

## Experiment Report Form

**The double page inside this form is to be filled in by all users or groups of users who have had access to beam time for measurements at the ESRF.**

Once completed, the report should be submitted electronically to the User Office via the User Portal:

<https://www.esrf.fr/misapps/SMISWebClient/protected/welcome.do>

### ***Reports supporting requests for additional beam time***

Reports can be submitted independently of new proposals – it is necessary simply to indicate the number of the report(s) supporting a new proposal on the proposal form.

The Review Committees reserve the right to reject new proposals from groups who have not reported on the use of beam time allocated previously.

### ***Reports on experiments relating to long term projects***

Proposers awarded beam time for a long term project are required to submit an interim report at the end of each year, irrespective of the number of shifts of beam time they have used.

### ***Published papers***

All users must give proper credit to ESRF staff members and proper mention to ESRF facilities which were essential for the results described in any ensuing publication. Further, they are obliged to send to the Joint ESRF/ ILL library the complete reference and the abstract of all papers appearing in print, and resulting from the use of the ESRF.

Should you wish to make more general comments on the experiment, please note them on the User Evaluation Form, and send both the Report and the Evaluation Form to the User Office.

### **Deadlines for submission of Experimental Reports**

- 1st March for experiments carried out up until June of the previous year;
- 1st September for experiments carried out up until January of the same year.

### **Instructions for preparing your Report**

- fill in a separate form for each project or series of measurements.
- type your report, in English.
- include the reference number of the proposal to which the report refers.
- make sure that the text, tables and figures fit into the space available.
- if your work is published or is in press, you may prefer to paste in the abstract, and add full reference details. If the abstract is in a language other than English, please include an English translation.



	<b>Experiment title:</b> Synchrotron light on the most primitive jawed vertebrates: a microtomographic investigation on the unique Early Devonian placoderms of the Prague Basin	<b>Experiment number:</b> ES-505
<b>Beamline:</b> ID19	<b>Date of experiment:</b> from: 15. 9. 2016 to: 3. 10. 2016	<b>Date of report:</b> 15. 2. 2017
<b>Shifts:</b> 12	<b>Local contact(s):</b> Paul Tafforeau	<i>Received at ESRF:</i>

**Names and affiliations of applicants (\* indicates experimentalists):**

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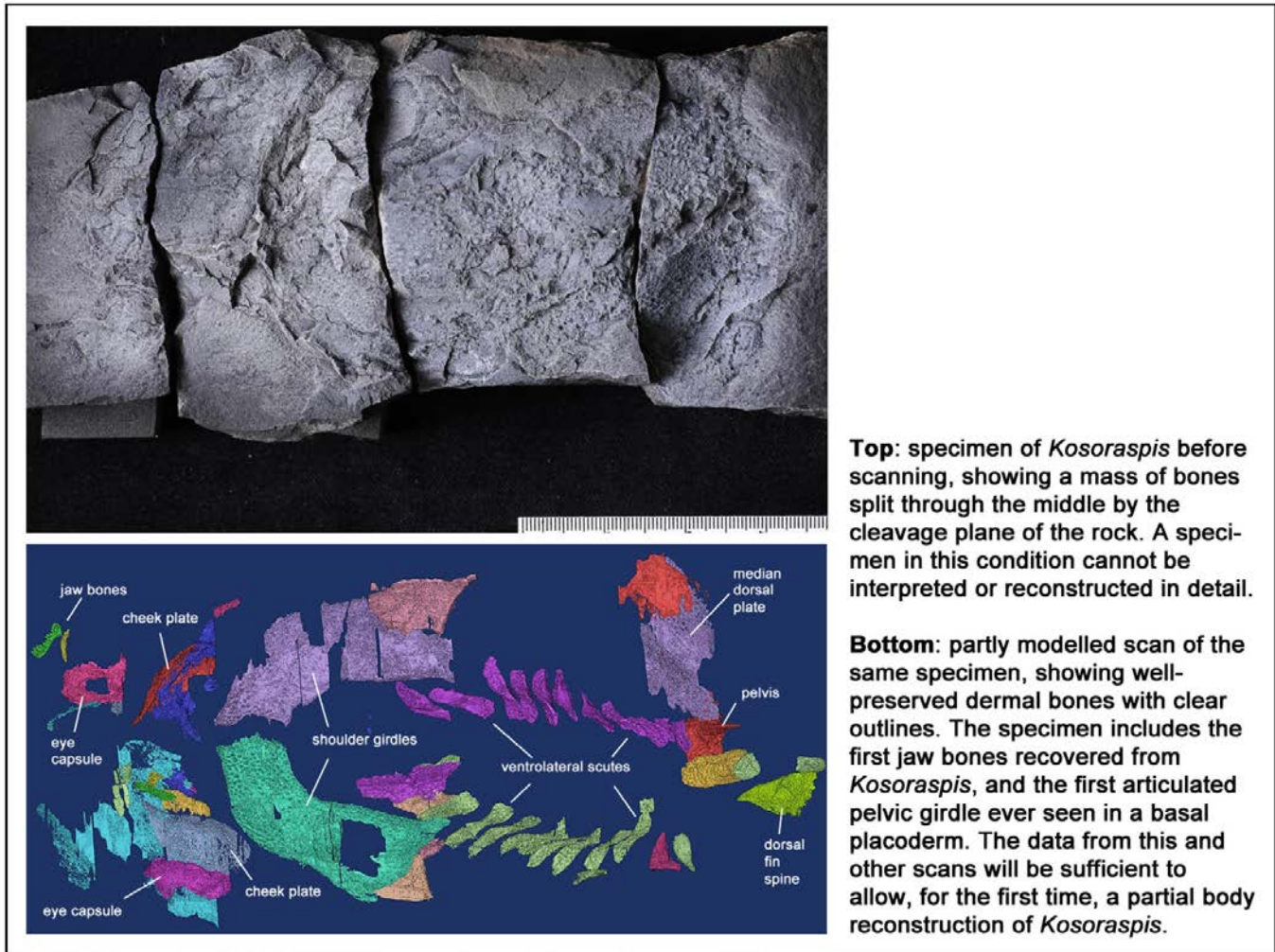
**Report:** The main aim of the experiment was to use propagation phase contrast synchrotron microtomography (PPC-SR $\mu$ CT) to investigate the anatomy of Early Devonian acanthothoracid placoderm material from the National Museum (Prague, Czech Republic) collections. 21 placoderm specimens were chosen from the collection of the National Museum. This selection was composed of a range of semi-articulated specimens, isolated skulls, and isolated bones, which have traditionally been attributed to the genera *Radotina*, *Kosoraspis* and *Holopetalichthys*, but which in fact also contain two new genera (*Tlaspis* and *Sudaspis* Vaskaninova et Ahlberg, submitted).

