



**HAL**  
open science

## **Superconducting photosensitive interfaces for triggering RSFQ circuits**

Pascal Febvre, Siham Badi, Hannes Toepfer, Thomas Ortlepp, Björn Ebert, F.H.  
Uhlmann

► **To cite this version:**

Pascal Febvre, Siham Badi, Hannes Toepfer, Thomas Ortlepp, Björn Ebert, et al.. Superconducting photosensitive interfaces for triggering RSFQ circuits. Applied Superconductivity Conference (ASC 2006), Aug 2006, Seattle, United States. <10.1109/TASC.2007.898682>. <hal-04925809>

**HAL Id: hal-04925809**

**<https://hal.science/hal-04925809v1>**

Submitted on 7 Feb 2025

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

# Superconducting photosensitive interfaces for triggering RSFQ circuits

**Pascal FEBVRE, Siham BADI**

LAHC – Campus scientifique – Université de Savoie  
73376 Le Bourget du Lac Cedex – France  
<http://www.lahc.univ-savoie.fr>  
e-mail: pascal.febvre@univ-savoie.fr

**Hannes TOEPFER**

Institute of Microelectronic and Mechatronic Systems gGmbH  
System Design Department  
Ehrenbergstraße 27  
D-98693 Ilmenau Germany

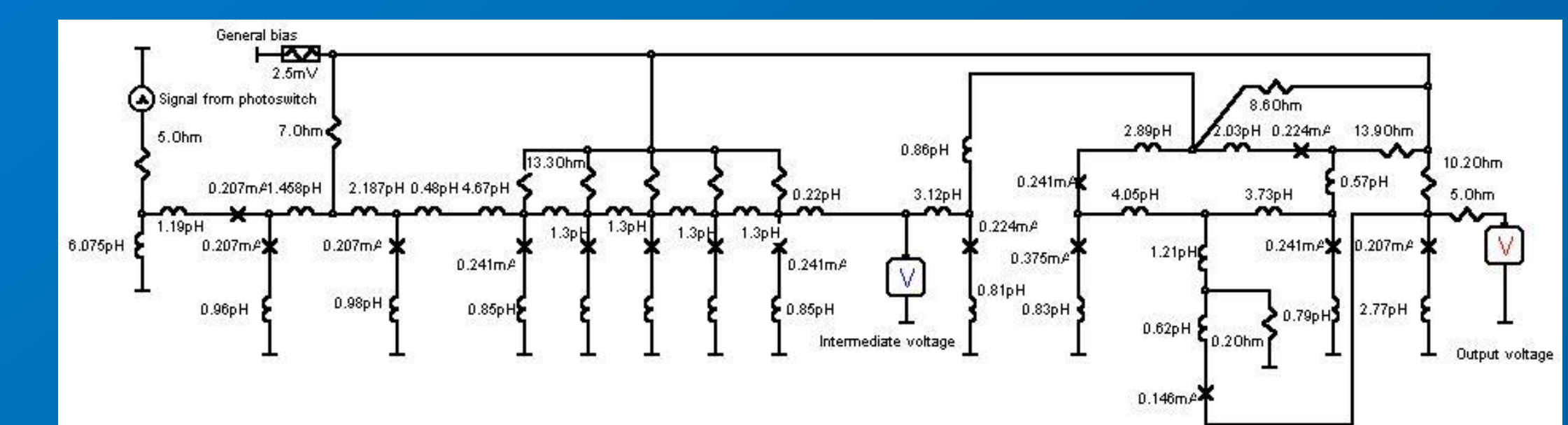
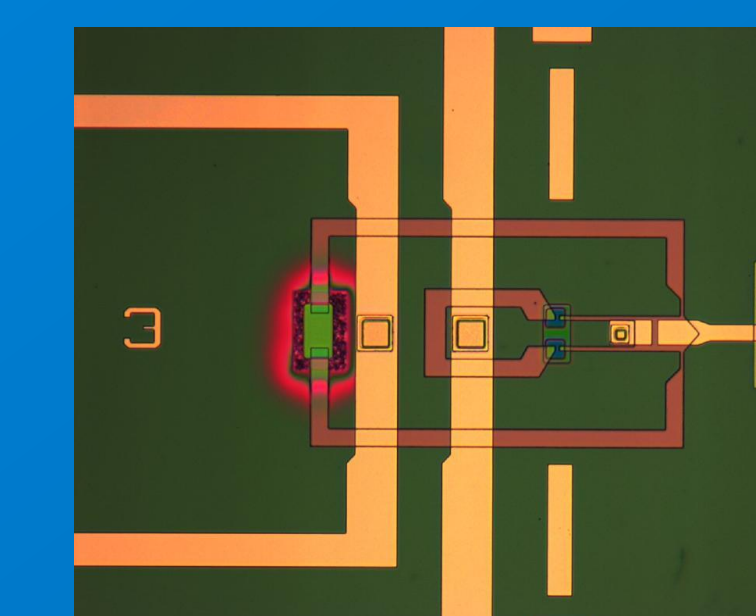
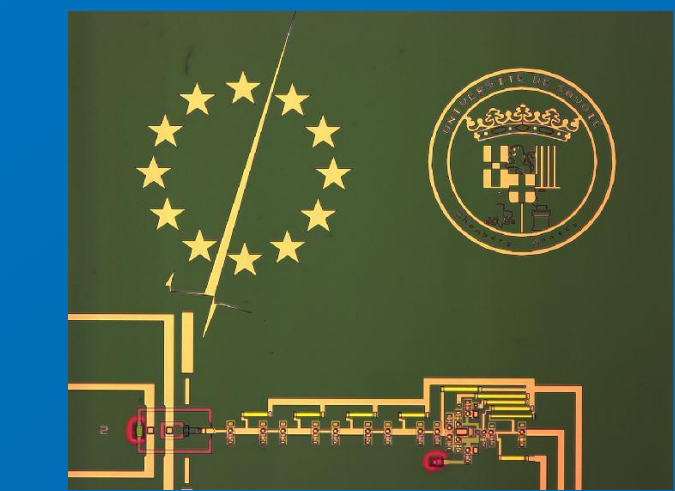
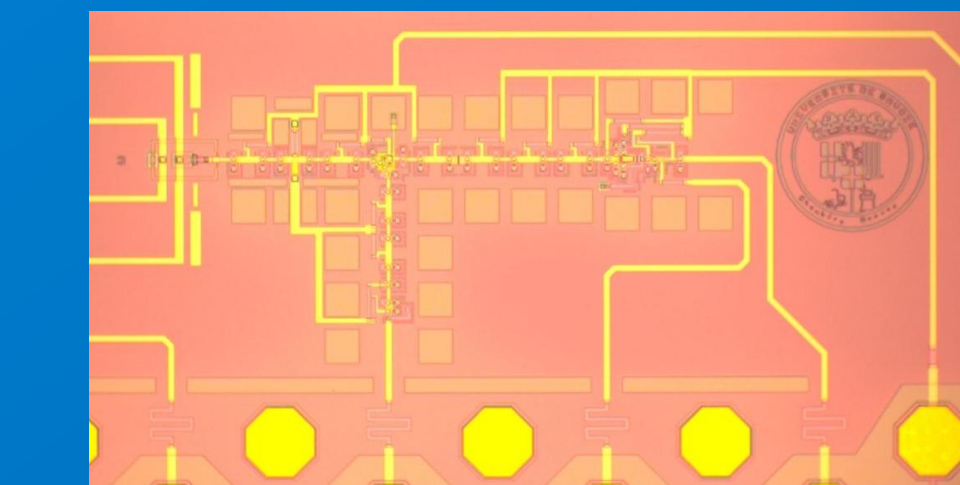
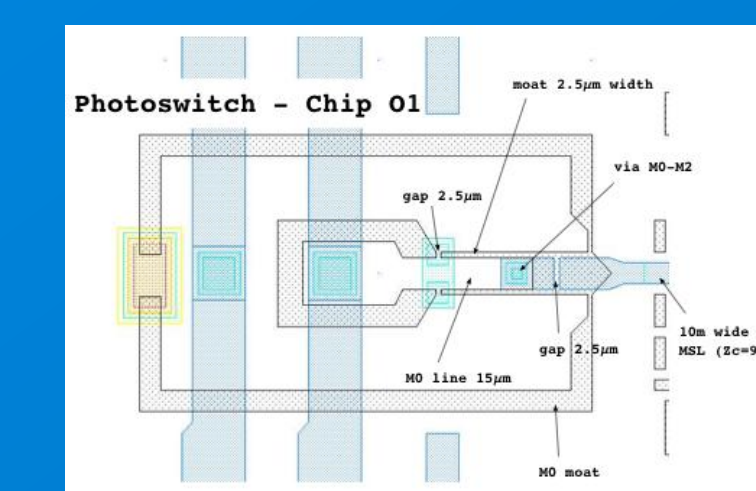
**Thomas ORTLEPP, Björn EBERT, F. Hermann UHLMANN**

