Isotopic Characterisation of Amphetamines

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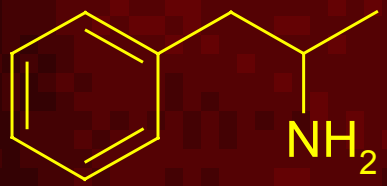
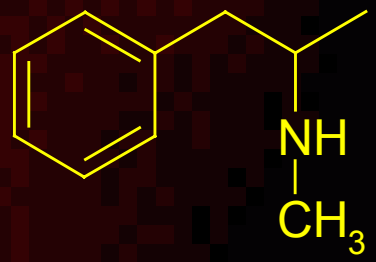
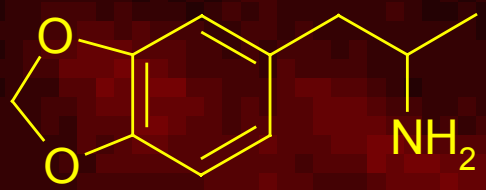
Amphetamines



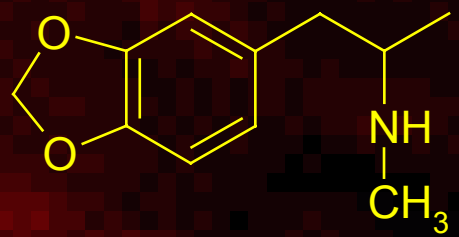
amphetamine



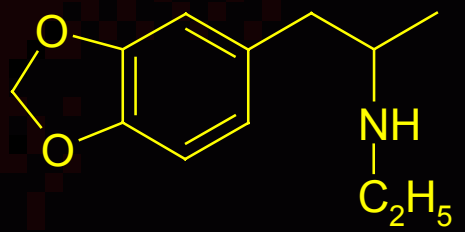
methamphetamine



MDA

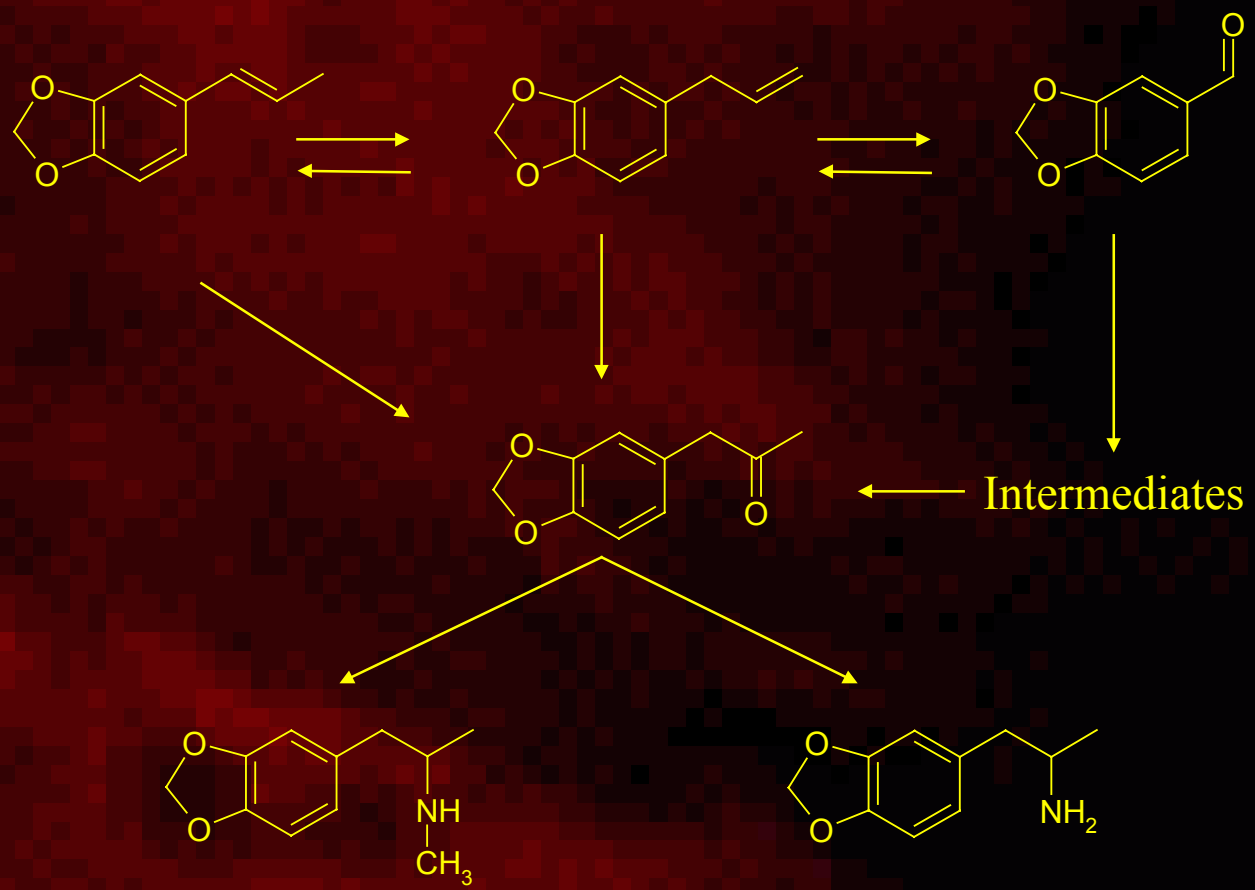


MDMA



MDEA

Synthesis



Overall Aim

- Use “isotopic fingerprint” or “DNA” to:
- Distinguish Batch – Batch
- Link “trace” and “bulk” evidence
- Trace drugs to a common source of manufacture or supply
- Determine synthetic method

Why Bother ?

