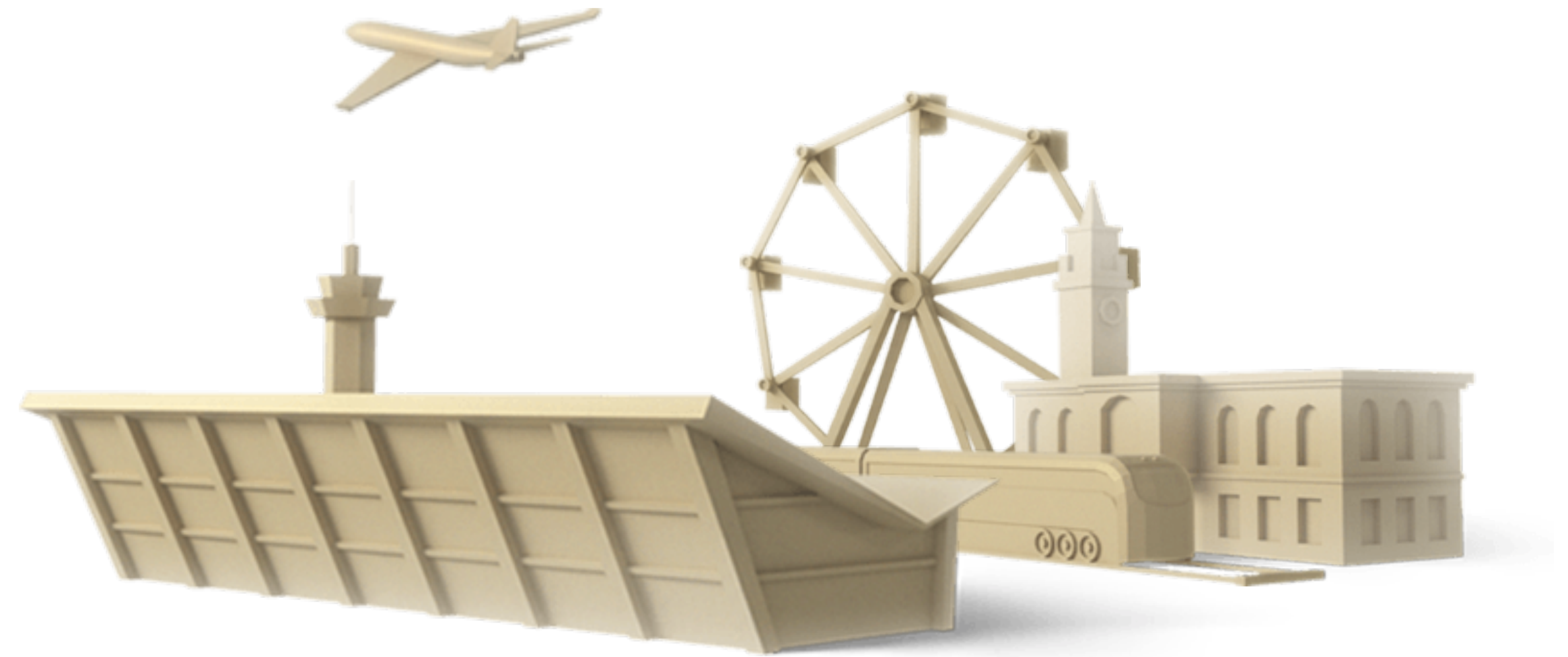


KÄRSA



Potential for touch-less inspection of cargo and packages using mass spectrometry

www.karsa.fi © Karsa Ltd
Dr. H.J. Jost, CEO, hj.jost@karsa.fi
21 June 2018 ADSA-CPB-01

Ultra-sensitive detection of threat molecules

- Screening cargo and mail, detect threat particles without touch $<0.1\%$ FA or vapors as low as ppq; AI/ML data analysis
- Use world leading sensitive, robust mass spectrometry originally developed for atmospheric research
- Demonstrated on explosives at airport (TRL 6), currently extending to more explosives, drugs, TIC, CWA....
- hj.jost@karsa.fi +358 45 699 5005



What do the most cited geoscientist
and a bomb sniffer have in common?



What do most cited geoscientist and a bomb sniffer have in common?



Atmospheric Pressure Chemical Ionization
Mass Spectrometry (APCI)

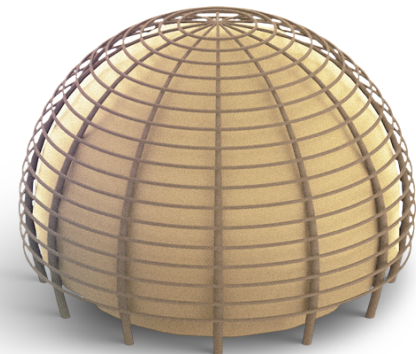
What do most cited geoscientist and a bomb sniffer have in common?



