BE PART OF THE KOLOR SPCCT Imaging ERC starting grant

"KOLOR SPCCT Imaging for a single breath-hold comprehensive imaging of lung diseases using K-edge spectral photon-counting CT"

Thesis title: Development of lung applications of Color K-edge inflammation imaging using Spectral Photon-Counting Computed Tomography in combination with dedicated contrast agents

Laboratory: Research lab CREATIS - https://www.creatis.insa-lyon.fr/

Supervisor: Salim Si-Mohamed (MD, PhD, Professor, cardiovascular and thoracic radiologist, University of Lyon, Hôpital Louis Pradel)

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Research team:

- KOLOR SPCCT Imaging team, led by Salim Si-Mohamed: 3 PhD, 1 post-doc, 2 Engineers, 1 zootechnician and many national and international collaborations
- MYRIAD Team - https://creatis-myriad.github.io/, led by Olivier Bernard

Length: 3/5 years starting in 2025

Gratification: 2100 €/month/1st year, 2200 €/month/2nd year, 2300 €/month/3rd year

Location:

- Campus de la Doua, 21 Avenue Jean Capelle, 69621 Villeurbanne
- Hôpital Louis Pradel: 59 Bd Pinel, 69500 Bron
- CERMEP Platform: 59 Bd Pinel, 69500 Bron

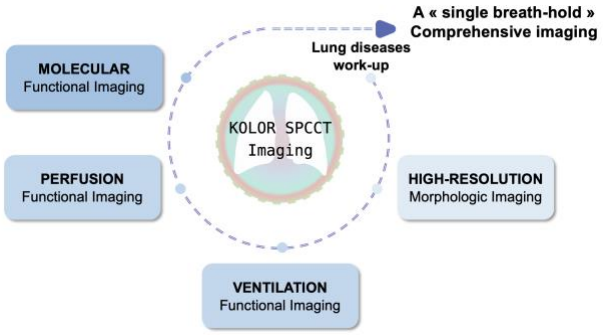
Position: Funded by the ERC Starting Grant "KOLOR SPCCT Imaging"

Keywords: Lung diseases; Spectral photon-counting CT; Inflammatio; Morphologic imaging; Functional imaging; Contrast agent; Ventilation imaging; Perfusion imaging; Molecular imaging; animal studies; clinical translation.

Scientific context:

X-ray computed tomography (CT) is the mainstay of lung imaging due to its higher spatial resolution, convenience, availability and faster acquisition time compared to other imaging methods such as magnetic resonance imaging and nuclear imaging. However, it only provides morphological characterization, which is not fully suitable for lung diseases that are a complex combination of respiratory, vascular and inflammatory dysfunctions. Their diagnosis requires both morphological and functional analysis of ventilation, perfusion and molecular biomarkers. As so, standard of care relies on a multimodal diagnostic workup involving scintigraphy, positron emission tomography and tissue biopsy. This has three main drawbacks: it's either not precise enough or is invasive, and in any case it's time-consuming while worsening the patient's prognosis.

The spectral photon-counting CT (SPCCT) is an emerging technology that not only capitalizes on all the advantages of morphological CT imaging, but also offers a cutting-edge imaging method known as K-edge color imaging[1–8]. This method allows the specific and quantitative identification of one or more atoms concomitantly within a tissue, enabling the simultaneous functional imaging of independent or interactive processes. However, Color K-edge imaging is still limited by its low sensitivity and the scarcity of tracers for potential use in humans, and has therefore not yet been put into practice.



By combining medical imaging, respirology, chemistry and physics, **KOLOR SPCCT Imaging** will bridge morphological and functional imaging in one single breath-hold. To reach this goal, it will provide:

1. **Color lung K-Edge imaging:** develop a high-sensitive dedicated imaging tool
2. **Diagnosis of lung diseases:** provide a “one-breath hold” ventilation and perfusion imaging in healthy animals and animal models
3. **Prediction of lung diseases: provide a “one-breath-hold” monitoring of the molecular inflammatory burden in animal models**

KOLOR SPCCT Imaging will provide unprecedented knowledge on ventilation, perfusion, molecular inflammatory response and their interaction. It will develop K-edge Color imaging to provide specific and quantitative high-resolution imaging with the use of non-specific and specific tracers on key pulmonary applications in animal models: pulmonary embolism, cancer and fibrosis. It will bring a paradigm shift for diagnosis and prognosis of lung diseases, allowing an earlier and more precise diagnosis of lung disease for a higher chance of survival of the patients.

Thesis objectives:

1. Develop high-resolution quantitative inflammation imaging in combination with nebulised K-edge contrast agents in *ex vivo* lungs and *in vivo* healthy animals
2. Monitor the molecular inflammatory burden in animal models of lung fibrosis and cancer, known as a key factor of recurrency and growth of lung diseases
3. Validate quantification of inflammation burden in comparison with method of reference (translocator protein-specific positron emission tomography (PET) radiotracer that is specific to the translocator protein (TSPO), multi-scale spectral phase contrast imaging at the European Synchrotron Radiation Facility, in-depth histology).

