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Bunch Purity Measurement and Improvement

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Abstract

signal electron level purity is mandatory for a nuclear resonant scattering experiment. For the establishing such kind of beamlines on High Energy Photon Source (HEPS), a new time-correlated single photon counting system has been implemented on the storage ring of Beijing Electron-Positron Collider II (BEPCII), which is used to monitor the purity. The system could track the purity deterioration process. The possible reason of impurity growth is analyzed, the measurement results confirmed that Touschek scattering and pre-accelerators of the storage ring are the main mechanisms of impurity growth. A bunch cleaning technique based on a sinusoidal signal mixed a pseudo-square wave has been verified which could improve the purity to the level of 10^{-7}. This paper mainly describes the experiment details and measurement results of purity measurement and improvement..

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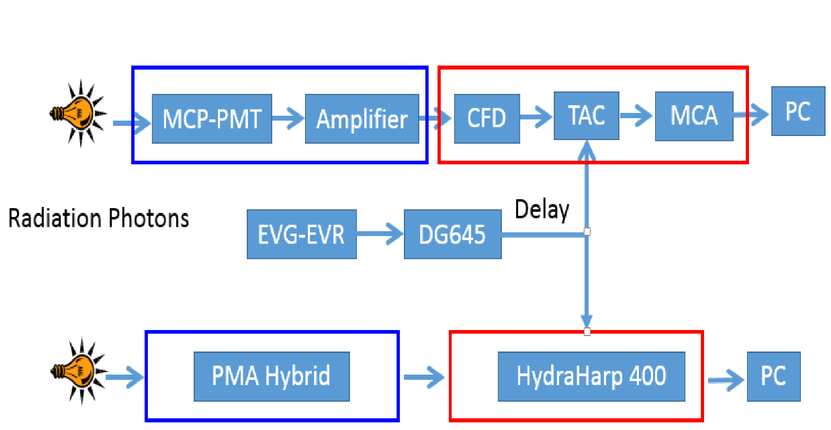

Figure 1:diagram of the bunch purity measurement system.

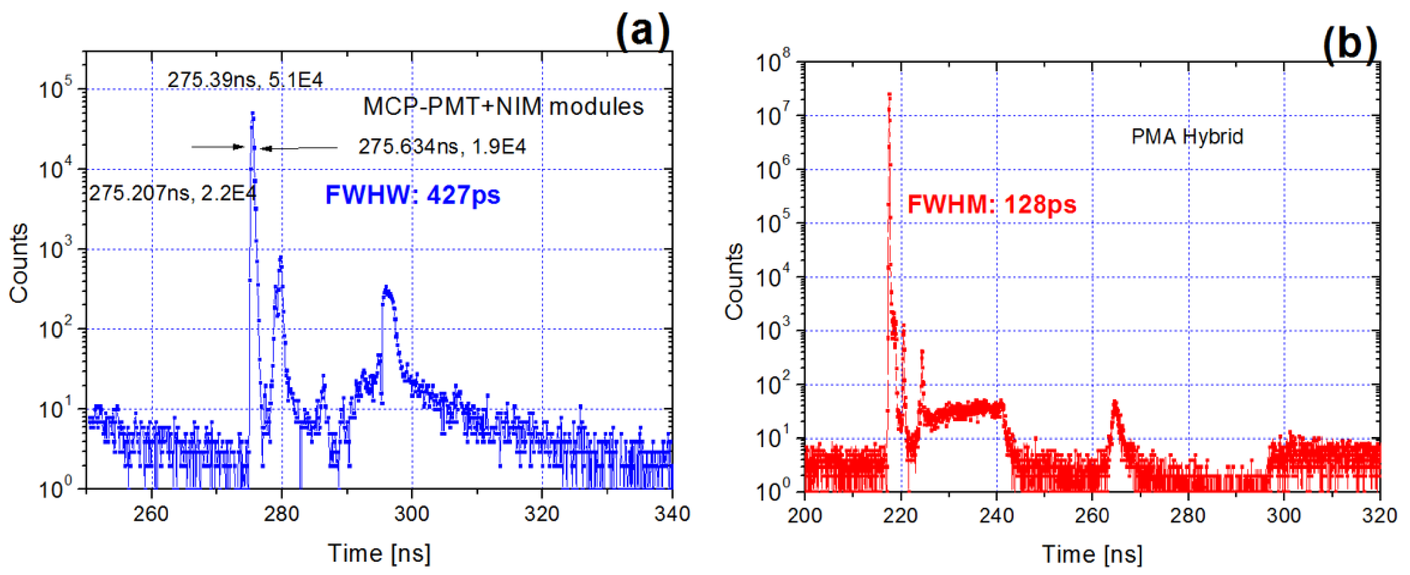

Figure 4: Single bunch purity measurement results with (a) MCP-PMT + NIM moles and (b)Hybrid + HydraHarp.

