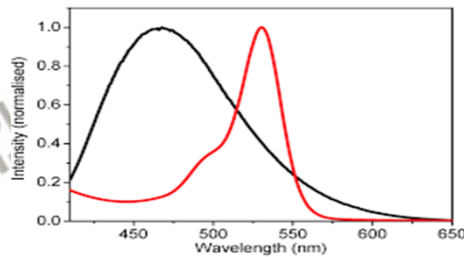


시분해 형광 장비 선택

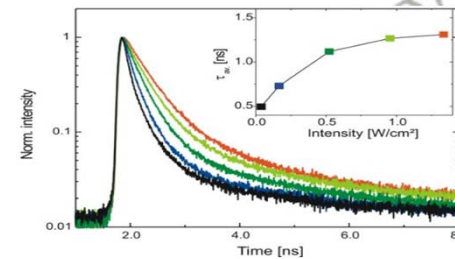
형광기

- Steady-state fluorescence
- Fluorescence spectra



TCSPC 장비

- Time-resolved fluorescence
- Fluorescence decays (lifetimes)



- Spectrofluorophotometer with option for TCSPC

장점; 설치, 관리, 사용 용이, 단점; 확장성 제한

- TCSPC with function of wavelength scan

장점; 확장성, 응용성 좋음, 단점; 설치 및 관리 상대적 어려움



TCSPC Setup

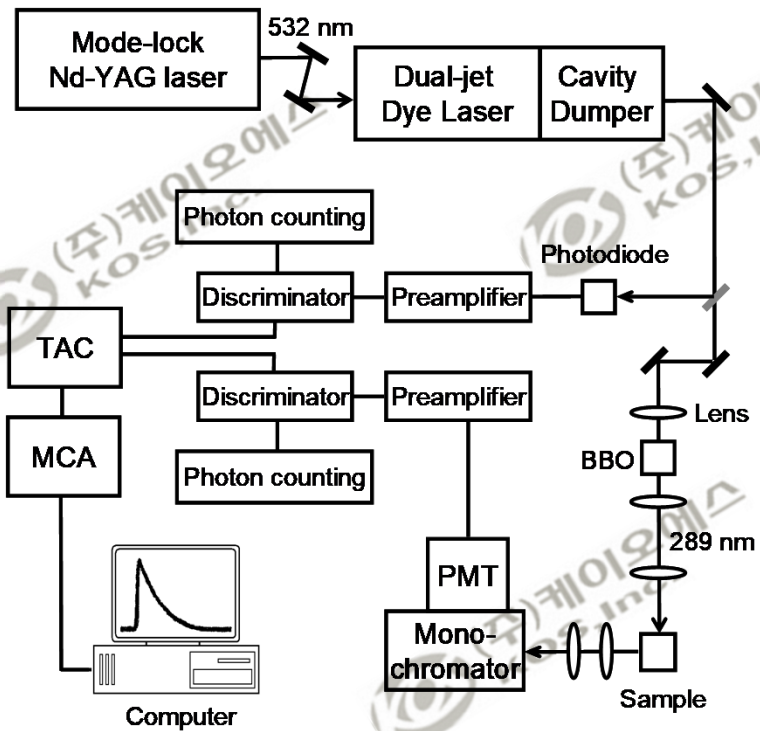
Old style



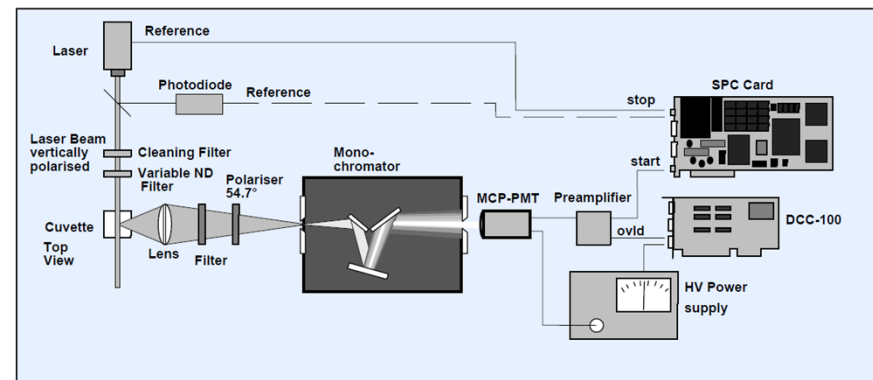
Mode-locked laser



NIM-BIN electronics



