Imaging plates

		BAS Series							FLA Series					FDL Series
		2000	1000 1500	2500	1800	1800II	3000	5000	2000	3000G	5000 5100	7000	8000	5000
BAS-MS High sensitivity water resistance	BAS-MS 2025	●			●	●		●	●	●	●	●		
	BAS-MS 2040	●	●	●					●	●	●	●		
	BAS-MS 2325					●				●	●			
	BAS-MS 2340									●	●			
	BAS-MS 3543										●			
BAS-SR High resolution water resistance	BAS-SR 2025	●			●	●		●	●	●	●	●		
	BAS-SR 2040	●	●	●					●	●	●	●		
	BAS-SR 12.7x12.7						●							
	BAS-SR 0813												●	
BAS-TR For ^{3}H detection	BAS-TR 2025	●			●	●		●	●	●	●	●		
	BAS-TR 2040	●	●	●					●	●	●	●		
	BAS-TR 12.7x12.7						●							
BAS-ND For Neutron detection	BAS-ND 2025	●			●	●		●	●	●	●	●		
	BAS-ND 2040	●	●	●					●	●	●	●		
FDL-URV	10 x 8.1													●

What is Imaging Plate?

Fujifilm's Proprietary Imaging Plate

The "Imaging Plate" is a new film-like radiation image sensor comprised of specifically designed phosphors that trap and store the radiation energy. The stored energy is stable until scanned with a laser beam, which releases the energy as luminescence. This phosphor technology, launched in its first application to the medical X-ray diagnostic field, portends great promise in a wide range of newer scientific and technological applications.

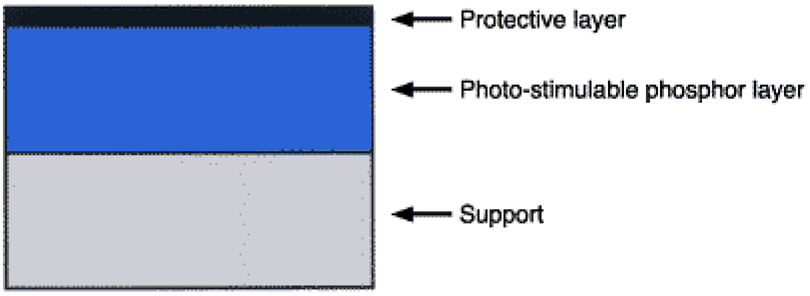
Photo-stimulable Phosphor

A special phosphor was designed for the Imaging Plate. A certain substance has been known to emit light when irradiated with radiation, UV rays or an electron beam, or when heated, or mechanically hit or stimulated by chemical reaction in some cases. Materials of this kind are generally called fluorescent substances. In particular, the substances which are powders with practical applicabilities are often called phosphors. A phosphor emits light when stimulated by, for example, radiation. The light disappears instantaneously when the stimulation ceases. This phenomenon is called "fluorescence." Some of the phosphors, however, continue emitting lights for a while after the stimulation stops, which is called "phosphorescence." "Luminescence" incorporates both of these light emission phenomena. The luminescence characteristics, specifically those of fluorescence and phosphorescence, should be taken into account when developing phosphors for practical usage. And depending on the application, these characteristics are accurately adjusted by varying the phosphor composition or manufacturing conditions. The phosphor used for the Imaging Plate has special properties differing from those previously known, but which have not yet been put to practical use. It utilizes the "photostimulated luminescence" (PSL) phenomenon which is neither "fluorescent" nor "phosphorescent." The PSL phenomenon is said to have been discovered by the world-famous Becquerel of France in the mid-19th century. This phenomenon involves a substance that emits light again upon the second stimulation by light having a longer wavelength than the luminescence wavelength of the first stimulation by, for example, radiation. The PSL phenomenon, however, did not attract much interest until recently. In Japan, it was studied by military researchers until the end of World War II to develop an infrared -ray detection system. In the U.S., research was carried out in 1947 in which PSL was taken using photo-film for detecting the radiation image. No other studies were reported for some time afterwards. This PSL phenomenon satisfies our basic concept of the Imaging Plate as an X-ray image sensor, which stores the first radiation information and releases that information as light.

