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HF Radiation Project

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Objectives

- Start the studies of radiation using physics parameters related with the operation of the CMS detector.
- Estimate the activity in a determined region in the HF detector.
- Study the Ambient Dose Equivalent rate in the region of the HF detector.

Definitions

- **Activity:** Number of Nuclei activated per unit of time. The units of this parameter is the Becquerel (Decays per second).
- **Ambient dose equivalent:** For area monitoring of penetrating radiation the operational quantity is the ambient dose equivalent. It gives us a conservative estimate of the effective dose a person would receive when staying at this point. The units of this parameter is the Sievert [Sv] (Energy per unit of mass).
  If we study the ambient dose equivalent rate or ambient dose equivalent per unit of time, the units are the Sievert per hour [Sv/h] (Energy per unit of mass per unit of time).

- **Cooling time:** It is a time after the operation of the detector.

Description of the simulation

- **Description of software parameters**

  The simulation was made in FLUKA.

  - **Activity**
    The cards used were RESNUCLEI and DCYSCORE.

- **Ambient dose equivalent rate**
  This study is the ambient dose equivalent per unit of time (Sievert per hour). The cards used were USRBIN, DCYSCORE and AUXSCORE.

The simulation was made using 3000 primaries in Lxplus at CERN with a time of 4 days.

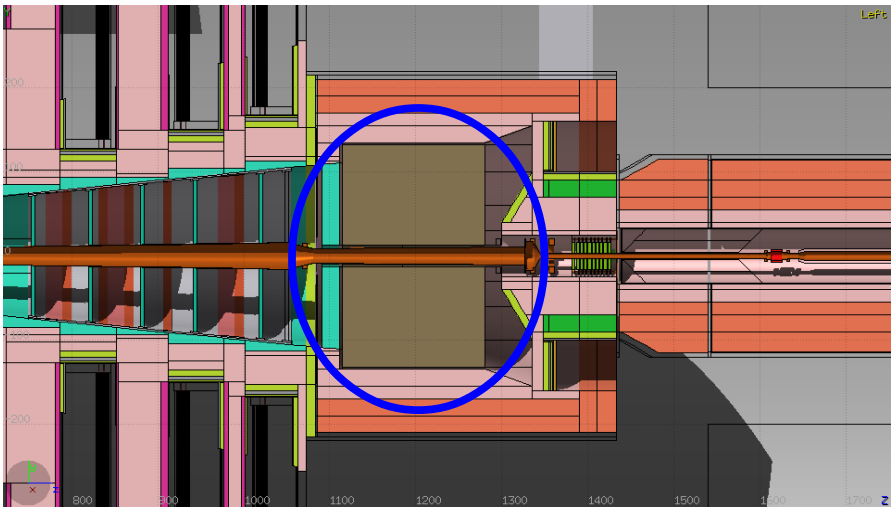
- **Description of physics parameters**

  - **CMS detector**
    - 1 year of continuous LHC operation
    - Instantaneous luminosity: $10^{-34}\,Hz\,cm^{-2}$
    - Total cross section (proton-proton collison at 14 TeV): 76mb
    - Intensity of the collision: $7.6\,10^{8}\,pp/s$
    - Integrated luminosity: $315.36\,fb^{-1}$
    - Measurements in different cooling times: 1 hour, 8 hours, 1 day, 7 days, 1 month, 4 months
  - **Beam**

    - The center of mass of the pp collision was 14 TeV.
    - Lab momentum x-component equal to 0.42 G/eV and a $\sigma_z = 5.$