The experiment was performed according to plan in 12 shifts. One to several (as much as 6) specimens of similar size were stacked vertically in plastic tubes and PPC-SR $\mu$ CT scanned at once, what proved to be a very effective method and allowed to successfully image all of the extremely important material borrowed from the National Museum in Prague including substitutes as well as a few additional specimens borrowed from Chinese and British colleagues.

In the first session (15.-19. September 2016) a total of 14 specimens were PPC-SR $\mu$ CT scanned at low resolution (voxel size 24.59  $\mu$ m) and another 10 specimens at a slightly higher resolution (voxel size 13,49  $\mu$ m). The additional session on 2. October was focused on high resolution spot histology scans with voxel size 2,26  $\mu$ m.

We received all of the data at the end of November 2016, apart from the scans of one tube (voxel size 13,49  $\mu$ m) which have proved difficult to reconstruct (P. Tafforeau, pers. comm.) and have not yet been returned to us. At the moment we are in the process of creating projects in 3D rendering software (Mimics Research) and evaluating the obtained data. Most of the scans prove to be very informative. The contrast between bone and matrix is generally good, making modelling fairly easy. Furthermore, in contrast with the established perception that these specimens are so strongly flattened that they contain virtually no 3D information, we find that the dermal bones in particular have good three-dimensionality. It is already clear that the scanned specimens constitute an extremely informative data set, possibly the best in the world for Early Devonian placoderms, and that they will have a major impact on our understanding of early vertebrate

evolution (see figure). However, we estimate that complete modelling and description of the scanned specimens will take at least two years.



One observation of particular importance is the discovery of tooth-bearing jaw bones in *Kosoraspis* (figure), *Tlaspis* and *Radotina*. Acanthothoracid placoderms are widely regarded as among the most primitive jawed vertebrates, and thus potentially informative about the origin of the vertebrate dentition, but only a single supposed example of an acanthothoracid dentition has ever been described. We now have more complete dentitions from three acanthothoracids – and they are so different from the published example as to suggest the latter has been misidentified. The dentitions in our specimens combine features seen in osteichthyans (bony fishes) and chondrichthyans (cartilaginous fishes), and are thus potentially of great importance from an evolutionary perspective. However, we need to image these dentitions at histological resolution (voxel size of approximately 0.7  $\mu\text{m}$ ) in order to determine their growth mode and the presence or absence of resorption, before their relationship to the dentitions of other early vertebrates can be fully understood. For this reason, we are submitting a follow-up beamtime application to the next round (1 March deadline).

We will present our first results from ES-505 at the 14th International Symposium on Early and Lower Vertebrates in the Holy Cross Mountains, Poland, in June 2017. All the results from this project will be of substantial interest to the vertebrate palaeontology community and will be presented at major international meetings such as SVP, SVPCA and ICVM over the coming years. In terms of publications, we expect to submit a paper on the dentition to *Nature* or *Science* once we have the histological data. Descriptions of other aspects of the anatomy will most likely be targeted to high-visibility journals such as *Proceedings of the Royal Society*. We anticipate that ES-505 will produce at least five major descriptive papers (dealing with *Radotina*, *Kosoraspis*, *Tlaspis*, *Sudaspsis* and *Holopetalichthys*) in addition to the dentition paper.