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Requirements for a CGEM IT at BESIII

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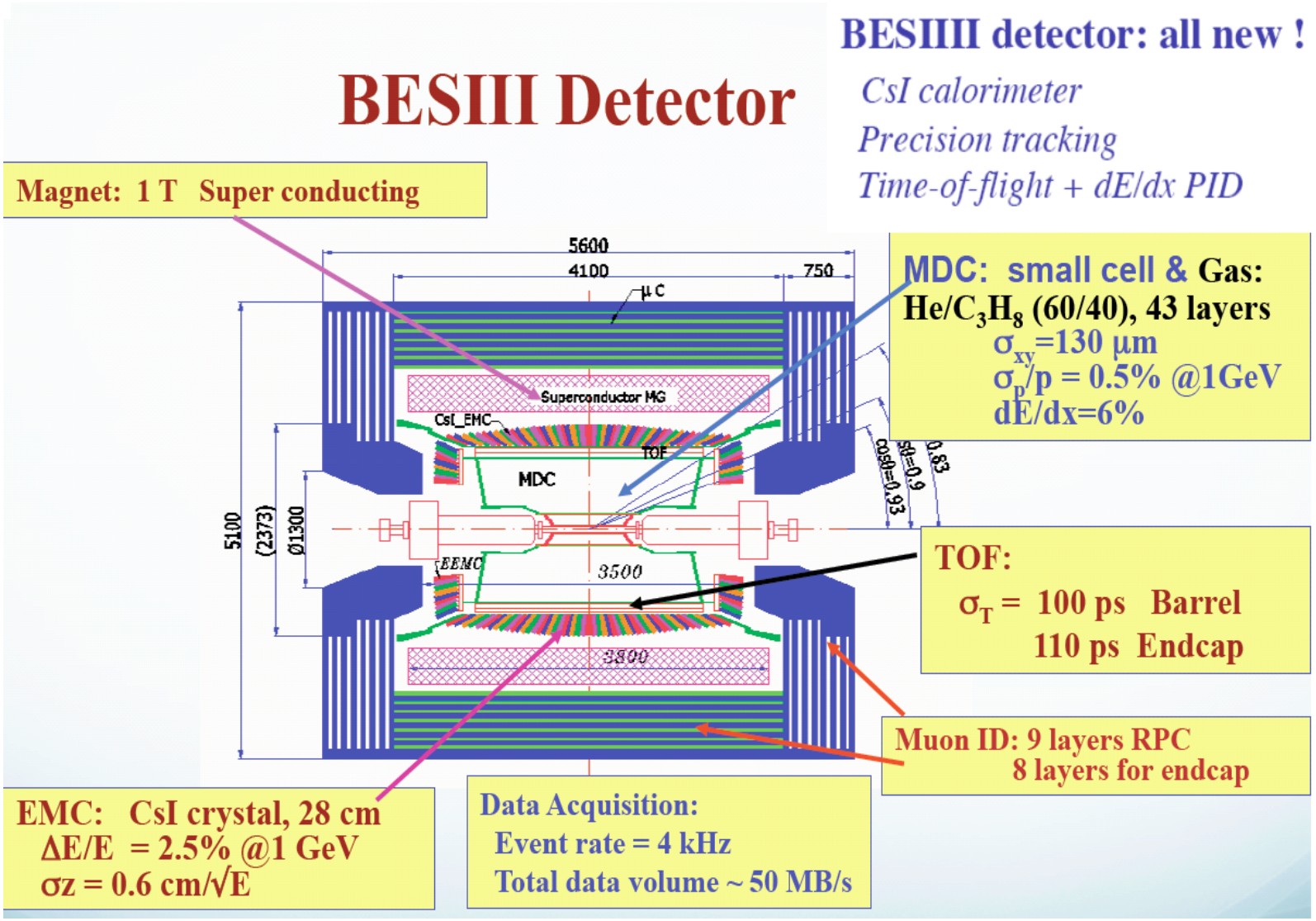
Outline

