

# **Entwicklung eines Strahlkamarasystems zur Analyse von Ionenstrahlen**

Development of a Beam Camera System for  
the Analysis of Ion Beams

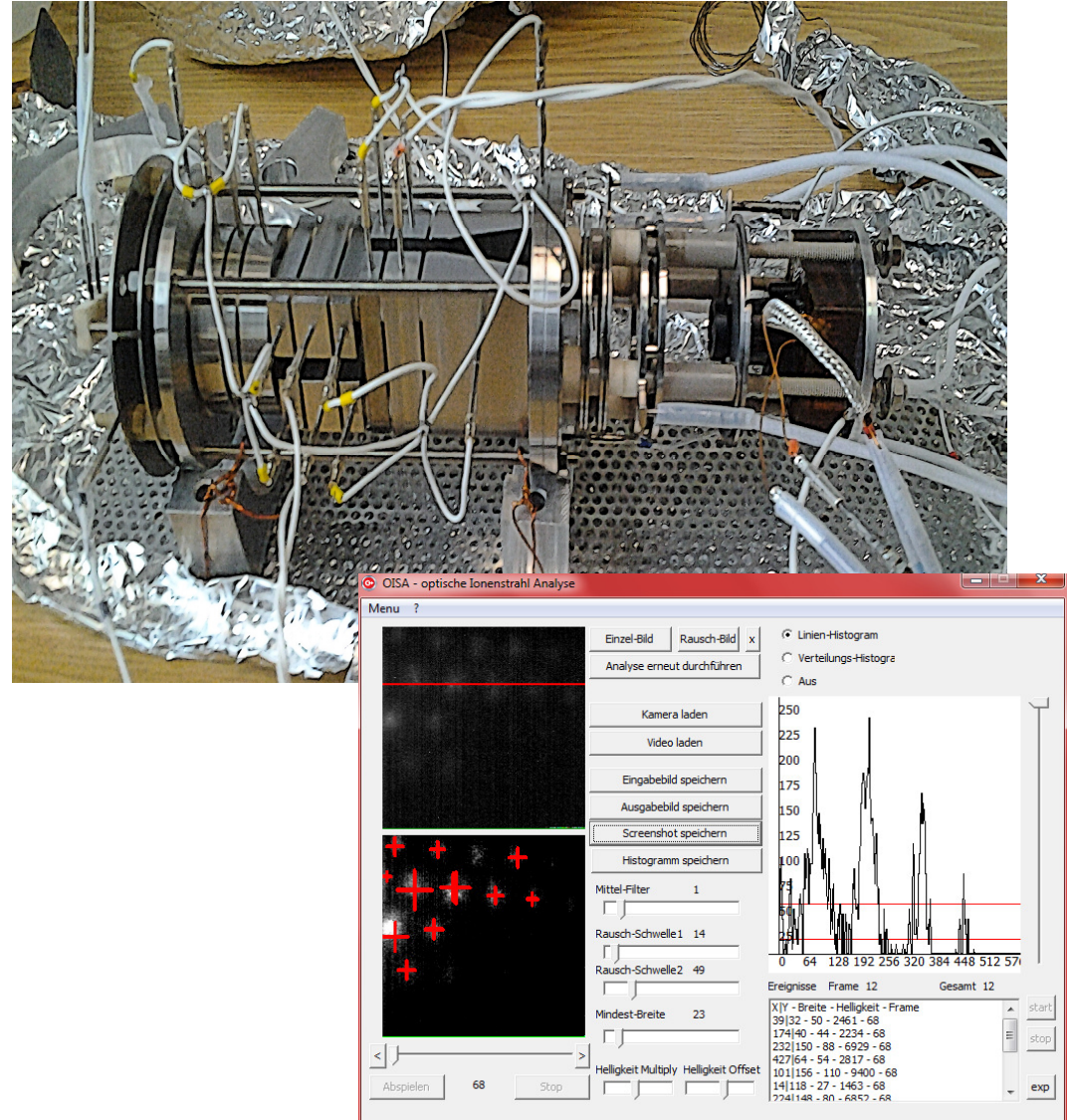
Bachelor-Thesis, Julian Bergmann, 2012

# What has been done

Within the Ion Beam Camera a new digital camera sensor has been bought and integrated.

A software to control the camera and analyze its output has been developed.

The System has been tested within a vacuum for Ion Beam and Single Ion detection.



