# Project Title: **Innovation of photonic and electrochemical biosensors for cholangiocarcinoma diagnosis**

Background :

Cholangiocarcinoma (CCA) is prevalent in the Greater Mekong Subregion, especially in northeastern Thailand and Lao PDR, where the liver fluke *Opisthorchis viverrini* is endemic. Most patients with CCA are diagnosed at an advanced stage, resulting in limited survival times post-surgery due to the absence of reliable biomarkers. Currently, CCA diagnosis relies on radiological and histopathological techniques, which are both expensive and time-consuming. Our research has identified numerous biomarkers for CCA in animal models, which have been successfully adapted for clinical applications in patients. The emergence of biosensor platforms, utilizing photonic and electrochemical detection technologies, offers a significant advantage due to their high integration capabilities. This advancement facilitates the transition of these tools from research laboratories to practical use in analytical chemistry and clinical medicine, allowing large-scale detection across various sample types, including urine, feces, and serum. We hypothesize that the deployment of these biosensor platforms for detecting trace levels of CCA biomarkers in animal models has the potential to be translated effectively into clinical applications for patient diagnosis.

Targets: To develop photonic and electrochemical biosensors for cholangiocarcinoma diagnosis.

Speaker: **Dr. Somchai Pinlaor,** Dr.Chavis Srichan, Dr. Pobporn Danvirutai

# Project Title: **Innovation of photonic and electrochemical biosensors for cholangiocarcinoma diagnosis**

## Project Members :


**KKU (THA)** : **Somchai Pinlaor**, Chavis Srichan, Pobporn Danvirutai, Kitti Intuyod, Apisit Chaidee, Sirinapha Klungsaeng

**CMU (THA)** : Ukrit Mankong, Suruk Udomsom

**TMEC** : Nithi Atthi

**BIOTECH** : Sittiruk Roytrakul, Janthima Jaresitthikunchai, Narumon Phaonakrop

**NECTEC** : Noppadon Nuntawong, Mati Horprathum, Pitak Eiamchai, Saksorn Limwichean

**Mittaphab Hospital (LAO)** : Champadeng Vongdala, Keooudone Thammavong

**NICT (JPN)** : Toshimasa Umezawa, Atsushi Matsumoto, Kouichi Akahane


## Project Duration : 24 months

First Year : May 1st , 2023 to April 30th , 2024
Second Year: May 1st , 2024 to April 30th , 2025

## Project Budget: 80,000 USD

First Year : 40,000 USD
Second Year: 40,000 USD

# Background

## Old hypothesis

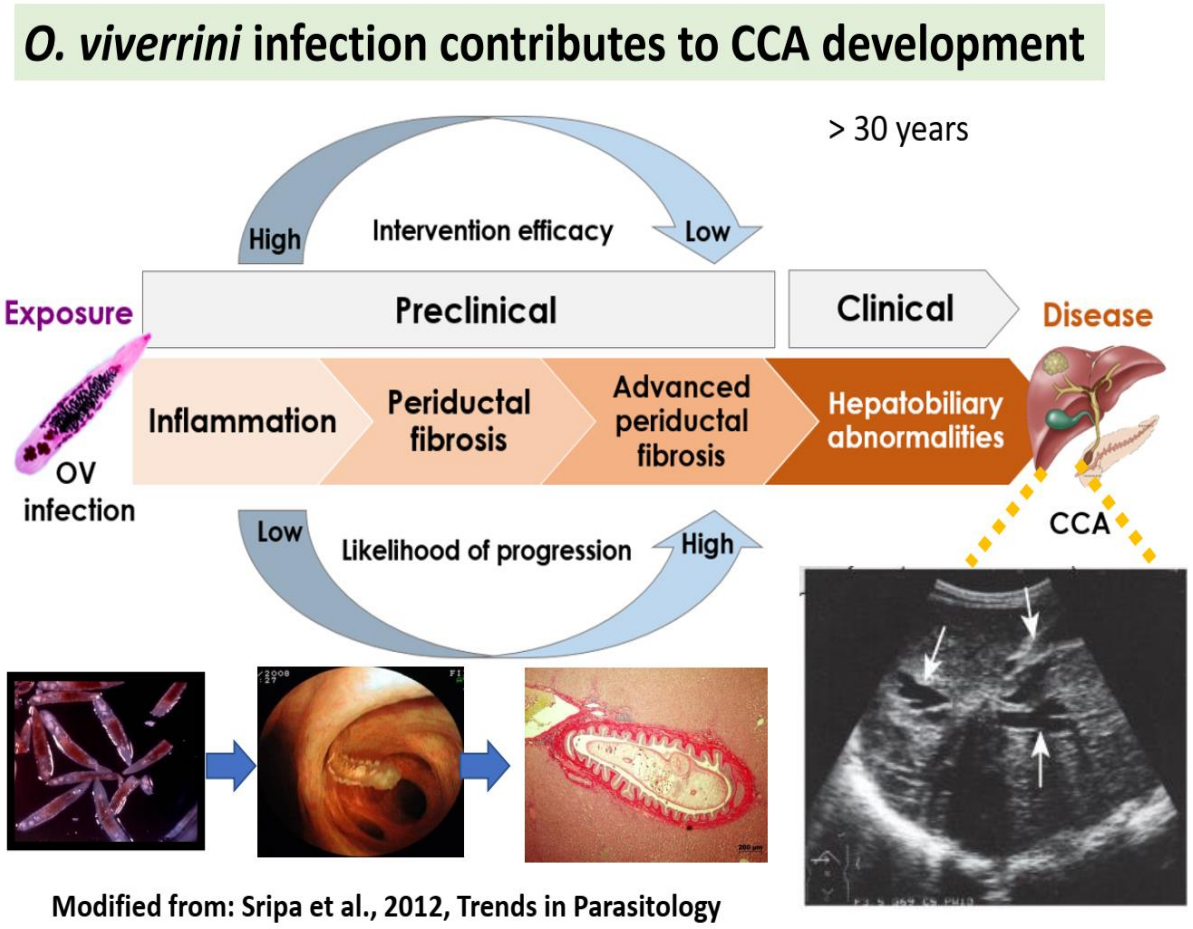



Fig.1 OV-induced inflammation, fibrosis, advanced fibrosis, and contribution risk to CCA. Thus, radiology such as MRI & Ultrasound are used for CCA screening.

## New hypothesis

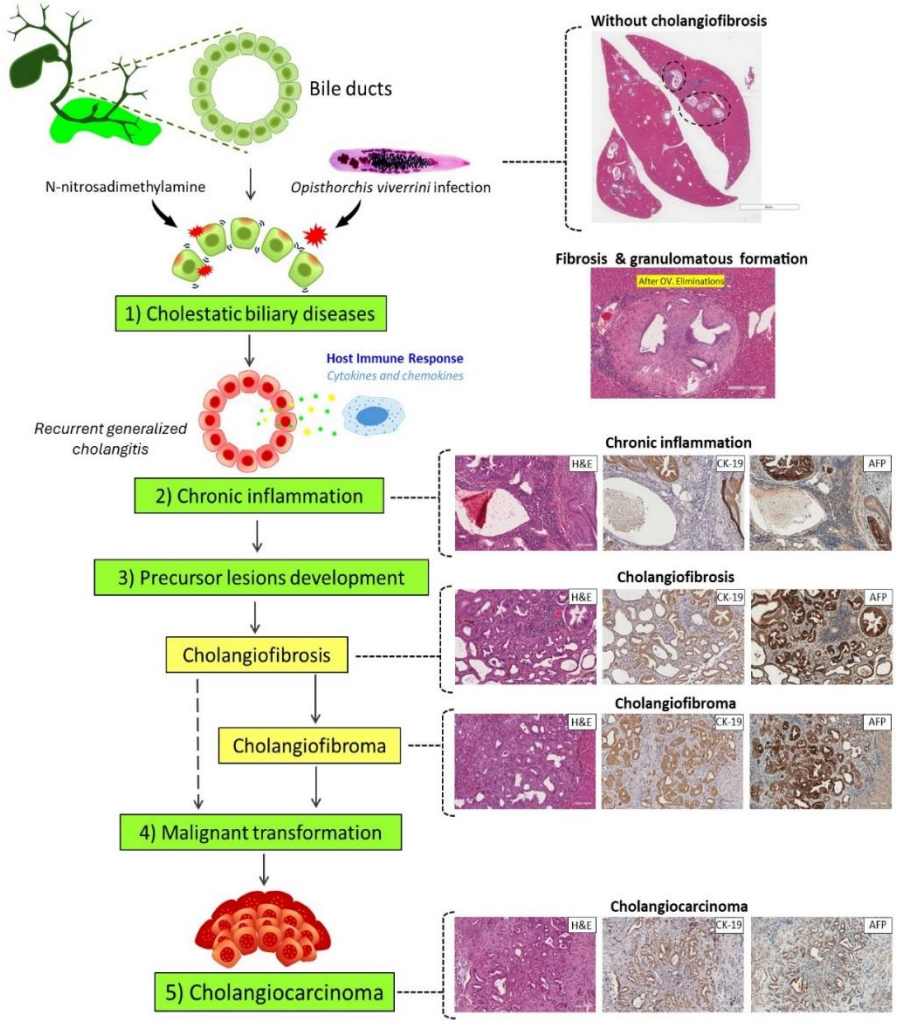



Fig.2 OV-induced chronic inflammation, precancerous lesion and CCA development

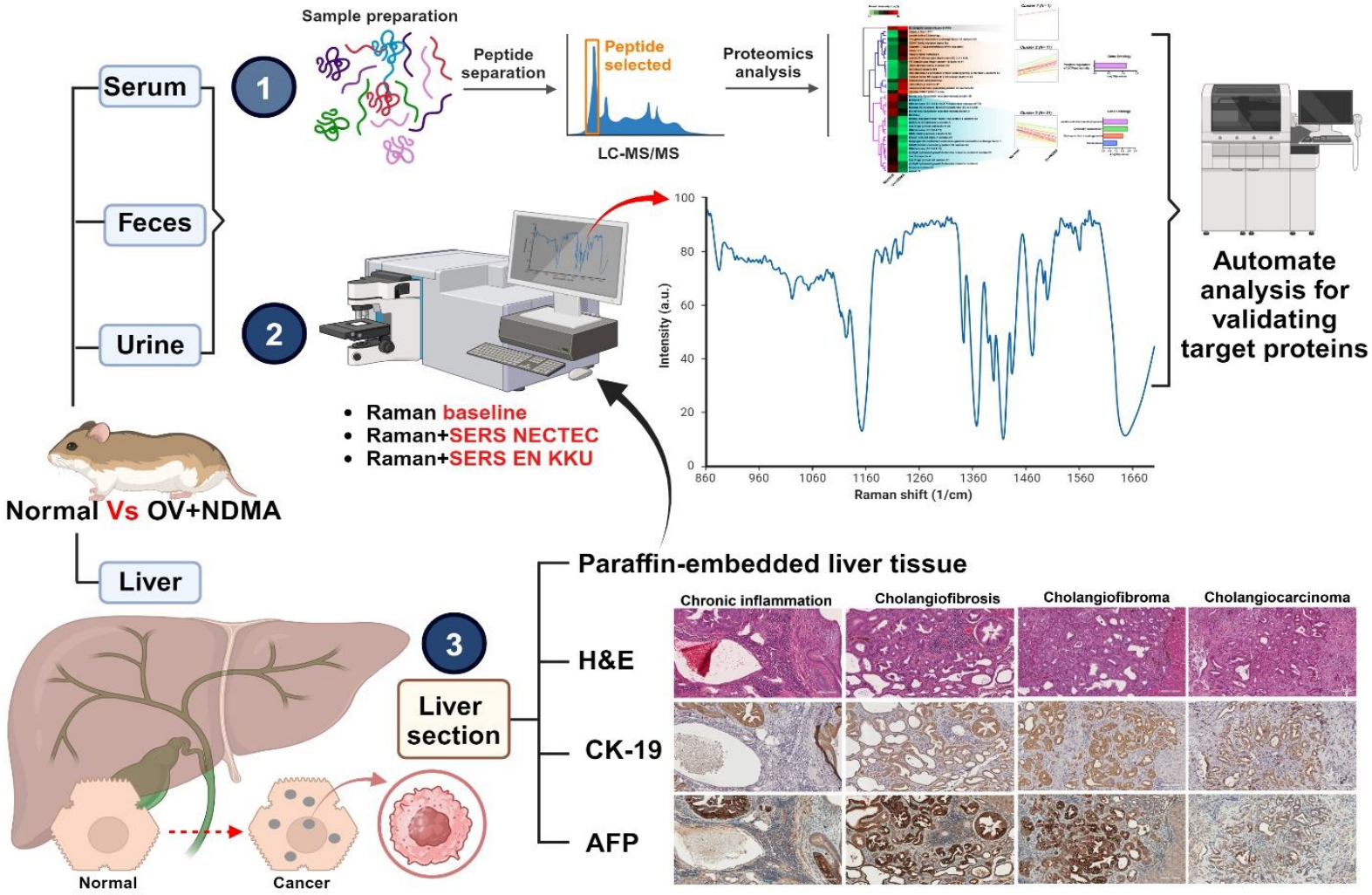



**Fig.3 Schematic diagram illustration of the scope of the study in animal model.** The early marker for CCA diagnosis was discovered in hamster model and apply in the patients. The step include 1) proteomic analysis for protein identification, 2) Raman spectroscopy based on based line peak, SERS from NECTEC and SERS from EN-KKU, and 3) histopathological study by staining with hematoxylin-eosin (H&E), cytokeratin-19 (CK-19) and alpha-fetoprotein (AFP).

