Mimosa 26 performance with laser

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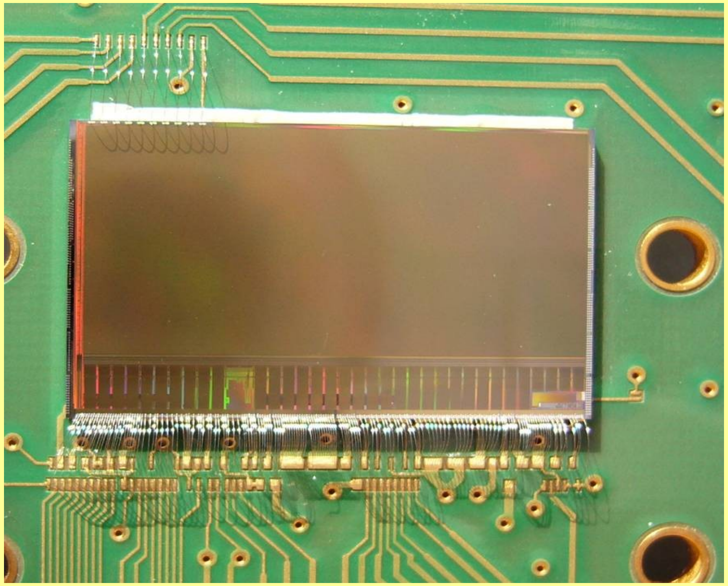
PLUME phone call, 11 January 2012

Mimosa 26



- Monolitic active pixel sensor with fast binary readout
- the device fabricated in a standard 0.35 μm CMOS process
- size 13.7 mm x 21.5 mm, 576x1152 pixels of 18.4 μm pitch
- thickness of the epitaxial layer is 14-20 μm (depending on chip version)
- integrated zero suppression
- on-pixel amplification and double sampling operation
- one discriminator per column

Mimosa 26

Three readout modes:

• normal mode → digital data after zero suppression

• two digital test modes:

- reading one line during each integration period
- automatic scanning of the 576 lines, one per integration time

• two analogue test modes:

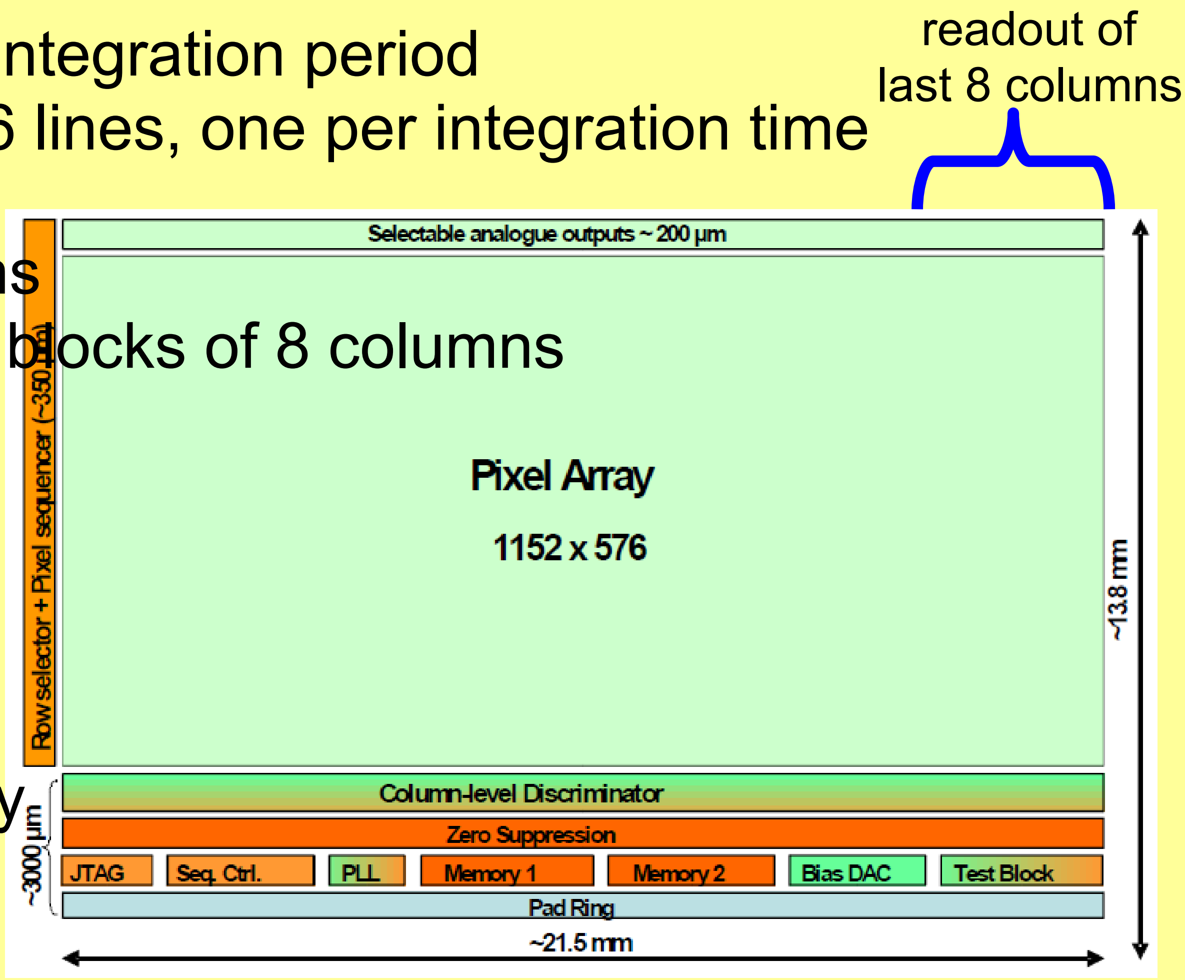
- readout of rightmost 8 columns
- scanning the whole matrix by blocks of 8 columns

Two clock frequencies:

• 80 MHz (nominal)

• 20 MHz (for analogue tests)

