OPERATIONAL EXPERIENCE WITH THE IUAC LINAC

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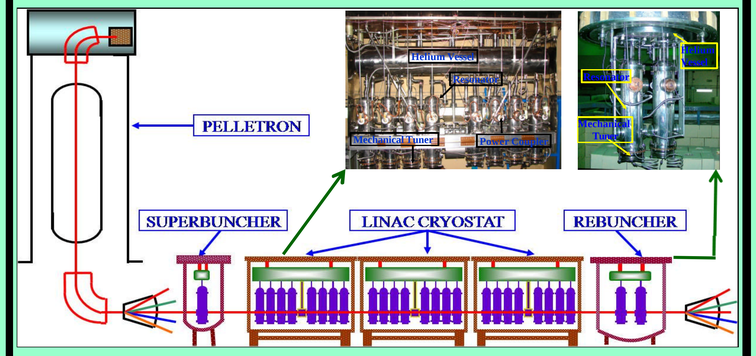
Introduction

The Superconducting LINAC

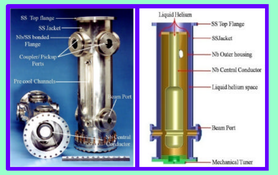
- Booster to the existing 15 UD Pelletron accelerator.
- Niobium Quarter Wave Resonator (QWR) used as the accelerating element.
- Designed to have:
  - A Superbuncher (SB) ⟶ One QWR
  - Three Accelerating Modules ⟶ Eight QWR's each
  - A Rebuncher (RB) ⟶ Two QWR's
- Full LINAC will accelerate heavy ions up to mass ~100 above coulomb barrier.
- Present status:
  One Accelerating module + Superbuncher + Rebuncher operational.

The Accelerator System



The Quarter Wave Resonator

Parameters @ 1MV/m	
Frequency	97MHz
Synchronous Velocity	0.08
Stored Energy	0.110 J
Peak Electric Field	3.9 MV/m
Peak Magnetic Field	106 G
Geometric Factor QRs	17.3 Ω
Active Length	15.9cm



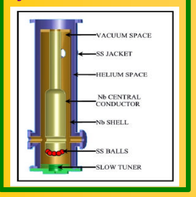
The First Module : Operation

Initial Operation

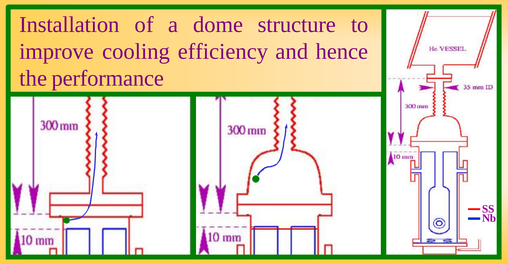
- Initial Operation started a few years ago.
- Several problems prevented smooth functioning.
  - ➟ Large power requirements for phase control of cavities
  - ➟ Low accelerating field levels in LINAC
  - ➟ Leaks from the transition flange bellows and the mechanical tuner bellows
- Problems solved by suitable design modifications and implementation of an ingenious vibration damping technique.

Solutions to the initial problems

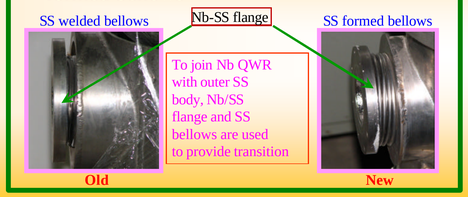
Vibration Damping by SS balls



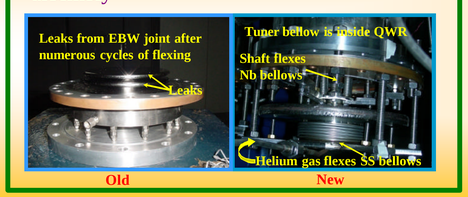
Installation of a dome structure to improve cooling efficiency and hence the performance



