Scope of Industry in National and International Accelerator facility

Alok Chakrabarti

1. Accelerators for research and Applications (the justification)
2. Involvement of Industries /other institutes in the accelerator activities spearheaded by VECC & Other Institutes
3. The challenges and opportunities that lie ahead for Indian Industries
4. The Indian Scenario and the reality (what we can expect in terms of funding of big projects)
5. India's aspirations: what we might strive to achieve in future in the R&D sector

The justification

Discovery of Higgs Boson at Large Hadron Collider at CERN

Cost of Higgs boson discovery > 10 billion US $ (including the costs of detectors); spent over 10 years;
@ Current Conversion: about 800 billion INR= 8 X 10^{11} = 80000 crore

"I think the primary justification for this sort of science that we do is fundamental human curiosity…It is true, of course, that every previous generation that has made some breakthrough in understanding nature has seen those discoveries translated into new technologies, new possibilities for the human race. That may well happen with the Higgs boson. Quite frankly, at the moment I don't see how you can use the Higgs boson for anything useful "- John Ellis

(if all the curiosity driven activities are stopped people will die of 'Boredom" Pandemic)

The justification (cont..)

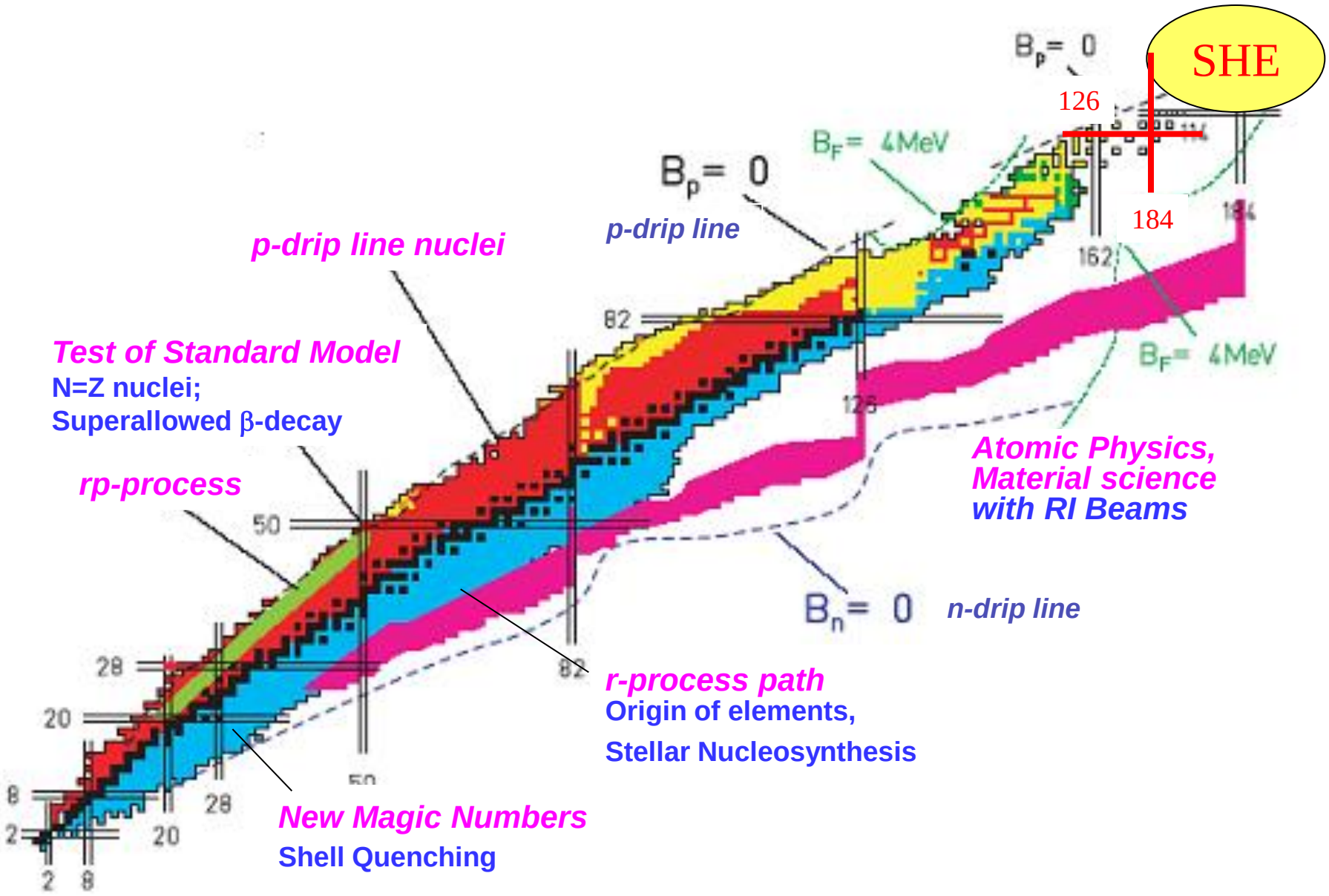
Defending the budget for building of Fermilab's first accelerator

- *This new knowledge has all to do with honour and country but it has nothing to do directly with defending our country except to help make it worth defending – Robert Woodrow Wilson (Nobel Prize in 1978 for CMB)*

