Universität Basel

# Research Project

## Synergetic Development of Steady State Imaging Concepts and Registration Methods for In-Vivo Functional and Morphological Magnetic Resonance Imaging of the Lung in Paediatric Pneumology

### Third-party funded project

**Project title** Synergetic Development of Steady State Imaging Concepts and Registration Methods for In-Vivo Functional and Morphological Magnetic Resonance Imaging of the Lung in Paediatric Pneumology
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**Organisation / Research unit**
Departement Biomedical Engineering / Center for medical Image Analysis & Navigation (Cattin)
**Department**
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**Probable end** 31.10.2016
**Status** Completed

It is well known that chronic disease of the lung in early childhood will affect lung growth and development, and thus determine long term respiratory morbidity in later age. Early detection of chronic lung disease and early treatment are the cornerstones of successful paediatric respiratory medicine in order to prevent alterations in lung growth and development. Typical paediatric disorders are not only cystic fibrosis, chronic lung disease of prematurity or severe asthma but also inborn alterations of the lung and thorax malformations. The University Children's Hospital in Basel (UKBB) is a competence centre for chronic respiratory disease as well as for inborn malformation of the chest and spine.

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Children with such disorders often show progression of lung fibrosis, severe ventilation inhomogeneities or bronchiectasis with increasing age. Targeted treatment, aims to prevent these severe complications.

Normal chest X-ray, currently the gold standard, often fails to detect early signs of such lung fibrosis, severe ventilation inhomogeneities or bronchiectasis. To detect such structural abnormalities, multibreath gas washout lung function tests and plethysmography are used, whereas CO-diffusion tests are used to detect functional abnormalities in children. Often structural and functional monitoring is needed to adequately diagnose and monitor the disease progression in these children. The main drawback is the implied high radiation dose, particularly when used in yearly intervals.

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There is an urgent need for X-ray radiation free imaging methods to detect structural abnormalities. However, direct visualisation of the lung parenchyma with corresponding airspaces, associated with the bronchial structure, represents one of the remaining fundamental challenges with proton-based MRI. This issue can be overcome by the inhalation of hyperpolarised gases to visualise the airspaces rather than the parenchyma, but requires dedicated instrumentation and technology that is typically limited to research laboratories. Only recently, we were able to visualise, for the first time, directly the lung parenchyma and corresponding airspaces with high contrast-to-noise using a novel ultra-fast steady state imaging approach.

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Based on our initial experience with this novel imaging approach in combination with the required post-processing of the data (image registration), we will be able to non-invasively assess functional as well as structural aspects of the lung in children. Thanks to the strong track record of the UKBB in developmental physiology and physiological measurements of the lung, the current project will allow comparing such new MRI techniques to clinical routine lung function measurements immediately and seamlessly.

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In the proposed research we plan on developing the techniques allowing to expand the knowledge about lung function in children. In particular we aim at developing new MR pulse-sequences for lung imaging and the post-processing of the data to extract dynamic ventilation information (in 2D and 3D), as well as 2D perfusion maps.

**Financed by**
Swiss National Science Foundation (SNSF)

**Add publication**

**Published results**

4409998, Sandkuehler, Robin; Jud, Christoph; Cattin, Philippe Claude, Adaptie Graph Diffusion Regularisation for Discontinuity Preserving Image Coregistration, Publication: ConferencePaper (Artikel, die in Tagungsbänden erschienen sind)

4410012, Jud, Christoph; Sandkuehler, Robin; Cattin, Philippe Claude, An Inhomogeneous Multi-resolution Regularization Concept for Discontinuity Preserving Image Registration, Publication: ConferencePaper (Artikel, die in Tagungsbänden erschienen sind)

3765803, Sandkuehler, Robin; Jud, Christoph; Cattin, Philippe C., On a Spectral Image Metric for Non-Rigid Group-wise Registration of Dynamic MR Image Series, Publication: ConferencePaper (Artikel, die in Tagungsbänden erschienen sind)

4410067, Jud, Christoph; Giger, Alina; Sandkuehler, Robin; Cattin, Philippe C., A Localized Statistical Motion Model as a Reproducing Kernel for Non-rigid Image Registration, 0302-9743 ; 1611-3349 ; 978-3-319-66184-1 ; 978-3-319-66185-8, Publication: ConferencePaper (Artikel, die in Tagungsbänden erschienen sind)

4410076, Jud, Christoph; Sandkuehler, Robin; Moeri, Nadia; Cattin, Philippe C., Directional Averages for Motion Segmentation in Discontinuity Preserving Image Registration, 0302-9743 ; 1611-3349 ; 978-3-319-66181-0 ; 978-3-319-66182-7, Publication: ConferencePaper (Artikel, die in Tagungsbänden erschienen sind)

**Add documents**

**Specify cooperation partners**