Beamtest of ATLAS SCT Barrel and Endcap Modules, 1 - 22 August 2001 at the CERN SPS H8 Beamline

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Modules

Nine SCT modules, all built in 2001 with ABCD3T-A readout chips:

- Six Barrel modules built for the Barrel Module FDR/PRR
- Three Endcap modules built with the K4 version of the endcap hybrid

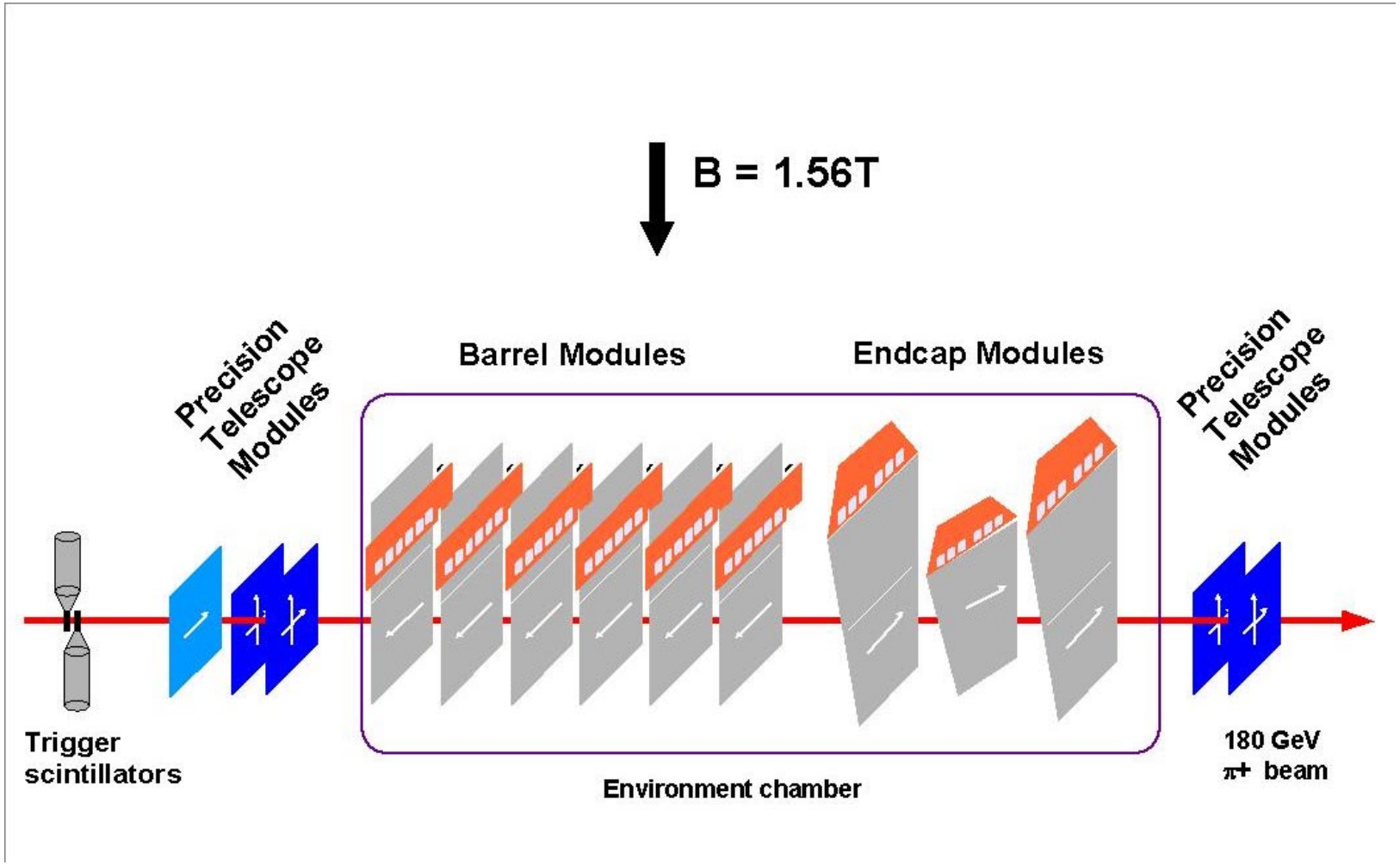
Three of these modules (two barrel, one endcap) were irradiated with protons in April 2001 at the CERN PS to a fluence of 3 x 10^14 p/cm^2.

