
Automation of SRF cavities optical inspection

October, 4, 2010

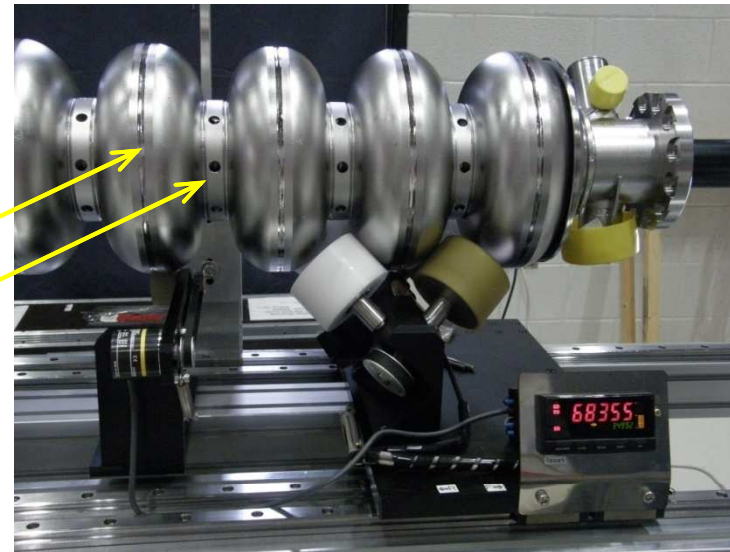
[Evgeny Toropov](#), TD/SRF department

Optical inspection system

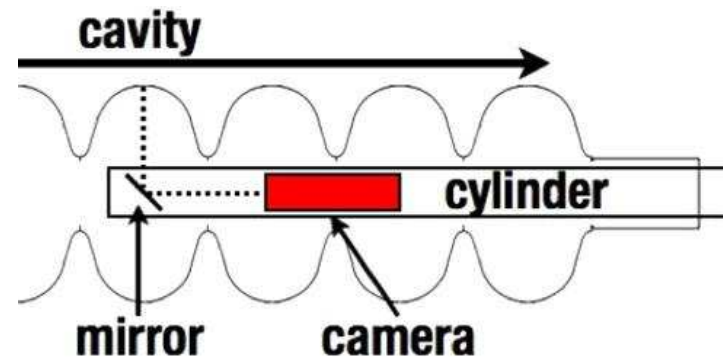
Optical inspection system is designed to study the inner surface of cavities for defects

This includes

- equator welds
- iris welds



Optical camera is used to inspect iris & equator welds



Automation system outline

At present:

- the system performs inspection in **3 hours**
- can work **autonomously**
- still needs some **manual adjustments**

Automation system outline

Main optical inspection program window

The screenshot displays the 'Main optical inspection program window' with two main sections: 'Input' and 'Progress'.

Input Section:

