COLLEGE OF ARTS & MEDIA
National Center for Media Forensics
UNIVERSITY OF COLORADO DENVER

Forensic Media Analysis

Mini-STEM School

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Disclaimer

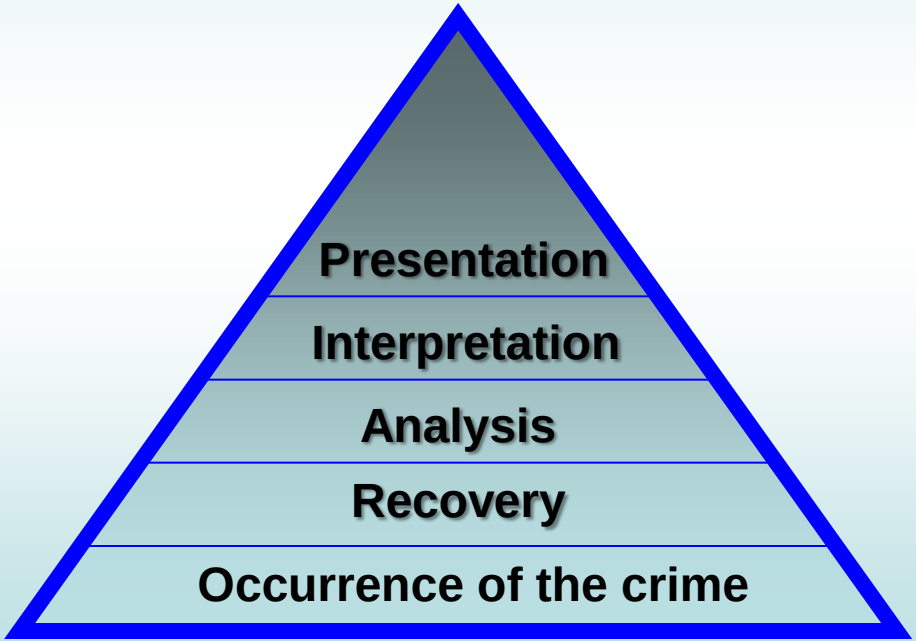
The products, software and images presented in these slides are only mentioned and used as tools and examples for forensic analysis and the intention of this presentation is solely educational.

What’s media forensics ?

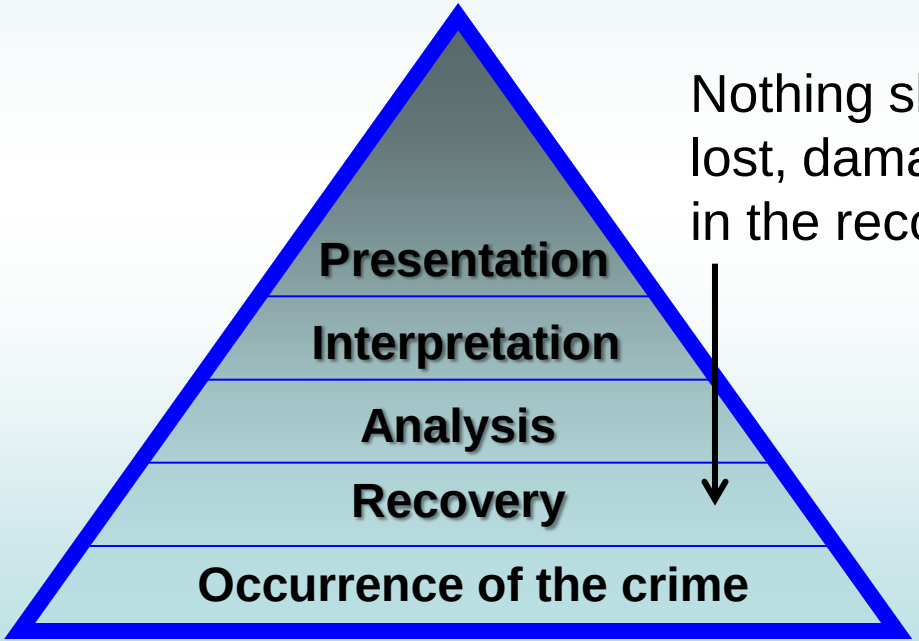
Media forensics is scientific study into the collection, analysis, interpretation, and presentation of **audio, video, and image** evidence:

- obtained during the course of judicial investigations and litigious proceedings
- suitable to public discussion and debate.

How do we work ?

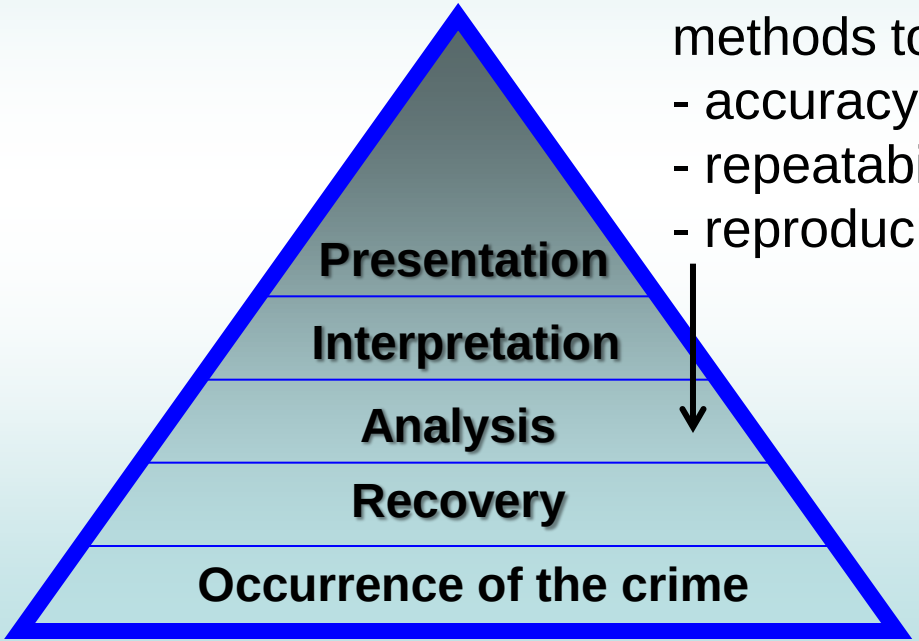


How do we work ?



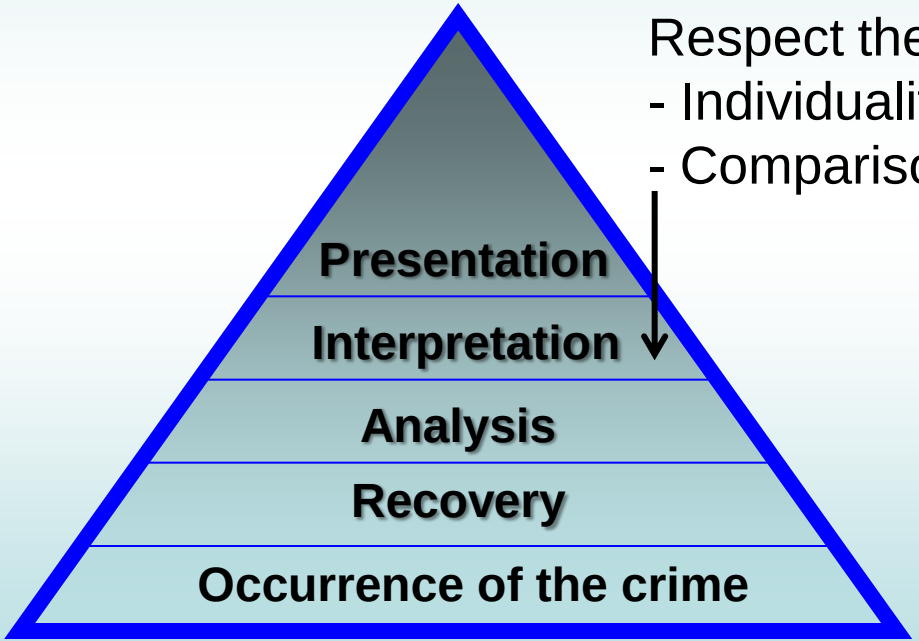
Nothing should be added, lost, damaged or obliterated in the recovery process.

How do we work ?



Use scientific validated methods to ensure:
- accuracy & precision
- repeatability
- reproducibility

How do we work ?



Respect the principles of:
- Individuality
- Comparison

How do we work ?

Working within an ethical framework, a forensic scientist should fully disclose and present impartial evidence which is readily understandable and neither overstated nor understated.

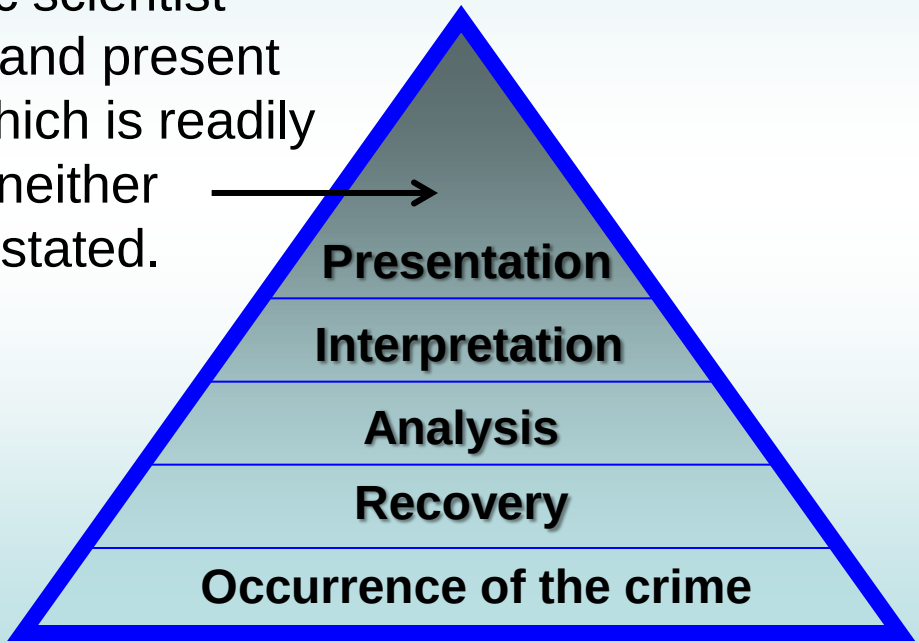


Image Analysis Examples Forensic Enhancement


Nature Made
agnesium


Nature Made
Magnesium
250 mg
Helps Nerve & Muscle Function!


CREDIT SUISSE LIFE & PENSIONS
1647

CREDIT SUISSE LIFE & PENSIONS
1647

Image Analysis Examples Forensic Authentication

Forensic image analysis in real cases, media and research integrity investigations

The most common image editing/manipulation techniques that were found in research papers consist in:

1) Copy + Paste (+ Rescale) of the original image/photo
2) Image reconstruction (usually for schematics, plans)
3) Clone inside the same image
4) Clone + B/C adjustments to mask the visible cloning traces
5) Advanced editing techniques

ARIO-05-A.jpg

Does this image look suspicious? Please explain your answer(s).

ARIO-05-A.jpg after ⇨ Colors ⇨ Auto ⇨ Equalize

Image inconsistencies due to a local editing (copy/paste from another image)

ARIO-05-A.jpg after ⇨ Image ⇨ Error Level Analysis ⇨ Quality: 0.9

Image inconsistencies due to a local editing (copy/paste from another image)

ARIO-05-A.jpg after ⇨ CFA Map analysis

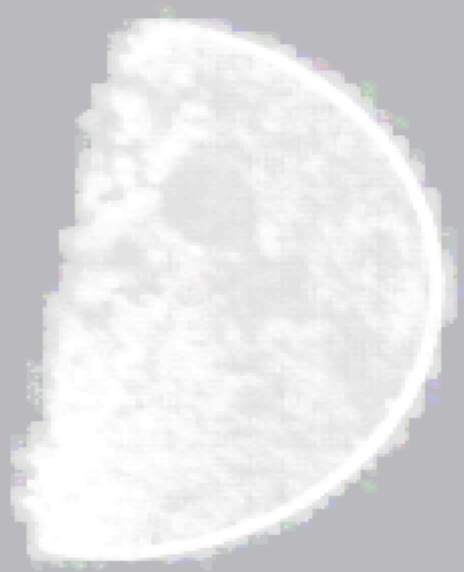


Image inconsistencies due to a local editing (copy/paste from another image)

ARIO-05-A.jpg after ⇨ DCT Map analysis

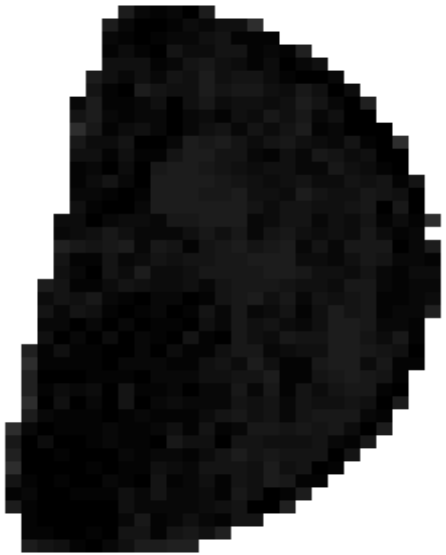
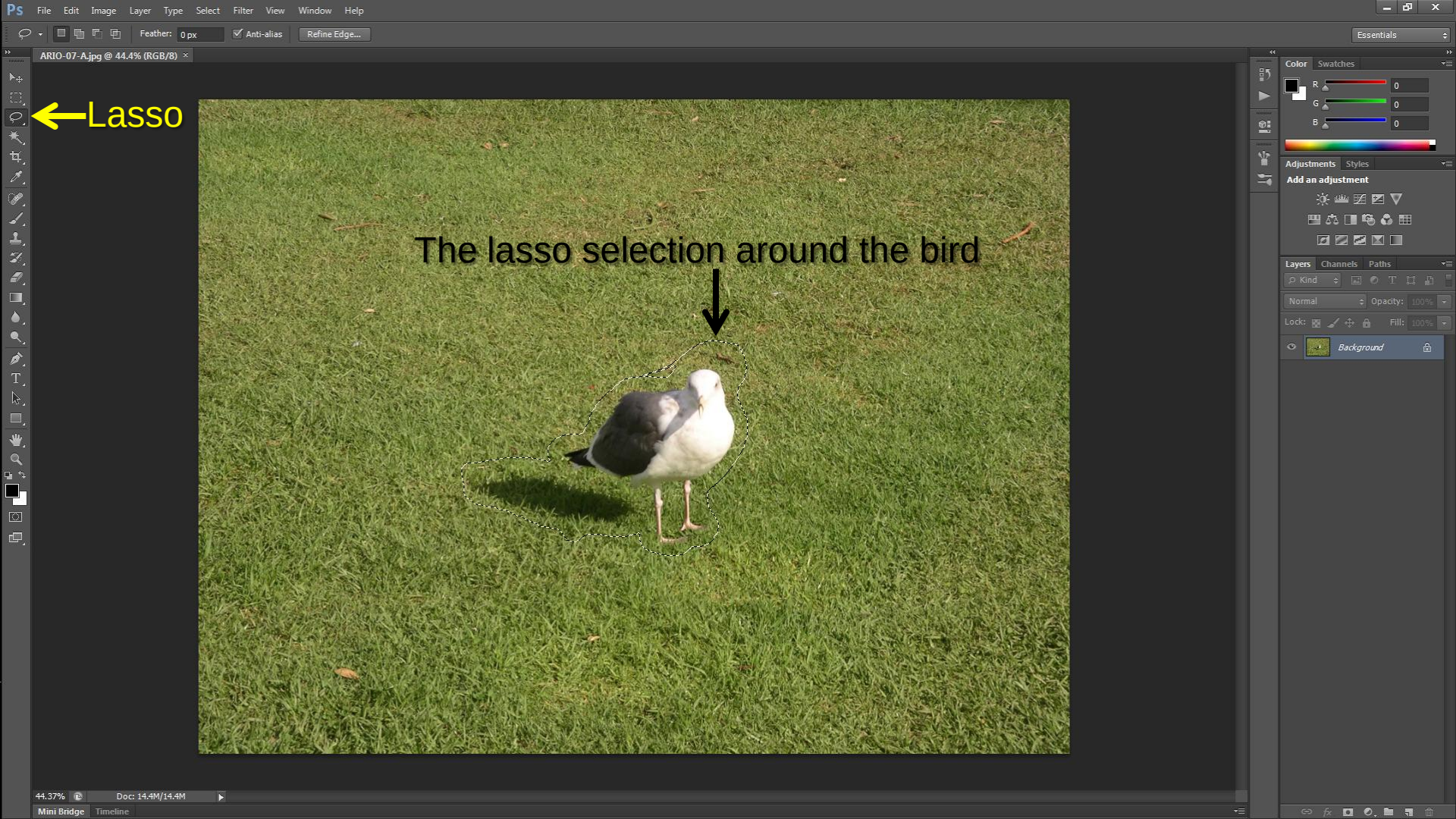


