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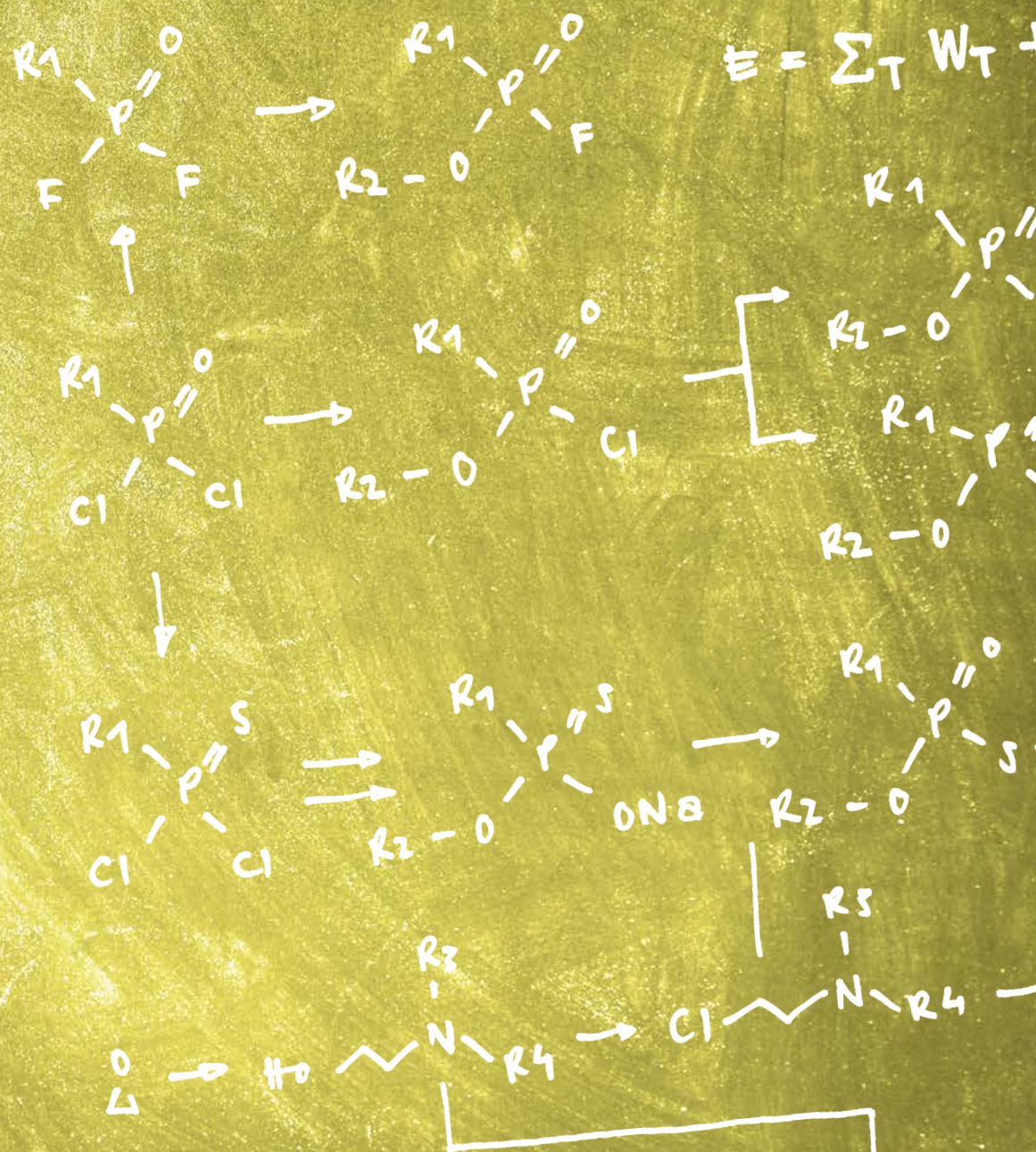
SPIEZ LABORATORY

Annual report 2018

SPIEZ LABORATORY



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Dr. Andreas B. Bucher

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Editor
Federal Department of Defence, Civil Protection and Sport DDPS,
Federal Office for Civil Protection FOCP
Spiez Laboratory
CH-3700 Spiez
Tel. +41 58 468 14 00
Fax +41 58 468 14 02
laborspiez@babs.admin.ch
www.labor-spiez.ch

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Dear readers,

At Spiez Laboratory, we try to follow the motto "do good and make it known". However, some of our tasks are of a confidential nature and we cannot report on them. What we can say though is; that in the light of recent geopolitical developments, our analytical capabilities have been called upon on more than one occasion.

In the spring of 2018, our work was brought to public attention by other parties. Reports appeared in the media that we had been requested by the Organisation for the Prohibition of Chemical Weapons (OPCW) to investigate samples from the attack in Salisbury, UK, and to test for the presence of the nerve agent Novichok. For a few days, we became the object of differing political interests – a rather unusual situation for a laboratory. We could not respond publicly due to a confidentiality clause we have as an OPCW designated laboratory. (See the report from the chemical weapons arms control expert Ralf Trapp about the Skripal affair on page 4). In the context of controversies surrounding the OPCW, we also became the target of a cyber-attack, and our name was misused for the distribution of computer malware, an additional impediment for our work. Our security installations were always sufficient and never breached; nevertheless, we have taken additional steps to optimise the protection of our facilities. These developments put demands in particular on our Logistics, Quality and Security Division as well as our Head of Communications, who responded to fake news with facts – utilising our Twitter account @SpiezLab.

Developments of this nature however, do not make us shut ourselves off, quite the opposite: Our goal remains to stay as transparent as possible within our legal boundaries; because without open communication, we cannot fulfill our tasks for civil protection, disarmament and arms control in a meaningful manner. In 2018 as in the years before, we have been very busy running projects about which we can, and will, report here. We participated (again) in missions of the UN Environmental Programme and the International Atomic Energy Agency in the Marshall Islands in the South Pacific, where we introduced staff from the local environmental authority to on-site measurements of radioactivity. Between 1946 and 1954, due to nuclear weapon testing, some of the atolls were con-

Spiez Laboratory works for all seven departments of the Federal Administration:

1. DDPS – Viola Amherd
   - Procurement support for armasuisse
   - Support for intelligence investigations
   - Competence Centre Radiation Protection of the DDPS
   - Training NBC specialists of the army
   - Approval body for protective construction components subject to testing
2. DETEC – Simonetta Sommaruga
   - International Atomic Energy Agency
3. EAER – Guy Parmelin
   - Support of the State Secretariat for Economic Affairs SECO in export-control issues
4. FDF – Ueli Maurer
   - Supporting the Swiss Customs Administration with mobile measurement systems for border controls in connection with radioactive material.
5. FDFA – Ignazio Cassis
   - Supporting the Division for Security Policy (Directorate of Political Affairs)
   - Expertise for disarmament negotiations
   - Member of various arms control committees
6. FDHA – Alain Berset
   - Operating special biocontainment laboratories for the diagnosis of human pathogens of the highest risk groups.
   - Reference functions for the Federal Food Safety and Veterinary Office (FSVO)
   - Reference functions for the Federal Office of Public Health (FOPH)
7. FDJP – Karin Keller Suter
   - Forensic services for Federal Office of Police fedpol and the Office of the Attorney General of Switzerland

Dr. Marc Cadisch
Director Spiez Laboratory

taminated to such a high degree, that monitoring of radioactivity levels is still necessary today. In Iraq, we supported the government to set up science-based environmental assessments. One of the most pressing environmental risks in Iraq today is oil pollution caused by the Islamic State, who destroyed numerous industrial facilities and oil fields.

In the field of nuclear arms control, we participated in the development of effective verification measures: in the context of previous treaties, disarmament of delivery systems (missiles) has always been the target of verification; however, up to now the destruction of a nuclear warhead has not been subject to verification. This challenge has been taken up by the International Partnership for Verification of Nuclear Disarmament, of which Spiez Laboratory (Switzerland) is an active participant (page 13).

Also in 2018, we were able to attract first-rate speakers and participants to our international workshops in the areas of chemical and biological arms control. These were well received and included the third meeting in our conference series *Spiez CONVERGENCE,* which is devoted to advances in biology and chemistry. The workshop identified new developments that might impact the Biological as well as the Chemical Weapons Convention (page 18).

In 2015, Switzerland started an initiative towards the establishment of a network of designated laboratories in the biological field. The Swiss initiative's aim is to strengthen the UN Secretary-General's Mechanism – an important instrument of the international community to investigate suspected uses of chemical, biological and toxin weapons. The fourth workshop in this series addressed practical steps towards setting up a robust network of trusted laboratories by launching quality assurance exercises (page 21).

Most of all however, our laboratory services are in demand in Switzerland. The adjoining illustration shows how we as the Swiss government's NBC laboratory support all other Federal Departments. We could not accomplish this to the satisfaction of our clients without our accredited testing laboratories. Our first accreditation was obtained 20 years ago (page 11).

The forensic tent, covering the bench where Sergei Skripal and his daughter Yulia were found, is repositioned by officials in protective suits in the centre of Salisbury, Britain, 8 March 2018.

Novichok, the Skripal Affair and the Chemical Weapons Convention

Dr. Ralf Trapp, Independent advisor on chemical and biological weapons disarmament, Chessenaz, France, e-mail: ralf.trapp@gmail.com

The poisoning of Sergei and Yulia Skripal brought into the limelight a class of chemical weapons that until recently many people may have never heard about, and that insiders had hoped had been left behind in the past: Novichok.

On 4 March 2018, former Russian military intelligence officer Sergei Skripal and his daughter Yulia fell ill to poisoning on a park bench with what appeared to doctors to have been some kind of a nerve agent,[1] and which was eventually confirmed as one of the Novichok agents.[2] Four months later, Charlie Rowley and Dawn Sturgess were discovered in a critical state in their house in Amesbury near Salisbury, UK. They too, tested positive for Novichok.[3] Dawn Sturgess died in hospital whilst Rowley was released after two weeks of treatment.

1 Mark Peplow "Assassination attempt of Russian spy sparks chemical forensics investigation" Chem. Engin. News, web version published 8 March 2018, https://cen.acs.org/articles/96/i12/Nerve-agent-attack-on-spy-used-Novichok-poison.html last accessed 20 May 2018.
2 Statement by Ambassador Peter Wilson at the 87th Session of the OPCW Executive Council, EC-87/NAT.5 (13 March 2018).
3 Lizzie Dearden "Amesbury novichok incident: Chemical weapons inspectors to gather new samples for testing", Independent (7 August 2018), https://www.independent.co.uk/news/uk/crime/amesbury-novichok-salisbury-chemical-weapons-inspectors-samples-testing-opcw-a8481591.html.

The British Defence Science and Technology Laboratory (DSTL) Porton Down conducted the identification of the agent. For confirmatory reasons, the UK requested technical assistance from the Organisation for the Prohibition of Chemical Weapons (OPCW). An OPCW mission collected its own clinical and environmental samples. Subsequently, four OPCW Designated Laboratories conducted analyses of these samples and confirmed the findings of the UK. The analyses also confirmed that the agent had been of very high purity – suggesting that in all likelihood, it had come from a State laboratory. This conclusion was based on the recognition of the scientific, technical and safety challenges of synthesising and handling this type of extremely toxic chemical.

The affair brought to the forefront fundamental concerns about Novichoks, their relevance for the Chemical Weapons Convention (CWC), and about the state of affairs concerning global chemical weapons disarmament.

Novichoks

The term "Novichok" (literally meaning "Newcomer") was coined to refer to a wide range of next-generation chemical warfare agents that were being developed in the Soviet Union and subsequently Russia, during the 1970s.

After the Second World War, chemical weapons had been developed and stockpiled by several countries. Russia and the United States accumulated by far the largest stockpiles – in total some 70 000 tonnes. Talks towards a global chemical weapons ban have taken place in the Geneva Conference of the Committee on Disarmament (today the Conference on Disarmament) since the 1970s. Parallel negotiations were conducted between the Soviet Union and the United States on a bilateral ban of the most dangerous, lethal chemical weapons (nerve agents in particular). These bilateral negotiations failed at the end of the 1970s. Nevertheless, negotiations on the CWC took off soon again, both multilaterally in Geneva as well as again bilaterally between the two Super Powers. At the same time, the Sovjet Union and the United States accelerated their development and procurement of new chemical weapons.

The Novichok programme (code named "Foliant") was an attempt by the Soviet Union to counter-balance the introduction by the United States of VX and of binary chemical weapons. Its objectives were to circumvent NATO detection equipment, to defeat NATO protective means, and to introduce chemical weapons that were safer to handle. A further objective was to develop types of agents and precursors that might fall through the net of the control system of the future CWC.

Spiez Laboratory in the firing line of cyber attacks

Successful spear-phishing attacks always follow a similar pattern: An apparently harmless word document of an unsuspicious sender is attached to an e-mail. When opening the file, the victim receives a recommendation to allow macros. If one follows this recommendation, it is already too late in most cases: the attacker has access to confidential data or can manipulate entire IT systems. It became apparent in early summer of 2018 that attackers had targeted institutions in the area of NBC protection: months prior to our Spiez CONVERGENCE workshop, (see page 18) a fact sheet with information about the event was circulated as a word document, using a fake e-mail address sent in our name. Inside this document, a malicious programme had been embedded.

Attributing such attacks is difficult. However, according to the security company Kaspersky, there is evidence that this action can be traced back to the hacker group *Sandworm*.[1] This group specialises in cyber sabotage and is considered an APT group. APT stands for *Advanced Persisting Threat*, in other words a complex, targeted and effective threat to critical infrastructure and/or confidential information. Kaspersky sees parallels to the attempted cyber sabotage against the Olympic Winter Games in South Korea. At the time, a campaign that called itself *Olympic Destroyer* had attacked the infrastructure of the Winter Games – it too, used clever deception maneuvers by employing convincing decoy documents, which contained hidden malicious programmes.

In autumn of 2018, the Dutch intelligence services confirmed several reports in the media that had reported an attempted hacking attack against the headquarters of the Organisation for the Prohibition of Chemical Weapons (OPCW) in The Hague. At the time, the OPCW was investigating allegations about chemical weapons attacks in the Syrian civil war as well as the attack on the Russian ex-spy Sergei Skripal in the United Kingdom. The suspects were arrested and expelled from the country.[2] According to the Dutch authorities, they carried in their luggage, amongst other things, train tickets for a journey from Utrecht to Basel. The destination of that journey, it appears, was the *Bernese Oberland.* On the computer of one of the arrested, evidence was found that shortly before the arrest, searches had been conducted about Spiez Laboratory. The Federal Intelligence Service (FIS) confirmed to the media that it had actively participated in this operation.

Illustration of a blog post by Kaspersky Lab from 19 June, 2018:
"It appears that Olympic Destroyer, an advanced threat actor that was trying to sabotage the 2018 Winter Olympic Games, in South Korea, has returned. Our experts recently found traces of activity similar to Olympic Destroyer, but this time they are targeting financial organizations in Russia, and biological and chemical threat prevention laboratories in the Netherlands, Germany, France, Switzerland, and Ukraine."

1 https://securelist.com/olympic-destroyer-is-still-alive/86169/
2 https://www.justice.gov/opa/page/file/1098571/download

The programme had clearly progressed beyond the stage of laboratory research by the late 1980s. Several phosphororganic chemicals had been selected and extensively tested, among them A234 that would later be identified in Salisbury.[4] Field tests had been conducted to detect the agents in ambient air as well as disseminate them using prototype chemical weapons. General Anatoli Kunzewich, Deputy Head of the Soviet Chemical Troops from 1984 to 1991, received in secret the Lenin Price in 1991 for the successful industrial-scale production of Novichok.[5]

No official data exist about the types of agents that actually developed to the weaponisation stage, nor the amounts that were produced. However, it appears that the formulas published by Vil Mirzayanov (see below) were basically accurate,[6] and that some of the agents were produced at the beginning of the 1990s in tens of tonnes for experimental purposes.[7] Mirzayanov, who directed air-monitoring experiments under the Novichok programme, drew attention to the programme and the risk it posed to people and the environment in the Moscow newspaper *Kuranty* in October 1991. In September 1992, together with Liv Fedorov, he published an article in the *Moscow News,* in which the authors drew attention to the continuing development and production of new chemical weapons in Russia, including binary weapons and Novichok field tests at the Nukus test site in Uzbekistan.[8] Mirzayanov was arrested for divulging state secrets. Other scientists from the State Union Scientific Research Institute for Organic Chemistry and Technology (GOSNIIOKhT) in Shikhany, who worked for the Foliant programme, went public in support of his case: Vladimir Uglev, a lead scientist of the Foliant programme, confirmed the existence of the programme in an interview with the magazine *Novoye Vremya* in February 1993.[9] Andrej Zheleznyakov, who had been contaminated with one of the agents in a laboratory accident in 1987 and had suffered permanent organ damage, also went public in 1992.[10] Mirzayanov's case was finally dismissed in 1994, and he subsequently emigrated to the United States.

