Physics of tau and charm

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The physics of tau and charm started in early 70's after J/ψ and τ were discovered. Since then several dedicated accelerators and experiments were built with increasing luminosities and studies on light hadron spectroscopy, charmonium, electroweak and QCD were never interupted. New interests and surprises are not rare in this area. With the newly built BEPCII/BESIII, an even brighter future is foreseen.

1 introduction: physics at tau-charm colliders

Since the successful test of ADA, several electron-positron colliders were built in late 60's and early 70's. The most successful one is SPEAR, which discovered both the ψ and tau, marking the beginning of the tau-charm physics. Many members of the charmonium family and charmed mesons were then discovered at SPEAR and Doris, and many unknowns and controversies were resolved up to 80's.

The precision physics at tau-charm energy region began from BEPC/BES, the first accelerator even built for high energy physics in China in early 90's. The luminosity were improved by an order of magnitude over SPEAR, and this record was surpassed by CESR-c in 2004, as shown in Fig. 1.

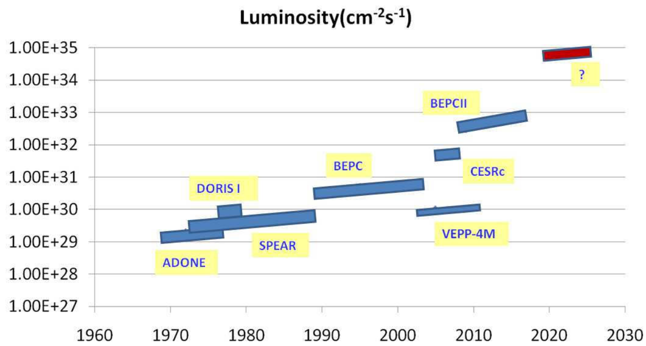

Figure 1: A history of accelerators running for tau-charm physics.

The newly built BEPCII/BESIII is an upgrade to the previous BEPC/BES [1, 2]. The designed peak luminosity is 1×10^{33} cm^{-2}s^{-1}, another order of magnitude over CESR-c. The

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race may continue with the idea of a super-tau-charm factory with a luminosity of about $1 \times 10^{35} cm^{-2}s^{-1}$.

Why we are so interested in building tau-charm colliders in the last 40 years, even now in the era of LHC, and possibly in the future? In fact, J/ψ and its family can be produced at e^+e^- colliders with huge cross sections and abundant resonances, providing an ideal laboratory for charm, charmonium and QCD studies. Charm quark is actually a bridge between pQCD and non-pQCD, and relevant information becomes a ruler for Lattice QCD. Charmonium decays through the so-called three-gluon loop is one of the best channels to search for glueballs and hybrids. The threshold production of charmonia and taus has a lot of advantages on background suppression, kinematic constraints and quantum correlations. In the era of LHC, high precision flavor physics is complementary since new phenomena at high energies should also evident via virtual loops and secondary effects at lower energies.

The latest progress of tau-charm physics and prospects at the newly built high luminosity tau-charm collider, BEPCII, is summarized in the book "Physics at BESIII [3], which covers all the areas including the charm physics, charmonium physics, tau physics, QCD studies and light hadron spectroscopy. Examples of highlights include $D\bar{D}$ mixing, precision measurement of CKM matrix elements and the tau mass, charmonium transition and spectroscopy, exotic hadron searches, new hadrons above the open charm threshold, etc.

In this talk, I will select a few topics to report the progress in this field.

2 CLEOc: a fruitful short program on charm physics

CESRc started its charm program since 2004 and ceased operation in 2008. Although very short, it is a very fruitful program in charm and charmonium physics.

Threshold production of charmed mesons is of particular importance since D and $\bar{D}$ are doubly produced at $\psi(3770)$ at rest. $D\bar{D}$ mixing can then be studied in an almost background-free environment with quantum correlations. Even the statistics is low and there is no time-development, the double-tag technique allows to reduce systematic errors, hence a complementary to that at B-factories. CLEO reported a first determination of cosδ using the quantum correlation between two D's produced at rest from $\psi(3770)$ decays [4]. In fact, due to the mixing, tagging one D^0 in a CP eigenstate, the other side is a mixture of D^0 and $\bar{D}^0$ with an event rate proportional to $B_1B_2(1 + 2rcos\delta)$, where B_1 and B_2 are branching ratios of D's at each side, and cosδ is the quantum correlation, which is related to the mixing parameters. A global fit is performed for 8 hadronic D decay channels and δ is determined to be $(22^{+11+9}_{-12-11})^o$, limited by statistics. Clearly with BESIII, a significant improvement can be expected.

