Synopsis
In order to investigate the energy resolution and line shape dependence of a biased parametric Hemispherical Deflector Analyzer (HDA) on the distance \( h \) (see Fig. 1) between the HDA exit focal plane and the detection plane of our 2-D position sensitive detector (PSD), we have installed a piezoelectrically controlled stepper motor that can be controlled by LabVIEW from the outside of the vacuum chamber.

General principles
It is very common for modern HDAs to be equipped with an electrostatic injection zoom lens at their entrance, combined with a PSD for the collection of the energy analyzed electrons at their exit. Practical geometrical constraints such as fringing field correctors and grids do not always allow the PSD placement at the optimal position, i.e., the first-order focal plane following 180° deflection. The only study to date by Page and Read [1] have shown in simulations that an optimal choice on the distance \( h \) might exist for which non-linearities in the energy of the electrons across the PSD become minimized. Our goal is to study the \( h \)-dependence of the energy resolution and line shape of our biased parametric HDA. Our HDA is equipped with a 4-element focusing/retardation lens at the entry and a 2-dimensional PSD in operation with a doubly-differentially pumped gas target. The whole setup is displayed in Fig.2. This apparatus is part of the experimental station developed for research initiative APAPES(2), funded by THALES and located at the SMV TANDEM of the NCGR “Demokritos” in Athens. The setup is primarily dedicated to zero-degree Auger projectil spectroscopy, performing high resolution studies of electrons emitted from highly charged ions excited in collisions with gas targets.

Fig. 1: Schematic geometry of typical lens-HDA spectrometer [4]. The object diameter \( d_0 \) is focused by the lens and imaged onto the HDA entry plane as \( \Delta x_0 \). After the 180° travel of the electrons through the HDA they are imaged at the PSD with a radial width of \( \Delta x \), \( \Delta y \) will depend on the distance \( h \) between the PSD and the analyzer. The drawing has been simplified by approximating the real dimensions of the lens as a thin lens.

Fig. 2: Schematic view of the HDA spectrometer showing the piezoelectric motor (PM). The PSD is placed at a distance \( h \) from the focusing plane of the HDA.

Installation
Recently, a piezoelectric motor (PM) that can move the shaft on which the PSD is supported has been installed in the HDA (see Figs. 2-3). This allows for the high accuracy electronic control of the distance \( h \) between the PSD and the HDA exit focal plane and the experimental study of its effect upon the measured line shape. Moreover, we want to confirm that, at different values of \( h \), the injection lens voltages have been optimized appropriately [3]. A hot-wire electron gun will be mostly utilized, while Auger electrons resulting from ion-atom collisions at zero-degrees with respect to the ion beam will complement the study. The SIMION 8.1 ion optics simulation package will also be used and compared to the experimental results.

Concluding points and Expectations
• An extended investigation to determine the optimum focusing parameters (spectrometer voltages, \( h \) value) will be performed using an e-gun before the next experiment in an effort to have the best possible resolution.
• A real-time investigation of the effect of \( h \)-value on the resolution will also be possible during the measurements.
• The parametric HDA properties will be further investigated on a larger scale.
• Investigation of non-linearities in the energy calibration will also be investigated as a function of \( h \).

References