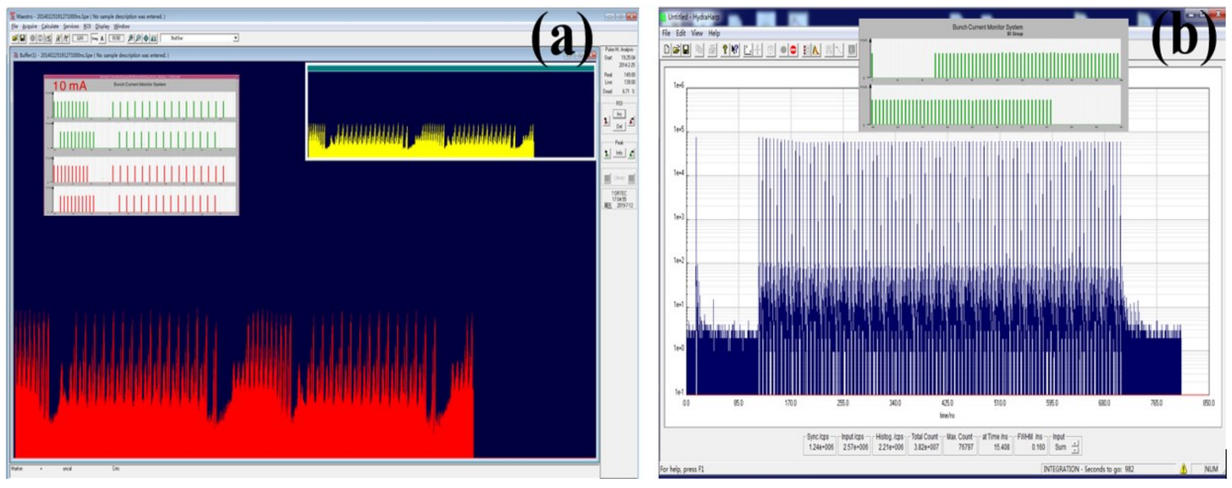

Figure 2: A Purity measurement interfaces of the two systems. The inset shows the Bunch Current Monitor result. The time axis is reversed for two systems. (a) Collider mode, three trains with a spacing of 50 ns, the spacing of bunches is 6ns or 8 ns in a train. (b) Synchrotron mode, a single bunch + 99 bunch with a 6ns spacing. Single bunch located in the center of a 200ns spacing

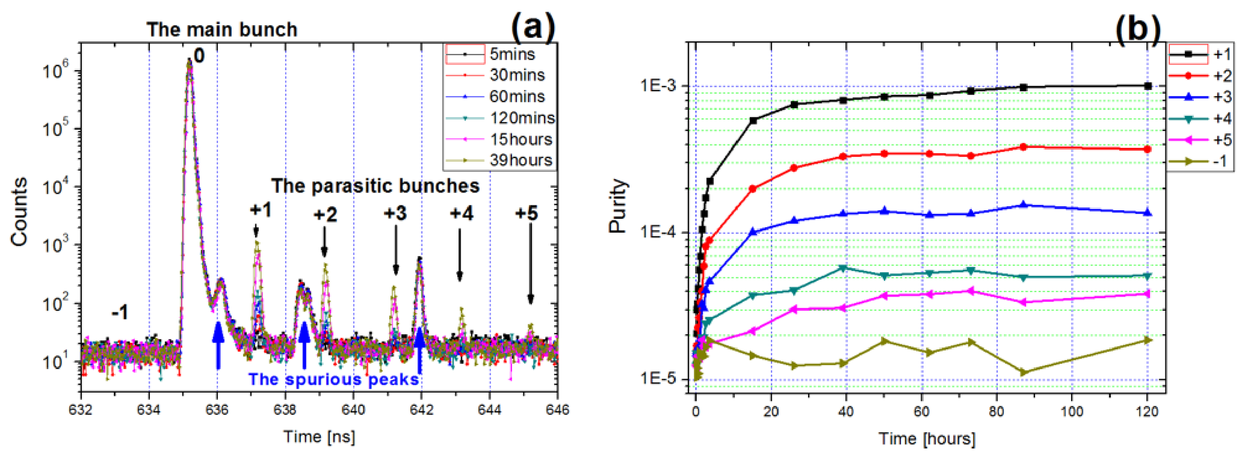

Figure 5: (a) The purity measurement results of SR mode Top-up operation after the first injection, it shows the 14 ns details around the main bunch. As shown in Fig. 2(b), the main bunch located the centre of a 200 ns spacing away for another 100 bunches. (b) The purity changes of different parasitic bunches after injection.