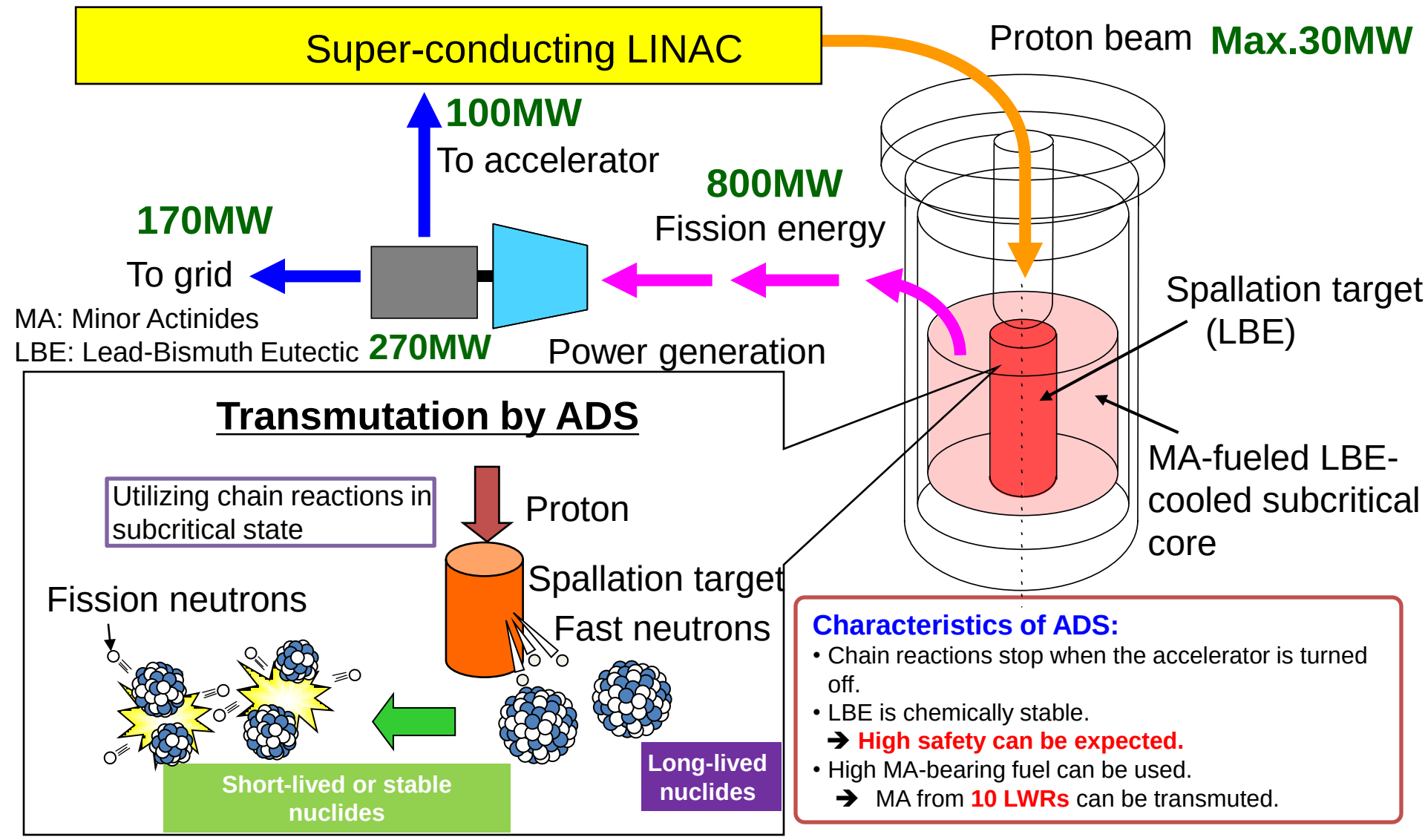
The justification (cont..): Accelerators are going to stay..

- Accelerators to understand the origin of ourselves; explosive stellar nucleo-synthesis
- Accelerator to understand the limits of nuclear existence
- Accelerators for safe nuclear energy production (ADSS)
- Accelerators for Isotope production (e.g. VECC's Medical Cyclotron for diagnosis and cancer therapy) and radiation therapy
- Accelerators for studies in Material Science and Biology/Radiation Biology

Physics with Rare Ion Beams



Accelerator Driven Sub-critical *System (ADSS)*



DAE Medical Cyclotron at Kolkata (30 MeV, 500 μA p)

Importance in Atomic Energy Program:

- Material Science R&D on structural materials for Nuclear Reactor
- R&D on LBE target for ADSS

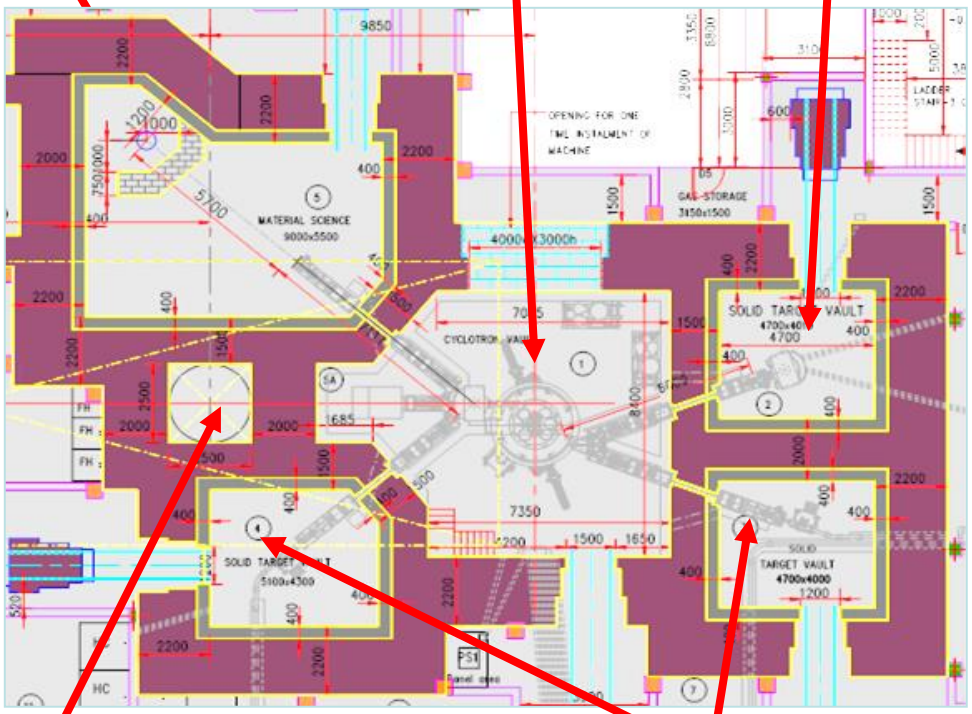
Societal Benefit:

Production of SPECT (Ga-67, Tl-201) and PET radio-isotopes and processing radio-pharmaceuticals used in nuclear imaging of cancerous tumors.

