

DEPFET TB summary

DEPFET SuperBelle meeting – July 21st 2009

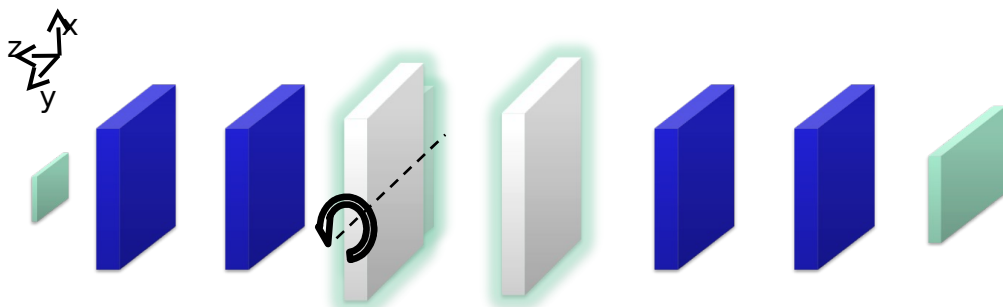
Marcel Vos, IFIC Valencia



IFIC



Test Beam Setup

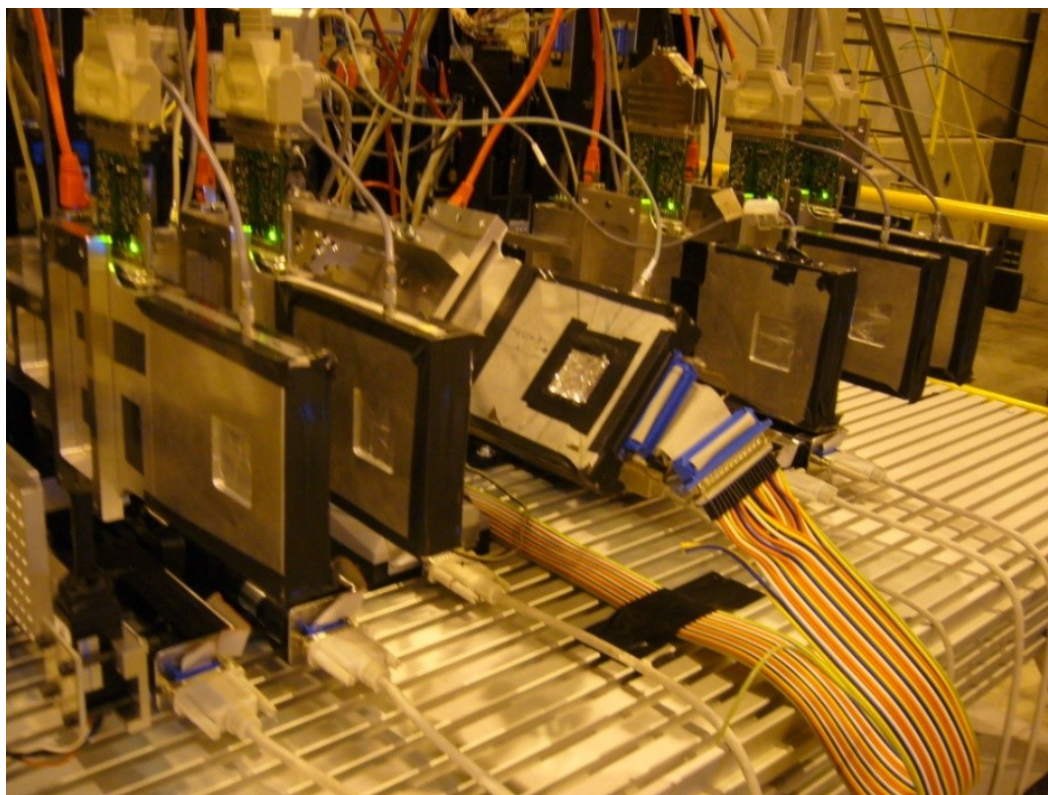


4 Telescope planes:

- $32 \times 24 \mu\text{m}^2$
- Common Clear Gate
- 128×64 pixels
- $450 \mu\text{m}$ thick