Principle of Imaging Plate Methodology

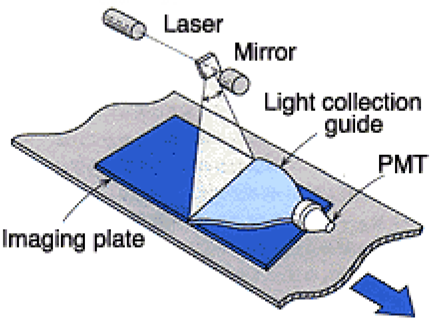
The Imaging Plate is a flexible image sensor in which bunches of very small crystals (grain size: about 5 µm) of photo-stimulable phosphor of barium fluorobromide containing a trace amount of bivalent europium as a luminescence center, formulated as BaFBr: Eu^{2+}, are uniformly coated on a polyester support film. The composite structure of the Imaging Plate is shown in Figure 1.

Figure 1:
Composite structure of the Imaging Plate



Exposure of samples to the Imaging Plate is performed in a manner similar to that of photo-film. The exposed Imaging Plate is scanned with a laser beam of red light while the plate is being conveyed with high accuracy in a phosphor reader as shown in Figure 2.

Figure 2:
Principle of reading the radiation image from the Imaging Plate

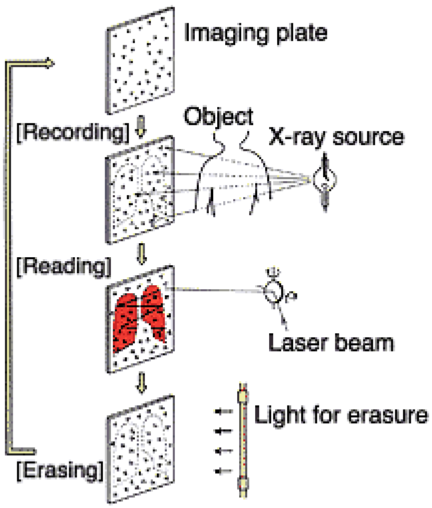


The exposed Imaging Plate, while being conveyed, is scanned with a focused laser beam. The PSL released upon the laser is collected into the photomultiplier tube (PMT) through the light collection guide and is converted to electric signals.

Depending on the purpose, the reading density may be selected from 5 to 40 pixels/mm. The reading sensitivity and sensitivity range can also be selected according to the purpose. A bluish purple (400 nm) PSL, released upon laser excitation, is collected through the light collection guide to the photo-multiplier tube (PMT), and converted there to analog electric signals in chronological order. Subsequently, these are converted to digital signals of 8 to 16 bits, again depending on the intended purpose.

Image analysis and data processing are done on the CRT screen. The processed image, if necessary, is printed either as a color or grayscale hard copy. The image or data processings include those of image density/gradation, spatial frequency, operational reduction or addition between multiple numbers of images, and measurements of radiation dose, length or area. Application calculation processing then becomes possible based on these data. It is a particularly great advantage to quantify the image on the CRT as accurately as the scintillation counter method. The Imaging Plate is reusable after erasing the residual latent image with uniformly irradiated visible light as shown in Figure 3.

Figure 3:
Process of recording, reading, erasing and reusingthe radiation image by the Imaging Plate method

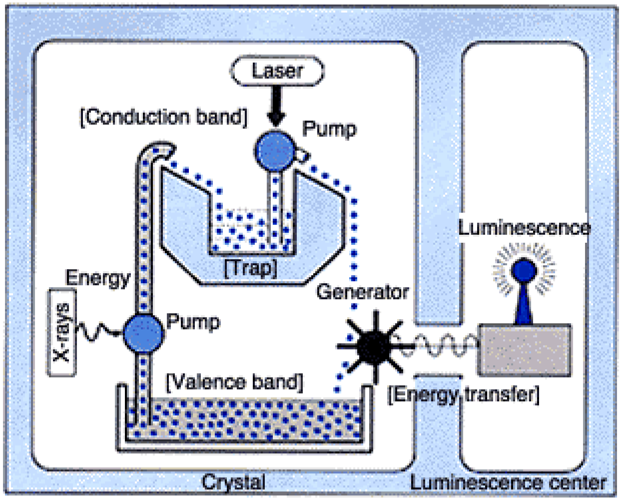


The exposed Imaging Plate is reusable after erasing the residual latent image with uniformly irradiated visible light.

