



ONKOLOŠKI
INŠTITUT
LJUBLJANA

Medical physics

Andrej Studen

F9 retreat, 28. 9. 2026, Krvavec

Overview

Mandate: Medical Physics is a branch of Applied Physics, pursued by medical physicists, that uses **physics** principles, methods and techniques in practice and research for the **prevention, diagnosis and treatment** of human diseases with a specific goal of improving human health and well-being.

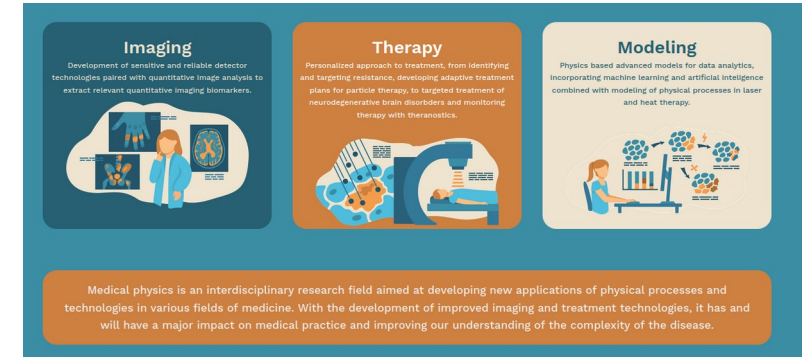
- IOMP definition

Mission: Unique **multidisciplinary platform** for:

- Translation of fundamental physics research into clinical practice,
- Translation of cutting edge medical technologies from academia to commercialization,
- Support to university-level education in Medical Physics in Slovenia.

Major areas of activities:

- Biomarker development
- Outcome prediction
- Disease modeling
- Treatment optimization



Medical physics group,
<http://medfiz.si>



Univerza v Ljubljani
Fakulteta za matematiko
in fiziko



ONKOLOŠKI
INŠTITUT
LJUBLJANA

4 organizations
50+ members
800+ papers
21000+ citations

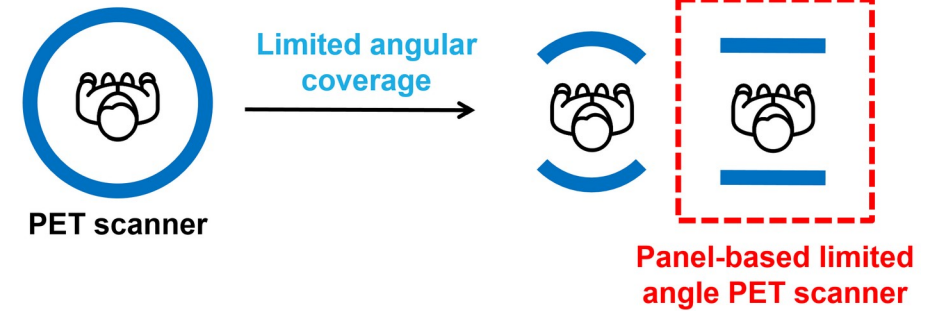
Biomarker development

PET-VISION: 2023-2028
ARIS-PET: 7/2024 - 7/2027
FASTSIGHT: 2025-2029

Development of instrumentation and analysis for biomarker extraction:

- PET instrumentation

- X-ray fluorescence
- risk in breast cancer
- biomarkers of adverse events in cancer treatment
- biomarkers of neuro-degeneration (Alzheimer/Parkinson disease)
- Multiscale instrumentation



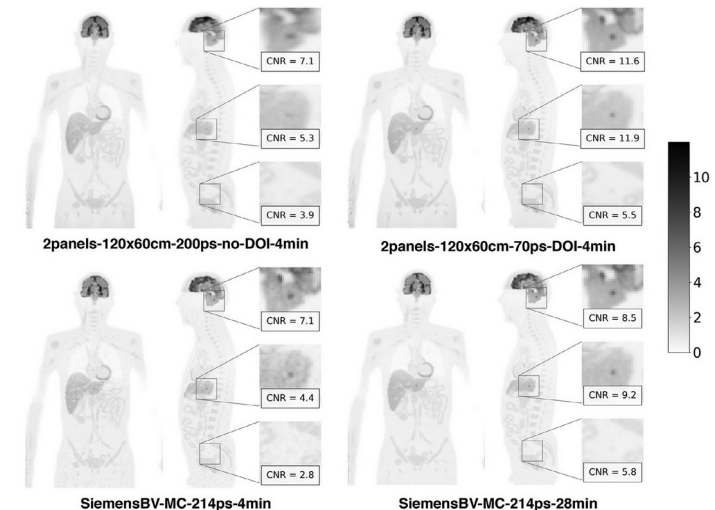
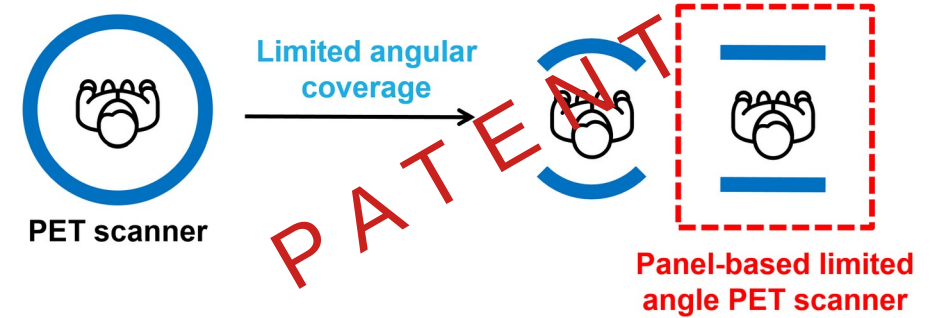
Biomarker development

