



Surface Science Instruments with Real Vision™

FTA1000 Drop Shape Instrumentation

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The FTA1000 is a modular video drop shape system that allows you to

- purchase an instrument to meet your needs
- minimize your cost
- upgrade later while protecting your investment
- easily perform maintenance by module swap

This guide will help you make the best choices for your application. There are separate modules for

- the basic support frame
- specimen stage or chamber
- video camera
- microscope optics
- backlight
- liquid dispense
- controllers and pumps
- autosampler
- top view (overhead) video camera

At first this seems complicated, but we will explain each choice carefully and provide examples. You will like the fact that you can see how your total instrument cost adds up. Almost all systems will have one module from each of the first seven types — only expensive instruments will have optional autosamplers or top view cameras.

You may also wish to add additional modules as accessories. This is an easy way to upgrade later or divide an expensive system into two year's budgets. Examples of FTA1000 equivalents of familiar legacy FTA instruments are included at the end of this catalog.

All modules are listed on the facing inside cover. The inside of the back cover has a flow diagram for the module selection process. Finally there is a default choice for each module type. Use it until you know there is a better choice for you.

Software: FTA software requires Microsoft® Windows 2000, XP or Vista. Vista places certain limitations on the system as not all cameras have the required drivers. This is discussed more in the camera section. Generally speaking, the operating system sets the requirements for the computer, not the FTA software. The requirements for satisfactory Vista operation are substantial and it provides no advantages to FTA software.

FTA uses USB ports to control the instrument. These may be 1.1 or 2.0.

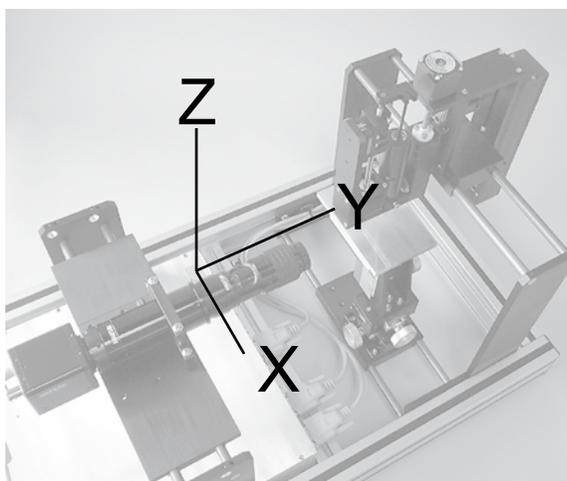
Certain FTA cameras use 6-pin IEEE-1394a (Firewire) ports. These are Vista compatible and you should obtain any Vista computer with them. Our fastest Firewire cameras require the 9-pin IEEE-1394b port.

- Instruments always include the required software. You may download upgrades to your software from the FTA website without charge.
- Licenses for FTA software are site-wide, meaning members of your group may make copies as necessary to use with the FTA instrument.
- Vista compatible software carries a surcharge. If you wish to upgrade an older system to Vista, consult the factory. Additional details also appear on the FTA website.
- There are no separate charges for software modules: if your hardware can support the software function, it is made available to you. If it comes available in the future, you can download it from the website.

Other Details: Each group of modules, say the cameras, has a unique character position in the overall part number. The letter or number that goes in that position will be listed for each choice. A zero in a position means no module of this type is included. The examples at the end will show complete part numbers. Your distributor or FTA can lead you through building the complete part number.

- Within the FTA1000 system, +Z is always up and -Z down. +Y is along the optical axis of the horizontal microscope, towards the specimen. -Y is back towards the camera. Looking along this optical axis, +X is to the right and -X is to the left. This is a right-hand coordinate system. You need this orientation information to fully understand the dimensions of the specimen stages and their motion capability.
- Check the FTA website for the availability of all modules and for new additions. This is particularly

important if you wish to run Microsoft's Vista, as the availability of many camera drivers is uncertain at the time of this publication.



Contact angle meters were originally called *goniometers* because they incorporated a mechanical stage of that name — we now do it with computers

FRAMES

There are three classes of FTA1000 instruments: A, B and C. The support frame of each class is the primary determinant of its functionality and cost. The frame size determines the footprint on the table top and what accessories can be added.

If you need a small instrument and need to minimize cost, choose the B frame. If you want an expandable, general purpose instrument, choose the C frame. If you are going to integrate specific modules into your instrument, look first at the A class. A-class instruments

include robotics mounted devices. They have a separate catalog, but are briefly described below.

All model numbers start with the frame size letter code: A, B, or C. This tells us how the module is mounted and wired. B and C frames are constructed from extruded aluminum struts with T slots running their length. Most modules mount in the T slots. This allows flexibility in positioning and ease of removal.

Class	Purpose	Approximate Size and Weight
A	portable and OEM modules	≈75mm wide, 100mm deep, 200mm high, 1kg
B	economical, small bench top instruments	565mm wide, 330mm wide, 355mm high, 15kg
C	general purpose lab instruments	730mm wide, 442mm deep, 460mm high, 40kg

A-class modules address two specific needs:

- functional building blocks to incorporate into your larger instrument or system (OEM use)
- simple stand-alone instruments suitable for portable or factory floor use

They are different from the B and C classes in that they

- include their own microprocessor, so do not need to be run from a Windows computer
- support local displays and simple control keyboards for operator input, but
- can be completely controlled from a remote host over an Ethernet (LAN) or the Internet
- provide minimal, but robust, automated functions

Another important difference is the A-class is designed to allow small light weight measurement and dispense heads to be located remotely from the controller. The controller is heavier since it contains the local user display and keyboard. The liquid pump may be located next to either the controller or the head. This flexibility accommodates the needs of robotics designers.

NanoDispense™ heads are the key to the design. They provide advanced liquid dispense and contact angle measurement capabilities. These are completely automated functions with no operator input. The heads are optimized to automatically

- dispense precise liquid volumes, particularly small volumes
- position themselves the needed distance above the surface (automatic tip Z)
- measure contact angles of liquids on surface

Some of the heads are optimized for dispense and omit the contact angle function. All include a miniature built-in video system to automate and verify the dispense volume. Notice such functions as interfacial tension measurement and surface energy calculation are not included in these building blocks. This minimizes size and cost. A-class heads include

- top view contact angle: excellent for low contact angles, down to 0° even though it can measure above 90°, and for those situations when you must measure *down in a well* and you can not view the drop from the side
- side view contact angle: classic contact angle measurements with macroscopic (≈μl) drops
- small drop dispense: picoliter (20pl) to microliter (1μl) verified dispense, dip-and-sip capability for minimal prime requirements, viscosities up to 20mPa-s. High dispense rates.
- polymer jetter dispense: picoliter dispense of heated polymers. Includes thermal control to 240C.
- solder jetter dispense: picoliter dispense of molten solders. Includes thermal control to 240C and nitrogen blanket to prevent oxidation.

1mm ≈ .04"
 25.4mm = 1"
 75mm = 2.95"
 100mm = 3.94"
 200mm = 7.87"
 565mm = 22.24"
 730mm = 28.74"
 1kg = 2.2 lbs
 15kg = 33 lbs
 40kg = 88 lbs

STAGES & CHAMBERS

In some ways, this is the most difficult choice as there are many options. You may find it useful to order more than one stage or chamber. You can easily interchange them. The software will automatically detect modules that accept automatic control and will adjust itself accordingly.

How to choose a stage or chamber:

- how big are your samples?
- do you plan single measurements or step-and-repeat across the surface?
- do you require ambient temperature or atmosphere control?
- do you have precise, constant size samples, like wafers, or random sizes?
- do you specialize in either liquids or solids?

Start with the simplest solution that will suffice. Chambers are more complicated than stages. If you require a chamber, and wish to dispense liquid into it, remember only the dispense needle is maintained at the chamber temperature. If the liquid will freeze at room temperature, you require a syringe heater.

Look through the offerings and see what seems to fit best. Stages and chambers are the one area we are constantly expanding our line to meet new demands. Request a special, if necessary.

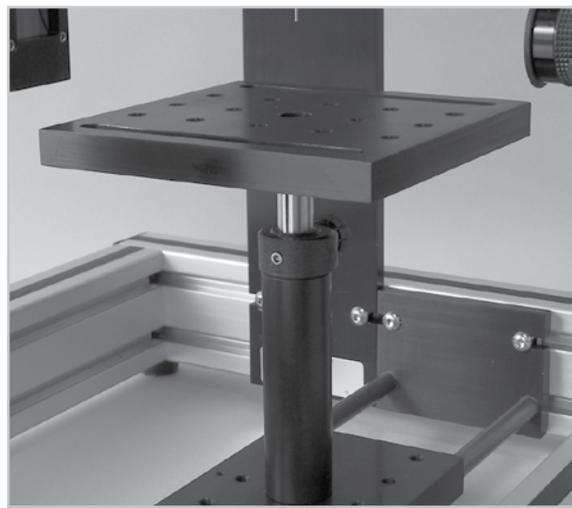
Each available module will be described in the following by its part number and name.

Default B stage	B 1: simple manual table
Default C stage	C 4: 150mm motorized XYZ

B 1	Stage, simple table
C 1	

The lowest cost specimen stage. A square table provides a support surface for your specimen and also has an array of M6 threaded holes into which you can mount your own sample holder. The table is supported on a round post with adjustable Z position. The Z position is fixed by a locking knob. You can mount other tables on the post. There is no automation with this table.

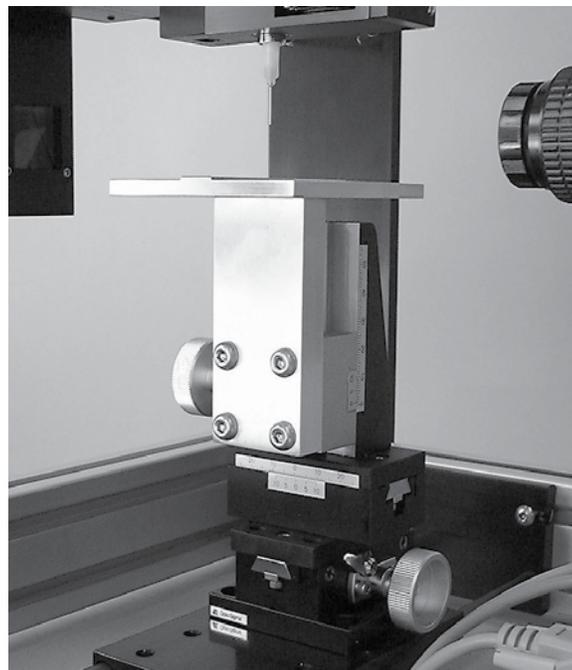
Platform	125 × 125mm
Adjustment range	
Z:	50mm with locking knob
Y:	(only by setscrew)
X:	(only by T-nut)



B 2	Stage, rack-and-pinion
C 2	

A manual stage with no automation, but the rack-and-pinion gearing allows you to adjust the stage along all three axes. Fixtures are available to support small specimens and flexible samples like paper or foil. This is a full-featured manual stage and is useful for handling samples of the order of 25mm in size. This table is similar, but not identical, to that furnished with the FTA200.

Platform	75mm (Y) × 115mm (X)
Adjustment range	
Z:	30mm
Y:	30mm
X:	30mm



STAGES & CHAMBERS

B 3	Stage, rotary table
C 3	

A simple motorized rotary stage so you can bring several samples into view under software control. The B frame version has a 100mm diameter round platform and the C 150mm. Samples are normally placed around the periphery of the stage. This arrangement provides substantial linear distance along which to position samples. The Z height is adjustable by mounting screws in slots. It is often used when external robotics

are to position samples on the stage. This is the least expensive motorized stage.

