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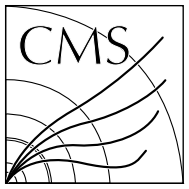
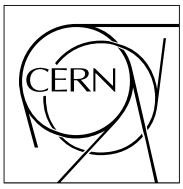
CMS DP -2024/103



The Compact Muon Solenoid Experiment

CMS Performance Note

Mailing address: CMS CERN, CH-1211 GENEVA 23, Switzerland



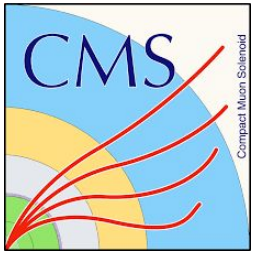
28 October 2024

FLUKA Simulations for Radiation Levels in Tracker and ECAL Regions for Phase II

CMS Collaboration

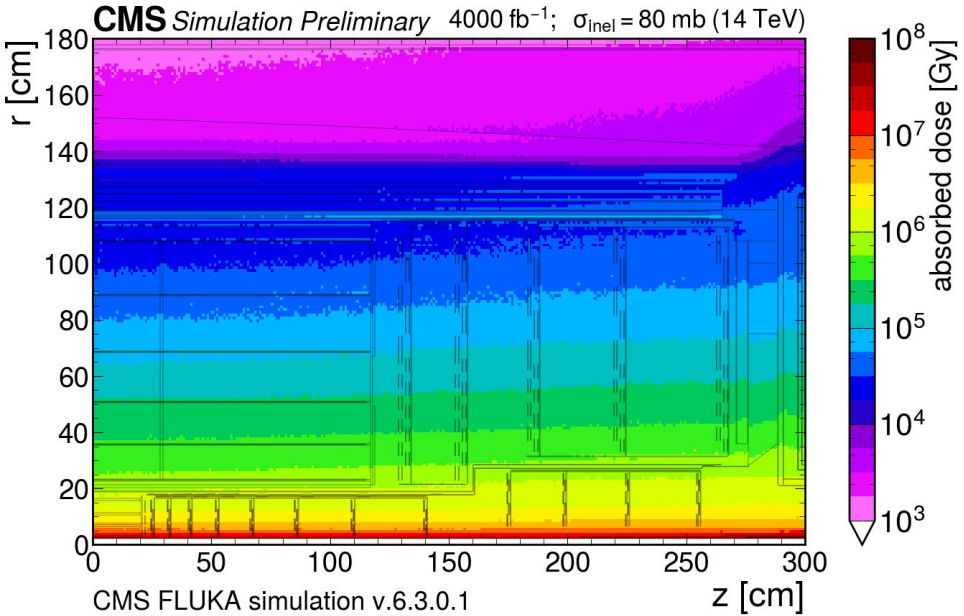
Abstract

Monte Carlo estimation of the fluence or absorbed dose in the CMS Tracker and ECAL Barrel regions from simulation runs v.6.3.0.1 and v.6.3.0.18 using proton-proton collisions at an energy of 7 TeV per beam as the primary radiation source. The inelastic collision cross section used for normalization is 80 mb. CMS FLUKA simulation runs v.6.3.0.1 and v6.3.0.18 use identical geometry models that represent a Phase-2 CMS configuration.

