Low and high voltage power supply for STS detector electronics

P. Koczoń[1], *B. Ernst*[1], *and C.J. Schmidt*[1]
[1]GSI, Darmstadt, Germany

Environmental conditions for STS at CBM

The silicon tracking detector STS for the CBM experiment at FAIR will work inside a magnetic field of 1 T and will have to stand a radiation load of up to 10^{14} n_{eq}/cm^2 in the regions close to the beam pipe. It consists of more than 1200 double sided silicon sensors arranged in 8 planes covering a cone of the opening angle of ± 25 degrees, illustrated in Fig. 1 [1].

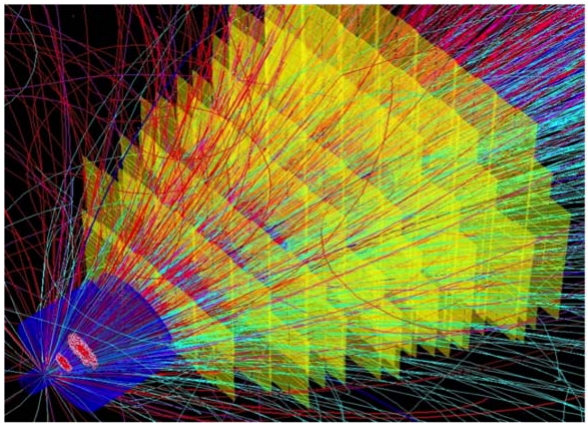

Figure 1: Silicon Tracking System with simulated tracks.

The readout electronics should work floating what means that each side of every sensor has to be operated on electric potential of up to ± 250 V (sensor bias up to 500 V) and read out independently of each other.

High voltage supply system

Each side of each silicon sensor will be supplied with a half of the nominal biasing voltage to achieve full depletion and floating operation mode. Low leakage currents in the sensors allow sufficiently compact feed-through construction and off-the-shelf system for full control of the depletion voltages from outside of the STS thermal enclosure.

Low voltage power supply system

The electrical supply needs are a power of about 45 W per detector module at several voltages (1.2, 1.5, 3.3 V). These voltages have to be delivered for each side of every sensor separately. The sheer number of feed-throughs with pin cross sections allowing for currents of 1 - 3 A would exceed the available mounting surface. Cable power losses would require additional sensing wires and would heat-up the surrounding volume. Instead, DC/DC conversion inside the temperature controlled STS-container is proposed.

DC/DC converter

Several DC/DC converter ICs have been evaluated, both isolated discrete systems (like VICORS P048T048T24AL and B048F012T30) and non-isolated systems (Linear Technology LT3605, LT3610, LTM4619, Texas Instruments LM2596 or Yutaka Electric YSD812). All investigated buck (step-down) systems are equipped with an inductance driven by a pair of high-power transistors. An air-coil type inductivity can work in a magnetic field in contrary to ferrite coils which saturate and cause system malfunction.

Both isolated DC/DC converters appeared to break down already at 50 mT due to the failure of the built-in ferrite inductivity. Measurements of converters based on other chips proved that some of them can work in a magnetic field of up to 0.7 T (field strength at the STS periphery) with efficiency of 80 - 90 % (Fig. 2). Since the evaluation boards in test have been equipped with metal oxide coils there is still a room for efficiency improvement by using air coils.

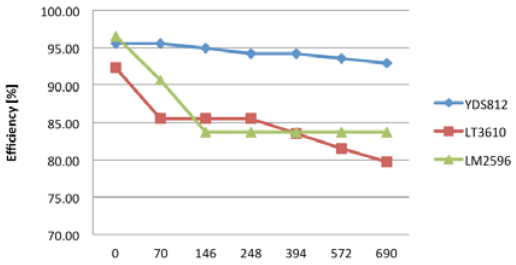

Figure 2: Converter efficiency as function of the magnetic field [mT].

Selected DC/DC converter chips have been tested for radiation hardness and results of these measurements are reported in [2] together with other electronic parts.

References

[1] STS Technical Design Report, 2013.

[2] S. Löchner, GSI Annual Report 2013

 doi:10.15120/GR-2014-1-NQM-CBM-13