

Argo RPC Readout Electronics in COMET

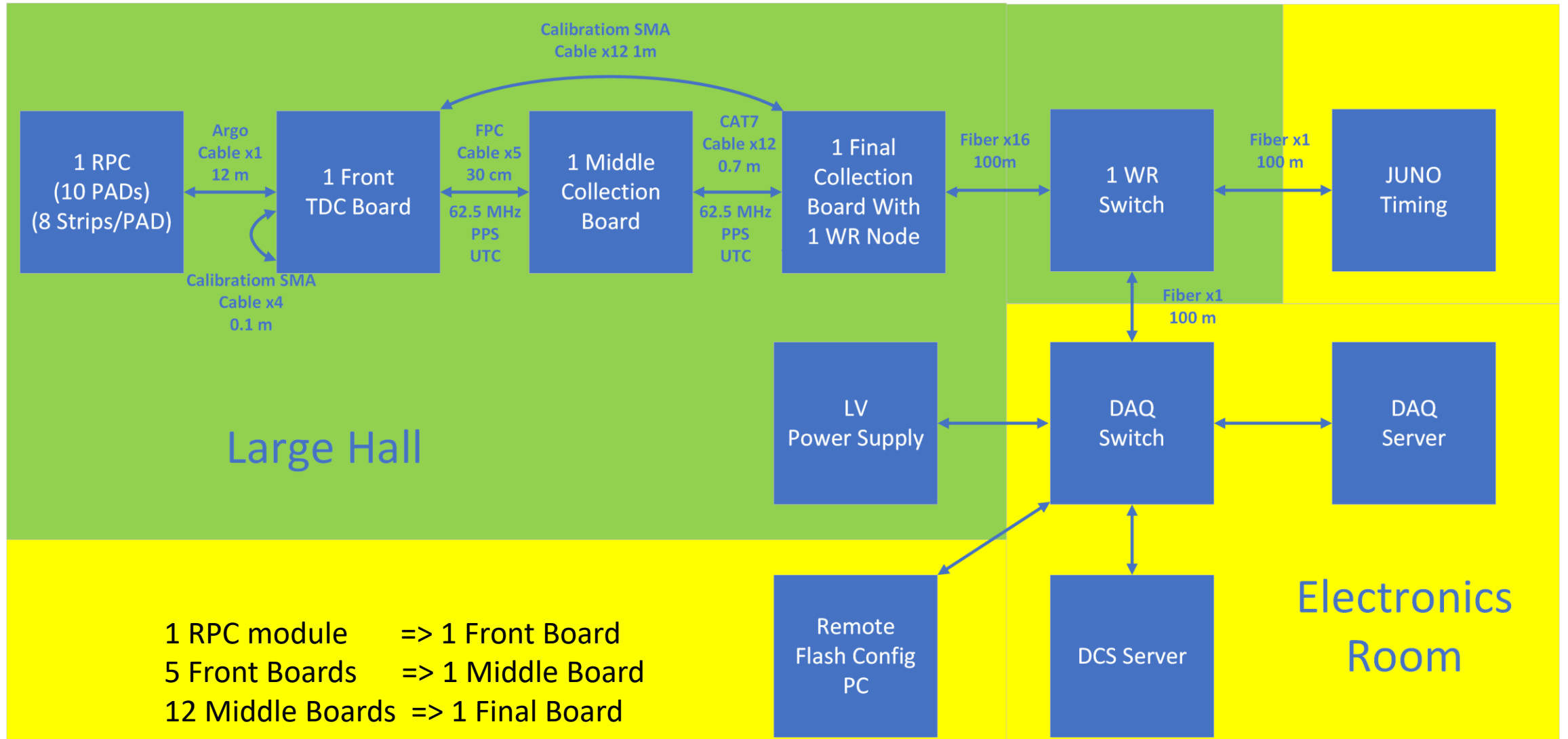
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2026.10.10

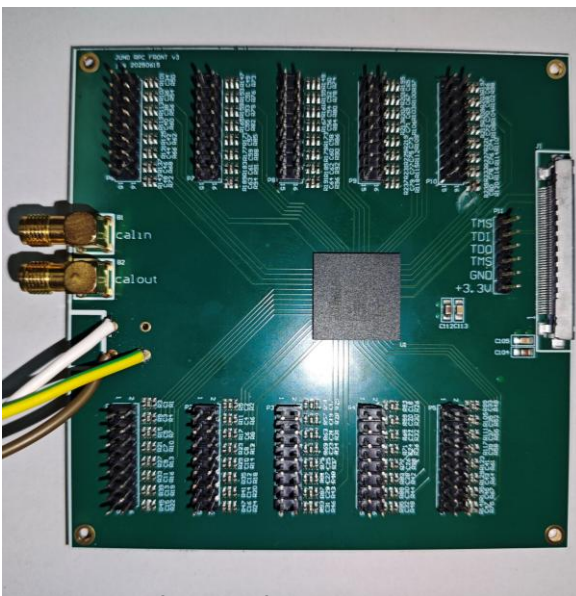
Outline

- 1. JUNO RPC electronics introduction;
- 2. COMET ARGO RPC Electronics requirement;
- 3. Concept design of COMET ARGO RPC Electronics;
- 4. Next plan;

