Metal micro-detector TimePix imaging synchrotron radiation beams at the ESRF Bio-Medical Beamline ID17

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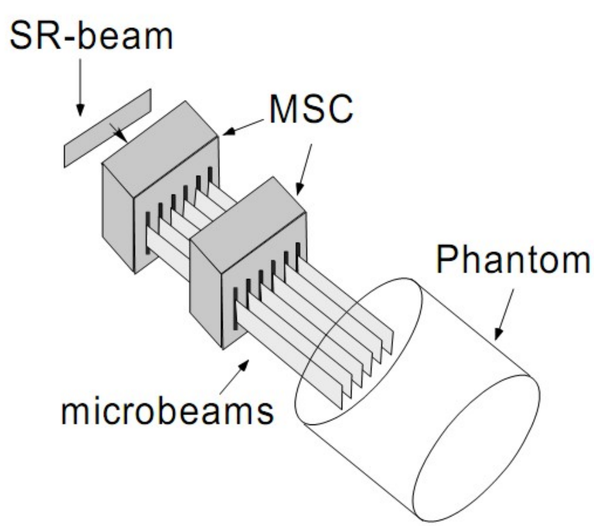
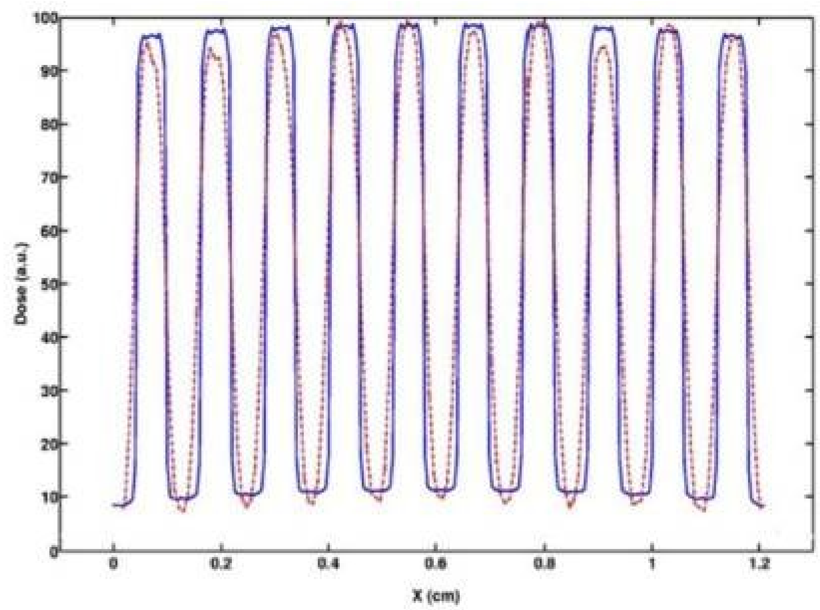
Introduction

- **The main goal of radiotherapy is to deposit a high dose of ionizing radiation in a tumor while keeping the absorbed dose in the surrounding healthy tissue at a tolerant level.**

