White paper

NAEOTOM Alpha® in cardiac imaging

Benefits of photon-counting technology for cardiac CT

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Trends in cardiac CT

CT is an increasingly pivotal tool to assist the physician in the diagnosis of cardiovascular disease and for the preprocedural planning for structural intervention and for device implantation.

Chest pain guidelines published in 2021 by various cardiac professional organizations (ACC, AHA and SCCT) [1] have put CT imaging at the forefront of the assessment of patients with stable chest pain with no known coronary artery disease (CAD – defined here as a minimum of calcified plaques), regardless of their risk levels. Coronary CT angiography (CCTA) was identified in guidelines as a class 1 strength of recommendation with the highest evidence of being clinically effective, and coronary artery calcium scoring (CACS) as group 2a with moderate recommendation for usefulness. In the recent DISCHARGE multicenter trial of over 3500 patients comparing CT with invasive coronary angiography (ICA) as an initial diagnostic imaging strategy for guiding the treatment of patients with stable chest pain who were clinically referred for ICA, the frequency of major procedure-related complications was lower with an initial CT strategy [2].

Furthermore, recent European Society of Cardiology (ESC) guidelines [3] recommend CCTA as first line test to evaluate the presence and extent of CAD, while also suggesting CCTA as a highly valuable tool to exclude significant CAD in patients with newly diagnosed dilated cardiomyopathy. The guidelines also suggest CCTA as an alternative to ICA in patients with newly diagnosed reduction of ejection fraction to establish the presence and extent of CAD and evaluate clinical indication to myocardial revascularization. In addition, CACS is a well-established method for early detection and prevention of adverse cardiovascular events, as a decision-aiding tool for initiation of preventative therapy, and as a negative risk factor for excluding cardiovascular risk in symptomatic and asymptomatic patients [4]. Updated CAD-RADS 2.0 guidelines [5] state that plaque burden should be estimated whenever present and can be accomplished using either an evaluation of the amount of calcium (i.e., CACS), a segment involvement score (SIS), or a visual assessment leading to a category of total plaque burden from P1–P4 (mild, moderate, severe, extensive). With this prominence of cardiac CT in clinical guidelines in both diagnosis and disease stratification and the increased growth in the use of CCTAs of up to 355% in a decade [6], accurate quantification of CT imaging biomarkers of relevant pathophysiology is of utmost importance in efficient patient management. Parallel to CT use in CCTAs, the field of transcatheter valve and structural interventions has seen rapid growth and maturation over the last decade and represents a rapidly growing area of cardiology, especially as the number of devices to address valvular and nonvalvular heart disease continues to increase. CT imaging is thus a critical component for many aspects of structural heart treatment, from disease assessment and patient selection, to device selection and sizing, as well as procedural risk prediction.

Cardiac imaging with NAEOTOM Alpha® represents a major paradigm shift in cardiac CT, with unparalleled* ability to assist clinicians in the classification and quantification of disease using breakthrough technological advancements developed by Siemens Healthineers. This white paper aims to demonstrate the improved imaging potential for cardiac imaging brought about by the introduction of NAEOTOM Alpha.

** data on file*

Technical advancements of NAEOTOM Alpha for cardiac CT

Accurate imaging of the millimeter size of epicardial coronary arteries and the structure of the heart have been a great challenge for CT imaging because rapid cardiac motion and patient breathing may cause image blurring. Because of this, cardiac imaging requires both excellent temporal and spatial resolution to create adequate visualization of the vessels. Dual Source CT (DSCT) scanning technology from Siemens Healthineers improved routine temporal resolution to below 100 ms. New detector designs with the use of submillimeter collimations also deliver better spatial resolution along the z-axis. The pioneering development of high-performance X-ray tubes, such as the Vectron®, enabled the delivery of sufficient photon flux to maintain image quality at all kV levels for patients of all sizes, especially those who are obese.

With the launch of NAEOTOM Alpha and the implementation of photon-counting CT technology in a Dual Source, whole-body, routine capable CT scanner, a quantum leap over conventional CT imaging has been achieved. Benefits include ultra-high spatial resolution due to smaller detector elements, improved contrast to noise ratio (CNR) through equal weighting of low and high energy photons, elimination of electronic noise due to thresholding of electrical pulses, and intrinsic spectral sensitivity. Further, building on the successful high-end dual-source CT architecture, NAEOTOM Alpha uniquely combines ultra-high resolution, spectral capabilities, and industry-leading temporal resolution of up to 66 ms* without compromises. This in many cases allows a cardiac CT acquisition without the use of beta blockers to control heart rate. These and other benefits have been highlighted and summarized in the NAEOTOM Alpha – CT redefined white paper [7] and are briefly described in Figure 1. When imaging the heart, these technical benefits lead to clinical imaging improvements such as a reduction of calcium blooming, in-stent imaging, visualization of small arteries, highly detailed plaque imaging, and detailed prosthetic valve/endograft imaging.