Atmospheric Pressure Chemical Ionization
Mass Spectrometry (APCI)

OK, enough gibberish!

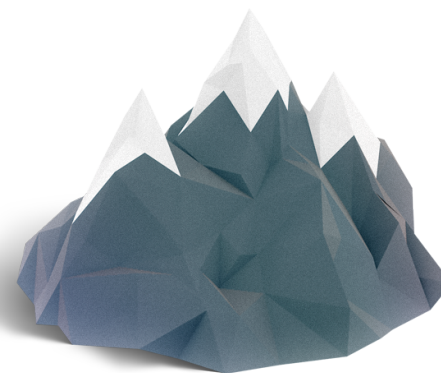
APCI technology has proven robust and reliable through years of worldwide measurement campaigns



CERN:
SWITZERLAND



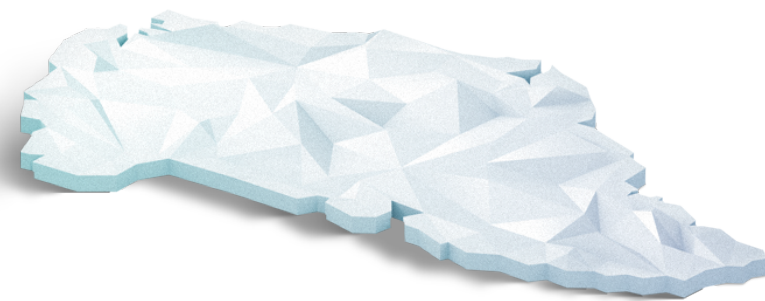
UNIVERSITY OF
HELSINKI



HIMALAYAS



BOREAL FORESTS



POLAR SITES:
GREENLAND

Direct Observations of Atmospheric Aerosol Nucleation

Markku Kulmala,^{1,*} Jenni Kontkanen,¹ Heikki Junninen,¹ Katrianne Lehtipala,¹ Hanna E. Manninen,¹ Tuomo Nieminen,^{1,14} Tuukka Petäjä,¹ Mikko Sipilä,¹ Siegfried Schobesberger,¹ Pekka Rantala,¹ Alessandro Franchin,¹ Tuija Jokinen,¹ Emma Järvinen,¹ Mikko Äijälä,¹ Juha Kangasluoma,¹ Jani Hakala,¹ Pasi P. A. Pauli Paasonen,¹ Jyri Mikkilä,² Joonas Vanhanen,² Juho Aalto,³ Hannele Hallenka,⁴ Ulla Makkonen,⁴ Taina Ruuskanen,¹ Roy L. Mauldin III,^{1,5} Jonathan Duplissy,¹ Hanna Vehkamäki,¹ Jaana Bäck,⁶ Aki Kortelainen,⁷ Ilona Riipinen,⁸ Theo Kurten,⁹ Murray V. Johnston,¹⁰ James N. Smith,^{7,11} Mikael Ehn,^{1,12} Thomas F. Mentel,¹ Kari E. J. Lehtinen,^{4,7} Ari Laaksonen,^{4,7} Veli-Matti Kerminen,¹ Douglas R. Worsnop

Atmospheric nucleation is the dominant source of aerosol particles in the global atmosphere and an important player in aerosol climatic effects. The key steps of this process of sub-2-nanometer (nm) size range, in which direct size-segregated observations were not possible until very recently. Here, we present detailed observations of atmospheric nucleation and clusters down to 1-nm mobility diameter. We identified three separate size regimes of 2-nm diameter that build up a physically, chemically, and dynamically consistent picture of atmospheric nucleation—more specifically, aerosol formation via neutral pathways. Our findings emphasize the important role of organic compounds in atmospheric aerosol nucleation, subsequent aerosol growth, radiative forcing and associated feedbacks between aerosols, clouds, and climate.

Atmospheric aerosol formation [that is, the formation of molecular clusters and their growth to larger sizes (J , Z)] has an important effect on aerosol particle number concentrations (3, 4) and on climate through indirect radiative effects (5, 6). To understand the initial steps of atmospheric aerosol formation, one must have detailed knowledge of the concentrations of neutral and charged clusters, their chemical composition, and gaseous compounds participating in their formation. Atmospheric aerosol nucleation is a very rare, and until now, not observed comprehensively and simultaneously in the atmosphere. Recent technical developments have made it possible to measure the concentrations of ions, molecular clusters, and nanoparticles in the 1- to 2-nm size range and to simultaneously observe the chemical composition of these clusters.

