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Algorithm-Enabled Dual- or Multi-Energy (i.e., Photon-Counting) CT for Possible Security-Scan Applications

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So What? Who Cares?

- *Motivation:* Rapid design and prototype dual-energy (DE) or multi-energy (ME) (or photon-counting) CT for possible security-scan applications
- *Solution*: Develop algorithms to enable the design and prototyping of DE/ME CTs that are tailored *rapidly* to specific applications and *cost-effective*.
- Results: Demonstrate an algorithm-enabled CNT-based DE CT in simulation studies. DE-CT systems/scans with other readily available hardware components can also be designed and prototyped.
- TRL: 5~? (Technology development and demonstration)
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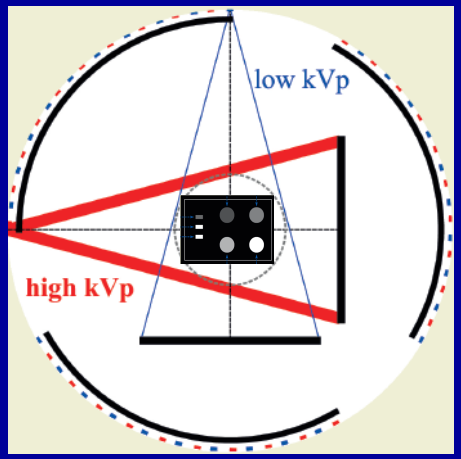
Algorithm-Enabled CNT-Based DE CT

- It is unrealistic to use current CNT hardware to develop DE/ME CT satisfying the restrictive imaging conditions required by existing algorithms.
- It is unclear whether it is practically possible to make CNT hardware satisfying the restrictive imaging conditions. Even if so, it is likely to be of high cost.

- New algorithms have been developed recently for image reconstruction images from DE/ME data collected at alternating sparse views over partial-angular ranges.
- They can thus be exploited to prototype and enable rapidly the design of CNT-based DE/ME CT with practically realistic CNT hardware and scan configurations.



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Algorithm-Enabled DE/ME Imaging

Both hardware and algorithm impact the application success.

Current DE/ME R&D focuses largely on new hardware, while existing algorithms are used, which often impose highly restrictive constraints on data collection. Meeting the conditions can lead to increased cost and slowed process of significant hardware addition/modification.

New algorithms develoeped enable new DE/ME system and/or scan configurations with standard hardware without significant hardware modification/addition, thus reducing the development cost and time.

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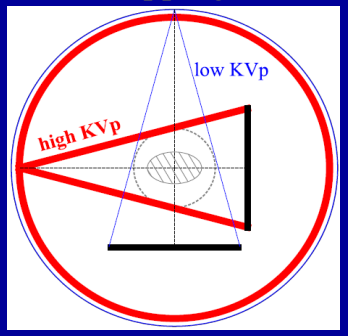
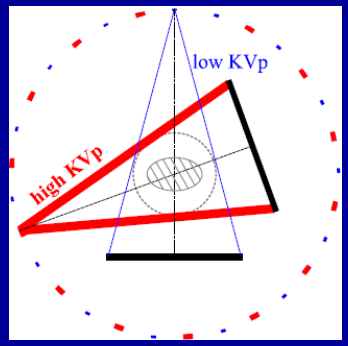
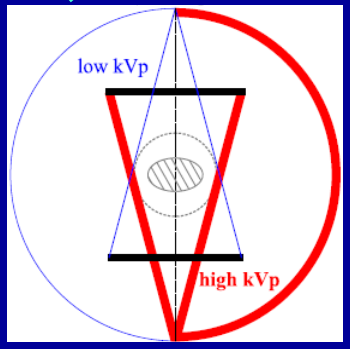
Alternating-Sparse-View-Scan DE CT
Standard-Scan DE CT
Alternating-Partial-Angular-Scan DE CT

