RD51 COLLABORATION MEETING

Preliminary measurements on 10x10 Cu-Apical-DLC GEM

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on behalf of GDD, MPT and USTC

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Introduction

Motivation for using the (single side) DLC GEM:

- low material budget – thin layer of DLC instead of 5 um Cu
- no intrinsic fluorescence – as Cu, Cr, …
- avoid reflection in optical readout - might improve spatial resolution
- small energy released during a spark
- …

Final goals:

- aiming to double side DLC - *for the moment only one side, enough to perform preliminary measurements*
- aiming to low resistivity DLC - *to avoid charging up and rate issues; for the moment 100 MOhm/sq*

References

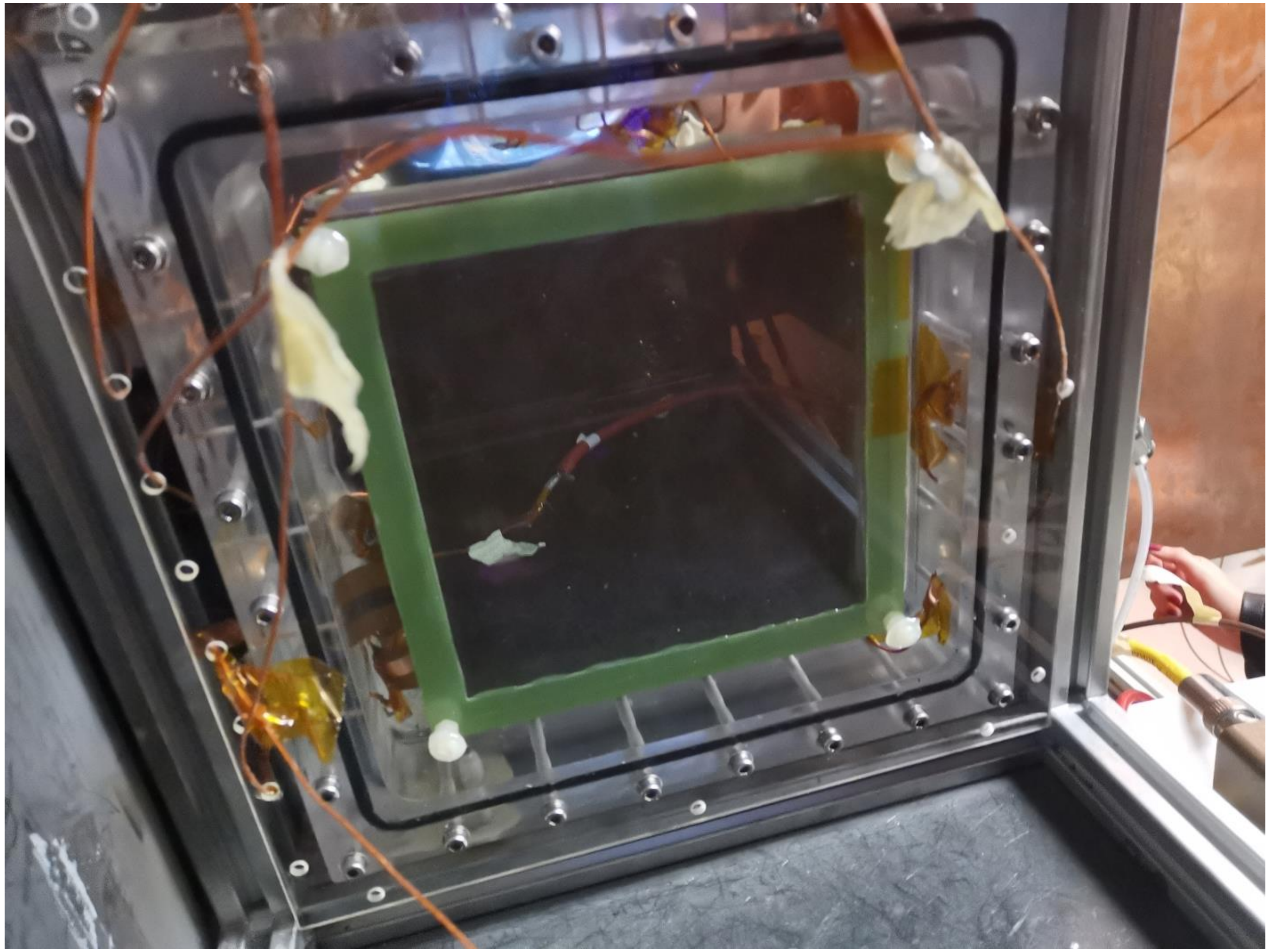
- Resistive DLC, Yi Zhou:

https://indico.cern.ch/event/843711/contributions/3607904/

- GEM production, Rui De Oliveira:

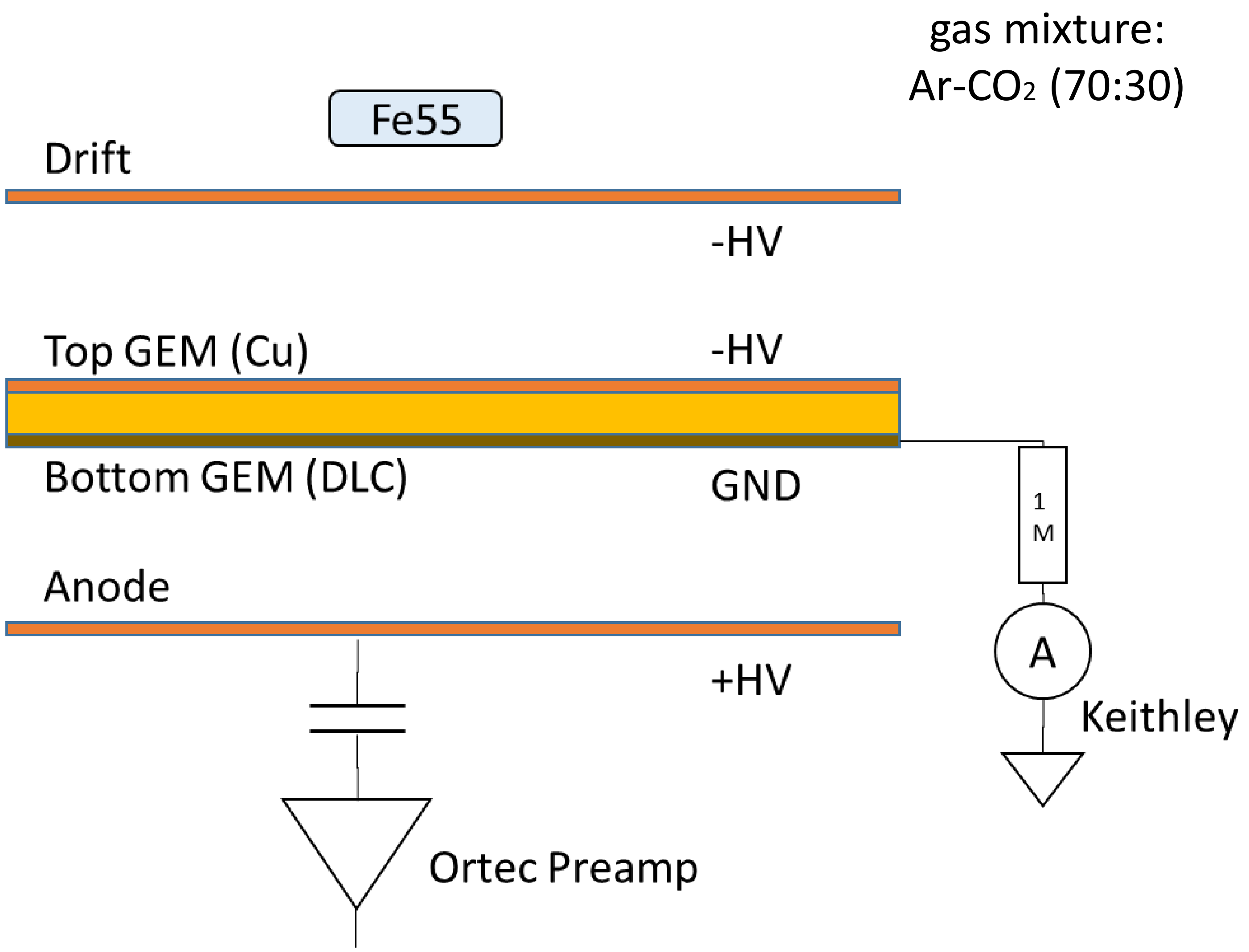
https://indico.cern.ch/event/843711/contributions/3607915/