Oxidation Products of Organic Compounds Contribute to Atmospheric Particle Growth

Francesco Riccobono,^{1,*} Siegfried Schobesberger,² Carlos Ismael K. Ortega,^{2,†} Linda Rondo,⁴ João Almeida,⁴ Alexander N. Kuvshinov,⁴ Martin Breitenlechner,⁶ André David,⁷ Andrew Downson,⁷ Jonathan Duplissy,^{2,12} Sebastian Ehrhart,⁴ Richard C. Flagan,¹² Stefan Frey,⁴ Armin Hansel,⁶ Heikki Junninen,² Maija Kajos,² Helmi Keskinen,⁴ Andreas Kürten,⁴ Alexander N. Kuvshinov,¹¹ Ari Laaksonen,¹¹ Vladimir Makhmutov,¹¹ Serge Mathot,⁷ Tuomo Nieminen,¹

A new atmospherically relevant pathway for sulphur dioxide

R. L. Mauldin III^{1,2,3}, T. Berndt⁴, M. Sipilä^{1,4,5}, P. Paasonen¹, T. Petäjä¹ & M. Kulmala¹

Atmospheric oxidation is a key process in atmospheric chemistry with global impacts, such as climate change¹, soil acidification², and the formation of soils and water³, and the formation of aerosols⁴.

Role of sulphuric acid, ammonia and organic vapours in atmospheric aerosol nucleation

Jasper Kirkby¹, Joachim Curtius¹, Alessandro Franchin⁵, Francesco Riccobono⁹, Federico Bianchi^{9,11}, Mikko Sipilä¹, Richard C. Flagan¹², Stefan Frey⁴, Alexander Kuvshinov¹³, Alexander N. Kuvshinov¹³, Serge Mathot¹, Jyri Mikkilä², Ralf Schnitzhofer⁸, John H. Seinfeld⁸, Yrjö Viisanen¹⁶, Aron V. Williams¹⁶, Kenneth S. Carslaw⁴, Douglas R. Worsnop

Atmospheric aerosols exert a significant influence on the climate system through their effects on the radiation balance and the invigoration of convective clouds. It is estimated that almost half of the aerosol mass in the atmospheric boundary layer is composed of organic aerosols from trace condensation of organic vapours.

The Role of Sulfuric Acid in Atmospheric Nucleation

Mikko Sipilä,^{1,2,3,*} Torsten Berndt,¹ Tuukka Petäjä,² David Brus,^{4,5} Joonas Vanhanen,² Frank Stratmann,¹ Johanna Patokoski,² Roy L. Mauldin III,⁶ Antti-Pekka Heikkilä,⁵ Markku Kulmala^{2,7}

Nucleation is a fundamental step in atmospheric new-particle formation. Despite decades of experiments on nucleation have systematically failed to demonstrate sulfuric acid formation rates as high as those necessary to account for ambient atmospheric nucleation, the role of sulfuric acid in atmospheric nucleation has remained a mystery. Here, we show that measurements of new particles (with diameters of approximately 1.5 nm) immediately after their formation at atmospherically relevant sulfuric acid concentrations suggest that freshly formed particles contain one to two molecules of sulfuric acid. Furthermore, we show that correlations between measured nucleation rates and sulfuric acid concentrations suggest that freshly formed particles contain one to two molecules of sulfuric acid. These findings into global models should improve the understanding of the role of particle formation on climate.

Nucleation of particles in the atmosphere has been observed to be strongly dependent on the abundance of sulfuric acid. However, laboratory experiments have systematically failed to

large indirect effects of aerosols on climate. Laboratory experiments have systematically failed to

Molecular understanding of particle nucleation in the atmosphere

João Almeida^{1,2}, Siegfried Schobesberger³, Andre Alexey Adamov³, Antonio Amorim⁵, Federico Bianchi⁹, Andrew Downard⁸, Eimear Dunne⁹, Jonathan Duplissy¹, Roberto Guida², Jani Hakala³, Armin Hansel⁶, Maija Kajos³, Juha Kangasluoma³, Helmi Keskinen⁴, Ari Laaksonen^{10,14}, Katrianne Lehtipala³, Markus Mathot², Matthew J. McGrath¹⁵, Tuomo Nieminen¹⁷, Ilona Riipinen¹⁷, Matti Rissanen⁹, Linda Rondo¹, Ralf Schnitzhofer⁶, John H. Seinfeld⁸, Mario Simón-Jiménez¹⁴, Georgios Tsagkogeorgas¹⁸, Petri Vaari¹, Ernest Weingartner⁴, Heike Wex¹⁸, Christina Willmann¹, Markku Kulmala¹⁶, Joachim Curtius¹, Ulla Makkonen⁴

Team



MIKKO SIPILÄ
Science Fellow



H.J. JOST
Chief Executive Officer



ALEKSEI SHCHERBININ
Chief Product Officer
Chief Financial Officer



JANI HAKALA
Senior Scientist



OSKARI KAUSIALA
Algorithm Engineer



JAYAPRASAD BOJJA
Senior Software Specialist



VERNER HEMMILÄ
Product Development
Engineer



JYRI MIKKILÄ
Director of Engineering

World leading sampling and
detection experts

150
PUBLICATIONS

12
IN SCIENCE/
NATURE

4
RELVANT
PATENTS

Silicon Valley veteran CEO

The Problem

We live in a world where terrorists are trying to disrupt our way of life and too many people loose their lives to illicit drugs.

