

## Home-made 16mm Telecine



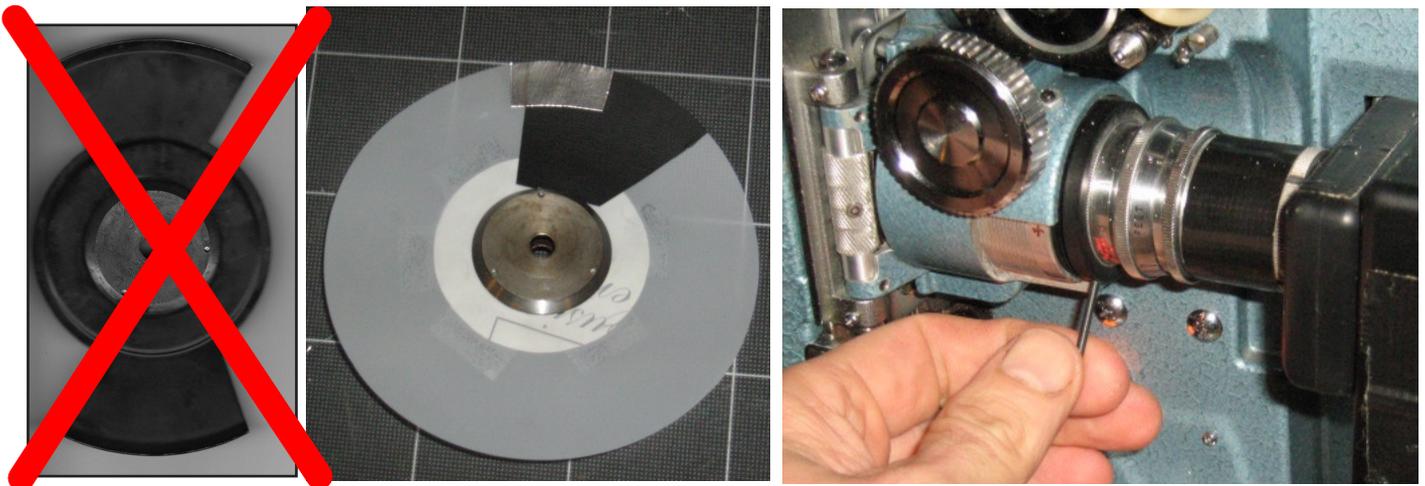
That is a modified Eiki with a camera mounted in place of the projection lens. One can now buy video cameras with a trigger input that can be electronically used to synch up the camera with the film transport. We used this one (but there are other brands and models) :

<http://www.unibrain.com/Products/VisionImg/boardXGA.htm>

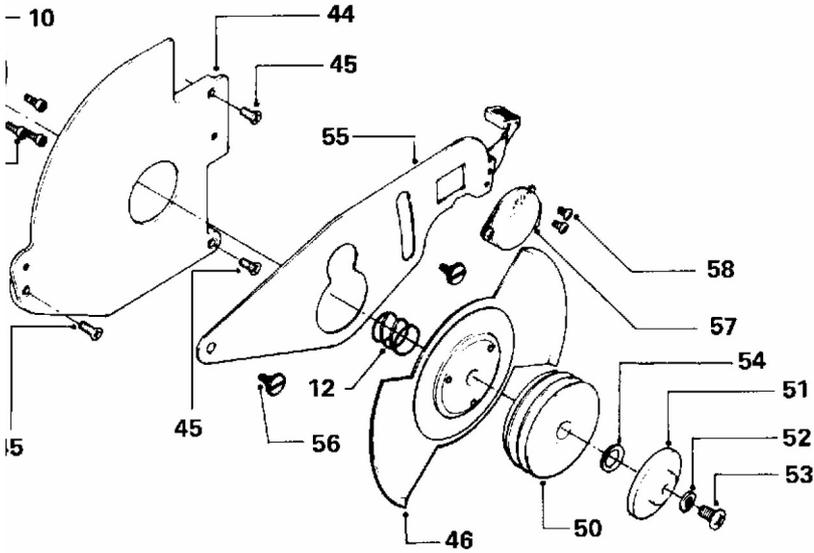
XGA means the maximum quality the camera can record is 1024 x 768 pixels. It means film clips are recorded in a non compressed format with a bit depth of 8 bit per color (RGB24) in a better resolution than SD. The data rate is pretty much the maximum Firewire 400 can handle, but with a good PC and the software that comes with the camera, it works fine at 18 fps, the Eiki «silent» speed.

