Fine-Pixel Detector FPIX Realizing Sub-micron Spatial Resolution Developed Based on FD-SOI Technology

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Project supported by JSPS Grant-in-Aid for Scientific Research on Innovative Areas Japan/US Cooperation Program in the Field of High Energy Physics KEK Detector Technology Project

SOI PIXEL DEVICES



FINE-PIXEL DETECTOR: FPIX2



Courtesy of Lapis semiconductor

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FNAL TEST BEAM



- Trigger generated by a SEABAS2 board using Scint.(5mm-sq) and ATLAS FE-I4 (2mmx1.75mm ROI)
- Data of 4 FPIX2 and 2 SOFIST sensors acquired per TLU request.
 All R/O boards (SEABAS2) implemented with same TimeStamp firmware
- Last FPIX2 made accessible for exchanging to irradiated DSOI

SEABAS2(Soi EvAluation BoArd with Sitcp): 16ch 12bit 40MHz ADCs, Giga-bit Ethernet

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SINGLE/CLUSTER CHARGE

Q(ADC) of single pixel w/ max. in an event

Qsum(7x7) vs ClusterSize(Qi>Qsum/49)



BIAS DEPENDENCE



FPIX2:DSOI 100KGY

5x5 cluster charge about the maximum charge pixel in an event

5x5 cluster charge [ADC]







RESIDUALS in X

Residuals of DUT hit wrt the track reconstructed using other three FPIXs



RESIDUALS in Y

Residuals of DUT hit wrt the track reconstructed using other three FPIXs



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INTRINSIC SPATIAL RESOLUTION

Observed residual spread: $\sigma_{
m obs}$

$$\sigma_{\rm obs} = \sqrt{\sigma_{\rm int}^2 + \sigma_{\rm track}^2}$$

under an assumption <u>all four FPIXs</u> <u>have the same intrinsic resolution</u> and contributions of misalignment/ multiple scattering are negligible (=conservative σ_{track} value), we can calculate σ_{int} analytically



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Bias=700∨

Resolution evaluated better in the order

 $2^{nd} \sim 3^{rd} >> 1^{st}$ in X $2^{nd} >> 1^{st} \sim 3^{rd}$ in Y

Better resolution of 2nd Y could be explained by the beam injected at normal... Suspect X-talk in X for degraded resolution... under investigation **COMPARISON TO PREVIOUS STUDIES**



CONCLUSION

Performance of FPIXs of 8 μm pixel size has been evaluated successfully in 120 GeV test beam.

Intrinsic spatial resolution of

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- 0.71~0.80 μm in X 0.59~0.76 μm in Y obtained (imperfect alignment may remain) by simple charge-weighted mean hit position calculation method.
- Silicon detector achieving sub-micron spatial resolution was possible with a 0.20 μm SOI technology.
- SOI detector irradiated to 100 kGy showed no degradation in charge collection.

SOFIST

SOFIST residual to FPIX track

Bias=130V (~500um depletion) Readout: on-chip 8-b ADCs







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FE_ST_SOURCE_SCAN 6.

Beam spot measured with FE-I4