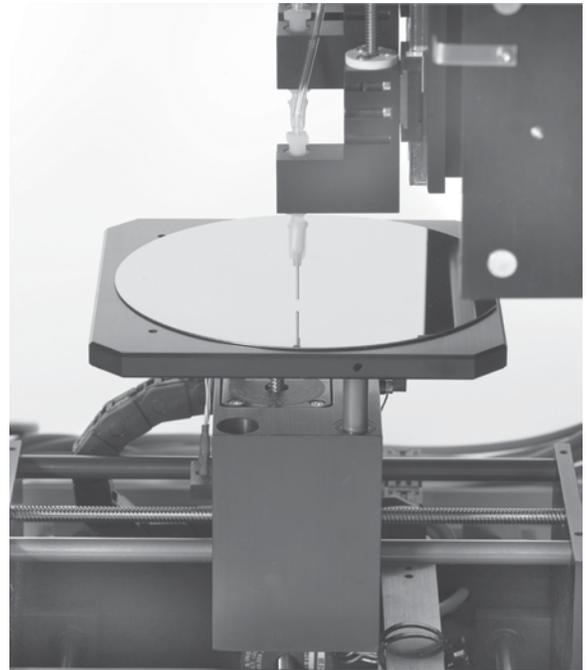
Platform	100/150mm diameter circle
Adjustment range	25mm by shaft screw (only by setscrew) (only by T-nut)
Z:	
Y:	
X:	
Motion Range Rate	360° θ 30°/s

	Stage, 150mm XYZ motorized
C 4	

Stepper motors provide 150mm drive in X and Y and 25mm in Z with software control. You can easily fasten sub-stages of your own design to the platform.

Platform	150mm square
Motion Range	150mm 25mm 50mm/s all axes
X, Y	
Z	
Rate	

This and other large platforms place restrictions on the optics. The shorter working distance of many FTA microscopes bring the end of the microscope into the travel range of the stage. You can either take care in programming stage movements or choose a microscope with a working distance of 150mm or more, in which case the stage can not reach the microscope.



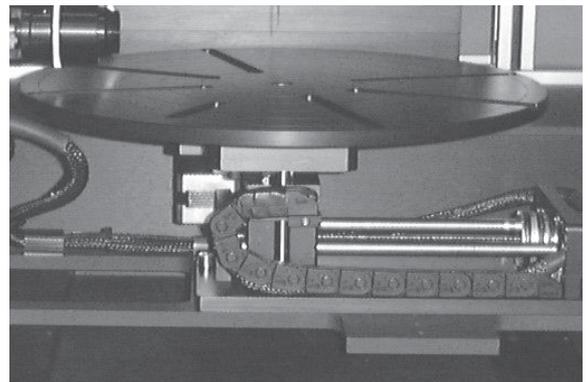
	Stage, 300mm R- θ -Z motorized
C 5	

This stage was designed for 300mm wafers, but you can mount any samples you wish, including smaller wafers and rectangular ones, within its perimeter. The dispense tip can access any point through its rotation (θ) and X axes. You can choose to move the stage in cylindrical coordinates (R- θ -Z) or Cartesian coordinates (X-Y-Z). You achieve the equivalent of Y motion through a combination of X and θ motions. The trigonometric translation is provided in software.

For semiconductor manufacturers, we offer FOUF interfaces and the SECS protocol.

This stage is the largest automatic stage for the C frame. If you have larger samples, you should consider an A-class measurement head that moves over the sample, rather than a stage, like this one, which moves under the dispense tip. The specimen table is mounted with a single central M6 flat head screw, making it easy to attach your own custom table.

Platform	300mm diameter circle (all points accessible)
Motion Range	150mm 25mm 12.5mm/s 30°/s
X	
Z	
Rate	
X	
θ	

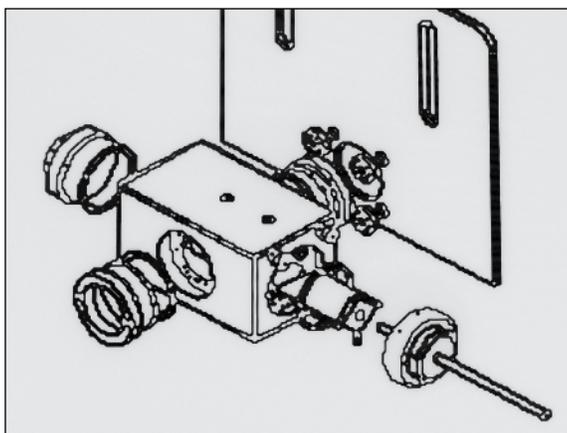
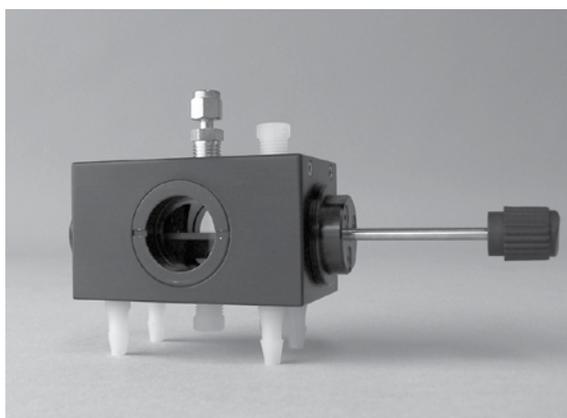


STAGES & CHAMBERS

B A	Chamber, sealed IFT
C A	

A small sealed chamber suitable for liquid-vapor, liquid-liquid, liquid-solid-vapor, and liquid-liquid-solid measurements under controlled conditions. A removable sliding stage can position solid surfaces in the field of view. Temperature is stabilized by a user-provided circulating bath through two loops in the aluminum chamber body. The chamber is Viton O-ring sealed and rated to 6 bar (100 PSI). The temperature range is from slightly below ambient (until condensation forms on the windows) to 200C if a suitable circulating fluid, tubing, and fittings are used.

15mm diameter windows on the front and back provide light passage. The sample stage for contact angle work is controlled manually by a rod passing through an O-ring seal on the Y face of the chamber. You would normally remove it for pendant drop work. A needle port is provided on both the +Z and -Z faces, so a straight needle can approach from above or below. There are two additional fill/drain/pressure ports on the +Z and -Z faces. The internal volume is approximately 22ml. The chamber can be disassembled to clean.



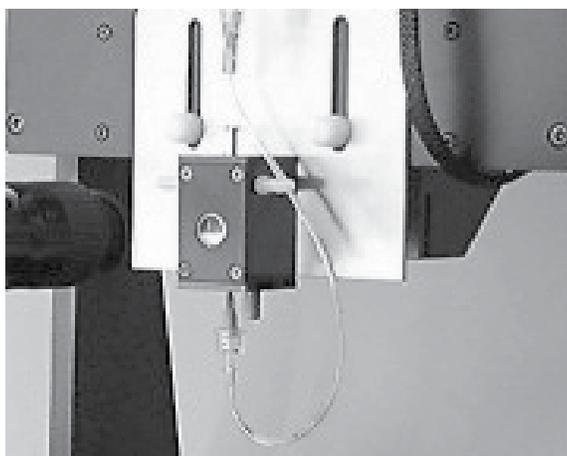
Exploded view showing removable ports and stage

Platform	15mm x 20mm removable
Adjustment range	
Z:	centered by mounting screw
Y:	none
X:	manual rod positions sample

B B	Chamber, 12.5mm cuvette holder
C B	

Holds standard 10mm path, 4.5ml volume cuvettes for liquid-liquid work. The holder can be turned over to accommodate a straight needle from below, as shown in the photo. A tubing loop then connects the needle to the pump fitting. The holder is temperature stabilized by a user-provided circulating bath. Like the sealed IFT chamber, the temperature range is limited on the low end by window condensation and on the upper end by the cuvettes themselves, the circulating liquid, and the tubing and fittings employed. The holder has its own windows which help prevent condensation against the cuvette itself.

FTA can provide accessory cuvettes and mating caps that seal the top and have needle holes in them so they can operate upside down. Consult your distributor or FTA to determine the best choice for your needs. Note that upside down sealed cuvettes must have sufficient vapor (air) enclosed that you can inject what you wish through the needle without raising the pressure to the point that the caps leak.



STAGES & CHAMBERS

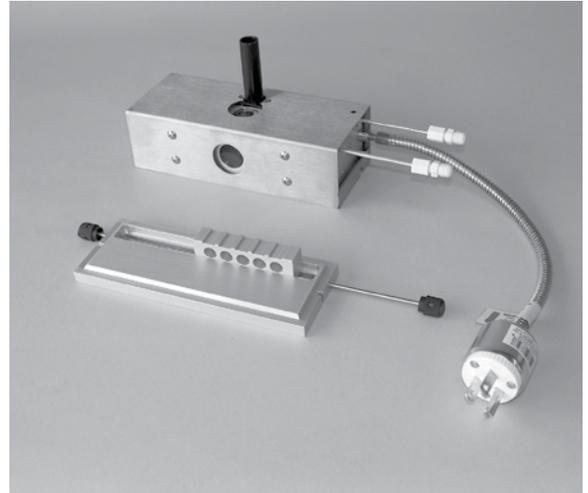
B C	Chamber, 300C environmental
C C	

An electrically heated chamber oriented at contact angle measurements. A linear slide provides manual positioning of a removable sample carrier with space for five small samples. This allows you to measure several samples during a thermal cycle. The chamber has two gas ports to flood it with nitrogen or argon; it is not sealed for use with obnoxious gases. There is a loop through the body so you can use a circulating bath to stabilize the temperature. Two 20mm diameter windows provide light passage through the chamber for measurements. An additional window on the top allows you to inspect the sample.

A needle port is provided above the sample. The needle will normally equilibrate to the chamber wall temperature quickly, so the dispensed liquid is at the chamber temperature. If the sample is solid at room temperature, use a syringe heater available with direct drive syringe pumps. The chamber also comes with an accessory part that will enclose a manually operated glass syringe. This will maintain the syringe at close to the chamber body temperature. A Kevlar cover is provided to improve stability and protect the user from the hot surface.

B frame chambers use an external temperature controller. C frame systems have an internal controller integrated with the software.

Platform	15mm × 75mm removable
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	Chamber, 500C hot stage
C D	

This stage provides rapid thermal cycling between ambient and elevated temperatures. Intended for small samples that are in intimate thermal contact with the stage surface. Solder studies are an obvious application. Nitrogen flooding is possible to maintain a non-oxidizing atmosphere. Uses electrical heating and optional nitrogen flow through the housing for rapid cooling.

Sample region is 25mm square with a maximum height of 10mm. Temperature ramps of 100C/min are possible under software control.

Note this chamber is fundamentally different from an environmental chamber, such as C A or C C, which stabilize the walls and the interior space at some presumed constant temperature. Environmental chambers might well be called equilibrium chambers. This hot stage does not attempt to do that. It has a heat shield around the stage, but that is to limit heat radiation, not to maintain an equilibrium. The temperature of the stage under the sample is controlled, rather than the temperature of the surrounding walls. Hot stages can change temperature rapidly compared to environmental chambers because they have much lower mass (less metal).

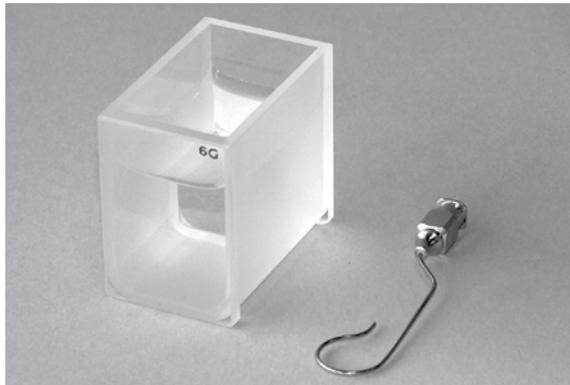
	Chamber, 0-125C Peltier
C E	

A small stage and chamber using Peltier modules for both heating and cooling. No liquids involved. This is an alternative to using an external circulating bath to stabilize a chamber. Sample region is 50mm square with a maximum height of 10mm. Temperature can be ramped under software control. Stage can be operated as high as 200C with reduced life expectancy, as temperature cycles with the max temperature above 100C degrade all thermoelectric cells.

	Chamber, 20mm cuvette holder
C F	

Block to support large, open top cuvette with 20 × 24mm internal footprint. 20mm optical path. Height is 40mm and interval volume 14ml. Cell has polished, optically flat windows. Includes one cuvette. Aluminum body has liquid paths for external circulating bath temperature stabilization.

