TNAAF – Neutron techniques for Archaeology and Forensic Science

Tecniche Neutroniche per Archeologia ed Analisi Forense

Coordinator: Roberto Senesi, Università degli Studi di Roma Tor Vergata, Centro NAST

Participants:

Università Tor Vergata – *Team: C. Andreani, R. Senesi, C. M. Labarga, O. Rickards (Centro NAST).*

Centro Fermi – *Team: G. Festa, L. Arcidiacono (October 2017- September 2018)*

Università di Firenze - *Team: P. Baglioni;* **Università di Milano-Bicocca –** *Team:* G. Gorini

University College London (UK**)** Science and Engineering in Art, Heritage and Archaeology (SEAHA) Centre for Doctoral Training - *Team: Marcos Martinon-Torres*

Place of work & Collaborations:

Place of Work

- Centro Fermi - **Research and Heritage Institution**
- ISIS Spallation Neutron Source (Harwell, UK) **– Research Institution**
- University College London (UK) – SEAHA, http://www.seaha-cdt.ac.uk - **Research Institution**
- Università degli Studi di Roma Tor Vergata - **Research Institution**

Collaborations

- **Research Institutions:** Consiglio Nazionale delle Ricerche (CNR-IBAM Catania and CNR-IPCF Messina) ; MOLAB (I), Oak Ridge National Laboratory (USA), Helmholtz-Zentrum Berlin (G), Argonne National Laboratory (USA); Sapienza Università di Roma (I); Universita' di Milano Bicocca (I) ; Scuola Normale Superiore (I); Universita' di Palermo (I); University of Coimbra (PT); Università degli Studi di Firenze (I).
- **Heritage Institutions:** Anthropological Service, Soprintendenza Archeologia del Lazio e dell'Etruria Meridionale - (MIBACT, I) Museo Egizio, Torino (I) ; Tarisio – Fine Instrumentations & Bows (UK)**,** Fondazione Pro Canale **(I);** University of Coimbra (PT); Scuola Normale Superiore (I);.

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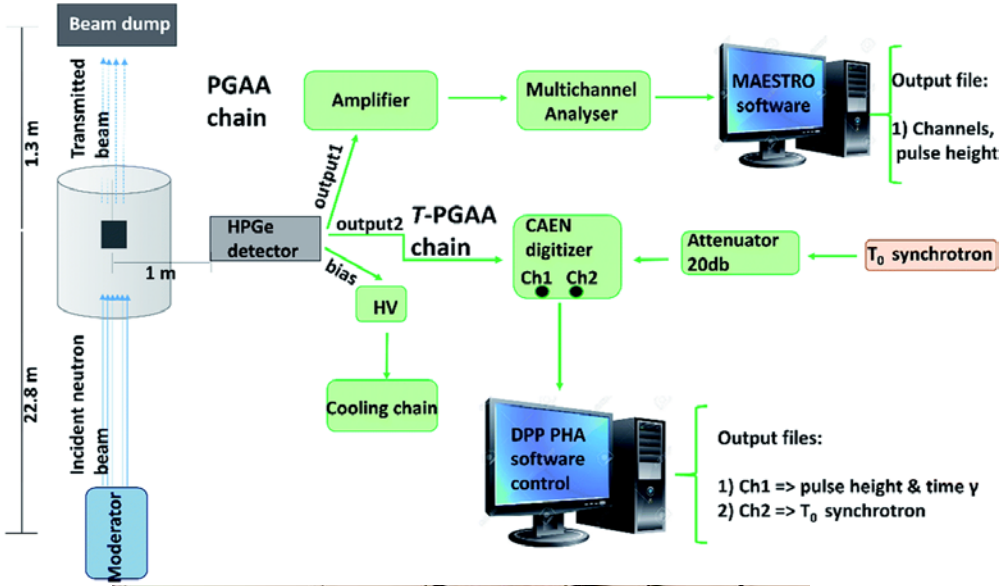
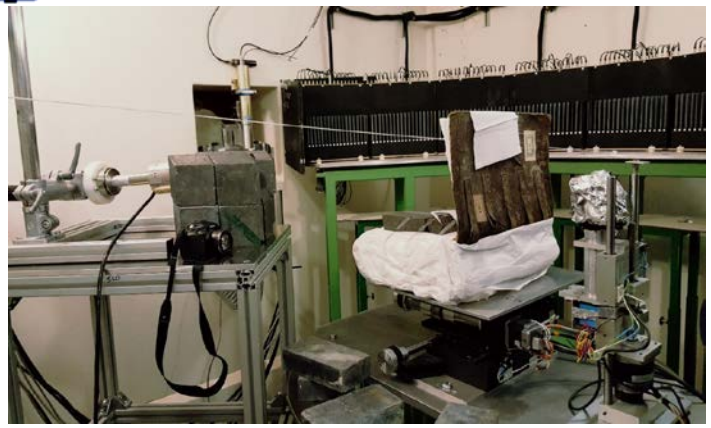
Project main goals and results achieved in 2017

