Feasibility study of tau-lepton anomalous magnetic moment measurements with ultra-peripheral collisions at the LHC

Authors: **Paul Bühler**[1], Nazar Burmasov[2], Evgeny Kryshen[2]

[1] *Stefan Meyer Institute, Vienna*
[2] *PNPI*

Precision measurements of the anomalous electromagnetic moments of leptons (a_l) may serve as one of the most promising directions in searches for physics beyond the Standard Model. While the experimental value of the electron magnetic moment agrees with theoretical predictions with up to 10 significant digits, the muon magnetic moment shows deviations from the SM at the level of 3.7 σ indicating possible emergence of BSM effects. Deviations from the Standard Model predictions may point to a composite nature of leptons or existence of supersymmetric particles at a scale M_S, inducing radiative corrections of the order of $\Delta(a_l) \approx m_l^2/M_S^2$, where m_l is the lepton mass. Thus the anomalous magnetic moment a_τ of the tau lepton can be $m_\tau^2/m_\mu^2 \approx 280$ times more sensitive to BSM physics than a_μ.

The SM value for a_τ is close to zero and is known with 10^{-5} precision. However the experimental data on a_τ is scarce since the standard spin precession methods are not applicable for a_τ measurements due to the very short tau lifetime. The strongest experimental constraints on a_τ come from the kinematics of the $e^+e^- \to e^+e^-\tau\tau$ production, measured by the DELPHI collaboration at the LEP collider yielding a limit of $-0.052 < a_\tau < 0.013(95\%, CL)$

Ultra-peripheral collisions (UPC) of heavy ions at the LHC may serve as a very promising tool to measure a_τ. UPCs are characterized by impact parameters larger than the sum of ion radii thus leading to the dominance of long-distance electromagnetic processes. In the equivalent photon approximation, the electromagnetic fields surrounding heavy ions can be described as a flux of quasi-real photons. The photon flux is proportional to the squared nuclear charge leading to high cross sections of photon induced reactions at the LHC and providing unique opportunities to study $\gamma\gamma$ and γ-nuclear interactions. In particular, Pb-Pb UPCs at the LHC can be used to study electromagnetic properties of the tau lepton in the di-tau production process $\gamma\gamma \to \tau\tau$ containing two $\gamma\tau\tau$ vertices and providing enhanced sensitivity to the anomalous magnetic and electric moments.

In this contribution we will discuss the feasibility of the a_τ measurement in UPCs with the ALICE fiducial acceptance and present projections of the sensitivity of the measurement for the upcoming heavy ion run in 2022.