SLHC Proposal B Status

Optical Readout System Irradiation Guidelines

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Report from sub-group B
Optical Readout System Irradiation Guidelines

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Abstract

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Met every 2 – 3 weeks

Scope of document

- Agreement on irradiation guidelines bw ATLAS & CMS
  - Aim: Comparison of test result between different groups.
  - Basis for irradiation protocols for the (pre-)production phase
- Optoelectronic readout system for *detectors* at SLHC
- Protocols about quality assurances will be published in a future document.
- Components covered:
  - Lasers
  - p-i-n diodes
  - fibres
  - (de)serializer chips

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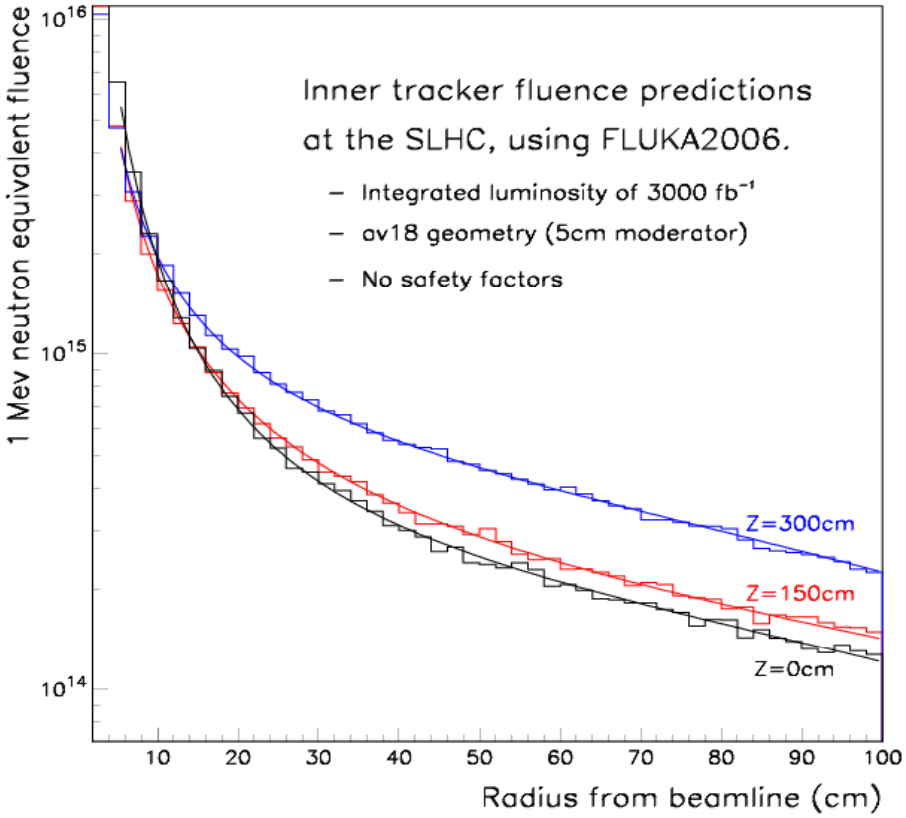
Radiation Environment at the SLHC

- Detectors designed for 3000 fb^{-1}.
- Devices should be irradiated up to
  - **$15.00 \cdot 10^{14}$** 1MeV neutron equivalents/cm-2 (Si)
  - **0.5 MGy**.
- Safety Factor, **SF = 1.5**
- SF needs to be revisited once LHC starts.

I. Dawson



Sample Sizes

- First exploratory tests: 5 (3 for SEE)
- Minimum sample needed to establish an upper limit on the failure probability of less than 10% at the 90% confidence level:

Failures	Sample
0	23
1	39
2	54

- For SEE 10 devices for each batch recommended.
- In all tests, several unirradiated samples from the same lot should be kept as control samples.

Failure Criteria

- DUT fails to function according to the system operating specifications
- Any device failure should be analyzed post-mortem.
- **Annealing data will be necessary** in order to be able to extrapolate test results to real environment.
- This section will be revisited once we know set of possible candidate devices and specifications.

Evaluation of DUTs before Irradiation

- Run for an extended amount of time in the irradiation test setup;
- Their performance should be measured during this run in periodic intervals;
- The performance of the devices should be measured as function of T.
- If performance T dependent → mandatory to measure the T during irradiation.
- Only burned-in devices should be irradiated.

Lab. Simulation of rad. Environment

- no dose rate dependency → extrapolation of the damage and annealing results to real environment.

- Care is required when using NIEL to make judgments.
  - Not directly applicable for complex structures.

- A wider experimental approach should be followed
  - ideally radiation damage and annealing and wearout tests made under different operating conditions, i.e. bias, temperature.
  - A variety of radiation sources:
    - 24 GeV protons, 200 MeV pions, 1 MeV neutrons

Radiation Tolerance Validation

- Fibres ✓
- Lasers ✓
- p-i-n diodes ✓
- (de)serializer chips ✓
- LLD *needs to be written*
- Trans-impedance amplifier *needs to be written*
- optical transmitter and receiver subassemblies ✓

Details see document.

Single Event Effect (SEE) Test

- (de)serializer chips ✓
- oTx and oRx Modules ✓

- SEU protons > 60 MeV
- SEU cross section as a function of the linear energy transfer (LET)
- measured with heavy ions, is not required.
- To avoid mixing the SEU with TID effect, the proton flux needs to be kept low (< 10^6 proton/cm2/sec.)

Effects of Irradiation on Ageing and Long Term Reliability Tests

- seriously considered devices:
  - At least 20 irradiated & 20 unirradiated devices per wafer-lot should be passed through a thermally accelerated ageing step
  - devices should be operated at 80°C for at least 1000 hours

Appendices

- Appendix A: Radiation Sources *needs work*
- Appendix B: NIEL Values/Refences *needs work*
- Appendix C: Irradiation Checklist
- Appendix D: History of Document

Work left to do…

- LLD and TIA irradiation guidelines needs to be written
- Appendix A and B needs to be completed
- Section 3.5 and 3.6 polishing needed
- Overall document: cosmetics and references
- Introduction needs a bit of work.

- Publication end of October 07.

Feedback/Comments needed!

Send them to us.