Archivelaser Project: Accurate Long-Term Storage of Analog Originals and Digital Data with Laser Technology on Color Preservation Microfilm

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Abstract

Laser recording technology of digital data on color microfilm offers new perspectives in accurate and safe long-term storage. It will outperform existing storage and preservation methods. The development of a novel laser recording system – the so called **ArchiveLaser** – will provide users with a unique tool for the preservation of analog originals and digital data of any kind. By embedding the ArchiveLaser technology in a versatile workflow, the digital and analog world is combined into a perfect long-term storage concept.

Challenge and Motivation – Closing the Gap Between Digital and Analog Technology

Archives and libraries face a twofold challenge: To provide rapid access to digitized versions of originals and to guarantee safe long-term storage of information. Today, the solutions to these challenges are often organized in two entirely separate workflows. This is labor-intensive and thus expensive. Moreover, each of the customary technologies has severe limitations: (1) analog color microfilming has a low handling flexibility and requires high light exposure, and (2) safe long-term storage of digital data is dubious and costly.

Solution – Blending of the Best

The ArchiveLaser project is designed to build a bridge between these two technologies, combining the advantages of long-term preservation film and digital data management:

Digitizing originals with high quality scanners requires low light exposure. The digital data can be arranged on computer systems and metadata can easily be added. The prepared data is recorded on color microfilm using laser technology. From such preservation film, any data can be re-digitized if needed, and can be printed out to produce a nearly perfect facsimile of the original. An innovative color management takes care of the color fidelity along that chain.

Technology – Laser Recording of Digital Data on Color Preservation Microfilm

The new ArchiveLaser technology is working with a red, green and blue laser (*fig. 1a and 1b*). The individual laser beams are modulated according to the image information using acousto-optic modulators and are finally combined through a special optical device.

The combined beam is brought down to a pixel size of 3 µm when recording the data on microfilm *(fig. 2a and 2b).* The data is recorded on 35 mm b/w or color preservation microfilm within frames of 32 x 45 mm. The preservation film has a resolution of up to 160 line pairs per millimeter and a life expectancy of over 500 years.

Using this technology, the ArchiveLaser is able to produce true colors and grayscales, finest details and high contrast with a superior productivity. Data can be recorded as analog image and/or digital code. Costs per image or per gigabyte are considerably lower than with any other existing long-term storage technology.

The solid engineering and robust construction of the ArchiveLaser system is based on a proven and very successful technology developed for the cine film recording industry – with up to 150 running systems worldwide and has been awarded the „Scientific and Engineering Award“ from the Academy of Motion Picture Arts & Sciences in 2002.

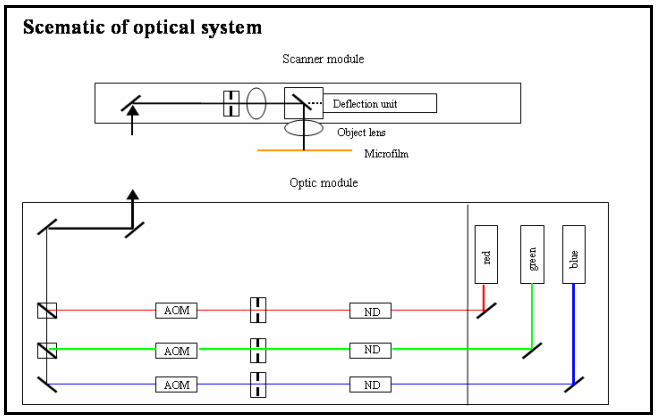


Figure 1a. System of red, green and blue laser beams

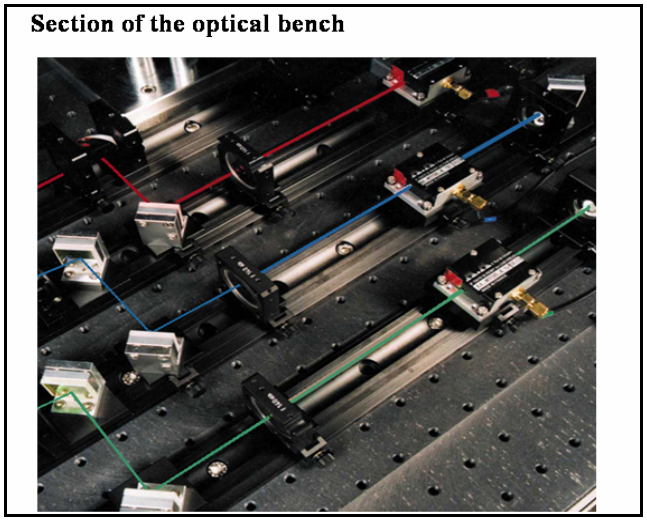


Figure 1b. Picture of optical bench: Three acousto-optic modulators together with focusing lenses and mirrors.