Recent style



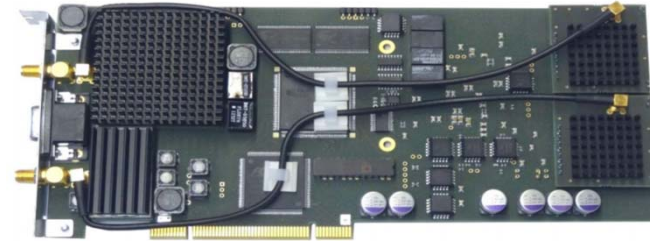
TCSPC 장비 구성

Light source (ps lasers)



Wavelengths: 375, 405, 475, 485, 510, 635, 640,
655, 670, 785, 800, 980, 1064 nm
Pulse width: ~ 100 ps (40 ps min.)

TCSPC module



CFD, TAC, ADC all included module
Minimum time channel: 815 fs

Detector

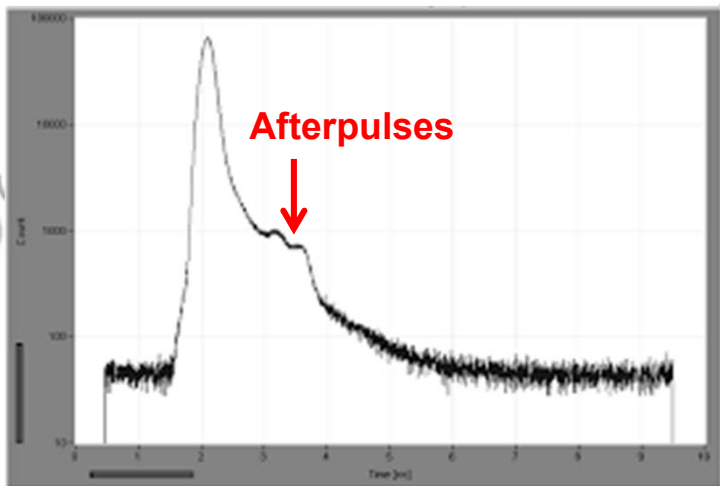
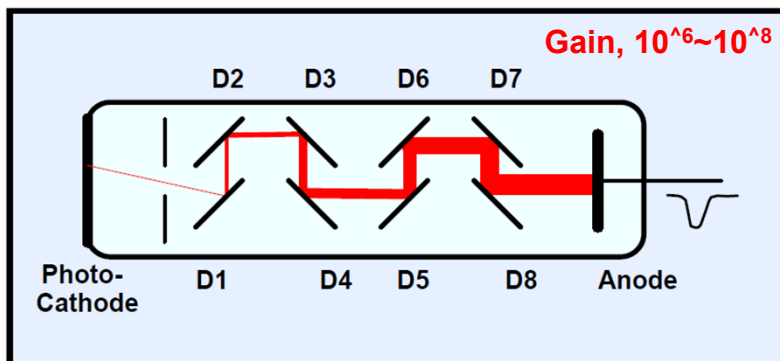
PMT (R5600, R7400, H5773, H11900, H10721)
MCP-PMT (R3809U)
Hybrid PMT (R10467)
SPAD (single-photon avalanche photodiode)
NIR-PMT (InGaAs SPAD, id230)

