BESIII Trigger system

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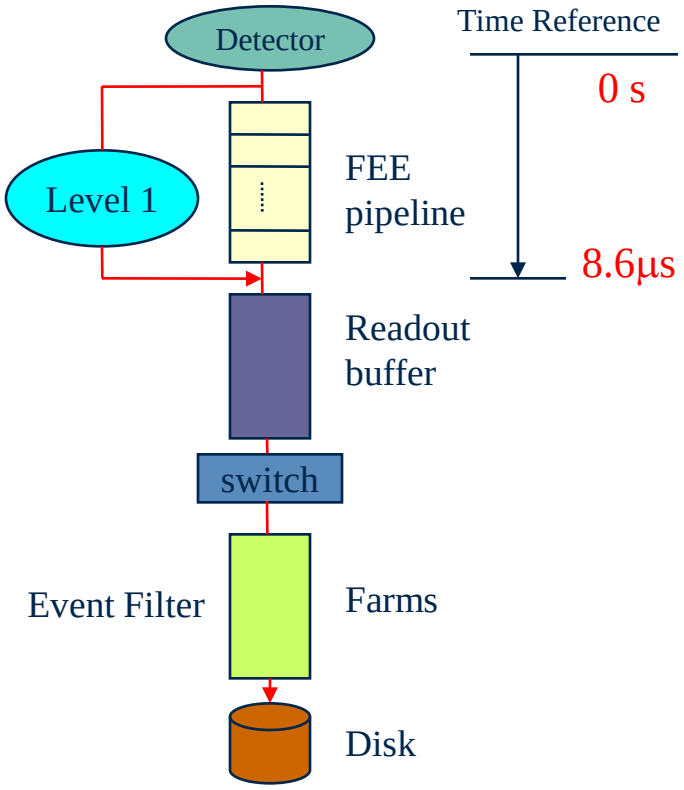
Outline

- Trigger system introduction
  - BESIII performance
  - Trigger system introduction
- Fast control sub-system
- Summary

