Purpose
To establish that a spectroscopic (multi-energy) CT scanner can differentiate multiple contrast agents and background tissues. This is clinically significant because it enables multi-phase contrast studies to be performed in a single scan. For example, a "three-phase liver" is possible in a one-acquisition. This is a significant improvement from dual energy CT which is limited to non-contrast and post-contrast images from a single acquisition.

Method and Materials
A spectroscopic photon counting micro-CT scanner was constructed. This scanner, dubbed MARS-CT, uses CERN's energy selective photon counting detector Medipix. CT scanners based using this technology are often referred to as Medipix All Resolution Systems (MARS) since the scanners produce data with energy, spatial, and temporal information.

Spectroscopic (energy resolved) images where obtained by adjusting the energy threshold above which the Medipix detector counts photon interactions. Non-energy resolved images were obtained by summing together all energies producing images similar to single energy CT images.

K-edge Contrast agents included pharmacological preparations of barium, iodine, gadolinium, and lead were imaged in both phantoms and mice. Principal Components Analysis (PCA) was applied in the spectral (energy) domain to differentiated the contrast agents.
RESULTS
K-edge contrast have measurably different spectral characteristics. Within mice this allows differentiation of contrast agents. On single energy CT these contrast agents are all "bright" and can not be differentiated. The left side of the figure shows a volume rendering of standard intensity CT of a mouse's chest. The right side of the figure demonstrates the application of PCA to identify iodine and barium. Iodine in the vascular system is red and barium in the lungs in blue.

CONCLUSION
Spectroscopic (multi-energy) CT can differentiate multiple contrast agents. This allows multi-phase imaging protocols to be performed in a single acquisition. eg. Pre-, portal venous, and delayed phase contrast in a single scan. This will reduce patient x-ray dose and increase patient throughput.

CLINICAL RELEVANCE/APPLICATION
Multi-energy (spectroscopic) CT allows many phases of contrast enhancement to be acquired from a single scan.

FIGURE (OPTIONAL)
Uploaded Image

View Larger Image

Disclosures:

Director, MBI Ltd  Anthony Butler
Nothing to disclose: Nigel Anderson
Nothing to disclose: Michael Hurrell
Nothing to disclose: Nick Cook
Nothing to disclose: Nicola Scott
Director MBI Ltd Phil Butler
Questions:

1. **Published email:** Do you wish to have an email address published in the RSNA program?
   
   Yes
   
   If yes, please provide one email address:
   
   anthony.butler@otago.ac.nz

2. **RSNA Research and Education Fund:** Was this work supported by a grant from the RSNA Research and Education Fund?
   
   No

3. **Previously Presented/Published:** The RSNA requires that all abstracts submitted for scientific presentation be original work, not previously presented at other national or international radiological society meetings and not previously published. An abstract which includes an increased number of cases with a new analysis of the data and additionally demonstrates a significant change in results is considered new research; therefore, such work is eligible for consideration. If an abstract merely reflects an increase in the number of cases with no significant difference in the results, it will not be considered.

   Has this work been previously presented or published?
   
   No
   
   If yes, please indicate where previously published or presented and specify if the current results are substantially different. PLEASE NOTE, if the work--or a substantial part of it--has been previously presented or published, the presenter must discuss with Scientific Program Committee Chair Dr Robert Quencer the acceptability of submitting this same work to the RSNA. Send inquiries to prog2009@rsna.org.

   **No response**

4. **Trainee Research Prize:** If you are interested in the Research or Medical Student award, the principal investigator and presenter must be the same and from North America. Non-imaging trainees are eligible if they are mentored by a member of the RSNA, AAPM or ASTRO. Please check below:

   Not Applicable
5. **Disclosure of "Off-Label" usage:** The RSNA recognizes the authors may discuss the application of devices, materials, or pharmaceuticals that are not FDA approved for the discussed application. In keeping with the highest standards of professional integrity and ethics, the RSNA requires full disclosure of the discussion of the unlabeled use of a medical device, product, or pharmaceutical that has not been approved by FDA. Please mark the appropriate response below as to whether you or any of your co-authors will or will not describe the investigational or "Off-label" use of a medical device, product or pharmaceutical that is classified by the FDA as investigational for the intended use. If you or any of your co-authors will discuss or describe investigational or unlabeled products, the presenting author is responsible for disclosing the information to the audience.

No, I do not intend to discuss off-label uses

6. **Molecular Imaging Travel Award:** RSNA will offer travel awards for abstracts accepted for presentation in the Molecular Imaging section (description and eligibility requirements for the award can be viewed in HELP>General Information). Are you submitting an abstract to the Molecular Imaging section?

No

7. Molecular Imaging Travel Award Eligibility (a response is required for every submission): Have you been awarded your doctoral degree no more than seven years prior to the time of submission?

Not applying for the travel award listed above

8. **Digital Scientific Presentations:** If your presentation is accepted, and with the permission of the authors, RSNA will post digital scientific presentations on the Web for a maximum of one year after the RSNA annual meeting. RSNA scientific presentations posted on the Web are not considered prior publication by the editors of *Radiology* and *Medical Physics*. Thus the manuscript of your presentation will be considered for publication if you choose to submit it.

I give RSNA permission to record and post my presentation.

9. **The work for this abstract was primarily conducted at:** (Provide institution name, city, state [or country] only, no addresses, please.)
Ex: University of Name, Chicago, IL --or-- University of Name, Athens, Greece)
University of Otago Christchurch New Zealand

10. Please provide the name of the department chair for the institution listed above:
Prof Tim Buckenham

11. Institution: RSNA provides department chairs a list of presenters of accepted presentations associated with physicians from their institutions. In order to ensure that this work is appropriately recognized, please indicate the institution at which the presenter is affiliated:
University of Otago Christchurch New Zealand

12. Department Chair: Please indicate the name of the presenter's department chair or highest ranking supervisor:
Prof Tim Buckenham

13. Department Chair Email Address: Please provide the email address for the person indicated above:
Tim.Buckenham@cdhb.govt.nz

14. Quantitative Imaging is the extraction of quantifiable features from medical images which add to the clinical assessment of the severity, degree of change, or relative status of a disease, injury, or chronic condition. Quantitative imaging is the development, standardization, and optimization of anatomical, functional, and molecular imaging acquisition protocols, data analyses, display methods, and reporting structures in order to permit the validation of precisely and accurately obtained image-derived metrics with physiologically relevant parameters, including treatment response to novel interventions and clinical outcomes, and the use of such metrics in clinical research and patient care.

Does this work include Quantitative Imaging which is the extraction of clinically relevant quantifiable features from medical images?
Yes