Slot	Type	SerialNumber	Origin	Irradiated ?	Temperature
0	Barrel	20220170100029	Scandinavia	No	-6
1	Barrel	20220170100018	UK	No	-7
2	Barrel	20220170100020	Japan	Yes	-5
3	Barrel	20220170100037	Japan	Yes	-4
4	Barrel	20220170100035	Japan	No	-1
5	Barrel	20220170100036	Japan	No	-7
6	Outer Endcap	K4-218	CERN-Geneva	Yes	+4
7	Inner Endcap	K4-229	NIKHEF	No	+25
8	Outer Endcap	K4-200	Freiburg	No	+11

Temperatures as reported by hybrid thermistors, typically varied only by +/-1 degree.

Standard response curves obtained in-situ for all modules at operating T

Layout


B = 1.56T
Precision Telescope Modules
Barrel Modules
Endcap Modules
Precision Telescope Modules
Trigger scintillators
Environment chamber
180 GeV π+ beam

Setup

- Support Cards: SC2001 with Barrel or Forward Electrical Patch Cards
- Cables: all 25m, one each per module
  - Signal: twisted pairs, over-all shielded, IDC15 connectors
  - Power: Systemtest-type prototypes (most from this year's batch) , IDC25 connectors
- DAQ (*SCTDAQ + TBDAQ + ROOT*):
  - CLOAC (1), MuSTARD (x2), SLOG (x2) &nsbp *for up to 12 SCT modules*
  - TDC (CAEN V488) *measures TRIGGER - CLOCK EDGE SYNCHRONISATION (0-25ns)*
  - IRAMS (x4) *for 4 telescopes*
- Power Supplies:
  - SCTLV-3 (x5) *with working Temperature Readout*
  - SCTHV (x3) *Great improvement over bench supplies & first prototype crate*
- VME Crate: One only, *fully occupied*
- Computers:
  - 800MHz PIII running NT4 for Acquisition, with new 40GB local disk
  - HP Workstation running HP-UX for automatic Central Data Recording (CDR) to CASTOR via 100Mb/s dedicated ethernet
  - 1GHz PIII running Linux Redhat 7.1 for quick-turn-around Offline Analysis

changes from last year in red

Environment

- Module Boxes
  - Barrels - standard QMW boxes
  - Forwards - new Valencia boxes
  - ... all boxes with BSPP fittings replaced for 1/4" silicone tube
- Environment Chamber
  - Same mechanics as previous years
  - New 10-module cold fluid manifold with
  - Colder quick-connects and 1/4" silicone tubing
  - New easy-access insulated lid
- Chillers
  - Two Air-cooled Hubers, one for chamber and
  - one for the modules using new manifold
- Temperature Monitoring
  - Thermistors via SCTLV-3
  - Pt1000's via HP Multiplexer

Temperatures were very stable throughout.

Program

Each measurement point consisted of an automated **Threshold Scan** , 16 runs of 15,000 events each at set threshold steps from 0.7 to 6.0 fC, taking around 4 hours:

Qthr	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	fC

Parameters varied:

- **Detector Bias Voltage 100/150/200/250 V Unirradiated, 300/350/400/450 V Irradiated**
- **Magnetic field 0 or 1.56 T**
- **Incidence Angle -14 to +16 degrees, concentating on Normal Incidence and Maximum**
- **Position along strips**
- **Special positions near edge of sensors and at end of strips**

Scans interleaved to avoid repetition, but some repetition required due to interruptions and changes of beam conditions:

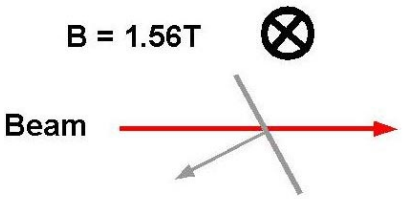
- Before: Module characterisation, especially In-Situ at operating temperature
- Week 1: SCT Main User (180 GeV pi+, stable beam, magnet)
  Angle/Magnet/Bias program
- Week 2: Tiles Main User (20-100 GeV e+, mu+, pi+, very variable; no magnet)

Small stand-alone programs - Edge, Gap studies etc.

