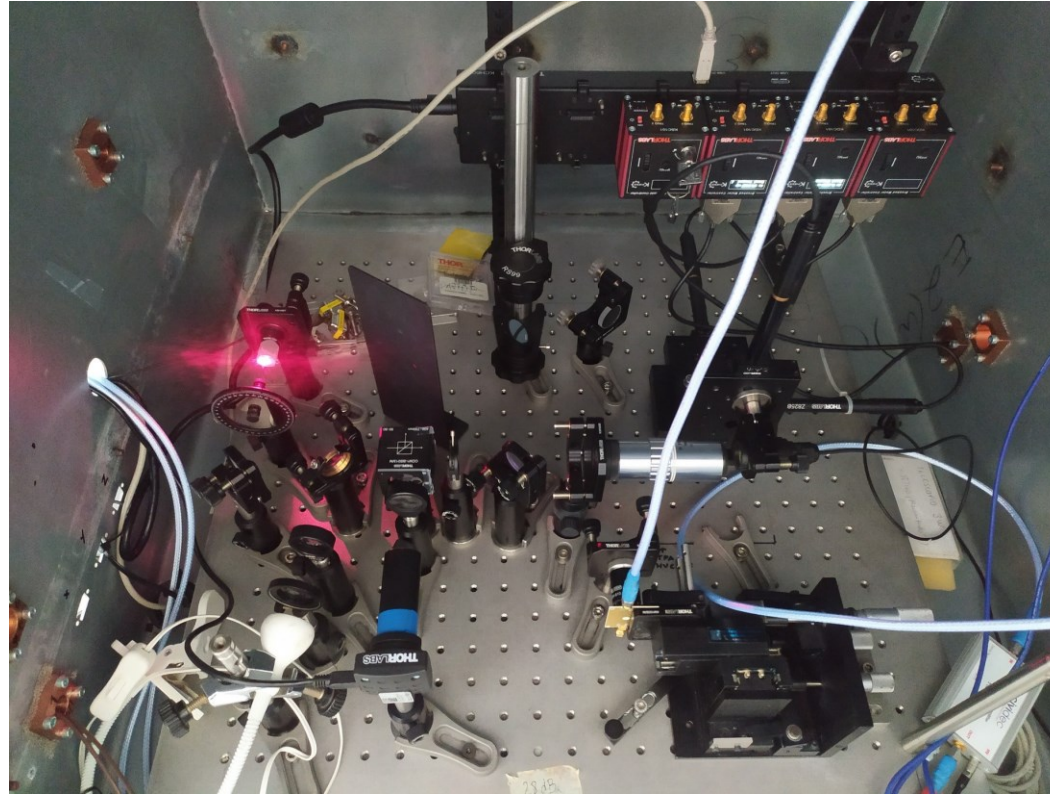


3PA-TCT in SiC

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Outline



- Three-Photon-Absorption basics
- Experimental set-up for 3PA-TCT in SiC
- DUT description
- Experimental evidence of 3PA-TCT in SiC
- Validation in non-irradiated and neutron-irradiated p-in-n diodes
- Summary

3PA process basics



- Three-photon absorption (3PA) is a nonlinear optical process where a material simultaneously absorbs three photons, collectively providing enough energy to transition an electron from a lower to a higher energy state.

