



New Physics Searches at BESIII

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On behalf of the BESIII Collaboration

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BEPC Overview

Haibo Li

- 项目启动: 1984
质心能量 : 2-4.6 GeV
- 1988-2005 (BEPC):
 $L_{\text{peak}}=1.0 \times 10^{31} / \text{cm}^2\text{s}$
- 2008-至今 (BEPCII):
 $L_{\text{peak}}=1.0 \times 10^{33} / \text{cm}^2\text{s}$
(2016年4月5日)



BESIII Data and Physics

物理分类	重要的问题	现有数据	最终数据样本	国际竞争
轻强子谱学	胶子球、奇特态、 $X(pp)$ 、标量、张量态等，重子谱	5.5 billion J/ψ 0.5 billion $\psi(2S)$ 其它能点数据	10 billion J/ψ 5 billion $\psi(2S)$ 其它能点数据	独具特色
夸克偶素衰变	粲偶素的跃迁、OZI压低衰变、与轻子的耦合、轻夸克偶素的衰变	5.5 billion J/ψ 0.5 billion $\psi(2S)$ 高激发态扫描	10 billion J/ψ 5 billion $\psi(2S)$ 高激发态扫描数据	独具特色
粲偶素谱学	高激发态谱学、类粲偶素谱	高激发态扫描 (12/fb)	高激发态扫描数据 阈值附近高亮度	Belle-II(日本) LHCb (CERN) PANDA (德国)
粲介子&粲重子衰变	量子关联 - D介子关联因子、强相位、CPV、形状因子、衰变常数、CKM	2.9/fb @ $\psi(3770)$ 0.56/fb @ 4.6 GeV 3.1/fb @ 4.180 GeV	20/fb @ $\psi(3770)$ 5/fb @ 4.64 GeV 5/fb @ 4.18 GeV 5/fb @ 4.96 GeV	Belle-II(日本) LHCb (CERN) 互补关系
R值&QCD	R值、重子形状因子、遍举强子截面、ISR物理、谱学等	130能点数据(2.0-4.6GeV)	20/fb @ $\psi(3770)$ ISR物理	Belle-II(日本) 俄罗斯
新物理	粲介子稀有、粲偶素稀有、禁闭衰变等	1.3 billion J/ψ 0.5 billion $\psi(2S)$ 2.9/fb @ $\psi(3770)$	10 billion J/ψ 5 billion $\psi(2S)$ 20/fb @ $\psi(3770)$	Belle-II(日本) LHCb (CERN)

New Physics Group Topics

- Forbidden symmetry violation processes
- FCNC processes
- Invisible decays
- Exotic searches
- ...

Forbidden symmetry violation processes

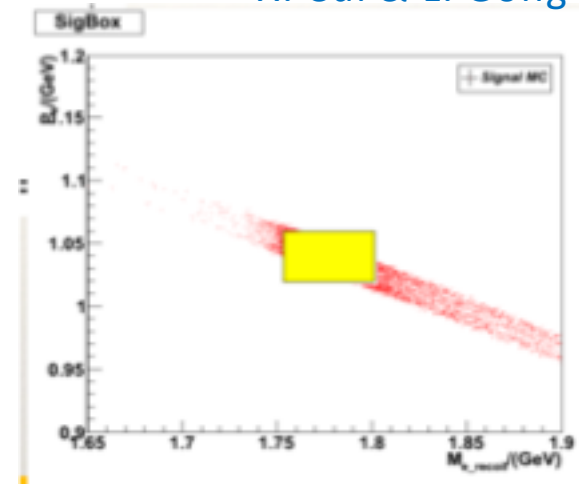
- Lepton Flavor Violation (LFV)
- Baryon number violation (BNV)
- Lepton number violation (LNV)

Lepton Flavor Violation

- $J/\psi \rightarrow e/\mu + \tau$

Model	Up-limit $Br(J/\psi \rightarrow \tau l)$
Model independent	6.0×10^{-7}
Leptoquark Model	3.0×10^{-8}
SUSY Model	5.0×10^{-9}
TC2 Model	3.3×10^{-8}

