BINARY READ-OUT IN THE ATLAS BEAM TEST IN H8 AT CERN IN SUMMER 1995:

Binary r-ϕ Modules in the H8 Beam Test

Tested Module	Hybrid	Detector [side,type,AC]			Pitch [micron]	Length [cm]	# of strips	Amp Chip	Pipe Line
UCSC	Kapton	n	n	AC	50	6,12	384	LBIC	CDP128
DDR2	Kapton	p	n	AC	50	6	384	LBIC	DDR2
LBIC1,LBIC2	Ceramic	p	n	DC	75	12	1536	LBIC	CDP128
ATT1,ATT2	Ceramic	p	n	DC	75	12	256,128	CAFE	CDP128
ATT	Ceramic	n	p	DC	75	12	180	CAFE	CDP128

All detector strips are directly bonded to the FEE.
The hybrid, which carries the FEE and the data and control signals,
is mounted across the detector strips in the approximate center of the 12cm silicon detector module.

Objectives of the Binary H8 Beam Test

√ Test of ATLAS style front-end chips & detectors
√ Determination of noise for 6cm and 12cm strip length
Determination of signal(efficiency) for inclined tracks in 75m pitch detectors
√ On-chip data sparsification (ATLAS style data transmission protocol)
√ Test of clock pick-up for hybrids mounted across detectors
√ Module fabrication techniques
√ High speed DAQ (40MHz) based on DSP modules
√ On-line monitoring

MONITORING SIGNAL-TO-NOISE: THRESHOLD SCANS

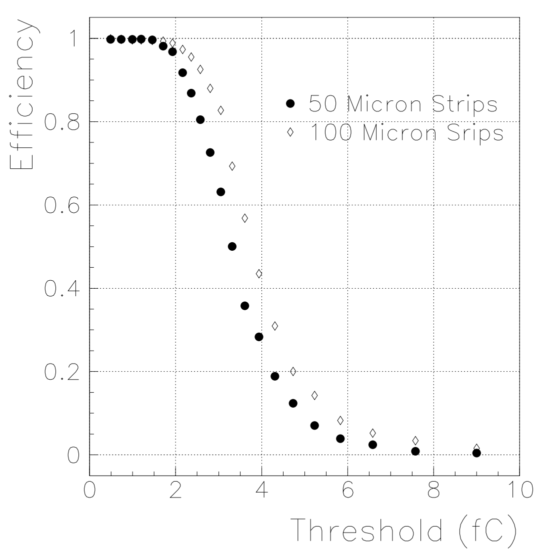
By recording the counting rate as a function of varying threshold, the pulse height spectrum can be extracted.

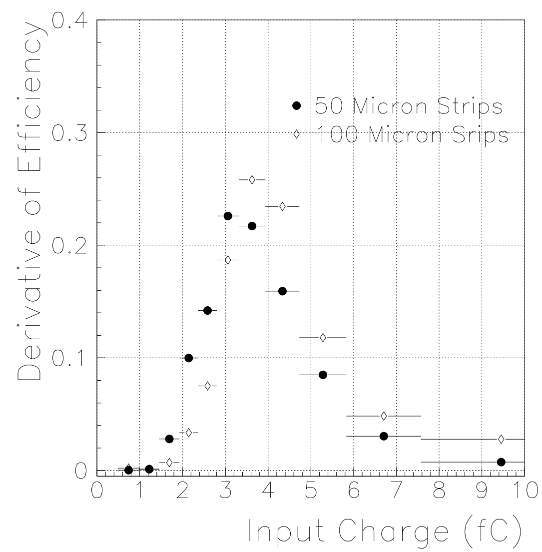
Threshold scans yield the efficiency = integral spectrum of all hits with pulse height exceeding the threshold.

Its derivative is the pulse height spectrum.

KEK Beam Test

In the KEK beam tests, a tracking program was used to determine the efficiency of each of the planes.
This was done off-line after a careful alignment of all the planes relative to each other.
Inefficiencies of less than 0.1% at 1fC threshold for the n-side operating with bias far above depletion.
The pulse height spectrum peaks close to the expected value of 4fC.