During the 1980s, other countries too, had shown an interest in these new types of nerve agents. According to Masek and Matoušek, the United States was working on what they called GV agents or "intermediate volatility agents" (IVA) – nerve agents that would have physical properties somewhere in between the G and V agents. They would exhibit toxicity similar to or higher than Sarin, be more persistent than Sarin, and be more efficient than VX in overcoming protective barriers.[11]

Czechoslovakia's former Research Institute 070 in Brno and the Department of Toxicology of the Military Medical Academy in Hradec Kralove worked on the synthesis, characterisation and analysis of toxic chemicals that were chemically close to the Novichoks and IVAs. This work was purely defensive and directed to developing effective protection against these types of novel chemical weapons.[12]

Once chemical structures associated with the Novichoks became known, it is likely that other countries too, worked on their synthesis and characterisation. This would have been sensible given that countries needed to be able to protect their troops and populations against such new types of chemical weapons.

Novichoks and the Chemical Weapons Convention

Novichoks were not included in the CWC Schedules of Chemicals. The control lists had been discussed over a decade before in the Geneva Conference on Disarmament, and reviewed again during the finalisation of the verification package for the chemical industry. The existence of novel agents was not publically acknowledged at that time; it was assumed that no such stockpiles had been procured.

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4 See Vladimir Uglev, former senior researcher in the Foliant programme, in The Bell: "The scientist who developed 'Novichok': "Doses ranged from 20 grams to several kilograms", The Bell 20 March 2018, https://thebell.io/en/the-scientist-who-developed-novichok-doses-ranged-from-20-grams-to-several-kilos/ last accessed on 14 May 2018.
5 Jonathan Tucker "War of nerves – chemical warfare from World War I to Al-Qaeda", Pantheon Books (2006), p. 315.
6 Karel Knip "'Unknown' newcomer novichok was long known" NRC (21 March 2018), https://www.nrc.nl/nieuws/2018/03/21/unknown-newcomer-novichok-was-long-known-a1596490 last accessed 14 May 2018.
7 Mark Peplow "Nerve agent attack on spy used 'Novichok' poison" Chem. Engin. News 96 (12), p. 3 (19 March 2018)
8 Mirzayanov, p. 262
9 "Volsk-17 scientist discusses new chemical for binary weapons" Novoye Vremya No. 6, February 1993 (in Russian), published in English by JPRS-UMA-93-022 of m29 June 1993, pp. 18–20 (http://www.dtic.mil/dtic/tr/fulltext/u2/a333126.pdf, last accessed 13 May 2018).
10 Andrew Roth and Tom McCarthy "'It's got me' – lonely death of Soviet scientist poisoned by Novichok" The Guardian (22 March 2018).
11 I. Mazek, O. J. Mika, Z. Safarik, and D. Vicar "Interesting group of high-toxic organophosphorous compounds", Security research – The science for population protection No. 2 (215), pp. 1–13
12 I. Masek and J. Matoušek "On the potential supertoxic lethal organophosphorous chemical warfare agents with intermediate volatility" The ASA Newsletter, No. 44 (1994), p. 1, 10–11. ISSN 1057-9419

The final text of the CWC did however, contain a General Purpose Criterion that prohibits the development, production, stockpiling, transfer and use of *any* toxic or precursor chemical for CW purposes, as a "safety net".[13] Also there are CWC provisions that allow adapting of the Schedules,[14] and there are obligations to declare, verify and destroy facilities with a production capacity above 1 tonne per year for such new CW agents.[15]

None of these provisions were invoked after the CWC entered into force. This is not to say that there were no concerns about the absence of declarations of Novichoks. Tucker noted that Russia had not provided any information to the United States about the Novichoks under the Wyoming Agreement; he then pointed out that in bilateral US-Russian consultations, the Russians did not dispute the facts Mirzayanov had disclosed, they merely disagreed with the interpretation of these data.[16] These differences in interpretation also surfaced subsequently, for example with regard to the declaration of chemical weapons development facilities.

Proposals for a review of the Schedules were taken up by the OPCW Scientific Advisory Board (SAB) in the run-up to the First Review Conference of the CWC in 2003.[17] In its report, the SAB recommended that for "these and similar compounds ..., Schedule 1, from a scientific perspective would be the appropriate category to place them".[18]

No action was taken on the matter by the States Parties. The SAB addressed the question of Novichoks again in 2011,[19] stating that very little peer-reviewed information had appeared about such chemicals in the public domain. One year later, at the Third Review Conference, the SAB repeated this assessment.[20]

In 2016, Iran published a number of chemical structures and their analytical data, and submitted a recommendation to the OPCW to include them in the OPCW's Central Analytical Database (OPAC).[21] These were organophosphonates closely related to the Novichok agents. The research was set in the context of CW terrorism as well as chemical weapons disarmament.

Finally, on 16 October 2018 Canada, the Netherlands and the United States submitted a proposal to include two new groups of chemicals into Schedule 1 of the CWC.[22] This proposal included the known Novichok structures. On 14 January 2019, after the Director-General, in accordance with the rules of the CWC, had published his evaluation of the proposal, the Executive Council recommended that the States Parties include these chemicals into Schedule 1 .[23] If no State Party had objected to the recommendation, it would have become effective after 90 days. Russia, however, in the meantime objected to the inclusion of these Novichoks into Schedule 1 – the request for inclusion will thus come forward for decision at the next session of the Conference of the States Parties.[24]

Implications for the CWC

At the Executive Council meeting in March 2018, the UK linked the Salisbury attack with other recent incidents – the use of chemical weapons in Syria, in Iraq, and in Malaysia. It also alluded to the International Partnership Against Impunity for the Use of Chemical Weapons. This was set up as a follow-up to the mechanism established by the UN Security Council to identify those responsible for the uses of chemical weapons in Syria (the *Joint Investigative Mechanism* – JIM) after said mechanism could not be extended because of Russian vetoes in the Security Council.

In addition, the UK requested a Special Session of the Conference of the States Parties to adopt

13 CWC, Article I paragraph 1 and Article II paragraph 1.
14 CWC, Verification Annex Part IV(A), paragraph 2(a).
15 CWC, Article II, paragraph 8(a)(i)(2).
16 Tucker (2006), p. 323
17 OPCW document SAB-V/1, Annex 2 (1 November 2002).
18 OPCW: RC-1/DG.2 (23 April 2003), Annex paragraph 3.11.
19 OPCW: SAB-16/1 (6 April 2011), paragrapogs 11.1–11.3.
20 OPCW: RC-3/DG.1 (29 October 2012), paragraph 9
21 S. E. Hosseini, H. Saeitian, A. Amozadeh, M. T. Naseri and M. Babri "Fragmentation pathways and structural characterization of organophosphorous compounds related to the Chemical Weapons Convention by electron ionization and electrospray ionization tandem mass spectrometry", Rapid Communications in Mass Spectrometry volume 30, issue 24 (30 December 2016), pp. 2585–2593
22 OPCW: EC-M-62/2, 14.1.2018, paragraph 3.
23 OPCW: EC-M-62/3, 14.1.2019, paragraph 3.10.
24 Global Affairs Canada: Canada alarmed by Russia's objection to banning Novichoks under Chemical Weapons Convention, 11.4.2019, https://www.canada.ca/en/global-affairs/news/2019/04/canada-alarmed-by-russias-objection-to-banning-novichoks-under-chemical-weapons-convention.html . Russia had in turn proposed the extension of Schedule 1.This recommendation overlapped in part with the proposal of the three Western countries; it was more narrow in certain respects and on the other hand included other compounds (cp. EC-M-63/DEC.CRP.1, 19 Feb 2019) the relevance of which Western countries disputed; for the evaluation of the Director-General see EC-M-63/DG.1, 29 Jan 2019. No report of this Executive Council Meeting has been published.

measures against the threats of chemical weapons. This special session took place in June 2018 and tasked the Technical Secretariat to establish measures to identify those responsible for chemical weapons uses in Syria. It also authorised the Director-General to provide technical assistance to States Parties who were investigating possible CW uses on their territory, with respect to identifying those responsible for these acts.[25] The decision was adopted by vote.[26] This mechanism – the *Investigation and Identification Team* (IIT) – has in the meantime been set up.

The experiences of the JIM as well as the investigation of the Salisbury attack have shown that investigations aiming at attribution can easily be politicised. Russia, but also Western countries, used their political weight to try to steer these investigations in directions they desired.[27]

An example was when, in April 2018, Russian Foreign Minister Sergei Lavrov, citing "confidential information", stated that one of the OPCW Designated Laboratories (Spiez Laboratory) had not only identified a Novichok agent (A-234) in the samples from Salisbury, but also traces of the nerve agent BZ.[28] According to Lavrov, Spiez Laboratory had stated in its report that "this composition was in operational service in the armies of the US, the UK and other NATO countries. The Soviet Union and Russia neither designed nor stored such chemical agents."

Lavrov was poorly advised. It would be against established practice that a laboratory report of any OPCW Designated Laboratory would allude to a past weaponisation programme in specific countries.[29] A reading of the documents at the 50th Executive Council meeting shows[30],[31] that the chemical found in Salisbury was the very same agent previously identified by the UK. The allusion to BZ could only have been a reference to a spiking chemical in one of the control samples (however, not BZ – toxic scheduled chemicals are never used as controls – but a derivative thereof). In short: there was no BZ in any sample from Salisbury.

Investigations aiming at attribution are politically highly sensitive. Demands for one hundred per cent evidential certainty can easily be used to question the results of an investigation. It is important, therefore, that the OPCW further enhance its forensic capabilities in the Technical Secretariat and at the Designated Laboratories. Already in 2016, the SAB took up the issue of chemical forensics, in an international workshop organised together with the Finnish verification laboratory VERIFIN. The workshop discussed a range of still-evolving analytical techniques and identified areas where further development was needed.[32]

Most recently, the SAB established a temporary working group dealing with investigative science and technology.[33] This alone will not guarantee that all actors will accept the technical conclusions at a political level, but without confidence in the technical investigation, the evidence basis will remain uncertain and can easily be questioned or distorted.

Final thoughts

The continued use of chemical weapons in flagrant violation of international norms, concerns about chemical weapons programmes of States not party to the CWC, and the visible polarisation in the policy making organs of the OPCW, have casted doubts on the strength of the norm against chemical weapons. A return to more pragmatic approaches is paramount.

A first pragmatic step will be the inclusion of the Novichoks in Schedule 1. This will create a legal limit on the maximum amount of such chemicals that any State Party can possess or produce; it will direct Novichok production to declared Schedule 1 facilities and trigger systematic on-site inspections; it would make the end uses of these chemicals declarable; and it would subject these chemicals to the export and transfer controls and prohibitions that apply to other Schedule 1 chemicals.

Perhaps, this step might even result in the declaration, verification and destruction of former Novichok production facilities; and a clarification of what needs to be declared as a facility "primarily" for the development of chemical weapons under the CWC.

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25 OPCW: C-SS-4/DEC.3 (27 June 2018).
26 OPCW: C-SS-4/3 (27 June 2018).
27 See, e.g., Edmond Mulet, "How the Security Council Failed the Syria Chemical Weapons Investigators and Victims," The New York Times, 29 Dec 2017.
28 Foreign Minister Sergei Lavrov's speech to the 26th Assembly of the Council on Foreign and Defense Policy is available on the website of the Russian Foreign Ministry: http://www.mid.ru/press_service/minister_speeches/-/asset_publisher/7OvQR5KJWVmR/content/id/3169545 last accessed 16 May 2018.
29 See also the statement of the Swiss delegation to the 59th meeting of the Executive Council on 18 April 2018, OPCW document EC-M-59/NAT.2 (18 April 2018).
30 OPCW: EC-M-59/3 (18 April 2018) and EC-M-59/DG.1 (18 April 2018).
31 OPCW: S/1612/2018 (12 April 2018).
32 OPCW: SAB-24/WP.1 (14 July 2016).
33 OPCW document SAB-27/WP.1 (26 February 2018).

The Fourth Review Conference of the Chemical Weapons Convention (CWC) took place in The Hague from 21–30 November 2018.

Conflict over the Future of the Chemical Weapons Convention

The plan for the Fourth Review Conference of the Chemical Weapons Convention was to take stock of the achievements in the implementation of the Convention and to adopt recommendations for the future work of the Organisation for the Prohibition of Chemical Weapons. In the debates, however, opinions among the States Parties diverged to such a degree that they were unable to agree on a common Final Document.

"For the sake of all mankind" – so the words of the preamble of the Chemical Weapons Convention (CWC) – *"to exclude completely the possibility of the use of chemical weapons".* The CWC, which entered into force on 29 April 1997, prohibits the development, production, possession, transfer and use of chemical weapons. Every five years, the States Parties meet in order to review its operation and to discuss future developments. At the previous Review Conference in 2013, it looked like the world was still largely in order. The destruction of chemical weapons dating back to the times of the Cold War was making rapid progress: today 97 per cent of the declared stockpiles are destroyed.

However, the fourth edition of the Review Conference series, (21–30 November 2018) took place against a fundamentally different background. Since 2013, chemical weapons were repeatedly used in the Syrian civil war, and there have been several attacks against individuals in which nerve agents were used: The half-brother of the North Korean ruler Kim Jong Un was killed at Kuala Lumpur on 13 February 2017, with the nerve agent VX. Furthermore, the former

Diplomats studying the structural formulas of elements relevant to chemical warfare agents at the side event of Spiez Laboratory: *Science for Diplomats at RC-4 and Spiez Laboratory – CONVERGENCE and solving mysteries – a transdisciplinary look at scientific advances and problem solving.* The event also said goodbye to the retiring Chair of the Scientific Advisory Board, Dr. Christopher Timperley, and welcomed the new SAB leadership committee Cheng Tang (Chair) and Christophe Curty (Vice-Chair) for 2019.

Russian agent Sergei Skripal and his daughter Yulia were poisoned on 4 March 2018 with a substance belonging to the family of Novichok agents.

Approximately half a year before the Review Conference, the UK along with the support of ten other States requested a Special Session of the CWC States Parties. The UK government justified its motion by stating that the international community had to take urgent action in light of the breaches of the norm against the use of chemical weapons. Its intention was to have the Conference adopt a decision that would allow the OPCW to investigate the perpetrators of attacks with chemical weapons. Several months earlier, the mandate of the so-called *Joint Investigative Mechanism* (JIM) of the UN and the OPCW had expired – an investigation body that was set-up to identify the culprits responsible for chemical weapons uses in Syria to the UN Security Council. In two cases, the evidence had been sufficient for the JIM to identify the perpetrators responsible. The Syrian regime as well as the Islamic State had been identified as responsible for specific attacks. Russia, however, blocked an extension of the mandate of the investigation body by casting its veto in the Security Council, and thereby terminated the mechanism that would have enabled the identification of future perpetrators. At the beginning of 2018, the number of reports about new chemical weapons attacks in Syria grew, except that this time, an effective instrument to hold those responsible to account was lacking.

In the end, Britain succeeded with its initiative: after two days of diplomatic wrangling, the States Parties of the CWC decided with two-thirds majority to equip the OPCW with the necessary instruments. These tools were to allow the OPCW to collect indications and evidence to be able to identify the originators of a chemical weapons attack after such an act had been committed.