X. Cui & L. Gong (NKU)



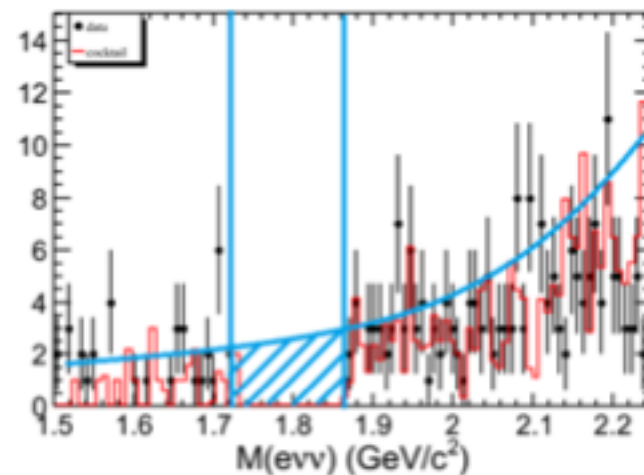
- $J/\psi \rightarrow \gamma \mu/e \tau$

X. Wang & D. Wang (PKU)

$$BR(h \rightarrow \tau\mu) < 1.51\% \text{ (95\% C.L.)}$$

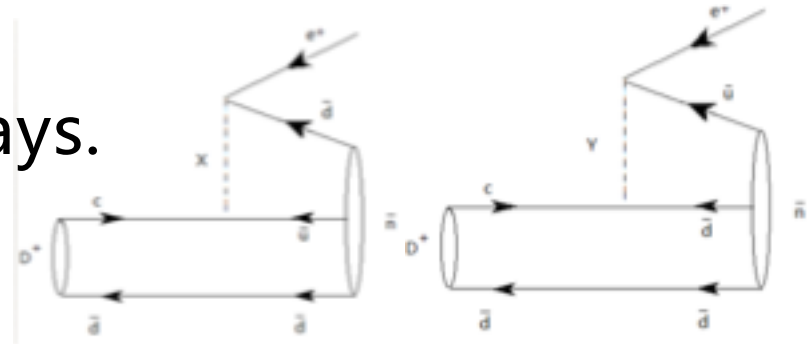
$$BR(h \rightarrow \tau\mu) = 0.89^{+0.39}_{-0.37}\% \text{ (2.46}\sigma\text{)}$$

$$|y_{\tau\mu}| \leq 3.6 \times 10^{-3}$$



BNV & LNV Processes

- BSM predict proton decays.



- $D^+ \rightarrow \bar{n} e^+$ and $D^- \rightarrow n e^-$

Study of $D_s^- \rightarrow \Lambda e^-$

S. X. Du¹, X. Q. Hao², L. Y. Dong³

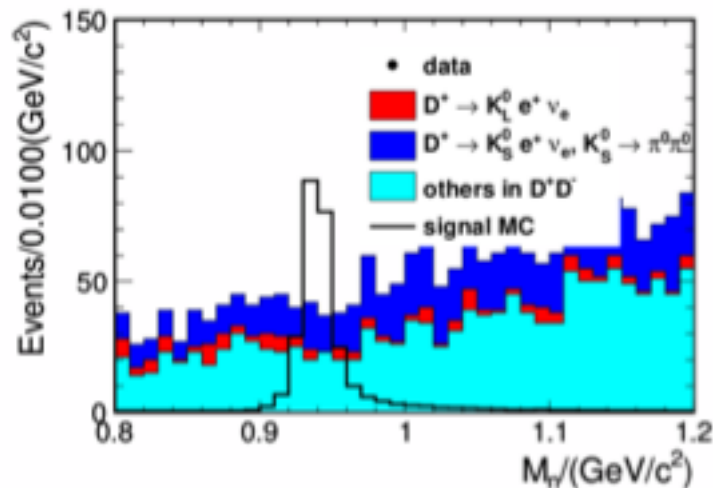
Searching for $\eta' \rightarrow \eta e^+ e^-$

Zhang Penglong, Hao Xiqing, Dong Liaoyuan

SEARCHING FOR
 $\eta' \rightarrow \pi^0 e^+ e^-$
 JINGYI ZHOU,
 ZHENYU ZHANG,
 XIANG ZHOU

$D^- \rightarrow ne^-, D^+ \rightarrow \text{tagmode}$

H. Shi & H. Peng (USTC)



BNV & LNV Processes in J/ψ

Searching for BNV process of $J/\psi \rightarrow e^+ \text{anti-}\Lambda_c^- + \text{c.c.}$