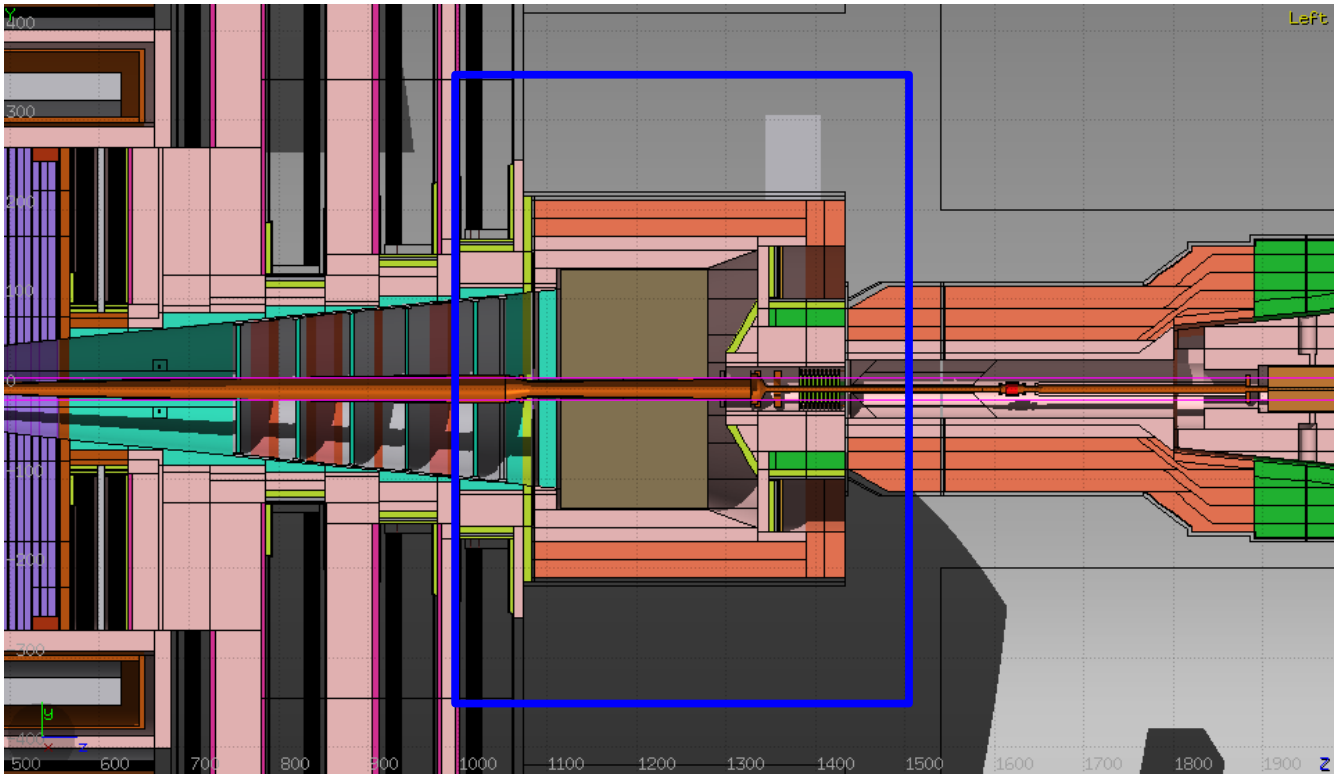
- **Graphic description of the region where was studied the activity.**

The study was made inside the HF detector in the region that you can see in the picture painted in brown and surrounded:



Picture 1: Region that I used for the study of activity. The volume of this region is 9019512.51 cm3.

- **Graphic description of the region where was studied the ambient dose equivalent rate**



Picture 2: Region that I used for the study of ambient dose equivalent rate. The coordinates of the region for this study were:X=[-300,300],Y=[-350.350],Z=[1000,1500] from the interaction point (IP). **Including HF-FEE**.

