Report of Working Group V:
Photon Optics for Future Light Sources

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The Working Group's task was to establish the needs for x-ray optics suitable to preserve the high peak brilliance and the full lateral coherence of future light sources, in particular of free electron lasers in the x-ray domain.

The presentations started with a summary and the conclusion of a meeting held at Stanford in January 1997 on "Interactions of Intense Sub-picosecond X-Rays with Matter" (Report SLAC-WP-12) by J. Arthur (SSRL). The conclusions were: *"Much is not known about the interaction of an XFEL pulse with matter: theoretical work and numerical simulation could greatly help in this area"* and: *"XFEL optics will be different from 3rd-generation synchrotron optics: development efforts should start immediately on XFEL optics and detectors"*. It turned out after the following presentations and discussions during the Working Group V meetings (see program) that these conclusions have remained the same for the present workshop. Practically no progress has been made since two years on the consequences of possible radiation damage of ultra-intense (10^{10} V/m or 1 V/Å) and ultra-short (100 fs wide envelope consisting of many 1 fs long spikes) X-ray pulses. Very crude estimations seem to indicate, however, that the critical threshold of severe damage would be in this region of peak fields: an interesting study! On the other hand, no problem is expected from the average power loading and improved multilayers have recently shown to preserve coherence to within 80%.

Therefore, the main message from Working Group V is that it has become even more urgent to start numerical simulations. Model calculations should be launched at Lawrence Livermore National Laboratory that has the computing capabilities to predict, to within the limits of extrapolations, the performances of materials used for X-ray optics under extremely bright ultra-short X-ray pulses. It was also concluded that it would not be possible to conduct experiments in focused beams at presently available stations on 3rd-generation storage rings to validate the simulations. On the other hand, it was recommended that the power should be variable so that optics performances could be tested progressively. Still the first optical element in a beamline would be an attenuator. It is very likely that the study of the behaviour of a gas attenuation call as proposed for the LCLS would be one of the first experimental investigations. From the experiments proposed it was obvious that optical elements would still be needed for beam shaping and cleaning, focusing and monochromatization, but that their number should be absolutely minimized.

In conclusion, similar to the situation regarding the present knowledge of the SASE process, a 100% safe prediction of the optics performance is presently impossible, but there is reasonable evidence that the optics will be able to work. Finally, only the experiment will show if the experiment will work.