Connecting People, Science and Regulation

NEW TECNIQUE FOR THE INSPECTION OF AMPOULES TIPS IN PRESENCE OF LIQUID DROPS

A CASE STUDY

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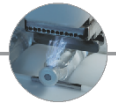
Inspection Machines

— High speed solution

Continuous motion
(up to 400 pcs/min)

Exacta Plus — *Tracking cameras for high accuracy in detection*

Exacta Easy — *Fixed cameras for high productivity and low maintenance*



LKD — *Leak test machine*

— Medium speed solution

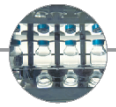
Intermittent motion
(up to 200 pcs/min)

MCA — *Very flexible machines for inspection of a wide range of products*

FD — *Dedicated machine for Freeze-Dried products*

— Semi-automatic solution

(up to 100 pcs/min)



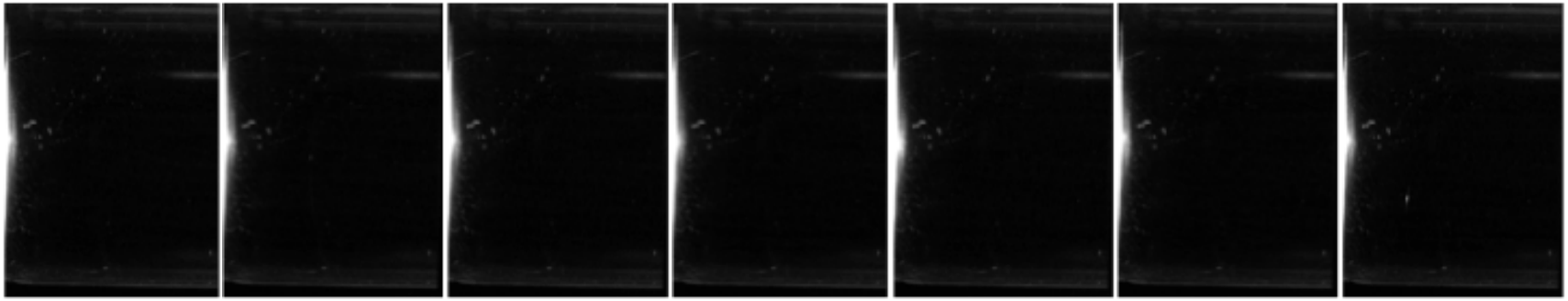
PWL — *Ideal for small volume inspection or critical products*

Summary

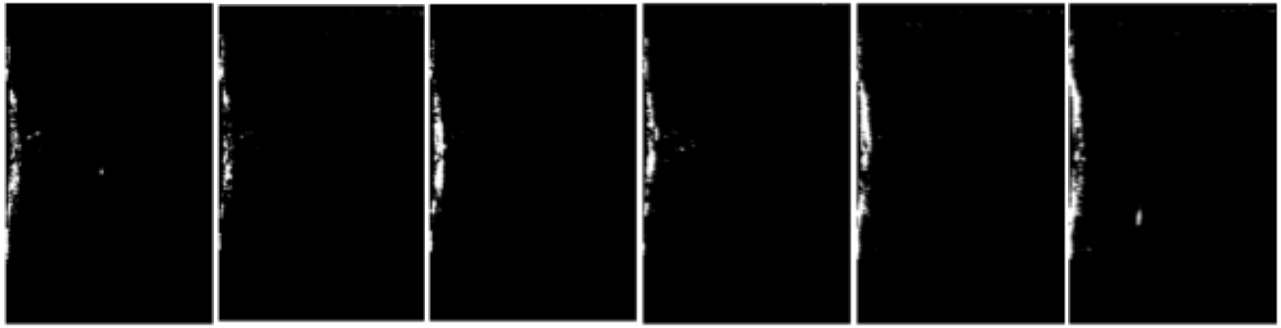
- Optrel data
- Dynamic analysis in particles detection
- Case study – Advanced Tip inspection
- Standard approach difficulties
- Dynamic analysis applied to cosmetic inspection
- High Accuracy Tip Inspection Machine - ATI400

Standard Inter-frame Analysis for Particle Inspection

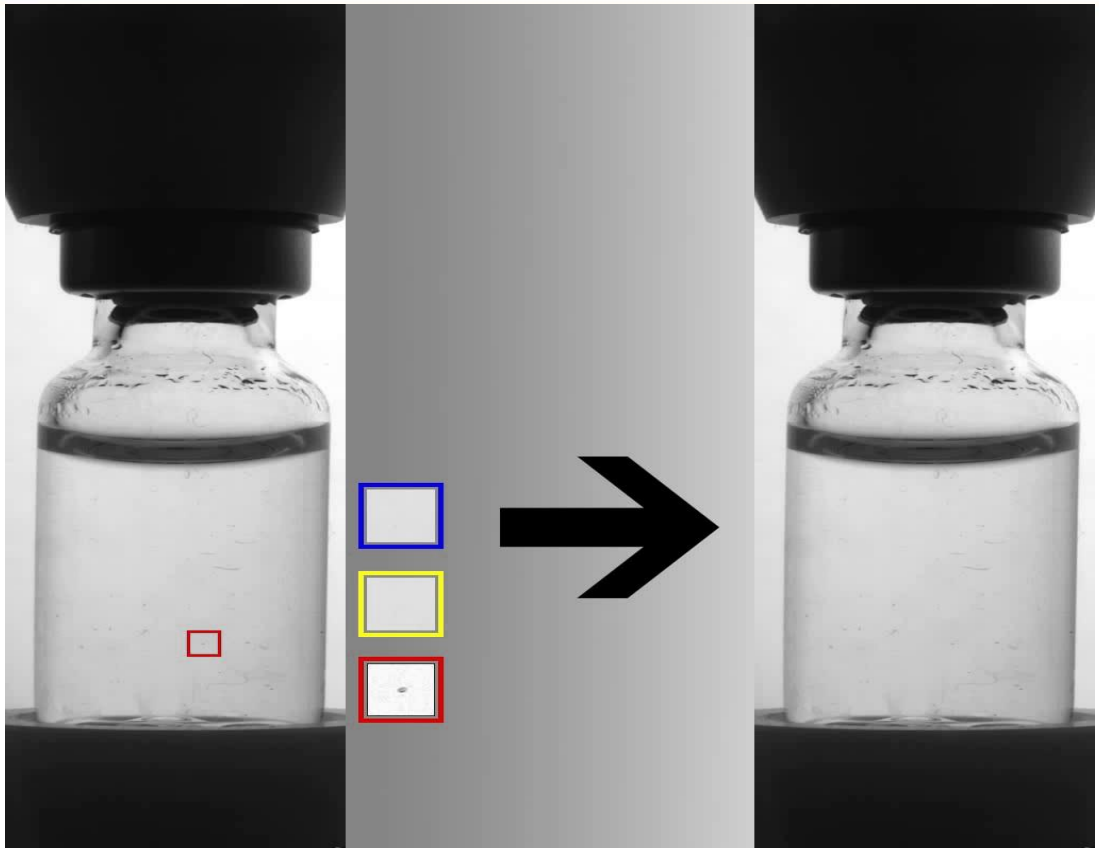
Acquisition of a sequence of 12 up to 60 images from the container under inspection



