

VÉRO MISCHITZ

SPIDoc's

Training the Next Generation

A TALE OF LASER BEAMS AND BUILDING TEAMS



Training the Next Generation - Who is Who?



JENS is a biologist at the University of Lübeck. He is working with viruses. Jens thrives to understand how they build their viral shell. To do so, he needs a powerful X-ray laser which enables him to take a super-close look at them.



YARA is a physicist working at DESY. She specialised in the field of X-ray laser-technology and is now supporting scientists from all over the world to obtain the best X-ray images possible for their research.



AVJAAN is a biologist specialised in biotechnology. At SPIDoc's he is working on sample delivery for single particle imaging, focusing on protein orientation and detection. Avjaan enjoys music, games, cooking and learning.



ASSEL is a biologist specialised in molecular medicine. At SPIDoc's she uses native mass spectrometry to find out more about coronaviral protein complexes. Assel enjoys walking, pilates and reading.



MAY is an analytical chemist specialised in native mass spectrometry. At SPIDoc's she studies protein structure by combining spectroscopy and mass spectrometry experiments. May enjoys cycling, camping, and generally being outside, as well as needlework (knitting, crocheting, embroidery - you name it!)



PANAGIOTIS holds a masters degree in chemistry and is specialised in analytical science with biomolecular samples. At SPIDoc's he focuses on gas-phase photodissociation processes of relevance for imaging biomolecules. Panagiotis enjoys sports like football and boxing as well as taking pictures.



FREDERIK is an analytical chemist with experience in computation. At SPIDoc's he studies the conformational stability of proteins from solution to the gas phase. Frederik is interested in cultural experiences such as concerts and cultural music events, but he enjoys camping, too.



LAIS holds a masters degree in astrophysics, particle physics and cosmology. At SPIDoc's she explores photon-matter interactions in single particle imaging experiments with the XFEL-laser. Laïs loves dancing. She enjoys the outdoors as much as traveling and learning about history, politics, science and languages.



GALAXY is a chemist specialised in ChEMoinformatics. At SPIDoc's she works in field orientation theory. Galaxy loves playing games (especially puzzle games), watching theater performances, rock climbing, and trying new activities and experiences.



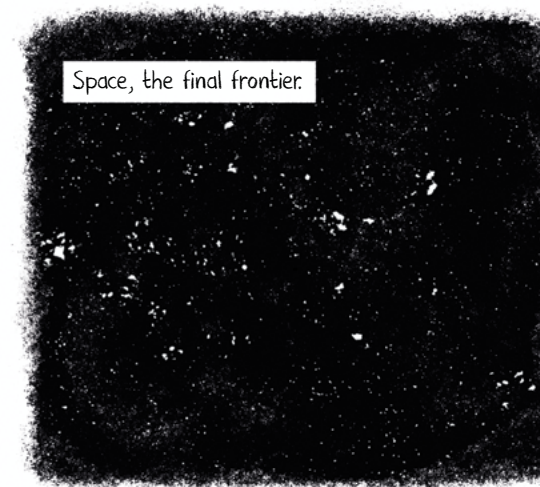
HENDRIK holds a masters degree in biochemistry. At SPIDoc's he is responsible for the application and integration of novel mass spectrometry technologies for the studies of virus particles. Hendrik enjoys board games and D&D amongst others as well as baking, reading and engaging in creative endeavours.



PIERRE is a physicist specialised in instrumental development for micro- and nanotechnology. At SPIDoc's he examines and plans to build mass spectrometry instrumentation dedicated to the studies of viral protein complexes and particles. Pierre loves adventures, sports and music.



EZGI is a biochemist specialised in biomedical sciences. At SPIDoc's she examines a norovirus protein using native mass spectrometry with advanced fragmentation schemes. Ezgi enjoys adventurous outdoor activities like mountain hiking and scuba diving as well as cooking and painting.



Our approach with MS SPIDOC* combines mass spectrometry (MS), allowing us to sort molecules by size and shape, with X-rays for single particle imaging (SPI).

Basically meaning, that we are able to take extremely sharp pictures of viral structures ...

... and explore their dynamic nature. One of our goals is to capture how viruses are built.

proteins → protein complex → virus

And now it is finally time to train the NEXT GENERATION of Spidoc-scientists! Are you excited? Because I am!

PROJECT 1
Sample delivery for SPI: protein orientation and detection
Ajvan (India)

PROJECT 2
Structural investigations using Native MS and SPI of coronavirus
Galaxy (China)

PROJECT 3
MS-based approaches for analysis of protein drug interactions
May (Canada)

PROJECT 4
Gas-phase photodissociation processes of relevance for imaging biomolecules and understanding protein drug interaction
Panagiotis (Greece)

PROJECT 5
Probing the conformational stability of proteins from solution to the gas phase by combining lasers to MS and Ion Mobility (IM)
Frederik (Germany)

PROJECT 6
Photon-matter interaction: Orientation from Coulomb explosion
Lais (Germany)

PROJECT 7
Field orientation theory
Assel (Austria)

PROJECT 8
Protein structural characterization using native MS with advanced fragmentation schemes
Ezgi (Turkey)

PROJECT 9
MS instrumentation dedicated to the studies of viral protein complexes and particles
Pierre (France)

PROJECT 10
Application of novel MS technologies for the studies of virus particles
Hendrik (Germany)

Me too. So many exciting perspectives. I can't wait to exchange ideas!

* MS-what?! Find out more about this exciting research project in our first comic NOROVIRUS SUPERSTAR.

