Techniques and Instruments for Studying the Autograph Manuscripts of Lope de Vega*

Técnicas e instrumentos para el estudio de los manuscritos autógrafos de Lope de Vega

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Abstract. Lope de Vega's autographs allow us to approach the genesis of a play, analyse the cross-outs, changes and additions of the playwright and understand his *modus operandi*. Moreover, these documents also contain annotations and corrections of other agents involved in the Golden Age Theatre market that could substantially modify the text. On many occasions, the philological and codicological analysis only allows making hypotheses about what happened and does not offer reliable solutions to questions about the composition of theatrical text. Through this paper, we present the results of the analysis of several of Lope de Vega autograph manuscripts done with techniques and instruments related to photography and spectroscopy ranging from spectral photography to X-ray fluorescence. We shall demonstrate that the application of these techniques to the study of manuscripts from the Spanish Drama of the Golden Age will also make it possible to obtain information that is relevant to and valuable in delving into the development and circulation of a particular work, but also in gaining a much more complete understanding of the formation of Spanish classical theatre.

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Keywords. Lope de Vega; Autograph Manuscripts; spectral photography; X-ray Fluorescence; X-Raman.

Resumen. Los manuscritos autógrafos de Lope de Vega permiten acercarnos a la génesis de la obra, comprender el *modus operandi* del dramaturgo, y analizar las tachaduras, los cambios y los añadidos. Además, estas obras también contienen anotaciones y marcas de otros agentes implicados en mercado teatral áureo que podían modificar y alterar sustancialmente el texto. En muchas ocasiones, el análisis filológico y codicológico solo permite hacer meras hipótesis sobre lo ocurrido y no ofrece soluciones a cuestiones sobre la composición de la comedia áurea. A través de este trabajo presentamos los resultados del análisis de varios manuscritos autógrafos de Lope de Vega con técnicas e instrumentos relacionados con la fotografía y la espectroscopía, desde la fotografía espectral hasta la fluorescencia de rayos X. La aplicación de estas técnicas va a permitir obtener información relevante y valiosa, no solo para adentrarnos en la gestación y circulación de una obra en particular, sino también para comprender de manera mucho más completa la formación del teatro clásico español.

Palabras clave. Lope de Vega; Manuscritos autógrafos; fotografía hiperespectral; fluorescencia de Rayos X; X-Raman.

In 1864, Salustiano de Olózaga, a renowned bibliophile and former prime minister of Spain, wrote to the Catalan printer Francesc López Fabra, thanking him for his work on the production of a photostatic reproduction of Lope de Vega's autograph manuscript *El bastardo Mudarra*:

> La sociedad Foto-Zincográfica, de que Ud. es digno Director, ha reproducido admirablemente la comedia autógrafa de Lope de Vega titulada *El Bastardo Mudarra* y, deseando que todos puedan adquirir a poca costa este como los demás manuscritos que poseo, autorizo a Ud. para que la publiquen, reservándome el original, si es que puede distinguirse de la reproducción por alguna señal particular.
>
> Los progresos de la mecánica han hecho que las clases menos acomodadas usen en nuestros días telas más delicadas que las que en otros tiempos ostentaban únicamente los príncipes y magnates; y el vapor nos permite viajar a los particulares mucho más velozmente y con una comodidad que jamás conocieron los monarcas más poderosos de la tierra. Así, la invención que Ud. ha planteado en España extenderá por todas partes los autógrafos de nuestros grandes ingenios que hasta aquí se han guardado escondidos, sin contar con los muchos que hay en el extranjero, en nuestras bibliotecas o en las librerías de algunos curiosos, y se hará popular y útil, y más digno de su memoria el cariño y hasta el culto que merecen[1].

1. I transcribe this passage and the rest of the texts appearing in this article with standardised spelling and punctuation. The letter is dated 13 November 1864 and can be consulted along with the phototype reproduction of the *El bastardo Mudarra* autograph in the Ateneo de Madrid Library (G-9744) and also in the National Library of Spain (BNE, Res/39).

It was the first time that a facsimile reproduction was made in Spain and the first time that these photography-linked mechanical techniques and advances were applied to the printing press. As the driving force behind the project and the founder of the Foto-Zincográfica Society, Olózaga's goal was clear: democratise knowledge and «extender por todas partes» the manuscript treasures of the great geniuses. It is no wonder that the play chosen for undertaking this project was precisely an autograph manuscript of a comedia by the *Fénix de los Ingenios*[2].

Since then, «los progresos de la mecánica» have developed at an abysmal speed, unimaginable for Olózaga, Fabra and his contemporaries, but —just as before— the value of the items to be studied remains incalculable. From a philological point of view and in terms of the creative process, Lope de Vega's autographs allow us to approach the genesis of the play, understand the *modus operandi* of the playwright, discover writing techniques and practices, and analyse the successive modifications of a text until it reaches its final form. The *pentimenti* —cross-outs, deletions or additions, whether *in itenere* or at a later time— offer a precise vision of the process of writing a play[3]. In addition to the literary and aesthetic value, however, the manuscripts of Lope de Vega's comedia also had legal value, since the autograph was the document that the playwright sold to the directors of the theatre company; with it, they would also acquire the exclusive rights to the performance of the play. Once they had possession of the manuscript, directors (called *autores de comedias* back then) could modify the text to suit the circumstances of the performance, the characteristics of their companies or the spectator type. These changes were not overseen by the playwright since the sale of the manuscript entailed the loss of their rights thereto. Moreover, the manuscript required approval granted by a member of the Council of Castile —which usually assigned a qualified censor to examine it— before its performance. This individual had full authority to intervene in the manuscript and modify or remove any passages he deemed inappropriate or indecorous. Thus, in addition to the playwright's own notes and corrections, autographs contain traces of the interventions made in the play by both *autores de comedias* and censors. All this reveals the process of creation, review, adaptation and censorship to which the text was subjected.

Although succinct, this explanation is intended to highlight the importance of the autographic comedias in understanding the composition of Golden Age drama and —at the same time— how complex their study is because of the difficulty in identifying and interpreting the various interventions we find in these manuscripts. It is precisely along this line that new techniques and instruments can be useful to philologists and provide them with objective information to reveal some of the mysteries that these testimonies still conceal.

2. See Grotta (1984). In 1871, Francesc Fabra and Juan Eugenio Hartzenbusch (then director of the National Library of Spain), made the phototype reproduction of both parts of *El Quijote* (Torres Santo Domingo, 2005).

3. It is worth mentioning that we have a total of 44 of Lope de Vega's autographs partially or totally conserved. This is an exceptional and unparalleled corpus in European Baroque literature.

