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## Revealing the secrets of ancient Japanese helmets

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The armour and the sword of the samurai have long been considered to be objects of absolute beauty, from both an aesthetic and a technological point of view. Much literature exists about Japanese swords, but far less is known about the technology of Japanese helmets, the kabuto. In the 15th century when large armies of foot soldiers were becoming more common and fighting on horseback was in decline, the kabuto became one of the most important elements among an armour's constituents since it allowed the samurai to stand out in the battlefield. From the second half of the 16th century, with the introduction of firearms, the construction technique and style of Japanese armourers changed to increase the protection offered by the armours and helmets.

Here, we present extensive results on the investigation of seven 17th Century kabuto from different schools, conducted through a combination of neutron diffraction and imaging techniques. Neutron powder diffraction, performed using the INES and ENGIN-X beamlines (ISIS, UK), allowed us to obtain the quantitative phase composition of selected parts of the helmets and to map the residual strain distribution inside a few single platelets along their section. Neutron tomography, carried out at the NEUTRA beamline (SINQ, CH), allowed to determine the inner structure and manufacturing techniques of one kabuto, revealing some otherwise invisible details.

**Primary author:** Dr FEDRIGO, Anna (STFC)

**Co-authors:** GRAZZI, Francesco (CNR-ISC); SALVEMINI, Filomena (Istituto dei Sistemi Complessi-Consiglio Nazionale delle Ricerche); SCHERILLO, Antonella (STFC-ISIS); WILLIAMS, Alan (The Wallace Collection)

**Presenter:** Dr FEDRIGO, Anna (STFC)

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