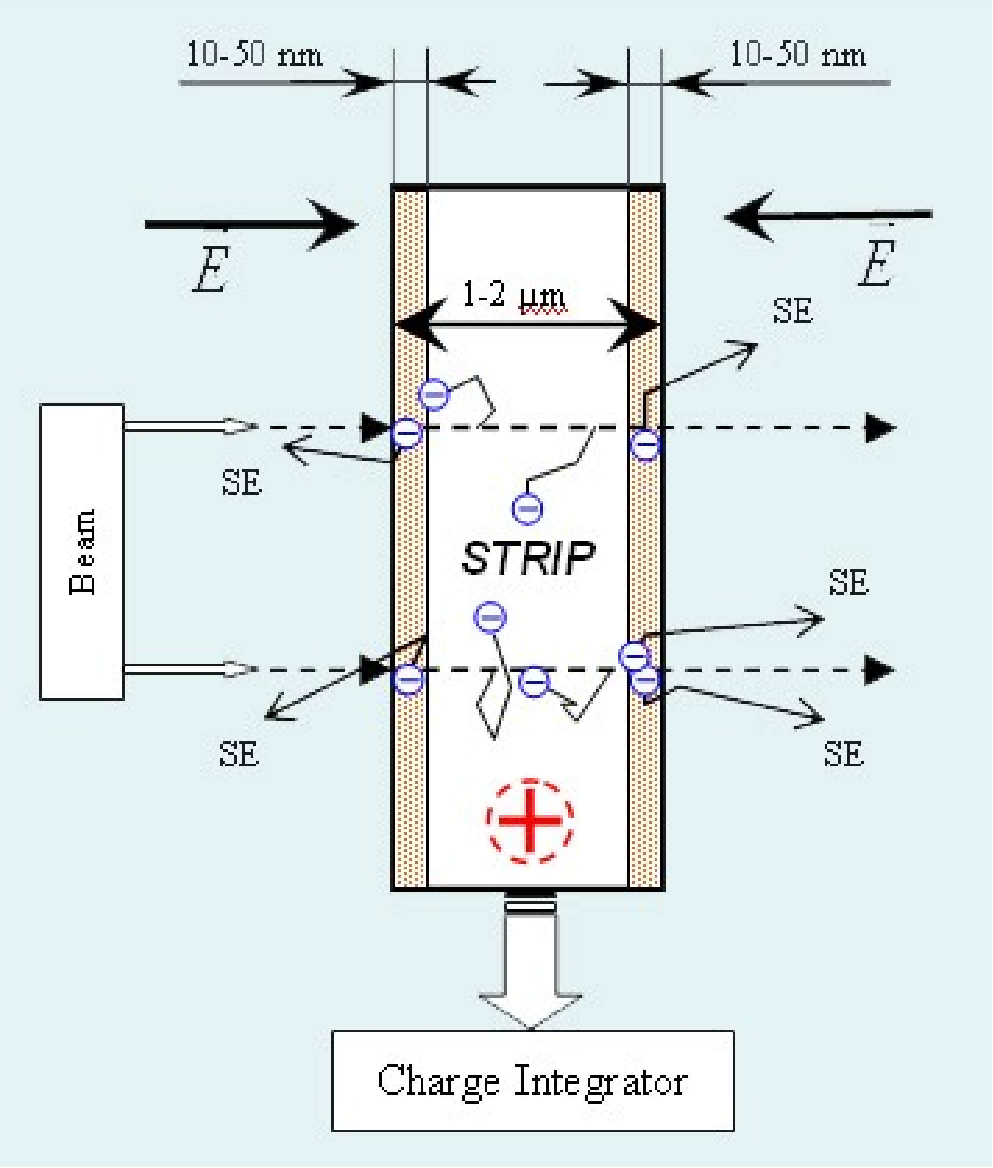
- **For measurement of such high dose radiation proof detector is needed. Metal detector is actually the radiation hard detector.**

The high intensity X-ray mini-beams (50-600 keV, Intensity: 2,7×10^{9} photons/(s×mm^{2})) with sizes of 600 μm and 1200 μm center-to-center separation have to be delivered with a Multi Slit Collimator (MSC), inserted into the beam.





