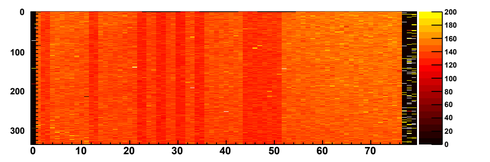
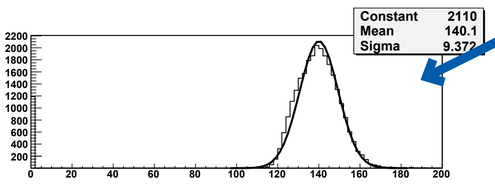
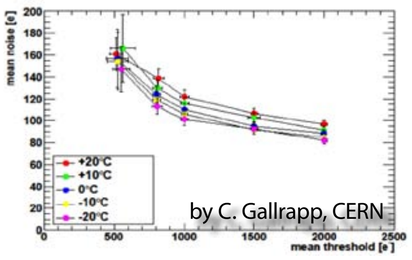
Hybrid Diamond Pixel Detectors for the Upgrade of ATLAS

Module Test Results





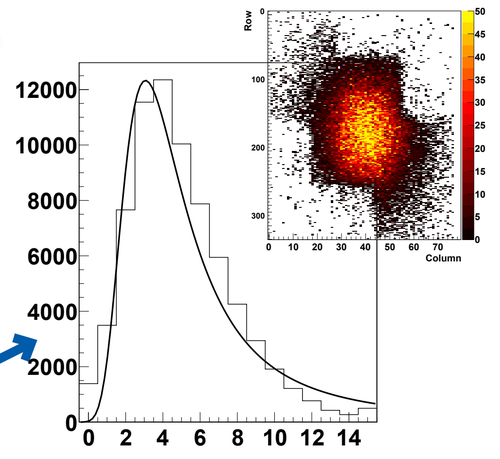


Low Threshold Operation with FE-I4

- FE-I4 allows low threshold tuning for all 26,880 pixel
- 140e⁻ noise @ 800e⁻ threshold
- noise depends strongly on feedback current
- noise rises for very low thresholds

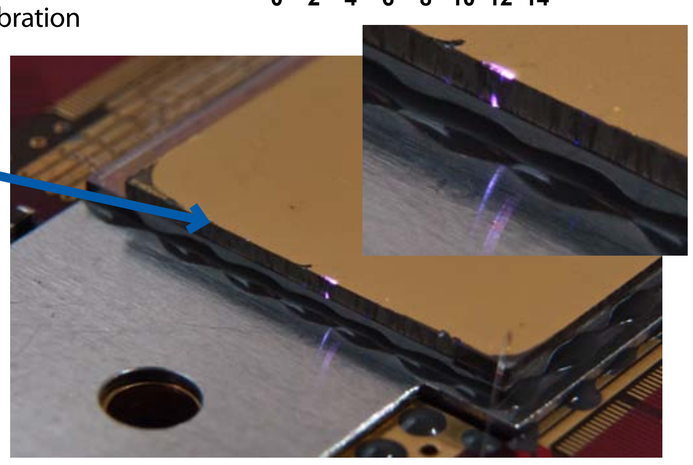
^{90}Sr Source Test

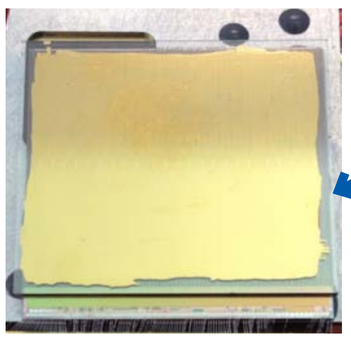
- nice hitmap of the source
- ToT distribution reasonable
- still needs a charge calibration



HV Sparking

- 1st modules didn't hold HV
- sparks due to backside metallization too close to the edge

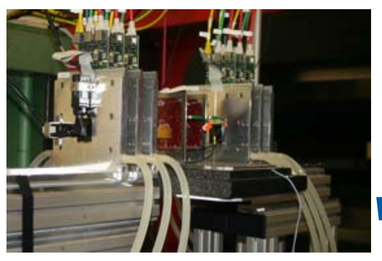




Backside Metallization

- improved backside sputtering by introducing a mask
- removed the metall close to the edge of sensor