During the regular meeting of the States Parties in November 2018, the diplomatic tightrope walk continued: The main task of this gathering was the adoption of the programme and budget of the OPCW for the year 2019. With a clear majority, the States Parties accepted the draft budget. This also included a financial component for the implementation of the decision of the Special Session. The OPCW is now in the process of setting up a so-called attribution team, which will follow up on clues to identify those responsible for the cases that the "Fact Finding Mission" of the OPCW in Syria has confirmed. The OPCW now needs a multidisciplinary team of specialists, which would include investigating magistrates and experienced investigators with special qualifications in, amongst others, evidence collection and analysis. The budget of the OPCW, consequently, has been increased by 2.4 million Euros, totaling 69.7 million Euros. Russia and 26 other countries voted against this step. They went on record stating that assigning this new competence to the OPCW would infringe on the prerogative of the United Nations Security Council.

Directly after this unusual Conference of the States Parties, the conflicting parties met in The Hague for the Fourth Review Conference. Now, the agenda was to take stock of the implementation of the Chemical Weapons Convention and adopt recommendations for the future work of the OPCW. Yet, opinions expressed in the discussions diverged to such a degree that the Review Conference was not able to agree on a Final Document. In light of the controversies over the OPCW attribution team, this should not have come as a surprise. In total, 18 paragraphs of the Final Document remained contentious. On the one side, there were those countries that were convinced that the Syrian government had used chemical weapons, on the other side there were Russia and its allies, who rejected the attribution of chemical weapons uses as an unjustified politicisation of the Convention.

So far, collecting and analysing the evidence for the use of chemical weapons in Syria had to be done under difficult and at times dangerous circumstances. It was not always possible to verify every single aspect of each allegation or accusation. The investigations of the *Joint Investigative Mechanism* (JIM) were however by no means without success. On the contrary: one could argue that the JIM has been criticised precisely because of its successes with the identification of the perpetrators, and that it was this success that led to its work being terminated through a series of vetoes in the Security Council. The OPCW's own Investigation and Identification Team can now implement the attribution mechanisms. There are high expectations, albeit ones that *can* be met, which this team has to now fulfill.

The first testing laboratory in Spiez was accredited in 1993.

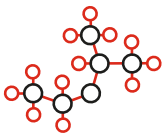
20 Years of Accredited Testing at Spiez Laboratory

Trust in tests and analyses stands and falls with the competence of the experts who perform these services. This holds for tests in the field of environmental protection, public health and food safety, and of course, also for our work in Spiez. Without objective evaluation or certification we cannot fulfill our tasks. We must be able to demonstrate to our clients and partners that the methods and systems we are using are trustworthy with regard to both safety and quality.

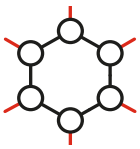
As a federal specialised laboratory and as a designated laboratory for several international organisations, we have to ensure and demonstrate that our work complies with a minimum technical standard and that it is in conformity with relevant guidelines and norms. This is the purpose of a so-called accreditation (from the Latin word *accredere* for “believe”). In an accreditation procedure, we have to prove to an accreditation body that we conduct our work in a competent manner, comply with the regulatory requirements, and work at a level that meets international standards. In Switzerland, it is the Schweizerische Akkreditierungsstelle (Swiss Accreditation Body – SAS) that reviews and certifies the competence and quality of laboratories, based on ISO norms (CASCO) and CEN/CENELEC norms. Administratively, the SAS is part of the State Secretariat of Economy (SECO). It does, however, make its decisions about accreditations independently.

The process of accreditation begins with a registration with the SAS. Following that, the scope of the accreditation will be determined, and the laboratory implements measures to comply with the respective norms. After a preliminary briefing, the SAS technical experts gain access to the laboratory to be evaluated. Technical competence, infrastructure and management systems of the candidate laboratory will be assessed on the basis of checklists. If all requirements are met, the assessors will submit an application to grant the accreditation, and the Swiss Federal Accreditation Commission will issue an opinion on this application. Each time an accreditation is granted, it remains valid for five years. After that period of time, a new assessment is necessary. Since the 1990s, the following testing facilities have been accredited at Spiez Laboratory:

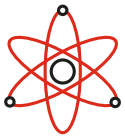
Accredited laboratories in Spiez



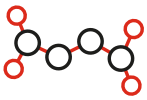
STS 0019 Testing laboratory for the analysis of samples of chemical warfare agents and related compounds (since 1993)



STS 0022 Testing laboratory for adsorbents and respiratory protection filters (since 1993)

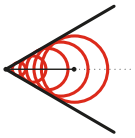


STS 0028 Testing laboratory for the determination of radionuclides and elemental analysis (since 1993)



STS 0036 Testing laboratory for Polymers and Rubber, and for the Protection Performance of Polymers, Rubber and Textiles against Chemical Warfare Agents (since 1993)

STS 0054 Testing laboratory for the detection of biological agents (since 1994)



STS 0055 Testing laboratory for NBC protection material, shelter equipment and shelter installations (since 1994).

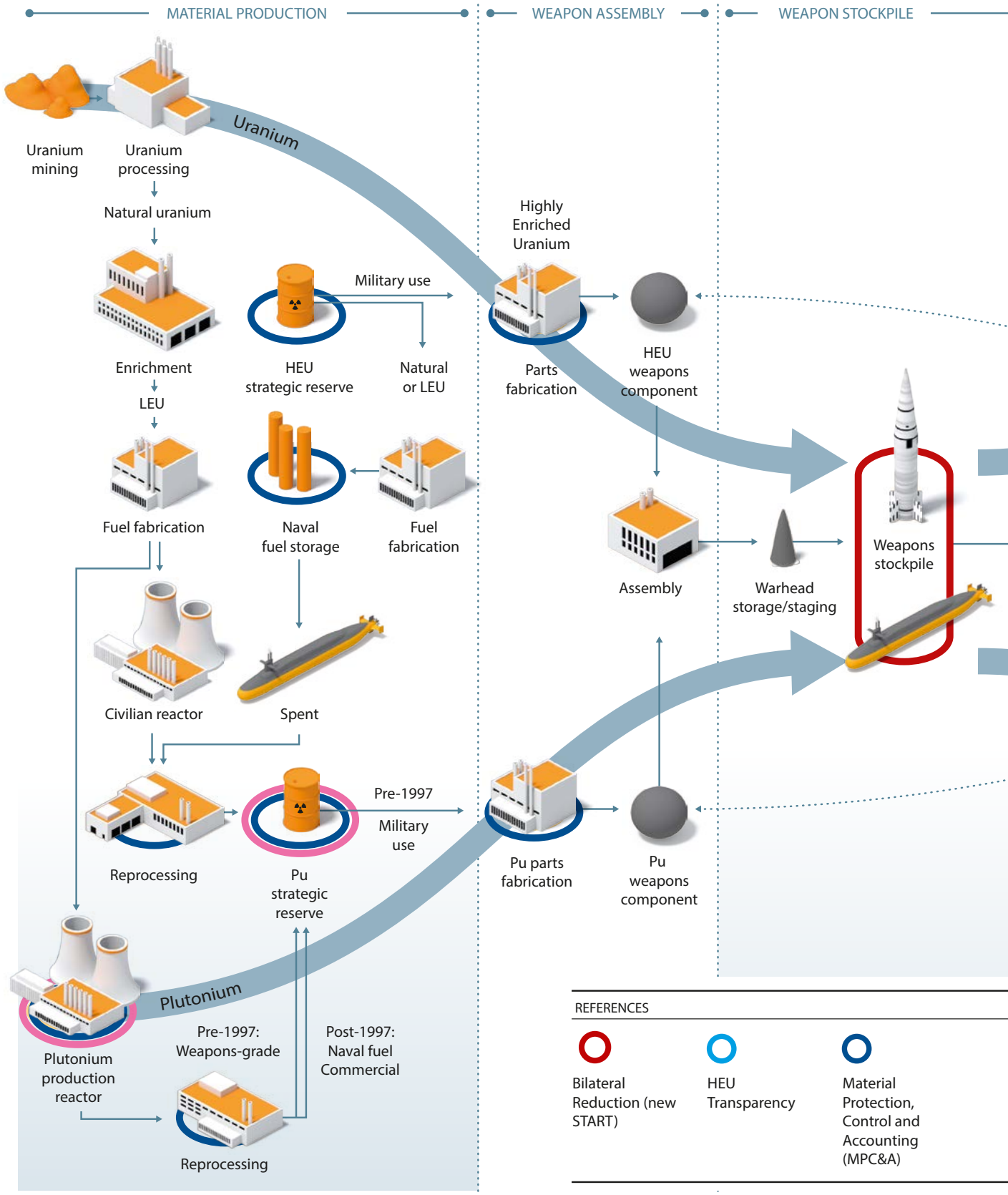
A US Air Force missile maintenance team removes the upper section of an intercontinental ballistic missile with a nuclear warhead in an undated USAF photo at Malmstrom Air Force Base, Montana.

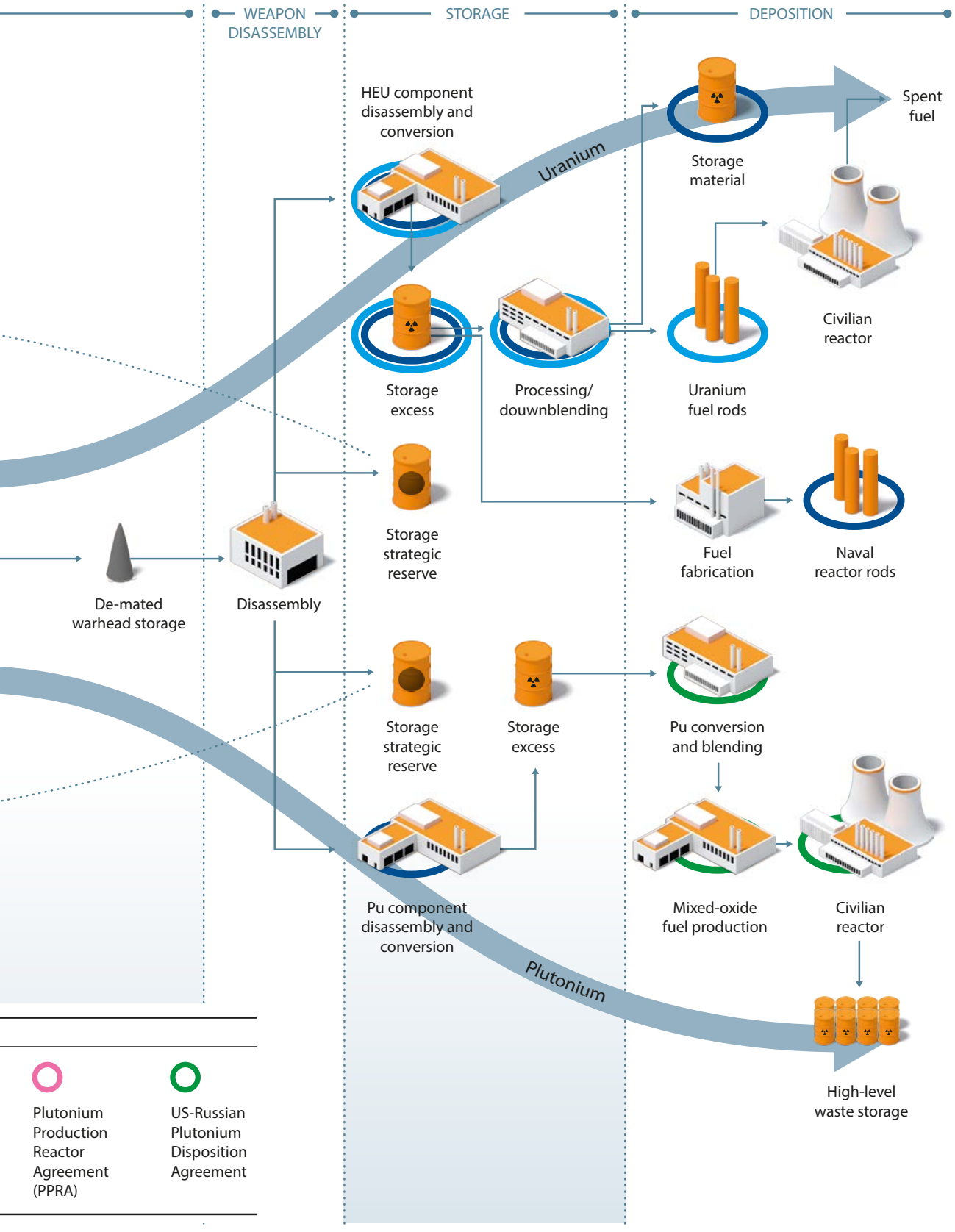
Nuclear Disarmament: Trust, but Verify

Verification is essential for every agreement about nuclear disarmament. But can this be achieved even in the field of sensitive nuclear weapons technology? This question is being investigated by an initiative launched in 2015 by Barack Obama – the International Partnership for Nuclear Disarmament Verification. This network researches techniques and procedures for the declaration and verified disarmament of nuclear weapons. Twenty-five States participate in the initiative, nuclear weapons states as well as non-nuclear weapons states, including Switzerland with Spiez Laboratory.

Today, attempts to discuss nuclear weapons disarmament may appear somewhat unrealistic. Pakistan and India continue to arm themselves, North Korea is developing intercontinental missiles. According to estimates of the Congressional Budget Office (CBO), the nuclear weapons forces of the US will create expenses in the order of just under 500 billion US dollars over the coming ten years. The United States have revoked the Iran Deal, and they have conveyed to Russia that they are terminating the Intermediate Range Nuclear Forces Treaty (INF Treaty). This notice of termination will take effect in August 2019, and the US consider their obligations under the treaty as already suspended, given Russian violations of the agreement. Additional diplomatic efforts to rescue the treaty are to be expected, but they will in all probability remain without success. Russia, in turn, considers a legally binding limitation of missile defense systems as a precondition for the continuation of nuclear weapons disarmament. The US, on the other hand, have consistently rejected that condition. The Missile Defense Review published in January 2019

Nuclear Weapons Lifecycle - Confidence Building through Cooperative Initiatives

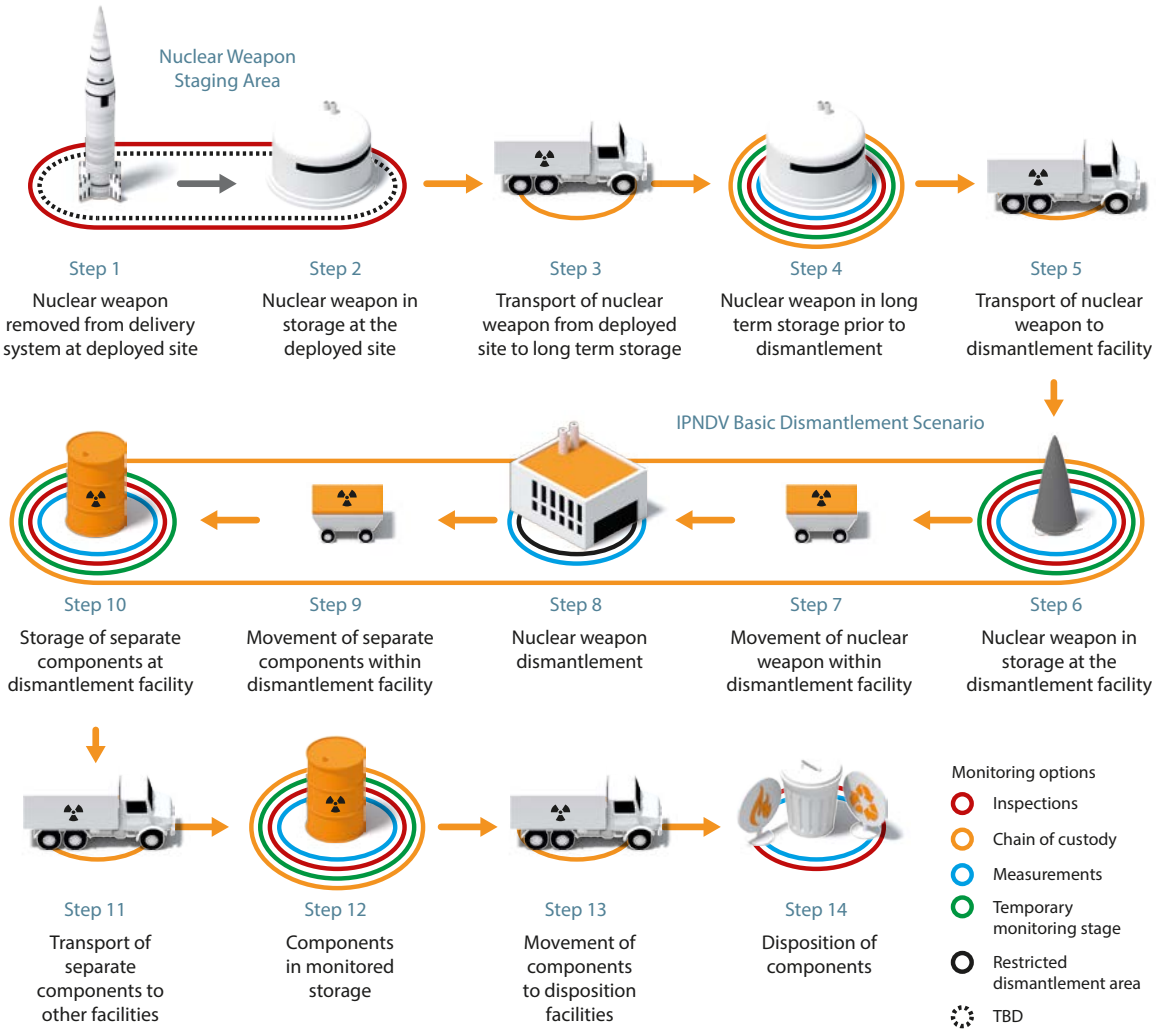




Source: US DOE, NNSA, Office of Nonproliferation Research and Engineering, Technology R&D for Arms Control, Spring 2001

Dismantling Nuclear Weapons

Monitoring and verification activities, as identified by the IPNDV, for key steps in the process of dismantling Nuclear Weapons



We make the assumption that there will be declarations at each step in the process.

continues to categorically exclude any legally binding limits on American defense systems. However, behind all these threatening postures, diplomats continue to meet and discuss disarmament.

