A Reconfigurable Detector for Measuring the Spatial Distribution of Radiation Dose for Applications in the Preparation of Individual Patient Treatment Plans

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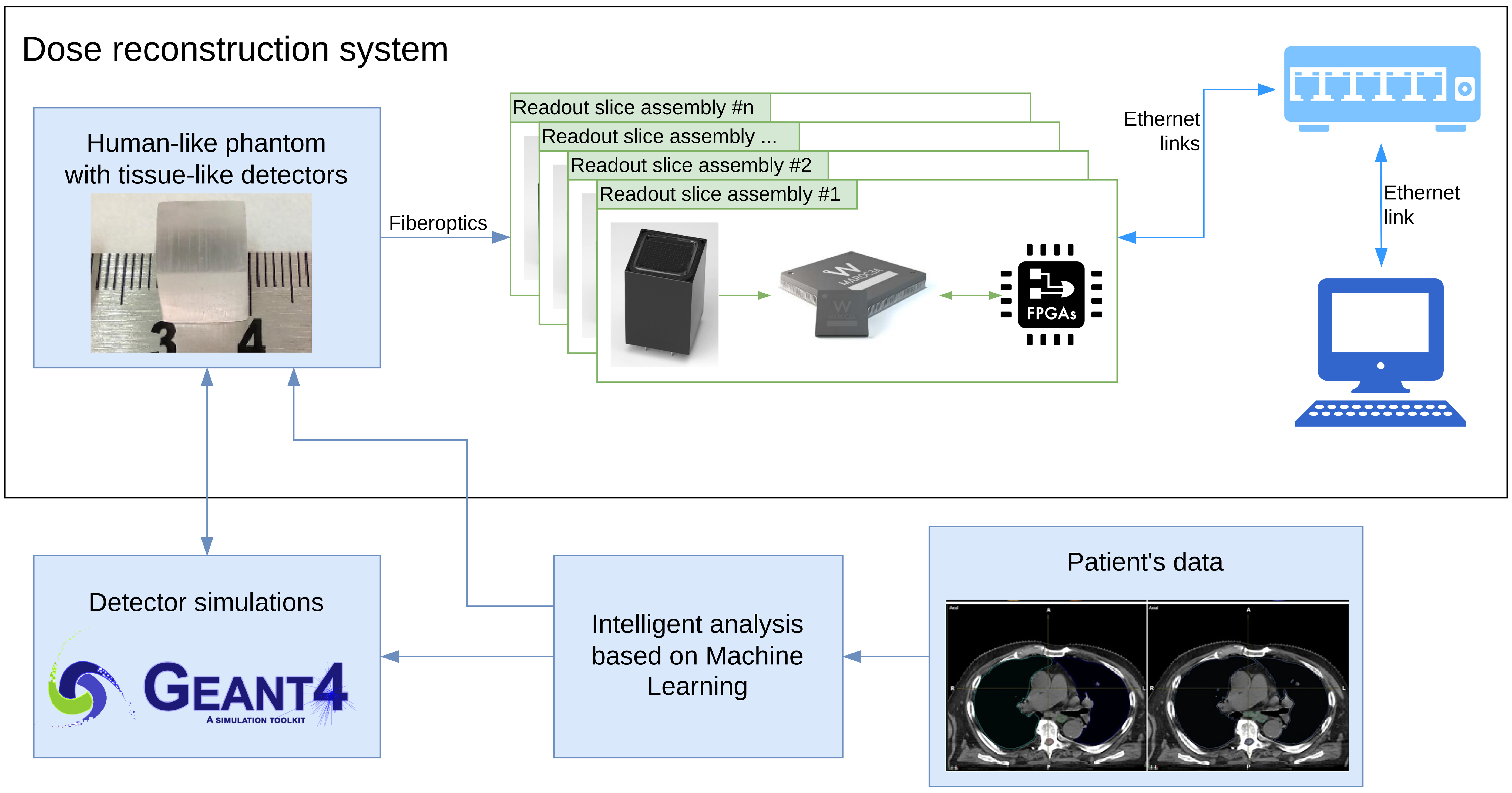
Overview