Image inconsistencies due to a local editing (copy/paste from another image)

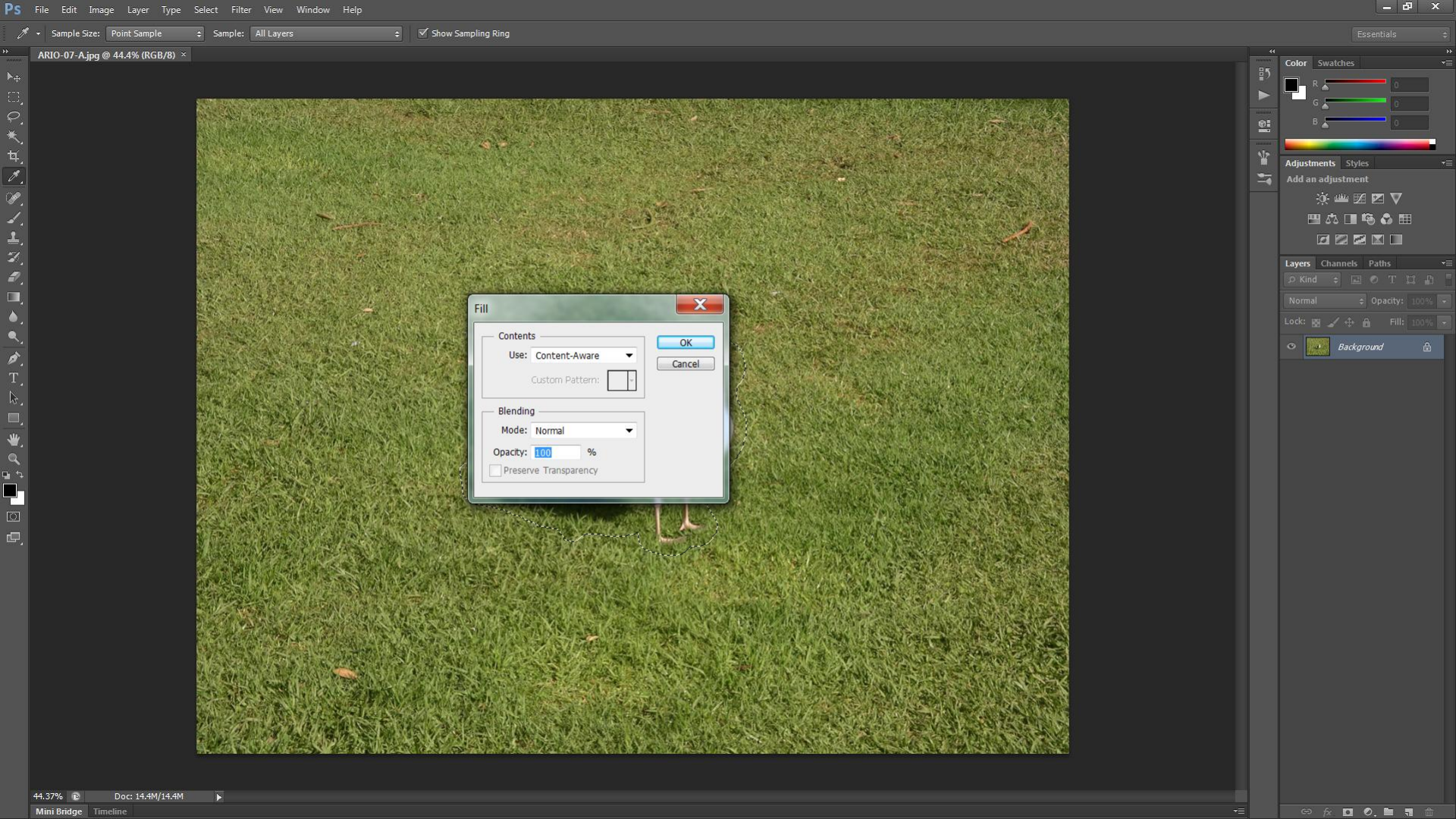
The anatomy of a forgery

1) Content-Aware example

ARIO-07-A.jpg


Lasso
The lasso selection around the bird


File Edit Image Layer Type Select Filter View Window Help
Undo Lasso Ctrl+Z
Step Forward Shift+Ctrl+Z
Step Backward Alt+Ctrl+Z
Fade... Shift+Ctrl+F
Cut Ctrl+X
Copy Ctrl+C
Copy Merged Shift+Ctrl+C
Paste Ctrl+V
Paste Special
Clear
Check Spelling...
Find and Replace Text...
Fill... Shift+F5
Stroke...
Content-Aware Scale Alt+Shift+Ctrl+C
Puppet Warp
Free Transform Ctrl+T
Transform
Auto-Align Layers...
Auto-Blend Layers...
Define Brush Preset...
Define Pattern...
Define Custom Shape...
Purge
Adobe PDF Presets...
Presets
Remote Connections...
Color Settings... Shift+Ctrl+K
Assign Profile...
Convert to Profile...
Keyboard Shortcuts... Alt+Shift+Ctrl+K
Menus... Alt+Shift+Ctrl+M
Preferences
Essentials
Color Swatches
Adjustments Styles
Add an adjustment
Layers Channels Paths
Background
44.37% Doc: 14.4M/14.4M
Mini Bridge Timeline


File
Contents
Use: Content-Aware
Custom Pattern:
Blending
Mode: Normal
Opacity: 100 %
Preserve Transparency
OK
Cancel

ARIO-05-A.jpg ⇨ forensic structure analysis with HxD

```
Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00000000  FF D8 FF E1 D8 45 45 78 69 66 00 00 49 49 2A 00  ÿØÿáØEExif..II*.
00000010  08 00 00 00 0A 00 0F 01 02 00 13 00 00 00 86 00  ..............†.
00000020  00 00 10 01 02 00 11 00 00 00 9E 00 00 00 1A 01  ..........ž.....
00000030  05 00 01 00 00 00 B6 00 00 00 1B 01 05 00 01 00  ......¶.........
00000040  00 00 BE 00 00 00 28 01 03 00 01 00 00 00 02 00  ..¾...(.........
00000050  00 00 31 01 02 00 05 00 00 00 C6 00 00 00 32 01  ..1.......Æ...2.
00000060  02 00 14 00 00 00 E6 00 00 00 13 02 03 00 01 00  ......æ.........
00000070  00 00 02 00 00 00 69 87 04 00 01 00 00 00 F6 01  ......i‡......ö.
00000080  00 00 A5 C4 07 00 80 00 00 00 FA 00 00 00 AC 03  ..¥Ä..€...ú...¬.
00000090  00 00 50 45 4E 54 41 58 20 43 6F 72 70 6F 72 61  ..PENTAX Corpora
000000A0  74 69 6F 6E 00 00 00 00 00 00 50 45 4E 54 41 58  tion......PENTAX
000000B0  20 4F 70 74 69 6F 20 35 35 30 00 00 00 00 00 00   Optio 550......
000000C0  00 00 48 00 00 00 01 00 00 00 48 00 00 00 01 00  ..H.......H.....
000000D0  00 00 31 2E 30 30 00 00 00 00 00 00 00 00 00 00  ..1.00..........
000000E0  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
000000F0  00 00 32 30 31 32 3A 31 30 3A 32 33 20 31 31 3A  ..2012:10:23 11:
00000100  30 37 3A 30 33 00 50 72 69 6E 74 49 4D 00 30 32  07:03.PrintIM.02
00000110  35 30 00 00 0C 00 01 00 16 00 16 00 02 00 00 00  50..............
```

ARIO-07-B.jpg ⇨ forensic structure analysis with HxD

```
Offset(h)  00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00000000   FF D8 FF E1 1A 8F 45 78 69 66 00 00 49 49 2A 00  ÿØÿá..Exif..II*.
00000010   08 00 00 00 10 00 00 01 03 00 01 00 00 00 20 0A  .............. .
00000020   00 00 01 01 03 00 01 00 00 00 98 07 00 00 02 01  ..........˜.....
00000030   03 00 03 00 00 00 CE 00 00 00 06 01 03 00 01 00  ......Î.........
00000040   00 00 02 00 00 00 0F 01 02 00 13 00 00 00 D4 00  ..............Ô.
00000050   00 00 10 01 02 00 11 00 00 00 E7 00 00 00 12 01  ..........ç.....
00000060   03 00 01 00 00 00 01 00 00 00 15 01 03 00 01 00  ................
00000070   00 00 03 00 00 00 1A 01 05 00 01 00 00 00 F8 00  ..............ø.
00000080   00 00 1B 01 05 00 01 00 00 00 00 01 00 00 28 01  ..............(.
00000090   03 00 01 00 00 00 02 00 00 00 31 01 02 00 1E 00  ..........1.....
000000A0   00 00 08 01 00 00 32 01 02 00 14 00 00 00 26 01  ......2.......&.
000000B0   00 00 13 02 03 00 01 00 00 00 02 00 00 00 A5 C4  ..............¥Ä
000000C0   07 00 80 00 00 00 3A 01 00 00 69 87 04 00 01 00  ..€...:...i‡....
000000D0   00 00 BC 01 00 00 B0 03 00 00 08 00 08 00 08 00  ..¼...°.........
000000E0   50 45 4E 54 41 58 20 43 6F 72 70 6F 72 61 74 69  PENTAX Corporati
000000F0   6F 6E 00 50 45 4E 54 41 58 20 4F 70 74 69 6F 20  on.PENTAX Optio
00000100   35 35 30 00 80 FC 0A 00 10 27 00 00 80 FC 0A 00  550.€ü...'..€ü..
00000110   10 27 00 00 41 64 6F 62 65 20 50 68 6F 74 6F 73  .'..Adobe Photos
00000120   68 6F 70 20 43 53 35 2E 31 20 57 69 6E 64 6F 77  hop CS5.1 Window
00000130   73 00 32 30 31 32 3A 31 31 3A 30 34 20 30 35 3A  s.2012:11:04 05:
00000140   32 30 3A 35 33 00 50 72 69 6E 74 49 4D 00 30 32  20:53.PrintIM.02
```

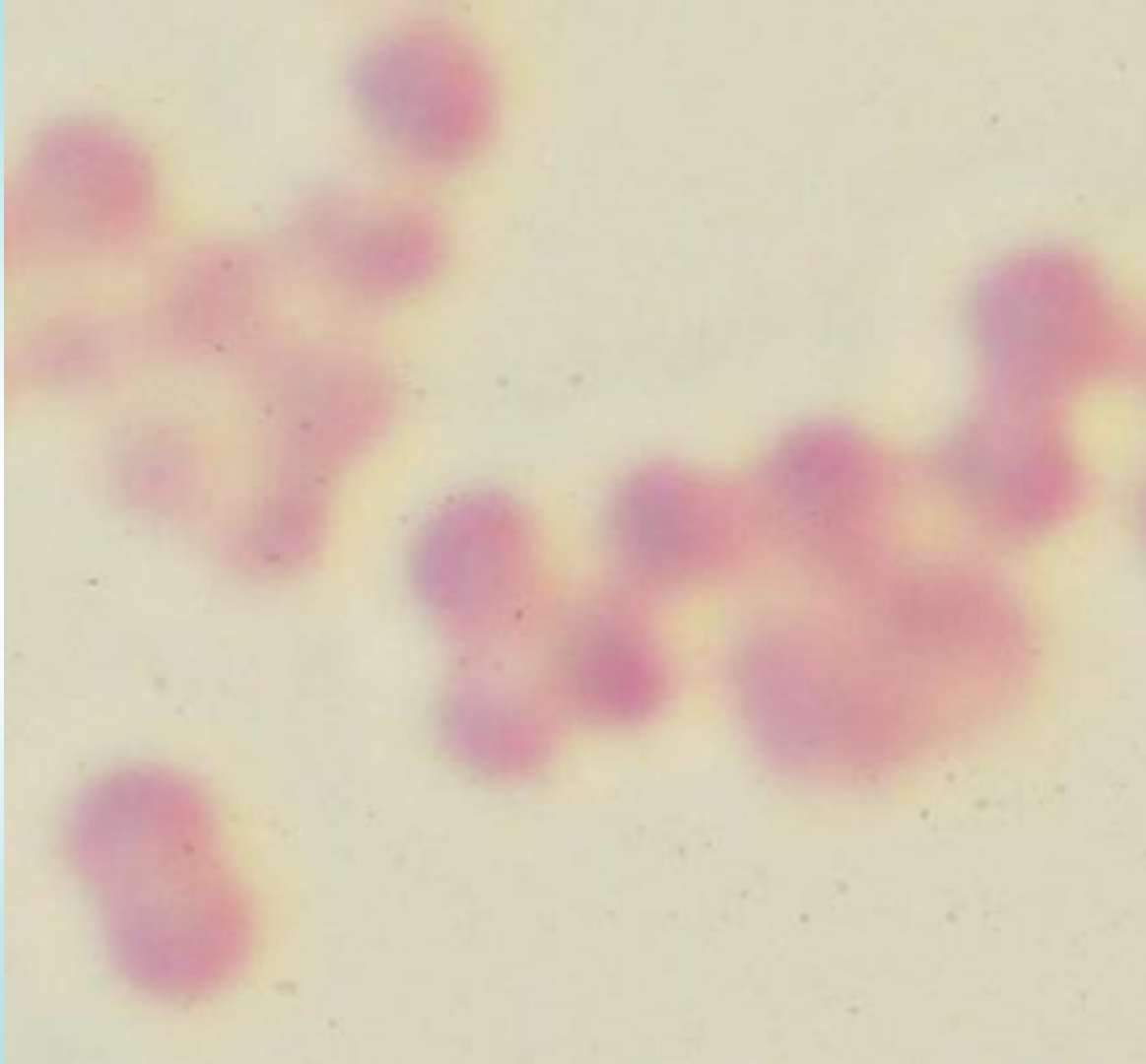
ARIO-07-B.jpg after ⇨ Image ⇨ Error Level Analysis ⇨ Quality: 0.7

Image inconsistencies due to a local editing
(Adobe Photoshop Content-Aware)

