**Press conference ESA BIC Prague**

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English translation from the Czech transcripiton

**Kateřina Syslová**

I would like to wish you a nice day and welcome you to the ESA BIC business incubator conference to present Rafael's painting and its analysis using space radiography by Insight Art. It is a project incubated in our ESA BIC business incubator.

Thank you very much for gathering here today, even in this slightly unfavorable time, the time of face masks. Our theme is an example of the intertwining of two worlds: the scientific and artistic worlds, the exact world with the creative one. And it is also a merging of ideas. The one that originated here on earth, along with space technology that orbits hundreds of kilometers above us.

Let me introduce today's guests: art historian and former director of the National Gallery, Mr. Jiří Fajt. Furthermore, Mr. Jiří Lauterkranc, an authenticator and restorer with more than ten years of experience, who worked on the artworks of Rafael and Vincent van Gogh. Last but not least, Mr. Josef Uher, a physicist and an expert in spectral radiography and the development of radiation imaging systems.From the list of today's guests, it is possible to deduce the connection of seemingly unrelated worlds. The merge of the earthly world with the universe. And that is what our ESA BIC incubator is dealing with.

My name is Kateřina Syslová and I am the manager of ESA BIC Incubator. In its name, I welcome you here today. ESA BIC is an incubator of the European Space Agency, the second largest space agency. We are developing projects that generated the idea of using space technologies here on earth. Also, we develop new technologies that may potentially be used in space. You may know popular examples of the use of space technology, such as Velcro or Teflon. But there are many more of these examples. It's in navigation systems, it's in ATMs or the tiny cameras in our phones. In the incubator, you will find startups and projects with a very wide range of focus. From suborbital rockets to navigation for fishermen. One of our startups, for example, came up with the idea of using technology that was originally developed at CERN and used on the International Space Station and turned it into an X-ray for art analysis. This project is run by Prague Insight Art, which participated in the analysis of the painting of Rafael, the Madonna with Child. It helped with its authentication.

The history of this painting will be presented by Mr. Jiří Fajt and I hereby give him the floor.

**Jiří Fajt**

Good morning and thank you.

You have heard a lot about technology and I will focus on what the technology can be used for and what specific outputs it has. We used the technology in the case of this painting, as has already been said. The painting is not completely unknown in the literature, but there have always been great doubts as to whether it is Rafael's work or whether it is a copy, a workshop copy. Or some imitation from later centuries. These are the questions that art history deals with. I came to the painting in connection with the preparation of a more broadly conceived exhibition of Raphael and his patrons, especially Leo X. He is the first of the popes of the Medici family. You probably know, who the Medici family of Florence was. The first bankers and one of the most powerful aristocrats of their time on the European continent. The exhibition was to be opened this autumn at the Royal Museum in Brussels. Due to the pandemic, it was postponed by a year, expected to be made available next October. I suspect the planned opening is the 15th of October.

The painting, as you can see on the first slide, is signed and dated. You can clearly see it saying, *Rafael Urbinas Pingebat, 1517, Roma*. This has also been questioned, which in itself does not mean that the painting was created by Rafael. We know several similarly signed paintings, which have little to do with the master who signed that painting. So that's not enough proof on its own. We began to focus on this painting, as I said, in the more broadly conceived study and preparation of the exhibition. We have invited a number of world-renowned experts to do this, Jiří Lauterkranc will talk in more detail about the advisory board we comprised for it. We began to focus on this not only from an artistic-historical point of view but also from a technological and restoration point of view.

