SCT Testbeam Analysis : Plans & Progress

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SSG 14 Nov. 2000

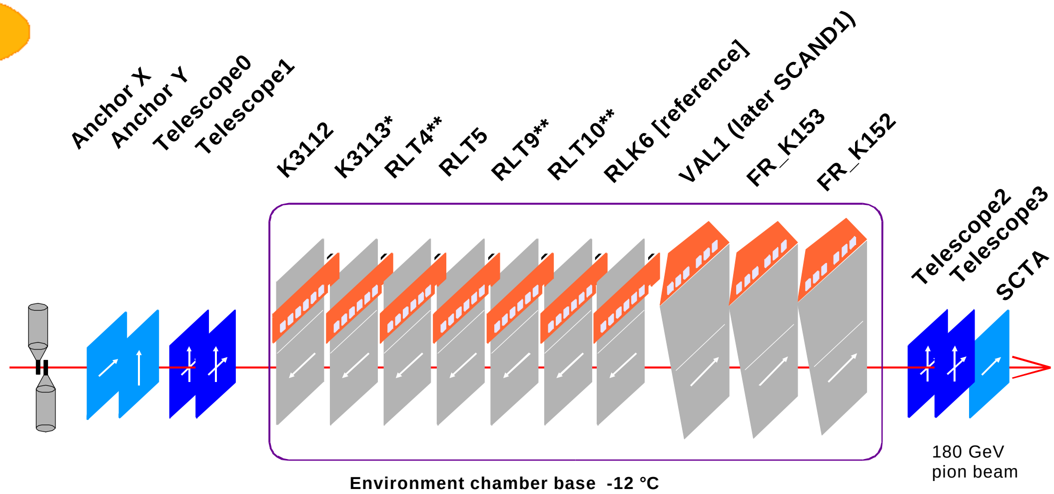
Summary:

- Three H8 runs in 2000:
  May – 25ns runs; already presented
  June – Cooling, long cable problems for irrad. dets.
  Data set incomplete & superseded by August
  August – Main problems solved; large, clean dataset
- Current work **concentrating on August:**
  Threshold scans (12 runs of 5k events) of
  9 scanneded Modules (18 planes) with
  5 Bias * 5 Angle * 2 Magnet settings
  = **~1000 Threshold S-curves**
- Alignment and DST production recently completed by
  Marcel Vos and Valencia
- Summary **ntuples** (ROOT format) developed
- Detailed analysis well underway
- Summary ntuples make data ***very accessible***
- Several independent analyses

Note: Most of the analysis presented here is the work of Marcel Vos and the Valencia offline team: See http://ific.uv.es/~vos/tb2000/aug2000.

For general access to testbeam information, refer to the SCT/testbeam web site.

Modules in August 2000



Environment chamber base -12 °C

Unirradiated barrel modules +3 - +5 °C
**Irradiated barrel modules with direct fluid & grease -6 - -7 °C
* Irradiated barrel module with direct fluid only -3 °C