A film can therefore be quite simply and rapidly transferred to a video clip in which each video frame exactly corresponds to a film frame. The exact speed at which the transfer occurs is of no importance, as afterwards the clip is attributed a framerate in relation to the original film (18, 24, 25 fps etc.). At this stage the images are not at all recalculated : one just changes the metadata of the file in order to instruct the computer a playback speed.

The camera is installed directly on the barrel where the projection lens usually sits, and refilms the film frame in macro directly in the gate. This is done to avoid hot spots or distortions that occur when you project an image. We used a circuit-board camera and made the housing ourselves, but the same camera also comes in a prefabricated case that looks more professional. The lens we used is a standard Bolex C-mount 1-inch lens with an extension tube on the camera end. On the projector end, it is inserted into a tube that matches the inner diameter of the Eiki lens barrel. Focusing is done with the original Eiki focusing knob. We mounted a small handle on the aperture ring to be able to easily control the f-stop during capture. F-stop adjusting is rather critical as 8-bit video is quite limited in terms of contrast to be able to properly cover the dynamic range of a film image (especially in black & white). It is done «on the fly» as the film is running and it sometimes takes half a second to adjust - you can't have everything. Once you get used to the process though, it's possible to get pretty good results.

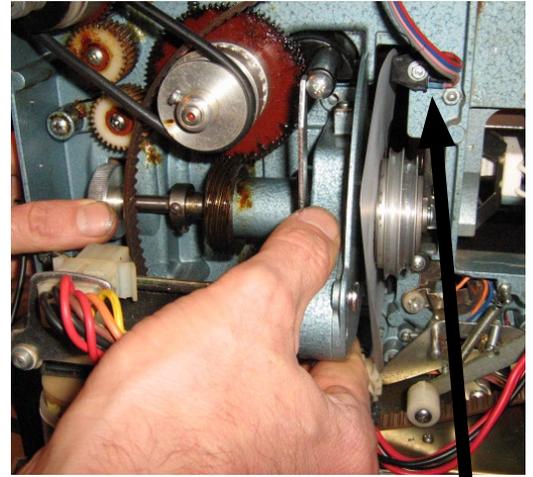
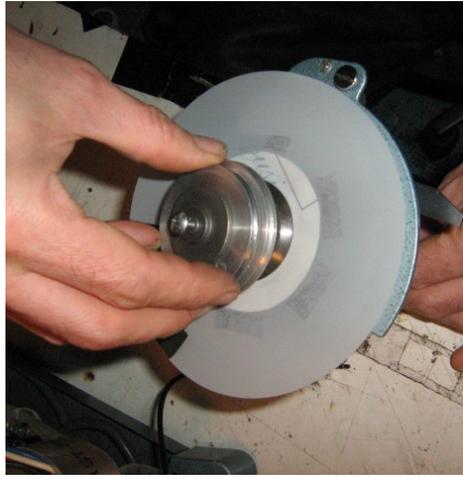
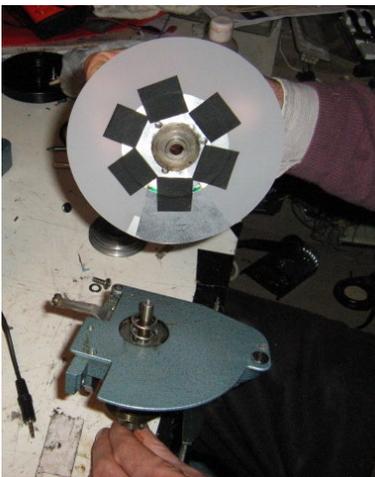


The Eiki shutter was removed and replaced by a disc made of tracing paper whose purpose is to mask the light source. Black paper replaces the blade that usually masks the film as it advances in the gate - this only helps perfect the system, because images should only be recorded when the gate is open and the film static. This synchronization is obtained by placing a small metal tape on the disc which is detected once every full turn of the circle. (Every turn of the shutter corresponds to one frame - the second blade on the original shutter is only here to cut the flickering of light on the screen. In our case, we need to maximize the time that the image is static in the gate to have enough time to capture the frame.) (A 1:1 schematic of the tracing paper disc is on page 4).

