



# Timing adjusting of eight kickers and a method to calibrate the kicker current curves during the beam commissioning for CSNS

M.Y. Huang<sup>#</sup>, D.P. Jin, L. Shen, S. Wang, S.Y. Xu, P. Zhu

1: Institute of High Energy Physics, Chinese Academy of Sciences, Beijing, China

2: Dongguan Neutron Science Center, Dongguan, China

WEP2PO023

Wednesday

## Abstract

The extraction system is a key part of the China Spallation Neutron Source (CSNS) accelerator. It consists of two kinds of magnets: eight kickers and one lambertson. During the beam commissioning, the timing adjustment of eight kickers is a very important problem. In the paper, firstly, the timing adjustment, including the overall timing adjustment of eight kickers and the independent timing adjustment of different kickers, was studied. The adjustment methods were applied to the beam commissioning. Secondly, during the timing adjustment of the kickers, a possible method to calibrate the kicker current curves was developed and would be confirmed in the future beam commissioning.

## INTRODUCTION

CSNS is the first high power proton accelerator-based facility in China. Its technical acceptance had been completed in March 2018. The accelerator consists of an 80MeV  $H^-$  Linac and a 1.6GeV RCS. The RCS accelerates the 80MeV injection beam to the designed energy of 1.6GeV and extracts the high energy beam to the target. The design goal of beam power is 100kW and capable of upgrading to 500kW.

