ANEXA 1.A

Annual Summary Document 2016

1. Cover Page (1 page):

- **Group list (physicists, staff, postdocs, students);**

  The project team was composed by the following members:

  1. Livius TRACHE, Project Director, CS I
  2. Alexandra-Ionela CHILUG, PhD student, Physicist
  3. Dana TUDOR, PhD student, Physicist
  4. Ionut-Catalin STEFANESCU, student, Physicist
  5. Valentin BALANICA, Physicist
  6. Gherghina STAN, staff, Economist

- **Specific scientific focus of group (state physics of subfield of focus and group's role)**

The focus of the group is the use of indirect methods with radioactive beams for nuclear astrophysics. The first milestone of this project was established to be: The experiments of the SAMURAI HI-p collaboration. These are tentatively scheduled for the 2017 campaign of Radioactive Ion Beam Facility of RIKEN, Wako, Japan. Our particular emphasis will be on getting good data about the breakup of 9C. A package of simulations based on G software is being prepared.

- **Summary of accomplishments during the reporting period.**

In the short (about) two months from the start of this project, we had time to prepare the Nuclear Astrophysics Group (NAG) and the collaborators for the entire 3 years of the project and concentrated on the subject of this first report: "Preparations for the breakup experiments at RIBF RIKEN".

2. Scientific accomplishments (max. 3 pages) – Results obtained during the reporting period.

1. Introduction

This is an intermediate report for the project identified above, written before the end of November 2016. In the short (about) two months from the start of this project, we had time to prepare the Nuclear Astrophysics Group (NAG) and the collaborators for the entire 3 years of the project and concentrated on the subject of this first report: "Preparations for the breakup experiments at RIBF RIKEN".

The first milestone of the project is established to be:

*The **experiments of the SAMURAI HI-p collaboration**. These are tentatively scheduled for the 2017 campaign of Radioactive Ion Beam Facility of RIKEN, Wako, Japan. Our particular emphasis will be on getting good data about the breakup of 9C. Data should be analyzed by the end of 2018 and then published. A package of **simulations** based on G software will be prepared.*

and the first deliverable:

A tracking system of position sensitive silicon detectors to be placed after target at the entrance of the spectrometer SAMURAI will be realized with our collaborators involved in the program at RIBF, RIKEN, Japan.

Therefore these were the first priorities we had. I am reporting here about the progress along these lines.

2. General report

With the short available time and money, and given the regulations for public acquisitions in the country, we started work on:

a) Planning the tracking system, determining the particular position sensitive Si detectors that will be used and getting prepared for their procurement (we presume that other funds will be used, not those of this project).
b) Preparing for detailed simulations of this detector setup, and later of the whole experiment.
c) Plans about the preparation of the actual experiments in the fall of 2017, including the training of the students involved.

Most of this work is preliminary, therefore, I will not detail it here in most cases.

3. The NP1412-SAMURAI29R1 project and companion experiments of SAMURAI HI-p collaboration at RIBF RIKEN

The motivation for the experiment at RIBF of the Nishina Center at RIKEN, Wako, Japan, and its first main challenge are given in the proposal:

In the proposal NP1412-SAMURAI29R1 we planned to study the nuclear and Coulomb breakup of ^{9}C at 100 and 300 MeV/nucleon using the beams from BigRIPS at RIBF and the superconducting spectrometer SAMURAI. The main motivation of this proposal is nuclear astrophysics: the current knowledge of the rate of the $^{8}B(p,\gamma)^{9}C$ reaction in stellar conditions is contradictory at best and there is no hope to determine it, now or ever, by other means than by indirect methods. This reaction gives a possible path to the hot pp chain pp-IV at high temperatures and away from it toward a rapid alpha process rap I at high temperatures and densities …

This involves the simultaneous detection of the proton and of the core, and precise determination of their relative angle.

