Key Forensic Services Limited

integenX

RapidDNA News

October 2013

RapidHIT® provides DNA processing from sample to profile, in under 90 minutes

Rapid DNA Processing

For some time now, DNA profiling has been carried out routinely by forensic service providers within a controlled laboratory environment, utilising an array of costly and sophisticated scientific instruments and taking many hours to complete the processing.

In June 2012, this changed for ever, with the launch of the RapidHIT® Rapid DNA Processing System.

RapidHIT® provides DNA processing from sample to profile, in under 90 minutes utilising a portable instrument and no specialist scientific skills to operate it.

Whilst some of the benefits of increasing the speed of DNA analysis in the laboratory are clear, discussions with various users and stakeholders in the field of human identification highlight a significant range of deployment scenarios and opportunities for capitalising on rapid DNA testing. Various public and private sector agencies have considerably different requirements for DNA testing, which vary widely depending on many factors including legislation, infrastructure and geography.

Rapid matching of arrestees with unsolved crimes

For countries with arrestee DNA sampling legislation such as the United Kingdom, the benefits of using DNA in associating arrestees either with the crime for which they were arrested, or with other previously unsolved crimes, has long been documented.

However, even in such countries, DNA turnaround times currently preclude matching of suspects with crime-stain profiles until after arrest, and frequently after the suspects have been released from custody on bail. This scenario often results in suspects absconding or reoffending prior to obtaining the DNA match.

Rapid crime stain DNA profiling

In most countries it is true that the majority of crimes are perpetrated by a relatively small, criminal minority. It is also well recognised in the police environment that volume crime offenders commit sprees of many offences.

Commonly, suspects will commit 20-50 burglaries or thefts over the course of a few months. For those countries, or police jurisdictions, with a database of offenders and evidence this represents a significant opportunity to quickly identify suspects from evidence left at crime scenes.

This not only has significant benefits in major crime investigations but has also been put to good use in a number of volume crime initiatives in the USA. These include a burglary cost efficiency study in Denver, and a study by Palm Bay Police Department in Florida.

Rapid Intelligence in serious and organised crime investigations

As part of the fight against international serious and organised crime, national crime agencies, such as the Dutch National Crime Squad the KLPD, are required to keep close track of criminal operations and suspects. This requires rapid, up to date, and reliable intelligence at the fingertips of operatives, enabling them to make decisions during fast moving police operations. To achieve this, the Dutch Crime Squad has pioneered the use of mobile forensics in recent years with a state of the art forensic vehicle for fingerprint and digital analysis. In collaboration with the Netherlands Forensic Institute, the KLPD also introduced 6-hour DNA testing for rapid intelligence in 2010. The ability to conduct DNA testing and database searching within 90 minutes in such a vehicle gives the police even greater advantages in the fight against these major crimes. For example giving the police the name of a suspect leaving a crime scene whilst they still have him under surveillance, enabling them to decide whether to arrest him or not.

"Rapid DNA offers investigating officers the potential to have the results of this search in less than 90 minutes after arriving at the crime scene and recovering the evidential material."

In this inaugural edition of RapidDNA News we look at some of the important applications of this revolutionary technology and share the outstanding results of our validation study.

Early Validation Studies on the **RapidHIT® 200** Instrument

Lesley Ives, DNA Technical Lead.

The forensic community is continually striving to improve the analysis of DNA, particularly with the development of more rapid and efficient processing techniques. The first commercially available solution is the IntegenX RapidHIT®200 instrument. The instrument integrates sample handling steps through DNA extraction, normalisation, amplification, separation and detection.

The entire process is carried out in approximately 90 minutes offering a significant reduction in processing time compared to both existing manual and automated processes.

Set out here is data from two preliminary studies carried out by KFS. The initial study was conducted on an early release version of the instrument utilising the Promega PowerPlex® 16 chemistry. Protocols for improving the robustness of the instrument, including a more efficient lysis step and the introduction of next generation chemistries were implemented and a further study followed. The objective of the combined studies was to demonstrate that accurate and reliable results can be achieved from the RapidHIT®200 instrument.

Methods

For both studies samples were collected from donors using Whatman® Omni swabs, the swab of choice for the UK National DNA Database sampling kits. 114 samples were processed during the initial study generating PowerPlex® 16 (PP16) profiles, and 100 samples were processed during the second study generating Promega PowerPlex® ESI16 (ESI16) profiles. Within the first study an additional 16 blank swabs were included to assess the instrument in terms of sample to sample and environmental contamination.

