



FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers



JASCO FT-IR Solutions

Part II

FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

Rapid scan & Step Scan

Static

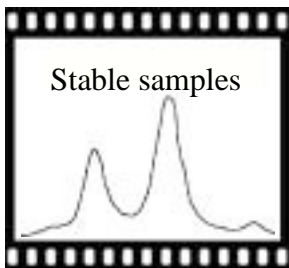
Normal scan



Photo



Stable samples



Dynamic

Interval scan

Rapid scan

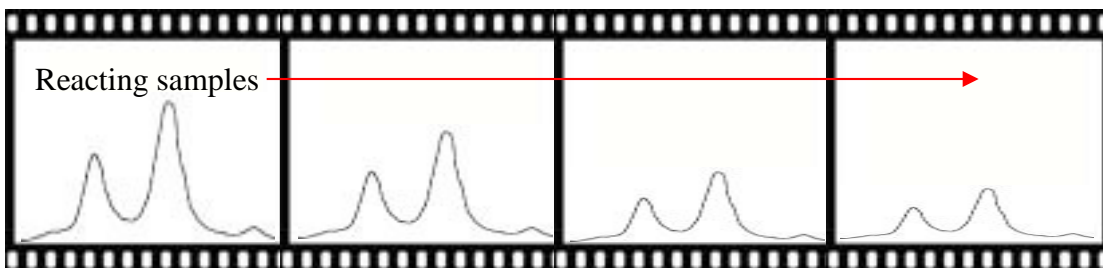
Step scan



Movie



Reacting samples



Time

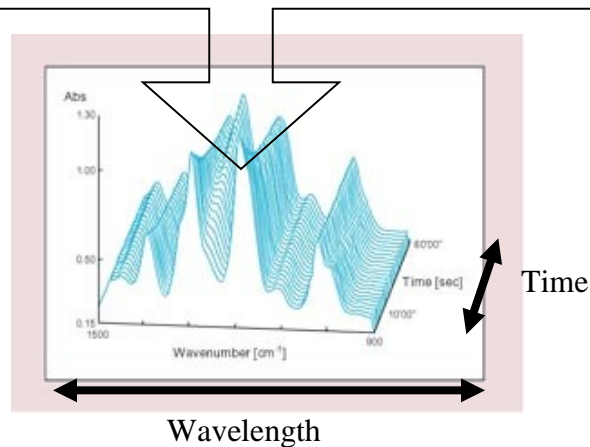
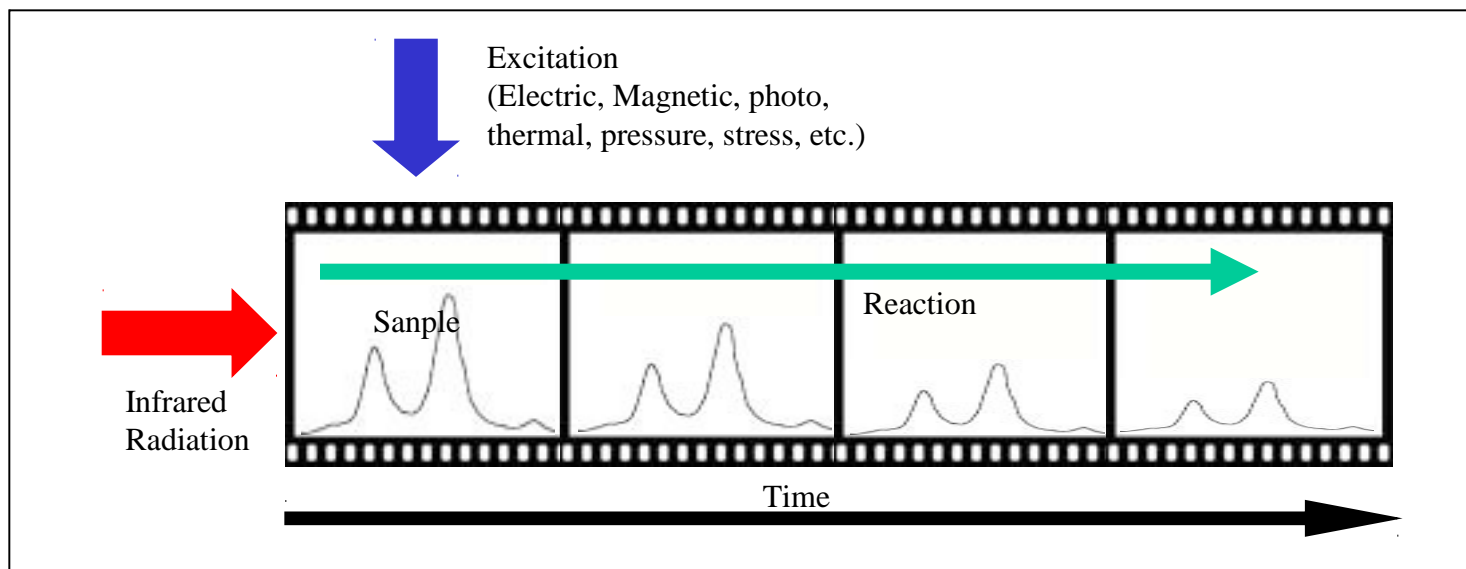


FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

Rapid scan & Step Scan

Rapid scan & Step scan can be used record the infrared spectra of time-dependent dynamic systems

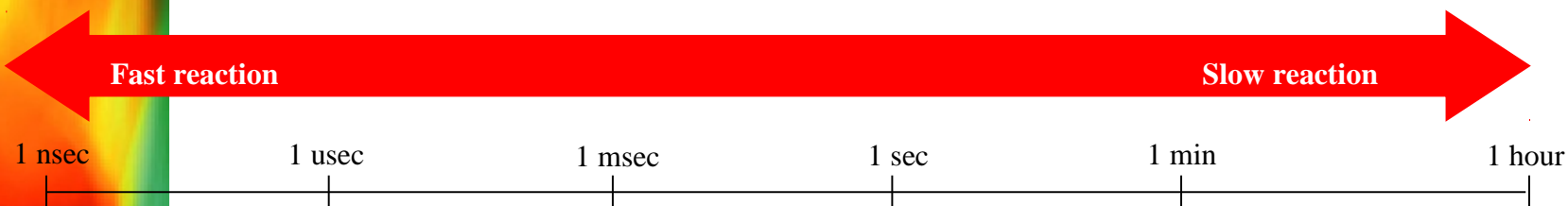


FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

Rapid scan & Step Scan

Dynamic phenomena
(Time-dependent phenomena)



Step scan

For dynamic system which has component changes or transient lifetimes shorter than the scan time

(In this case, Event should be reproducible.)

Rapid scan

Increased scan speed

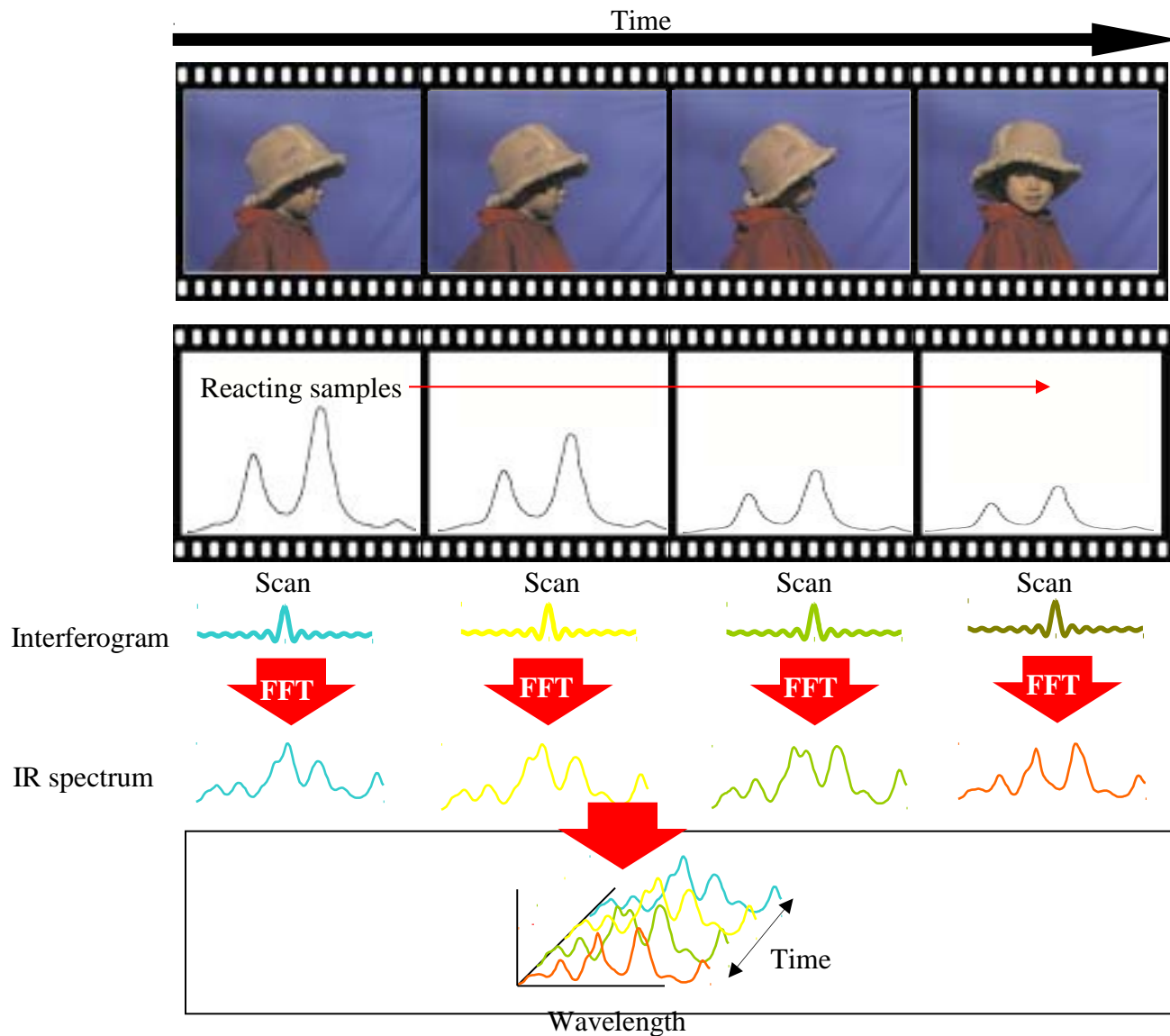
Interval scan (Continuous scan)

The most easily studied systems have a relatively slow rate of change with respect to the scanning time of the interferometer.

FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

Continuous Scan / Rapid Scan



New

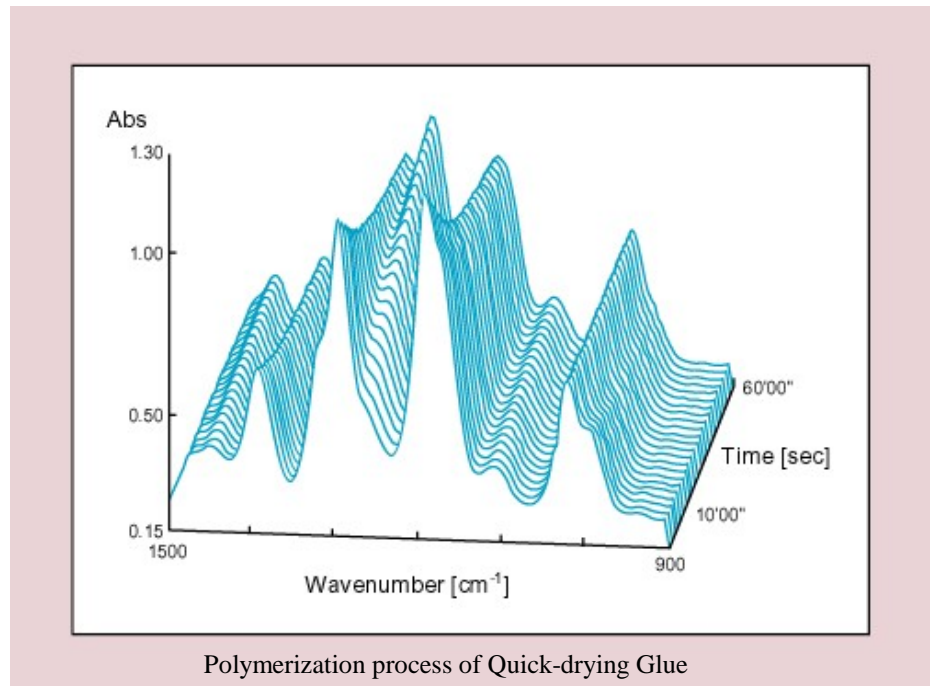
FT/IR-4000/6000 Series

✓ Rapid scan

	FT/IR-6100/6200/6300	FT/IR-4100/4200
Scan speed	0.125 - 8 mm.sec	1 - 4 mm/sec
Rapid scan	Option (20Hz)	Option (10Hz)

The rapid scan function is optional for the FT/IR-4100/4200 and FT/IR-6100/6200 and provided as a standard feature of the FT/IR-6300. The rapid scan system enables the instrument to perform up to 20 scans per second for the FT/IR-6100/6200/6300 and 10 scans per second for the FT/IR-4100/4200 providing real time analysis of reaction kinetics.

Scan speed (mm/sec)	20	10	4	3	2	1
Rapid scan (Hz)	10	5	2.5	1.8	1.2	0.6

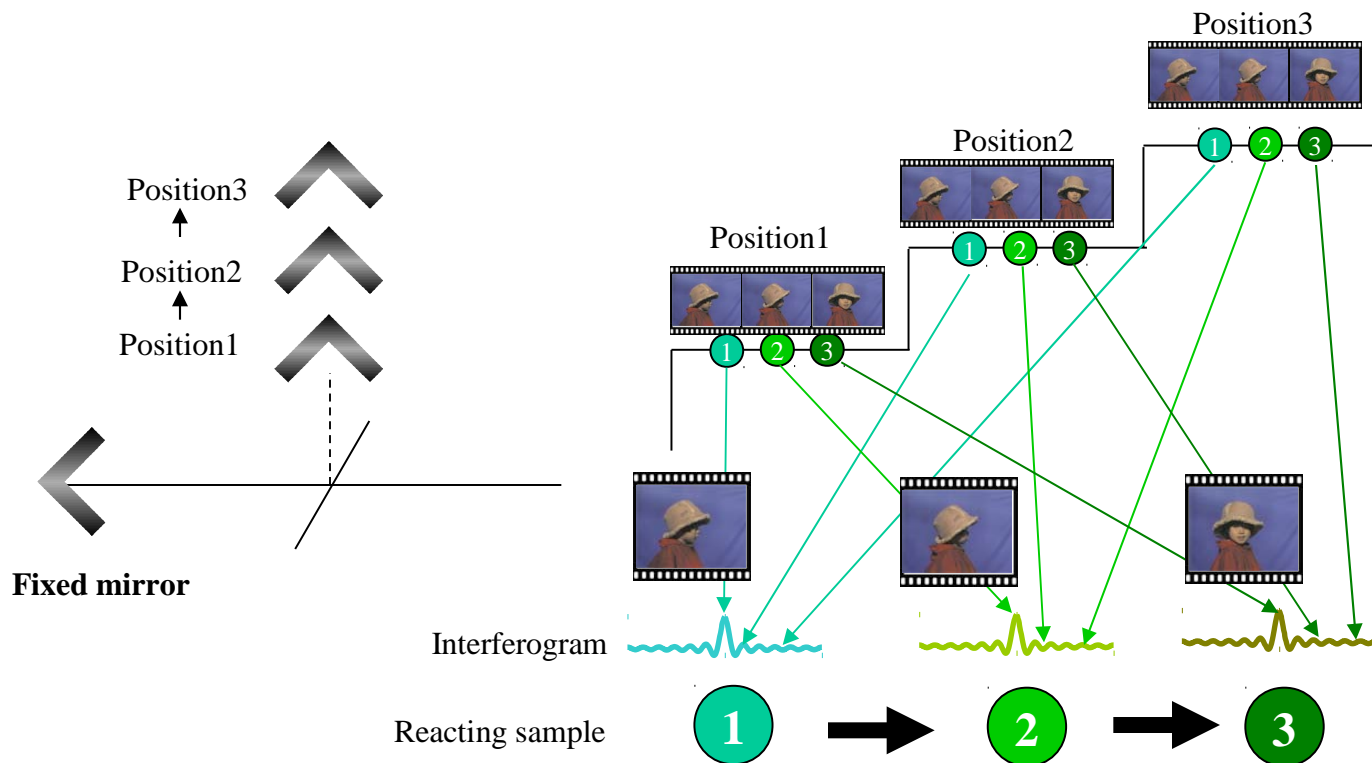


	16 cm ⁻¹	8 cm ⁻¹	4 cm ⁻¹	2 cm ⁻¹	1 cm ⁻¹	0.5 cm ⁻¹	0.25 cm ⁻¹
FT/IR-4000	10Hz	7.5Hz	6Hz	4Hz	2.5Hz	-	-
FT/IR-6000	20Hz	15Hz	12Hz	8.5Hz	5Hz	3Hz	1.5Hz

Step Scan

General description (1)

Step-scan FT-IR spectroscopy offers a very attractive approach to obtain rapid time-resolved infrared measurements. This technique covers the entire mid-IR region allowing simultaneous measurement at all frequencies while maintaining the high throughput and multiplex advantages of FT-IR. The time resolved step-scan FT-IR technique involves displacing the moveable mirror of the interferometer in a step-wise manner. At each mirror position, the time-dependent change in IR intensity is measured producing time dependent interferograms. Fourier transformation of an interferogram at a particular time delay of the reaction yields the spectral intensity changes at that particular time slice and this is easily converted to the corresponding absorption spectra. Repeating this process at a variety of time delays results in a series of time-resolved spectra. Using the step-scan technique it is possible to monitor the progress of very fast and reproducible events.



Step Scan

General description (2)

Step-scan major applications are

- **Time-resolved**
- **Phase-modulated (Photoacoustic depth profiling)**
- **Amplitude-modulated**

Basically, JASCO Step scan can do all of above.

Step scan experiments can be classified into two categories: step scan with or without phase modulation (PM) on the mirror. They are also referred to on occasion as time-or frequency-domain experiments. In the former, both mirrors are stopped completely when the data are collected at each mirror position, while in the latter, one of the mirrors is oscillated back and forth at a fixed frequency to modulate the infrared light.

Examples of time-domain experiments include time-resolved spectroscopy (TRS) and amplitude modulation experiments where the data are collected with both mirrors stopped completely. Photoacoustic depth profiling and polymer stretching are examples of frequency-domain experiments that are conducted with PM on the mirror.

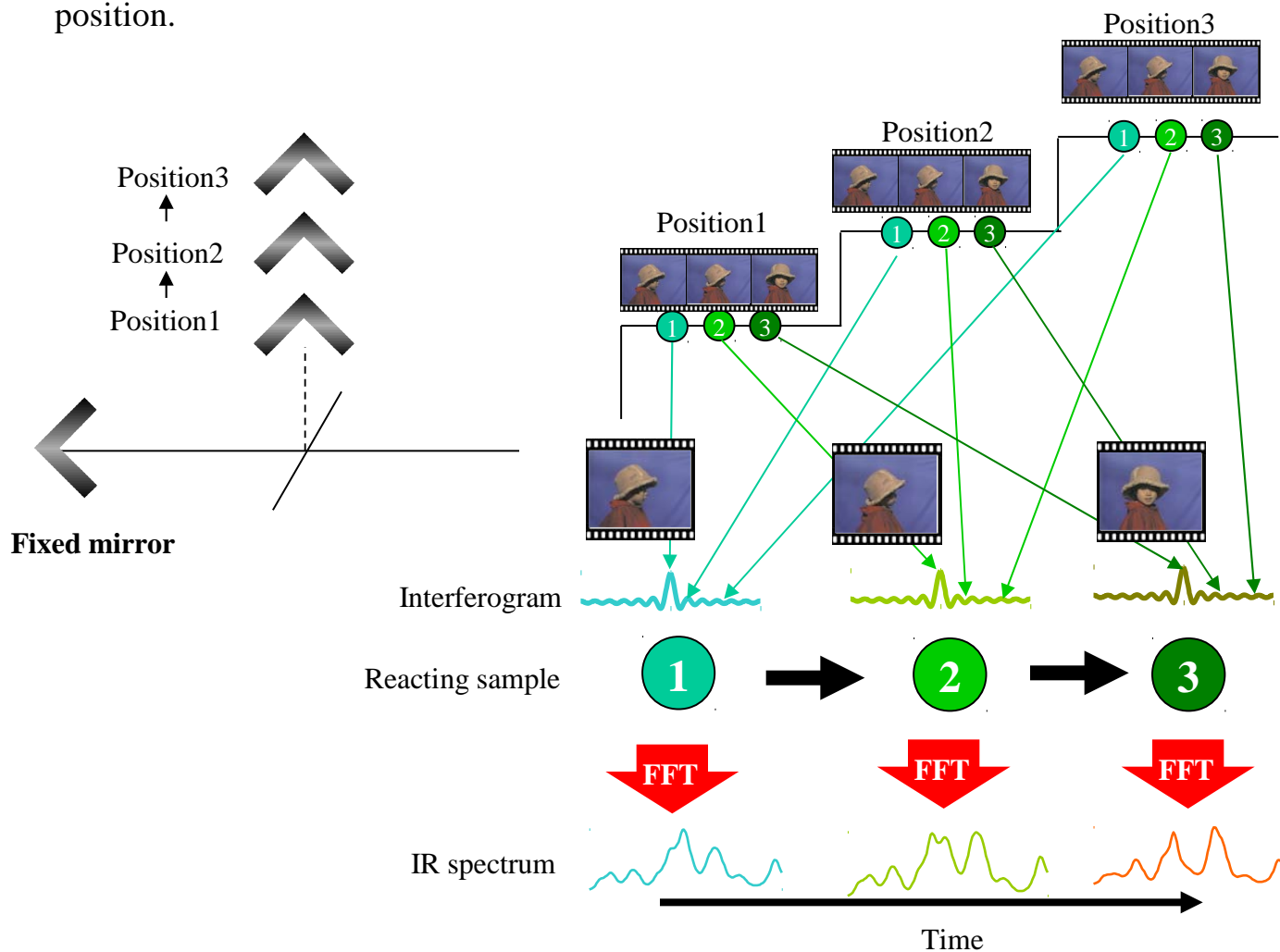
**In case of step-scan,
a reaction to be analyzed must be repeated (must be reproducible).**

