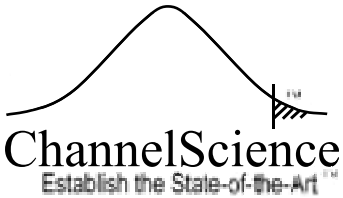
ChannelScience

Establish the State-of-the-Art SM

Multi-format, Do-No-Harm Legacy Tape Reader

"There is New Value in Old Data!"

IEEE MMM Conference, Dallas TX
October 3-5, 2023



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SBIR Grant Award: DE-SC0021879

DOE-Funded Development

SBIR Grant Award: DE-SC0021879

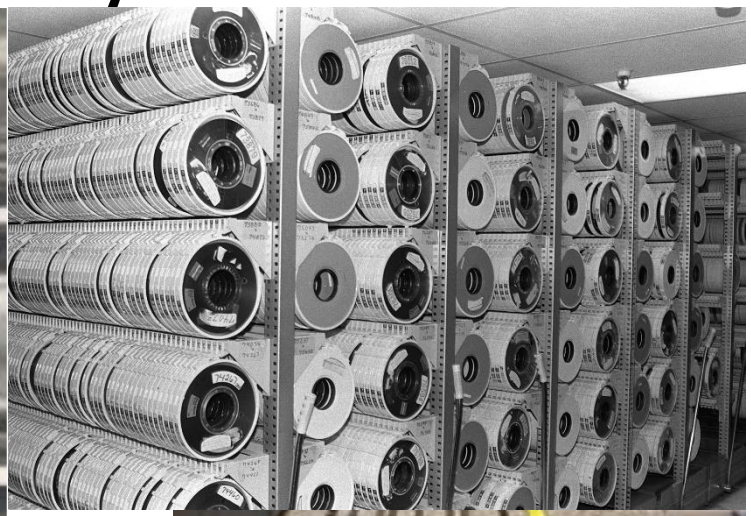
Unlock the value of irreproducible data on deteriorating legacy magnetic tapes for AI/ML

Developing the best tape reader ever created for legacy formats

Add us to your budget for next year: Lower-cost recovery of rare data sets

Join our remote team!

Irreproducible Data is being Lost on Deteriorating Legacy Media



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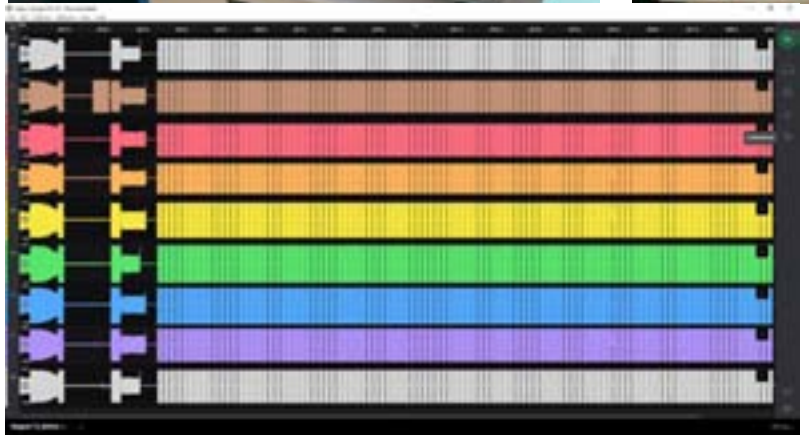
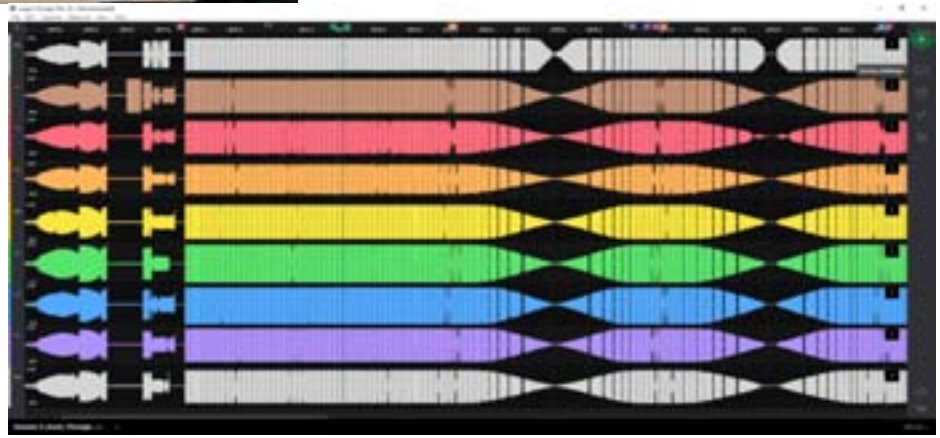
Recovery with Refurbished Vintage Drives

- QualStar drives are fantastic!
- But they will never perform better than their analog-filtered peak detection allows