$D\bar{D}$ mixing has been firmly established, thanks mainly to B-factories with great statistical advantages. A global fit shows that mixing is established at 10.2 σ level, and consistent with CP conservation [5]. These results are consistent with the Standard Model as well as many New Physics models. In fact, Standard Model can not give a reliable prediction due to the complication at hadron level. In order to understand the origin of the mixing, we need to integrate all the flavor physics results, correlate them with other mixing results, have more data on rare decays and CP violation limits to constrain New Physics models. CLEO searched for the CP violation in many D and D_s decays [6]. BESIII at a high luminosity machine can in fact improve the limit significantly.

CKM matrix elements can be measured precisely via leptonic and semi-leptonic decays of

D mesons. In the leptonic case, the decay width follows

$$\Gamma(D_{(s)} \to l\nu) = f_{D_{(s)}}^2 |V_{cq}|^2 \frac{G_F^2}{8\pi} m_{D_{(s)}} m_l^2 (1 - \frac{m_l^2}{m_{D_{(s)}}^2})^2.$$

CLEO recently reported their measurements of $D^+ \to \mu^+\nu$, $D_s^+ \to \mu^+\nu$ and $D_s^+ \to \tau^+\nu$, giving $f_D = (205.8 \pm 8.5 \pm 2.5)$ MeV, $f_{D_s} = (259.5 \pm 6.6 \pm 3.1)$ MeV [7]. While f_D is in perfect agreement with the prediction of lattice QCD [8], i.e. (208 ± 4) MeV from the HPQCD-UKQCD group, f_{D_s} is 2.3 σ away from the prediction of (241 ± 3) MeV. BESIII may resolve this issue with a larger statistics and better precision.

In the semi-leptonic case, the differential decay width follows

$$\frac{d\Gamma(X \to X' l\nu)}{dq^2} = [f_+^{X \to X'}(q^2)|V_{Qq}|]^2 \frac{G_F^2}{24\pi^3} p_{X'}^3.$$

By fitting this formula with data and using LQCD prediction of $f_+^K(0)$ and $f_+^\pi(0)$, as shown in Fig. 2, CLEO obtained new CKM matrix element measurement [9], $|V_{cd}| = 0.234 \pm 0.007(stat.) \pm 0.002(syst.) \pm 0.025(LQCD)$, and $|V_{cs}| = 0.985 \pm 0.009(stat.) \pm 0.006(syst.) \pm 0.103(LQCD)$. Several new D and D_s semi-leptonic decay modes are observed for the first time by CLEO [10], as listed in Table 1. These new D decay modes are interesting for glueball searches, while new D_s decay modes are Cabibbo-suppressed and scalers.

decay mode	branching fraction
$D^+ \to \eta e^+\nu$	$0.133 \pm 0.020 \pm 0.006$
$D^+ \to \eta' e^+\nu$	<0.035
$D^+ \to \phi e^+\nu$	< 0.016
$D_s^+ \to \eta e^+\nu$	$2.48 \pm 0.29 \pm 0.13$
$D_s^+ \to \eta' e^+\nu$	$0.91 \pm 0.33 \pm 0.05$
$D_s^+ \to \phi e^+\nu$	$2.29 \pm 0.37 \pm 0.11$
$D_s^+ \to K^0 e^+\nu$	$0.37 \pm 0.10 \pm 0.02$
$D_s^+ \to K^{*0} e^+\nu$	$0.18 \pm 0.07 \pm 0.01$
$D_s^+ \to f_0(\to \pi^+\pi^-) e^+\nu$	$0.13 \pm 0.04 \pm 0.01$

Table 1: Branching ratios of several new semi-leptonic decay modes measured by CLEO.

Only a small fraction of charm physics results from CLEO are reported here. For more information, please refer to recent publications of the CLEO collaboration. Now let's turn to charmonium physics.

