BEPCII Transverse Feedback System

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Outline

Including three parts:

- The main parameters of BEPCII
- The coupled bunch instability
- The bunch by bunch feedback system

I : Some Parameters of BEPCII

Beam Energy, E	GeV	1.89
Circumference, *C*	m	237.53
Total beam current, I_0	A	0.91
Bunch current, I_b	mA	9.8
Revolution frequency, f_0	MHz	1.2621
RF frequency, f_{RF}	MHz	499.8
Harmonic Number, *h*		396
Tunes, $\mathrm{v}_x / \nu_y / \nu_z$		6.57/7.61/0.034
Radiation damping times, $\tau_x / \tau_y / \tau_z$	ms	25/25/12.5
Number of Bunches, *B*		93
Bunch spacing, S_b	m	2.4
Bunch frequency, f_b	MHz	125

II :The Coupled Bunch Instability

The high beam current (0.9 A) and the large number of bunches (93 bunches) will cause the coupled bunch instabilities (CBI) in BEPCII

Fastest growing time in the case of 99 bunches and 9.8mA per bunch

	HOMs	Resistive wall	ECI
Transverse (ms)	26.6	4.3	0.5
Longitudinal (ms)	12.8		

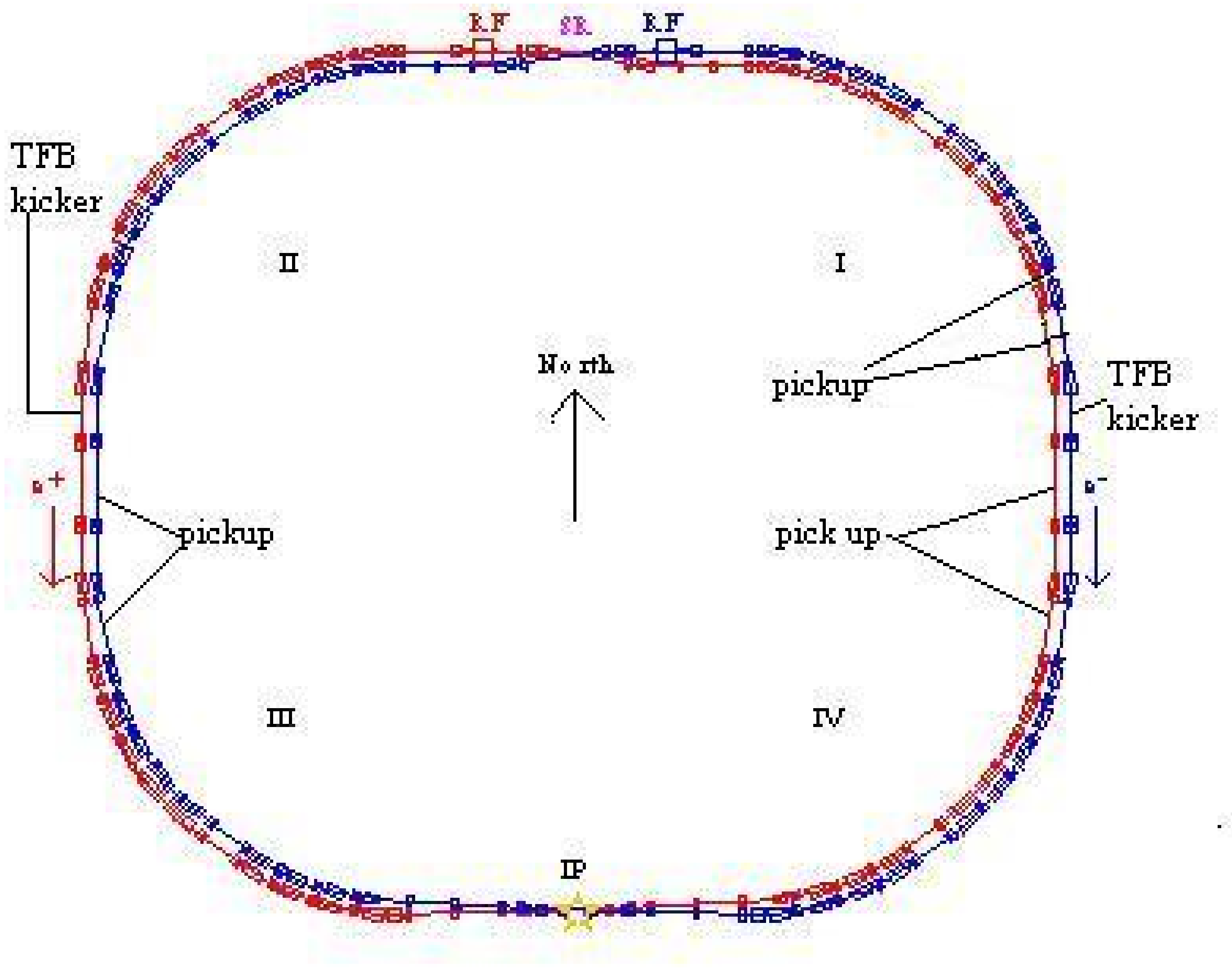
- Two source
  - ❖ The higher order modes (HOMs) of RF cavities
  - ❖ The resistive wall impedance

