



Maastricht University

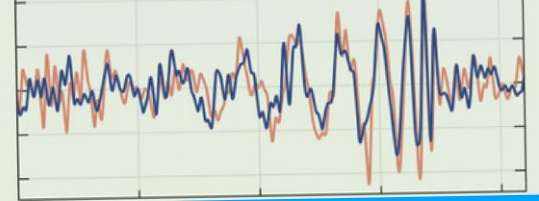
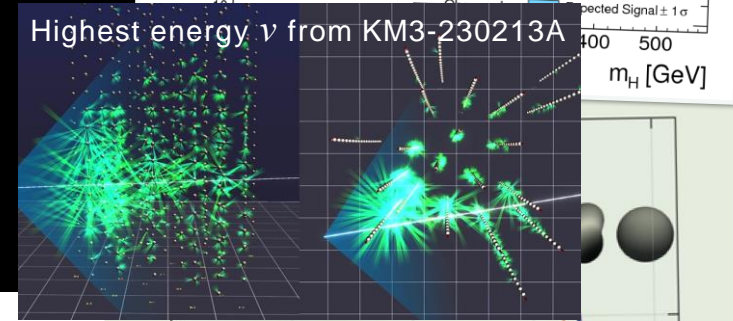
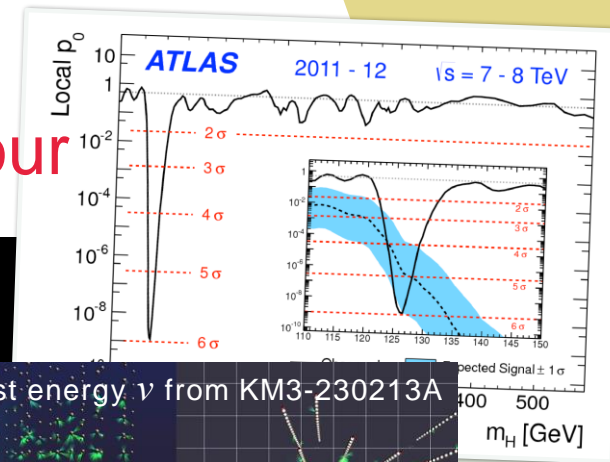
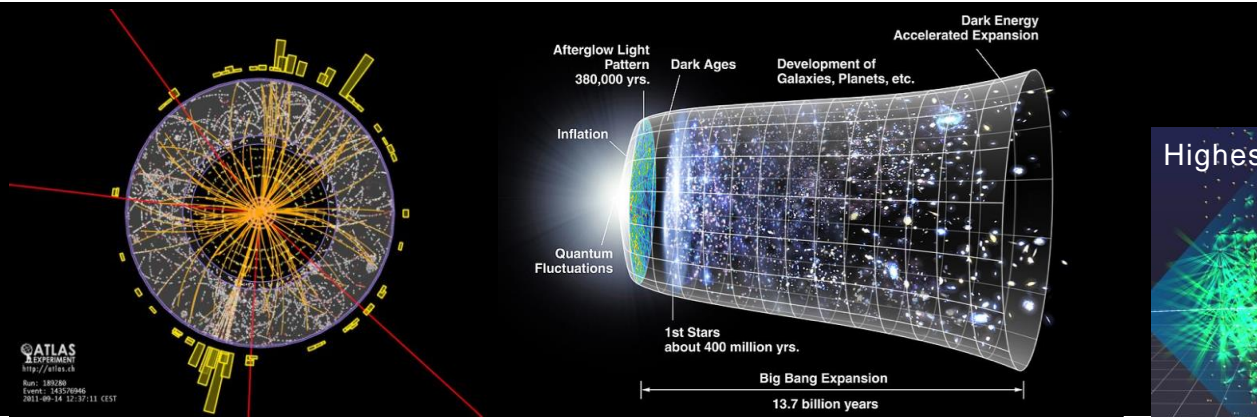
computing and networks for research  
crossing country borders with ease

Collaborative  
e-infrastructures

David Groep

*Italian Cultural Institute  
Amsterdam  
May 2025*

# A few words on Nikhef and sub-atomic physics as a global endeavour



We probe our world, made of particles and fields,

- with collider physics, primarily at CERN
- astroparticle physics:  
particles, radiation, and ripples coming from the universe