Project goals: **Element/isotope analysis, microstructure and spectroscopy on samples of archaeological and forensic relevance**.

1) To realise a Time-Resolved Prompt Gamma Activation Analysis (T-PGAA) apparatus not yet available at Spallation Neutron Sources→ broaden the scope of chemical/isotope analysis for Cultural Heritage and forensic studies.
2) To create an outpost in UK of the Centro Fermi - TNAAF team (under the CNR-STFC Agreement) for interdisciplinary research activities and projects: Harwell, London.
3) To integrate advanced neutron techniques with molecular and atomic spectroscopy techniques for the study of cultural heritage artefacts, materials and forensic samples.





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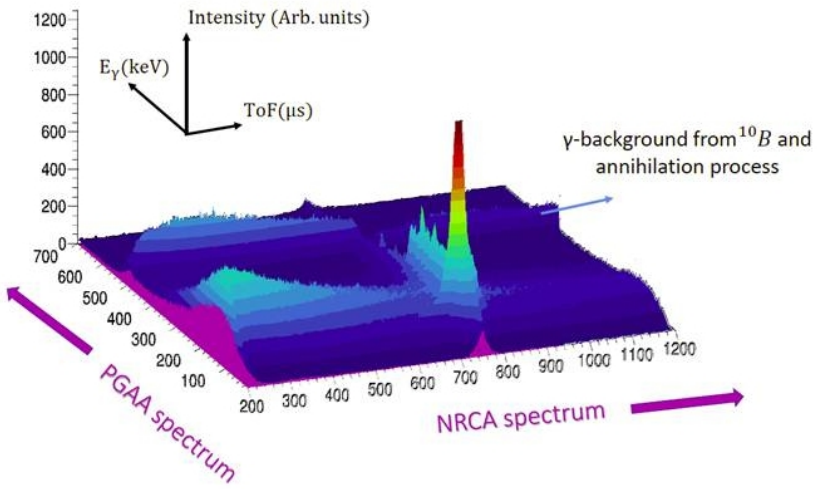
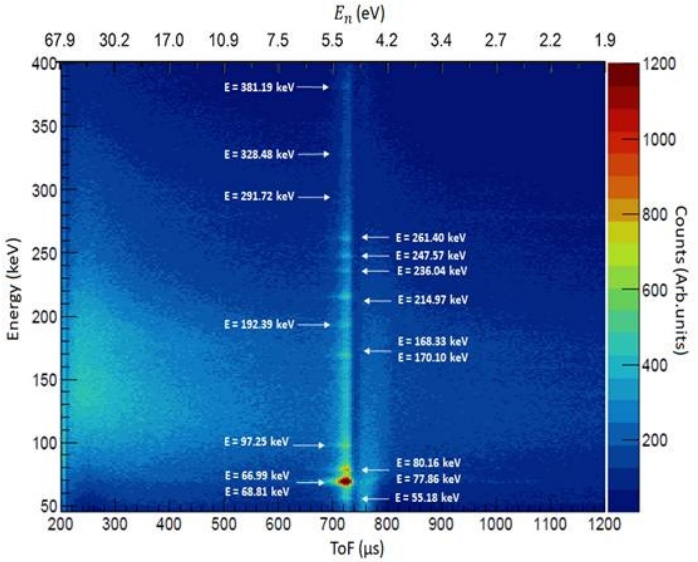
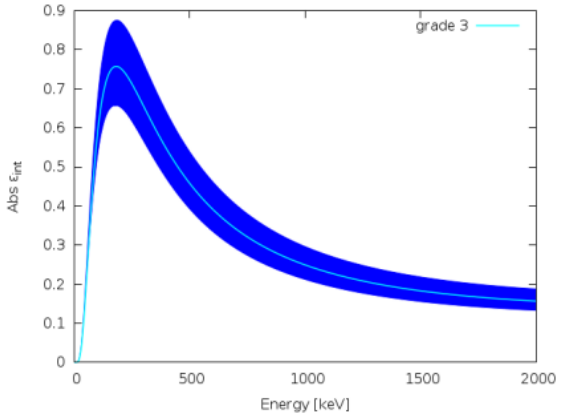
Project results achieved in 2017+ eV Neutrons Workshop 2017