- Active feedback systems are required to suppress CBI

III: Bunch by bunch Transverse Feedback System

- Three set of analog system. BEPCII will operate on colliding mode and synchrotron mode. So our transverse feedback will have three sets: electron ring, positron ring, and synchrotron ring.
- The electronics bandwidth should be at least half of the bunch frequency
    - colliding mode 62.5MHz
    - synchronous radiation mode 250MHz
- The damping time of transverse feedback system is 0.5ms

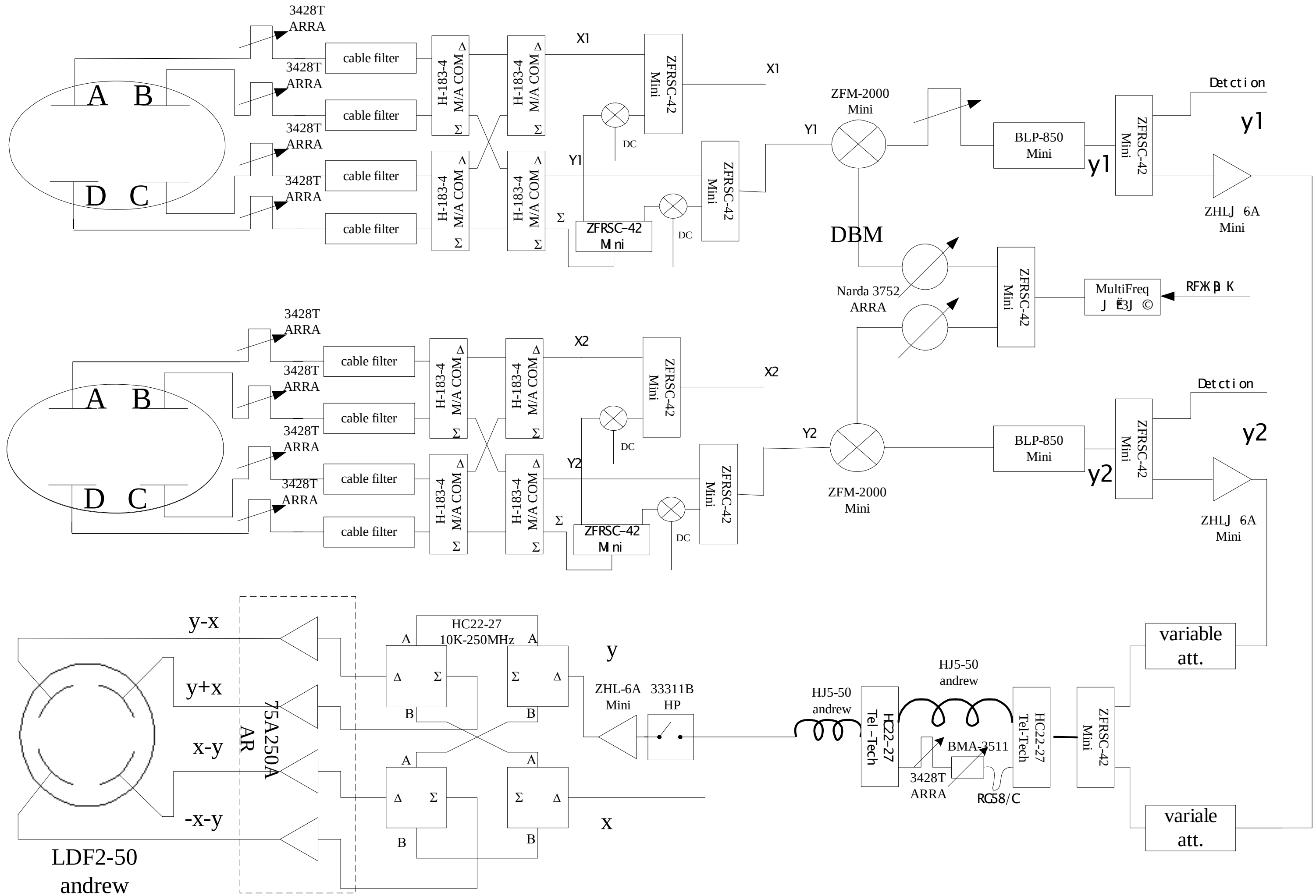
Transverse feedback system located in the storage ring



