PHILIPS

Computed tomography

Research study

# Employing **spectral detector CT imaging** in routine diagnosis

## Adding spectral results to improve clinical value and diagnostic confidence

Zimam Romman, PhD; Galit Kafri, PhD; Ekta Dharaiya, MS

Purpose: To investigate the clinical additions and diagnostic confidence of spectral images generated from spectral detector CT to routine conventional image data. The following is a summary of a comprehensive research study carried out by radiologists from the University of Texas Southwestern Medical Center (UTSW, Texas, USA).

### Introduction

The Philips IQon Spectral CT is the world's first spectral detector-based computed tomography (SDCT) scanner. Unlike other multi-energy CT scanners, the IQon has a single X-ray source and a two-layer detector. The top layer of the detector selectively absorbs low-energy photons and the bottom layer absorbs high-energy photons, thus providing two distinct energy data sets.[1] In addition to the conventional images that are obtained by utilizing combined data from both detector layers, additional spectral analysis can be obtained by decomposition of the low- and high-energy data. A unique feature of this technology is that there is no need to prospectively screen and select patients for dual-energy mode since all the patients scanned on this scanner will have spectral information, available 100% of the time, even in patients in whom there would have been no specific clinical indication for a dual-energy acquisition. Hence, there is no need to change the existing clinical protocol or workflow. Other advantages of the scanner include spatial and temporal alignment, projection space decomposition with lower artifacts, availability of all dose tools, and no field-of-view limitations or cross-scatter effects. Spectral CT imaging can add different spectral image types and clinical value to the conventional data.

Spectral results derived from SDCT, including iodine-based results, virtual non-contrast (VNC), and virtual monoenergetic images (from 40-200 keV), assist in clinical decision-making. A brief description of these spectral results along with their clinical benefits are listed below.

- **Iodine-based results** – Material density images that allow iodine quantification.
- **Virtual non-contrast image** – Shows image as if iodine component is removed. It can be used for non-contrast imaging without non-contrast scanning.
- **Monoenergetic image (MonoE)** – Image that shows attenuation as if a single monochromatic energy (keV) were used to scan. It can be used for boosting an iodine signal, improvements in contrast to noise, beam hardening artifact reduction, and metal artifact reduction.

## Approach

A detailed image evaluation was performed by 11 UTSW radiologists. These 11 radiologists had different ranges of experience (4-15 years). The radiologists performed the review of a total of 53 CT studies (9 brain and 44 body). Different spectral results were reviewed for different scans as listed in **Table 1** below.

For body with contrast, a total of nine different spectral results were reviewed including different MonoE settings, virtual non-contrast, and iodine-based results. For body with no contrast only, the images with high MonoE spectral results were reviewed. For brain with contrast, seven different spectral results were reviewed, and for brain with no contrast six different spectral results were reviewed (as listed in Table 1). A total of 449 review forms were completed for 53 data sets by 11 radiologists.

Each spectral image type was analyzed for potential added clinical value and diagnostic confidence.

- For clinical value, a range of 1-5 grade scale was used where any rank ≥ 3 was considered satisfactory
- For diagnostic confidence, a grade scale 1-4 was used where any rank ≥ 2 was considered satisfactory
- The pass criteria for the clinical value and diagnostic confidence were combined and was set to 2.7 (2/3*3 + 1/3*2)

Weighted ranks which included the clinical value grade and the diagnostic confidence were calculated for each result as follows: 2/3 of the average clinical value rank + 1/3 of the average related diagnostic confidence.

- Weighted ranks ≥ 2.7 were considered "Satisfactory added clinical value over conventional image"
- Weighted ranks < 2.7 were considered "Not satisfactory added clinical value over conventional image"

| | 40 keV | 50 keV | 60 keV | 100 keV | 140 keV | MonoE kV-equiv. | Iodine-based | VNC |
|---|---|---|---|---|---|---|---|---|
| Body with contrast | • | • | • | • | • | • | • | • |
| Body no contrast | | | | • | • | • | | |
| Brain with contrast | • | • | • | • | • | • | • | |
| Brain no contrast | • | • | • | • | • | • | | |

**Table 1** Spectral results reviewed for various CT exams.

## Results

The diagnostic value and diagnostic confidence for the various spectral results for brain and body are listed in **Figure 1** below. Diagnostic value for all the results was greater than 3 and diagnostic confidence for all the results was greater than 2, and therefore considered satisfactory.