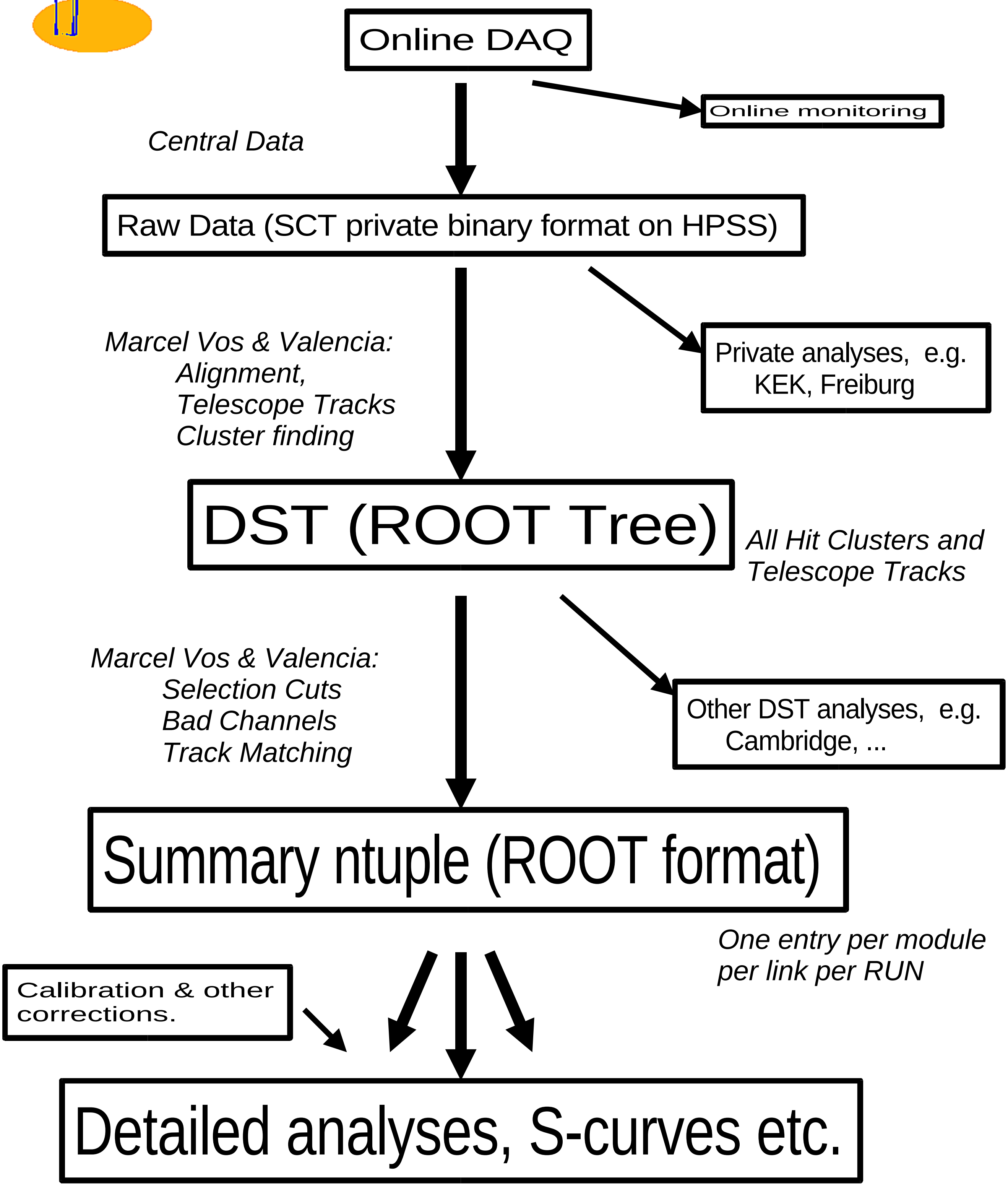
Unirradiated forward modules +40 - +50 °C

Inside cold chamber & Magnet, & rotated in
Angle scans : 10 Fully-populated Modules (20 streams)

K3112	KEK	<100>	285μm	Unirradiated	Scans Qthr,Vdet
K3113	KEK	<100>	285μm	Irrad. Detectors	Scans Qthr,Vdet
RLT5	UK	<111>	325μm	Unirradiated	Scans Qthr,Vdet
RLT4	UK	<111>	325μm	Irrad. Module	Scans Qthr,Vdet
RLK6	UK			Unirradiated	Reference (fixed Qthr,Vdet)
RLT9	UK	<111>	285μm	Irrad. Detectors	Scans Qthr,Vdet
RLT10	UK	<100>	285μm	Irrad. Detectors	Scans Qthr,Vdet
VAL1	Val.			Unirradiated	Scans Qthr,Vdet
SCAND1	Scand.			Unirradiated	Scans Qthr,Vdet
K152	FR			Unirradiated	Scans Qthr,Vdet
K153	FR			Unirradiated	Scans Qthr,Vdet