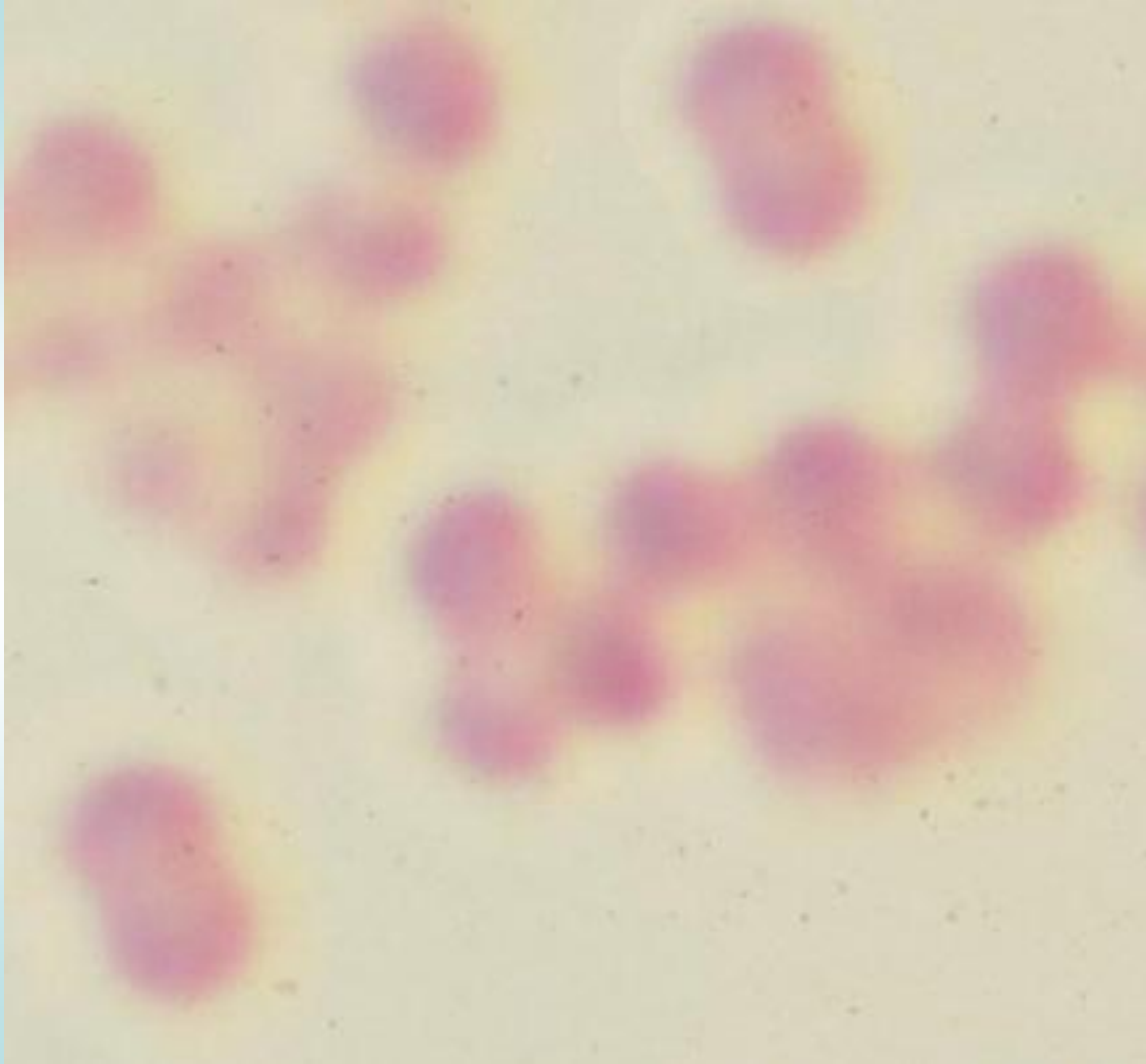
The anatomy of a forgery

1) Content-Aware example
2) Clone / Copy+Paste example

ARIO-15-A.bmp



ARIO-15-B.bmp

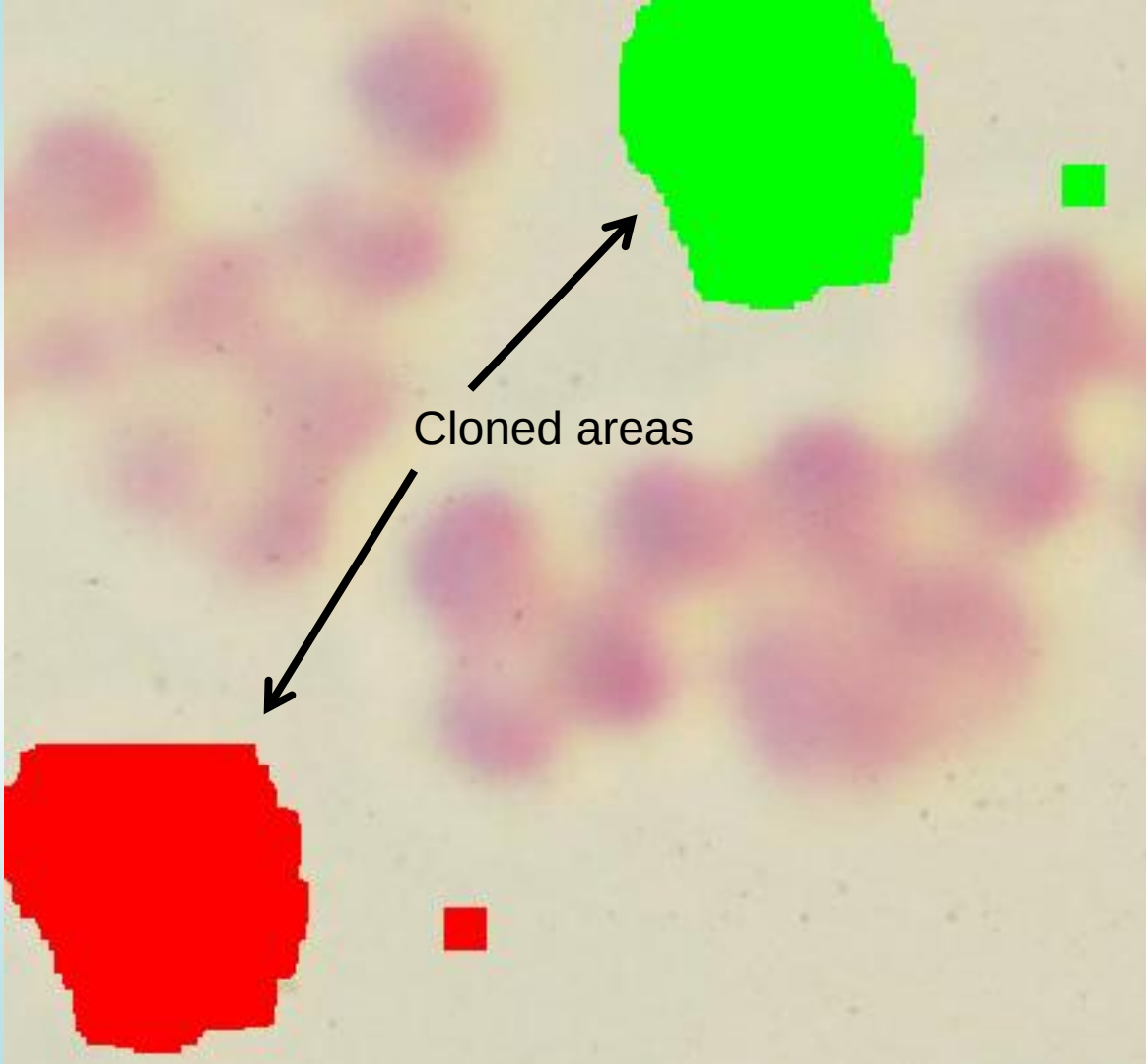


ARIO-15-B.bmp

Image

⇨ Copy Move…

Q=1, T=100

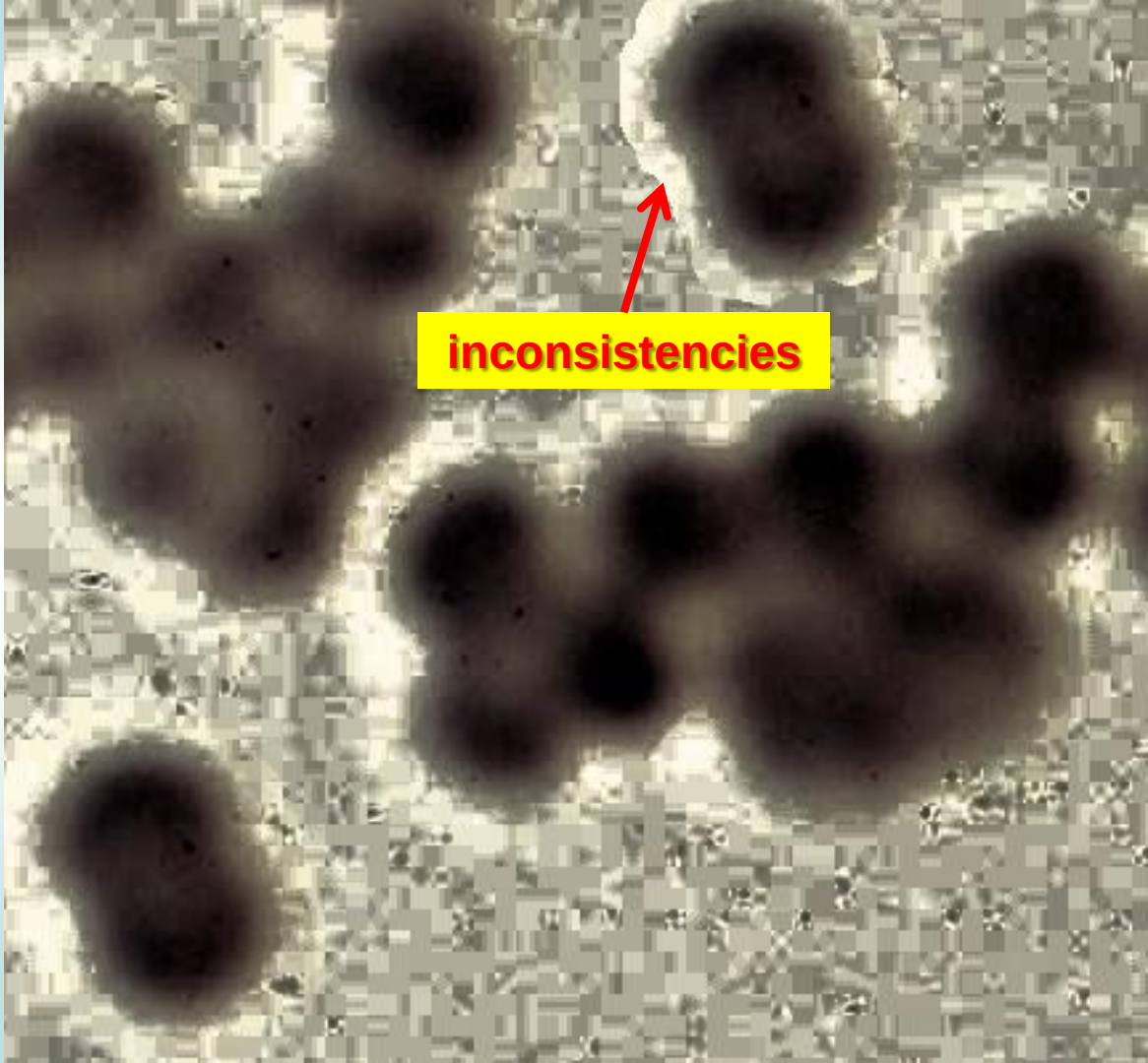


ARIO-15-B.bmp

Colors

⇨ Auto

⇨ Equalize



ARIO-15-D.bmp

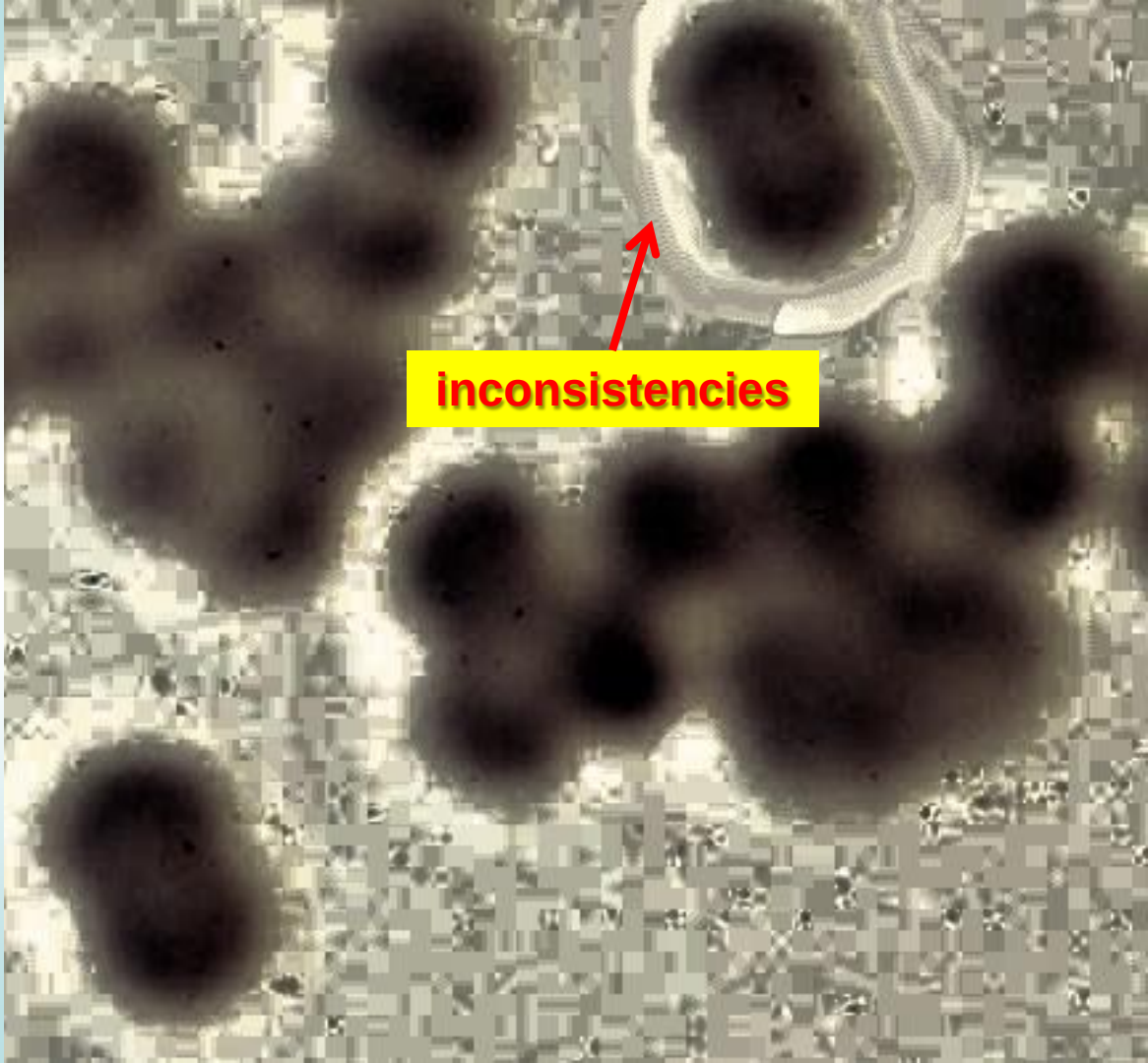
(a better image

tampering using Blur)