Results

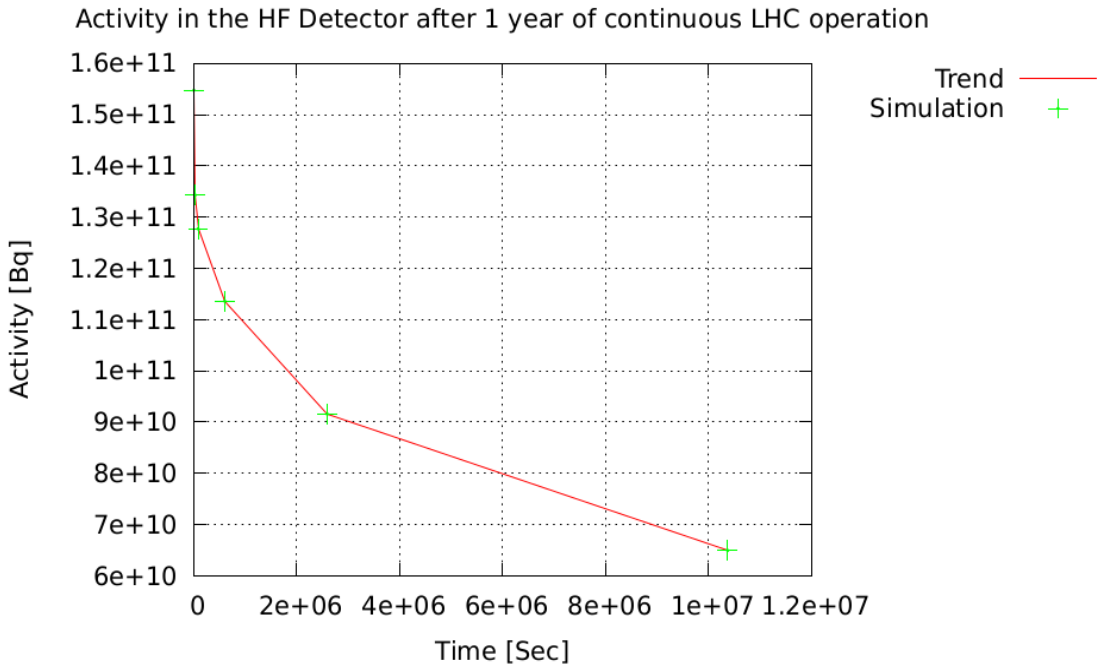
1. Activity

The results of the simulation were:

Cooling time	Time [Second]	Activity[Bq/cmc]	Activity[Bq]
1hour	3600	17153.447	154715734000
8 hours	28800	14888.302	134285230000
1 day	86400	14156.248	127682462000
7 days	604800	12592.043	113574101000
1 month	2592000	10151.12	91558158300
4 months	10368000	7198.607	64927932400

Table1: Number of Becquerel after different cooling times in the region studied.

In this graphic you find the trend of the decay:



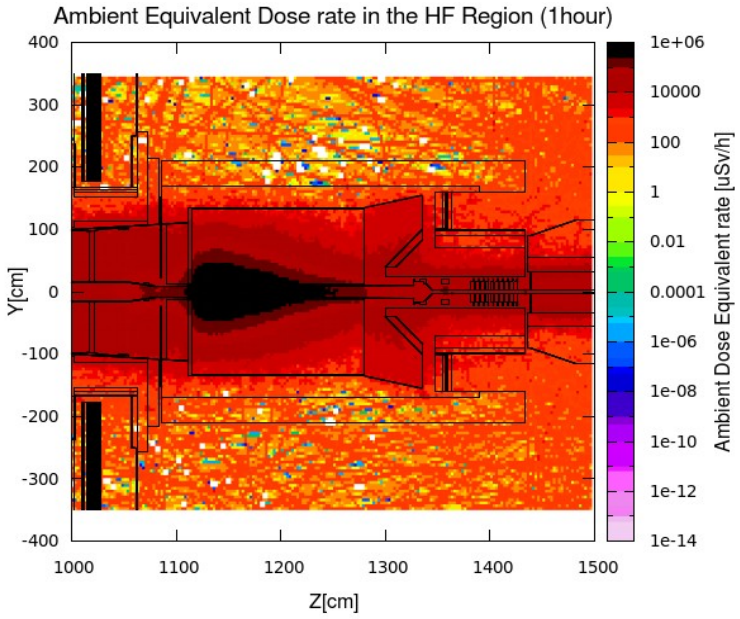
Picture 3: Activity in the determined region of HF detector.

2. Ambient dose equivalent rate maps

The results for these studies are presented in one and two dimensions plots for different cooling times:

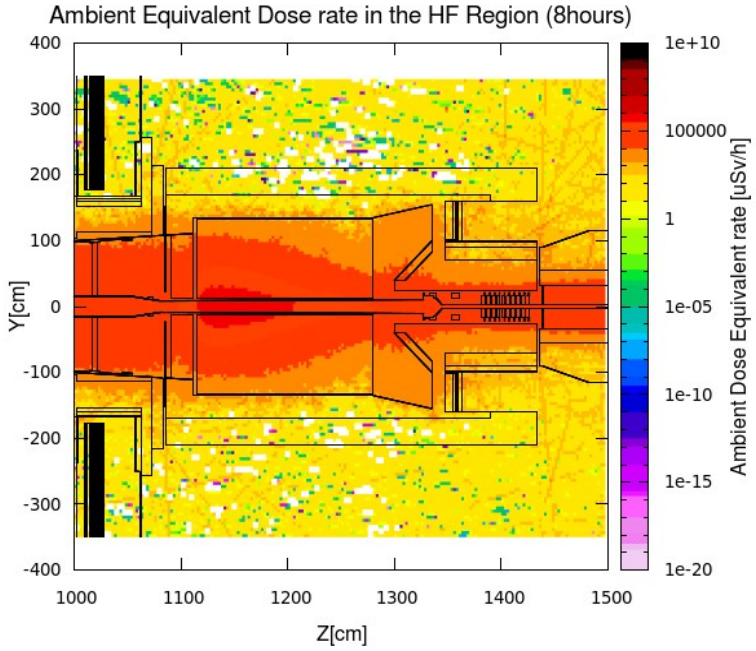
2. 1. Two dimensions plots

- 1 hour



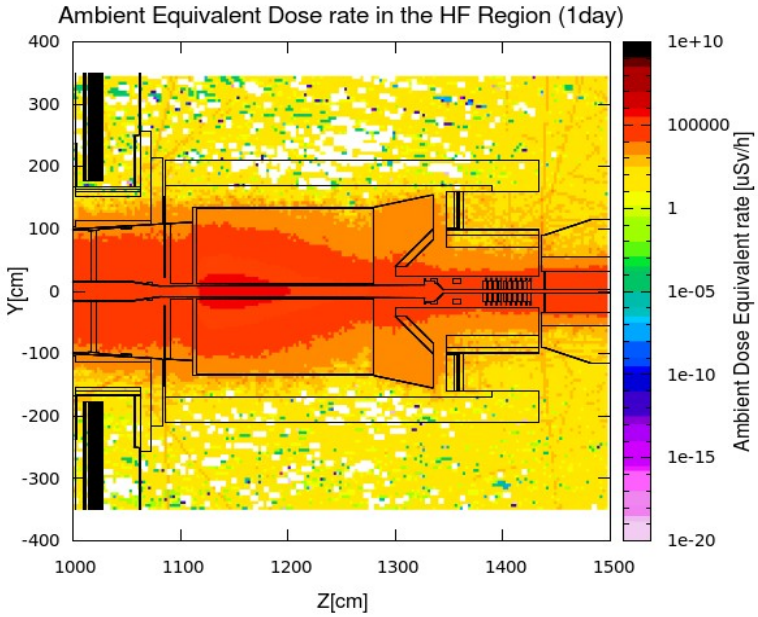
Picture 4: Ambient dose equivalent rate after 1 hour of cooling time

- 8 hours



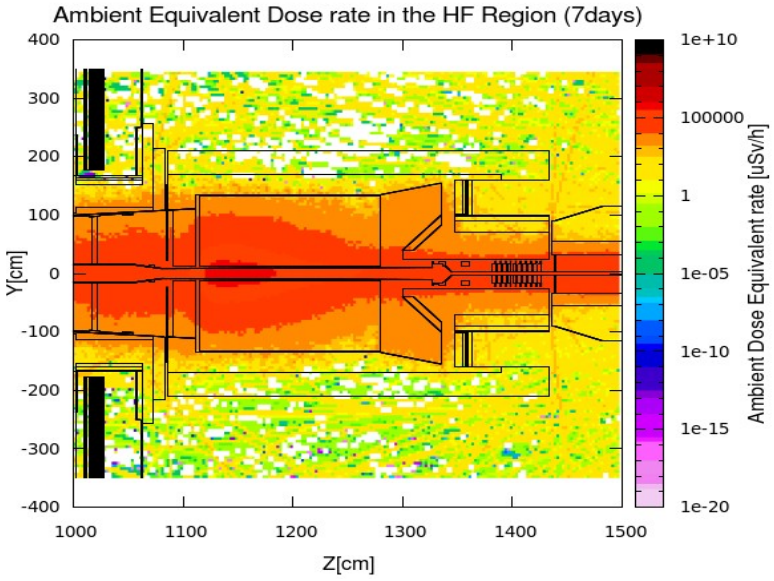
Picture 5: Ambient dose equivalent rate after 8 hours of cooling time.