JUNO RPC Electronics Topology



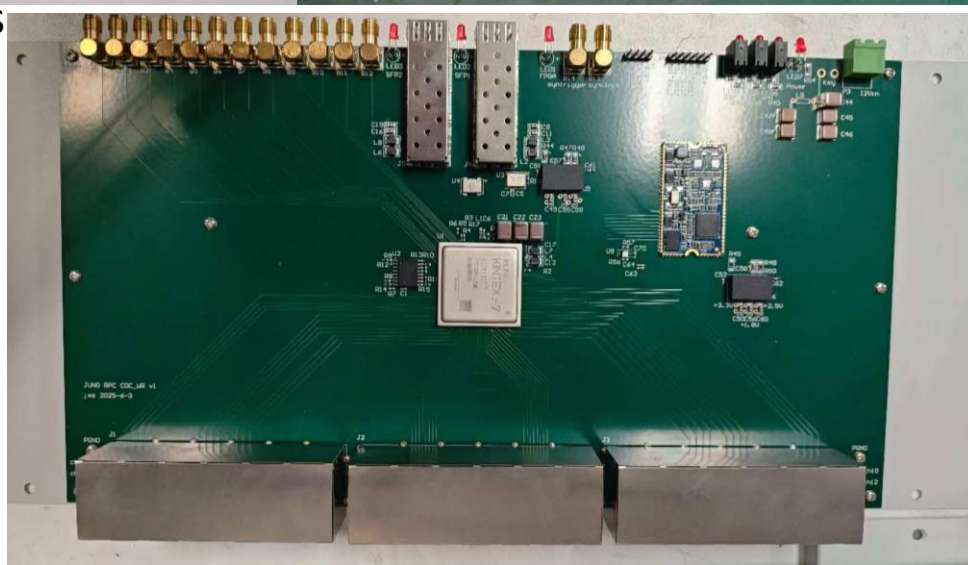
Installed RPC electronics



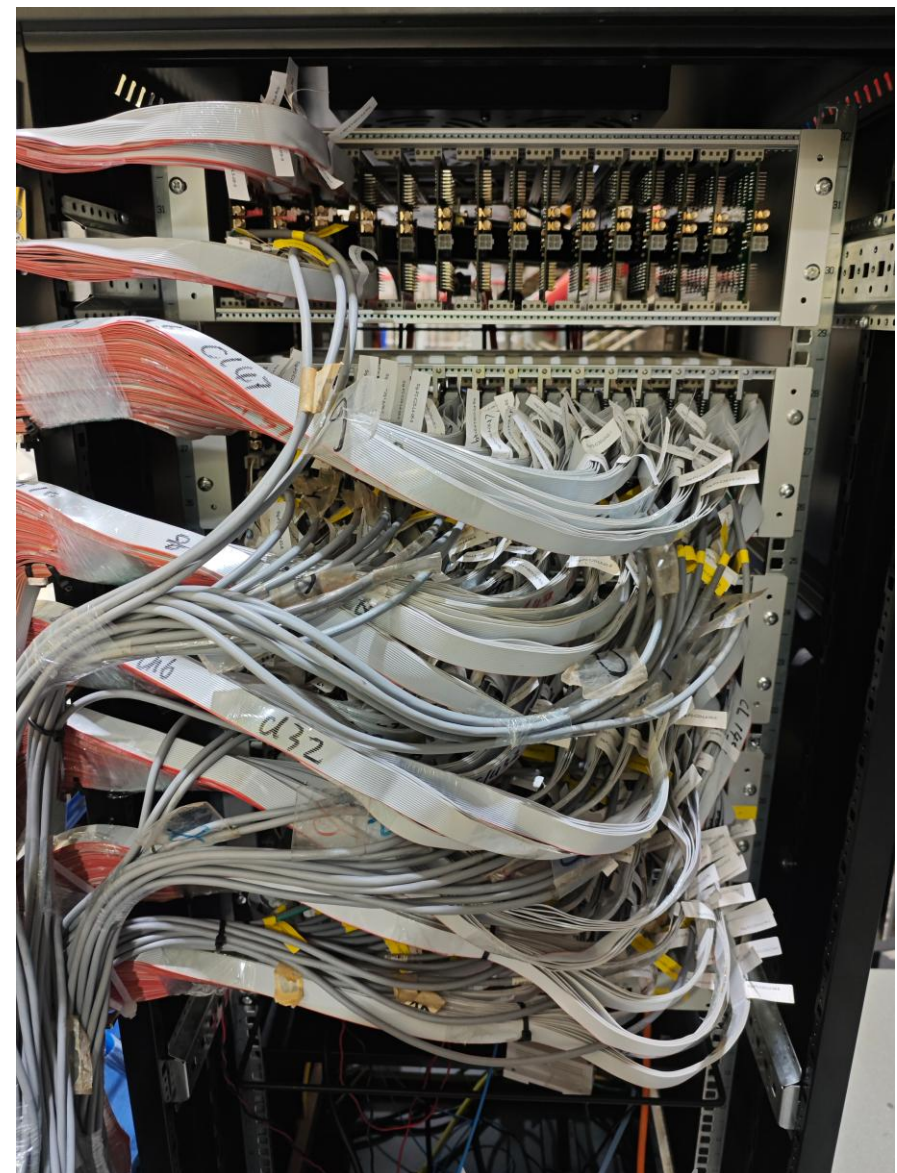
