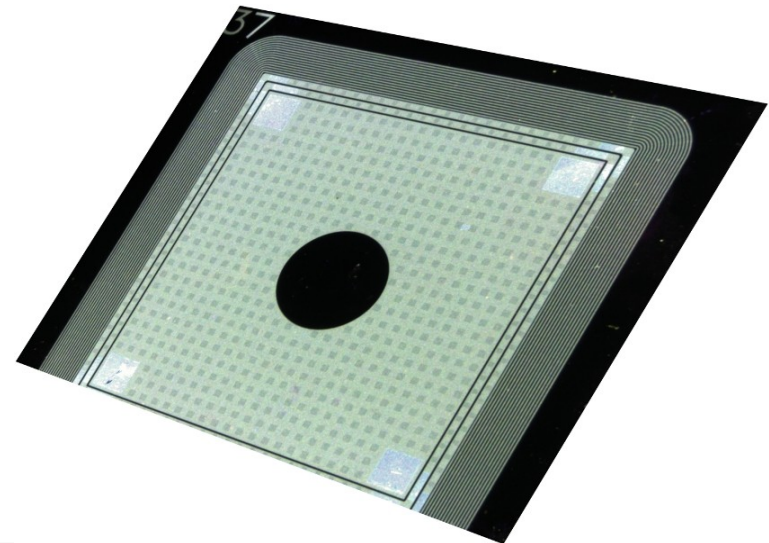


CCE and TCT measurements in Karlsruhe System Commissioning

Robert Eber

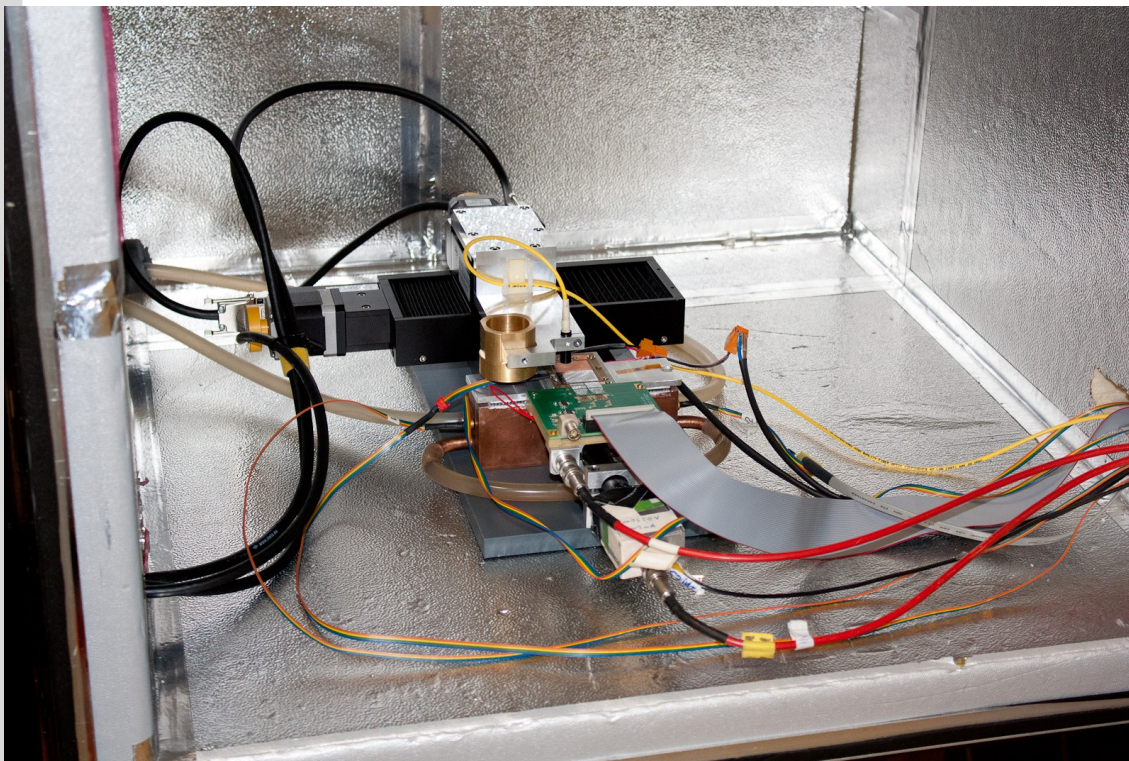
T. Pfister, M. Frey, A. Dierlamm, Th. Müller, W. de Boer, Th. Weiler, T. Barvich, P. Steck

Institut für Experimentelle Kernphysik, KIT

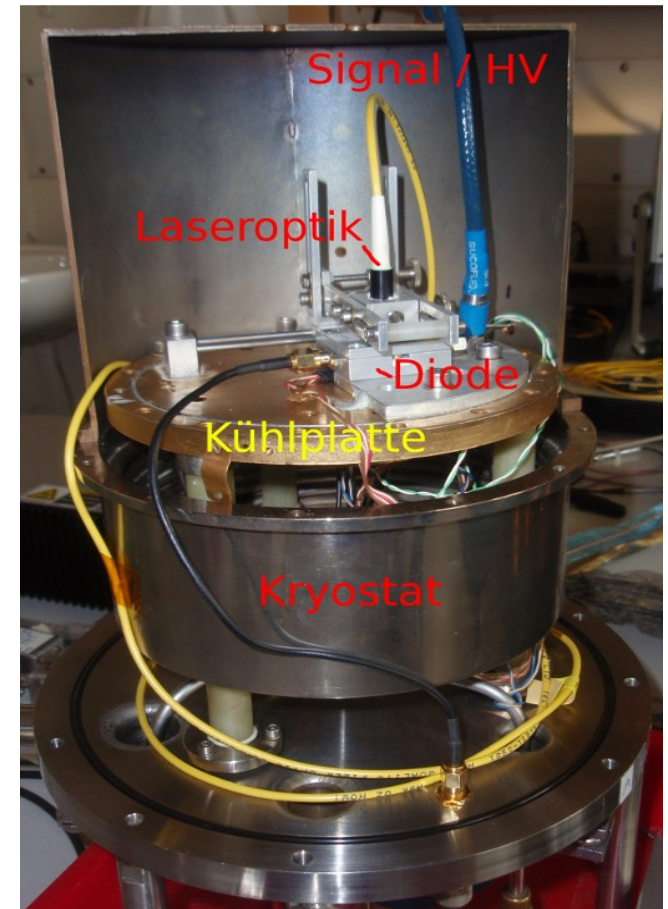


Introduction

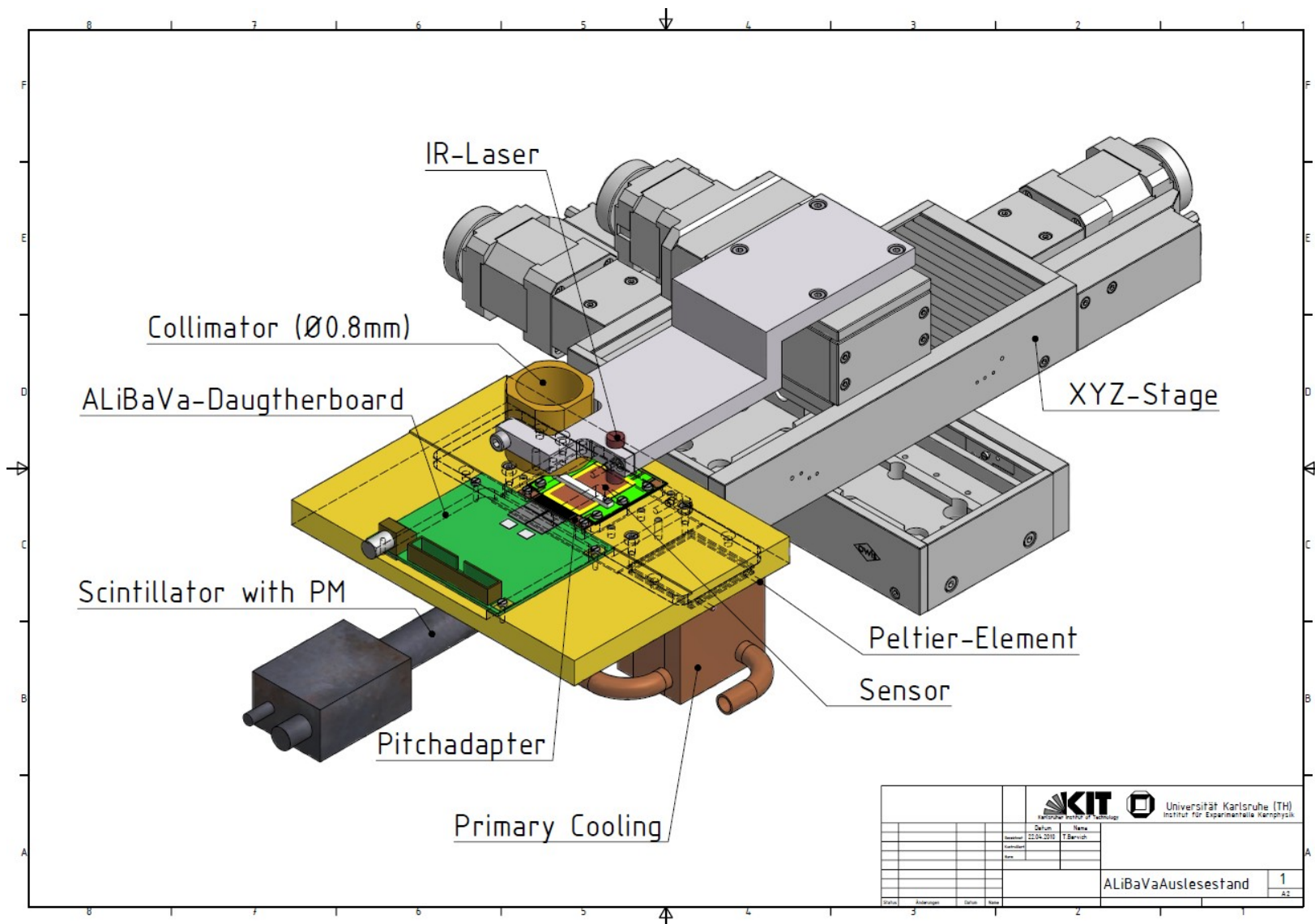
■ ALiBaVa



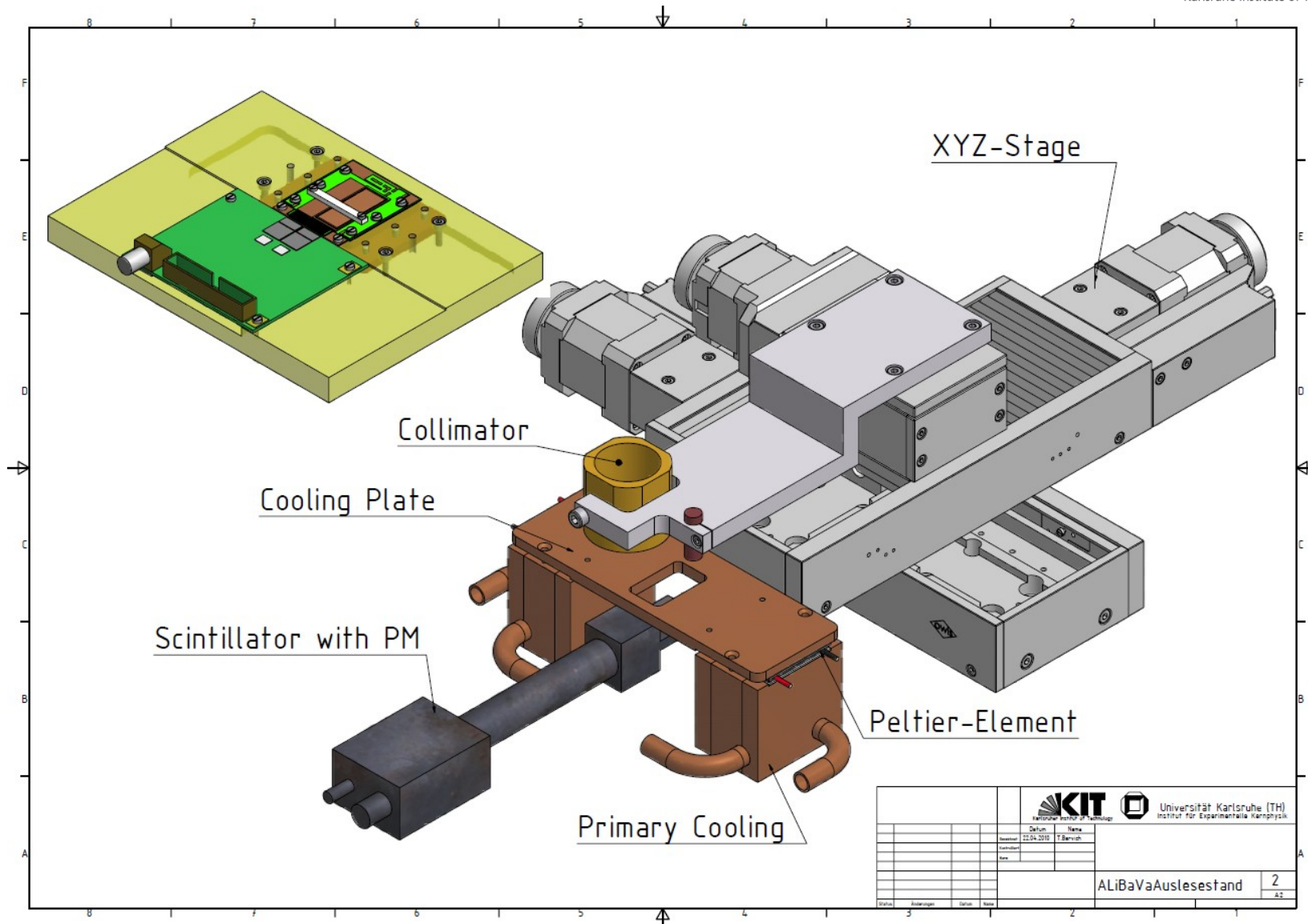
■ TCT





Setup around ALiBaVa



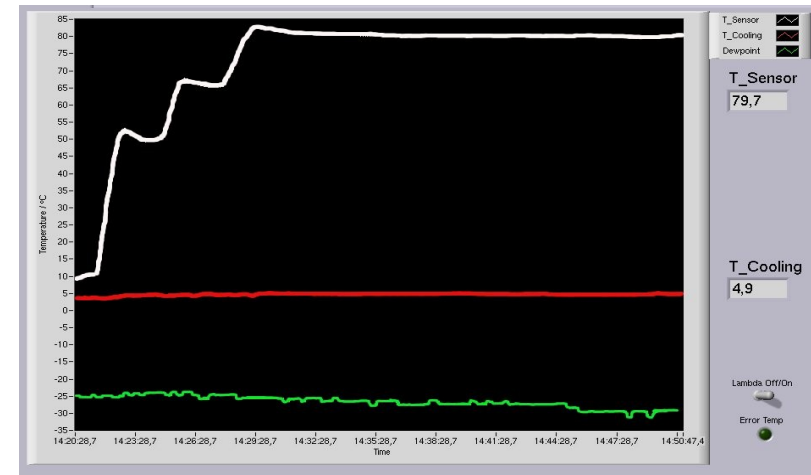
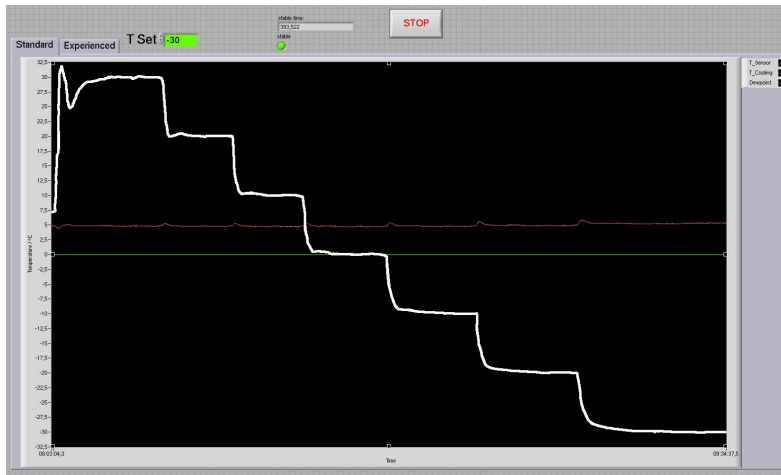
Setup around ALiBaVa