DLC GEM photo



Electronic readout

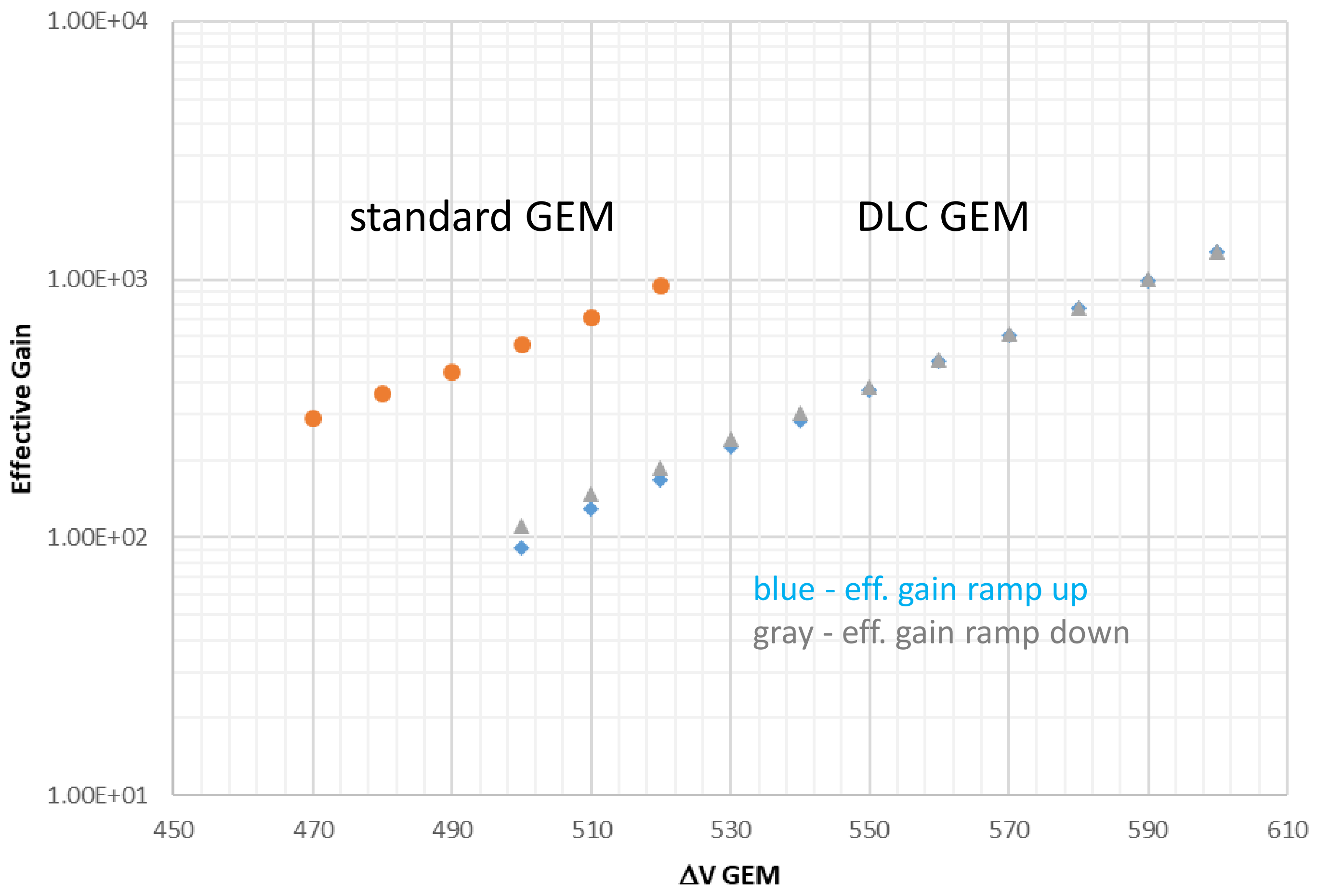
Set up



Effective gain

comparison with a standard GEM

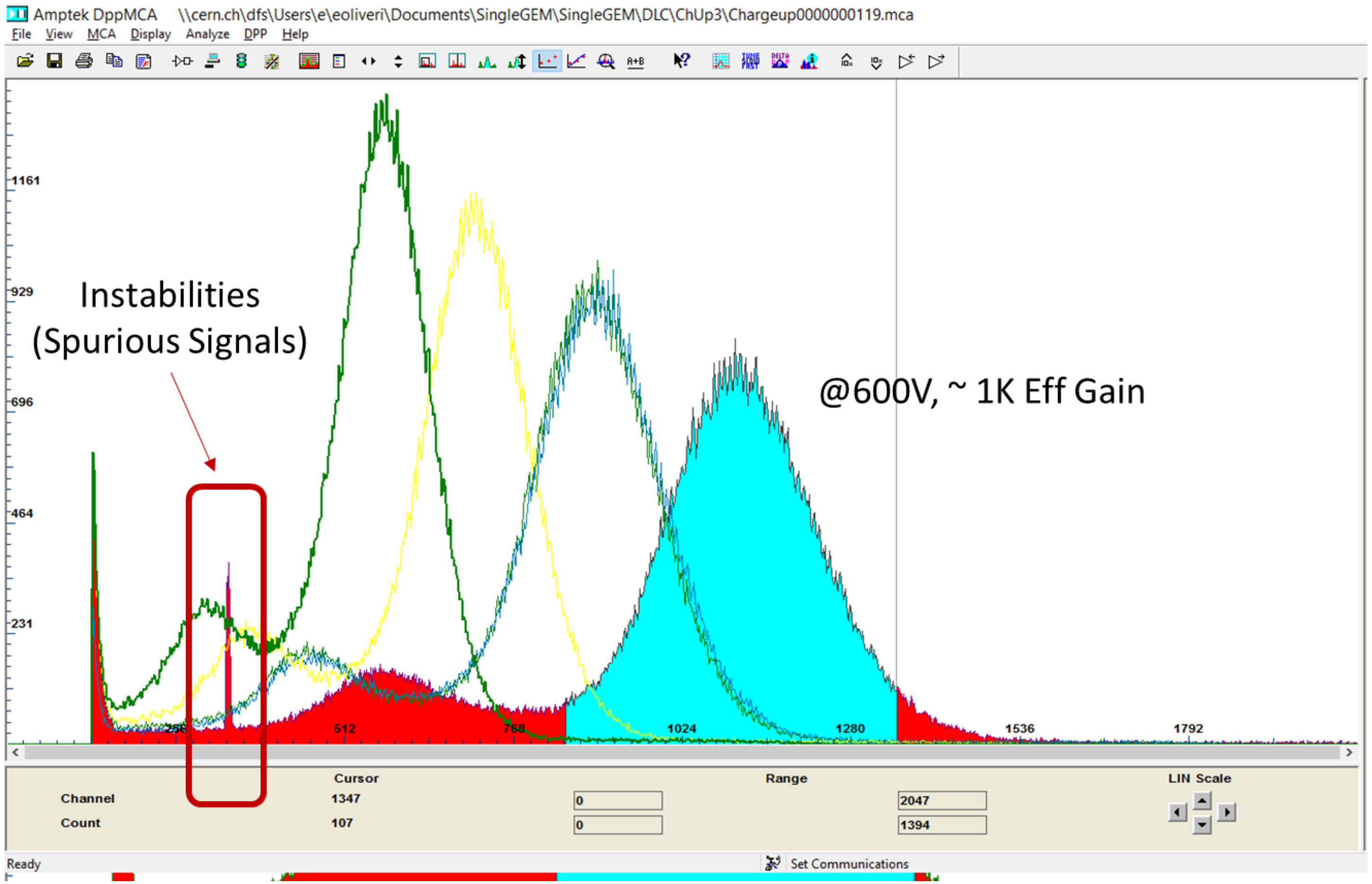
- effective gain measured using the current collected at the bottom of the DLC
- DLC GEM not too different from a standard GEM (in terms of max. reachable gain) - about 100 V more to get a similar gain



Spectrum

of a collimated measurement, i.e. with the source irradiating a small area of the detector

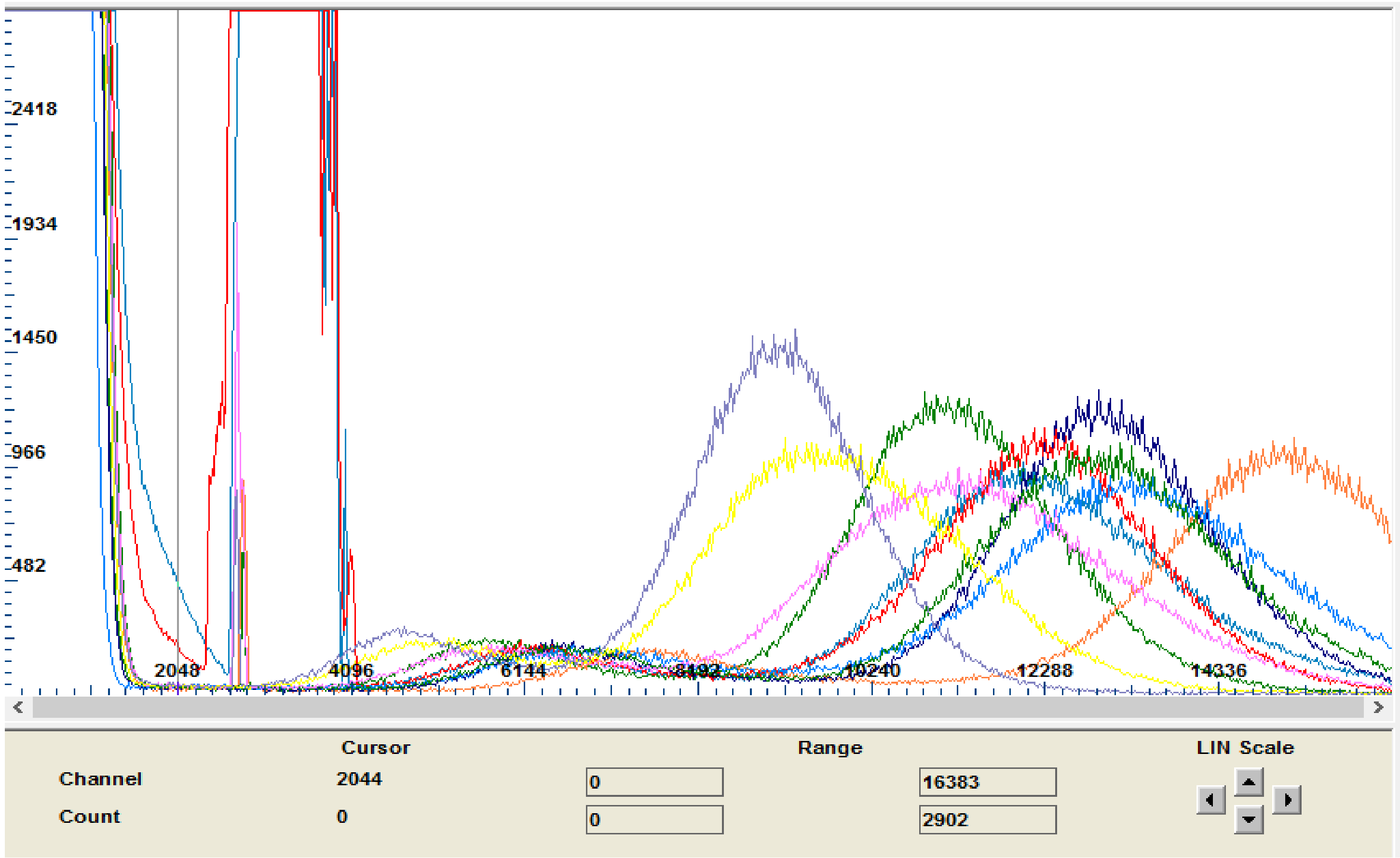
- different peaks represent different voltages (and different gains)
- localized instabilities coming after irradiation
- to be studied using optical readout