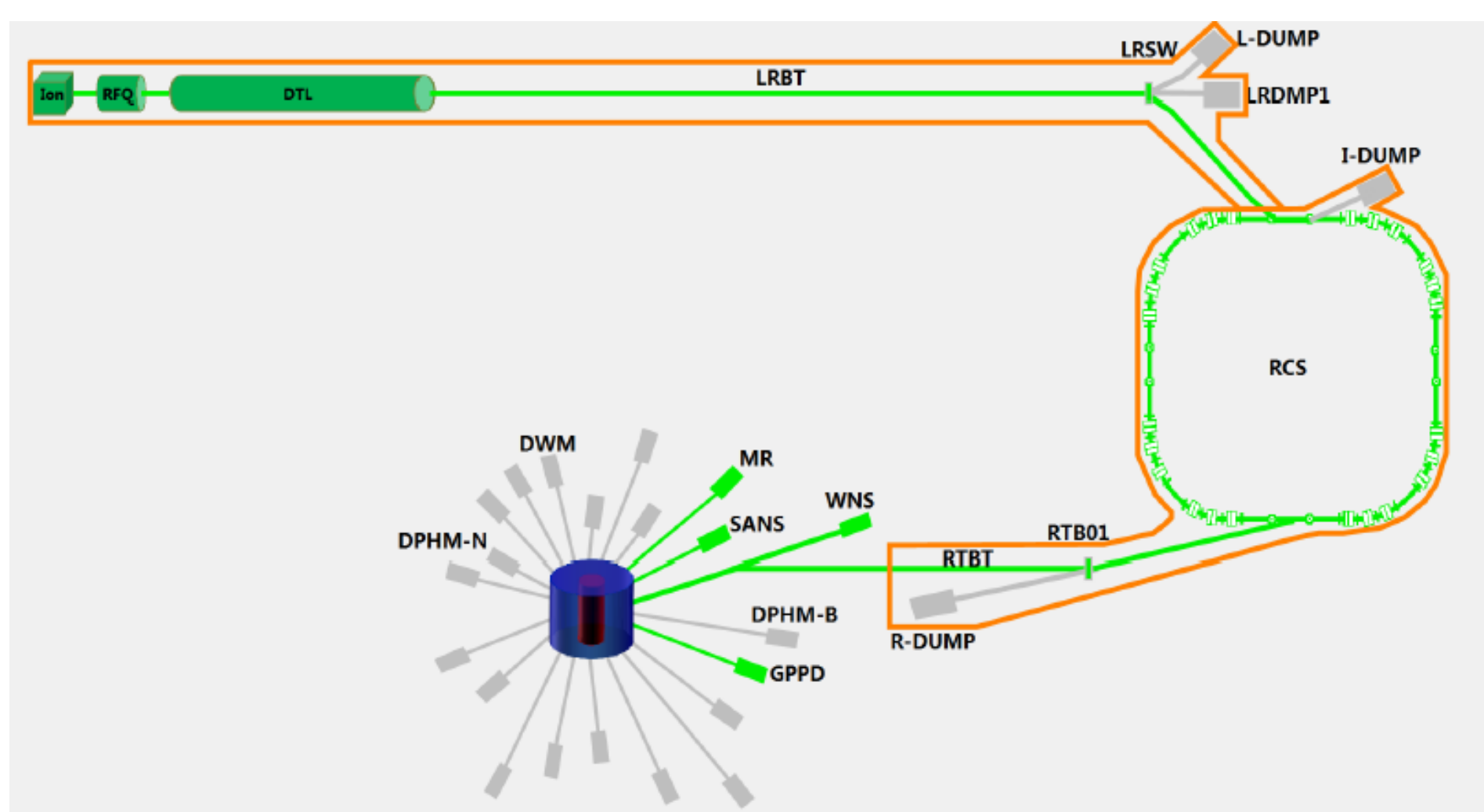


Fig. 1: CSNS layout.

The RCS has a four-fold lattice with four long straight sections of the injection, extraction, radio frequency and beam collimation. The extraction system mainly consists of eight kickers and one lambertson magnet. The fast one-turn extraction is used in transfer of the proton beam from the RCS to the target.

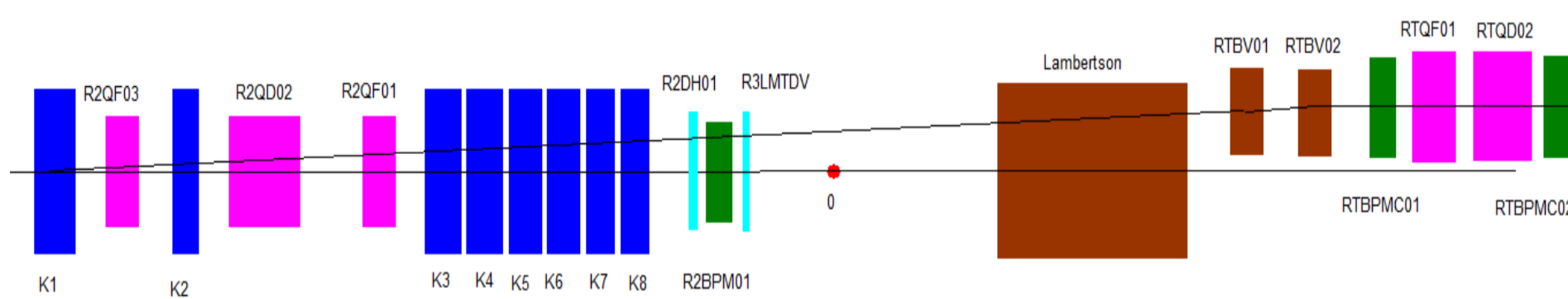


Fig. 2: Layout of CSNS extraction system.

## TIMING ADJUSTING OF EIGHT KICKERS



Fig. 3: Current curves of eight kickers.

