I/UCRC Executive Summary - Project Synopsis	**Date**: March 2019

Center/Site: CANFSA/Colorado School of Mines

Tracking No.: 32-L: Development of Cabinet Based Computed Tomography Methods for Studies of Microstructures and Defects in Metals	**Phone:** (720) 363-3626	**E-mail:** chbecker@mines.edu

Center/Site Director: M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Chandler "Gus" Becker	**Proposed Budget**: $240,000, Leveraged

Project Description: X-ray radiography and computed tomography (CT) will be used to characterize microstructures and defects and the links to materials processing and properties. The focus will be on learning and establishing high-energy micro-focus X-ray radiography and CT in the laboratory at Mines, and the limitations of this technique for "seeing" microstructural characteristics of interest, such as defects produced by additive manufacturing. The ability to use this technique to study material dynamics (e.g. during processing) will also be explored. Comparisons will be made to other imaging techniques, such as synchrotron X-ray radiography, proton radiography, and electron radiography. The techniques used in processing and reconstructing tomographic radiography data will be evaluated, and the data obtained in this project will be used to inform and develop materials process models when appropriate.

Experimental plan: Processing and analyzing of data from previous *in-situ* radiography experiments is underway, which will be followed by experiments with E-6 at Los Alamos National Laboratory (LANL) to gain familiarity with radiography and CT. In the proposed project, this knowledge and these skills will be used to set up a laboratory capability for in-situ experiments at Mines.

Related work elsewhere: Experiments will be carried out at E-6 at LANL and at the Advanced Photon Source (APS) at Argonne National Laboratory. Similar experiments at Mines are an ultimate goal of this project. Comparisons with proton and electron radiography may also be performed.

How this project is different: This project seeks to further develop X-ray radiography techniques by establishing state-of-the-art micro-focus X-ray imaging capabilities at Mines. Further understanding of microstructural and defect evolution related to solidification is also an interest in this project.

Milestones for the current proposed year: Increased amount of quantitative information extracted from radiography data. Reconstruction of tomography data from synchrotron experiments. The X-ray cabinet donated by LANL is in the final steps of hardware refurbishment before delivery to Mines.

Deliverables for the current proposed year: Deliverables for the current year include: increasingly refined processing of synchrotron and laboratory X-ray radiography data to extract microstructural characteristics and evolution, applying powerful Python algorithms to data processing, and initial tomography on additive manufacturing (AM)-built lattice structures acquired from the national laboratories.

How the project may be transformative and/or benefit society: This project will enable the imaging of dynamic materials processes in the laboratory, without the need to travel to a synchrotron source at a national user facility. Laboratory X-ray imaging and computed tomography will also be useful for static imaging of metal parts to check for quality and potential defects and characterization of AM-built parts.

Research areas of expertise needed for project success: Radiography, image processing, image analysis, metallurgy, materials science, physics, materials processing.

Potential Member Company Benefits: This project is of direct interest to LANL, but non-destructive evaluation is also of interest to Sandia National Laboratories and CANFSA's aerospace members that need to qualify and certify parts by identifying performance-limiting defects.

Progress to Date: Extraction of quantitative information from AM Simulator experiments. Development of ImageJ and Python scripts to efficiently process large datasets of radiography data.

Estimated Start Date: Fall 2017	**Estimated Knowledge Transfer Date**: Spring 2021

The Executive Summary is used by corporate stakeholders in evaluating the value of their leveraged investment in the center and its projects. It also enables stakeholders to discuss and decide on the projects that provide value to their respective organizations. **Ideally, the tool is completed and shared in advance of IAB meetings to help enable rational decision making.**