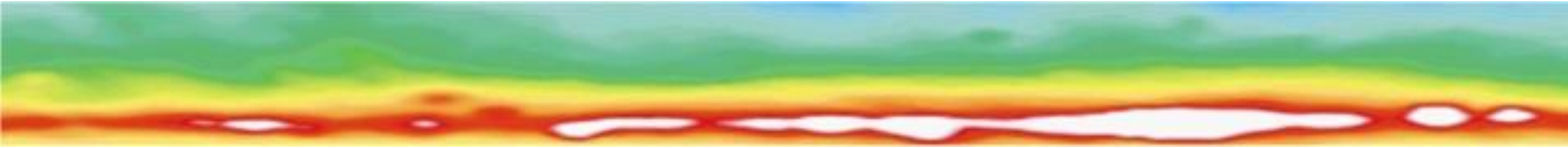


Education for Inventing the Future

(Kaohsiung Medical University, Dec. 17 2019)

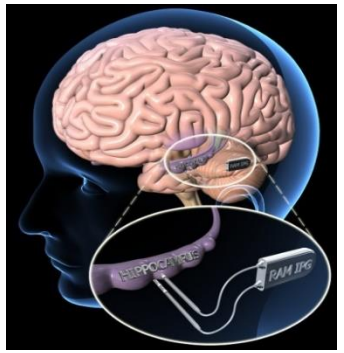
Mau-Chung Frank Chang
President Emeritus, National Chiao Tung University
Wintek Chair and Distinguished Professor, UCLA

Brave New Cambrian !

GRAND CHALLENGES quest for fundamental discoveries and AI , Big Data, Robotics, Prosthesis, Digital Medicine related engineering inventions promising biggest opportunity for Humanity in the 21st Century!

- ***Artificial/Human Augmented Intelligence***
- ***Self-Learning Computing***
- ***Virtual/Physical Systems***
- ***Cognitive Robots and Prosthesis***
- ***Internet of Everything***
- ***Autonomous Vehicles (Air/Ground/ (Sub)-Marine)***

Interface brain with external memories!



A Grand Challenge for the 21st Century!

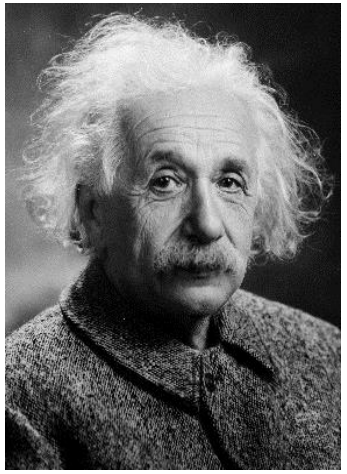
「假作真時，真亦假；無為有處，有還無。」紅樓夢的太虛幻境是未來世界的寫實

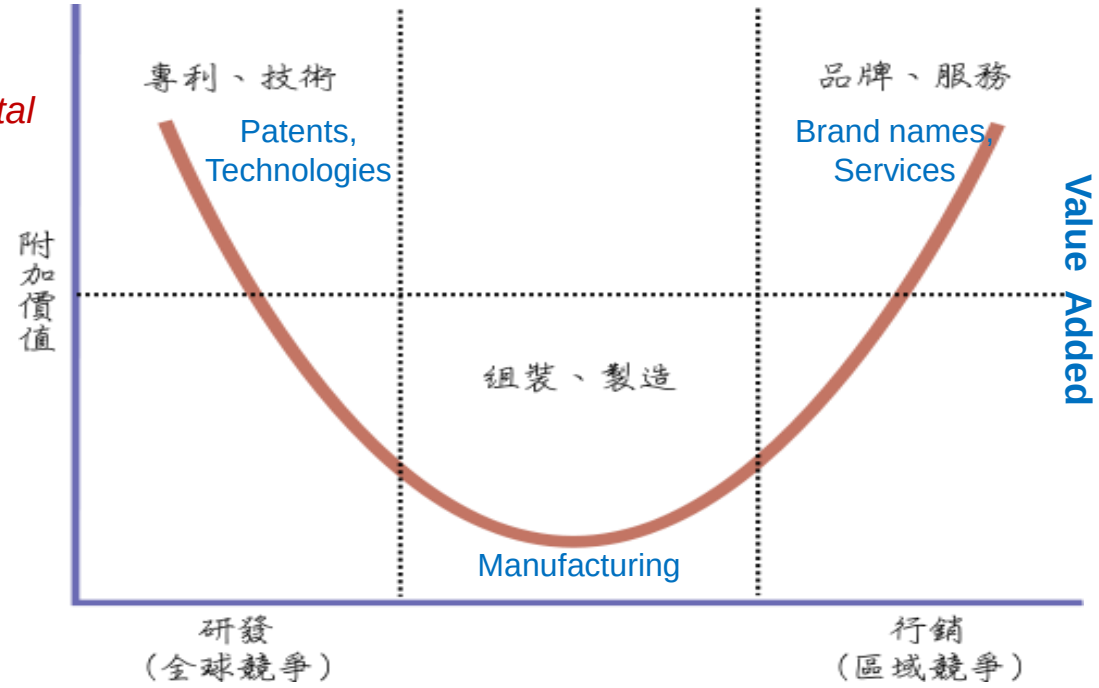
When "false" is taken as "truth", the "truth" becomes "false";
When "nothing" is taken as "being", the "being" becomes "nothing" !
(Dream of the Red Chamber, 18th Century Chinese Classical Novel by Cao Xueqin)

Stan Shih's (Acer Founder) Smiling Curve

Creativity

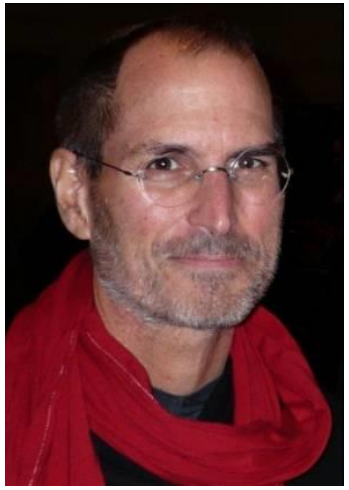
-Define & frame right questions to comprehend nature and humanity
-Hypotheses, theories, experimental proofs…
-Eng. Solutions, IPs…





Innovation

-Define & frame right questions to comprehend market and societal unmet needs
-End Products
-Brand Names
-Services……



Past → **Present** → **Future?**

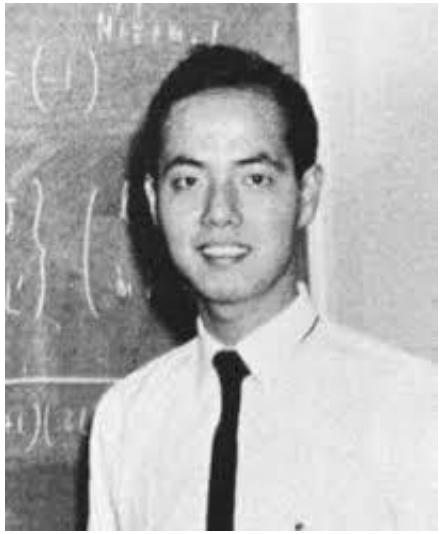
Creativity > Innovation

Innovation > Creativity

Learn How to Question

求學問, 需學問;只學答, 不學問, 非學問!!

When pursuing the scholarship, one must learn how to question and define the problem, not just trying to solve the problem !!