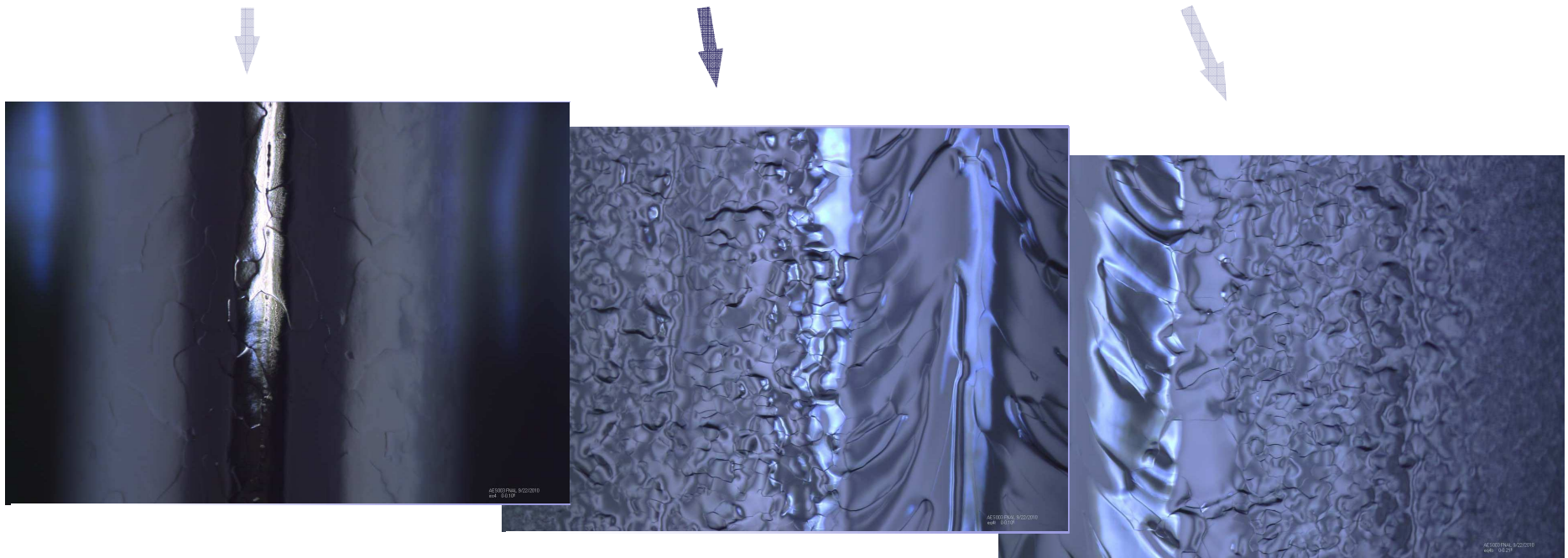
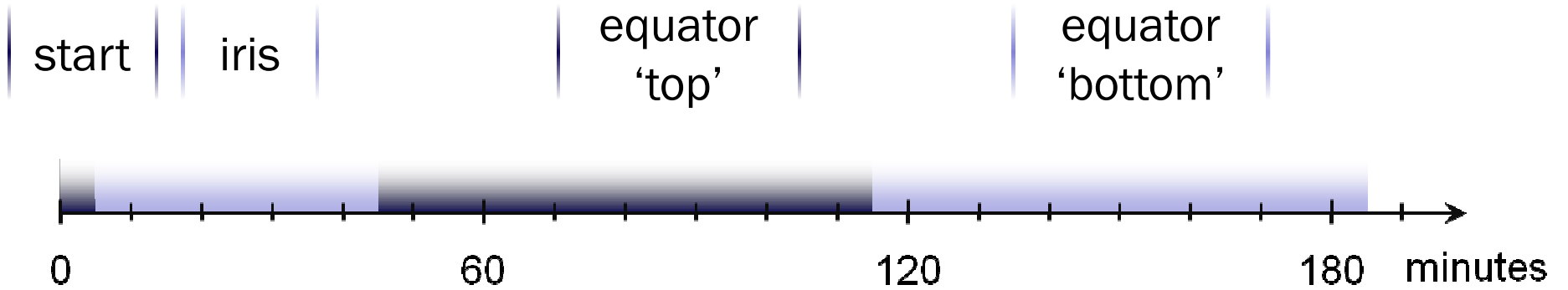
- VISA Table:** A dropdown menu showing '%COM3'.
- VISA Camera:** A dropdown menu showing '%COM5'.
- VISA Omron:** A dropdown menu showing '%COM1'.
- Full turn Omron:** A numeric input field containing '10555'.
- All cells on/off:** A checkbox labeled 'OFF/ON'.
- Cells:** A list of seven checkboxes, each labeled 'OFF/ON'. The first three are unchecked, and the last four are checked.
- path:** A text input field containing 'D:\9-cell cavity' with a folder icon to its right. A note above it says '*cavity name will be added to the path'.
- Cavity name:** A text input field containing 'tb9aes011'.
- equator bottom:** A dropdown menu showing 'equator bottom'.
- Steps per cell:** A numeric input field containing '120'.

