Status and prospects for BESIII

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Outline

- **Introduction of BEPCII and BESIII**
- **Status and upgrade of BESIII detectors**

  focus on:

  the Main Drift Chamber (MDC);

  the Time Of Flight counter(TOF);

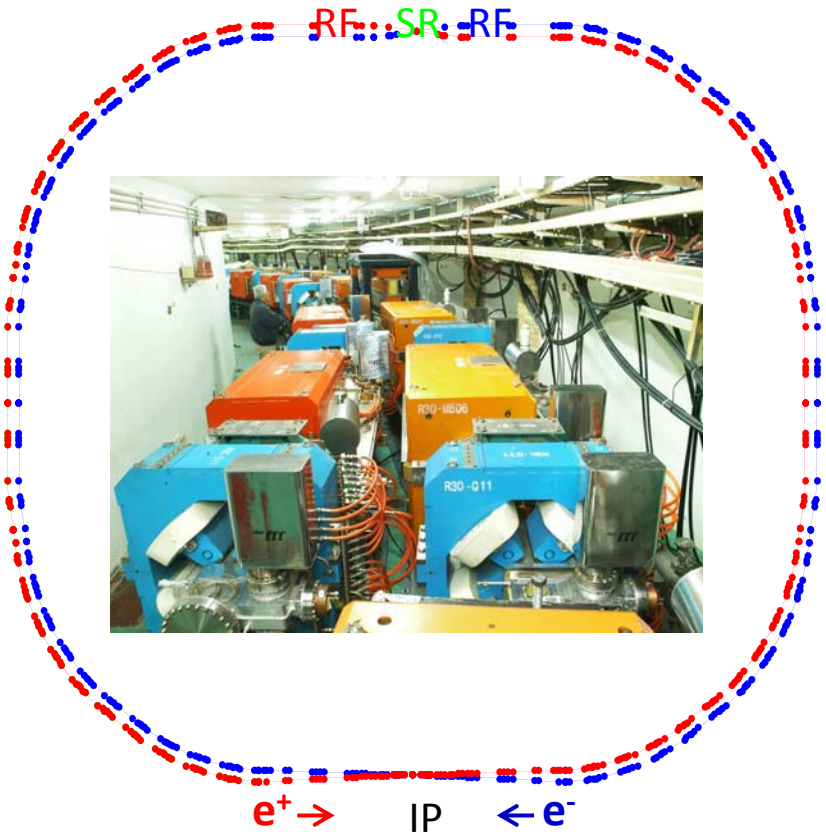
  generally on:

  the Electro-Magnetic Calorimeter (EMC);

  the Super-conducting Solenoid Magnet (SSC);

  the Muon Chamber (MUC);
- **Summary**

The Tau-Charm physics collider: BEPCII



A high luminosity, double ring e^-e^+ collider:

- **Beam energy:** 1.0-2.3 GeV
- **Design Luminosity:** 1×10^{33} $cm^{-2}s^{-1}$
- **Optimum energy:** 1.89 GeV
- **Energy spread:** 5.16×10^{-4}
- **No. of bunches:** 93
- **Micro β_y^*:** 1.5 cm
- **Total current:** 0.91 A
- **SR mode:** 0.25A @ 2.5 GeV
- **Large cross angle:** 22 mrad

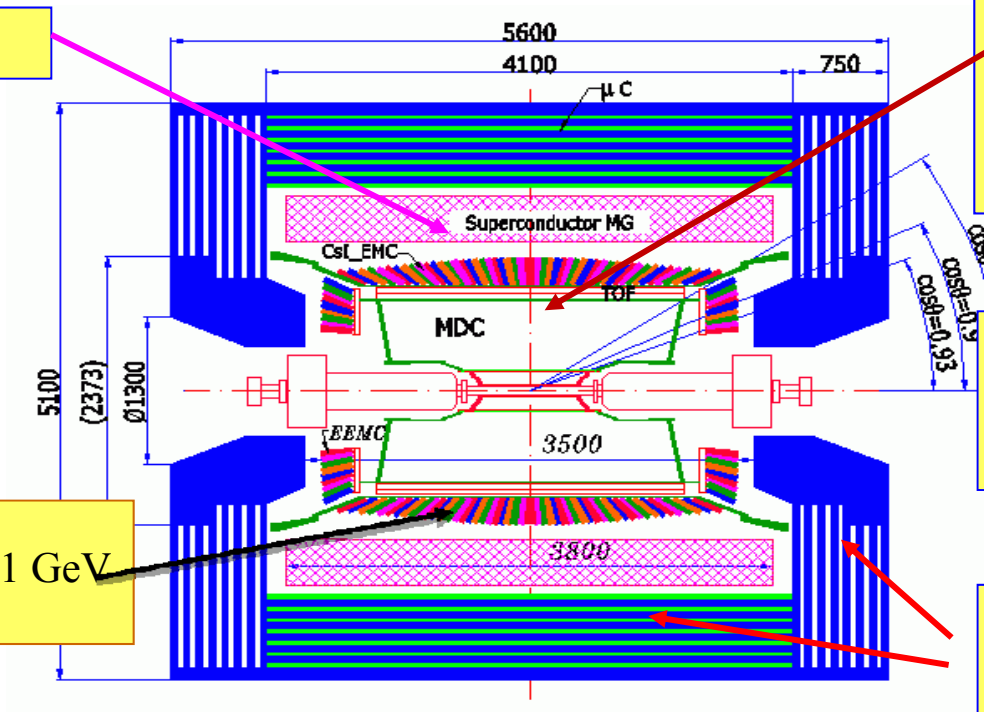
A record peak lumi. $L_{peak} = 7.08\times10^{32}\ cm^{-2}s^{-1}$ @1.89GeV recently; Running in its high energy marginal region (~2.3GeV) to explore the new physics;

BESIII@BEPCII

High performance spectrometer adapt to high lumi. BEPCII:

- **Consisting of five complicated subsystems/detectors**
  MDC, TOF, EMC, SSM and MUC
- **Running stably since 2009 data taking**