  Universität Karlsruhe (TH) Institut für Experimentelle Kernphysik		Datum		Name	
		22.04.2010		T. Berlich	
ALiBaVaAuslesestand		2		42	

Features

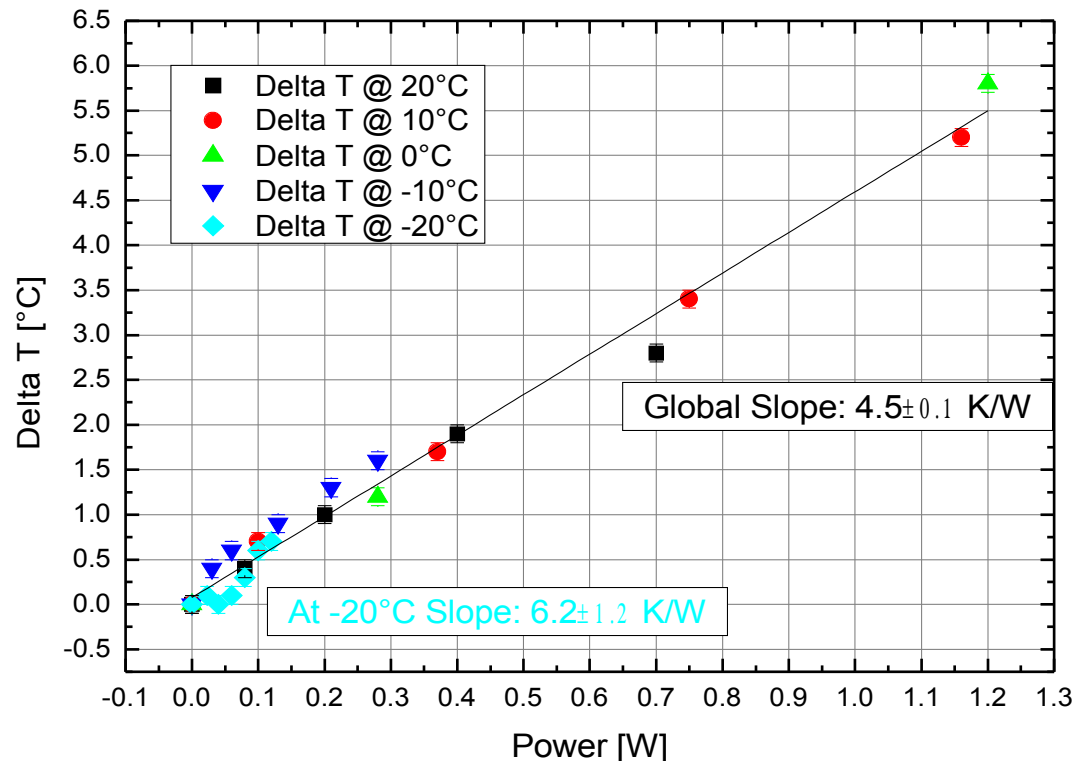
- Fast and stable temperature
- Annealing in situ



- Good thermal insulation to Daughterboard (DtB)
 - Sensor: +20°C → -20°C – DtB: +25.2°C → +22.3°C
 - Sensor: +20°C → +80°C – DtB: +25.2°C → +27°C
- Everything controlled via LabView
 - Control loops and device communication done in LabView
 - AliBaVa called as command line execution
 - Monitoring of file size to get end of run

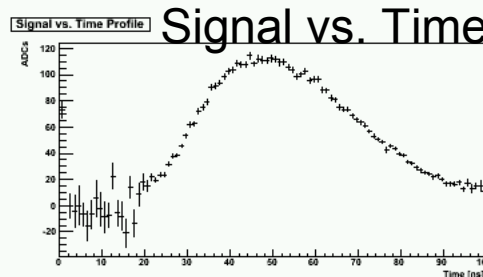
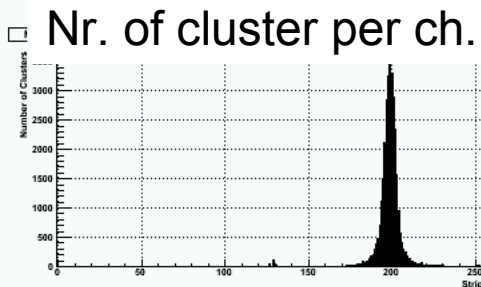
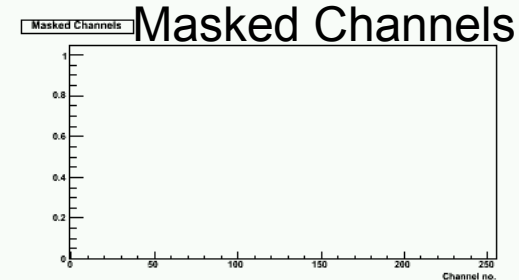
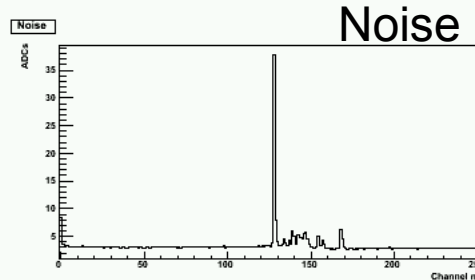
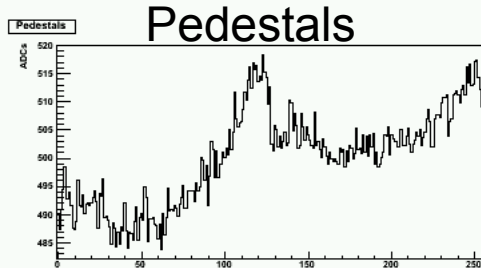
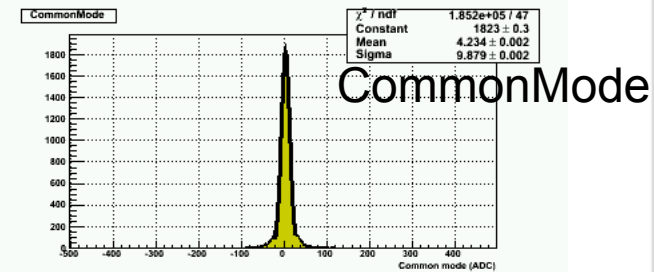
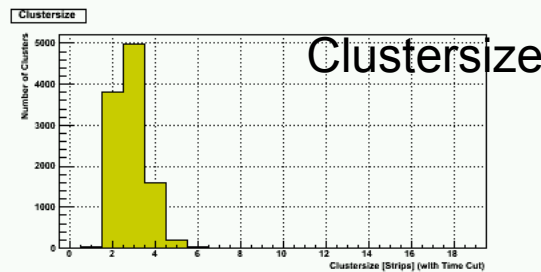
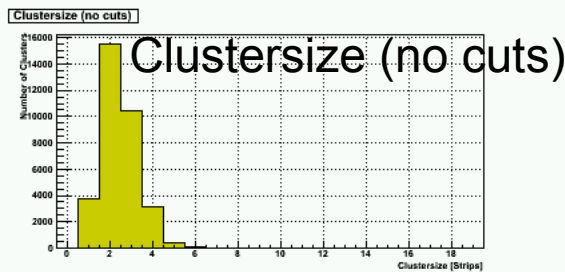
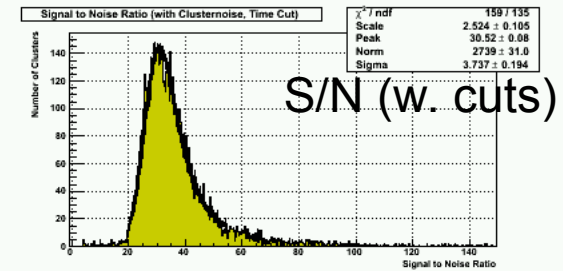
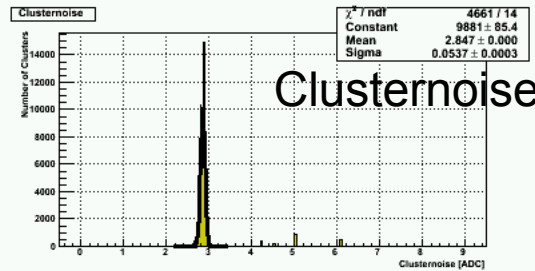
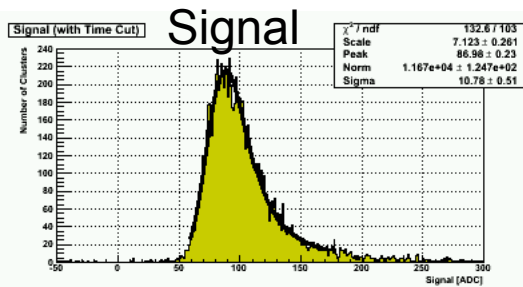
dT vs. Power

- Heating of irradiated sensor due to leakage current causes difference in sensor temperature vs. hybrid temperature
- Temperature difference measured for several heating powers and set temperatures
- → Allows to correct sensor temperature



- Analysis based on the original macros
 - Several modifications to the original macros
- Produces a results page for a quick quality check
- Main analysis results sent to local database
 - Database is required to handle a large number of measurements
 - CMS HPK campaign
 - Upcoming projects
 - DB Development
 - Data from AliBaVa Run and Analysis
 - Irradiations and Annealing
 - Data also from other projects: probe stations, TCT and Lorentz angle measurements
- Access Data
 - Plot and fetch data via web page

Analysis results page



CMSmini1
Non-Irradiated
Run 46
RS
Temperature: 20.0 °C
Bias Voltage: 150.0 V
Leakage Current: 0.0 A
Spectrum with Time Cut [38,61]

Web page frontend



IEKP ALiBaVa Database

Projects:
 striptest
 TanjatestetCMSmini
 TCT
 TCT-Calibration
 TempCalibration

Sensors:
 CMSmini1

Groups:
 alibava_re
 delete
 CMSmini_Set4.5

View:
 377_CMSmini1

X-Parameters:
 Voltage

Y-Parameters:
 Signal (MPV)

Date:
 Voltage: ± 2
 Temperature: ± 2 °C
 Fluence: ± 1e14 neq/cm²
 Annealing: ± 5 h

Restrictions:

Source:
 Station:
 Material:
 Doping:

2608
 2606
 2604

2602
 2600
 2599

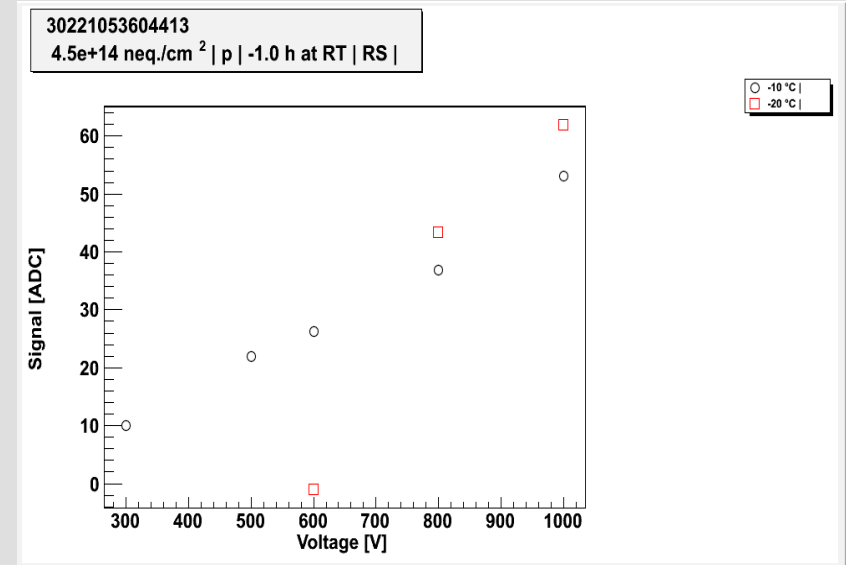
Curve 1 Curve 2

Sorting Sequence:
 date,annealing,fluence,source,temperature,voltage

Plot Normal Logarithmic Histogram Histogram LogX

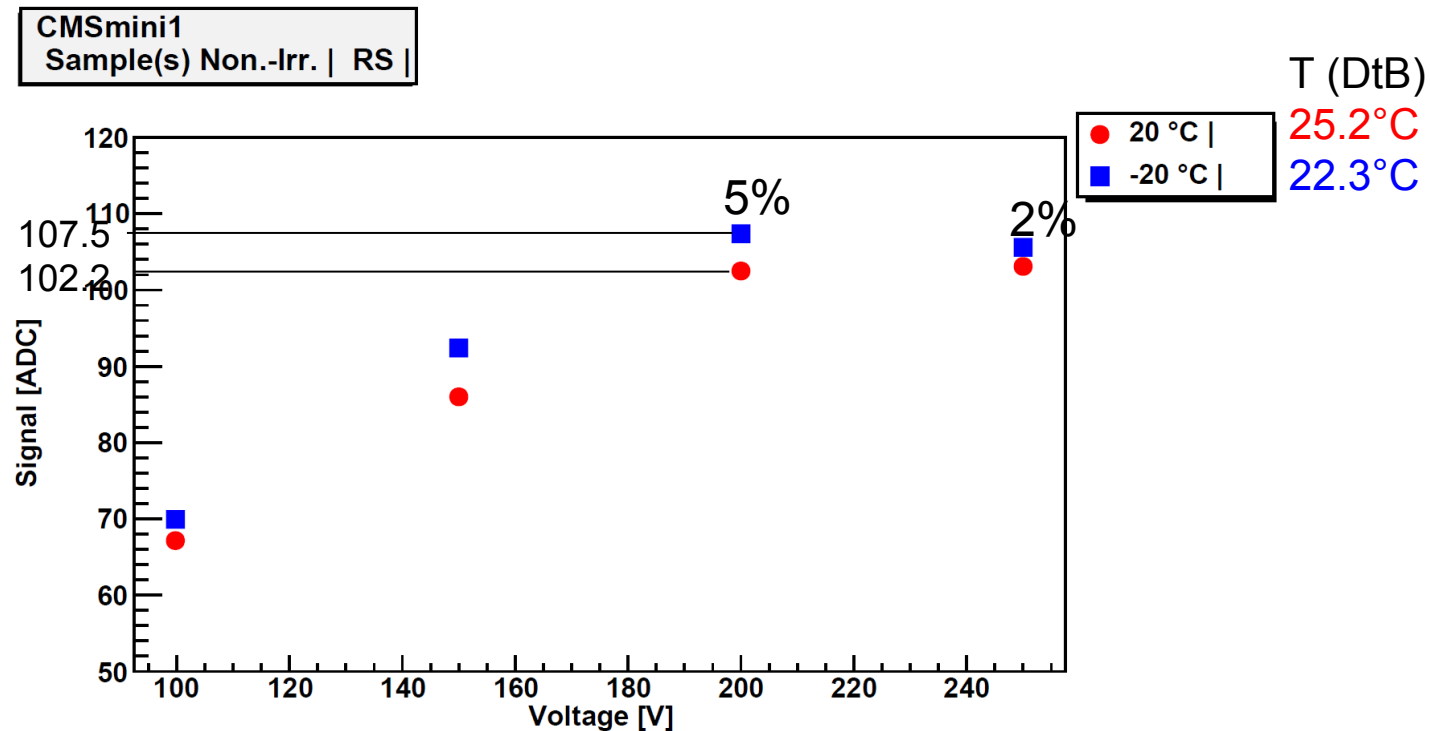
XRange YRange

CMSmini1 TanjatestetCMSmini	Pedestal Run	Date	Operator	Source	Voltage[V]	Current[A]	T [°C]	F[neq/cm ²]	Type	tAnneal@20°C[h]	Signal	#Trigger	Comment
<input checked="" type="checkbox"/> 2608	2607	2010-05-07 13:15:20	pfister	laser	600.6	6.1e-05	-20.08	0.00e+0		0.00	68.91465	30000	software check bestrahlter Sensor
<input checked="" type="checkbox"/> 2606	2605	2010-05-07 13:10:15	pfister	laser	800.8	7.4e-05	-20.03	0.00e+0		0.00	99.330422	30000	software check bestrahlter Sensor
<input checked="" type="checkbox"/> 2604	2603	2010-05-07 13:06:00	pfister	laser	1000	9e-05	-19.93	0.00e+0		0.00	133.026197	30000	software check bestrahlter Sensor



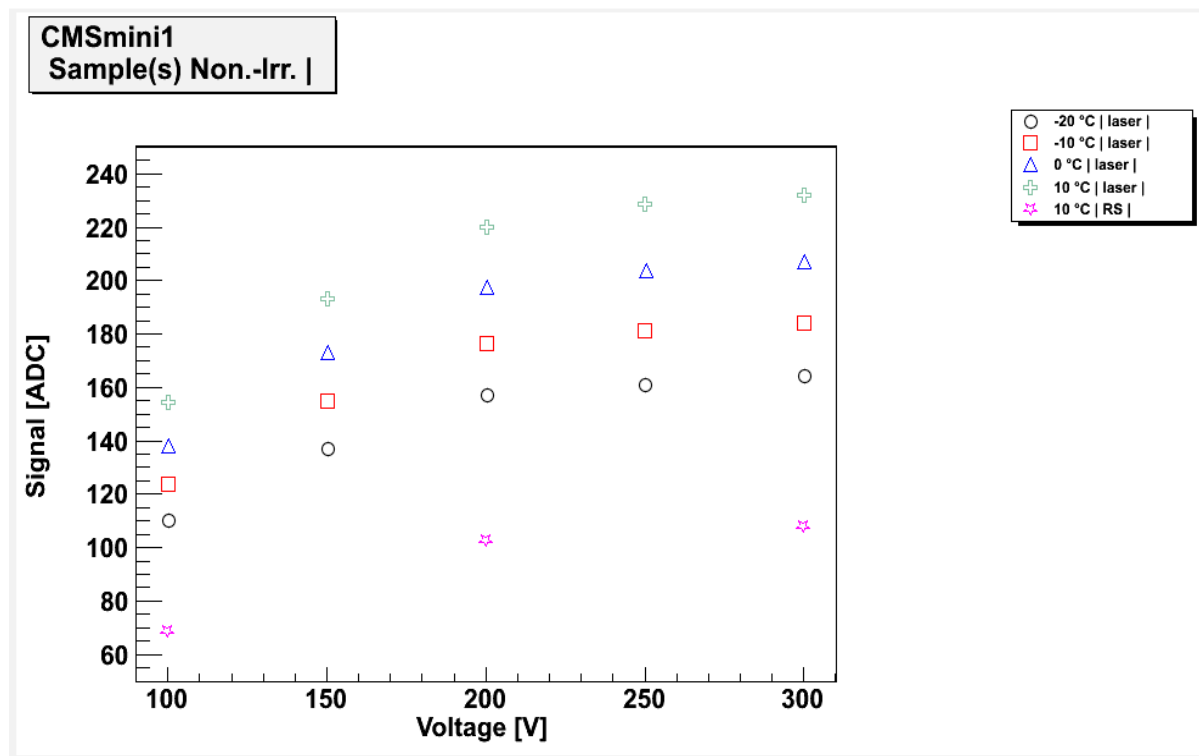
MIP signal vs. temperature

- Sr-90 signal at -20°C and +20°C (chip gain)
- Looks like chip gain is about ~1% / °C

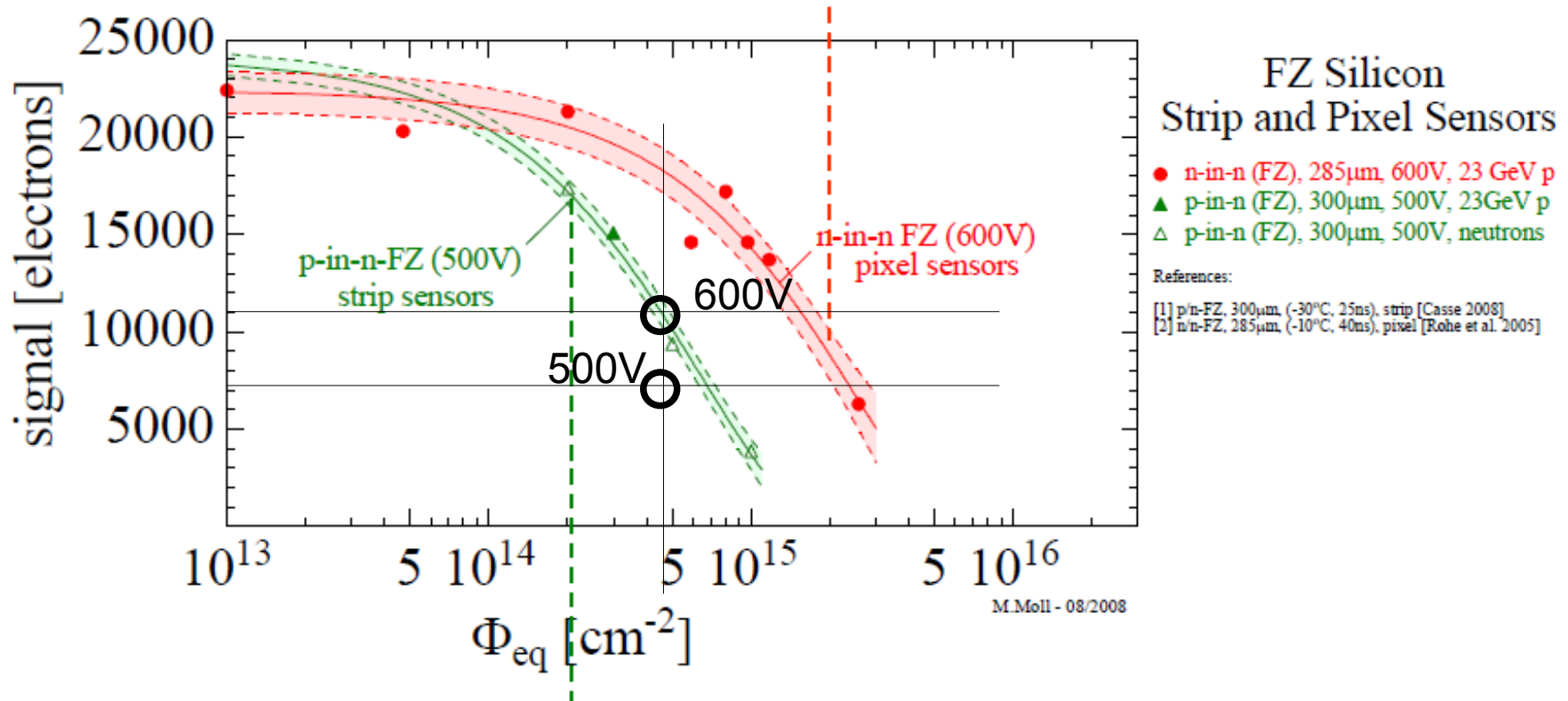


IR Laser Signal

- Penetration of Laser dependent on temperature
- Shape of signal ramp with IR Laser same as for Sr-90
 - IR Laser can be used to fill coarsely spaced voltage ramp with Sr-90 source to speed up measurement
 - IR Laser signal needs to be scaled to Sr-90 signals



Test with irradiated Sensor



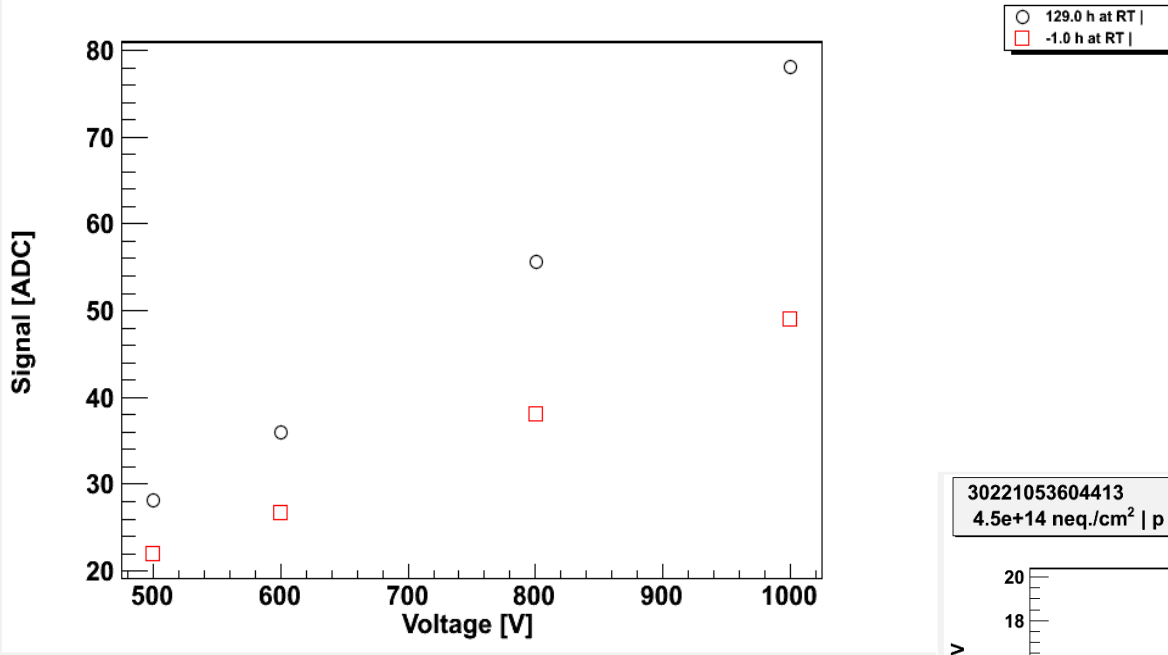
- n-FZ
- 500μm thick
- $F \sim 4.5 \cdot 10^{14} n_{eq}/cm^2$

- 25 MeV proton irradiated
- T_{anneal} : 30min @ 60°C
- ca. 129h @ RT

Annealing n-FZ, 500 μ m, $F \sim 4.5 \cdot 10^{14} \text{ n}_{\text{eq}}/\text{cm}^2$

30221053604413

4.5e+14 neq./cm² | p | -10 °C | RS |



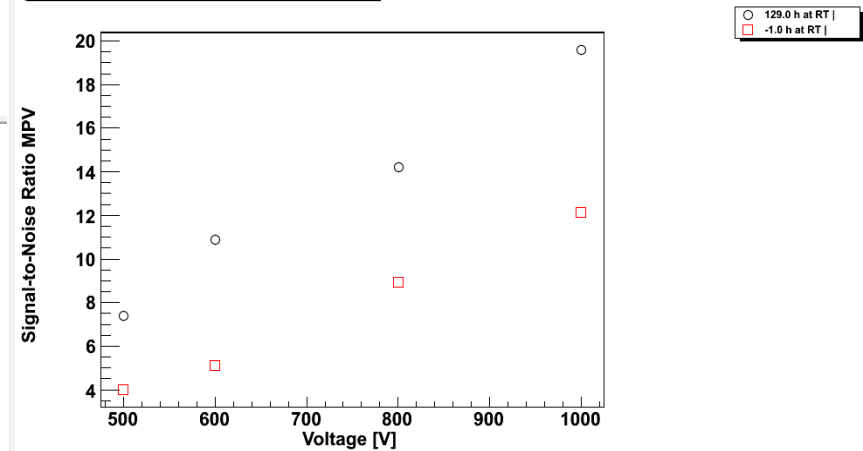
- Still half of maximum signal of non-irradiated sensor:
ca. 80/160 ADC counts