Step Scan

General description (3)

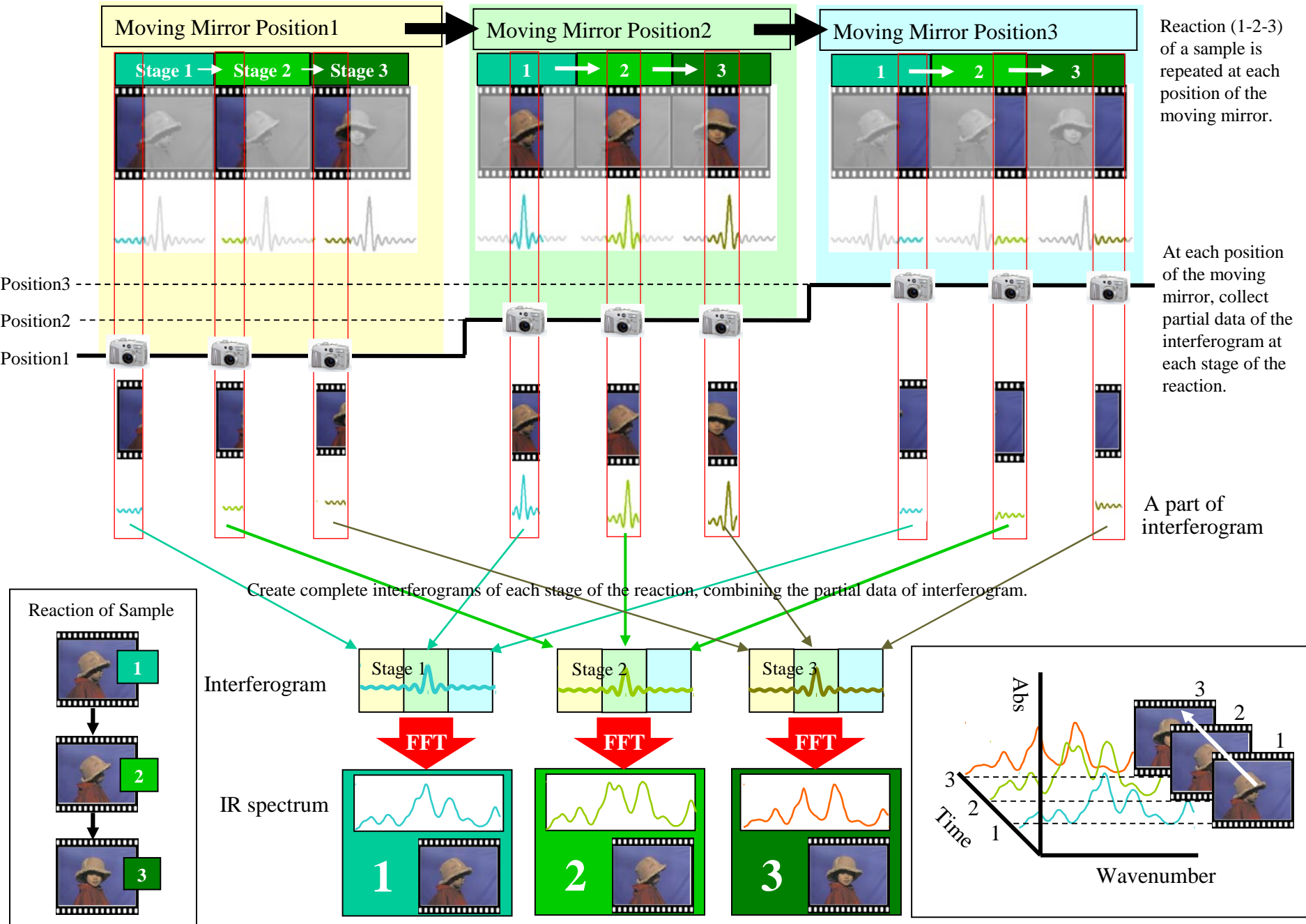
- Time-resolved

Both mirrors are stopped completely when the data are collected at each mirror position.



Step Scan

Time-resolved analysis of a single point by a single-element detector



Step Scan

General description (4)

- Phase-modulated (Photoacoustic depth profiling)

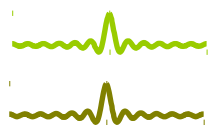
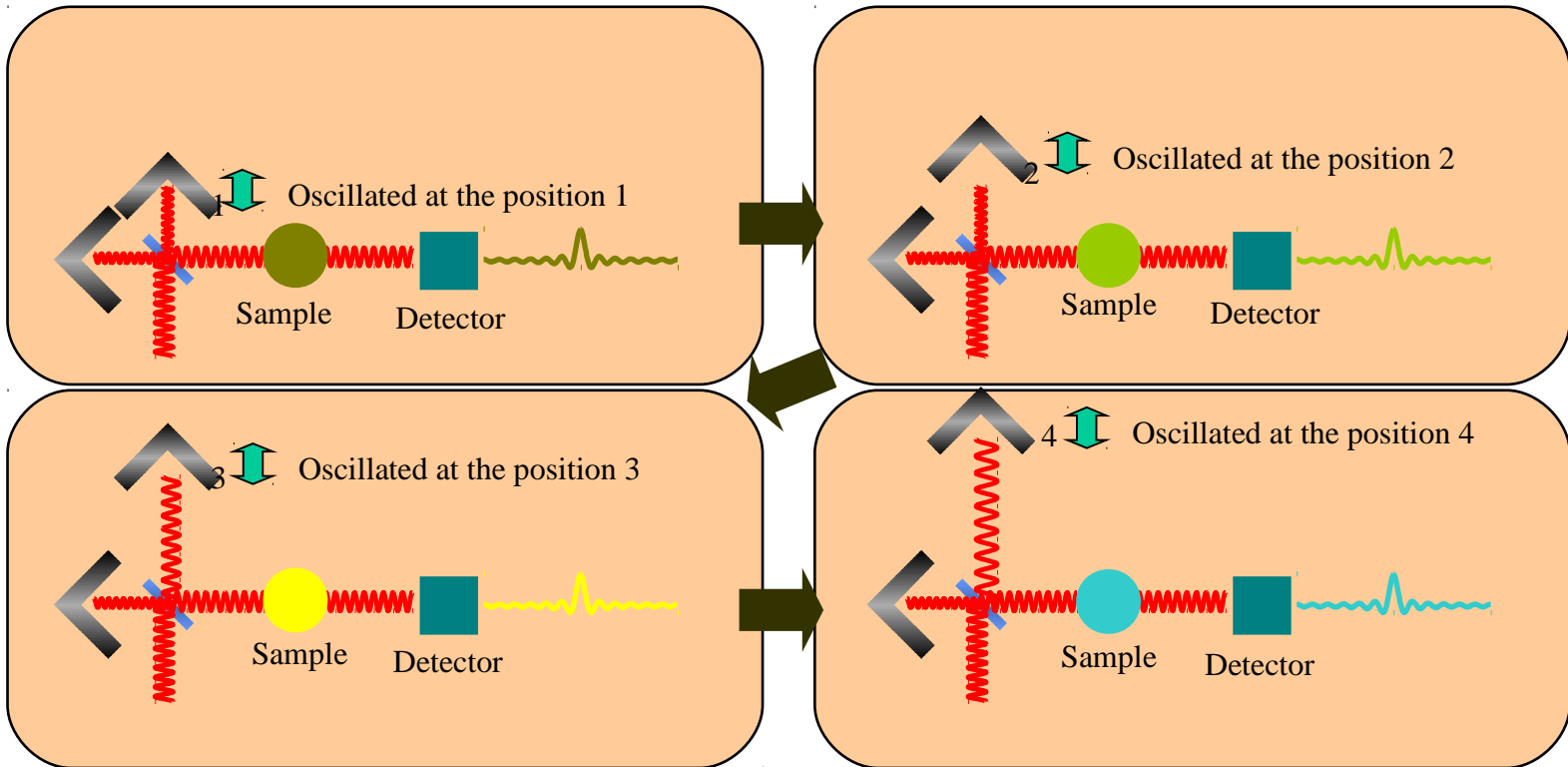
One of the mirrors is oscillated back and forth at a fixed frequency to modulate the infrared light.

As same as Time-resolved spectroscopy mode,
the moving mirror is stopped at each data acquisition point.
But, the moving mirror is not completely stopped.
At near to each data acquisition point,
the mirror is oscillated back and forth at a fixed frequency
to modulate the infrared light.
The signals are detected by Photoacoustic detector.

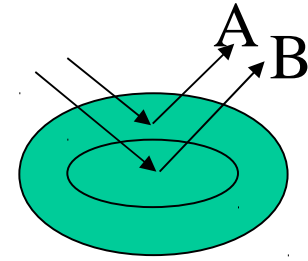
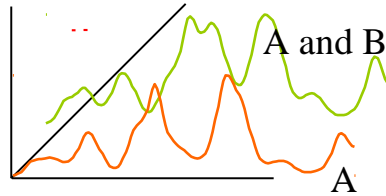
When we change frequency of the oscillation,
we can get different interferogram
and different spectra which show depth profiling of sample.

- Phase-modulated (Photoacoustic depth profiling)

The mirror is oscillated back and forth at a fixed frequency to modulate the infrared light.



FFT



When we change frequency of the oscillation, we can get different interferogram and different spectra which show depth profiling of sample.

Sample

Step Scan

General description (5)

- Amplitude-modulated

Both mirrors are stopped completely when the data are collected at each mirror position.

As same as Time-resolved spectroscopy mode, the moving mirror is stopped at each data acquisition point. In this case, the moving mirror is completely stopped.

