

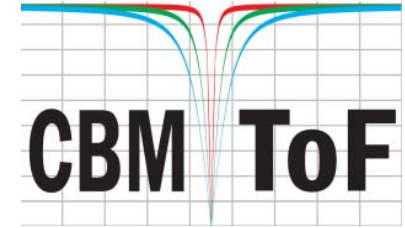
MRPC3b for CBM TOF

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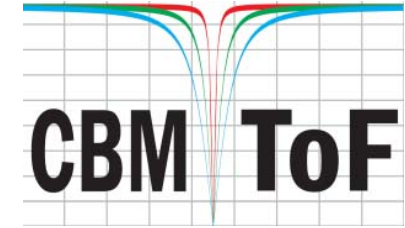
Outline



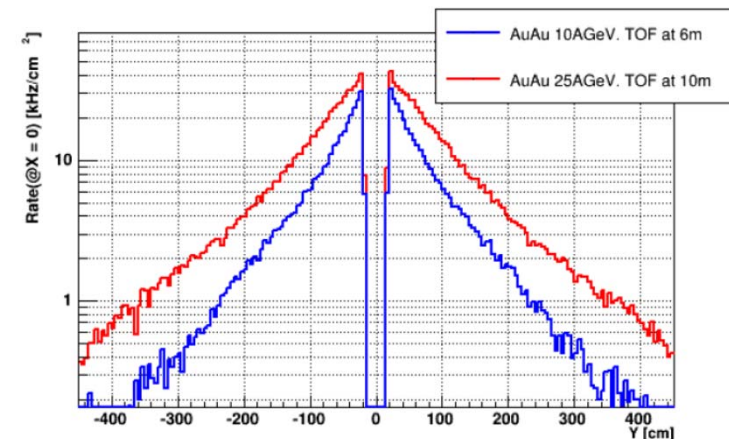
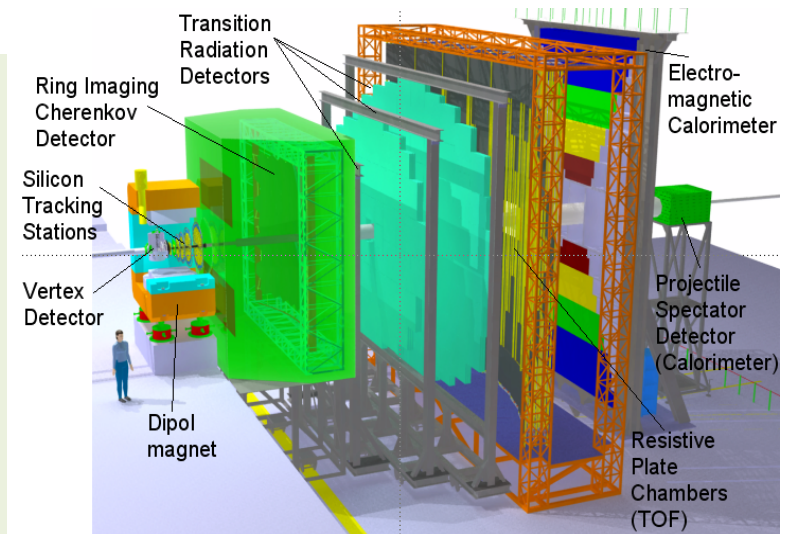
- Introduction
- MRPC3b——design and characteristics
- Production: Quality Control & Assurance
- Status and time line
- Summary



MRPC TOF for CBM

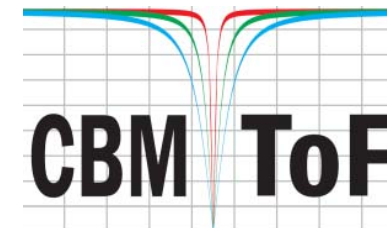


- CBM: a future (2024) **fix target** heavy ion collision experiment at FAIR in Germany.
- MRPC TOF is the key PID system for CBM.
- **Special requirements:**
 - Large area: $\sim 120 \text{ m}^2$
 - High rate: $0.1\text{-}100 \text{ kHz/cm}^2$
 - Free streaming DAQ: Triggerless