PRINCIPLE OF OPERATION

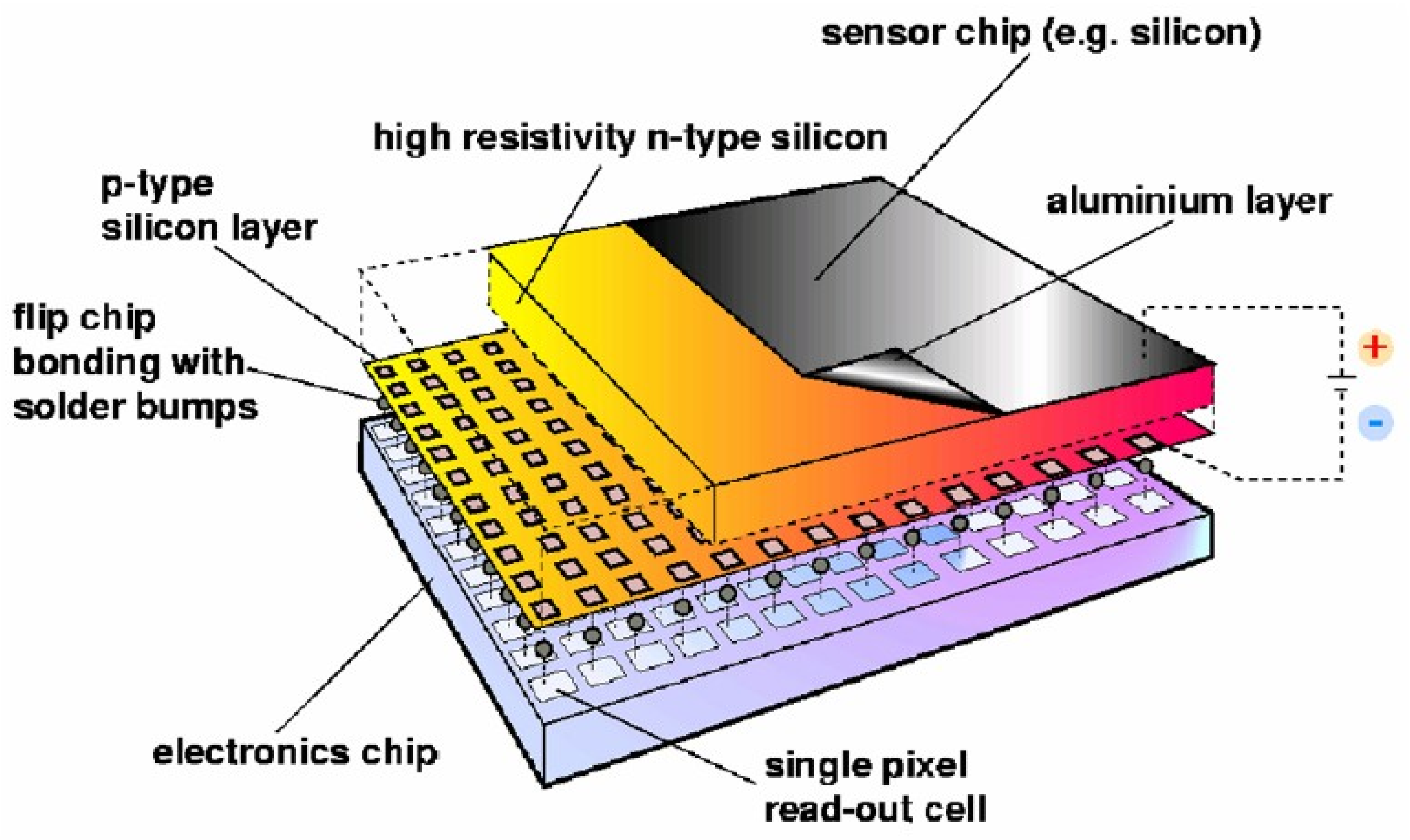


Incident particles on the strips initiate secondary electron emission as they pass through the nearly transparent medium. When this happens, a positive charge appears at the integrator end is measured.

To improve the extraction of secondary electrons an accelerating electric field is applied around the strip.

This technology works with x-rays, protons and ion beams. Additionally, the strips are nearly transparent to beams, significantly reducing degradation that is experienced by absorbing detectors.