PET-VISION: 2023-2028
ARIS-PET: 7/2024 - 7/2027
FASTSIGHT: 2025-2029

Development of instrumentation and analysis for biomarker extraction:

- PET instrumentation

- X-ray fluorescence
- risk in breast cancer
- biomarkers of adverse events in cancer treatment
- biomarkers of neuro-degeneration (Alzheimer/Parkinson disease)
- Multiscale instrumentation



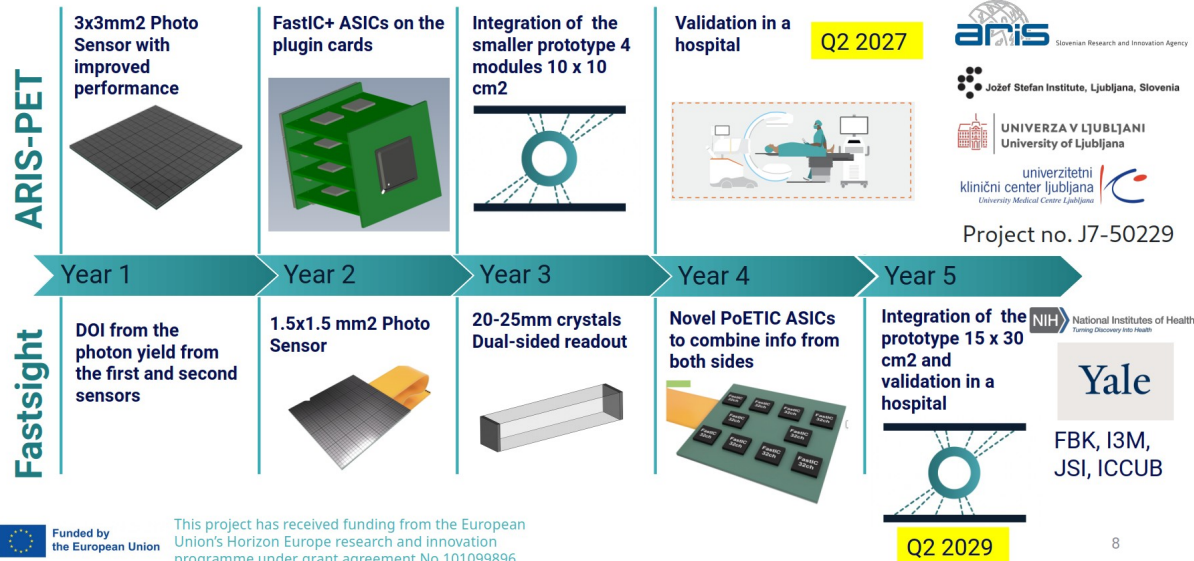
Biomarker development

PET-VISION: 2023-2028
ARIS-PET: 7/2024 - 7/2027
FASTSIGHT: 2025-2029

Development of instrumentation and analysis for biomarker extraction:

- PET instrumentation

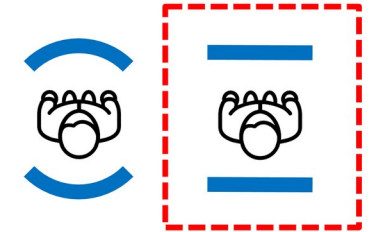
- X-ray fluorescence
- risk in breast cancer
- biomarkers of adverse events in cancer treatment
- biomarkers of neuro-degeneration (Alzheimer/Parkinson disease)
- Multiscale instrumentation



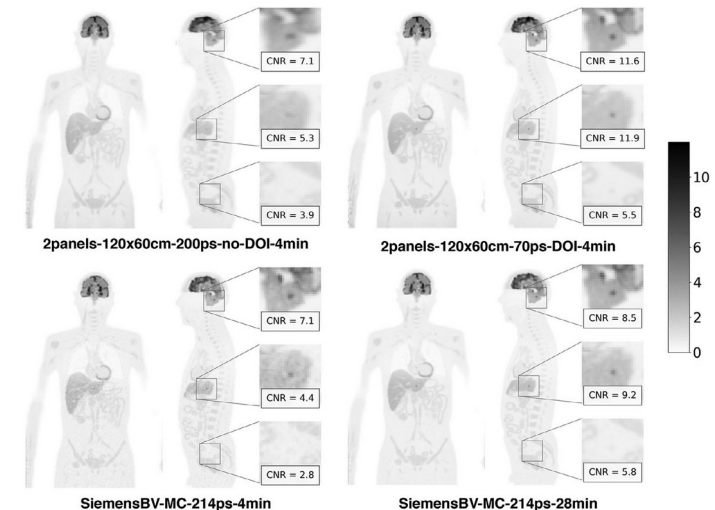
Funded by the European Union
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101099896



Limited angular coverage



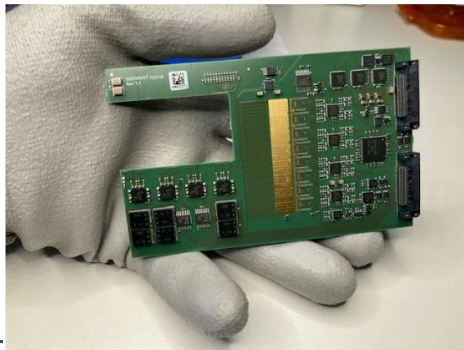
Panel-based limited angle PET scanner



Biomarker development

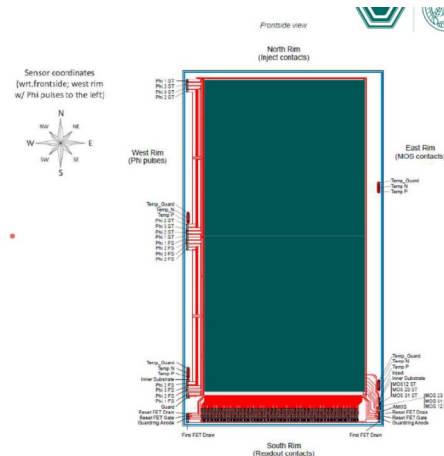
Development of instrumentation and analysis for biomarker extraction:

- PET instrumentation
- **X-ray fluorescence**
- risk in breast cancer
- biomarkers of adverse events in cancer treatment
- biomarkers of neuro-degeneration (Alzheimer/Parkinson disease)
- Multiscale instrumentation



SPARE CCD DEVICE

- Small Pixel Area Reduced
- Device characteristics:
- 2 x 512 x 512 pixels
- 36 x 36 μm^2 pixel size
- Monoframe framestore pn-CCD
- Sensitive region
- 18.43 x 18.34 mm^2 (framestore mode operation)
- 18.34 x 36.86 mm^2 (standard mode operation)

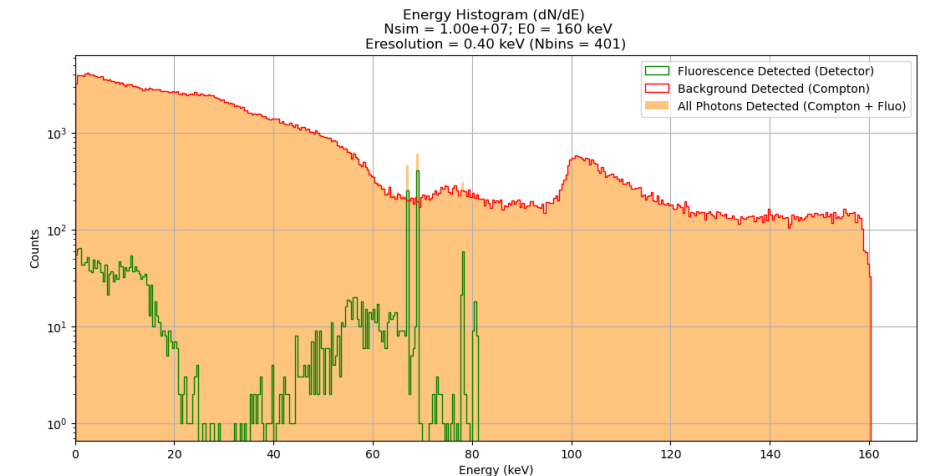


IMMPRINT, PR-13333, 15.3.2023-15.3.2027 (extension pending)

X-ray Fluorescence imaging simulation

author: Matevž Hudovernik

Mentor: doc. dr. Andrej Studen

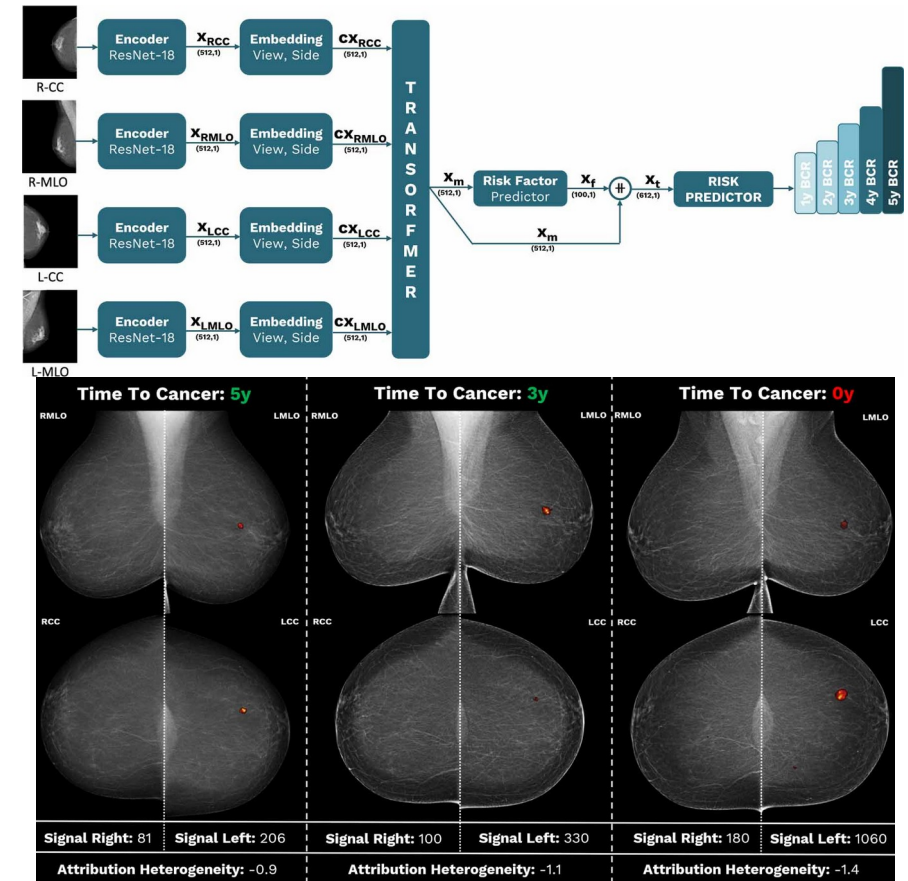


Biomarker development

Development of instrumentation and analysis for biomarker extraction:

- PET instrumentation
- X-ray fluorescence
- **risk in breast cancer**
- biomarkers of adverse events in cancer treatment
- biomarkers of neuro-degeneration (Alzheimer/Parkinson disease)
- Multiscale instrumentation