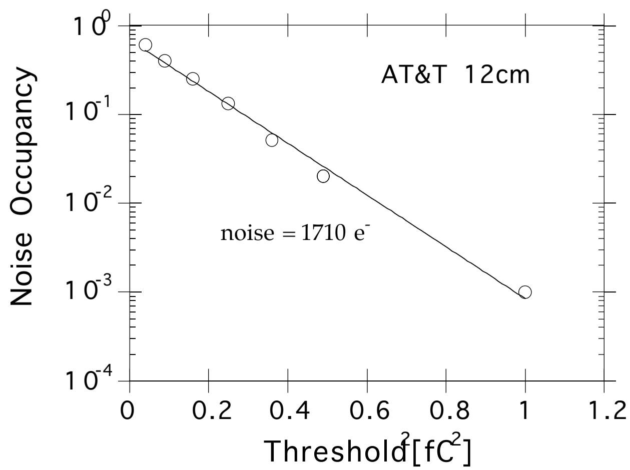




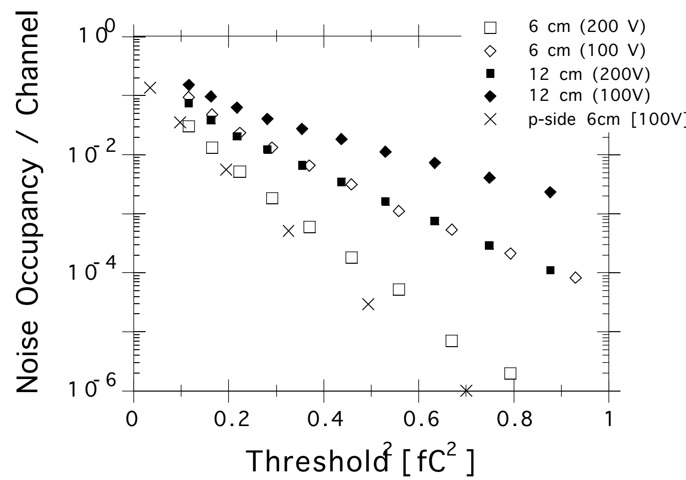
Noise:

Threshold Scan without Beams => Noise Occupancy => Erf fit => Noise Charge [e^-]

On-line : ATT module (12cm p-bulk n-side)



Off-line: UCSC module (6 & 12cm n-bulk n-side)



The extracted noise sigma for the ATT module is somewhat higher than desired.

Detector was not optimized for low interstrip capacitance (narrow p-isolation strips)

The noise improves with wider p-isolations (Hamamatsu detectors of the "UCSC" module)

Noise Charge derived from Occupancy Plots of UCSC Module

Side: n/p	Length [cm]	Bias [V]	σ_n [e^-]
n	6	100	1370
n	6	200	1180
n	12	100	1860
n	12	200	1550
p	6	100	1060

12cm long n-side detectors with binary readout can be operated with noise occupancy of close to 10^{-4} (noise charge of 1500 electrons)

ON-LINE EFFICIENCY MONITORING

Efficiency and noise occupancy are the performance parameters which are directly usable in tracking programs.

The binary system does not rely on determining the charge sharing between adjacent strips,

(position resolution = pitch/$\sqrt{(12)}$)

=> resolution is automatically ok if the efficiency is high and the noise is low.

=> no need to monitor the position resolution on-line in addition to efficiency and noise occupancy.

The binary data lends itself ideally to the task of <u>on-line</u> monitoring,

because no data corrections are needed (and are even possible!).

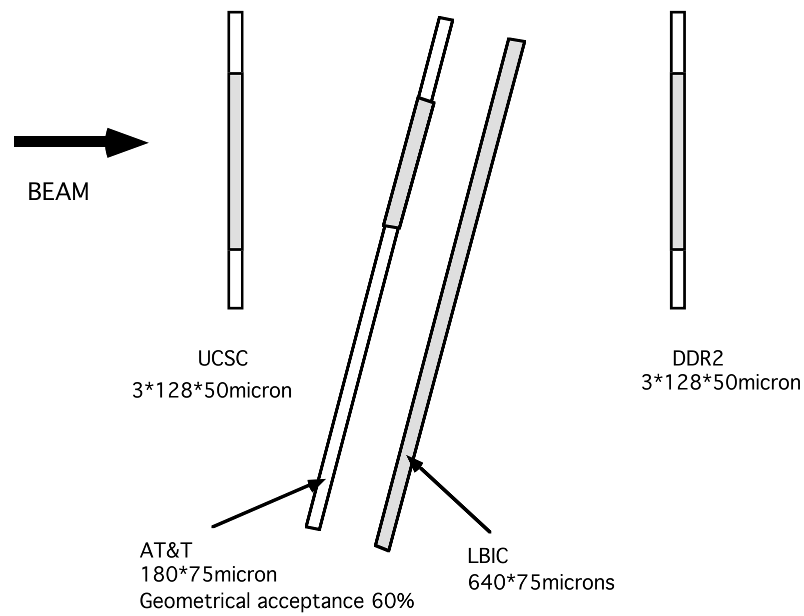
The requirements for the on-line tracking program are modest due to the low occupancy of the system.