3 DUTs:

- $24 \times 24 \mu\text{m}^2$
- Capacitive coupled clear gate
- 128×64 pixels
- $450 \mu\text{m}$ thick



- ❑ **Voltage scans:** Cross-check, we're running in optimal settings
 - V_{Bias} to the wafer 150-220V
 - V_{Edge}
 - $V_{\text{ClearHigh}}$
- ❑ **Angular scan:** To study resolution vs. Cluster size
 - -5, -4, -3, -2, -1.5, -1, -0.5, 0, 0.5, 1, 1.5, 2, 3, 4, 5, 6, 9, 12, 18, 36
- ❑ **Beam energy scan:** To analyse wheter the separation "multi-scattering-intrinsic resolution" is performed correctly
 - 20, 40, 60, 80, 120 GeV
- ❑ **Large statistics:**
 - Charge collection uniformity studies
 - In-pixel studies

3.5 TB of data

20 Million events

Enormous amount of good-quality* data

(* Every 16th event is corrupted (understood DAQ problem, solved). CCGG module

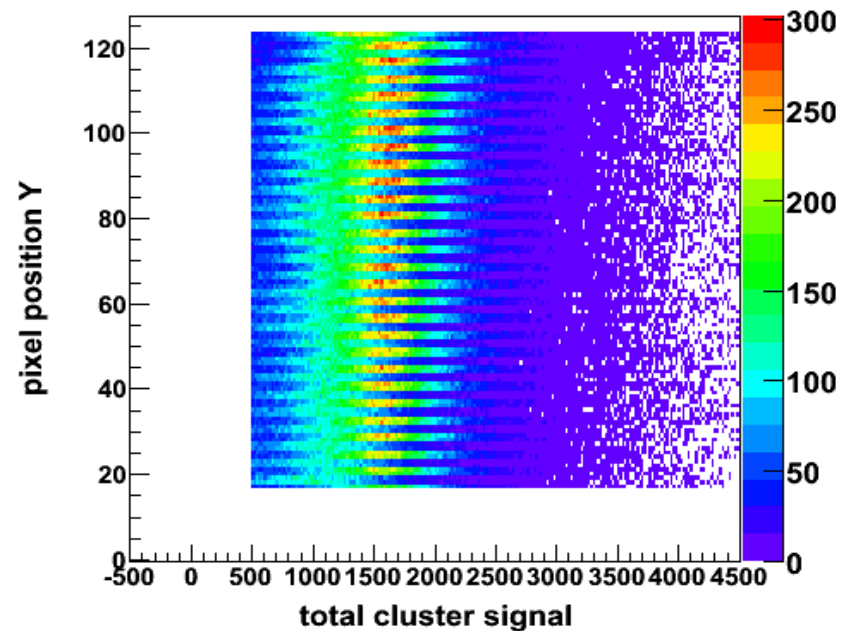
Experience 2008 in a nutshell

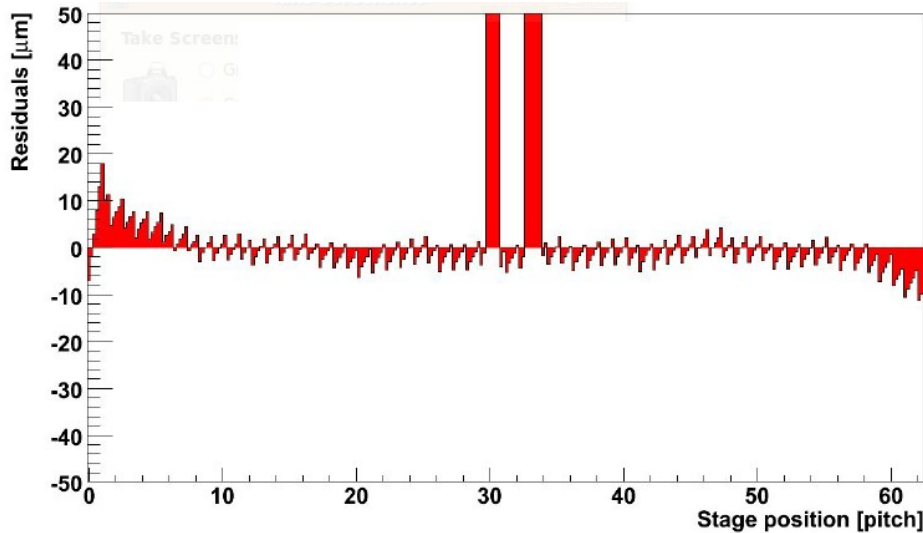
Gain variations.

