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Slides for Opto-Working Group on COTS and PIC Microcontroller

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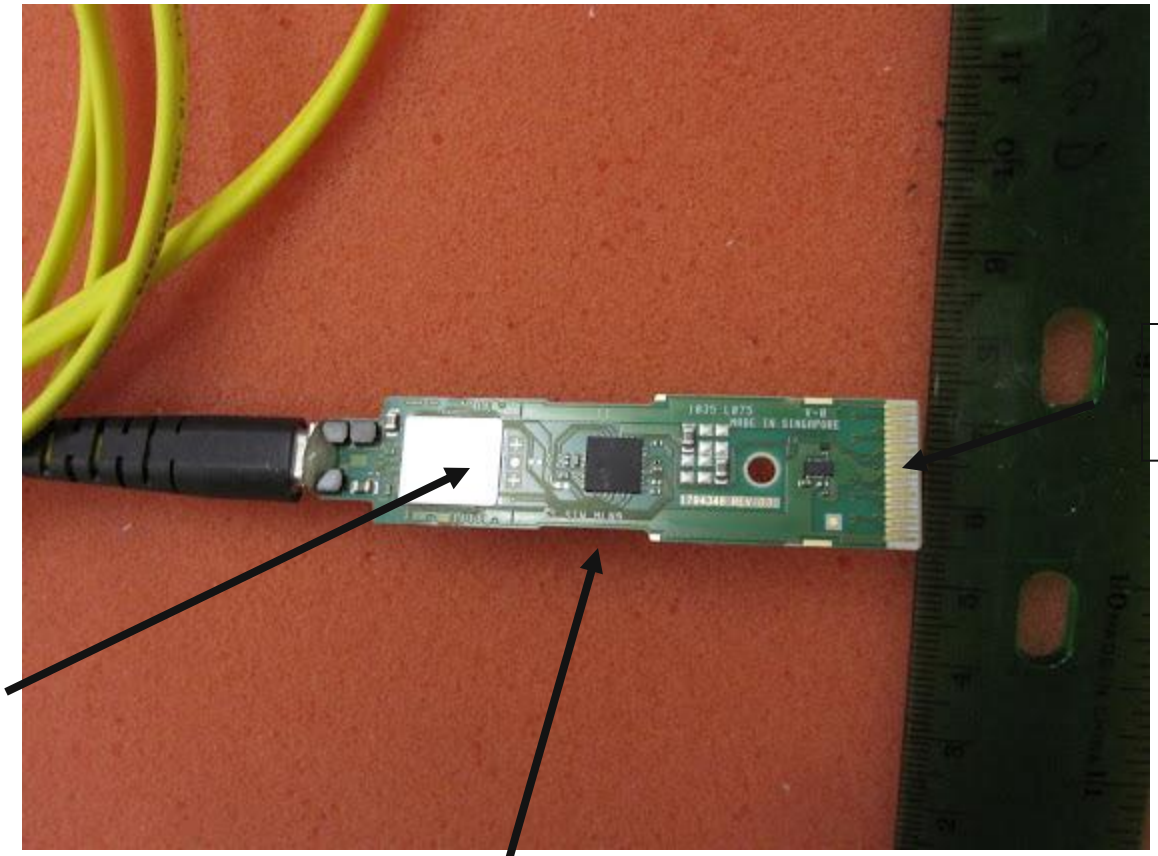
Levels of Radiation Sensitivity in Modulator-based COTS devices

- Modulator
- Logic and RF circuitry in Modulator chip
- Attached CW Laser
- Voltage regulators
- Glue, Capacitors, etc
- Control Unit (PIC uC or FPGA or..) ← Only Issue So Far

QSFP UNIT



8-Fiber Cable

Modulator etc chip

QSFP Connector

PIC microcontroller

ANL Radiation Tests on Modulators

- Tested 3 different types of modulators, Luxtera included, at the cyclotron at Massachusetts General Hospital (proton beam); Energy scanned from 207 to 85 MeV
  - TID of 64 krad, fluence of 8 x 10^{11} p/cm^2
  - No SEU. Device functionality acceptable for data readout
    - *Requirements for HL-LHC Tilecal: 45 krad, NIEL 1.5x10^{12} 1 MeV neutron/cm^2 as per Kelby*
- 2 TID tests of Luxtera modulators at ANL van de Graaff electron beam (3MeV).
  - Device functionality certified to ~100 kRad.
  - Some issue with temperature readout being investigated by Luxtera

Internal PIC uC in Luxtera / Molex COTS failed during both tests, but did not affect operation until power-down

For TileCal - rad-hard level is adequate but more devices must be tested

In this Luxtera / Molex device

uC is used for startup

reads and sets parameters for operation

also allows readout of temperature, current, etc

After startup, the device will continue to operate

until power down

(or perhaps some large change in device)