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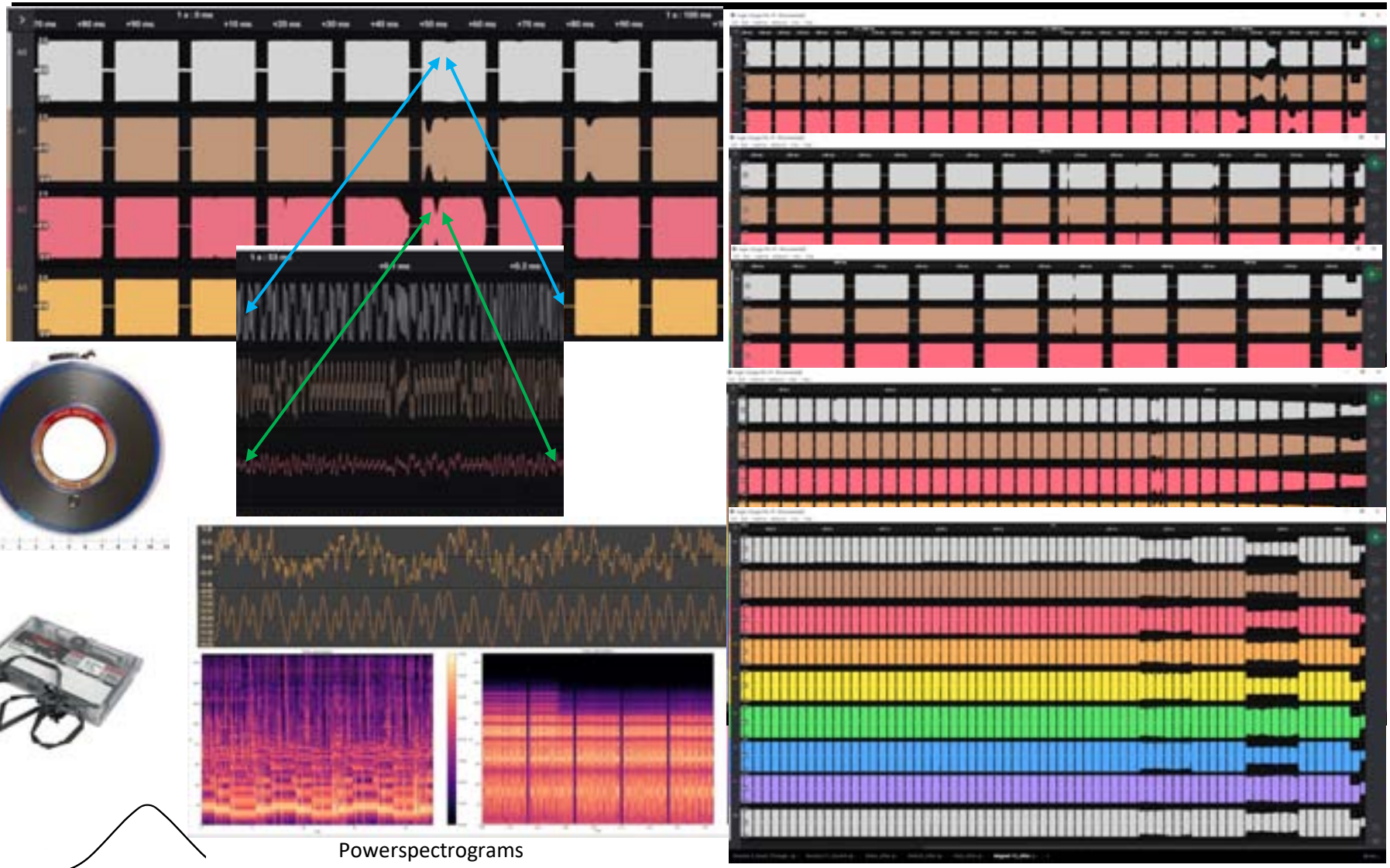
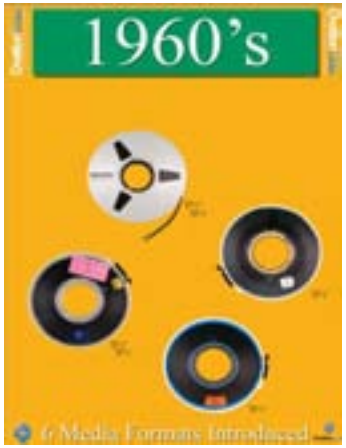
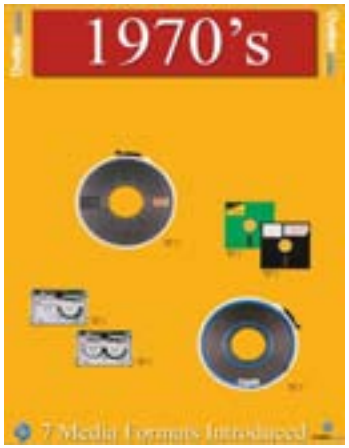
Damage and Deterioration Analysis