The basic challenges are:

- Very good position resolution is needed for the detection of the proton and of the heavy

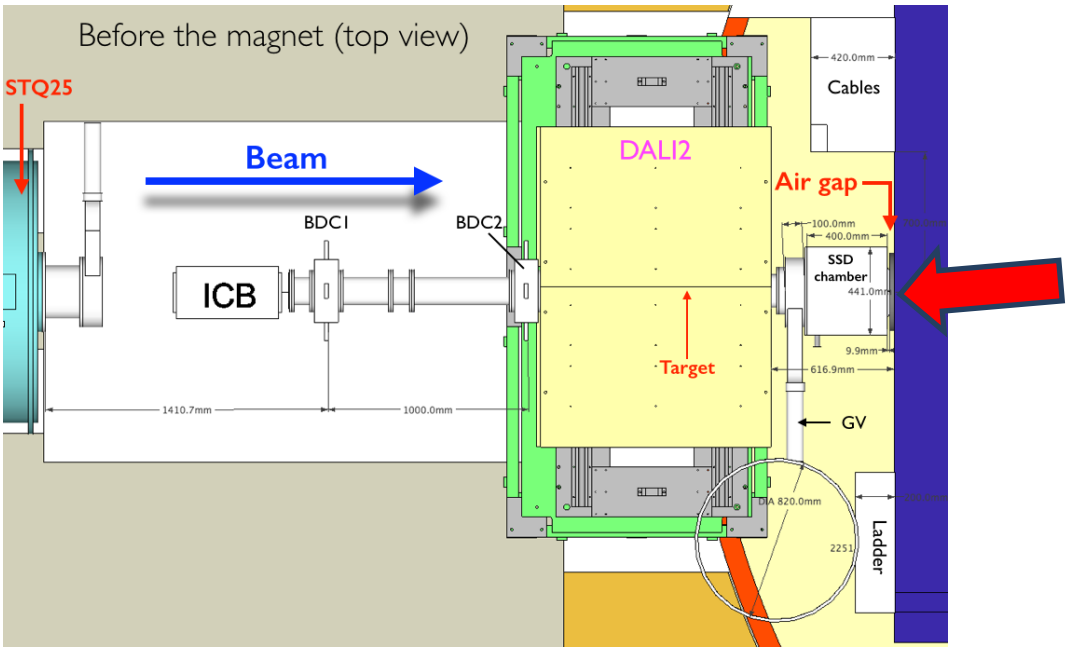

Figure 1. Configuration of SAMURAI exp.

core, for a good resolution of the relative angle of the two in the exit reaction channel, therefore, detectors with large granularities are needed, leading to

- A large number of signals (electronics channels) and
- a large dynamic range as the high energy protons leave very little energy in detectors (2-300 keV), while a heavier core may leave hundreds of MeV (as is the case for the companion experiments).

These were the problems that we had in mind in these latter few months. In particular (in the notation of Sec. 2):

a) The SAMURAI HI-p collaboration has chosen a detection system consisting of large, position sensitive Si detectors, separated by about 50 cm, between the target and the entrance into the spectrometer (shown by a red arrow in fig. 1).

The status of the preparation of this setup was included in the proposal. It remains the "plan A" for the collaboration. However, we expect to have problems with this setup as it implies handling a large counting rate due to the fact that the unreacted beam goes through the same detectors and its rate and the secondary electrons emitted by the beam going thru (delta-electrons) may cause problems. We are preparing an alternative, with double-sided Si strip detectors that have a hole in the middle, allowing the beam to pass thru. These are S4-type detectors from Micron Semiconductor Ltd, UK, 300 and 500 microns thick. For now, we did:

- made preliminary assessments of the type of detectors needed
- obtain commercial offers from the company
- prepared to ordered them thru the complex system of public acquisitions
- prepared to have the complex set of connectors from these S4 detectors to the acquisition system (based on the HINP16 v4 ASIC chips of Washington University, St. Louis, MO, USA) mounted on PCBs.

I emphasize that Micron Semiconductor Ltd is (unfortunately!) the only supplier of such equipment, but remark that it is willing to work with us (and many scientists in the field) to get optimal parameters from their detectors.

b) Our students, members of the NAGroup (not involved till now in the preparations for these experiments) start to do complete simulations of the experimental setup and of the experiment itself. Initial simulations were done with LISE++ (one such result was shown in Fig. 3 of the proposal). Now, they get trained in the use of GEANT4 for complete simulations. It is too early to present results here. I have to mention that since the present proposal was submitted one of the students of the group, Alexandra Chilug, was admitted for a PhD program at the University of Bucharest, with a subject involving this experiment at RIBF.

c) From my point of view the training of the students for this experiment, for this kind of experiments in general, will be the crucial task of the next 6-9 months. As such I prepared a number of activities for 2017:

    - Get the approval and support of the management of the Nishina Center of RIKEN to have one or two students of the group to work for a few months at RIBF under a fellowship program (International Program Associate) of that institute;
    - Get one student to work with the WU people on the electronics and data acquisition systems.

While both these agreements are still pending, I am confident that some results will ensue.