# Benefits of the new camera sensor

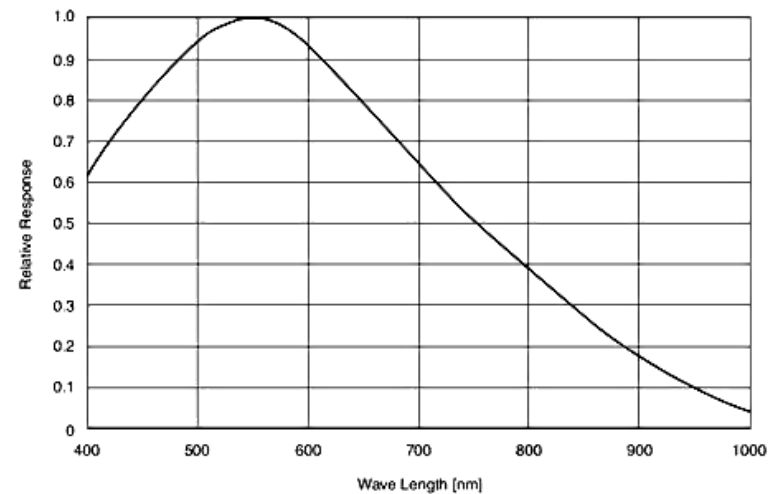
The new sensor has a luminosity of 0.005 lux

The signal is transported digital now → less noise

The camera's settings are changeable while it is working within the vacuum (Shutter speed, Gain)

The Sensor uses only 1.3 W and is powered and controlled via USB2 (5V)

It was possible to get a higher vacuum ( $2.2 \times 10^{-8}$  mbar instead of  $3 \times 10^{-8}$  mbar )

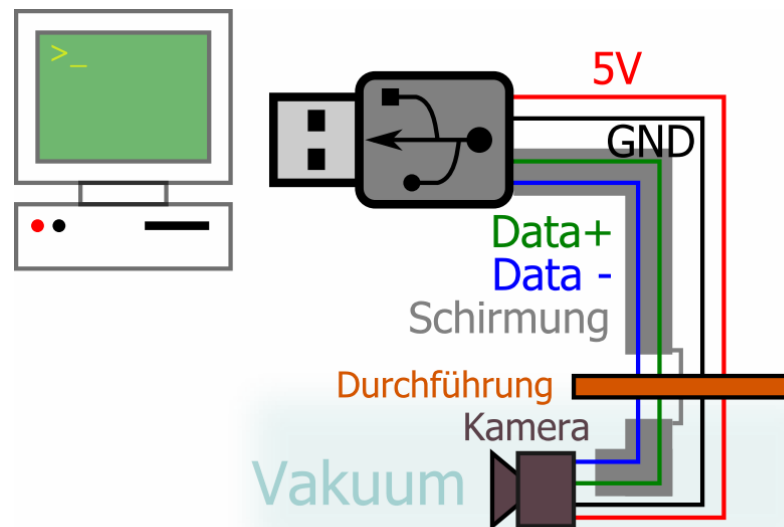
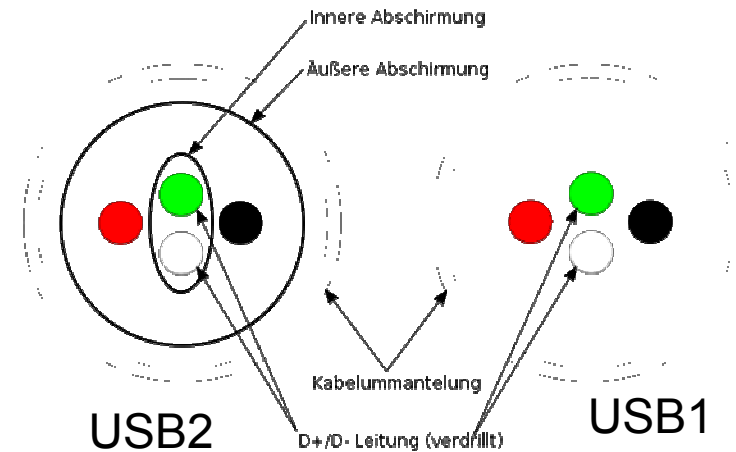