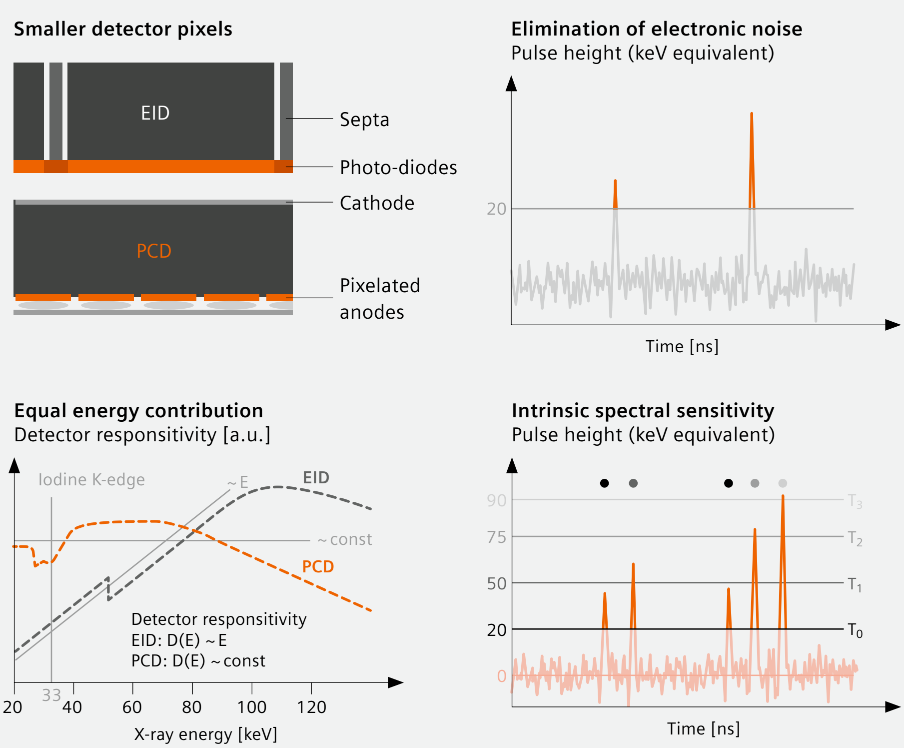


Figure 1: Benefits of using QuantaMax detectors demonstrating four technological benefits of smaller detector pixels, the removal of electronic noise, equal energy weighting of high and low energy photons, and spectral sensitivity.

Spectral imaging and advanced spectral reconstructions

The ability to fully integrate spectral capabilities in cardiac CT without compromises in temporal or spatial resolution makes it possible to selectively detect and differentiate iodine and calcium through material decomposition (Figure 2). In NAEOTOM Alpha, this has translated into two new applications: Quantum PURE Lumen** in which calcifications are spectrally removed by a dedicated material-based decomposition enabling the unobstructed visibility of the vessel lumen; and Quantum PURE Calcium in which the contribution of iodine is removed from contrast-enhanced images while calcium is aimed to be left unmodified. This feature enables quantitative calcium scoring evaluations.

Quantum PURE Lumen – Seeing through calcifications

In conventional CT imaging, calcified plaques can appear larger than they actually are due to partial volume effects (commonly known as "blooming"), in turn potentially leading to overestimation of arterial stenoses. The Quantum PURE Lumen algorithm removes calcifications, enabling highly accurate stenosis quantifications as the impact of calcium blooming is negated, revealing the accurate lumen underneath (Figure 3).

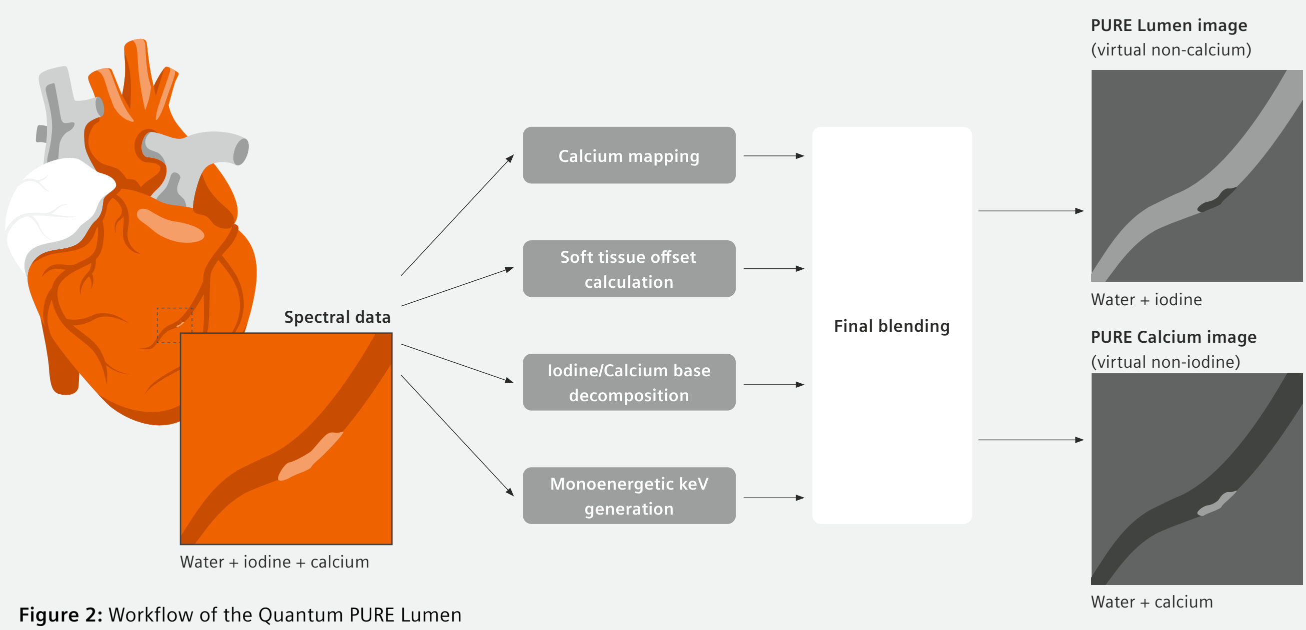


Figure 2: Workflow of the Quantum PURE Lumen & Quantum PURE Calcium algorithms and how spectral data is utilized to produce the final datasets