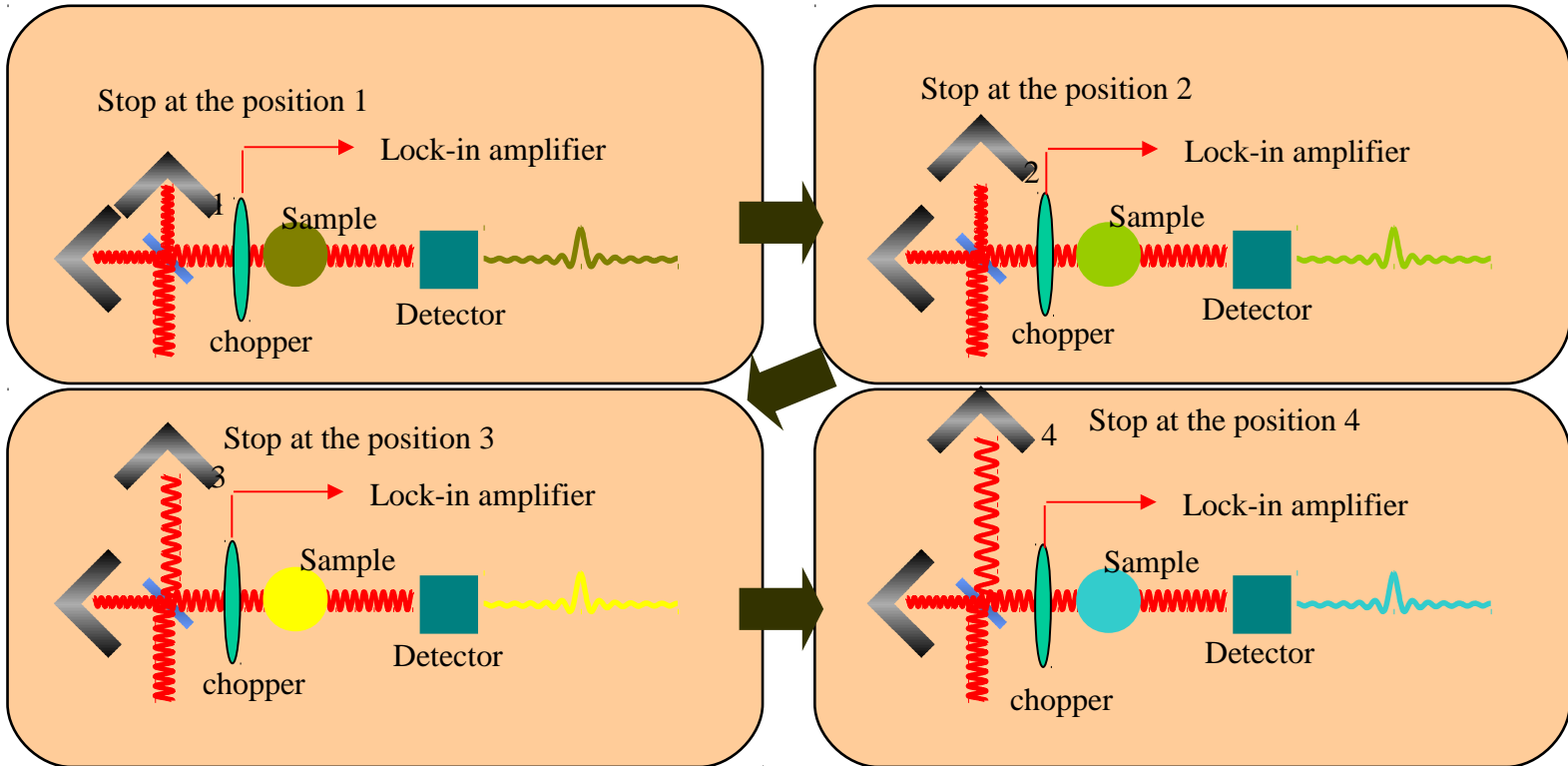
The chopper between the interferometer and a sample is rotated, which effectively removes the high unwanted constant signal level of an ordinary interferogram, thereby greatly increasing the dynamic range of the detection electronics.

The reference signal is sent to the lock-in amplifier.

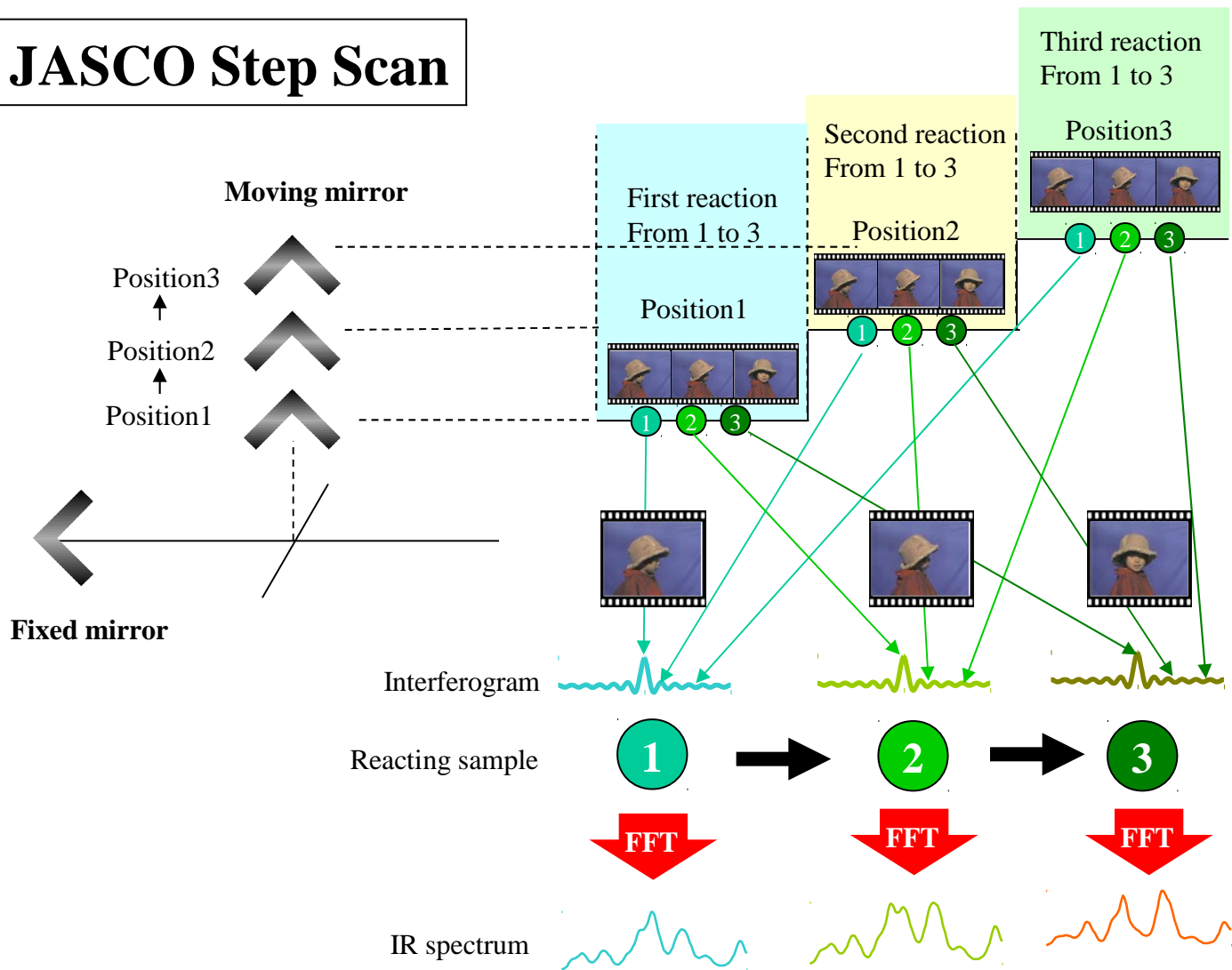
The signal detected by the lock-in amplifier is sent back to the system.

This mode is used for detection of very weak signal.

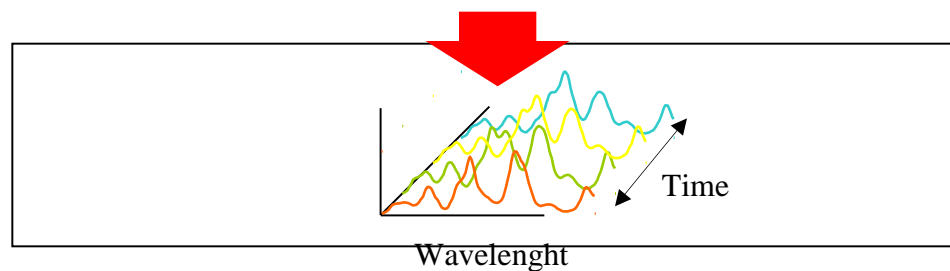
- Amplitude-modulated



JASCO Step Scan



During the reaction is repeated, each part of the interferogram at each time is recorded at each step of the moving mirror. After all, each interferogram is completed.



New

FT/IR-4000/6000 Series



Step scan

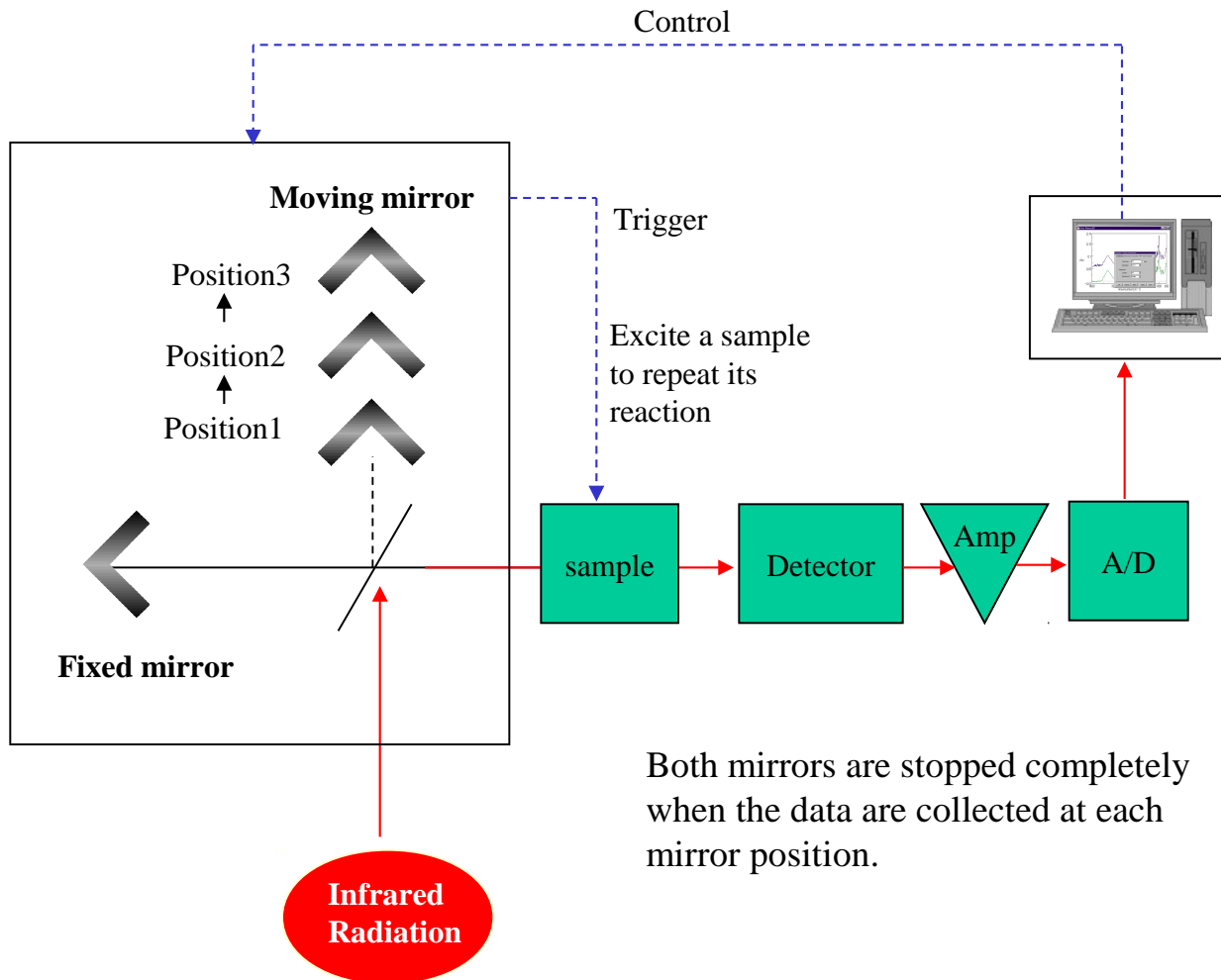
	FT/IR-6100/6200/6300	FT/IR-4100/4200
Step scan	Option (100 to 0.002Hz)	NA
	100, 50, 20, 10, 5, 1, 0.5, 0.2, 0.1, 0.05, 0.02, 0.01, 0.005, 0.002 (Hz)	