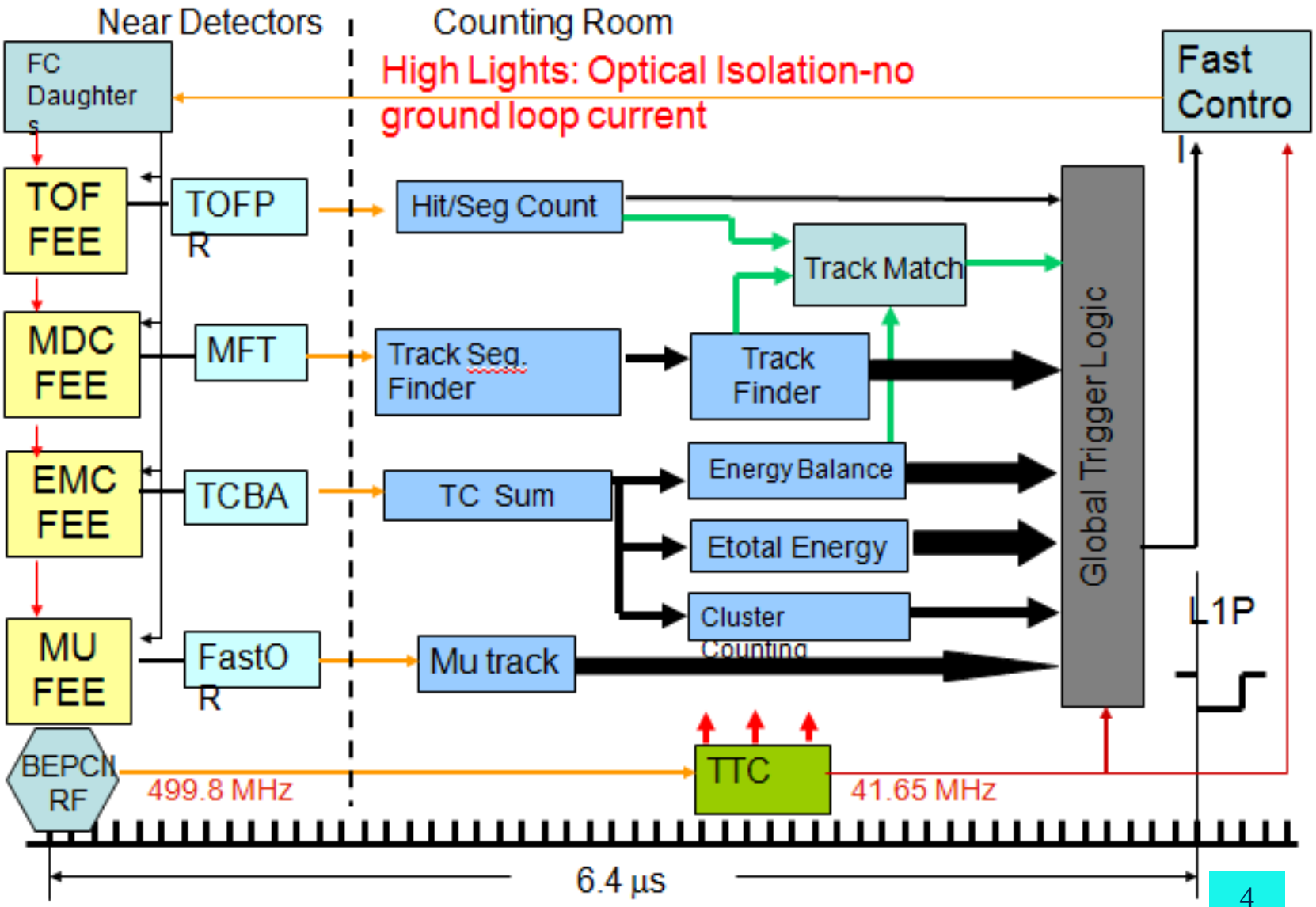
BESIII performance

- **Event rate**
  - **Good event rate: ~ 2000Hz**
  - **Bhabha rate: ~800Hz**
  - **Cosmic event rate: <200Hz, rejection > 10:1**
  - **Beam background rate: <2000Hz, rejection > 10000:1**
  - **Total event rate: 4000 Hz**
- **Trigger system work in Pipeline Mode**
  - **BEPCII Muliti-bunch（93），Bunch interval：8ns**
- **L1 Latency：8.6μs (ETOF)，data are saved in FIFO.**
- **L1 Dead time: 3 μs.**
- **L1 only for data reading, can not be used for timing reference.**



BESIII FEE pipeline and Data flow

BESIII Trigger system



Trigger Conditions Table(1)

Detector	Trigger Condition	Numbering in GTL(00 – 47)	**Comments**
TOF 6	ETOF_BB	16	Endcap TOF Back to Back
	BTOF_BB	17	Barrel TOF Back to Back
	NETOF.GE.2	18	Endcap TOF hits number >= 2
	NETOF.GE.1	19	Endcap TOF hits number >= 1
	NBTOF.GE.2	20	Barrel TOF hits number >= 2
	NBTOF.GE.1	21	Barrel TOF hits number >= 1
	NTOF.GE.1	22	TOF hits number >= 1
MDC 10	STrk_BB	38	Short Track Back to Back
	NStrk.GE.N	39	Short Tracks number >= N
	NStrk.GE.2	40	Short Tracks number >= 2
	NStrk.GE.1	41	Short Tracks number >= 1
	LTrk_BB	42	Long Track Back to Back
	NLtrk.GE.N	43	Long Tracks number >= N
	NLtrk.GE.2	44	Long Tracks number >= 2
	NLtrk.GE.1	45	Long Tracks number >= 1
	NItrk.GE.2	46	Inner Tracks number >= 2
	NItrk.GE.1	47	Inner Tracks number >= 1
EMC 16	NClus.GE.1	00	Number of Clusters >= 1
	NClus.GE.2	01	Number of Clusters >= 2
	BClus_BB	02	Barrel Cluster Back to Back
	EClus_BB	03	Endcap Cluster Back to Back
	Clus_Z	04	Cluster Balance in Z direction
	BClus_Phi	05	Barrel Cluster Balance in Phi direction
	EClus_Phi	06	Endcap Cluster Balance in Phi direction
	BEtot_H	07	Barrel total Energy Higher threshold
	EEtot_H	08	Endcap total Energy Higher threshold
	Etot_L	09	Total Energy Lower threshold
	Etot_M	10	Total Energy Middle threshold
	BL_EngZ	11	Energy Balance in "Z" direction
	NBClus.GE.1	12	Barrel Energy Difference Balance
	NEClus.GE.1	13	Endcap Energy Difference Balance
	BL_BBLK	14	Energy Block Balance
	BL_EBLK	15	Endcap Energy Balance

