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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), 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 dose.
- Compare the results with other Pablo's report and other references.

Description of the simulation

- **Description of software parameters**

  The software used for making this simulation was FLUKA [1]. Based on the CMS Geometry file sent by Moritz Guthoff [2].

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

  This simulation was sent to batch system at CERN using 988 jobs and 100 primaries per job, a total number of 98800 primaries. It was made in 6 days.

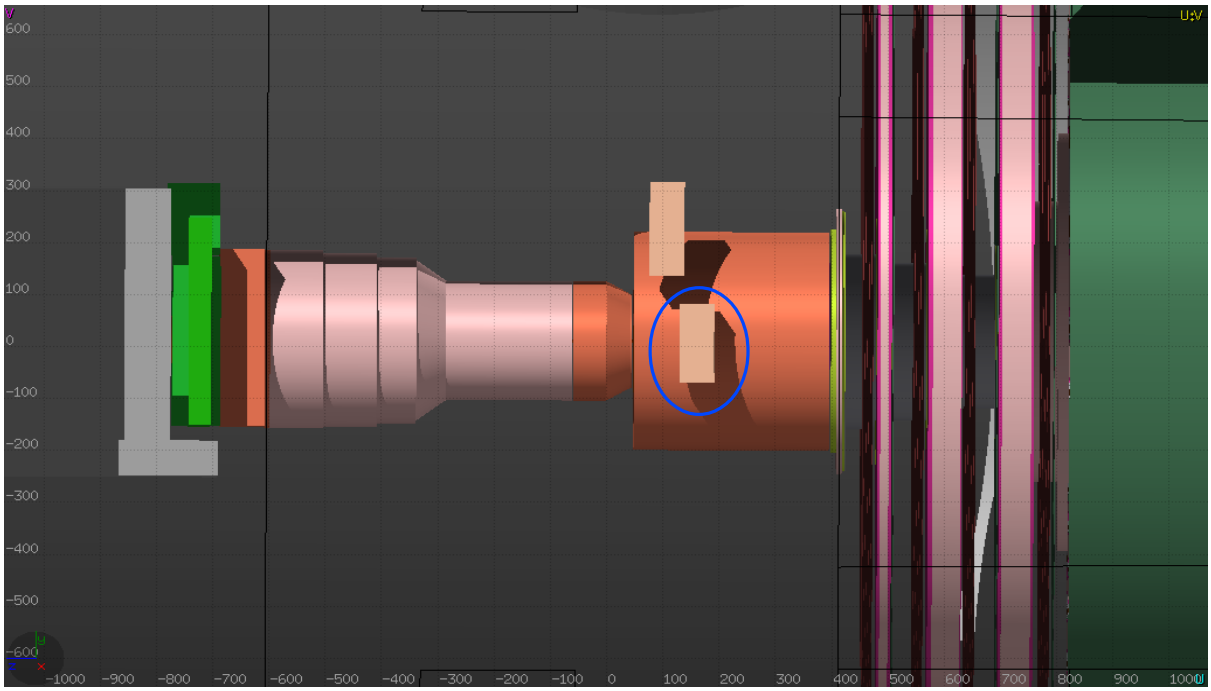
- **Description of physics parameters**

  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 and position of each box, please refer to [2].

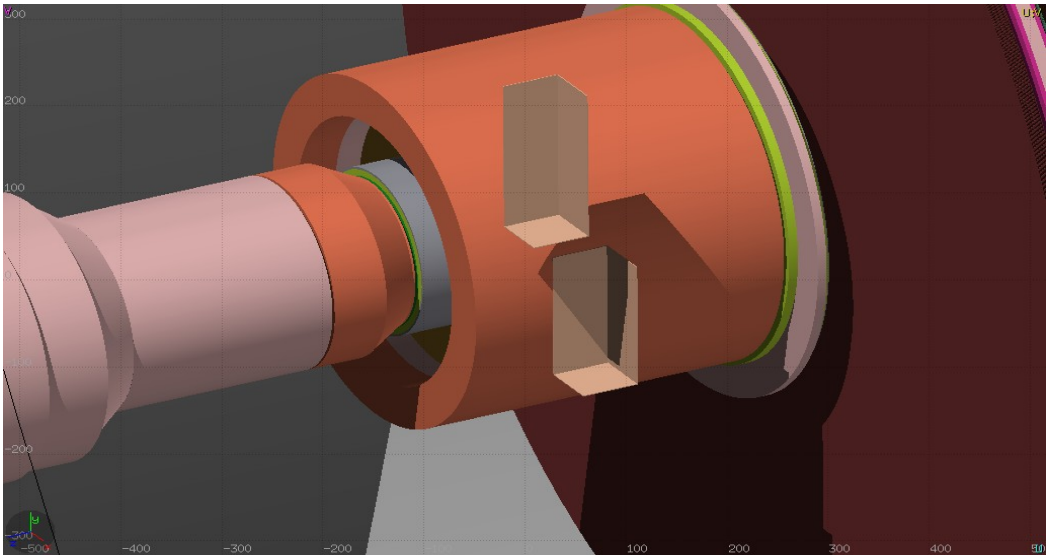
The center of mass of the proton-proton collision was 14 TeV, lab momentum x-component equal to 0.42 G/eV and σ_z=5.

