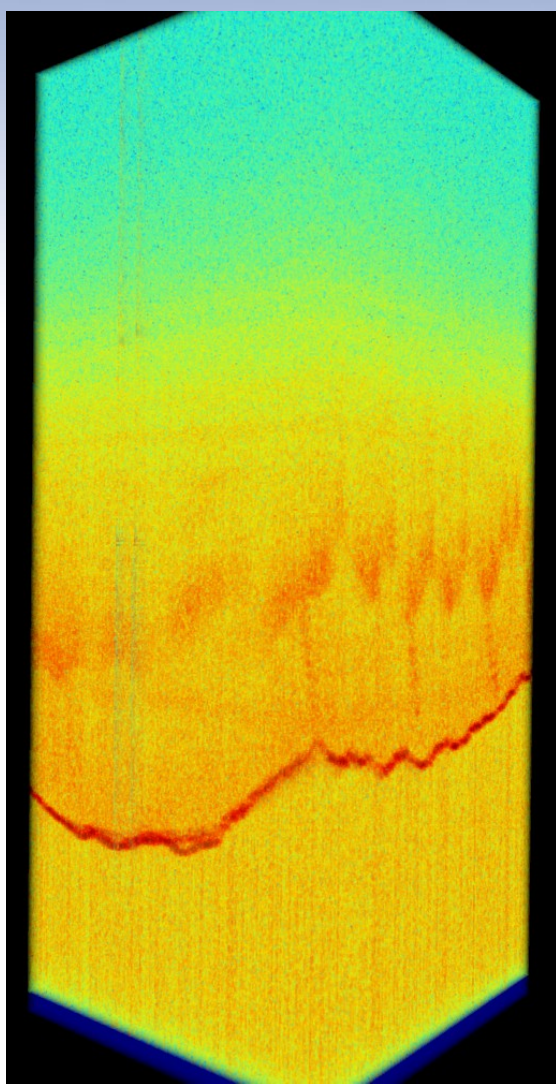
Fingerprint Presentation Attack Detection with OCT



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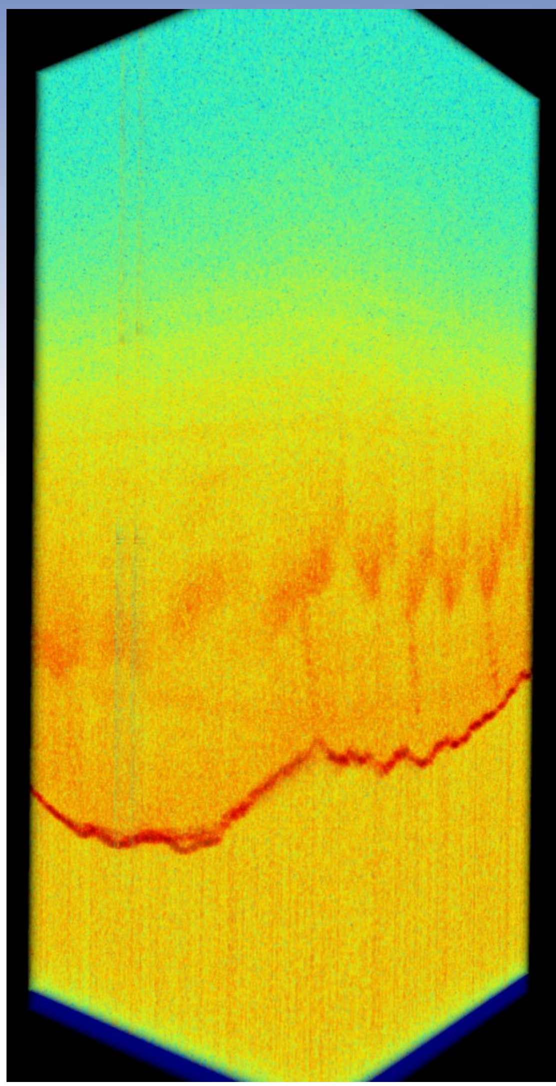
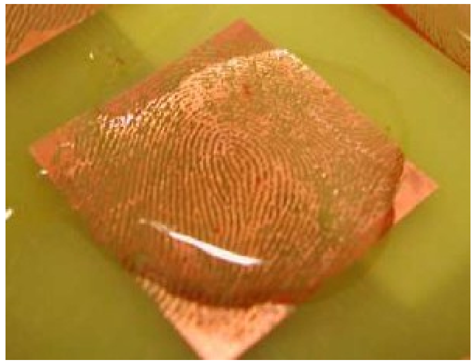
Outline



- Motivation
- Advantages
- Method
- Results
- Conclusion
- Future plans

Motivation

[1]



[2]

- Fingerprint sensors are vulnerable to spoofing attacks
- Fingerprint spoofing is widely researched
- Fingerprint Presentation Attack Detection (PAD) methods proposed as a countermeasure
- State-of-the art countermeasures are vulnerable to high-quality artefact fingerprints fabricated using novel approaches

Motivation

State-of-the-art in fingerprint Presentation Attack Detection (PAD)

- Countermeasures based on the original scan
  - Typically try to make use of a 2D representation of the fingerprint provided by 2D sensors
  - Results not satisfactory for high-quality artifact fingerprints
- Countermeasures based on extra sensors
  - Try to measure various properties of genuine fingerprints
  - Vulnerable to novel fake fingerprint fabrication methods that take the measured properties into account

Motivation

State-of-the-art in fingerprint Presentation Attack Detection (PAD)

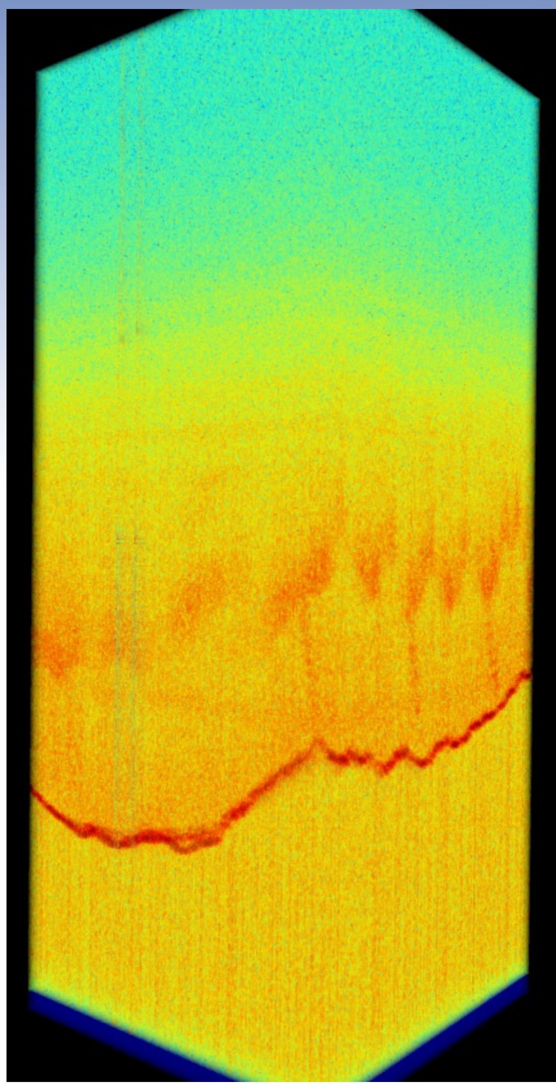
- Possible solution
  - Combining a large number of different information channels about the genuine properties
  - Additional sensors and complex analysis of the 2D scan
- Problems
  - Too much information to be considered – machine learning necessary
  - Hard to teach how to recognize novel, previously unexpected, fakes