PIC microcontroller uses flash memory

This typically dies at ~ 20 K Rad

(maybe just SEE ? But this would require reprogramming)

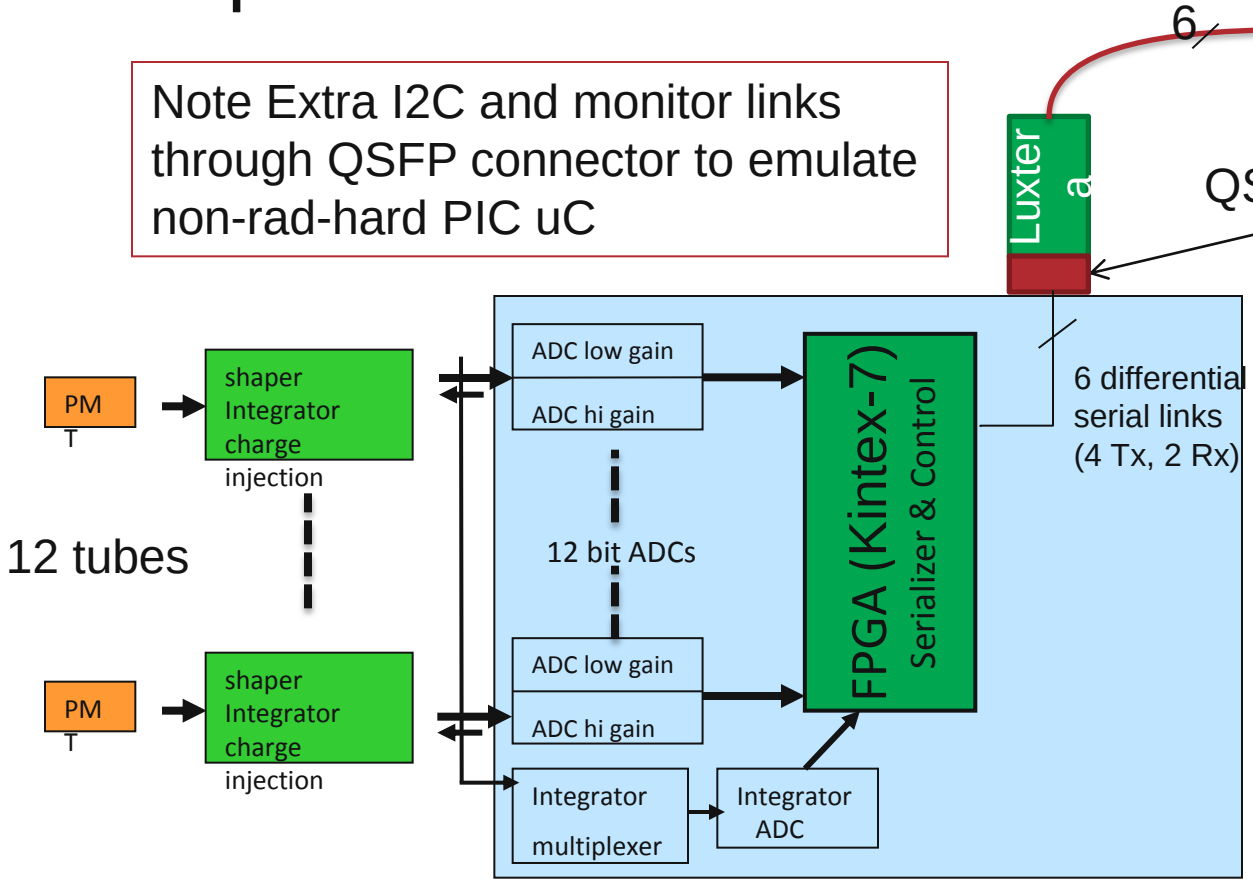
[PIC] I.Galysh, K.Doherty, J. McGuire, H.Heidt, D.Niemi,G.Dutchover, (The StenSat Group) "CubeSat: Developing a Standard Bus for Picosatellites" http://www.stensat.org/Publications/SPIE.PDF.

An FPGA can be order 1000 x better
but won't fit onto COTS PC board

[FPGA] Z.K.Baker, M.E.Dunham, K.Morgan, M.Pigue, M.Stettler, P.Graham, E.N.Schmierer, J.Power (Los Alamos) "Space Based FPGA Radio receiver Design, Debug, and Development of a Radiation Tolerant Computing System".International Journal of reconfigurable Computing, Volume 2010,Article ID 546217, doi:10.1155/2010/546217.

A Proposed Interface to the TileCal Main Board

Note Extra I2C and monitor links through QSFP connector to emulate non-rad-hard PIC uC



Stockholm and Valencia are now designing the mainboard and ROD to accommodate the Luxtera QSFP package.

Luxtera QSFP has 4 x 14 Gb/s transceivers

QSFP: Quad Small Form Factor Pluggable

Inside ATLAS Tilecal Iron Girder