The readout time of last 8 columns at nominal frequency is 115 us



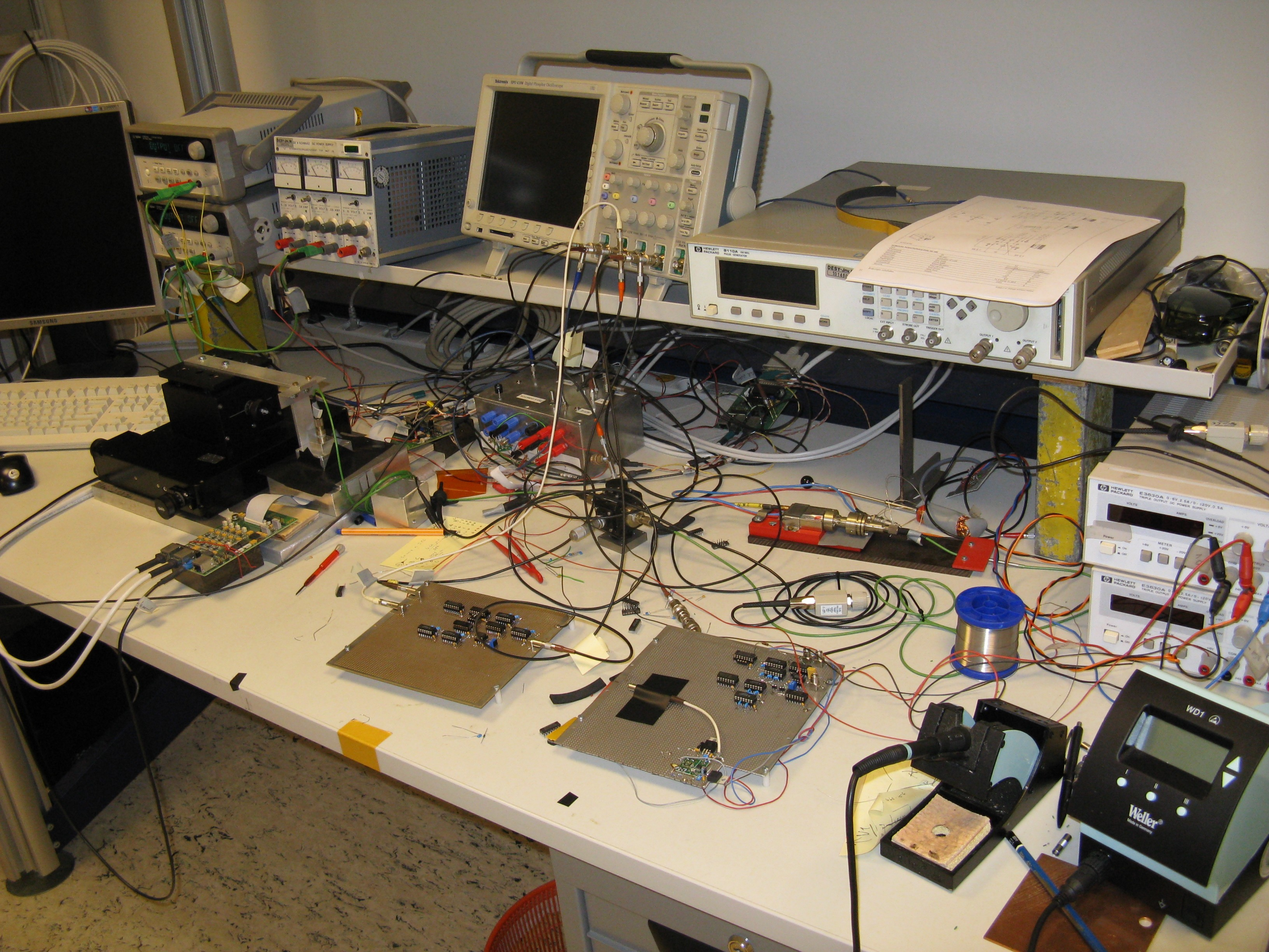
Laser

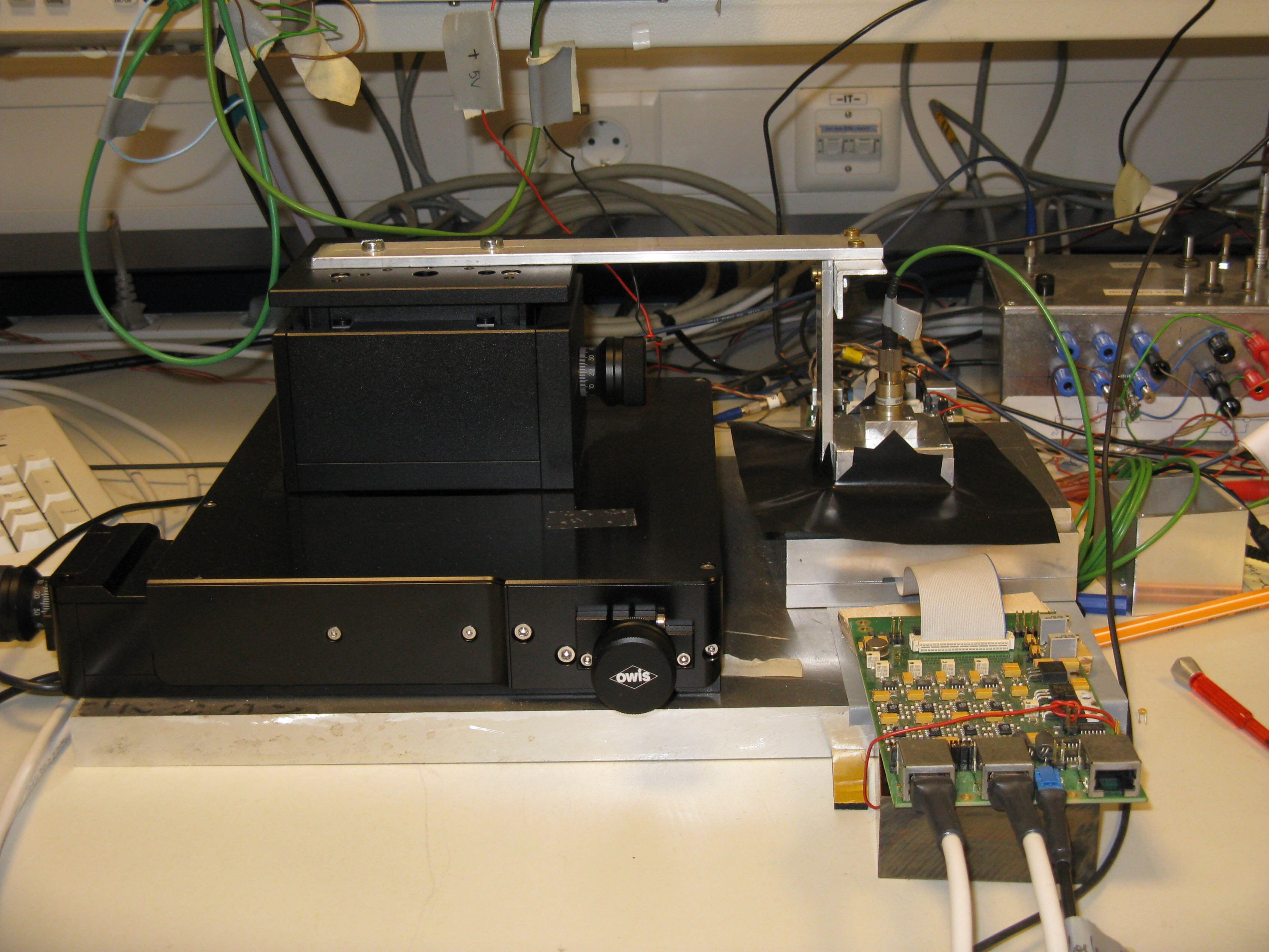
Advantages of sensor studies using laser shots in comparison to studies with the radioactive source (Fe-55):

- possibility to set exact position of the beamspot (and even vary it within one pixel)
- possibility to change shots frequency and intensity $\rightarrow$ study timing performance of the sensor

