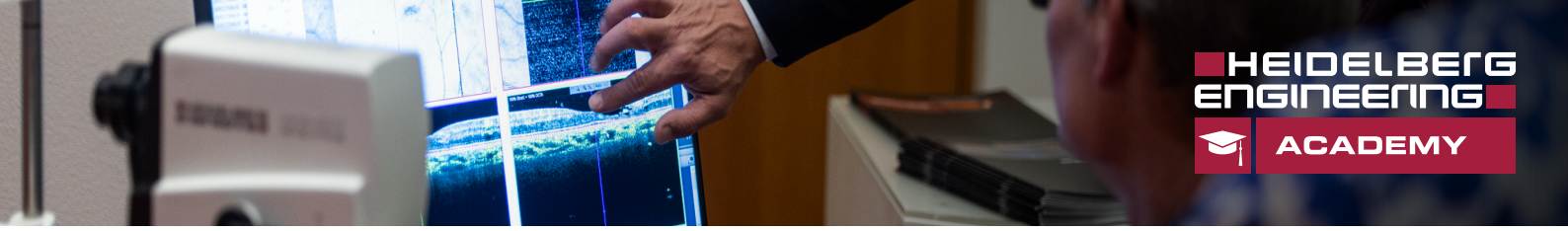

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Comparison of OCTA Scan Times of the SPECTRALIS OCT2 and OCTA Modules at 85 kHz versus the SPECTRALIS OCTA Module with SHIFT Technology at 85 kHz and 125 kHz

Kellogg Eye Center

ABSTRACT

The Kellogg Eye Center in Ann Arbor, Michigan, USA, conducted a study to analyze the accelerated scan time of OCT angiography (OCTA) using the SPECTRALIS OCTA Module with SHIFT technology at 85 kHz and 125 kHz A-scan rate instead of the SPECTRALIS OCTA and OCT2 Modules at 85 kHz and by reducing the default value for Automatic Real Time Mean (ART) from 5 to 4. The study involved adult patients undergoing OCTA imaging. The measured median actual scan time of the OCT2 Module (ART 5) was 59.41 s [48.80 s; 72.36 s] at 85 kHz while SHIFT technology (ART 4) achieved 37.09 s [31.38 s; 52.36 s] at 85 kHz and 29.67 s [22.73 s; 38.82 s] at 125 kHz (both p<0.001 vs. OCT2 Module)*. Median acquistion times for an OCTA 20x20° scan were 37% faster at 85 kHz and 50% faster at 125 kHz when using SHIFT technology with ART 4 instead of the OCT2 Module with ART 5.*

Key Words: *Retina; optical coherence tomography; OCT; OCT angiography; OCTA; SPECTRALIS OCT2 Module; SPECTRALIS OCTA Module with SHIFT technology; Heidelberg Engineering.*

INTRODUCTION

High-resolution images of ocular tissues obtained using optical coherence tomography (OCT) have become an integral part of eye care. Since the technology's introduction more than 30 years ago, resolution and acquisition time have been continuously improved.

In 2017[1], the Kellogg Eye Center in Ann Arbor, Michigan, USA demonstrated in a prospective study that the conversion of the Heidelberg Engineering SPECTRALIS OCT with 42.5 kHz to the OCT2 Module with 85 kHz scan rate reduced chair time per patient by 1.5 minutes and thus improved the clinical workflow.

The introduction of OCT angiography (OCTA), which generates high-resolution images of the retinal vasculature based on a high number of OCT B-scans, required a further improvement in scanning speed. This was achieved by introducing the SPECTRALIS OCTA Module with SHIFT technology offering 85 kHz and 125 kHz A-scan rates.

In the current study, the Kellogg Eye Center analyzed whether OCTA scan time could be accelerated using the SPECTRALIS OCTA Module with SHIFT technology at an A-Scan rate of 85 kHz (**SHIFT 85**) and 125 kHz (**SHIFT 125**) compared to the SPECTRALIS OCT2 and OCTA Modules at 85 kHz (**OCT2**).

METHODS

The clinical data collection for the prospective observational study was performed at the Kellogg Eye Center between October 1 and December 31, 2022.

Patients

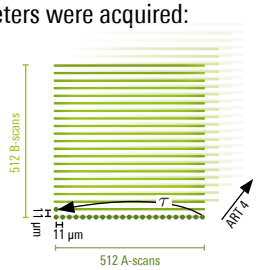
Adults undergoing ophthalmic exams where OCTA imaging was indicated were asked to participate. The study was approved by the University of Michigan IRB and followed the tenets set forth in the Declaration of Helsinki, and applicable local regulations. Eyes were excluded if not all scans could be performed.

Data Acquisition

Each of the 85 eyes (43 patients) was scanned three times – first with the OCT2 followed by the SHIFT 85 and the SHIFT 125.

