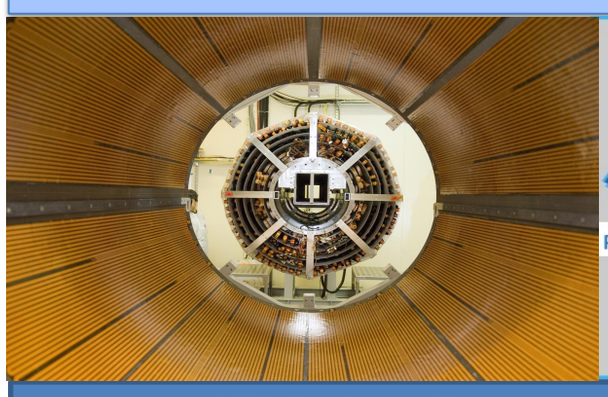
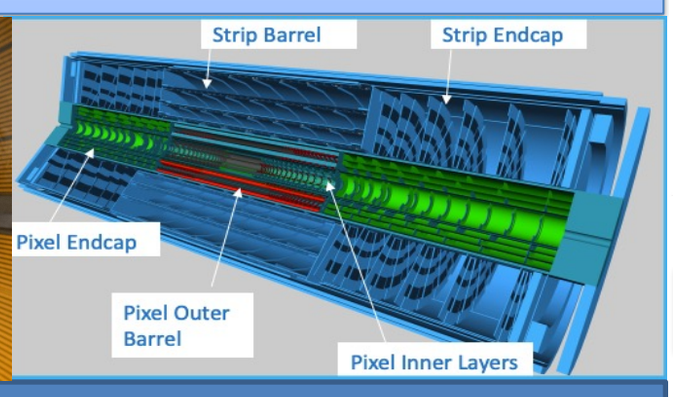
Quality Assurance for the ATLAS Inner Tracker strip sensor 2022, 23rd-27th November

In order to monitor nearly 22,000 large area silicon strip sensors production for the ATLAS Inner Tracker, a Quality Assurance (QA) strategy has been prepared to be carried out during the whole production period. A detailed irradiation and a testing plan has been prepared. The programme with the Mini sensors focuses on the target fluence 1.6e15 neq/cm2 utilizing the Associated Proton Experiment Platform (APEP) in China Spallation Neutron Source (CSNS) and the study of Charge Collection Efficiency (CCE) as a function of reverse bias voltage using the ALiBaVa LHC-speed analogue Beetle ASIC read-out system will be presented.

Introduction

The current ATLAS Inner Detector at CERN will undergo a complete upgrade in order to meet the requirements of the High Luminosity Large Hadron Collider (HL-LHC).The new Inner Tracker (ITk) will be made completely of silicon sensors. Nearly 22,000 large area sensors will be produced over a period of about five years by Hamamatsu Photonics K.K. (HPK). Quality Assurance (QA) is focused on providing confidence that quality requirements will be fulfilled in production and a detailed irradiation and testing plan has been prepared by the ATLAS-ITk Collaboration.