The BaFX: Eu^{2+} (X = Cl, Br or I) crystal is an ionic crystal having a tetragonal structure, and Ba is replaced with the Eu^{2+} ion to create a solid solution. This crystal, when irradiated by radiation, for example, produces mainly two types of color centers in the crystal where an electron is trapped in an empty lattice of the F or X ion. The color center actually produced mainly depends on the discrepancy between the stoichiometric composition of F and X. The type of color center can be determined by comparing the theoretical value with the measured value from the electron spin resonance (ESR) spectrum by assuming an empty lattice for each anion. Experiments carried out for the composition of X = Br reveal that the spectra of the PSL excitation process produced by visible rays after sufficient X-ray irradiation coincide well with the peak of the optical density, light current, ESR intensity and PSL intensity at the color center. The relative change between the intensity of blue luminescence with the Eu^{2+} ion and that of red luminescence with the Eu^{3+} ion detected in a trace amount is also observed before and after the PSL excitation process.

From these data, the luminescence mechanism of the BaFBr: Eu^{2+} photo-stimulable phosphor is interpreted as follows. Part of the Eu^{2+} ionsbecome Eu^{3+} ions through the primary excitation by X-rays, for example, with electrons being released into the conduction band. These electrons are trapped into the Br ion empty lattices of the lattice defects, which are inherently present in the crystal, and color centers of the metastable state are formed. When the PSL excitation light to be absorbed by the color center is irradiated, the trapped electrons are liberated again into the conduction band, or Eu^{3+} ions, becoming an excitation state of the Eu^{2+} ion, to release PSL. The luminescence mechanism is schematically shown in Figure 4.

Figure 4:
Imaging plate luminescene mechanism



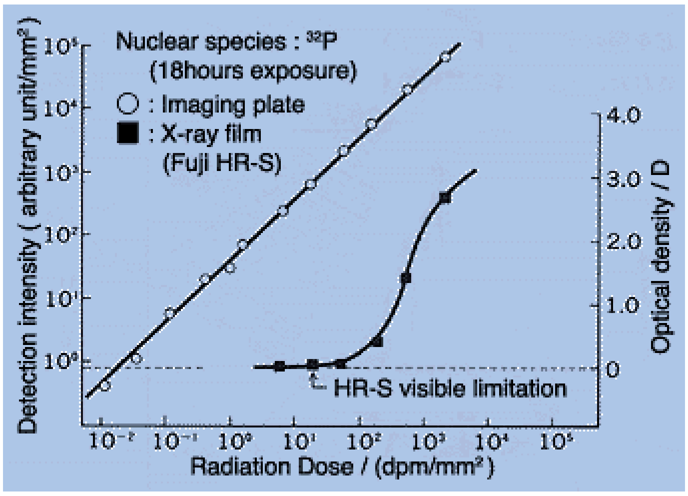
An excited electron is trapped into the halogen ion empty lattice in the crystal, makes a color center having a metastable state, and emits the radiation energy. Irradiation by the laser beam to be absorbed by the color center excites the electron again, and the recombination energy with the hole is transferred to the Eu ion, the luminescence center, resulting in luminescence.

Although the PSL mechanism is unclear in some respects, research in the future shall well elucidate the mechanism.

Features of Imaging Plate Methodology

Several techniques have been developed for detecting radiation: the ionization chamber; scintillation counter, and proportional counter tube. However, very few have been established for detecting a radiation image two-dimensionally: photo-film, the two-dimensional proportional counter tube, X-ray image intensifier and X-ray TV. Among these, the means most widely used in various fields is photo-film. The differences between the Imaging Plate and photo-film are clearly illustrated characteristically in Figure 5, depicting the detection of beta rays from radioactive isotope ^{32}P.

Figure 5:
Comparison of characteristics between Imaging Plate and photographic methods (for autoradiography).



The abscissa is radiation of a standard sample of ^{32}P (beta rays 1.7 MeV) used for exposure, measured by liquid scintillation counter. The left ordinate is the amount of luminescence from the imaging plate. The right ordinate is the blackened density of photo-film. The visible limitation is the limit necessary to distinguish between the "presence and absence" of an image, and is generally about 1/10 of the determination limit. Similar characteristics are obtained with other beta rays of different energies, electron rays, X-rays, and gamma-rays. The features of the Imaging Plate method become clear when compared with other radiation image sensors.

1. Ultrahigh sensitivity. Several ten times more sensitive than film, and several thousand times depending on the sample.
2. Wider dynamic range. A wider range of 10^4 to 10^5 over the 10^2 range of the photographic method.
3. Superior linearity. The fluorescence emission is proportional to the dose in the entire range.
4. Higher spatial resolution. When compared with other electronic systems, a higher pixel density can be designed to meet the system purpose though less freely than film.
5. Digital electric signals are directly available from the reader. Computer processing or combination with other electronic systems is easy.
6. Due to an integral-type detector, the IP method produces less detection counting errors even at a high flux density, which often happen with pulse-type detectors such as the proportional counter tube and scintillation counter.
7. The accumulated background can be erased before use.