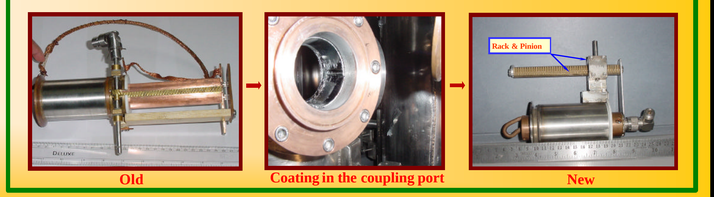
Replacement of edge welded bellows with formed bellows



Modifications in the mechanical tuner assembly



Design Changes in the power coupler



Recent Operation

Beams accelerated with all the eight cavities operational

Beam	Energy from Tandem (MeV)	ΔT Harmonic Buncher (ns)	ΔT Super Buncher (ps)	Energy gain LINAC (MeV)	ΔT Re Buncher (ps)
$^{12}C^{+6}$	87	0.95	250	19.2	OFF
$^{16}O^{+8}$	100	0.95	163	18	342
$^{18}O^{+8}$	100	0.96	182	20	378
$^{19}F^{+9}$	115	1.08	190	25.8	354
$^{28}Si^{+11}$	130	1.2	182	37.5	OFF
$^{48}Ti^{+14}$	162	1.68	176	51.2	OFF
$^{107}Ag^{+21}$	225	1.7	232	74.6	OFF

Problems encountered and the corresponding corrective measures

Problems Encountered	Probable cause	Corrective action
Sudden Q drop of the superbuncher cavity during operation 3×10^8 ➟ 5×10^6	Not fully understood Perhaps heating up of the superconducting surface due to trapped helium gas	Cavity emptied of liquid helium and warmed up t o 24K Q value recovered on subsequent cool down
Failure of one rebuncher cavity	Fault in the power line of the cavity	Cavity was switched off Rebunching at target achieved with the single operational cavity

What's Next

The Piezo tuner

➢ The Present phase control scheme of IUAC QWR

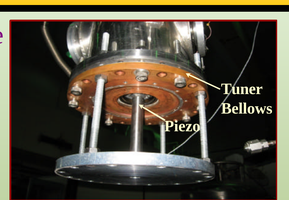
Fast electronic tuner ⟷ Mechanical tuner ⟶

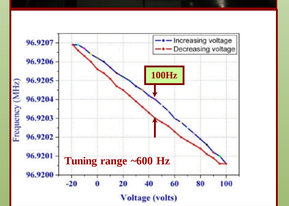
- Supplies additional reactive power from amplifier to control the phase.
- Time scale of operation ~ 100 μs to ~20ms
- Corrects for vibrations picked from the ambience.

- Niobium bellows operated by pressurizing with pure helium gas
- Time scale of operation ~few seconds
- Corrects for slow drifts from helium pressure fluctuations

➢ Scheme is working fine with the present module
However!!
Average power requirements high ~150 W
Use of pure Helium gas proving expensive
Therefore for the upcoming modules 2&3

➢ Use of Piezo based tuning scheme planned
Piezo response time ~100 ms
Intermediate between the fast and the mechanical tuner
➟ Expected reduction in forward power
Coarse tuning by moving the Niobium bellows with motor
➟ Use of Helium gas will be avoided





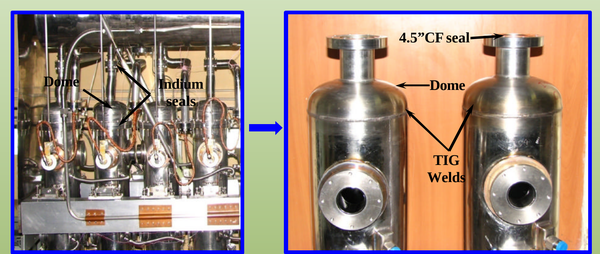
➢ Initial test results encouraging

➢ Cavity successfully phase locked @ a moderate field level ~ 3 MV/m with piezo operating in conjugation with the fast tuner

➢ Development and integration of the mechanical arrangement for coarse tuning is underway..

The second and third LINAC modules

➢ Design modification in cavities



- Indium seal replaced with CF joints.
- Dome integral part of SS Jacket

➢ Cavities and other accessories are ready

➢ The fabrication work of the two cryostats is completed.

➢ Installation of Resonators will begin shortly.

➢ Beam acceleration through full LINAC is expected by the spring of next year

The New LINAC Cryostat