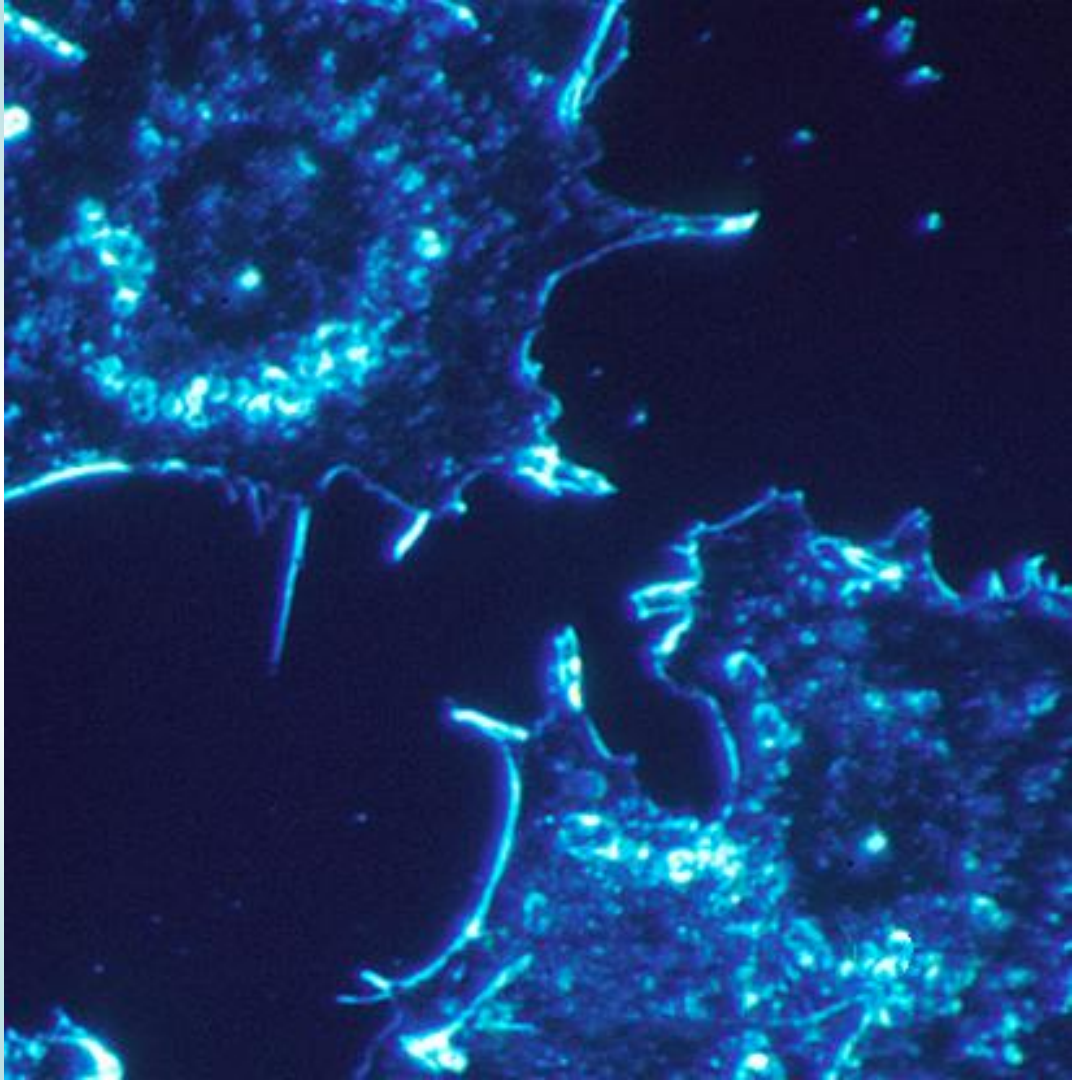
Colors

⇨ **Auto**

⇨ **Equalize**



ARIO-18-B.bmp

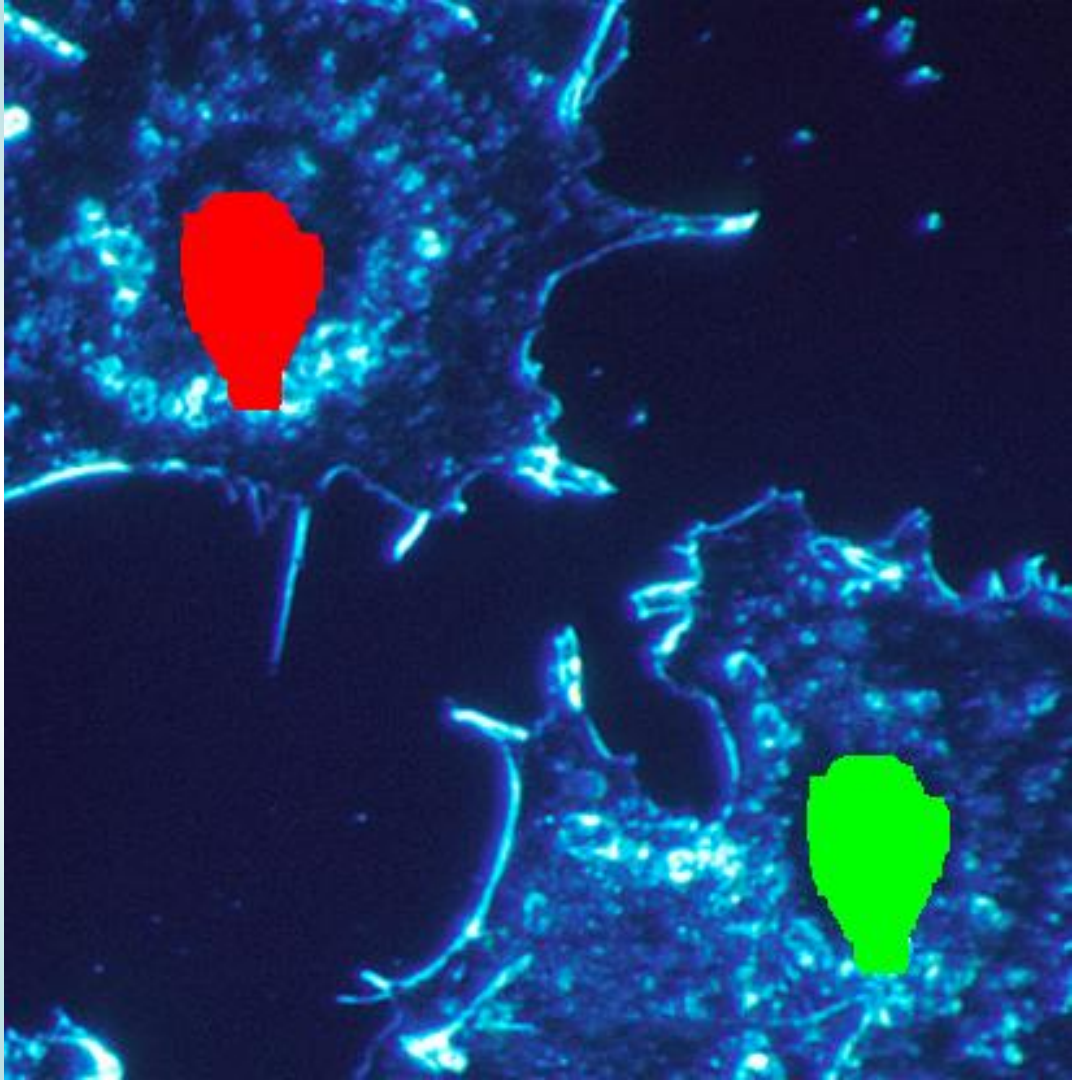


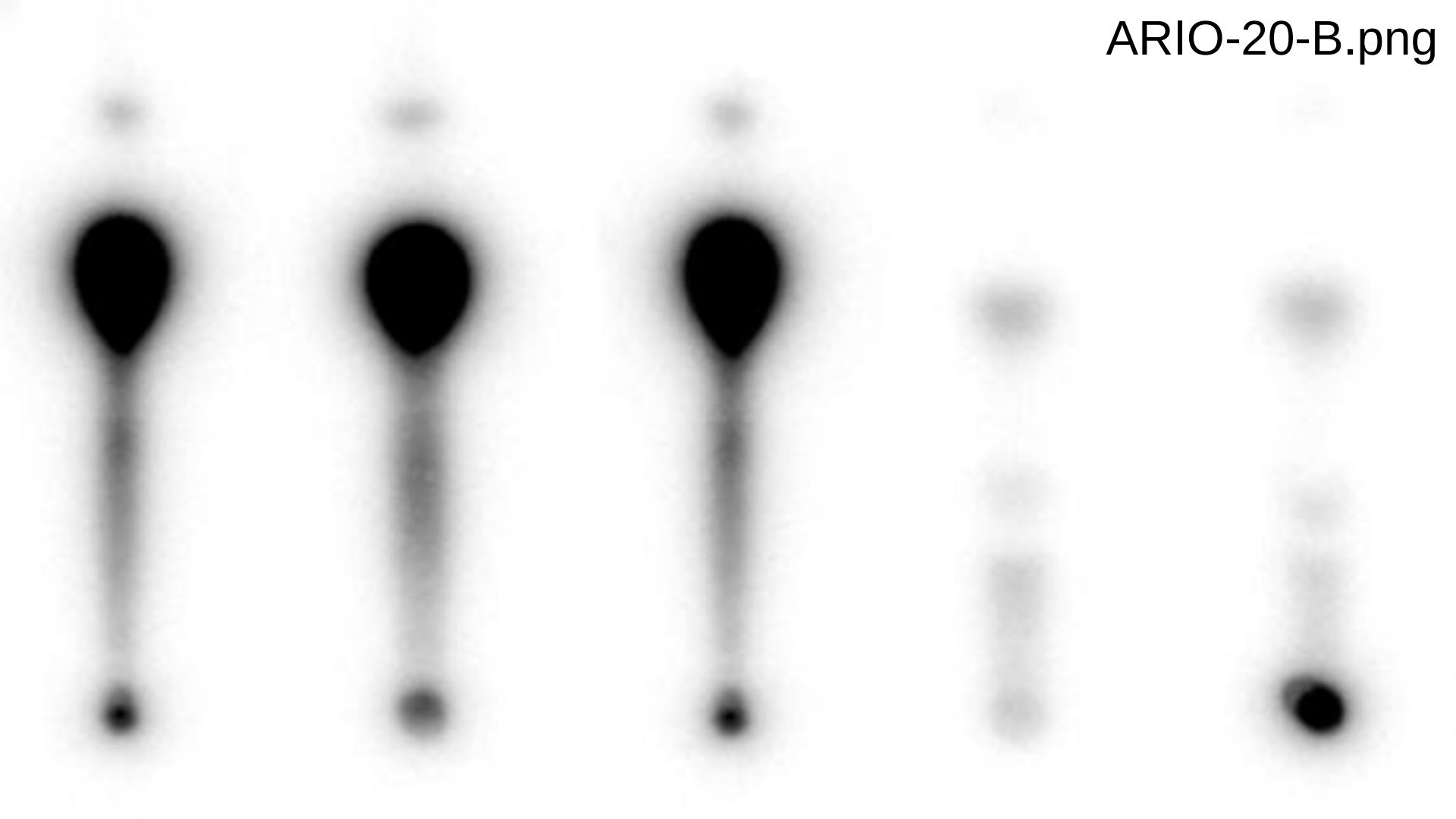
ARIO-18-B.bmp

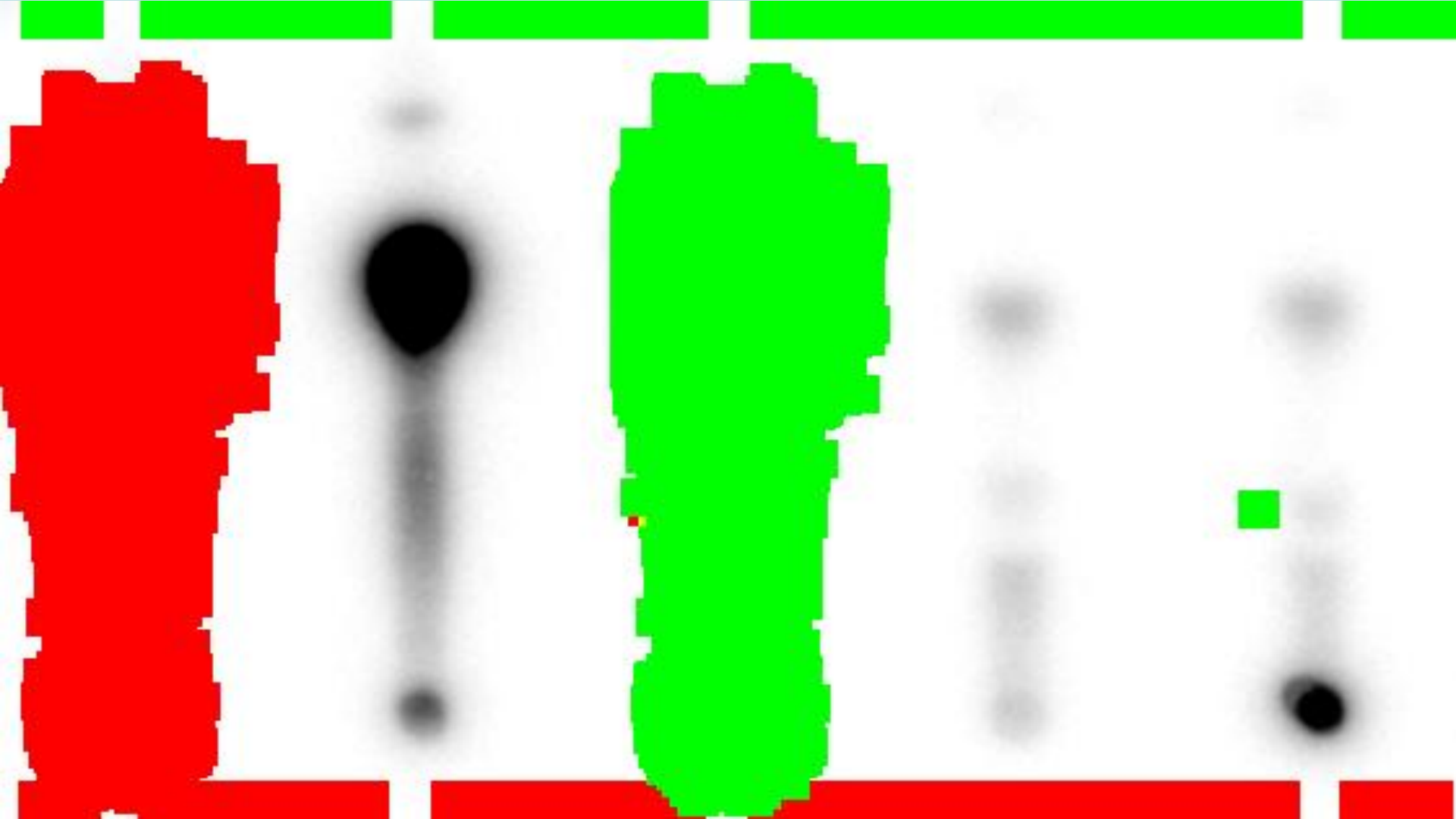
Image

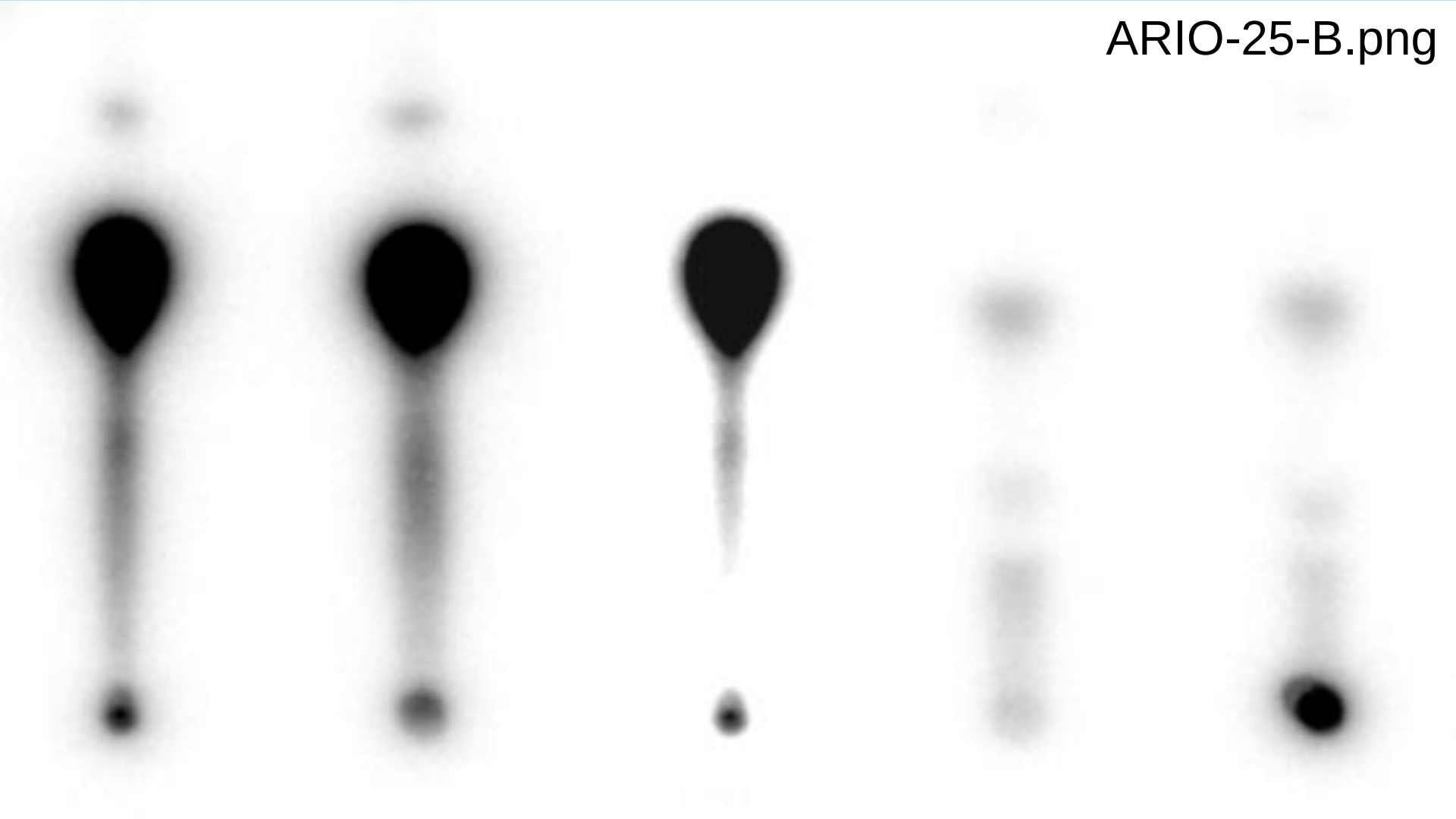
⇨ Copy Move…

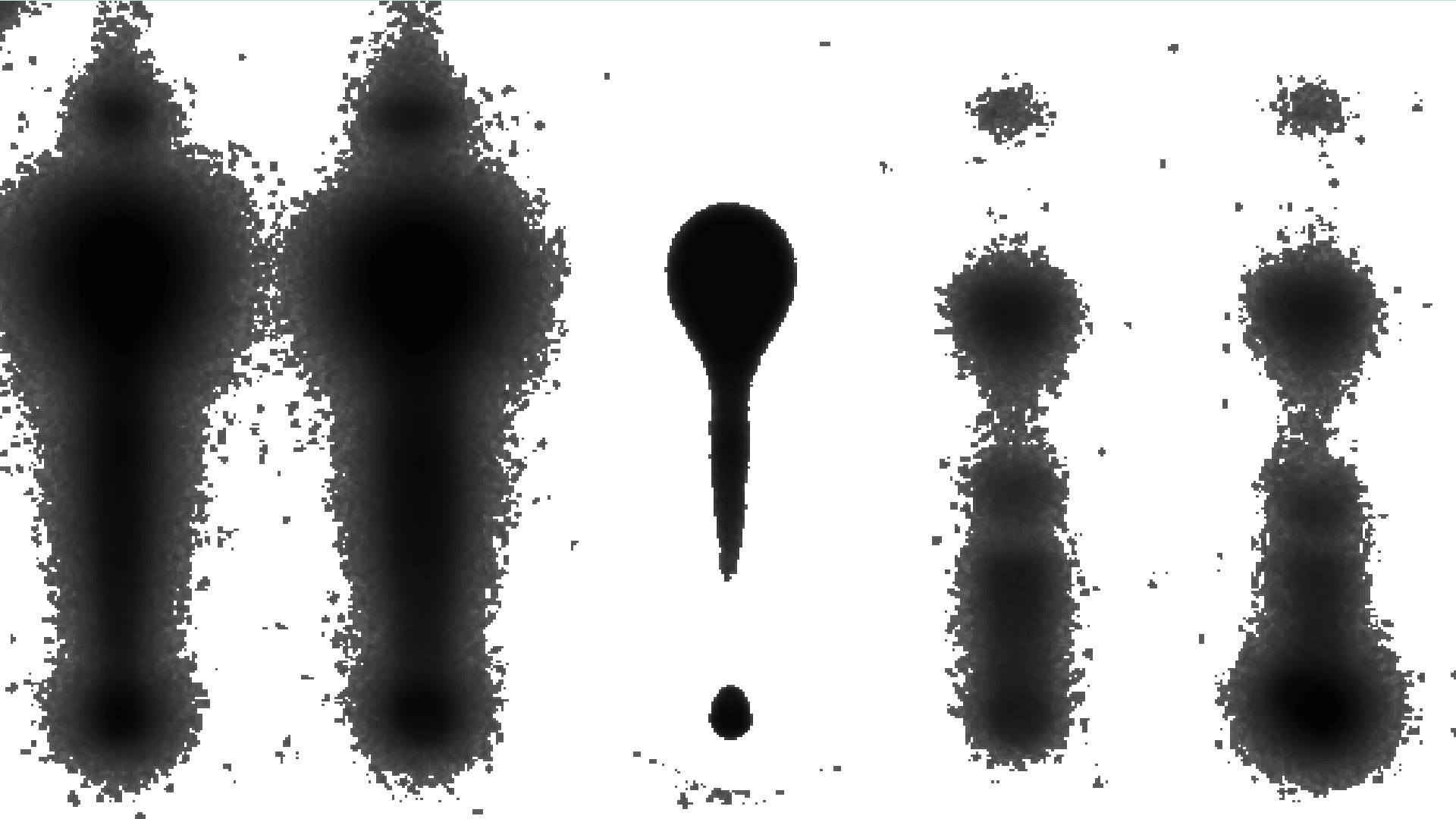
Q=1, T=100



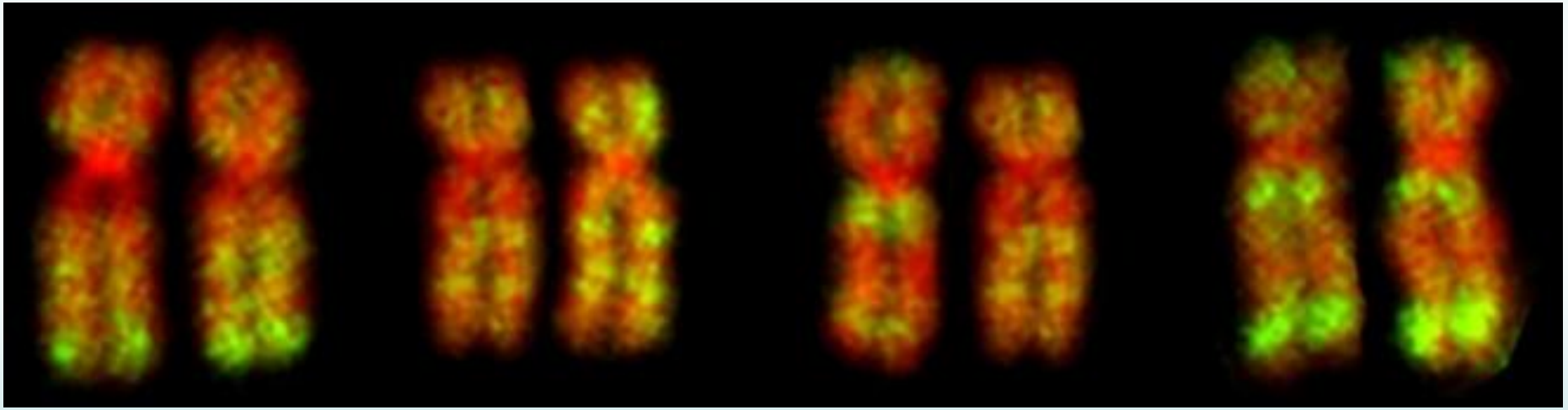

ARIO-20-B.png



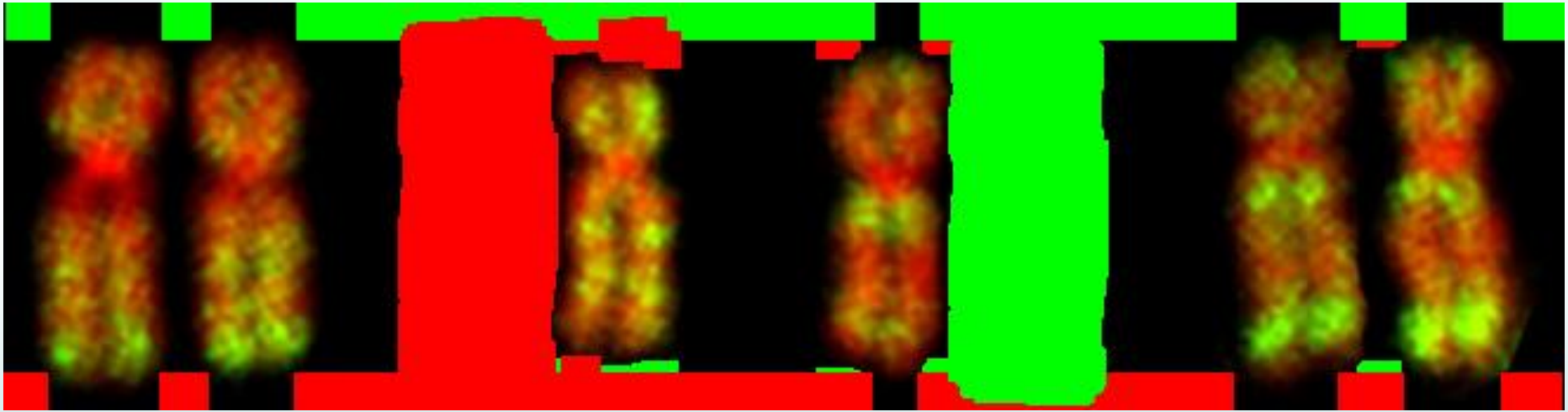

ARIO-25-B.png



What do you think about this image ?

