



# ATLAS SCT Barrel Module FDR/2001

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## SCT Barrel Module FDR Document

# SCT Barrel Module Components Section 5.1: Silicon Microstrip Detectors

### *Abstract*

This document describes the technical status and procurement of the silicon microstrip detectors for the SCT barrel modules.

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## 1 SCOPE OF THE DOCUMENT

This document describes the silicon microstrip detectors that form part of the ATLAS SCT barrel module. It covers their Technical Specification; results from the detector Pre-series; procurement status, QA procedures in place and status of the Series deliveries.

## 2 INTRODUCTION

Each barrel module contains four silicon microstrip detectors, with two on each side glued back-to-back on the barrel baseboard, as described in SCT-BM-FDR-4. A total of approximately 10,600 barrel detectors will be required for construction of the SCT, the exact number depending of the actual loss factors in series module construction and in the assembly of modules to barrels. Because the lead time is long for the delivery and acceptance of such a large number of detectors, the procurement phase for this component was begun in 1999.

The ATLAS detector FDR was held in May 1999, and contracts for the Pre-series and Series production of detectors were placed in autumn 1999. The Pre-series detectors were delivered in the spring of 2000 and thoroughly evaluated by the ATLAS Institutes. The detector PRR was held in August 2000. The barrel detector Series production was released with Hamamatsu Photonics, who will supply at least 94% of the barrel SCT silicon detectors. The remaining detectors will be supplied either by SINTEF or by Hamamatsu, depending on the quality of a second Pre-series being produced by SINTEF in summer 2001.

The documents presented at the silicon detector PRR are located on EDMS. They are:

ATLAS SCT/Detector PRR/00-1	Contractual documentation, including Technical Specification, Delivery Schedule, Provisional Acceptance, Quality Assurance
ATLAS SCT/Detector PRR/00-2	Detector Procurement Arrangements
ATLAS SCT/Detector PRR/00-3	Database for Detectors
ATLAS SCT/Detector PRR/00-4	Quality Assurance at the Institutes
ATLAS SCT/Detector PRR/00-5	Reports on the Pre-series Detectors
ATLAS SCT/Detector PRR/00-6	Detectors in Modules.

## 3 DETECTOR TECHNICAL SPECIFICATION

The full contractual Technical Specification of the detectors is located on EDMS, as are the detector engineering drawings. They are also appended to this document for completeness. (The Technical Specification covers also the detectors of the Forward SCT, which is not part of this FDR).

Following evaluation of both oxygenated and thin (260  $\mu\text{m}$  thick) detectors for the innermost of the four barrels, where the radiation levels are highest, the decision has been made to use 285  $\mu\text{m}$  thick detectors on a standard silicon substrate for all layers of the SCT. These are the B2 detectors in the Technical specification. The detectors have a rectangular geometry, with 768 ac-coupled readout strips at a pitch of 80  $\mu\text{m}$ .

After 10 years of LHC operation, the detectors in the innermost regions are expected to be operated at about 400V bias, with over 90% charge collection efficiency.

## 4 PRE-SERIES AND SERIES PRODUCTION RELEASE

The results of the pre- and post-irradiation evaluation of the Hamamatsu barrel Pre-series production are summarised in ATLAS SCT/Detector PRR/00-5. The Pre-series detectors were in general of excellent quality with on average more than 99.9% of good readout strips per detector and a pre-irradiation average leakage current of only 140nA at 350V bias at 20°C. The post-irradiation characteristics, after exposure to  $3 \times 10^{14}$   $\text{pcm}^{-2}$  24 GeV/c protons, were as measured in the prototype R&D phase of the project, and fully satisfied the post-irradiation requirements of the Technical Specification.