- Function
  - TOF
    - For charged particles timing and trigger
    - Reduce background
  - MDC
    - For charged particles trigger
    - Reduce background
  - EMC
    - For neutral particles trigger

Trigger Conditions Table(2)

MUON A : 2 of 4 Tracking C : 3 of 4 Tracking	NABMU.GE.1	32	Barrel Tracks number >= 1 for A
	NAEMU.GE.1	33	Endcap Tracks number >= 1 for A
	NCBMU.GE.1	34	Barrel Tracks number >= 1 for C
	NCEMU.GE.1	35	Endcap Tracks number >= 1 for C
	CBMU_BB	36	Barrel Track Back to Back for C
	CEMU_BB	37	Endcap Track Back to Back for C
MATCH	CTrk_BB	23	C Track Back to Back
	NCTrk.GE.2	24	C Tracks number >= 2
	NCTrk.GE.1	25	C Tracks number >= 1
	BTrk_BB	26	B Track Back to Back
	NBTrk.GE.2	27	B Tracks number >= 2
	NBTrk.GE.1	28	B Tracks number >= 1
	ATrk_BB	29	A Track Back to Back
	NATrk.GE.2	30	A Tracks number >= 2
	NATrk.GE.1	31	A Tracks number >= 1
ATrk：Ltrk&BTOF；BTrk：Ltrk&BTOF&BEMC；CTrk：Strk&Endcap-TOF			
Total		48	