The Imaging Plate method, replacing the conventional radiation image sensors, not only visualizes the latent radiation image with a high sensitivity through the digital process of conventional radiation image sensors, but also makes it possible to quantify the position and intensity of the radiation image.

A Host of Imaging Plate Applications

Nature has reported that the "Imaging Plate illuminates many fields." Applications of the

Imaging Plate are being widely tried to dramatically improve conventional methods in the medical X-ray diagnostic field as well as in scientific and technological fields requiring radiation image processing. The latter includes X-ray crystallography, microstructure analyses by electron microscope, and analyses by autoradiography.

Reference

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  Applications of imaging plate.

1xxx IP durability

1101

Q: How long does an IP last?

A: As for the BAS-MS IP, if you use it properly, its characteristics do not change after being used 1000 times and stored for 5 years. Presumably, its practical durability is several fold of these values.

1102

Q: What is proper use of IP for BAS (multi-purpose IP)?

A: The following are the essential procedures. 1) Use well dried samples for direct contact.
2) Completely wrap the sample with polyvinylidene chloride sheet (e.g. Saranwrap) of 10 micron thickness.
3) Avoid high temperature, high humidity (dew condensation) and direct sunlight (UV light) to store the IP.

1103

Q: What does the durability data of IP suggest?

A: We have made sure the following concerning the durability of BAS-III IP (the most widely used IP with BAS) used with BAS-2000 scanner. Its durability when used with BAS-2500 and others is probably higher than that with BAS-2000 since other BAS machines are designed to have smaller mechanical load on IP. It is considered that other multi-purpose IPs other than BAS-III have about the same durability for their designs. 1)There is no characteristic change recognized in photostimulable phosphor due to the usage cycle from exposure, scanning to erasing in the radioactive environment even after the 1000 cycles.

2)The deterioration of characteristics due to mechanical load along with the usage cycle has not been detected after 1000 times with BAS-2000. After 5000 cycles, damage was recognized on the 3mm inside from the edge. However, the IP was still usable.
3)There was no characteristic difference between the new IP and the IP that had been stored for 5 years in normal temperature and humidity.

1104

Q When IP contacts water, how does it affect the durability of IP?

A If the IPs for BAS-III and BAS-IIIS contact water in such cases of exposing the sample that is not adequately dried, the parts of IP that have contacted water will deteriorate in sensitivity and turn yellow. However, MS-, SR- and MP-type IPs are almost completely anti-deterioration from contacting water.

1201

Q Are there any IPs that do not yellow?

A As for IPs for BAS, yellowing phenomenon has been recognized with BAS-III, BAS-IIIS, BAS-TR, BAS-YR, TR2040, TR2040S. Yellowing does not occur on MS, SR and MP series.

1202

Q How does yellowing progress?

A BAS-III IP started deterioration in sensitivity when it touches water, and the yellowing is visibly recognizable after two weeks. The deterioration steadily continues and the sensitivity becomes about 1/3 of other parts that had not touched water. It is impossible to restore the deterioration.

1203

Q What should we do when yellowing occurs to BAS-III IP?

A The yellowed IP will not recover the original characteristics. It is highly recommended to use MS IP or SR IP to which yellowing will not occur. However, it is important to keep the IP surface from touching the water containing RI elements in order to avoid radioactive contamination.

1204

Q What is element constituting Imaging Plates?

A In case of MS-IP

Layer type	Thickness	Density (g/cm3)	Material
Surface Layer	9	1.4	polyethyleneterephthalate
Phosphor layer	115	3.3	phosphor*:urethane = 25:1 *Ba:F:Br:I (atomic number

			ratio 1:1:0.85:0.15, density 5.2g/cm^3)
Back layer	12	1.4	plastic
Base layer	190	1.4	polyethyleneterephthalate
Ferrite layer	80	3.0	MnO, ZnO, Fe203 + plastic
Back protective layer	25	1.4	polyethyleneterephthalate

2xxx ^{3}H IP, Neutron Detection IP

2101

Q What is the structural difference between IP for ^{3}H and multi-purpose IP?

