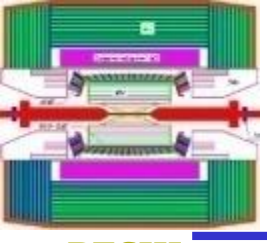


BESIII

MRPC detector for the upgrade of BESIII E-TOF

Rongxing Yang

University of Science and Technology of China

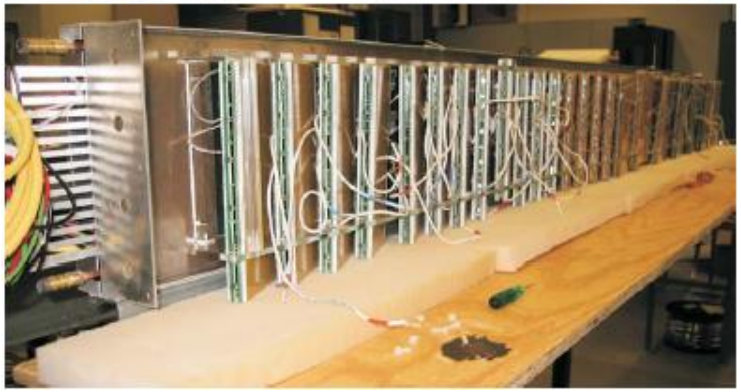
The Multi-gap Resistive Plate Chamber

BESIII

- The current BESIII E-TOF：EJ204 scintillator + R5924 PMT
  - μ: 110ps
  - e: 148ps
  - π: 138ps

→ average 1.0 GeV for 2σ π/K separation

MRPC technology has been used as TOF on LHC/ALICE, RHIC/STAR, etc.



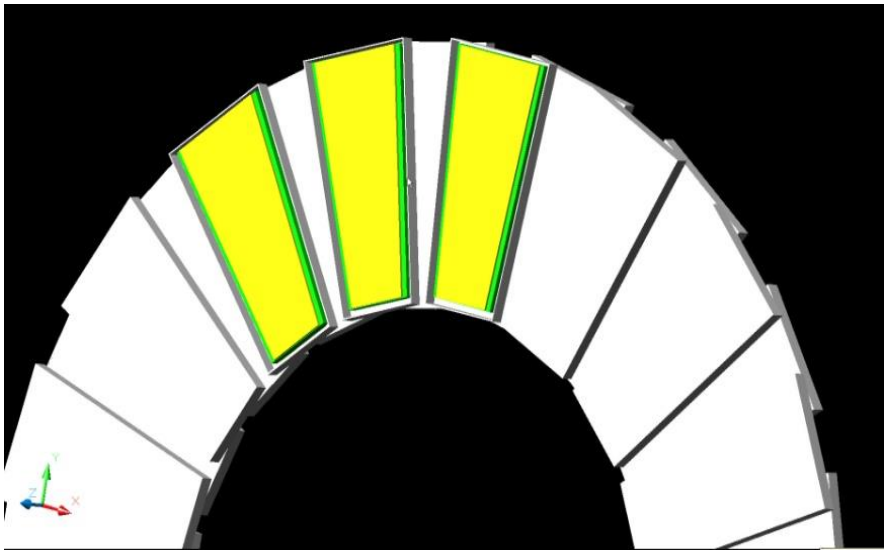
- Upgrade with MRPC
  - Higher granularity
  - Better time resolution：
    - **MRPC intrinsic: <55ps**
    - **Non-intrinsic: ~50ps**

