STCT Test on LGAD Sensor at USTC

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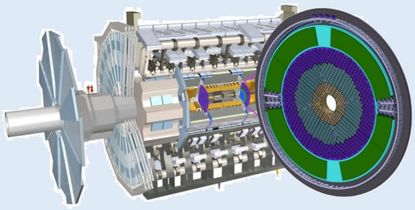
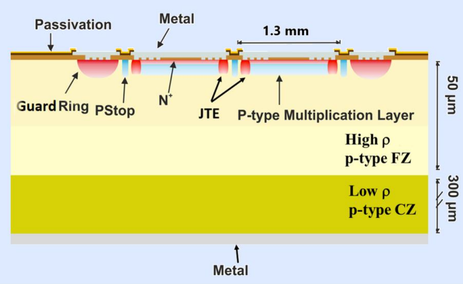
LGAD in HGTD



Position of HGTD in ATLAS

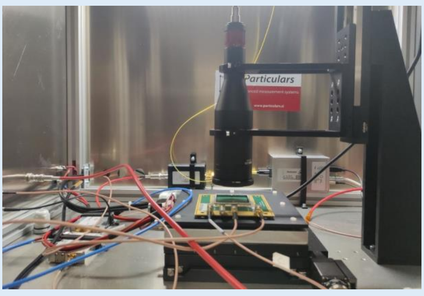
A major challenge for ATLAS Inner Tracker (ITk) in high-luminosity phase of LHC is the pileup suppression, especially in the end-cap region.
HGTD (High-Granularity Timing Detector) is introduced to provide high-precision time measurements for charged particles. HGTD active area covers range $2.4 < |\eta| < 4.0$.



Cross section of 2×2 LGAD array

HGTD consists of silicon-based Low Gain Avalanche Detectors (LGADs). LGADs are low-gain and thin semiconductor detectors, providing good time resolution.

STCT Test



STCT system at USTC

Transient Current Technique (TCT) uses infrared laser to produce charge carriers in semiconductor detectors, which can simulate signal of ionization from charged particles crossing the detector.

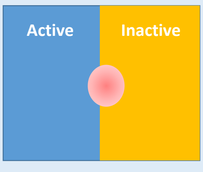
For Scanning TCT (STCT) , laser beam is perpendicular to active surface of sensor. A stepper motor (move vertically) is used to focus the laser beam on surface of test sensor, and another two (move horizontally) are used to let laser beam scan the test area.

STCT are currently used at USTC to measure width of inter-pad gap, which means dead zone between active areas of 2 pads. This width has significance effect on fill factor of detector.

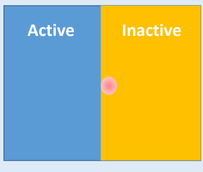
Laser Beam Focusing

Laser beam should focus on the surface of test sensor to get best position resolution.

Usually the beam is focus at an edge of active area.



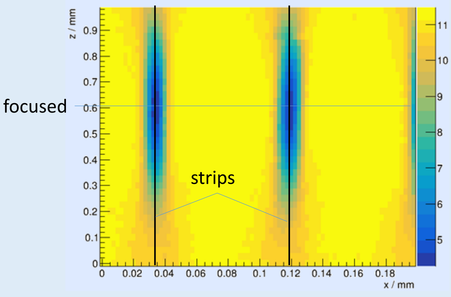
Not focused



Focused

When beam center is on inactive area but near the edge with active area, beam not focused will have larger part on active area and produce larger signal than focused beam.

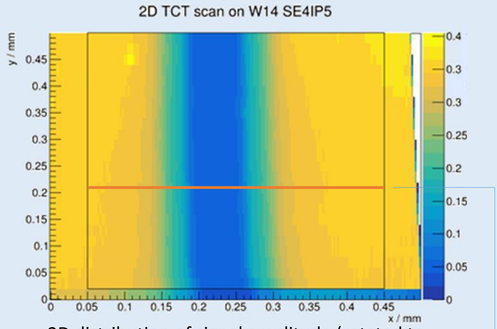
An x-z scan (x is defined as the horizontal direction perpendicular to edge and z is defined as vertical direction) can focus the beam very well but also cost more time.



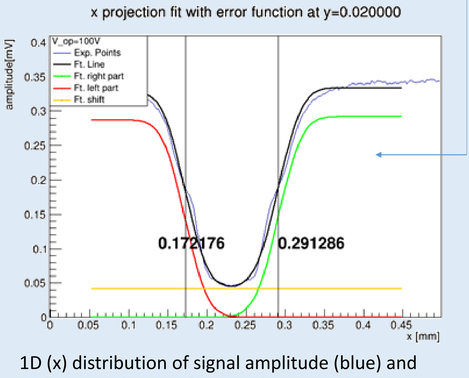
Signal amplitude from an x-z scan on sensor with mental strips that laser can not penetrate

Test result

Signal amplitude distribution near inter-pad gap are measured. Amplitude distribution on direction perpendicular to gap is fitted with sum of two error function (based on energy distribution of Gaussian Beam). Gap width is defined as distance between middle of 2 error functions.



2D distribution of signal amplitude (rotated to let gap parallel with y axis)



1D (x) distribution of signal amplitude (blue) and fitting with sum of 2 error functions (black)
Red, green and yellow line shows 2 error functions and constant from fitting