Structure of Medipix detector



TimePix – Metal Detector

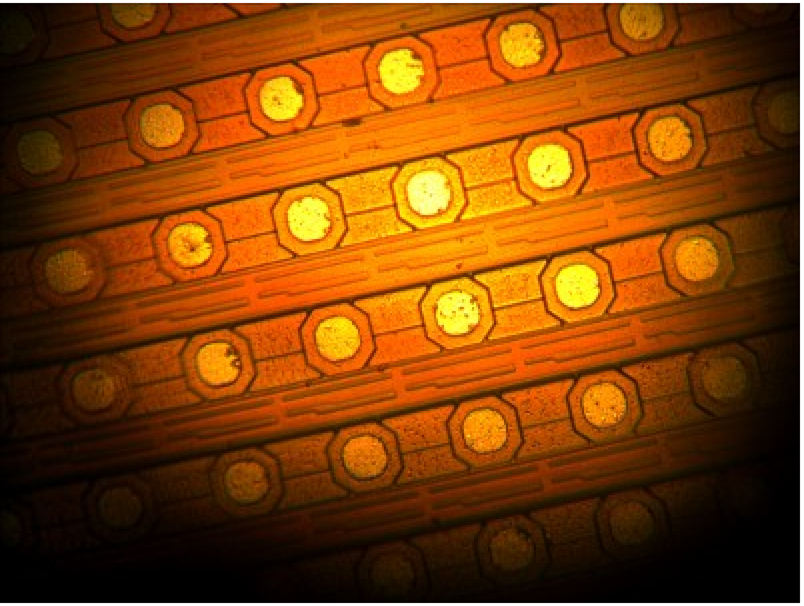
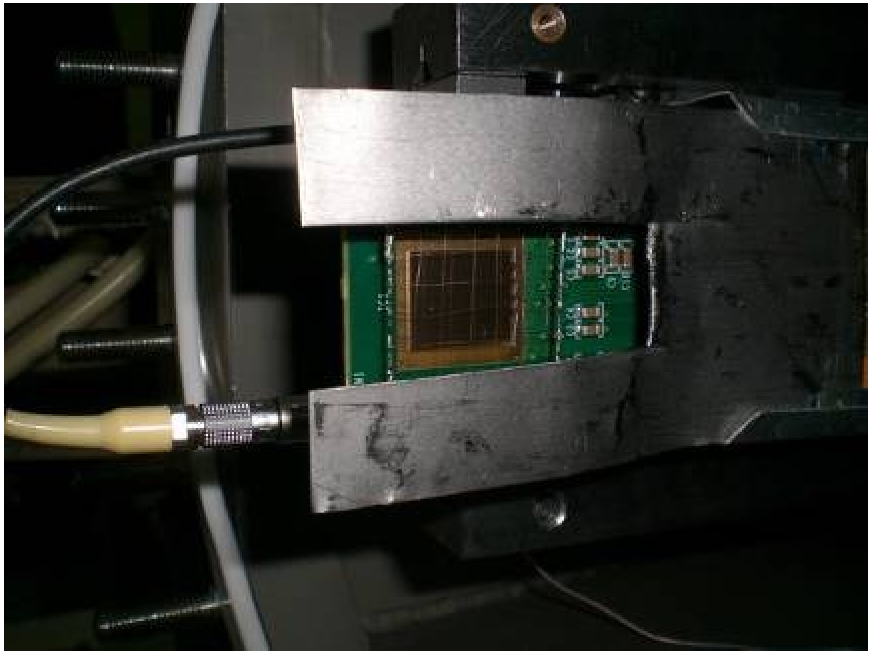


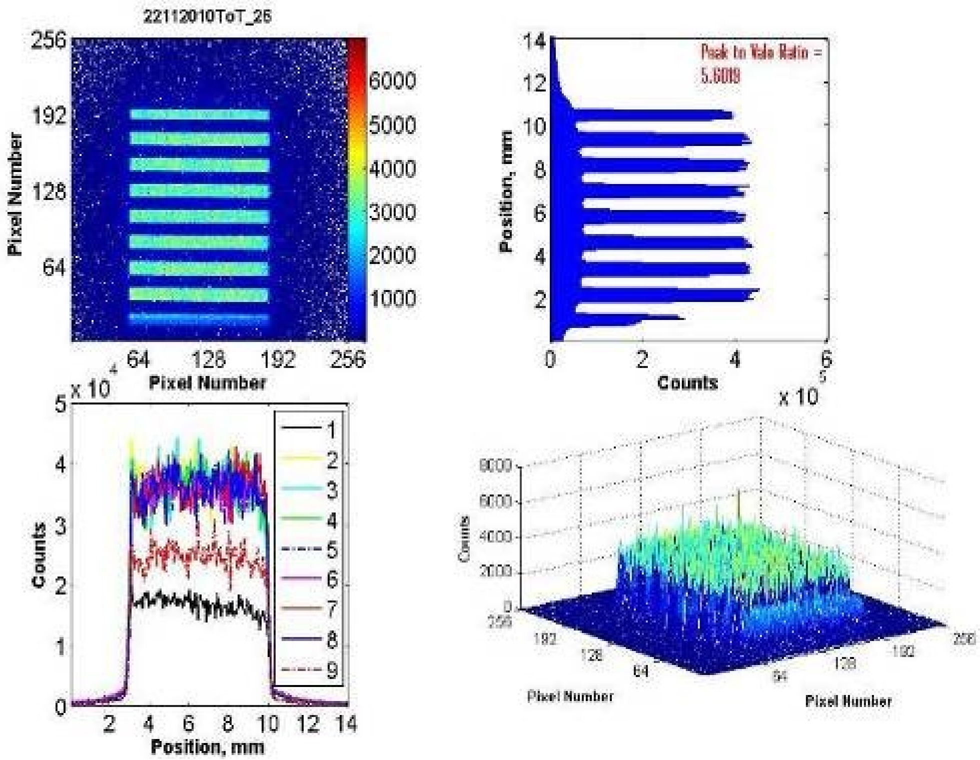
Photo of the individual pixels of the TimePIx chip (55 x 55 μm², 256 x 256 pixels) CERN, MEDIPIX Collaboration.