- 1 day



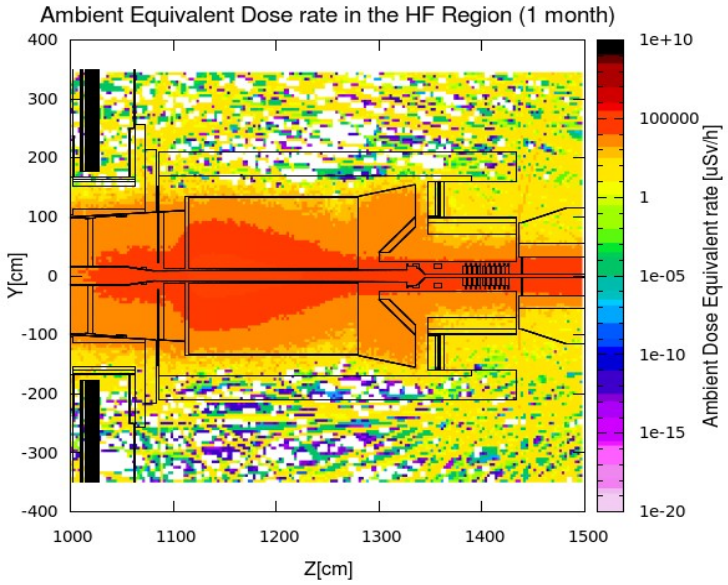
Picture 6: Ambient dose equivalent rate after 1 day of cooling time microsievert per hour

- 7 days



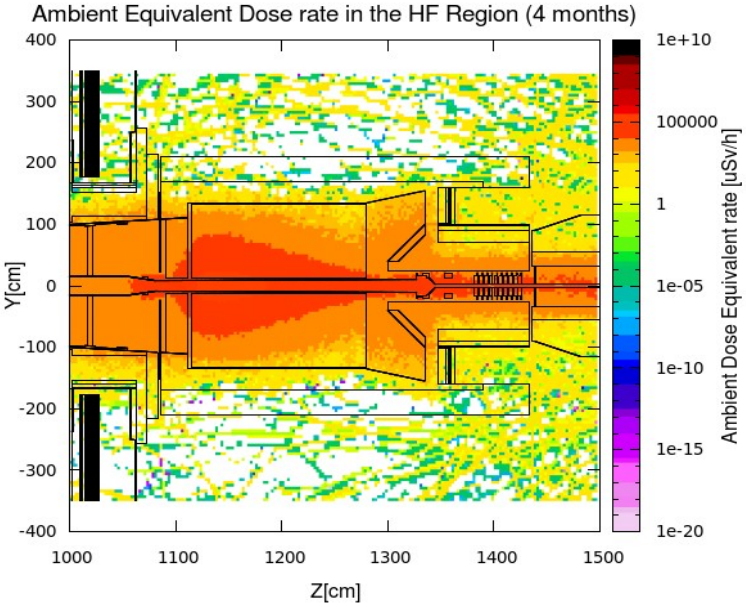
Picture 7: Ambient dose equivalent rate after 7 days of cooling time in microsievert per hour

- 1 month



Picture 8:Ambient dose equivalent rate after 1 month of cooling time in microsievert per hour

- 4 months



Picture 9: Ambient dose equivalent rate after 1 month of cooling time in microsievert per hour

The minimum and maximum values of ambient dose equivalent rate for each cooling time you can find it in the next table:

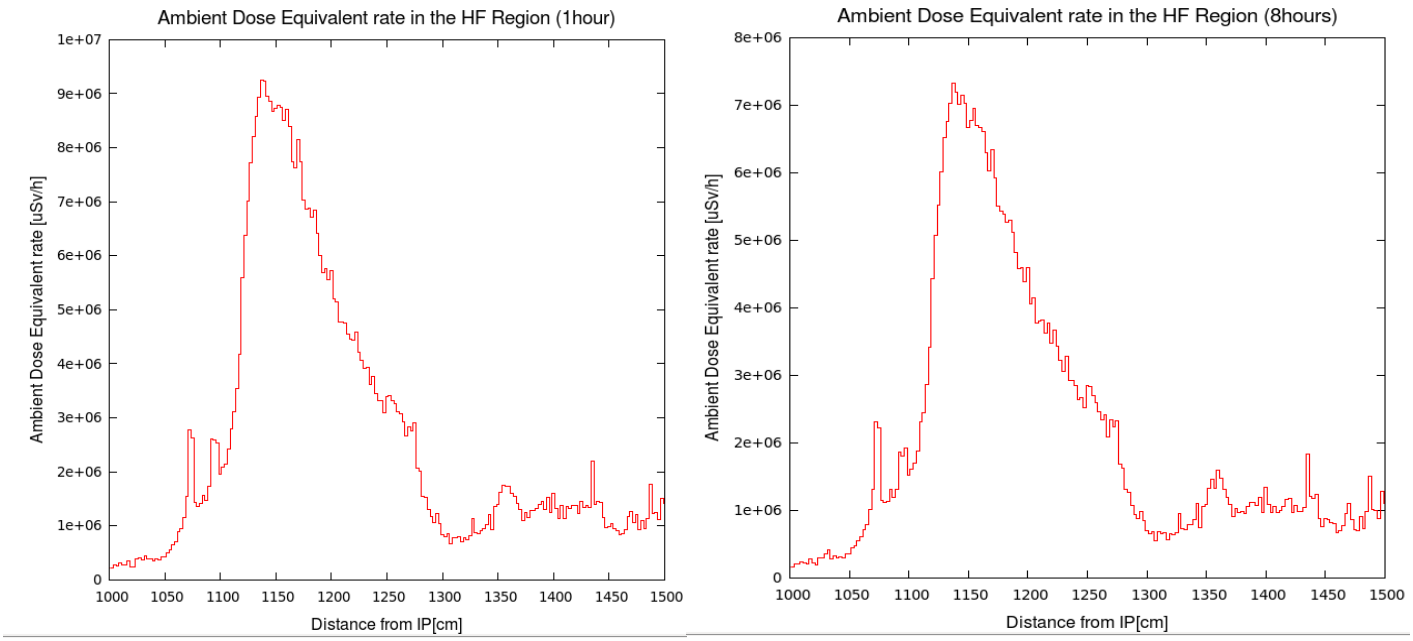
Cooling time	Minimum [uSv/h]	Maximum [uSv/h]
1 hour	3.96E-13	942909.75
8 hours	8.49E-20	735132.688
1 day	6.98E-20	672048.688
7 days	1.11E-19	506215.344
1 month	2.68E-17	307208
4 months	5.98E-20	169950.594

Table 2: Maximum and minimum values of ambient dose equivalent in microsievert per hour

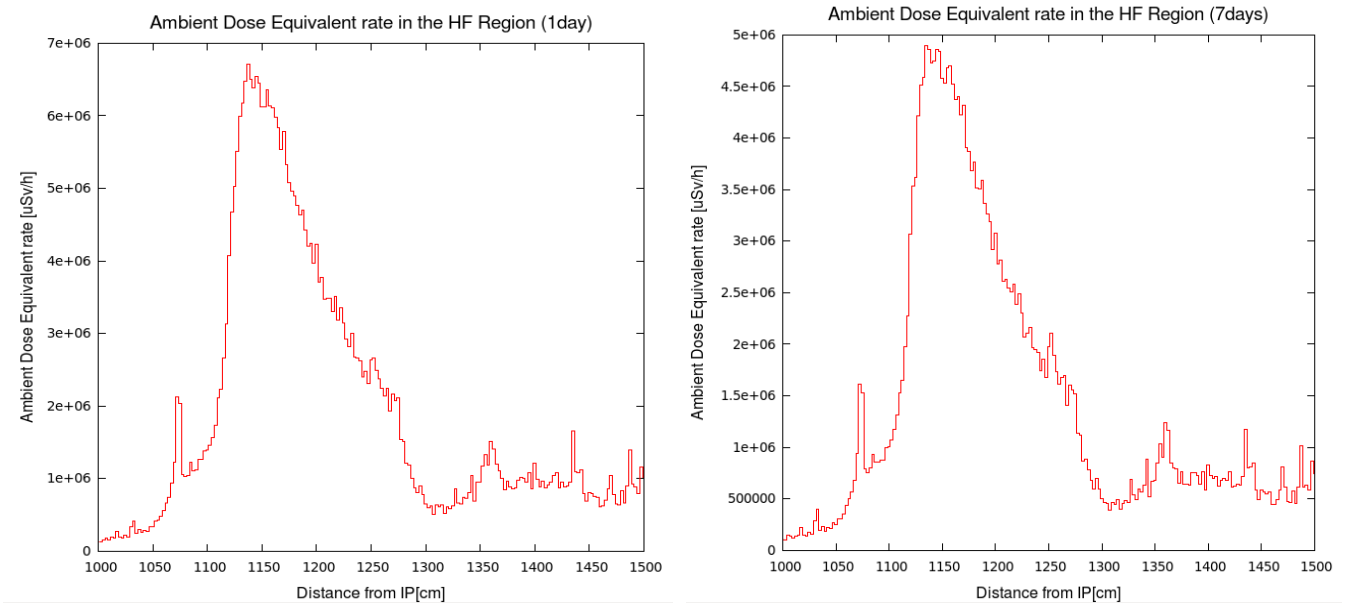
2.2. One dimension plots

These plots give us the maximum ambient equivalent dose value in one specific direction. In this case, I made the study in the Z axis from IP, because in this axis we will have the maximum values of radiation.