** data on file*

*** PURE Lumen (Vascular Calcium Removal [VCR]) can be used to measure vessel (e.g., coronary) stenoses by removing the contributions of calcium from images; based on a phantom evaluation (Allmendinger T. et al., Invest Radiol. 2022;57(6):399-405)*

Quantum PURE Calcium – Removing iodine contributions

The Quantum PURE Calcium algorithm leverages the advanced spectral capabilities of NAEOTOM Alpha to virtually remove iodine material from CT images while selectively preserving calcifications. The resulting virtual non-iodine images reflect the information found in non-contrast CT examinations, such as CACS examinations. It has already been demonstrated [8] that comparable information to a non-contrast CACS was acquired by leveraging the Quantum PURE Calcium algorithm without the need of an additional examination. Eliminating the non-contrast scan would result in workflow savings of scan time and radiation dose. Agatston score estimates from Quantum PURE Calcium scans strongly correlate with estimates from conventional scans using 120 kV, demonstrating accurate removal of the iodine contrast [8] (Figure 4).

Of note, the key difference between virtual non-iodine images of Quantum PURE Calcium with other Siemens Healthineers applications that provide virtual-unenhanced images such as DE Virtual Unenhanced (VUE), is the use of different basis materials for decomposition. Quantum PURE Calcium uses iodine, calcium and water as basis materials; while VUE uses iodine, water and air. While the VUE algorithm has been shown to be very successful at removing iodine, it does not maintain the original calcium contribution due to the selected material base and reduces the calcium contribution in the final image, making it unsuitable for quantitative calcium scoring.

* *Pure Lumen (Vascular Calcium Removal (VCR)) can be used to measure vessel (e.g., coronary) stenoses by removing the contributions of calcium from images; based on a phantom evaluation (Allmendinger T. et al., Invest Radiol. 2022;57(6):399-405).*

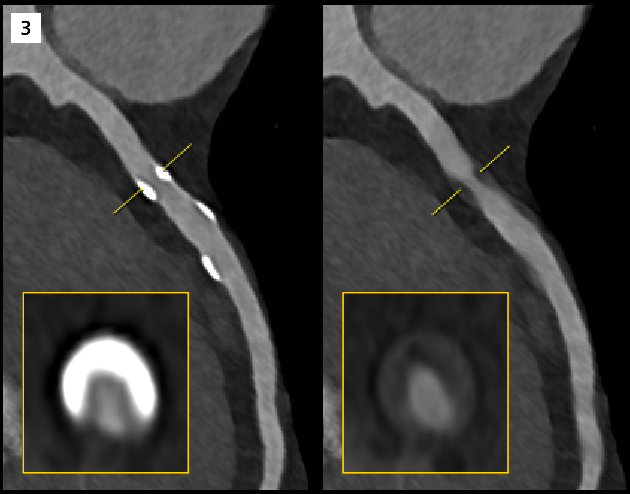
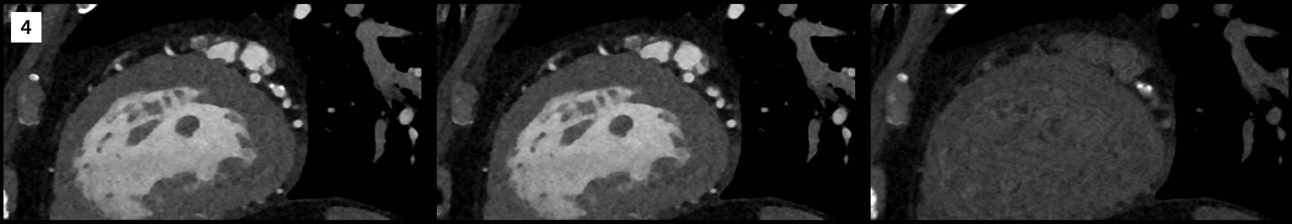


Figure 3: The use of Quantum PURE Lumen* to reveal the underlying reality of the pathology due to the virtual removal of calcifications from the result image. Severe calcifications in CAD mask the pathology and distort the severity of the stenosis (i.e., no clinical value is delivered). Quantum PURE Lumen reveals the underlying reality of the pathology and can guide the radiologists and cardiologists with non-invasive imaging in advanced CAD. *Courtesy of Centre Cardio-Thoracique, Monte Carlo, Monaco.*

Figure 4: Left – Monoenergetic image (65keV), center – Quantum PURE Lumen, and right – Quantum PURE Calcium reconstructions demonstrating separation and subsequent visualisation of iodine and calcium only. 0.6 mm slice thickness, Bv40, QIR3, 512 matrix. *Courtesy of University Hospital Zurich, Switzerland.*



Quantum HD Cardiac: Ushering in the era of ultra-high resolution imaging

A paradigm changing feature of NAEOTOM Alpha is the minimum detector element size of 0.176 × 0.151 mm^2 at the isocenter. This is possible becasue the detector pixel spacing is defined by a matrix of pixelated anodes. A strong electric field applied between the cathode and anode pixels eliminates the requirement for additional separation septa. This optimizes geometric dose efficiency and allows smaller detector size, translating to a maximum spatial in-plane image resolution of 0.11 mm and a maximum through-plane resolution of 0.16 mm. The number of acquisition channels per row in detectors A and B compared to standard resolution imaging are increased from 1376 (A) and 992 (B) to 2752 (A) and 1984 (B) respectively. With typical size of coronary vessels of around 1 to 4 mm, ultra-high resolution imaging may provide significant benefits in the accurate assessment of such small vasculature and the potential to observe even smaller plaques and calcifications or to evaluate stent patency not previously possible. Since calcium blooming is related to the partial volume effect, enabling ultra-high resolution reconstruction capabilities is an additional non-spectral approach to solve this critical clinical challenge. In cardiac imaging, we call this ultra-high resolution technology Quantum HD Cardiac.