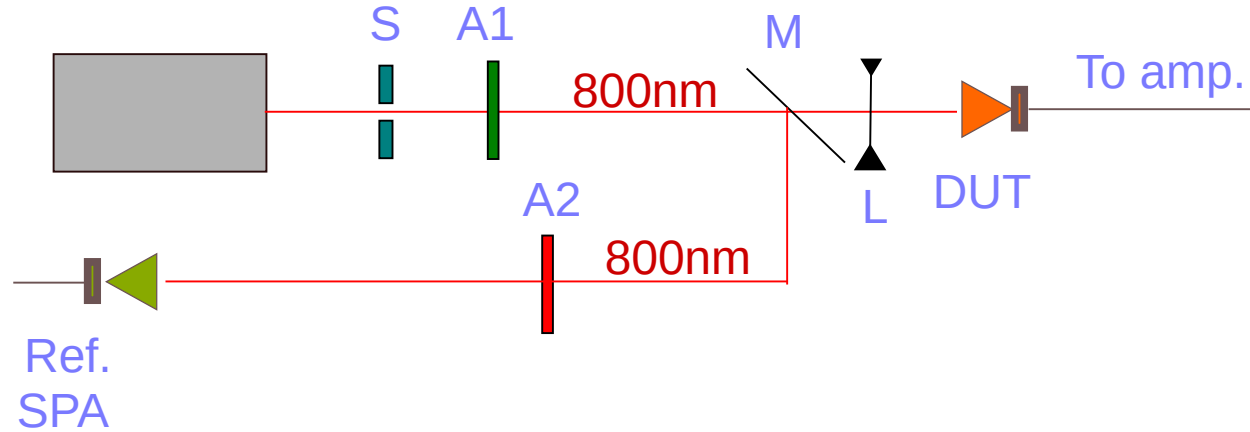
$$\frac{dI}{dz'} = -\alpha I - \beta I^2 - \gamma I^3$$

- the attenuation of light intensity (I) as it propagates through a medium (z'), where α is the linear absorption coefficient, β is the two-photon absorption (TPA) coefficient, and γ is the three-photon absorption (3PA) coefficient.

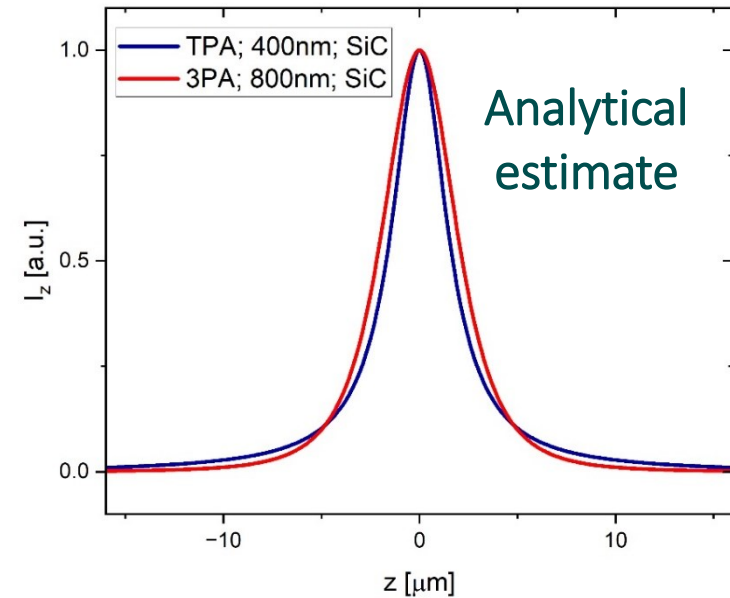
3PA in SiC: Experimental Arrangement



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- S: Shutter
- A1: Attenuator
- M: Mirrors
- A2: Attenuator
- Ref.: Laser power reference
- L: focusing lens
- DUT: Device under test



Although the wavelength has doubled, a similar spatial resolution is achieved with a smaller fraction of the signal present in the profile's foot regions

Simpler experimental setup: using the femtosecond laser primary wavelength

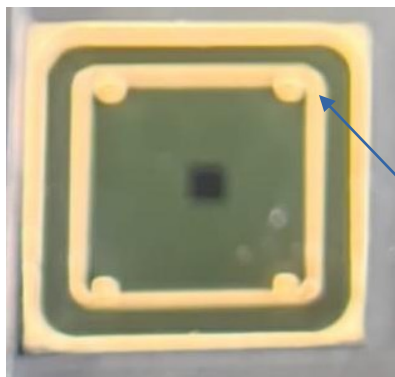
Two-Photon Absorption (TPA): 42.7 ± 3.3 pJ (400 nm)

Three-Photon Absorption (3PA): 481.3 ± 3.8 pJ (800 nm)

