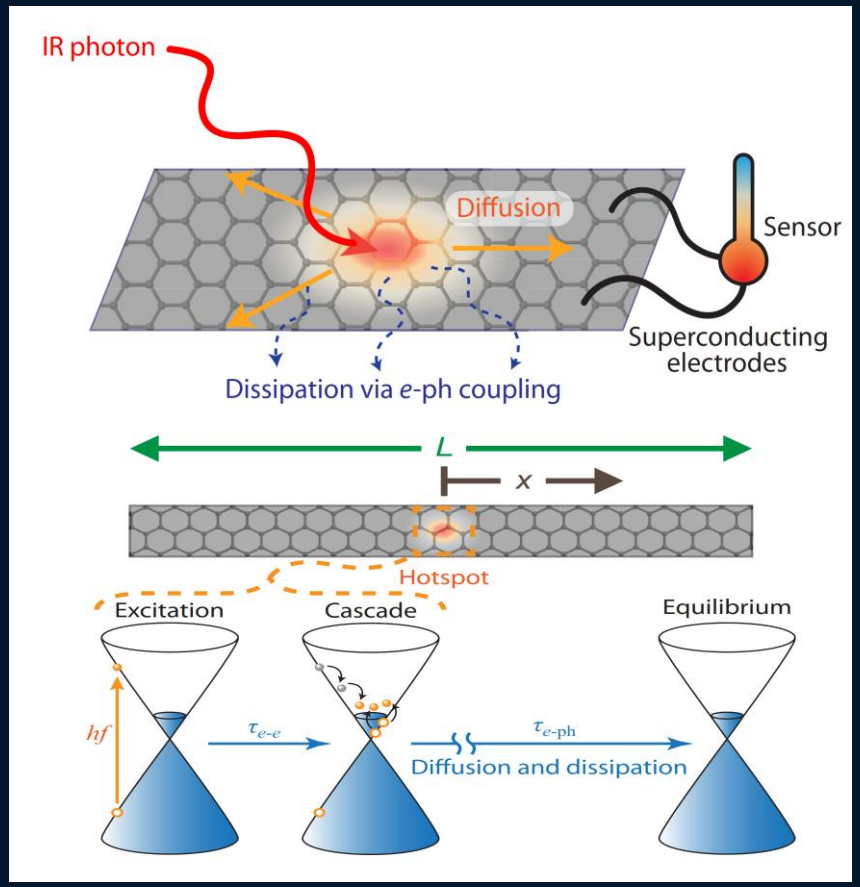
GRASP

GRAPHENE JOSEPHSON BOLOMETERS FOR QUANTUM SENSING & DARK MATTER DETECTION

SHORT CONFERENCE OVERVIEW •
ADAMOS / BRASS / MICROWAVE SINGLE-PHOTON DETECTION



CORE IDEA: MAKE MICROWAVE PHOTONS COUNTABLE, NOT JUST AMPLIFIABLE

ANTONIOS GARDIKIOTIS • NCSRD DEMOKRITOS / UHAM COLLABORATION

THE DETECTION GAP: MICROWAVE PHOTONS ARE TOO QUIET

ABOVE 10 GHZ, BOTH DARK-MATTER SEARCHES AND QUANTUM TECHNOLOGIES NEED TRUE MICROWAVE PHOTON COUNTING.

WEAK SIGNALS

AXION CONVERSION POWER CAN BE AT THE PHOTON-PER-HOUR LEVEL.

AMPLIFIER LIMIT

HETERODYNE CHAINS MEASURE FIELDS; THEY DO NOT REGISTER INDIVIDUAL MICROWAVE QUANTA.

