BESIII Prospects

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Outline

• Introduction
• Status of BESIII
• Highlights of BESIII
• Upgrade plan and physics prospects
• Summary
Beijing Electron Positron Collider (BEPC)

beam energy: 1.0 – 2.3 GeV

2004: started BEPCII upgrade, BESIII construction
2008: test run
2009 - now: BESIII physics run

- 1989-2004 (BEPC):
  \[ L_{\text{peak}} = 1.0 \times 10^{31} /\text{cm}^2\text{s} \]
- 2009-now (BEPCII):
  \[ L_{\text{peak}} = 1.0 \times 10^{33} /\text{cm}^2 \]
  (4/5/2016)
Features of the BEPC Energy Region

- Rich of resonances: charmonia and charmed mesons
- Threshold characteristics (pairs of $\tau$, D, $D_s$, ...)
- Transition between smooth and resonances, perturbative and non-perturbative QCD
- Energy location of the new hadrons: glueballs, hybrids, multi-quark states
New forms of hadrons

- Conventional hadrons consist of 2 or 3 quarks:

  Naive Quark Model:
  - Meson
  - Baryon

- QCD predicts the new forms of hadrons:
  - Multi-quark states: Number of quarks \( \geq 4 \)
  - Hybrids: \( q\bar{q}g, \, qqg \ldots \)
  - Glueballs: \( gg, \, ggg \ldots \)

None of the new forms of hadrons is settled!
Charmonium decays provide ideal hunting ground for light glueballs and hybrids

- “Gluon-rich” process
- Clean high statistics data samples from $e^+e^-$ annihilation
- $I(J^{PC})$ filter in strong decays of charmonium
Charmonium spectroscopy

- Charmonium states below open charm threshold are all observed

Above open charm threshold:
- many expected states not observed
- many unexpected observed

from Ryan Mitchell

- $\eta_c(1^3S_0)$
- $\psi(2^3S_1)$
- $\psi'(1^3S_1)$
- $\psi(1^3S_1)$
- $J/\psi(1^3S_1)$
- $\eta_c(1^1S_0)$
- $\chi_{c1}(3^3P_1)$
- $\chi_{c0}(3^3P_0)$
- $\chi_{c2}(3^3P_2)$
- $X(3915)$
- $X(3940)$
- $X(3915)$
- $X(4160)$
- $X(3872)$
- $Y(4008)$
- $Y(4140)$
- $Y(4260)$
- $Y(4360)$
- $X(4350)$
- $Y(4660)$
- $Z(4430)$
- $Z(4250)$
- $Z(4050)$
- $Z(3900)$
- $XYZ(3940)$
Precision measurement of CKM elements  
-- Test EW theory

CKM matrix elements are fundamental SM parameters that describe the mixing of quark fields due to weak interaction.

\[
\begin{pmatrix}
  d' \\
  s' \\
  b'
\end{pmatrix} =
\begin{pmatrix}
  V_{ud} & V_{us} & V_{ub} \\
  V_{cd} & V_{cs} & V_{cb} \\
  V_{td} & V_{ts} & V_{tb}
\end{pmatrix}
\begin{pmatrix}
  d \\
  s \\
  b
\end{pmatrix}
\]

Three generations of quark?  
Unitary matrix?

Expected precision < 2% at BESIII  
BESIII + B factories + LQCD

Precision measurement of CKM matrix elements  
-- a precise test of SM model  
New physics beyond SM?
Nucleon Form Factor

- Fundamental properties of the nucleon
  - Connected to charge, magnetization distribution
  - Crucial testing ground for models of the nucleon internal structure
  - Necessary input for experiments probing nuclear structure, or trying to understand modification of nucleon structure in nuclear medium

- Can be measured from space-like processes (eN) (precision 1%) or time-like process (e^+e^- annihilation) (precision 10%-30%)
Status of BESIII
~ 450 members from 57 institutions in 13 countries
BESIII data samples

World largest $J/\psi$, $\psi(2S)$, $\psi(3770)$, $\psi(4180)$, $Y(4260)$, … produced directly from $e^+e^-$ collision
**BESIII Detector**

