Hemispherical Deflector Analyzer input lens optimization using SIMION

A. Kanellakopoulos[1], N. Angelinos[2], I. Madesis[2,3], T.J.M. Zouros[2,3], M. Fernández-Martín[4], G. Martínez[4], and T.J. Mertzimekis[1]

[1] *Faculty of Physics, Univ. of Athens, Zografou Campus, GR-15784 Athens, Greece*
[2] *Dept. of Physics, Univ. of Crete, P.O Box 2208, GR-71003 Heraklion, Greece*
[3] *INPP, NCSR "Demokritos", GR-15310 Ag. Paraskevi, Greece*
[4] *Department Fisica Aplicada III, Fac. de Fisica, UCM 28040-Madrid, Spain*

Abstract

We report on the optimization of the new atomic physics experimental station located at the Tandem Accelerator Laboratory (TAL) of INPP, NSCR "Demokritos" [1]. The station consists of a hemispherical deflector analyzer (HDA) with a 4-element injection lens and a 2-D position sensitive detector (PSD). The optimization was carried out by simulations using the SIMION v8.1 package [2]. Utilizing the finite difference method, SIMION solves the Laplace equation in the lens and HDA for the given simulated geometry of the experimental setup. Simple initial distributions were used to fly electrons through the lens entry aperture and record their distribution as detected at the PSD. Lens voltages were optimized using a special interactive SIMION- lua program which searched for the lens voltages giving rise to the narrowest beam widths at the PSD. The simulations were carried out for various lens pre-retardation factors for which the behavior of the system for various voltages was derived. Results for this work are presented.

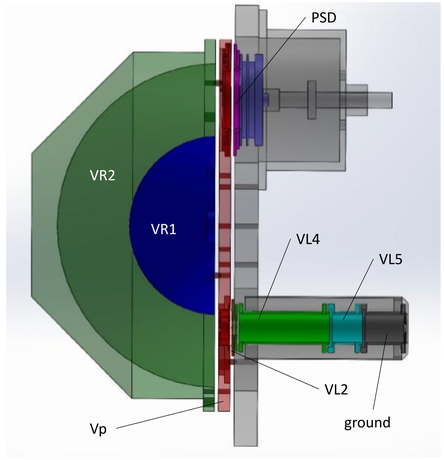

Figure 1: Geometry representation of the injections lens – HDA – PSD system. All the important elements are shown. Each colour represents a different voltage

Vp is responsible for the final electron deceleration.

Main Points

- Geometry simulation was performed using SIMION's geometry-creation, code-based, integrated system with optimized accuracy conditions for both system dimensions and point density
- Independent parameter control was made available for the voltages of each element of the injection lens and the initial conditions of the electron beam. All other parameters were expressed as a function of the former
- Optimal lens voltages were determined by using brute processor force on estimating the beam spot dimensions taking into account various pre-retardation factors
- Detailed simulations were carried out around the desired voltage phase space aiming at improving our accuracy

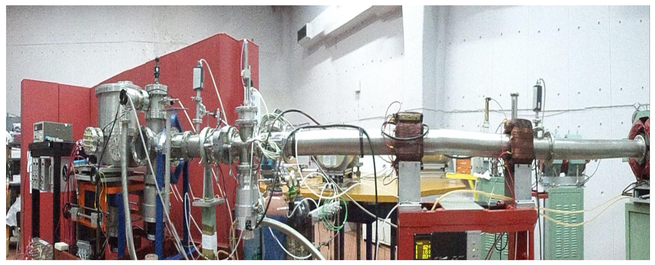

Figure 2: Panoramic view of the APAPES beamline

Results

The results of the simulations are presented below. White points represent the optimized voltages derived from our simulations, while the black points represent experimental data from Ref. [3].