Several trials have been conducted in this vein in recent years. Back in a now-distant 1991, Margaret Greer and Gerardo Kurtz published the interesting results of applying certain photographic and computer-based techniques to the autograph of *La Santa Juana* by Tirso de Molina (BNE, Ms. Res. 249). This testimony, along with several corrections by the playwright himself, contained extensive marginal comments from a censor, passages that were subsequently crossed out by another, unknown, hand. Researchers applied different photographic techniques —reflected infrared light, infrared luminescence and reflected ultraviolet light— to the manuscript in order to read under the latter cross-outs, although the technique with the most results was induced or cross-polarisation. Given the differences between the inks used, this methodology was able to produce negative images that facilitated the reading of the crossed-out passages. The digital analysis also provided them with results along the same line, and thus they were able to make the crossed-out text legible[4].

In 1993, the Dead Sea Scrolls became the first manuscripts studied with spectral images in an attempt to recover texts and passages that had faded or were illegible[5]. A few years later, in 1998, the *Archimedes Palimpsest* project was launched. It analysed and studied the well-known Archimedes Palimpsest with several methods of digital image processing —including spectral— and this made it possible to read most of the deleted text by Archimedes[6].

Returning to the realm of the Spanish language, in 2007, the GEMCEMYSO (*Génesis y evolución de la materia cidiana en la Edad Media y el Siglo de Oro)* research project led by Professor Alberto Montaner analysed the unique manuscript of *Cantar de mio Cid* (BNE, Mss. Vitr/7/17) with hyperspectral photography[7]. This photographic technique had been used with good results in the study of several palimpsests, as demonstrated by the *Rinascimento virtuale: Digitale Palimpsesforschung* project led by Professor Dieter Harlfinger (Hamburg University). In the case of *Cantar del mio Cid*, hyperspectral photography provided relevant results, especially as far as the legibility of passages is concerned. Using this methodology, they managed to read passages that had been blackened in the manuscript as a result of the

4. More recently, Zugasti y Greer (2019) published an article with the transcription of these passages in which the images resulting from these processes can be seen.
5. For more information, please refer to the project website (<www.deadseascrolls.org.il>).
6. All the images of the manuscript and the information relating to the project are available on the website (<www.archimedespalimpsest.org>).
7. The instrument used, a MuSIS device (Multi-spectral Imaging System) developed by Forth Photonics is the same one used to analyse the Codex Sinaiticus in the British Library. See Knight (2009). Imaging techniques are not intrusive or destructive and offer additional information that is imperceptible to the human eye, such as viewing hidden elements in a document. Spectral photography consists of expanding the spectrum of visible light —the one that we humans are able to see— and has a wavelength ranging from approximately 380 to 750 nanometres. These techniques, therefore, allow us to see beyond visible light and expand the spectral range. They are able to capture a range from the ultraviolet spectrum (below 380 nanometres) to the infrared spectrum (more than 750 nanometres). For practical purposes, this means that a text obscured by a spot —and thus illegible in the spectrum of visible light— can be legible in another band of the spectrum.

effect of reagents and also to discover a drawing in one of the margins that was invisible[8]. Furthermore, the combination of this photographic technique with other imaging technologies also enabled researchers at Northwestern University-Art Institute of Chicago Center for Scientific Studies (NU-ACCESS) to recover a 6th-century Roman criminal law manuscript that had been recycled in the 16th century to craft the binding of a volume of works by the Greek poet Hesiod.

In addition to specific projects and initiatives by some researchers or research groups, in recent years several conservation institutions or agencies have used digital techniques and tools to read and restore heritage. A case in point is the British Library, which has instruments and a qualified technical team for analysing palimpsests and manuscripts from its extensive bibliographic using spectral imaging techniques (Duffy, 2018). Another is the Vatican Library, whose restoration department has successfully applied these techniques in the restoration of several documents (Schuler *et al.*, 2017). In this vein, analytical techniques in the field of preservation have been used to study some important codices. This was done with the autograph of *Diario spirituale* of Saint Ignatius of Loyola —recently analysed with spectroscopic techniques such as diffuse reflectance, X-ray fluorescence (XRF) and a Raman laser (Zoleo, 2018; Giovè Marchioli y De Rubeis, 2018)— and the letters written by Marie-Antoinette of Austria to Count Axel von Fersen, whose censored passages have been recovered thanks to X-ray fluorescence[9].

While in the above-mentioned cases the results of the application of these techniques have been positive and have allowed the restoration of documents and the recovery of illegible text, we must understand that this success is dependent on several factors, such as the characteristics of the document under review, the type of media and the composition of the inks used. Analysing parchment is not the same as analysing vellum or paper, nor is restoring a passage that is stained with moisture, burnt, rendered illegible because of a reagent, or containing inks of similar or different compositions. The specific circumstances are infinite, as are the types of documents we conserve. For this reason, the analysis of manuscripts with photographic and spectrographic methods is becoming increasingly necessary. Each one must be analysed in the light of these variables, and only in this way shall we know whether obtaining results is feasible with the above techniques.

Given the particularities of the documents on which our research is focused, the comedia autographs by Lope de Vega, we believe it is necessary to conduct a series of tests with different techniques and tools to find out what information might be obtained from them. Also bear in mind the various types of illegible passages presented by the corpus of conserved autographs; these range from passages that are crossed out, stuck on, stained by ink and by moisture, as well as the different inks that appear on the document, which may be different, similar or even identical to each other.

8. For the techniques used and the results obtained, see Montaner (2009).
9. This investigation has been carried out within the REXII project led by Fabien Pottier and has been assisted by several members of the National Archives of France.

In what follows, we present some of the instruments used and the results at which we have arrived:

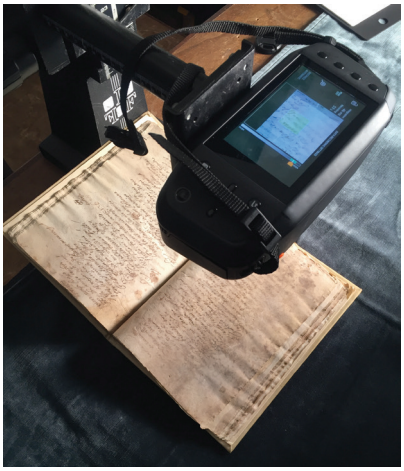
> Instrument: Specim IQ hyperspectral camera[10].
> Document analysed: Lope de Vega, *El cardenal de Belén*, autograph manuscript, Medicea Laurenziana Library in Florence, Ms. Ashb. 1898.
> Issues particular to the manuscript: stains from moisture, crossed-out passages, differentiation of inks.

The dimensions of the IQ hyperespectral camera are very similar to those of a conventional reflex camera (20cm long by about 10 wide) and has a considerable wavelength, ranging from 400 nanometres (ultraviolet) to 1,000 nanometres (infrared) with a spectral resolution of 7 nanometres. On this occasion, the document analysed presents some particular characteristics: in addition to the corrections and autograph notes, it has several handwritings, some of them linked to the theatrical performance and others to the printing press[11]. In addition, it has significant moisture stains that make several passages in the play virtually illegible.

The results we obtained from the analysis of the manuscript with the IQ camera did not help us read under the cross-outs, which had mostly been done in the playwright's own hand, nor were not very useful in rebuilding the passages of the text that were illegible because of the moisture. However, the spectrographic ink analyses —a technique that analyses the composition of the pigment used and makes it possible to determine the similarities or differences between the inks— that we conducted on certain folios did give us relevant information.

