Summer Student Report

CHARM

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Introduction to CHARM

CHARM (CERN High energy AcceleRator Mixed field facility) is a completely new facility being built now in the east area building 157, and is currently under the commissioning phase. It is to be used as a facility for radiation testing electronics. CHARM uses a 24 GeV beam to hit a target creating a mixed field of radiation. The target is a rotating revolver with four different targets to choose from, two copper, one solid aluminum and one aluminum with holes in it. Four movable shields allows the user to change the field to simulate the radiation that would be received in LHC tunnel, adjacent areas, in space etc. A years worth of radiation exposure in the LHC could be simulated in only a few days in CHARM. There will be two conveyor systems for bringing electronics into the test position. One for small electronic boards mounted in a $300 \times 300 \times 200$ mm box, and can have a maximum weight of 10 kg. This system is Called MONTRAC, and will automatically bring the test box on a shuttle from behind concrete shielding, into the test area, and then bring the electronics out again, with out personnel ever having to enter the activated test area. The shuttle also pushes a trolley with cable mounts, and pulls a trolley with mounted cameras. The other conveyor system will be for larger electronics or racks, with dimensions up to 1000×1000 mm, 2 m height and maximum weight of 1000 kg. CHARM is the worlds only facility where such a high energy mixed field is produced for radiation testing of electronics[3].

Projects

There are three main projects I have been working on. The calibration of sealed argon ionization chamber[1], the commissioning of MONTRAC conveyor system, and the writing of an operational procedure for the MONTRAC system. In addition I also took part in the mounting radiation hardened cameras from Thermo Scientific, writing software for getting image a video stream from these cameras, commissioning of the target revolver, and doing FLUKA[2][4] simulations on the ionization chamber.

Ionization Chamber

The ionization chamber will be used together with a secondary emission counter to to measure the intensity (number of protons) of the beam. The ionization chamber covers intensities with an order of magnitude from 10^6 to 10^{10}, and the secondary emission chamber from 10^9 and up. An accurate calibration of the ionization chamber is important because the it will later be used to calibrate the secondary emission chamber. The ionization chamber will be calibrated by the use of two scintillators in coincidence.

On July 10^{th} I participated in a meeting discussing how and when the calibration would be preformed and what the format of the data would be. After the meeting I started a working on a MATLAB program together with the unofficial summer student Maris Tali for analyzing the data produced by the calibration. We assumed that we would get the data from Timber, and that the data would consist of counts from two scintillators, coincidence between the scintillators and the count from the ionization chamber. The coincidence is incremented only if both of the scintillators have a count, so if one counts 10 and the other counts 20 the coincidence is 10, this removes the noise.
Since the scintillators had been calibrated earlier, we knew what the coincidence count corresponds to in number of charged particles. Thus we could plot the coincidence vs the ionization chamber count rate, and the rate of change of the linear fit of the plot would be our calibration constant. By multiplying the calibration constant with the ionization chamber count, we get the number of charge particles, and thus the intensity of the beam. Figure 1 shows the GUI and result of running the MATLAB program on data from an earlier calibration at H4IRRAD.

T9 only has a maximum energy of up to 10 GeV, while T8 has 24 GeV. To find out how this would affect the calibration results, I ran a fluka simulation together with Maris Tali, where we designed the ionization chamber and shot a beam at it, varying the energy from 5 GeV to 25 GeV. The simulated beam contained 75% protons 20% pions and 5%kaons. We ran the simulation 5 times with a million particles on the clueet cluster. Figure 2 shows the results of the simulations. There is only a $7.75\ \% \pm 0.27\ \%$ increase between 10 GeV and 24 GeV in the absorbed dose, see figure 2.

The week before the calibration, on 7^{th} of August, I went to a PS/SPS meeting to discuss our use of the T9 beam line for calibration of the beam. I got to meet the person in charge of T9 during the calibration, Simon Mataguez. Afterwards I got to coordinate the time of calibration, and was responsible to make sure the people needed for the calibration were told of the timing and would be present. On the 12^{th} of August, we met for calibration at the T9 control room. It turned out that we did not have automatic logging with timber after all. Some of the data taking was done by hand, Maris Tali made a script for taking screen shots of the data. Afterwards I wrote a Python script using optical character recog-