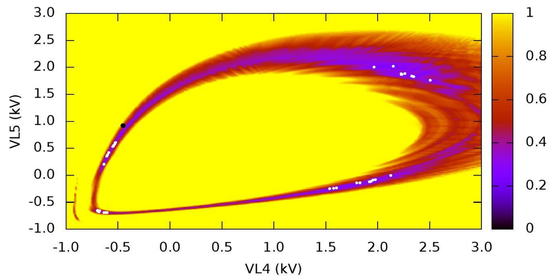

Figure 3: Beam width vs. VL4 and VL5 for pre-retardation factor F=1

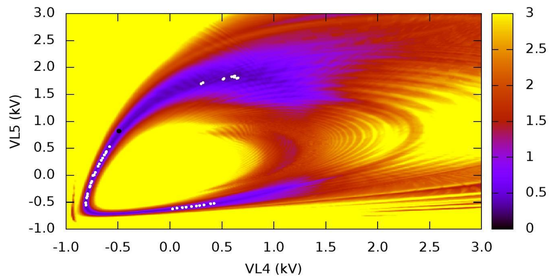

Figure 4: Beam width vs. VL4 and VL5 for pre-retardation factor F=2

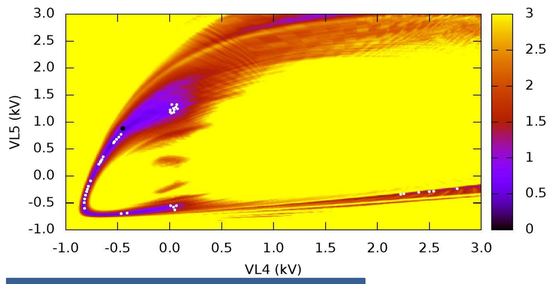

Figure 5: Beam width vs. VL4 and VL5 for pre-retardation factor F=4

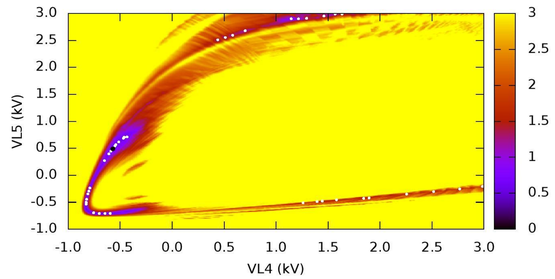

Figure 6: Beam width vs. VL4 and VL5 for pre-retardation factor F=6

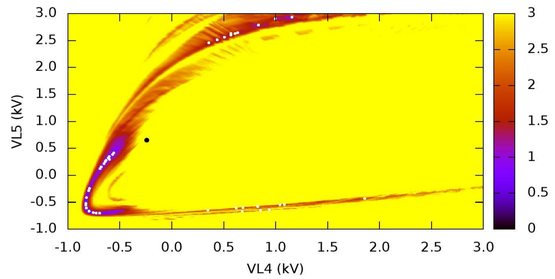

Figure 7: Beam width vs. VL4 and VL5 for pre-retardation factor F=8

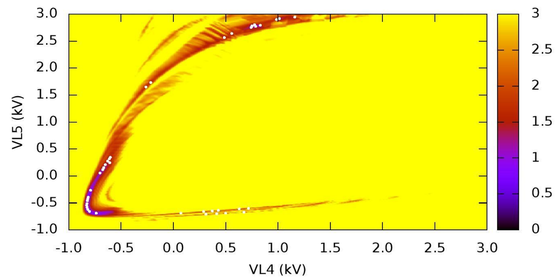

Figure 8: Beam width vs. VL4 and VL5 for pre-retardation factor F=10

Conclusions

- As the pre-retardation factors are increasing, the optimal values of voltages appear for the negative voltages quadrant, which corresponds to electron deceleration
- The present simulation agrees with the available experimental data and covers a much larger area in the voltage phase space

Financed by the European Union (European Social Fund - ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) Research Funding Program: THALES. Investing in knowledge society through the European Social Fund (Grant No. MIS 377289)

References

1. APAPES, url: http://apapes.physics.uoc.gr
2. SIMION v.8.1, url: http://simion.com
3. E. Benis, Ph.D. Thesis, Univ. of Crete, 2001

Contact

T.J.M Zouros
University of Crete
Email: tzouros@phys.uoc.gr