# Project Activities: MDKKU-NECTEC

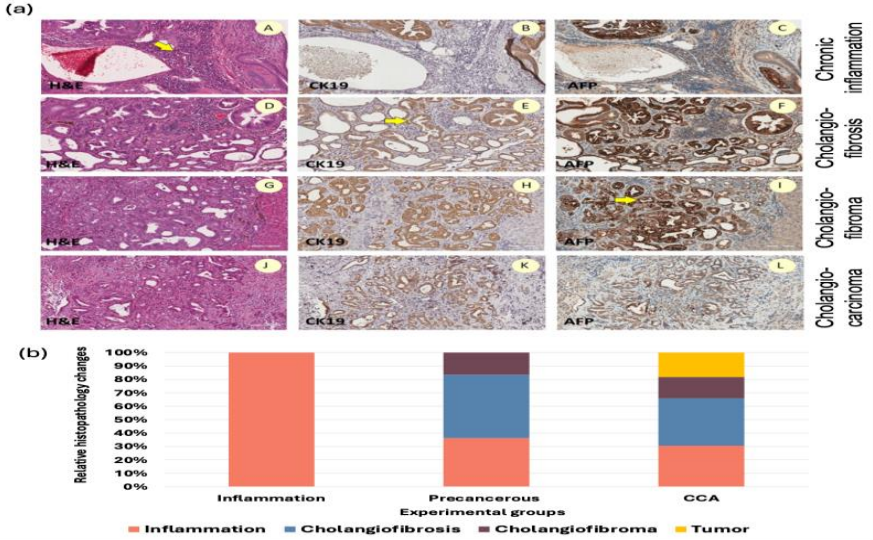



**Fig.4** CCA development is classified into inflammation, pre-cancerous lesion and tumor lesion according to histopathological changes

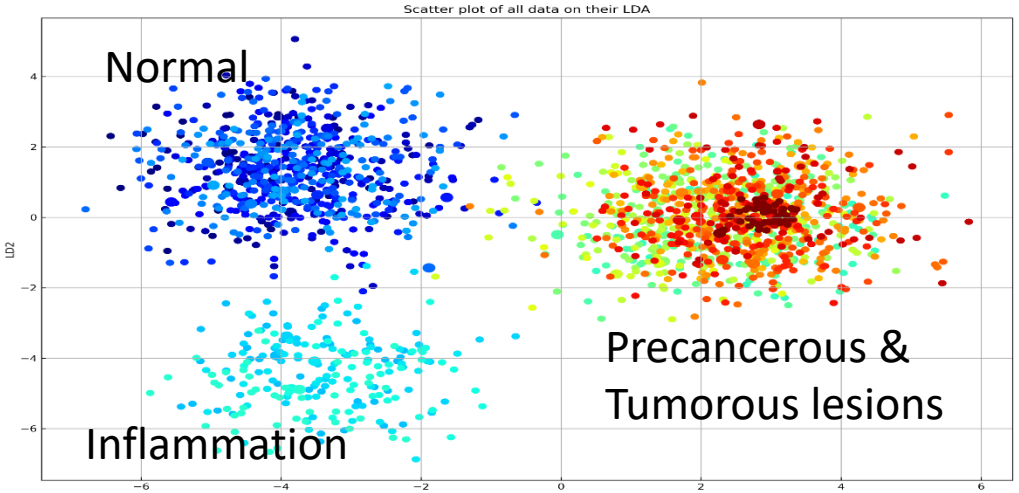



**Fig.5 Comparison among principle components analysis (PCA) results of Raman spectra** of four classes of normal, inflammation, pre-cancerous and tumor. However, Raman intensities couldn't distinguish between pre-cancerous and CCA groups based on classical machine (ML) algorithm.

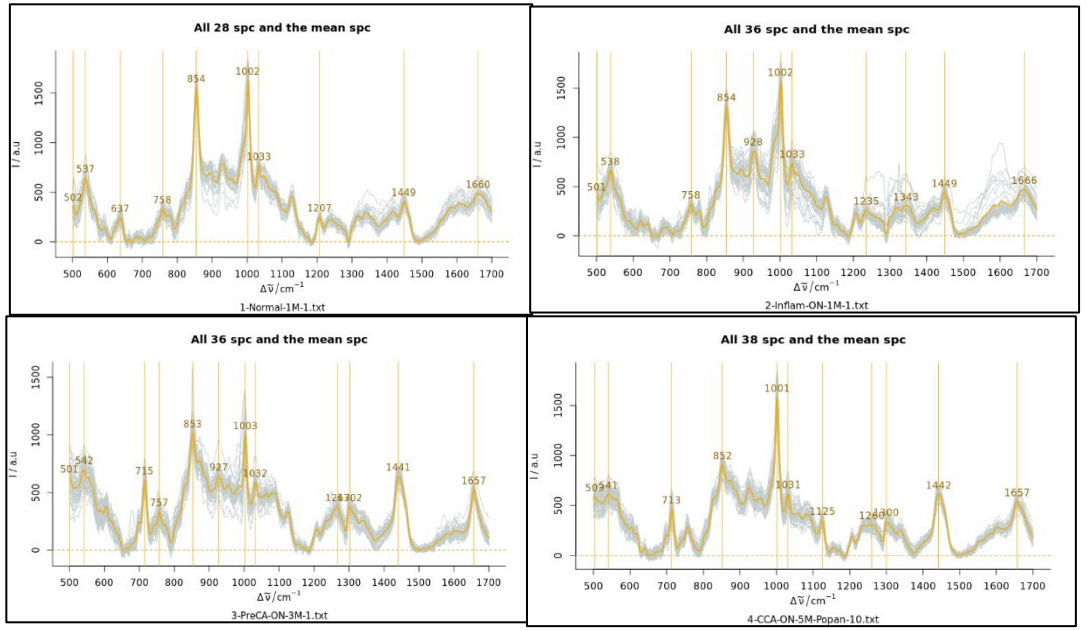



**Fig.6 Comparison among Raman peak based on classical machine (ML) algorithm** of four classes based on normal, inflammation, pre-cancerous and tumor features.

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Group 1-N | 0.61 | 0.84 | 0.71 | 231 |
| Group 2-I | 0.40 | 0.07 | 0.11 | 61 |
| Group 3-P | 0.61 | 0.51 | 0.56 | 210 |
| Group 4-C | 0.65 | 0.65 | 0.65 | 220 |
| accuracy | | | 0.62 | 722 |
| macro avg | 0.57 | 0.52 | 0.51 | 722 |
| weighted avg | 0.61 | 0.62 | 0.60 | 722 |

SERS couple with PCA couldn't distinguish precancerous-tumor lesion and yield accuracy of test 62%.

# Project Activities: MDKKU-ENKKU

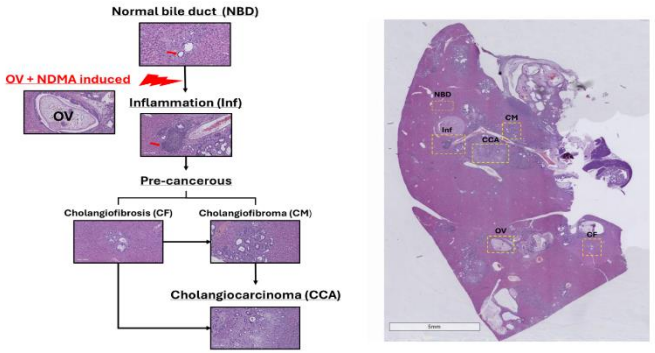






Fig.7 Different staging of CCA development was established.

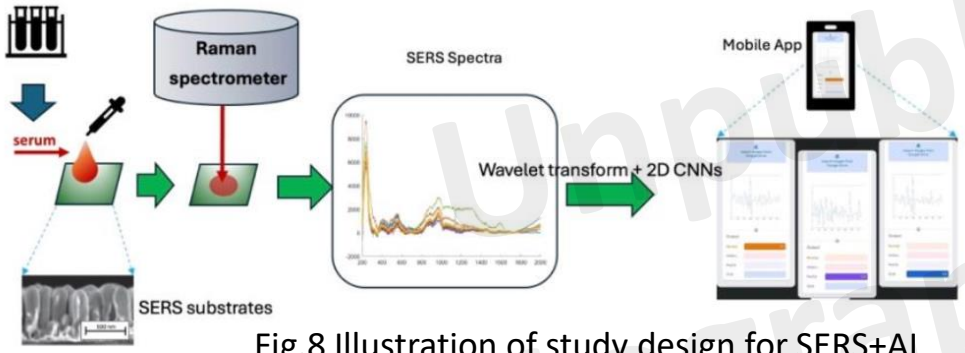



Fig.8 Illustration of study design for SERS+AI marks early stage of CCA

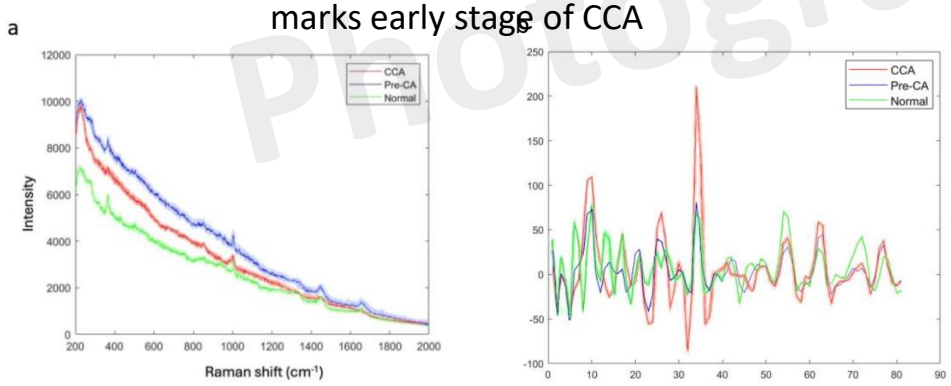



**Fig.9** Raman peak identifies the different staging of inflammation, precancerous (Pre-CA) and CCA lesions

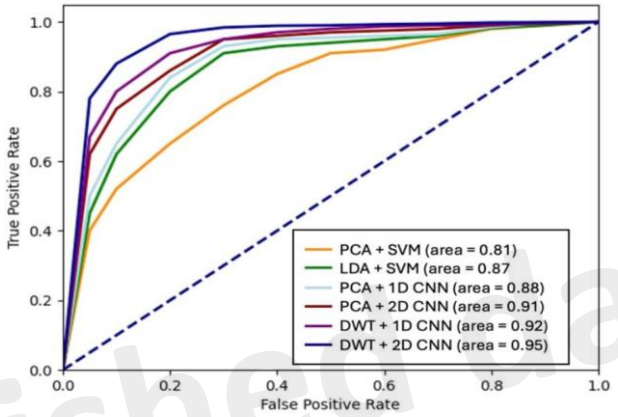



**Fig.10 ROC curves analysis the performance of various classification models.** The DWT + 2D CNN model achieved an AUC of 0.95, which gave the highest accuracy performance for CCA diagnosis compared to the other models.