# Modifications made on the new camera sensor

Embedding the sensor within a plastic-block onto a aluminum-plate

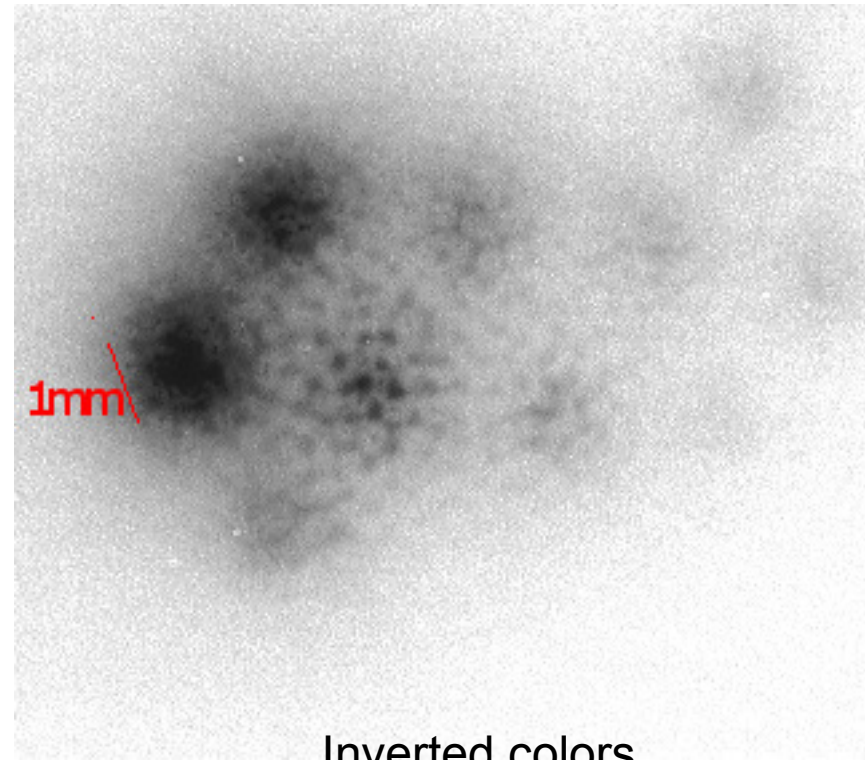
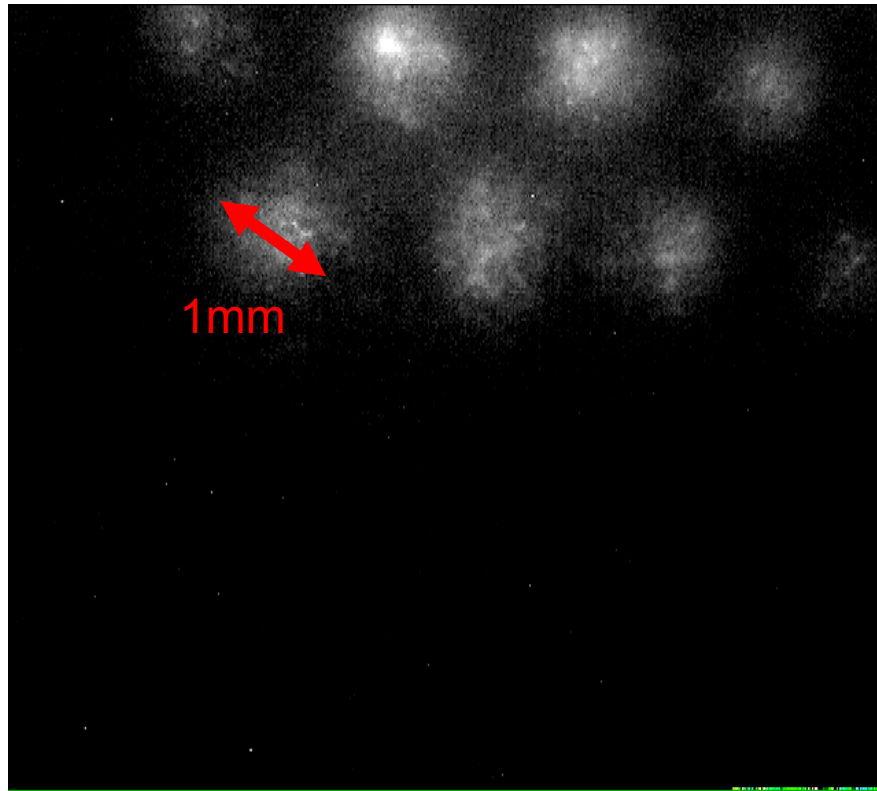
Soldering cables onto the sensors electric contacts

Shielding the cables to ensure USB2 speed



# Camera sensor pictures

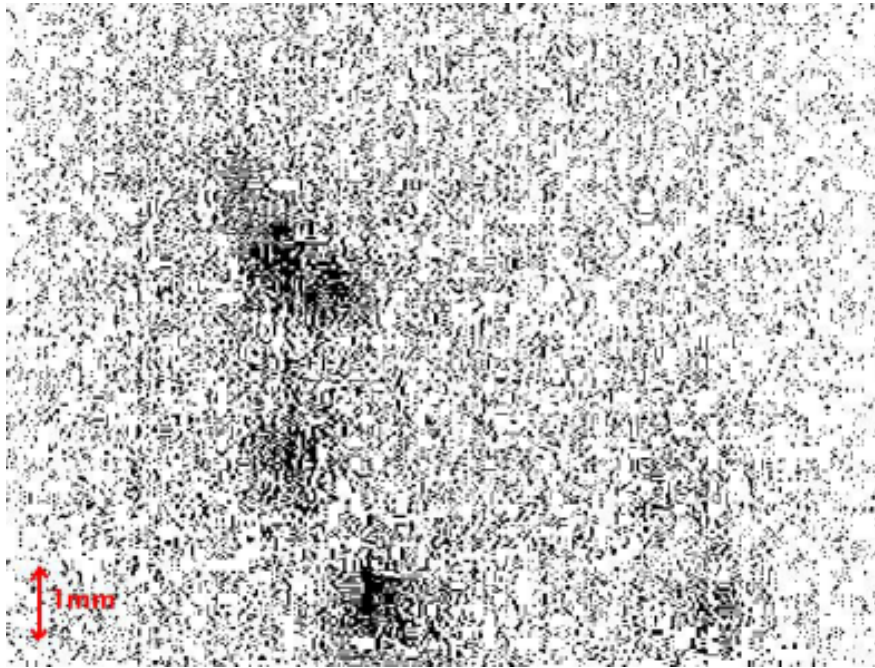
Pictures of the new beam camera system of a  
ion beam coming through a 1 mm grate