1. Status of MDC operation @ BESIII

2. Requirements for the inner drift chamber upgrade

Cylindrical GEM Mini-workshop
INFN – LNF Aula Seminari, 25 – 26 October, 2012

Status of MDC operation @ BESIII

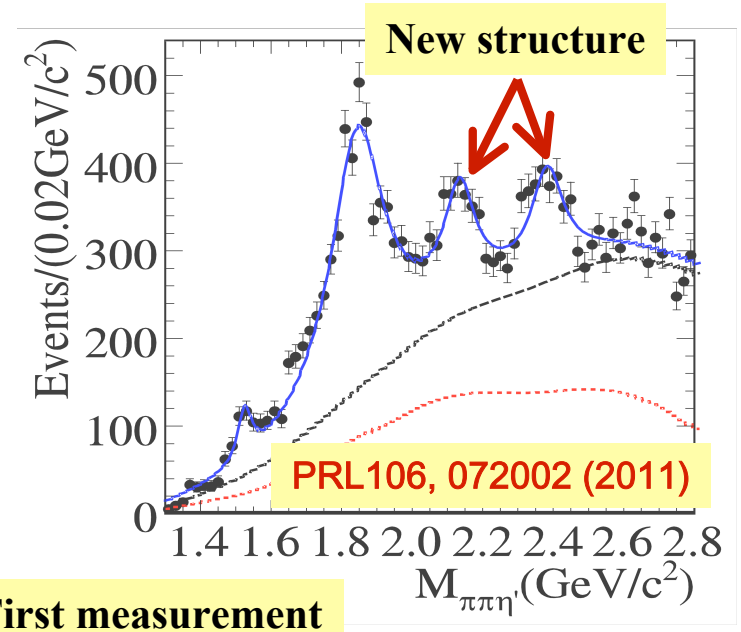


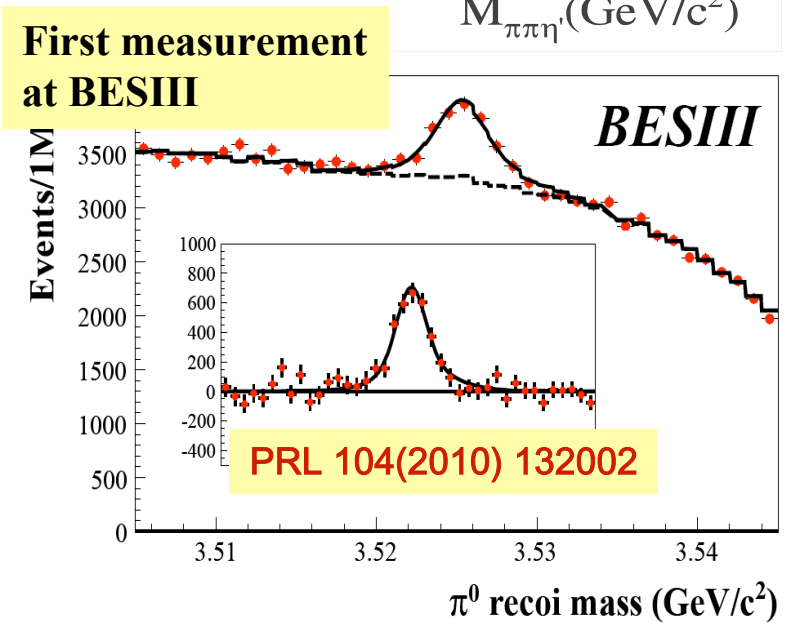
MDC inner chamber：the first 8 layers, all are stereo wires.

