Developing photonics and specific peptides platform towards point-of-care screening for cholangiocarcinoma diagnosis in Lao PDR

Project duration:
September 16, 2025 to
September 15, 2027

1st year report:
Mar 10, 2026,
Indonesia

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Members' IVO Project: Thailand (KKU-CMU), Laos, Philippines, NICT

Project leader: Prof.Somchai Pinlaor

Thai

Party 1 KKU : Vor Luvira, Anucha Ahooja, Prakasit Sa-ngiamwibool, Piti Uengareewittaya, Kitti Intuyod, Apisit Chaidee, Suppakrit Kongsintaweesuk

Party 2 CMU: **Ukrit Mongkol**, Suruk Udomsom, Nipon Theera-Umpon, Sansanee Auephanwiriyakul

Party 3 Laos, National Cancer Center Laos
: **Champadeng Vongdala**, Keooudone Thammavong

Party 4 Philippines (Ateneo Innovation Centre, Ateneo De Manila University, Quezon City)
Benjamin Dingel, Kent Soria, Edric Hao, Clint Dominic Bennett

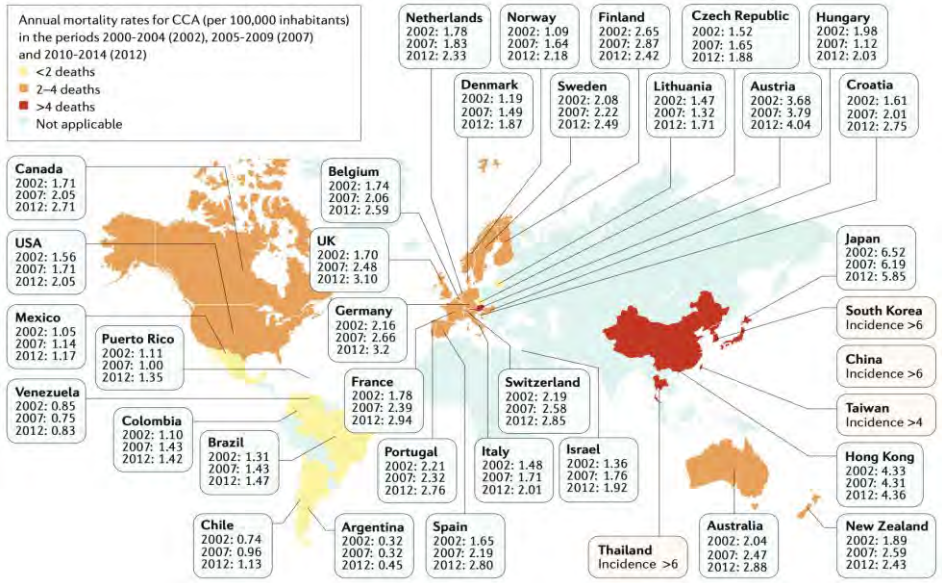
Japan

NICT: **Toshimasa Umezawa**, Kouichi Akahane, Atsushi Matsumoto,

Party 5 Waseda University: Tetsuya Kawanishi

Party 6 **Suzuka University of Medical Science**: Ning Ma

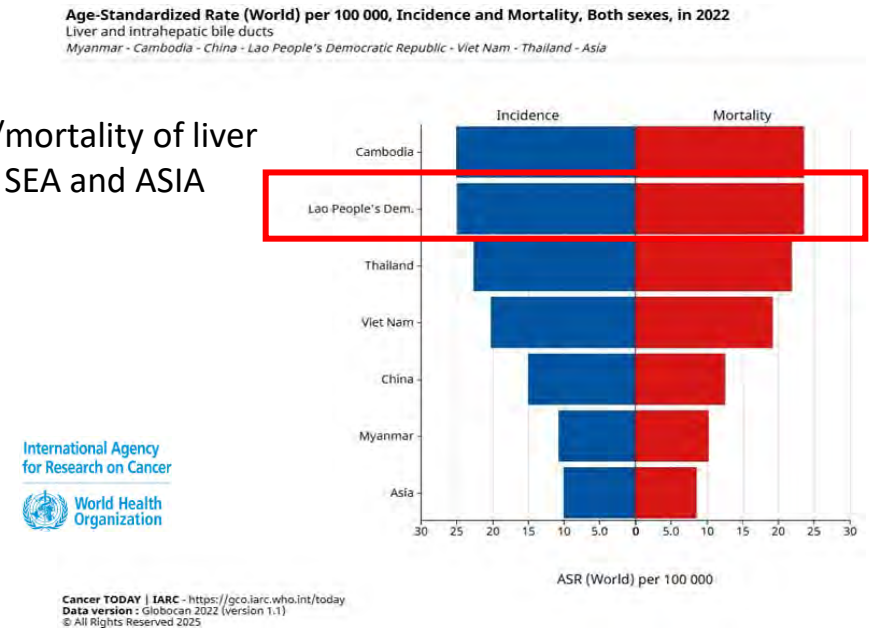
BACKGROUND



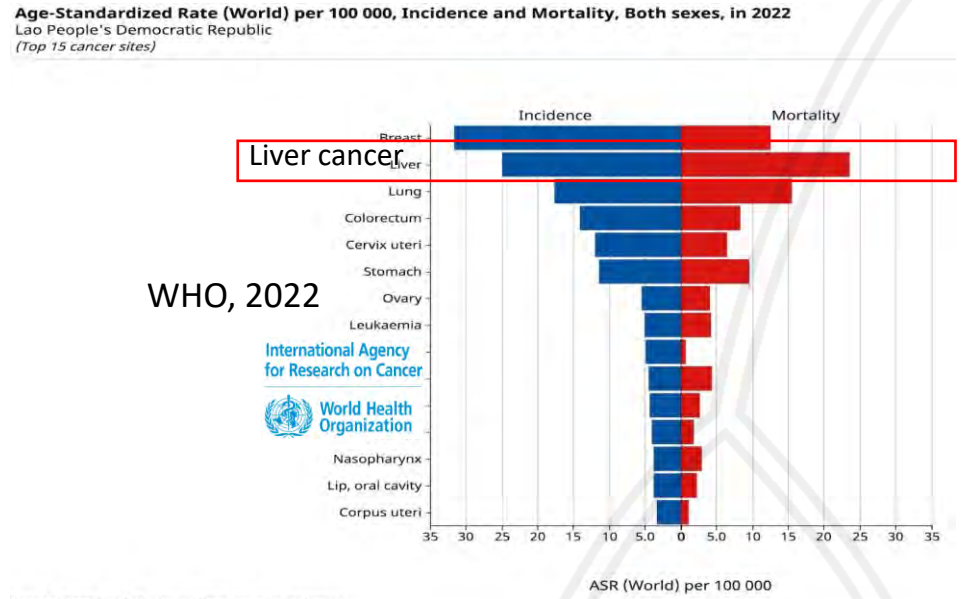
Banales. J.M. et al, 2020

Liver cancer is the highest incident rate in greater Mekong sub-region

Incidence/mortality of liver cancers in SEA and ASIA

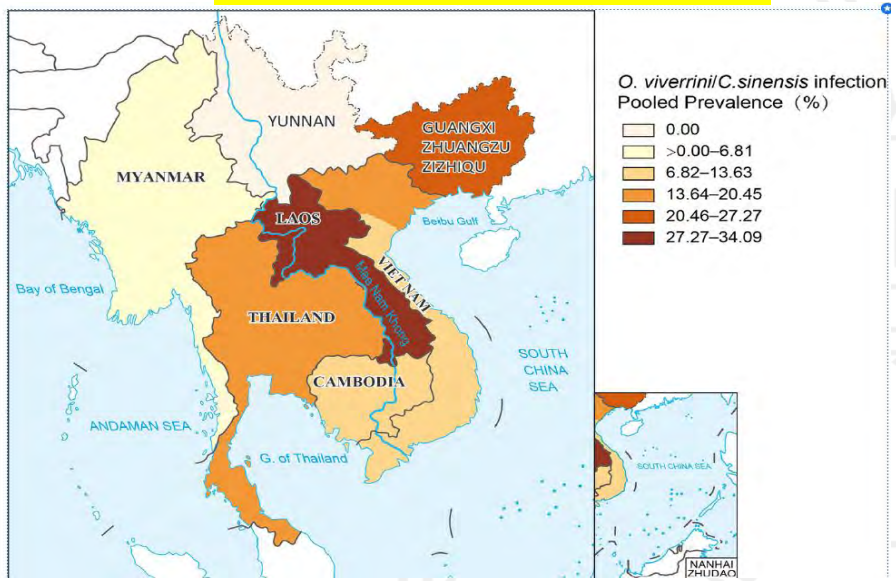


Incidence/mortality of various cancers in Laos



WHO, 2022

It incidence is related with liver fluke infection.

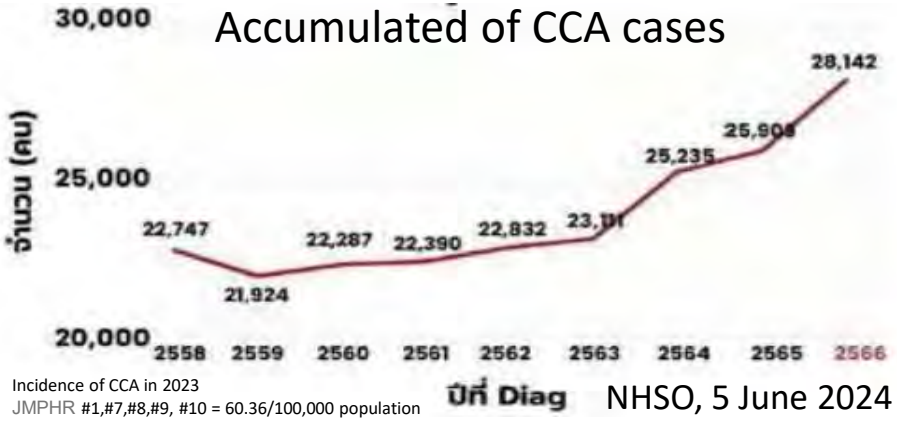


Sota, 2024

BACKGROUND

Cholangiocarcinoma (CCA) in Thailand

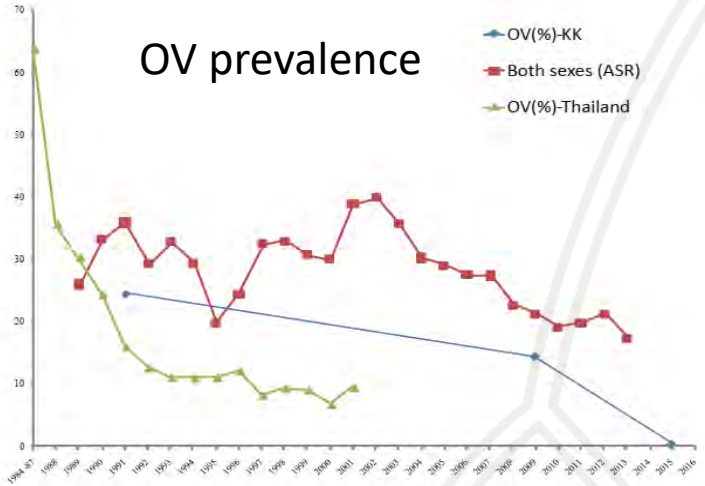
Accumulated of CCA cases



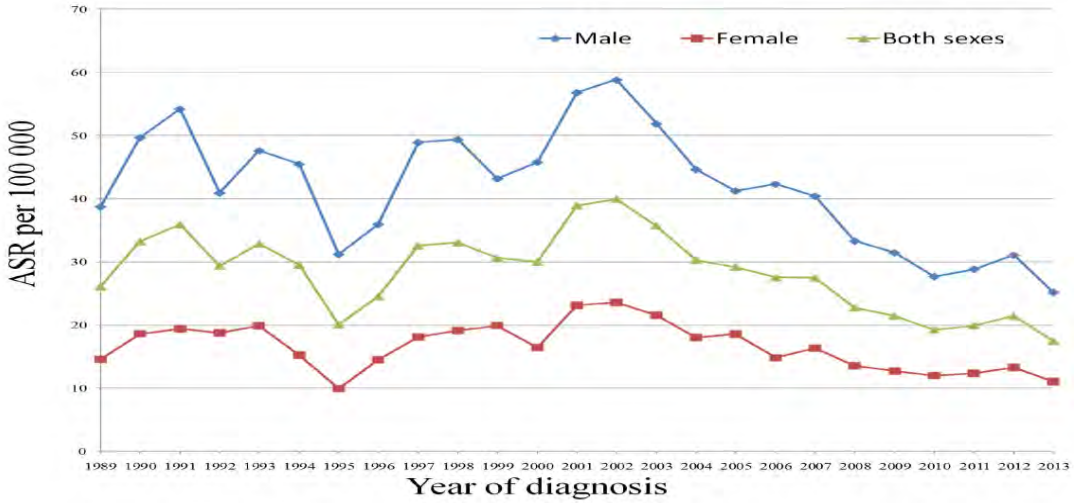
Incidence of CCA in 2023
JMPHR #1,#7,#8,#9, #10 = 60.36/100,000 population
Over all country = 41.87/100,000 population

NHSO, 5 June 2024

OV prevalence

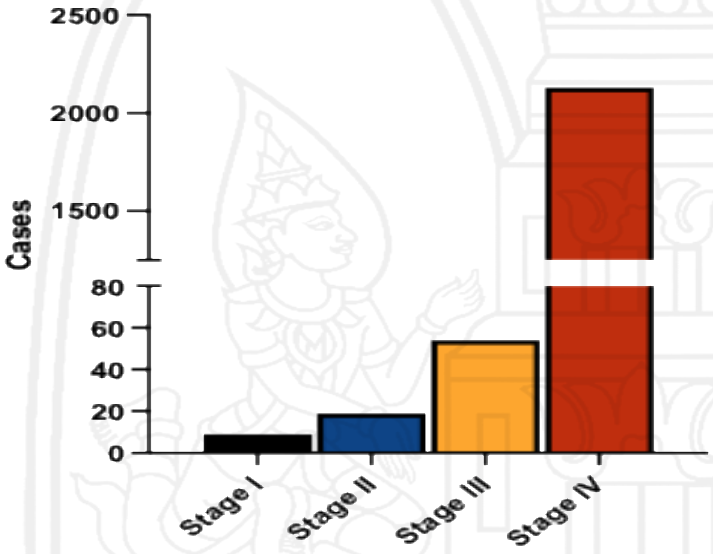


Age-adjusted rates per 100,000 (both sexes, ASR), OV (%)-Thailand, and OV (%)-KK in Khon Kaen Province trend downward. ASR, age standardized rate; KK, Khon Kaen Province; OV, *Opisthorchis viverrini*.



1. Incidence rates (per 100,000 per year) for CCA by sex in Khon Kaen Province from 1989 through 2013.

Stage at diagnosis



Journal of Medical and Public Health Region (JMPHR)

BACKGROUND

Current CCA diagnostic techniques

Radiology

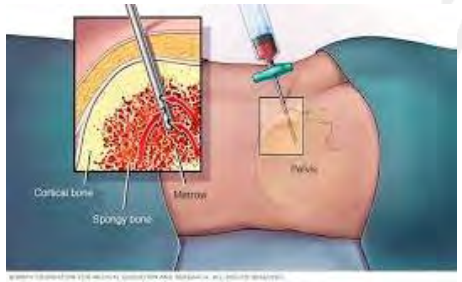
Pathology

Surgery

Tumor screening → **Confirmation** → **Tumor type identifying & staging**

Ultrasound

CT/MRI/MRCP

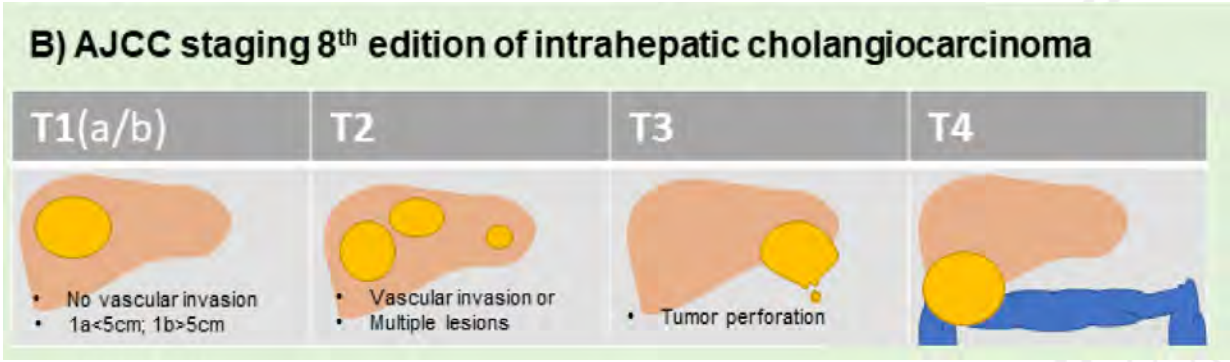


Tissue biopsy

Tumor markers: CA19-9, CEA, AFP

Oncology

CCA staging



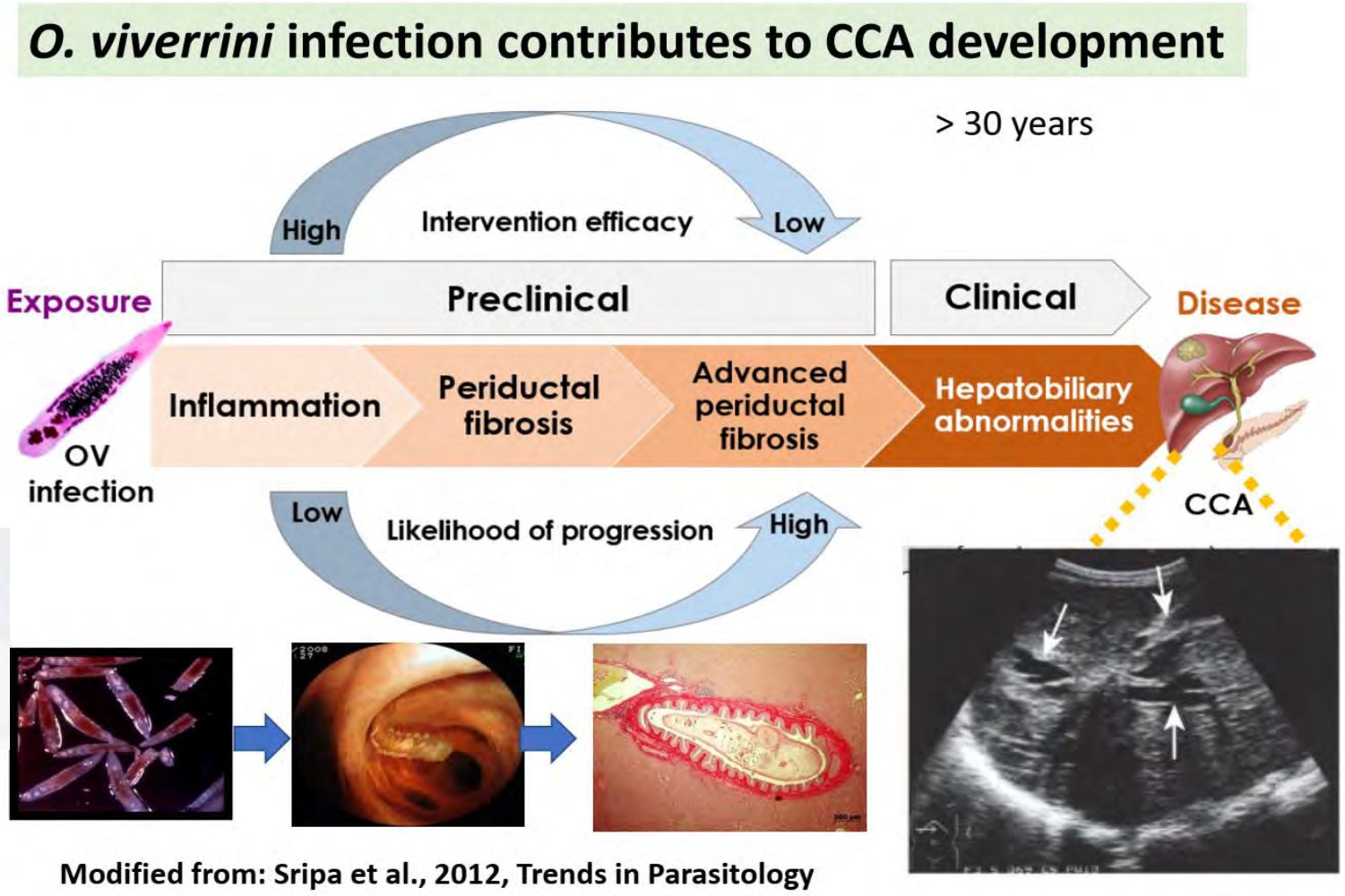
early | early | Locally Advance | Metastasis

< T3 will surgery
T4 give supportive treatment

Cancers, 2022

BACKGROUND

Current CCA screening



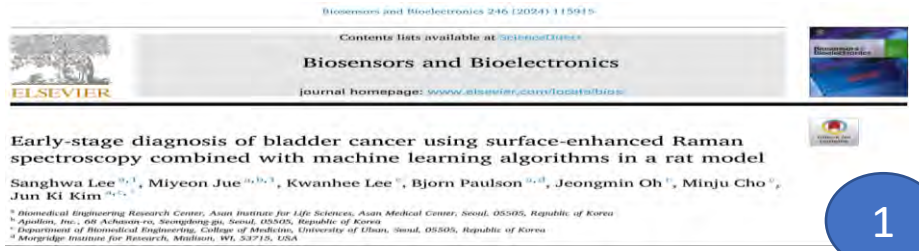
"Cholangiocarcinoma Screening and Care Program (CASCAP)", in August 2013

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

ASEAN IVO phase I, 2023

Project title: Innovation of photonic and electrochemical biosensors for cholangiocarcinoma diagnosis

Proposed methods


Biosensors and Bioelectronics 246 (2024) 115915

Contents lists available at ScienceDirect

Biosensors and Bioelectronics

journal homepage: www.elsevier.com/locate/bios

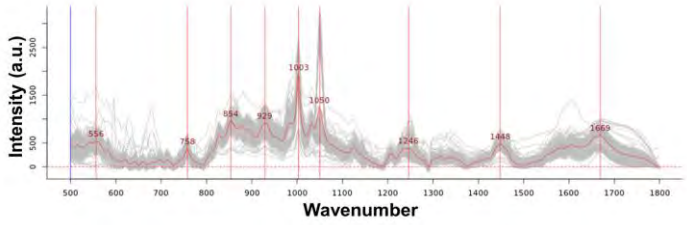
Early-stage diagnosis of bladder cancer using surface-enhanced Raman spectroscopy combined with machine learning algorithms in a rat model

