# UPLIFT

## UPright radiotherapy: Learning, Innovation, Fellowship and Training

Dr. Lennart Volz

Deputy Head Medical Physics Group

Biophysics, GSI, Darmstadt, Germany

The UPLIFT project is funded by the European Union under Grant Agreement No. 101168955. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Commission. Neither the European Union nor the granting authority can be held responsible for them.
This work has received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI).

Project funded by
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

UK Research and Innovation

Funded by the European Union

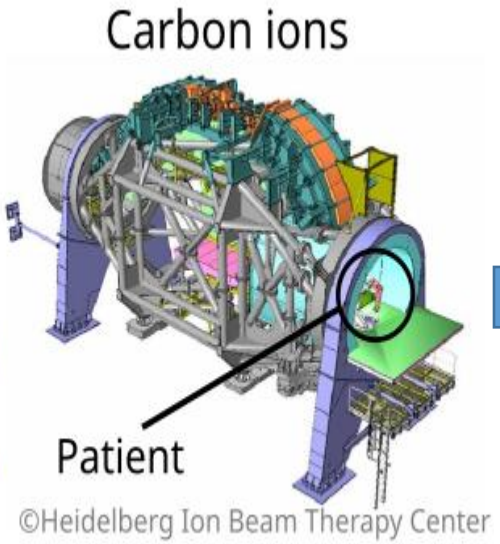
# How it all started

- Brainstorming with Tracy Underwood and Ye Zhang for upright radiotherapy opportunities in **Dec 2022**
- Call for joint proposals at the first upright consortium meeting in **May 2023**
- Shaping up the ideas at PTCOG, **June 2023**
- Submission of proposal **November 2023**
- Funding confirmation in **April 2024**

The UPLIFT proposal received a score of 98%, underlining the interest in our cause


https://www.uprightresearchconsortium.com/resources/vienna2023recordings

# The rationale for upright radiotherapy


Cost

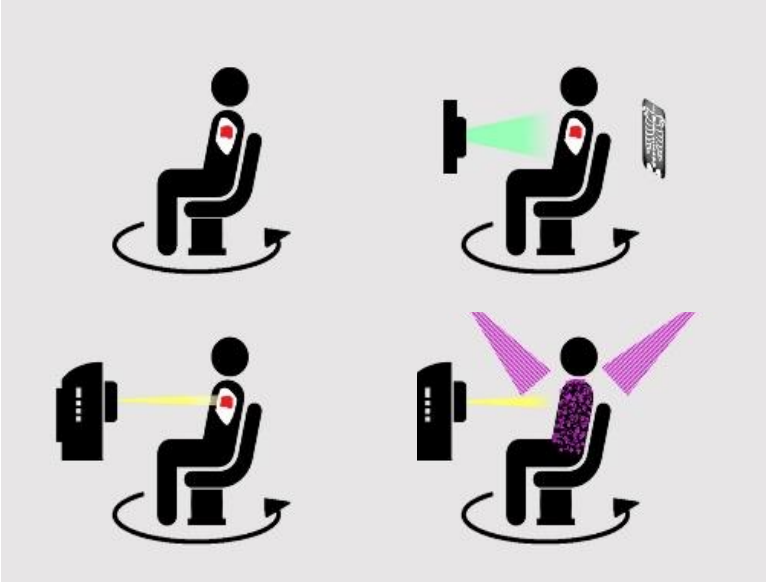
Comfort

Anatomy

Innovation

# Literature on upright patient positioning

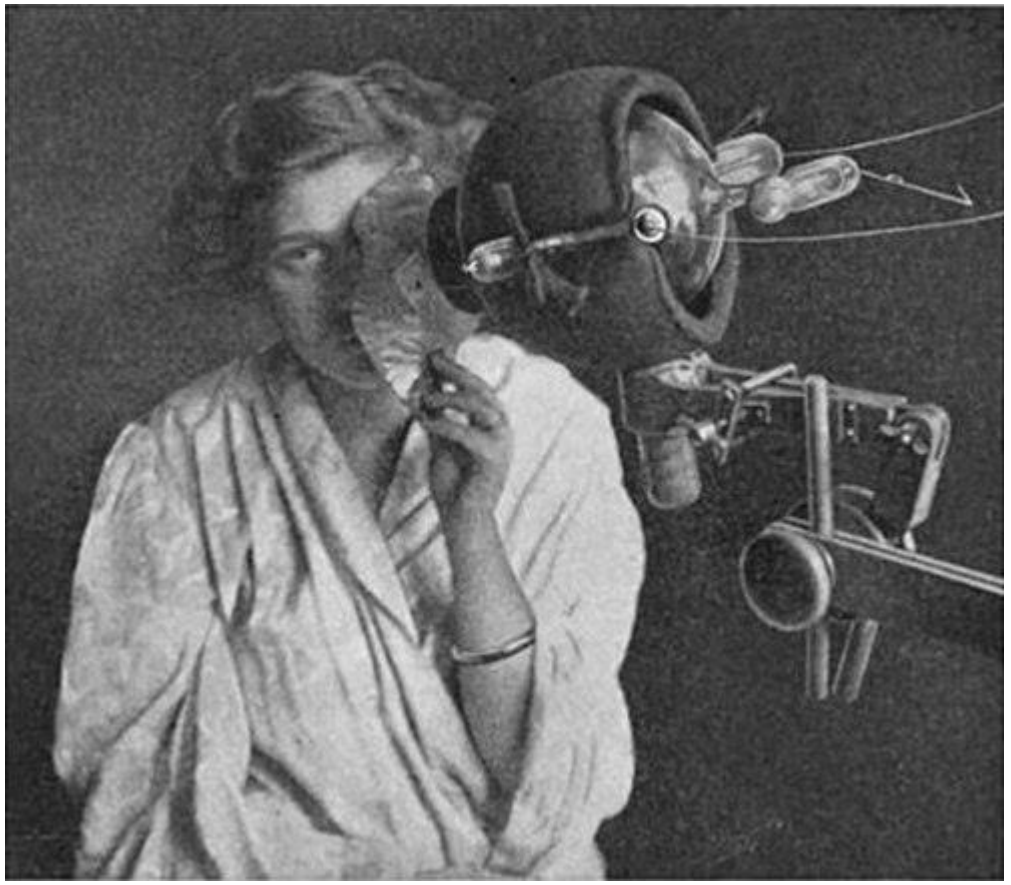
- Review of upright **photon** therapy [1]
- Review of upright **particle** therapy [2]
- Commentary on the challenges of upright therapy and some suggested solutions [3]
- In-depth review on past and present upright endeavours [4]




[1] Rahim, Sulman, et al. "Upright radiation therapy—A historical reflection and opportunities for future applications." Frontiers in Oncology 10 (2020): 213.
[2] Volz, Lennart, et al. "Considerations for upright particle therapy patient positioning and associated image guidance." Frontiers in Oncology 12 (2022): 930850.
[3] Hegarty, Sarah, et al. "Please Place Your Seat in the Full Upright Position: A Technical Framework for Landing Upright Radiation Therapy in the 21st Century." Frontiers in Oncology 12 (2022): 821887.
[4] Volz, Lennart et al. “Opportunities and challenges of upright patient positioning in radiotherapy” PMB 2024

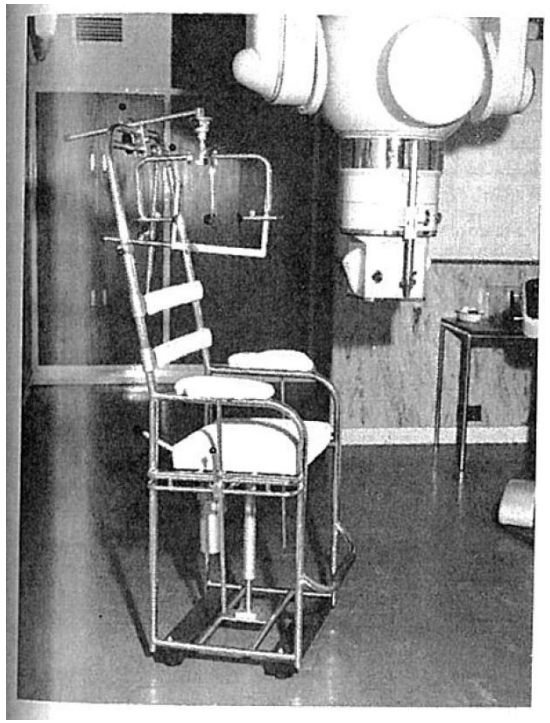
# Upright is not new


*Elements of general radio-therapy for practitioners*
Freund, 1915

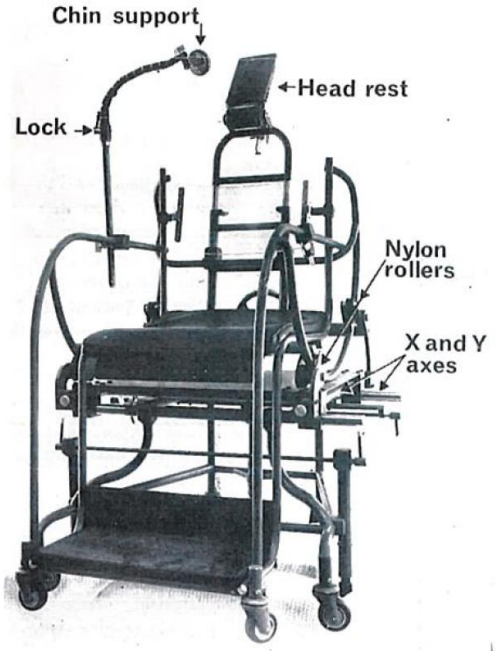


*Medical electricity Röntgen rays and radium: with a practical chapter on phototherapy*
Tousey, 1915

# Upright photon therapy chairs



Wiernik, George. BJR 34.406 (1961): 676-678.