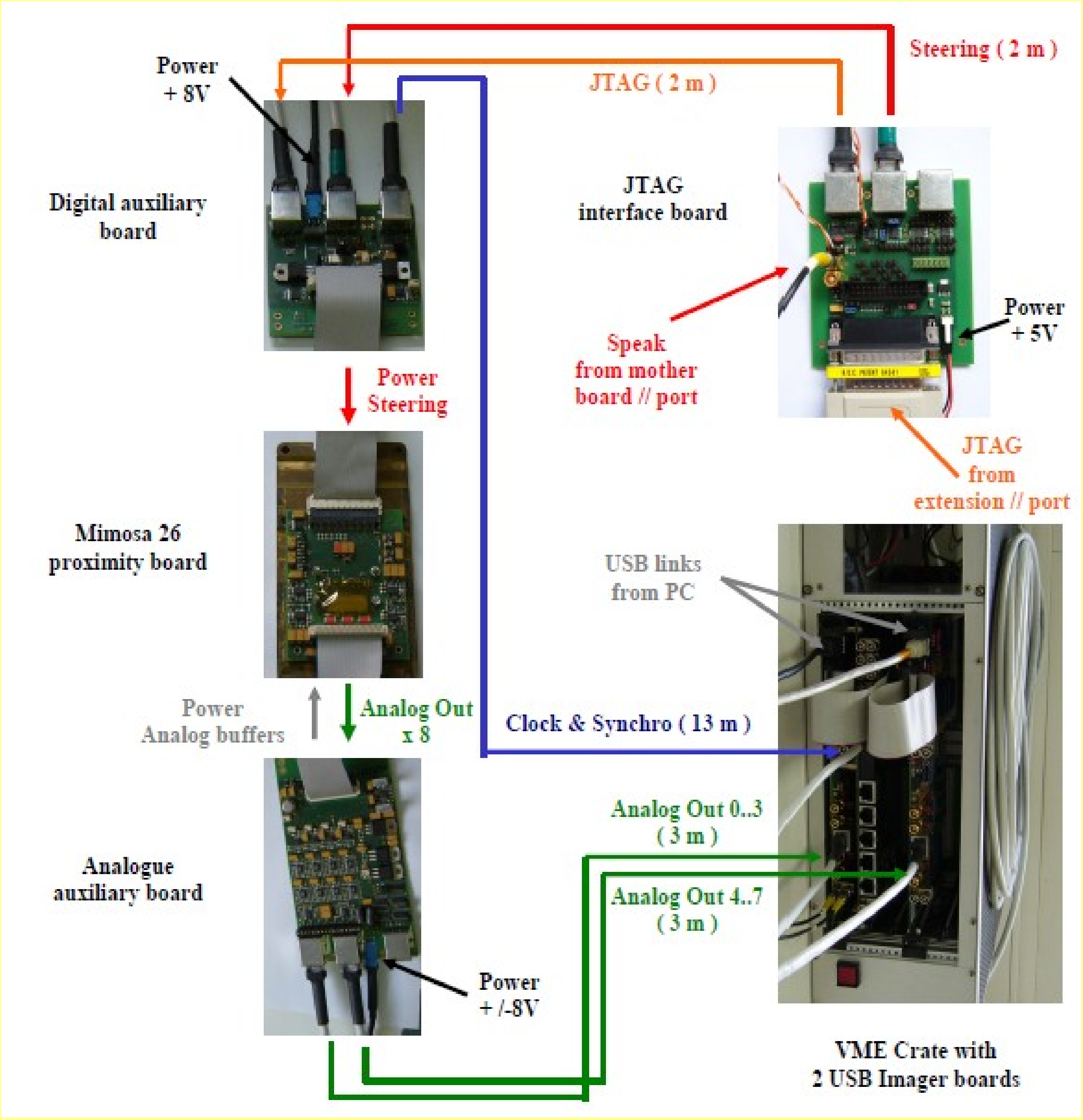
Characteristics of the used laser: $\left(\textit{specified by manufacter} \right)$

- wavelength: 904 nm (absorbtion length in silicon: ~25 um)
- bandwidth: 3.5 nm
- pulse duration (FWHM): 10 ns
- rise time: ≤ 1 ns, fall time: ≤ 18 ns
- max. impulse frequency: 10 kHz for full power, 20 kHz for half-power
- collimator:
  - focal length: 20.1 mm
  - diameter of focused beam: ≈ 5 um
  - mounted on precision stages, scale division is 10 um for horizontal movements and 5 um for vertical