Swabs were processed on the instrument in batches of five, with three control samples (Positive control, negative control and an allelic ladder). Data was analysed on the instrument in the first instance using the integrated Softgenetics GeneMarker® software and the results confirmed by manual review.

Assessment of Blank Swabs

The blank swabs processed within the PP16 data set were all clear demonstrating that there were no incidences of contamination from either the environment, or other samples processed alongside.

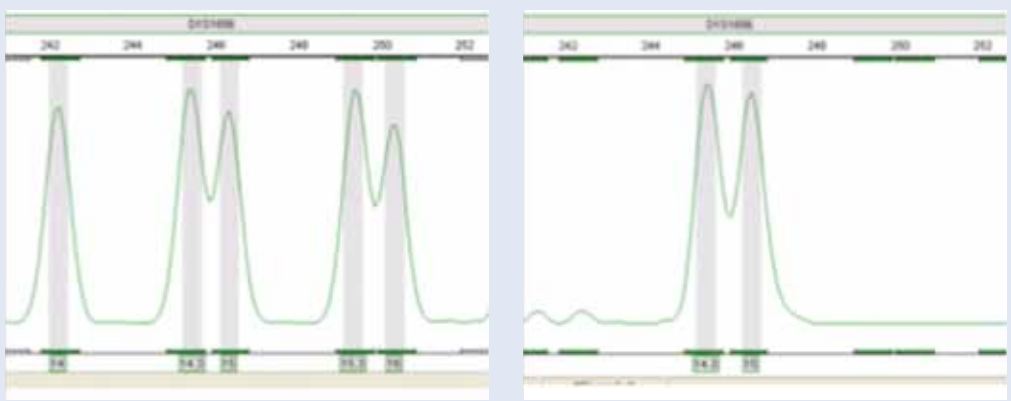
Accuracy

The accuracy of the instrument was determined by assessing both the concordance of the samples to the expected donor profiles, and the one base pair resolution observed.

All samples within both data sets were fully concordant with the donor profiles demonstrating that accurate allele designation had occurred within all samples.

Within the ESI16 data set 11 donor samples contained a single locus with a heterozygous pair one base pair apart. In order to distinguish between two alleles this close together and accurately designate them the instrument must be able to resolve the signal within this region.

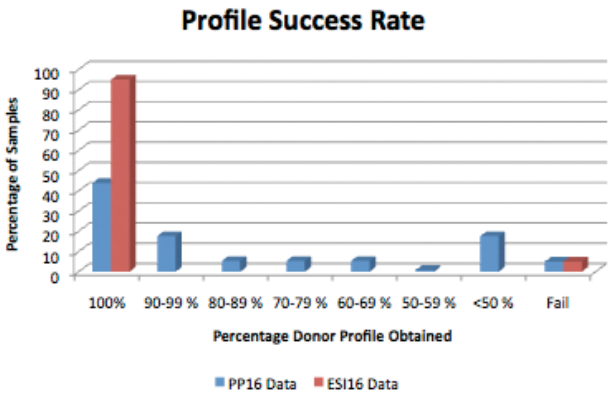
All 11 samples demonstrated good resolution, as shown in Figure 1.



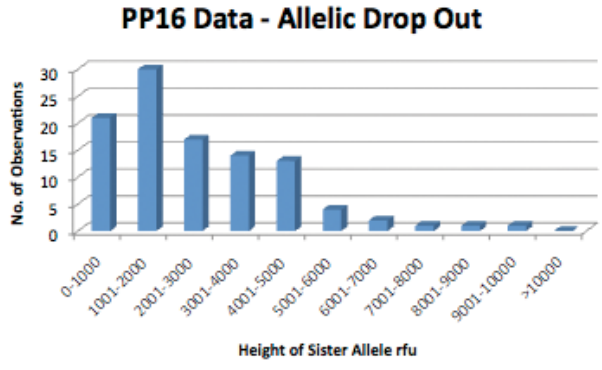
▲ **Figure 1.** The degree of resolution achieved by the instrument.

Profile Quality

Of the 114 samples processed within first study, the PP16 data set, 50 samples contained all expected donor alleles. In comparison, of the 100 samples within the ESI16 data set 95 contained the full complement of donor alleles. A breakdown of the results is shown in **Figure 2**. This demonstrates that whilst good profiles were obtained within the PP16 data set a much higher success rate is being achieved with the improved instrument protocols, and ESI16 chemistry.