To leverage this capability, Siemens Healthineers has developed sharper high resolution reconstruction kernels (such as Br72-Br98, Qr71-Qr89) that currently cannot be implemented on conventional CT. Newly available kernels, slice thickness routinely at 0.2 mm and 0.4 mm, flexibility on acquisition modes (retrospective spiral, prospective sequential scanning and TurboFlash modes), and the desire to further reduce radiation dose create system demands that only Quantum Technology can address. QuantaMax detectors without electronic noise and advanced Quantum Iterative Reconstruction® are essential enablers of the technology. For conventional CT, a typical resolution observed in the highest resolution mode is approximately ≤ 20 lp/cm. For ECG-gated Quantum HD Cardiac spiral acquisitions, up to 30 lp/cm can be visualized.

Figure 5: Curved MPR images (Figs. 5a & 5b) show a proximal RCA stenosis caused by calcified plaques (arrows). Images are reconstructed at 0.6 mm with kernel Bv40 (Fig. 5a) and at 0.2 mm with kernel Bv60 (Fig. 5b). The corresponding axial slices, perpendicular to the vessel centerlines at the stenosis, are shown in the left lower corners. The blooming effect of the calcified plaques affecting the visualization of the vessel lumen and the stenosis grading is clearly reduced in the UHR images. An invasive catheter coronary angiography (Fig. 5c) confirmed a mild stenosis in the proximal RCA (arrow) consistent with the result from the UHR image evaluation.
Courtesy of University Hospital Zurich, Switzerland.

Benefits of NAEOTOM Alpha in routine clinical cardiac imaging

Coronary artery calcium scoring

CACS resulting from an unenhanced ECG-triggered CT is a well-established screening method to detect coronary artery calcifications. It is associated with excellent cardiovascular risk stratification and management as well as prognosis of clinical outcomes.

The four technological benefits outlined in the previous chapter and in Figure 1 have a direct effect on CACS. Through the use of virtual monoenergetic imaging, standardized calcium scoring is available regardless of the tube potential used for acquisition and using Quantum HD Cardiac may provide greater diagnostic confidence for CACS in patients with high calcium burden due to reduced blooming with higher spatial resolution. On NAEOTOM Alpha, phantom studies indicate that CACS is independent of the applied tube potential down to 90 kV using a 70 keV monoenergetic reconstruction [9], with the potential to allow for up to 53% dose-reduced calcium scoring scanning in patients compared to conventional CT imaging [10].

"Despite > 700 CAC score in LAD, we could rule out coronary stenosis. High resolution and high keV spectral imaging make a difference!"

Prof. Pal Maurovich-Horvat, MD, PhD · Director of Medical Imaging, Semmelweis University, Budapest, Hungary

CAD evaluation

A significant percentage of ICA procedures are not necessary procedures for patients with suspected CAD. As per CAD-RADS 2.0 sub-classification, a more accurate assessment of vessel stenoses is of improved benefit to patients and practices. CCTA imaging by conventional CT is limited by its accuracy in the evaluation of calcified lesions where a high coronary calcium burden often leads to an overestimation of the degree of stenoses and hence to false-positive diagnoses in CT assessment. Delineation of the luminal stenosis can also be inaccurate in the presence of severe calcifications and partial volume artifact due to high-density calcifications averaged with density of other tissues in a single voxel combined with motion artifact can result in blurring of interfaces.

A 15% reduction in calcium blooming artefacts is achievable together with improved image sharpness and image quality when imaging coronary plaques in Quantum HD Cardiac (0.2 mm) mode compared to standard (0.6 mm) reconstructions [11], coupled with much improved visualization of spatial details, including potential identification of plaques with fibrous caps [12] (Figure 6), partially calcified plaques [11] (Figure 7), and differences in CAD-RADS classification [13] (Figure 5).

Figure 6: In the image reconstructed with standard resolution (Bv40, 0.6 mm) (Fig. 6a), only calcified plaques are visible in the distal segment 3 of the RCA. In the UHR image (Bv64, 0.2 mm) (Fig. 6b), a fibrous cap beneath the calcified plaque is visualized, due to reduced calcium blooming. OCT correlation (Fig. 6c) of the same plaque confirms the plaque composition. *Courtesy of Johannes Gutenberg University Medical Center, Mainz, Germany.*

"Ultra-high-resolution CCTA with PCD-CT enabled a remarkably precise characterization of partially calcified plaques discerning noncalcified and calcified parts, potentially improving the identification of plaques prone to rupture."

Prof Dr Hatem Alkadhi · Head of Cardiovascular Imaging, University Hospital Zürich, Switzerland

Stent imaging

CCTA has emerged as a viable alternative to ICA and has demonstrated high diagnostic performance for the detection and exclusion of high-grade anatomic stenoses in native coronary arteries. However, CCTA on conventional CT systems exhibits a lower diagnostic performance for evaluation of intracoronary stents largely due to partial volume effects and beam hardening artifacts. The presence of heavy calcifications in a stented segment further enhances metal artifacts as it contributes to beam hardening. Importantly, diagnostic performance is dependent upon stent size and type, with higher accuracy for larger over smaller diameters, and for polymer-based scaffolds over metallic stents due to metal artifacts (causing stent struts to appear to be thicker, in turn causing underestimation of the stent lumen). Limited spatial resolution of conventional CT systems compounds imaging in implanted stents with characteristics unfavorable for stent imaging, such as thick-strut stents and stents with diameters less than 3 mm.

