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In this issue:

- Automated scanning – why?
- Automated scanning – how?
- Image of the month
- Bruker microCT news
- Upcoming events

Welcome

Welcome to the first issue of the Bruker microCT Academy newsletter in 2017! On behalf of the entire crew, we wish all our users good health, happiness, and success this year. In this issue, we address the possibilities and advantages of automated scanning of samples using the pushbutton operation option of the SkyScan 1275, which are described in more detail in the method note. The registration for 2017 MicroCT User Meeting is now open, discover more details in below!

Automated scanning – why?

More and more, micro-CT is being used as a tool in elaborate studies that include a large number samples, for quality control in a production environment, or for the digital preservation of large collections of artefacts or specimens. All of these applications require a high sample throughput, with as little of individual sample settings as possible. Furthermore, the increasing availability of the technology makes it accessible to many new users, including undergraduate students and staff members without technical background. This creates the need for an intuitive, straight-forward workflow.

The SkyScan1275 desktop micro-CT scanner has the capability to start scanning a sample with a single push of a button. The same push will automatically start the reconstruction of the acquired projection data, and even launch one of our visualization packages if required.

Automated scanning – how?

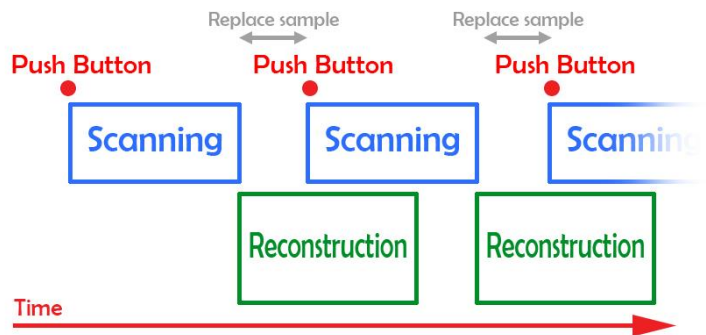
The pushbutton workflow in the SkyScan1275 is set up in a way that a few basic scan setting need to be defined by the user. These settings include the important selection of filter and voltage, defining the acquisition parameters such as the magnification, an appropriate rotation step, an image format and a destination folder for all following automated scans.

The same counts for the reconstruction. The user defines a set of reconstruction parameters for a certain sample type, and can save this as a protocol. If different types of samples will be scanned, different reconstruction protocols can be defined and used whenever necessary.

After all settings are defined, the green pushbutton of the SkyScan1275 can be used, and all there's left to do is push, sit back, and watch the results being produced.



Click the image to see the movie of the entire process, which only takes a few minutes with the fast scan on SkyScan 1275.



Scanning and reconstruction overlap, ensuring an optimal efficiency and almost no dead time between different scans.

The automated scanning procedure can work simultaneously with the reconstruction and analysis software, allowing an optimized workflow, with as little dead time as possible. Just instants after the acquisition procedure is finished, scanning of the next sample can be started.

A detailed workflow to enable and use pushbutton operation on the SkyScan1275 can be found in '[MN100 Automated scanning using the SkyScan1275 Pushbutton operation](#)'