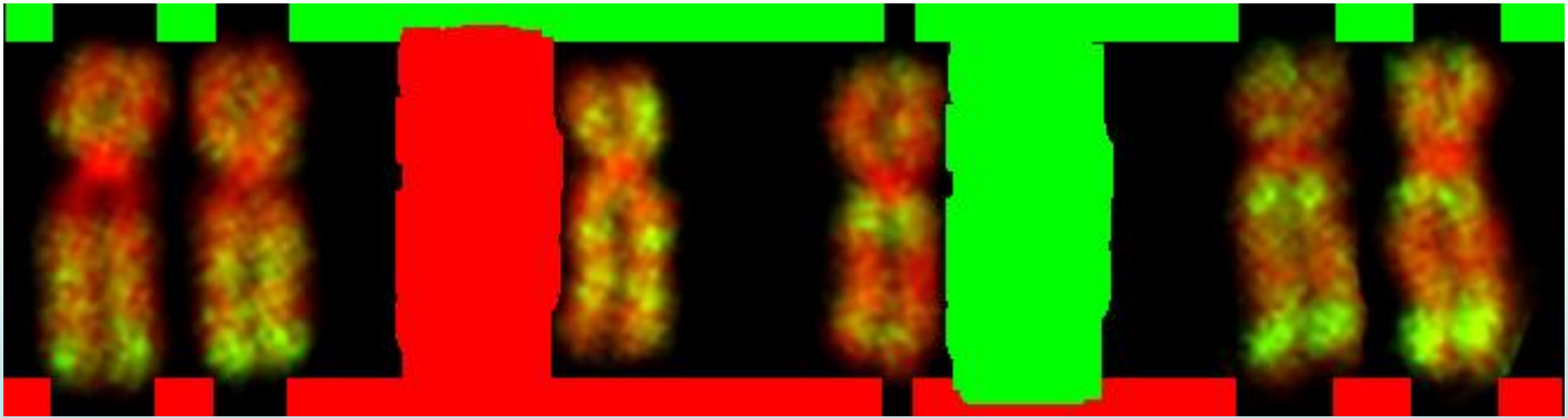


⇨ Image ⇨ Copy Move… ⇨ Q=1, T=10

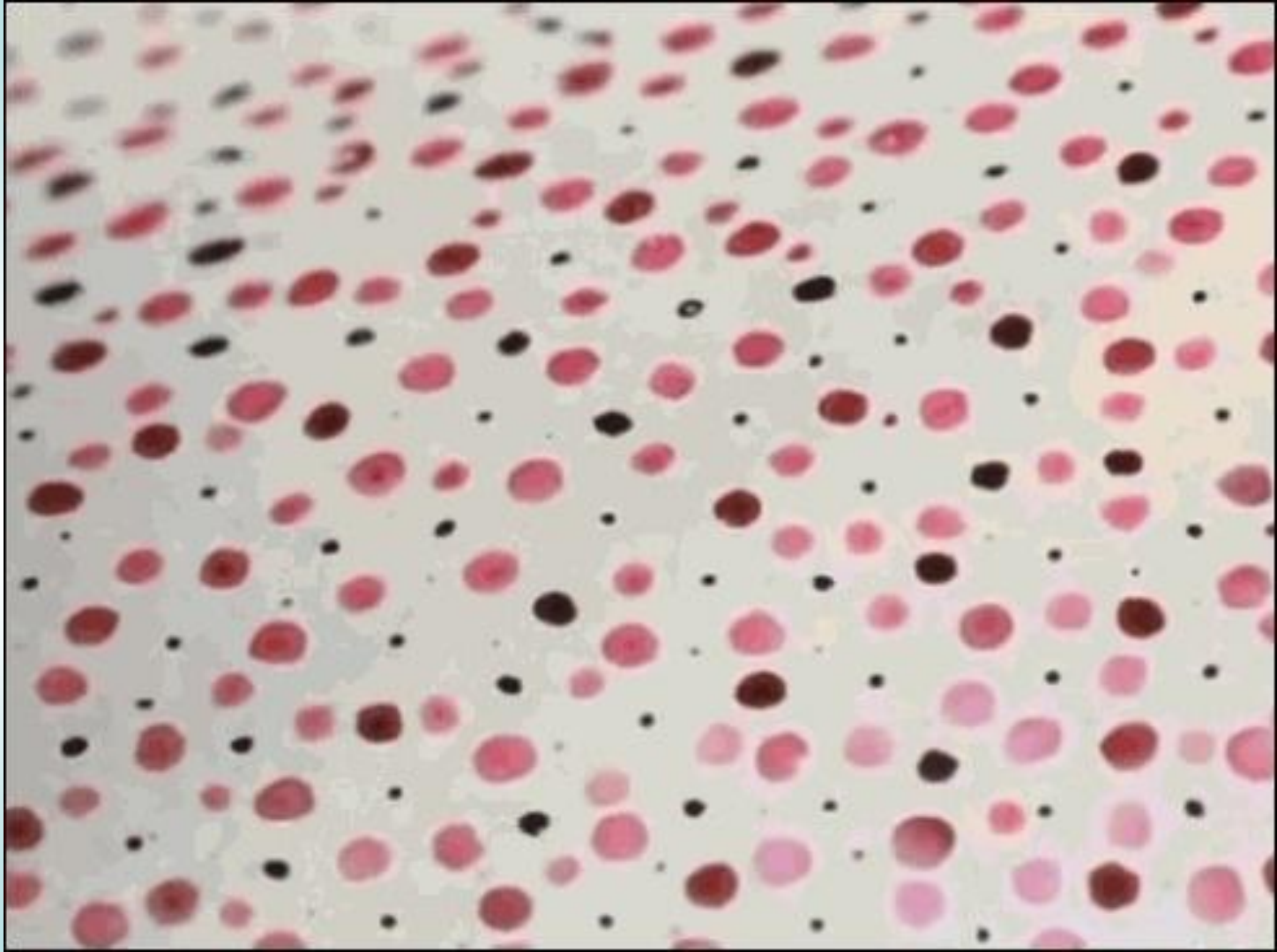


Practice with some real case reconstructions

⇨ Image ⇨ Copy Move… ⇨ Q=2, T=100



ARIO-35-B.jpg

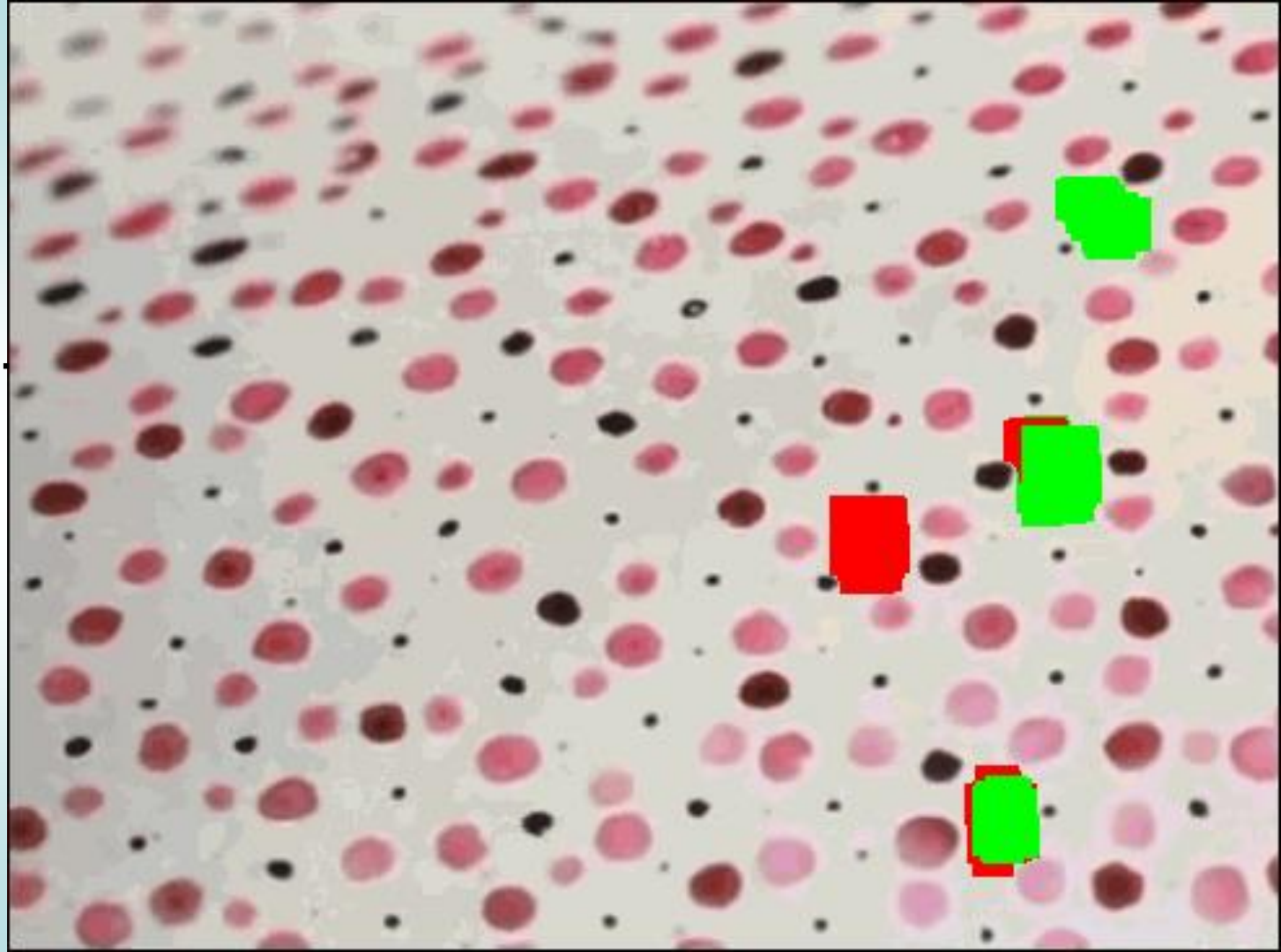


ARIO-35-B.jpg

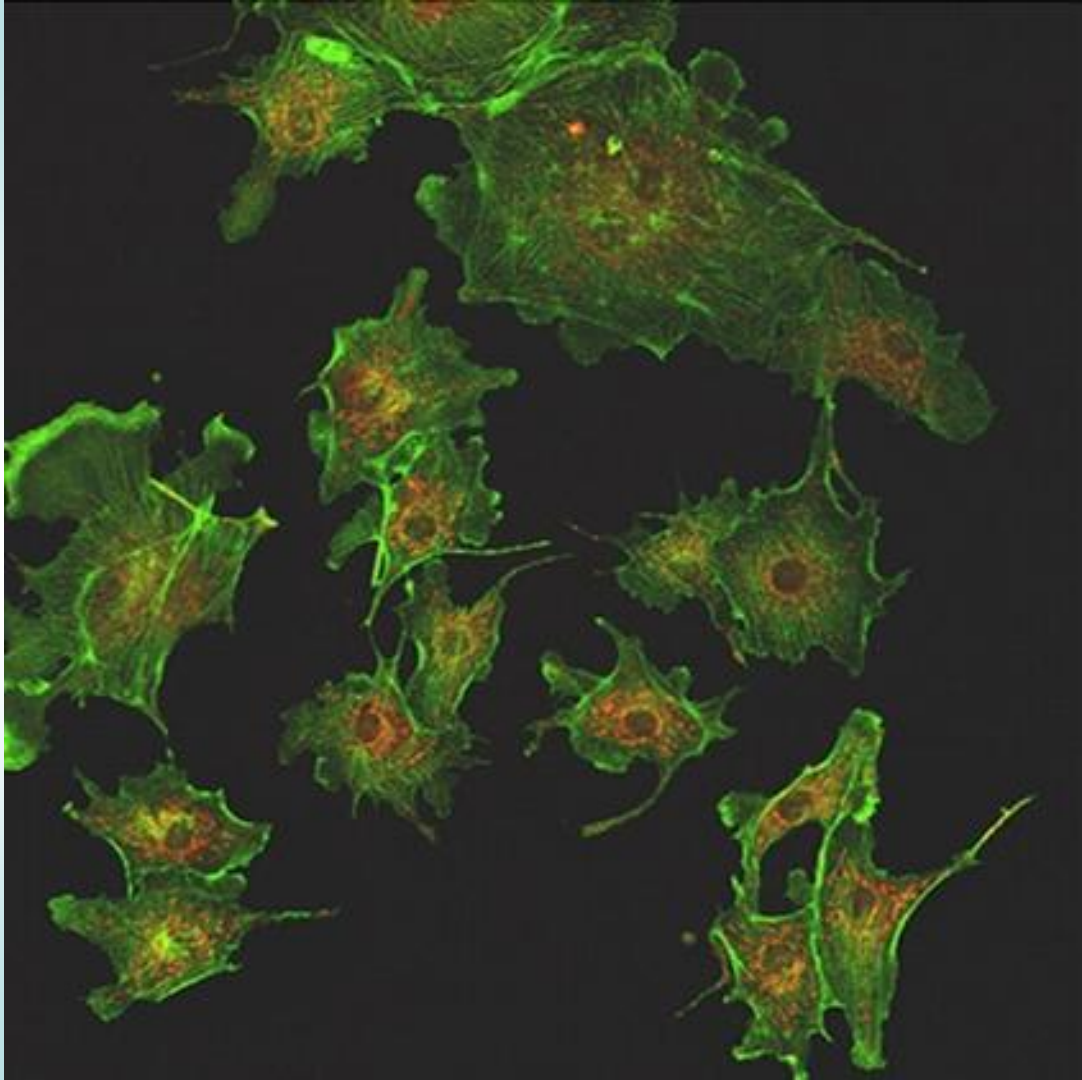
Image

⇨ Copy Move…

Q=1, T=10



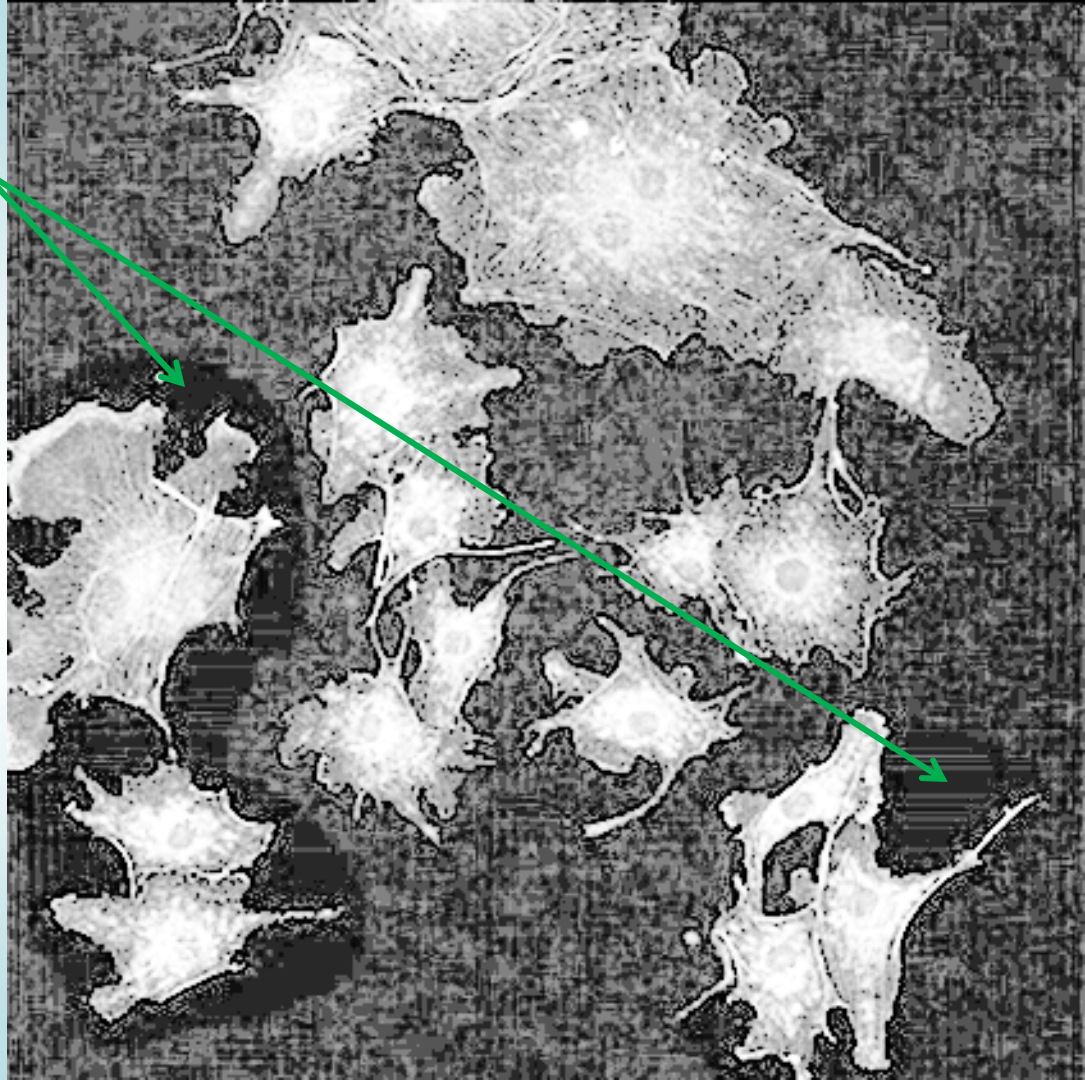
Questioned image submitted for forensic analysis.



