Surface Analysis Technology | Vacuum Components | SPECS® | Surface Analysis System Software | Computer Technology

SPM 150 Aarhus with KolibriSensor™

Atomic Resolution NC-AFM on Si(111)-(7x7)

Application Notes

- Highest Resolution, constant detuning NC-AFM imaging at room temperature
- Atomic corrugation up to 120 pm
- Stable imaging of adsorbates and vacancies on the surface
- Identification of faulted and unfaulted half in NC-AFM images
- Atomic resolution imaging of an atomic step
- Constant detuning imaging in the repulsive interaction region with atomic resolution

All of the following data was recorded with no external dampers on the UHV system at SPECS' Laboratories.

Displayed images represent raw data with no filtering or smoothing applied.

KolibriSensor™

Measurement: S. Torbrügge, SPECS GmbH

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Highest Resolution NC-AFM imaging on Si(111)-(7x7)

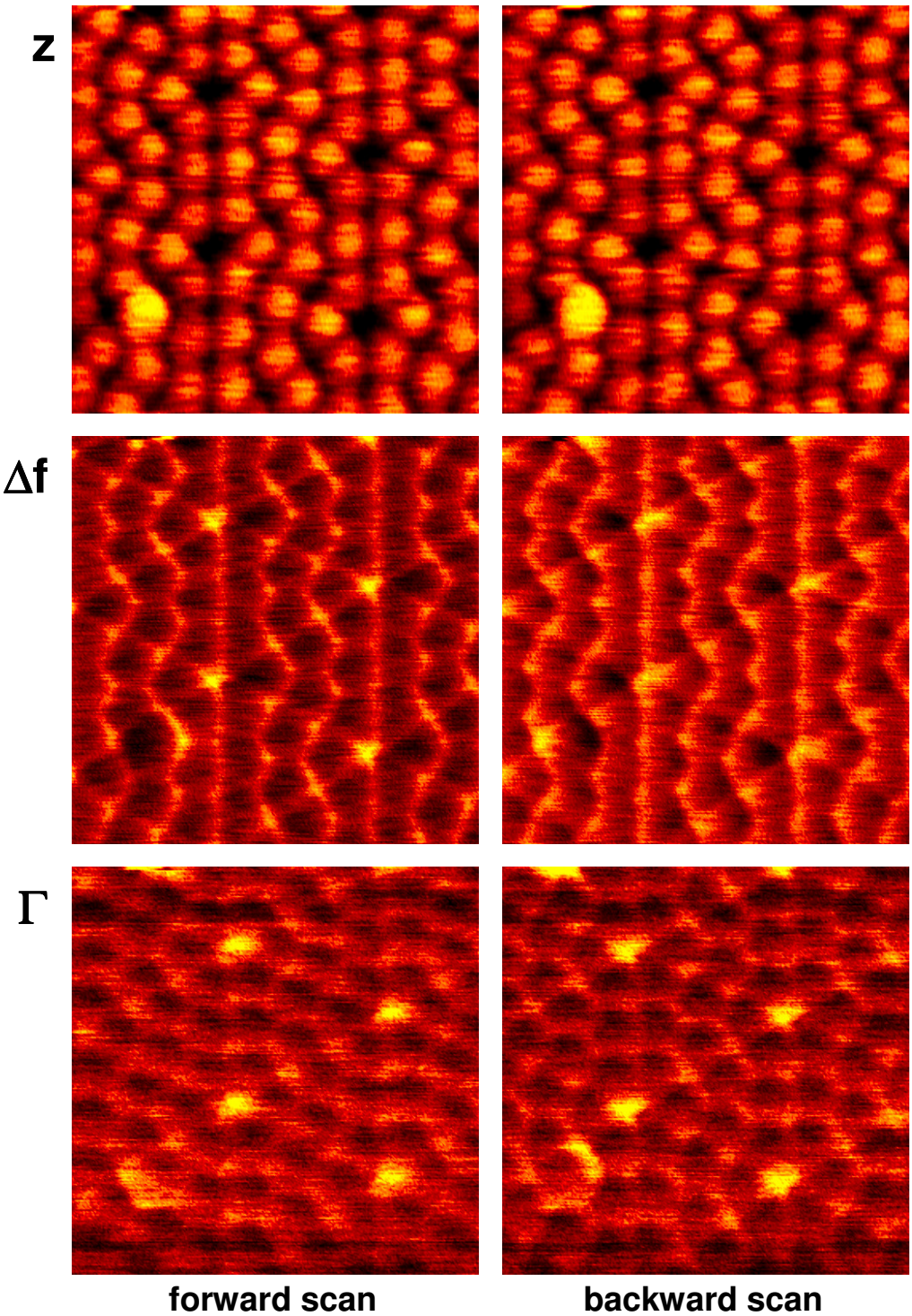

Figure 1: Constant detuning NC-AFM image.