- Not random: there is a definite row modulo 4 structure, but the behaviour is still too irregular to correct using a simple row-wise correction factor.
- Observed initially and very clearly in one telescope module, but present to some level in all modules, including small-pixel DUT (and 2009 S3b modules?)
- Variations of the strength of the effect with time have been observed
- Not understood: looking for a voltage that is distributed to groups of four rows
- Distorts position measurement to a measurable level and must be corrected for

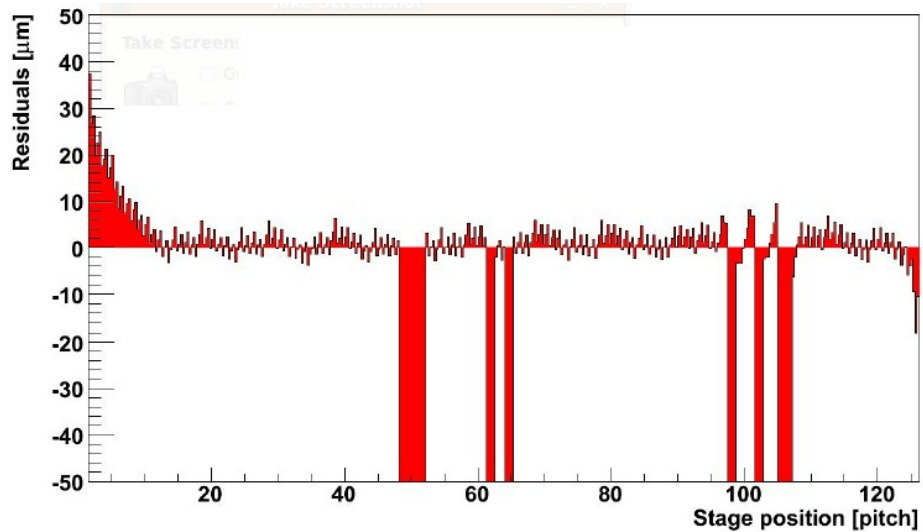
Strong (10 % and more) variations in the signal gain are observed in some modules (module 4). In some other modules (telescope 1, 2, 5 and the DUT) and runs (1262) the effect is at the 1 % level or less.

Module 5: cluster PH vs. Y-position





Edge effect, observed in laser scans, confirmed by test beam data. Variations of V_{edge} have no visible effect.
 Estimate effect on $50 \mu\text{m}$ sensor.



Edge effect (measurement in last few pixels is significantly biased)



TB2008:

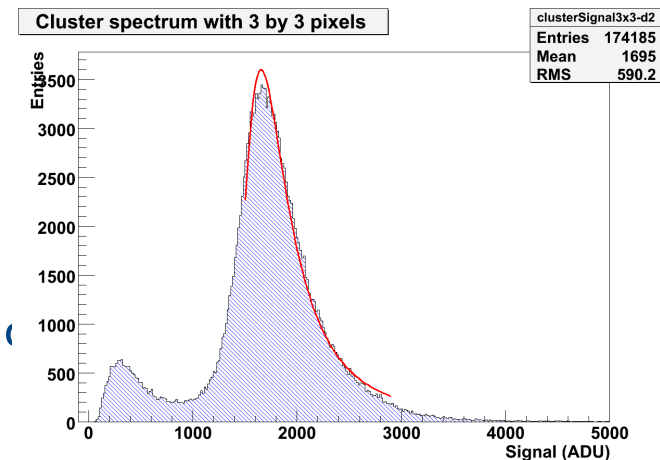
Results I: charge collection (depend only on clustering)