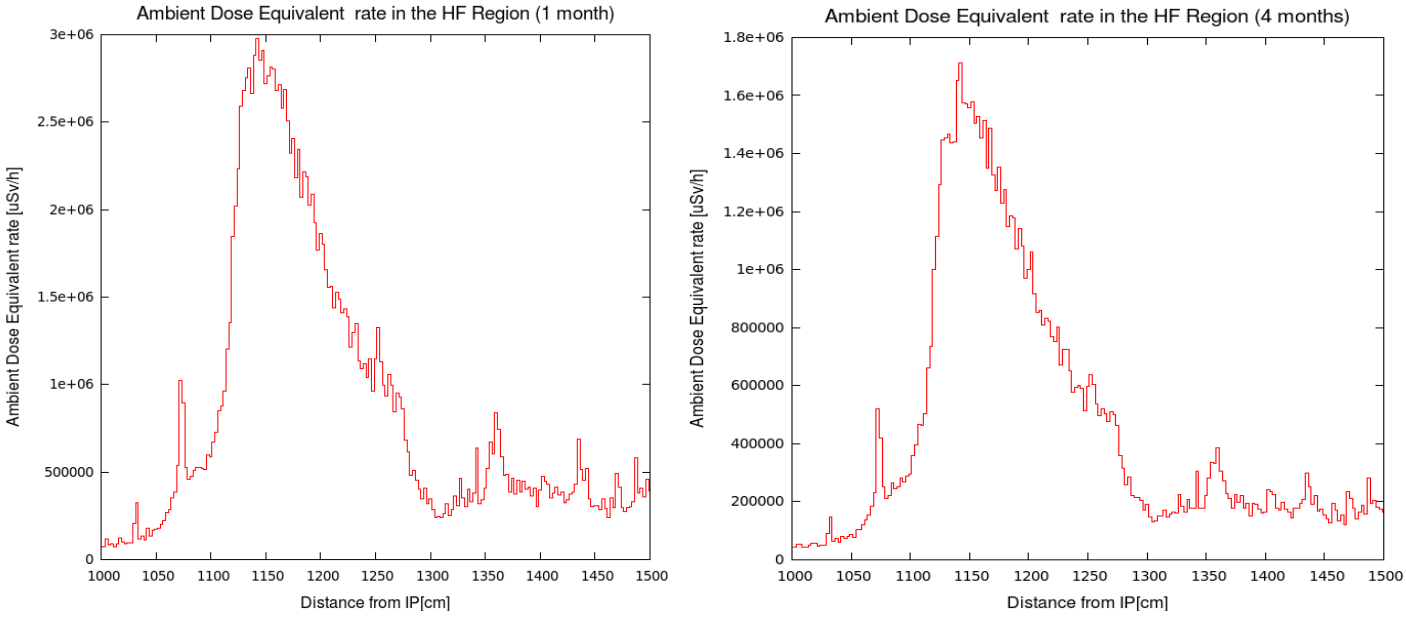
Note: You have to see at the scale of the Ambient Dose Equivalent rate (uSv/h) in each plot to notice the difference between the values of radiation in the different cooling times.



Picture 10: Maximum value in the Z axis. Left: Ambient dose equivalent rate after 1 hour of cooling time in microsievert per hour. Right: Ambient dose equivalent rate after 1 hour of cooling time in microsievert per hour.



Picture 11: Maximum value in the Z axis. Left: Ambient dose equivalent rate after 1 day of cooling time in microsievert per hour. Right: Ambient dose equivalent rate after 7 days of cooling time in microsievert per hour.



Picture 12: Maximum value in the Z axis. Left: Ambient dose equivalent rate after 1 month of cooling time in microsievert per hour. Right: Ambient dose equivalent rate after 4 months of cooling time in microsievert per hour.

REFERENCES

[1] Residual dose rate maps, air activation and prompt dose in the adjacent tunnel at IR5. M. Fuerstner, D. Forkel-Wirth, S. Roesler. CERN-DG-2009-057-RP-TN

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