A critical point in any agreement about nuclear disarmament will be the verification of whether the obligation to disarm has in practice been complied with. But there is a problem: No nuclear weapons power on earth wants to actually disclose how its nuclear warheads are designed. While, in the context of past agreements, the disarmament of the delivery systems has been verified, verification of the destruction of a nuclear warhead has never been undertaken. Yet, the destruction of the warheads is a key precondition for genuine disarmament. It is not enough to simply dismantle a warhead and break it up into its components. If that was all that was required, the weapons could easily be reassembled in a short time.

Such verification has to overcome high technical obstacles: one has to be certain that a warhead has indeed been destroyed or rendered unusable in an irreversible manner. At the same time, however, the State that is disarming does not want to provide unnecessary insight into sensitive areas. As non-nuclear weapons states too, are involved in the verification process, providing insights into the construction and function of a nuclear warhead would even contravene the Nuclear Nonproliferation Treaty.

In order to approach these challenges, verification methods are being developed in the framework of the IPNDV. In a first phase, the IPNDV has elaborated the conceptual requirements

for effective verification. To this end, the destruction of a nuclear warhead has been divided up into 14 steps, from the missile base to the final storage of the nuclear waste (see page 16). The disarmament must also ensure that Plutonium from the warheads will be removed from the fuel cycle and that it can no longer be used (see the overview of the nuclear fuel cycle on page 14).

At the end of 2017, the delegates of the IPNDV adopted the following interim summary for the first phase of the initiative: *"...potentially applicable technologies, information barriers, and inspection procedures provide a path forward that should make possible multilaterally monitored nuclear warhead dismantlement."* In other words, the excuse that disarmament cannot be verified will soon no longer hold. It has become clear that science and technology can support diplomacy in a significant manner.

The second phase of the initiative will continue until the end of 2019, ending just before the Review Conference of the Treaty on the Non-proliferation of Nuclear Weapons (NPT). Phase two builds on the findings of the first phase and will focus on the verification of declarations of nuclear weapons as well as certain selected verification technologies. To this end, the following working groups have been set up:

Verification of Nuclear Weapons Declarations
This is about how declarations of the number of nuclear weapons in a country can be verified. Earlier experiences such as from the START Treaty will be applied to create a framework for verification.

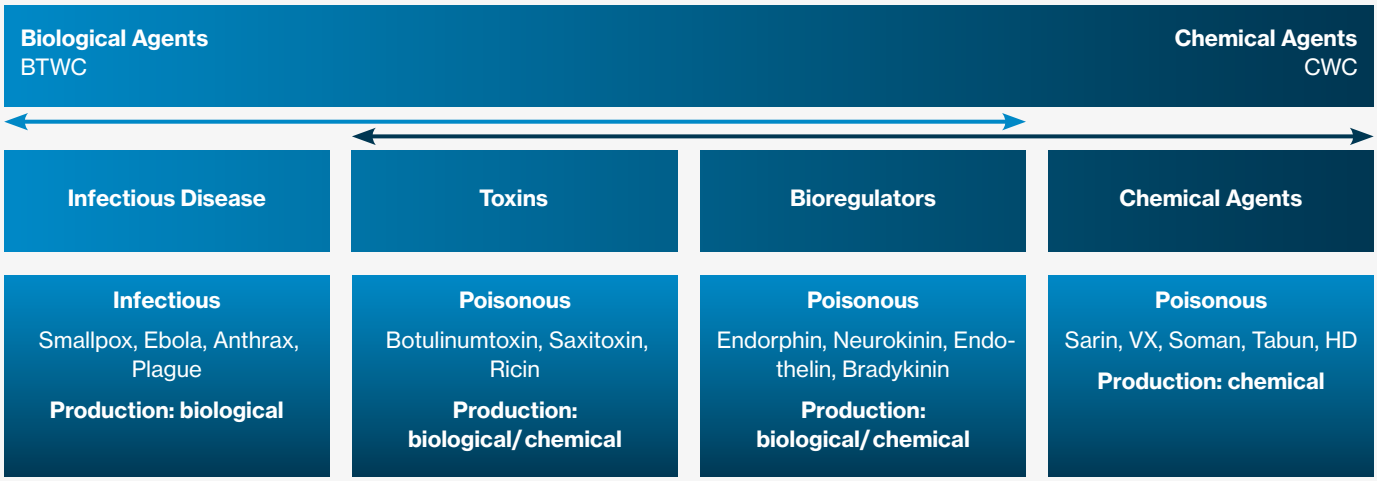
Verification of Reductions
This team deals with the verification of the reduction of the number of nuclear weapons. Proceeding from the dismantling scheme, which includes 14 steps, each individual step will be analysed in detail and developed further.

Verification Technologies
This group will focus on the further development of a limited number of verification technologies that are relevant for the other working groups. The dismantling scheme (page 16) will form the basis for the respective technologies and analytical methods.

Each working group will also organise practical verification exercises. The exercise of the working group "Verification Technologies", in which Spiez Laboratory is one of the participants, will take place in September 2019 at the Belgian Nuclear Research Centre. For this exercise, arrays of Mixed Oxide (MOX) rods will be assembled – fuel rods that contain Plutonium and Uranium. These MOX rods will be used to test methods and equipment for the measurement of fissile materials. This is to investigate how well one can distinguish between nuclear weapons materials and reactor materials, and how strong the interference of shielding materials will be with the instruments.

In this way, the work of the IPNDV is progressing largely unhampered by the current impasse in the disarmament process. It will be important to expand the IPNDV to include other countries, and to make more known. Just before the NPT Review Conference in the spring of 2020, Switzerland will organise an Outreach Meeting in Geneva. The objective will be to present the findings of the first two work phases to a wide group of interested parties (disarmament delegates, the media, students, Think Tanks, etc.).

Biological / Chemical Agents



Spiez CONVERGENCE 2018

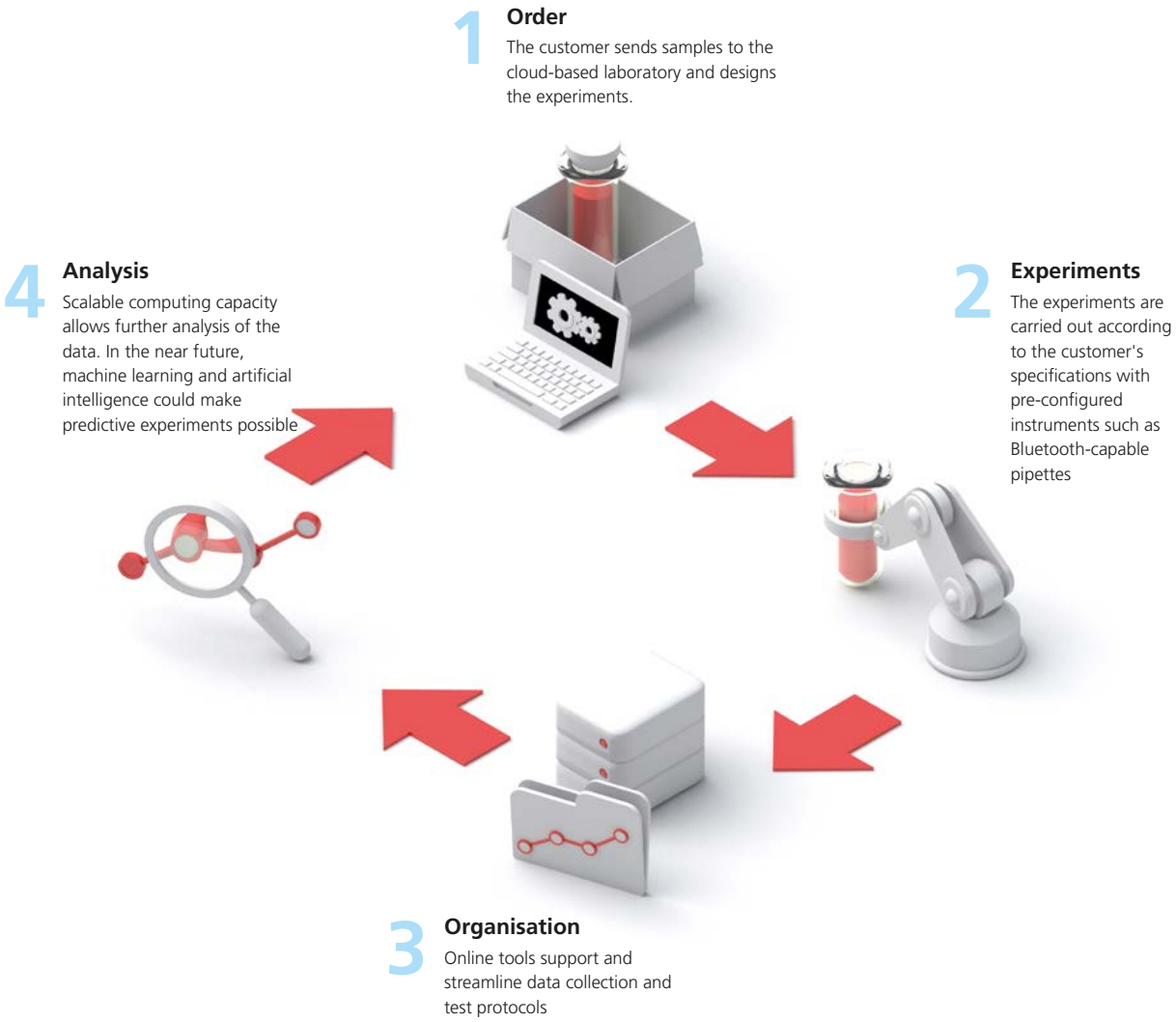
In 2014, the Spiez CONVERGENCE workshop series set out to identify advances in Science and Technology (S&T) that may pose a challenge to the regimes governing the prohibition of chemical and biological weapons. The focus of the series is on technological breakthroughs, or scientific game changers that may affect our understanding and perception of such weapons. Spiez CONVERGENCE 2018 was the third workshop to review developments in S&T at the crossroads of chemistry and biology with specialists from academia, the chemical and biotech industries, and the arms control and security community.

The past two editions covered a wide range of subjects and some of these were addressed again this year because of their continued relevance. Revisiting particular subjects leads to a deeper understanding of their state of maturity. On the one hand it shows how fast progress is made, on the other hand it uncovers that not all S&T promises may become reality. By revisiting earlier assessments, better predictions for the short or medium term period can be made. For this annual report, we focus on the developments in the fields of Synthetic Biology, Nanomaterials and Additive Manufacturing.

Synthetic Biology

Today, industry manufactures a number of complex biomolecules using Synthetic Biology. Complex *in vitro* designs are attractive as they provide access to interesting products while expanding the space of biotechnology. For example, a practical application of synthetic and systems biology is the development of rapid diagnostic tests for the emergence of antibiotic resistance in bacteria. But despite the progress made, there remain limitations to the engineering of biological systems. In this context, the introduction of so-called cloud laboratories

Cloudbased laboratories coordinate scientific processes, instruments and robotics and connect all necessary components of a project via the internet – from research protocols and pipettes to data storage. Instead of buying a server farm, researchers can send their data to the cloud and request exactly the resources they need. This reduces the requirements for investment and enables cooperation on a global level in real-time. Today, the cloud is typically used for certain technologies such as next-generation sequencing or mass spectrometry. However, the emergence of cloud laboratories in synthetic biology also raises questions: It must be ensured that customers of these labs do not misuse these opportunities for malicious purposes.



for synthetic biology promises to increase the speed of synthesis and agent characterisation because they provide a reproducible environment using standardised protocols. These fully robotic, modular cloud laboratories allow users to interact through computing devices with remote laboratory modules. In the past, global collaborations have evolved around the sharing of data, whilst the laboratory environment itself has changed little. Today, cloud laboratories are an indicator of a new form of collaboration in cyberspace, for wet chemical / biological experimentation. However, the emergence of cloud laboratories in synthetic biology also raises questions about how to ensure that users do not misuse the technology for malevolent purposes. In addition, such laboratories themselves could become targets of remote attacks. The industry is actively addressing these problems, and applies customer-screening protocols, screens molecular structures, implements reagent access controls, and relies on trusted user networks and firewalls. This mirrors approaches taken by companies that provide DNA synthesis services

Nanomaterials

In the discussion on nanomaterials during Spiez CONVERGENCE 2016, DNA origami was characterised as early-stage exploratory research. Today, first experiments with DNA objects as cancer therapeutics are being conducted in laboratory animals. Triangular DNA origami structures can be stacked to form capsid-like structures up to 200 nm in diameter. They are rigid and could be developed as tar-

geted drug delivery vehicles. The stability of DNA origami structures *in vivo* however remains problematic and practical applications in medicine or industry would require mass production, for which manufacturing costs will have to be reduced. This requires economising the manufacturing of the staple strands. These are manufactured today by solid-state synthesis, at a price of around € 200 000 per gram DNA origami.

A wide range of chemotherapeutics, cancer treatments, nucleic acids, proteins, and other biomolecules use different types of graphene oxides (GO) for their application and delivery. GO are two-dimensional nano-scale carbon structures. Different derivatives of GO are of particular interest as they are biocompatible, easy to functionalise, suitable as efficient drug loading structures, scalable, and inexpensive. Biological effects as well as toxicity of GO nanoparticles depend on their particle size, oxidation groups, and functionalisation as well as the type of cell. In a CBW context, it is possible that such nanoparticles could be delivered as aerosols and inhaled into the lungs for uptake through the blood brain barrier. They may therefore be suitable for the targeted delivery of high amounts of toxins or bioregulators.

Additive Manufacturing

Additive Manufacturing (AM) has been a topic at all three workshops since 2014 and the industry continues to grow rapidly. AM gives the end user the control over the product design and has the ability to disrupt conventional supply chains. Of particular interest in the context of CBW arms control are AM processes to build 3D objects that can withstand high temperature, pressure steam sterilisation, or highly corrosive chemicals. Today, only industrial AM systems are able to produce such high-quality parts to a standard that can compete with other current industrial processes. Such industrial systems require professional knowledge and technical competence. It is unlikely that 3D printers capable of manufacturing corrosion resistant parts or equipment would be available to individuals or consumers soon. Over the next 5 years the list of printable materials is likely to grow significantly and AM is expected to be adopted across multiple industries as well as enter into education. Regulatory standards for 3D printing and processing will have to be developed.