Diameter of the area for bonding ~15 μm.



A positive voltage has been applied to a mesh over the chip area – to collect Secondary electrons emitted by metal surface of the chip

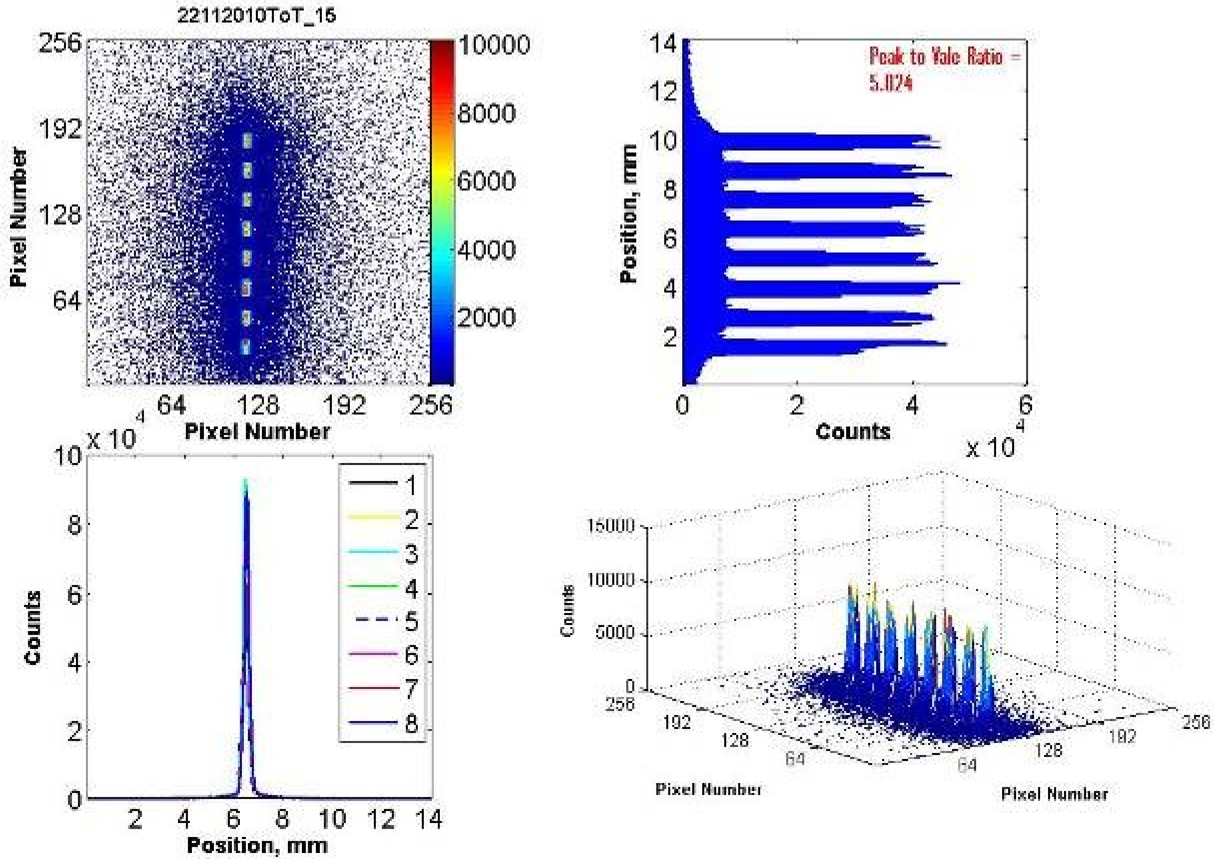
Metal TimePix detector performance at the Bio-medical beamline ID17 (ESRF, Grenoble, November 2010).