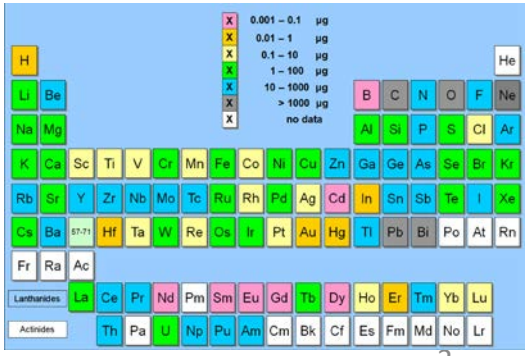
1) Two –dimensional (photon energy-neutron energy) Prompt gamma emission from gold in the thermal and resonance region





2) Ge detector absolute efficiency calibration (path towards quantitative analysis)





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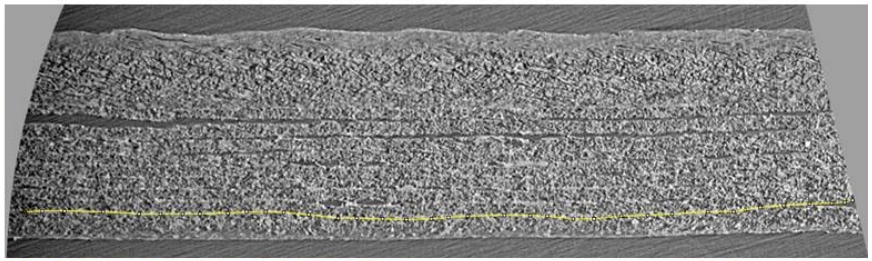
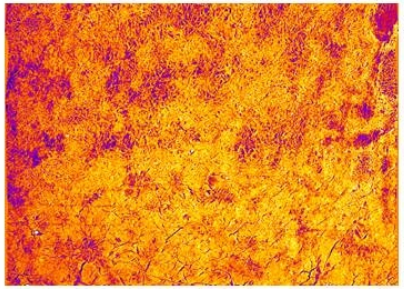
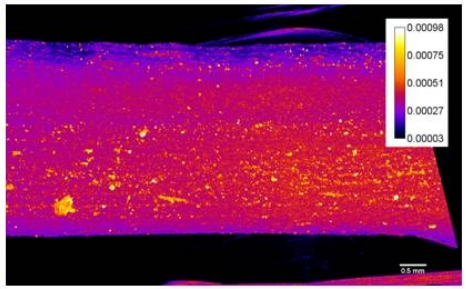
Project results achieved in 2017

3) Integration of neutron and photon techniques for the analysis of manuscripts/books



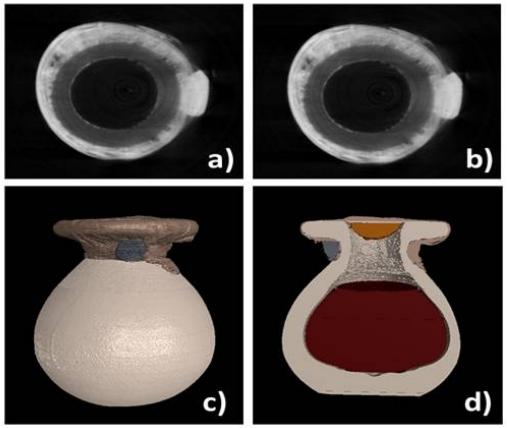


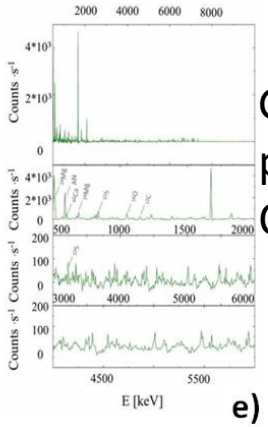


Synchrotron X-Ray (DIAMOND- UK) tomography of a XVII century book from archivio Salviati (SNS)