Your goal is to work across all borders and build THE LEAGUE OF VIRAL RESEARCHERS! The path ahead is full of challenges, both personal and professional.

MISCOMMUNICATION
The deadline is tomorrow??
Don't panic. We can do this! I think.
Grumbl.

STRESS
Try me and I'll blast you into oblivion with my laser!
Uh, actually ... there's a system malfunction. Again.
Zzzzz ...

CONFLICT ISOLATION
What do you mean, the funding got delayed?
Hello?

WORK-LIFE-BALANCE
But if you cooperate wisely across platforms and disciplines, you can generate unprecedented insight!

Dude, are you ok?
Oh ... all good, hehe. Sometimes I get carried away a bit.

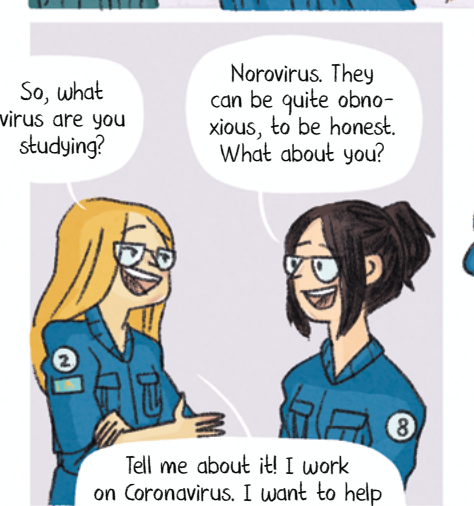
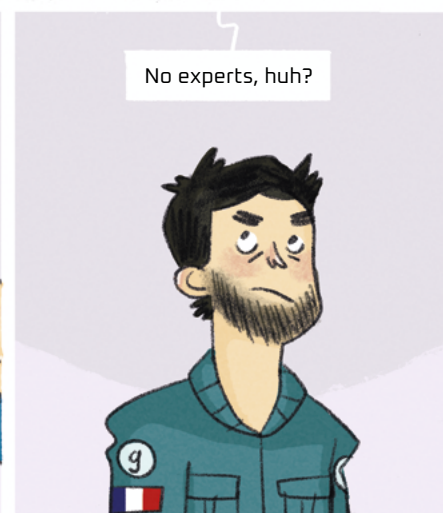
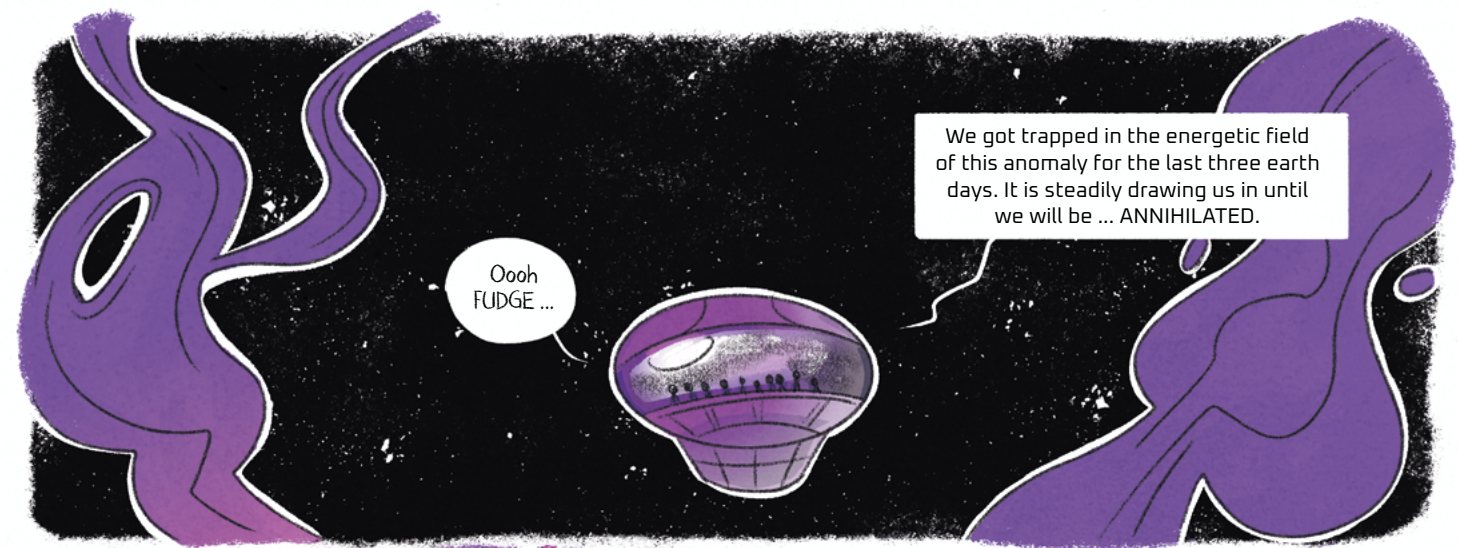
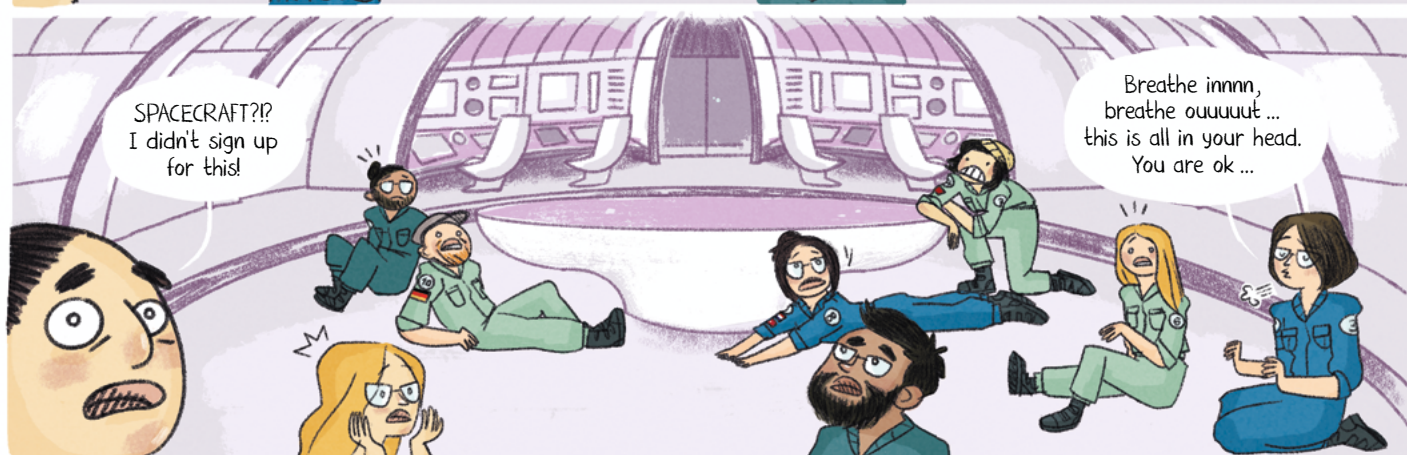
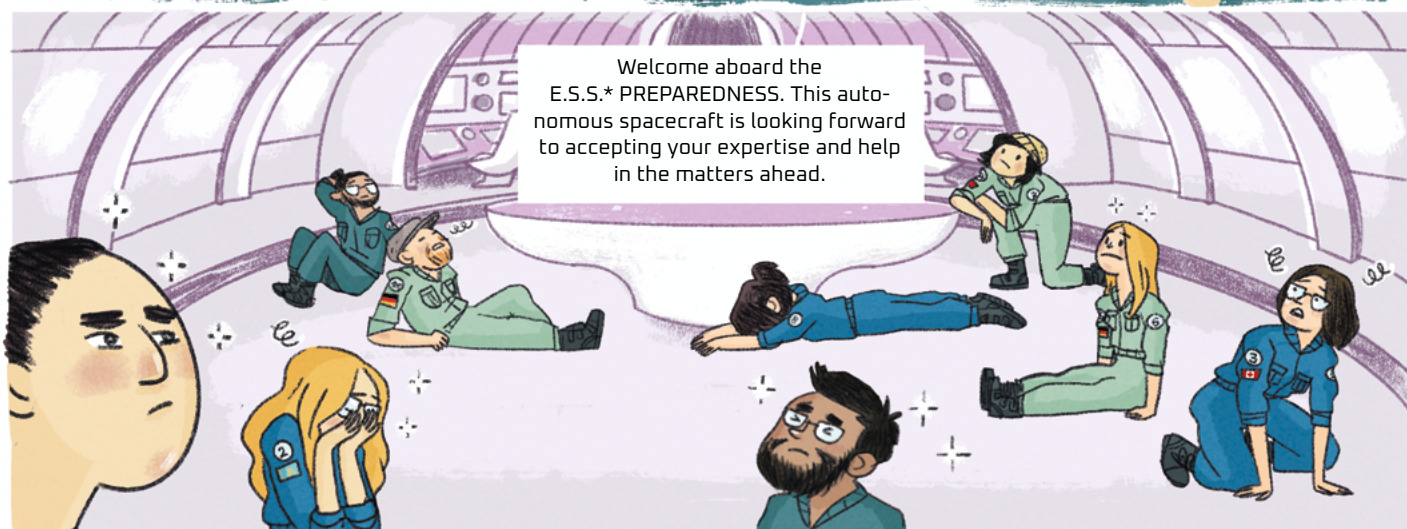
So - what's YOUR project about?
I'm here to calibrate the different instruments involved. Eventually I hope to develop a shared software that helps analyse the outputs from all instruments.
Sweet.