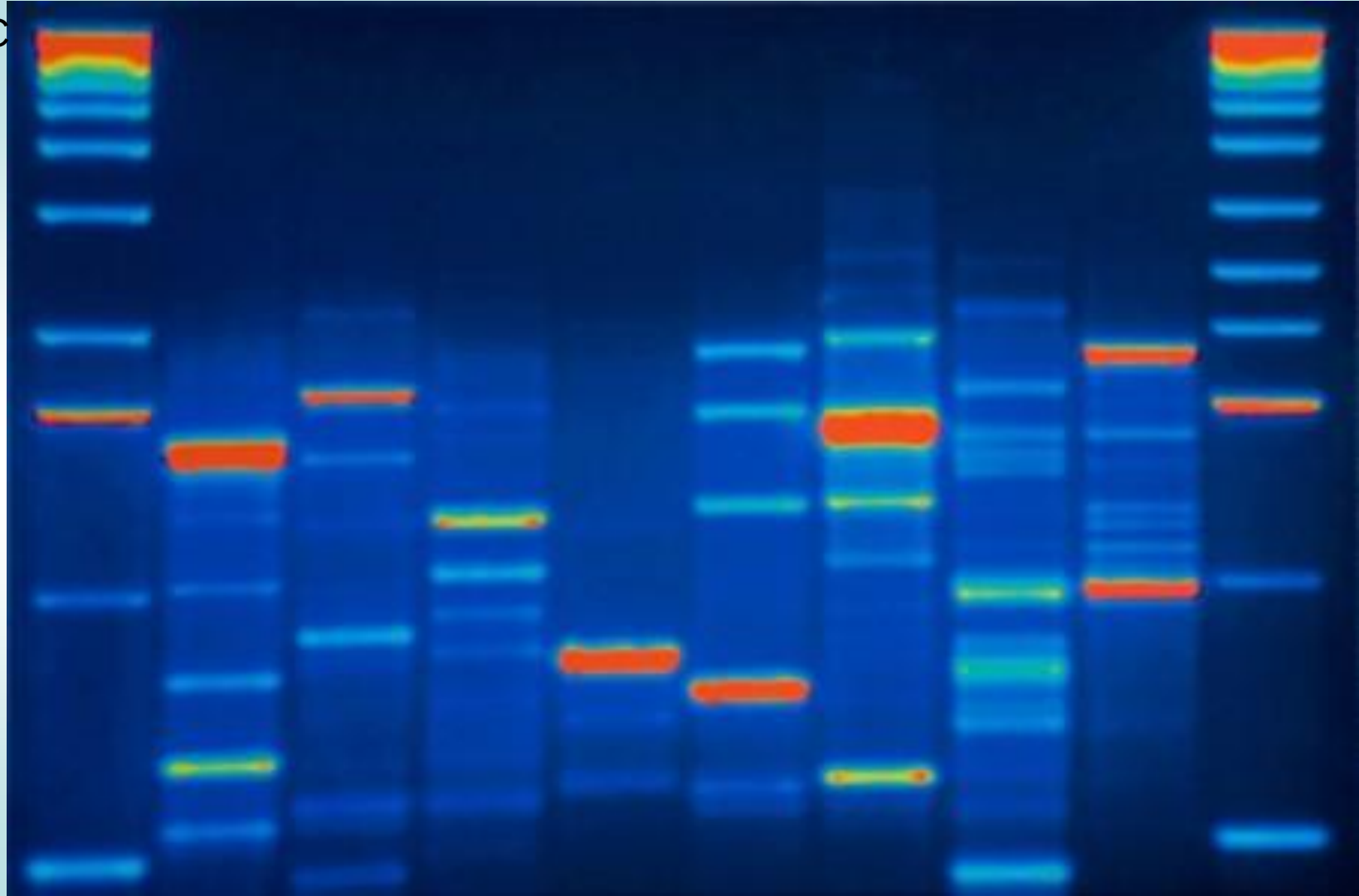
Local inconsistencies

Disable Green & Blue Layers

⇨ Colors ⇨ Auto ⇨ Equalize

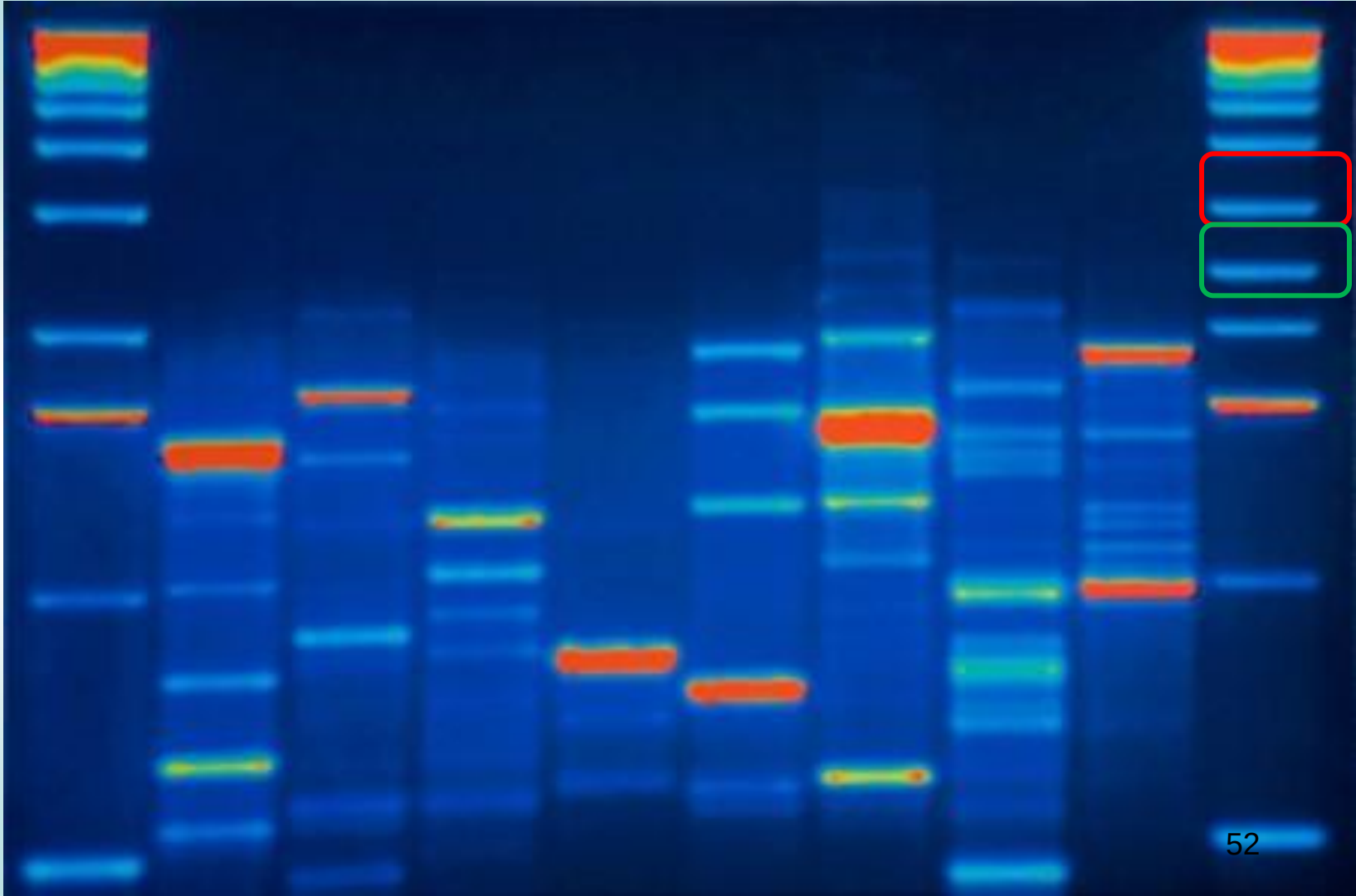


LIMITS-10-C



LIMITS-10-C

Clone detection with a specialized forensic system



Forensic image analysis

Conclusion

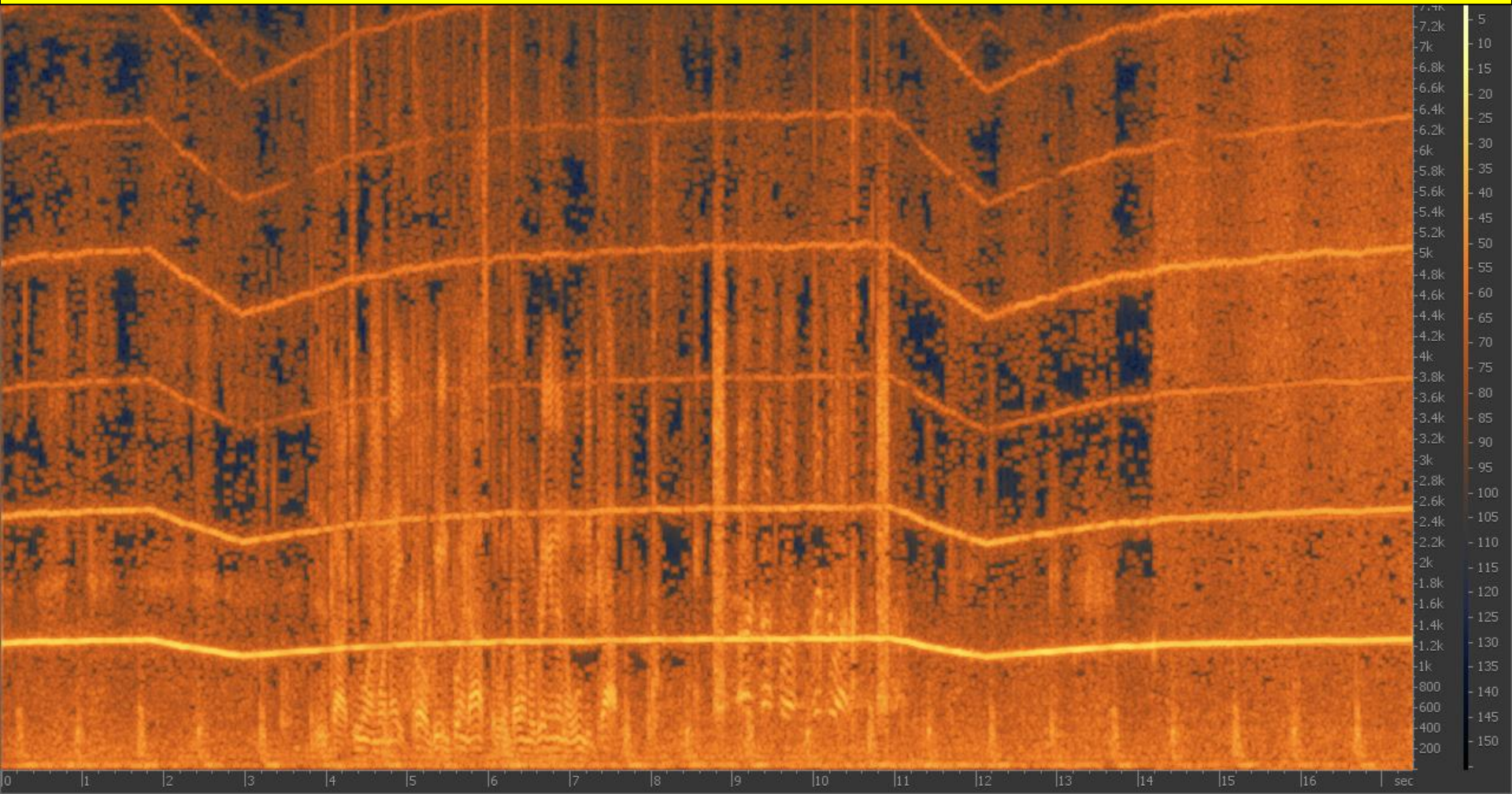
1) An improvement of image “manipulation” techniques was noticed during the past years.