Deadly Delivery: Opioids By Mail

May 24, 2018 · 5:00 AM ET

BRIAN NAYLOR



U.S. Postal Service mail vehicle. Justin Sullivan/Getty Images

The nation's opioid prescription of pain

TSA Misses 70% Of Fake Weapons But That's An Improvement



TSA agents work at the security checkpoint at the Fort Lauderdale-Hollywood International airport on March 14, 2017 in Fort Lauderdale, Florida. (Photo by Joe Raedle/Getty Images)

When does a 70% failure rate actually represent an improvement? When we are talking about the efforts of the Transportation Security Administration (TSA) to detect weapons at airport checkpoints.

Solution

Karsa creates innovative
molecular threat detectors.



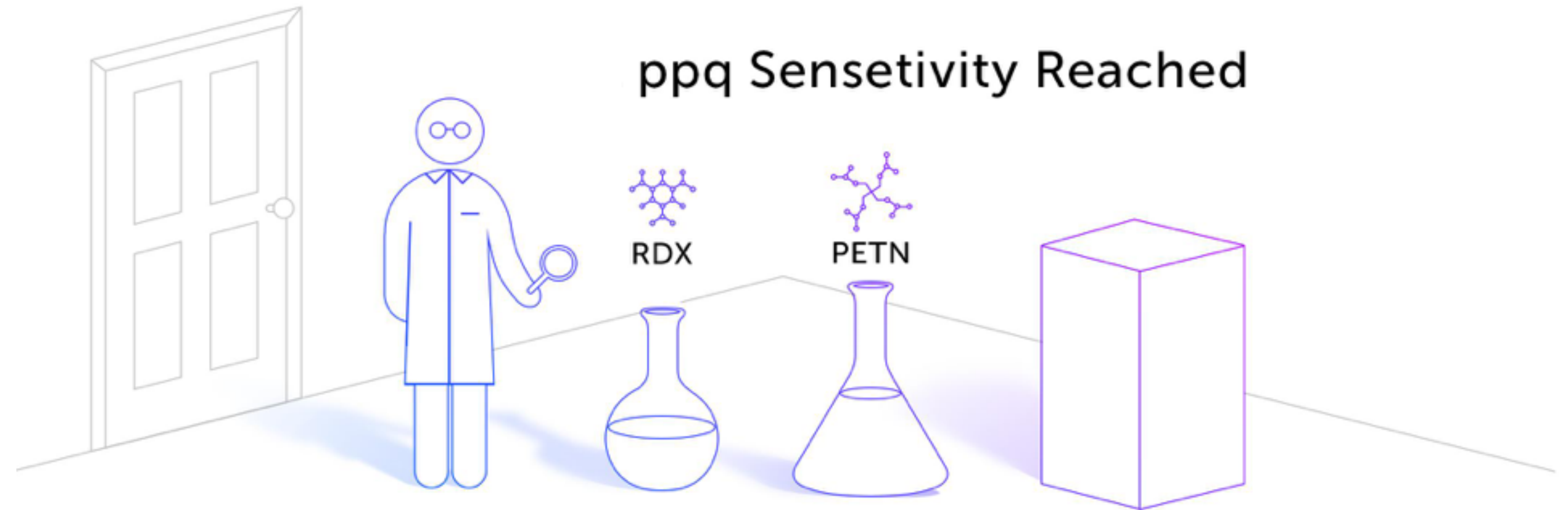
Milestones

2014

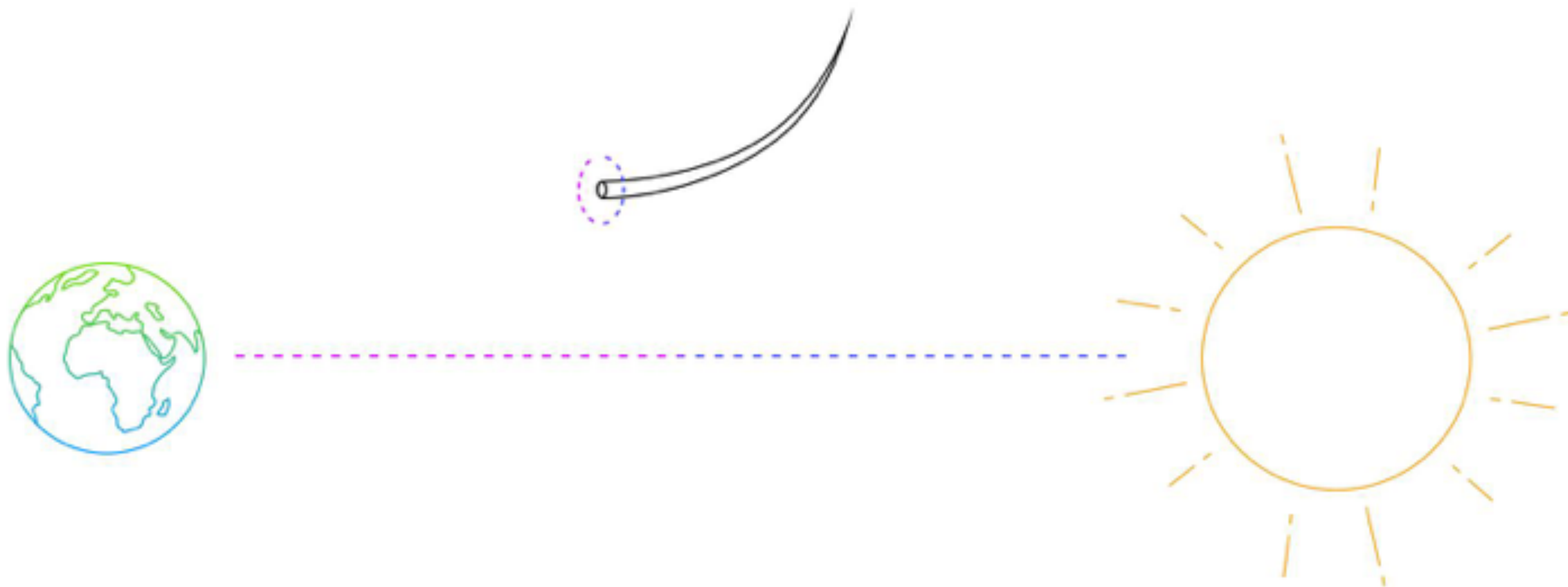
measurements
of explosives

Know-how applied in Explosives Trace Detection

ppq Sensitivity Reached



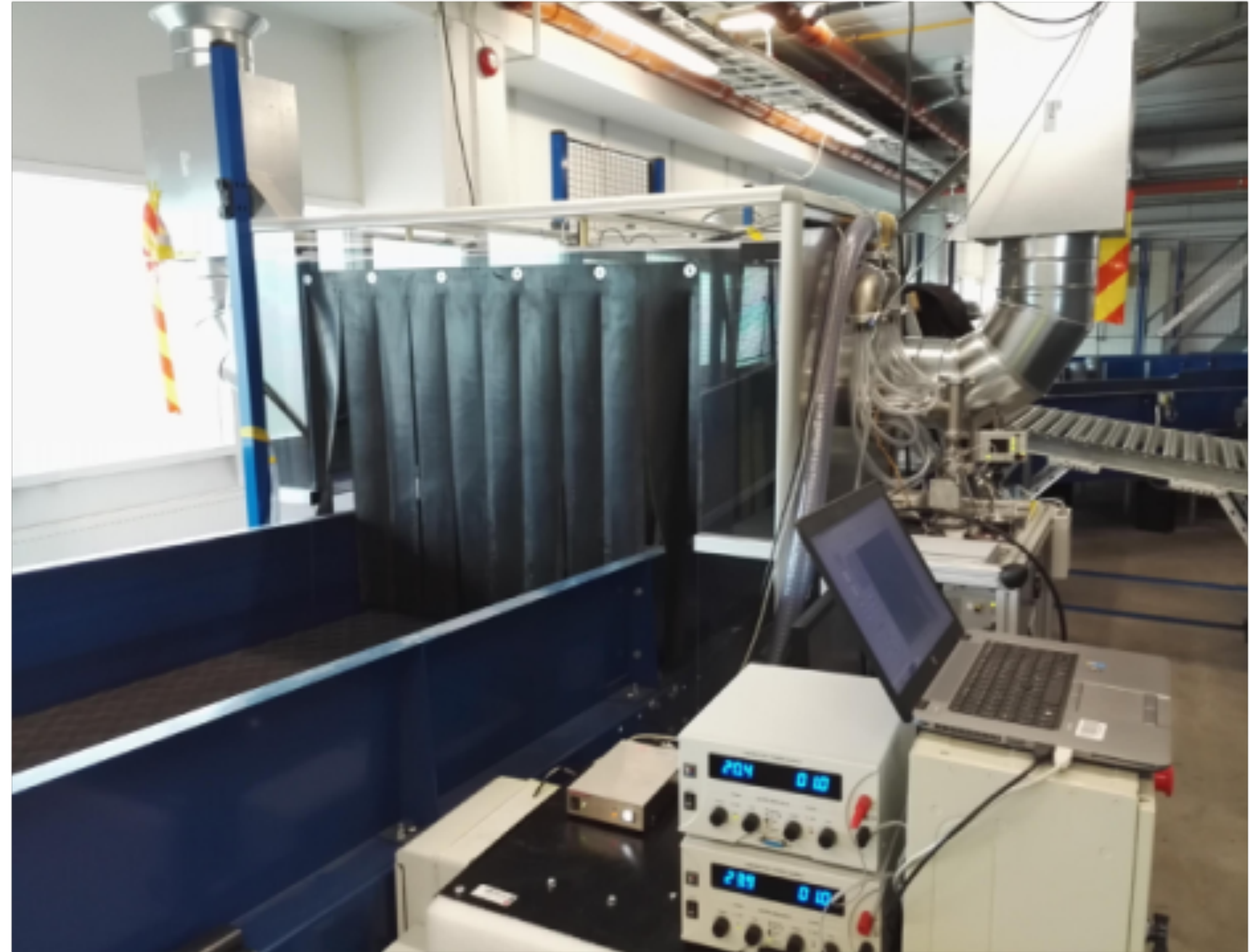
**Diameter of a hair
corresponds to 1 part per quadrillion
of distance between Earth and Sun**