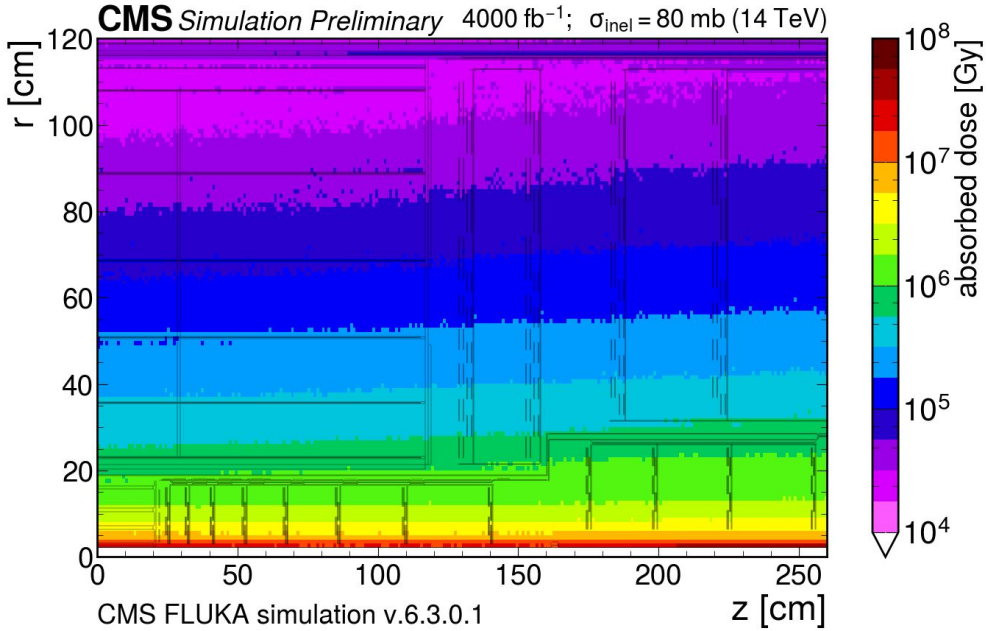


FLUKA Simulations for Radiation Levels in Tracker and ECAL Regions for Phase II

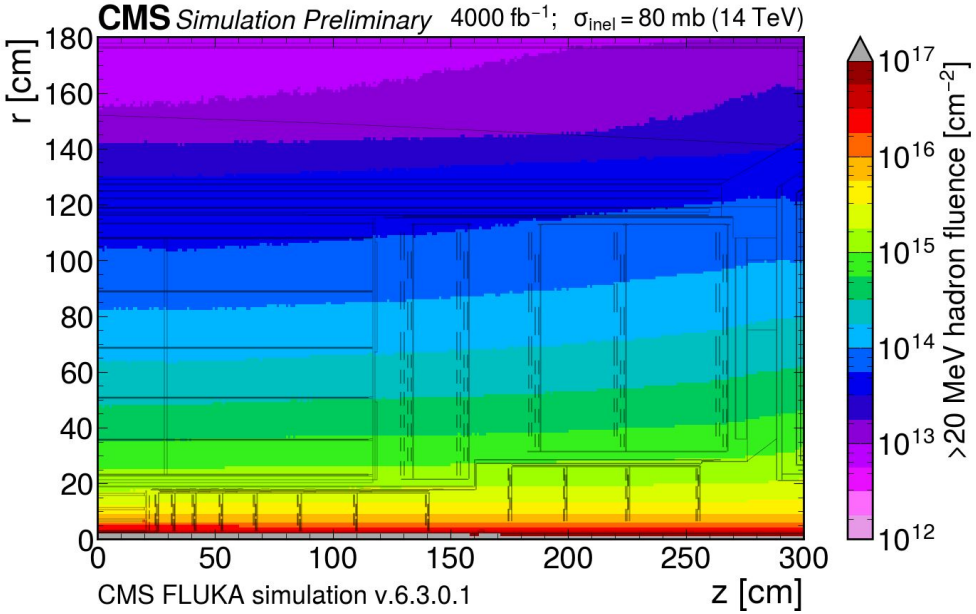
cms-dpg-conveners-bril@cern.ch



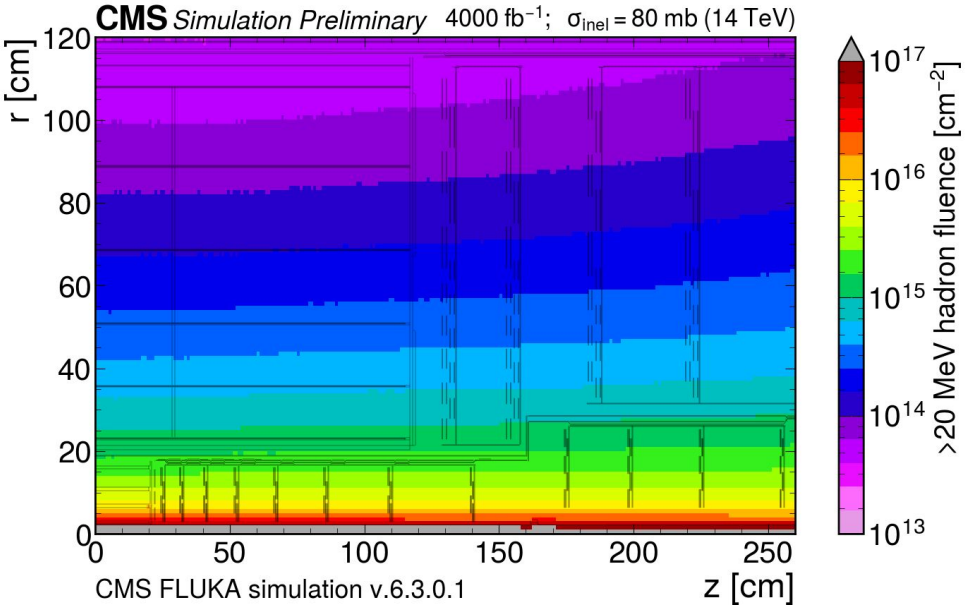
Monte Carlo estimation of absorbed dose at CMS from simulation run v.6.3.0.1. This run uses CERN FLUKA code 4-2.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot shows the absorbed dose distribution in the CMS detector for an integrated luminosity of 4000 fb^{-1}. The inelastic collision cross section used for normalization is 80 mb. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.1 uses a geometry model that represents the Phase-2 CMS configuration. Results are averaged over 360 degrees in azimuthal angle. The geometry visualization, in black, is a slice in the Z-X plane at Y=0.



