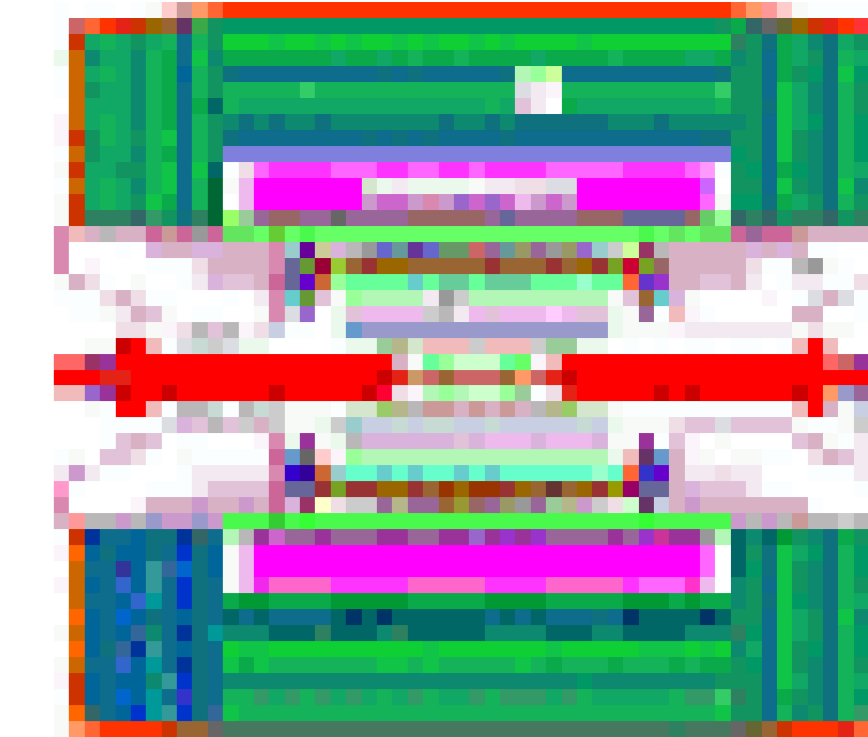


IHEP, Beijing

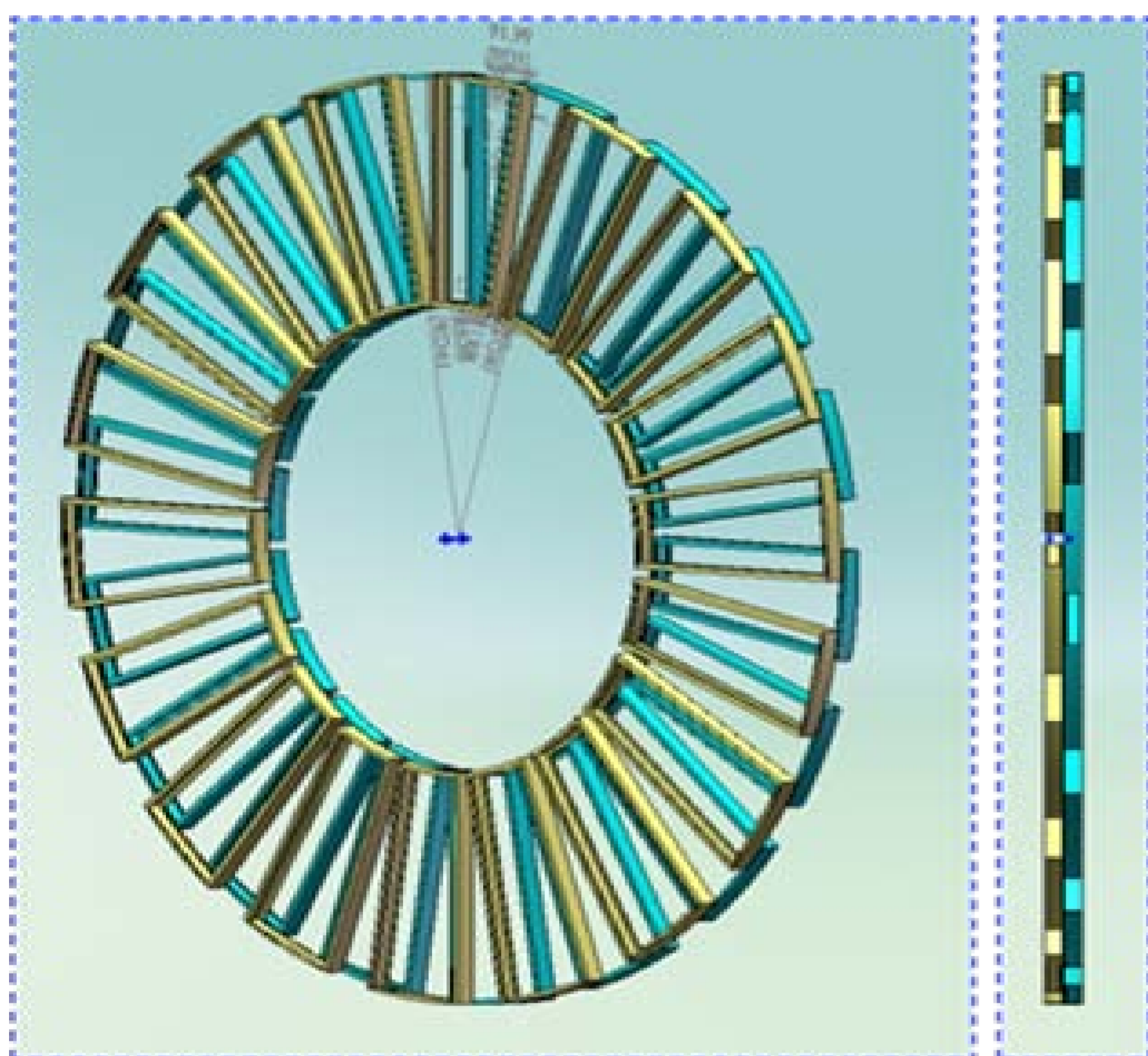
# Upgrade of End-cap TOF Trigger system on BESIII



