Non-equilibrium quasiparticle dynamics in disordered superconductors after absorption of single photons

Steven de Rooij, Kian Syaifoel, Thomas Rugers, Kevin Kouwenhoven, Tonny Coppens, David J. Thoen, Jochem J. A. Baselmans and Pieter J. de Visser

rooij@physics.leidenuniv.nl

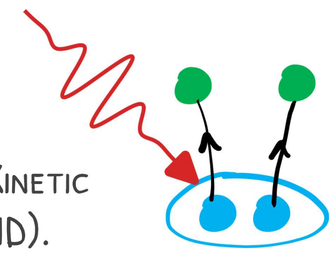
SRON Space Research Organisation Netherlands

TU Delft

Energy resolving, single photon detectors

Photons break Cooper-pairs into quasiparticles.

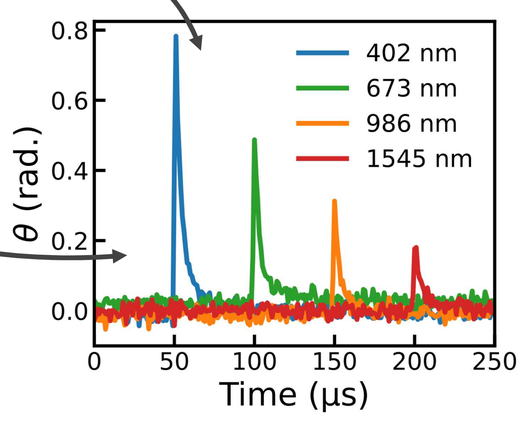
This changes the kinetic inductance (L_k) of the superconductor, which is measured in a Microwave Kinetic Inductance Detector (MKID).