In particular, we used this technique to analyse the ink of a drawing that appears on folio 10 verso of the third act manuscript[12]. This is a sketch that indicates how the staging was to be and that depicts the birth of Jesus in the middle and, on the sides, two hills from which several characters are descending. It is the only autograph manuscript containing a drawing of these characteristics and critics have debated its authenticity. Since the manuscript contains interventions by other people, apart from personal impressions, there is no empirical evidence that makes it possible to determine whether it was done by Lope de Vega —which would indicate that it was he who wanted to clarify how the elements on stage had to be positioned in order to create the image of a Nativity scene— or whether it was the work of the hand of another, probably linked to a theatrical company.

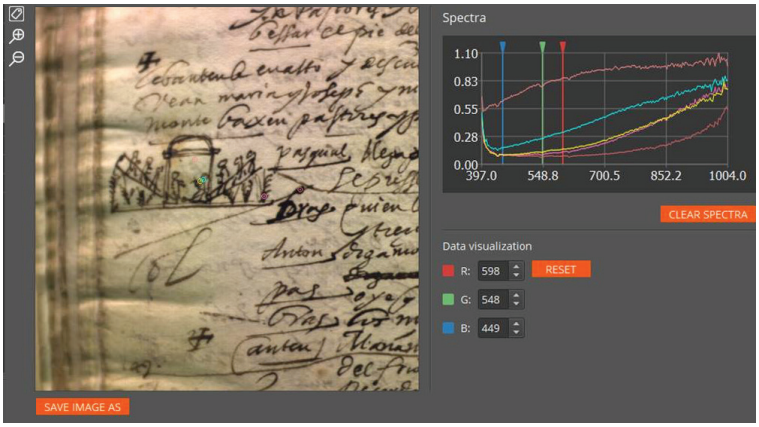
10. The test was done thanks to the collaboration of Lorenzo Marchesini, a Bruker Italia salesperson, and the technician Simone Paziani de LOT-QuantumDesign, in addition to the generosity of the staff of the Medicea Laurenziana Library in Florence, especially Eugenia Antonucci.
11. For the analysis of the hands of the manuscript, see Hamilton (1948), Fernández Rodríguez (Lope de Vega, *El cardenal de Belén*), the *MANOS* database and Presotto (2020).
12. For the graphic elements appearing in Lope de Vega's autographs, see Boadas (2018).



Lope de Vega, *El cardenal de Belén*, Act III, folio 10 verso

The drawing appears immediately after a stage direction in which we can read: «Levántenle [a San Jerónimo] en alto y descúbrase una cortina en que se vean María y José y Niño, y por un lado del monte bajen pastores y por otro tres Reyes». The stage direction indicated that the protagonist, St Jerome, had to be lifted so that the vision he had experienced could be staged as described in the previous lines.

While we have a number of elements that seem to point to Lope de Vega's authorship, such as the similarity between the represented silhouettes and the Eucharistic symbols of the angels and the chalice that appear at the beginning of the acts, and the colour of the ink used —similar to that of the stage direction— are insufficiently determinant elements by objective parameters that may lead to subjective assessments and errors of interpretation.



In this case, the spectrographic ink analysis we conducted with the Specim IQ camera provided relevant information about the authenticity of the drawing. The spectral curves that can be seen on the chart show that the characteristics of the ink with which the drawing was made are virtually identical to those of the ink used to write the stage direction. We can conclude from this that the drawing is autographic and that Lope de Vega most likely did it while he was writing the comedia, to make it clear to the future directors of the comedia how the staging of this picture should be done[13].

Instrument: Xpectraltek X01 multispectral camera[14].

Documents analysed: Pedro Calderón de la Barca, *El secreto a voces*, autograph, National Library of Spain, Mss. Res/117; Lope de Vega, *Don Lope de Cardona,* manuscript copy, National Library of Spain, Mss. 17417; Lope de Vega, *El Bastardo Mudarra*, autograph, Royal Academy of Spain, Ms. 390.

Issues particular to the manuscripts: pages stuck together, crossed-out passages, differentiation of inks.

The X01 multispectral camera is small and spherical, about 25 centimetres in diameter and easy to transport[15]. Its technical characteristics include a wide-spectrum range (from 350 to 1200 nanometres) and it captures up to 30 spectrum

13. Although the manuscript does not conserve the lists of *dramatis personae* at the beginning of the acts or the distribution of actors, the final licences mention that the permit for performing the comedia was granted to Domingo Balbin. See Rennert (1909, p. 430).

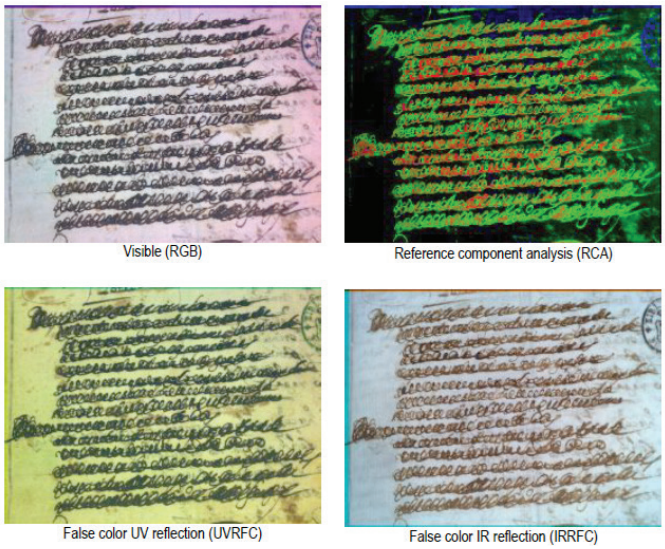
14. The test was carried out thanks to the participation of Marco Presotto, Professor of the Università di Bologna, of Lorenzo Marchesini, representative of Bruker, and the photographic technician Josè Cardoso, as well as the kindness and availability of the staff of the Library of the Royal Spanish Academy and the National Library of Spain, with special thanks to the invaluable assistance provided by Javier Docampo (†) and María José Rucio.

15. The main difference between multispectral and hyperspectral photography is the number of bands they can capture and their amplitude. Multispectral images generally capture 3 to 10 relatively wide bands, while hyperspectral images capture a greater amount of bands, but they are much narrower (usually every 10 and 20 nanometres). This produces a higher level of detail in the images but, at the same time, a greater complexity for processing information and subsequent data management.

bands. We used this instrument to analyse several manuscripts that presented different types of illegible passages. First, we examined a case of pages stuck together to find out whether it was possible to read the text that was hidden under another paper. To do this, we used Calderón de la Barca's autograph *El secreto a voces*, since folio 57 recto has a sheet with lines stuck on top of the initial text.