**MDC**
- R inner: 63mm
- R outer: 810 mm
- Length: 2582 mm
- Layers: 43

**CsI(Tl) EMC**
- Crystals: 28 cm (15 X₀)
- Barrel: |cosθ| < 0.83
- Endcap: 0.85 < |cosθ| < 0.93

**RPC MUC**
- BMUC: 9 layers – 72 modules
- EMUC: 8 layers – 64 modules

**TOF**
- BTOF: two layers
- ETOF: 48 scintillators for each
  - MRPC --- new ETOF
# BESIII Detector Performance

<table>
<thead>
<tr>
<th>Exps.</th>
<th>MDC Spatial resolution</th>
<th>MDC dE/dx resolution</th>
<th>EMC Energy resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLEOc</td>
<td>110 µm</td>
<td>5%</td>
<td>2.2-2.4%</td>
</tr>
<tr>
<td>Babar</td>
<td>125 µm</td>
<td>7%</td>
<td>2.67%</td>
</tr>
<tr>
<td>Belle</td>
<td>130 µm</td>
<td>5.6%</td>
<td>2.2%</td>
</tr>
<tr>
<td>BESIII</td>
<td>115 µm</td>
<td>&lt;5% (Bhabha)</td>
<td>2.4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exps.</th>
<th>TOF Time resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDFII</td>
<td>100 ps</td>
</tr>
<tr>
<td>Belle</td>
<td>90 ps</td>
</tr>
<tr>
<td>BESIII</td>
<td>68 ps (BTOF) 60 ps (ETOF)</td>
</tr>
</tbody>
</table>

**MUC:** Efficiency ~ 96%
BG level: < 0.04 Hz/cm²(B-MUC), < 0.1 Hz/cm²(E-MUC)
Data/Monte-Carlo Consistency

- For tracking efficiency
data/MC difference < 1%

- For photon detection efficiency
data/MC difference < 1%

\[ \text{Relative diff. between data/MC} \]

\[ \Delta \text{Efficiency (mc-data)} \]

\[ \gamma \text{ detection eff.} \]
• For particle identification efficiency, data/MC difference <2% (BTOF+ dE/dx)

Relative difference between data and MC
Selected BESIII highlights

• Hadron spectroscopy
  – XYZ
  – Light hadron spectroscopy
• $\Lambda_c$ absolute branching fractions

(For more results and details, please see other BESIII talks at this workshop)
Gang Rong (IHEP): Leptonic, semi-leptonic and rare decays at BESIII
Xiaorui Lyu (UCAS): Overview on charm baryons decays (BESIII, LHCb, ...)
Yutie Liang (Giessen U.): Charmonium and Exotics Production and Spectroscopy at BESIII
Minggang ZHAO (NKU): CP Violation, Mixing and non-leptonic decays at BESIII
Jake Bennett (Minnesota U.): Amplitude analyses (BESIII and B factories)

Jianbin Jiao (SDU): Study of decay psi(1S,2S) -> baryon pairs
Liang Yan (Torino): Hadronic transitions above 4 GeV at BESIII
Ronggang Ping (IHEP): Radiative transitions above 4 GeV at BESIII
Elisa Fioravanti (Ferrara): Studies of charmonium decays at BESIII
Guang Zhao (IHEP): Ds physics at BESIII
Zhenglei Dou (NJU): Study of D0(+) -> P (P=Peudecalor) e+ nu at BESIII
Lei Zhang (TSU): Study of D0(+) to V (V=Vector) e+ nu at BESIII
Yu Lu (IHEP): Amplitude analysis of D0 to K-π+π+π- and measurements of D two body decays
Wenjing Zheng (SDU): Measurements of CP asymmetries of D+ to KS/L X
Jingyi Zhao (IHEP): Non-DD-bar decays of psi(3770)
Binlong Wang (UCAS): Hadronic decays of Lamda_c
Fengyun Li (PKU): Search for low-mass new physics at BESIII