Policy Discussions

Spiez CONVERGENCE always closes with a policy discussion about the impact that advances in S&T may have on the treaties and regimes related to CBW. For instance, the introduction of cloud laboratories for synthetic biology centralises laboratory work and separates the scientists from the actual laboratory experiment. As a result of this, the role of the end-user or actors in the process is changing and access to data as well as intangible transfers are becoming more relevant from a regulatory and control perspective. These changes would also affect potential CBW programmes. Novel CBW production facilities would have a smaller footprint and different technological features compared to what is known from past state programmes. In the case of non-state actors attempting to acquire CBW capabilities, such attempts are likely to remain opportunistic and constraints continue to exist regarding access to critical materials and equipment, methods for effective dissemination of agents and programme related costs. For a state actor it is difficult to assess how new materials and methods discussed in this workshop would fit into a contemporary CBW programme. Such an assessment would have to differentiate between CB weapons developed as WMD and those developed for small-scale purposes such as sabotage or assassinations. The question that must be asked in this context is: are implementation systems adopted by the States Parties of the two Conventions as well as national export control measures still effective in the changing environment? Many of the S&T advances call for multi-stakeholder approaches between the research community, industry, and National Authorities to develop partnerships and governance systems. Our evaluations may have a short and a longer-term perspective: e.g., 3D printers that use polyfluorinated polymers that could undermine export controls require a swift response to manage emerging risks, whereas the use of cloud services in chemical and biological manufacturing may affect implementation over time.

Group photo of the fourth Swiss UNSGM Designated Laboratories Workshop in Spiez.

A Network of Trusted Laboratories Serving the United Nations

In order to investigate the alleged use of biological and toxin weapons, States are required to notify the UN Secretary-General Mechanism (UNSGM) of appropriate laboratories to support the investigations. In September 2018, we organised the fourth Swiss UNSGM-workshop in Spiez in order to establish a functioning network of trustworthy institutions with these laboratories. The initiative connects to the UN Secretary-General's disarmament agenda, which asks for adequate preparations to respond to any credible allegation of use of biological weapons.

The outcomes from previous workshops confirmed the desirability of developing a collaborative network of UNSGM designated laboratories that provides transparency and confidence in scientific competence, analytical skills, and quality assurance systems. Recent efforts have moved from conceptualisation and general discussions of benefits and requirements, to practical steps, most notably in the form of dedicated confidence building and quality assurance exercises.

In this year's issue of the workshop series, participants reviewed a number of recently conducted exercises, discussed the multi- faceted interface between the investigation team and designated laboratories, and explored additional elements for quality assured laboratory evidence.

The laboratory exercises organised by Germany provide a framework for self- evaluation and im-

The UNSGM mechanism is based on UN Security Council Resolution 620 of 26 August 1988, which was adopted unanimously against the background of the use of chemical weapons in the first Gulf War between Iraq and Iran.

"The Security Council (...) profoundly concerned by the danger of possible use of chemical weapons in the future (...) decides to consider immediately, taking into account the investigations of the Secretary-General, appropriate and effective measures in accordance with the Charter of the United Nations, should there be any future use of chemical weapons in violation of international law, wherever and by whomever committed.

provement for participating laboratories. Twelve laboratories from ten Member States took part in a pilot exercise in which all participants were able to correctly identify the biological agent at the subspecies level. Additional tasks, aimed at characterisation of the biological agent, resulted in a more nuanced picture of capabilities of participating laboratories, especially when it pertained to whether evidence would hint at an outbreak of natural or deliberate origin.

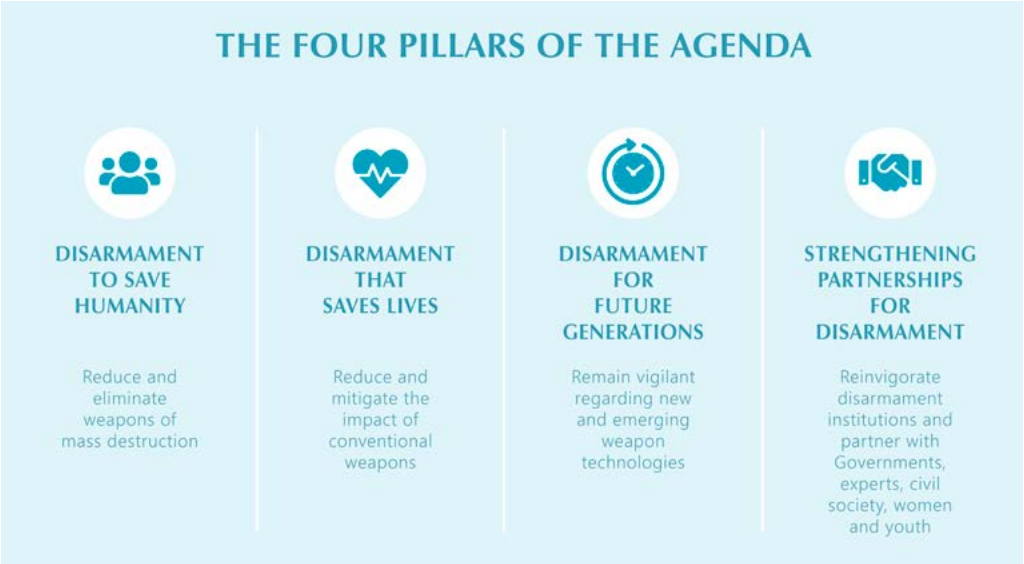
The workshop suggested a number of improvements for future exercises and identified a range of issues that merit further discussion. This included broader geographical participation, recommendations for operating procedures, development of scenarios, sample transfers, chain of custody documentation, specialisation of laboratories, report writing, and data protection. Since some of these aspects are mission critical, a robust system needs to be developed step-by-step, while sensitising political actors and regulators to the importance of addressing these matters.

A range of notable benefits for participating laboratories was also identified, such as promotion of global collaborations, and the opportunity to benchmark capabilities. Further exercises are planned for the coming years with increasing levels of difficulty, progressing towards in-depth sample analysis that will move well beyond 'every-day' clinical diagnostics. These exercises would provide the UNSG, assisted by expert consultants, with an evidence-based data set for selecting bio-analytical laboratories possessing accurate capabilities for specific scenarios. In that sense, Member States are encouraged to nominate experts from their roster laboratories as consultants to the UNSGM.

Denmark in collaboration with Sweden started a project to strengthen UNSGM capabilities in the bio-analytical field through confidence building exercises aimed at specific detection and characterisation of a bio- logical agent and its associated genetic markers using genome analysis. Results from the 60 participants showed that apart from Africa and South America, the capabilities are wide-spread in geographical and sector-wise terms. Therefore, several candidates may bear the potential to significantly expand the current roster of UNSGM bio-analytical laboratories.

The Organisation for the Prohibition of Chemical Weapons (OPCW) has already completed two toxin exercises. The second confidence building exercise included samples containing Ricin and Abrin, and used a scoring system for evaluating performance. Results obtained from 21 participating laboratories from 18 Member States indicated that good progress has been made since the first OPCW toxin exercise. Nevertheless, there are areas for improvement, since some participating laboratories reported a number of false positives and false negatives. Continued efforts in the field of toxins remain important; as current thinking is that an investigation involving a toxin would be deferred from the UNSGM to the OPCW and its Designated Laboratories.

Previous workshops already identified the interface between the investigation team and laboratories as an important element requiring further in-depth discussions. Participants recognised that UNSGM missions need to have intrinsic laboratory expertise to ensure that the investigation team clearly understands the laboratories' capabilities and sample submission criteria. All processes involved in sample analysis, from sample collection to reporting, must be robust so they can withstand political and legal scrutiny. Therefore, an analysis must follow forensic principles, such as strictly observ-



The UNSGM workshops connect to the UN Secretary-General's disarmament agenda which is divided into four pillars.

ing the chain of custody and ensuring sample identity.

This thinking lends support to the concept of using a hub laboratory as a direct link to the mission. To be able to fulfil such a coordination role, a hub laboratory needs to be impartial and nominated to the UNSGM roster, and it should meet agreed technical criteria. Since the context determines the concrete functions a hub lab will perform, it is important to remain flexible in terms of approach. Ultimately, it will be up to the Head of Mission to make any decisions on how a hub laboratory should support a mission structure.

Furthermore, workshop participants took a broader look at the issue of how the laboratory capability of the UNSGM has been evolving, and where more action is needed. Efforts have to be redoubled in attracting additional laboratories to broaden the geographical participation, and the network's performance needs to be tested on a regular basis through exercises. Member States that have taken on an active role in developing the laboratory capacity of the UNSGM need to work with other Member States to broaden political support for more transparency, share information on the laboratories they have nominated to the UNSGM roster, and encourage interaction between these laboratories.

There is significant common ground on what is required to strengthen the operational capacity of the UNSGM with regard to bioanalytical laboratories. Further developing a laboratory network through exercises and exchanges comes with significant benefits to Member States and their laboratories participating in such a process. This includes both intellectual growth and capacity development. Current awareness and general support for further development of the network must now be turned into commitments for sustained funding. Broader political engagement in support of this action would be one way to achieve this.

We are committed to support this bottom-up approach of roster laboratories and to engage in further developing common understandings for a laboratory network. We will therefore continue to provide a dedicated workshop platform for the sharing of results and experiences as well as to circulate new ideas and plans among the laboratories.

The fifth Swiss UNSGM Designated Laboratories Workshop is planned for 11–13 September 2019.

Oilfields burned by Islamic State fighters in Qayyara south of Mosul, Iraq.

International Missions 2018

In 2018, we again took part in international activities for the benefit of the environment and health, in the context of international missions of the UN Environmental Programme as well as the International Atomic Energy Agency – on the Marshall Islands, in Jordan, Thailand, Uruguay and Iraq.

Our work in the field of NBC protection requires a wide range of technical knowledge that can also be utilised in other areas. In the sense of a cross-sectional task and as a synergistic service, we also use our know-how for analytical investigations in the framework of international environmental missions. In such cases we cover the costs for our personnel. Expenses for travel, accommodation and security are covered by the International Organisations involved. We profit from these engagements, as we cannot gather these kinds of field and laboratory experiences with conventional exercise scenarios in our own country. In this way, our missions abroad also benefit the protection of the population in Switzerland.

UNEP Mission in Iraq

Iraq was already struggling with the toxic remnants of previous wars before the conflict with the Islamic State (ISIS). The Iraqi government had set up a monitoring system for environmental pollution and for other problems such as water shortage. The UN Environmental Programme (UNEP) has been contributing to the strengthening of the environmental regulations

Massive environmental pollution as a result of the war in al-Qayyara south of Mosul, on the western bank of the river Tigris. In August 2016, the town was liberated from the Islamic State and later served as a base for the storming of the Iraqi city of Mosul.

and has helped the authorities with setting up capabilities for remediation work. However, after the Islamic State occupied large areas of Northern Iraq, these efforts came to a standstill. Even worse, the scorched earth tactics the Islamists applied during their rule over large parts of Iraq and during their retreat had devastating effects. Dozens of oil wells were burning for months, and the conflict left behind polluted water sources, millions of tonnes of debris and rubble, as well as poisonous waste from industrial facilities and oil refineries. Until today, the Iraqi authorities have neither the personnel nor the technical and financial means to tackle these problems by themselves.

In order to support the Iraqi authorities, the UN Environmental Programme organised a three-day workshop in Bagdad to provide an overview of *Best Practices* in the evaluation of environmental pollution. Fourty staff members from the Iraqi Ministry of Health and the Environment and other partner ministries participated in the workshop. In addition to UNEP staff, the team of instructors also included environmental experts from Canada and Australia as well as two representatives from Spiez Laboratory.

The workshop instructed Iraqi specialists in methods for the investigation of contaminated sites. The focus was on the strategies for correct sample collection, because the impact of sample collection on subsequent decision-making is often underestimated. Even the very best laboratory cannot correct mistakes that were made during sample acquisition. For environmental analytical investigations in particular, conclusions that are based on sample collection are of paramount importance for subsequent decisions, and sampling errors can potentially have serious consequences. As a rule, the source of a wrong decision is often related to the sample collection rather than the subsequent analysis at the laboratory.

During post-conflict reconstruction work, the fight against environmental damage and public health risks often has to compete against other urgent humanitarian issues, even though reasonably intact environmental conditions are a requirement for socio-economic development. In the near future, the international community will have to provide significant technical and financial means to support the identification and remediation of the most urgent environmental hot spots in Iraq. Unfortunately, the financial aspects are anything but clear: Non-governmental armed groups or terrorists such as ISIS are not going to pay for this. So who will fund the remediation of the environmental pollution? On 6 December 2017, the third UN Environ-

Collecting soil samples during a practical exercise on Laura island in the western part of the Majuro atoll.

ment Assembly passed a resolution submitted by Iraq on "Pollution prevention and control in areas affected by terrorist operations and armed conflicts". This resolution calls for International Organisations to assist with the identification, monitoring and clean-up of toxic remnants of armed conflicts. This resolution is non-binding. Although long-term financing poses a challenge, efficient measures for the remediation of environmental problems during the reconstruction after armed conflicts should bring cost benefits for the international community in the long run.

IAEA Mission to the Marshall Islands

The Marshall Islands are a small island group in the middle of the Pacific. After the Second World War and until 1986, they were a trust territory of the United States. For years, the US used the region as a nuclear proving ground. Between 1946 and 1958, 67 atomic and hydrogen bombs were detonated on the atolls of Eniwetok and Bikini. This resulted in thousands of cubic meters of radioactive waste. On the small island of Runit belonging to the Eniwetok atoll, where 14 of 43 bombs were detonated, contractors and US military personnel removed the contaminated soil, mixed the radioactive material with cement, and poured it into the nearly 100-meter-wide crater that had been formed in 1958 by the drop of an 18-kilotonne bomb onto the island. The crater was sealed with a concrete dome. Material that did not fit into the crater was dumped into the lagoon; a prohibition for the dumping of nuclear waste only applied to the open sea.

Today, the dome is showing cracks. There is a concern that tropical cyclones or tidal storms might loosen the concrete plates, or flood the area directly around the dome. On average, the Marshall Islands lie only about 2 meters above sea level. There are just a few meters of land between the lagoon and the cupola. On the other side of the island, all that separates the construction from the sea is a wall of piled-up stones.

By now, bits of sediment from the lagoon are reaching the open sea. Traces of the plutonium released can be detected as far away as the

The Runit Dome: On the island Runit, one of about 40 islands of the Eniwetok atoll, a nuclear weapons test formed a crater with a diameter of more than 100 m. The crater was later filled with more than 100 000 cubic meters of plutonium-containing soil from other parts of the atoll and covered with a cement dome.

South China Sea.[1] Although the range of monitoring devices installed on site do not show any leaks in the concrete dome, it is possible that over time, seawater will seep into the cupola from the underside. Were the dome to break through, larger amounts of radioactive materials could spill into the surrounding waters. Only exact measurements can provide a basis for a reliable estimation of the risk for the local population.

Because of the concerns of the local population with regard to possible radioactive contamination – not only on Runit but also on other islands – the government with the support of the IAEA has launched a project for radioactivity monitoring on site. Within this project, a staff member from our Nuclear Chemistry Division provided training to several members of the local environmental protection authority. The two-week course covered the basics of collection and preparation of environmental samples for radioactivity analysis. The samples were analysed by several laboratories worldwide, including Spiez Laboratory. There are also plans in the future to train selected candidates from the Marshall Islands in Spiez, in order to reinforce the knowledge imparted on site.