Spectrometer

Monochromator
Polychromator
Band-pass filter

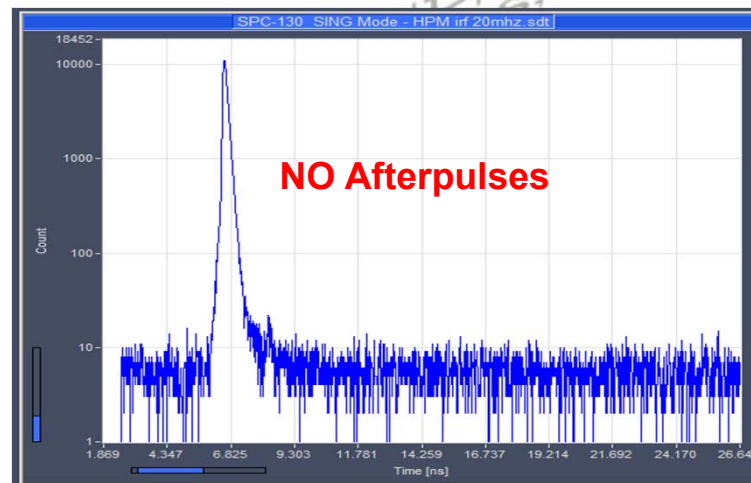
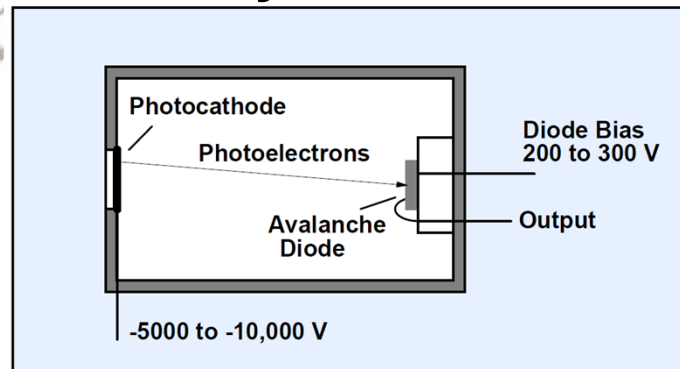
Photomultiplier Tubes (PMT)

Conventional PMT



IRF

Hybrid PMT

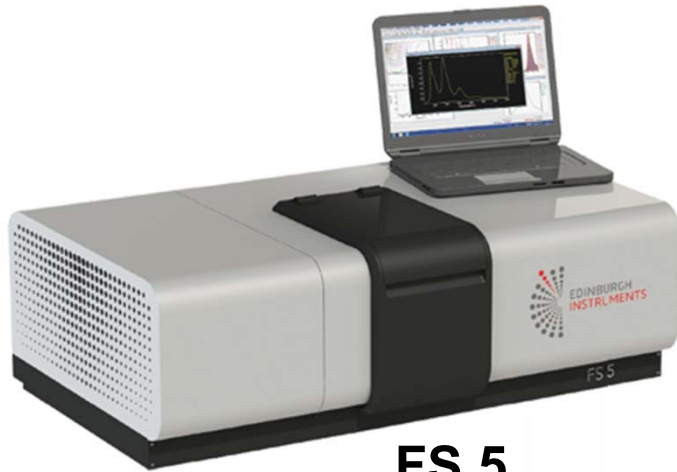


Problems

1. Afterpulse in ns range; scattered e at 1st dynode
2. Aftrepulsing in μ s range; ionization of residual gas

- Large gain obtained by single step
- Fast transit time (50 ps)
- No significant tails, bumps, secondary peaks

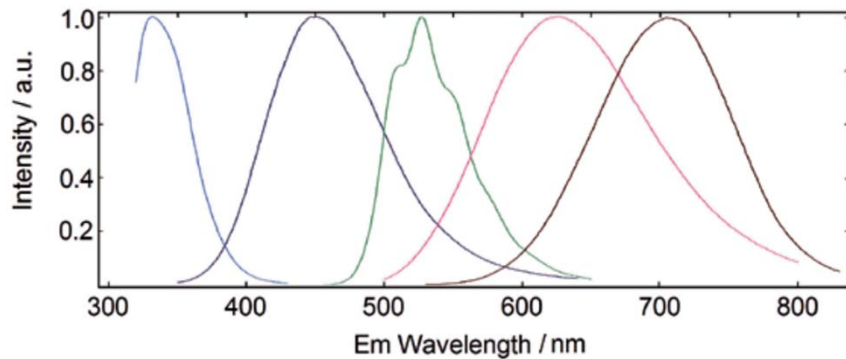
형광기 기반 TCSPC 1.



FS 5

Spectrofluorophotometer

- 150 W Xe lamp
- 225 mm focal length spectrometer



TCSPC or MCS upgrade

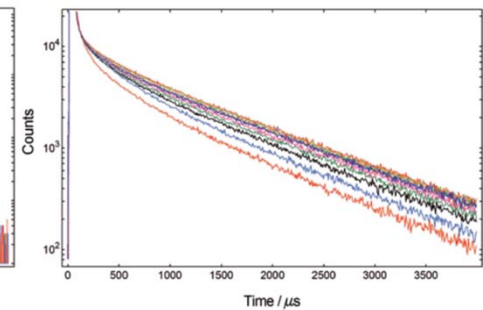
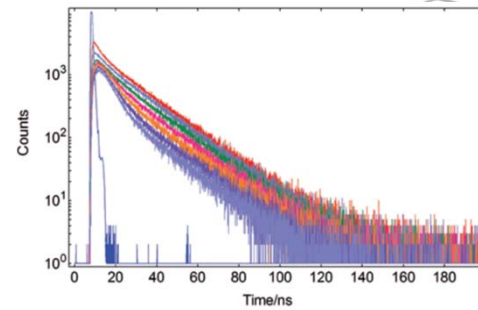


