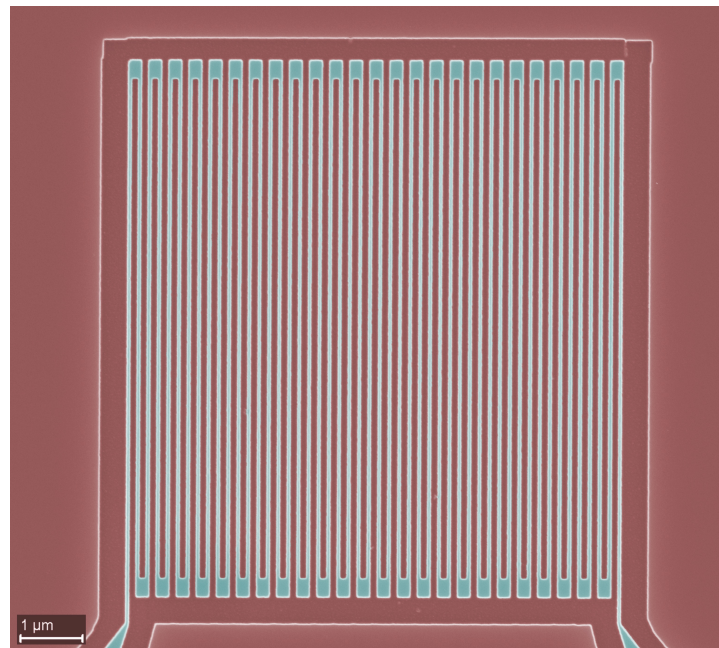


SUPERCONDUCTING NANOWIRE DETECTORS

TOMAS POLAKOVIC
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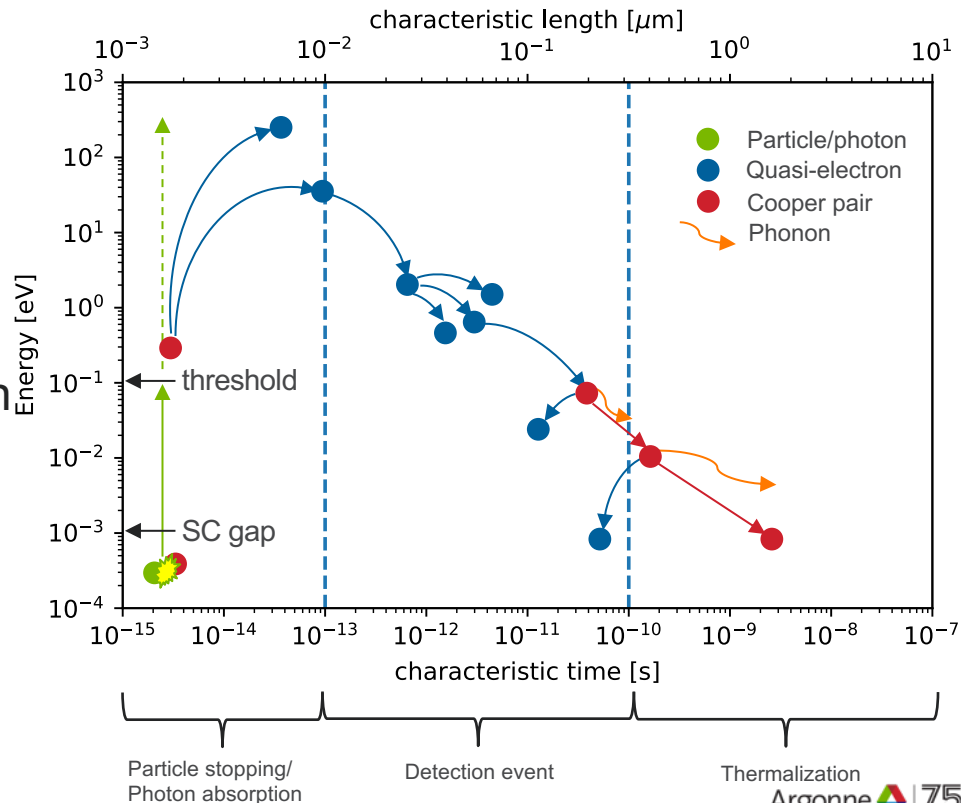
SUPERCONDUCTING NANOWIRE DETECTORS

- Superconducting thin film-based sensors
 - ~10 nm thick film
 - Wide range of possible substrates (even 10 μm membranes)
- Individual pixel size on the order of 10-100 μm
- Simple readout
 - 2-wire voltage drop measurement
 - Minimal preamplification necessary