Boag, J. W., and H. J. Hodt. BJR 44.520 (1971): 316-317.

FIG. 1.

Watson, Shuttleworth, Deeley. BJR 44.520 (1971): 317-318.

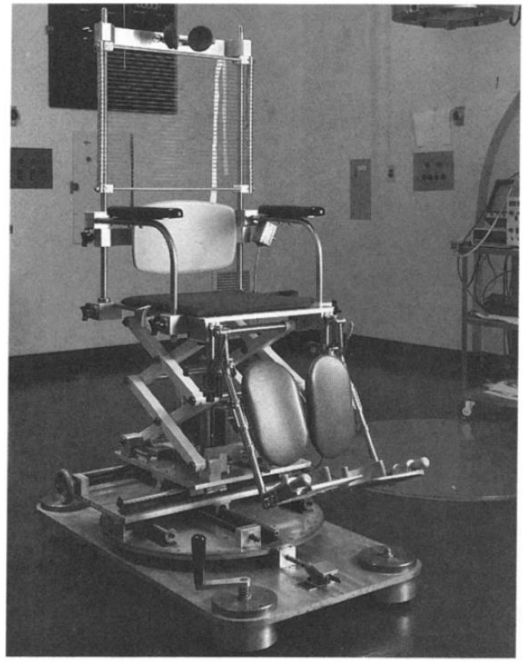


Fig. 1. The isocentric treatment chair.

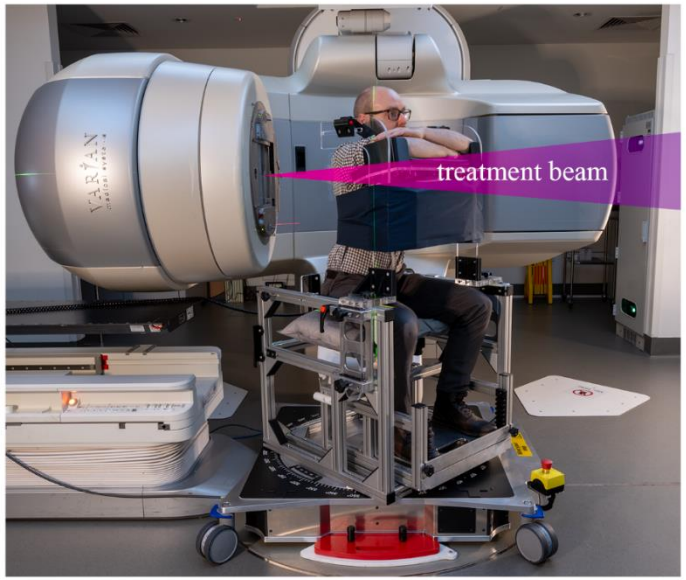
Miller, R. W., et al. IntJ Rad Onc Biol Phys 21.2 (1991): 469-473.

# Upright photon therapy chairs

MT-2000 Treatment Chair, Med-Tec Inc.

McCarroll, Rachel E., et al JACMP 18.1 (2017): 223-229.


Eve Positioning System, Leo Cancer Care
Boisbouvier et al. 2022, TiPSRO




J. Korte et al. (2025) Med. Phys. 52(2):1133-1145

# Upright particle therapy


Currently 6 particle centers with upright positioning (excluding ocular)

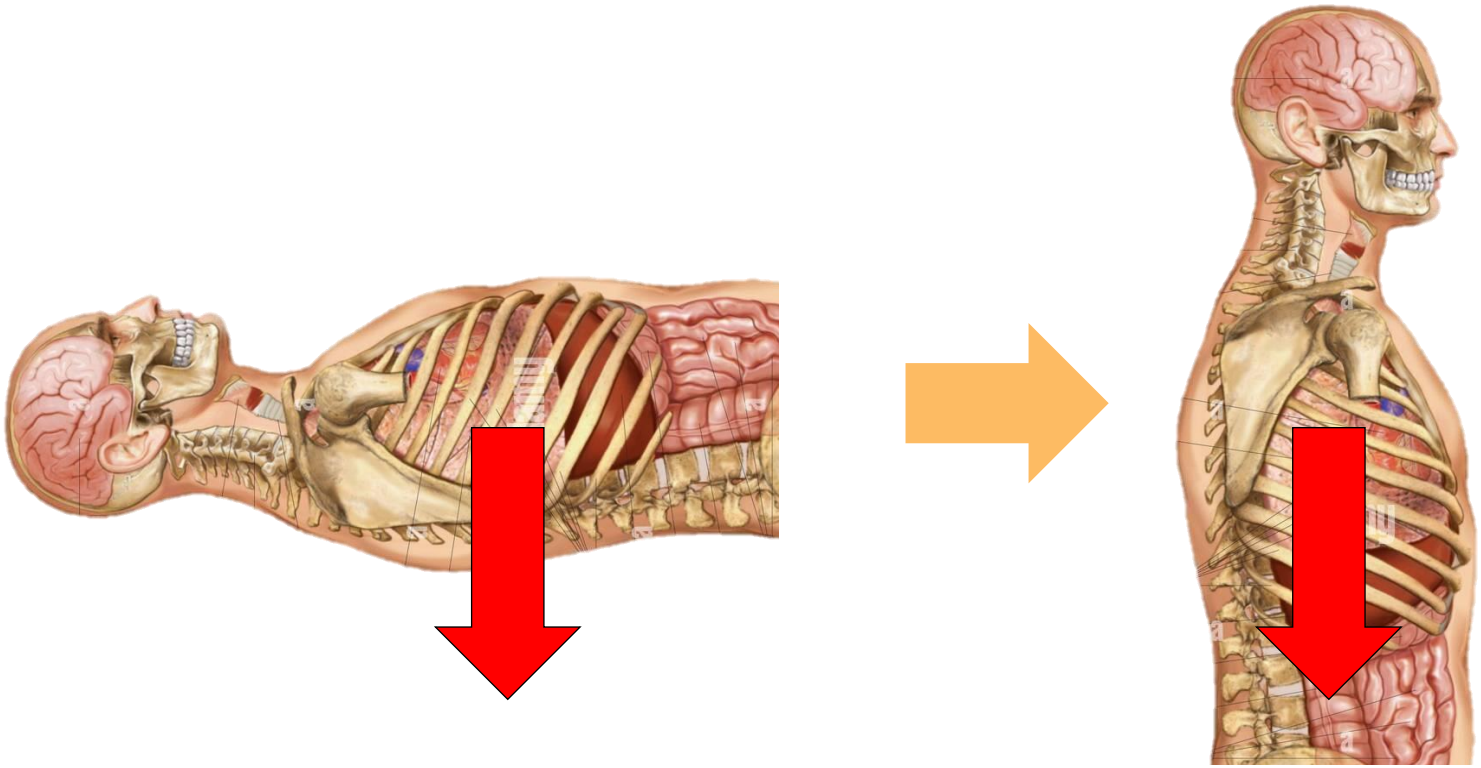
SPHIC (CHN), Orsay (FRA), Protvino (RUS), Chicago (USA), Hadassah (IS)