Physics @ BESIII

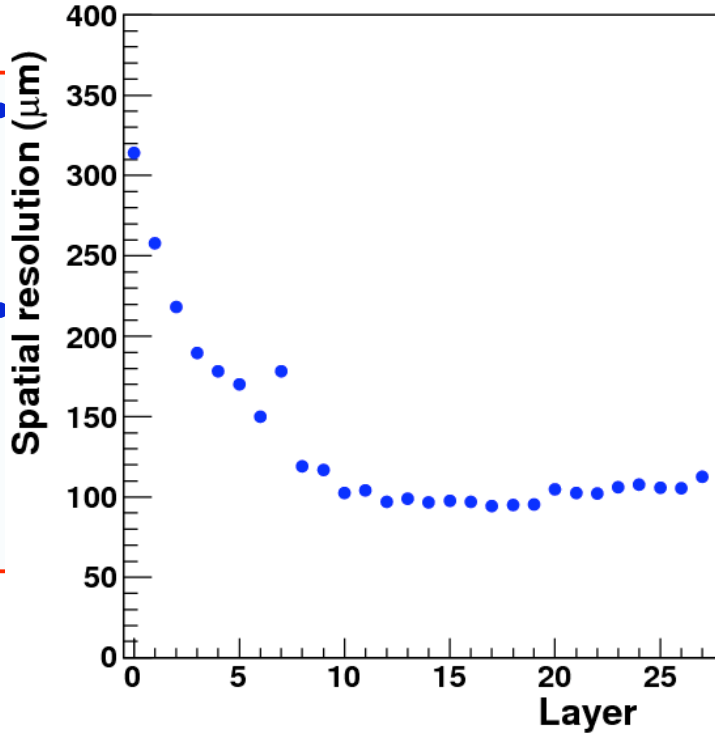
- Light Hadron Spectroscopy
  (1.2B J/ψ events)
- Charmonium physics
  (0.5B ψ′ events)
- Charm physics
  (2.9 fb^{-1} ψ(3770))

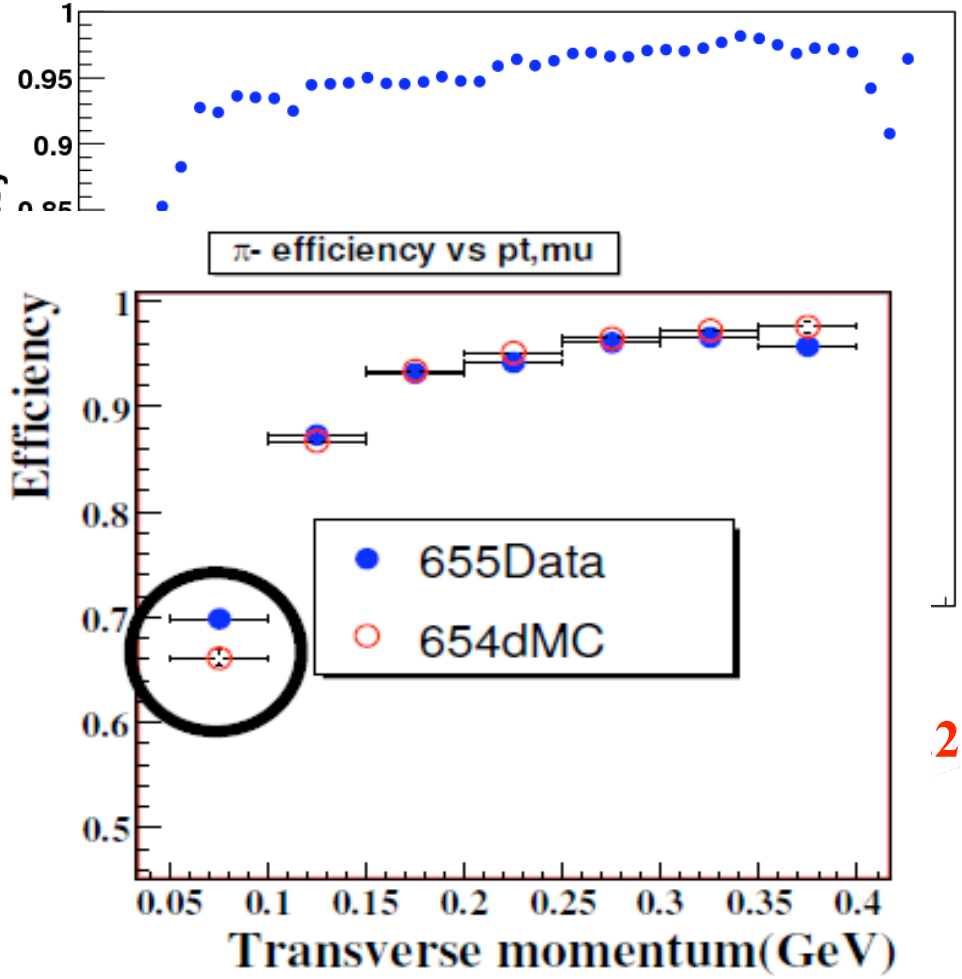
World's largest sample of J/ ψ, ψ (2S) and ψ(3770) (more than 20 physics papers) and still growing