SAMSUNG
HEWLETT PACKARD
8110A
E3630A
WD1
Weller


+ 5V
-IT-
owis

Hardware

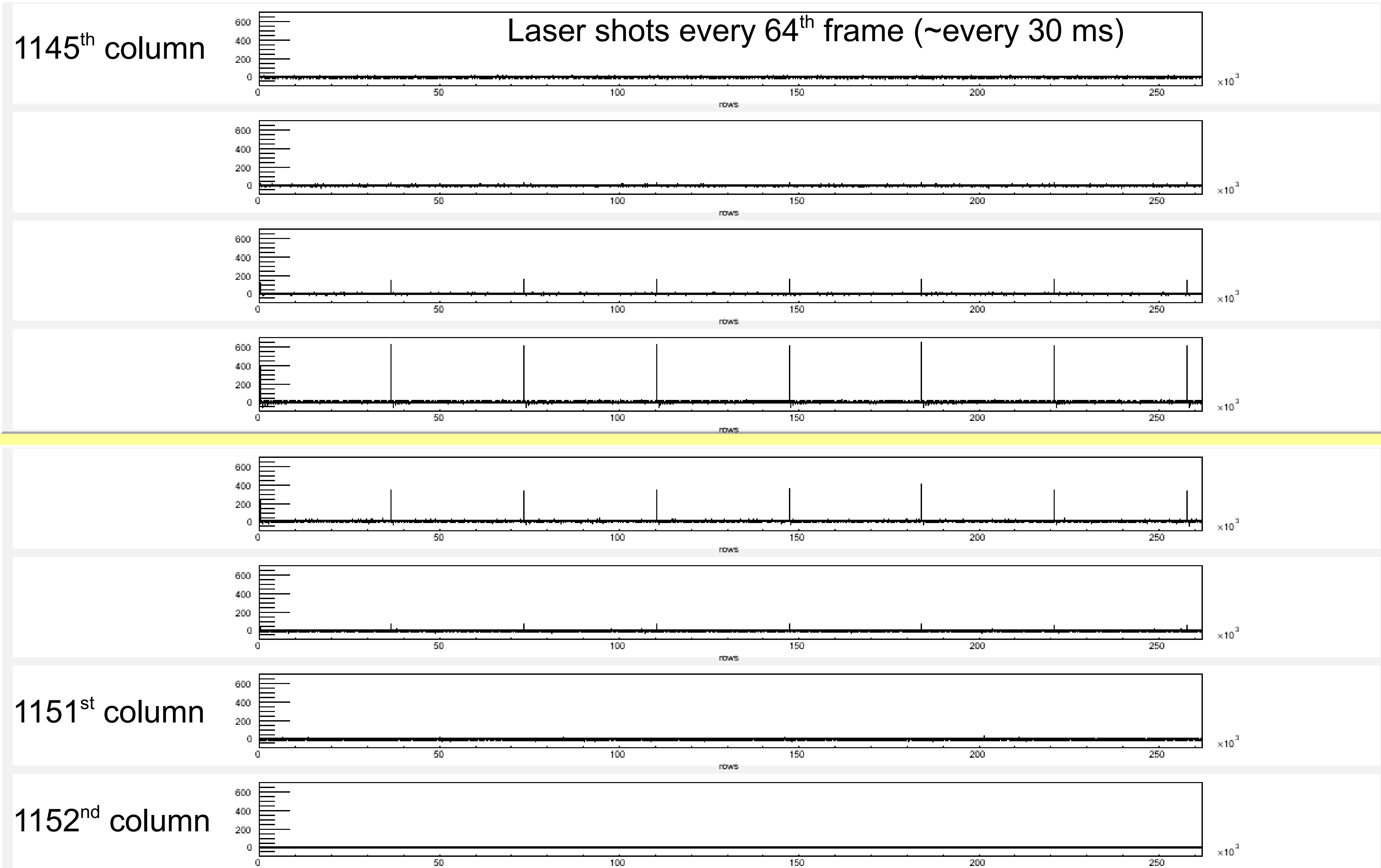


20 MHz clock

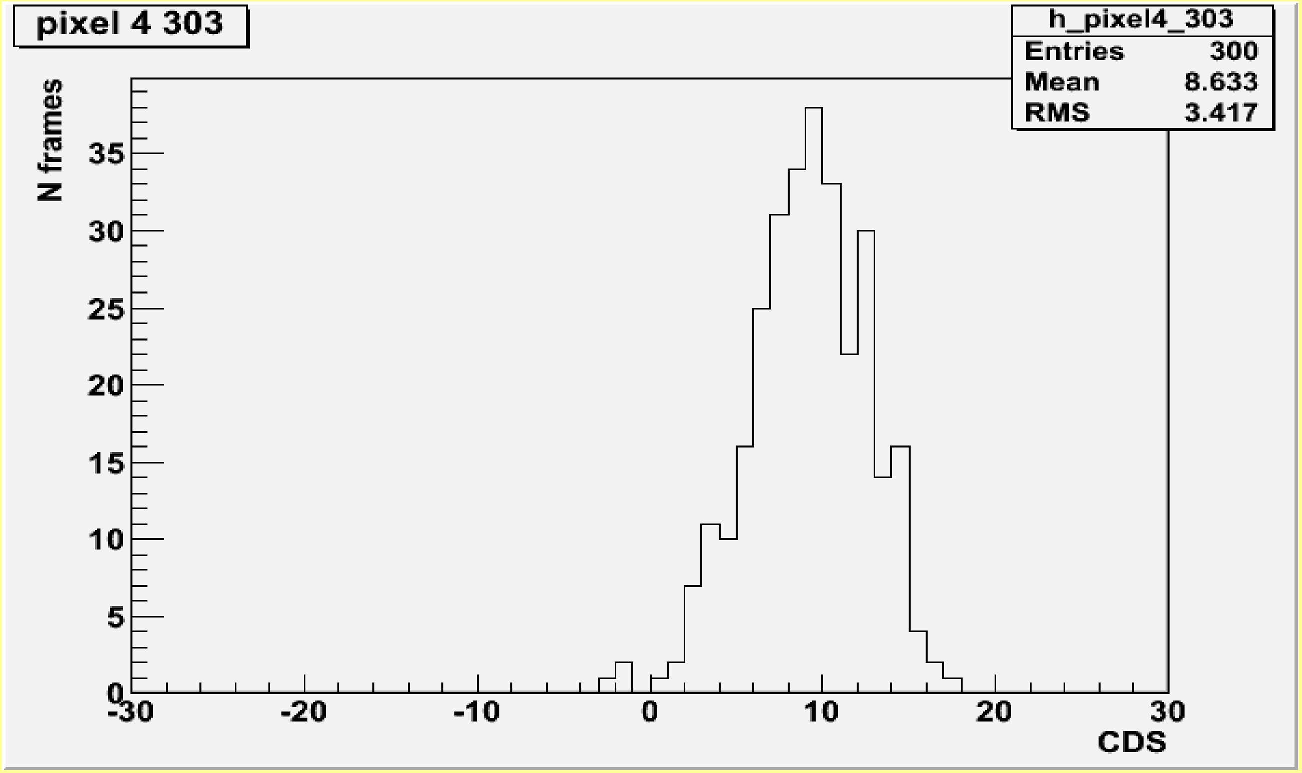
Two USB imager boards
on VME crate:
readout cycle 455 frames
(209 ms)

Results

Signal in different columns



Distribution of noise in single pixel

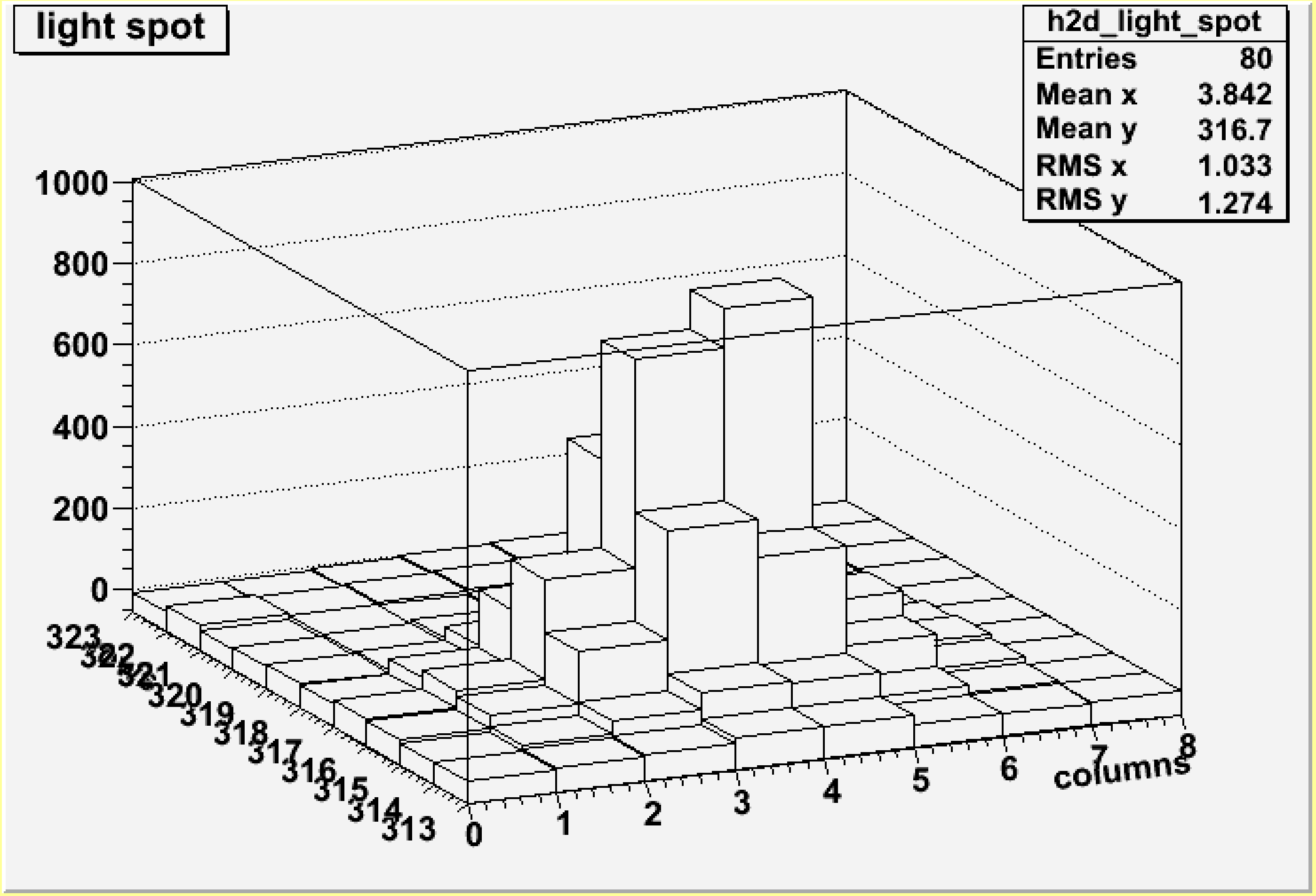


pedestal $= 8.6$, sigma $= 3.4$

on the following plots pedestals are subtracted

(it is taken, that there is a signal in pixel if its amplitude is greater than pedestal + 3sigma)