Spectrum

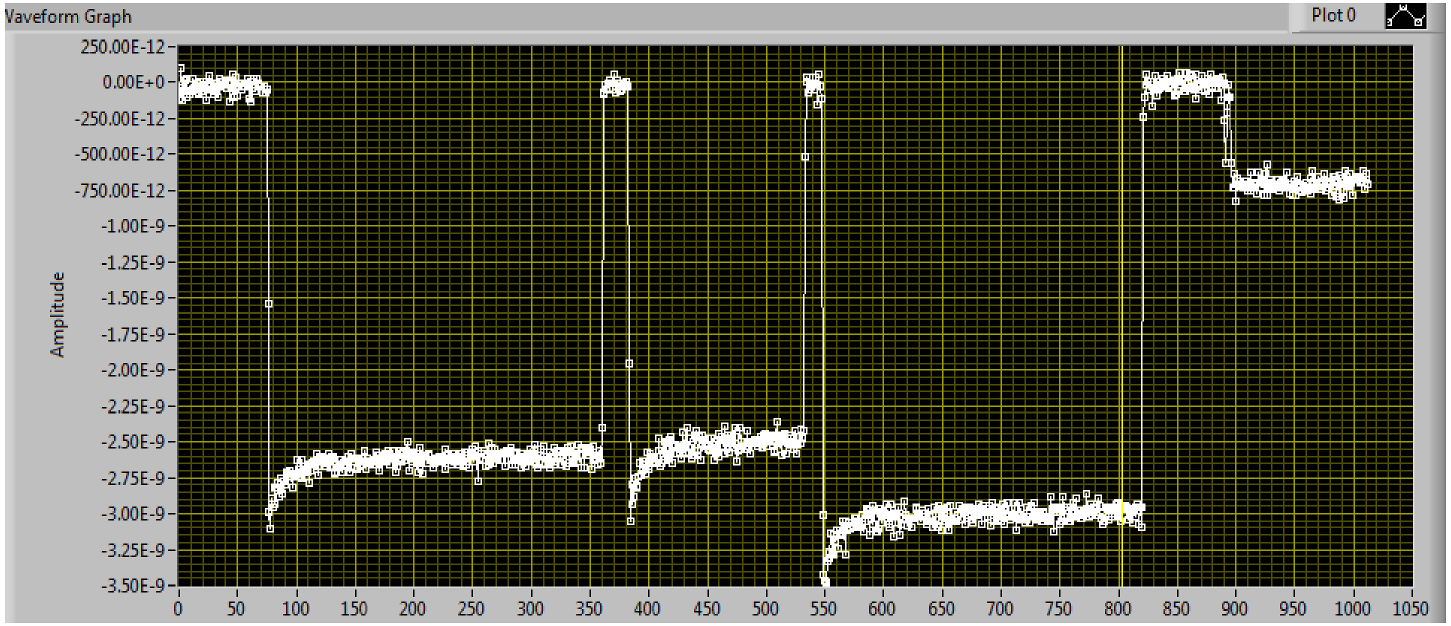
of a collimated measurement, i.e. with the source irradiating a small area of the detector

- different peaks represent different irradiated regions
- response is not uniform
- to be studied vs position



Charging up

- due to the resistivity of the DLC layer there are some charging up behavior which will be investigated more closely