1 Isotopic Composition and Distribution of Plutonium in Northern South China Sea Sediments Revealed Continuous Release and Transport of Pu from the Marshall Islands Article in *Environmental Science & Technology* 48(6)

Publications and Reports

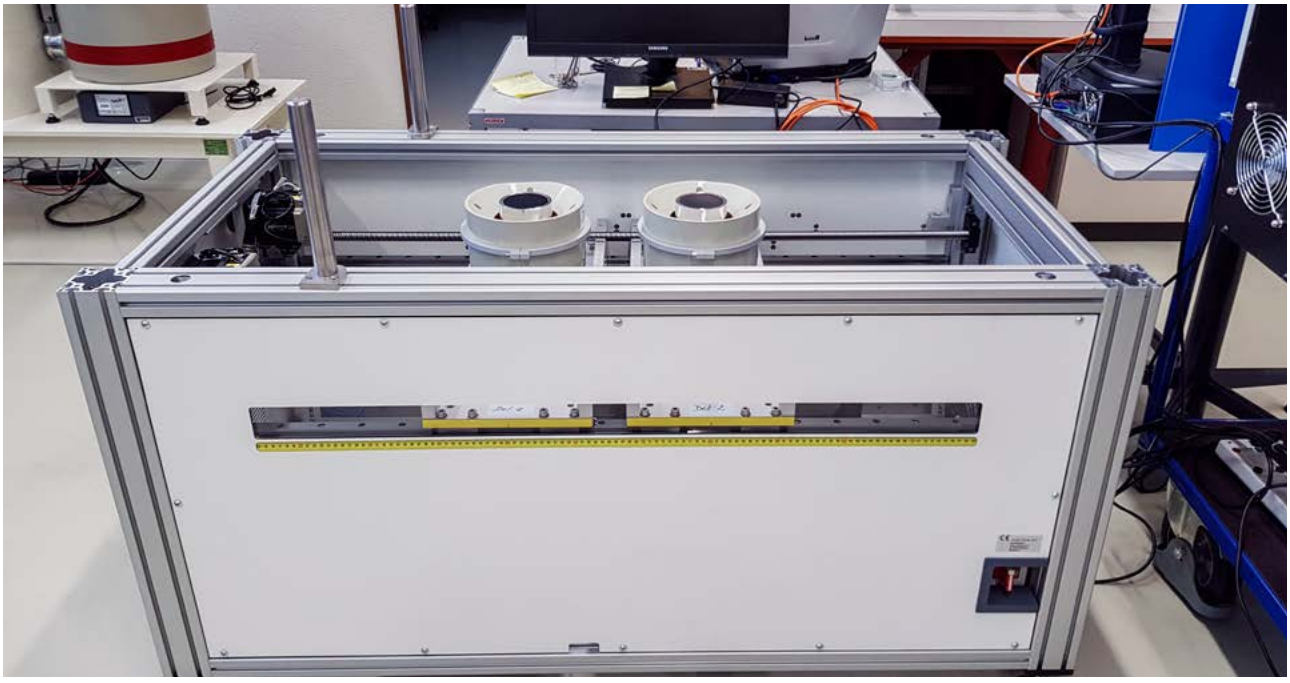
Nuclear Chemistry Division

Althaus Rolf
Radioactivity measurements in the former ammunitions depot Mitholz and its surroundings
LS 2018-10

On 19 and 27 November 2018, the Radioactivity Branch of Spiez Laboratory conducted dose rate measurements at the former ammunitions depot Mitholz and its immediate surroundings. These measurements were safety measures to ensure that the depot did not contain any radioactive materials of non-natural origin. The measurement results showed that the radiation load within the facility was significantly lower than at the surface. This can be explained by the shielding of cosmic radiation by rock. The highly sensitive measurements did not show any indications that radioactive material had resulted in a contamination of the Mitholz facility or its vicinity. All measurements showed merely the natural radioactive background for the facility and its surroundings.

Mosimann Nina
Validierung der gammaspektrometrischen Personenmessung mit einem Ganzkörperzähler
LN 2018-01 SNIN

According to experts for dosimetry from the Swiss Federal Commission for Radiation Protection and Radioactivity Monitoring (KSR), it is desirable to establish three whole-body measuring centres in Switzerland for the measurement of the incorporation of radioactive nuclides (internal radiation). Today, however, only two of these measuring centres have actually been set up (one at the Paul-Scherrer-Institute, the other one at the University Hospital in Geneva). Now, a third whole-body measuring centre will be established in Spiez. In addition to normal cases, this centre must also be equipped to manage the measurement of larger numbers of individuals in an emergency. In the context of this project, the Nuclear Chemistry Division is validating the measurement of persons with a whole-body counter that is composed of two positionable Germanium detectors arranged in a bed geometry, combined with the software package Apex InVivo from Canberra. An annual round robin test conducted by the German Federal Office for Radiation Protection verifies its accuracy. The round robin tests conducted so far, have shown that the acceptance criteria under the German Regulation for Physical Radiation Protection Control for the determination of the whole-body dose have been met.



Whole-body counter with two positionable Germanium detectors.

Von Gunten Cédric
Bestimmung der Probenahme-Unsicherheit von Wasser-, Gras- und Bodenproben in der Prüfstelle STS 0028
LS 2019-01 VGCE

The Inorganic Analysis Branch combines expertise in sample collection with laboratory analysis. Sample collection is among one of the most important preconditions for accurate analysis. If samples are not collected correctly in an area of large inhomogeneity with regard to composition and distribution, the analytical results of even the best of laboratories will carry a high degree of uncertainty of up to several hundred per cent. The Inorganic Analysis Branch has successfully determined the measurement uncertainties for soil, grass and water samples. Depending on the matrix and the element to be measured, this uncertainty can range from 15 to 300% (P=95%). Some of the uncertainties that exceeded 300% turned out far bigger than expected. The upper limit for the so-called Global Estimation Error is 35% maximum (P=68%). After a more detailed scrutiny of the types of error involved, and taking into account the large inhomogeneity of the soil samples concerned, the underlying problems have been clarified. This insight can now be taken into account for future sample collections. By taking account of the Theory of Sampling as well as the knowledge about the relevant errors and error reductions, the sample collection method can remain in use as a validated method and is in accordance with the new ISO 17025:2018 standard.

Sample collection in a settling pond. We are regularly brought in by armasuisse to ensure compliance with the Environmental Protection Law. The knowledge about how the collection of samples influences analysis is in high demand, in particular in an international context such the UN Environmental Programme or the work of the Swiss Corps for Humanitarian Assistance (SKH).

Wirz Christoph, Astner Markus
Dosis herrührend von Neutronen
LN 2018-01 WIC

In order to locate a neutron source during a “Nuclear Forensics” mission, the most sensitive neutron probe available at Spiez Laboratory will be deployed. This probe, however, does not measure the dose rate, but instead impulses per second. Nuclide specific conversion factors were determined, and on this basis, alert thresholds were defined, so that mission members are alerted on time when the neutron radiation exceeds an established risk level.

Carnero-Bravoa Vladislav, Sanchez-Cabeza Joan-Albert, Ruiz-Fernández Ana Carolina, Merino-Ibarrad Martín, Corcho-Alvarado José Antonio, Sahli Hans, Hélief Jean-François Preda Michel, Zavala-Hidalgo Jorge
Sea level rise sedimentary record and organic carbon fluxes in a low-lying tropical coastal ecosystem
Catena, Vol 162 (2018): 421-430

Meyzonnat Guillaume, Barbecot Florent, Corcho-Alvarado José A., Tognelli Antoine, Zeyen Hermann, Mattei Alexandra, McCormack Renald
High-Resolution Wellbore Temperature Logging Combined with a Borehole-Scale Heat Budget: Conceptual and Analytical Approaches to Characterize Hydraulically Active Fractures and Groundwater Origin
Geofluids, Vol. 2018, Article ID 9461214
https://doi.org/10.1155/2018/9461214

Mosimann Nina
Berechnung der Nachweisgrenze für Gammamessungen nach Currie
LN 2018-02 SNIN

Ossola Jasmin
Validierung des Rotors 41HVT56 für das Mikrowellenaufschlusssystem Multiwave PRO von Anton Paar
LN 2018-01 OSJA

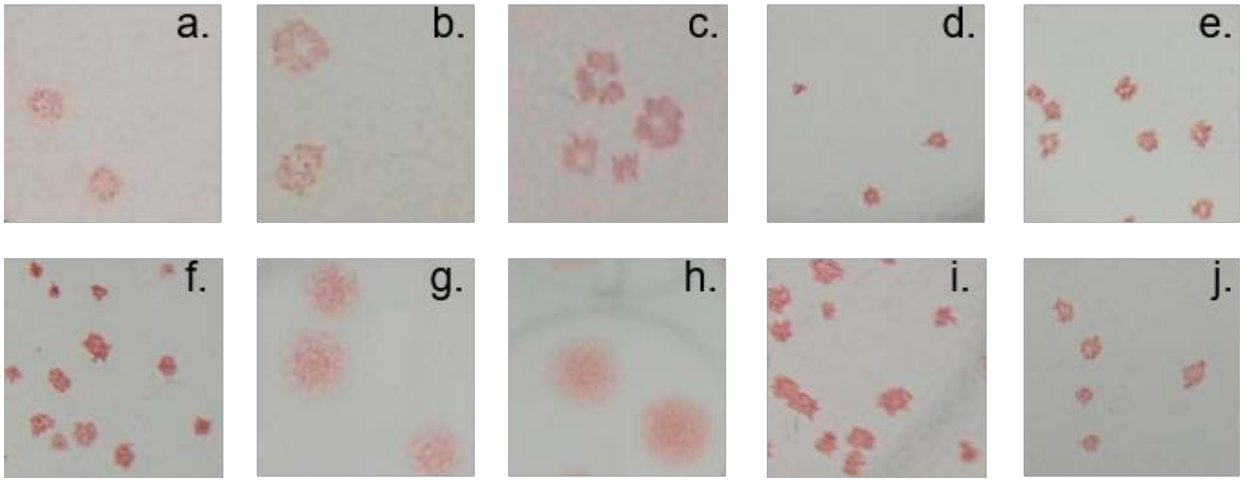
Von Gunten Cédric
Validierung des Mikrowellentotalaufschlusses für Grasproben
LN 2018-01 VGCE

Von Gunten Cédric
NexION 300D Neue Standardvorlagen
LN 2018-02 VGCE

Biology Division

Ackermann Rahel, Siegrist Denise, Züst Roland, Signer Johanna, Lenz Nicole, Engler Olivier
Standardized focus assay protocol for biosafety level four viruses
Journal of Virological Methods 2019 Feb; 264:51-54 (Epub 2018 Dec 1).
https://doi.org/10.1016/j.jviromet.2018.12.002

Laboratory work at biosafety level 4 is complex and time consuming. Therefore, the protocols used should be as consistent as possible, simple to implement, and easy to read. This report describes the use of a widely applicable method for the quantification of highly pathogenic viruses in cell cultures. With this method, it is possible to assess the effectiveness of vaccines as well as medicines in a simple and standardised manner. All required reagents including the primary and secondary antibodies are freely available on the market. This facilitates the transfer of the protocol to other laboratories. The work is a good example for a successful methods development at Spiez Laboratory, based on close and interdisciplinary collaboration.



Virus isolates tested; the width of each image corresponds to 5 mm. a) Crimean-Congo hemorrhagic fever virus Afg09-2990; b) Lassa virus Josiah; c) Lassa virus Lib05-1580/121; d) Marburg virus Leiden; e) Marburg virus Musoke; f) Marburg virus Popp; g) tick borne encephalitis far-eastern subtype Moskva; h) tick borne encephalitis virus Siberian subtype Vasilchenko; i) Zaire Ebola virus Gueckedou-C07; j) Zaire Ebola virus Mayinga-76

van der Hoeka Lia, Verschoor Ernst, Beer Martin, Höper Dirk, Wernike Kerstin, van Ranst Marc, Matthijnssens Jelle, Maes Piet, Sastre Patricia, Rueda Paloma, Drexler Jan Felix, Barr John, Edwards Thomas, Millner Paul, Vermeij Paul, de Groof Ad, Thiel Volker, Dijkmani Ronald, Suter-Riniker Franziska, Leib Stephen, Koller Roger, Ramette Alban, Engler Olivier, Beuret Christian

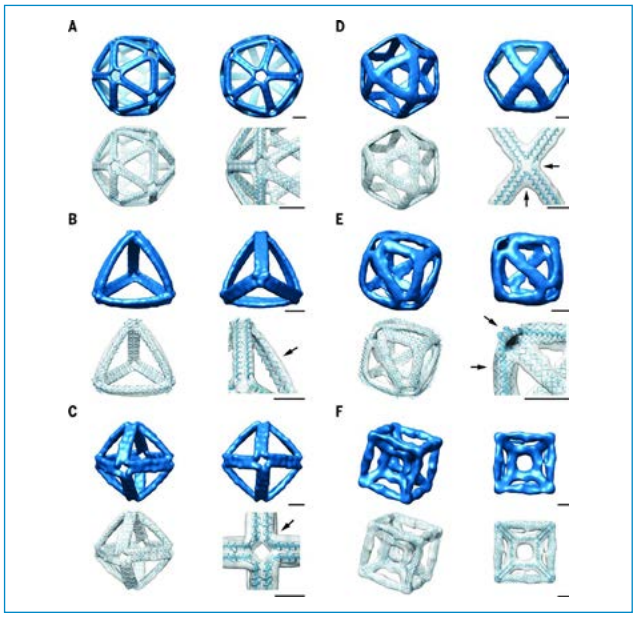
Host switching pathogens, infectious outbreaks and zoonosis: A Marie Skłodowska-Curie innovative training network (HONOURs)

Virus Research 2018 Sep 15; 257:120-124.
https://doi.org/10.1016/j.virusres.2018.09.002

HONOURs is a training network of the Marie-Skłodowska-Curie-Actions (MSCA, Horizon 2020) that deals with host-shifting pathogens, outbreaks of infectious diseases, and zoonoses. The goal of HONOURs is to train 15 early stage researchers in all areas of disease outbreak. The consortium includes 10 high-class universities, research institutions and enterprises, and the coordination is performed by the Academic Medical Center of Amsterdam University. The partners are located in Belgium, Germany, the Netherlands, Spain, Switzerland and the United Kingdom.

PhD student Joyce Odeke Akello is registered as an early stage researcher at the Graduate School for Cellular and Biomedical Sciences (GCB) at the University of Bern. She conducts 70% of her research at the IFIK Bern, and 30% at Spiez Laboratory. Her doctoral thesis covers the development of analytical methods for the identification and characterisation of new and emerging viruses in clinical and environmental samples. At both institutions, next (third) generation sequencing methods (nanopores) are being optimised to study both the molecular epidemiology of human Adeno viruses in Switzerland, and the vector-transmitted pathogens from ticks, mosquitos and rodents.

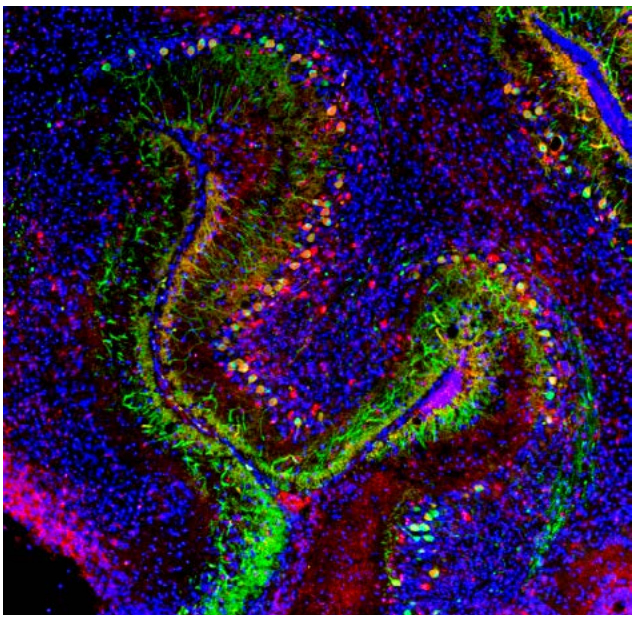
Lentzos Filippa, Invernizzi Cédric
DNA origami: Unfolding risk?
Bulletin of the Atomic Scientists, Analysis 2018, Jan 25



DNA is a unique building material because it can store information, is well defined and flexible, and it can be folded. The field of biotechnological research known as DNA origami folds DNA into forms that can implement particular mechanical functions or biological interactions. As of today, the technology had not advanced very far, but it already shows promising results in the fields of drug delivery, antibody production, and electronics. Potentially harmful effects or the misuse of this technology should be discussed at an early stage: would it be possible to program nano robots to release harmful substances in the human body? Could the building blocks of life be converted into destructive swarms of double helix which to wreak havoc at the cellular level?

