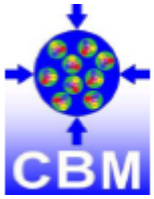


Nuclear Physics and Atomic Energy

KINR

Quality Assurance of the Microstrip Detectors for CBM Silicon Tracker Station.
Tests at KINR.

Ia. Panasenko, V. Kyva, I. Momot,
V. Pugatch, V. Militsiya

Institute for Nuclear Research NASU, Kiev.

Ukrainian-German Workshop
"Cooperation in the Framework of FAIR Project"
Kharkiv, Ukraine, 26th September 2014.

KINR at the CBM Collaboration.
CBM – experiment (FAIR)

High Energy Physics Department

Kiev Institute for Nuclear Research NASU (KINR)

CBM Team of KINR:

M. Borysova, A. Kovalchuk, V. Kyva, V. Militsija, I. Panasenko, V. Pugatch, D. Storozhyk, A. Lymanets (KINR & Tübingen, Physikalisches Institut, Eberhard Karls Universität Tübingen), A. Malygina (KINR & Frankfurt, Institut für Kernphysik, Goethe Universität Frankfurt), I. Sorokin (KINR & GSI, Darmstadt)

STS TDR.
KINR group planned contribution.

STS development and prototyping (year 2014 + ...)

- **Testing of sensors – (in collaboration with GSI, CIS)**
  - **Sensor prototype with STS-XYTER FEE (in collaboration with GSI)**
  - **Sensor prototype with STS-XYTER FEE and tap bonded flat cables (in collaboration with GSI)**
- **Integration of components into ladder prototype (in collaboration with GSI, Tubingen, KINR)**
  - **Test Ladder prototype (in collaboration with GSI)**

- **For carrying out this work KINR team has built the laser and radioactive sources test stand equipped with the whole readout chain based on the STS-XYTER FEE.**

Later stages of the CBM Construction (2015 -2016) KINR team plans.

- **Production, Assembly and System Integration**
- **STS Modules pre-production as well as production (in collaboration with GSI, Tubingen, JINR)**
- **STS Ladders production (in collaboration with GSI, Tubingen, JINR).**

Currently this is planned to be performed on the basis of participation of the KINR team members in construction work at GSI, Tubingen.

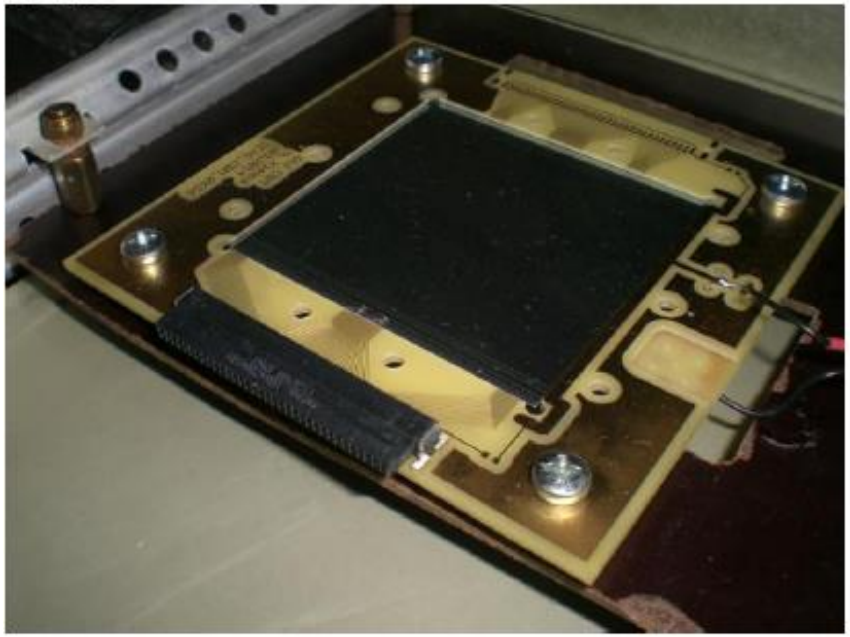
We plan to apply for grants from the Ministry of Science and Education and State Agency on Science ... (?) of Ukraine for building a necessary infrastructure at KINR.

Characterization of prototype sensors for the CBM Silicon Tracking System.
Year 2014. (Examples of Results).

Full size CBM-05

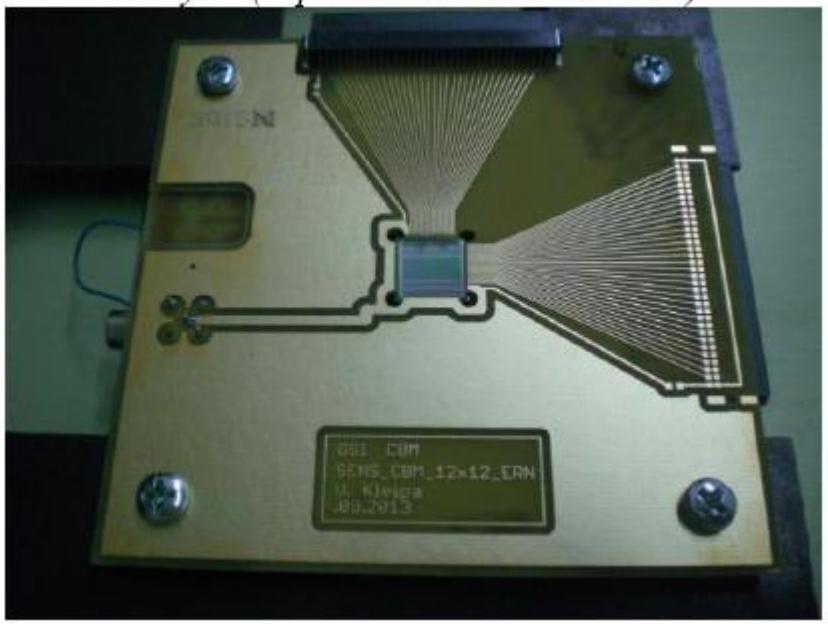
(transferred to Kiev from Kharkiv, June 2014)

CBM05



Three Baby-CBM-05 sensors (from GSI – June 2014)