TDC boards



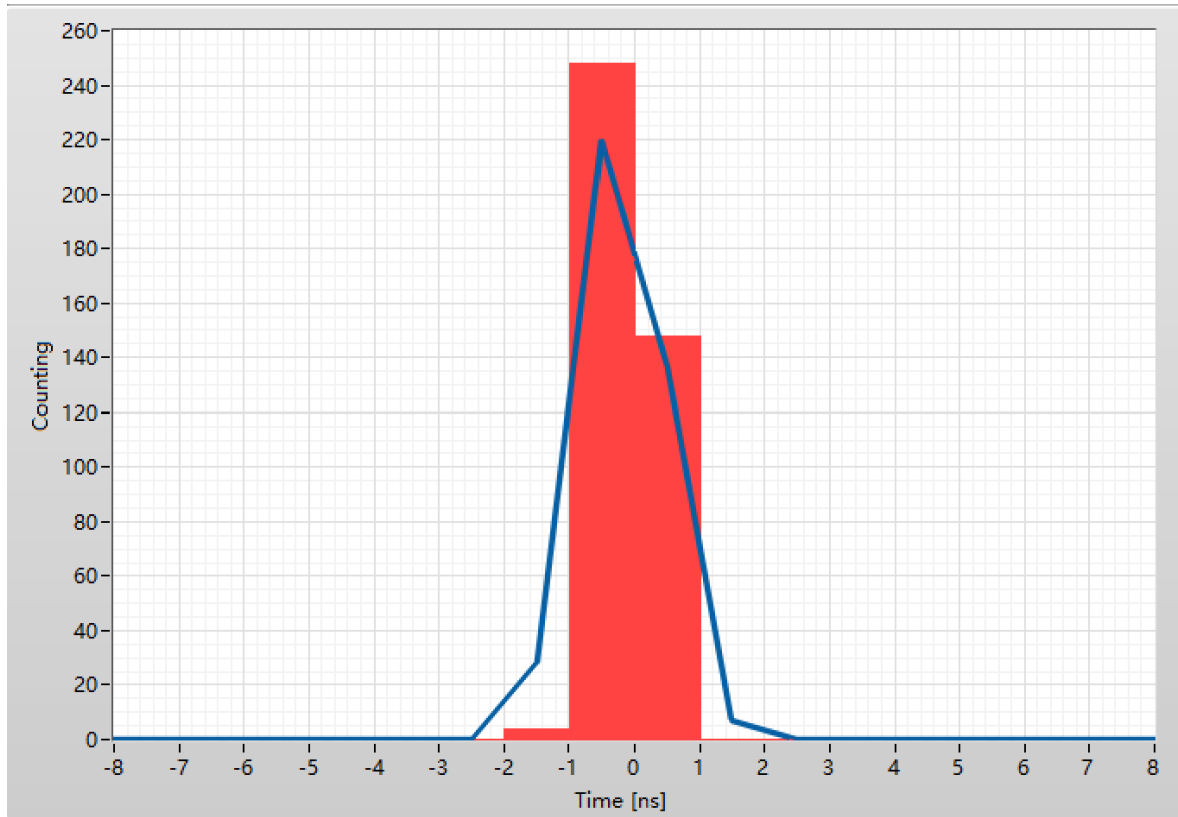
Middle boards



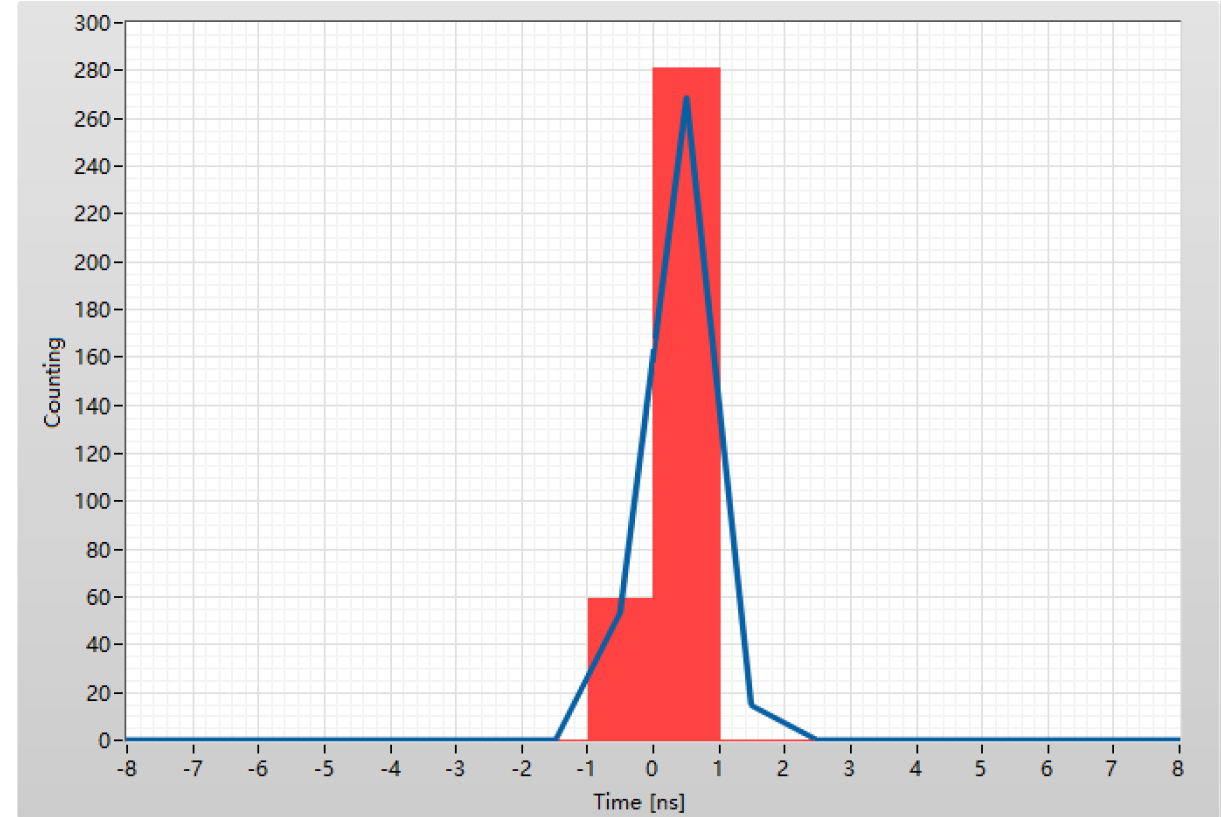
Backend boards