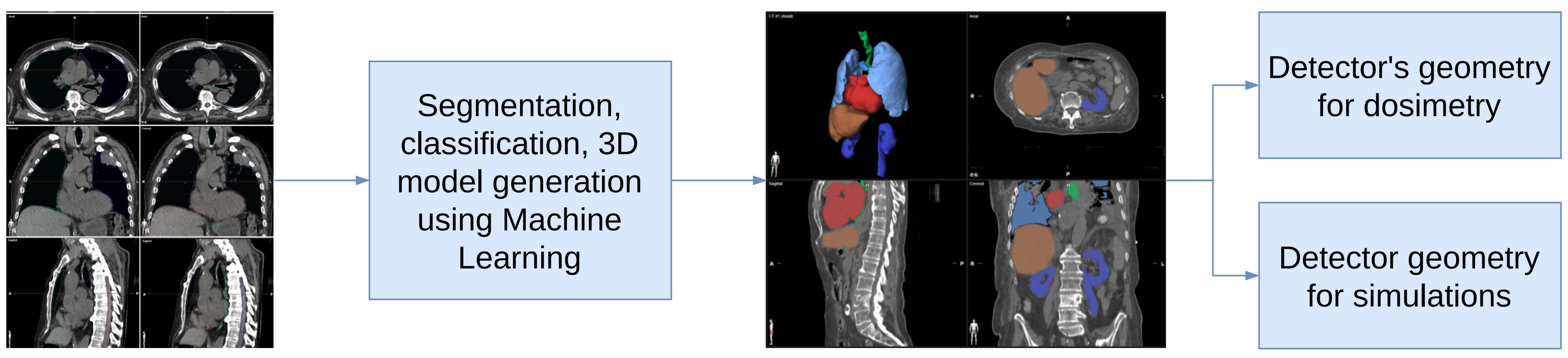
A reconfigurable Detector for Measuring the Spatial Distribution of Radiation Dose for Applications in the Preparation of Individual Patient Treatment Plans project aims to build a reconfigurable detector for the measurement of radiation dose spatial distribution. It is an extremely important field of study since cancer is one of the deadliest diseases worldwide, accounting for nearly ten million deaths in 2020 [1]. The better is our understanding of dose deposition in tissue, the more accurate patient treatment planning can be. As a result, chances of the patient's full recovery are increased, and potential excessive neighbouring tissue damage is reduced.

- Detection head allowing for changes in geometry dependant on patient's needs
- Scalable Data Acquisition (DAQ) system supporting reconfigurability
- High-level software package using machine learning techniques to analyse medical imaging and generate detector geometry for the configuration and simulations



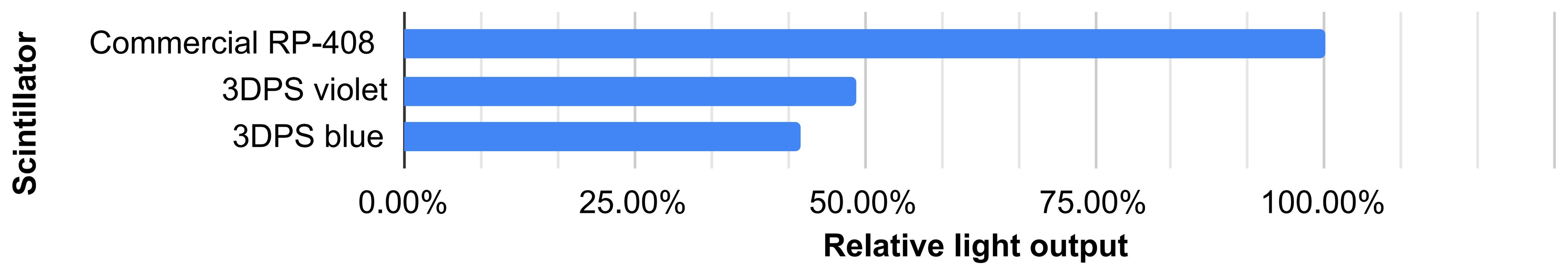
High-level software and data analysis

- CT data segmented and classified using machine learning techniques
- Analysed data used to create an accurate detector geometry for:
  - the detector head
  - *Monte Carlo* simulations
- Simulations enable precise therapy planning ⇒ see contribution **Medical Imaging Data Analysis Using 3D Deep Learning Models Towards Improving the Individual Treatment Plans**
- The detector verifies simulation results *in situ*