Compute the sequence of differential images one by one

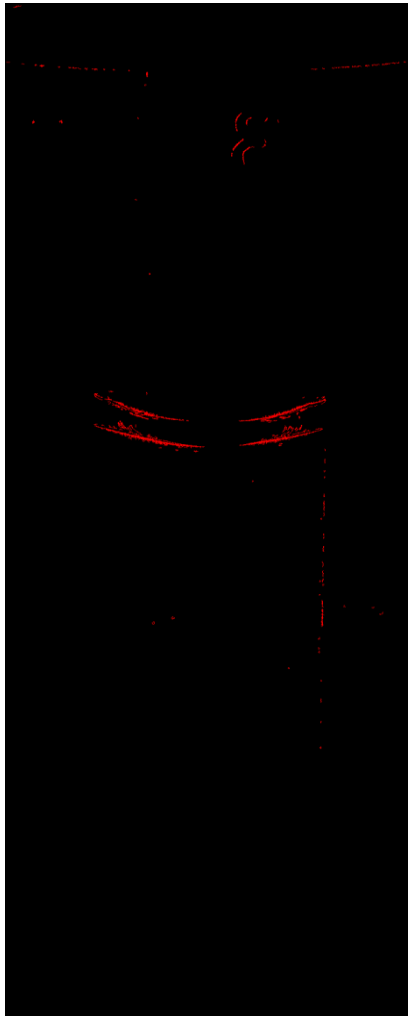


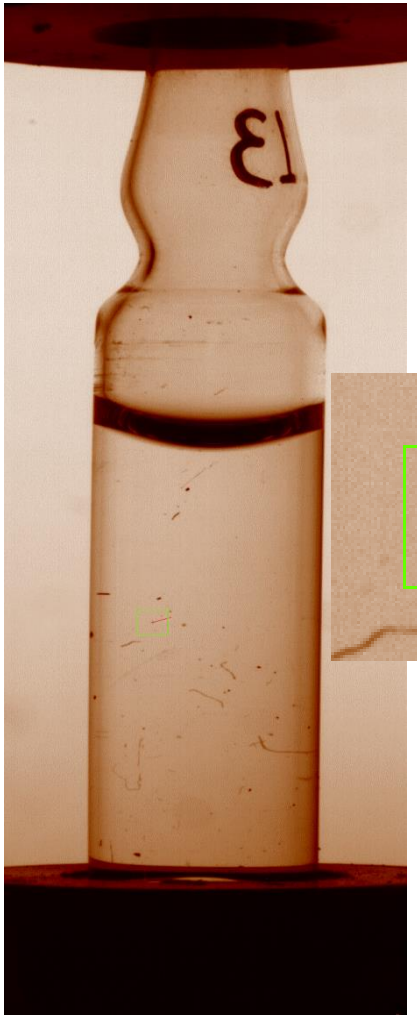
Dynamic Analysis For Particle Inspection



- Particle trajectory reconstruction using the Kalman filter
- Trajectory post analysis filtering – lower false reject
- Analysis of the meniscus – floating particle inspection
- Analysis of the container bottom – heavy particle inspection

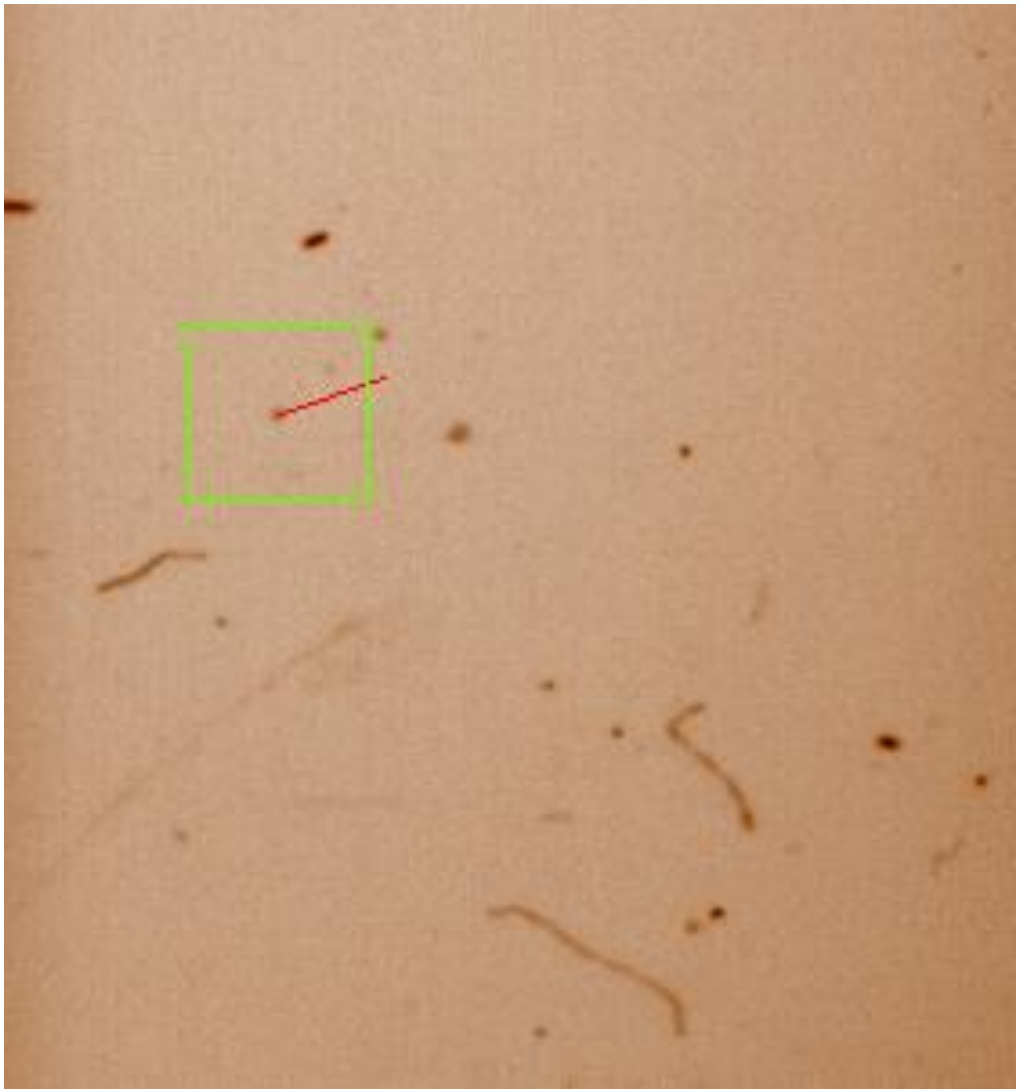
Particle Inspection: Dynamic vs Interframe Analysis



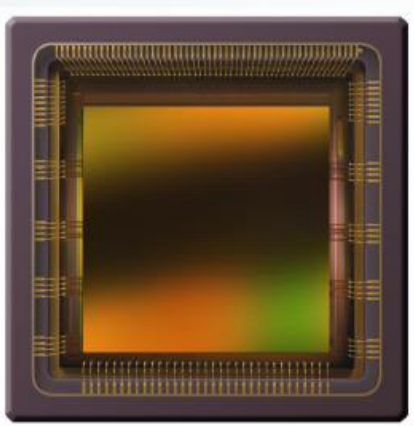


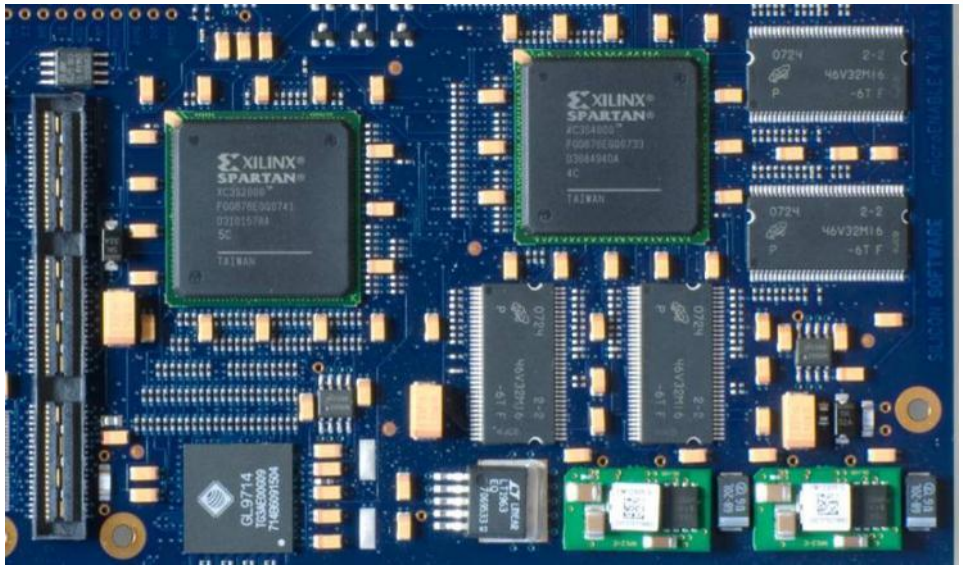
Particle Inspection: Trajectory details

Diff Threshold =12
Area Threshold = 5
Particle size < 50µm
Trajectory life= 16 frames
Field of View = 10 ml