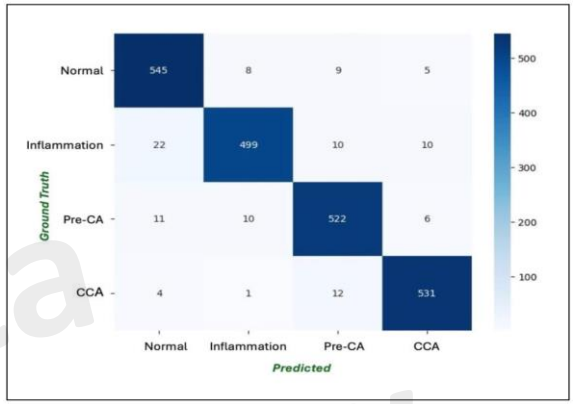



**Fig.11** Confusion matrices of each signal processing and machine learning methods by 2D CNN.

| Method | Accuracy (%) | Sensitivity (Recall) (%) | Specificity (%) | F1 Score (%) |
|---|---|---|---|---|
| DWT + 2D CNN | 95.10 | 95.08 | 98.36 | 95.10 |
| DWT + 1D CNN | 92.00 | 91.50 | 96.00 | 91.75 |
| PCA + 1D CNN | 88.00 | 87.50 | 94.00 | 87.75 |
| LDA + SVM | 84.50 | 84.00 | 90.50 | 84.25 |
| PCA + SVM | 82.40 | 82.00 | 88.40 | 82.20 |

Accuracy 95%, sensitivity 95%. Specificity 96%

**Raman spectrometry coupled with machine learning, especially, 2D CNN, could distinguish stage-specific for CCA development for normal, inflammation, pre-cancerous and tumor, but doesn't by classical machine learning of Raman intensity. Integrative SERS with 2D CNN explores high accuracy performance for early CCA diagnosis, which can apply for a mobile application use.**

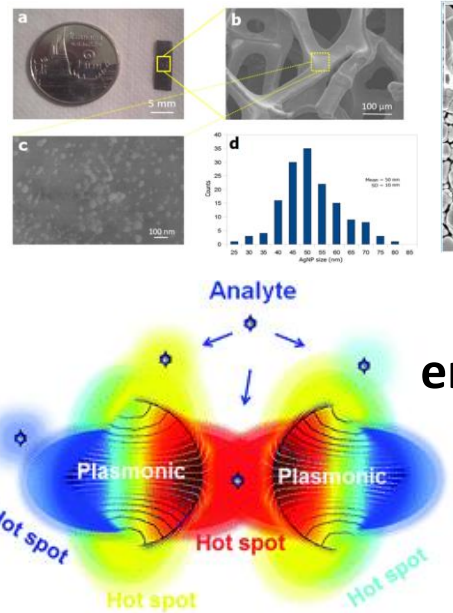
Unpublished data
Photograph do not allow

# ENKKU: Biosensing platform based on SERS

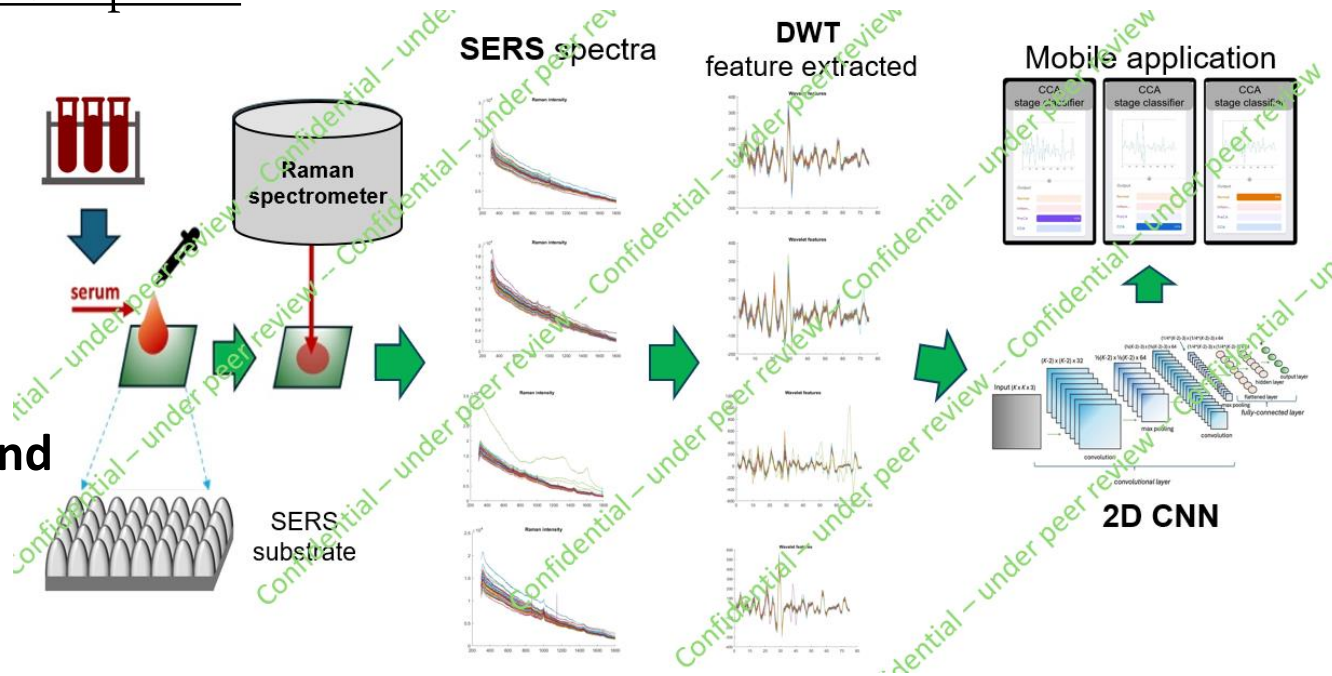
1. **Biosensing platform development based on Raman spectroscopy techniques**

Surface Enhance Raman Spectroscopic (SERS) chip development

(a)




**enhanced hotspot with linkers and receptors for biomarker**

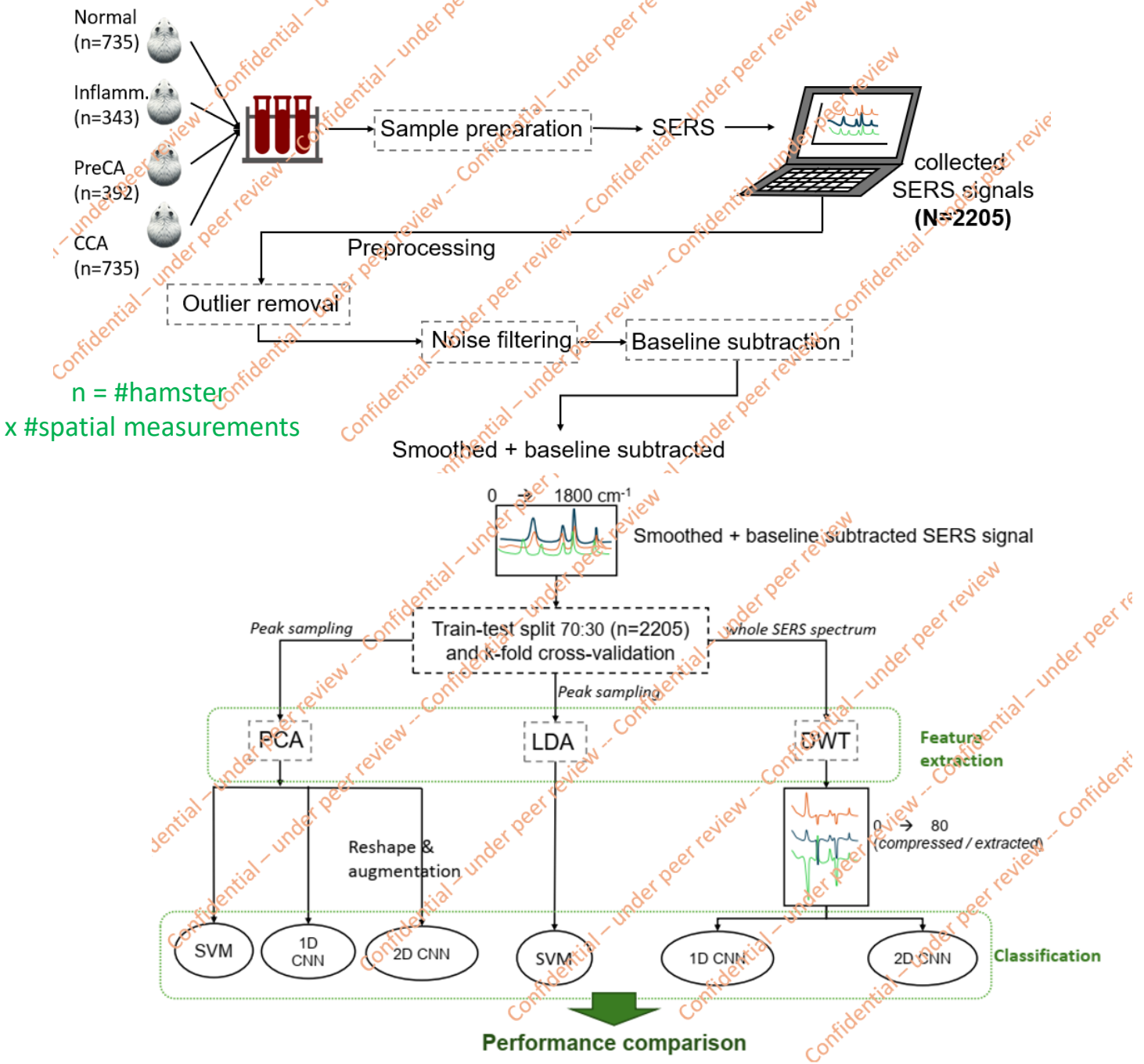



SERS chip using (a) 3D microporous graphene (Srichan *et al.*, 2016) (b) Silver nanorods fabricated by glancing angle method (Botta *et al.*, 2018) (c) electrochemically synthesized silver nanowires (Fang *et al.*, 2012) (d) Hot spot model as one of the mechanisms behind Raman signal enhancement (Radziuk & Moehwald, 2015).

(a) Raman peak selection for a specific analyte (Srichan *et al.*, 2016), (b) designed portable SERS-based sensor for early CCA detection (this proposal).