TDC Electronics Self Test



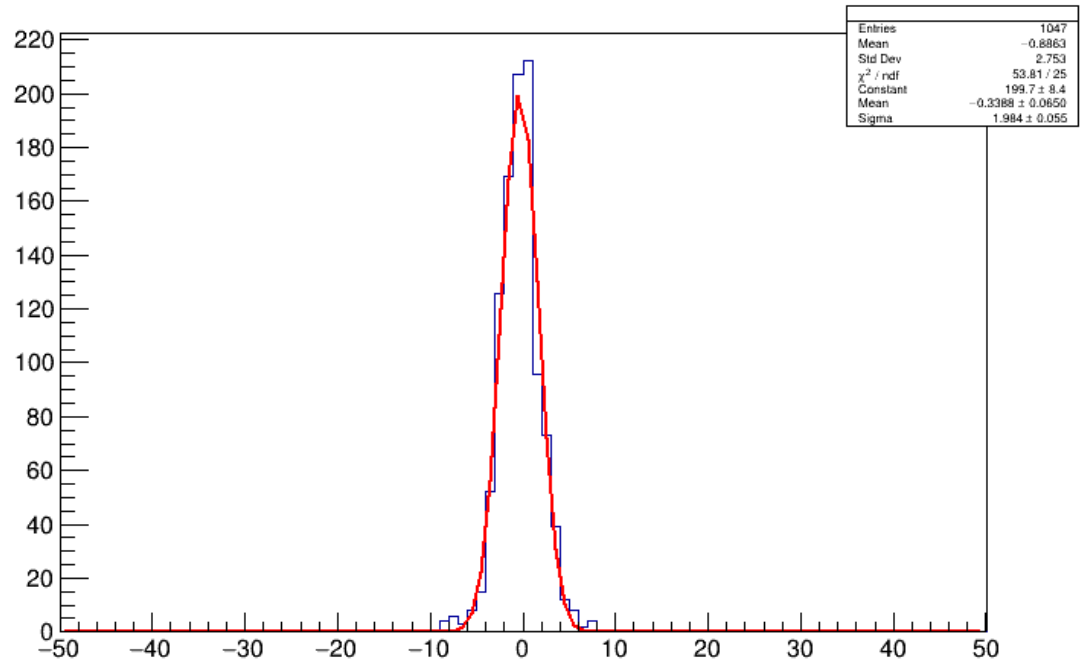
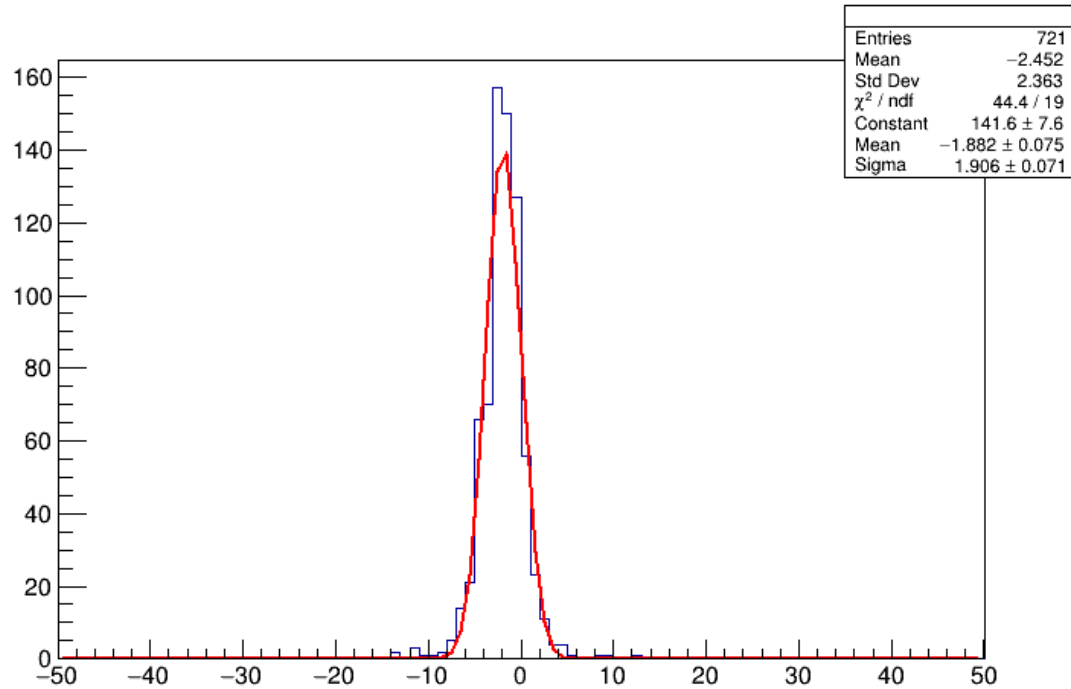
CTR of two channel in the same middle board