- First annealing only 30mins @ 60°C

• Signal is expected to increase with further annealing

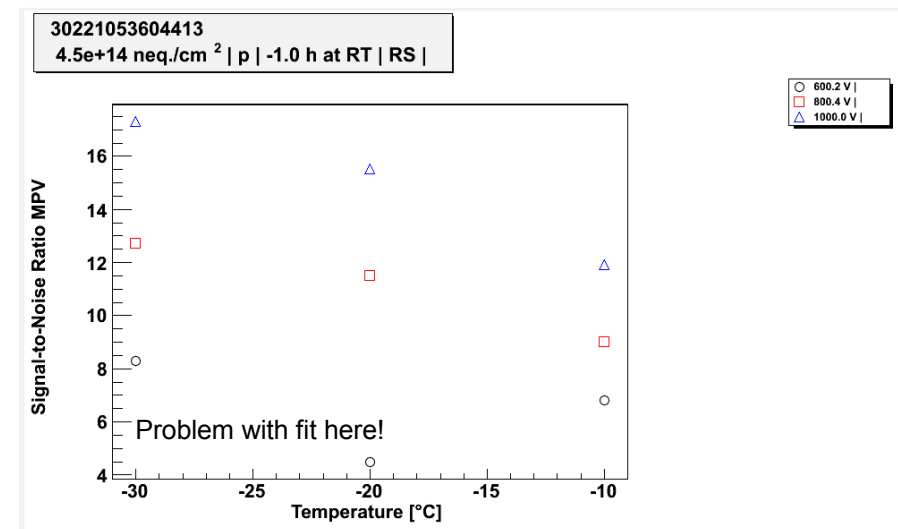
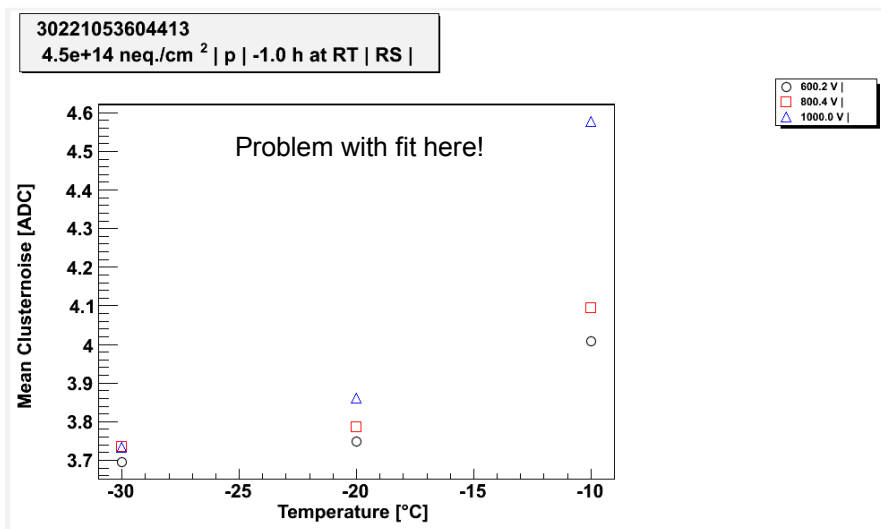
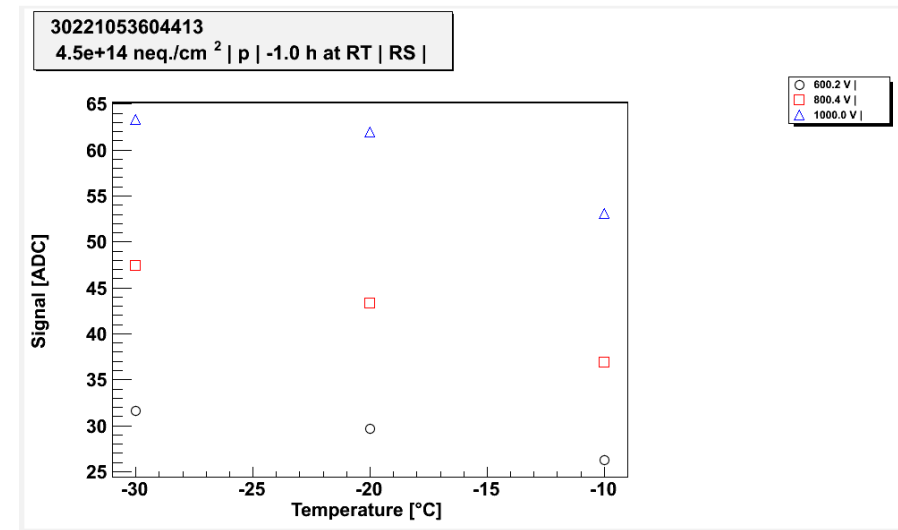
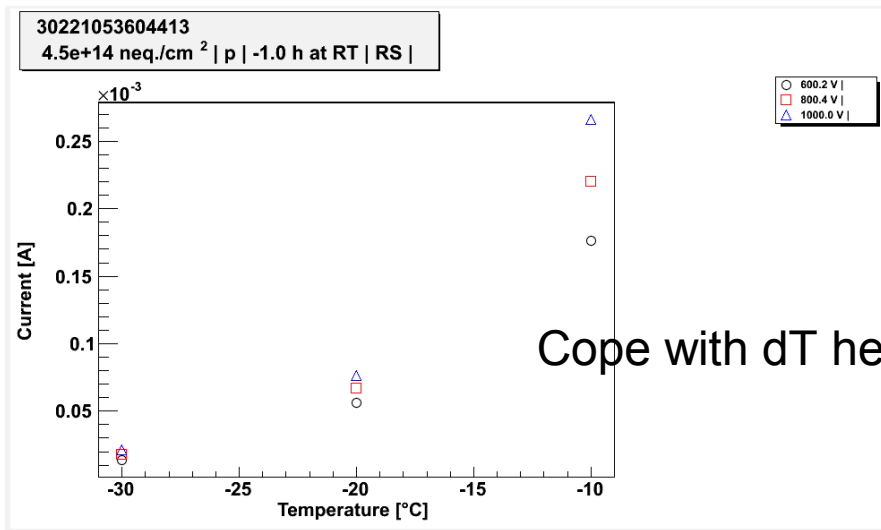
30221053604413

4.5e+14 neq./cm² | p | -10 °C | RS |



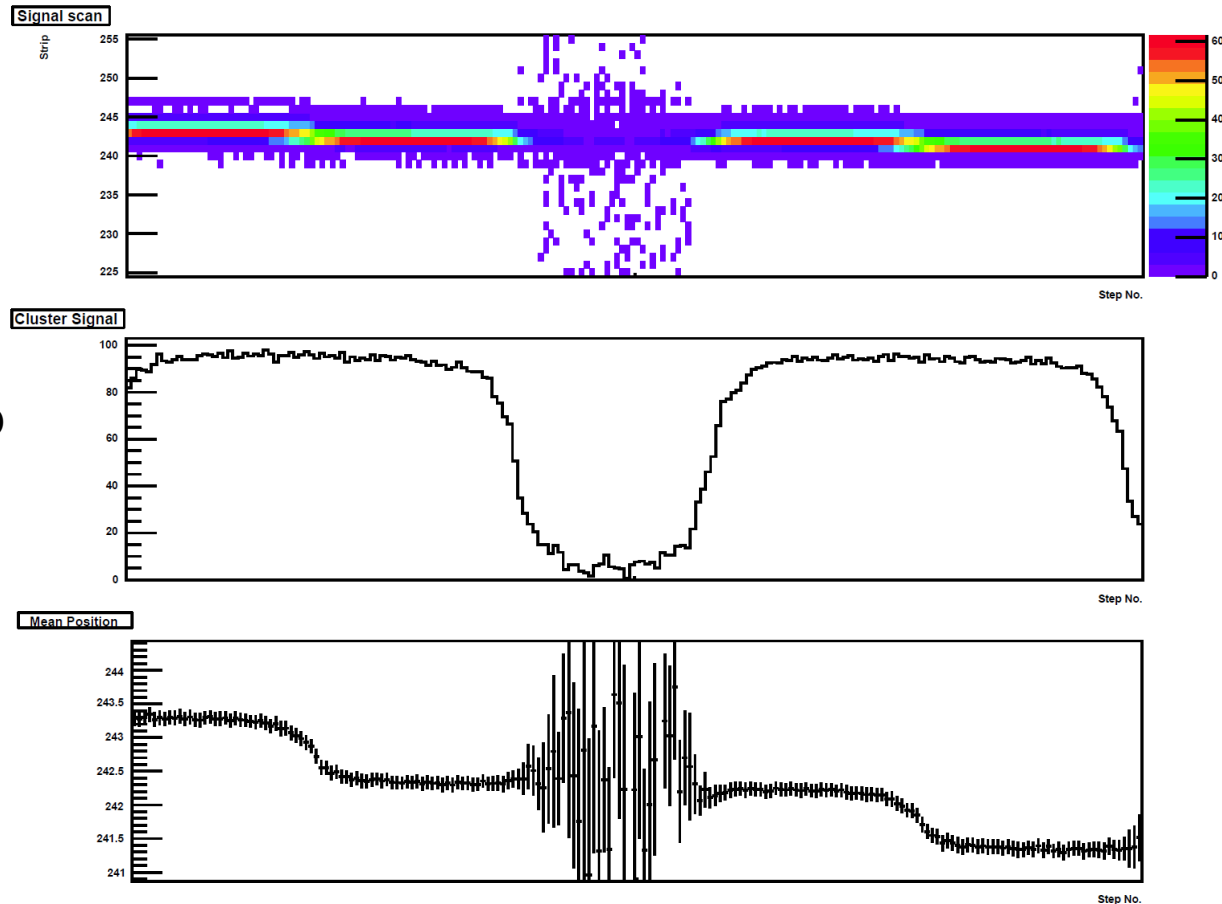
Irradiated n-FZ 500 μ m, $F \sim 4.5 \cdot 10^{14} \text{ n}_{\text{eq}}/\text{cm}^2$

not annealed



Laser scan with focused beam

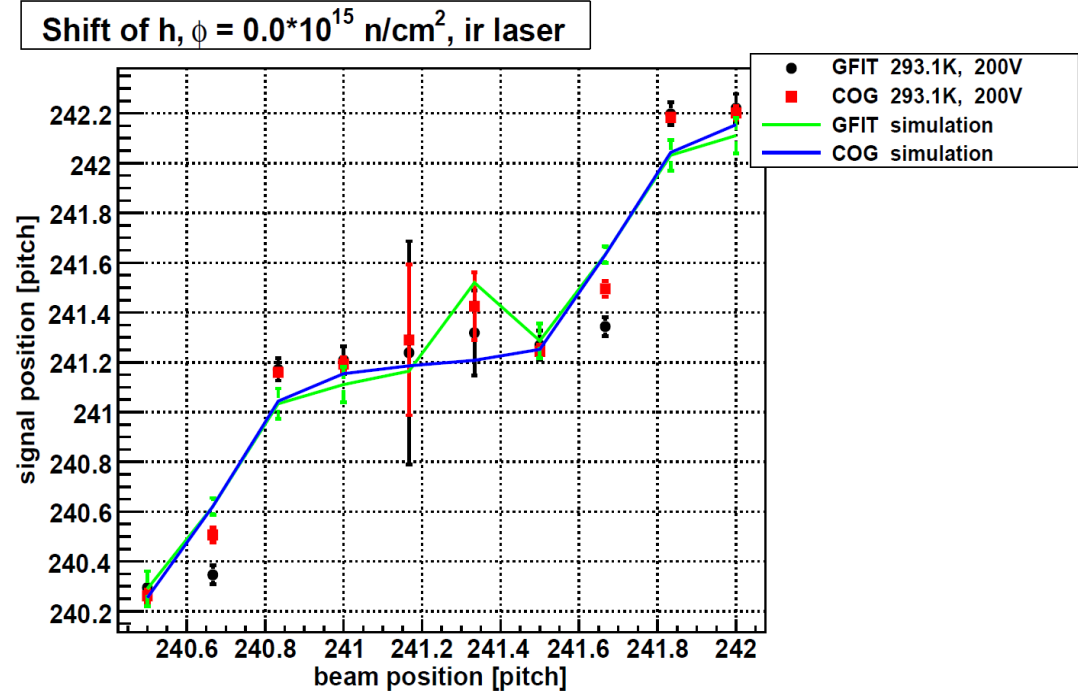
- Focus Spot size $\sim 10\mu\text{m}$
- Step size $\sim 1\mu\text{m}$
- Strip sensor with $40\mu\text{m}$ Al width and $120\mu\text{m}$ pitch
- Laser reflected at Al strip
- Steep transition between strips
- Allows for better reconstruction
- Used to test simulated strip coupling



Simulation of strip response

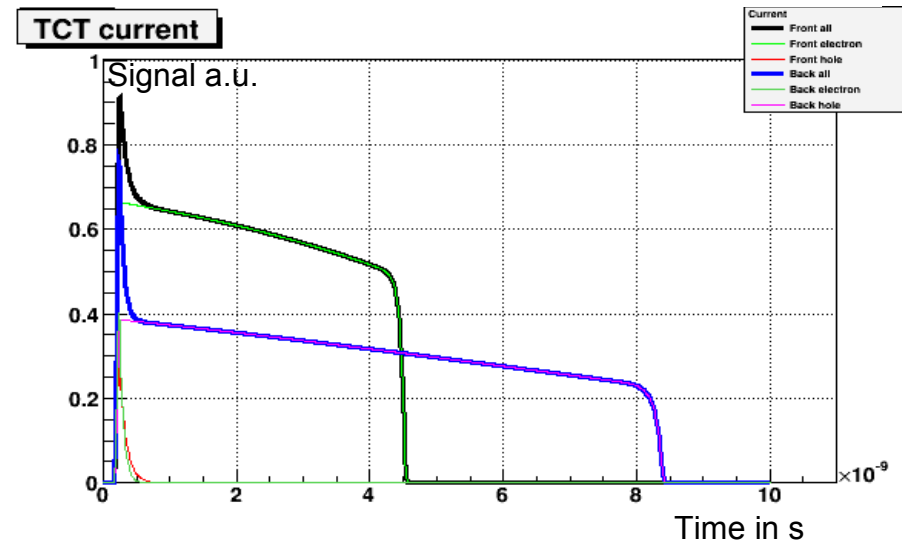
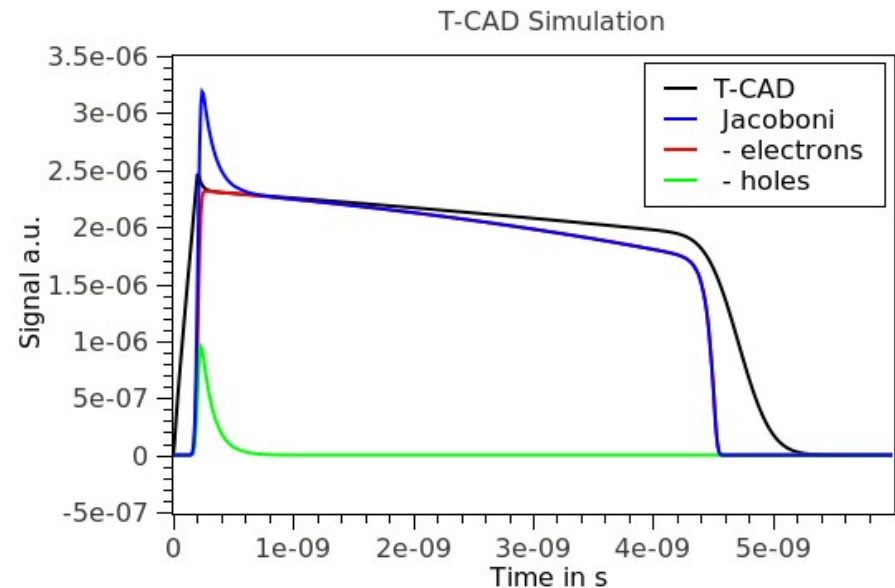
- Derivation of Lorentz angles
- Device simulation using electric fields and weighting potentials from T-CAD
- Charge carriers are tracked through the field
- Induced signals read out