Specification of ArchiveLaser

Frame size	32 x 45 mm (on 35mm film)
Pixel size	3 µm (160 line pairs/mm)
Pixel per frame	10,666 x 15,000 pixel (159.9 million)
Film material	b/w or color microfilm (Ilford, Kodak, Agfa)
Exposure time	40 sec. per frame
Film transport	magazines of up to 600 m (13,000 frames)
Diminution factor	34 (i.e. 1 DIN A0 images per frame)
Storage capacity	images: 16 DIN A4 images per frame) digital data: 1 Gigabyte pe 25 cm film
Productivity	approx. 1 km film in four days (4 Terabytes

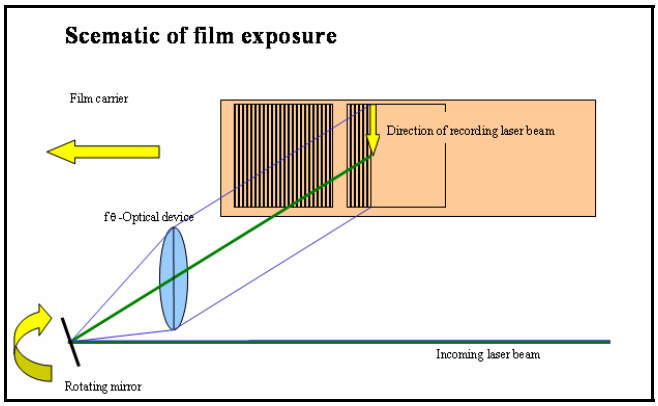


Figure 2a. Drawing of film exposure: Each image is recorded line by line within the given frame using the combined red, green and blue laser beam.

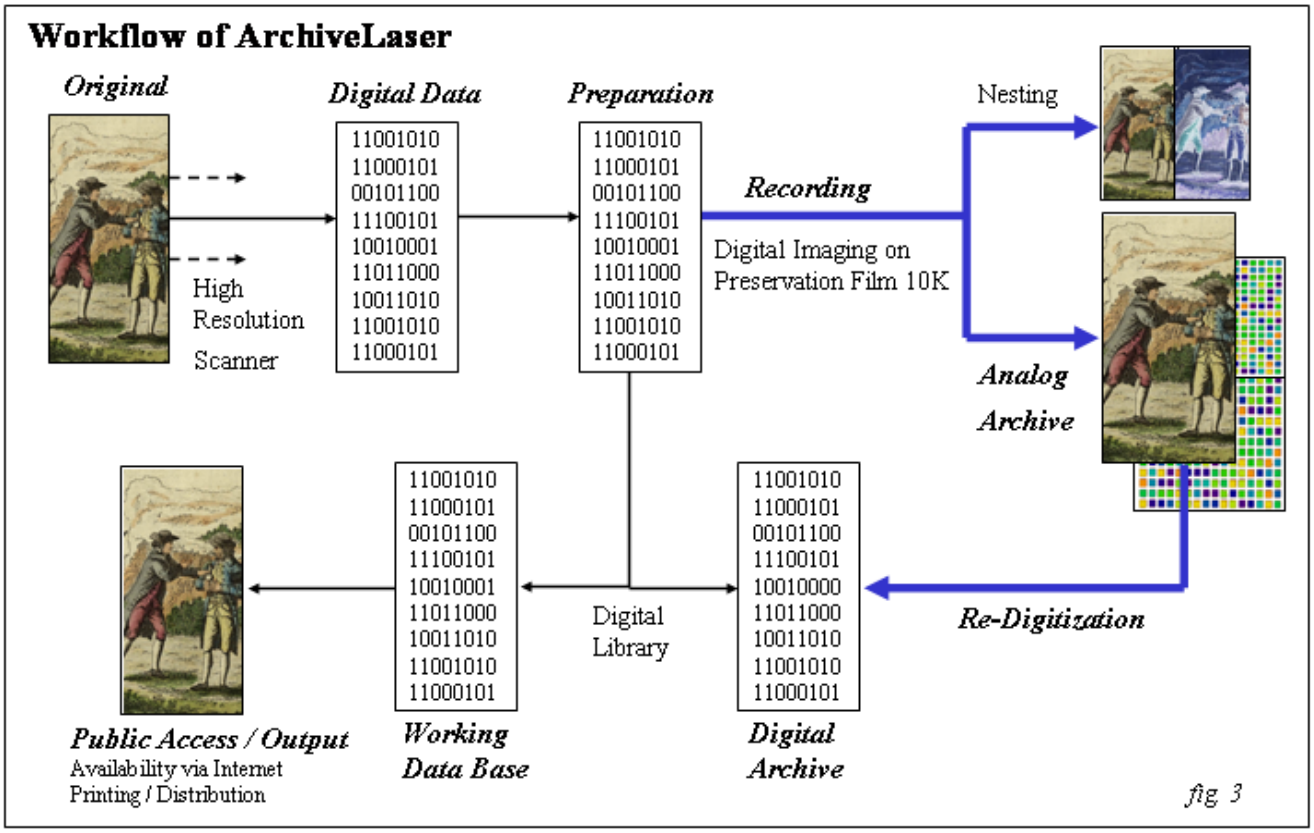
Figure 2b. Picture of rotating mirror unit: The combined laser beam is deflected and afterwards sent through the optical device for recording.