2010s 2020s



Graeff, Volz, Durante (2023) PPNP

# Why is it not a standard (yet)?

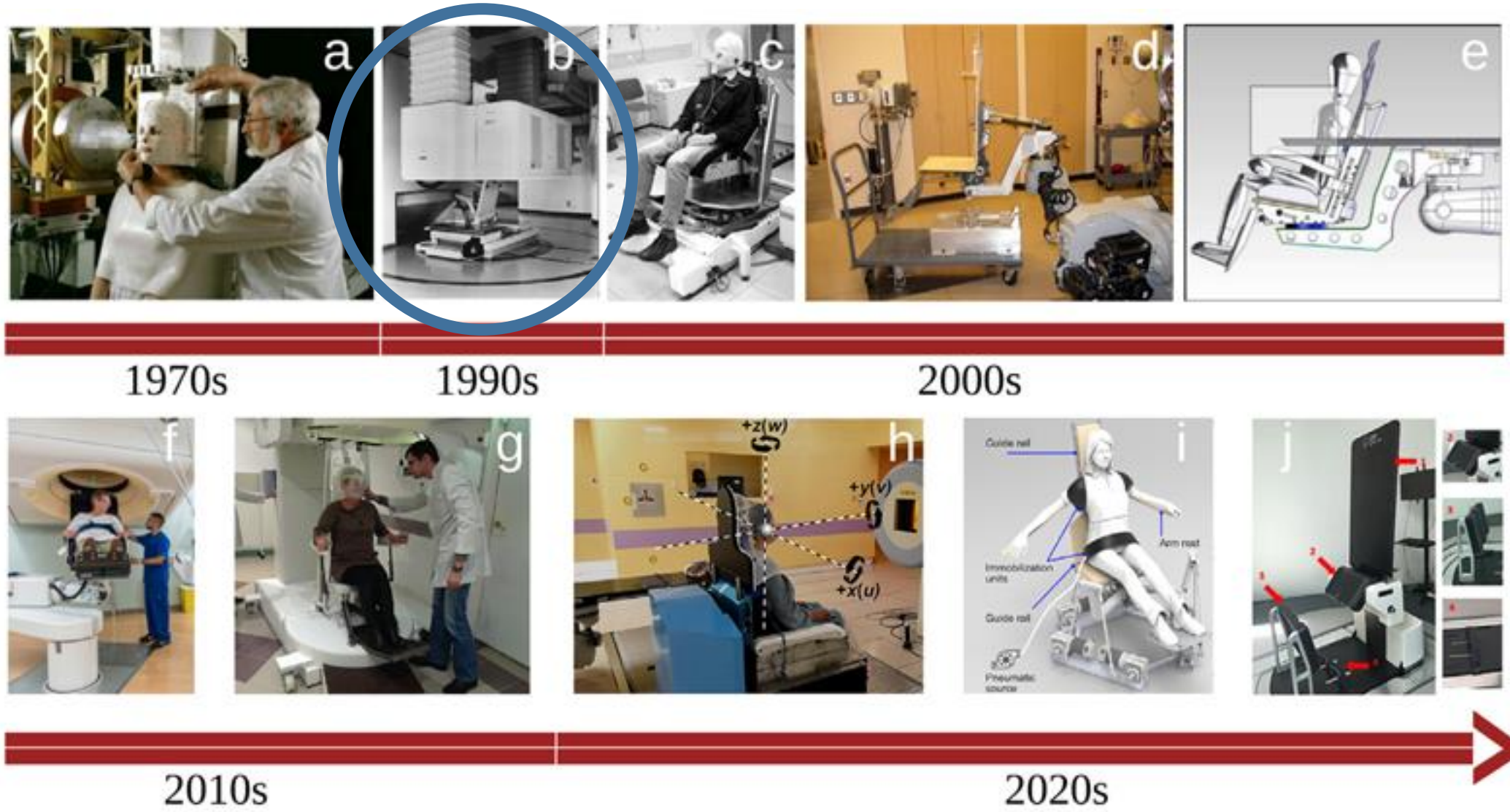


Nearly all sites affected by anatomical differences

# Advent of CT: the reason for lack of upright treatment

Godfrey Hounsfield stands beside the EMI-Scanner in 1972, Smithsonian magazine

# Upright CT


a
b
c
d
e
1970s
1990s
2000s
f
g
h
+z(w)
+y(v)
+x(u)
i
Guide rail
Arm rest
Immobilization units
Guide rail
Pneumatic source
j
2010s
2020s

# Upright is not new!

- Important to reflect on past challenges!
  - ➢Lack of upright imaging
  - ➢Lack of understanding of anatomical uncertainties
- Often specialized prototype solutions:
  - ➢Lack of standardization and commercial maintenance
- No adaptive workflows

Kamada, Tadashi, et al. Radiotherapy and oncology 50.2 (1999): 235-237.

# Modern imaging solutions

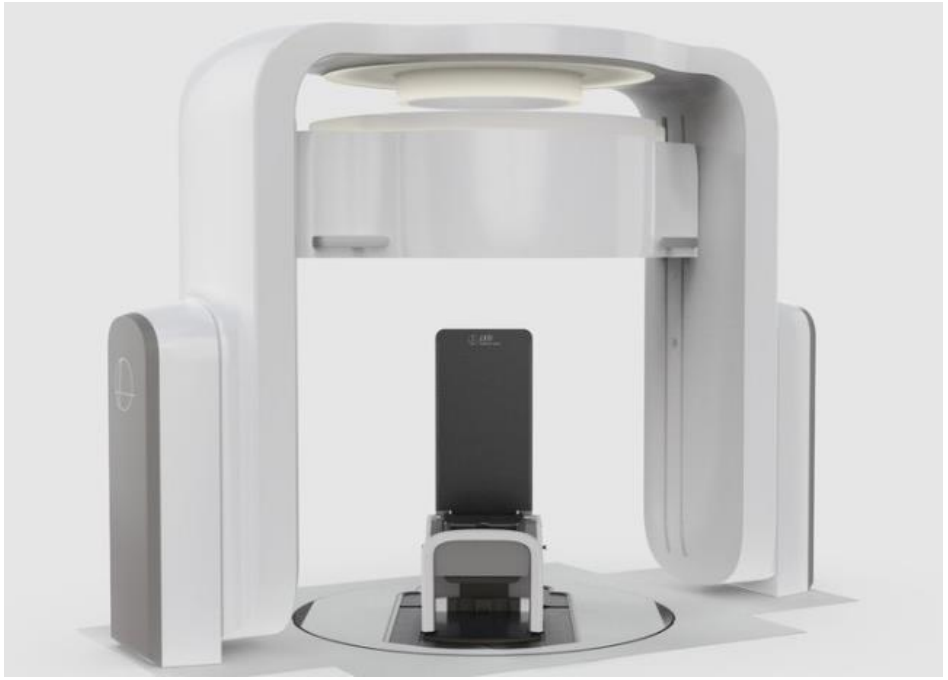

Jinsaki et al. (2020) Invest. Radiol.
Canon Medical

P-Cure

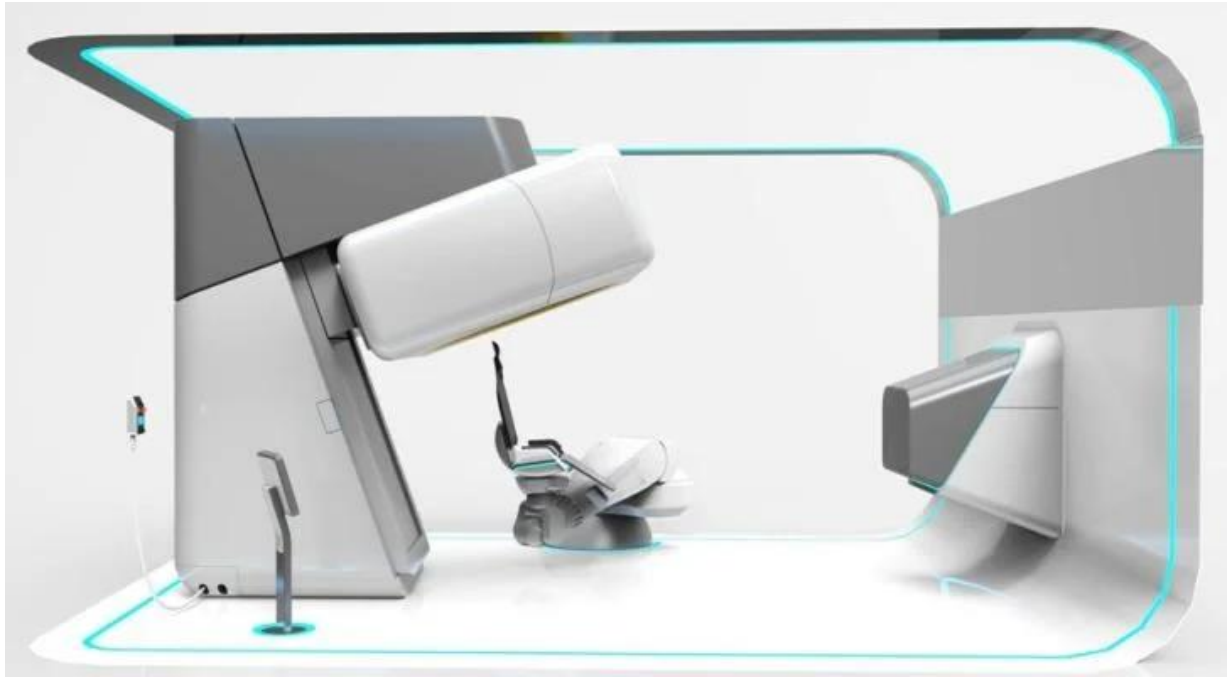
Leo Cancer Care


ASG Superconductors

# FDA approved upright radiotherapy vendors



*Marie ™ - **Leo Cancer Care** upright patient positioning system and CT scanner*