R&D

Cyclotron

PET



ADSS

SPECT

Cyclotron Purchased from IBA Belgium but installed by VECC

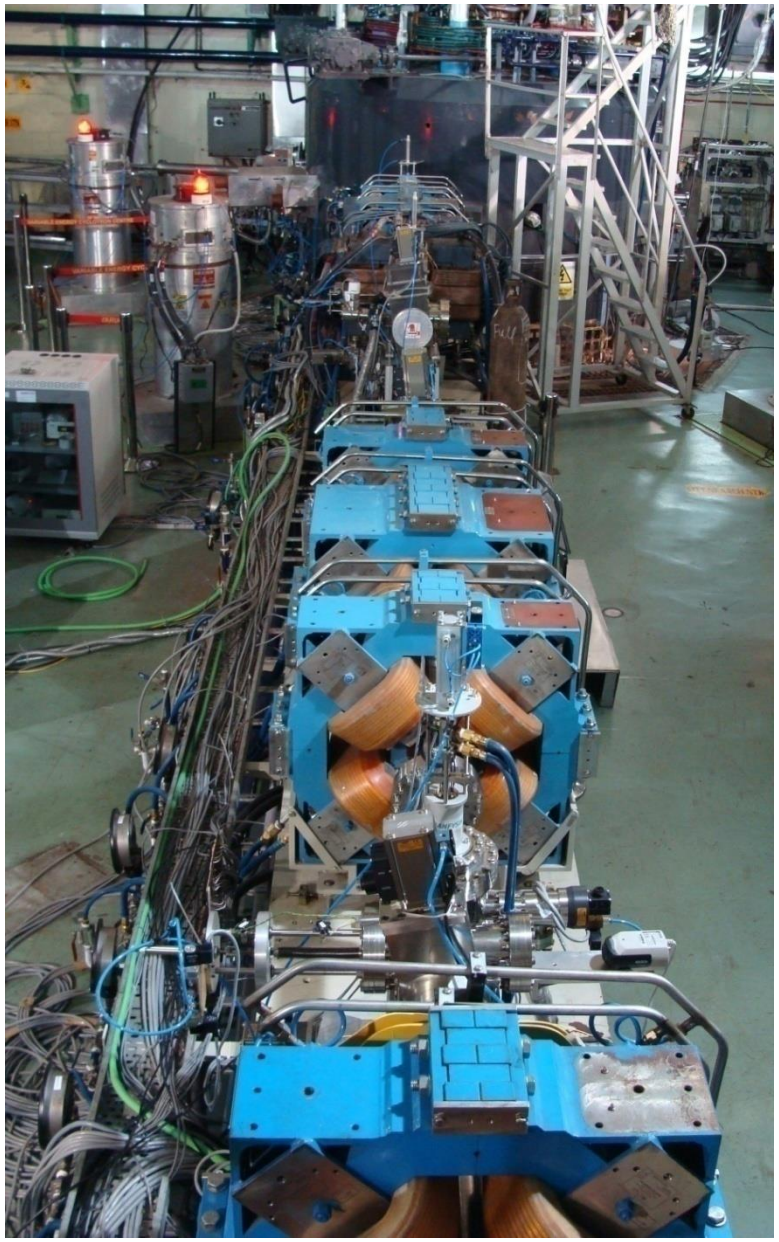
2. Involvement of Industry in Indian Accelerators

Apart from VECC the other major Accelerator Institutes in India are:

- RRCAT, Indore
- IUAC, New Delhi
- TIFR-BARC
- BARC
- About 55 industries participated in building accelerator components for accelerators in these institutes, including VECC.
- Additionally a good number of industries have contributed in Tokamak activities at IPR, Gandhinagar including participation in ITER-India(e.g. Cryo-lines for ITER project).

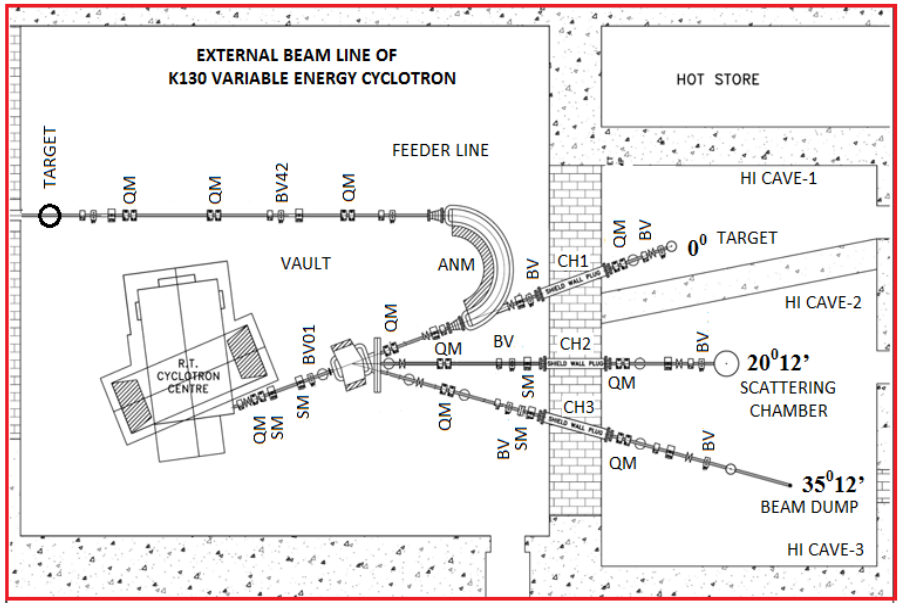
No	Industries contributed in VEC projects*	Job done
1	Heavy Engineering Corporation , Ranchi	80 Ton Main Magnet Iron Structure of *K* 500 cyclotron
2	Vacuum Techniques, Bangalore	RFQ(part) , Linac, Buncher, HV Beam-lines for RIB project
3	CMERI, Durgapur	RFQ vanes, ECRIS; for RIB project
4	Indo Danish Tool Room, Jamshedpur	Dee of RF cavity for *K* 500 Cyclotron
5	Central Tool Room , Kolkata	Fabrication of Niobium half-cells
6	M/S. Dutta & Dasgupta, Kolkata	Fabrication of Niobium half-cells
7	SAMEER, Mumbai	RF Amplifiers for RIB
8	IClean, Hyderabad	Class 1000 clean room for RIB project
9	Gauss Magnetics, Kalyani	Permanent Magnet for ECR for RIB
10	Mansha Vacuum, Bangalore	HV Chambers for RIB
11	SMP enterprises, Pune	HV Chambers for RIB
12	DivyaInfotech, Mumbai	Sputter-Ion Pump
13	Fourvac, Pune	HV Chambers for RIB

