



# CT scanning helped reveal complex mysteries of Antikythera Mechanism

In an exciting link-up between high-tech industry and international universities, the secrets of a 2000 year old astronomical calculating device – the Antikythera Mechanism – were unraveled. Researchers counted on the unique 400kV microfocus computed tomography (CT) system. The outcome not only led to an astonishing new theory of how the mechanism worked, but also to the reading of inscriptions that remained unseen for more than 2,000 years.

## Salvaged 100 years ago from a shipwreck

Named after its place of discovery in 1901 in a Roman shipwreck, the Antikythera Mechanism is technically more complex than any other device for at least a millennium afterwards. The team of scientists behind the Antikythera Mechanism Research Project succeeded in solving the puzzle of its purpose. Project results confirm that the mechanical computer was designed to track the movements of heavenly bodies, specifically the Sun, Moon and Planets.

The extraordinary mechanism is an agglomeration of bronze gearwheels, dials and inscriptions that has puzzled and amazed scientists for more than a hundred years. It consists of myriad gears, cogs and differentials to accommodate the eccentricities of the wandering stars. The Antikythera Mechanism is now understood to operate as a complex mechanical “computer” that is designed to track the cycles of the Solar System and calculate calendars or astrological events.

The Antikythera Mechanism Research Project aimed at resolving the riddle once and for all. Cardiff University, the National and Kapodistrian University of Athens, the Aristotle University of Thessaloniki and the National Archaeological Museum of Athens teamed with imaging specialists Metris / X-Tek and Hewlett-Packard to focus the latest imaging technologies on the mechanism.

## Astonishingly detailed 3D X-ray images

Although the mechanism is no bigger than a shoe box, it is too priceless and unique to leave the National Archaeological Museum in Athens, so a major expedition in late 2005 brought a 400kV microfocus X-Tek / Metris tomography machine – weighing over 7.500kg – to examine the artifact in Greece.

Originally designed to search for imperfections in turbine blades and other industrial devices, the X-Tek / Metris machine creates astonishingly detailed 3D X-ray images. The imaging equipment has been instrumental in advancing our current understanding of the mechanism. It was originally thought that the CT results would be vital in producing good images of the gear train, allowing researchers to obtain good teeth counts for the mechanism’s gears, and finally resolving any arguments regarding the relationships between the gears. The CT results have achieved this, and much more.

The results have revealed many more details of the mechanism, including the so-called ‘pointer follower’ in Fragment B, which allows the back dial to be interpreted as spiral dials, not circular dials as previously thought. 3D CT images have also revealed the pin and slot mechanism that has allowed researchers to discover that the mechanism models the first anomaly of the Moon’s motion.



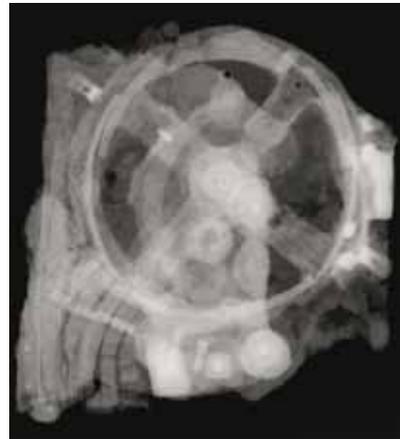
*The Antikythera Mechanism is technically more complex than any other device for at least a millennium afterwards.*

### Revealing details of inscriptions and gearing

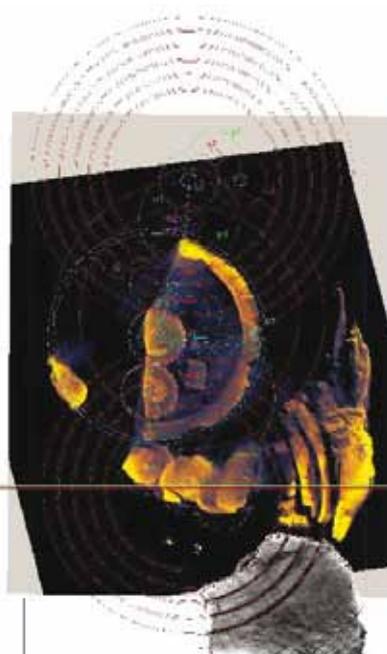
However, the great surprise has been the ability of the CT results to show the hidden inscriptions in many of the Fragments. The CT images, viewed at various angles, enabled the research project to read 932 characters, far more than any previous attempt. Looking at the data with X-Tek, academic principal investigator Professor Mike Edmunds commented. "The outstanding results obtained from X-Tek's 3D X-rays enable us to make a definitive investigation of the Antikythera Mechanism. I do not believe it will ever be possible to do better."

Using CT scanning, the researchers have managed to read all the month names on a sophisticated 19-year calendar on the back of the Mechanism. Really surprisingly was the discovery that the corroded and calcified Antikythera Mechanism also showed the four-year cycle of ancient Greek games, including the Olympic Games. Technology-driven research has opened a remarkable window on microscopic internal details of inscriptions and gearing at a resolution better than one tenth of a millimeter! It seems Antikythera's mysteries are finally revealed – thanks, finally, not to deciphering the apparatus, but the manual that came with it. The latest project results have been published in the magazine Nature.

More information about CT scanning can be found at <http://www.nikonmetrology.com/Products/X-ray-and-CT-Inspection>



*CT scanning resulted in this high-resolution digital radiograph of fragment A of the Antikythera Mechanism.*



*Putting it all together, CT slices and geometry of the Antikythera Mechanism. The Metonic calendar at the top, with its subsidiary Calliptic dial. The Saros eclipse cycle is below, with its subsidiary Exeligmos dial.*