***P-Cure Ltd.**, compact 360° gantry-less adaptive proton therapy system*

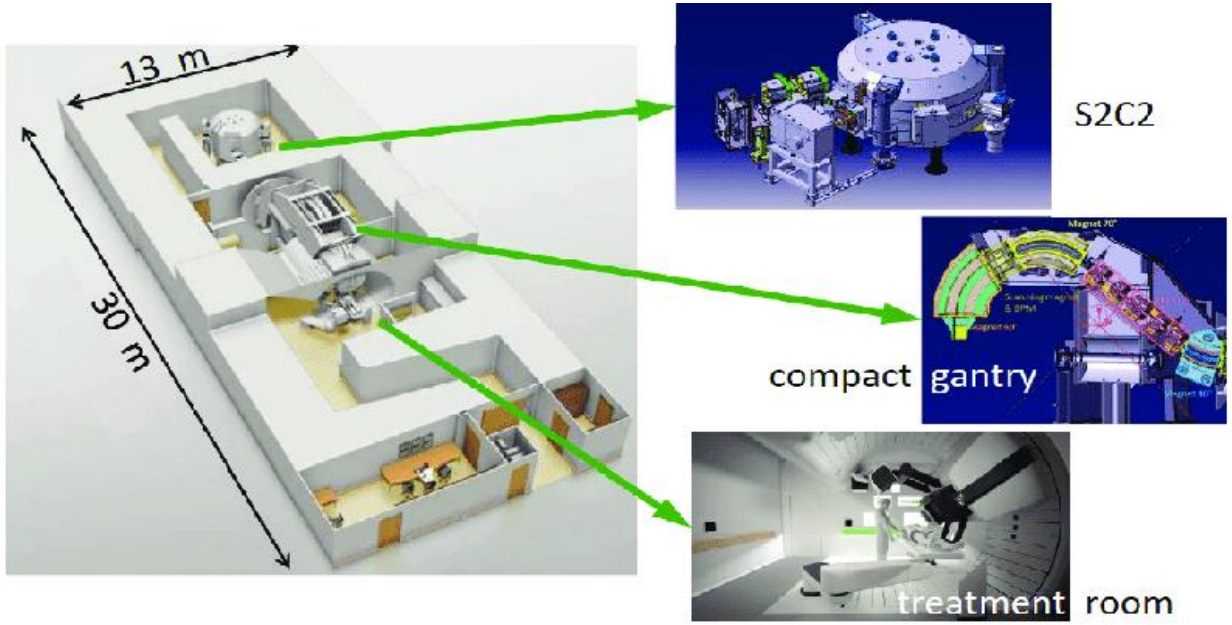
# Advantages of upright: cost

- Possibly faster patient setup
- Possibly faster treatment, e.g. due to faster beam application
- Stationary beam instead of rotating beamline
  - Beam shielding only in one direction
  - Beam commissioning in stationary coordinate system