Three-dimensional structural characterisation of DNA origami nanoparticles (Bild: Science 24 Jun 2016: Vol. 352, Issue 6293, pp. 1534)

Lenz Nicole, Engler Olivier, Grandgirard Denis, Leib Stephen L., Ackermann Rahel
Evaluation of antivirals against tick-borne encephalitis virus in organotypic brain slices of rat cerebellum
PLoS One 2018 Oct 9;13(10):e0205294 (eCollection 2018).
https://doi.org/10.1371/journal.pone.0205294

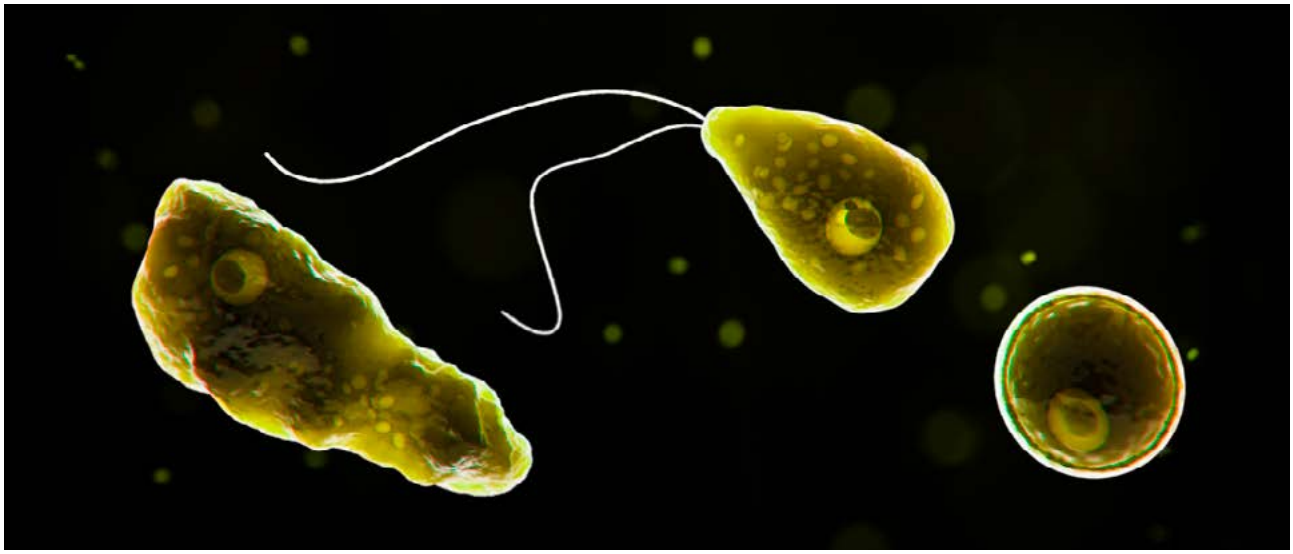


Antiviral treatments are usually evaluated first in cell culture and with appropriate candidates in animal test models – often causing severe strain to the animal. The manufacturing of organ-typical tissue sections, on the other hand, burdens the animals only slightly. These cultures provide a better reflection of the complex relations of the different cell types in the target tissue than cell cultures do. To this end, cultures of organ-typical cerebellum sections have been developed because the FSME virus, in particular, infests this part of the brain. In tests with antiviral drugs of known effects against the FSME virus, this model has been shown to yield results comparable to cell culture and animal tests.

Detail of a cerebellum section. The virus appears in red, the Purkinje cells in green, and Dapi (cell nuclei) in blue.

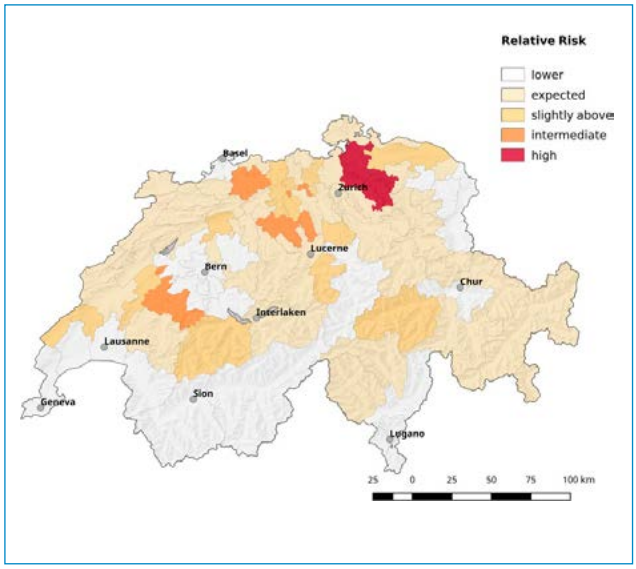
Liechti Nicole, Schürch Nadia, Bruggmann Remy, Wittwer Matthias
The genome of *Naegleria lovaniensis*, the basis for a comparative approach to unravel pathogenicity factors of the human pathogenic amoeba *N. fowleri*
BMC Genomics 2018 Sep 5; 19(1):654.
https://doi.org/10.1186/s12864-018-4994-1

Naegleria fowleri is a wild form amoeba species that can cause a rare but in most cases lethal infection of the brain. It has been studied at Spiez Laboratory for many years. To study its pathogenicity, the closest non-pathogenic relative, *Naegleria lovaniensis*, has now been sequenced. Genome based comparisons have allowed the identification of genes which are present exclusively in the *N. fowleri*, and which play a role in the vesicular transport and the shaping of the cytoskeleton. The identification and isolation of the proteins involved could potentially provide the basis for a therapeutic approach.



N. fowleri has been listed by the Center of Disease Control (USA) as a potential bioweapon because of the almost 100 % mortality rate, the rapid disease progression and the absence of therapeutic possibilities.

Wittwer Matthias, Altpeter Ekkehard, Pilo Paola, Gygli Sebastian, Beuret Christian, Foucault Frederic, Ackermann Rahel, Karrer Urs, Jacob Daniela, Grunow Roland, Schürch Nadia
Population Genomics of *Francisella tularensis subsp. holarctica* and its Implication on the Eco-Epidemiology of Tularemia in Switzerland
Frontiers in Cellular and Infection Microbiology 2018 Mar 22; 8:89 (eCollection 2018).
https://doi.org/10.3389/fcimb.2018.00089



Francisella tularensis causes an infectious disease that can be transmitted to humans primarily by direct contact with infected animals or tick bites. In Switzerland, it leads to around 100 clinical cases each year. This study describes for the first time the population structure of the pathogen in a micro-geographical context. To this end, 59 isolates from humans, animals and ticks have been analysed by high resolution sequencing methods, and incorporated into the international nomenclature. In doing so, a new genotype was discovered. In addition, the study describes the role of ticks in the occurrence of the infection, by correlating clinical evidence with climate and ecological factors that can have an impact on the persistence of the ticks.

Spatial distribution of cases by postal code area (first two digits). The estimated relative risk is shown, which is defined by the ratio of observed cases to expected ones. Most areas have less cases than expected, e.g., the relative risk is below 1 (blank zone). The remaining areas are shaded from orange to red according to their relative risk value.

Wittwer Matthias, Wüthrich Fritz
Validierung des real-time PCR Nachweises des *Burkholderia mallei/pseudomallei Komplex*
LS 2018-11

On behalf of the Federal Office of Public Health, Spiez Laboratory offers for the first time the reference diagnostics for the bacterium *Burkholderia pseudomallei*. It is based on cultivation, PCR determination and, when indicated, antibiotic resistance testing. The pathogen is not endemic in Switzerland but is sporadically being brought into the country by returning travellers. The disease Meliodiosis is widespread in tropical regions in particular in Southeast Asia, South Asia and Northern Australia. The infection takes place via environmental factors, and the incubation period varies. An acute and severe disease progression is observed in particular in immunosuppressed patients.

Ackermann Rahel, Eyer Claudia, Leib Stephen, Niederhauser Christoph
Comparison of Four Commercial IgG-Enzyme-Linked Immunosorbent Assays for the Detection of Tick-Borne Encephalitis Virus Antibodies
Vector-borne and Zoonotic Diseases 2018, Dec. 4
https://www.liebertpub.com/doi/10.1089/vbz.2018.2359

Ackermann Rahel, Tritten Marie-Lise, Hassan Mona, Reto Lienhard
Comparison of three commercial IgG and IgM ELISA kits for the detection of tick-borne encephalitis virus antibodies
Ticks and Tick-borne Diseases 2018 May; 9(4):956-962 (Epub 2018 Mar 28).
https://doi.org/10.1016/j.ttbdis.2018.03.031

Beuret Christian, Siegrist Denise, Engler Olivier
Interlabor-Vergleich HUG-LS für den real-time RT-PCR Nachweis von Viren der Gattung Orthohantavirus
LS 2018-07

Beuret Christian, Siegrist Denise
Validierung des real-time RT-PCR Nachweises von Dobrava-Belgrade Orthohantavirus (DOBV)
LS 2018-02

Beuret Christian, Ryter Sarah, Siegrist Denise
Validierung des real-time RT-PCR Nachweises von Puumala Orthohantavirus (PUUV)
LS 2018-01

García-Nicolás Obdulio, V'kovski Philip, Vielle Nathalie, Ebert Nadine, Züst Roland, Portmann Jasmine, Stalder Hanspeter, Gaschen Véronique, Vieyres Gabrielle, Stoffel Michael, Schweizer Matthias, Summerfield Artur, Engler Olivier, Pietschmann Thomas, Todt Daniel, Alves Marco, Thiel Volker, Pfaender Stephanie
The Small-Compound Inhibitor K22 Displays Broad Antiviral Activity against Different Members of the Family Flaviviridae and Offers Potential as a Panviral Inhibitor
Antimicrobial Agents and Chemotherapy 2018 Oct 24; 62(11). pii: e01206-18 (Print 2018 Nov).
https://doi.org/10.1128/AAC.01206-18

Huttner Angela, Agnandij Selidji Todagbe, Combescure Christophe, Fernandes José F, Bache Emmanuel Bache, Kabwde Lumeka, Ndungu Francis Maina, Brosnahan Jessica, Monath Thomas P, Lemaitre Barbara, Grillet Stéphane, Botto Miriam, Engler Olivier, Portmann Jasmine, Siegrist Denise, Bejon Philip, Silvera Peter, Kremsner Peter, Siegrist Claire-Anne
VEBCON, VSV-EBOVAC, VSV-EBOPLUS Consortia
Determinants of antibody persistence across doses and continents after single-dose rVSV-ZEBVO vaccination for Ebola virus disease: an observational cohort study
The Lancet – Infectious Diseases 2018 Jul; 18(7):738-748 (Epub 2018 Apr 5).
https://doi.org/10.1016/S1473-3099(18)30165-8

Kuenzli Andrea, Marschall Jonas, Schefold Joerg, Schafer Margaret, Engler Olivier, Ackermann Rahel, Reineke David, Suter-Riniker Franziska, Staehelin Cornelia.
Hantavirus Cardiopulmonary Syndrome Due to Imported Andes Hantavirus Infection in Switzerland: A Multidisciplinary Challenge, Two Cases and a Literature Review
Clinical Infectious Diseases, 2018 Nov 13:67(11): 1788-1795.
https://doi.org/10.1093/cid/ciy443

Luedin Samuel, Pothier Joel, Danza Francesco, Storelli Nicola, Frigaard Niels-Ulrik, Wittwer Matthias, Tonolla Mauro
Complete genome sequence of "Thiodictyon syntrophicum" sp. nov. strain Cad16T, a photolithoautotrophic purple sulfur bacterium isolated from the alpine meromictic Lake Cadagno
Standards in Genomic Sciences 2018 May 9;13:14 (eCollection 2018).
https://doi.org/10.1186/s40793-018-0317-z

Oechslin Corinne, Lenz Nicole, Liechti Nicole, Ryter Sarah, Agyeman Philipp, Bruggmann Rémy, Leib Stephen, Beuret Christian
Limited Correlation of Shotgun Metagenomics Following Host Depletion and Routine Diagnostics for Viruses and Bacteria in Low Concentrated Surrogate and Clinical *Sample***s**
Frontiers in Cellular and Infection Microbiology 2018 Oct 23;8:375 (eCollection 2018).
https://doi.org/10.3389/fcimb.2018.00375

Pilloux Ludovic, Baumgartner Andreas, Jaton Katia, Lienhard Reto, Ackermann Rahel, Beuret Christian, Greub Gilbert
Prevalence of *Anaplasma phagocytophilum* and *Coxiella burnetii* in *Ixodes ricinus* ticks in Switzerland: an underestimated epidemiologic risk
New Microbes and New Infections 2018 Sep 6; 27:22-26 (eCollection 2019 Jan).
https://doi.org/10.1016/j.nmni.2018.08.017

Remy Melissa, Alfter Michele, Chiem Manh-Nhi, Barbani Maria, Engler Olivier, Suter-Riniker Franziska.
Effective chemical virus inactivation of patient serum compatible with accurate serodiagnosis of infections
Clinical Microbiology and Infection 2018 Oct 28. pii: S1198-743X(18)30721-3 (Epub ahead of print).
https://doi.org/10.1016/j.cmi.2018.10.016

Rusterholz Simonne, Fiechter René, Eriksson Urs, Altpeter Ekkehardt, Wittwer Matthias, Schürch Nadia, Karrer Urs, Hofer Daniel
Tularämie – eine seltene Ursache der Pneumonie
Swiss Medical Forum 2018; 18(32):636-640.
https://medicalforum.ch/de/issue/edn/smf.2018.32/

Ryter Sarah, Beuret Christian, Engler Olivier
Validierung des real-time RT-PCR Nachweises von Guanarito Mammarenavirus (GTOV)
LN 2018-01 BRC

Ryter Sarah, Beuret Christian, Engler Olivier
Validierung des real-time RT-PCR Nachweises von Junin Mammarenavirus (JUNV)
LN 2018-02 BRC

Ryter Sarah, Beuret Christian, Engler Olivier
Validierung des real-time RT-PCR Nachweises von Sabia Mammarenavirus (SABV)
LN 2018-03 BRC

Ryter Sarah, Beuret Christian, Engler Olivier
Validierung des real-time RT-PCR Nachweises von Lassa Mammarenavirus (LASV)
LN 2018-04 BRC

Ryter Sarah, Beuret Christian, Engler Olivier
Validierung des real-time RT-PCR Nachweises von Sudan Ebolavirus (SUDV)
LN 2018-05 BRC

Wittwer Matthias, Luedin Samuel
Complete genome sequence of "Thiodictyon syntrophicum" sp. nov. strain Cad16T, a photolithoautotrophic purple sulfur bacterium isolated from the alpine meromictic Lake Cadagno
Standards in Genomic Sciences, 2018, 13:14

Züst Roland
Identifikation von Hantaviren mittels Pan-Hanta RT-PCR und Sequenzierung
LN 2018-03 ZUET

Chemistry Division

Arnold Michael, Guidetti Fausto
Prüfung Nachweispapiere CALID – 3P von Oritest für flüssige Kampfstoffe
LN 2018-01 ARND

Messkampagne mit MX908 von 908 Devices
LN 2018-01 GIF-ARND

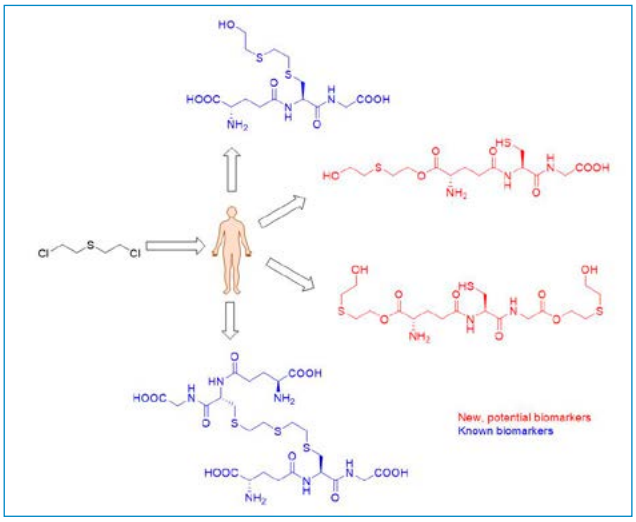
Messkampagne mit GDA-P und GDA-X von Airsense
LN 2018-02 GIF-ARND

Messungen mit FAT-IMS Forschungsgerät der Universität Hannover
LN 2018-03

Überprüfung von C-Nachweisgeräten 2018
LN 2018-01 GIF

A large number of detection devices available on the international market are being offered for the detection of specific chemical warfare agents. At Spiez Laboratory, we have the capability to comprehensively evaluate such devices. This enables us to provide competent advice to our task force C-EEVBS, to International Organisations, to the Cantons and other partners. Since 2018, the Organic Chemistry, Detection and Decontamination Branch of the Chemistry Division has been testing a wide range of technologies. Some of these systems are already market-established, others are still at the prototype stage, or they are only part of a research project. In addition to evaluating new systems, we also test already-introduced devices of the army or the C-EEVBS to ensure their operational readiness for emergency situations.