Use this cuvette with J needles when a bubble-up measurement is required. Its large size makes handling the J needle easy compared to the 12.5mm cuvette.



Large Cuvette and #20 J needle

B T	Stage, full instrument tilt

This cradle supports the entire B frame and tilts it through 90° for tilting plate advancing/receding contact angle measurements. Similar in appearance to the

C frame C T model, except smaller. Unique support brackets stabilize the FTA1000 when not in tilt mode. Tilt rate is software controlled. Max suggested rate is 2°/s.

	Stage, full instrument tilt
C T	

This cradle supports the entire C frame and tilts it through 90° for tilting plate advancing/receding contact angle measurements. It occupies 1144mm (45") by 600mm (23 1/4") on the bench. Unique support brackets stabilize the FTA1000 when not in tilt mode. Tilt rate is software controlled. Max suggested rate is 2°/s. Photo shows tilting an empty C frame.



STAGES & CHAMBERS

CAMERAS

Cameras turn the image from the microscope into an electrical signal that the computer can use. In general, any camera can be fitted with any microscope because they use a common C-mount interface.

Camera selection can be quite technical, as can the selection of optics. See the box below for details.

How to choose a camera:

- if you require precise timing for contact angle and absorption work, choose a frame grabber camera or an IEEE-1394 camera, not a USB camera
- if you use Microsoft's Vista, choose an IEEE-1394 camera
- if you want to run from a laptop, choose a USB or

IEEE-1394 camera

- if you must minimize cost, choose a USB 1.1
- if you want maximum performance in a laptop based camera, choose IEEE-1394
- do not choose a high speed camera unless you need frame rates faster than 60 per second, because these cameras are more difficult to use.

Note that the camera (something with electronics) is quite independent of the microscope (with glass lens).

Default B camera	B 0B: USB 2 monochrome
Default C camera	C 0E: 1/2" RS170 + F.G.

1 The most obvious distinction between the cameras is whether they use a frame grabber, USB, or IEEE-1394 port. IEEE-1394 is also called Firewire. USB ports offer the convenience of not having to add hardware to your computer (so you can use them with laptop computers), but they do not offer the degree of control over camera operation that frame grabbers do. Frame grabbers require you to install a board in a PCI slot inside. The board is furnished with the camera, but the installation must normally be done locally. IEEE-1394 ports are increasingly available and offer the convenience of USB with the performance of frame grabbers. Their primary disadvantages are they cost more and older computers may not have the port built-in. IEEE-1394 ports are available as options on new laptops.

2 The second distinction is the size of the sensor. The two common sizes are 1/2" (6.4mm horizontal × 4.8mm vertical) and 1/3" (4.8mm × 3.6mm). The smaller the sensor, the larger its magnification. This apparent paradox follows from the fact that the image is mapped into a constant area in the computer, so the ratio (i.e., magnification) is greater with smaller sensors. This is called electronic magnification, to distinguish it from optical magnification. Electronic magnification is convenient and economical, but better resolution is obtained with optical magnification. Larger sensors cost more than smaller sensors. You must be aware of the field of view of your camera + optics combination. It is possible to combine a small camera sensor with a high, fixed magnification lens and have only a small field of view available; you will then only be able to look at small samples.

3 The third distinction is the number of pixels in the sensor. The native image format for FTA software is 640 × 480. All FTA cameras have at least this many pixels. Some FTA cameras are megapixel. Our 640 × 480 image has nominal 10µm pixels in a 1/2" sensor (6.4mm ÷ 640 = .01mm = 10µm). The total number of pixels in an image is 307,200. With a 1280 × 960 pixel camera and the same 1/2" sensor size, each pixel is ≈5µm in size and there are 1.23M pixels in the sensor. When working with magnified images, camera pixels smaller than the resolution of the lens are not useful. Consider the "lens pixel size" of your microscope and choose a camera with its pixel size larger than the lens.

4 The fourth distinction is whether you want color or monochrome (black and white). The analytical images we use are intrinsically monochrome. In particular they are refraction images with no sense of color. Color images have 1/2 the resolution in each direction and require 4× the storage space and require 4× the time to transfer, which lowers the frame rate of USB cameras accordingly. All of this follows from the fact that the sensor must have 4 pixels to detect color, in place of one for monochrome. These pixels occupy space on the sensor and their signals take time to transfer.

5 The fifth and final distinction is the camera's frame rate. High frame rates are only necessary when you are measuring absorption. Ordinary cameras will provide 60 images per second, which is sufficient for most work. High speed cameras are expensive and require much brighter illumination. They provide their very highest rates by reducing their image size.

4-pin IEEE-1394 plugs are the most common, but do not power the camera — FTA does not use these.

6-pin plugs power the camera and have a D shape. These are 1394a.

9-pin plugs are slightly smaller than 6-pin (!) and are rectangular. These are 1394b.

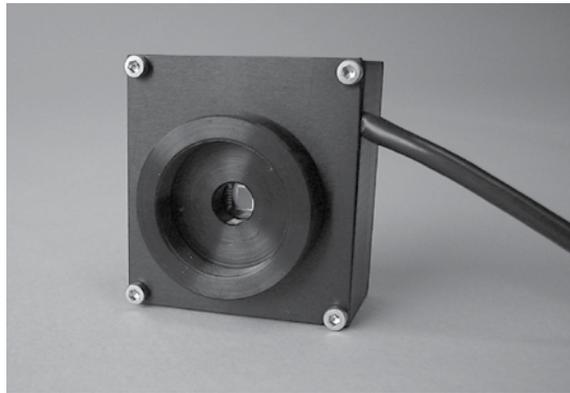
CAMERAS

B 0A	Camera, USB 1.1 mono/color
C 0A	

This low power 1/4" format CCD camera can easily run from and be powered by a laptop, to make a completely portable system. It is a color camera, but it is also effective in monochrome mode.

Its principal limitation is that the full-sized image frame rate is 15 frames per second rather than 30. It does support 30fps at 320 x 240 pixels, which provides an image with the full field of view but only one half the pixels in each direction.

It is our lowest priced camera, but we like it so much we use in our Top View Camera. It is unique in its extensive set of options to control image acquisition. See the section later on Top View Cameras for examples of the zoom and pan capabilities of this camera.



Sensor size	3.6mm x 2.4mm (1/4")
Pixel count	640 x 480 = 307,200
Pixel size	5.6µm
Max frame rate 640 x 480 320 x 240	15fps 30fps
Zoom and pan	Yes (electronic) Zoom to 3x

B 0B	USB 2 monochrome
C 0B	

This is a high performance USB 2.0 CMOS camera. It requires a competent computer—not all laptops are suitable. A half speed driver is provided for slower computers. The megapixel sensor provides zoom and pan. It provides internal zoom and pan.



Sensor size	6.4mm x 4.8mm (1/2")
Pixel count	1280 x 1024 = 1.31M
Pixel size	4.9µm
Max frame rate 640 x 480	45fps
Zoom and pan	Yes

B 0C	USB 2 color
C 0C	

The color model has the same appearance as the monochrome model. Because it is a color camera, the pixels are grouped in quads to provide color. Compared to the monochrome camera, you get 1/4 the independent pixels. The frame rate at 640 x 480 is 15fps. Effectively the pixel size is 9.8µm. CMOS sensor.

Camera sensors come in two types: CCD and CMOS.

CCD = charge coupled device, is the older of the two, offers superior sensitivity but is not used for megapixel cameras because of cost.

CMOS = complementary metal oxide semiconductor and provides megapixel capability.

CAMERAS

B 0D	Camera, 1/3"
C 0D	+ PCI frame grabber

Frame grabber cameras provide better time accuracy which is important for absorption measurements. The included PCI frame grabber is full height ($\approx 100\text{mm}$ or 4 inches); note some compact computer boxes provide only half height. This is an inexpensive CCD camera.

Sensor size	4.8mm \times 3.6mm (1/3")
Pixel count	640 \times 480 = 307,200
Pixel size	7.0 μm
Max frame rate 640 \times 480	60fps
Zoom and pan	No



B 0E	Camera, 1/2"
C 0E	+ PCI frame grabber

The larger CCD of this camera provides better optical resolution and larger field of view compared to 1/3 or 1/4" models. This is an excellent camera. You can see the difference, particularly in demanding situations such as 175mm working distances.

Sensor size	6.4mm \times 4.8mm (1/2")
Pixel count	768 \times 494 = 379,392
Pixel size	9.0 μm
Max frame rate 640 \times 480	60fps
Zoom and pan	No



B 0F	Camera, high speed 360fps
C 0F	+ PCI frame grabber

This CCD camera can read to 360fps using reduced vertical image size. It is a relatively economical way to achieve higher frame rates. Frame rates are set by switches on the back of the camera. The reduced height images have only a portion of the original field of view. This is called region of interest (ROI). The ROI's of this camera are fixed in the middle of the image.

Sensor size	6.4mm \times 4.8mm (1/2")
Pixel count	768 \times 494 = 379,392
Pixel size	9.0 μm
Max frame rate 640 \times 480 640 \times 240 640 \times 134	120fps 240fps (ROI) 360fps (ROI)
Zoom and pan	No



CAMERAS

B 0G	Camera, high speed 2000fps + PCI frame grabber
C 0G	

This is our fastest camera. It uses a Camera Link PCI frame grabber (≈100mm/4 inches high). Partial scan (ROI) frame rates to 2000fps, selected under software control. Partial scan images can be panned vertically, an unusual and useful feature. This is a high quality, easy to use, fast CMOS camera. Other high speed cameras available upon request.



Sensor size	6.4mm × 4.8mm (1/2")
Pixel count	640 × 480 = 307,200
Pixel size	10µm
Max frame rate	
640 × 480	250fps
640 × 240	500fps (ROI)
640 × 60	2000fps (ROI)

B 0J	Camera, IEEE-1394a low cost
C 0J	

Our lowest cost IEEE-1394 CMOS camera and it is Vista compatible. It offers faster than normal image rates by region of interest. ROI is a pan within the full 640 × 480 image space. 6 pin IEEE-1394a connector.

Sensor size	4.8mm × 3.6mm (1/3")
Pixel count	752 × 480 = 360,960
Pixel size	6.0µm
Max frame rate	
640 × 480	60fps
320 × 240	120fps (ROI)
Zoom and pan	Pan only

B 0K	Camera, IEEE-1394b high performance
C 0K	

CCD sensor for lowest noise. IEEE-1394b 9-pin connector, but can run at reduced rates on 6-pin 1394a. Vista compatible. Larger pixel size and CCD sensor compared to the above C 0J.

Sensor size	4.8mm × 3.6mm (1/3")
Pixel count	640 × 480 = 307,200
Pixel size	7.4µm
Max frame rate	(1394b connector)
640 × 480	80fps
320 × 240	135fps (ROI)
Zoom and pan	Pan only

B 0L	Camera, IEEE-1394b high speed 450fps
C 0L	

This is our fastest IEEE-1394 camera. Note it uses the 9-pin IEEE-1394b connector. Vista compatible.

Uses a CCD, rather than CMOS, sensor for superior sensitivity and noise level. ROI means panning within the overall field of view and only seeing a portion of it. Binning means maintaining the full field of view but combining pixels in the data stream sent to the host. This boosts image rate but cuts true resolution. Interpolation within the FTA software restores most of the resolution.

Max frame rate	requires true 1394b port
640 × 480	200fps
320 × 240	320fps (ROI)
640 × 480	350fps (binning)
160 × 120	450fps (ROI)
Zoom and pan	Pan only

Sensor size	4.8mm × 3.6mm (1/3")
Pixel count	640 × 480 = 307,200
Pixel size	7µm



MICROSCOPES

Optics provide the magnification and focusing of the image onto the sensor. We use a microscope, which is a lens with relatively high magnification. As with the camera, optics selection is technical and you may wish to use the default selection. You care about

- is the lens a zoom?
- what is the working distance?
- what is the field of view?

