BESIII

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1 The BESIII experiment

The BESIII experiment [1] is taking data at the BEPCII electron-positron collider at IHEP, Beijing. The center-of-mass energy region from 2 to 4.9 GeV offers vast and diverse physics opportunities at the boundary between the perturbative and non-perturbative regimes of QCD. Results from BESIII are playing an important role in the understanding of the Standard Model and will also provide important calibrations for the Lattice Gage community. Studies of tau-charm physics could reveal or indicate the possible presence of new physics in the low energy region.

BESIII is a multi-purpose detector designed to study physics in the tau-charm energy region of BEPCII double ring electron-positron collider. The rich physics program includes:

- tests of electroweak interactions with high precision in both the quark and lepton sectors
- high statistics study of light hadron spectroscopy and decay properties
- study of the production and decay properties of J/ψ, $\psi(3686)$, $\psi(3770)$ states with large data samples and search for glueballs, quark-hybrids, multi-quark states and other exotic states via charmonium hadronic and radiative decays
- studies of XYZ states
- studies ot tau-physics
- precision measurements of QCD parameters and CKM parameters
- barion form factors measurements via ISR process and via energy scan
- search for new physics by studying rare and forbidden decays, oscillations, and CP violations in c-hadron and tau-lepton sectors.

The LNF group is involved in the upgrade of the BESIII Inner tracker (IT) with a new Cylindrical GEM (CGEM) detector. The project, among Ferrara and Turin INFN sections, also includes groups from Mainz, Uppsala and IHEP, has been recognized as a Great Relevance Project within the Executive Program for Scientific and Technological Cooperation between Italy and P.R.C. for the years 2013-2015, it has been funded by the European Commission within the BESIIICGEM RISE-MSCA-H2020-2014 project which lasted until 2018, while in 2019 it received funding within the FEST RISE-MSCA-H2020-2020 project, started in 2020.
The group is also involved, together with the Perugia group, in the analysis of several physics processes involving baryons and light hadrons.

2 Physics analysis

First exploration of the physical Riemann surfaces of the ratio $G_E^{\Lambda}/G_M^{\Lambda}$

We analyze the BESIII recent measurement on the modulus and the phase of the ratio between the electric, G_E, and magnetic, G_M, form factors of the Λ baryon, together with other available data, using a dispersive procedure based on analyticity and theoretical constraints. We determine, for the first time, the complex structure of the ratio G_E/G_M. We obtain interesting properties such as space-like zeros or unexpected large determinations for the phase of the G_E/G_M ratio [2].

Amplitudes separation and strong-EM relative phase in the $\psi(2S)$ decays into baryons

Using the available data from the BESIII collaboration and the PDG we separate, for the first time, the strong, EM and mixed strong-EM amplitudes of the $\psi(2S)$ meson decays in baryon-antibaryon pairs, using a model based on an effective Lagrangian [3]. We show that at the mass of the $\psi(2S)$ meson the QCD regime is not completely perturbative, similarly to the case of the J/ψ meson.

Analysis of $e^+e^- \to J/\psi \to \omega\pi^0$

Using recent data from BESIII we analyze the cross section of $e^+e^- \to \omega\pi^0$ at $q^2 = M^2_{J/\psi}$. From a theoretical point of view, the J/ψ meson has negative G-parity hence the decay into $\omega\pi^0$ should be purely electromagnetic, in the limit of isospin conservation. We can compare the total branching ratio with the electromagnetic one to investigate for the presence of a mixed strong-electromagnetic contribution, as done in the case of $J/\psi \to \pi^+\pi^-$, see Ref. [4].

3 The BESIII CGEM Status

Based on the experience of the KLOE2-CGEM Inner Tracker, we started developing a three-layer triple-GEM detector [5] with analog readout as IT for the BESIII experiment. The analog readout is the most important improvement with respect to KLOE2, and offers the best compromise between improved spatial resolution and reasonable number of instrumented channels.
L1 and L2 cylinders are at IHEP in stable conditions taking cosmic rays events, remote data taking being carried out by the Italian groups.

3.1 L3 Status

The third cylinder L3, completed in Frascati at the end of 2020, has been tested for gas leaks and HV but it did not performed well, instabilities happened when trying to rise the transfer field to nominal values. Several investigations have been performed to understand the mis-beahaviour.
At LNF, a first scan of the inner detector was performed with x-rays by the Radelet agency that came on-site allowing the detector not to be moved. Here, some movements among the GEM foils were spotted and the investigation continued. The detector was then brought to Modena at the TecEurolab company, the shipping being done by the Montenovi company with the case prepared for its final shipment. In Modena a complete CT scan was performed. Preliminary results were relised by the company by means of videos of the inside of the detector from different points of view. We elaborated these images showing a clear buckling effect. With the raw data of the CT scan, another company extracted the full volume of each single GEM element to be used to analyze the magnitude of the problem and study possible solutions.
Such study brought to light the necessity to perform a drop test with the only GEM foil in a cylindrical shape.

This was done in Frascati by an external company, Powerflex. It confirmed the engineering studies that underlined a very high fragility of this structure to the buckling effect.

The investigations performed by KLOE-II colleagues regarding the uses of spacing grids to ensure the GEM stays cylindrical have been reviewed. In parallel we organized a CT scan of the KLOEII-IT itself at TecEurolab to take look at its situation inside, having it spacing grids in the two outer layers.
It has been then planned to perform a test with a mockup of the detector with spacing grids. This mockup detector has been designed to have two mechanical structures on the inner and outer surface as the final detector, two GEMs, and two spacing grids, one on the cathode and one on GEM1. Next year the mockup will be constructed and tested with a drop test together with a CT scan after every drop to fully register the situation.

References

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