A key requirement for diagnostic imaging in cases where stents are present is the ability to visualize inside the stent to determine in-stent lumen visibility as an investigative tool for in-stent restenosis (ISR), which may occur due to developments such as neointimal hyperplasia, in-stent thrombosis, and stent fracture.

Figure 7: Identification of a mixed plaque in distal left main coronary artery plaque in a patient with severe aortic stenosis. With Quantum HD Cardiac, improvement of the delineation of the partially calcified plaque is evident showing superior anatomic detail. Left – cVRT, 0.2 mm slice thickness, Bv44, 512 matrix. Middle – MPR, 0.6 mm slice thickness, Bv40, 512 matrix. Right – MPR, 0.2 mm slice thickness, Bv72, 512 matrix. *Courtesy of University Hospital Zurich, Zurich, Switzerland.*

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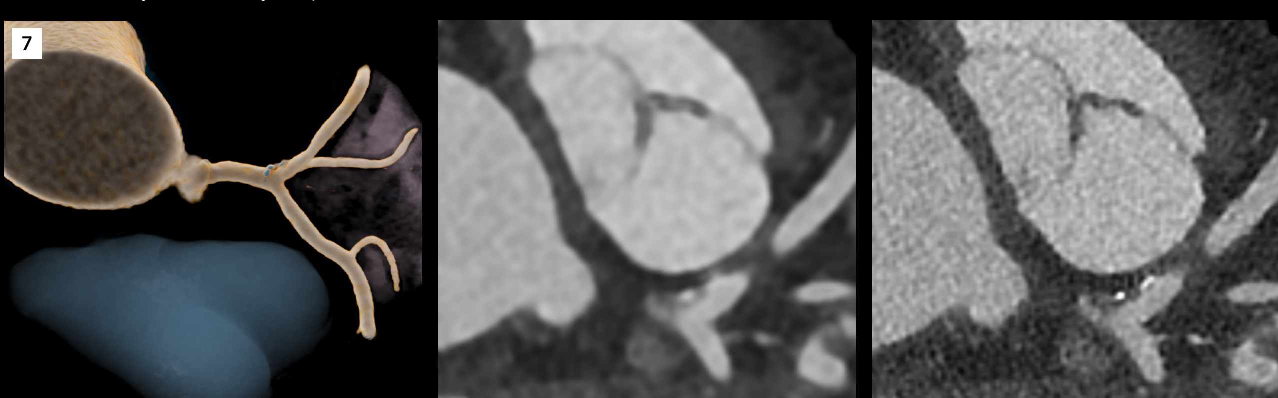
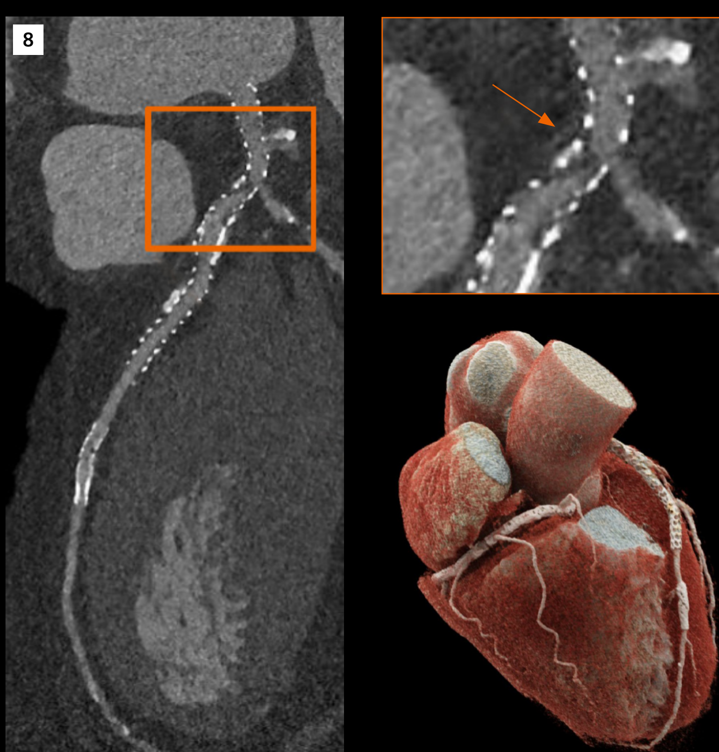


Although the incidence of ISR has declined due to the development of drug-eluting stents, it still occurs with a rate of approximately 3% to 20% of patients [12]. A major potential benefit of NAEOTOM Alpha through the use of Quantum HD Cardiac would be to offer interventional operators the ability to assess stenoses in stented segments of coronary arteries, in bypass grafts, and in native coronaries as accurately as with invasive coronary angiography and to position photon-counting CT of the coronaries as the method of choice for revascularization follow-up and thus therapeutic decision making (Figure 8) [15].

Phantom studies of commonly used coronary stents have demonstrated that NAEOTOM Alpha significantly improves coronary stent delineation and might overcome technical limitations of conventional energy integrated detector (EID) CT concerning in-stent lumen visualization [16]. With small stents of diameters between 2.5 mm to 4.0 mm, imaging with NAEOTOM Alpha described higher lumen visibility, lower in-stent CT attenuation, and lower image noise compared to conventional CT imaging at twice the radiation dose of NAEOTOM Alpha scans [16].