- Week 3: SCT/PIXEL Co-Main-Users (180 GeV pi+, stable beam, magnet)
  Repeat some Edge studies; continue Angle/Magnet/Bias program

The Gory Details

Bias Scans at Min/Max Angle and Min/Max Magnetic Field strength

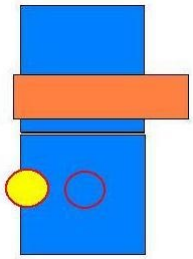


Magnet	OFF	OFF	ON	ON
Angle	0	16	0	16
Bias Voltage				
100/300 V	Ba	Ka	Ca	Da
150/350 V	Bb	Kb	Cb	Db
200/400 V	Bc	Kc	Cc	Dc
250/450 V	Bd	Kd	Cd	Dd

Angle Scans at Nominal Bias Voltages (150V Unirradiated, 350V Irradiated)

Magnet	OFF	ON
Angle		
42 (=16deg)	Kb	Db
37	La	Ea
32	Lb	Eb
27	Lc	Ec
24 (=0deg)	Ld,Bb	Cb
22	Le	Ed
17	Lf	Ee
15		Eg
12	Lg	Eh
8.5 (=-14deg)	Lh	Ei

Barrel Module Edge Study - interleaved modules Edge/Centre



Bias Voltage	

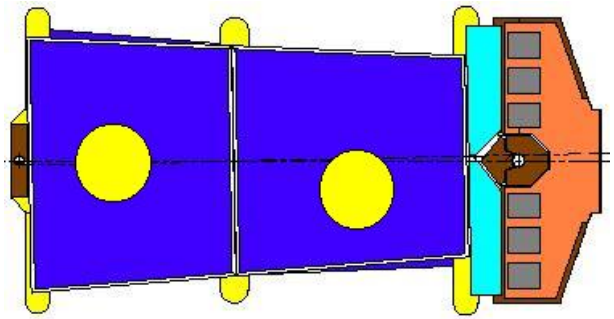
100V / 300V	Fa
150V / 350V	Fb
200V / 400V	Fc
250V / 450V	Fd

