

Introduction of EMC in BESIII

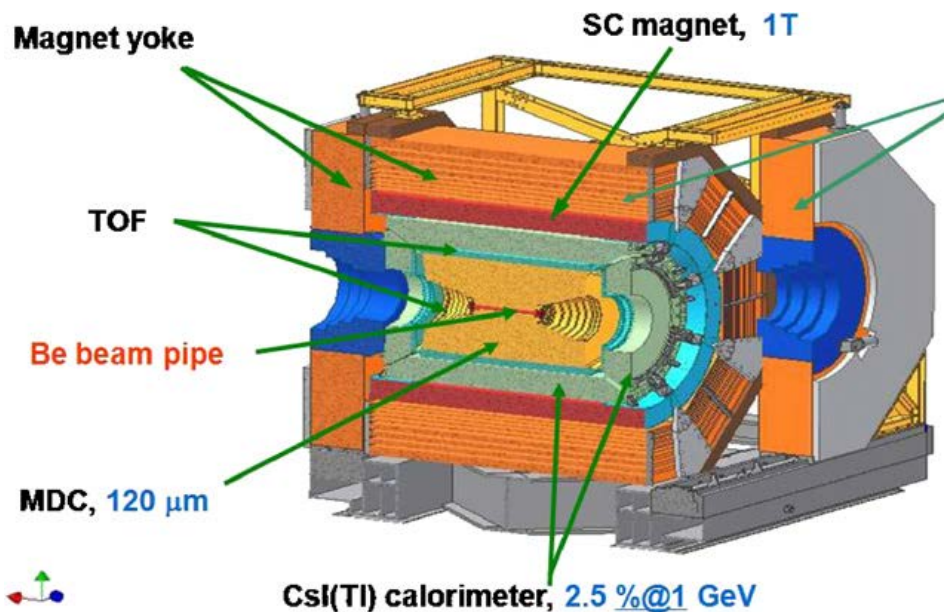
- BESIII detector
- EMC
 - Physics requirements
 - Specifications of EMC
 - Geometric parameters
 - CsI(Tl) scintillating crystals

