

# 第七届XYZ粒子学术研讨会

7<sup>th</sup> workshop on the XYZ particles

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2021年5月18日 青岛

# 提纲

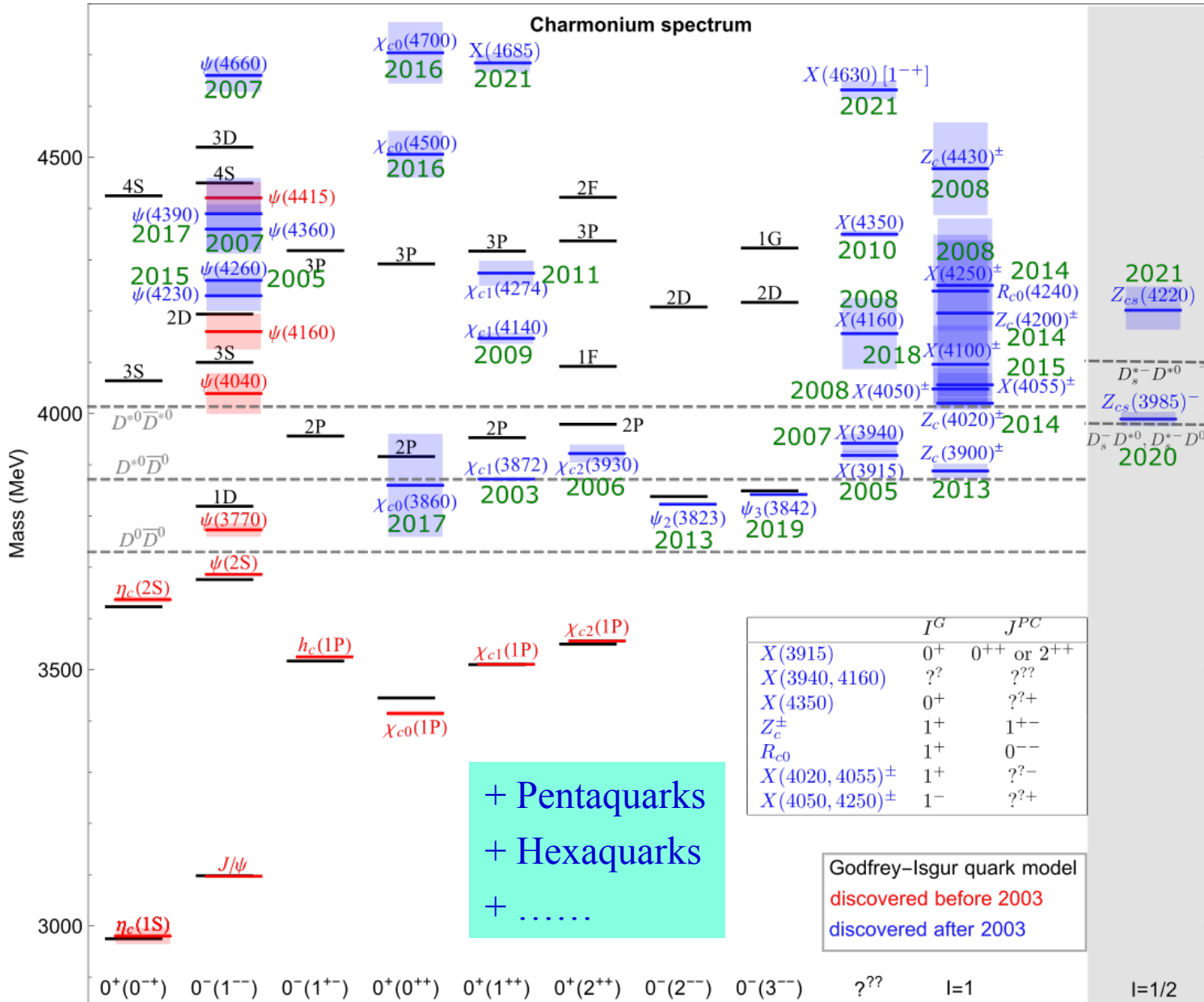
- 会议总结
- XYZ研讨会回顾
- 致谢

# 42 plenary talks

- 1 overview
- 12 experimental talks
  - BESIII, LHCb, Belle, Belle II, CMS
- 29 theoretical talks
  - New tools
  - 2-, 3-, 4-, 5-, 6-, 7-, 8-quarks
  - Meson, baryon, compact multiquark states, atom, molecule, kinematic effect
  - Spectroscopy, properties, nature, production, decay