## Preliminary Results

- In literature we sampling peaks before processing SERS signal
- We propose novel technique that use whole spectrum with multiresolution compression and CNNs



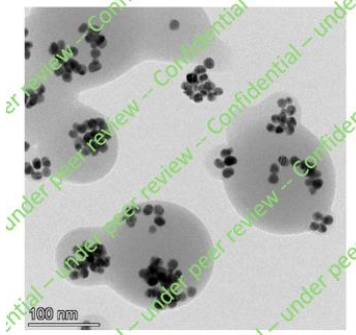
# Project Activities: **ENKKU: Biosensing platform based on SERS**

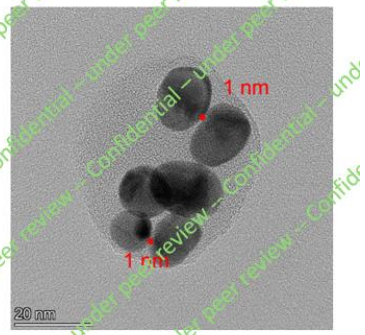
**Biosensing platform development based on Raman spectroscopy techniques**

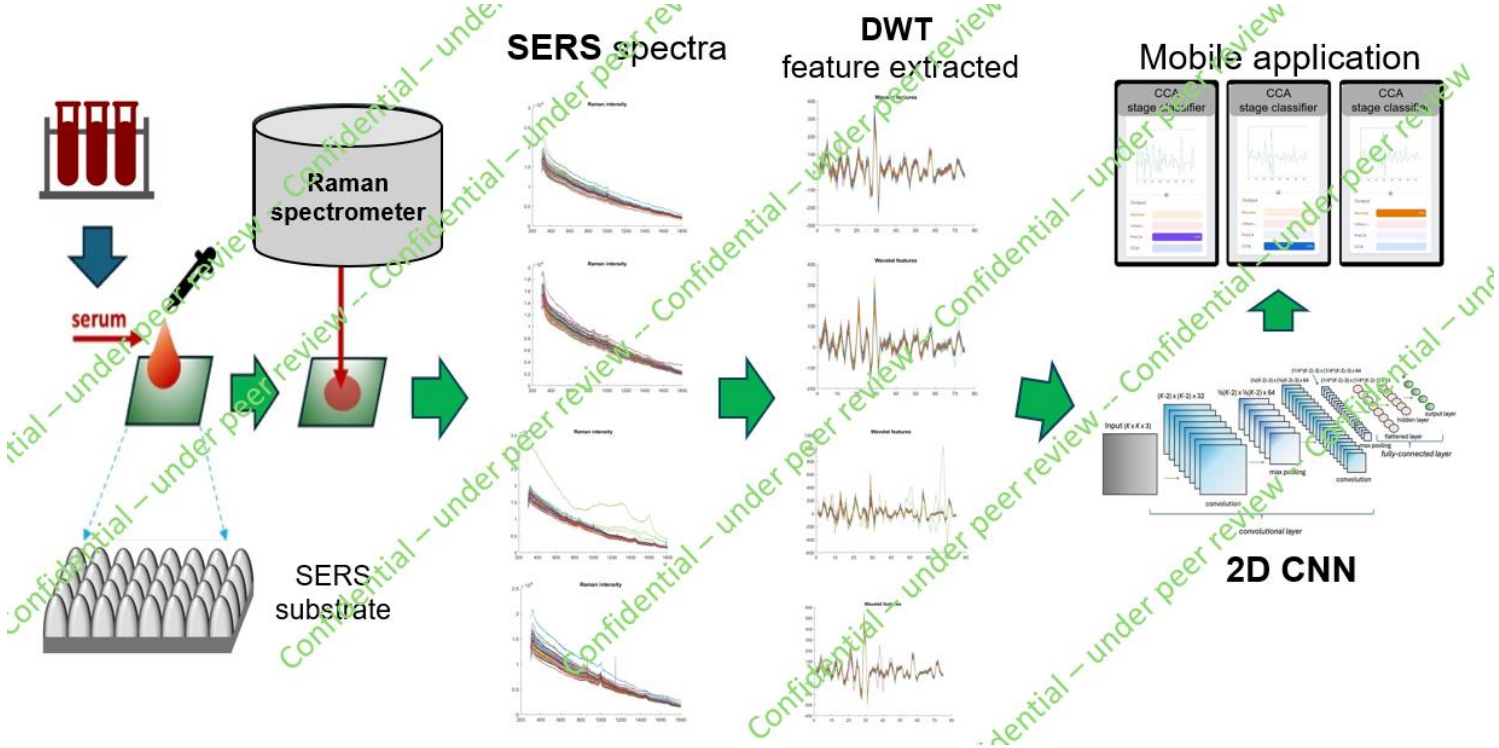
Surface Enhance Raman Spectroscopic (SERS) chip development

Part I: Synthesis of AuNPs and novel techniques to pair nanoparticles to yield greatest enhancement

**Received (see page20)**
**1 Software license**
**2 (Tier 1) Paper under intensive peer review [ Nature Scientific Reports]**
**3. (Scopus-index) Conference paper to appear in IEEEXplore**



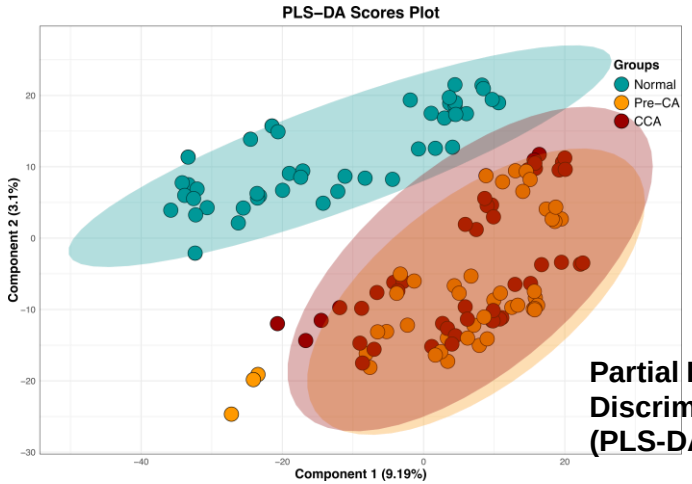



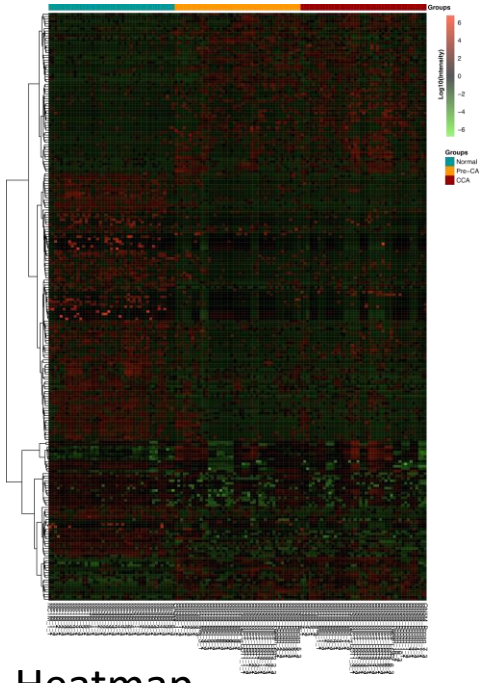

+ carried out characterization on TEMs, SEM, processing technique, etc. (Figures will be licensed under publisher)

# Project Activities: MDKKU-BIOTECH

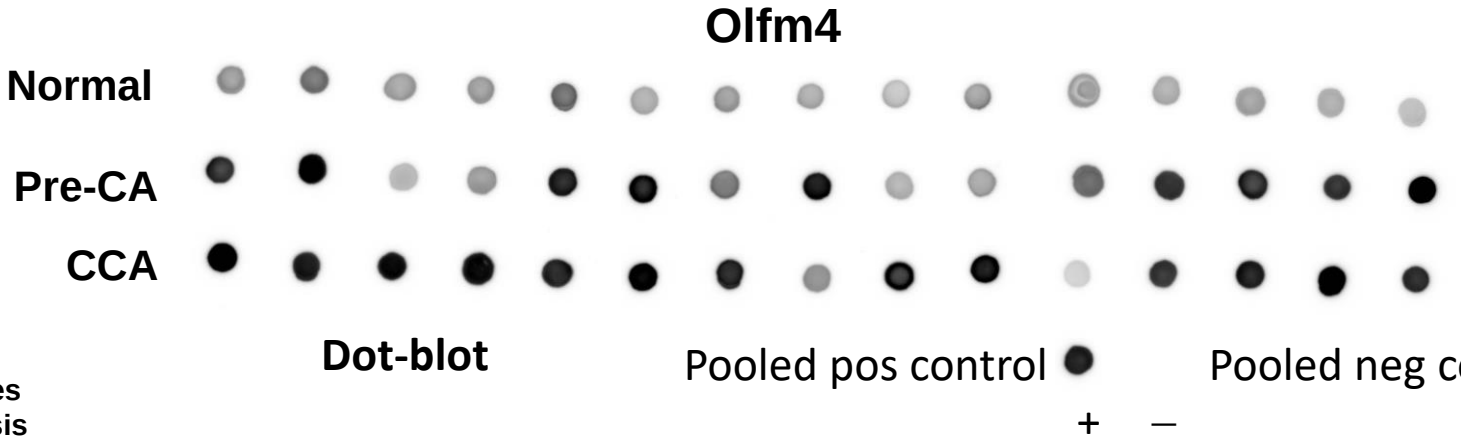
Proteomics discovery Olf4, SMC2, B4GALT4 for CCA diagnosis