Prof. T.D. Lee,
1957 Nobel Physics Laureate
at age of 30 years old

Observations on Local College Students

Polite, Gentle and even Skillful but Lacking

- **Passion to pursue the truth (Curiosity)**
- **Ability to define and scope the problem (Creativity, Innovation)**
- **Leadership and Initiative (Vision and Drive)**
- **Judgement and Accountability**

- **Lack of "Can Do" spirit and "Think-Out-of-Box" ability can jeopardize their future competitiveness**
- **"Passive" personality formed largely by their learning habit overly concentrating on problem solving**
- **Active education with emphasis on "Learn how to question" is essential to promote creativity and innovation**

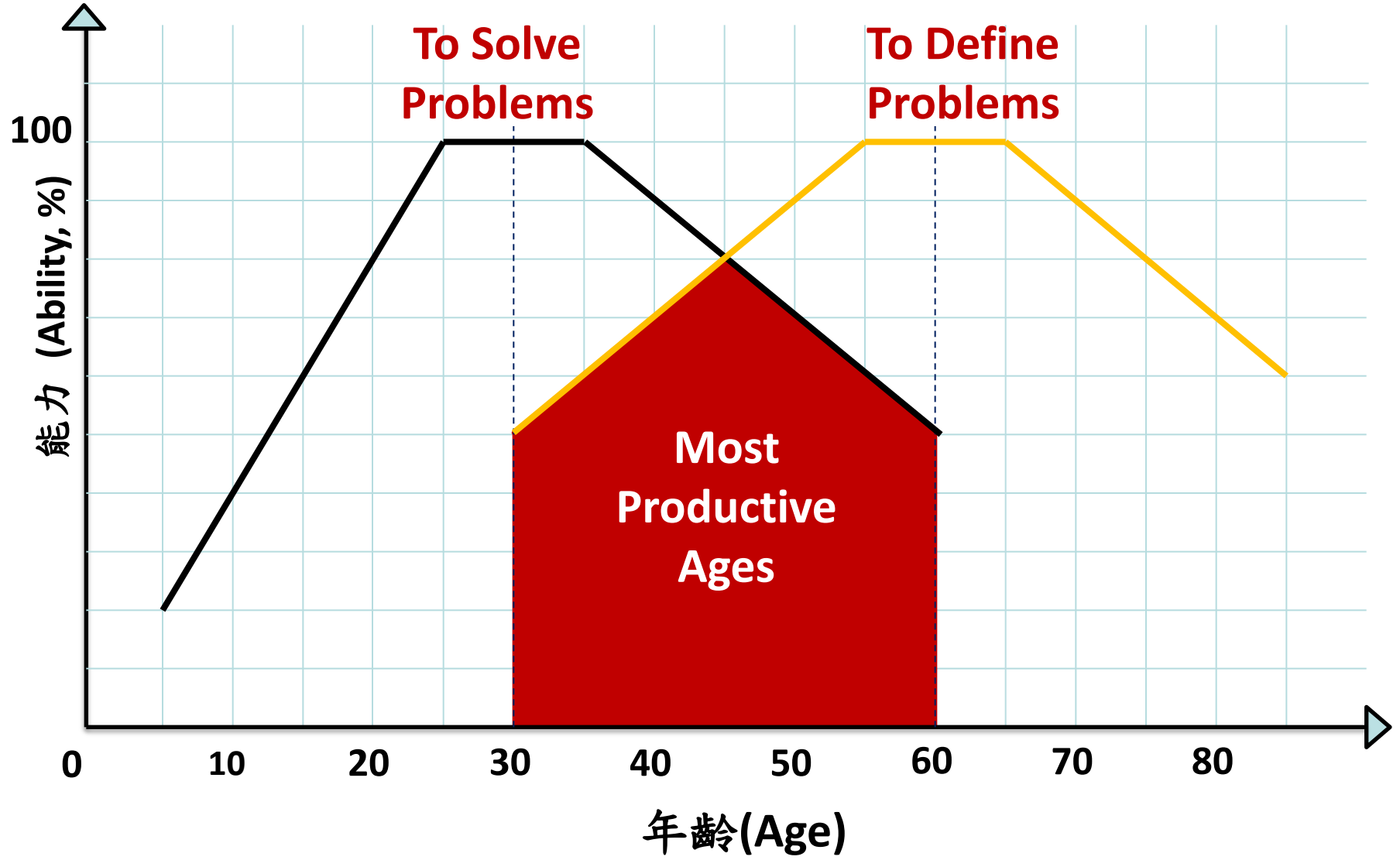
College Education is Crucial

- **Time to develop one's character, integrity, leadership and learn tools/disciplines to unveil the truth**
- **Time to identify and develop one's talents**
- **Time to question out-of-the-box and learn to define/frame worth solving problems and search for solutions**
- **Time to learn how to express/present oneself and work with others**

They are with great promise for innovative discoveries & development, as evidenced in past history:

W. Heisenberg 24 yrs (1932), P. De Broglie 25 yrs (1929), W. Bragg 25 yrs (1915), J. Schrieffer 25yrs (1972), A. Einstein 26 yrs (1921), J. Watson 24yrs (1952), Steve Job, Bill Gates, Jerry Yang (Chief Yahoo), Steven Chen (YouTube) ……

Most Productive Ages



Great University for Inventing the Future

Great University

Can identify, challenge and prepare Leaders and Pioneers to advance human knowledge base and/or elevate human civilization in quantum scale.

Great university must always pursue the truth and nurture leaders and pioneers to invent and shape the future

- **Creating cross-disciplinary environment to enable faculty/students developing disruptive concepts, methodologies, and tools worthy of new values and applications**
- **Challenging/preparing students for creativity/innovation, leadership, global view, and execution capability to collaborate & compete with counterparts**
- **Building students' Character and Integrity with arts/design capability，grown into society's back bone and role models**

ACT Together, We Go Far !!

- **A**ctive Education/Placement
- **C**ross-disciplinary Research
- **T**rustees for Institution and Endowment

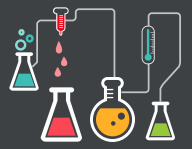
高醫大與交大合作綜覽

AI醫療	智慧醫院	Bio-ICT(光電)	校務研究(IR)	智慧藥物	生物資訊	智慧校園
曾新穆教授 楊瑞成副院長	柯立偉教授 楊瑞成副院長	李大嵩研發長 吳文正產學長	王蒞君主任 戴嘉言主任秘書	王雲銘教授 洪文俊副校長	楊進木教授 洪文俊副校長	林一平副校長 戴嘉言主任秘書 黃耀斌總務長

高醫-交大 Bio-ICT®

Focus on Practices in Precision Medicine







01

建置早產兒與極低體重兒神經發展預測模型

(小兒科)

幫助早產兒找出影響神經發育之潛在風險，達到提早預防及治療，降低家庭情感及社會經濟負擔的目的

02

血管偵測儀發展計畫

(泌尿科)

透過光學偵測技術發展一新型的血管偵測儀，可偵測組織下部的組織結構，進而偵測血管的位置，協助醫師在進行腹腔鏡手術時找尋血管位置所在

03

新式無線電酸鹼值感測器敷材檢測傷口感染運用

(外科)

將可撓式pH感測電極、處理晶片與傳能天線與新式敷材整合，透過長時間且連續的偵測傷口變化，協助評估敷料之有效性與精確掌握換藥時機，大幅減少醫療資源與人力消耗

04

藉由二倍頻智慧影像來即時評估骨組織癒合

(骨科)

二倍頻顯微鏡可針對骨折組織中的膠原蛋白於癒合過程組成變化進行探討，進而使外科醫生能夠為患者提供多種治療選擇和改善結果，並縮短治療時程

05

下肢功能性電刺激神經反饋於腦中風復健之應用

(復健科)

應用生理電訊號結合感測裝置做為神經復健步態分析之評估，探討病患利用電刺激輔助進行復健訓練對於腦傷區域於腦波訊號上的影響。

06

肢體腔室症候群非侵入性早期偵測儀器

(急診外科)

研發非侵入式肢體檢測儀，能早期評估病人是否為高危險肢體腔室症候群，提供臨床醫師盡早適當處置，減低後續需要重症單位照顧的成本付出

07

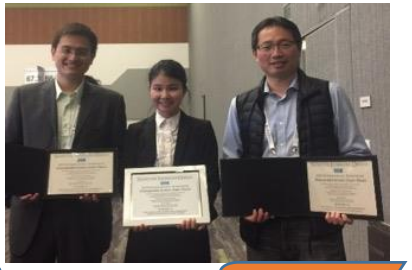
利用生理時鐘和生物恆定性相關生物指標研發輪班制人員睡眠健康失調的預警系統

(神經內科)