-Match

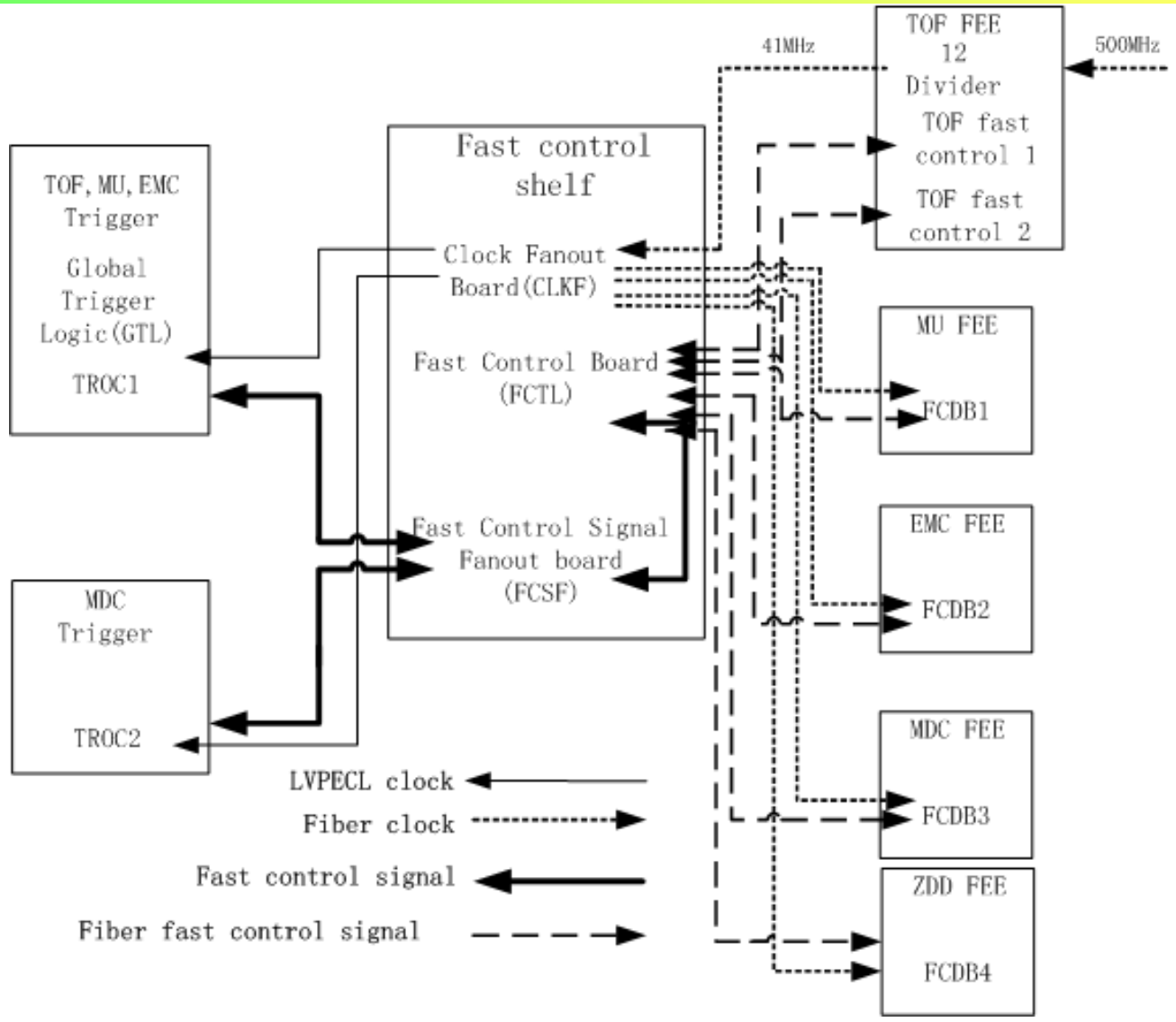
Track match for reducing background

-Total: 48 conditions

Trigger table for Physics run

			CH01	CH02	CH03	CH04	CH05	CH06	CH07	CH08	CH09	CH10	CH11	CH12	CH13	CH14	CH15	CH16
			Y	Y	N	Y	Y	Y	N	N	Y	Y	N	Y	N	N	N	N
EMC	Etot_L	09					Y								Y			
	NBClus.GE.1	12		Y				Y										
	NEClus.GE.1	13	Y															
	ECLUS_BB	3																Y
TOF	BTOF_BB	17				Y										Y		
	NETOF.GE.2	18																
	NETOF.GE.1	19	Y															
	NBTOF.GE.2	20		Y	Y								Y					
	NBTOF.GE.1	21					Y	Y										
	NTOF.GE.1	22													Y			
MDC	LTrk_BB	42				Y							Y					
	STrk_BB	38	Y															
	NLtrk.GE.N	43																
	NLtrk.GE.2	44		Y	Y			Y										
	NLtrk.GE.1	45					Y											
EMC	NClus.GE.1	48									Y						Y	
	NClus.GE.2	49												Y				
	BEtot_H	55									Y							
	EEtot_H	56																
	Etot_M	58												Y				

Fast control sub-system



Fast control and Clock Fan-out

- Fast control signals and Clock are distributed to each sub-FEE system by optical fiber. Each sub-system is responsible for fast signals and clock fan out used in internal system.

- Fast control signal,

Total 6 fibers, all used.

- 1 used by ZDD FEE
- 1 used by MDC FEE
- 1 used by EMC FEE
- 2 used by TOF FEE
- 1 used by MU FEE

- Clock signal,

Total 4 fibers, all used.