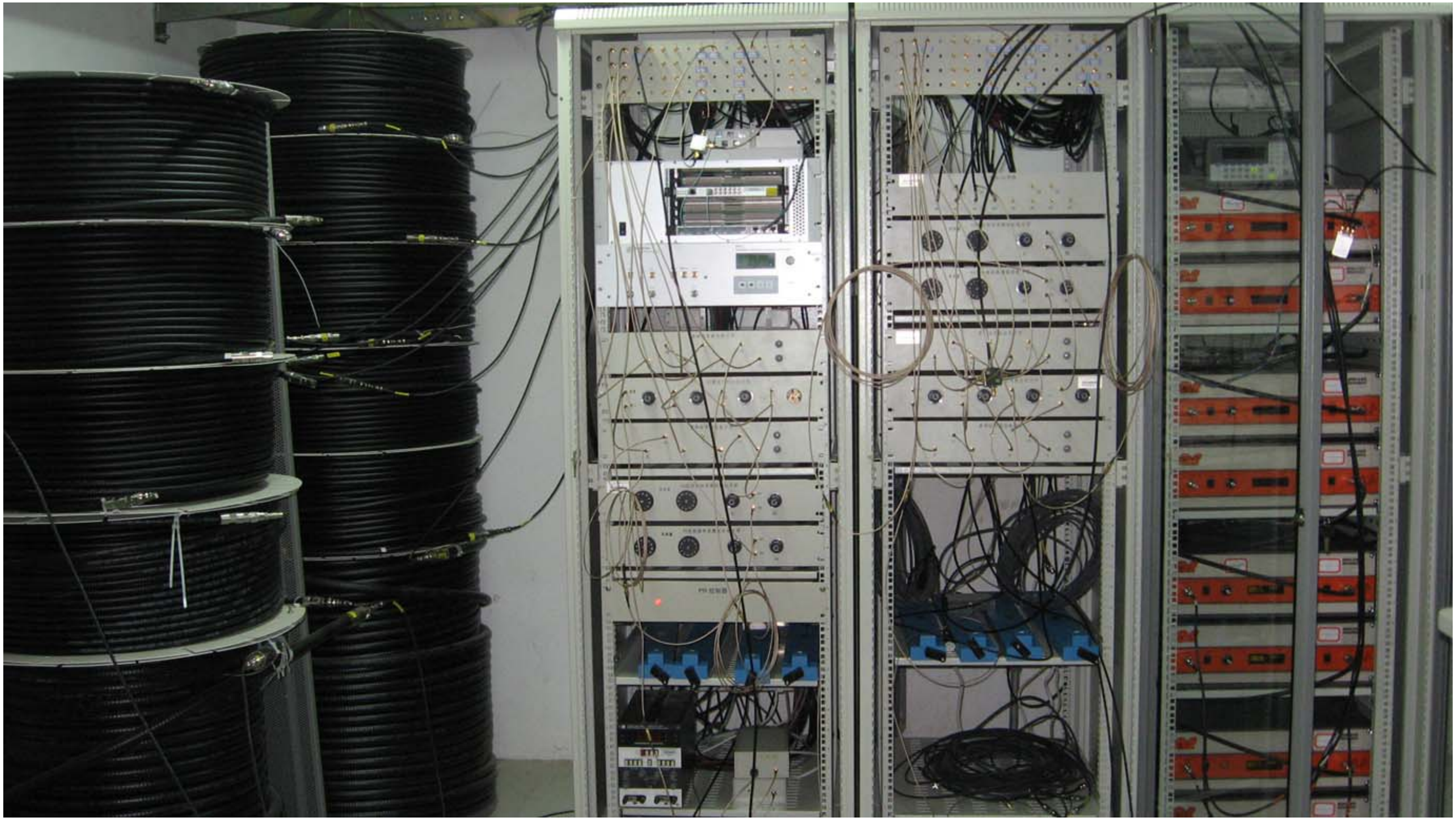
The Transverse Feedback System

- Schematic diagram
- Front-end electronics
- Signal processing system
- Kicker and power amplifier
- Parameters of Transverse Feedback System
- The experiments of BEPCII TFB

