

# The FIRMS Network – from the Early Years to Now – but what of the future?

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[dstl]

FIRMS Conference  
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# Plan

- 1. Background**
- 2. Establishing the Network**
- 3. First FIRMS conference**
- 4. FIRMS Workshop**
- 5. Update**
- 6. Audience participation**



# The Forensic Isotope Ratio Mass Spectrometry (FIRMS) network



- Formed in Jan 2002 by the University of Reading and the Forensic Explosives Laboratory (FEL)
- Funded by the The Engineering and Physical Sciences Research Council (EPSRC) for three years
- Now extended by a further 4 months



# Original members of the partnership



1. Max Coleman - University of Reading
2. Sean Doyle - The Forensic Explosives Laboratory, [dstl]
3. Steven Brookes - Iso Analytical, Sandbach
4. Tony Fallick - SUERC, East Kilbride
5. Ian Thompson - NERC CEH, Oxford
6. James Ehleringer - University of Utah
7. Peter White - Strathclyde University
8. Ian Abell - Micromass UK Ltd.
9. Alex Alan - Forensic Alliance Limited
10. Mark Bailey - NERC CEH, Oxford



# Background - Analytical science to support the justice system



- Establish degree of similarity between substances by identifying
  - Constituent elements
  - Cations
  - Anions
  - Functional groups
  - Structure
- Potential for stable isotopes
- If SIs work, then
  - No need for adding taggants for regulatory or crime reduction purposes
  - Possible major economic advantage
- Extensive IRMS application to natural materials to understand natural processes
  - Geological
  - Biological
  - Cosmological
- IRMS application to manufactured products
  - Foodstuffs
  - Environmental pollutants



# Background - The Challenge - use IRMS to get origin of illicit substances



- **Geographical (from which country or region)**
  - incorporation of hydrogen or oxygen from local water in a synthesised compound should be distinctive
  - rain/snow varies considerably in isotopic composition (Dansgaard, 1964, etc.)
- **Commercial (from which manufacturer)**
  - Differences in manufacturing processes change isotopic compositions
  - Even if produced from same chemical feedstocks
- **This challenge can be best addressed by a network integrating the analytical expertise and experience with the understanding of forensic requirements and use**



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# Establishing the Network



# Response to the challenge: The Network 1



- **Rapidly expand the Network**
- **Widely-distributed questionnaire**
- **Establish the current level of knowledge of isotopic compositions of manufactured substances**
- **Raise awareness of the potential opportunities for isotope analysis in forensic science**
- **Identify potential and hypothetical problems in use of stable isotope characterisation of materials**
- **In what circumstances they might be relevant (e.g. microbial processes which cause isotopic fractionation)**
- **Identify instrument development needs, address and resolve them - Key requirements**
  - short turn around times (high throughput)
  - ease of use
  - applicability to all non-genetic materials of possible evidential value (eg fibres, textiles, glass, paints, papers, inks, plastics, adhesives, etc.)



# Response to the challenge: The Network - 2



- **Increase network size and scope**
  - Academia
  - Industry
  - instrument manufacturers
  - forensic practitioners
  - investigating and prosecuting authorities
  - Lawyers
  - Appropriate Home Office policy units
  - All agencies that would in any way benefit from or contribute towards the development of IRMS



# Objectives 1

- To identify the ranges and extent of heterogeneity of isotopic compositions of a number of manufactured materials and note
  - distinctive values
  - ranges of values
  - distributions of values of internal heterogeneity
- To determine which factors control these values
- To identify which processes, if any, might alter the compositions after manufacture



# Objectives 2

- **to extend the scope of the technique beyond explosives and drugs to include**
  - **Fibres**
  - **Textiles**
  - **Glass**
  - **Paints**
  - **Papers**
  - **Inks**
  - **Plastics**
  - **Adhesives**
  - **Others (this is not an exhaustive list)**
- **to identify the range of materials to which the technique may be applied**
- **to define all the limitations of the technique**



# Deliverables promised



- A major advance in benefits accruing to the justice system from analytical science, as well as an expansion of that science
- A report of the state of the art of potential use of IRMS in forensic applications
- A strategy for development of IRMS results as evidence of origin or history
- Definition of research priorities for forensic IRMS
- Facilitation of research support for necessary technical developments



# How to achieve the Objectives



- **FIRMS conference**
- **Report on the current state-of-the-art**
- **Newsletter**
- **Website**
- **Strategy document**
- **Research priorities document**
- **Facilitation of research resources - hope to involve the United Kingdom Analytical Partnership (UKAP)**



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# **First FIRMS Conference**



# Objectives of the first conference



- **Exchange information between the researchers and end users**
- **Expand the network**
- **Understand the statement of requirement**
- **Formulate a strategy for development**
- **Determine interest in a workshop to define research priorities**



