

AnaBHEL Single Photon IR detector R&D

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Contents

Overview

AnaBHEL Description

INTRO

A review of SPD candidates

INTRO

[1]

[2]

Detector	NEP (W/\sqrt{Hz})	Single-photon sensitive?	Efficiency
MCT (HgCdTe)	10^{-19}	Preliminary results	High
SC detectors (KID/TES/HEP)	10^{-16}	Yes	High
Mid-IR up-conversion	Detector-dependent	Detector-dependent	$\sim 20\%$
Commercial (InAsSb)	10^{-11}	No	
SNSPD	10^{-21}	Yes	20% (current, 2um)

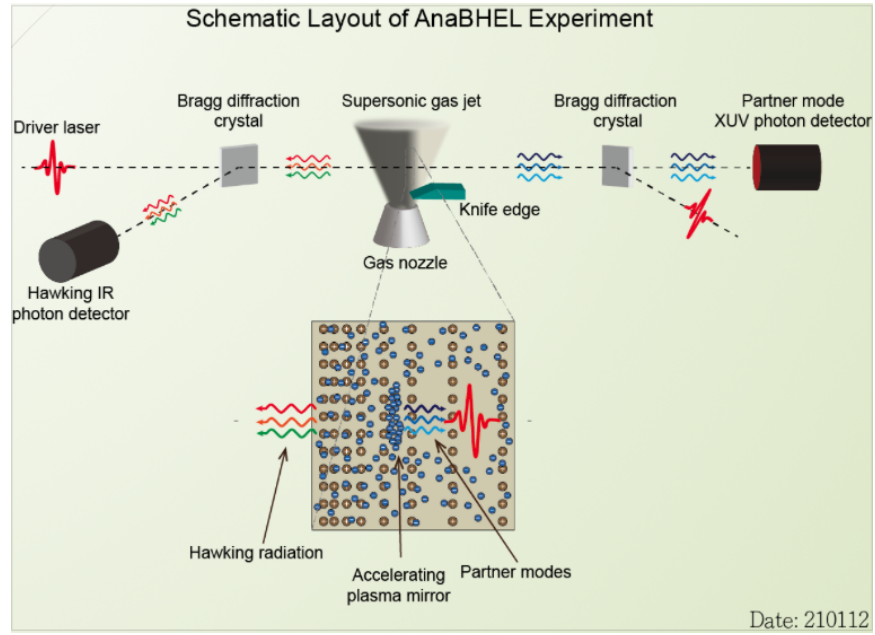


Figure 1: Schematic layout of the AnaBHEL experiment. On the left is where we would receive the expected red shifted Hawking IR photon, and the partner mode would be on the other side which an XUV single photon detector is used. The signal photon pair are extracted from vacuum, therefore entangled and polarization anticorrelated.

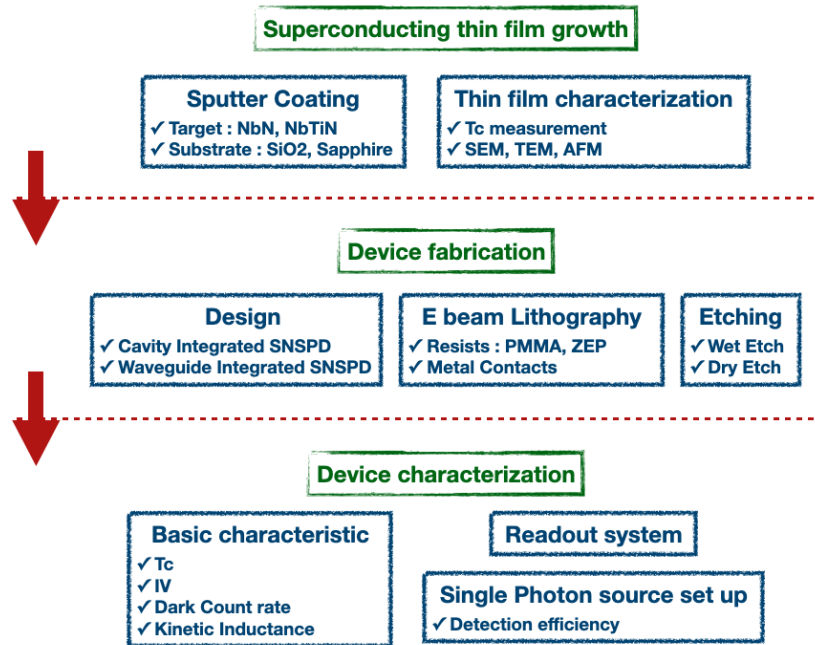
SPAD

SNSPD

KID

Detector R&D Flow Chart

PLAN:INTRO



Todo

Create shared platform to edit project documents GENERAL

HI HI

STRT Finalize the format

TODO Create git repository

Sputter Coating

SPUTTER

First thin film @ NEMS Facility

Goal: To get familiar with superconducting thin film growing, measure the superconductivity in a cryogenic system. I plan to grow a 300nm Nb film on

top of SiO₂ substrate using the sputter machine at NEMS facility.[3]

WAIT Nb & Ti Target SPUTTER Ordered with Gredmann group on 2021-06-07

Contact : Bella Leng
Mail : bella.leng@gredmann.com
Quotation

TODO Substrate **SPUTTER**

TODO Discuss Parameters

Device Fabrication

Here are the needed fabrication and experiment steps for building SNSPD. Many parts is inspired of the work from Glasgow University group, and modified to the equipment we have here. [4]

Sputter

E beam Lithography

Etching

Experimental Methods

Cryogenic system **CRYOGENIC**

Tc measurement **CRYOGENIC:CHARACTERISTIC**

SEM **CHARACTERISTIC**

Readout system **DAQ**

Single Photon source **CHARACTERISTIC:SINGLEPHOTON**

Log

2021-07-07 Sputter cost discussion **SPUTTER**

We have two options:

1. Get 50% discount everytime we use.

2. Get us a period of free operation time

Estimate cost for one thin film : 1k NTD

Reference

References

- [1] Dmitry Morozov, Archan Banerjee, Kleanthis Erotokritou, Gregor Taylor, Nathan R. Gemmell, Dilini Hemakumara, Iain Thayne, and Robert H. Hadfield. Superconducting nanowire materials for mid infrared single photon detection (conference presentation). In *Advanced Photon Counting Techniques XII*, page nil, 5 2018.
- [2] Gregor G. Taylor, Dmitry Morozov, Kleanthis Erotokritou, Shigehito Miki, Hirotaka Terai, and Robert H. Hadfield. Mid infrared single photon detection with superconducting nanowires (conference presentation). In *Advanced Photon Counting Techniques XIV*, page nil, 4 2020.
- [3] NEMS. NEMS official website. [Online; accessed 07-July-2021].
- [4] Kleanthis Erotokritou. Next generation superconducting nanowire single-photon detectors. *University of Glasgow*, nil(nil):nil, 2019.