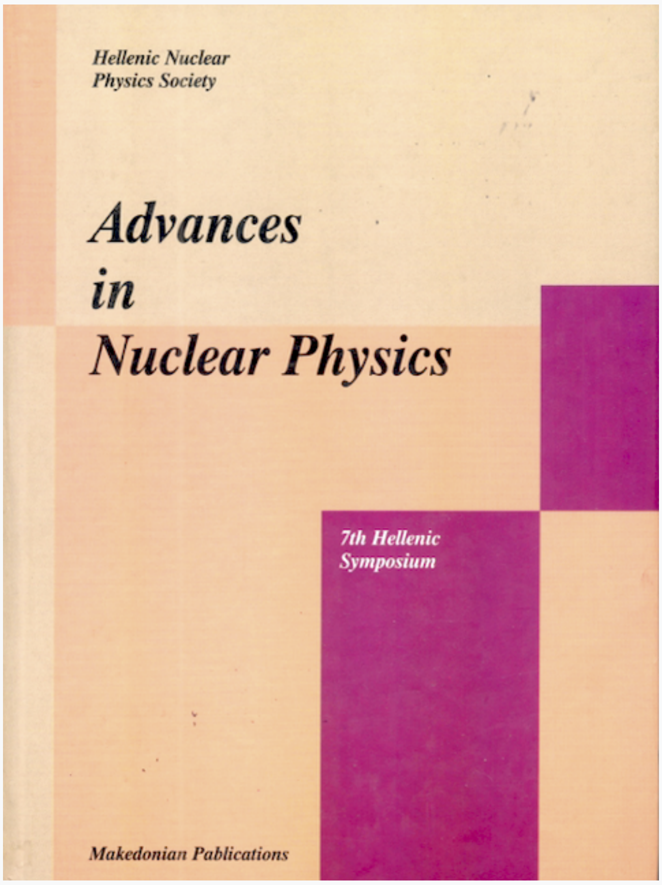
HNPS Advances in Nuclear Physics

Vol 7 (1996)

HNPS1996



Optics for the IASA cw RTM

N. Sparveris, A. V. Filippas, H. Herminghaus, K. Hizanidis, A. Karabarbounis, N. Papadakis, C. N. Papanicolas, E. Stiliaris, N. Vodinas

doi: [10.12681/hnps.2405](https://doi.org/10.12681/hnps.2405)

Optics for the IASA cw RTM

N. Sparveris, A.V. Filippas, H. Herminghaus, K. Hizanidis, A. Karabarbounis, N. Papadakis, C.N. Papanicolas, E. Stiliaris, N. Vodinas

Institute of Accelerating Systems and Applications (IASA), P.O.Box 17214, GR–10024 Athens, GREECE

Abstract

A Continuous Wave Cascade Racetrack Microtron (RTM) is being built at the Institute of Accelerating Systems and Applications (IASA). Making optimal use of the available equipment (obtained from NIST and the University of Illinois), a two-stage $\nu = 1$ Cascade scheme with optics similar to those of the Mainz RTM was adopted. The IASA CW RTM will provide a variable output energy from 6.5 to 246 MeV, with current intensity exceeding $100\mu A$. The LANL side-coupled linear accelerator structure operates at the RF frequency of 2380 MHz. The new design provides excellent emittance characteristics. Details of the optics design and results of the 100 keV beam Line of the Athens CW Cascade RTM are presented.

1 Introduction

The IASA Continuous Wave Race Track Microtron is being built mainly from components of the NIST/LANL and the University of Illinois research RTM projects [1]. The adopted scheme consists of a 6.5 MeV injector linac followed by a cascade of two Race Track Microtrons with output energies of approximately 42 and 246 MeV respectively.

The reasons for this choice among other alternatives ([2]) were:

- Highest output energy obtainable with the available RF equipment and end magnets.
- Stable operating environment and a simple tuning procedure.

The cascade scheme philosophy was originally suggested and successfully realized in the MAMI accelerator [3].

2 General Considerations

A schematic view of the proposed IASA Cascade RTM is given in Figure 1. In this variant the injector consists of the original 5 MeV NIST injector linac, followed by a longitudinal matching system, which will also serve as an energy booster to 6.5 MeV [4]. This energy increase can easily be accomplished by a 1.0m/1.43MeV linac, which is realized by reconfiguring one of the two 4m main linac sections of the original NIST RTM. The first stage, RTM-I, also uses a similar 1m linac, while the remaining linac section, which is about 6m long, will be used for RTM-II. Studies for the longitudinal and transverse matching between injector and RTM-I (Interface-1), and between the two Microtrons (Interface-2) are now in progress.