A There are two kinds of IPs for detection of RI: TR-IP and multi-purpose IP. In addition, there is ND-IP for neutron detection. Multi-purpose IP can detect and measure all the RI except ^{3}H. TR-IP can detect ^{3}H as well as other elements that can be detected with multi-purpose IP. The difference between the two types of IP is the layer structure. TR-IP does not have the protection layer and has thinner photostimulable phosphor layer than the multi-purpose IP.

2102

Q Is the usage of ^{3}H IP different from that of the multi-purpose IP?

A Multi-purpose IPs are intended to be used repeatedly. Therefore, in order to prevent radioactive and other contamination of IP, samples must be completely wrapped with e.g. Saranwrap. When exposing a ^{3}H-labeled sample on TR-IP, samples must not be wrapped but put directly on the detection surface because the energy of beta-ray of ^{3}H is too weak to pass through Saranwrap. Since samples are directly contacting on TR-IP, the radioactivity from the samples is wholly or partially transferred to the IP surface. IP after the exposure, therefore, must be handled as radioactive contaminated object. Also, due to the remaining radioactivity transferred to the IP surface after the first use, the image from the first exposure might be recognized vaguely overlapping the second image as if there is an after-image. So, to obtain a perfect result, it can be used only once. Practically, if the sample is small, the used part can be markerd and the same IP can be used repeatedly by using other parts of the IP.

2103

Q Can ^{3}H IP be used for RI autoradiographies other than ^{3}H?

A Yes it can be used for detection and measurement of RI's other than ^{3}H. In such case, there are two kinds of usage. One is the same as the usage of multi-purpose

IP in which the sample is completely wrapped with e.g. Saranwrap when exposing. Therefore, the IP can be repeatedly used. Another usage method is the same as exposing ^{3}H labeled sample, i.e., exposure is done directly to the detection surface of IP without wrapping the sample. In this case, the IP after exposure must be treated in the same way of the IP used for exposure of ^{3}H labeled samples. In the latter method, the resolution of images increases because there is no space between the sample surface and the photostimulable phosphor layer (that contributes the most to radioactivity detection among all other structural layers of IP). The degree of resolution increase depends on the conditions of RI sample and exposure.

2104

Does touching the surface of ^{3}H IP cause a functional damage unlike ^{3}H film.

The functions of ^{3}H IP does not get damaged when its prespiration is touched by hands, although it is necessary to ware gloves to prevent the grease or other substance from transferring to the surface. Emulsion layer of ^{3}H film is too weak to be processed in a roller-type automatic film processor while almost all the automatic film processors for X-ray film are of this type. When used in such a film processor, a bat phenomenon occurs to the film and emulsion touched by hands or tweezers comes off. So, using ^{3}H IP instead of ^{3}H film can avoid these risks.

2105

Is BAS-TR IP sensitive to beta ray, X-ray and gamma rays other than ^{3}H?

BAS-TR IP is also sensitive to beta ray, X-ray, gamma ray and alpha rays in addition to ^{3}H.

2201

Is ^{3}H IP expensive?

Some say that ^{3}H IP is too expensive because it is not reusable. However, the difference between BAS-SR IP is removal of the protective layer. Main photostimulable phosphor layer is the same.

2202

What is a “RI saving effect” of ^{3}H IP?

Since ^{3}H IP has high sensitivity and high linearity, the amount of ^{3}H labeling reagent necessary for an experiment can be reduced dramatically. The reduction in the reagent cost by this effect is sometimes higher than the price of ^{3}H IP.

2203

It is said ^{3}H IP can make some impossible things possible. What are they?

^{3}H IP is often used for detecting and quantifying weak samples that can be imaged after as long as 4 weeks of exposure. Actually in one case, a sample was imaged after 10 months of exposure. Imaging or quantitation of such weak samples is impossible without ^{3}H IP.

2204

What kind of “time-saving effect” did TR-IP bring?

A: We have received a lot of reports that TR-IP made it possible to finish within a day the experiment that usually takes 2 weeks by film for detection and measurement. Usually a series of experiments takes 6 to 12 months because the next experiment is planned after obtaining the result from the current experiment, but TR-IP accelerates the progress of a study.

2301

Q: Why is the quality-assurance of ^{3}H IP limited to once?

A: Since the energy of beta-ray of ^{3}H is too weak to penetrate the wrapped sample, it is presupposed that samples are directly contacting the IP surface while exposure. Therefore, the IP surface could have been contaminated by RI due to the direct contact with the sample containing RI. If the TR-IP is contaminated, the contamination will also be imaged in the second and later usages.

2302

Q: How about reusing the IP part that was not used for exposure in the first use?