This is the heart of MS-SPI-DOC.
It took a group of specialists from various fields FIVE YEARS to get this platform up and running.
What are they looking at right now?

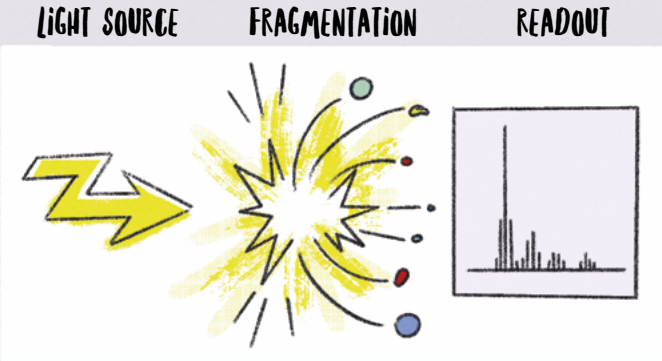
They are examining the assembly of virus-proteins*. Do you want to see some of the readouts?
Oh, I'd love to!

RRRRUMBLE!
CRRAASH!
Whoah! Is that another experiment?

* Viruses multiply by hijacking our cells to build new virus 'shells' (capsids) from proteins. Once we understand how exactly they puzzle together their shells, we may be able to develop more effective drugs against them.



So, in many of our projects we use laser beams to break down complex molecules into smaller pieces, right?