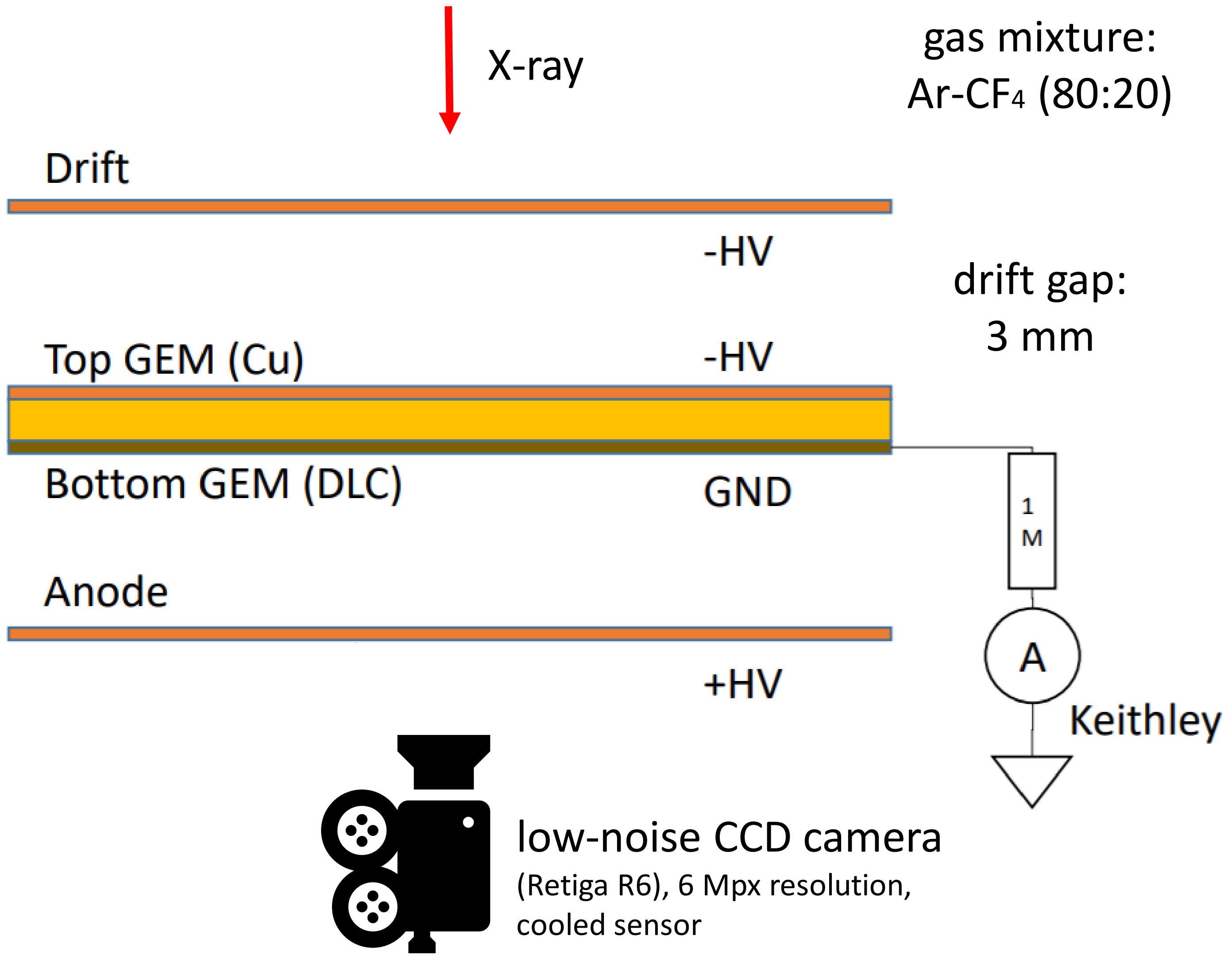


Time (~sec)

Optical readout

Motivation:

- it is easy to localize defects such as the discharge that was observed in the electronic measurements



Discharges

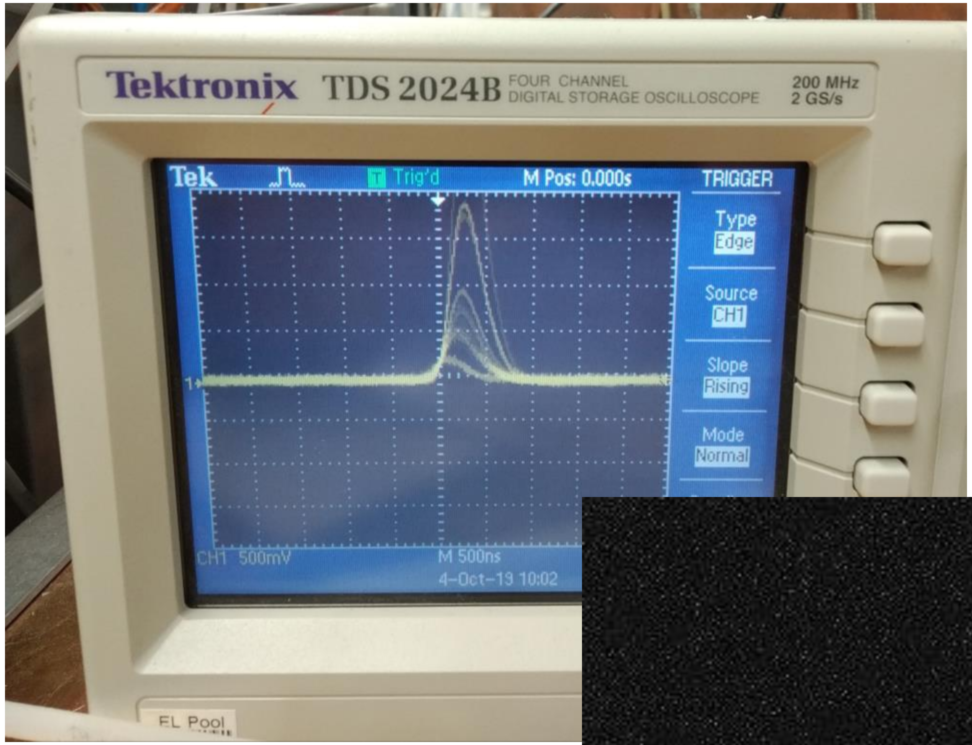
X-ray OFF

GEM Top: U = 480-520 V

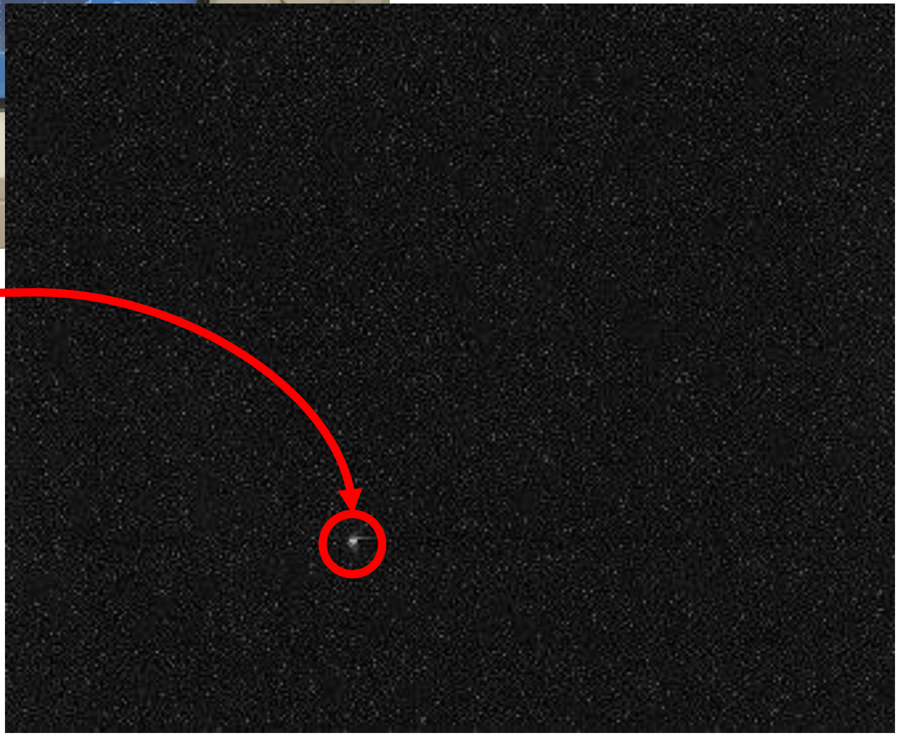
Cathode: U = 810 V

Exposure time: 100 ms

Binning: 8x8



Electronic readout: Visible weak point on the oscilloscope.



Due to the resistivity of the DLC layer we have only small energy released during a spark and the camera can record a discharge.

