



T. Lari – Efficiency 2004



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Efficiency 2004

First measurements of efficiency on not-irradiated and irradiated FEI-3 modules (August 04 test beam data)

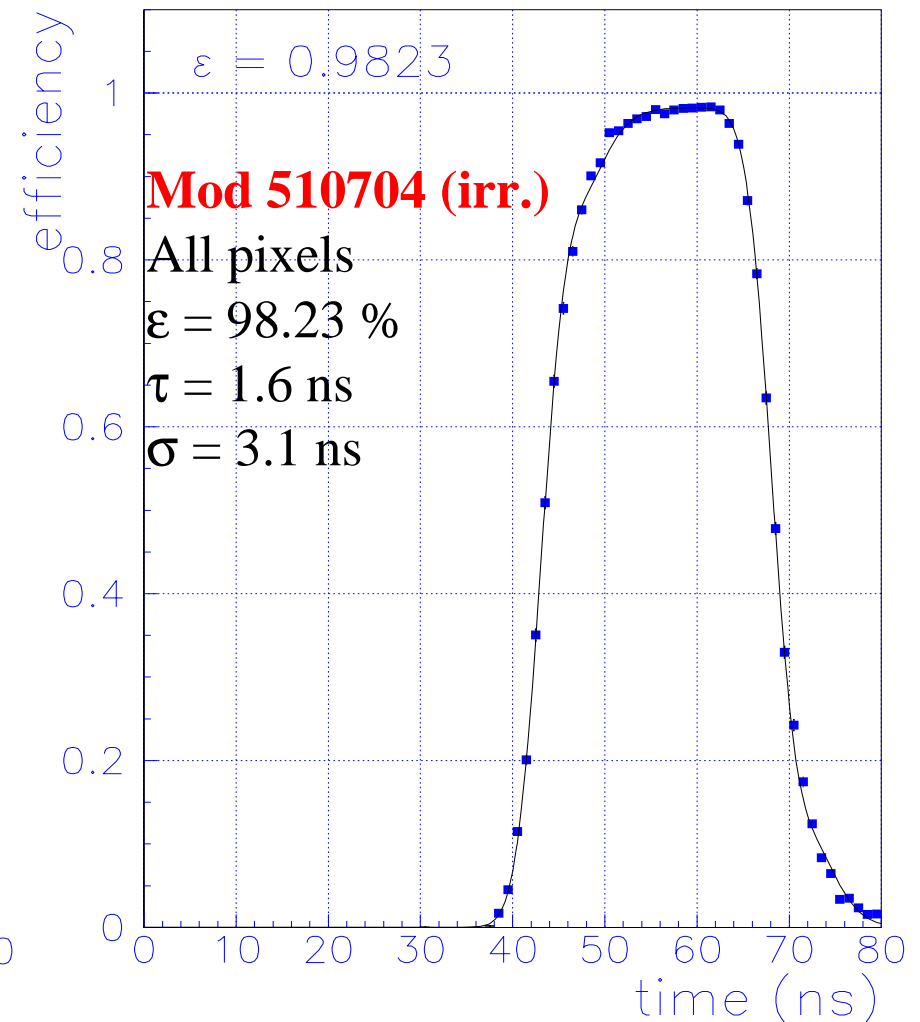
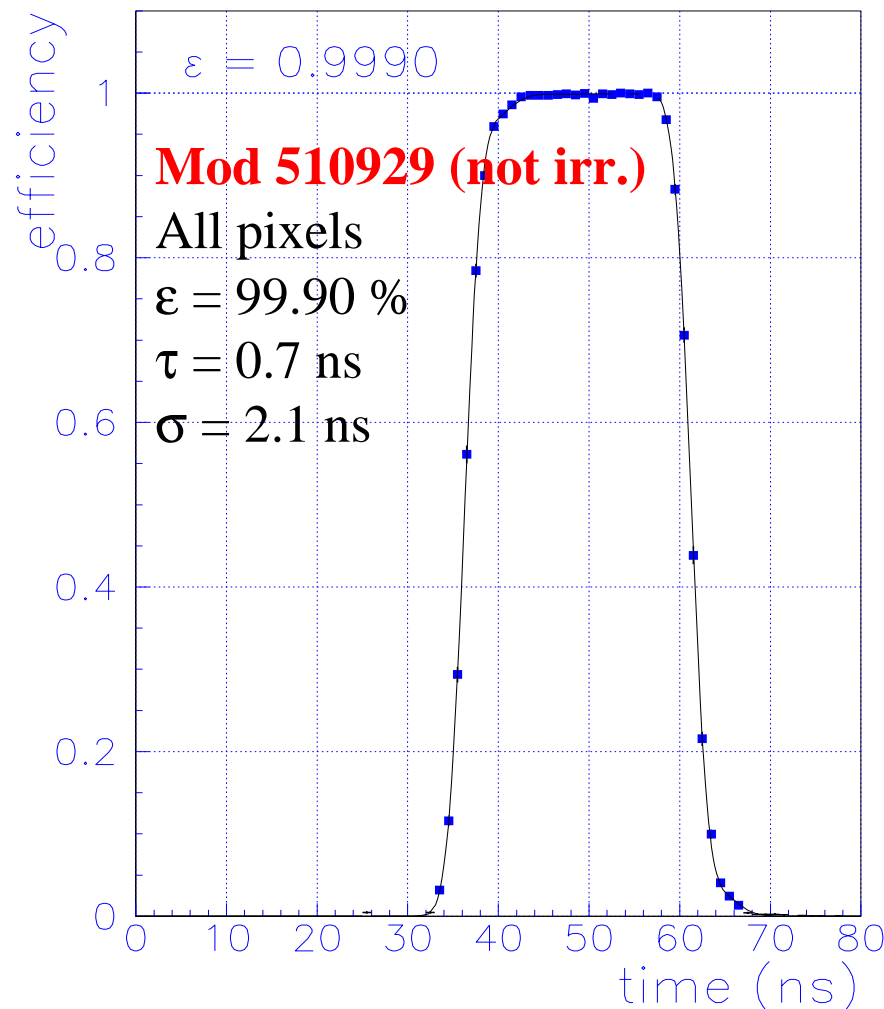
Test beam meeting
27 September 2004