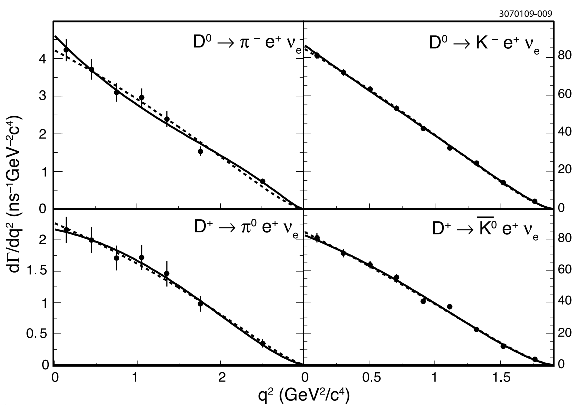

Figure 2: The momentum spectrum of semi-leptonic decays from CLEO experiment

Charmonium family, an interesting lab for pQCD and non-pQCD, can be used to calibrate LQCD. Their productions, transitions, decays and the spectroscopy are not fully understood yet and examples of interesting and long-standing issues including the $\rho\pi$ puzzle, mixing state, missing states, and new XYZ states. For detailed discussion, please refer to reference [3].

η_c is the lowest state of the charmonium family, its mass and width are hence critical. However, current mass measurements are not consistent, and this problem is traced by CLEO to be the distorted line-shape of η_c [11] from a standard Breit-Wigner form,as shown in Fig 3. The reason is not known yet, and CLEO fitted the data with a modified empirical Breit-Wigner formula. We are waiting for results from BESIII on exclusive channels and energy dependent $\psi(1S, 2S) \to \gamma\eta_c$ matrix element measurements.

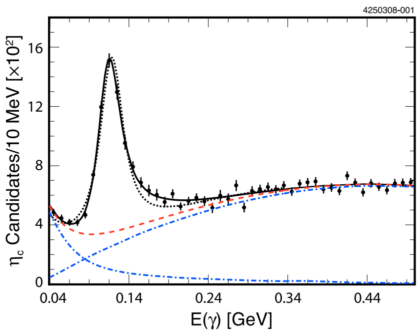

Figure 3: Fits to the photon spectrum in exclusive $J/\psi \to \gamma\eta_c$ decays using relativistic Breit-Wigner (dotted) and modified (solid) signal line shapes convolved with a 4.8 MeV wide resolution function.

χ_{cJ} from ψ' decays is ideal for the light hadron spectroscopy since they have clean and multiple J^{PC} states. In two body decays they can be used to study the role of the color octet mechanism and to probe the gluon content in final states. CLEO reported results for two-baryon final states previously [12], and two-meson final states recently including $\pi\pi$, $\eta\eta$, $\eta\eta'$, $\eta'\eta'$, KK, etc. [13]. Radiative decay processes of χ_{cJ} to light vectors, $\chi_{cJ} \to \gamma(\rho, \omega, \phi)$, similar to that of the glueball production of $J/\psi \to \gamma f_J$, have been searched for. For the first time, the decay modes of $\chi_{c1} \to \gamma\rho$ and $\chi_{c1} \to \gamma\omega$ are observed [14]. Figure 4 shows the observed signals and table 2 list the results in comparison with the prediction based on pQCD calculations [15]. However, the prediction is one order of magnitude below the observation.

decay mode	BR×10^6	U.L.[10^{-6}]	pQCD[10^{-6}]
$\chi_{c0} \to \gamma\rho^0$		<9.6	1.2
$\chi_{c1} \to \gamma\rho^0$	$243 \pm 19 \pm 22$		14
$\chi_{c2} \to \gamma\rho^0$	$25 \pm 10^{+8}_{-14}$	<50	4.4
$\chi_{c0} \to \gamma\omega$		<8.8	0.13
$\chi_{c1} \to \gamma\omega$	$83 \pm 15 \pm 12$		1.6
$\chi_{c2} \to \gamma\omega$		<7.0	0.5
$\chi_{c0} \to \gamma\phi$		<6.4	0.46
$\chi_{c1} \to \gamma\phi$	$12.8 \pm 7.6 \pm 1.5$	<26	3.6
$\chi_{c2} \to \gamma\phi$		<13	1.1

Table 2: Measured Branching ratios or up limits in comparison with pQCD calculations

CLEO also reported charmonia(J/ψ, $\psi(2S)$ and $\psi(3770)$) radiative decays to pesude-vectors, including π^0, η and η' [16]. Improvements over previous measurements on J/ψ and $\psi(2S)$ decays