TCSPC option

- ps diode laser
- TCSPC module
- 2.5 ns ~ 10 μ s

MCS option

- μ s flashed Xe lamp
- MCS module
- 5 μ s ~ 10 s

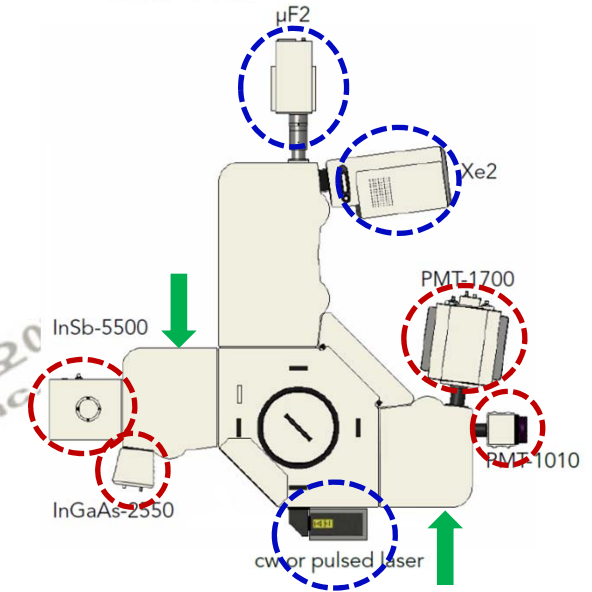
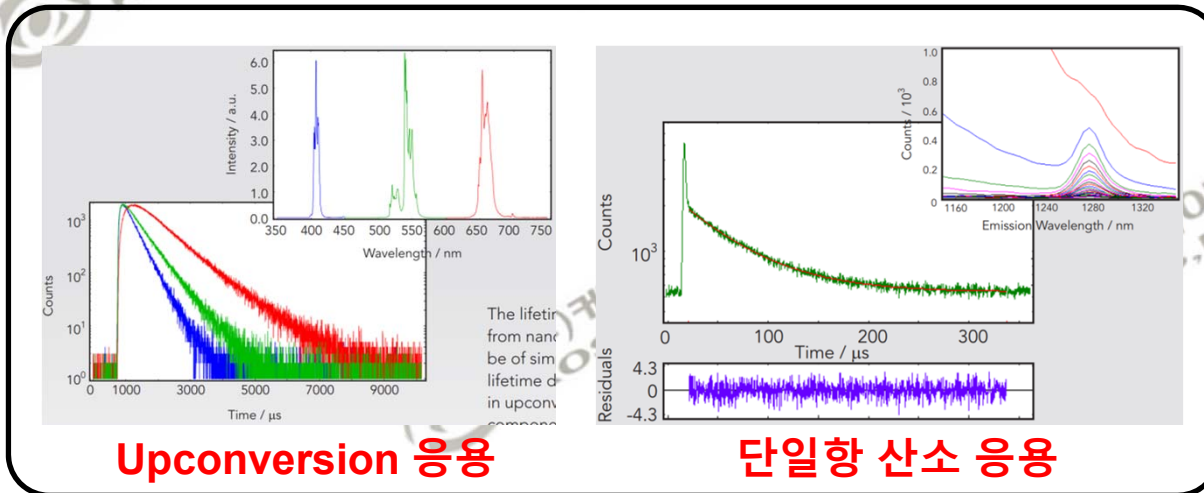
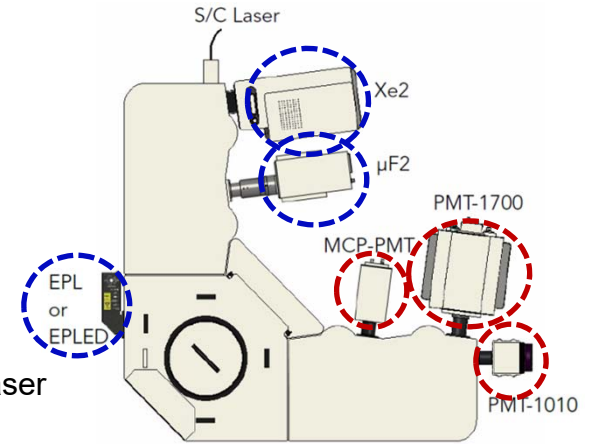


형광기 기반 TCSPC 2.