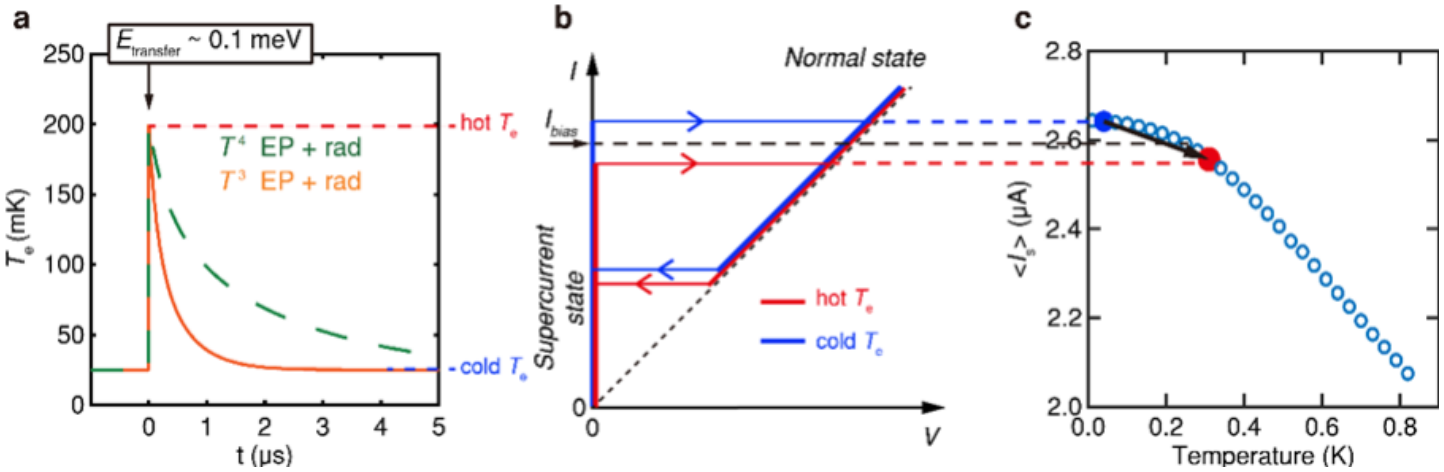
GRASP ROUTE

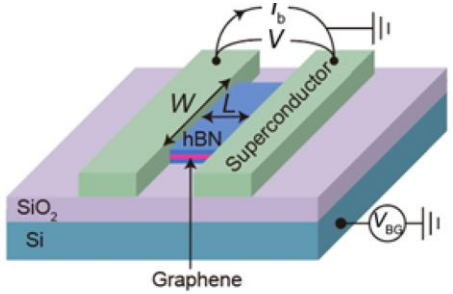
USE GRAPHENE HOT-ELECTRON CALORIMETRY + JOSEPHSON SWITCHING FOR DIGITAL PHOTON EVENTS.

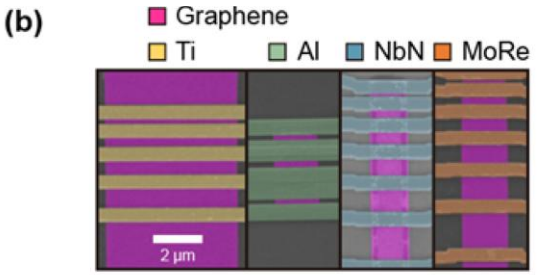
GRASP TURNS A LIMITATION INTO A DETECTOR PLATFORM: CALORIMETRY INSTEAD OF AMPLIFICATION.

DETECTOR PRINCIPLE: HOT ELECTRONS + JOSEPHSON SWITCHING

Simulated time







1 MICROWAVE PHOTON → ELECTRON TEMPERATURE RISE

Graphene's tiny electronic heat capacity makes tens of μev measurable at mk temperatures.