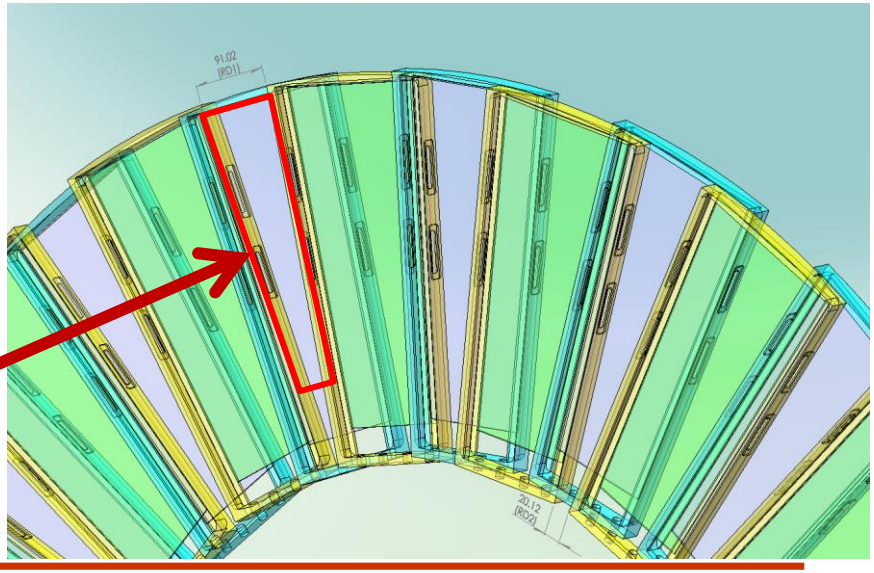
→ Total resolution <80ps

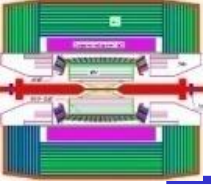
→ 1.4 GeV for 2σ π/K separation!

The design for BESIII E-TOF

- Each E-TOF ring:
  - 36 overlapping MRPCs
- MRPC modules:
  - sealed in gas-tight boxes
- Thickness of each box:
  - < 25 mm
- FEE boards:
  - between nearby boxes