Yuzhen Yang
2018.02.02

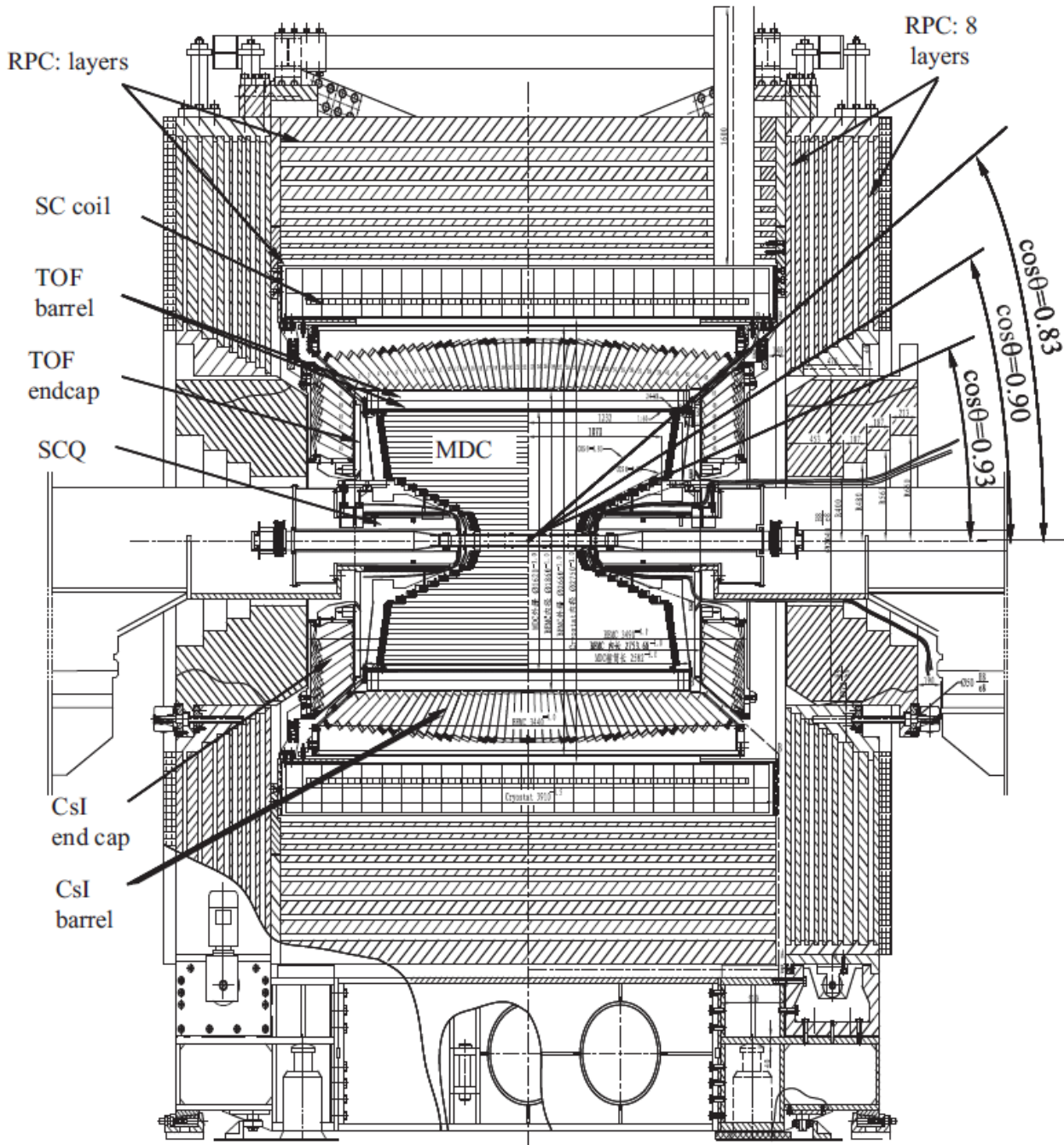
Special Topic

BESIII detector

The BESIII detector is designed to study physics in the τ -charm energy region, which uses the new high luminosity BEPCII double ring e^+e^- collider.



- ◆ MDC (Main Drift Chamber)
tracking and momentum measurements for charged particle
- ◆ TOF (Time of Flight)
particle identify
- ◆ EMC (Electromagnetic Calorimeter)
measure the energy EM showers by CsI(Tl) crystal calorimeter
- ◆ SCM (Superconducting Magnet)
superconducting solenoid magnet of 1T
- ◆ MUC (Muon Counter)
RPC based muon counter
- ◆ Trigger, DAQ, and so on.....



Subsystem	BESIII
MDC	
Single wire $\sigma_{r\phi}$ (μm)	130
$\sigma_{p/p}$ (1 GeV/c) (%)	0.5
σ (dE/dx) (%)	6
EMC	
σ_E/E (1 GeV) (%)	2.5
Position resolution (1 GeV) (cm)	0.6
TOF	
σ_T (ps)	
Barrel	100
End cap	110
Muon	
No. of layers (barrel/end cap)	9/8
Cut-off momentum (MeV/c)	0.4
Solenoid magnet field (T)	1.0
$\Delta Q/4\pi$	93%

EMC

Physics requirements

- ◆ High energy resolution and adequate position resolution
- ◆ Accurately reconstruct the invariant mass of π^0
- ◆ e/π separation

Specifications of EMC

- Energy range of electron or photon from ~ 20 MeV to ~ 2 GeV with energy resolution of 2.5% at 1 GeV and 4 MeV at 100 MeV.
- Photon hit position resolution $\sigma_{xy} \leq 6 \text{ mm} / \sqrt{E(\text{GeV})}$
- A good e/π separation

Geometric parameters of EMC

Parameter	Values
Crystal length	28 cm (15.1 X_0)
Typical front and rear sizes (cm × cm)	$5.2 \times 5.2 - 6.4 \times 6.4$
Number of ϕ -sectors	120
Barrel	
Number of θ -rings	44
Number of crystals	5280
Inner radius (cm)	94
θ -coverage	$\cos \theta < 0.82$
Total weight (tons)	21.56
End caps	
Number of θ -rings	6
Number of crystals	960
Distance to IP (cm)	± 138
Ring inner radius (cm)	88
Ring outer radius (cm)	110
θ -coverage	$0.83 < \cos \theta < 0.93$
Total weight (tons)	4.05

