Fast Piezo X-Ray Shutters FPS 200M, 400M & 900M

The precise exposure of samples to X-ray beam is needed for reliable data acquisition. With modern synchrotron sources, the exposure times get shorter and the coordination between spindle movement and shutter opening needs to be accurate in order to get reproducible exposed images.

Objective

Developed in collaboration with Mr. Florent Capriani from EMBL, the fast piezoelectric X-Ray shutter FPS200M (Fig.1a) is made of two Amplified Piezo Actuators (APA200M) facing each other with a special optical head*(fig 1.b). Similarly, the FPS400M is made of two APA400M and the FPS900M of 2 APA900M

EMBL

They are mounted on a solid stage to cut a laser or a X-Ray beam. When voltage is applied the two APA® contract and the shutter opens. The aperture size is 0.3x5 mm (FPS200M), 0.7x5 mm (FPS400M) and 1.1x5mm (FPS900M). (fig. 2)

**made of stainless steel*

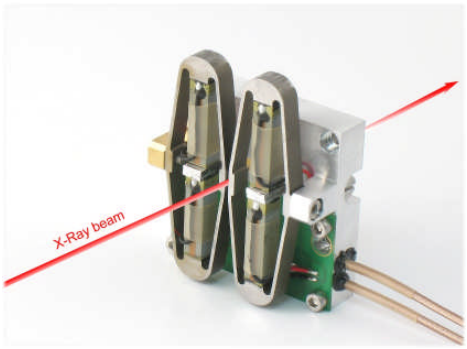

Fig.1a: FPS200M

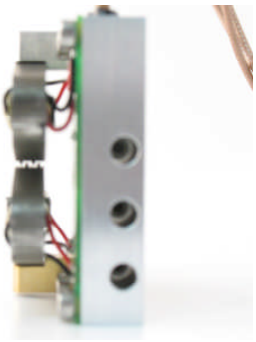

Fig.1b: FPS200M side view

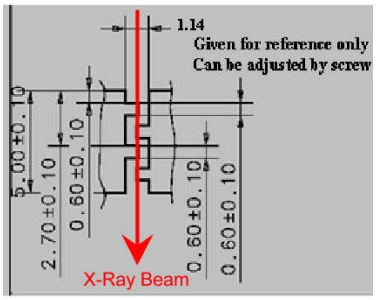

Fig.2: Dimensional view of aperture

Under request, the optical head can be made of tungsten (W) teeth for higher energy beam stopping.

This normally close shutter is driven by a standard electronic board SP75A-2 (Fig.3) from Cedrat Technologies. The SPA75A delivers a TTL signal: -20 or 150V.

Fig.3: SP75A ON/OFF Amplifier

Performances

Typical performances are given in the following table (Fig.3). This table is not exhaustive as many others Fast Piezo X-Ray Shutter can be designed by Cedrat Technologies starting with other standard amplified piezo actuators.

References	Unit	FPS200M	FPS400M	FPS900M
Item Code		***V-FPSM200***	***V-FPSM400***	***V-FPSM900***
Notes		-	-	-
Sensors option		SG	SG	SG
Active axis		TX	TX	TX
Max. No-load displacement (Tx)	µm	400	800	1600
Max. beam diameter	mm	0.3	0.7	1.1
Voltage range	V	-20 … 150	-20 … 150	-20 … 150
Stiffness	N/µm	3.17	0.10	0.10
Heigth (Z axis)	mm	21.0	21.0	23.0
Dimensions (X & Y axis)	mm	60 * 44	60 * 44	60 * 44
Mass	g	150	150	150
Unloaded resonance frequency (in the actuation's direction)	Hz	900	495	200
Opening & closing time	ms	2.00	4.00	10.00
Capacitance (per electrical port)	µF	3.15	3.15	3.15
Mechanical interfaces (payload)		4 slits (width 0.6 mm)	4 slits (width 0.6 mm)	4 slits (width 0.6 mm)
Mechanical interfaces (frame)		4 holes Ø 2.7mm on [] 24*38 mm	4 holes Ø 2.7mm on [] 24*38 mm	4 holes Ø 2.7mm on [] 24*38 mm
Electrical interfaces		2 RG178B/U coaxial cables	2 RG178B/U coaxial cables	2 RG178B/U coaxial cables

Fig.4: Characteristics of the FPS X-Ray Shutters

In summary, the FPS technology offers:

	FPS200M	FPS400M	FPS900M
Very low jitter (µs)	<100	<100	<100
Response time with SPA75-2 (ms)	2	4	10
Large displacement (µm)	> 300	> 700	>1100
Life time (cycles)	$>10^{10}$	$>10^{10}$	$>10^{10}$

Advantages:

- Very good jitter
- Vacuum compatible
- Proportional aperture
- Extremely Reliable
- Immune to Magnetic Fields
- Very Compact
- No particles generated

References

Fast Piezo Shutter presently operating successfully in below mentioned Beamlines:

- 7 Beamlines at ESRF - ID14-1, ID14-2, ID14-3, ID14-4, ID23-1, ID23-2 & ID29 – France.(Fig.6)
- 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
- 1 Beamline at Spring 8 – Japan
- 2 Beamlines at PETRA III - Germany

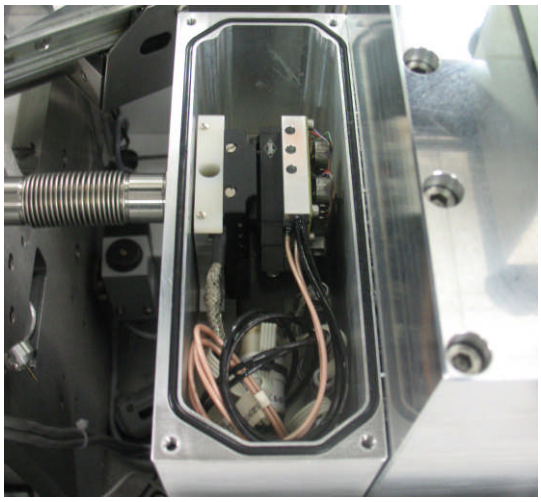

Fig.6: FPS200M on a XY stage on a MX Beamline (Courtesy ESRF)

Remarks

- CEDRAT TECHNOLOGIES is the only company to manufacture, test and establish successfully the Fast Piezo Shutter for X - Ray beamlines application.
- CEDRAT TECHNOLOGIES's laboratories are equipped with a complete library of engineering software and specialized measurement apparatus.
- CEDRAT TECHNOLOGIES is a high technology French SME company with 18 years of experience in designing and developing Piezo based mechanisms.

Keywords: *X-Ray, Xray, piezo, shutter, synchrotron, beamline, Macromollecular, MX*