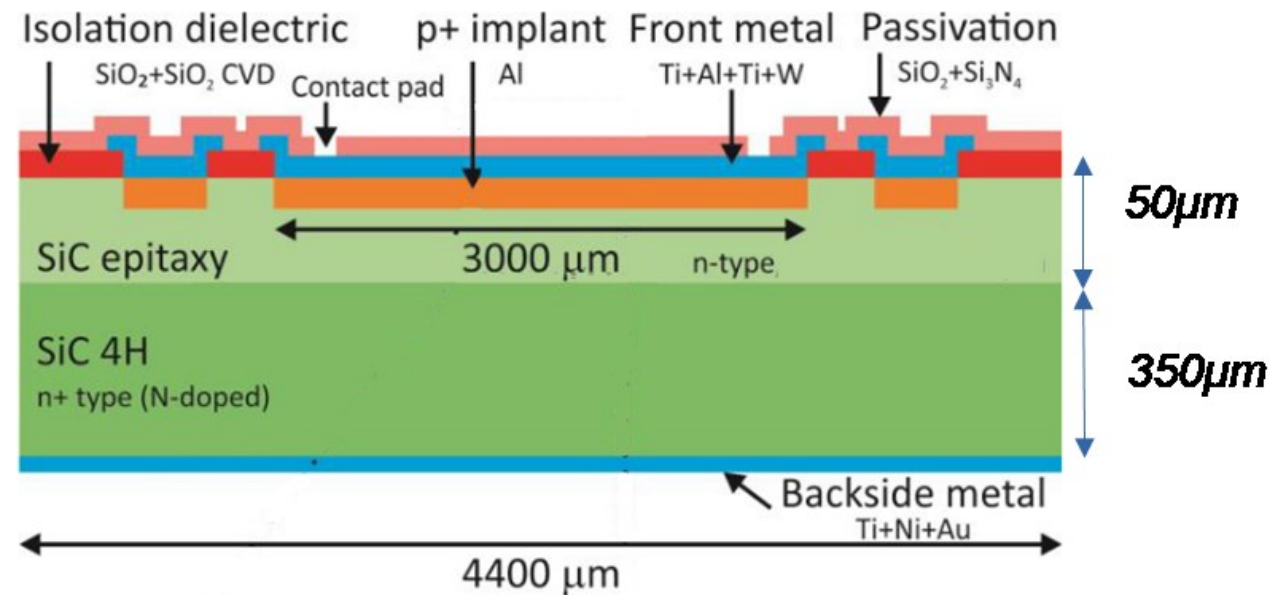
VERY MODERATE energy per pulse

3PA in SiC: DUT description

- CNM SiC planar pad diodes P in N
- Neutron-irradiated (ATI Vienna)
- Samples (**non metallized contact**):
 - 1MW2 (Non-irradiated)
 - F2W1 ($1e15 n_{eq}/cm^2$)
 - K6W1 ($5e14 n_{eq}/cm^2$)

