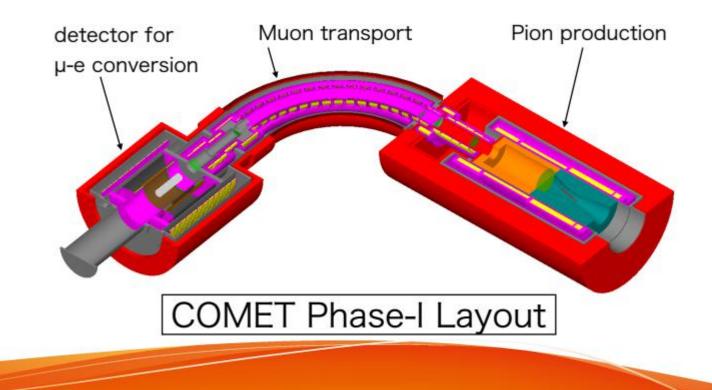
# AURORA COMMUNICATION BETWEEN RECBE AND COTTRI BOARD IN COMET EXPERIMENT

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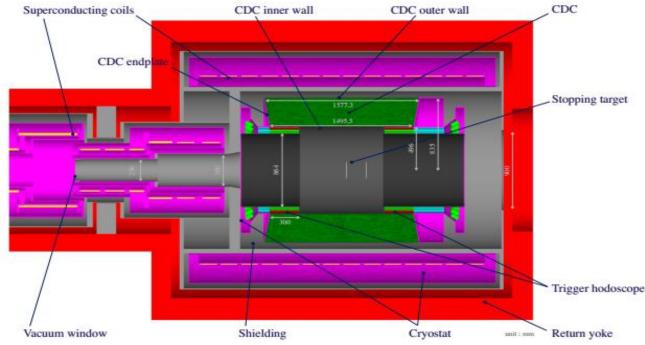
• Measure the neutrinoless, coherent transition of  $\mu$  - e in the Al field

 $\mu^{-}Al \rightarrow e^{-}Al$ 

- Single event sensitivity  $3 \times 10^{-15}$
- Layout of COMET experiment:



• Cylindrical Detector System (Cydet)



- Main detector system for COMET experiment.
- Consist of cylindrical drift chamber (CDC) and cherenkov trigger hodoscope (CTH).

• CDC is used to:

\_ Reconstructing tracks of charged particles.

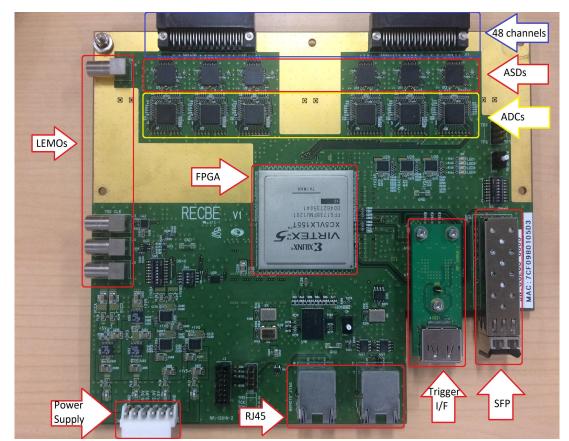
\_ Measuring particles's momenta precisely.

• CTH is used to:

\_ Make the first level trigger for COMET experiment.

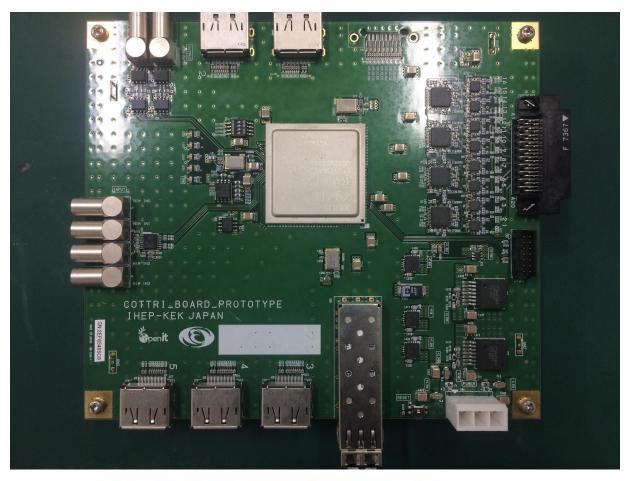
• RECBE (Readout Electronics for Central drift chamber of BElla II experiment) board - chosen as the front-end readout electronics for CDC with approriate modification.

#### RECBE board



- RECBE board converts the charge data from CDC to hit information by digital processing.
- To reject CTH trigger from background particles:
- \_Using hit information from a large number of CDC channels.
- \_ Then combine to the CTH hit information to make the trigger decision.
- => Need one board this purpose.
- => COmeT TRIgger (COTTRI) board.
- Therefore, transferring CDC hit information from RECBE to COTTRI boad is necessary.
- Aurora protocol is used for this purpose.

