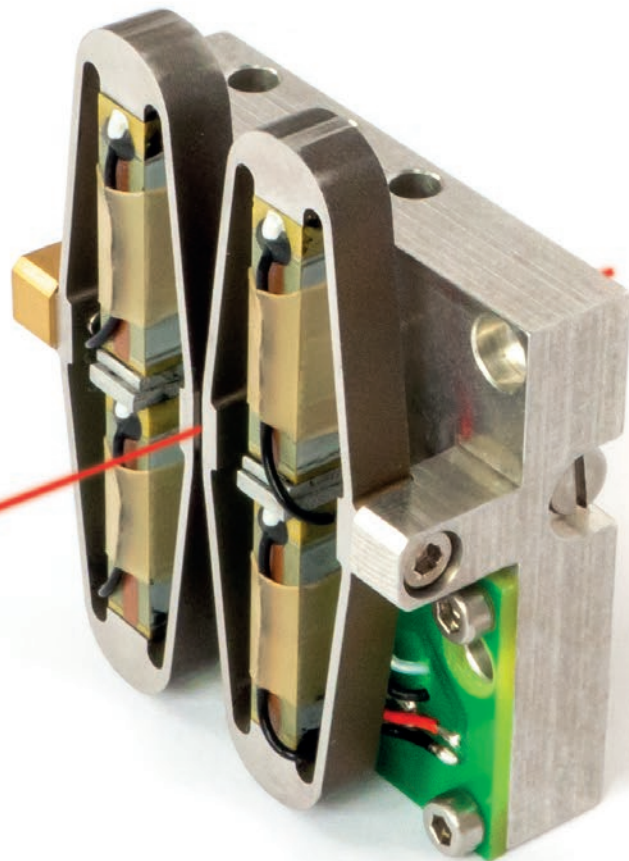


# MECHANISMS FOR SYNCHROTRON

COMPACT - DYNAMIC - PRECISE





# CEDRAT TECHNOLOGIES MECHANISMS FOR SYNCHROTRON

Cedrat Technologies (CTEC) specialized in mechatronics systems has developed a specific products range for the synchrotron applications:

| ENVIRONMENT   | Synchrotron  |      |                             |                                    |            |                                 |
|---------------|--------------|------|-----------------------------|------------------------------------|------------|---------------------------------|
| APPLICATIONS  | Fast Shutter |      | Beam shapper / Active slits | Samples positioning                |            | Fast attenuation device         |
| CTEC PRODUCTS | FPS          | FAPS | Microslits                  | Nano positioning Stages X, XY, XYZ | X - Tripod | Active filter positioning array |

Table a : Products range for the synchrotron applications

## 1. FAST PIEZO SHUTTERS

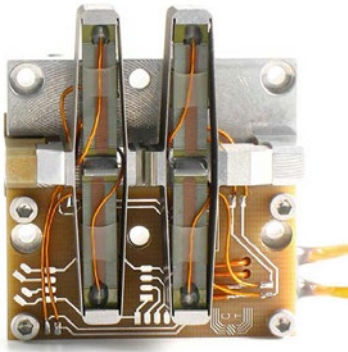


Fig. 1 : FPS900M option UHV

The Cedrat Technologies (CTEC) Fast Piezoelectric Shutters FPS have been developed to provide very fine and repeatable X Ray pulses in the optical path of the continuous X Ray beamline. On top of that the FPS solved the Magnetic Shutters reliability issues.

Standards products have been designed (see technical sheet below) but if you have a specific need we are able to design custom shutters.