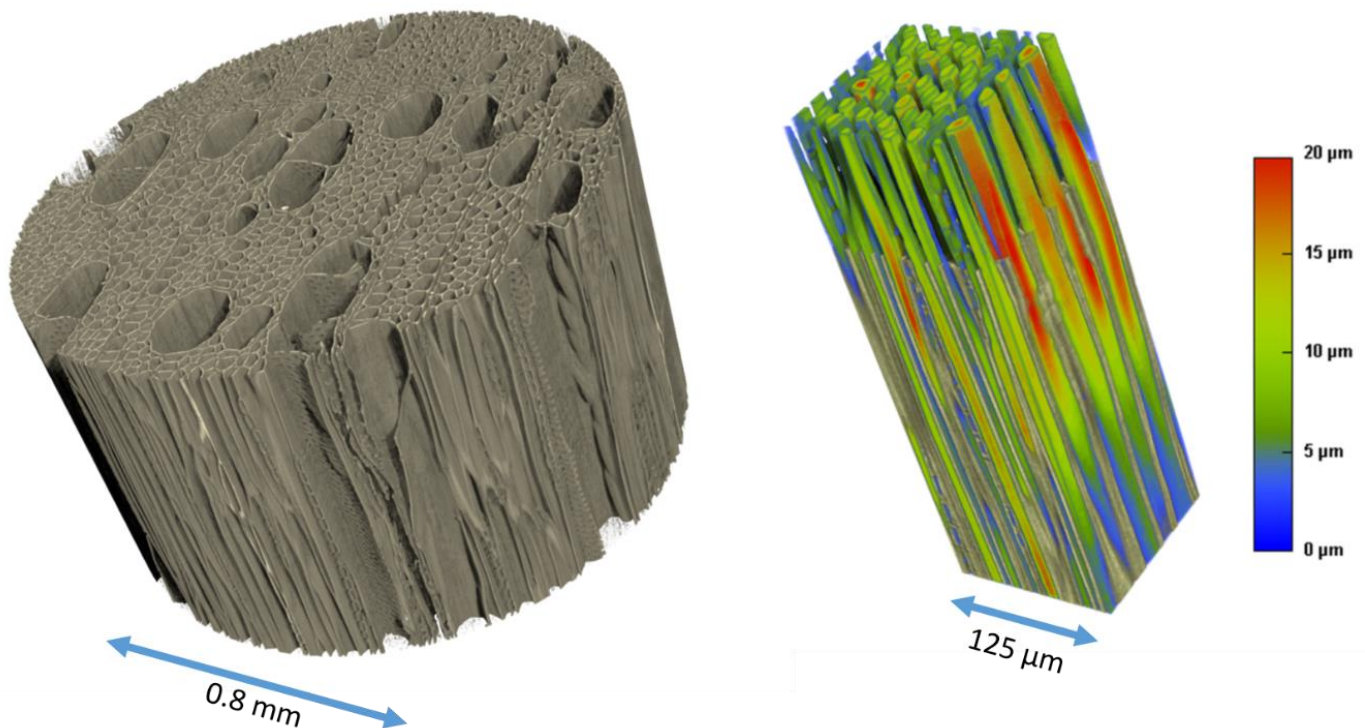
● Bruker microCT news

The registration for the microCT user meeting is now open. Find out how to earn up to 3 free nights in Brussels on [our website!](#)

● Image of the month

Left: Volume render of a high-resolution scan of a piece of wood. The voxel size is 200 nm, scanned using the SkyScan2211.

Right: sub-volume from the same dataset, where the vascular network of the wood is color-coded to local thickness.



● Upcoming events

Bruker microCT will participate with an exhibit in the forthcoming conferences. Please click the link below for more information. We hope to see you there!

- [ORS](#) Mar. 19 – 22 San Diego, USA
- [IADR](#) Mar. 22 – 25 San Francisco, USA
- [AACR](#) Apr. 01 – 05 Washington DC, USA
- [EMIM](#) Apr. 05 – 07 Cologne, Germany
- [Interpore](#) May 08 – 11 Rotterdam, The Netherlands
- [ECTS](#) May 13 – 16 Salzburg, Austria
- [ATS](#) May 19 – 24 Washington DC, USA
- [ICTMS](#) Jun. 26 – 30 Lund, Sweden

