BESIII Future Plans

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for the BESIII collaboration

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13th international workshop on heavy quarkonium

SFB 1044 THE LOW-ENERGY FRONTIER OF THE STANDARD MODEL

JG|U JOHANNES GUTENBERG UNIVERSITÄT MAINZ

PRISMA+

Physics in the τ-charm region in China

Long and successful history:

1981 T. D. Lee and W. Panofsky suggest e^+e^- collider in China

1982 e^+e^- collider endorsed by Deng Xiaoping

1984 Approval and ground breaking with Deng Xiaoping wielding shovel

1988 First collisions in BEPC

1991 US scientists join BES ($\approx$ 145 authors)

2003 Approval of major upgrade: BEPCII and BESIII

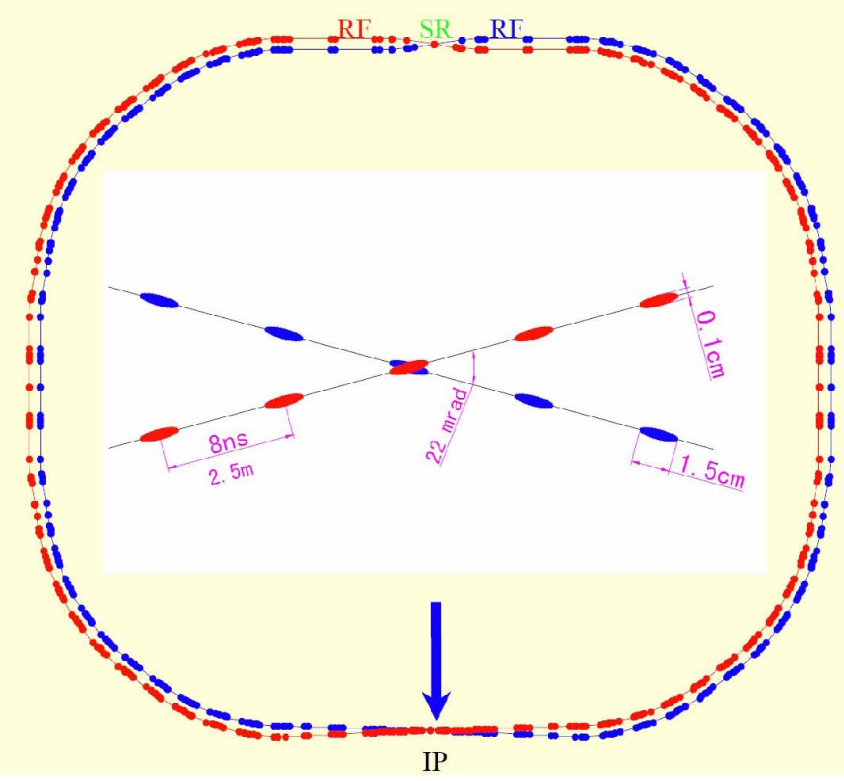
2008 First hadron events recorded in BESIII