Discharges

X-ray ON

X-ray: U = 20 kV,
I = 0,1 mA

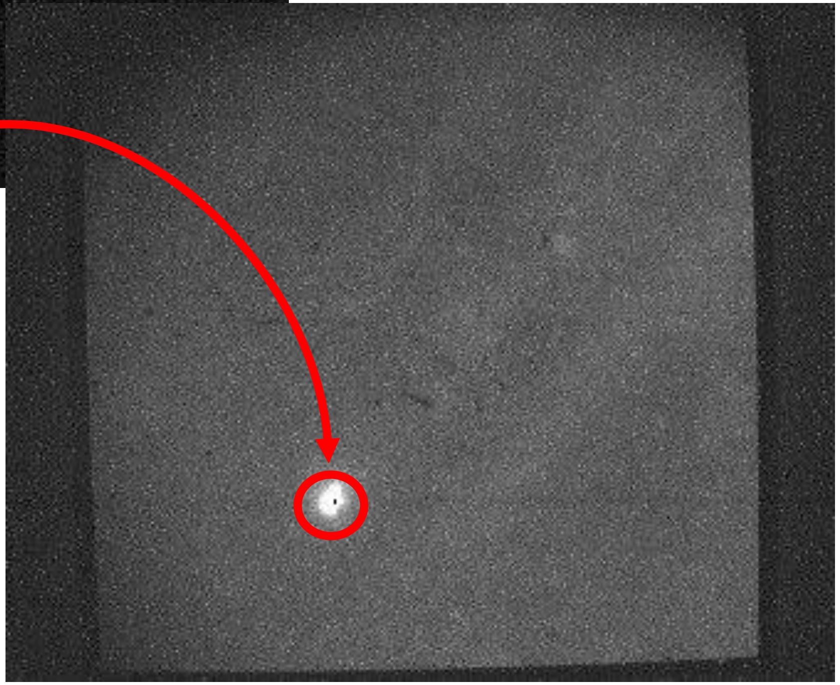
GEM Top: U = 480-520 V

Cathode: U = 810 V

Exposure time: 100 ms

Binning: 8x8

The intensity of the discharge is so small that it does not saturate the camera and it is still possible to see the signal from the rest of the active area.