Barrel Module Gap / Bias Resistor Study

Bias Voltage	
100V / 300V	Ga
150V / 350V	Gb
200V / 400V	Gc
250V / 450V	Gd

Endcap Module Near-sensor Study / ADBCD Edge Mode ON/OFF

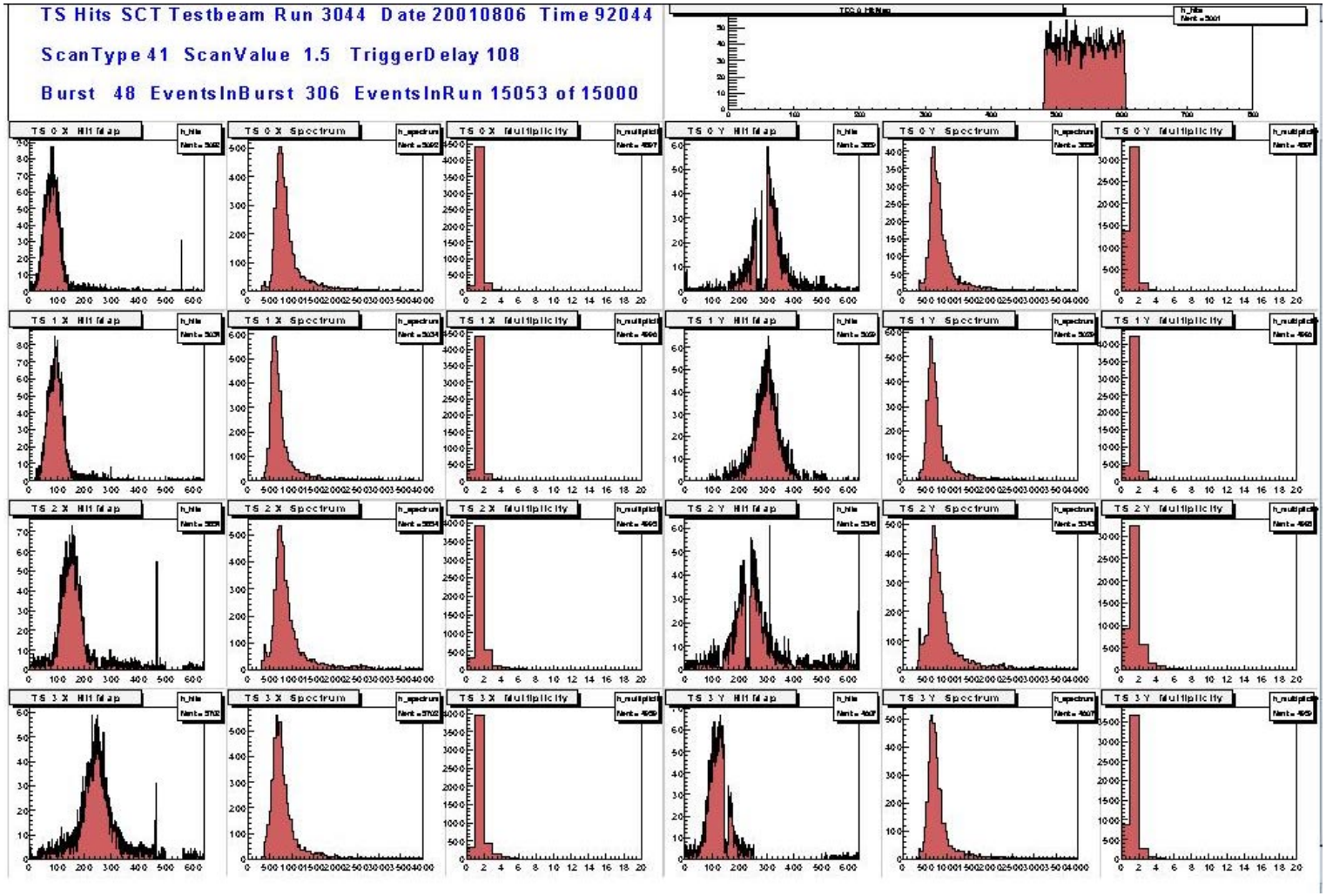
Note: forward modules turned on their side for beam to reach near detector region