SSM: 1T



MDC:
σ_{xy}=130 μm
σ_p/p = 0.5% @1GeV
dE/dx=6%

TOF:
σ_T = 100ps Barrel
110ps Endcap

EMC(CsI)
ΔE/E = 2.5% @1 GeV
σz = 0.6 cm/√E

Muon chamber:
9 layers RPC
8 layers for endcap

- **in following the status and upgrade of each detector will be presented.**

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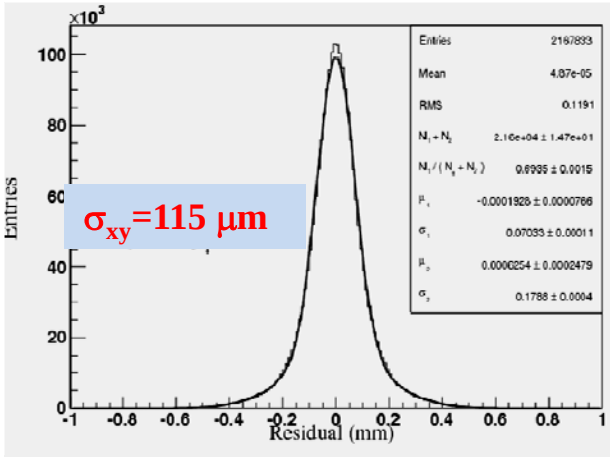
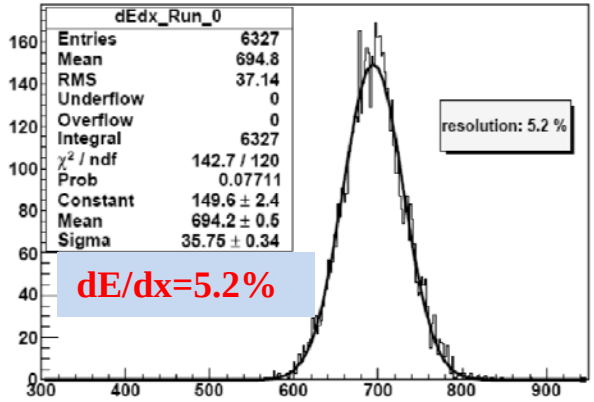
  the Muon Chamber (MuC);
- Summary & Future

MDC Performance overview

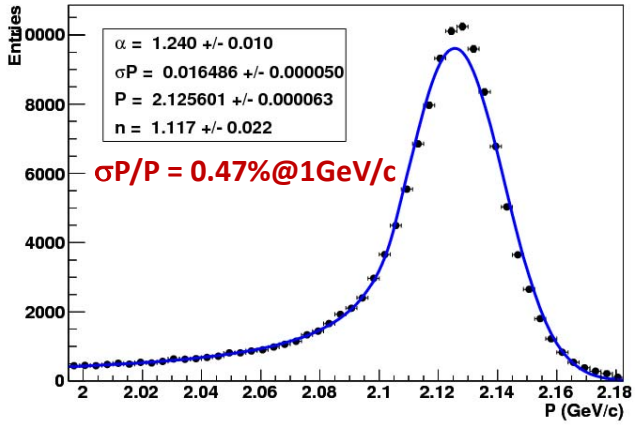
- **Works stably since 2009, currently reaching its best performance over the years**

- Spatial resolution:
  σ_{xy}=115 μm over all layers
  (design value: 130 μm)





- Momentum resolution:
  σ_p/p = 0.47% @1GeV
  (design : 0.5% @1GeV)

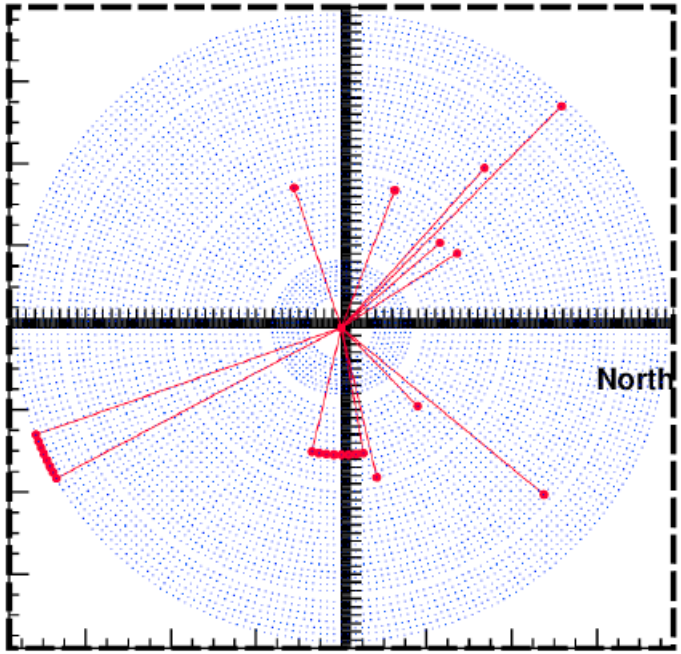


- Energy loss resolution:
  dE/dx=5.2% (design: 6~7%)

Status of MDC hardware

- No any wire broken so far, very good quality.
- Total 22 dead channels (~0.3%), most of them are preamplifier problems.

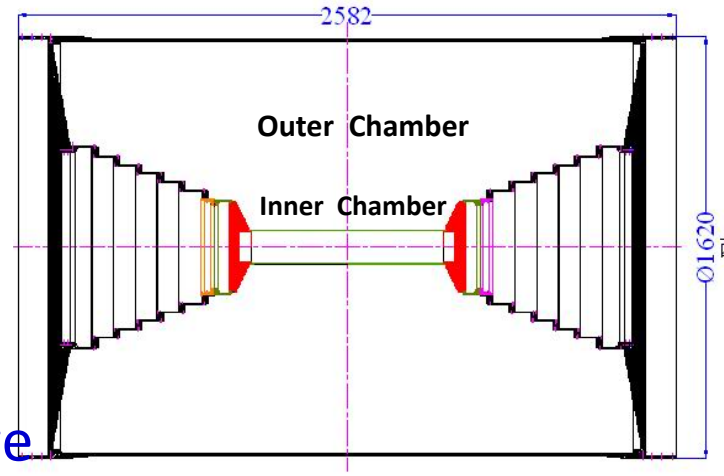
No. of sense wires	Preamp.	Date	Problems
43S21-1~8 （S43-161~168）	W43-21	2010.3.23	Preamplifier discharge
16S11-1~8 （S16-81~88）	E16-11	2010.6.16	Preamplifier discharge
17S2-5 （S17-13）	W17-2	2009.5.14	preamplifier dead
20S14-7 （S20-111）	E20-14	2010.1.12	Preamplifier dead
28S4-1 （S28-25）	E28-4		Preamplifier dead
42S5-6 （S42-38）	E42-5	2007	wire short to ground
13S11-8（S13-88）	W13-11	2012.3.23	Preamplifier dead
16S2-6（S16-14）	E16-2	2012.3.23	Preamplifier dead



to reduce the impacts of dead channels to neighboring cells, calibrating the x-t relation individually for those cells.

