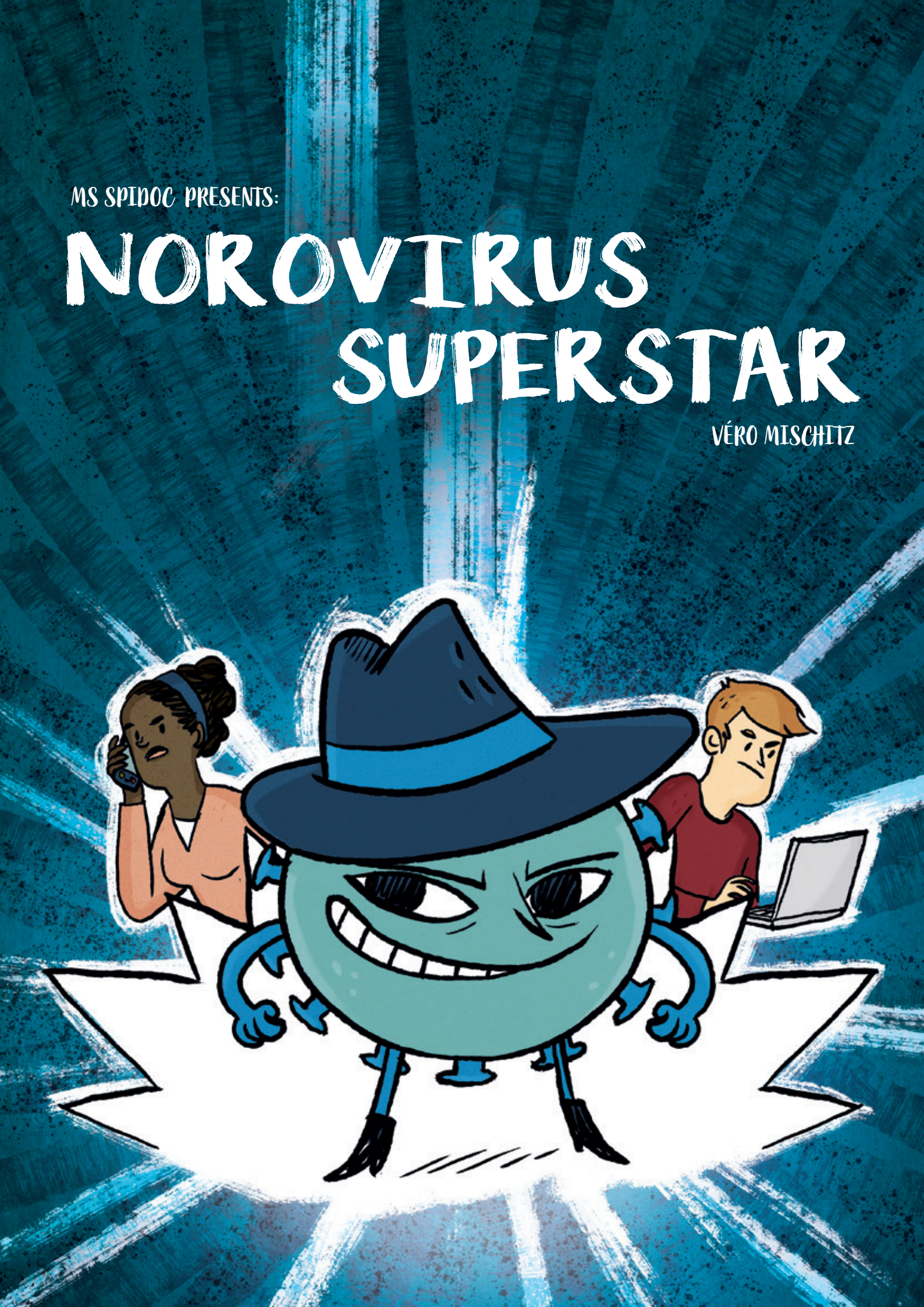
MS SPIDOC PRESENTS:

NOROVIRUS SUPERSTAR

VÉRO MISCHITZ



NOROVIRUS SUPERSTAR - Who is Who?

NOTORIOUS V.I.R. - aka Noro - is a rising star amongst an exclusive group of social media "influenzers". He is constantly trying to infect more people and boost his community, just like he should as a virus.

JENS is a biologist. At the European XFEL he is working with viruses. He wants 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 at the European XFEL. 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.

PROJECT FUNDING

The MS SPIDOC project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 801406.

IMPRINT

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Publisher: European XFEL GmbH, Holzkoppel 4, 22869 Schenefeld, Germany **www.xfel.eu**

Text & Illustration: Véro Mischitz **Scientific advice:** Charlotte Uetrecht, Kristina Lorenzen
Editorial: Arwen Cross, Silvia Wissel **Composition:** Veronika Mischitz **Printing:** Druckerei Siepmann GmbH, Hamburg