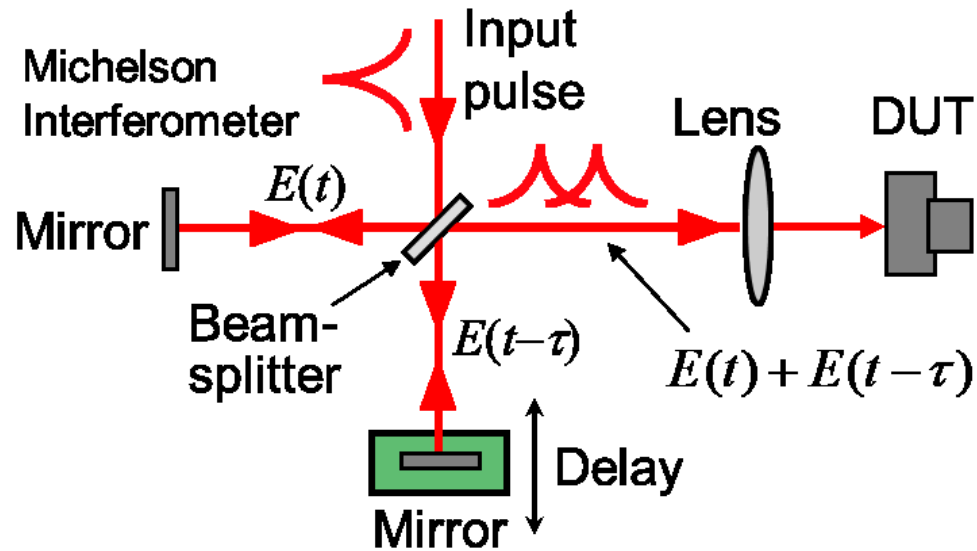


Signal collection ring

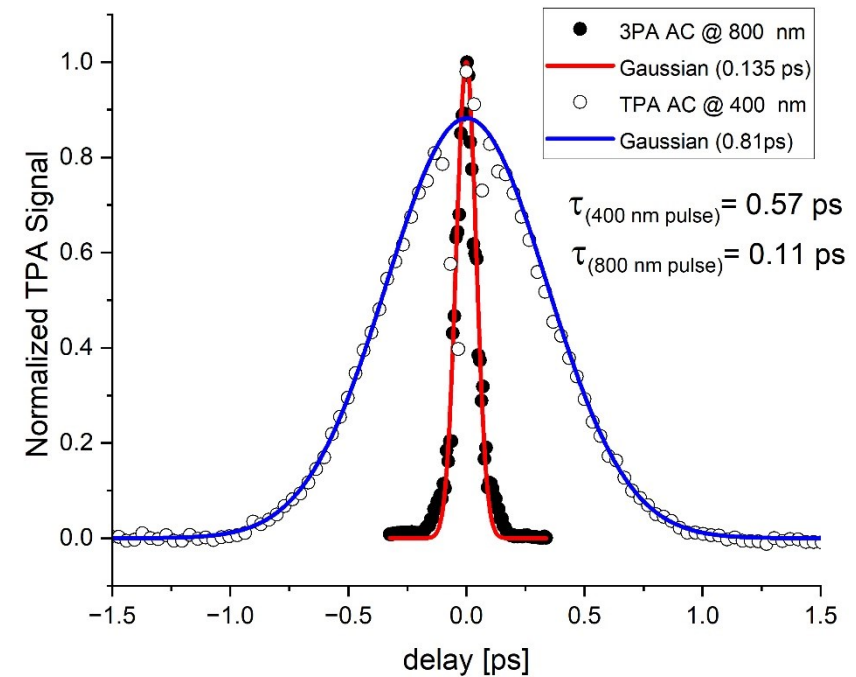


3PA in SiC: Pulse temporal profile

Interferometric autocorrelation in collinear configuration



$$I \propto [E(t) + E(t-\tau)]^2 \quad A(\tau) \equiv \int_{-\infty}^{\infty} I(t) I(t-\tau)^2 dt$$