All the measurements were made at the position R=250 cm and Z=1317 cm (center of the rack) from the interaction point, please look picture 1.

- **Graphic description of racks**



Picture 1. Racks created and located in HF-Front End Electronics in the CMS geometry. The rack studied is surrounded by a blue circle.



Picture 2. Racks located up to HCAL.

Results

The simulation gave us the next results. You can look and compare with Pablo Jácome's results [3] and with reference [4].

1. Dose

1.1. Dose per primary

My Results

Material	Volume [cm3]	Dose per primary [Gy/prim]	Uncert. [%]
Silicon	22417	3.51E-17	13.52

Pablo Jácome's Results

Material	Volume [cm3]	Dose per primary [Gy/prim]	Uncert. [%]
Silicon	22417	3.07E-17	33.73

1.2. Dose integrated by $3000\,fb^{-1}$

My Results

Material	Dose integrated by 3000 fb-1 [Gy]*	Uncert. [%]
Silicon	8.15E+00	13.52

Pablo Jácome's Results

Material	Dose integrated by 3000 fb-1 [Gy]*	Uncert. [%]
Silicon	7.01E+00	33.73

Other references**

Dose integrated by 3000 fb-1 [Gy]*
2.64E+01

*Number of events expected at $3000\,fb^{-1}$ are $2.28\,x\,10^{17}$ events

** The studies were made using $500\,fb^{-1}$ in the position R=3m and Z=13m and they were multiplied by 6.

2. Fluence

2.1. Particle Fluence in the silicon rack per primary

My Results

[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

Pablo Jácome's Results

[part/(cm2*prim)]	Whole range energy	%Uncer.	>100KeV	%Uncer.
Neutrons	6.07E-06	1.5	2.89E-06	2.1
Charged Hadrons	1.89E-08	24.0	1.88E-08	24.0

[part/(cm2*prim)]	>1MeV	%Uncer.	>10MeV	%Uncer.	>20MeV	%Uncer.
Neutrons	2.06E-06	2.4	1.15E-06	3.1	1.00E-06	3.3
Charged Hadrons	1.88E-08	24.1	1.68E-08	25.0	1.58E-08	26.2

2.2. Particle Fluence in Silicon rack integrated by $3000\,fb^{-1}$.

My Results

[part/(cm2)]	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

Pablo Jácome's Results

[part/cm2]	Whole range energy	%Uncer.	>100KeV	%Uncer.
Neutrons	1.38E+12	1.5	6.58E+11	2.1
Charged Hadrons	4.30E+09	24.0	4.30E+09	24.0

[part/cm2]	>1MeV	%Uncer.	>10MeV	%Uncer.	>20MeV	%Uncer.
Neutrons	4.69E+11	2.4	2.62E+11	3.1	2.28E+1	3.3
Charged Hadrons	4.28E+09	24.1	3.82E+09	25.0	3.60E+09	26.2

Other references**

[part/cm2]	Whole range energy
Neutrons	8.64E+11
Charged hadrons	7.08E+09

*Number of events expected at $3000\,fb^{-1}$ are $2.28\,x\,10^{17}$ events

** The studies were made using $500\,fb^{-1}$ in the position R=3m and Z=13m and they were multiplied by 6.

Conclusions and Recommendations

- The dose calculated by this simulation has similar results that Pablo's got in his last report. The difference is in the uncertainty. I got the middle of his uncertainty, but both are small.

- The neutrons and charged hadrons fluence have differences in the results between Pablo and I. Results are different by a factor of 2 or 3 approximately, but Pablo did the simulation in the position R=260 and z=1310. It would be important to know how critic is that difference for the studies.

- A point of study or comparison could be the influence of the distribution of jobs, the number of lots used for the simulation, at the batch system in the statistics of the results.

References

[1] FLUKA Online Manual.
http://www.fluka.org/fluka.php?id=man_onl

[2] Twiki of HCAL Radiation Project.
https://twiki.cern.ch/twiki/bin/view/Sandbox/HCALRadiationProject

[3] HF Radiation Project Report, P. Jácome.
https://cms-docdb.cern.ch/cgi-bin/DocDB/RetrieveFile?docid=6031&version=1&filename=HF-Radiation-Project-v3.pdf

[4] CMS NOTE 2000/068: “Optimization of the CMS forward shielding“, Mika Huhtinen. Table 5, pg. 14.
http://cdsweb.cern.ch/record/687289/files/note00_068.pdf