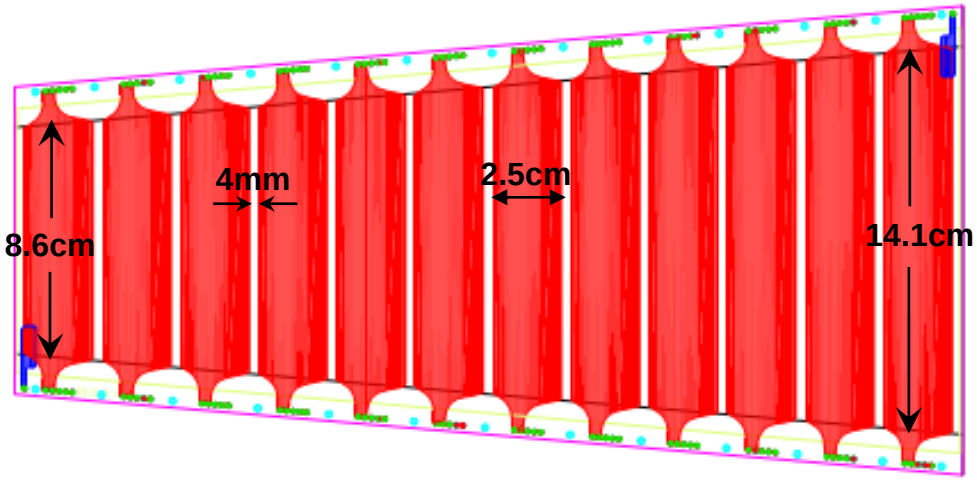




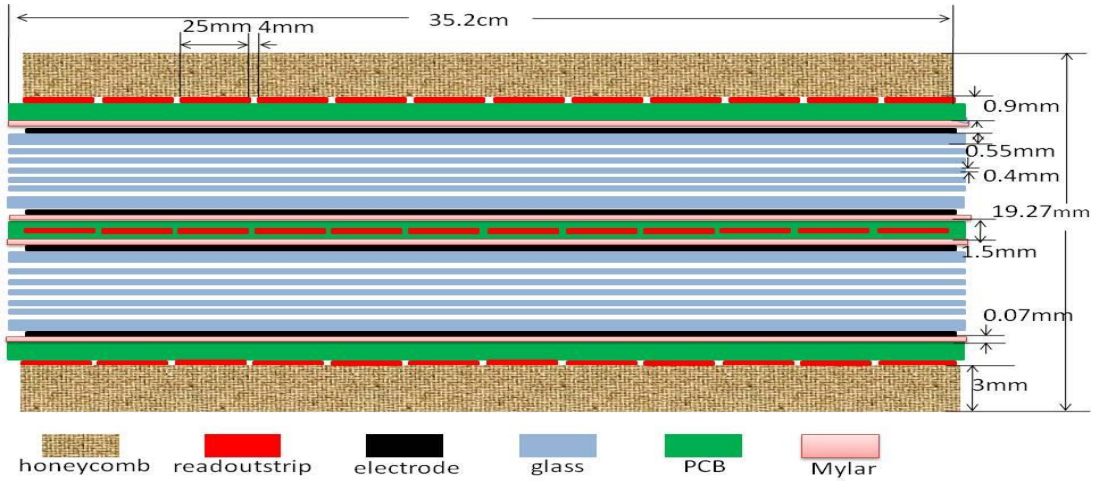


BESIII

Structure of the MRPC



- **Double-end readout strip:**
  - **Width: 2.5 cm**
  - **Length: 8.6-14.1 cm**
- **24 channels/module**
  - **➔ 24 x 36 x 2 = 1728**

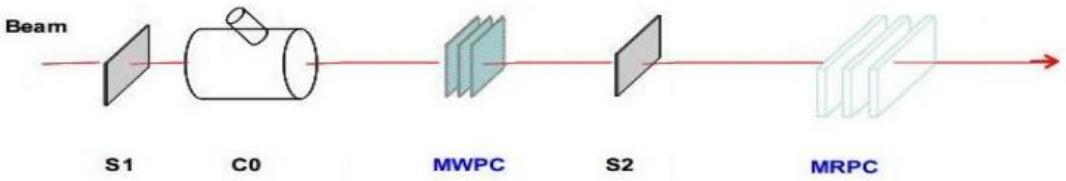


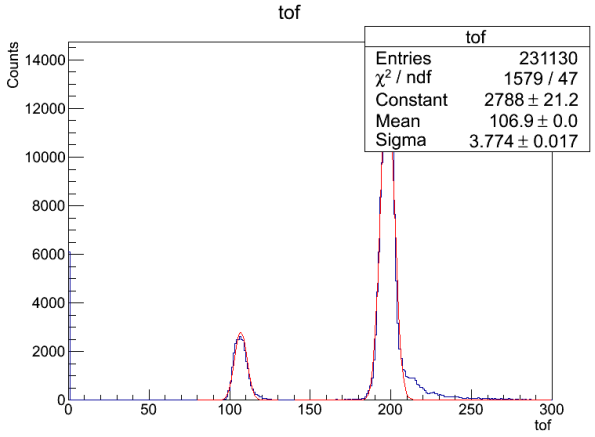
- **Gas gap: 2 x 6**
- **Gap size: 0.22 mm**
- **Resistive plate: floating glass**
- **Total thickness: ~20 mm**

Beam test specifications

BESIII

Beam test at E3@BEPC





- Secondary beam: pion + proton
- PID: flight time between S1 & S2

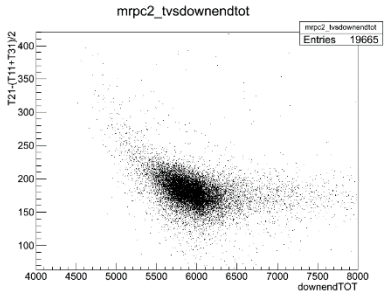
1. **Three MRPCs aligned along the beam and tested together.**
2. **Use MRPC as time reference (T0); Self-calibration method**
3. **Slewing correction by T-TOT**
4. **Analysis pion (MIP) and proton events at different momentum.**

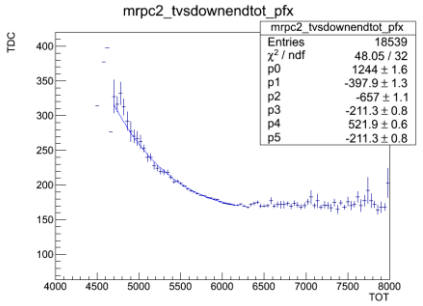
Slewing correction

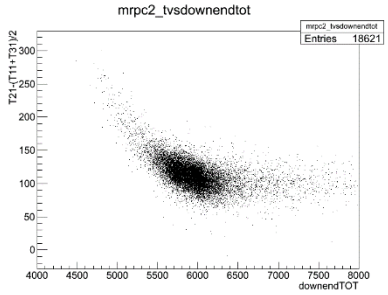
BESIII

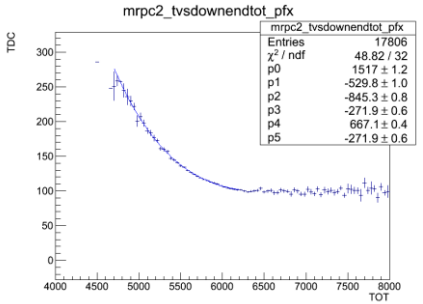
T-TOT slewing correction:

- Fit the T-TOT correlation for each MRPC. The reference time is the mean time of the other two MRPCs.
- Recycle these steps with the corrected time for 3-4 times.
- The time resolution of each MRPC achieved.

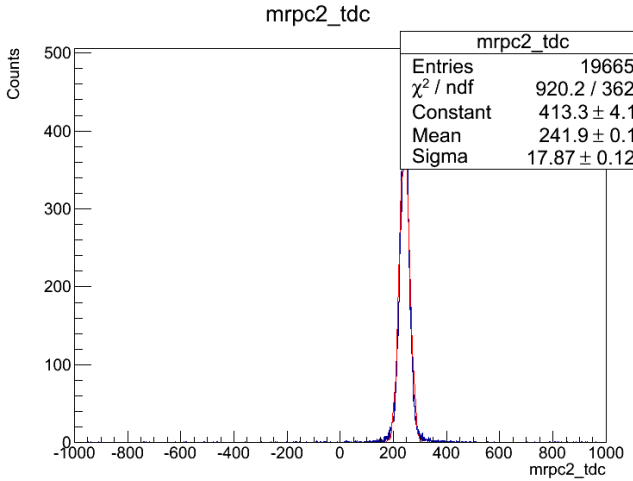


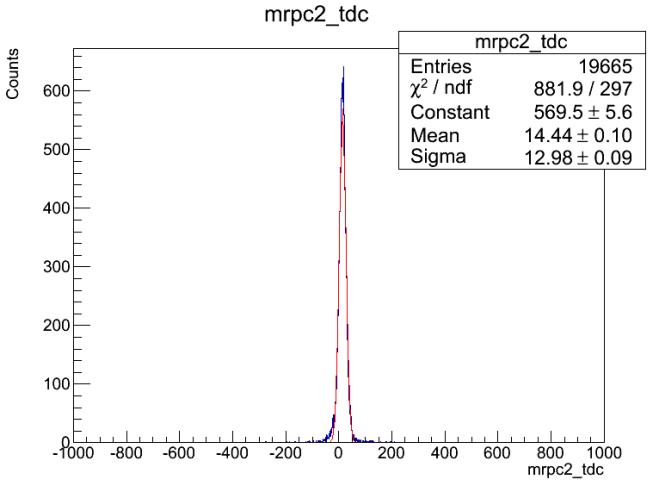


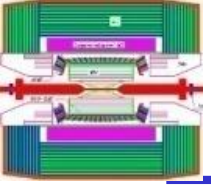




This method will be very helpful for the performance test in the mass production!