### Options

- Tungsten teeth
- UHV compatibility
- Shutter status feedback (Open/Close) with Strain Gauge (SG) sensors
- Vacuum box with KF40 interface

### Advantages

- UHV compatibility
- Lifetime : > 100 million cycles
- High repeatability
- Low jitter : < 100  $\mu$ s

### Related electronics

- Amplifier SP75-2 for ON/OFF
- Amplifier LA75X for an high resolution position control
- Strain gauge conditioner SG75-1



Fig. 2 : Electronics and vacuum box

| PARAMETER                         | UNIT    | FPS200M                    | FPS400M                    | FPS900M     | FAPS400M    |
|-----------------------------------|---------|----------------------------|----------------------------|-------------|-------------|
| Max. beam diameter                | mm      | 0.30                       | 0.70                       | 1.1         | 3.0         |
| Aperture & closing time           | ms      | 2                          | 4                          | 10          | 8           |
| Voltage range                     | V       | -20 ... 150                | -20 ... 150                | -20 ... 150 | -20 ... 150 |
| Capacitance (per electrical port) | $\mu$ F | 3.2                        | 3.2                        | 3.2         | 3.2         |
| Slits material                    | -       | Stainless steel / Tungsten | Stainless steel / Tungsten | Tungsten    | Tungsten    |
| Slits depth                       | mm      | 2.4                        | 2.4 / 4.8                  | 4.8         | 3.0         |
| SG option                         | -       | ✓                          | ✓                          | ✓           | ✓ (b.1)     |
| Dimensions (X×Y×Z)                | mm      | 60×44×21                   | 60×44×21                   | 60×44×23    | 73×54×65    |
| Mass                              | g       | 150                        | 150                        | 150         | 150         |

Table b : Characteristics of piezo shutters

## 1.1. FPS PRODUCT

Developed in collaboration with M. CAPRIANI from EMBL (European Molecular Biology Laboratory), the fastest piezoelectric X-Ray shutter FPS200M as well as the other shutters of this products range are made of two Amplified Piezo Actuators (APA®) facing each other with a special optical head. They are mounted on a solid stage to cut a beam. When voltage is applied, the two APA® retract and the shutter opens (see Fig. 3).

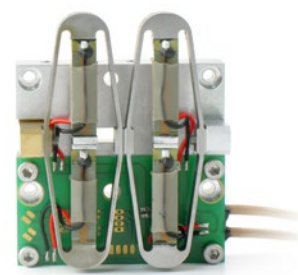


Fig. 3 : FPS200M

## 1.2. FAPS PRODUCT

To tackle apertures more than 1 mm, we developed a new product range: the Fast Amplified Piezoelectric Shutter FAPS. The optical heads for these shutters are mounted on a lever arm to amplify the APA® movement (Fig. 4).

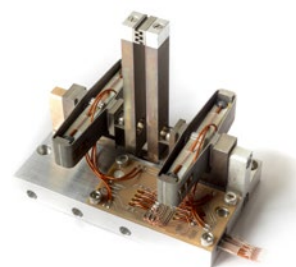


Fig. 4 : FAPS400M

## 1.3. VACUUM BOX

CTEC has developed a fully integrated solution for FPS and FAPS products in Vacuum Environments. The Shutter is mounted inside the Box with vacuum cable feedthrough.

The shutter can be unmounted and mounted again without removing the Vacuum Box from the beamline (Fig. 5).



Fig. 5 : FAPS in vacuum box

| PARAMETER             | UNIT     | VACUUM BOX     |
|-----------------------|----------|----------------|
| Clamping interface    |          | KF40           |
| Vacuum level          | mbar     | $10^{-6}$      |
| Leakage rate          | mbar.L/s | $10^{-10}$     |
| Dimension (L × W × H) | mm       | 93 × 105 × 144 |
| Weight                | Kg       | 1.3            |

Table h : Characteristics of Vacuum Box

## 2. FAST POSITIONER FOR FILTER ARRAY



Fig. 6 : Fast positioner for filter array

Cedrat Technologies (CTEC) has designed and produced a fast positioner for filter array composed by 6 APA600MML in a monolithic structure in collaboration with SOLEIL to reach high performances and robustness.

This project has been done in collaboration with SOLEIL for the SixS beamline to modify the energy of a beam by using a series of piezo actuated filters.

Each arm is holding a filter and can move independently up to 3.5 mm with a high resolution.