Image size: 6 nm x 6 nm, f_{res} = 996,577 Hz, Q= 17500, Δf = -0.3 Hz, A = 200 pm,
U_{CPD} = 0.070 V, imaging speed: 2.5 lines/s, (512 x 512) pixels

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Highest Resolution NC-AFM imaging on Si(111)-(7x7)

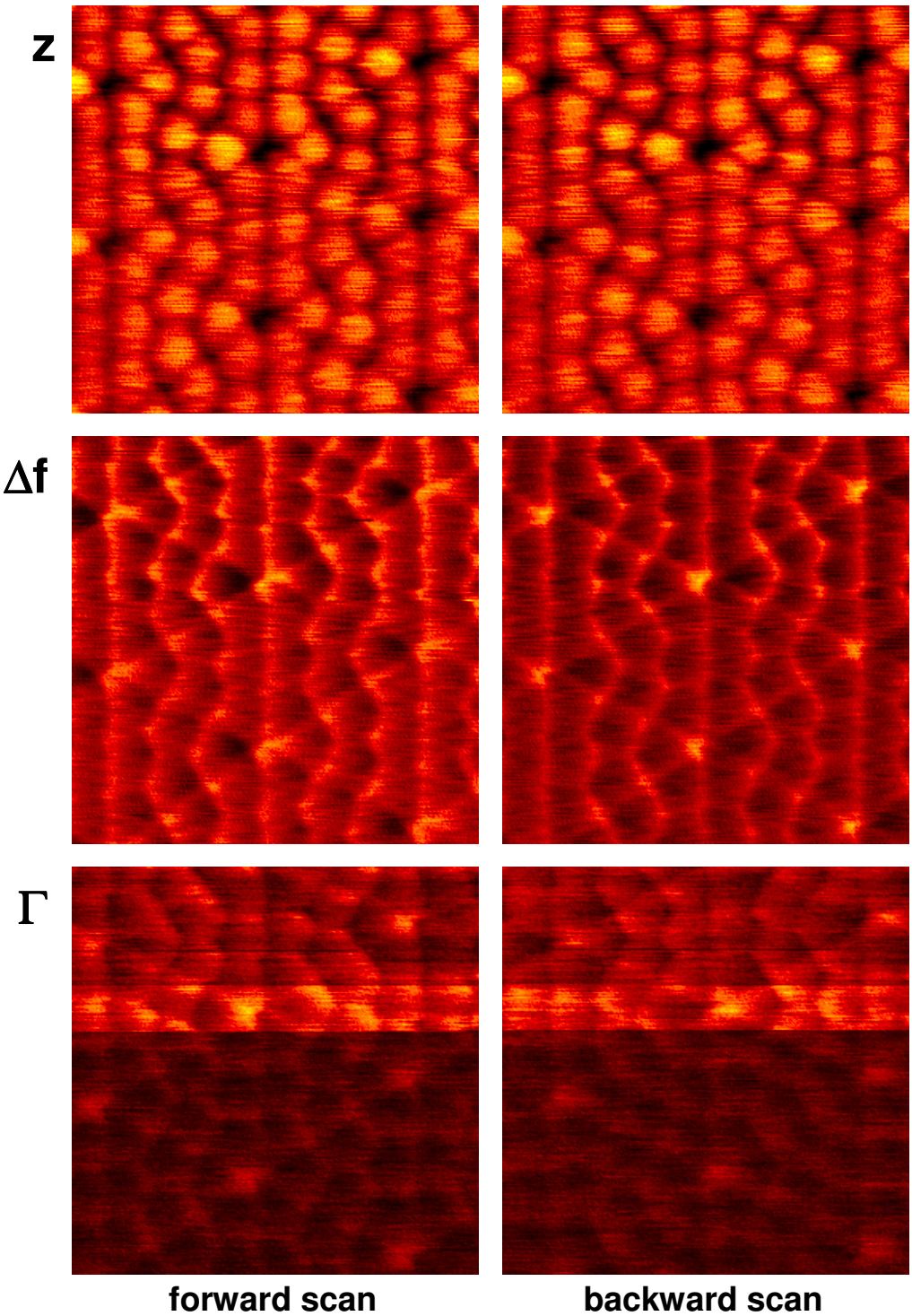

Figure 2: Constant detuning NC-AFM image.

Image size: 6 nm x 6 nm, f_{res} = 996,577 Hz, Q= 17500, Δf = -0.5 Hz, A = 200 pm,
U_{CPD} = 0.070 V, imaging speed: 2.5 lines/s, (256 x 256) pixels

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Highest Resolution NC-AFM imaging on Si(111)-(7x7)