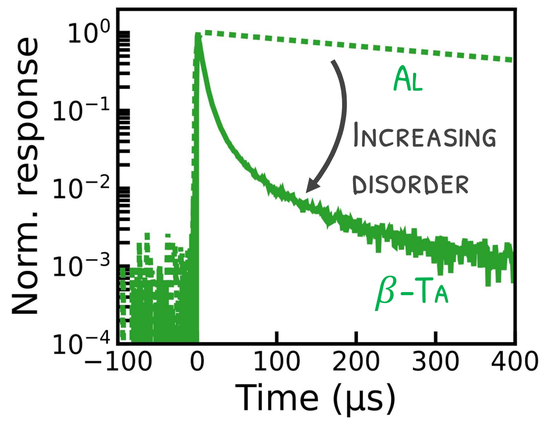
Disordered superconductors for MKIDs

1. High absorption efficiency
2. More L_k

$$L_k \uparrow = \frac{\hbar R_n \uparrow}{\pi \Delta}$$

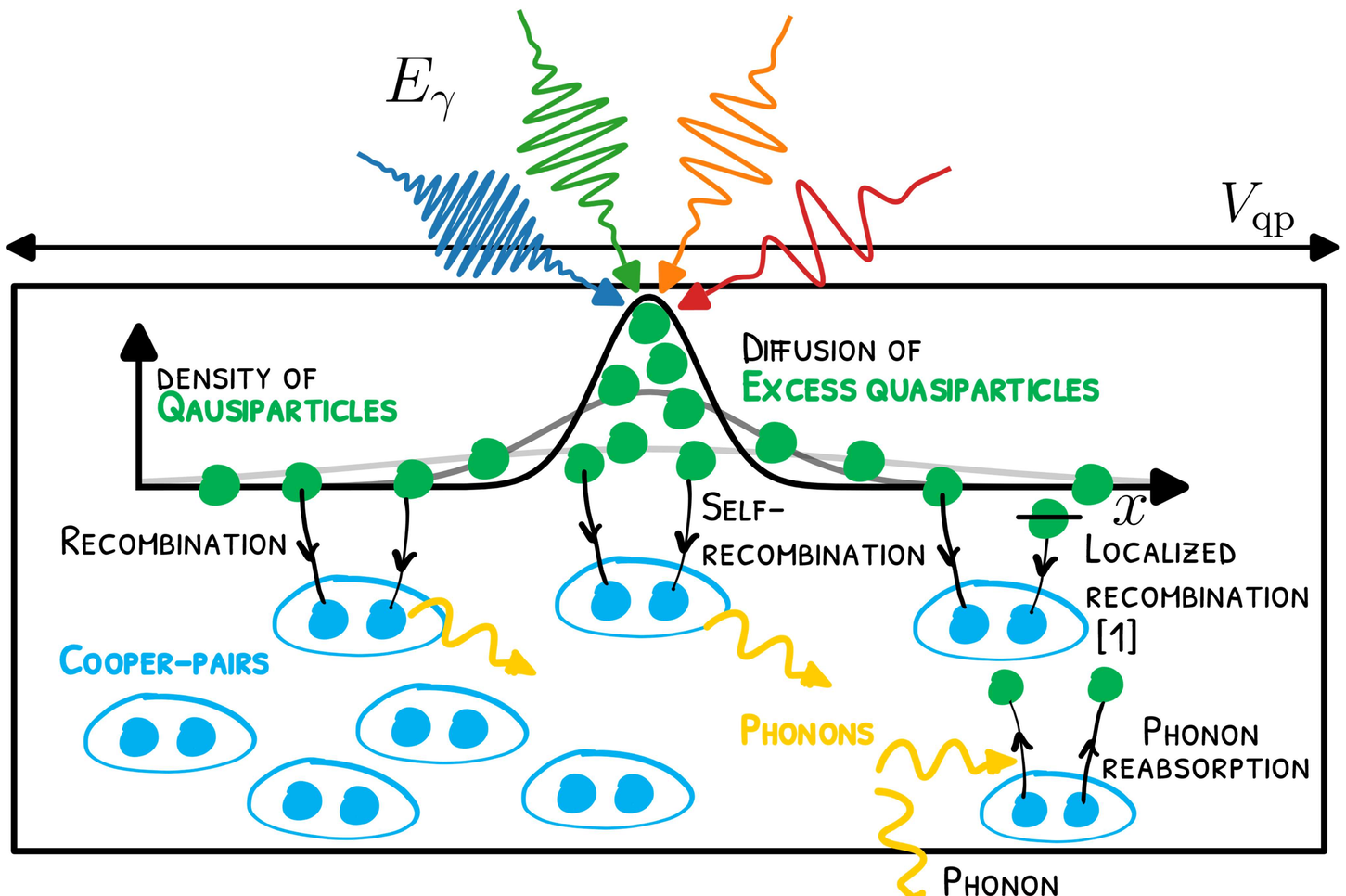


Effect of disorder on single photon response

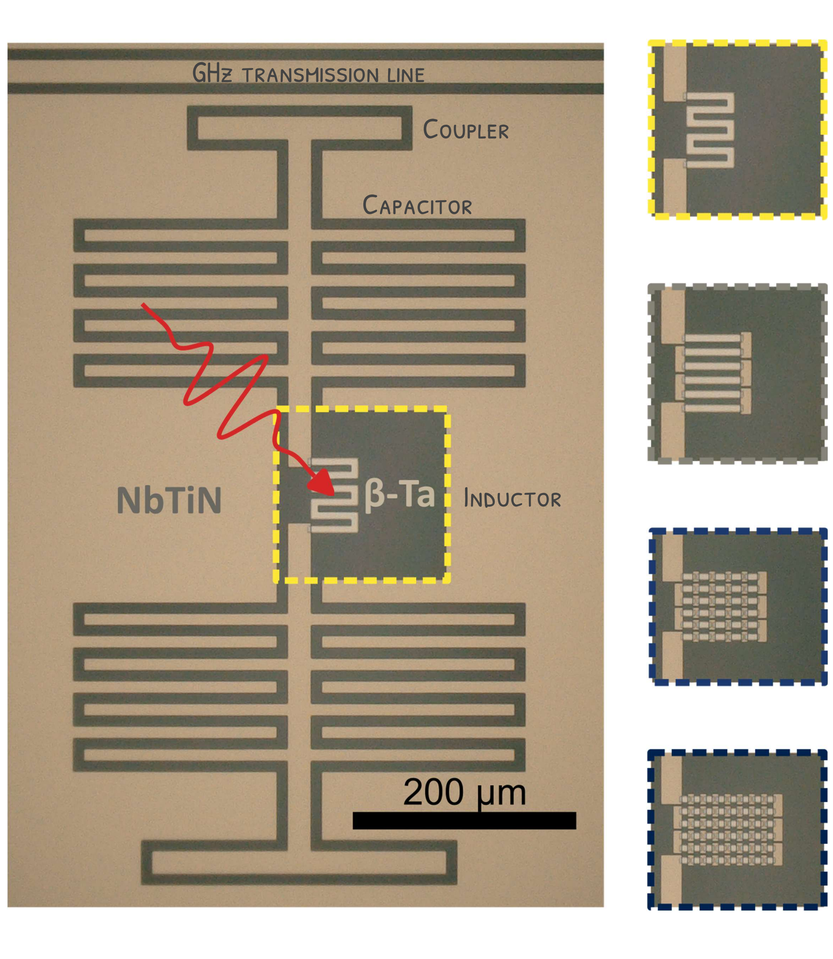


Why is the single photon pulse so short for disordered superconductors?

