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## FLOW SORT X-RAY DIAMOND RECOVERY MACHINES

### TRAINING MATERIAL

In the following write-up I shall attempt to use photography as an analogue to the functionality of an X-ray fluorescence based diamond recovery machine.

To make this simpler to understand lets start with a table of comparison /terminology reference.

### **CAMERA**

1. LIGHT SOURCE

2. LENS APERTURE

3. EXPOSURE TIME

4. FOCAL LENGTH OF LENS

5. FOCUS

6. FILM

7. FILM SPEED

8. MAIN PICTURE OBJECT

9. COMPLETE PICTURE

10. WHITE BALANCE

11. OVER-EXPOSURE

12. UNDER-EXPOSURE

13. SPECTRAL FILTER

# X-RAY SORTER

1. X-RAY SOURCE (TUBE)
2. OPTICAL WINDOW
3. SPEED OF DIAMONDS
4. OPTICS TO DIAMOND DISTANCE
5. OPTICS TO DIAMOND DISTANCE
6. PHOTO MULTIPLIER TUBE (PMT)
7. SENSITIVITY OF PMT
8. FLUORESCENT DIAMOND

9. PARTICLES SIMULTANEOUSLY  
IN FRONT OF WINDOW

10. FLUORESCENCE OF LEAD  
GLASS WINDOW PANEL
11. PMT TOO SENSITIVE
12. PMT NOT SENSITIVE ENOUGH
13. SPECTRAL FILTER

Well, you might say this is all more confusing than helping! You might be right, particularly if all you know about photography is pressing “the button” of your cell phone camera if you want to take a picture!

Just bear with me, all of you will understand how a FLOW SORT machine works by the time you have read this to the end.

If we compare taking a good picture of a chosen object with positively identifying a fluorescent diamond we find the following:

## PICTURE TAKING

1. The more light falls onto the object the more light is reflected onto the film.
2. The larger the lens aperture the more light will reach the film.
3. The longer the camera shutter remains open the more light reaches the film
4. Incorrect focus will produce a blurred image of the object to be photographed
5. The shorter the focal length of the lens the larger the area (at a given distance) from which light will reach the film.
6. The higher the light-sensitivity of the film used the higher the exposure of the film to a given amount light falling upon it.

## DIAMOND DETECTION

1. The more X-rays fall onto a diamond the more light the diamond sends to the PMT
2. The larger the optical window the more light emitted by a diamond reaches the PMT
3. The faster a diamond passes over the optical window the shorter the exposure of the PMT to the light emitted by the diamond
4. The further a diamond passes away from the ideal focal plane the more 'blurred' will a diamonds position appear.
5. The closer a diamond passes over the PMT the more light emitted by a diamond reaches the PMT
6. The higher the light-sensitivity of the PMT is set, the higher the "exposure signal" you get for a given amount of light falling upon it.

So, as you can see, there are many things that affect the outcome of a picture. There are just as many things that affect the diamond recovery efficiency of an X-ray diamond recovery machine!

Well, this is the reason why we made setting up a Flow Sort X-ray diamond recovery machine as simple as taking a picture with a fully automatic camera (as the camera installed in your cell phone).

**ALL SETTINGS EXCEPT FOR THE SENSITIVITY LEVEL OF THE PMT (THE FILM SPEED) ARE FIXED.**

The PMT sensitivity (the film-speed) can be set via the CHANNEL SENSITIVITY dials located under the Perspex window of the sorters control panel.

**IT IS IMPORTANT TO REMEMBER THAT EACH SORTER CHANNEL HAS GOT ITS OWN OPTIC SYSTEM.** In other words there is a camera taking pictures of the feed material passing through the LEFT SIDE and there is a separate camera dedicated to look at material passing through the RIGHT SIDE of the sorter. As each of these two cameras has got its own film so has each OPTIC SYSTEM its own PMT. And each PMT has got its own sensitivity adjustment which is totally independent from the other!

There are 6 (six) such dials. 3 (three) dials allow the selection of 3 (three) different PMT sensitivity settings (3 different film-speeds) for the optic looking at the LEFT HAND channel of the sorter. A further (three) dials allow the selection of 3 (three) different PMT sensitivity settings (3 different film-speeds) for the optic looking at the RIGHT HAND channel of the sorter.

The PMT sensitivity selected by any of these 6 dials can be read off the vernier-scale of these dials. The dial scales range from 0 (zero) to 10 (ten).

The "useful" PMT sensitivity range (film speed range) lies typically between 3.5 and 7.5

A further important hint: If you want to photograph a specific person that is amongst a group of people you have to make sure that this person is not hidden behind other people.

The same principle applies to your diamond recovery machine! If you wish to detect a diamond that is mixed with many other stones you must make sure that the diamond is not hidden (covered) behind other stones!

And a further analogy; It is easy to spot and photograph a person dressed in white that is standing amongst a group of people who are all dressed in black. Similarly is it easy to detect a brightly fluorescent diamond that is lying amongst totally non-fluorescent stones!

If you have to take a picture of a person dressed in light gray that is surrounded by a group of people all dressed in gray, just a bit darker in shade, and all that you can change in your camera is the film-speed, then you must very carefully choose a film with the correct speed so that the person that you want to photograph is neither over- or under-exposed!

And the same applies to selecting the correct PMT sensitivity when the task is to detect a fluorescent diamond that is surrounded by other weakly fluorescent particles. If you set the PMT sensitivity too low you will not detect the fluorescent diamond. On the other hand if you set the PMT sensitivity too high you will also detect some of the weakly fluorescent material thus producing too much concentrate!

Then, finally, just for completeness let us also look at this scenario in color. If the person to be photographed is wearing a bright blue suit and all other people that are within the view of the camera are dressed in bright red suits you just have to put a blue filter in front of the camera lens to keep your blue subject clearly visible whilst making all red dressed people invisible. I think that's simple enough to see the purpose of an optical filter, do use one if it improves the "picture"! Don't use one if it does not improve the picture that you want to take. If all persons in the picture wear blue suits which only marginally differ from each other in their shade of blue, there is nothing to be gained by using a filter! Using a blue filter in this case will only reduce the amount of light reaching the film and this is something you definitely don't want if there is very little light available to start off with!

Now again switching to our diamond recovery machine we apply exactly the same principle. If the diamond that we wish to detect fluoresces blue and the surrounding particles emit red (yellow etc.) light we simply fit a "blue-pass-filter" in front of the PMT. Through the blue filter we can still detect the "blue"-diamond whilst mineral-particles fluorescing yellow (any color other than blue) become invisible to the PMT.

O.K. It's that simple; If you can take a good picture with a "happy snappy" (fully automatic) camera then you can achieve good diamond recovery with a "Flow Sort"!

Now many of you wonder what this "picture taking story" was all about!? Its about the following:

**If your camera is set up properly and it takes good pictures of a given scenery don't change the film speed, as a matter of fact don't change anything!**

Now that you understand that a Flow Sort Diamond Recovery Machine is set-up and works pretty much like a camera then you will agree with the following:

**If your diamond recovery machine is set-up properly and your diamond recovery is good, don't change the PMT-sensitivity (film-speed), as a matter of fact don't change anything!**

If, at any stage, you encounter a problem with your sorter **you must find the cause of the problem**, don't change the PMT sensitivity (film-speed)! If you try to fix the problem by simply changing the film-speed you will end up getting a poor picture, which as you have learnt, translates directly into "poor diamond recovery"!

Peter Wolf

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