Workflow – Complete Archival Concept of the Archivelaser System

The ArchiveLaser is embedded into a complete archival concept. The respective workflow is illustrated below (*fig. 3*): The digitization of cultural heritage or any other originals with high resolution scanners is already established at many organizations. Respective workflows already exist.

After digitization, the data is organized and prepared with special data management and archiving systems. All kinds of information can be added as metadata (e.g. key words, particular content descriptions, technical information). This metadata does not only ensure a quick reconstruction of the original data structure, but also helps to find a specific document or image easily.

After preparation, the digital data and attached the related metadata (i) is recorded with a high degree of automation on microfilm using the ArchiveLaser, and (ii) can–entirely or partially–be stored in a digital library or a short-term digital archive.



In case the electronically stored data is accidentally lost or damaged, or intentionally manipulated or for cost reasons deleted, or migration problems arise, the preservation film serves as a safe backup medium and can easily be re-digitized to obtain the identical set of original digital data. Storage of the preservation film is simple and inexpensive.

Advantages at a Glance – Benefits of the New Laser Imaging Technology

In a nutshell, the advantages of the ArchiveLaser technology are: hybrid set of digital and analog data; safe and long-term preservation of information; exceptional image quality; high resolution; true colors and grayscales; no manipulation or virus attacks possible; high flexibility in adding metadata; superior productivity; high level of automation; embedded in existing workflows; low light exposure for originals; low costs per image; independent from actual soft- and hardware generations.

Conclusion and Outlook – Integrated Laser Recording on Color Microfilm

The ArchiveLaser system offers an excellent solution for the accurate and safe long-term preservation of analog originals and digital data of any kind. Archives, libraries, museums, publishers and other organizations are provided with an easy to handle high-quality, high-speed and low cost storage instrument.

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Biographies

A. Hofmann received his diploma in Physics in 1995 from the University of Freiburg. Before joining Fraunhofer IPM in 2000, he worked in several laser companies. He is the project coordinator of the ArchiveLaser Project.

W. J. Riedel received his diploma in Physics in 1972 from the University of Frankfurt. He worked eight years with the R&D division for diode lasers of AEG. In 1980 he joined Fraunhofer IPM. He is an expert in the areas of spectroscopy and laser recording and in 2002 was granted the „Scientific and Engineering Award“ from the Academy of Motion Picture Arts & Sciences for the design and development of the worldwide leading cine laser recording system.

K. Sassenscheid received his diploma in Physics in 1995 from the University of Würzburg. He joined Fraunhofer IPM in 1995 and received his PhD in 2000. He is the head of the Fraunhofer IPM department „Optical Spectroscopy and Systems“.

C. J. Angersbach received his education at the Universities of Freiburg, Berlin, Lausanne, Munich and Chicago. He holds academic degrees from the University of Munich and the University of Chicago. He is the managing director of MicroArchive Systems GmbH.