Krakow, Poland, 6.11. + 8.11.2017
Meeting Minutes WG1

I) November 6th, 2018: The end user perspective – state of the art of operational imaging technologies, issues limitations and desirables

1) **Welcome and outline for WG 1 meeting given by MMD:**

Michal Levin Elad (MLE, Israel), Wolfgang Greibl (WG, Austria), Jaap van der Weerp (JvW, The Netherlands) gave an insight into national laboratory equipment and responsibilities.

MLE:
in Israel there is 1 Division, that is responsible for identification & forensic sciences - 3 parts: Forensic Investigations, Chemistry & Marks, Forensic Biometrics

Focus 1 – Fingermarks, explanation why fingermark research is still of interest and explains need for new methods in terms of sensitivity
of interest:

- blood in fingermarks
- age of fingermarks - "holy grail of forensics
- visualisation of marks on problematic surfaces (skin, fired/unfired cartridge cases, rough metals

Focus 2 - explosives
of interest:

- nitrocellulose in mixture or after explosion (debris after explosion)
- metal in the 0-oxidation state

Focus 3 – drugs, synthetic and designer drugs
of interest:

- new drugs in the street —> ID of drug (process of legalisation —> drug becomes illegal —> drug disappears from street —> starts with new drug); proactive vs reactive analysis: designer drug families (analysis of drug body and not the side chains)

Focus 4 - questioned documents examination
of interest:

- ID inkjet printer based on ink, to understand printer model, ink cartridge, manufacture of ink
- without harming the document

Focus 5 - Biology and DNA
of interest:

- DNA location on material

WG:
ntroduces himself, lab structure and lab equipment

- Chem:

drug (ID and quantification)
paint (accidents, burglary, graffiti) - most is comparison
Arson (blamable liquids)
glass - problem: find the trace (small fragments)
miscellaneous (stained banknotes, powder in bags)
explosives, pyrotechnics

- Physics:
  Fire investigation (fires, explosions, …)
  Marks (tire, tools, …)
  Weapons (bullets, ammunition, technical expertise, …)
  Central Crime Scene Ammunition Database

- Documentation
  Database online
  cross-lines … what was first on the paper printing or line <— RRS ?
  handwriting examination (latent imprints without damaging the document

- Biology & Microscopy
  Textile & Fibre Analysis (comparison of clothes, …)
  Hair (what animal does it belong to, ….)
  Fabrics (what instrument did the damage to the fibre, …)
  Gun shot residues

- Imaging Devices:
  Microscopy - IR, Fluorescence, UV, Vis, …. Combine information
  IR Photography with Fluorescence

Demands?
Explosion cases - difficult to handle at crime scene,
how dangerous are explosion remains ?
evidence in the woods - find evidence fast
bottles filled with detonators and explosive material
illegal pyrotechnics - bomb squad had to secure scene

JvP:
presentation based on a cases (robbery in house/window broken/one suspect wears gloves)

what do we send to lab: glass, glove, stone, clothing
DNA on glove/glass
Fingermarks on glove/glass

methods / analysis
glass - compare Q(question) and A(answer) (refractive index, LA-ICP-MS) …
vacuum it, select shards (tweezer), cut clothes,
fibres - microscopy, MSP, FTIR, dye analysis (fibres of glove on stone?
fingerprints
DNA

What would you report to the police/judge?
ignore that there is more than one suspect ?
do not say that the suspect is guilty

how certain is an evidence an evidence —> statistics (Bayesian): explain which hypotheses explains the experimental results best
hypotheses are often not giving the answers —> activity-level reporting

Every presentation followed a short Q&A.

The presentations gave again raise to a discussion on the RRS setup and the group asked for the actual end-user demands.
The choice of samples (blood, ink, sweat/fingermarks) was explained, and it was pointed out that the aim of the RRS was to have evaluate capabilities/limitations of different methods in use.
MMD points out that at the moment the harmonization of the group is important and that the end user and academia learn to understand each other.

a) academia has to understand that the end-user will not use only one methodology
b) that the end user sees that academia provides a portfolio of different techniques which can be combined for further knowledge gain – which has to be tested.

Desirables of end users? Challenge coming from WG:
Explosion cases - something to sense where the explosive still is in order (safety), something to search big areas. Need a device to scan what's there in a confined space in order to keep personnel face. So main challenge will be contactless.

