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# Economic benefits offered by reduction of follow-up exams using spectral detector CT

**White Paper**

Philips CT Clinical Science • Philips Healthcare • USA

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IQon Elite Spectral CT abdomen, Body, bone marr calcium suppression, chest, Effective Z, follow up, fract iodine density, iodine no wa iodine overlay, lesion, Mono Musculoskeletal, Pelvis, prospective, retrospective, CT, uric acid, Vascular, virt contrast

## Introduction

While dual-energy CT scanners have long been available and are used across several clinical applications, existing source-based dual-energy scanners have not been routinely adopted into clinical workflow. This is largely due to the fact that for many dual-energy scanners, the decision regarding whether to operate the scanner in dual-energy mode is required prior to scan initiation. In addition, dual-energy scanning necessitates specific protocols in order to produce spectral results. Philips IQon Elite Spectral CT, however, is a detector-based spectral CT scanner that requires no special protocols for scanning in spectral mode, and these spectral results are always available on-demand.

Spectral results derived from IQon Elite Spectral CT include iodine-based results, virtual non-contrast (VNC), virtual monoenergetic images (from 40- 200 keV), effective atomic number, calcium-suppressed images and uric acid. These results assist in clinical decision-making.

A brief description of available spectral results follows:

- *Iodine-based results* – Material density image that shows materials that behave like iodine and not like water. The results are useful in identifying iodine uptake in images and also in quantifying iodine.
- *Virtual non-contrast (VNC)* – Shows image as if the iodine component is removed. The images are useful for simulating a non-contrast scan.
- *Monoenergetic (MonoE)* – Image shows attenuation as if a single monochromatic energy (keV) was used to scan. This result is useful in boosting the iodine signal, improving contrast-to-noise ratio at low keVs and reducing artifacts (metal and beam hardening) at high keVs.
- *Effective Z* (effective atomic number) – Shows effective atomic number value at every pixel, which is derived from the photon and scatter values computed from the low- and high-energy signals. This result is useful in material and tissue differentiation.
- *Uric acid* – Generated by computing and identifying pixels where uric acid is present. This result provides assistance in detection of uric acid stones, detection of uric acid deposits due to gout, and tendon visualization.
- *Calcium suppression* – Image that shows HU values without calcium contribution to the attenuation. This result can be used in the assessment of intervertebral disc herniation or visualization of bone marrow involvement when bone fractures are present.
- *Electron density* – The values presented in the image are relative to the electron density of water in units of percent. It can be used to estimate electron density of each voxel for therapy planning.

All of these results are available retrospectively and on-demand, providing additional information to improve diagnostic confidence of the radiologist by aiding in differential diagnosis and salvaging sub-optimal contrast-enhanced studies, especially in patients who

may not have been preselected to be scanned in spectral mode or in patients with incidental findings.

**CT study guidelines**
Chest-abdomen-pelvis (CAP) scans and CT angiography (CTA) scans are routinely performed on a CT scanner, comprising roughly 30-50% of total examinations. These scans are performed for a variety of clinical indications that may or may not warrant a spectral mode of scanning.

Incidental findings are so commonly encountered on abdomen CT scans (approximately 15-20%) that the American College of Radiology has issued guidance on management of incidental findings identified on abdominal CT. These guidelines recommend follow-up imaging exams on different modalities depending on the size and nature of the incidental finding to enhance diagnostic confidence.[1] Contrast timing is of utmost importance for a high-quality CTA exam. However, there are multiple factors that could affect the contrast timing, leading to a sub-optimal CTA exam. These exams would then need to be repeated in order to make a confident diagnosis, which may expose the patient to additional radiation or contrast dose.

A study was designed to identify indications from CAP and CTA exams that would benefits from spectral results such as MonoE, VNC, and iodine maps. The following summary discusses the results of the clinical study published in the Journal of Clinical Imaging,[2] and includes an additional economic analysis to show the potential economic value the IQon Elite Spectral CT can provide.

**Methods**
This study included 118 consecutive body CT cases that were scanned using the IQon Elite Spectral CT over a period of 10 months from October 2013 to August 2014. Data analysis was performed by two independent radiologists (Reader 1 and Reader 2). Based on the clinical indication of the scan, the two radiologists were asked if they would have prospectively requested a dual-energy scan for the patient. The radiologists then reviewed the conventional CT images from the IQon Elite Spectral CT independently, blinded to each other, and selected cases they believed would benefit from the availability of spectral results. The on-demand capability of IQon Elite was used to generate the requested spectral images. The clinical beneit of the spectral results in improving diagnostic capability was evaluated on a 5-point scale:

1. Very low significance
2. Low significance
3. Intermediate significance
4. Moderate significance
5. High significance.

A score of 3 was considered useful, and scores of 4 and 5 were considered clinically significant, making an impact on the final diagnosis. To evaluate the economic benefits of spectral results in CAP and CTA exams, an additional analysis was performed post-study to evaluate potential savings realized from a reduction in follow-up scans using spectral results for patients whose exams received a rating of 4 or 5.

