LOW ENERGY S–BAND ELECTRON LINEAR ACCELERATOR(S) DEVELOPMENT FOR RESEARCH AND APPLICATIONS HAVING SOCIO–ECONOMIC IMPACT

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Abstract: It is to report on the design & development of low energy RF based linear accelerator(s) for radiography, medical, cargo scanning and food irradiation applications. These applications are chosen considering high demand and direct socioeconomic impact in one of the most populated country (Pakistan) of the world. In the first phase, a 6 MeV standing–wave side–coupled linear accelerator structure has been designed and manufactured. The developed accelerator was then transformed into a Non–Destructive Testing (NDT) Radiography system, which shall be discussed at the conference. An in house accelerator test facility has been established, which comprises of 10 MW klystron powered by solid state modulator and the compatible RF transmission system. The research and development on various aspects of accelerator technology including electron gun, HV pulsed modulators, accelerator cavity design & manufacturing, e^- beam dynamics and diagnostics, X–rays target, vacuum brazing, RF conditioning, accelerator operation and control systems shall be presented. The progress on transformation of the developed accelerators into radiography, medical, cargo scanning and food irradiation systems shall also be presented.

Introduction: Small–to–medium energy electron linear accelerator systems (ELAS) encompass the technological domain that has multifaceted applications. This has potential to substantially impact the import–export imbalance and social well–being of a developing country.

Establishment of Accelerator Setup/ Facility: Considering the huge socioeconomic impact (need based) and training of young scientists/ engineers, an accelerator research and development setup has been established and is being extended to a full grown facility for design and development of low–to–medium energy commercial accelerators.

6 MeV Linac Design, Development and Testing: Initially, during phase–I of the project, design, manufacturing and testing of the maiden 6 MeV Linac was established. Table 1 below, lists the operational parameters of the developed Linac that coincides very well with the similar developments reported in literature [1].

Table 1. 6 MeV Linac Operational Parameters

S. No.	Parameter	Measured Value
i.	RF Injected Power	2.5 MW
ii.	Operating Frequency (f_o)	2997.7 MHz (@ 37°C)
iii.	RF Pulse Width (PW)	4 µsec
iv.	Pulse Repetition Frequency (PRF)	50 Hz
v.	Vacuum: Base Pressure	1E–9 mbar
vi.	Vacuum: Pressure with Beam	1E–7 mbar
vii.	E-Gun Filament Power	7.67 W
viii.	E-Gun Extraction Voltage	–29.6 KV
ix.	Beam Current (@ Target)	~ 120 mA (peak)
x.	Dose Rate (@ 100 cm)	110 cGy/min

6 MeV Radiography/ NDT Linac: The developed/ tested 6 MeV Linac was gradually transformed to Radiography (NDT) system. Following experiments were conducted to characterize the NDT Linac:

- Beam Profile Measurement;
- Penetration Measurement;
- Contrast Sensitivity;
- Exposure Chart;
- Spatial Resolution.

Other Linacs: Besides 6 MeV Radiography Linac, other single–energy deliverable systems being considered, as per country requirements are:

- 6 MeV Radiotherapy Linac;
- 6 MeV Cargo scanner Linac;
- 9 MeV Radiography Linac;
- 6–9 MeV Food irradiation Linac.

Conclusion: Pakistan being a developing country, could breakthrough in economy to offset the heavy export–import imbalance through technological developments in accelerators domain especially for medical, radiography, cargo scanning and food irradiation. These accelerator applications directly impact wellbeing of the large population. The developments in early phase of the project/ program shall be presented at the conference to seek collaboration with potential international partners.

REFERENCES

[1] Aubin et al., “An integrated 6 MV linear accelerator model from electron gun to dose in a water tank" Medical Physics vol. 37, no. No. 5, pp. 2279 - 2287, May 2010