Weighted averages for the different spectral results demonstrate that the weighted value is greater than 2.7 for all the spectral results (**Figure 2**).

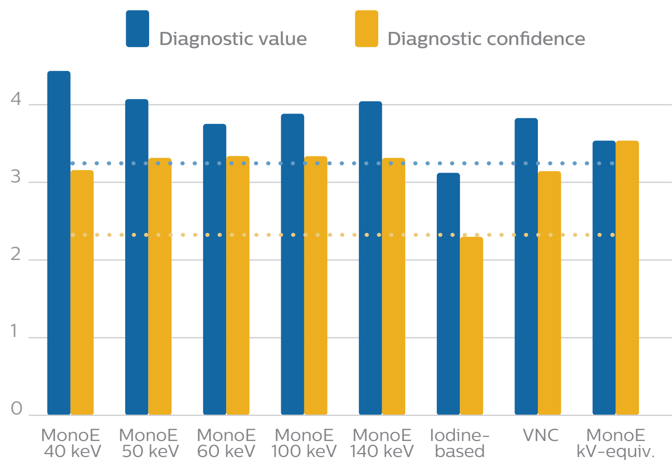


**Figure 1** Diagnostic value and diagnostic confidence for various spectral results.

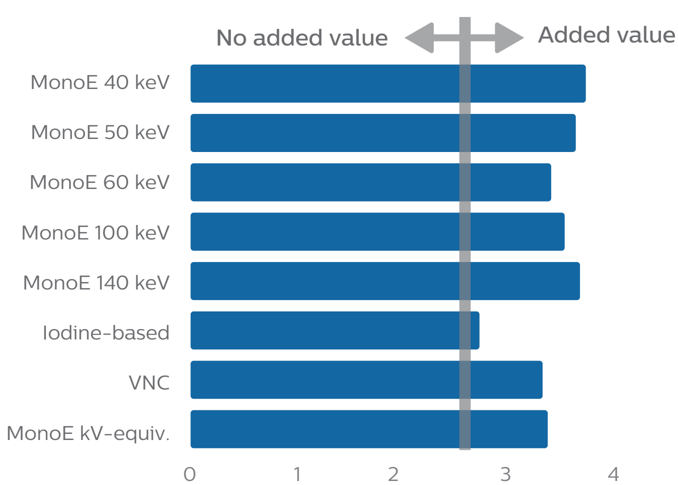


**Figure 2** Weighted averages for various spectral results for brain and body cases.

Based on the feedback from the radiologists, the following benefits were observed for various spectral results in body images:

- Improved iodine enhancement was observed at 40 keV, 50 keV, 60 keV, and iodine-based images
- Better structure (hypo-dense and hyper-dense) visualization was observed at 40 keV, 50 keV, 60 keV, and iodine-based images
- Artifact reduction was observed at 100 keV and 140 keV
- Virtual non-contrast results were used for creating non-contrast images from a contrast-enhanced scan

Following are clinical benefits that the radiologists observed in brain images:

- Improved iodine enhancement was observed at 40 keV, 50 keV, 60 keV, and iodine-based images
- Better structure (hypo-dense and hyper-dense) visualization was observed at 40 keV, 50 keV, and 60 keV
- Better gray and white matter differentiation was observed at 40 keV, 50 keV, and 60 keV
- Artifact reduction was observed at 100 keV and 140 keV
- Virtual non-contrast results were used for creating non-contrast images from a contrast-enhanced scan

Overall improved image quality for all brain and body cases was observed for kVp equivalent MonoE images.

## Conclusion

Employing spectral images generated from the Philips IQon Spectral CT can add clinical value to conventional data sets. Employing spectral image data sets in routine workups can aid in diagnostic capabilities and improve visualization of iodinated structures, gray and white matter differentiation, and non-contrast information, and reduce metal artifacts.


1. Johnson T FC, Schönberg SO, Reiser, MF VA, eds. Dual layer CT. In: Dual energy CT in clinical practice Heidelberg, Germany: Springer. 2011;21–34.

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