

# National training courses in Radiation Protection organized at Instituto Superior Técnico in Portugal: a pandemic experience

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3. IST - Laboratório de Proteção e Segurança Radiológica (LPSR)
4. IST - Centro de Ciências e Tecnologias Nucleares (C2TN)  
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8<sup>th</sup> International Conference on Education and Training in Radiation Protection  
Groningen (The Netherlands) 27<sup>th</sup> to 30<sup>th</sup> of June of 2023

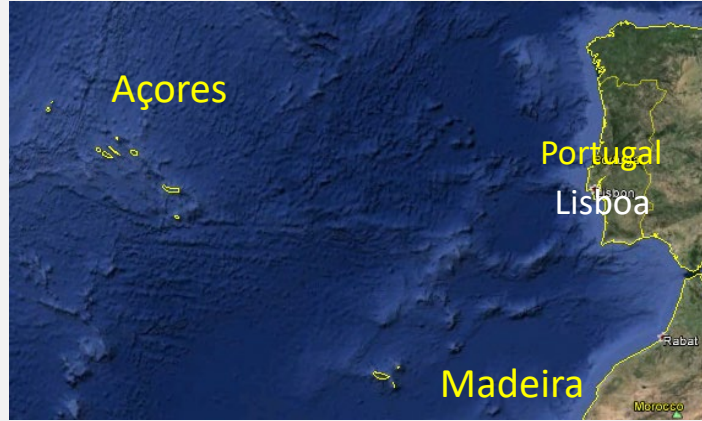
## Outline

1. Introduction
2. Organization of approved TCs in Radiation Protection
3. TC in Radiation Protection for RPO
4. Appraisal of TC and Trainers by the RPO attendants
5. SWOT analysis
6. Conclusions

8<sup>th</sup> International Conference on Education and Training in Radiation Protection  
Groningen (The Netherlands), 27<sup>th</sup> to 30<sup>th</sup> of June of 2023



- Portugal: population 10.6 M
- No NPP
- No U ore extraction
- Radiation sources are used in Medicine, Industry and Research



@ IST - CTN

- 1 MW pool type Research Reactor (since 1961)  
(May 2016 shutdown; SF sent to USA in 2019; preparation for decommissioning)
- Laboratory for Metrology of Ionizing Radiation
- Radioactive Waste Management facility (LLW+ILW, surface)
- Radiosterilization Unit

...



## Campus Tecnológico e Nuclear , CTN

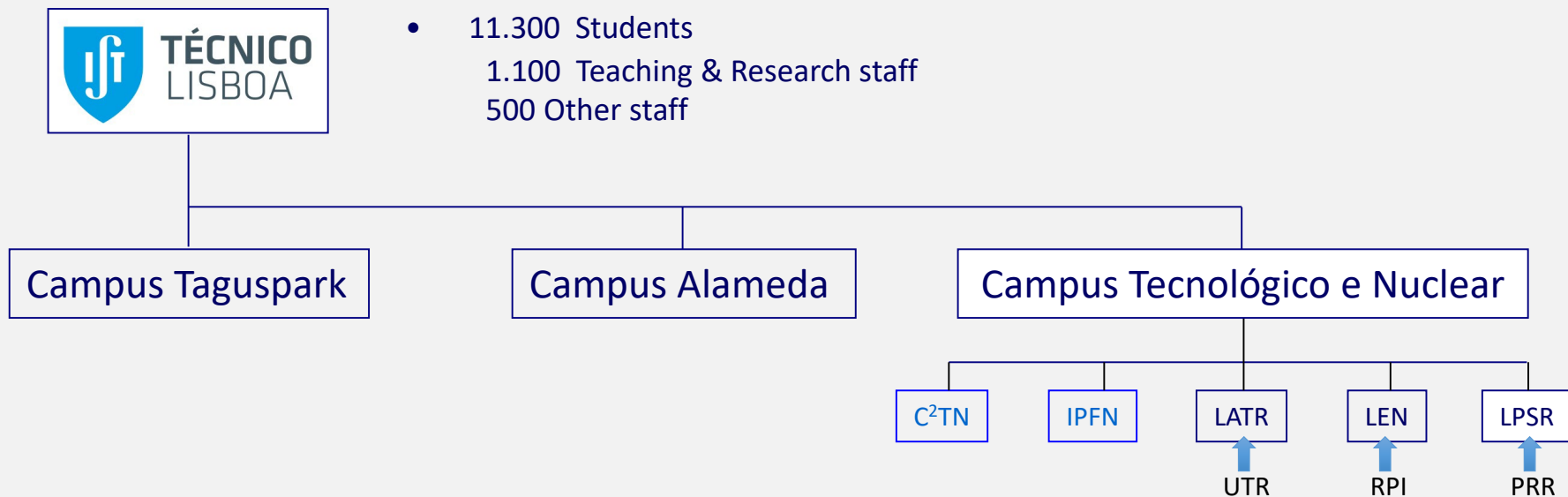
- The former ITN Instituto Tecnológico e Nuclear, was a State Laboratory since the 1960s
- In Feb-2012, ITN was extinguished and incorporated into IST
- All human resources, infrastructures and responsibilities in Law were assumed by IST