All FTA1000 optics come with the appropriate mounting mechanics for the frame. These always provide coarse focus and the ability to position the microscope from side to side. C frame mounts also include a quick way of adjusting the downward tilt of the optical path from the normal 0° horizontal to 3° or 6° lookdown. The mount is not shown in the following individual microscope photographs, as it obscures details.

The optical systems of the B and C frame systems are all direct view, meaning they have no mirrors or

prisms between the object and the lens to become corrupted with dust or other contamination. The Top View Cameras do, however, use a turning mirror. This mirror is a substantial distance above the sample and is therefore somewhat protected. Also, the Top View Cameras are not normally used for analytical work.

- Choose the shortest working distance your sample, stage or chamber allow as this will give you the highest resolution
- only choose autozoom/focus for automated operation, as a good operator can quickly focus a microscope and autozoom/focus is relatively expensive
- until you know better, choose the default optics for your frame type.

Default B optics	B 001: 92mm W.D. fixed mag
Default C optics	C 00E: 93mm enhanced 6x zoom

1 The first distinction is whether the magnification can be varied without changing the focal distance. A lens that has this variable magnification is called a zoom lens. Inexpensive systems will use a fixed magnification lens that can not zoom. All FTA microscopes, fixed or zoom, provide reasonable magnification for the experiments you will conduct. Only very special circumstances require magnification outside this range. Fixed magnification lens can have their magnification scaled by a constant amount by changing the back focal distance of the camera. This is done with a spacer or with another special lens that is inserted between the camera and the microscope. Consult FTA or your distributor if you need a different fixed magnification.

2 The second distinction is the working distance (W.D.) of the lens. The working distance is the distance from the object to the first mechanical element of the lens. Basically it sets how close the lens can be to the drop or the sample.

3 The third and final distinction is the numerical aperture (N.A.) of the lens. A higher N.A. results in higher optical resolution but less depth of focus (D.O.F). The depth of focus, in mm, is given by $D.O.F = .0005 / N.A.^2$

so small N.A.'s are required to give large depths of focus. The trade-off is between depth of focus (ease of seeing things outside focal plane) and optical resolution (focus quality).

Optical term	Meaning
Zoom lens	To change magnification without changing focus
Parfocal	A precise zoom lens that does not need any focus trim
Working distance	The distance from the object to the first mechanical element of the lens
Microscope	A lens with a relatively high magnification
Depth of focus	The distance away from the focal plane that still has acceptable focus
Resolution	The resolvable distance on the object; expressed in line pairs per mm
Numerical aperture	Measure of the diameter of the lens; bigger provides higher resolution
Field of view	How much of the object that can imaged at one time; depends on sensor size
Coarse focus	To move the lens as a whole to achieve focus; always available on FTA optics
Fine focus	To trim the lens position by an easily turned knob, provided by most FTA optics
Iris/variable aperture	Mechanics to decrease the numerical aperture; improves depth of focus

MICROSCOPES

B 001	Microscope, 92mm fixed mag
C 001	

Excellent resolution and stability. Because it has 1.2× magnification, it should be used with 1/2" format cameras. A 1/4" format camera should be used only if you want a very small field of view (≈3mm).

Magnification	1.2×
Working distance	92mm
Horizontal field of view	
1/3"	4.0mm
1/2"	5.3mm
Numerical aperture	0.71
Lens pixel size	2.8μm
Fine focus	3mm
Variable aperture (iris)	No
Magnification detents	Effectively (fixed mag)



B 002	Microscope, 175mm fixed mag
C 002	

Similar in appearance to B 001 and C 001. Highest resolution we have available at 175mm W.D.

Magnification	0.9×
Working distance	175mm
Horizontal field of view	
1/3"	5.3mm
1/2"	7.1mm
Numerical aperture	0.035
Lens pixel size	4.2μm
Fine focus	3mm
Variable aperture (iris)	No
Magnification detents	Effectively (fixed mag)

B 003	Microscope, 100mm fixed mag

This is our least expensive lens. It is a competent fixed-focus lens with high depth of field. Because it has low magnification (0.8×) it is the only lens recommended for 1/4" cameras such as the USB 1.1.

Magnification	0.8×
Working distance	100mm
Horizontal field of view	
1/4"	4.5mm
1/3"	6.0mm
1/2"	8.0mm
Numerical aperture	0.020
Fine focus	No
Variable aperture (iris)	Yes
Magnification detents	Effectively (fixed mag)



MICROSCOPES

B 00A	Microscope, 93mm
C 00A	basic 6× zoom

Our least expensive zoom microscope. The variable magnification is particularly useful in pendant drop IFT work. It also helps with very low contact angles where the sessile drop spreads widely. This is an economical choice for a general purpose instrument.

Magnification	0.7× → 4.5×
Working distance	93mm
Horizontal field of view 1/3", low to high mag 1/2", low to high mag	6.86mm → 1.07mm 9.14mm → 1.42mm
Numerical aperture Low mag High mag	0.020 0.071
Lens pixel size Low mag High mag	5.0µm 10.6µm
Fine focus	12mm
Variable aperture (iris)	No
Magnification detents	No



B 00D	Microscope, 93mm
C 00D	enhanced 6× zoom

A flexible, top-of-the-line microscope. Has a variable aperture and magnification detents. Magnification detents provide stops for the zoom at easily remembered values: "1×", "2×", etc. The precise calibration can be software recorded, so constant recalibration is not required as zoom is changed. If you are going to use this with the 150mm XYZ stage, or other similar large

stages, note the 93mm working distance of this microscope will restrict stage movement in the Y direction. Remedies include purchasing an 0.75× attachment lens as an accessory to increase the working distance to 113mm, or switching to the 175mm W.D. version C 00G.

Same specifications as the B 00A and C 00A except it has an adjustable aperture and magnification detents.

	Microscope, 93mm
C 00E	6× autozoom/focus

This microscope has stepper motor driven focus and zoom that can be controlled by software. A variable iris is not included because autofocus does not work well with a constricted iris setting. The magnification calibration table for the zoom is stored in software and updates the magnification setting as the zoom is changed by the stepper motor. The software has an autofocus routine.

Same specifications as the B 00A and C00A but with stepper motors on the zoom and focus axes.



MICROSCOPES

	Microscope, 175mm basic 6× zoom
C 00F	

This microscope is similar in appearance to C 00A, the 93mm W.D. version. An attachment lens is added to the front to provide the longer working distance. The longer working distance accommodates larger samples but at some expense in resolution. You can see this is in the lower N.A. and the larger lens pixels sizes.

Magnification	0.7× → 4.5×
Working distance	175mm
Horizontal field of view 1/3", low to high mag 1/2", low to high mag	6.86mm → 1.07mm 9.14mm → 1.42mm
Numerical aperture Low mag High mag	0.010 0.035
Lens pixel size Low mag High mag	10.0µm 21.2µm
Fine focus	12mm
Variable aperture (iris)	No
Magnification detents	No

	Microscope, 175mm enhanced 6× zoom
C 00G	

Same specifications as the basic model, C 00F, except it adds a variable aperture and magnification detents.

	Microscope, 175mm auto zoom/focus
C 00H	

Same specifications as the basic model, C 00F, except it adds motorized zoom and focus. Software maintains magnification and provides autofocus.

	Microscope, 86mm enhanced 12× zoom
C 00J	

An extremely fine, stable, high resolution microscope. It has a wider zoom range than the 6× and a higher numerical aperture for better optical resolution.

Magnification	0.58× → 7×
Working distance	86mm
Horizontal field of view 1/3", low to high mag 1/2", low to high mag	8.28mm → 0.68mm 11.0mm → 0.91mm
Numerical aperture Low mag High mag	0.02 0.10
Lens pixel size Low mag High mag	5.4µm 11.7µm
Fine focus	12mm
Variable aperture (iris)	Yes



	Microscope, 165mm enhanced 12x zoom
C 00K	

Similar in appearance to C 00J, it has a longer 165mm working distance. The magnification, W.D., and field of view specifications are the same.

Numerical aperture Low mag High mag	0.01 0.05
Lens pixel size Low mag High mag	10.7µm 23.3µm

BACKLIGHTS

The backlight is a specialized illumination source that sits behind the sample so the image is a silhouette. The source must be bright enough that ordinary room light does not interfere with the image. For normal drop shape analysis, a single color source will focus better and provide a sharper image. A shorter wavelength, a color towards the blue end of the visible spectrum, will focus better than a longer wavelength red. The actual color does not, of course, appear in a monochrome image; light simply appears as brightness. If you use a color camera, you probably want a white light source so you can see natural colors.

The source must be large enough to fill the image background. The lower the magnification, the larger the field of view, and the larger the source must be. Conversely, high magnification images can use small sources. The source must be physically larger than the image field of view so that the image background appears uniform.

A rule of thumb is that the source should be 2x, or maybe 2.5x, the size of the field of view. As an example, FTA 25mm backlights are useful to 10mm field of views. A 6.4mm sensor, used with a 0.7x magnification (the low end of the 6x zoom), will have a $6.4 \div 0.7 = 9.1$ mm field of view and will be satisfactory.

B 000 1	Backlight, 25mm blue LED
C 000 1	

This wide area LED source is bright and uniform. It employs 16 LEDs in a square array to achieve uniform illumination. The blue color offers best image resolution because its wavelength is the shortest of the available colors. LED sources are very long-lived and generate essentially no heat.

B 000 2	Backlight, 25mm white LED
C 000 2	

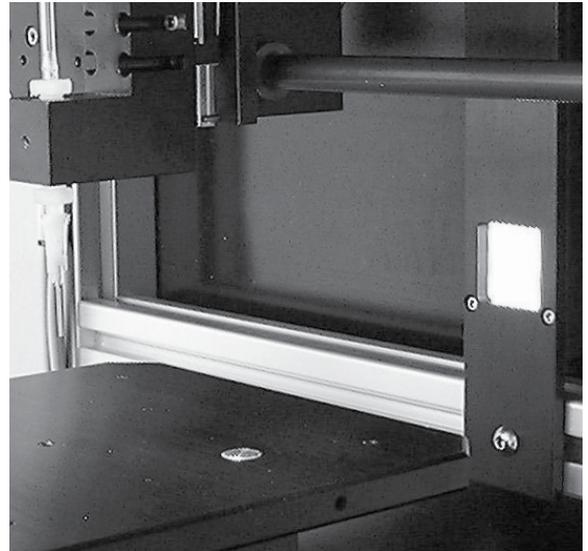
This source is the same as the blue source above except white LEDs are used. It is intended for color cameras, where a white source is required in order to reproduce colors.

The next question is whether the light intensity can be varied. The 25mm red backlights draw power from a computer's USB port and do not have software control over intensity. Instead they have an on/off switch. They are intended for laptop powered applications and situations where you have no FTA controller. All other backlights have software control providing three levels of brightness plus off via the system controller box. The ability to vary the backlight intensity is a convenience, but not a necessity, as the intensity can be lowered by a microscope aperture and it can be raised and lowered by camera brightness and gain controls. The main requirement is that the source be bright enough.

Finally, higher magnification optics and high speed cameras require a brighter source. Halogen sources are used for the very fastest and highest magnification systems. The loss of resolution from using a white source is not as important as having high intensity.

- LED sources are preferred except for high speed cameras
- blue is the best color
- must use red for laptop powered systems

Default B light	B 000 1: 25mm blue LED
Default C light	C 000 1: 25mm blue LED



B 000 3	Backlight, 25mm red LED
C 000 3	

Similar to the above two sources in construction, it employs lower voltage red LEDs so that it can be directly powered by the 5V USB ports on computers. This allows it to run from battery powered laptops. If you want a laptop powered system, choose the B 0A USB 1.1 camera and this source. This source can also be used with USB 2.0 cameras, but USB 2.0 cameras consume more power and are less suited to battery powered operation. This source, because it is powered by a USB port, does not have intensity control like the other FTA1000 sources, but does have an on/off toggle switch.

	Backlight, 35mm blue LED
C 000 4	

A large format source for unusually large fields of view (low magnification). Has 25 blue LEDs in square array.