- Home Office statistics for 1999:
- 29% of 16-29 year olds have experienced hallucinogenic drugs
- Police and HM Customs seized approximately 6.5 million ecstacy tablets
- Estimated supply of 26 million tablets

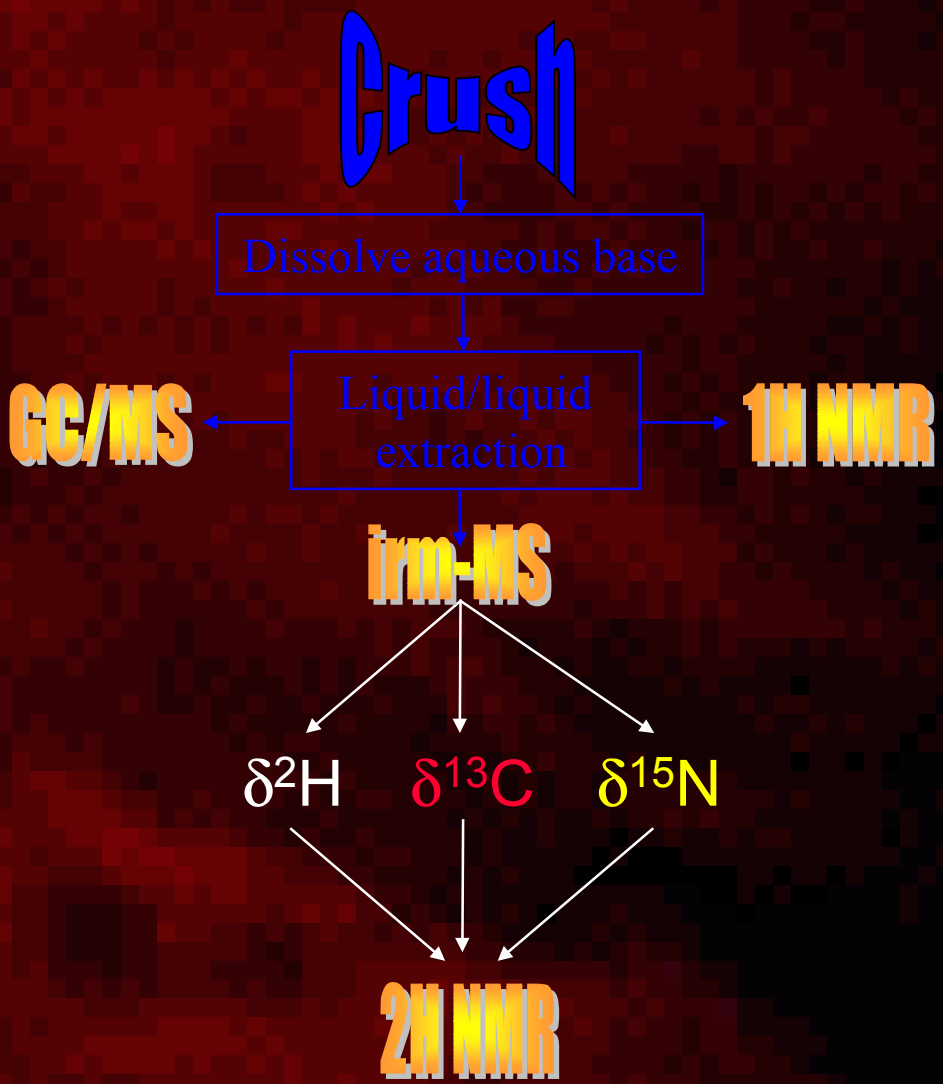
Study I

Five batches of “ecstasy” tablet

supplied by Avon & Somerset Constabulary, Scientific Investigations

RN/2932/99 RN/1491/00 RN/6108/00 RN/883/00 RN/1061/00

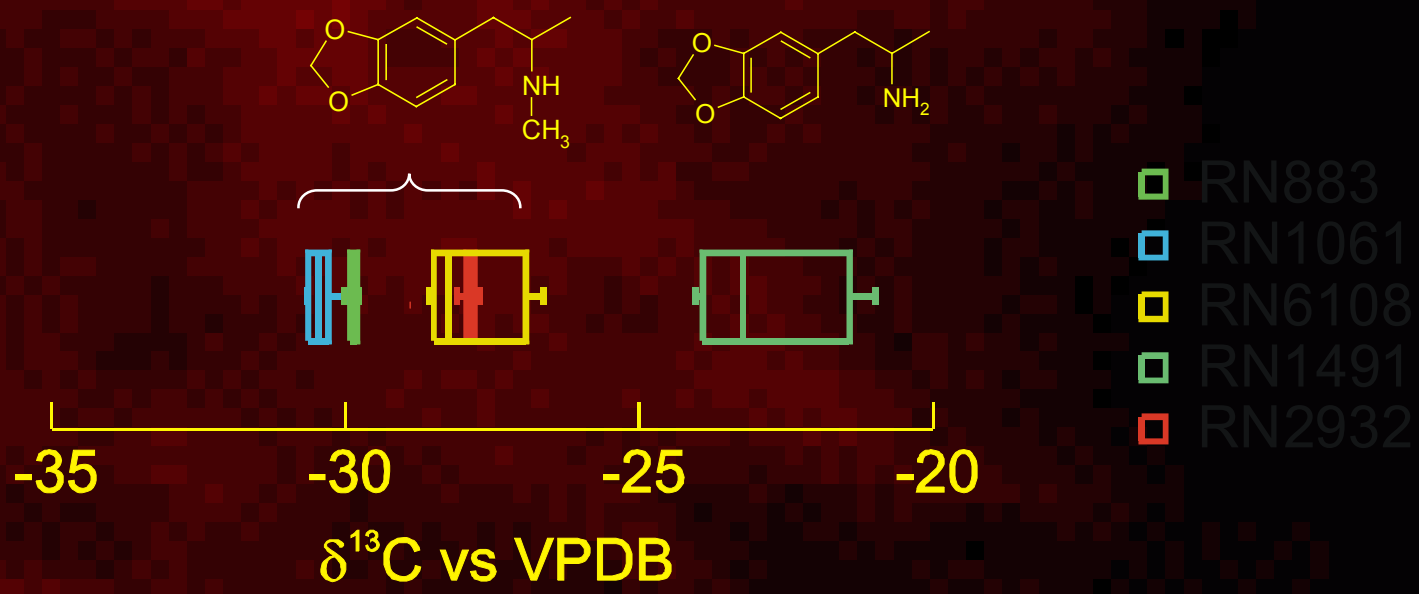
Methodology



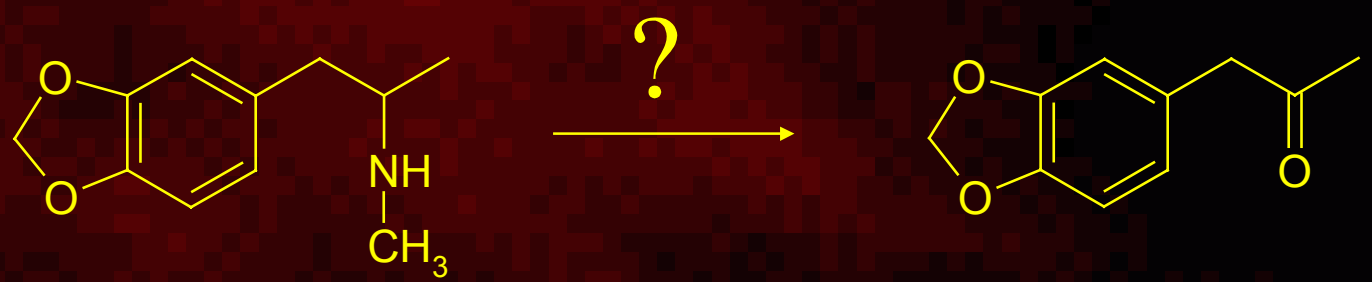
$\delta^{13}C$ analysis

- ThermoFinnigan Delta^{PLUS}XL
- GCC III interface