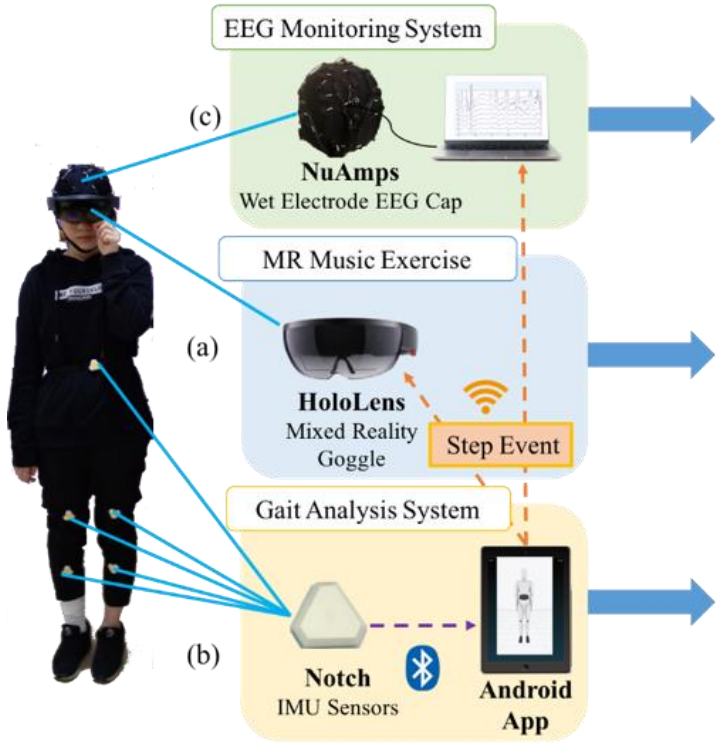
藉由睡眠腦波資料分析，應用於臨床睡眠醫療。結合免疫系統細胞激素表現偵測，將作為新興的健康評估工具，節省醫療體系的支出與人力負擔。

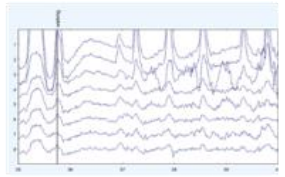
BCI System for Post-Stroke Lower Limb Rehabilitation

- 高醫復健科陳嘉炘主任與交大生科系柯立偉教授團隊合作
- 開發**整合擴增實境(AR)於腦機介面復健系統能有效改善垂足狀態，提升中風病患復健成效**
- **獲2019 SID最佳論文獎，國家新創獎， 新發明專利**



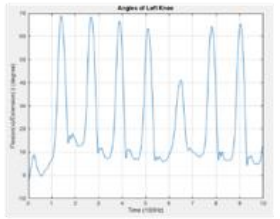
2019 SID Distinguished Paper Award
2019 國家新創獎





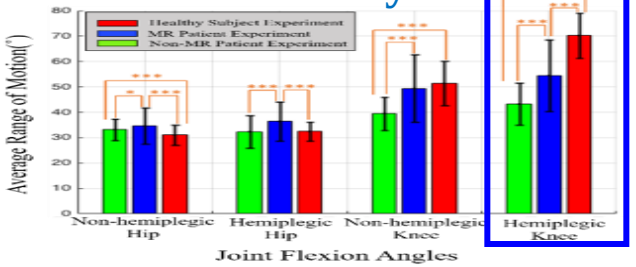
EEG Data

MR Music Exercise

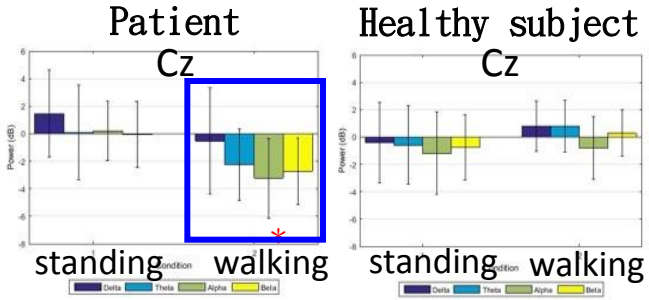


Gait Data

Gait Analysis



EEG Analysis



全球首創探討肝炎病毒-糖尿病-肝癌之機轉關聯性及藥物開發策略

Specific aim 1: Study the mechanisms between hepatitis virus, diabetes mellitus and liver cancer

Specific aim 2: Developing therapy strategy (biomarkers and drugs)

楊進木 教授

王雲銘 教授

系統生物藥物設計領域

- Intelligent Computing Precision Medical and Drug Development Platform
- Chemical synthesis

生化及藥物輸送領域

吳妍華 院士

劉典謨 教授

張家靖 教授

麥如村 教授

邱光裕 教授

趙瑞益 教授

Discovery HCV-DM-HCC mechanism

臨床領域

- Clinical pathology
- Taiwan liver cancer network

國衛院黃秀芬醫師

高醫余明隆醫師

- HCC / HCV Mechanism
- Molecular mechanism
- Animal models
- Physiological mechanism
- Drug delivery