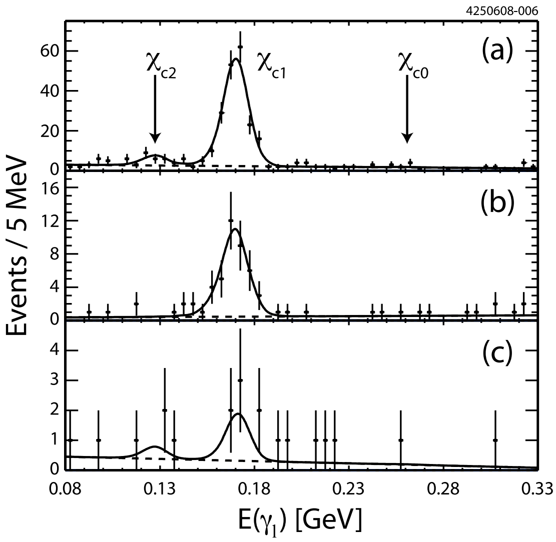

Figure 4: Observed signal of $\chi_{cJ} \to \gamma V$. The $\psi(2S) \to \gamma\chi_{cJ}$ transition photon (γ_1) energy distribution for (a) $\chi_{cJ} \to \gamma\rho^0$, (b) $\chi_{cJ} \to \gamma\omega$, and (c) $\chi_{cJ} \to \gamma\phi$ candidates. The data are shown by the points; the fit is shown as a solid line. The background component of the fit is indicated by the dashed line.

were observed, while no $\psi(3770)$ decays was observed. A new decay mode of $J/\psi \to \gamma\gamma\gamma$ was observed [17], and the branching fraction is measured to be $(1.2 \pm 0.3 \pm 0.2) \times 10^{-5}$. This is the quarkonium analogue of ortho-positronium decay, and no similar decays have been observed for any particles so far.

The last member of the charmonium family under the open charm threshold, h_c was discovered by CLEO [18] and an updated product branching fraction, $B(\psi(2s) \to \pi^0 h_c) \times B(h_c \to \gamma\eta_c)$, was reported to be $(4.19 \pm 0.32 \pm 0.45) \times 10^{-4}$ [19], averaging the inclusive and exclusive channels. Later I will report the first BESIII results which improves this measurements. In fact, with a much larger data sample and a great detector, BESIII will improve significantly all the results mentioned above, and new discoveries are expected.

3 KEDR: a special dedication to mass measurement

The VEPP-4M accelerator and the KEDR detector at Novosibirsk in Russia started operation in 2002 and the luminosity is about $1 \times 10^{30} cm^{-2}s^{-1}$. A special physics program was performed by calibrating the beam energy precisely. Two techniques are developed: Resonance Spin Depolarization with a precision better than 30 keV and Back Compton Scattering with a precision better than 150 keV. The mass of particles in the tau-charm

particles	mass(MeV)
tau	$1776.69^{+0.17}_{-0.19} \pm 0.15$
J/ψ	$3096.924 \pm 0.010 \pm 0.017$
$\psi(2s)$	$3686.125 \pm 0.010 \pm 0.015$
$\psi(3770)$	$3772.8 \pm 0.5 \pm 0.6$
$D^{\pm}$	$1869.32 \pm 0.48 \pm 0.21$
D^0	$1865.53 \pm 0.39 \pm 0.24$

Table 3: Recent mass measurements at KEDR

energy region, including tau, J/ψ,ψ', D mesons etc. are measured to an un-precedent precision. Table 3 lists their results[20]. Results are consistent with previous measurements and further improvements are expected. The Back Compton Scattering technique will be used at BESIII and an even more precised tau mass measurement is expected.

4 BESII: a final legacy

The partial upgrade of the BES detector, called BESII, stop operation in 2004, however, physics results on light hadron spectroscopy and QCD studies are still coming based on the existing data sample. Since the production cross section of J/ψ is huge, its decay is an ideal place for light hadron spectroscopy study. A few examples are given here.

κ is a very interesting particle needed by the Chiral Perturbative Theory. There was a hot debate since it was observed for the first time in $K\pi$ scattering. The E791 experiment found the evidence of neutral κ in 2004 from $D^+ \to K^-\pi^+\pi^+$ and BESII firmly established its existence in 2006 from $J\psi \to K^{*0}K\pi \to K\pi K\pi$ decays [21]. CLEO reported the necessity of charged κ in $D^0 \to K^+K^-\pi^0$, however, no $\kappa^\pm \to K^\pm\pi^0$ is needed in BABAR data. BESII recently observed charged κ in $J/\psi \to K^{*\pm}\kappa^\mp \to K_s\pi^\pm K^\mp\pi^0$, as shown in Fig. 5 [22]. The pole position is measured to be $(841 \pm 51^{+14}_{-28}) - i(288 \pm 101^{+64}_{-30}) MeV/c^2$, in consistent with that of the neutral one.