A: It is sufficiently reusable. Personally, when I expose small samples, I mark on the IP surface to discern the used parts. It is necessary to erase the previous data on IP before reusing and such IP must be treated as contaminated. In order not to contaminate the IP eraser, wrap the used IP before erasing.

2303

Q: Is it always the case that TR IP gets contaminated?

A: Empirically, when using a dried gel as sample, contamination rarely occurs or is very slight. However, it is almost always the case that contamination occurs when using tissue samples. In case of the tissue section containing ^{3}H, the previous sample is imaged after the same period of exposure with 1/10 of imaging intensity.

2401

Q: When conducting autoradiography of ^{3}H-labeled sample using BAS-TR IP, would a sensitizer such as Amersham's Amplify used for film make the experiment more effective?

A: Sensitizer has a negative effect on the autoradiography using BAS-TR IP. Films are much more sensitive to blue light than to beta ray. Sensitizer converts a part of beta ray energy into blue light in order to increase the film sensitivity. IP however has low sensitivity to blue light and rather work on erasing direction. Therefore, it is better not to use sensitizer in autoradiography using BAS-TR IP.

2601

Q: What is Neutron Detection IP?

A: Neutron Detection IP has the photostimulable phosphor layer, a mixture of neutron converter and the photo stimulated luminescence substance that is the major consistent of general IP, in order to detect and quantify neutron effectively. The neutron converter absorbs neutron effectively and emits secondary radiation and this secondary radiation is detected by the photo stimulable phosphor. This IP is currently called BAS-ND IP that adopts Gd203 as the neutron converter and the ratio of neutron converter and photo stimulable phosphor is 1:1.

2602

Q What is the difference between the usages of Neutron Detection IP and general-purpose IP?

A Unlike general purpose IP, ND IP would be exposed to neutron but reading process is the same as general purpose IP. However, we must be careful when activating IP. Autoradiography is rare in the exposure process but the neutron radiography and neutron radiation diffraction are often conducted.

2603

Q Is Neutron Detection IP only sensitive to neutron? How about beta ray, X-ray and gamma rays?

A ND IP is sensitive to beta ray, X-ray, gamma-ray and alpha rays in addition to neutron. In order to detect only neutron, it is necessary to avoid the influence of gamma ray.

3xxx BAS images and data characteristics

3201

Q The longer the time between the exposure completion and reading-out becomes, the smaller the detection value is. Is this phenomenon what is called “fading”?

A As the longer the time between the completion of exposure and the start of read-out, the lower the detected value becomes compared to when reading-out IP immediately after the completion of exposure. This phenomenon is called fading.

3202

Q Why does fading occur?

A In the IP that has been exposed to radiation source and such, electrons are excited and maintained in meta-stable state. In such a state, when electrons are stimulated by red light during the scanning process, they emit blue photostimulable luminescence. These photostimulable luminescence are detected electrically for a detected value. They, however, sometimes get thermal influence other than this detection process, through which some electrons in meta-stable state lose energy before scanning. This eventually causes the fading phenomenon.

3203

Q What quantitative characteristics does the fading have?

A Under the conditions of conventional autoradiography (exposure for more than 1 hour in room temperature), the detection value decreases at a certain pace despite the nuclide of the used RI. The higher the temperature is, the sharper the detected value decreases but the decrease of detected value cannot be detected at the temperature of 5 degrees or lower. The longer the exposure time is, the slower the detected value decreases. Although this is confirmed only with the BAS-III IP, since the fading progresses even during exposure, it is likely the case with other IPs for BAS currently sold by Fujifilm.

3204

Q What should we be careful about concerning the fading phenomenon?

A Since the autoradiography using IP generates fading phenomenon, we must be careful about the following points when IP is used for quantitative purpose. -There is no linearity in detected value of BAS system regardless of exposure time.(However, Dr. P. Fernyhough, Dr. B. R. Whitby reported at the Society for Whole Body Autoradiography Meeting (Michigan, USA, 1997) that linearity depending on exposure time can be obtained by using refrigerated shield box.) -When exposure and reading take place in different locations, and when comparing the experiment results from different experiments, it is necessary to arrange not only exposure times but the times between completion of exposure and scanning. -The extent of fading varies depending on temperature. Therefore, when the exposure time is less than 10 minutes, if the temperature of IP became higher than the room temperature while being in the IP eraser, it is better to cool it down to the room temperature by putting it into a cassette and such for stability of the data. -When the exposure time is as short as less than 10 minutes, the extent of fading varies very much depending on the time before the reading, which causes unevenness. To prevent this, reading must be started 10 to 30 minutes after the completion of exposure.