Not irradiated vs irradiated

FE-13 not irradiated

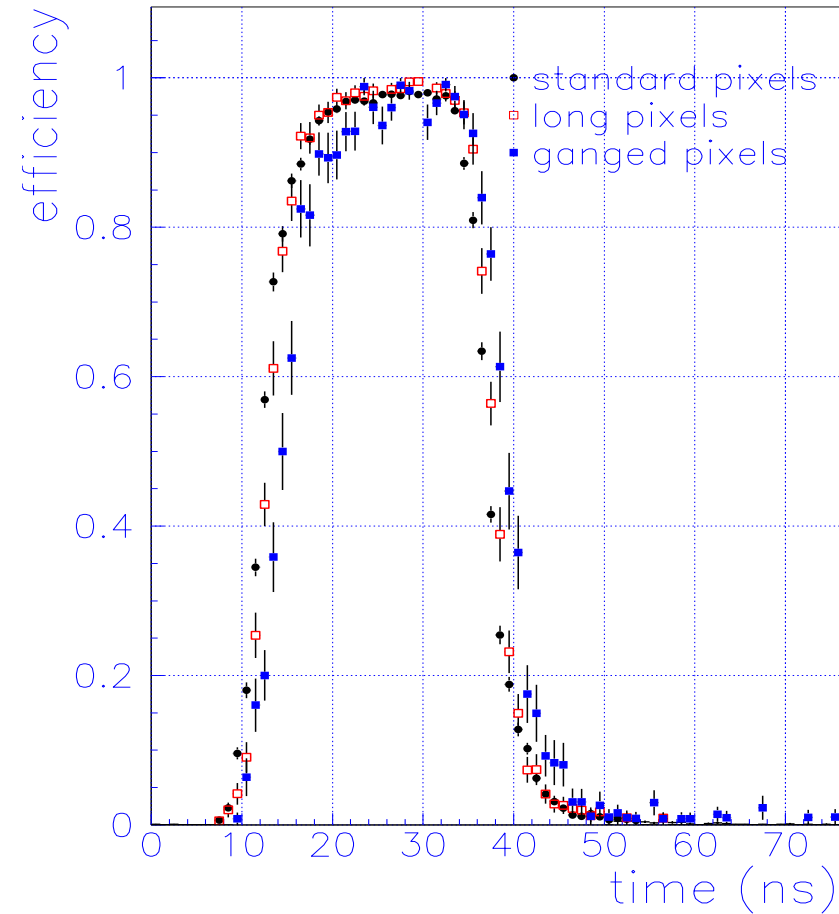
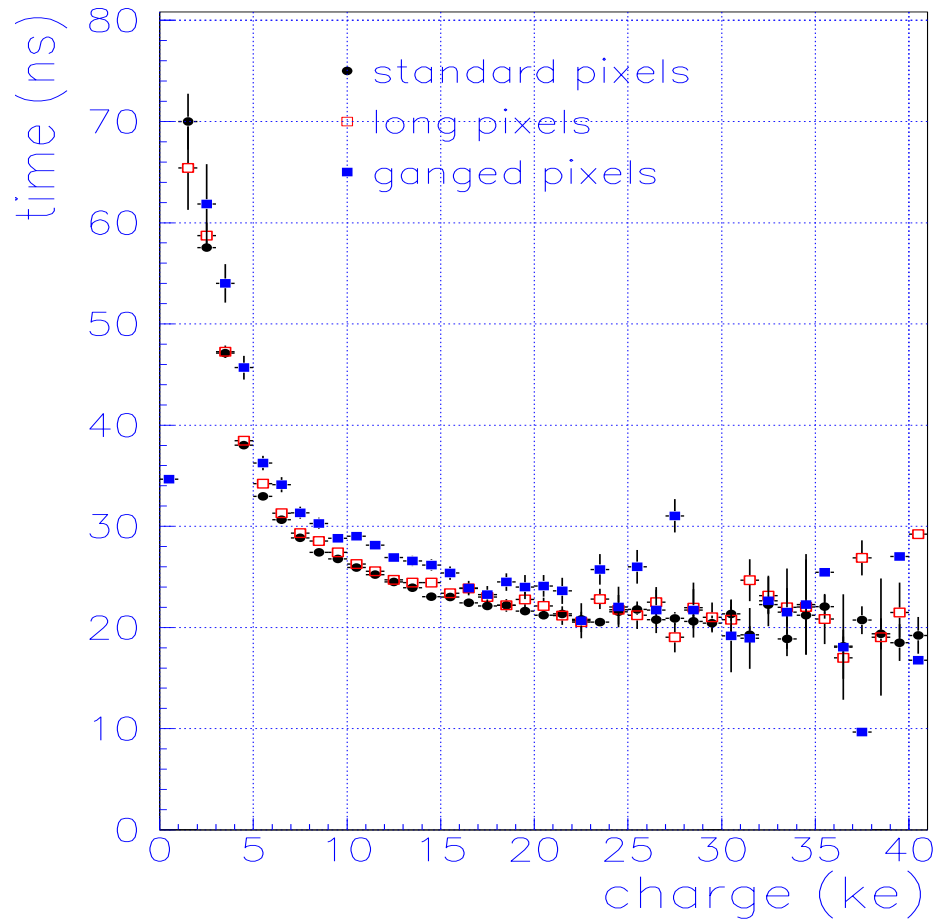
FE-13 irradiated





