

# Spectral CT: It Pays to Weigh the Costs and Benefits

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- Discover the clinical and financial benefits of spectral CT
- Assess the potential costs of spectral CT – and see how Philips Spectral CT 7500 mitigates them

Since the first commercial dual-energy computed tomography (CT) scanners made their debut more than 20 years ago, there has been ongoing advances such as the launch of Philips Spectral CT 7500. The unique dual-layer Spectral detector takes dual energy to the next level, allowing for “always-on” spectral results regardless of patient type. This allows for all the benefits of multi-energy CT without any of the draw backs of traditional dual energy systems, making a compelling case for adding them.

As with any significant acquisition of new technology it pays for facilities to perform a cost-benefit analysis to ensure such an investment makes sense, from both financial and clinical perspectives.

## Clinical benefits of implementing Spectral CT

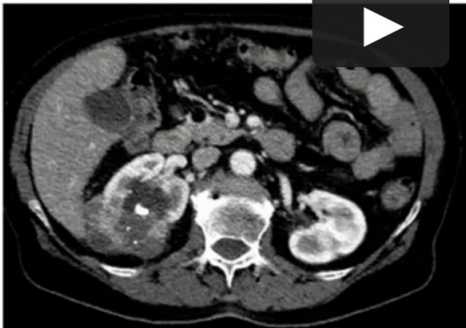
Spectral CT has many advantages over conventional CT, one of these is the availability of an iodine decomposition map, said Aran Toshav, MD, adjunct clinical associate professor of radiology at Louisiana State University in New Orleans.

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### Material Decomposition

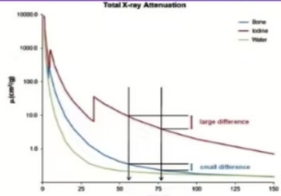
Conventional



Iodine Decomposition Map



View a video-of Dr. Toshav's comments.



“For me, the most important thing is the iodine decomposition map because it tells me where iodine is displayed using the two spectral/photon energy points,” Dr. Toshav explained, citing the example of a patient with renal cancer being treated with an inhibitor. In this case, the spectral CT iodine decomposition map revealed the lack of enhancement in portions of the renal mass, conventional CT images will not.

“There’s some iodine still going to this mass, so there’s still parts of this tumor that are viable,” he said. “But I’m able to show that there is treatment response, which is something I wouldn’t be able to do on a conventional CT.”

Spectral CT also enables radiologists to choose different spectral/photon energy points for viewing images. At a low mono-chromatic keV of 45, the conspicuity of iodine within images can be increased, helping them to easily identify liver lesions and view differential enhancement of the pancreas.

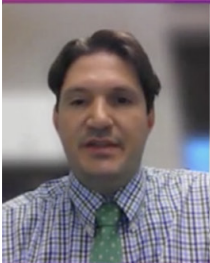
Conversely, a higher spectral/photon energy point allows for reductions in noise and artifacts. In addition, spectral CT’s Z-effective – the atomic energy display – color codes lesions for ready visualization.

So before we begin any cost benefit analysis, we have to talk about what are the potential benefits of dual energy CT. And by far and away the most important thing to me is this page, the iodine decomposition map. They’re basically telling me where iodine is displayed and we know how we achieve iodine. Hopefully, lots of people have talked about it, but it’s basically using the two energy points.

This is a patient who had a known renal cell cancer, could not receive nephrectomy due to underlying medical problems, went on an inhibitor and you can see in this image, there is no enhancement in portions of this renal mass. And I know that because there’s no iodine displayed there, which I get from the iodine decomposition map. But I also know that there is some iodine that’s still going to this mass. So there are still parts of this tumor that are viable, but I’m able to show that there is treatment response and it’s something I wouldn’t be able to do on a conventional CT.


Similarly, the ability to choose different energy points to view my imaging. So if I go to a low keV, 45, I’m really increasing the conspicuity of iodine within my images. So lesions in the liver pop. The differential enhancement of the pancreas pops. Whereas, if I go to a much higher energy, I can get rid of noise, shoulder artifacts, any sort of effects from things like the stomach. There’s some inherent advantages of having this material, this information. And then finally, the Z-effective, which is the atomic energy display. And there’s this lesion again. And it color codes it so it’s a little bit easier to understand. It is also very useful.

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## Comparison of Conventional and Dual Energy CT

Conventional



MonoE



*View a video-of Dr. Toshav's comments.*

## Value vs. Costs of Spectral CT

As hospital administrators evaluate the cost benefit of conventional CT vs. Spectral CT, the evaluation of a few features need to be taken into consideration to ensure the correct decision is being made to benefit the patient, hospital and referring community.

First, consideration must be given to patient safety, diagnostic accuracy, and efficiency of the CT Suite. For example, the workflow for the technologist and radiologist is paramount consideration especially in the current environment of the developing technologist shortage; Q: how to ensure consistence from scan to scan? Also, in many cases, conventional CT can require more time to protocol patients; Q: how to drive throughput while maintaining patient safety and diagnostic accuracy? In addition, patient selection can also be challenging. For example, other dual-energy CT's in the market can't image patients weighing more than 270 pounds or with a BMI of 30 or higher, due to the amount of energy that must be delivered with the lower energy source. Historically, a higher radiation burden is required to make low-dose sequence possible on larger patients. With Spectral CT 7500, the challenges of patient selection are negated and workflow issues can be significantly minimized as this solution has no weight limitations for Spectral.

Dr. Toshav said these challenges can be largely mitigated with Philips' new Spectral CT 7500, which provides spectral information for every patient without compromising image quality, dose, or workflow. The fast, always-on spectral detector delivers rich results in a single scan and requires no special protocols.