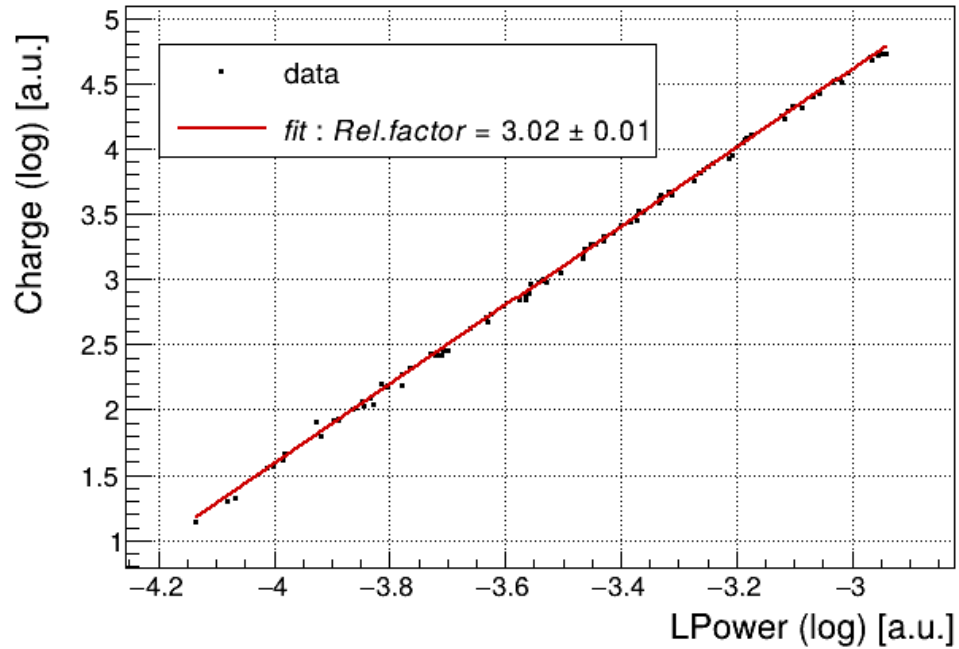


Much reduced pulse duration due to small wavelegth dispersion

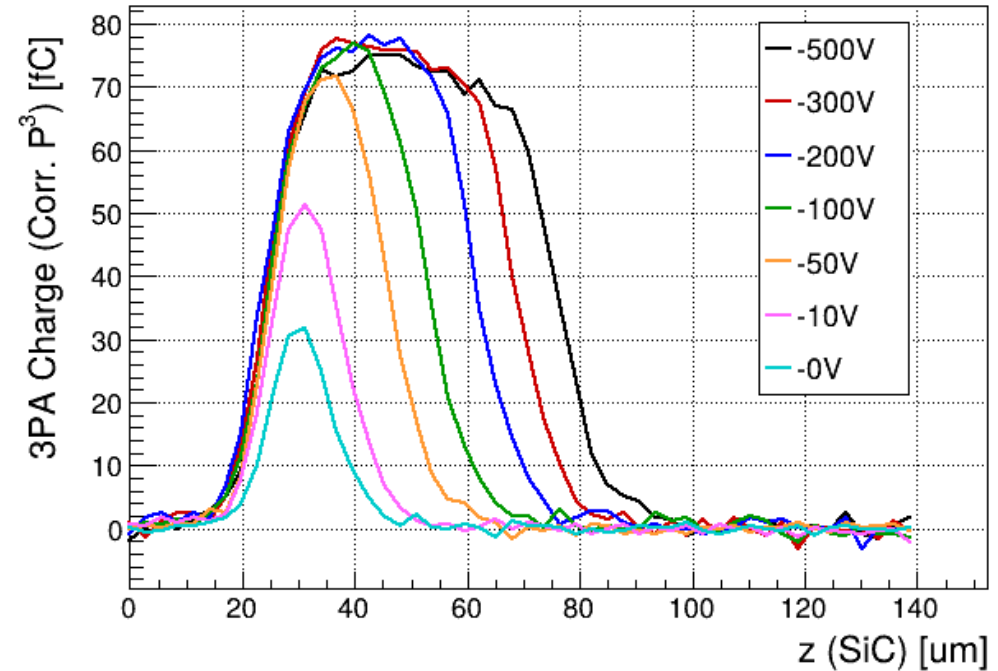
3PA in SiC: Power scan and Z-Scan of fresh diodes