High speed, high resolution cameras with on-board processing





The new camera numbers:

- 2048x2048 pixels sensor
- 359 frames per second
- 1.2 GHz Dual Core RISC processor
- 90 KLE FPGA
- 4 GByte onboard data storage
- Gigabit Ethernet Interface

EXACTA MODELS

Easy

- Still cameras and illuminators
- Electronic tracking system
- 40 µm resolution
- Ampoules up to 20ml with one camera
- Vials up to 20ml
- Cartridges

Plus

- Camera tracking system
- 25 µm resolution
- High speed 300 fps
- Cosmetic controls
- Freeze dried inspection
- Hybrid version for solid/liquid

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- High Accuracy Tip Inspection Machine - ATI400

Customer requests

- Important multinational customer asked us to develop a machine for inspecting ampoules' tip for small black spot (<50µm) and tip shape deviations
- The product, being an ethanol-based solution, has a relevant disposition to produce drops of liquid difficult to remove
- The product is light dark so even a proper illumination is not enough for reducing the impact of liquids drop on the control

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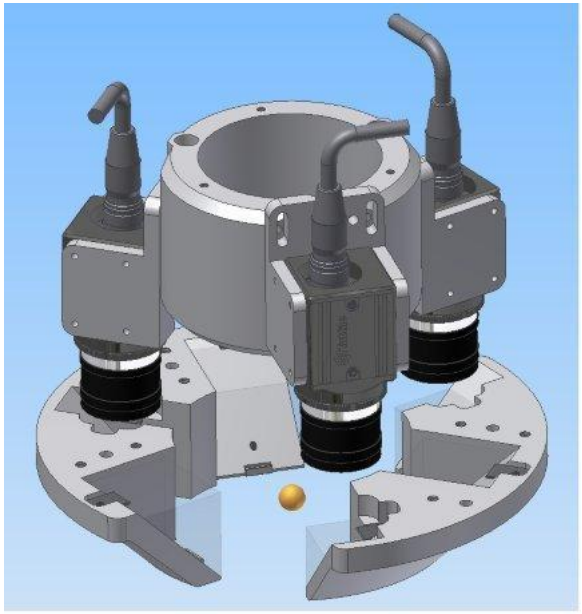
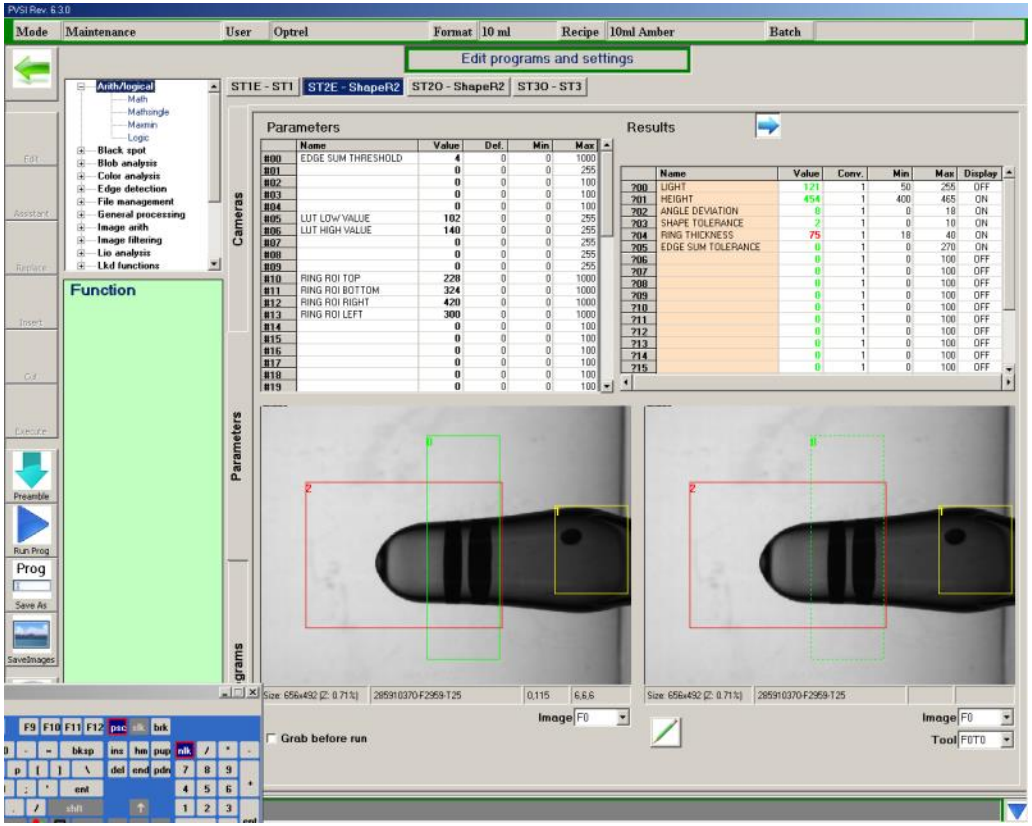
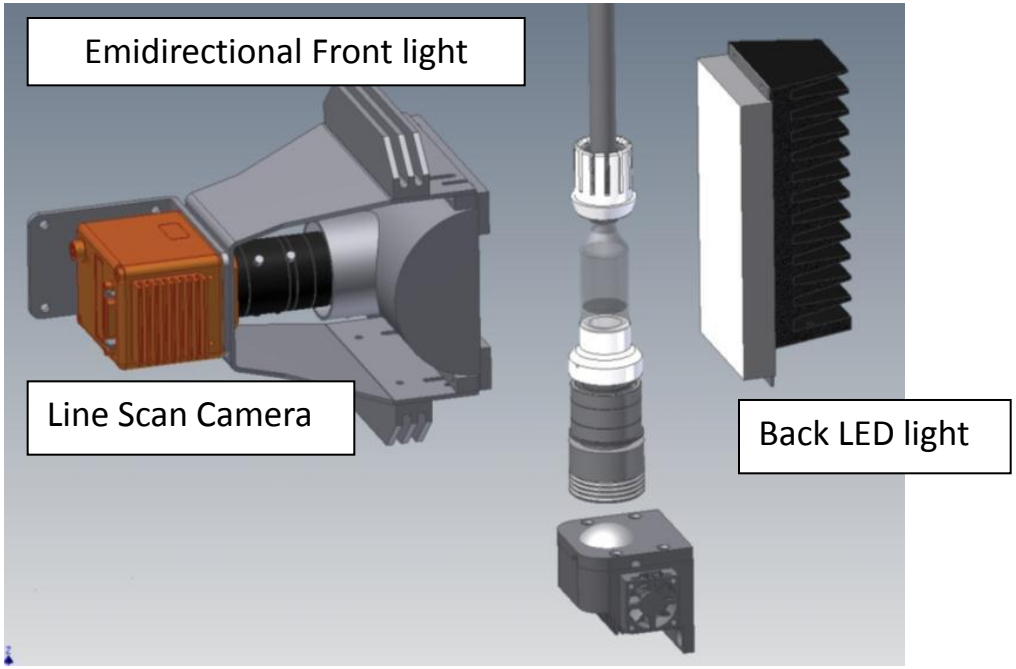
Standard Tip Shape inspection