Z.-Y. Qu¹, K.-L. Zhang¹, M.-G. Zhao^{1*}, B. Zheng², X.-Q. Hao³

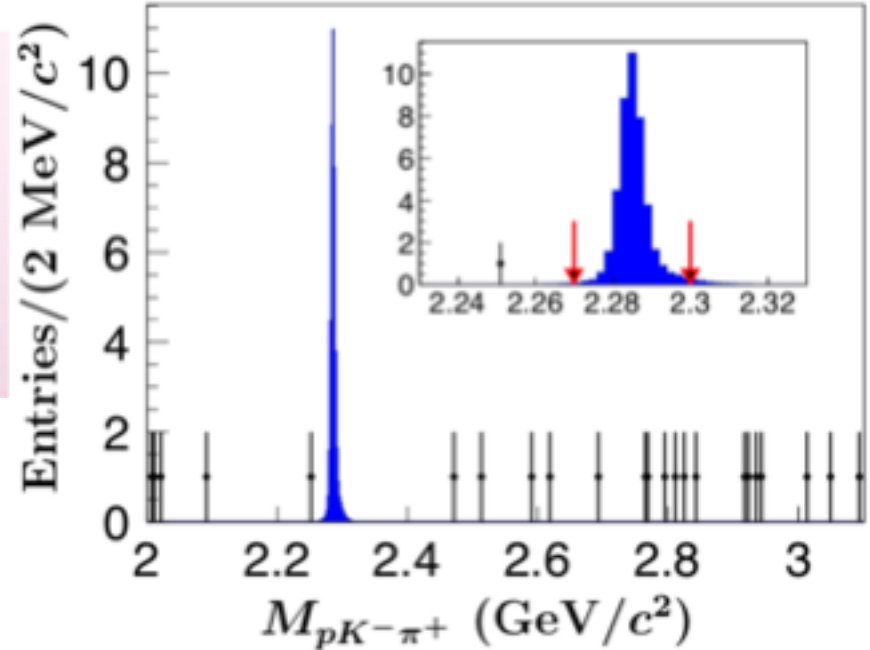
¹Nankai University

²University of South China

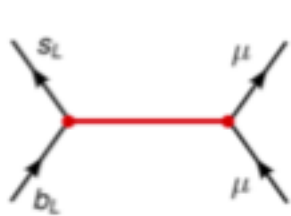
³Henan Normal University

$$\mathcal{B}(J/\psi \rightarrow \Lambda_c^+ e^-) < 6.9 \times 10^{-8}.$$

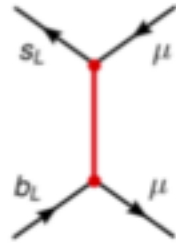
Submitted to PRD
Arxiv: 1803.04789



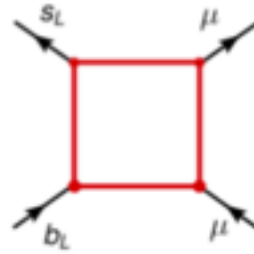
Flavor Changing Neutral Current (FCNC) processes



- ▶ Z'
- ▶ $SU(2)_L$ singlet or triplet

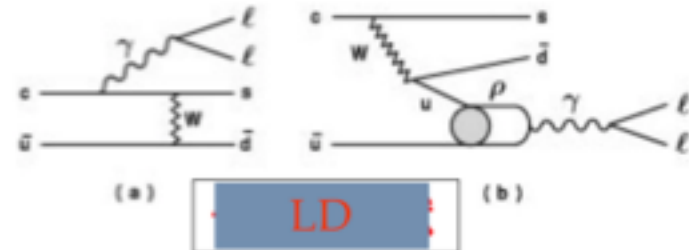
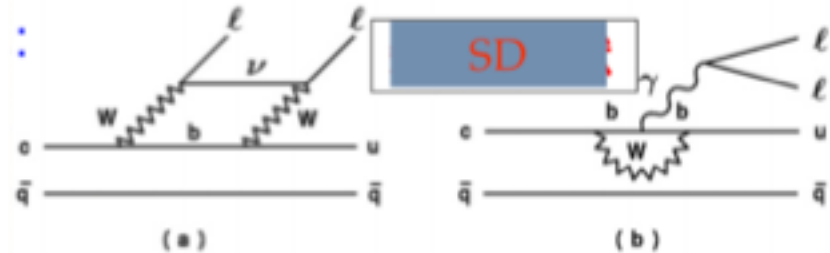


