pertechnetate from a  $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$  generator;
- Preparation of radiopharmaceuticals from lyophilized kits according to the manufacturer's instructions; and
- Performance of quality control procedures on the prepared radiopharmaceuticals.
- Perform regular quality control of activity meter and other relevant equipment;
- Perform regular quality control of gamma camera;
- Perform regular workplace monitoring;
- Correct handling of the equipment and safety accessories.