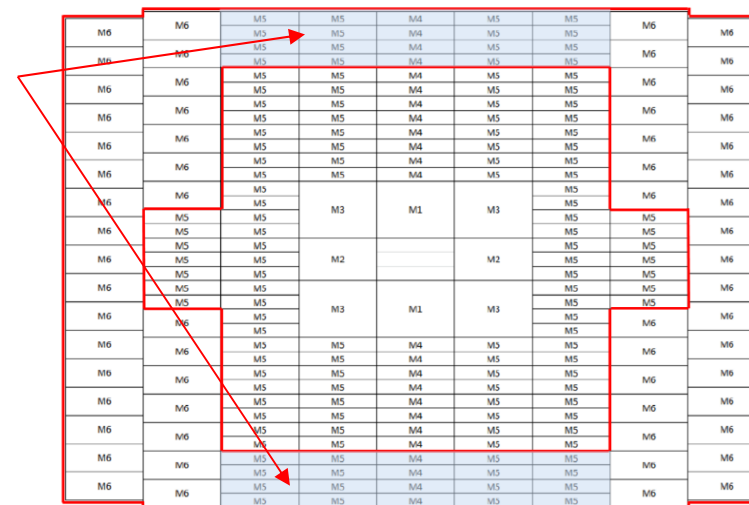




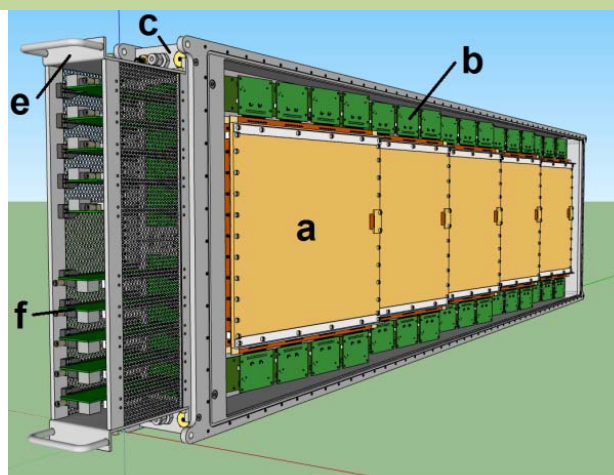
MRPC3b on CBM TOF wall



- MRPC3b: for the low rate region of CBM TOF
- Rate requirement: $<1 \text{ kHz/cm}^2$
- Thin float glass as electrodes
- 200 MRPC3b needed for CBM TOF



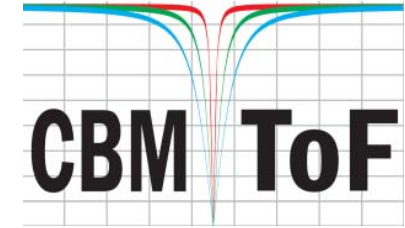
5 MRPC3b in one CBM module



MRPC notation	MRPC1	MRPC2	MRPC3a	MRPC3b	MRPC4
Number of MRPCs	40	246	580	200	310
Active area [mm ²]	300 × 100	300 × 200	320 × 270	320 × 270	320 × 530
Number of Strips per MRPC	72	72	32	32	32
Strip length [mm]	100	200	270	270	530
Granularity (cell size) [mm ²]	416.7	833.3	2700	2700	5300
Number of gas gaps	10	10	8	8	8
Gap size μm	140	140	220	220	220
Glass size [mm ²]	320 × 100	320 × 200	330 × 280	330 × 280	330 × 540
Glass thickness [mm]	0.7	0.7	0.7	0.5	0.5
Number of glass plates	12	12	9	9	9
Glass type	low res.	low res.	low res.	float	float
Total glass surface [m ²]	15.36	188.93	482.33	166.32	497.18