- **Mission activities are ensured by:**
  - LATR - Accelerators and Radiation Technology Laboratory
  - LEN - Nuclear Engineering Laboratory
  - LPSR - Radiological Protection and Safety Laboratory
- **Academic department:**
  - DECN – Nuclear Science and Engineering Department
- **R&D activities:**
  - C<sup>2</sup>TN (Centre for Nuclear Science and Technology), among others



- 18 Faculties & Institutes
- 47.500 Students  
3.400 Teaching staff  
400 Researchers  
2.100 other staff
- 11.300 Students  
1.100 Teaching & Research staff  
500 Other staff



*LPSR - Laboratório de Proteção e Segurança Radiológica*  
Radiation Protection and Safety Laboratory

Quality

Secretariat

Metrology and Dosimetry

Environmental Radioactivity

Operational Radiation Protection

- Emergency preparedness and response
- Support to the Government in RP matters
- Education and training in Radiation Protection

### Radiation Protection activities and services

- Metrology of Ionizing radiation (DI, IAEA/WHO-SSDL)
- Individual and environmental monitoring
- Radiobiology
  
- Radioanalytical techniques for measurement of natural and artificial radionuclides in environmental samples, foodstuff, feedstuff, construction materials, water for human consumption, indoor Rn, ...
  
- Safety assessment of radiological facilities
- Monitoring of the environment (e.g. visit of nuclear vessels to national harbors)
- Transport of radioactive material
- Radioactive waste management (storage facility for ILW, LLW),

*LPSR - Laboratório de Proteção e Segurança Radiológica*  
Radiation Protection and Safety Laboratory

Quality

Secretariat

Licença n.º LIC-73/20



Metrology and Dosimetry

Environmental Radioactivity

Operational Radiation Protection

- Emergency preparedness and response
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- **Education and training in Radiation Protection**

Rec n.º APF 02/20, 03/20, 04/20

### Radiation Protection activities and services

- Metrology of Ionizing radiation (DI, IAEA/WHO-SSDL)
- Individual and environmental monitoring [Rec n.º 3/20](#)
- Radiobiology
- Radioanalytical techniques for measurement of natural and artificial radionuclides in environmental samples, foodstuff, feedstuff, construction materials, water for human consumption, indoor Rn, ... [CC n.º 3/22](#)
- Safety assessment of radiological facilities [Rec n.º 3/20](#)
- Monitoring of the environment (e.g. visit of nuclear vessels to national harbors)
- Transport of radioactive material
- Radioactive waste management (storage facility for ILW, LLW), [Licença n.º LIC-RR 02/21](#)

*Cursos de Formação profissional em PR não conferente de grau académico, reconhecidos pela Agência Portuguesa do Ambiente (APA, autoridade reguladora)*

*Nível I - Perito Qualificado, (APF-02/20)*

*Nível II - Técnico Qualificado, (APF-03/20)*

*Nível III - Técnico Operador, (APF-04/20)*

- Decree-Law 108/2018, 3<sup>rd</sup> of December, transposes Council Directive 2013/59/EURATOM (BSS).

Syllabus of the training programs are set in:

Decree-Law 227/2008, 25<sup>th</sup> of November for *nível I and II – Perito and Técnico Qualificado*

Decree-Law 167/2002 modified by DL 184/2015, for *nível III – Técnico Operador*

TC in RP that do not award an academic degree, approved by APA (regulatory body)

Radiation Protection Expert

Radiation Protection Officer

100h (50h in-class, 50h practical)

Graduation requested

Radiation Technician

19h (OpA and B Med, OpC and D Ind, E&T, Res)

High school diploma requested



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Approval, Organization and Trainers from:

*LPSR - Laboratório de Proteção e Segurança Radiológica*  
Radiation Protection and Safety Laboratory

+

*DECN – Departamento de Engenharia e Ciências Nucleares*  
Department of Nuclear Sciences and Engineering

Logistics support from:



Takes care of announcements, registrations and logistics, namely provide access to Moodle and Zoom electronic platforms, ...

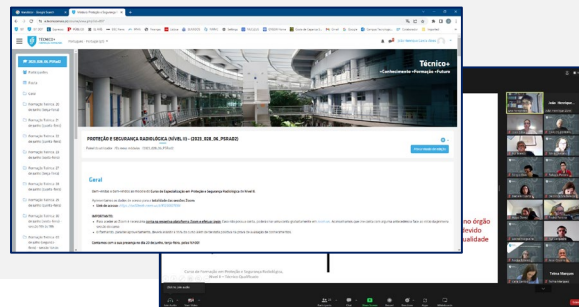
## 2. Organization of approved TC in Radiation Protection

TC in RP that do not award an academic degree, approved by APA (regulatory body)

Radiation Protection Expert

Radiation Protection Officer

Radiation Technician



### Chronology of events:

(lockdowns, resuming activities with restrictions, ... )