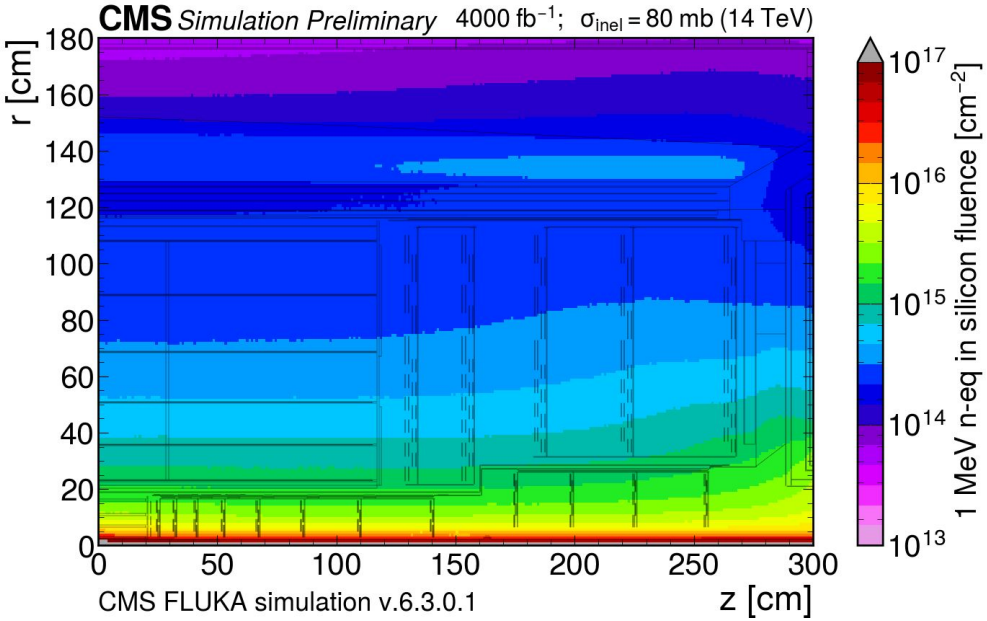
Monte Carlo estimation of absorbed dose at CMS from simulation run v.6.3.0.1. This run uses CERN FLUKA code 4-2.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot shows the absorbed dose distribution in the CMS detector for an integrated luminosity of 4000 fb^{-1}. The inelastic collision cross section used for normalization is 80 mb. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.1 uses a geometry model that represents the Phase-2 CMS configuration. Results are averaged over 360 degrees in azimuthal angle. The geometry visualization, in black, is a slice in the Z-X plane at Y=0.