感谢报告人提供精彩的报告！

# Charmonium(-like) structures



# Theoretical methods

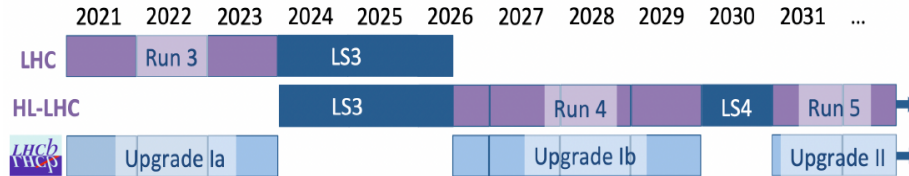
- **Hadronic level: nonrelativistic EFT** Talks by 蒋军、张振华、杨智、吴天伟
  - nonrelativistic expansion + heavy quark symmetry, with and w/o pion exchange
  - poles correspond to hadronic molecules (purely molecules with only constant contact terms in single channel)
  - mixing with charmonia can change the pole positions  
E. Cincioglu, J. Nieves et al. (2016); Friedrichs model: Z.-Y. Zhou, Z.-G. Xiao (2016-2000); ...
  - Low-energy constants unknown
- **Hadronic level: meson exchange model** Talks by 朱俊韬、王福来、陈锐
  - unknown/poorly known couplings
  - cutoff dependence and ambiguous treatment of the short-distance potential
- **Quark level: quark model** Talks by 陈晓云、谭悦、刘风萧、王国利、吴雨衡
  - models based on chromomagnetic interactions Talk by 安洪涛
  - diquark model
  - unquenched quark model Talk by 罗肆强  
Y. Lu, N. Anwar, B.-S. Zou (2017); P. Ortega, J. Segovia, D. Entem, F. Fernandez (2018); ...
  - screened potential B.-Q. Li, K.-T. Chao (2009); ...
- **Quark level: QCD sum rules** Talks by 陈伟、王志刚
- **Kinematical triangle singularities** Talks by 景豪杰、刘晓海、杜蒙列

# A few issues of interest

- Width of the  $X(3872)$
- Width of the  $D_{s0}^*(2317)$
- $\Gamma_{ee}$  of the  $Y(4230)$  and other charmonium(like) states
- Spin-parity of the pentaquark states
- Production/decay rate of any predicted states
- Criteria to discriminate different theoretical models
- What measurements can BESIII, LHCb, Belle II do to understand any of these (exotic) states
- Expectation for states in bottom sector

# Future

## LHCb Upgrade



Upgrade I

$2 \times 10^{33} \text{ cm}^{-2}\text{s}^{-1}$

$23 \text{ fb}^{-1}$  run3 by 2023

$50 \text{ fb}^{-1}$  run4 by 2029

Upgrade II

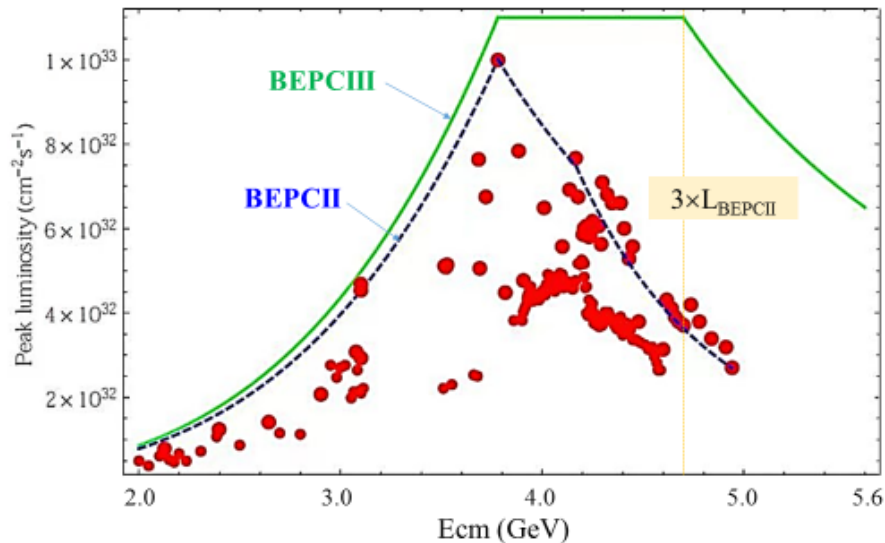
$2 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$

