

Workshop on AI-based in-vivo dosimetry with EPID

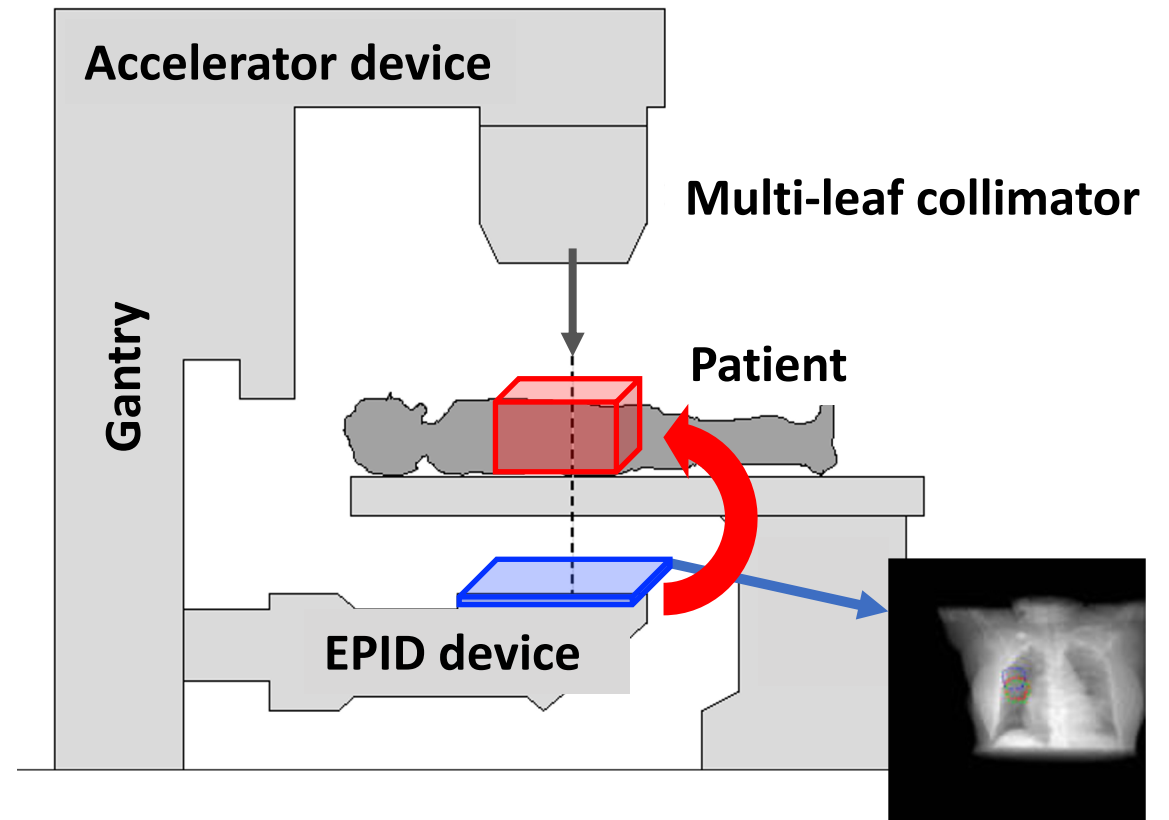
Organizers: Aafke Christine Kraan and Cinzia Talamonti

INFN, Pisa, Italy
University and INFN Firenze
Careggi University Hospital

AI-based in-vivo dosimetry

- In-vivo dose verification needed to comply with current regulations regarding patient safety
- **Electronic Portal Imaging Devices** can be used to obtain dosimetric information

- Article 160 comma e Decreto Legislativo 101/2020
- Article 63 of the EU directive 2013/59/EURATOM



AI-based in-vivo dosimetry

Much research... conventional methods

- Van Elmpt et al, A literature review of electronic portal imaging for radiotherapy dosimetry. *Radiother Oncol* 2008;88:289–309.
- Mijnheer, B., et al, In vivo dosimetry in external beam radiotherapy. *Med. Phys.*, 40: 070903.
- Olaciregui-Ruiz I, et al. In vivo dosimetry in external beam photon radiotherapy: Requirements and future directions for research, development, and clinical practice. *Phys Imaging Radiat Oncol* 2020;15:108–16.
- Berry SL, et al. Initial clinical experience performing patient treatment verification with an electronic portal imaging device transit dosimeter. *Int J Radiat Oncol Biol Phys.* 2014 Jan 1;88(1):204-9.
- Chytyk-Praznik K, et al. Model-based prediction of portal dose images during patient treatment. *Med Phys.* 2013 ;40(3):031713.
- Wendling et al. A simple backprojection algorithm for 3D in vivo EPID dosimetry of IMRT treatments. *Med Phys* 36, 3310-3321 (2009)
- Esposito, M.; et al Method for EPID In Vivo Dosimetry Algorithms. *Appl. Sci.* 2021, 11, 10715
- Wendling et al. Accurate two-dimensional IMRT verification using a back-projection EPID dosimetry method. *Med Phys* 33, 259- 273 (2006)
- Olaciregui-Ruiz et al. Virtual patient 3D dose reconstruction using in air EPID measurements and a back-projection algorithm for IMRT and VMAT treatments. *Phys Med* 37, 49-57 (2017)
- Chang J, Mageras GS, Ling CC, Lutz W. An iterative EPID calibration procedure for dosimetric verification that considers the EPID scattering factor. *Med Phys* 2001;28:2247–57.
- Talamonti C, et al., Pretreatment verification of IMRT absolute dose distributions using a commercial a-Si EPID. *Med Phys* 2006;33:4367–78.
- Warkentin B, et al. Dosimetric IMRT verification with a flat-panel EPID. *Med Phys* 2003;30:3143–55.
- ...