OCTA volume scans with the following parameters were acquired:

- 20° x 20° scan dimension
- 512 OCT B-scans
  (11 µm distance between the B-scans)
- High speed
  (11 µm distance between the A-scans)
- ART 5 (OCT2)
  ART 4 (SHIFT 85 and SHIFT 125)



In order to attain the optimal scanning speed for the SHIFT 85 and the SHIFT 125, the image averaging (ART mean)[2] was reduced from the standard value ART 5 to the smallest possible value ART 4.

Data Analysis

Ideal Scan Times

The ideal scan time describes the minimal time that the OCT scanner needs to perform the scan on a target, independent of eye movements, complications and other external factors. The ideal scan times can be calculated for 85 kHz and 125 kHz with ART 4 and ART 5 using the following formula:

$$Ideal\ Time\ [sec] = \left(\frac{n_{A\text{-}scans}}{A\text{-}scan\ Rate\ [Hz]} + \tau\right) * n_{ART} * n_{B\text{-}scans}$$

$n_{A\text{-}Scan}$ .....Amount of A-scans

A-scan rate..... Amount of A-scans per second

n_{ART} .....Amount of scan averaging per scan line

τ.....Time required from the last A-scan in a scan line to the first A-scan in the next B-scan

$n_{B\text{-}Scan}$.....Amount of B-scans

Actual Scan Times

The acutal scan times (start and end of the OCTA scan acquisition) were extracted from log files and are reported as medians with the first and third quartile [Q1; Q3]. The Wilcoxon rank sum test was used to check whether the scan times between the OCT2 (ART 5) versus the SHIFT 85 (ART 4) and the SHIFT 125 (ART 4) were significantly different.

[1] STEFFENS, T.: New OCT Technology Shortens Examination Time without Sacrificing Quality. Heidelberg Engineering White Paper. Article No. 200272-001 GL.AE17. 2017

[2] ART mean, Automatic Real Time mean. ART 5 automatically averages 5 images per scan line. Image averaging improves image quality based on noise reduction. Reducing the number of averaged images speeds up aquisition.

RESULTS

Ideal Scan Times

When comparing the ideal scan times, Table 1 shows that the SHIFT 85 is technically **7% faster** and the SHIFT 125 is **31% faster** than the OCT2. Furthermore, a decrease of ART mean from the standard value **ART 5** to **ART 4** reduces the ideal scanning time by **20%**.

Table 1: Calculated ideal and the measured actual scan times for an OCTA 20x20° scan with ART 4 and ART 5 at 85 kHz and 125 kHz A-scan rates.

Parameter	OCT2		SHIFT 85		SHIFT 125	
$n_{A\text{-scan}}$	512	512	512	512	512	512
A-scan Rate [Hz]	85 000	85 000	85 000	85 000	125 000	125 000
τ [s]	0.002	0.002	0.0014	0.0014	0.0014	0.0014
$n_{Repeats}$	**ART 5**	**ART 4**	**ART 5**	**ART 4**	**ART 5**	**ART 4**
$n_{B\text{-scan}}$	512	512	512	512	512	512
Calculated Ideal Time [s]	**20.5**	**16.4**	**19.0**	**15.2**	**14.1**	**11.3**
Measured Median Actual Time [s]	**59.41**	not measured	not measured	**37.09**	not measured	**29.67**

Actual Scan Times

The **median** actual scan time of the OCT2 was **59.41 s** [48.80 s; 72.36 s]. The SHIFT 85 achieved a median actual scan time of **37.09 s** [31.38 s; 52.36 s] and the SHIFT 125 of **29.67 s** [22.73 s; 38.82 s] (both p<0.001 vs. OCT2).

As a result, the median acquistion times for an OCTA 20x20° scan were **37% faster** when using the SHIFT 85 and **50% faster** when using the SHIFT 125 (both with ART 4), compared to the OCT2 with ART 5. When comparing both SHIFT scanning speeds, the scan time of the SHIFT 125 is **20% faster** than the SHIFT 85.

Fig. 2 displays a scatter plot visualizing the scan time of both devices: For each eye, the gray data points show the scan times of SHIFT 85 vs. OCT2, while the red data points show the scan times of SHIFT 125 vs. OCT2.

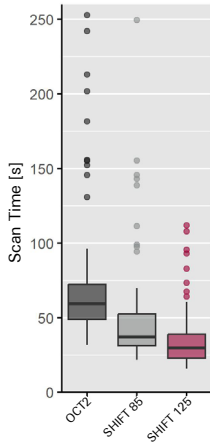


Figure 1: Boxplot showing the median scan times and the quartiles of OCT2, SHIFT 85 and SHIFT 125.