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images: atlas.cern.ch, CERN, LIGO-Virgo Collaboration

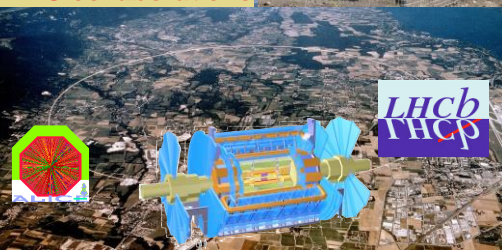


Nikhef

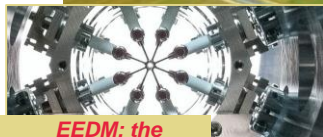
# ... and almost all beyond the Netherlands



**LHC collaborations**



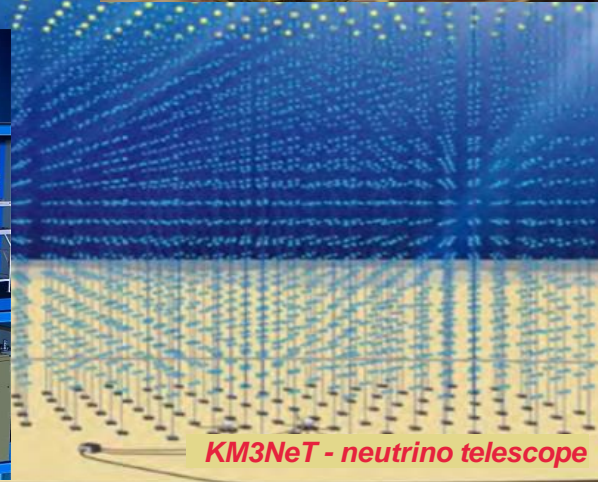
**Gravitational Waves  
at Virgo**



**XENONnT - Dark Matter**



**KM3NeT - neutrino telescope**



images: Pierre Auger collaboration, Virgo collaboration, Xenon-nT collaboration, KM3NeT collaboration, INFN, LNSG, Nikhef

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Nikhef

# ICT Infrastructure research for Research Infrastructure at Nikhef

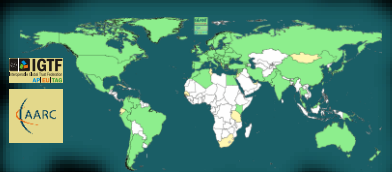
## Algorithmic design patterns and software

- scientific software (GPU) acceleration, ML tracking, application architecture
- software design patterns for workflow & data orchestration, and (energy) efficiency



## Infrastructure for trusted collaboration

- trust and identity for enabling communities
- managing complexity of collaboration mechanisms
- securing the infrastructure of our open science cloud



## Infrastructure, network and systems R&D

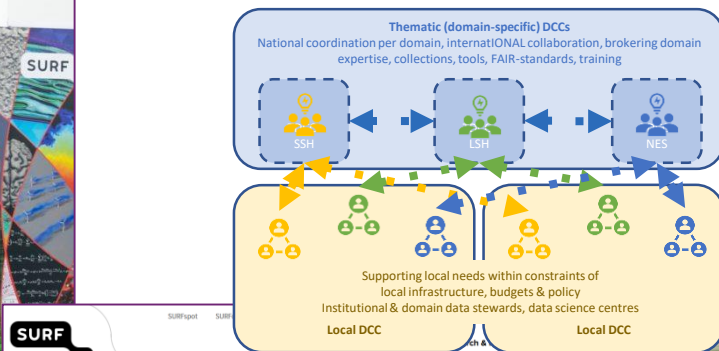
- building 'research IT facilities'
- co-design & development
- data throughput innovation
- research *on* IT infrastructure





# ICT infrastructure for research as research infrastructure

## *hardware, software, services, competences and people*



**SURF**

**High-performance data processing**

Do you want to process and store large volumes of data? Our team of experts can support you in using our high-throughput data processing systems and storage solutions.