3205

Q Will there be IPs with which no fading occurs?

A In terms of technology and industry, it is unlikely that IP with no fading phenomenon will be launched in next 2-3 years. At this moment, it remains to be wise to avoid the influence of this phenomenon or to use some adjustment measures if necessary.

3301

Q The detected value does not change proportionately with time.

A The detected value of BAS system has no linearity against exposure time, which you must be careful about. No linearity specifically means that the detected value of 14C, or other sample with which the loss of RI can be neglected, after 10-hour exposure is not 10 times its detected value after 1-hour exposure (It will actually be 8 times). (However, Dr. P. Fernyhough and Dr. B. R. Whitby reported at the Society for Whole Body Autoradiography Meeting (Michigan, USA, 1997) that linearity depending on exposure time can be obtained by using refrigerated shield box.).

3401

Q Does a detected value have higher and lower limits?

A There are maximum and minimum values determined by the reading conditions of BAS system. For example, with sensitivity(S)=10,000 and latitude(L)=4, which is an usual setting, the maximum value is around 4,000 and minimum value (except for 0) is 0.4 when expressed in the PSL/mm2 dimension. The pixels higher than the maximum value are to be recorded as the maximum value and the pixels lower than the minimum value, as the minimum value. So, when the reading L=2, values expressed in the PSL/mm2 dimension, the maximum value is about 400 and the minimum value (except for 0) is about 4.0. When the exposed IP, that is supposed to show the PSL/mm2 in the range of 1.0 and 3.0, is read with S=10,000 and L=2, the image becomes 0 and is invisible. If the same IP is read under the conditions with S=10,000 and L=4, an appropriate image data can be obtained.

3402

Q How big is the A/D conversion error in a detected value?

A The error that occurs when converting continuous analog data into digital data that is discrete is called “quantum error.” BAS system keeps the quantum error at a certain ratio for the whole density range. When the reading conditionis latitude L=4 and Gradation=256, this error ratio is 3.7%, i.e., the original PSL of data with PSL/mm2=100 range from 100 to 103.7 and PSL/mm2=1.0 range from 1.0 to 1.037. With BAS system when the quantizing error becomes smaller, the number of gradation is larger and the latitude is smaller. With BAS-2000, therefore, the smallest error is about 0.2%. This value is between about 4.6 to 0.014% with BAS-2500 ( ) and BAS-5000. Since the image density detected as PSL/mm2 is addition of the background and the sample, the quantum error ratio of the image intensity (PSL/mm2-BG) becomes large when the background noise is high. For example, an image data read with BAS-2000 at latitude=4 and gradation=1024 has 0.9% of qunatizaion error. In case the detected value is PSL/mm2=100 and background noise is PSL/mm2=90, the sample density is (PSL-BG/mm2)=10. (It has been confirmed that even when the background contribution is 90% of the detected value, BAS has enough linearity for a 1x1cm sample with uniform concentration.) In such case, the quantum error is 0.9PSL/mm2. Therefore, when quantifing a very small amount of sample accurately it is effective to set the gradation as large as possible and lower the background noise using a lead shield box. Although lowering latitude is effective with regard to minimizing quantum error ratio, we do not recommend it for autoradiography applications because it narrows the quantitation range.

3501

Q How does a pixel size relate to resolution?

A A system such as BAS scans an object with laser beam to create a two dimensional image data. The pixel size is the pitch of the object surface (here, the surface of IP). It can be calculated by multiplying the sampling time and scanning speed. Therefore, the pixel size does not mean resolution. Resolution is affected by many factors such as machine, type of IP exposure, sample and so on. Resolution, however, will not be better than the pixel size.

3502

Q What causes an image lacking in resolution?

A Among BAS series, the smallest pixel size varies from 200x200µm to 25x25µm. Whichever BAS is used, its highest image resolution does not exceed that of X-ray film autoradiography. However, when BAS images are considered as “low resolution,” “rough image,” “lack of resolving power” the reason might not be of the BAS performance but of the radiation distribution from the sample. The number of disintegrated RI must be statistically treatable in order for the radiation amount to a pixel can be correlated to the RI distribution within a sample. In other words, the shorter the exposure time, the rougher an image becomes due to the statistical variation of the RI disintegration. BAS can generate images within 1/100 exposure time of X-ray film and the image obtained is quantifiable. Therefore, the exposure time in autoradiography using BAS tends to be short. When quantification result is only the matter of interest, exposure time can be short, however, for obtaining a high-quality image, exposure time must be long enough.