doi:10.22003/XFEL.EU-COMIC-2021-001-EN

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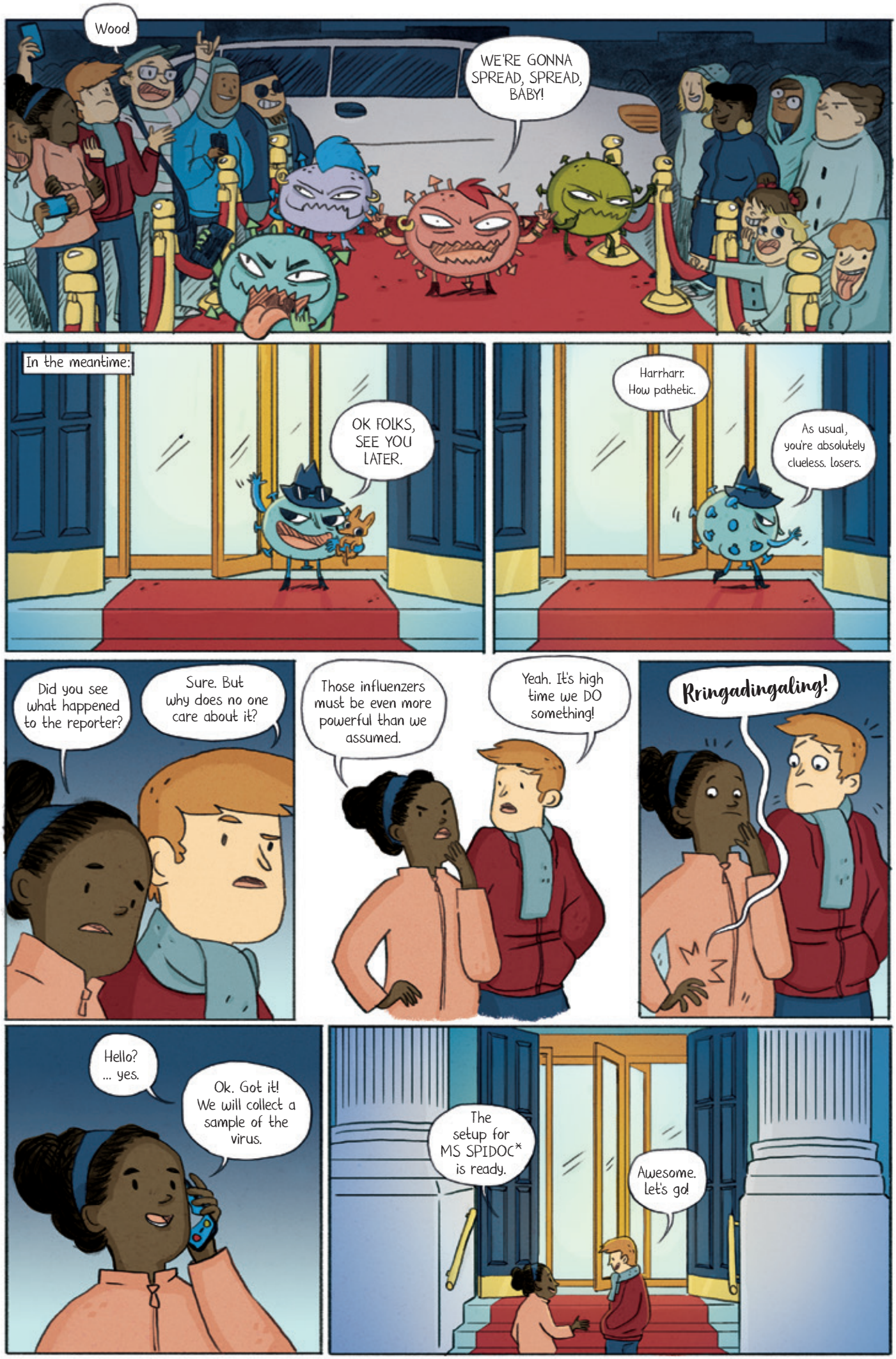
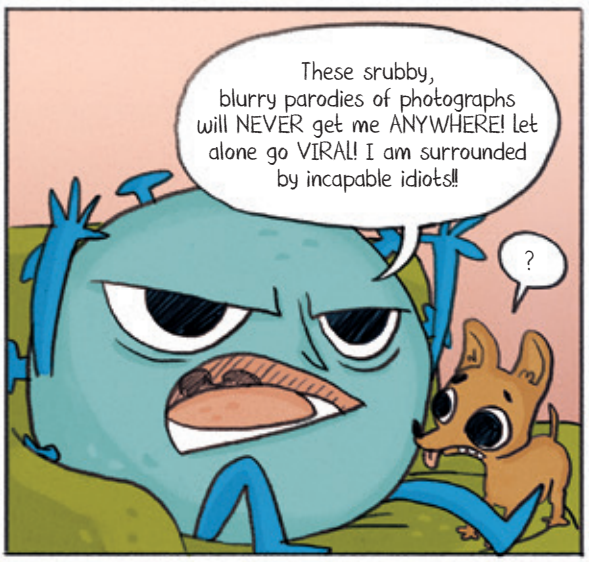
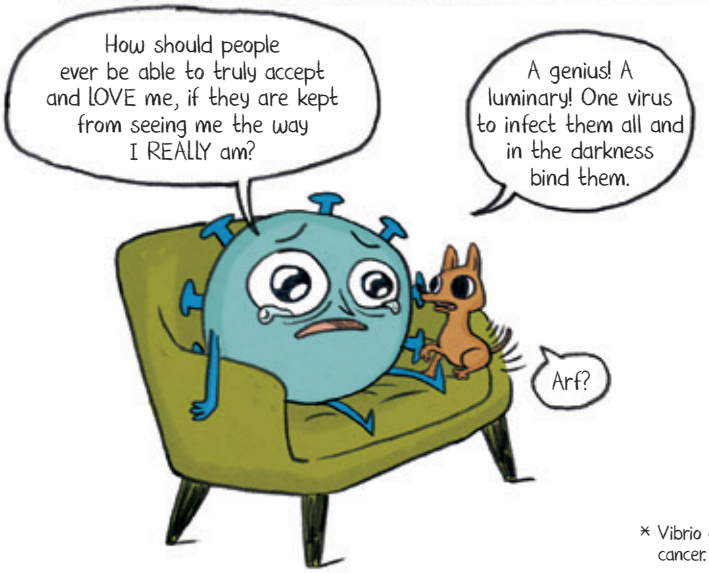
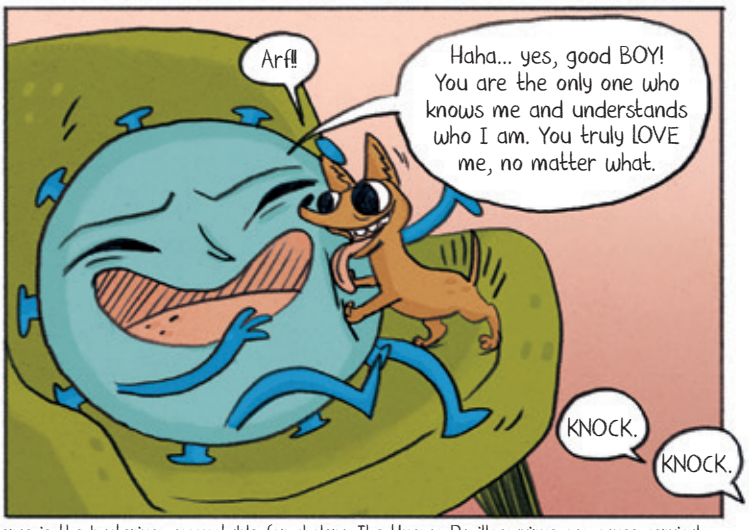
"Welcome back to the SPREADY AWARDS. Are you ready to meet the top influenzers tonight?"
OMG, NORO!!
NORO!! OVER HERE!
Hey folks, what's up?
I NEED A SELFIE!
"Notorious V.I.R" aka Noro just arrived on the red carpet. He is the HOTTEST influenzer in town right now, so let's get him over to the mic!
Watch TV
Noro! ... Notorious V.I.R.! Over here, please!
Thank you! So you've been nominated for a SPREADY - again! How does it feel to take the lead in popularity so many years in a row?
It's Fantastic! I am bursting to go VIRAL!
Sounds good. Let's get some facts straight for our viewers: You have achieved absolutely EVERYTHING in your career: fame, riches. And yet you are carrying on. What keeps you going?
Watch TV
Oh, I am far from retirement, my dear. I expect my community to continue growing and multiplying. That's what ALL OF US truly want. Am I right?
Yeees ... infect, grow, multiply ...
... oooh, I'm feeling queasy ...
OMG, LOOK! THE MEASLES!