### Related electronics

- Amplifier LA75 for a high resolution position control

| PARAMETER     | UNIT | COMB FILTER          |
|---------------|------|----------------------|
| Stroke        | mm   | 3.5                  |
| Response time | ms   | < 10                 |
| Frequency     | Hz   | 1                    |
| Vacuum option | mbar | 10-6                 |
| Filter weight | g    | 1.7 <sup>(h.1)</sup> |

Table c : Characteristics of comb filter

*h.1 For each*

## 3. BEAM SHAPER

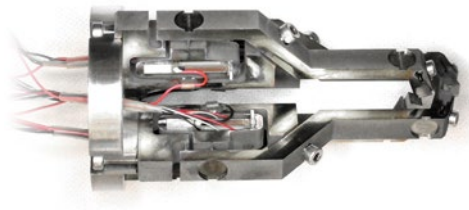


Fig. 7 : Beamshaper

CTEC has developed in collaboration with SOLEIL a beamshaper to adjust the beam shape. With this mechanism the shape of the X ray beam is a rectangle and can be adjusted.

This product is fitted with 4 piezo actuators APA50XS every 90° in a monolithic design and 4 lips at the extremities of each arms.

The aperture is more than 1 mm.

### Related electronics

- Amplifier LA75 for high resolution position control

| PARAMETER                 | UNIT | BEAM SHAPPER |
|---------------------------|------|--------------|
| Stroke                    | µm   | 600          |
| Resolution in closed loop | µm   | > 1          |
| Frequency                 | Hz   | 1            |
| Vacuum option             | mbar | 10-6         |

Table d : Characteristics of beam shapper

## 4. SAMPLES POSITIONER

Thanks to our XY or Rotation Stages and our large angle Tip Tilt products, you will be able to position your samples accurately in the center of the beam.

### 4.1. TRANSLATION STAGES UP TO 3 TRANSLATIONS

Nano positioning to position samples

#### Advantages

- No backlash compared to ball screw devices
- Accurate positioning

#### Option

- Strain Gauge (SG) sensor

#### Related electronics

- Amplifier LA75 for a high resolution position control



Fig. 8 : XYZ200M



Fig. 9 : XY25XS

| PARAMETER | UNIT | X60S        | X120S       | XY25XS   | XY200M   | XY400M      | XYZ200M  |
|-----------|------|-------------|-------------|----------|----------|-------------|----------|
|           | -    | Preliminary | Preliminary | Standard | Standard | Preliminary | Standard |

#### > Specifications

|                                   |    |             |             |             |             |             |             |
|-----------------------------------|----|-------------|-------------|-------------|-------------|-------------|-------------|
| Active axis                       | -  | TX          | TX          | TX, TY      | TX, TY      | TX, TY      | TX, TY, TZ  |
| Displacement (unloaded)           | µm | 55          | 110         | 25          | 200         | 400         | 200         |
| Unloaded resonance frequency      | Hz | 1 840       | 850         | 3 000       | 580         | 260         | 380         |
| Resolution                        | nm | 6           | 11          | 3           | 20          | 40          | 20          |
| Voltage range                     | V  | -20 ... 150 | -20 ... 150 | -20 ... 150 | -20 ... 150 | -20 ... 150 | -20 ... 150 |
| Capacitance (per electrical port) | µF | 1.6         | 1.6         | 0.50        | 6.3         | 6.3         | 6.3         |

#### > Mechanical properties

|                    |      |          |          |          |            |            |            |
|--------------------|------|----------|----------|----------|------------|------------|------------|
| Stiffness          | N/µm | 1.2      | 0.26     | 2.5      | 0.59       | 0.14       | 0.59       |
| Dimensions (X×Y×Z) | mm   | 30×30×12 | 30×30×12 | 50×50×19 | 100×100×22 | 100×100×27 | 100×100×49 |
| Mass               | g    | 23       | 23       | 80       | 450        | 500        | 540        |

Table e : Characteristics of piezoelectric stages

## 4.2. TRIPOD ACTUATOR

The Tripod Actuator (TrAC) by Cedrat Technologies is a 3 degrees of freedom mechanism (2 rotations and 1 translation).