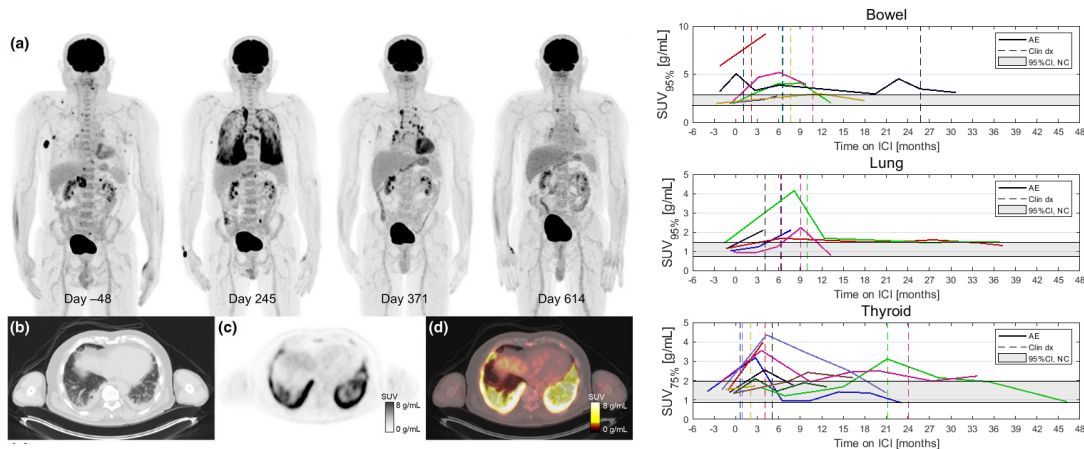
Bilateral project (FMF) with KU Leuven (2021-2025).



Biomarker development

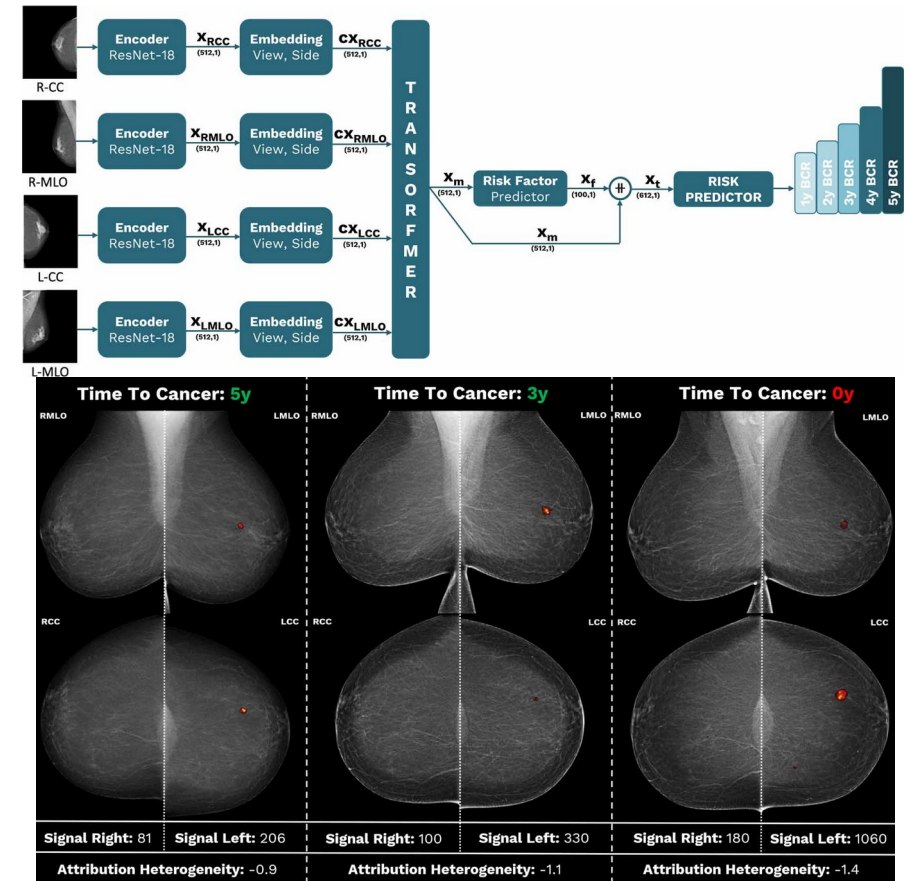
Development of instrumentation and analysis for biomarker extraction:

- PET instrumentation
- X-ray fluorescence
- **risk in breast cancer**
- **biomarkers of adverse events in cancer treatment**
- biomarkers of neuro-degeneration (Alzheimer/Parkinson disease)
- Multiscale instrumentation



Hribernik et al. 2022

Bilateral project (FMF) with KU Leuven (2021-2025).

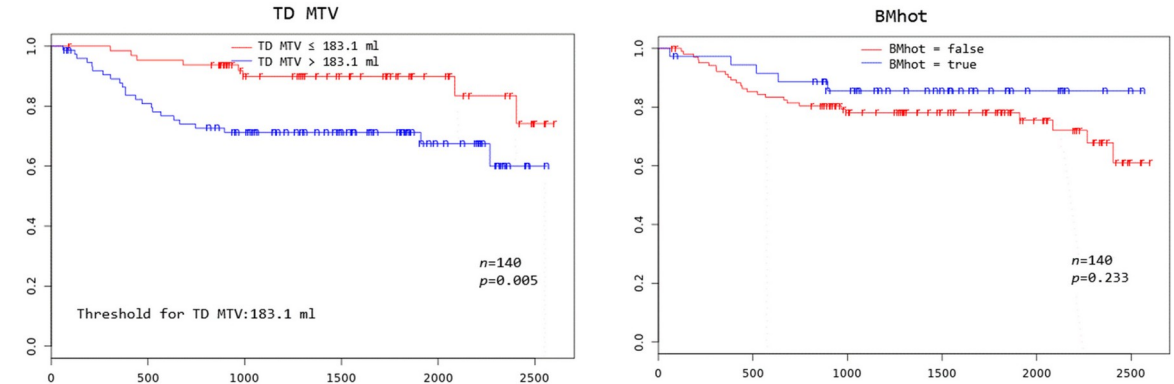


Klanecek et al. 2025

Outcome prediction

Association of biomarkers with treatment outcome

- Role of PET in treatment of lymphoma
- brain patterns and cancer treatment
- AE and immunotherapy