Material to be provided by Valencia + others

- g_q , S/N

Compare to lab measurements

g_q measurements repeatable to $\sim 10\%$



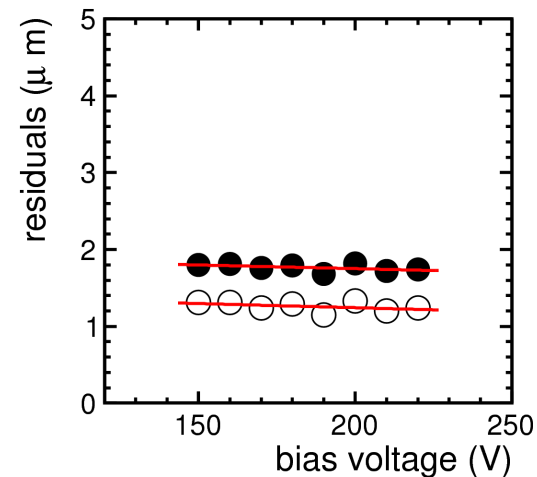
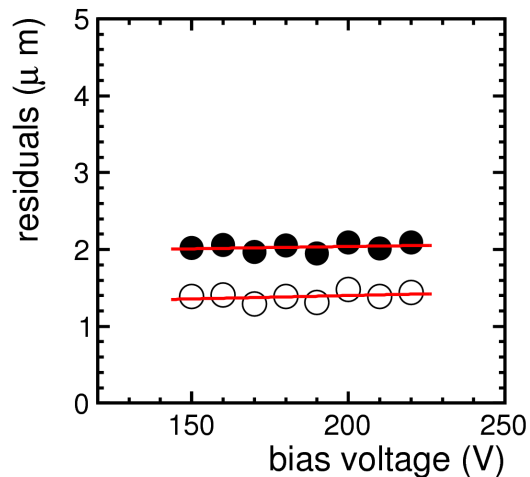
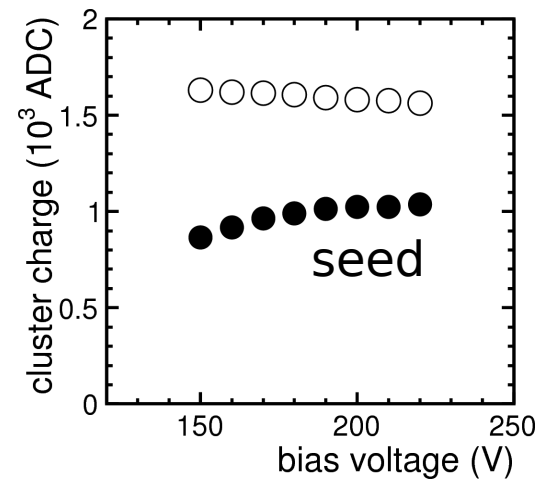
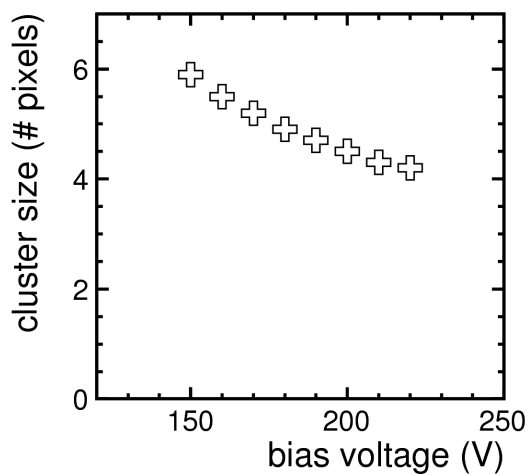
CAVEAT: expect better gain results in 2009

Peter Fischer@Ringberg: compare shape to GEANT4 prediction. Tail is indeed depleted. Single pixel response saturates at 4000 ADC. The small-pixel DUT seems to saturate earlier: at ~ 2000 ADC

TB2008: charge collection

Scanning the sensor bias voltage from 150 to 220 V reveals a strong effect on the lateral dispersion of the signal (#pixels with signal > 2.5 sigma, fraction of charge in the seed pixel). The spatial resolution is only mildly affected.