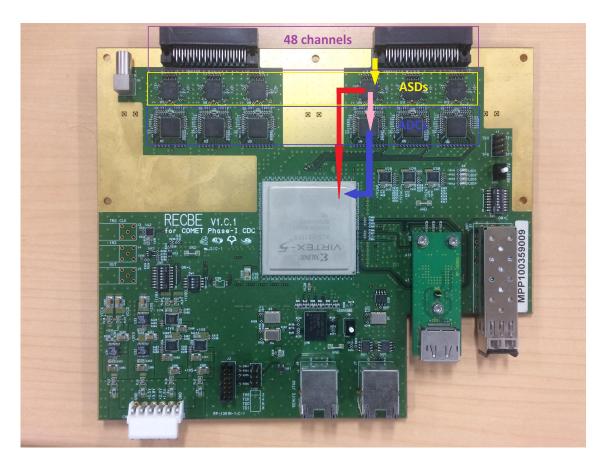
• COTTRI board



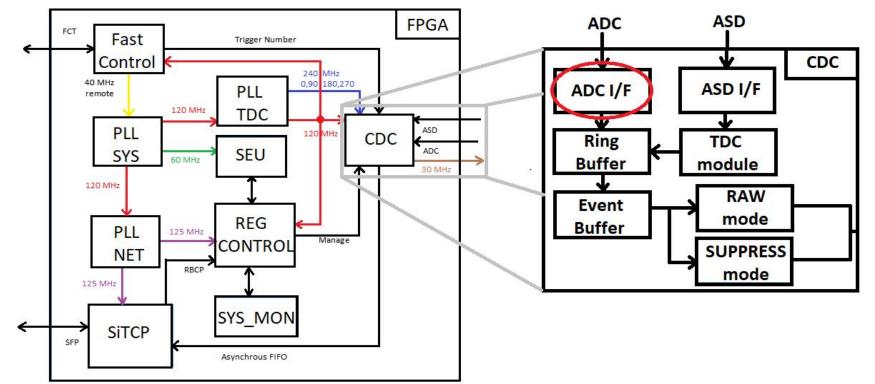
## II. Experimental details

1) Data processing on RECBE board:

- analog aignals (yellow line).
- analog signals (pink line).
- digitial signal (red line).
- digital signal (blue line)



- II. Experimental details
- 2) FPGA firmware ADC I/F:
- FPGA firmware of RECBE board:



#### II. Experimental details

- ADC I/F : serialize separately data coming from ADCs for 48 channels in one samples.
- For one samples, ADC data (480 bit) can be obtained for 48 channels.
- This data is too big to transfer from RECBE board to COTTRI board.
- => This ADC data need to be suppressed from 480 bit to 96 bit.
- => It means that 10-bit resolution is reduced to 2-bit for 1 channels.
- => 96 bit data is suitable for RECBE transfer.

#### II. Experimental details

• The idea for getting the 96 bits data:

\_480 bits ADC data for one sampling can be separated into 10 bits for every channel.

For one channel, we sum the ADC data for every 3 samples.

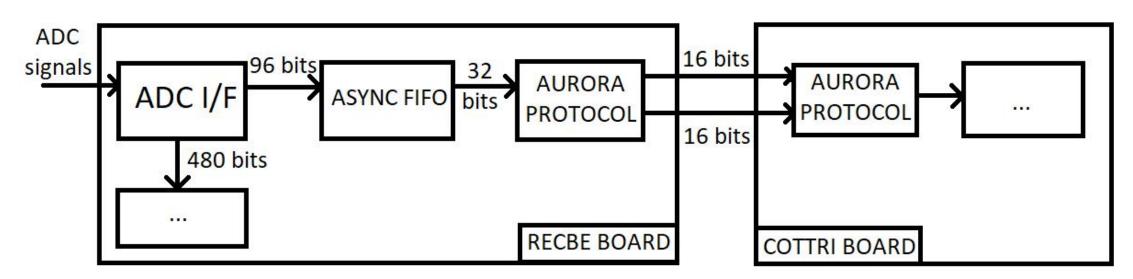
- Compare sum of ADC for every 3 samples with conditions.
- Then obtain the values 0,1,2,3 (2 bits) corresponding to conditions satisfied.
- 2 bits / 1 channel => 96 bits / 48 channels (data being considered)

#### II. Experimental details:

- 3) Conditions to compare with ADC data:
- Besides e from  $\mu$  e conversion, charged particles such as protons, pions, v.v. can be detected in CDC.
- The energy loss of these particles in CDC is higher than electron.
- => Need upper threshold to suppress the ADC data.
- To reject the background caused by low-energy particles, the lower threshold for ADC data is also set up
- => Need lower threshold to suppress the ADC data.

II. Experimental details:

4) Diagram to transfer data:



- 96 bits data goes into asychronous fifo and 32 bits data is output.
- Then 32 bits data go to Aurora protocol to transfer to COTTRI board.

### III. Results and Prospects:

#### Results:

- Used Aurora protocol example to transfer the sample data between RECBE boards before expanding RECBE to COTTRI.
- The firmware for sum of every 3 ADC samples.
- The firmware to connect asynchronous fifo and aurora protocol.
- Simulation of connection two above firmware work well.