The painting, as we discovered, together with my colleague Timothy Verdon, who is my partner, colleague and very good friend, with whom I work on the exhibition for Brussels. He is also the director of the Dome Museum in Florence. The painting was ordered by the gentleman you see in that painting. Pope Leo X. I have already mentioned him, as the first of the two Medici popes. An extremely important patron, who was mainly dedicated to supporting Rafael's work in the Vatican. You can see the Vatican depicted in the upper right picture and in the lower one you have the interior of the Holy Hut in Loreto. As you probably know, the Holy Hut, Santa Casa, is a very respected, very popular, and revered monument in the Christian world. It is one of the most important Christian pilgrimage sites in Europe. It's basically a stone house, very simple, although it doesn't look like that. Here is its renaissance alternative, in which the Virgin Mary lived when the archangel Gabriel proclaimed through the window that she would give birth to a son. The Holy Hut was located in the Middle East and in the 12th century it was, as an important relic, moved to Loreto, Italy. A very important place of pilgrimage has developed in Loreto, ever since the 12th century. In 1512, a very important date for us, the entire Loreta complex, with the central building of the Holy Hut, became the property of the Vatican popes. The predecessor of Leo X, Julius II, was involved in decorating the Holy Hut. He invited several outstanding Renaissance artists, such as Bramante and a number of sculptors, who decorated the Holy Hut with beautiful reliefs on the outside. Here you can see the interior. The interior is important to us, as if you notice the painting on the altar today, that painting is not the one that was originally intended to be there. The painting you have here in the one-to-one magnification format is the painting of Raphael, which was originally intended for this altar. It was placed in a stone aedicule in the Holy Hut. Here you also have a comparison of two works that are extremely interesting and which my colleague Lauterkranc will talk about. On the left, the painting we focused on, and on the right, another work that was attributed to Rafael and his workshop. This is the so-called Great Holy Family, now housed in the collections of the Louvre. It was a gift from Pope Leo X from 1518 to King Francis I of France. As you can see, the painting was created based on the same preparatory sketch, the same template as the painting on the left, the Virgin Mary with little Jesus. However, the whole composition was expanded by other figures, which were taken exactly from other well-known paintings of Rafael, both hanging or paintings on the wall. The work in the Louvre is important to us because in the professional literature it was considered that the painting on the left is a simple variant of the painting in the Louvre. We managed to find out that it is exactly the opposite, that the image on the left was the starting point for the image on the right. That the left painting is most likely the authentic work of Rafael himself, and that the work that is in Louvre today is the work of his workshop collaborators. Many excellent painters worked in the workshop, so they were not below-average painters. Giulio Romano, for example, one of the best painters of Europe at the time, painted there. But still, it was not Rafael, and it was Giulio Romano, with many other collaborators, who was probably the author of the painting in the French Louvre.

Otherwise, the painting we have here, which we are working on today, has a very interesting origin. Its fate can be traced back to 1517 when the painting is ordered by Pope Leo X and donated to Loreto. The painting then re-appears in the 17th century in the Vatican, where it is captured in the inventory and there are talks that the painting adorns the chapel of the butler of the Vatican Palace. Who is a very high-ranking representative of the Vatican state, and has direct access to the pope. So basically, we have a private papal chapel, where the painting is captured in the 17th century. Later comes Napoleon Bonaparte, who conquered Rome with his troops at the end of the 18th century. The troops came to the Holy City with a list of monuments that Napoleon Bonaparte wanted to bring back to Paris. This painting was on the list, so the painting was “stolen” from the Vatican and makes its way to Paris. It remained in Paris until the beginning of the 19th century, until the time of Louis XVIII. During his reign, the painting was sold to England. Mr. Bosanquet is the last English owner, and then the interesting part of the fate of the painting comes, the part that brings us to Prague. The painting was exhibited in Prague in 1936, as it is said here. The painting was purchased by Otomar Švehla in the 1930s, who was a relative of Antonín Švehla, the three-times prime minister of the Czechoslovakian Republic. The painting remains the property of Švehla’s family until 1992 when it was sold.

The painting was exhibited in Prague, so it is not a complete unknown for the local experts. The brand new piece of information is its attribution to Rafael himself. Here are three more preparatory drawings, which were mentioned in the context of the Louvre painting. We managed to prove that the drawings did not serve as a preparatory piece for the painting in the Louvre, but for the painting that we have in front of us. One of the preparatory drawings is in Louvre, Paris, and two are kept in the Uffizi Gallery in Florence. This slide shows what I was talking about, that the painting was very often imitated. The most significant copy of the painting is the picture on the left, painted by Hemessen, which dates to the 1920s and which demonstrates that "our" painting is the one being copied. Then there are other copies, like this graphic, which was created at a time when the painting was kept in England. Other copies from the 19th century can be seen, and the artistic quality itself indicates that we are far from Rafael's original.