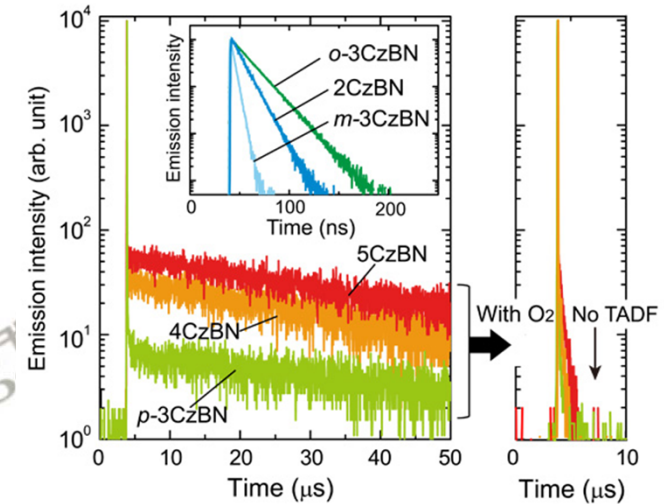
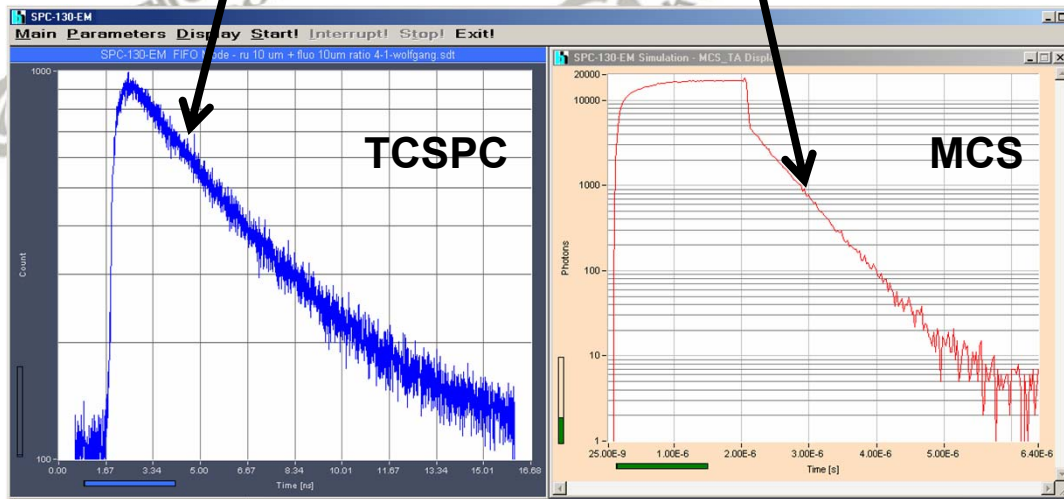
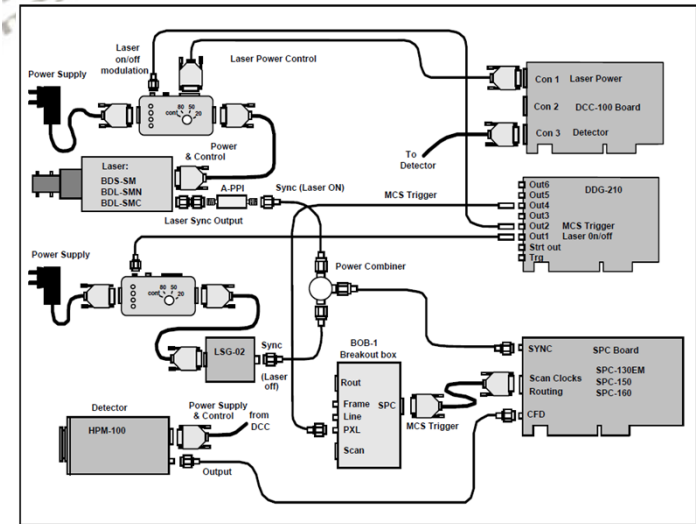
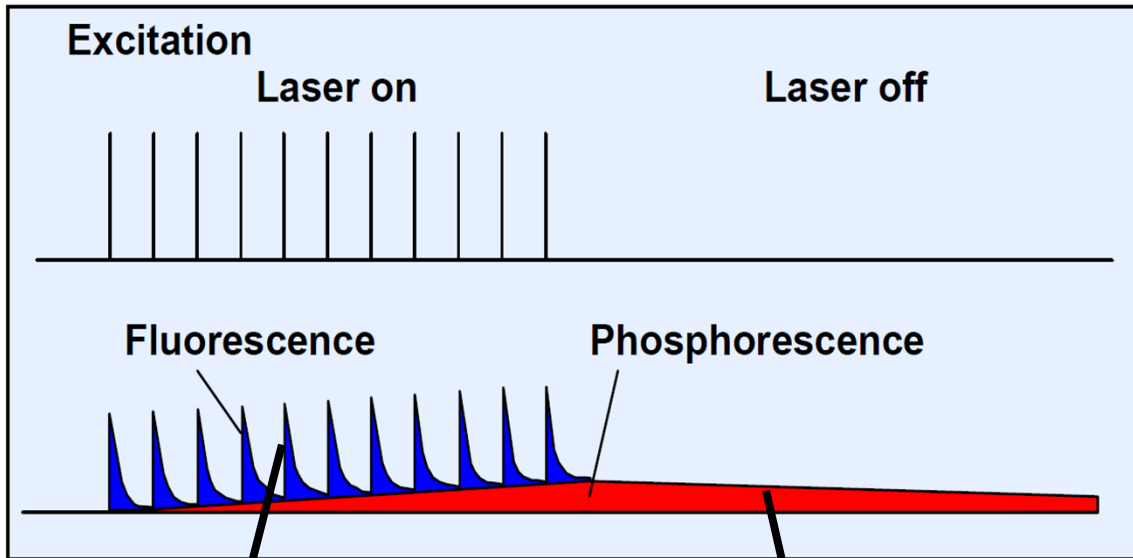