Progress Section:

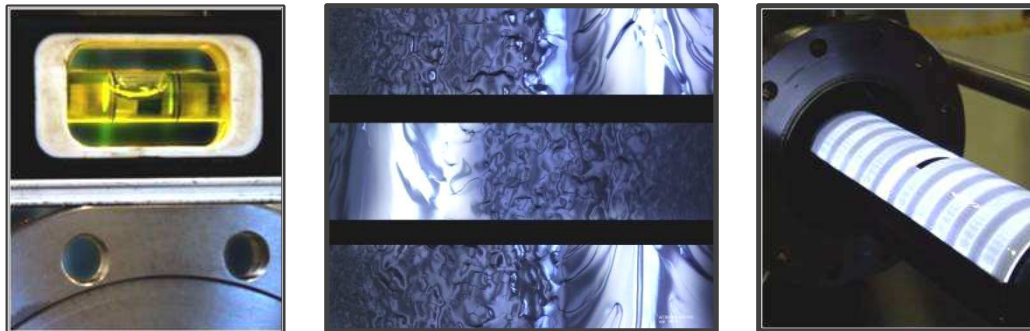
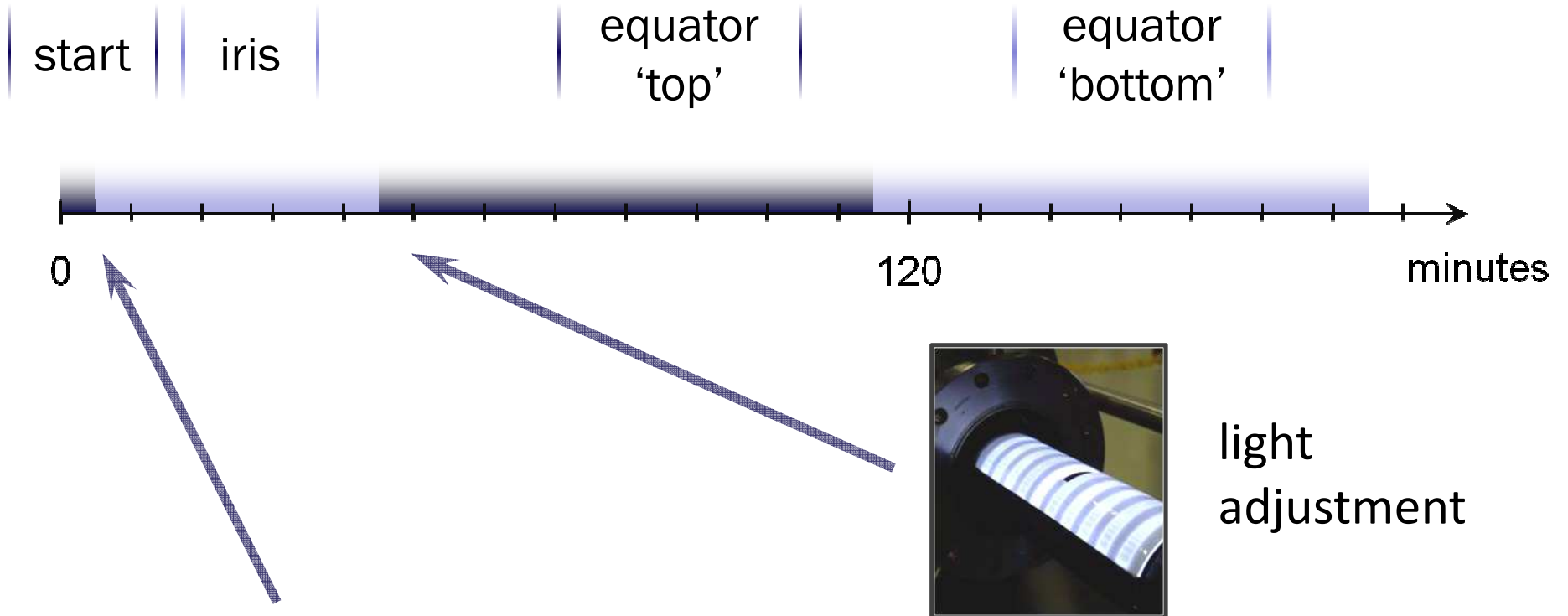
- Step:** A dropdown menu showing '6. Going to 1st cell'.
- Cell number:** A numeric input field containing '9'.
- Degrees:** A numeric input field containing '3.6'.
- Time passed:** A text input field containing '0 h 40 min 30 sec'.