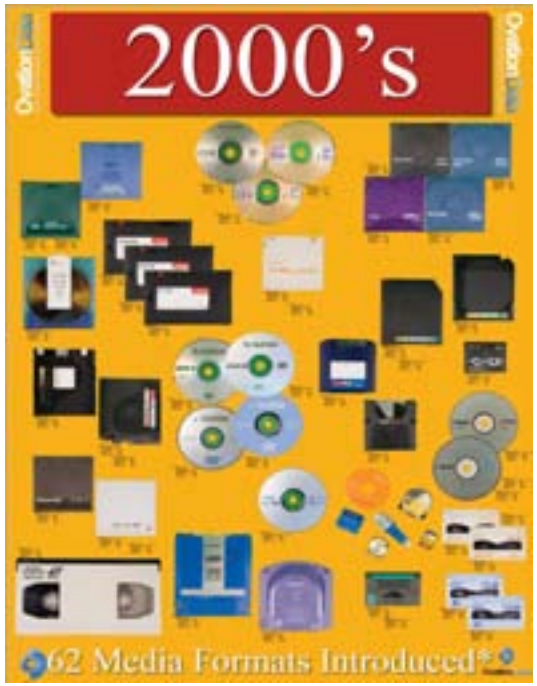


Powerspectrograms

Recovery Market Opportunity
275+ Different Formats



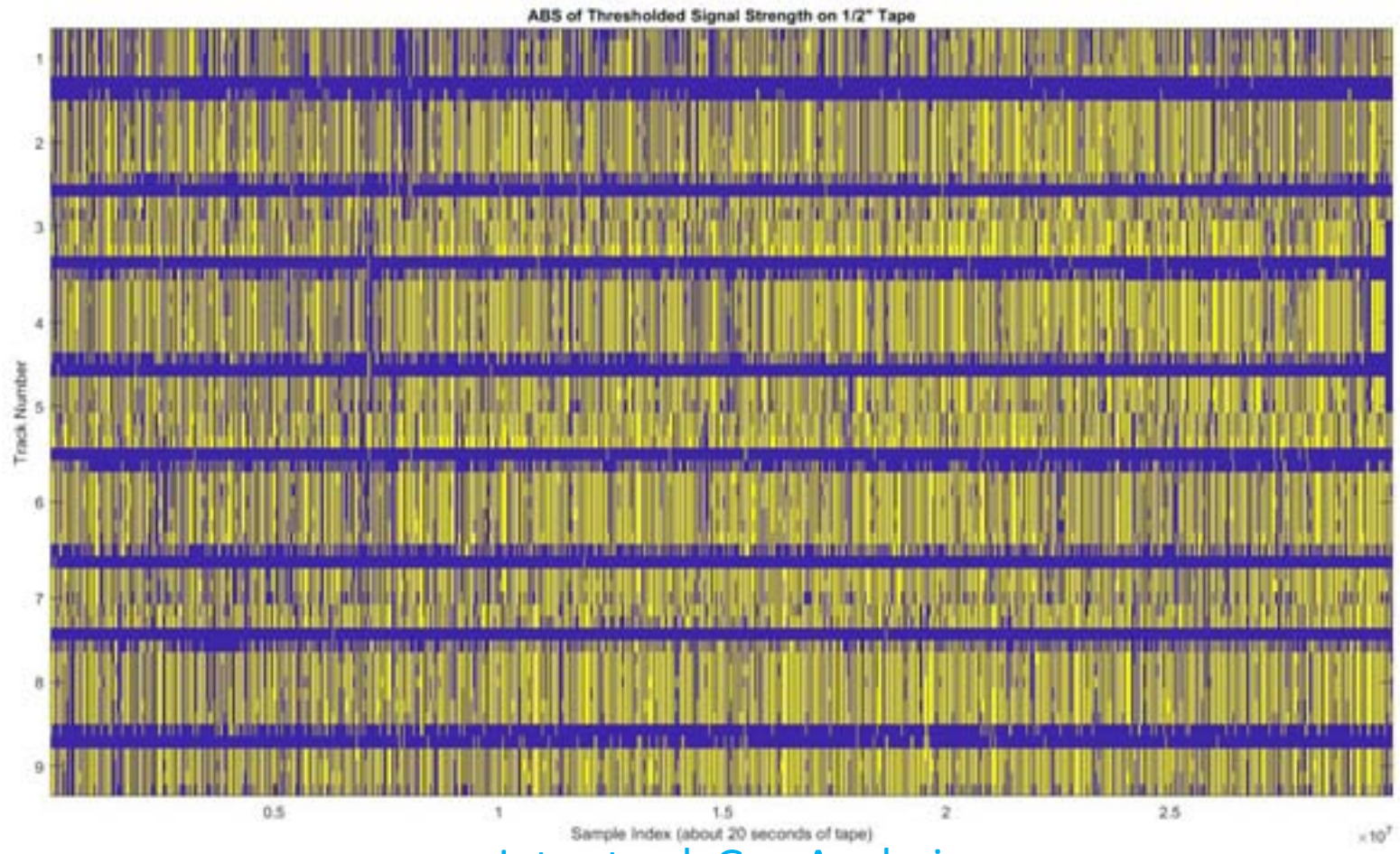




Courtesy: Ovation Data Services

Recovery of each format requires
- Refurbished drives
- Replacement heads
- Skilled technicians and operators

Vintage ½” 9-track Tape



Inter-track Gap Analysis

Unprecedented Erasure Verification!