Giulio Mezzadri (Ferrara): Measurement of the relative phase between strong and electromagnetic decay amplitudes of Charmonia at BESIII
Summary of Zc’s at BESIII

\[ \text{e}^+ \text{e}^- \rightarrow \pi^- \pi^+ J/\psi \]

\[ \text{e}^+ \text{e}^- \rightarrow \pi^0 \pi^0 J/\psi \]

\[ \text{e}^+ \text{e}^- \rightarrow \pi^- \pi^+ h_c \]

\[ \text{e}^+ \text{e}^- \rightarrow \pi^0 \pi^0 h_c \]

\[ \text{e}^+ \text{e}^- \rightarrow \pi^- (D\bar{D}^*)^0 \pi^0 \]

\[ \text{e}^+ \text{e}^- \rightarrow \pi^- (D^*\bar{D}^*)^+ \]

\[ \text{e}^+ \text{e}^- \rightarrow \pi^0 (D^{*}\bar{D}^*)^0 \]
## Summary of Zc’s at BESIII

<table>
<thead>
<tr>
<th>$Z_c^{\pm}$ (3900)</th>
<th>$Z_c^{\pm}$ (4020)</th>
</tr>
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<tbody>
<tr>
<td>$e^+e^- \rightarrow \pi^+\pi^-J/\psi$</td>
<td>$e^+e^- \rightarrow \pi^+\pi^-h_c$</td>
</tr>
<tr>
<td>$M = 3899.0 \pm 3.6 \pm 4.9$ MeV</td>
<td>$M = 4022.9 \pm 0.8 \pm 2.7$ MeV</td>
</tr>
<tr>
<td>$\Gamma = 46 \pm 10 \pm 20$ MeV</td>
<td>$\Gamma = 7.9 \pm 2.7 \pm 2.6$ MeV</td>
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</tbody>
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<tr>
<td>$e^+e^- \rightarrow \pi^0\pi^0J/\psi$</td>
<td>$e^+e^- \rightarrow \pi^0\pi^0h_c$</td>
</tr>
<tr>
<td>$M = 3894.8 \pm 2.3$ MeV</td>
<td>$M = 4023.9 \pm 2.2 \pm 3.8$ MeV</td>
</tr>
<tr>
<td>$\Gamma = 29.6 \pm 8.2$ MeV</td>
<td>$\Gamma$ Fixed at $Z_c^{\pm}$ (4020)</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>$Z_c^{\pm}$ (3885)</th>
<th>$Z_c^{\pm}$ (4025)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e^+e^- \rightarrow \pi(D^*D)^{\pm}$</td>
<td>$e^+e^- \rightarrow \pi(D^<em>D^</em>)^{\pm}$</td>
</tr>
<tr>
<td>$M = 3882.2 \pm 1.1 \pm 1.5$ MeV</td>
<td>$M = 4026.3 \pm 2.6 \pm 3.7$ MeV</td>
</tr>
<tr>
<td>$\Gamma = 26.5 \pm 1.7 \pm 2.1$ MeV</td>
<td>$\Gamma = 24.8 \pm 5.6 \pm 7.7$ MeV</td>
</tr>
</tbody>
</table>

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<th>$Z_c^{0}$ (3885)</th>
<th>$Z_c^{0}$ (4025)</th>
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<tr>
<td>$e^+e^- \rightarrow \pi^0(D^*D)^{0}$</td>
<td>$e^+e^- \rightarrow \pi^0(D^<em>D^</em>)^{0}$</td>
</tr>
<tr>
<td>$M = 3885.7 \pm 5.7 \pm 8.4$ MeV</td>
<td>$M = 4025.5 \pm 4.7 \pm 3.1$ MeV</td>
</tr>
<tr>
<td>$\Gamma = 35 \pm 12 \pm 15$ MeV</td>
<td>$\Gamma = 23.0 \pm 6.0 \pm 1.0$ MeV</td>
</tr>
</tbody>
</table>
2013: BESIII confirmed X(1835) and observed X(2120) & X(2370)

- First observation of high mass resonances in J/ψ radiative decays
- LQCD predicts 0\(^{+}\) glueball to be at 2.4 GeV/c\(^2\).
- X(2120)/X(2370)?
  - 0\(^{+}\) glueball?