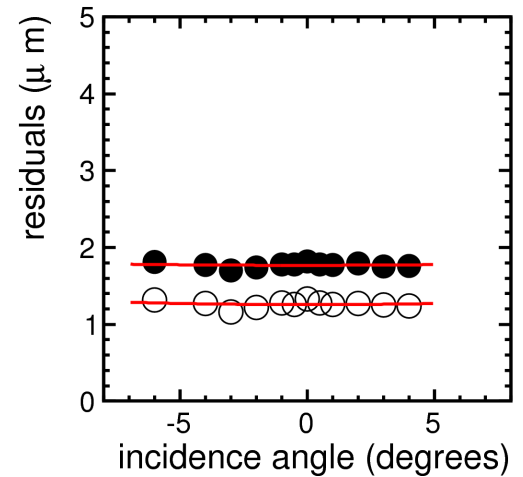
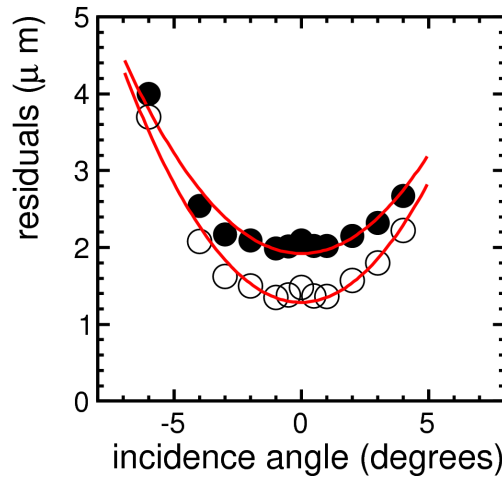
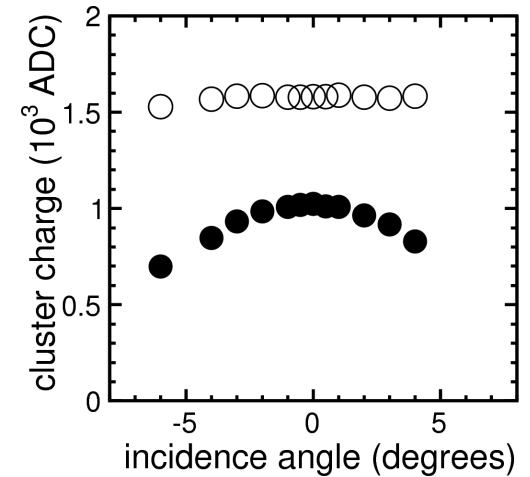
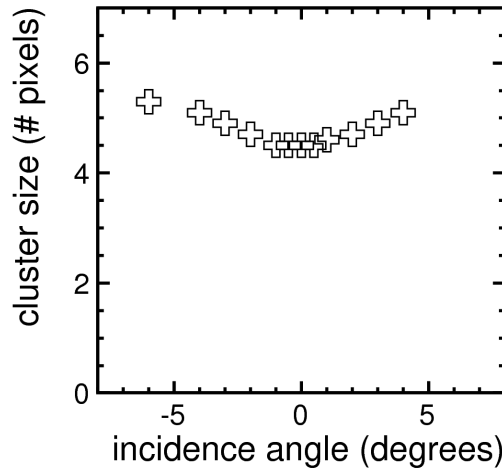
- resolution
- residuals



TB2008: charge collection

Rotating the small-pixel DUT through small angles ($-5^{\circ}, 5^{\circ}$) the cluster size and seed fraction reflect the increased charge sharing under non-perpendicular incidence. The resolution of the X-coordinate improves slightly for $1-3^{\circ}$ angles. The resolution shows a strong deterioration beyond 4° .

- resolution
- residuals



Results II: resolution (multiple scattering, telescope)

We cannot ignore multiple scattering (even at 120 GeV) or telescope resolution. DUT resolution measurement obtained by plugging in a theoretical expectation for the Multiple Coulomb scattering (either by simulating the setup in GEANT4 or by a fit like P. Kvasnicka).

module	0	1	2	3	4	5
PRG residual	2.8	2.1	2.1	2.0	3.0	3.4
PRG resolution	2.0	1.5	1.7	1.4	2.5	2.5

Energy scan is a useful x-check to see we disentangle intrinsic resolution correctly. First attempt failed.