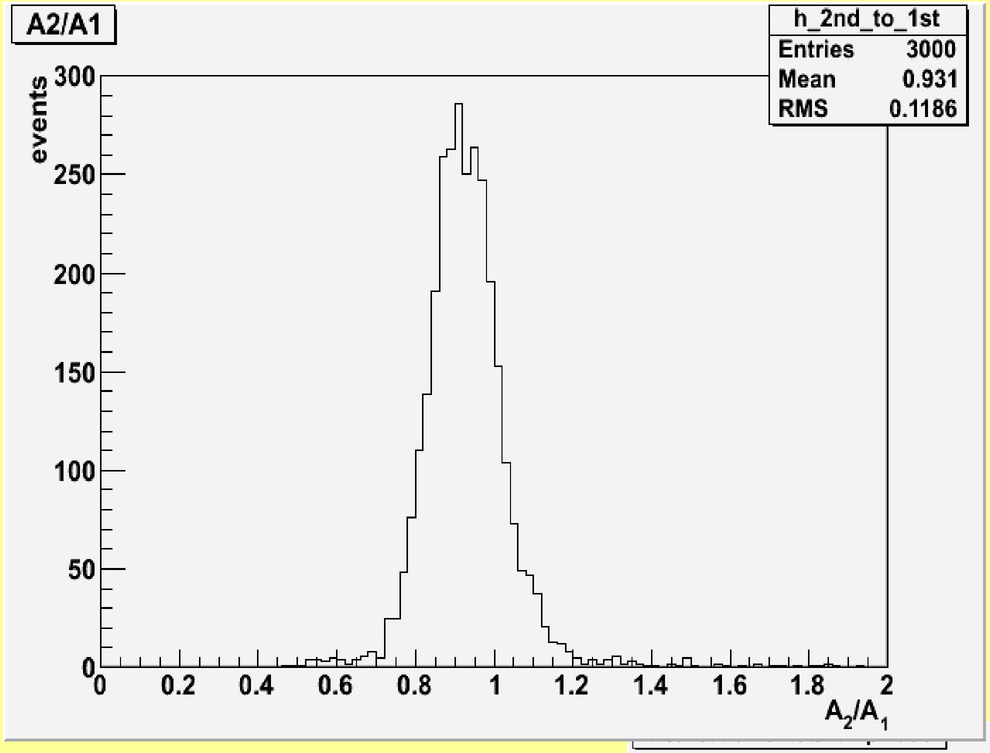
Light spot

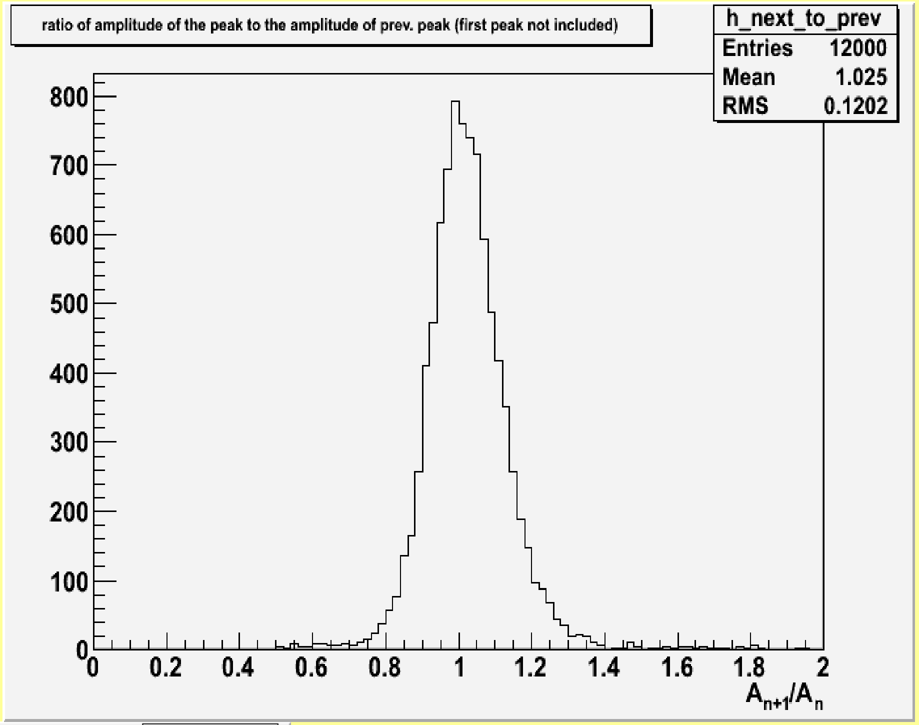


- response on single laser shot is shown
- signal mainly contains in ~3x3 cluster

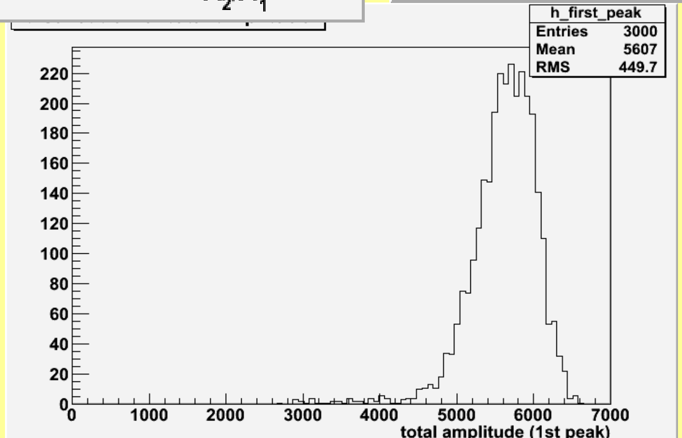
A_2/A_1

Ratio of responce to 2nd laser shot to responce to 1st laser shot at high intensities of the laser is smaller than 1 (goes down to about 0.9)