$>300 \text{ fb}^{-1}$  run5

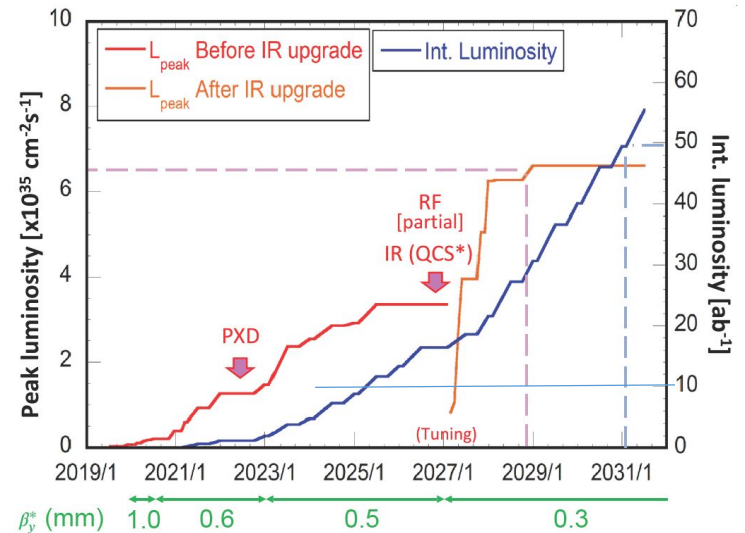


Lots of data at ATLAS,  
CMS, ALICE experiments

## BEPCII luminosity



- $L_{\text{peak}} > 6 \times 10^{35} \text{ cm}^{-2}\text{s}^{-1}$  after modification of SuperKEKB (partial RF, IR, ...)
- Reach  $50 \text{ ab}^{-1}$  goal around 2030





# 1<sup>st</sup> workshop on the XYZ particles

( 2013年5月10-11日 , 北京四季御园 )

25人参会


09:00 **welcome address** 5'  
Speaker: Prof. Yifang Wang (IHEP)

09:05 **Zc & Zb states** 40'  
Speaker: Mr. Zhiqing LIU (IHEP)  
Material: **Slides** 

09:45 **Zc on the lattice** 45'  
Speaker: Prof. Chuan Liu (School of Physics, Peking University)  
Material: **Slides** 


10:30 - 11:00 coffee break


11:00 - 12:30 Morning 2  
Convener: Xiaoyan Shen (IHEP)

11:00 **Exotic vector charmonium and its leptonic decay width** 1h30'  
Speaker: Dr. Ying Chen (Institute of High Energy Physics, Chinese Academy of Sciences, China)  
Material: **Slides** 

12:30 - 14:30 Lunch

14:30 - 16:00 Afternoon 1  
Convener: Keh-Fei Liu

14:30 **XYZ states** 45'  
Speaker: Dr. Chengping Shen (Beihang University)  
Material: **Slides** 

15:15 **Models for XYZ particles** 45'  
Speaker: Prof. Qiang Zhao (Institute of High Energy Physics, Chinese Academy of Sciences)  
Material: **Slides** 