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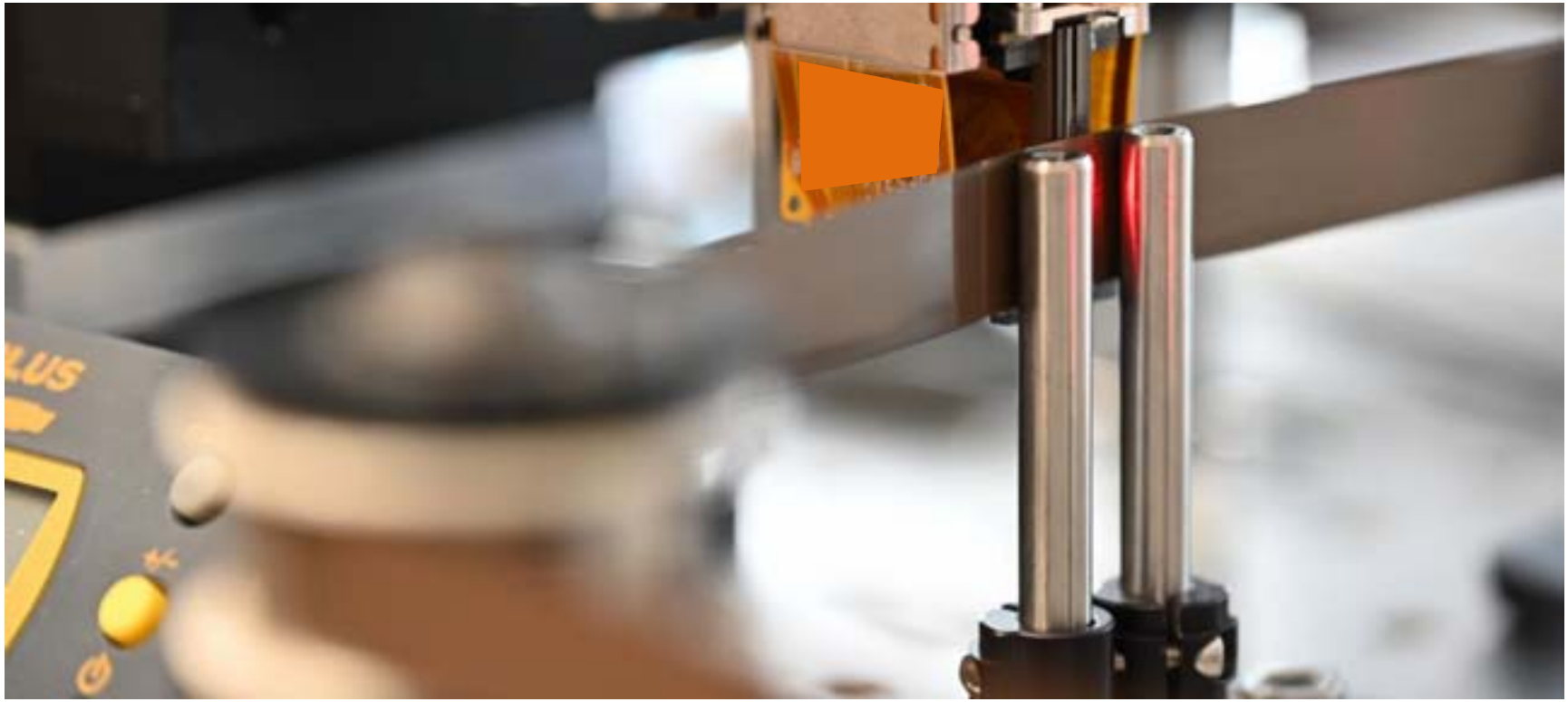
4th Generation Tape Transport Prototype



We are looking for customers, partners, and employees!

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U.S. DEPARTMENT OF ENERGY
AWARDEE™

SBIR Grant Award: DE-SC0021879

ChannelScience's Breakthrough Solution

Sophisticated custom tape transport

- Flexible tape path, high speed, minimal touch

More-sensitive, modern, low-cost heads

Custom electronics for high-fidelity signal capture

Leading-edge signal processing and detection

Simply put: The best tape reader ever built for legacy formats

There are Fewer and Fewer Vintage Heads

In short supply
Expensive
Wear out

ChannelScience's Breakthrough Solution

- Sophisticated custom tape transport
  - Flexible tape path, high speed, minimal touch
- More-sensitive, modern, low-cost heads
- Custom electronics for high-fidelity signal capture
- Leading-edge signal processing and detection
- Patents pending

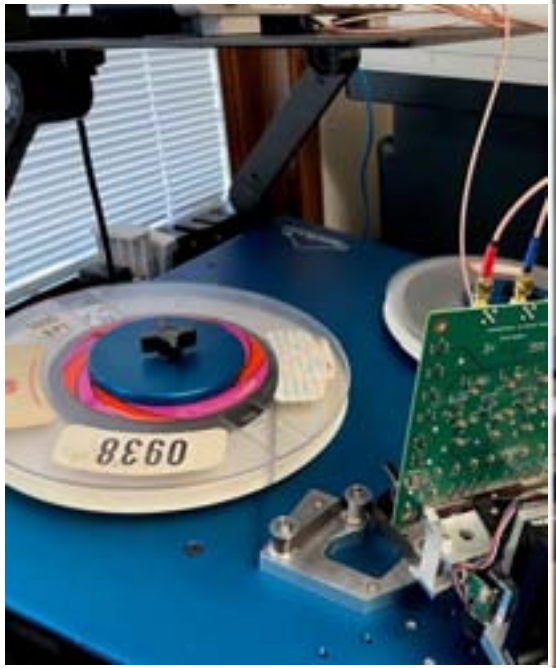
Winner of 3 SBIR grants from US DOE!