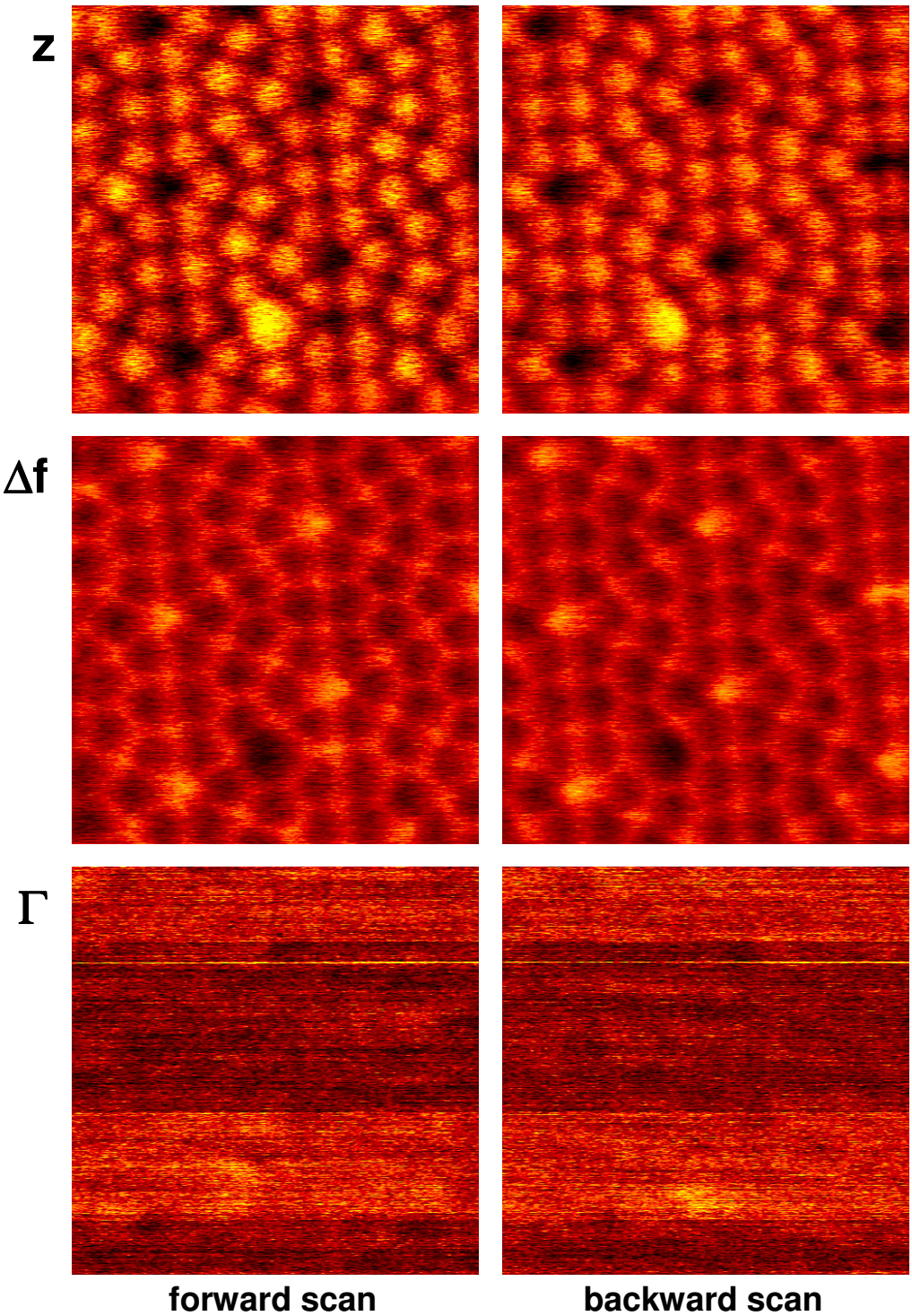

Figure 3: Constant detuning NC-AFM image.

Image size: 6 nm x 6 nm, f_{res} = 996,577 Hz, Q= 17500, Δf = -0.3 Hz, A = 200 pm,
U_{CPD} = 0.070 V, imaging speed: 20 lines/s, (512 x 512) pixels

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Highest Resolution NC-AFM imaging on Si(111)-(7x7)