Partial Least Squares Discriminant Analysis (PLS-DA) analysis



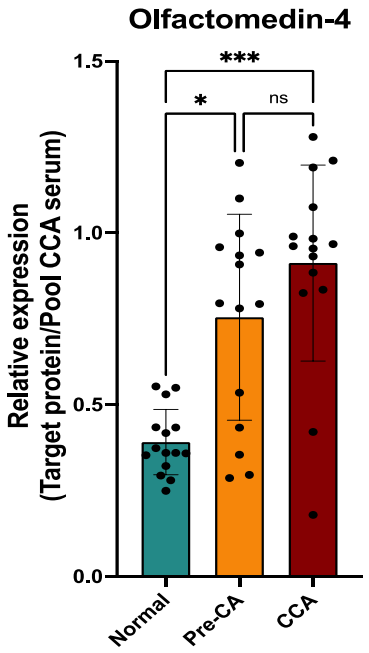
Heatmap

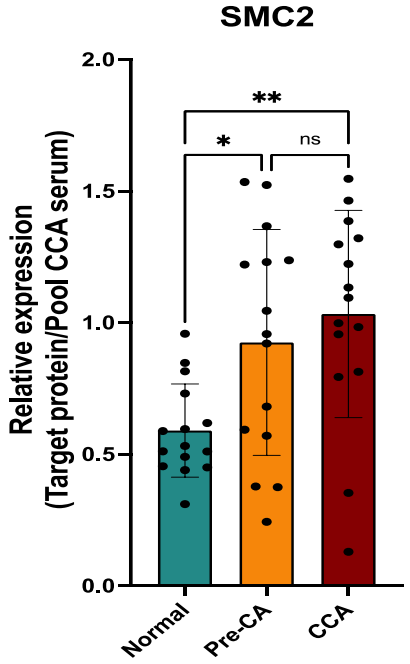


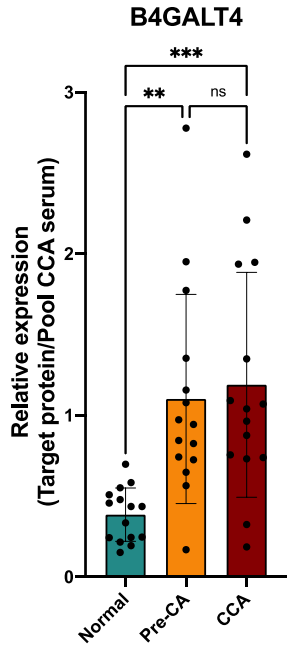

Dot-blot

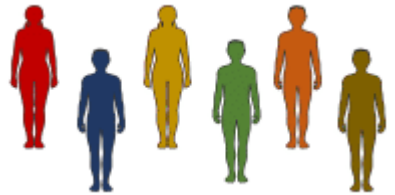
Pooled pos control +

Pooled neg control –



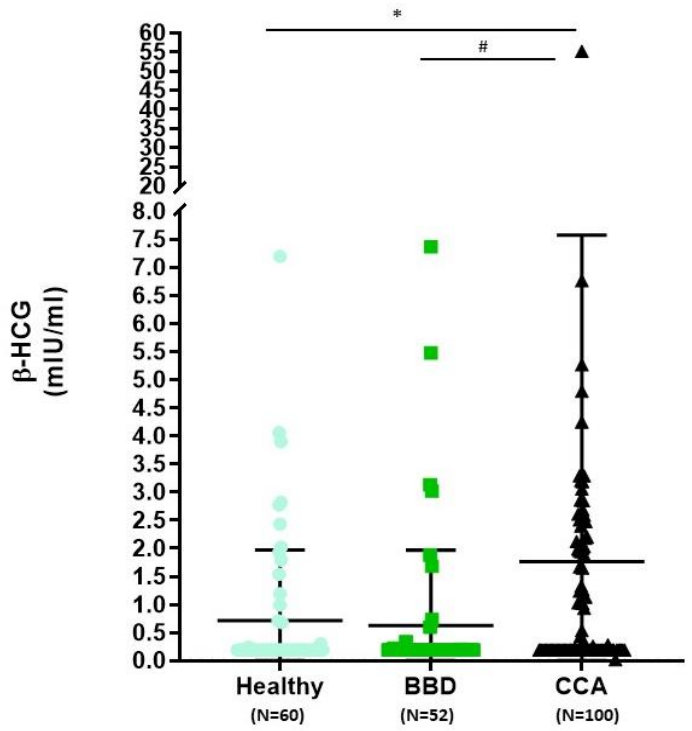



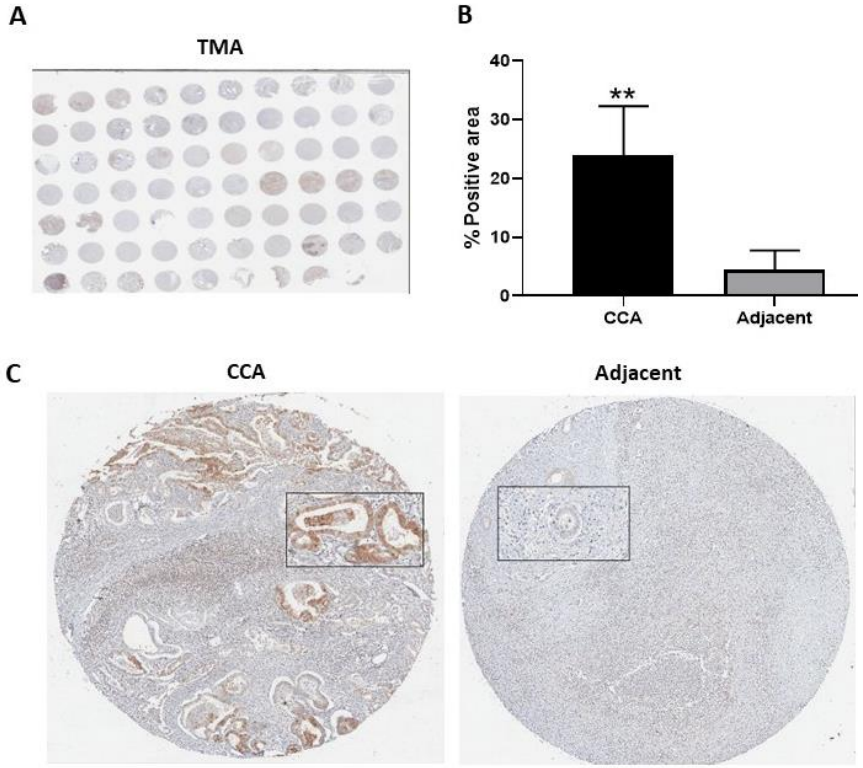



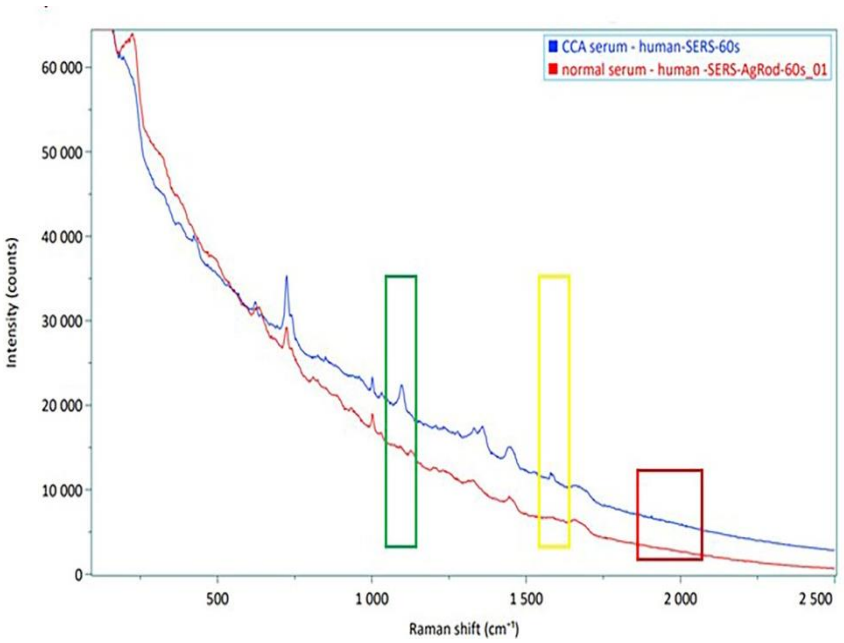



In progress to verify in human samples

# Project activities: MDKKU; Sample collection, identification and evaluation of biomarker in CCA patients




Determination of β-HCG levels in human serum. Serum β-HCG levels in healthy (N=60), Bening biliary disease (N=52), and CCA patient (N=100) were determined using electrochemiluminescence immunoassay. * P<0.05 compared with healthy group. #P<0.05 compared with BBD group.

Immunohistochemical staining for β-hCG in cholangiocarcinoma and adjacent tissues. Staining pattern of the TMA section (A). Immunoreactive positive area (%) in cancerous tissues was higher than in adjacent tissues (B). Images showing β-hCG staining in CCA (C), and adjacent tissues (D). ** P<0.001 compared with adjacent tissue.

Raman peak separates serum CCA from the patients from normal serum by Raman spectroscopy. Upper line is CCA, and under line is normal.

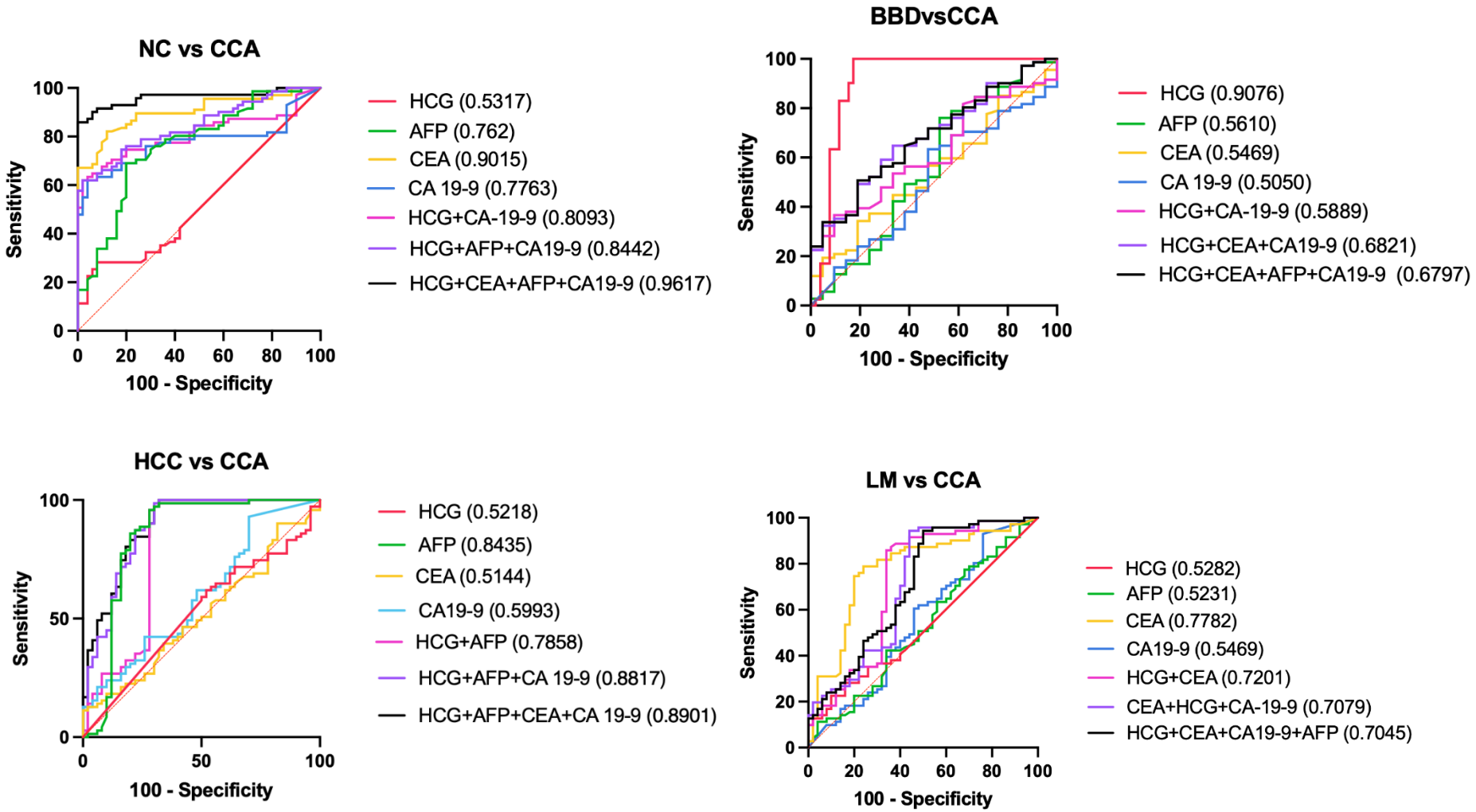



**Figure** 8. ROC analysis results when combined HCG, AFP, CEA and CA19-9

# Project Activities: MDKKU, ENKKU, NECTEC, BIOTECH

Budget usage for the 1st year ✓ COMPLETED

| Activities | Budget |
|---|---|
| Hamsters' CCA setting, samples collection and histopathological confirmation | 4,000 USD |
| Discovery of Raman peak for CCA diagnosis | 3,000 USD |
| Patients sample collection | 2,500 USD |
| Identification & evaluation of biomarker in CCA patients: training set | 3,500 USD |
| Verification of electrochemical sensor for CCA diagnosis: verification set | 3,000 USD |
| SERS development: Synthesis | 4,000 USD |
| SERS development: Characterization | 1,000 USD |
| **Total** | **21,00 USD** |

Budget usage for the 2nd year

INPROGRESS

| Activities | Budget |
|---|---|
| Sample collection and providing standard protein & antibody for CMUs' team | 4,000 USD |
| Proteins panel discovery and identification | 7,500 USD |
| Raman spectrum identification | 5,000 USD |
| Construct AI & Machine learning model | 2,000 USD |
| Transfer technology of SERS and AI for CCA diagnosis to Laos' team | 2,500 USD |
| KKU facilities services | 2,100 USD |
| Total | 21,000 USD |

Overview of research objectives and activities of CMU

# CMU: Biosensing platform based on silicon photonic development

Biomedical Engineering Institute
Chiang Mai University

## Activities in ASEAN IVO 2023

1. Sensor device design investigation specifically for the detection of CCA biomarker (s)
2. Simulation of silicon nitride biosensor devices

## Activities in ASEAN IVO 2024

1. Prototype sensor system development
2. Sensing experiment using samples provided by KKU or Laos
   - Detection of new CCA biomarkers from KKU
   - Comparison with conventional method

**(Year 1) Key elements demonstrated in laboratory**

| Budget usage | Budget |
|---|---|
| Survey report of the photonic sensor technologies that are applicable to cholangiocarcinoma detection. | $3000 ✓ |
| investigation of new photonic sensor design and simulation results using numerical based simulation. | $3000 ✓ |
| Computer-aided design (CAD) drawing of silicon photonic sensor mask design | $1500 ✓ |

**(Year 2) Device manufacturing & performance assessment using standard testing method**

| Budget usage | Budget |
|---|---|
| Photonic (resonator) sensor devices and a prototype of the measuring system | $7000 |
| Project workshop and meeting | $3500 |