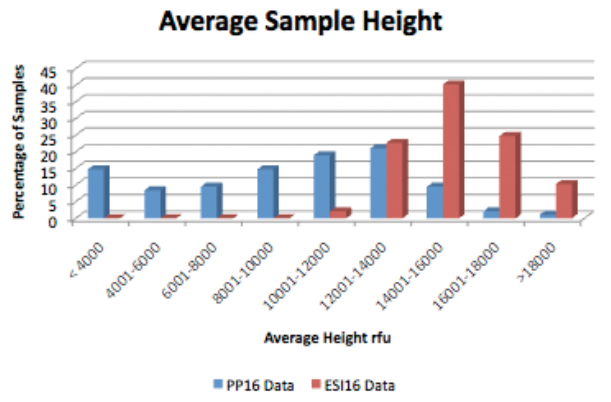
▲ **Figure 2.** Success rates of the samples within the data sets from both studies.



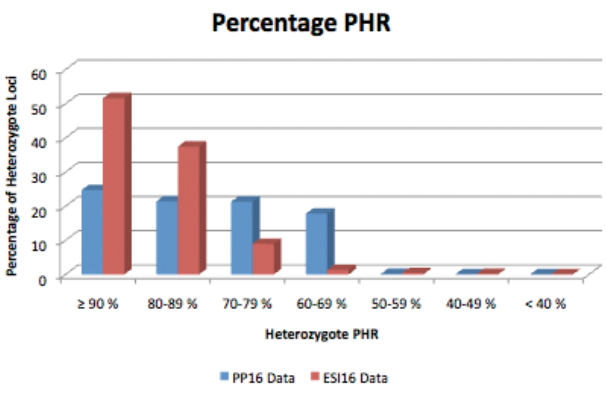
▲ **Figure 3.** The height of the observed allele where 'drop out' has occurred.

The success rates for the PP16 data set were affected by the occurrence of allelic 'drop out', which is where a heterozygote is observed within the profile as a homozygote. This cause of 'drop out' is generally considered to be due to the stochastic variation associated with inefficient amplification. Within this data set there were 105 observations across all loci, mainly occurring within loci with a low peak height, as shown in **Figure 3**. In contrast there were no observations of 'drop out' within the ESI16 dataset, demonstrating more robust processing and increased amplification efficiency.

The results were analysed in more detail in terms of relative average peak height of the samples. The peak height is determined by measuring the relative fluorescent units (rfu) which is directly related to the signal strength of the samples. Buccal samples are generally a very high source of DNA and therefore the expectation is that consistent peak heights will be obtained across the samples. **Figure 4** shows the peak height comparison across the two data sets. Higher signal strength was observed within the ESI16 data set which is consistent with the higher success rate being achieved, and absence of 'drop out'.



▲ **Figure 4.** The relative average height for the samples within the two data sets.



▲ **Figure 5.** The percentage peak height ratio (PHR) of the heterozygous pairs within each data set.

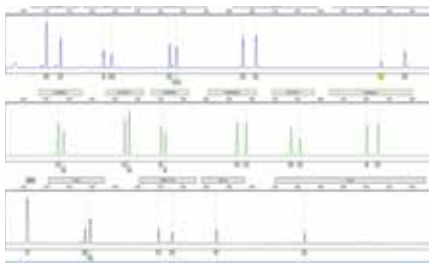
A further measure of profile quality is the assessment of the intra-locus balance within the profile results. This was measured by calculating the percentage peak height ratio (PHR) of the heterozygous pairs;

(height of small peak/height of large peak) x 100.

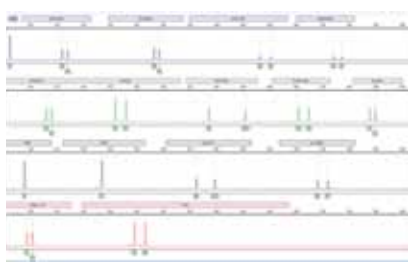
Intra locus balance is directly related to the efficiency of amplification therefore in samples with a good source of DNA the expectation is that the PHR would be high.

As shown in **Figure 5** the intra-locus balance is high, above 60% in the majority of the samples within both data sets. In terms of the ESI16 data set 98% of the heterozygous pairs were ≥70%. This again demonstrates consistency within the results obtained and that significant improvements have been achieved with the new protocols and a different chemistry.

Figure 6a and 6b below show examples of the profile results achieved from the two studies. They demonstrate that overall the quality of the data obtained from the instrument is high. It can be seen though that the overall profile balance within the ESI16 dataset is significantly enhanced.