2019 BESIII: international collaboration with 500 members

IHEP

IHEP

BEPCII storage rings: a τ-charm factory



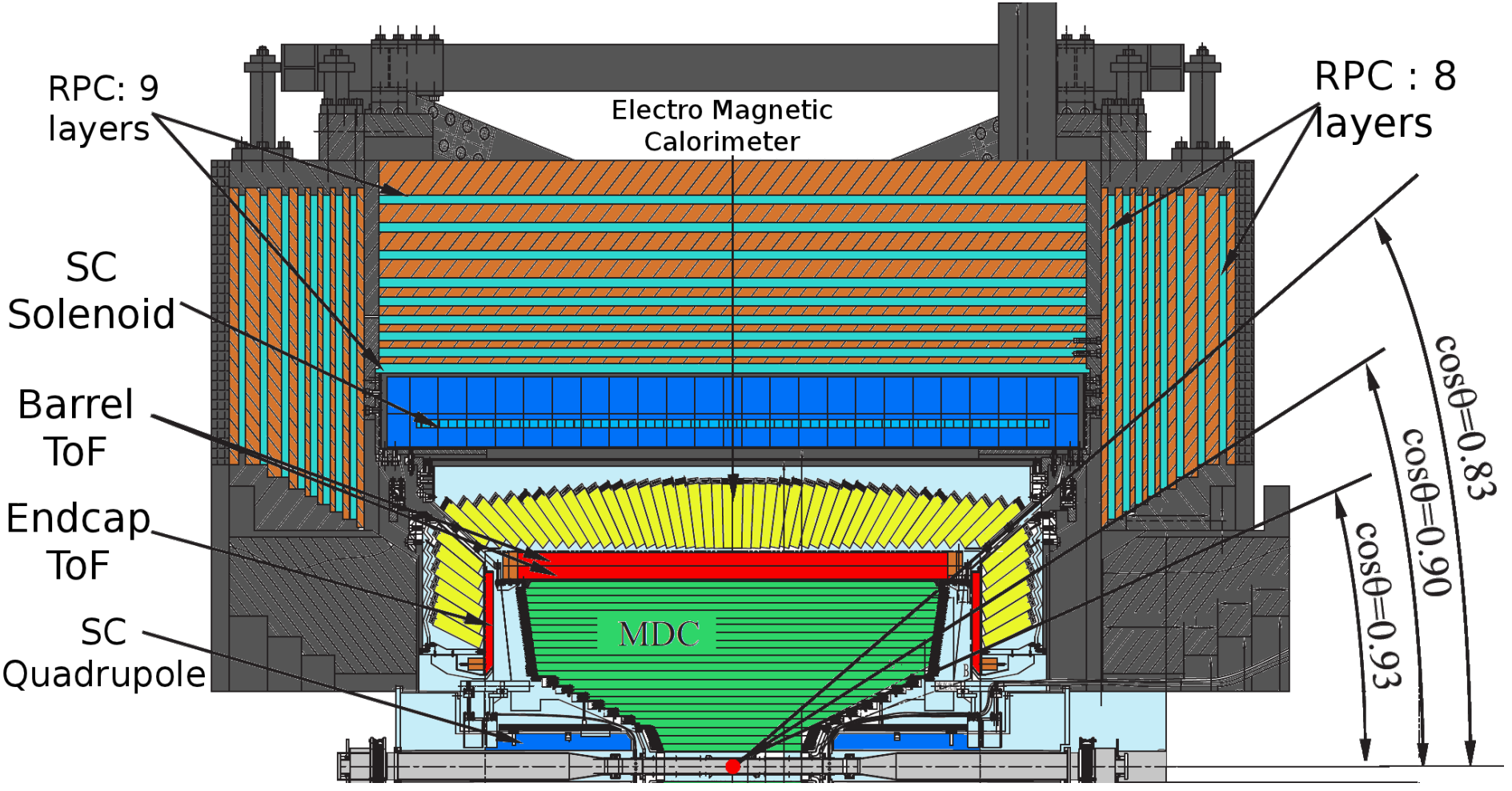
Upgrade of BEPC (started 2004, first collisions July 2008)

Beam energy	1 GeV to 2.3 GeV
Optimum energy	1.89 GeV
Single beam current	0.91 A
Crossing angle	± 11 mrad