- Needed to incorporate high magnetic fields for Lorentz angle simulations, Synopsis T-CAD cannot cope with 4T

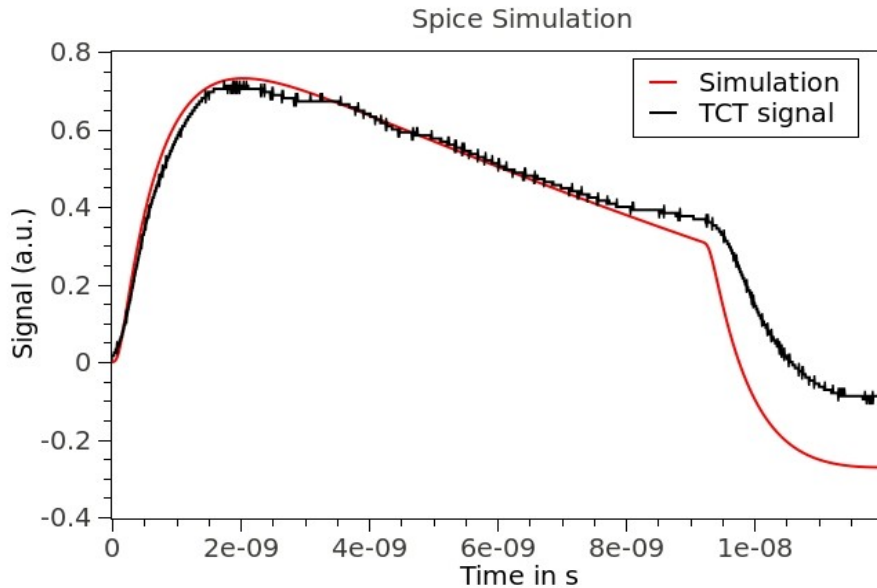


TCT Setup - commissioning

- Understanding the setup and measurements
 - Simulation of TCT pulse of non-irradiated diode
 - Drift model of Jacoboni
 - Synopsis T-CAD
- Simulations here:
 - n-FZ
 - 300 μm thick
 - Red Laser ($\sim 670\text{nm}$) front injection
 - Not irradiated
- Difference: diffusion of charge carriers in T-CAD



Spice Simulation



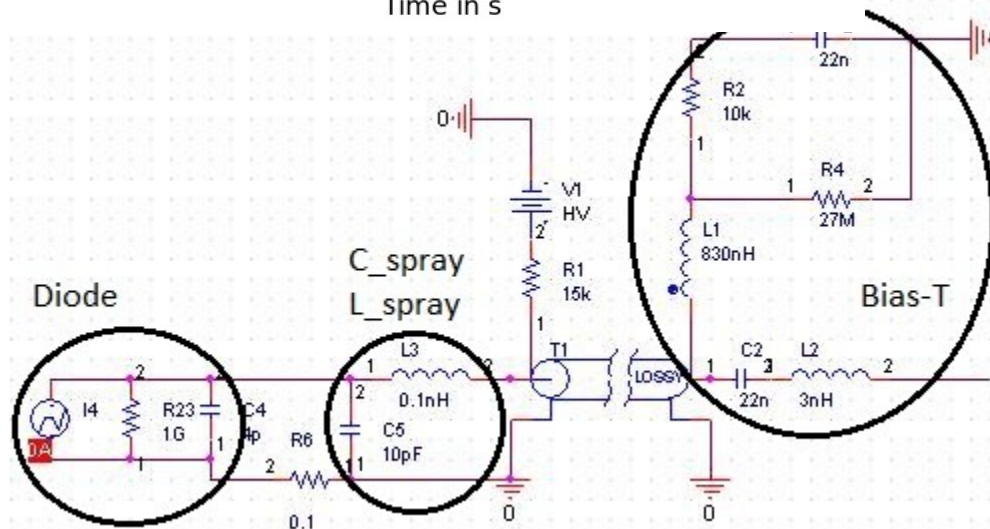
- Spice simulation to determine spray capacitance and spray inductivity

- $C_{\text{spray}} \sim 9\text{pF}$
- L_{spray} : few nH ($\sim 1\text{nH}$)

- Improving the setup

- Reduce C_{spray} (mainly comes from diode box)

- Planned:
TCT calibration campaign
between several setups
with a non-irradiated and an
irradiated sample



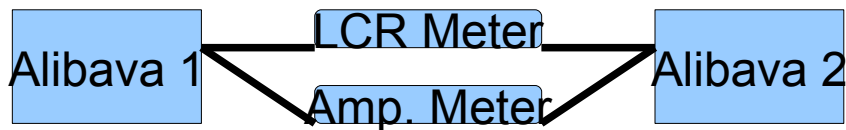
Summary & Outlook

■ ALiBaVa

- ALiBaVa Setup and surrounding systems are finished do a good job
- Second ALiBaVa setup in Karlsruhe under construction
- IV- and CV- measurements in the ALiBaVa, sharing instruments between the setups
- Looking forward to handle many sensors with different materials, thickness and doping

■ TCT

- Further simulations of irradiated diodes with T-CAD
- Fit of a real TCT signal with help of drift simulation to determine electric field
- Automated extraction of trapping time (in collaboration with other institutes)
- Large variety of materials and even larger variance of fluence for diodes in the HPK campaign



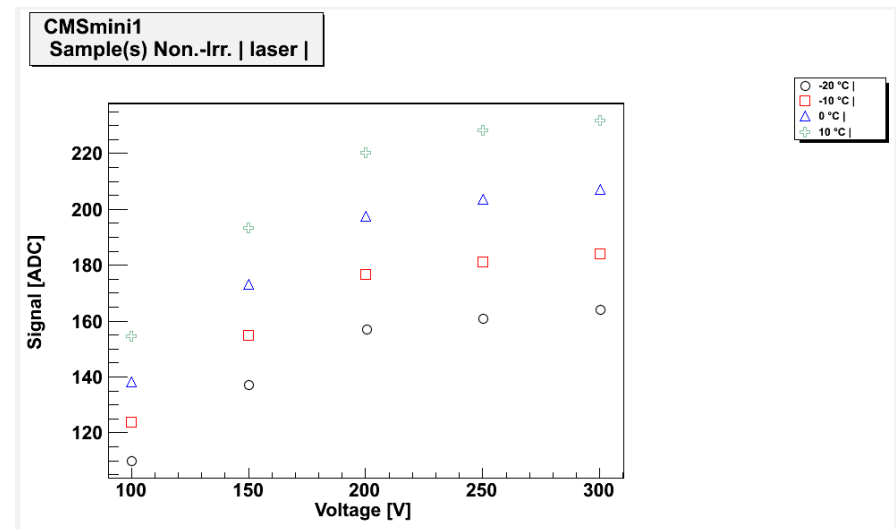
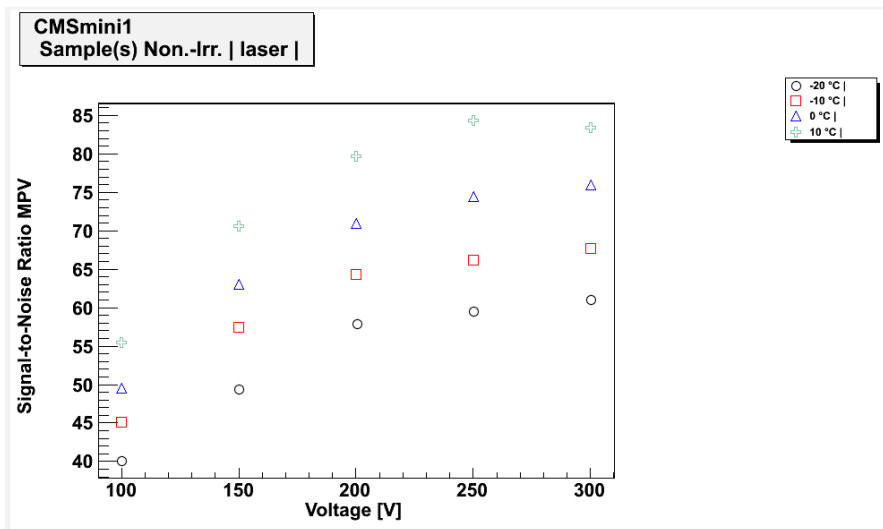
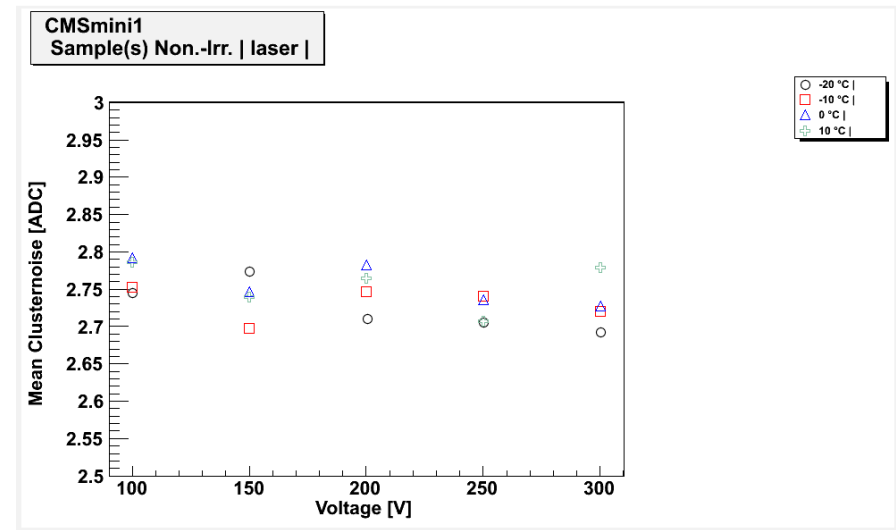
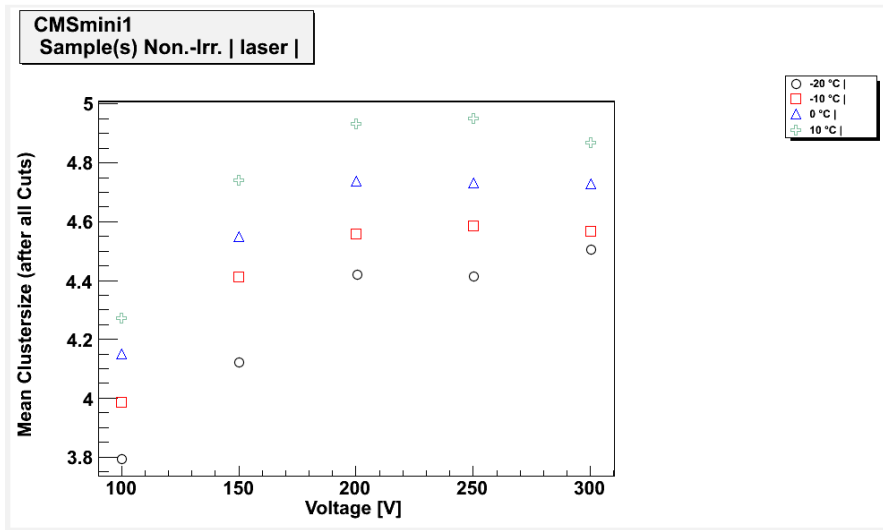
The End

- Thank You for your Attention!