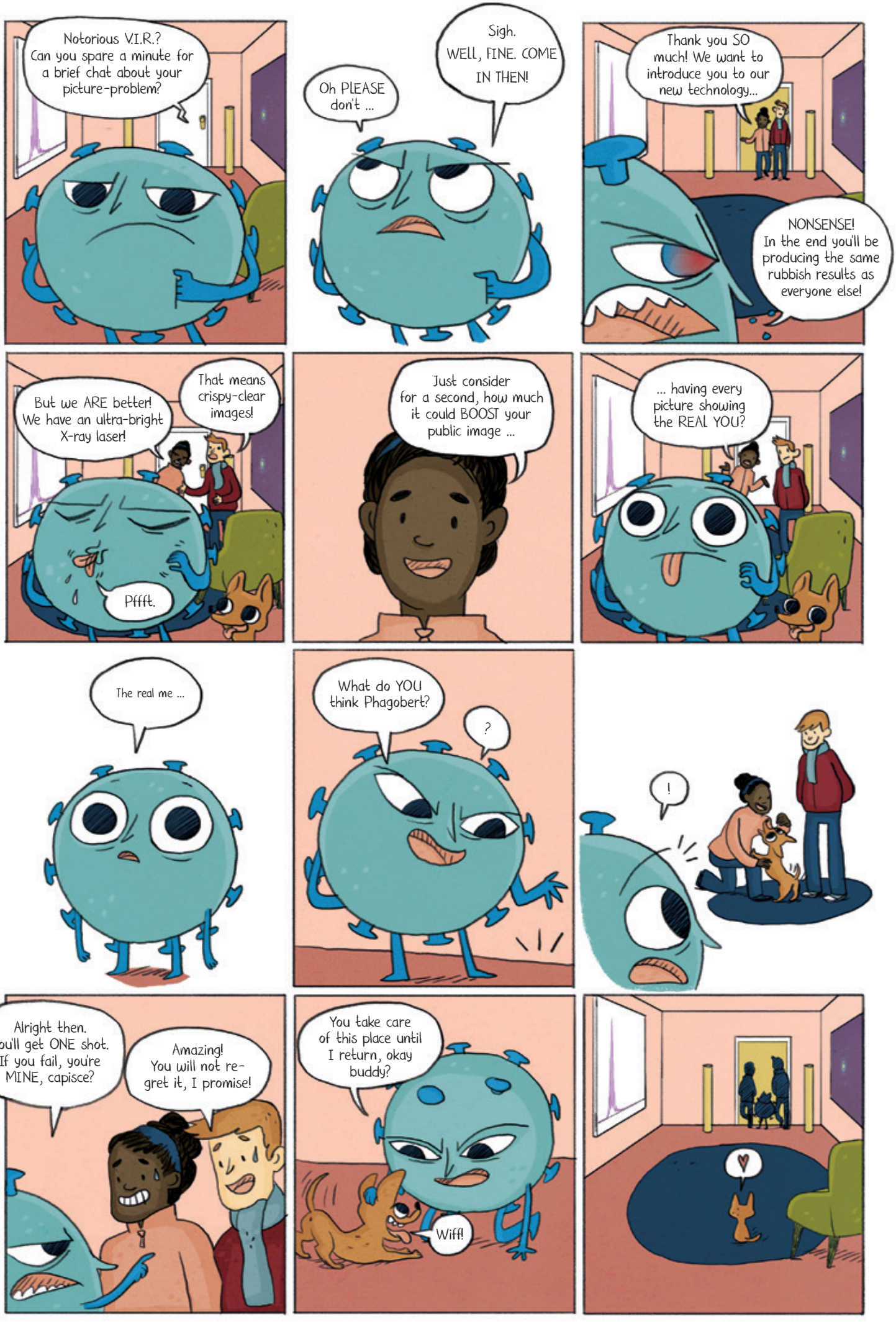
* MS-what?! Find out more about this exciting research project under www.ms-spidoc.eu







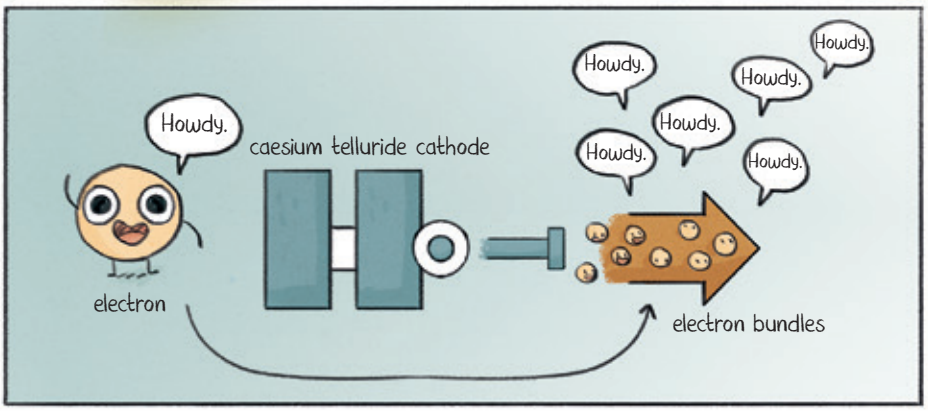
* Vibrio cholerae is the bacterium accountable for cholera. The Human Papillomavirus can cause cervical cancer. Norovirus itself can cause acute gastro-intestinal disease including severe vomiting and diarrhea.