CBM05-baby #1 (опромінений великою дозою)

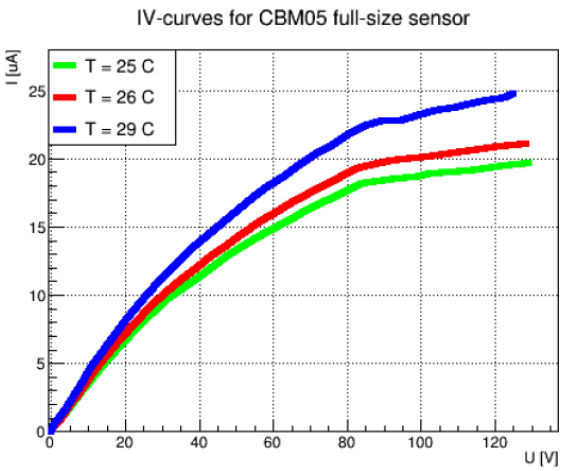


Two sensors were irradiated at the KINR isochronous cyclotron:

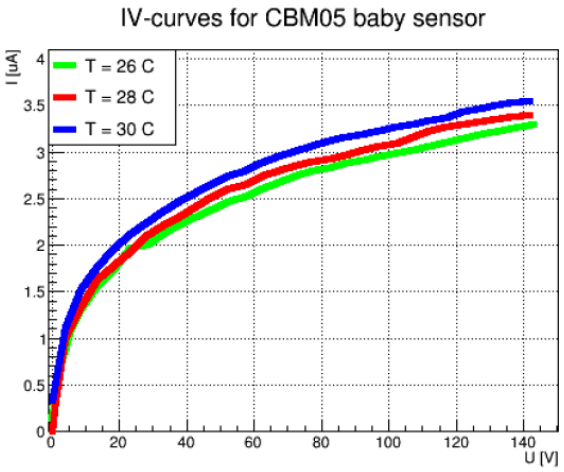
Alpha – particles – 86 MeV.

IV - measurements

IV. Non-irradiated sensors

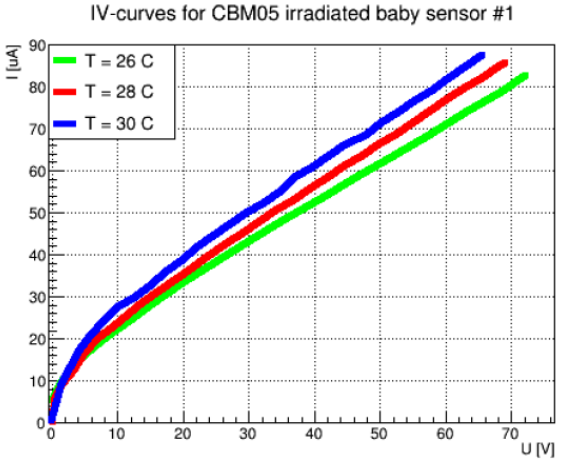


Full-size CBM-05



Baby-sensor

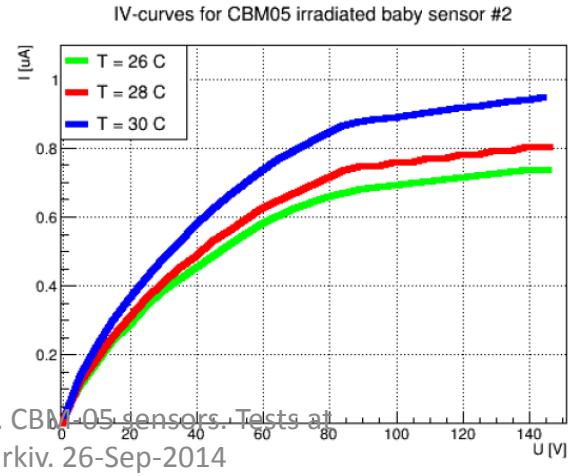
IV. Irradiated sensors.



Fluence:
1.1 x 10 ^{14} n_{eq} / cm^2

FDV (?) = >150 V

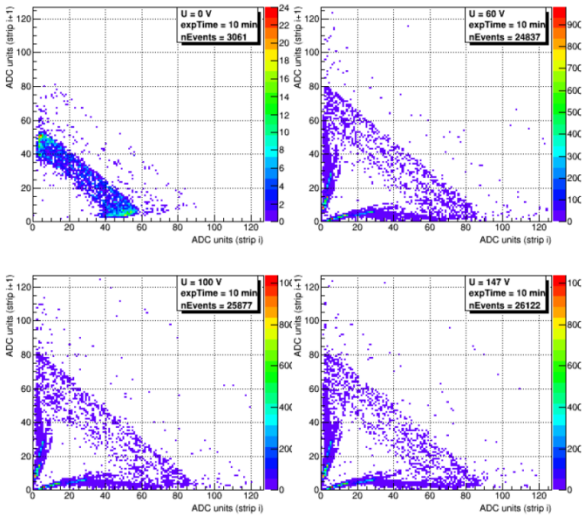
Alpha-particles – 86 MeV.



Fluence:
1.2 x 10 ^{13} n_{eq} / cm^2
FDV = 25 V

Studies with ^{239}Pu α – source
(coincident two-dimensional spectra at different bias voltages)

Baby – sensor (non-irradiated)
data from p-side (α – source from p-side)



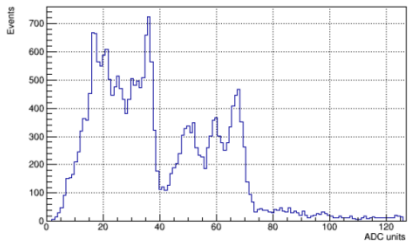
Bias Voltage:

0 V, 60 V

Correlated events – straight loci?

