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1. Introduction: Particle Accelerators are tools of discovery and have wide spread applications in physical, chemical, life, and earth sciences, archaeology, material research, nuclear medicines etc. Due to the sophisticated technologies used in accelerator construction, it is important to train the younger generation hands on in this field. Due to this, India also has undertaken accelerator development in a big way. Accelerator facilities were created in Delhi, Mumbai, Kolkata, Indore etc. India is also investing in international facilities: CERN, FAIR, ITER etc. where our researchers gain hands on knowledge in the latest accelerator Science & Technology. However, there is not even a single accelerator in the entire NE region.

It is also true that our researchers do not have state-of-art tools to investigate several domains of contemporary interest: Nuclear Astrophysics, Neutron Science or materials for nuclear industry etc.

In 2019, Dean R&D, Cotton University, initiated the formation of CUPAC-NE Collaboration to formulate a proposal to construct a World Class accelerator Centre. Its members are from Universities, Institutes & Colleges of the region as shown in Fig.1.



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

2. Brief outline of the project: The fundamental motivation of creating the facility is to provide opportunity to NE students and researchers to get hands on experience in design, construction and operation of accelerators, beam lines and research facilities. Simultaneously, it will also enable Indian researchers to perform experiments of/in: nuclear astrophysics (NA), neutron science and nuclear material which are currently not possible in the country.

• **World Class Particle Accelerator facility:** Existing HI facilities in India e.g.: [IUAC](#), [BARC-TIFR](#),

[FRENA](#), [CCCM](#), [IGCAR](#), [IITK](#) etc. have some basic limitations: cannot produce beams of Gr-VIII elements (Xe, Kr or Au, Ta etc. at $\sim 1\mu\text{A}$, 100 MeV) due to the use of older tandem technology.

JAERI 20 MV folded Pelletron Tandem accelerator

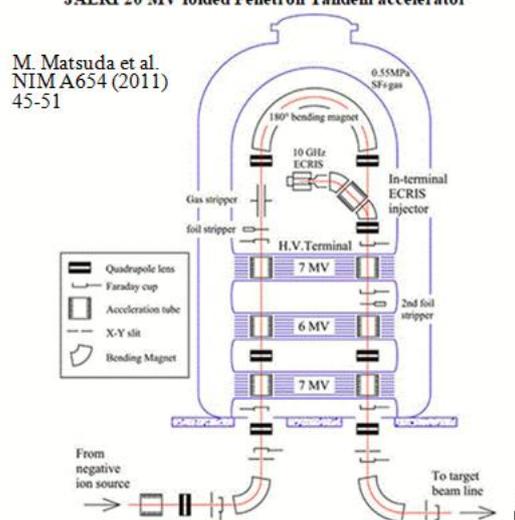


Figure 2: The proposed CUPAC-NE accelerator is modelled along the JAERI design with Nanogan ECRIS at the High Voltage Terminal. There will be 8 beam lines: SHIM (3), Neutron Source for fundamental Science & AD-BNCT (1), Nuclear Astrophysics (1) and Educational & training (1). The Beam Lines will be constructed and operated by one each of the NE states and names after that state.

• **The first novel accelerator of the proposal** is a 5 MV Pelletron accelerator with ECRIS (Electron Cyclotron Resonance Ion Source) at the high voltage terminal. This will provide (1-1000 μA) of current including inert species. This technology was invented in JAERI where the existing 20 MV tandem was modified by installing an ECRIS at the terminal as shown in Fig. 2. The latest version of this technology is used in the proposed accelerator and will completely eliminate the limitations of the 60 year old tandem technology prevalent in Indian facilities.

• **The second novel accelerator** is the [PIMS](#) (Positive Ion Mass Spectrometry) accelerator. PIMS is the latest generation AMS (Accelerator Mass Spectrometry) technique. It uses an ECRIS (instead of SNICS as used in AMS) which results in far superior efficiencies. Due to this, a PIMS facility will be able to process far more number of samples than an AMS facility. We estimate, e.g. CUPAC-NE facility will process more samples in a year than combined capacity of all existing dedicated national AMS facilities ([IUAC](#), [Wadia Institute](#), [PRL](#) & [Mumbai University](#)) together.
Available online at www.symmpnp.org/proceedings

- There were tremendous responses to the accelerator project from researchers in the region. We received 10 LOIs for using PIMS alone soon after the project was conceptualized. These were from the fields of History, Archaeology, Culture and Geology.