Not much progress in extrapolation to BELLE-II and ILC

	P1	P2	P3	P4	P5	P6
	35 30 Apr 4 Jun	35 4 Jun 9 Jul	35 9 Jul 13 Aug	35 13 Aug 17 Sep	35 17 Sep 22 Oct	32 22 Oct 23 Nov
T2 -H2	NA CMS LACTOR 3 7	CMS HCAL 11	CMS HCAL 13	NA61 18	NA61 35	NA61 24
T2 -H4	NA CMS ECAL 3 7	CMS HCAL 11	CMS HCAL 13	NA61 18	NA61 35	NA61 24
T4 -H6	NA CMS ECAL 3 7	CMS HCAL 11	CMS HCAL 13	NA61 18	NA61 35	NA61 24
T4 -H8	NA CMS ECAL 3 7	CMS HCAL 11	CMS HCAL 13	NA61 18	NA61 35	NA61 24
T4 -P0	NA CMS ECAL 3 7	CMS HCAL 11	CMS HCAL 13	NA61 18	NA61 35	NA61 24
T6 -M2	NA CMS ECAL 3 7	CMS HCAL 11	CMS HCAL 13	NA61 18	NA61 35	NA61 24
CNGS	NA CMS ECAL 3 7	CMS HCAL 11	CMS HCAL 13	NA61 18	NA61 35	NA61 24

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Comments:
 - Shift and Compress Schedule by 1 week w.r.t V1.0

This summer's TB programme:

- main user's period in second week of August
- EUDET (including DEPFET DUT) starts two weeks earlier

Setup of DEPFET telescope from 23rd of July, to be in the beam by end of July. Some TB team members have arrived at CERN yesterday!

SPS H6 schedule

	=====	=====	=====
Date	23/7 - 6/8	6/8 - 13/8	13/8 - 19/8
Main user	EUDET	DEPFET	LCFI
Parasitic/DUT	DEPFET	?	DEPFET?



New “telescope” successfully built

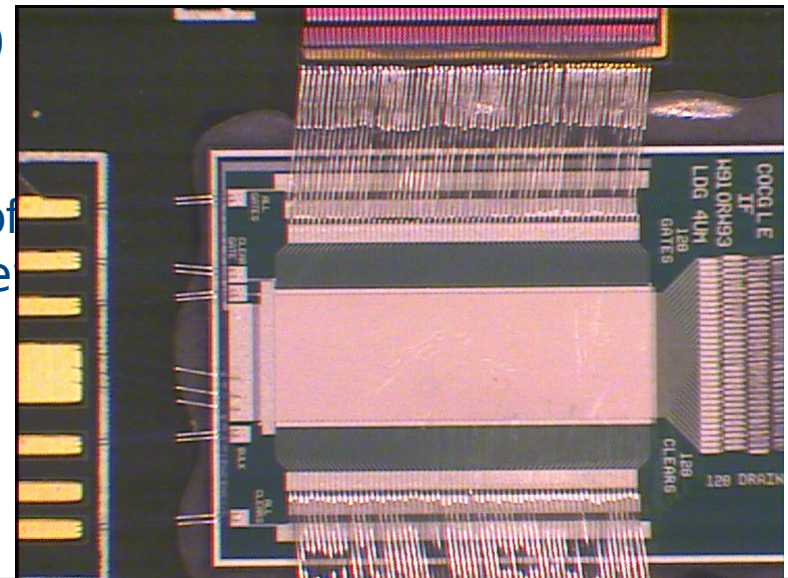
- 128x128 pixel PXD5 matrices
- S3b system, the new work-horse module (Bonn, including tutorial)
- Standard power supplies (connected to modules with a single cable)
- Centralized characterization at MPI Jelena + visiting experts

DUTs:

- Irradiated module will not be tested (matrix died)
- CCGG module (SB default). First two modules are behaving badly (noisy pixels, hot spots). A third should be bonded in Bonn this week.
- Smaller pixel size ($20 \times 20 \mu\text{m}^2$)
- Shorter gate length (technology problem)

<http://aldebaran.hll.mpg.de/twiki/bin/view/Dept>

<http://aldebaran.hll.mpg.de/twiki/bin/view>



IEEE talk assigned (to Laci)

Some possibilities, combined test beams, TB in magnetic field, etc., will be discussed in a TB workshop at LAL, 3rd - 6th of November

As silicon tracking/vertexing representative in the scientific committee I should collect ideas in this community and find candidate speakers