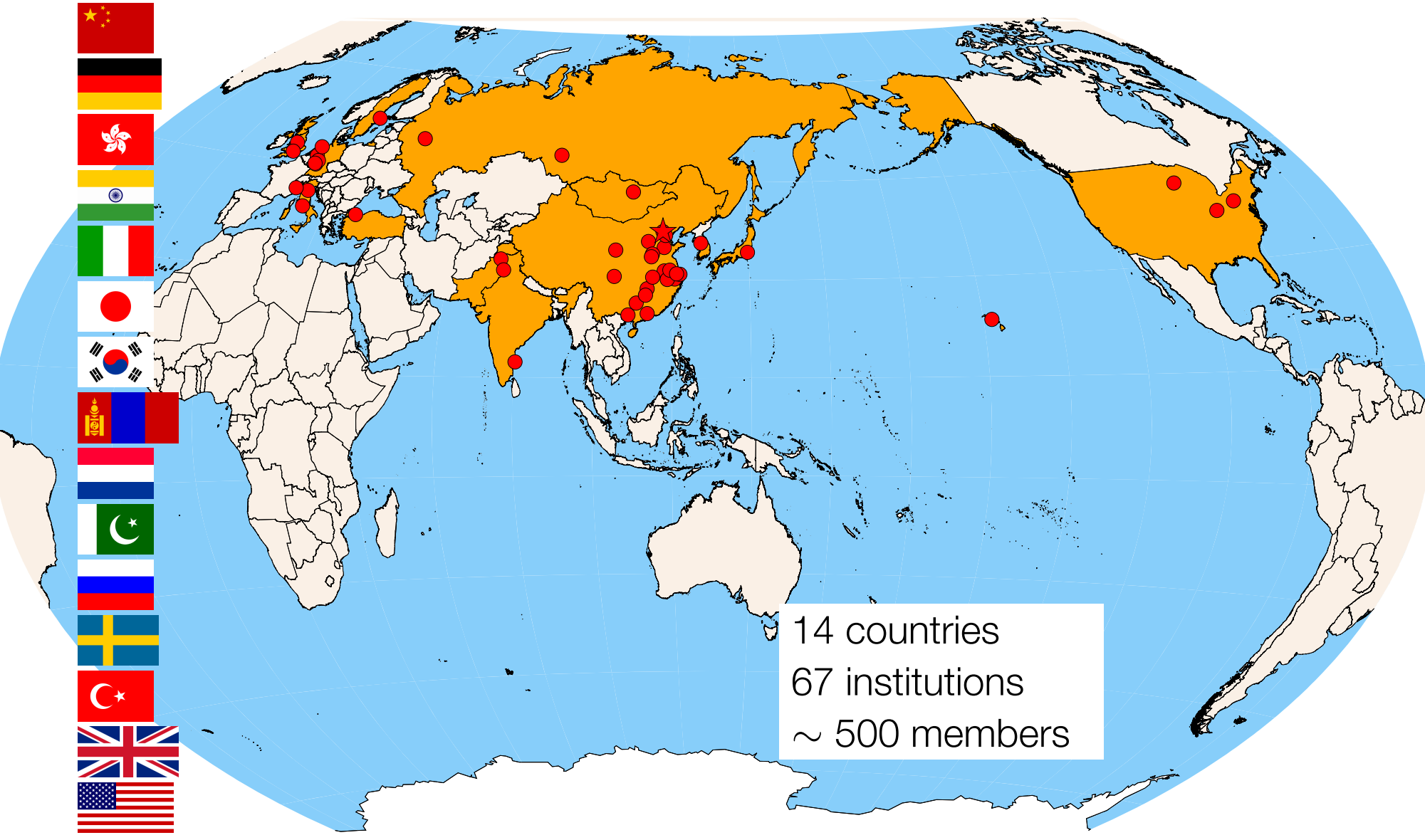
Design luminosity $1 \times 10^{33}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$
Achieved in 2016

Beam energy measurement:
Laser Compton backscattering
$\Delta E/E \approx 2 \times 10^{-5}$
(contributes ≈ 50 keV to m_τ uncertainty)

