Status of the LLRF Development for the ESR Barrier-Bucket System*

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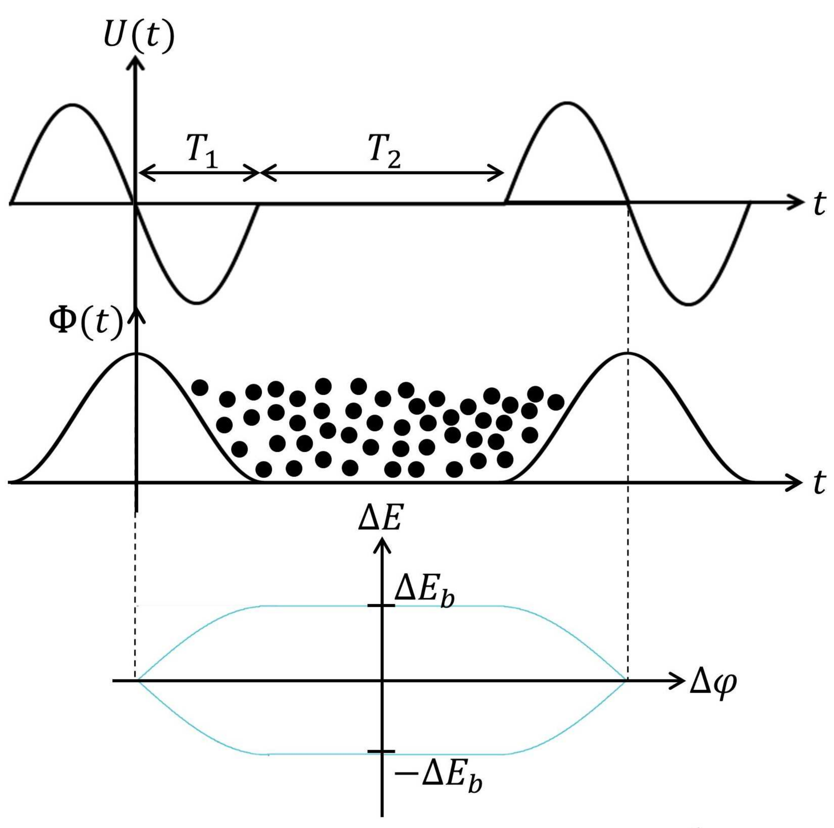
1 Introduction

For sophisticated longitudinal beam manipulations, the Experimental Storage Ring (ESR) at GSI, Darmstadt, is to be equipped with a Barrier-Bucket (BB) RF System. This system will consist of two broadband RF cavities, each driven by a solid state amplifier, with the purpose to produce two voltage pulses per beam revolution to longitudinally capture the beam (Figure 1). By shifting the pulses towards each other, the beam can be compressed or decompressed which can be used for particle accumulation. For the generation of the BB pulses, two cavity systems will be installed in the ESR, providing one pulse per revolution each. In stacking mode [2], the desired pulses are clean (ringing <2.5%) 5 MHz single sine pulses with a repetition frequency of 900 kHz - 2 MHz. To reach the high quality requirements, a mathematical model of the cavity system has been developed in order to generate predistorted input signals [3].



$$\Delta E_b = \left(\frac{2\beta^2 E_0}{|\eta|} \frac{\left|\int_0^{T_1} eU(t)dt\right|}{T_0}\right)^{\frac{1}{2}}$$

Figure 1: Creating potential barriers with single-sine voltages, ΔE_b: [1]