nature COMMUNICATIONS

CaMPNets

大數據破解癌症成因

世界獨創膜蛋白癌症追蹤地圖

國立交通大學


楊進木 教授


林峻宇 助理教授


吳妍華 院士

高雄醫學大學

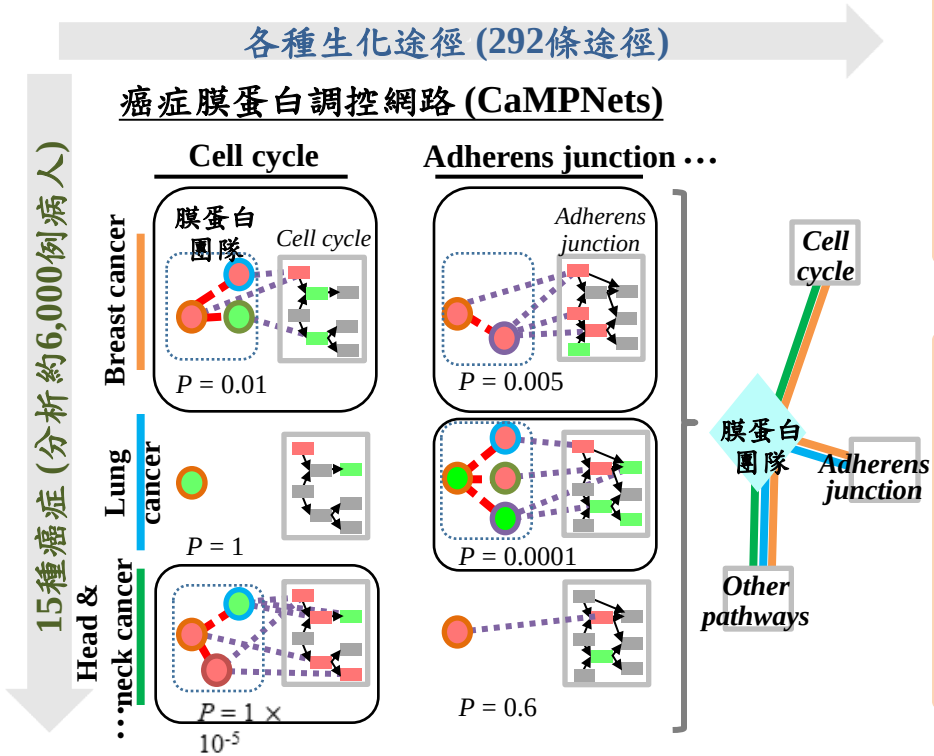

鐘育志 校長

台北醫學大學

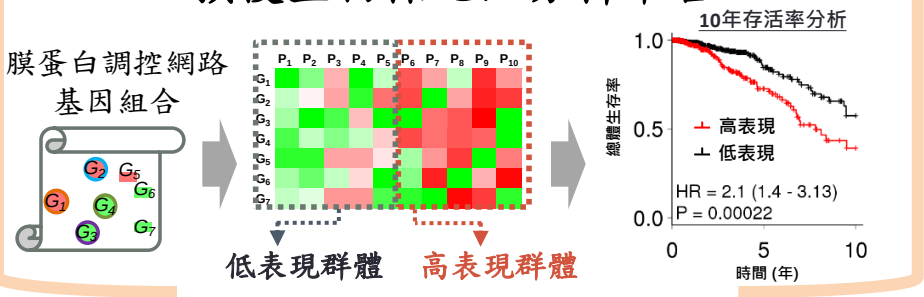

何元順 教授


李嘉華 副教授

揭開“膜蛋白”於不同癌症扮演之角色



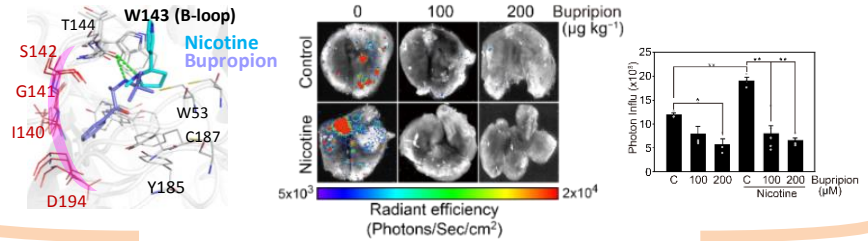
預後生物標記組分析平台



膜蛋白標靶藥物分析平台

Bupropion (舊藥新用):
原為抗憂鬱藥及戒菸輔助用藥

抗三陰性乳癌轉移用藥



高醫大-交大 Medical AI 合作計畫

- 結合高醫大之醫療專業及交大之人工智慧技術能量，由108年起推動三年期合作計畫，每年投入1000萬元經費，共同發展 Medical AI 之創新技術與應用
- 合作單位高醫大包括神經內科、胸腔內科、心臟內科、小兒部、胃腸內科、牙科部、檢驗醫學部、感染內科等科部；交大包括資訊學院、電機學院、生科院、管理學院等，充分發揮跨領域合作精神與能量
- 合作研究主題涵括失智症生物標記發掘、新興濫用藥物偵測分析、睡眠發作性疾患診斷系統、敗血症治療、降低脊髓肌肉萎縮症之併發症、早期食道癌變偵測、牙部疾病智慧診斷、呼吸器脫離指標建立、眼底攝影影像預測腎病變、皮膚交感神經活性分析、失智症病人照護預警系統等創新議題
- 預期可於智慧醫療及精準醫療領域產出Medical AI新模式，提升醫療診斷之精準度及智慧性，發表頂尖論文及申請專利，並共同爭取科技部/經濟部計畫及產學合作經費

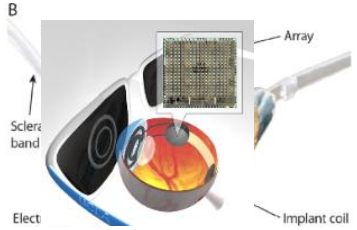
合作計畫列表

KMU計畫主持人	NCTU計畫主持人	計畫主題
楊淵韓/神經內科	曾新穆/資訊學院	建立阿茲海默失智症中以人工智能為基礎的生物標記
林宜靜/檢驗醫學部	洪瑞鴻/資訊學院	利用人工智慧進行新興濫用藥物的偵測分析
徐崇堯/神經內科	易志偉/資訊學院	睡眠發作性疾患之人工智慧診斷系統之研發
盧柏樑/感染內科	胡毓志/資訊學院	以智慧抗生素系統改善敗血症之治療
徐仲豪/小兒部	柯力偉/生科院	以人工智慧降低第1型脊髓肌肉萎縮症之併發症
吳宜珍/胃腸內科	何信瑩/生科院	以人工智慧協助偵測早期食道癌變
杜哲光/牙科部	王才沛/資訊學院	AI輔助之口內蛀牙與牙周病變之初步診斷
蔡忠榮/胸腔內科	蕭子健/資訊學院	探索新的呼吸器脫離指標
林昆德/內分泌內科	李鎮宜/電機學院	以人工智慧分析糖尿病病患眼底攝影影像預測腎病變的發生
蔡維中/心臟內科	林顯豐/電機學院	心肌梗塞疾患的皮膚交感神經活性
張揚沛/神經科	劉建良/管理學院	結合人工智慧及穿戴裝置之失智症病人照護預警系統

BioICT® 合一願景例舉

Let Blind People See,
Paralyzed People Walk,
Cancer Patients Regain Health,
Aged People Restore Mechanism, Abilities, Memories, Life……

Retinal Prosthesis to Restore Vision in Blind Patients

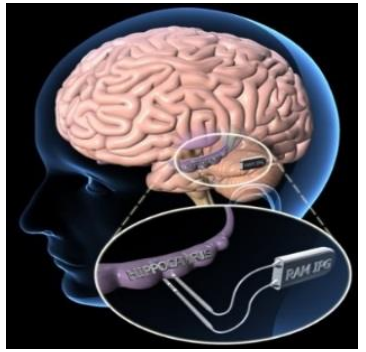


NCTU Prof. 吳重雨 and Prof. 劉文泰（玉山學者）are looking for NYMU faculty in pursuing next generation retina implant R&D & Clinical Trial

Prosthesis to Restore Mobility in SCI Patients

NCTU PhD Student 巫震華 and Prof. 胡竹生 are looking for NYMU faculty in fully developing “Free-Walker” for SCI patients

Together, we can interface brain with external memories!



A Grand Challenge for the 21st Century!