Motivation

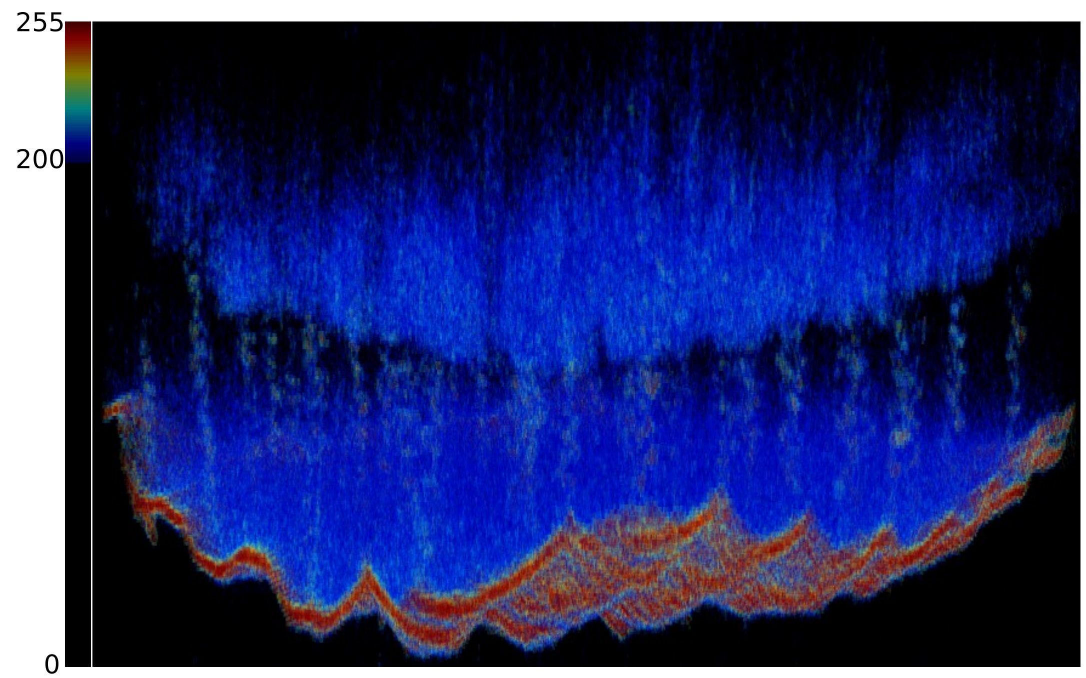
Rather a single scanning technology that:

- **Can capture enough information for the biometric recognition purposes**
- **Can capture enough information for Presentation Attack Detection**
- **Provides for scans that can be understood, and the genuine data can be defined**

Method

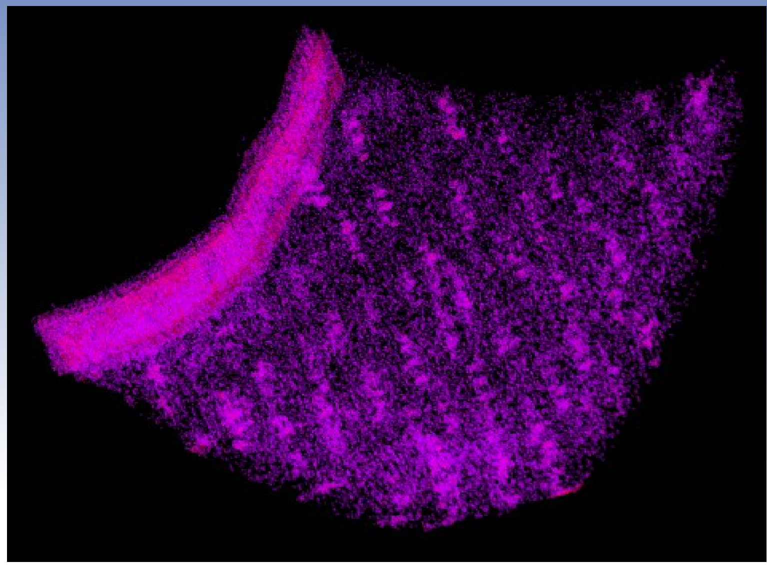


- **Analysis of 3D volumetric data**
- **Scanning of the 3D internal structure of the fingertip**
- **Optical Coherence Tomography (OCT)**