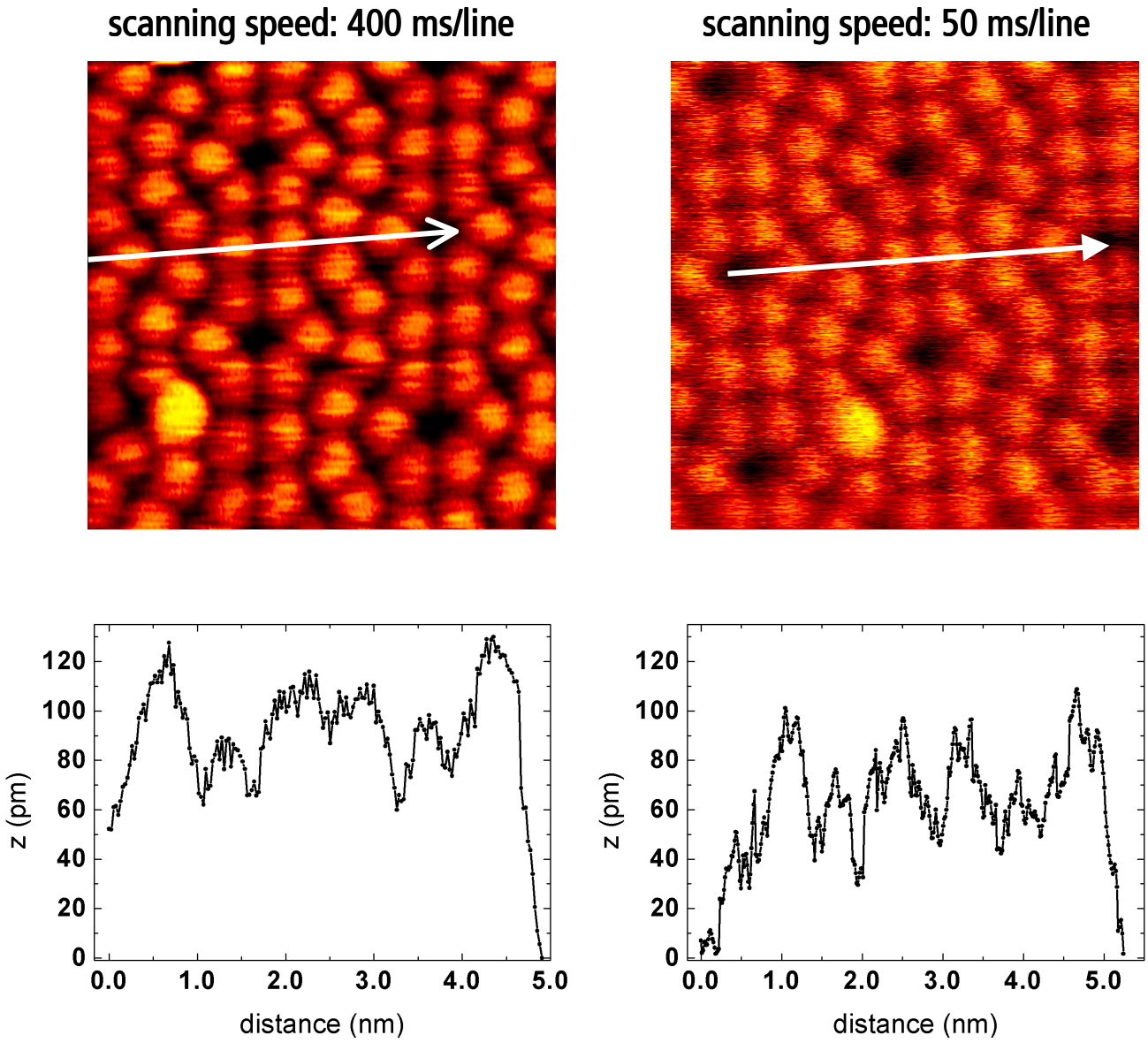

Figure 4: Height Profile Analysis

A typical corrugation of 120 pm is observed

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NC-AFM imaging of adsorbates and vacancies on Si(111)-(7x7)

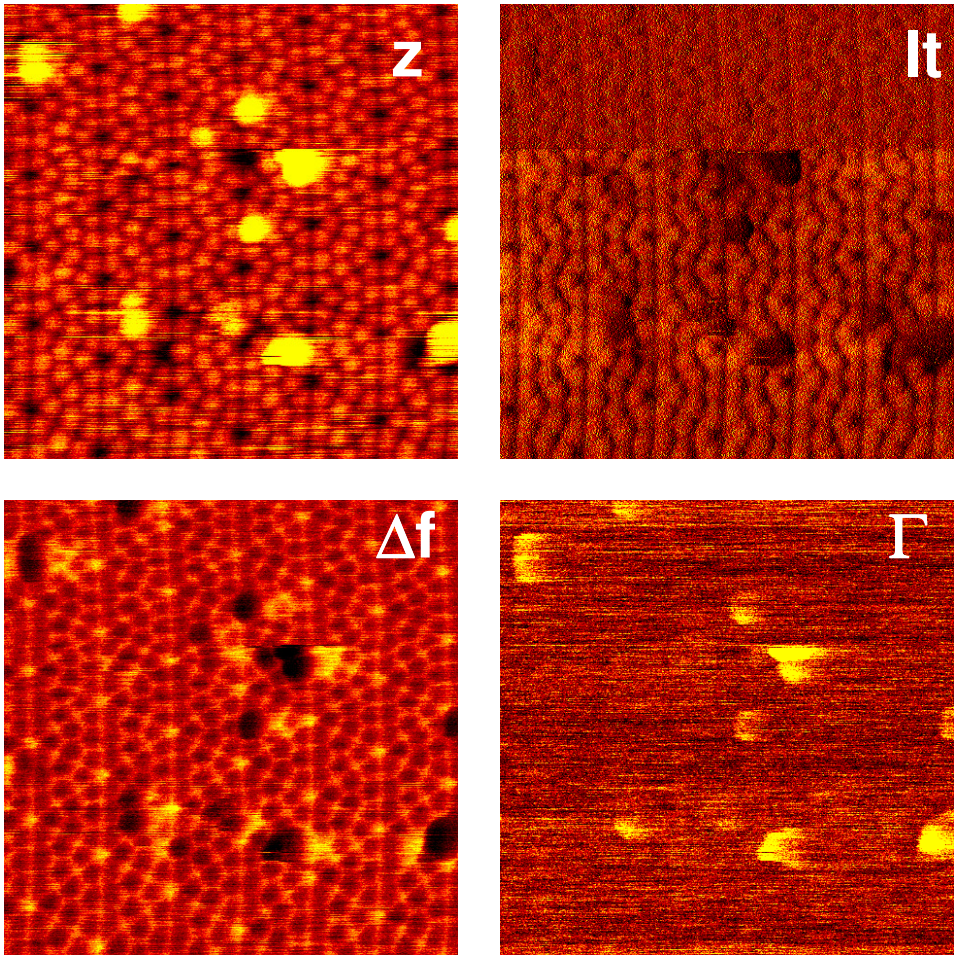

Figure 5: Constant detuning image of defects on the Si(111)-(7x7) surface

Image size: 15 nm x 15 nm, f_{res} = 996,577 Hz, Q= 17500, Δf = -0.45 Hz, A = 200 pm, U_{CPD} = 0.070 V, imaging speed: 2.5 lines/s, (512 x 512) pixels

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NC-AFM imaging of clean and defective areas on Si(111)-(7x7)