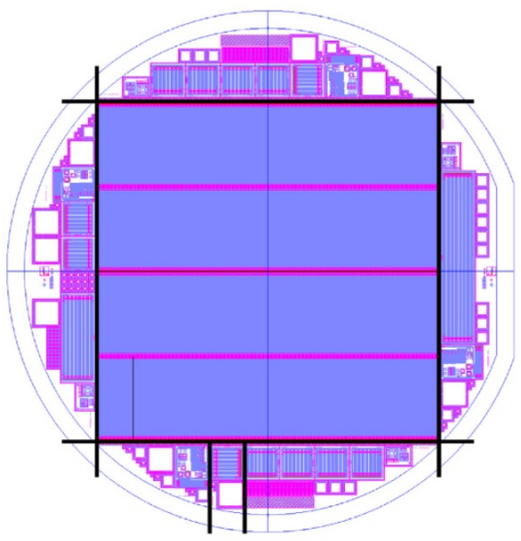


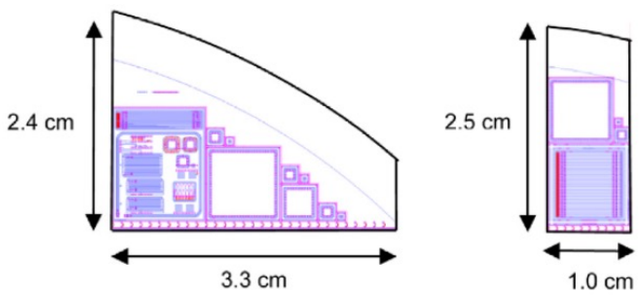


ITK Quality assurance strategy

1. Test samples

The main devices that will be used by the collaboration for QA purposes are the miniature strip sensors, with the same design as the MAIN (large format) sensor but with 1×1 cm^2 dimensions; the monitor diodes of 8×8 mm^2 size with contactable guard ring; and the ATLAS test chip.





Dicing scheme for the wafers (left), Testchip & MD8 (center) and Mini & MD8 (right).

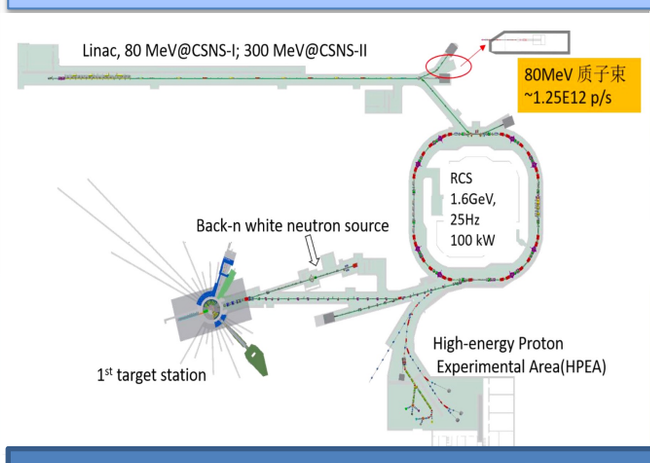
2. Planned irradiations and tests

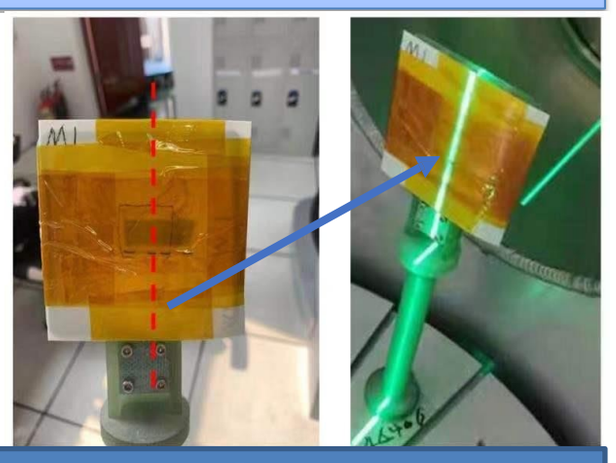
With the standard safety factors on projected particle fluences, a conservative target for the required radiation hardness of the ITk strip sensors is taken to be withstanding an integrated total ionizing dose (TID) of 660 kGy (66 Mrad) and a neutron equivalent fluence of 1.6×10^{15}eq/cm^2

Device:	Batches					
Mini	odd	even	#per batch	#per shipment	#per month	Testing sites
Pre-irrad	*2*	*3*	*2.5*	*15*	*30*	*--Available for tests--*
p (CYRIC)	*		0	0	0	Tsukuba
p (Bham)		1	0.5	3	6	Toronto, (2 CCE/month), Birmingham (4 CCE/month), Others
n (Ljubl)	1		0.5	3	6	Ljubljana (4 CCE/month), Toronto (2 CCE/month)
n (Ljubl) 5e14	1		0.5	3	6	*--Available for tests--*
γ (Prague)						-
TOTAL	4	4	4	*24*	*48*	