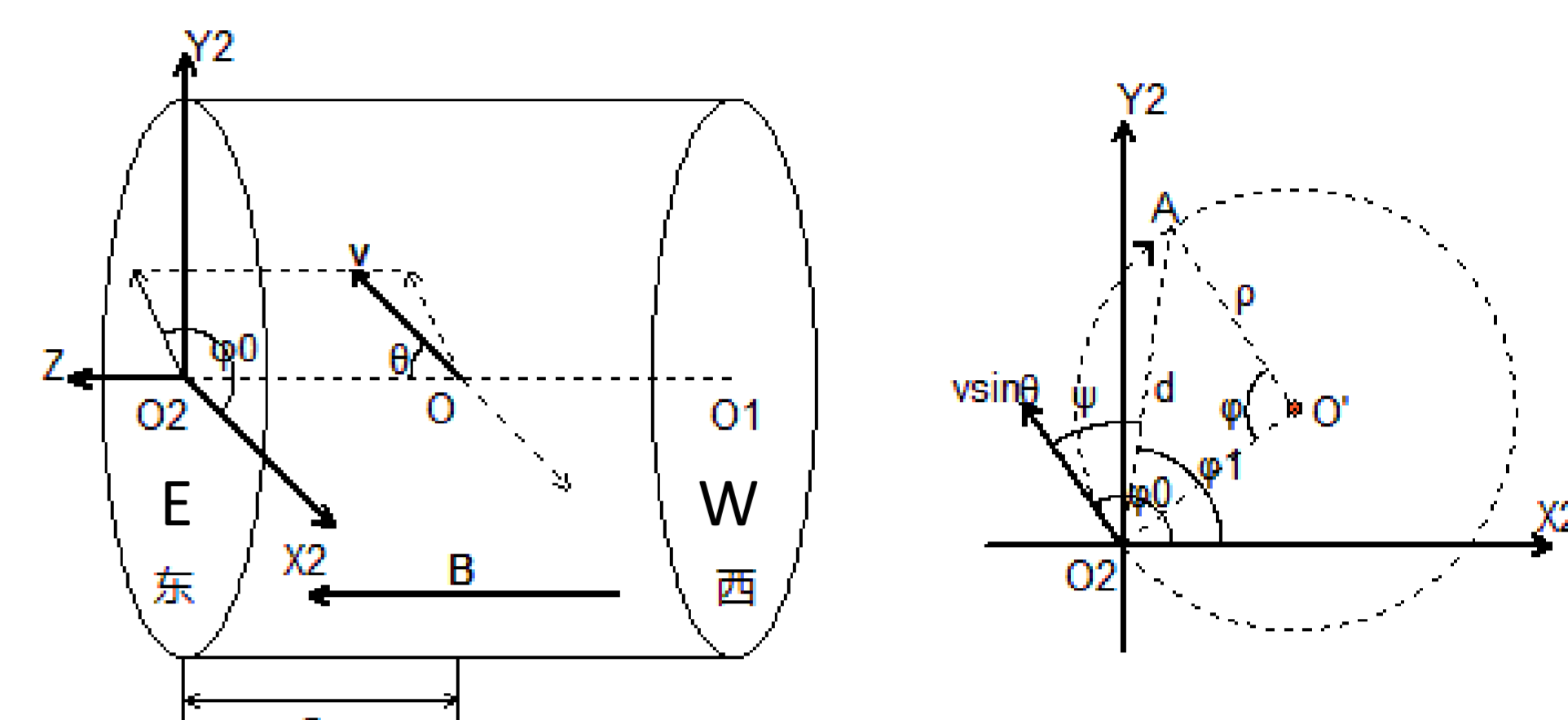
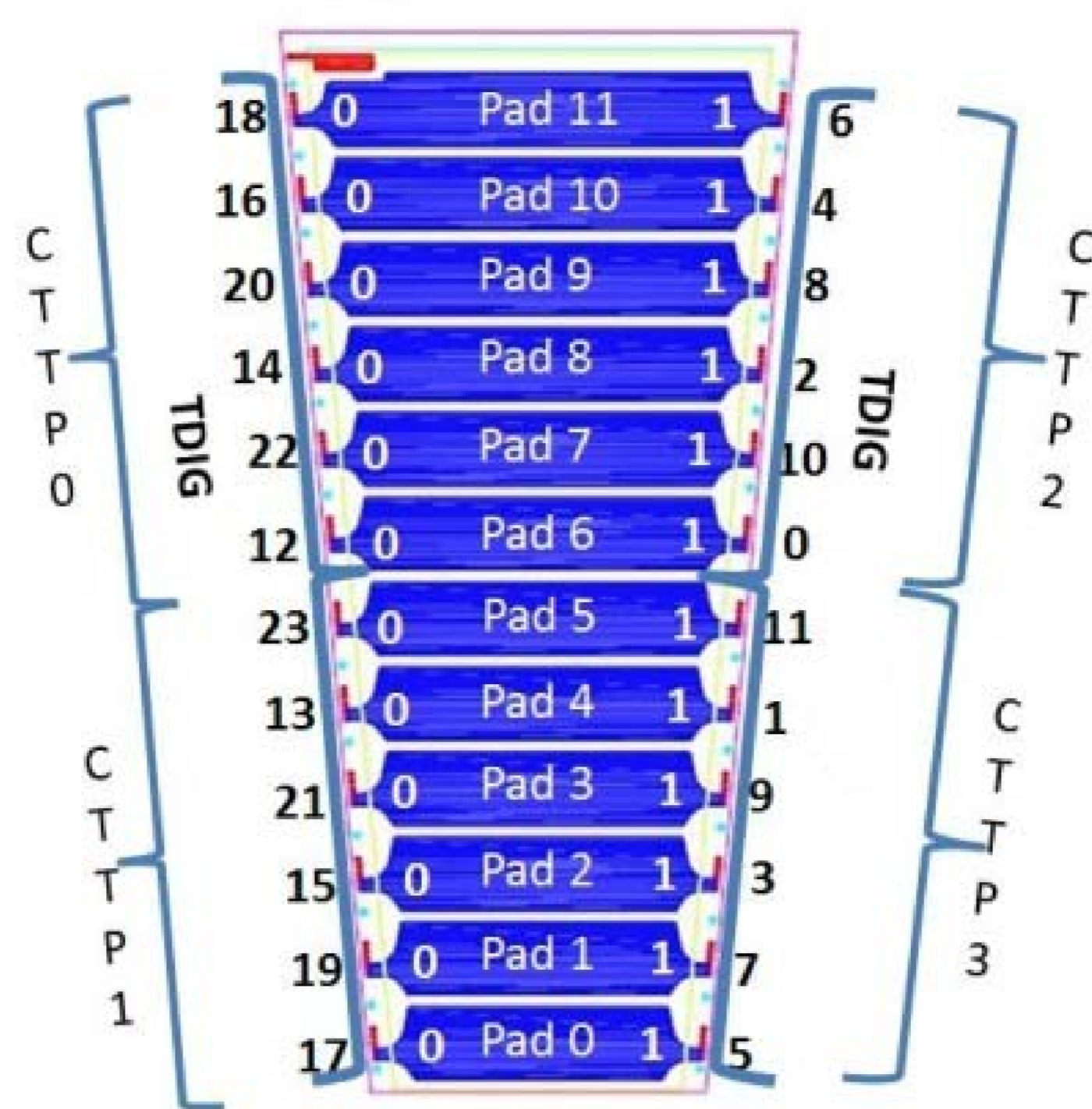
Jingzhou ZHAO, Zhen-An LIU, Wenxuan GONG, Fang DENG, Libo CHENG, Zhi WU, Ke WANG, Jie HUANG