- ▶ Leptoquark
- ▶ Spin 0 or 1



- ▶ New scalars/vectors, also leptoquarks possible

- Charmominum decays
- Charm decays



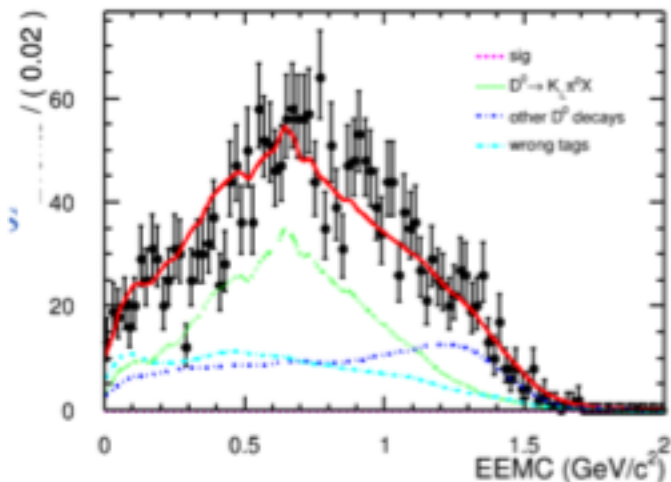
FCNC Searches

- $D^0 \rightarrow h h e e$ and $h^0 e e$

Submitted to PRD
Arxiv: 1802.09752

- Rare decay $D^0 \rightarrow \pi^0 \nu \nu$

Y. Zhang (UCAS) et al



D. Xiao (IHEP) & Y. Zhang (UCAS) et al.

Signal decays	\mathcal{B} ($\times 10^{-5}$)	PDG [10] ($\times 10^{-5}$)
$D^+ \rightarrow \pi^+ \pi^0 e^+ e^-$	< 1.4	-
$D^+ \rightarrow K^+ \pi^0 e^+ e^-$	< 1.5	-
$D^+ \rightarrow K_S^0 \pi^+ e^+ e^-$	< 2.6	-
$D^+ \rightarrow K_S^0 K^+ e^+ e^-$	< 1.1	-
$D^0 \rightarrow K^- K^+ e^+ e^-$	< 1.1	< 31.5
$D^0 \rightarrow \pi^+ \pi^- e^+ e^-$	< 0.7	< 37.3
$D^0 \rightarrow K^- \pi^+ e^+ e^-$	< 4.1	< 38.5
$D^0 \rightarrow \pi^0 e^+ e^-$	< 0.4	< 4.5
$D^0 \rightarrow \eta e^+ e^-$	< 0.3	< 11
$D^0 \rightarrow \omega e^+ e^-$	< 0.6	< 18
$D^0 \rightarrow K_S^0 e^+ e^-$	< 1.2	< 11
† in $M_{e^+e^-}$ regions:		
[0.00, 0.20] GeV/c^2	$< 3.0(1.5_{-1.0}^{+0.9})$	-
[0.20, 0.65] GeV/c^2	< 0.7	-
[0.65, 0.90] GeV/c^2	$< 1.9(1.0_{-0.4}^{+0.5})$	-

- J/ψ (pisp) $\rightarrow D^{\text{bar}} e^+ e^-$

Y. Zhang (USTC) et al

$$J/\psi \rightarrow \overline{D^0} e^+ e^- + c.c. < 8.5 \times 10^{-8} @ 90\% C.L.$$

$$\psi(3686) \rightarrow \overline{D^0} e^+ e^- + c.c. < 1.4 \times 10^{-7} 90\% C.L.$$

published
Phy.Rev.D(RC)
Phys. Rev.
D96,111101(2017)