CTR of two channel in different final board

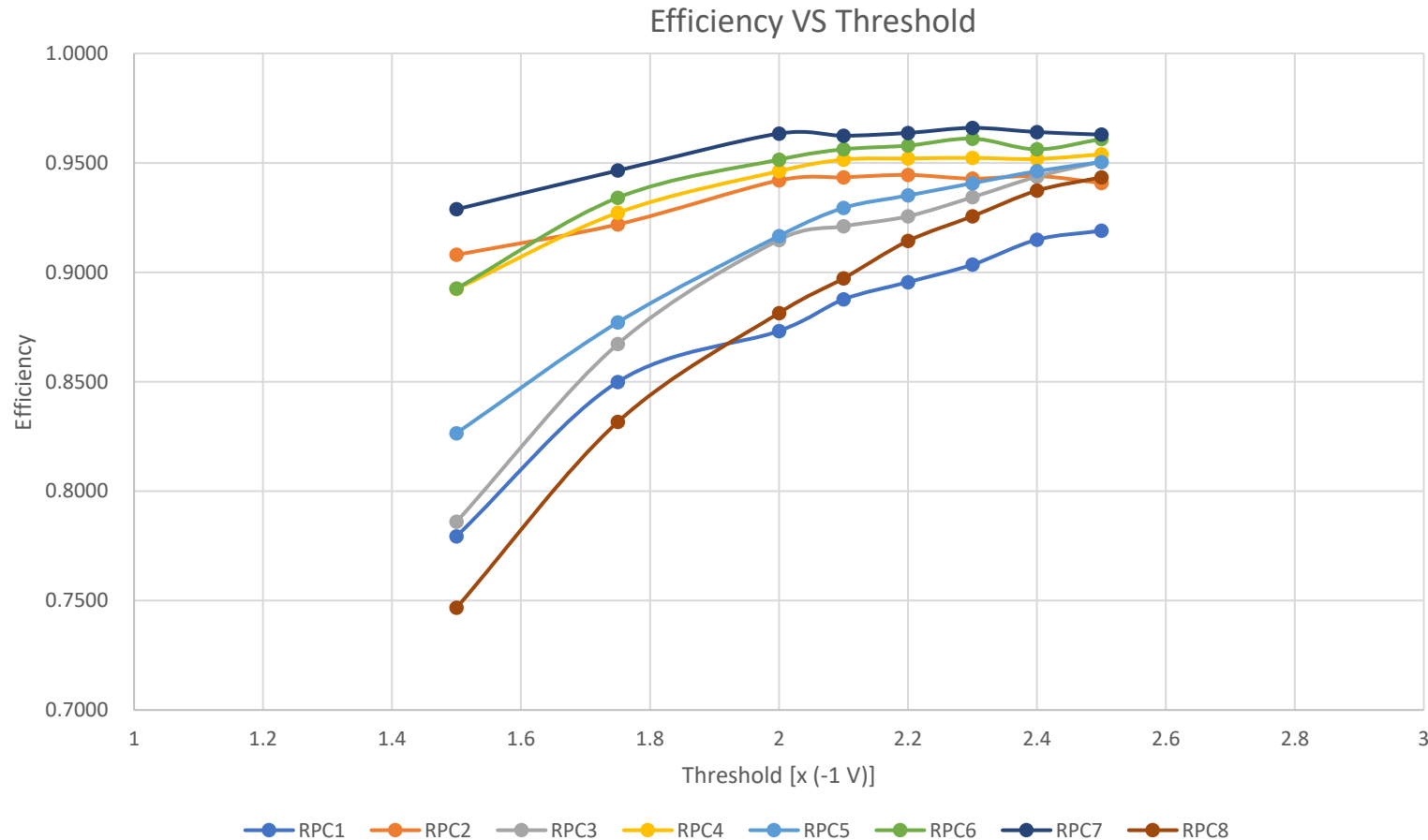
LSB = 1 ns

CTR with RPC



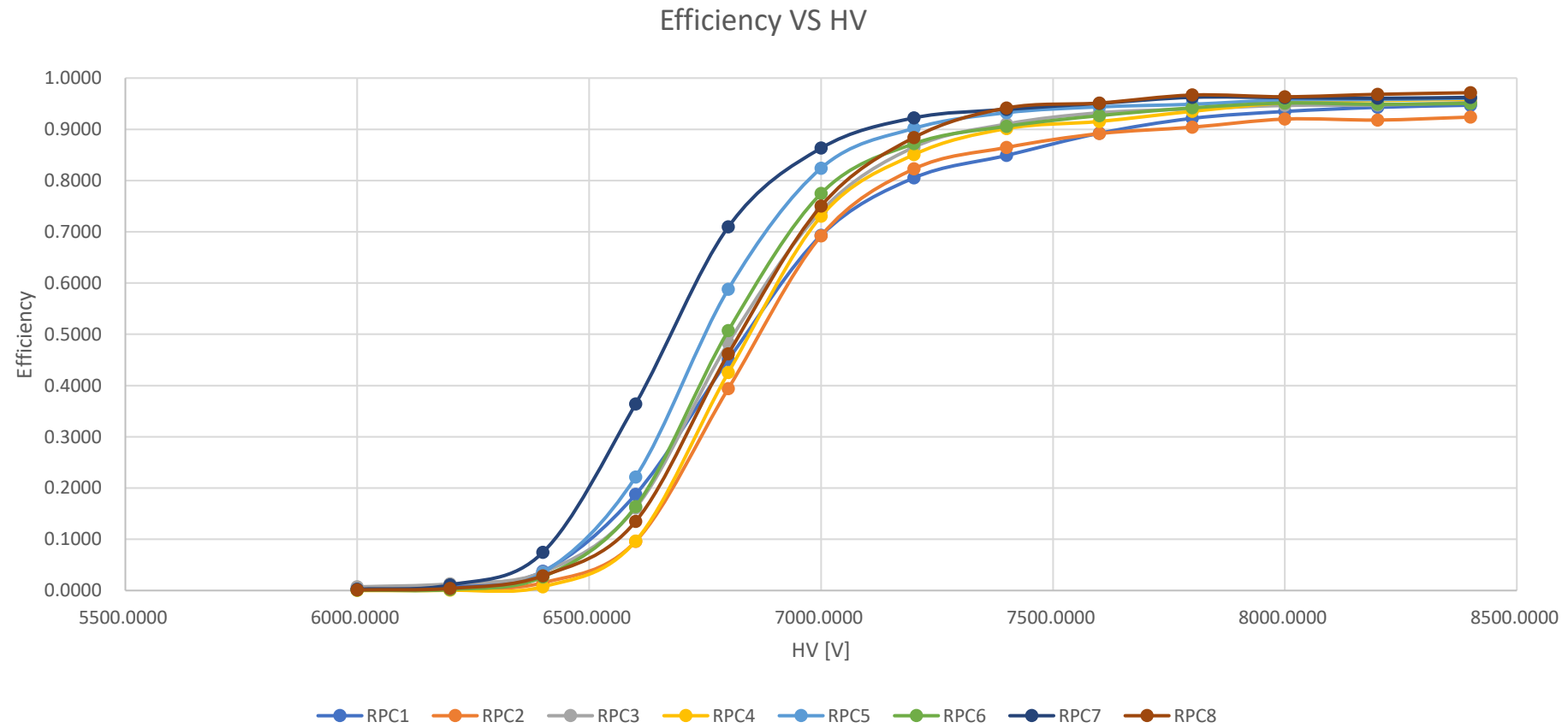
$\sigma = 1.9/\sqrt{2} \text{ ns} < 2 \text{ ns requirement}$
The result is similar to Argo' result