MDC status





2×10^5

Hz/wire (i,e.

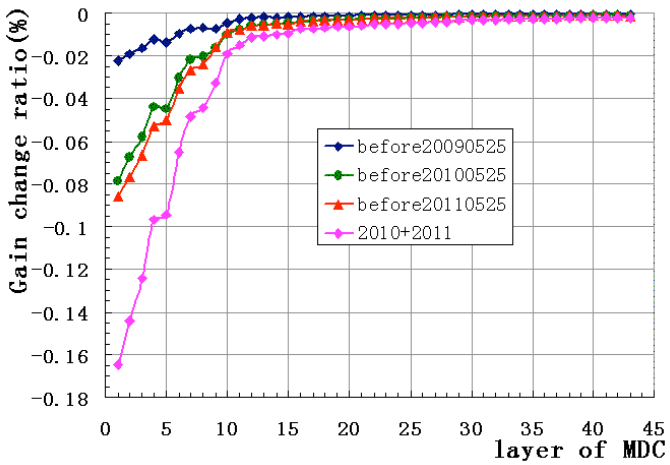
- 1st layer:

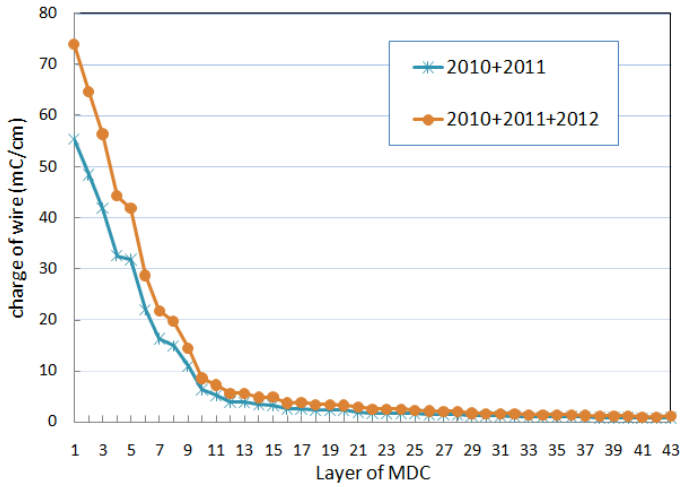
(2) Performance

- σ_{xy} > 300μm (the worst case)
- ε_{cell} ~ 70% (the worst case)

(3) Aging effect

- **field wires: Malter effect**
  - Non-stopped discharge up to some μA/wire, possible large area damage to detector
  - Water vapor about 2000ppm @ 22 ˚C has been added, no Malter effect again. But, long term operation needs investigation.
- **sense wires**
  - 2009 — 2011, gain degraded for the 1st 5 layers: 10% —15%
  - The accumulated charge of the sense wire on the first layer is 74mC/cm
    ≈ the specification of BESIII design for 5 full-year running