Invisible decays

- Light meson invisible decays
- Charmonium invisible decays

Invisible decays

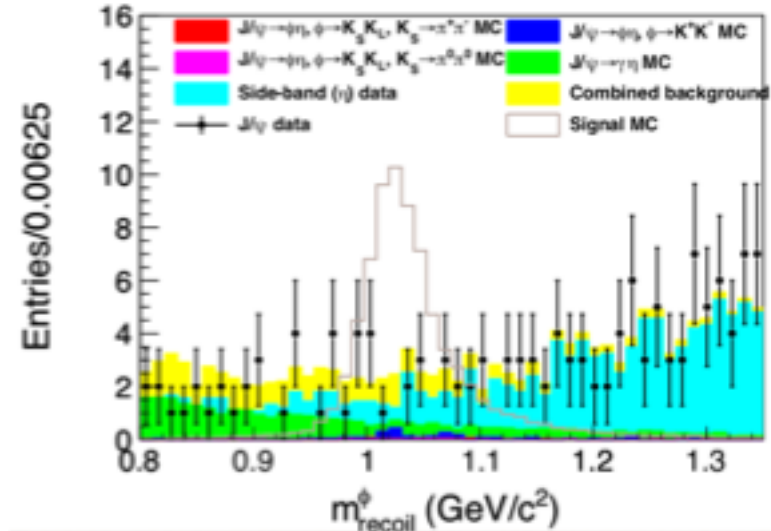
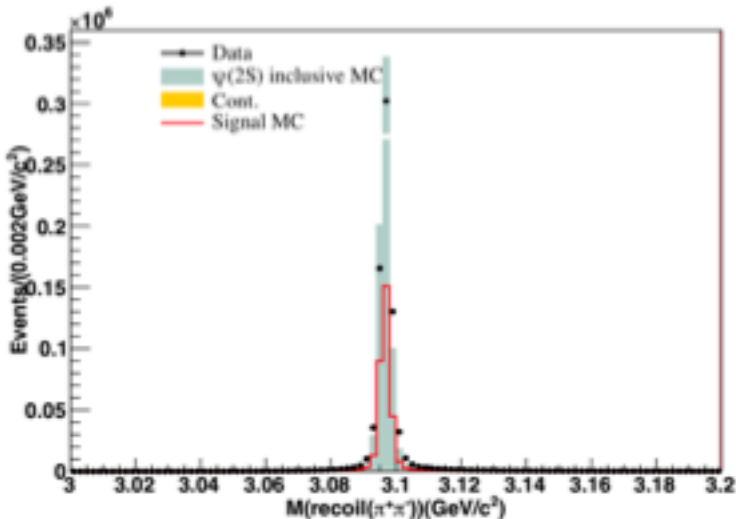
V. Prasad et.al. (USTC)

- Omega/phi Invisible

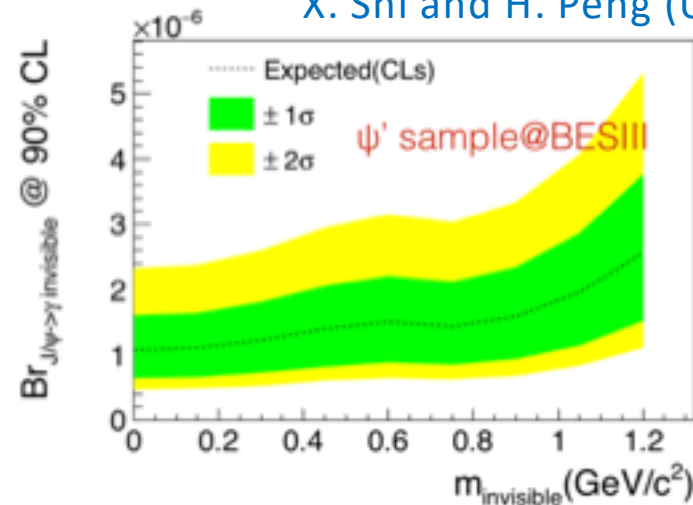
arXiv:1805.05613

- J/psi -> invisible decay

Q. Chen (PKU) and S. Xiao (IHEP) et. al.



- J/psi -> gamma invisible
X. Shi and H. Peng (USTC)