Parametric definition of the tip shape model



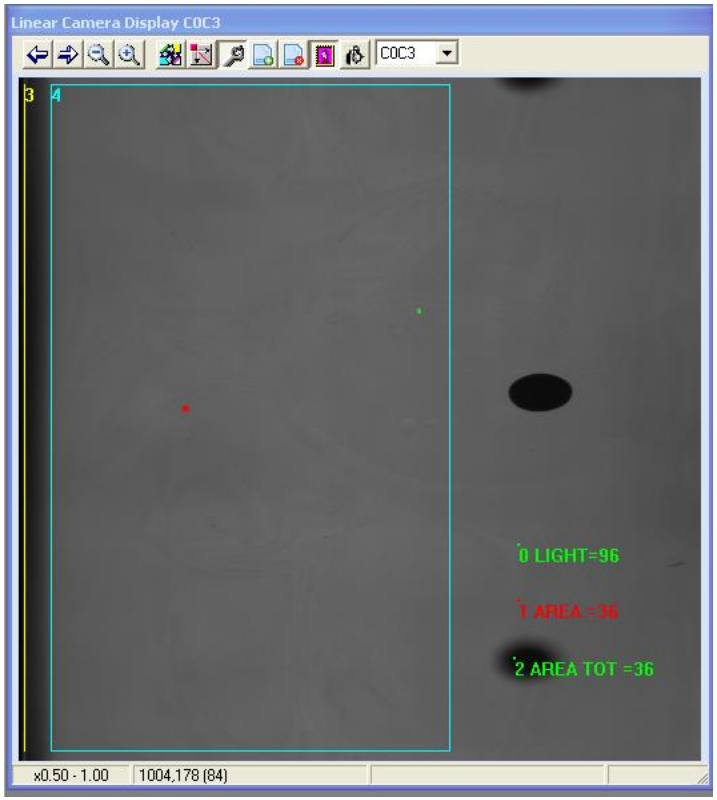
Linear Scan Camera for Standard Tip Inspection

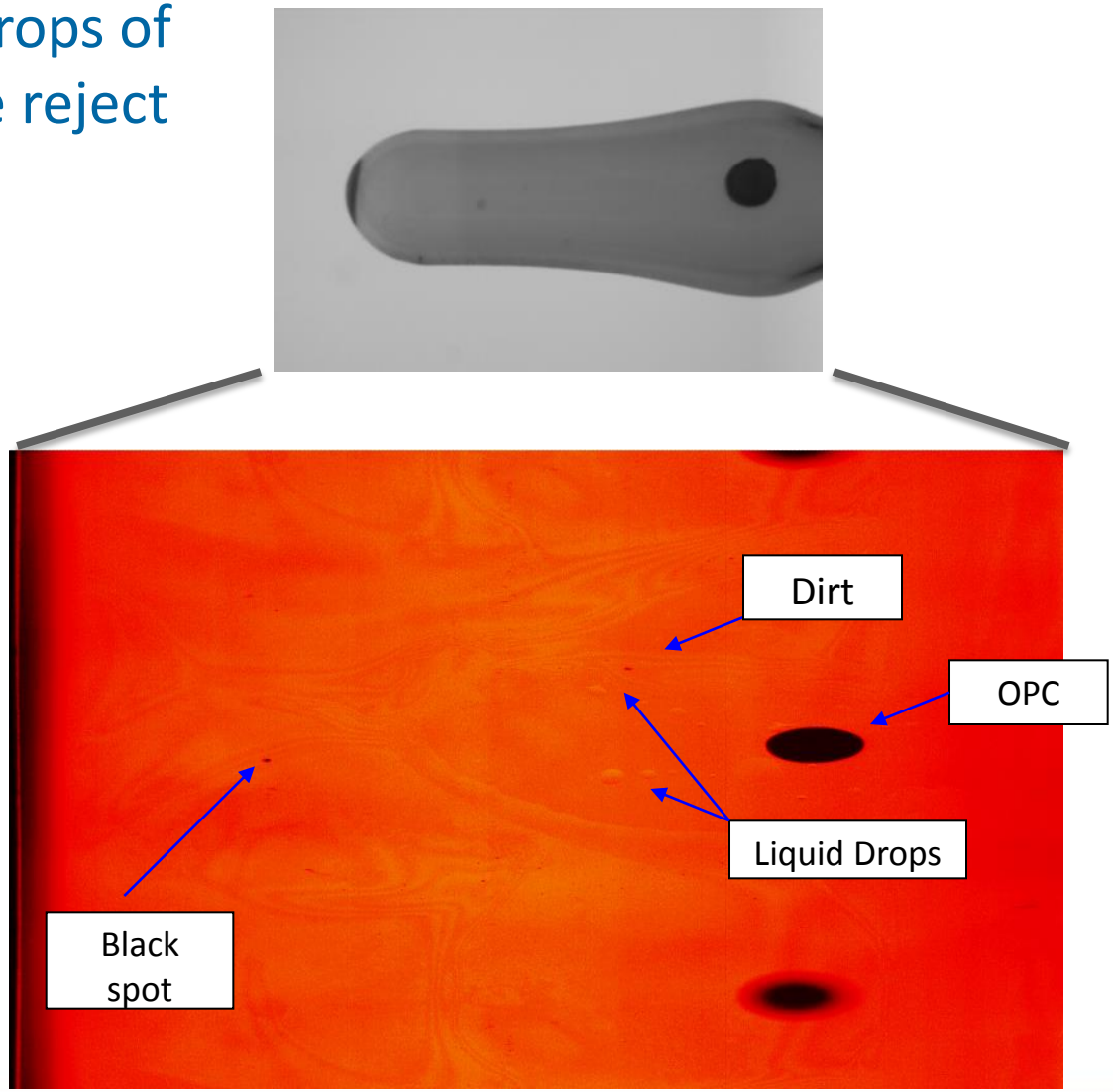


- Special linear scan camera ranging from 512 pixel up to 2048 pixel that guarantee high inspection resolution.
- Special emidirectional light sources developed by Stevanato Engineering.
- The container is rotated in front of the camera in order to scan the whole surface of the vial.

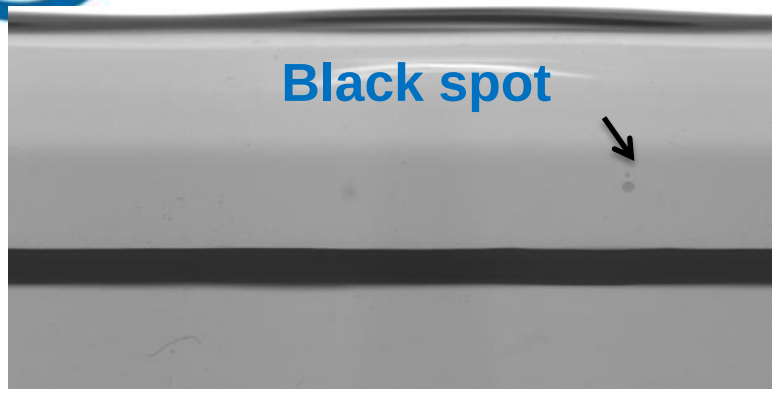
Standard product carbonization on ampoules tip

Using linear cameras the drops of liquid don't cause any false reject in **normal conditions**