- Initial adjustments for lights, ...
- Various error handling
- Basic LabView functions library for further software development

Optical inspection is four-steps:



Manual adjustments are necessary

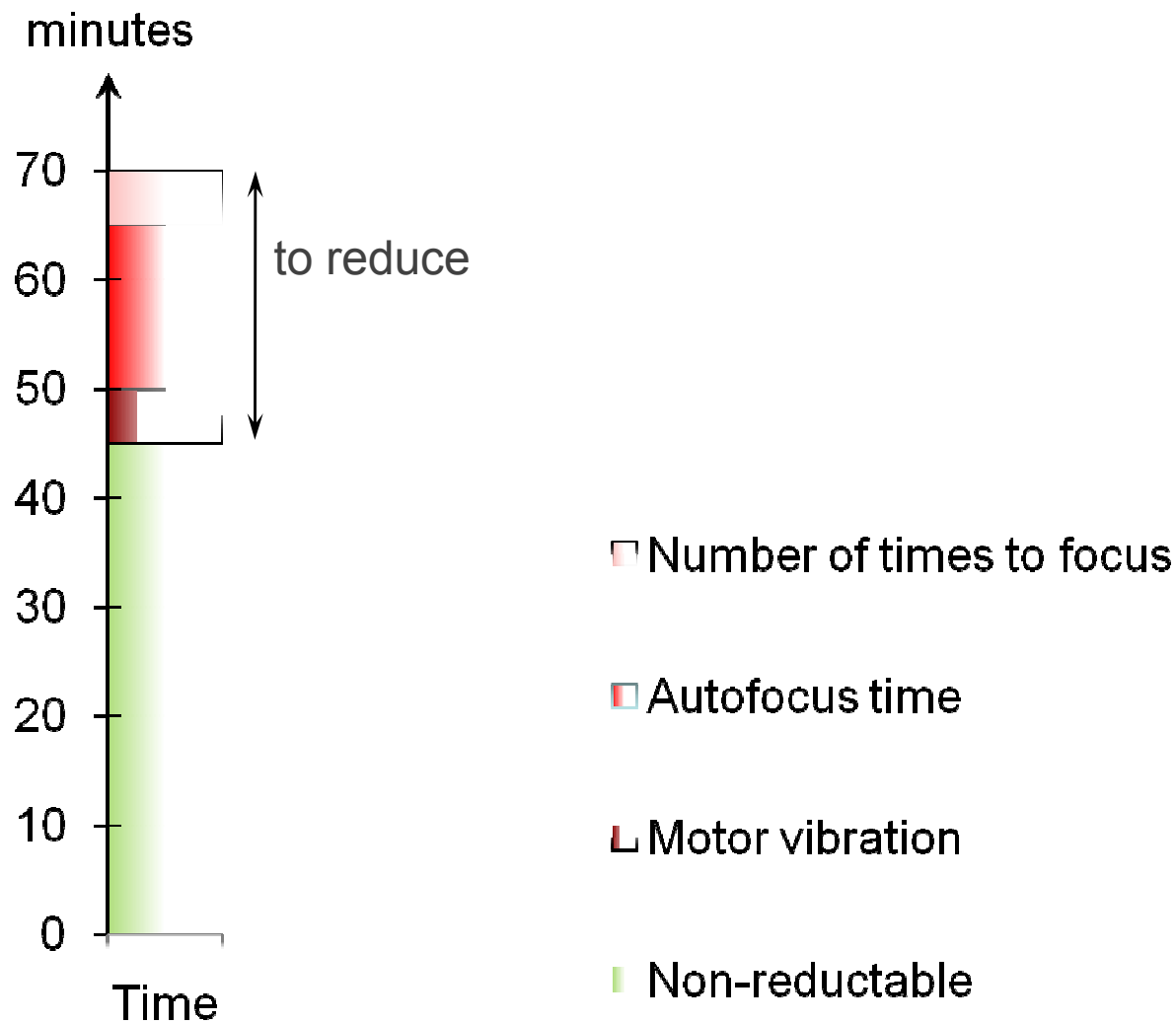


1. horizontal level,
2. wavy equator,
3. light adjustment

Next steps