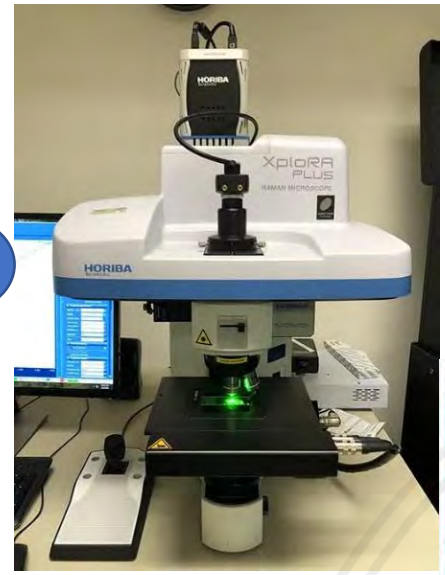
Sanghwa Lee [a,1], Miyeon Jue [a,b,1], Kwanhee Lee [c], Bjorn Paulson [a,d], Jeongmin Oh [c], Minju Cho [c], Jun Ki Kim [a,c,*]

[a] Biomedical Engineering Research Center, Asan Institute for Life Sciences, Asan Medical Center, Seoul, 05505, Republic of Korea
[b] Apollon, Inc., 68 Achasan-ro, Seongdong-gu, Seoul, 05505, Republic of Korea
[c] Department of Biomedical Engineering, College of Medicine, University of Ulsan, Seoul, 05505, Republic of Korea
[d] Morgridge Institute for Research, Madison, WI, 53715, USA

1

DNA, RNA, protein, peptide, lipid, etc.,

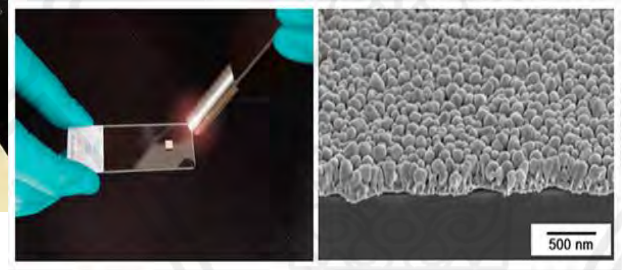




Raman spectroscopy

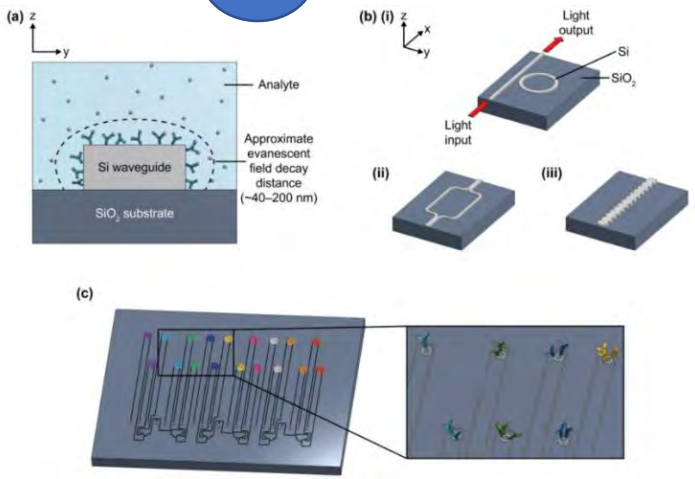
Surface-enhanced Raman spectroscopy (SERS)

NECTEC SERS Chips



BiPhos

4

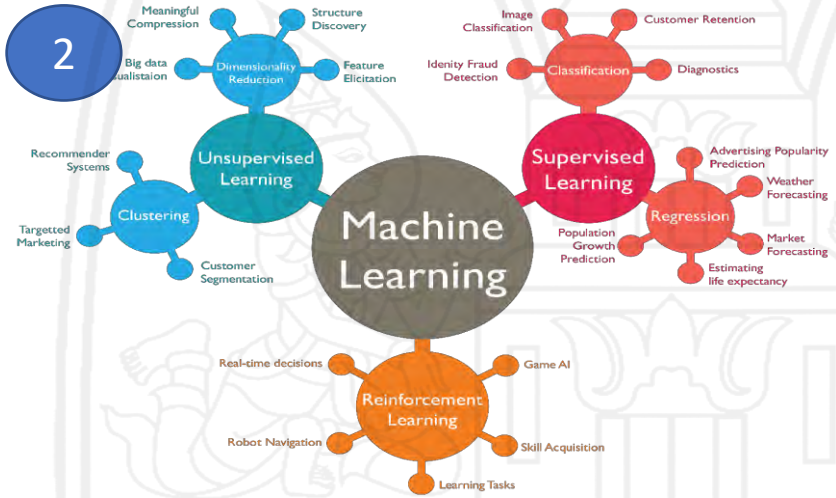


Silicon photonic sensor

3

LC-MS/MS

2

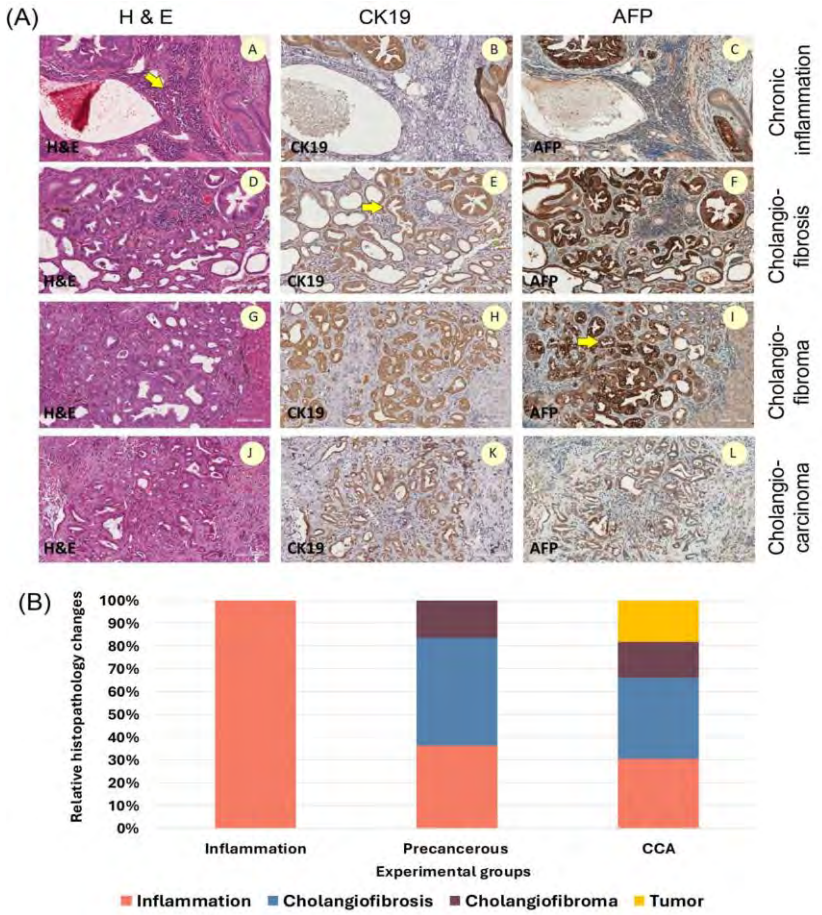


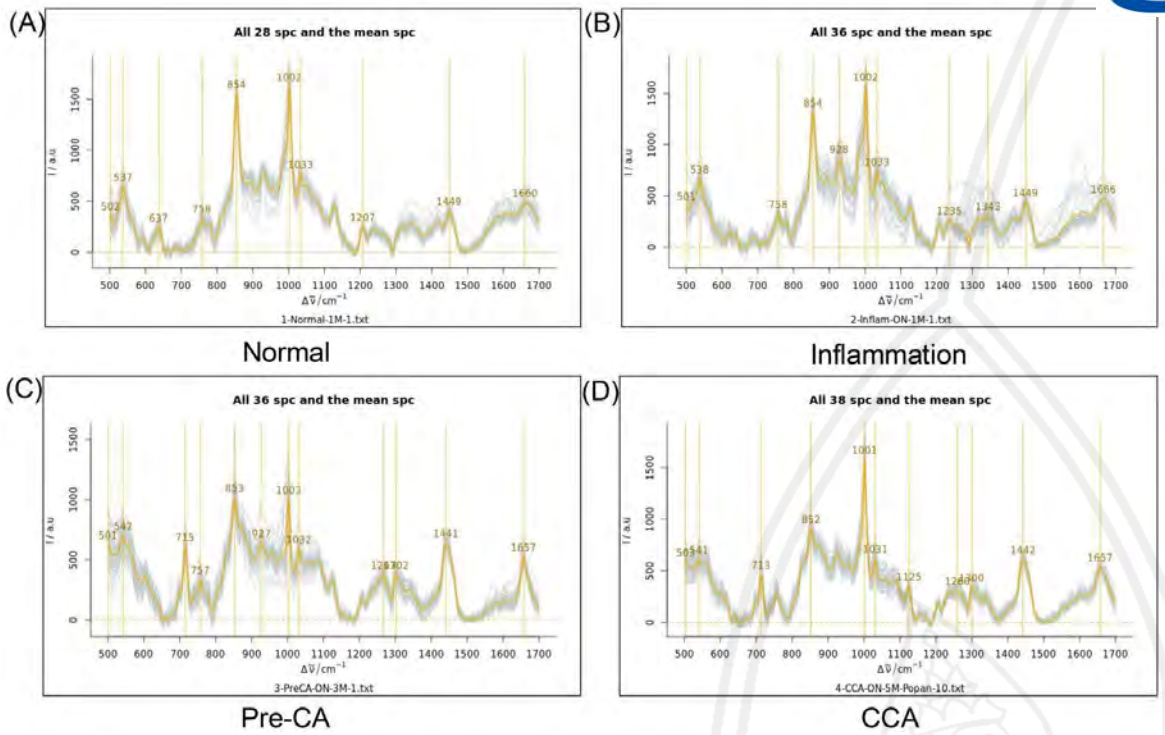
Q1

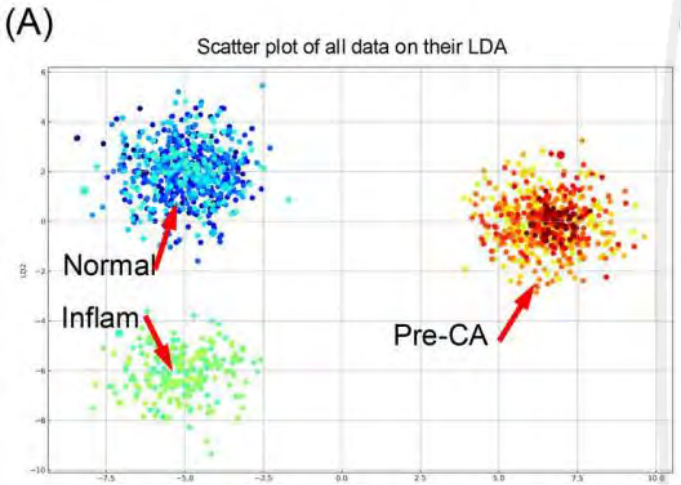
RESEARCH ARTICLE

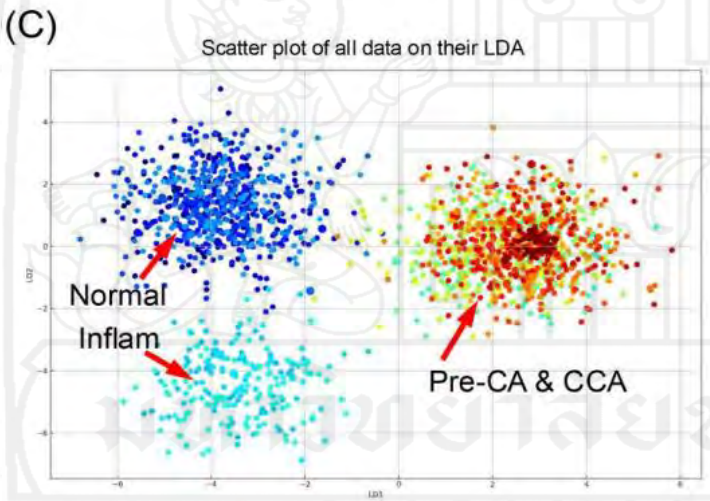
Minimally invasive detection of early-stage opisthorchiasis-associated cholangiocarcinoma using label-free surface-enhanced Raman spectroscopy (SERS) of hamster serum

Apisit Chaidee[1,2], Suppakrit Kongsintaweesuk[3,4], Thatsanapong Pongking[1], Keerapach Tunbenjasiri[4], Aye Myat Mon[4], Chawalit Pairojkul[2,5], Pakornkiat Tanasuka[2,5], Tullayakorn Plengsuriyakarn[6], Kesara Na-Bangchang[6,7] Naruechar Charoenram[1,2], David Blair[8], Somchai Pinlaor[1,2,*]









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

PLOS ONE, 2025; https://doi.org/10.1371/journal.pone.0334916

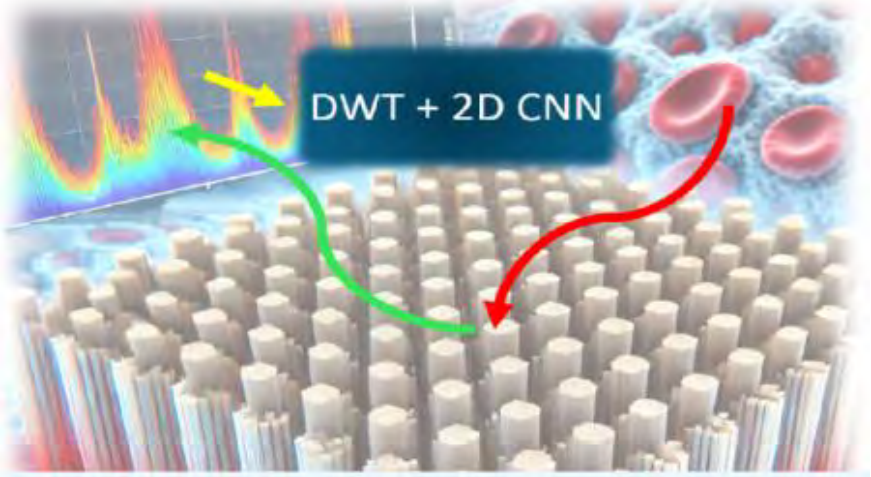
ACS OMEGA

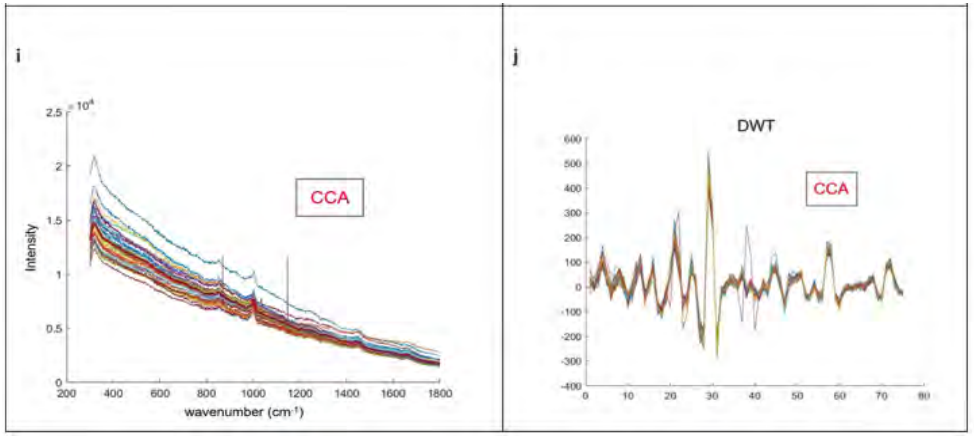
Q1

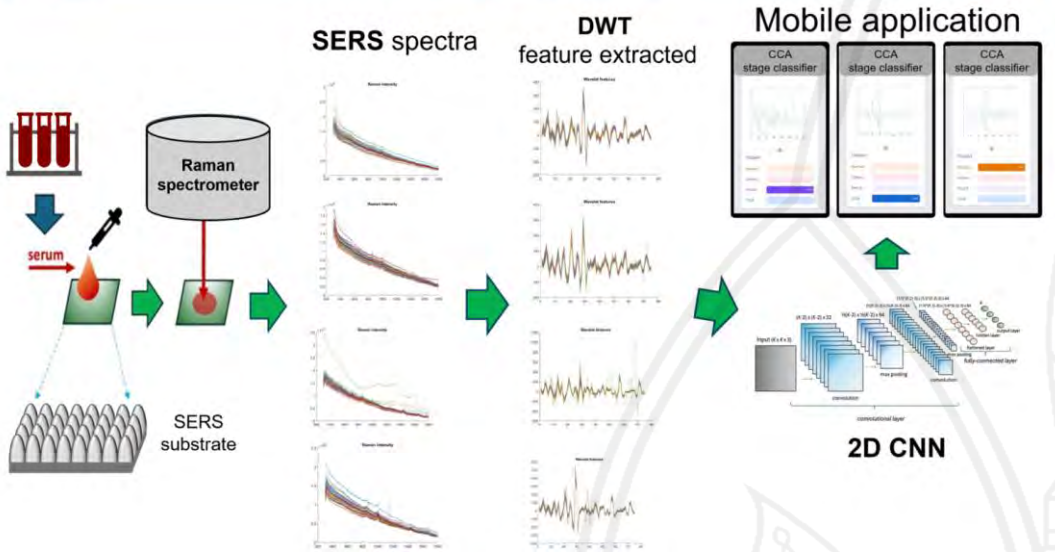
http://pubs.acs.org/journal/acsodf
Article

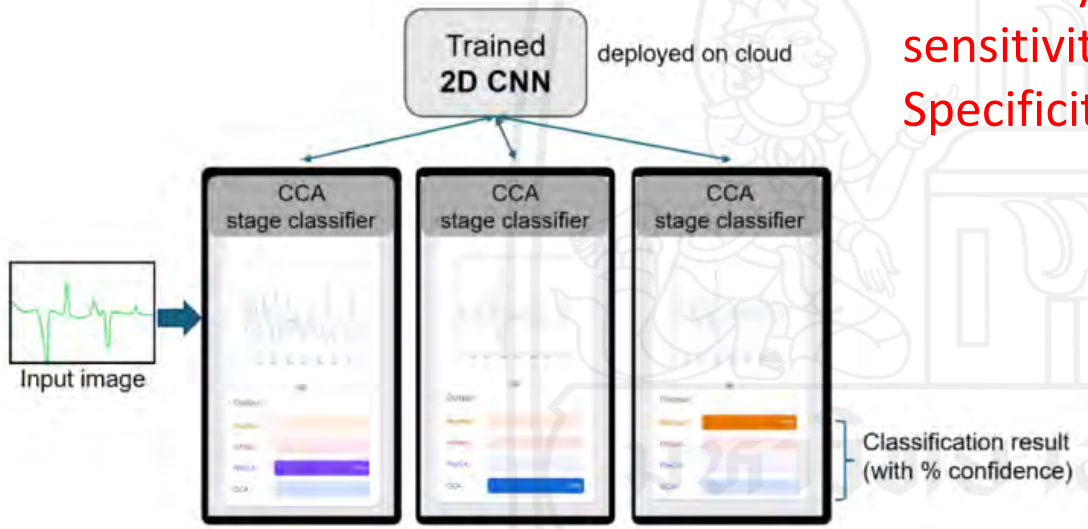
Highly Accurate and Robust Early Stage Detection of Cholangiocarcinoma Using Near-Lossless SERS Signal Processing with Machine Learning and 2D CNN for Point-of-care Mobile Application

Pobporn Danvirutai, Thatsanapong Pongking, Suppakrit Kongsintaweesuk, Somchai Pinlaor, Sartra Wongthanavasu, and Chavis Srichan*







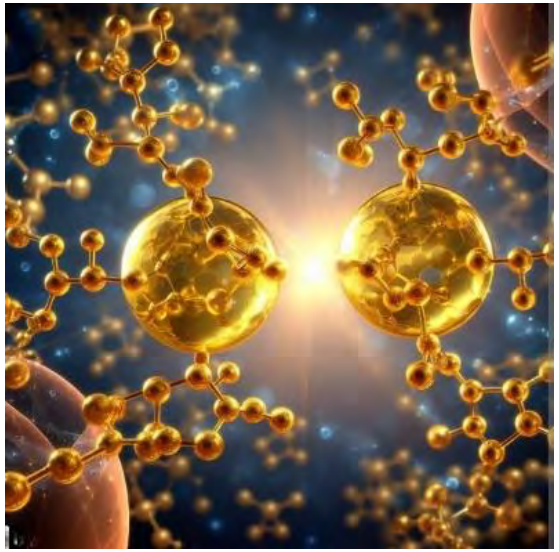


Accuracy 95%, sensitivity 95%. Specificity 96%

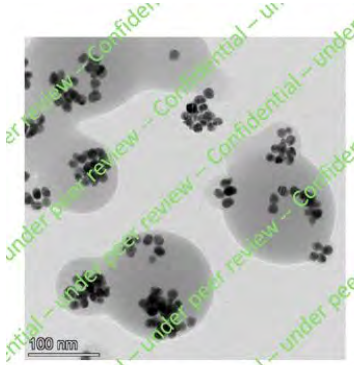
https://pubs.acs.org/doi/10.1021/acsomega.4c11078

Develop colloidal Surface Enhance Raman Spectroscopic (SERS) chip

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



Q1



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

Manuscript submitted (under review)

ทะเบียนข้อมูลเลขที่ ว1.011364

คำขอแจ้งข้อมูลเลขที่ 446105

หนังสือแสดงการแจ้งข้อมูลลิขสิทธิ์

ออกให้เพื่อแสดงว่า

มหาวิทยาลัยขอนแก่น

ได้แจ้งข้อมูลลิขสิทธิ์ไว้ต่อกรมทรัพย์สินทางปัญญา

เมื่อวันที่ 5 เดือน สิงหาคม พ.ศ. 2567

ประเภทงาน วรรณกรรม สิ่งบันทึกงาน 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

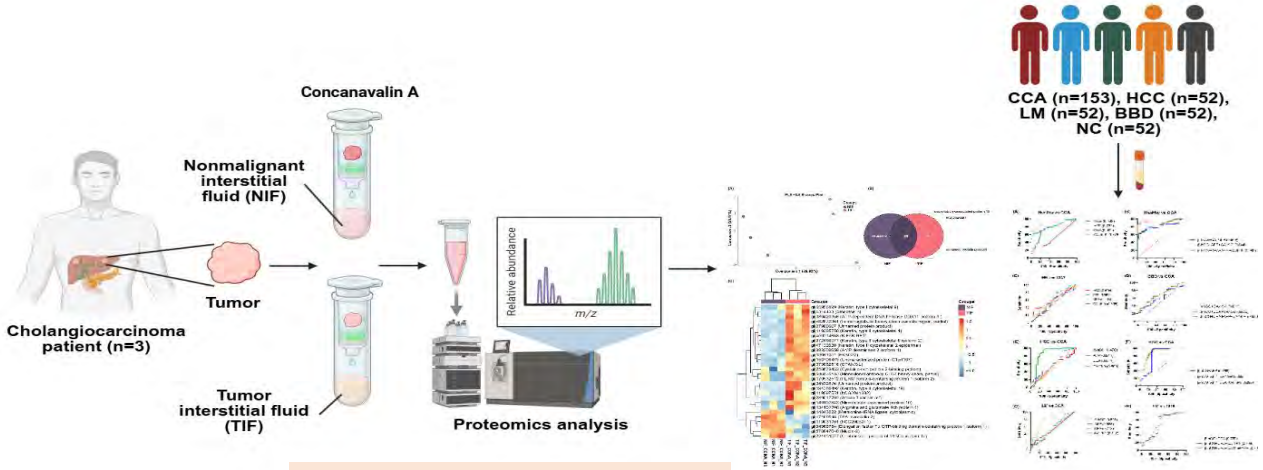
ปฏิบัติราชการแทนผู้อำนวยการกองลิขสิทธิ์

หมายเหตุ เอกสารนี้มิได้รับรองความเป็นเจ้าของลิขสิทธิ์ ในกรณีมีข้อพิพาทศาลจะเป็นผู้วินิจฉัยชี้ขาดความเป็นเจ้าของลิขสิทธิ์