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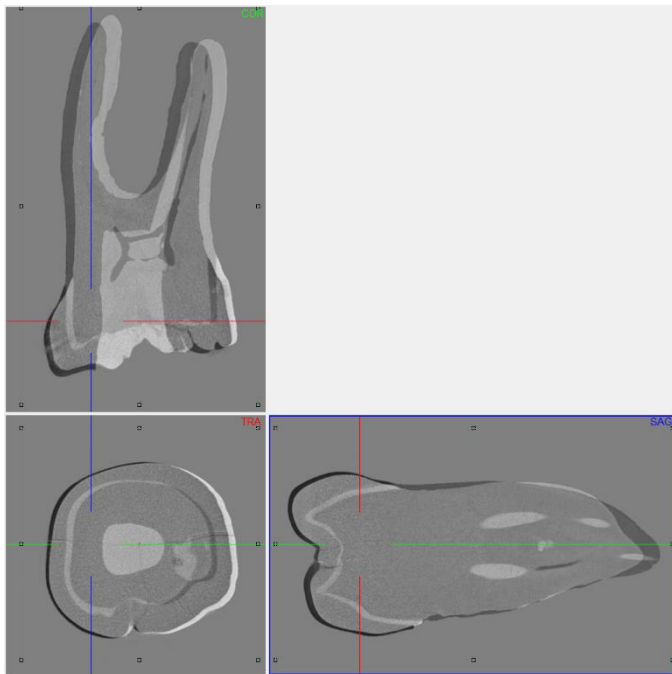
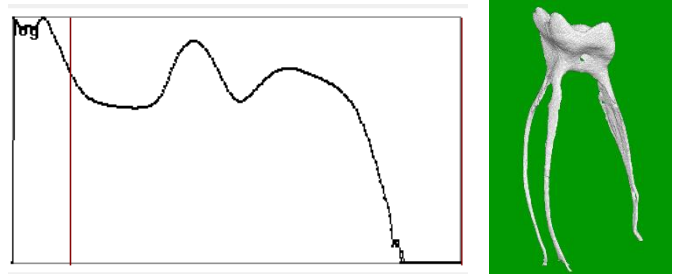
- 3D registration in DataViewer of a molar tooth before and after root canal drilling
- Save binary images of the root canals in registered reference and target datasets Image of the month
- Analysis 1: Removed (drilled) and added (debris) material
- Analysis 2: Touched (eroded by drilling) and untouched root canal surfaces
- Bruker microCT news
- Upcoming events
- Image of the month

● **Welcome**

Welcome to the second issue of the Bruker microCT Academy newsletter in 2017! This month our topic is the dentist's chair - specifically, the tooth root canal. MicroCT imaging in endodontic research often involves assessing root canal procedures such as drilling the canals and addition or removal of filler material.

● **3D registration in DataViewer of a molar tooth before and after root canal drilling**

Method notes are already available for general 3D registration in DataViewer. Here the "before and after" molar tooth scans are loaded as reference and target respectively. When registering the tooth scans it can help to move up the lower threshold (green/red lines) on the displayed histogram. This removes surrounding material like plastic tubes or paper tissue from the 3D registration.



● **Save binary images of the root canals in registered reference and target datasets**

In CTAn open the reference dataset in the "Registration" subfolder. Create a binary dataset of the root canals by the following steps: (1) apply inverse binary threshold to

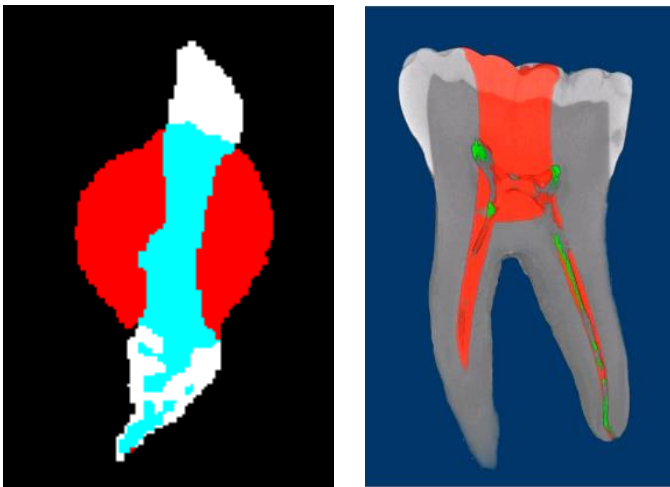
the tooth; (2) in custom processing run despeckle /remove outer objects (2D); 3 – despeckle / sweep (3D) all but largest object; 4 – save bitmaps / image (BMP, monochrome)

● **Analysis 1: Removed (drilled) and added (debris) material**



In CTAn open the binarized root canal dataset from the registered reference ("before") scan. Then load the binarized root canal dataset from the target ("after") scan, either as a BMP ROI, or as a clipboard (note that in CTAn 1.16 you can open a second dataset in the clipboard channel). With these two datasets loaded, we now go to custom processing and do some simple "image arithmetic". Just subtracting one root canal binary from the other, before minus after equals what has been removed – the drilled out dental tissue. And after minus before equals what has been added – in practice this means the drilling debris (Bitwise, the SUB operation). This is an important outcome for endodontists to be able to both visualize and quantify. The image in the next page shows the result of this image arithmetic. The original

image from the before scan – the smaller elongated canal cross-section, is in white. The canal in red is larger after the drilling and circular in cross-section. Blue-shaded white region means space present both before and after. However the pure white areas were space before but solid after, and are debris from the drilling. Both the removed material (before minus after) and the debris (after minus before) can be saved as binarized image datasets using the “save bitmaps” plugin.