Standard vs Ganged vs Long Pixels

FE-13 irradiated





Std vs Long vs Ganged (II)

	standard	long	ganged
ϵ (%)	98.0	99.1	97.7
t_0 (ns)	11.7	12.4	13.7
τ (ns)	1.4	1.3	1.4
σ (ns)	2.6	2.7	2.8

- Ganged pixels late by some 2 ns (as for FE-I2)
- Ganged have lower efficiency
- Long have higher efficiency

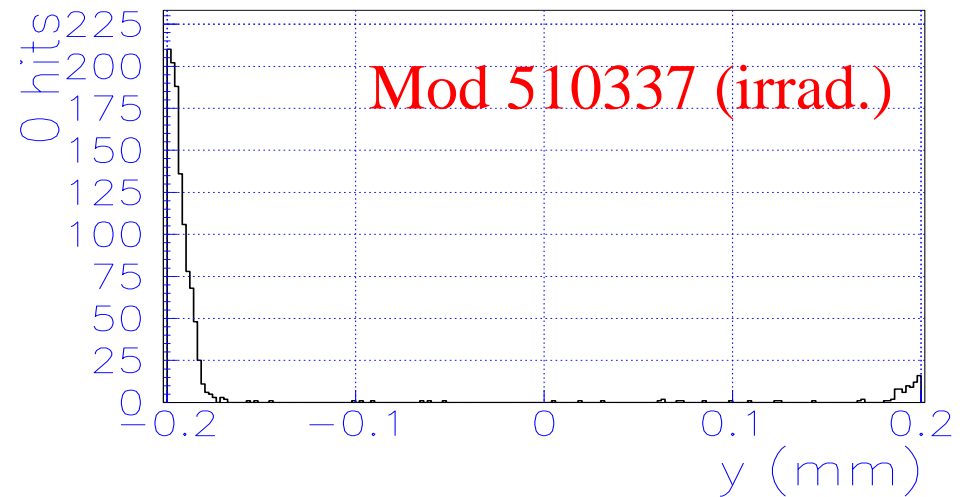
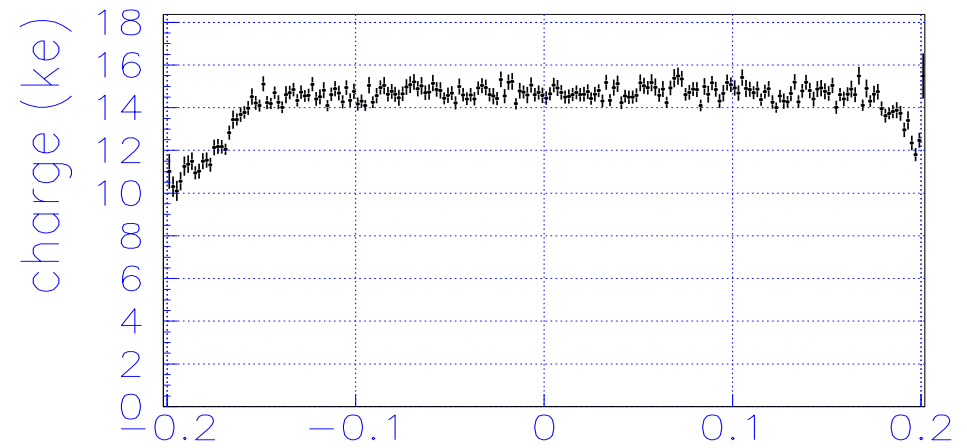
Module 510852 (irr.)