Efficiency VS Threshold



The test result is similar to the result based on the system

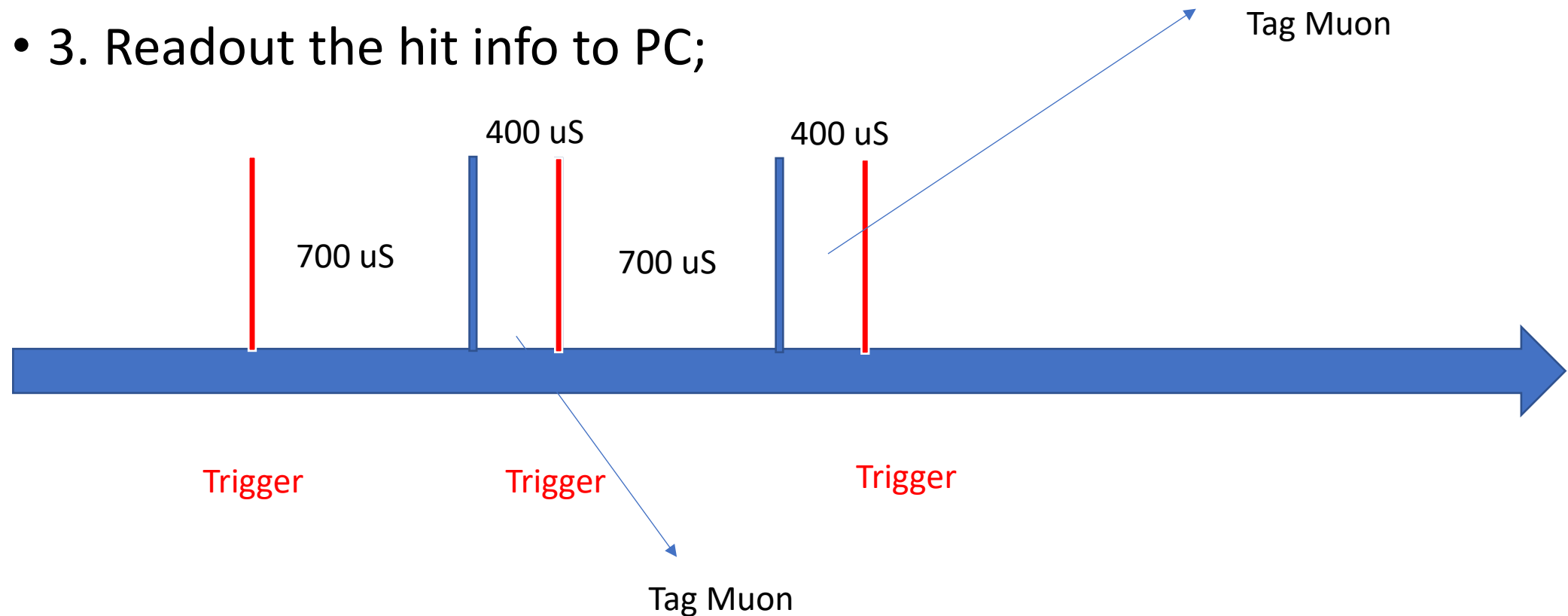
Efficiency VS HV



The test result is similar to the result based on the system

Requirement

- 1. Tag the timestamp of hits only in 400 μ s;
- 2. Upload the hit info to trigger system;
- 3. Readout the hit info to PC;

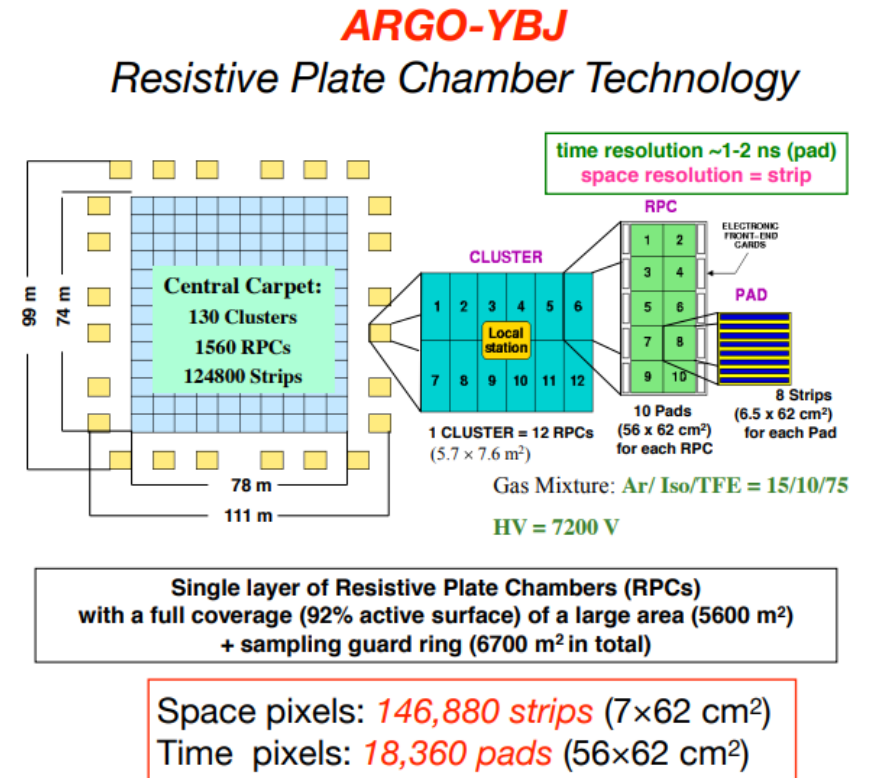


和JUNO RPC电子学区别

- 1. COMET RPC工作在束流模式，计数率极高，因此对带宽要求高；
- 2. COMET RPC工作气体用的是CMS iRPC气体，导致信号幅度不同，需要放大；
- 3. 需要电子学设计考虑抗辐照；

Event rates

- Input: 300 Hz/cm²; Event size: 16 Bytes;
- Strips: 7x62x300 = 130200 Hz/strip;
- RPC: 80x130200 = 10,416,000 Hz/RPC;
- Events: 16x10,416,000 = 167 MB/s



TDC boards design

- 1. Use multi phase of clock as a TDC, now TDC LSB=1 ns, RPC detector timing sigma = 2 ns in JUNO; it is possible to optimize TDC LSB = 250 ps;
- 2. More than one RPC shared one TDC board for low cost;
- 3. Radiation Hardening:
 - 3.1 Loading firmware remotely;
 - 3.2 Loading firmware periodically;
 - 3.3 No local oscillator;