Notorious V.I.R.? Can you spare a minute for a brief chat about your picture-problem?
Oh PLEASE don't ...
Sigh. WELL, FINE. COME IN THEN!
Thank you SO much! We want to introduce you to our new technology...
NONSENSE! In the end you'll be producing the same rubbish results as everyone else!
But we ARE better! We have an ultra-bright X-ray laser!
That means crispy-clear images!
Pffft.
Just consider for a second, how much it could BOOST your public image ...
... having every picture showing the REAL YOU?
The real me ...
What do YOU think Phagobert?
?
!
Alright then. You'll get ONE shot. If you fail, you're MINE, capisce?
Amazing! You will not regret it, I promise!
You take care of this place until I return, okay buddy?
Wiff!

You tell him where to go and we're off.
To the EUROPEAN XFEL in Schenefeld please.
... We're gonna spread, spread, Baby! Until you're dead, dead, maybe! ...
Gosh, I HATE this song.
Click.
Alright ...
... I want to learn EVERYTHING there is to know about that X-ray laser thingy and all the other stuff!.
Sure! So first, the free-electron X-ray laser creates FREE ELECTRONS (negatively charged particles which are no longer associated with positively charged particles). They are generated in the so-called injector by an electron gun. Here a laser-beam hits a cathode made of caesium telluride and smashes the electrons out of the material. Those electrons fly away from the cathode and then... blahblah
?
WHOAH, HOLD ON! Are we supposed to UNDERSTAND this?!
...
Let's try this one more time. But make it simple and understandable.
Okay, sooo ...

... we are on our way to the EUROPEAN XFEL. This is where we create the brightest and fastest X-ray flashes in the world. They enable us to shoot incredible, high-quality images, even of viruses ... ehm, I mean influenzers, of course.

1 ELECTRON SOURCE



We use electrons as ENERGY CARRIERS. Electrons are tiny, negatively charged particles. Our ELECTRON SOURCE (cathode) emits a cloud of billions of these electrons ten times per second. Since they carry a charge, we can manipulate them with electric and magnetic fields. At this stage for example, we use a strong magnet to bundle them and send them off towards the particle accelerator.

3.4 km

3

2

accelerator tunnel

This section of the underground tunnel system is 1.7 km long, a bit longer than we depicted here.

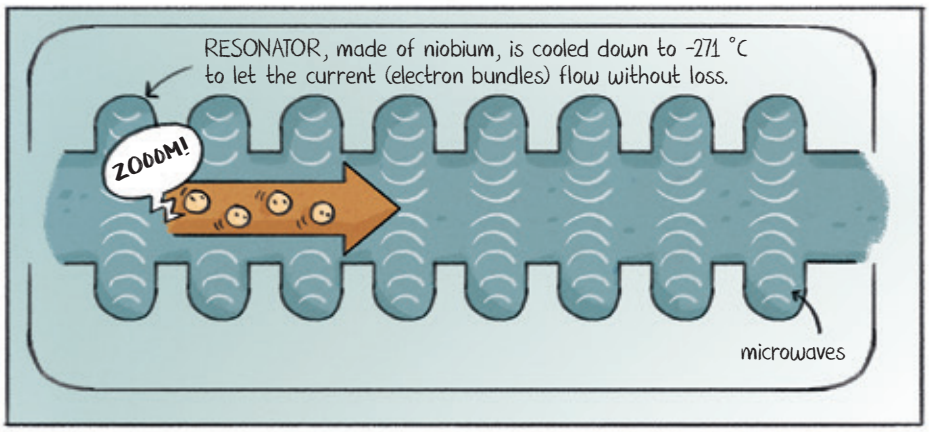
1

electron source

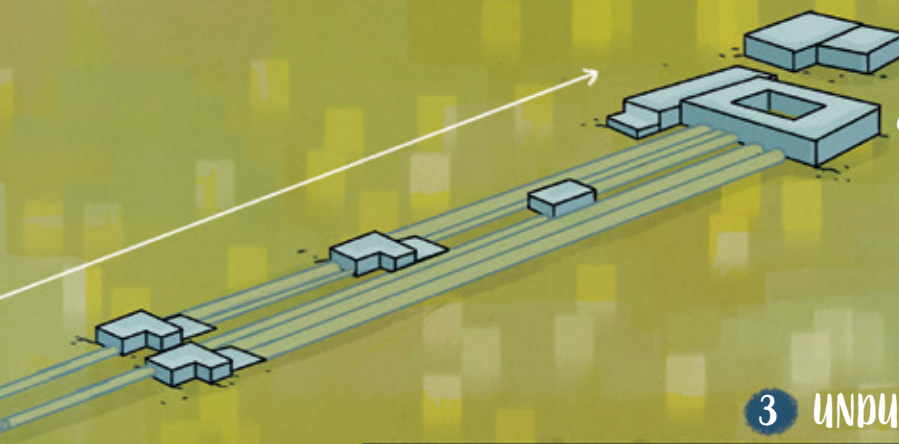
Welcome at the Science-Campus Bahrenfeld! This is where the electrons start their 3.4 km journey through the research facility.

Individual components such as the cathode or the undulators were developed, built and perfected by joint experts from all over the world in order to create the fastest and most powerful X-ray laser possible.