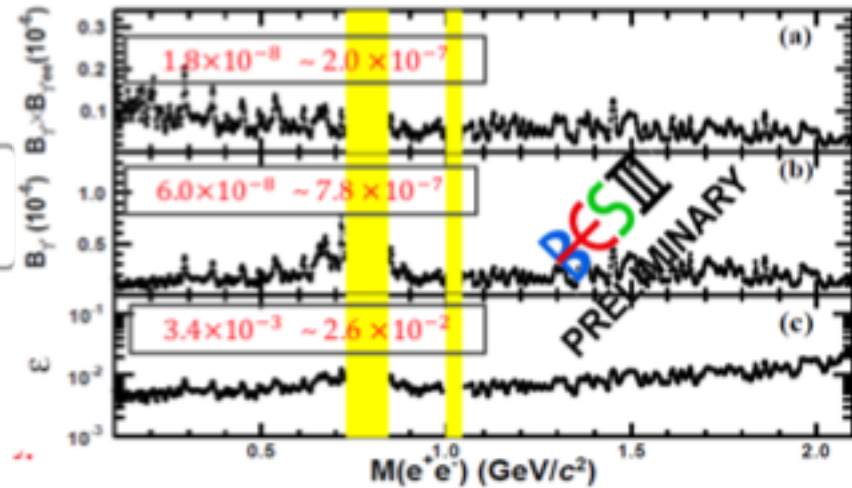
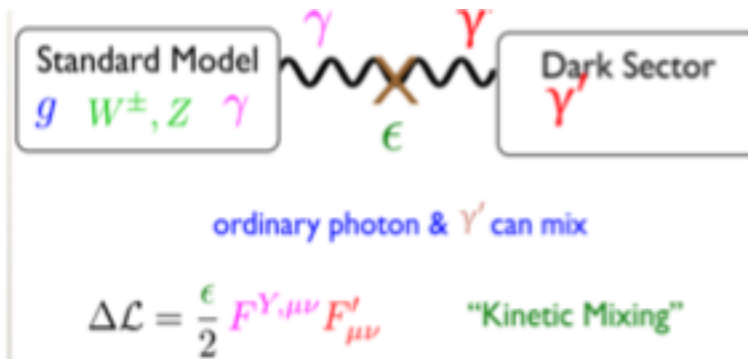
Exotic searches

- Dark photon through ISR, invisible
- Dark photon in meson decays
- LUV dark scalar
- Light Higgs, dark Higgs, X(16.7), inflaton
- ...

Exotic searches

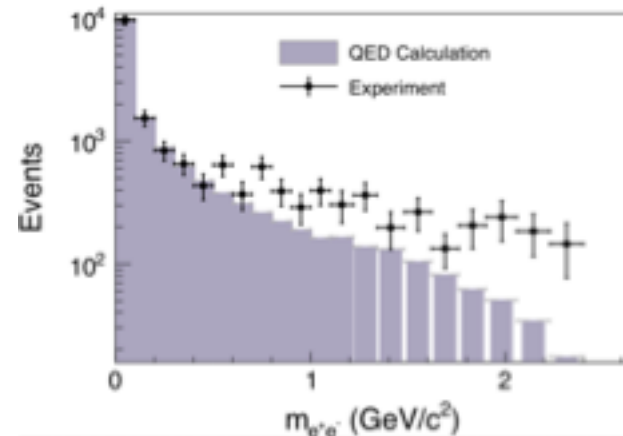
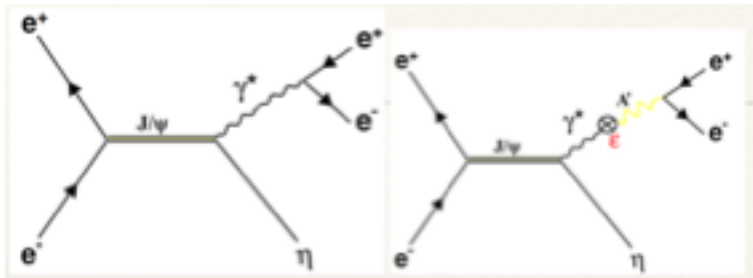
F. Li et.al. (PKU)

- Dark photon with $J/\psi \rightarrow \eta' e^+e^-$



- $J/\psi \rightarrow \eta/\pi^0 ee$

V. Prasad et.al. (USTC)



Summary

- Active searches ongoing at BESIII
- Covering broad topics for new physics beyond SM (Forbidden, FCNC, invisible, etc)
- Welcome to join!