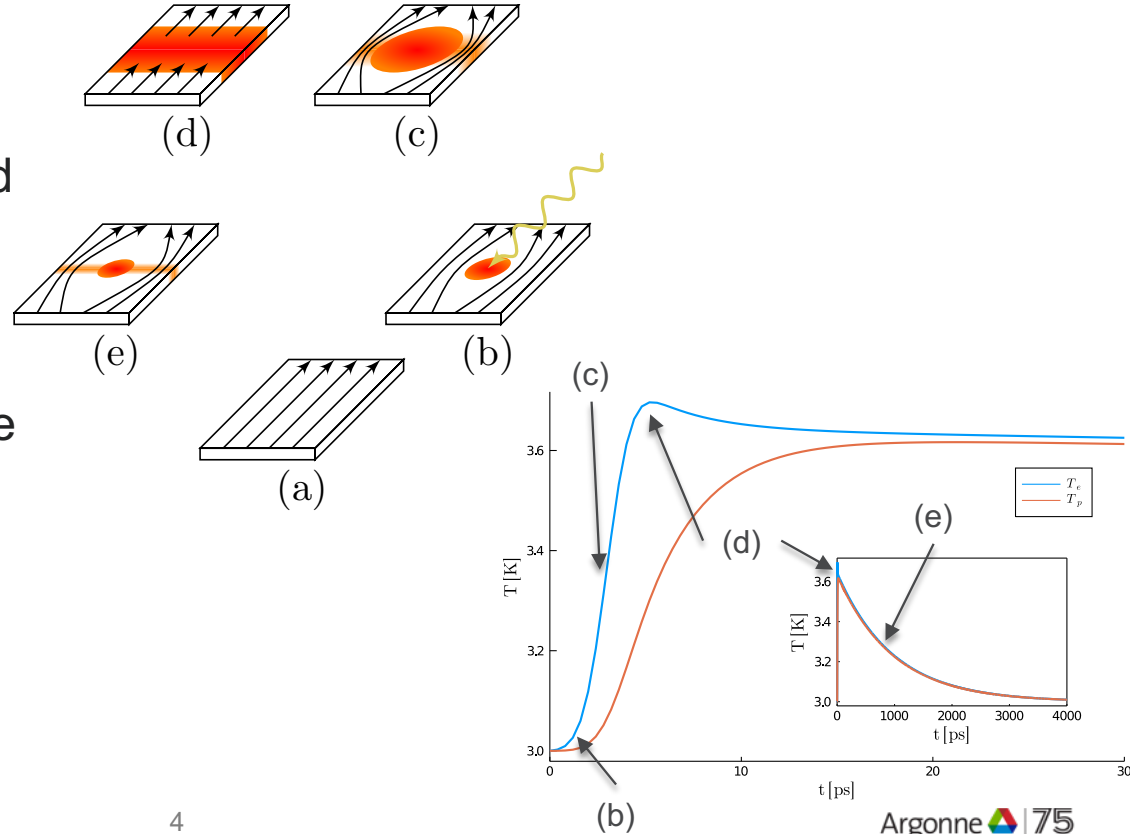
OPERATION

- Uses quasi-particle avalanche process inside a current biased superconducting nanowire to detect scattering/absorption of individual quantum excitations
- Much faster and more sensitive than ionization avalanches in semiconductor detectors



OPERATION

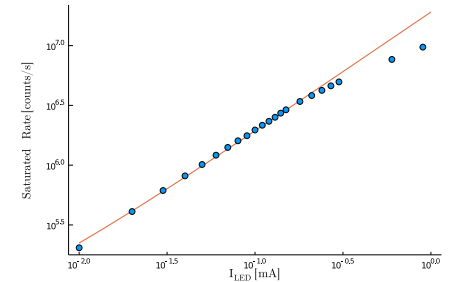
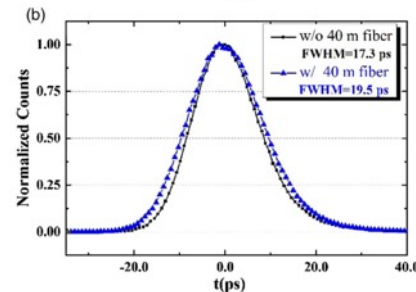
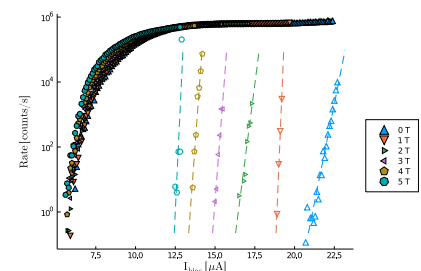
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METRICS