- 1 used by ZDD FEE
- 1 used by MDC FEE
- 1 used by EMC FEE
- 1 used by MU FEE

Fast control signal

Downside：Fast control to FEE

（1）L1 ： Level 1 trigger signal

（2）CHK ： trigger event count check，

（3）RST ： system reset

（4）RLOAD： FPGA reload

（5）FRST ： Fiber alignment reset

（6）TSYNC： Transmit synchronous check

（7）TPD0，TPD1： read out mode

Upside：FEE to Fast control

（8）CRSV ：reserved signal

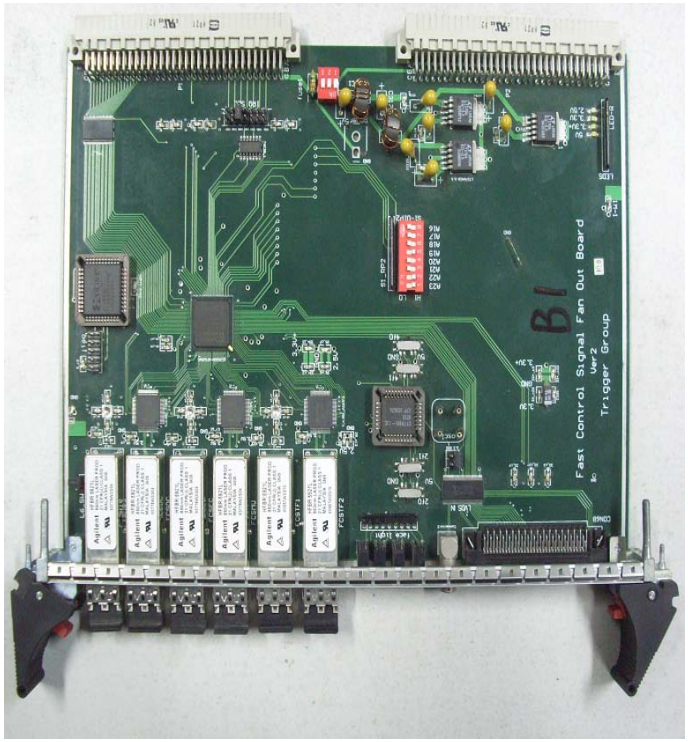
（9）FULL ： Read fifo full

（10）RERR： read or other error

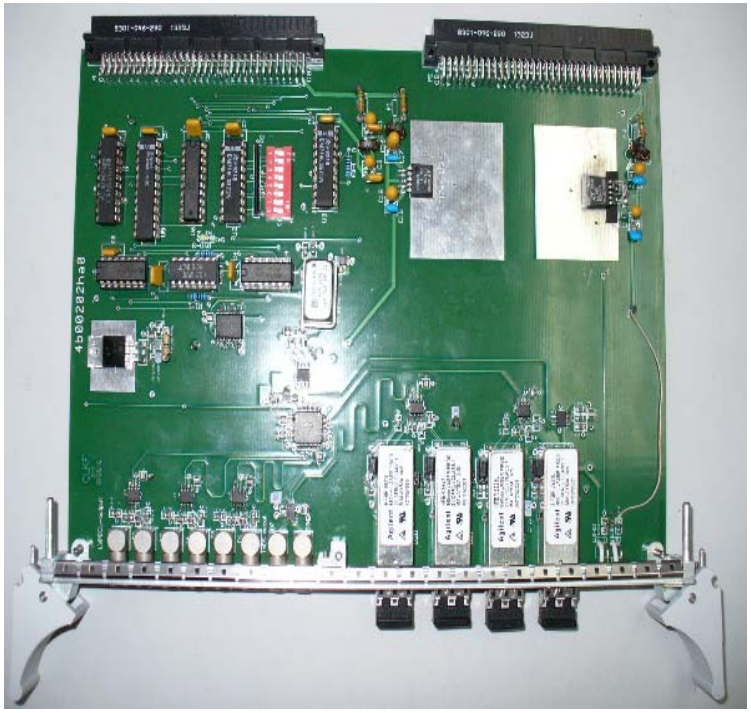
（11）SRSV，SRSV2 : reserved signal,

（12）FUERR: Fiber transmit error .