2) New image analysis techniques were published in peer reviewed journals.

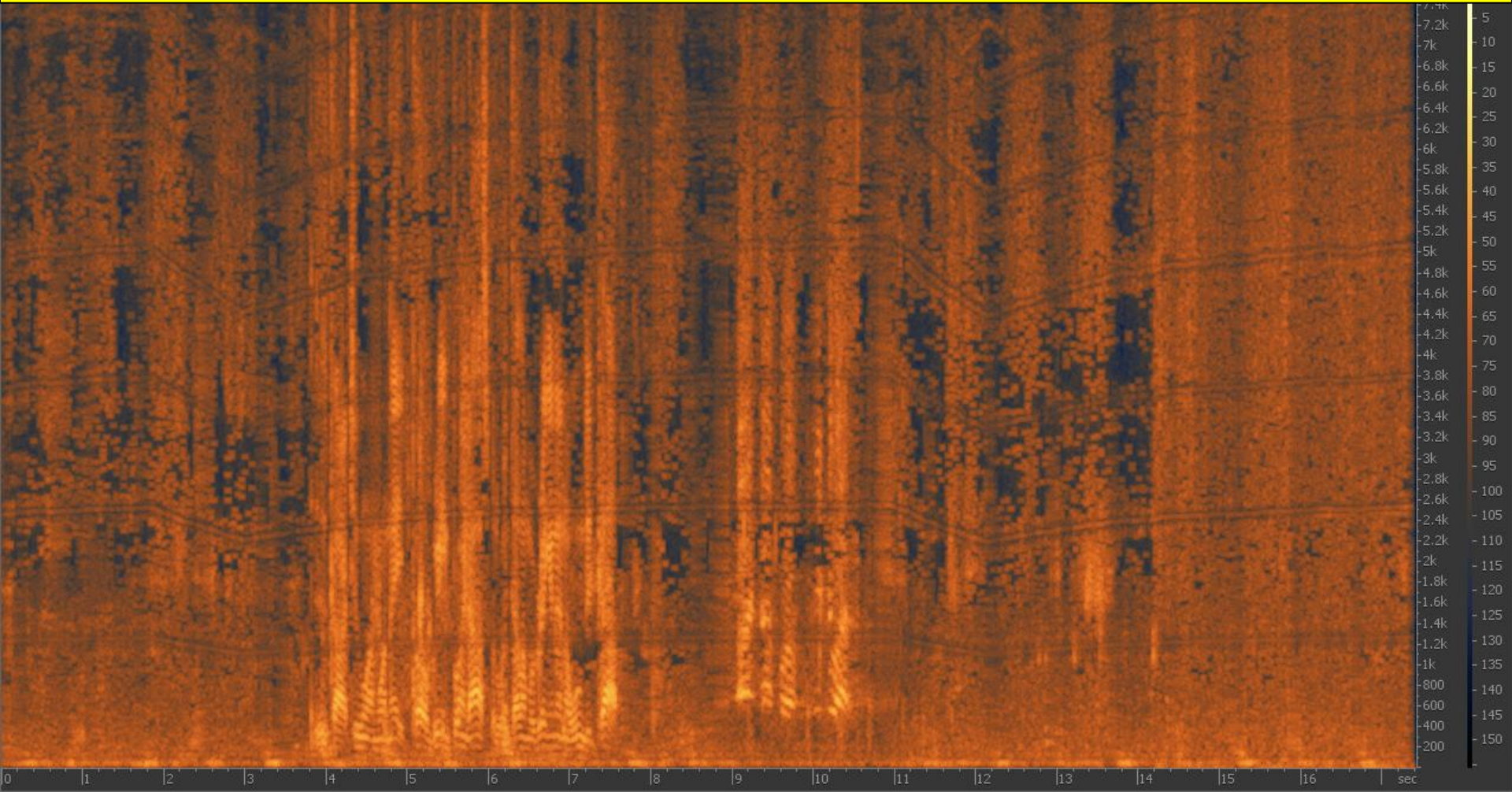
3) Forensic image analysis can be a good asset to detect traces of image tampering in scientific research, media, and judicial proceedings.

Audio Analysis Examples

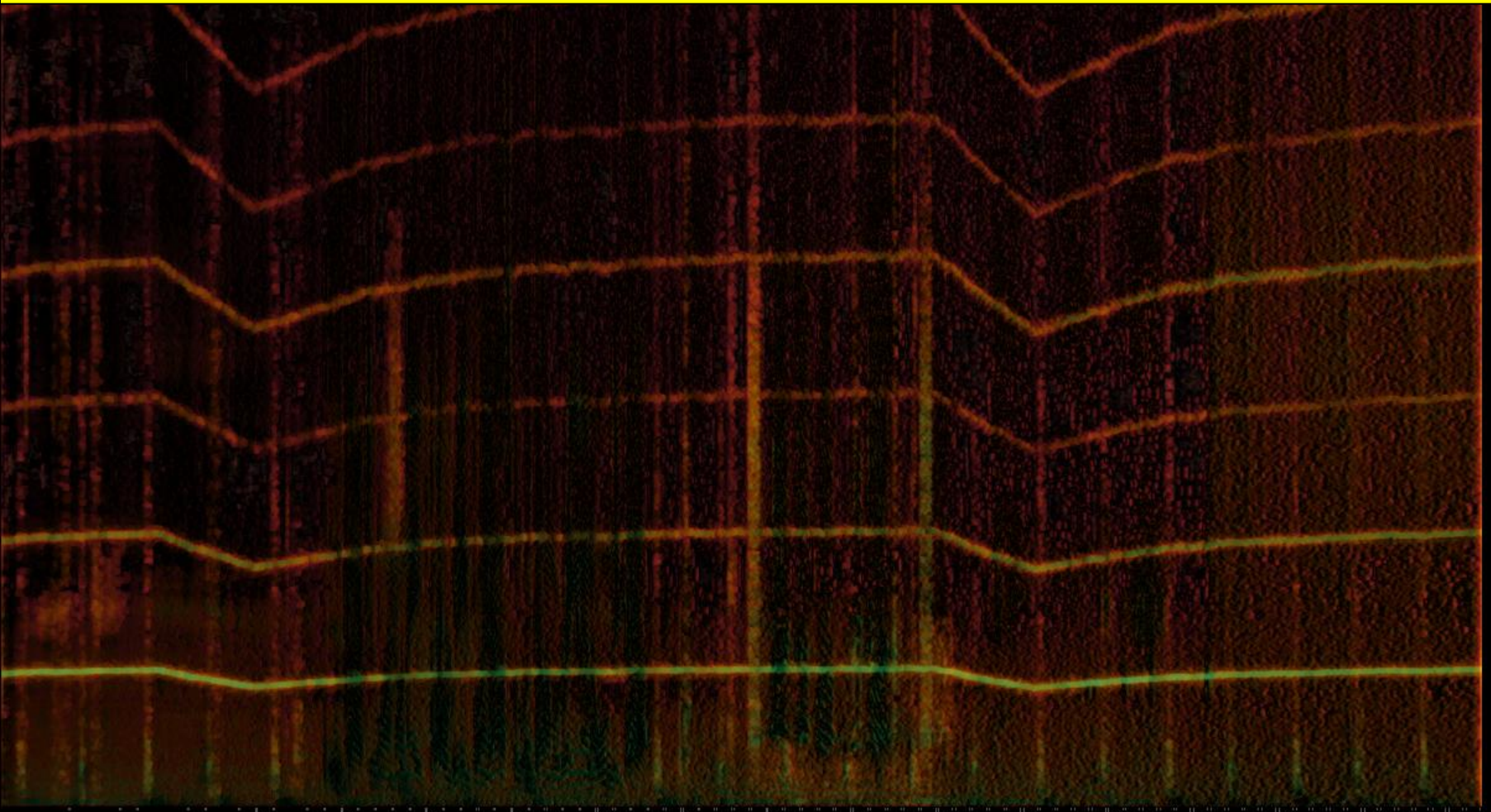
Noisy recording containing: speech, sirens, windshield wiper, background noise...



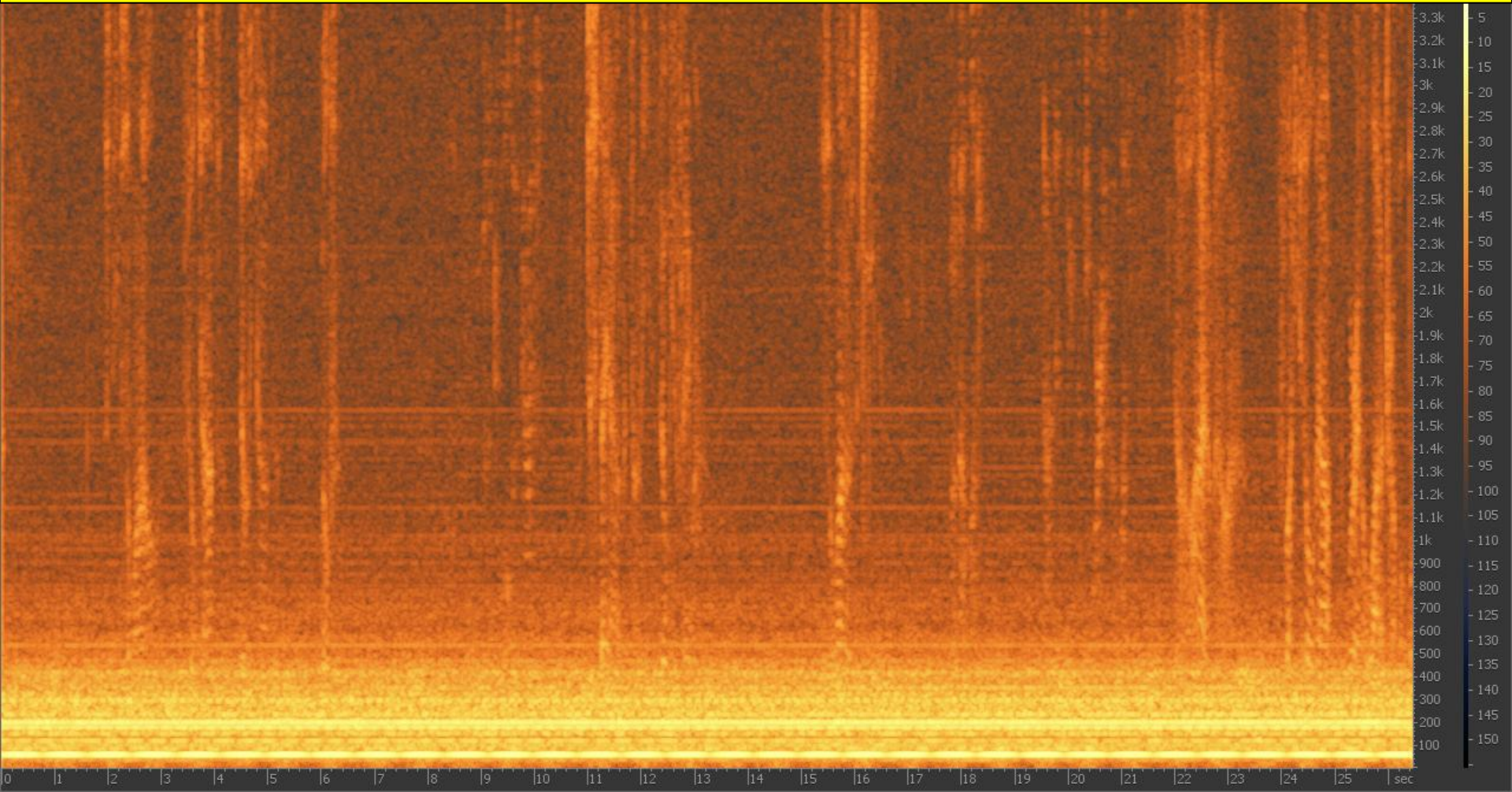
Forensic enhanced recording without sirens, windshield wiper, background noise.



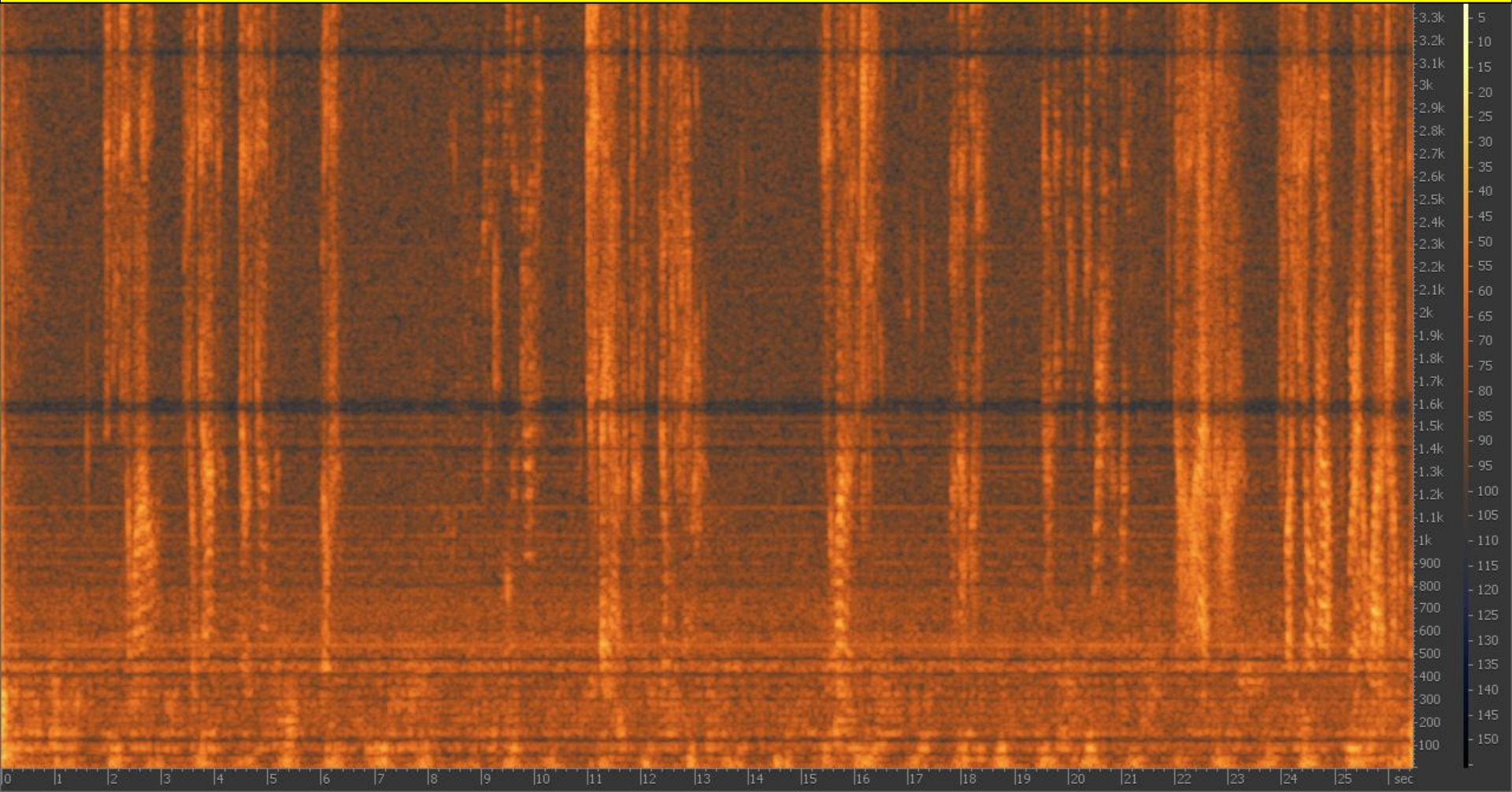
The removed sirens, windshield wiper, background noises...



