How to write a good proposal for synchrotron radiation time

Guidelines of the European Synchrotron User Organization working group on proposals
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Short version:

The objective of this short document is provide some guidance on how to write a proposal for a Synchrotron Radiation (SR) experiment which will stand a good chance of being approved. SR facilities are funded to provide a service to the scientific community, but they are both *relatively expensive and in large demand*; therefore, the facility's management cannot provide beam time for just any experiment proposed. Instead, there is a review process in place to select those proposed experiments that take advantage as well as possible of the instrumental characteristics of the source and beamline requested, and that address an interesting and possibly topical scientific issue or material; the proposal will be rated according to its potential to be ground-breaking both in technique and topic. Thus it is usually not sufficient for a proposal to be merely scientifically correct for it to be approved; it will have to be *evaluated and prioritized* in relation to other proposals according to the criteria mentioned above.

To this purpose, proposals for experiments with SR are normally examined by a review panel composed by scientists knowledgeable in the field of the proposal. Members of such review panels are usually not staff of the synchrotron radiation facility itself; the scientists in charge of the beamlines will, however, be asked to give their opinion on the *technical feasibility* of the proposed experiments. Experiments which are judged technically not feasible are often not forwarded for evaluation on scientific merit by review panels, and will be looked at very critically in any case. Thus it is important that you, as the proposer, seek advice from the scientists involved in operating the beamline on the technical and instrumental aspects of your proposal before submitting it.

In most cases the review panels physically meet for a two or three day intensive meeting in which all proposals are comparatively evaluated and prioritized; sometimes, additional advice from referees external to the review panel is obtained. In any case, you should be aware that these meetings are quite intensive; review panel members have to make decisions on a large number of proposals in a limited amount of time and will typically not have the time and means to perform in-depth literature searches on every proposal before or during the meeting. Therefore please put all *necessary references in the proposal text*, including those to your own work.

SR should be considered as a tool necessary when other types of photon sources cannot solve the problem at hand, that is, it is not a routine experimental tool. It is important to show in the proposal that *relevant in-house characterization methods have been used* to set the background of the SR experiment; for example, for a structural investigation it might be useful to quote or report the results of in-house X-ray diffraction measurements, possibly with a short table or small figure reporting the results.

A *clear experimental plan* is indispensable. State the number of samples, their characteristics, the number of measurements planned, and the estimated time required. In case the technique proposed for the measurements is not standard on the requested beamline, give all necessary details. If you plan to bring specific additional instrumentation to the beamline, give details, highlighting the extra value you will add to the experiment.

The allocation panel's view of proposals

At first sight it seems rather obvious how to write a good proposal for SR beamtime: explain the scientific case and some practical aspects of the experiment, and send it in.

Everybody who downloads the templates to put together a proposal for beamtime at one of the European synchrotron facilities might be a bit surprised, however: there are strict length limits and specific questions, and some of them seem to be asked more than once. Roughly following the ESRF template as an example, a proposal (beside the 'technical' data like: which beamline is required, how many shifts, how large are the samples etc.) contains the following items:

- Proposal Summary
- Aims of the experiments and background (scientific background)
- Experimental Methods (measurement strategy)
- Beamlines and Beamtime requested
- Results Expected
- References

Everything should fit onto two pages anyway, so why is a summary required? The expected results should be clear anyhow from such a brief proposal, so why repeat this in a summary? One might think that either this is delicate tactics to check whether the user will contradict himself within the proposal, or that the referees are rather dumb scientists ... None of these suspicions is correct, however, and the outline is actually required for very good reasons. To understand this, one has to know how the beam time allocation process works. So let's look at it from the 'other side':

Assume, in a completely made up example, that we want to find out the distribution of strain and chemical species in InGaAsP nanostructures, which could be used for faster electronic devices. We would like to do so using X-ray diffraction with SR and we want to study a small series of samples to find out under which growth conditions one gets the best results, say a sharp interface which is needed for optimum functionality.

A referee will receive a bunch of proposals and is asked to read them carefully and grade them, several weeks before the proposals are discussed in a review panel consisting of typically 4-10 referees. The number will depend on the scientific field, but the reviewer will typically have to grade 50 to 100 proposals. Since referees are usually experts in their field, they have to plan their reviewing activities parallel to their other work. We can estimate that before spending 5-15 minutes on our proposal, a reviewer will already have read 30 others, with a similar number more to go. From this it follows directly that, in order to have a chance to get the referee's attention and convince him/her to give a sufficiently high grade, we need to make our point crystal clear.