Integrated System-on-Chip for Medical Applications

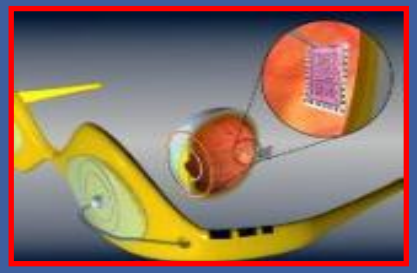
Visual Prosthesis

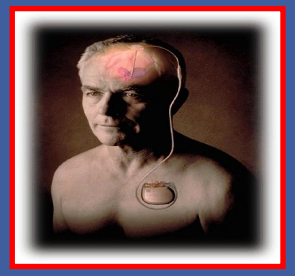
Deep Brain Stimulation

Cochlear Implant

Spinal Cord Injury Prosthesis

Medical Applications Platform





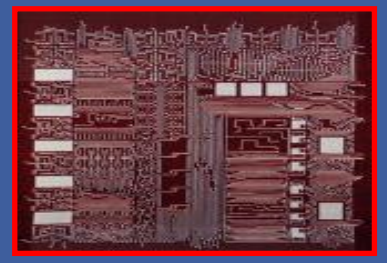
Packaging and Integration

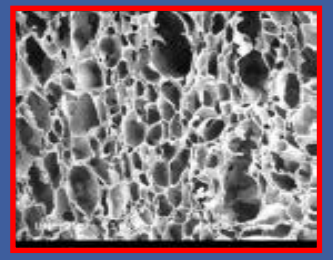
Biotic-Abiotic Interface

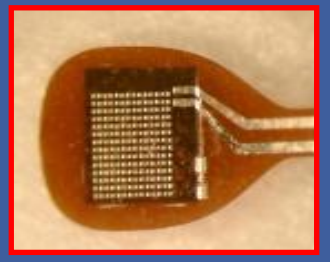
Microelectronics

Biomaterials

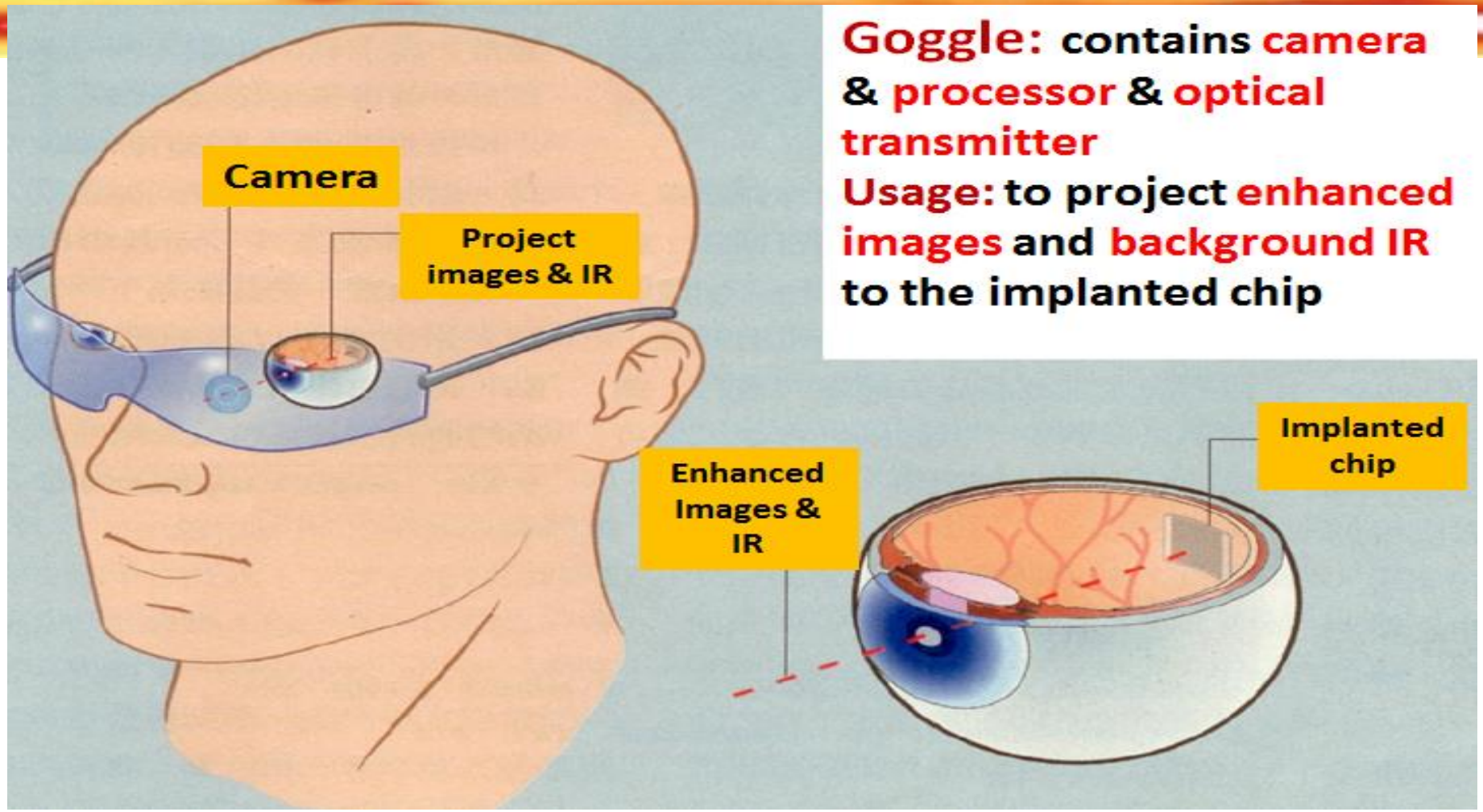
Technology Platform







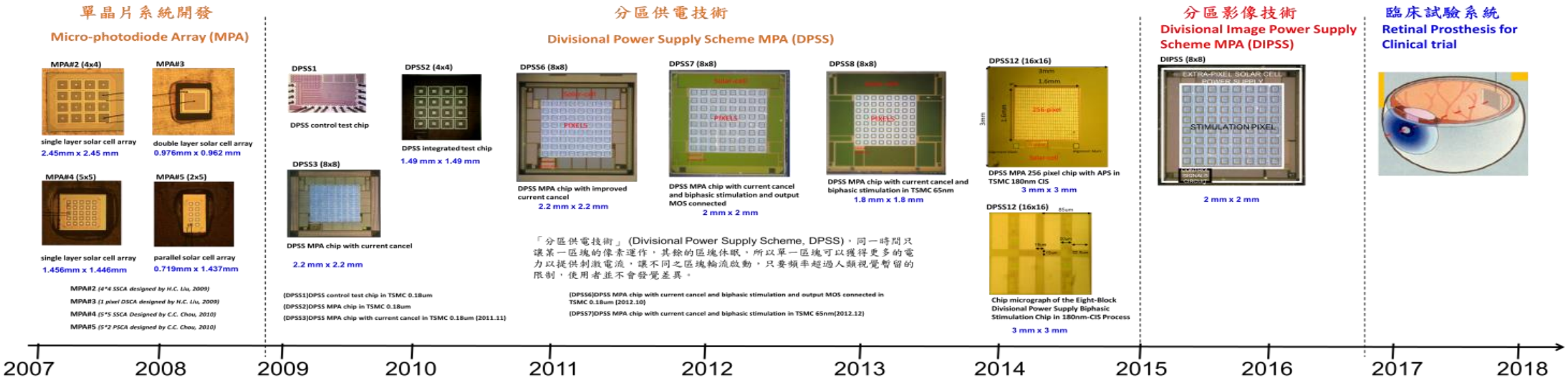
交大之植入式人工視網膜系統之研發



- 2017年4月,台北榮總與長庚醫院分別於兩病患上完成由UCLA 劉文泰卓越教授(交大校友)所帶領設計之電子眼系統植入手術,為台灣電子眼發展的一項創舉。
  新聞資料: https://news.tvbs.com.tw/tech/722607
  http://www2.businesstoday.com.tw/article/category/80394/post/201704190018

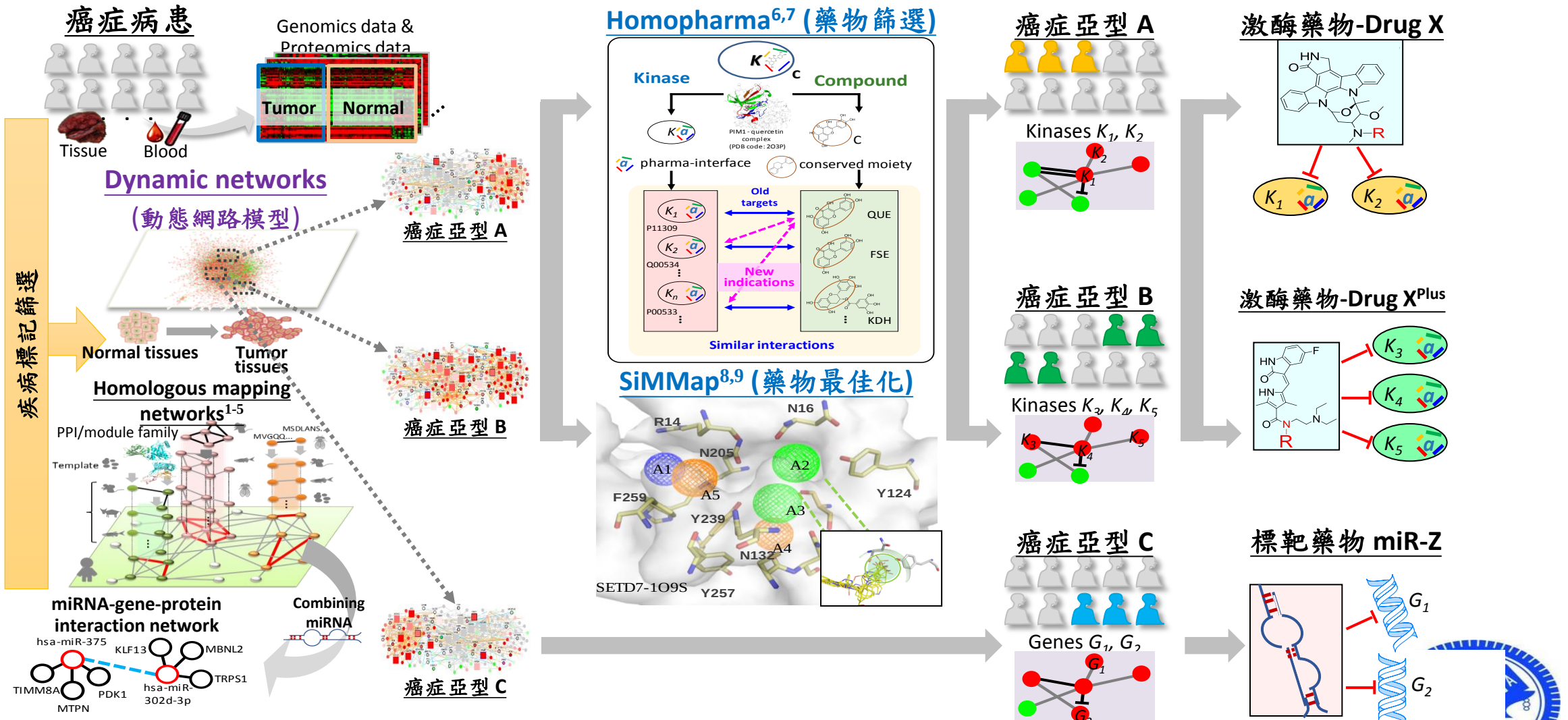
植入式人工視網膜系統之研發

- 首先建立單晶片系統平台，並在平台上建立「高效能自供電技術」、「雙光源系統創新架構」、「背景干擾消除技術」、「分區供電技術」、「分區影像技術」，成功開發全世界第一顆「以光伏電池自供電之人工視網膜晶片系統」。目前已完成長期植入動物試驗，將進入「臨床試驗系統」開發，最終將完成「植入式人工視網膜系統」開發。