- **Apr 2020:** IST requested approval of the TC in RP program to the regulatory body;
- **Jun 2020:** Approval received for 2020-23 period (APF-02/20; APF-03/20, APF-04/20);
- **Oct 2020:** Limited activities in person @IST allowed with restrictions  
Organization of the 1st TC for **Radiation Technicians** (Internal staff of IST: Op C+D: XR, RSS plus UnRS )
- **Nov 2020:** Organization of a tailor made TC in RP for the inspection body (IGAMAOT) in person;
- **Feb 2021:** Restricted access @IST ⇒ 1<sup>st</sup> TC for external **Radiation Technicians** given *online*;
- **Sep 2021:** Limited activities @IST ⇒ 1<sup>st</sup> TC for **Radiation Protection Officers** combined *online* and *in person*;
- **Mar 2023:** renovation of the approval requested to APA. License valid for 3y;
- **Jun 2023:** 1st TC refresh for Radiation Workers internal staff of IST.

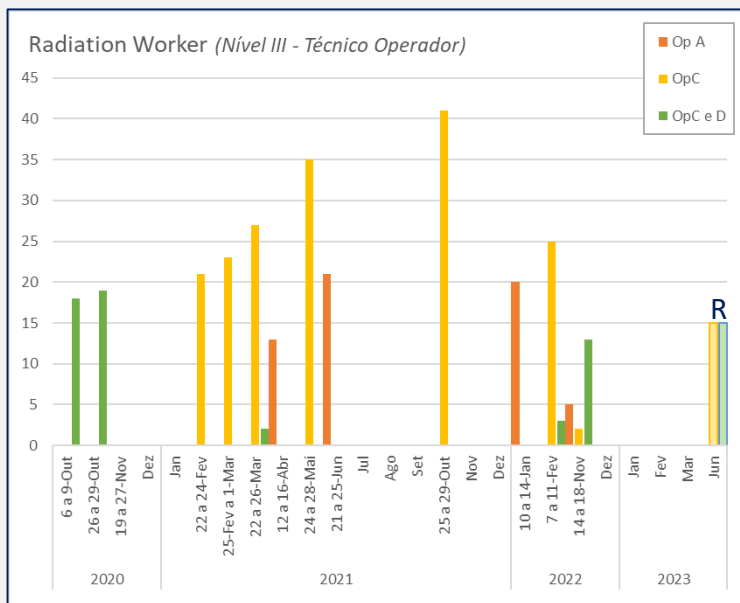
### Training Courses for Radiation Technician

19h, 3d (online), 9 eds +R

Total: 320 of which 59 OpA Med (XR, RSS)

189 OpC Ind, E&T, Res (XR, RSS)

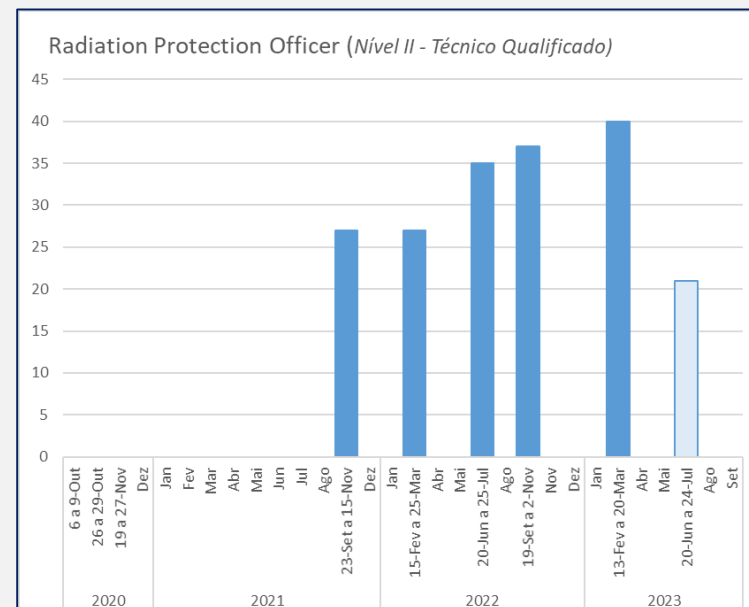
70 OpC+D Ind, E&T, Res (UnSRS)