*Boisbouvier, tipsRO 2022*

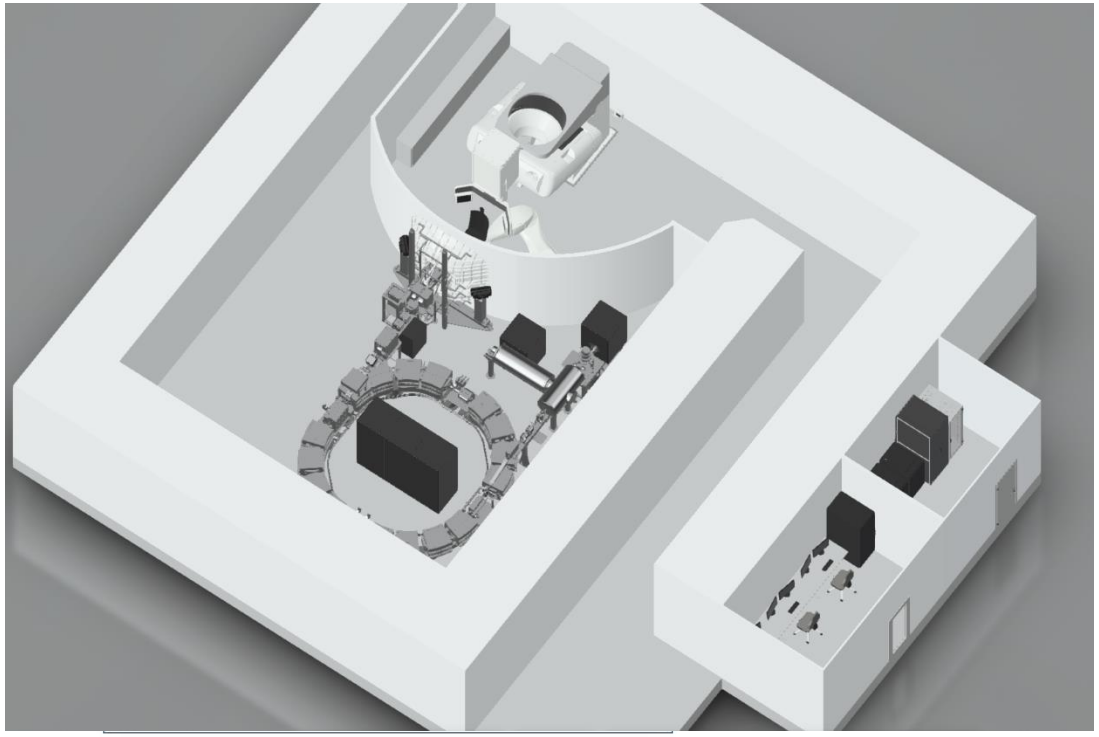
# Advantages of upright: cost

## Gantry



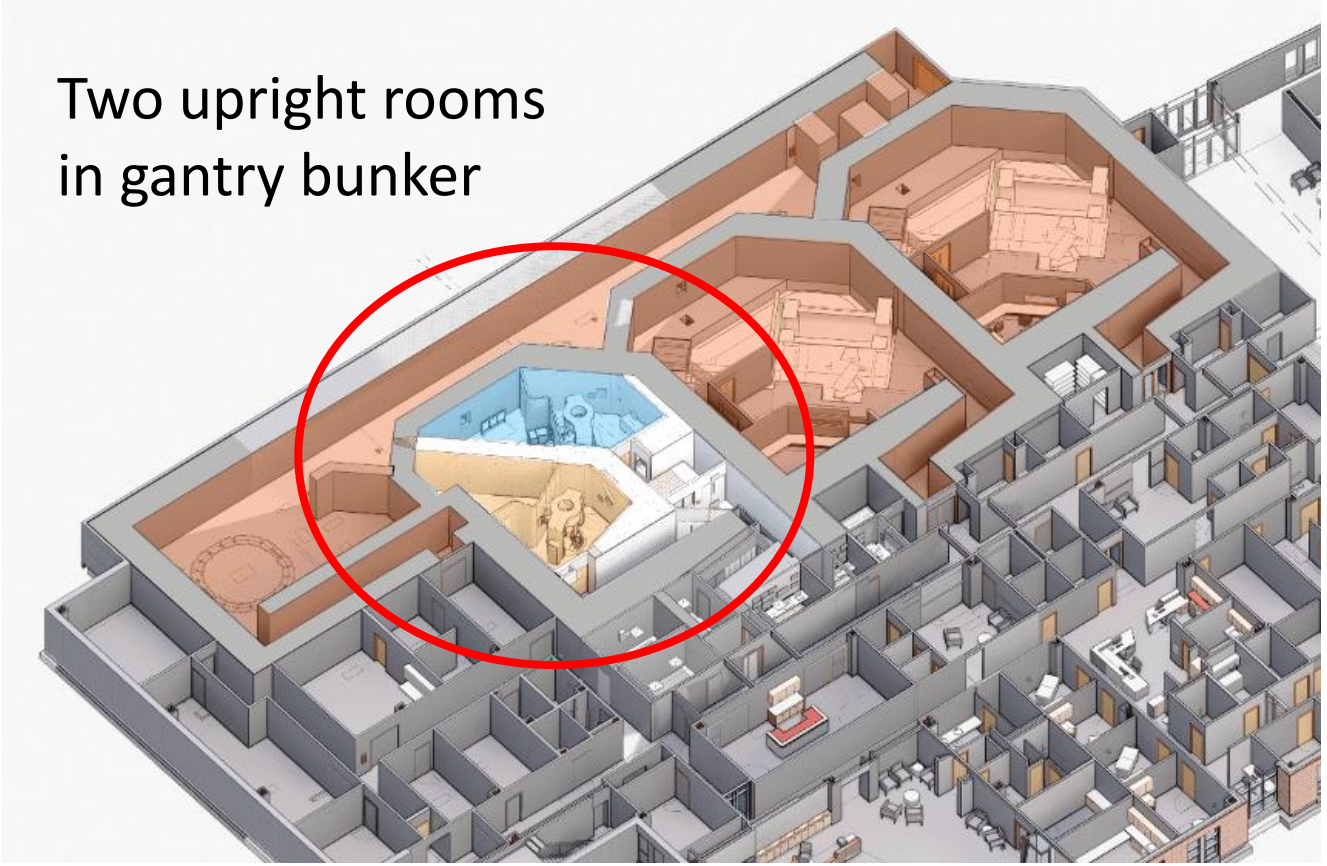

U. Amaldi (2015) Modern Physics Letters A 30(17):1540018

## Upright



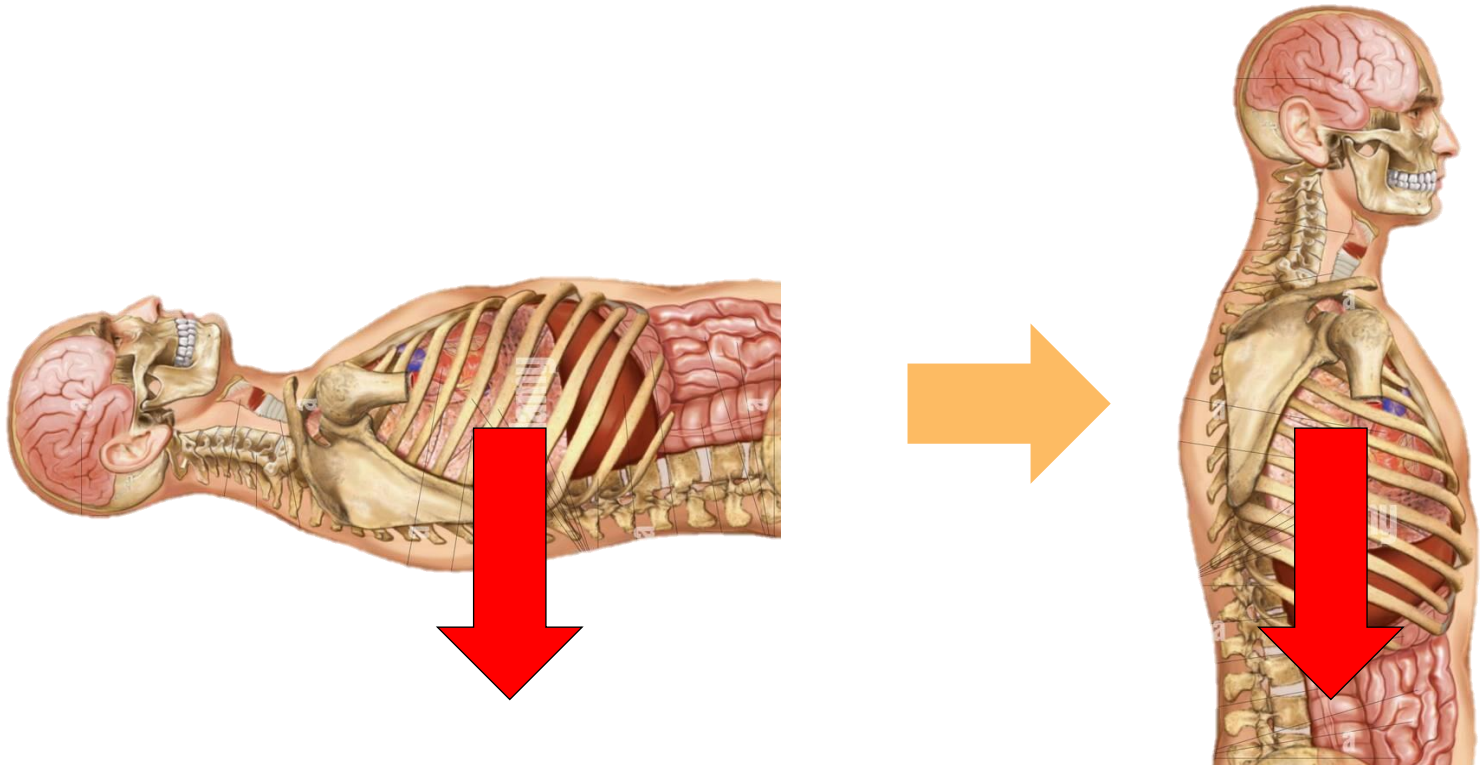
Render of the PCure upright solution
Courtesy to A. Pryanichnikov

