Iranian Test Stand Electron Linear Accelerator

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- 1. IPM Linac project
- 2. Commissioning activities
- 3. The project current status and the future plans

1. IPM Linac project

IPM Linac project

IPM Linac project

- > Parameters
 - ✓ Beam energy: 8 MeV
 - ✓ Beam current: 10 mA
 - ✓ Pulse length: 7 μ s
 - ✓ Repetition rate: 255 Hz
- ➢ Goals
 - \checkmark R & D in Accelerator physics
 - ✓ HR Training
 - ✓ Feasibility study
- Applications
 - ✓ Medical
 - ✓ Industrial
 - ✓ Injector of a larger facility.



IPM Linac project

- \succ The structure
 - Low energy injector
 Electron gun
 Steerer magnets
 - Matching solenoidPre-buncher
 - ✓ TW structures
 - ✓ Focusing solenoid
 - ✓ Diagnostics box
 - ✓ RF source
 - Generator
 - Amplifier (klystron & modulator)
 - Wave guide system



IPM Linac project

Iran's first Linac

 \checkmark Fully designed and constructed within the country.

- ➢ Human resource training: 25
 - ✓ Graduated M.Sc. Student: 14
 - ✓ Graduated PhD student: 4
 - ✓ Post-doctoral research fellow: 7

Publications: 51

- \checkmark In the international peer-viewed journals: 7
- \checkmark In the internal peer-viewed journals: 11
- ✓ In international conferences: 13
- ✓ In internal conferences: 20

Commissioning phases

- ➢ Low energy injector (40 keV)
- ➤ TW buncher (1.5 MeV)
- > 1^{st} acc. Tube (5 MeV)
- ➤ 2nd acc. Tube (8 MeV)





Simulation, Fabrication and installation of electron gun



Assembling and first days of operation of electron gun 6



Fixture and hollow conductors for pancake type solenoid around buncher cavity

Installation and measurement of solenoids on the beam line test bench





Installation and RF conditioning of buncher cavity



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Commissioning activities

Detection of 1.5 MeV beam (Azar 96)

- \succ RF source
- ➢ Linac



Bremsstrahlung spectrum



1500 KW - Counts Per Channels





Beam profile measurement with YAG and ZnS Scintillators











Select Camera





Beam profile measurement and Emittance measurement with soll-scan method

Measured data

Gun energy = 10 keV



Calculated Beam Parameters at the gun exit: rms beam size = 3.0 ± 0.1 mm Derivetive of rms beam size = 5.3 ± 2.1 mrad Geometric emittance = 68.3 ± 4.4 mm-mrad

2995 -1997 -999 -







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Solenoid magnet measurement in different currents for Sol-Scan measurement at the end of linac 13



Raw measured data



Interpolated measured data



Squared field integral (Measured)





Polishing and Ice cleaning Before assembling





Plunger Setup for frequency measurement and tuning







Plunger Setup, Frequency tuning and Beadpull Measurement



Frequency Spectrum and electric field profile









Control room and cavity conditioning for second phase with 4 MeV 18





Signel Analyz Marker Value 14.07500 Attenuator Value 79.1 dB Throshold 10. dB	of Power 2077.304 kw	Gauge #1 2.886E-7	Gauge #2 3.8276-7	RF drive Interlock Vac. Threshold (Bar) 1.0E-6	Set
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User Interface

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Gun Filament conditioning

Autotrans Voltage (V)	Filament Current (A)	Beam Current
112.5	1.10	16 nA
125	1.16	120 nA
137.5	1.25	2.3 μA
150	1.30	10 μA
162.5	1.36	90 μA
175	1.40	550 μA
187.5	1.44	4 mA





S-Parameters [Magnitude in dB]



Development of Cavity BPM for IPM e-Linac



S-Parameters [Magnitude in dB] ----- S1,1 S1,1:-14.93402 -2 -6 -8 -10 --12 --14 -16 -2970 2990 3010 3030 2950 Frequency / MHz

FRONT END ELECTRONIC FOR BPM AND PASSIVE PROTOTYPES

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PRACTICAL MEASUREMENT OF PICK-UP CAVITY AS A CURRENT DIAGNOSTIC







Pick-up and pre-buncher cavity

Experimental setup

Tested antenna



Internal structure of cavity with antenna

PRACTICAL MEASUREMENT OF PICK-UP CAVITY AS A CURRENT DIAGNOSTIC









The structure and placement of the plunger on the cavity



pre-buncher s-parameter



Vacuum measurement setup, gauge and LabView software output

PRACTICAL MEASUREMENT OF PICK-UP CAVITY AS A CURRENT DIAGNOSTIC



Experimental setup



for 10 and 20 electron volt beam energies

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spectrum w/o beam



spectrum with beam



Faraday cup output oscilloscope



TWO TYPES OF STEERER MAGNETS AND HARP DETECTOR











THREE PART OF LINAC ASSEMBLY

- 1. ELECTRON GUN AND MATCHING SECTION
- 2. CAVITY AND SOLENOIDS
- 3. OUTPUT OF LINAC WITH SOLENOID MAGNET AND DIAGNOSTIC BO





WHOLE OF STRUCTURE (DIFFERENT VIEWS)25







Beam diagnostics instruments



Parameters to be measured and the energy range

- Current 1.
- Energy 2.
- Energy spread 3.
- **Transverse Profile** 4.
- 5. Beam size
- Derivative of the Beam size 6.
- 7. Emittance
- 8. Position
- 9.



Second phase of the Linac commissioning

Main characteristics of the second phase

- \checkmark Increasing of the beam energy from 1.5 MeV to around 4 MeV
- ✓ Increasing of the beam current from 0.1μ A to at least 10μ A
- ✓ The opportunity of direct measurement on the beam and hence the accelerator performance

> A unique facility in the country

- ✓ The first successful project on design and construction of linear accelerators
- \checkmark The access to a controllable and measurable electron beam of 4 MeV energy

Future plans

- > Short term
 - ✓ Completing the Linac commissioning
 - \rightarrow Reaching the maximum possible energy for the beam (~ 7 MeV)
- ➢ Long term
 - ✓ Moving towards High Power Electron Linacs
 - Extracting the maximum power for the beam (available RF power = 3.9 kW)
 - With the current electron gun

$$I = 1 \, mA \longrightarrow P_{peak} = 7kW \xrightarrow{Duty \ cycle \cong 0.002} P_{av} \cong 14W$$

• Replacing the electron gun

 $I = 100 \ mA \longrightarrow \begin{cases} P_{av} \sim 1.2 \ kW \\ E \sim 6 \ MeV \ (14\% \ \checkmark) \end{cases}$

Thanks for your attention!

Team Members

- 1. M. Lamehi Rachti
- 2. Hamed Shaker
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