- Cu/Ni/Pt oxidation reactor 950 ºC
- Cu reduction reactor 600 ºC
- Calibrated to NIST sucrose (-10.47‰ *vs* VPDB)

$\delta^{13}C$ results



Aside



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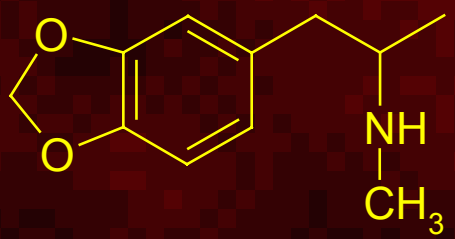
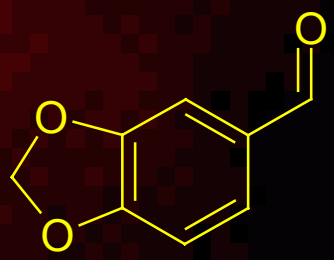


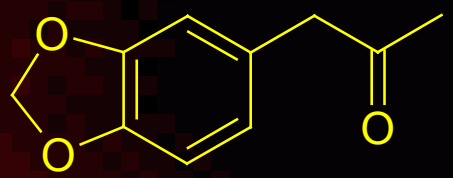
$KMn0_4$

$CuSO_4$

(48hrs)



10%



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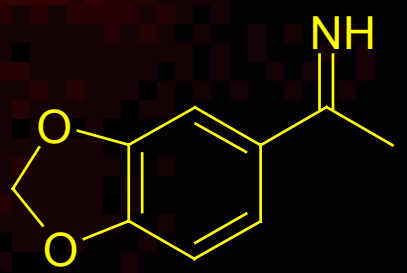

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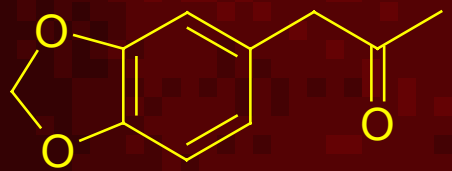
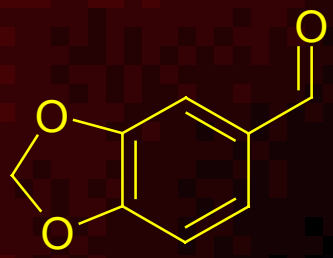