Just as the editors of the play —Aichinger, Kroll and Rodríguez-Gallego (2015, pp. 141-142)— discussed, the hand transcribing the lines on this stuck page is not autographic. They identified it with the M510 acronyms on the *MANOS* webpage and noted that it was probably a company prompter. This hand usually used to make clean copies of the short passages of text that Calderón had retouched several times, i.e. passages containing corrections and cross-outs that could hinder its understanding. This is precisely what happened on folio 57 recto. The editors claim that the copied text matches Calderón's latest corrected version, the one appearing in the page's margins and whose first lines are still visible on the right margin («fuera de que la palabra / de darme a Laura me has dado / […]»), but precisely the stuck sheet prevents seeing the changes and corrections made by Calderón himself. This time, multispectral photography could not read under the paper. This technique only provides the information contained on the surface of the document and is not able to go through objects, but other techniques such as tomography are likely to resolve cases such as these[16].

Another test conducted was aimed at finding out whether the technique could facilitate reading crossed-out passages. To do this, we analysed manuscripts with different types of corrections. The first one we shall discuss is the sonnet that appears in Lope de Vega's manuscript *Don Lope de Cardona*'.

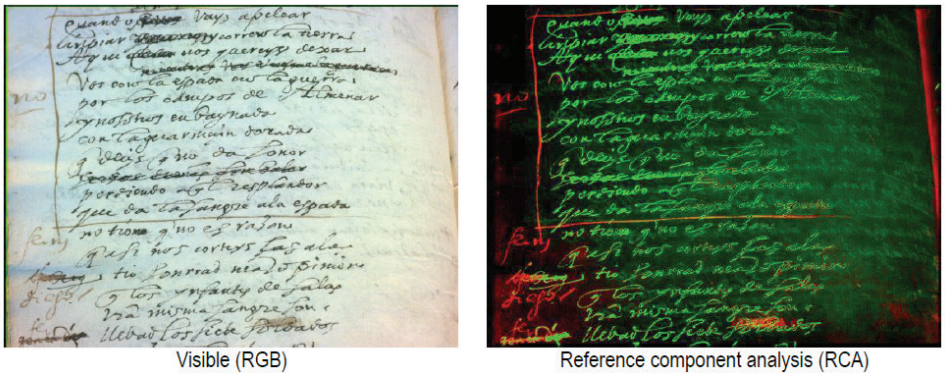


Lope de Vega, *Don Lope de Cardona*, folio 21 recto.

16. For more on this, see Albertin *et al*. (2019).

In this case, neither the image in the ultraviolet range or that in the infrared range area helped us read the deleted text. The Reference Component Analysis (RCA) —an approach to spectral deconvolution that makes it possible to separate two pigments and their mapping[17]— is also unable to distinguish between the inks used. It follows that the inks used to write the text and for cross-outs had very similar characteristics and therefore this technique does not allow them to be distinguished. The colours observed in the RCA —green and red tones— not indicate a difference in the composition of the inks, but rather relate to their thicknesses —i.e. they indicate the level of ink concentration.

On other occasions, the Reference Component Analysis clearly distinguishes two different inks, as is the case in the *El bastardo Mudurra* autograph. The original text written by Lope de Vega is seen in green and this same colour marks the *in itinere* corrections appearing at the top of the folio. However, the additions made —most likely those of an *autor de comedias* performing the play at a later time— are shown in red. We can see how the non-autographic hand enclose a set of verses using vertical and horizontal lines, added a «no» in the left margin and modified the stage blockings. In this case, multispectral photography confirms something that can be seen in plain sight because the differences in the colours of the inks are perceptible when observing the manuscript with the naked eye. However, we should bear in mind that the human eye is not infallible and that it can deceive us because what at the simple sight seem to be two different inks may, in fact, not be or vice versa. In this case, the technique offers an empirical and objective confirmation and allows us to state that they are two different inks.



Visible (RGB) Reference component analysis (RCA)

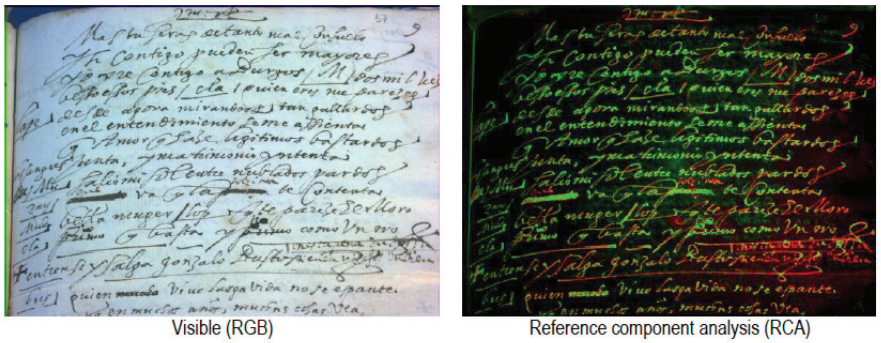
Lope de Vega, *El bastardo Mudarra*, Act II, folio 5 verso

However, the analysis of other folios in the same manuscript reveals the limited reliability of this technique where the differentiation of inks is concerned. On folio 9 recto of the third act, a hand crossed out the original text several times, sometimes with great zeal, rendering the original text illegible and proposing an alternative text above each one.

17. A technique that allows us to view the bands that make up the composite spectrum.

LOPE	Desde agora, mirándoos tan gallardos, en el entendimiento se me asienta que amor que hace legítimos bastardos las sangres junta y matrimonio intenta.
MUDARRA	Salió mi sol entre nublados pardos.
ZAYDE	<- … \ que> va que la <- …\ sobrina> te contenta.
MUDARRA	Bella mujer.
LOPE	¿Qué te parece el moro?
CLARA	<-Primo \ Tío> que basta y <-primo \ tío> como un oro[18]. (Act III, folio 9 recto)

The type of cross-out and the calligraphy of the added words reveal that it is not an autographic correction, but the RCA analysis detects no difference in ink and indicates that the cross-outs were done with ink similar to that of the rest of the text (green). Moreover, the added words —written at the same time as the cross-outs because they exactly replace the deleted words— appear red, as do the last words in each line. In this case, the RCA is not able to differentiate the inks and the colours seem to indicate the differences in the thickness of the ink. Thus, we concluded that the Reference Component Analysis is useful in distinguishing inks and provides relevant information if they have sufficient differences between them.