Simply put:

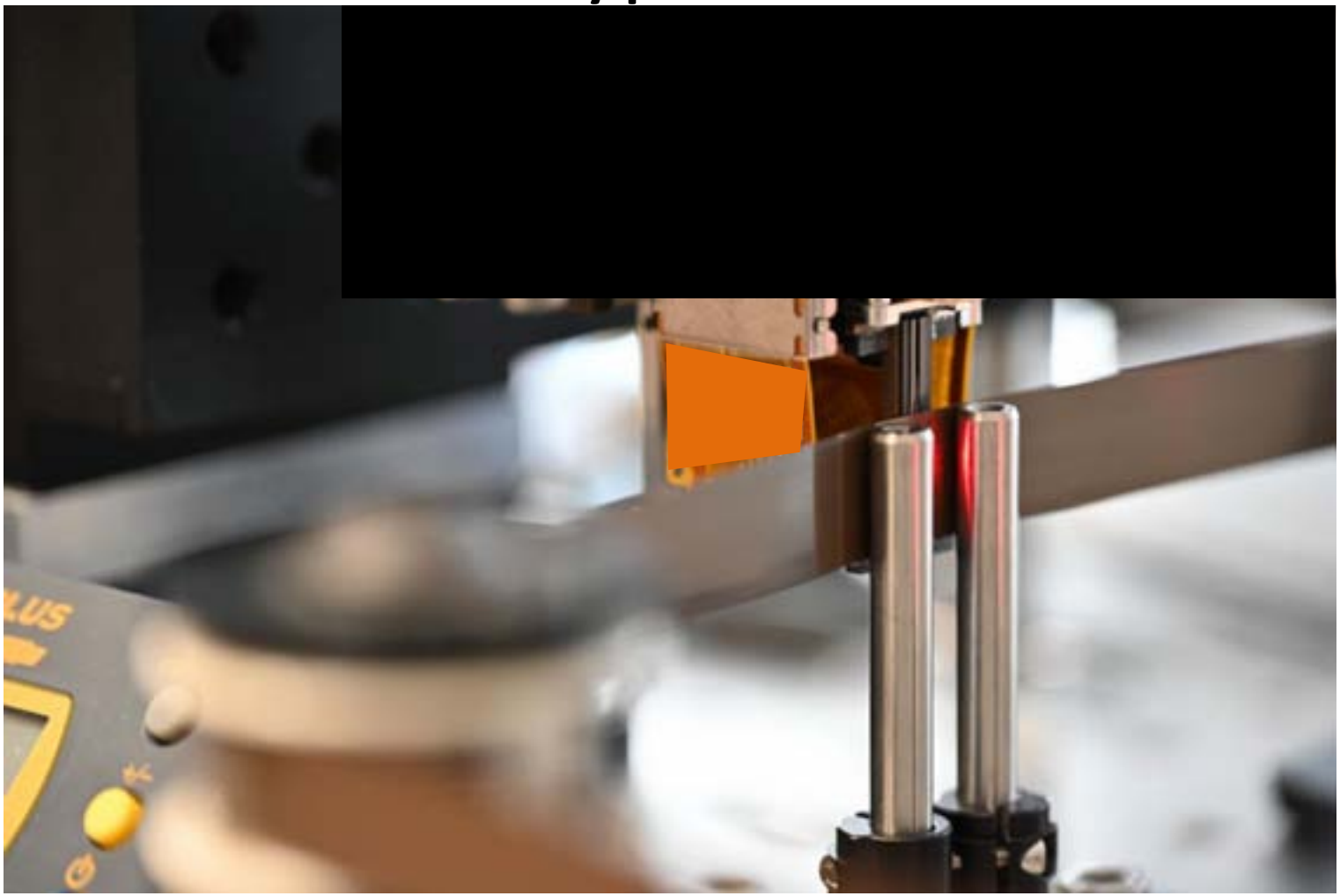
The best tape reader ever built for legacy formats

SBIR Grant Award: DE-SC0021879

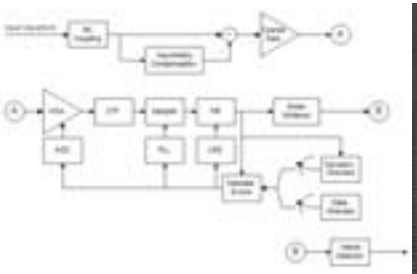
3rd Generation Tape Transport Development Platform