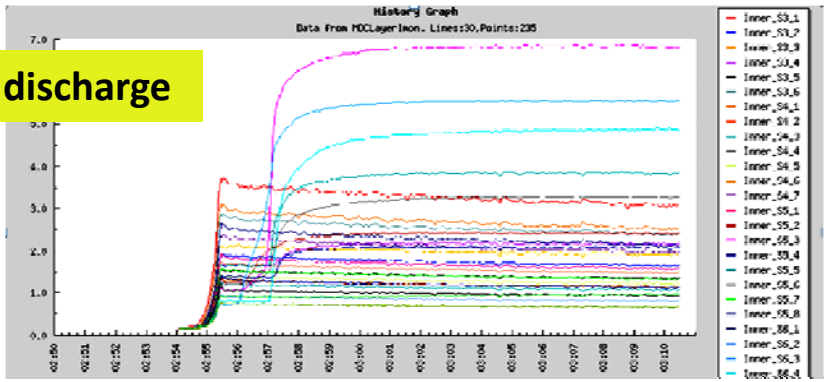
- MDC other systems, such as high voltage, operating gas and gas monitor have no problems

MDC Aging

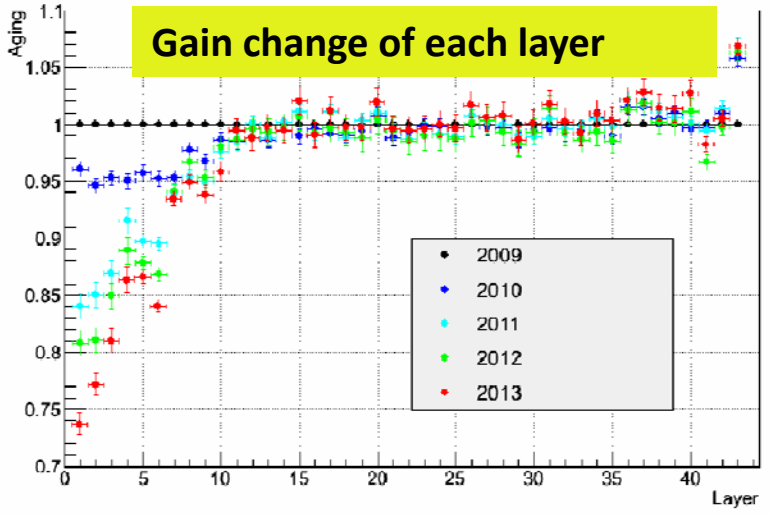


However, the inner drift chamber suffered from high beam related background most of the time, appearing aging effect now:

- Cathode (field) wire aging- Malter discharge
  - Many cells in inner MDC drawn large current (6~7 times larger than normal)
  - Adding ~2000ppm water vapor into the gases solved this problem



- Anode (sense) wire aging- gain drop
  - Compared with 2009, now the gas gains of first 5 layers decrease about 26% -14%
  - The gains of the first 10 layers have an obvious decrease
  - The gains of the outer chamber have no obvious change



MDC upgrade plan

So far only the upgrade of inner drift chamber(inner MDC) is considered, no concerns from outer MDC given its good performance:

Three proposals ever considered in the past several years:

- A new inner drift chamber;
- A Cylindrical-GEM (C-GEM);
- A pixel inner tracker;

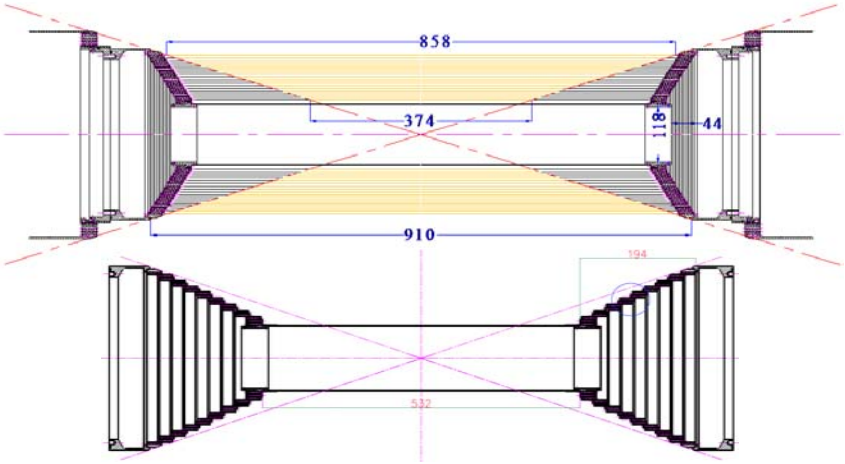
Now the situation a bit clear:

- **Short-term upgrade plan:** a new inner MDC will replace the old one in summer, 2015. Project approved by CAS (~3.6 M rmb);
- **Longer-term upgrade plan :** a 3-layer C-GEMs will be ready in 2017, the chamber can by replaced by 2017 or 2018;
- Other plan: a pixel inner tracker still being the option but need more R&D effort;

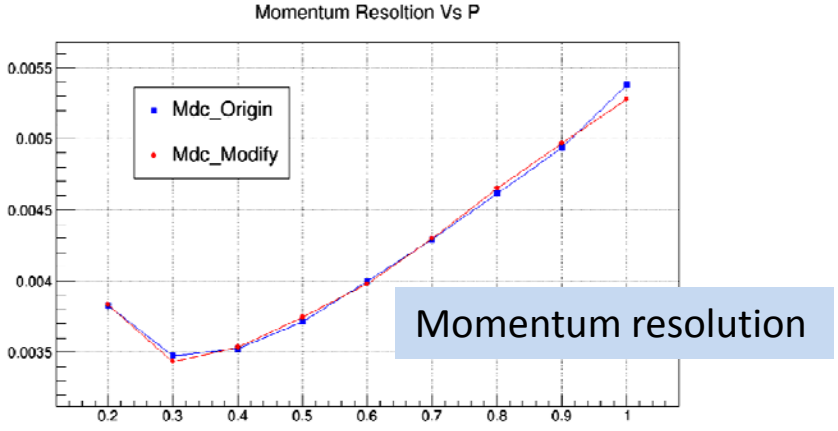
the new inner chamber

- **A new feature:** **Shorten the ineffective wire length to reduce the counting rate, >30% reduction for 1st layer**

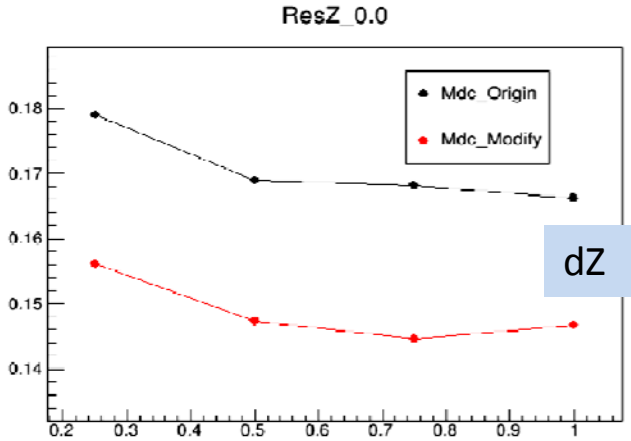
Wire Layer	Current wire length (cm)	Wire length after shorten (cm)	Counting rate Reduction
#1	78.0	53.8	—31%
# 2	79.2	58.0	—27%
#3	80.4	62.2	—23%
#4	81.6	66.4	—19%
#5	82.8	70.6	—15%
#6	84.0	74.8	—11%
#7	85.2	79.0	—7%
#8	86.4	83.2	—4%