Superconducting Cyclotron and Beam Line



Room temperature Cyclotron

The first internal beam : June1977



- Accelerated particles : alpha, proton & deuteron with internal PIG Ion Source

& light heavy-ions using ECR

The major in-house future project at

VECC is

"ANURIB"

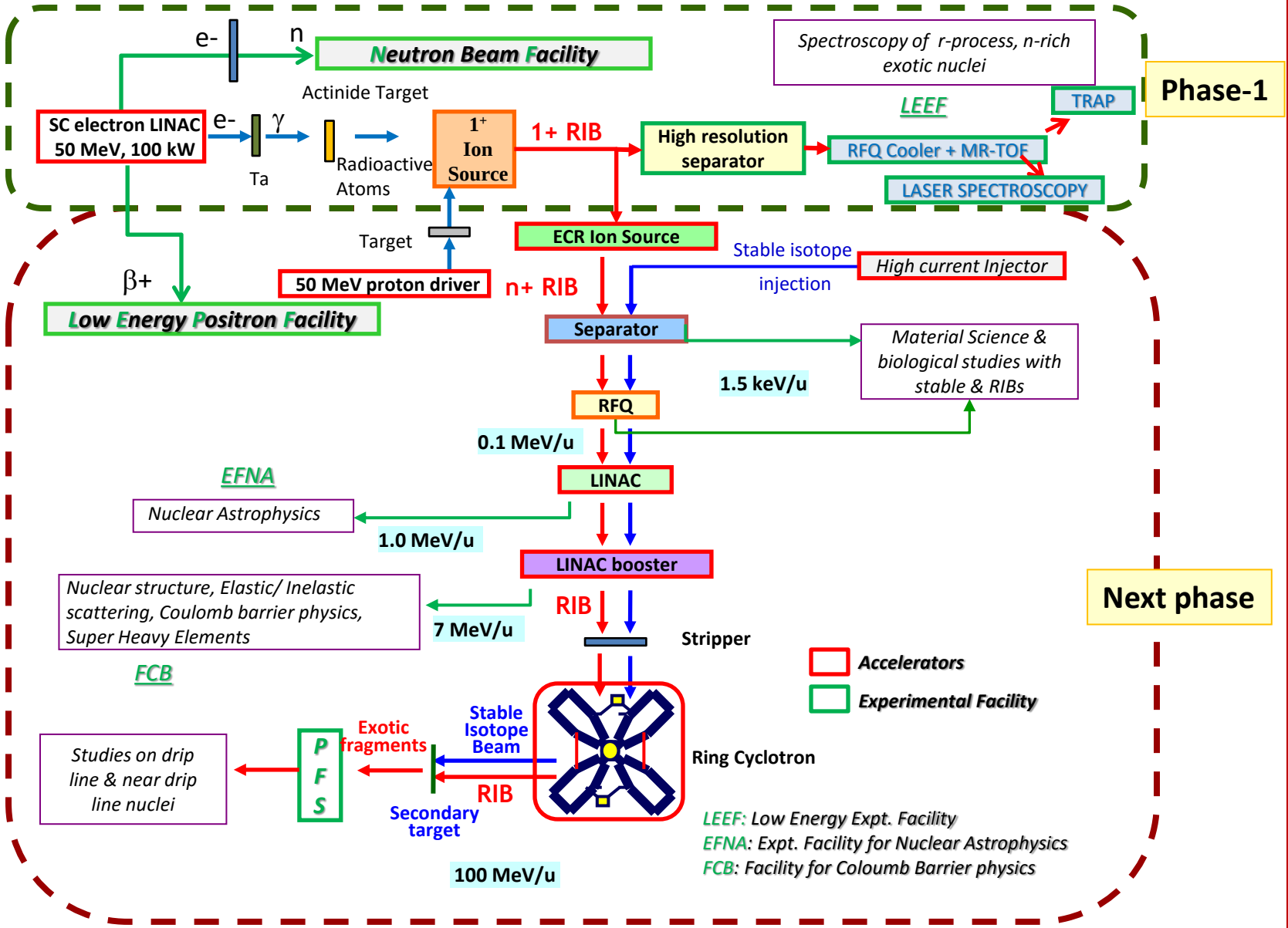