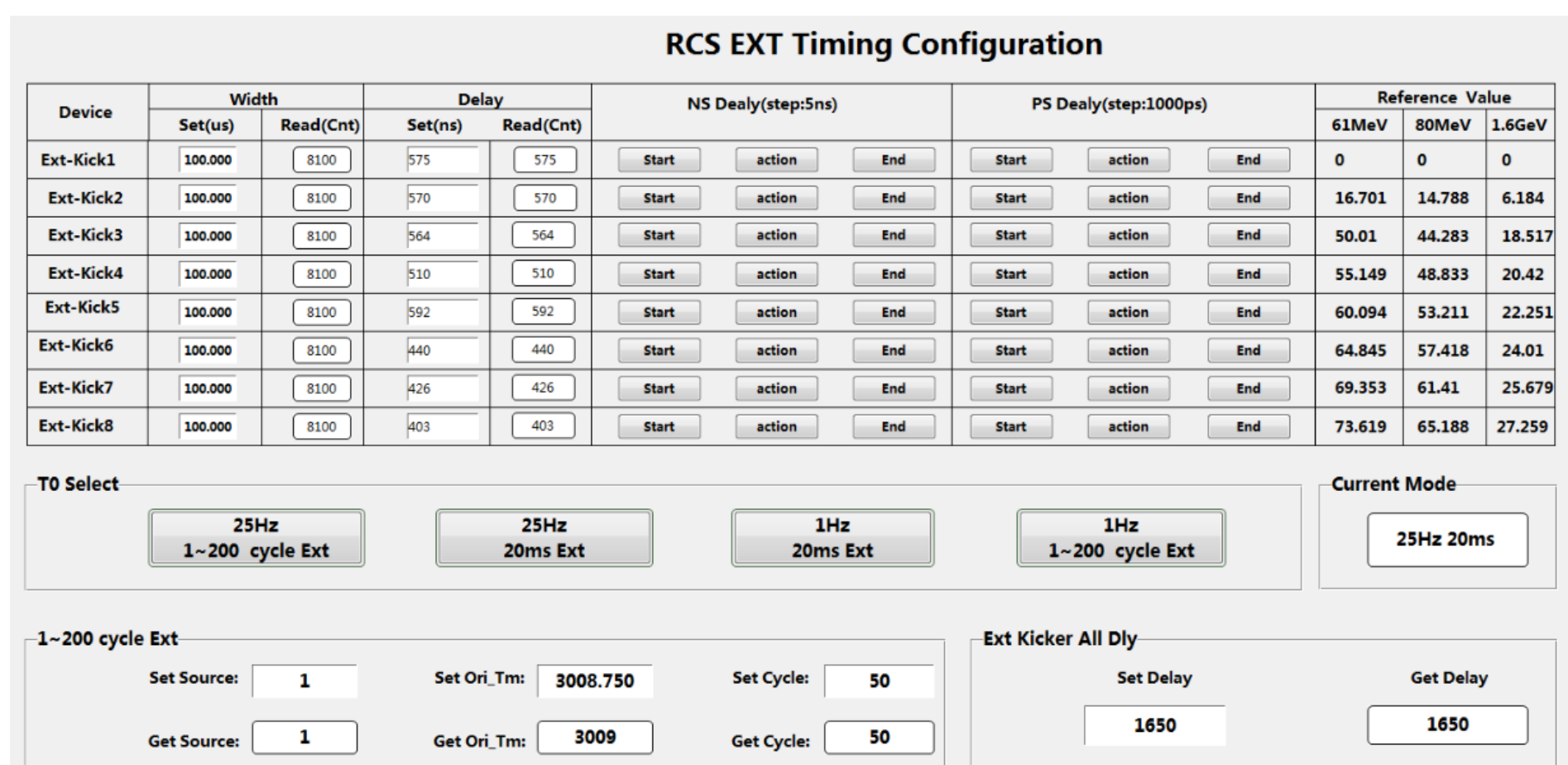


Fig. 4: Control interface of the extraction timing system.

## ACKNOWLEDGMENTS

The authors would like to thank other CSNS colleagues for the discussions and consultations.

## CONCLUSION

In the early stage of beam commissioning, the beam power and extraction beam size are relatively small. In order to extract the beam from the RCS as soon as possible, simple timing adjustment of eight kickers, including the relative timing of different kickers and the overall timing adjustment of eight kickers, should be made which can make the beam loss of the extraction system at a relatively small level. Latter, in order to reduce the beam loss and make the two extracted bunches have the same extraction coordinates, the independent timing adjustment of different kickers was studied and made. During the kicker timing adjustment, by using the position information measured by the BPM on the RTBT, a possible method to calibrate the kicker current curves was developed. This calibration method would be confirmed in the future beam commissioning.

During the beam commissioning, in order to extract the RCS beam to the target smoothly, the timing of eight kickers need to satisfy suitable conditions. The timing adjustment of eight kickers is essentially the translation of different kicker current curves. It consists of two parts: the overall timing adjustment of eight kickers and the independent timing adjustment of different kickers.