跨領域精準醫療於新世代激酶藥物開發及癌症的應用

提出以演化、網路及分子交互作用家族之原創概念，開發跨領域精準藥物設計平台。相關論文被引用超過千次，已成功發現超過30個先導藥物，獲得國家新創獎



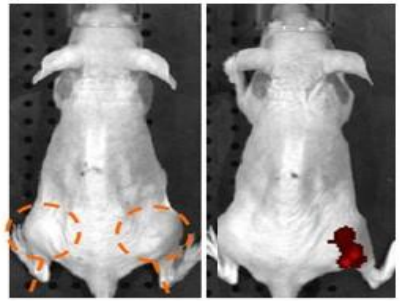
1. Lin CY, et. al. *Scientific Reports* (2015)
2. Lin CY, et. al. *Nucleic Acids Res* (2012)
3. Lo YS, et. al. *Nucleic Acids Res* (2010)
4. Chen CC, et. al. *Nucleic Acids Res* (2009)
5. Chen YC, et. al. *Nucleic Acids Res* (2007)
6. Chiu YY, et. al. *BMC genomics* (2014)
7. Chiu YY, et. al. *Nucleic Acids Res* (2013)
8. Hsu KC, et. al. *PLoS Comput Biol* (2013)
9. Chen YF, et. al. *Nucleic Acids Res* (2010)

多功能攜藥奈米載體

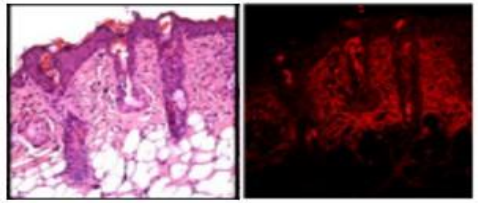
Laio KW Lab.

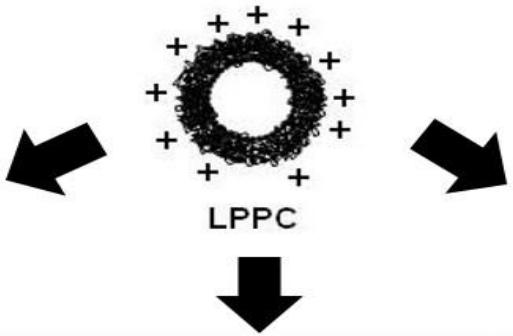
Drug delivery

Intravenous therapy (Specific target therapy)

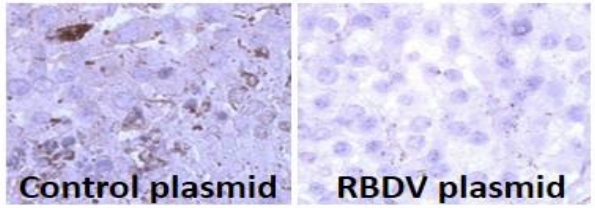


Transdermal therapy



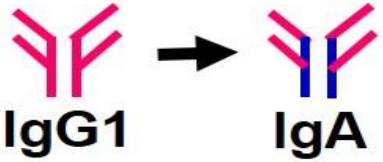


Gene therapy

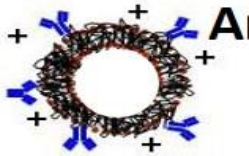


Anti-angiogenesis

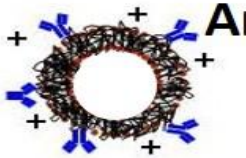
Immune regulation



Antibody class switch



T cell activation



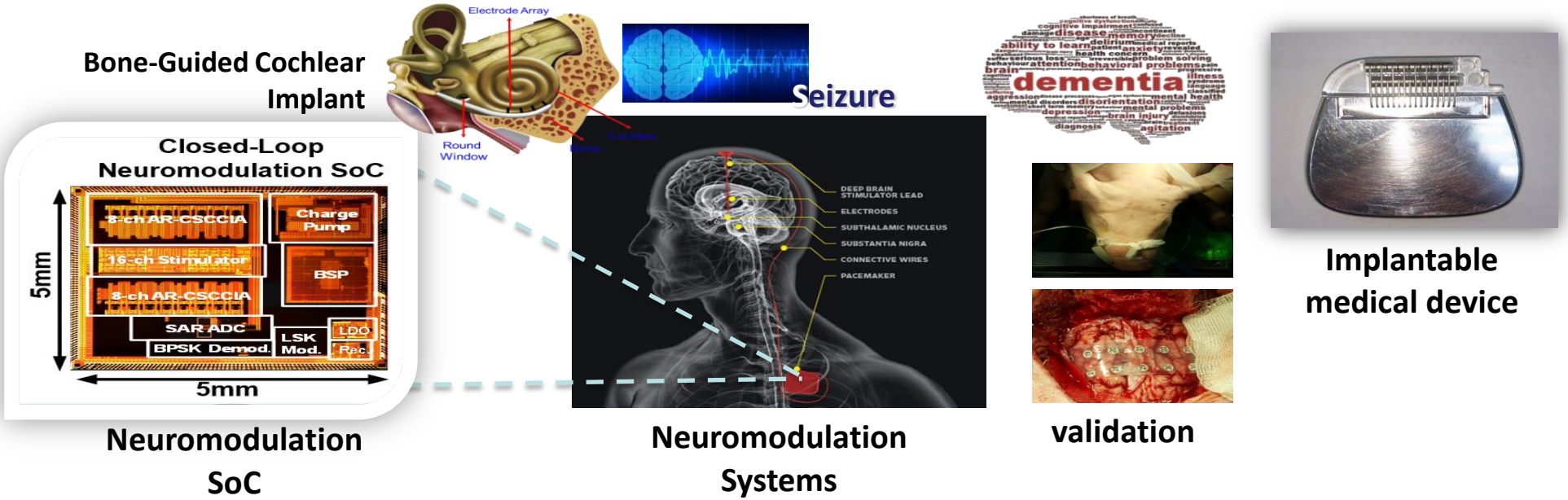
T cell suppression

本研究團隊共同研發展「多功能攜藥奈米載體」，此為全球唯一多功能之藥物載體，可達到一載體多方面消滅癌細胞之功能。本奈米藥物載體可提供各種化療藥物包覆、基因治療及免疫調節等功能，其研究成果已發表多篇研究論文於國際期刊，並取得4項台灣與美國專利。此奈米載體以10,500,000台幣成功技轉予康鶴生醫股份有限公司，並進行新藥開發之臨床試驗 (CRO)。

Center for Neuromodulation Medical Electronics Systems

Strategic Development Objectives

- The center focuses on researches and developments of implantable medical electronics systems with SoC technology and biocompatible materials, especially for close-loop neuromodulation to treatment the neuro disorders by electrical voltage/current. The developed neuromodulation systems will be validated in animal tests. Finally, the clinical trials will be performed.



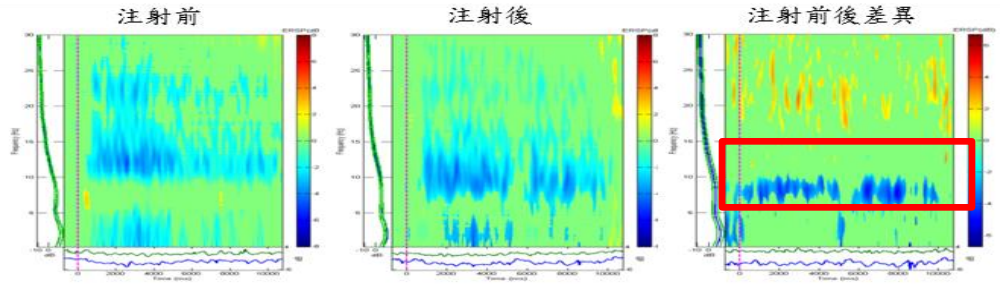
Brain Computer Interface in Clinical Applications