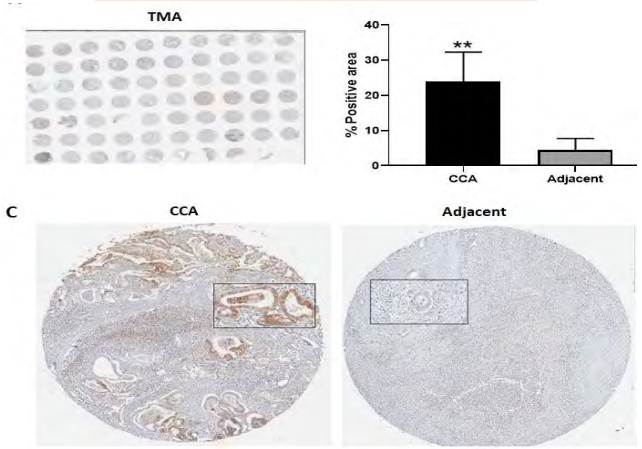
Q1

Development and clinical validation of a β-hCG-based panel for cholangiocarcinoma screening: from proteomics to clinical validation

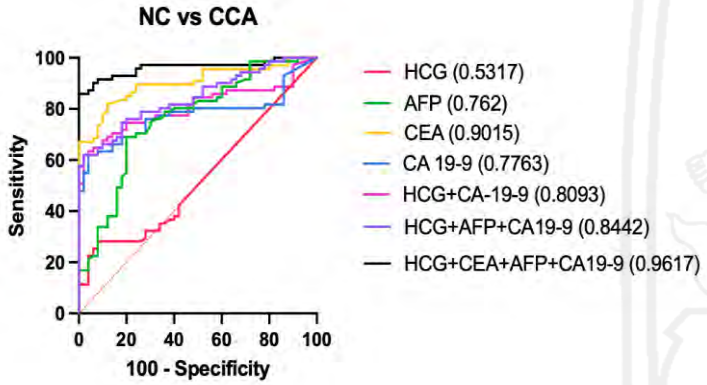
Suppakrit Kongsintaweesuk [1,2], Thatsanapong Pongking [2], Keerapach Tunbenjasiri [2], Pakornkiat Tanasuka [3], Sittiruk Roytrakul [4], Sudarat Onsurathum [5], Chawalit Pairojkul [3], Kitti Intuyod [3,6], Vor Luvira [6,7], Somchai Pinlaor [6,8]

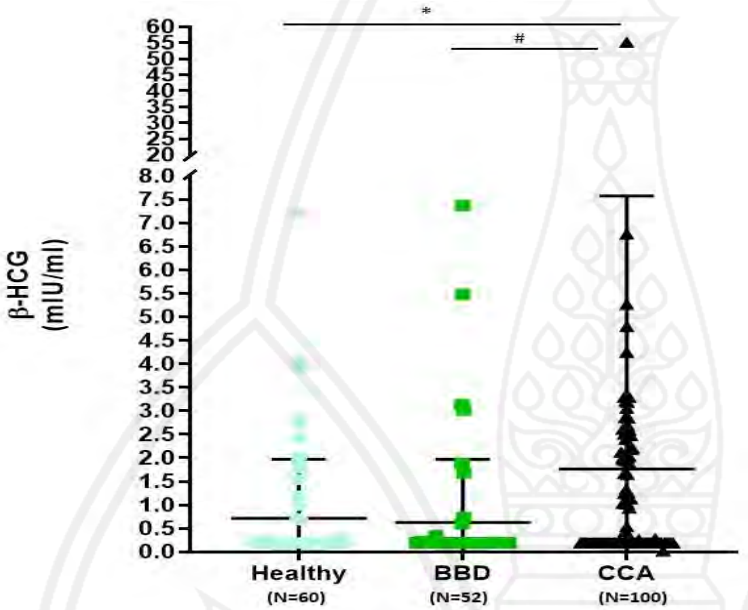


Flow chart of the study

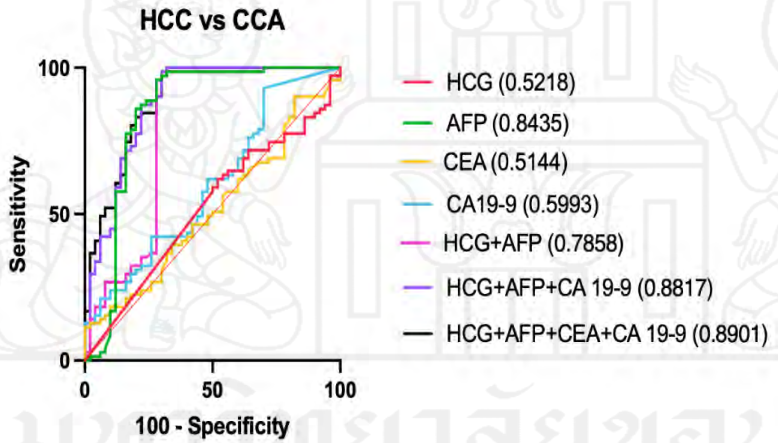


Verify beta-HCG expression in CCA array by IHC technique





Determine beta HCG level by automate



ROC analysis for the efficacy of its performance by compare/combine with routine biomarkers.

Manuscript submitted (under review)

ACS APPLIED NANO MATERIALS

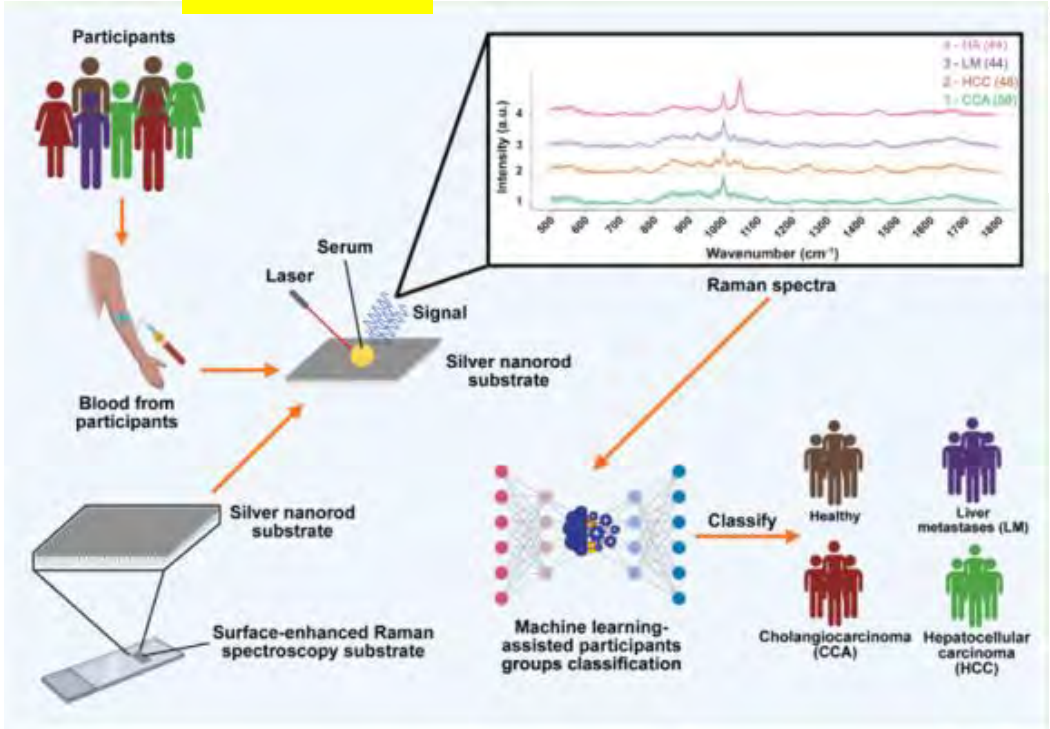
Q1

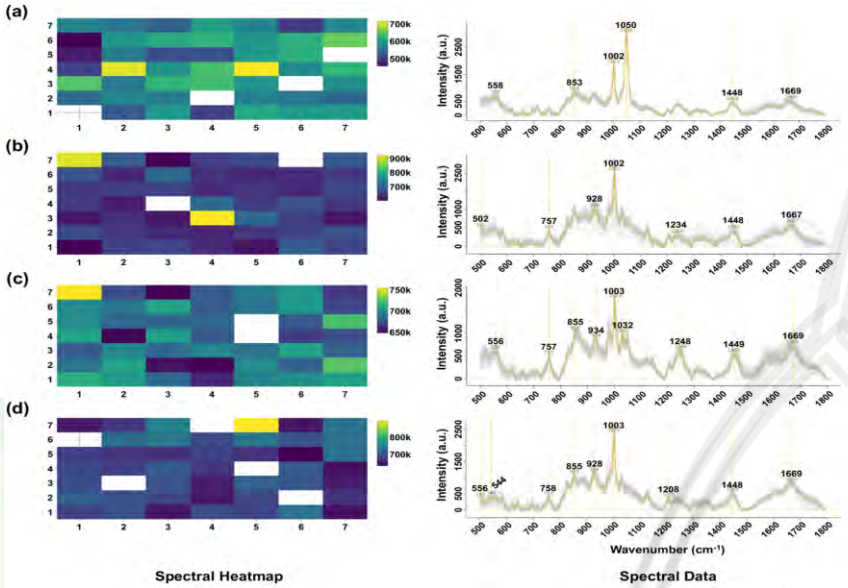
www.acsanm.org Article

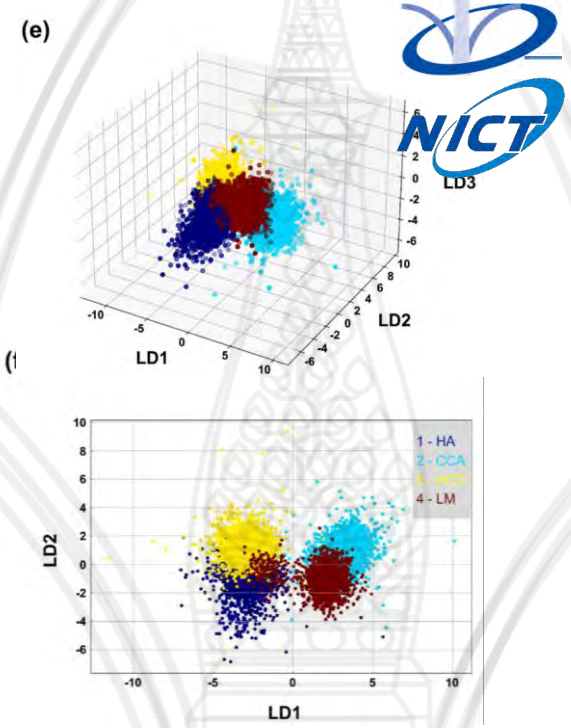
Combination of Label-Free SERS-Based Nanosensors and Machine Learning for Diagnosis of Cholangiocarcinoma

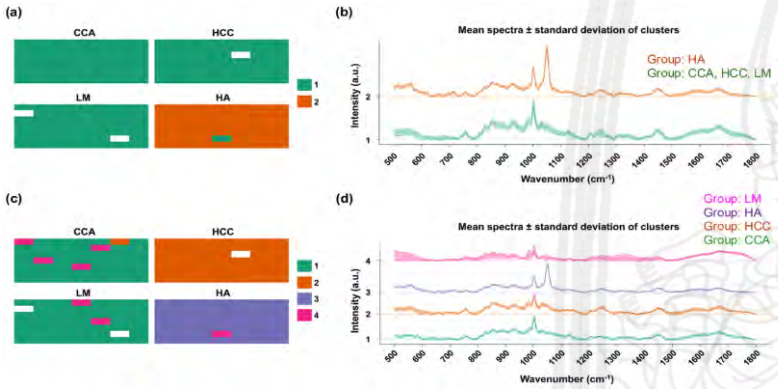
Kitti Intuyod, Suppakrit Kongsintaweesuk, Pitak Eiamchai, Vor Luvira, Apisit Chaidee, Anchalee Techasen, Porntip Pinlaor, Chawalit Pairojkul, David Blair, Toshimasa Umezawa, Atsushi Matsumoto, Kouichi Akahane, Mati Horprathum, Saksorn Limwichean, Noppadon Nuntawong,* and Somchai Pinlaor*

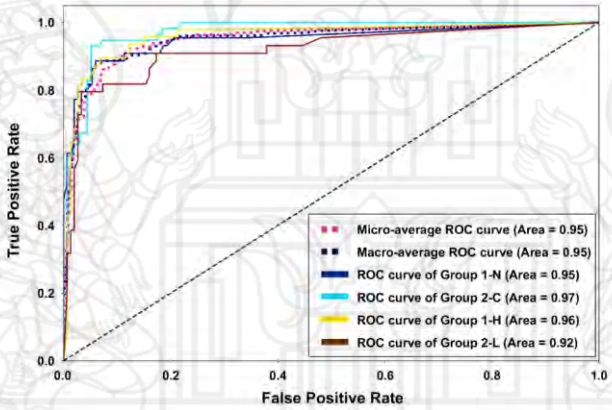
200 cases











ACS Appl. Nano Mater. 2026, 9, 250−263

Objectives

ASEAN IVO Phase II

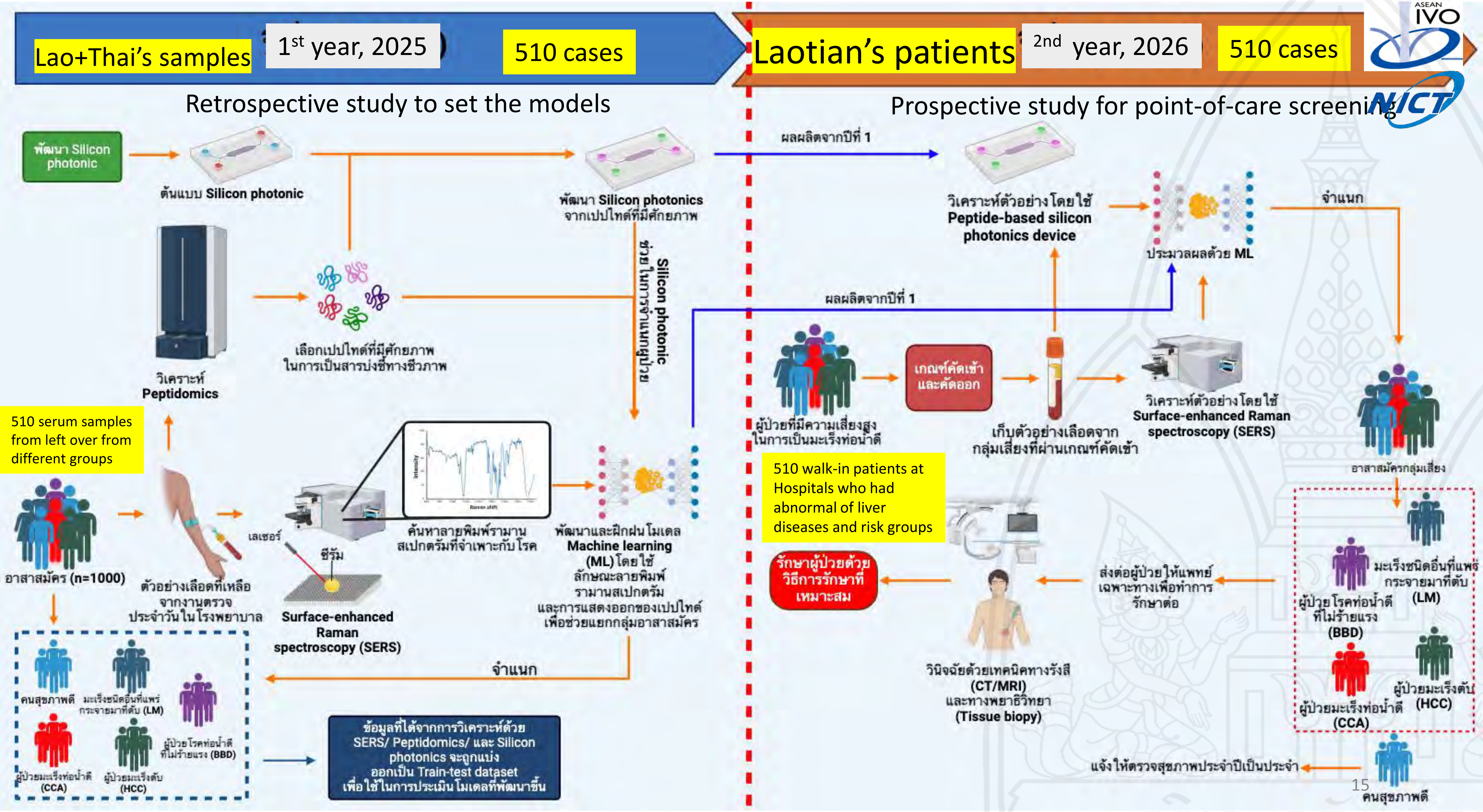
- To achieve the models of SERS, peptidomics and photonic biosensor (BiPhoS) for CCA diagnosis in left over specimens.
- To conduct point-of-care screening for CCA diagnosis in Lao patients using SERS, peptidomics and photonic biosensor (BiPhoS).
- To transfer the SERS, peptidomics and photonic biosensor (BiPhoS) technology for CCA diagnosis to Laos.

ASEAN IVO phase II

- Increase samples size from 200 to 1,020 cases; 510 cases for retrospective/ 510 cases for prospective cohort
- Include variety groups of patients classification 4 to 6 groups: HA, BBD, CCA, HCC, LM, other CA
- Implement in Lao's patients
- Include new member and countries: ADMU from Philippines, Suzuka University, Japan

Mission

To develop the new platforms screening program for CCA diagnosis.

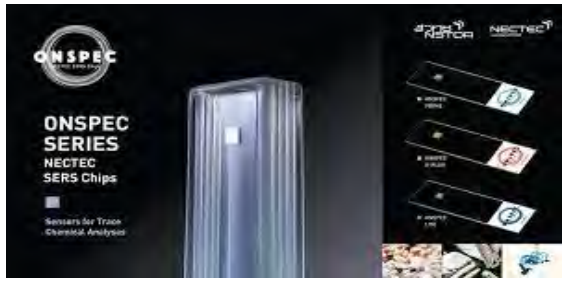


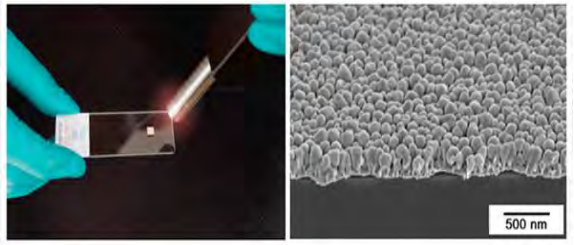
Lao+Thai’s samples
1st year, 2025
510 cases
Laotian’s patients
2nd year, 2026
510 cases
Retrospective study to set the models
Prospective study for point-of-care screening
พัฒนา Silicon photonic
ต้นแบบ Silicon photonic
พัฒนา Silicon photonics จากเปปไทด์ที่มีศักยภาพ
Silicon photonic ช่วยในการจำแนกผู้ป่วย
วิเคราะห์ Peptidomics
เลือกเปปไทด์ที่มีศักยภาพในการเป็นสารบ่งชี้ทางชีวภาพ
510 serum samples from left over from different groups
อาสาสมัคร (n=1000)
ตัวอย่างเลือดที่เหลือจากงานตรวจประจำวันในโรงพยาบาล
เลเซอร์
ซีรัม
Surface-enhanced Raman spectroscopy (SERS)
Intensity
Raman shift
ค้นหาลายพิมพ์รามานสเปกตรัมที่จำเพาะกับโรค
พัฒนาและฝึกฝนโมเดล Machine learning (ML) โดยใช้ลักษณะลายพิมพ์รามานสเปกตรัม และการแสดงออกของเปปไทด์เพื่อช่วยแยกกลุ่มอาสาสมัคร
จำแนก
คนสุขภาพดี
มะเร็งชนิดอื่นที่แพร่กระจายมาที่ตับ (LM)
ผู้ป่วยโรคท่อน้ำดีที่ไม่ร้ายแรง (BBD)
ผู้ป่วยมะเร็งท่อน้ำดี (CCA)
ผู้ป่วยมะเร็งตับ (HCC)
ข้อมูลที่ได้จากการวิเคราะห์ด้วย SERS/ Peptidomics/ และ Silicon photonics จะถูกแบ่งออกเป็น Train-test dataset เพื่อใช้ในการประเมินโมเดลที่พัฒนาขึ้น
ผลผลิตจากปีที่ 1
วิเคราะห์ตัวอย่างโดยใช้ Peptide-based silicon photonics device
ประมวลผลด้วย ML
จำแนก
ผลผลิตจากปีที่ 1
ผู้ป่วยที่มีความเสี่ยงสูงในการเป็นมะเร็งท่อน้ำดี
เกณฑ์คัดเข้าและคัดออก
เก็บตัวอย่างเลือดจากกลุ่มเสี่ยงที่ผ่านเกณฑ์คัดเข้า
วิเคราะห์ตัวอย่างโดยใช้ Surface-enhanced Raman spectroscopy (SERS)
อาสาสมัครกลุ่มเสี่ยง
510 walk-in patients at Hospitals who had abnormal of liver diseases and risk groups
รักษาผู้ป่วยด้วยวิธีการรักษาที่เหมาะสม
ส่งต่อผู้ป่วยให้แพทย์เฉพาะทางเพื่อทำการรักษาต่อ
วินิจฉัยด้วยเทคนิคทางรังสี (CT/MRI) และทางพยาธิวิทยา (Tissue biopy)
มะเร็งชนิดอื่นที่แพร่กระจายมาที่ตับ (LM)
ผู้ป่วยโรคท่อน้ำดีที่ไม่ร้ายแรง (BBD)
ผู้ป่วยมะเร็งท่อน้ำดี (CCA)
ผู้ป่วยมะเร็งตับ (HCC)
แจ้งให้ตรวจสุขภาพประจำปีเป็นประจำ
คนสุขภาพดี