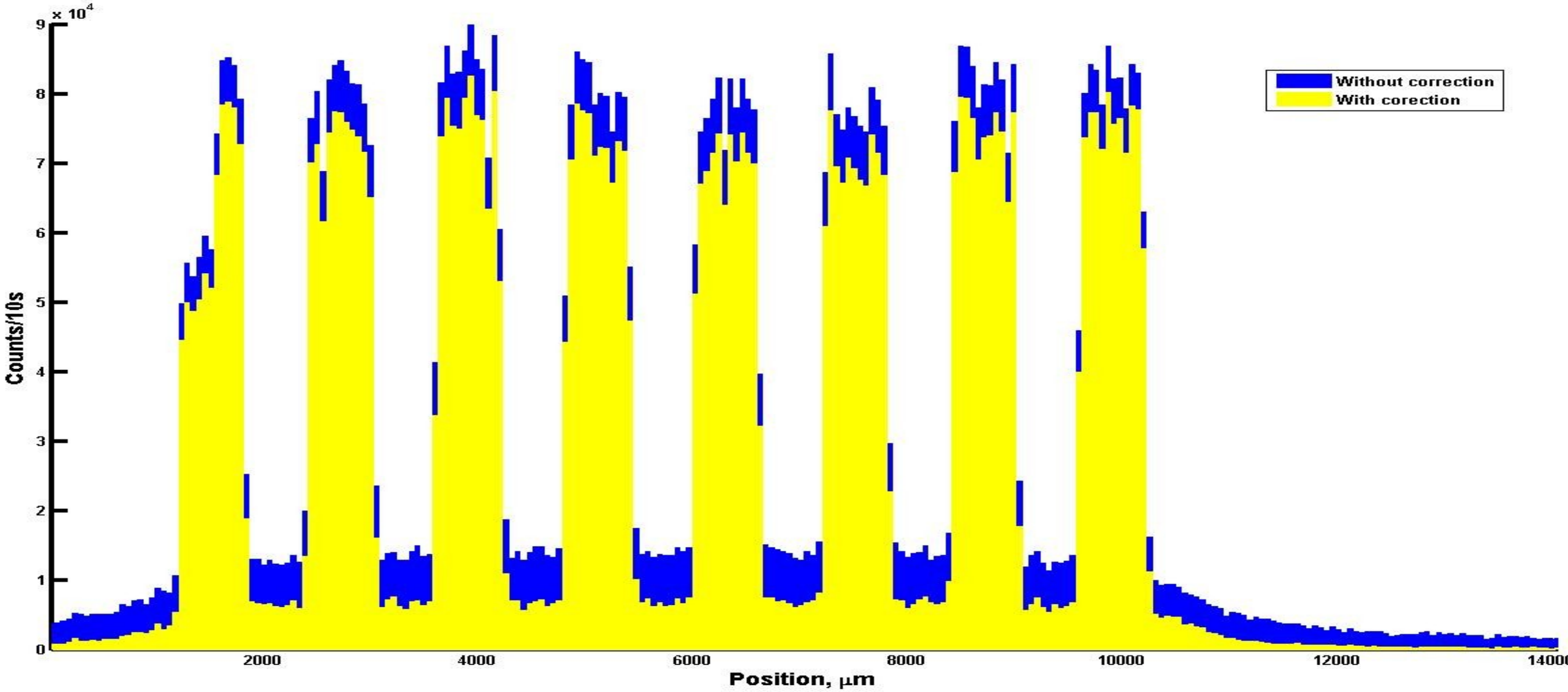
•Rotation of the chopper and vertical movement of the gonio-meter table with a TimePix detector were synchronized:

• SR beam shaped by the collimating system was impinging the detector area 10 times, shifted every time by 1200 μm.

Metal TimePix detector performance at the Bio-medical beamline ID17 (ESRF, Grenoble, November 2010).



