MS 12/08/08

Test plan for latch up tests at TVDG in January 2009

The primary goal of this test is to measure the latch up cross-section in the SUZE and Mimosa 22 prototypes. Tests with SUZE should tell us the latch up tolerance of the zero suppression circuit built using standard cells that is planned to be implemented in the Ultimate sensor. Tests with Mimosa22 will provide for the measurement of a circuit architecture that is similar to Phase1 and, to some extent, Ultimate. It is reasonable to expect that the most latch-up sensitive part of the chip would be the digital part (JTAG controller/registers, column level discriminators, digital multiplexers, and readout circuitry). However, the pixel cell of Mimosa 22 is much more densely packed than MimoSTAR2 and should be studied as well.

These tests require powering up the chips and monitoring over-current protection of power supplies on:

1) SUZE: 3.3V FIFO power supply and 3.3V chip power supply.
2) Mimosa22: 3.3 digital power supply and 3.3V analog power supply

In addition, if time and resources allow, it would be interesting to test JTAG section in Mimosa22 for soft errors. It would require continuous readout of the JTAG programming sequence and comparing it with the original one to search for discrepancies caused by SEU. This test would also require monitoring of integrity of marker signals. I believe it is important to perform these tests at some point and in my opinion it is reasonable to combine them with these basic latch-up tests.

Steps required for performing the latch up tests:

1) Hardware preparations
   - Make appropriate mounting holes in the mounting plate
     - For Mimosa22 (one additional hole)
     - For SUZE (3 holes in PCB and 3 holes in metal mount)
   - Verify if Mimosa22 board requires modifications for obtaining direct access to chips power lines.
2) Setup full test bench in the lab and verify its operation (power sources, relays, LV control including latch up reset and event counting) (only minor modifications of the MimoSTAR2 setup are expected)
   - For SUZE (2 voltages to monitor)
   - For Mimosa 22 (2 voltages to monitor)
3) Reserve time at TVDG after making sure that all people involved are allowed to access the facility (currently January is mostly available)
   - Requires BNL guest access and TVDG related trainings.
     - MS needs to reactivate his BNL guest status
   - Is anyone else coming along?

Testing procedure

According to the TVDG webstite:

Typically, it takes about 5 minutes to pump the Test Chamber down to operating vacuum. It takes about 15 minutes to change the energy of a given beam and between 30 and 40 minutes to change to a different ion.
Our experience with TVDG from 2006 and MimoSTAR2 tests is that the vacuum is indeed obtained very quickly. In addition, as I recall, the ion targets can rotate and a selection between different ions in one target is faster than 40 min for the given set of ions.

Previously, we observed latch-ups in MimoSTAR2 for the following ion beams: Cl-35, Ni-58, Br-81,I-127, Au-197 (LET: ~12, ~30, ~40, ~56, ~64. We also observed soft upsets for O-16, F-19, Si-28, Cl-35 (LET: ~3, ~5, ~8, ~12 MeV cm2/mg).

The records from these tests indicate that each scan took approximately 2 hr to perform, including 15-20 min for changing ion species. Typical exposure in our tests was about 2 min long.

Assuming that Mimosa22 and SUZE will show a similar performance to MimoSTAR2, it is reasonable to expect that only high LET scans will be required to measure their latch-up cross-sections.
If we assume that the senor setup time and pumping of the vacuum takes about 15 min per sensor, we should be able to perform both tests in the total of about 5 hrs.
If the behavior is different and the high LET scan needs to be accompanied by the low LET scan, the time extends to about 9 hrs.

Depending on the measured characteristics, it could be interesting to add additional steps with LET at ~16, ~20, ~25 (C-12, Ca-40, Cr-52) if the time needed for replacing the ion target is acceptable. My initial guess is that this would add approximately 2 hrs of testing time per sensor.

Testing the sensitivity of Mimosa22 to soft errors might require extending the time of the low LET runs. Limited speed of JTAG programming might require an extended testing time to collect satisfactory statistics. It seems reasonable to allocate 3 hrs for these tests.

The table below summarizes the time estimates for the three testing plans. We should consider adding a 50% contingency on top of the testing time.

	installation	Low LET	High LET	Total:
High LET only				
• Mimosa22	15 min	-	~2 hrs	
• SUZE	15 min	-	~2 hrs	~5 hrs
Full scans (latch up only)				
• Mimosa22	15 min	~2 hrs	~2 hrs	
• SUZE	15 min	~2 hrs	~2 hrs	~9 hrs
Including soft error tests:				
• Mimosa22	15 min	~3 hrs	~2 hrs	
• SUZE	15 min	~2 hrs	~2 hrs	~10 hrs

The downside of performing these tests early in January is twofold:

1) Beginning of January, we expect to have Phase1 available for testing. Using this chip for latch up tests would allow for direct testing of a full size chip with one type of pixels. (TVDG allows for beam diameters up to 3.0 cm.)
2) Assuming we could expect soft errors in memories of SUZE, it would be advantageous to prepare tests that allow us to study this phenomenon and the rate of its occurrence. Preparation of this test would require active involvement on the IPHC side.

Based on information from Marc, at the end of February, IPHC expects to have the Mimosa26 prototype, which features all functionality of Ultimate but with a different pixel and output arrangement.

Final thoughts:

It needs to be decided if waiting for Mimosa26 and preparing it for latch up tests is a reasonable approach and if it would provide us with more information that testing SUZE alone.

We should consider including in our testing plan the Phase-1 prototype. It could come as an additional prototype or it could replace Mimosa22.

	Advantage	Disadvantage
Phase-1	• Full size prototype • One pixel type (compatible with Ultimate)	• Large pixel size (30 um)
Mimosa22	• Pixel size compatible with Ultimate (18.4 um)	• Small size prototype • Variety of pixel types