# First FIRMS conference



- **16th and 17th September 2002**
- **Many people from all over the world**
- **Three working groups formed**
  - **Explosives - facilitator, Sean Doyle**
  - **Drugs - facilitator, Emma Titterton**
  - **General Forensics - facilitator, Pam Hamer**
- **Much interest in a workshop to define research priorities**



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# Other results of the first conference



**Participants at the first conference also decided to**

- **Publish the conference proceedings**
- **Produce a quarterly newsletter**
- **Establish and maintain an on-line forum**
- **Identify and facilitate research priorities**
- **Secure funding for a second conference in year 4**
- **Produce the final EPSRC report**

# **FIRMS Workshop**



# **FIRMS workshop at [dstl] Fort Halstead**



- **14th May 2003**
- **The working groups contributed to produce a technical strategy**
  - **Short-term objectives**
  - **Medium-term objectives**
  - **Long-term objectives**



# Technical Strategy Recommendations



- **Identify fora for publicising the network and attended by network members**
- **Formation of a funding working group - different types**
  - Academia
  - Government
- **Review current status of R&D for IRMS in forensic science - past, present and forward scope of current progs**
- **Identify FIRMS Network members able to undertake experimental work**



# Tech Strat priority target materials



- Different labs in different countries may have different priorities
- Choose materials common or beneficial to all labs
- Explosives
  - Organic high explosives e.g. RDX, PETN, TNT, NG ( $^{13}\text{C}$ ,  $^{15}\text{N}$ ,  $^{18}\text{O}$ )
  - Smokeless powders ( $^{13}\text{C}$ ,  $^{15}\text{N}$ ,  $^{18}\text{O}$ )
  - Inorganic nitrates e.g. ammonium nitrate, potassium nitrate ( $^{15}\text{N}$ ,  $^{18}\text{O}$ )
  - TATP ( $^{13}\text{C}$ ,  $^{18}\text{O}$ )
  - Sodium chlorate, sodium perchlorate ( $^{37}\text{Cl}$ )
  - Accelerants ( $^{13}\text{C}$ )
- Drugs
  - Amphetamines ( $^{13}\text{C}$ ,  $^{15}\text{N}$ )
  - Heroin ( $^{13}\text{C}$ ,  $^{15}\text{N}$ )
  - Cocaine ( $^{13}\text{C}$ ,  $^{15}\text{N}$ )
- General Forensics
  - Packaging materials ( $^{13}\text{C}$ ,  $^2\text{H}$ )



# Tech Strat - Target applications



- Forensic comparison of bulk samples
- Forensic comparison of trace materials to a bulk or other trace.
- Determination of the origin of bulk or trace materials.
- Other forensic applications of IRMS
  - Prediction of the isotopic signature of a product from knowledge of the signatures of the starting material (to link, for example, an improvised explosive found in a device to starting materials found at a suspects house).
  - Identification of human movement from knowledge of the turnover of elements in the body



# Short Term Objectives (within 3 years)



- Research and development of validated standard methods or standardised results for the target materials at bulk level
- Agreement and validation of reference materials and working standards
- Preliminary investigation of batch variation during the synthesis or manufacture of commercial and improvised materials
- Investigation of the effect of packaging/storage on the preservation of isotopic ratios of bulk target materials/elements
- Databases – preliminary study into requirements, structure, custody and population



# Medium Term Objectives (3 - 5 years)



- To allow compound specific analysis and the forensic comparison of trace and bulk materials.
- Compound specific IRMS – using off-line techniques, investigation of isotopic fractionation during the preparative process.
- Preliminary investigation into trace techniques.
- Continuation of batch variation studies.
- Population of databases.
- Review of the technical strategy and long term objectives



# Long Term Objectives (5 - 10 years)



- High throughput screening of samples and broadening the scope to other materials and applications.
- On-line compound specific IRMS – development of analytical techniques and investigation of isotopic fractionation.
- Trace analysis – including the effect of sample recovery, extraction and cleanup techniques on the preservation of isotopic ratios.
- Determination of the origin of traces and bulk materials.
- High sample throughput.
- Population of databases.
- Broadening the scope to other materials

**Update**



# Update



- **FIRMS focus group meeting  
29/7/04**
- **First inter-laboratory calibration /  
comparison exercise - 2004**
- **Workshop: Introduction to IRMS**
  - held yesterday 8<sup>th</sup> March 2005
  - half a day lectures - theory and pitfalls
  - half a day - practical experience
- **We now have over 100 members**

# **Audience Participation**



# The aim of this talk (at last)



- **Introduction to a discussion session**
- **Harvest your opinions**
- **Want/need frank input**
  - a) **review the network and its work to date**
  - b) **what do you want for the future? (start the process for tomorrow's final session)**