3503

Q How can you improve image quality?

A When resolution of the BAS image seems low, in most of the case this occurred because the exposure time was too short. The first thing you can do for quality improvement is extending exposure time. If extending exposure time does not make much difference, then it is effective to use machine with smaller pixel size. When using a machine that allows you to choose a pixel size, choosing larger pixel size will decrease the noise in the image and the resolution seems higher. Smoothing can be done by an image processing software such as L Process software for Macintosh and Windows.

3504

Q What should you be careful about when choosing a small pixel size?

A Choosing a smaller pixel size means that you need a high quality image. In order to obtain a high quality image with a small pixel size, the exposure time must be extended. Please extend the exposure time according to the reverse ratio of the pixel area ratio.

3505

Q Even after a long enough exposure, what if the image quality is not satisfactory?

A BAS series consists of machines with smallest pixel sizes of from 200x200µm to 25x25µm. Image quality might be improved by using smaller pixel size or using high-resolution type IP such as BAS SR IP or ^{3}H IP

4xxx Contribution of BAS data to academic journals, explanations on units

4101

Q Can a Pictrography image be used for submission to journals?

A Generally, it can be accepted. This depends on the policies of each science journal and some journals do not clearly state so. The following are the old and recent journals that accepted and carried the Pictrography images.
Yaeta Tndo, Anton Gluck, Ira. G. Wool: J. Mol. Biol. (1991) 221, 193-207
Takayuki Nakano, Toshiyuki Satoh, Keiji Mori, and Osamu Inoue: Neuroscience Letters (1998) 250, 161-164
Yasuo Suda, Keiji Mori, Karyn Bird, Dalila Marques, Julie Ormsby, Satoshi Tanaka, Shuhei koshida, Megumi Nakamura, Shoichi Kusumoto, Michael Sobel: J. Biochem. (1999) 125, 1011-1015

4201

Q What does PSL stand for?

A It is an acronym for photo-stimulated luminescence that is generated when IP is scanned with laser light in BAS.

4202

Q How PSL can be defined quantitatively?

A: The image data obtained from a standard IP exposed to the X-ray of 3.87x10-8C/kg(0.15mR) with accelerated voltage of 80kV as tungusten target is defined as 100PSL/mm2. The value of PSL/mm2 becomes smaller even when exposed to the same radiation and its amount, as more exposure time passes, the temperature of IP increases, or the time between exposure and scanning expands. Also, its value is affected by the radiation, radiation quality, IP type or reading condition. Therefore, the above quantitative definition is significant in terms of system designing and adjustment but is less significant in actual usage of IP.

4203

Q: What actual meaning does PSL value carry?

A: For those who use IP for quantitative autoradiography, PSL and PSL/mm2 values have the following meanings. - PSL/mm2 is a radiation amount unit unique to BAS system. - PSL/mm2 approximately is in proportion with the Bq/mm2 of the exposed sample multiplied by the exposure time. This proportional factor varies depending on the thickness of the nuclide and sample. - PSL is the value reached by multiplication of PSL/mm2 and the determination area (mm2). PSL is approximately in proportion with (Bq x (exposure time)) of the sample. - For a relative comparison within one image, comparing PSL/mm2 or PSL gives fairly accurate result. - The longer the exposure time or the time between the completion of exposure and the reading out is, or the higher the temperature is the smaller the PSL/mm2 value is. - There is no equation to convert PSL/mm2 or PSL values into absolute values such as Bq.

4204

Q: How is PSL value to be expressed in publication paper?

A: Basically it depends on the structure of the paper but when comparing the amounts or on the y-axis of a coordinate, it can be expressed as dose (PSL/mm2) or IP response. When discussing data within an image, it can be expressed as relative activity (PSL).

7xxx Peripheral Items

7101

Q: For the exposure in autoradiography using IP, can we use other cassettes other than the BAS cassette?

A: It is possible to use other medical X-ray cassette for autoradiography using IP. However, medical X-ray cassettes generally have lead plate on their lids, which makes higher background images due to the lead when exposing for more than 24 hours to detect a small amount of RI. So, they are not appropriate for long-time exposure.

Also, it is also possible in principle to use the cassette for film autoradiography, but IR is far more sensitive to a small amount of radioactive contamination than film, which might cause some problems. When using the cassette for film, please make sure there is no such contamination of RI.