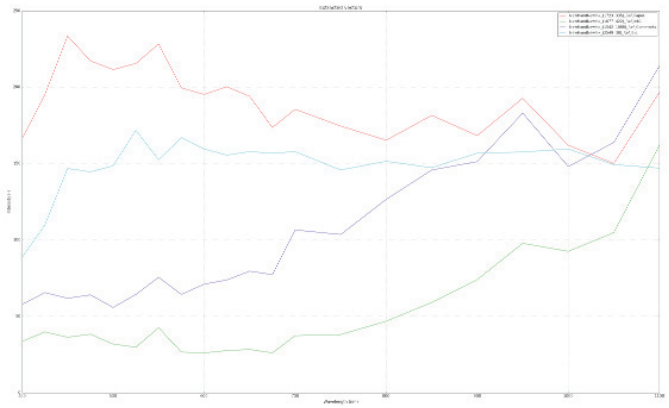
Visible (RGB) — Reference component analysis (RCA)

False color UV reflection (UVRFC) — False color IR reflection (IRRFC)

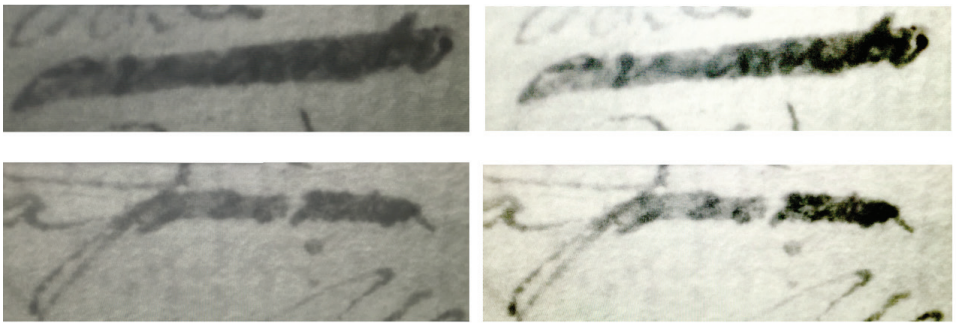
Lope de Vega, *El bastardo Mudarra*, Act III, folio 9 recto

18. Standardised spelling and punctuation. The signs adopted by Masai (1950) are used for the modifications.

The reflection curves do not provide much more information. In the following chart, where the X-axis indicates wavelength and the Y-axis measures intensity (0-250), slight differences can be seen in the curves that mark the inks (green represents the original ink and dark blue represents the ink of the added passages), although only as regards their intensity, since their behaviours are virtually identical.



However, analysing the different spectra can provide us with relevant information to reading the crossed-out word of this passage. If we look closely at the aforementioned *loci critici* in the range of approximately 800 to 900 nanometres, it is possible to read the text hidden under the cross-outs where Lope wrote the terms «cuanto» and «prima». The figures show the images obtained in the range of 800-900 nanometres and the same images treated with colour adjustment filters.

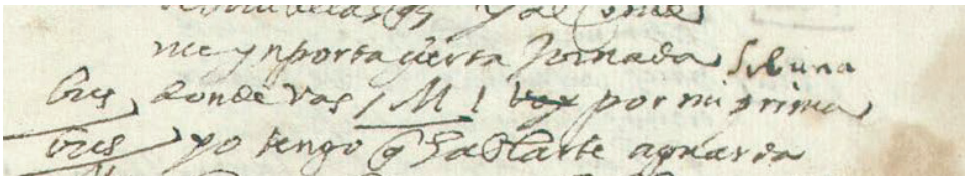


Lope de Vega, *El bastardo Mudarra*, Act III, folio 9 recto

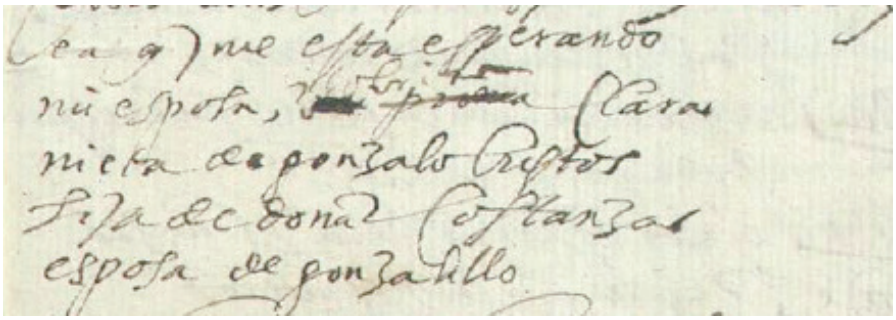
In this case, the original text can be recovered for several reasons: first, because of the different compositions of the inks used; and second, because the inks did not mix, i.e., the first one dried and the correction was made at a later time. With this information, we can infer that line 2253 originally read «¿Cuánto va que la prima te contenta?», corrected to «Qué va que la sobrina te contenta?». This amendment was beyond the control of the playwright and likely came from the hand of an *autor*

de comedias. This time —and even though the RCA and the reflection curves do not provide data relevant to their differentiation, the infrared spectrum made it possible to read the crossed-out passage.

If we dig a bit deeper into the motivation for these changes, we shall see that this alteration follows the same pattern as other corrections found in the manuscript. We find the same type of correction on folios 13 recto and 15 recto in the third act and, once again, the references to the cousin were deleted and replaced with references to the niece.



BUSTOS ¿Dónde vas?
MUDARRA <- Voy> por mi prima <\sobrina>.
(Act III, folio 13 recto)



¡Ea, que me está esperando
mi esposa y <-mi prima \ y sobrina> Clara,
nieta de Gonzalo Bustos,
hija de doña Constanza,
esposa de Gonzalillo!
(Act III, folio 15 recto)

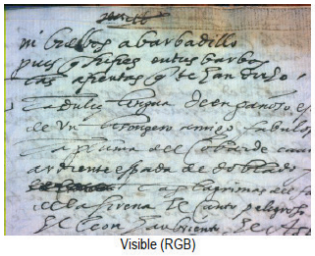
Thus, at several points in the play, a hand other than that of Lope de Vega modified the kinship relationship that existed between the Mudarra and Clara characters. In the original text, Lope presented them as cousins, but the *autor de comedias* may have believed it was better for them to be uncle and niece[19]. The family relationship between the two protagonists did not affect the plot or development of the action, and the change is the result of the ages of the actors performing the play. If they

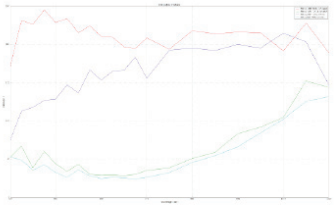
19. These changes also caused the modifications of «tío» for «primo», found in folio 8 verso and 9 recto of the third act.

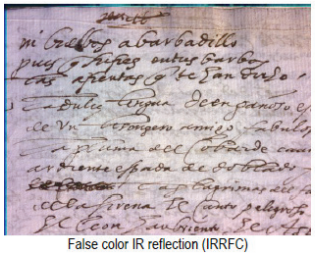
were of a similar age, it was more credible for the spectators to present the characters as cousins rather than as uncle and niece.

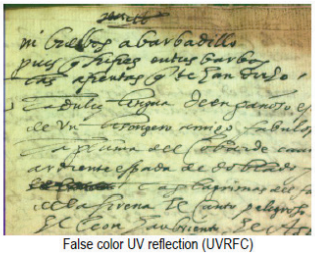
It is also worth mentioning that in the modern editions of the play the text that has been edited in these cases is «sobrina», betraying the will of Lope de Vega and attributing to him someone else's text —most likely proposed by a director for the performance of the play— as though it were his. In fact, the error already appeared in the play's *editio princeps*, published in *Parte XXIV* (Zaragoza, Pedro Verges, 1641), where the text was printed with the combination of «tío-sobrina»[20].