LIGHT SOURCE

FRAGMENTATION

READOUT

We use a variety of light sources such as ultraviolet, X-ray or infrared lasers.

Once the laser hits, the molecules react to that boost of energy, sometimes by exploding into smaller pieces.

We then detect and measure all those pieces carefully. The data helps us to 'look' at tiny, invisible molecules.

In the lab, we do this to learn about the molecules, their movements and their structure.

But HERE we could illuminate the anomaly and set us free as it breaks apart!

I am intrigued.

But how do we make sure we won't get hit by random pieces, if that thing blows up?

I study explosion patterns of molecules. If I had some data on the anomaly, maybe I could help predict the number and trajectory of the pieces?

Computer, can you scan the anomaly for structural information?

With pleasure. Please wait.

...

Negative. The data you requested cannot be obtained.

Oh no.

Sooo ... are we going to try anyway? I mean, it COULD work.

I am not comfortable with the risk. On the other hand: I am not comfortable with being annihilated by this ... THING either.

Maybe let's ... vote or something?

Should we try to break free by laser-force?

Yes.

Yes.

Yeah.

Let's DO this!

What could possibly go wrong, right?

Ok, then. Let's GO.

Computer say, can we shoot a high-energy laser beam at that monstrosity?

Oh, absolutely. I'd suggest to hold on to something though.

Do you folks mind if I ... I've ALWAYS wanted to do this.

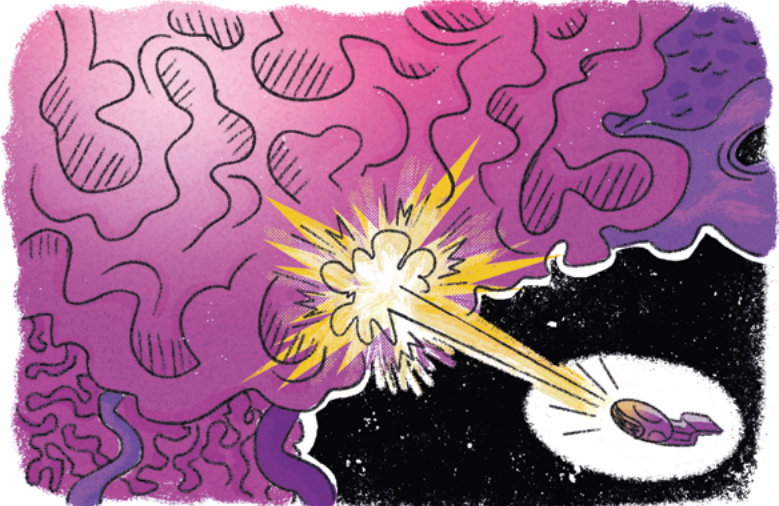
Sure.

Please.

Ok then, Computer, activate calibrating sequence!

Calibrating weapon systems -- Aligning target array -- Acquiring firing position -- Firing position acquired -- systems ready for offensive.

Excellent! Forward all available energy to the main weapon systems and ... FIRE!



Gosh, I hope it does.

Does it work?


No idea.