# Advantages of upright: cost



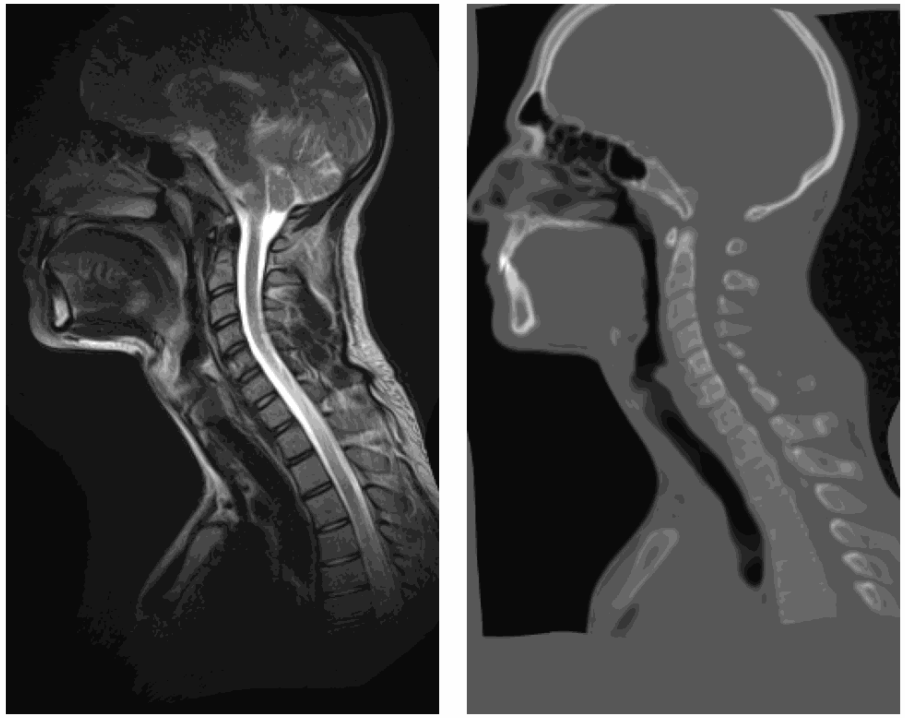

Courtesy Dr. Hesham Gayar, McLaren Cancer Center

# Advantages of upright: patient anatomy



Different ≠ bad

# Anatomical differences supine to upright



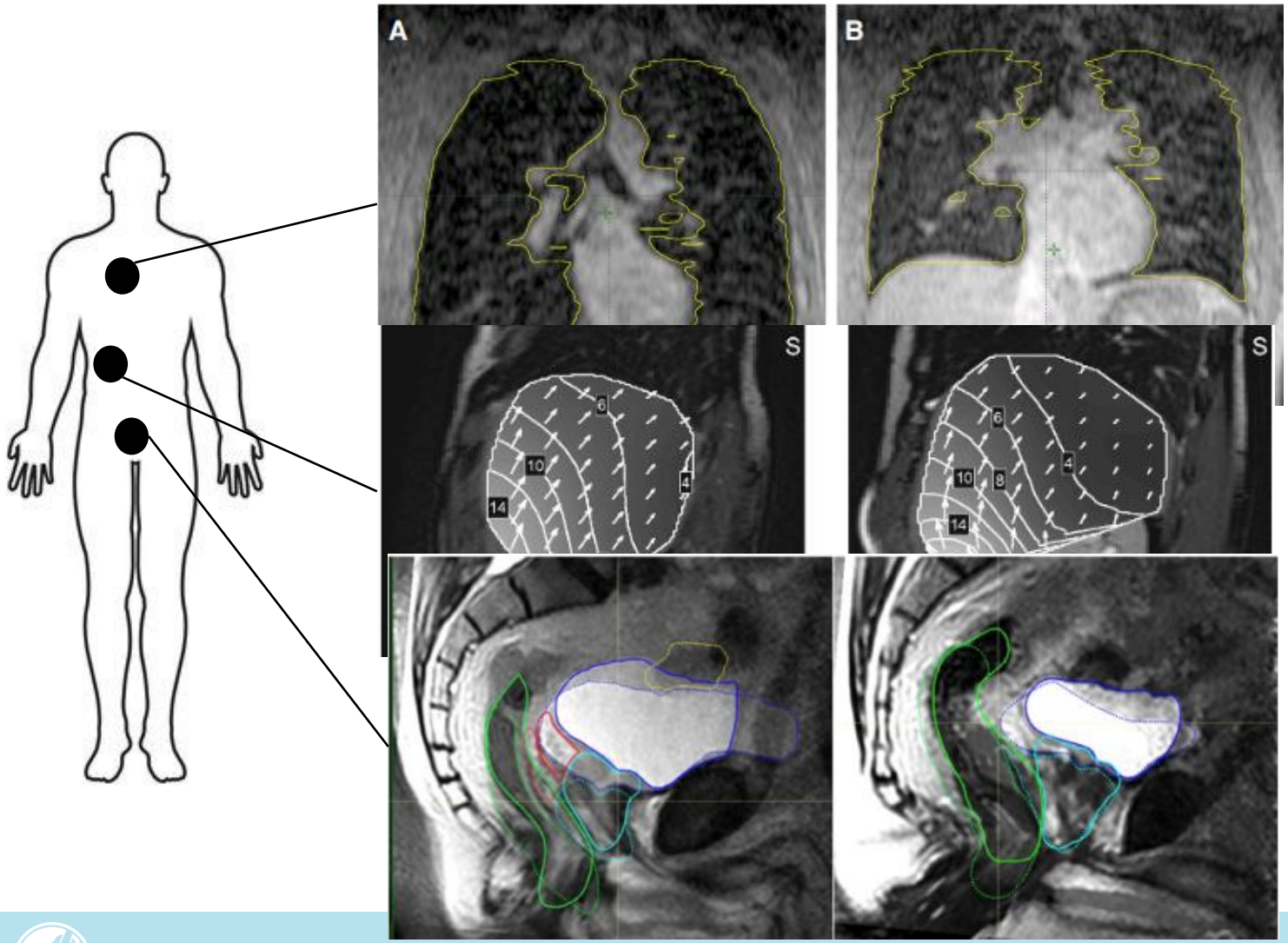
Li et al. (2024) ArXiv

Courtesy Ye Zhang (PSI

CPT-DIR (xialipku.github.io)


Data from Chicago Proton Center, from PhD thesis of Chiara Martire @GSI

# Anatomical differences: opportunity for better treatment




- Increased lung volume, inferior heart position (Yang et al. 2014 Med. Phys., Marano et al. 2024 JACMP)
- Possibly more stable liver postion (von Siebenthal et a. 2007, Med. Phys)
- Possibly more stable prostate positon (Schreuder et al. JACMP 2023)

# Advantages of upright: Patient comfort

- "…all patients (with lung cancer) experienced the sitting position as more comfortable than the supine position" [1]
- "…regarding comfort in the arms during treatment, patients (with HNC cancer) preferred the seated position over the supine position" [2]
- "(pelvic) …the scores suggested positively in favour of the upright positioning system or at least similar…patients appreciated the easiness of getting in and out of the chair, they could breathe more easily, and most patients felt more stable in the upright position." [3]
- 7 of 9 participants (breast) reported preferring the upright position [4]

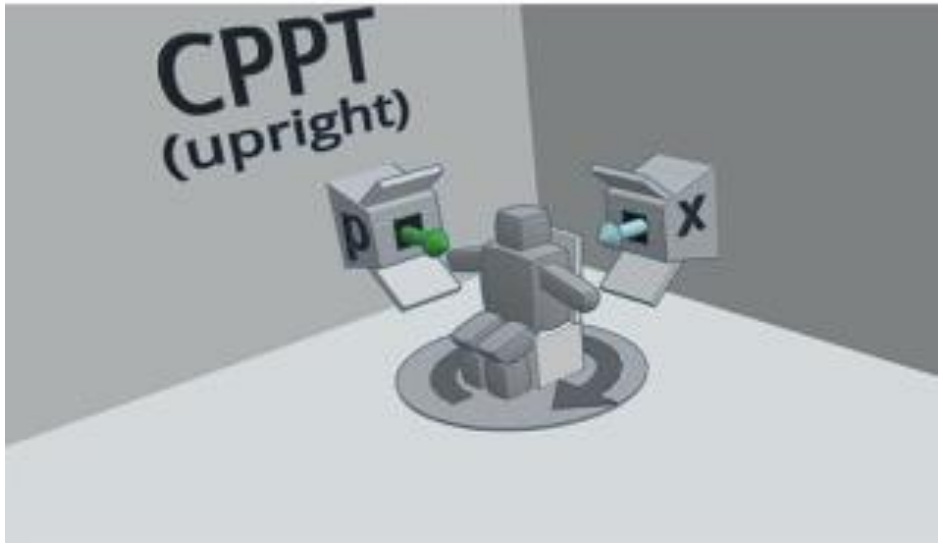
[2]


[1] Duisters, Cindy, et al. Radiotherapy and oncology 79.3 (2006): 285-287.
[2] McCarroll, Rachel E., et al. JACMP 18.1 (2017): 223-229.
[3] Boisbouvier, S., et al. Technical Innovations & Patient Support in Radiation Oncology 24 (2022): 124-130.
[4] Boisbouvier, S., et al. Frontiers in Oncology 13 (2023): 1250678.

# Advantages of upright: innovation

**Advancement through simplification**

Combined photon-particle therapy: F. Amstutz et al.




Amstutz et al. (2024) Rad. Onc. Volume 190, 109973, January 202

MR-guided proton therapy: A. Hoffmann, OncoRay

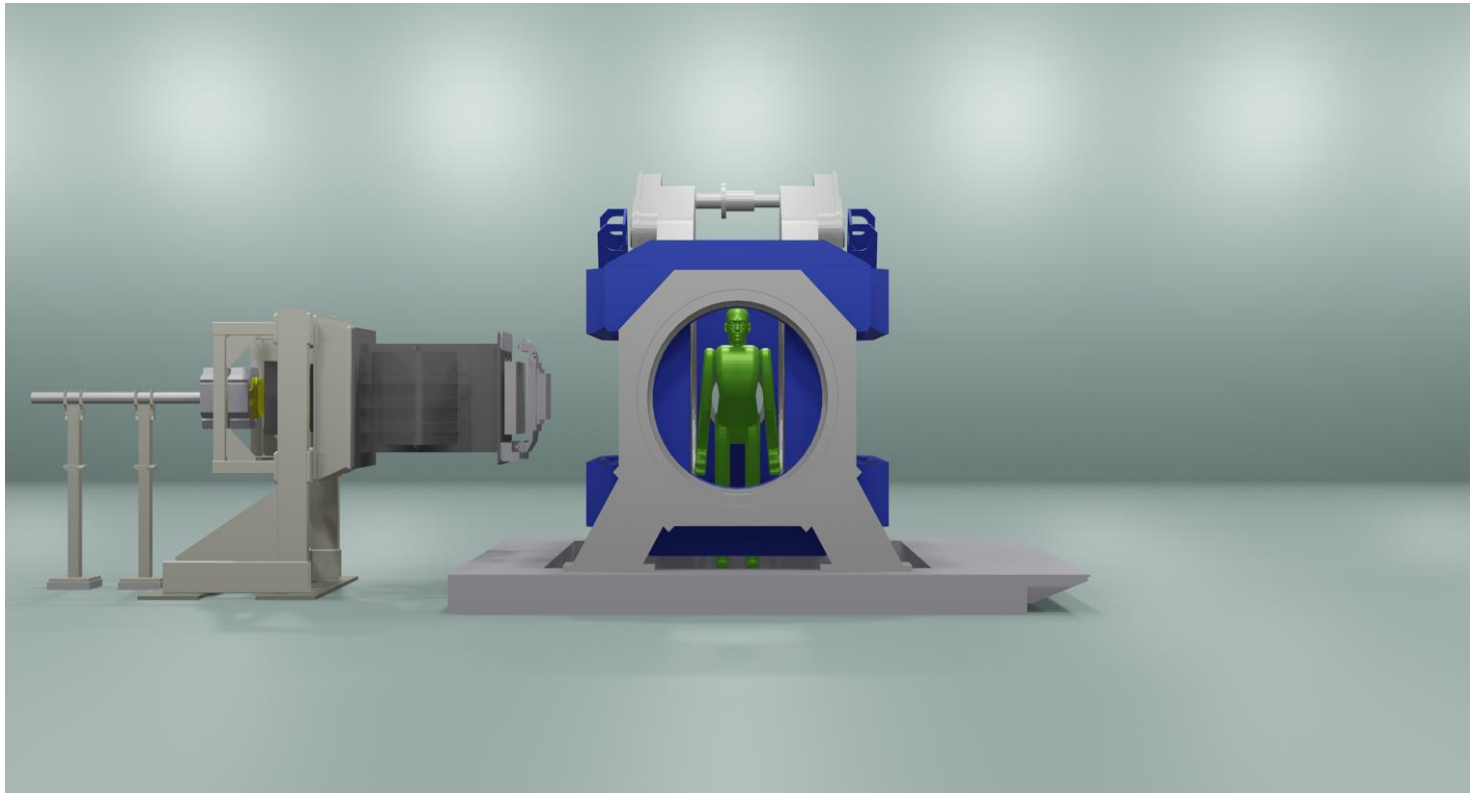
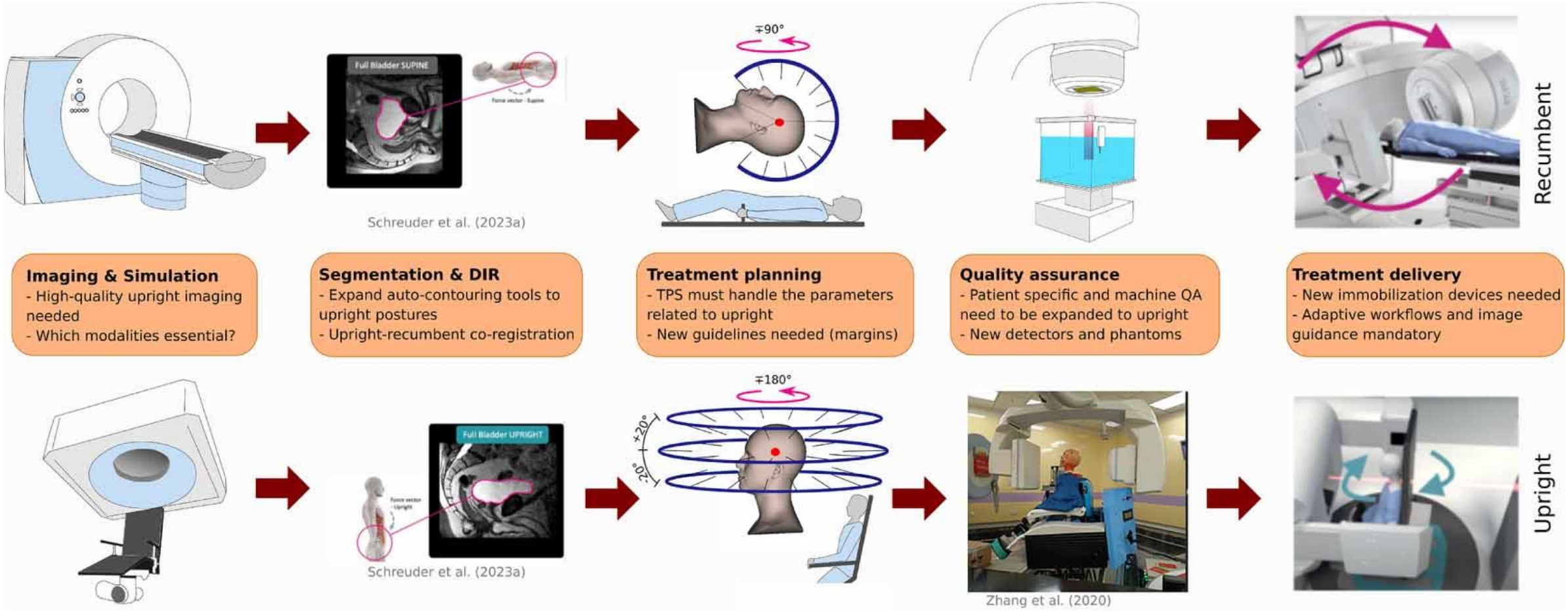