MMD asked for the views of the other end users. Were all the issues covered? No end user spoke. Three topics were chosen for further discussion. For this participants were divided in three groups having 30-45 min to discuss one of the following topics:

- Fingermarks - problems solutions
- Non-destructive/non-contact Analysis - contactless survey of crime scene
- Ink and questioned documents

Findings:

Fingermarks:

a. Improving enhancement of fingermarks (rough metals, skin, fired cartridges, fabrics) – two possible crazy approaches on skin (1 and 2):

1) anticadaverin antibody linked to a fluorescent tag to produce a negative image of a mark left by a strangler on the body of a murder victim
   or detecting drugs special substances in the killer's fingerprints
2) Metal Fired cartridges - IR Raman -left overs of the corrosion process?
3) Magnetic powders-improving particle size and homogeneity

b. Compositional of fingermarks to the case

c. age of the fingermark (depth profiling perhaps comparing outside with a deeper layer) SIMS. + some published approaches worth pursuing?

solutions:- quantum dots (non toxic Carbon based)
-antibody functionalised nano-particles

d. cross contamination of fingermarks with bodyfluids

Non-destructive/non-contact Analysis - contactless survey of crime scene:

a. portable imaging equipment (miniaturized); possibilities are:

1) photoionization detector (PIDs) / IMD – sensitivity issue
2) NIR-VIS imaging with chemometric classification & quantification – either high spatial resolution with low spectral resolution or low lateral resolution with high spectral resolution; need for high spatial and spectral resolution

b. XPS / XRF – no imaging but good sensitivity (ppm)

needed: field instrumentation, 1 or multiple instruments

Questioned documents (ink):

a. characterize:

1) substrate (e.g. paper)
2) printing/writing medium (e.g. ink, toner, paint)

Key issues: -) how to normalize collected data
-) crossing lines

b. dating

A summary of the Paper RRS is presented by MMD (details see attached pdf). An extensive review for fingermarks and other impressions was received from Andy Bécue and Christophe Champod.

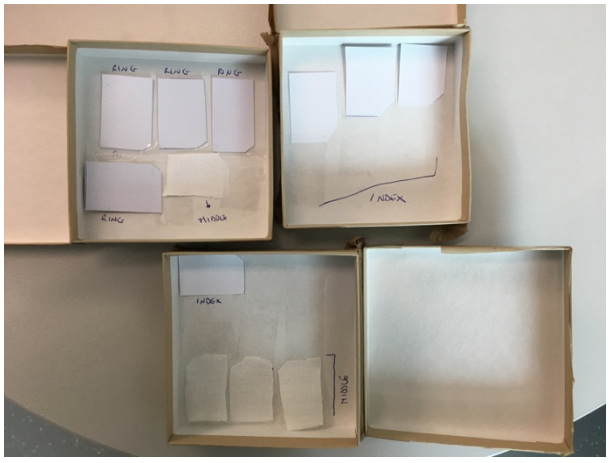
II) November 8th, 2018: Analytical Strand – RRS 2017/2018 results

MMD explains the aim of the RRS again for all new WG1 participants, reminds people about the samples (blood, Ink, sweat/fingermarks), the techniques applied (imaging technology available in lab) and that an aligned analysis was requested.

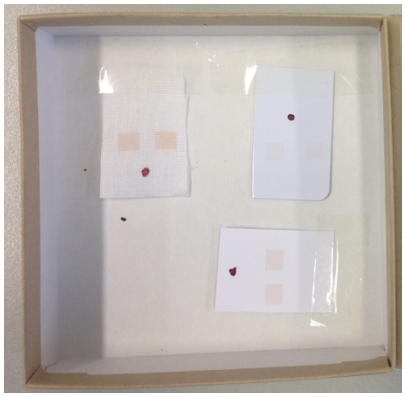
What to learn?
What technologies are available – limits and possibilities
Can the information be combined to help the end user

Samples were prepared as follows:
Substrates: paper (100 or 160 g/cm^2), fabric (cotton), plastic (PVC)
Evidence: equine blood (prepared by Martina Marchetti-Deschmann),
Sweat (prepared by Simona Francese)
4 inks (prepared by Alexandra Guedes)

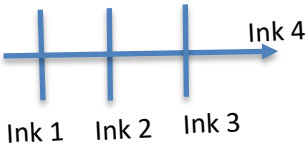
Fingermarks (Simona Francese): prepared on Sept 11th, 2017
Simona is a "bad" donor (little sweating), prepared samples within 1 day; middle finger/cotton, ring finger/PVC, index finger/paper
Exemplary sample set:



Blood (Martina Marchetti-Deschmann): prepared Sept 19th + Oct 4th, 2017
Chemical inkjet printer used for printing, 2 square areas: 1+4 dilution with ddH_2O, 250 µm pitch size, 5x5 mm , 240 pL/spot; additionally a blood spot prepared with a pipette - 0.5 µL undiluted blood
Exemplary sample set:



Ink (Alexandra Guedes): sent Sept 29th, 2017
BIC cristal, Pentel SuperB, Staedtler triplus ball, Paper Mate
Exemplary sample set:



Reports were requested but only received from very few participants:
Bécue
Pospiskova
Guedes
Frascione
Safarik

Presentation were given by WG1 members. Quick summary of results:
Francese:

- measured blood on fabric, paper and PVC — files corrupted - no knowledge on substrate and sample
- fingermarks - directly from fabrics, difficult sample because of porosity, m/z 284.5 shows some marks
- then matrix is sprayed evenly on fabric and measured again …. no result for fingermarks but polymer detected
- some results from fingermark lift
- ink results available via LDI, more signals after MALDI application

Marchetti-Deschmann

Measured blood, ink and fingermarks from paper and plastic, not cotton because of short currents (fibres)
Measurements done in 2 days because of limitations on instrument
Analysis after Ag sputtering and matrix deposition is possible for blood, ink and sweat – more time has to be spent for method optimization
For ink – characteristic m/z values were found; for sweat – partial fingermarks from plastic visualized at high lateral resolution; blood spots from printing experiment found.