2 ACCELERATOR



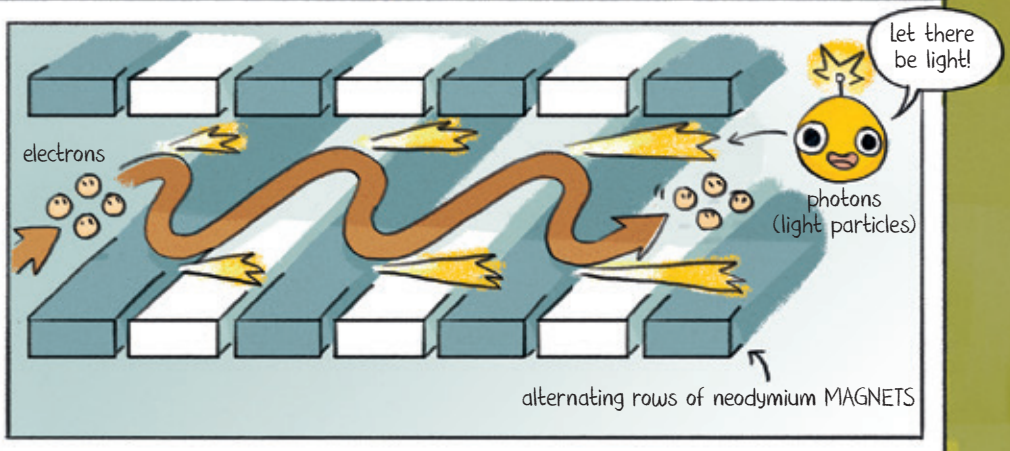
This is where the electron bundles get hustled and pulled through the ACCELERATOR by electro-magnetic waves. With every push and pull the electrons gain energy. Did you know that electrons move almost at the speed of light while zooming through the accelerator? The individual sections of the accelerator are called RESONATORS.



experiment hall

Here at the European XFEL in Schenefeld we direct the laser flashes into six experiment stations.

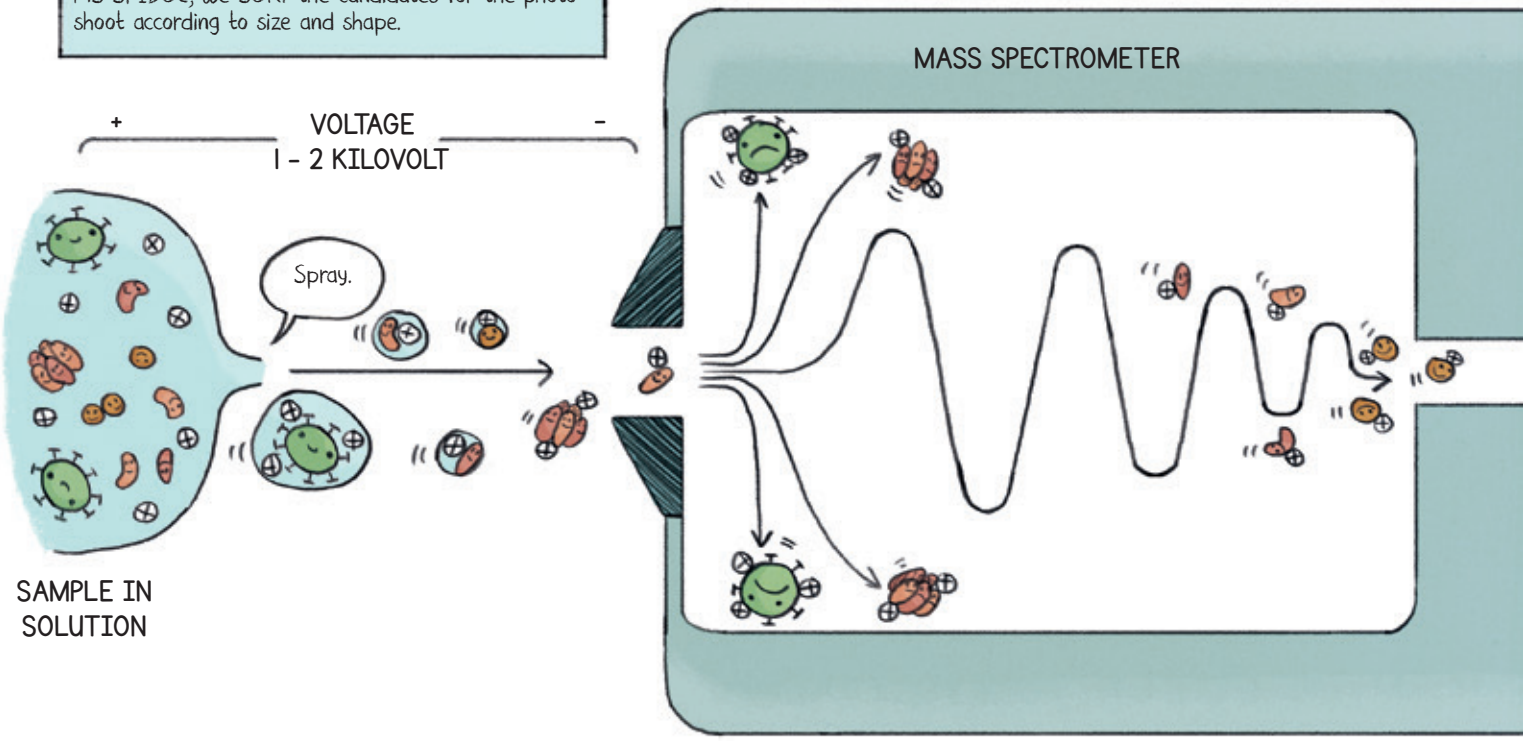
3 UNDULATOR



We force the electrons on a zigzag course using magnets again. With every change of direction the electrons give off a part of their kinetic energy as light. This light then further excites the neighboring electron bundels. In the end, this results in extremely bright flashes of light, only a few femtoseconds in length.

