FVTX DAQ Components: Radiation Issues

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References

- Radiation Study in the PHENIX IR (S. Batsouli)
- http://focus.ti.com/pdfs/space/TLK2711-ICS-TID-Data.pdf
- ALICE Technical Forum info
- NASA
- http://pvd.chm.bnl.gov/twiki/pub/VTX/FpgaTechnologyEvaluation/Evaluation_of_FPGA_Technology_for_FVTX.pdf
- A scalable analytic model for single event upsets in radiation-hardened field programmable gate arrays in the PHENIX interaction region by Steve Skutnik
- Lots more…

Components

Component	Radiation Tolerance (Rad)	Radius (cm)	Source
TLK2711	25-50k	40	TI Report
Actel FLASH FPGA	>100k	30	Actel Report
FO Tx/Rx	Untested/~50-100k	40	NASA/Boeing
Voltage Regulators	10-20k	30	NASA
Pulser Components	Untested/Unknown	30	-

Radiation Environment

Radius (cm)	PHENIX pp	RHIC-2 pp500	RHIC-2 pp200	RHIC-2 AuAu	RHIC-2 CuCu	RHIC-2 10 yr Dose	Units
10	0.19602	67.02536	11.43450	6.80625	11.57063	156.45948	kRads
20	0.04901	16.75634	2.85863	1.70156	2.89266	39.11487	kRads
30	0.02178	7.44726	1.27050	0.75625	1.28563	17.38439	kRads
40	0.01225	4.18908	0.71466	0.42539	0.72316	9.77872	kRads
50	0.00784	2.68101	0.45738	0.27225	0.46283	6.25838	kRads
dndy	3.6	4	3.6	3.6	3.6		
npart	2	2	2	100	35		
cs	4.20E-02	4.70E-02	4.20E-02	7.00E+00	3.40E+00		b
lum	1.20E+04	3.30E+06	7.00E+05	5.00E+01	5.00E+02		nb-1
dose	0.018	6.15	1.05	0.63	1.06		kRad
Radius	33	33.00	33.00	33.00	33.00		cm

Mark Prokop calculations based on S. Batsouli – Radiation Study in the PHENIX IR

Mitigation Techniques

- Radiation Hard components
  - SERDES unique
  - Voltage regulator parts with higher rad tolerance but less features
  - FPGA next step is anti-fuse RTAX
- Daughter board for sensitive components
- Increases in radiation hardness for components translates directly to increased cost.
  - 200kRad Actel RTAX proto (not QML tested) ~$2k each
- Triple redundancy firmware (if necessary)

Issues

- Bit Error Rate does not yet include radiation effects
- Pulser Components not evaluated for radiation
- Failure mode analysis not complete
- Current risk acceptable