Assis:

easy analysis for ink, stereomicroscope used,
gel ink - stroke 4
ball ink for stroke 1-3

video spectral comparator (VSC) - different illuminations, e.g. IR fluorescence light - shows 4 different ink types
differentiation of ink is key, not which stroke came first
limitations: two different papers cannot be compared by VSC —> another instrument: microspectrophotometer
µRaman – no time for analysis
more information needed for ID of ink, other technologies are used
but for > 90% of documents this technology is sufficient
alternatives are: reflective light
comparative results can only be achieved from same paper
demands: e.g. differentiate different entries in document, work contract - manipulation;

Algarra:

fingerprints by XPS
no image - single points of analysis over the paper
signal of cellulose and non-cellulosic material seen
limit - almost no print on paper
no blood samples received

Safarik:

ink comparison
microscopic images analysed with ImageJ software,
using also Color Inspector 3D plugin
analyses similarity of ink colors
— sees ink differences and shows ink similarities

Szynkowska:

SEM and dispersive diffraction, LA ICP MS, SIMS
non conductive material - flood gun

fingermarks:
on paper … fibre structure was visualised but not the fingermark
blood: focus on proteins (haemoglobin, …)
sees micro satellites
sees some Fe distributions
lipid fragments
no fragment for proteins (heme, histidine (m/z 110), …)
blood spot … better intensities

ink:

m/z values 256, 268, 269, 304
Phtalocyanine, Rhodamine, Basic blue, crystal violet, methyl violet
Intensity differences
analysis - what was drawn first: different results (not arrow was drawn first)

Veres:

Ink analysis with white light interferometry
Can be used from flat surfaces
can reveal if the ink on the paper has been placed by handwriting – the grooves can be detected on the paper surface

Champod/Bécue:

Hyperspectral imaging of blood spots on all probes, fingermarl only after cyanoacrylate fuming, ink analysis with NIR ViS successful (different inks)

Bailey:

Fingerprint analysis by SIMS, problems with ion source
No detail recovered from fabric samples
Difficult analysis because localization of fingermark not known

Guedes:

Optical images from fingermarks and blood samples taken by Raman spectroscopy
Ink samples were partially imaged (area too large) – characteristic signals found for ink types

Bogdanovic Radovic:

SIMS analysis of ink
characteristic signals for different inks
small scan size — no full ink mark could be seen
crossings were measured
blood on plastics (not textile - signals too low)
sees satellite spots from blood printing (Na, K, PDMS m/z 147)

Vella:

imaging without putting anything on the surface for SEM/EDAX analysis
ink sample: too much charging, terrible results
blood on paper: used 0.5 µL spot, no Fe image (EDAX), only O/C/Na visible
fingerprint on cotton: nightmare, only with in-lens detector some patches on cotton fibres no images

Romolo:

Low spatial resolution for blood on substrates but visible by Laser induced fluorescence
Ink differentiated by elemental compositions

Conclusions for RRS:

Michal Levin clearly pointed out that this RRS is of importance so academia and end users start to understand each other.
The group came to an agreement that the RRS was not successful, because

- groups did not follow time constraints for analyses
- significant percentage of WG members “failed” on analysis due to various reasons (data corrupted, instrument time, sensitivity, ….)
- it was unclear what results have to be produced

But WG1 came to an agreement to redo the RRS.
However, the setup has to be improved, especially as the end users have to benefit from the RRS.
The aim of the RRS has to be an improved result – i.e. information beyond state of the art results.

Samples of interest:
It was decided that blood samples are not useful, as there are enough techniques available for blood analyses, even differentiation between animal/human blood.
TO DO:

However, "drugs in blood" is an important topic and should be addressed. Eva will prepare a list for drugs that can be mixed with blood and spotted on a surface for analysis.
Decision on how these analyses may look like (experimental design) will be discussed in next WG meeting.

Fingermarks
Michal Levin offered to prepare appropriate samples, mimicking "real world" samples (end user prepares sample)
Request from RRS participants: image of fingermark for reconstruction is necessary
How will the fingermarks be done?

- stamp with artificial sweat
- latent and partially enhanced fingermark will be provided
- substrate is paper (because techniques for glass are available); bullet cartridges were discussed shortly but left out (sample surface is not even)

All participants have to take photo at time of receiving and at time of analyses (fingermark loses integrity over time)

Ink/Questioned documents
Ana offered to prepare samples and a list of questions to be answered by the RRS participants (questionnaire). This RRS should simulate a case work: document forgery.

General remarks:

- Martina prepares new google sheet
- Martina organizes cloud space for raw data/data transfer
- Fingermark and document samples will be handed out during next WG meeting or sent to participants not available at the meeting.
- Evidence has to be documented (photos) over the time span
- RRS results presented at a meeting by the end of 2018/beginning 2019 (enough time for analyses)
- Martina sends template for WG1 report