BACKGROUND: CHALLENCE PLATFORM

1

Raman spectroscopy

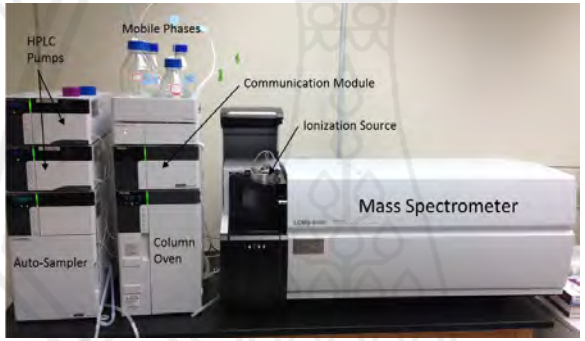




NECTEC SERs Chips

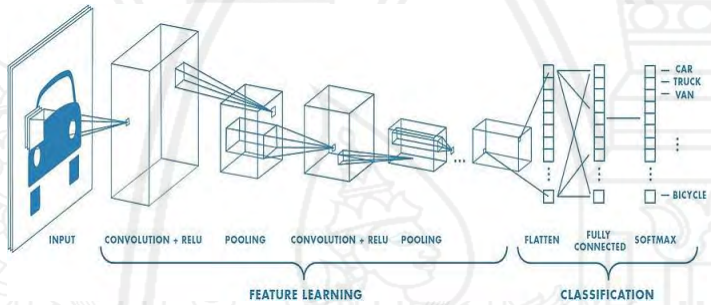
2 Peptidomics platform

MALDI-TOF

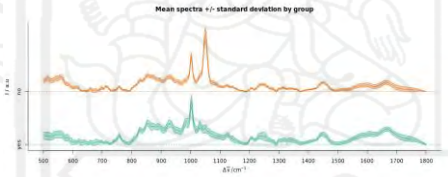


LC-MS/MS

3



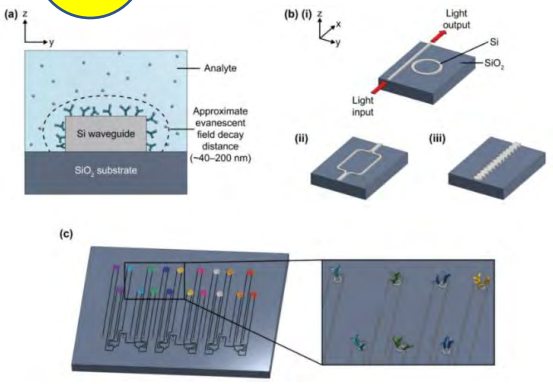
Machine Learning: PCA, LDA, SVM,
Convolutional neuron network, CNN, etc.,



NC
CCA+HCC+LM

BiPhos Ver.3

4



Silicon photonic sensor

1st year performing

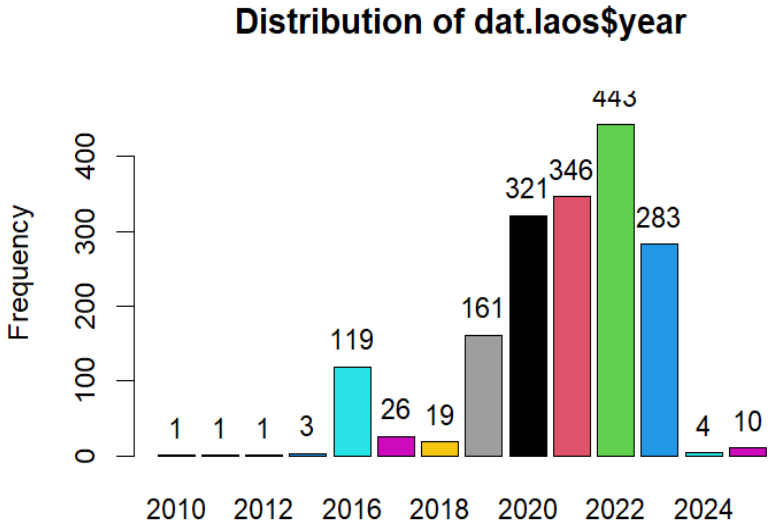
Retrospective study

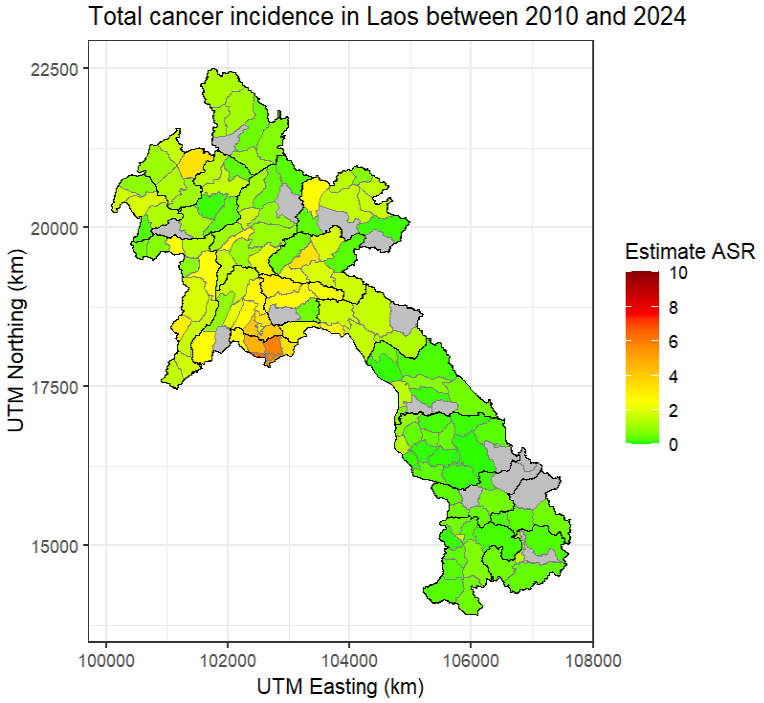
31 Mar 26

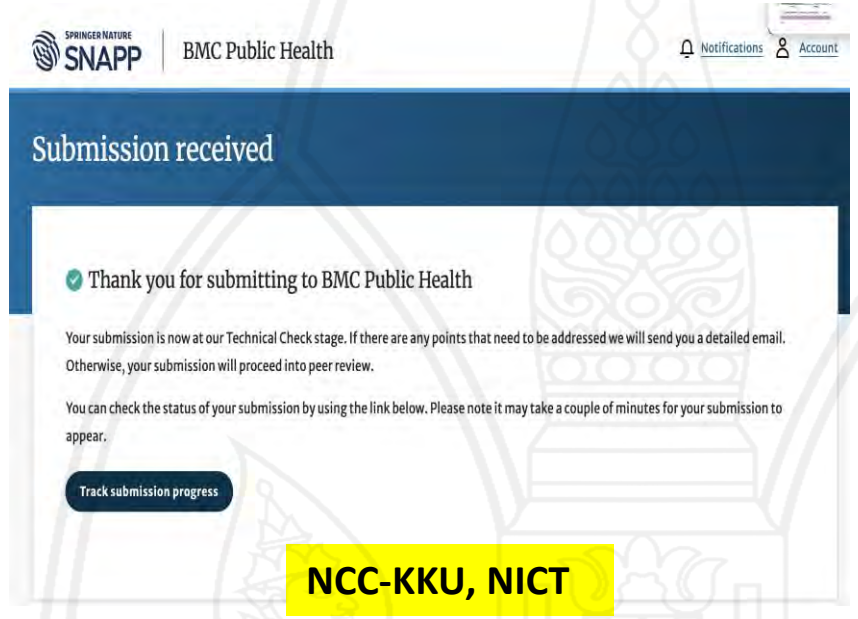
Activities	Project approve	Kick-off	CRDA approve	Budget usage approve
	16 Sep 2025	10 Oct, 2025	02 Dec, 2025	27 Jan to 31 Mar 2026
1. Human ethic approval for retrospective study (LAOS & KKU)---HE : HE684049				
2. Samples collection of various groups (NCC & KKU) 510 cases				
3. Investigation of SERS & peptidomics analysis (KKU-NECTEC, -BIOTEC)—510 cases				
4. Data analysis and models setting (ADMU, Philippine)				
5. Construct of BiPhos of multiplex peptide based for CCA diagnosis (CMU-TMEC)				
6. BiPhos testing & analysis (CMU)				
7. Meeting: Report of SERS & peptidomics models and BiPhos setting (KKU-CMU-LAOS-Philippine)				

Cancer register at NCC, Vientiane, LAO

Spatial Distribution of Cancer Cases registered in a National Hospital-Based Registry in Lao People's Democratic Republic from 2010 to 2024







NCC-KKU, NICT

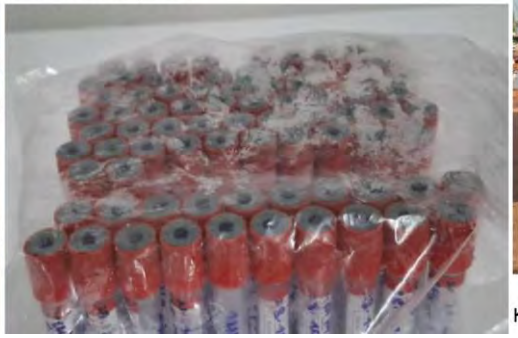
HCC 40 cases/year; CCA, 20 cases/year

The most common cancers are liver cancer in males and cervical and breast cancer in females.

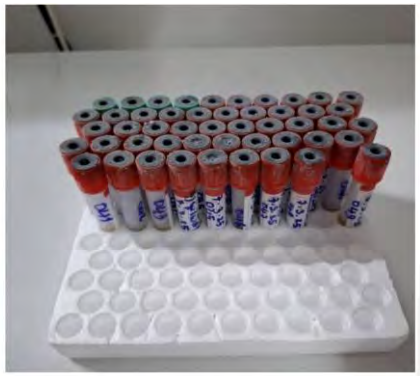
Revised manuscript in BMC Public Health, Q1

Summary of LaoPDR serum samples

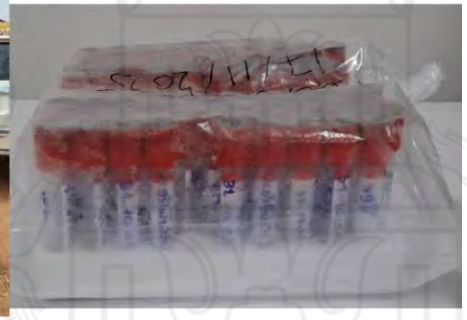
Patients' data	Total samples	Small amount samples	Undentified samples	Missing data	Completed samples
1st batch (L-0001 to L-0049)	49	-	-	-	49
2nd batch (L-0050 to L-0138)	89	3	11	17	58
3rd batch (L-0130 to L-0180)	51	2	9	-	40
4th batch (L-0181 to L-0272)	92	17	-	-	75
Total	281	22	20	17	222



KKU received the 2nd batch of 89 samples from the NCC at the Thai-Lao border on November 16, 2025.



KKU received the 3rd batch of 51 samples from the NCC at the Thai-Lao border on December 10, 2025.



KKU received the 4th batch of 92 samples from the NCC at the Thai-Lao border on January 24, 2026.

Collection and shipping serum by Khon Kaen University (KKU)

No.	Different groups of samples	No. of samples
1	Cholangiocarcinoma (CCA)	194
2	Hepatocellular carcinoma (HCC)	180
3	Liver metastasis (LM)	99
4	Benign biliary diseases (BBD)	115
5	Healthy control (NC)	67
Total		655

KKU has sent 510 samples (from Lao and KKU) to BIOTEC twice time via NN Health Science Part., Ltd.

Shipping to BIOTEC

SERS Investigations

KKU investigate Raman spectroscopy using SERS Chip from NECTEC

Sensors:
NECTEC OnSpec PRIME SERS Chips

KKU-NECTEC

Sample Preparation:
Specimens from human serum

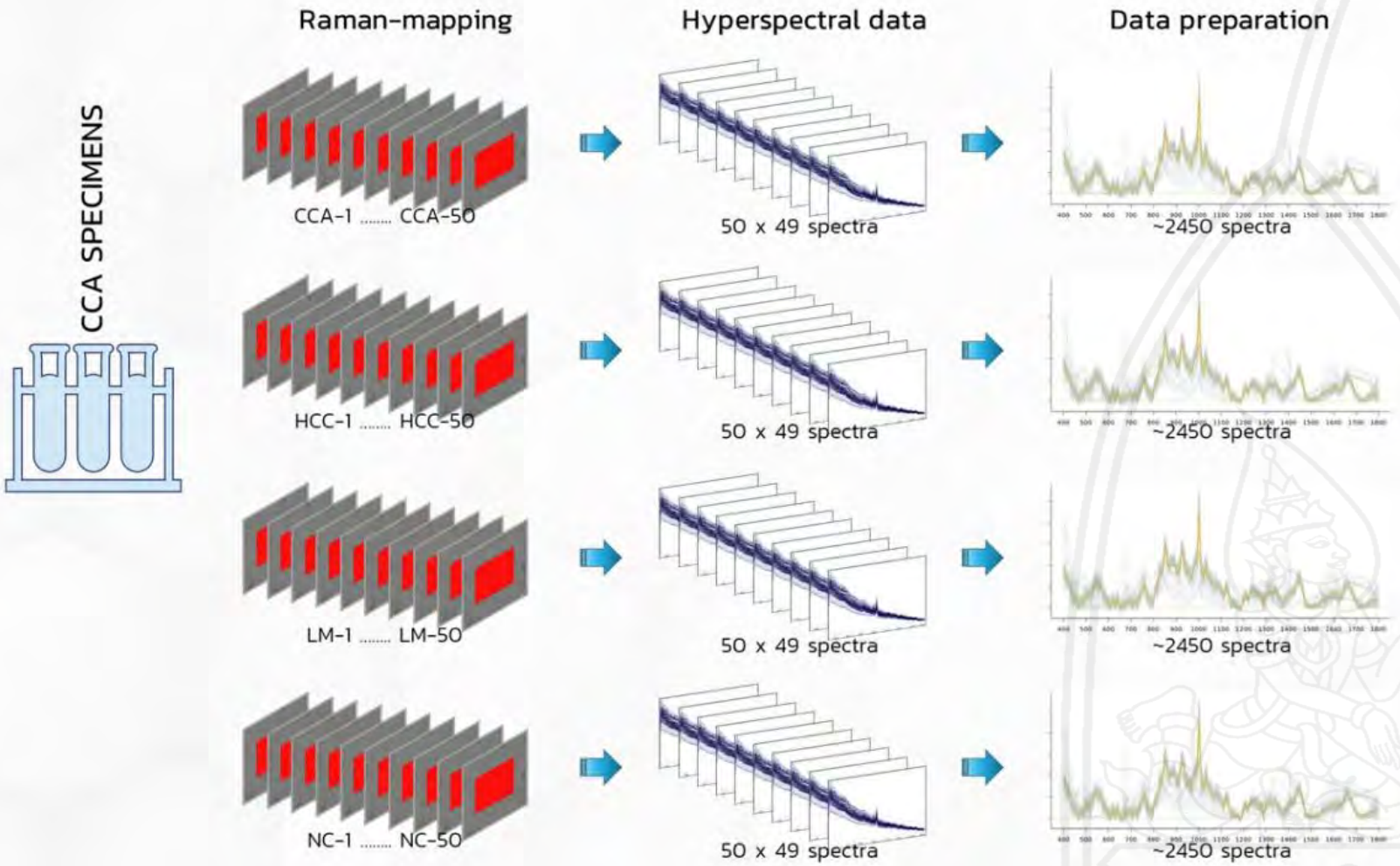
Raman Measurements:
HORIBA XploRA Plus
785 nm excitation
Filter 25%, acq 10 s, acc 1
Raman mapping: 49 positions per sample

	CCA	HCC	LM	BBD	NC	Other CA	Total
Laos samples	20	17	26	-	-	43	106
KKU samples	-	24	47	50	-	-	121
SERS data from KKU	58	48	44	0	44	-	194
Total	78	89	117	50	44	43	421

Current Sample Set

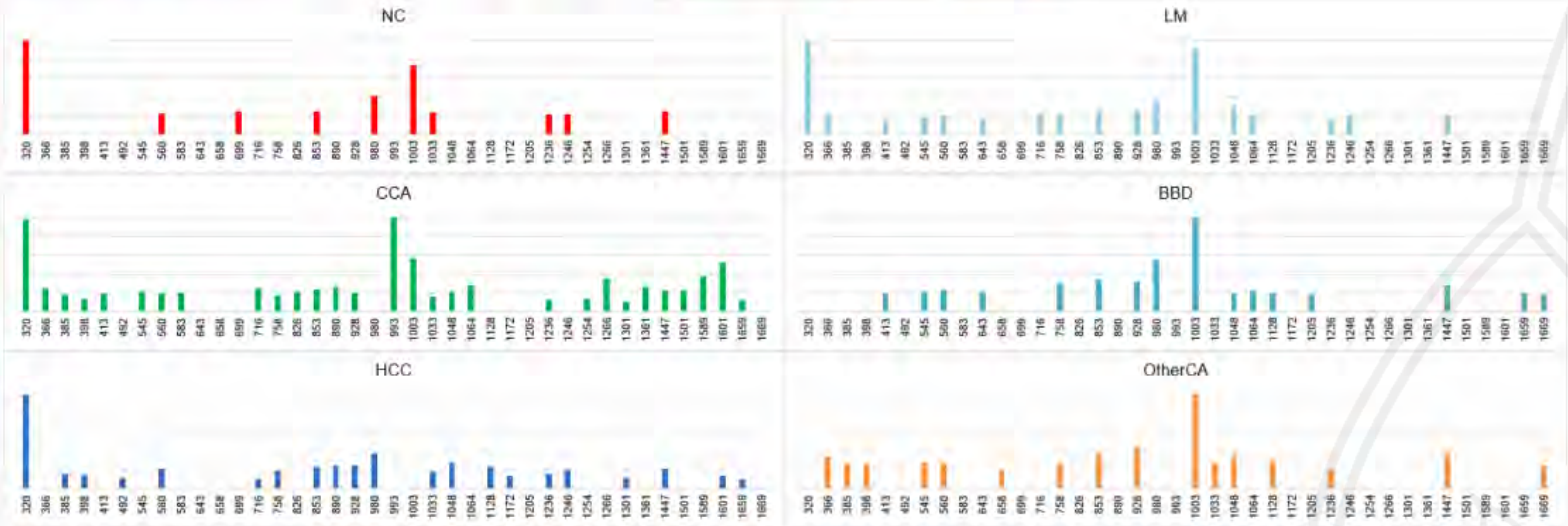
Current Measurement System

Data Processing & Analysis



Spectral Data – All Samples

Peak of interest

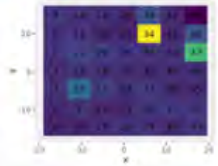


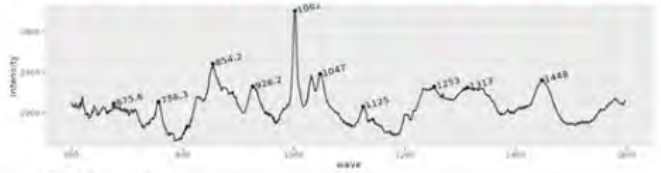
Peak assignments

Raman Shift (cm^{-1})	Identified Peak in Sample Groups	Peak Assignments	Vibration Mode/Chemical Bond	Reference
556	HCC	Tryptophan-containing protein	Indole ring breathing	40
757/758	CCA, HCC, LM	Tryptophan symmetric and DNA/RNA ring breathing modes, reflecting altered DNA/RNA content or structure	Ring breathing mode (DNA/RNA bases)	41
854/855	HCC, LM	C–C stretching vibrations in proteins, tyrosine-containing proteins may indicate altered phosphorylation states	C–C stretching; aromatic ring vibrations	42
928/929	CCA, LM	C–C backbone stretching in proteins, changes in collagen structure/content are common in liver cancers	Protein backbone vibration (α-helix)	43
1002/1003	HA, CCA, HCC, LM	Phenylalanine-containing proteins may indicate altered metabolism	Ring breathing of phenylalanine	43
1050	HA	C–O stretching, C–N stretching in proteins, alterations in DNA/RNA structure or content	Stretching of nucleic acid and protein bonds	44
1246 or 1248	HCC	Amide III band of proteins, CH_2 wagging variations can indicate altered membrane composition, CN stretching and NH bending	Amide III (C–N stretch, N–H bend)	43
1448/1449	HA, CCA, HCC, LM	CH_2 and CH_3 bending vibrations of proteins and lipids, provides significant insights into cancer-related biochemical changes	$\delta(CH_2)$, $\delta(CH_3)$ bending	45
1669	HA, CCA, HCC, LM	C=O stretching in protein backbone structures, carries significant implications for cancer-related structural changes in proteins	C=O stretching of peptide bond	41

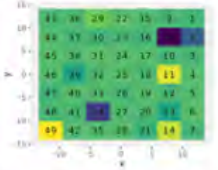
ACS Appl. Nano Mater. 2026, 9, 1, 250–263

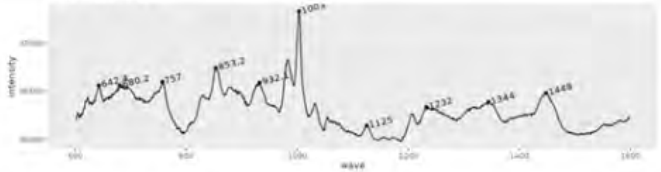
Spectral Data – Laos: LM & OtherCA





Pattern 1





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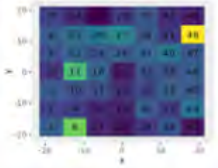

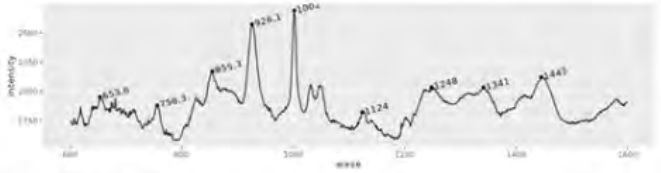

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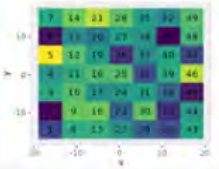

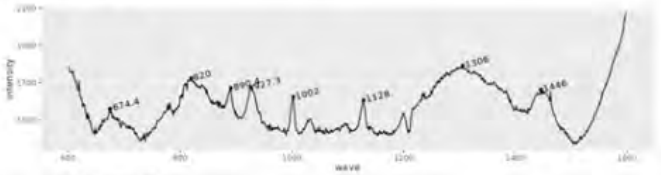

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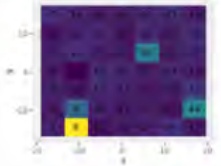

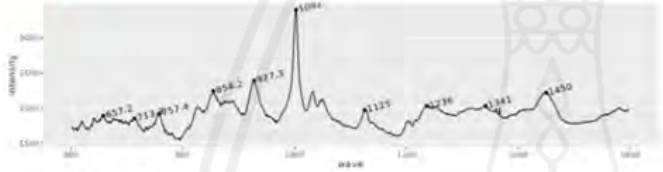

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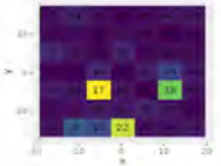