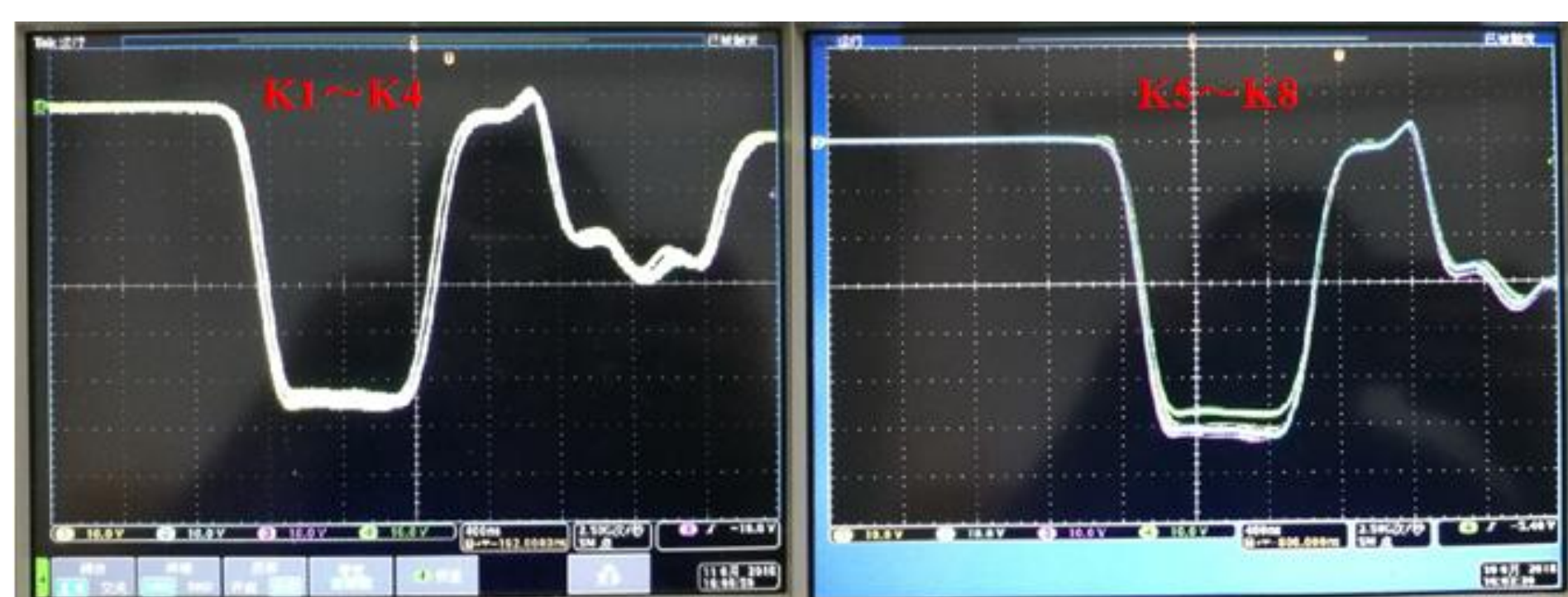


Fig. 5: Current curves of eight kickers after the relative timing adjustment of eight kickers.