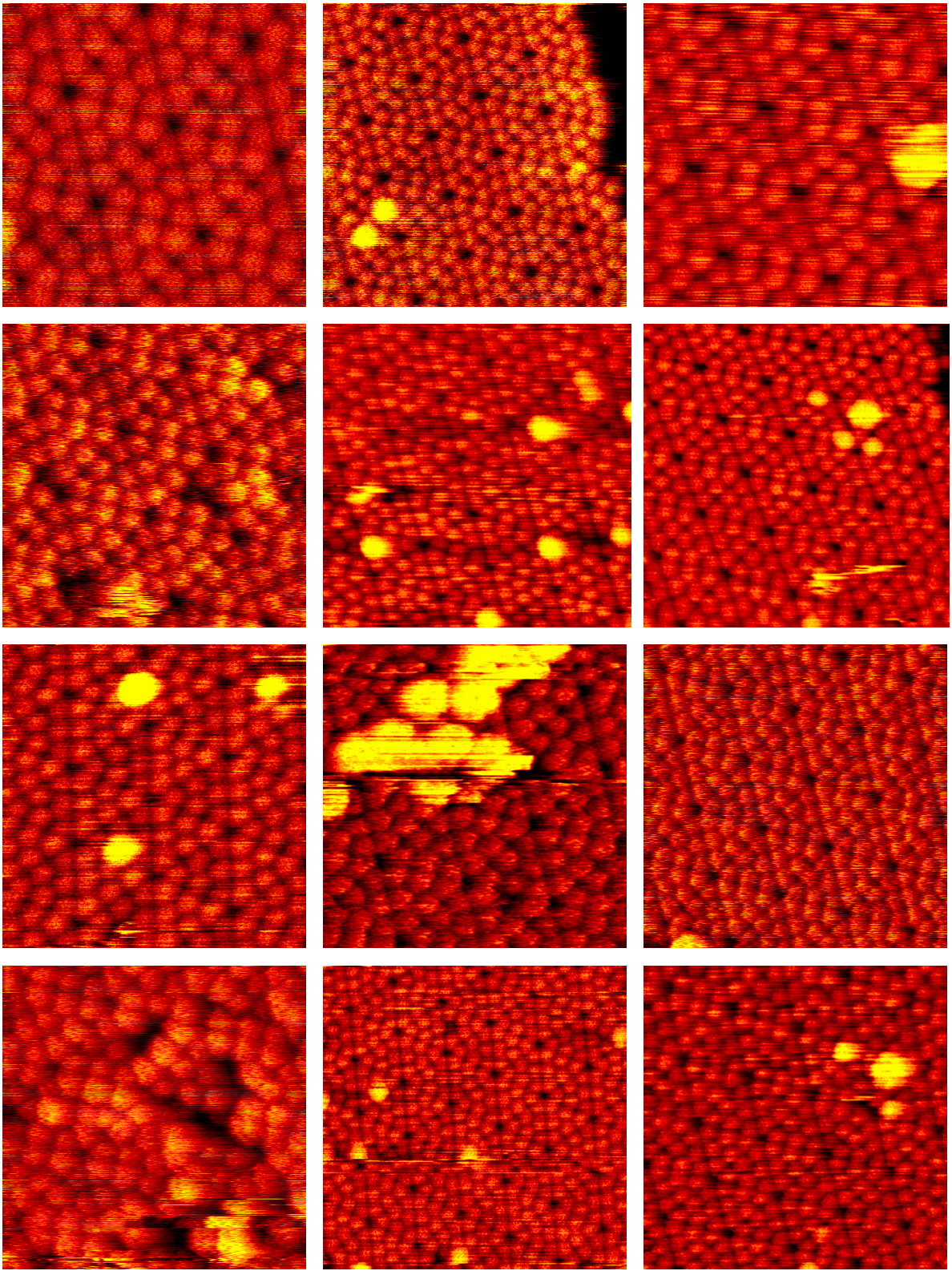

Figure 6: NC-AFM constant detuning (topography) imaging of defects on the surface.

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Identification of faulted and unfaulted half on Si(111)-(7x7) in NC-AFM imaging