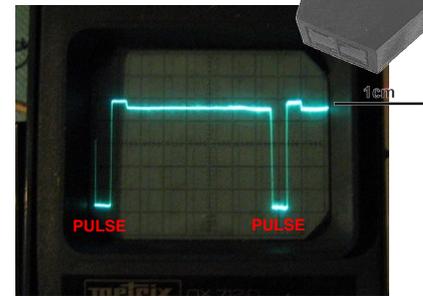
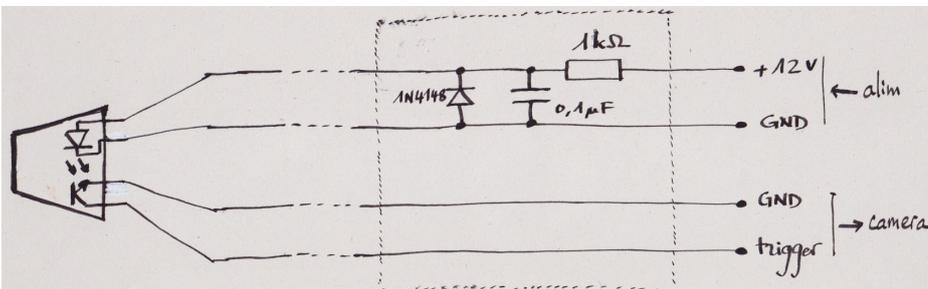


An Eiki (a.k.a. Elf) projector was chosen because it's so easy to take apart to reach the shutterblade.

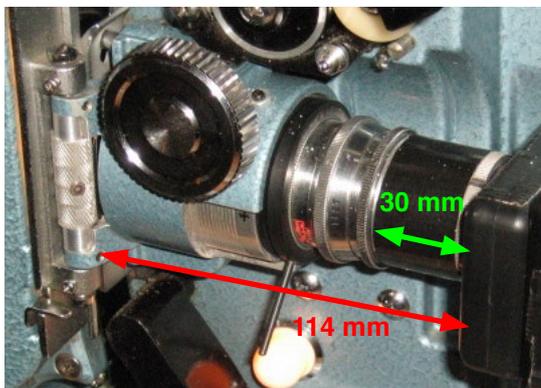
First, remove the motor belt, the motor assembly (3 screws) and preferably the lens barrel assembly (2 screws) to ease the coming out of the claws. The shutter assembly can now be easily removed as it is fastened by only two screws. It is then easy to disassemble the pulleys (50) and reach the shutter (46). By removing the three small screws on (46) the blades themselves can be disposed of and the tracing paper disc, mounted on a small metal disc to give it rigidity, can be installed. Everything can easily be put back together. (The freeze frame assembly (55) is no longer useful and can be discarded.)



An infrared reflective sensor detects the moment when the image has stopped in the gate and the camera receives the signal pulse that tells it to capture a frame and add it to the video clip that is recorded on a hard disk. It's the only tricky part: the signal has to be clean (in the proposed schematic, the voltage drops to 0V when the IR light is reflected by the metal tape). Signals have to be near-square with a stable tension of 12V between pulses. The electronics are ultra-minimal: three components! Be careful of the connections (be sure to verify the pinout of the sensor in the manufacturer's documentation as this can change in some models, as well as the recommended distance between the sensor and the metal tape).



The lamp was replaced by a dichroic mirror lamp of the same size, but much dimmer: 24V 20W. That lamp, already quite weaker than the original 250W lamp, is dimmed further electronically. One has to find the proper brightness so that the aperture is correct about midway through when the shutter speed of the camera has been set (10 msec). Many people building telecines use LED lamps, which is a possibility; another is installing an ND filter pack. Color can be adjusted in the capture software, but having a near-white lamp prevents hitting the edges of the adjustment range.



