

CEIPEX BUT TOPIC 8

Položka / Field	Obsah / Content
CEIPEX RESEARCH TOPIC LEVEL 1	Industrial Cybernetics
CEIPEX RESEARCH TOPIC LEVEL 2	Advanced instrumentation and methods for materials characterization
NAME OF THE RESEARCH GROUP	Advanced Instrumentation and Methods for Materials Characterization (RG-1-06)
SUPERVISOR	Prof. Jozef Kaiser
POTENTIAL CO-SUPERVISOR	Dr. Markéta Kaiser
PROPOSED RESEARCH TOPIC TITLE	4D in-vivo X-ray microCT for longitudinal imaging of coral biomineralization and skeletal dynamics
RESEARCH TOPIC DESCRIPTION	Reef-building corals construct their skeletons through biomineralization, a biologically controlled process that is highly sensitive to environmental change and central to reef resilience under ocean warming and acidification. Understanding how corals build, remodel, and compete for space at the skeletal level requires imaging methods capable of resolving structural change over time. However, most existing X-ray microCT studies of corals rely on ex-vivo, single-timepoint scans, which cannot capture dynamic growth processes and preclude longitudinal analysis of individual colonies. Emerging evidence suggests in-vivo microCT imaging of living corals is feasible, but no standardized, validated methodology currently exists to guide safe and reproducible acquisition. This project aims to develop and rigorously validate a 4D X-ray microCT framework for longitudinal, non-destructive imaging of living corals, establishing a transferable methodology for tracking biomineralization dynamics and competitive skeletal interactions under environmental stress. The project will (i) characterise radiation effects in living coral tissue, including absorbed dose, exposure duration, and species-specific sensitivity, to establish safe scanning thresholds, building on pilot in-vivo scans already acquired; (ii) systematically optimise acquisition parameters as scan duration and inter-scan recovery intervals to minimise cumulative radiation exposure while preserving imaging fidelity; (iii) improve reconstruction quality through voxel resolution optimisation, noise reduction, and sparse-view imaging strategies to reduce scan time without compromising resolution; and (iv) apply the validated 4D protocol to quantify skeletal growth rate, density banding, and competitive interactions (e.g., overgrowth, boundary formation) between coral colonies across environmental gradients such as temperature, pH or nutrients. This project directly contributes to CEITEC's research priorities in advanced imaging methodology, non-destructive characterisation, and quantitative structural analysis of biological materials. By establishing the first standardized, radiation-safe protocol for in-vivo 4D microCT of living organisms, the project extends the expertise in computed tomography into a novel biological application domain, with a transferable framework applicable to other CaCO₃-biomineralizing and structurally dynamic living systems.

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KEYWORDS	X-ray microcomputed tomography; 4D imaging; coral biomineralization; skeletal growth; in-vivo imaging; radiation dose; environmental stress; coral reefs
INTERDISCIPLINARY DIMENSION	This project embodies CEITEC's core mission of bridging biology and technological advancement, bringing together X-ray microtomography, radiation dosimetry, image processing, and quantitative structural analysis with coral physiology and reef ecology. By combining these imaging and analytical methods within a single validated framework, the project will generate a transferable, radiation-safe protocol for in-vivo 4D imaging of living organisms extending CEITEC's technological expertise into a novel biological application domain and positioning the resulting methodology and findings for recognition at the highest international level, with relevance extending to other CaCO₃-biomineralizing and structurally dynamic living systems.
WEBPAGE OF THE RESEARCH GROUP	https://www.ceitec.eu/advanced-instrumentation-and-methods-for-materials-characterization/rg6