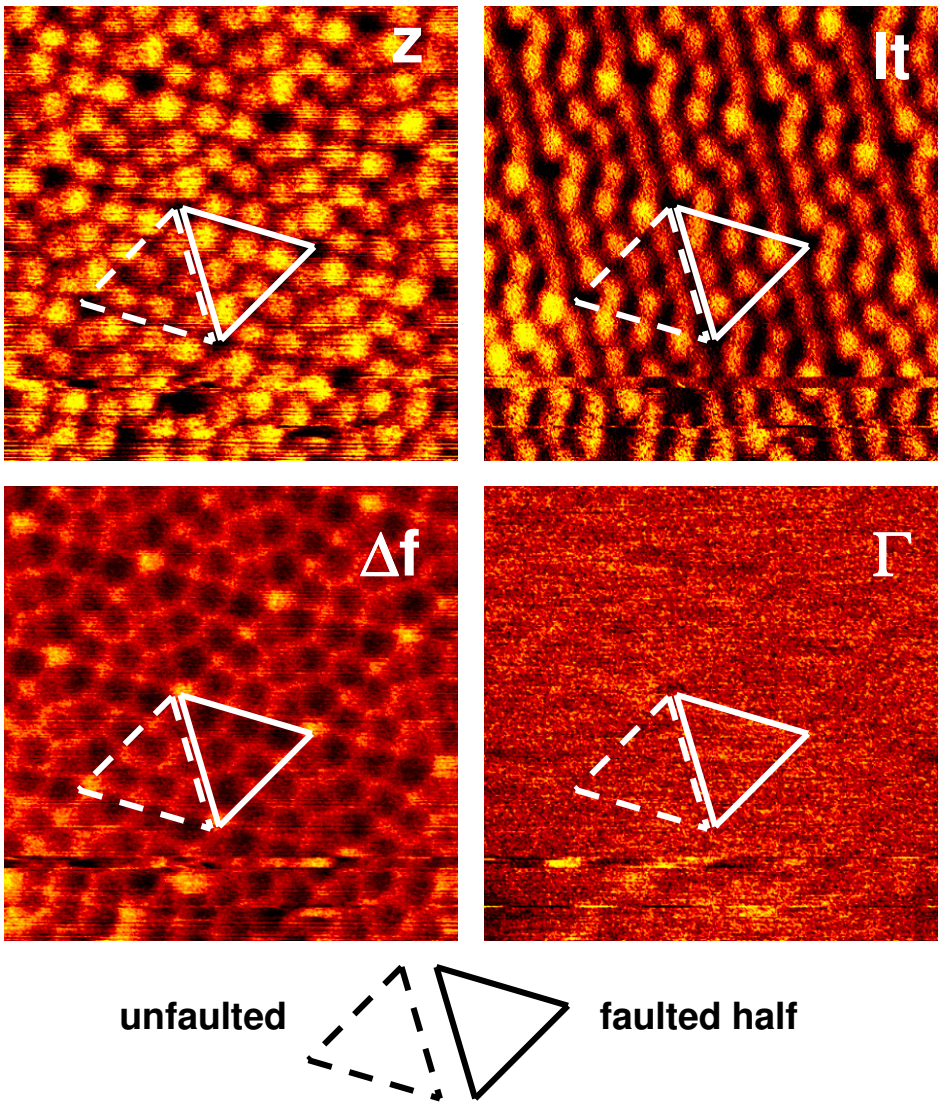

Figure 7: NC-AFM constant detuning (topography) image of the faulted and unfaulted half
Image size: 12 nm x 12 nm, f_{res} = 996,577 Hz, Q= 17500, Δf = -0.60 Hz, A = 200 pm, U_{CPD} = -0.19 V, imaging speed: 6.6 lines/s, (512 x 512) pixels

The faulted half is contrasted bright compared with the unfaulted half, and the corner hole adatoms are observed brighter than the center adatoms [1].

[1] Atomically resolved imaging by low-temperature frequency-modulation atomic force microscopy using a quartz length-extension resonator
T. An et al, Rev. Sci. Instrum., **79,** 033703 (2008)

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NC-AFM imaging of an atomic step on Si(111)-(7x7)