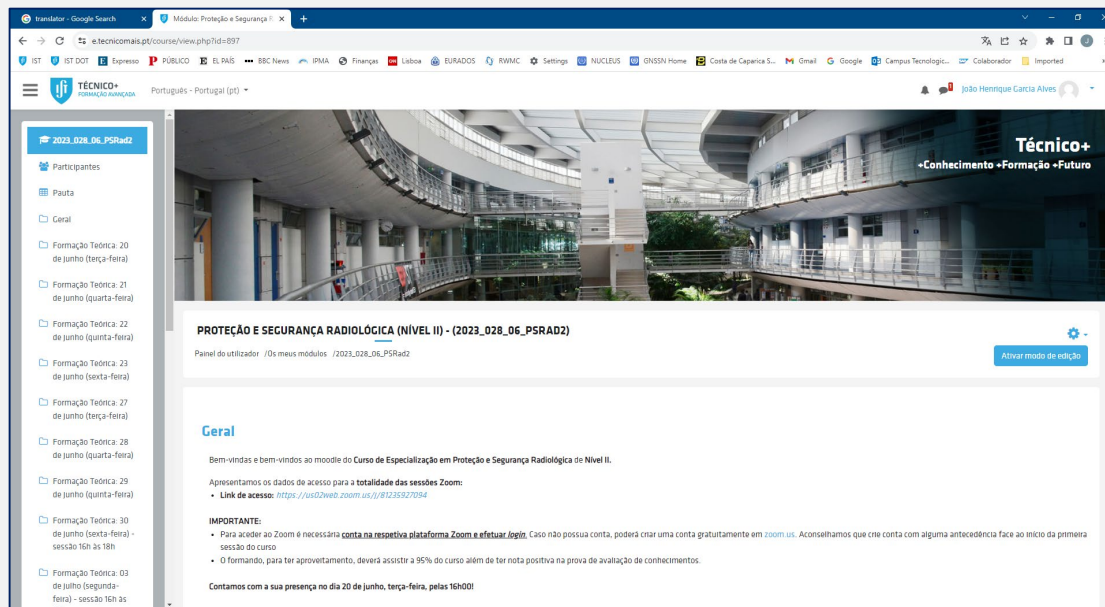
### Training Courses for Radiation Protection Officers

100h, 5w (50h online, 50h in person), 6+1 eds

Total: 166 (+21 ongoing) Med, Ind, E&T, Res



- Moodle platform



- Zoom platform
- Lectures imparted *online*
- Valued by attendants not from Lisboa

- Dissemination of information (forum)
- Time-tables, Lectures, References;
- Evaluation of the trainees;
- Evaluation of the TC by the trainees.

**Dose equivalente**

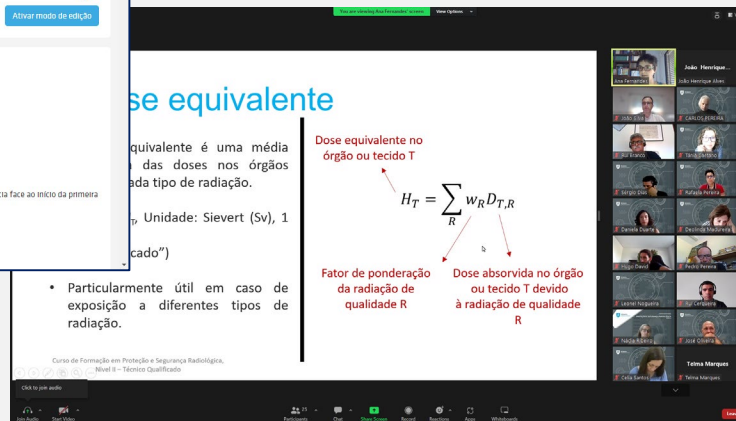
Dose equivalente é uma média das doses nos órgãos para cada tipo de radiação.

Unidade: Sievert (Sv), 1 (radiação)

$$H_T = \sum_R w_R D_{T,R}$$

Fator de ponderação da radiação de qualidade R

Dose absorvida no órgão ou tecido T devido à radiação de qualidade R



## Radiation Technician

*Nível III - Técnico Operador, (APF-04/20)*

Regulations and Standards	A	2
Organization of RP at the facility	B	2
General technical concepts	C	8

+ 1 module:

Option A - Radiodiagnostics	Op A	6
Option B - Used of unsealed radioactive sources	Op B	6
Option C - IR generation devices: X-Rays and RSS	Op C	6
Option D - Used of unsealed radioactive sources	Op D	6

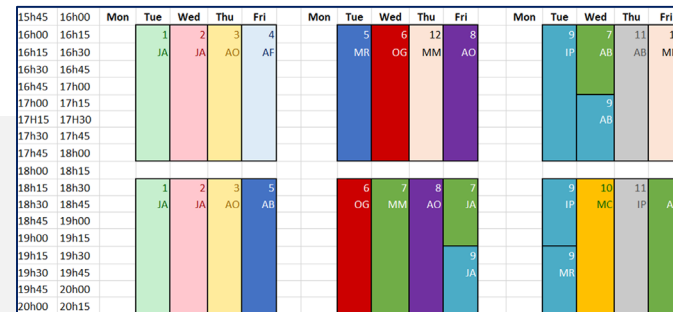
- High school diploma
- Total of lectures 19h:  
 12h common to all  
 6h Option  
 1h evaluation test
- Zoom: online lectures
- Moodle platform: disseminate training material, evaluation test
- 9 editions organized
- 1 refresh (@IST, for internal staff)

Op A, Op B – Medical applications

Op C, Op D – Industry, E&T, Research applications

## Radiation Protection Officer

- 3 weeks, **online** lectures using Zoom (16h00 - 20h15)