That's all from me, thank you for your attention.

**Jiří Lauterkranc**

**[Technical issues]**

Hello, my name is Jiří Lauterkranc. I will introduce the restoration side and the technological side. I will focus more on technology. First of all, I would like to thank the ESA BIC incubator for the care it has given us, and for allowing us to present our work here at this conference. Where we can present such an important topic, the Rafael painting. I would also like to thank Czech Invest for this opportunity.

Hold on a second.

**(Technical issues)**

As has already been said, my field is restoration. I'm a restorer. With my colleague Jiří Živný, who is present, we had the honor of restoring the final version of this artwork. I say final because of course, the work has undergone some restorations and interventions in the past. I will talk about them in more detail. In this slide, you see the whole painting framed and located under the Roma inscription, which is the signature and dating of the artwork. Several world experts have been involved in the examination of the art since the 1930s. The first expert opinion dates to 1936 done by Professor Petr, who was already cooperating with the Museum of Louvre at that time. We managed to find reviews from the year 1936 that are of very high quality. Subsequently, professors Baldini, De Vecchi, Chiarini, Marabotti and Carlo Pedretti, and many, many others took part. Indeed, there are many materials available that relate to the technical side of the work. The photo on the left shows the art, prior to being restored by Professor Ondráček, who carried out the first modern restoration in 2002. My colleague Živný and I took over the baton and managed to complete the restoration in 2019. The last photo on the right shows our work.

For the restoration itself, there is also the examination of the painting, since restoration is not just about physical work. You have to do a lot of analysis. You have to determine the restoration procedures, find out what condition the painting is in. You need to address the unclear elements of authentication, which are discussed and is needed to be verified. A lot of technical analysis has been done in the past, but as time goes on and we have new possibilities, it was necessary to update this knowledge with the help of our current technology. This was done using the scanner from Insight Art. To determine the precise technological procedures of the restoration, we have established an international Advisory Board, with which we have devised the individual steps. We all had to agree on how the restoration and analysis would look like. The members included restorers from the Vatican Museums, such as Lorenzo d'Alessandro, Antonio Forcellino, Paolo Violini. Timothy Verdon and my colleague Jiří Fajt. I would also like to mention an important point, that the procedure and the method of research were consulted with experts from the Louvre Museum. Vincent Delieu, the chief curator of 16th-century collections, specializing in Italian paintings, helped us a lot there.

Here is an example of some approaches to technical ways of analyzing a work of art. The first image is a photograph of the work in ultraviolet light before restoration. What glows green in the picture are the old paints that have gone dark, dirty, and that need to be removed from the picture. To highlight the original concept of the author. Another image, black and white, is an infrared photograph, where you can reveal the way of underdrawing, underpainting, and other aspects of the work. Then you see another variant of the infrared image, the image on the top right. That is a radiographic image taken by the robotic scanner of Insight Art. I will have a closer look at it later. Then we did microscopic imaging, X-ray fluorescence, and other analysis. Here you can see a black and white X-ray image, in high resolution, which is a standard product of our Insight Art scanner, which can also produce color images. Colleague Uher will comment in more detail on this later. On the other side, you see an image that is a combination of an infrared X-ray and a daylight photograph with outlines of various minor damages and with the structure of the lacquer layers that must be removed. This is how we analyze the painting, prior to the restoration. That allows us to determine the exact procedures to be performed, and where.