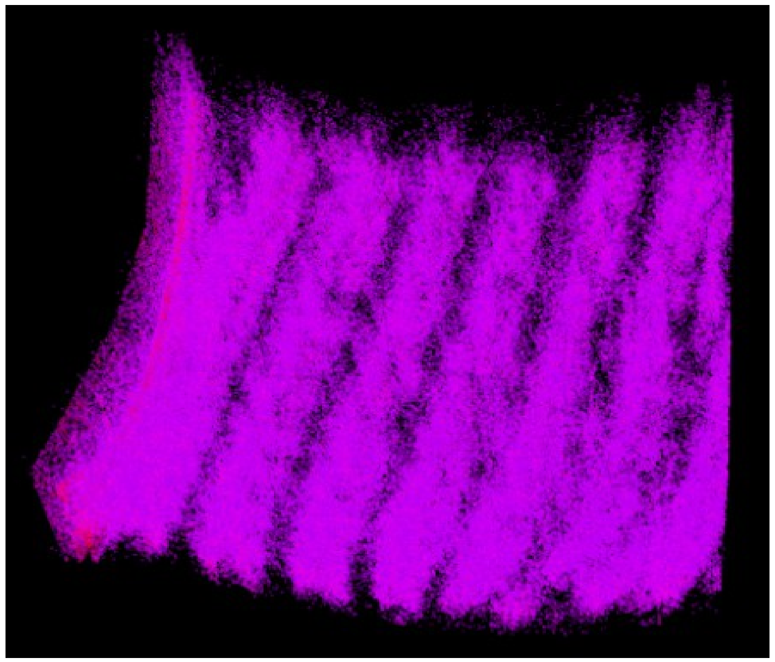


Advantages

Sweat glands

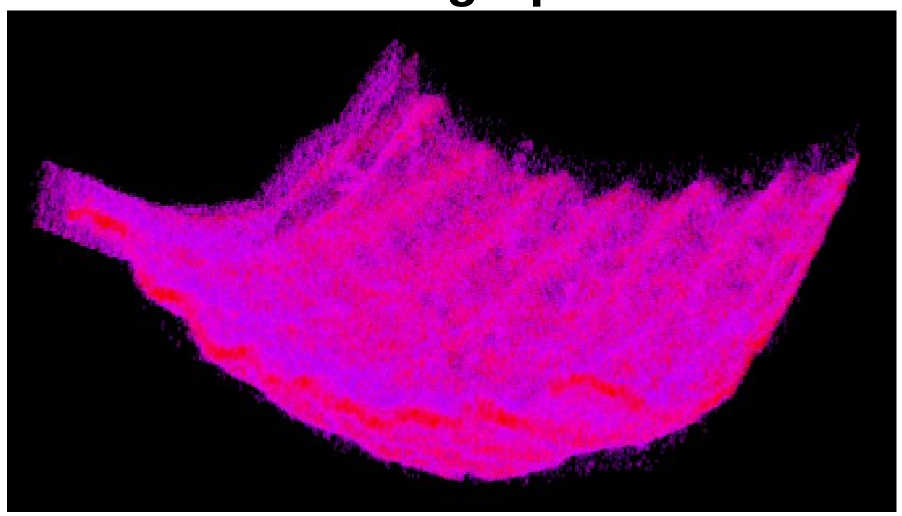


Inner fingerprint

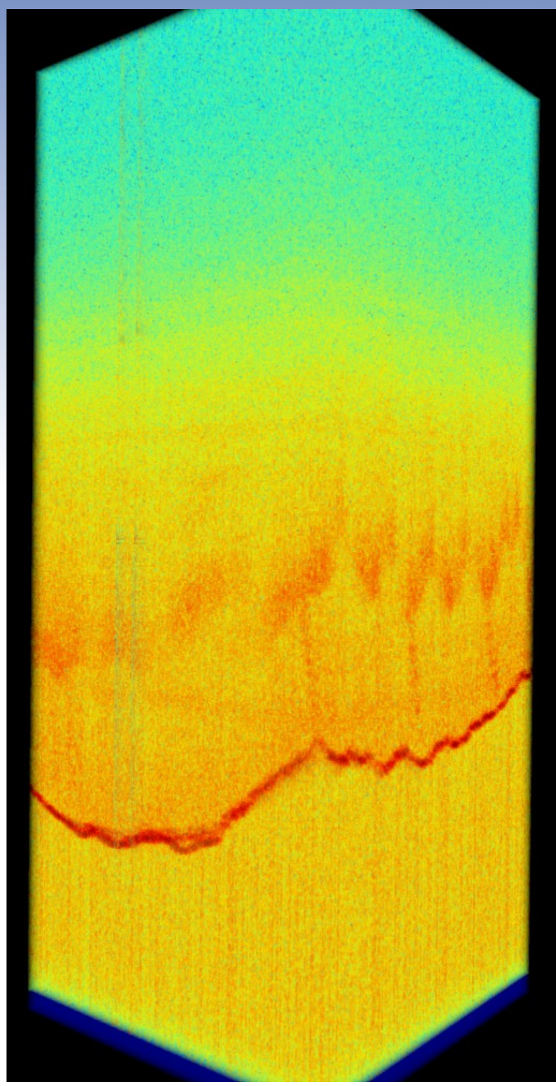


- **3D scanning of the fingertip**
- **Greatly increases the difficulty of spoofing the sensor**
- **Actual scanning of the inner fingerprint**
- **Better functionality under difficult conditions – wet, greasy fingers**

Outer fingerprint

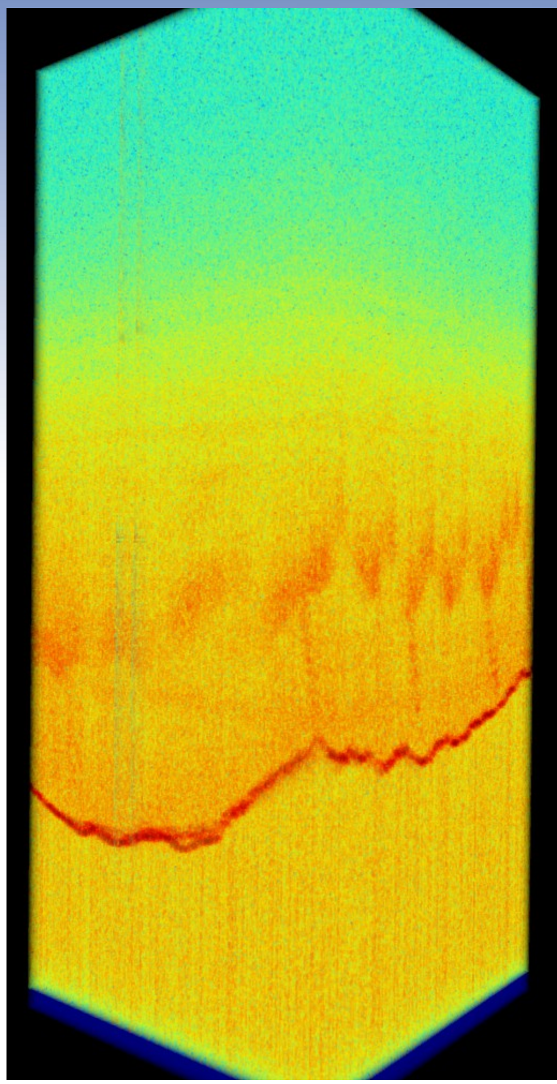


Challenges



- Large amount of volumetric data to be processed in a matter of seconds
- Applicability to even larger amounts of data for wider scanning areas and resolutions
- Non-compliant capture subject behavior
- Noise in the OCT data

Database

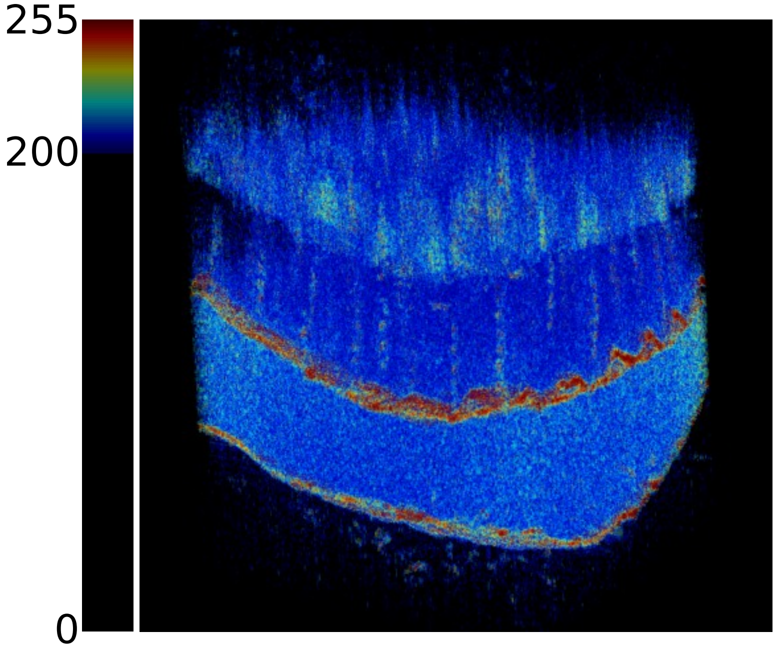


- 4 x 4 x 2.5 mm large scanning volume
- 200 x 200 x 512 voxels resolution
- 226 subjects, 3 fingers per subject, 11 scans per finger
- > 7400 scans of genuine fingerprints
- 30 classes of artefact fabrication approaches, 9 artefact fingerprints per class, 11 scans per artefact fingerprint
- > 2900 scans of artefact fingerprints

Database

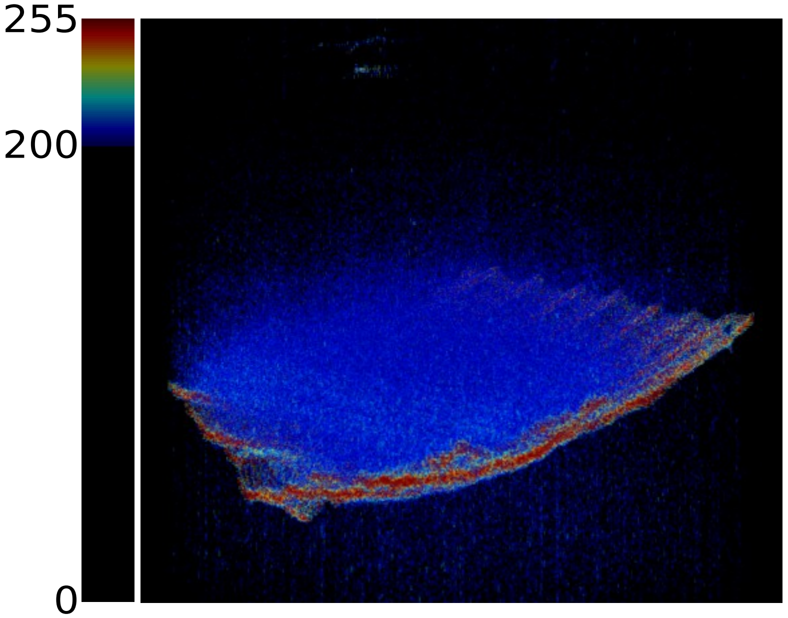
Thin-layered artefact

[1]