CSNS irradiation

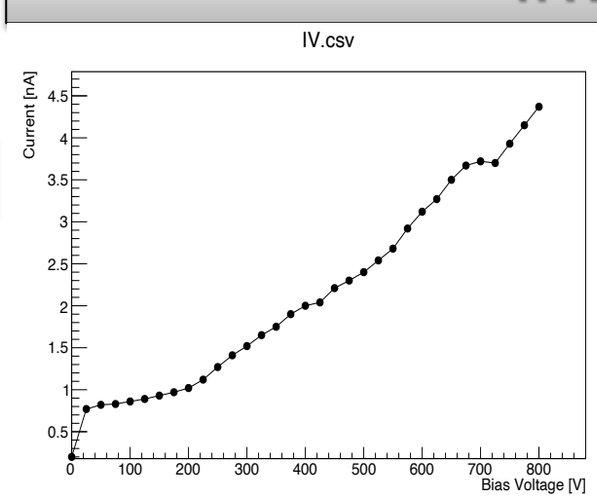
China Spallation Neutron Source (CSNS) locates at Dongguan city. It is the first pulsed neutron source facility in China. We use the Associated Proton Experiment Platform (APEP) in CSNS to irradiate the test samples.

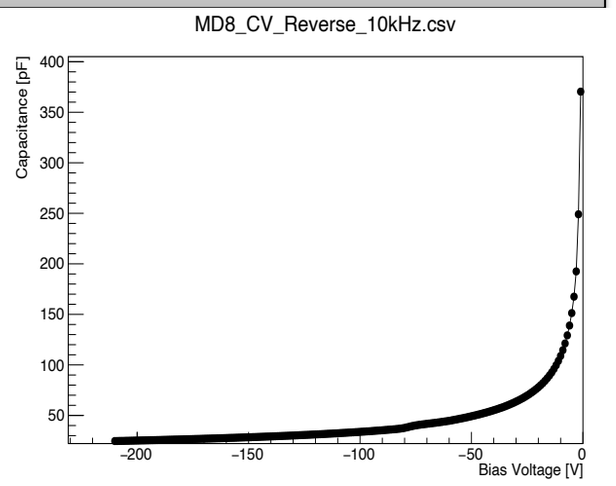




Our preliminary results

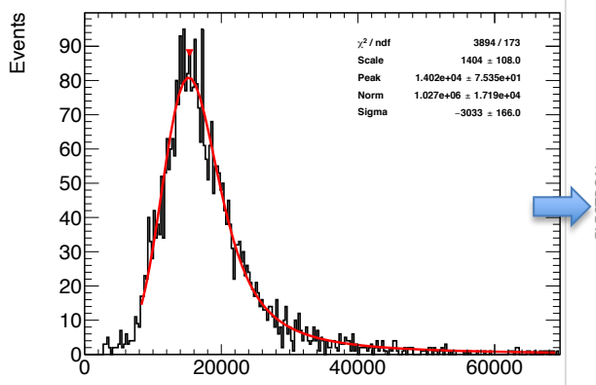
1. IV & CV

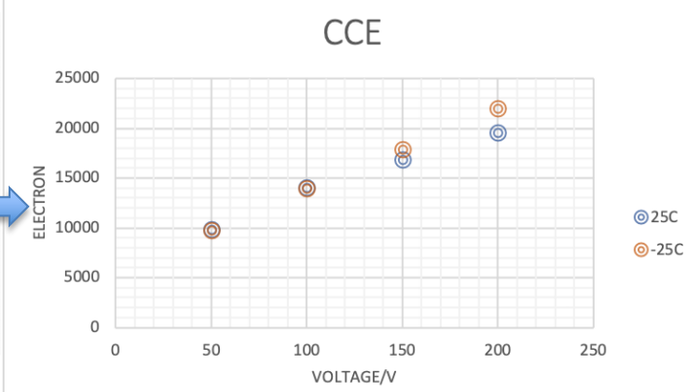




Before irradiation, the IV and CV measurements on the MD8 diodes should provide the basic parameters of the devices.

2. CCE





The minis after irradiation need to be operated at or below -20°C and the charge collection efficiency measured with the analogue read-out beetle chip using the ALiBaVa set-up.

Summary and plan

We tested the IV, CV, CCE of the QA test samples before irradiation. Preliminary reasonable results were obtained. Next, we will irradiate the chip at -20°C in APEP, and do post-irradiation tests to see if CSNS can become a QA irradiation site.

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