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# Form factor of baryons and light hadrons at BESIII: Recent results and next program

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**Summary.** — The BESIII experiment at the Beijing $\tau$-*charm* factory BEPCII has recently embarked at a series of form factor measurements both of light mesons and light baryons. The goal is to measure for the first time hyperon form factors and to improve experimental knowledge of the hadronic contributions to $g_\mu$-2. The preliminary results and the expected improvements, based on the integrated luminosity collected during 2012–2015 runs, are presented.

## 1. – The BESIII@BEPCII $\tau$-*charm* factory

BESIII is a multi-purpose detector operating at the $e^+e^-$ storage ring BEPCII at the University of Chinese Academy of Science in Beijing. The machine is the only currently running in the center-of-mass energy range $\sqrt{s} \approx 2$–$4.6\,\mathrm{GeV}$. It has recently achieved the design luminosity of $\mathcal{L} = 10^{33}\,\mathrm{cm}^{-2}\,\mathrm{s}^{-1}$ and up to now it has collected the world largest sample of $J/\psi$, $\psi'$ etc. directly produced in this energy range.

## 2. – $p\bar{p}$ and other baryon timelike form factors

The 2012 data collected at 12 energy scan points between $2.232\,\mathrm{GeV} < \sqrt{s} < 3.080\,\mathrm{GeV}$ corresponding to an integrated luminosity of $157\,\mathrm{pb}^{-1}$ have been analysed [1, 2]. The first direct measurements of the magnetic, $G_M$, and electric, $G_E$, form

Table I. – *$G_M$ and $G_E$ of $p\bar{p}$ directly measured at BESIII via angular distribution.*

| $\sqrt{s}$[GeV] | $\|G_E/G_M\|$ | $\|G_M\|$ ($\times 10^{-2}$) |
|---|---|---|
| 2.2324 | $0.87 \pm 0.24 \pm 0.05$ | $63.2 \pm 4.7 \pm 3.7$ |
| 2.4000 | $0.91 \pm 0.38 \pm 0.12$ | $11.30 \pm 4.73 \pm 1.53$ |
| $3.05 \div 3.08$ | $0.95 \pm 0.45 \pm 0.21$ | $3.61 \pm 1.71 \pm 0.82$ |

 

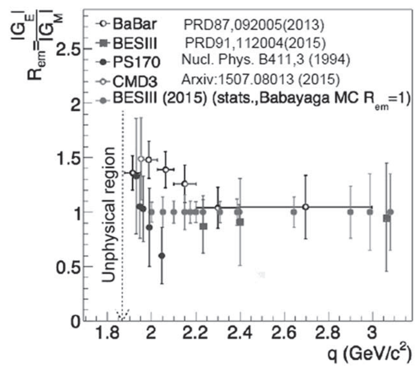


Fig. 1. – $G_E/G_M$ ratio of $p\bar{p}$. The results listed in table I are shown in dark grey; the new data and expected statistical improvement, simulated assuming $G_E/G_M = 1$ are shown in light grey.

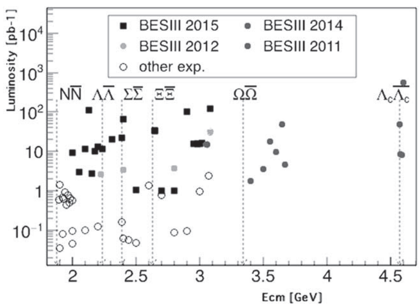


Fig. 2. – Integrated luminosity collected in last years by BESIII just above the hyperon threshold.

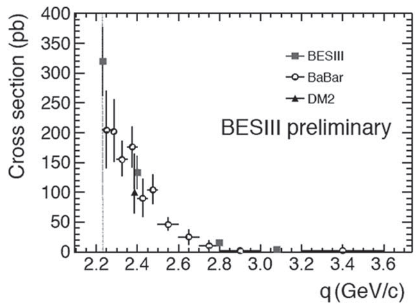


Fig. 3. – $\Lambda\bar{\Lambda}$ cross section measurement from BESIII, compared with existing data from DM2 [3] and BABAR [4].

factors (FF) have been obtained by fitting the angular distribution of proton-antiproton final state, as shown in table I. A great improvement is expected from the analysis of the full data set, corresponding to an integrated luminosity of about $552\,\text{pb}^{-1}$, collected in 2015, at the $p\bar{p}$ threshold, as shown in fig. 1. Data from BABAR [5], PS170 [6] and CMD3 [7] are also shown for comparison.

Large data set at the production threshold of hyperons ($\Lambda\bar{\Lambda}$, $\Sigma\bar{\Sigma}$, $\Xi\bar{\Xi}\ldots$) have been collected in 2015. The integrated luminosity collected by BESIII is shown in fig. 2.