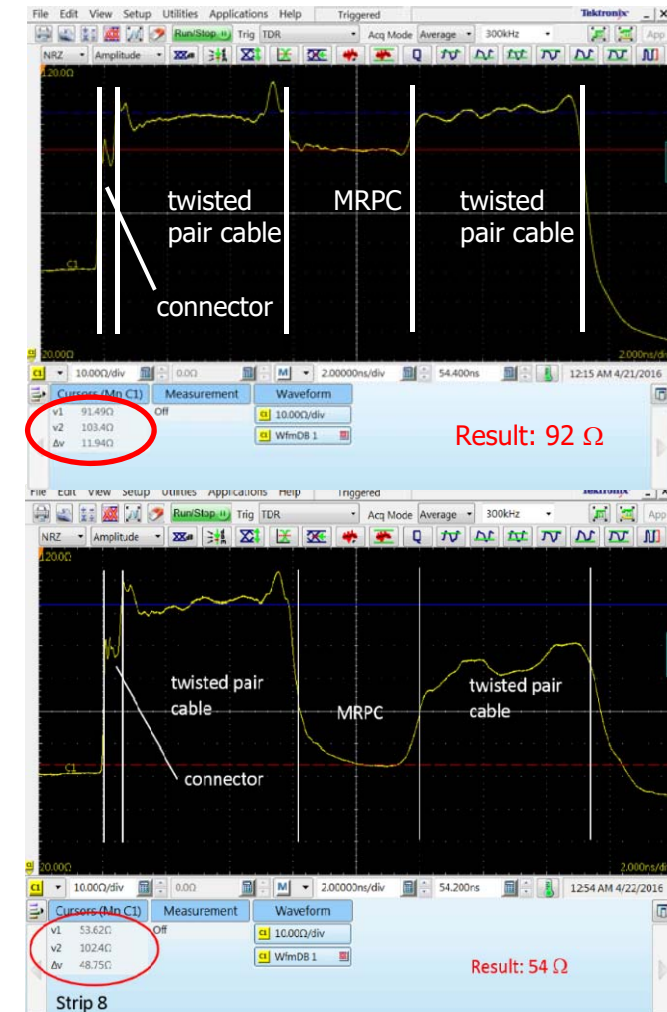


Impedance matching



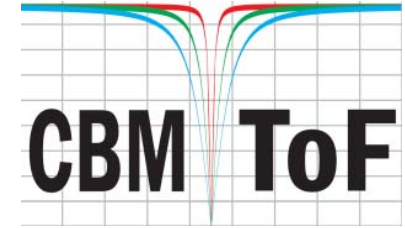
MRPC impedance is **LOW**!

- Unmatched impedance leads to **reflections** which is not acceptable for the triggerless CBM DAQ.
 - FEE input impedance: $\sim 100 \Omega$
 - Increase MRPC impedance by:
 - ✓ Thinner strip width: 7 mm + 3 mm
 - ✓ Larger distance between opposite strips
 - Single- & double-stack MRPC were built and tested.
 - Impedance $\sim 100 \Omega$ and 50Ω achieved.
- Double-stack chosen for MRPC3b due to the less HV needed.

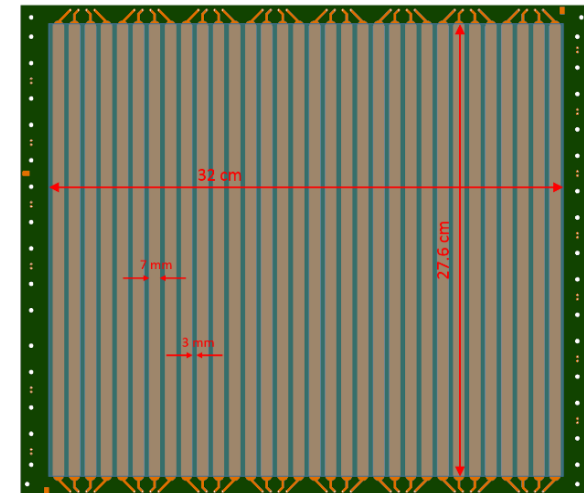
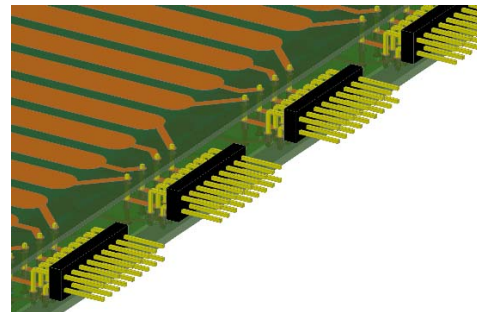
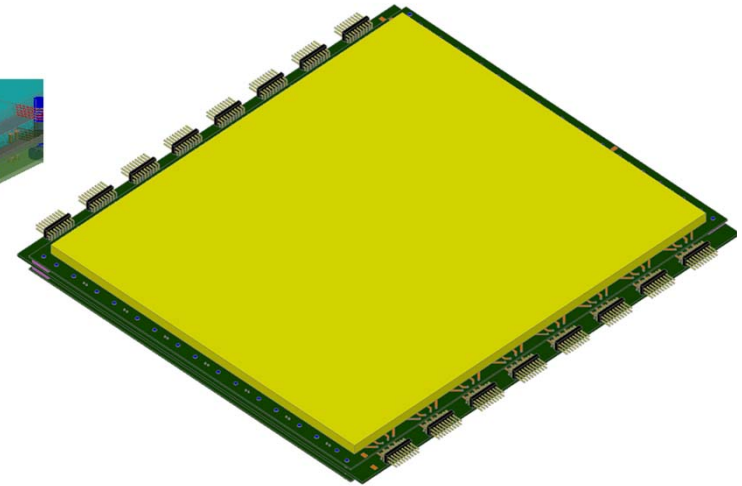
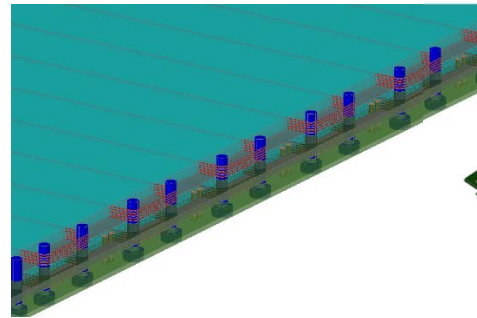




