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The main goals of this project are: a) measurement of the elastic cross-section and determination of the total cross-section for proton-proton interaction at 8 TeV centre of mass energy, b) studies of soft diffraction processes, particular their cross-sections as a function of different kinematic variables, c) studies of neutral particles produced at small angles in coincidence with a forward proton.

An essential ingredient for the above issues is the ALFA detector system. In all analyzes it will be required to have at least one proton that left the interaction point intact to be registered in ALFA. These detectors use the so-called Roman pot technology, which allows to place the active part of the apparatus in a vacuum chamber of the accelerator. ALFA consists of four stations placed symmetrically with respect to the ATLAS interaction point at a distance of approximately 240m. Each station includes an upper and a lower pot, the position of which can be independently regulated. The active part of each detector is made up of 20 layers of scintillating fibers oriented at an angle of +-45 degrees. The detectors provide information on the position of the trajectory of the scattered proton with an accuracy of approximately 30um. These measurements allow the reconstruction of kinematic properties of the proton. Each pot contains also the so-called outer detectors - scintillation detectors that primary use is to determine the relative positions between the top and the bottom pots of the station. In addition to the ALFA data, the studies will take advantage of other parts of the ATLAS detector, which will provide detailed information on the properties produced state.

Measurement of elastic cross section is one of the standard measurements performed at each newly available energy. The scattering angles of the protons emerging from such an interaction are very small. This feature combined with the requirement of precision measurement lead to the use of the Roman pot technology. The measurement is based on counting the number of events of elastic scattering - the events where there are exactly two protons in the final state - and dividing that number by the value of the luminosity provided by the accelerator during the measurement. It should be noted that this ratio must be further corrected for a variety of experimental effects. Measurement of elastic cross-section differentially as a function of the four-momentum transfer squared, t, allows the extrapolation of the scattering amplitude to t = 0. This, by using the optical theorem, allows the determination of the total cross-section at a given energy.

Soft diffraction processes are characterized by two features: the existence of rapidity regions in which no particles are produced - rapidity gaps - and the presence of fast protons produced in the forward direction (double diffraction dissociation lies beyond the scope of the project). Both of these features are to be exploited in the proposed measurements. Using these characteristics can be possible only when the accelerator runs with beams of relatively small intensities. Then, the background of multiple proton-proton interactions occurring in the same event is either very small or completely negligence. The forward proton will be recorded in ALFA, while the central state in the ATLAS detector. Various properties of the events will be studied: proton energy, four-momentum transfer, particle multiplicities, etc.

The studies of the properties of events with neutral particles produced in the forward direction in coincidence with the forward proton will be possible thanks to ALFA and also the detectors dedicated for measurements of neutral particles at small angles - ZDC and LHCf. These detectors are located about 140m from the interaction point and they provide information about the energy and the transverse position of the particles. Measurements of such events will be used for tuning of phenomenological models, which are also used for the simulation of cosmic rays interactions with the atmosphere.