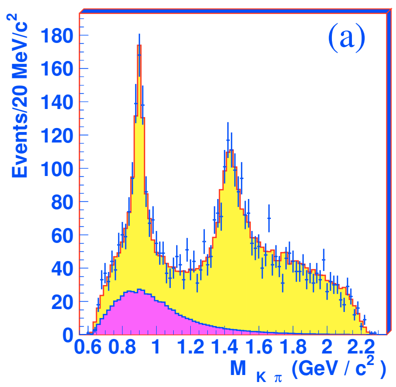

Figure 5: The observed $\kappa^\pm$ signal at BESIII from an invariant mass spectrum of $K^\pm\pi^0$. Shaded area are κ signals.

In addition to light hadron physics, QCD studies at the tau-charm energy region is of particular importance since it is at the boundary between pQCD and non-pQCD. Precision measurement of the R-value in this region will provide valuable input for vacuum polarization, improving the prediction of Higgs mass and g-2. BESII recently reported a new measurement of R at the center-of-mass energies of 2.6 GeV, 3.07 GeV and 3.65 GeV respectively, reducing the error from about 6% to 3.5% [23].

5 BESIII: a bright future

The newly completed upgrade of Beijing Electron-Positron Collider(BEPCII) and the new detector(BESIII) represents the future of the field [1]. BEPCII is a double-ring accelerator with a designed peak luminosity of 10^{33} $cm^{-2}s^{-1}$ at a beam current of 0.93 A. Both the machine and the detector worked remarkably well since beginning and world largest data samples of J/ψ and ψ' have been collected. It is believed that physics at the tau-charm region will be renewed dramatically and important discoveries will be possible.In the following I will gave a short summary about their performance and the initial results recently published.

5.1 Status of BEPCII/BESIII and data taking

The BEPCII/BESIII upgrade started in 2003 and successfully completed in 2008. BEPCII managed to accumulate a beam current of 500 mA in the storage ring, and obtained a collision luminosity close to $10^{32}\text{cm}^{-2}\text{s}^{-1}$ in March 2008. While the BESIII detector completed installation at the end of 2007 and the first full cosmic-ray event was recorded in March 2008. The detector was successfully moved to the interaction point on April 30, 2008. With a careful tuning of the machine, the first e^+e^- collision event was recorded by the BESIII detector on July 19, 2008, and a total of 14 million ψ' events was collected until Nov. 2008. Over this period, the BEPCII performance continued to improve by the lattice optimization, system debugging, and vacuum improvements. After a 1.5-month synchrotron radiation run and a winter maintenance, the machine resumed collision and its luminosity gradually improved from 1×10^{32} $cm^{-2}s^{-1}$ to 3×10^{32} $cm^{-2}s^{-1}$.

Starting from March of 2009, BES-III successfully collected 100 million $\psi(2S)$ events and 200 million J/ψ events, about a factor of 4 larger than the previous data samples from CLEO-c and BES-II, respectively. The peak luminosity was stable, typically at the level of 2×10^{32} $\text{cm}^{-2}\text{s}^{-1}$ during the data taking at $\psi(2S)$, and 0.6×10^{32} $\text{cm}^{-2}\text{s}^{-1}$ at J/ψ. An energy scan of the $\psi(2S)$ line-shape shows that the beam energy spread is about 1.4 MeV, and the effective peak cross section of $\psi(2s)$ is about 700 nb. The data taking efficiency of the detector is more than 85%.

The BESIII detector [1, 2], as shown in Fig. 6, consists of the following main components: 1) a main draft chamber (MDC) equipped with about 6500 signal wires and 23000 field wires arranged as small cells with 43 layers. The designed single wire resolution is 130 μm and the momentum resolution 0.5% at 1 GeV; 2) an electromagnetic calorimeter(EMC) made of 6240 CsI(Tl) crystals. The designed energy resolution is 2.5%@1.0 GeV and position resolution 6mm@1.0 GeV; 3) a particle identification system using Time-Of-Flight counters made of 2.4 m long plastic scintillators. The designed resolution is 80 ps for two layers, corresponding to a K/π separation (2σ level) up to 0.8 GeV; 4)a superconducting magnet with a field of 1 tesla; 5) a muon chamber system made of Resistive Plate Chambers(RPC).