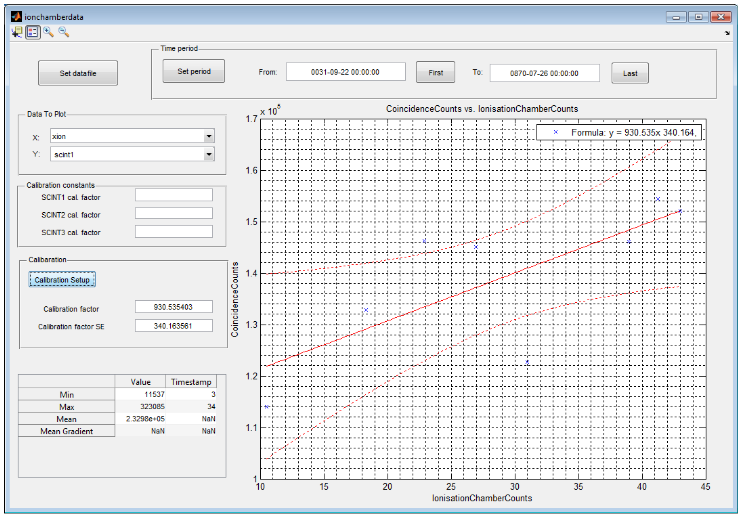

Figure 1: Image from the MATLAB program for analyzing data from the ionization chamber.

nition to retrieve the data from the PNGs.
Both of the scripts and the data images can be found at `https://github.com/einoj/CIDER` (Custom Image Data ExtractoR). The results of the calibration is shown in figure 3.

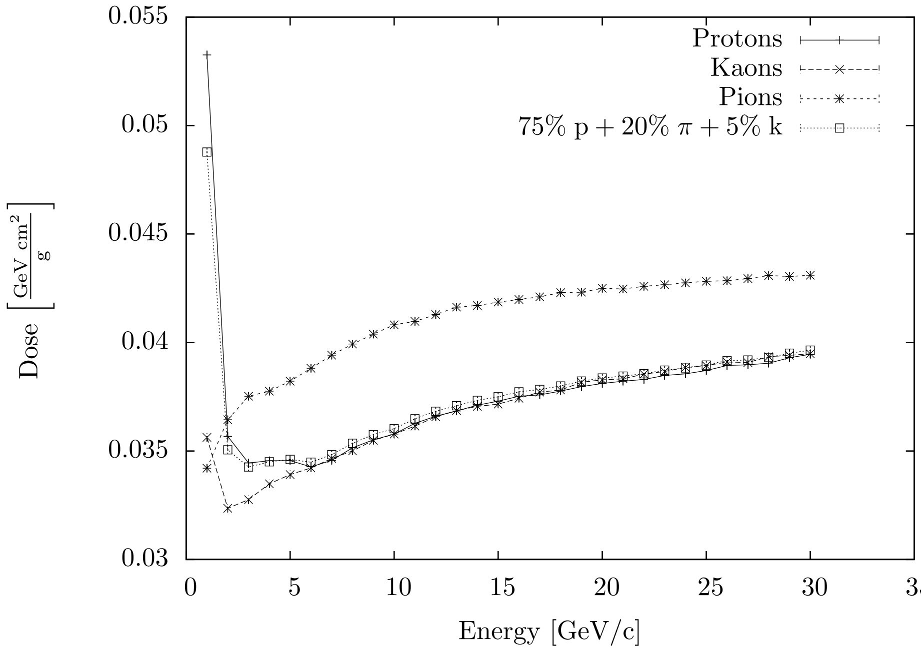

Figure 2: Plot of the results from the FLUKA[2][4] simulation. The errobars are so small (10^{-5}) that they can not be seen.

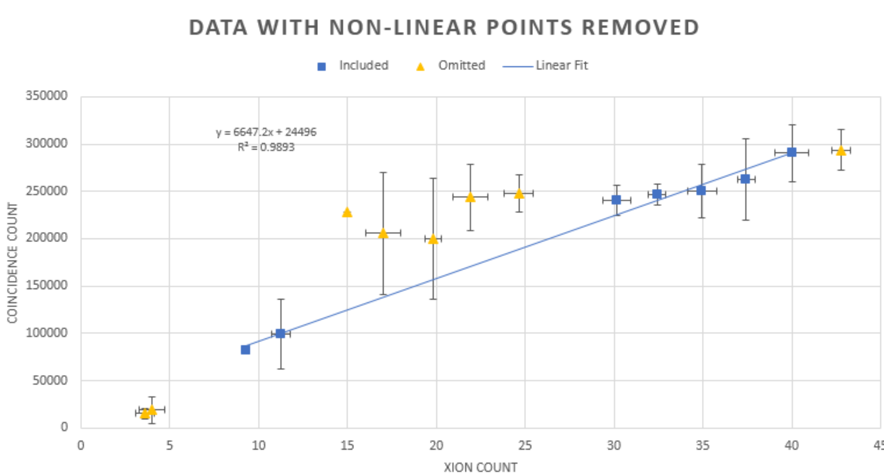

Figure 3: Data from ionization chamber calibration, collected using OCR.