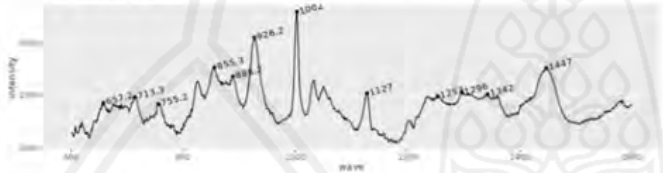

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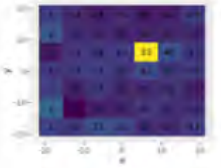

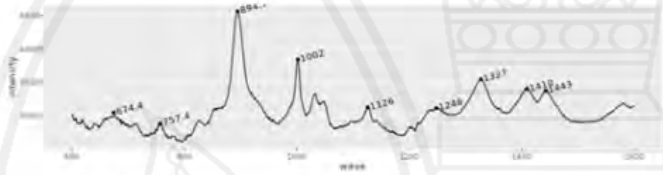

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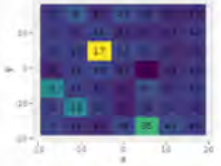

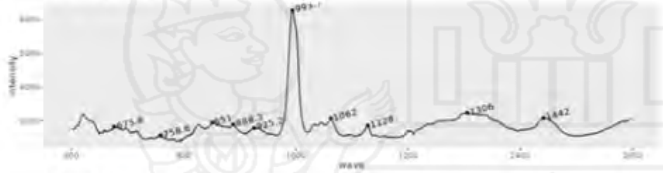

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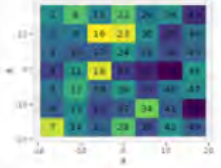
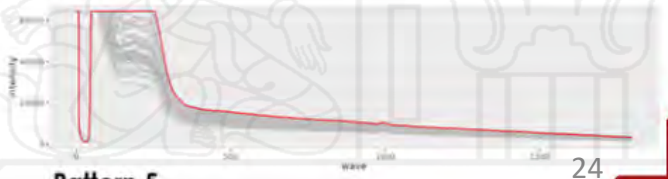
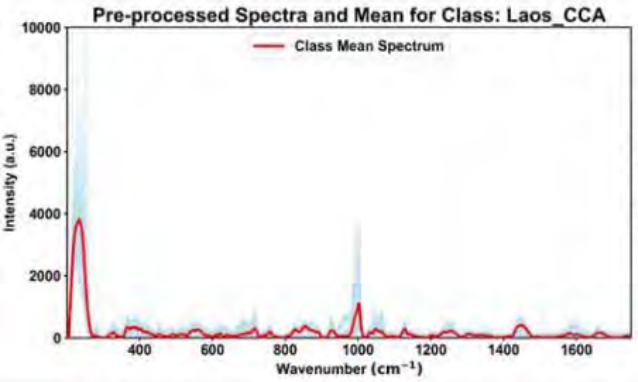
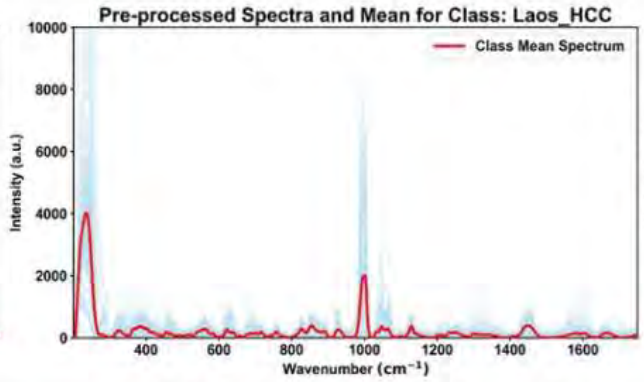


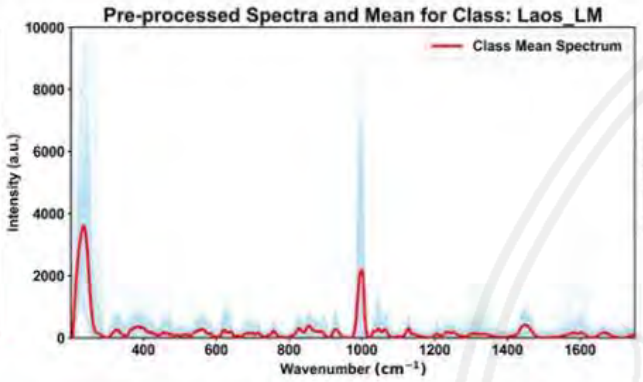


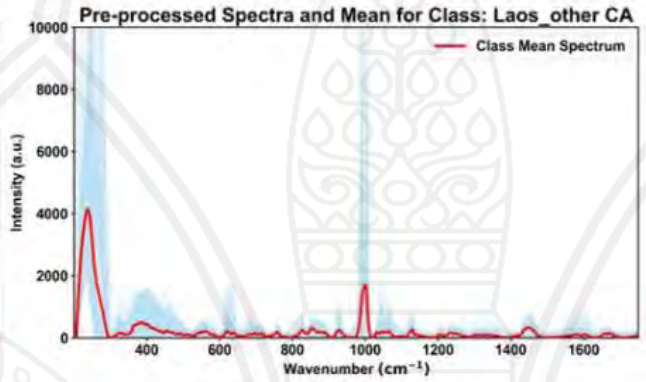
Pattern 5

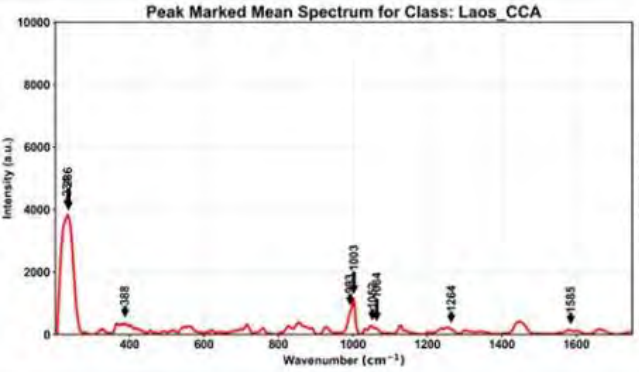
Spectral Data - Laos

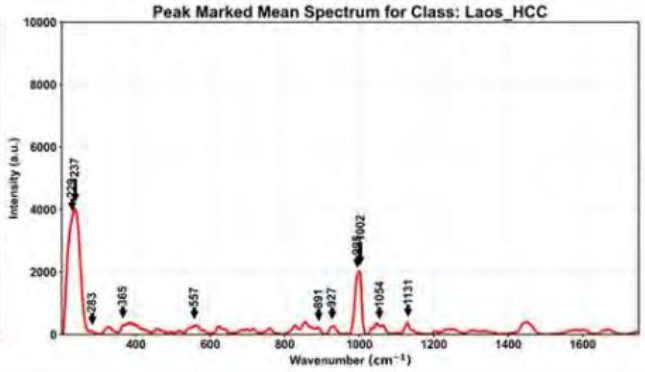


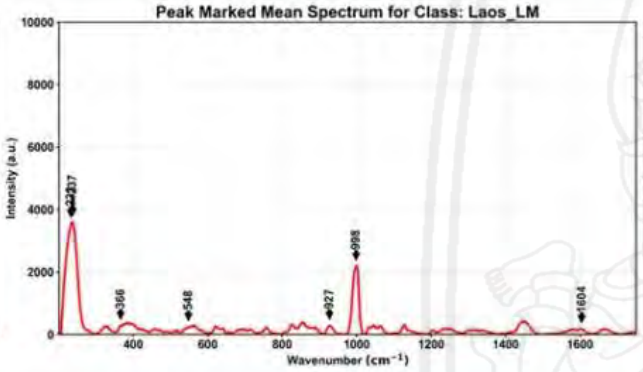


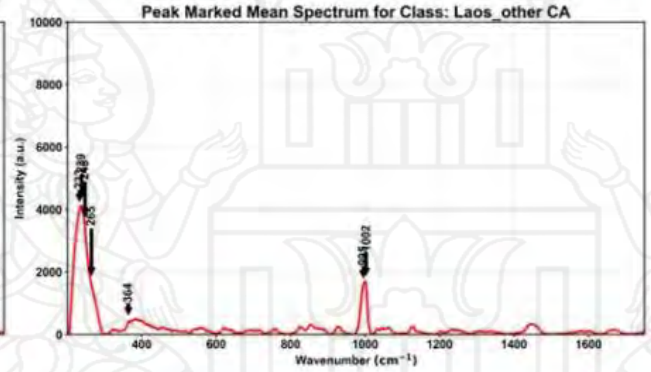




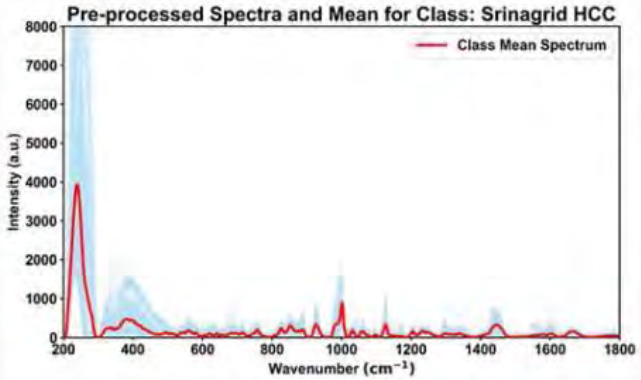


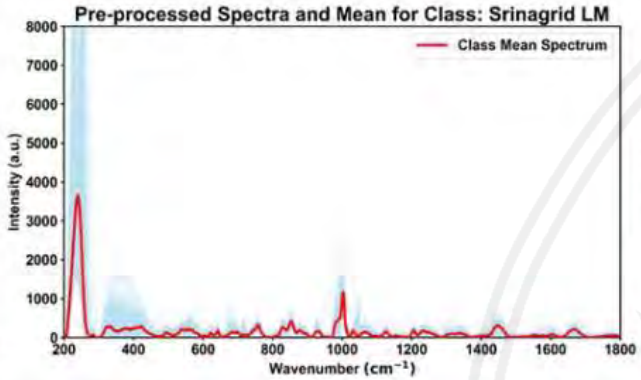


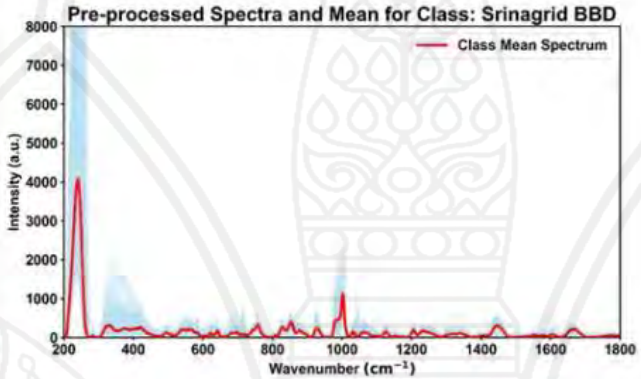


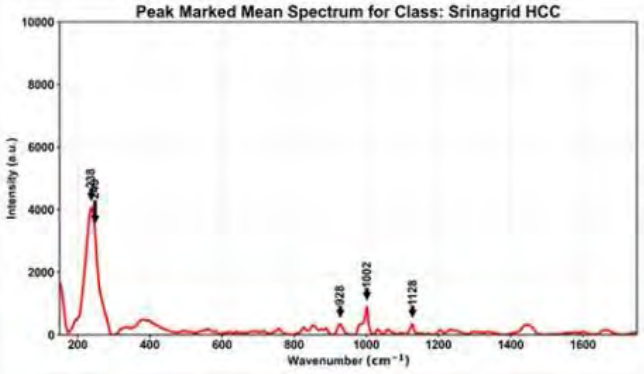


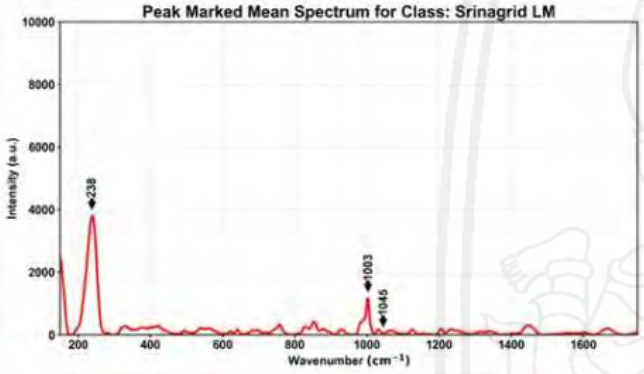
Spectral Data - KKU

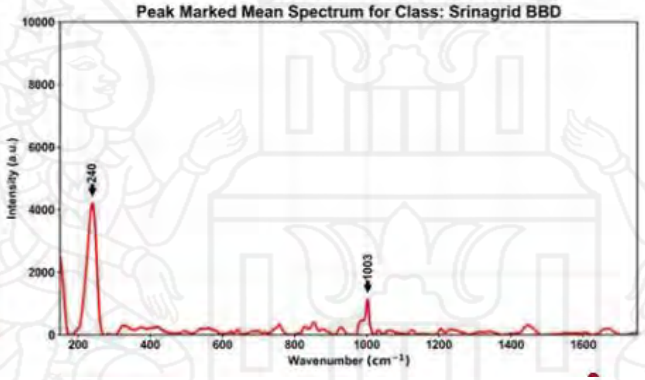












Challenges

Complexity of Biomolecular Signals:

SERS spectra from human serum or plasma are highly intricate, as diverse proteins, lipids, and metabolites create overlapping peaks that are difficult to isolate.

Diagnostic Sensitivity:

Precise peak interpretation is critical, as subtle shifts in vibrational signatures directly dictate the accuracy of cancer diagnostics.

The Interpretation-AI Gap:

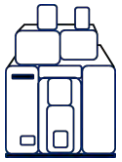
While Machine Learning excels at classification, a significant disconnect remains between AI-driven results and the biochemical assignment of specific molecular peaks.

Peptidomics platform for CCA

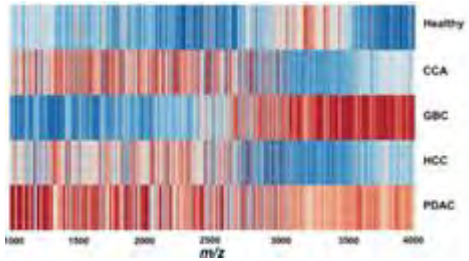
BIOTEC a member of NSTDA

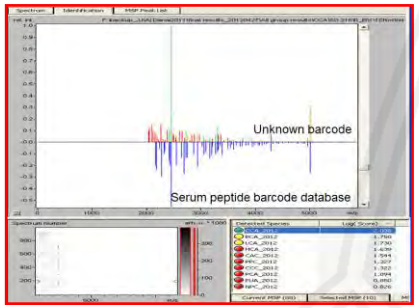
ASEAN IVO NICT

Native peptide



Maldi-TOF MS analysis





"Peptide barcode" for rapid screening

accuracy = 95%, precision = 96.29%,
sensitivity = 92.86%, specificity = 96.88%

LC-MS analysis

Peptide sequence	MH+ (Da)	Accession number	Protein name
ILYDFTAR	999.3821	gi|21264616	epidermal growth factor receptor kinase substrate 8-like protein 2
GRWFLSALFR	1252.488	gi|161728552	T cell receptor alpha variable 8
KAVGPVVEQAVR	1251.792	gi|119581499	DEAD (Asp-Glu-Ala-Asp) box polypeptide 56, isoform CRA_c
LPLLPPESPGPLRQR	1668.503	gi|32812252	CRIB1

Peptide sequence

Peptide biomarker

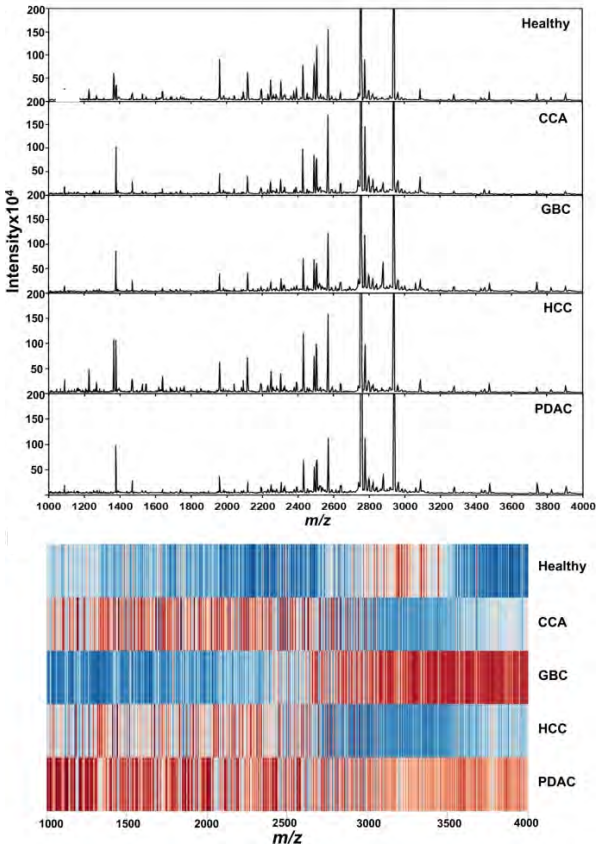
"Peptidome" for future diagnostic technology

Cholangiocarcinoma (CCA) peptidome research

Serum peptide biomarkers by MALDI-TOF MS coupled with machine learning for diagnosis and classification of hepato-pancreato-biliary cancers

scientific reports

Piya Prajumwongs[1], Attapol Titapun[1,2], Vasin Thanasukarn[1,2], Apiwat Jareanrat[1,2], Natcha Khuntikeo[1,2], Krit Rattanarak[1,2], Nisana Namwat[1,3], Poramate Klanrit[1,3], Arporn Wangwiwatsin[1,3], Jarin Chindaprasirt[1,4], Supinda Koonmee[1,5], Prakasit Sa-Ngiamwibool[1,5], Nattha Muangritdech[1], Sawanya Charoenlappanit[6], Janthima Jaresitthikunchai[6], Sittiruk Roytrakul[6] & Watcharin Loilome[1,3]✉



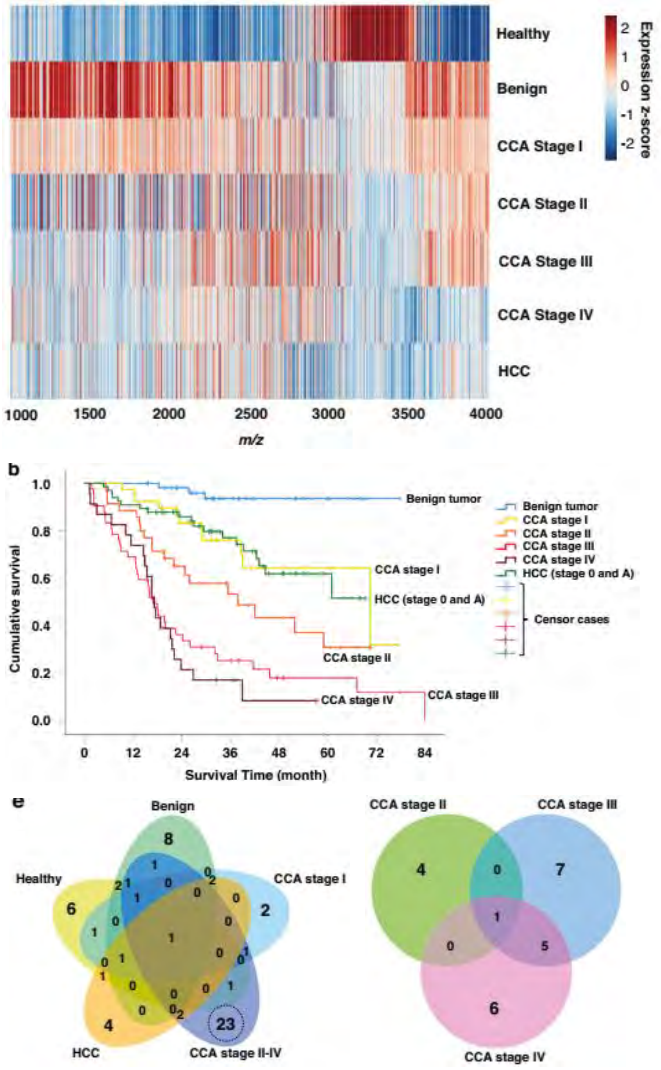
297 participants

accuracy = 95%, precision = 96.29%, sensitivity = 92.86%, specificity = 96.88%

Identification of serum peptide biomarkers for cholangiocarcinoma diagnosis and staging via MALDI-TOF MS and LC-MS/MS

Apiwat Jareanrat[1,3], Piya Prajumwongs[1], Attapol Titapun[1,3], Vasin Thanasukarn[1,3], Natcha Khuntikeo[1,3], Krit Rattanarak[1,3], Nisana Namwat[1,4], Poramate Klanrit[1,4], Arporn Wangwiwatsin[1,4], Jarin Chindaprasirt[1,5], Supinda Koonmee[1,6], Prakasit Sa-Ngiamwibool[1,6], Nattha Muangritdech[1], Sawanya Charoenlappanit[1], Janthima Jaresitthikunchai[2], Sittiruk Roytrakul[2] and Watcharin Loilome[1,4,5]

British Journal of Cancer

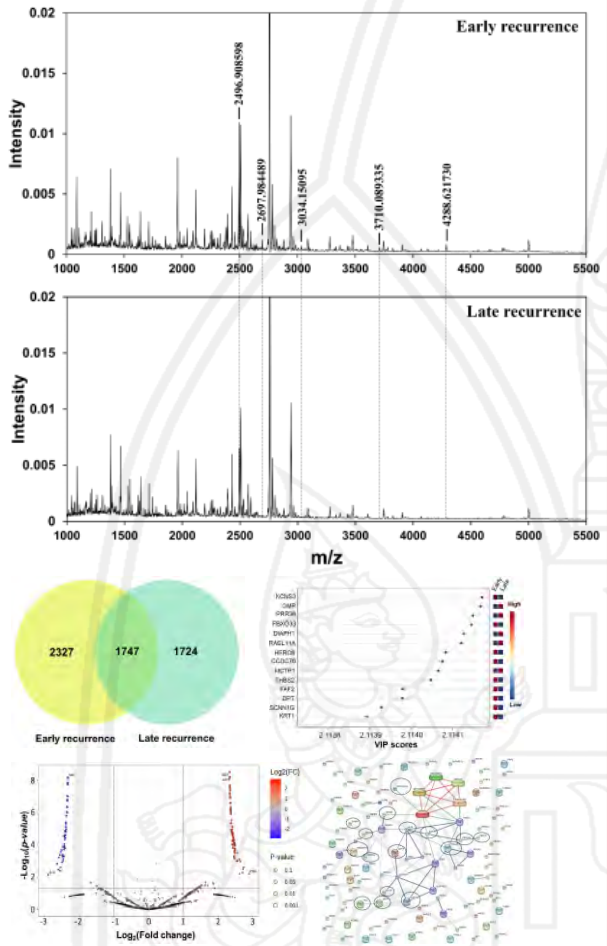


256 participants

Discovery of novel serum peptide biomarkers for cholangiocarcinoma recurrence through MALDI-TOF MS and LC–MS/MS peptidome analysis