Bielmann Andreas, Sambiagio Nicolas, Wehr Nathalie, Gerber-Lemaire Sandrine, Bochet Christian G., Curty Christophe
Synthesis of different glutathione-sulfur mustard adducts of verified and potential biomarkers
RSC Advances 2018, 8(42): 23881-23890.



Sulfur Mustard (SM) is a blistering agent used as a chemical weapon. Glutathione (GSH) is involved in the β-lyase degradation pathway of SM and recently bioadducts between SM and GSH were observed *in vitro*. While these bioadducts have never been isolated from *in vivo* tests or real poisoning with SM, they could be of interest as potential future biomarkers for the retrospective validation of exposure. We herein report the synthesis of different observed and new potential GSH-SM bioadducts as reference materials for analytical investigation. Two distinct approaches were investigated: The building block pathway and the direct reaction with GSH. The availability of these references will aid future studies and may lead to the discovery of new GSH-SM biomarkers.

OPCW
Report of the Scientific Advisory Board on Developments in Science and Technology for the Fourth Special Session of the Conference of the States Parties to Review the Operation of the Chemical Weapons Convention RC-4/DG.1, dated 30 April 2018
http://www.opcw.org/sites/default/files/documents/CSP/RC-4/en/rc4dg01_e_.pdf.

The Organisation for the Prohibition of chemical Weapons (OPCW) is responsible for ensuring that States Partners of the Chemical Weapons Convention implement this agreement. In accordance with paragraphs 21(h) and 45 of Article VIII, the OPCW has established a Scientific Advisory Board. This board is made up of 25 members who are appointed by the Director-General. The task of the SAB is to provide advice to the Director-General on scientific questions that arise in the context of the Chemical Weapons Convention. For the Conference of the States Parties of the Convention from 21 to 30 November 2018, the Scientific Advisory Board prepared a report, which analysed relevant developments in science and technology over the past five years and provided recommendations in this regard. In these recommendations, specific questions were taken up which may affect the implementation of the Convention and the work of the Technical Secretariat. Some of these themes have been published in peer-reviewed journals, thereby reaching out to the entire scientific community.

Forman Jonathan E., Curty Christophe et al.
Innovative technologies for chemical security
Pure and Applied Chemistry, 90(10): 1527-1557, 2018

Timperley Christopher M., Curty Christophe et al.
Advice from the Scientific Advisory Board of the Organisation for the Prohibition of Chemical Weapons on isotopically labelled chemicals and stereoisomers in relation to the Chemical Weapons Convention
Pure and Applied Chemistry, 90(10): 1647-1670, 2018

Timperley, Christopher M., Curty Christophe et al.
Advice on chemical weapons sample stability and storage provided by the Scientific Advisory Board of the Organisation for the Prohibition of Chemical Weapons to increase investigative capabilities worldwide
Talanta, 2018, 188: 808-832.

Group photo of the Scientific Advisory Board of the OPCW from 2018. Dr. Christophe Curty (back row, first from the left), Deputy of the Chemistry Division in Spiez Laboratory, is currently the deputy chair of the board.

Clare Thomas, Schorer Andreas, Siegenthaler Peter
Validierung des GC-NPD/FID Systems Agilent 7890B (NPD2)
LN 2018-06 CLA/ANDRS/SIG

Meier Urs
Schnelle NMR Methoden für die Analyse von CWÜ relevanten Verbindungen in Umweltproben
LN 2018-07 MRU

Schär Martin
Evaluationsbericht zur Beschaffung eines LS-MS/MS Systems
LN 2018-01 SCM

Schorer Andreas
Test verschiedener Probenfläschchen (µ-Vials)
LN 2018-04 ANDRS

Schorer Andreas
Optimierung der PCI-Ionenquellen-Temperatur des Q-TOF GC-MS-Systems Agilent 7890A/7200
LN 2018-05 ANDRS

Schorer Andreas, Siegenthaler Peter
Validierung des GC-TripleQuad-MS Systems Agilent 7890B / 7010 im EI-Modus (GC-QQQ)
LN 2018-02 ANDRS/SIG

Siegenthaler Peter
Evaluation eines Thermodesorptions-GC-MS Systems mit Dual-Flammenphotometer (TD-GC-MS/dFPD)
LN 2018-03 SIG

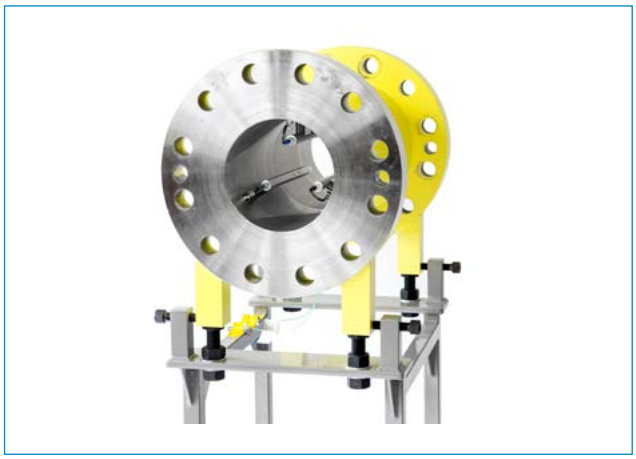
NBC-Protection Division

Friedrich Thomas, Richner Gilles
Individuelle ABC Schutzausrüstung neue Generation (IABCS NG) – Technische Erprobung
LS 2018-08

In the framework of evaluating a new NBC protective suite for the army (project IABC NG), Spiez Laboratory has conducted technical testing of NBC protective suits from different vendors. Amongst others, these tests included integral protective suit tests, CW agent resistance tests (swatch tests), aerosol permeability tests as well as extended materials testing. Optimum protective suits offer a compromise between long-lasting protection and good wearing comfort. The wearing comfort (breathing activity) of contemporary suits is significantly better than that of past suits. This is why one cannot expect a higher protective performance of new systems *vis-à-vis* liquid chemical warfare agents in comparison to the old protective suit of the Swiss army. What has improved significantly however, is the protective performance against gaseous chemical warfare agents, the protection against aerosols, and the overall system performance.

Sample material contaminated with yperite.

Lorenzo Ronny, Clausen Mario, Hulliger Bruno, Seitz Angelo, Zahnd André
Shock Tube Assessment of the error introduced by misaligning pencil probes
Military Aspects of Blasts and Shock (MABS), 2018



In order to achieve reliable measurement data of *in situ* pressure measurements during explosion tests, the use of suitable sensors is essential. In collaboration with *armasuisse* W+T characterisation and calibration measurements are being conducted using the shock wave tube of Spiez Laboratory and pressure measuring lances of different manufacturers. During the most recent measurement campaign, the impact of misalignment of measuring lances on the measurement accuracy was investigated. The products of two manufacturers were assembled with both horizontal and vertical misalignment of 5 degrees, and the measured pressure-time-progression was compared to reference sensors.

Segment of the shock wave tube.

Zahnd André
Technischer Projektschlussbericht Erneuerung Vertikalschockprüfanlage Prüfstelle STS 0055
LS 2018-06

Using the only vertical shock test rig available in Europe – VESPA – earth impacts resulting from explosions can be simulated experimentally. The installation, which was put into service in 1990, is predominantly utilised for acceptance tests of NBC protection components and systems. Over a period of three years, the installation was comprehensively overhauled. This overhaul was completed in the spring of 2018. The project was highly challenging with regard to individual components as well as the control and regulation system because it pushed the limits of what is physically possible.

Main cylinder unit of the vertical shock test rig (VESPA).

Deuber Fabian, Mousavi Sara, Federer Lukas, Hofer Marco, Adlhart Christian
Exploration of Ultralight Nanofiber Aerogels as Particle Filters: Capacity and Efficiency
ACS Applied Materials & Interfaces 2018, 10(10): 9069-9076

Friedrich Thomas
Langjährige Laborleistung der Prüfstelle für Kunststoffe und Gummi STS 0036
LS 2018-09

Gloor Christian, Metzger César
Einfluss von Gesichtsbehaarung auf den Fit Faktor von Schutzmasken
LS 2018-12

Gosteli Regula
YPAP 21 Indikatorpapiermethode mit Yperit: Kritische Faktoren mit Einfluss auf die Messergebnisse
LS 2018-04

Gurtner Markus
Ersatz der Referenzstandardaktivkohle PCREF-99-1 durch die chromfreie Aktivkohle PCREF-17-1
LN 2018-01 GM

Stalder Johann
Lebensdauerermittlung von Kleinbelüftungsgeräten Werterhalt von Schutzbauten
LS 2018-03

Zahnd André
ABC-Qualifizierungsprüfungen an Fahrzeugen der Schweizer Armee
LS 2018-05

Accredited Activities

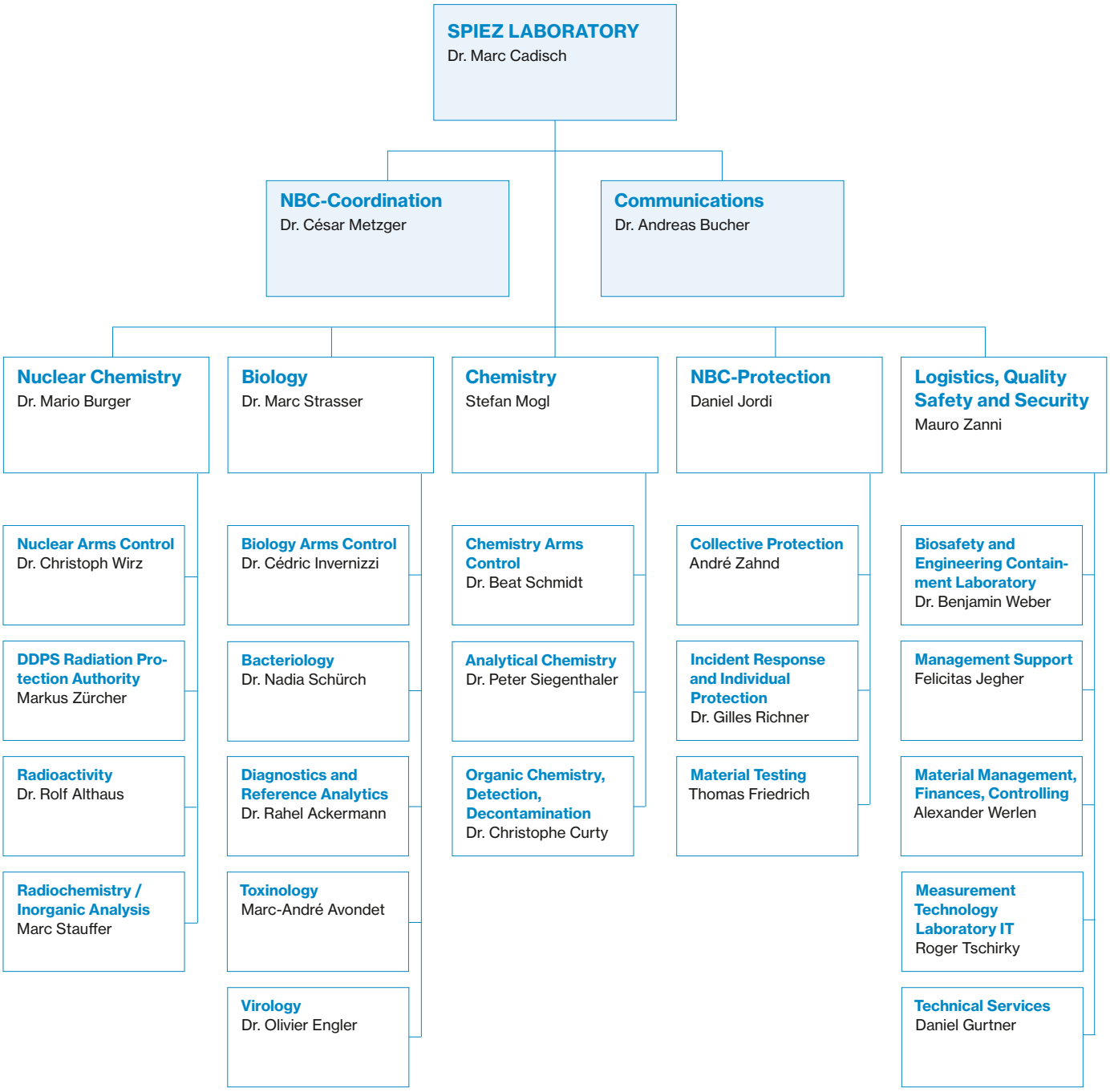
ISO/IEC 17025 accredited laboratories

STS 0019 Testing laboratory for the analysis of samples of chemical warfare agents and related compounds
STS 0022 Testing laboratory for adsorbents and respiratory protection filters
STS 0028 Testing laboratory for the determination of radionuclides and elemental analysis
STS 0036 Testing laboratory for Polymers and Rubber, and for the Protection Performance of Polymers, Rubber and Textiles against Chemical Warfare Agents.
STS 0054 Testing laboratory for the detection of biological agents
STS 0055 Testing laboratory for NBC protection material, shelter equipment and shelter installations

Round Robin tests October 2017–September 2018

Accredited laboratory		Number	Type and partner
STS 0019	Chemical analysis/verification	0	Due to successfully concluded OPCW analysis assignments, Spiez Laboratory was released from participation in the proficiency tests and has been able to ensure the OPCW designation for another year.
STS 0022	Adsorbents and respiratory protection filters	1	Comparative sorbent tests (chloropicrin, cyanogen chloride, hydrocyanic acid, SO2, ammonia) with WIS Munster
STS 0028	Radionuclides	9	– Water samples (ielab, Spain) – Soil samples (ISE, University of Wageningen, NL) – Gamma emitter (IRA Lausanne) – Alpha-, Beta-, Gamma emitters (IAEA RML 2017) – Alpha-, Beta-, Gamma emitters (IAEA PT ALMERA) – Gamma emitter whole body counter (Federal Office for Radiation Protection, D)
STS 0036	Polymers and rubber	14	– Comparative tests ISO 17043 (OFI-pts2018) – OFI Technologie & Innovation GmbH, Austria
STS 0054	Biological toxins	1	Ricin-Exercise OPCW 2018
	Medical biochemistry	0	
	Diagnostics of bacteria – drinking water	4	Public Health England (http://www.phe-eqa.org.uk/)
	Diagnostics of bacteria – molecular biology	2	– Instand round robin: Coxiella burnetti, Francisella tulerensis, Brucella spp, Borrelia burgdorferi, 05.2018 – EMERGE round robin: Bacillus anthracis, Yersinia pestis, Francisella tularensis ssp, Coxielle burnetti, Burkholderia mallei/pseundomellei, Brucella ssp., 03.2018
	Diagnostics of viruses – molecular biology	3	– EVDLabNet yellow fever PCR, 03.2018 – QCMD Dengue PCR, 06.2018 – Instand FSME PCR, 09.2018
	Diagnostics of viruses – serology	3	– Instand Hanta Serology, 09.2018 – Instand FSME Serology, 06.2018 – Instand FSME Serology, 11.2018
STS 0055	Venitlation	0	
	Air blast effects	0	
	Ground shock effects	0	

Organisation



Status:
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SPIEZ LABORATORY
Federal Office for Civil Protection FOCP
CH-3700 Spiez
Tel. +41 (0)58 468 14 00
Fax +41 (0)58 468 14 02
laborspiez@babs.admin.ch

88.003 d 05.18 1500 860399284