# 2<sup>nd</sup> workshop on the XYZ particles ( 2013年11月20-22日 , 黄山 )

## 2nd Workshop on the XYZ Particles



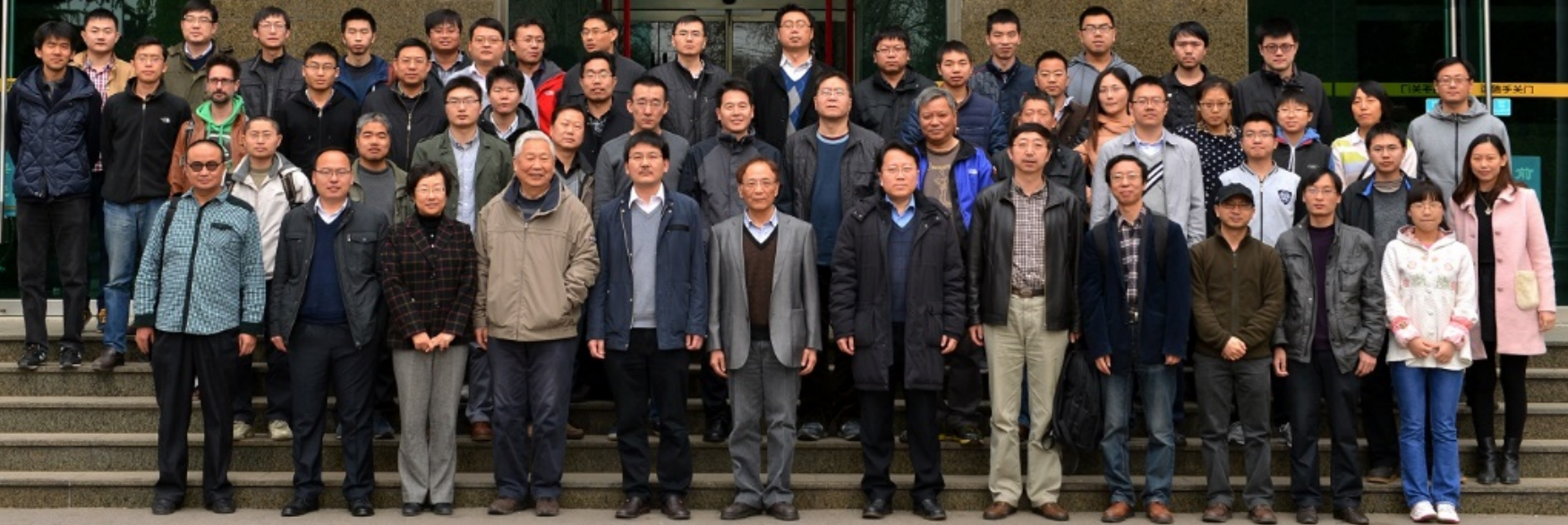
2013.11 黄山



# 3<sup>rd</sup> workshop on the XYZ particles

3<sup>rd</sup> workshop on the XYZ particles

April 1-3, 2015, IHEP, Beijing





# 4<sup>th</sup> workshop on the XYZ particles

( 2016年11月23-25日 , 北京航空航天大学 )





# 5<sup>th</sup> workshop on the XYZ particles

( 2018年10月19-23日 , 郑州大学 )

中国土木工程学会水工业分会2018年给水深度处理研讨会  
热烈欢迎第五届XYZ粒子学术研讨会与会专家





# 6<sup>th</sup> workshop on the XYZ particles

( 2020年1月11-13日, 复旦大学 )



首次放开注册, 注册人数136人!  
【前疫情时代】



# 7<sup>th</sup> workshop on the XYZ particles

( 2021年5月15-18日 , 山东大学 )

第七届XYZ粒子研讨会 山东大学 ( 青岛 ) 2021.5.15-18



后疫情时代，注册人数271人！  
感谢大家参加、提交报告、参与讨论！

**XYZ = 奇特强子态相关研究**

# 感谢组织第七届XYZ粒子研讨会

- **山东大学前沿交叉科学青岛研究院粒子科学技术研究中心**
  - 梁作堂、黄性涛、张学尧、……
- **刘智青等老师及团队**
  - **老师**：刘智青（主席），焦健斌，李晓玲，秦小帅，孙振田
  - **秘书**：尹娜，张兰，孙默瑶，周梦丽
  - **学生与博士后**
    - 李起鑫，吉钰瑶，国梦娇，崔佳佳，谢 勇
    - 曾凡蕊，王吉鹏，王玉林，韩婷婷，李井文
    - 牛 艳，周 航，姜侯兵，廖龙洲



