Radiation Effects at the LHC Experiments and Impact on Operation and Performance

Workshop with focus on silicon detector systems

23-24 April 2018 at CERN: indico.cern.ch/event/695271

Sessions on: sensor measurements & simulations; radiation background simulation and benchmarking; effects on electronics/optoelectronics

Organising Committee: C.Barth (KIT), E.Butz (KIT), M.van Beuzekom (Nikhef), J.Buytaert (CERN), M.Bomben (LPNHE), P.Collins (CERN), I.Dawson (Sheffield), S.Mallows (KIT), M.Moll (CERN), A.Mucha (AGH UST), B.Nachman (LBNL), D.Robinson (Cambridge), A.Rozanov (CNRS)

ALICE ATLAS EXPERIMENT CMS LHCb RD50

Welcome!

- **4th workshop in this series:**
  Oct 2011: https://indico.cern.ch/event/156565/
  Mar 2012: https://indico.cern.ch/event/178194/
  Nov 2017: https://indico.cern.ch/event/663851/ (held during RD50 week)

However this workshop is bigger in scope - going beyond sensors to include all aspects of radiation on full detector systems

- Over 115 participants registered!
- Cost of coffee and biscuits has been covered equally by all experiments :)
- Big thanks to all the speakers (preparing talks while preparing for collisions), and colleagues in their help and support of the workshop: K. Einsweiler; P. Farthouat; D. Ferrere; K. Gill; M. Hansen; J. Hegeman; K. Jakobs; M. Kocian; L. Pontecorvo; V. Wedlake

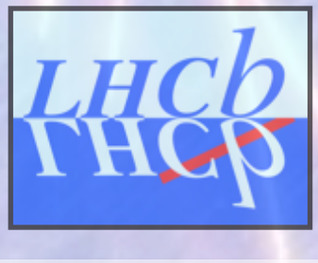
Why this workshop, why now?

- There main motivation is simply to provide a forum to **exchange** knowledge and experiences across the experiments and learn from each other. All the experts in one room!
  - ➡ Are the detector systems operating & performing as **expected**?
  - ➡ How **accurate** are the radiation damage models and predictions? Our understanding and modelling of radiation effects was originally tested in irradiation facilities, so strong motivation to cross check in-situ in the complex radiation fields of the LHC
  - ➡ Have there been **unexpected** effects?
  - ➡ What **mitigation** strategies have been developed?
- **Timely!** With over 120 fb^{-1} of delivered luminosity, radiation effects becoming increasingly evident!
- Final **opportunity** to impact LHC experiment upgrade designs?

Goals of this workshop

- Share and **document** our knowledge and experiences in running detector systems in the harsh radiation environments of the LHC
- Provide **direction** for further studies
- **Input** to a CERN Yellow Report (early 2019)
  - Follow up workshop after Run 2 to **finalise** input for the Yellow Report?
  - Extend scope? E.g. radiation effects on commercial electronics?

What lessons have been learned at the LHC that we can pass on to the experiment upgrades, as well as future collider experiments?



Agenda

- **4 sessions**, all in this auditorium
- Monday am: **Sensor measurements**

  Overview of radiation induced changes of sensor properties and the resulting degradation of the LHC tracking performance.
- Monday pm: **Electronics/optoelectronics**

  Overview of ionising and non-ionising radiation effects on tracking detector electronics. Low and high dose-effects. SEUs etc.
- Tuesday am: **Radiation background simulation & benchmarking**

  Overview of the radiation background simulations performed at the LHC experiments. Comparison of simulated predictions with the LHC Run 1 & Run 2 measurements.
- Tuesday pm: **Sensor simulation**

  Review strategies and algorithms deployed by the LHC experimental collaborations to simulate fluence-dependent effects in silicon tracking detectors.

Session 1: Sensor measurements

	Registration *6-2-024 - BE Auditorium Meyrin, CERN*	08:30 - 09:00
09:00	**Workshop welcome & goals** *6-2-024 - BE Auditorium Meyrin, CERN*	*Ian Dawson* 09:00 - 09:10
	Session introduction *6-2-024 - BE Auditorium Meyrin, CERN*	09:10 - 09:15
	Pixel Leakage Current Measurements from ATLAS (20'+5') *6-2-024 - BE Auditorium Meyrin, CERN*	*Aidan Grummer* 09:15 - 09:40
	Leakage Current Measurements from LHCb (20'+5') *6-2-024 - BE Auditorium Meyrin, CERN*	*Vinicius Franco Lima* 09:40 - 10:05
10:00	**CMS Pixel and Strip radiation damage measurements (20'+10')** *6-2-024 - BE Auditorium Meyrin, CERN*	*Julia Alexandra Hunt et al.* 10:05 - 10:35
	Coffee Break *6-2-024 - BE Auditorium Meyrin, CERN*	10:35 - 11:00
11:00	**Pixel Depletion Voltage Measurements from ATLAS (15'+5')** *6-2-024 - BE Auditorium Meyrin, CERN*	*Julien-Christopher Beyer* 11:00 - 11:20
	Depletion Voltage Measurements from LHCb (20'+5') *6-2-024 - BE Auditorium Meyrin, CERN*	*William James Barter* 11:20 - 11:45
	Measurements with the ATLAS strip detector (20'+5') *6-2-024 - BE Auditorium Meyrin, CERN*	*Taka Kondo* 11:45 - 12:10
12:00	**Latest News from RD50 (15'+5')** *6-2-024 - BE Auditorium Meyrin, CERN*	*Matteo Centis Vignali* 12:10 - 12:30
	Lunch Break