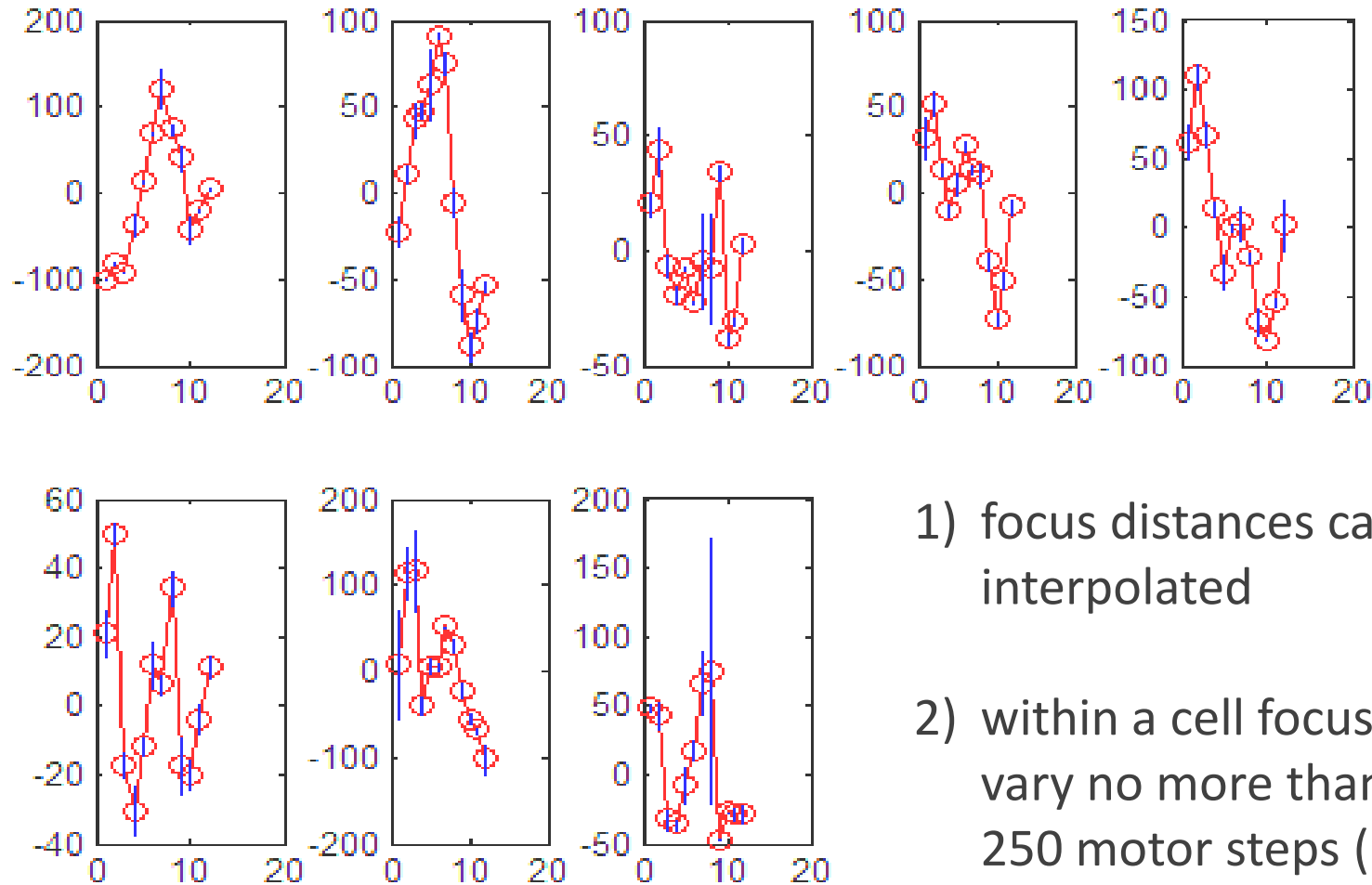
1. Time reduction
(goal: ~2 hours)
2. Automation of light adjustment
3. Working on quality problems
(horizontal level shift, ...)
4. Images processing

There are options for time reduction



1. Reduction of number of times to focus

Focus distances for 8 irises for angles 0-360:

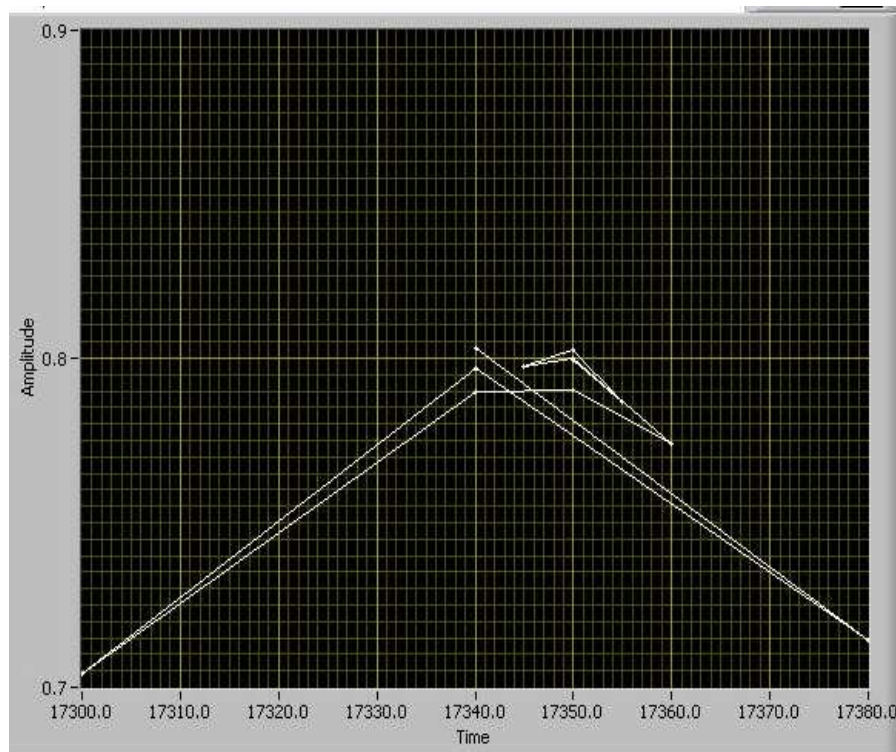


- 1) focus distances can be interpolated
- 2) within a cell focus distances vary no more than by 250 motor steps (1 mm) (while 10 steps are noticeable)

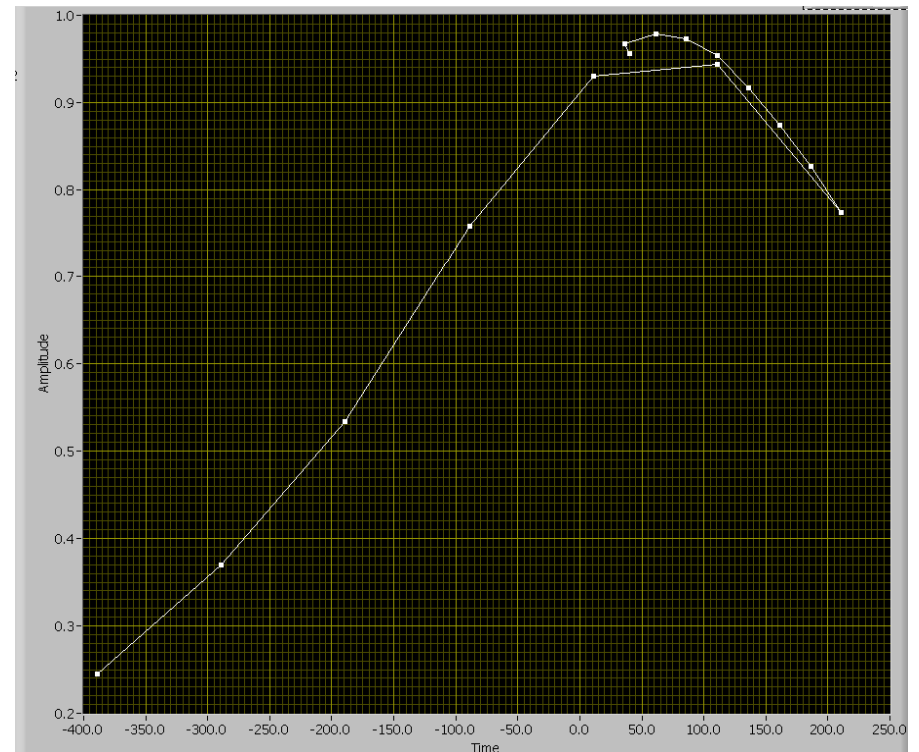
2. Autofocus time reduction

In many cases simple hill-climbing algorithm is too time-consuming because a new focus distance is close to the previous one (left image)