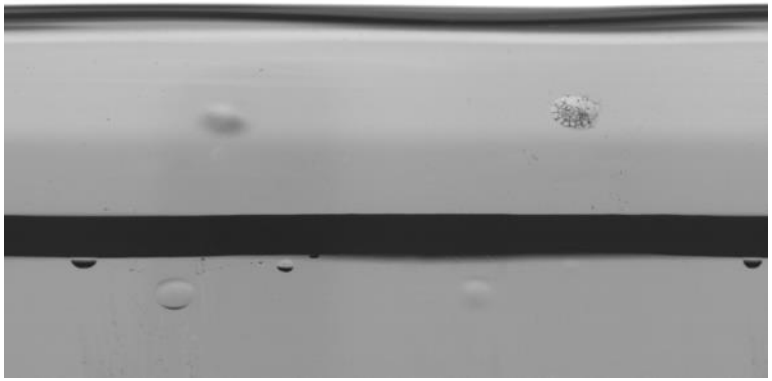


Customer's Product Difficulties with Standard Inspection

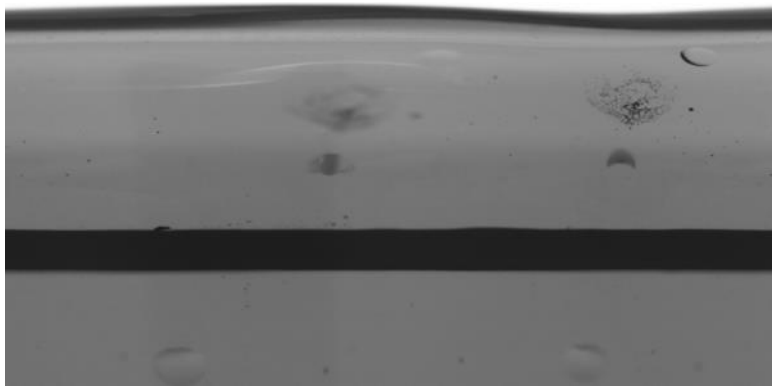


Ideal situation

Drops below color ring



Drops below color ring

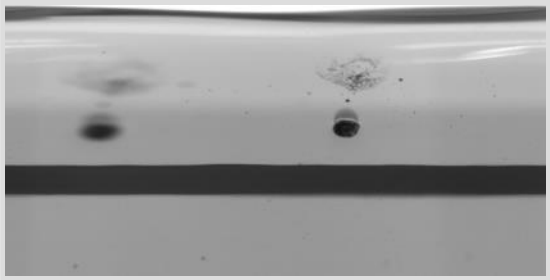
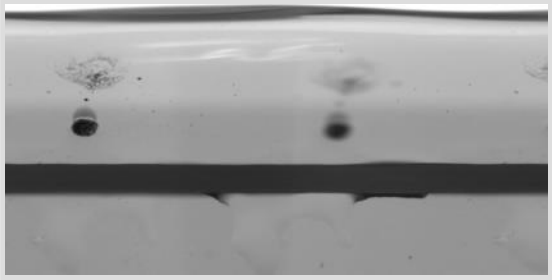
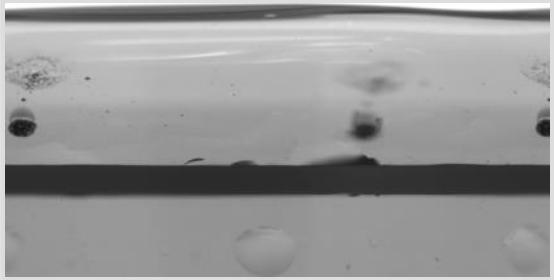


Drops below tip

No Effective Strategy for Keeping Empty Tip

We tried also to investigate any possible method for emptying the ampoules' tip just before inspection but **drops grow very fast** again.

The effect is a consequence of the fact that the volatile part present in the product has a lower surface tension than the water part. If, for example, alcohol is mixed with water, a region with a lower concentration of alcohol will pull on the surrounding fluid more strongly than a region with a higher alcohol concentration.
The concentration difference is probably due to the fact that both alcohol and water evaporate from the film present on the tip after emptying, but the alcohol evaporates faster, due to its higher vapor pressure.
The resulting decrease in the concentration of alcohol causes the surface tension of the liquid to increase, and this causes more liquid to be drawn up from the film to form the large drops.

After emptying	
After 10 seconds	
After 20 seconds	
After 30 seconds	

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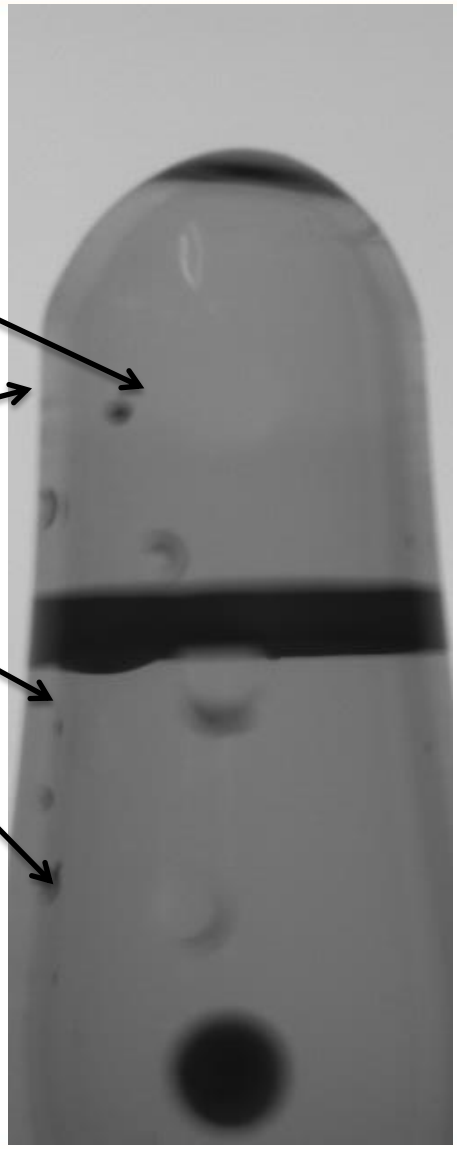
Dynamic Analysis of black spot in presence of drops

Black spot

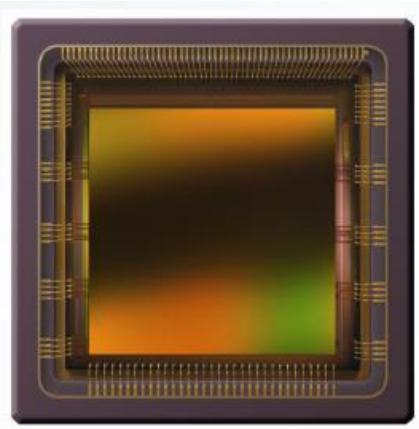
Drops

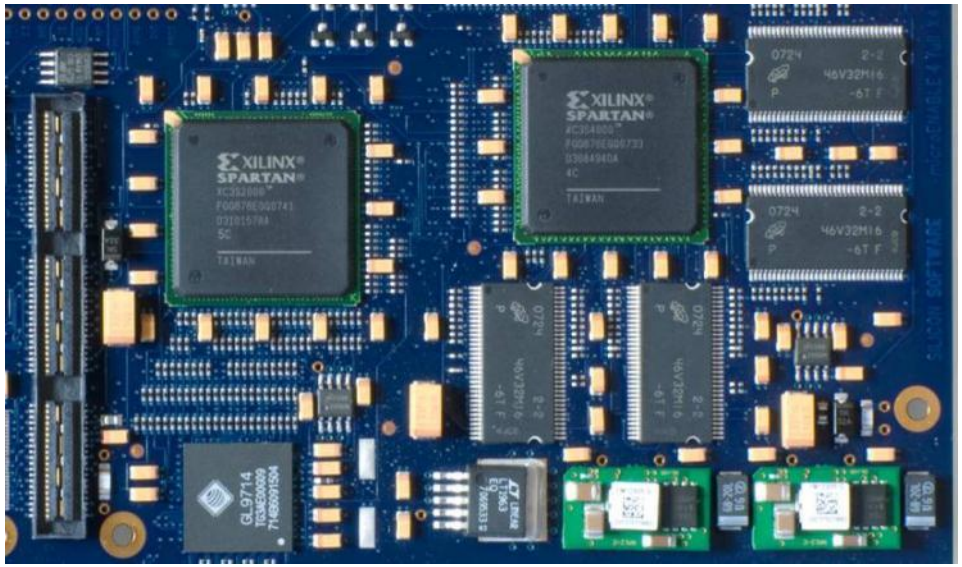


IDEA: liquid drops behave differently from cosmetic defects.
Following the change of appearance it is possible to determine the nature of the contamination