Keep the MDC alive

BESIII: data taken for the coming years

- **J/ψ： 1.2B ➔ 10B**
- **Ψ′： 0.5B ➔1B**
- **ψ(3770)： 2.9 fb^{-1} ➔ 20 fb^{-1}**
- **R scan…**

Actions: luminosity increasing

- **Construct a new inner drift chamber (spared)**
  - **demo prototype for removing process**
  - **new inner drift chamber →starting from 2013**
- **Investigate new technologies**

Requirements for the inner drift chamber upgrade

- **Rating capability:** $\sim 10^4$ Hz/cm^2
- **Spatial resolution:** $\sigma_{xy} \sim 100\mu m$; $\sigma_z \sim 1mm$;
- **Momentum resolution:** $\sigma_{pt}/p_t \sim 0.5\%$ @1GeV;
- **Efficiency:** $\varepsilon \sim 98\%$
- **Material budget:** < 1.5% all layers
- **Coverage:** 93% 4π
- **Operation duration:** ~ 5 years

Possible options:

- **CGEM:** based on KLOE-2 technology, collaboration between Italian and Chinese groups
- **Monolithic pixels:** CPS developed by IPHC in Strasburg

Simulation with TRACKERR

	Intrinsic resolution(μm)	σ_{dr} (μm) 0.1GeV/1GeV	σ_{dz} (μm) 0.1GeV/1GeV	σ_{pt}/p_t(%) 0.1GeV/1GeV	σ_p(MeV) 0.1GeV/1GeV
Inner MDC	130	1330 / 117	2033 / 1017	0.59 / 0.46	0.586 / 4.61
Si(600)	30	1325 / 116	1331 / 124	0.65 / 0.48	0.649 / 4.77
Si(200)	30	926 / 87	929 / 103	0.59 / 0.47	0.589 / 4.72
Si(600)	60	1352 / 140	1359 / 165	0.65 / 0.49	0.649 / 4.90
Si(200)	60	958 / 106	961 / 142	0.59 / 0.48	0.589 / 4.83
CGEM(4L)	120	1335 / 174	2078 / 451	0.59 / 0.51	0.592 / 5.11
CGEM(5L)	120	1341 / 180	2032 / 438	0.59 / 0.51	0.593 / 5.12

***less material budget input the calculation**

(4 slides from Rinaldo's presentation)