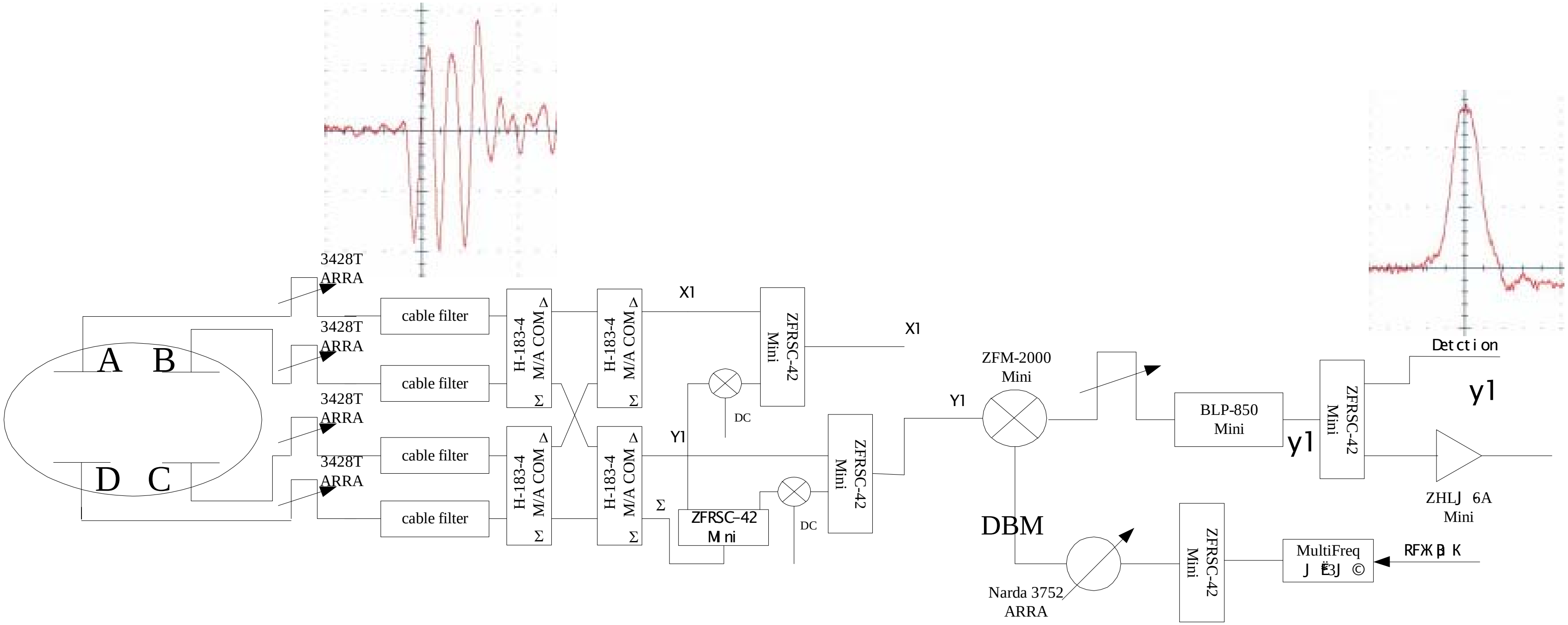
The Schematic Diagram of TFB System



The local station of the Transverse Feedback System



Front-end electronics



Transfer the signal whose bandwidth is 500MHz at the center frequency of 1.5GHz to base band.