Full module scan (average of 4 runs)



Losses

Efficiency losses occur in the region of reduced charge collection near the bias grid.



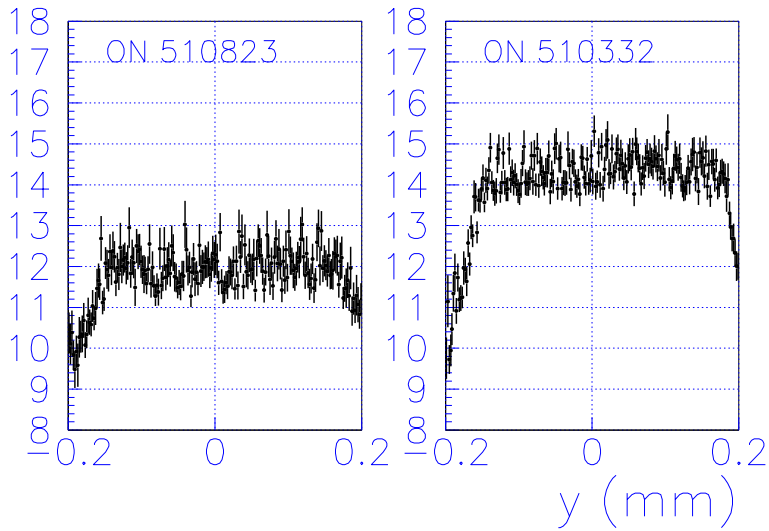
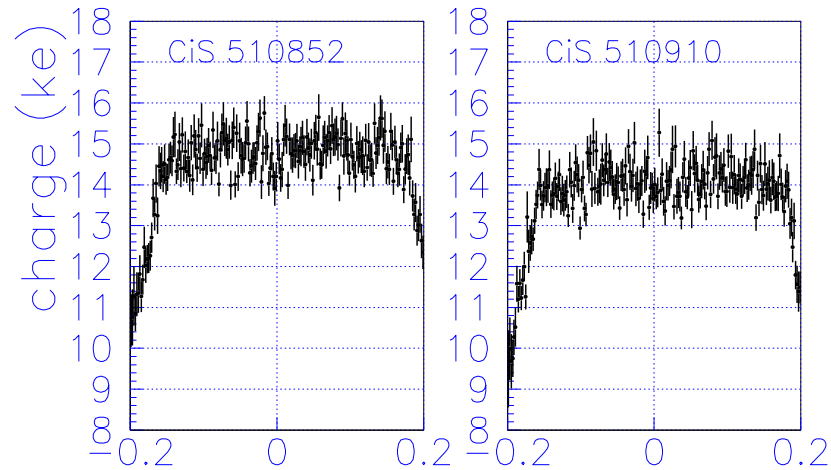