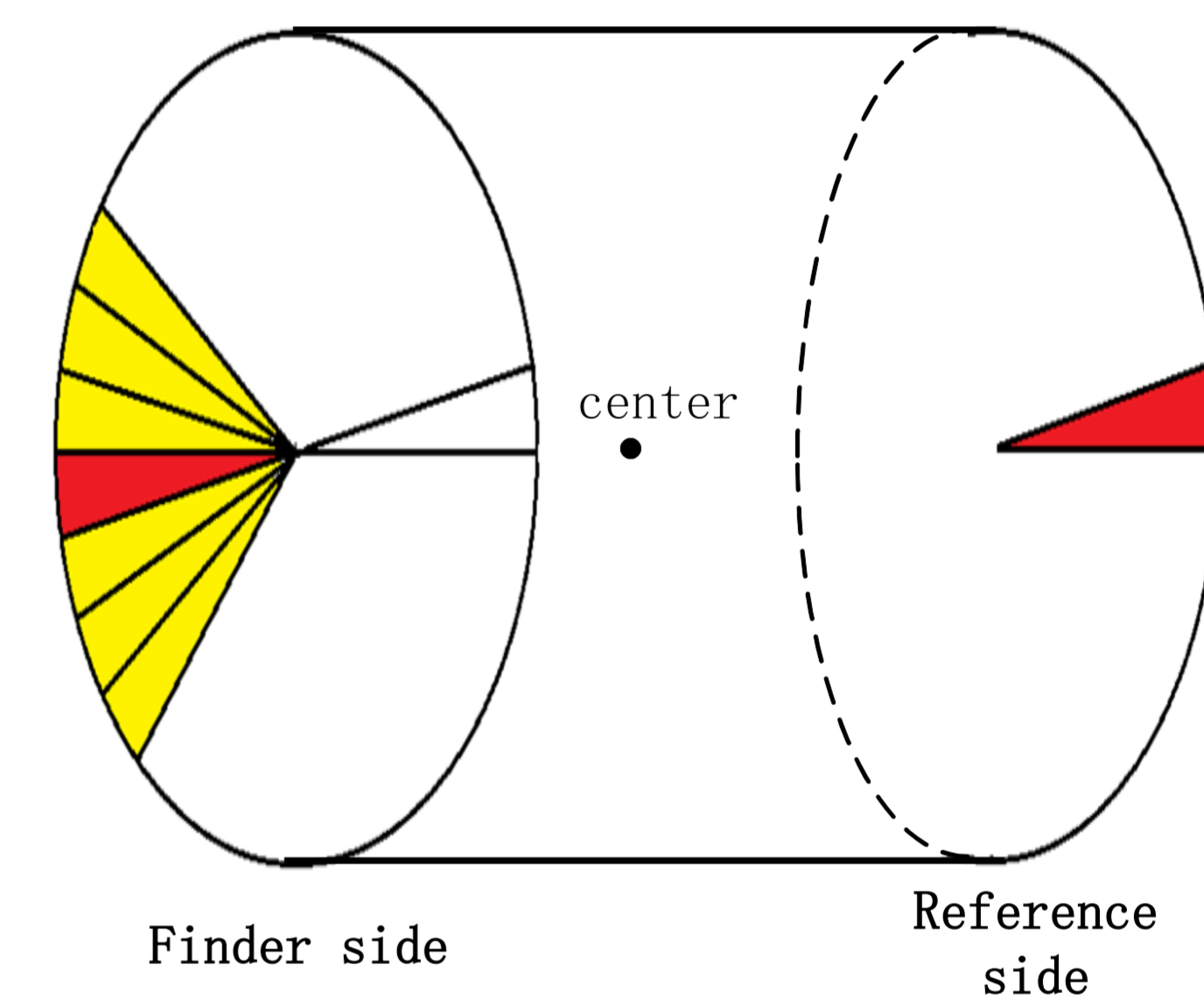
In the ETOF(End-cap TOF) upgrade of BESIII, MRPC(Multi-gap Resistive Plate Chamber) detectors are used. ETOF is designed with 72 MRPCs. 24 channels signals are generated from each MRPC, in which 6 neighbouring channels OR together in Front-End Electronic(FEE) side. So 288 channel hit signals are sent to ETOF trigger system for trigger logic. The MRPC hit signal is about 30 ns width after FEE. Hit signals are stretched and trigger data are stored by TDPP (Trigger Data Pre-Processor) and then sent to ETOFT (End-cap TOF Trigger) through 10 high speed fiber links. Trigger data are aligned and stored in FIFO in ETOFT. Trigger logic in the center FPGA counts hits signals and Back to Back events and gives out ETOF trigger conditions: NETOF.GE.1, NETOF .GE.2 and NETOF.BB. ETOF trigger conditions are integrated with other detector trigger conditions by SIF2(Signal Integrate and Fan-out Version2) to Global Trigger to generate L1 signal.