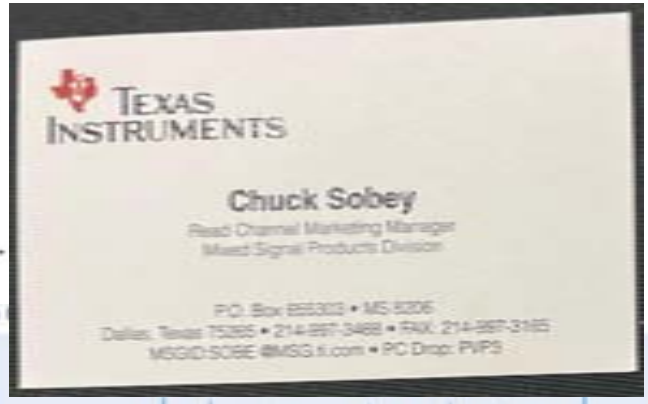


4th Generation Tape Transport Prototype in Use

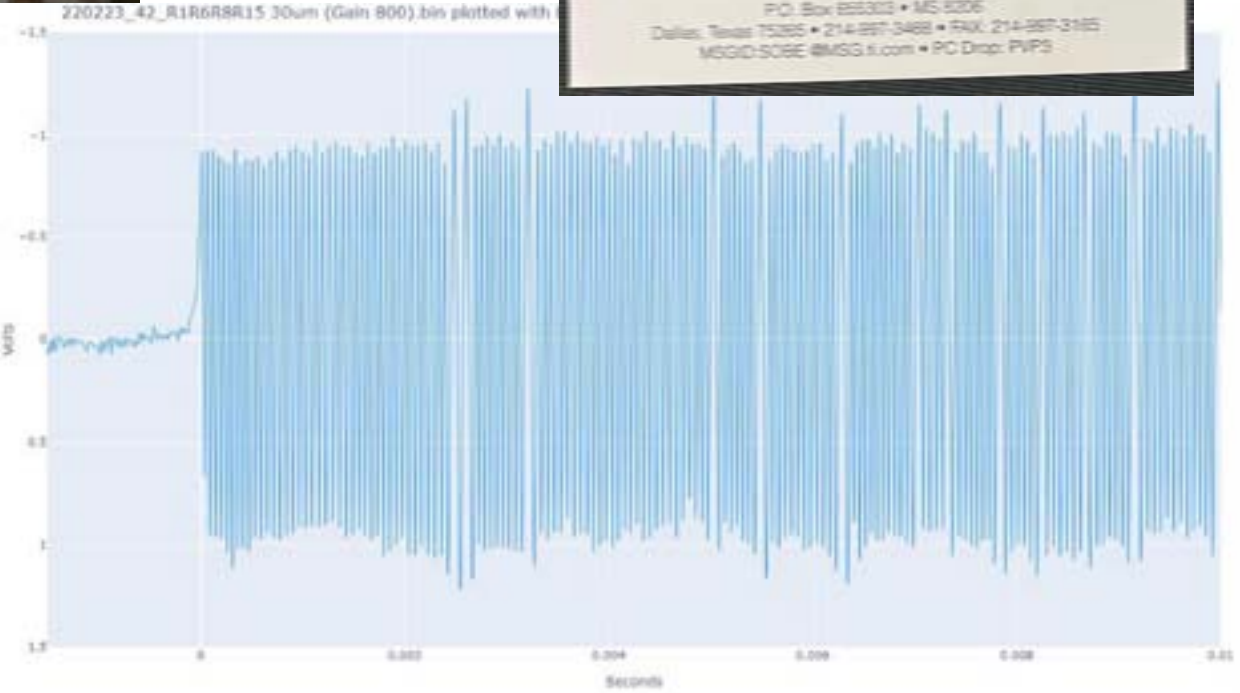


Custom High-Fidelity Electronics and State-of-the-Art Signal Processing, Detection, and AI/ML