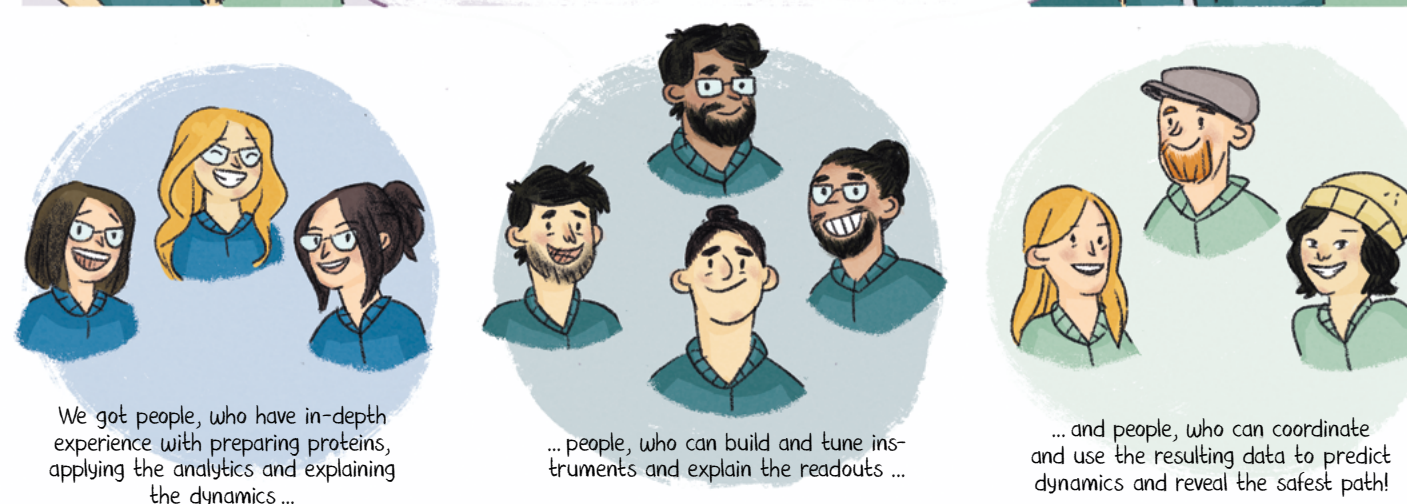
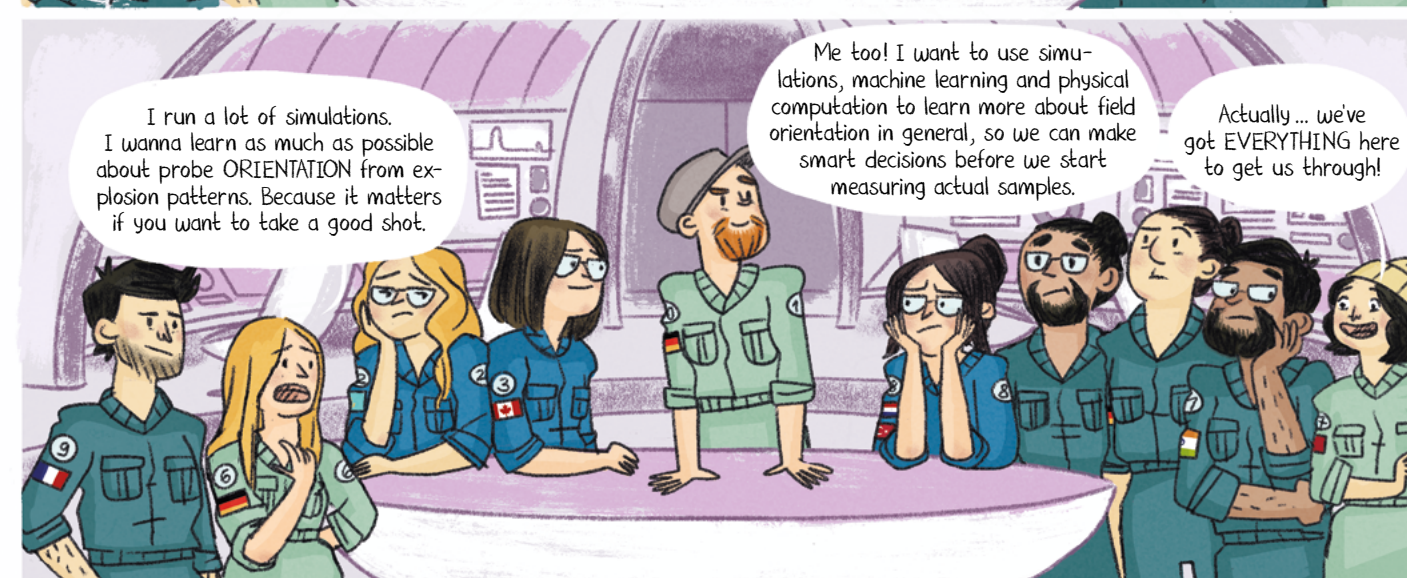
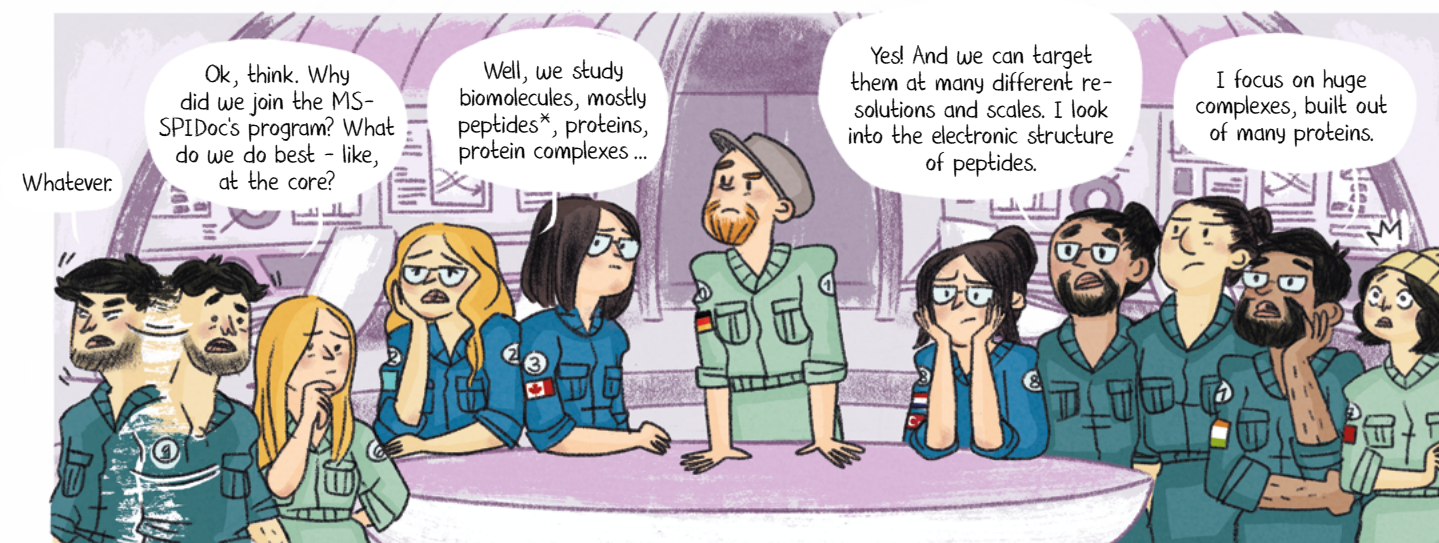