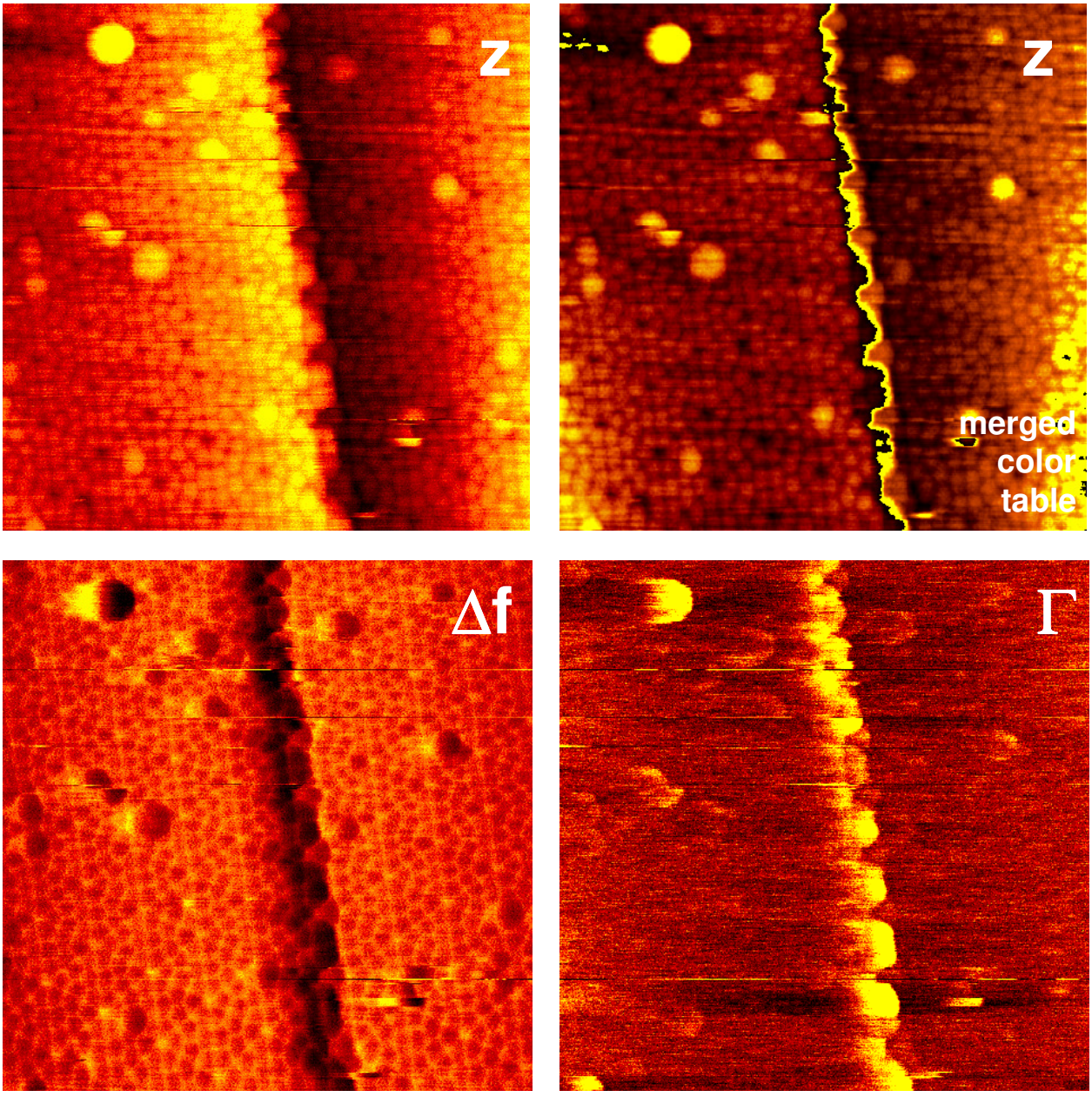

Figure 8: NC-AFM constant detuning image of an atomic step

Image size: 20 nm x 20nm, f_{res} = 996,577 Hz, Q= 17500, Δf = -0.33 Hz, A = 200 pm,
U_{CPD} = 0.070 V, imaging speed: 2.0 lines/s, (512 x 512) pixels

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Atomically resolved NC-AFM imaging in the attractive and repulsive regime on Si(111)-(7x7)

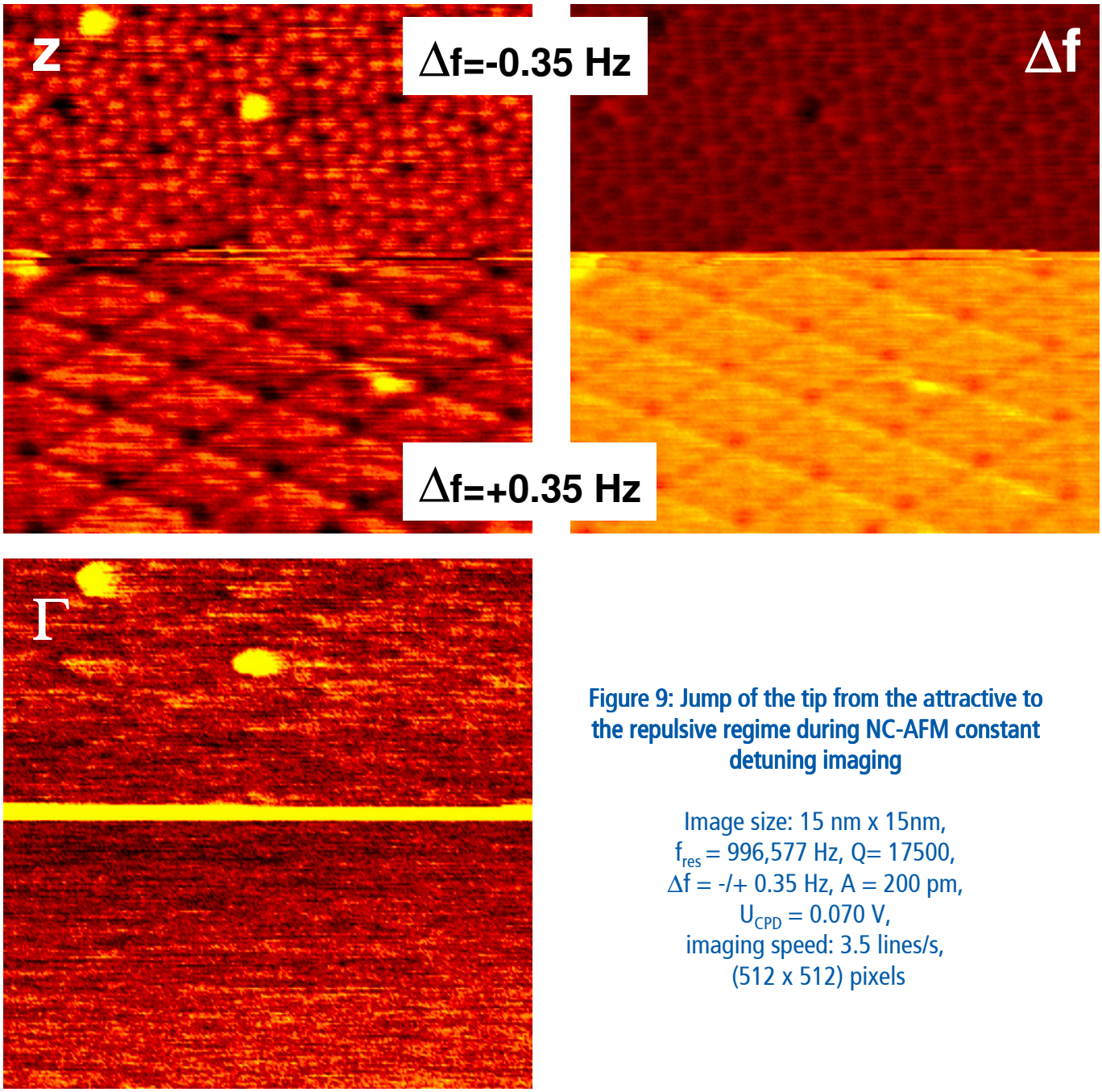

Figure 9: Jump of the tip from the attractive to the repulsive regime during NC-AFM constant detuning imaging