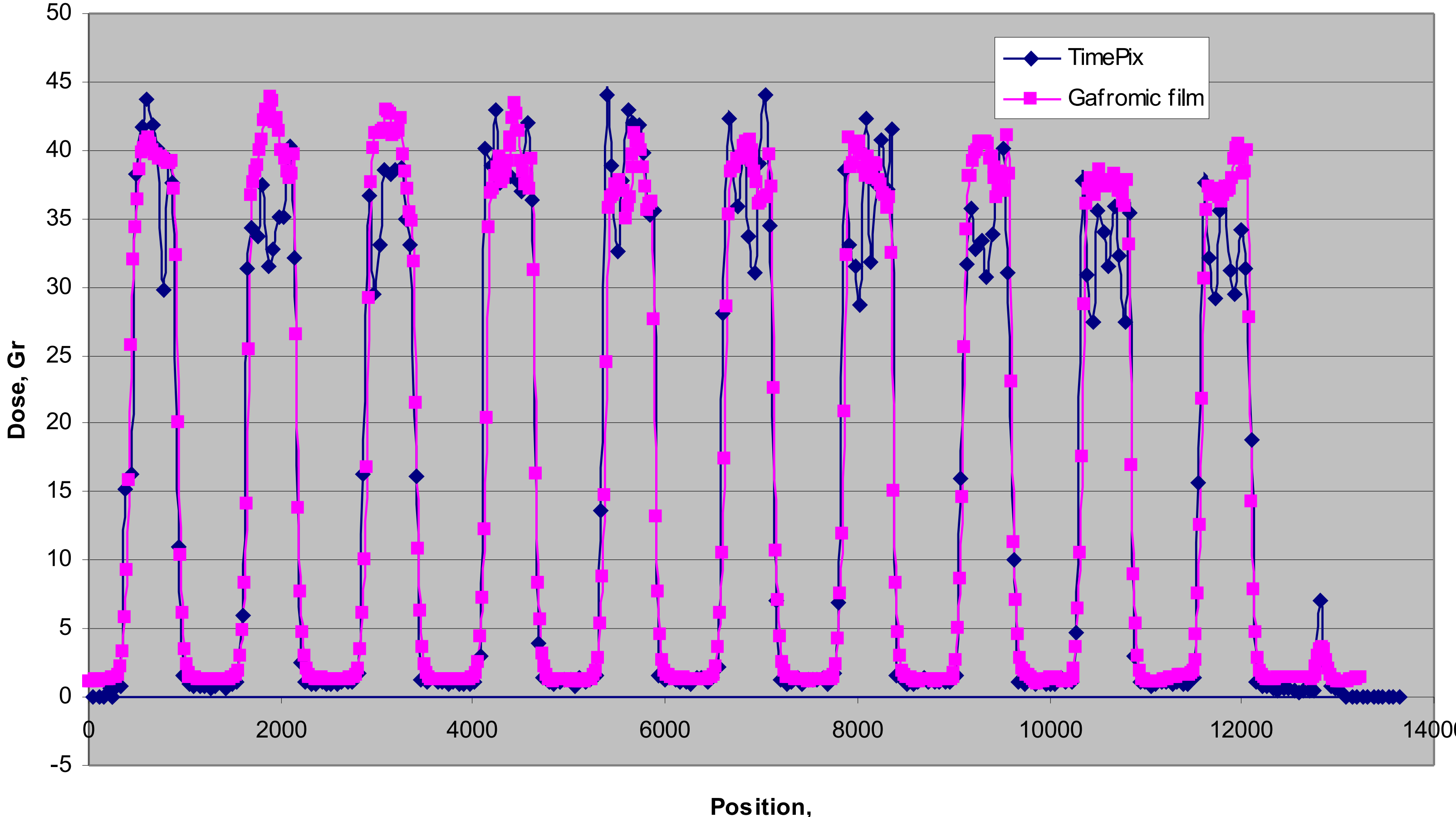
Very important value is the peak-to-valley dose ratio (PVDR). When we used all data from detector (including cloud) PVDR is ~ 5. But when we used only data in peaks and between peaks our one dimension figure changes. Value of cloud is blue value minus yellow value.



One dimension presentation of 8 beams.

Blue – with cloud. Yellow – without.

TimePix (Metal) and Gafchromic films measuring dose distribution at the Bio-medical beamline ID17 (ESRF, Grenoble, November 2010).