Next comes the panel meeting, where every proposal is discussed among the experts. Typically the 50-100 proposals will be discussed within one day, so again the review panel can only spend a few minutes on each proposal to determine the final mark and grading. Now we have to consider another boundary condition the panel has to consider: the beamline we have been asking for is most likely oversubscribed, and the panel has to turn down, say, half of the proposals. A panel typically consists of several experts with complementary experience, so from the five reviewers grading our proposal there maybe just one expert with more or less the same expertise we have ourselves, two which have a rather good idea about the field and method, and two who will either not know the scientific field or the method in very great detail. So for instance, they might know the method we propose in general, and what can be learned, but not know whether our idea to study InGaAsP material is actually new and exciting, or just an iteration of a standard characterization, which has been done for InAs, GaAs, InP, GaInP, GaAsP, but just not for InGaAsP. How important is the result really for the scientific field? This is a matter of discussion in the panel, and it is important that the panel members with expertise in III-V compound semiconductors are able to find this information quickly in our proposal, either because we have made this a separate item in the

'results expected' section, or because we made a good summary where we explain why our experiment is particularly important and how it is embedded into the scientific field. Be aware that the proposal will not only be graded by X-ray diffraction panel members who themselves might be experts/more interested in studies on e.g. lipid-DNA complexes, but that it will also have to be prioritized relative to X-ray diffraction experiments on such topics, so be sure to provide the panel members speaking for your proposal with the well-organized ammunition to give it a high grade after the discussion. If your proposal is not rated sufficiently high, it may end up in a range of grades just around or below the 'cutoff' below which proposals will not be allocated beamtime.

The proposal step by step

From this scenario given above, we understand how the outline of the proposal is evolving:

- **Aims of the experiments and background (scientific background)**

We need to explain in a rather compact manner the status of our field, what the open questions are, and what is needed to answer the question we are concerned with. It is actually rather difficult to do that in a very compact format of ½ page or so. We have to give an introduction in only few sentences; we have to make the point of what is still problematic, unsolved, unknown; and we need to explain how we are addressing this particular question. It is also important to show that our sample has already been characterized by as many non-SR techniques as possible. We must use literature references, but not too many, because space for them at the end of the proposal is limited, and we also want to refer to our own work on the topic, with or without SR, as well. Since at least a number (if not all) of the panel members are experts of the field and know the literature, they will get an impression from the references whether we know the literature: quoting one or two important references is therefore a good idea, since this indirectly shows our expertise.

- **Experimental Methods (measurement strategy)**

Here we need to explain how in particular we are going to perform the measurement, what do we need for instrumentation (this can be shifted in part in the next section), and how we are going to analyse the data. This section has two purposes: first, beside the referees also the beamline scientist will review our proposal and has to comment whether the proposed experiment is feasible at all on his/her beamline. Second, the referee will be able to judge from this section how experienced we are, how difficult and feasible the experiment is. This does not mean that the experiment should be described as rather easy. If it is particularly challenging and ground-breaking, this can also be very attractive. Synchrotron facilities are not the places to do standard characterization, but prefer to host the most forefront experiments.

- **Beamlines and Beamtime requested**

Here we must justify why we ask for a specific beamline, and how much beamtime is required for our experiment. The selection of the beamline is sometimes critical, but we suppose we know already that a certain beamline is well suited for the experiment we propose: we can use the proper X-ray energy, the primary beam properties (monochromaticity, brilliance) are all right, the goniometer allows to use the scattering geometry we propose, the detectors available enable collection of the required data in a reasonable time frame.

The amount of beamtime is another question: on the one hand, while we want as much as possible, asking for unrealistically many "shifts" (typically 8 hours, so one day are three

shifts) will rather be seen as a negative aspect of the proposal: reviewers will assume we know how synchrotrons operate and how beamtime is allocated, and boldly asking too much might appear as an offence. On the other hand it is clear that a certain measurement takes some time, we might need to measure at least three samples to get a trend of one parameter, and to ask for one shift extra for setup of the beamline is usually o.k. It is a good idea to shortly detail how we come to the requested number of shifts. In the case that our proposal is at the border of acceptance, the referees might suggest to grant beamtime, but somewhat less than requested. Such a move is easier if the referees can make a useful suggestion like: they asked for 15 shifts for 5 samples, if they can measure 3 samples in 9 shifts, they can show that the method works and request beamtime again, with first data and the proof of success already given. If it is unclear whether shortening is possible or not (there are experiments that cannot be shortened in a meaningful way), this option is already ruled out. At some SR facilities the amount of beamtime allocated to a proposal can even be cut down in spite of it being above the cut-off, if the panel agrees that the requested amount is excessive.