2 Planned topology for the ESR BB System

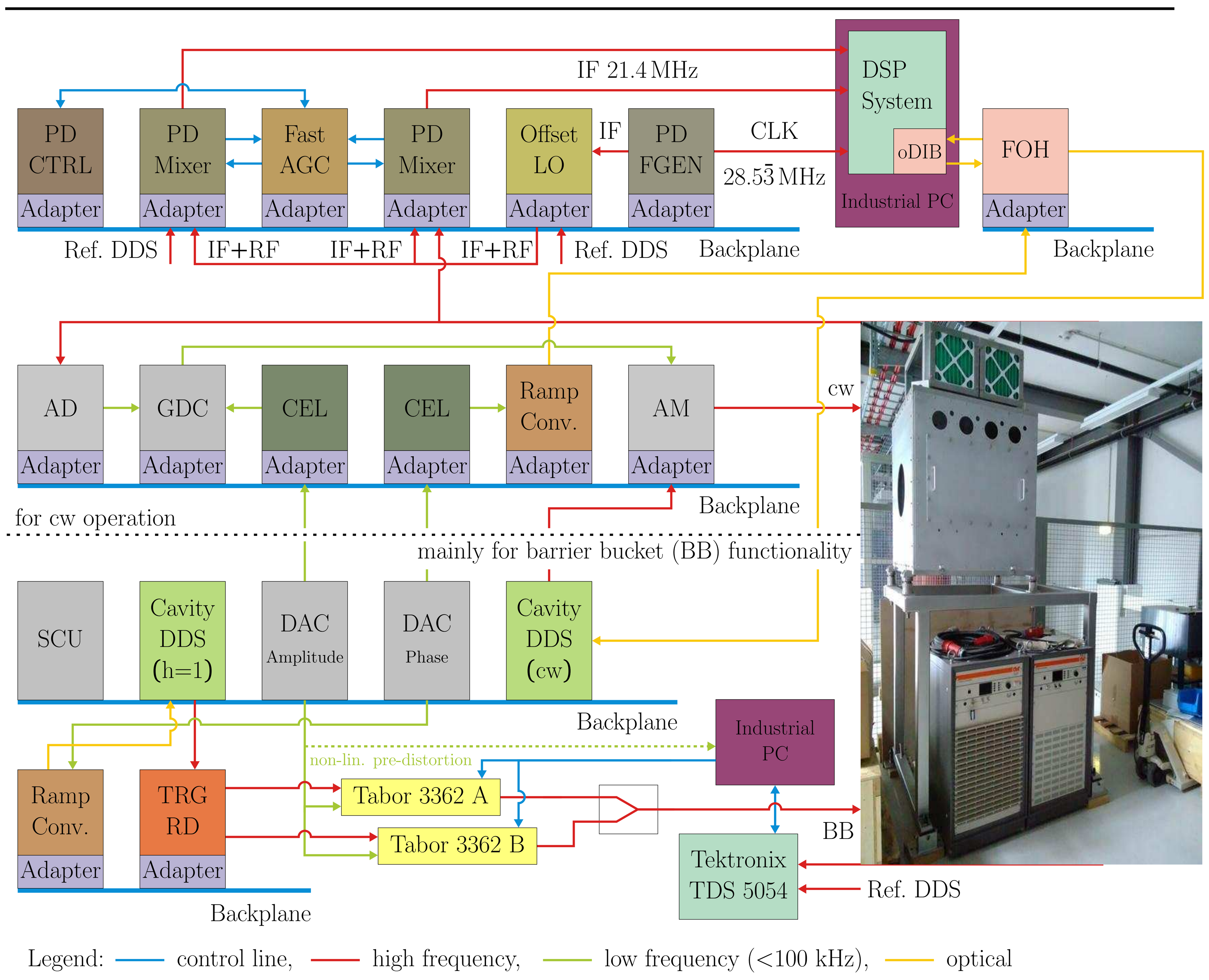


Figure 2: Current topology of the ESR BB LLRF System [4]

Figure 2 shows the current LLRF topology for one cavity system. As the system will also perform cw operation, some parts of the shown topology will not be discussed in this contribution.
The predistorted signals will be stored in Tabor 3362 Waveform Generators. Repetition frequency will vary during pulse shifts which might lead to conditions, where a new pulse sequence has to be started while the former sequence is still running. Therefore, two Tabor Generators are alternately triggered by the TRG-Module. Amplitude and phase ramps are loaded in the Scalable Control Unit (SCU). While the phase information will influence the signal trigger generated by direct digital synthesis (DDS), the amplitude is directly manipulated inside the Waveform Generators.