- Detection frequency is 1.5GHz,   triple of RF
- The local DC rejection circuit in fixed-voltage mode

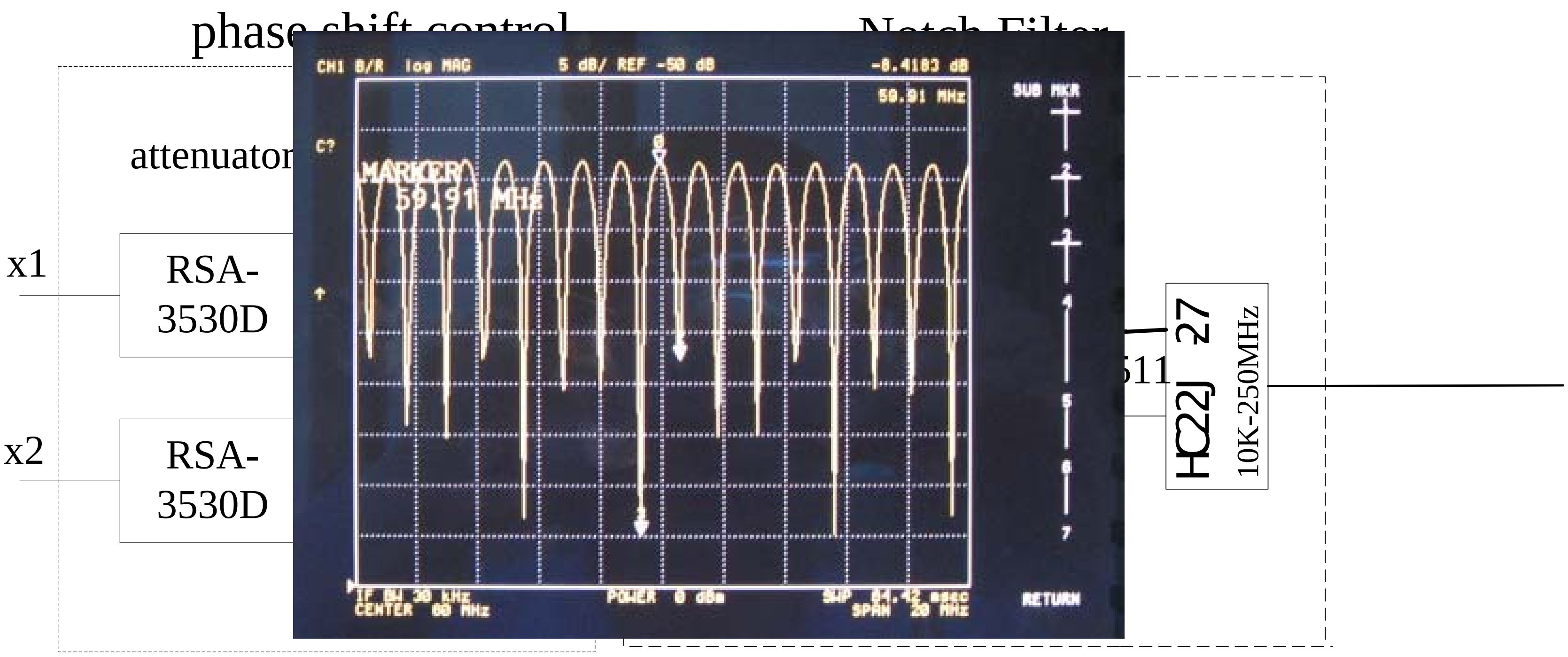
Signal processing system

Full analog system simply using the cable line

- Three functions
    - ❖ Making the 90 phase shift
    - ❖ Rejection the closed orbit signal
    - ❖ One turn delay
- Realization
    - ❖ Two manual attenuators for 90 phase shift control
    - ❖ Notch filter rejection the revolution frequency
    - ❖ The time delay by cable