MRPC3b – design

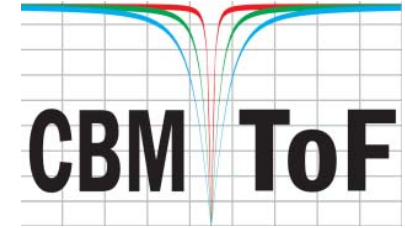


- Thin float glass electrodes
 - 0.28 mm
- Double stacks
 - $230\ \mu\text{m} \times 5 \times 2$
- Impedance matching
 - $50\ \Omega$
- Double-end strip readout
 - 7 mm strip + 3 mm gap = 1 cm pitch
- Differential signals
- Active area
 - $32\ \text{cm} \times 27.6\ \text{cm}$
- Detector size
 - $354 \times 324 \times 22\ \text{mm}$

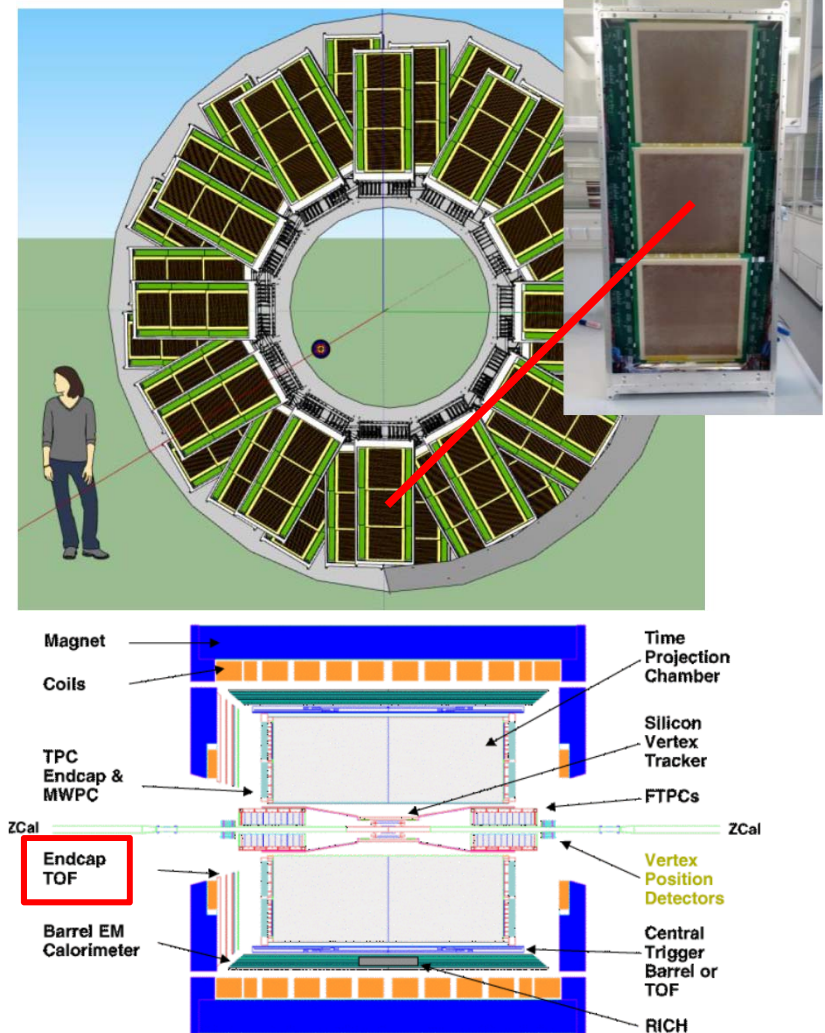




FAIR Phase-0 @ STAR eTOF

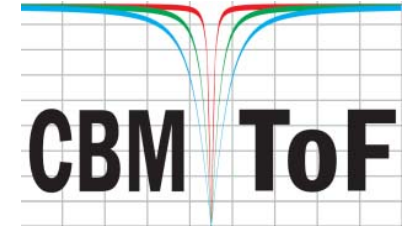


- 120 MRPC3a/b will be installed @ STAR as eTOF for runs 2019-2021.
- Extending the PID coverage and physical potential for STAR.
- Systematical test for CBM TOF.
- MRPC3b mass production started @ USTC from March 2017 after a readiness review.
- Production procedures and QC&QA methods established.