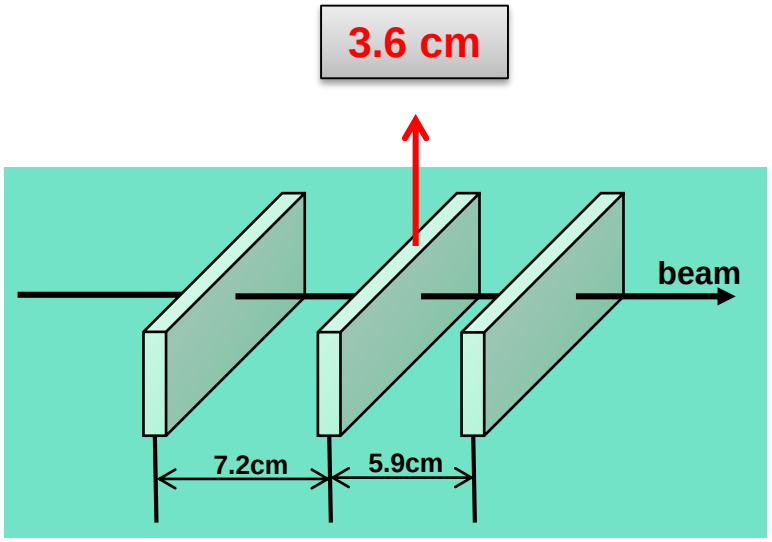
BESIII

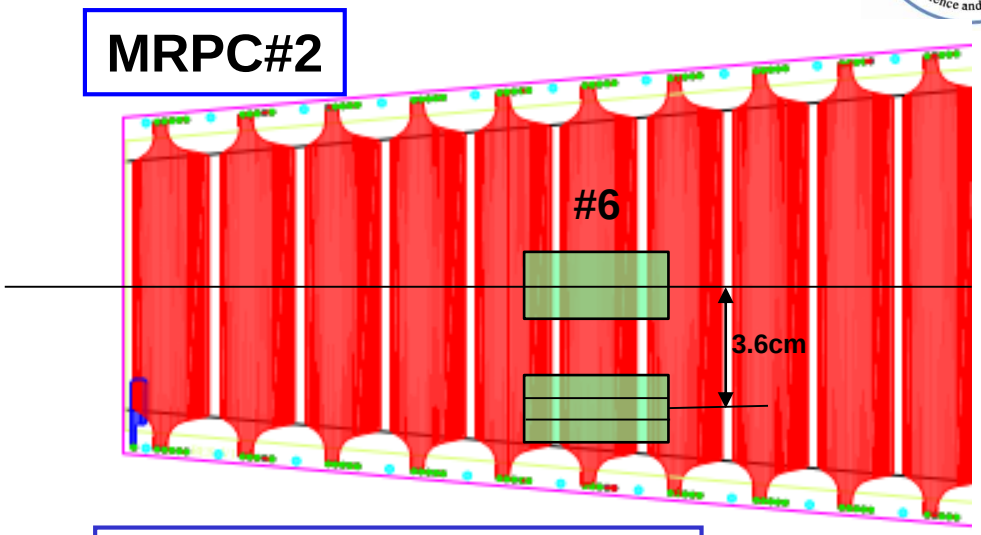
The test results

Momentum		500MeV	600MeV	800MeV
Pion sample	MRPC #1	56 ps	47 ps	45 ps
	MRPC #2	51 ps	48 ps	40 ps
	MRPC #3	46 ps	48 ps	45 ps
Proton sample	MRPC #1	29 ps	32 ps	36 ps
	MRPC #2	28 ps	30 ps	35 ps
	MRPC #3	31 ps	31 ps	35 ps

- **Unit: ps HV = ±7250 V stripID: #6**
- **Beam incident position: center of strip #6**
- **Time resolution:**
  - **Pion (MIP): ~50 ps**
  - **Proton: much better (higher dE/dx, More primary ionizations generate in the MRPC gas gaps)**

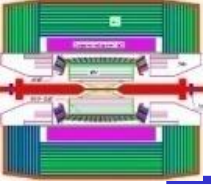
Performance dependence on position





Each trigger area can be divided into 3 regions.

MRPC#2 @600MeV	Strip center → Strip end					
Pion	48 ps			49 ps	49 ps	47 ps
Proton	29 ps	27 ps	26 ps	29 ps	31 ps	36 ps



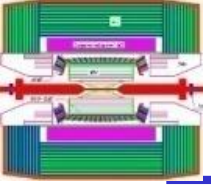
BESIII

Performance @ different HV

600MeV		7250V	7300V	7500V
Pion	M1	47	47	49
	M2	48	48	46
	M3	48	49	48
Proton	M1	32	33	34
	M2	30	29	30
	M3	31	32	32

(Unit: ps)

The stable performance benefits from the long plateau of MRPC.



BESIII

Summary

- Successfully design, built and test the MRPC prototype for BESIII ETOF.
  - 12 gas gap structure
  - double-end readout strips.
- The proposed performance achieved.
  - Time resolution ~50 ps for MIPs

  (including the custom designed electronics)
- The detector shows stable performance at different position & working HV.
- The systematic construction project has been approved and will start soon.

Thank you !