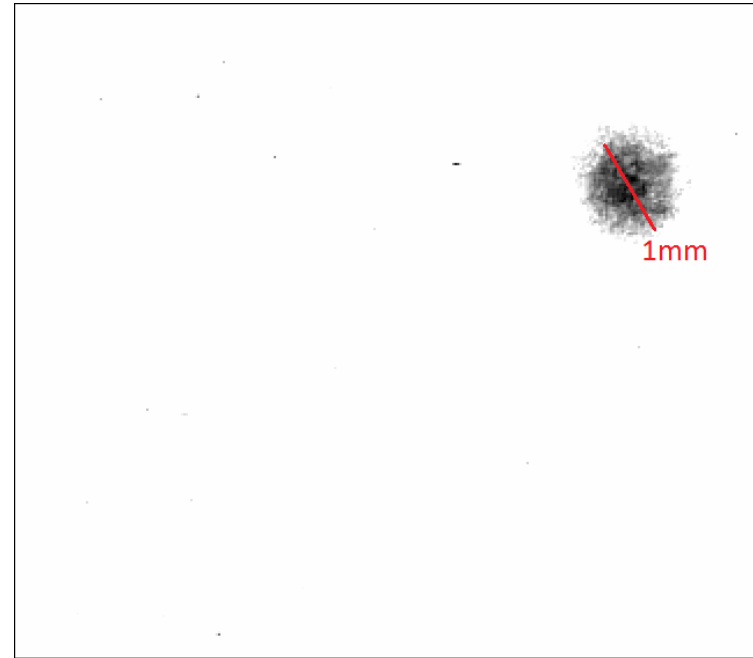
Inverted colors

# Camera sensor pictures

Comparison with the old beam camera system  
(single ion detection, inverted colors)



Old system

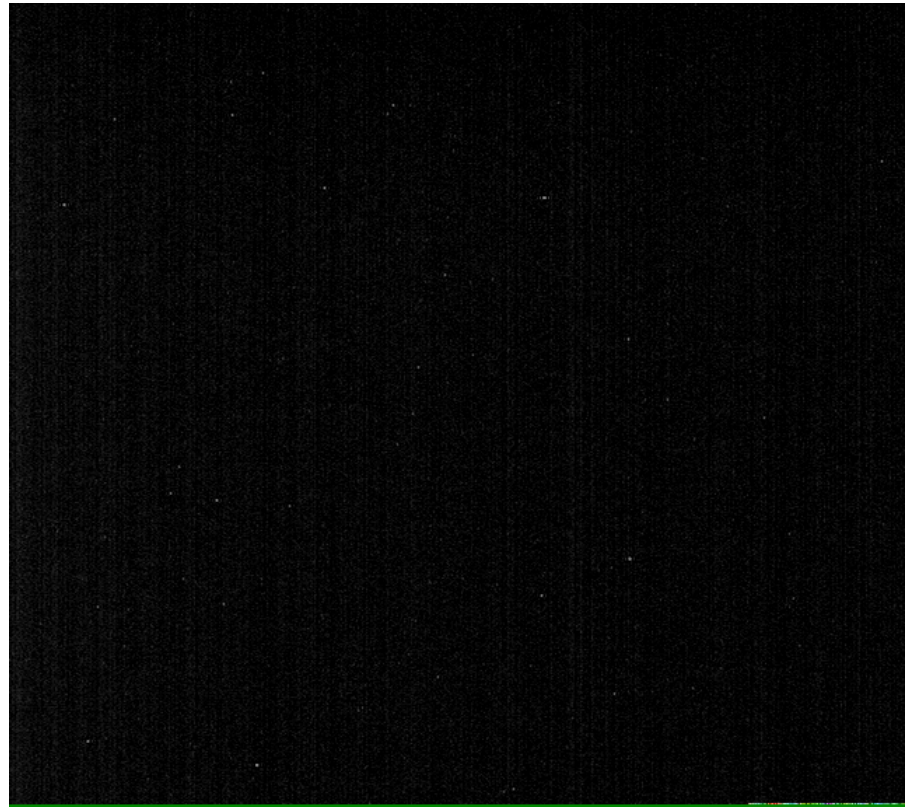
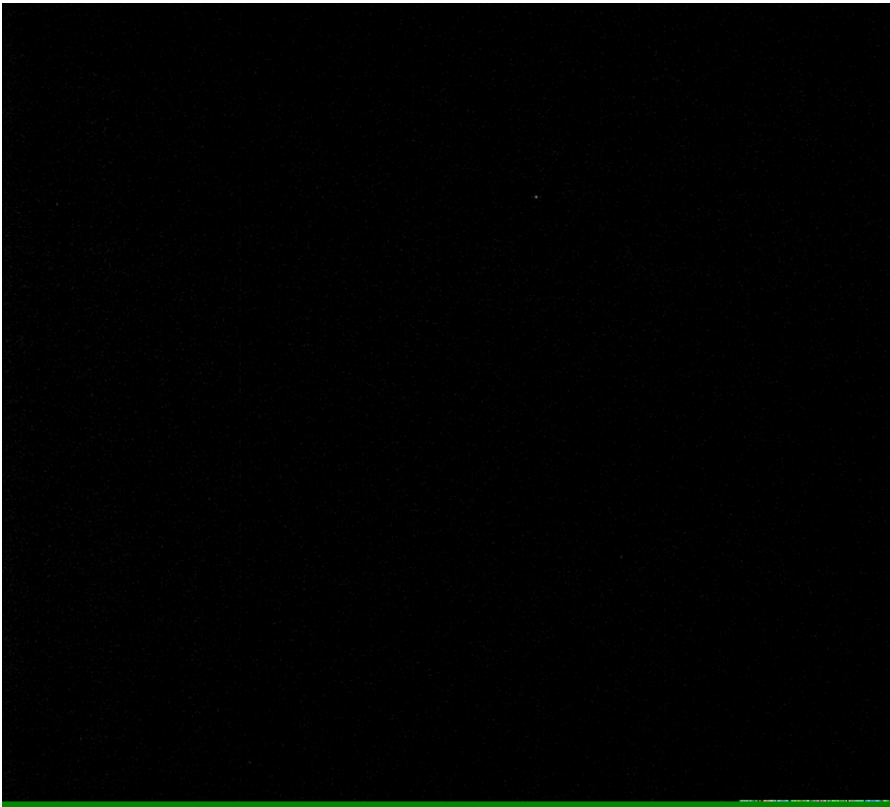


