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Episode transcription as follows:

"Let's quickly talk about semiconductors. These are also often called solid state detectors. These are also called CZT detectors with different variations on that. CZT is cadmium, zinc, telluride.

These are semiconductors that are dense and therefore they have a lot of stopping power and they are also very efficient in converting photons into an electrical signal.

There is no scintillation involved with a semiconductor. These are fast and efficient. So, what that means is that you can often image with lower doses when you have a CZT or other semiconductor (detectors) compared to a scintillation detector, such as a sodium iodide crystal.

These (semiconductor detectors) are also expensive. When you hear about things like digital PET, although there are some differences (between scanners), these use direct digital conversion from semiconductors that are fast and efficient. Therefore, digital PET scanners image faster at lower doses, but they are also very expensive.

Quickly for PET detector crystals: These vary in different ways and from my experience they won't expect you to really have memorized which ones are denser, and what ones yield more light but do be aware there are differences between LYSO, BGO, GSO and sodium iodide doped with thallium. Really, nobody uses sodium iodide doped with thallium (for PET), although sodium iodide crystals work very well for gamma camera imaging. They don't work so well for PET because they are not very dense and they have a hard time stopping the high energy 511 keV photons. They do decay very quickly (note this is a good thing as it will allow the detector to reset and detect the next event faster, therefore giving you more counts using the same dose/time). Sodium iodide works well for a gamma camera because it has a really high light yield, a very short decay time, and when you're dealing with lower energies it stops enough of them to give you a good image. But when you get to PET, not so much (i.e. sodium iodide struggles with PET due to the high 511 keV photons).

So, you have to go with things that are denser, such as LYSO.

Let's conclude this by talking about the full width half maximum. This is something I found really confusing until it clicked. Now I don't think it's very confusing anymore.

Remember this is a measure of resolution that can apply to MRI or other imaging systems. It's not only unique to nucs, although I think you'll encounter it more often in nuclear medicine than other areas. The full width half maximum is a measure of energy resolution, and the energy resolution is the ability of a detector to accurately determine the energy of the incoming radiation.

Every imaging detector has some imperfections, and no system can image 100% precisely what the actual energy is that striking it. So, what we end up is a range of values coming from a gamma camera. In this instance, we've already established that a gamma camera is able to distinguish different energies, and if we are imaging technetium, we would expect all of the energy to be 140 keV. OK, we know in reality there are some differences (i.e. technetium does not have 100% pure 140 keV emissions), but say that we are expecting 140 keV photons to come to the crystal. But when we actually look at what the system is detecting, we see a range. Let's say, first of all, that that range is 139 to 141 keV and almost all of them are 140. That's pretty awesome. In this case, the system has a very high ability to resolve energies.

On the other hand, let's say the system is detecting everything between 100 to 200 keV. That is fairly poor. We would expect (or want) a tighter curve.

In the first example, where we have 139 to 141, the system will be able to determine within two keV what the actual incoming energy is, which is awesome. In the other (second) case we have a 100 keV range and that is not as good.

The whole point is that we must know what the actual energy is coming out of the system (i.e. true counts) compared to what is just scattered radiation that has had a change in energy due to scattering. This ultimately determines the spatial resolution of the system. This is the concept that I think made it difficult for me to understand as a resident: The better the ability of your system to distinguish between energies and show you the energy accurately, the better you can get rid of scattered radiation that will only degrade your image quality and the better your spatial resolution will be. Because if you have two points right by each other, you really need to be able to get rid of all that background (i.e. scattered radiation) and only detect your signal. By so doing you will improve the spatial resolution of the system and one measure of this is the full width at half maximum.

How I like to think about the full-length half maximum is if you were to plot out every energy that the camera is seeing, in the case of technetium, you would expect most of the counts to be right at or immediately by 140 keV. Then on both sides (i.e. in the ranges above and below 140 keV) you'll see it taper down to other energies and you get this nice bell curve. If your camera is good, you want that bell curve to be very narrow. What you do is take the height of the curve and then the very base of the curve and you measure down 50% and then you measure what that width Is. If you have really good energy resolution, you're going to have a very narrow curve and that 50% value is going to be very narrow. If you have a poor energy resolution system, you're going to have a wide curve and as you measure down 50% from the peak to the base, you're going to have a very large (width) measurement.

Typical energy resolution for gamma cameras at 140 keV is something around 12%.

One final suggestion is that you need to know what various detectors look like. Make sure you look at images or walk around your nuclear medicine department to see what the thyroid uptake probe looks like, what a well counter looks like, what a dose calibrator looks like, what a Geiger Mueller counter looks like and know what a Cutie Pie looks like."