BESIII detector



Completely new detector in 2008

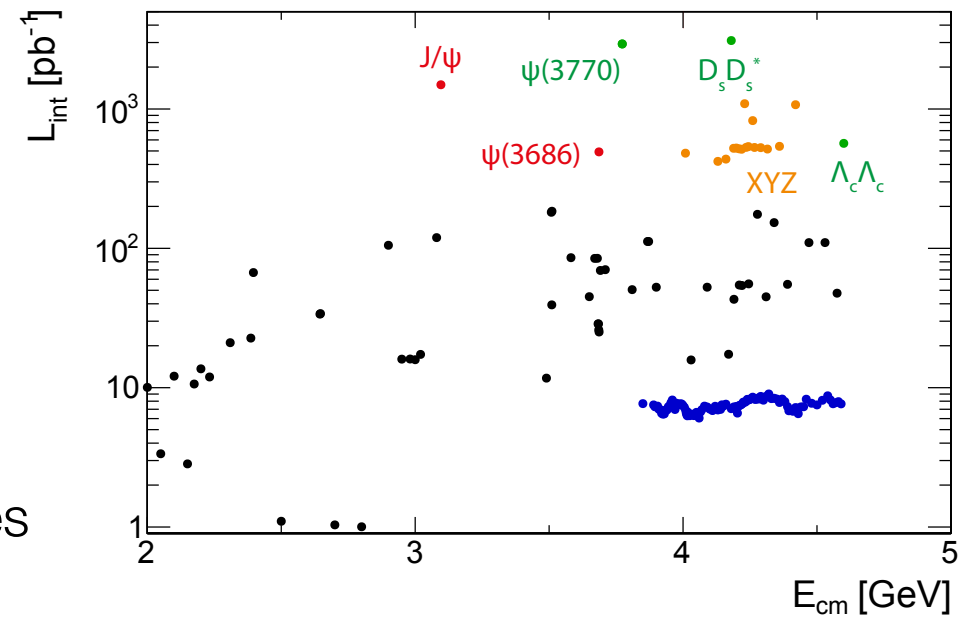


The BESIII Collaboration 2019

10 years data taking at BESIII

Data sets collected so far include

- 10×10^9 J/ψ events
- 448×10^6 ψ' events
- scan data between 2.0 and 3.08 GeV, and above 3.735 GeV
- large datasets for XYZ studies



Unique data sets for open charm:

$\sqrt{s}$ / GeV	$\mathcal{L}$ / fb^{-1}	
3.77	2.93	$D\bar{D}$
4.008	0.48	DD^*, $\psi(4040)$, $D_s^+ D_s^-$
4.18	3.2	$D_s D_s^*$
4.6	0.59	$\Lambda_c^+ \bar{\Lambda}_c^-$

10 years data taking at BESIII

More than 250 papers published or submitted so far
several new results shown at this workshop

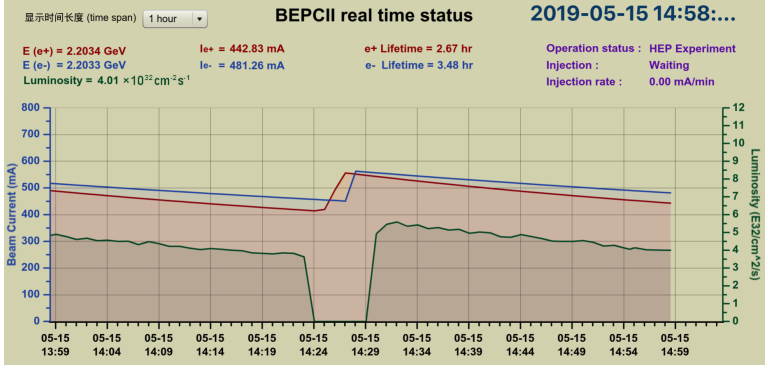
Highlights include:

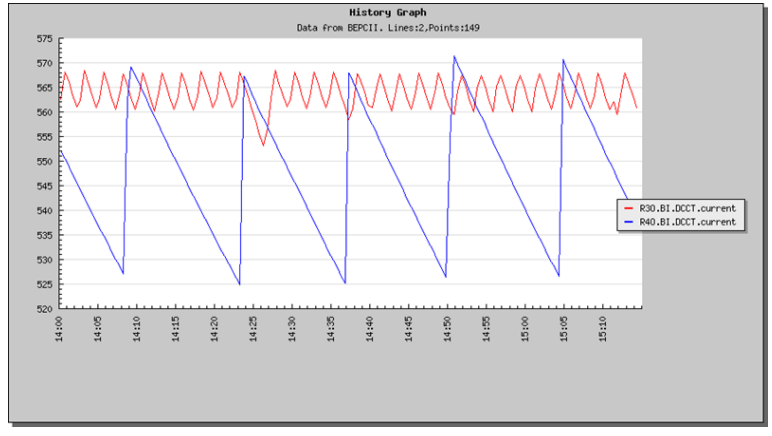
- Precision measurement of τ mass
  (expect improved measurement soon!)
- Form factors of charmed hadrons, $|V_{cs}|$, $|V_{cd}|$
- Λ_c^+ production at threshold, Λ_c^+ decays
- G_E, G_M of proton
- Polarisation of Λ from J/ψ decays
- Charmonium and XYZ spectroscopy
  $Z_c(3900)$, $Z_c(4020)$, $Y(4260)$, $X(3872)$ ...