The detector was calibrated using the $\psi(2S)$ events and the main performance parameters of the BES-III detector is shown in Fig. 7. Clearly, the detector is in a very good condition and all the design specifications have been satisfied.

A comprehensive Monte Carlo simulation code, largely based on the first principle of particles interacting with detector materials, was developed to model the performance of the BES-III detector. A good agreement was observed, not only on average numbers, but also on the details functional shape. This agreement ensures the well control of systematic errors and precision physics measurement.

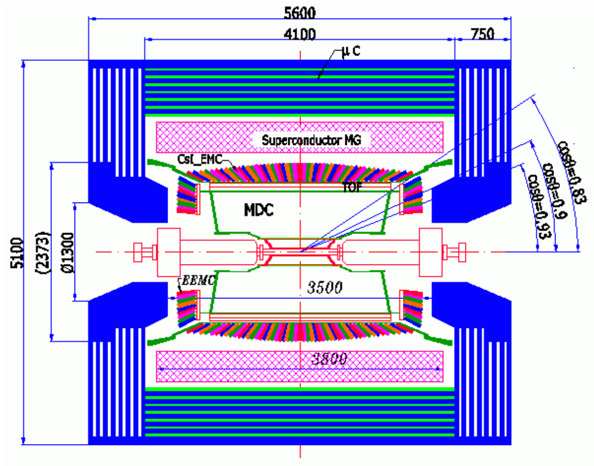

Figure 6: A schematic view of the BESIII detector.

5.2 Preliminary physics results

Physics at BESIII are very rich [3]. An initial physics program has been planned for the $\psi(2S)$ data set, including, but not limited to, the following topics:

- Spin-singlet studies(h_c, η_c, η_c');
- $\psi(2S)$ hadronic decays ($\rho\pi$ puzzle, new states);
- χ_c decays (search for new states and new decays).

A first glance of the $\psi(2S)$ data shows that a lot of resonances can be clearly seen. Fig. 8 shows the inclusive photon spectrum from the electromagnetic calorimeter. Signals from the electromagnetic transition between charmoniuum states can be well identified and they demonstrate the impressive performance of the CsI(Tl) crystal calorimeter.

Initial physics results have been obtained, ranging from the confirmation of BES-II and CLEO-c results, to completely new observations. Fig. 9 shows the prompt photon spectrum from $\psi(2S) \to \gamma\pi^0\pi^0$ (left) and $\psi(2S) \to \gamma\eta\eta$ (right) [24]. Signals from χ_{c0} and χ_{c2} are observed and their branching ratios are measured, which are consistent with recent results from CLEO-c [13].

The last member of the charmoniuum family below the open charm threshold called h_c was observed by CLEO-c in 2005 from $\psi(2S)$ decays to $\pi^0 h_c$, $h_c \to \gamma\eta_c$ [18] and an improved measurement was performed recently [19]. BESIII performed a similar analysis with a larger data sample, and a clear signal can be seen by tagging the prompt photon in the h_c decays [25], as shown in Fig. 10. In addition, BESIII tried to look for inclusive π^0 from $\psi(2S)$ decays and clear signals can be also seen. Branching fractions of $\psi(2S) \to \pi^0 h_c$, $h_c \to \gamma\eta_c$ can be individually measured for the first time, together with the width of h_c. Results are listed in the table 4 in comparison with recent CLEO results [19]. Good agreement can be seen.