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FT/IR-6000 Series

Fourier Transform Infrared Spectrometers

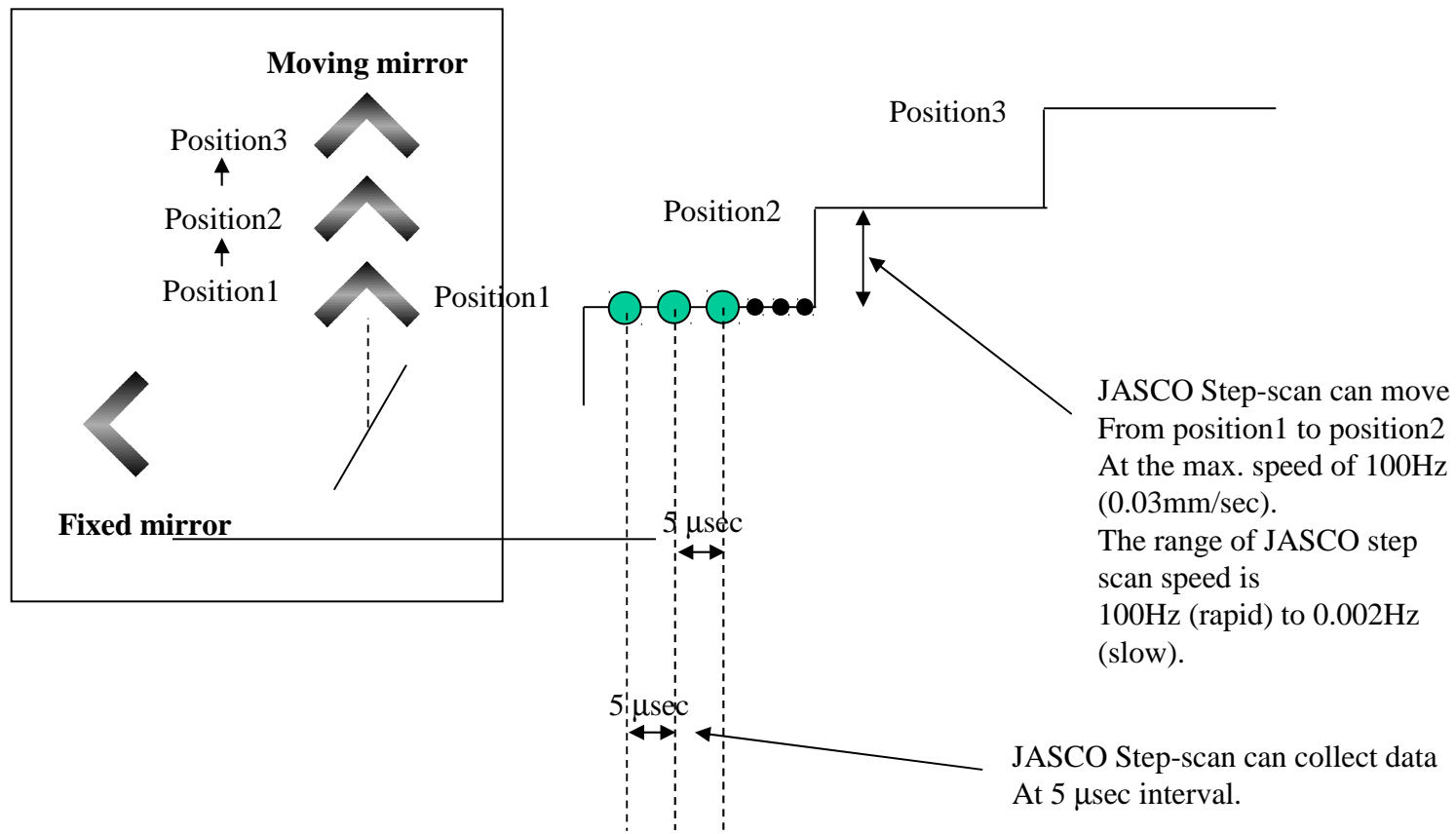
JASCO Step Scan



FT/IR-6000 Series

Fourier Transform Infrared Spectrometers

JASCO Step Scan



FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

New

Microscope (Two types)

- ✓ **IRT-3000 Infrared Microscope**
- ✓ **IMV-4000 Multi-channel Infrared Microscope**



FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

IMV-4000 Multi-channel Infrared Microscope



FTIR Main unit :	All models of this series: FT/IR-4100/4200 FT/IR-6100/6200/6300
Detector	Linear array MCT
Number of elements	1 x 16 (Max 96)
Element size	30 x 30 μm
Wavenumber range	7800 -750 cm^{-1} (MCT) 10000-1900 cm^{-1} (InSb)
Scan method	10 Hz - rapid scan
2D Imaging	1 D detector with scan mirror
Others	ATR-TPZ Imaging Time-resolved Step scan θ stage

New

FT/IR-4000/6000 Series

Microscope / IR Imaging

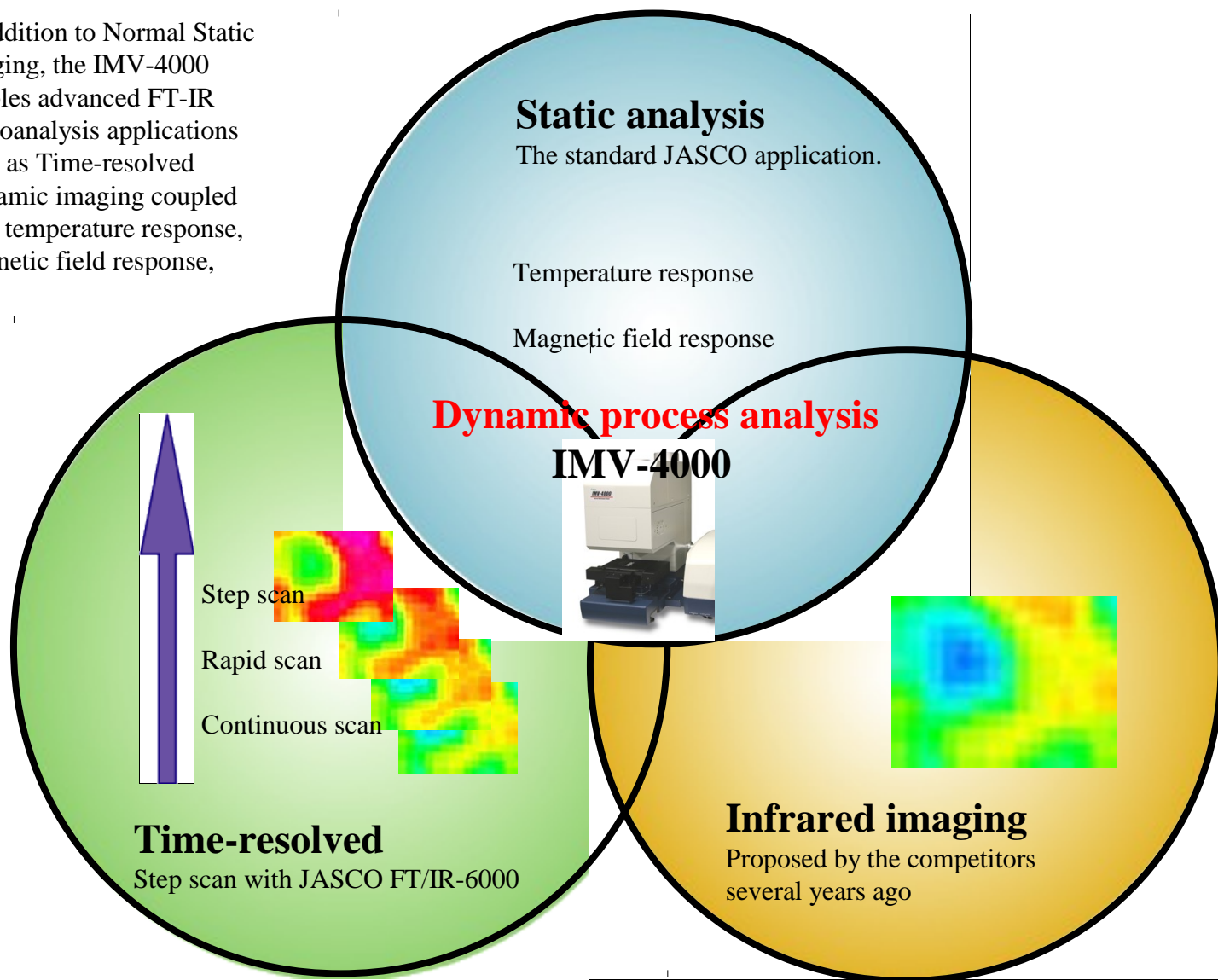
	FT/IR-6100/6200/6300	FT/IR-4100/4200
IRT-3000	Option	Option
IMV-4000 Linear array MCT	Option (IR Imaging with Rapid scan) Time-resolved step scan	Option (IR Imaging with Rapid scan)

FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

IMV-4000 Multi-channel Infrared Microscope

In addition to Normal Static Imaging, the IMV-4000 enables advanced FT-IR microanalysis applications such as Time-resolved Dynamic imaging coupled with temperature response, magnetic field response, etc.