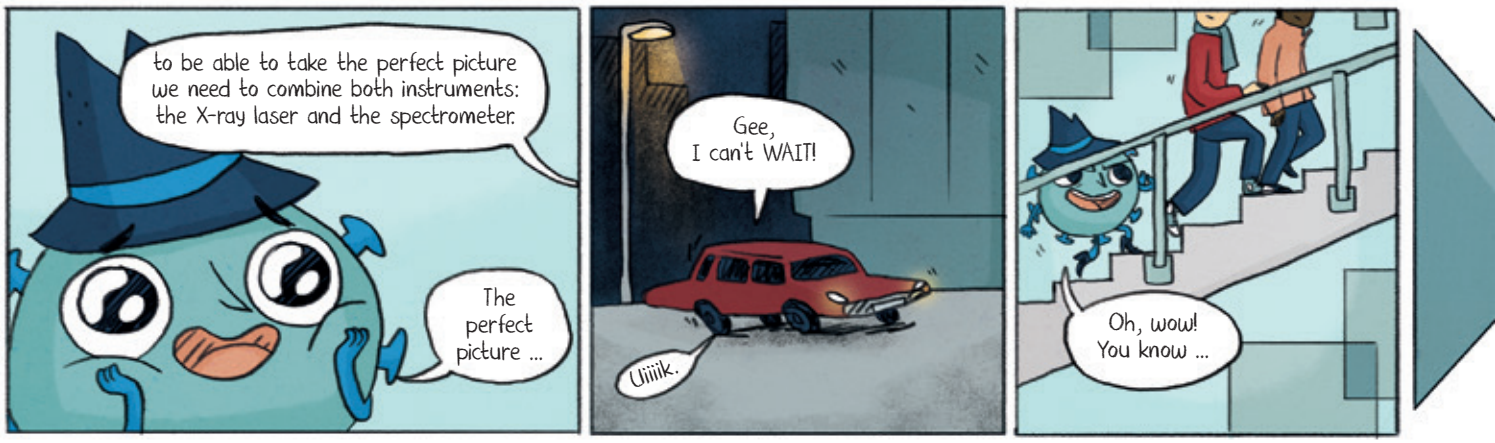
These ultrashort pulses of super intense light help us to shoot thousands of pictures per second at three experiment stations simultaneously - enabling us to study even single molecules!

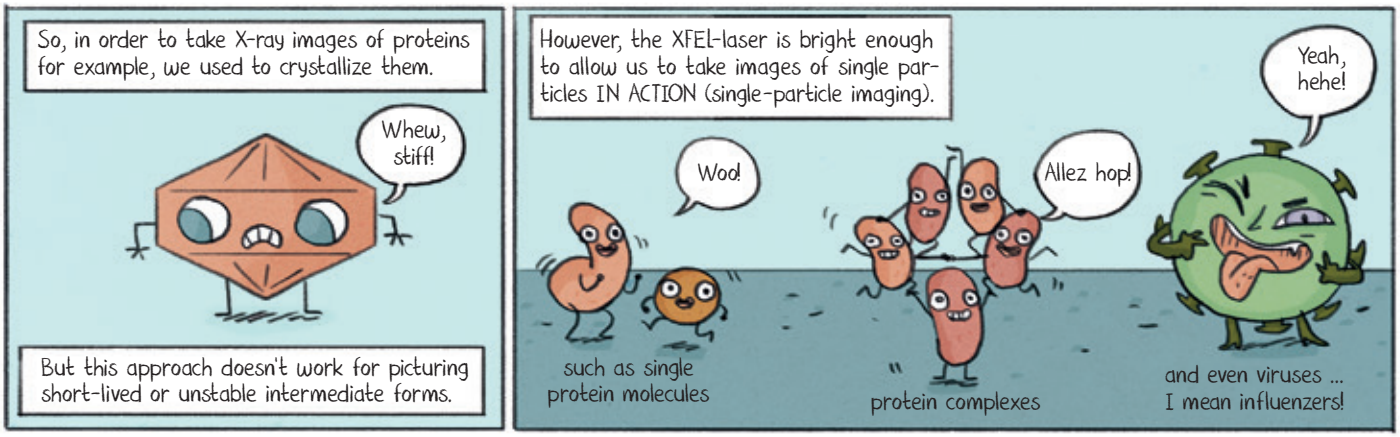
With a special kind of mass spectrometer, designed by MS SPIDOC, we SORT the candidates for the photo shoot according to size and shape.