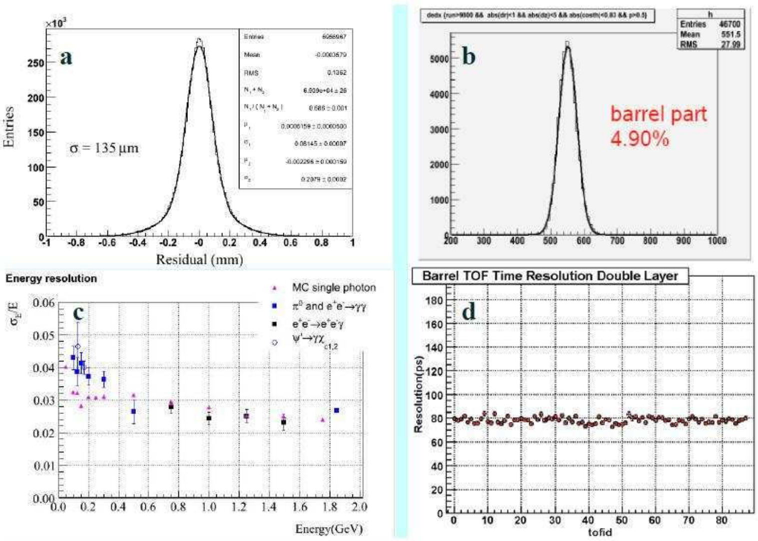

Figure 7: Main performance parameters of the calibrated BESIII detector: a) Single wire resolution of the drift chamber; b) dE/dx resolution of the drift chamber in the barrel part(w/ all wires); c) energy resolution of the CsI(Tl) crystal calorimeter as a function of photon energy from different physics processes; d) time resolution of TOF counters averaged over two layers for each counter ID in phi direction.

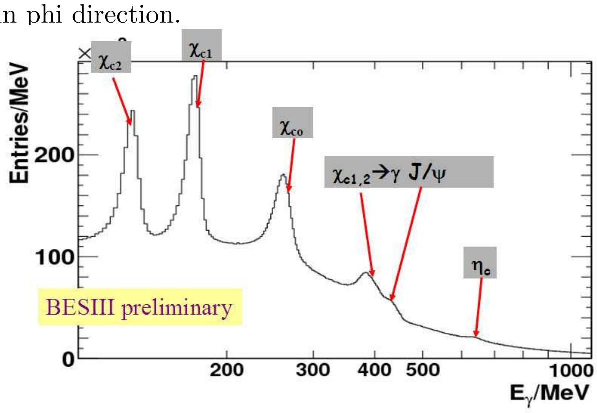

Figure 8: Measured inclusive photon spectrum from $\psi(2S)$ decays.

Parameters	BESIII result	CLEO results
M_{h_c}	$3525.40 \pm 0.13 \pm 0.18$ MeV	$3525.28 \pm 0.19 \pm 0.12$ MeV
Γ_{h_c}	$(0.73 \pm 0.45 \pm 0.28)$ MeV	-
$B(\psi' \to \pi^0 h_c)$	$(8.4 \pm 1.3 \pm 1.0) \times 10^{-4}$	-
$B(h_c \to \gamma\eta_c)$	$(54.3 \pm 6.7 \pm 5.2)\%$	-
$B(\psi' \to \pi^0 h_c) \times B(h_c \to \gamma\eta_c)$	$(4.58 \pm 0.40 \pm 0.50) \times 10^{-4}$	$(4.19 \pm 0.32 \pm 0.45) \times 10^{-4}$

Table 4: Measured results of h_c in comparison with recent CLEO results. During the fit, Γ_{h_c} is floating at BESIII while CLEO fixes $\Gamma_{h_c} = \Gamma_{\chi_c 1} = 0.9 MeV$

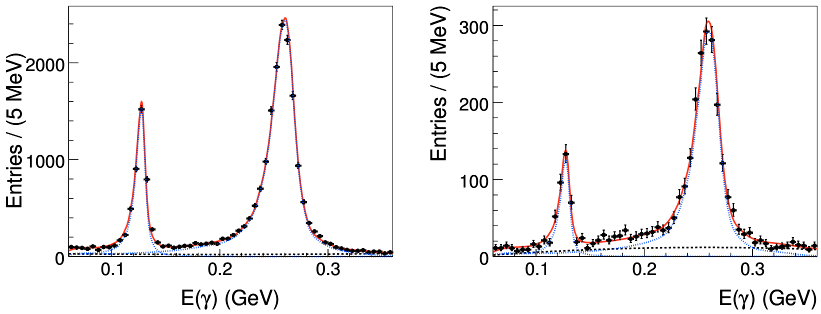

Figure 9: Observed χ_{c0} and χ_{c2} signal from $\psi(2S) \to \gamma\pi^0\pi^0$ (left) and $\psi(2S) \to \gamma\eta\eta$ (right) channels.

