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2012 J. Phys.: Conf. Ser. 337 012025

(http://iopscience.iop.org/1742-6596/337/1/012025)

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Abstract. The project of a new and more powerful in-flight fragment separator ACCULINNA-2 at U-400M cyclotron in FLNR, JINR planned to build in addition to the existing separator ACCULINNA is presented. The new separator will provide high intensity RIBs in the lowest energy range (5÷50 MeV/nucleon) which is attainable for in-flight separators. The possibilities for the astrophysics studies at the proposed device are presented. ACCULINNA–2 separator is planned to be constructed in the years 2010-2015. The current status of the project is reported.

1. Introduction

An important part of the planned third generation of Dubna Radioactive Ion Beams (DRIBs) facilities [1] at the Flerov Laboratory of Nuclear Reactions of the Joint Institute for Nuclear Research (FLNR, JINR) in Dubna is the construction of the in-flight fragment separator ACCULINNA-2 [2,3] as an upgrade of the existing separator ACCULINNA [4]. The project of the new separator should be realized in parallel with continuous operation of ACCULINNA fragment separator and should gradually replace the latter after commissioning. The new facility is expected to be a more universal and powerful instrument providing wider range of high quality light exotic beams for nuclear physics studies. One of the key points of the project is to significantly increase the intensities of radioactive beams at the FLNR. The separator, together with the beam diagnostics system, should become a standard instrumentation for the laboratory as well as external users. Construction of the facility is planned in the years 2011-2015.

2. Anticipated scientific agenda

The proposed ACCULINNA-2 project is focused on the experimental study of nuclear properties far from the stability valley in the area of light nuclei. The investigation of nuclei far from β-stability valley and even beyond the nuclear stability lines is important for understanding the properties of nuclear matter under extreme conditions. Major physical topics related to the study of the phenomena observed in light exotic nuclei to be considered by means of the future facility are: nuclear reactions, nuclear structure and astrophysical applications. Each of them has a preferable set of methods by which its problems could be best analyzed. The scientific agenda of the ACCULINNA-2 separator considers a wide range of physical methods to study the properties of the exotic nuclear systems which should be accessible with this instrument. A strong emphasis is put on the possibility of the astrophysics studies. It is very important to carry out focused, dedicated investigations of some special cases difficult for the experimental study but crucial for the stellar burning cycles. Most nuclear reactions in stars involve short-lived proton-rich and neutron-rich nuclei. Moreover, nuclear astrophysics benefits in several ways from the investigation of unstable nuclei where the major aspect is new information on the nuclear matter properties and relevant nuclear reactions. A group of adequate methods as possibilities for the program of astrophysical studies with radioactive beams within the frame of the proposed project and details of the research program are given in the letter of intent [2].

3. Outline of ACCULINNA-2 separator

Figure 1 shows a schematic layout of two-stage separation ion-optical system of the separator. The first stage is represented by an energy loss achromat, the second one is a 15-meter straight beam line with beam diagnostics and detector array. Moreover a RF-kicker allowing to significantly improve the RIB purity (especially in case of the proton rich nuclei) is planed to be installed in the second part. The new separator will provide RIBs in the broad range of energies 6÷60 AMeV – the lowest energy

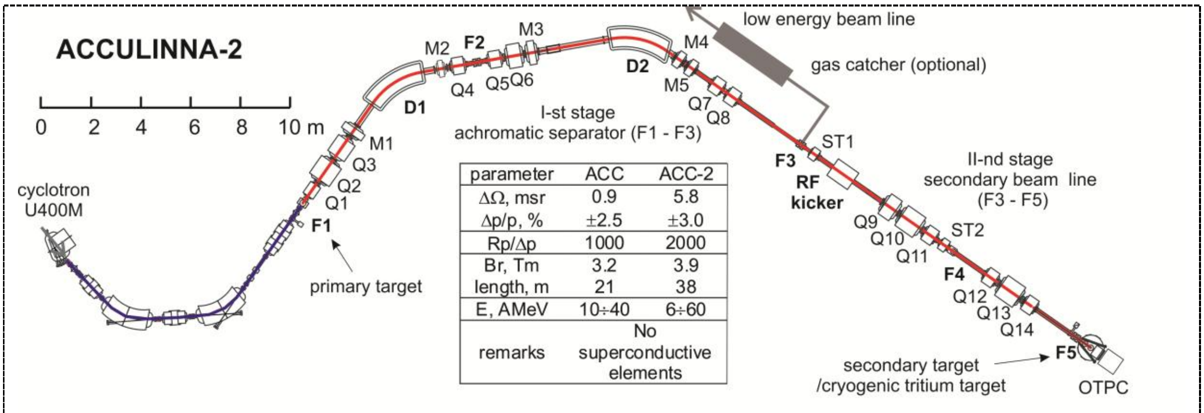

Figure 1. A schematic layout of the ACCULINNA-2 fragment separator. F_n denote focuses, dipoles, quadrupole lenses, miltipoles, steerers are indicated by D_n, Q_n, M_n, ST_n, respectively.

range which is attainable for in-flight separators. The solid angle acceptance and the energy spread are 5.8 msr and 6%, respectively. These issues together with cyclotron upgrade will allow to increase the RIB intensities by a factor of 10-15 as compared to the intensities achieved at the ACCULINNA beam line [4]. The expected RIBs intensities at the ACCULINNA-2 separator are listed in Ref. [2].

The new separator will be also equipped with a unique cryogenic tritium target with record characteristics in the world. The combination of the cryogenic target system [5] with a standard instrumentation (silicon shell, gamma and neutron arrays, etc) should be a distinctive feature of this facility giving unique possibilities for the reaction and nuclear structure studies carried out in vicinity and beyond the neutron drip-line. Moreover a novel type of the ionization chamber with optical readout designed for the rare decay studies, the so-called Optical Time Projection Chamber (OTPC) [6] is already being constructed in collaboration with Warsaw University. This device was originally developed to study two proton radioactivity [6] and allows a full kinematics reconstruction of decay event. The results of the experimental studies with OTPC at the beams delivered by the ACCULINNA separator demonstrated that such type of detector offers a unique possibility to study the decay and the structure of both proton and neutron-rich dripline nuclei [7]. Even though the low-cost separator cannot compete with new large in-flight separators in the sense of “crude power”, but taking advantages of a unique instrumentation combined with the low intermediate energy secondary beams, the results of the experimental studies are expected to be competitive for many years.

4. Status of the projects

The realization of the project is divided into two main phases: the first in the years 2011-2013 - construction and installation of the achromatic separator beam line and the second phase in the years 2011-2015 - is the developments of the beam diagnostic, control and detection systems, testing and first experiments running. The tentative timetable of the project realization is given in Table 1.

Table 1. The tentative timetable of the ACCULINNA-2 project realization.

	2011	2012	2013	2014	2015
Separator					
Contract for delivery of the main elements of the separator					
Simulation of the experiments & experimental tests at the existing ACCULINA-1 beam line					
First run of the new separator, tuning, first experiments running (F1-F3)					
Radiation shield & gas cell					
DAC					
Prototypes / final variant					

Acknowledgments

The authors are grateful to Profs. S.N. Dmitriev, A.G. Popeko and G.G. Gulbekian for overall support of the project.

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