- Analysis 2: Touched (eroded by drilling) and untouched root canal surfaces

The analysis of touched and untouched surfaces starts in just the same way as the analysis above of the drilled out and debris material. First the before-and-after scans are registered in 3D. After that, we again make the binary datasets of the root canal spaces in the registered before-and-after datasets. (We can in fact just load the binarized root canal datasets that we already created for analysis 1, above.) Then however we introduce a new step – making binary images of a thin boundary around the root canal only, not the whole root canal volume. We start this with the before, reference dataset, already binarized. First threshold the image dataset in custom processing (necessary even for binary images), then following steps will create a one-pixel thick boundary just one pixel external to the original binary of the root canal:

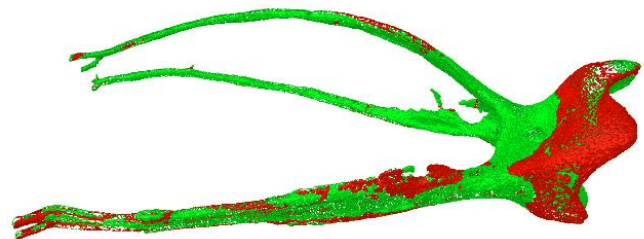
1 – Bitwise / ROI = COPY IMAGE; 2 – Morphological operations / dilate (3D, 1 voxel) applied to ROI; 3 – Bitwise

/ IMAGE = ROI SUB IMAGE; 4 – Save Bitmaps / Image, BMP, monochrome (1-bit).

After this, load into CTAn the binarized dataset (already created from Analysis 2) of the after-scan root canal. Follow a similar procedure but modified to create a 3 pixel thick boundary layer, not just one pixel.

1 – Bitwise / ROI = COPY IMAGE; 2 – Morphological operations / dilate (3D, 2 voxel) applied to ROI; 3 – Morphological operations / erode (3D, 1 voxel) applied to IMAGE; 4 – Bitwise / IMAGE = ROI SUB IMAGE; 5 – Save Bitmaps / Image, BMP, monochrome (1-bit).

The reason for this is to allow for registration error of ± 1 pixel. The part of the 1-pixel-thick root canal boundary from the before-scan which coincides in space with the 3-pixel-thick root canal boundary from the after-scan, will be considered to be untouched surface, not changed by the experimental procedure. All other surfaces thus will be assigned as touched surface, eroded by the drilling procedure.



In the above image, generated by CTVol as surface rendered models, green means touched surface (eroded by drilling) and red means untouched surface (not changed between scans before and after drilling).

As with the removed and added material (debris) in analysis 1 above, the binary datasets created of the touched and untouched surfaces allow quantitative analysis also in CTAn. Note that in the case of the boundary binary image of untouched surface, since it is 1-pixel thick, it means that the measured volume in voxels cubed also equals the surface area in voxels squared, simplifying the assessment of untouched surface.

These two analyses are described in the “[MN110 endodontic root canal analysis-debris and untouched surfaces](#)”.

● Bruker microCT news

For this year's User Meeting more than 80 abstracts have been submitted from all over the world covering the most diverse microCT applications both in life science as well as in material science.

We are looking forward to welcome you all to another memorable event where we hope you will be able to enjoy the scientific and the social program! Don't forget to submit your picture/movie before May 5th and possibly win an iPhone or iPad!

More information on the User Meeting can be found at: <http://bruker-microct.com/company/usersmeeting2017.htm>