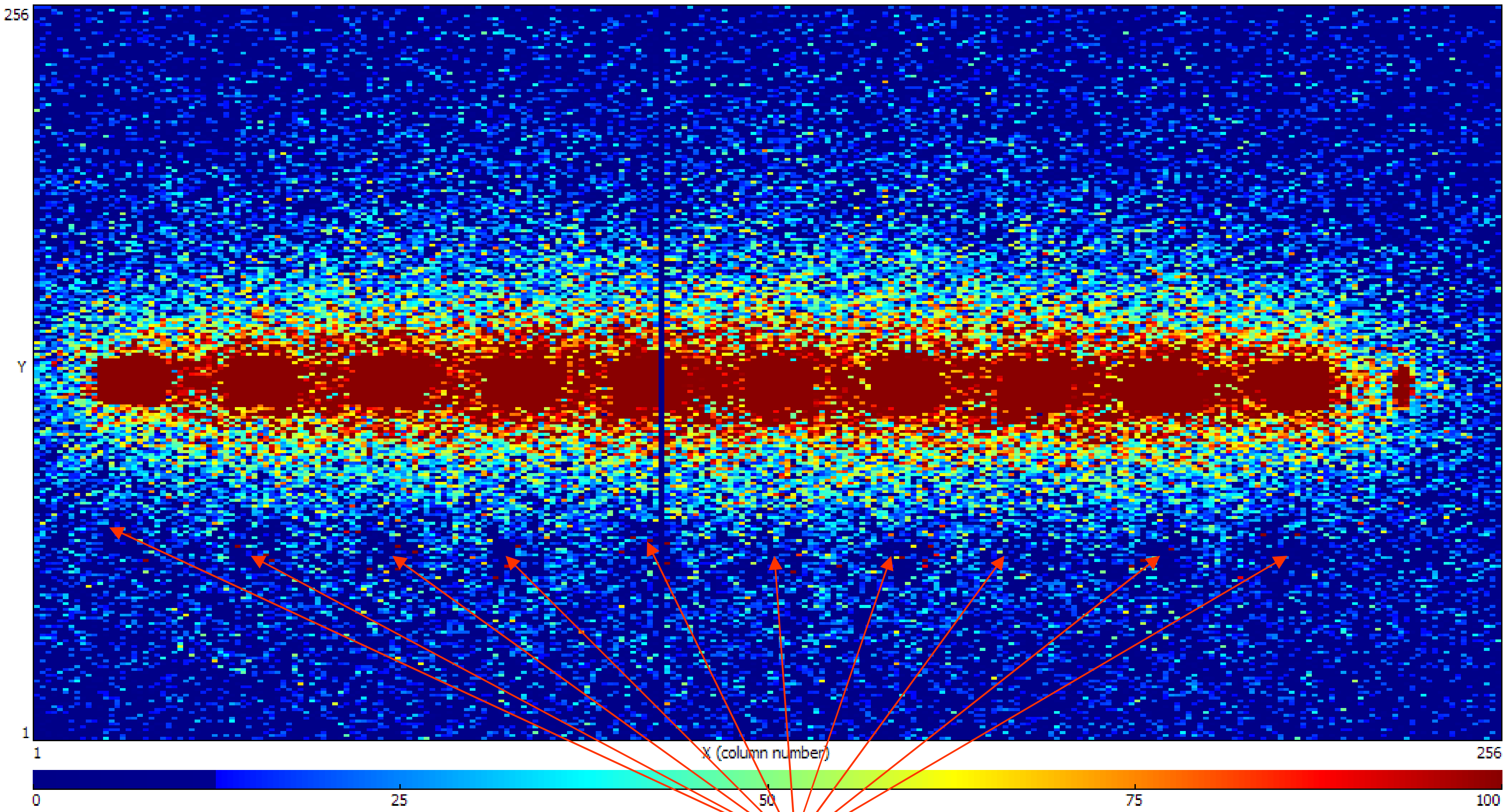


Nearly perfect correspondence of the two measurements WITH A DIFFERENCE:

TimePix provides IMAGING IMMEDIATELY!

Conventional dose distribution measurement (gafchromic films) using scanning microscope technique takes up to 24 hours.

Metal TimePix detector performance at the Bio-medical beamline ID17 (ESRF, Grenoble, November 2010)



Irradiation impact – 'memory' of the beams

CONCLUSIONS

The TimePix metal detector is a suitable tool for the Minibeam Radiation therapy applications. The results obtained for high intensity synchrotron radiation illustrate an excellent performance of the TimePix providing in real time 2D image of the dose distribution over many beams with a spatial resolution of about 10 μm. Peak-to-Valley Dose Ratios measured by the Time-Pix and gafhromic films agree well.

- ✓ In our measurements we show that we have some clouds close to peaks and value of this clouds must be considered when cure will be created for the patients.

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