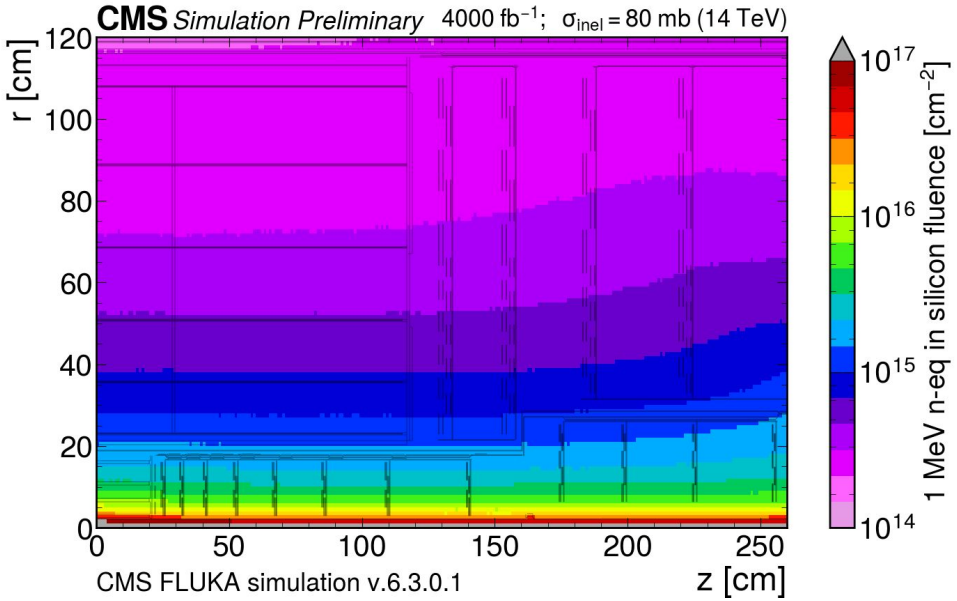
Monte Carlo estimation of the fluence of hadrons with a kinetic energy above 20 MeV at CMS from simulation run v.6.3.0.1. This run uses CERN FLUKA code 4-2.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot shows the fluence distribution of hadrons with a kinetic energy greater than 20 MeV in the CMS detector for an integrated luminosity of 4000 fb^{-1}. The inelastic collision cross section used for normalization is 80 mb. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.1 uses a geometry model that represents the Phase-2 CMS configuration. Results are averaged over 360 degrees in azimuthal angle. The geometry visualization, in black, is a slice in the Z-X plane at Y=0.



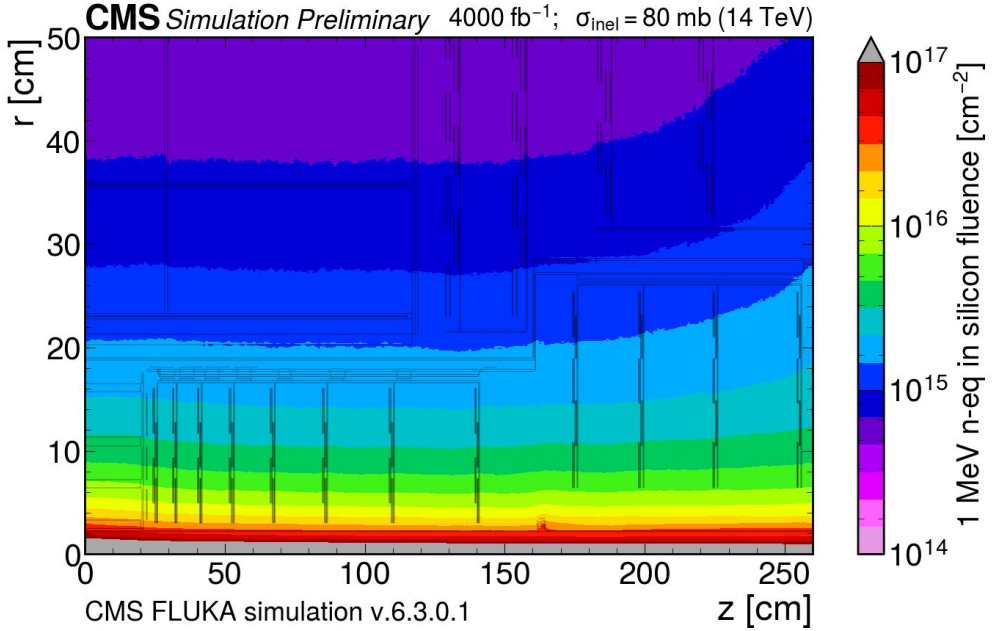
Monte Carlo estimation of the fluence of hadrons with a kinetic energy above 20 MeV at CMS from simulation run v.6.3.0.1. This run uses CERN FLUKA code 4-2.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot shows the fluence distribution of hadrons with a kinetic energy greater than 20 MeV in the CMS detector for an integrated luminosity of 4000 fb^{-1}. The inelastic collision cross section used for normalization is 80 mb. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.1 uses a geometry model that represents the Phase-2 CMS configuration. Results are averaged over 360 degrees in azimuthal angle. The geometry visualization, in black, is a slice in the Z-X plane at Y=0.