Milestones

H1 2016

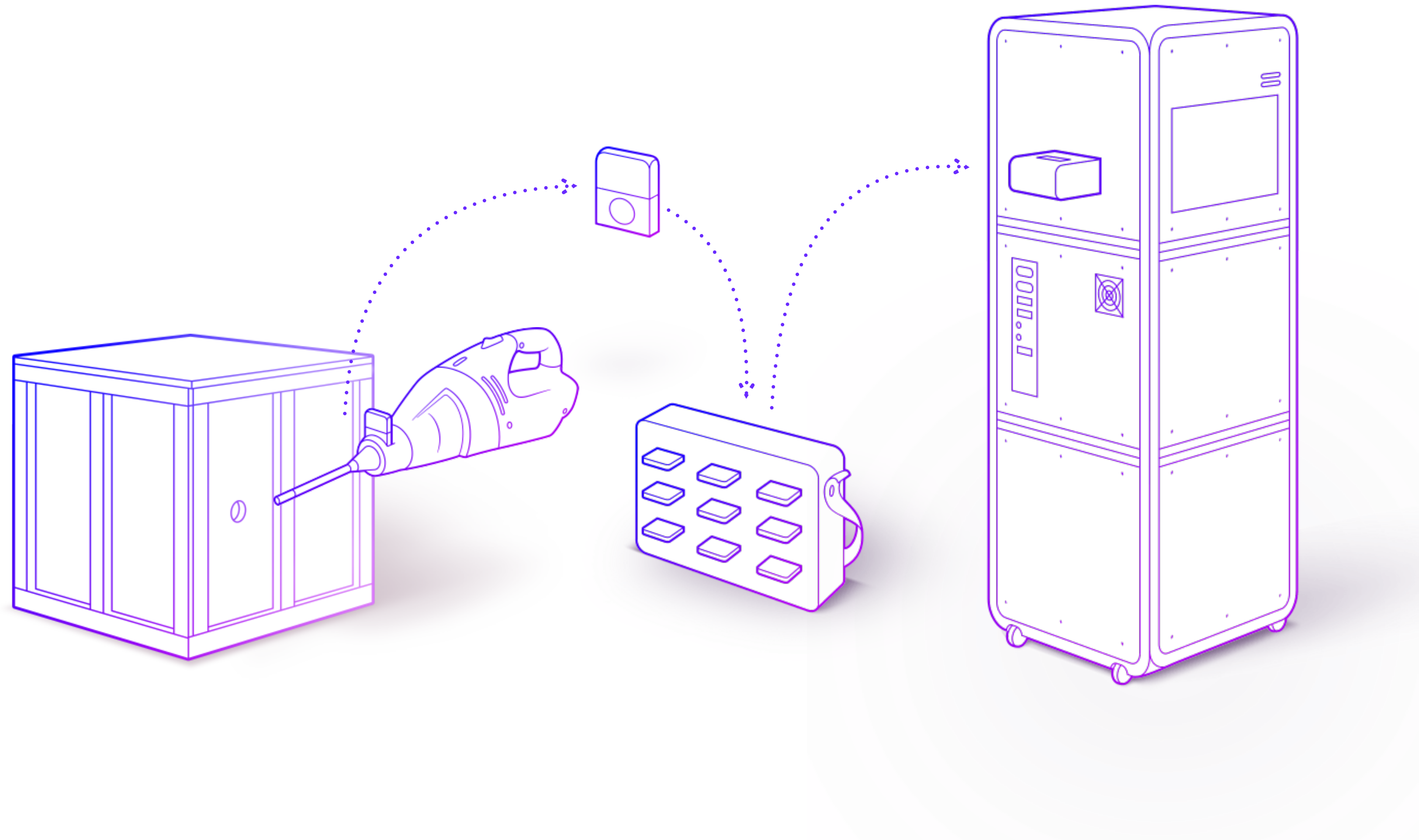
- 9000 bags scanned at airport
- $< 0.1\%$ false positives
- Up to 2000 objects/hour
- Detecting amounts of explosives without touch