BESIII:
PRL. 108 (2011)112003

\(\Rightarrow\) spin-parity?
\(\Rightarrow\) more decay modes?
- Nature of X(2120)/X(2370)? 0\(^{+}\) glueball?
- X(1835)? multi-quark state?
X(1835) lineshape: significant distortion

Flatte formula:
X(1835) \rightarrow ppbar, \eta'\pi\pi
Strong coupling to ppbar
X(1920) significant

Coherent sum of two BWs
X(1835)+X(1870)
X(1920) not needed

PRL 117 (2016) 042002
Observation and spin-parity determination of $X(1835)$ in $J/\psi \rightarrow \gamma K_s K_s \eta$

- Measure the spin-parity of $X(1835)$ to be $0^{-+}$;
- Found new decay mode of $X(1835)$

$\Lambda c^+$: the lightest charmed baryon

- Its property is crucial input for $b$- and $c$- baryons, as many of their decays go to $\Lambda c$

- However, the experimental data are very old and in poor precisions.

  ✓ Absolute BF of $\Lambda c^+$ decays are still not well determined since its discovery 30 years ago.

    PDG2014: $\delta B/B \sim 25\%$; BELLE2014: $\delta B/B \sim 4.7\%$

  ✓ Tagging technique @BESIII will provide the most simple and straightforward measurement

- BESIII accumulates 567/pb data near $\Lambda c^+$-pair threshold
• The absolute BF can be obtained by the ratio of double tag yields to single tag yields.
• A global least square fit to 12 hadronic modes

[Chinese Phys. C37(2013)106201]

✓ First direct measurement on \( \Lambda_c \) BFs at threshold
✓ \( B(pK^-\pi^+) \): BESIII precision comparable with Belle’s
✓ Improved precisions of the other 11 modes significantly
BF for $\Lambda_c^+ \rightarrow \Lambda e^+ \nu_e$

- $\Lambda_c^+ \rightarrow \Lambda e^+ \nu_e$ is a $c \rightarrow s l^+ \nu_l$ dominated process.
- Urgently needed for LQCD calculations.
- No direct absolute measurement for $B(\Lambda_c^+ \rightarrow \Lambda e^+ \nu_e)$ available.

$$B(\Lambda_c^+ \rightarrow \Lambda e^+ \nu_e) = (2.1 \pm 0.6)\%$$ PDG 2014

11 hadronic single tag modes are used

- First absolute measurement of the semi-leptonic decay
- Statistics limited
- Best precision to date: twofold improvement
- We also measure the muonic mode: stay tuned

$B(\Lambda_c^+ \rightarrow \Lambda e^+ \nu_e) = (3.63 \pm 0.38 \pm 0.20)\%$
Upgrade plan and physics prospects
BESIII upgrade

- MDC: Malter effect found in inner chamber in 2012, add water vapor to the chamber to cure the aging problem.
  - New inner chamber, built by IHEP, is ready now.
  - CGEM as the inner chamber ongoing: Italy group in collaboration with other groups.

- New ETOF (built by USTC & IHEP) was installed last year to improve the time resolution.

- Other possible upgrade plan is under discussion
New Inner Drift Chamber

- An aluminum outer cylinder was manufactured for the chamber cosmic-ray test
- The outer cylinder was assembled after wiring had been finished
The performance of the new chamber

After half year’s cosmic ray test, the efficiency > 99%

**HV @2200V**

**Spatial res. 129μm**

**dE/dx res. 7.8%**

**55 samplings**

The chamber is stored in a clean room and is ready to be replaced.
BESIII is building a cylindrical GEM detector (CGEM-IT) to replace the BESIII Inner MDC to recover some efficiency loss due to aging and to improve the secondary vertex resolution.

- Low Material budget $\leq 1.5\%$ of $X_0$ for all layers
- High Rate capability: $\sim 10^4$ Hz/cm$^2$
- Coverage: 93%
- Spatial resolution $\sigma_{r\phi} \sim 130$ $\mu$m in 1 T magnetic field
- Operation duration at least 5 years

Each layer composed by a triple cylindrical GEM

The CGEM is co-funded by the European Commission Research and Innovation Staff Exchange (RISE) project 2015-2018.