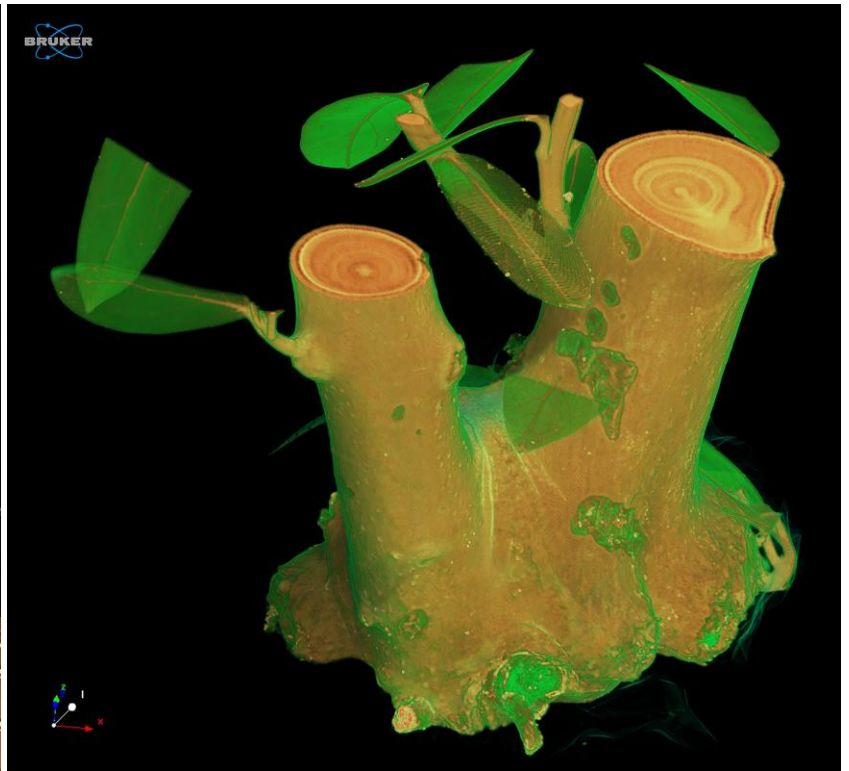
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- [ATS](#) May 19 – 24 Washington DC, USA
- [BRS](#) Jun. 25 – 27 Bristol, UK
- [ICTMS](#) Jun. 26 – 30 Lund, Sweden
- [URTEC](#) Jul. 24 – 26 Austin, USA

● Image of the month

A part of an olive tree scanned in the SkyScan1173. This desktop scanner can accommodate large and irregular objects.



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In this issue:

- Understanding the transfer function editor
- Create an rgb marker
- Subvolume
- Bruker microCT news
- Upcoming events
- Image of the month

● **Welcome**

Thanks for joining us again in the third Bruker microCT Academy of 2017. This month we hosted our annual User Meeting in Belgium’s capital Brussels, where we also introduced the newest version of CTVox. For those who could not attend we’ll highlight the novel features in this newsletter.

● **Understanding the transfer function editor**

CTVox offers a transfer function editor for fast and flexible creation of images with vivid and revealing color and texture. The transfer function allows to map grey values in the volume dataset with the parameters of emission color and opacity through different components or channels. Note if the color channels are linked, only 2 channels are available: L (luminescence or intensity) and opacity. One single color can be applied by assigning a base color. When applying different colors 4 channels are available : R, G, B, and opacity. These channels can be combined in order to create any desired color scheme for realistic visualization. [Method note MN102](#) describes in detail how to conveniently use this transfer function editor.

● **Create an rgb marker**

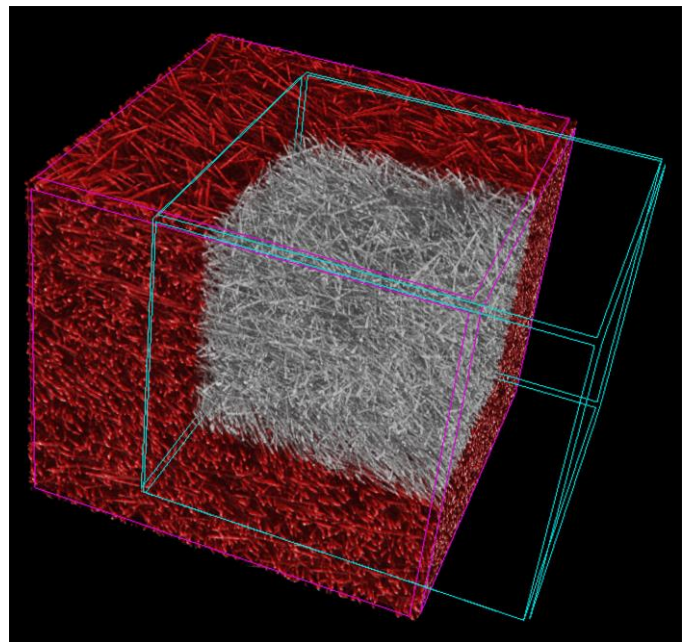
Now from CTVox 3.3 there is the possibility to choose an RGB marker from a color panel and place it at a specific point on the transfer function editor window. The R, G and B channel will be adjusted simultaneously to meet the chosen color at the specific point. [MN103](#) shows how to create an RGB marker from any color. Note that the smoothest results are obtained when using splines, which might combine unexpectedly when using multiple RGB marker.