NATIONAL CHIAO TUNG UNIVERSITY
NEURAL ENGINEERING LAB

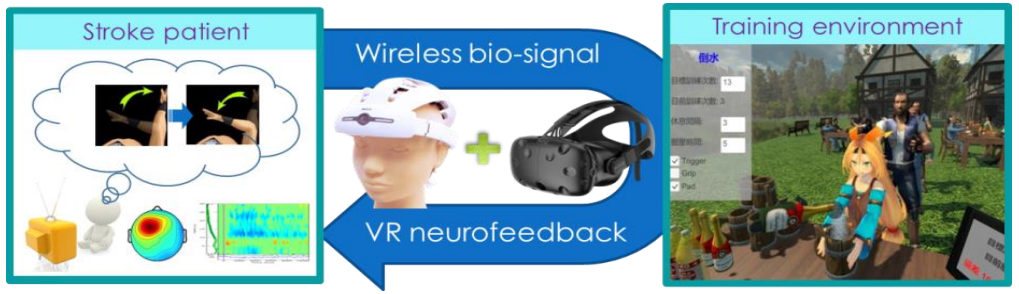
Stroke Neurorehabilitation

(Collaboration with NTUH-CHB)

- Botox injection treatment on the stroke patient's paralysis upper limb can change the neural plasticity in the motor cortex and enhance the rehabilitation performance.
- Integrating with virtual reality technology for neural rehabilitation training



Brain dynamic changing



Neurorehabilitation training system

SSVEP-based BCI for Robotic Arm Control Tech.

(Collaboration with Foxconn)

- Assisting disabled people to improve their life quality such as eating, watching, entertainment.

Feeding Assistant

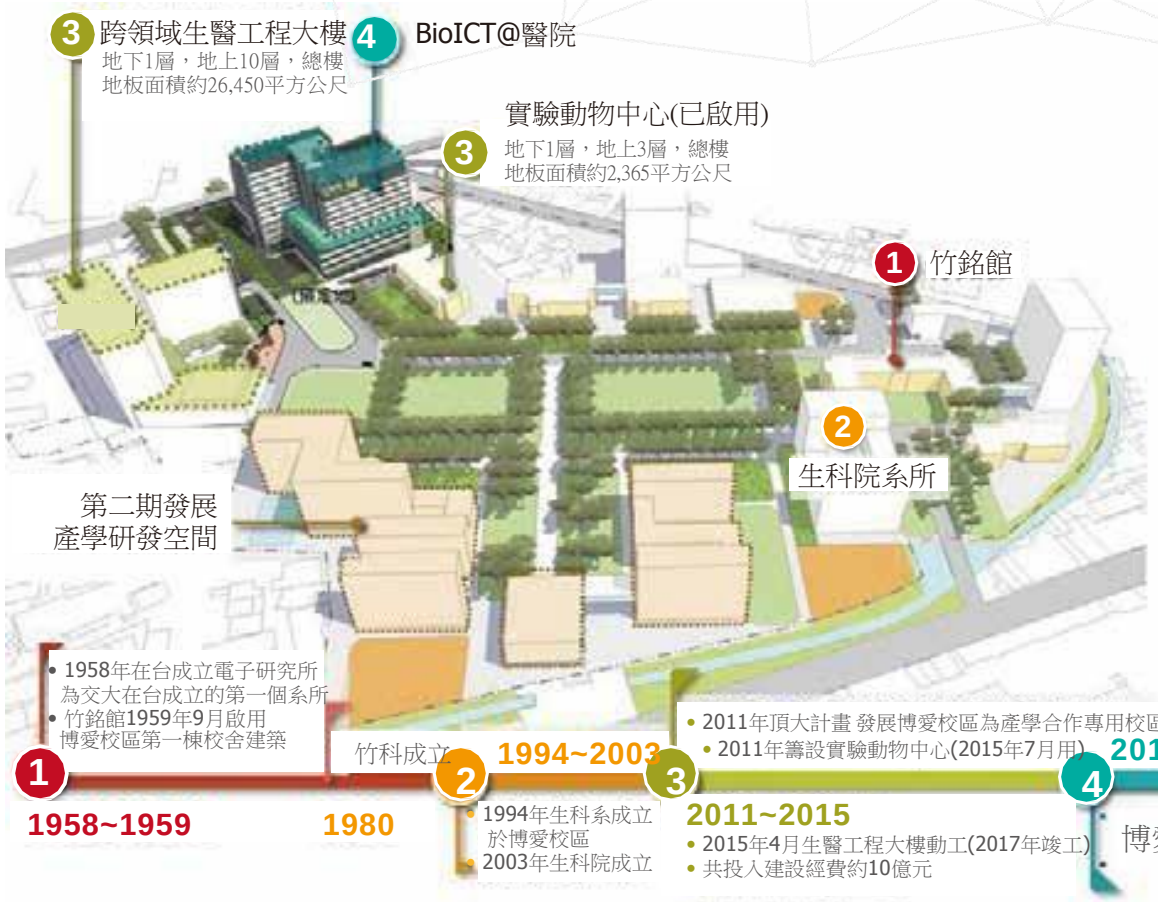
BCI for Migraine States Classification

(Collaboration with TVGH)

- Predicting the patient's migraine attacks earlier
- Accuracy can achieve 90% using O1 EEG channel with 15 Hz flicking stimuli