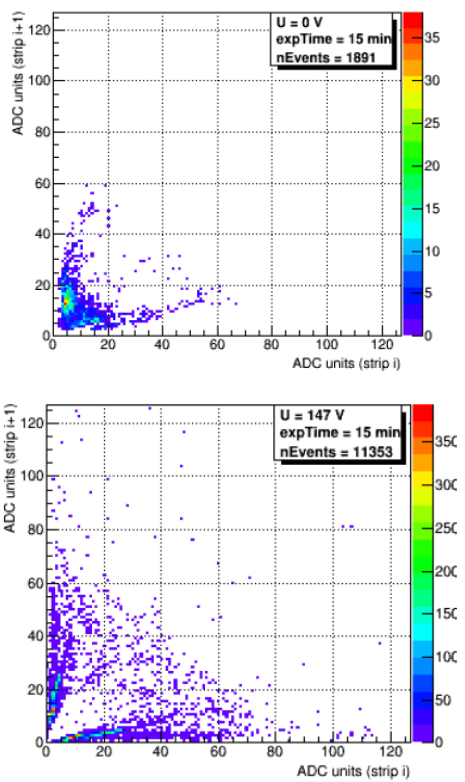
100 , 147 V

I проекція амплітудного розподілу з міжстріпового проміжку при 147 В дає три альфа-лінії:



Single dimensional spectrum – projection over the diagonal

Baby – sensor (irradiated)
data from p-side (α – source from p-side)



Bias Voltage:

0 V,

147 V

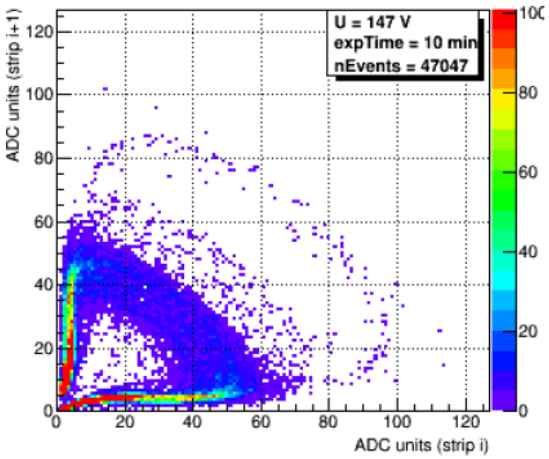
No clear Lines from ^{239}Pu α – source

Negative pulses ?

Correlated events – straight loci?

Studies with ^{239}Pu α – source
(coincident two-dimensional spectra at different bias voltages)

Baby – sensor (non-irradiated)
data from n-side (α – source from p-side)



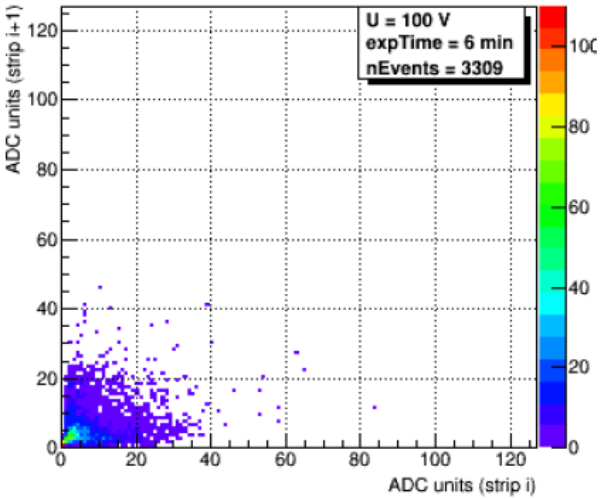
Bias Voltage:

147 V

Data appear already at 10 V

Correlated signals- straight loci ?

Baby – sensor (irradiated)
data from n-side (α – source from p-side)



Bias Voltage:

100 V

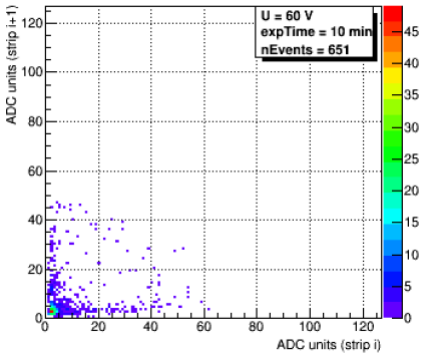
High noise

Full depletion was not reached

Studies with ^{239}Pu α – source
(coincident two-dimensional spectra at different bias voltages)

Baby – sensor (non-irradiated)

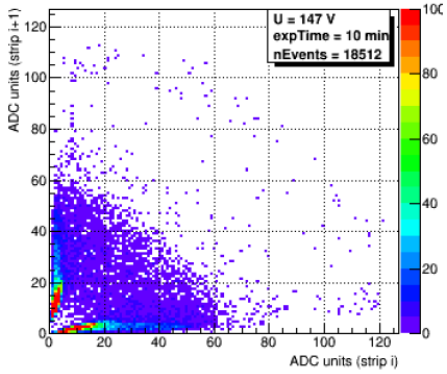
data from p-side (α – source from n-side)



Bias Voltage:

Data appear at

60 V

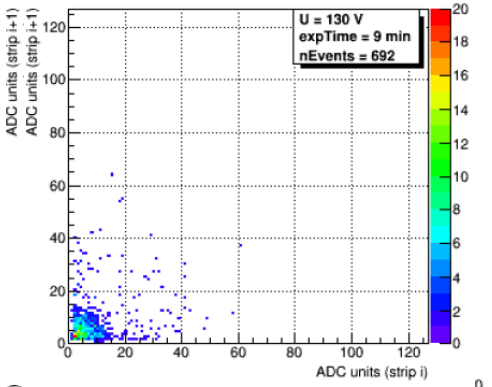


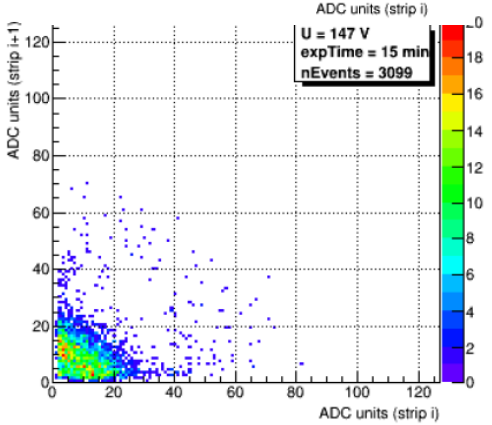
147 V

Correlated signals- straight loci ?