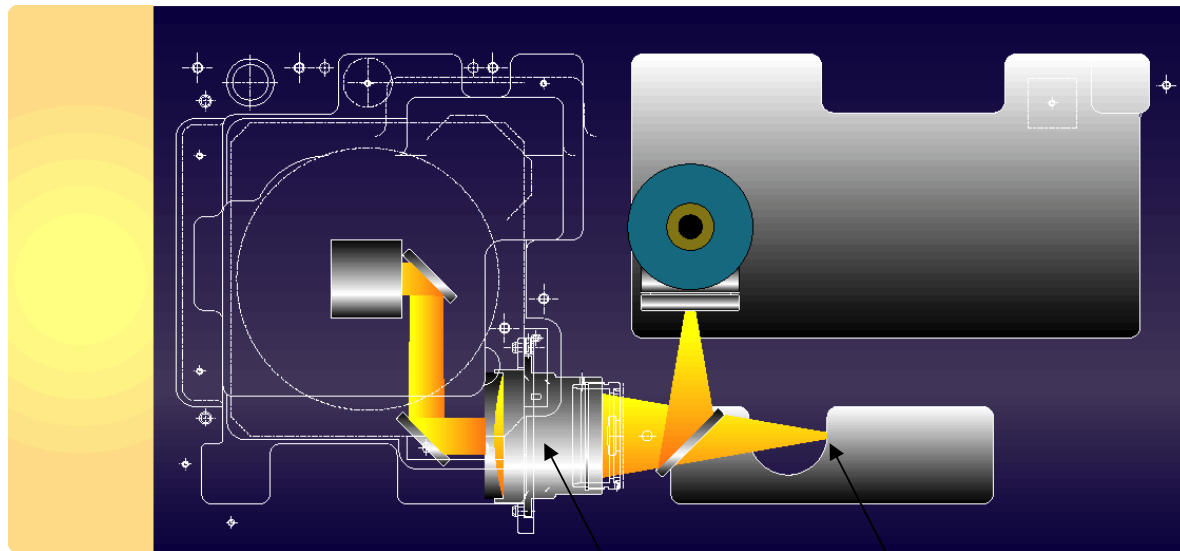


FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

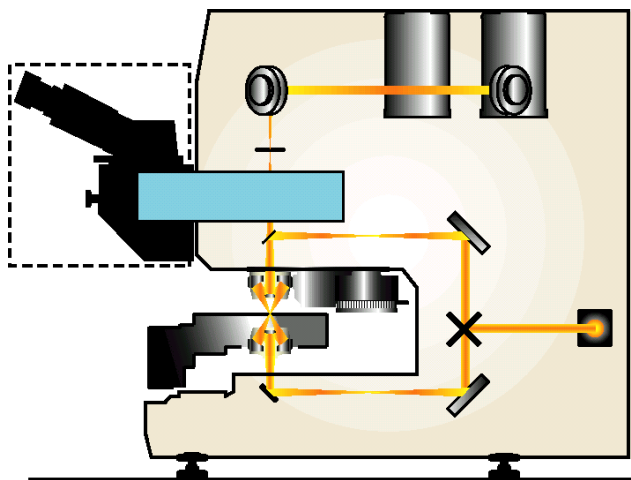
IMV-4000 Multi-channel Infrared Microscope

Top view

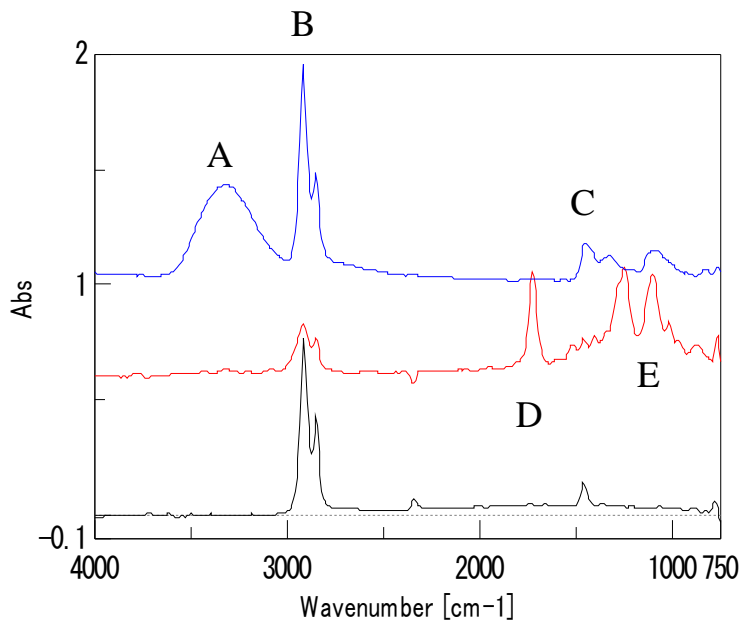
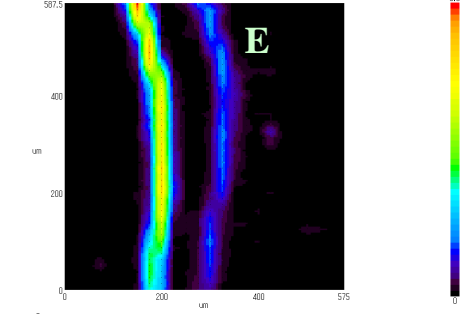
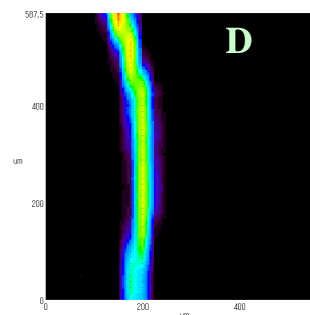
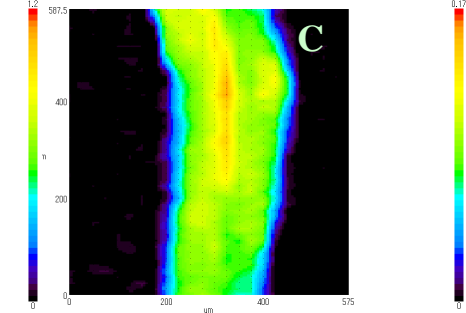
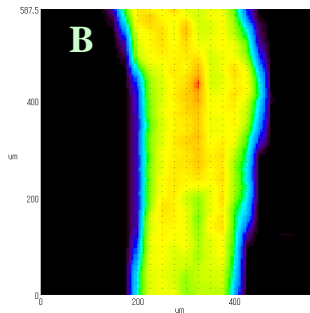
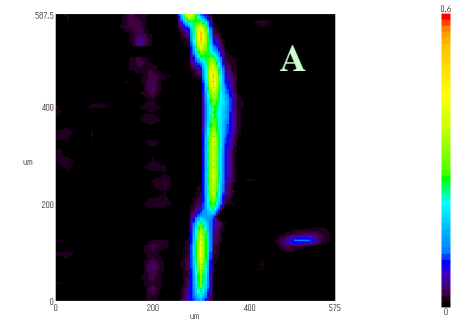
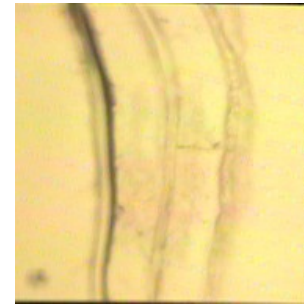


Beam
condenser

Linear array



Measurement area : 600 x 600 μm
Number of measurement point : 48 x 48
Spatial resolution : 12.5 x 12.5 μm
Resolution : 16 cm^{-1}
Accumulation: 16
Collection time : Approx. 4 minutes



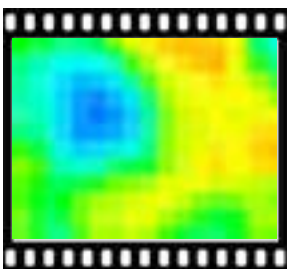
Area analysis

Static
Mapping

IR Imaging



Photo

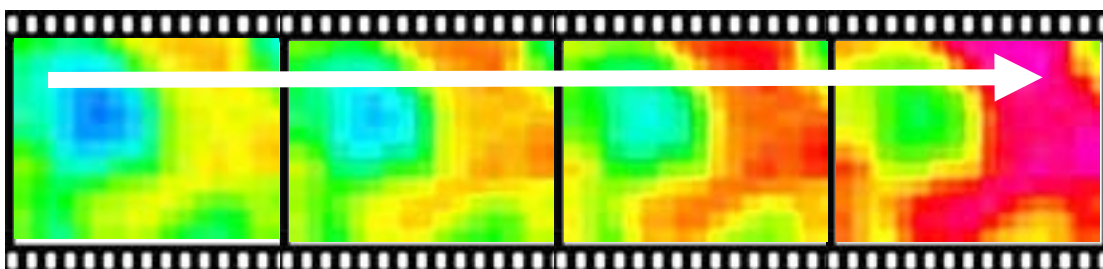


Stable samples

Dynamic
Imaging



Movie



Reacting samples

Time

Area analysis

Static Mapping

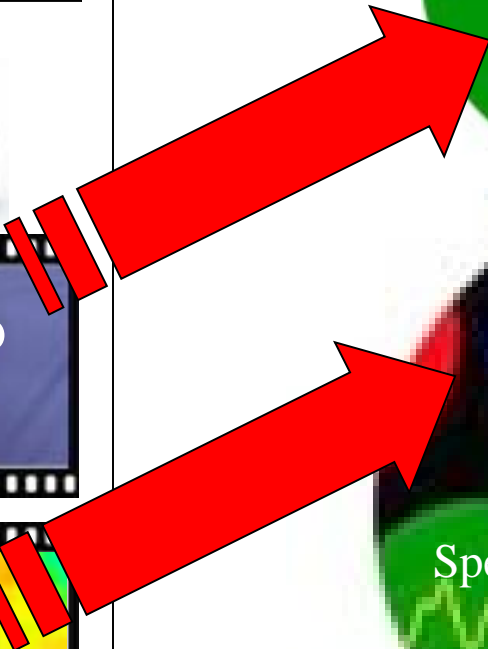
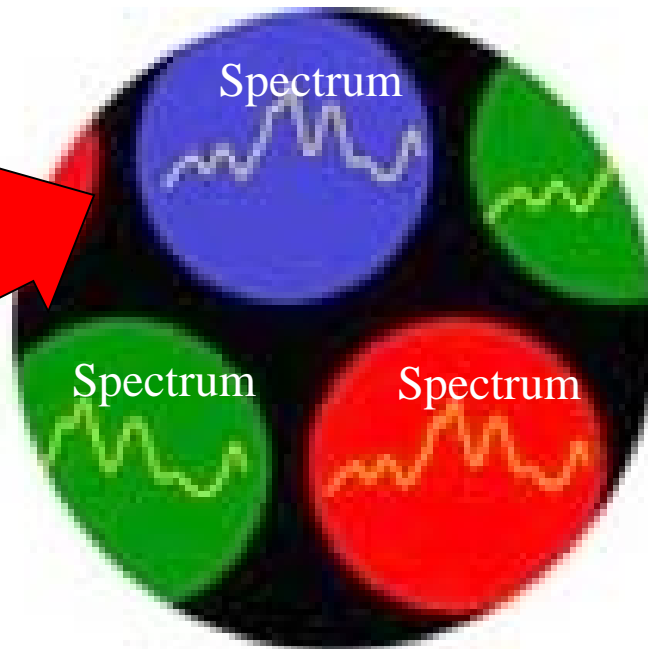
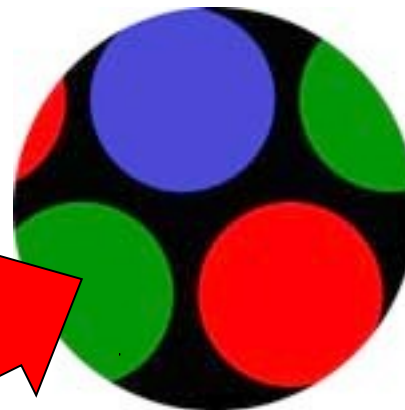
IR Imaging