B 000 A	Backlight, 15mm white halogen
C 000 A	

A smaller, but very intense source powered by a 5W halogen bulb. Adjusting screws provide fine positioning of the illumination field. The intensity can be controlled to three levels of brightness by the FTA controller.

DISPENSERS

The dispenser is the portion of the liquid handling system that delivers the drop to the sample. All FTA1000 systems have some means of raising and lowering the dispense tip while a drop is hung from the tip. This means that direct touch-off of sessile drops is always available. In simple systems, a rack-and-pinion lift is used to position the tip. More sophisticated systems use stepper motor tip Z stages. Some FTA1000 dispensers handle more than one tip. These have a stepper motor driven tip rack that moves back and forth in the X direction to position the selected tip in the image.

FTA1000 motorized dispensers employ small removable cars (holders) cars to adapt to the desired needle type. These are normally used with remote pumps connected by flexible tubing, but they can also hold syringes for those situations where the user wishes to manually control the drop formation. Finally, some dispensers include the pump directly on the tip car, rather than having it located remotely and connected by flexible tubing. We call these direct-drive pumps to differentiate them from the remote Kloehn type syringe pumps.

You must choose whether to work with Kloehn® syringe pumps, mounted in the controller box, or with direct drive syringe pumps mounted on dispenser cars. Each type of pump has pros and cons.

- Kloehn pumps are precision, high resolution syringe pumps. They can be fitted with a variety of syringe sizes to scale drop size. Their biggest feature is they self-prime because they have a valve on top of the syringe to select between a liquid source vial and the dispense tip. You never need to handle syringes directly. The biggest disadvantage of this arrangement is the tubing between the pump and the tip: if you need to clean the system often, say because you change liquids, this tubing must be cleaned or replaced along with the other liquid-handling components.
- Direct drive pumps use a stepper motor to directly move the plunger of a syringe mounted on the dispense car. The Luer hub needle attaches directly to the bottom of the syringe. You can use disposable syringes. You have the option of heating these syringes. The biggest disadvantage of direct drive pumps is that you must manually prime (fill) the syringe.

Dispensers are matched with controllers that furnish the electronics for the system. Once you have chosen your dispenser type, the controller is fixed also.

Your choice of dispensers is somewhat simplified by the fact that B frame systems do not offer Kloehn pumps whereas C frame systems give you a choice of either pump type. If you want a C frame instrument but either dispenser seems OK, choose the Kloehn pump.

Default B dispenser	B 000 04, motorized syringe and motorized tip
Default C dispenser	C 000 03, 4-tip XZ rack (for Kloehn pumps)

B Frame Systems		
Syringe and Tip	Dispenser	Required Controller
manual syringe and tip Z	B 000 01	none
manual syringe, motorized tip Z	B 000 02	B 000 001
direct drive pump, manual tip Z	B 000 03	B 000 001
direct drive pump, motorized tip Z	B 000 04	B 000 001

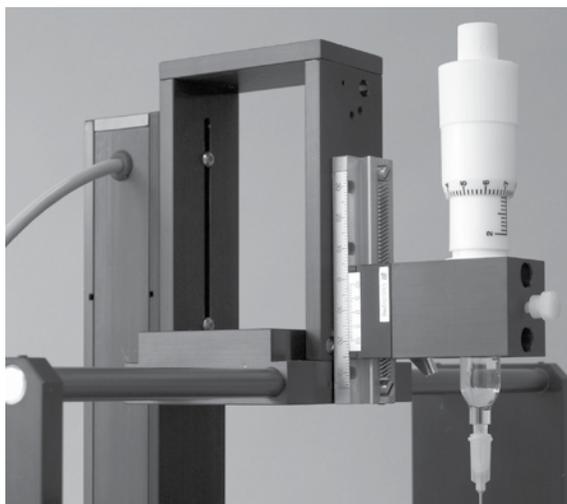
C Frame Systems		
Syringe and Tip	Dispenser	Required Controller
manual syringe and tip Z	C 000 01	none
1 Kloehn pump, motorized tip Z	C 000 02	C 000 002
4 Kloehn pumps, motorized tip Z's	C 000 03	C 000 003
1 direct drive pump, motorized tip Z	C 000 04	C 000 004
4 direct drive pumps, motorized tip Z's	C 000 05	C 000 005

Kloehn is the brand of valved syringe pumps FTA uses. They mount remotely in the controller box and connect to the tip via tubing.

DISPENSERS

B 000 01	Dispenser, single manual syringe and manual tip Z
C 000 01	

This is the simplest dispenser. It can accommodate several manual syringe types. The user forms a pendant drop on the needle attached to the syringe, then positions the drop in the image using the manual rack-and-pinion Z stage. It includes an adaptor for Gilmont® 2cc micrometer syringes and one syringe. You may purchase other adaptors for Hamilton® glass and BD disposable plastic syringes. Does not require a controller.



Syringe dispense	manual
Tip Z axis Range	rack-and-pinion 50mm

B 000 02	Dispenser, single manual syringe and motorized tip Z

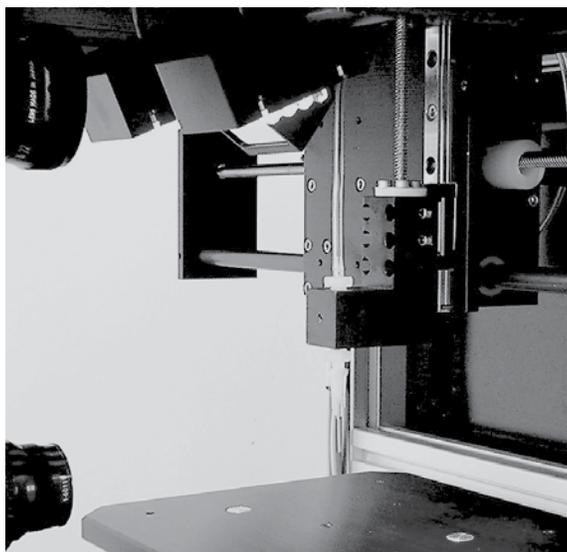
The tip Z mechanization enables software to automatically touch off sessile drops for contact angle measurements. Includes an adaptor for a Gilmont 2cc syringe and one Gilmont syringe. You may purchase other adaptors for Hamilton glass and BD disposable

plastic syringes. This and subsequent dispensers with motors require controllers.

Syringe dispense	manual
Tip Z axis Range	stepper motor 75mm
Resolution	6.35µm
Rate	50mm/s

	Dispenser, 1 motorized XZ tip
C 000 02	

This is a single tip, lower cost version of the C 000 03 4-tip dispenser. It has the same X rack, but only one tip Z stage. This 1-tip version can not be upgraded to a 4-tip in the field. It is used with the C 000 002 controller which contains one remote Kloehn syringe pump.



Syringe dispense	for Kloehn pump
Tip X axis Range	stepper motor 225mm
Resolution	15.8µm
Rate	40mm/s
Tip Z axis (cars) Range	stepper motor 75mm
Resolution	6.35µm
Rate	50mm/s

B 000 03	Dispenser, single motorized syringe and manual tip Z

The motorized syringe is a direct drive syringe pump which enables the software to control drop volume on the tip. Adaptors are available for Hamilton glass syringes in the 25µl to 500µl range and BD disposable 3ml (3cc) plastic syringes. The dispenser comes with a Hamilton adaptor and syringe.

Syringe dispense Range	direct drive pump ≈syringe capacity
Resolution	syringe capacity ÷ 9500 250µl → 26nl
Tip Z axis Range	rack-and-pinion 50mm

Direct drive pumps come with the dispenser because they are physically mounted to the dispenser.

Kloehn pumps come with the controller box because they are mounted in the box.

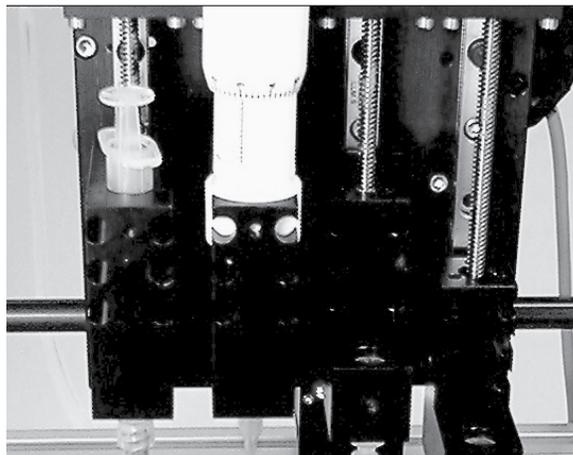
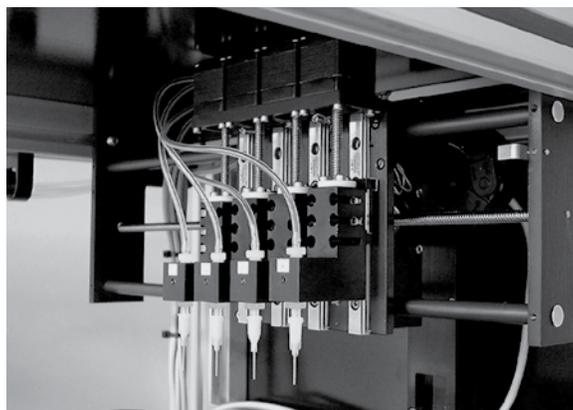
The dispenser for Kloehn pumps has a simple tubing union to join the tube to the needle.

DISPENSERS

	Dispenser, 4 motorized XZ tips
C 000 03	

The X tip rack moves the active tip horizontally in the image and can also move tips over to an optional auto-sampler. The Luer hub adapter connects tubing from the remote Kloehn pump to the disposable needle. Software provides automated touch-off action for depositing sessile drops. The individual cars on the tip Z stages can be replaced to carry Gilmont or disposable plastic syringes instead of the tubing adapter. The photo at the right has a BD 3cc in the far left, a Gimont next to it, and the two right cars carry unions for Kloehn pump tubing. Custom cars can be constructed to carry other syringes.

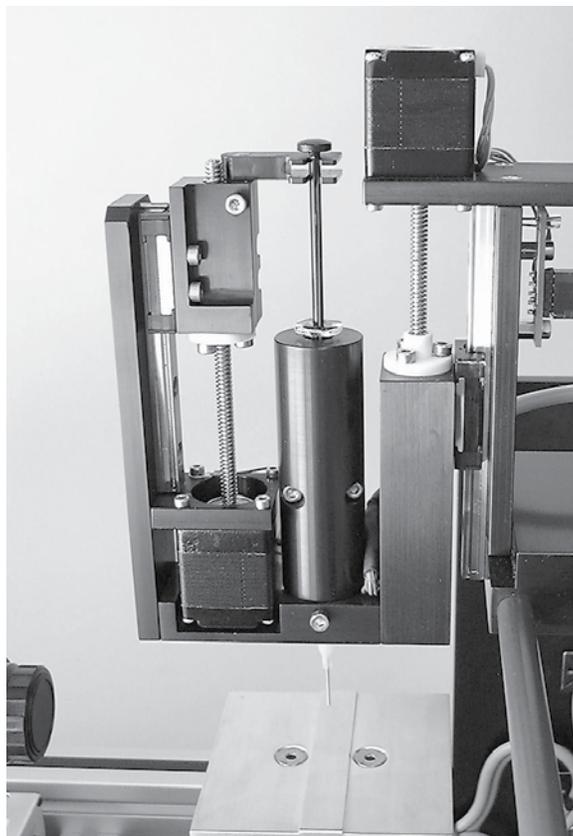
Syringe dispense	for Kloehn pump
Tip X axis	stepper motor
Range	225mm
Resolution	15.8µm
Rate	40mm/s
Tip Z axis (cars)	stepper motor
Range	75mm
Resolution	6.35µm
Rate	50mm/s



B 000 04	Dispenser, single motorized syringe and motorized tip Z

Fully automated single syringe dispenser can form drops of selected volume and automatically touch them off on samples for contact angle measurements. Adaptors are available for Hamilton glass syringes in the 25µl to 500µl range and BD disposable 3ml (3cc) plastic syringes. The dispenser comes with a Hamilton adaptor and syringe. In the photo at the right, the left hand lead screw motor drives the syringe plunger and the right hand motor moves the whole pump to position the tip. The syringe is enclosed in the round carrier.