FLS 1000

- **Multiple light sources**
 - Xe lamp, flashed Xe lamp, ps laser
- **Multiple detectors**
 - PMT, CCD
- **Dual monochromator**
 - eg, visible and NIR

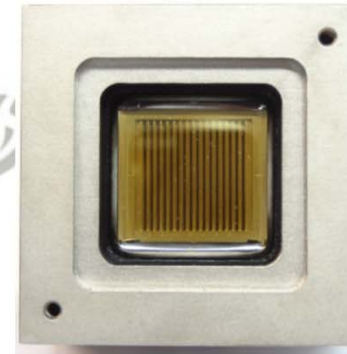
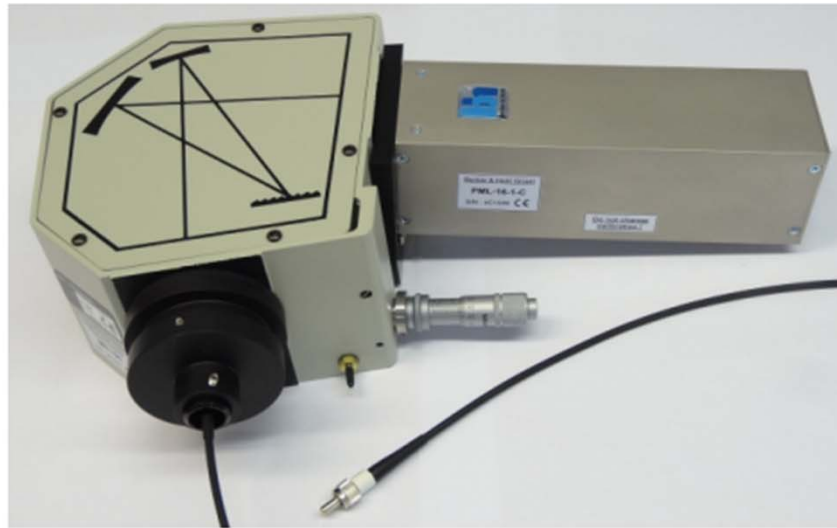