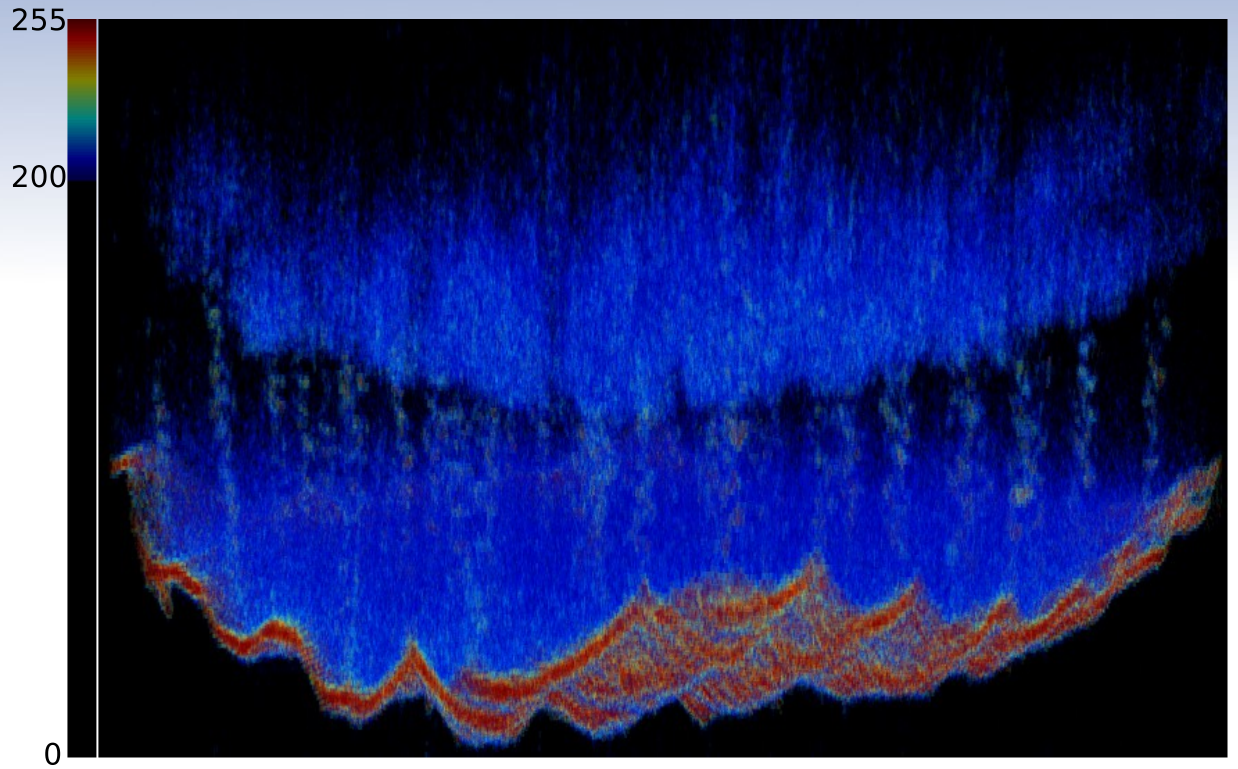


Thick-layered artefact

[2]