-26.95‰±0.24

-26.51‰±0.27

-26.85‰±1.05

-25.03‰±0.23

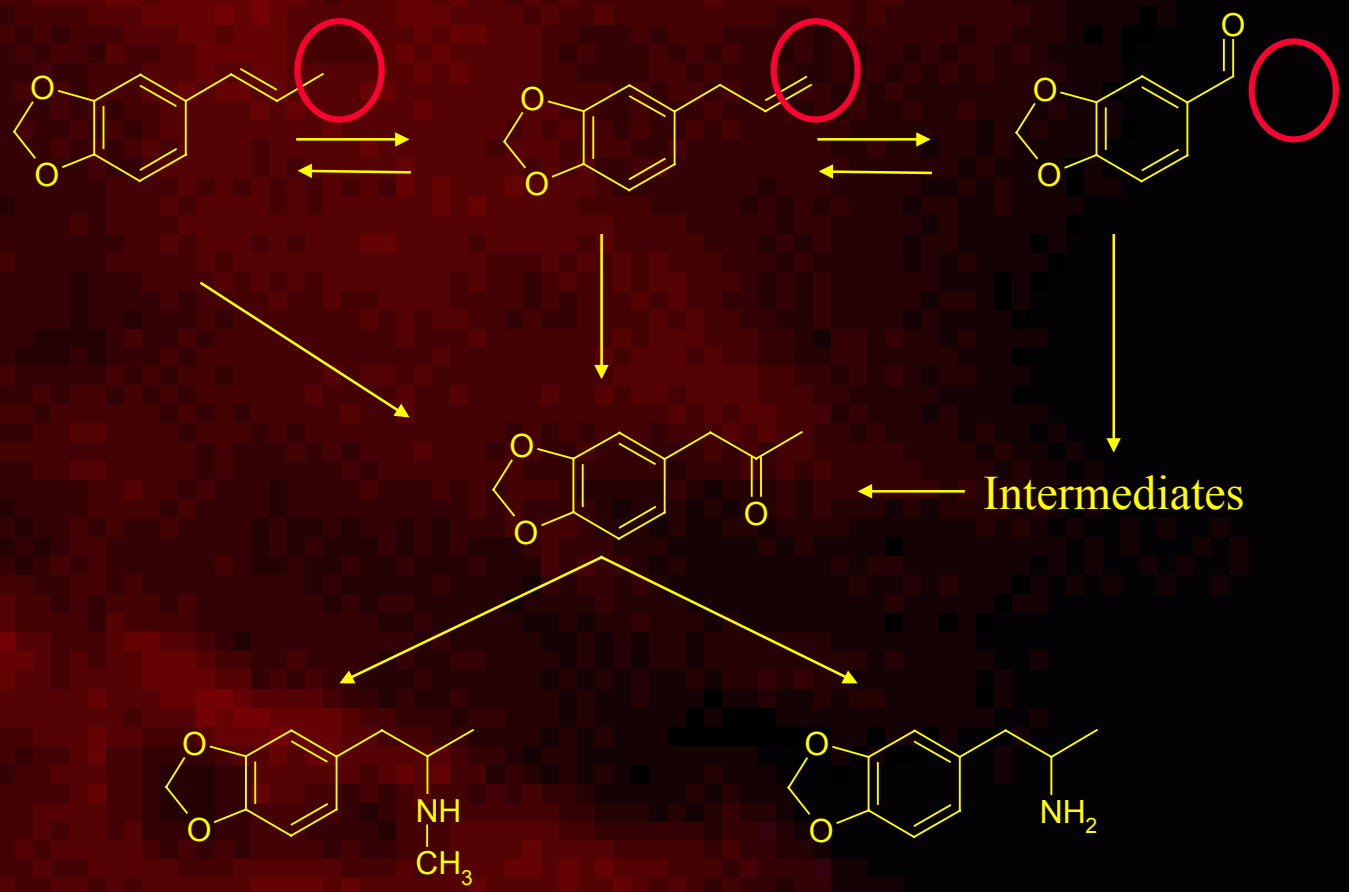
-27.28‰±0.08

-26.14‰±0.32

-26.56‰±1.15

-22.11‰±0.25

Synthesis

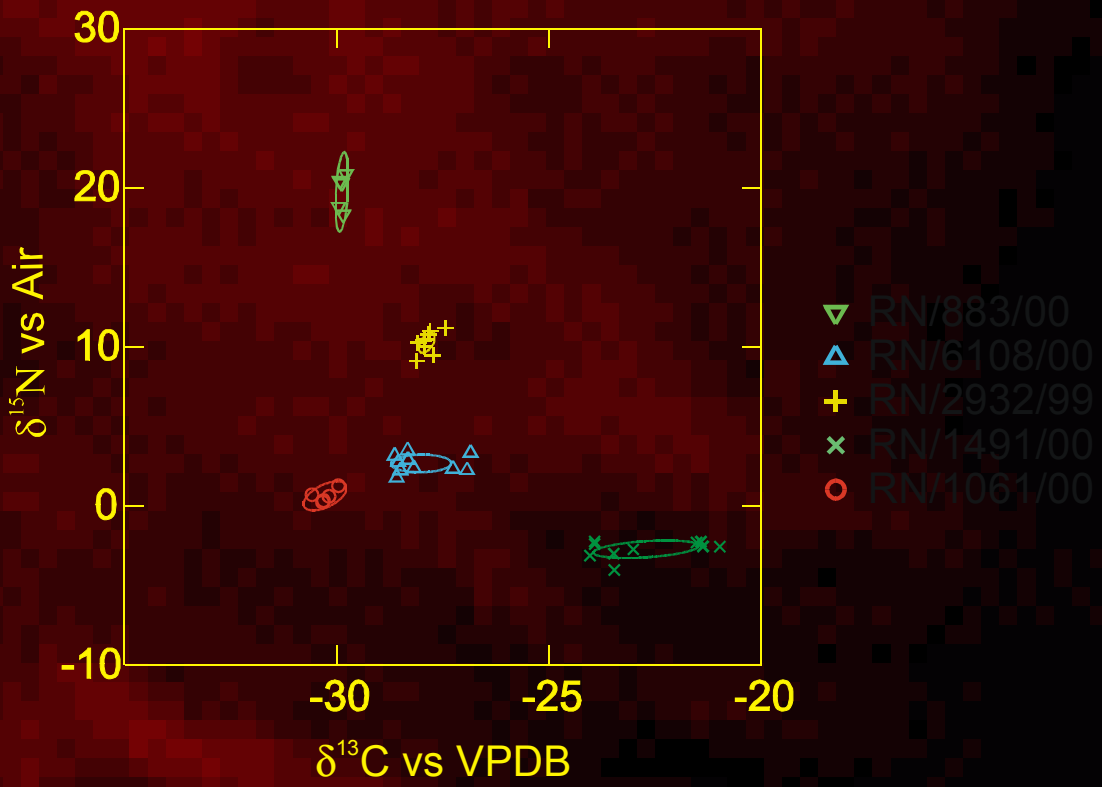


$\delta^{15}N$ analysis

- CarloErba 2500 EA
  ThermoFinnigan Delta^{PLUS}XL
- Cr oxide and Ag/Co oxide at 1050 ºC
- Cu reduction at 640 ºC
- Calibrated to NIST ammonium sulphate
  (0.4‰ and 20.3 ‰ *vs* air)

$\delta^{15}N$ results

$\delta^{13}C/\delta^{15}N$ results

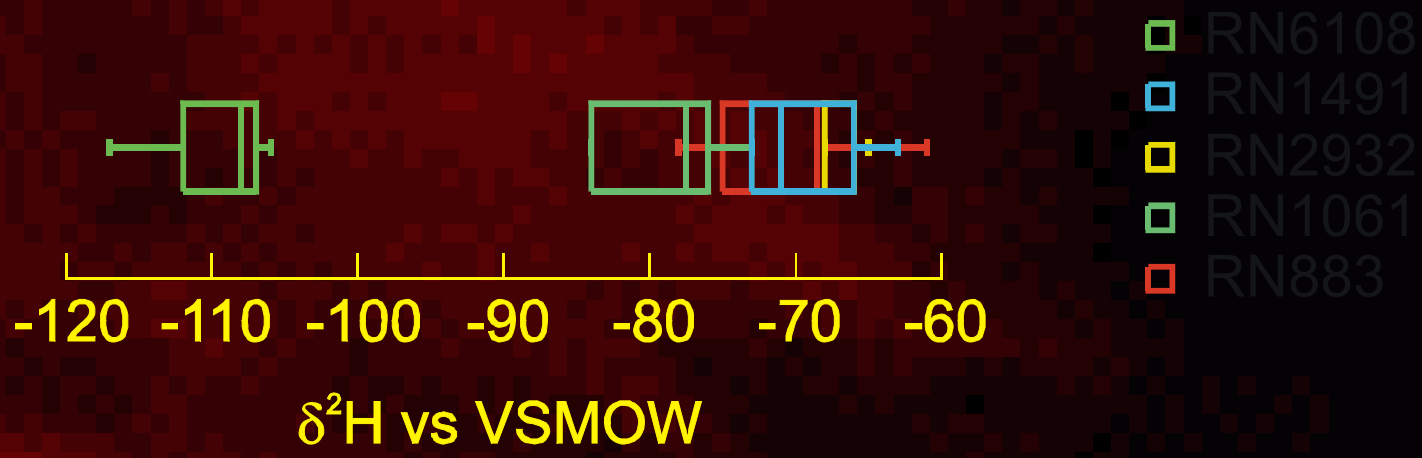


δ^2H analysis (n=9)