Photo



Stable samples

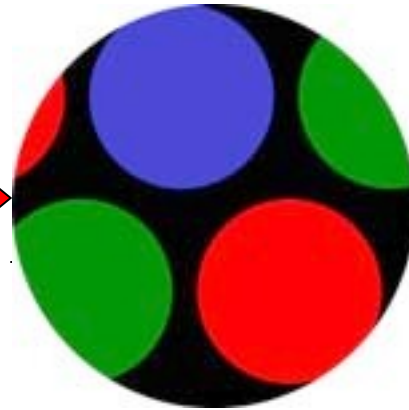


Static Area Analysis



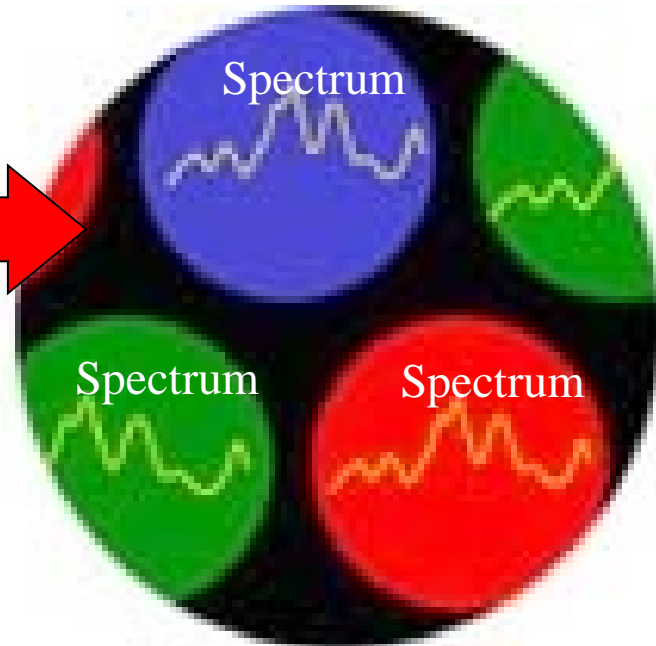
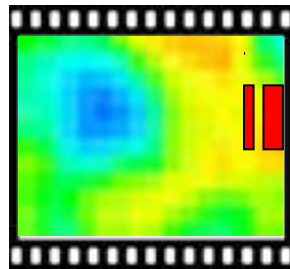
Camera

Photo



IMV-4000

IR Imaging



FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

Area analysis

Static Mapping

IR Imaging



Photo

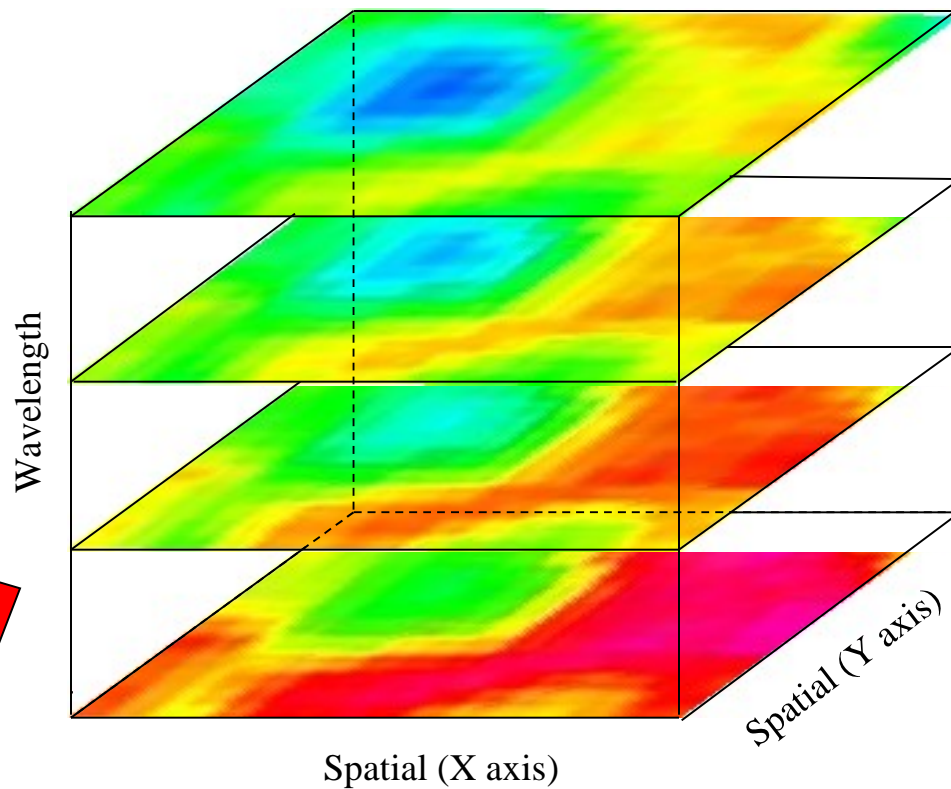


Stable samples



A vertical sequence of four images illustrating the process of area analysis. From top to bottom: the text 'Static Mapping', the text 'IR Imaging' above a silver IR camera, the text 'Photo' above a film strip showing a person's profile, and the text 'Stable samples' above a film strip showing a spectral image of a sample. A large red arrow points from the bottom image towards the 'Data Cube'.

Data Cube



FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

Area analysis

Static Mapping

IR Imaging

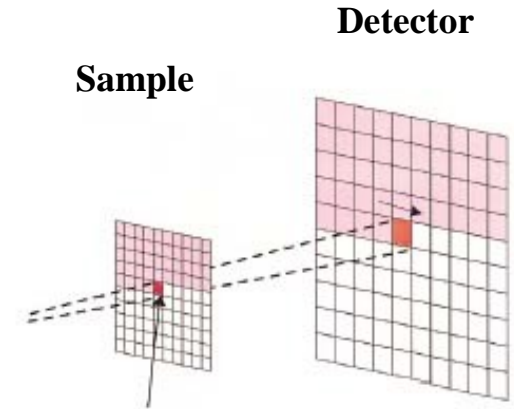


Photo

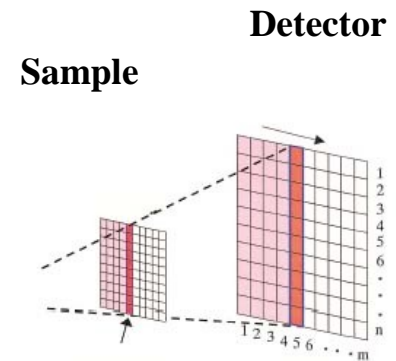


Stable samples

Conventional Mapping
Point by point



Rapid Scan Imaging
By Linear array detector



FT/IR-4000/6000 Series

Fourier Transform Infrared Spectrometers

Area analysis

Static Mapping

IR Imaging



Photo

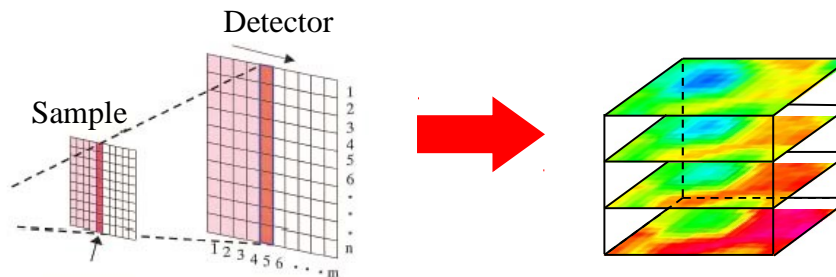


Stable samples

JASCO IR Imaging System FT/IR-4100 with IMV-4000 (Linear array detector and Rapid scan)



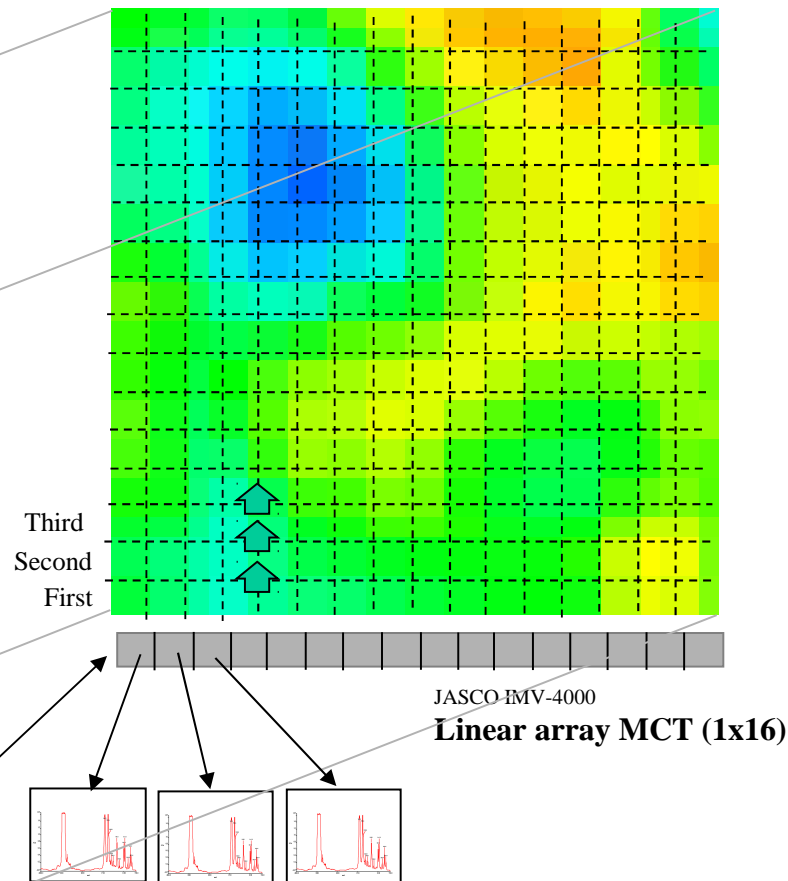
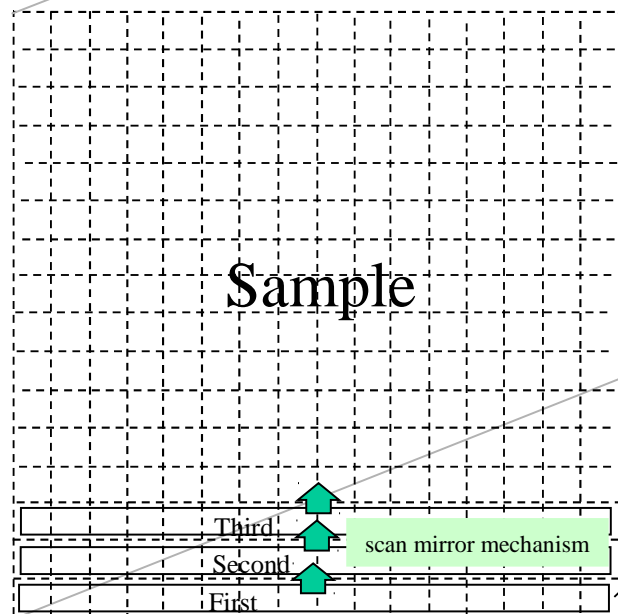
Rapid Scan Imaging By Linear array detector



JASCO IR Imaging System
FT/IR-4100 with IMV-4000
(Linear array detector and Rapid scan)