FCTL and CLKF boards

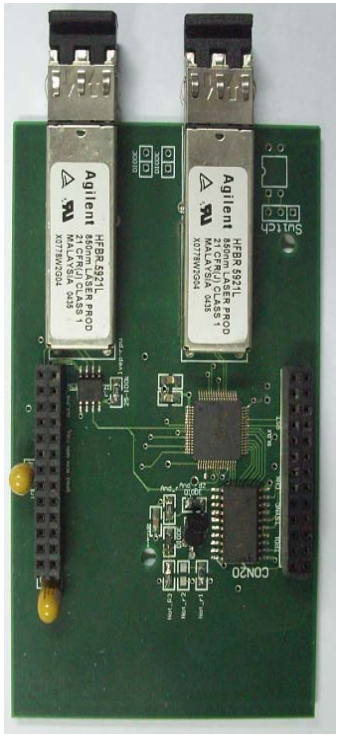


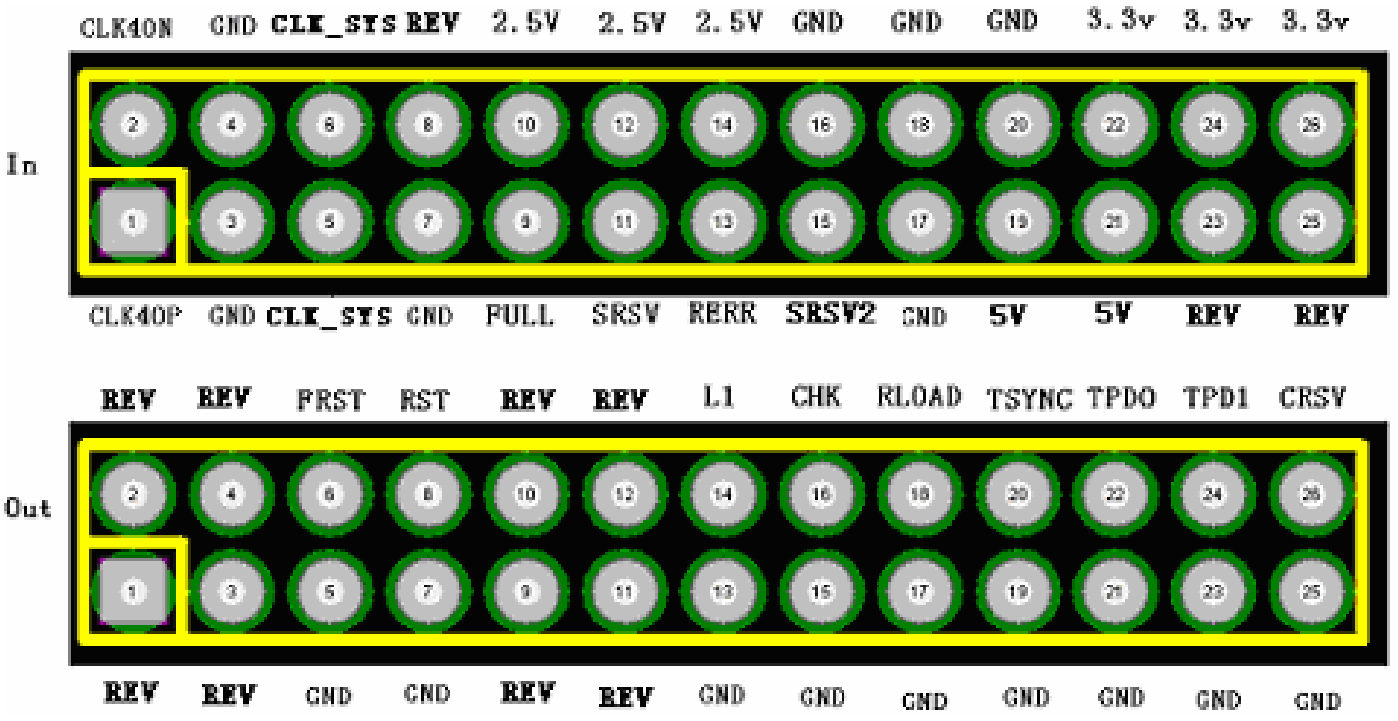
FCTL board



CLKF board

FCDB cards




In
CLK40N GND CLK_SYS REV 2.5V 2.5V 2.5V GND GND GND 3.3v 3.3v 3.3v
2 4 6 8 10 12 14 16 18 20 22 24 26
1 3 5 7 9 11 13 15 17 19 21 23 25
CLK40P GND CLK_SYS GND PULL SRSV RERR SRSV2 GND 5V 5V REV REV
Out
REV REV FRST RST REV REV L1 CHK RLOAD TSYNC TPDO TPD1 CRSV
2 4 6 8 10 12 14 16 18 20 22 24 26
1 3 5 7 9 11 13 15 17 19 21 23 25
REV REV GND GND REV REV GND GND GND GND GND GND GND

Summary

- BESIII total event trigger rate: 4KHz
- L1 Latency: 8.6 μs(ETOF).
- Trigger, Timing and Fast control signals are fanned out to FEE by Fast control sub-system via optical fiber.

Thanks