3 Measurement results

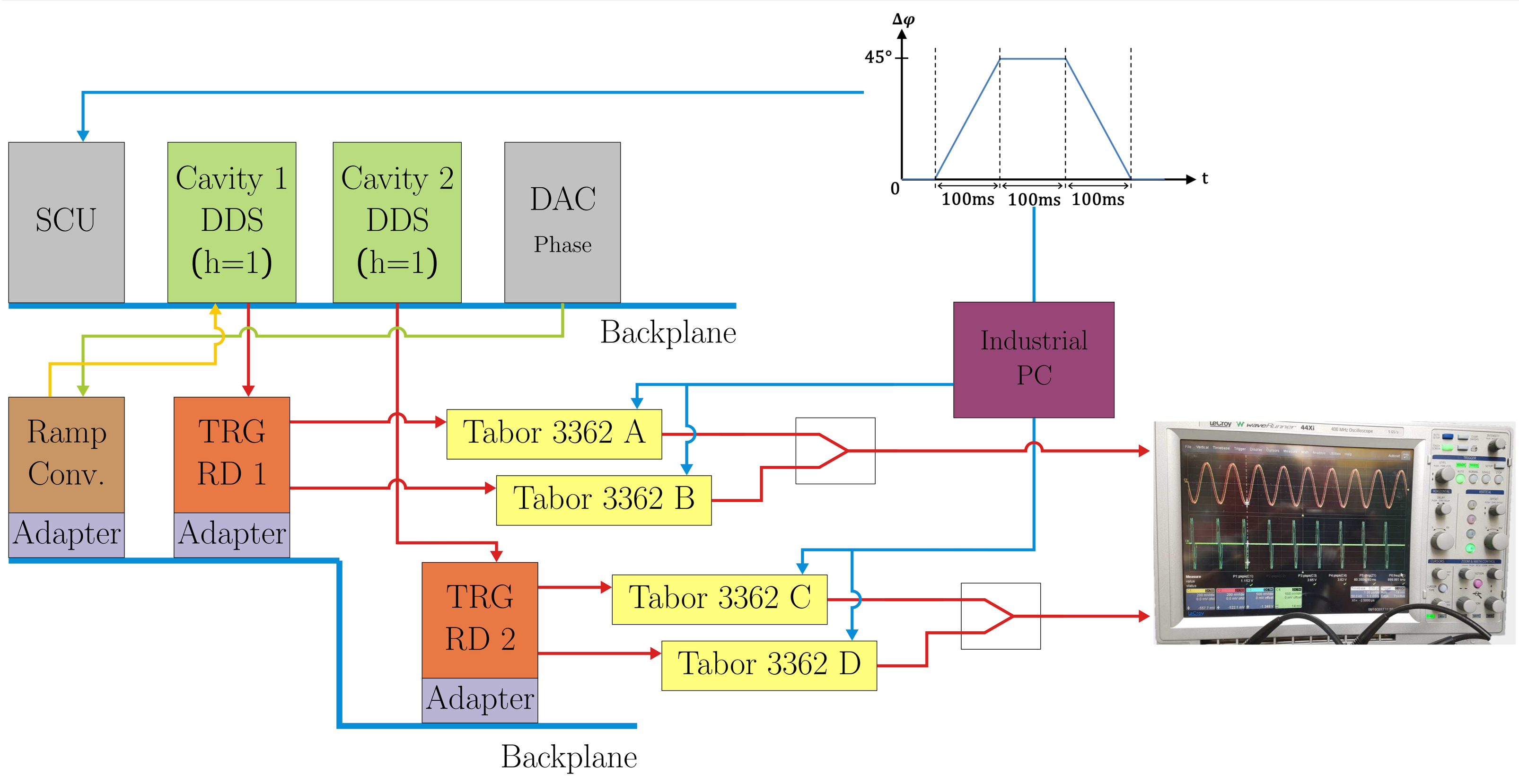


Figure 3: Measurement setup for phase shifting

Figure 3 shows the measurement setup to test the phase shift functionality of the system. Two signal chains were implemented, one providing a stationary pulse, the other providing a shifted pulse. The result is plotted in Figure 4. The ripple of the shifted pulse is an artifact caused by the time resolution of the measurement.