State of the art Linear accelerators,

Ring Cyclotron,

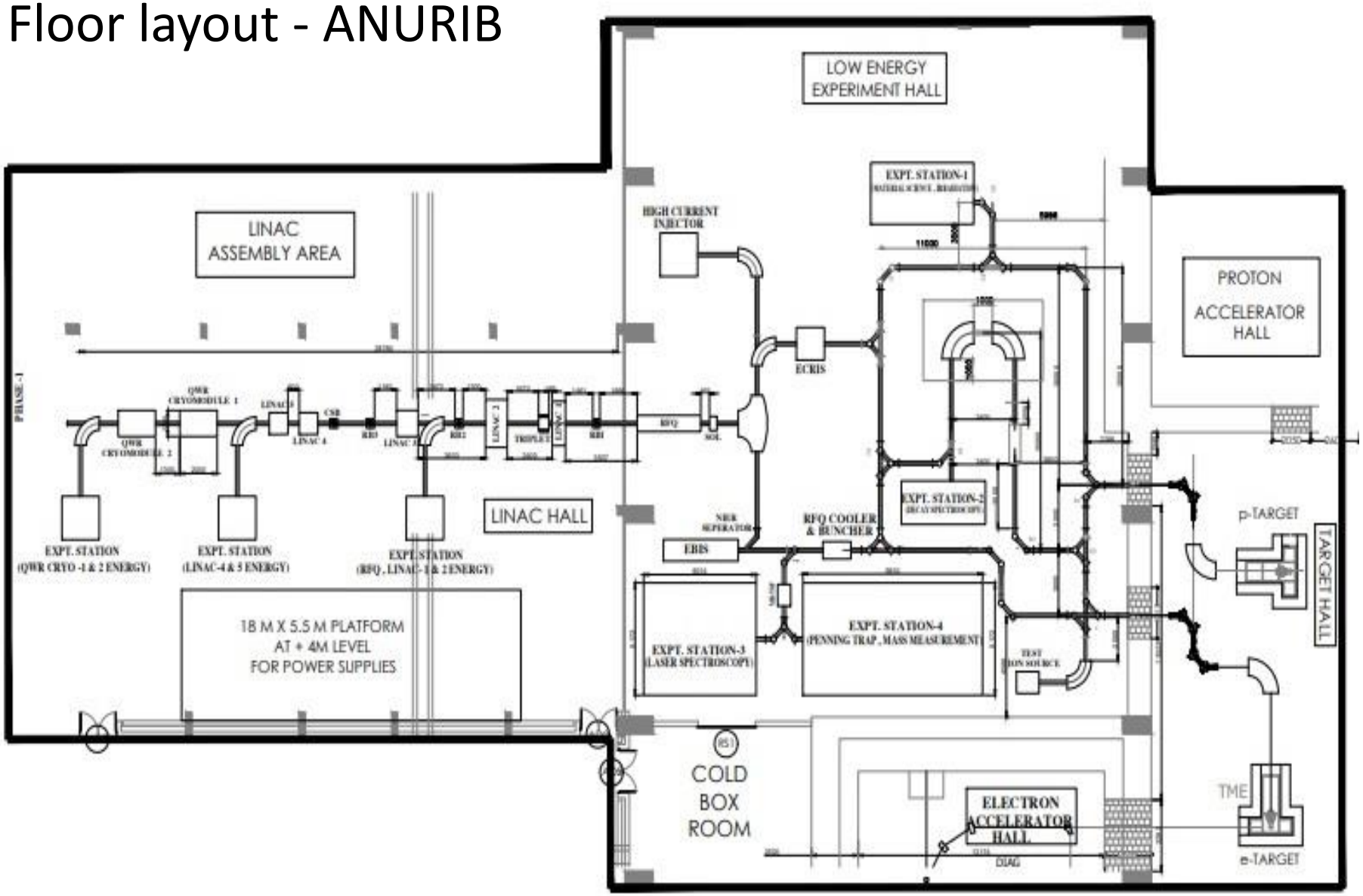
and sophisticated detector facilities

Schematic layout of ANURIB facility –the bigger dream

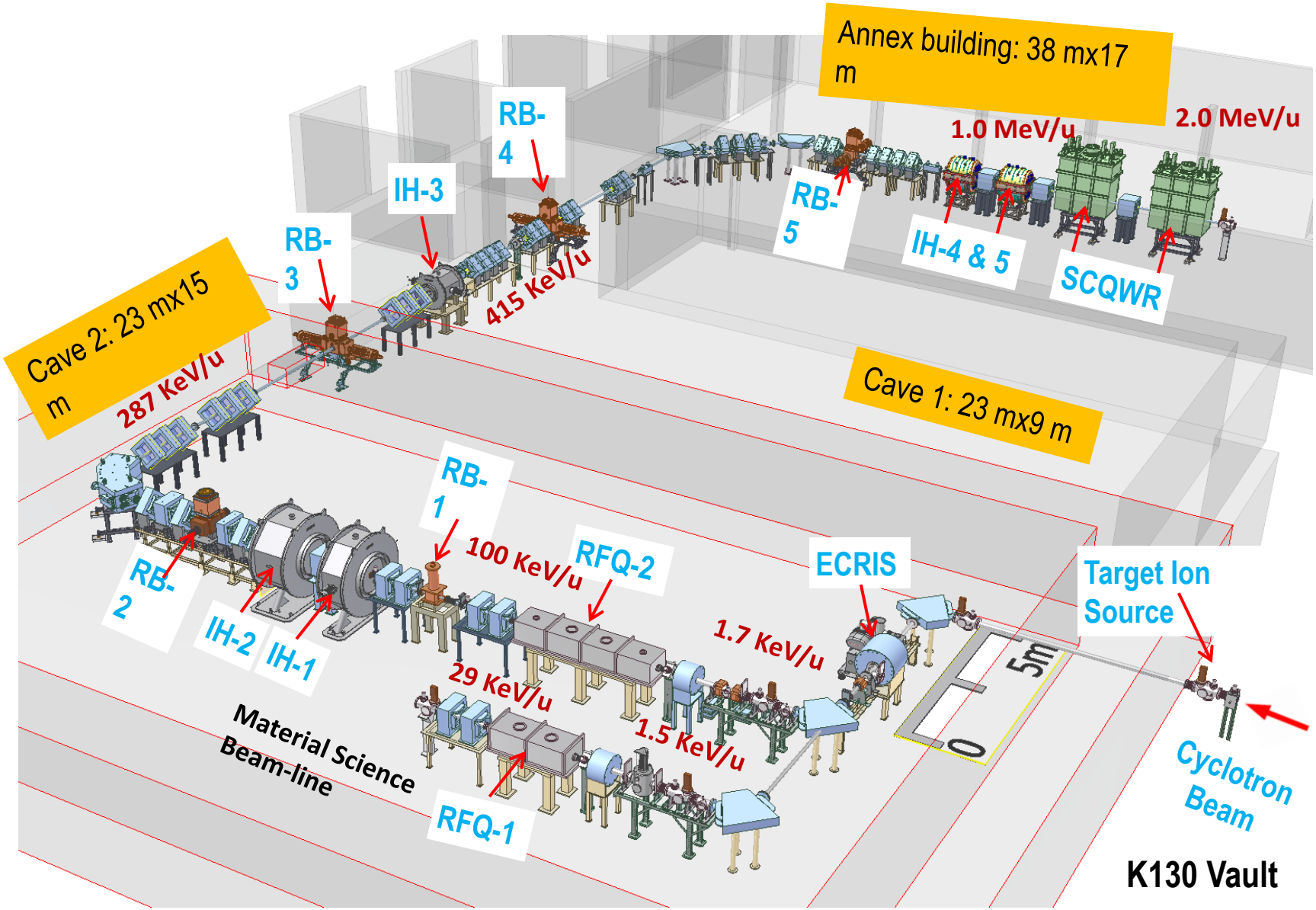
Advanced National Facility for Unstable and Rare Isotope Beams