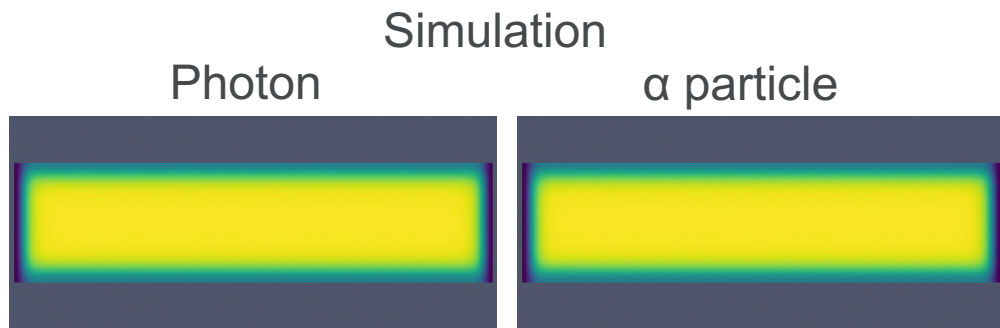
- The fastest and most precise “first-gen” quantum detector of individual particles
 - Energy thresholds as low as ~100 meV
 - Timing jitter easily 20-40 ps (current record at 2.7 ps)
 - Reset times can be as low as 5-10 ns
 - Conveniently operates at roughly LHe temperatures
 - Can operate in magnetic fields of > 5 T

Parameter	SOA 2020	Goal by 2025
Efficiency	98% @ 1550nm	>80 % @10 μ m
Energy Threshold	0.125 eV (10 μ m)	12.5 meV (100 μ m)
Timing Jitter	2.7 ps	< 1ps
Active Area	1 mm ²	100 cm ²
Max Count Rate	1.2 Gcps	100 Gcps
Pixel Count	1 kilopixel	16 megapixel
Operating Temperature	4.3K	25 K

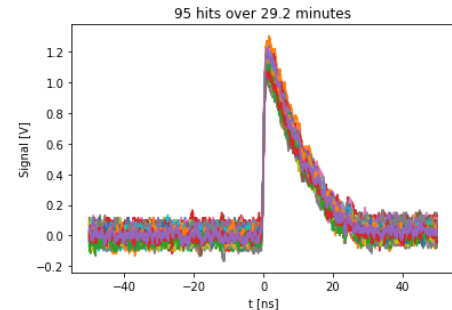
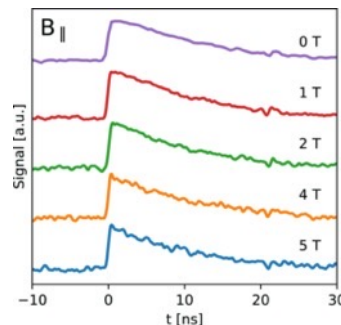
Wu, et al. *Applied optics* (2017)Polakovic, et. al. *NIM A* (2020)

PARTICLE DETECTION

- Have been demonstrated to also detect low/medium-energy (~ 5 MeV) α , β particles and neutrons (indirectly)
 - All important metrics (timing, efficiency, etc.) seem to be the same
 - Detection of high energy particles still an open question



Experiment

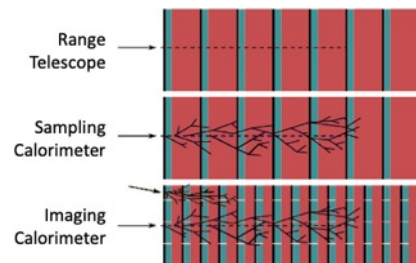
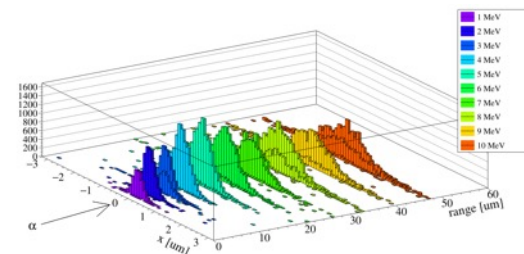
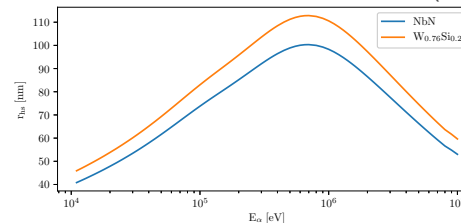


Polakovic, et. al. NIM A (2020)

PARTICLE DETECTION

- Have been demonstrated to also detect low/medium-energy (~ 5 MeV) α , β particles and neutrons (indirectly)
 - All important metrics (timing, efficiency, etc.) seem to be the same
 - Detection of high energy particles still an open question
 - Potential also for calorimetry

Polakovic, et. al., Nanomaterials (2020)



LARGER AREA DETECTORS

- Looking into fabrication of larger multi-pixel arrays