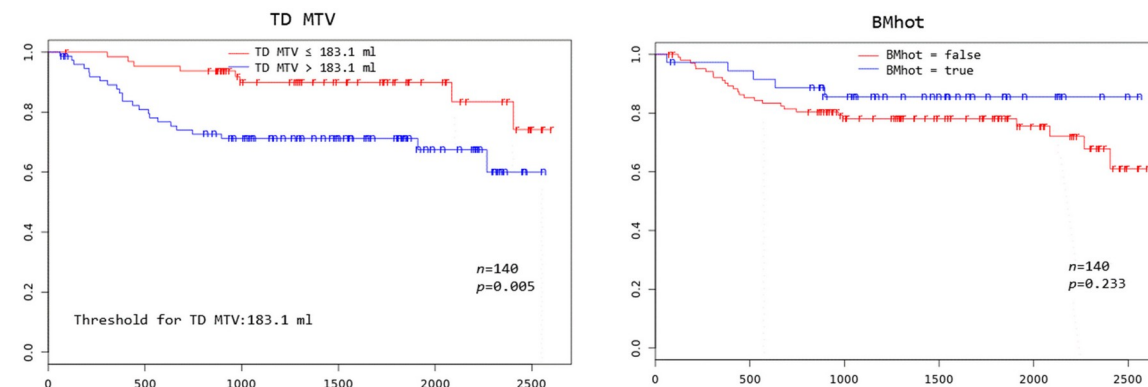
Doma et al. 2024

Hribernik et al. 2025

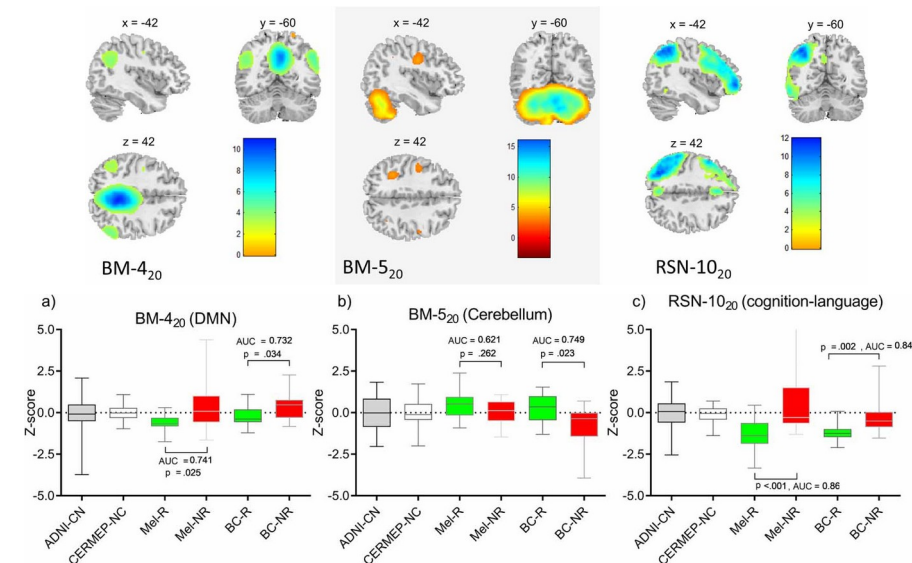
Outcome prediction

Association of biomarkers with treatment outcome

- Role of PET in treatment of lymphoma
- brain patterns and cancer treatment
- AE and immunotherapy