"The synthetic monoenergetic images created from the low- and high-energy detector-based imaging are actually better than the conventional imaging. There's less noise, partly because of how Philips does dual energy from the detector. There's anti-correlating noise suppression, and because there's perfect co-registration with the detector-based imaging, Philips can lower the noise in these images," said Dr. Toshav.

In addition, the single-source, dual-detector has expanded accessibility of spectral CT to obese patient populations previously considered inappropriate for dual-energy scanners. The dual-energy monoenergetic images provide excellent contrast and signal-to-noise ratio in these patients, and the scanners' iodine maps are of diagnostic quality.

"We saw all of this without a dose penalty on the Spectral CT 7500. This is one of the 'costs' that was automatically reduced because dual-energy imaging was appropriate for the entire patient population, because the dual-energy imaging is always there," he said.

So one of the first things that we saw, which was truly, was very useful, was that the MonoE images, which is the images created, the synthetic MonoE images created from the low and high energy detector based imaging were actually better than

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Follow-up Categories	CT with iodine map (CTIM)			CT without iodine map (CCT)			P Value ( $\chi^2$ )
	Study Count	Follow-up Requests	Follow-up Request Rate (%)	Study Count	Follow-up Requests	Follow-up Request Rate (%)	
Total	1,423	278	19.5	1,798	385	21.4	.19
Recommended modality							
Advanced imaging (MRI and PET/CT)		13	9.6		234	13.0	.003 <sup>±</sup>
MRI		125	8.8		206	11.5	.013 <sup>±</sup>
PET/CT		12	0.8		28	1.6	.08
US		49	3.4		66	3.7	.73
CT		83	5.8		114	6.3	.55

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the conventional imaging. There was less noise. And part of that is because of how Philips does dual energy, right? There's anti-correlating noise suppression. So they use the low and high energy.

And because there's perfect co-registration with the detector based imaging, they can lower the noise. Now there is some amount of post-processing algorithm, IMR or iodose that goes into this as well. So that reduces the noise. And the other thing that's really useful about the Philips detector is that this is a plot that when you do enough dual energy imaging, you get pretty used to, and it's what happens to noise as you go to the lower end energy spectrums, and for a lot of scanners, this is, as you get really low in energy level, this goes really way up. And what is nice about the Philips detector based imaging is that yes, it goes way up, but it's pretty flat even in the lower edge of the spectrum. And it only shoots up really high towards the end. So noise is actually improved on those monochromatic images.

So in these obese patients that we looked at and we published this back in 2019, the single source dual detector expanded the accessibility of dual energy CT to the obese patient populations previously considered inappropriate for dual energy scanners. The dual energy MonoE images provided excellent contrast and noise ratio in obese patients, and the iodine maps on dual energy detector systems, material decomposition are of diagnostic quality in obese patients. And we saw this without a dose penalty. So this was one of the costs that was automatically reduced because you could say that dual energy imaging was appropriate for the entire patient population, that the dual energy imaging is always there.

## Cost-benefit analysis

Spectral detector CT helps salvage sub-optimal injection scans without requiring patients to be re-scanned, which shortens time to diagnosis. The Spectral CT 7500 was designed for first-time-right diagnosis; in a recent analysis, the technology reduced time to diagnosis by 34%, repeat scans by 25%, and follow-up scans by 30%.<sup>1</sup>

To fully understand the impact of these issues, Dr. Toshav led a cost-benefit analysis through a single-center, retrospective review of patients receiving contrasted abdominal and pelvic CT imaging.

They started with follow-up recommendations in three categories of exams: single-energy CT, dual-energy CT without the iodine map, and dual-energy CT with the iodine map. Findings showed that follow-up imaging was significantly lower after studies that used an iodine map. Combined, follow-up MRI and PET/CT exams dropped from 13% to 9.6%.

"We found that incomplete diagnosis was significantly higher in the conventional CT reports than in the iodine-mapped CT, dual-energy images," he said.

Based on these findings, Dr. Toshav believes facilities using the Medicare reimbursement schedule for physician fees could realize significant cost savings with iodine-mapped, dual-energy CT versus conventional CT.

"We felt there was a strong potential for cost savings and multiple results suggesting improved radiologists' diagnostic certainty with the dual-energy data sets," concluded Dr. Toshav.

Of the 1400 studies done with an iodine map versus the 1800 done without an iodine map, our biggest finding was advanced imaging, both MRI and PET-CT went from 13% down to 9.6%, which was statistically significant. MRI went from 11.5% down to 8.8% and PET-CT, which was also significant. And PET-CT went from 28 to 12 for 1.6 to 0.8%. And there were not enough numbers to power this, but it was trending towards significant.

So when we looked at all this, we found that incomplete diagnosis was significantly higher in the conventional CT reports than in the iodine mapped CT, dual energy images. The conventional CT reports recommended follow-up because of an incomplete diagnosis and CTIM reports recommended follow-up because of incomplete diagnosis at a rate of only 9.1%. Advanced imaging was significantly higher in the conventional CT reports and conventional CT reports recommended advanced imaging follow-up at those rates that I had discussed before.

Theoretically, if you use Medicare reimbursement for physician fee only, this is just physician fee. You could see potential savings between the CTIM, which is the imaging set versus conventional. Again, this is purely theoretical. And so our main conclusions were impact of including dual energy CT generated iodine maps into a routine CTIM workflow. Statistically significant decrease in MR. Significantly in follow-up recommendations and near statistic in PET-CT. We felt like there was a strong potential for cost savings and multiple results suggesting improved radiologists diagnostic certainty with the dual energy data sets.

<sup>1</sup>Analysis by CARTI Cancer Center in Little Rock Arkansas and University Hospitals of Cleveland - Results from case studies are not predictive of results in other cases. Results in other cases may vary.