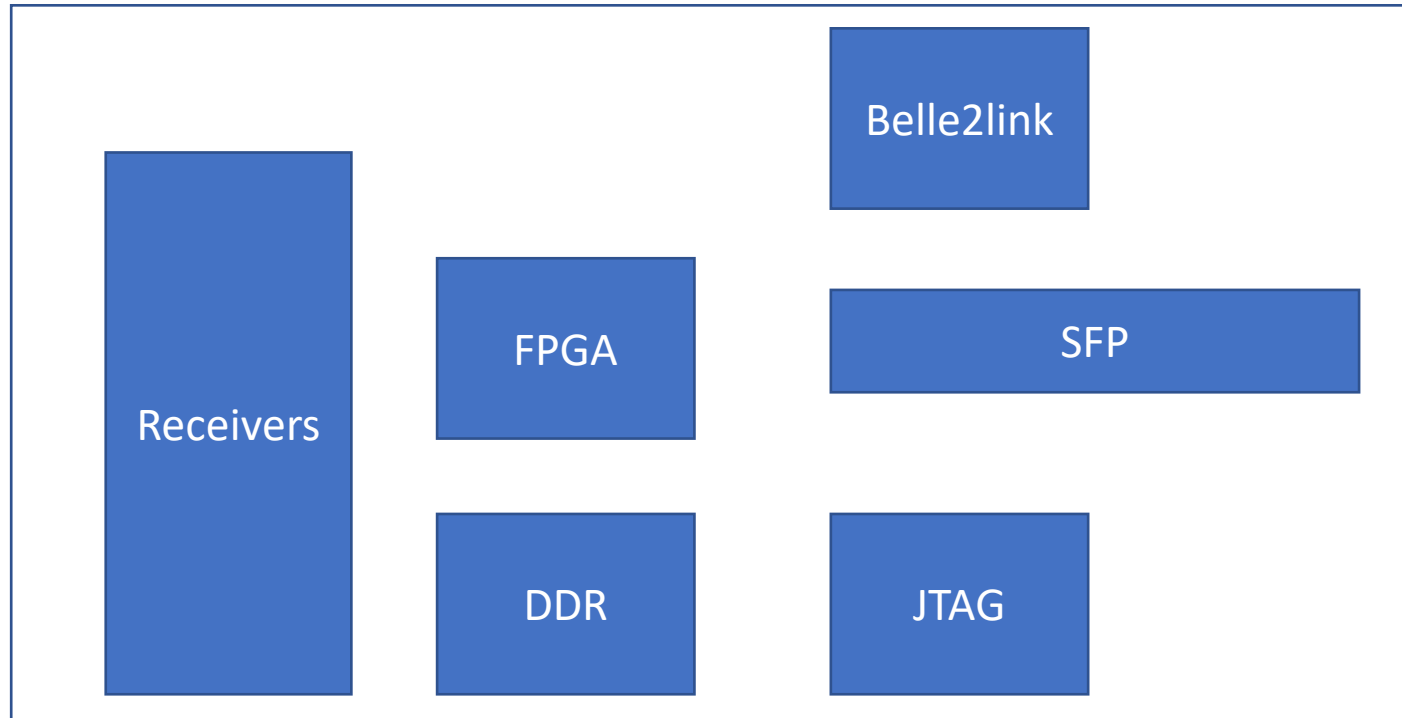
ARGO RPC Signal



- Blue: raw signal from flat cables;
- Yellow : from ATLAS receivers;

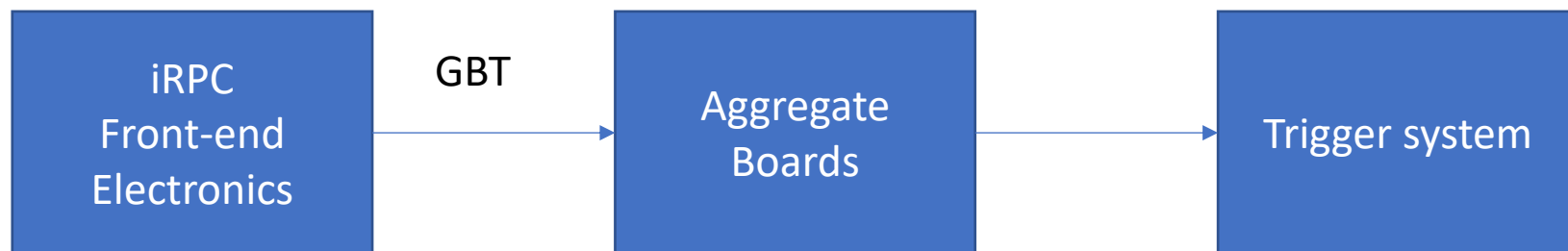
The picture is from Zhaoke

TDC Boards



- 1. Receivers design for amplification;
- 2. Power dissipation;
- 3. Multi phase TDC;