Back to the manuscript, and considering that the results obtained may vary depending on the composition of the inks used, we also conducted several tests based on the type of cross-outs, trying to differentiate between those that had been performed *in itinere* and, therefore, with the same ink, or those that were done *a posteriori* and, perhaps, with a different ink. There is an *in itinere* autographic correction on folio 13 recto of the same manuscript. This is an illegible term that Lope de Vega wrote and immediately crossed out and then continues by transcribing the «las lágrimas del falso cocodrilo» line. The results of the multispectral analysis do not provide information relevant to the reading of this passage. The images of the ultraviolet and infrared spectra do not facilitate the interpretation of the cross-out, and the spectral curves indicate that the ink of the deleted word and the cross-out are identical (light green and dark green), which is why it is not possible to differentiate them and make the passage legible[21].


Visible (RGB)


Reflection Spectrum of 2 inks (green lines)

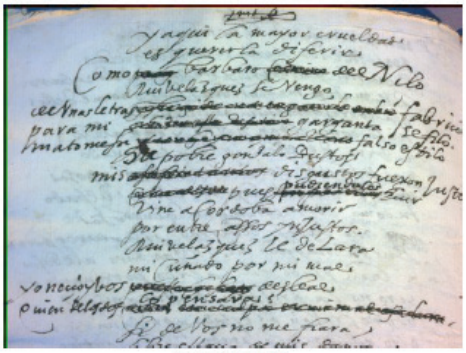

False color IR reflection (IRRFC)


False color UV reflection (UVRFC)

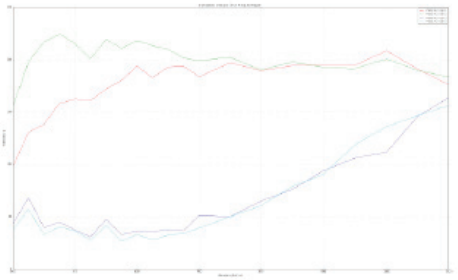
Lope de Vega, *El bastardo Mudarra*, Act I, folio 13 recto

20. In the *editio princeps*, just as in Gálvez' copy (BNE, Mss. 22424) and the 19th-century manuscript (BNE, Mss. 14612/31), «sobrina» is transcribed on folios 9 recto and 15 recto and «prima» on folio 13 recto.
21. The curves at the top, blue and red side, represent the analysis of two different points on the paper. Because of the size of the space used by the cross-out and the content of the line he wrote below, Lope de Vega may have removed the «El cocodrilo» syntagm, but this hypothesis is pure speculation.

Similar results are obtained when analysing a fragment with an *a posteriori* correction, as is the case on folio 2 verso of the second act in the same manuscript. On this occasion, Lope de Vega first wrote a set of lines and, sometime later —we cannot specify exactly when— he decided to replace these lines with others. The location of the corrected lines —which had to be placed in the margins— shows that the correction was not *in itinere*, because the text had already been transcribed in the middle of the folio. In this case, infrared and ultraviolet spectra also do not facilitate reading the crossed-out passages although the spectral curves offer additional information about the inks. The similarity of the two blue curves —one corresponds to the ink of the crossed-out text and the other with that of the words added in the margin— indicates that the corrections were made with the same ink. We, therefore, deduced that the modifications were made at a time relatively close to the writing of the text.

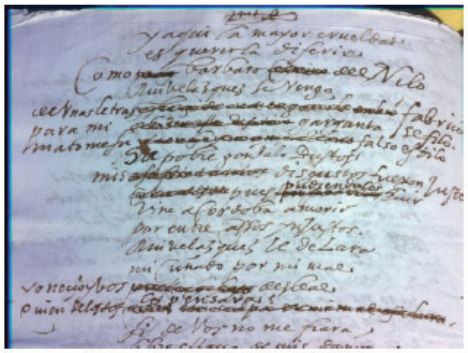


Visible (RGB)



Reflection Spectrum of 2 inks (green-blue line)

False color IR reflection (IRRFC)



False color UV reflection (UVRFC)

Lope de Vega, *El bastardo Mudarra*, Act II, folio 2 verso

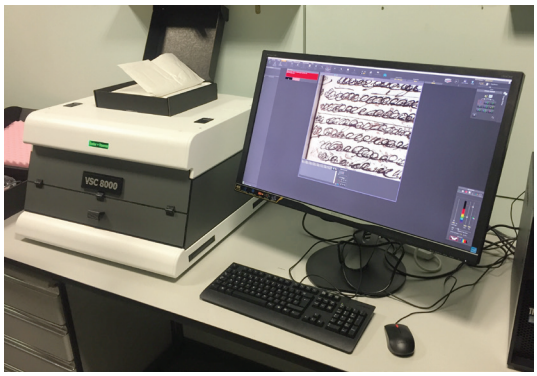
The analyses carried out infer that the results will vary depending on the composition of the inks. The multispectral technique will not offer additional information in cases in which the inks used have very similar characteristics. Consequently, it will not facilitate the reading of crossed-out passages *in itinere* or *a posteriori* corrections if the ink used is very similar to the original.

Instrument: Foster&Freeman VSC 8000[22].

Documents analysed: Lope de Vega, *Amor con vista*, autograph, National Library of Spain, Mss. Res. 85; Lope de Vega, *La niñez del padre Rojas*, National Library of Spain, Mss. Res. 248.

Issues particular to the manuscripts: crossed-out passages, differentiation of inks.

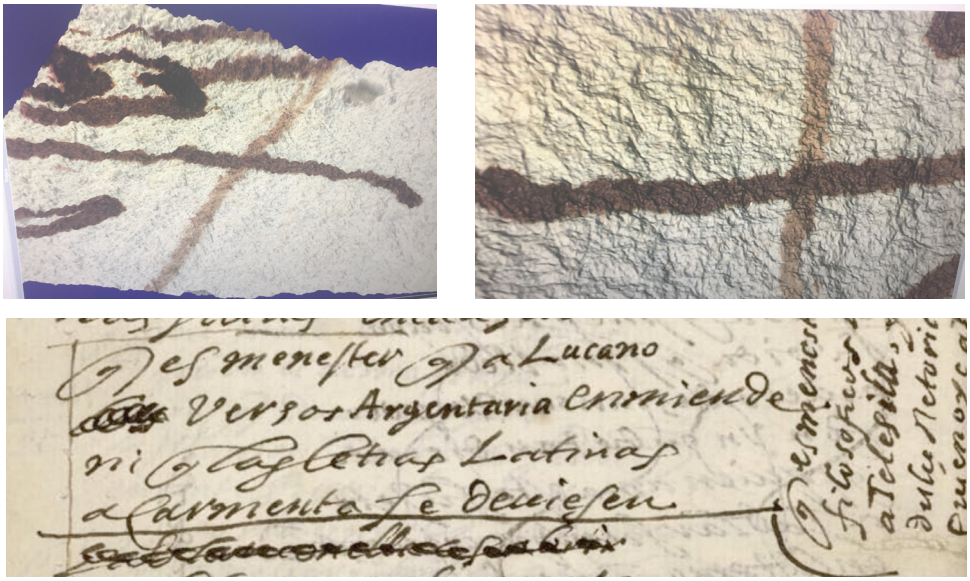
The VSC 8000 is a Foster&Freeman device designed for forensic examination of documents (forged passports, national identity cards, banknotes, etc.). It is a tool that combines digital imaging with multi-wavelength LED technology. It includes a microspectrophotometer, an instrument designed to measure several light spectra (UV-visible-IR) of microscopic samples. It also makes it possible to do analyses with transmitted, reflected and polarised light, in addition to other types of luminescence, such as raking light.