Signal processing system –

Phase shift and Notch Filter



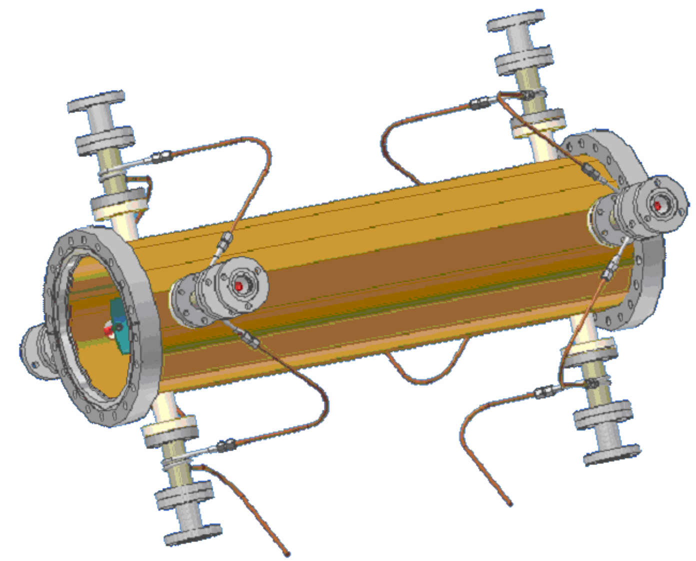
Kicker and Power Amplifier

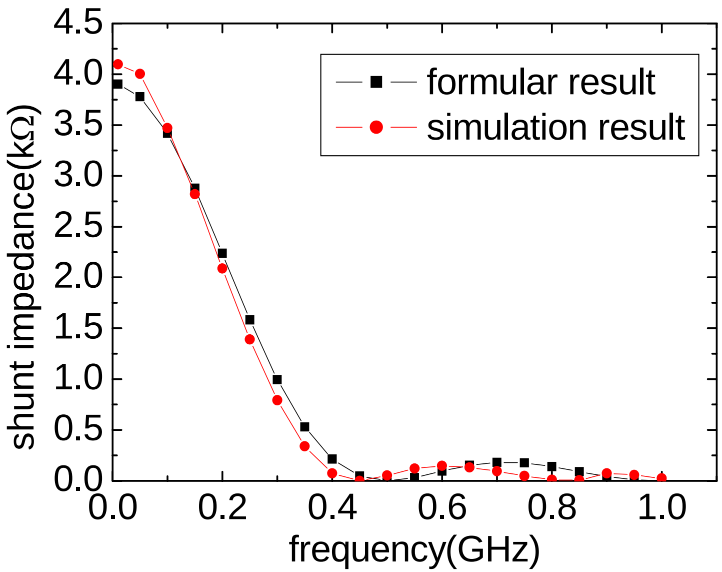
- Four strip line electrode as kicker

(considering it is easy to realize, so the kicker length is 600mm just for every other bunches)

- One kicker per ring because the limited space
- Model 75A250A power amplifier is selected.
- Two 75A250A are connected in the differential style