● **Subvolume**

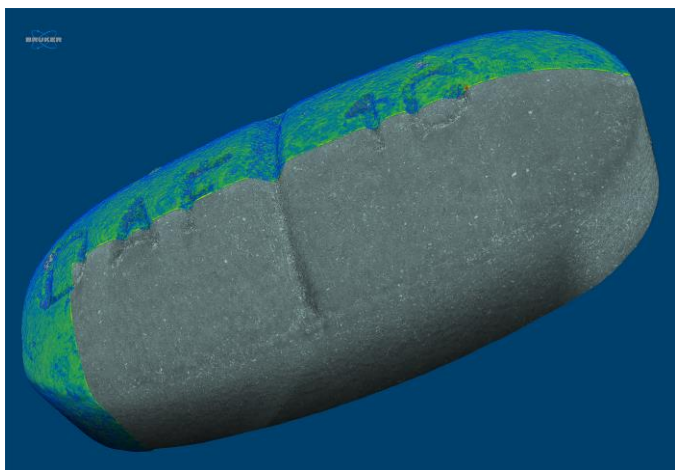
Multiple volumes can be loaded in CTVox. When working with multiple volumes the Volume Manager pane is central to present additional information for each volume. In addition to the visibility of the volume, the volume label, the volume weight and the volume base color, now you can also adjust the cutting/clipping mode: the effect of the cutting/clipping shape can be set per volume to cutting, clipping or neither through the drop down menu, as indicated with the arrow.

The subvolume cutting and clipping functionality allows to assign different opacity and color schemes to subvolumes representing 3D distribution of morphometric parameters across the scanned volume, but also to different parts of the dataset, simply by loading the same volume twice. Some more examples can be found in [MN103](#).

Volume Manager					
	<input checked="" type="checkbox"/>	Volume	%	Color	Cut/clip
1	<input checked="" type="checkbox"/>	sample1_1.3um_ir_rec_tra_tra0000	50		None
2	<input checked="" type="checkbox"/>	sample1_1.3um_ir_rec_tra_tra0000	50	Red	Cut



Different colors and clipping/cutting functionalities have been assigned to different volumes of the same scanned volume (glass fibers). Subvolume 2 is red and the part indicated with the blue box is cut, to reveal subvolume 1 which is grey and has no cutting or clipping applied to it.



3D rendering of paracetamol tablet. The coating has been color-coded for thickness. 5 μm voxel size, 50 kV, no filter, 11mm sample size.

● Bruker microCT news

Bruker microCT User Meeting 2017 took place this month in the heart of Europe, Brussels. With more than 100 attendees and more than 80 scientific contributions, this year's event turned out to be a great success again! The abstracts and the group photo are now on the [website!](#) Check them out!

We would like to congratulate Jana Goyens from the University of Antwerp. Her talk on "Comparison of conventional and synchrotron X-ray microCT scanning of thin membranes in the inner ear" was selected by the participants as the best oral presentation. The best poster came from Christoph Schürmann from Goethe University Frankfurt. The visualisation work from Javier Alba-Tercedor from the University of Granada and Carla Geeroms from Catholic University Leuven were selected for the respective picture and movie awards. Congratulations to all and thank you to all users for participating in the voting.

If you would like to learn more on this edition's new features of SkyScan software CTVox, we also organize a user exclusive live demonstration webinar on July 12th. [Register now!](#)

● Upcoming events

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- [URTEC](#) Jul. 24 – 26 Austin, USA
- [SCA](#) Aug. 28 – Sep. 1 Vienna, Austria
- [ESB](#) Sep. 4 – 8 Athens, Greece
- [JASIS](#) Sep. 6 – 8 Chiba, Japan
- [ASBMR](#) Sep. 9 – 12 Colorado, USA
- [WMIC](#) Sep. 13 – 16 Philadelphia, USA
- [Entomology](#) Nov. 5 – 8 Denver, USA

● Image of the month

This month's image of month is a little taste of the user meeting, the best picture awards: Javier Alba-Tercedor, University of Granada 'Honey worker bees'!