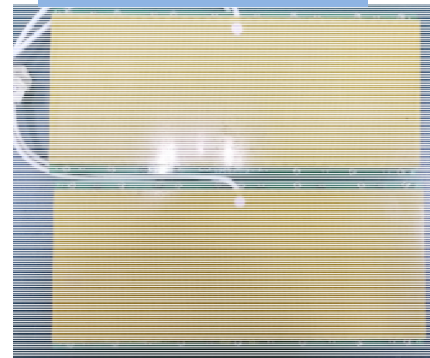


Mass production at USTC



- USTC has the production experience from STAR TOF, STAR MTD, BESIII ETOF, etc.
- More than **1350 / 46 m²** MRPC have been produced.

STAR-TOF MRPC



STAR-MTD MRPC



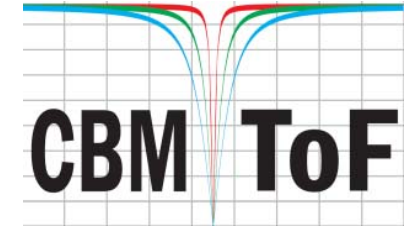
BESIII-eTOF MRPC



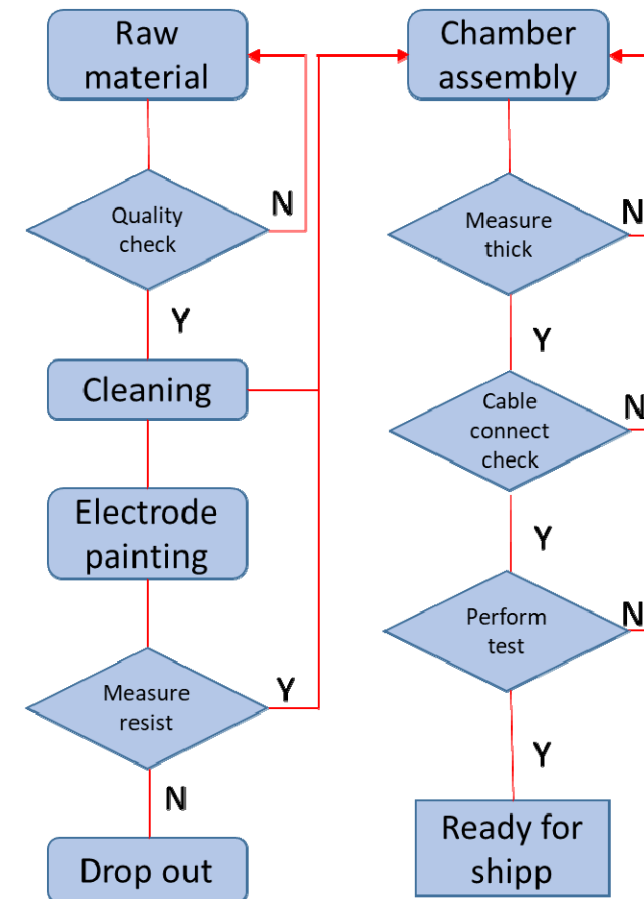
- STAR-TOF **1210** MRPC production(1/3). Time resolution < **80 ps**
- STAR-MTD **59** MRPC production(1/2). System time resolution~**120 ps**
Position resolution~**1 cm**
- BESIII-eTOF **80** MRPC production(100%). System time resolution~**60 ps**



QC process

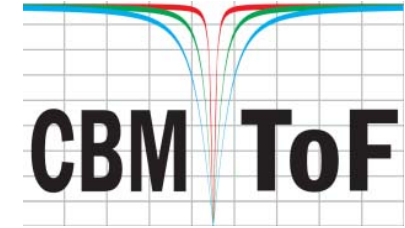


- **Material check**
 - Honeycomb board, PCB, Kapton foil, glass, fishing line, ...
 - Flatness, dimensions, surface quality, resistivity, ...
- **Process check**
 - Cleanness, electrical connections, thickness, dimension, gas gap ...
- **Performance check**
 - Gas conditioning, HV training, dark current, noise rate, efficiency, time resolution, ...