Near future: Upgrades to accelerator

Planned and funded upgrades of BEPCII:

- Top-up injection: level off instantaneous luminosity
  gain ≈ 30% in $\mathcal{L}_{\text{int}}$
  Upgrades to feedback systems, accelerator steering, BESIII trigger (inhibit L1 trigger around injection) …all done!
  Test runs taken a few days ago look promising





Near future: Upgrades to accelerator (II)

- Energy upgrade
  - currently, $E_b^{\max} = 2.3\,\text{GeV}$ due to power supplies, cooling of magnets
  - upgrade I: $E_b^{\max} = 2.35\,\text{GeV}$: done in summer shutdown 2018
  - upgrade II: $E_b^{\max} = 2.45\,\text{GeV}$: requires rebuilt septum magnets (in progress)

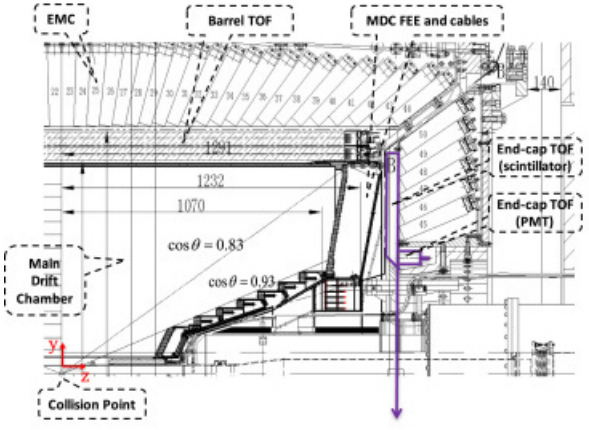
  will give access to resonance around 4.66 GeV seen by Belle in $\Lambda_c^+ \bar{\Lambda}_c^-$ and much larger Λ_c^+ sample (and via $\Sigma_c^+ \bar{\Lambda}_c^-$, absolute BF of Σ_c^+)
- More extensive luminosity upgrade under study

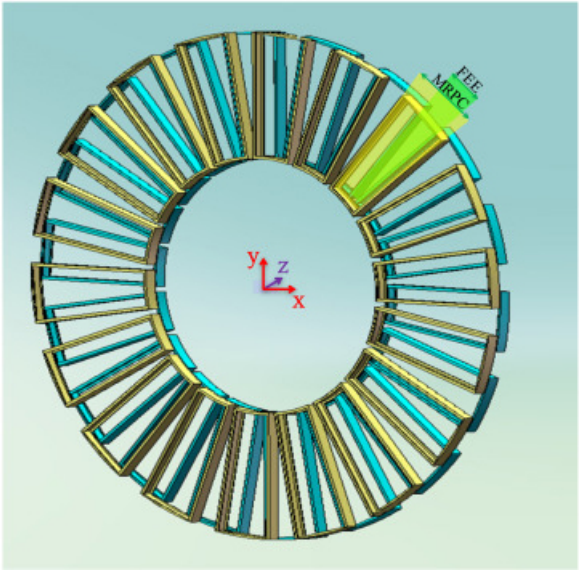
Magnet power supply room during 4.6 GeV running in winter 2013/14

Near past and future: upgrades to detector

Detector has been running very smoothly,
performance generally excellent.