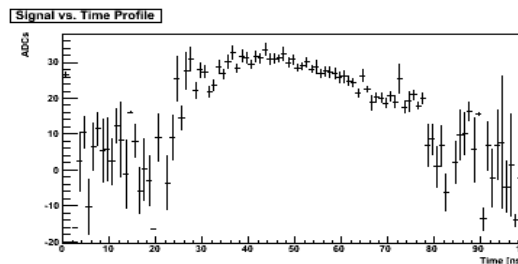
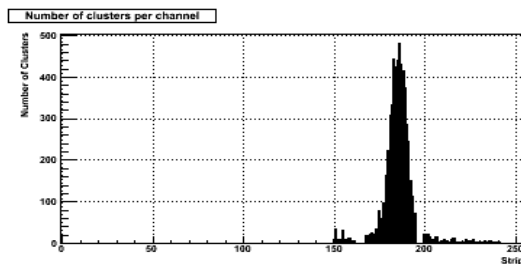
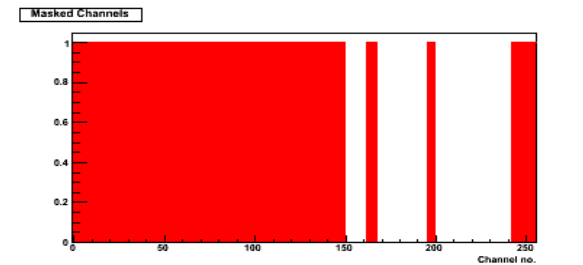
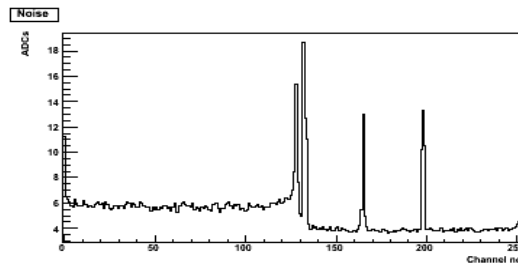
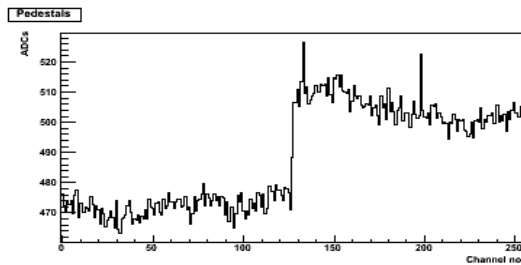
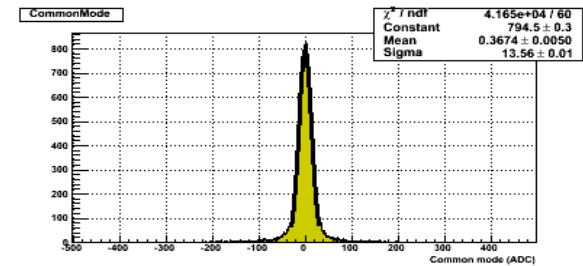
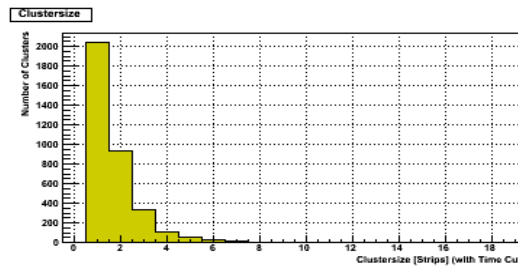
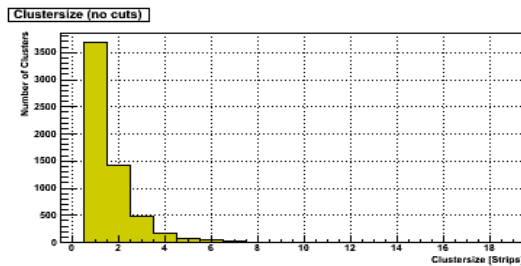
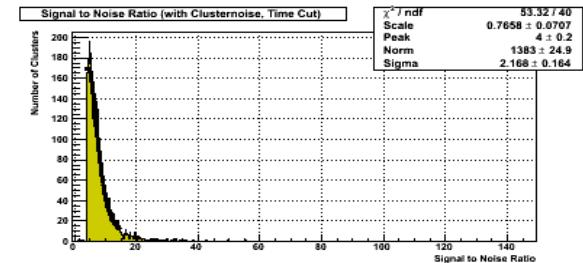
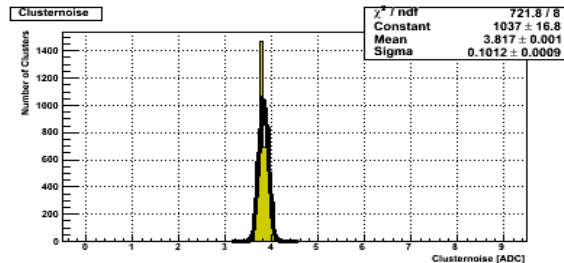
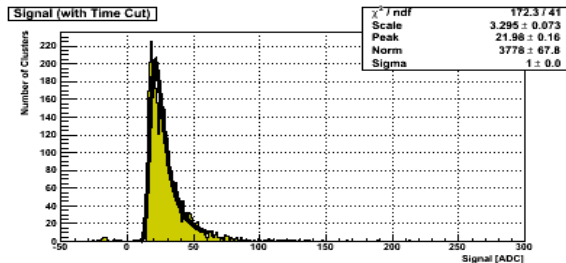
- Questions?

- Thanks to
 - Tanja Pfister
 - Thomas Eichhorn

Further Parameters with IR Laser

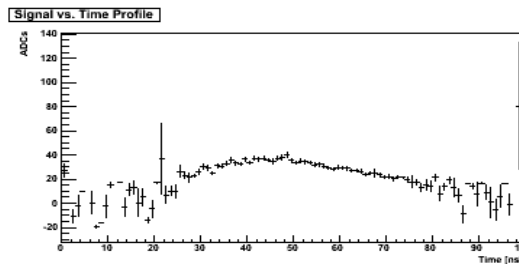
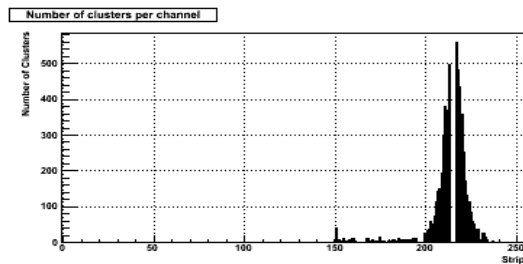
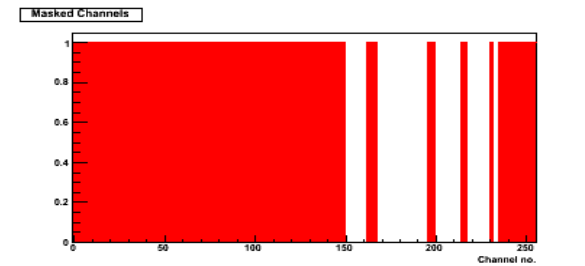
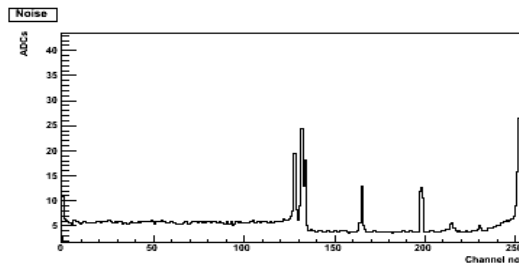
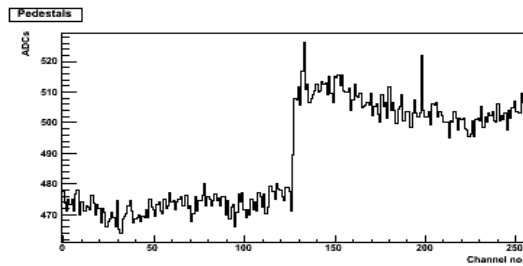
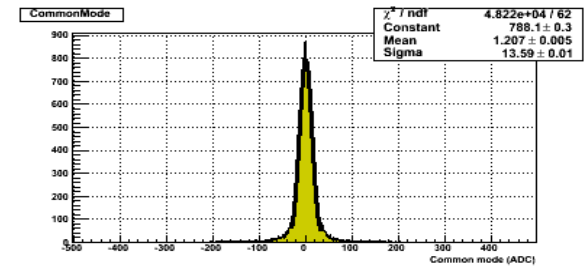
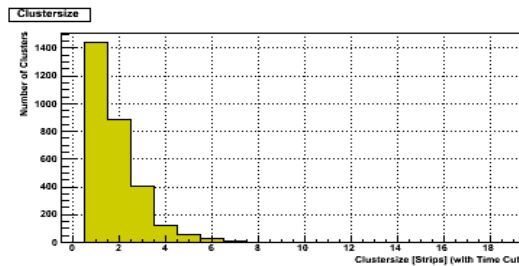
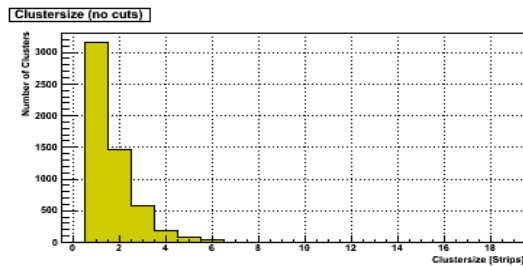
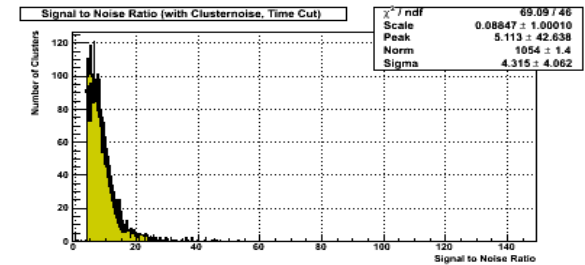
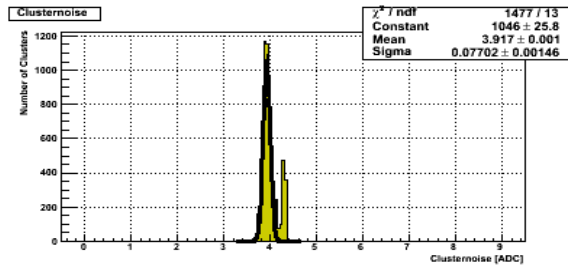
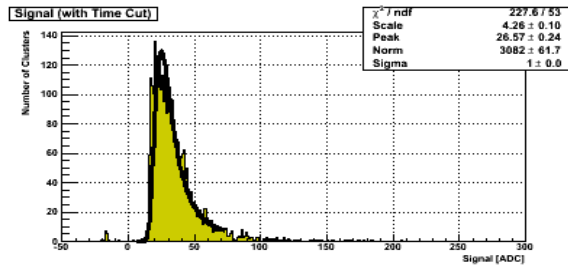


Analysis page -10°C not annealed, 500V



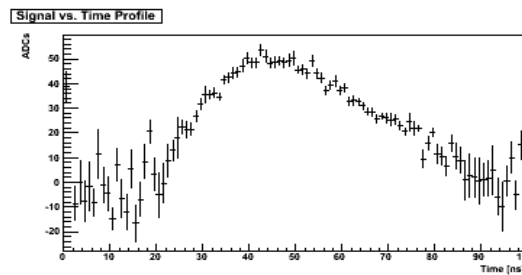
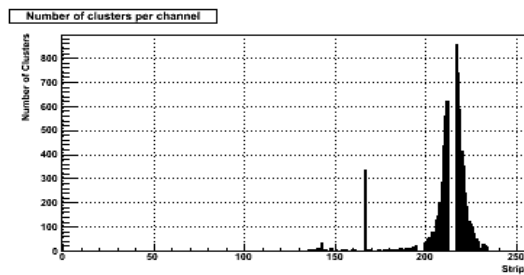
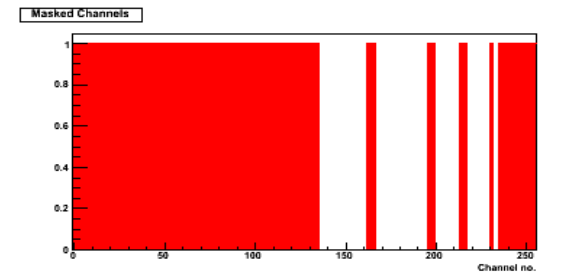
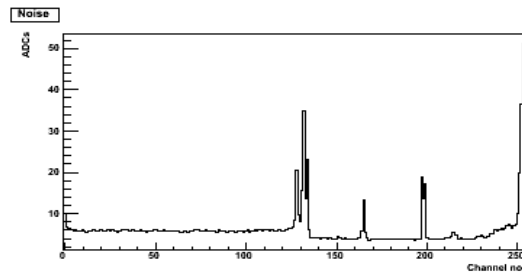
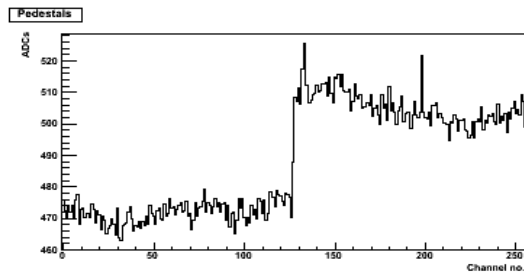
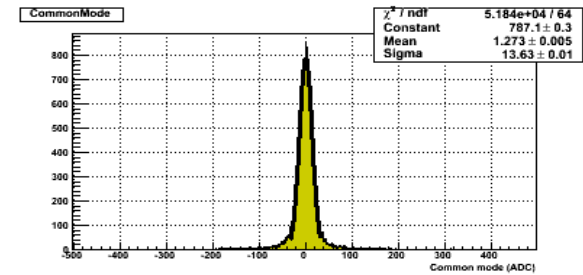
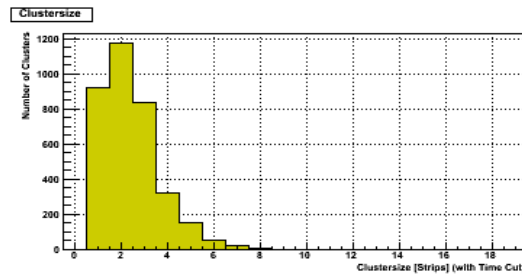
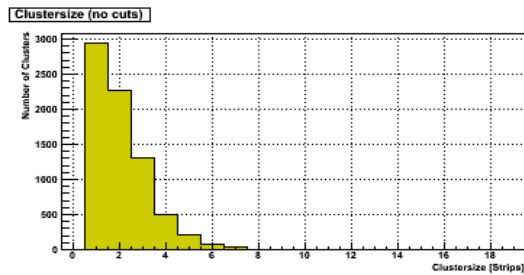
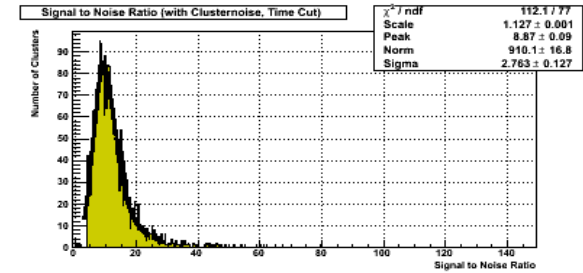
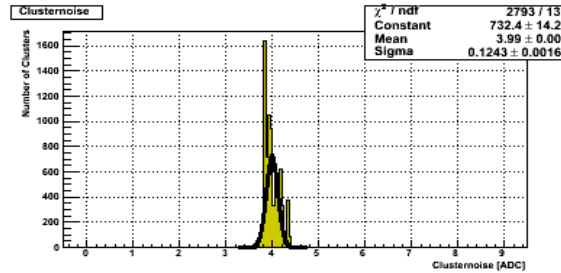
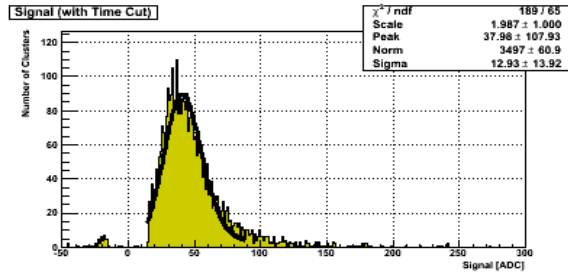
30221053604413
 Fluence: 4.5e+14 neq./cm²
 Run 2642
 RS
 Temperature: -10.1 °C
 Bias Voltage: 500.1 V
 Leakage Current: 0.156 mA
 Spectrum with Time Cut [36,58]