plus four Viking Telescopes and two ABCD2NT Anchors

Data Production & Analysis



Alignment & DST Production

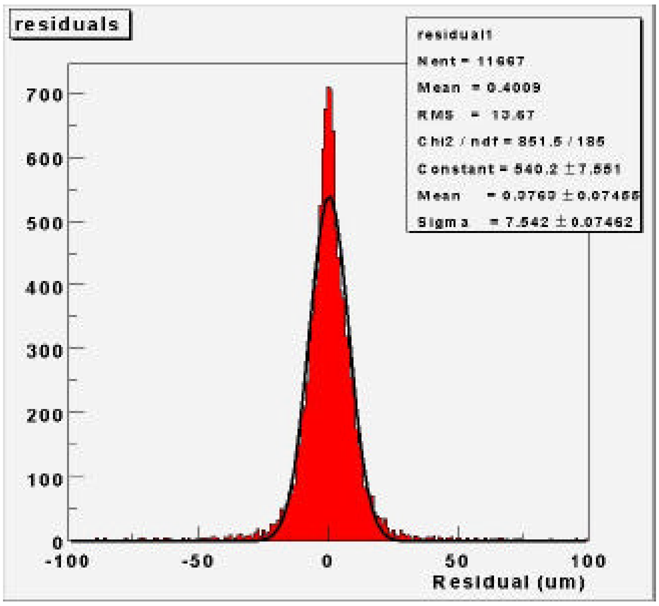
Raw data format has changed due to the Online change to the testbeam version of SCTDAQ. This has occasioned a complete re-write of the traditional H8 offline software, but concepts, algorithm and DST content very similar.

Alignment: Minimise residuals for each sensitive plane (telescope and modules) as a function of 5 spatial parameters (R,Z,φ, θ,η)

Telescope Tracks:
- 3 or 4 of 4 planes required
- divergence and χ^2 cuts

studied for event single-track efficiency vs resolution
- useful resolution ~10μm

with loose cuts for reasonable efficiency and noise statistics



DST Production:
- ROOT "Tree" Format (OO version of ntuple idea)
- All raw module hits and timebin information
- Aligned and clusterised module hits
- Aligned telescope tracks & TDC information
- Example analysis macros published on Offline website

Alignment & DST Production is a very time-consuming process, so we should be sure that sufficient generality is preserved, and that track selection criteria are generally agreed.

Analysis

Using the telescope tracks and module hit clusters in the DSTs, and applying cuts and corrections. We should agree on the appropriate cuts and corrections.

Telescope track cuts: loose for efficiency, noise etc.; tight for residuals, interstrip position etc.

Track – hit spatial matching: Efficient hit within 100µm, off-track noise hit outside 2mm.

Timing (TDC): Data in August was acquired EDGE-OFF, ANYHIT.
Efficient hit: any time bin (i.e., ***no TDC cut***)
Noise occupancy: all timebins summed and divided by 3

Bad channels: Determine from superset of Online Mask & offline dead/hot channel finder. Use bad channels & ***all immediate neighbours***:
- to exclude events from efficiency cacluation
- to exclude hits from noise calculations

Module	K3112	K3113	RLT4	RLT5	RLT9	RLT10	VAL1	SCAND1	FRK153	FRK152
# Bad Ch.	94	126	279	19	201	229	38	277	147	93

Corrections to resulting plots:

Recalibration if indicated by in-situ calibrations scans

In August, particularly the Freiburg module nominal charges were set using an inappropriate quadratic fit which underestimates the low charge region by around 0.5fC.