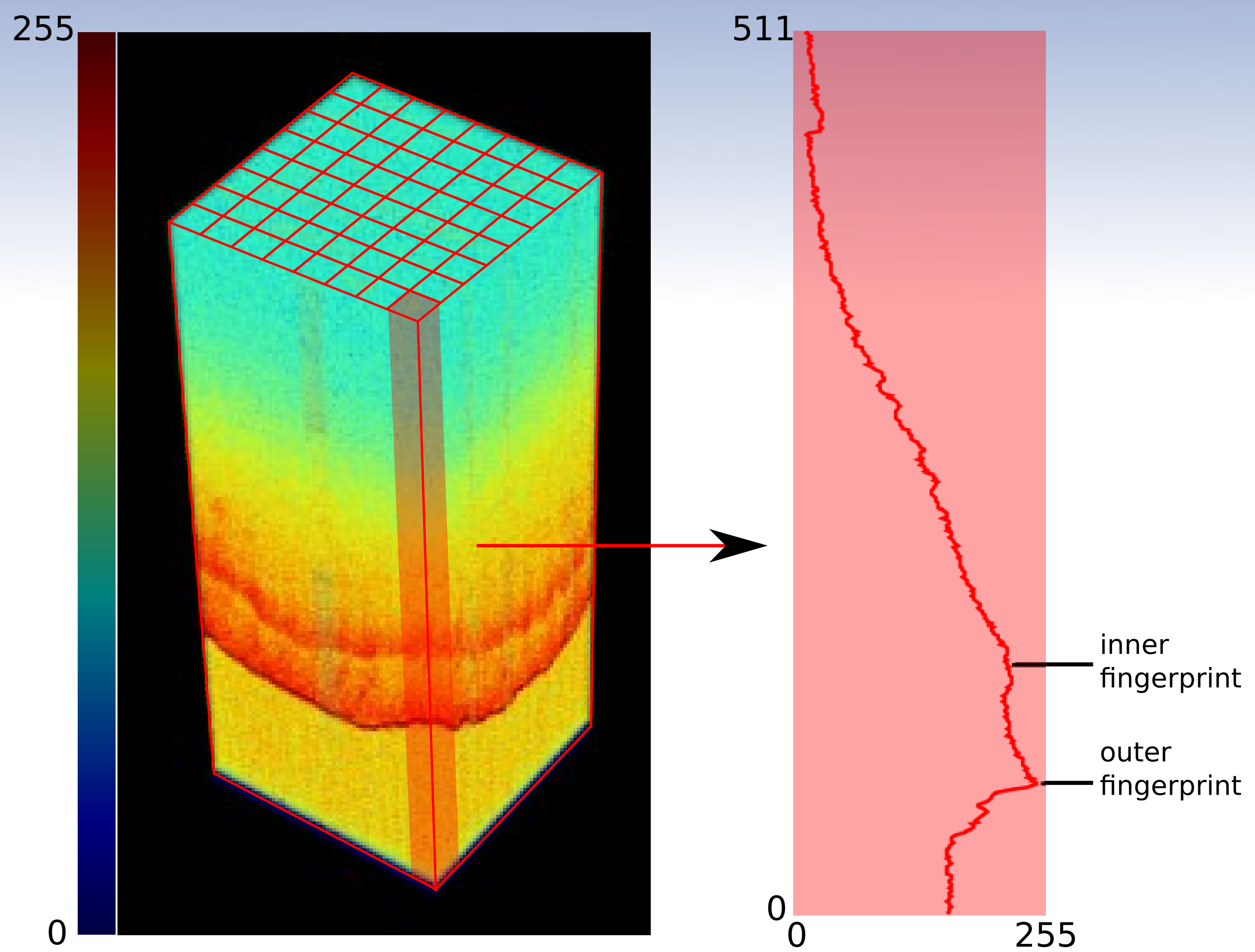
Proposed approach



Inner fingerprint layer

Outer fingerprint layer

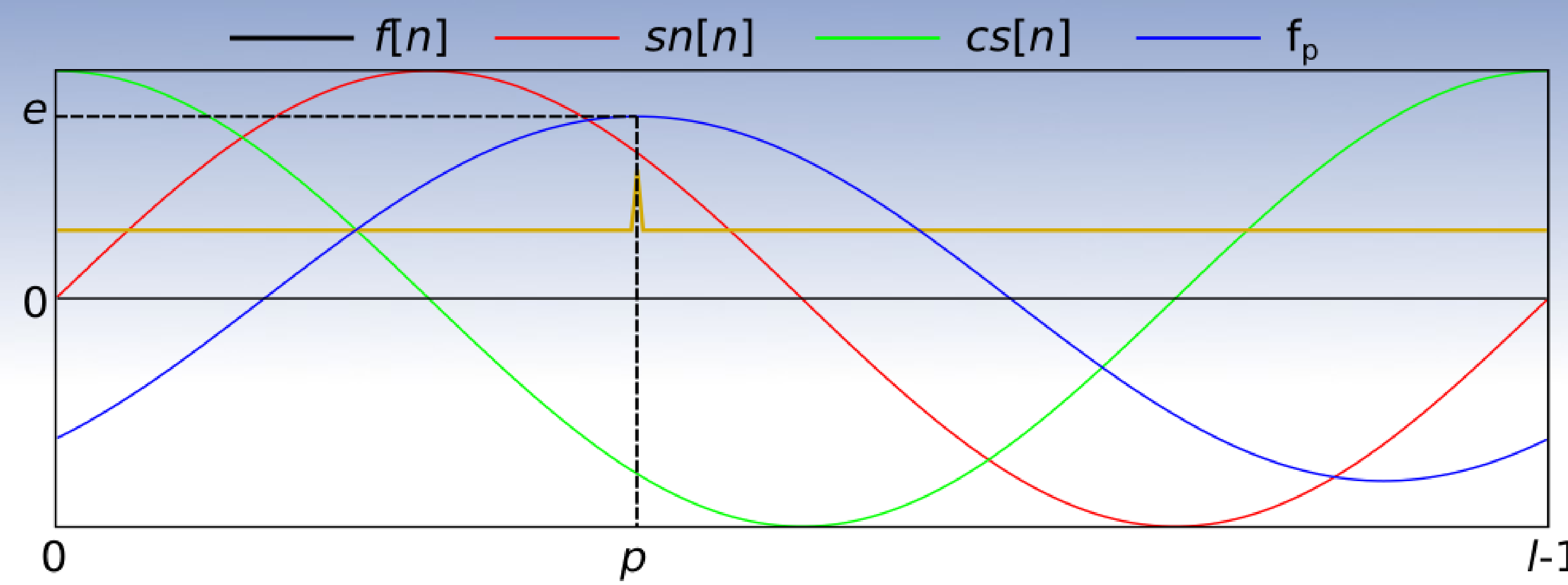
Proposed approach



[4]

- **Volume divided into w_g x h_g columns**
- **In each column, all the row data added together to form a single function**

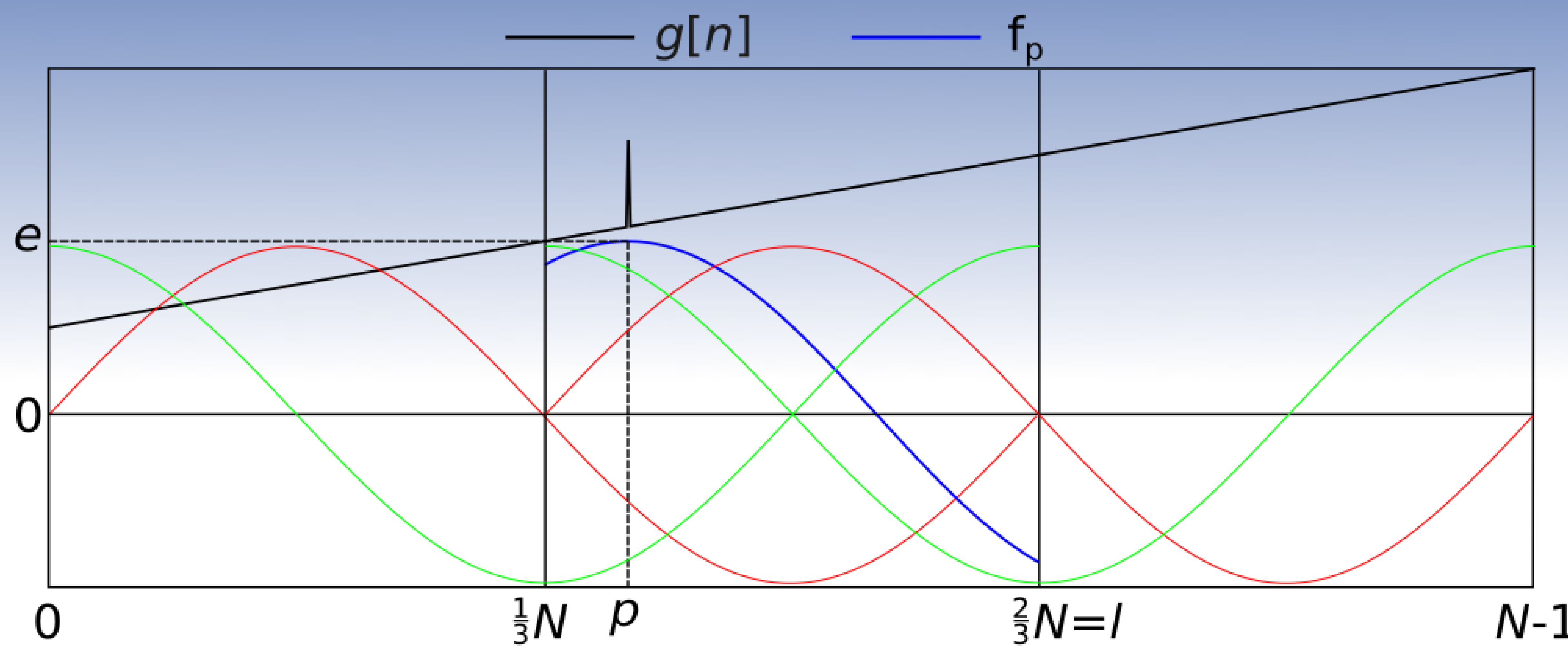
Proposed approach



[4]

- **Detection of peak position *p* and approximate peak energy *e* for an otherwise constant function**