IR Imaging

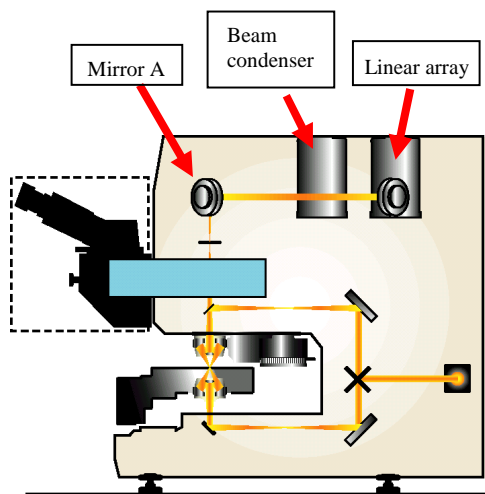
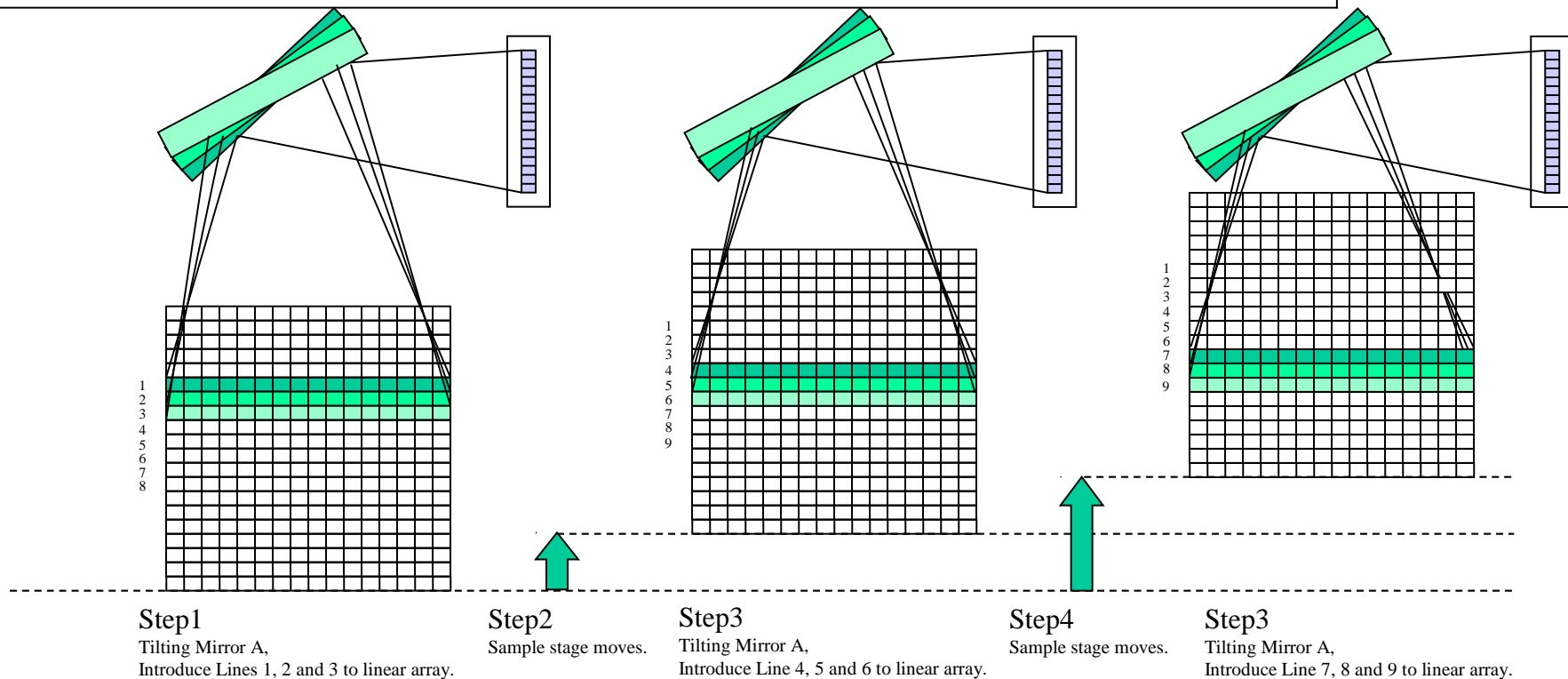
IMV-4000 Multi-channel Infrared Microscope
employs a rapid scan spectrometer rather than an
expensive and complex step scan instrument.



3D display – line map
Peak height or peak ratio 2-D
map

JASCO IR Imaging System

FT/IR-4100 with IMV-4000 (Linear array detector and Rapid scan)



Tilting Mirror A, introduce 5 lines of the sample to the detector line by line. After that, the sample stage moves and Mirror A returns to the initial position. Again, tilting Mirror A to introduce the next 5 lines. Repeat this and scan the entire specified area.

FT/IR-6000 Series

Fourier Transform Infrared Spectrometers

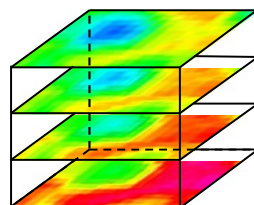
Area analysis

Dynamic
Imaging

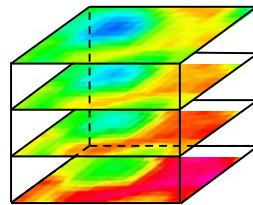
JASCO IR Imaging System
FT/IR-6000 Series with IMV-4000
(Linear array detector and **Step scan)**



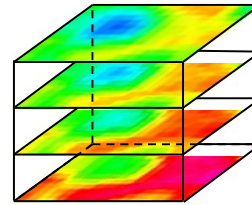
10 μ sec



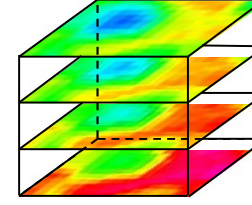
20 μ sec



30 μ sec



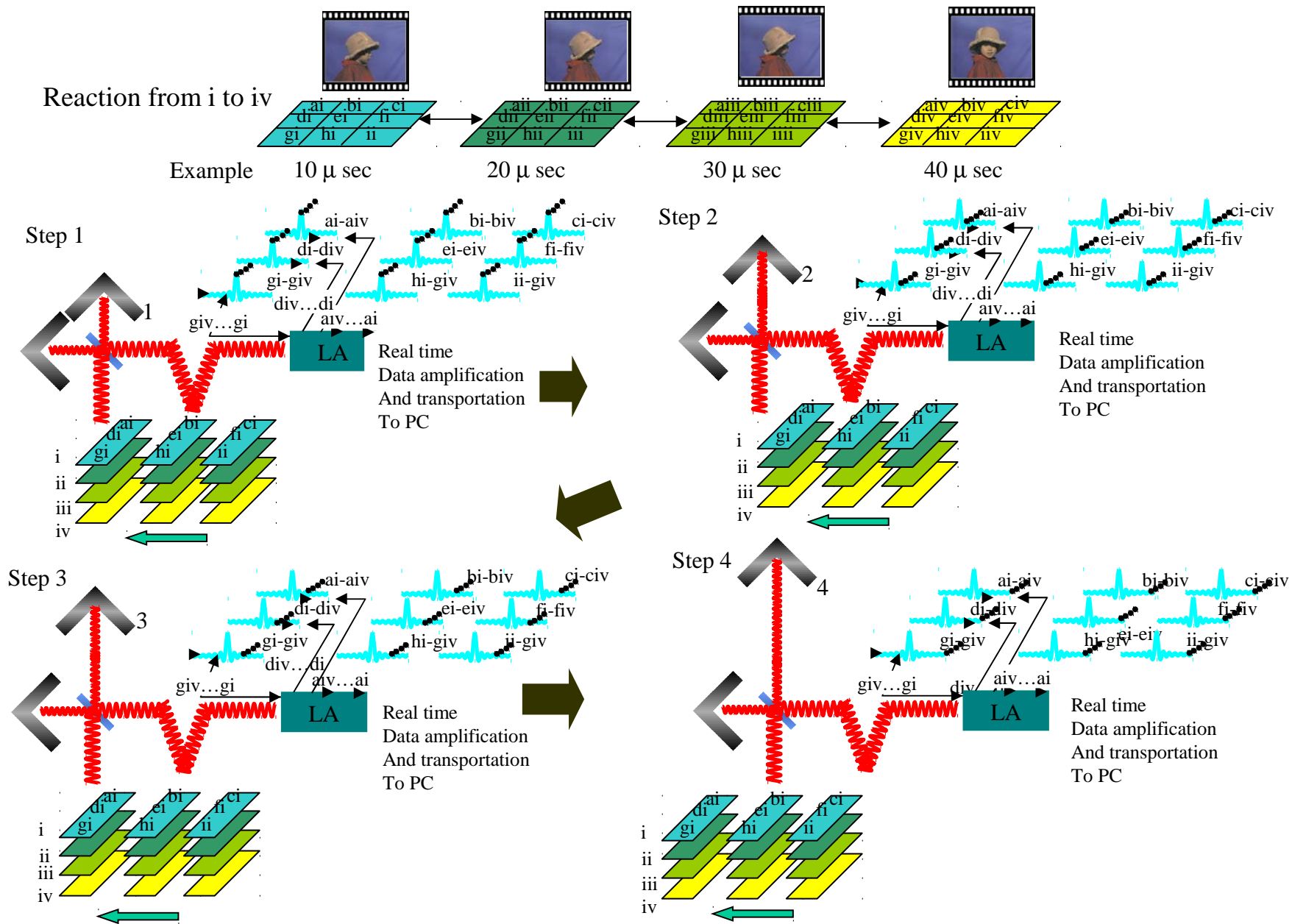
40 μ sec

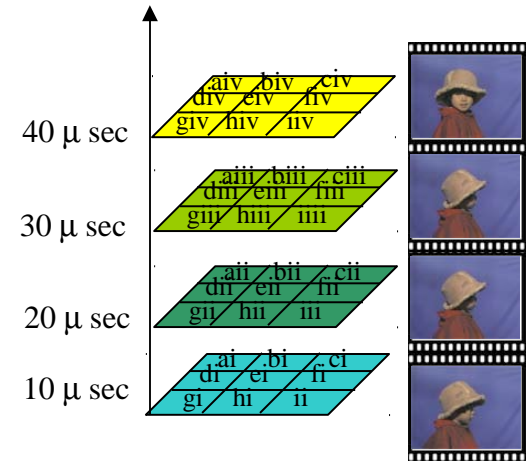
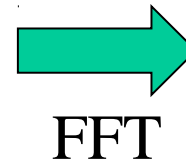
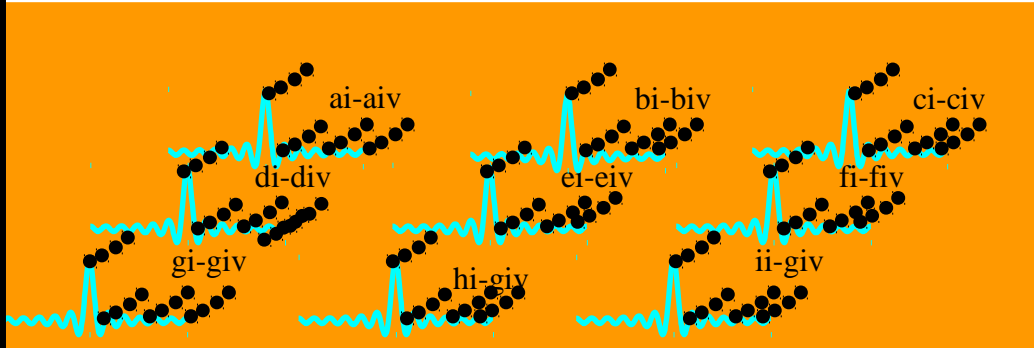


Reacting samples

Time







The JASCO Step-scan imaging system uses 16 amplifiers for the 16 detector elements. Signal amplification is completed simultaneously, thus the system can perform 'dynamic imaging' using several time-resolved images.