2020年1月，上海：



带着你的最新成果，明年青岛见！



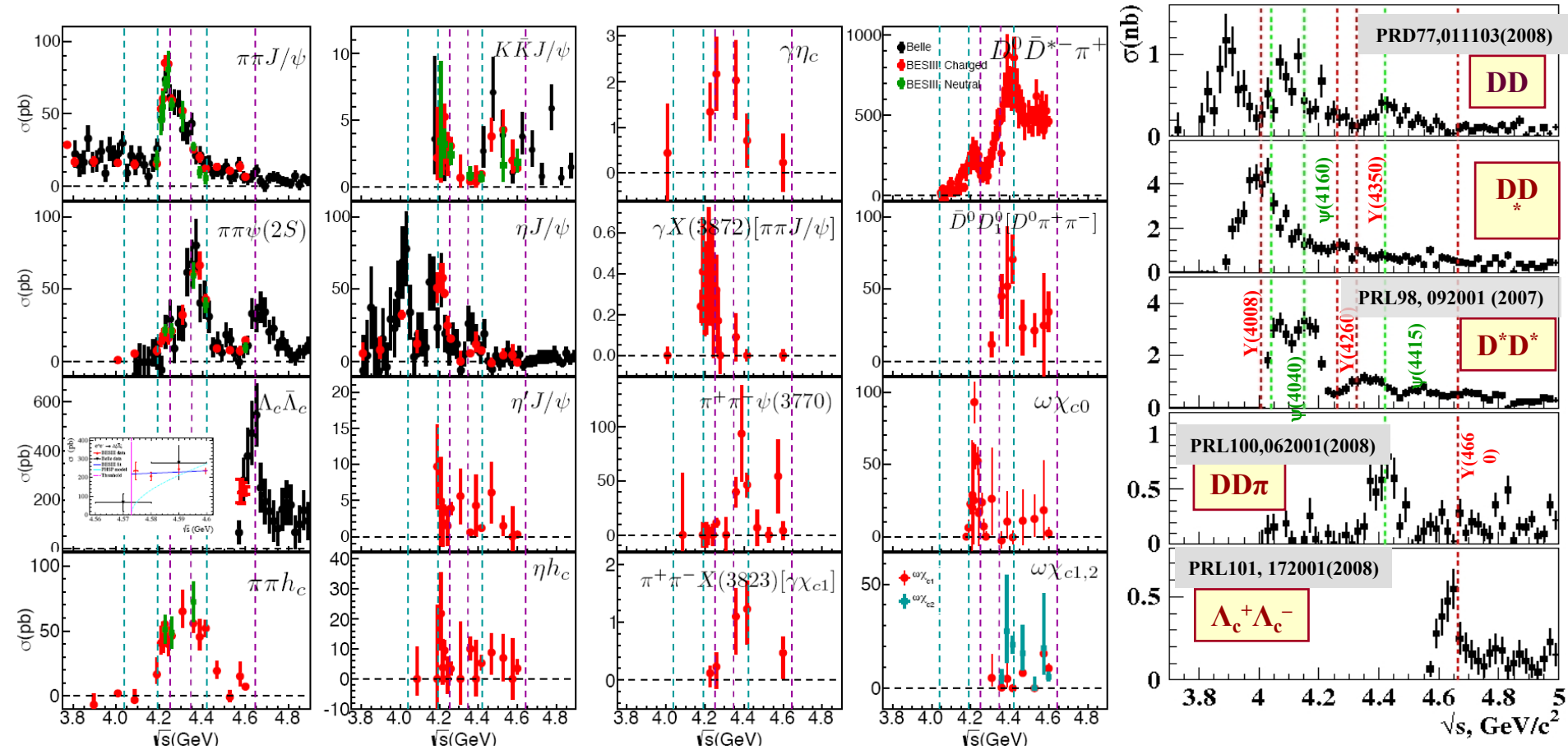
2021年5月，青岛：



带着你的最新成果，明年奔向长春！

backup

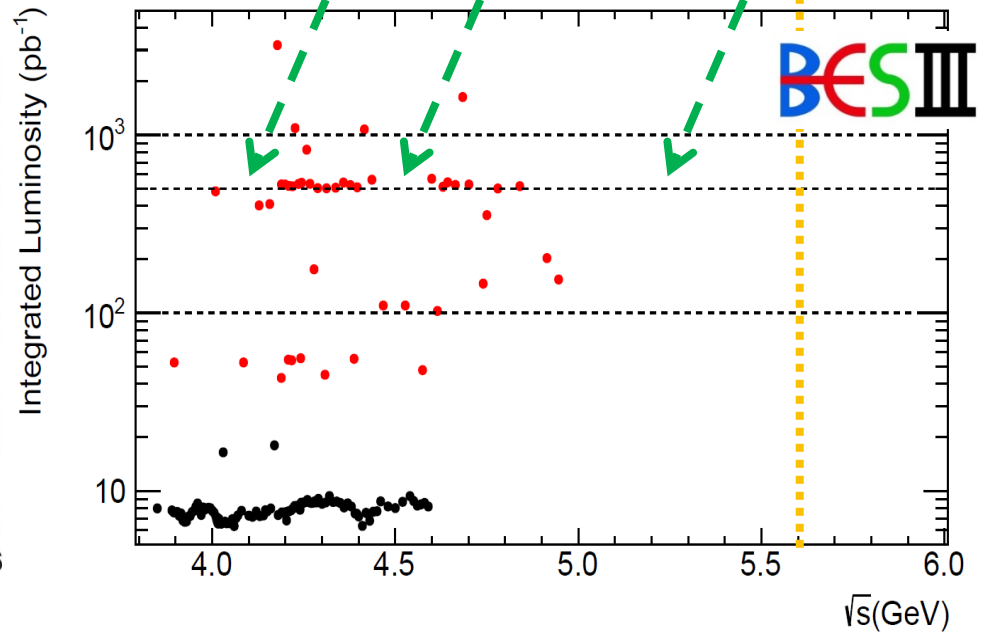
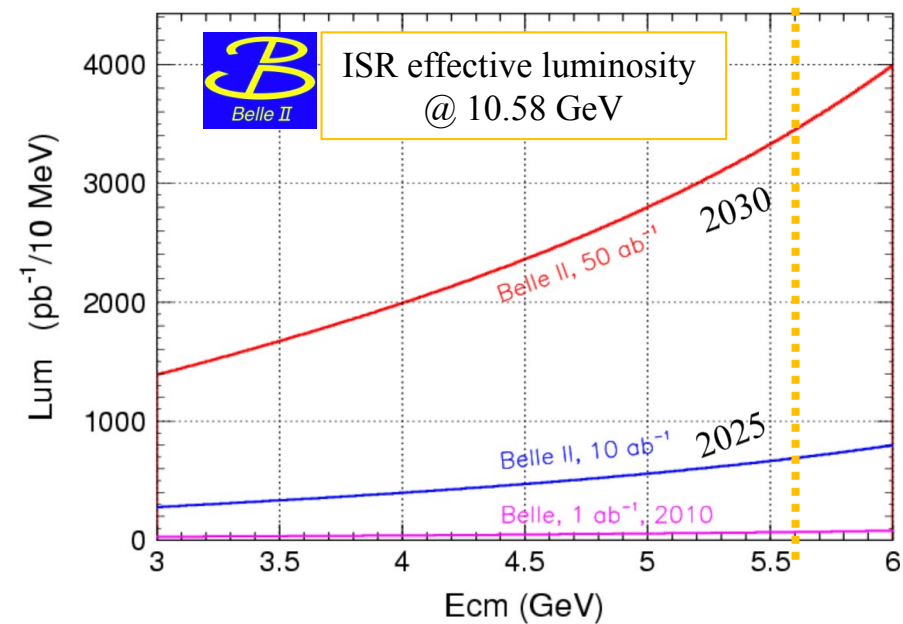
After we have measured all the  $e^+e^-$  annihilation cross sections, what do we do to get the resonant parameters of the vector charmonium(-like) states?



From Yuping Guo, talk @ Hadron2019, Guilin

From Galina Pakhlova

# Comparison between Belle II ISR & BESIII



# Belle II vs. BESIII in XYZ study

Full Belle II data sample (50 ab<sup>-1</sup> at 10.58 GeV, ISR events in 10 MeV)  
 compared with 0.5 fb<sup>-1</sup> at BESIII/BEPCII [or BEPCIII]

ISR mode	$L_{\text{BESIII}}/L_{\text{Belle II}}$	$\epsilon_{\text{BESIII}}/\epsilon_{\text{Belle II}}$	$N_{\text{BESIII}}/N_{\text{Belle II}}$