Image courtesy: A. Hoffmann, OncoRay, Dresden, Germany

# UPLIFT's aim: making upright a successful clinical solution




Volz et al. (2024) PMB

# Upright is on the rise

- Major societies recognize the importance of upright
- Several new centers
- First prospective trials

ESTRO

Corporate Members E-Library

About ESTRO Membership School **Workshops**

Dr Tracy Underwood (Leo Cancer Care and University College London, UK)

Dr Cristina Garibaldi (European Institute of Oncology, Italy)

**Motivation**

Eliminating the gantry by rotating the patient instead of the radiotherapy beam offers the opportunity to reduce 1) equipment costs, 2) radiation shielding requirements, and 3) treatment room footprints for all radiation modalities. Consequently, gantry-less treatments can potentially
cessibility of radiotherapy. Furthermore, gantry-less
fixed beamlines and additional space around the
ed/exotic treatment beams (e.g., FLASH, VHEE, or

Clinical Trial › Radioth

Epub 2025 Aug 11.

**Prospective cli**
**proton therapy**
**and brain mali**

Philip Blumenfeld [1], Alexander Pryanichnikov [2], Yair Hillman [1], Ella Wajnryt [1], Aviad Berger [1], Shimshon Winograd [3], Marc Wygoda [1], Ayman Salhab [1], Marcel Fang [1], Jon Feldman [1], Aron Popovtzer [1]

Affiliations + expand

PMID: 40803484 DOI: 10.1016/j.radonc.2025.111097

# The consortium

Sheffield Hallam University
Knowledge Applied
Loughborough University
LEO CANCER CARE
GSI
dkfz.
THERAPANACEA
CENTRE LEON BERARD
CNAO
RaySearch Laboratories
HZDR
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF
UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE
ČVUT
COSYLAB
PSI
ASG

- 19 PhD projects at 15 supervising institutions, more than 20 partners
- 9 countries
- >5M Euro in funding

# UPLIFT: designed for innovation acceleration


PROGRAMME MANAGEMENT **WP 6**

**WP 1**

## TRAINING

Career development plan
3 training schools
3 topical workshops

**TO1: Foundation for success**
- Transferable skills
- Scientific prowess
- Innovation

**TO2: Scientific Savvy**
- Cutting-edge technology
- Best practices
- Artificial intelligence

**TO3: Fellowship**
- Open-minded leaders
- Lasting collaborations
- Career opportunities

**UPLIFT**
**INNOVATION ACCELERATION**

**WP 3**


**WP 2**

**WP 4**

**WP 5**

## DISSEMINATION

**Scientific outreach**
- Publications, conferences
- 17 PhD theses
- Consensus guidelines

**Industry outreach**
- Marketable solutions
- Technology transfer, patents

**Public outreach**
- Patient interest groups
- International RT networks
- Open courseware

New leaders for medical physics
Bespoke urpight RT solutions
Lasting European collaboration

UPLIFT: trained professionals and next generation solutions for upright radiotherapy

# WP1: Training (head: Petra Trnkova)

- Oversees DC training
  - Training through research
  - Career development
  - Thesis advisory committee

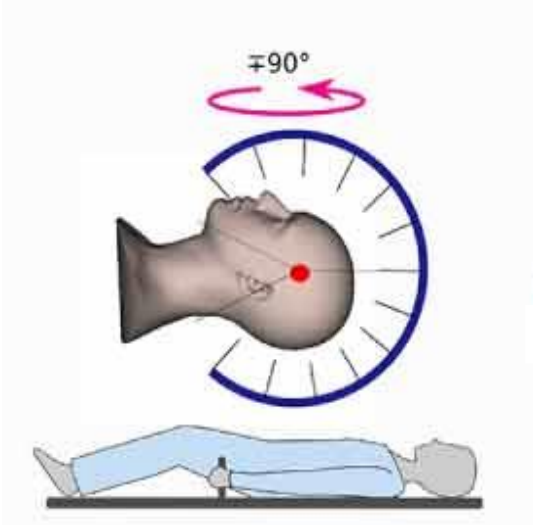
- Training schools and workshops
  - Advanced RT, AI in RT, Equipment design

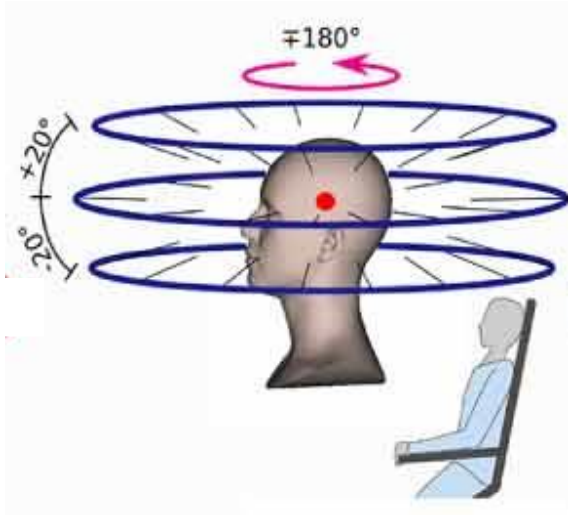
1st UPLIFT school: registrations are open!