Severe in-stent restenosis at the ostium of the LAD

Figure 8: Stent imaged in Quantum HD Cardiac mode (Bv72, 1024 × 1024, QIR 4, 0.2 mm slice thickness) on NAEOTOM Alpha, demonstrating in-stent restenosis. The patient underwent coronary stent implantation multiple times and had 8 stents implanted in total in the left and right coronary arteries. The orange arrow shows a focal, severe in-stent restenosis at the ostium of the LAD. *Courtesy of Semmelweis University Hospital, Budapest, Hungary.*

Structural heart planning

Transcatheter aortic valve replacement (TAVR) planning is used to plan for transcatheter aortic valve implantation in patients with severe aortic stenosis. CT imaging allows for a map of cardiac anatomy including the assessment of the aortic root and valve annulus to facilitate the safe deployment of appropriately sized aortic valve prostheses.

In traditional CT imaging, retrospective ECG-gated or prospective ECG-triggered scanning covers at least the aortic root in order to provide anatomical information of the aortic root, followed commonly by non-ECG-gated CTA data acquisition of the aorto-iliofemoral vasculature for assessment of the access vasculature. Typically, both acquisitions are combined in a comprehensive scanning protocol with a single contrast administration.

A new milestone with NAEOTOM Alpha in the planning for TAVR scans includes a new imaging protocol dedicated to high-pitch Turbo Flash TAVR imaging. This feature enables an ECG triggered Turbo Flash scan mode, which allows for an independent control of the z-position of the ECG target phase within the scan range. This enables, for example, a high-pitch scan over the entire thorax from the aortic arch down to the iliac, while separately specifying the cardiac start phase at 30% at the level of the aortic valve in end-systole. As a result, it is possible to perform TAVR valve measurements (i.e., aortic diameter below valve plane, left and right sinus heights, sinus of Valsalva diameter and left main and right coronary artery heights) and to plan the access for TAVR procedures based on a single Turbo Flash scan range in under one second of scan time.

Figure 9: Post-procedure prosthetic valve imaging. Left and Center – Cinematic VRT. Right – Representative slice from 55 keV virtual monoenergetic image (VMI), Bv40 kernel, 0.8 mm slice thickness. *Courtesy of Erasmus Medical Centre, Rotterdam, The Netherlands.*

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Radiation dose and contrast media

Scanning with NAEOTOM Alpha with the imaging benefits brought by spectral imaging and reduced electronic noise also allows a potential reduction of the use of contrast media, which remains an important consideration for patients suffering from chronic kidney disease. Quantum Technology enables better weighting of low-energy quanta, potentially allowing for a reduction in contrast media volume. Recently, phantom studies have evaluated imaging strategies to reduce contrast media volumes for CCTA, showing that in a dynamic cardiac vessel phantom, using VMI reconstructions at 40 keV with a reduction in contrast media concentration of 50%, could obtain diagnostic attenuation and objective image quality for CCTA imaging [8]. Recent clinical studies of thoracic CTAs have demonstrated that a reduction of 25% of injected contrast is possible when comparing VMI at 50 keV and conventional CT at a matched radiation dose, resulting in PCCT images above the boundaries of inferiority [17].

A recent case report presented an aortoiliac CTA case using NAEOTOM Alpha, performed with a total iodine dose of just 9.8 g, with roughly one third of the contrast media volume typically used by the authors on high-end conventional CT [18]. A comparable case from the same institute is shown below in Figure 10.

Furthermore, the pediatric population has a very strong focus on radiation dose. CTA examinations for suspected anomalous coronary arteries of young patients have demonstrated higher spatial resolution (a key requirement in younger patients), better image quality, and over 3 times lower radiation doses compared to conventional CT imaging [19].

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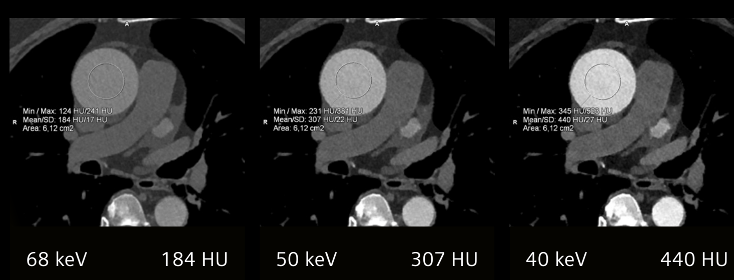


Figure 10: A 74-year-old male patient, with a known history of an ascending aortic aneurysm, was referred for a CT follow-up. An aortoiliac CTA was performed using a QuantumPlus Turbo Flash mode. A total volume of 38 mL of contrast media, blended with 70% Ultravist370 and 30% saline, was injected followed by a saline chaser. A total iodine dose of 9.8 g, less than one-third of that used in the standard protocol, was applied – resulting in optimal contrast enhancement. The unique combination of acquiring spectral information with high temporal resolution using NAEOTOM Alpha provides great advantages for vessel evaluation. *Courtesy of Freiburg University Hospital, Germany*

Workflow improvements of NAEOTOM Alpha for cardiac applications

By providing comprehensive diagnostic information in a single scan, NAEOTOM Alpha can help improve diagnostic confidence and potentially minimizing the need for additional imaging. For example, one scan could provide the following: CACS, coronary vessels, spectral data (Quantum PURE Lumen, Quantum PURE Calcium), valves, myocaridum (early phase perfusion, ECV). Thus, major changes to a conventional workflow can be implemented.