TCSPC 3. 형광과 인광(지연 발광) 동시 측정



TADF in OLED 응용

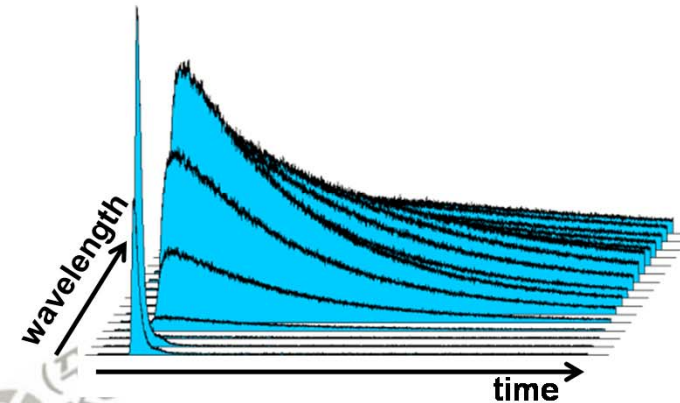
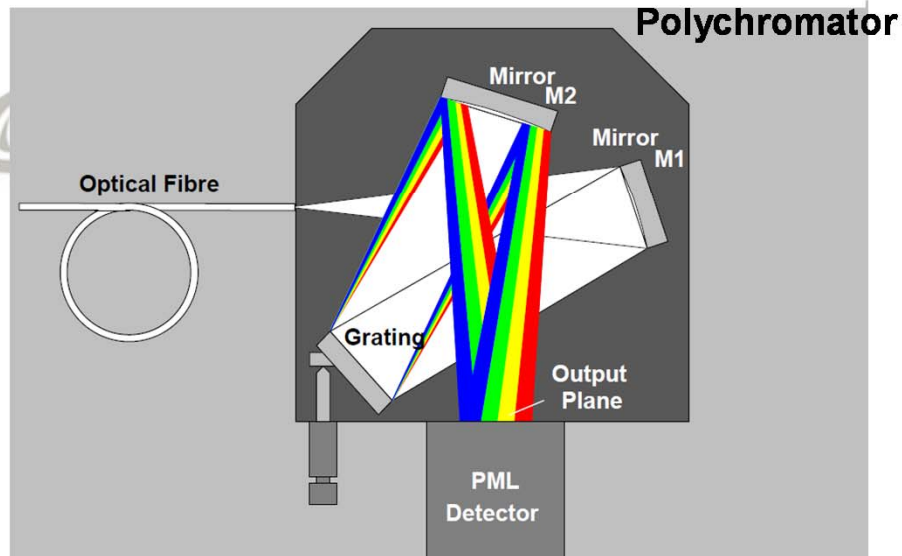
TCSPC 4. Multi-channel Detector



1-D array PMT structure

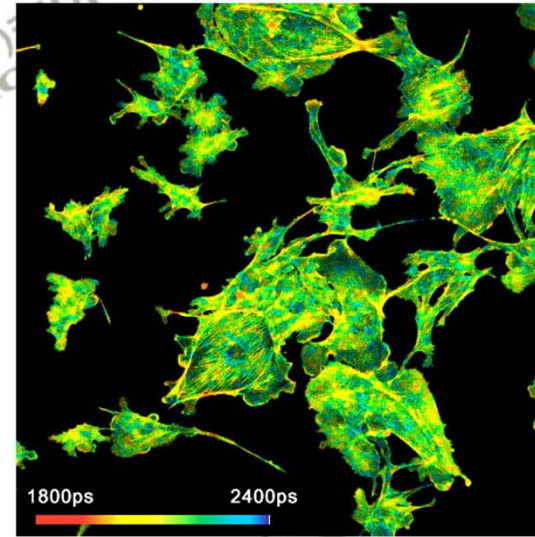
PML-SPEC

- Parallel multi-wavelength detection
- 16 channel PMT modules
- Minimum channel width of 6.65 nm