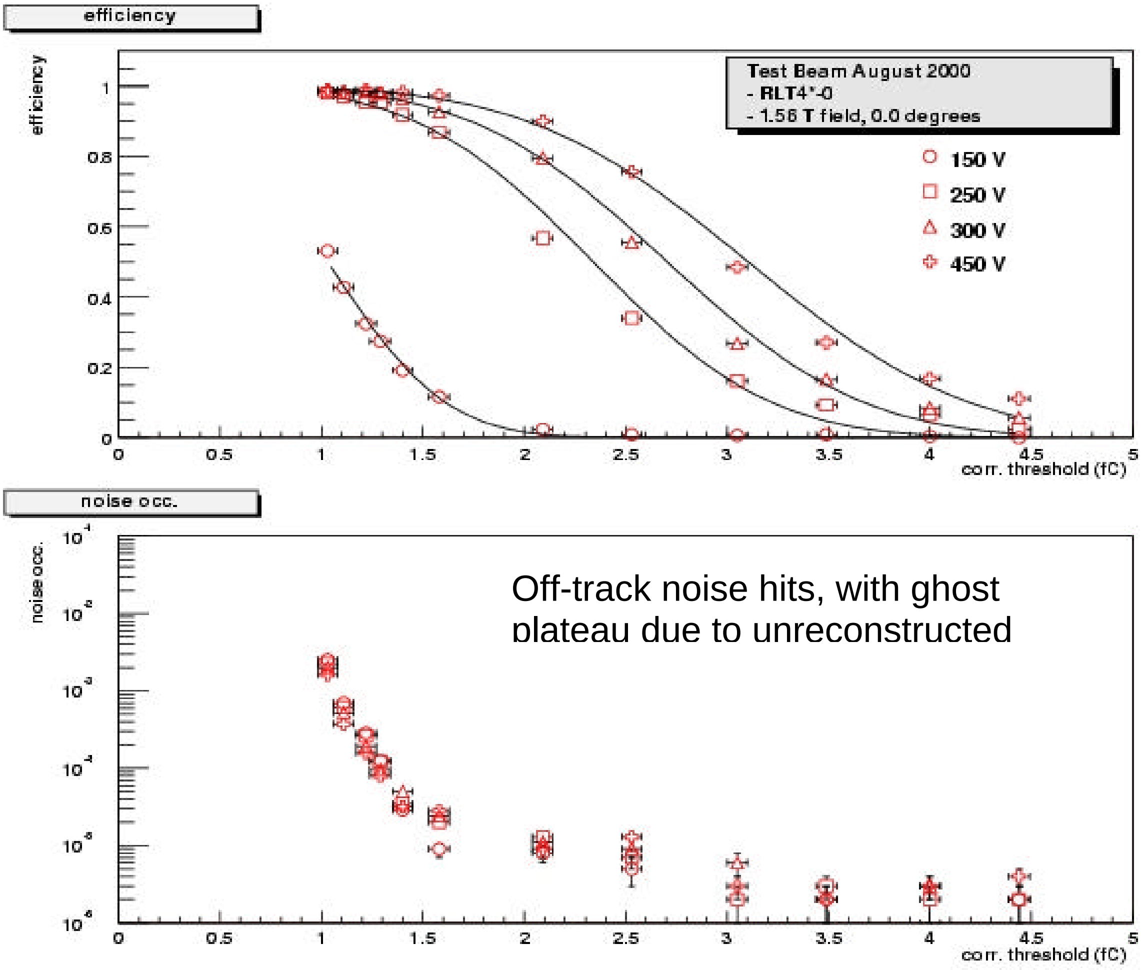
Detector thickness (325/285 µm) for certain detectors

Bias voltage, for the bias resistance at the high (few mA) leakage current of irradiated detectors.

Some hybrids have a bias resistance differing from the SCT spec. Should we adjust the quoted bias to the nominal resistance, or quote all modules subtracting the bias resistor voltage ?

Efficiency & Noise Occupancy

Many analyses start from Efficiency vs Threshold S-curves, and Noise-occupancy vs Threshold plots from which important parameters are derived...



How to handle ~1000 S-curves and as many noise-occupancy scans, plus special beam-off noise runs, from August alone ?

→ **Summary ntuple, one entry per module, per link,**

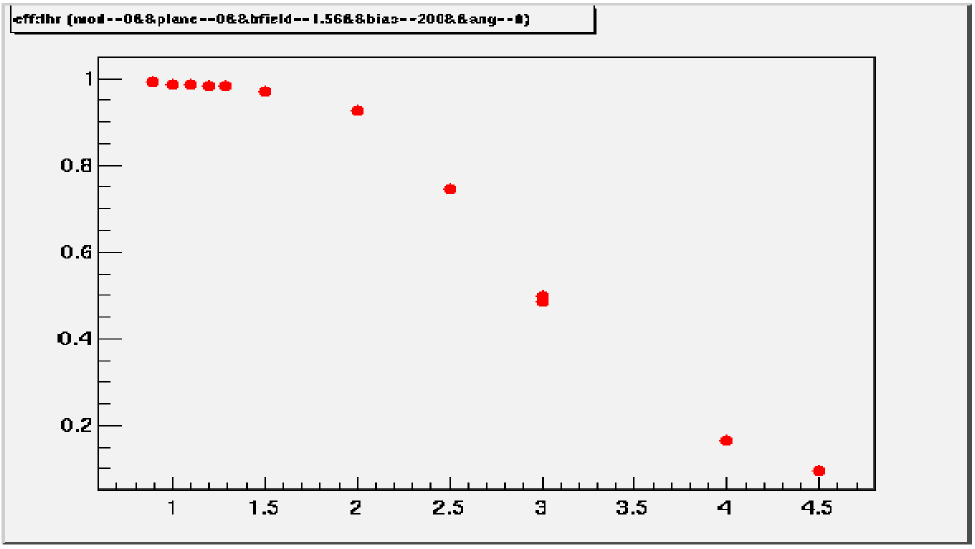
run : thr : irr : bias : ang : bfield : module : plane : ntracks :
eff : efferr : noise : nerr : width : res : rerr : tdc width :