✓ COMPLETED

PENDING/ INPROGRESS

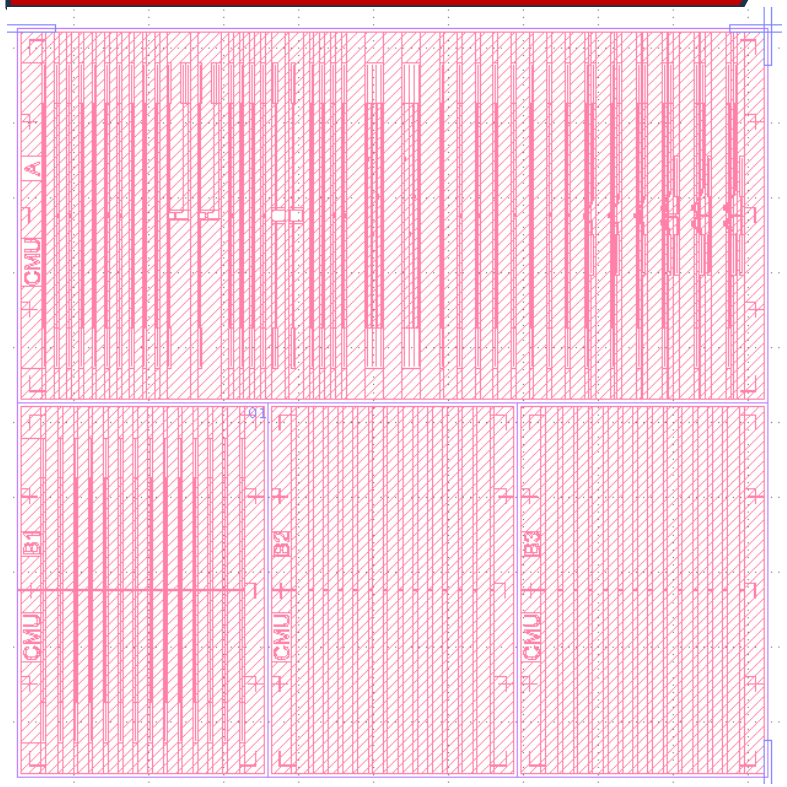
Confidential

2024 PROGRESS

# CMU: Biosensing platform based on silicon photonic development

Biomedical Engineering Institute
Chiang Mai University

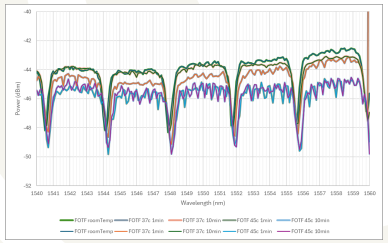
## Fabrication of silicon photonic sensors

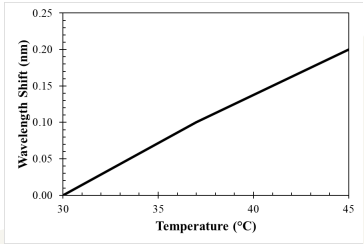



Photomask designs submitted to manufacturer (TMEC)
**August 2024** ✓

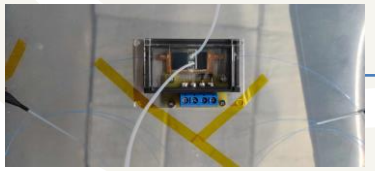
Fabricated sensors expected by
**December 2024**

## Development of New sensor measurement system prototype






Proof of concept In Laboratory
**September 2024** ✓

broadband source →  → MEMS filter → Power Meter

SENSOR

## Measurement system prototype and sensors purchase order

**October 2024 – January 2025**

The project will order a developer to created a system based on the laboratory concept with software contro

Tech transfer (workshop in CMU, demo of the prototype)

CCA detection test (Pending samples provided by KKU and Laos Team

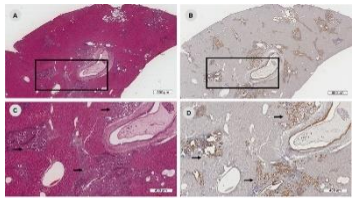
**February 2025**

✓ COMPLETED

PENDING/ INPROGRESS

# Biosensing potable platform for clinical sample of Laos CCA patients in various specimens

Collect and verify CCA samples: urine, serum

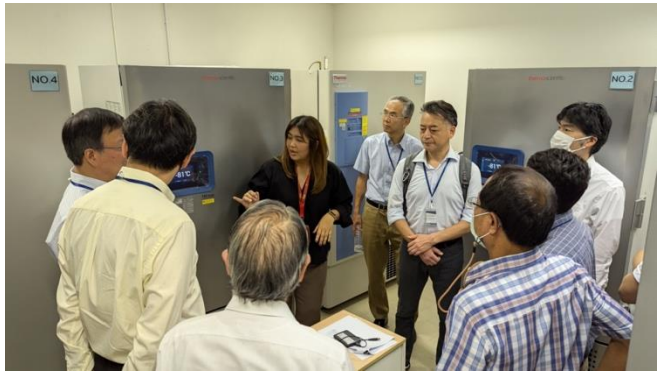


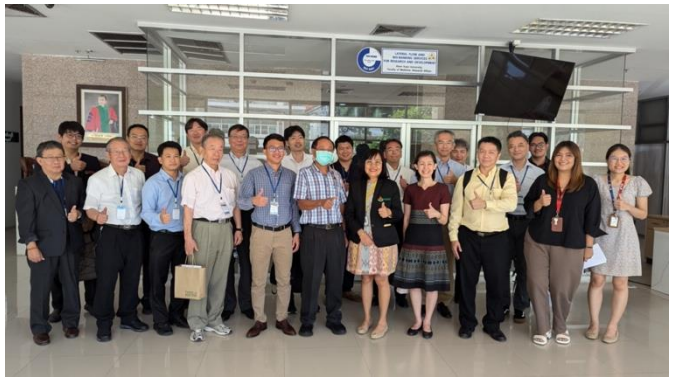
| Budget usage | Budget |
|---|---|
| Collection of various samples from the patients: healthy, CCA, HCC, and other cancers; materials, volunteer compensation, physician, surgeon, etc., | $2500 |
| Identification & evaluation of biomarker in CCA patients: training set | $1500 |
| Total | $4000 |

Budget plan for year 2

# Project Activities: Workshop on Nov 13-16, 2023 at Vientiane, LAO PDR

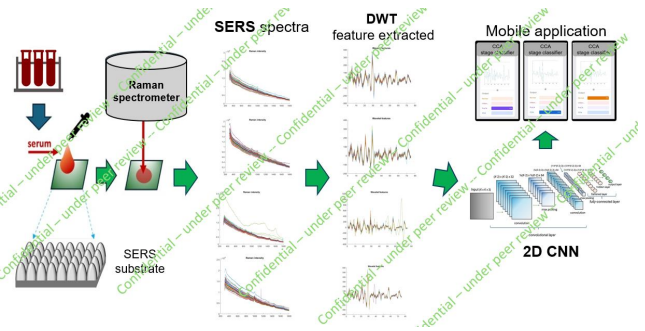
# Project Activities: Workshop on June 20-21, 2024 at KKU, Thailand

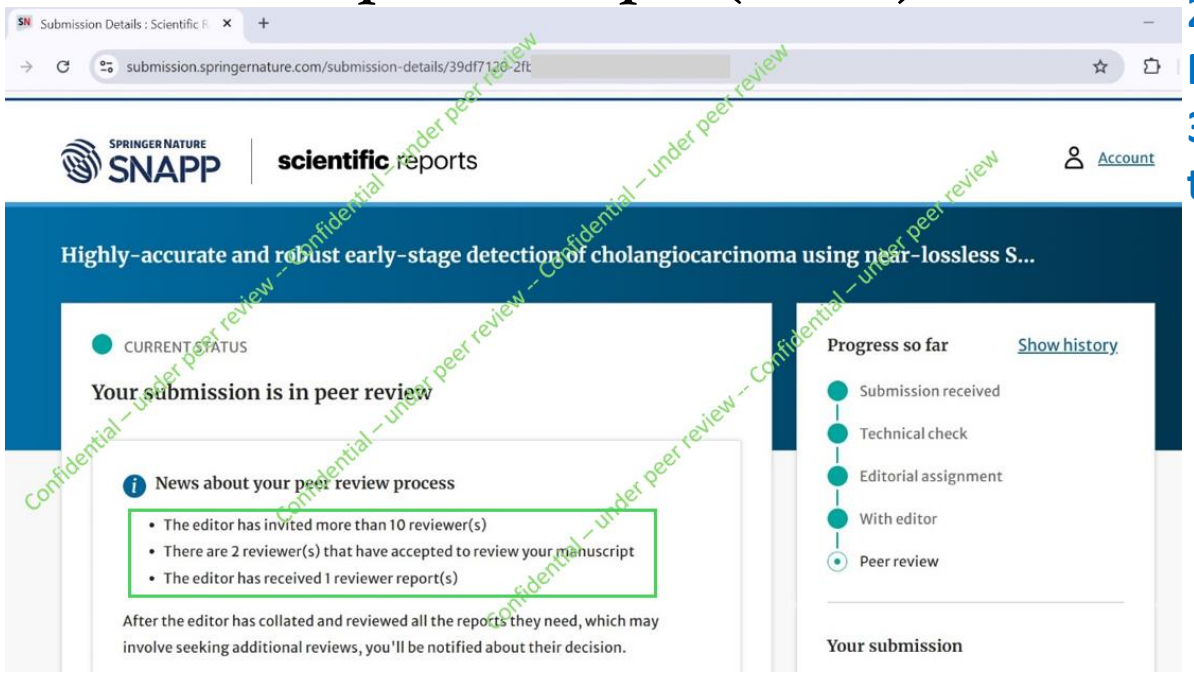


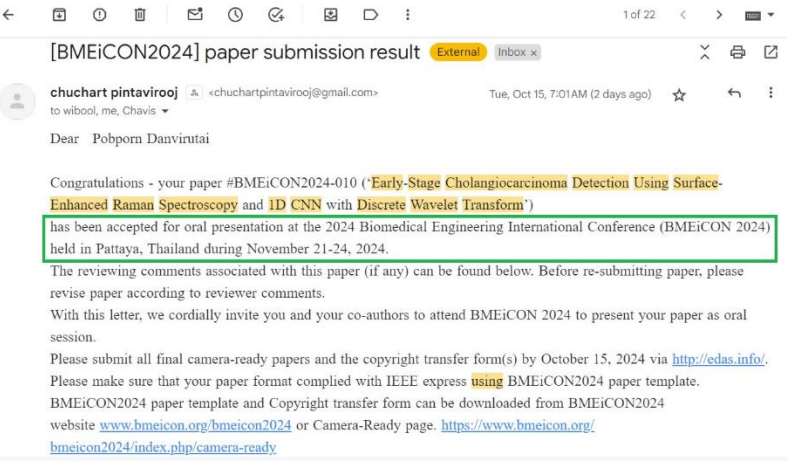



# R&D results: ENKKU-MDKKU; Biosensing platform development based on Raman spectroscopy techniques.

## ENKKU: Surface Enhance Raman Spectroscopic (SERS) chip development.



[BMEiCON2024] paper submission result External Inbox

chuchart pintavirooj <chuchartpintavirooj@gmail.com> Tue, Oct 15, 7:01AM (2 days ago)
to wibool, me, Chavis

Dear Pobporn Danvirutai

Congratulations - your paper #BMEiCON2024-010 ('Early-Stage Cholangiocarcinoma Detection Using Surface-Enhanced Raman Spectroscopy and 1D CNN with Discrete Wavelet Transform')
has been accepted for oral presentation at the 2024 Biomedical Engineering International Conference (BMEiCON 2024) held in Pattaya, Thailand during November 21-24, 2024.
The reviewing comments associated with this paper (if any) can be found below. Before re-submitting paper, please revise paper according to reviewer comments.
With this letter, we cordially invite you and your co-authors to attend BMEiCON 2024 to present your paper as oral session.
Please submit all final camera-ready papers and the copyright transfer form(s) by October 15, 2024 via http://edas.info/.
Please make sure that your paper format complied with IEEE express using BMEiCON2024 paper template.
BMEiCON2024 paper template and Copyright transfer form can be downloaded from BMEiCON2024 website www.bmeicon.org/bmeicon2024 or Camera-Ready page. https://www.bmeicon.org/bmeicon2024/index.php/camera-ready


## ACKNOWLEDGMENT

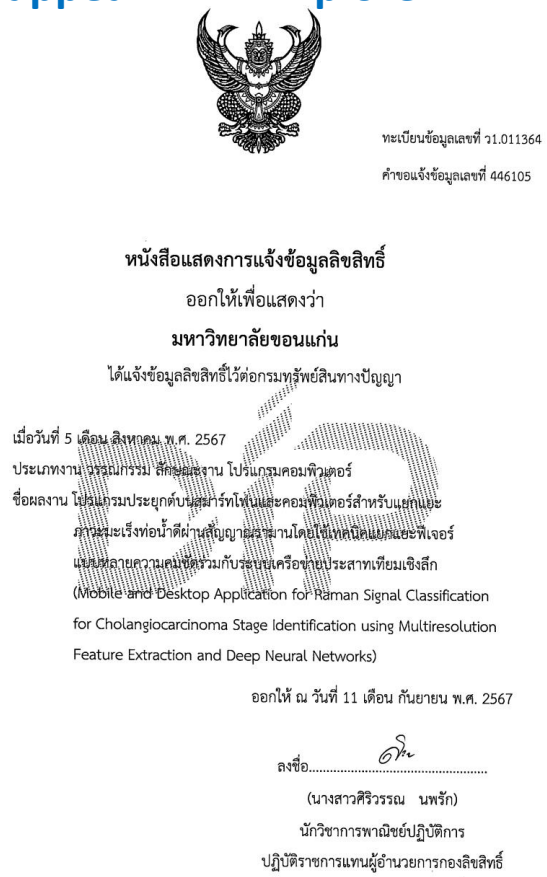
We acknowledge the funding support from NICT, Japan, under the ASEAN IVO 2023 Project, "Innovation of Photonic and Electrochemical Biosensors for Cholangiocarcinoma Diagnosis." Special thanks are extended to Dr. Sirinapa Klungsaeng for her contributions during the initial phase of this work. Collaborations with NECTEC team through Dr. Pitak Eiamchai and Dr. Noppadon Nuntawong are greatly appreciated.