Formation of a consortium: INFN (Ferrara, Frascati, Perugia and Torino), Mainz, Uppsala, IHEP
Project timeline

2012
Initial proposal

2013
R&D and CDR preparation

2014
CDR approval
R&D and detector design

2015
Detector design
Begin construction
Start RISE project.

2016
Complete detector design
Concontinue detector construction
Electronics development

2017
Continue detector and electronics production
Full CGEM-IT test

2018
Installation and commissioning (summer 2018)
Expected performance of CGEM

Track fitting with Kalman Filter

Approaching point resolution

\[ \sigma_p \]

\[ \sigma_z \]

Momentum resolution
Installation of MRPC Endcap TOF

- Scintillator Endcap TOF: time resolution for $\pi$ is 138ps.
- New MRPC Endcap-TOF built
- The installation of MRPC ETOF completed in the Oct. of 2015
MRPC Endcap TOF

Time resolution vs Strip Number

Efficiency vs Module Number

Time resolution of 60ps achieved; Efficiency ~97%
**Data/MC discrepancy – Main source of the syst. err.**

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>2016</th>
<th>2019?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking eff./track</td>
<td>~2%</td>
<td>~1%</td>
<td>~0.5%</td>
</tr>
<tr>
<td>PID/track</td>
<td>~2%</td>
<td>~1%</td>
<td>~0.5%</td>
</tr>
<tr>
<td>Photon eff./photon</td>
<td>~1%</td>
<td>0.5-1%</td>
<td>~0.5%</td>
</tr>
</tbody>
</table>
• **BEPC2**
  – Replace one cavity in summer of 2017 (~3 months for the replacement, takes time for ramping up).
  – mini-workshop with machine people for the possible upgrade of BEPC2
    • Top up plan?
    • Increase the beam energy?
      currently: 2.30 GeV
      I: → 2.35 GeV (hardware replacement, ....)
      II: 2.35 GeV < E < 2.45 GeV
        bottleneck: ISPB, new magnet and power supply
      III: > 2.45 GeV bottleneck: ISPB and SCQ
## BESIII data taking status & plan

<table>
<thead>
<tr>
<th></th>
<th>Previous data</th>
<th>BESIII present &amp; future</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>$J/\psi$</td>
<td>BESII 58M</td>
<td>1.2 B 20* BESII</td>
<td>10 B</td>
</tr>
<tr>
<td>$\psi'$</td>
<td>CLEO: 28 M</td>
<td>0.5 B 20* CLEOc</td>
<td>3 B</td>
</tr>
<tr>
<td>$\psi''$</td>
<td>CLEO: 0.8/fb</td>
<td>2.9/fb 3.5*CLEOc</td>
<td>20 fb</td>
</tr>
<tr>
<td>Above open charm threshold</td>
<td>CLEO: 0.6/fb @ $\psi(4160)$</td>
<td>0.5/fb @ $\psi(4040)$ 2.3/fb@~4260, 0.5/fb@4360 0.5/fb@4600, 1/fb@4420</td>
<td>5-10 fb</td>
</tr>
<tr>
<td>R scan &amp; Tau</td>
<td>BESII</td>
<td>3.8-4.6 GeV at 105 energy points 2.0-3.1 GeV at 20 energy points</td>
<td></td>
</tr>
<tr>
<td>$Y(2175)$</td>
<td></td>
<td>100 pb$^{-1}$</td>
<td></td>
</tr>
<tr>
<td>$\psi(4170)$</td>
<td></td>
<td>3 fb$^{-1}$ (this run)</td>
<td></td>
</tr>
<tr>
<td>4.2-4.3 GeV</td>
<td></td>
<td>5 fb$^{-1}$ (next run)</td>
<td></td>
</tr>
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</table>
Glueball search

- **LQCD**: the lightest glueball is $0^{++}$, mass $\sim 1.5$-$1.7$ GeV
- the lightest $2^{++}$ glueball: mass $\sim 2.4$ GeV
- the lightest $0^{-+}$, mass $> 2.3$ GeV

**Couple channel analysis**

- $J/\psi \to \gamma \eta \eta', \gamma \eta' \eta'$
- $J/\psi \to \gamma \pi \pi$, $\gamma K K$