Requirements for Dynamic Analysis of Tip @<50µm

- High resolution – 2000x2000
- High speed – 32 images per rotation
- 128 Mbytes per container to elaborate in 150 msec
- Pre-processing in FPGA

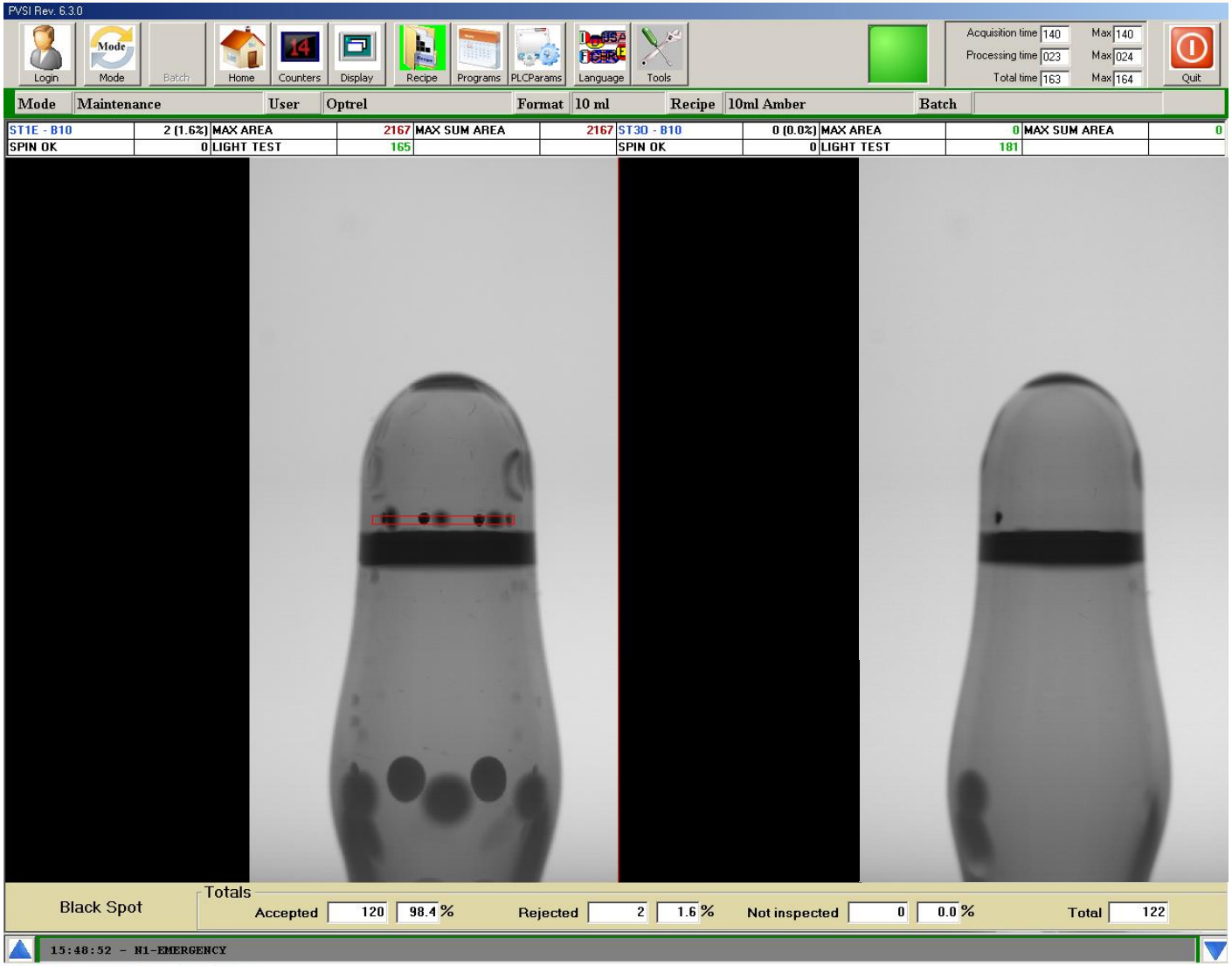




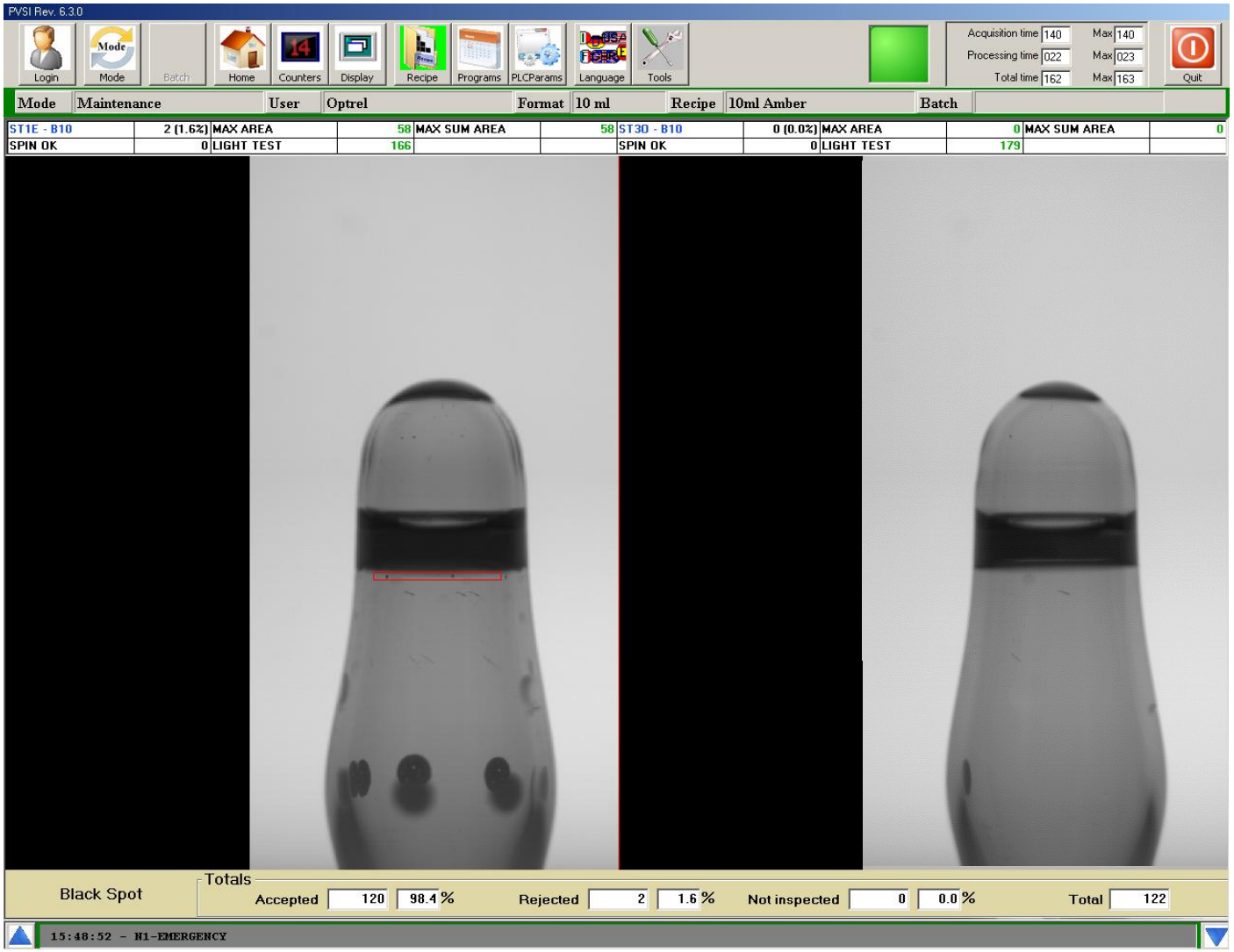
Examples of Tip Dynamic Analysis

False reject < 1% even in presence of liquid drops

