

# Radiocarbon dating of ancient written documents: a feasibility study on carbon-based inks



Istituto Nazionale di Fisica Nucleare  
Cultural Heritage Network

S. Barone, S. Dominici, M. Fedi, L. Liccioli

*serena.barone@fi.infn.it*



# Radiocarbon dating

- $^{14}\text{C}$  dating gives us informations about the «death» of an organic material
- This date represents a *terminus post quem* for the manufacturing of an artefact

**Which «event»  
are we actually dating?**



# Dating ancient documents

	Supports (paper, papyrus, parchment...)	Ink or pigments
What we date	A moment closer to the making of the support	A moment closer to the actual writing
What we sample	A fragment of the support, from the edges	A portion of the text
How much we collect	No strict limitation about the mass	As lower as possible



- Dating the ink gets us closer to the «real date» in which the document was written
- We have to preserve the readability of the document itself

# Papyrus supports

- Papyrus supports were firstly produced in ancient Egypt
- Papyrus is the most widespread writing support in the antiquity
- it was made from the stems of the papyrus plant, placed side by side in overlapping layers



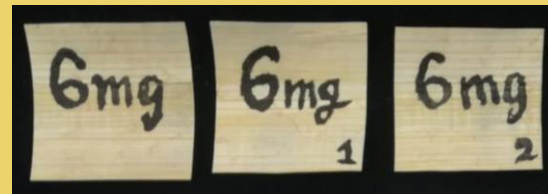
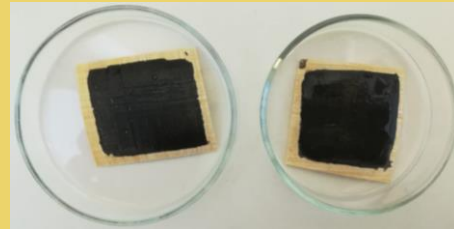
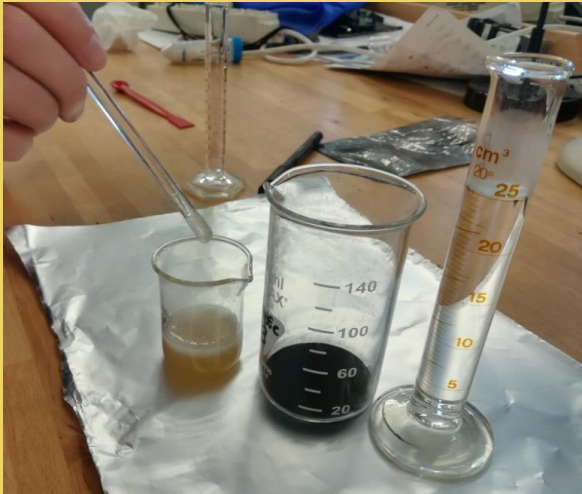
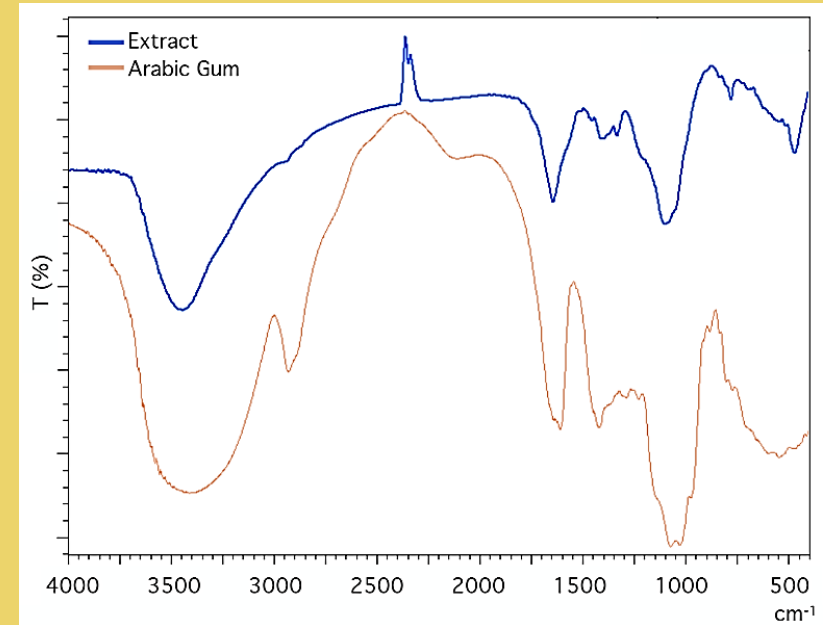
# Charcoal-based inks