$J/\psi \to \gamma \text{vector } + \text{vector}$

$J/\psi \to \gamma \gamma \text{ vector, ...}$
Puzzles on XYZ (one example)

\[ e^+e^- \rightarrow \pi^+\pi^- J/\psi \] at BESIII

Two resonances? What are they?
### Prospects of Charm Physics at BESIII

**Data at 3.773 or 4.18 GeV**

<table>
<thead>
<tr>
<th>Systematic</th>
<th>Statistical</th>
</tr>
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<tbody>
<tr>
<td>~3 fb⁻¹</td>
<td>+10 fb⁻¹</td>
</tr>
</tbody>
</table>

| $\Delta f_{D^+}/f_{D^+}$ | $~0.9\%^{\text{BESIII}}$ | 2.6% |
| $\Delta f_{D_{s}^+}/f_{D_{s}^+}(\mu+\tau)$ | $~1.4\%^{\text{CLEO-c}}$ | $~1.4\%$ |
| $\Delta f_{D\rightarrow K}/f_{D\rightarrow K}$ | $~0.5\%^{\text{BESIII}}$ | 0.4% |
| $\Delta f_{D\rightarrow \pi}/f_{D\rightarrow \pi}$ | $~0.7\%^{\text{BESIII}}$ | 1.3% |
| $|V_{cs}|^{D_{s}\rightarrow l+v}(\mu+\tau)$ | $~1.4\%^{\text{CLEO-c}}$ | $~0.7\%$ |
| $|V_{cs}|^{D_0\rightarrow K-e+v}$ | $2.5\%^{\text{BESIII}}(2.4\%^{\text{LQCD}})$ | 0.4% |
| $|V_{cd}|^{D\rightarrow \mu+v}$ | $2.1\%^{\text{BESIII}}(1.9\rightarrow 0.5\%^{\text{LQCD}})$ | 2.6% |
| $|V_{cd}|^{D_{0}\rightarrow \pi-e+v}$ | $4.5\%^{\text{BESIII}}(4.4\%^{\text{LQCD}})$ | 1.3% |
| $(c_i,s_i)$ in $D^0\rightarrow K^0\pi^+\pi^-$ | constrain to $\gamma/\phi_3$ | 2.1%(tot) |
| $\Lambda_{c}^{+}\rightarrow pK^-\pi^+$ | 4.8% |
| (0.6fb⁻¹@4.6) |
| (3fb⁻¹@4.6X) | ~2% |
Summary

• BESIII: successfully operating since 2009
  – Collected large data samples in the τ-charm mass region
• Study of X, Y and Z states
• Light hadron spectroscopy from charmonium and charm decays
• Charmed mesons and baryons
• R-QCD regions:
  • BEPCII/BESIII upgrade: trackers, ETOF, beam energy ...

Thank you!
• 4 charged Zc’s at BESIII

Z_c(3900)  

PRL 110, 252001 (2013)

Z_c(3885)  

PRL 112, 022001 (2014)

Z_c(4020)  

PRL 111, 242001 (2013)

Z_c(4025)  

PRL 112, 132001 (2014)
Neutral Zc(3900), Zc(3885), Zc(4020), Zc(4025)

**Zc⁰(3900) in e⁺e⁻ → π⁰π⁰J/ψ**

\[ e^+ e^- \rightarrow Z_c(3885)^0 \pi^0 \rightarrow (D \bar{D}^*)^0 \pi^0 \]

**PRL, 115, 112003**

**Zc⁰(4020) → π⁰h_c in e⁺e⁻ → π⁰π⁰h_c**

\[ Z_c(4025)^0 \text{ in } e^+ e^- \rightarrow (D^* \bar{D}^*)^0 \pi^0 \]

**PRL, 113, 212002**

**PRL.115.222002**

**PRL,115,18,182002**
Peculiarities and innovations of the BESIII design

• Materials and detector design

The detector must be very light: \( \leq 1.5\% \) of \( X_0 \): the mechanical rigidity is given by
- a kapton-Rohacell-Kapton sandwich in the active area.
- permaglass rings outside the sensitive area

• Combined time and charge readout

  - To achieve high tracking performance in strong magnetic field an hybrid, \textit{microTPC + charge centroid}, readout will be used.

  - Successfully tested with beam on prototypes: first implementation of microTPC algorithms in strong magnetic field for GEM detectors.

• Frontend electronics

  • The hybrid readout will be carried out by a \textit{dedicated ASIC} chip that is currently under development.
Status of the detector construction

The first CGEM-IT has been constructed, and recently validated with cosmics.

1) The 5 electrodes (cathode, anode and 3 GEM foils) are cylindrically shaped on aluminum molds,

2) They are then inserted one inside the other.

3) First detector layer being equipped with gas, HV and electronics