[Questions? Contact info@surfara.nl](mailto:info@surfara.nl)

**For processing large, structured datasets**

Our high-throughput data processing services are suited for projects that require processing of large, structured datasets. Such as instrument data from sensors, DNA sequencers, telescopes, and satellites.

Live data processing services for:



Images: ATLAS Rucio volume, (from rucio.cern.ch); optical network: NDPF 'deel'; User meeting Stoomboot Office Hours (both Nikhef); Snellius opening visit; HPDC service page (both SURF); TDCC image by Ruben Kok, LSH TDCC and DTL

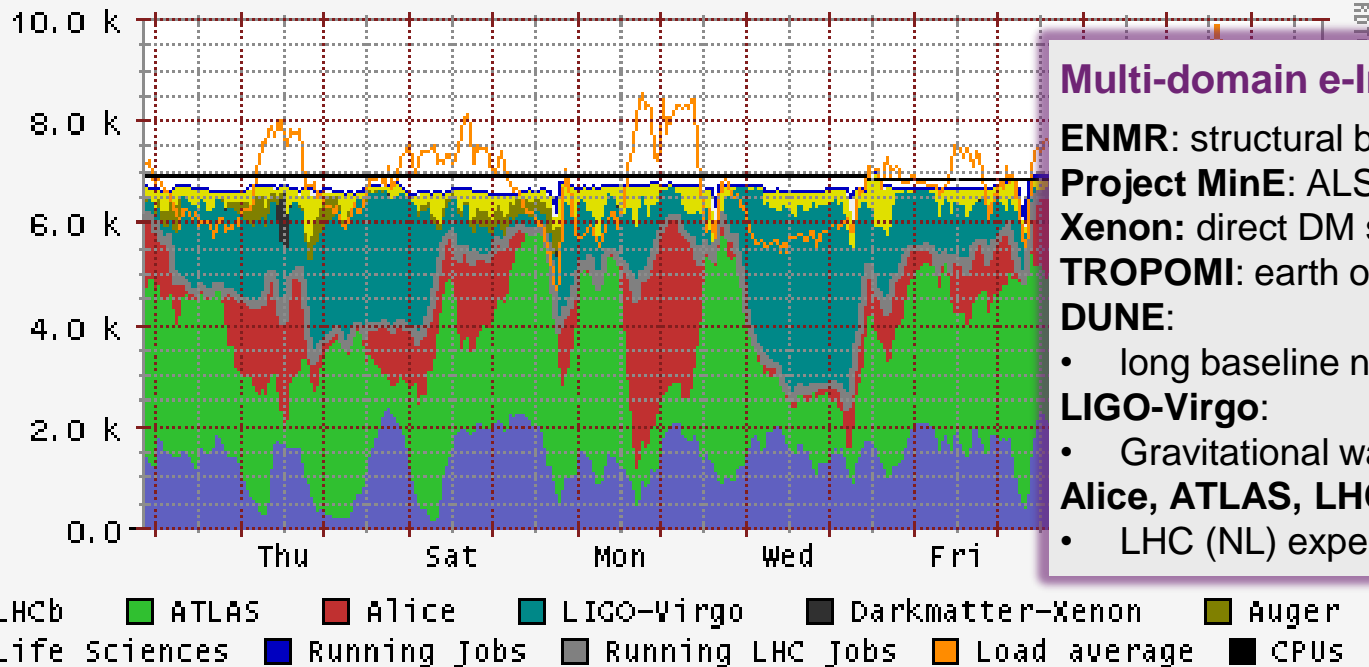
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# HTC/HPC infrastructure: federated joint processing in NL

One of the processing sites of the joint federated infrastructure

Cumulative cores per community on the Nikhef  
NDPF part of the DNI federated HTC Tier-1 infra



