16th International Particle Accelerator Conference, Taipei, Taiwan JACoW Publishing
ISBN: 978-3-95450-248-6 ISSN: 2673-5490 doi: 10.18429/JACoW-IPAC2025-TUPB037

NEW LINAC DESIGNS BY HIGH ENERGY SOURCES R&D GROUP AT VAREX IMAGING

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Abstract

The High Energy Sources R&D group at Varex Imaging Corporation (Varex) has developed several Accelerator Beam Centerlines (ABCs) and Linear Accelerators (LINACs) [1]. Here we present a summary of our recent progress on several new designs. The M9V Linatron™ featuring our new ABC, see Fig. 1, is being developed to further improve the characteristics of a 9 MeV accelerator. The new ABC is shorter than the 9 MeV guide that was previously supplied by a 3rd party, and in our new design, the focusing solenoid is completely removed, reducing the LINAC weight and complexity. The overall system design permits an increased dose rate compared to its predecessor. In addition, we are working on V15 – a new version of our K15 Linatron™ redesigned using a patented hybrid Standing Wave (SW) and Traveling Wave (TW) reverse feed configuration. We expect V15 to produce a higher dose rate of up to 40000 Rad/min at 1 m. The first SW section of this LINAC may be used separately in a 9 MeV system we called V9, see Fig. 2, which is also expected to deliver higher dose rate of up to 20000 Rad/min, while substantially reducing neutron yield compared to a higher energy machine. We have also tested a new MicroBeam (MB) design to reduce the electron beam focal spot size to 350±150 µm without any external magnetic systems.

M9V

The current 9 MeV LINAC is available at Varex in the Linatron™ M9A. With this product it is possible for the energy to be switched between 6.5 MeV and 9.5 MeV with dose rate of 800 Rad/min@1m from the target and 3000 Rad/min@1m from the target, correspondingly [2]. The smallest possible spot size measured at full width half maximum (FWHM) may vary within approximately 0.6-1.2 mm range. The new M9V LINAC developed at Varex is based on the new 9 MeV ABC design that does not require a solenoid to operate, which simplifies manufacturing, setup and high-power testing, therefore, decreasing complexity and weight of the system. The latter allows integration with a higher power 3 MW peak, 4 kW average magnetron. The new design has been successfully tested at Varex and achieved maximum dose rate of approximately 5000 Rad/min at 1 m from the target. The substantially increased dose rate output from the LINAC as well as utilization of a triode electron gun operated by a Varex produced Triode E-gun Driver improves the flexibility of M9V LINAC for customers in the Non-Destructive Testing (NDT) industry.

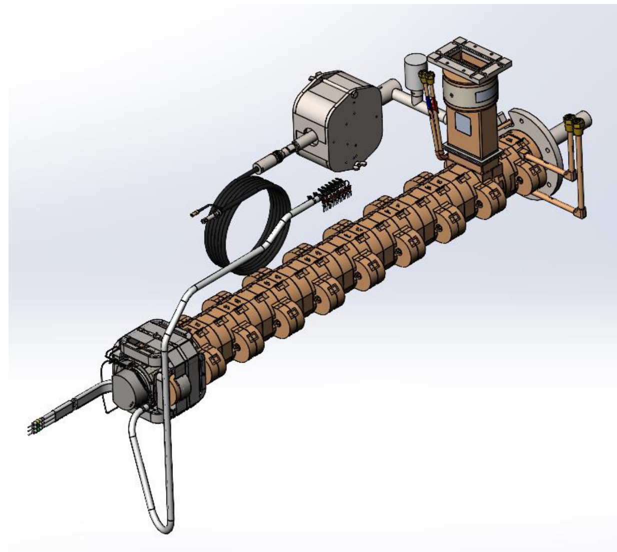

Figure 1: A model of 9 MeV ABC used on M9V.

NEW 9 AND 15 MEV ABCS

We continue development of a High-Power Platform (HPP) – a replacement for currently produced Linatron™ K15, the most powerful industrial LINAC available at Varex, with nominal energy of 15 MeV and maximum energy of 20 MeV, see Fig. 2 and Fig. 3, for HPP models.