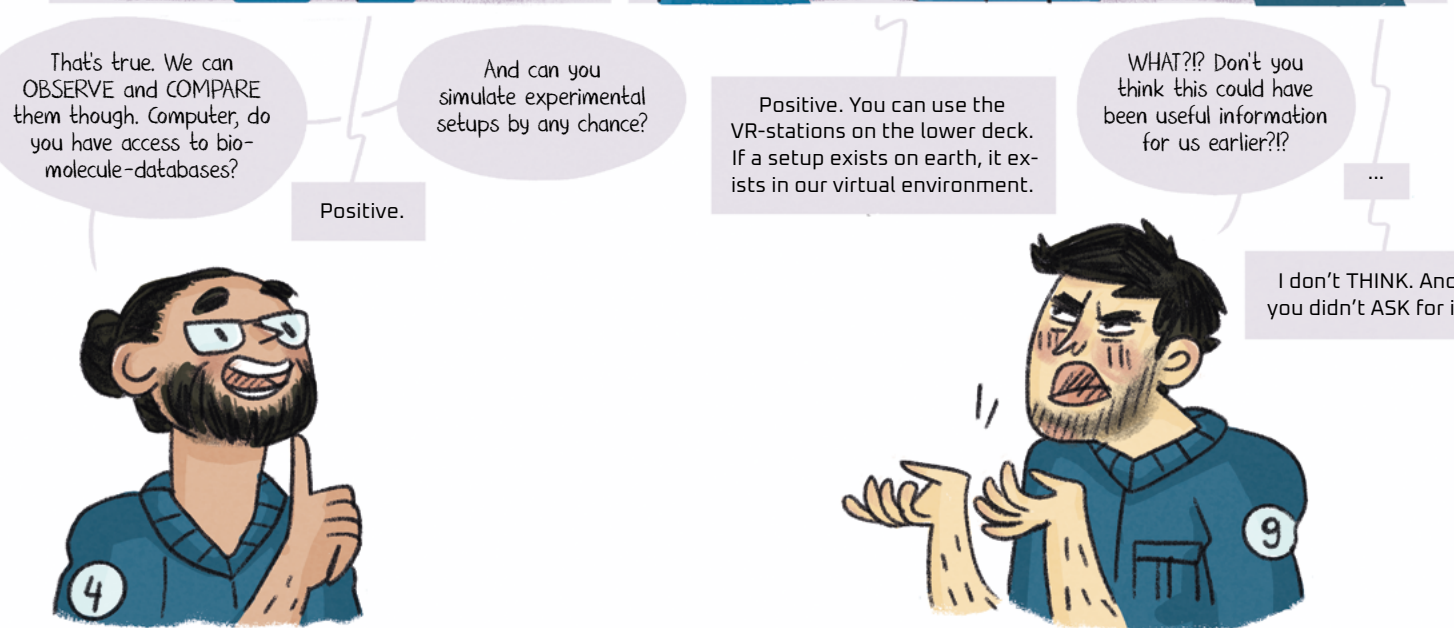
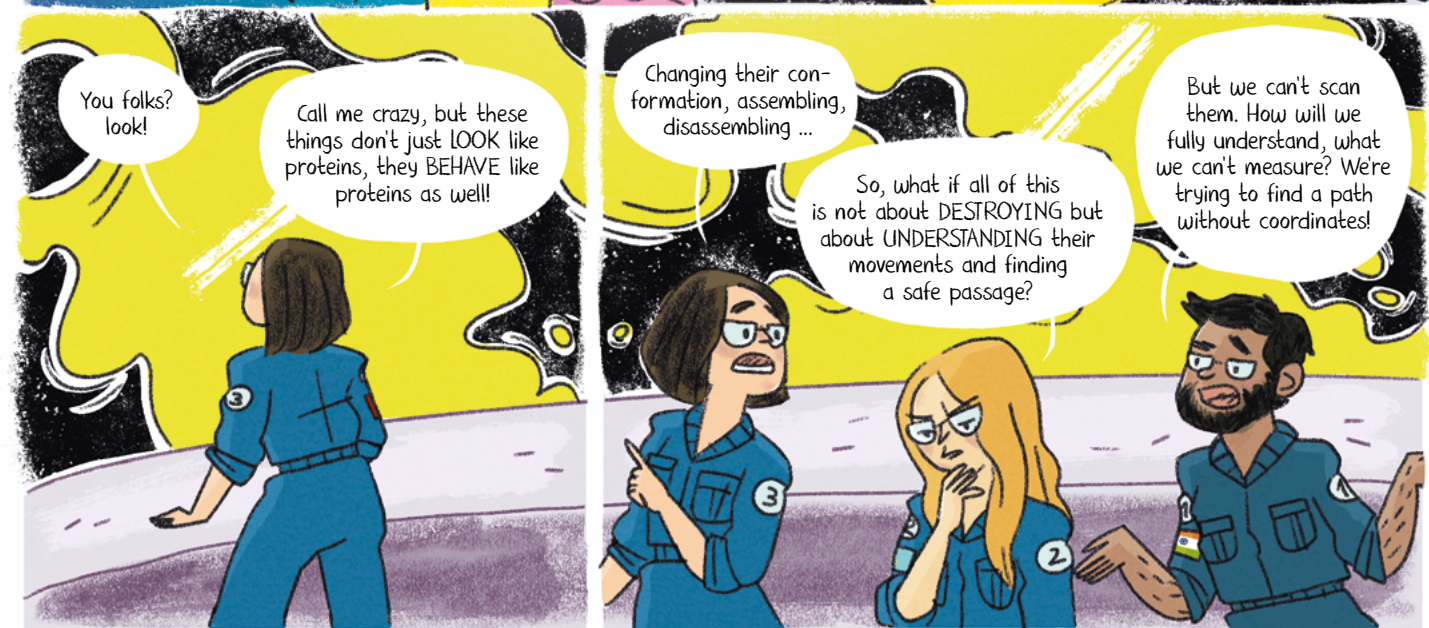