Department of Fundamentals and Theory of Electrical Eng.  
University of Technology Ilmenau, Germany

## CONTEXT

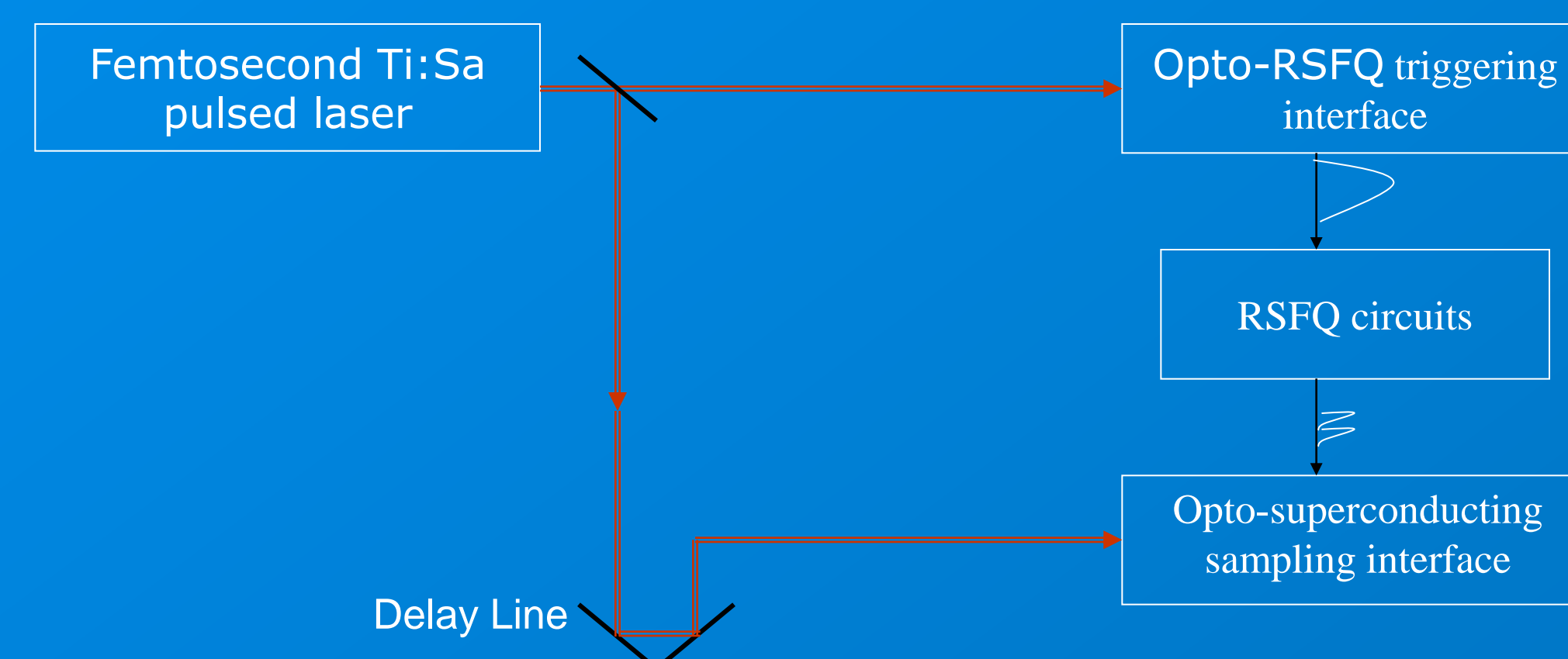
- We investigate the properties of superconducting bridges integrated with RSFQ circuits in order to trigger them by optical means for time-resolved diagnostic purposes.
- The ultimate goal is to be able to sample the output of RSFQ circuits and RSFQ pulses themselves in a time-resolved manner at ultrafast speed, in order to get direct informations about the RSFQ circuit behaviour.
- At this stage, we want to prove that RSFQ circuits can be correctly triggered through optical means, i.e. with a femtosecond Ti-Sa pulsed laser synchronized with a readout setup.
- Superconducting bridges of different dimensions, based on niobium films, have been designed and included in a microwave custom-made circuit connected to simple RSFQ processing cells based on the 1 kA/cm<sup>2</sup> JeSEF RSFQ process of IPHT Jena (see <http://www.fluxonics.org>).