Vasin Thanasukarn[1,2], Piya Prajumwongs[2], Nattha Muangritdech[2], Watcharin Loilome[2,3], Nisana Namwat[2,3], Poramate Klanrit[2,3], Arporn Wangwiwatsin[2,3], Sawanya Charoenlappanit[4], Janthima Jaresitthikunchai[4], Sittiruk Roytrakul[4] & Attapol Titapun[1,2]✉

scientific reports



81 participants

Maldi-TOF

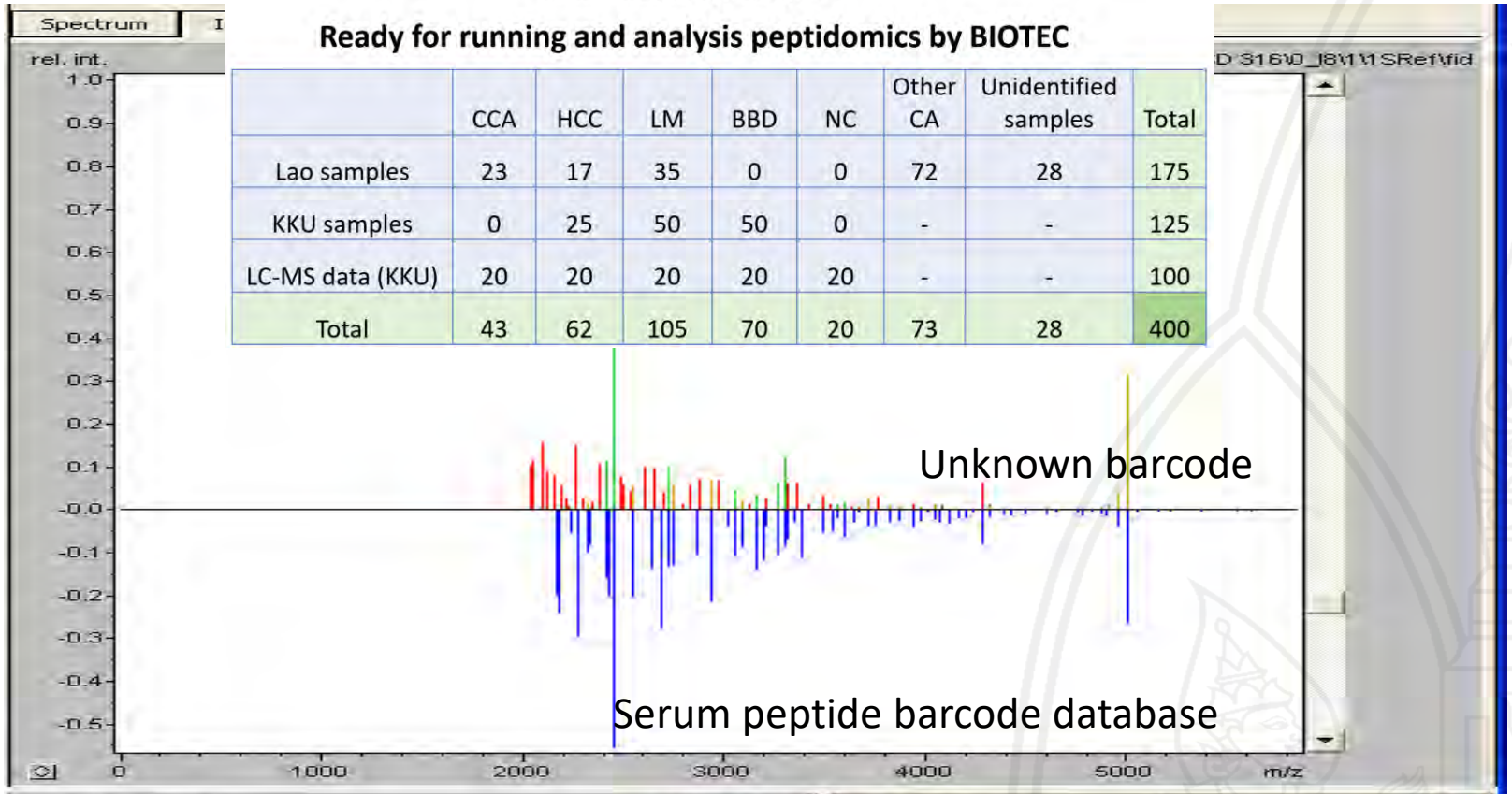
Objective: CCA serum peptide barcode database of KKU and Lao PDR cohorts

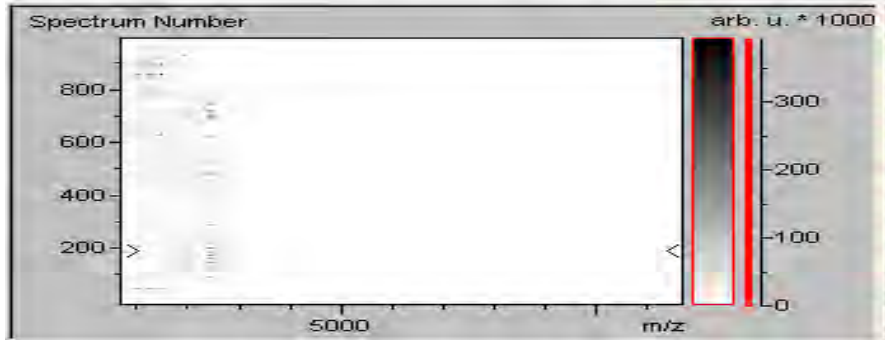
CLINPROT™ clinprotools 2.0

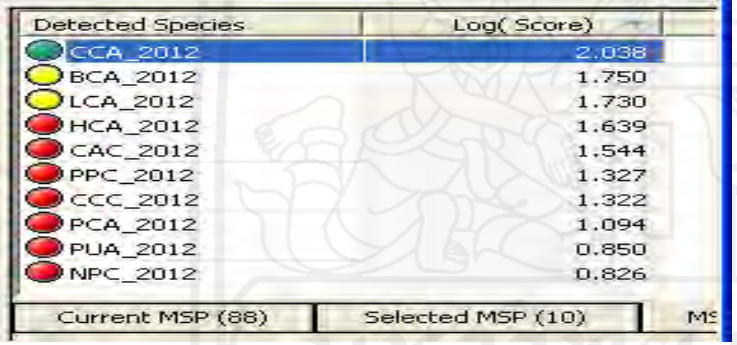
Preliminary study/ analysis

Ready for running and analysis peptidomics by BIOTEC

	CCA	HCC	LM	BBD	NC	Other CA	Unidentified samples	Total
Lao samples	23	17	35	0	0	72	28	175
KKU samples	0	25	50	50	0	-	-	125
LC-MS data (KKU)	20	20	20	20	20	-	-	100
Total	43	62	105	70	20	73	28	400

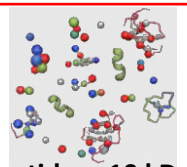




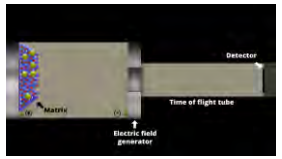


Peptide barcode

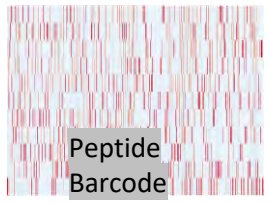
Peptidome



Peptides <10 kDa

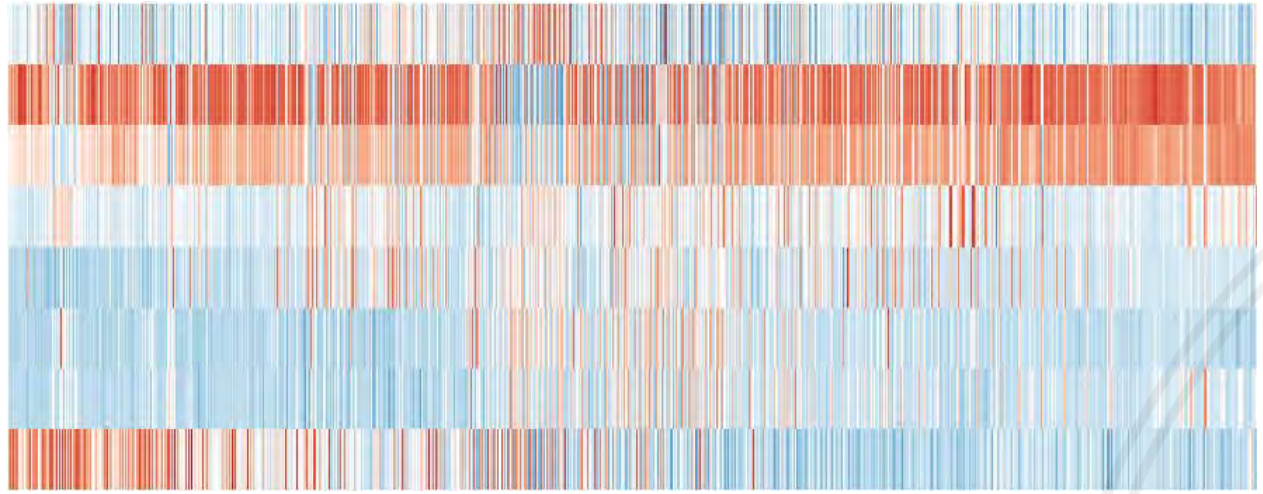


Maldi-TOF MS analysis



Peptide Barcode

1792 peptides were detected

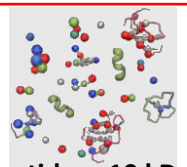


Difference between peptide barcode of
KKU-HCC and LAO-HCC,
KKU-LM and LAO-LM

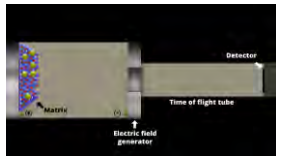
BBD: Benign Biliary Diseases
CCA: Cholangiocarcinoma
HCC: Hepatocellular Carcinoma
LM: Liver Metastasis
NC: Healthy control