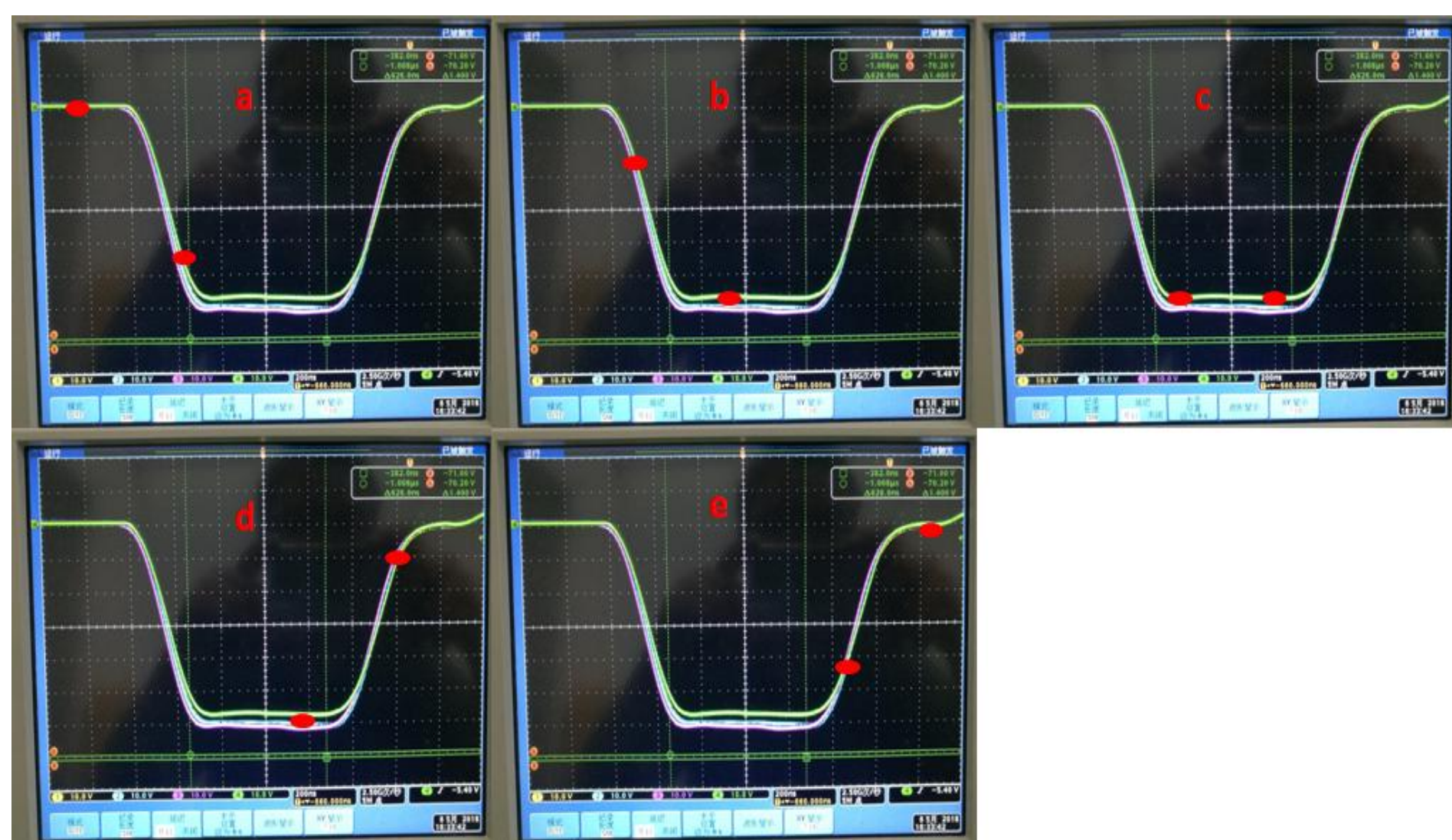


Fig. 6: Two extracted bunches which set at different positions of the current curves of eight kickers.

In the early stage of beam commissioning, the beam power and extraction beam size are relatively small. In order to extract the beam from the RCS as soon as possible, simple timing adjustment of eight kickers was made and the beam loss of the extraction system was controlled at a relatively small level. Firstly, the relative timing of different kickers was adjusted and the relative timing errors were controlled at a small level. Secondly, the overall timing adjustment of eight kickers was made and the beam loss of the extraction system was relatively small. It can be found that, by the overall translation of the current curves of eight kickers, the two extracted bunches can be placed on the flat tops of the eight current curves. After that, the two bunches can be extracted from the RCS smoothly.

During the beam commissioning, if one extracted bunch or two extracted bunches are not placed on the flat tops of the current curves of some kickers, the two extracted bunches would have different extraction coordinates which can be measured by the BPMs on the RTBT. In addition, there may be large beam loss on the RTBT which can be detected by the BLMs. In order to reduce the beam loss and make the two extracted bunches have the same extraction coordinates, the independent timing adjustment of different kickers was studied and made. It can be found that, by the translation of the kicker current curve, the two extracted bunches can be placed on the flat tops of the kicker current curve. If the two extracted bunches can be placed on the flat tops of the current curves of eight kickers, they would have the same extraction coordinates and can be extracted from the RCS smoothly. It can be known that the beam loss of the extraction system is very small.