Installing the camera in the place of the Eiki lens takes a bit of work but the advantage of making one piece from the camera and the system is not to lose time making the same adjustment over and over again. With the filmlabs macro calculator <http://www.filmlabs.org/docs/calculmacrofr.xls> you can enter the size of the object you are filming and the image size you want to get in order to determine the length of the extension tube to place between the camera and the lens, as well as the total distance between the projector gate and the sensor. In our case, on the “image” side, the sensor manufacturer’s documentation gives us (number of pixels x size of each pixel):  
 Active length :  $1024 \times 4,65 \mu\text{m} = 4,76 \text{ mm}$   
 Active height :  $768 \times 4,65 \mu\text{m} = 3,57 \text{ mm}$

On the “object” side, the original size of the Eiki gate is 9.50 x 7.10mm but we decided to make it even better by widening it to the size of the standard 16mm camera gate (10.20 x 7.42 mm) in order to show everything on the frame and to avoid cropping too much of the edges during the capture. We therefore also made an adjustment on the hinge of the barrel holder allowing us to perfectly align the film and the sensor. I would call that a refinement! With the above data, the calculator gives a distance of 11.4cm between the film and the camera sensor and a 12mm extension tube. That last distance has to be added to the standard distance between the back of the C-mount lens and the sensor (the flange focal distance) which is 17.52mm, so that there should be a total of approximately 3cm between the lens and the sensor. It all sounds a bit complicated but making that kind of computation in advance will tell you if the lens you intend to use will work, that it will fit, and will save quite some time on testing...

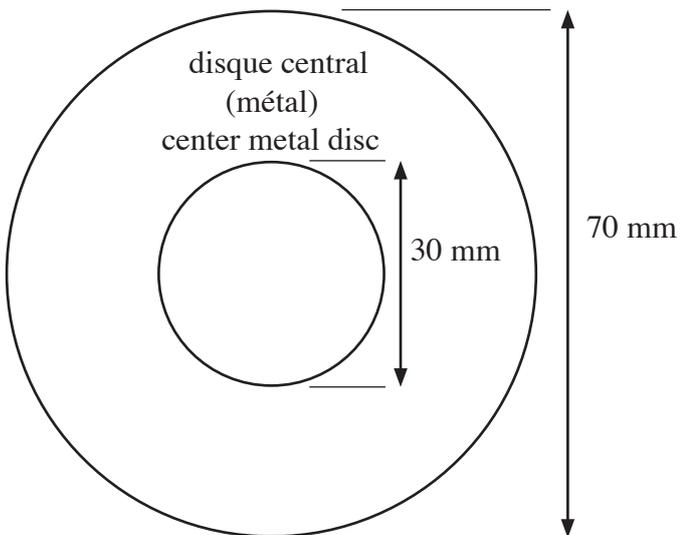
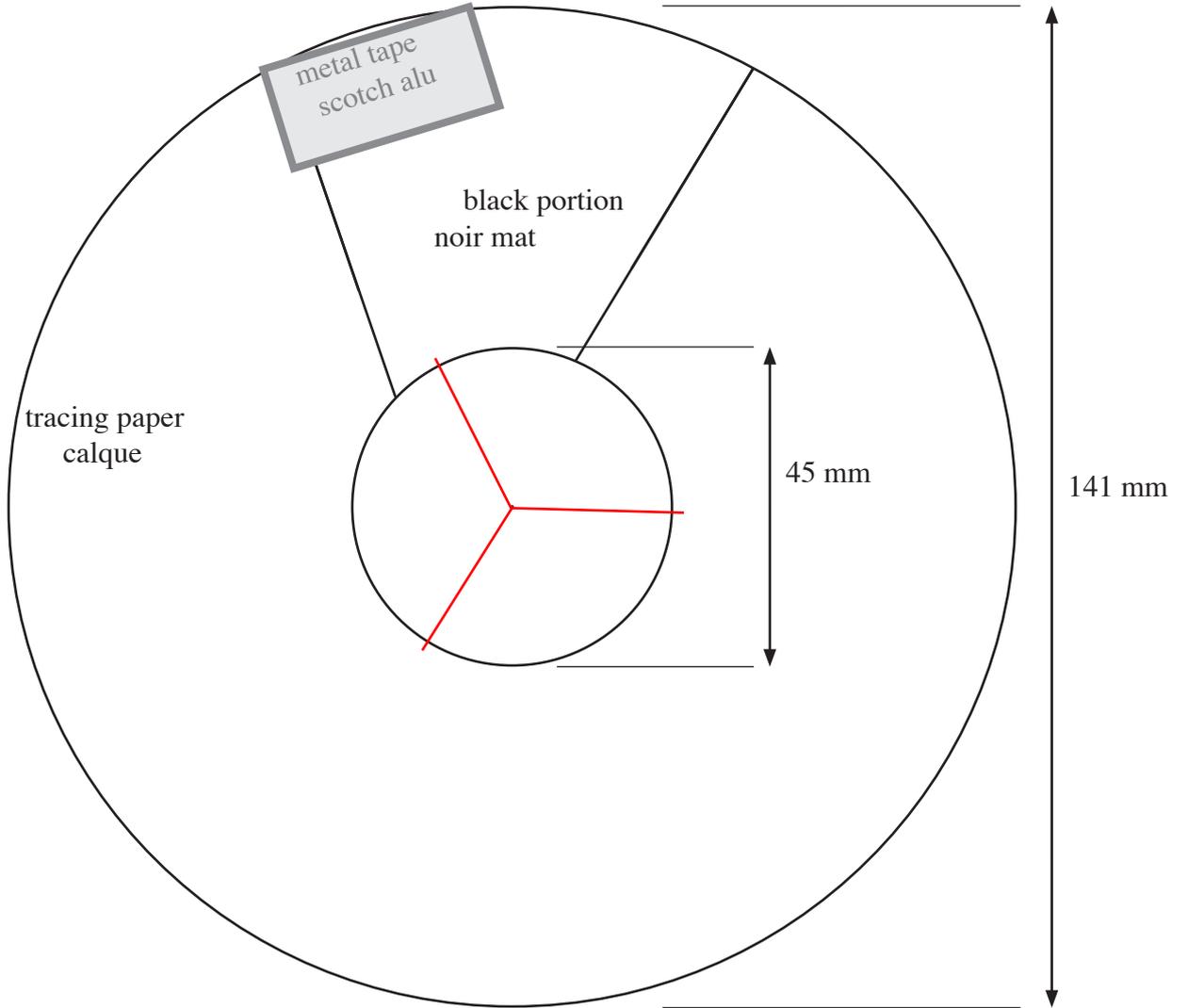
Now the assembly has to be built. Though it helps to use a lathe, I’m sure it can be done by sacrificing an old 2-inch projection lens in order to use the tube, etc. Things have to be adjustable but sufficiently tight so that nothing moves during the telecine. C-mount extension tubes can be found for peanuts. You might have to recut an element or add an extra cardboard ring to end up with the right size. The aperture ring has to be accessible! And if you’d rather pay for a lens that has been built for this use, there is one: the Megapixel Macro Zoom Lens.

