

RECENT BEAM SIZE MEASUREMENT RESULT USING SYNCHROTRON RADIATION INTERFEROMETER IN TPS

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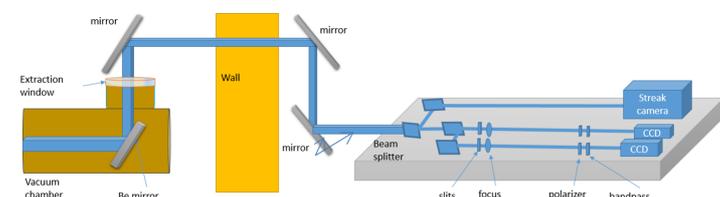
Organisation: National Synchrotron Radiation Research Center



Abstract

Taiwan Photon Source (TPS) was under commissioning operation in 2015. An optical diagnostic beam line was constructed in TPS 40th beam port for the diagnostics of the electron beam properties. A synchrotron radiation interferometer, one instrument of this diagnostic beam line, operates for monitoring the beam size. In the beginning, the interferogram of the vertical beam is usually distorted. We found the stray light affected the vertical interferogram obviously while the beam current was raised. This paper describes the problems we met and how to eliminate the stray light for better beam size estimation. In the normal course of events, TPS is driven in 300mA and the horizontal beam size is 56 μ m and the vertical beam size is 32 μ m. The beam current of TPS is maximumly driven to 518mA in June, 2016. This paper also presents the trend of beam size during current running up.

Beamline construction & SR Interferometer



- A cooled beryllium mirror was adopted to prevent distortion, with profile quality under $1/4 \lambda$. The extraction window was with profile quality within $\frac{\lambda}{10}$.
- After passing the extraction window, one aluminium reflection mirror is adopted for transport light through the shielding wall.
- In the outside of the shielding wall, two folding mirrors are used to connect the synchrotron light source to the SRI beam-size monitoring system.
- Synchrotron light is separated to three channels by two beam splitter. 50% light is delicate for SR interferometer and the other 50% light is for streak camera monitoring.



Component list

- The distance from the source point to the double slit is 22m (R).
- The centre wavelength of the bandpass filter is 500 nm with 10 nm bandwidth.
- An eyepiece is applied to magnify the interferogram
- Two CCD (Basler ava2300-30km) are applied to observe the horizontal and vertical interferograms respectively.

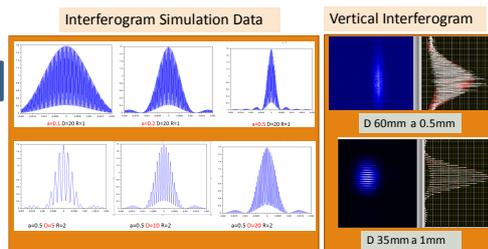
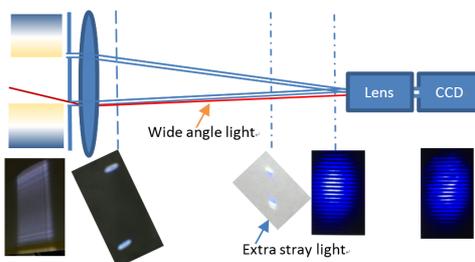
Interferogram equation

$$I(y_1) = I_0 \left[\text{sinc} \left(\frac{2\pi a}{\lambda R} y_1 \right) \right]^2 \left[1 + |\gamma(v)| \cos \frac{2\pi D}{\lambda R} y_1 + \phi \right]$$

$$\sigma_{beam} = \frac{\lambda R}{\pi D} \sqrt{\frac{1}{2} \ln \left(\frac{1}{\gamma} \right)}$$

- γ : visibility
- R: distance from object to double slit
- D: double slit separation
- a: half width of slit opening

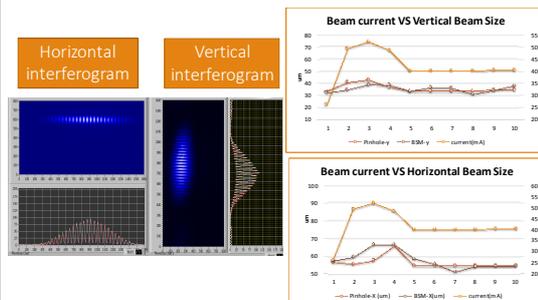
Tests and results



- The interferogram pattern of the vertical direction is very sensitive to the position of the double slit.
- The ray trace is done for checking the optical system.
- Closing to the focus plane, an un-expected light spot point appears under the double slit light spot. The wild angle light is produced during light propagation and has the interference with the edge of vacuum pipe.
- Counter measures
 - ✓ We enlarge the half opening (a) of the vertical double slit to enhance the intensity of slit entrance light and the stray light noise level is declined.
 - ✓ The color band must be blocked for preventing entering the SRI monitor.
- By reference to beam size error function, the recommend visibility is in the range of 0.2 to 0.8. At 30 μ m beam size level, the best separation value (D) is 40mm for system resolution compensation.

Tests and results

- For a horizontal beam size monitor, the slit separation (D) is 20 mm and the half opening (a) is 0.5 mm. The horizontal beam size is 57.5 μ m during 300mA operation.
- For a vertical beam size, the slit separation (D) is 50 mm and the half opening (a) is 1.5 mm. The vertical beam size is 35.8 μ m during 300mA operation.
- The beam current of TPS is maximumly driven to 518mA in June, 2016. The measurement result of SRI has good correlation to X-ray pinhole camera.



Summary

- A SRI beam size monitor was installed and operated in NSRRC TPS from Sep, 2015. To minimize the measurement error of the vertical beam size, the stray light is eliminated by minimization the separation of the slit and enlarging the half-height of slit.
- Since TPS starts operation, the SRI keeps monitoring the horizontal and the vertical beam sizes, the measurement result of SRI has good correlation to another instrument, pinhole camera. For improving the resolution, the intensity imbalance of the light path of the SR interferometer will be introduced to reduce the effect of the measurement error in the future.