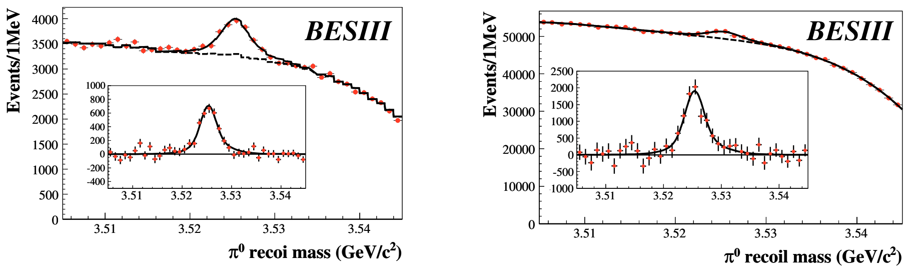

Figure 10: h_c observed in BES-III. Upper: tagging the prompt photon in the $h_c \to \eta_c$ decays, lower: tagging π^0 from $\psi(2s) \to \pi^0 h_c$ decays.

Other preliminary results of BESIII include, for example, the study of $\psi(2S) \to \gamma VV$, $V = \phi, \omega$, $\psi(2S) \to \gamma\gamma V$, $V = \rho, \phi, \omega$, $\psi(2S) \to \gamma P$, $P = \pi^0, \eta, \eta'$. New decay modes have been seen and results will be finalized soon.

BES-III also confirmed many observations by BES-II [26]. Fig. 11 shows the $p\bar{p}$ invariant mass from a) $\psi(2S) \to \pi\pi J/\psi$, $J/\psi \to \gamma p\bar{p}$, and b) $\psi(2S) \to \gamma p\bar{p}$ [27]. Clearly, a threshold enhancement can be seen in J/ψ decays, but not in $\psi(2S)$ decays, consistent with BES-II observations.

6 Summary

Charm physics will not stop at BEPCII/BESIII. The newly operational LHCb experiment, the upgrade of the B-factory at KEK to be operational in 2014, the PANDA experiment at FAIR planed to be operational in 2015, will all join the race. The super-flavor factory planed at FRASCATI and the super-tau-charm factory proposed at Novosirbisk, may substantial change the field. It is remarkable that tau-charm collider has a life time much more than 50 years.

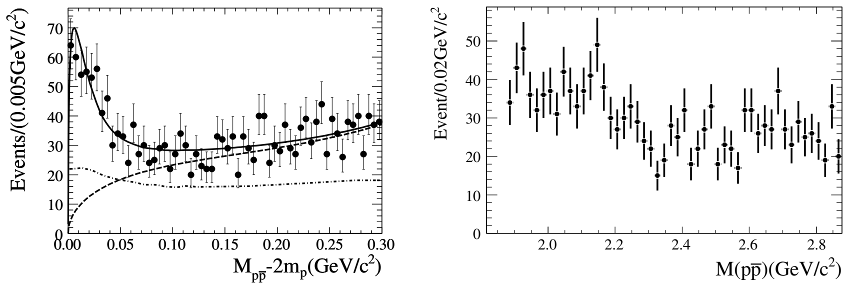

Figure 11: Invariant mass of $p\bar{p}$ from (left) $\psi(2s) \to \pi\pi J/\psi$, $J\psi \to \gamma p\bar{p}$, and (right) $\psi(2s) \to \gamma p\bar{p}$.

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Discussion

Sacha Kopp (University of Texas): I was confused about the distribution of the lineshape of the η_c in $J/\Psi \rightarrow \gamma\eta_c$ decays. Is it truly necessary to suggest it does not follow a Breit-Wigner, or can we just say that the shape is distorted due to an interference with another state in the decay?
Answer: It is not clear why the shape is distorted. There are suggestions that J/Ψ and ψ' decays does not follow Breit-Wigner, rather needs an $E_g^n amma$ correction, where n=3 for J/Ψ and n=7 for ψ'. However, even if J/Ψ can be fitted with this modified Breit-Wigner, Ψ' can not. Up to now there are no evidence for interference. We need more data to fit exclusive channels individually.
Sakue Yamada (KEK): It is a comment on your introduction. You did not mention about DORIS, which made the first confirmation of J/Ψ and also made other contributions like the discovery of χ_c states. I wish to remind of this history, particularly as this LP09 is being held in Hamburg.
Answer: Sorry about that. It should be mentioned.
Hans Bienlein (DESY): Do You plan to analyze $\gamma\gamma$ hadron production in BES-III? This could help you to identify gluonium states by comparing $\gamma\gamma$ production with γgg-production from J/Ψ decays.
Answer: Yes, we will do it. It is in our plans.