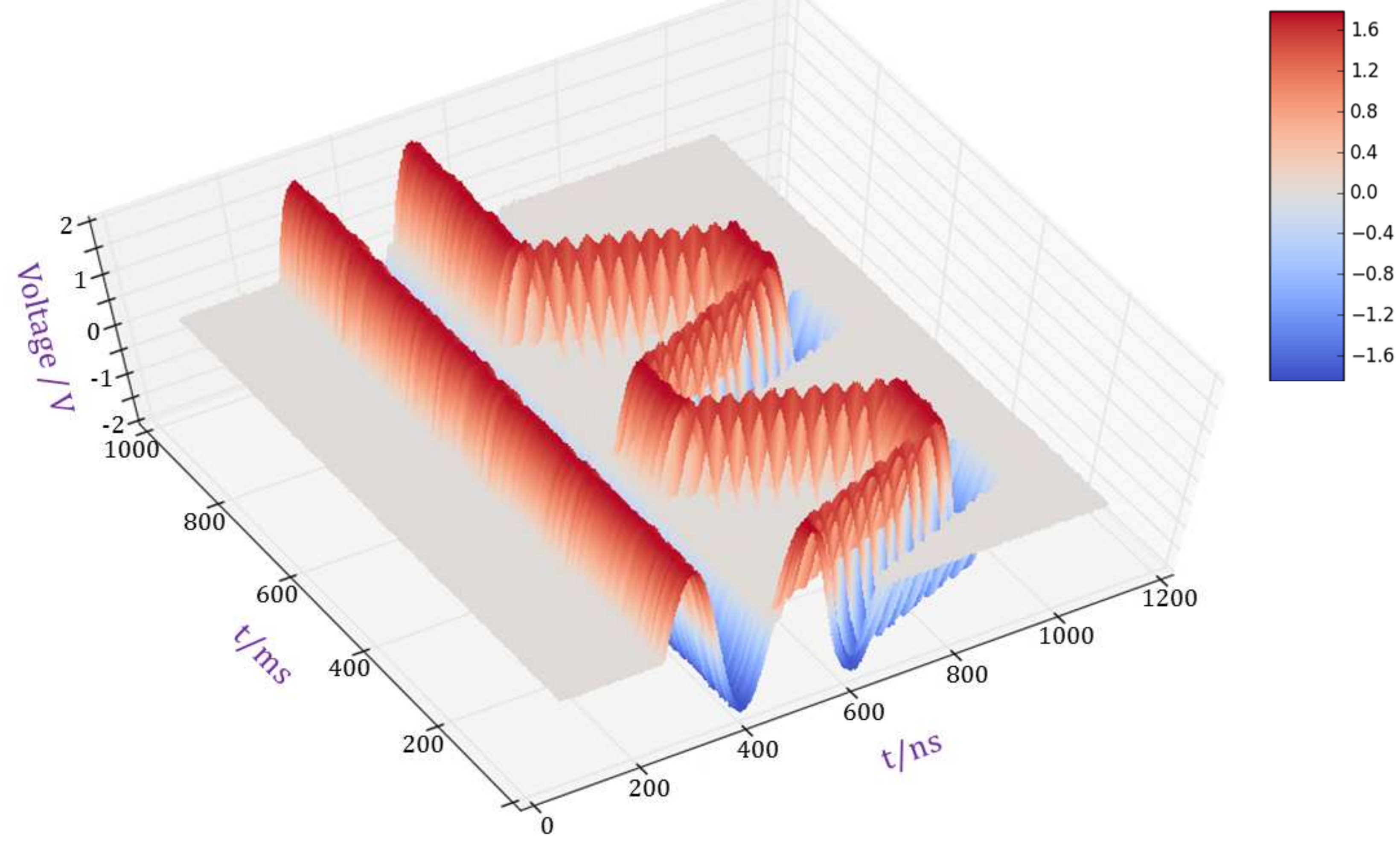


Figure 4: Measurement of shifted pulses at the ESR BB LLRF prototype setup, plot created by STARFISH^{PY} [5]

4 Outlook

- Implementation of amplitude control.
- Test of the full system including amplifiers and cavities and using linearly predistorted signals.
- Test and integration of LLRF solution for nonlinear predistortion.
- Preparing the system for standard operation (e.g. configuration after power blackout).
- Installation of the system inside the ESR in 2018.
- Integration of online signal optimization?

References

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