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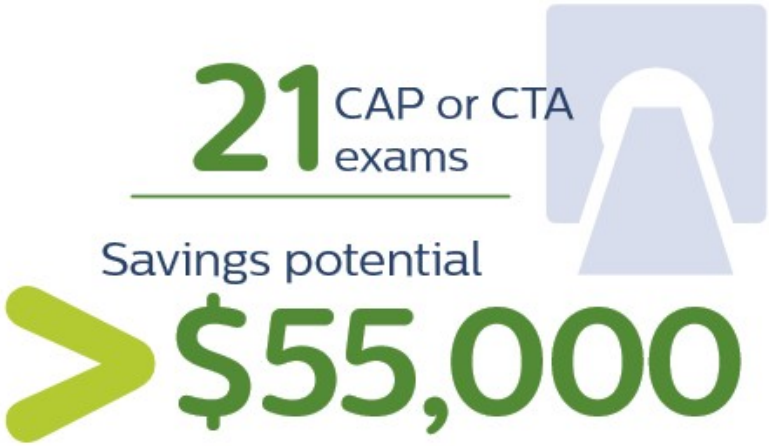
**Results**
Based on clinical indications, Reader 1 would have prospectively opted for a dual-energy scan in 20 (17%) of the 118 cases and Reader 2 would have prospectively opted for a dual-energy scan in 25 (21%) of the 118 cases.

Following review of the conventional images, Reader 1 desired spectral results retrospectively in 94 cases (80%), and Reader 2 chose additional spectral results retrospectively in 96 cases (81%). Reader 1 assigned a score of 4 or 5 to 31% of the 94 cases. Reader 2 assigned a score of 4 or 5 to 28% of the 96 cases. These were cases where spectral results added additional diagnostic information and follow-up scans could have been eliminated due to a high clinical benefit score of 4 or 5. The indications that contributed to the decrease in follow-up scans were increased confidence in lesion detection and diagnosis, salvaging sub-optimally enhanced studies, or characterization of incidentally detected lesions. Different spectral results including low and high MonoE, VNC, iodine-based images, effective Z images, and uric acid results were of clinical benefit based on the varying indications of the scans.

| Results | Total exams reviewed | Exams in which spectral results were desired upon review | Exams in which spectral results added clinically significant information, increasing diagnostic information and potentially eliminating need for follow-up scans |
|---|---|---|---|
| Reader 1 | 118 | 94 (80%) | 31% |
| Reader 2 | 118 | 96 (81%) | 28% |

Based on the analysis, on average (for Reader 1 and Reader 2) 30% of the 95 exams would not need follow-up scans due to the additional information provided by spectral results. Examining the clinical indications of the various exams, it was estimated, based on clinician feedback and scan type, that 75% of the follow-up scans would be performed on magnetic resonance imaging (MRI) and 25% of the follow-up scans would be performed on computed tomography (CT). Using an average estimated cost of $1,109.43 for MRI and $346 for CT, based on clinician feedback and scan type, this could result in a potential average savings of $25,742.99.

Extrapolating the savings over the 10-month period to a year would result in a potential savings of $30,891.59. These savings are based on data collected from October 2013 to August 2014.




Currently, using the IQon Elite Spectral CT, the study site performs about 21 CAP or CTA

scans on a monthly basis, resulting in 252 scans per year on the scanner. Using the same calculations as above on reduction in follow-up scans, this would result in a potential savings of $55,008.71 per year.

We can take the clinical and economic impact that we have seen with this study and apply it to a large health system or an Integrated Diagnostic Network (IDN) that would perform a large number of such scans annually (˜1500). Applying the methodology and calculations mentioned earlier, significant economic benefits can be realized.

**Summary**

IQon Elite Spectral CT allows retrospective access to spectral results, providing benefits even in patients who would not have been preselected for a dual-energy protocol. Availability of spectral information could eliminate the need for follow-up scanning in patients with sub-optimal exams and incidental findings, increasing the diagnostic confidence of radiologists and resulting in a potential annual savings of $55,000 or higher depending on the practice and number of exams.

**References**

1. Berland L, et al. *Managing incidental findings on abdominal CT: White paper of the ACR Incidental Findings Committee*. J Am Coll Radiol. 2010;7:754-773.
2. Rajiah P, et al. *Benefit and clinical significance of retrospectively obtained spectral data with a novel detector-based spectral computed tomography – Initial experiences and results.* Clin Imaging. 2017 Oct 31;49:65-72.

** Results from case studies are not predictive of results in other cases. Results in other cases may vary.*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This white paper describes how the availability of spectral information could eliminate the need for follow-up scanning in patients with sub-optimal exams and incidental findings.

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