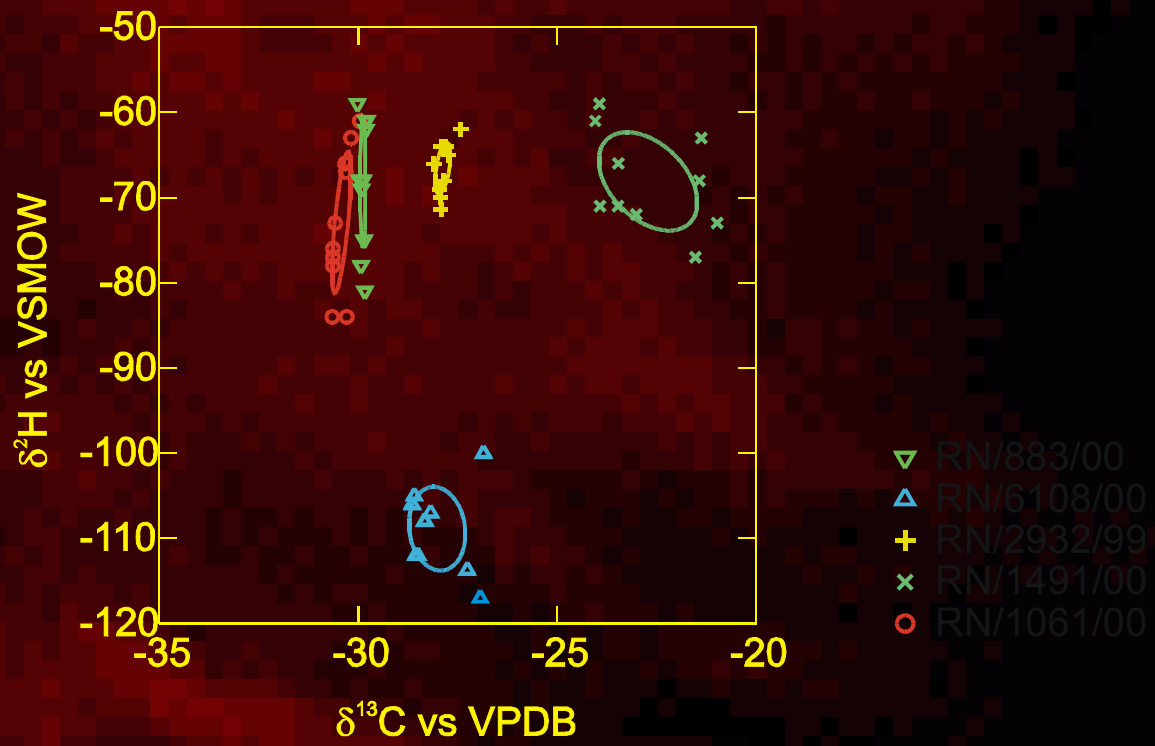
- ThermoFinnigan Delta^{PLUS}XL GC-TC-IRMS
- Thermal conversion at 1450 ºC
- Calibrated to a suite of n-alkanes

  (C_{16} - C_{30} - calibrated against VSMOW)