iRPC读出结构



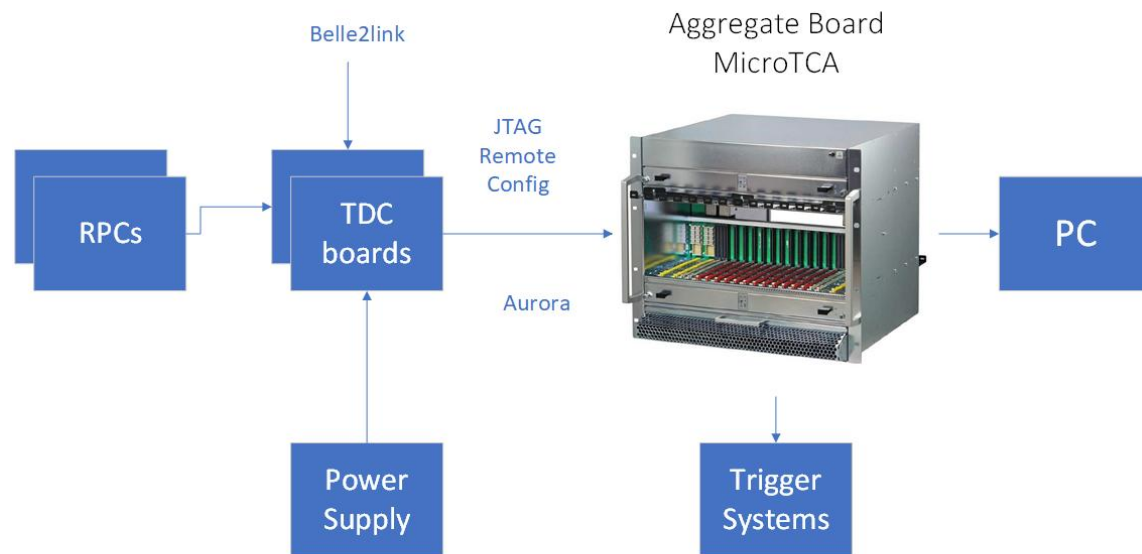
MicroTCA板卡（支持4个iRPC）
ATCA板卡

MicroTCA板卡：计划用于iRPC在COMET demo；但是板卡数量很少，且接口停产，批量使用需要改版；

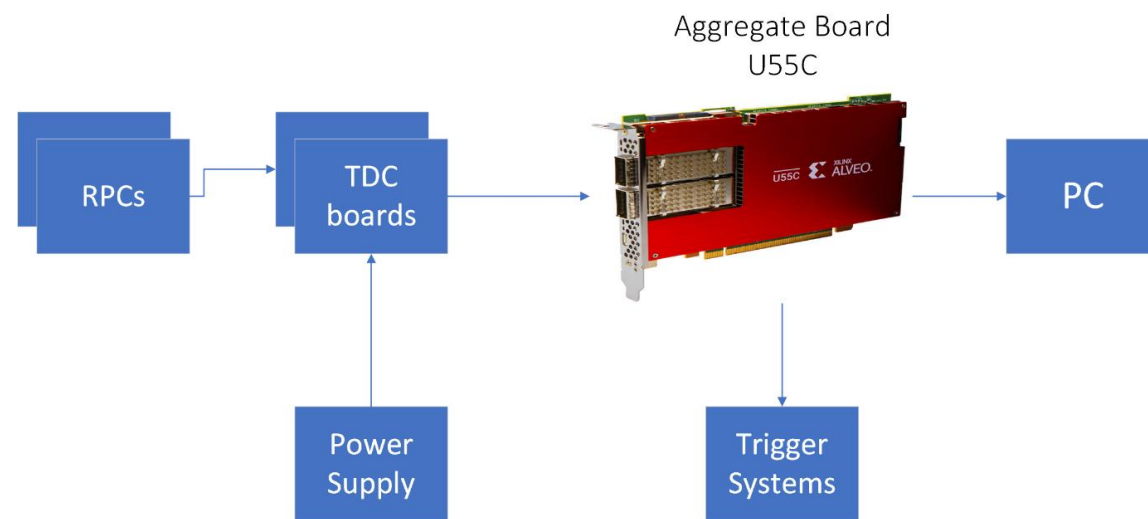
ACTA板卡：用在COMET？

ARGO RPC和iRPC统一使用相同的汇总系统？

可能的读出结构

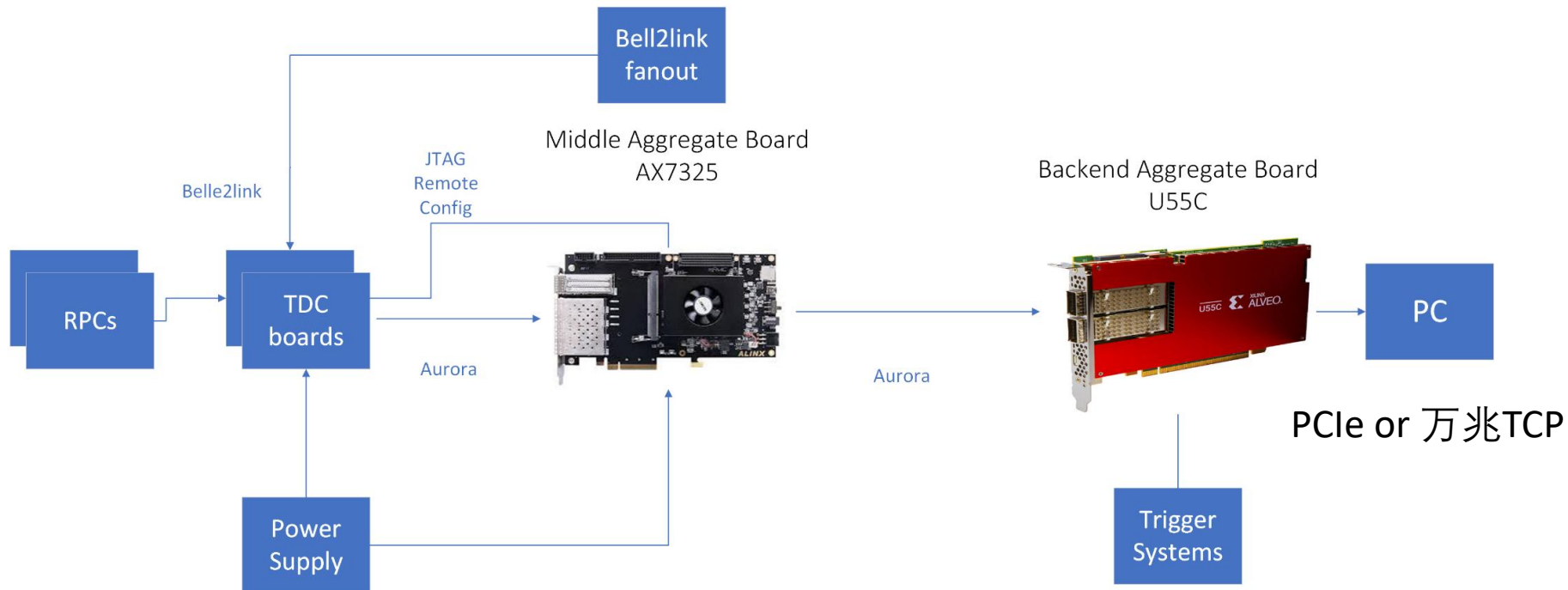


One scheme A based on MicroTCA



One scheme B based on Xilinx Alveo Boards

More details about Scheme B



TDC Boards: Middle Boards = 4:1

Middle Boards: Backend Boards = 8:1

Possible Aggregate

TDC boards	Middle boards	Backend boards	Power Supply
72 (1 RPC to 1 TDC)	20	3	8
36 (2 RPC to 1 TDC)	11	2	4
12 (6 RPC to 1 TDC)	0	2	2

Depend on receiver design

Open questions

- 1. How to purchase MicroTCA or Power Supply or PC;
- 2. How to use physics calibration to cancel the timing offset for TDC boards?

下一步计划

- 1. 和Maxime, Giulio合作，完成receiver的设计，实现信号调理和甄别，我个人评估目前这个信号幅度，其实不太需要receiver；
- 2. 初步实现链路读出，目前从别的项目借来一块U55C，可以开展研究；