New system



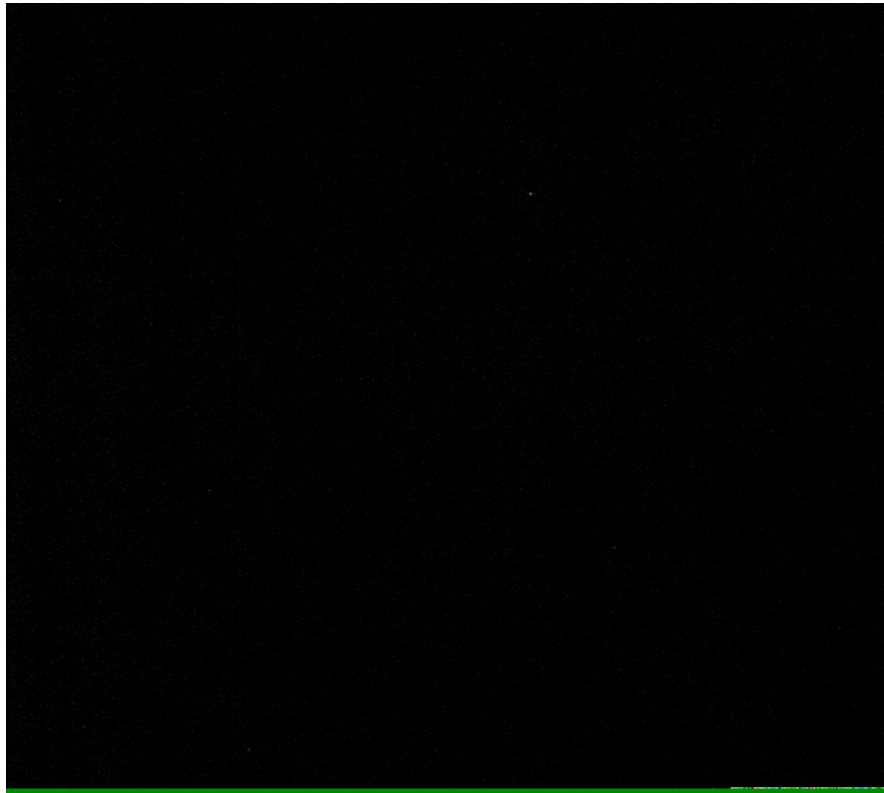
## Camera sensor pictures

After using the system for an hour slowly faint vertical lines appears.  
After disconnecting the sensor for 5 minutes they disappeared again