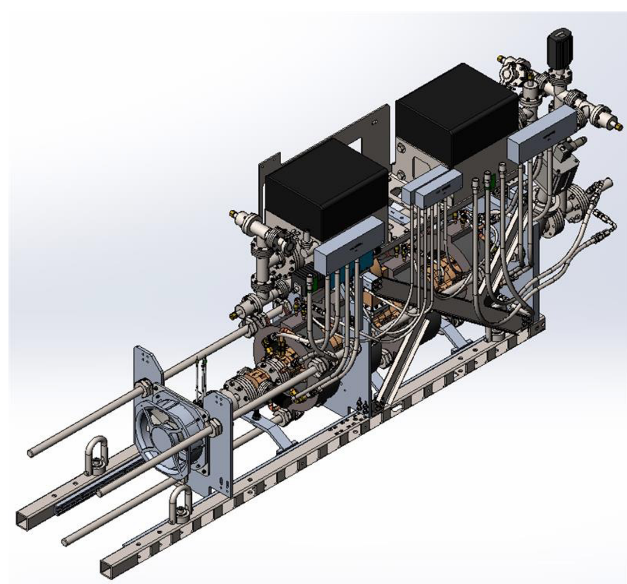

Figure 2: HPP V9 model.

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The results of our developments in an early stage were reported during the last year IPAC conference [3]. Since HPP utilizes a modular design, which permits use of various accelerating sections and other components, a lower energy option HPP-V9 was introduced. V9 is based on one SW accelerating structure and is fed by a klystron. 7.5 MW peak and 7.5 kW average power klystron was selected for the project. The ABC consists of a commercially available triode electron gun, an e-gun, magnetic lens, and a pre-buncher cavity with a feed through phase shifter. The pre-buncher design is similar like the one described in [4].

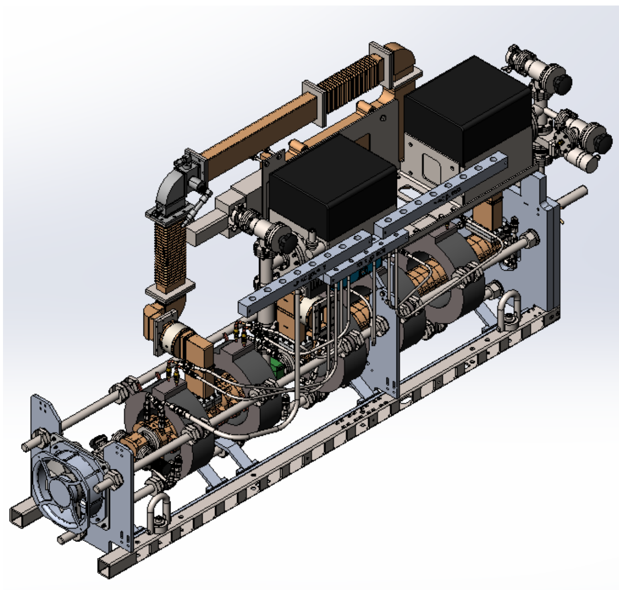

Figure 3: HPP-V15 model.

Currently, the ABC is being manufactured for preliminary high-power testing with the magnetron.

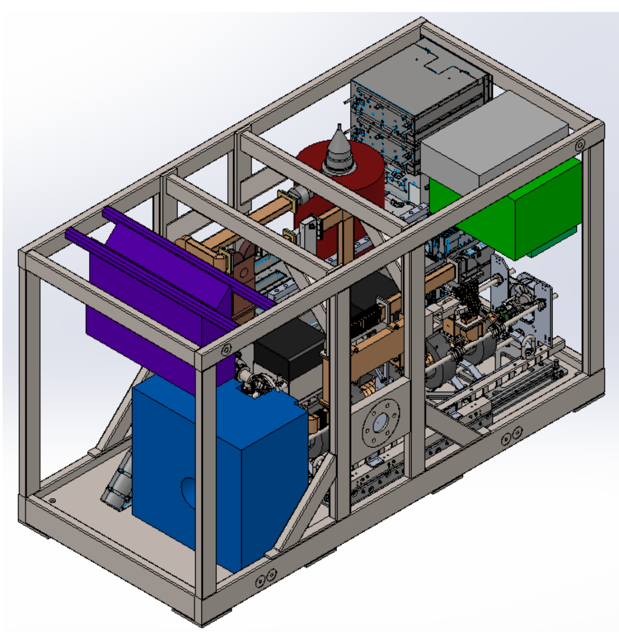

Figure 4: V15 X-Ray head model.