Different peptide barcode between KKU-HCC and LAO-HCC

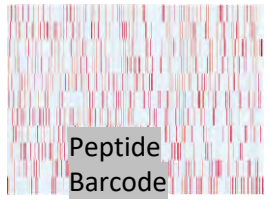
Peptidome



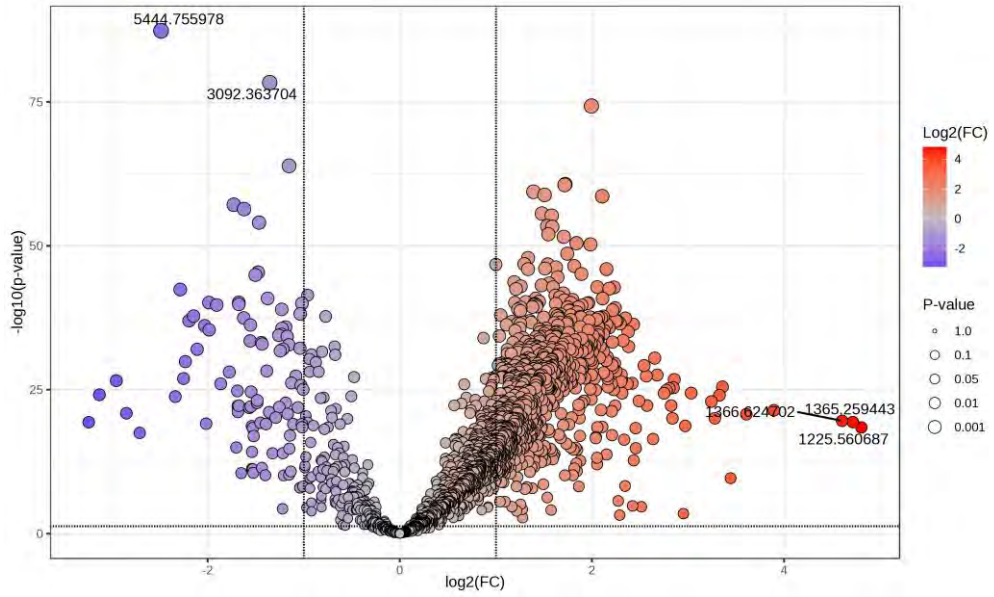
Peptides <10 kDa



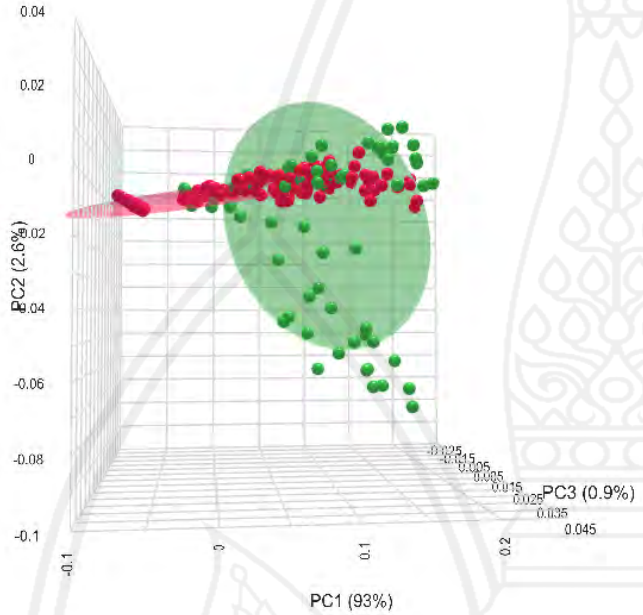
Maldi-TOF MS analysis



Peptide Barcode

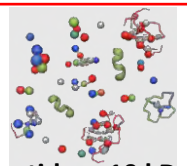


93 downregulated peptides
764 upregulated peptides

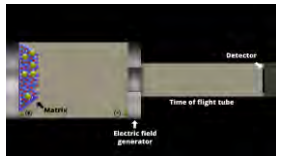


Different peptide barcode between KKU-LM and LAO-LM

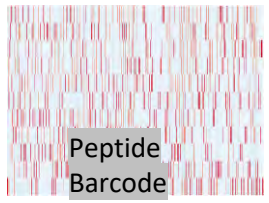
Peptidome



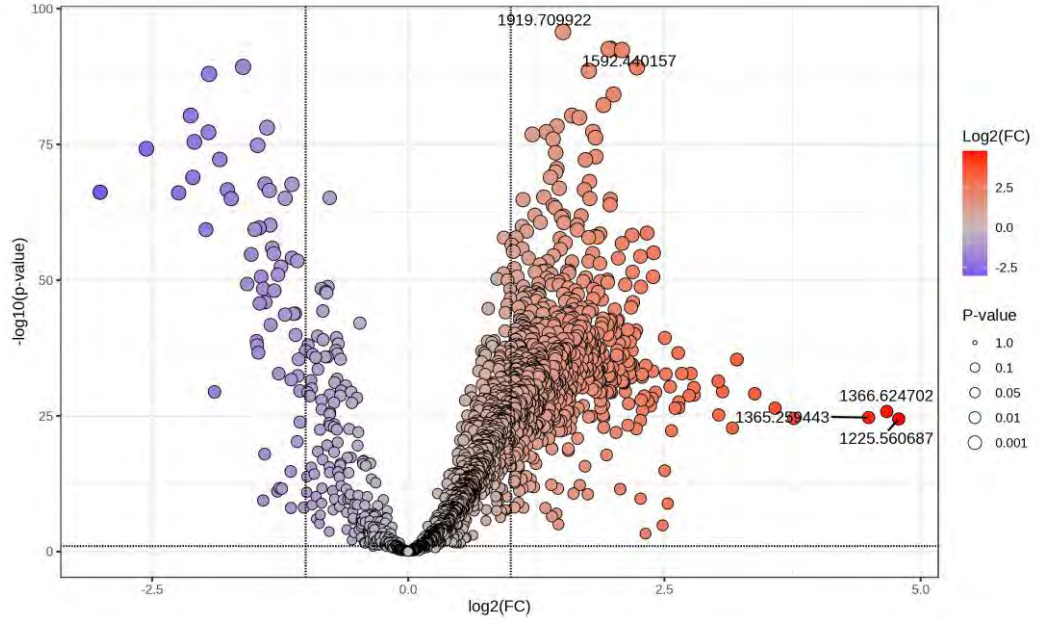
Peptides <10 kDa

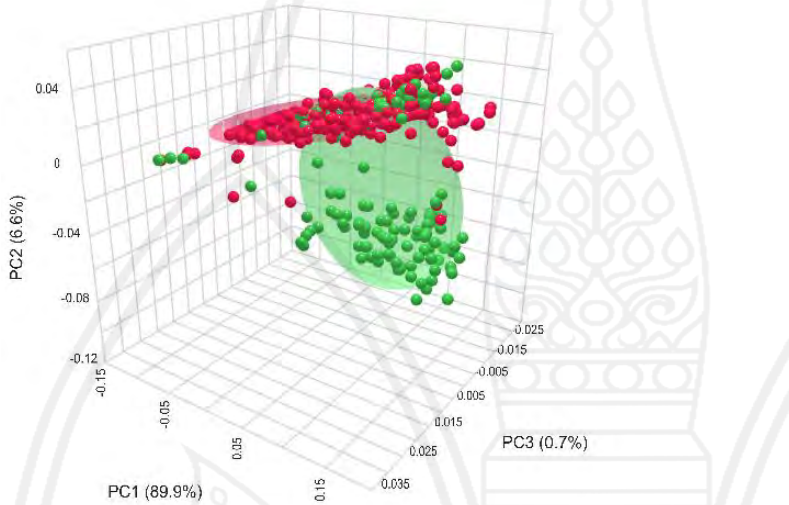


Maldi-TOF MS analysis



Peptide Barcode



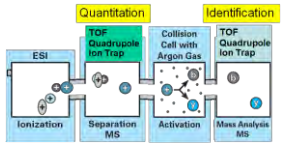


60 downregulated peptides
692 upregulated peptide

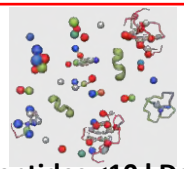
Serum peptidome by LC-MS

Peptidome

Peptide biomarker

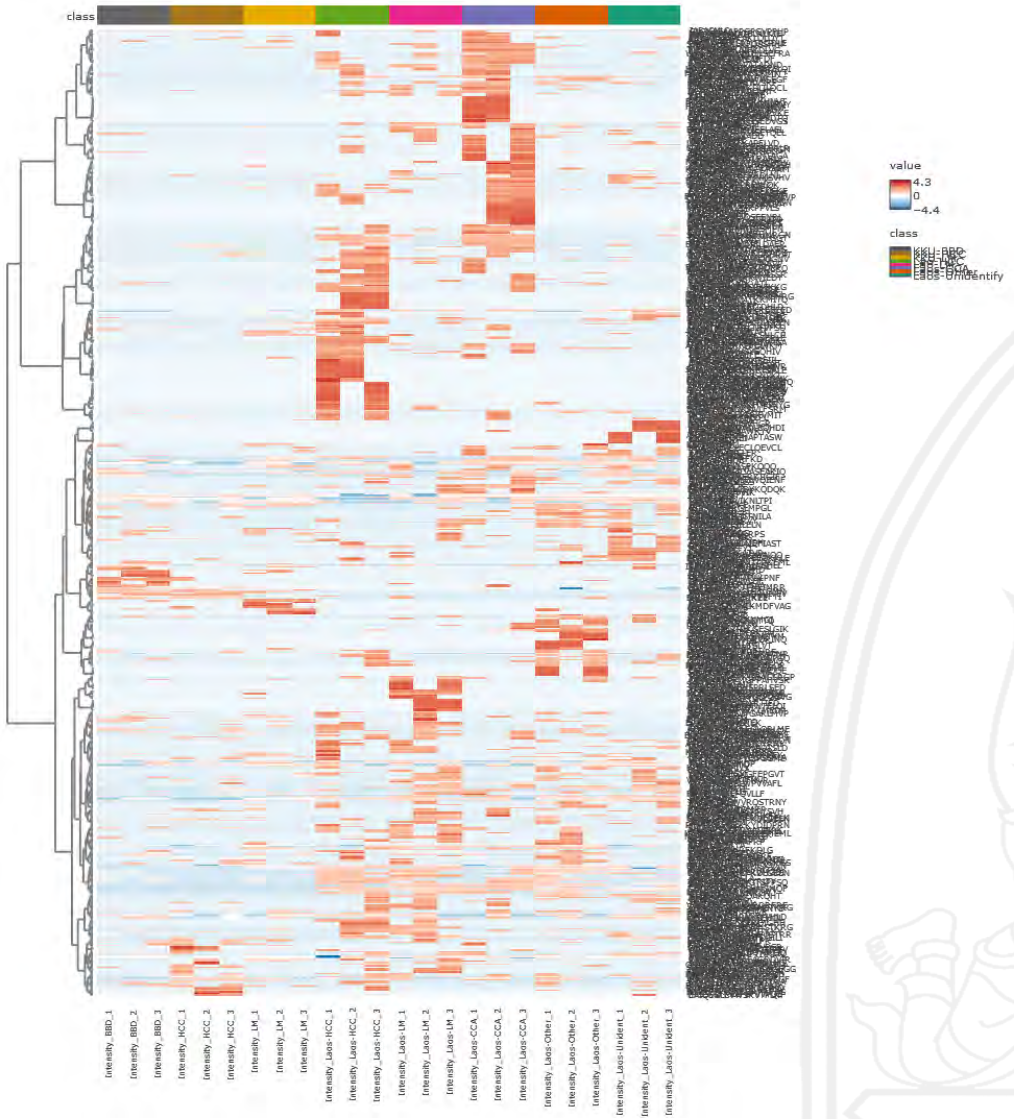


LC-MS analysis



Peptides <10 kDa

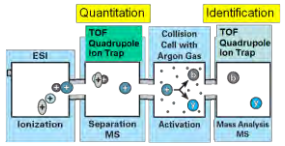
625 peptides were identified



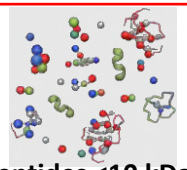
Serum peptidome by LC-MS

Peptidome

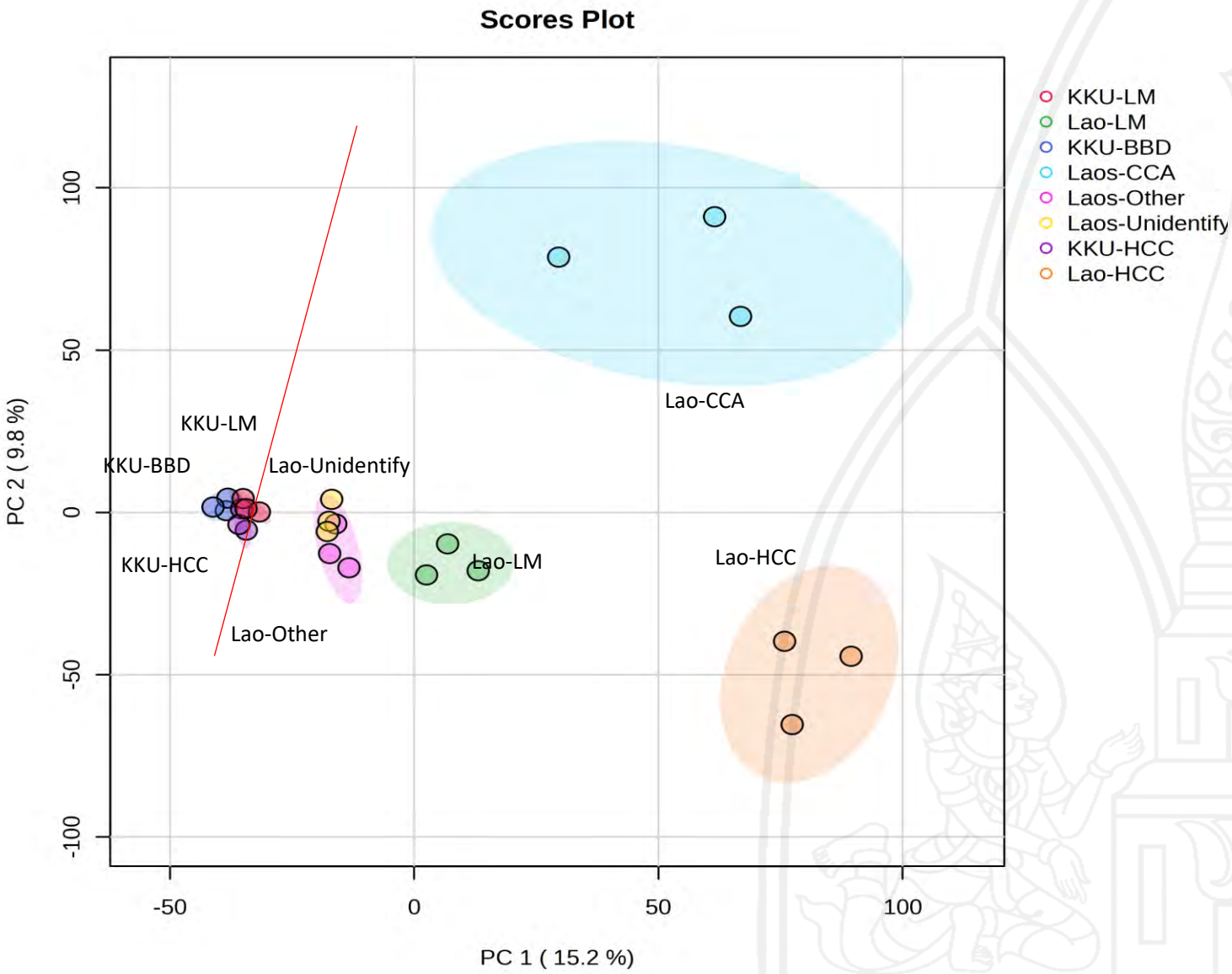
Peptide biomarker



LC-MS analysis



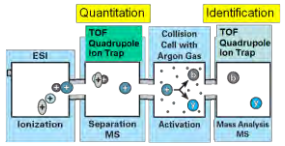
Peptides <10 kDa



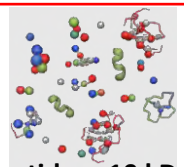
Serum peptidome by LC-MS

Peptidome

Peptide biomarker

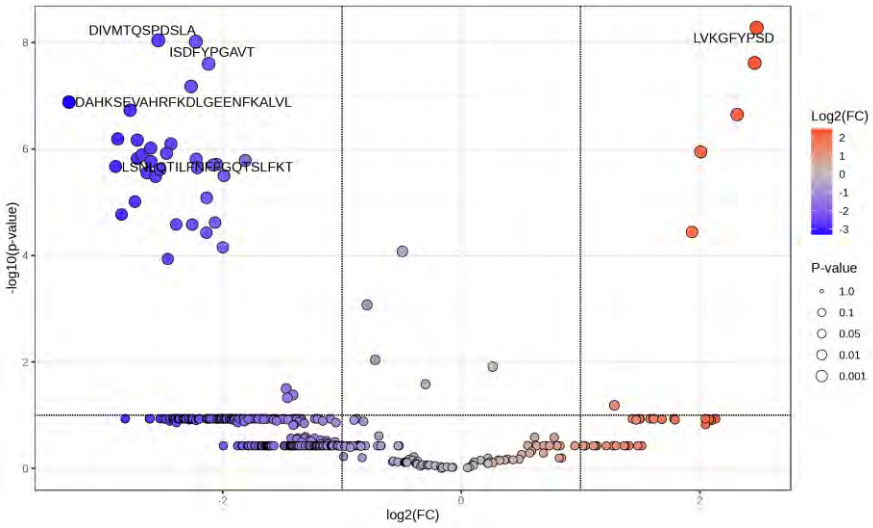


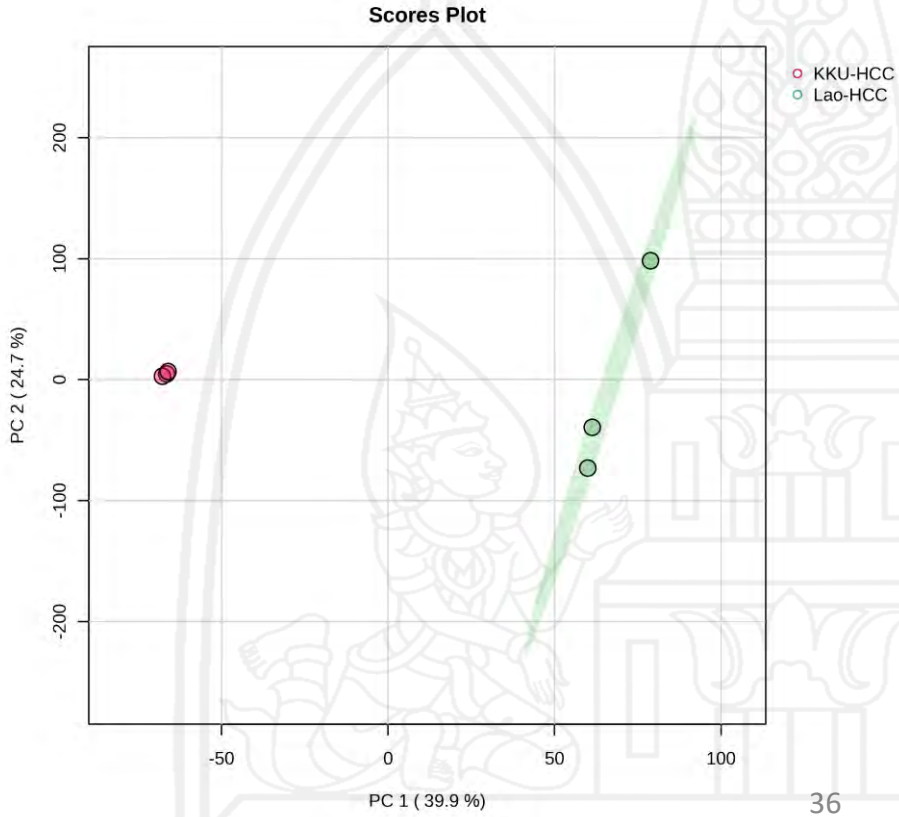
LC-MS analysis



Peptides <10 kDa

36 downregulated peptides
6 upregulated peptides

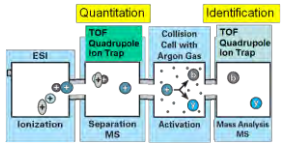




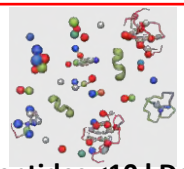
Serum peptidome by LC-MS

Peptidome

Peptide biomarker

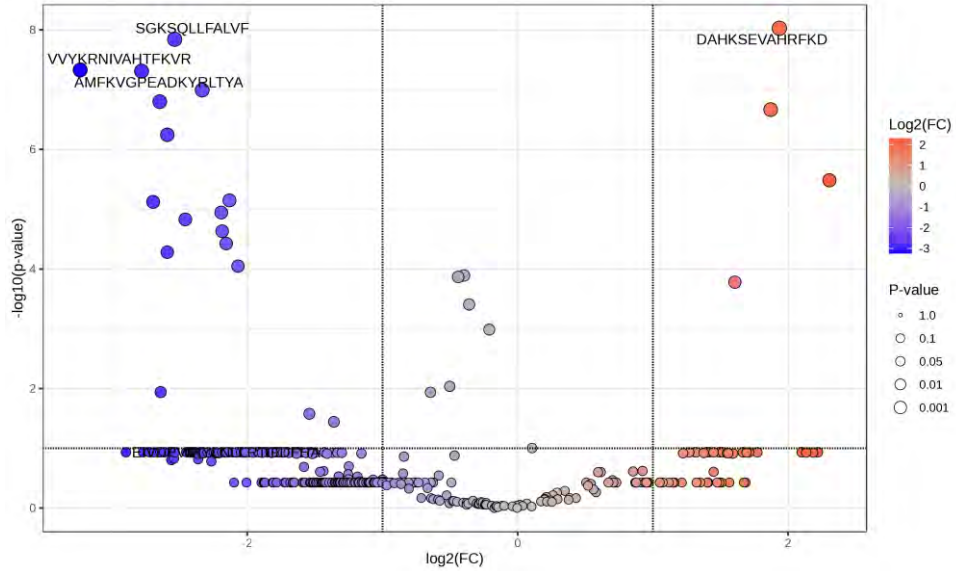


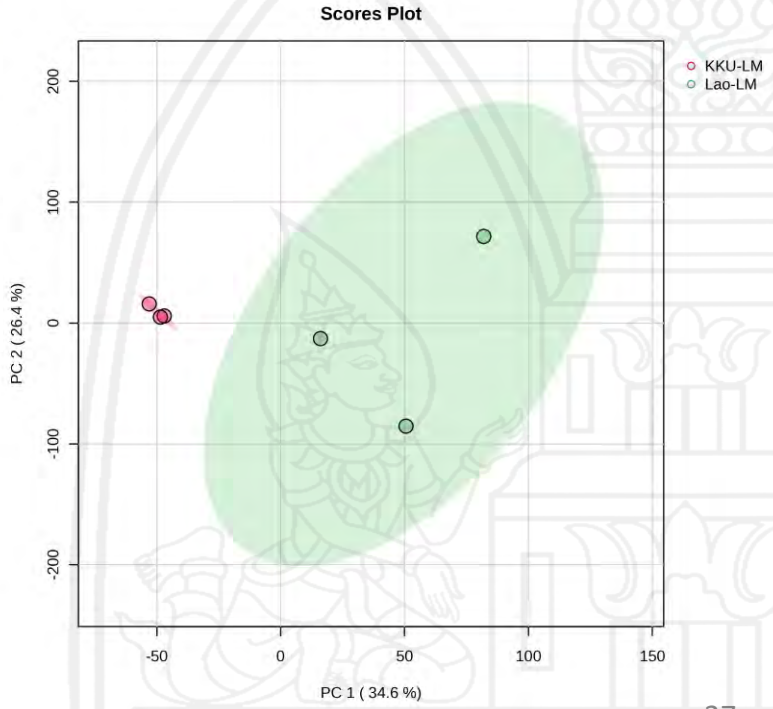
LC-MS analysis



Peptides <10 kDa

17 downregulated peptides
4 upregulated peptides

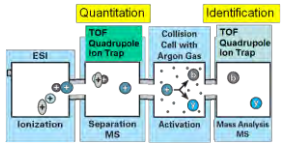




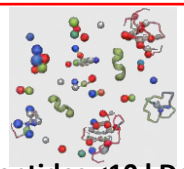
Serum peptidome by LC-MS

Peptidome

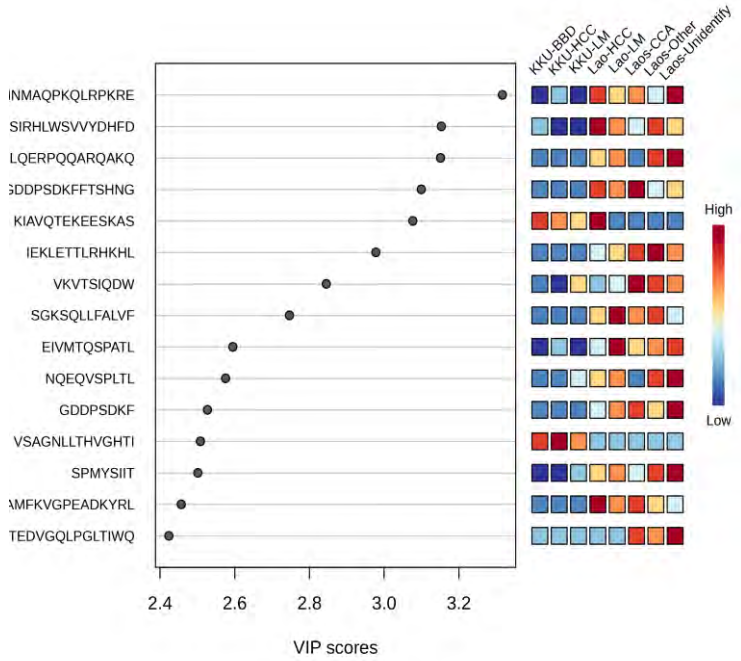
Peptide biomarker



LC-MS analysis

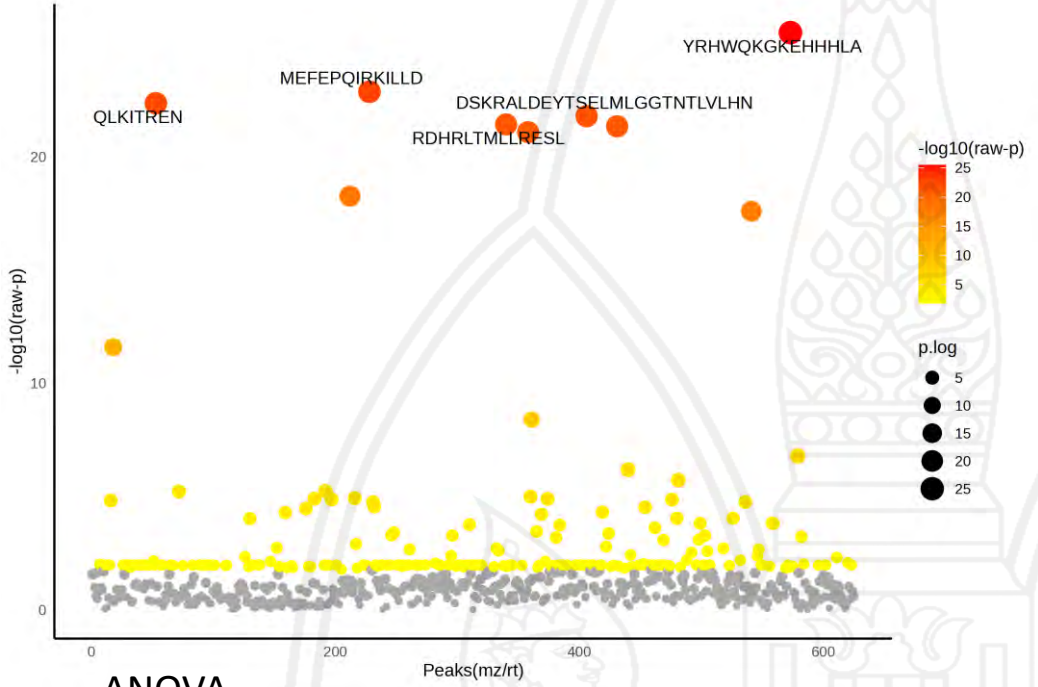


Peptides <10 kDa



VIP (Variable Importance in Projection) scores of PLSDA analysis

206 DEPs

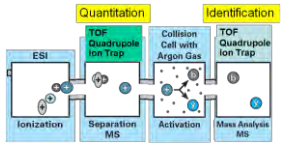


ANOVA

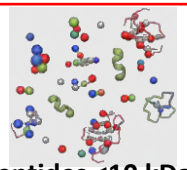
Serum peptidome by LC-MS

Peptidome

Peptide biomarker



LC-MS analysis



Peptides <10 kDa

KKU-BBD

KKU-HCC

KKU-LM

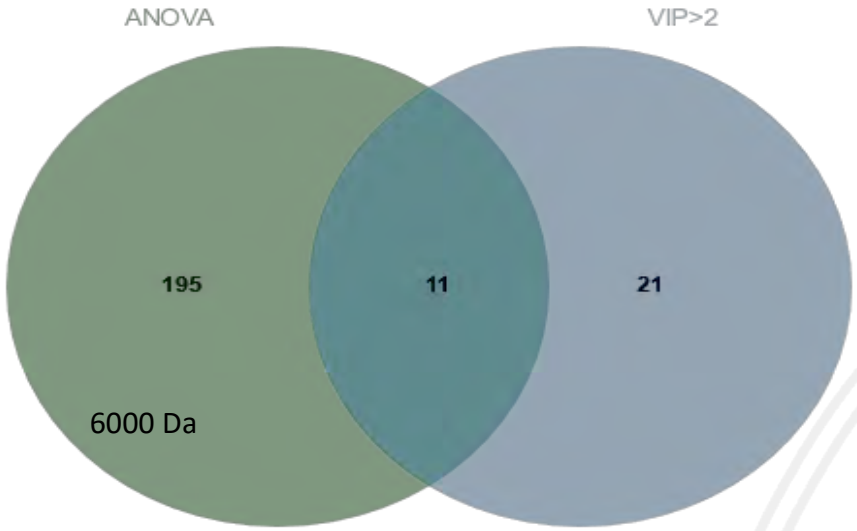
LAO-CCA

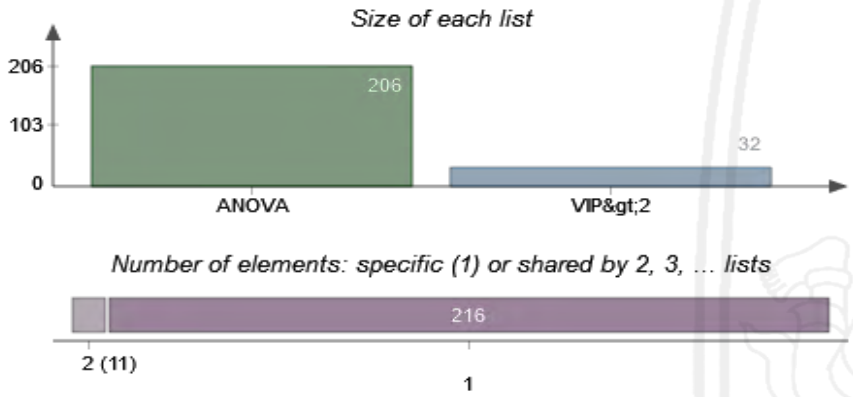
LAO-HCC

LAO-LM

LAO-other CA

LAO-unidentified

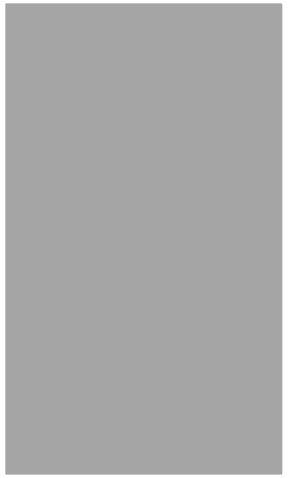


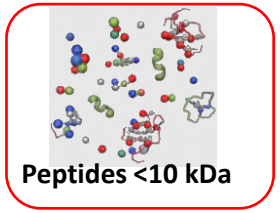


Peptide candidate:
GDDPSDKFFTSHNGMQF
VSAGNLLTHVGHTILGMNTVQL
FLVAFGSD
ALFQCVAAVFIAQ
FDNPWAGGAL
SGKSQLLFALVF
SIRHLWSVVYDHFDVV
EKVYGSGEKVAGRVIVEVCEVT
NQEQVSPLTL
AMFKVGPEADKYRLTYA
INEQWLLTT

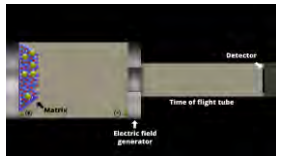
Peptide barcode and Peptidome

Peptidome

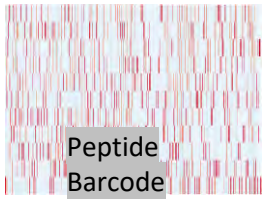




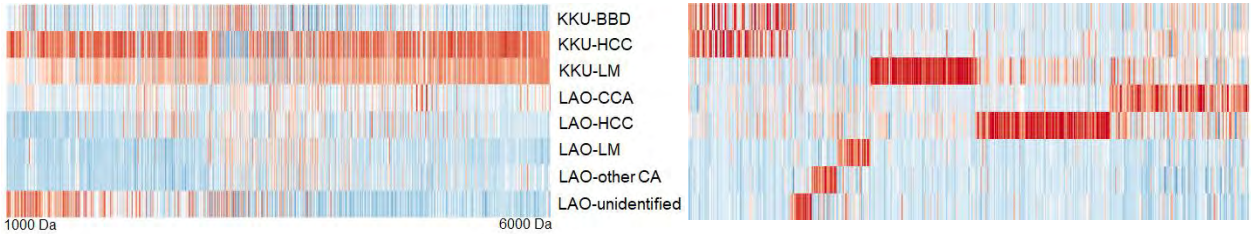
Peptides <10 kDa

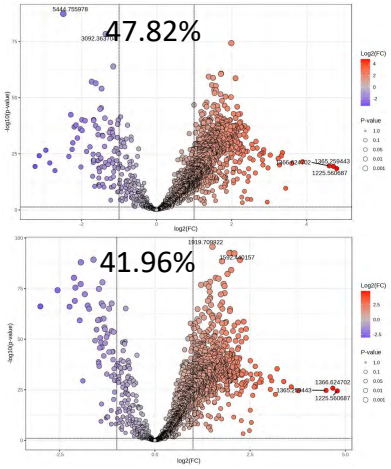


Maldi-TOF MS analysis



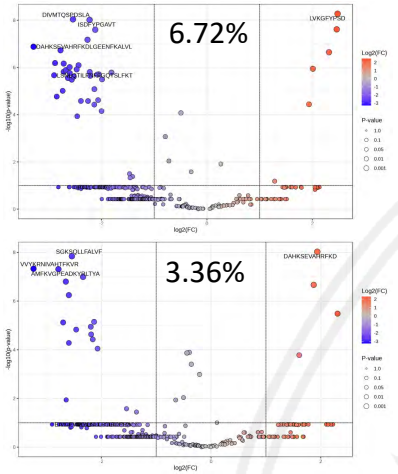
Peptide Barcode





Difference between KKU-HCC and LAO-HCC

Difference between KKU-LM and LAO-LM

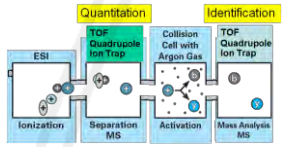


Factors: Maldi-TOF MS
- sample degradation
- contamination
- storage temperature

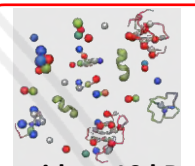
Solution: sample handling
- re-analyze the peptide barcode
- AI assisted data cleaning and normalization

