

HF Radiation Project

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Supervisors and Collaborators

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Objectives

- This simulation aims to estimate the Total Ionizing Dose (TID) and Neutrons and Charged Hadrons Fluence in the front-end electronics in the HCAL Forward (HF).
- Integrate the results in a high-luminosity scenario of 3000 fb^{-1} .
- Use the Pablo Jácome's conclusions about the scoring in FLUKA output files (1cm³ detector studies) in the calculation of Dose.

Description of the simulation

- **Description of software parameters**

The software used for making this simulation was FLUKA. Based on the CMS Geometry file sent by Moritz Guthoff.

The cards used were USRBIN REGION FLUKA card to get the Dose and USRTRACK card to get the neutrons and charged hadrons fluence as a function of their energy. The total number of particles are defined in several range of energy (>100keV, >1MeV, >10MeV, >20MeV).

This simulation was sent it to batch system at CERN using 1000 jobs and 100 primaries per job, a total number of 98800 primaries. It was made in 6 days.

- **Description of physics parameters**

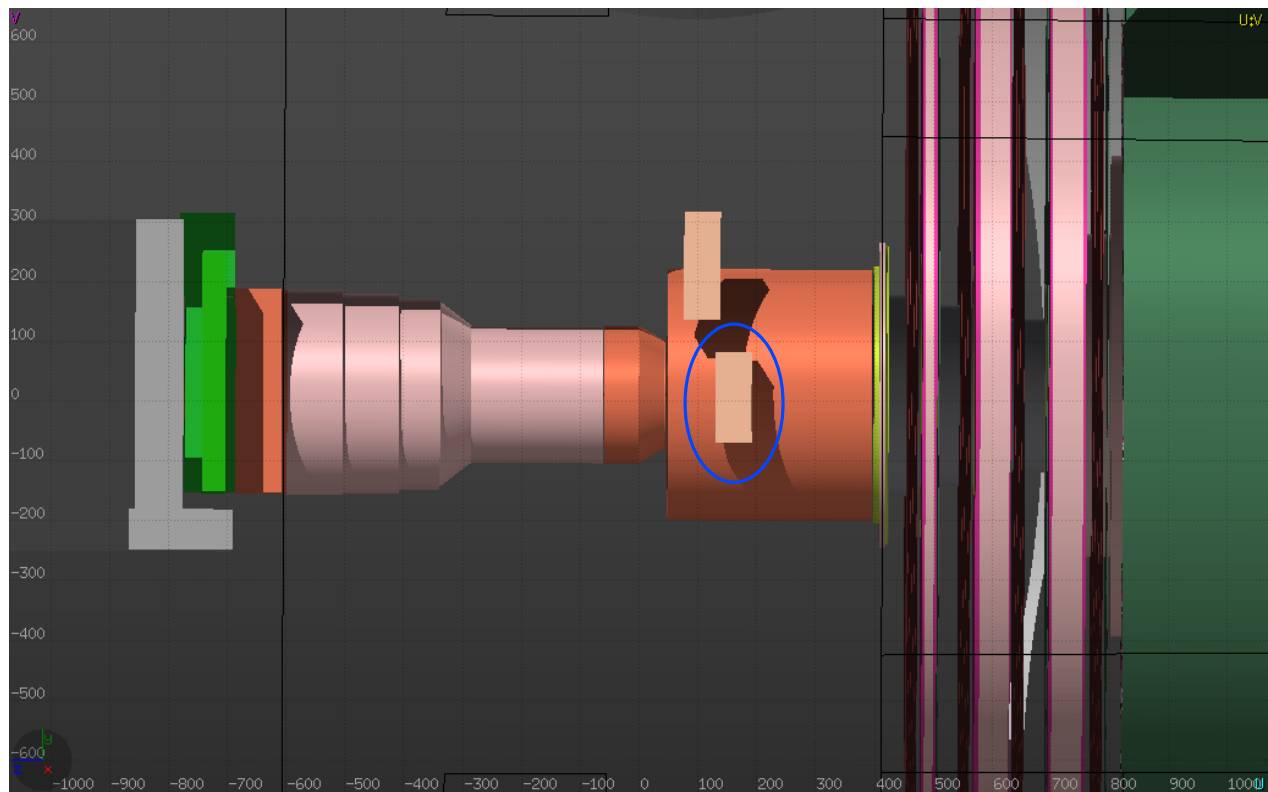
The CMS geometry file was modified to create two silicon boxes in the position where HF electronics are placed. The boxes are a simplified rack of just 3 faces with 1cm of thickness. For dimension of the boxes, please refer to:

<https://twiki.cern.ch/twiki/bin/view/Sandbox/HCALRadiationProject>

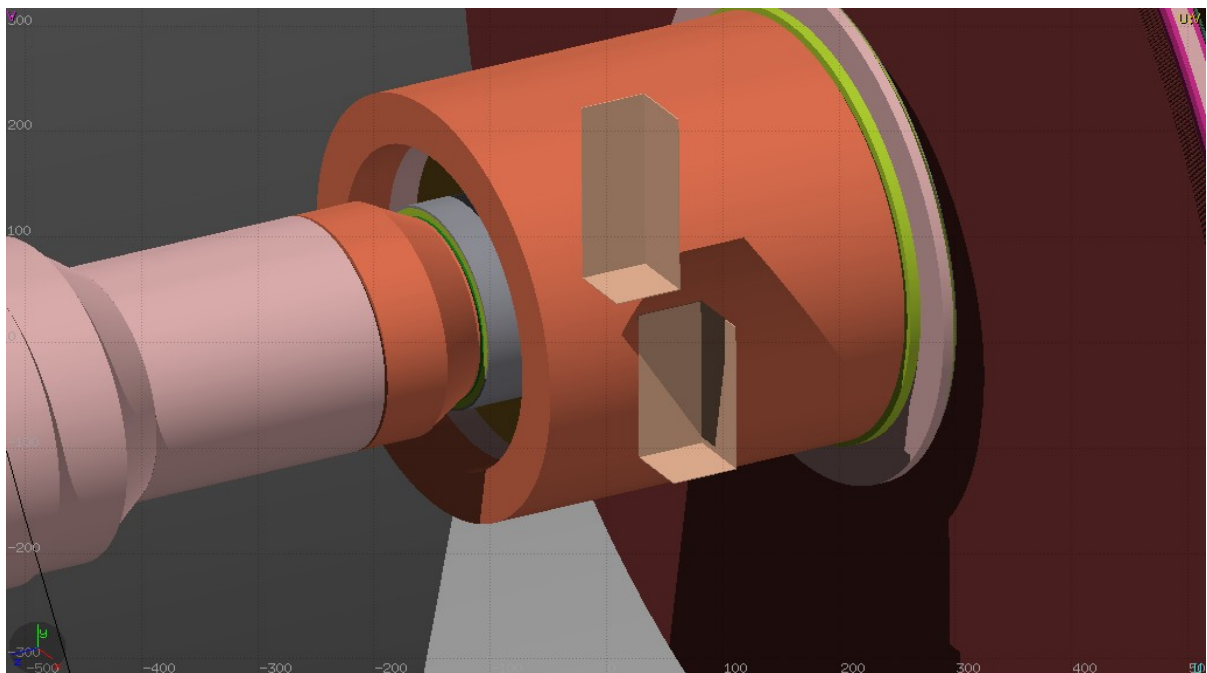
The center of mass of the pp collision was 14 TeV, lab momentum x-component equal to 0.42 G/eV and sigma_z equal to 5.

- **Graphic description of racks**

The studies of Dose and Particle Fluence were made in the low rack in the picture 1.



Picture1. Racks created and located in HF-Front End Electronics in the CMS geometry. The rack studied is surrounded in a blue circle.



Picture2. Rack located up to HCAL.

Results

1. Dose

1.1. Dose per primary

Material	Volume [cm3]	Dose per primary [Gy/prim]	Uncert. [%]
Silicon	22417	3.5178E-17	13.52
Air	561871	5.1489E-17	20.33

1.2. Dose integrated by 3000 fb⁻¹

Material	Dose integrated by 3000 fb ⁻¹ [Gy]*	Uncert. [%]
Silicon	8.15784	13.52
Air	11.739492	20.33

*Number of events expected at 3000 fb⁻¹ are 2.28x 10¹⁷ events.

2. Fluence

2.1. Particle Fluence in Silicon rack

[part/(cm2*prim)]	Whole range energy	%Uncer.	>100KeV	%Uncer.
Neutrons	3.45299E-06	2.42	1.56155E-06	3.77
Charged Hadrons	5.95400E-09	29.38	5.95277E-09	29.38

[part/(cm2*prim)]	>1MeV	%Uncer.	>10MeV	%Uncer.	>20MeV	%Uncer.
Neutrons	1.03611E-06	4.69	5.58880E-07	6.08	4.79011E-07	6.67
Charged Hadrons	5.93580E-09	29.44	5.48261E-09	30.84	4.86173E-09	32.56

2.2. Particle Fluence in Silicon rack integrated by 3000 fb⁻¹ .

[part/(cm2*prim)]	Whole range energy	%Uncer.	>100KeV	%Uncer.
Neutrons	7.87281E+11	2.42	3.56033E+11	3.77
Charged Hadrons	1.35751E+09	29.38	1.35723E+09	29.38

[part/(cm2*prim)]	>1MeV	%Uncer.	>10MeV	%Uncer.	>20MeV	%Uncer.
Neutrons	2.36233E+11	4.69	1.27424E+11	6.08	1.09214E+11	6.67
Charged Hadrons	1.35336E+09	29.44	1.25003E+09	30.84	1.10847E+09	32.56

2.3. Particle Fluence in the Air inside the rack.

[part/(cm2*prim)]	Whole range energy	%Uncer.	>100KeV	%Uncer.
Neutrons	3.85409E-06	1.86	1.72306E-06	2.75
Charged Hadrons	7.40808E-09	40.86	7.38680E-09	40.97

[part/(cm2*prim)]	>1MeV	%Uncer.	>10MeV	%Uncer.	>20MeV	%Uncer.
Neutrons	1.15528E-06	3.21	6.26463E-07	4.10	5.35315E-07	4.31
Charged Hadrons	7.20192E-09	42.00	7.12015E-09	42.48	7.12015E-09	42.48

2.4. Particle Fluence in the Air inside the rack integrated by 3000 fb⁻¹ .

[part/cm2]	Whole range energy	%Uncer.	>100KeV	%Uncer.
Neutrons	8.78732E+11	1.86	3.92857E+11	2.75
Charged Hadrons	1.68904E+09	40.86	1.68419E+09	40.97

[part/(cm2*prim)]	>1MeV	%Uncer.	>10MeV	%Uncer.	>20MeV	%Uncer.
Neutrons	2.63403E+11	3.21	1.42833E+11	4.10	1.22051E+11	4.31
Charged Hadrons	1.64203E+09	42.00	1.62339E+09	42.48	1.62339E-09	42.48