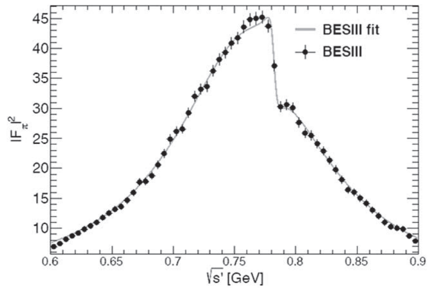


Fig. 4. – Pion form factor in the energy range $600\,\text{MeV} < \sqrt{s} < 900\,\text{MeV}$.

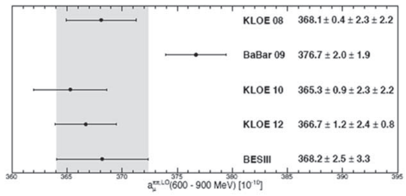


Fig. 5. – Comparison of hadronic contribution to $g_\mu$-2 according to KLOE, BABAR and BESIII measurements.

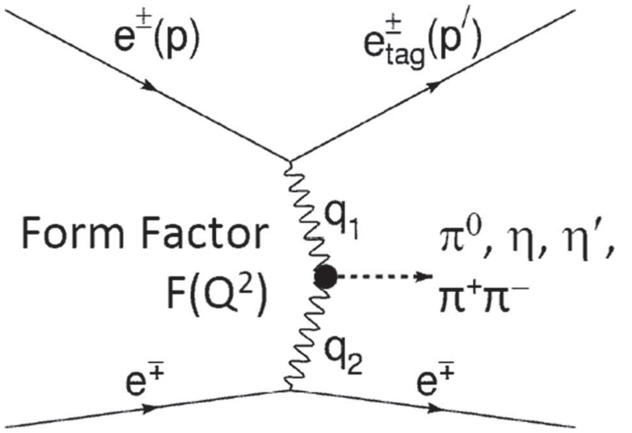


Fig. 6. – Skematic of meson transition form factor measurement via Light-by-Light scattering.

A preliminary analysis of the $\Lambda\bar{\Lambda}$ decay polarization is ongoing [2]. Form factors for heavier hyperons are expected to be extracted for the first time with a comparable precision with respect to $p\bar{p}$ form factor. Preliminary results for the $\Lambda\bar{\Lambda}$ cross section are shown in fig. 3.

## 3. – $\pi^+\pi^-$ form factor via Initial State Radiation (ISR)

The process $e^+e^- \to \gamma_{ISR}+\gamma^*(\to \pi^+\pi^-)$ has been exploited to measure the pion form factor in the range $600 < \sqrt{s} < 900\,\text{MeV}$ [8], corresponding to the $\rho$ resonance. The study of this processes is possible in BESIII at a rate comparable to BABAR, despite the lower nominal luminosity, due to the more favorable kinematics. This range is relevant for

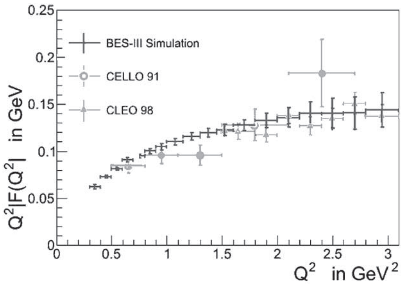


Fig. 7. – $\pi_0$ transition form factor improvement as expected from simulation in BESIII.

calculation of hadronic contribution to $g_\mu$-2, above all for the large contribution to its error, given also the existing discrepancy between BABAR and KLOE measurements. Pion form factor from BESIII data is shown in fig. 4, and the contribution to $g_\mu$-2, compared with other measurements, is shown in fig. 5. The measurement of meson transition form factor via the Light-by-Light scattering, as schematically shown in fig. 6 is expected to largely improve the very old measurements by CELLO and CLEO, as shown in the simulation in fig. 7 for the $\pi_0$ form factor [9].

REFERENCES

[1] BESIII Collaboration (Ablikim M. *et al.*), *Phys. Rev. D*, **91** (2015) 112004.
[2] Morales C., *AIP Conf. Proc.*, **1735** (2016) 050006.
[3] Bisello D. *et al.*, *Phys. Rev. D*, **87** (2013) 092005.
[4] BaBar Collaboration (Aubert B. *et al.*), *Phys. Rev. D*, **76** (2007) 092006.
[5] Lees J. P. *et al.*, *Phys. Rev. D*, **87** (2013) 092005.
[6] Bardin G. *et al.*, *Nucl. Phys. D*, **B411** (1994) 3.
[7] Patten D. R. *et al.*, arXiv:1507.08013 (2015).
[8] BESIII Collaboration (Ablikim M. *et al.*), *Phys. Lett. B*, **753** (2016) 629, arXiv:1507.08188.
[9] Guangshun Huang, *Hadron form factor and Collins effect at BESIII*, presented at *7th Workshop on Hadron Physics in China, August 2015*, `http://indico.ihep.ac.cn/event/4783`.