醫院場域驗證

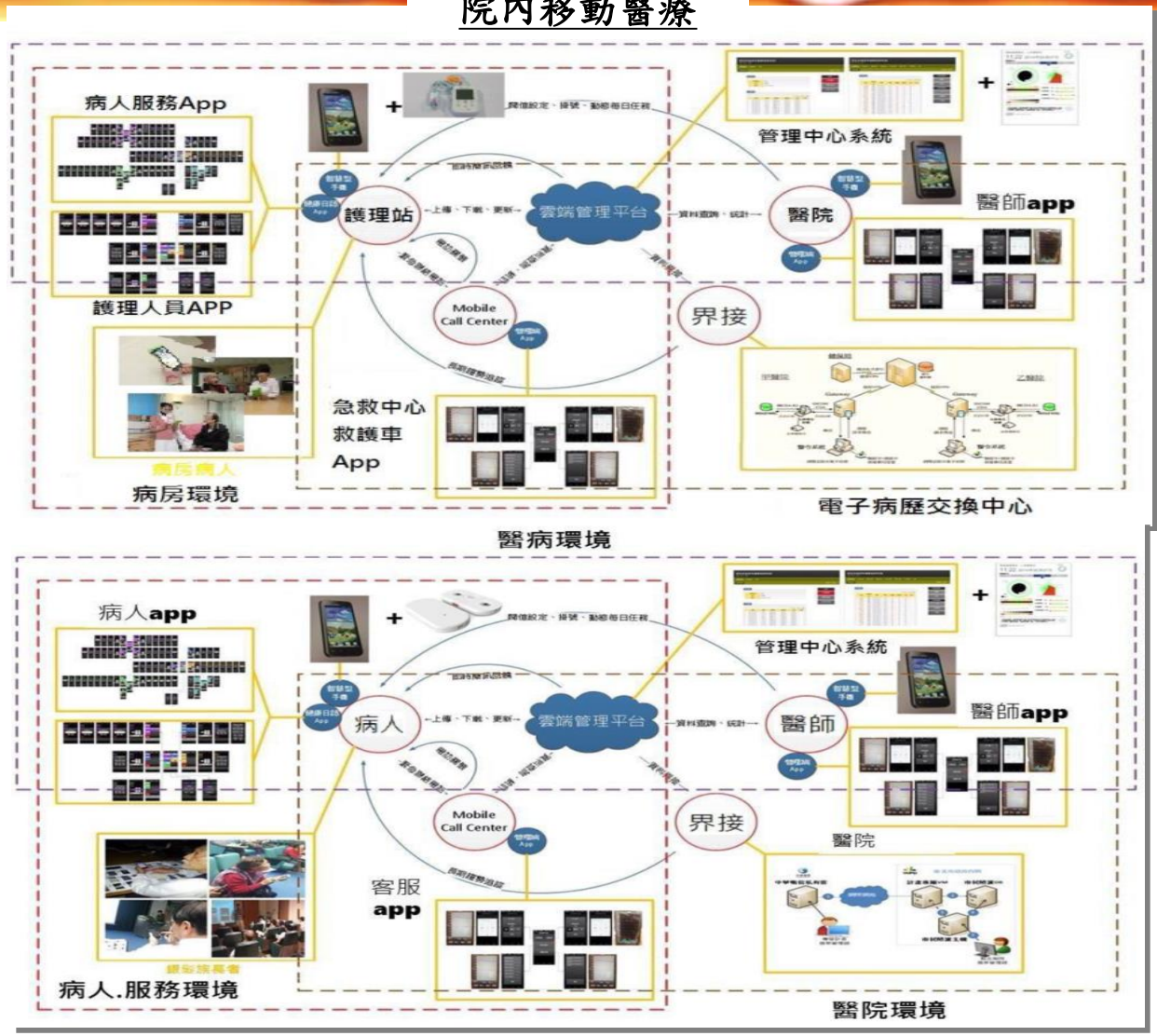
Trials in the Hospitals



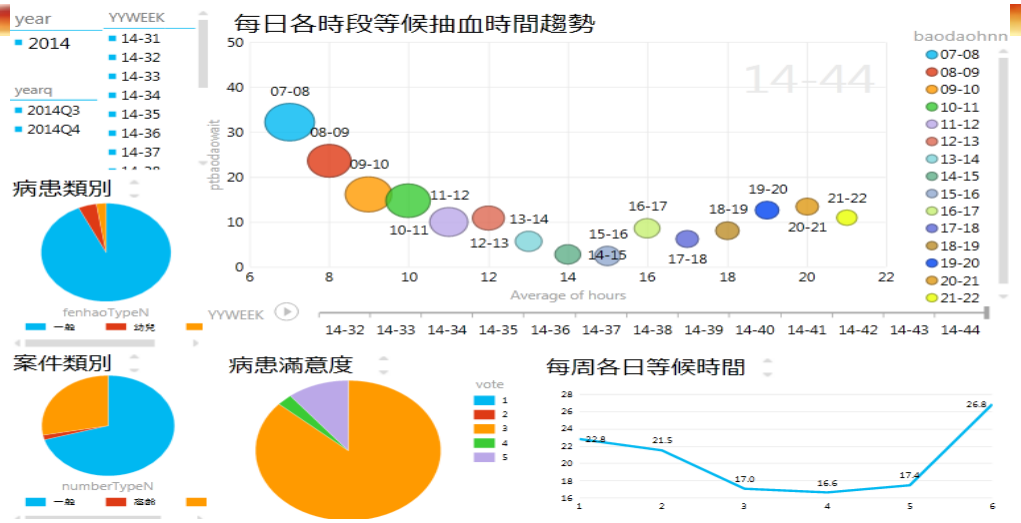
BioICT@ Incubator & Accelerator
Simulation Facilities
YMCT Associated Hospital
(2022)

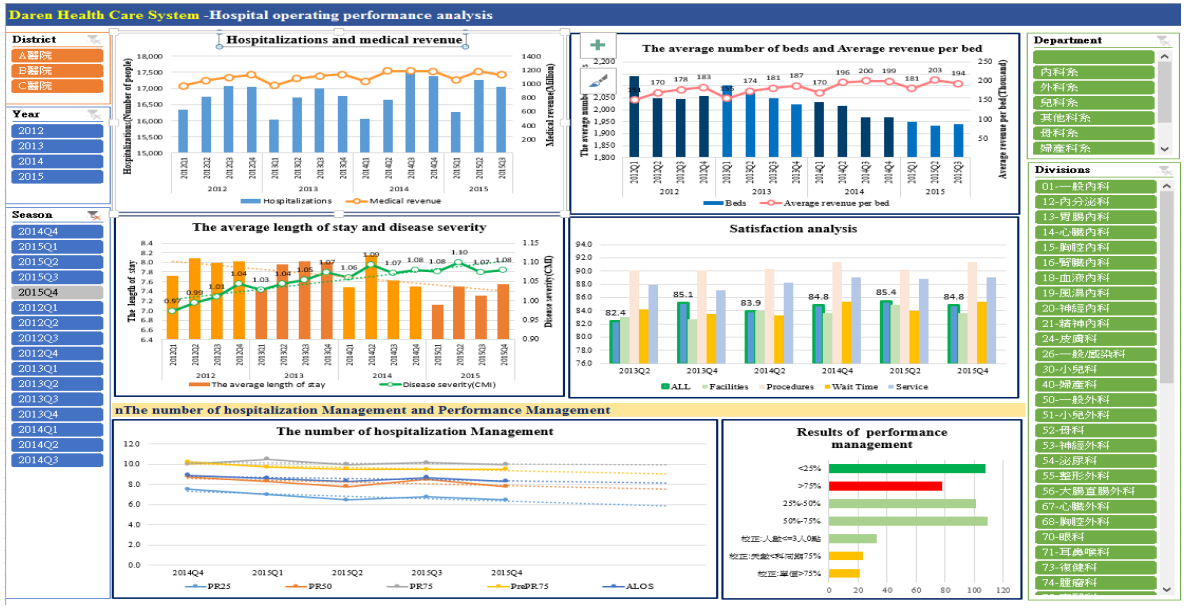
以BioICT®科技改變醫病環境

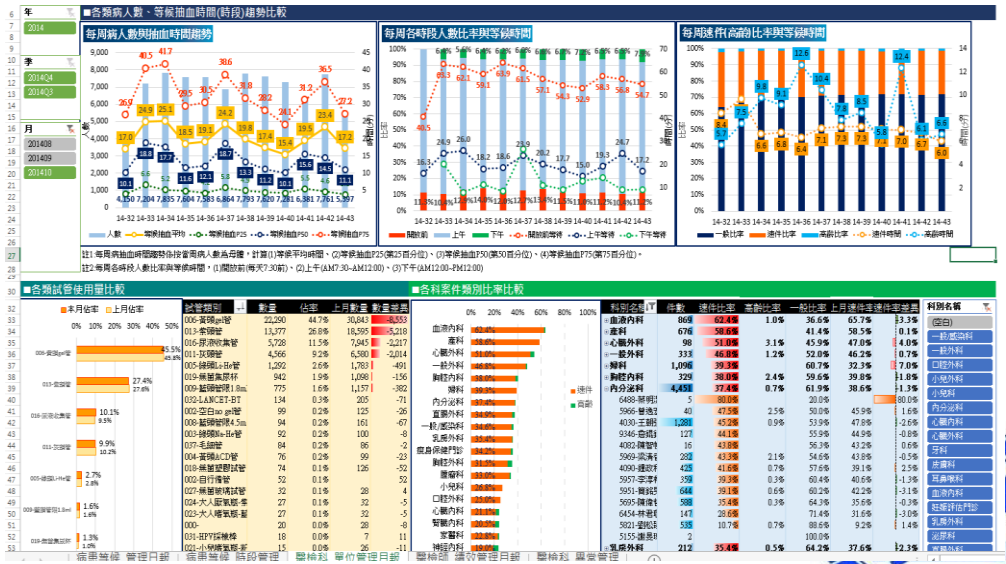
院內移動醫療



運用智能化的雲端管理提昇效率增進醫療品質



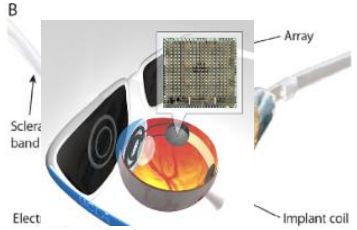




A Dream You Dream Together is Reality!

Let Blind People See,
Paralyzed People Walk,
Cancer Patients Regain Health,
Aged People Restore Mechanism, Abilities,
Memories, Life……

Retinal Prosthesis to Restore Vision in Blind Patients

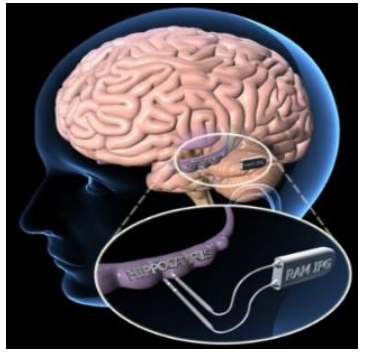


NCTU Prof. 吳重雨 and Prof. 劉文泰（玉山學者）are looking for NYMU faculty in pursuing next generation retina implant R&D & Clinical Trial

Prosthesis to Restore Mobility in SCI Patients

NCTU PhD Student 巫震華 and Prof. 胡竹生 are looking for NYMU faculty in fully developing “Free-Walker” for SCI patients

Together, we can interface brain with external memories!



A Grand Challenge for the 21st Century!