- Endcap TOF: upgrade finished 2015
  replace single-layer plastic scintillator with multigap RPC
  TOF resolution: 110 ps ➡ 60 ps
  95% π/K separation up to 1.4 GeV

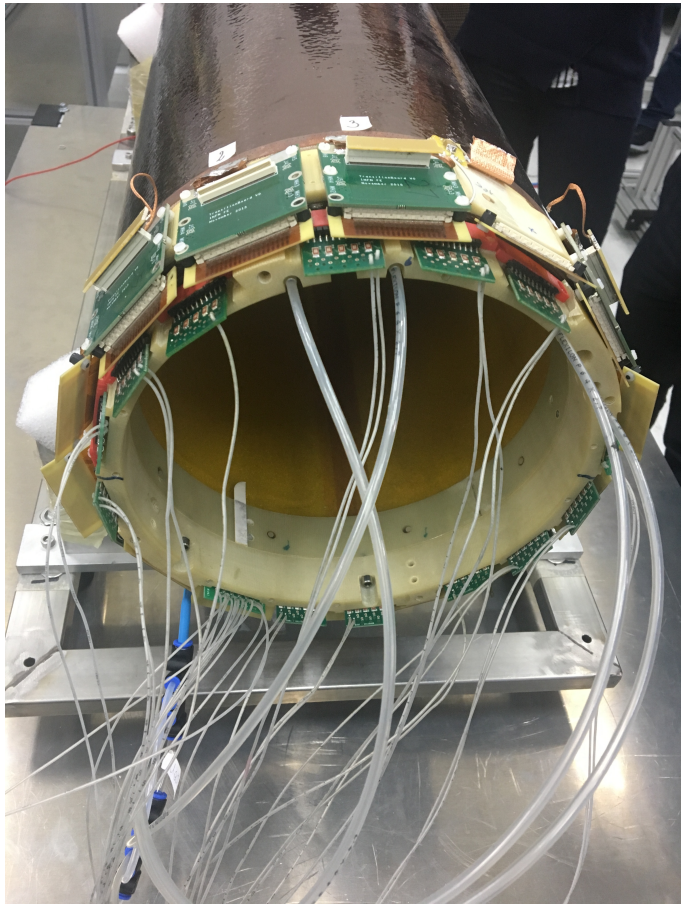




Near past and future: upgrades to detector (II)

Innermost part of drift chamber shows signs of ageing
halted by changing gas mixture, slightly lower HV
➡ efficiency deteriorating

- New inner MDC built and available
- CGEM: upgrade in progress
  (installation 2020)
  three layers of cylindrical GEM detectors.
  Radiation hard, efficient, fast, better hit resolution along beam direction.
  Improvements w.r.t. KLOE CGEM detector:
  - Improved anode design
  - Analogue readout (new ASIC, designed in Torino)
  - Micro-TPC reconstruction: get coordinates and direction