TEMPERATURE RISE → CRITICAL CURRENT SHIFT

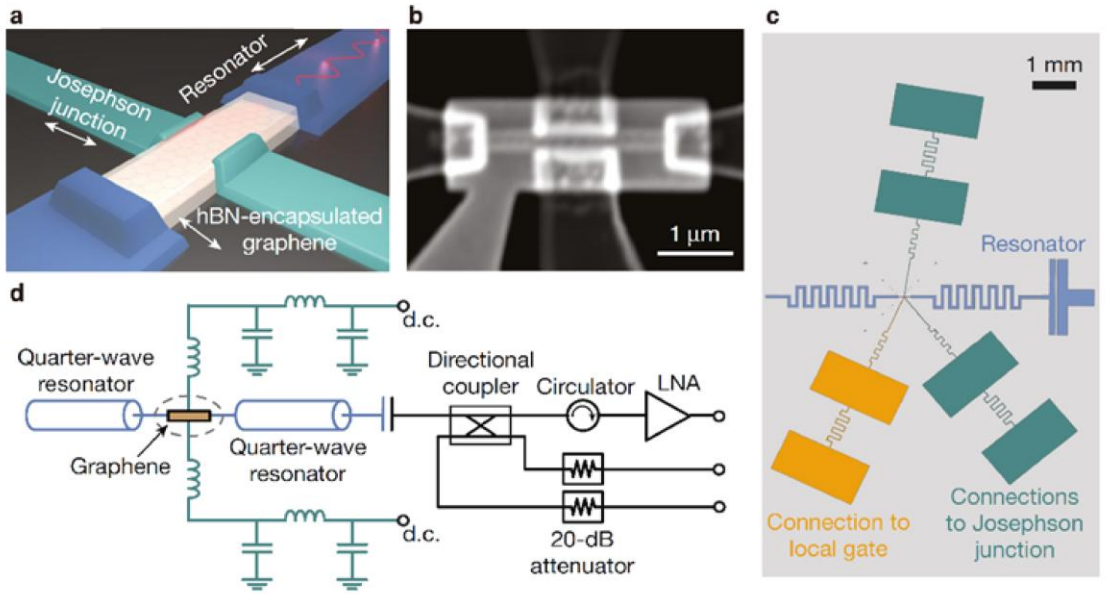
The GJJ is biased close to Ic, so photon absorption changes the stochastic switching probability.

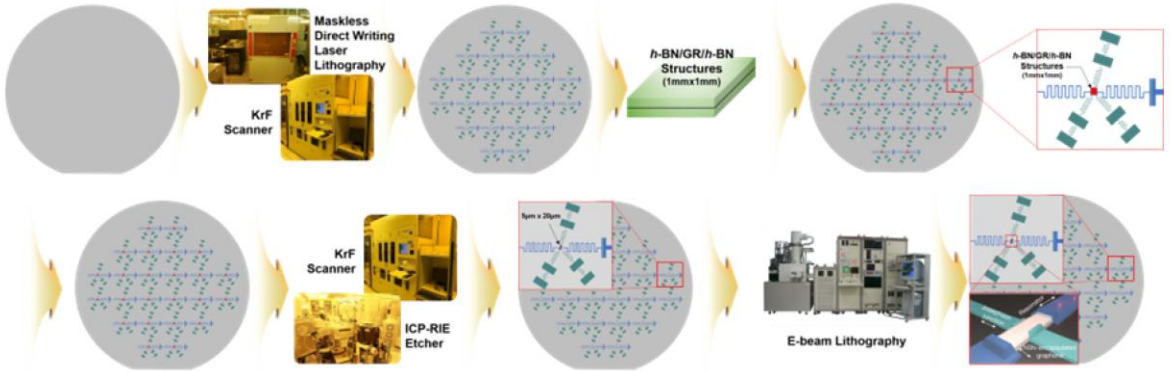
SWITCHING → DIGITAL VOLTAGE PULSE

a tiny thermal event is converted into an easily time-tagged macroscopic signal.

FROM RECORD DEVICE TO REPRODUCIBLE PLATFORM

GRASP FOCUSES ON BATCH FABRICATION, CROSS-SITE CALIBRATION AND DEPLOYABLE MODULES.