- **Simulation show similar performance to the current one but with better Z resolution**



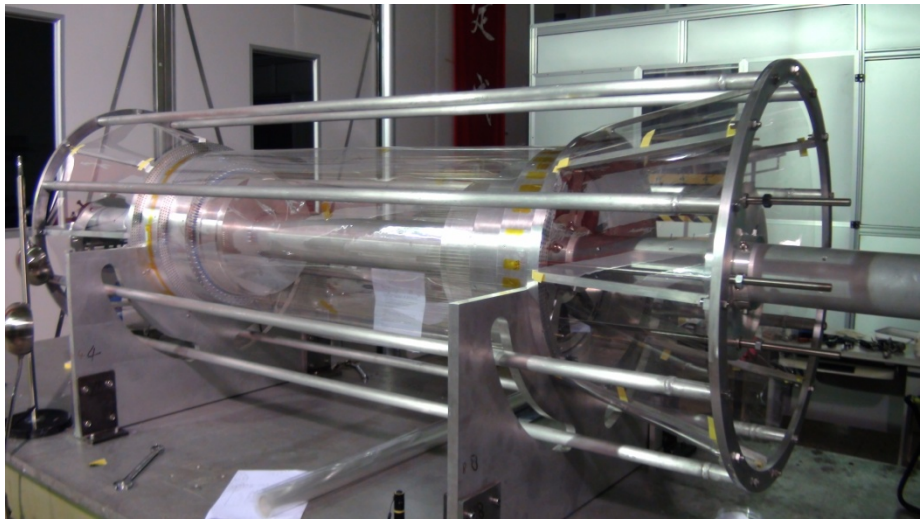
Momentum resolution



dZ

status and plan of the new chamber

- Prototype study on mechanical removing and installation of the chamber finished in May 2013. conclusion: positive.
- Fabrication of the new feed-throughs finished in July, 2013: 7000 feed-throughs produced and tested;
- Inner cylinders currently under machining, will be ready in Sep. 2013
- Chamber endplates in machining, will be ready by October, 2013
- Wire stringing will start from November, 2013
- cosmic-ray test will start from Jan. 2014 ,
- The new chamber will be ready in April. 2014

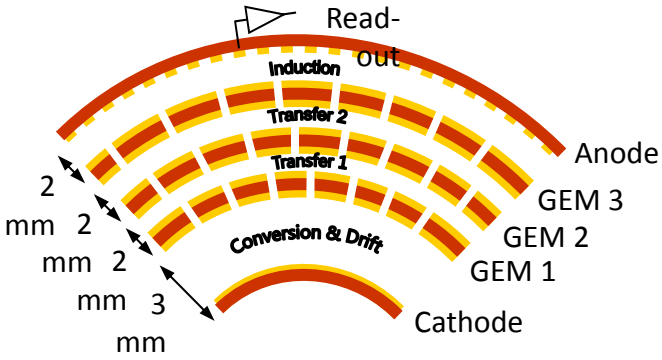


Removing and installation Prototype

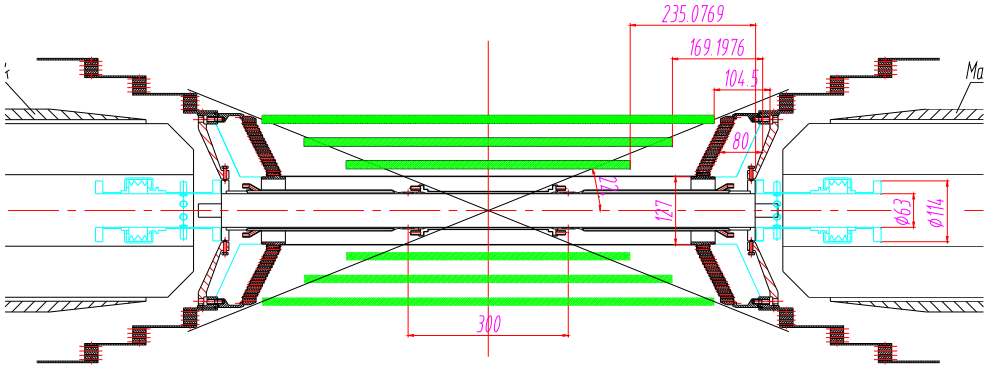
The prototype of a new chamber

The Cylindrical-GEM

- Proposed by BESIII Italy group : a 3-layer C-GEM foils to build up a inner tracker (IT): a KlOE2-like IT

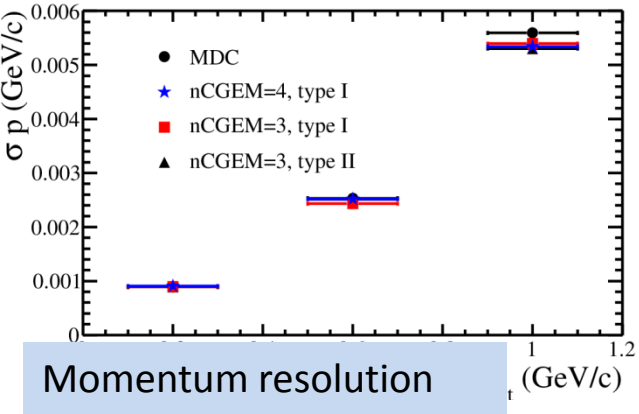


Conceptual view of the C-GEM

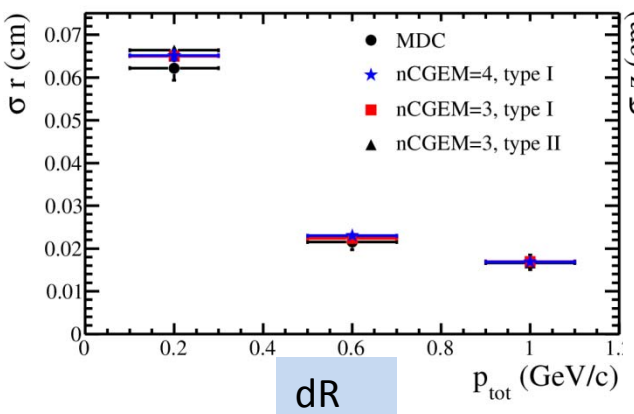


Schematic view of the C-GEM

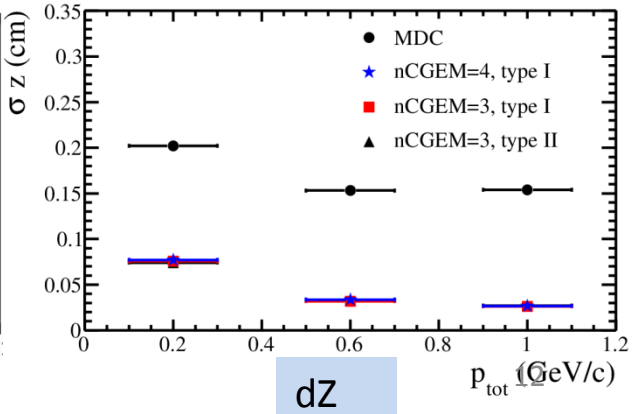
- Simulation shows comparable dR resolution and momentum resolution, and improved dZ resolution than the current chamber;



