R&Ds of the beamline and the related facilities at the Photon Factory

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●Abstract

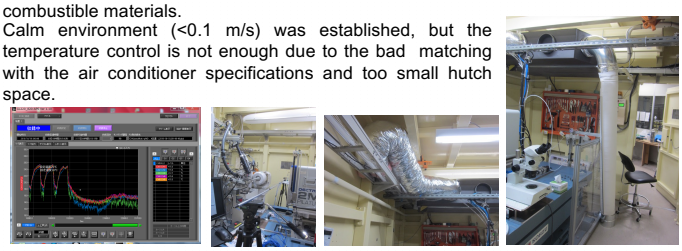
The Photon Factory in the KEK has been operating two SR sources, the PF-ring and the PF-AR for over thirty years. Although even now the 2 rings are used extensively in the wide science fields, the aging problems are quite critical so that we started considering the upgrades of the rings and a new SR facility.
Assuming an extremely low-emittance storage ring, we are studying in 5 items, beamline optics design, vibration reduction, heat-load management, beam control and beamline vacuum. In particular, the vibration reduction and heat-load management are quite important issues and we are antecedently conducting necessary R&Ds of the beamline and the related facilities, first mirror heat-load management with test chamber, vibration evaluation with fine encoder, development of the phase separator for stable nitrogen supply and the development of the GRIDCOP direct-cooling mirror system. Here, we will introduce some of our R&Ds.

●Investigation of vibration on the experimental floor

In order to consider about substructure design for the next low emittance light source, detailed investigation of the existing experimental floor has been pursued. The following points are mainly measured,
(1) Effect of truck running outside of facility
(2) Effect of forklift running inside
(3) Effect of operation with compressor and air conditioner
Tinput loss and and characteristics on vibration propagation and the excitation force of the apparatus are being analyzed. The results are compared with the simulation calculations, which are reflected to the design of the new/update of the facility.

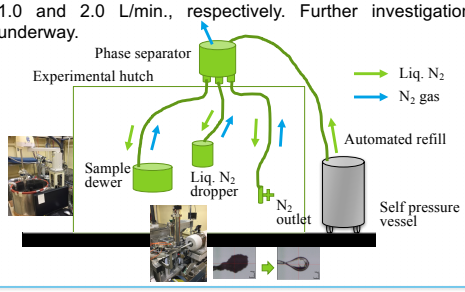
●Calm air condition and precise temperature control in the hutch

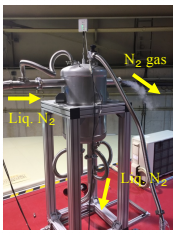
Convection restriction as well as precise temperature control in the experimental hutch is very critical for the high brilliance beam activity. Air sock duct system has been tested at the BL-5A, macromolecular crystallography beamline. The sock duct is NONNEN FABLIC DUCT (FUJIMORI SANGYO), which is made of non-combustible materials.
Calm environment (<0.1 m/s) was established, but the temperature control is not enough due to the bad matching with the air conditioner specifications and too small hutch space.



●Phase separator for liquid nitrogen supply

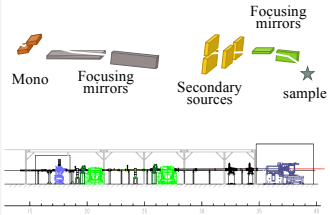
Liquid nitrogen supply is very important on optics stabilization and vibration issues. Japanese raw as for the high-pressure gas is very distinct. We have developed a original phase separator at AR-NE3A. We checked the performance. The refill time is 25 min, consumption rate is <10 L/day, and input and output speed of liq. N_2 are 1.0 and 2.0 L/min., respectively. Further investigation and development are underway.



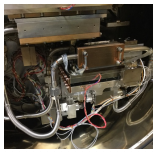


●Direct vibration measurement on optics element

In order to measure the vibration on the optics element in the liq. N_2 cooled double crystal monochromator, very fine encoder system was added on the 1st crystal of BL-17A (This idea is originally applied at NSLS-II). We have just modified and will analyze the vibration composition compared with the fluctuations of beam intensity. If the cause of the vibration can be distinguished, we will implement this system on the other optics and improve the beam instability.



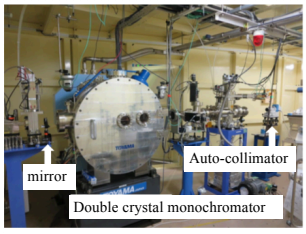
Optics layout of BL-17A

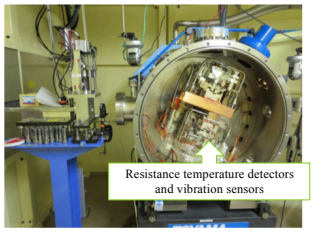


Encoder resolution is 45 nrad, corresponding to the 1.7 μm at sample position

●Off-line *In-situ* measurement of liq. N_2 cooled monochromator

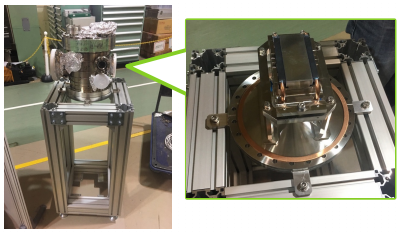
In order to observe the vibration and the parallelism defects of the liq. N_2 cooled double crystal monochromator In operation but off-line, we developed a measurement method using auto-collimator at BL-15A. The flanges with safire widow are set upstream and downstream of the monochromator. The results are validated and we are trying to fix the defects.





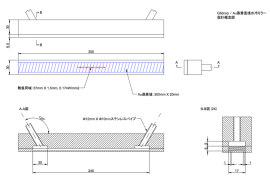
●Improvement of the thermal contact resistance and the holder structure of water cooled optics

As known well, the thermal contact resistance is a key for the optics cooling and the surface deformation. We made a test chamber for the off- line heat load studies. The holder structure is also important. With this test chamber, we will research the best solution and design the stable holder.

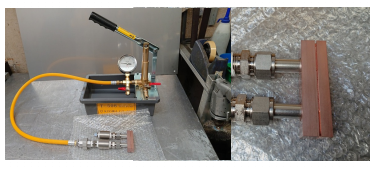


●Development of direct cooling mirror

Our FEA analysis for the low emittance light source shows that in-direct cooling is not enough for the first optics. In particular, the heat load problem is critical in the lower VUV and soft x-ray region. So, we started to develop the direct cooled mirror. GRIDCOP is now choosen as a base material. To clarify the technical points, we made a small test piece (80 x 20 x 20 mm). We are now checking the performance and will move ahead to making the target design.



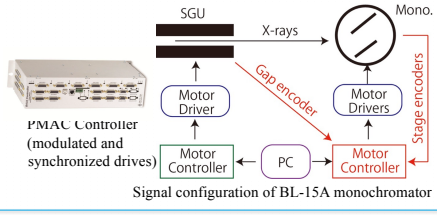
Target design



Test piece of direct cooled GRIDCOP mirror

●Real-time synchronization of multi-drives

Now more flux and faster detectors are available so that the fast on-the-fly measurements are critically efficient. We made choice of PMAC controller (DELTA TAU) which can control modulated and synchronized motions of multi-drives. First, we developed the synchronization system of the undulator and monochromator at BL-15A. The GAP encoder is bed on the PMAC controller, which control the modulated motions of 5 axes of the monochromator, θ,Y1,Z1, φ2, CB, as flowing the GAP motion.
Currently, due to the encoder resolution of the undulator, only monochromator drives are synchronized (θ encoder is reference of the other 4 axes). However, the controller software is established.



Signal configuration of BL-15A monochromator