Summary table

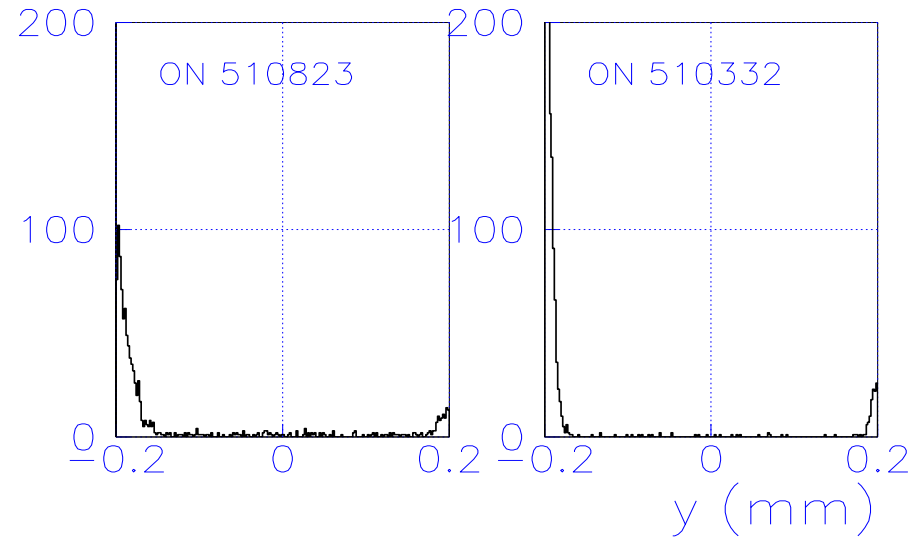
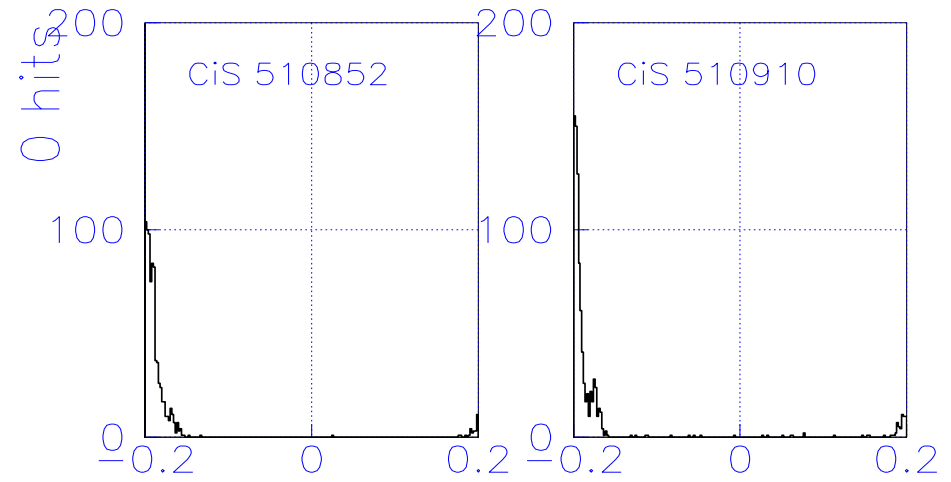
Module (510xxx)	929 (notirr.)	332	337	689	704	823	852	910
Sensor	?	ON	CiS	ON	CiS	CiS	CiS	CiS
Bumps	AMS	AMS	AMS	AMS	AMS	IZM	IZM	AMS
ϵ (%)	99.9	97.7	98.4	96.4	98.2	98.4	98.0	97.4
0 hits (%)	0.0	1.4	1.1	2.3	1.3	1.2	1.4	1.6
Late (%)	0.1	0.9	0.5	1.3	0.5	0.4	0.6	1.0
τ (ns)	0.7	1.8	1.5	2.0	1.6	1.4	1.4	1.6
σ (ns)	2.1	3.2	3.2	3.3	3.1	3.0	2.7	2.8
Masked	2	32	18	0	129	0	0	12



Charge profile



0 hits

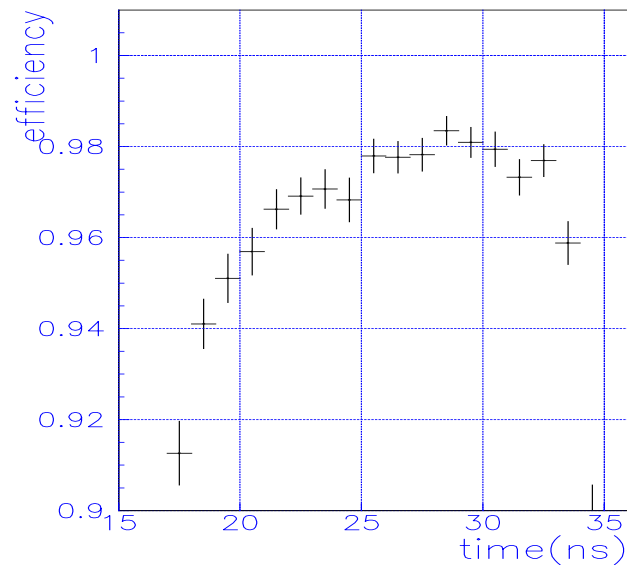




Chip-to-chip Uniformity

- The efficiency curves were fitted separately for the 16 chip of module 510852.
- Timing spread is **1.7 ns**.