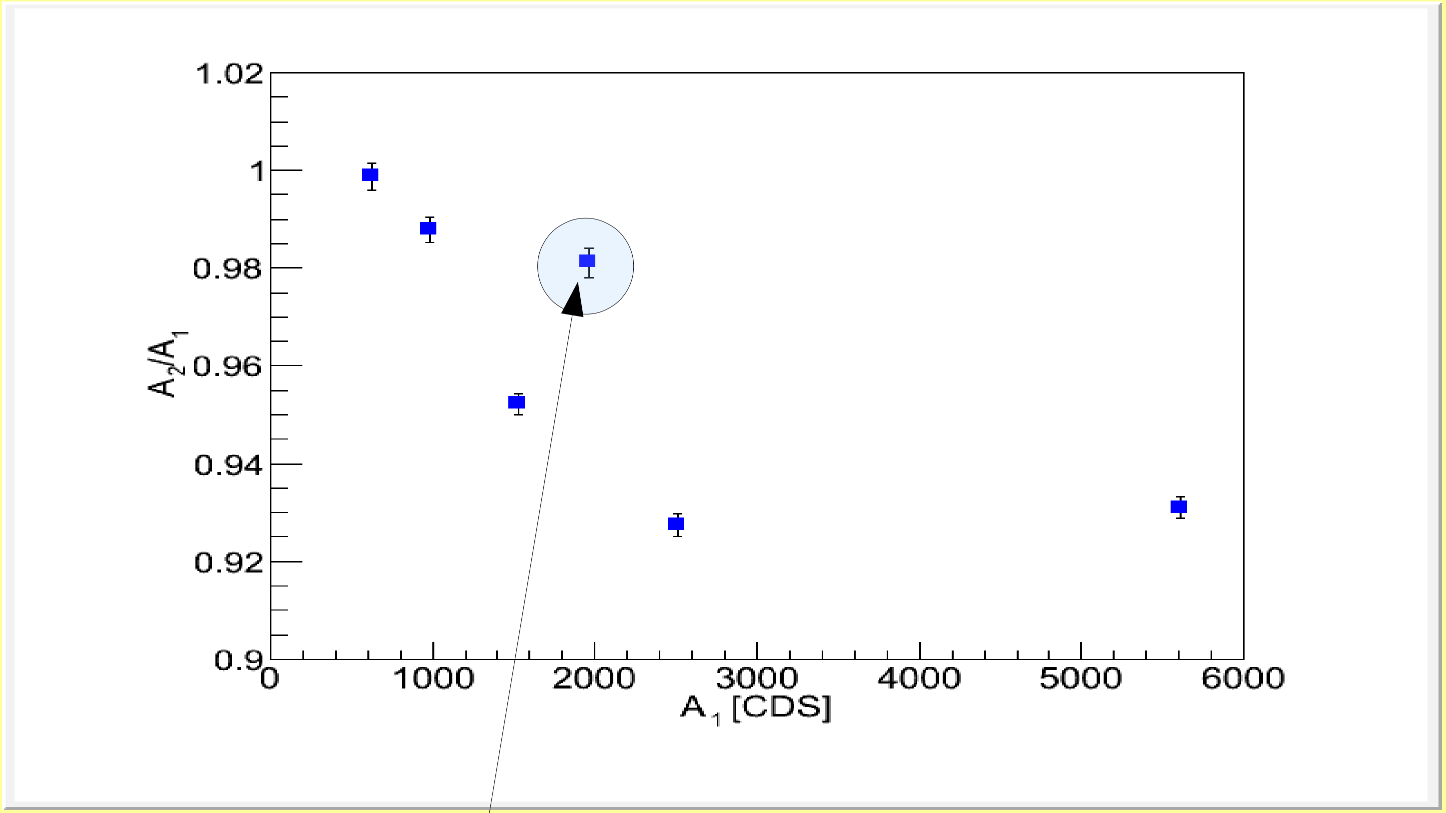




time between shots:
30 ms



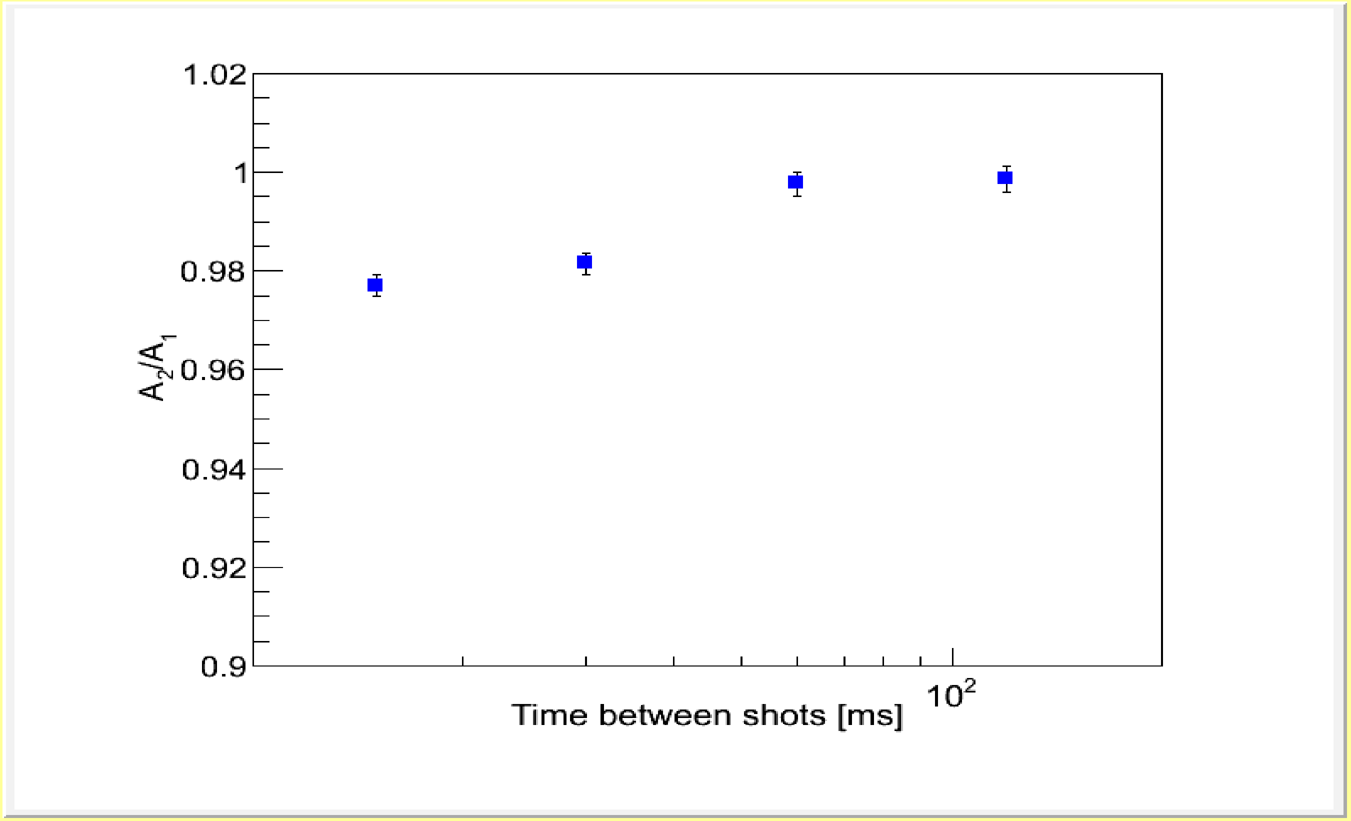
A_2/A_1 as function of A_1



time between shots: 30 ms

Probably geometrical position of stages was a little bit changed for this run

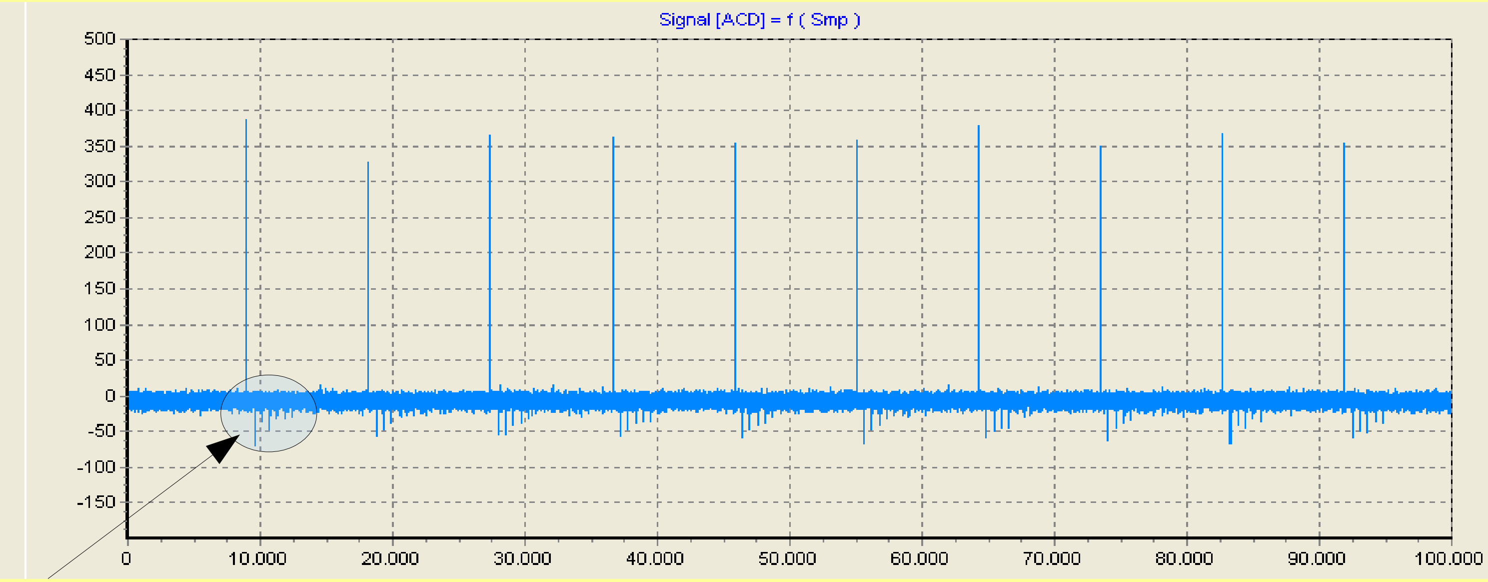
A_2/A_1 as function of shots frequency



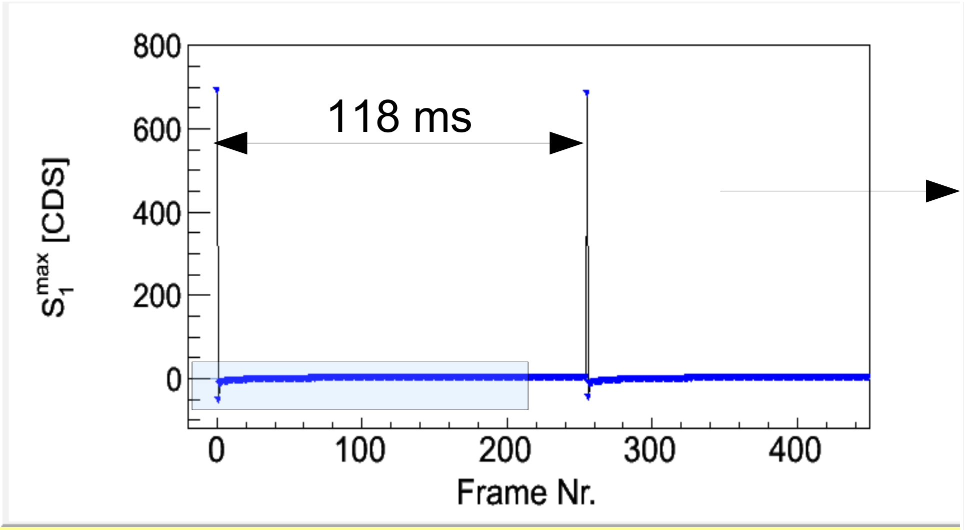
Total signal
of the cluster:
~ 1000 CDS
(this approximately
corresponds to
responce to the Fe-55)

