SEE Radiation Tolerance Criteria for the CSC Electronics
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The CSC on-detector electronics will receive a 10-year fluence F of 1.12×10^{12} cm^{-2} hadrons above 20 MeV which can cause single event effects (SEE). Hard SEE can destroy the device. Soft SEE corrupts data being processed by digital ICs.

Because of simulation uncertainty a safety factor of 5 is applied to the simulated fluences ($SF_{sim} = 5$).

Depending on whether the production lots will be known (homogeneous) or unknown, and whether testing for pre-selection or production qualification, other safety factors apply:

Type of lot	Type of test	Safety factor (SF_{lot})
Unknown	Pre-selection or qualification	4
Known	Pre-selection	2
Known	Qualification	1

The CSC subsystem collaboration is responsible for assuring the SEE-hardness of the two components which are not used by any other ATLAS subsystem. Also, for components which have been radiation tested by other subsystems the CSC group must check that SEE tests have been carried out to sufficient fluence to give meaningful SEE cross sections to be applied to the anticipated CSC environment. The CSC components vulnerable to SEE are:

Part number	Function	Mfg.	Data rate, f_0	Lot type	No. pieces in CSC, N_C	Comment
HDMP1024	Deserializer	Agilent	40 Mword/s	Unknown	160	--
Mux24-4	Multiplexer	Under development	40 Mword/s	Known	1280	Custom 0.5 μm CMOS
AD9042	A/D converter	Analog Devices	6.67 Mword/s	Known	2560	Tested by CMS
HDMP 1022	Serializer	Agilent	40 Mword/s	Unknown	320	Tested by ATLAS LArg

Assumptions used in cross section calculation:

1. 1 ATLAS-year = 10^7 seconds.
2. 0.1% data loss due to SEE is acceptable.

For hard SEE, we require the number of surviving parts after 10 years to be 99.9% of the initial number, i.e., we can tolerate $10^{-3}N_C$ chips failing. To determine the hard SEE cross section, $\sigma_{SEE\text{-}hard}$, we divide the number of failures by the fluence:

$$\sigma_{SEE\text{-}hard} = 10^{-3}N_C/(F*\mathrm{SF}).$$

For soft SEE, we determine the total number of data words processed by the device in 10 years of running: $N_W = f_0$ words/s * 10^7 sec/yr * 10yr. The acceptable number of words that can be corrupted by SEE is $10^{-3}N_W$. The soft SEE cross section, $\sigma_{SEE\text{-}soft}$, is

$$\sigma_{SEE\text{-}soft} = 10^{-3}N_W/(F*\mathrm{SF}).$$

The table below lists the radiation tolerance criteria for SEE (RTC_{SEE}) for each of the susceptible chips.

Chip	Pre-selection			Qualification		
	SF	$\sigma_{SEE\text{-}hard}$	$\sigma_{SEE\text{-}soft}$	SF	$\sigma_{SEE\text{-}hard}$	$\sigma_{SEE\text{-}soft}$
HDMP1024	4	$7.1*10^{-15}$	$1.8*10^{-1}$	4	$7.1*10^{-15}$	$1.8*10^{-1}$
Mux24-4	2	$1.1*10^{-13}$	$3.6*10^{-1}$	1	$2.3*10^{-13}$	$7.6*10^{-1}$
AD9042	2	$2.3*10^{-13}$	$6.0*10^{-2}$	1	$4.6*10^{-13}$	$1.2*10^{-1}$
HDMP1022	4	$1.4*10^{-14}$	$1.8*10^{-1}$	4	$1.4*10^{-14}$	$1.8*10^{-1}$
		cm^2	cm^2		cm^2	cm^2

During SEE testing, we irradiate several devices to the maximum anticipated fluence while monitoring hard and soft SEE. The measured cross section (number of SEE divided by fluence) is compared to the RTC_{SEE} from the table above. The dose rate must be low enough that the SEE-induced errors do not overlap, and statistics must be high enough to obtain a reliable cross section estimate.