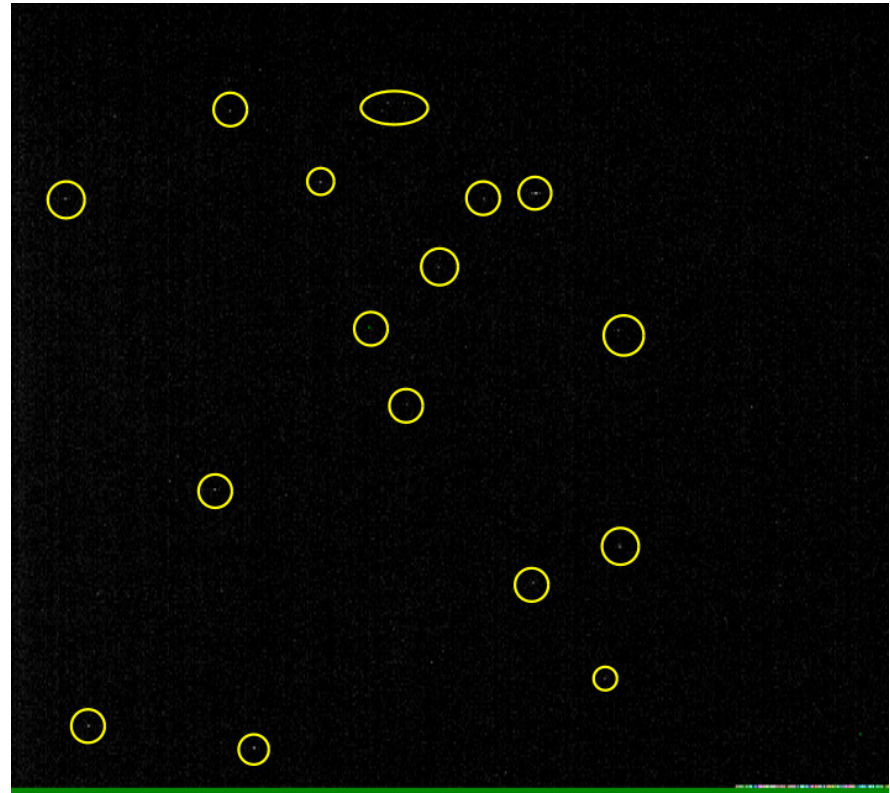


# Camera sensor pictures

Depending on shutter speed, single bright pixel showed up



Shutter speed  $1/500\text{s}$



Shutter speed  $4/25\text{s}$



# Software OISA

## Optische Ionen-Strahl Analyse

Source Picture  
(The red line determines the source of histogram)

Corrected Picture  
(red crosses show the currently detected signals)

Time navigation for video mode

Selecting source and noise-sample

Save one of shown pictures

Mode of shown histogram

Histogram picture

List of detected Signals

Picture correction and analysis settings

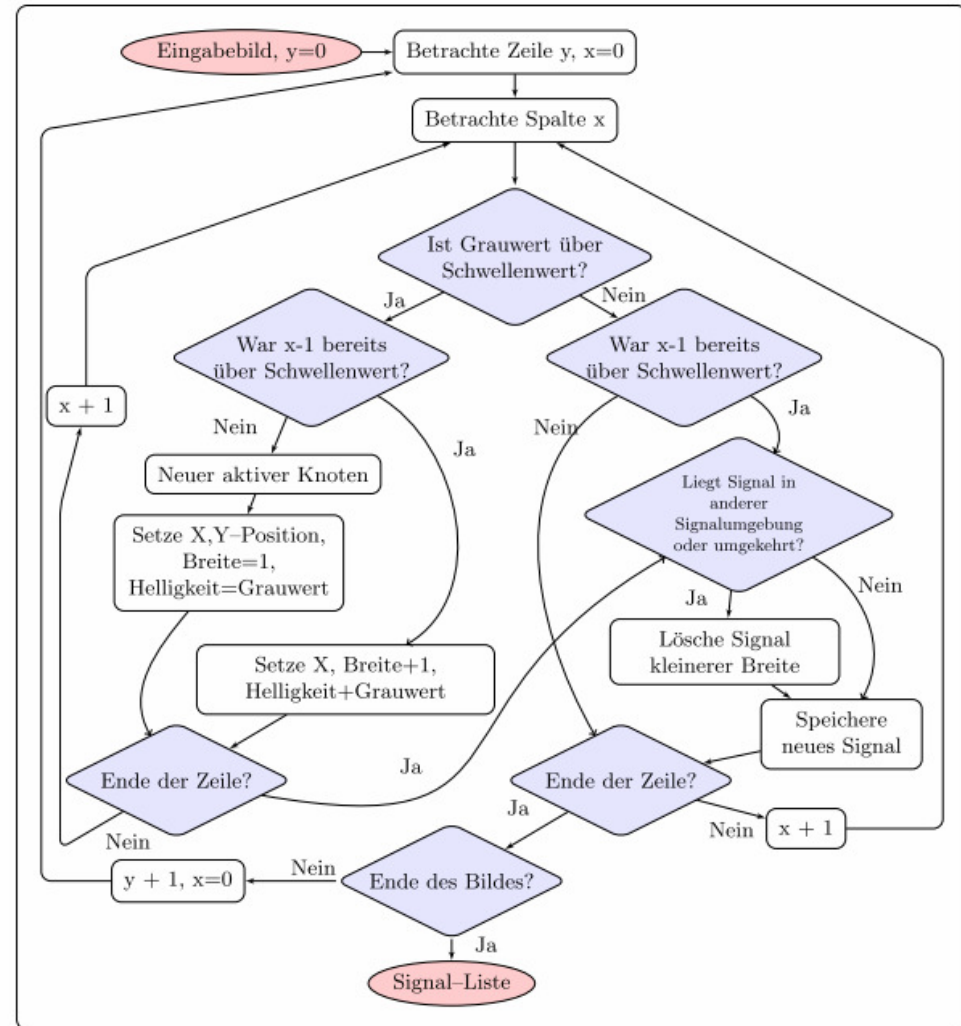
The screenshot shows the OISA software interface with the following components and callouts:

- 1**: Menu bar
- 2**: Buttons for 'Einzel-Bild', 'Rausch-Bild', and 'x' (close)
- 3**: Buttons for 'Kamera laden' and 'Video laden'
- 4**: Checkboxes for 'Eingabebild speichern', 'Ausgabebild speichern', 'Screenshot speichern', and 'Histogramm speichern'
- 5**: Settings for 'Mittel-Filter' (set to 1), 'Rausch-Schwelle1' (40), 'Rausch-Schwelle2' (50), and 'Mindest-Breite' (15)
- 6**: Source Picture (raw image)
- 7**: Corrected Picture (image with red crosses)
- 8**: Time navigation controls (play, stop, and a counter set to 0)
- 9**: Histogram mode selection (radio buttons for 'Linien-Histogramm', 'Verteilungs-Histogramm', and 'aus')
- 10**: Histogram picture (line graph)
- 11**: List of detected signals (table with columns: X|Y - Breite - Helligkeit - Frame)

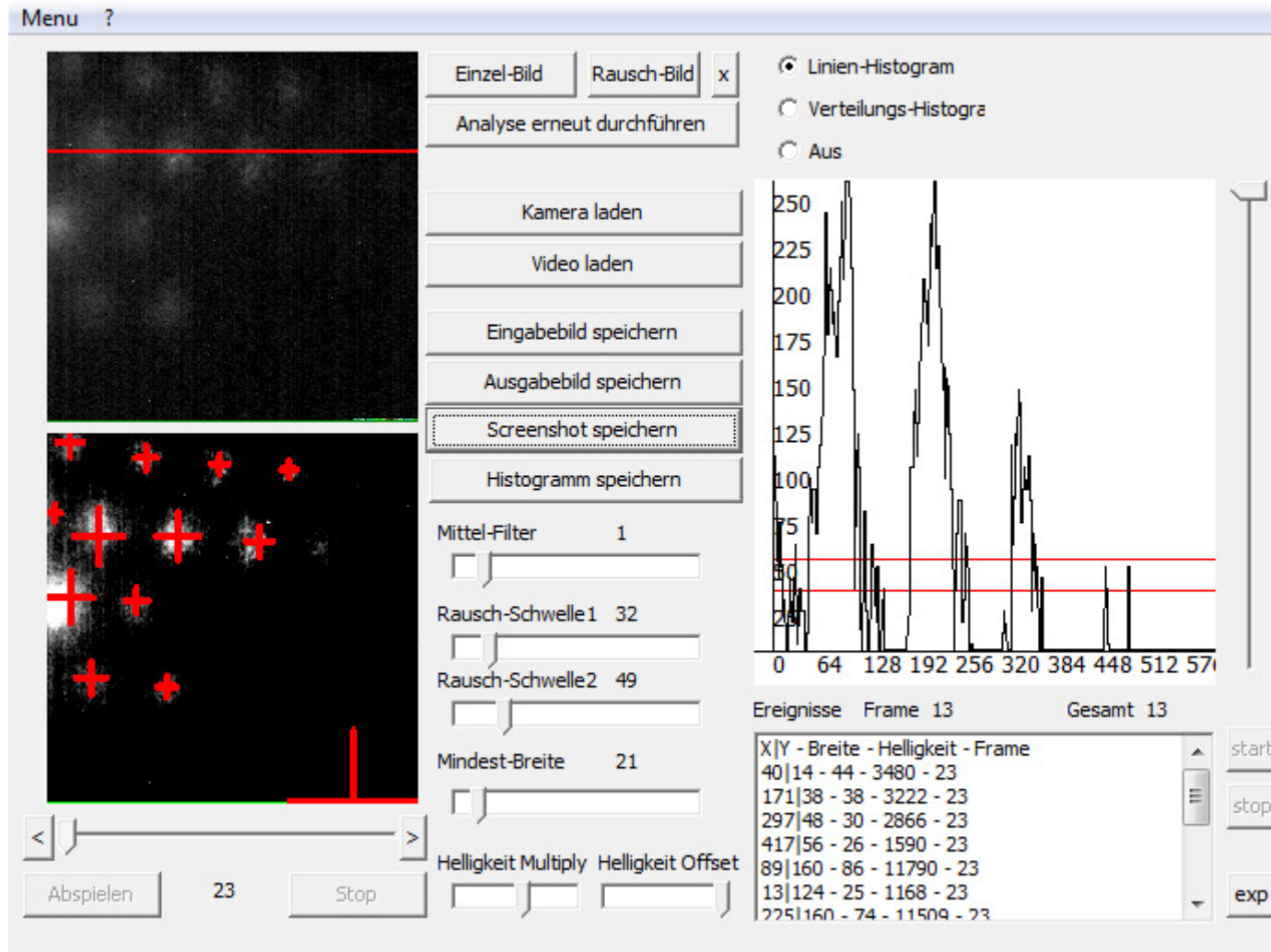
X Y - Breite - Helligkeit - Frame
289 40 - 94 - 19250 - 0
419 62 - 86 - 14613 - 0
554 52 - 36 - 3754 - 0
205 150 - 74 - 8849 - 0
176 138 - 20 - 1600 - 0
350 168 - 76 - 12136 - 0
485 174 - 47 - 4684 - 0