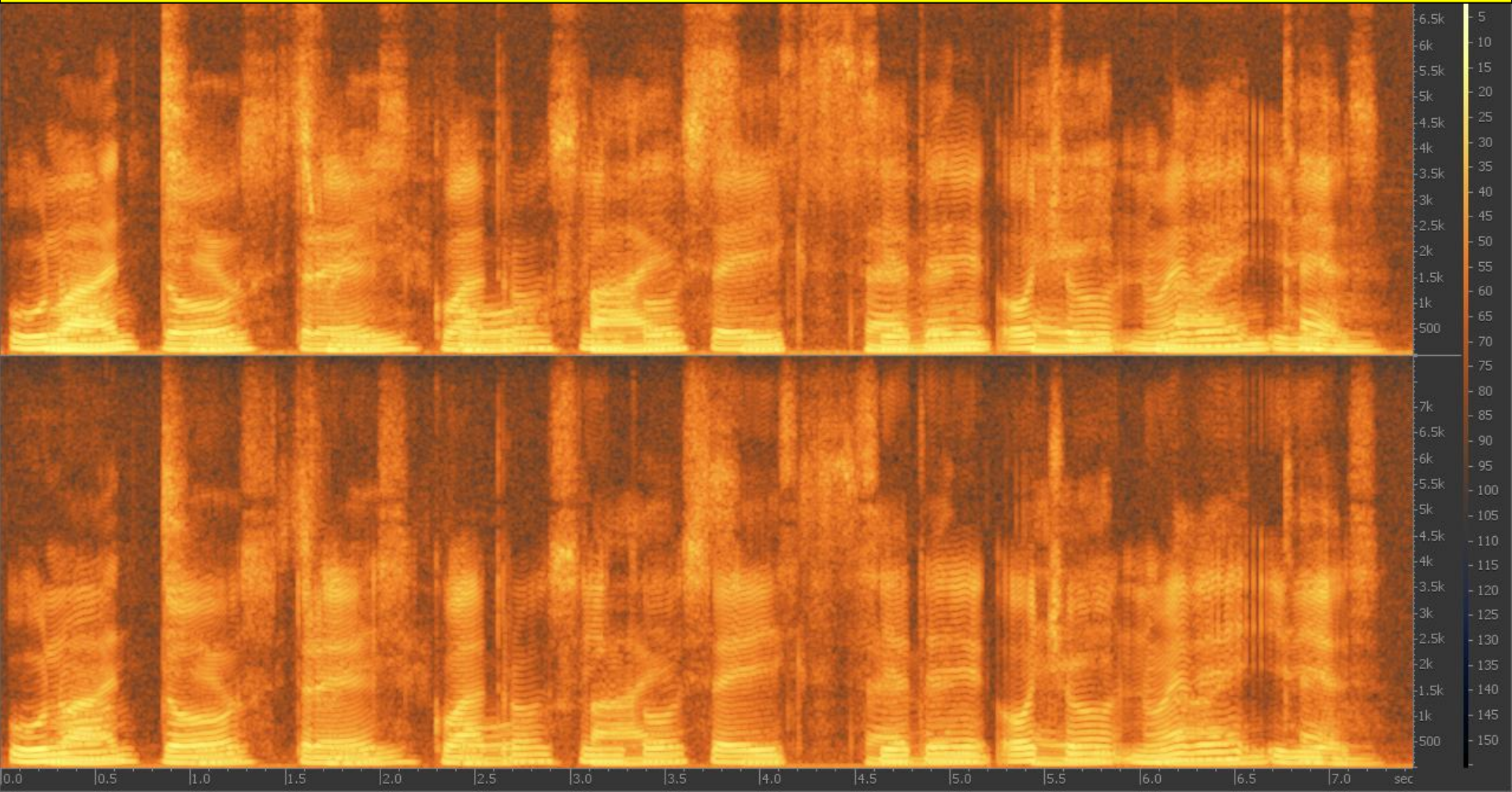
Noisy recording containing: speech, hum, broadband noise...



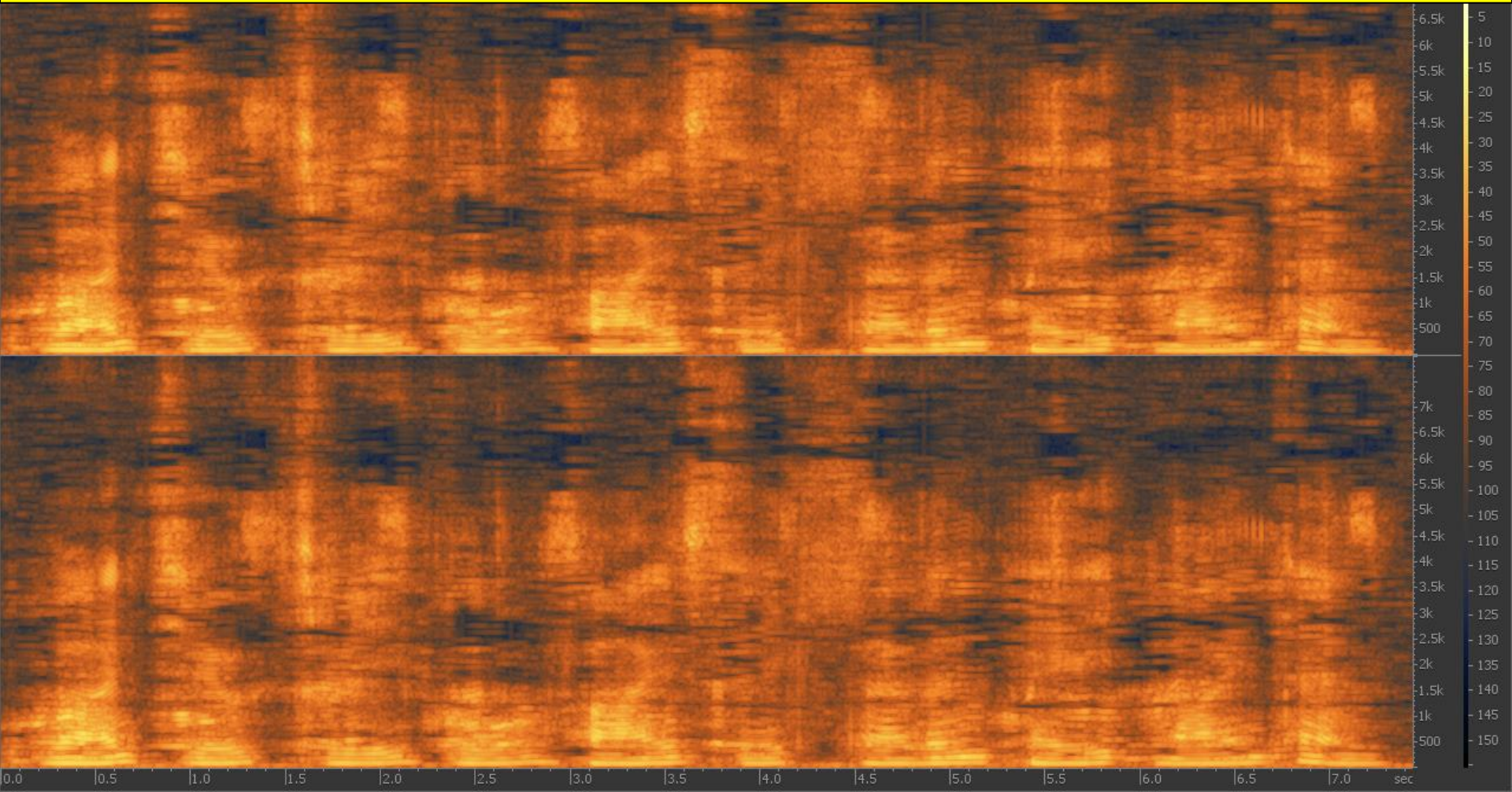
Forensic enhanced recording without hum, broadband noise...



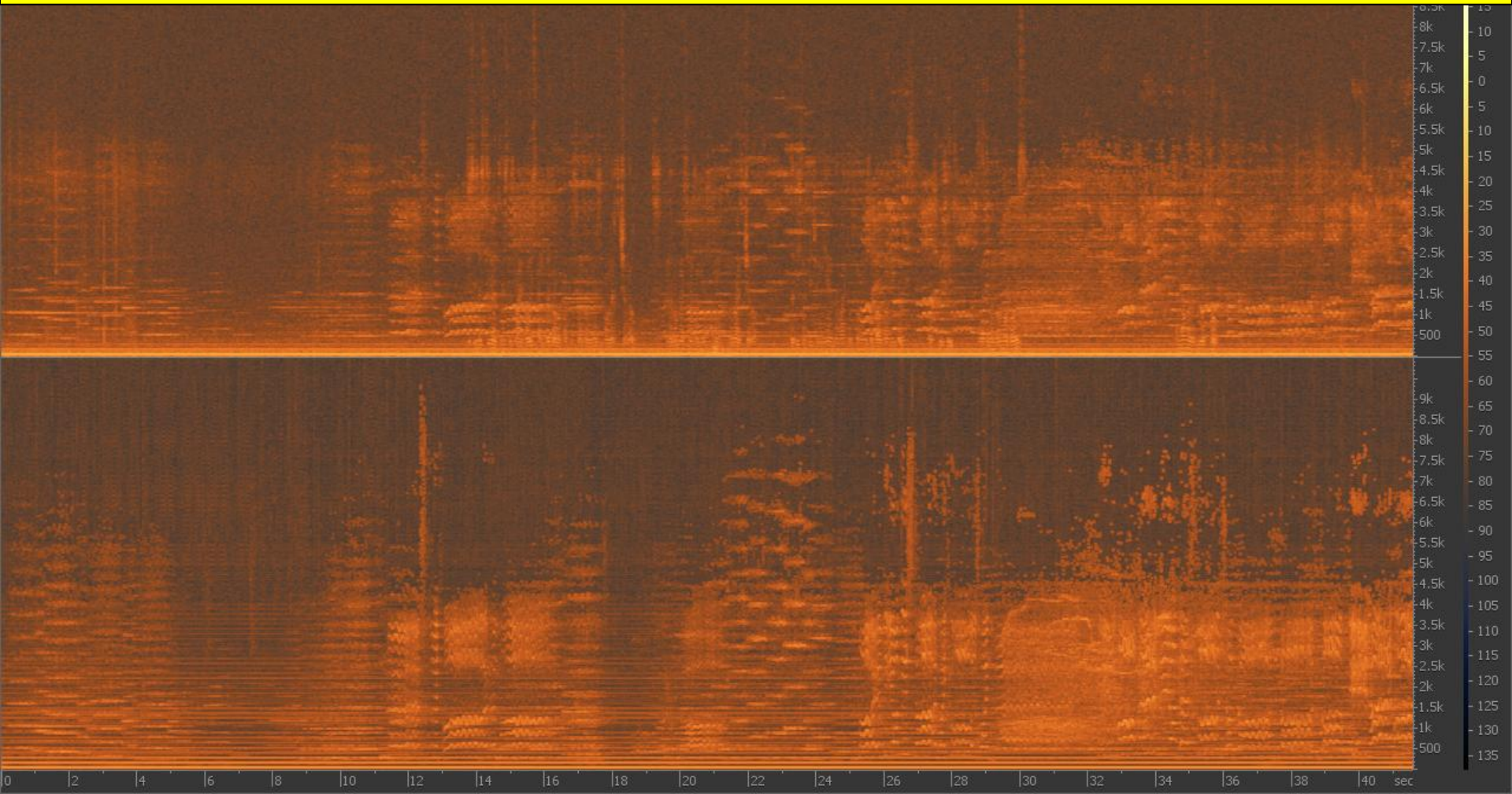
Two overlapped speakers



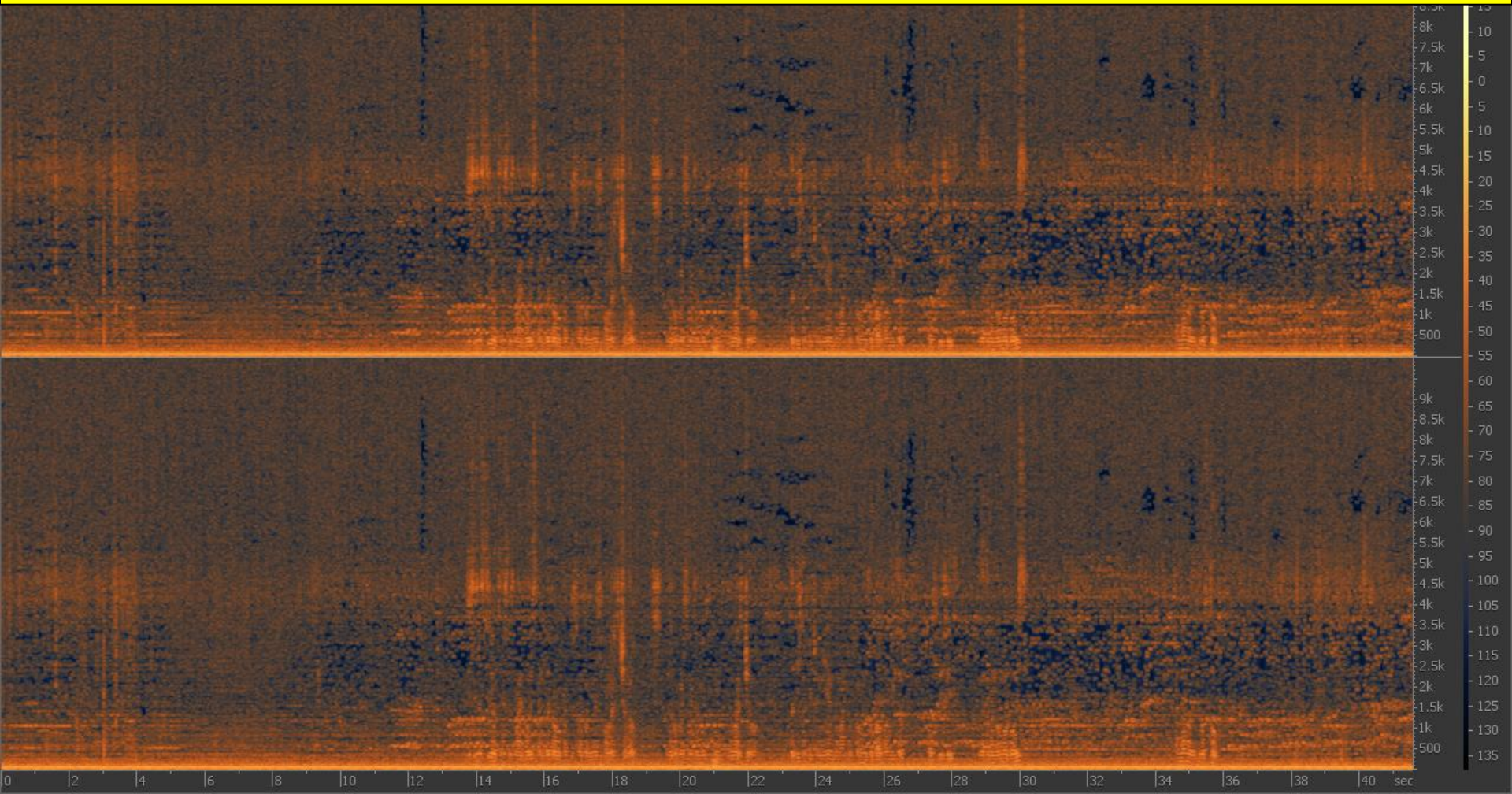
One speaker extracted



Noisy recording containing: speech, background music, background noise...



Forensic enhanced recording with attenuated music and noise...



More forensic media analysis includes

- Video authentication
- Audio authentication
- Audio background analysis
- Speaker recognition
- Face recognition, etc.