ϵ (%)	97.6 – 98.5
t_0 (ns)	11.0 - 12.7
τ (ns)	1.2 – 1.5
σ (ns)	2.4 – 3.0

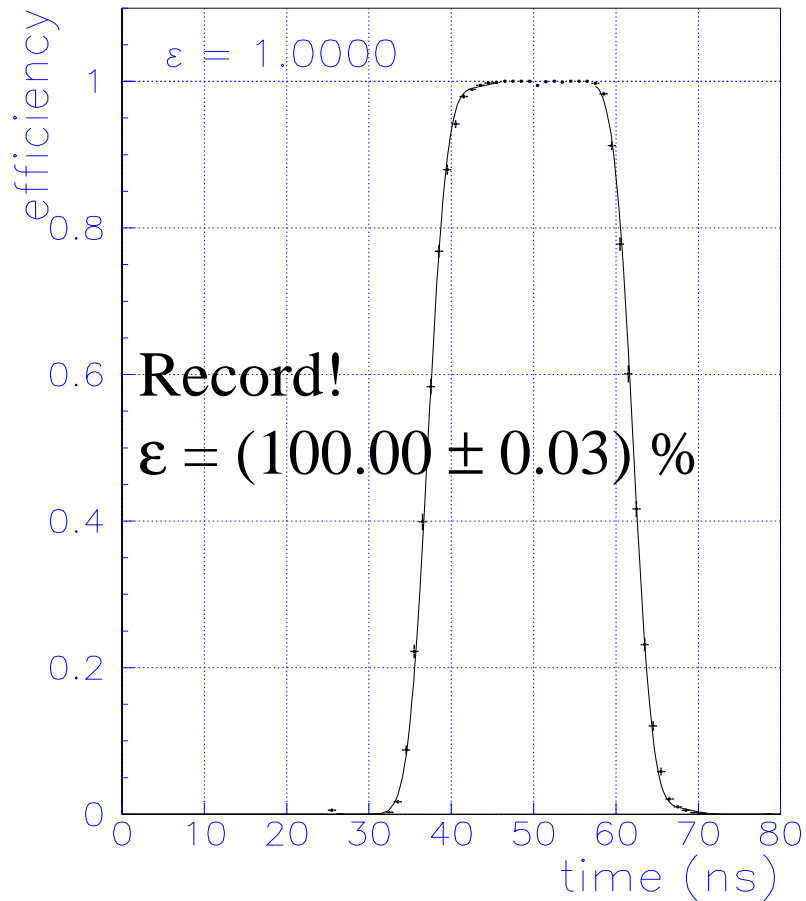


Plateau is **8 ns** wide



Angle and hit duplication

FE-I3 not irradiated, 10 deg.