Common hill-climbing case



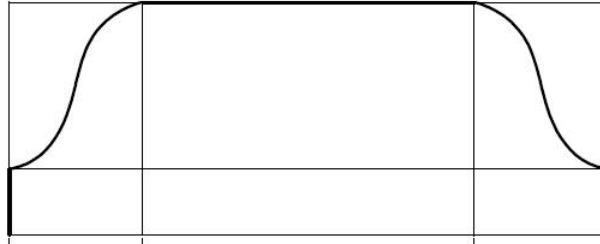
Ideal hill-climbing case



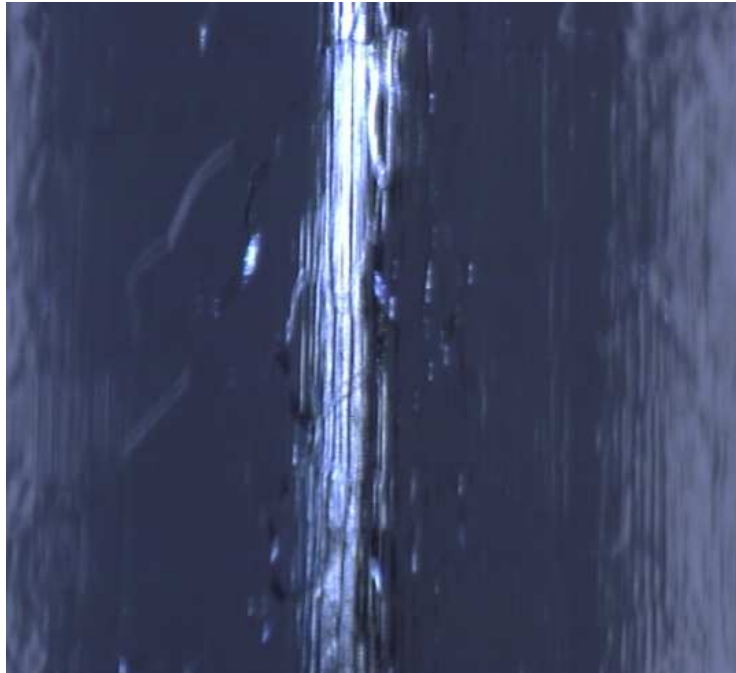
In other cases rough focus adjusting can be made with less steps than at present (right image)