Examples of Tip Dynamic Analysis #7

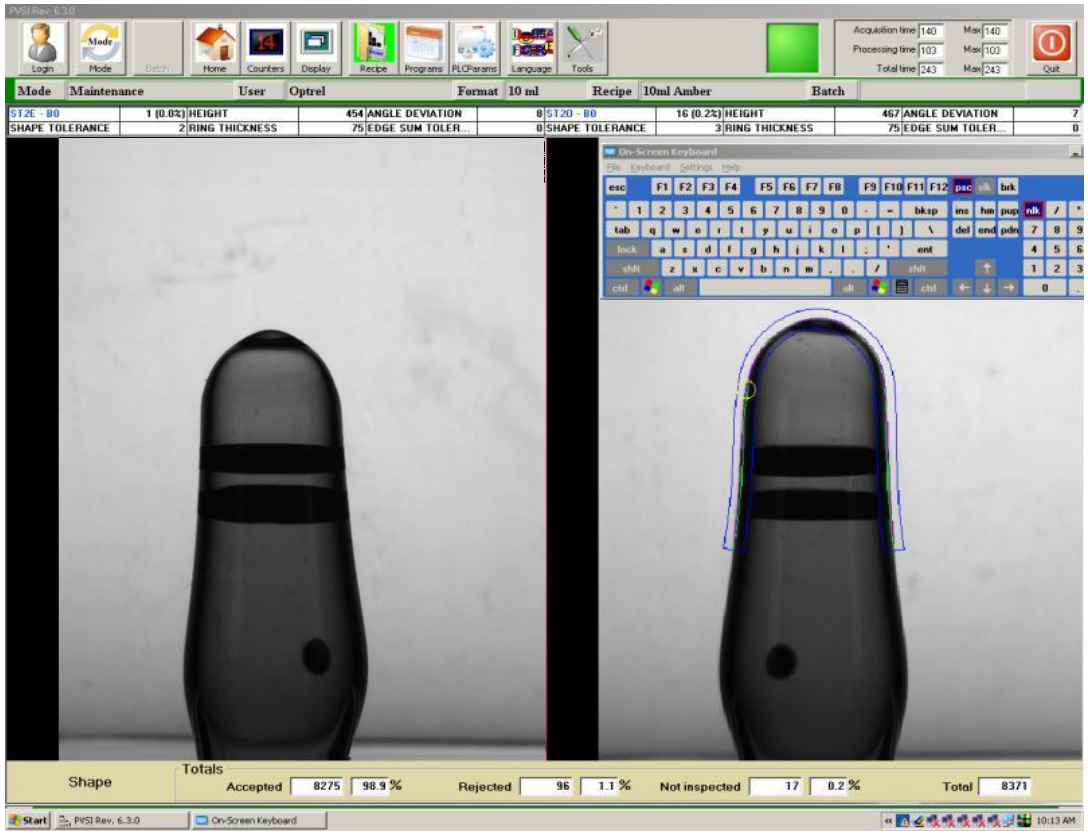


Examples of Tip Dynamic Analysis #4



Dynamic Tip Shape Analysis

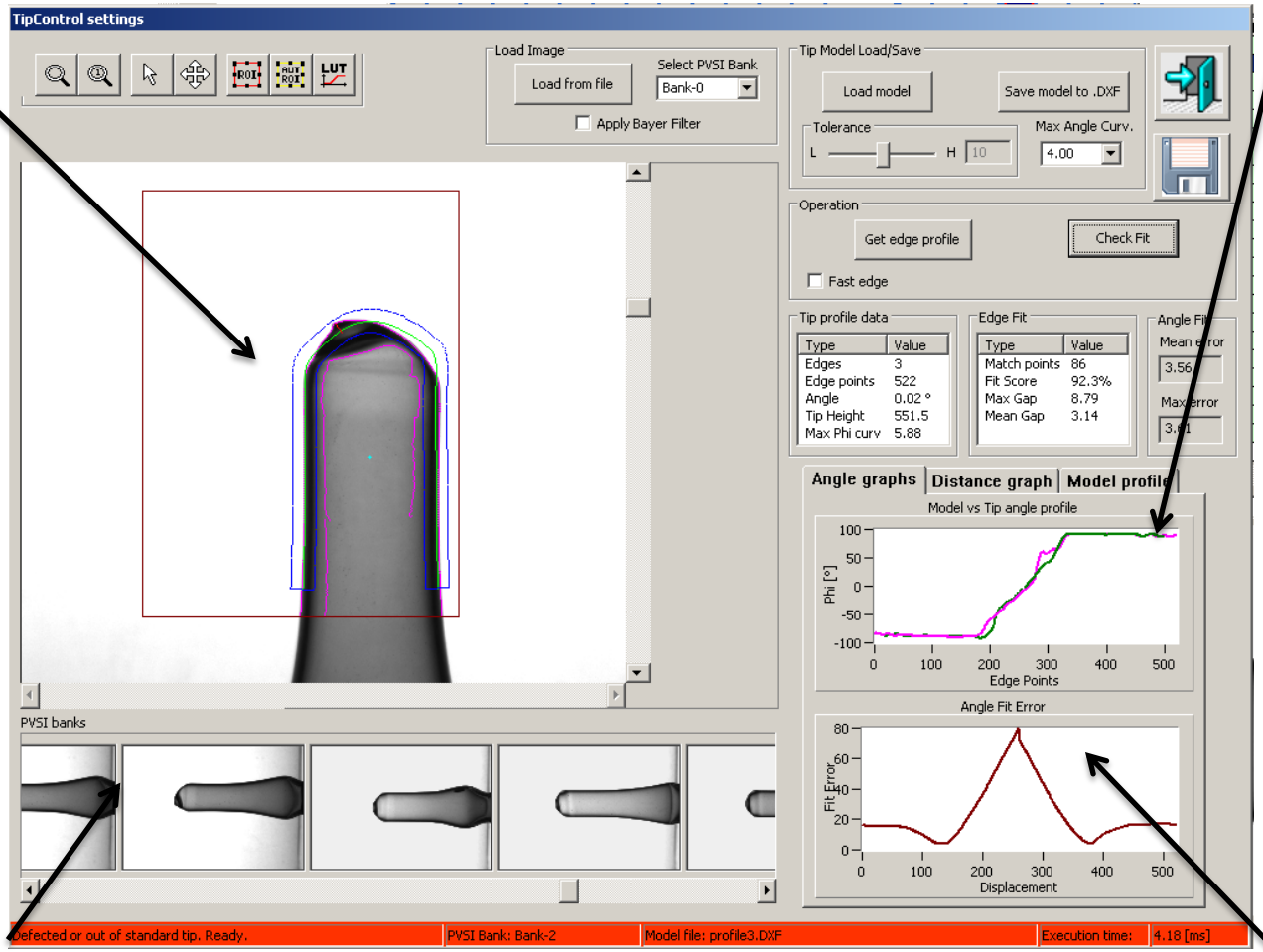
- Shape analysis in rotation on 8 images
- Automatic compensation of tip oscillation
- Worst deviation evaluated Inside and Outside correct shape