Analysis page -10°C not annealed, 600V



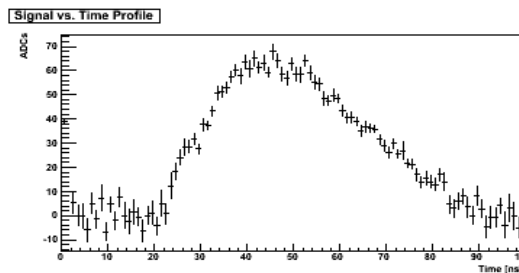
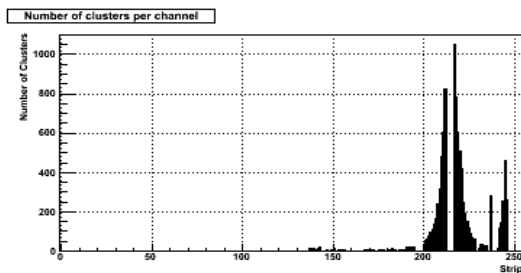
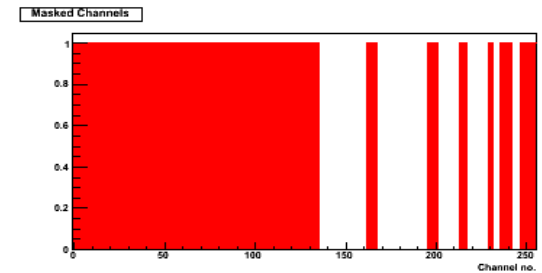
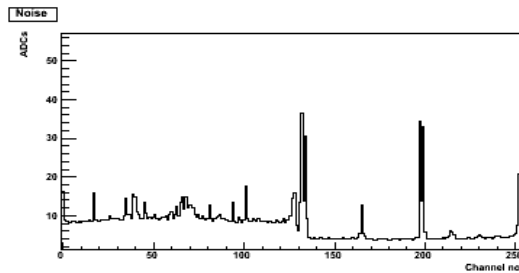
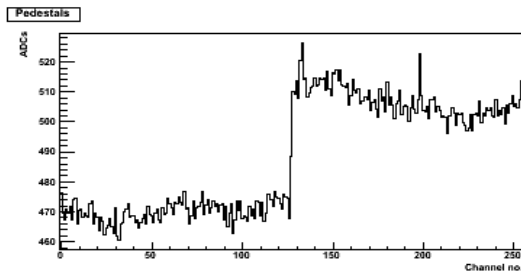
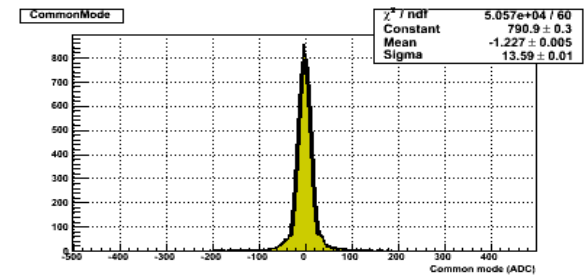
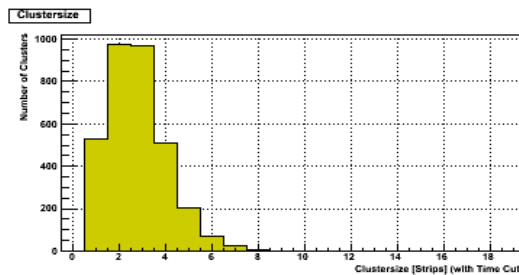
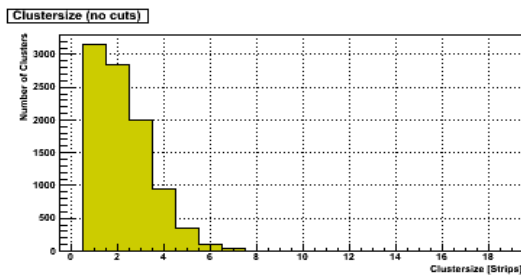
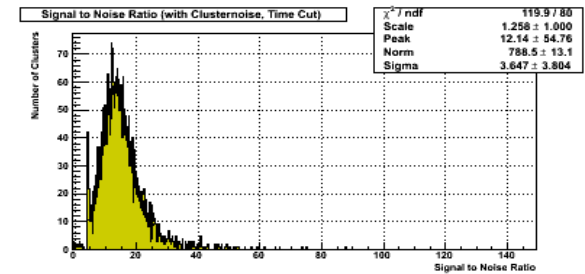
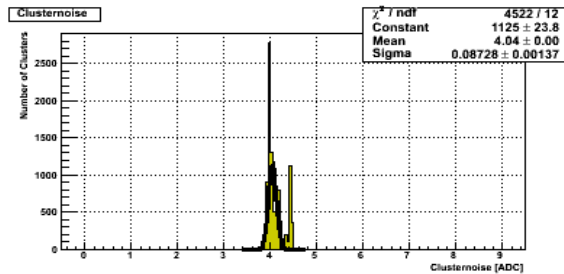
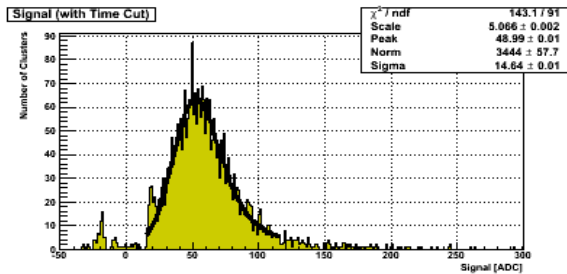
30221053604413
 Fluence: 4.5e+14 neq./cm²
 Run 2634
 RS
 Temperature: -10.1 °C
 Bias Voltage: 600.2 V
 Leakage Current: 0.176 mA
 Spectrum with Time Cut [36,54]

Analysis page -10°C not annealed, 800V



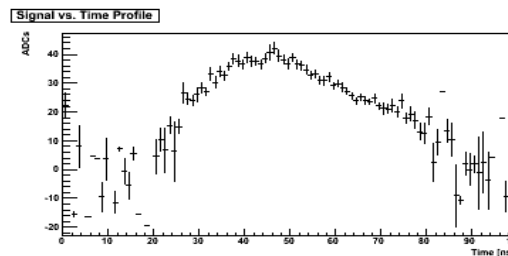
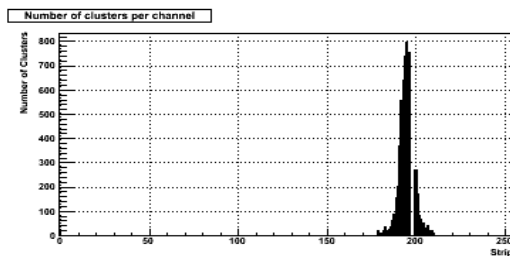
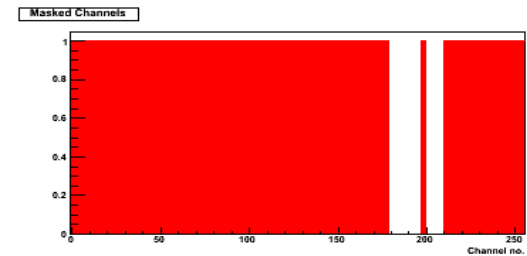
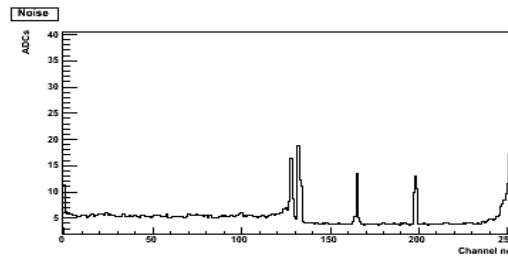
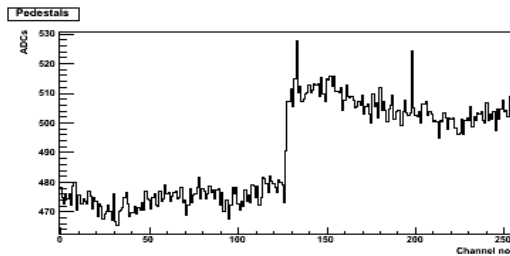
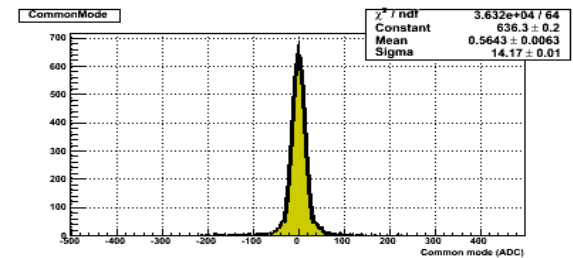
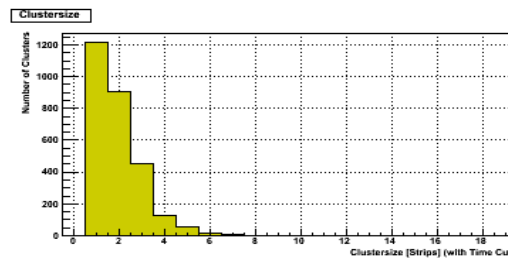
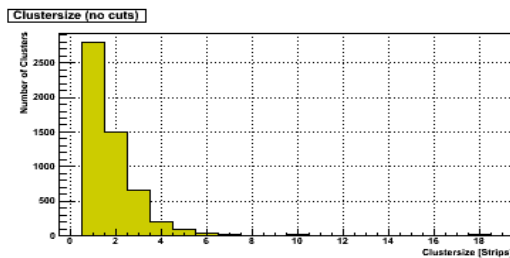
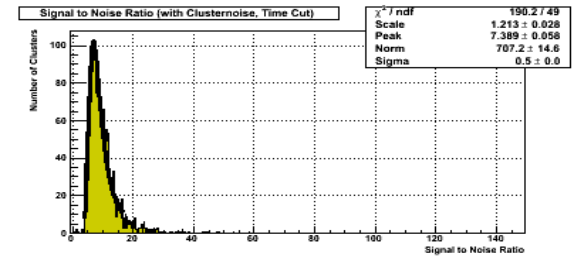
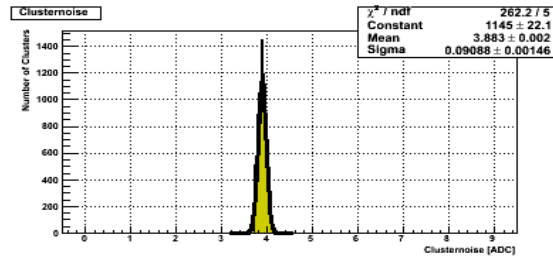
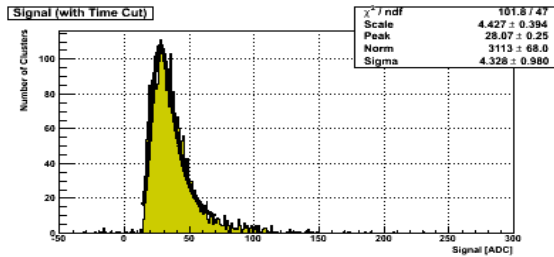
30221053604413
 Fluence: 4.5e+14 neq./cm²
 Run 2632
 RS
 Temperature: -10.2 °C
 Bias Voltage: 800.4 V
 Leakage Current: 0.220 mA
 Spectrum with Time Cut [37,55]

Analysis page -10°C not annealed, 1000V



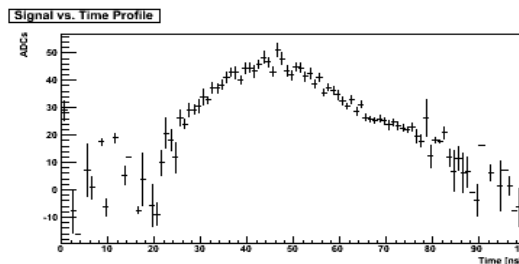
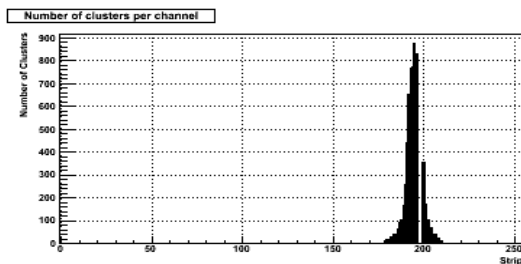
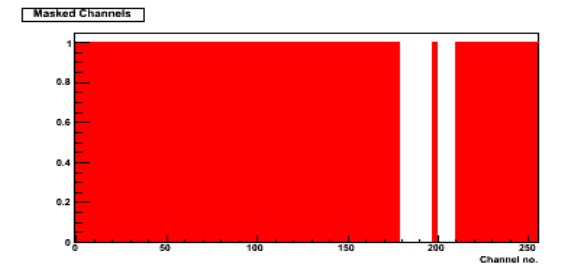
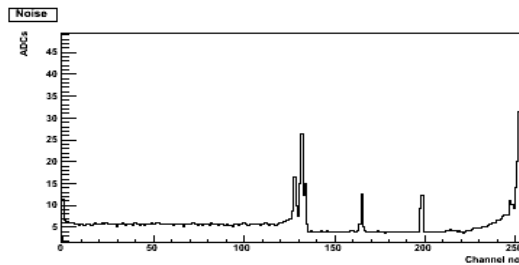
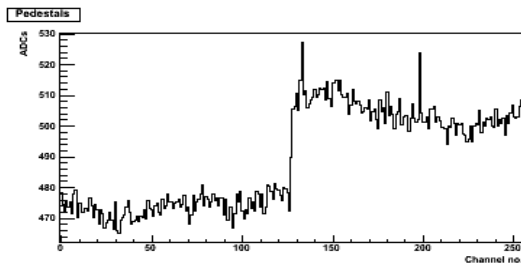
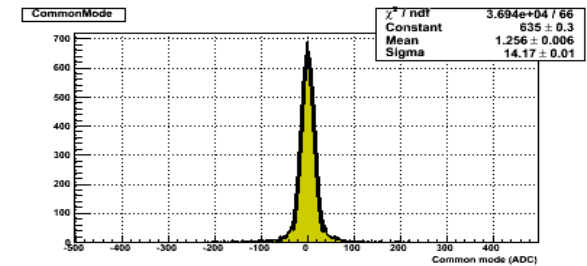
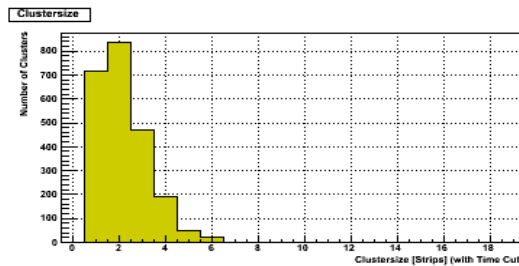
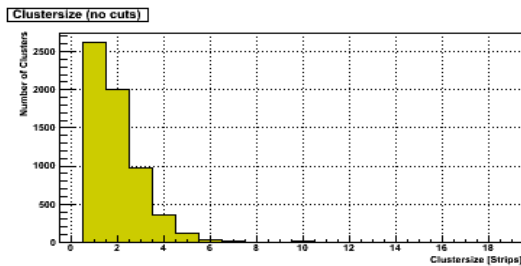
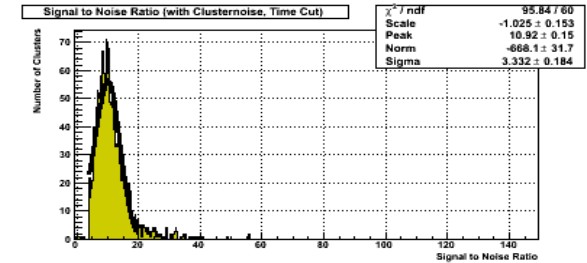
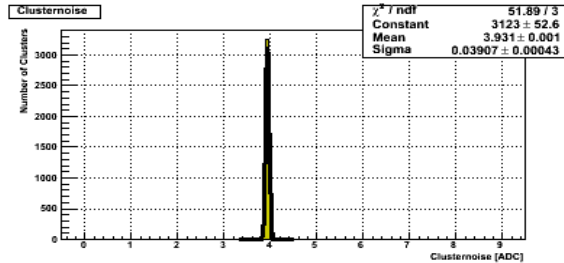
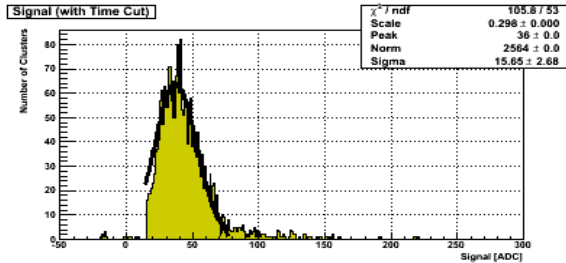
30221053604413
 Fluence: 4.5e+14 neq./cm²
 Run 2630
 RS
 Temperature: -10.1 °C
 Bias Voltage: 1000.0 V
 Leakage Current: 0.266 mA
 Spectrum with Time Cut [37,56]