## PHOTOSWITCH INTEGRATED WITH PROCESSING RSFQ CIRCUIT

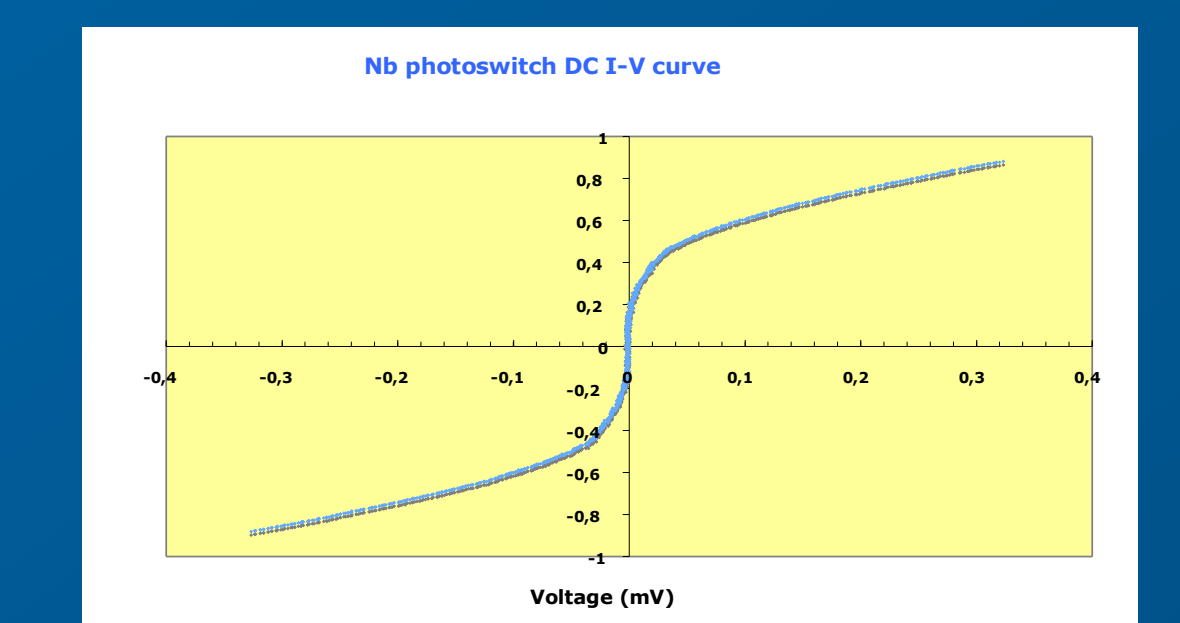
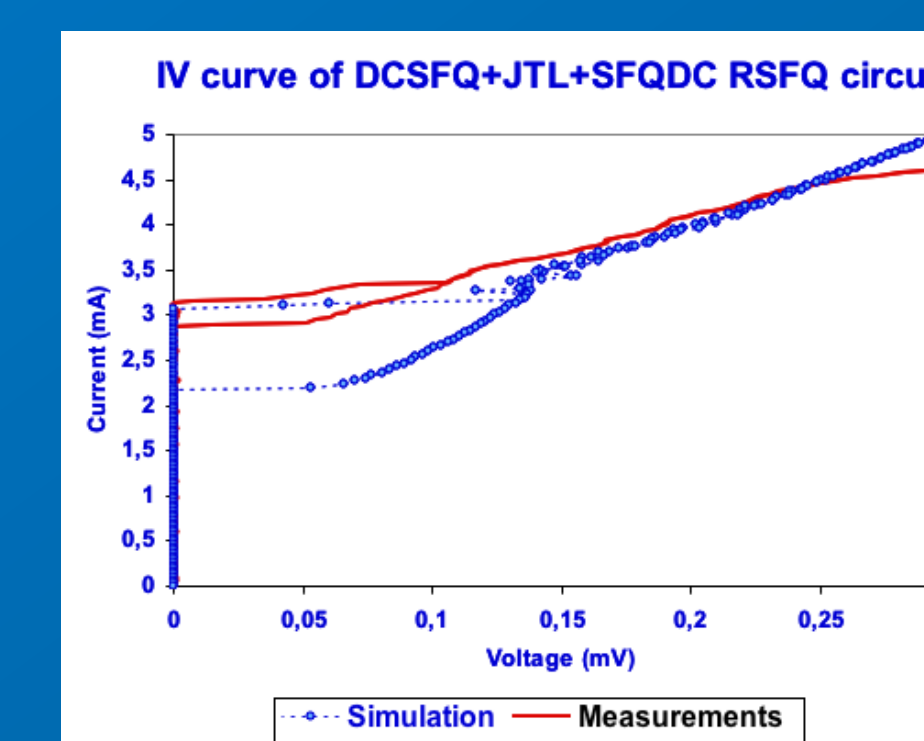