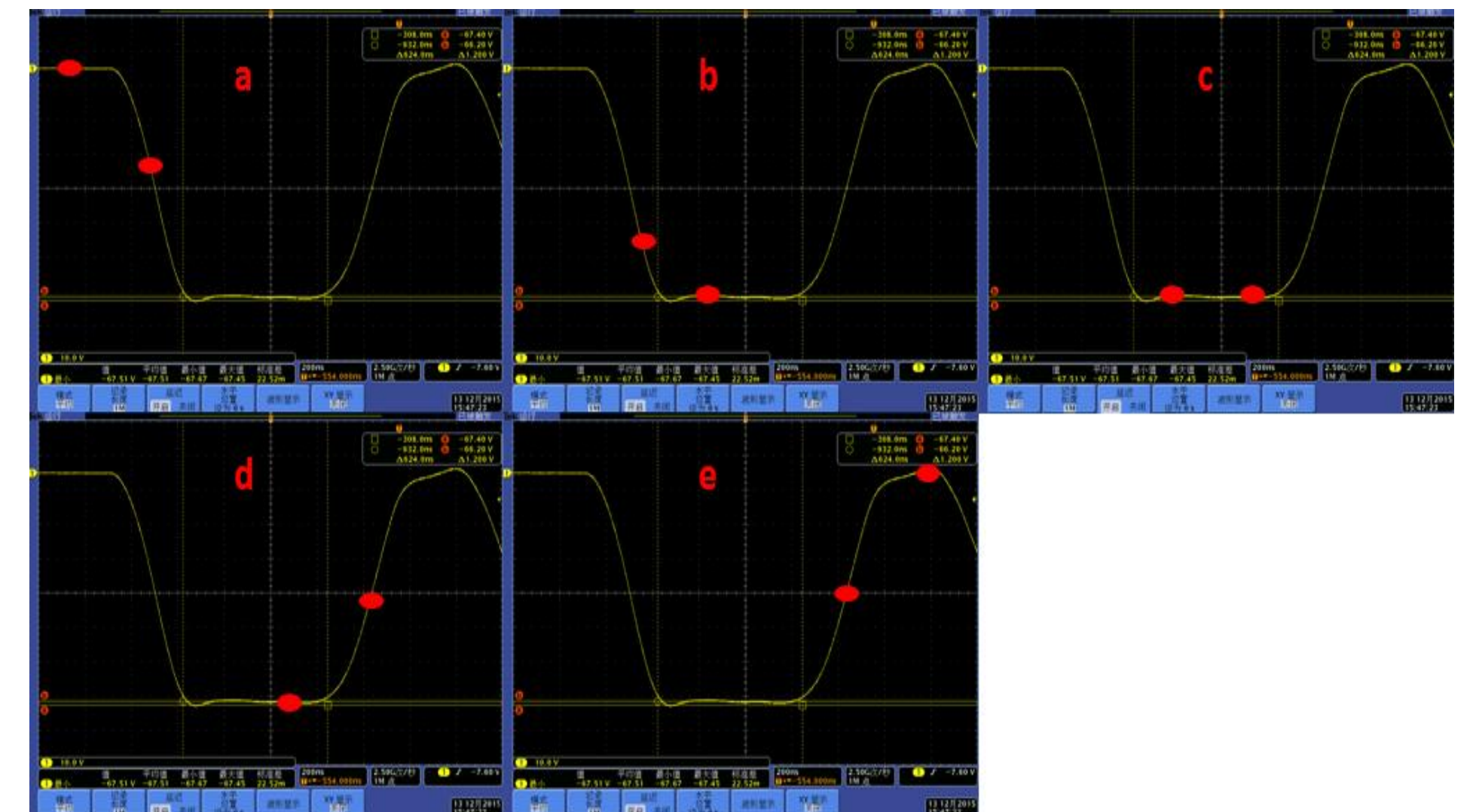


Fig. 7: Two extracted bunches which set at different positions of the kicker current curve.