Baby – sensor (irradiated)

data from p-side (α – source from n-side)





Bias Voltage:

(data appear at 115 V)

130 V,

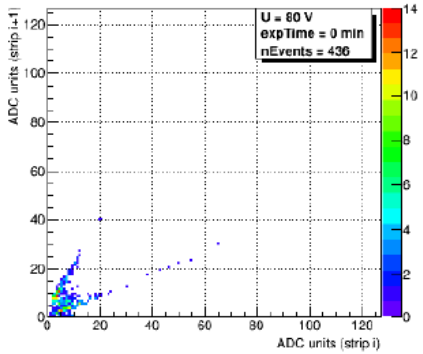
147 V

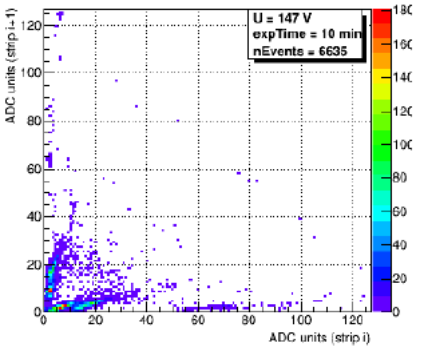
Much less events from ^{239}Pu α – source

Studies with ^{239}Pu α – source
(coincident two-dimensional spectra at different bias voltages)

Baby – sensor (non-irradiated)

data from n-side (α – source from n-side)





Bias Voltage:

80 V

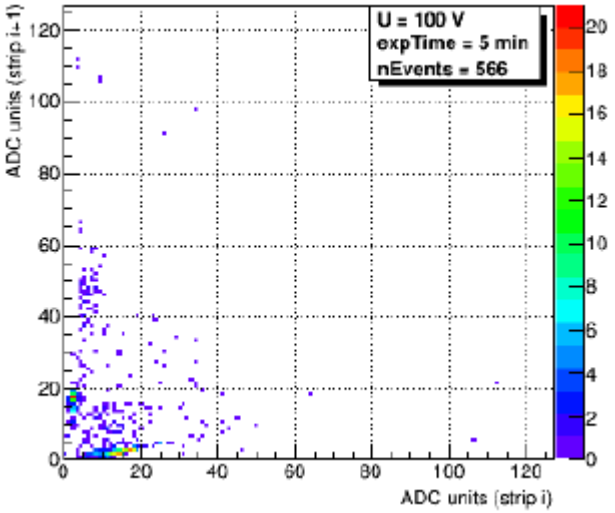
Data appear at 50 V

147 V

Correlated signals- straight loci ?

Baby – sensor (irradiated)

data from n-side (α – source from n-side)



Bias Voltage:

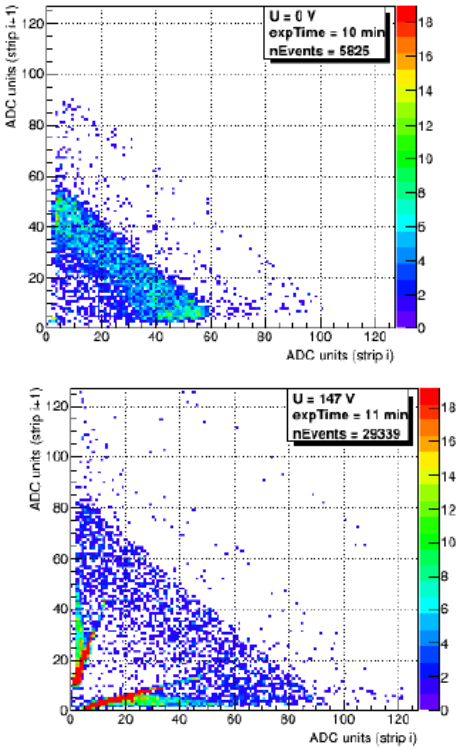
100 V,

Much less events from ^{239}Pu α – source

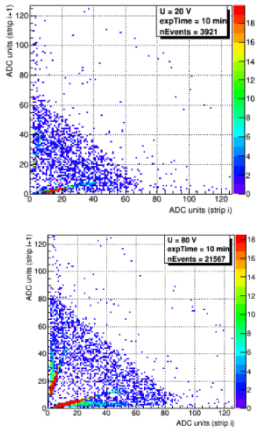
Negative pulses ?

Studies with ^{239}Pu α – source
(coincident two-dimensional spectra at different bias voltages)

Full size – sensor (non-irradiated)
data from p-side (α – source from p-side)



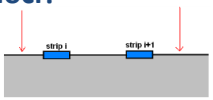
Bias Voltage:
0 V



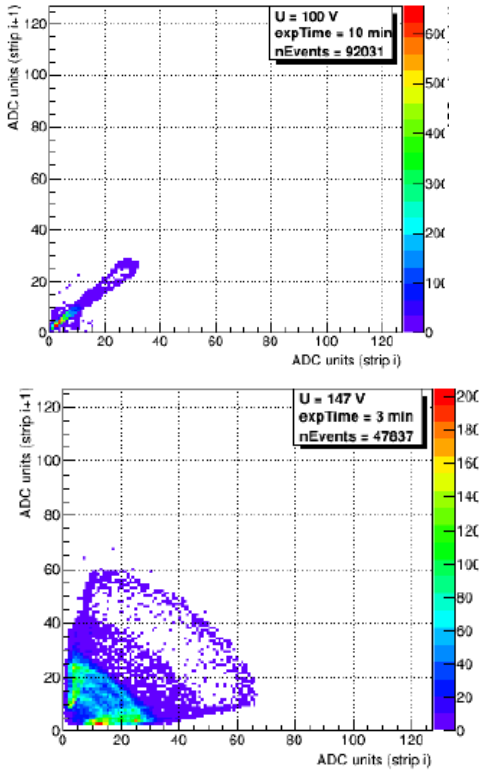
147 V

Poor resolution – no peaks from ^{239}Pu α – source

Correlated events – straight loci?