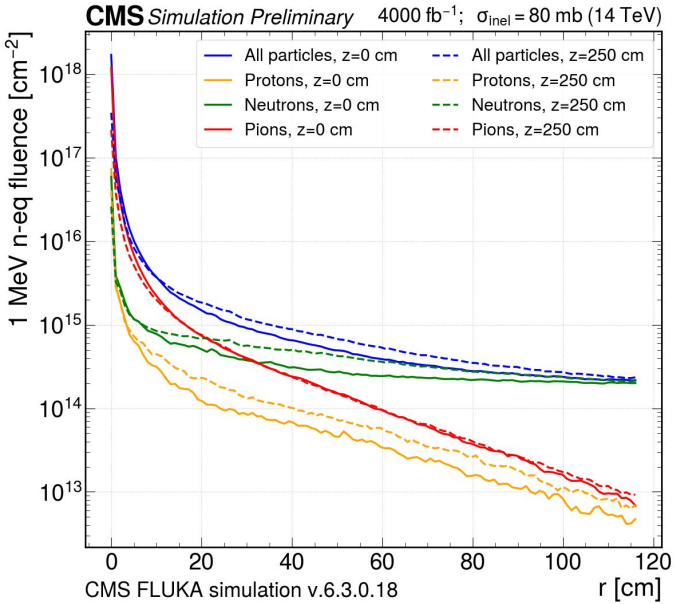
Monte Carlo estimation of the 1 MeV neutron equivalent fluence in silicon (1 MeV n-eq Si) at CMS from simulation run v.6.3.0.1. This run uses CERN FLUKA code 4-2.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot shows the distribution of the 1 MeV n-eq Si in the CMS detector for an integrated luminosity of 4000 fb^{-1}. The inelastic collision cross section used for normalization is 80 mb. In all regions, fluences vary as a result of both the collision source distribution and radiation interactions with the surrounding material. Weighting factors for 1 MeV n-eq Si fluence depend on particle type and energy which are particularly sensitive to localised interactions. The visible increase in the fluence in ECAL barrel crystal at approximately r = 135 cm and z = 150 - 250 cm relative to the surrounding region is, in part, due to a sharp increase in material density at this location. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.1 uses a geometry model that represents the Phase-2 CMS configuration. Results are averaged over 360 degrees in azimuthal angle. The geometry visualization, in black, is a slice in the Z-X plane at Y=0.



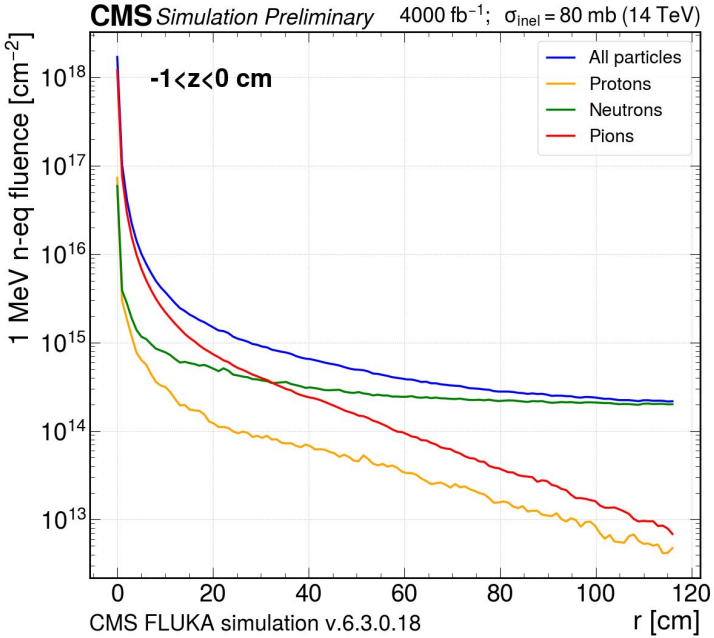
Monte Carlo estimation of the 1 MeV neutron equivalent fluence in silicon at CMS from simulation run v.6.3.0.1. This run uses CERN FLUKA code 4-2.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot shows the distribution of the 1 MeV neutron equivalent fluence in silicon in the CMS detector for an integrated luminosity of 4000 fb^{-1}. The inelastic collision cross section used for normalization is 80 mb. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.1 uses a geometry model that represents the Phase-2 CMS configuration. Results are averaged over 360 degrees in azimuthal angle. The geometry visualization, in black, is a slice in the Z-X plane at Y=0.