Documentations



- MRPC3b production process **MANUAL**
- 21 assembly steps → **Assembly CARDS**
- Flowchart of QC → **Check CARDS**
- 7 **Record TABLEs**
 - Material should be checked, labeled, measured, recorded and signed.
 - Each assembly step should be recorded and signed.
 - The performance check results will also be recorded.
- The records will be input to the **data base**.

Every counter can be traced back to the raw material and operators.

附件表二：蜂窝板质量检测登记表 2017.05.16 晚

附件表三：印刷线路板质量检测登记表 Top 2017.05.16 晚

编号	厚度 (单位: mm)								质量	检测人
	1	2	3	4	5	6	7	8		

Ref. 0.9mm

附件表六：电极表面电阻率测量登记表

编号	表面电阻率 (单位: MΩ/□)								检测人
	1	2	3	4	5	6	7	8	

附件表七：MRPC3b

MRPC 编号	CBM 编号	厚度 (mm)	平均电阻
蜂窝板	下		
	上		
PCB 板	下		
	中		
	上		
石墨电极	编号		
	平均电阻		
Kapton 膜			
玻璃			
鱼线	编号		

参加装配人员 (签名): 周健

玻璃清洗: 周健

Kapton 膜清洗: 周健

尼龙螺栓安装: 胡东标

厚度 (PCB to PCB):

厚度 (Total):

超净室条件:

装配负责人: 胡东标

备注:

CBM TOF

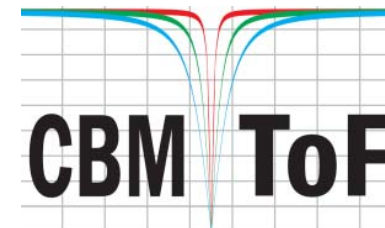
MRPC3b

制作工艺流程

2017.5.9 (V0)



Equipment



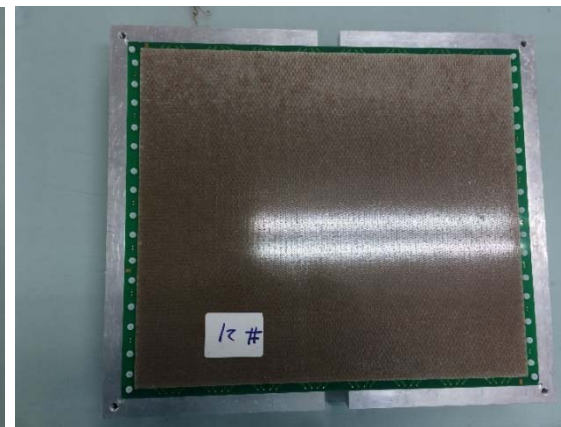
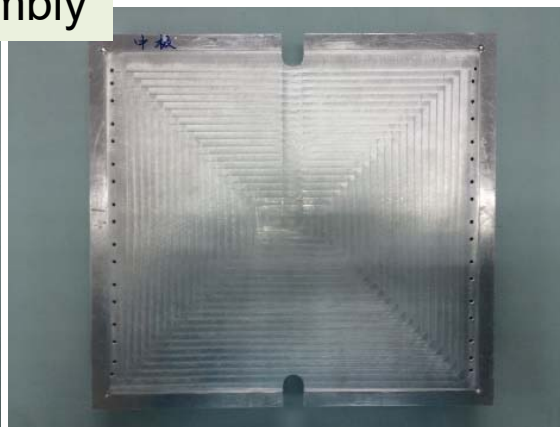
Clean room 100K