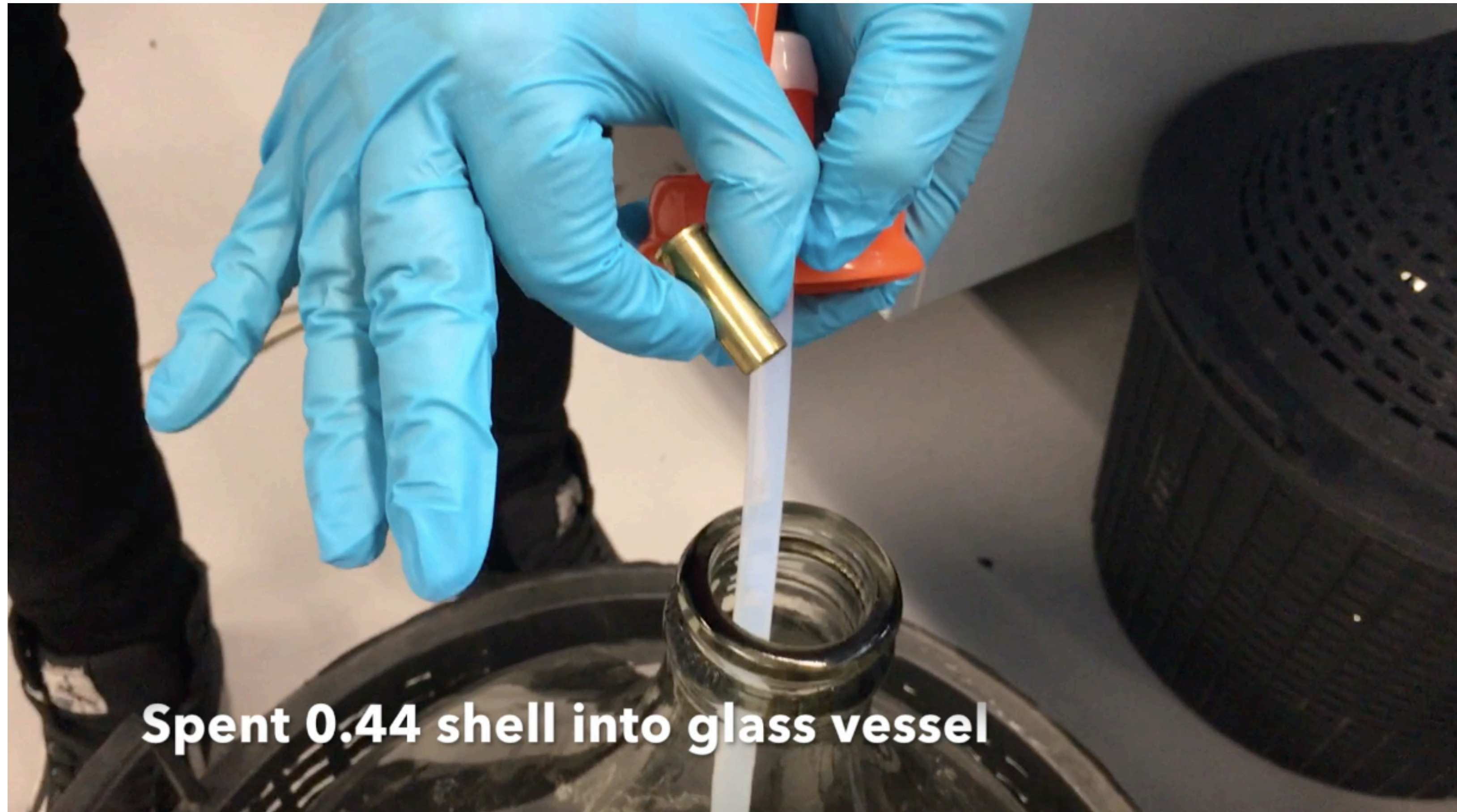
Scenthound™

Screening Air Cargo for Explosives Vapours

First certified product of its
kind for upcoming ECAC
Explosives Vapour Detection
(EVD) standard