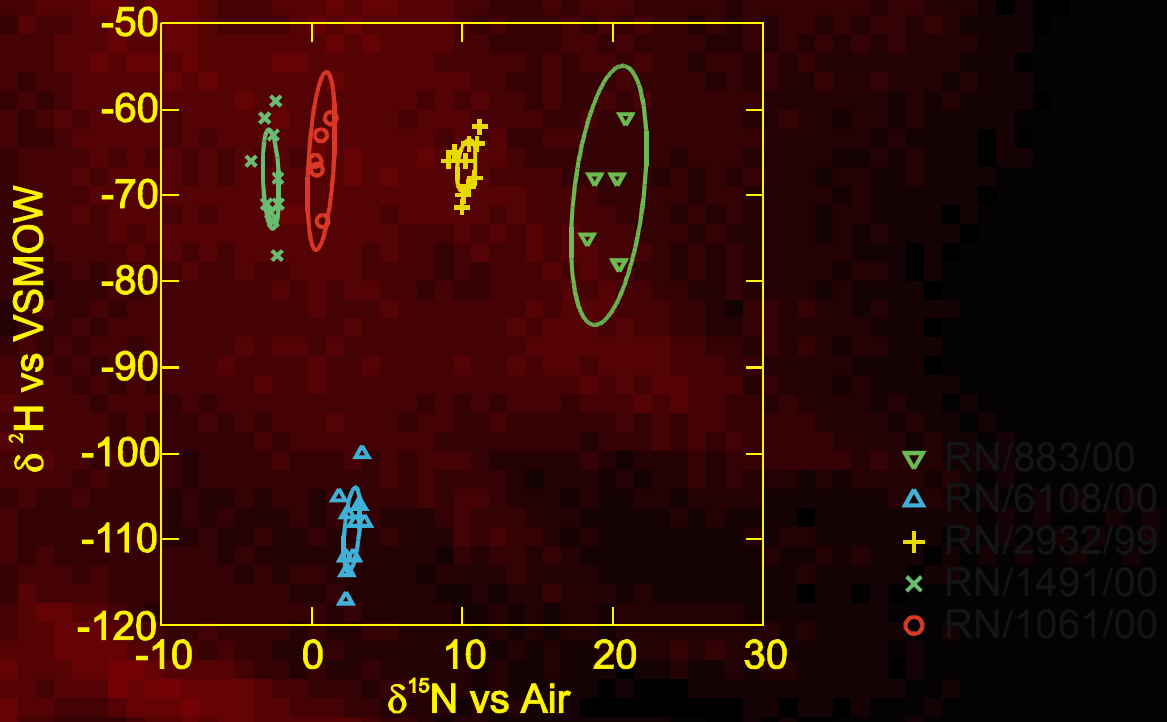
δ^2H results



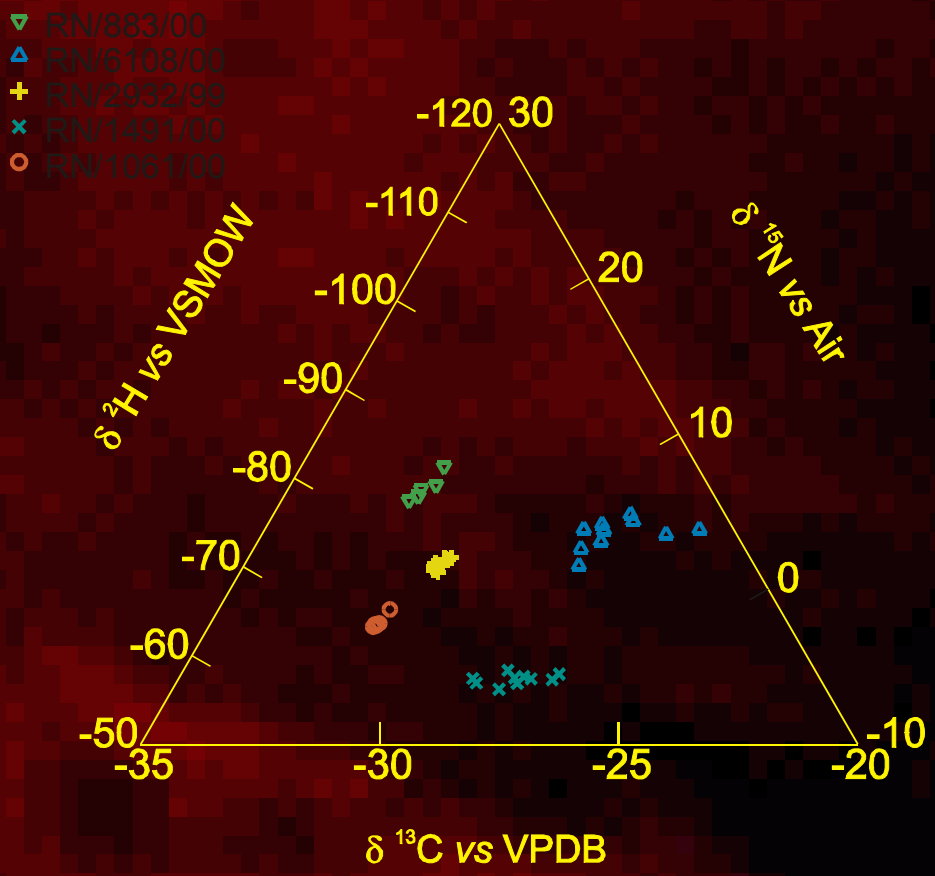
$\delta^2H/\delta^{13}C$ results



$\delta^2H/\delta^{15}N$ results



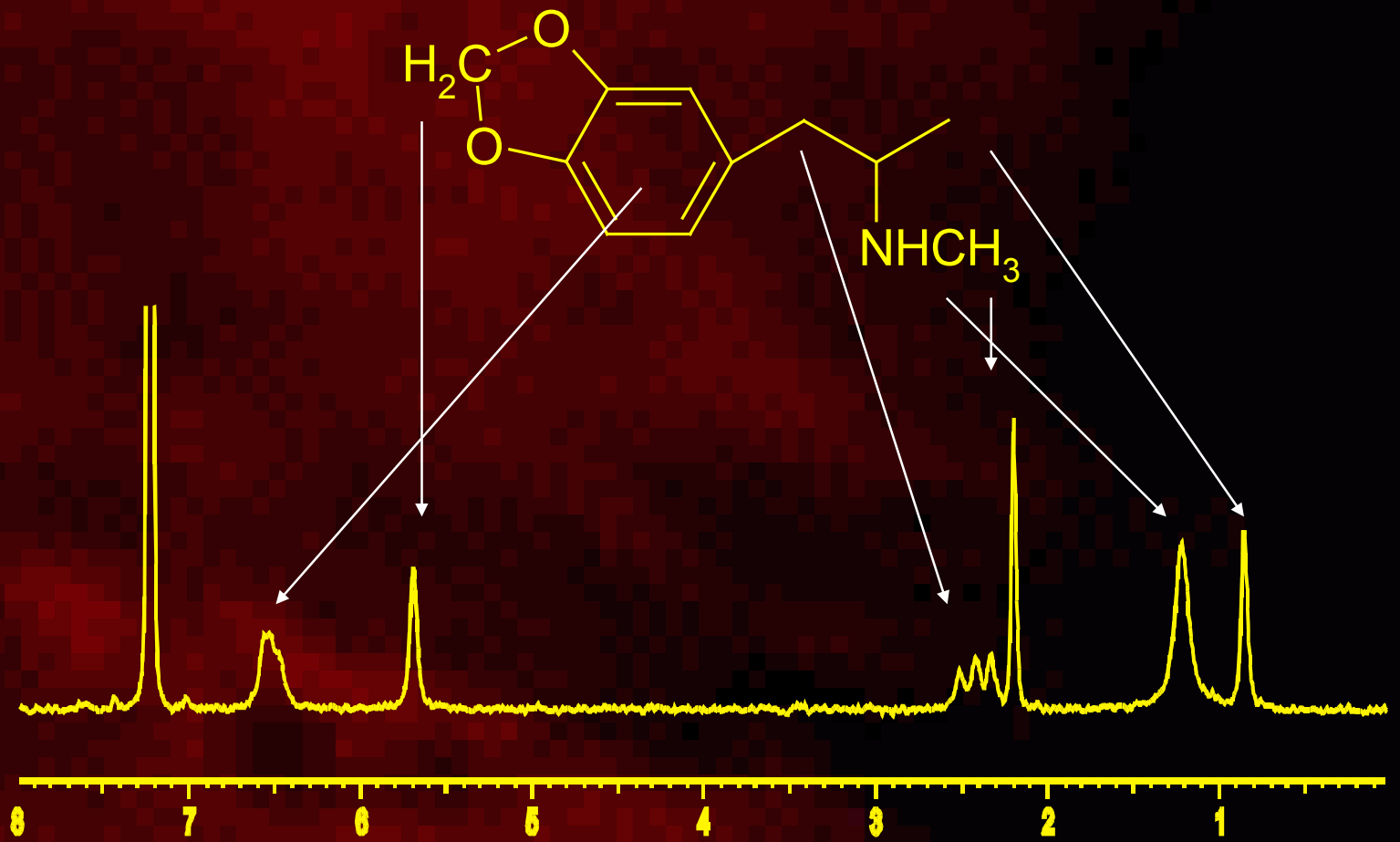
$\delta^{2}H/\delta^{13}C/\delta^{15}N$ results