What did we focus on in this work? It was mainly three things. Firstly, the most important was the inscription saying: Roma, which is on the blue rim of the Virgin Mary. It has been confusing historians, restorers, and technologists for a long time. Even in Louvre, Madonna has an inscription, but Romae and the difference between those inscriptions had to be explained. Why is it in both paintings, when the Madonna of Louvre was made for the French king and not for Rome? For this painting, it makes sense, as it was painted for the empire, the Holy Hut in Loreto, so there is justification. However, it was discovered, and it has been speculated before in Louvre, that the inscription on the Madonna of Louvre was written based on this painting, but it was not read correctly. Our painting says Roma, followed by the final sign, which was misread as the letter e. Due to this mistake, Romae was inscribed on the Louvre Madonna. Another very important aspect is the method of underdrawing. Many Rafaelists focus on proving authenticity by determining the type of underdrawing in the work. The art Madonna and Child has an ore underdrawing, hatched in red ore, which is visible even to the naked eye, in some details of the painting, so it is relatively well identifiable. On the Louvre version, there is a mere outline visible, which again proves well that this motif was used for the Louvre version and other motifs. These motifs have also been drawn from other artworks, and cardboard has been used to guide the folding line. We strongly focused on this. The author's changes in composition and pentimenti are the tiny details that you will find in the various technological analysis. It is possible to trace how the author himself, changed some details in the composition of the work. For some authors, pentimenti are more common to occur, the occurrence is still of great importance though. Here you see the process of scanning the painting, and the apparatus we built for it. We prepared the scan and started the Insight Art analysis process. This slide shows the various stages of photography - colleague Uher will discuss it in more detail later. These are energy sensitive radiographs, which is unique. We are the first in the world to put this radiographic method together. It helped us a lot in the study of the work to get acquainted with the structures within the layers of the painting. Here you see the next phases of the energies we have measured. On the left is an overall graphic with certain energies that we have measured. On the left, you can see a detailed image, where the energies of different materials can be recognized, as they manifest themselves in different colors. Each color represents a different composition, the composition of the pigment layers. Here I will try to describe it in more detail. Black and white x-ray. Here you see the various energies measured on the painting. Each represents a different group of materials. Why is it important for us to know these details? We don't have enough time to go deep into that, but the more information we have, the more precisely we understand the layers of the painting. Therefore we can give a clear result with more certainty. When we have enough information, we can make a relevant decision, both in the process of restoration itself and in the processes of authentication of the work. Here you can see a composite X-ray, where we can identify the given groups of materials. Here we can identify copper pigments, specifically green lead pigments. All those pigments fit into the structure of Rafael's work.

That would be all from me. I'll just play you a time-lapse video of the measurement process itself and give a word to my colleague Uher for a moment.

**Josef Uher**

I'm going to have to switch on the presentation.

I would like to say a few words about technology and how it works, how is it connected with space and particle research. I will also mention what other technologies our scanner uses and who is involved in the development of those technologies.

I'll start with this slide with the footage from our measurements. Our scanner consists of two robotic arms and an X-ray detector. I will talk more about it later. I would mention what the challenge of this particular measurement was. From a technological point of view, there were two basic pitfalls. First is the size of the painting, it is large. It means that it is a large artwork for our scanning system and we had to measure the work in three phases. It means that it took us three days and then we had to process and combine the data. The second challenge is that it is a rare and expensive work, which means that we had to be 100% sure that no defect would occur. We could not afford to damage the work in the slightest way. So we have implemented several layers of protection to be absolutely sure that no damage will occur under any circumstances.

The scanner is the creation of three companies. The robotic platform, which includes the mechanics of holding robots and especially software and robot control. As for X-ray imaging, the control must be very advanced and very precise. That robotic platform is being developed by Radalytica. The detector is a product of the Advacam company. Both are Czech companies, which means that we can talk about full-on Czech development and Czech equipment. The part that is related to art itself and the specifics of the application of X-ray imaging, that is the work of Insight Art.