Parameter	BESIII
$\Delta\Omega/4\pi$ (%)	93
Active media	CsI(Tl)
Depth (X_0)	15
σ_E at 1 GeV (MeV)	~ 25
σ_E at 100 MeV (MeV)	3.3
Position resolution at 1 GeV/c (mm)	6

number of crystal: 44×120

CsI(Tl) scintillating crystals

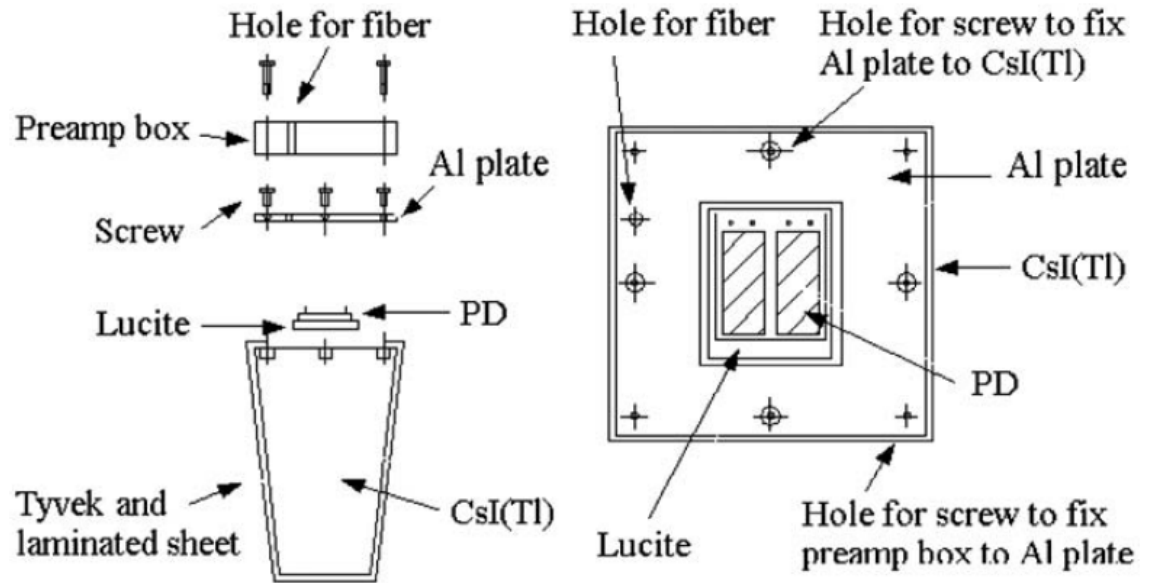
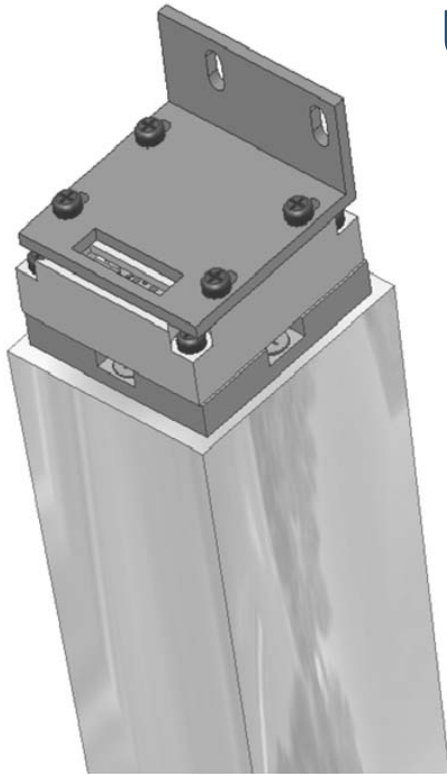
Why is thallium doped CsI(Tl) crystals?

Parameter	Values
Radiation length X_0	1.85 cm
Moliere radius	3.8 cm
Density	4.53 g/cm ³
Light yield (photodiode)	56,000 γ 's/MeV
Peak emission wavelength	560 nm
Signal decay time	680 ns (64%) 3.34 ms (36%)
Light yield temperature coefficient	0.3%/°C
dE/dx (per mip)	5.6 MeV/cm
Hygroscopic sensitivity	Slight

The high light yield of CsI(Tl), especially when read out by silicon photodiodes, is critical for high energy resolution of low energy photons.

EMC crystal unit

Using diode to read the signal.



The EMC crystal unit

Mechanical assembly of the crystal unit

Thank you!