AAAAAAAAAAAAAAAAAAAAHH!!!

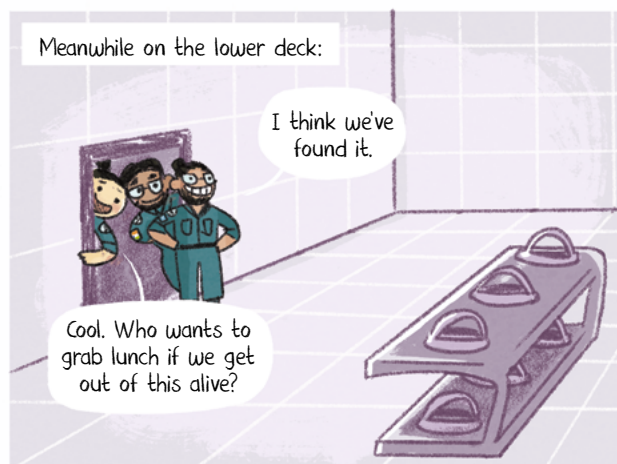
DANGER! DANGER!

Stop firing! We are NOT breaking free! We are getting sucked in FASTER!!

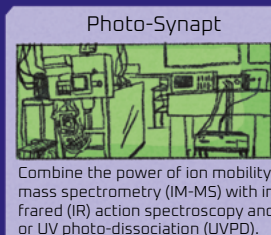





* Peptides are short protein chains. They serve many important functions in your body.



Browse E.S.S. Preparedness inventory:



Combine the power of ion mobility mass spectrometry (IM-MS) with infrared (IR) action spectroscopy and/or UV photo-dissociation (UVPD).



One ion trap alone simply doesn't do the job? Why not use and compare two state of the art models?



A modular, mobile and custom-made setup for your Near-Edge X-ray Absorption Mass Spectrometry (NEXAMS).

Tandem-IMS-MS instrument



Curious about (un)folding of proteins? Try this cutting-edge Ion-Mobility-Mass-Spectrometry-platform.

15T-Solarix



Multimodal fragmentation like no other! This platform offers electron based, collision induced and UV-photo-dissociation.

next >>

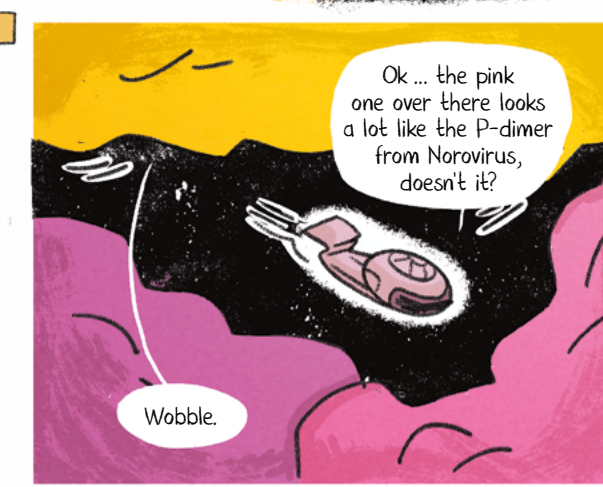
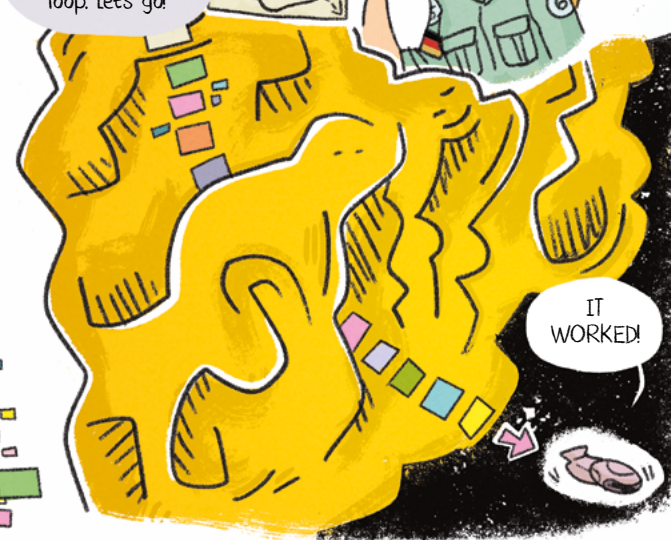
MS SPIDOC