Research environment

KOLOR SPCCT IMAGING will be performed on the unique clinical SPCCT prototype available in the world of Philips Healthcare already acquired by the University Claude Bernard Lyon 1 (UCBL), in the framework of the France Life Imaging (FLI) and H2020[1]. The SPCCT system (Philips Healthcare) is a large field-of-view (50 cm in-plane) clinical prototype CT equipped with energy-sensitive photon-counting detectors[9]. It is noteworthy to mention that an upgrade SPCCT system will be appointed in my hospital (centre hospitalier universitaire Louis Pradel, Lyon, FRANCE) that will enable to pursue both pre-clinical and clinical research.

Research will be performed at CERMEP (https://www.cermep.fr/), a local multimodal *in vivo* imaging platform that will enable the use of following validation methods: Spectral lung CT ventilation with Xenon, PET-CT with [11C](R)-PK11195 radioligand for inflammation imaging, lung V/Q scintigraphy and several imaging facilities for small animals: micro-PET-CT, 7T MRI and micro-CT. The CERMEP hosts research teams with complementary expertise (e.g., radiochemistry, instrumentation, biology, preclinical and clinical imaging, PET kinetic modelling) in collaboration with Hospices Civils de Lyon, and CREATIS imaging Lab. The proximity with the European Synchrotron Radiation Facility (Grenoble) provides the optimal conditions for technical development and benchmarking of Color K-edge imaging.

Expected outcomes

Types of outcomes	Description
Knowledge on SPCCT technology	Access to a high resolution quantitative and specific color K-edge imaging
Knowledge on contrast agent field	Access to biocompatible non specific and specific contrast agents dedicated to lung diseases
Knowledge on lung disease imaging	Accurate characterization of ventilation, perfusion and molecular physiopathological process and their interactions
Spread of a new imaging tool	Implementation in upcoming commercially SPCCT systems
Diagnosis and prognosis in one single breath hold	Earlier and accurate evaluation of lung diseases
Societal outcomes	Paradigm shift of the standard-of-care for all lung diseases for a greater survival
Economic outcomes	Access to a one-stop shop modality
Imaging-guided therapy	Access to a tool for guiding the therapy and monitoring the efficacy
Personalized medicine	Access to a specific and quantitative characterization of lung diseases
Theranostic imaging	Access to contrast agents able to be used as therapeutic platforms for drug delivery treatments

Candidate profile

- MSc in Biomedical Engineering
- Interdisciplinary experience
- Basic knowledge of medical imaging
- Proficiency in English.

Application

- Cover letter, Curriculum Vitae
- MSc diploma
- Any additional document: letter(s) of recommendation, publications, etc.
- Please feel free to contact me beforehand for any further pieces of information (salim.si-mohamed@chu-lyon.fr).

References

1. Si-Mohamed S, Bar-Ness D, Sigovan M, et al. Review of an initial experience with an experimental spectral photon-counting computed tomography system. *Nucl. Instrum. Methods Phys. Res. Sect. Accel. Spectrometers Detect. Assoc. Equip.* 2017;873:27–35.

2. Si-Mohamed S, Cormode DP, Bar-Ness D, et al. Evaluation of spectral photon counting computed tomography K-edge imaging for determination of gold nanoparticle biodistribution in vivo. *Nanoscale*. 2017;9(46):18246–18257.

3. Si-Mohamed SA, Sigovan M, Hsu JC, et al. In Vivo Molecular K-Edge Imaging of Atherosclerotic Plaque Using Photon-counting CT. *Radiology*. 2021;300(1):98–107.

4. Si-Mohamed S, Tatard-Leitman V, Laugerette A, et al. SPCCT in-vivo single-acquisition multi-phase liver imaging with a dual contrast agent protocol. *Sci. Rep.* 2019;9(1):8458.

5. Cormode DP, Si-Mohamed S, Bar-Ness D, et al. Multicolor spectral photon-counting computed tomography: in vivo dual contrast imaging with a high count rate scanner. *Sci. Rep.* 2017;7(1):4784.

6. Si-Mohamed S, Bar-Ness D, Sigovan M, et al. Multicolour imaging with spectral photon-counting CT: a phantom study. *Eur. Radiol. Exp.* 2018;2(1):34.

7. Si-Mohamed SA, Boccalini S, Villien M, et al. First experience with a whole-body spectral photon-counting CT clinical prototype. *Invest Radiol*. 2023.

8. Douek PC, Boccalini S, Oei EHG, et al. Clinical Applications of Photon-counting CT: A Review of Pioneer Studies and a Glimpse into the Future. *Radiology*. 2023;309(1):e222432.

9. Steadman R, Herrmann C, Livne A. ChromAIX2: A large area, high count-rate energy-resolving photon counting ASIC for a Spectral CT Prototype. *Nucl. Instrum. Methods Phys. Res. Sect. Accel. Spectrometers Detect. Assoc. Equip.* 2017;862:18–24.

Links

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PubMed – https://www.ncbi.nlm.nih.gov/myncbi/1bOP9mNpwa8Av/bibliography/public/

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