4) Integration of neutron tomography and Prompt Gamma Activation Analysis on Egyptian sealed vase from 1400 BC

Alabaster sealed with linen textiles and glue





G. Festa et al. Accepted for publication in Angewandte Chemie (2018)

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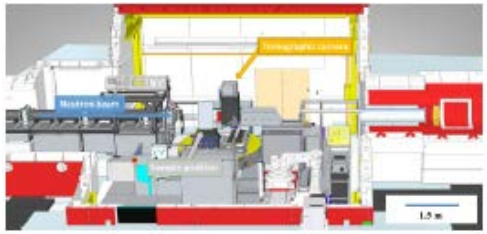
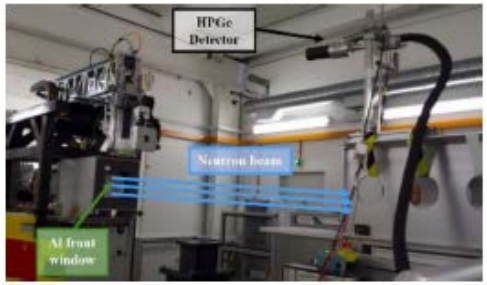
Project results achieved in 2017- two main publications

1) G Festa, C Andreani, L Arcidiacono, G Burca, W Kockelmann, T Minniti, R Senesi, "***Characterization of γ-ray background at IMAT beamline of ISIS Spallation Neutron Source***", Journal of Instrumentation 12, P08005 (2017).

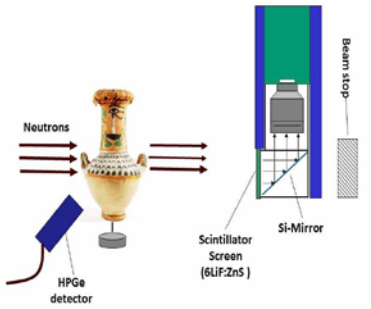
2) C Andreani, F Aliotta, L Arcidiacono, M Borla, D Di Martino, F Facchetti, E Ferraris, G Festa, G Gorini, W Kockelmann, J Kelleher, D Malfitana, D Micieli, T Minniti, E Perelli Cippo, R Ponterio, G Salvato, R Senesi, V Turina, C Vasi, C Greco, "***A neutron study of sealed pottery from the grave-goods of Kha and Merit",*** Journal of Analytical Atomic Spectrometry 32, 1342 (2017).

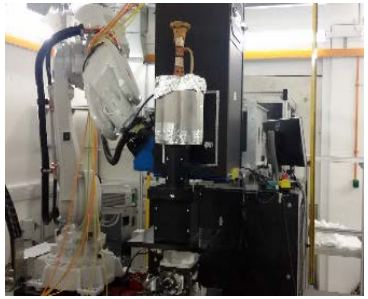




← Instrumentation development

Applications to CH →





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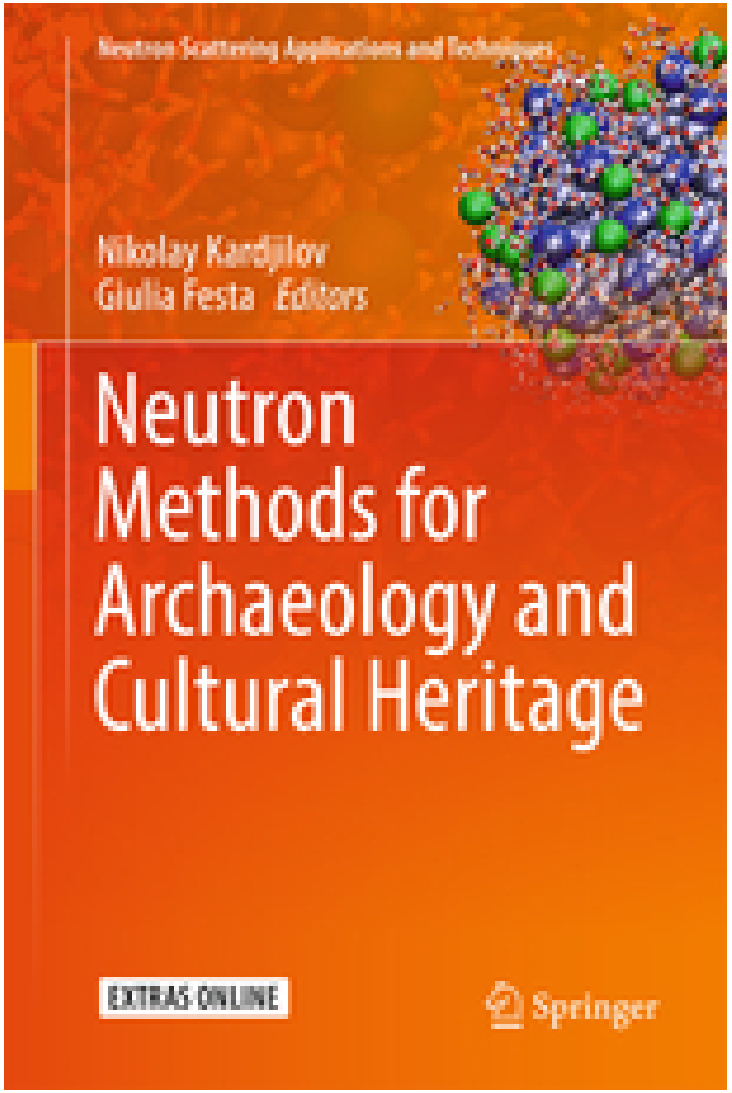
Project results achieved in 2017- two main publications- plus a book!