Kicker and Power Amplifier

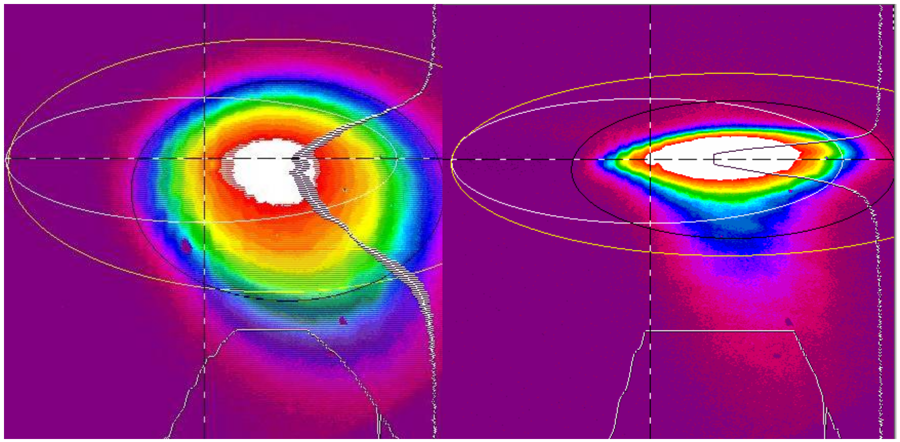




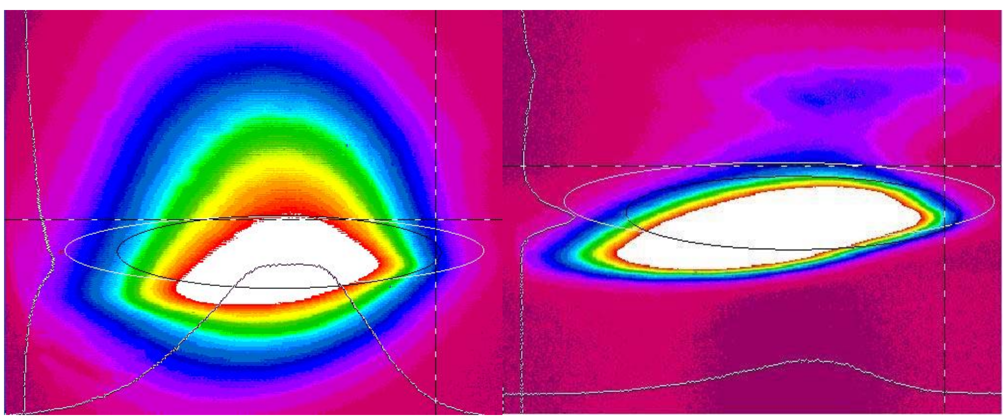
Specifications of the TFB system

RF frequency	MHz	499.8
Bunch spacing	ns	8
Feedback damping time	ms	0.5
Detection frequency	GHz	1.5
Number of kickers per plane per ring		1
Kicker shunt impedance (at 125MHz)	kΩ	4.0
Total damping voltage per turn	V	800
Kicker power for 800 V	w	106
Number of power amplifiers per plane per ring		2
Bandwidth of power amplifier	MHz	250

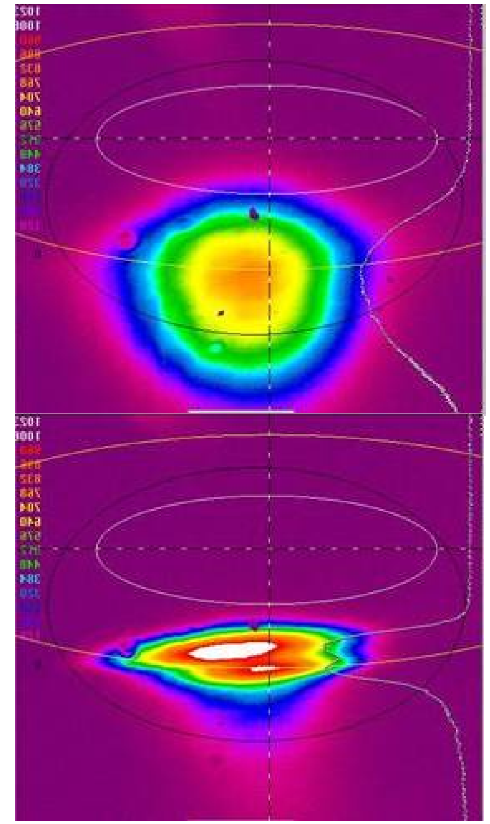
Beam profiles with TFB turning off and on