Standard overlapping-dense-view scan





Alternating-sparse-view samples



Alternating-partial-angular scan

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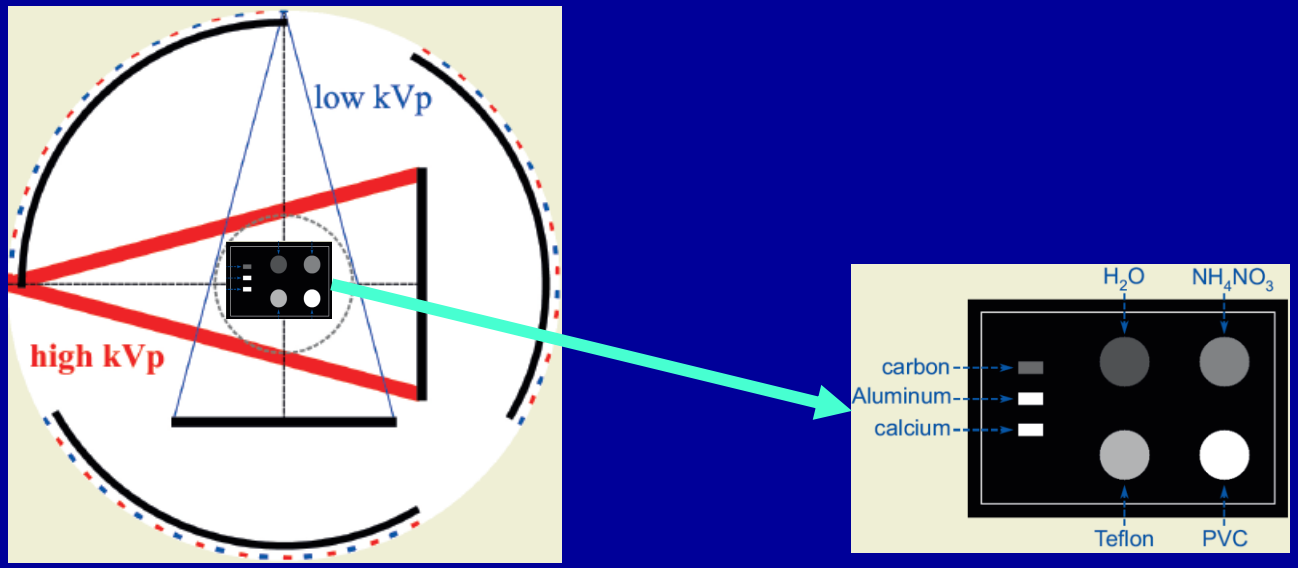
CNT-Based DE CT

- It is unrealistic to use current CNT hardware to develop DE/ME CT satisfying the restrictive imaging conditions required by existing algorithms.

- The new algorithms may reconstruct images from DE/ME data collected at alternating sparse views over partial-angular ranges.
- It may thus be exploited to enable the design of CNT-based DE/ME CT with practically realistic CNT hardware and scan configurations.



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Reconstructed Parameter Images

Atomic-# Images

Atomic # image (z-image)

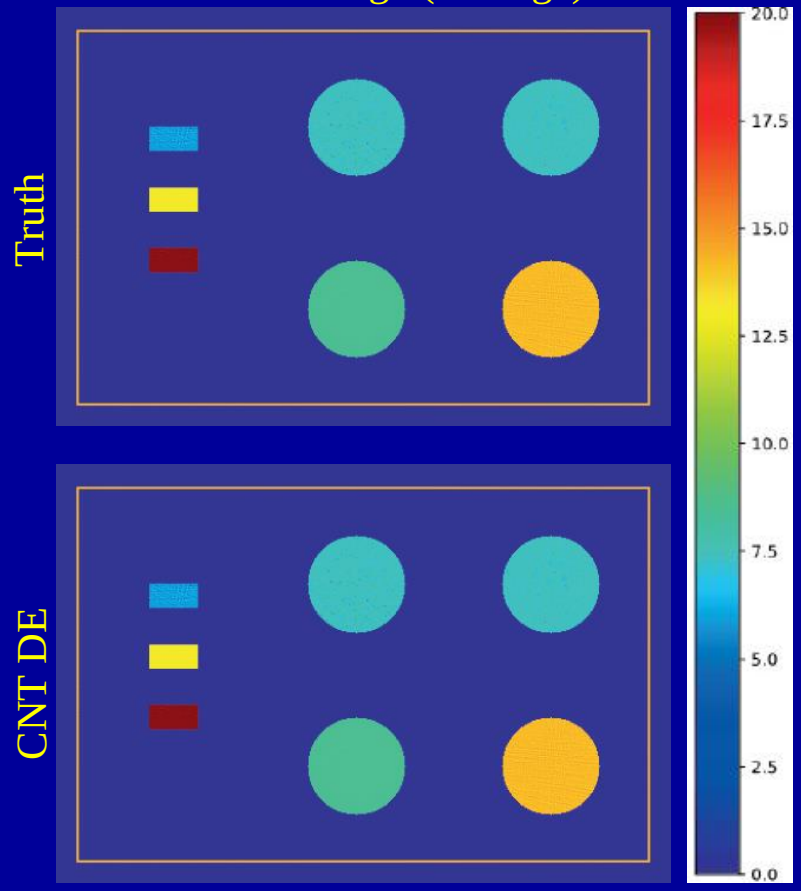

TABLE I: effective atomic number results

	truth*	standard	CNT DE
C	6	5.97	5.93
Al	13	13.06	13.06
Ca	20	19.94	19.94
H_2O	7.42	7.44	7.43
NH_4NO_3	7.40	7.42	7.41
Teflon	8.43	8.47	8.47
PVC	13.86	14.17	14.17

* reference values calculated using Murty's formula

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Discussion

- Algorithms can be exploited to design, prototype, and enable the development of DE/ME CT systems and/or scans, tailored to specific applications, yet w/o significant hardware modification or addition. (Low-cost and rapidness)
- An example design of CNT-based DE CT using current CNT hardware is discussed and demonstrated in a simulation study.
- We are interested in possible collaboration on the development of DE/ME CT by use of standard scanners and/or currently readily available hardware tailored to specific imaging conditions and applications of the collaborators' interest.

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Thank you for your attention.