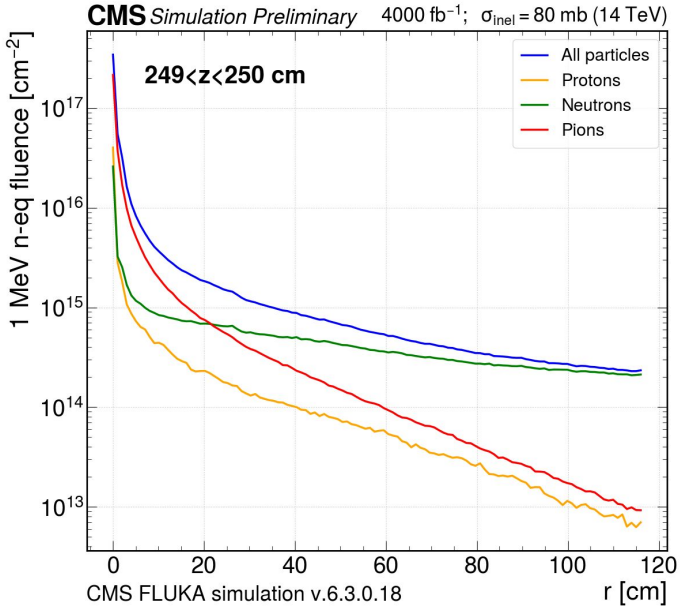
Monte Carlo estimation of the 1 MeV neutron equivalent fluence in silicon at CMS from simulation run v.6.3.0.1. This run uses CERN FLUKA code 4-2.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot shows the distribution of the 1 MeV neutron equivalent fluence in silicon in the CMS detector for an integrated luminosity of 4000 fb^{-1}. The inelastic collision cross section used for normalization is 80 mb. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.1 uses a geometry model that represents the Phase-2 CMS configuration. Results are averaged over 360 degrees in azimuthal angle. The geometry visualization, in black, is a slice in the Z-X plane at Y=0.



Monte Carlo estimation of the contribution to the 1 MeV neutron equivalent fluence in silicon by different particles; protons, neutrons and pions from simulation run v.6.3.0.18. This run uses CERN FLUKA code 4-3.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot displays radial projections at two different z-ranges (z between z=-1 cm and z=0 cm, identified as z = 0 cm in legend, and z between z=249 cm and z=250 cm, identified as z = 250 cm in legend, showing the estimated contribution to the 1 MeV n-eq fluence by particle type for a radial distance up to 116 cm and an integrated luminosity of 4000 fb-1. The inelastic collision cross section used for normalization is 80 mb. Results are averaged over 360 degrees in azimuthal angle. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.18 uses a Phase-2 CMS configuration geometry model and settings identical to those in v.6.3.0.1.



Monte Carlo estimation of the contribution to the 1 MeV neutron equivalent fluence in silicon by different particles; protons, neutrons and pions from simulation run v.6.3.0.18. This run uses CERN FLUKA code 4-3.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot displays radial projections for z values between z=-1 and z=0 cm, showing the estimated contribution to the 1 MeV n-eq fluence by particle type for a radial distance up to 116 cm and an integrated luminosity of 4000 fb-1. The inelastic collision cross section used for normalization is 80 mb. Results are averaged over 360 degrees in azimuthal angle. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.18 uses a Phase-2 CMS configuration geometry model and settings identical to those in v6.3.0.1.



Monte Carlo estimation of the contribution to the 1 MeV neutron equivalent fluence in silicon by different particles; protons, neutrons and pions from simulation run v.6.3.0.18. This run uses CERN FLUKA code 4-3.0 to simulate proton-proton collisions at an energy of 7 TeV per beam. The plot displays radial projections for z values between z=249 and z=250 cm, showing the estimated contribution to the 1 MeV n-eq fluence by particle type for a radial distance up to 116 cm and an integrated luminosity of 4000 fb^{-1}. The inelastic collision cross section used for normalization is 80 mb. Results are averaged over 360 degrees in azimuthal angle. Simulation energy cutoffs in the region shown are: Electrons ≥100 keV, Photons ≥ 10 keV, Hadrons ≥ 1 keV, Neutrons ≥ 0.01 meV. CMS FLUKA simulation run 6.3.0.18 uses a Phase-2 CMS configuration geometry model and settings identical to those in v.6.3.0.1.