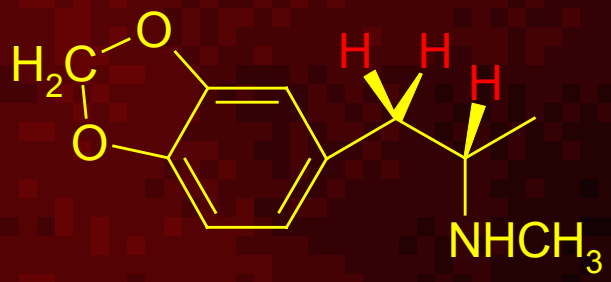
^{2}H SNIF-NMR

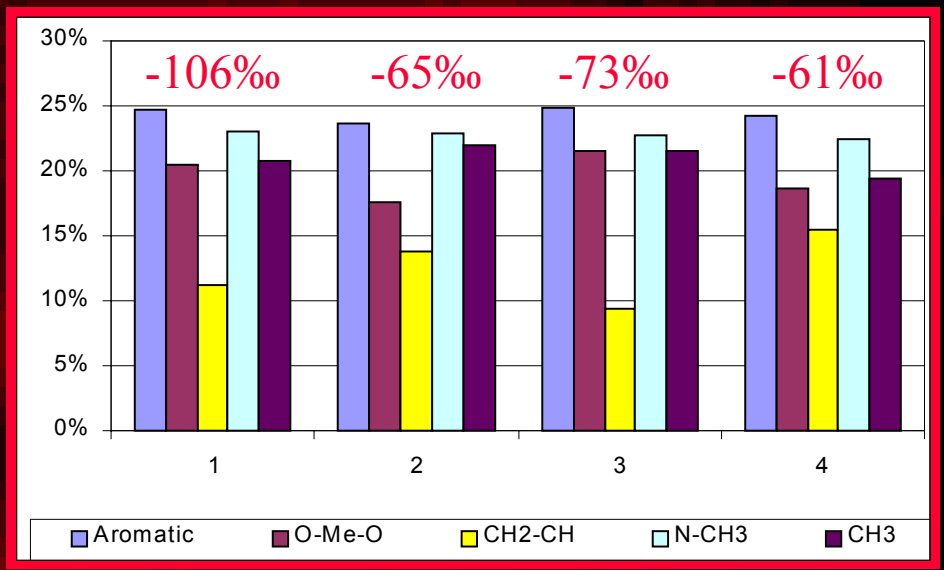
- Stable Natural Isotope Fractionation - NMR
- Site specific ^{2}H substitution
- Jeol Alpha 500MHz
- 500-1000mg analyte in $CHCl_3$
- 30,000 scans = 22 hours