Electron ring

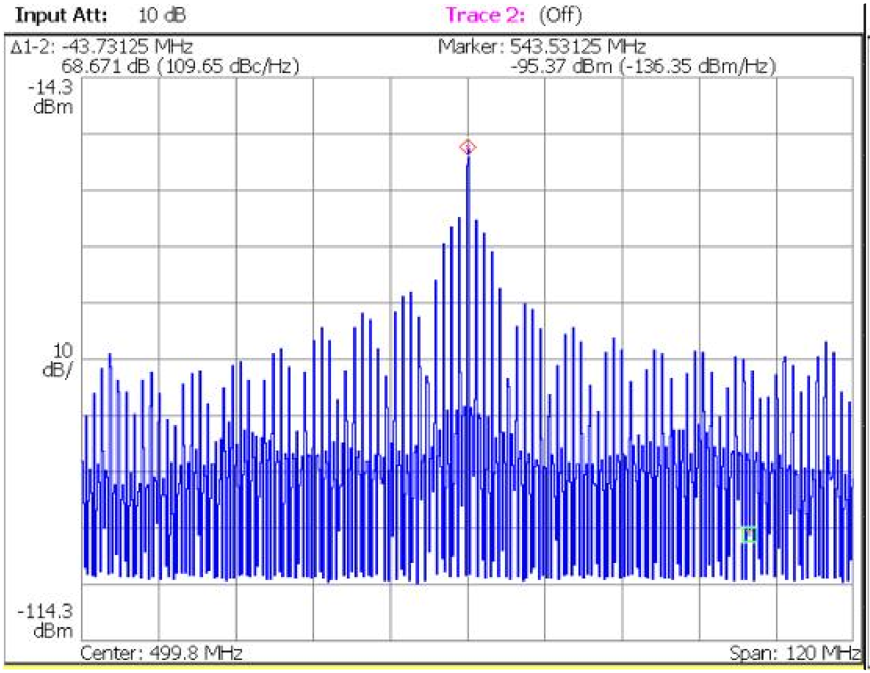


Positron ring

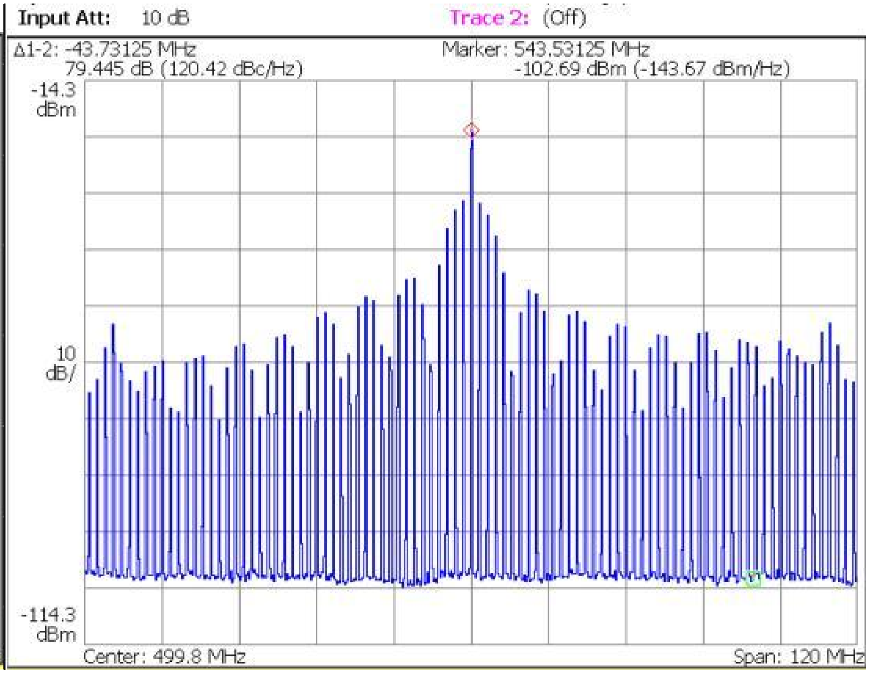


Synchrotron ring

Sidebands suppressed by TFB system



TFB off



TFB on

Transverse instabilities in full bandwidth of 125MHz suppressed by TFB system with beam current 243mA with 99 bunches in positron ring. The background frequency lines are revolution frequency harmonics and the dark-coloured lines are instability sidebands. We can see that the magnitude of instability sidebands is attenuated more than 30dB when the feedback is on.

Summary

- The transverse feedback systems of BEPCII have been installed and played an important role during the commissioning of BEPCII double rings. It can suppress the strong multi-bunch instabilities at the higher beam current of over 500mA. In the next stage, we need careful tuning the system and make sure of suppressing the transverse instabilities at more higher current. In addition, remote control and damping time measurement will be completed.

Acknowledgement

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