Syringe dispense	direct drive pump
Range	≈syringe capacity
Resolution	syringe capacity ÷ 9500
	250µl → 26nl
Tip Z axis	stepper motor
Range	75mm
Resolution	6.35µm
Rate	50mm/s



Luer hubs are an industry standard for a friction-fit tapered junction of syringes and needles. They are widely used in medical practice.

	Dispenser, single motorized syringe and motorized XZ tip
C 000 04	

3cc plastic syringes. The dispenser comes with a Hamilton adaptor and syringe. Syringes may be heated by purchasing an optional syringe adaptor such as C 000 0J. XZ specifications are the same as for C 000 02.

Similar to the C 000 02 dispenser, except includes a direct drive pump on the car. This is the same direct drive pump used on B frame motorized syringe pumps (e.g., B 000 04). Adaptors are available for Hamilton glass syringes in the 25µl to 500µl range and BD disposable

Syringe dispense Range Resolution	direct drive pump ≈syringe capacity syringe capacity ÷ 9500 250µl → 26nl
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	Dispenser, 4 motorized syringes and XZ tips
C 000 05	

This is a 4-tip version of C 000 04. It includes 4 direct drive pumps.

The following cars are optional. They let you put other manual syringes on the dispenser's tip Z car. All dispensers come with one of these cars, as indicated in their description which will list the intended pump. Kloehn systems come with a union car and the necessary interconnection tubing.

B Frame Systems		Works with these dispensers manual tip Z: B 000 01 and B 000 03 motorized tip Z: B 000 02 and B 000 04
Order Number	Dispenser	Syringes
B 000 0A	Dispense Car, Gilmont syringe	2ml micrometer Luer tip
B 000 0B	Dispense Car, Hamilton GasTight™ syringe	25µl to 500µl glass Luer tip
B 000 0C	Dispense Car, BD plastic syringe	3ml (3cc) Luer tip
B 000 0D	Dispense Car, ¼-28 union	union for remote pump tubing
B 000 0E	Dispense Car, M6 union	metric union for remote pump tubing

C Frame Systems		Works with these dispensers manual tip Z: C 000 01 motorized tip Z: C 000 02 and C 000 03 (Kloehn) C 000 04 and C 000 05 (direct drive)
Order Number	Dispenser	Syringes
C 000 0A	Dispense Car, Gilmont syringe	2ml micrometer Luer tip
C 000 0B	Dispense Car, Hamilton GasTight syringe	25µl to 500µl glass Luer tip
C 000 0C	Dispense Car, BD plastic syringe	3ml (3cc) Luer tip
C 000 0D	Dispense Car, ¼-28 union	union for remote pump tubing
C 000 0E	Dispense Car, M6 union	metric union for remote pump tubing

These adaptors let you change the syringe type for direct drive motorized syringe pumps (not for Kloehns).

B and C Frame Systems		
Order Number	Dispenser	Syringes
B 000 0F C 000 0F	Syringe Adaptor, Hamilton	25µl to 500µl glass Luer tip, comes standard with direct drive pumps
B 000 0G C 000 0G	Syringe Adaptor, BD	plastic 3ml
C 000 0H	Syringe Adaptor, heated Hamilton	similar to C 000 0F but contains heater
C 000 0J	Syringe Adaptor, heated BD	similar to C 000 0G but contains heater

CONTROLLERS

The controller is the centralized electronics interface for all motorized mechanics. If you have anything that is electronically controlled, other than the video camera, you must have a controller. All FTA1000 controllers connect to their host computer through a USB port. This port can either be USB 1.1 or 2.0.

All FTA1000 stages and chambers connect to the controller through DB9 connectors on the rear panel of the controller. This allows easy swapping of stages and, for that matter, controllers. It is possible to quickly remove all electronics and wiring from the FTA1000 frame, making repair or re-configuration a snap.

C frame systems also support secondary controllers. These are slaves to the main controller and provide specialized functions, typically for heated chambers. You can add more than one slave if you need to, as they daisy-chain from the main controller.

B frame controllers have no built-in pump. C frame controllers have the option of built-in Kloehn pumps, which are valved syringe pumps, or direct drive pumps like the B frame. Pump selection is discussed in the Dispensers section.

All main controllers have universal 100-240V, 50-60Hz power supplies that draw a maximum of 240W. The power supplies are power factor corrected and meet emissions standards. Detachable cords meet local standards. Secondary, or slave, controllers are powered through the main controller.

Default B controller	B 000 001, basic
Default C dispenser	C 000 003, 4 Kloehn pumps

B 000 001	Controller, basic
-----------	-------------------

Basic controller for B frame systems. Provides software control of backlight intensity, a motorized direct drive pump, tip Z movement for the needle and one axis of specimen stage movement. If you do not have a controller, your B frame system is entirely manual.

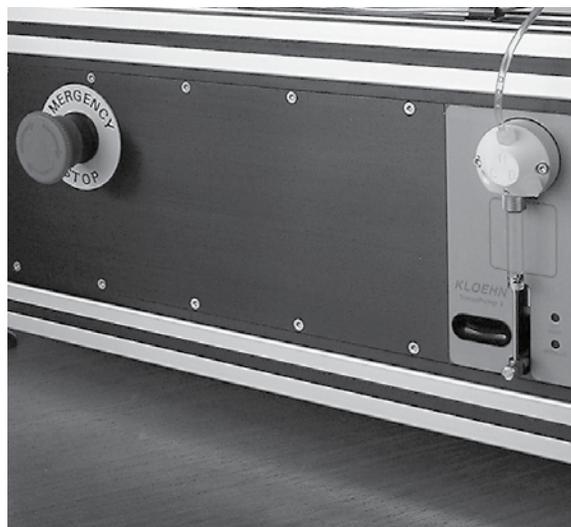


C 000 001	Controller, no pumps
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Most C frame systems will have an automated controller, but this simplified model provides back light control and power to electrically heated chambers for special applications.

C 000 002	Controller, 1 Kloehn pump
-----------	---------------------------

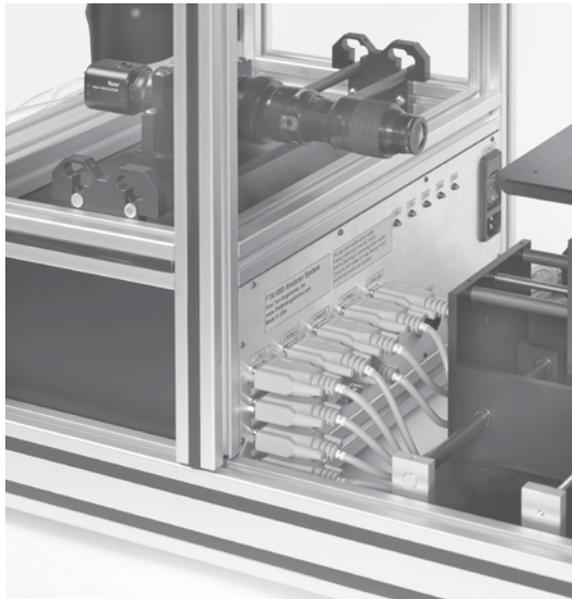
Automated main controller with one Kloehn syringe pump built in. The Kloehn pump can be equipped with a variety of syringe sizes from 50µl to 5µl. 250µl is standard. The pump has a valve that allows it to both aspirate and dispense, so it can self-prime. Tubing connects the pump's output valve port to the union on the tip Z car.



Syringe dispense Range Resolution	Kloehn pump syringe capacity syringe capacity ÷ 12000 250µl → 20nl
-----------------------------------	--

	Controller, 4 Kloehn pumps
C 000 003	

Automated controller with four Kloehn syringe pumps built in. Each pump has the same specifications as C 000 002. The pumps may have different syringe sizes.



CONTROLLERS

	Controller, for 1 direct drive pump
C 000 004	

Automated main controller that has drive electronics for one dispenser-mounted direct drive pump (rather than a built-in Kloehn pump). Otherwise has same capabilities as C 000 002. The direct drive pumps themselves come with the selected dispenser. Can drive a heated syringe if the necessary syringe adaptor is purchased.

	Controller, for 4 direct drive pumps
C 000 005	

Automated main controller that has drive electronics for four dispenser mounted direct drive pumps (rather than built-in Kloehn pumps). Otherwise has same ca-

pabilities as C 000 002. The direct drive pumps themselves come with the selected dispenser. Can drive heated syringes if the necessary syringe adaptors are purchased.

AUTOSAMPLER

Autosamplers enable the dispense tip to pickup (aspirate) liquid from user-supplied vials, which means a large number of samples can be analyzed with automated script sequences. Autosamplers are not available for the B frame. The FTA vial tray autosampler also can change tips to ensure no sample-to-sample cross contamination.

	Autosampler, vial tray
C 000 000 1	

Vial rack Y axis	
Range	350mm
Resolution	15.8µm
Rate	40mm/s

The tray holds two 96-well microtiter plates, or the equivalent. The tray moves along the Y axis, offset to the left from the main dispense location. It moves out of the way when not needed. When the tray is moved to the target position, the tip rack X axis will move the tip Z stage over any point in the tray. Then the tip can move down to aspirate or dispense liquid or change tips.

Note that the right-hand most tip stage in a 4-tip dispenser rack can not access the left half autosampler locations. The other three tips can access all autosampler locations. A single-tip dispenser can also access all locations.

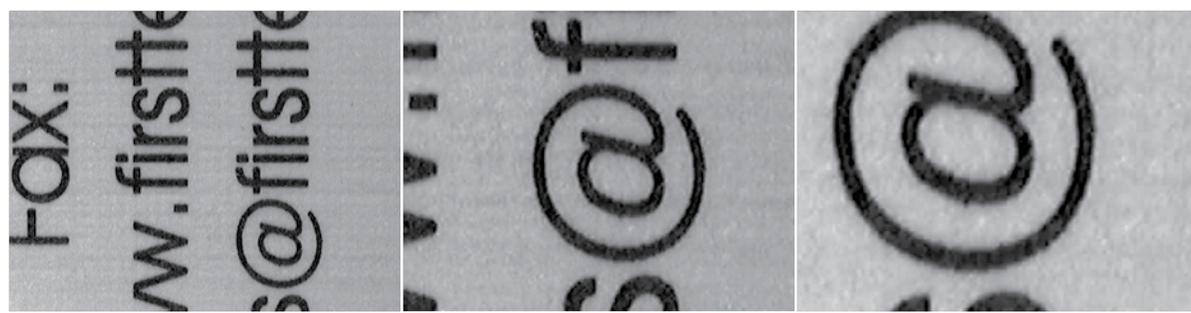
If you wish to automatically change tips, you must use short (1/2") tips and you must allocate space within the tray for the supply of new tips. There is a built-in waste location for used tips.



Top view cameras allow you to view the sample from above as a bird would. This helps you position drops over specific features on the sample. This viewpoint also lets you judge whether liquid is spreading evenly on the surface. They are very handy in setting up automated measurement sequences. Top view cameras are not available for the B frame.

	Top View Camera, USB 1.1
C 000 000 01	

USB camera operates in a separate video channel from the main analytical microscope. Look-down angle is approximately 75°, obtained with an adjustable turning mirror. Two LED arrays provide software controlled lighting. Camera has electronic zoom and pan to provide details where you need them. The example images below of a business card show this. The middle image is panned in addition to zoomed (else the @ symbol would not appear in the center).