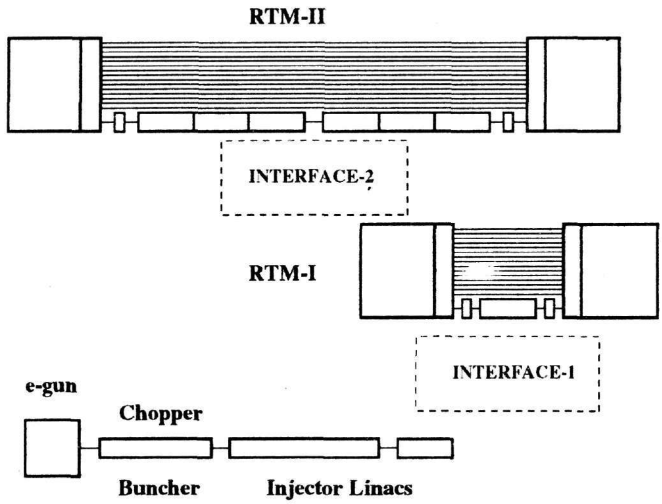


Fig.1 Schematic View of the IASA Cascade Microtron

The main characteristics of this configuration are summarized in Table 1.

3 Injector Optics Calculations

The optics of the transport line and the preaccelerator section has been extensively studied [5]. The purpose of this study is the better understanding of the injector functionality, since this part of the accelerator plays an important role in the definition of the beam characteristics and in the longitudinal matching with the first stage RTM-I. Both TRANSPORT and PARMELA codes were used for the simulation [6]. TRANSPORT is based on a second order matrix calculation while PARMELA based on an integration method

	NIST	RTM-I	RTM-II
Injection Energy [MeV]	5	6.5	42.3
Gain per Turn [MeV]	12	1.43	8.5
Number of Recirculations	15	25	24
Max Output Energy [MeV]	185	42.3	246.7
Max Current [μA]	550	100	100
Frequency [MHz]	2380	2380	2380
Incremental Number ν	2	1	1
Magnets Field [T]	1.0	0.2379	1.414
RF Power Consum. [KW]	305	30	143
End Magnets Spacing [m]	12.5	3.25	8.6

Table 1
The main characteristics of the IASA Cascade RTM compared to the original NIST/LANL design.

applies to standing-wave electron linacs and transport lines, taking in account space charge forces. Both programs show an identical beam behaviour for the injector line (Figure 2).

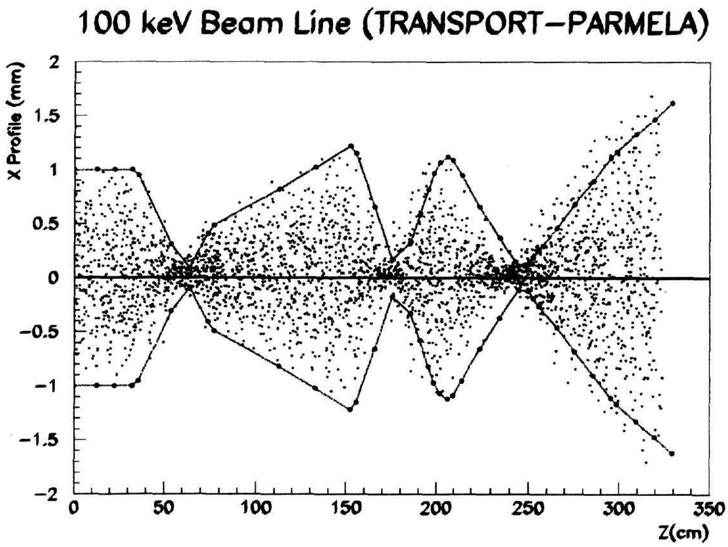


Fig.2 Comparison of the PARMELA (dots) and TRANSPORT (solid line) results on the 100 keV beam profile. Main focusing elements are solenoid lenses.

The simple schematic view of the 100 keV beam line is reproduced in Figure 3, where the main elements of the injector line (lenses, chopper–buncher cavities and apertures) can be seen. Figure 4 displays a two-dimensional beam profile (x–z) along the injector line as well as the transversal profile (x–y) of the beam at the three apertures (A1, A2, A3) calculated with the PARMELA program (zero beam current). Results of the transverse emittance (x, x_p) at the end of the elements along the injector line are summarized in Figure 5.