Once the triggering works and the camera is in place, one just has to setup the software...

- the camera can be mounted upside-down to refilm the frame as it appears in the gate. Still, the image must be inverted left-right. A button in the software does just that.
- the trigger mode has to be defined. (We use «Trigger mode 0» and Trigger polarity «Low» since the pulses are made up of 0V segments.)
- disable automatic exposure and other adjustments that the camera can make during capture (for us, Black Level and Sharpness at 512). Set the electronic shutter time of the camera (We use 10 ms - one has to remember that a full circle of the shutter at 18fps takes 55ms. The camera has this much time to capture the image and send it through the Firewire. Unibrain says the maximum frame rate at full resolution is about 20 fps).

To avoid any useless computation during transfer, capture is made in non-compressed mode (RGB24). The sequence (3GB/minute) can then be recalculated down to a less demanding format with software like MPEG Streamclip or Quicktime Pro. The hard disk used during capture HAS to be hooked up by SATA interface, whether it is an internal or external drive, so that it doesn’t slow down the process. Sequences are recorded in AVI format (the software that comes with the camera is PC only and Mac software that could recognize it can’t access the trigger mode and all the advanced features we need). Once the clip is recorded, a small free app like AVIFrate can instantly define the right frame rate that you want. Strangely, Quicktime doesn’t understand that change (a complicated issue that has to do with the way Quicktime works) and if you want to use the video clip on a Mac, you should copy the file as a .mov and then use CinemaTools to conform that clip to the proper frame rate.

One last thing: if you are ready to run your negatives through what is left of a projector, you can transfer them this way. In black & white, it’s child’s play: an «invert» button in the software will do the trick. In color, things are trickier because of the orange mask and there is no way to get a proper image directly. Using software like After Effects in a second step should be able to transform the photographic negative image into a good-looking positive. And, as every video frame corresponds to one film frame, you could even define the key-code position using Cinema Tools (very simple to do), edit the film in video and automatically build a professional cut-list in the end in order to cut the negative and strike a film print. Wasn’t that the idea?



ech. 1:1 scale  
*if printed without scaling*  
*si imprimé sans mise à l'échelle*