3. Group members (table):

- List each member, his/her role in project and the Full Time Equivalent (FTE) time in project. The FTE formula to be used is: FTE = Total number of worked hours /Total number of hours per reporting period[*];

Nr. Crt	Name and Surname	Role in project	Full Time Equivalent (FTE)
1	Livius TRACHE	Project director	225 h / 595 h= 0.37
2	Alexandra-Ionela CHILUG	Team member	384 h / 595 h= 0.64
3	Dana TUDOR	Team member	384 h / 595 h= 0.64
4	Ionut-Catalin STEFANESCU	Team member	310 h / 595 h= 0.52
5	Valentin BALANICA	Team member	75 h / 595 h= 0.12
6	Gherghina STAN	Team member	138 h / 595 h= 0.23

- **List PhD/Master students and current position/job in the institution.**
  1) Alexandra-Ionela CHILUG, PhD student, Physicist
  2) Dana TUDOR, PhD student, Physicist
  3) Ionut-Catalin STEFANESCU, student, Physicist

4. Deliverables in the last year related to the project:

- List of papers (journal or conference proceeding);
- List of talks of group members (title, conference or meeting, date);
- Other deliverables (patents, books etc.).

5. **Further group activities (max. 1 page):**

- Collaborations, education, outreach.

According with the information provided in the Project Description, the NA Group is involved in 4 experiments at RIBF of RIKEN, Japan and other collaborations at TAMU (Texas) and FAIR/GSI (Germany).

The Project Director, Livius Trache is also member in other projects, having leading functions:

-Program Director of the PN 16 42 program of the whole IFIN-HH, which includes 14 projects

- Project Director of the project PN 16 42 03 02 with the title: ”Structuring a Center for the study and preservation of cultural heritage”

- Deputy Group Leader of Work Group NUSPRASEN of ENSAR2, an European H2020 project

- Vice Chair of the Governing Board of the European project GENERA, part in H2020

Also the activity of the NA Group has an outreach component focused on the ”Scoala Altfel” program and on the Summer school for the finalists at the Physics Olympiad.

6. Financial Report (budget usage) for the reporting period (see the Annex).

7. Research plan and goals for the next year (max. 1 page).

According with the Project Proposal, the next stage of this project will have two main purposes:

- the experiments at RIBF of RIKEN, Japan, and

[*] Total number of hours (for a certain period) = 170 average monthly hours x number of months (e.g., for a full year: 170 hours/month x 12 months = 2040 hours)

- experiment(s) on beta-delayed proton decay at Texas A&M University using the ASTROBOX2 detector. An European version of it is under construction.

ANEXA 1.B Indicatori de realizare intermediară

Tip indicator	Număr	Scurtă descriere (dacă este cazul)
Număr de articole ştiinţifice în reviste şi volume indexate		
Număr co-publicaţii		
Număr articole publicate în top 10% cele mai citate publicaţii		
Număr de brevete obţinute la nivel naţional şi internaţional		
Număr de brevete în curs de obţinere la nivel naţional şi internaţional		
Numărul altor forme de DPI solicitate: desene, mărci în domeniul strategic.		
Număr de tehnologii elaborate/transferate		
Număr de modele experimentale/prototitpuri		
Numărul de posturi de cercetatori echivalent normă întreagă (ENI) susţinute *		
Numărul de cercetători cu doctorat susţinuţi *	1	
Numărul de ingineri susţinuţi *		
Numărul de tehnicieni susţinuţi *		
Numărul personalului economic/administrativ susţinut *	1	
Numărul de doctoranzi susţinuţi *	2	
Număr de masteranzi susţinuţi *	1	
Număr de conferinţe organizate *		
Număr de participări la Conferinţe Internaţionale*		
Număr de prezentări la Conferinţe Internaţionale		
Număr de postere prezentate la Conferinţe Internaţionale*		
Număr de participanţi la Workshopuri*	4	
Număr de prezentări orale la Workshopuri	1	
Număr de postere prezentate la Workshopuri		
Numarul participantilor la intruniri FAIR –din cadrul Colaborarilor (Collaboration Meetings)	1	
Numărul de proiecte Orizont 2020 (inclusiv cele ale partenerilor dacă este cazul)	1	
Numărul de evenimente de comunicare şi popularizare a ştiinţei susţinute *		
Număr de cursuri de instruire sau perfecţionare realizate		
Altele (specificaţi)		

*) din Fondurile Programului

Director de proiect,
Dr. Livius Trache