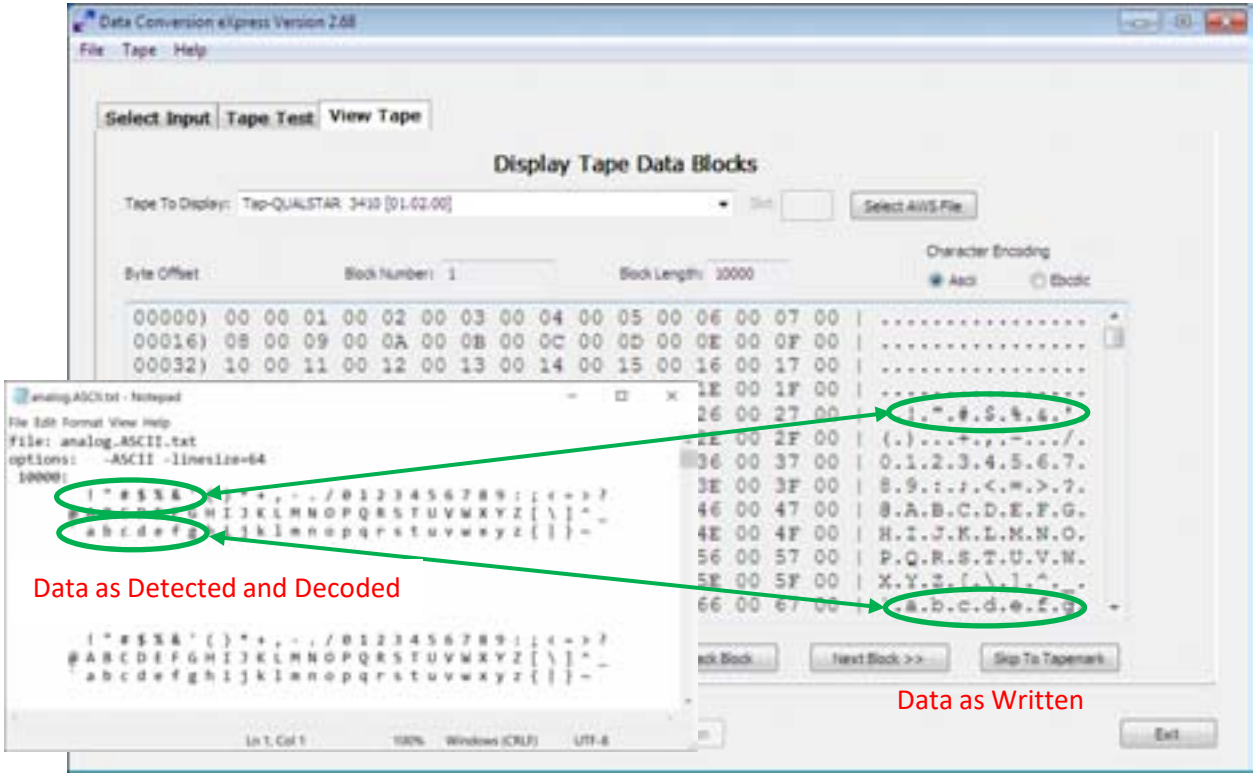




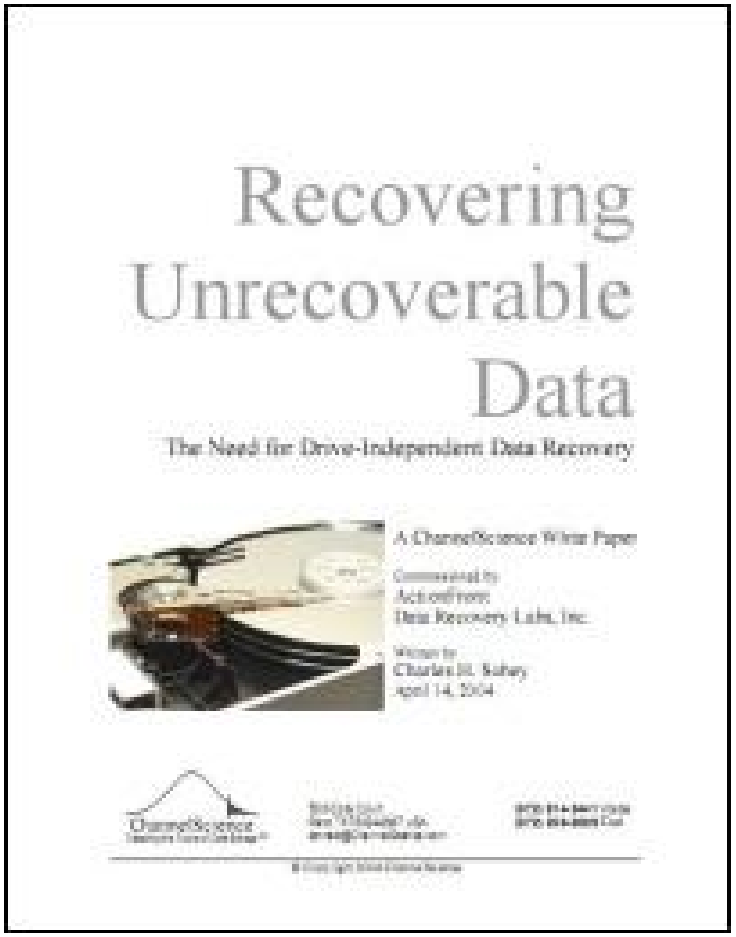
ChannelScience's PRML*pro*™ read channel model



Detection and Decoding



We Literally Wrote the Paper on How to Recover Unrecoverable Data



Recovering Unrecoverable Data

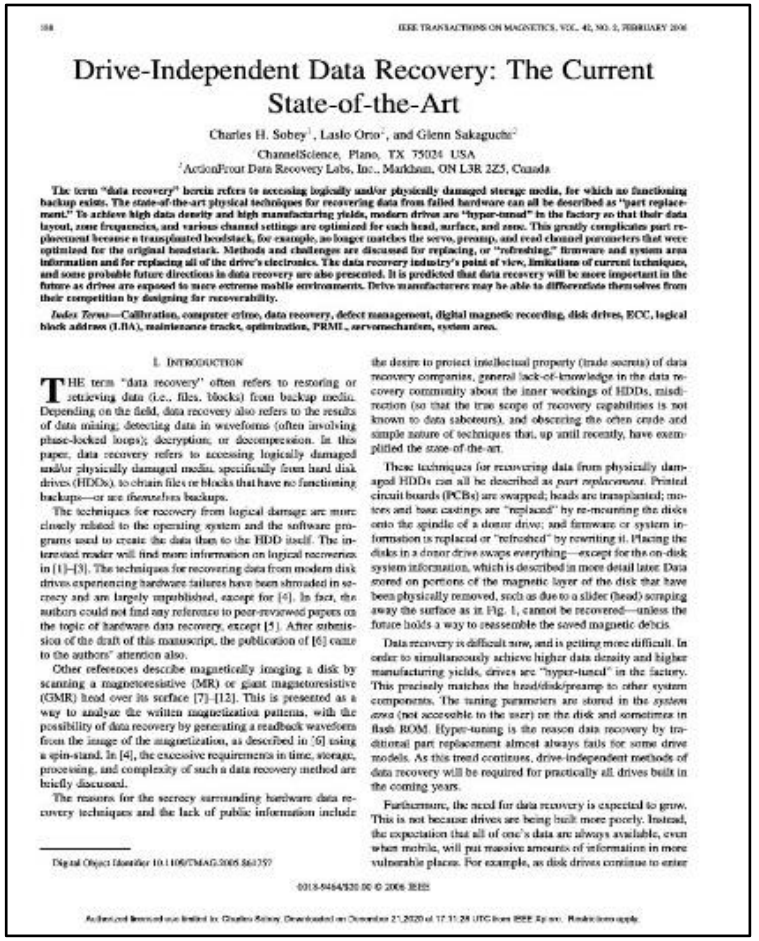
The Need for Drive-Independent Data Recovery

A ChannelScience White Paper

Commissioned by
ActionFront
Data Recovery Labs, Inc.