Image size: 15 nm x 15nm,
f_{res} = 996,577 Hz, Q= 17500,
Δf = -/+ 0.35 Hz, A = 200 pm,
U_{CPD} = 0.070 V,
imaging speed: 3.5 lines/s,
(512 x 512) pixels

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Repulsive region imaging on Si(111)-(7x7)

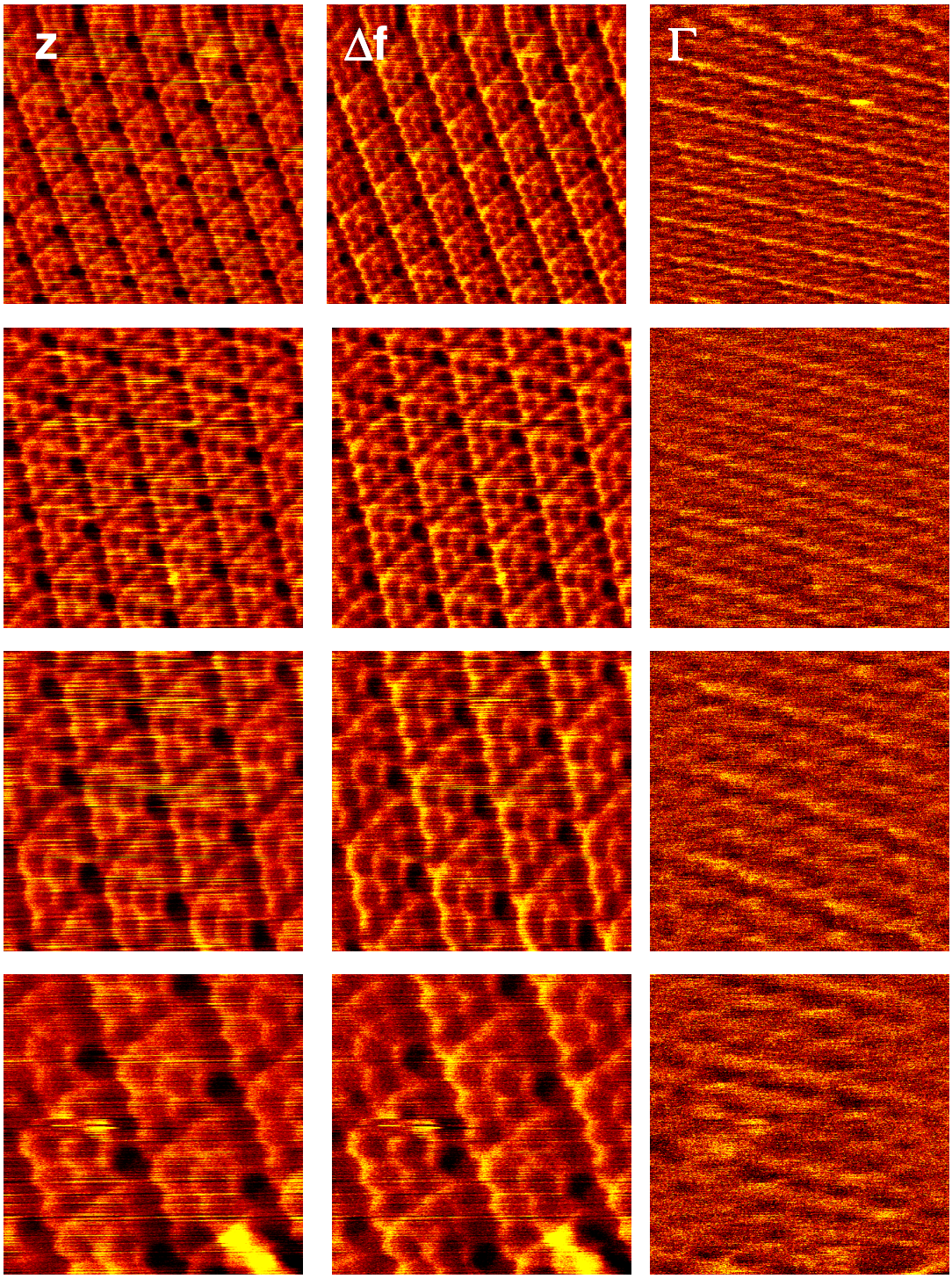

Figure 10: Consecutive recorded constant detuning images in the repulsive region

Image size: (20 x 20), (15 x 15), (12 x 12), (8 x 8) nm^2,
f_{res} = 996,577 Hz, Q= 17500, Δf = + 0.44 Hz, A = 200 pm,
U_{CPD} = 0.070 V, imaging speed: 3.5 lines/s, (512 x 512) pixels, respectively

SPECS GmbH
Surface Analysis and Computer Technology
Voltastrasse 5
13355 Berlin · GERMANY

Phone: +49 30 467824-0
Fax: +49 30 4642083
E-mail: support@specs.de
http://www.specs.de