The results we obtained using false colour with Lope de Vega's autographs did not provide relevant information, nor did tests with transmitted light or polarized light[23]. Raking light also did not prove useful to this type of manuscript because the instrument used for writing did not leave any kind of groove. Hence the 3D reconstruction that the VSC 8000 makes with the extracted data cannot provide any relevant information. In the images, we see the results we obtained from using the raking light and from the three-dimensional reconstruction of a passage from the *Amor con vista* autograph.

22. I am utterly grateful to Foster&Freeman technicians (Enrique Ballesteros y Romain Le Bloa), as well as to Santiago Sánchez-Cortés, chemist and researcher at CSIC, María del Valle Ojeda, professor at Università Ca' Foscari of Venice and all the staff of National Library of Spain.

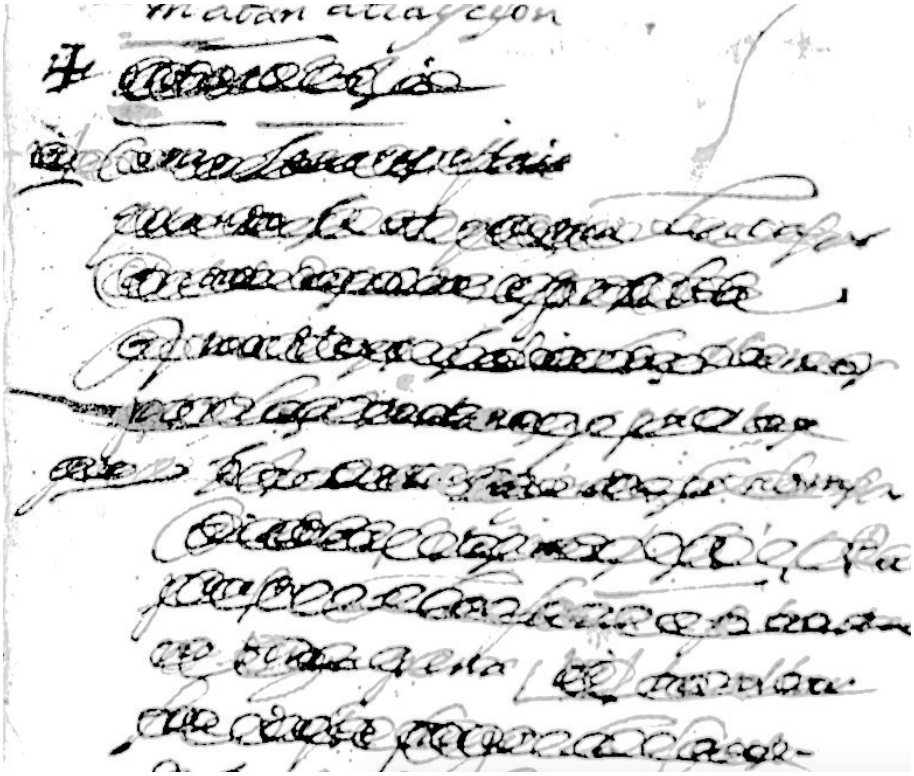
23. The false colour technique consists of modifying the greyscale by transforming it into a particular colour so that any possible differences are highlighted.



Lope de Vega, *Amor con vista*, Act II, folio 7 verso

In this case, the point where the two lines —supposedly drawn by two different hands— meet was analysed with raking light. Everything points to the horizontal line seen in the reproduction of the manuscript being done by the hand of Lope de Vega, who included it to show the exact place where the passage from the right margin was to be inserted. It is possible that the vertical line seen on the left margin of the lines may have come from another hand —that of an *autor de comedias*— aimed at pointing out a passage that was to be eliminated from the performance. The purpose of analysing the crossing-point of these lines was to have evidence proving which of the two had been produced earlier. If the evidence were to reveal that the vertical line was made before the horizontal, then we could say that Lope de Vega corrected the manuscript after someone else intervened in it.

The goal of the analysing *La niñez del padre Rojas* manuscript with the VSC 8000 was to try to read the end of the second act, where more than 25 lines are completely crossed out and nearly impossible to read. Although none of the techniques provided an optimal solution to the problem, in some places, the image captured in the spectrum band of 540 nanometres —subsequently modified using image filters (contrast, saturation and sharpness)— highlights the differences between the ink of the text (which generally appears more tenuous and greyish) and that of the cross-outs, which tends to be darker, thus facilitating the reading of some passages.



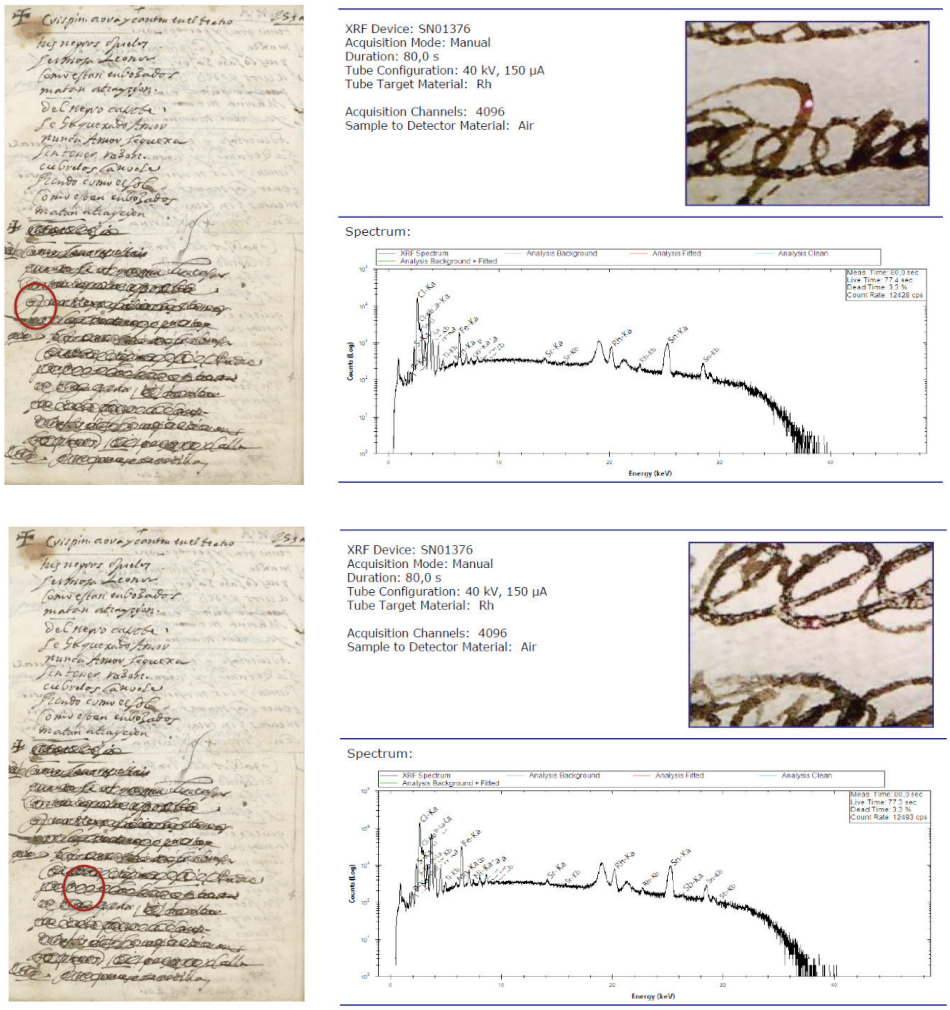
Lope de Vega, *La niñez del padre Rojas*, Act II, folio 15 verso. Image 540 nm. with image filters