I also want to mention the notion of Inspection 4.0. Industry 4.0 is a popular topic today - there are technologies commonly used in Industry 4.0 that spill over to many other areas. In this case, it is non-destructive testing. The basic principle of the whole scanner is the standard one you know from hospitals. This means classic X-ray imaging, where on one side there is an X-ray lamp that emits X-rays. It passes through the examined sample and there is an imaging detector below the sample. It's a shadow play, just a different kind of radiation is used for it. The major change occurs in the management of the whole procedure. This means changing the position of the X-ray machine and the detector. The basic limit or problem, as you may know from hospitals, is that classic X-ray imaging is always black and white. This means that the used digital panels are only able to measure the intensity of the radiation, not its wavelength. It´s shown in this sample picture, which consists of different pure metal foils. Those metal foils should differ in some way, nevertheless, they don't. What happens is that a thick layer of light metal looks the same as a thin layer of heavy metal, which in the case of art means that pigments that contain lead can look similar to thicker layers of lighter pigments. I like to demonstrate that downside in this picture. It is nicely visible if you take a black and white photo of the stained glass. Especially at the top, there are places where you have the same shade of gray and if you would like to make some other analysis (for example for restoration purposes), it would be not clear whether the materials differed in the place or not and whether you should treat them differently. When you take a color picture, you don't know why red is red and why blue is blue, in other words, what chemical materials or elements are there. However, what you can tell, is that there must be a different and more accurate method of analysis applied. And that's something we're trying to do with our scanner. We give additional information to restorers so that they can study certain points of interest, in more detail.

Detector technology has a relatively long history. Work on the detector began twenty years ago at CERN, where teams have been developing detectors to be applied for the accelerator of particle physics. In the late 1990s, they decided the know-how could be utilized outside of particle physics. This was the beginning of the **Medipix Collaboration, w**hich is still led by CERN. It was gradually joined by many institutions, including institutions in the Czech Republic. So we started working on that technology as Ph.D. students at the Department of Technical and Experimental Physics of CTU of Prague. After a few years of development, the **Medipix Collaboration** decided to release licenses. It was the beginning of the Czech Advacam company, which begins to develop and manufacture detectors for global markets. The connection to outer space emerged early on, a particle detection technology is extremely useful when applied in space. Because the detectors and chips we use are very light and compact and at the same time supply a huge amount of data. Therefore NASA and ESA started using our chips for various applications in outer space, such as measuring cosmic rays and radiation doses, that the astronauts on the ISS are exposed to. You can see one of the cornerstones of our detectors here. It is a fully digital chip with a detecting layer attached to it. What is the advantage of using such technology? You can see a black and white image here. Thanks to the fact that our chips can measure the wavelength of X-rays, we can measure how X-rays change after passing through the sample. Not just how it dampens overall, but how the composition of the wavelengths changes. Based on this, it is possible to determine the composition of elements. Thus, the pigments are different, and further analysis, which uses, for example, X-ray fluorescence, can now focus on specific areas of the painting. Here you can see it again: first, there is a black-and-white image, and now we see it in color. You can immediately see which areas to focus on. When I go back, there are a lot of places where we have the same shade of gray. But if we look at the spectral method, we can immediately see the differences and where to focus further research on.

The second part I would like to talk about is the robotic platform. This video shows the enormous flexibility that using robots gives us. You see, I have a smile on my face. We didn't have to wear masks at that time. What we are trying to achieve, is not only to expand the data from X-ray imaging but also to simplify it. So people who do not have experience with X-ray imaging, who are not experts in non-destructive testing, can use this system for their work. And to make it as effortless as possible for them. We have done a great job of synchronizing the robot's cooperation. That is absolutely essential for X-ray imaging as we use it. Here is a sample of other options. Thanks to robots, we don't have to limit ourselves to two-dimensional image scanning, but we can extend it to the third dimension. Here are a couple of robots, an X-ray machine, and a detector scanning individual projections of the statuette from different angles. They virtually rotate around the statue. And this information can be used to create a 3D reconstruction. The computed tomography is used here. It is basically the same as the one used in hospitals, the principle is very similar. Here, you can see the resulting 3D reconstruction. In other words, thanks to the robotic platform, we can extend all the benefits we discussed to sculptures, furniture, and any other art objects. Here is a sample of our measurements, in cooperation with the National Gallery in Prague. In the last slide, I would like to demonstrate the immense flexibility of this technology. Both the detectors and the robotic system. The applications lie not in art only, but also in other industries. Besides, thanks to robotics, we can get the device to the object we need to examine. We do not have to bring the object to the device. Typically, if you want to check the statue, the restorers will take the statue and take it to the hospital at night. They do a CT and then they have to take the statue back. On the contrary, it is not a problem for us to get our system to the statue, to examine what is needed, and to take the scanner back to the laboratory.