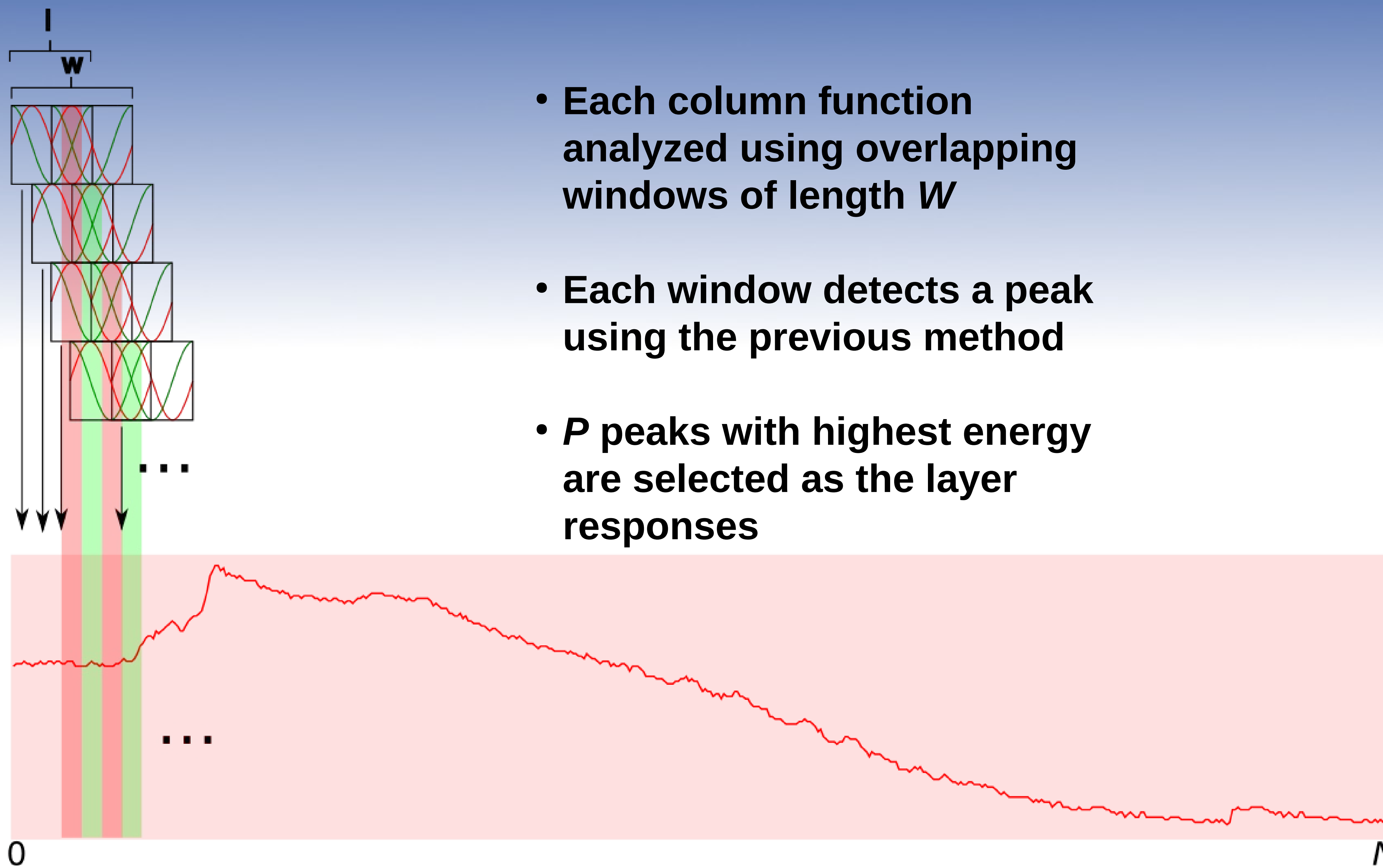
Proposed approach



[4]

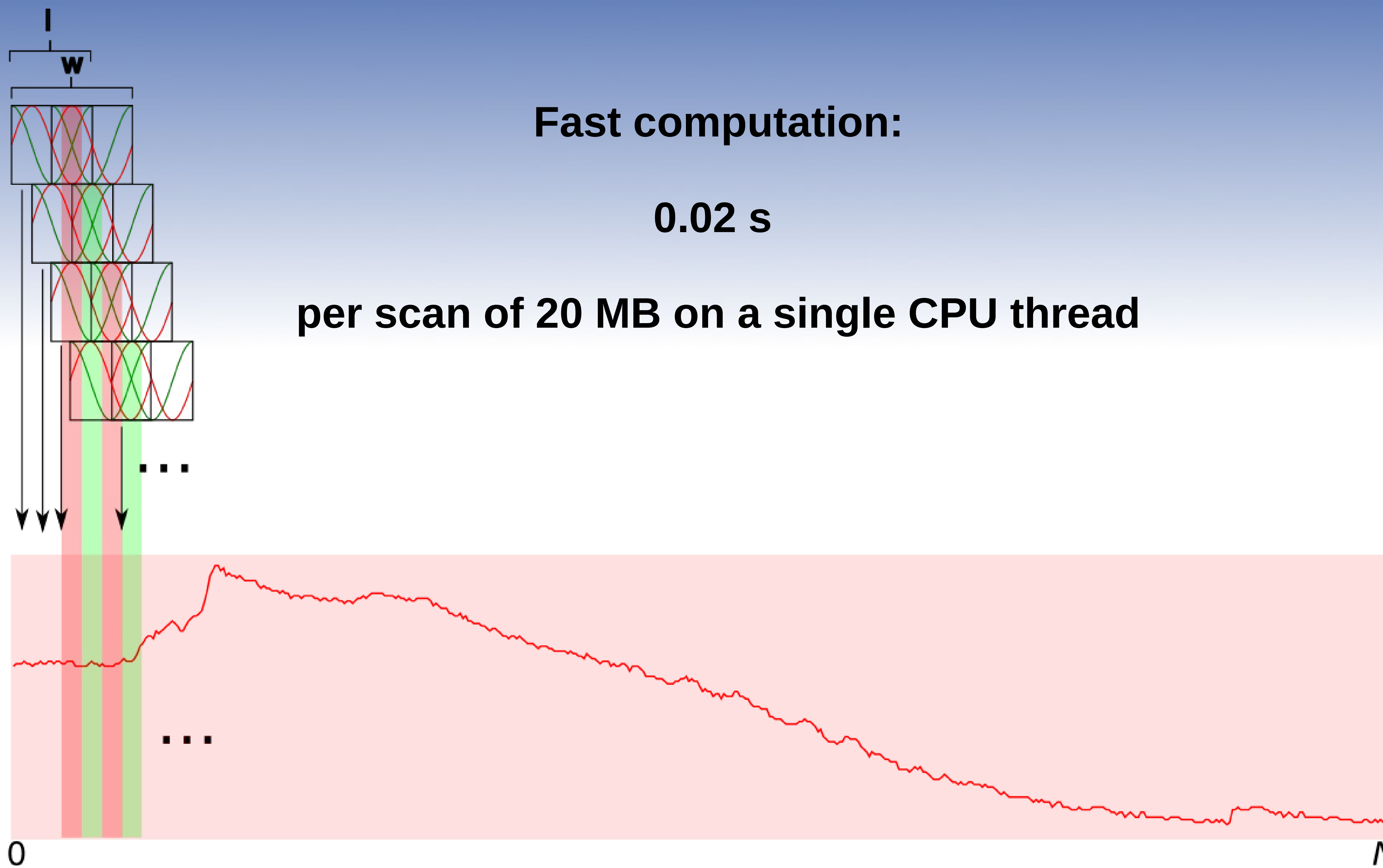
- **Detection of peak position *p* and approximate peak energy *e* for a function with an otherwise constant slope**

Proposed approach



- **Each column function analyzed using overlapping windows of length *W***
- **Each window detects a peak using the previous method**
- ***P* peaks with highest energy are selected as the layer responses**

Proposed approach



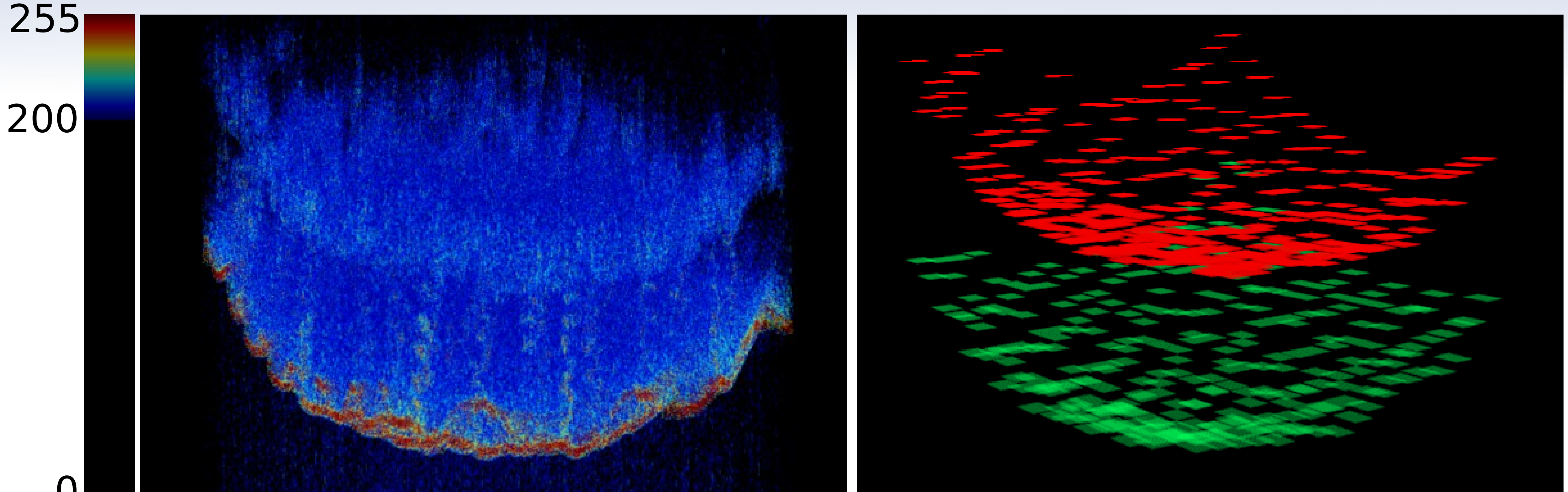
Fast computation:

0.02 s

per scan of 20 MB on a single CPU thread

Results

Genuine finger scan

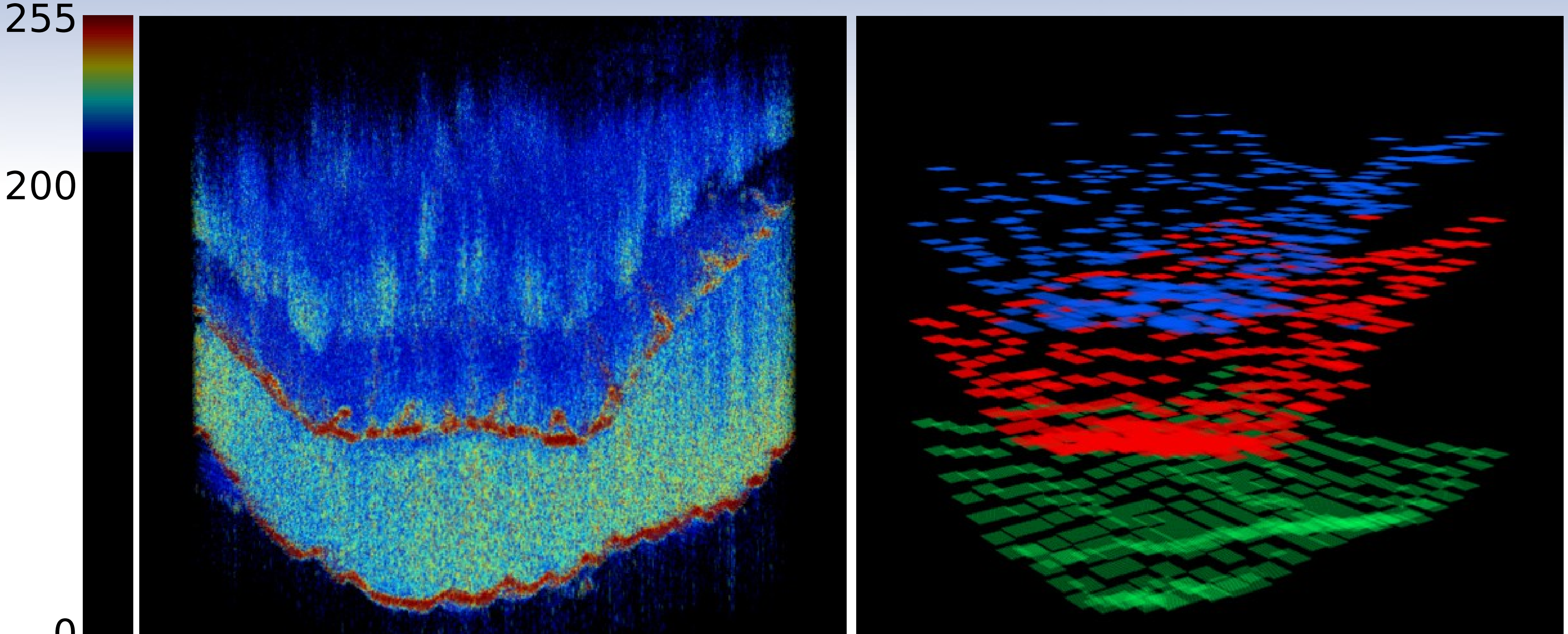


OCT scan

Layers detected

Results

Artefact finger scan



OCT scan

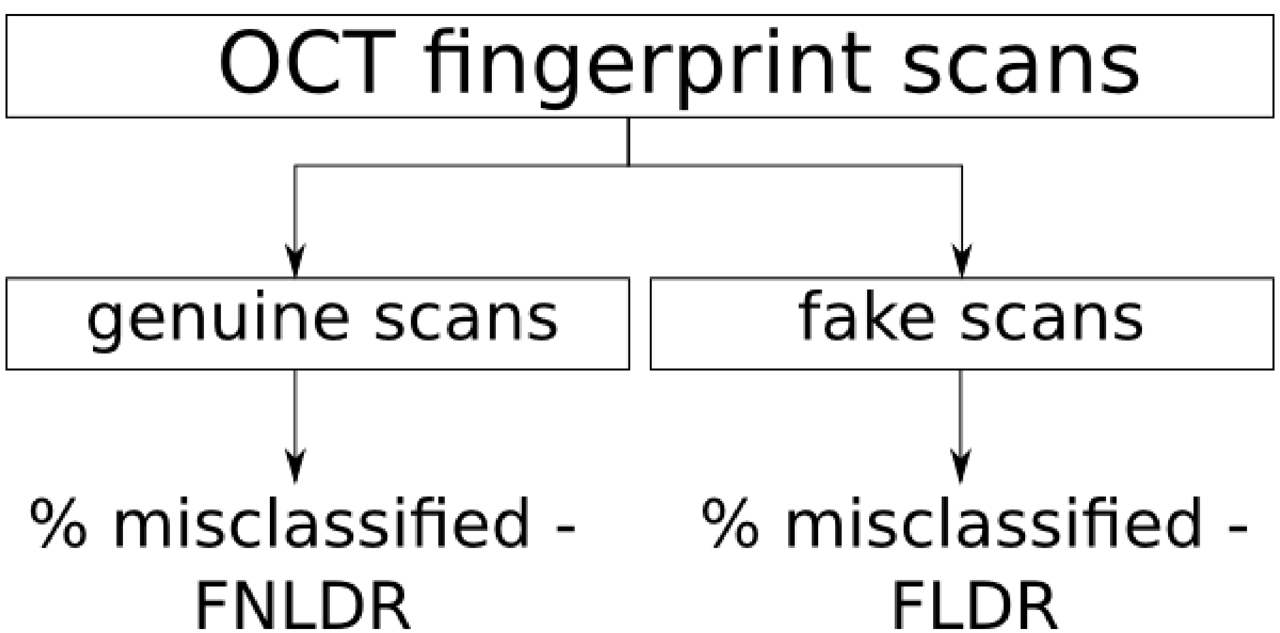
Layers detected

Results

ISO/IEC WD 30107 liveness detection metrics [3]

- ***False Live Detection Rate (FLDR)*****: proportion of non-live presentation characteristics incorrectly classified as being live.**

- ***False Non-Live Detection Rate (FNLDR)*****: proportion of live presentation characteristics incorrectly classified as being non-live.**

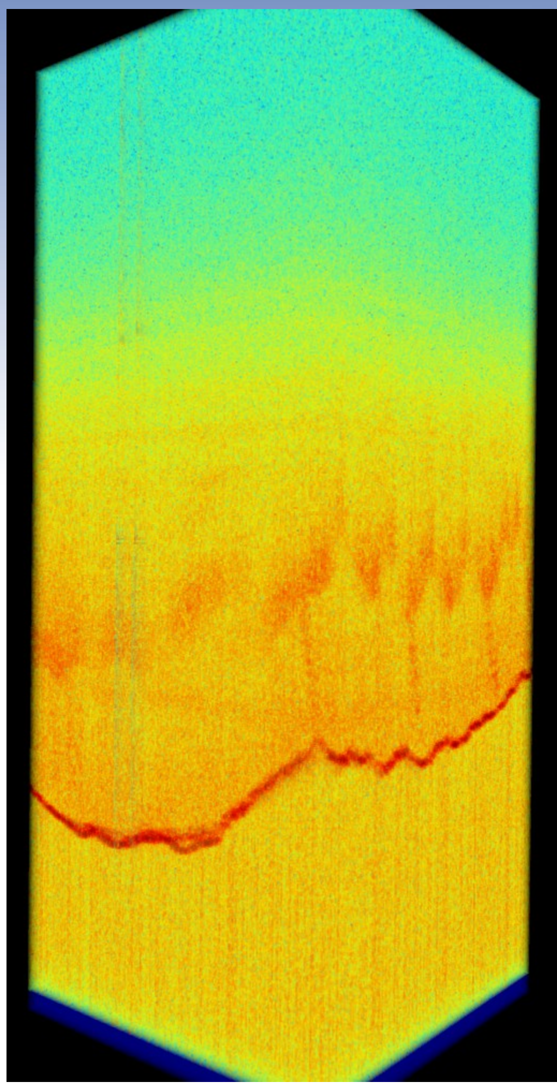


Results

- **Classification using the strength of the responses when detecting the scans**