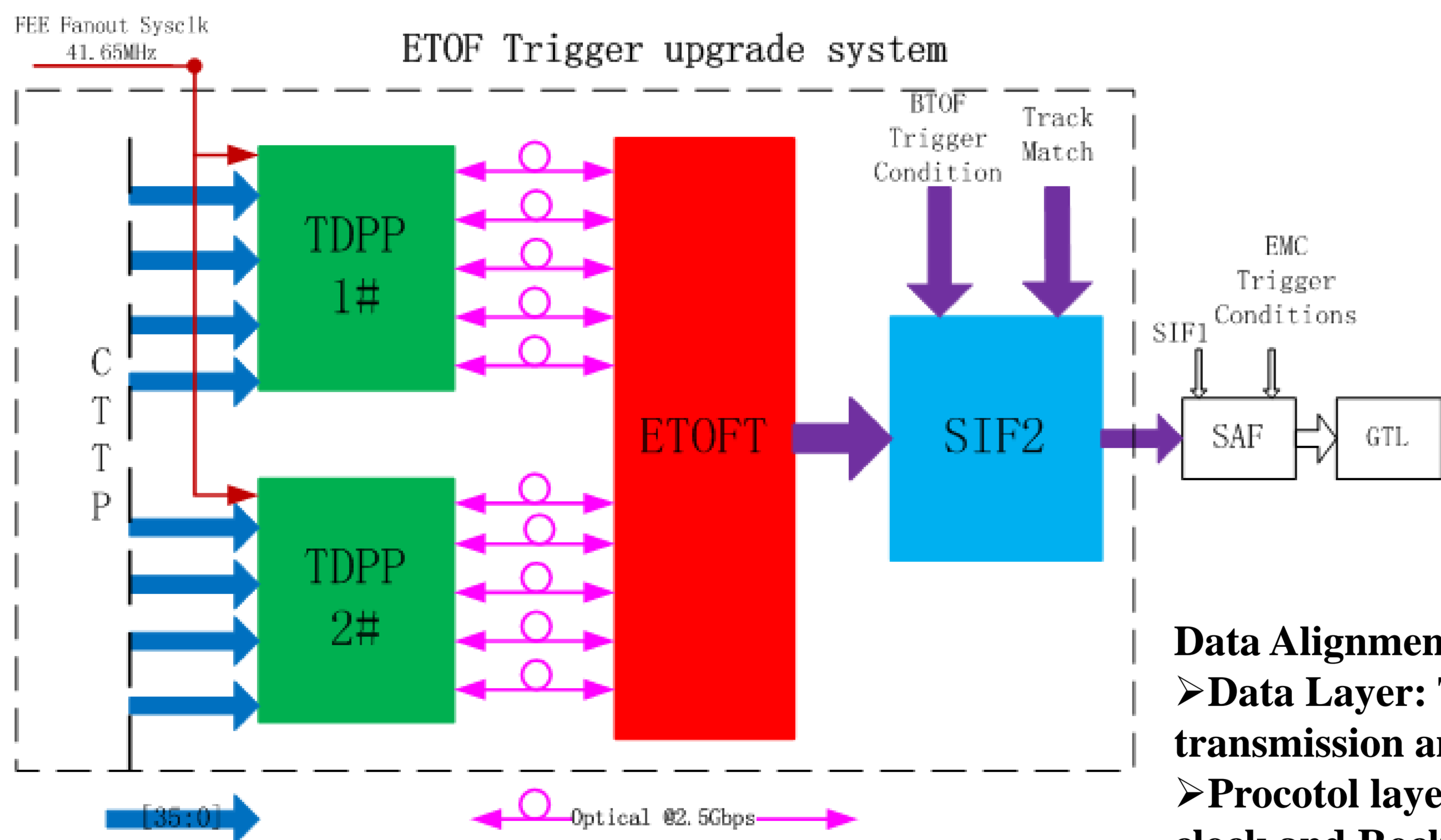
ETOF detector module: 36 MRPCs on each side. MRPCs are staggered in two layers to make sure its area detect percent is more than 99%.