Written by
Charles H. Sobey
April 14, 2004

ChannelScience



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Drive-Independent Data Recovery: The Current State-of-the-Art

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The term "data recovery" herein refers to accessing logically and/or physically damaged storage media, for which no functioning backup exists. The state-of-the-art physical techniques for recovering data from failed hardware can all be described as "part replacement." To achieve high data density and high manufacturing yields, modern drives are "hyper-tuned" in the factory so that their data layout, zone frequencies, and various channel settings are optimized for each head, surface, and zone. This greatly complicates part replacement because a transplanted headstack, for example, no longer matches the servo, preamp, and read channel parameters that were optimized for the original headstack. Methods and challenges are discussed for replacing, or "refreshing," firmware and system area information and for replacing all of the drive's electronics. The data recovery industry's point of view, limitations of current techniques, and some probable future directions in data recovery are also presented. It is predicted that data recovery will be more important in the future as drives are exposed to more extreme mobile environments. Drive manufacturers may be able to differentiate themselves from their competition by designing for recoverability.

***Index Terms*—Calibration, computer crime, data recovery, defect management, digital magnetic recording, disk drives, ECC, logical block address (LBA), maintenance tracks, optimization, PRML, servomechanism, system area.**

I. Introduction

THE term "data recovery" often refers to restoring or retrieving data (i.e., files, blocks) from backup media. Depending on the field, data recovery also refers to the results of data mining; detecting data in waveforms (often involving phase-locked loops); decryption; or decompression. In this paper, data recovery refers to accessing logically damaged and/or physically damaged media, specifically from hard disk drives (HDDs), to obtain files or blocks that have no functioning backups—or are *themselves* backups.

The techniques for recovery from logical damage are more closely related to the operating system and the software programs used to create the data than to the HDD itself. The interested reader will find more information on logical recoveries in [1]–[3]. The techniques for recovering data from modern disk drives experiencing hardware failures have been shrouded in secrecy and are largely unpublished, except for [4]. In fact, the authors could not find any reference to peer-reviewed papers on the topic of hardware data recovery, except [5]. After submission of the draft of this manuscript, the publication of [6] came to the authors' attention also.

Other references describe magnetically imaging a disk by scanning a magnetoresistive (MR) or giant magnetoresistive (GMR) head over its surface [7]–[12]. This is presented as a way to analyze the written magnetization patterns, with the possibility of data recovery by generating a readback waveform from the image of the magnetization, as described in [6] using a spin-stand. In [4], the excessive requirements in time, storage, processing, and complexity of such a data recovery method are briefly discussed.

The reasons for the secrecy surrounding hardware data recovery techniques and the lack of public information include the desire to protect intellectual property (trade secrets) of data recovery companies, general lack-of-knowledge in the data recovery community about the inner workings of HDDs, misdirection (so that the true scope of recovery capabilities is not known to data saboteurs), and obscuring the often crude and simple nature of techniques that, up until recently, have exemplified the state-of-the-art.

These techniques for recovering data from physically damaged HDDs can all be described as *part replacement*. Printed circuit boards (PCBs) are swapped; heads are transplanted; motors and base castings are "replaced" by re-mounting the disks onto the spindle of a donor drive; and firmware or system information is replaced or "refreshed" by rewriting it. Placing the disks in a donor drive swaps everything—except for the on-disk system information, which is described in more detail later. Data stored on portions of the magnetic layer of the disk that have been physically removed, such as due to a slider (head) scraping away the surface as in Fig. 1, cannot be recovered—unless the future holds a way to reassemble the saved magnetic debris.

Data recovery is difficult now, and is getting more difficult. In order to simultaneously achieve higher data density and higher manufacturing yields, drives are "hyper-tuned" in the factory. This precisely matches the head/disk/preamp to other system components. The tuning parameters are stored in the *system area* (not accessible to the user) on the disk and sometimes in flash ROM. Hyper-tuning is the reason data recovery by traditional part replacement almost always fails for some drive models. As this trend continues, drive-independent methods of data recovery will be required for practically all drives built in the coming years.

Furthermore, the need for data recovery is expected to grow. This is not because drives are being built more poorly. Instead, the expectation that all of one's data are always available, even when mobile, will put massive amounts of information in more vulnerable places. For example, as disk drives continue to enter

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Please Join Us!

We are looking for

- Pilot recovery projects
- Partners
- Employees (remote is fine; Retirees welcome!)
  - Engineers: Mechanical, Channel, Data

"There is new value in old data."

Your career experience in tape is needed!