3. Motor vibration effect



Sharp and smooth speed changes result in blurred and clear images respectively



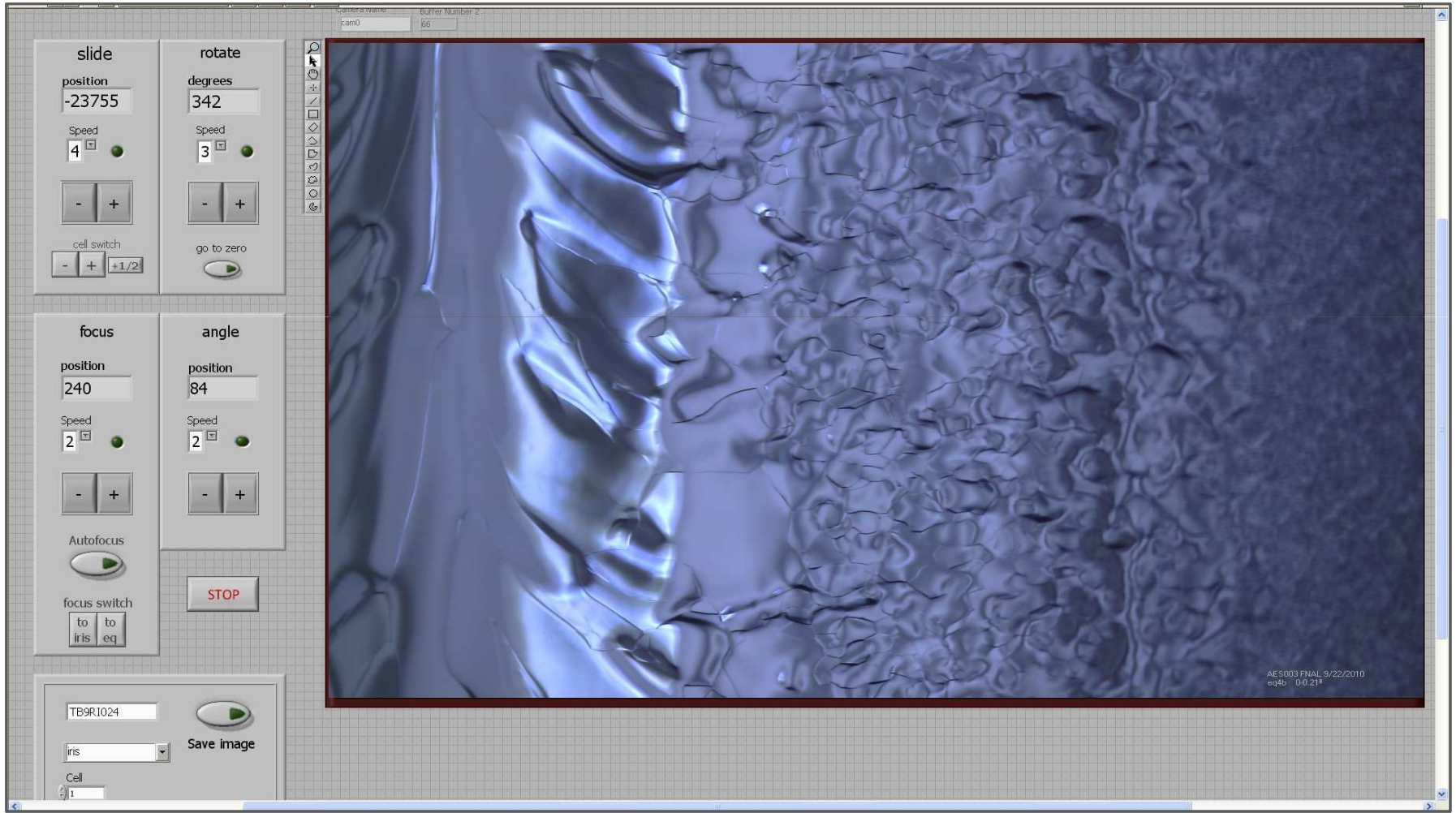
Hence, for the sharp speed function it is necessary to wait 600-1000 ms before taking picture



Q & A

Appendix-1

Control tool - basic



Appendix-2

Control tool - 2

The interface is divided into three main control panels:

- CAMERA CONTROL:**
 - Focus:** Includes fields for 'position to go focus' (0), 'position focus' (375), and '# pulses / step' (500). It features 'GO', 'STEP', and 'Set to ZERO' buttons, along with 'Step UP/DOWN' and 'Autofocus' controls.
 - Angle:** Includes fields for 'position to go' (0) and 'position angle' (0). It features 'GO', 'STEP', and 'Set to ZERO' buttons, along with 'Step UP/DOWN' controls.
- TABLE CONTROL:**
 - Slide:** Includes fields for 'position to go' (0) and 'position slide' (250). It features 'GO', 'STEP', and 'Set to ZERO' buttons, along with 'Step UP/DOWN' controls.
 - Rotate:** Includes fields for 'position to go' (0) and 'position rotate' (0). It features 'GO', 'STEP', and 'Set to ZERO' buttons, along with 'Step UP/DOWN' and 'Precise turn' controls.
- Save Image:** Includes a file name field (TB9RI024), an 'iris' dropdown, a 'Cell' field (1), a 'path' field (D:\Images), and an 'Omron position' field (-1). It features 'Full turn Omron' (10505) and a 'Save image' button.

At the bottom, there are motor selection dropdowns: 'Camera motor' (%COM5), 'Table motor' (%COM3), and 'Omron' (%COM1), along with a red 'STOP' button. A status bar at the bottom left shows 'Camera Name: cam0' and 'Buffer Number 2: 706'. A video feed window is visible at the bottom of the interface.