Analysis page -10°C, 30min @ 60°C, 500V



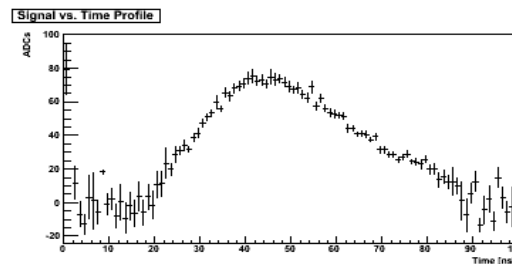
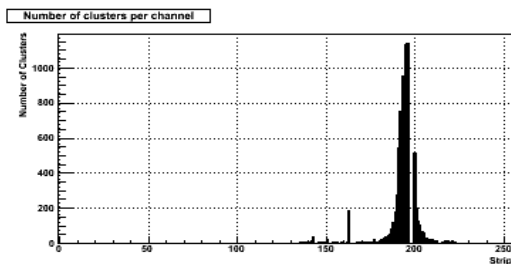
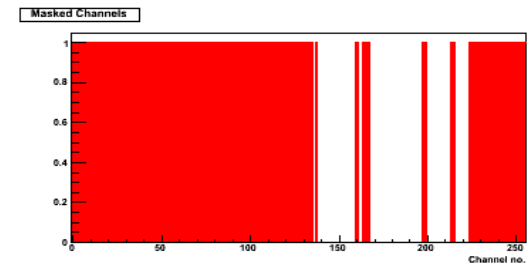
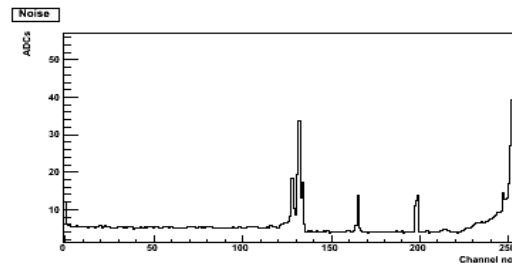
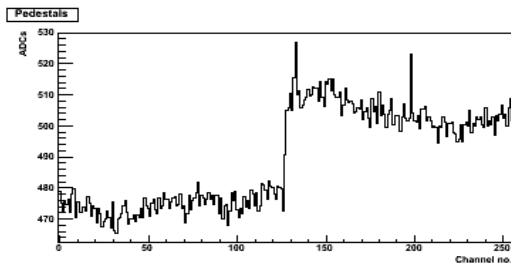
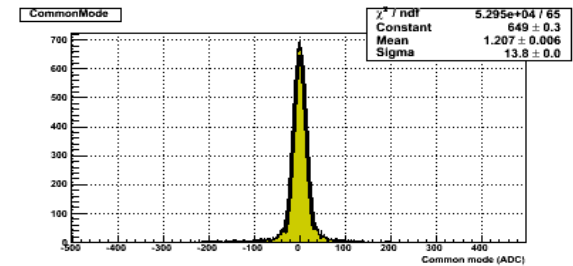
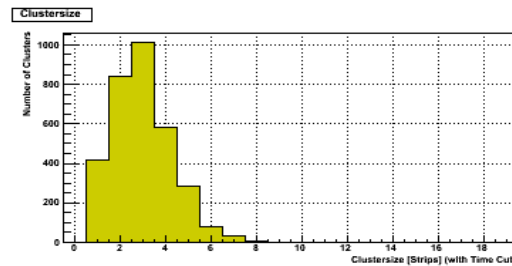
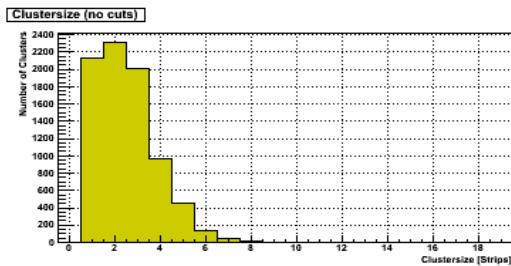
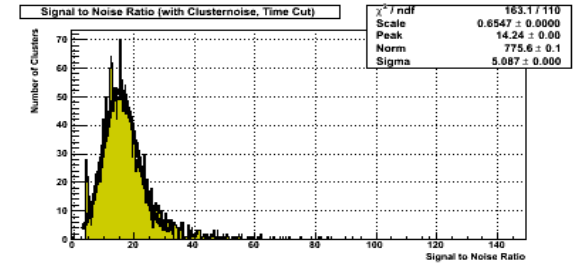
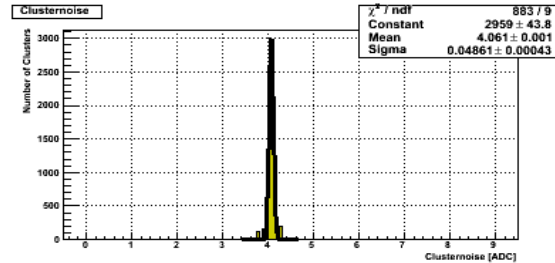
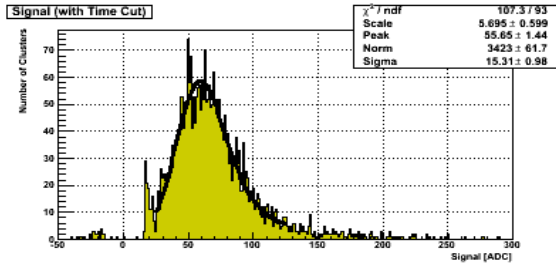
30221053604413
 Fluence: 4.5e+14 neq./cm²
 Annealingtime: 129.0 h at RT
 Run 2686
 RS
 Temperature: -10.2 °C
 Bias Voltage: 500.2 V
 Leakage Current: 0.150 mA
 Spectrum with Time Cut [37,54]

Analysis page -10°C, 30min @ 60°C, 600V



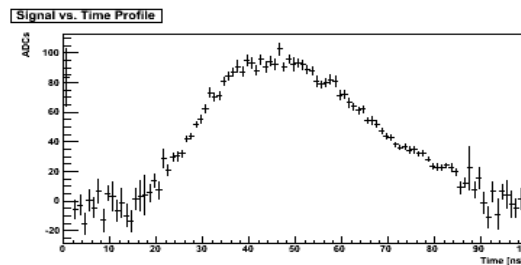
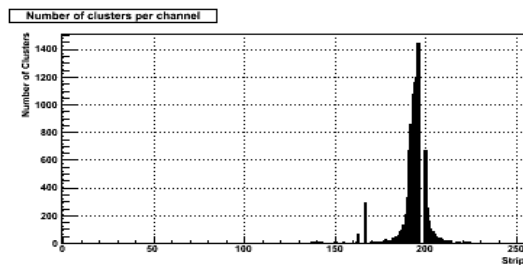
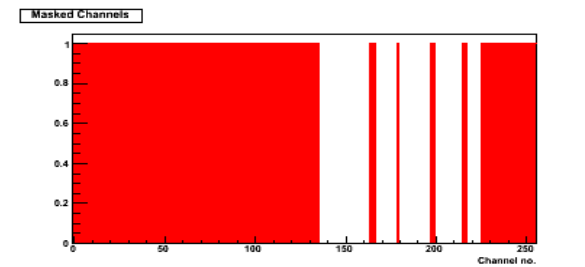
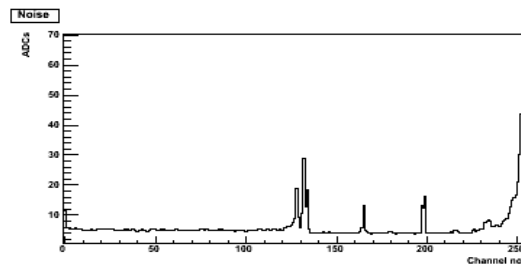
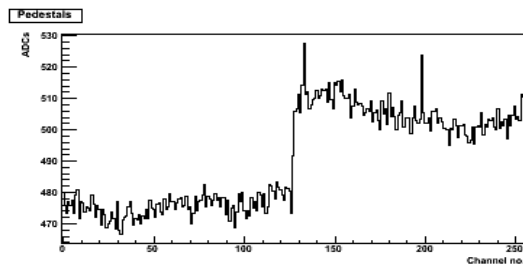
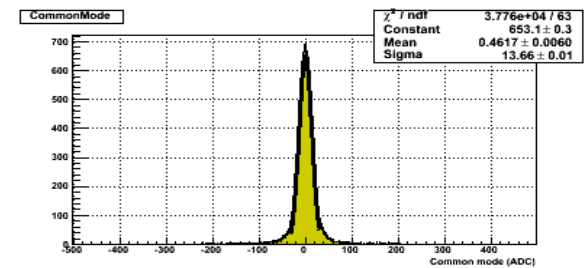
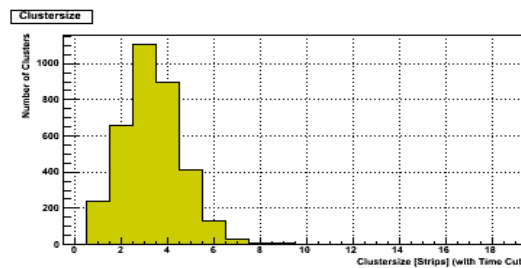
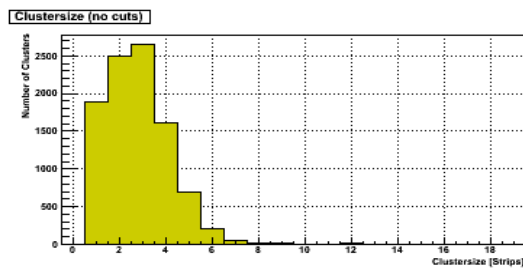
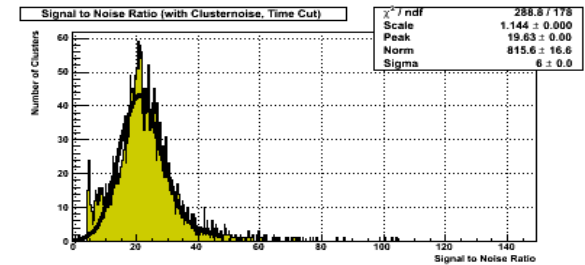
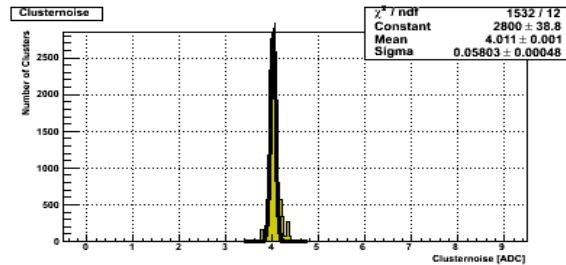
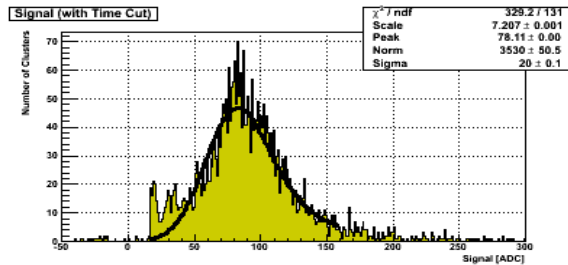
30221053604413
 Fluence: 4.5e+14 neq./cm²
 Annealingtime: 129.0 h at RT
 Run 2684
 RS
 Temperature: -10.3 °C
 Bias Voltage: 600.4 V
 Leakage Current: 0.167 mA
 Spectrum with Time Cut [40,54]

Analysis page -10°C, 30min @ 60°C, 800V



30221053604413
 Fluence: 4.5e+14 neq./cm²
 Run 2682
 RS
 Temperature: -10.3 °C
 Bias Voltage: 800.6 V
 Leakage Current: 0.200 mA
 Spectrum with Time Cut [36,55]

Analysis page -10°C, 30min @ 60°C, 1000V



30221053604413
 Fluence: 4.5e+14 neq./cm²
 Run 2680
 RS
 Temperature: -10.3 °C
 Bias Voltage: 1000.0 V
 Leakage Current: 0.236 mA
 Spectrum with Time Cut [36,54]

ALiBaVa Analysis

- Added:
 - Signal to noise definition
 - Cluster noise
 - Cluster size
 - Strip with most hits
 - Connection to database