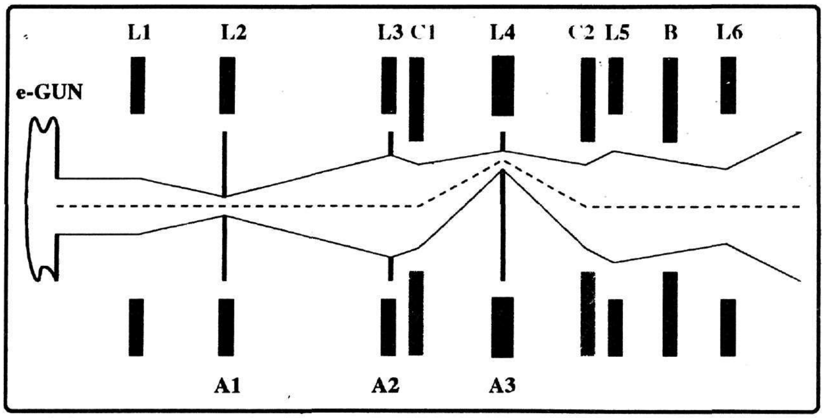


Fig.3 The 100 keV beam line

Space charge effects are not negligible in this energy region. A more detailed study taking in account their influence on the beam characteristics along the first accelerating sections is still in progress.

4 Conclusion

The two-stage Cascade scheme for the Athens Microtron described here has been chosen among three variants because of its simplicity, stable operation and optimal use of the available equipment. It operates with smaller RF consumption than the original NIST configuration and provides a satisfactory acceptance and low sensitivity to external misalignments. Optics for the injector has been extensively studied while studies for the matching systems are in progress.

References

[1] S. Penner et al., Progress Report on the NBS / Los Alamos RTM, *IEEE Transactions on Nuclear Science*, Vol. NS–32 (1985) 2269–2271

L.S. Cardman, The Illinois Cascade Microtron: A proposal for a High Duty Factor, Intermediate Energy Electron Accelerator, *IEEE Transactions on Nuclear Science*, Vol. NS-30 (1983) 3267–3273

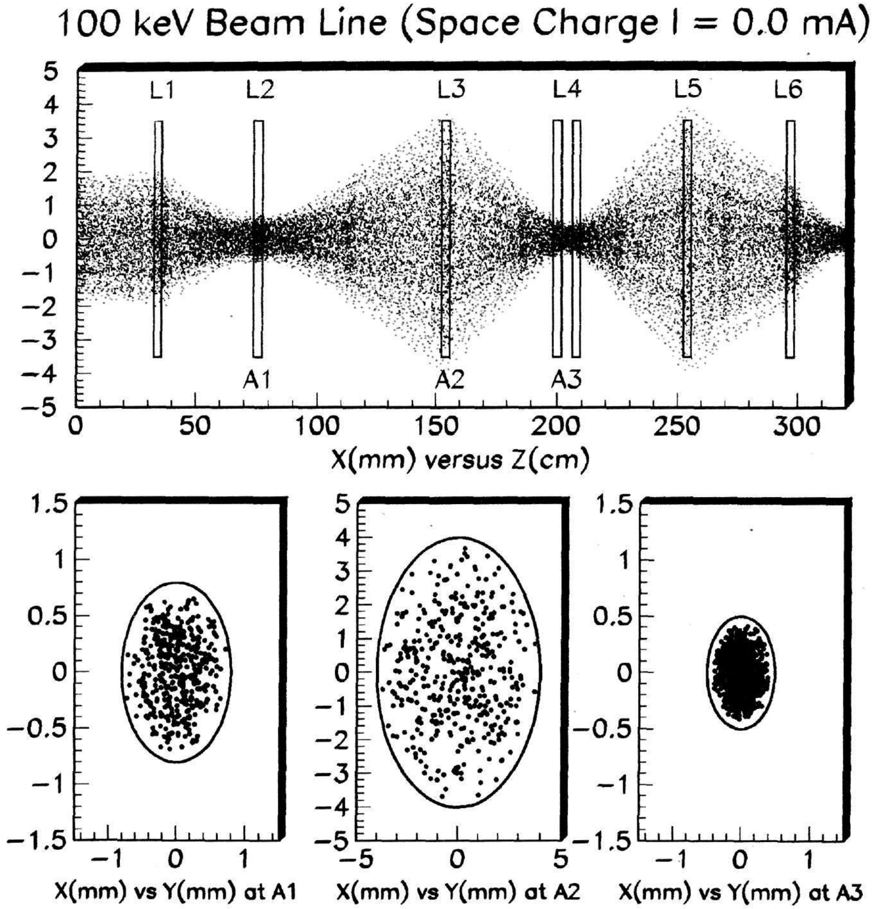


Fig.4 Profile of the 100 keV beam line and the transverse profile at the three apertures A1, A2 and A3

[2] A.V. Tiunov, V.I. Shvedunov, I.V. Surma and K. Hizanidis, C. Trikalinos, C.N. Papanicolas, Variants of Optics Schemes and Accelerator Configurations for the Athens Microtron: Preliminary Considerations, *Paper presented at the PAC95 Conference* (1995), Dallas, USA