- RSFQ circuit (JTLs+SFQDC) to be triggered by the input photoswitch (DCSFQ is for simulation purposes only)
- Output voltage can be read after JTL or after SFQDC converter, depending on measuring equipment.

## PRINCIPLE OF RSFQ CIRCUIT HIGH-SPEED DIAGNOSTIC



## PRELIMINARY MEASUREMENTS



Good agreement between simulation and dc measurements of the RSFQ part

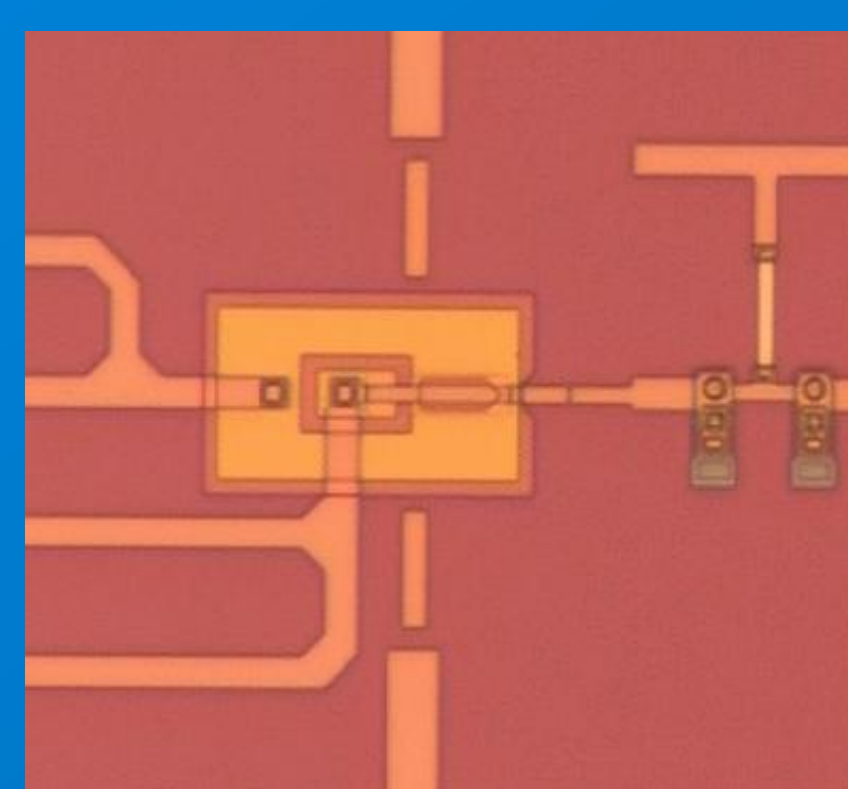
DC I-V curve of Nb photoswitch

## CONCEPT OF OPTICAL TRIGGERING OF RSFQ CIRCUITS

2 types of triggering interfaces for synchronous measurements:

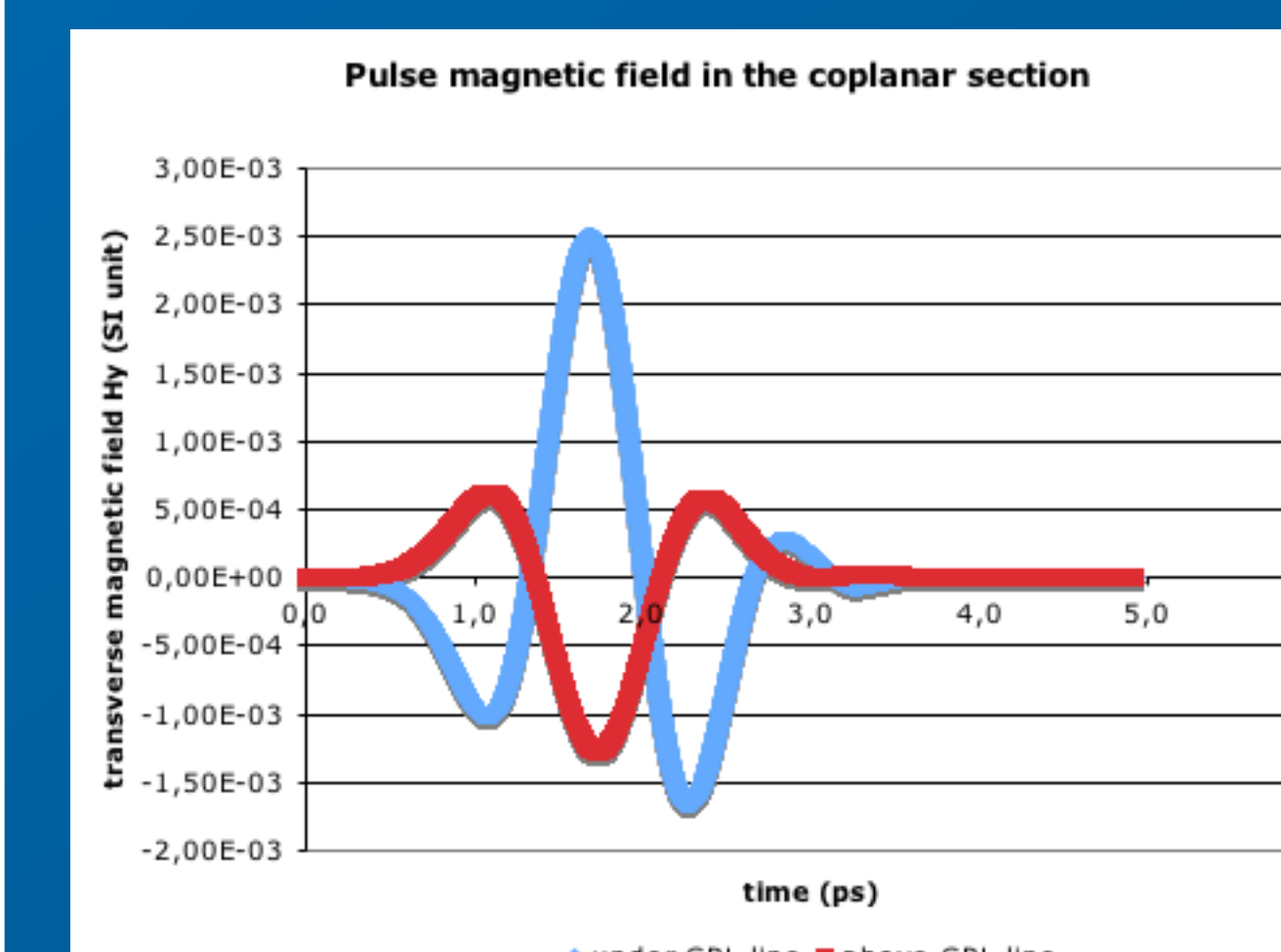
- 1° based on an external low-temperature-grown GaAs photoswitch (not presented here)
- 2° based on an integrated superconducting Nb film deposited close to the RSFQ circuit

In both cases, the input interface is a photoswitch illuminated by a pulsed femtosecond Ti-Sa laser of 800 nm wavelength.