MONTRAC

Work on the MONTRAC started as soon as I had received my dosimeter. There had already been set up an identical copy of the MONTRAC in a mock up outside for training purposes, the one I helped assemble was put up inside of CHARM.

The MONTRAC is a system consisting of a monorail track with a shuttle and two trolleys to put electronics on. To mount electronics on the MONTRAC, one has to go into the area classified as NON-ACCESSIBLE area. This area can only be accessed when the beam is off, when it is considered a "controlled area". When the electronics are mounted, they will be driven into the test area by the shuttle. An image of the MONTRAC with shuttle and trolleys can be seen in figure 4.

After assembling the MONTRAC, we ran three different tests on the mock up MONTRAC. A first test, just to see if the shuttle could be controlled by the PLC system remotely. It was discovered that several additional switches needed to be added to the MONTRAC in order to automate the process of lifting the plate holding the test box with the electronics off the shuttle, connecting the shuttle to the cabling using a system called Hypertac, and then releasing the shuttle from the trolley containing the cabling, so the shuttle could leave the test area leaving the test electronics and trolley behind. Another problem we discovered was that there was friction damage to the track and wheels of the shuttle. One of the ways we tried to fix this was leveling the entire track, and reducing the gaps between the joints. We were able to reduce the gaps of most of the joints from $200 - 250$ μm to $50 - 100$ μm, basically less than the width of a human hair. The graphical user interface of the MONTRAC also went through several editions during the testing phase.

All the knowledge I gained during the assembly and testing of the MONTRAC I used to write a operational protocol for the use of the MONTRAC system. This manual will be used by future users of CHARM, and will be uploaded to CHARM's website `http://charm.web.cern.ch/`.

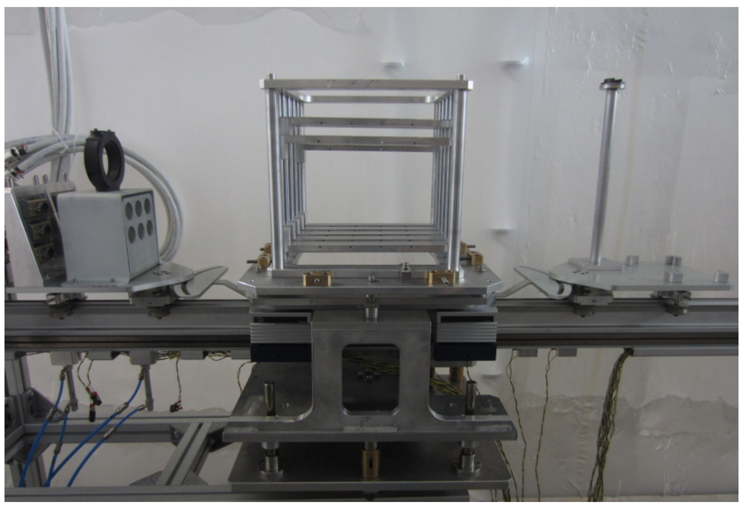

Figure 4: The MONTRAC with the trolley and Hypetac connections on the left, shuttle with box for electronics in the middle and shuttle on the right.

Bibliography

[1] V. Agoritsas. A sealed metal argon ionisation chamber (argonion). *IEEE Transactions on Nuclear Science*, 28(3), June 1981.

[2] G. Battistoni, S. Muraro, P.R. Sala, Cerutti. F., A. Ferrari, S. Roesler, A. Fasso‘, and J. Ranft. The FLUKA code: Description and benchmarking. *AIP Conference Proceeding*, 896:31–49, 2007.

[3] CHARM. About CHARM. `http://http://charm.web.cern.ch/CHARM/charm.php`, August 2014.

[4] A. Ferrari, P.R. Sala, A. Fasso‘, and J. Ranft. FLUKA: a multi particle transport code. *CERN-2005-10*, INFN/TC_05/11:SLAC–R–773, 2005.