Scintillators

- 3D-printed scintillator cubes of 10x10x10 mm^3 to be used
- A comparison between commercial and 3D printed samples done [2]



References

[1] Jacques Ferlay et al. "Cancer statistics for the year 2020: An overview". In: *International Journal of Cancer* 149.4 (2021). DOI: 10.1002/ijc.33588.

[2] Dong-geon Kim et al. "Performance of 3D printed plastic scintillators for gamma-ray detection". In: *Nuclear Engineering and Technology* (). DOI: 10.1016/j.net.2020.05.030.

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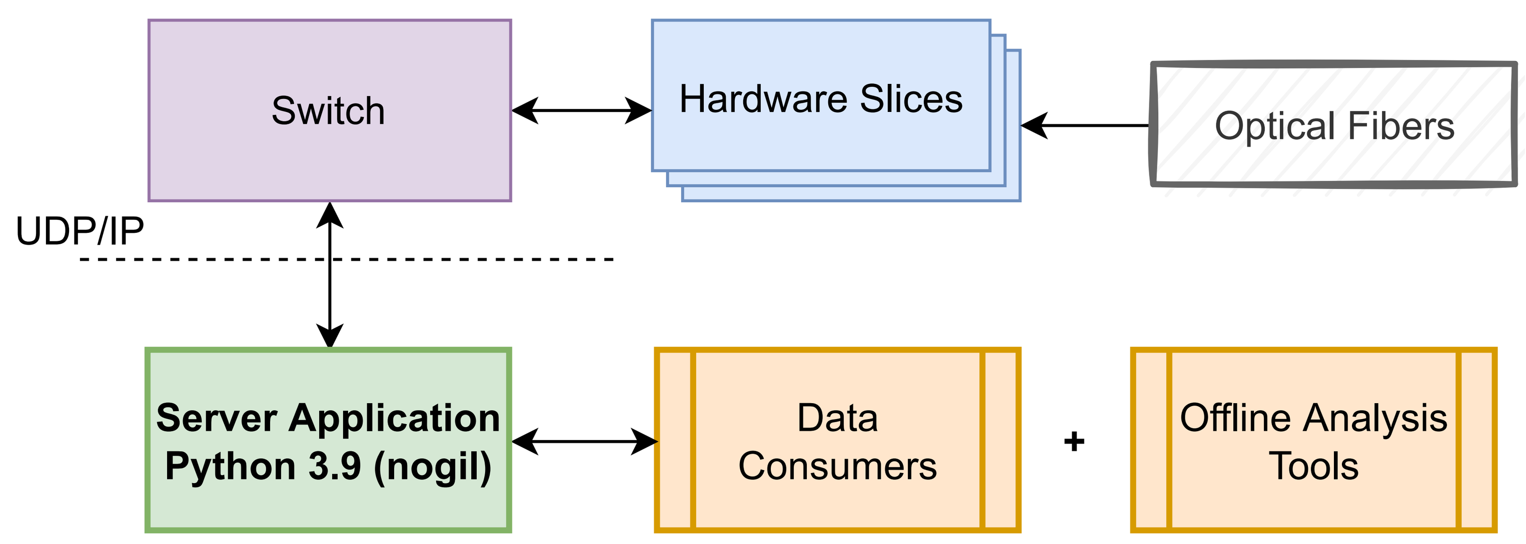
DAQ System

- Communication with different number of slices, depending on the needs possible [3] ⇒ see contribution **A Modular Data Acquisition System for Reconstruction of Radiation Dose Spatial Distribution in Radiotherapy Treatment Planning**
- Slices synchronised using Precision Time Protocol (PTP) to align the data in the time domain
- 8×8 multianode photomultiplier tube assembly used



Conclusion

- 3D printed scintillators offer needed performance
- DAQ system operational and first calibration done
- Detection system construction feasibility confirmed

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