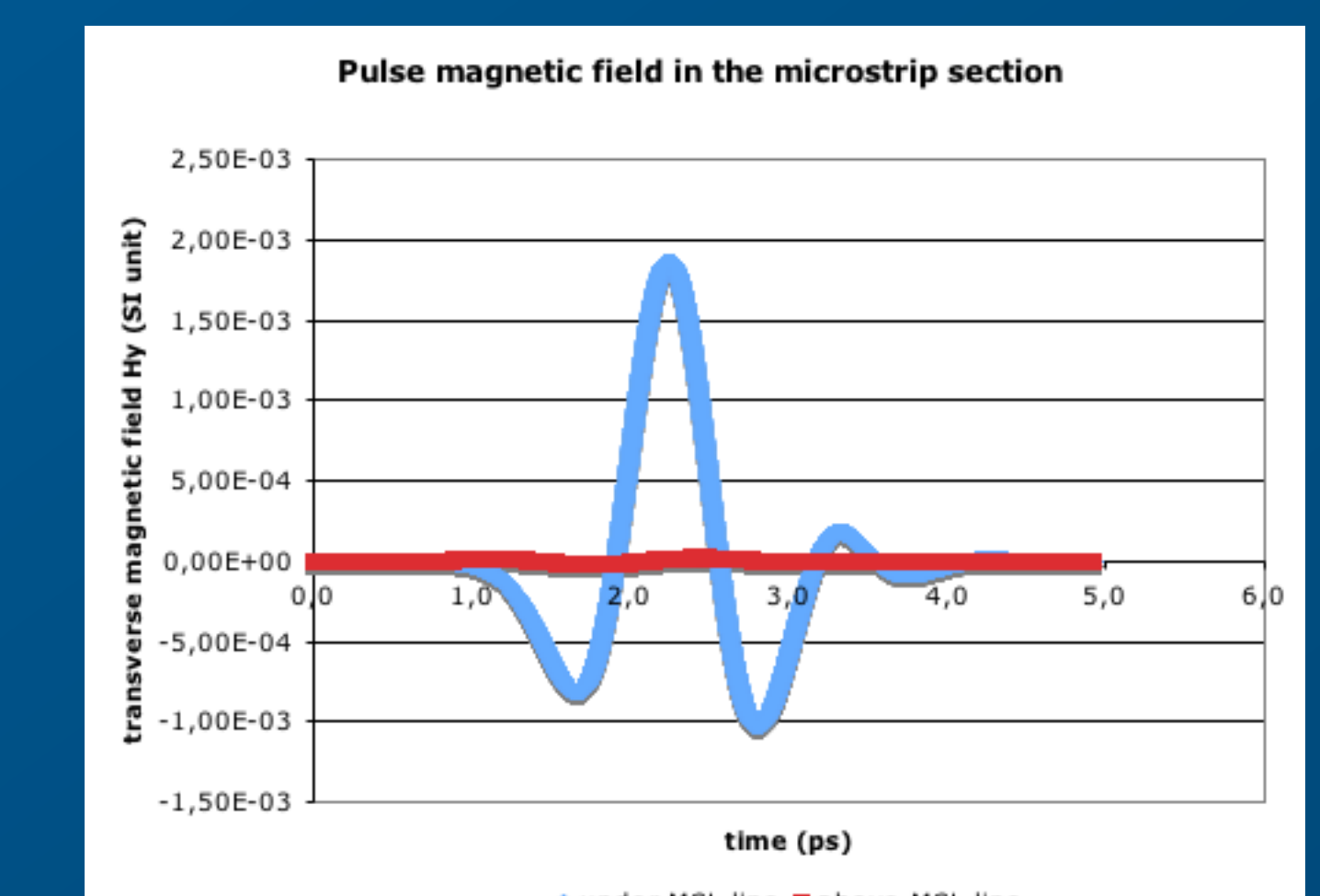
- Example of a photoswitch integrated with a RSFQ Circuit
- Fabrication made at the low-Tc FLUXONICS foundry located at IPHT Jena (<http://www.fluxonics.org>)
- Standard RSFQ Nb/Al-AIOx/Nb process with 1kA/cm<sup>2</sup> current density

## FINITE-DIFFERENCE TIME-DOMAIN (FDTD) SIMULATIONS



### Assumptions

- Laser pulse width of 0.45 ps FWHM
- Amplitude corresponding to  $E_y = 30V/m$



Transmission of signal between coplanar part and microstrip part of -26 dB according to simulations