Neutron Scattering Applications and Techniques
© 2017
Neutron Methods for Archaeology and Cultural Heritage

Editors: Kardjilov, Nikolay, Festa, Giulia (Eds.)

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Milestones 2018

1) Compton suppression and background optimization systems for T-PGAA
2) Consolidation of experimental plans and data analysis on textile samples from Museo Egizio
3) Data analysis on combusted bones (FTIR, neutron, Raman, PCA)
4) Three (at least) experiment proposals to be submitted to the ISIS Facility Access procedure on archaeometric standards, ancient books, oricalchos.

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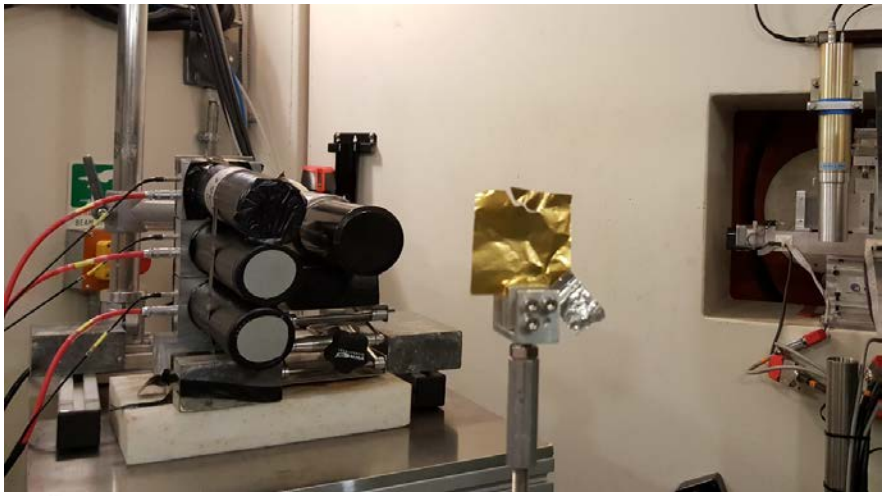
Plan of activities 2018 - 2020