Momentum resolution



dR



dZ

Status and plan of C-GEM

- Funding:

  a 360 k€ budget over a period of 3 years already co-funded by Italy and China.

- **Roadmap:**
  - 2013
    - start R&D program (cosmic setup, simulations)
    - write a Letter of Intent (LOI)
  - 2014
    - build prototype with IT middle layer layout
  - 2015
    - Prototype test and validation
    - TDR
    - IT design and material procurement
  - 2016
    - start IT construction
  - 2017
    - complete IT, test and validation

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TOF Status

- Barrel TOF, time resolution better than 70ps, efficiency larger than 96% most of the years

Year(data)	Time resolution	Efficiency\%	Status
2009(jpsi/psip)	67ps	~97	The HV config of PMT is the same during the 3 years
2010(psi3770)	70ps	~96	
2011(psi3770)	70ps	~94	
2012(psip/jpsi)	67ps	~97	The HV of PMTs are adjusted due to efficiency loss
2013(4260/4360)	68ps	~96	

- For endcap TOF, the performance is more affected by noise and background. The time resolution of Bhabha changes from 130~190ps in different years.

  Need a upgrade.

Abnormal channels since 2009

- Currently totally 3 dead channels, 2 from barrel and 1 from end-cap;

Channel ID	Problems	Year	Status
BOE65	Dead	2009	Repaired
EW48, EE36	Lower gain	2011	Repaired
BOW61	Dead	2012	-
EW20	Dead	2013	-
BIW20	Dead	2013	-

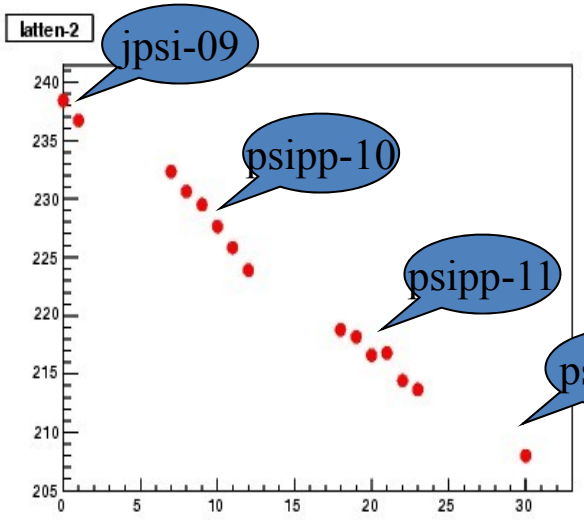
  - EW20 will be fixed in this summer;
  - The two barrel channels will be repaired later in summer, 2015 during ETOF upgrade.
  - No significant affect on the performance due to double-readout, still reaching 85ps resolution for those channels.

Barrel(B)TOF: two layers with double-readout; 88 scintillators for each layer
Endcap(E)TOF: one layer with single-readout; 48 scintillators for each part

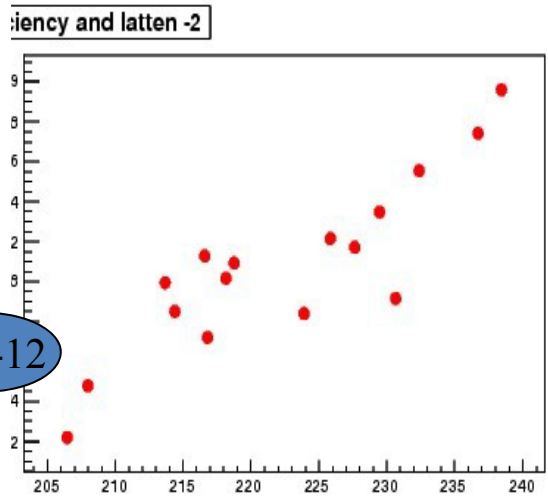
TOF Aging Effect

The attenuation length and light yield decreased versus time.

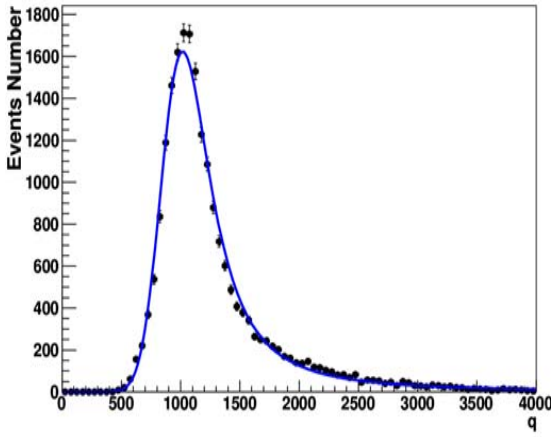
- The average decreasing rate of attenuation length is 4.3% per year.
- The efficiency decrease with the attenuation length decreasing.
- The change of time resolution is not observed with attenuation length decreasing.
- The average attenuation-rate of light yield is 0.49% per year.



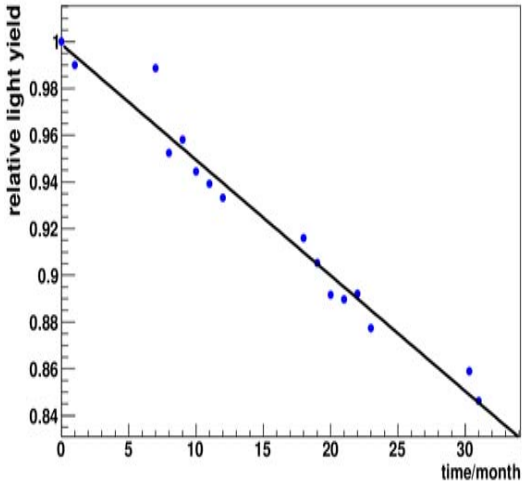
Attenuation length



Efficiency vs Attenuation length



Corrected QTC



Normalized corrected MPV of QTC vs time

The upgrade of ETOF

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

  → average 1.0 GeV for 2σ π/K separation

  Possible reasons:
  - **Scattering effect**
  - **Multi-hit**
  - **Tracking**
- 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 ETOF