There were five areas to be followed up with Hamamatsu from the Pre-series results, before Series production release:

- (a) *The quality of the cut edge of the detector.* It is important that the detector edges are clean, with no loose or rough pieces of silicon or aluminium present. This is because the edge is at the full post-irradiation bias potential, and so any danger of shorting to the grounded bond wires or to exposed grounded areas of neighbouring modules on the barrel structure must be avoided. The detector edge quality of the Pre-series was variable. As a result, new visual inspection procedures have been agreed and instituted at Hamamatsu for the Series production, and these are being carefully checked during the QA of the Institutes. To-date, the edge quality of the delivered Series detectors has been satisfactory.
- (b) *The detector passivation mask.* The prototype and Pre-series Hamamatsu detectors had openings in the passivation mask that were used by the Company for QA purposes. These again presented some risk of shorts developing to bond wires or to neighbouring modules. A new passivation mask, without these openings, has been made and is being used for the Series detectors to eliminate this particular risk.
- (c) *Strip quality tests.* There were some discrepancies between the identification of bad strips between the QA at Hamamatsu and at the Institutes in the Pre-series detectors. This is now fully understood and resolved.
- (d) *Orientation of silicon substrate.* Detectors have been processed on both  $\langle 111 \rangle$  and  $\langle 100 \rangle$  silicon substrates by Hamamatsu and fully tested both pre- and post-irradiation by the SCT. No significant differences in performance were found. The final choice of substrate was in the end dictated by the availability of supply;  $\langle 111 \rangle$  silicon is being used for the Series production.
- (e) *Series delivery schedule.* The schedule agreed with Hamamatsu for the basic supply is shown in Table 1. Additional detectors will be ordered as required for delivery in 2002 through contract purchase options.

All details of the Series production release were agreed with Hamamatsu in autumn 2000, and the Series detectors are now being delivered.

<b>Hamamatsu Delivery Schedule for B2 Detectors</b>				
<b>Year/month</b>	<b>Number to be delivered to Japan</b>	<b>Number to be delivered to UK</b>	<b>Number to be delivered to Norway</b>	<b>Total monthly delivery</b>
<b>01/01</b>		10		<b>10</b>
<b>01/02</b>	230	135		<b>365</b>
<b>01/03</b>	230	135		<b>365</b>
<b>01/04</b>	230	120	100	<b>450</b>
<b>01/05</b>	230	120	100	<b>450</b>
<b>01/06</b>	230	120	100	<b>450</b>
<b>01/07</b>	230	120	100	<b>450</b>
<b>01/08</b>	230	120	100	<b>450</b>
<b>01/09</b>	230	120	100	<b>450</b>
<b>01/10</b>	230	120	100	<b>450</b>
<b>01/11</b>	230	120	100	<b>450</b>
<b>01/12</b>	230	120	100	<b>450</b>
<b>02/01</b>	230	120	100	<b>450</b>
<b>02/02</b>	230	120	100	<b>450</b>
<b>02/03</b>	230	120	100	<b>450</b>
<b>02/04</b>	230	120		<b>350</b>
<b>02/05</b>	230	120		<b>350</b>
<b>02/06</b>	230	120		<b>350</b>
<b>02/07</b>	230	120		<b>350</b>
<b>02/08</b>	260	100		<b>360</b>
<b>02/09</b>	350			<b>350</b>
<b>02/10</b>	350			<b>350</b>

*Table 1: Delivery Schedule for the basic supply of Hamamatsu barrel detectors*

## **5 DETECTOR QA AT THE INSTITUTES**

The detector acceptance QA carried out at the SCT Institutes is detailed in Appendix 1 of the Technical Specification. This is now in operation for the Series detector deliveries. The Institute responsibilities are shown in Table 1 of SCT-BM-FDR-2.

## **6 DATABASE**

The use of the SCT database is well developed for detectors. The Contractors enter their tests and agreed data directly into the database and ship the detectors electronically at delivery. The Institutes receive the detectors in the database and enter their acceptance test data. Detectors are shipped to the module building cluster after their provisional acceptance.

## **7 SUMMARY**

The silicon detector procurement for the barrel modules is so far proceeding to plan. The start of series barrel module production in autumn 2001 will allow build yields to be assessed within the contractual timeframe of the detector purchase options.