More recently by using AI

- Zhang J, et al. A feasibility study for in vivo treatment verification of IMRT using Monte Carlo dose calculation and deep learning-based modelling of EPID detector response. *Radiat Oncol* 2022;17:1–12.
- Chan Maria F., et al Integration of AI and Machine Learning in Radiotherapy QA , *Frontiers in Artificial Intelligence*, 3, 2020
- Avanzo, M.; et al. Artificial Intelligence and the Medical Physicist: Welcome to the Machine. *Appl. Sci.* 2021, 11, 1691.
- Kalantzis G, Vasquez-Quino LA, Zalman T, Pratz G, Lei Y. Toward IMRT 2D dose modeling using artificial neural networks: A feasibility study. *Med Phys* 2011;38:5807–17.
- Li Y, Xiao F, Liu B, Qi M, Lu X, Cai J, et al. Deep learning-based 3D in vivo dose reconstruction with an electronic portal imaging device for magnetic resonance-linear accelerators: a proof of concept study. *Phys Med Biol* 2021;66.
- Bosco LD, et al. A convolutional neural network model for EPID-based non-transit dosimetry. *J Appl Clin Med Phys.* 2023, 24(6):e13923. 18
- Xiao F, et al, TransDose: a transformer-based Unet model for fast and accurate dose calculation for MR-LINACs. *Phys Med Biol.* 2022;67(12).
- Martins J. et al. Towards real-time EPID-based 3D in vivo dosimetry for IMRT with Deep Neural Networks: A feasibility study, *Phys Med.* 2023 Oct;114:103148.

TODAY

TODAY

AI-based in- vivo dosimetry

Recently two projects financed!

- Proof of principle to perform 3D patient dose reconstruction with AI
 - Create and implement basics of model

INTREPID

- Budget 225k
- 2 years (mostly for personnel)
- **InTrEPID: In vivo 3D dosimetry in radiotherapy Treatments with EPID**
- CUP B53D23004090006 - codice progetto 2022CWXR8K, finanziato 1 all'interno del Bando PRIN 2022 del MUR (D.D. n. 104 del 02/02/2022) nell'ambito del Piano Nazionale di Ripresa e Resilienza, Missione 4, Componente 2, Investimento 1.1 "Progetti di Ricerca di Rilevante Interesse Nazionale (PRIN)", finanziato dall'Unione europea – NextGenerationEU,

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Hospital,
Florence,
Italy

AI-based in- vivo dosimetry

Recently two projects financed!

- Focus on heterogeneous geometries (challenging!)
 - Design and create 3D printed phantoms
 - Real patients
- Create alert system

ARTEMIS

- Budget 45k
- 3 years (mostly for hardware)
- **ARTEMIS: Artificial Intelligence in RadioTherapy with EPID Monitoring System**
- Commissione 5 Istituto Nazionale di Fisica Nucleare (inter-disciplinary research)

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Program today

Public Europe/Rome A. Kraan

Workshop on AI-based in-vivo dosimetry with EPID

Friday 7 Jun 2024, 09:00 → 19:00 Europe/Rome
131 (INFN)

Registration Participants Register

Participants

- Aafke Kraan
- Alessandra Retico
- Alessia Giuliano
- Camilla Scapicchio
- Cinzia Talamonti
- Francesca Lizzi
- Juliana Cristina Martins
- Lorenzo Marini
- maria bisogni
- Maria Evelina Fantacci
- Martina Moglioni
- Michele Avanzo
- Rossana Lanzillotta
- Stefania Pallotta
- Yongbao Li

Aafke Christine Kraan, Cinzia Talamonti +39 348 470 8409

09:00 → 10:00 **Tour Centro Pisano Radioterapia FLASH** 1h

10:30 → 10:40 **Welcome** 10m
Speaker: Cinzia Talamonti, Aafke Kraan

10:40 → 11:20 **Deep learning-based 3D in vivo dose reconstruction with EPID for magnetic resonance-linear accelerators** 40m
Speaker: Prof. Yongbao Li (Sun Yat-sen University Cancer Center, Guangzhou, China)

11:30 → 12:00 **In-vivo Dose Reconstruction with EPID Detectors in radiotherapy** 30m
Speaker: Carlotta Mozzi (University of Firenze, Firenze, Italy)

12:00 → 12:30 **Deep learning methods for 2D in-vivo dose reconstruction with EPID detector** 30m
Speaker: Mr Lorenzo Marini (Università di Pisa)

12:35 → 12:45 **Discussion** 10m

12:45 → 14:15 **Lunch** 1h 30m

15:00 → 16:00 **Scientific seminar INFN: Towards Real-Time EPID-Based 3D in vivo Dosimetry for IMRT with Deep Neural Networks** 1h
Speaker: Dr Juliana Martins (University of München)

16:00 → 16:30 **Discussion** 30m

<https://agenda.infn.it/event/41817/>

Goal

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To discuss several common issues/problems in AI-based in-vivo dosimetry with EPID systems

Who?

Starters



Experts

How

Informal discussions

Speakers

Yongbau Li:

Sun Yat-sen University Cancer Center
Guangzhou, China

Carlotta Mozzi:

University of Firenze, Italy

Lorenzo Marini:

University of Pisa, Italy

Juliana Martins:

University of München, Germany,
China

Lunch

- 13.00
- Ristorante il Quore
- Via del Cuore, 1

