I/UCRC Executive Summary - Project Synopsis	**Date**: April 2022
Center/Site: CANFSA/Colorado School of Mines	
Tracking No.: 32-L: Algorithmic Analyses of X-Radiography and Computed Tomography for Multiscale Structural Investigations of 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**: $320K, Leveraged

Project Description: X-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 microfocus x-radiography and CT in the laboratory at Mines and the limitations of this technique for resolving microstructural characteristics of interest, such as defects produced by additive manufacturing (AM) or in mock high explosives (HE). The ability to use this technique to study material dynamics (e.g. during processing) will also be explored. Comparisons will be made to other forms of non-destructive testing (NDT), such as synchrotron x-radiography and proton radiography. Processing and reconstruction techniques for x-radiography and CT datasets will be evaluated. Data obtained in this project will inform and develop materials process or deformation models, when appropriate.

Experimental plan: Processing and analyzing of data from previous in-situ radiography experiments performed with E-6 at Los Alamos National Laboratory (LANL) are underway 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 x-radiography, CT, and possibly in-situ experiments at Mines.

Related work elsewhere: Experiments will be carried out at the Advanced Photon Source (APS) at Argonne National Laboratory and with available laboratory capabilities. Comparisons with proton radiography and/or dynamic transmission electron microscopy (DTEM) may also be performed.

How this project is different: This project seeks to further develop x-radiography techniques by establishing novel micro-focus x-ray imaging capabilities at Mines. Further understanding of microstructural and defect evolution related to processing and deformation of materials is of interest.

Milestones for the current proposed year: Continued adaptation of processing and analysis routines to Python Jupyter notebooks for improved reproducibility and presentation of methods and results. Produce a novel routine for segmenting pieces of crystals from binder in mock HE after CT scans.

Deliverables for the current proposed year: Publication exhibiting automated procedures for identifying solid-liquid interfaces across two separate experiments: AM simulator experiments performed at the APS and rapid solidification DTEM experiments. A procedure is also being developed to segment crystals encased in a binder in mock HE, enabling transfer of quantitative information regarding the shape and distribution of individual particles from CT-scanned experiments to modeling of materials processing and deformation.

How the project may be transformative and/or benefit society: This project will enable 2D and 3D imaging of dynamic materials processes in the laboratory, without the need to travel to a synchrotron source. Laboratory x-ray imaging and CT will also be useful for static imaging of metal parts and particulate composites (e.g., mock HE), for example, checking for quality and potential defects.

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

Potential Member Company Benefits: This project is of direct interest to LANL, but NDT is also of interest to Sandia National Laboratories, Lawrence Livermore National Laboratory, 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 workflows to efficiently process large datasets of radiography data. Development of a web app to track solidification velocities from in-situ solidification experiments. CT and reconstruction of AM-built lattice structures and image segmentation of mock high explosives.

Estimated Start Date: Fall 2017	**Estimated Knowledge Transfer Date**: Fall 2022

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.**