UPLIFT Launches First Training School on Advanced Radiotherapy in Lyon

# WP 2: Treatment planning and simulation (head: Ye Zhang)

- **RO1: Dedicated infrastructure for treatment planning and image guidance tailored to upright positioning**
  - **Identifying treatment planning and image guidance possibilities and challenges is essential to achieving highest treatment accuracy in modern RT techniques.**
  - **Provides advanced imaging and planning tools to ensure optimal plan quality**



# WP3: Clinical workflow (head: Vincent Gregoire)

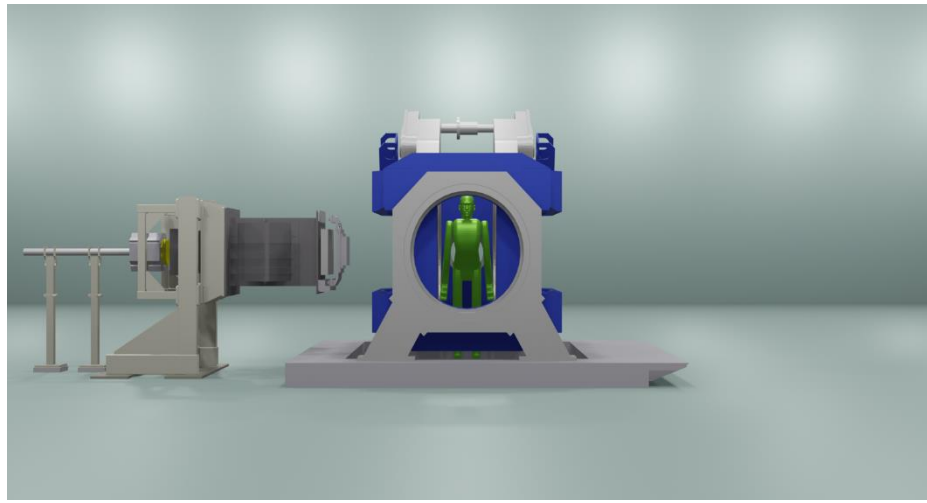
- Concerns questions of patient selection, in-room positioning, quality assurance devices, and provides the constraints any upright device or plan must fulfil for clinical application.
- Considers IMRT/VMAT and PT workflows, their synergies and differences, to bring forward ideal equipment applicable to a wide range of treatment options and patient sites.
- Prioritize patient comfort without compromising treatment accuracy, keeping a close eye on cost- and workflow efficiency

*Boisbouvier, tipsRO 2022*

# WP4: Equipment design and human comfort (head: Tracy Underwood)

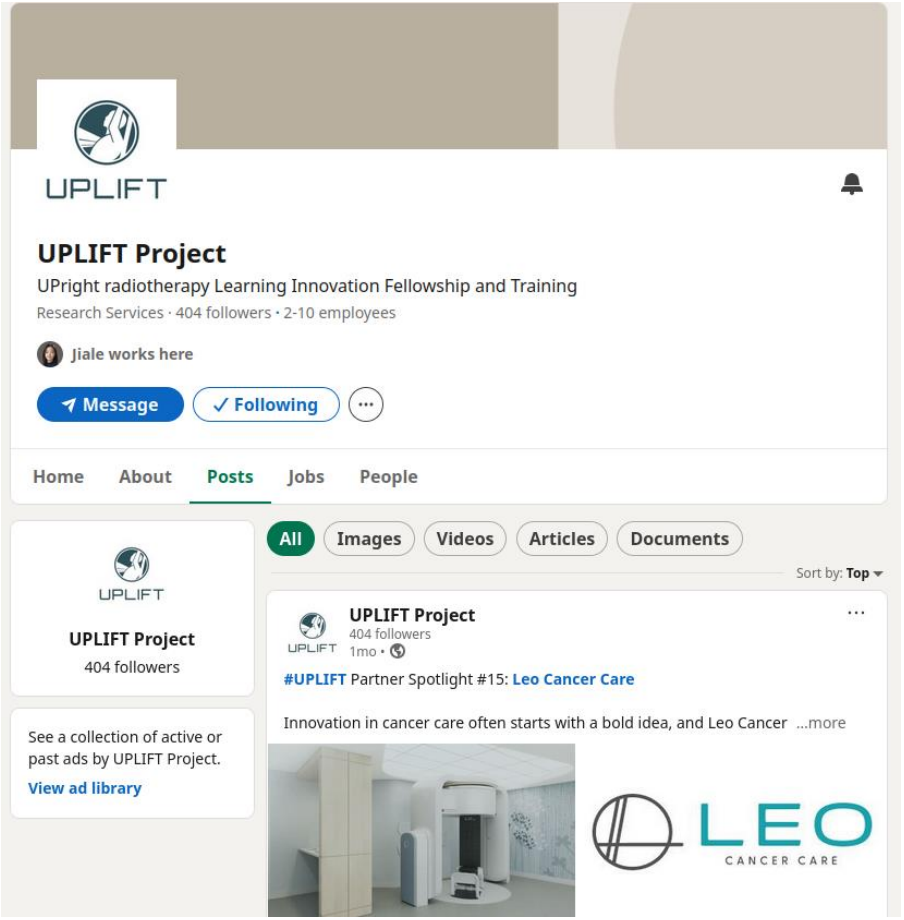
- Develops upRT equipment aligned with treatment planning and clinical workflow needs.
- Focus areas include:
  - Upright imaging solutions
  - Anthropomorphic body phantoms
  - Patient immobilization devices
- Incorporates socio-economic analyses and patient comfort studies.
- Ensures solutions deliver **broad societal impact**.

In-beam MR-guidance: A. Hoffmann, OncoRay



# WP 5: Dissemination (head: Kristjan Anderle)

- Webpage (www.uplift-project.eu)
- Regular posts on social media
- Introduction round on Doctoral Candidates (coming soon)
- Follow us on LinkedIn ☺
  https://www.linkedin.com/company/uplift-project-eu



# WP 6: management (head: Christian Graeff)

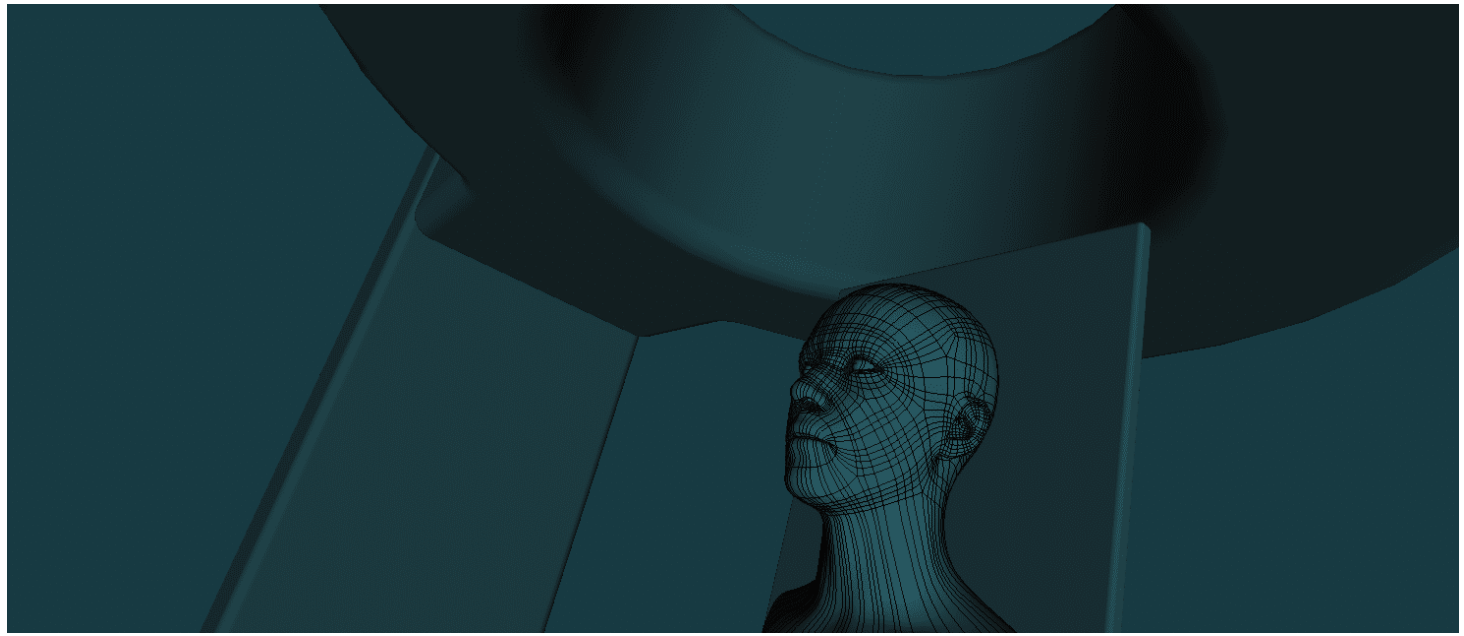
- Well… project management

# Recruitment successful

275 applications from over 60 countries, ~50 shortlist candidates…

- 19 doctoral candidates with strong and diverse backgrounds

- United towards one goal: Make upright radiotherapy a clinical standard



# Thank you for your attention!

Contact us at uplift@gsi.de, follow us on LinkedIn etc.

We are excited for all that's to come ☺

Funded by the European Union

Project funded by

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs, Education and Research EAER
**State Secretariat for Education, Research and Innovation SERI**

UK Research and Innovation