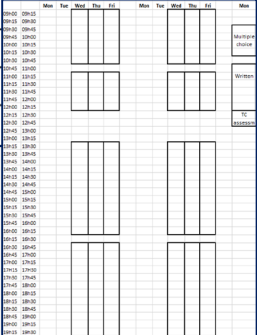
Online classes (using Zoom)		Horas	
1	Atomic physics and radioactivity	J. Alves	4
2	Interaction of radiation with matter	J. Alves	4
3	Sources of radiation: sealed and unsealed sources, X-rays and Linacs	A. Oliveira	4
4	Quantities and units	A. Fernandes	2
5	Fundamentals of radiation detection	A. Baptista, M. Reis	4
6	Fundamentals of radiobiology	O.M. Gil	4
7	Radiation Protection: general principles	M. Meruje, J. Alves, A. Baptista, A. Oliveira	6
8	Radiation Protection of patients	A. Oliveira	4
9	Radiation Protection of workers	J. Alves, I. Paiva, A. Baptista, M. Reis	6
10	Quality control and quality management	M. Caldeira	2
11	Intervention in case of a radiological emergency	A. Baptista, I. Paiva	4
12	National organizations, national and international legislation	M. Meruje	4

1 to 6 General topics necessary to understand  
 7 a 12 specific Radiation Protection topics

## Radiation Protection Officer

- 2 weeks, in-person practical sessions (Wed to Fri, 09h00 - 19h30)

Practical sessions (attendance in person)			
1	Ionizing radiation monitoring: different sources, types of detectors	Y. Romanets, L. Torres, A. Baptista	6
2	Ionizing radiation metrology	A. Fernandes, M. Caldeira	6
3	Individual monitoring	J. Alves, J. Santos	6
4	Manipulation of unsealed radioactive sources	M.L. Gano	3
5	Environmental radioactivity	M. Reis, M. Santos, A. Gomes, E. Carvalho	6
6	Applying for a license for a practice and/or facility	M. Meruje	6
7	Manipulation of sealed sources and Intervention in case of an accident	A. Baptista, Y. Romanets, L. Torres	6
8	Image quality; Radiation shielding	A. Oliveira	
9	Radioactive waste management	I. Paiva	
10	Biological dosimetry	O.M. Gil	
	Evaluation test - test	J. Alves	



Organized into groups of 3 each; guided, questions; report at the end of each session.

Tutorial training on routine activities: e.g. choice and use of a monitoring device, reading a calibration and/or a verification certificate, applying for a license (or license renovation) process, ...

# Radiation Protection Officer

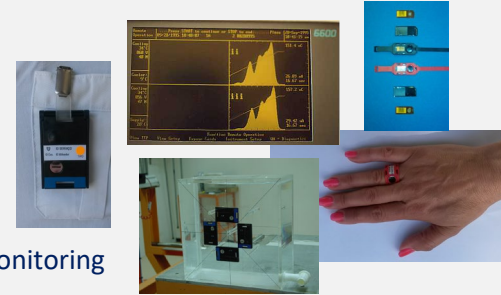
## Individual monitoring

Trainers: X, Y, Z

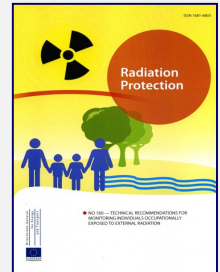
At: Individual Monitoring Service at IST

- Dosimetry system (readers, irradiators, dosimeters)
- Whole-body, extremity, eye-lens, area dosimeters
- TLD: LiF:Mg,Ti (TLD-100) and LiF:Mg,Cu,P (TLD-100H)
- Main properties (TL curve, TTP, reuse, linearity, energy angle dependences, ...)
- Calibration (phantoms)
- Quality control, uncertainty assessment
- Intercomparison results, trumpet curves
- Documents of relevance (legislation, EC recommendations)

- Individual and workplace monitoring
- Classification of workers and monitoring periods
- Routine (allocation of dosimeters, issuing, receiving, integrity...)
- Dose assessment
- Dose reporting (reading a dose report, compliance with dose limits)
- Dose recording
- Special cases (high dose levels)

