PaRaDeSEC: CMS related activities

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December 9, 2019
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List of projects

1. Single event upset in CMS pixel Token bit manager chip
   – SEU rate measurement with ion (micro-probe) beam at RBI

2. CMS Layer1 pixel module production in 2019
   – assembly, test and calibrate 150 modules at PSI and ETH Zurich

3. Irradiation of various CMS Tracker components up to 1.5GRad with RBI Co-60 gamma source

4. Low dose rate long term irradiation with RBI Co-60 source
   – HL-LHC dose rate at 3cm from p-p Interaction Point
   – stage 1: RD53A chip (Phase2 pixel detector) for 4-6month
   – stage 2: CROC (Phase2 CMS pixel chip) for 6 month or longer

5. Preparation for Phase2 CMS pixel module production
   – 200-300 endcap pixel modules to be built in 2023/25
Single Event Upset beam test at RBI

• Reasons
  – due to SEU in TBM chip, pixel module stuck and CMS has to stop data taking and reset TBM => dead time
  – non rad. hard circuit identified: transistors in Flip-Flops (20x70μm)
  – TBM chip design improved
  – confirmation of improvements were needed

• Beam tests
  – 4 beam tests in 2018 with protons and Li ions
  – 2 beam test in Jan-Apr with Carbon ions
  – higher tolerance of new TBM chip confirmed
CMS Layer1 module production

• Reasons
  – PROC600 and TBM chip SEU problems require production of new 150 Layer 1 modules

• Production will be done at PSI (Villigen) and X-ray calibration at ETH Zurich
  – preparation starts in February 2019
  – production scheduled for Jan-Mar 2020

• RBI CMS group responsibility
  – test of 150 High Density Interconnect flexes
  – 150 module assembly, protection cap gluing, quality assurance and calibrations

• CMS Tracker and PSI finance this project
  – CMS: CHF 48k
  – PSI: up to CHF 20k
Irradiation with Co-60 gamma source

• Reasons
  – many components of CMS pixel detector require verification of radiation tolerance
  – Layer1 module stuff irradiate up to 120MRad
  – Phase2 component irradiated up to 1.5GRad

• Irradiation facility:
  – in the center the rate is 2.5MRad/hour
  – 1.5m away from the Co-60 source the rate is equivalent to one expected at HL-LHC at 3cm from p-p interaction point

• What have been irradiated
  – ROCs: psi46digV2 and RPOC600, cables, HDIs
  – Peltier elements for cold box, cables, SCCs, connectors, foams, glues
  – Phase2 pixel HDIs
  – 3D printer filaments
Low dose rate long term irradiation

• **What:** new pixel chips for CMS Phase 2 pixel detector upgrade

• **Why:** RD53A chips build in 65nm technology that shows dependence of the radiation damage from the dose rate

• **Irradiation facility:**
  – in the corner of the irradiation chamber 1.5m away from the Co-60 source
  – setup in the irradiation chamber requires: 1) shielding of FPGA cards; 2) 2 cold boxes that hold chips at -20C and +20C; 3) full operation during 12 month of irradiation

• **Responsibilities:**
  – **RBI:** 1) radiation facilities; 2) mechanical setup with shielding; 3) operation of setup and conducting experiment
  – **CERN:** 1) cold boxes; 2) 6 PCs; 3) 6 low voltage PS; 4) chiller; 5) 6 FPGA cards and 6 SCC [more than CHF 20k investment + expert support]
Low dose rate long term irradiation
Low dose rate long term irradiation
CMS Phase 2 related activity

- RBI is CMS Ph2 pixel module production center (incl. in TDR in 2017)
- First (digital) modules built at PSI (Villigen, CH) in Nov 2019
- In 2020 build prototype modules at RBI
Teams

• **CERN:**
  Luis Miguel Jara Casas, Ahmed Abdirashid Ahmed, Andromachi Tsirou, Eric Albert, Jean-Francois Pernot

• **PSI (Villigen, CH)**
  Wolfram Erdmann, Hans-Christian Kaestli, Danek Kotlinski, Tilman Rohe, Silvan Streuli, Stephan Burkhalter

• **RBI, Radiation Chemistry and Dosimetry Laboratory:**
  Branka Mihaljević, Marija Majer, Marijana Nodilo, Igor Sajko, Vlatko Trputec, Svetozar Jančić

• **RBI, Laboratory for ion beam interactions:**
  Stjepko Frazinic, Milko Jaksic, Georgios Provatas

• **RBI, Laboratory for High Energy Physics:**
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