NAEOTOM Alpha joins the era of intelligent imaging powered by myExam Companion and myExam Compass, enhancing consistency of CT procedures, and ensuring the use of this breakthrough CT scanner is easy and intuitive, independent of operator skills (Figure 11). The FAST 3D Camera helps align the patient at the correct isocenter, eliminating variability between operators, and also ensuring the correct part of the body is scanned. myExam Companion and myExam Compass help reduce the number of protocols and complexity of advanced examinations, by suggesting which settings can be tailored for each patient based on the answers to patient-specific questions (e.g., "does the CaScore scan show a coronary stent?"). Based on the procedure and patient characteristics, it guides users to find the optimal combination of acquisition and reconstruction parameters, appropriate spectral imaging settings, standardized results, and always the right dose. By measuring heart rate and rhythm, the system can automatically choose the most appropriate phase of the heart cycle to scan and later, to reconstruct.

"We installed NAEOTOM Alpha at our institution in September 2021. We were impressed how robust and stable the system was running from day one. Today we routinely scan around 60 patients per day – while producing excellent clinical results."

Univ.-Prof. Dr. med Jan Borggrefe
Director of Department of Radiology, Neurology & Nuclear Medicine, Johannes Wesling Klinikum Minden, Minden, Germany

The Quantum Cardiac Imaging package allows for comprehensive cardiac assessment and clinical consistency in cardiac CT with ease. Optimized, fully tablet-operated scan preparation, fast scanning, and standardized results in every cardiac case enabled by the integrated GO technologies (postprocessing & 3D visualization) allow the users to devote more time to patients. With Recon&GO software, many result series are available as zero-click in-line results such as cardiac ranges, vessel ranges, heart isolation, coronary tree and no-click inline CaScoring (automatically calculates total Agatston Score and Coronary Age and archives them directly in the PACS).

To power the new workflows and the increased data handling requirements resulting from new technologies such as spectral imaging and Quantum HD Cardiac acquisitions, the computer systems of NAEOTOM Alpha have been uniquely designed to cope with the increased computational demands. Both the Image Reconstruction System and Image Control System have vastly increased processing and storage power to ensure adequate image reconstruction speed and data storage requirements, ensuring that fast, efficient imaging can be performed when needed.

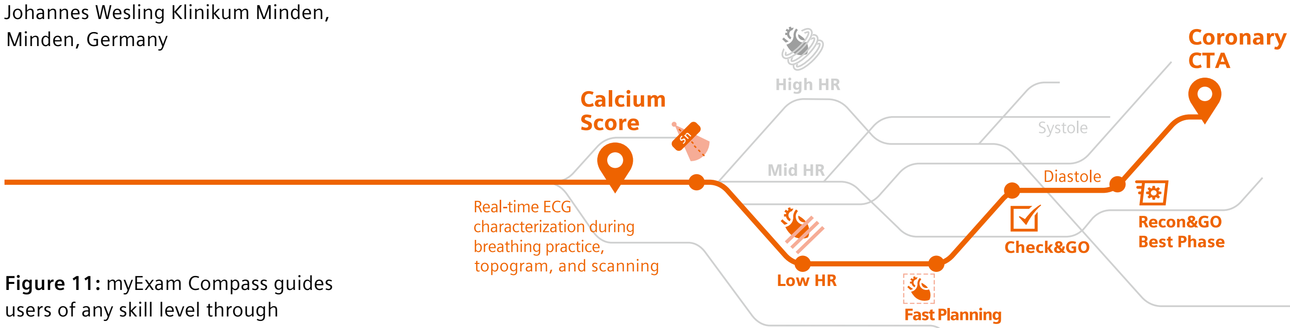


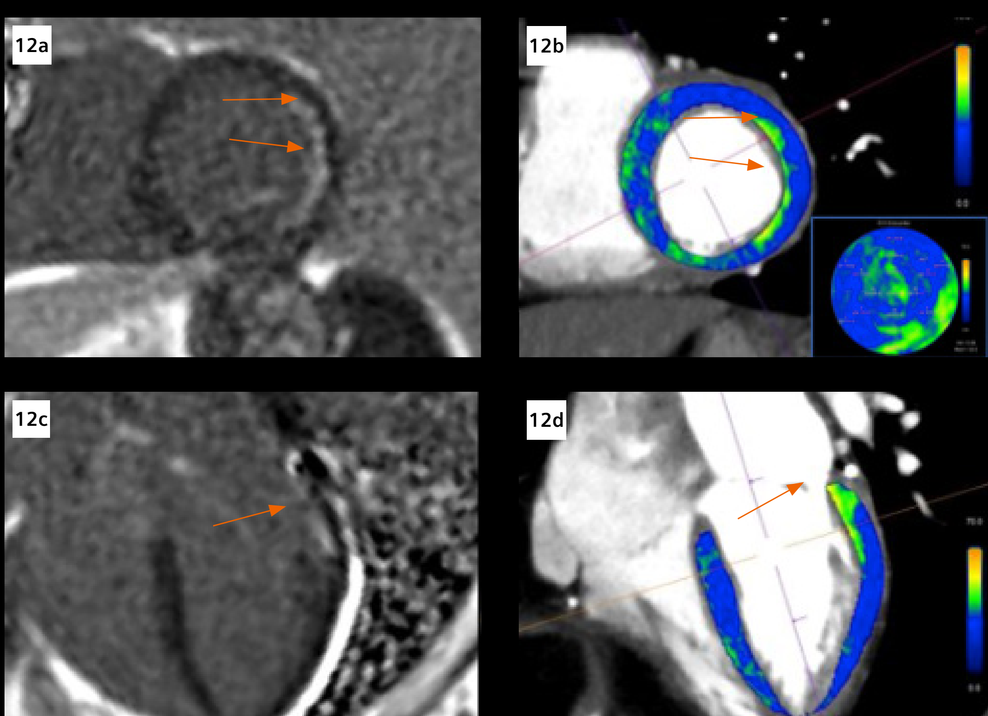
Figure 11: myExam Compass guides users of any skill level through complex cardiac CT procedures.