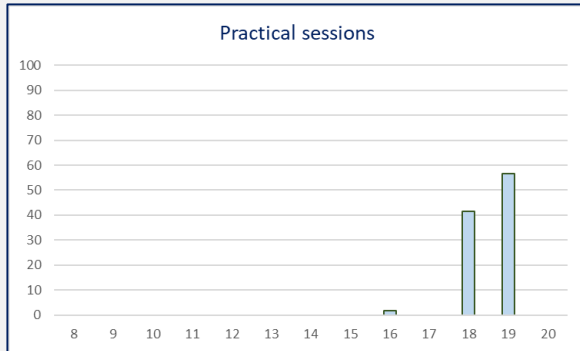
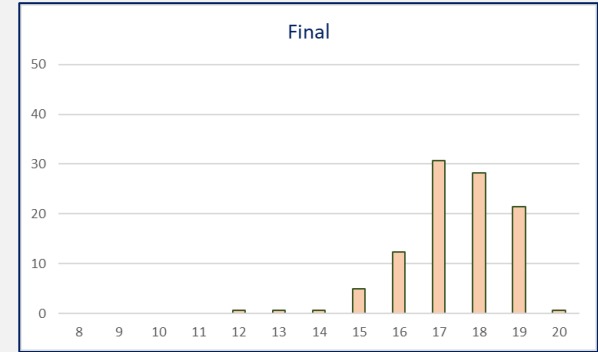
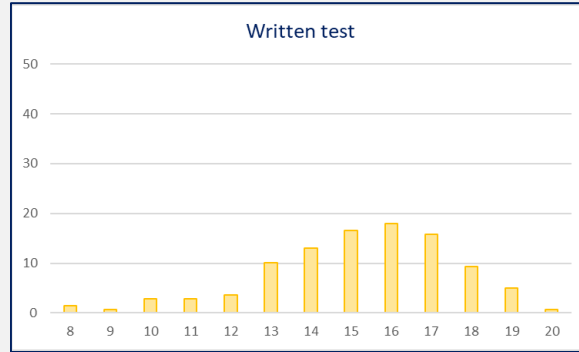
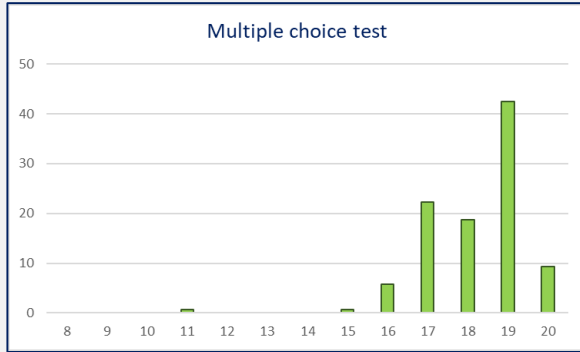


**Objectives:** Different dosimeter types (wb, ext, eye-lens, area),  
Quantities and units  
Dose assessment  
Interpretation (reading) a dose report.





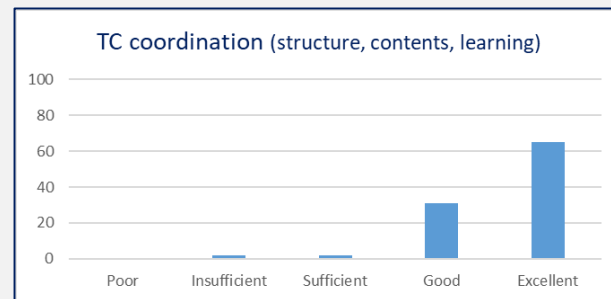
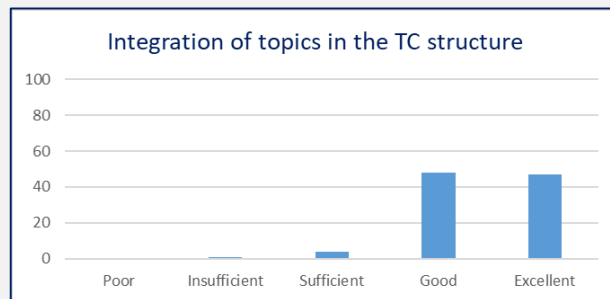
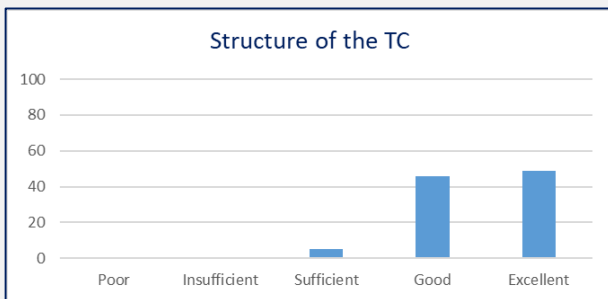
- Evaluation of RPO



- Moodle conditions: *camera on, micro off*, Two evaluation tests (marks out of 20);
- Multiple choice questions (30, 1 correct in 3, randomly shown *on the screen*);
- Written test: questions dealt with in practical sessions (*replies uploaded*);
- Information from practical sessions: guided lessons with questions;
- Final mark: 70% test + 30% practical