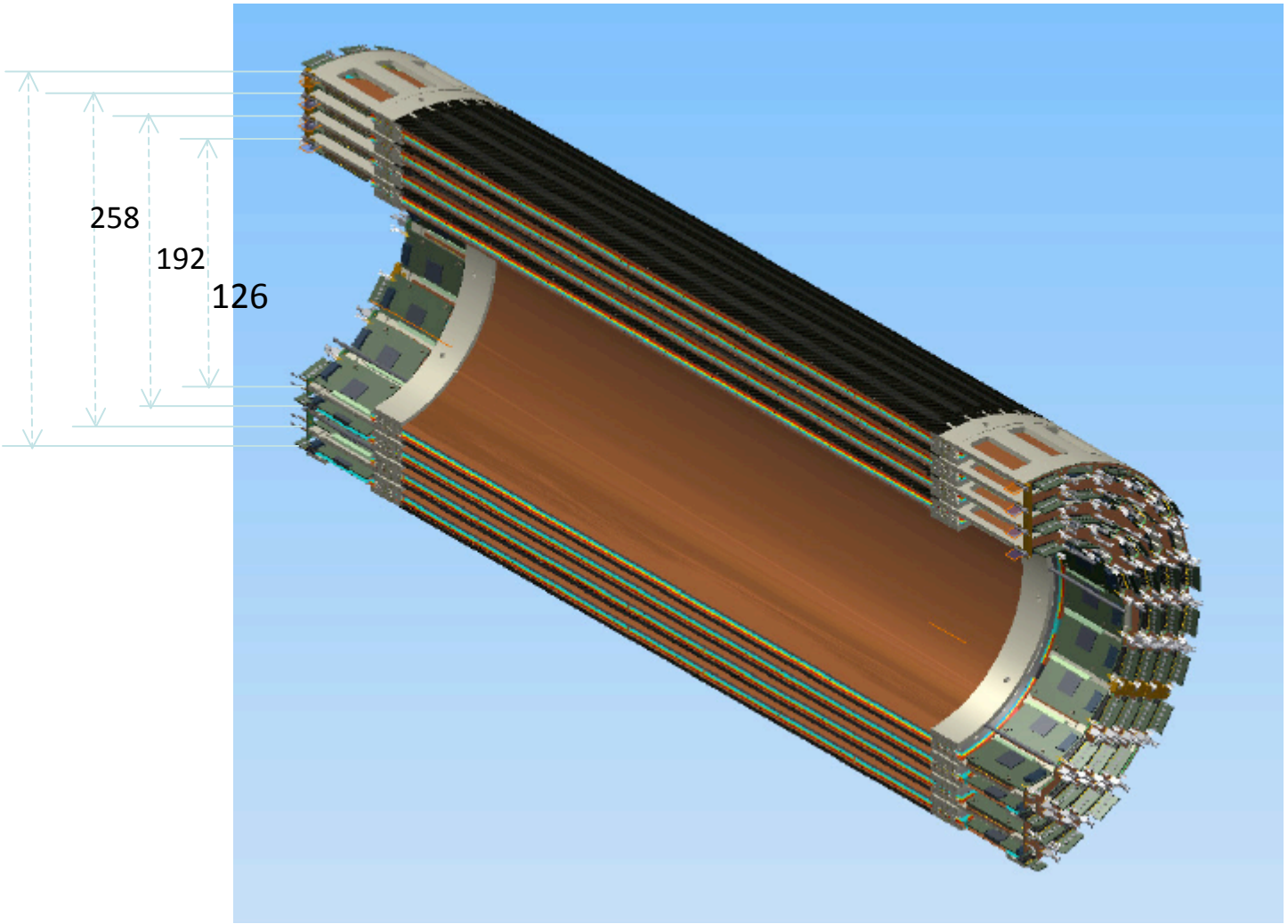
BESIII GEM
possible geometrical parameters

Layer	Int.diam (mm)	Length (mm)	Foils
1	126		1
2	192		2
3	258		2
4	324	870	2

N. strips ~ 20000 (KLOE2 ~ 30000)

Stereo angle ~ 40^0 (like KLOE2)

Pictorial view of IT for BESIII



Toy MC to achieve information on longitudinal resolution

Assuming:

- KLOE2 pitch (650 μm)

- Analog readout (extrapolated from COMPASS results)
  - σ_x ~ 650/400 x 330/200 x 50 ~ 130 μm
    pitch B COMPASS
  - σ_z ~ 370/200 x 130 ~ 250- 300 μm
    KLOE2
- s_{GEM} ~ 0.45 % X_0 (like the inner cylinder)

- Simulation of Outer Chamber stereo wires and Inner Chamber or CGEM stereo resolutions, including ms

Momentum Resolution

- ϕ resolution: CGEM ~ Inner

- Momentum resolution:
  - The worst scenario (mostly from the outer chamber)

    L : 70 -> 62 cm

    $\sigma_{readout} \propto 1/L^2$, $\sigma_{ms} \propto 1/\sqrt{L}$

    $(\sigma_p / P)_{GEM} \sim (\sigma_p / P)_{Inner} \times$ (1.07 -> 1.25 depending on P_t)

- $\theta_{ms} \times L_{GEM} < \sigma_x$ @ P > 0.7 GeV

  ms should not affect extrapolation from the Outer Chamber

  A toy MC is under development

  However a full detailed simulation is needed to settle all that

Some preliminary results will be presented during the BESIII meeting next month.

Summary

- MDC @ BESIII is facing aging problem;
- Time to start new technology R&D;
- CGEM prototype study has been initialized.

Thank you !