MATERIALS

HBN/GRAPHENE/HBN STACKS

→

CONTACTS

NBN / MORE EDGE CONTACTS

→

MICROWAVE

15–25 GHz RESONATOR COUPLING

→

CALIBRATION

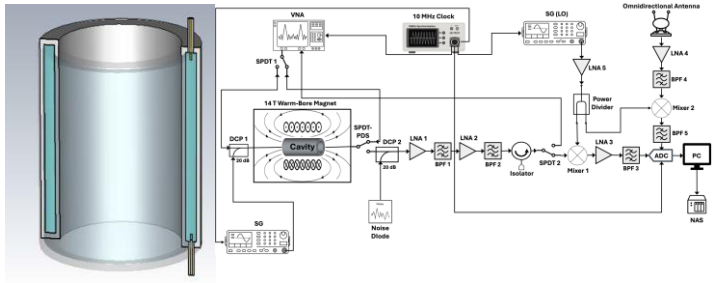
η, DCR, jitter, NEP

Nature 586, 42–46 (2020)

THREE PHYSICS USE-CASES, ONE DETECTOR TECHNOLOGY

ADAMOS → **RESONANT HALOSCOPE**

15–25 GHZ
60–100 μeV AXIONS

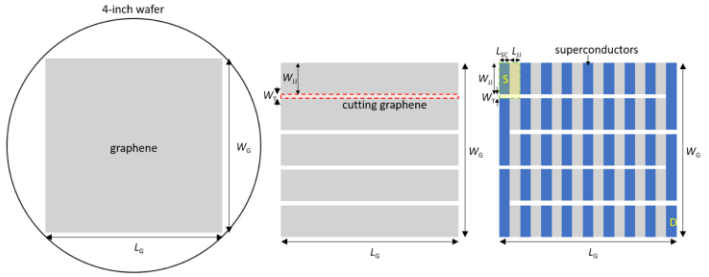


BRASS → **BROADBAND DISH / ANTENNA**

10 GHZ–THZ
AXIONS & HIDDEN PHOTONS

SCATTERING → **GRAPHENE TARGET = SENSOR**

0.1–1 KeV
SUPER-LIGHT
DARK MATTER



COMMON VALUE PROPOSITION

CALORIMETRIC MICROWAVE PHOTON COUNTING AT MILLIKELVIN TEMPERATURES

PHYSICAL REVIEW D 112, 015002 (2025)

EU–KOREA CONSORTIUM: COMPLETE INNOVATION CHAIN

EUROPE

NCSRD DEMOKRITOS
UNIVERSITY OF HAMBURG
UNIVERSIDAD DE GRANADA
UNIVERSITY OF TWENTE

UNIQUE INFRASTRUCTURE: ADAMOS, BRASS, CRYOGENIC RF, NANOFABRICATION AND THEORY.

KOREA

POSTECH
SOGANG UNIVERSITY
CHUNGNAM NATIONAL UNIVERSITY

WORLD-LEADING GRAPHENE JOSEPHSON DEVICES, WAFER-SCALE PROCESS DEVELOPMENT AND CHARACTERIZATION.

MATERIALS → DEVICES → CALIBRATION → DEPLOYMENT

QUANTITATIVE TARGETS THAT MAKE THE PROJECT TESTABLE

η ≥70%	DETECTION EFFICIENCY
DCR ≤10^{-3} counts s^{-1}	DARK-COUNT RATE
Timing jitter ≤100 ns	TIME TAGGING
NEP ≤10^{-19} W $Hz^{-1/2}$	THERMAL-NOISE FLOOR
ADAMOS ≥100 MHz	EXPLORED BANDWIDTH
BRASS ≥24 h	STABLE OPERATION

THE PROJECT SUCCESS IS NOT VAGUE: IT IS MEASURED BY CALIBRATED DEVICES, STABLE CRYOGENIC OPERATION AND DEPLOYMENT IN ADAMOS/BRASS.

TAKE-HOME MESSAGE

GRASP AIMS TO MAKE THE MICROWAVE SINGLE PHOTON A COUNTABLE OBJECT.

- **PHYSICS** — OPENS HIGH-FREQUENCY AXION AND HIDDEN-PHOTON SEARCHES
- **TECHNOLOGY** — BUILDS A REPRODUCIBLE MICROWAVE SPD PLATFORM
- **STRATEGY** — CONNECTS EU INFRASTRUCTURES WITH KOREAN GRAPHENE EXPERTISE

THANK YOU