Total: 166  
Response rate >87%

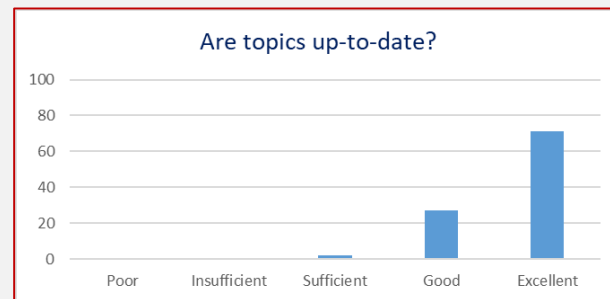
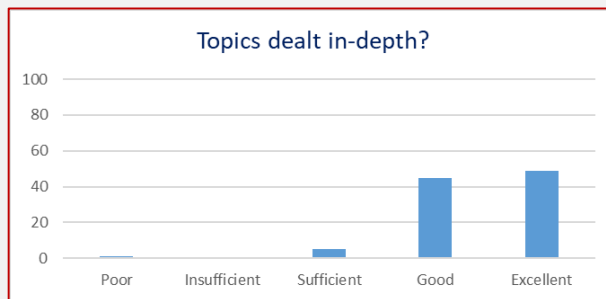
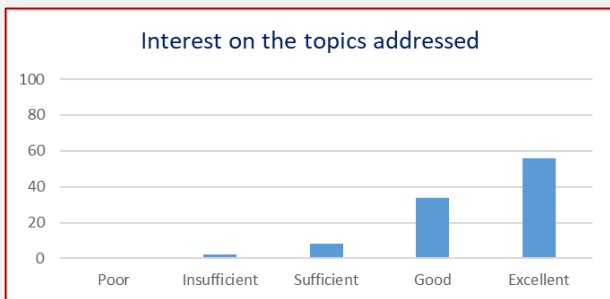
- Appraisal of the TC by the attendants (RPO)



- Taking into account the TC is compulsory for RPO;
- Very positive feedback;
- Good + Excellent  $\approx$  95%,

- Appraisal of the TC by the attendants (RPO)

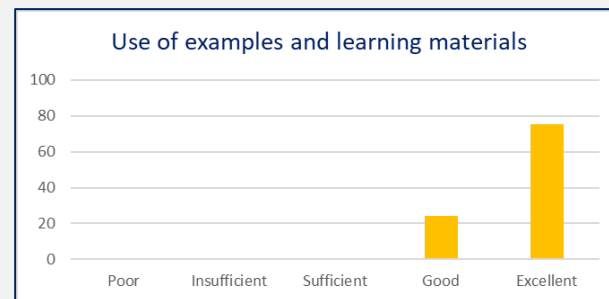
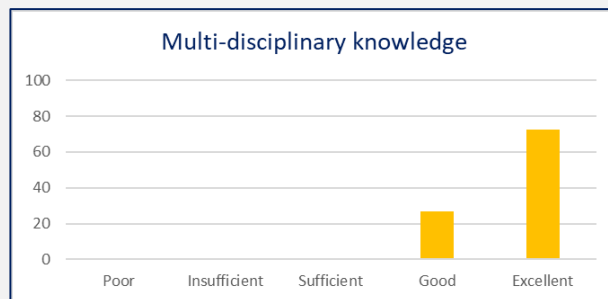
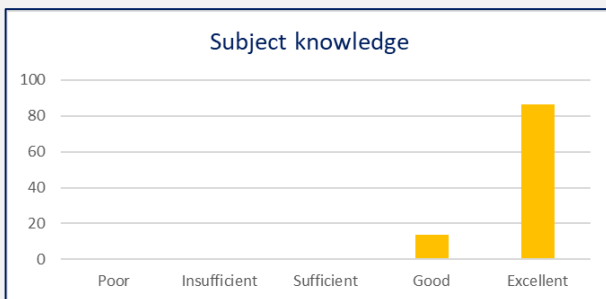
Total: 166  
Response rate >87%



- Taking into account the TC is compulsory for RPO;
- Very positive feedback;
- Interest on topics: 90%;
- Topics dealt in-depth: 94%
- Up-to-date of topics: 98%

- Appraisal of the Trainers by the attendants (RPO)

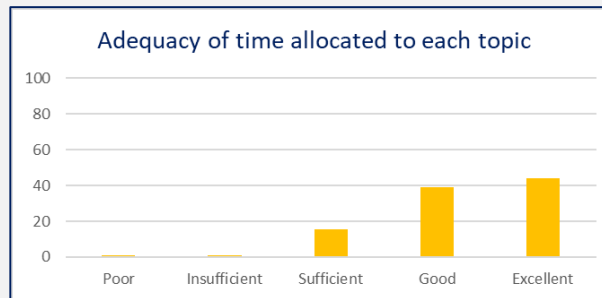
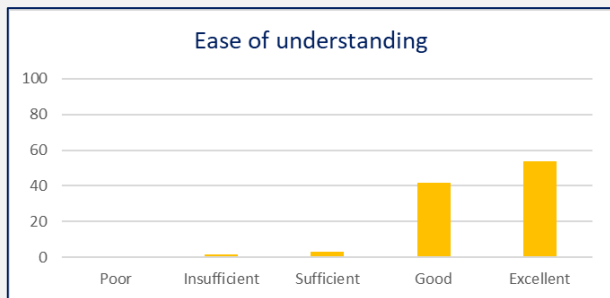
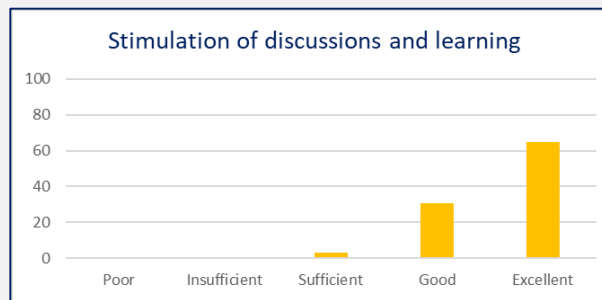
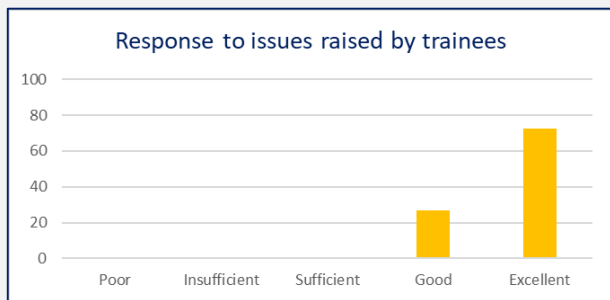
Total: 166  
Response rate >80%