The V15, see Fig. 4, is designed to utilize a patented "reverse RF feeding" scheme, previously described in [5]. The components of V15 are being procured. Klystron based testing of both V9 and V15 versions of High-Power Platform is expected to follow.

MBL6

The High Energy Sources R&D group at Varex has been developing a new commercial technology (patent pending) that permits creating LINACs with beam FWHM focal spot size < 0.5 mm without utilization of any magnetic systems [1-16], which in turn, permits high-resolution radiography of large objects using LINACs in 1-9 MeV energy range. Until recently, micro and submillimeter spots have been available in Varex X-ray and 1 MeV energy accelerators [17]. However, high energy accelerators provide much better penetration and can be used in aerospace industry or other applications to locate microcracks.

As part of this new development, we have built two ABCs for our future 6 MeV MicroBeam LINAC (MBL6). The first ABC was tested at 4 MeV and 6 MeV energies, producing up to 700 Rad/min at 1 m from the target. The latter is only about 15-20% less than from Linatron™ Mi6SSM, standard <1.5 mm spot 4-6 MeV LINAC. Example of the smallest micro beam spot obtained with the second ABC, designed to minimize the focal spot is shown in Fig. 5. This latter ABC was installed in a Linatron™ head and tested as MBL6 preproduction system.

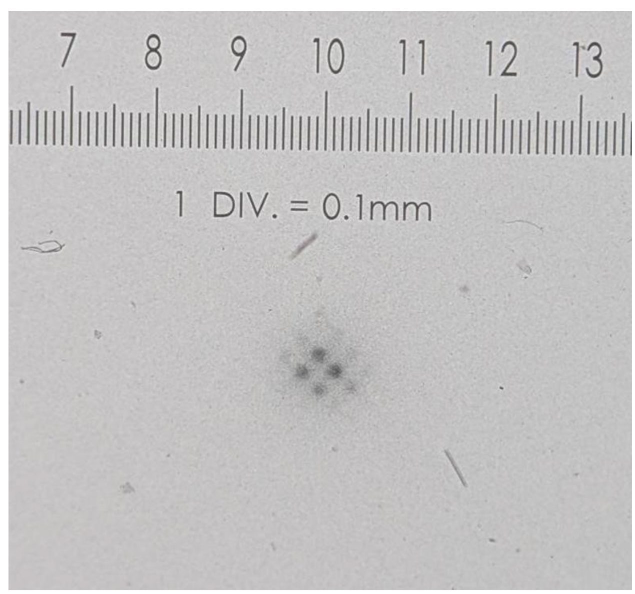

Figure 5: The smallest spot with size of 0.2-0.3 mm FWHM (Low Mode).

More details on MBL6 development will be presented at 10th International Symposium on Digital Industrial Radiography and Computed Tomography in Paris from July 1st to 3rd, 2025 [18].

CONCLUSION

In this paper we presented recent results of linear accelerator development at Varex Imaging, including the new 9

ISBN: 978-3-95450-248-6 ISSN: 2673-5490 doi: 10.18429/JACoW-IPAC2025-TUPB037

MeV system upgrade, the status of high-power platform, and the series of unique micro beam accelerators that are making a breakthrough in radiographic evaluation of objects permitted to detect micro cracks behind few centimeters of steel.

The team is working on further improvements and higher power LINACs for high power NDT, security screening, radiation processing, sterilization, radiation therapy, etc.

ACKNOWLEDGEMENTS

This work is a result and continuation of many pre-existing efforts [1-16]. My sincere "Thank you" to Dr. Andrey Mishin, Vice President, who provides leadership and manages the High Energy Sources group and to all my colleagues: Rich LaFave, Yvette Toombes, Jonathan Cloud and Aren Anderton. This work could not have been completed without unified effort and collaboration with all HES employees and other departments of Varex Imaging. In conclusion, we appreciate continued support by Varex Senior Management, specifically, our CEO Sunny Sanyal, CFO Sam Maheshwari, and General Manager of Industrial Products Jesse Merkley.

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