Edge Mode	OFF	ON
Bias Voltage		

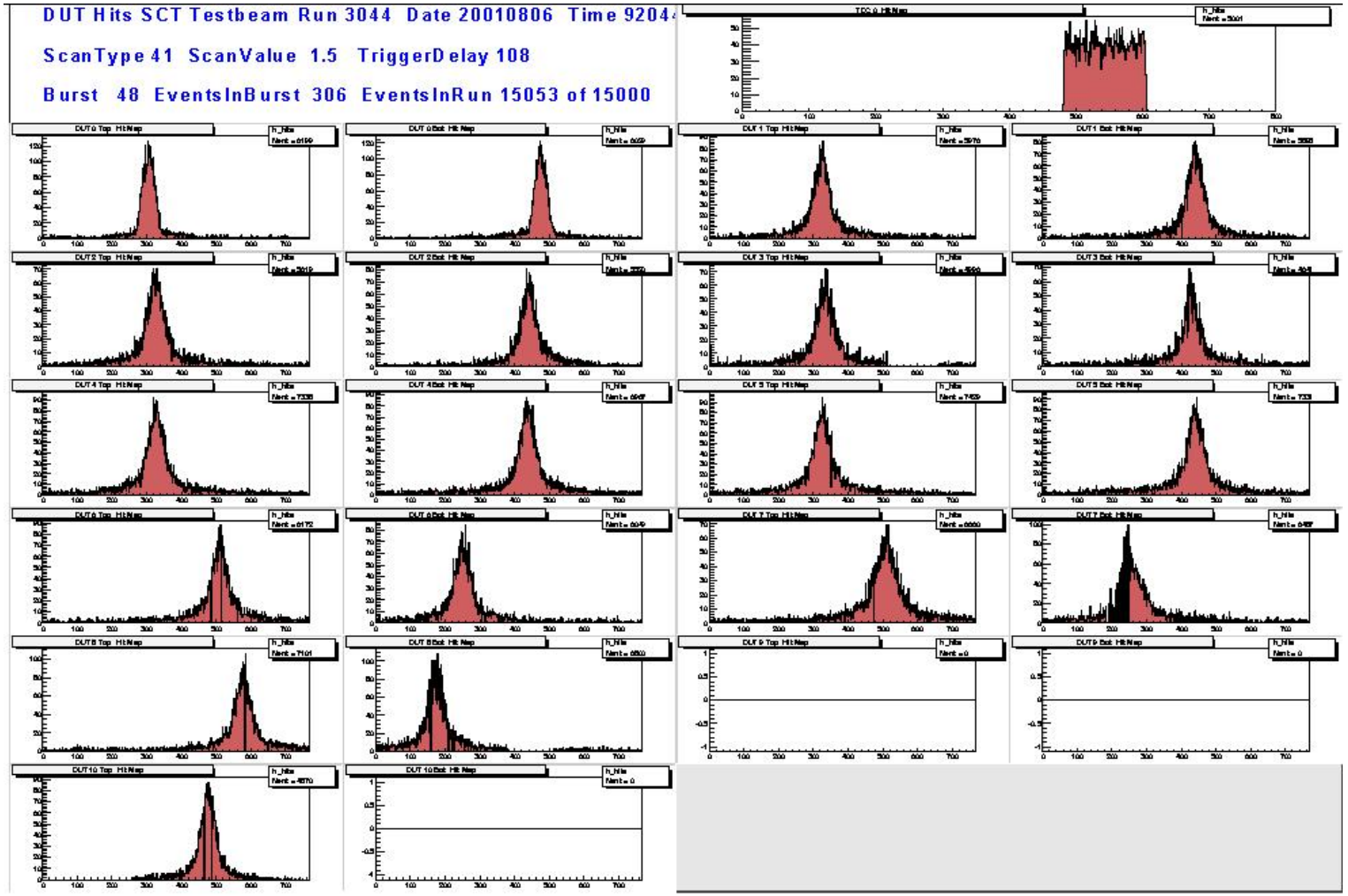
250V / 450V	Gd,Ib	Hb,Jb

Online Plots



Telescope Hit Maps / Pulse-Height Spectra / Cluster Multiplicity per Event

Note holes in telescope beam profiles due to failing elderly modules, as well as narrow beam shape.



Modules - Beam Profiles

Problems

- Damage in transit of the NIKHEF module
  - Serious thought must be given to safe courier transport of forward modules
- Difficulty of starting cold modules
  - Needed to spend >1 hour warming, re-starting, & cooling modules
  - Very reproducible behaviour
- CLOAC clock jitter
  - Episodes where clock jitter dramatically worsened (> 5ns)
  - Possibly VME crate overload and/or card temperature due to fully populated crate
  - Problem disappeared when CLOAC moved to end of crate
  - ... will obtain decent 2nd VME crate for next time
- Second VME crate
  - We had a recuperated Opal crate (no JAUX, no -5V)
  - NI-VXI, SCTDAQ etc installation OK, but
  - SCTLV gave frequent errors and trips
  - ... felt like cards (several types) did not seat well => crate problem
- Spread in CLK/COM phase between SLOG channels at end of long cables
  - Indicates OPTO readout should be pursued ?
