The beam transfer from SIS18 to ESR is achieved by the existing GSI control system, which is an event based system. The event execution will start at the corresponding immediately upon event receipt. Events are directly sent from a ``Pulszentrale``, who makes the schedule. Every accelerator has its own Pulszentrale, e.g. ESR is equiped with ESR-Pulszentrale and SIS18 with SIS-Pulszentrale.

time

time

SIS-timing master

ESR-timing master

Charge

process of extraction kicker

Timing Generator (EC)

Phase synchronization

SIS18 Group DDS

ESR Group DDS

ESR Group DDS

***Delay for phase match***

SIS18 Ext kicker control electronics

ESR Inj kicker control electronics

Digital signal

***Extratcion kicker delay***

***Injection kicker delay***

Charge

process of injection

kicker

Figure 1. The realization of the bunch-to-bucket transfer from SIS18 to ESR with GSI control system

Fig. 1 illustrates the realization of the bunch-to-bucket transfer from SIS18 to ESR with GSI control system. SIS18 needs longer time for the preparation, e.g. beam injection, beam acceleration, before the extraction than that of ESR before injection, so ESR is earlier fully prepared for the transfer. The preparation process is represented as red rectangle in Fig. 1. When SIS18 is fully prepared with the bunches to be transferred, the ready signal from ESR-Pulszentrale and SIS-Pulszentrale are inputed into a logic AND gate. When both SIS18 and ESR are prepared, namely the output of the logic AND gate is high, the extraction kicker charge event is sent from SIS-Pulszentrale and injection kicker charge event from ESR-Pulszentrale. The charge process of kicker is represented as yellow rectangle in Fig. 1. When two kickers are fully charged, the ready signal of extraction and injection kicker from ESR-Pulszentrale and SIS-Pulszentrale are inputed into second logic AND gate, as well as the phase synchronization signal from the RF system. The phase synchronization signal indicated the alignment of the zero-crossing of Reference RF Signals from Group DDS of SIS18 and ESR. The output of the 2nd AND gate works as an indication signal, starting the delay on the SIS18 rf signal for the correct phase match between SIS18 and ESR rf systems. ESR uses the injection orbit instead of the desin orbit, so the circumference ratio between SIS18 and ESR is close to an interger 2-0.003, SIS18 is with the harmonic number 4 and ESR with the harmonic number 2, so the rf frequency ratio is 4/4-0.006. The beating frequency is The phase difference between RF systems of SIS18 and ESR varies at the speed of the frequency difference Δf. The required phase difference ΔΦ must happen a specific time t after the zero-crossing alignment of two systems, see eq. 1.

 eq. 1

The operator configures the Timing generator with the extraction, injection kicker delay compensation and the specifc time for the correct phase difference.

goes to the Timing Generator, which produces the trigger for SIS18 extraction and ESR injection kickers.