Interactive Tip Shape Analysis

Tip under analysis

Tip shapes correlation



Tip shapes fit with model

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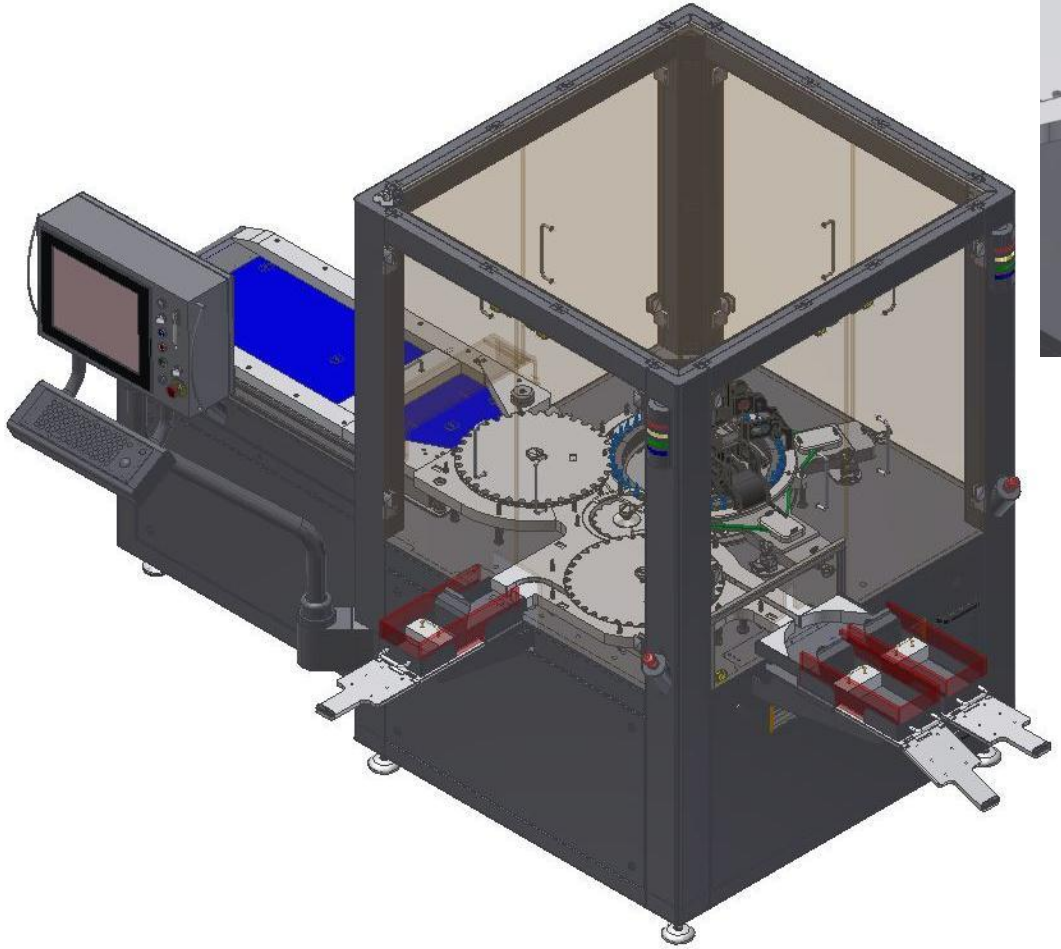
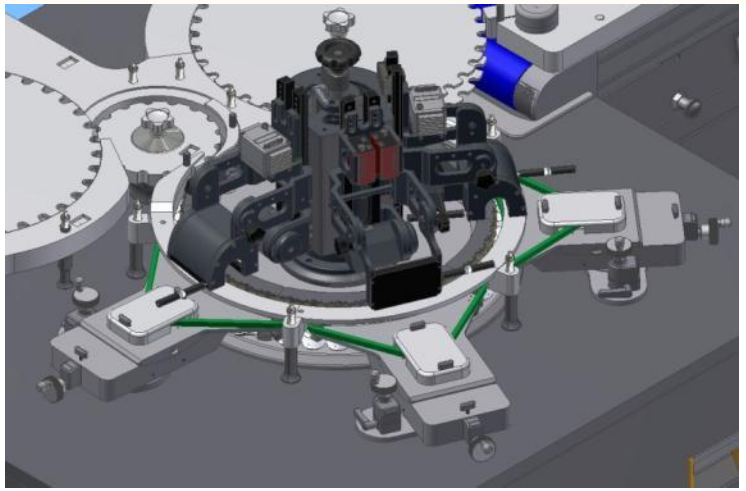
ATI400 - Small footprint, accessible, cleanable

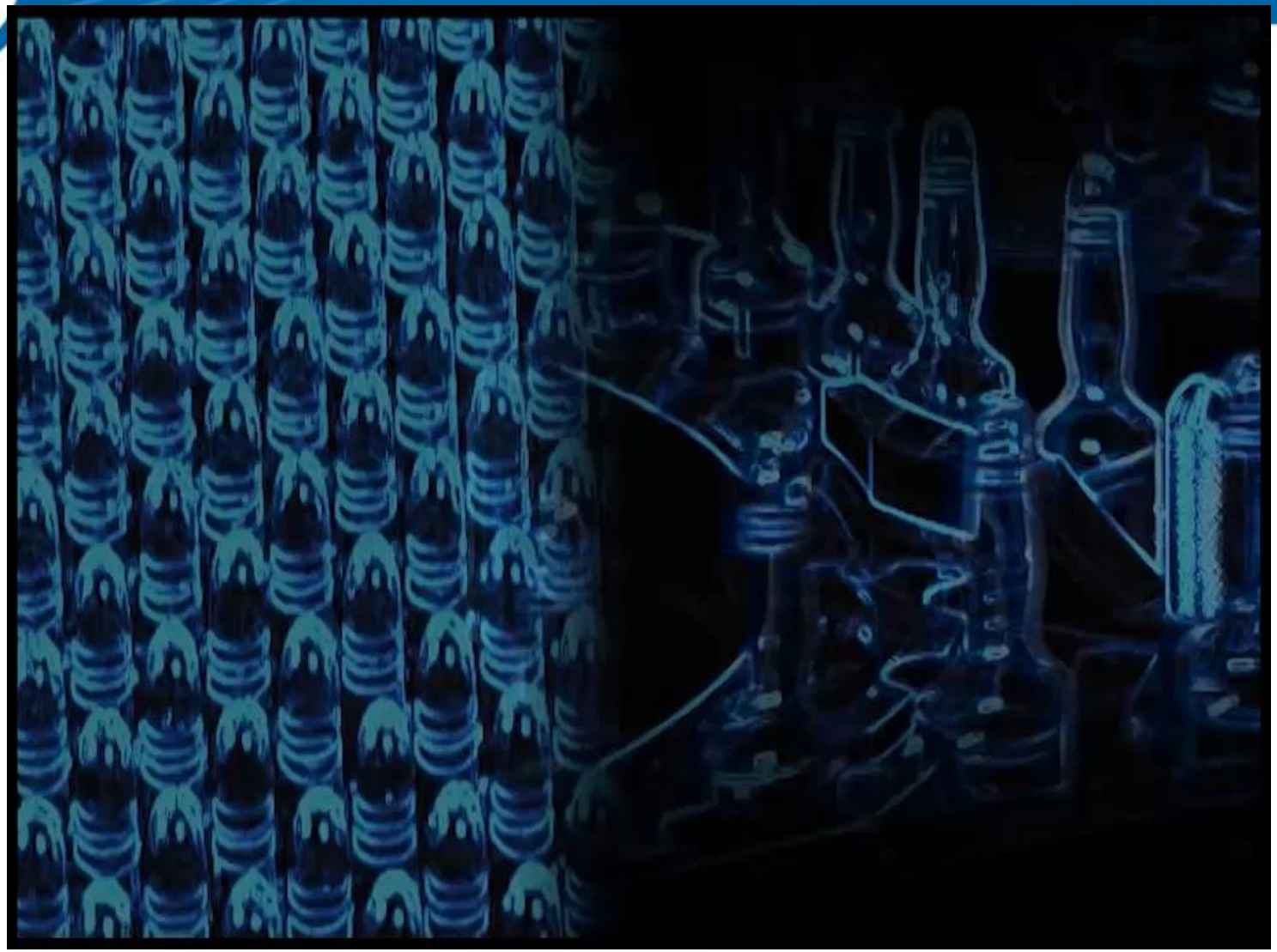
Tip completely free for unobstructed inspection





- Dedicated rotation for each inspection synchronized to vision
- Customized illumination system
- Easy change parts

Video ATI400



Thank you for your attention

www.stevanatogroup.com
www.optrelinspection.com