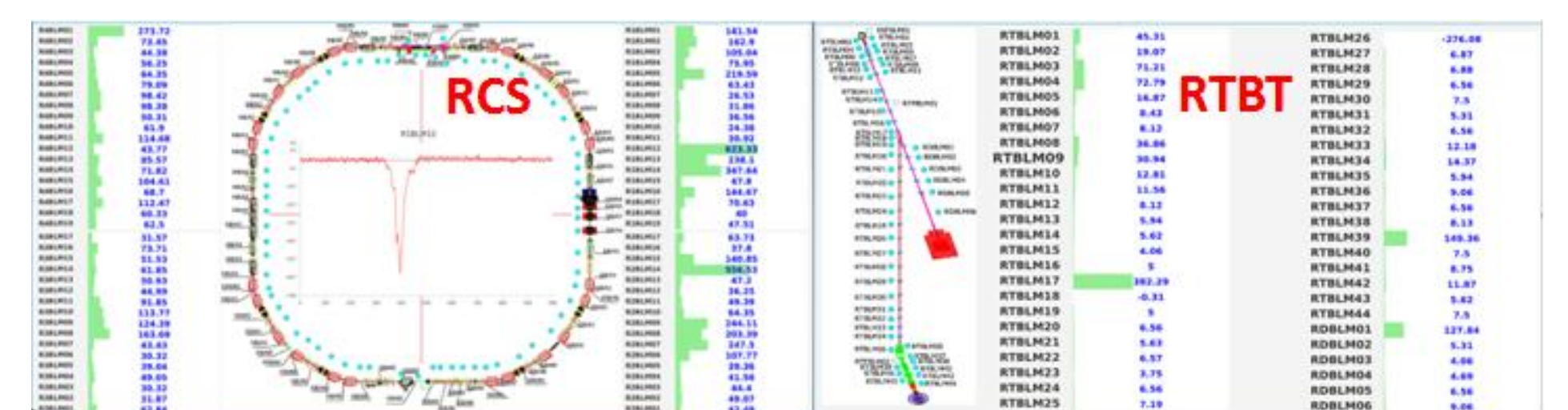


Fig. 8: Beam loss display of the RCS and RTBT.

## A METHOD TO CALIBRATE THE KICKER CURRENT CURVES

By adjusting the timing of the kicker, the current curve of the kicker would be translation. Then, the extracted bunch can be placed on different positions of the current curve and the BPM on the RTBT can measure different position information of the bunch. Therefore, after adjusting the timing of the kicker, by using the position information measured by the BPM on the RTBT, the kicker current curve can be calibrated.

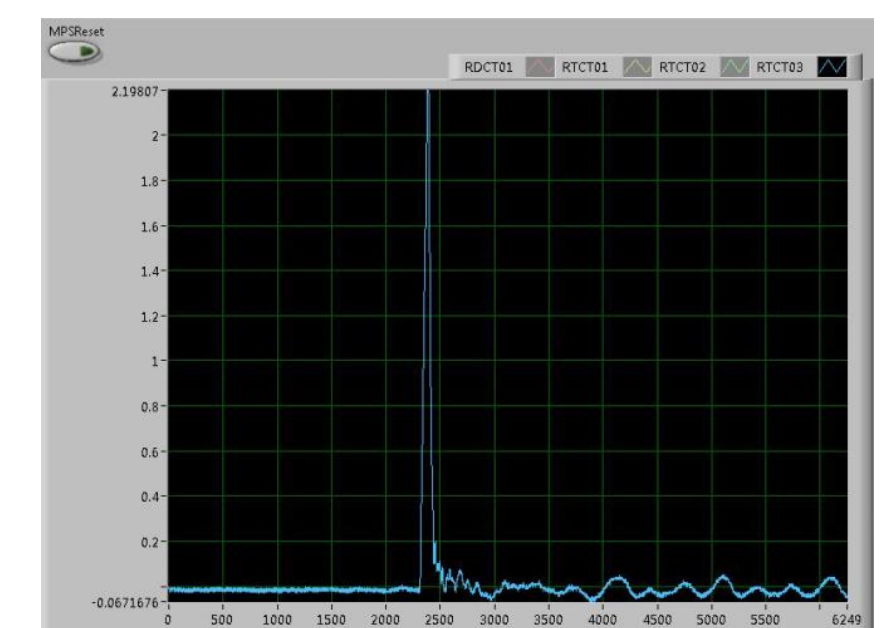


Fig. 9: Display of the single extracted bunch.

