Proposed accelerator facility for fundamental and applied sciences by CUPAC (Cotton University Particle Accelerator Centre)-North East

G. C. Wary[1], M Patgiri[1], A. Barthakur[1], K. Boruah[2], J.J. Das[*1], V. M. Datar[3] , B. Jyrwa4 , P. C. Rout[5], S. Santra[5] , D. Sarma[1] ,N. Nimai Singh[6]

[1]Department of Physics, Cotton University, Guwahati, Assam
[2]Department of Physics, Gauhati University, Guwahati, Assam
[3]Raja Ramanna Fellow, IMSc, Chennai
[4]Department of Physics, North Eastern Hill University, Shillong, Meghalaya
[5]Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai
[6]Department of Physics, Manipur University, Imphal, Manipur

Presenting author email: jibanjdas@cottonuniversity.ac.in

1.1 Introduction: The Department of Physics, Cotton University (erstwhile Cotton College, NAAC A+ Grade accredited Institution up graded to a University by Cotton University Act 2017, the Government of Assam) was one of the few Departments with which this premier institute started its epic journey in 1901. Also, one of the first five founder teachers of Cotton College, Prof Chunilal De belonged to this Department. Initially the Department conducted pre-university and under-graduate programmes under Calcutta University and later under Gauhati University on its establishment in 1948. The fame of academic excellence of the College was spread over the country and abroad since its inception. The Physics Department was the first to introduce the Post Graduate Courses in physics under Gauhati University in 1969. The Department was also the torch bearer in the field of research, particularly nuclear physics, since the mid of third decade of the last century in this part of the country. Stalwarts like Prof. H. C. Bhuyan, Prof. S. M. Mali, Prof. P. Shyam, Prof. G. C. Deka and Prof. K. D. Krori carried out their research works in this Department. Prof K. M. Pathak, former Vice-Chancellor of Tezpur University was an alumnus of this department and also a Ph D scholar who later became the first recipient of the PhD degree from Gauhati University.

1.2 Origin of the problem: The Department has a vision to enhance and strengthen its nuclear physics research along with its past glory. As particle accelerator is a "Tools of Discovery in modern science" with wide ranging applications in diverse fields of Science and medicine, the Physics Department has formulated a long-term vision, which is centered on constructing a state-of-the-art particle accelerator and allied experimental facilities for exploring processes in stars, Nano science and technology, history and archaeology and latest technology in cancer research.

Due to sophisticated technologies involved in accelerator construction, operation and maintenance, it is considered as a very important tool to train younger generation in several high-tech fields. In fact, it is considered as important technology in nation building. Realizing this, India also has undertaken accelerator development program in a big way. Several accelerator facilities were created in Delhi, Mumbai, Kolkata, Chennai etc. And India is also investing heavily in several international accelerator projects in Switzerland, Germany and France etc. Indian students and researchers are sponsored by Government to work in these accelerator facilities and learn latest technologies and perform some research in these new fields.

However, it is also true that there is not a single accelerator in the entire region of 8 states. It is a general perception of the research community that, due to this our students and researchers are not able to acquire hands on skills of accelerator construction and/or operation and this is depriving them of a critical technology of modern science. A state-of-the-art

accelerator in the region will fill that void in a substantial way.

This was the purpose with which Cotton University took the lead and worked with researchers from the Universities, Colleges and Institutes of all states of the NE region, which led to formation of CUPAC-NE Collaboration. In the map of Fig.1, we show the states to which the members of the collaboration belong.

Figure 1 *CUPAC-NE (Cotton University Particle Accelerator Centre and North East) Collaboration map.

At the same time, it is also true that accelerators are high investment projects. Therefore, it is expected that there is a commensurate scientific and social benefit and help achieving broad policy objectives and national priorities. We point out here the specific deliverables of the project and explain how it meets national priorities:

- **World class research:**
  - As of today, all the low energy accelerator facilities in India are based on exactly 50-year-old tandem technology. This has limited the scope of researchers in the nation, e.g., there is no facility in the country which can provide beams of Gr-VIII elements.
  - Experimental nuclear astrophysics is another field in which we are not able to compete globally because we neither have the proper accelerator nor the essential instrumentation like supersonic jet or RMS operating in inverse kinematics.
  - A modern neutron source is crucial to perform research in emerging frontier of applied and fundamental neutron science and as a nation, we lag our global peers.
- There are also new innovations in many fields. One such in accelerator technology is PIMS (The positive Ion Mass Spectrometry) [1] which is expected to revolutionize the field of AMS due to far superior efficiencies, better precision and substantially lower cost of the construction and the operation.
- **Enabling Discoveries:** It is a fact that the capabilities of Indian researchers are in no way inferior to our counterparts globally, so having the latest tools like PIMS (which will be only second in the World if funded timely), will allow us to make discoveries and will enhance the reputation of the nation. Some of our ideas are outlined in section 2.5. *But being timely is necessary as discoveries don't wait.*
- **Atmanirbhar Bharat.** A strong nation aspires to be self-reliant. We found, for example, technology for latest generation cancer therapy using neutron beam is prohibited for export by advanced countries. We propose to develop this technology from scratch.
- **Novel elements of the proposed facility**:
  - A 5 MV Pelletron Accelerator with ECR ion source (ECRIS) at High Voltage terminal
  - A PIMS facility
  - Supersonic gas jet in closed loop coupled to a RMS for Inverse Kinematics reactions.
  - 5 kW neutron source and complete AD-BNCT setup (Accelerator driven Boron Neutron Capture Therapy)
  - Beam lines (8 in total): SHIM (3), Neutron Source (2), Nuclear Physics (1), Nuclear Astrophysics (1) and Radiation Biology (1).
- **Implementation plan:** As our mission is to train younger students in accelerator as we do science, the accelerator construction and operation plan is tailored accordingly:
  - 100^{+} PhD students registered in Universities in NE will be involved in creation and running of the facility: Design, construction, installation, operation & maintenance. And precisely to achieve this objective, we made the project timeline as 15 years.
  - Temporary appointments at senior levels are requested to mentor the JRFs.
  - The beam lines and experimental facilities will be developed by a University group from a NE state and will take complete responsibility for its operation & maintenance during experiments. The beam lines will be named after the state developing it.