Trigger Simulation parameter:  
 •Magnetic field intensity  $B = 1$  Tesla;  
 •Semimajor of BTOF  $a=1.33m;$   
 •Radius of ETOF:  $R0=0.454m,$   
 $R1=0.649m, R2=0.844m.$   
 •Pt range:  $Pt>660Mev/C;$   
 • $\phi0$  range:  $0 \leq \phi0 < 2\pi;$

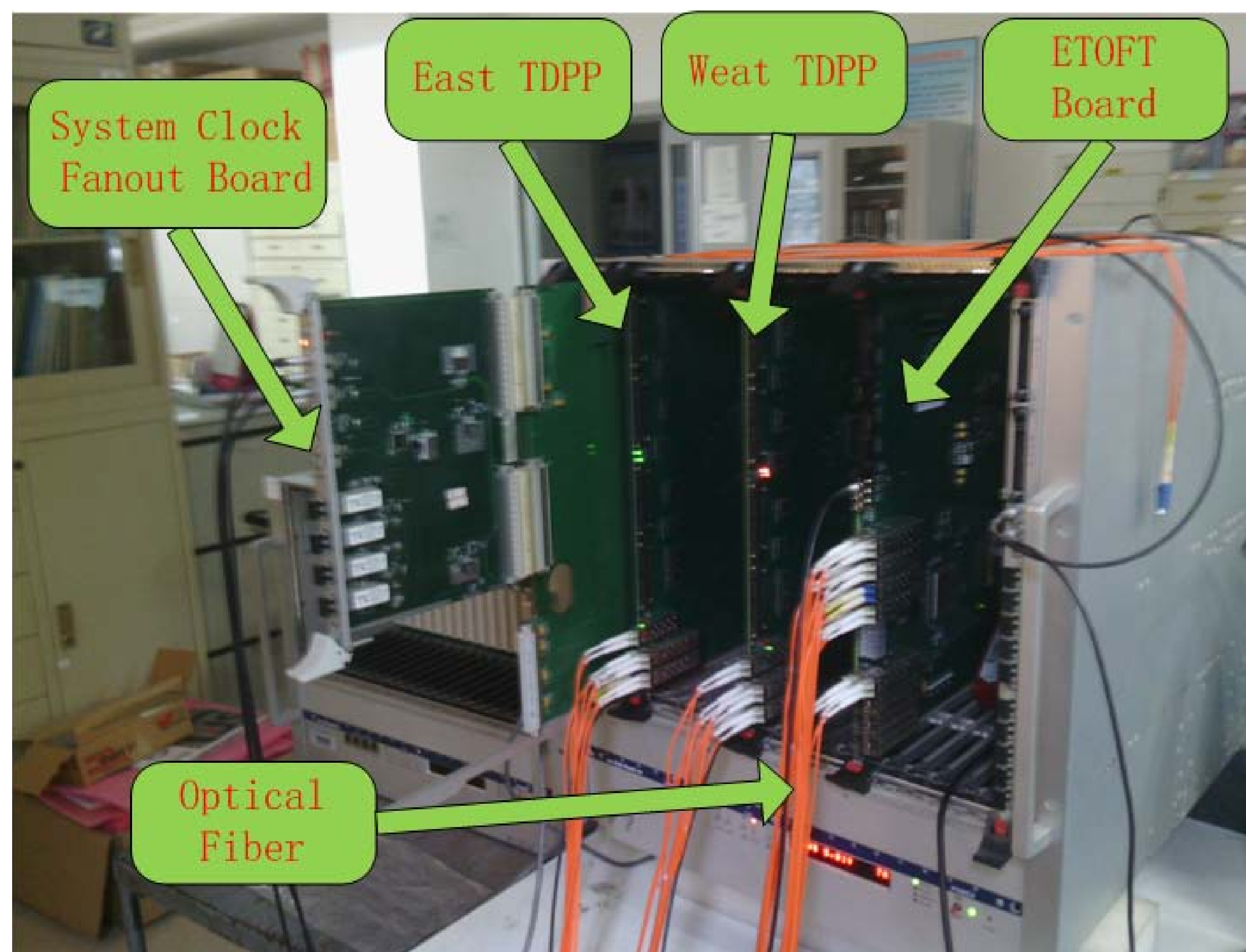
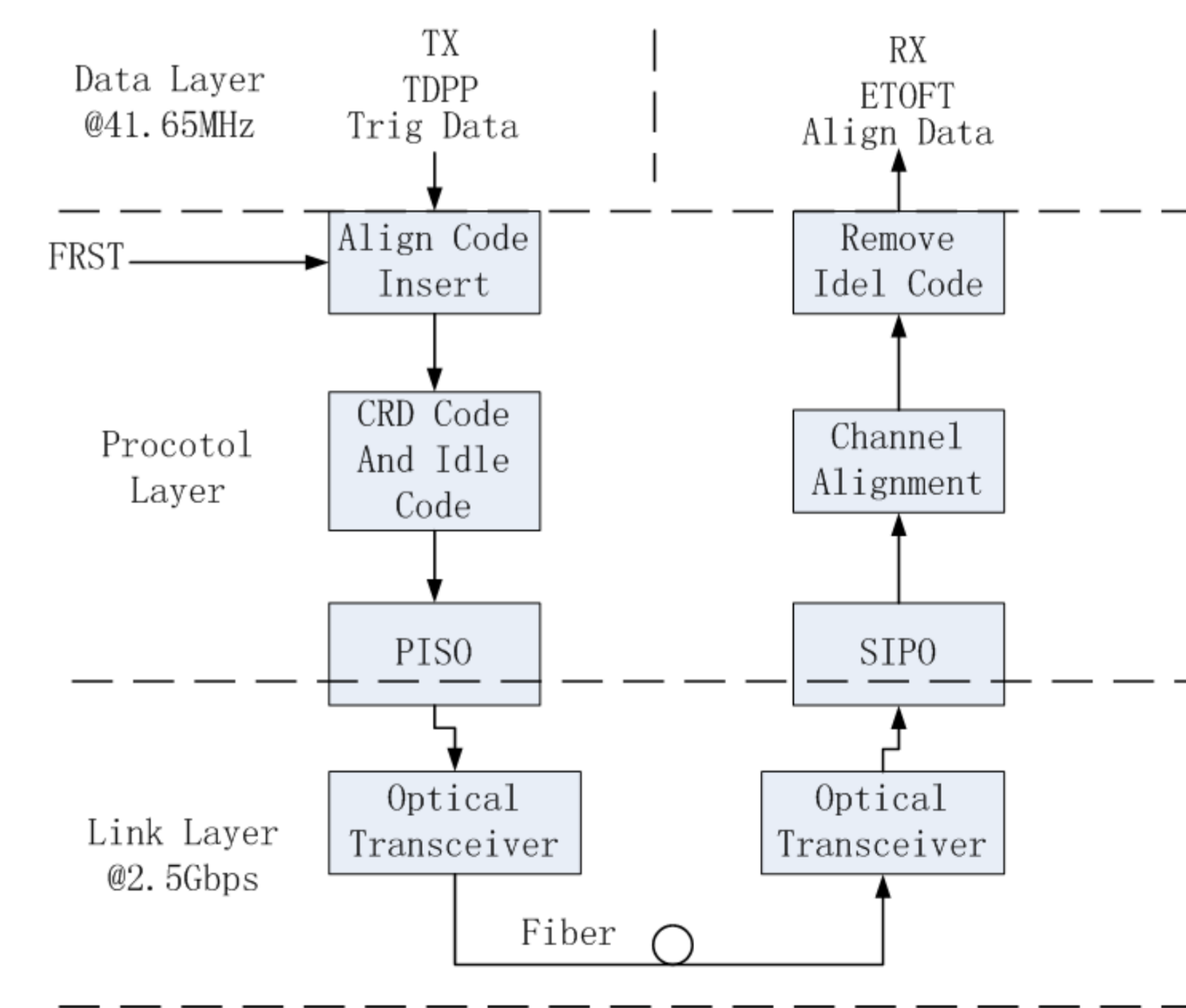