Instrument: XGLab-Bruker XRAMAN portable XRF and RAMAN spectrometer[24].
Documents analysed: Lope de Vega, *La niñez del padre Rojas*, autograph, National Library of Spain, Mss. Res. 248.
Issues particular to the manuscripts: differentiation of inks.

The instrument was developed by XGLab —now part of the Bruker Group— and combines X-ray fluorescence (XRF) with the Raman laser, i.e. it makes it possible to perform simultaneous element and molecular analyses. This is a tool that has been specifically designed for applications in the field of cultural heritage; thus, it does not damage, interact with or invade the material analysed. What is done with this technique is to radiate a specific area of the manuscript with X-rays, which makes each chemical element within the area we are radiating emit a certain secondary —or fluorescent— light containing a kind of digital fingerprint of the element, i.e. the chemical composition of the material being observed.

24. In addition to Bruker's sales force and technicians (Ángel J. Uceda, Michele Gironda and Max Buegler), I must express my appreciation to Santiago Sánchez-Cortes, Mercedes Iriarte and María del Valle Ojeda, as well as to the staff of the National Library of Spain.

As above mentioned, the manuscript analysed has an extensive crossed-out passage at the end of the second act (folios 15 verso and 16 recto). The deleted lines were autographic, as indicated by the inscription «Fin del Segundo acto» and the initials of Lope de Vega that appear at the end of cross-out (folio 16 recto). This shows that playwright initially wrote the end of the act in his own hand. Some time later, someone —or perhaps Lope de Vega himself— crossed out those lines, and a different hand —not autographic— re-wrote the following passages (folios 16 recto and 16 verso). This situation raises a number of questions: was it Lope de Vega who crossed out his own lines? If this is the case, why did another, different, hand re-write them? Did the same person cross out and then re-write the passage? For what reason?



Lope de Vega, *La niñez del padre Rojas*, Act II, folios 15 verso and 16 recto

The chemical analysis of the inks with X-ray fluorescence shows that there are three different inks on these folios: one is that of the Lope de Vega's original writing; another —very different— is that of the cross-out; and a third matches the re-written passage. What was most relevant about the case was the particular nature of one of the inks. The chemical combination of the elements used to make the ink used for the cross-out contained a high percentage of zinc —an unusual material in the composition of inks— and was not present in the other two. Initially, and far from resolving the question, this fact caused new questions to arise and —to a certain extent— it seemed contradictory: how could it be that the ink of the cross-out and that of the re-written passage are different? Did someone cross out the passage and not re-write it? Was the comedia left unfinished for some time?

The doubts faded away when we analysed other inks that appeared along the pages of the manuscript —and, more specifically, when we examined the chemical composition of the ink used to transcribe the performance licence signed by Pedro de Vargas Machuca (Act II, folio 16 recto). X-ray fluorescence shows that the ink used by the censor contains a much higher ratio of zinc than usual, that is identical to that used for the crossing out of the passage analysed and makes it possible to state with scientific and objective data that was the censor of the play, Pedro de Vargas Machuca, who eliminated the end of the second act. The type of cross-out used to prevent the passage from being read is also understood in this way[25].

At this point, we could offer some assumptions about who added the lines after the ending of the autograph was censored, but we prefer to refer to the data extracted from the chemical analysis of the composition of the inks. Among all the inks examined, we would like to highlight the one used to add an instruction in the right margin of the folio 6 verso of the third act. There, a note was added «este ha de ser el verso más celebrado de la comedia», in what would seem to be a stage instruction designed for the performance of the play, i.e. an addition that must come from the pen of the *autor de comedias* or of someone in his company. The results of the chemical analysis of this ink show that it has the same elementary composition as the ink with which the lines concluding the second act were written[26]. This would indicate that it was most likely a director who, at a later time and based on the need to have a proper ending for the second act —since the one that Lope had written had been crossed out by the censor— had to draft an alternative ending to finish up the act and to be able to perform it.

As a conclusion to the paper and the tests conducted, we must start by acknowledging that there is no single tool that offers a solution for all the questions faced by a scholar of Golden Age drama, but rather it is often the combination of several techniques that makes it possible to provide relevant results. The instruments described in this paper offer us objective information to identify Lope's inscriptions, as in the drawing of *El cardenal de Belén*; to read under cross-out fragments, as in the manuscript of *El bastardo Mudarra*; or even to identify the inks of inscriptions or erasures, as in *La niñez del padre Rojas*, where the inks' chemical composition reveals what exactly happened at the end of the second act.

The complexity and particularity of the Golden Age theatrical manuscripts and the variety of hands and inks found in them are clear, and the analysis of these documents with analytical and imaging tools is increasingly necessary to understand the process of composition and circulation of the text. The success of this analysis is undoubtedly the result of the combination of several techniques and instruments,

25. Despite being an infrequent and interesting case, there have been many researchers who have hypothesized on what would have happened at the end of the second act. Bastianutti, in his edition of the play (Lope de Vega, *La niñez del Padre Rojas*, pp. 212-213), attributes the cross-out and re-writing of the passage to Lope de Vega, while Presotto (2000, p. 289) already stated that the alternative ending could not be autographic.

26. Although the ink is very likely to be the same, an analysis of both using the X-Raman technique could confirm it without any doubt.

as well as of the collaboration between different specialists, necessarily including chemists, restorers, librarians, photographers and philologists. The sum of all their efforts, expertise and skills will offer extraordinary results in the near —rather than distant— future, and this will allow us to have a much deeper and more comprehensive understanding of Golden Age theatrical texts.

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