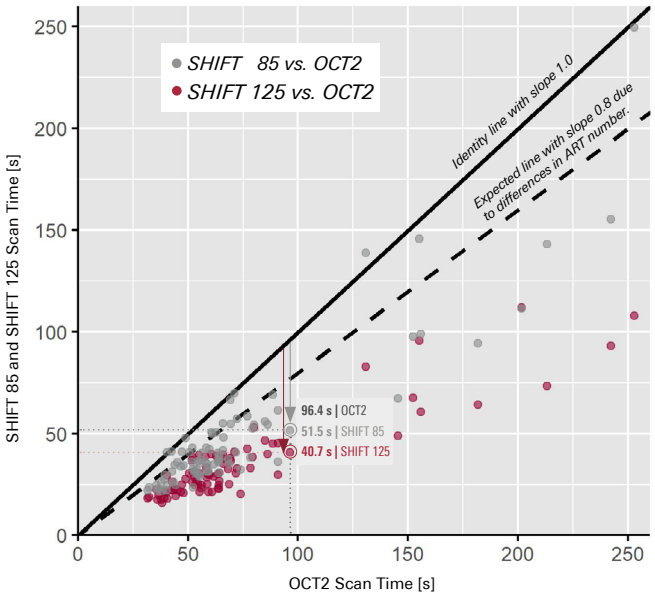


*Figure 2: Measured OCTA scan times with SHIFT 85 and SHIFT 125 vs. OCT2. Considering the circled data points of a randomly selected patient, OCTA acquisition required **96.4 s** with the OCT2, compared to **51.5 s** with the SHIFT 85 and **40.7 s** with the SHIFT 125. The gray/red arrows illustrate the time saving in this patient using SHIFT technology.*

The **black line** indicates, where data points would be expected if the devices showed identical scan times.

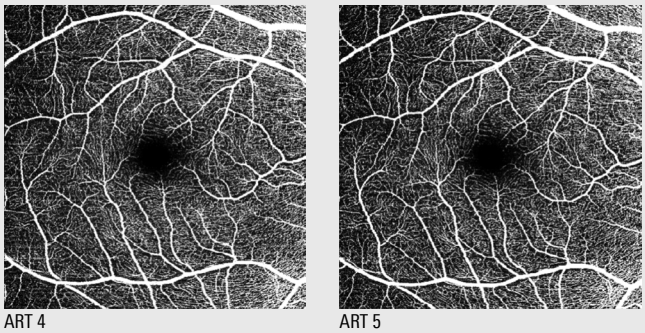
It is observed, that **100%** of the **red** and **97%** of the **gray** data points are below the black identity line indicating shorter OCTA scan times with SHIFT technology, consistently.

The **black dashed** line indicates the expected line, if the OCT2 was used at ART 4, instead of ART 5, assuming a linear dependency of scan time on the ART number. SHIFT 125 is still in **100%** and SHIFT 85 in **82%** of the cases faster than OCT2.

From Figure 2 it is also evident, that the absolute time savings are greater for eyes that were difficult to scan with OCT2.

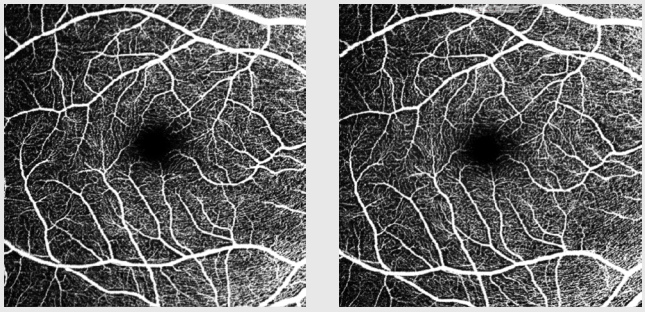
To illustrate the obtainable images at ART 4 and 5, Figure 3 shows a comparison of both devices using a healthy eye as an examplary case.

SPECTRALIS OCTA and OCT2 Modules, 85 kHz



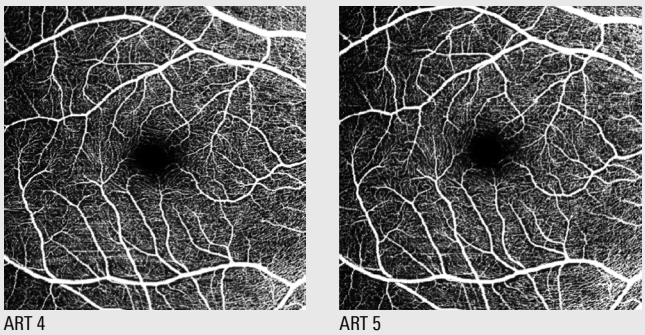
ART 4 ART 5

SPECTRALIS OCTA Module with SHIFT technology, 85 kHz



ART 4 ART 5

SPECTRALIS OCTA Module with SHIFT technology, 125 kHz



ART 4 ART 5

Figure 3: OCTA images (SVP, Superfical Vascular Plexus) in a healthy eye, acquired with OCT2, SHIFT 85 and SHIFT 125, show no clinically significant differences in image quality.

CONCLUSION

Using the SPECTRALIS OCTA Module with SHIFT technology, as well as reducing the ART number to the lowest possible setting ART 4 results in a 37% and 50% reduction of median acquisition times at 85 kHz and 125 kHz compared to the SPECTRALIS OCT2 and OCTA Modules with ART 5 at 85 kHz A-scan rate.