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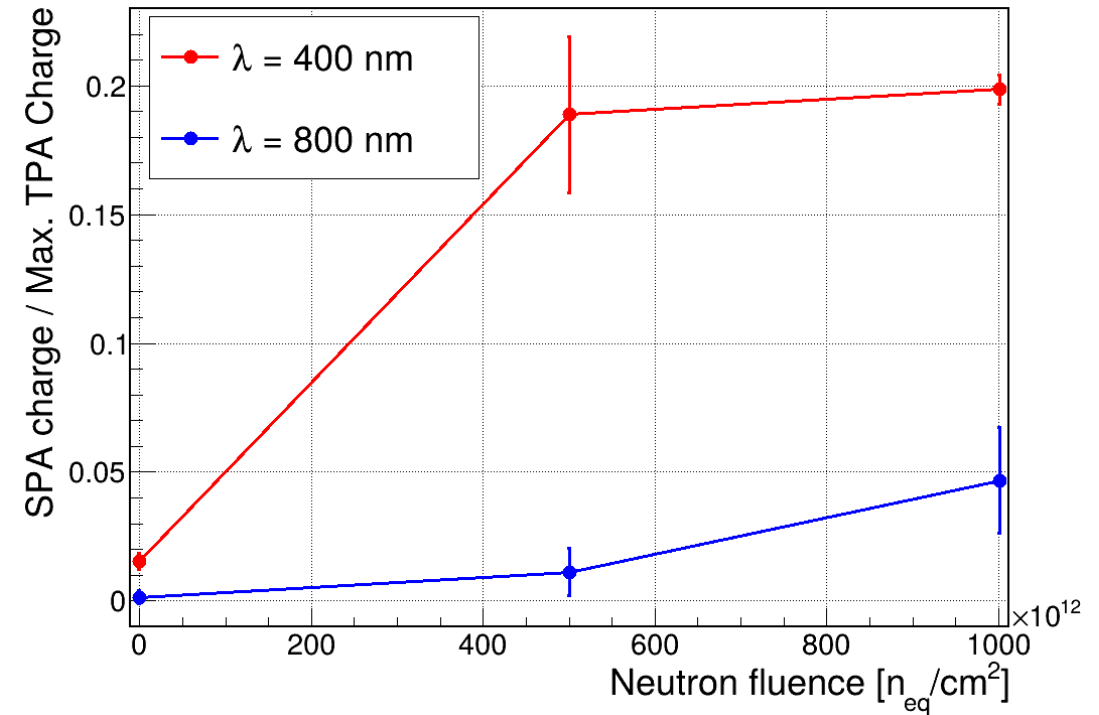
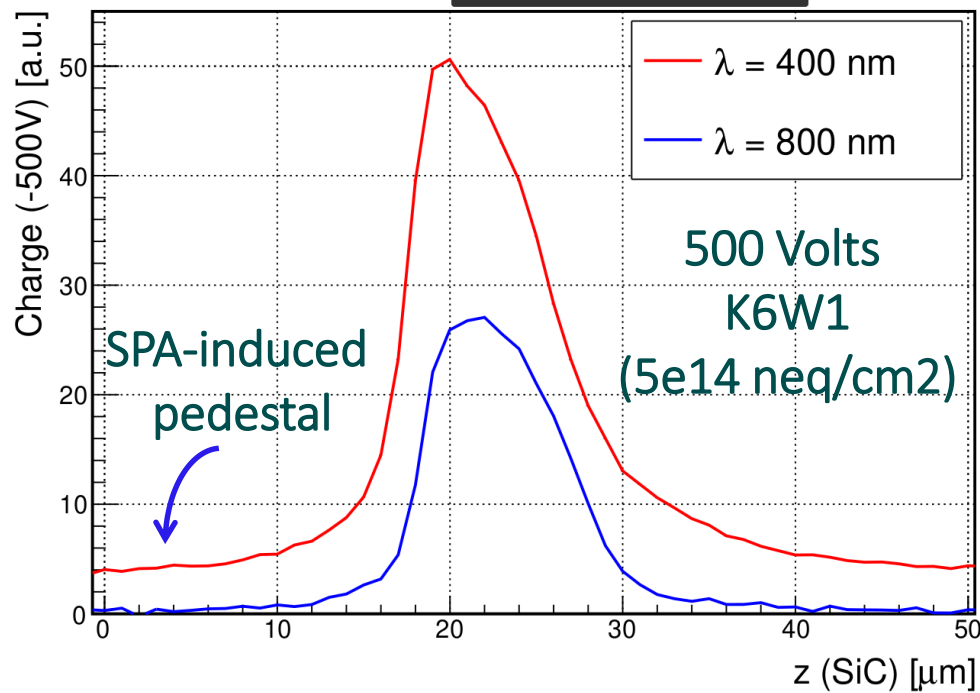
Excellent cubic dependence between the signal strength and the laser intensity



Z-scan dependence with bias voltage as expected

3PA-TCT: Irradiated SiC

- Relative suppression of the SPA contribution with respect to the TPA contribution