The future of cardiac CT using Quantum Technology

NAEOTOM Alpha with Quantum Technology is opening new avenues of clinical investigation through the acquisition of spectral data at the scanner's fastest temporal resolution. One area of investigation is to compare extracellular volume (ECV) calculated from CT imaging against the traditional benchmark of cardiac MR (CMR) T1 mapping in the characterization of myocardial fibrosis. [20] Recent work demonstrated that quantitative and qualitative analysis of ECV maps for myocardial tissue characterization is reliable on NAEOTOM Alpha and correlates well to the MRI reference standard [20] (Figure 12).

Recent investigations have suggested that evaluation of pericardial fat as an imaging biomarker of the early stages of atherosclerosis through the use of CT imaging can enhance cardiovascular risk scoring beyond the use of calcium scoring. Thus there may be a clinical desire for the use of CT systems to allow visualization and quantification of the inflammatory response inside the vessel wall, rather than only relying on visualization of plaque inside the vessel lumen. NAEOTOM Alpha is poised to meet the challenge of using such a biomarker, offering higher spatial resolution and image contrast for accurate segmentation of pericardial fat, with the potential to further develop an evolving new dimension in CCTA scanning. Preliminary investigations on NAEOTOM Alpha demonstrate that a relatively new biomarker known as the “fat attenuation index” (FAI), a CCTA-based marker of coronary inflammation, demonstrates a cutoff value that is affected by the selected keV level, and this may help standardize

Figure 12: Subendocardial late enhancement in an elderly patient with recent history of percutaneous coronary intervention in the obtuse marginal artery due to non-ST-elevation myocardial infarction. Cardiac MRI images (Figs. 12a & 12c) and CT ECV maps (Figs. 12b & 12d) demonstrate basal lateral wall subendocardial involvement on short axis (top, arrows) and long-axis views (bottom, arrows).



Evaluation of ECV is based on WIP software that is not commercially available.

evaluation of pericoronary inflammation by photon-counting CT as a measure of patients' cardiac risk [21].

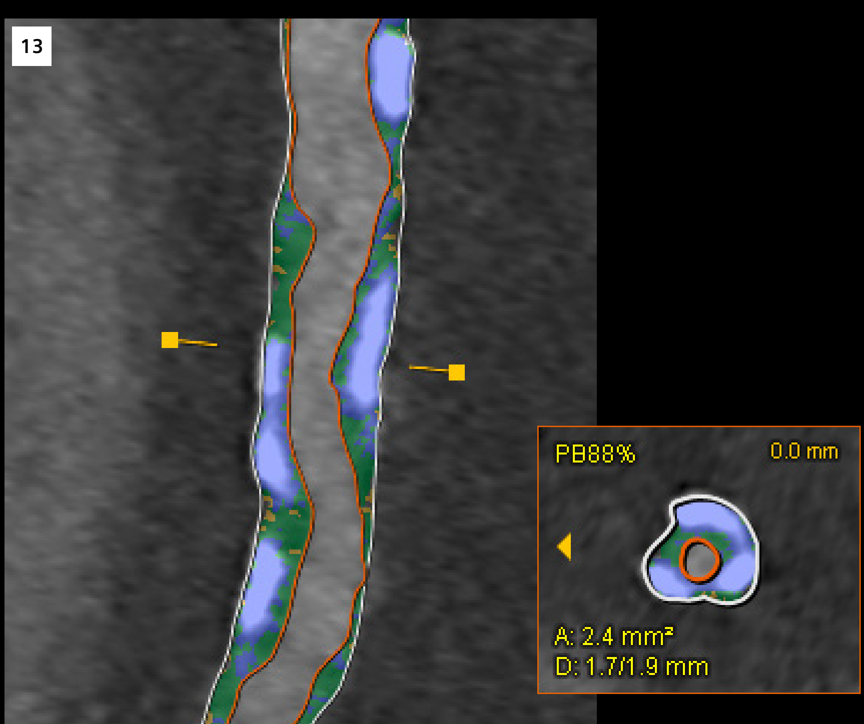
Utilizing high-resolution Quantum HD Cardiac images for quantitative coronary plaque analysis also seems to provide a high degree of accuracy. A preliminary investigation showed that due to reduced blooming artifacts when using 0.2 mm slice thickness coronary CTA images compared to 0.6 mm slices, an improved visualization of fibrotic and lipid-rich plaque components is possible while the calculated calcified plaque volume is significantly reduced [22].

With the benefits provided by photon-counting CT over conventional CT, this represents a major step forward in realizing the promise of this technology for cardiovascular imaging. These key features have opened the door for a improved performance of cardiac CT angiographic examinations, enhancing clinical diagnostic capabilities and decision making, and now represent the next milestone technical advance in clinical CT imaging.

"In the future, every CT will be a photon-counting CT."

Prof. Gabriel Krestin · Erasmus Medical Center, Rotterdam, Netherlands, Past President of the European Society of Radiology

Figure 13: Analysis of plaque volumes using Quantum HD Cardiac images demonstrating improved visualization of plaque components (yellow = calcified, green = fibrotic, and blue = lipid rich) with a slice thickness of 0.2 mm (Bv64 kernel).



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