## Received

1 Software license

2 (Tier 1) Article under peer review [ Nature Scientific Reports]

3. (Scopus-index) Conference paper to appear in IEEEXplore



ทะเบียนข้อมูลเลขที่ ว1.011364

คำขอแจ้งข้อมูลเลขที่ 446105

**หนังสือแสดงการแจ้งข้อมูลลิขสิทธิ์**

ออกให้เพื่อแสดงว่า

**มหาวิทยาลัยขอนแก่น**

ได้แจ้งข้อมูลลิขสิทธิ์ไว้ต่อกรมทรัพย์สินทางปัญญา

เมื่อวันที่ 5 เดือน สิงหาคม พ.ศ. 2567

ประเภทงาน วรรณกรรม สิ่งบันทึกงาน โปรแกรมคอมพิวเตอร์

ชื่อผลงาน โปรแกรมประยุกต์บนสมาร์ทโฟนและคอมพิวเตอร์สำหรับแยกแยะภาวะมะเร็งท่อน้ำดีผ่านสัญญาณรามานโดยใช้เทคนิคแยกและฟิเจอร์แบบหลายความคมชัดร่วมกับระบบเครือข่ายประสาทเทียมเชิงลึก (Mobile and Desktop Application for Raman Signal Classification for Cholangiocarcinoma Stage Identification using Multiresolution Feature Extraction and Deep Neural Networks)

ออกให้ ณ วันที่ 11 เดือน กันยายน พ.ศ. 2567

ลงชื่อ.....

(นางสาวศิริวรรณ นพรัก)

นักวิชาการพาณิชย์ปฏิบัติการ

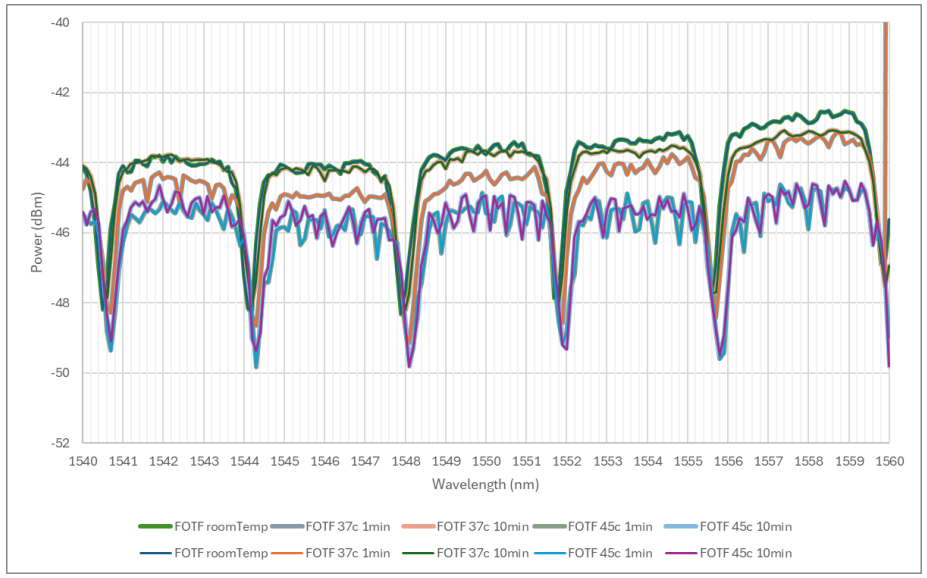
ปฏิบัติราชการแทนผู้อำนวยการกองลิขสิทธิ์

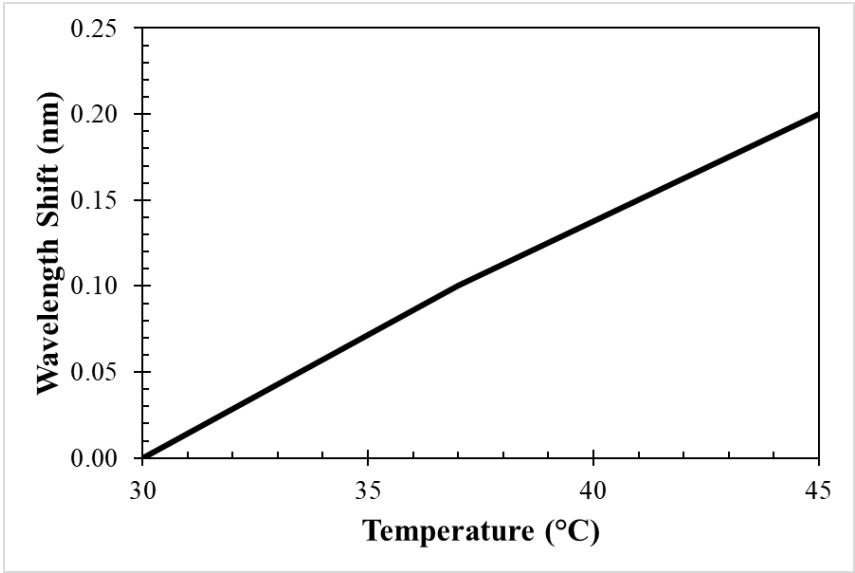
หมายเหตุ เอกสารนี้มิได้รับรองความเป็นเจ้าของลิขสิทธิ์ ในกรณีมีข้อพิพาทศาลจะเป็นผู้วินิจฉัยชี้ขาดความเป็นเจ้าของลิขสิทธิ์

Signed by DIP-CA

# R&D results: CMU

CMU: Designed and developed photonic sensor device for CCA diagnosis.




Sensing results: Laboratory proof of concept of the prototype

Next step CCA biomarker test

# Scientific Contribution:

## Presentations at International Conferences:

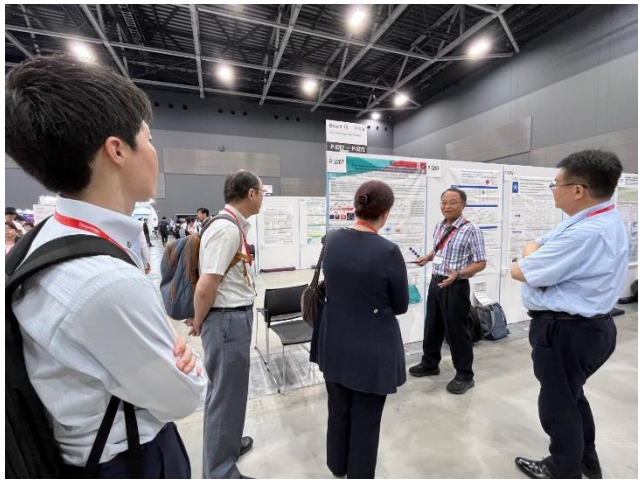
| No: | Paper title: | Author names | Affiliation | Conference name: | The date of the conference | The venue of the conference |
|---|---|---|---|---|---|---|
| 1 | Early diagnosis of cholangiocarcinoma using surface-enhanced Raman spectroscopy combined with AI in a hamster model | Somchai Pinlaor a,b, Chavis Srichanc, Pobporn Danvirutaid, Kitti Intuyodb,e, Apisit Chaideea,b, Chawalit Pairojkuleb,e, Thatsanapong Pongking b,f, Suppakrit Kongsintaweesuk b,f , Mati Horprathumg, Pitak Eiamchaig, Saksorn Limwicheang, Noppadon Nuntawongg | [a]Department of Parasitology, Faculty of Medicine, and [b]Cholangiocarcinoma Research Institute, [c]Faculty of Engineering, [d]College of Computing, [e]Department of Pathology, Faculty of Medicine, [f]Biomedical Sciences Program, Khon Kaen University, Khon Kaen 40002, Thailand. [g]National Electronics and Computer Technology Center (NECTEC), National Science and Technology Development Agency (NSTDA), Pathum Thani, Thailand | the 83rd Annual Meeting of the Japanese Cancer Association (JCA2024) | September 19 (Thu.) - 21 (Sat.), 2024 | Fukuoka, Japan |

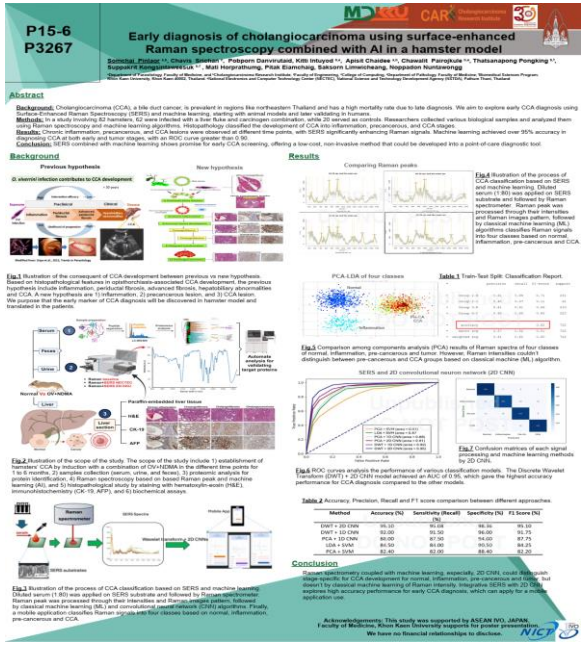
## Published Journal Papers:

| No: | Paper title: | Author names | Affiliation | Journal name: | The publisher of the Journal | The volume number and Pages |
|---|---|---|---|---|---|---|
| 1 | **Early Detection of Cholangiocarcinoma via Surface-Enhanced Raman Scattering using 2D Convolutional Neural Network in Point-of-Care Mobile Application** | Chavis Srichan1,2, Thatsanapong Pongking3, Suppakrit Kongsintaweesuk3, Sartra Wongthanavasu4, Somchai Pinlaor3,**, Pobporn Danvirutai4,* | 1Department of Computer Engineering, Faculty of Engineering, Khon Kaen University, Khon Kaen 40002, Thailand.<br>2Department of Biomedical Engineering, Faculty of Engineering, Khon Kaen University, Khon Kaen 40002, Thailand.<br>3Department of Parasitology, Faculty of Medicine, Khon Kaen University, Khon Kaen 40002, Thailand.<br>4College of Computing, Khon Kaen University, Khon Kaen 40002, Thailand. | Scientific Reports | Nature, Springer | Under review |

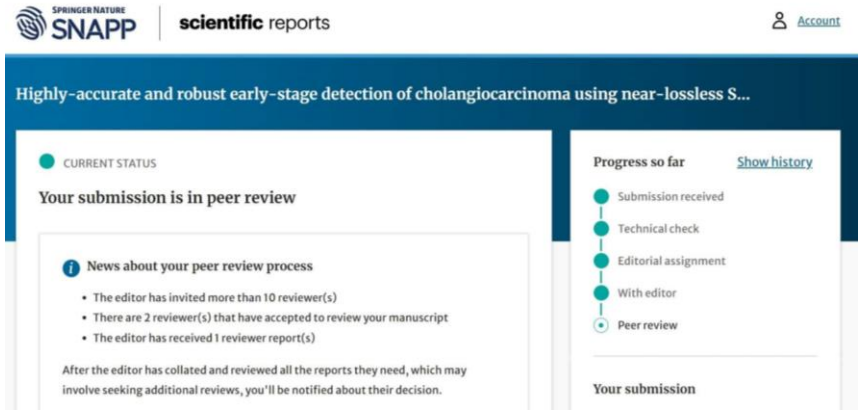
# Scientific Contribution:

## Poster presentation on JCA 2024






## Manuscript submitted




**Your submission**

Title
Highly-accurate and robust early-stage detection of cholangiocarcinoma using near-lossless SERS signal processing with machine learning and 2D CNN for point-of-care mobile application

Type
Article

Journal
Scientific Reports

Submission ID
39df7120-2fb1-4a14-ab82-61d7a75a76c9

## Copy Right

ทะเบียนข้อมูลเลขที่ ว1.011364
คำขอแจ้งข้อมูลเลขที่ 446105

**หนังสือแสดงการแจ้งข้อมูลลิขสิทธิ์**
ออกให้เพื่อแสดงว่า
**มหาวิทยาลัยขอนแก่น**
ได้แจ้งข้อมูลลิขสิทธิ์ไว้ต่อกรมทรัพย์สินทางปัญญา

เมื่อวันที่ 5 เดือน สิงหาคม พ.ศ. 2567
ประเภทงาน วรรณกรรม สิ่งพิมพ์งาน โปรแกรมคอมพิวเตอร์
ชื่อผลงาน โปรแกรมประยุกต์บนสมาร์ทโฟนและคอมพิวเตอร์สำหรับแยกแยะภาวะมะเร็งท่อน้ำดีผ่านสัญญาณรามานโดยใช้เทคนิคแยกและฟีเจอร์แบบหลายความคมชัดร่วมกับระบบเครือข่ายประสาทเทียมเชิงลึก
(Mobile and Desktop Application for Raman Signal Classification for Cholangiocarcinoma Stage Identification using Multiresolution Feature Extraction and Deep Neural Networks)

ออกให้ ณ วันที่ 11 เดือน กันยายน พ.ศ. 2567

ลงชื่อ.....
(นางสาวศิริวรรณ นพรัก)
นักวิชาการพาณิชย์ปฏิบัติการ
ปฏิบัติราชการแทนผู้อำนวยการกองลิขสิทธิ์

**หมายเหตุ** เอกสารนี้มิได้รับรองความเป็นเจ้าของลิขสิทธิ์
ในกรณีมีข้อพิพาทศาลจะเป็นผู้วินิจฉัยชี้ขาดความเป็นเจ้าของลิขสิทธิ์

Signed by DIP-CA

# Societal Impact:

1. Provided proteomics data: The accession numbers is ongoing to deposit for ProteomeXchange and JPST003398 for jPOST. Preview.
2. Submitted manuscript on Scientific Reports (under reviewed)
3. International conference on - The 83rd Annual Meeting of the Japanese Cancer Association (JCA)-, on September 19-21, 2024 at Fukuoka, Japan
4. Manuscript preparation on: INPROGRESS
    1. Proteomics identified candidate markers for CCA diagnosis
    2. beta-HCG marks for CCA diagnosis
    3. Incidence of liver cancer in Lao PDR

# Future works:

| Teams | Future works |
|---|---|
| MDKKU<br>ENKKU<br>BIOTECH<br>NECTEC | • Sample collection and Std protein & ab for CMUs' team<br>• Proteins panel discovery<br>• Raman spectrum identification<br>• Construct AI & Machine learning<br>• Transfer technology of SERS and AI for CCA diagnosis to Laos' team |
| CMU<br>TMEC | - Design and develop photonic sensor for CCA diagnosis<br>- Improve reproducibility of photonic sensor |
| LAO | - Sample collection of CCA patients<br>- Evaluate sensor to detect CCA diagnosis |

# Activity and budget planning in the 2nd year

| No | Activities | Budget (US) | Responsibility | Out put |
|---|---|---|---|---|
| **1** | 1. Sample collection and Std protein & ab for CMUs' team<br>2. Proteins panel discovery<br>3. Raman spectrum identification<br>4. Construct AI & Machine learning<br>5. Transfer technology of SERS and AI for CCA diagnosis to Laos' team | 21,000 | KKU (MD & EN)<br>BIOTECH<br>NECTEC | - Samples of CCA, HCC, metastasis liver and healthy subjects collection,<br>-At least 1 publication<br>-1 patent/pretty patent |
| **2** | Optical sensing development: equipment, materials, research exchange at NICT | 7,000 | CMU | -1 publication |
| **3** | Human sample & clinical data collection:<br>Surgery team & pathology team for samples collection, biobank, histopathological study, freezer, equipment, etc., | 4,000 | Laos | Team initiation, CCA sample & other cancer sample collection |
| **4** | Project meeting or workshop at the end of the 2nd year | 3,000 | KKU for all team (CMU-KKU-Laos) | Meeting & conference: 1 session for biosensor for CCA diagnosis |
| **5** | Project meeting or workshop at the end of the 2nd year | 3,500 | CMU for all team (CMU-KKU-Laos) | Meeting & conference: 1 session for biosensor for CCA diagnosis |
| **6** | **Project meeting and report (estimate)** | 1,500 | KKU team | Attend on Campodia, 6-7 Nov 2024 |
| | **Total** | **40,000** | | |

# Two years time line schedule

| Institution | Research activity | 2023 | | | | | | | | | | | | 2024 | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 |
| MD-KKU, NECTEC, BIOTECH | Supplies & Materials: Animal model setting, equipment, samples collection, Raman spectrometer finger print | | | | | | | | | | | | | | | | | | | | | | | | |
| EN-KKU, | SERS chip development : equipment & materials, SERS substrate synthesis and design of portable CCA specific SERS-based sensor, training with NICT | | | | | | | | | | | | | | | | | | | | | | | | |
| CMU | Optical sensing development: equipment, materials, training with NICT | | | | | | | | | | | | | | | | | | | | | | | | |
| MD-KKU | Surgery team & pathology team for samples collection, biobank, histopathological study, standard method confirmation by ELISA & WB | | | | | | | | | | | | | | | | | | | | | | | | |
| Lao PDR | Surgery & pathology team management, workshop, training, samples collection, prototype evaluation, team meeting and conference | | | | | | | | | | | | | | | | | | | | | | | | |
| MD-KKU, EN-KKU, CMU,BIOTECH, NECTEC, TMEC, Laos, NICT | Meeting and conference, transport, report, publication, biosensing prototype | | | | | | | | | | | | | | | | | | | | | | | | |

# Thank you

CARI Cholangiocarcinoma Research Institute

ASEAN IVO

สูนมะเร็ง Cancer Center Lao PDR Est. 2017

CMU CHIANG MAI UNIVERSITY

NICT

มหาวิทยาลัยขอนแก่น

MDKKU คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น FACULTY OF MEDICINE KHON KAEN UNIVERSITY

30th ANNIVERSARY Computer Engineering Khon kaen University

# Instructions for making your Project Review slides

**Note 1:**

1. The number of slides should be around 15 total.
2. The size of your PowerPoint PDF should be no more than 10MB.
3. Please follow the format starting from the next slide.
4. Please delete the first slide (this slide) and upload to the website.

**Note 2:**

1. You may submit three additional supporting files for a maximum of four files total.
2. Each additional file should be no more than 130MB.
3. Any supporting materials you submit must be saved as PDFs, where possible. This includes PowerPoint presentations, Word documents and Excel spreadsheets. Any audio you submit should be in mp3 format and any video you submit should be in mp4 or mov format.

**Note 3:**

1. A website for “Submission” is open from September 1, 2024. (https://naivo.org/index.php/2024project/papers/instruction)
2. The website for uploading presentation files will close on October 21, 2024.

# Project management

Sample setting : MD-KKU,
Discovery and verify CCA diagnosis : EN-KKU, MD-KKU, NECTEC, BIOTECH

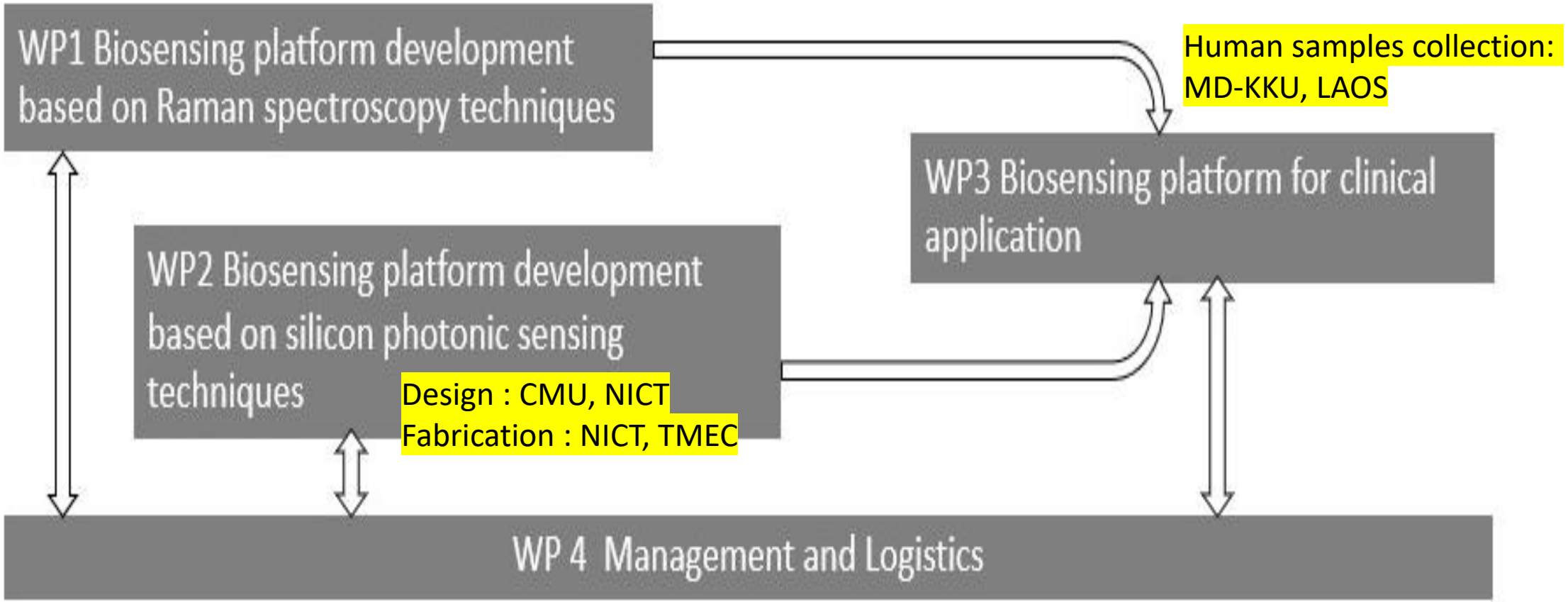



Fig.1 Workspace of project management

# Budget plan & purchased plan in the second year

| Institution | Equipment's & Chemical |
|---|---|
| **MD-KKU** | 1. Early biomarker for CCA: Animal sample; verification of proteomic results in the serum and tissue of animal and patients; Raman & data analysis in human samples, test tube, storage box, Eppendorf, autopipette tip, reagent for Raman, std protein, antibody, Chemical and reagent for H&E<br>2. Collection of various samples from the patients: healthy, BBD, CCA, and other cancers<br>3. Evaluation of electrochemical & photonic sensor in the patients compared with std method (ELISA & WB); reagent and chemical, WB reagent and chemical |
| **EN-KKU** | SERS & AI development for CCA diagnosis |
| NECTEC | SERS device & data analysis in human samples |
| BIOTEC | Proteomic technique & data analysis in human samples |
| **CMU-TEMEC** | 1. Student internship (up to 3 months) at NICT to train for the design, fabrication, and measurement of photonic ship<br>2. Staff visit to NICT |
| **Lao PDR** | Surgery & pathology team management, samples collection, test tube, storage box, Eppendorf, autopipette tip |
| MD-KKU, EN-KKU, NECTEC, BIOTEC, CMU, TMEC Laos, NICT | Meeting and conference: transport, registration, allowance, etc.,<br>1. Face-to-face project meeting at Bangkok (Tentative date Nov 9, 2023, co-location with annual CU-NICT workshop on Nov 10, 2024).<br>2. Conference or paper publication fee |