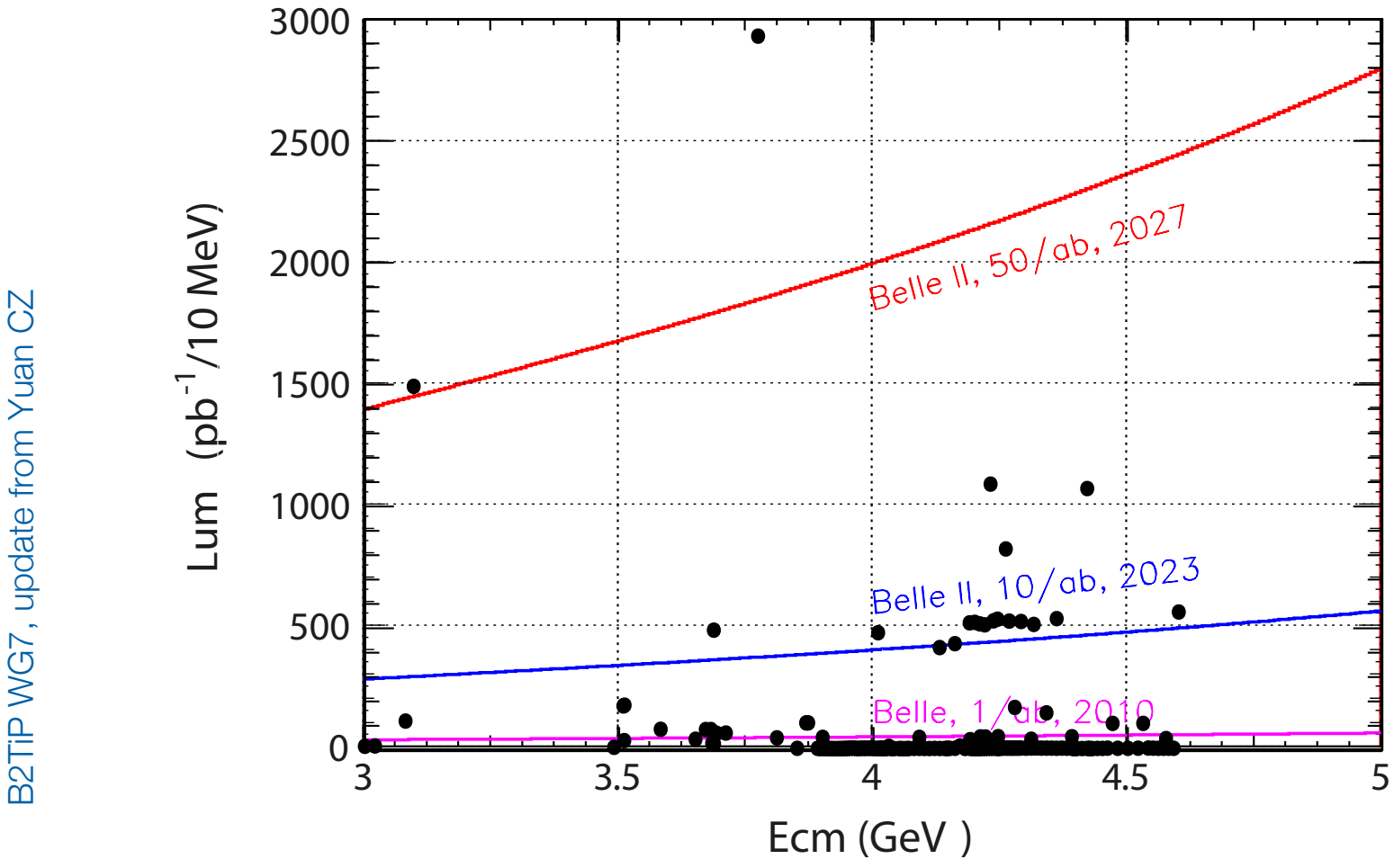
Physics programme for future data taking

Unordered list of data sets to be collected:

- 10 fb^{-1} on $\psi(3770)$ (better yet, 20 fb^{-1})
- 6 fb^{-1} at 4.18 GeV
- 5 fb^{-1} at 4.64 GeV
- scan at highest energies
- continue *XYZ* scan (500 fb^{-1} per point between 4.0 and 4.6 GeV)
- Large Z_c samples: 5 fb^{-1} each at 4.23, 4.42 GeV
- High-statistics data samples around 2.2, 2.4 GeV
- 3×10^9 $\psi(3686)$
- …

…wishlist comprises about 40 fb^{-1}

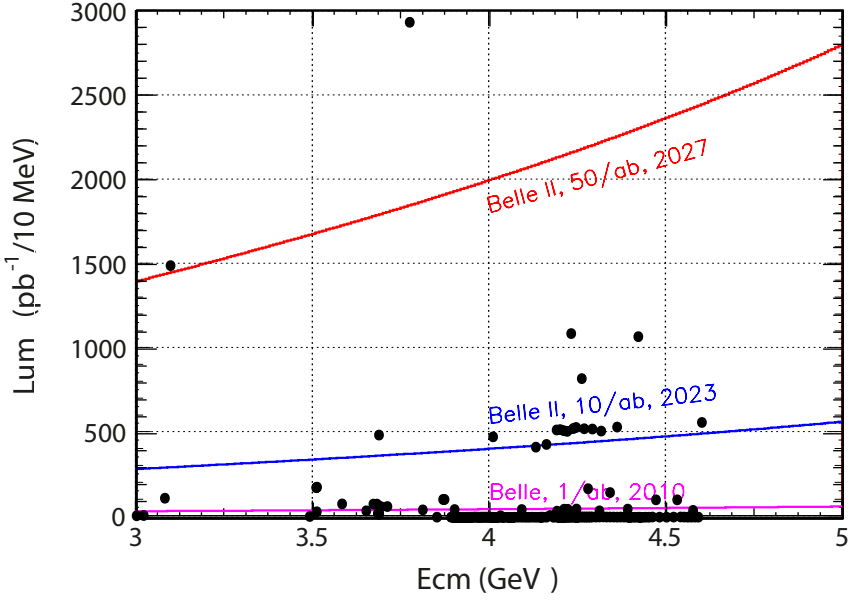
Competition from Belle II?