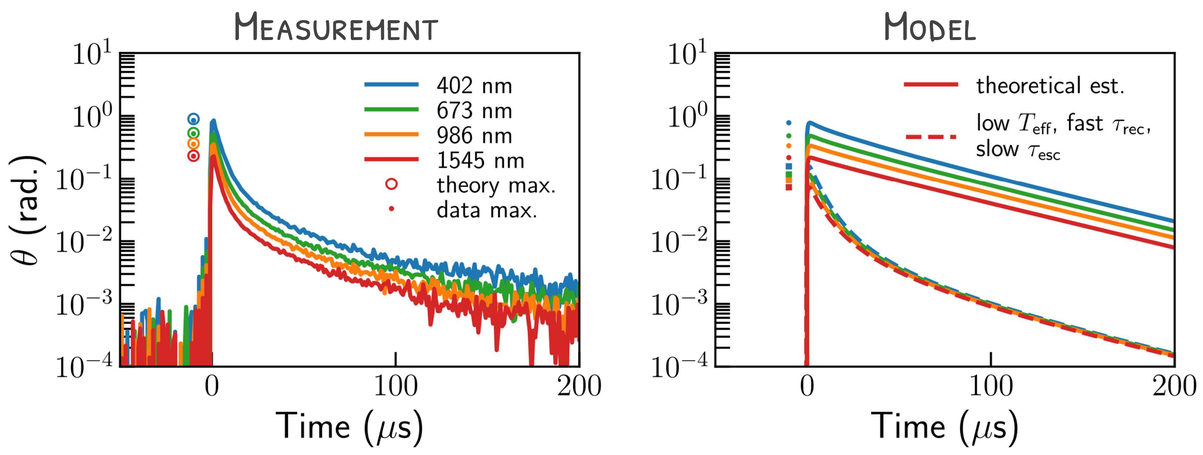
Quasiparticle dynamics model



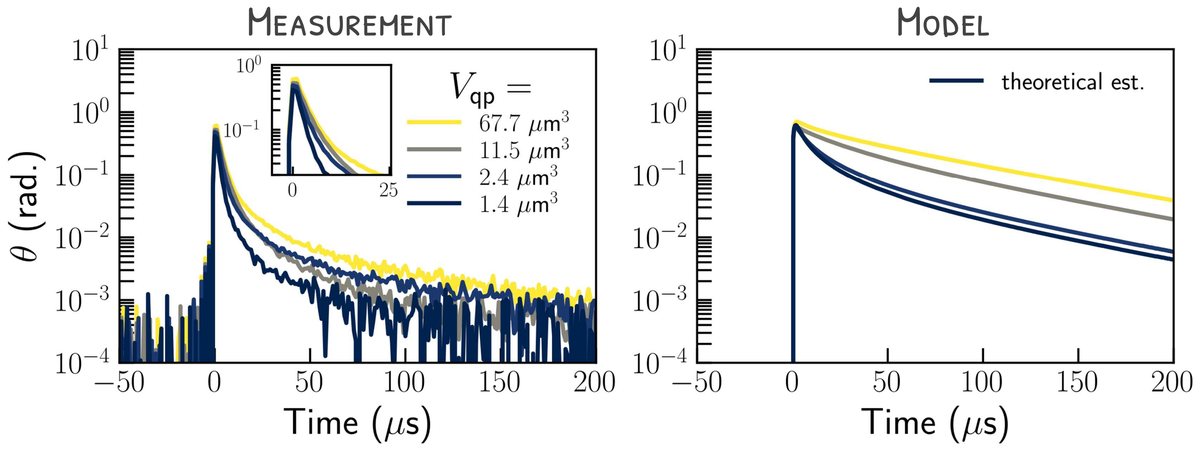
Device: microwave resonator



Varying photon energy (E_γ)



Varying quasiparticle volume (V_{qp})



Conclusions

- Disorder introduces a fast, non-exponential single photon pulse decay in MKIDs
- The decay is not dependent on photon energy, but is faster for smaller quasiparticle volumes
- This cannot be described by conventional quasiparticle dynamics, including diffusion, phonons and localized recombination
- The fast decay could be related to energy-dependent localization of quasiparticles [1].

[X]