- Charcoal-based ink was used in Egypt at least until the 4<sup>o</sup> century BCE
- It consists in small amorphous carbon particles, dispersed in an organic binder, typically arabic gum
- Removing the arabic gum (high solubility in water), the carbon particles will detach from the support



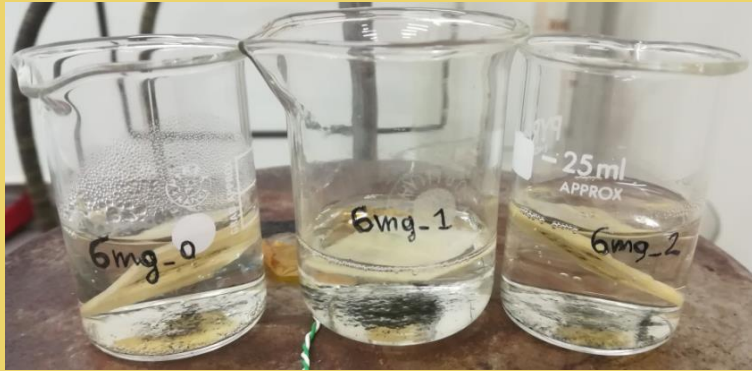
# Test samples

- Materials were characterized by FTIR
- The composition of the arabic gum is very similar to the papyrus extracts
- We decided to date the charcoal particles of the ink



- We prepared a home-made ink using charcoal and arabic gum
- We prepared test samples using the ink and a modern papyrus sheet

# Pre-treatment



$m_{\text{sample}} \approx 0.2 \text{ mg}$

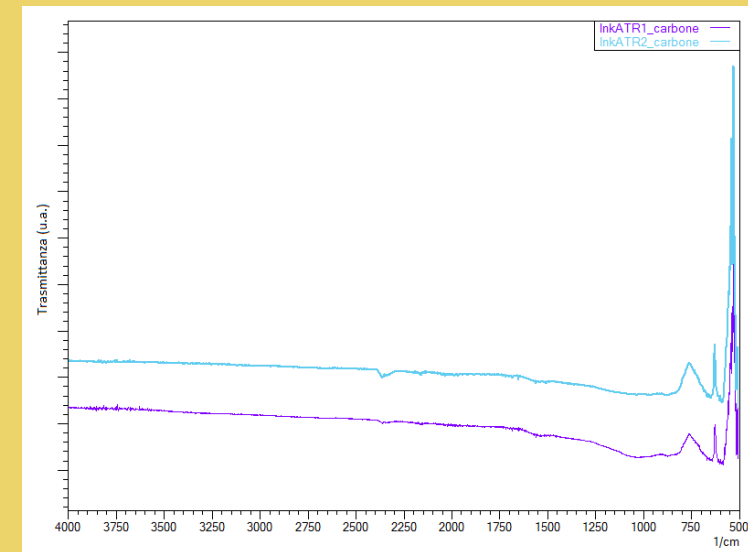
too small!

**Micro-samples set-up required\***

The procedure:

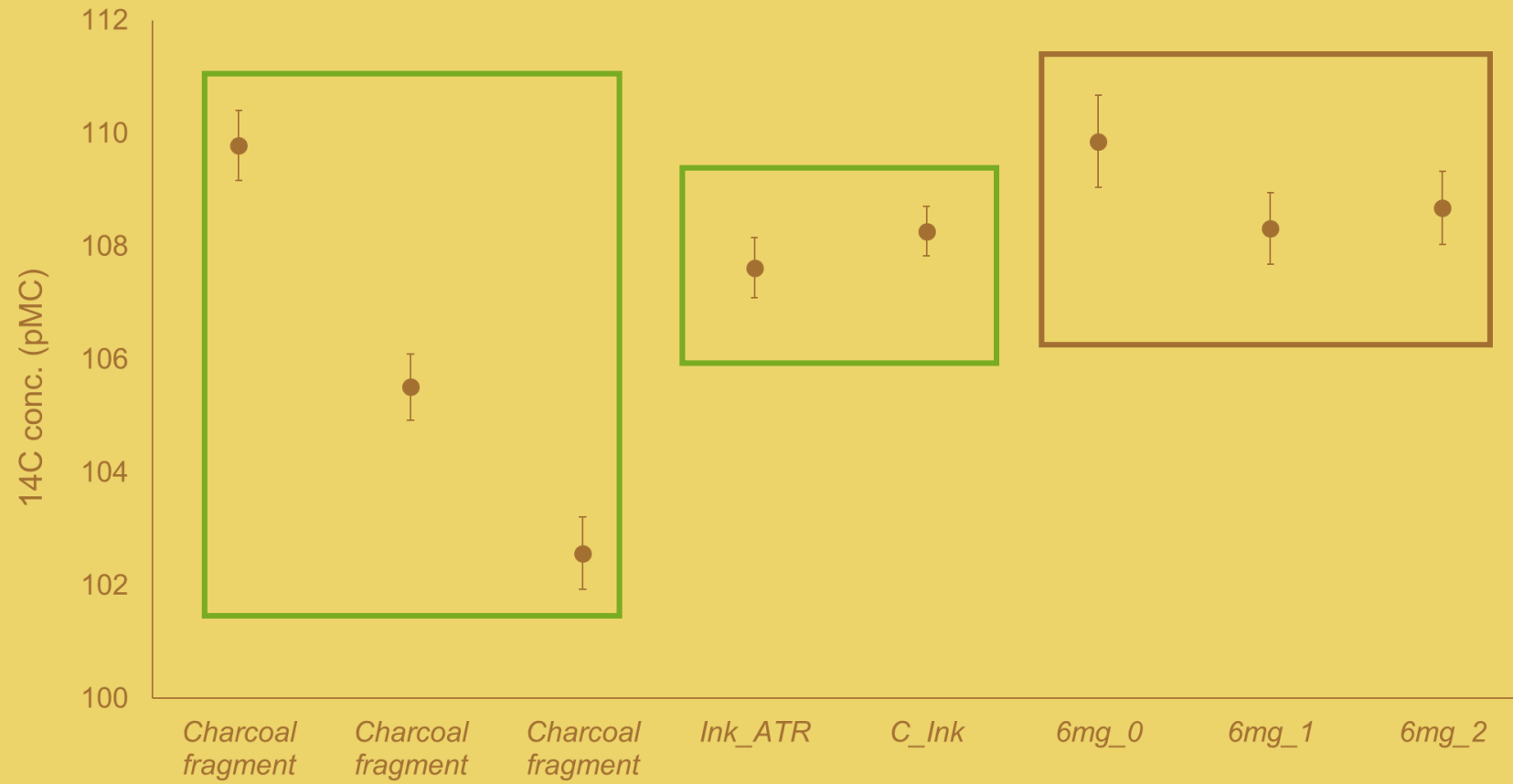
- Bath in ultra-pure water @50°C for 8 hrs
- Keeping @25°C for 16 hrs to allow for setting
- 1M HCl @80°C for 1 hr
- Drying into tin capsules for following EA

- The extracted charcoal particles were characterized by ATR
- No signal of Arabic gum is visible



\*M. Fedi, S. Barone, F. Barile, L. Liccioli, M. Manetti, L. Schiavulli, «Towards micro-samples radiocarbon dating at INFN-LABEC, Florence», N.I.M. B, 2020

# Results





# Conclusion

- The feasibility study to date charcoal-based black inks is presented
- The issue about this application is the invasivity of the analysis; we have reduced the mass required employing our new micro-samples set-up (see L. Liccioli's talk on Wednesday 16 afternoon, Hedi Lamarr room)
- We prepared test samples, using a commercial papyrus and a home-made black ink, obtained combining modern charcoal fragments and Arabic gum
- The procedure we used is efficient to remove all the contaminants and allowed us to collect enough material to perform radiocarbon dating



# Thank you for your attention

*[serena.barone@fi.infn.it](mailto:serena.barone@fi.infn.it)*