Doma et al. 2024

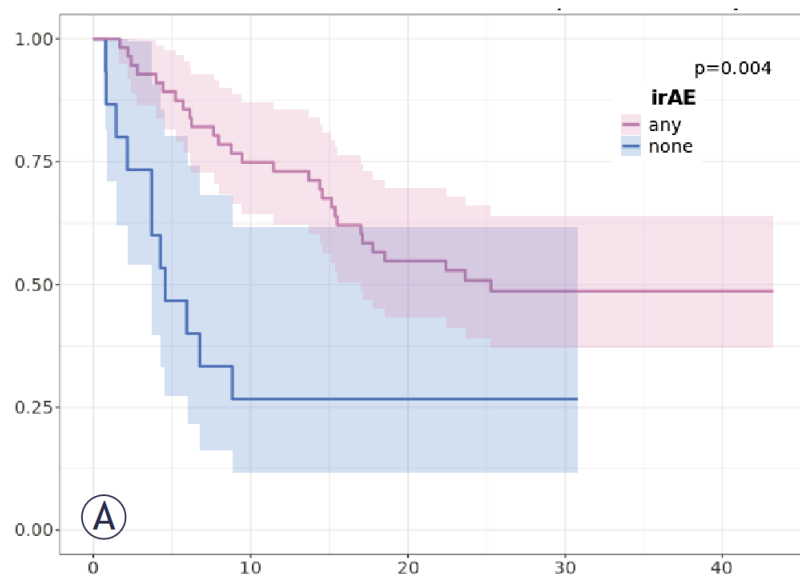


Namias et al. 2025

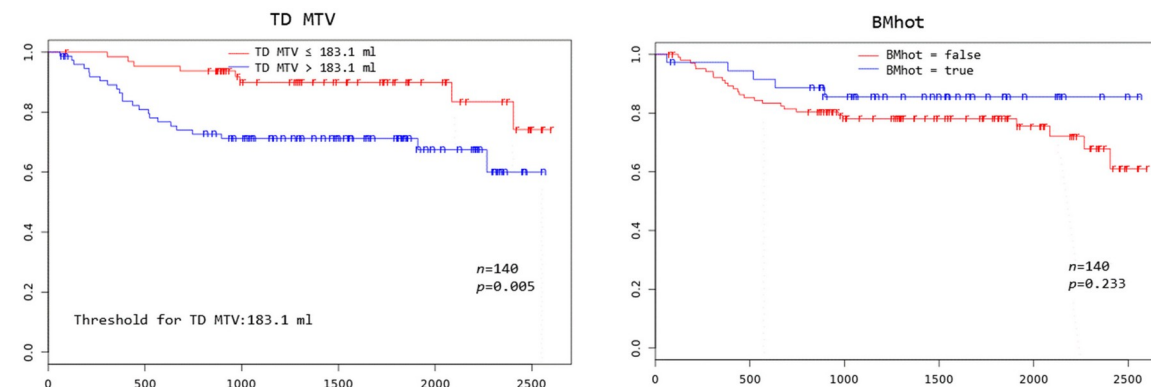
Outcome prediction

Association of biomarkers with treatment outcome

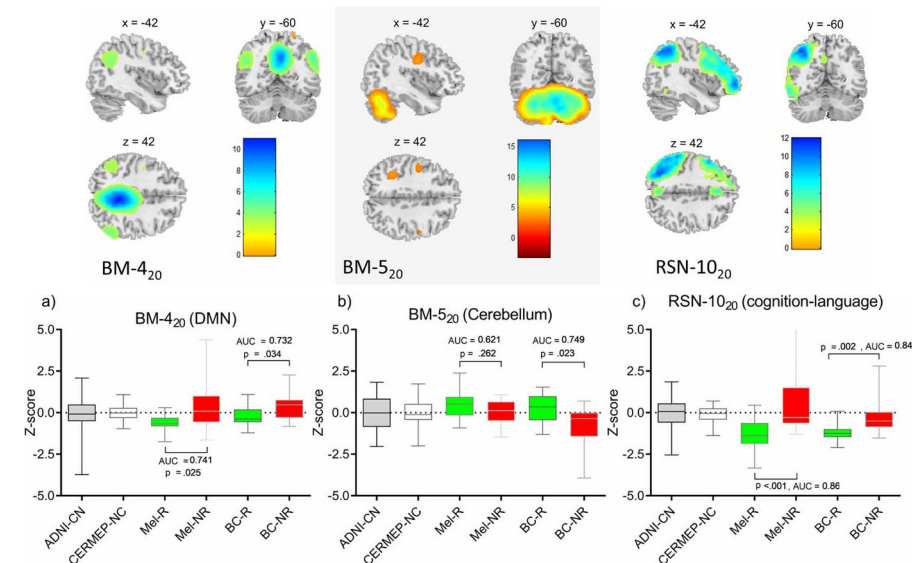
- Role of PET in treatment of lymphoma
- brain patterns and cancer treatment
- AE and immunotherapy