- Very positive feedback;
- Attendants in need of training

- Appraisal of the Trainers by the attendants (RPO)

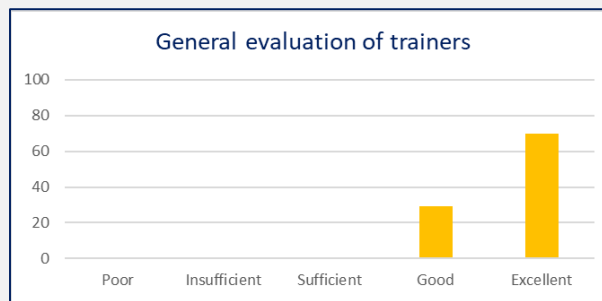
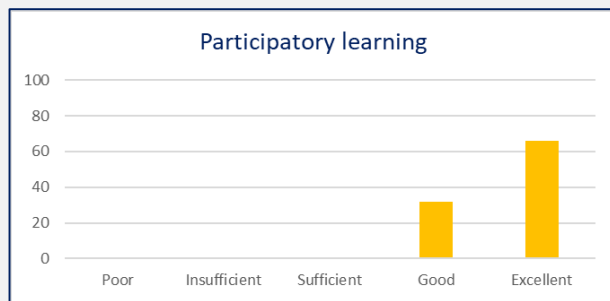
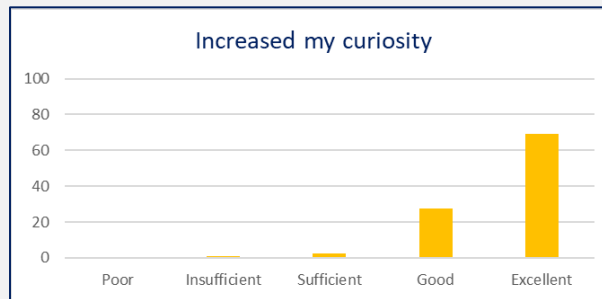
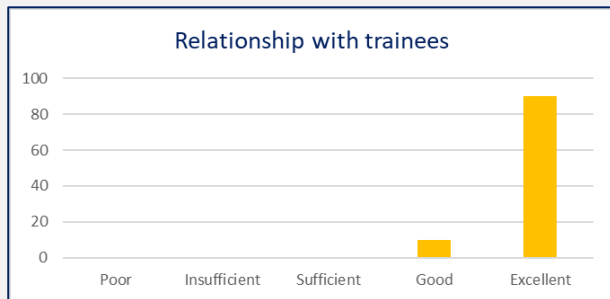
Total: 166  
 Response rate >80%



- Poor, insuff, suff:  
 Some topics need more  
 time and dedication

- Appraisal of the Trainers by the attendants (RPO)

Total: 166  
Response rate >80%



- SWOT analysis of the E&T actions in RP organized so far

### Strengths:

- TC in RP approved by APA (regulator)
- Expertise in RP matters
- Laboratories used for routine RP work available

### Opportunities:

- Demand of approved TC in RP
- TC delivered online for the 1<sup>st</sup> time
- Networking (EURADOS, EURAMET, NATO, IAEA)

### Weaknesses:

- Labs not intended for classes, few students at a time
- Ageing of equipment and laboratories
- No laboratories with medical devices

### Threats:

- Mishandling of equip also used for routine work
- Competition with other organizations
- Regulatory changes (uncertainties)

- Conclusion

- IST's programme of TC in RP were approved by the regulator (2020-23);
- Lockdowns due to SARS-2 Covid19 pandemic made *online* teaching and learning a challenge:
  - Accepted by the authorities;
  - Well accepted by RT (*online* TC), particularly welcomed if not from Lisboa;
  - Well accepted by RPO (balance of *online* and *in person* TC), particularly welcomed if not from Lisboa;
- Successfully organized 9+1R TC for RT and 5+1 for RPO;
- General feedback from attendants to both types of TC is very positive;
- Increased awareness by RPO to-be that there is need of E&T in Radiation Protection;
- Further approval by the regulator (2023-26), the Training scheme (*online* and *in person*) will continue.



Restrictions (masks, n. seats)



1<sup>st</sup> TC for RPO, Sep-Nov 2021



Last TC for RPO, Feb-Mar 2023



Thank you for your attention !!



**TÉCNICO** LISBOA