Beam Test Results

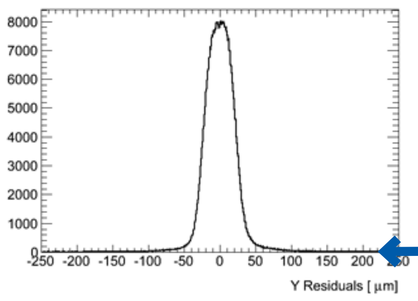


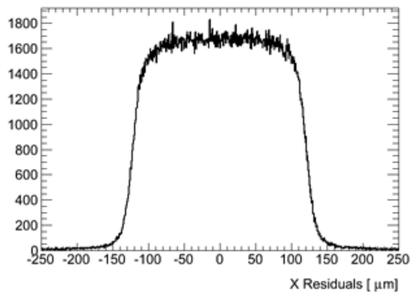
Beam Tests at CERN in 2011

- 180 GeV pions
- several modules tested
- suffered from high noise due HV sparks

Beam Test at DESY in March 2012

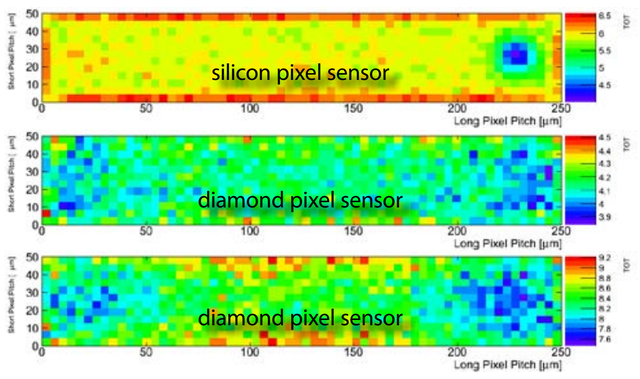
- 4 GeV positrons
- 2 modules tested with HV fixed

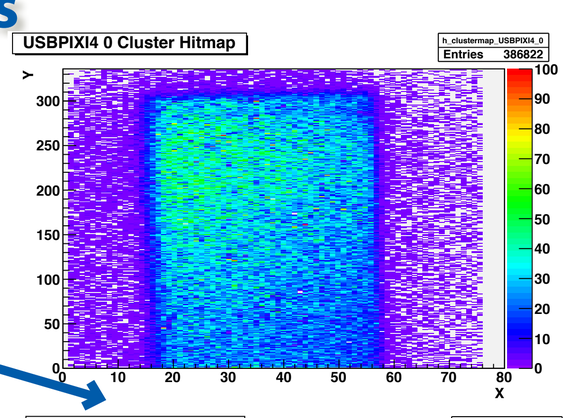


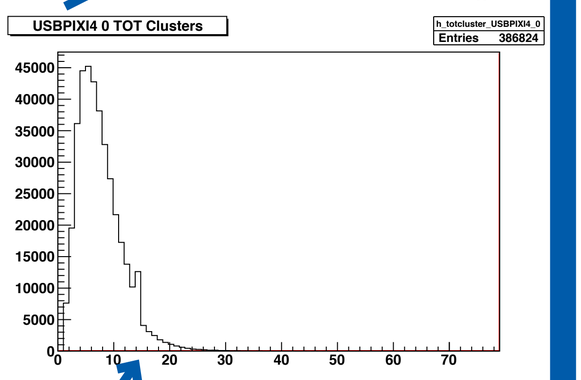


Results from CERN Beam Test

- Residuals are as expected for pixel size 50 x 250 µm²
- Efficiencies are reasonable but suffer from high noise level
- In pixel ToT maps show small charge loss around the bias dot as for silicon
- also some losses on the other pixel side which is not understood yet