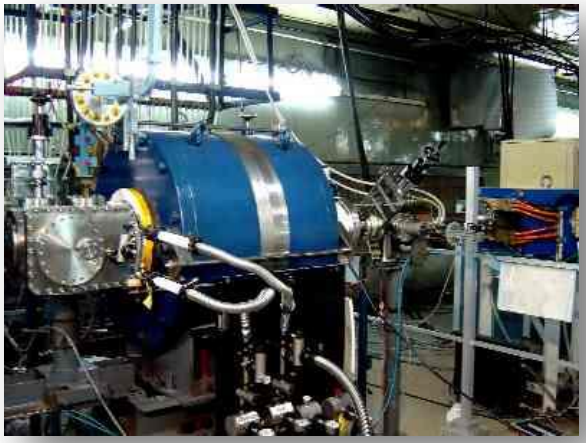
Floor layout - ANURIB

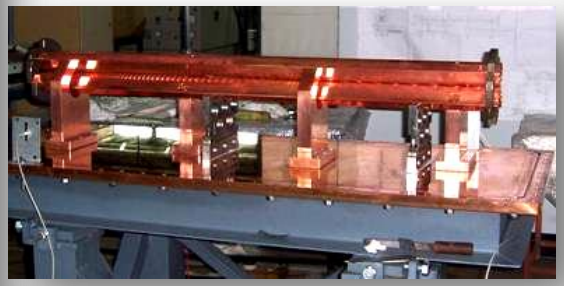


RIB facility at VEC Campus: preparation for ANURIB



VEC RIB facility (accelerators designed and built indigenously



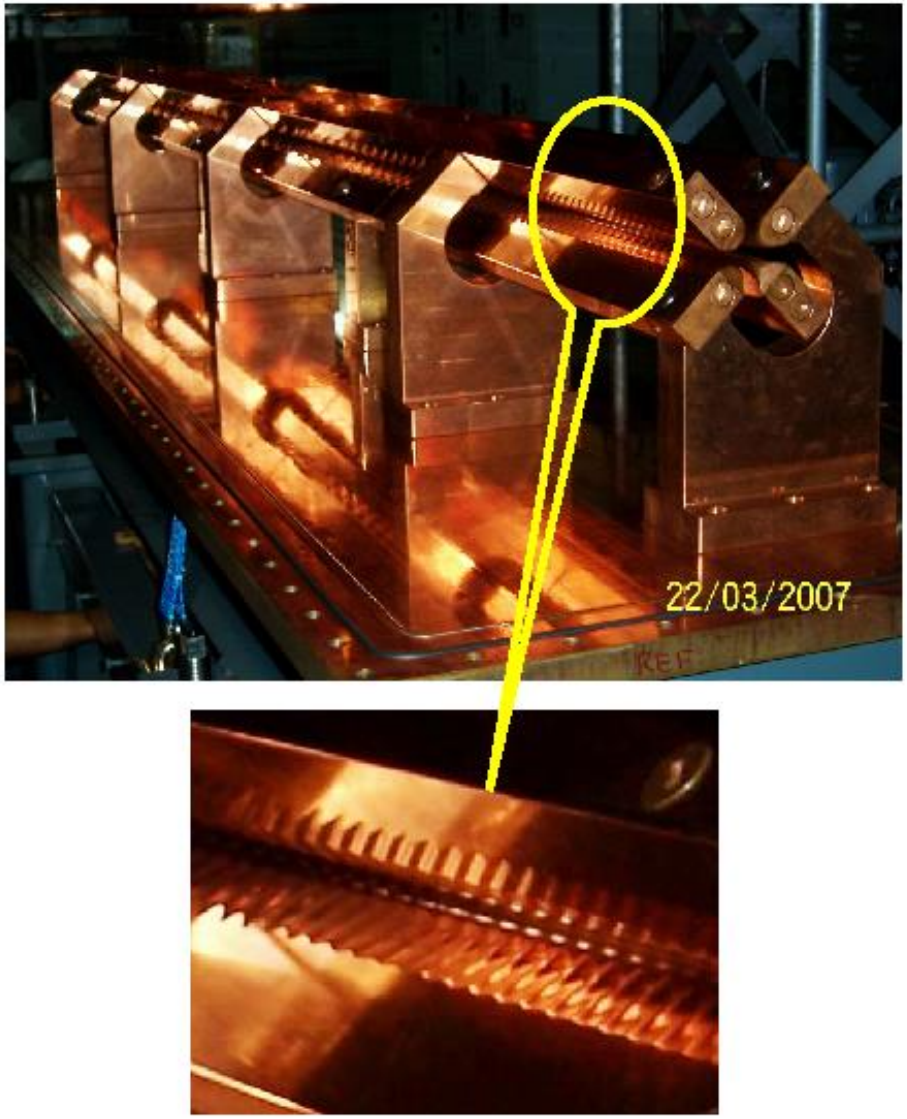


2005

ECR ion source **RFQ1** **RFQ2**

Linac 1 **Linac 2-3** Linac 4*

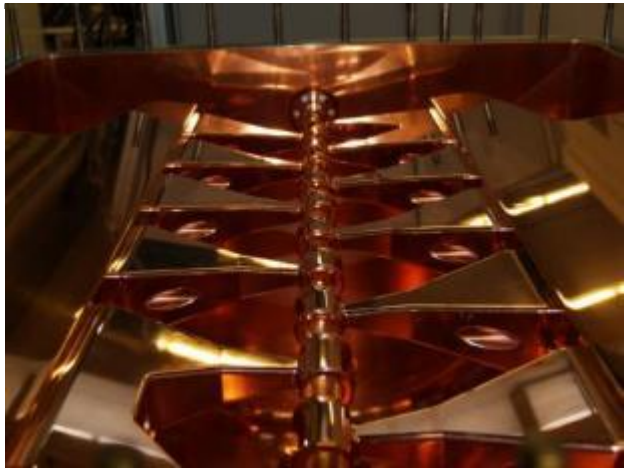
Machining of modulated vane – done at CSIR- CMERI , Durgapur