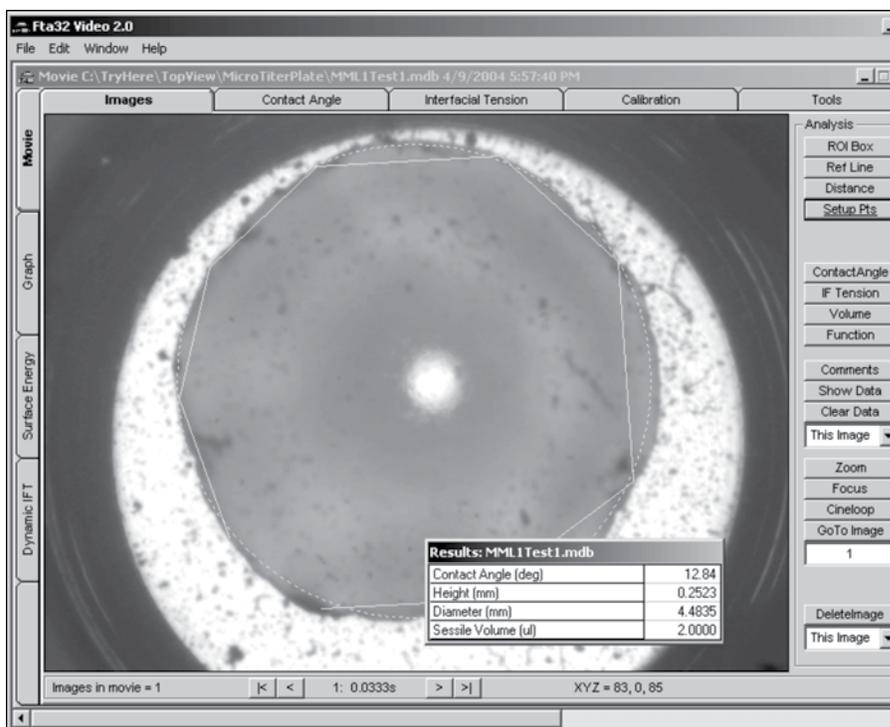


Another form of Top View: The A-class systems have a measurement head that truly looks straight down and can image drops in the bottom of wells or other places unseen by traditional side view. The screen shot below shows the image of a sessile drop deposited in the bottom of a well of a standard 96-well microtiter plate. The dispensed volume is 2.0µl, the measured contact angle 12.8° and the mean diameter of the sessile drop is 4.48mm.

This type of measurement requires a perfectly vertical camera. The illumination is coaxial inside the microscope. It is not from below. Therefore this setup can work with opaque samples. It does require a smooth sample surface, as the light is reflected from this surface. Most technical samples are sufficiently smooth, however.

The FTA dispenser is designed to detach the small volumes necessary when low contact angles are encountered. The drop obviously will spread over a wide area when the angle is small.

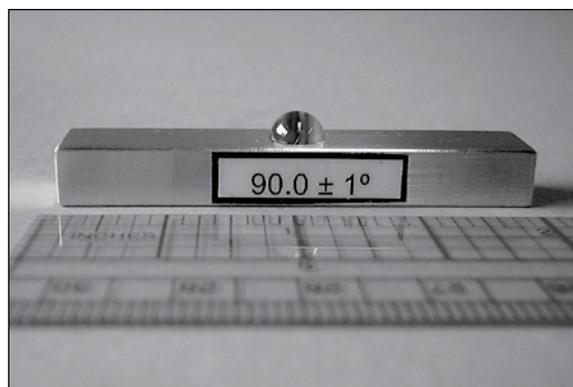
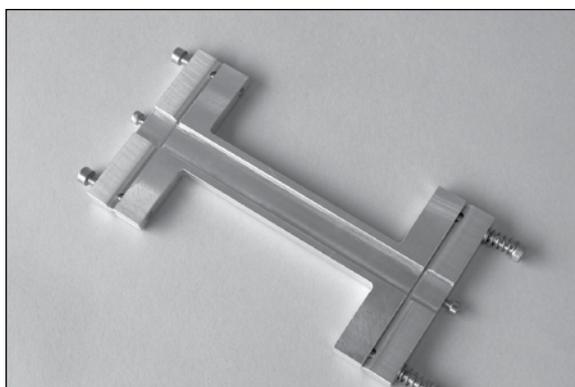
This system can also measure very low angles on flat surfaces such as glass plates.



ACCESSORIES

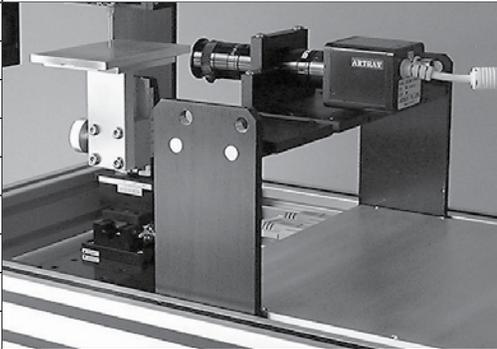
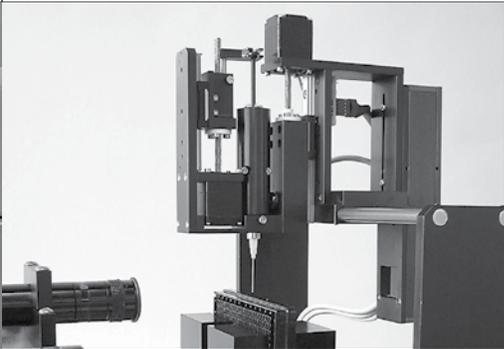
Accessories and supplies for FTA1000 systems are described on the website. The website also lists where common supplies can be purchased from industry vendors. The table gives an overview of what is available.

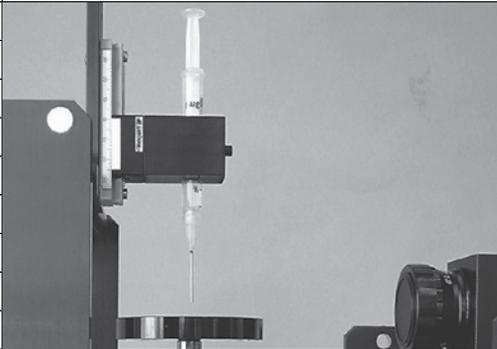
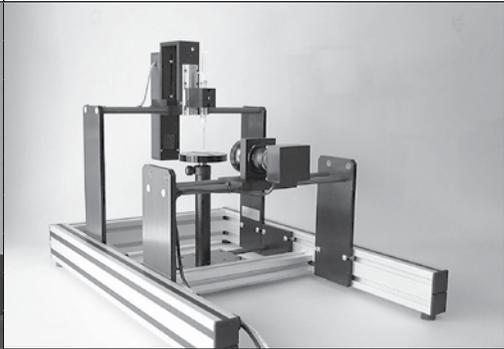
Contact angle standards	sapphire balls embedded in metal holders
Cuvettes	standard 12.5mm plastic and quartz + larger optical glass sizes
Cuvette caps	tight fitting with needle holes to allow upside down use
Fittings	liquid and needle fittings used within the FTA1000
Lens	attachment and adaptor lens to change magnification and W.D.
Needles, J	J needles to fit into cuvettes for bubble up measurements
Needles, straight	plastic and metal Luer hub, in many sizes
Paper and film holders	to go on rack-and-pinion specimen stage
Specimen tables	alternative sizes and shapes, vacuum hold down, wafer clips
Syringes, glass	various capacities that fit FTA dispensers
Syringes, Kloehn	syringes and valves that fit Kloehn pumps
Syringes, plastic	3cc disposable plastic



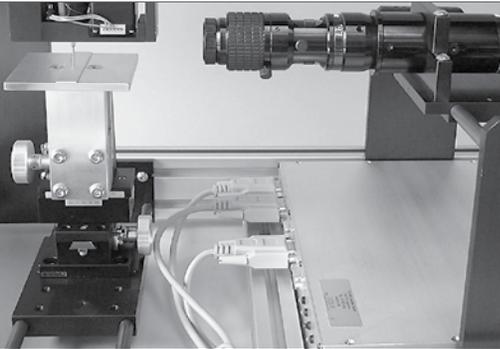
Standard Needle Sizes				
Guage #	Outside Diameter (mm)	Inside Diameter (mm) (typical)	Luer Plastic Hub Color (typical, can vary)	Max Water Volume before Drop Detachment (μl) (from Tate's Law)
14	2.108	1.702	dark green	49.2
15	1.829	1.524	orange	42.7
16	1.651	1.346	purple	38.5
17	1.499	1.194	white	35.0
18	1.270	0.991	pink	29.7
19	1.067	0.787	brown	24.9
20	0.914	0.635	yellow	21.3
21	0.813	0.559	green	19.0
22	0.711	0.483	translucent gray	16.6
23	0.635	0.406	light blue	14.8
24	0.584	0.356	red	13.6
25	0.508	0.305	blue	11.9
26	0.457	0.254	peach	10.7
27	0.406	0.229	tan	9.48
30	0.305	0.152	lavender	7.12
31	0.254	0.127	stainless, not plastic	5.93
32	0.229	0.102	stainless, not plastic	5.35
33	0.203	0.102	stainless, not plastic	4.74

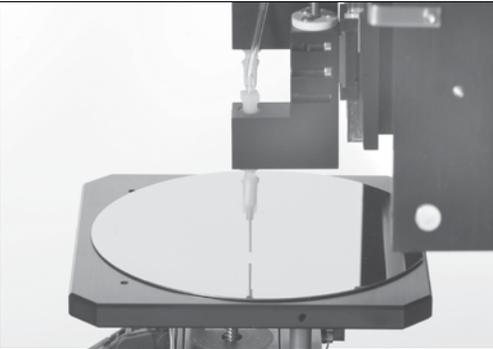
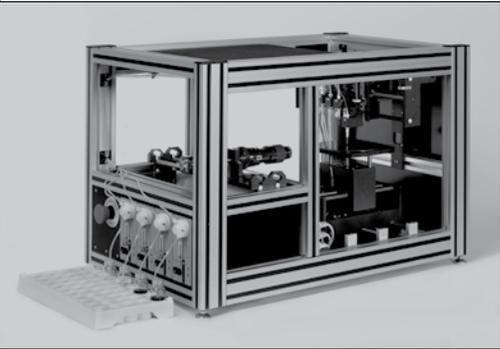
EXAMPLES

B 1B1 141	B frame default system	
	Economical, flexible general purpose system. Capable of fully automated touch-off measurements using scripts.	
B 1B1 141	B frame	
B 1B1 141	simple manual table	manual, locking Z
B 1B1 141	USB 2 monochrome camera	large area, has internal zoom and pan
B 1B1 141	92mm fixed mag microscope	one time calibration
B 1B1 141	25mm blue LED backlight	
B 1B1 141	motorized syringe and motorized tip Z	fully automated drop formation/touch-off
B 1B1 141	basic controller	
		
	With standard manual stage	With custom stage

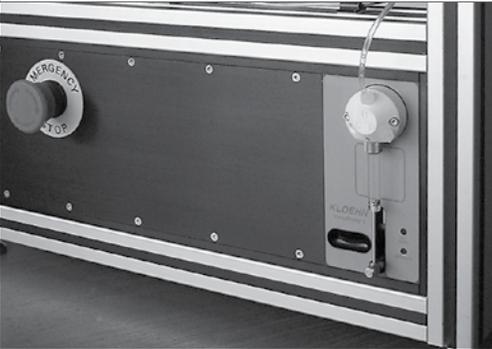
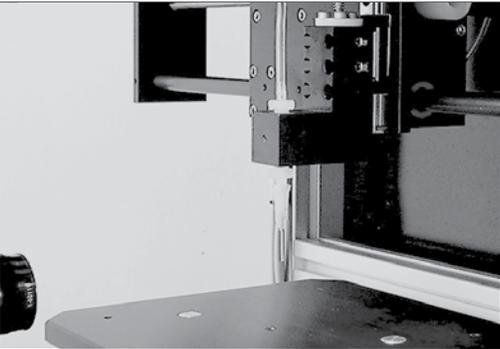
B 1A3 310	B frame lowest cost system	
	Most economical system. Special Internet price. Great for students and factory floors. Can be expanded later by adding controller.	
B 1A3 310	B frame	
B 1A3 310	simple manual table	manual, locking Z
B 1A3 310	USB 1.1 camera	has zoom and pan
B 1A3 310	100mm fixed mag microscope	has aperture, large depth of focus
B 1A3 310	25mm red LED backlight	USB powered
B 1A3 310	manual syringe and manual tip Z	rack-and-pinion lift on tip Z
B 1A3 310	no controller	
		