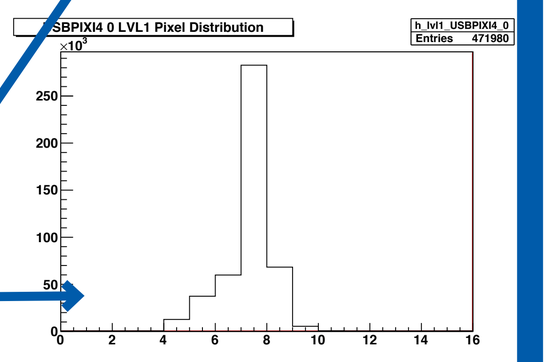






Results from DESY Beam Test

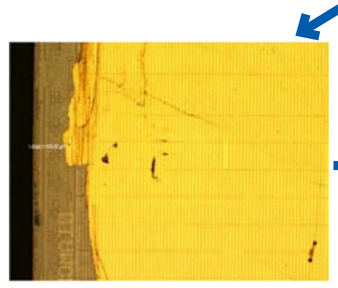
- ToT cluster hip map from online monitoring is fine
- ToT peak suggest collected charge ~6-7ke⁻ but final charge calibration is missing
- Level 1 distribution shows that no noise is visible with diamond biased at 500V



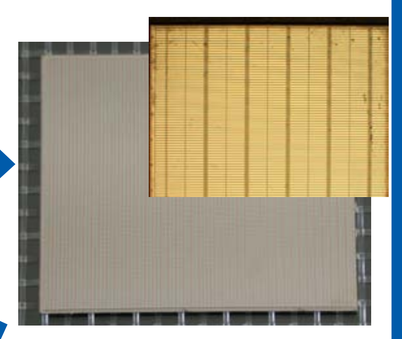
Module Building

100mm pCVD diamond wafer

pCVD sensor diced and embedded



pCVD sensor backside after sputtering with gold



pCVD sensor frontside after pixel metallization with Ti/W

pCVD sensor after flip chip to FE-I4

pCVD assembly mounted on test card and wire-bonded

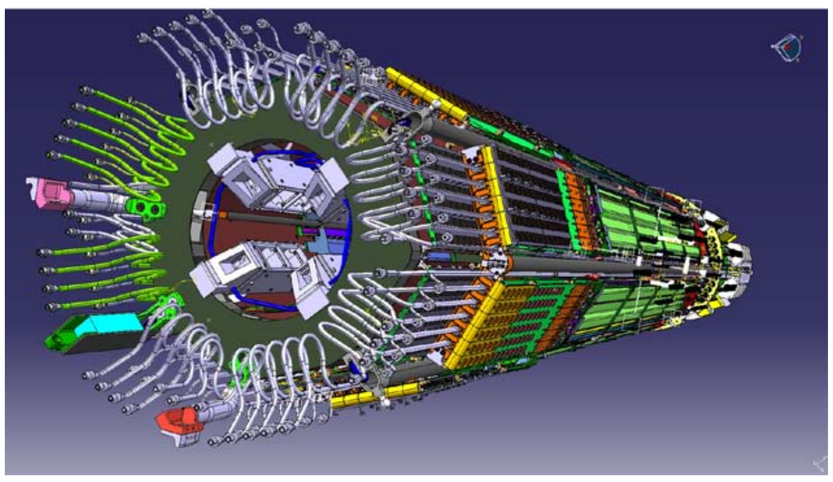
Process developed by Fraunhofer IZM with Bonn/OSU

1. Polishing of the diced pCVD sensor (500µm thick)
2. Acid cleaning of the sensor
3. Embedding into ceramic wafer
4. O_2-plasma cleaning
5. Ar re-sputtering on bias side: Ti/W + Au
6. Ar re-sputtering on pixel side: Ti/W + Cu
7. Lithography of pixel structure
8. Wet etch Ti/W between pixel and lift-off
9. Cutting out of wafer and cleaning
10. Annealing 450°C for 4 min
11. Flip chip to pixel readout chip

Application of Pixel Modules in ATLAS

Diamond Beam Monitor (DBM)

- 4 telescopes on both sides pointing to the IP
- 3 diamond pixel detectors per telescope
- Beam monitoring
- Bunch by bunch luminosity measurement
- Integrated into the pixel package below the nSQP
- Installation with IBL and nSQP in 2013/14 LHC shut-down



Fabian Hügging - Physikalisches Institut - University of Bonn - huegging@uni-bonn.de
J. Janssen, N. Wermes
for the DBM Collaboration