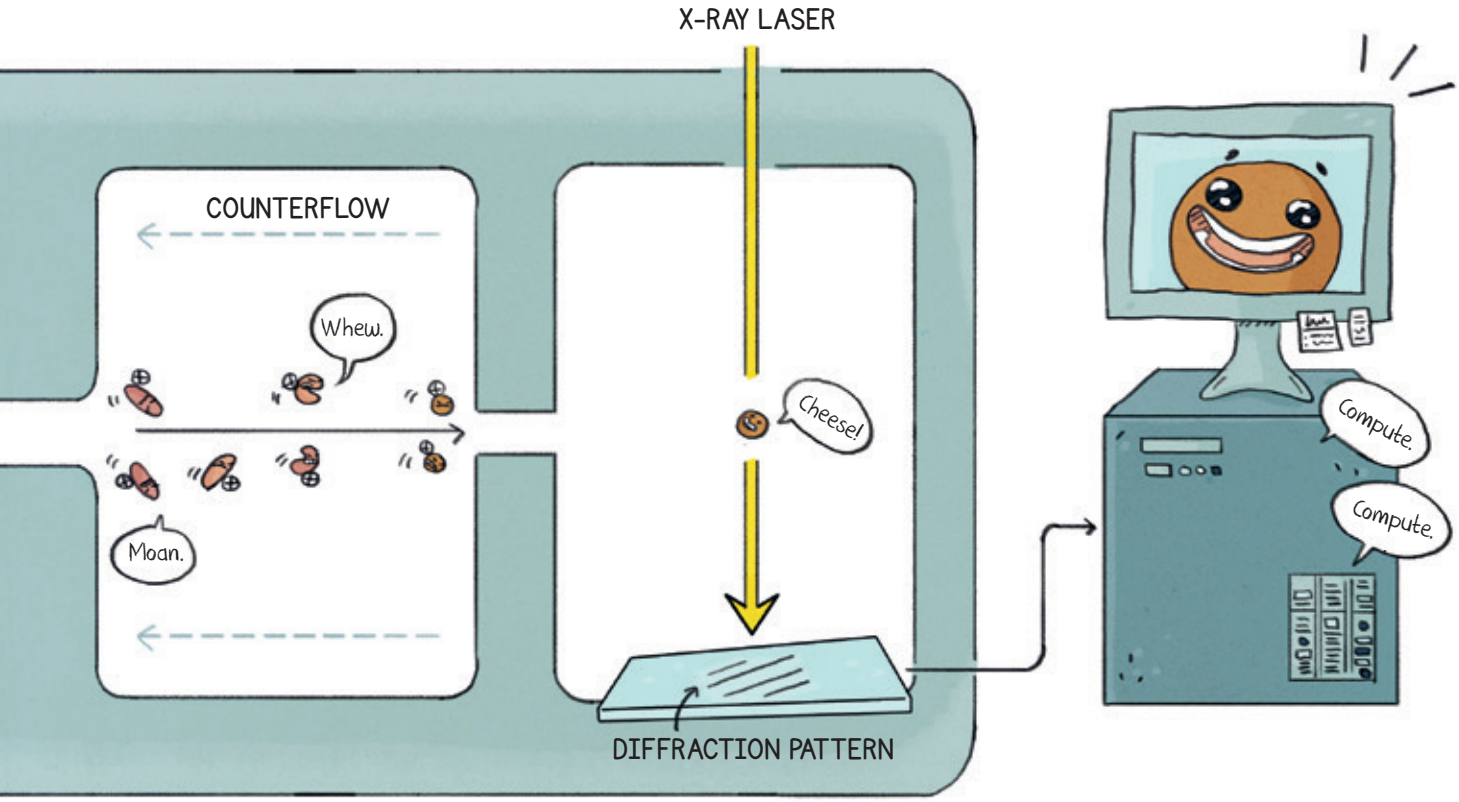


Protein building blocks are ACTIVE and can interact with each other within the SOLUTION. If we apply voltage, the solution starts spraying towards the mass spectrometer. On the way the solvent „dries" and positive charges are transferred onto the proteins. They are now charged particles themselves. We can use electric fields to manipulate them, for example make them fly through the entire apparatus.

In the first chamber of the spectrometer these charged particles (ions) fly through an alternating electric field. The frequency of the electric field determines which particles will pass and which will not. We separate all particles according to the ratio of mass to charge (m/z). Broadly speaking, any particle which is too heavy or too light won't make it through.