Full size – sensor (non-irradiated)
data from n-side (α – source from p-side)



Bias Voltage:

100 V,

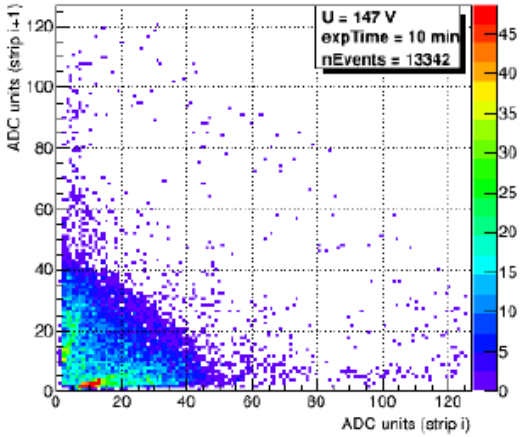
147 V

Lines from ^{239}Pu α – source are pronounced

The population of the straight loci grows up as the bias voltage increases.

Studies with ^{239}Pu α – source
(coincident two-dimensional spectra at different bias voltages)

Full size – sensor (non-irradiated)
data from p-side (α – source from n-side)



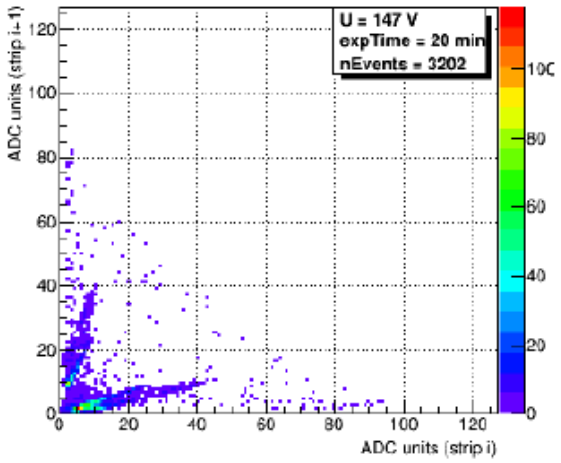
Bias Voltage:

147 V,

Correlated events – straight loci?

no peaks from ^{239}Pu α – source

Full size – sensor
data from n-side (α – source from p-side)



Bias Voltage:

147 V

Correlated events – straight loci?

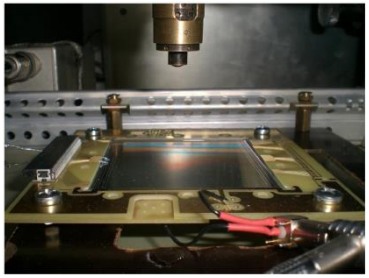
Brief Summary
on peculiarities of the alpha-tests data

- **All 4 tested sensors exhibit appearance of negative pulses (instead of expected positive ones) being irradiated from p-side as well as from n-side:**
  - **p-side – negative pulses go down as the biasing voltage increases**
  - **n-side – both polarities pulses are present**

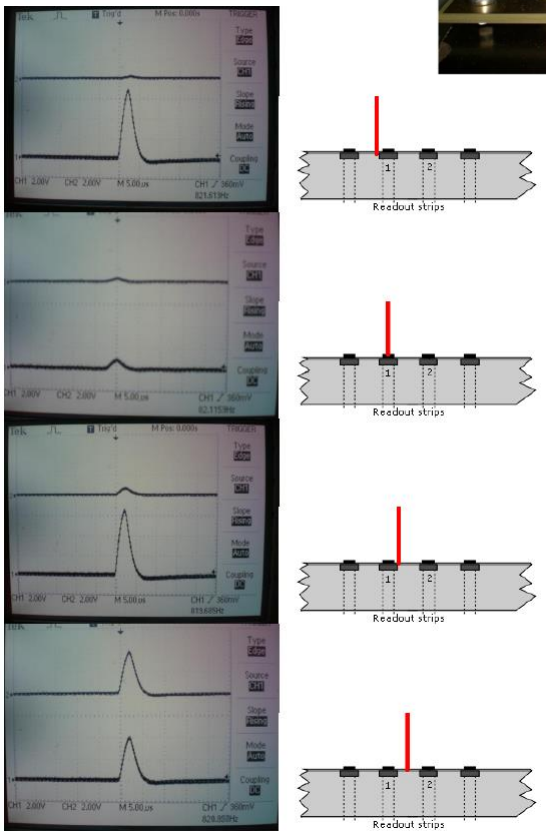
- **Smearing of the response to alphas indicated existence/appearance of the dead layer at both surfaces of sensors**

Studies with Laser stand (640 nm)
(coincident two-dimensional spectra at different bias voltages)

Full size – sensor data from p-side

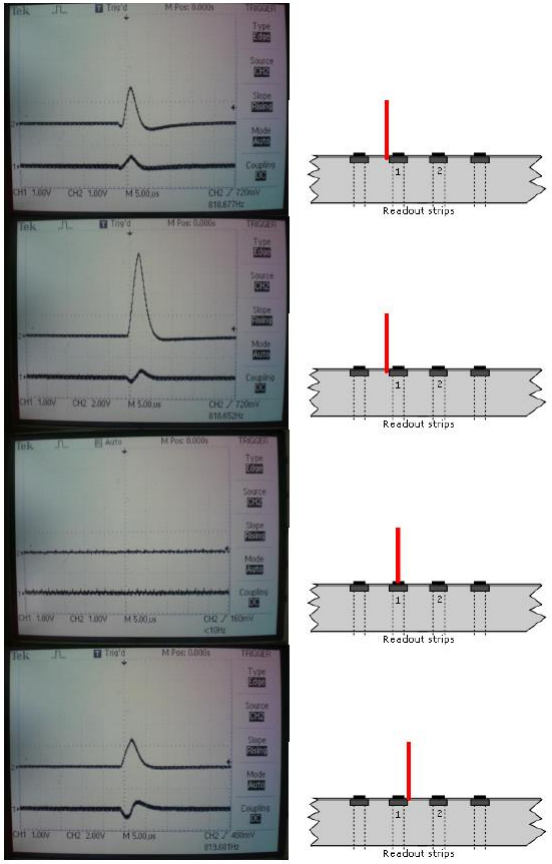


Full size – sensor data from p-side



Bias Voltage:

0 V

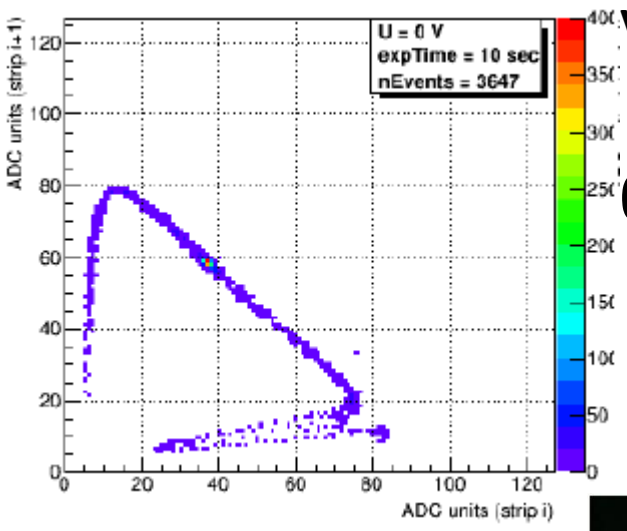


Bias Voltage:

147 V

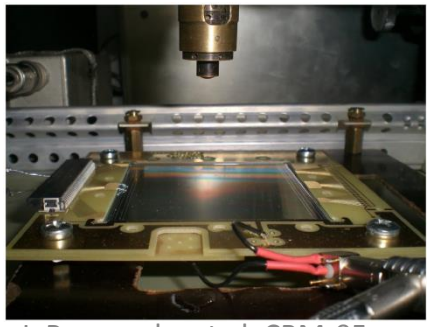
Studies with Laser stand (640 nm)
(coincident two-dimensional spectra at different bias voltages)

Full size – sensor
data from p-side

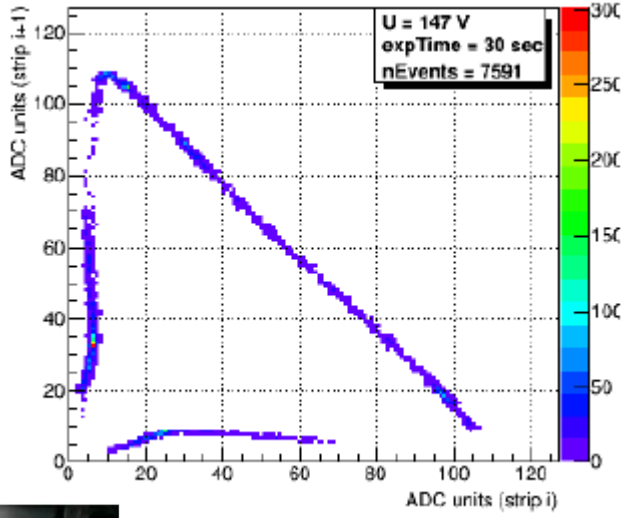


Bias Voltage:

0 V



Full size – sensor
data from p-side



Bias Voltage:

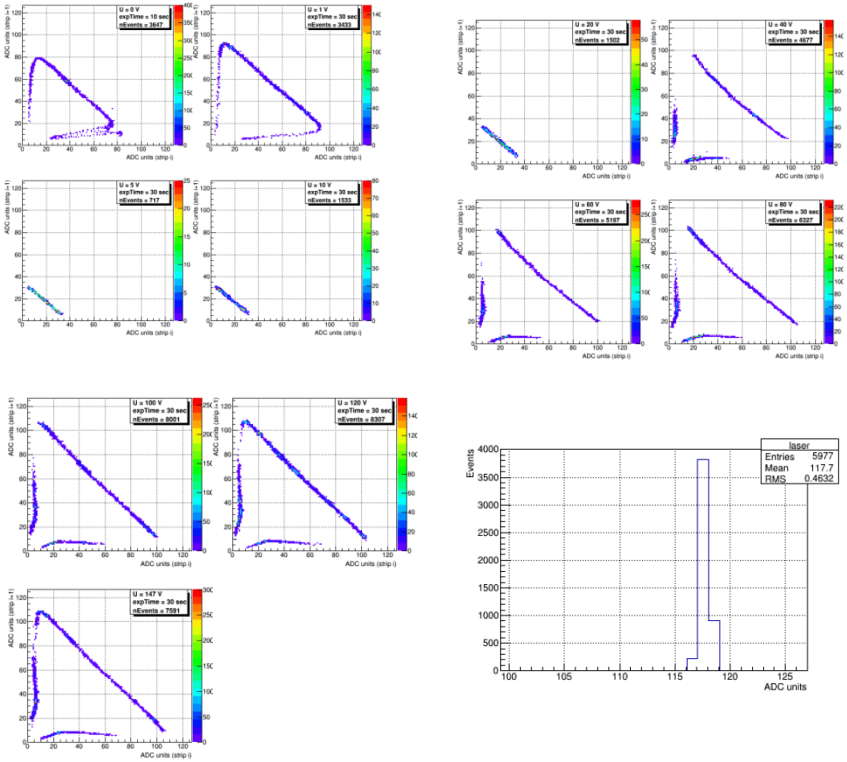
147 V

The sum of amplitudes 'Left+Right' strips grows up with the biasing voltage increase.