One 250k file from which many interesting plots can easily be generated.

Summary Ntuple

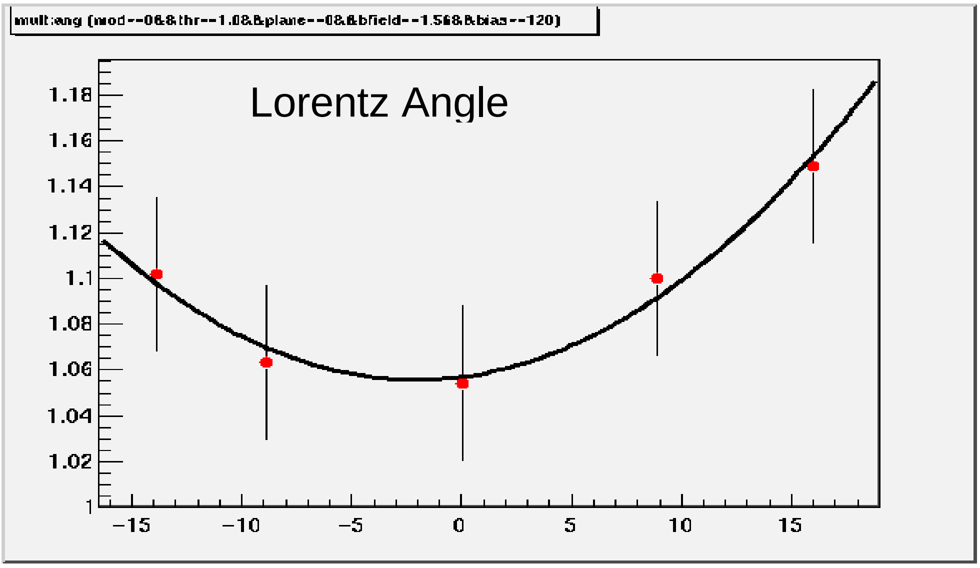
- Download sum_ntuple.root from Marcel's web site
- Start a ROOT session on Unix or Windows
- Type these C++ commands at the ROOT prompt:

```
TFile *f = new TFile("sum_ntuple.root");
ntuple->Draw("eff:thr","mod==0&&plane==0&&bfield==1.56&&bias==200&&ang==0");
```



More ambitious plots can be generated without much more difficulty.

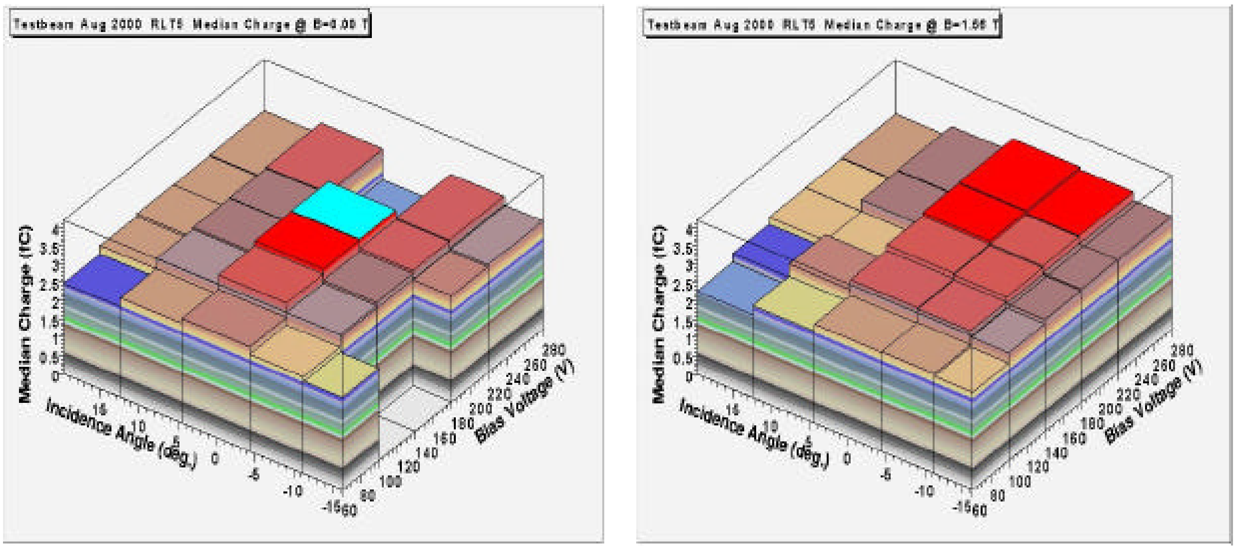
```
ntuple->Draw("mult:ang>>hprof",
        "mod==0&&plane==0&&thr==1.0&&bfield=1.56&&bias==80");
hprof->Fit("pol2");
```