Typical mass resolution for charged states in ISR physics: $\lesssim 5\,\mathrm{MeV}/c^2$

Spacing of BESIII R-scan points: 5 MeV (beam-energy spread $\sim$ 1.3 MeV), BEMS available!

Belle-II ISR vs BESIII



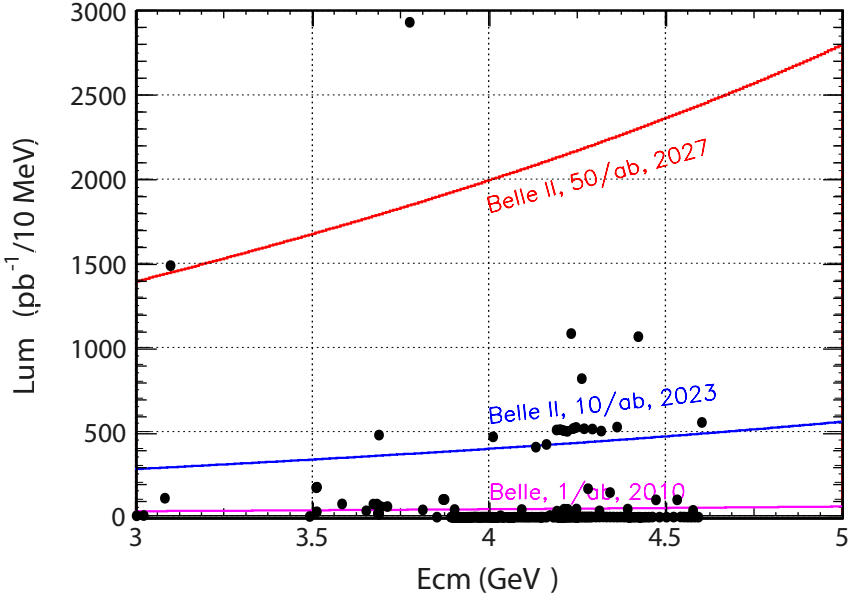
Direct scan

- (very) high luminosity at a few selected $\sqrt{s}$
- better resolution in $\sqrt{s}$ — relevant for direct production of 1^{--} states

ISR

- ISR: many $\sqrt{s}$ simultaneously
- reduced point-to-point systematics
- mass resolution limited by detector res.
- boost of hadronic system vs. γ_{ISR} may actually help efficiency

Belle-II ISR vs BESIII



BESIII still competitive,
even against full Belle II dataset

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Far future: HIEPA — Super-tau-charm factory in China

- Peak luminosity $1 \times 10^{35}\,\mathrm{cm}^{-2}\mathrm{s}^{-1}$ at $\sqrt{s} = 4\,\mathrm{GeV}$
- Energy range $E_{\mathrm{cm}} = 2 \cdots 7\,\mathrm{GeV}$

- Could come online 2030, after the end of BESIII operation
- Appears favourably in reports to Ministry of Science and Technology, Chinese National Science Foundation, and Chinese Academy of Science
- R&D funds allocated
- Site: under discussion (Hefei?) — synergy with other accelerator-based facilities
- Interplay with STCF in Novosibirsk?

Outlook

- BESIII collaboration has the strong support of IHEP lab management.
- Operation time and budget have to be requested periodically. Chinese funding agencies very supportive.
- Whitepaper with outline of physics programme for the next 5 $\sim$ 10 years in preparation.
  International review will start now, expect finished product by end of this year.
- Symposium to celebrate 30 years of τ-charm physics in Beijing: IHEP, 5 – 6 September 2019
  You are cordially invited to attend this event
  `https://indico.ihep.ac.cn/event/9761/`
- **A lot of exciting physics ahead of us with BESIII**