▲ **Figure 6a.** Electropherogram showing a profile result from the PP16 dataset. Peak imbalance is seen within the Penta E locus, and 'drop out' is observed at FGA (donor is 22, 23)



▲ **Figure 6b.** A profile result from the ESI16 data set demonstrating good intra-locus balance.

Conclusion

These studies demonstrate that the RapidHIT® instrument is capable of producing high quality reproducible profiles. The initial study carried out on the early release version of the instrument indicated that there were some limitations and further work would be beneficial to increase the robustness of the instrument. The results from the second study demonstrate that this has clearly been achieved. The improvements to both the instrument and the process have had a significant effect on the results obtained. Buccal swabs are known to be good sources of DNA and success rates from the manual system are generally >90%. This combined study demonstrates that the instrument is capable of achieving success rates comparable to those achieved from a manual process.

Validation Study conducted by Lesley Ives, DNA Technical Lead

Global Sales Continue to Grow

Proof that the RapidHIT® technology is now being embraced by all parts of the world… it is now fully deployed and operational in mainland Europe including the UK, the Netherlands (where it is legally signed off and operational for intelligence purposes), Denmark, USA (multiple central government agencies, state forensic labs e.g. Arizona, California and Florida; and private labs), Abu Dhabi, Japan, China, East Timor, Thailand and Malaysia.

Case Study

Antoni Imiela

Serial rapist Antoni Imiela was arrested for the suspected rape of nine women and girls between November 2001 and October 2002.

Once interviewed, a DNA sample was taken and Imiela was released on police bail pending the outcome of the DNA test.

Upon release, Imiela went on to indecently assault a 10-year girl before the DNA result matching him to the rapes was returned. This indecent assault could have been prevented if the police had the ability to test Imiela whilst still in custody. Rapid DNA offers the police the ability to make decisions related to charging and release of suspects with the outcome of DNA database searches available to them.

Serial rapist Antoni Imiela's assault on a 10-year old girl could have been prevented using rapid DNA.

Disaster Victim Identification

Tragically, 182 people lost their lives as a result of the Christchurch earthquake of 22 February 2011. Rapid identification of the deceased is important as it provides closure for the families of the missing so they can start the grieving process. A disaster victim identification process was initiated in a temporary facility just outside of Christchurch. Here the remains of the victims were examined for personal effects and underwent a post-mortem process that included, where appropriate, friction ridge analysis, odontology and sample collection for DNA analysis.

Appropriate samples were collected at the facility and were subsequently flown to ESR's forensic biology laboratory in Auckland for DNA analysis. Whilst the cost and effort involved in DNA testing were significant, these were secondary to the needs of the families.

Rapid DNA technology will enable testing of both deceased and reference samples, along with the matching of these DNA profiles against DVI databases, at the site of the disaster itself.

◀ **ChristChurch Cathedral, Christchurch.** The cathedral was severely damaged in the earthquake in 2011 that killed 182 people.

RapidHIT is cheaper and easier for forensic laboratories to implement compared with current technology for major disasters such as the Christchurch earthquake, and crucially, will be much faster, enabling closure for families of those missing to be obtained more quickly. Rapid DNA devices also eliminate the need to transport samples which may compromise the quality of the biological material and will reduce the impact of any increased workflow on the laboratory.

The Palm Bay Project

In the Palm Bay project, burglaries were reduced by 40% with the introduction of DNA testing for all crimes and the searching of these DNA profiles against the local criminal database.

Palm Bay Police Department largely attributes its reduction in burglaries primarily on the quick turnaround of DNA profiles in less than 30 days, thereby reducing the number of offences committed by the career criminal. With DNA testing now possible within hours rather than days, Palm Bay expects to prevent additional crimes and anticipates a further reduction in burglaries by as much as 50%.

We want your ideas!

We are looking for inventive ideas and suggestions for the use of Rapid DNA.

It may be that you have thought of opportunities for the RapidHIT® technology, in circumstances or environments which you encounter at work or elsewhere.

If so, please let us know and we will reward the most useful and novel suggestion with an iPad mini!

Please email your thoughts to our Marketing Manager, **paul.whitehouse@keyforensic.co.uk**

***One iPad mini (wi-fi version) will be presented and the award will be made at the judges' discretion.**

If you require any further information on the **RapidHIT® instrument** or if you wish to see a live demonstration, please contact our team on **+44 (0)2476 323393** or email **paul.whitehouse@keyforensic.co.uk**

Please call us on +44 (0)2476 323399
University of Warwick Science Park,
Sir William Lyons Road, Coventry CV4 7EZ, UK
e sales@keyforensic.co.uk w keyforensic.co.uk