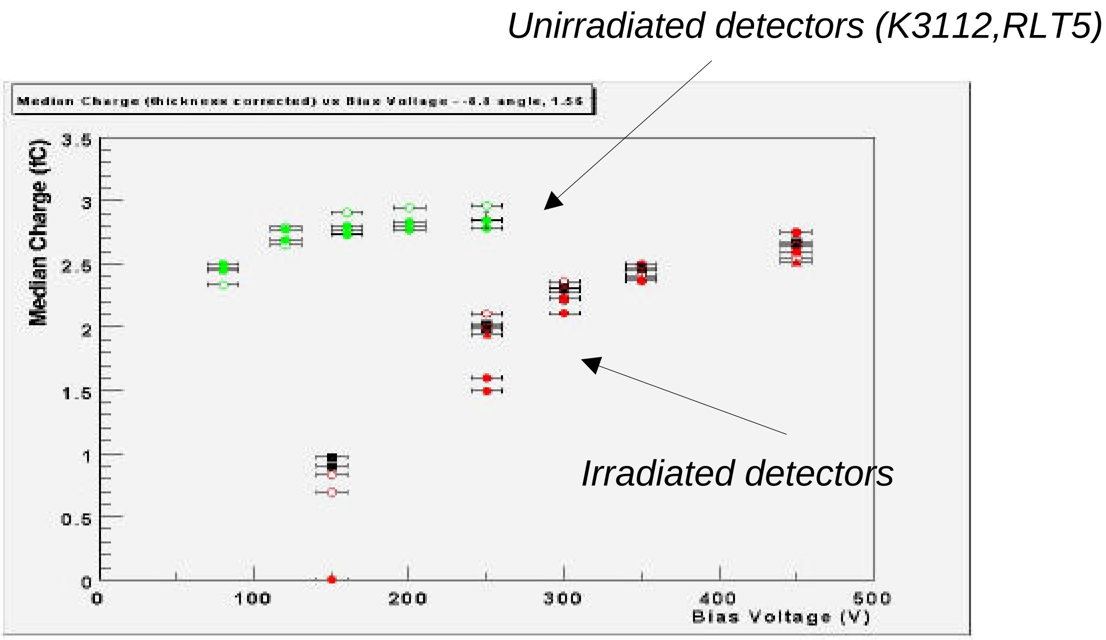
Median Charge

An example of use of the summary

From Error-function fit to S-curves, derive Median Charge at each Angle, Bias and Magnet setting:



RLT5, B == 0.0 and B == 1.56

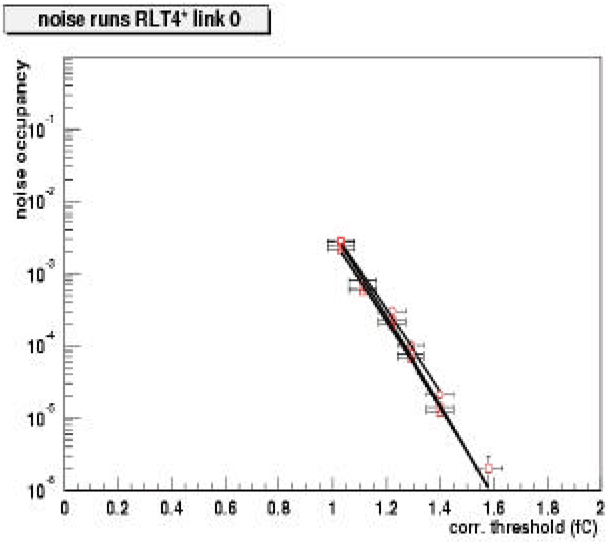


Median Charge vs Bias (Uncorrected)

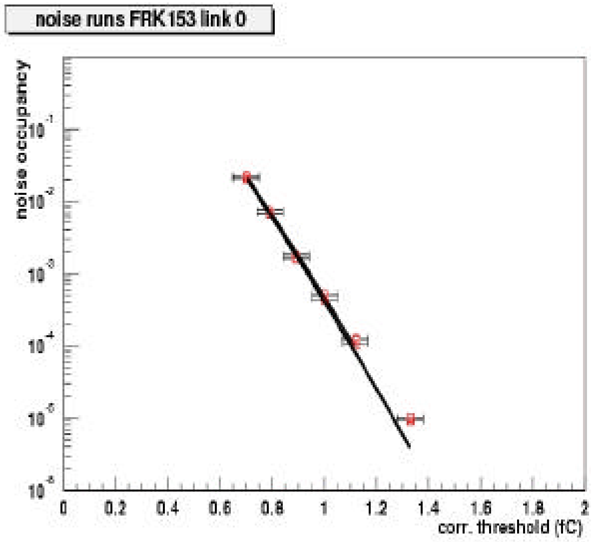
See Marcel's detailed note for a discussion of ballistic deficit

Noise Runs

Special, higher statistic noise runs are generally taken during MDs or after the end of beam time.



RLT4 at 250,350 & 450V



FRK153 at 120,200,250V

Module	occ(1fC) 250/450V	occ(1fC) 200/350V	occ(1fC) 120/250V
K3112-0	<10-5	<10-5	<10-5
K3112-1	<10-5	<10-5	<10-5
K3113-0	<10-5	<10-5	<10-5
K3113-1	<10-5	<10-5	<10-5
RLT4-0	0.0038	0.0037	0.0029
RLT4-1	0.0089	0.0084	0.0077
RLT5-0	<10-5	<10-5	<10-5
RLT5-1	0.000101	0.000063	0.000055
RLT9-0	0.000465	0.000402	0.000313
RLT10-0	0.000127	0.000125	0.000131
RLT10-1	0.000005	0.000005	0.000005
SCAND1-0	0.000003	0.000002	0.000002
SCAND1-1	<10-5	<10-5	<10-5
FRK153-0	0.000482	0.000424	0.000402
FRK153-1	0.000207	0.000215	0.000196
FRK152-0	0.000647	0.000532	0.000568
FRK152-1	0.000402	0.000323	0.000287

For the barrel modules, we didn't go low enough in threshold....

Forward modules much higher
(and also non-gaussian)

Plans

Marcel & Valencia have made a very extensive start.
We need to come to a consensus on methods,
selections, corrections etc.

Agreement on DST format

- simplifies comparisons by mutual application of analysis codes
- implement for KEK situation using H8 offline ?
- adopt in existing KEK offline ?
- Freiburg offline ?

Agreement on corrections to be applied:

- recalibration to in-situ linear fit
- detector thickness
- bias resistance (true Vdet or common Rbias ?)

Agreement on summary ntuple format

- selection criteria, cuts may differ
- simplifies comparisons by mutual application of analysis codes
- development of standard plots (i.e., macros to produce them)

Agreement on important selection cuts

Continue analyses

- eg, Valencia (Marcel), Cambridge (Alan Barr) are both using DSTs

Write an ATLAS-INDET note by end 2000

- should reflect common position where possible,
- but include various analyses
- should refer to DSTs and summary ntuples available to ID community, eg, for GEANT4 studies

December run at KEK separately analysed ?

- Will hopefully have much better calibration control (ABCD3T)
- Will hopefully have Forward modules which can be sensibly analysed

Gareth Moorhead, 14/11/2000