$\pi^+\pi^-J/\psi$ @ 4.26 GeV	0.5 fb <sup>-1</sup> / 2.2 fb <sup>-1</sup>	46% / 15%	0.70
$\pi^+\pi^-\psi'$ @ 4.36 GeV	0.5 fb <sup>-1</sup> / 2.3 fb <sup>-1</sup>	41% / 5%	1.82
@ 4.66 GeV	0.5 fb <sup>-1</sup> / 2.5 fb <sup>-1</sup>	35% / 6%	1.19
$\pi^+\pi^-h_c$ @ 4.26 GeV @ 4.36 GeV	0.5 fb <sup>-1</sup> / 2.2 fb <sup>-1</sup>	2.7% / —	> 5
$K^+K^-J/\psi$ @ 4.6 GeV	0.5 fb <sup>-1</sup> / 2.4 fb <sup>-1</sup>	40% / 7.5%	1.11
@ 4.9 GeV	0.5 fb <sup>-1</sup> / 2.7 fb <sup>-1</sup>	~40% / 10%	0.74
$\Lambda_c^+\Lambda_c^-$ @ 4.6 GeV	0.5 fb <sup>-1</sup> / 2.4 fb <sup>-1</sup>	51% / 7.5%	1.42
@ 4.9 GeV	0.5 fb <sup>-1</sup> / 2.7 fb <sup>-1</sup>	39% / 7.5%	0.96

Data taking strategy at BESIII is crucial! A few round of scans?