- The NE region is blessed with several mighty rivers like Brahmaputra. However, there are also perennial flood problems during monsoon. Historians have theories that there were major changes in course of these rivers which effected the growth of civilization. These obviously need scientific verification. Quaternary geologist point out that the course change of rivers were closely related to prevailing climate and propose to chronologically correlate flood and climate for last 60k yrs, This may lead to better understanding and scientific approach to flood control.

- We also understood from the researchers that AMS users in the Nation are facing long delays in getting beam time to investigate their samples. The proposed CUPAC-NE: Pelletron and PIMS accelerator will adequately address these issues.

3.Uniqueness of the Facility:

- **Pelletron with ECRIS:** With reference to Fig. 2, the design potential is 5MV with Nanogan ECRIS. The charging system will allow extracting full beam intensity of the ECR with extreme voltage stability required for NA experiments. We exhibit unique scientific potential of the proposed facility by citing World Class facilities from US and Europe below:

- Exhibit#1: 2 European Centre of Excellences in Material Research: [JANNUS,PARIS](#) [1] and [JRC,Geel](#) [2]. Both of these are Pelletron with ECRIS and are extensively used for advanced engineering and testing of materials for nuclear safety and waste management [3-5]. Also, 2 most widely used ion species are Xe/Kr at 100 MeV which cannot be done in India as of now..

- Exhibit#2: For [NA studies](#), the choice of the accelerator is crucial. We cite 3-leading facilities (LUNA-III,UND,US and [HZDR](#),Germany). All of these uses Pelletron accelerators with positive ion source [6-9]. Also, except LUNA (which is deep underground so measurements in direct kinematics could provide accurate data), the other two uses 5MV Pelletron for inverse kinematics reactions (IKR) for background elimination using recoil coincidence.

- It is trivially seen that a Tandem is not appropriate for NA studies. The minimum energy from a 3MV tandem is 0.5 MeV, which far exceeds the [Gamow Peak energy](#) for nearly all astrophysical reactions of contemporary interest. Similarly, the highest energy from such a tandem is grossly inadequate for NA studies using supersonic jet and RMS for IKRs.

- **Discovery potential:** First PIMS facility in the World was recently commissioned in [SUERC,UK](#). PIMS is so far established for ^{14}C dating only. As we know, following Nobel Prize winning invention of ^{14}C dating by William Libby in 1960, several new discoveries followed to extend time range that the method is applicable from 60k years ($\sim 10T_{1.2}^{14}\text{C}$) to millions of years by using longer lived isotopes: ^{10}Be , ^{26}Al , ^{36}Cl , ^{41}Ca , ^{129}I etc. If funded timely, we propose to pursue these discovery experiments and compete globally.

4. Current status: The draft CUPAC-NE Accelerator project report was reviewed first by a team of experts

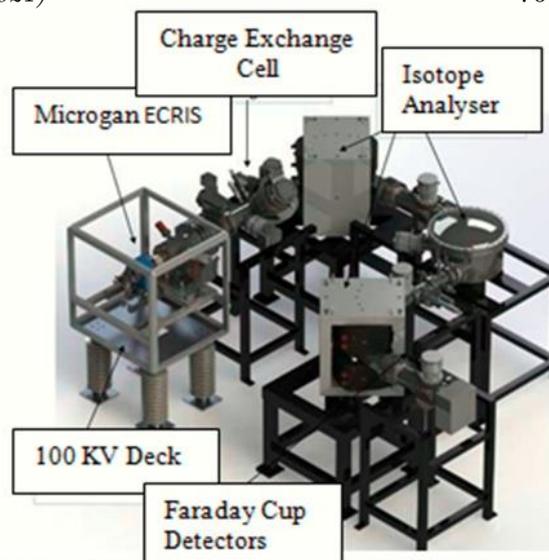


Figure 3: The layout of PIMS facility in the Brahmaputra Room, Phys. Dept, Cotton Univ. NEC-USA also concurred to the layout.

and subsequently discussed in the National Review Workshop at Cotton University on 23rd Jan 2021. DPR was finalized incorporating all the recommendations and was submitted to funding agencies.

We have also started R&D on PIMS (Differentially pumped cell (DPC) for charged exchange measurements and Electric deflectors) and [AD-BNCT](#) (Accelerator Driven Boron Neutron Capture Therapy): High Power [Li/Be Target and Neutron Optics](#) or BSA. The DPC will be prototype for supersonic jet target for NA. These will be first such R&D in the Nation.

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