So that's it. Thank you for your attention.

**Kateřina Syslová**

Ok, I would like to ask, if anyone in the audience has a question? We will gladly give you an answer.

**[The question part is missing – skipped. EDIT: The part is added to the subtitles]**

**Kateřina Syslová**

Thank you very much, I have a complementary question: what we say these days when someone asks about the value of the painting, is that it is priceless. Can you give at least a gross estimate of the value of the painting?

**Jiří Fajt**

Oh, that is a tough one (laughs). Paintings such as this one, rarely appear in the art market, therefore estimating their value is highly problematic. I can give you examples: lately a painting was sold, that was credited to Leonardo Da Vinci. I believe it was sold for 450 million dollars. However, it is complicated, to put it that way. There are many experts, who do not consider the painting as a direct work of Leonardo Da Vinci. It was sold as Leonardo’s painting though, therefore that could give us a hint about our price. Art museums value their paintings in case of renting them to expositors, and also when insurance companies require the insured value. I believe, that our price falls somewhere within hundreds of millions of euros or dollars.

**Kateřina Syslová**

(laughs) That truly is priceless, or perhaps unimaginable. I address the audience again: are there more questions, please.

**Question**

May I? The painting is currently abroad. Does the owner of the painting collaborate with you? Is the Czech state trying to acquire the painting for the national collection? Since there is a Czech trace in the artwork. There was a discussion about it at the Ministry of Culture a few years back. It seems like this might be a chance to acquire it for our collection. Would that be possible?

**Jiří Fajt**

There is indeed an interesting Czech trace in the artwork. We allowed ourselves to name the painting Rafaelo’s Madona of Prague, which is I believe the official name among the scientific community now. In the past, the approach of the Czech government was truly unfortunate. The State proclaimed the painting a Czech cultural heritage only after it was transferred abroad. There were major discussions about that. It would undoubtedly be great to have a painting such as this one in our Czech collection and galleries. Nevertheless, I can’t imagine anyone collecting the resources for the purchase. Even though with the budget of 500 billion at disposal, the government could spend a billion on a painting (laughs). That was meant as a joke. Truly, there are no negotiations with the Czech government. We are in contact with the owners directly, without their approval we could never get our hands on the painting, as it is truly abroad.

**Kateřina Syslová**

Do you have any questions? Ok. I would like to extend my gratitude to all. You can address the gentlemen from Insight Art directly, which questions regarding the technology, restoration, or authentication, in case you do not want to ask your question publicly. Ask Mr. Jiří Fajt in case you have a history question. The questions regarding the business or cosmic incubation you can ask me or my colleagues from the ESA BIC Incubator. We are also proud to have the representatives of educational office ESERO and The Academy of Science, alongside their project Space for Mankind. Direct your questions regarding space technologies or space in general towards them.

I would like to thank Insight Art and Mr. Jiří Fajt for being here. Further, I thank our partners in the ESA BIC Incubator, with our operator Czech Invest. Our main partner is the European Space Agency. Hereafter we are partners with the Capital city of Prague, South-Moravian county, South-Moravian innovation center, Ministry of Industry and Trade, and Ministry of Transportation. In addition to thanking you, I would like to invite you, for further discussions of the technology presented, to meet us at 1 pm at the Laboratory of Insight Art, where we will continue our presentation. The address is U Pergamenky 12. Thank you and best regards.