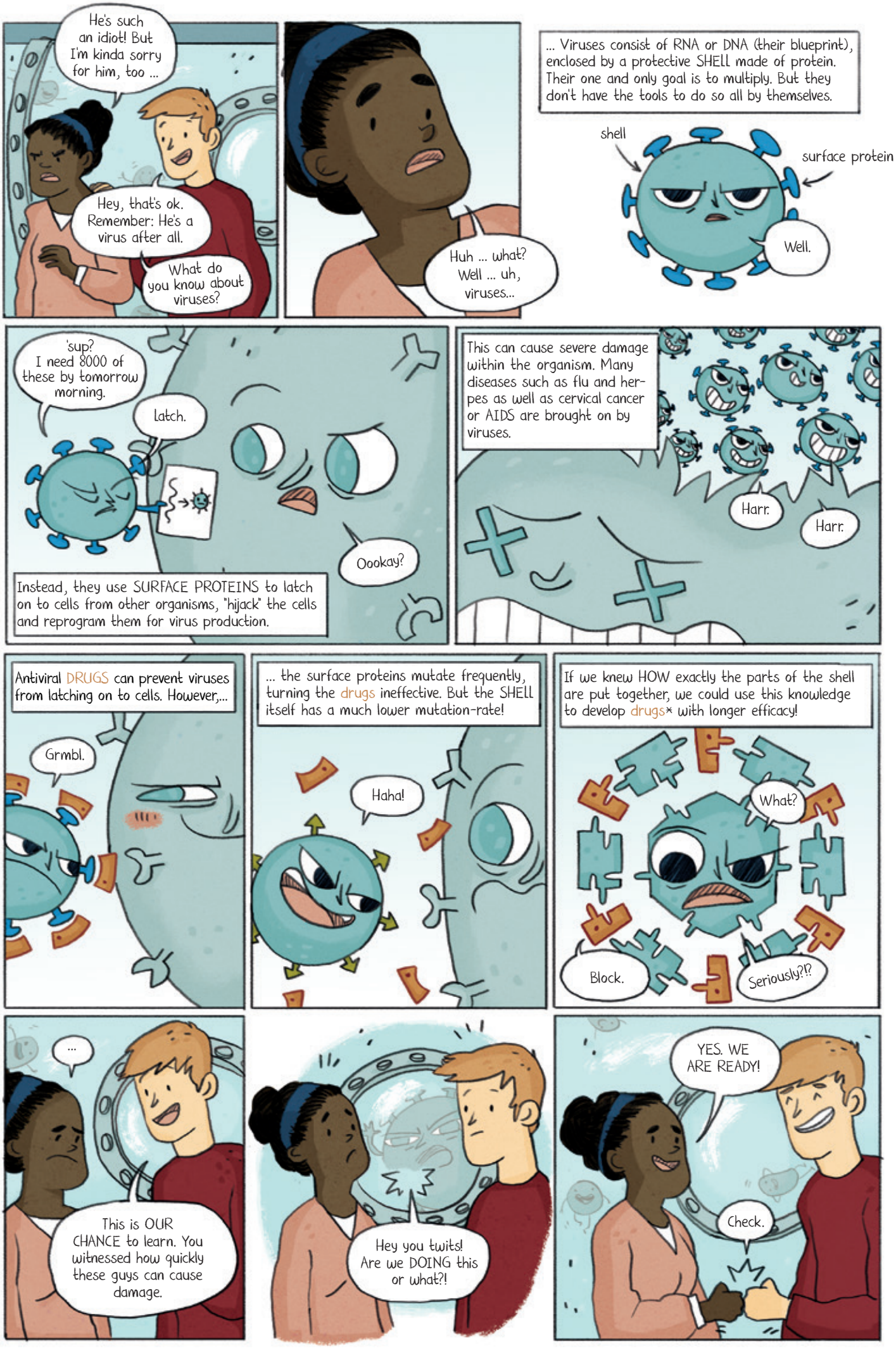




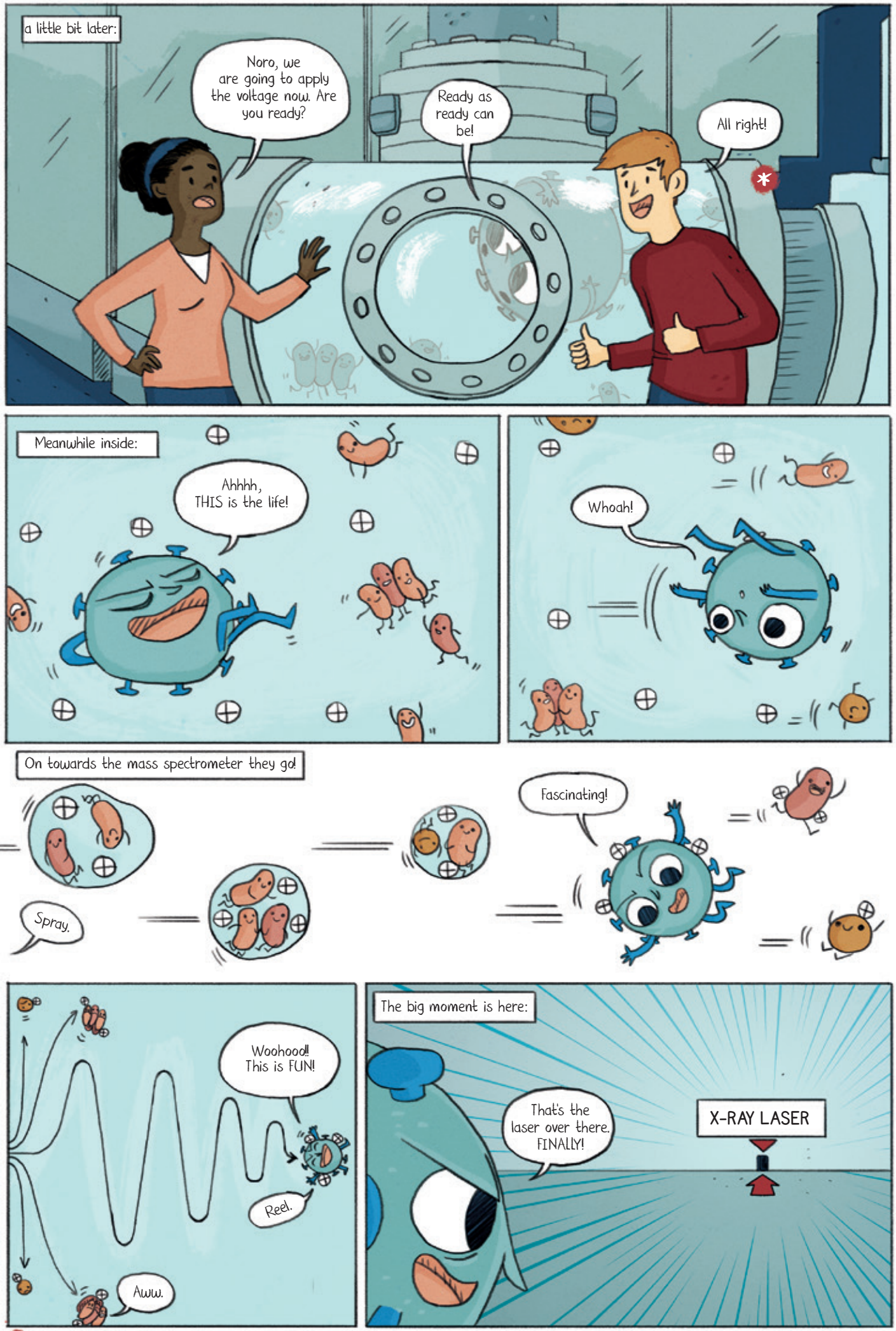
This part of the spectrometer works like a molecular "wind tunnel". Here we separate proteins and complexes of the same size based on their shape. Large area particles are slower than compact particles.

Now, if the X-RAY LASER hits a particle it creates a diffraction pattern, which can be recorded. Due to the careful separation by size and shape, we always know exactly WHO is being photographed and WHEN.

With this information at hand, "developing" the images becomes a lot easier. A computer collects and sorts all data and eventually CALCULATES the actual structures of the particle.



* Without vaccinations and antiviral drugs, we would be defenseless against many dangerous viruses.



The REAL experimental set-up for MS SPIDOC does look a bit different than depicted here, of course. You can ask to see it on one of our guided campus tours.

Wow! The light ... it's ... it's ... absolutely BEAUTIFUL!
ZAPP!
What? That's it? did it work?
We don't know yet. The computer is busy calculating.
This can take a while.
wrr.
wrr.
Bing!
Yeeees, we did it!!
A small step for Noro - a big one for scientists fighting viruses!
NOROVIRUS
LABNOTES

THE END

Team
NOROVIRUS SUPERSTAR

VÉRO MISCHITZ is a biologist and currently works as freelance comic artist in science communication. She created this comic.

CHARLOTTE UETRECHT is a structural virologist and group leader at HPI. She is coordinator of MS SPIDOC and had the original project idea to employ MS to image viruses at the X-ray laser.

KRISTINA LORENZEN is a structural biologist and head of the user laboratories at the EUROPEAN XFEL. She is the vice coordinator of MS SPIDOC, responsible for the integration of the project at the X-ray laser.

ARWEN CROSS is a science communicator with a background in biology. At European XFEL she is coordinator of the Visitor Centre.

SILVIA WISSEL is an economist and project manager at HPI. For MS SPIDOC she takes care of coordination of tasks among the partners and for reporting towards the European Commission.

About MS SPIDOC

Mass Spectrometry for Single-Particle Imaging of Dipole Oriented Protein Complexes

The X-ray laser European XFEL produces thousands of pulses of very brilliant light every second. The high-quality beam enables single particle imaging (SPI) of protein complexes, meaning the proteins do not need to be frozen in a crystal lattice for imaging. Using this method researchers aim to study transient states of proteins that are moving or changing shape. They will produce molecular movies that explain biological processes and functions. A bottleneck in this process is the amount of data required to reconstruct the individual structures that are the frames of these films. The project MS SPIDOC aims to simplify the structure calculations by improving sample delivery. The project is developing a native mass spectrometry (MS) system to deliver biological molecules to the X-ray laser for imaging. This system selects biomolecules by mass and conformation and orients them for imaging. Knowing the sample orientation makes the structure calculations simpler, reducing the size of datasets and speeding up analysis. Better analysis of biomolecules is useful in many fields including virus research, as described in the comic.

More information about the X-ray laser facility European XFEL and the EU-project MS SPIDOC:

www.xfel.eu **www.ms-spidoc.eu**

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