Movie



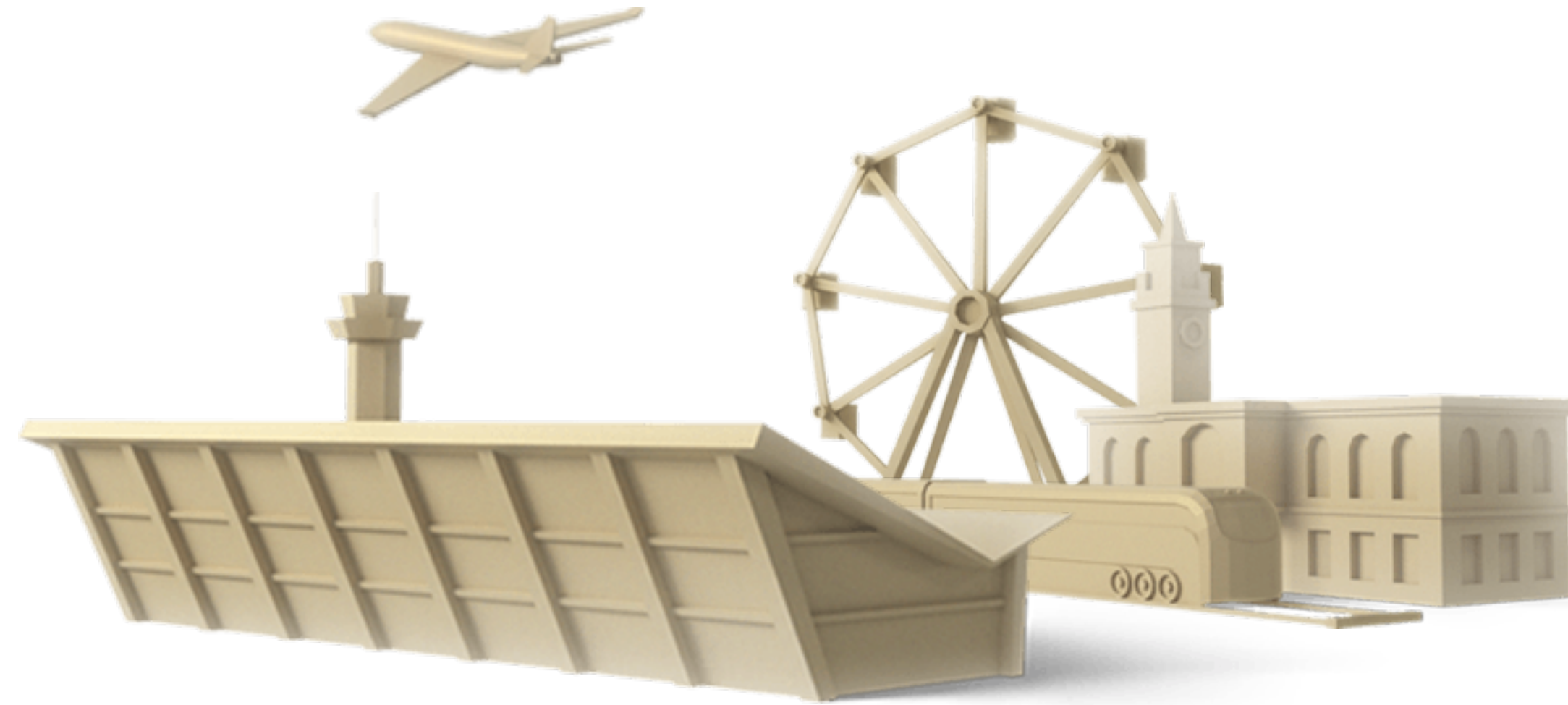
What does Karsa offer to CBP

- Proven touch less detection of explosives particles on outside of packages
- Demonstrated detection of explosives vapors from inside package
- Focused team of experts to solve sampling problems utilizing ultra sensitive, robust detection system
- Literature suggests APCI works for most threats, 10-1000x more sensitive than other methods
- Currently 14 explosives threats in library
- Planning to expand to 40 including drugs and CWA in 2019

What does Karsa expect from CBP

- Expecting to learn about CBP requirements:
 - priority of threats
 - Throughput
 - CONOPS
- AI and ML algorithms to detect threats in complex cargo background need data
- Looking for funding to demonstrate CBP relevant threats

KÄRSA



We are doing it for better security

www.karsa.fi © Karsa Ltd
Dr. H.J. Jost, CEO, hj.jost@karsa.fi
21 June 2018 ADSA-CPB-01

Sources:

Slide 3: Prof. Kulmala: University of Helsinki

Slide 8: front: Forbes

<https://www.forbes.com/sites/michaelgoldstein/2017/11/09/tsa-misses-70-of-fake-weapons-but-thats-an-improvement/#534e1a892a38>

Slide 8: back: NPR

<https://www.npr.org/2018/05/24/613762721/deadly-delivery-opioids-by-mail>

All other © Karsa