- **Results Expected**

This is one of the sections that at first sight seems superfluous for such a short proposal. It is not. We need to give a very compact view of what we hope to learn, in particular, from the proposed experiment. So do not put general phrases here that sound like 'don't worry, we will learn something anyhow' or 'we will for sure clarify every possible detail of the material system under investigation'. Of course you would never do that on purpose. But read your phrases again: could the impression the referee gets go in that direction? It is better to be very clear and put well-defined, attainable results here. Making a list is not a bad idea, it makes it easier for the reviewers to orient themselves in the proposal.

A particular problem is to find the balance between important enough results and not overdoing it. Having, in a realistic amount, the larger goal in mind, may help in cases, also to convince the panel with its diverse background that the scientific issue is topical and of a wider interest. 'Identifying the growth mechanism of …' might be more attractive than 'determining the dependence of layer growth rate on growth temperature and the rate of …', but on the other hand 'our results are crucial for solving the world's energy production problems' would be a claim that needs an extremely good proposal to support it.

- **References**

As mentioned above, references do not serve the same purpose in a short proposal than in a publication. Of course we must refer to the original literature when we make a claim that is not our work and not obvious, but a finding of somebody else. But since we do not have too much space, we can restrict ourselves to a few important papers of the field, high-impact ones and reviews, to show that we know the relevant literature. We must also refer to our own publications on the topic, with or without application of SR, to show that we are already experienced (to some extent) in the field, have done previous work (including characterization of the material by in-house, non-SR techniques), know the method etc. All this primarily serves the purpose of convincing the referee that we will manage to perform the proposed work. Beside the scientific attractiveness of our work, this is a very important point to make.

- **Proposal Summary**

The summary will usually be the last thing we write, although it will appear at the beginning. Its purpose is the following (in line with what we explained about how the panel works): reviewers that are forced to read many proposals will not memorize all of them very well. We need to give them a very quick way to remember what was our point, in order to allow them to 'defend' our proposal in the review panel meeting, and grade it appropriately.

Further general recommendations

Following the lines above, several other elements of a proposal become clear:

Figures may be a good means to transmit information in a compact way, and for some reason most people memorize figures better than paragraphs of text. Hence including a figure, a catchy one might not be bad, increases at least the 'memorizability' of our proposal

Title: the same is true here. A good title is important. A tip here: even if this is not foreseen in the proposal template, 'smuggling' the title onto the page of text can be a good idea. In some templates the title appears only on a page of 'statistical information', which looks the same for every proposal. So if the referee can see the title and remember what the proposal is about from the text part of it, this will rather be beneficial.

Colour: many proposals are sent out to referees as black-and-white copies. This will certainly change more and more, since electronic sending takes over, but especially images should be designed in a way that they look attractive even in black-and-white printing.

Font sizes and formatting: sometimes you might have the impression that your proposal is already condensed to the maximum (minimum, actually), and cannot be shortened any further. Since you are too long by only four lines, why not fiddle around with the paper margins or reduce the font size slightly?

Don't do it !

In some review panels, proposals are printed with size reduction to reduce the amount of paper in printing, and fonts are already rather small. Consider that reviewers might be senior scientists already wearing glasses, and they hate if they can't read the text. Check in particular the labels of figures etc., they frequently are too small.

Weak points of your proposal: if you are aware that your proposal has a weak point, e.g. you don't know enough about a sample, it is not clear the method will really yield the parameters you want, etc., there are always two ways out. One is to try to hide those weaknesses, hoping nobody will notice. This can be dangerous for two reasons: if the reviewers find such an aspect and discuss it, they will likely downgrade the proposal, as – for good reasons – they don't like the attempt at tricking them, or they get the impression that you are not aware of an evident weakness and hence did not consider your experiment well enough. It is usually much better to openly discuss the weaknesses. Admittedly this has the danger that reviewers will conclude that the proposed experiment is not likely to be successful, but the danger that you will be considered not to have thought enough about your proposal, or were trying to mislead the referees, is avoided.

What is the best beamline for your proposal: if you are writing the first proposals, you might probably not have a clear idea how to choose the right beamline, and it actually is not an easy task. Consider the sample environment you need, consider the energy range, the brilliance and coherence of the primary beam that match your needs (often one is tempted to go for the highest brilliance and coherence available; sometimes a lower coherence, but larger flux match the experimental needs better), the detectors. What else does your experiment need? Other means of sample characterization in close proximity? Sample preparation laboratories?

If you are already an expert in the field, you might be reading this only for curiosity, and you for sure know exactly which beamline to use. Think again. Do you know all recent developments at the European synchrotron sources? Is any new/refurbished beamline fulfilling your needs? Maybe outperforming your favourite one? You may have a look at the waytolight pages on http://www.wayforlight.eu/eng/home.aspx.