assembly desk

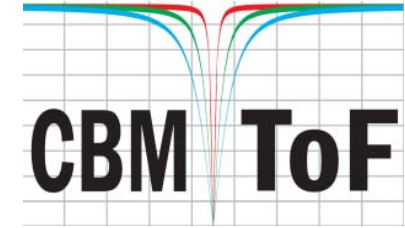


Tools for check & assembly

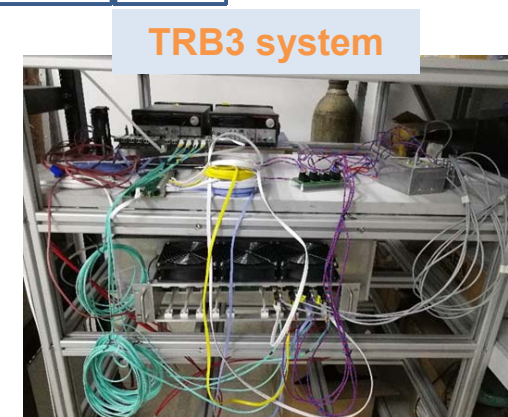
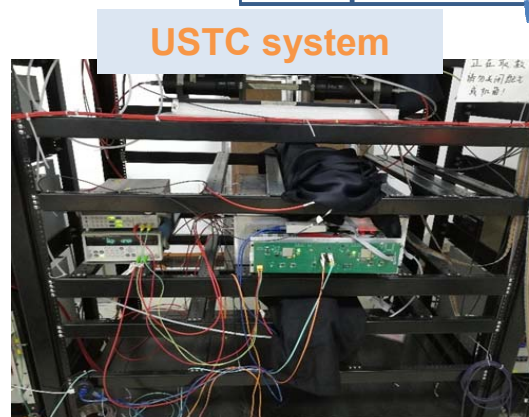
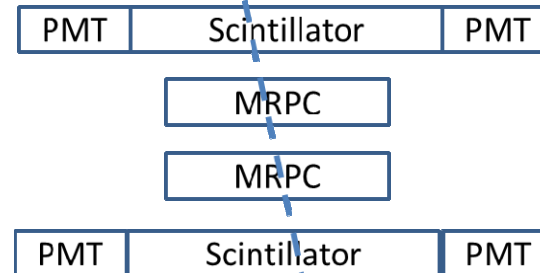
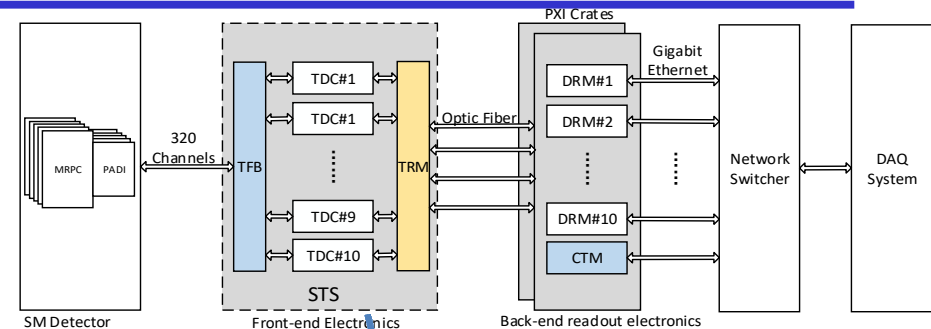