“The bat” X-ray scan

X-ray: U = 20 kV; I = 1.0 mA

GEM Top: U = 400 V; I = 84,1 nA

Cathode: U = 810 V

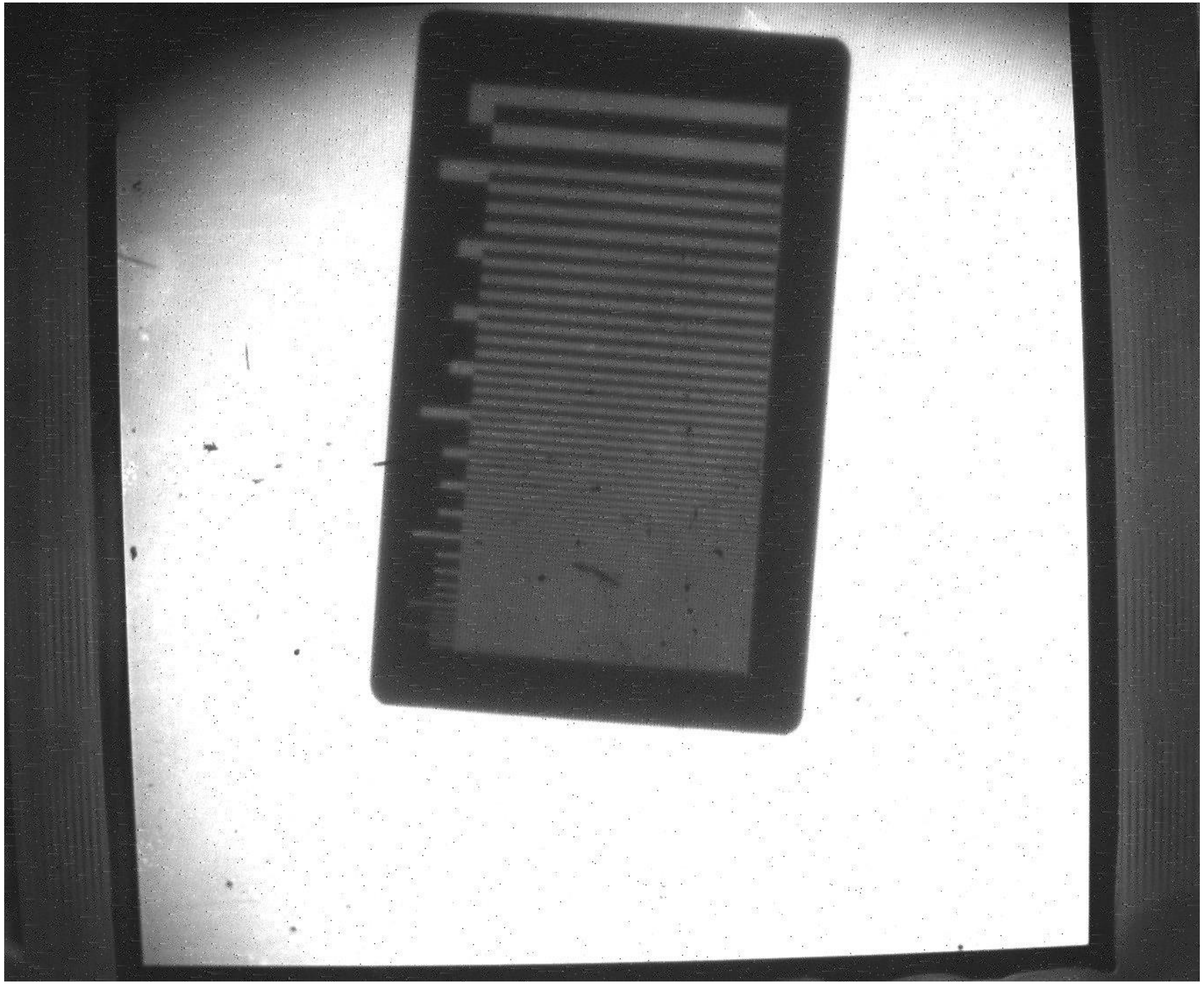
Exposure time: 100s

Binning: 2x2

A line mask X-ray scan

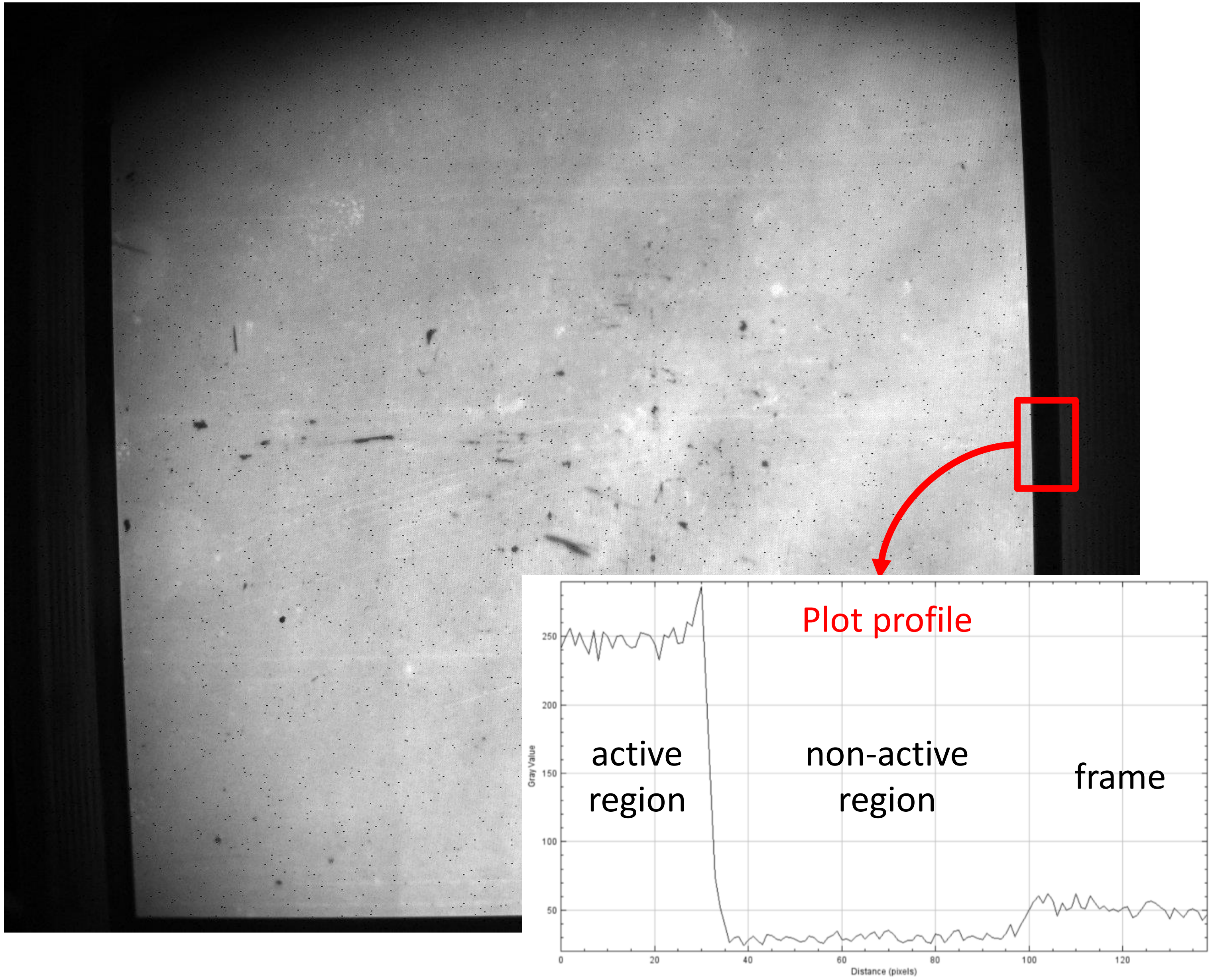
- quantify the measurement – characterization using the modulation transfer function (MTF)
- compare with a single GEM and a triple GEM

X-ray:	U = 20 kV; I = 1.0 mA
GEM Top:	U = 400 V; I = 84,1 nA
Cathode:	U = 810 V
Exposure time:	100s
Binning:	2x2



Reflectivity

- resistive DLC layer allows us to see the non-active region
- no reflections of the scintillation light produced
- might improve spatial resolution



X-ray:	U = 20 kV, I = 0,1 mA
GEM Top:	U = 400 V
Cathode:	U = 730 V
Exposure time:	100 s
Binning:	1x1

Nothing is for free

Usage of the resistive DLC layer will cause a voltage drop (induced by the current produced in the detector) that will effect detector performance.

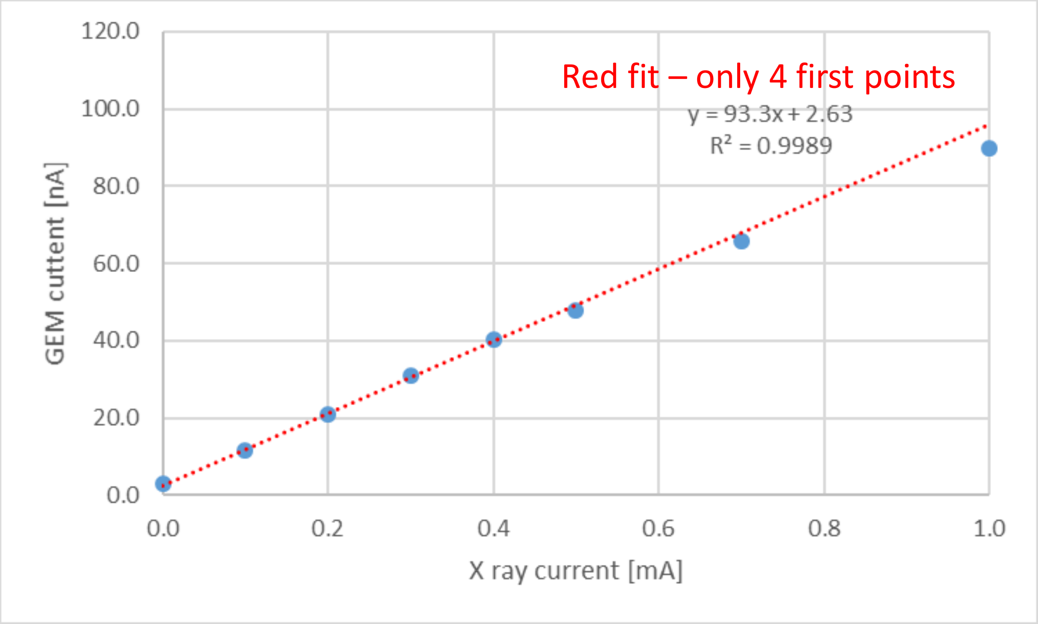
The optical readout allows us to quantify the gain variations and to localize them.