A.V. Filippas, A.V. Tiunov and I.V. Surma, Optics Schemes for the Athens CW RTM, *European Research Conference on Nuclear Physics: Polarization in Electron Scattering* (1995), Santorini, Greece

A.V. Tiunov, I.V. Surma and A.V. Filippas, Variants of Optics Schemes and Accelerator Configurations for the Athens Microtron, *IASA Internal Report* IASA-01/95

[3] H. Herminghaus et al., First Operation of the 855 MeV CW Electron Accelerator MAMI, *Proc. LINAC Conference* 1990, Albuquerque, New Mexico

[4] H. Herminghaus, First Order Design Proposal of the IASA Microtron Cascade, *IASA Internal Report* IASA–02/95

[5] N. Sparveris, Optics Studies on the 5 MeV Injector Line for the IASA Microtron, *Diploma Thesis, University of Athens*, 1996, unpublished

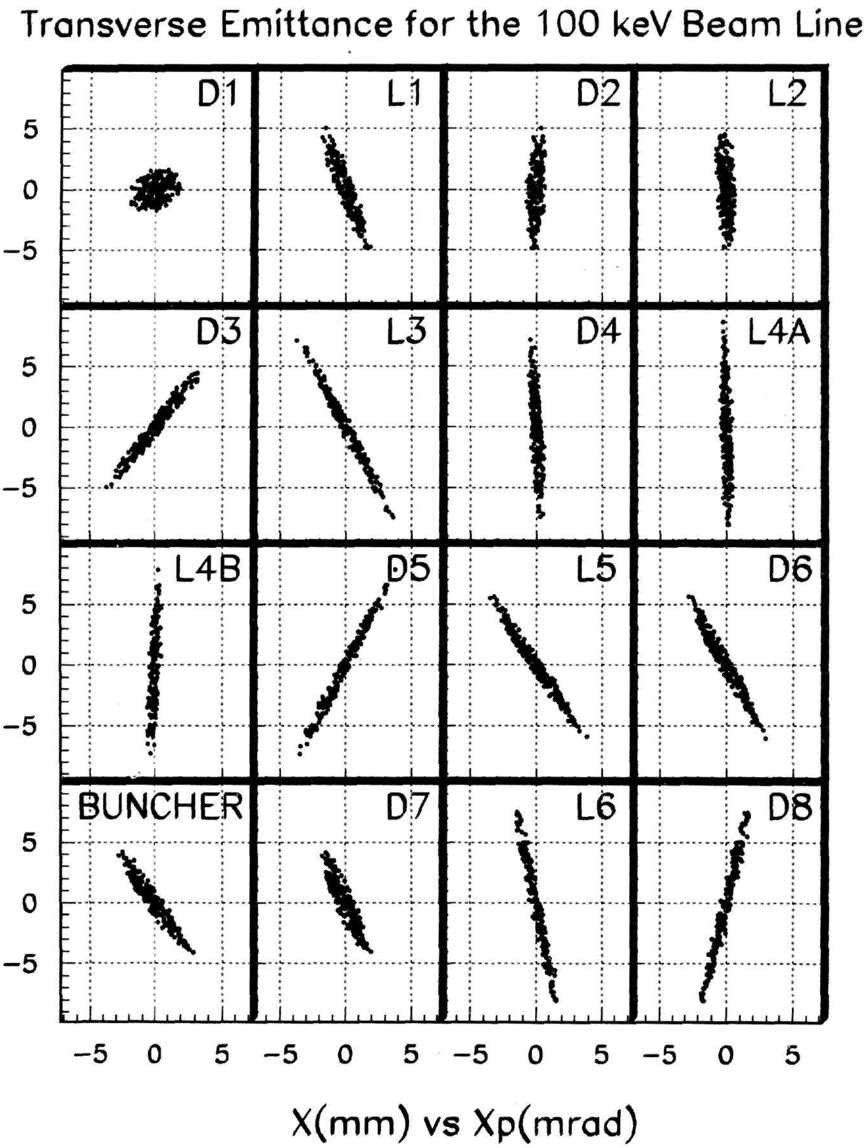


Fig.5 The transverse Emittance along the 100 keV beam line

[6] K.L. Brown, D.C. Carey, Ch. Iselin and F. Rothacker, TRANSPORT, A Computer Program for Designing Charded Particle Beam Transport Systems, *CERN 80-04, W150*, CERN Program Library

Lloyd M. Young, PARMELA, A Particle Dynamics Code for Electron Linacs, Accelerator Operations and Technology Division, Group AOT-1, Los Alamos, 1995