	BD 3cc adaptor detail	With accessory round stage

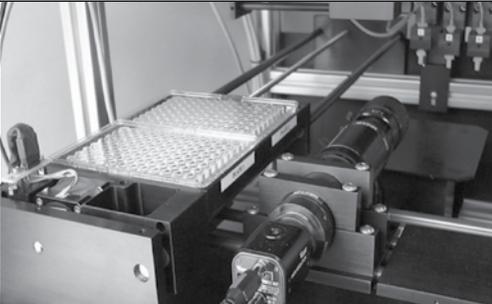
EXAMPLES

B 2DA 131	B frame equivalent of FTA200	
	Duplicates the functionality of the legacy FTA200 at minimum cost. Consider upgrading the dispenser to motorized tip Z.	
B 2DA 131	B frame	
B 2DA 131	rack-and-pinion specimen stage	manual, locking Z
B 2DA 131	RS170 1/3" camera + frame grabber	good stability and image timing
B 2DA 131	93mm 6x zoom microscope	flexible optics
B 2DA 131	25mm blue LED backlight	intensity varied by controller
B 2DA 131	motorized syringe and manual tip Z	consider B 000 04 dispenser
B 2DA 131	basic controller	provides automation
		
	Includes controller	Rack-and-pinion stage and zoom microscope

C 4EE 133	C frame default	
	Excellent general purpose laboratory instrument. Has zoom microscope and extensive automation.	
C 4EE 133	C frame	
C 4EE 133	150mm XYZ motorized stage	can do automated step-and-repeat
C 4EE 133	RS170 1/2" camera + frame grabber	excellent image quality
C 4EE 133	enhanced 93mm 6x zoom microscope	has aperture and magnification detents
C 4EE 133	25mm blue LED backlight	controller powered
C 4EE 133	4 Kloehn pump dispenser	valved syringe pumps, automated prime
C 4EE 133	4 Kloehn pump controller	
		
	Automated stage and touch-off	4 Kloehn pump system

EXAMPLES

C 2DA 122	C frame equivalent of FTA200	
	Duplicates the functionality of the legacy FTA200 on a C frame. More expensive than the B frame, but greater expandability.	
C 2DA 122	C frame	
C 2DA 122	rack-and-pinion specimen stage	
C 2DA 122	RS170 1/3" camera + frame grabber	good stability and image timing
C 2DA 122	93mm 6× zoom microscope	flexible optics
C 2DA 122	25mm blue LED backlight	high resolution
C 2DA 122	1 Kloehn pump dispenser	valved syringe pump, self priming
C 2DA 122	1 Kloehn pump controller	
		
		Single pump and tip Z system

C 4EE 133 11	C frame equivalent of FTA2000	
	Duplicates most functionality of FTA2000. Adds top view camera, autosampler and tilt stage to default C frame system.	
C 4EE 133 11	C frame	
C 4EE 133 11	150mm XYZ motorized stage	can do automated step-and-repeat
C 4EE 133 11	RS170 1/2" camera + frame grabber	excellent image quality
C 4EE 133 11	enhanced 6× 93mm microscope	has aperture and magnification detents
C 4EE 133 11	25mm blue LED backlight	controller powered
C 4EE 133 11	4 Kloehn pump dispenser	valved syringe pumps, automated prime
C 4EE 133 11	4 Kloehn pump controller	
C 4EE 133 11	vial tray autosampler	sample many liquids and/or change tips
C 4EE 133 11	top view camera	see where drop will be placed on sample
C T	full instrument tilt	
		

Script programs provide a way to run the instrument with complete flexibility in controlling operation. Scripts are an alternative to traditional “manual” operation. Scripts automate whatever you can do manually. Basically they push the same buttons and fill in the same text boxes that you would if you were executing a protocol in the traditional fashion. All FTA1000 B and C class instruments can execute scripts for whatever mechanical automation is present.

The script at your right is an actual program that does quite a lot. Assuming the instrument has the necessary dispenser, it

- runs a Home routine the first time during the Windows session but not each time the script is run thereafter
- measures the sample surface location to pre-determine the sessile drop baseline location
- forms a pendant drop, 5µl in this case
- touches the drop off on the surface
- takes a Movie
- skips some images at the beginning
- analyzes rest for contact angle
- saves the analyzed Movie to disk

Scripts are written by pointing and clicking on drop-down lists, and filling in text boxes when required by the selected operation. More importantly, scripts are in “plain English” so they can be understood by others. Scripts are stored in files, one script to a file. You can store any number of scripts and recall them when you wish from the main File menu. Scripts can be as long as you wish. There is no limit on size other than the practical issue of writing the script in the first place. Scripts can be printed or copied into other documents as a table.

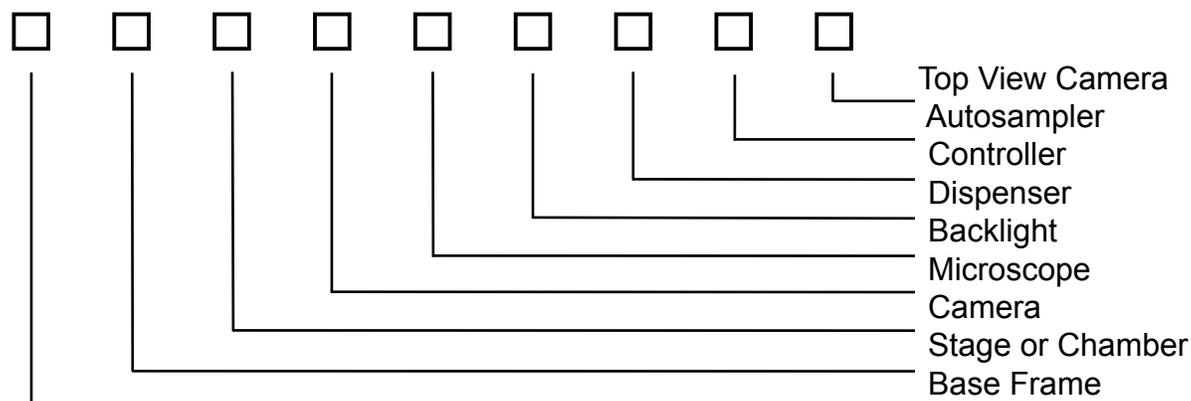
The script language includes loops (to do something many times), subroutines (for procedures you use again and again), and user queries and branches (questions the user is asked to answer at run time), and the ability to pause at any time for operator review.

You control execution of the script through the following 5 buttons:

- **Start:** run the script from the beginning
- **Single Step:** run the script from the beginning but take only one step (i.e., execute one instruction) before pausing. You take another step by clicking Single Step again. Lets you debug script. You can even click other buttons and do other things between steps.
- **Pause:** temporarily stop a running script.
- **Resume:** starting running full speed again.
- **Quit:** stop and discard any further instructions. Begin at the beginning with next Start.

Line	Operation	Parameters	Comment
1	No operation		Contact angle program for FTA1000
2	No operation		Keep track of changes here...
10	User Variable if then	1; 0; 13	Test var #1 for greater than 0 (var initialized to 0)
11	Set User Variable value	1; 1	Will cause if/then to execute only once
12	Call subroutine	900	Call home routine (only once)
13	No operation		Continue on
20	Call subroutine	800	Movie setup routine (could be done only once also)
30	Call subroutine	700	Dispense liquid and capture Movie
40	Call subroutine	600	Analyze Movie routine
90	Quit		End of program
600	No operation		Movie analysis
610	No operation		Could use SnapShot here instead of earlier Run
620	Open movie	15	Must have Open/Close Movie pair
630	No operation		Set analysis parameters
631	Use previous baseline	1	This default should be on (checked)
633	Reflection image type baseline	1	Normal case
634	Non-spherical mode analysis	1	You may prefer spherical mode
640	No operation		Move to first valid image (depends on Capture values)
641	Move to first image in movie		
642	Begin loop	1; 8	Loop #1 will skip to image #9
643	Move to next image in movie		
644	End loop	1	
645	Contact angle baseline		Leave parameters blank to use Macros' baseline
646	No operation		'C.A. baseline' must be set with target image present, therefore
647	No operation		move to desired Movie image first
650	Begin loop	2; 16	Loop #2 do rest of images in Movie (see your Capture)
651	Do contact angle measurement		Makes actual measurement
652	Move to next image in movie		
654	Wait time	2	So user can inspect (could remove)
655	End loop	2	
670	Close movie		
680	Status info	All done!	Could write something to log...
690	Return subroutine		
700	No operation		Dispense liquid and capture Movie
710	Syringe pump volume, rate	-2; 1	Pull in 2ul at 1ul/s to clear tip
720	Video	1	Setup Movie capture (can change)
721	Pretrigger images	5; .033	To show touch-off
722	Posttrigger images	20; .1; 1.05	Total time 3.3s (can change values)
723	No operation		Trigger will be provided by Touch-Off Macro
730	Position tip in image	25	Macro to put tip in top of image
740	Find potential baseline		Macro to find baseline from image
750	Dispense volume	5	Macro to form 5ul pendant drop (other volumes OK)
760	Run		Starts Movie acquisition; could also use SnapShot later, after touch-off
770	Touch off drop	- 0.05	Actual touch off
790	Return subroutine		
800	No operation		Setup saving movies; directory you choose must exist
810	Save movies as	Name	C:\Temp\CA_Data\Movie.mdb; 0 0 or no suffix = autoincrement within session
820	No operation		You could use "Run ID" for user entered name here also
890	Return subroutine		
900	No operation		Optional homing routine
910	Home Kloehn pump		
920	Home tip rack		
930	Move tip to video position		
990	Return subroutine		

Model Number Summary: The FTA1000 system uses a 9 character ordering code:



If you wish to order a specific module separately, not part of a whole system, you place 0's in the positions that do not apply. For example, say you wish to order a backlight type "1" for a C frame system. The model number for this backlight, as a stand-alone module, would be C 000 1. Trailing 0's may always be omitted.

Installation and Training: Installation and training are recommended for users who are new to these measurements.

FTA will provide basic training in the operation of your instrument at no charge if you come to the FTA factory. This is the recommended option since you get to run your instrument prior to its being shipped. Any problems can be corrected before the instrument leaves the factory. You are free to bring colleagues with you to this training.

For remote learning and training options, please see the FTA website:

<http://www.firsttenangstroms.com/faq/faq.html>

FTA provides a number of Internet-based support options. These are generally without charge.

FTA will install any software and boards that are part of your instrument at no charge when you purchase a computer from FTA. FTA will also, at no charge, install software and boards in your computer if it is shipped to FTA prior to shipping your instrument. You pay only for the shipping. FTA will provide free telephone support during the first 30 days when you self-install new equipment.

Specifications and Descriptions: This catalog is the sole authoritative description of the FTA1000 and its components. These specifications are subject to change without notice. All numeric values are understood to be approximate and rounded. FTA is not

responsible for typographical or clerical errors in preparing or distributing this catalog. This catalog supersedes any prior specifications or material that appears on the world wide web.

Warranty: FTA instruments are warranted to be free of defects in material and workmanship for a period of one year from the date of shipment. FTA will, at its option, repair or replace items that prove to

be defective. Any warranty repair to be returned to the distributor or FTA factory must have a Return Material Authorization (RMA) number. See order acknowledgment for complete warranty statement.

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 Portsmouth, Virginia 23704

How to Build An Instrument

☑ = Select ⌀ = Optional

A Class

Start with optional frame

+

☑ Controller

+

☑ Pump

+

☑ Measurement or
Dispense Head

B Class

Start with B Frame

+

☑ Stage or Chamber

+

☑ Camera, Microscope,
Backlight

+

☑ Dispenser and
Controller

C Class

Start with C Frame

+

☑ Stage or Chamber

+

☑ Camera, Microscope,
Backlight

+

☑ Dispenser and
Controller

+

⌀ Autosampler

+

⌀ Top View Camera