Summary



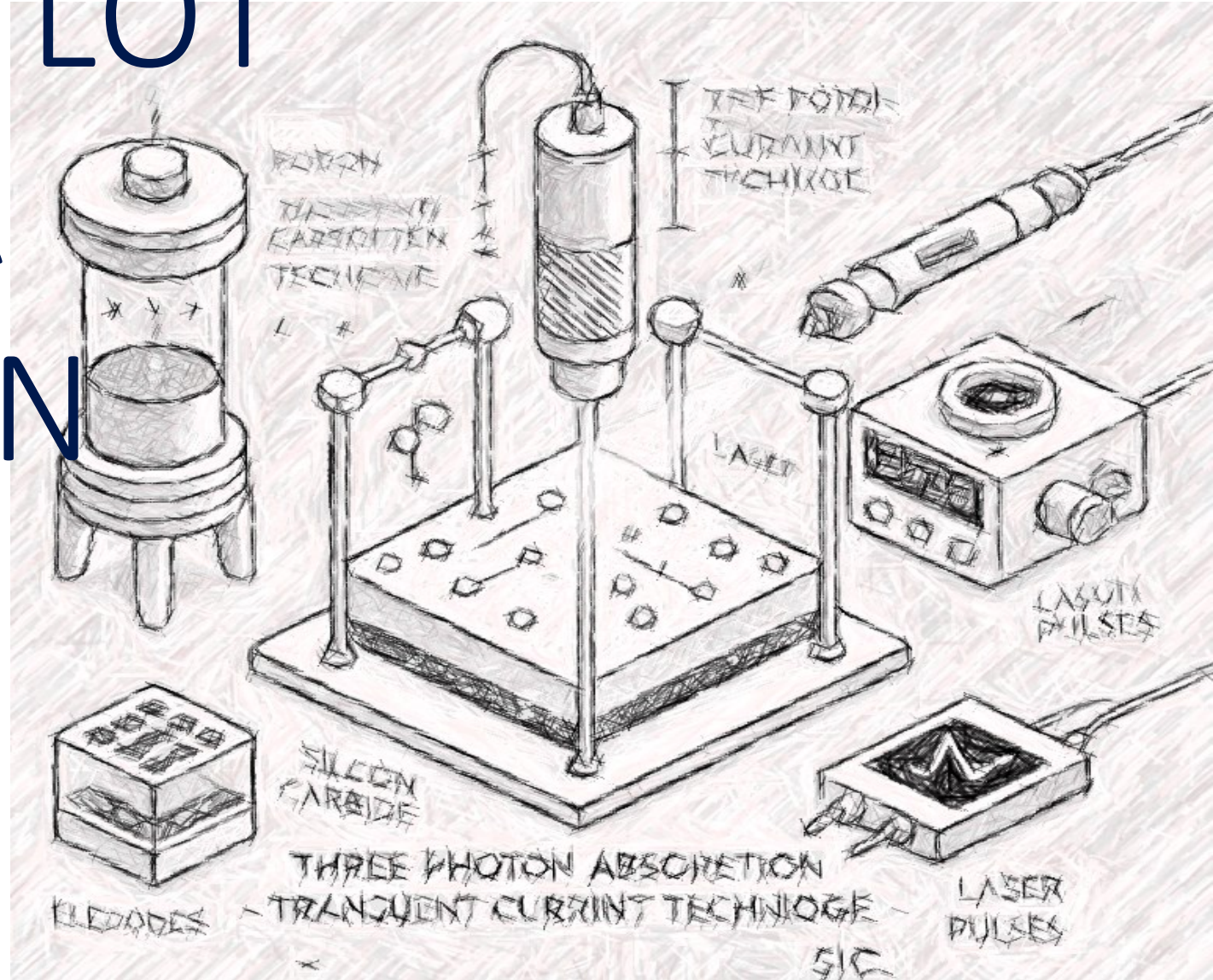
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- First demonstration of the 3PA-TCT in SiC.
- Moderate pulse energy enables the development of compact, fiber-based, table-top 3PA-TCT systems suitable for testing wideband semiconductors.
- Shorter pulse duration: suppression of SPA background.
- Other significant advantages:
 - _ Much simpler experimental setup.
 - _ A more friendly wavelength for optical components.

THANKS A LOT FOR YOUR ATTENTION



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Required AI-generated and HI-edited image for the closing slide that any decent talk should have these days