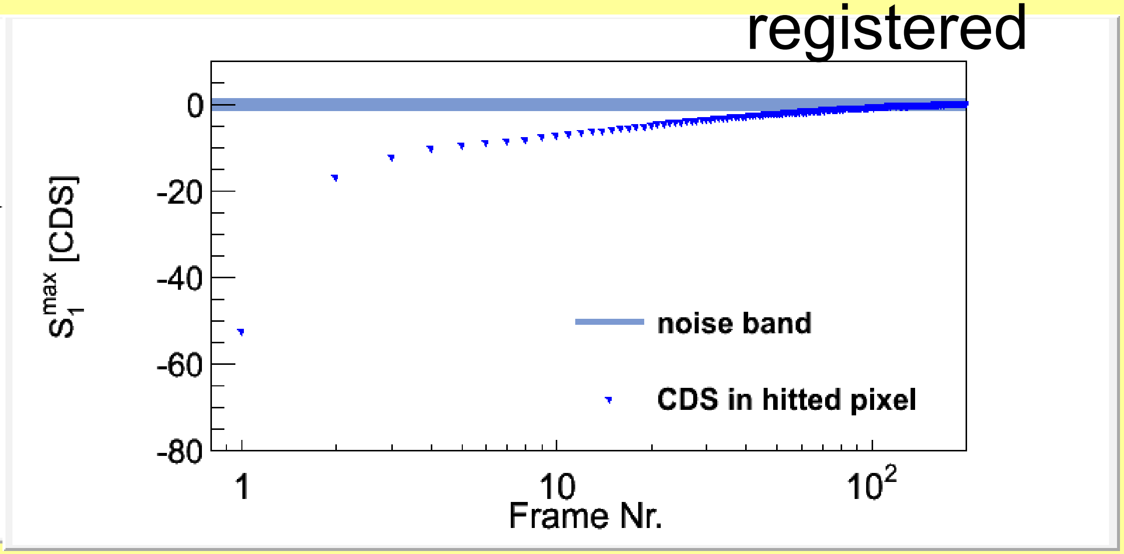
Seems, time needed for recovery is about 60-120 ms → as predicted by Mimosa experts from Strasbourg

Sensor recovery



There are pits in the next frames after the frame were laser shot was registered

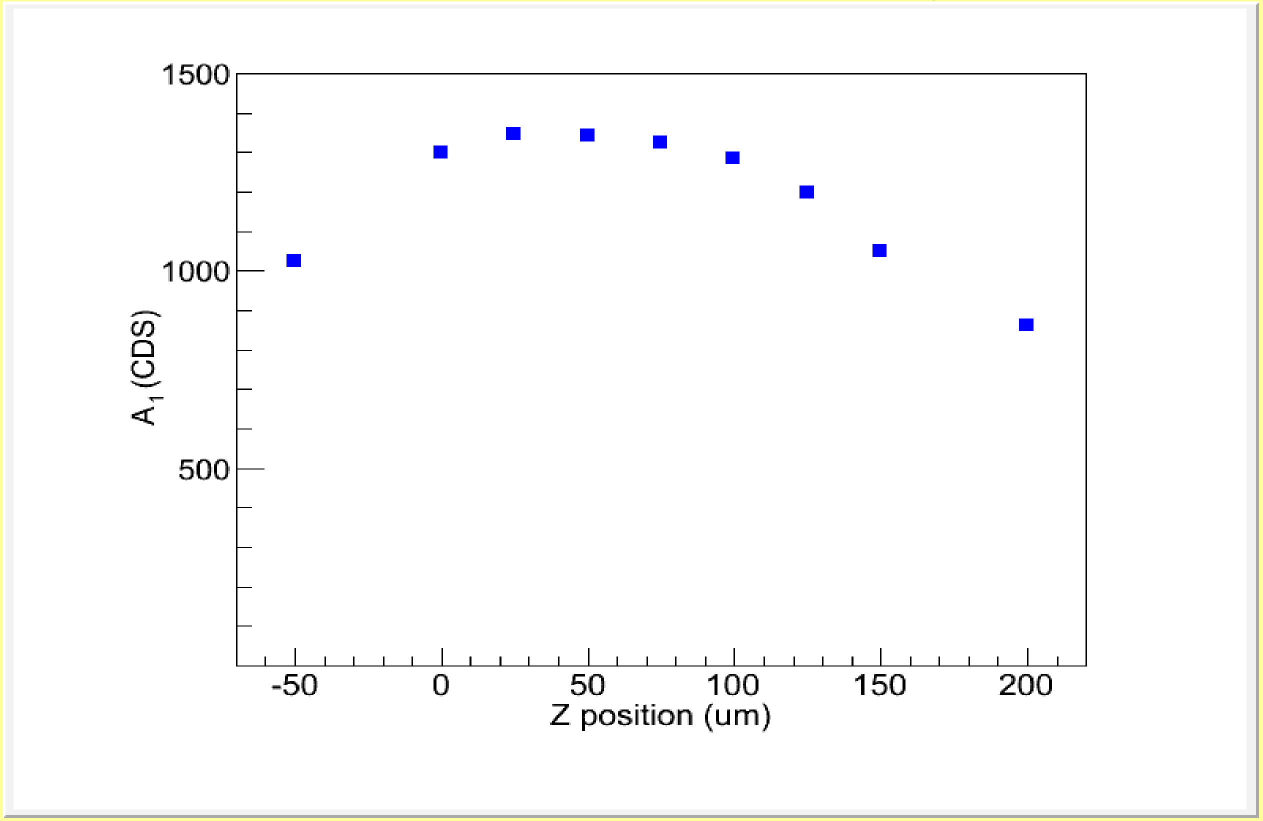




recovering to the noise level after ~100 frames (~46 ms)