Peptidome

Peptide biomarker

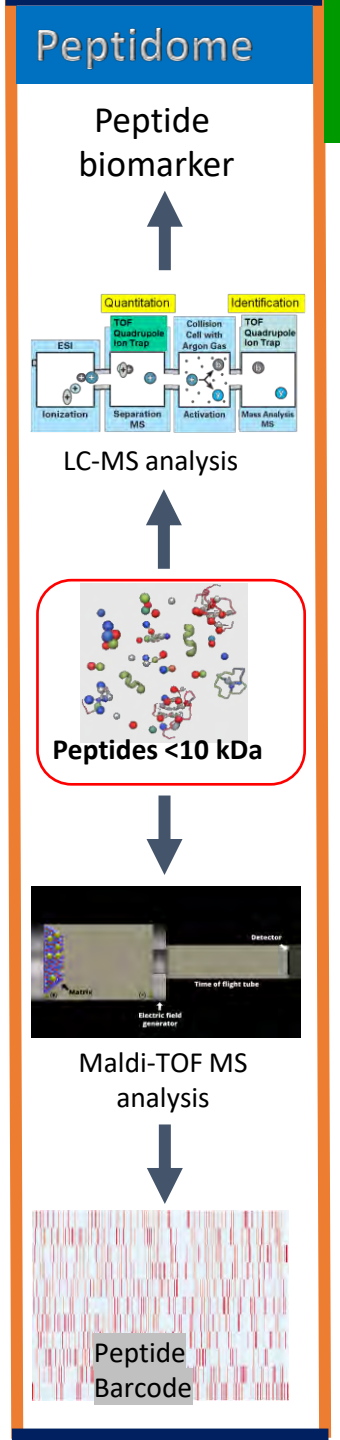


LC-MS analysis



Peptides <10 kDa

Future work

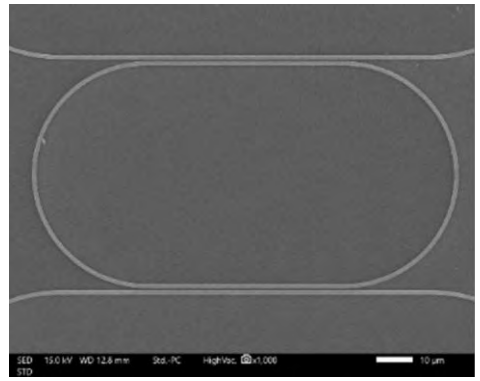


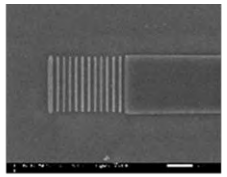
- Re-analyse the peptide barcode of all serum samples from KKU and Lao PDR using Maldi-TOF MS
  - NC - BBD - CCA
  - HCC - LM - other CA
- Analyse remaining serum samples from KKU and Lao PDR via LC-MS
- Identify specific peptide biomarkers for CMU team
- Ask for help from AI team (NECTEC or ADMU)
  - establish the Mass spectral Library
  - design the Mass spectral library searching software

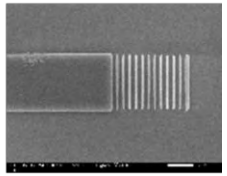
Bio photonic sensors analyzer (BiPhoS)

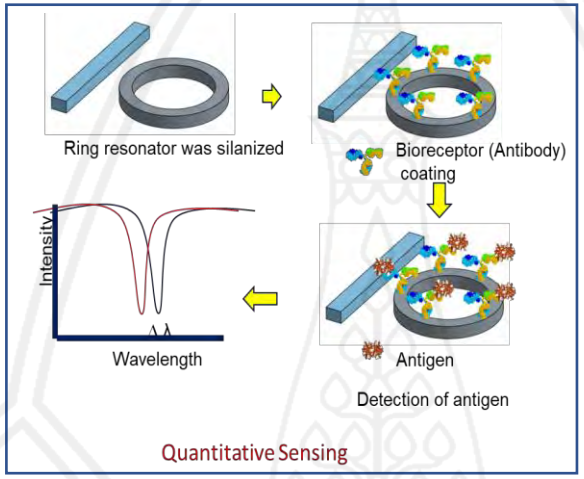
The multi-biological detection

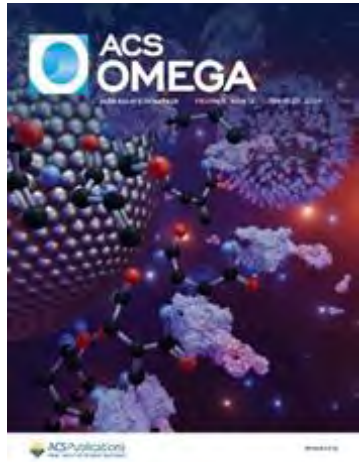
- Sensor1: CA19-9
- Senser2: 8NG
- Senser3: MUC5ac
- Senser4: beta-HCG





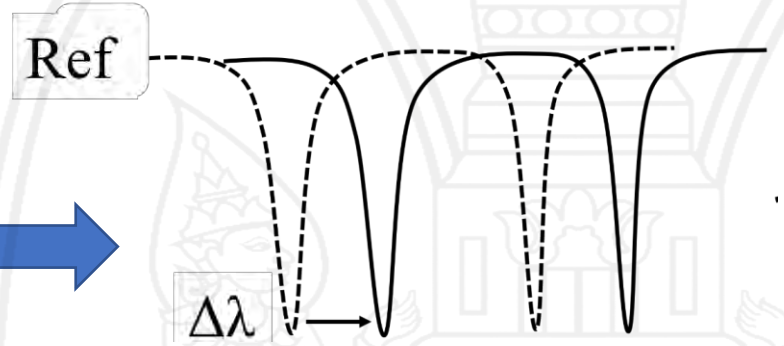






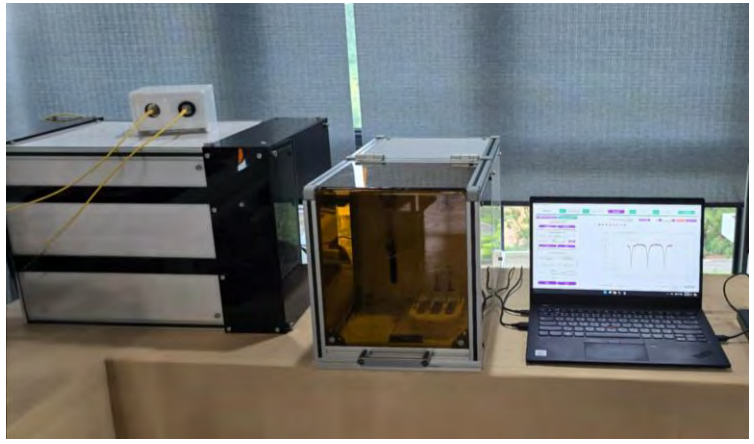
Protein coating on SiN sensor (Cover form S. Udomsom et al., ACS Omega, 2024.)

This technique is based on the changes of resonance wavelength from Ag-Ab reaction which generated by the SiN ring structure .



Resonance wavelength shift (Δλ)

Samples flowed to sensor by using microfluidic system



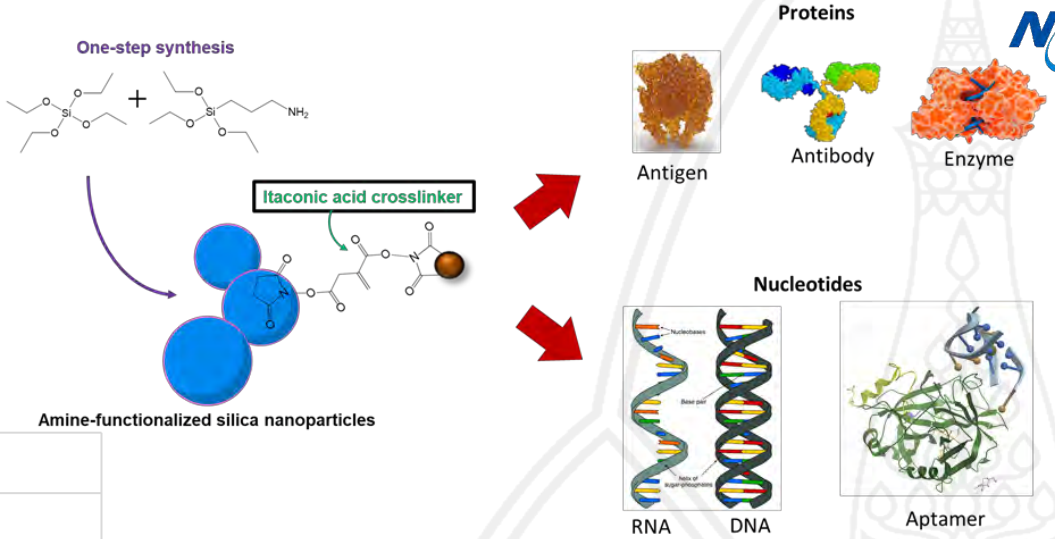
Input light source was generated by Tunable laser wavelength 1550 nm

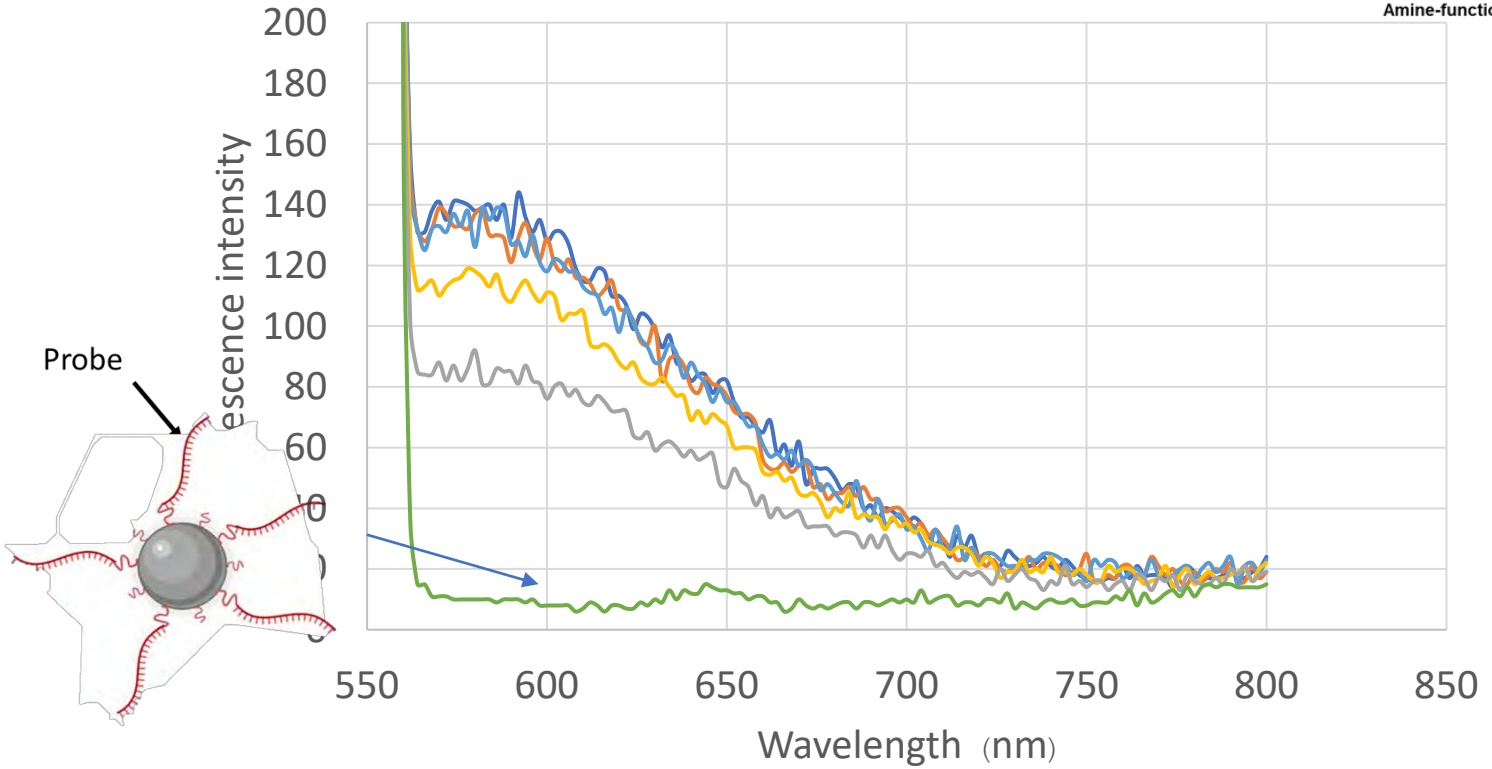
Δλ ∝ Concentration

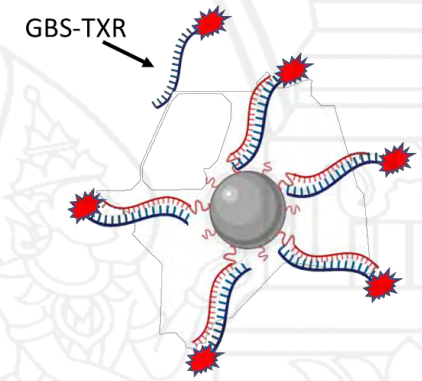
CMU's activities

Activities	Year 1		Year 2	
	1-6 months	6-12 months	13-18 months	19-24 months
Construct of BiPhos of multiplex peptide based for CCA diagnosis.	✓			
BiPhos testing & analysis.		✓		
Design and develop the aptamer or antibody to detect peptides based on CCA diagnosis.			✸	
BiPhos testing & analysis.				✸

Itaconic crosslink (IA crosslink)

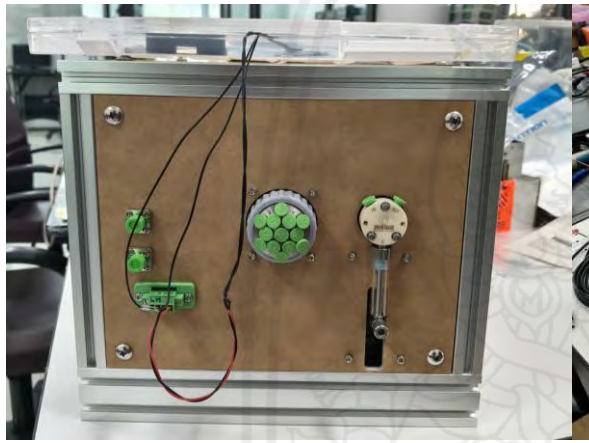


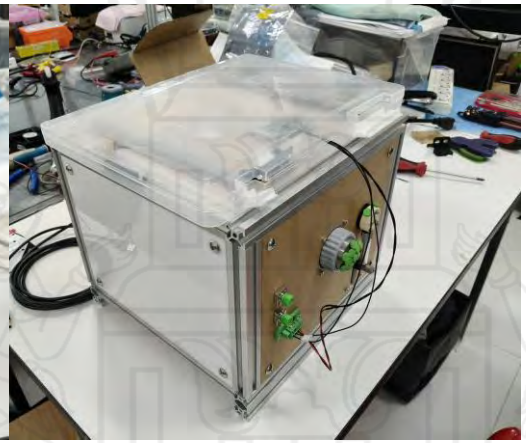




BiPhos Ver.3

Specification	BiPhos Ver.2	BiPhos Ver.3
Size	29*45*26 cm	30*27*24 cm
Light source	Broadband (1528-1563 nm)	Broadband (1528-1563 nm)
Detectors	Power meter	OSA
Measurement	5 min	2-5 s
Sensor for detection	Single sensor	Multiples-sensors

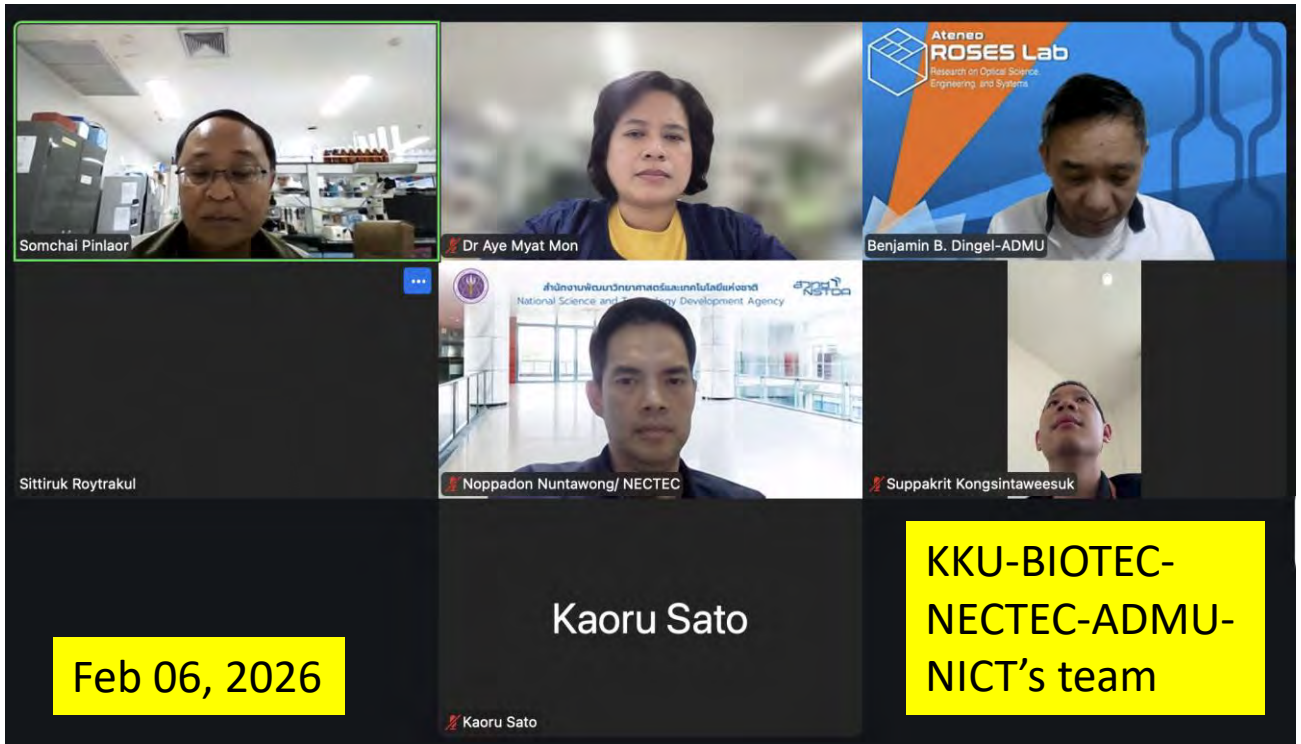




On line discussion

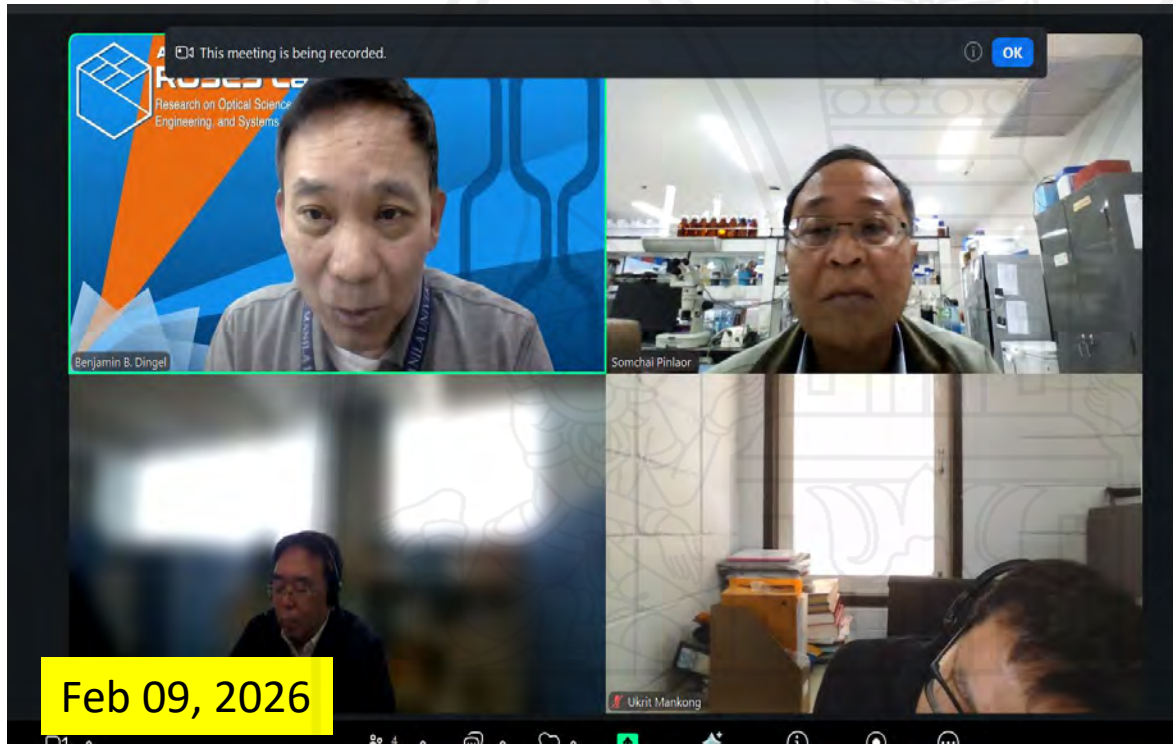
Project kick-off

20 Oct 2025



Feb 06, 2026

KKU-BIOTEC-NECTEC-ADMU-NICT's team



Feb 09, 2026

Workshop on Developing photonics and specific peptides platform towards point-of-care screening for cholangiocarcinoma diagnosis in Lao PDR
on February 12 to 13, 2026 at Vientiane, Laos

Visit four Hospital that will participate in 2nd study

Mahosot Hospital

Setthathirath Hospital


Mittaphab Hospital

National Cancer Center

Future works

1. Finish Raman & peptidomics investigations
2. Re-analyze Raman & peptidomics data
3. Integrate AL & Advanced ML for Raman & peptidomics analysis
4. Select candidate CCA marker and transfer to CMU for BioPhos development
5. Develop BioPhos for multi-markers CCA diagnosis and testing in real samples
6. Prepare cohort study in 4 hospitals in Lao's patients

ACKNOWLEDGEMENTS

CARI Cholangiocarcinoma Research Institute

ASEAN IVO

สูนมะเร็ง Cancer Center Lao PDR Est. 2017

ATENEO DE MANILA

CMU CHIANG MAI UNIVERSITY

NECTEC a member of NSTDA

NICT

มหาวิทยาลัยขอนแก่น

MDKKU คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น FACULTY OF MEDICINE KHON KAEN UNIVERSITY

30th ANNIVERSARY Computer Engineering Khon kaen University

BIOTEC a member of NSTDA