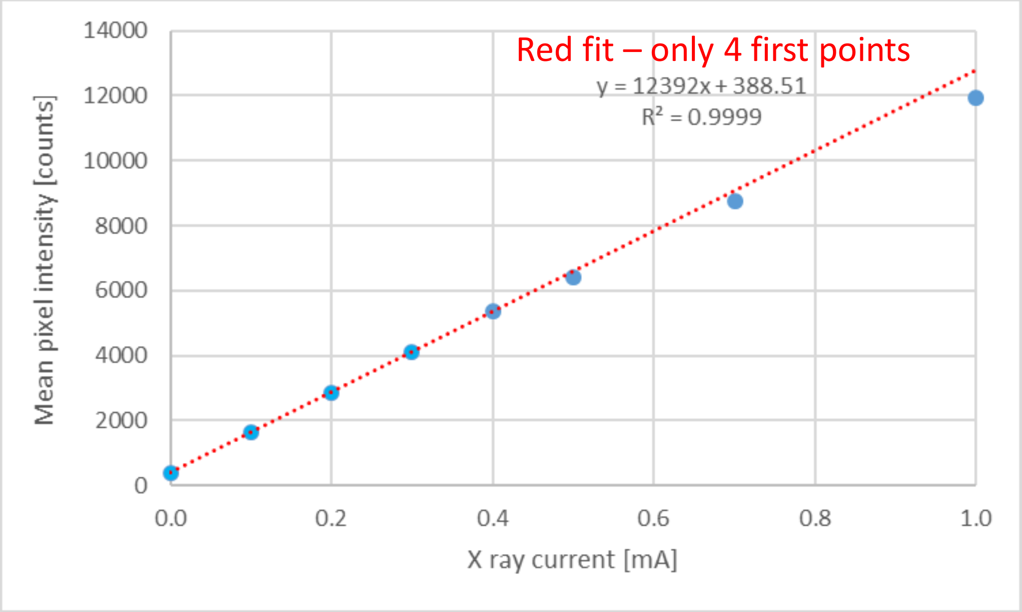
In the context of a resistive layer the localization is very crucial.

GEM current and Intensity vs X-ray current

average measurement

- the function is linear only for small values of the X-ray current
- for higher values of the X-ray current we start to observe a minor voltage drop due to the resistivity of the DLC

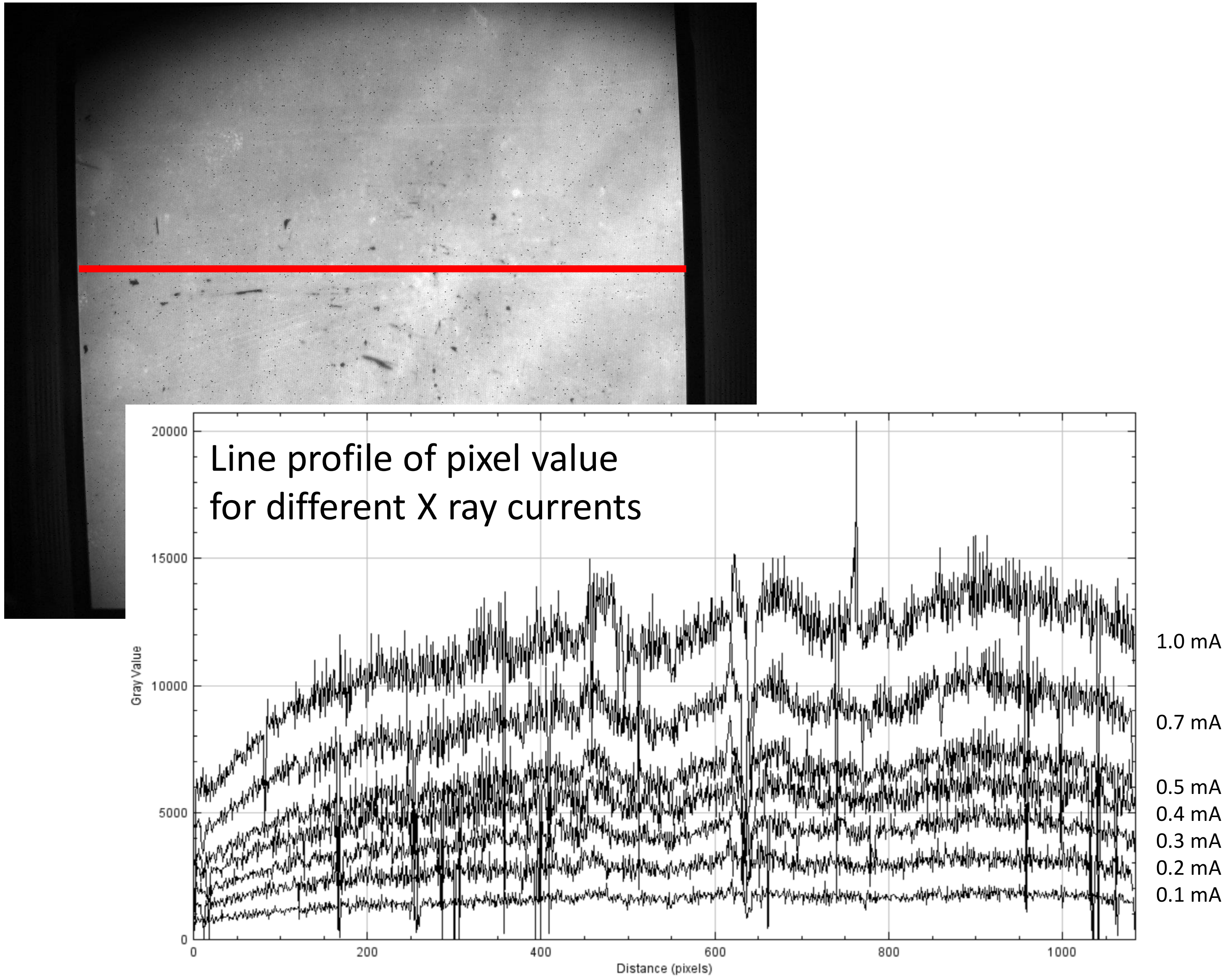




Intensity vs position

local measurement

- fluctuations may be due to the beam profile or other distortions caused by the detector
- it is not possible to observe obvious gain variations for the low X-ray current and it will be the subject of the further studies



Summary

Results of the preliminary measurements on the DLC GEM:

- able to operate a single DLC GEM detector with a gain up to about few 10^3
- not too different from standard GEM (in terms of max. reachable gain) – about 100 V more to get a similar gain
- response not uniform and depends on the position - to be studied
- observed weak points and instabilities during irradiation – can be located and studied using optical readout
- DLC layer might help to reduce reflections in optical readout of the detector – could help to achieve higher spatial resolution
- small energy released during a spark – preserving ability to acquire signals (electronic and optical) from other areas of the GEM despite local discharge

Next steps:

- study the uniformity (optical and multichannel readout)
- investigate the discharge propagation
- explore the gain limit
- study the evolution of instabilities

Thank you for your attention