Performance check

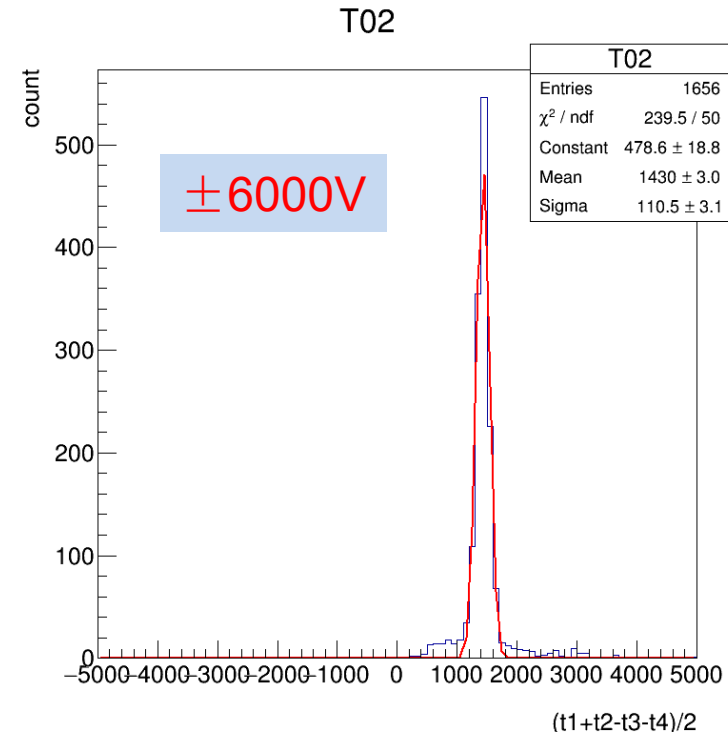
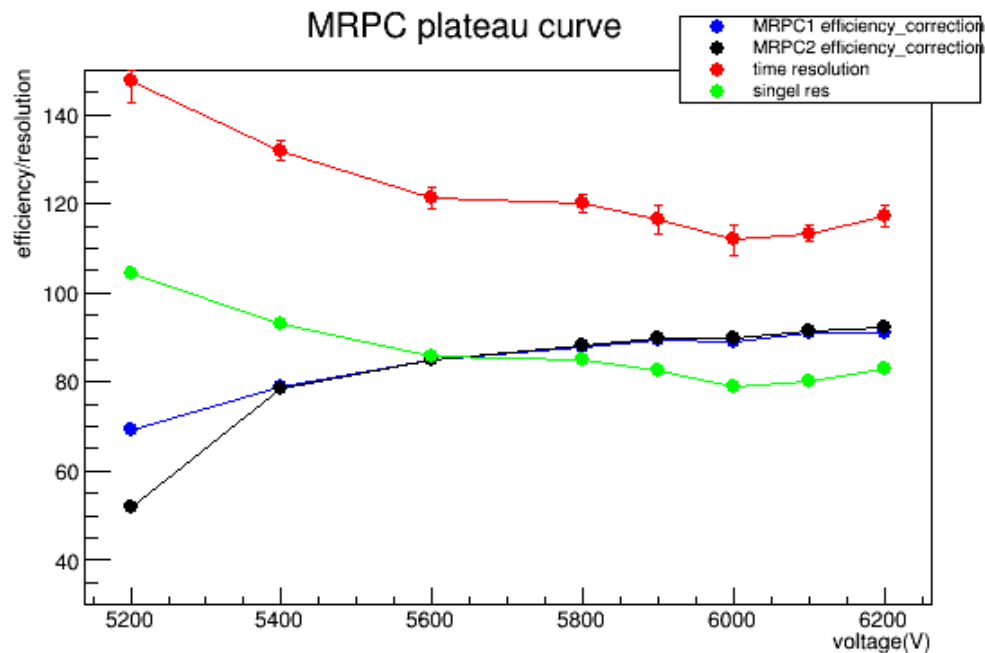
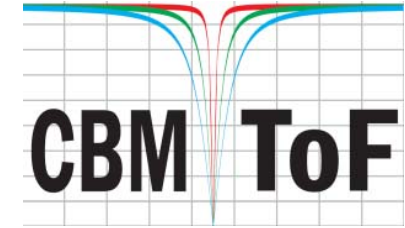


- Cosmic ray test to qualify the produced counters.
- A FPGA-based TDC and DAQ system have been setup by USTC electronics group and token data.
- Another TRB3 TDC and DAQ system is under installation.
- 4 + 4 counters test capability.
- Leak current, noise rate, efficiency, cluster size will be test for all counters.
- Time resolution tested for 1/5 counters.





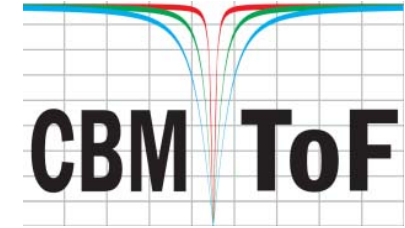
Preliminary results



- Set $\pm 6000V$ as the work voltage.
- Efficiency better than 91%.
- System time resolution $\sim 110\text{ps}$
- Single MRPC time resolution $\sim 78\text{ps}$.



Statues & Time line

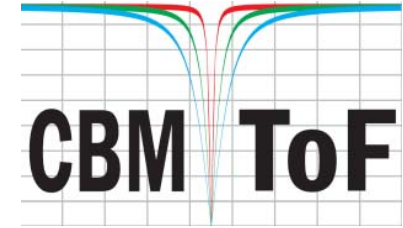


2018	J	F	M	A	M	J	J	A	S	O	N	D	J
R&D													
Counter component production													
Counter assembly		5	15	15	15	15	15						
Quality assurance		5	15	15	15	15	15						
MRPC shipment			20	15	15	15	15						

- 6 counters produced for 1st sector installation in Jan. 2018
- 80⁺ counters to be finished by the fall 2018 for STAR eTOF.
- Ensure the good and uniform quality & performance.



Summary



- MRPC3b, for the low rate region of CBM, has been investigated → Thin float glass as electrode and 50 Ω impedance achieved for the preferred double-stack structure.
- The design fixed for the mass production of STAR eTOF.
- The assembly procedures and QA&QC methods have been established.
- After the pre-mass production, 80 counters will be finished by the fall 2018.

Thank you!