^{2}H SNIF-NMR

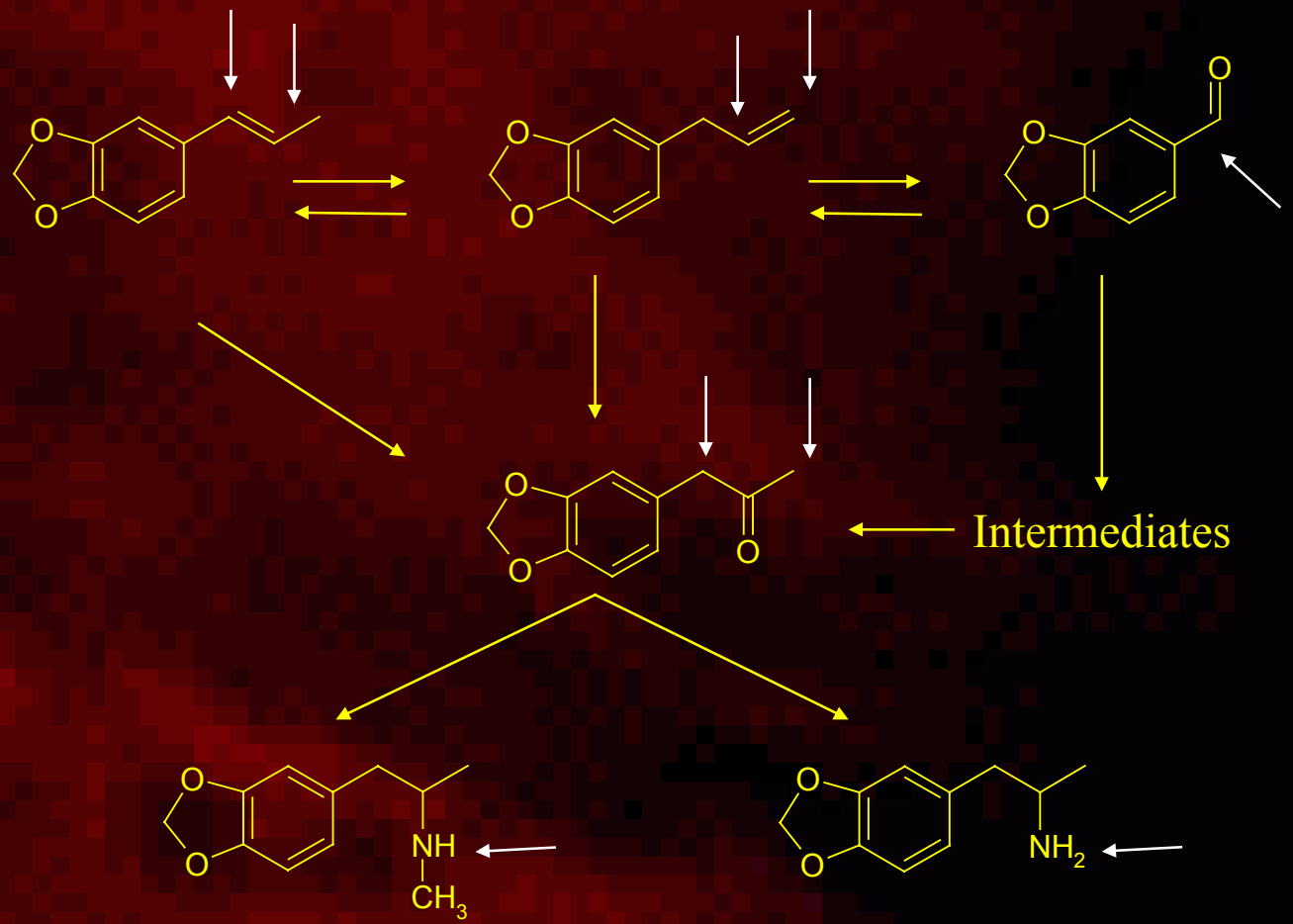


^{2}H SNIF-NMR


H2C
O
O
H
H
H
NHCH3


30%
25%
20%
15%
10%
5%
0%
-106‰
-65‰
-73‰
-61‰
1
2
3
4
Aromatic
O-Me-O
CH2-CH
N-CH3
CH3

Synthesis



Study II

$$Ca = (9Ck + Cm)/10$$

$\delta^{13}C$ results

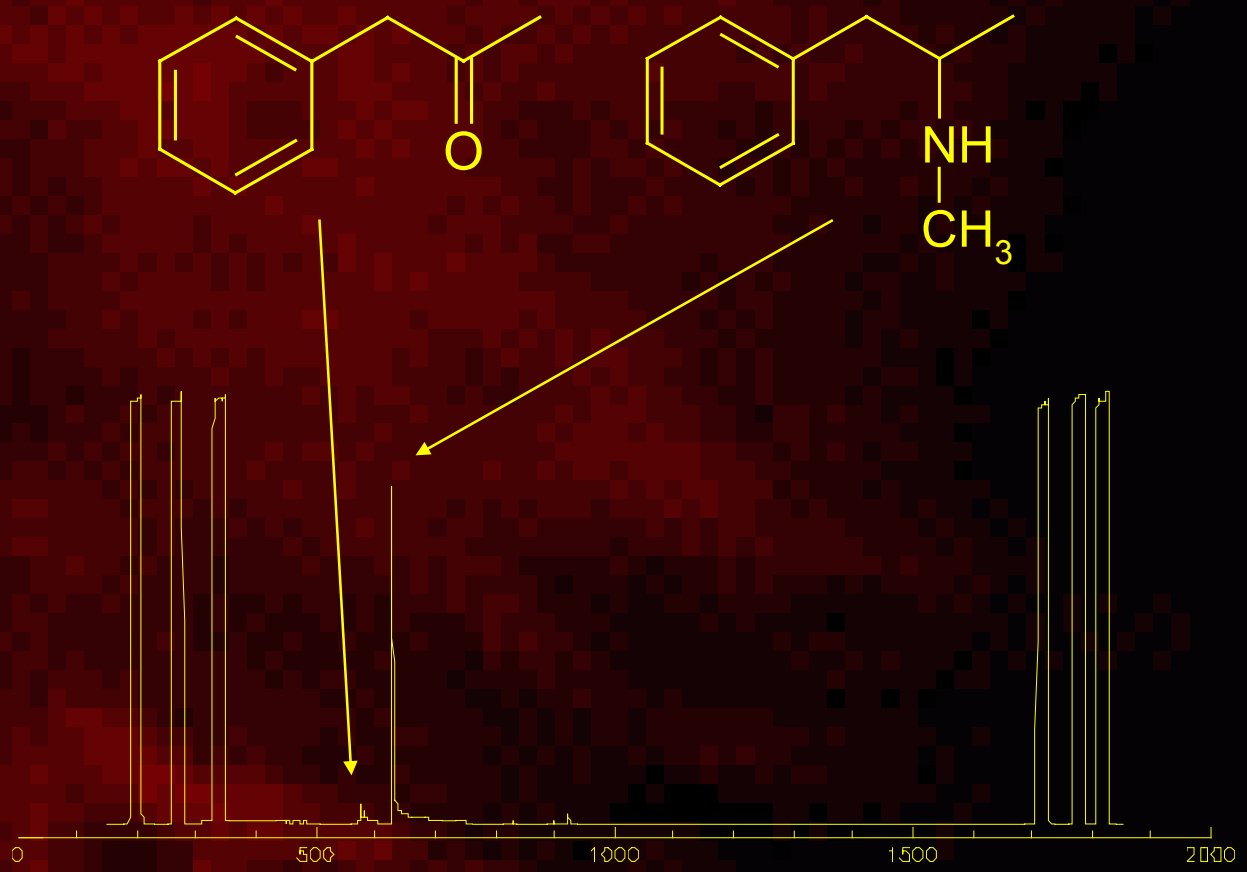
-29.25‰±0.37

-30.76‰±0.12

-29.4‰±0.39

-29.01‰±0.02

-29.34‰±0.57


O
NH
CH3
0
500
1000
1500
2000

$\delta^{13}C$ results

-29.25‰±0.37

-26.02‰±0.18

-23.47‰±0.26

-30.76‰±0.12

-29.4‰±0.39

$\delta^{15}N$ results

-1.54‰±0.16

+7.73‰±0.05

+4.20‰±0.51

$\delta^{15}N$ results

-1.54‰±0.16

+0.90‰±0.63

+7.73‰±0.05

+4.20‰±0.51

+7.24‰±0.11

+0.56‰±0.06

Conclusion

- Irm-MS provides a “fingerprint” or “DNA”
- $\delta^{15}N$ major discriminating factor
- $\delta^{2}H$ and $\delta^{13}C$ minor factors
- $\delta^{13}C$ and $\delta^{15}N$ reflect reductive amination
- $\delta^{2}H$ reflects origin and “solvent” history
- Applicable to few 100ng material
- Irm-MS and ^{2}H-NMR reveal synthesis

Acknowledgments

- NERC Organic Mass Spectrometry Facility
- Andy Stott and Helen Grant
  NERC ^{15}N Stable Isotope Facility
- Hugh Grundy & Eve Mason
  Avon and Somerset Constabulary
  Scientific Investigations
- Arndt Schimmelman
  Indiana University
- Prof Tim Gallagher