timsTOF

Leap Roboter

Thermo DMT

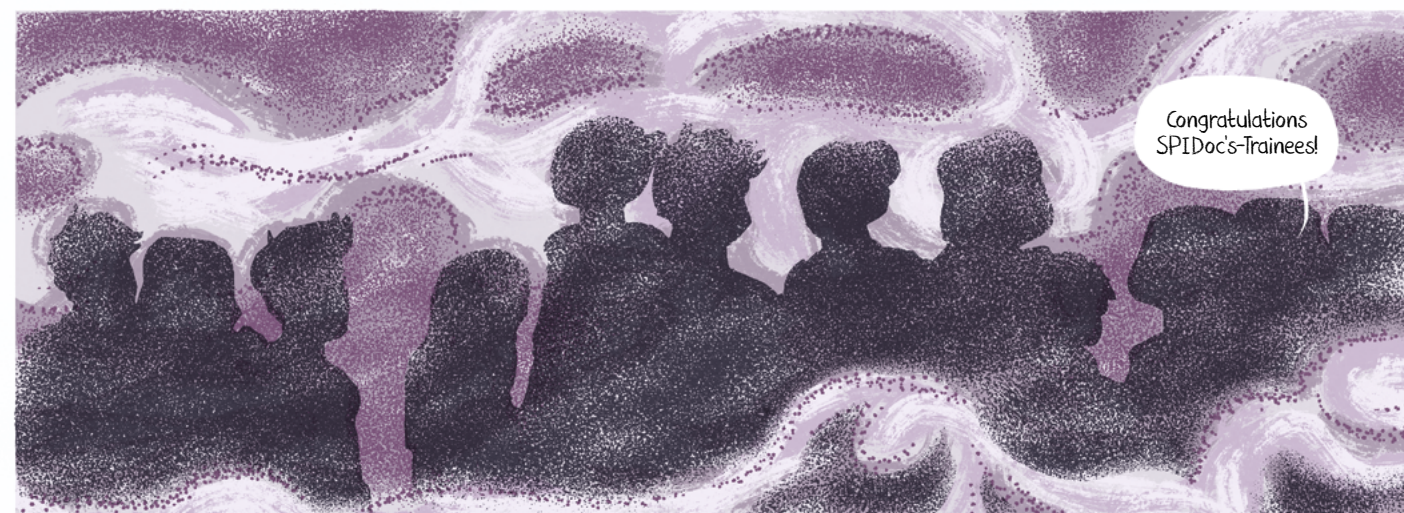
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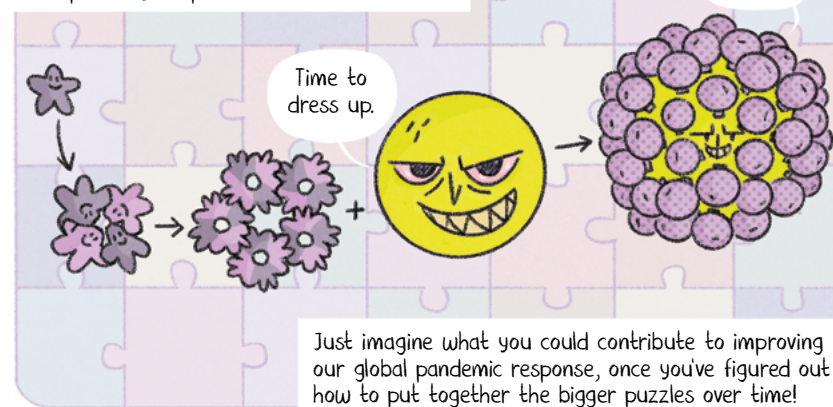
* A capsid is a three-dimensional shell around a virus, made from proteins. It encloses the viral genetic material.

* Charge Detection-MS is used to gather exact mass information about single particles.

** Hydrogen/Deuterium-Exchange-MS is used to examine protein-protein interactions. DigDig and DeutEX are software tools for analysing HDX data, developed by an academic lab in Prague (peterslab.org).



Successful teams evolve and grow by the joint effort to overcome challenges. You have more than proven your potential.



Just imagine what you could contribute to improving our global pandemic response, once you've figured out how to put together the bigger puzzles over time!



Even though holodeck-simulations and spaceship travels are reserved for sci-fi stories until further notice, SPIDoc's has some pretty cool tech going on already. Come check it out online and watch them build a molecular story together - one ion at a time.

The End?

Behind the scenes of Training the Next Generation

This comic would not have been possible without the people working behind the scenes: meeting, planning and pouring every ounce of skill and imagination into the story of 10 young scientists lost in space!



CHARLOTTE UETRECHT is a structural virologist and group leader at University of Lübeck. She is coordinator of SPIDoc's (and previously MS SPIDOC) and had the original idea merging MS and X-rays to image viruses.



LORENZA DALESSANDRO is a biologist. Currently she works as project manager of SPIDoc's, coordinating the training programme and all activities within the doctoral network.



VÉRO MISCHITZ is a biologist and currently works as freelance comic artist, author and university lecturer on visual science communication and scientific storytelling. She created this comic.

About SPIDoc's Training the Next Generation

SPIDoc's is an interdisciplinary and intersectoral doctoral network bringing together seven beneficiaries, seven associated partners, two associated partners linked to a beneficiary, three of which are industrial leaders, and most importantly the ten doctoral candidates.

The network delivers a tailored training programme designed to equip the next generation of scientists with advanced expertise in gas-phase structures of ions, light-matter interactions, and mass spectrometry innovation. SPIDoc's drives the development of mass spectrometry components optimized for large viral assemblies, adapting the MS SPIDOC design into a versatile toolkit for diverse light sources and applications.

By integrating mass spectrometry and advanced light-based techniques, SPIDoc's enables structural investigations of virus-ligand and virus-host interactions across multiple size and time scales, from local electronic transitions to viral particles. The engagement and collaboration among all partners are well established and based on the previous MS SPIDOC project (H2020, FETOPEN-01-2016-2017), see our first comic Norovirus Superstar (DOI: <https://doi.org/10.22003/XFEL.EU-COMIC-2021-001-EN>).

More information about the EU-project SPIDoc's: www.ms-spidoc.eu



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www.ms-spidoc.eu



SCIENCE is no more than an investigation of a miracle we can never explain, and art is an interpretation of that miracle.



Ray Bradbury, The Martian Chronicles



IT IS possible to commit no mistakes and still lose.
That is not weakness - that is life.

Jean Luc Picard

BENEFICIARIES



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UNIVERSITET



MBU

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of the Czech Academy of
Sciences



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