# Software OISA – Signal detection

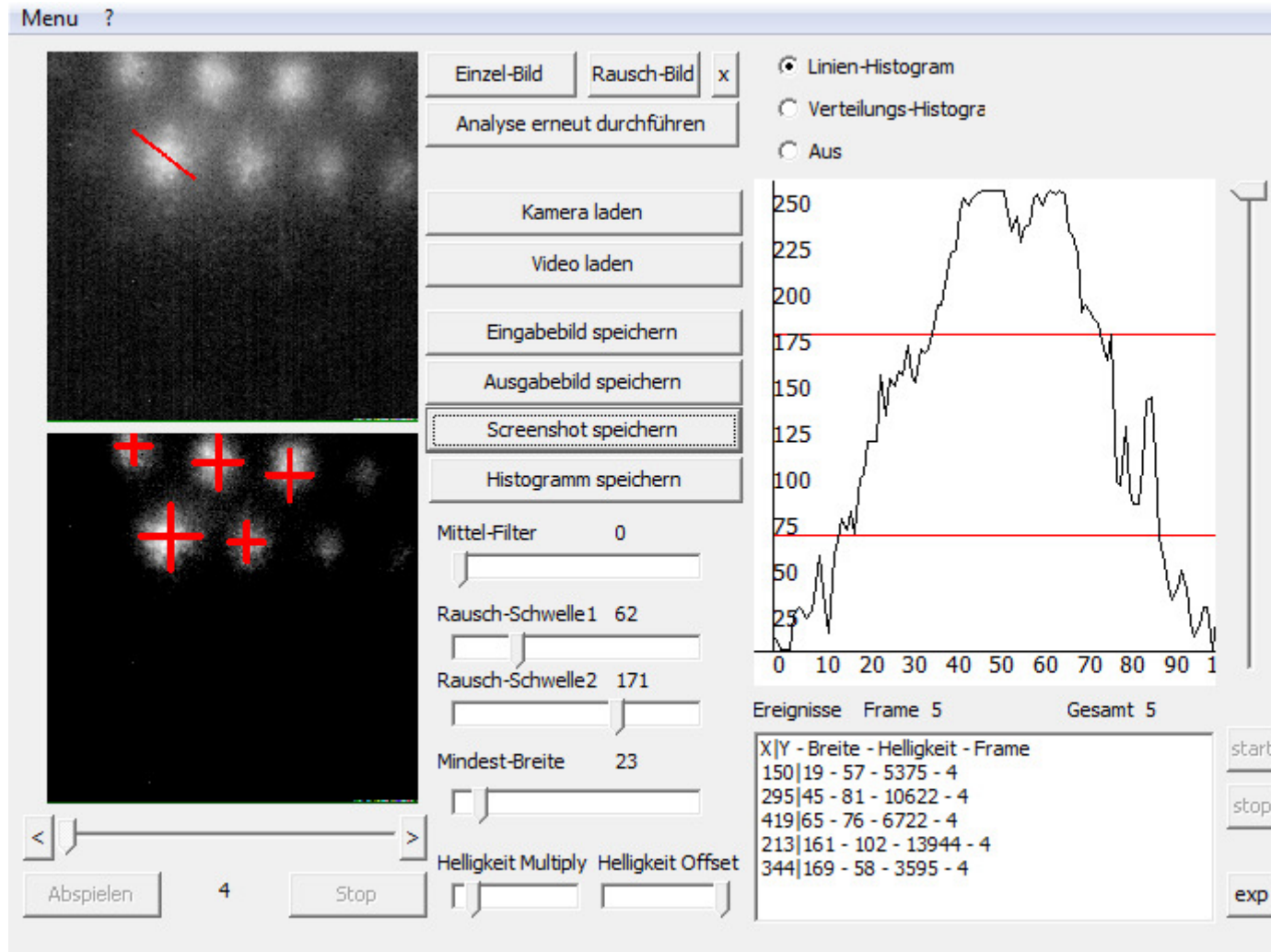
1. Scan every line for brightness over a certain constant
2. If it is over, uncrease a counter for the length/width of signal
3. Sum up the brightness of the pixel for signal-brightness
4. If the brightness is under the set constant, “finish” the signal and save its properties
5. Search for already finished signals that are within the signal’s area
6. If one is found, the current detected line is part of this signal. Delete the saved signal with smaller width then



# Using the beam camera system



# Using the beam camera system



# Tasks and future applications

Currently the system is able to...

- detect a signal and show its position, size and brightness
- use videos or a camera as source
- save pictures automatically to hard disk
- show histograms for a custom defined range
- generate a list of signals detected within a custom time

Later it is planned to be connected to a peltier-cooling and integrated into the Ambiprobe-MR-TOF-MS to enhance the ion beam guiding and a better phase advancing.