During the calibration experiment of the kicker current curves, the timing of eight kickers should be adjusted well firstly. In addition, to make the experiment simple, single bunch mode would be selected. By measuring the position information of the bunch, the position of the kicker current curve where the bunch placed on can be calculated. It can be found that, if all the positions of the kicker current curve are calculated, the kicker current curve can be calibrated. This calibration method can be applied for all the eight kickers.

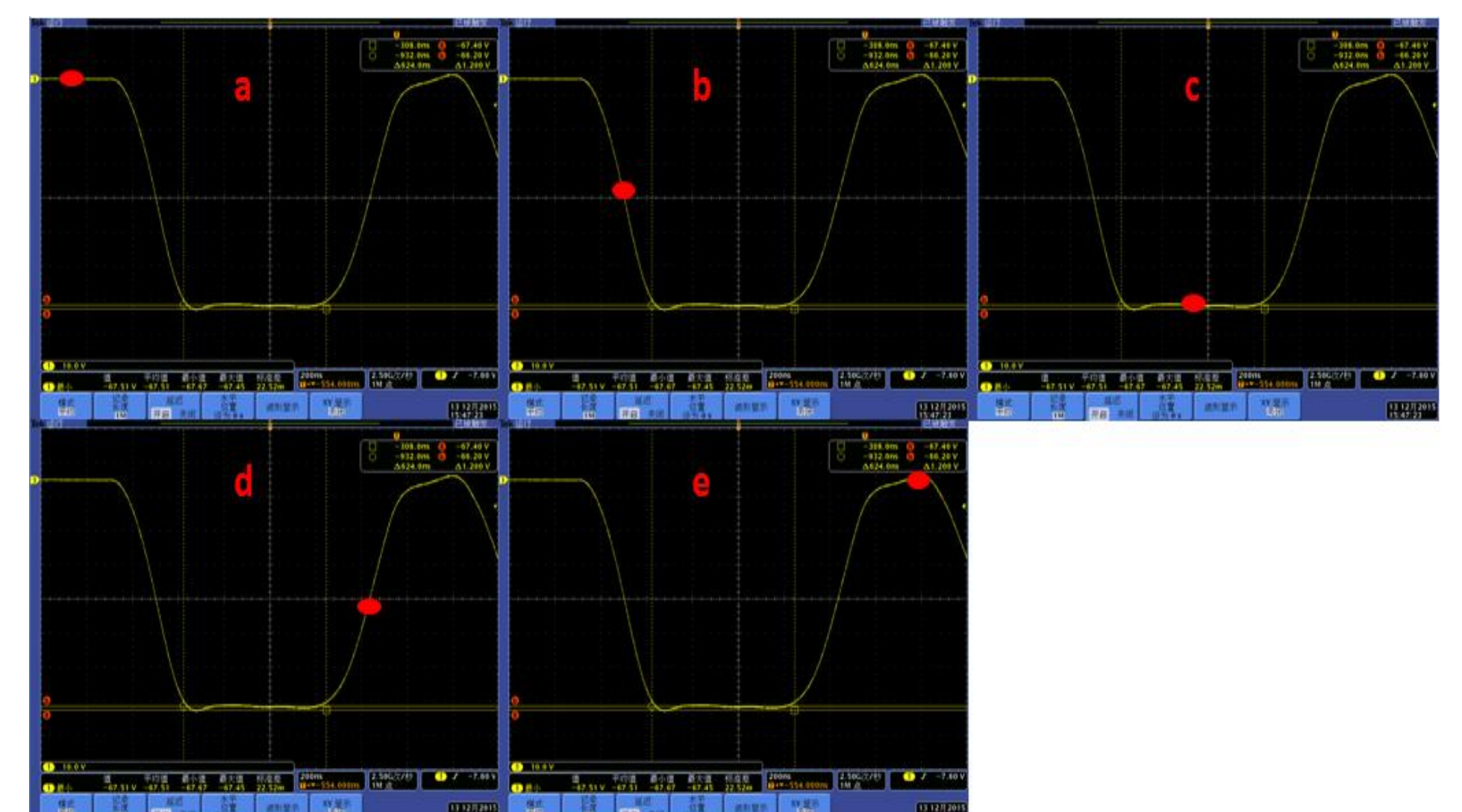


Fig. 10: Single extracted bunch which sets at different positions of the kicker current curve.