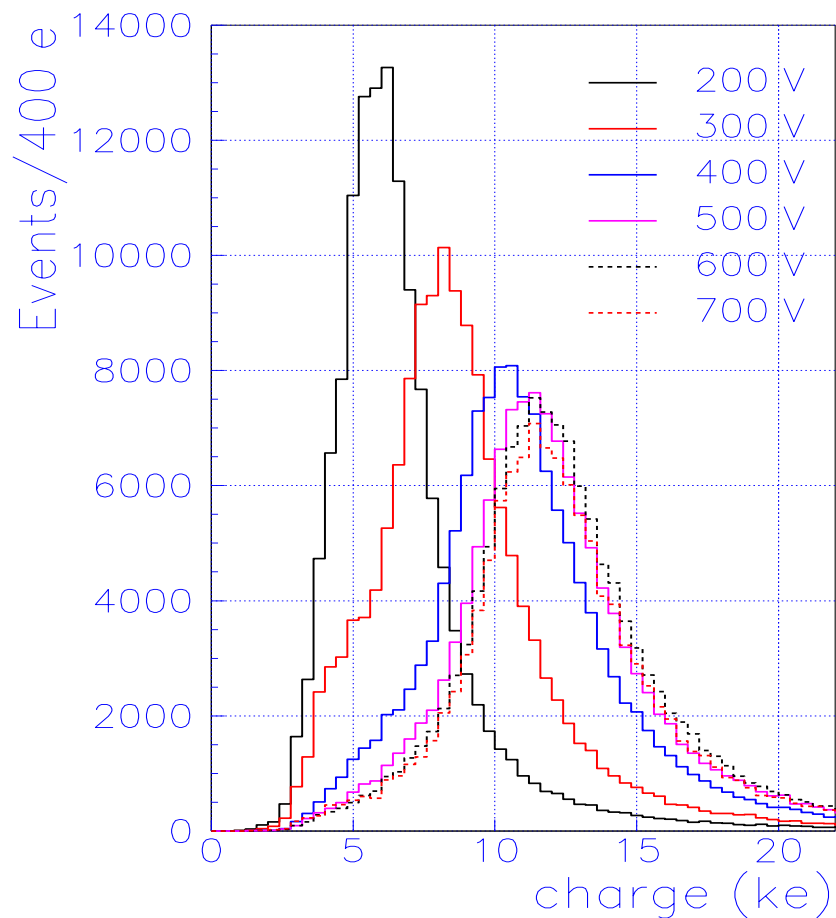


	510852	510910	510929
0°	98.0	97.4	99.9
10°	98.4	98.5	100.0
10° and Hit dupl. at TOT<5	98.3	98.2	100.0
10° and Hit dupl. at TOT<5	98.4	98.4	100.0