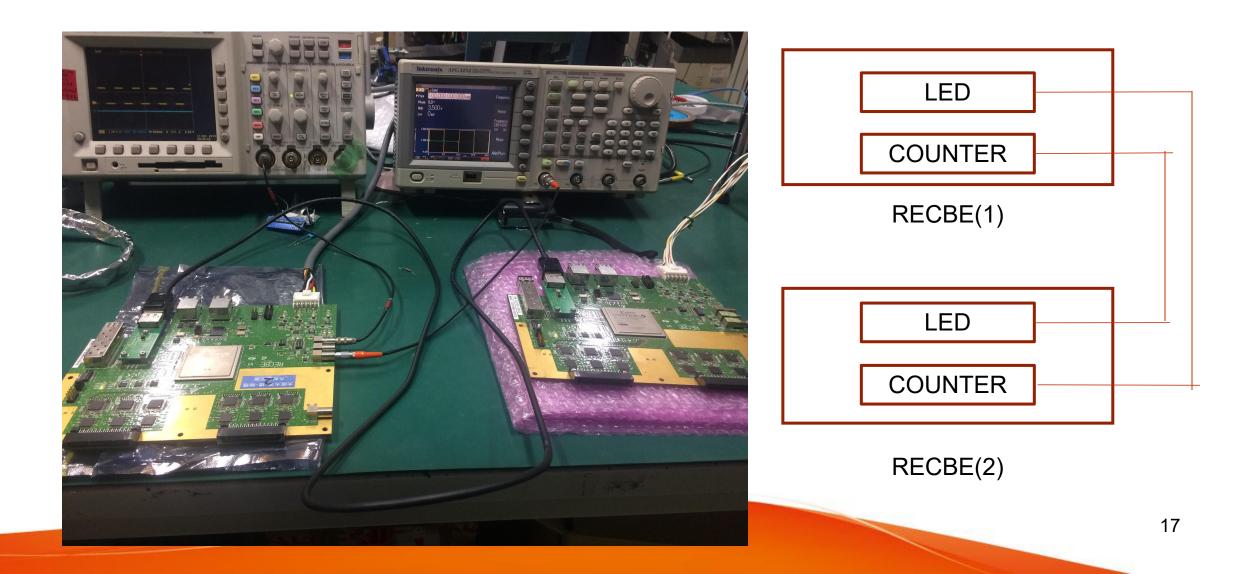
#### Prospects:

- In the next time, the firmware need to be implemented to FPGA of RECBE board to see how it works.
- The firmware for Aurora Protocol for COTTRI will be written.

# Thank you for your attention

# **BACK UP**

### AURORA COMMUNICATION RECBE & RECBE



### Sum of 3 sampling of ADC data:

Name	Value		250 ns		26	60 ns		270 ns		280	ns III		290 ns		13	300 ns		31.0	ns	32	!0 ns		330 ns		34	10 ns		350 ns		36	Dns	
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U ENB	1	1														-					-	2				-						
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DELAY_COUNT_CHECK[1:0]	01			00	-	X			01					1.0			<u></u>		00			X		01			X		10			-
SUM_0[10:0]	973								0								$\overline{\chi}$							973			·					1816
▶ <b>■</b> SUM_1[10:0]	1013								0				=				$\overline{\chi}$							1013							$\equiv$	1966
SUM_2[10:0]	984								0				=				Ϋ́ =							984							$\equiv$	2008
► 📲 SUM_3[10:0]	119								0	-							Ω=							119							$\equiv$	170
SUM_4[10:0]	198								0				=				$\overline{\chi}$					1000		198								416
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▶ 📲 SUM_6[10:0]	933								0							and the	X		_	and the second				933					-		-6	1970
▶ <b>₩</b> SUM_7[10:0]	887														-		X							887		-						200
DATA_0[10:0]	844					0						3	15	χ <u>60</u>	X 243	3 973	823	22	3 892	489	972	819	205	X 820	X 211	844	304	192	768	X	0	
DATA_1[10:0]	951					0						3	15	63	X 25	3 1013	983	86	3 383	509	1015	991	894	507	X 1005	951		880	X 448	768		
DATA_2[10:0]	1020					0						3	15	X 61	X 246	5 984	867	39	9 573	247	988	883	463	831	255	1020	1 008	960	768	X	0	
DATA_3[10:0]	45						0						1	X 7	X 28	119	476	88	1 455	789	125	500	976	834	X 267	45	180	720	X 832	256		
DATA_4[10:0]	204						0						3	X 12	X 49	198	792	99	9 397	565	212	848	323	268	χ 51	204	816	192	X 768	X	0	
DATA_5[10:0]	174						0						2	χ 10	X 4	164	656	57	8 264	X 34	138	552	162	X 650	χ 555	174	696	736	X 896	X 512		
DATA_6[10:0]	971					0						3	14	X 58	X 23	3 933	663	60	7 382	\$ 507	1 005	951	735	892	χ 498	174 971	812	176	χ 704	X 768		
DATA_7[10:0]	1022					0						3	13	X 55	X 221	887	479	89	5 1 509	X1014	987	879	447	X 767	X 1023		1016	992	X 896	X 512		
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