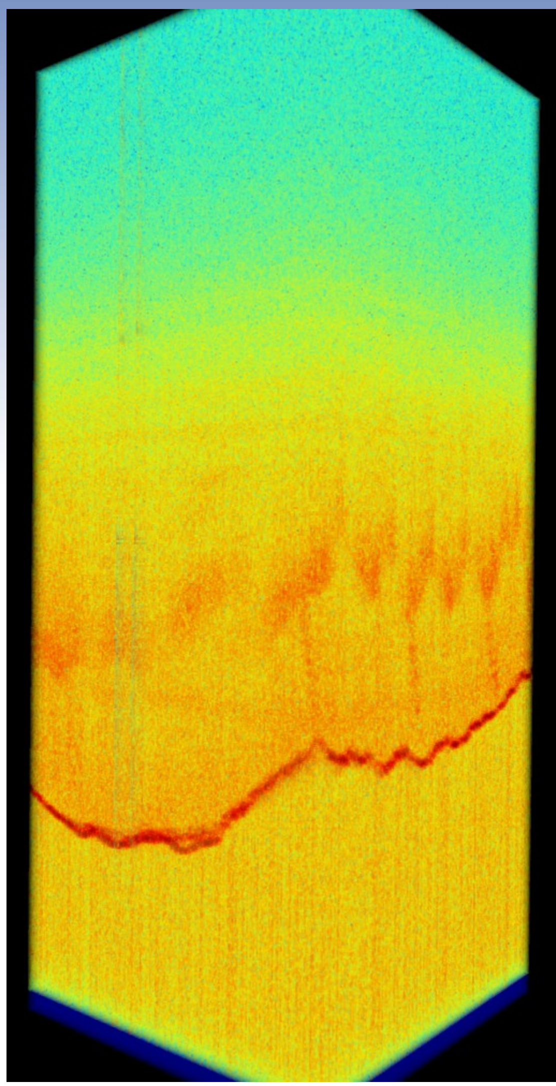
	FLDR	FNLDR
Our method	11.32%	3.52%
Menrath and Breithaupt	25.37%	6.17%

Conclusion



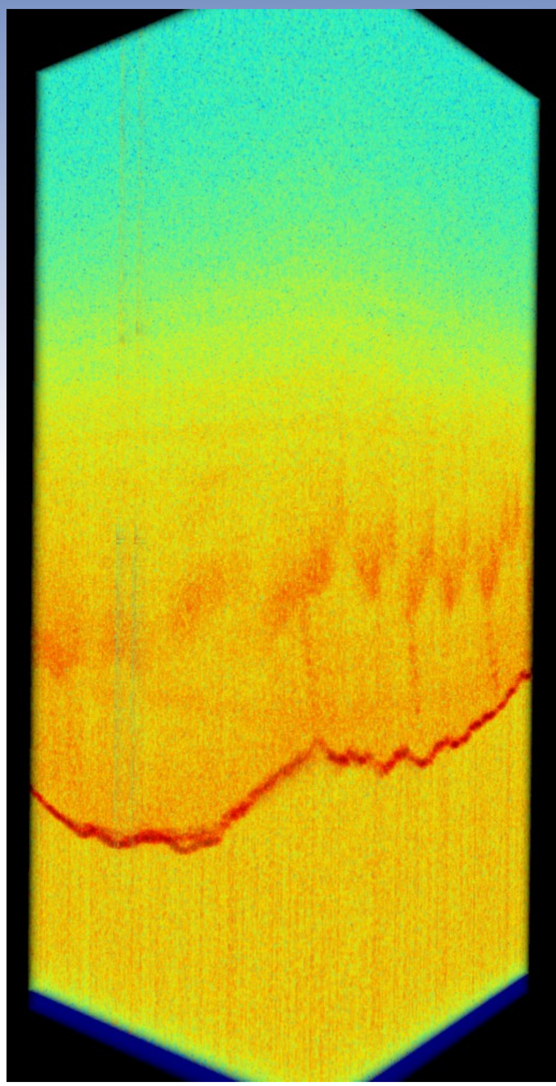
- **Fast and robust method for OCT scan layer detection**
- **Potential for further development**

Future plans

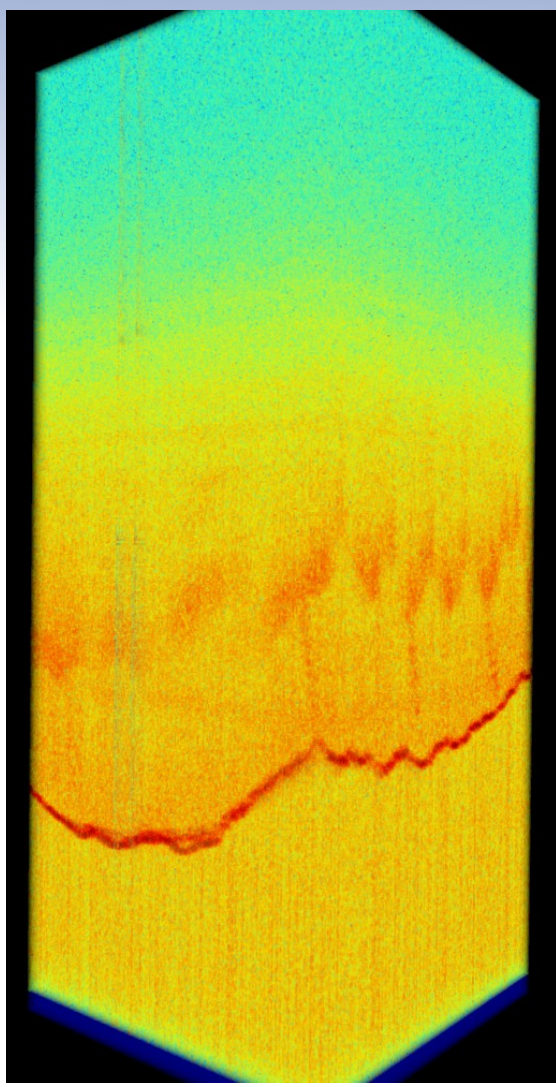


- New data collection in scope of the project OCT II
- Greater scanning volume
- Higher resolution
- Lower noise levels

Future plans



- **Sweat glands detection and analysis**
- **Inner fingerprint analysis and comparison to the outer fingerprint**
- **Outer fingerprint extraction to 2D format**



Thank you

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[1] M. Espinoza, C. Champod, and P. Margot. Vulnerabilities of fingerprint reader to fake fingerprints attacks. Forensic Science International, 204(1–3):41–49, 2011.

[2] A. Wiehe, T. Søndrol, O. Olsen, and F. Skarderud. Attacking Fingerprint Sensors. Technical report, NISlab/Gjøvik Univ. College, 2004.

[3] 208–215. ISO/IEC WD 30107, “Biometrics - Presentation Attack Detection.”

[4] Sousedik, C.; Breithaupt, R.; Busch, C., "Volumetric fingerprint data analysis using Optical Coherence Tomography," 2013 International Conference of the Biometrics Special Interest Group (BIOSIG), 5-6 Sept. 2013