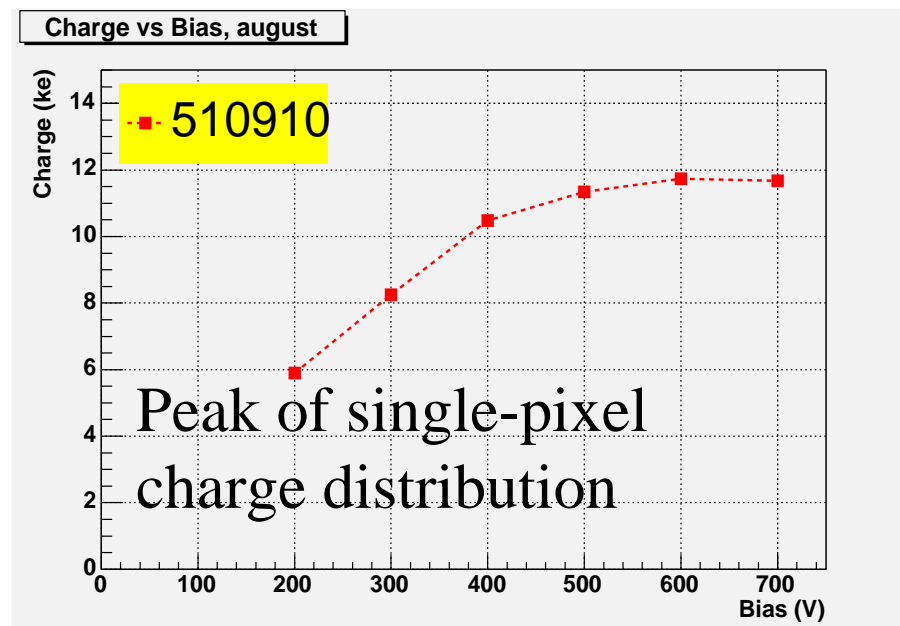


Charge vs Bias Voltage

FE-13 irradiated



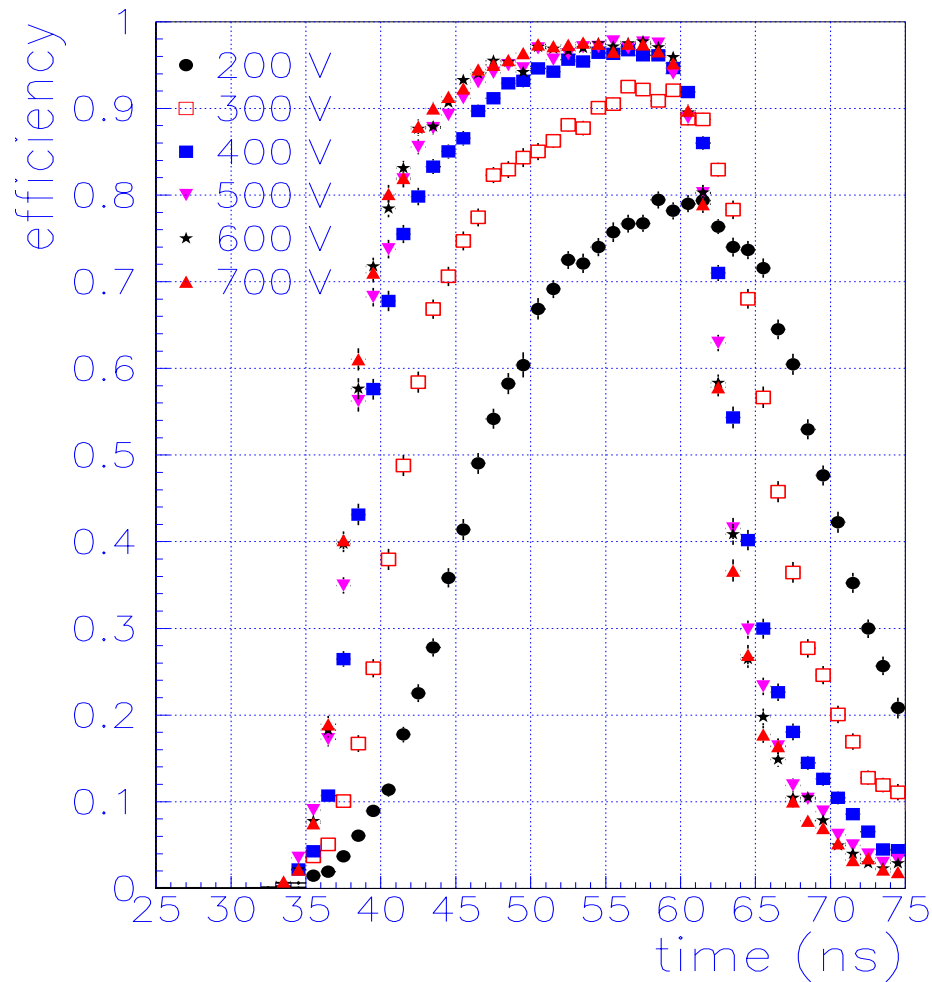
Full depletion at about 450 V



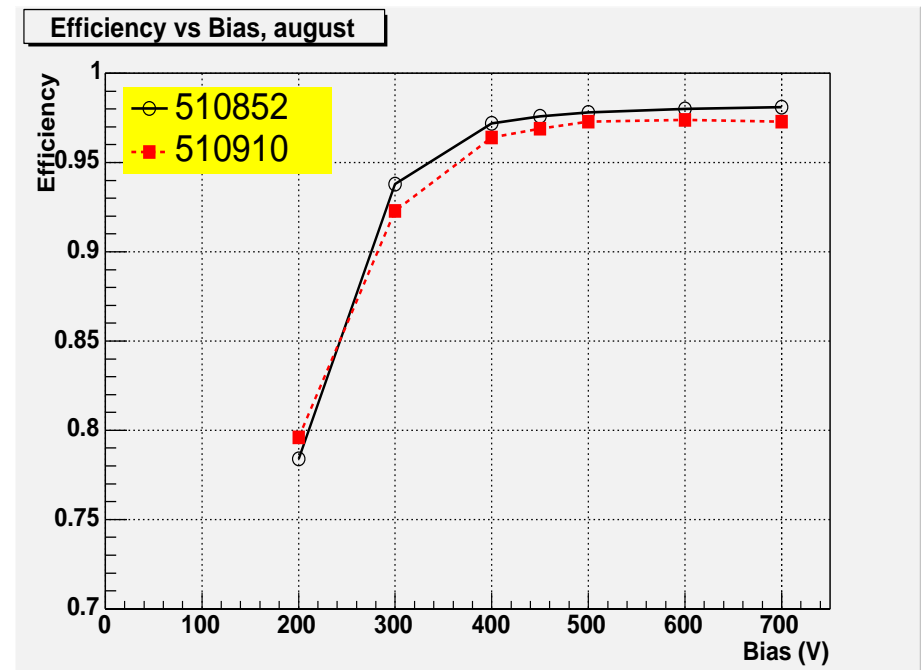


Efficiency vs bias voltage

FE-13 irradiated



Full efficiency at 400-500 V





Conclusions

FE-I3 modules have a very good efficiency even after irradiation:

- $\epsilon = (97.8 \pm 0.7)\%$ (7 modules statistic)
- plateau is **8 ns** wide, module timing uniformity is **1.7 ns**
- most losses occur for tracks close to the bias grid charge loss region
- efficiency is better at 10^0 than at normal incidence
- Full efficiency reached already at 500 V
- No obvious difference between sensor vendors/bonding firms

See Magda's presentation for efficiency at high intensity