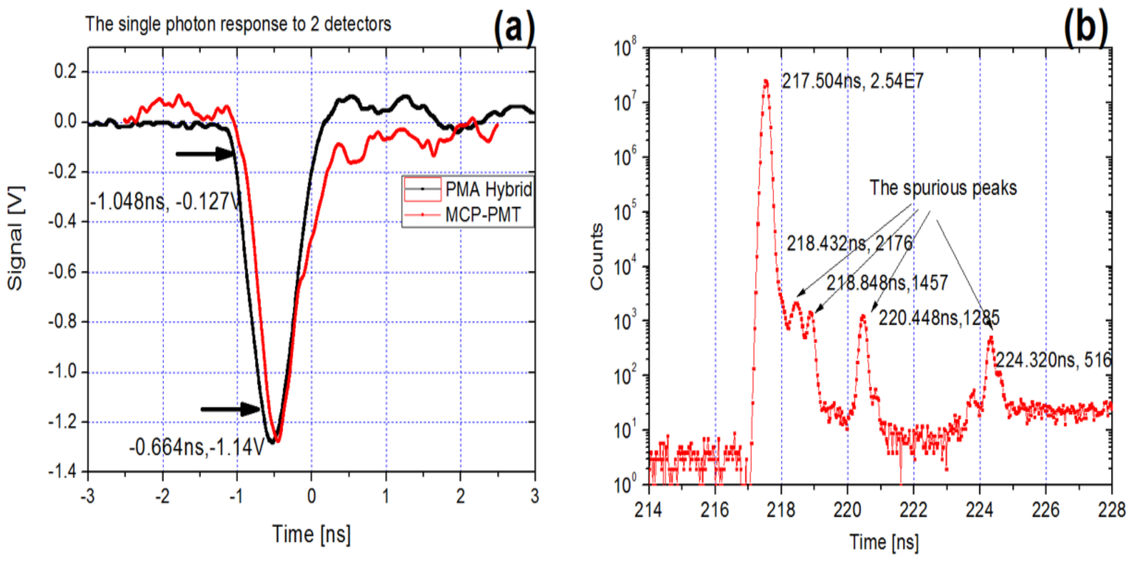

Figure 3: The single photon response of 2 detectors. (b) The spurious peaks of the PMA Hybrid detector.

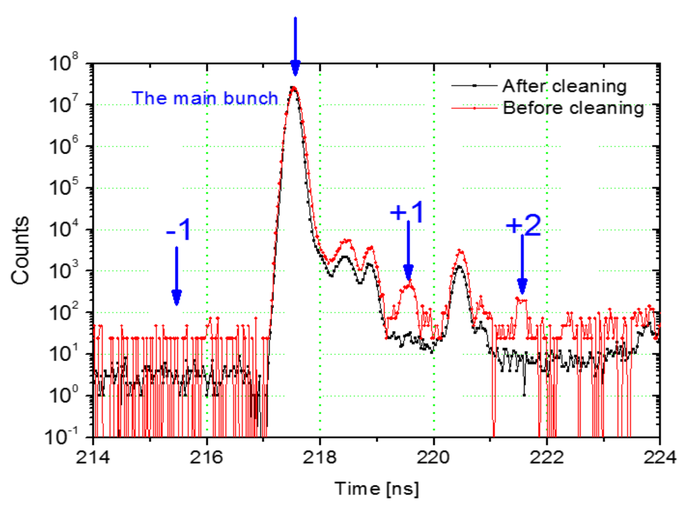

Table 1: The purity change after a cleaning system working.

	Purity before cleaning	Purity after cleaning
-1	9.53×10^{-7}	1.19×10^{-7}
+1	2.38×10^{-5}	9.12×10^{-7}
+2	8.57×10^{-6}	3.57×10^{-7}
+3	2.85×10^{-6}	5.95×10^{-7}

Fig. 6. Purity change after a cleaning system working for a single bunch operation. The purity results before cleaning is recorded in 5 minutes.

Conclusion

A new bunch purity measurement system has been implemented in the BEPCII storage ring as it could measure the bunch purity in dozens of seconds. Two sources for parasitic bunches have been identified; the linac with a sub-harmonic buncher system could induce more parasitic bunches than expect, and the Touschek scattering of the main bunch is another reason for impurity growth. An original purity of 10-5 after the injection, it became 10-4 in one day, then 10^{-3} in several days during Top-up operation. A purity of 10-7 is achieved after a RFKO system cleans the parasitic bunches. A clear purity gradient in different parasitic bunches has been detected. The growth rate of impurity has been recorded through a week's operation period. The purity growth theory of Obina has been approved as there is no obvious purity growth in a forward bunch and the most electron of backward parasitic bunches come from the main bunch in one step instead of transfer one by one.