7 MRPCs central asymmetry with 1 on reference side is the area to find back to back event.



ETOF trigger system consists of TDPP, ETOFT and SIF2 boards.

Data Alignment Protocol:  
 >Data Layer: Trigger data transmission and error rate check.  
 >Protocol layer: Match system clock and RocketIO Reference Clock.  
 >Link Layer: Consists of RocketIO, optical transceiver and fiber cable.



Trigger system in the lab. Now trigger system has been installed on BESIII in Sept.2015 and already run stable for half a year.

CH0	95BC	95BC	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	FFFF	DDDD	FFFF		
CH1	95BC	95BC	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	0000	FFFF	DDDD	0000	FFFF
CH2	95BC	95BC	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	FFFF	DDDD	FFFF		
CH3	95BC	95BC	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	FFFF	DDDD	FFFF		
CH4	FFFF	FFFF	95BC	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	0000	FFFF		
CH5	95BC	95BC	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	FFFF	DDDD	FFFF		
CH6	95BC	95BC	B5B5	957C	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	FFFF	DDDD	DDDD
CH7	95BC	95BC	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	FFFF	DDDD	DDDD		
CH8	95BC	95BC	B5B5	957C	B5B5	957C	B5B5	FFFF	CCCC	FFFF	DDDD	DDDD		
CH9	FFFF	FFFF	B5B5	95BC	B5B5	95BC	B5B5	95BC	B5B5	957C	B5B5	957C	B5B5	957C

Data after Deserial on ETOFT, viewed by Chipscope.

CH0	000000	000000	B5B5957C	AAAAAAAA	FFFFFFFF	BBBBBBBB
CH1	000000	000000	B5B5957C	AAAAAAAA	FFFFFFFF	BBBBBBBB
CH2	000000	000000	B5B5957C	AAAAAAAA	FFFFFFFF	BBBBBBBB
CH3	000000	000000	B5B5957C	AAAAAAAA	FFFFFFFF	BBBBBBBB
CH4	000000	000000	B5B5957C	0000AAAA	FFFFFFFF	0000BBBB
CH5	000000	000000	B5B5957C	AAAAAAAA	FFFFFFFF	BBBBBBBB
CH6	000000	000000	B5B5957C	AAAAAAAA	FFFFFFFF	BBBBBBBB
CH7	000000	000000	B5B5957C	AAAAAAAA	FFFFFFFF	BBBBBBBB
CH8	000000	000000	B5B5957C	AAAAAAAA	FFFFFFFF	BBBBBBBB
CH9	000000	000000	B5B5957C	0000AAAA	FFFFFFFF	0000BBBB

Data after alignment protocol on ETOFT, viewed by Chipscope.

Trigger Conditions	Efficiency
NETOF.GE.1	99.74%
NETOF.GE.2	97.73%
NETOF.BB	96.33%

ETOF trigger efficiency checked by Bhabha event selected online. NETOF.GE.1 is used for Physics data taking.