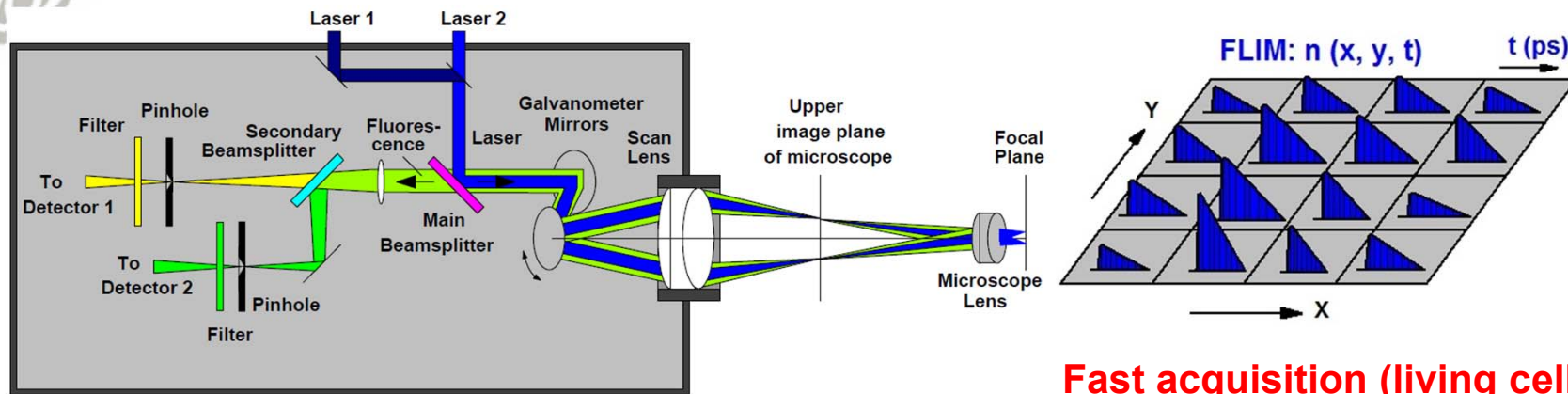


- 16개 파장 동시 측정 가능
- FRET 응용 (100 nm 영역)

Fluorescence Lifetime Imaging Microscope (FLIM)



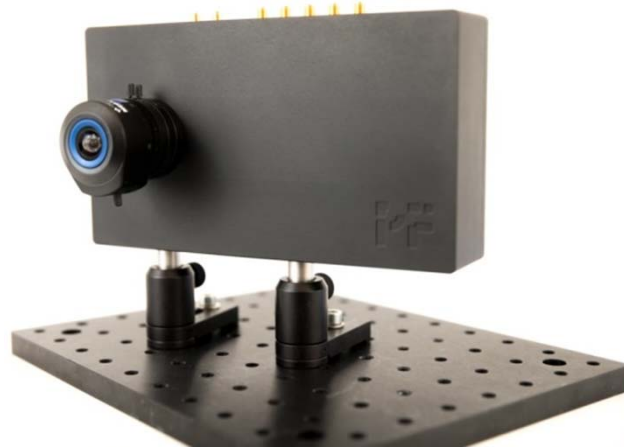
FLIM image of live cell recorded within 10 sec.
(512x512 pixels)



Galvanometer mirrors assembly

Fast acquisition (living cell)

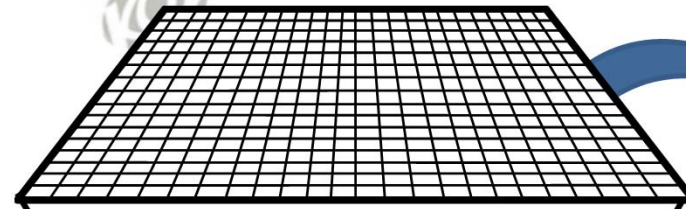
2D array detector for FLIM



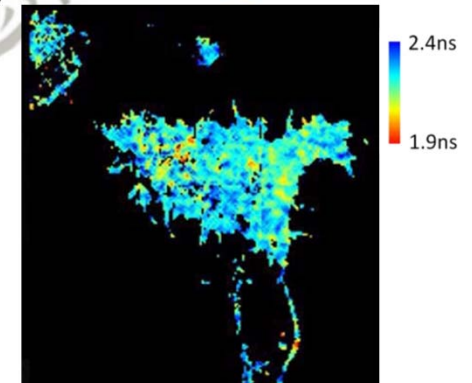
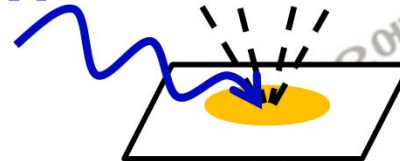
PF 32

- 32x32 array of time-resolved SPAD pixels
- Single-photon sensitivity
- Easy adoption of adapters
- Over 1000x faster than single channel detectors

32x32 array SPAD pixels



Laser



FLIM image of living cell

- 스캔이 어려운 부분
- 전하 주입되는 계면 연구 응용