Machined vane in assembled condition

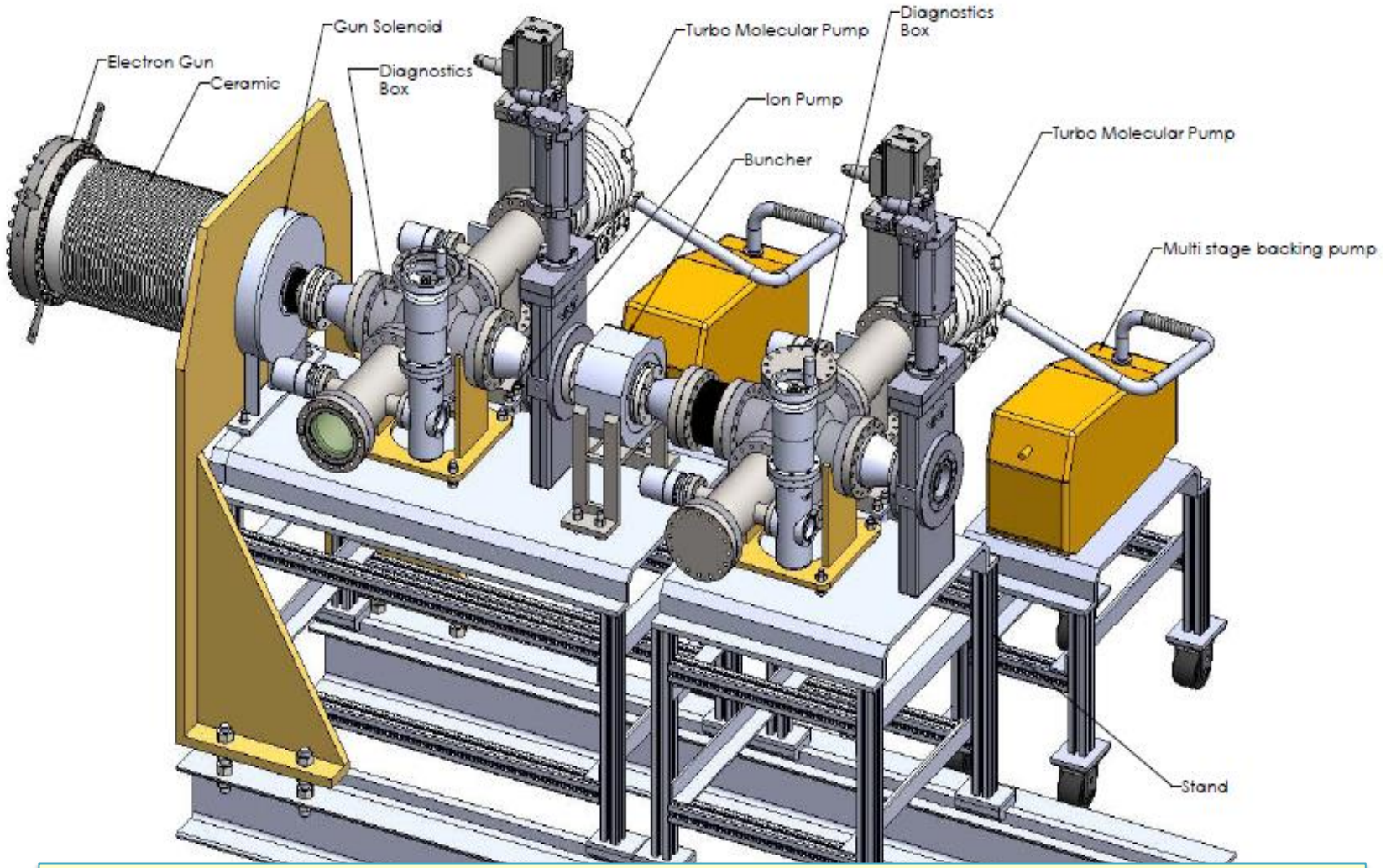
Linac1: 2008, energy = 187 keV/u

Linac2: 2010, energy = 289 keV/u



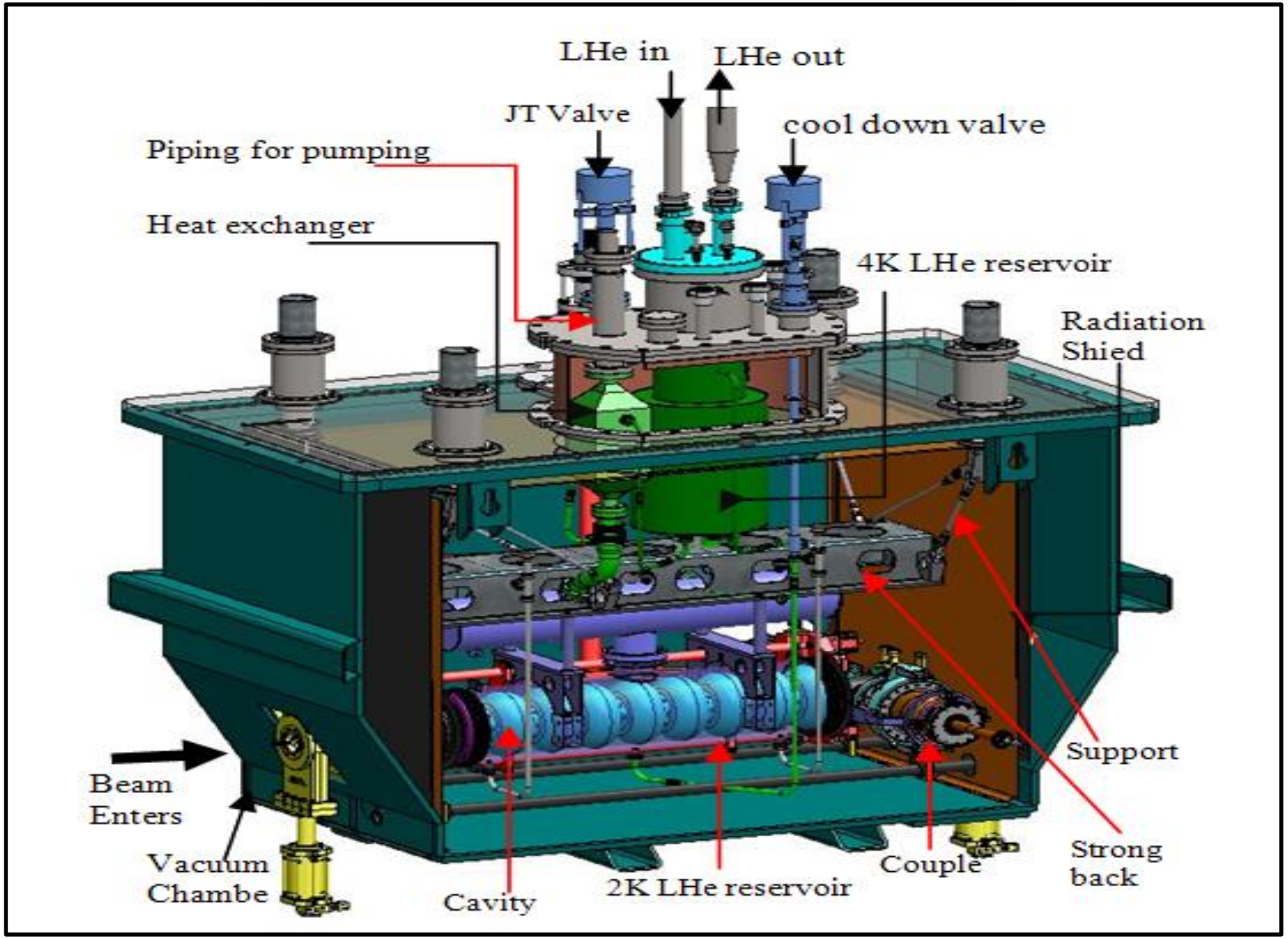
Linac3: 2011, energy = 415 keV/u

Linac4: 2012, energy = 718 keV/u



100 keV electron gun and LEBT line for VECC's 10 MeV Injector

E-linac: Injector Cryo - Module (ICM)



3. Challenges and Opportunities

- Accelerators are melting pots of different branches of technology: Mechanical Engineering, RF and Microwaves, Vacuum Science and technology, Cryogenics, Material Science, especially new materials to handle huge high power density beams (up to a few tens of GW per metre square in FAIR; the high instantaneous power causes another additional problem), High Voltage and High Current power supplies, Superconducting Magnets, RF Cavities: Normal and Superconducting; Data acquisition and readout systems, computers and so on….
- Industries of different specializations can take part in building accelerators.
- Accelerator components are similar all throughout the world

- Research in fundamental sciences always needs new technology. Accelerator technology represents the state of Art technology in almost all branches. It is challenging but rewarding too.
- Building Accelerator Components for International projects like FAIR allows the company to become a global player. To become a global player is a must for growth and survival in today's globalized world that is connected and has become much smaller.
- The cost of living in India is still less compared to the advanced countries of the West; Indian salaries are thus still comparatively lower. This gives Indian Companies an edge in International bidding.

4. The Indian Scenario and the reality

(what we can expect in terms of funding of big projects)

- Education budget in 2023 is about 1.13 trillion rupees, close 3% of the total budget (major shares: 65% in School Education followed by Higher Education).
- Budget for R&D is about 16000 crores; only a fraction of this money (let's assume about 3000 cr./yr) can be spent for Big Science Projects.
- And these "Big Science Projects" include collaboration and contributions in International projects like FAIR, FERMI Lab, ITER, etc.
- Our "Big Projects" should not cost more than a few thousand crores!

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5. India's aspirations

what we might strive to achieve In the R&D sector in future

- India aspires to become one of the most economically powerful country in the coming 10 years
- Given our tradition and the love for knowledge, the country would also aspire to be a leader in Science and Technology.
- Today's science require cutting edge of technology and a much higher level of investment. The lack of investment, which is a problem today, might not remain so in near future. Today's efforts would prepare us to make best use of the better funding situation, once that comes our way.

Thank you for your kind attention