The TraC is fitted with 3 Stepping Piezo Actuators which allow a sub-nanometer resolution and able to hold in position without power supply, a sample, a probe or a mirror for example.

### Related electronics

- Amplifier SPC45 for an high resolution position control



Fig. 10 : Tripod actuator TrAC

| PARAMETER                         | UNIT | TRIPOD ACTUATOR |
|-----------------------------------|------|-----------------|
| Rx Ry                             | °    | +/-35           |
| Tz                                | mm   | 10              |
| <b>&gt; Up speed</b>              |      |                 |
| Rx                                | mm/s | 20              |
| Ry                                | mm/s | 15              |
| Tz                                | mm/s | 25              |
| <b>&gt; Down speed</b>            |      |                 |
| Rx                                | mm/s | 40              |
| Ry                                | mm/s | 40              |
| Tz                                | mm/s | 50              |
| <b>&gt; Mechanical properties</b> |      |                 |
| Base                              | mm   | 50              |
| Height                            | mm   | 50              |

Table f : Characteristics of the Tripod Actuator TrAC



### 4.3. PIEZO MOTORISED LINEAR STAGE

Piezo motorised linear stage for accurate positioning (sample, lens, mirror...).

#### Related electronics

- Amplifier SPC45 for a high resolution position control



Fig. 11 : LSPS35XS

| PARAMETER   | UNIT   | LSPS35XS    |
|---|--------|-------------|
|   |        | Preliminary |
| <b>&gt; Stepping mode</b>                               |        |             |
| Travel range  | mm     | 10          |
| Nominal Speed <sup>(g.1)</sup> <sup>(g.2)</sup>         | mm/s   | 10          |
| Max speed <sup>(g.3)</sup>                              | mm/s   | 20          |
| Typical step size <sup>(g.1)</sup> <sup>(g.2)</sup>     | µm     | 5 ... 30    |
| <b>&gt; Fine positioning mode</b>                       |        |             |
| Stroke <sup>(g.1)</sup> <sup>(g.3)</sup>                | µm     | 54.0        |
| Resolution <sup>(g.3)</sup>                             | nm     | < 1         |
| Stiffness   | N/µm   | 0.50        |
| <b>&gt; Forces</b>                                      |        |             |
| Holding force without consumption                       | N      | 3           |
| Nominal driving force <sup>(g.1)</sup> <sup>(g.2)</sup> | N      | 0.8         |
| Max driving force <sup>(g.3)</sup>                      | N      | 2           |
| <b>&gt; Driver</b>                                      |        |             |
| Nominal driver  |        | SPC45       |
| <b>&gt; Mechanical properties</b>                       |        |             |
| Lifetime <sup>(g.4)</sup>                               | cycles | > 1 000 000 |
| Height  | mm     | 15.00       |
| Width   | mm     | 30.00       |
| Length (in actuation direction)                         | mm     | 30.00       |
| Mass  | g      | 30.00       |

Table g : Characteristics of LSPS

*g.1 Unloaded*

*g.2 With nominal driver*

*g.3 Custom version and driver*

*g.4 Unloaded, 2mm stroke, nominal speed, 50% duty-cycle*

Technologies already approved and integrated in the following beamlines, to name but a few :

- 7 Beamlines at ESRF - ID14-1, ID14-2, ID14-3, ID14-4, ID23-1, ID23-2 & ID29 – France
- 2 Beamlines at Soleil - PROXIMA 1&2 – France
- 4 Beamlines at Diamond - I24: Microfocus MX, I22: Non-crystalline diffraction – UK
- 5 Beamlines at APS Argonne – LSCAT & 21D-B – USA
- 1 Beamline at NSRRC – BL17 – Taiwan
- 2 Beamlines at SSRF - BL17U BL18U - Shanghai Synchrotron
- 1 Beamline at Spring 8 – Japan
- 2 Beamlines at PETRA III - Germany
- 2 Beamlines at MAX IV - Sweden
- 1 Beamline at PAL-XFEL - South Korea
- 1 Beamline at PLS-II - South Korea



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