take into account the Abrikosov vortices trapping during the thermal quench as a competitive effect [25]. In addition, a new detection principle based on the interaction of a single gamma-photon with trapped Abrikosov vortex is proposed for the development of a gamma -ray solid state detector with high intrinsic detection efficiency in the energy range up to 100 keV [26].

In this paper we present a theoretical study of the Fiske steps for a "small" Josephson junctions in the presence of randomly distributed Abrikosov vortices. Our approach is based on the extension of a well known Kulik analysis for low-dissipative uniform Josephson junctions [27] to the Josephson junctions with inhomogeneities. We obtain a peculiar regime where the Fiske steps amplitude shows a weak non-monotonic decrease with the vortex density n_A. We experimentally trapped different number of Abrikosov vortices and for each vortex density n_A we measured the dependencies of the critical current I_c and the Fiske steps amplitude I_F on n_A and on externally applied parallel to the junction plane magnetic field $B_\parallel$. A good agreement between our theory and experimental results was found.

The paper is organized as follows. In section II the theoretical model of a Josephson junction with randomly distributed misaligned Abrikosov vortices is presented. In section III by making use of a generic approach elaborated in the Ref. [27], we calculate the Fiske resonances in inhomogeneous Josephson junctions, and in the section IV the dependence of the Fiske steps amplitude I_F on the density of Abrikosov vortices n_A is analyzed. Section V is dedicated to the experimental details, namely, the experimental setup, the sample description and the procedure to measure the Josephson critical current I_c and the amplitude of first Fiske step I_F. In section VI we present the experimental results and the comparison with the theory. Section VII provides conclusions.

II. MODEL OF A JOSEPHSON JUNCTION WITH RANDOMLY DISTRIBUTED MISALIGNED ABRIKOSOV VORTICES

We consider a small, i.e. $W < \lambda_J$, Josephson junction in the presence of randomly distributed pinned misaligned Abrikosov vortices (here, W is the size of a Josephson junction, and λ_J is the Josephson penetration depth). A magnetic field of a misaligned Abrikosov vortex enters and leaves the superconducting electrodes of a junction in different points. The distance between these points determines the misalignment length δ (see Fig. 1).