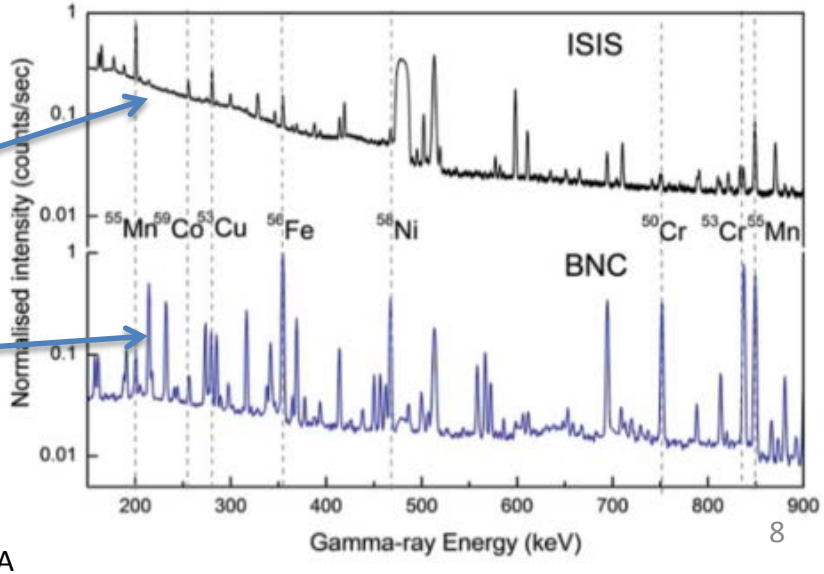
A) ***Instrumentation development***

1) Compton suppression systems: HpGe+YAP
2) Measurements of time of flight
- resolved background on 3 beam lines at ISIS
3) Optimization of shielding



No Compton- no shielding

Compton+ shielding



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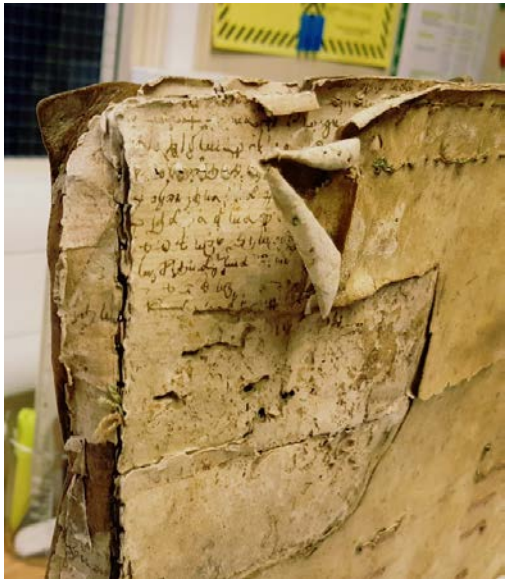
Plan of activities 2018 - 2020

B) Applications and techniques integration. Experiment proposals on:

1) Metallic archaeometric standards
2) Antique violins- integration with tomography and varnish surface analysis
3) Ancient books: Neutron and X Ray analysis
4) Orichalcos



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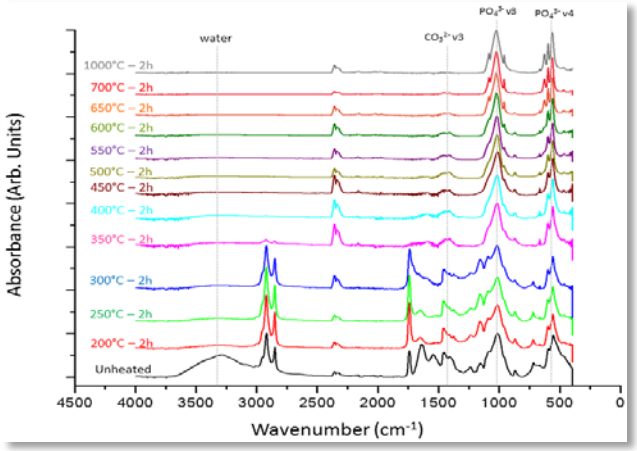
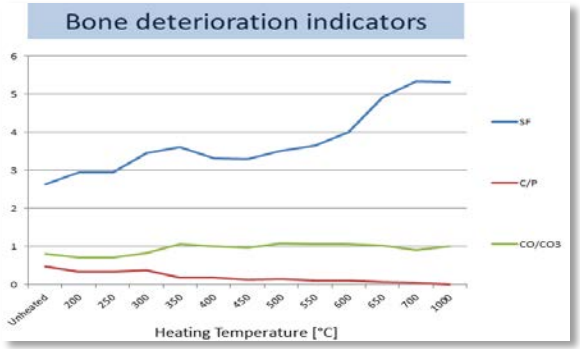
Plan of activities 2018 - 2020

C) X-Ray and neutron imaging, neutron spectroscopy and FTIR on combusted bones



D) Integration of the above techniques with EDXRF-Raman (see presentation by G. Festa)



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Expected funding in the 3-year period:

- **Request of funding by Centro Fermi**

Grant: 1 grant for 2019 (assegno di ricerca, 25 keuro); 1 grant for 2020 (assegno di ricerca, 25 keuro);

External funding : 1 grant for 2018 (assegno di ricerca, 25 keuro);

Travel/missions: 15 keuro/year for the years 2018,2019,2020

- **Potential external funding**

Bandi Distretto Regione Lazio BC, results expected in 2018