- Each ETOF ring:

  36 overlapping MRPCs

- MRPC modules:

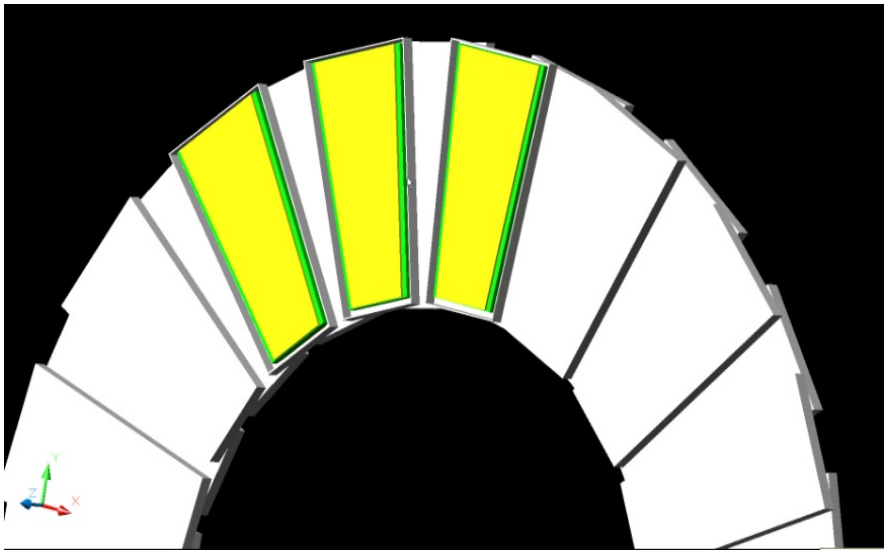
  sealed in gas-tight boxes

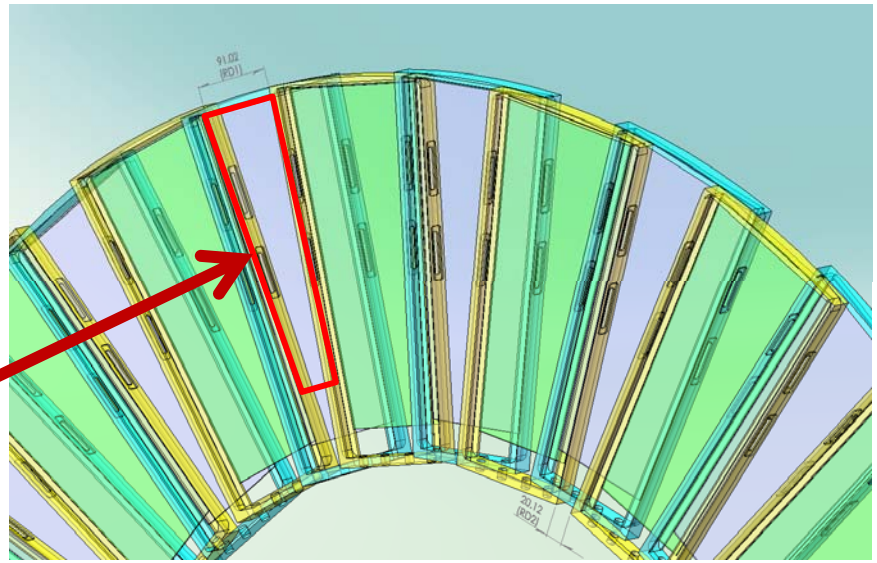
- Thickness of each box:

  < 25 mm

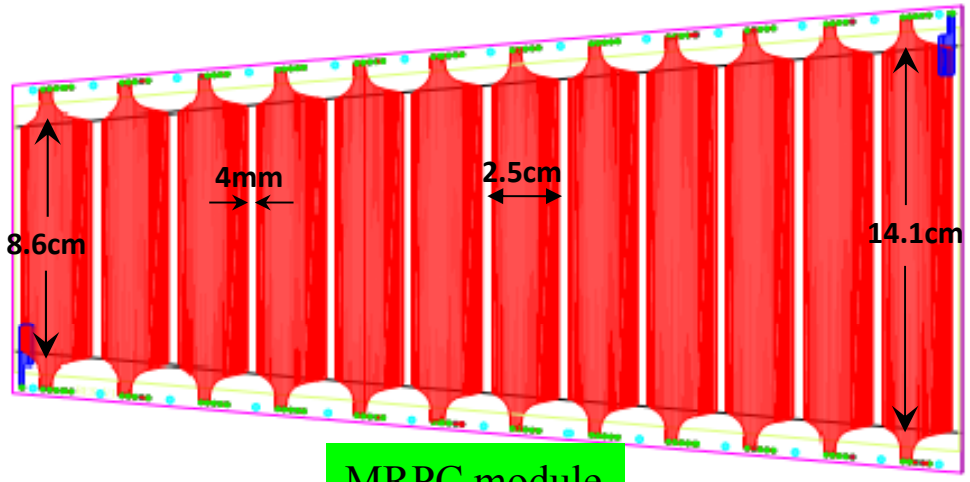
- FEE boards:

  between nearby boxes





Structure of the MRPC

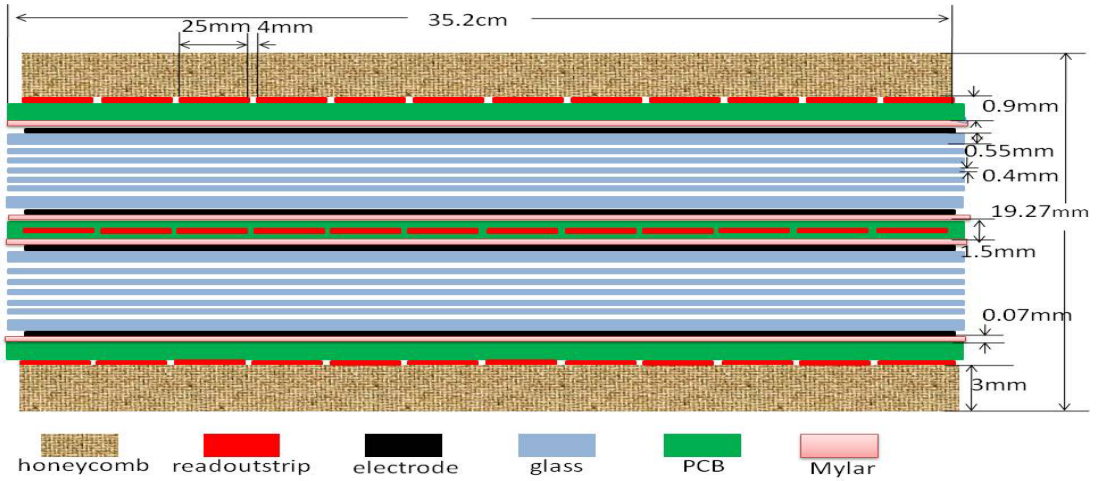


MRPC module

Readout strip:

- Width: 2.5 cm
- Length: 8.6-14.1 cm

24 channels / module ➔
24 x 36 x 2 = 1728

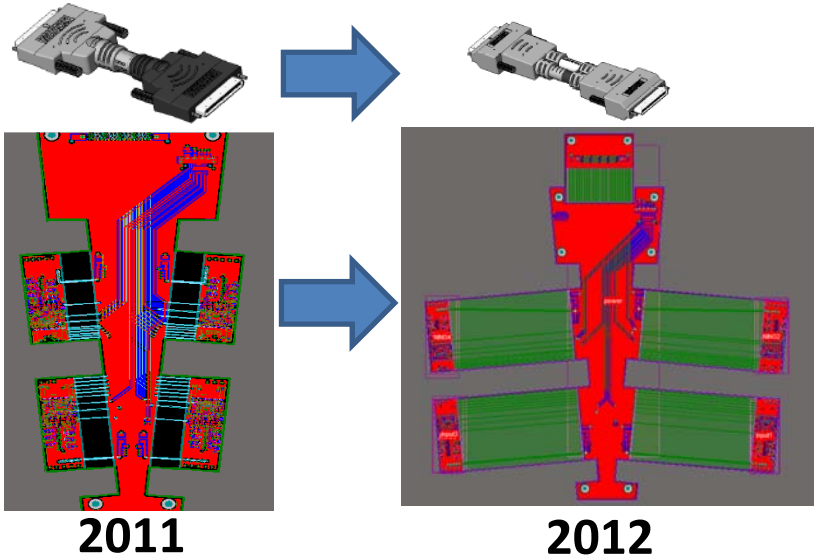


MRPC layout

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

New electronics

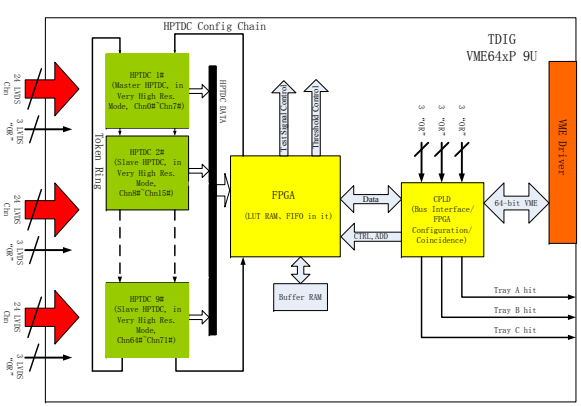
- FEE board
  - ✓Based on the NINO ASIC
  - ✓Differential input
  - ✓LVDS output
  - ✓Charge-TOT conversion
  - ✓Time jitter: ~10 ps
  - ✓Each board deals with *one* MRPC
  - ✓Better connectors



2011 2012

Front-end Elec.

- Far-end electronics
  - ✓Based on the HPTDC chips
  - ✓Leading-&.Trailing-edge recording
  - ✓72 channels / VME 9U module



Far-end Elec.

The schedule of TOF upgrade

- 01/2010: Got the 2.4M RMB support for pre-research
- 11/2012: Funding application is approved by CAS for the upgrade, ~12M RMB budget.
- 10/2013: Design review(1)
- 11/2013- 05/2014: The test of prototype
- 06/2014: Design review(2)
- 09/2014 - 06/2015: Mass production and test
- **07/2015 - 09/2015: Installation**

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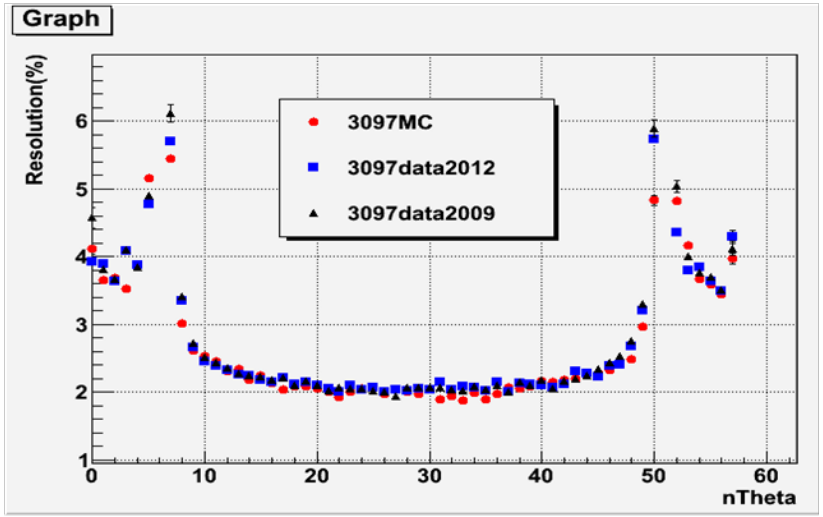
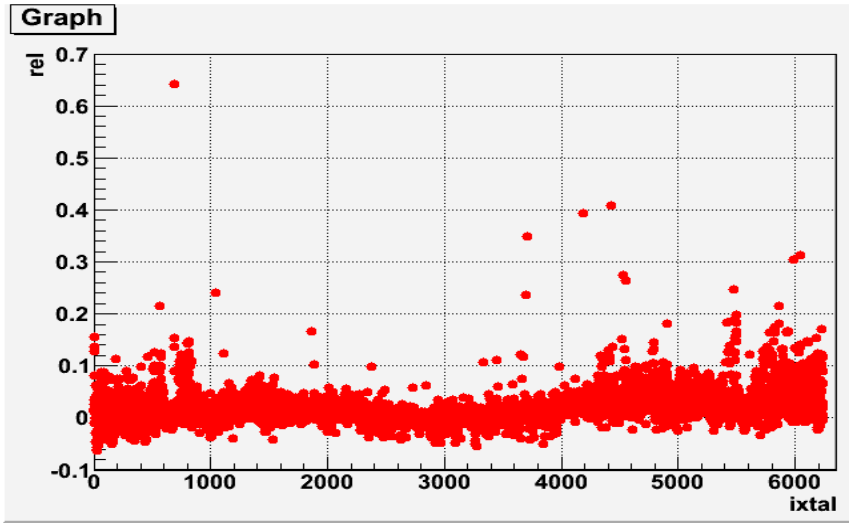
The Performance of EMC