Simple ratio's of 2-out-of-3 or 3-out-of-4 hits with modest p_t cut are sufficient,

=> will investigate the use of the LEVEL 2 lagorithm.

Set-up during a particular run period in September 1995:
two stationary detectors ("anchors") and two devices under test on a rotary stage.
Shaded areas are the extend of read out channels.

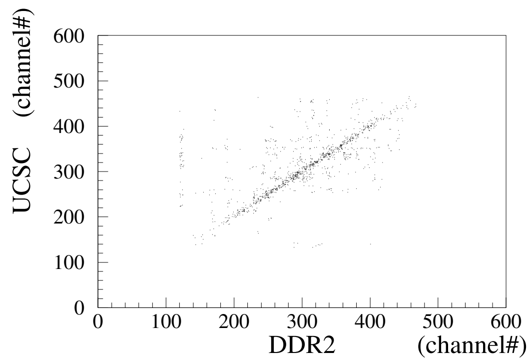
BINARY H8 Beam Test CERN 1995

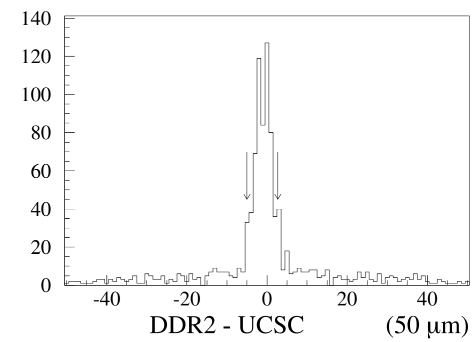


On-line monitoring during the beam test,
during a threshold scan at a fixed bias voltage and a rotation angle of 14^{o}
The rotation simulates worse case pulse height during ATLAS operations (pulse sharing among adjacent strips).

A simple procedure which relied on correlation plots was used to determine the efficiency.
Hits in two anchor planes (UCSC, DDR2) with fixed threshold of 1fC identified beam particles
Search for corresponding hits in the third plane (ATT).

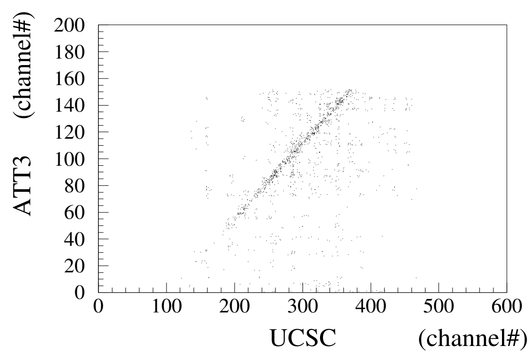
Finding the Beam in Anchors:

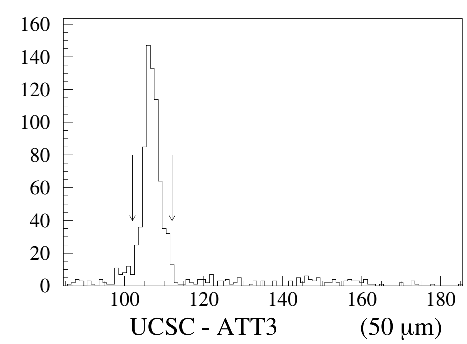




Correlation UCSC vs. DDR2 plane (threshold 1fC); Projection onto the line Δ = DDR2-UCS C

Finding the Beam in DUT:





Correlation of hits in the ATT and UCSC planes. Projection for beam particles

Efficiency = beam hits in ATT / beam hits in Anchors

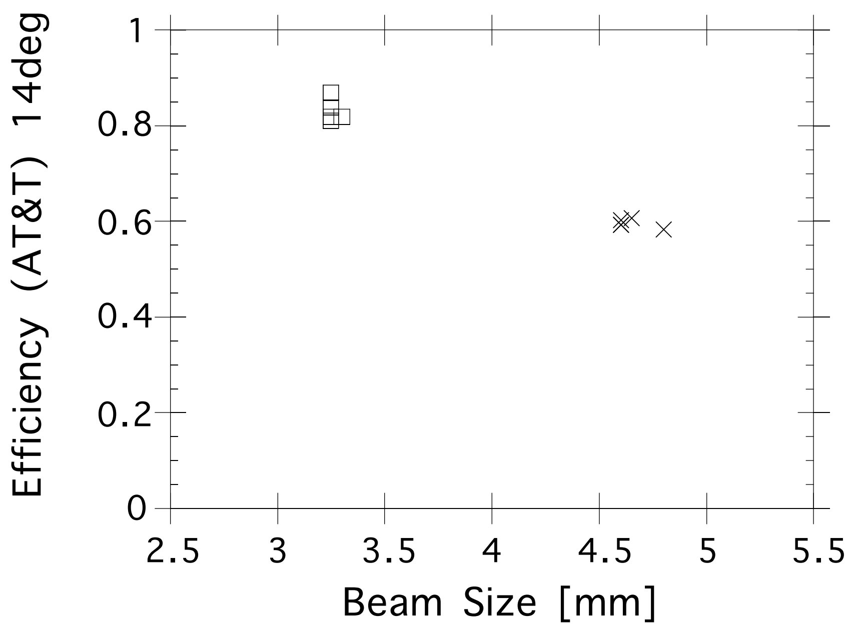
Acceptance of the anchor planes > Acceptance in ATT plane => relative Efficiencies.

(A cut on the beam position in the anchor planes would have given absolute efficiencies).

Monitor changing beam conditions

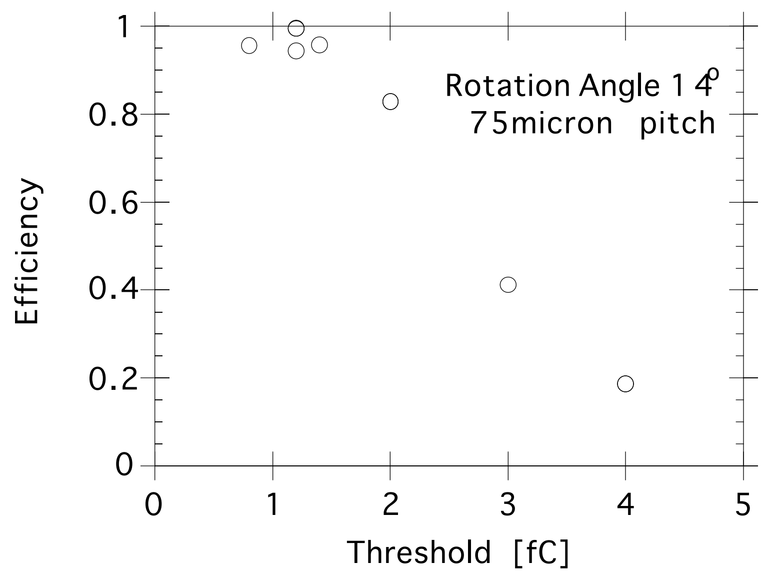
Beam not fully contained in the ATT detector => different relative efficiency for different beam sizes

On-line Efficiency at Thresholds of 0.8, 1.0 and 1.2 vs. Beam Size as determined in the UCSC Plane.



On-line Threshold Scan (small beam size)

(normalize efficiencies at low threshold to unity)



Efficiency has the same form as the one determined from off-line analysis in previous beam test.
The observed median is, as expected, lower than at normal incidence
because of the finite crossing angle of the beam.
Eficiency is still very high even at a threshold of 1.4fC.

CONCLUSIONS

The H8 beam test shows that binary modules have performance approaching the ATLAS requirements.

Threshold scans allow to determine the pulse height and noise charge.

Direct determination of efficiency and noise occupancy have been performed on-line during data taking.

Soon we will have off-line results on efficiencies as function of rotation angle.