Amplitude as function of laser position

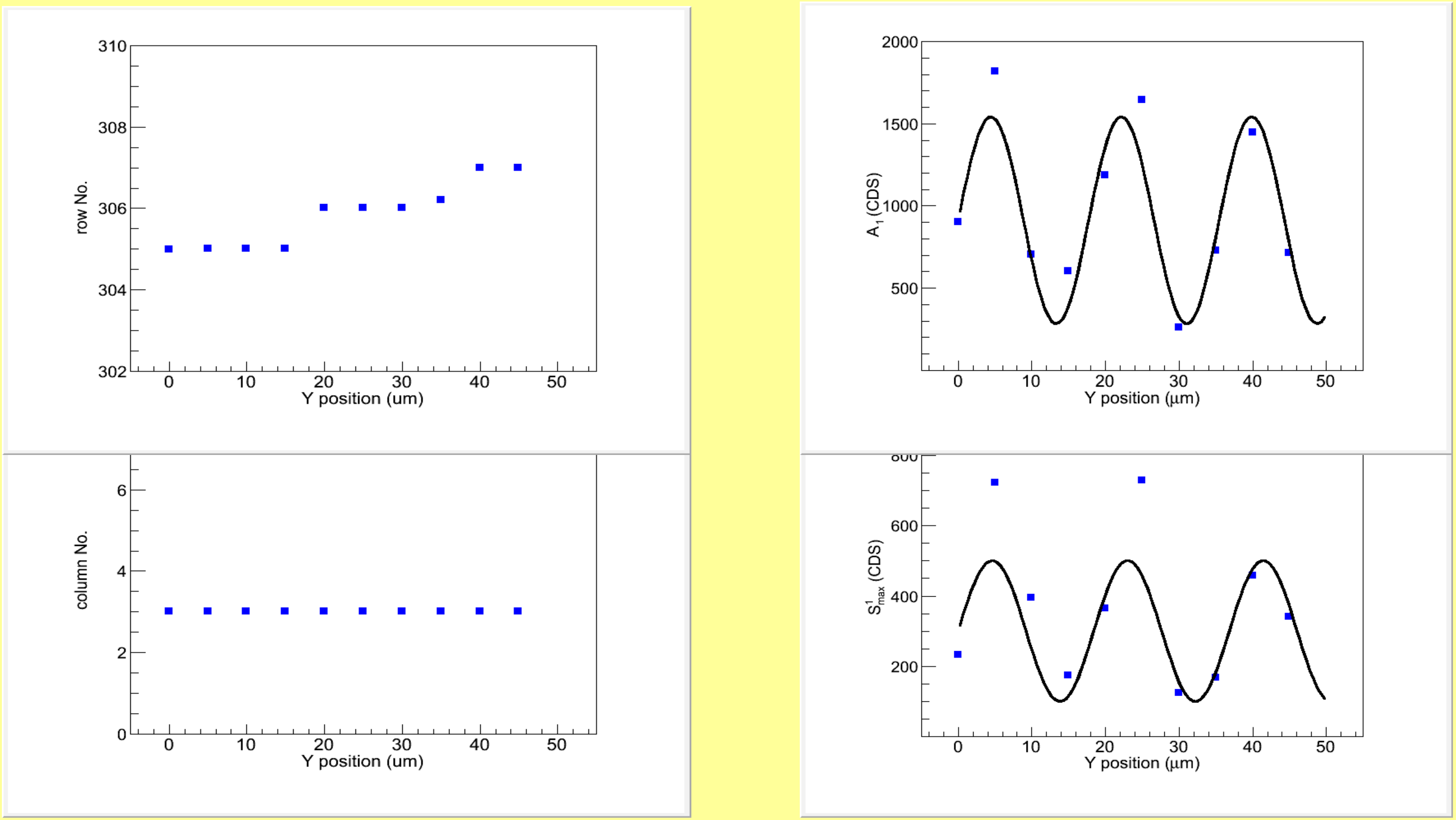
vertical position of the collimator was changed with step 50 or 25 um



more or less strong dependence appears at distances ~5x larger than width of the epitaxial layer

Amplitude as function of laser position

Scan sensor, moving laser collimator through the rows within one column; 10 measurements



Strong dependence of the response on the spot position within pixel

Conclusions

- sensor studies with laser give an unique opportunity to know time and geometrical performance
- signal in pixel seems to be very sensitive to the position of the hit (within pixel), $A_{max}/A_{min} \approx 5 \ldots 6$
- time of reading of one frame is not enough for pixel to recover

Outlook

Short term:

- continue studies with laser
- use optical splitter to monitor laser characteristics independently
- try power pulsing mode with laser
- study higher-resistivity version of the Mimosa 26
- get digital readout

Longer term:

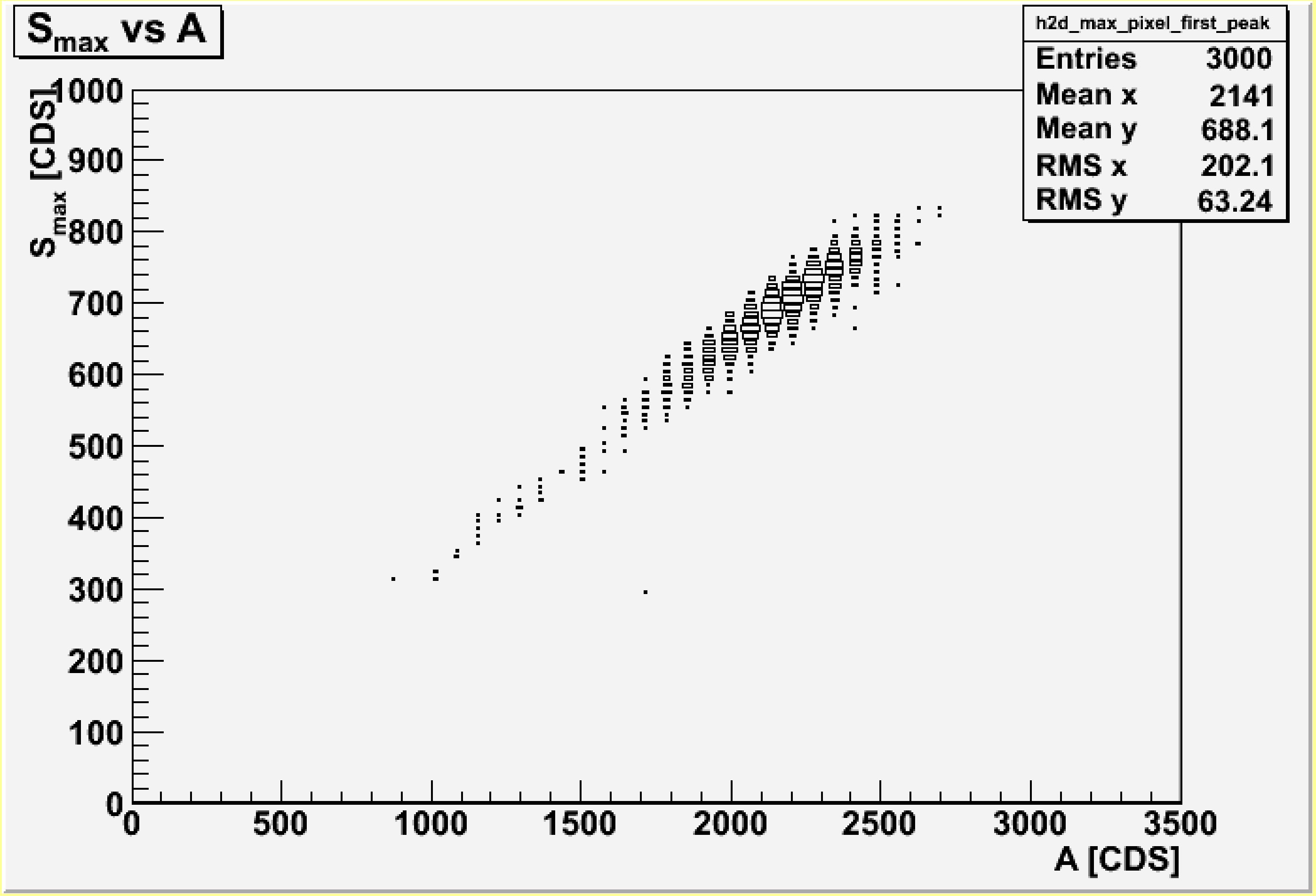
- digital readout in power pulsing mode
- power pulsing of Mimosa 28
- power pulsing of full ladder
- study chip performance in strong magnetic fields

Thanks to:

Lena Bachynska

Artem Kravchenko

Backup



S_{max} vs A
h2d_max_pixel_first_peak
Entries 3000
Mean x 2141
Mean y 688.1
RMS x 202.1
RMS y 63.24
S_{max} [CDS]
A [CDS]
0
100
200
300
400
500
600
700
800
900
1000
0
500
1000
1500
2000
2500
3000
3500