Hribernik et al. 2025



Doma et al. 2024

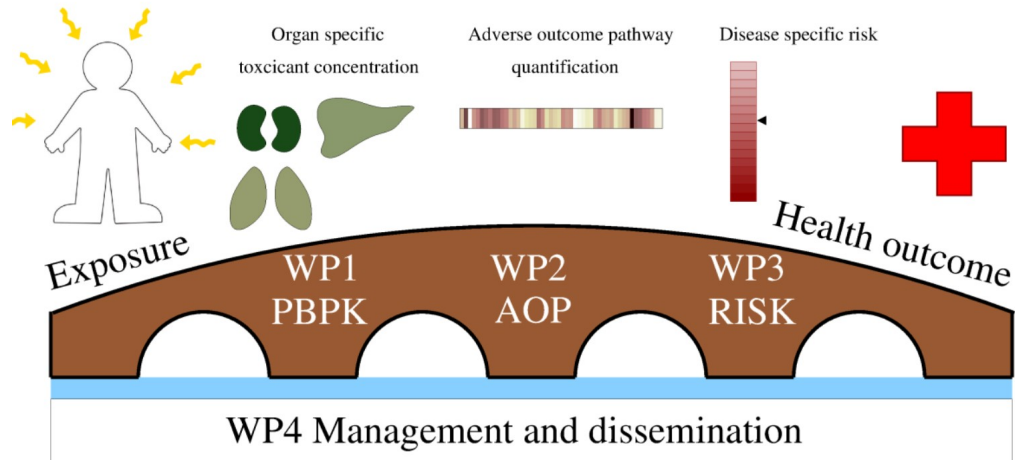


Namias et al. 2025

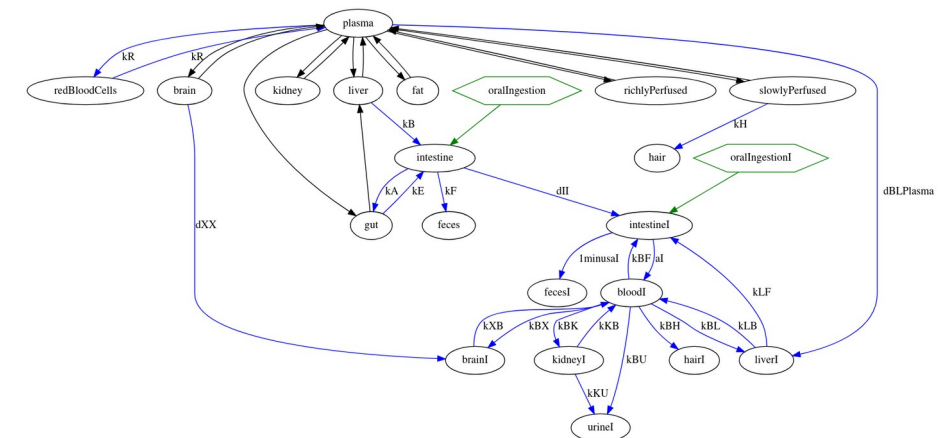
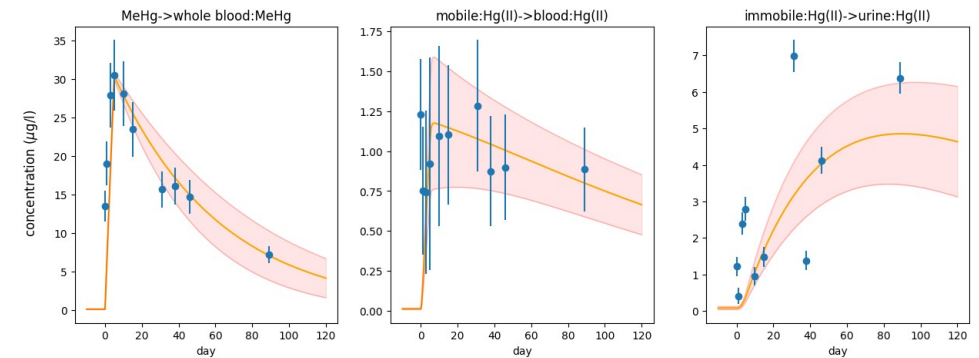
Disease modeling

Modeling of disease inception and treatment effects -environmental health physics.

- **Refined estimation of environmental exposure in vulnerable population groups** - quantifying risk in environmental toxin exposure:
- Distribution of (Me)Hg in organs



RSF-0039 (O-2, E-8, F-9) 1.7.2024 - 30.6.2028



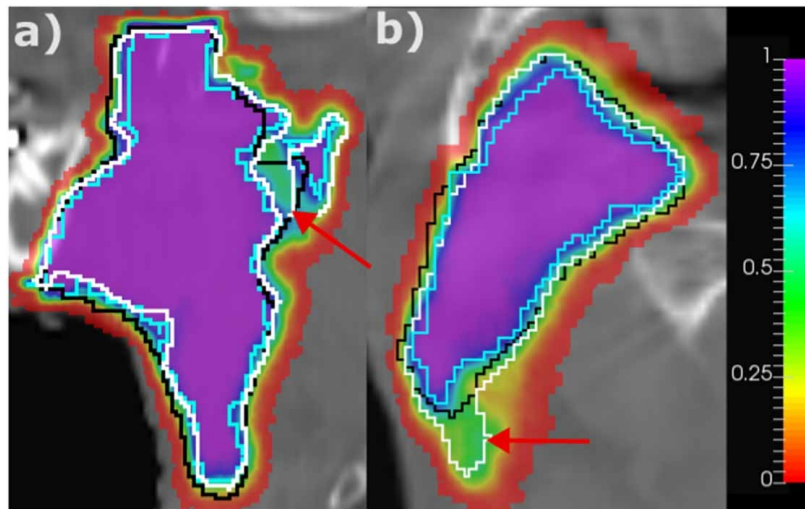
Studen et al. 2026

Treatment optimization

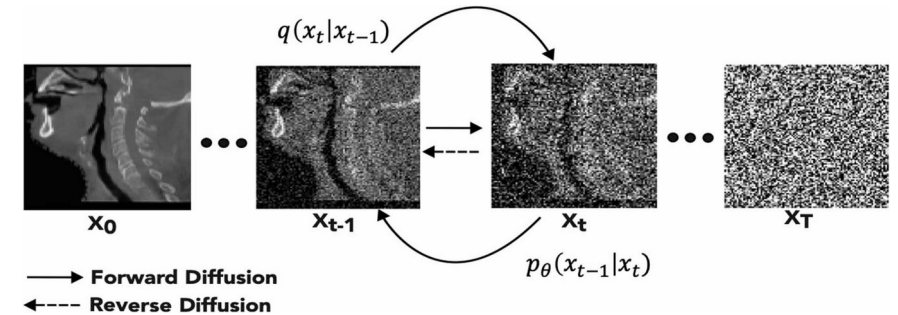
Personalization of treatment selection and delivery:

- **adaptive/probabilistic planning of RT**

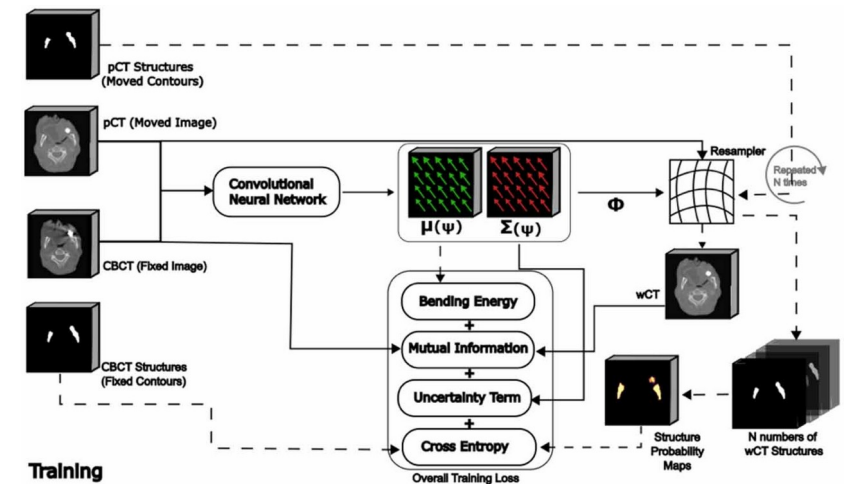
- risk-based screening
- therapy selection