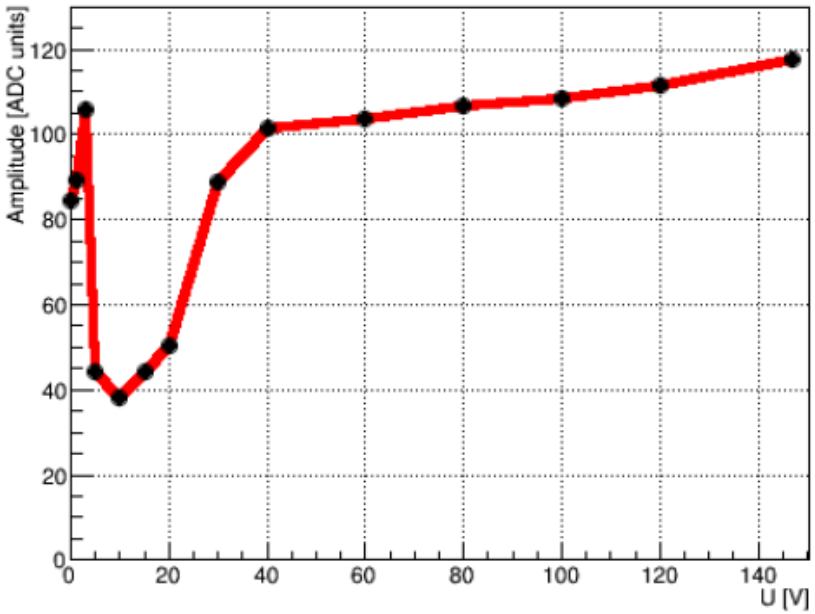
Yet! See the next slide 'peculiarity'

Studies with Laser stand (640 nm)
(coincident two-dimensional spectra at different bias voltages)

Full size – sensor data from p-side.
Biasing voltage increases for 0 to 147 V.

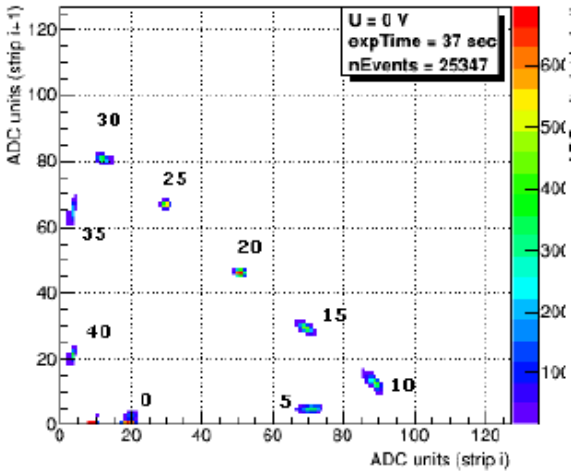


Full size – sensor data from p-side.
Biasing voltage increases for 0 to 147 V.



Studies with Laser stand (640 nm)
(coincident two-dimensional spectra at different bias voltages)

Full size – sensor
data from p-side

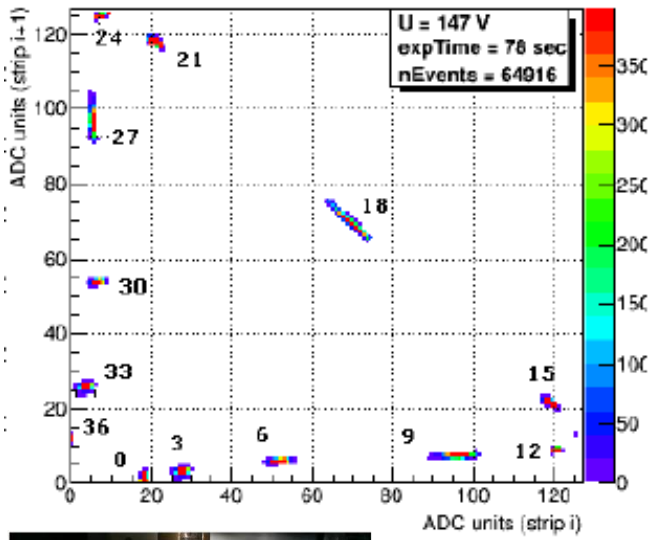


Bias Voltage:

0 V

5 mum Steps By laser

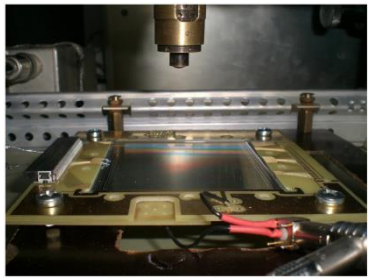
Full size – sensor
data from p-side



Bias Voltage:

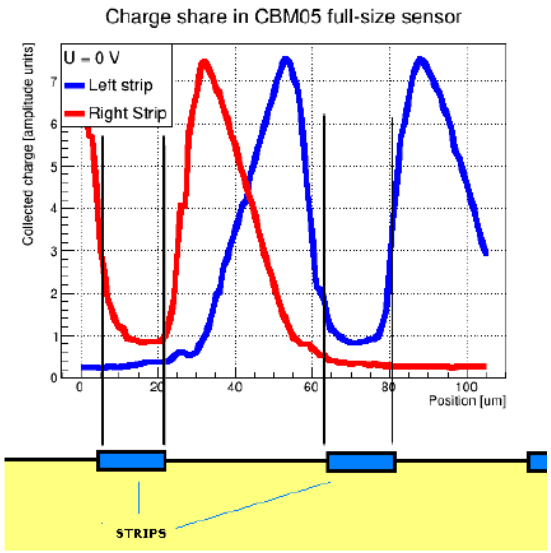
147 V

3 mum Steps By laser



Studies with Laser stand (640 nm)
(coincident two-dimensional spectra at different bias voltages)

Full size – sensor
data from p-side

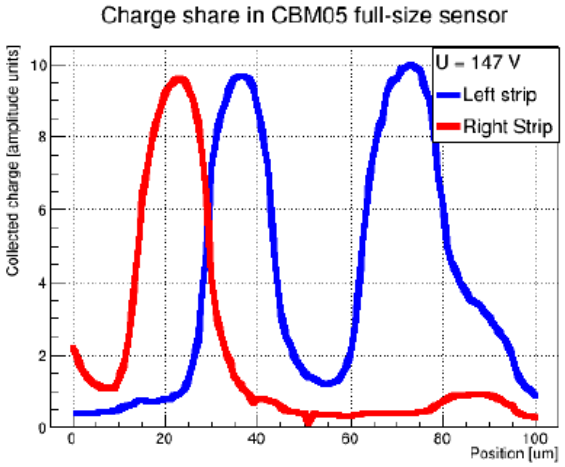


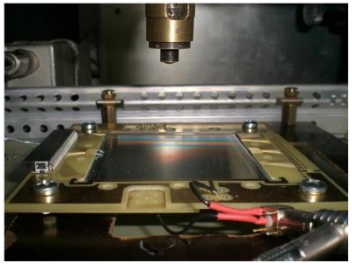
Bias Voltage:

0 V

5 mum Steps By laser

Full size – sensor
data from p-side





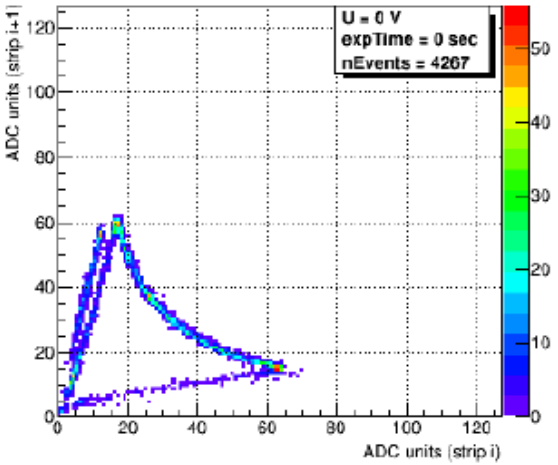
Bias Voltage:

147 V

3 mum Steps By laser

Studies with Laser stand (640 nm)
(coincident two-dimensional spectra at different bias voltages)

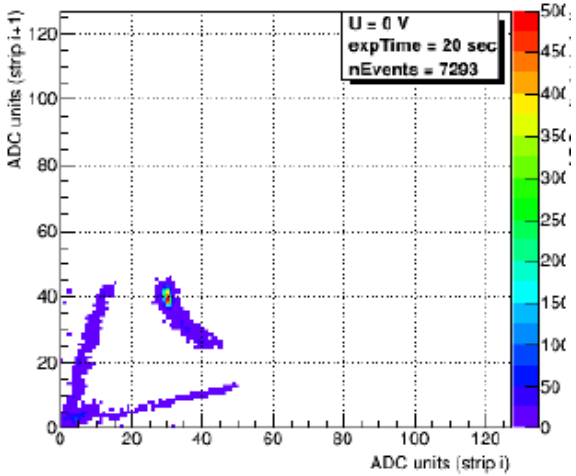
Baby– sensor (non- irradiated)
data from p-side



Bias Voltage:

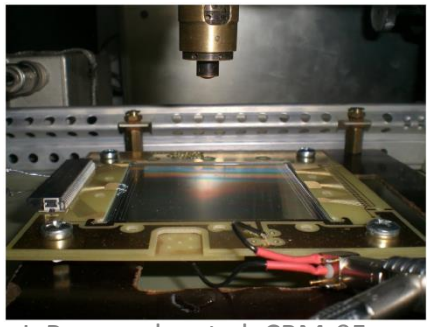
0 V

Baby– sensor (irradiated)
data from p-side



Bias Voltage:

0 V



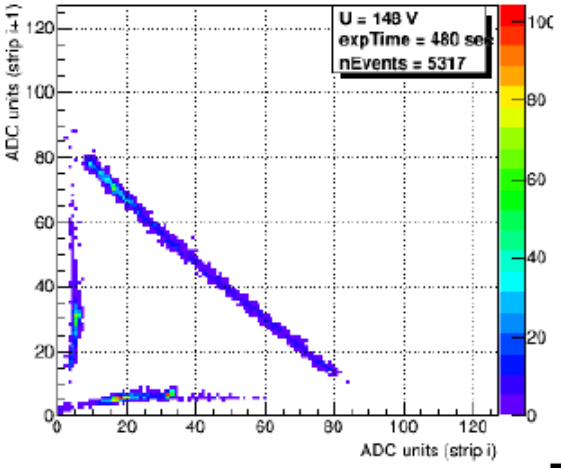
Studies with Laser stand (640 nm)

(coincident two-dimensional spectra at different bias voltages)

Baby– sensor (non- irradiated)
data from p-side

Bias Voltage:

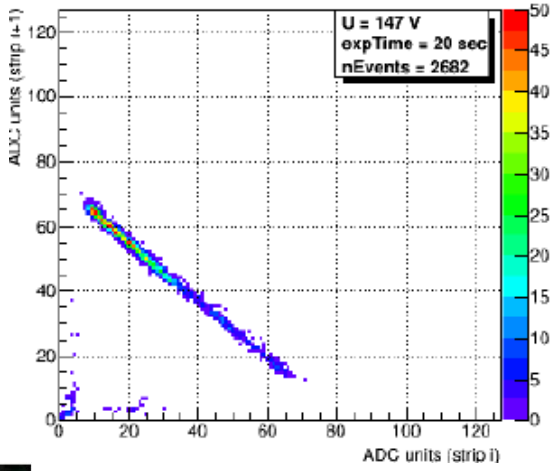
147 V

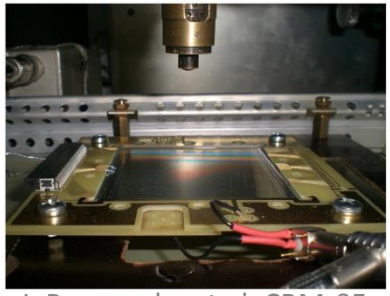


Baby– sensor (irradiated)
data from p-side

Bias Voltage:

147 V





Charge collected went down by ~ 25 %.

Summary and outlook

1. Quality assurance setups at KINR (alphas as well as laser) for Silicon Microstrip Sensors are in operation.
2. 2 sensors irradiated at KINR isochronous cyclotron and two non-irradiated sensors were characterized.
3. All 4 sensors tested by alphas as well as by laser demonstrated nearly expected performance wrt to charge sharing in the interstrip gap.
4. Very good position resolution !
5. YET … To be further studied/understood:

- appearance of the correlated events – 'straight loci' in two-dimensional distribution of the charge collected at adjacent strips (pick-up ?).
- opposite polarity pulses at adjacent strips?
- dead layers (10-20 mum) at the p-n-sides - ?

6. Next steps:
   - MIP – studies
   - New sensors

This work is ongoing and is partially funded via the NASU budget. On the time to time basis there are related business trips to GSI, supported by the CBM.

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Thank you for your attention !