Energy resolution of crystals by BhaBha at 1.5GeV



Relative decrease of light output by BhaBha Calibration

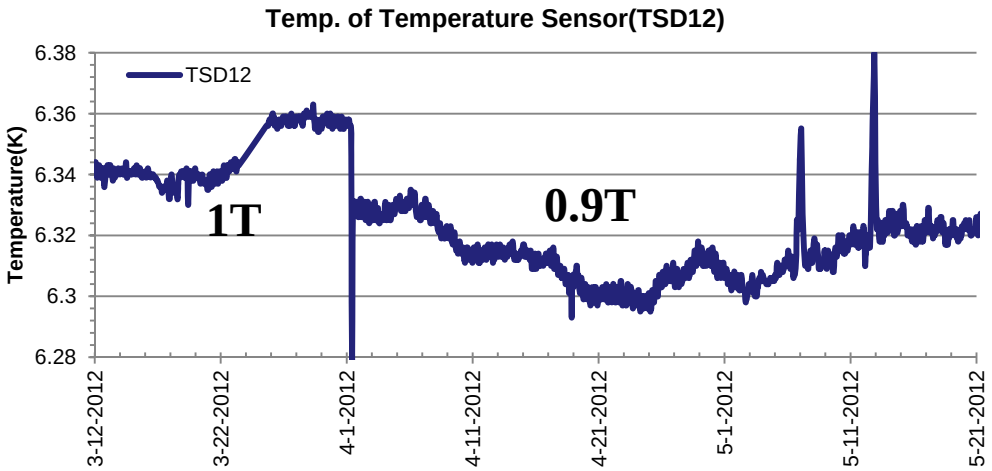
The performance of EMC is very good during the past five years:

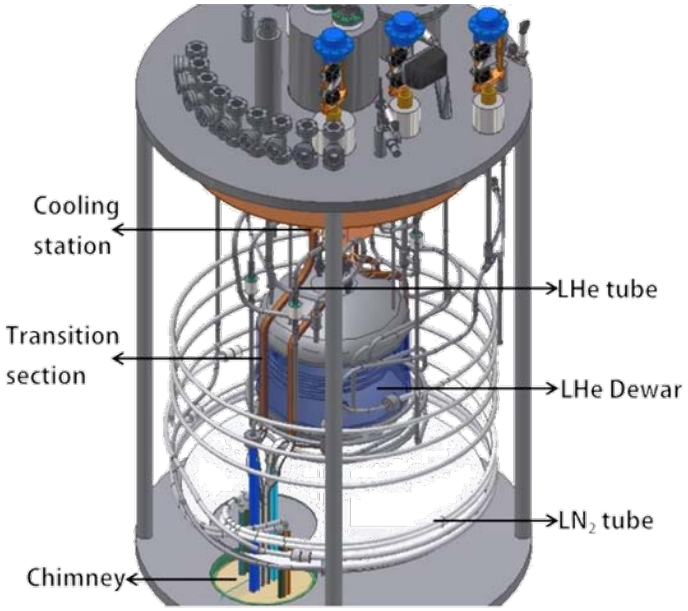
- Until now, there is no dead channel;
- The energy resolution of most crystals keeps unchanged:
- and for most crystals , the light outputs are not distinctly decreased:
  32 out of 6240 crystal decrease by 15%;
  12 out of 6240 crystal decrease by 20%;

So no reason that the EMC needs a upgrade in near future

Status of SSM

- Running in 1 Tesla most of the time
- From Feb. 2012, the temperature of the current leads transition section raised obviously, then SSM shifted to 0.9Tesla for safety for the remained running in 2012





- during 2013 data taking, the magnetic field back to 1.0T again and the temperature is stable

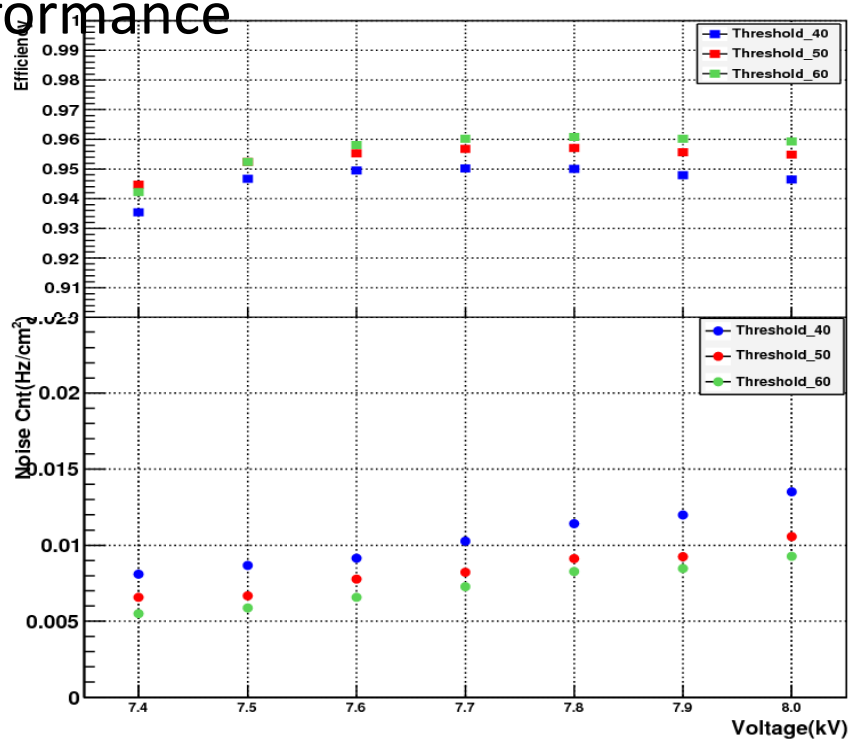
A backup Valve box will be built in one year.

Status of Muon chamber

- Major upgrade have already been done during summers of 2011 and 2012 for its front-end readout electronics (FECs)

- the Muon chamber now works stably, and the RPC HV decrease from 7.7k to 7.5k to protect the chamber and electronic without deteriorating the performance

- The efficiency reached to >95% at 7.5kV
- No affect in spatial resolution for HV reduction
- The noise level is less than 0.01Hz/cm2, no influence for tracking.



Summary

- A overview of the BESIII sub-detectors have been given, and currently BESIII work normally and smoothly;

- Two major upgrade already approved for MDC and TOF:
  - MDC had a short-term inner MDC upgrade plan (replaced by new inner drift chamber) in summer, 2015, and a longer-term upgrade plan (replaced by Cylindrical GEM) in 2017 or 2018.

    currently both upgrade activities are undergoing.
  - TOF had a ETOF upgrade plan with MRPC in summer, 2015, currently the work progress well.

- For others sub-detectors (EMC, SSM, MUC), it seems no major upgrade needed in near future, longer-term upgrade will be started to consider;

- We expect the BESIII can still work for 8-10 years from now.

Thank you
for your attention!