Rivetti et al. 2024



Smolders et al. 2024

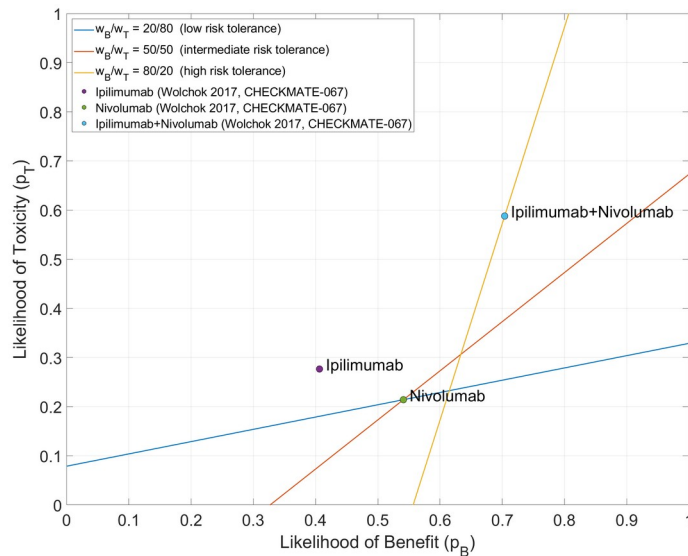


Rivetti et al. 2024

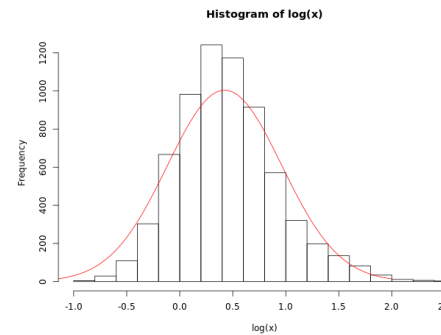
Treatment optimization

Personalization of treatment selection and delivery:

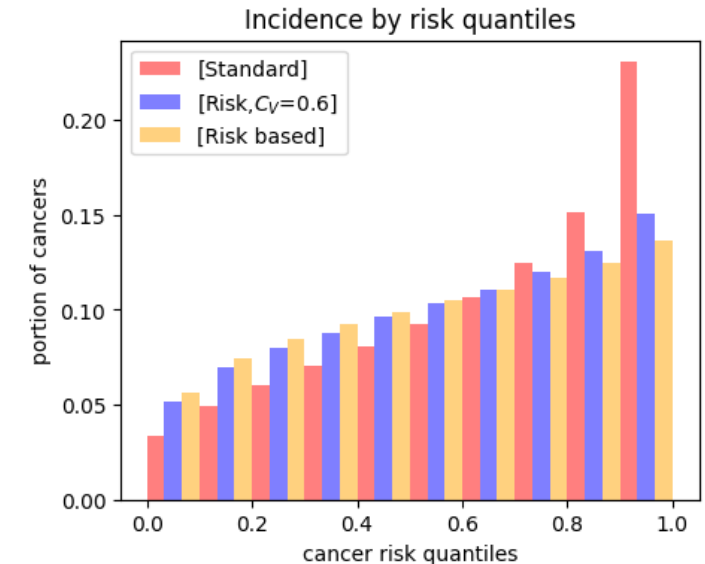
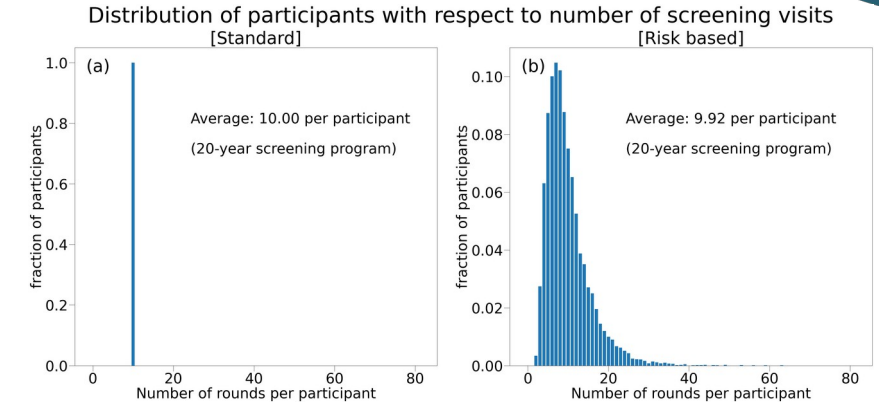
- adaptive/probabilistic planning of RT
- **risk-based screening**
- **therapy selection**



Huff et al. 2024



Distribution of risk
in population,
Jarm et al. 2023



Studen et al. 2026

Future of med-phys at F9

Goal (shared by med-phys group):

- Quantitative and predictive medicine

Measures (shared by med-phys group):

- development of biomarkers (reliability, availability)
- cutting edge modeling and analysis skills

Exploit **nurturing environment** at JSI:

- **Instrumentation:** prowess in biomarker development.
- **Analysis:** Incubation of biomarker inception skills, quantification of uncertainty.
- **Collaboration:** Common ground for transdisciplinary research.
- **Societal impact:** Translation of basic physics for benefit of society

Driven by **diverse funding:** ARIS, EIC, EURATOM-Pianoforte, IJS-RSF