## Multi-domain e-Infrastructure

**ENMR:** structural biochemistry

**Project MinE:** ALS (health)

**Xenon:** direct DM searches

**TROPOMI:** earth observation

**DUNE:**

- long baseline neutrinos

**LIGO-Virgo:**

- Gravitational waves

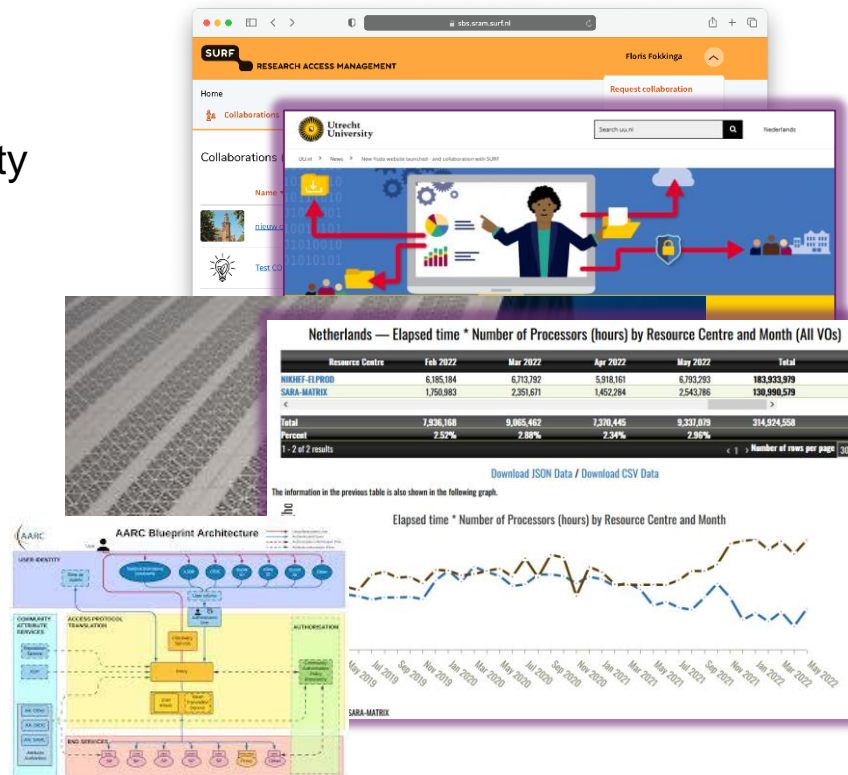
**Alice, ATLAS, LHCb**

- LHC (NL) experiments

# SURF as linking pin between research and e-infrastructure

- **National ‘Tier-1’** federated computing with heterogeneous HTC/HPC, Quantum, AI/ML capacity
- **Secure Supercomputing** for (social) sciences
- **Federating** institutional HPC facilities
- **Data archiving** and large FAIR repository services
- Stimulating - with NWO - ‘**digital competences**’ for researchers via the NL eScienceCenter
- **trust, identity, and AAI** research federation

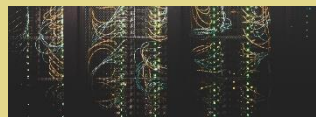
*as a transnational effort – like research itself*



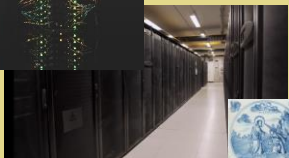
# Scalable HPC: from local “Tier-2” to European “Tier-0”



Nikhef “Stoomboot”  
Analysis Facility



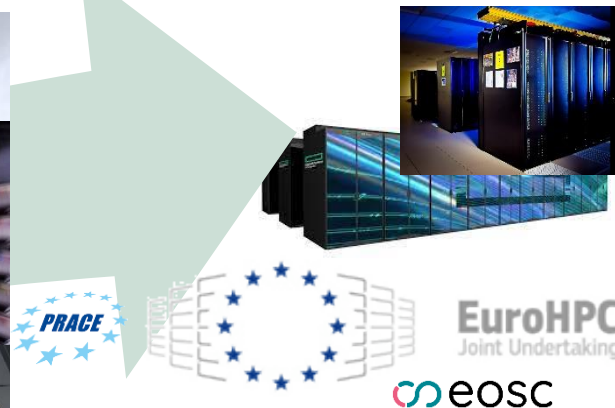
ALICE, Leiden



DelftBlue, TUD



SURF National Infrastructure  
foundation as *well* as stepping stone



with **local expertise**  
to enable exploitation  
**of European and**  
**global resources**

Computing and networks for research crossing borders with ease

Photos: Nikhef NDPF, DelftBlue/TUDelft, SURF Data Repository, Snellius, SURF @ DigitalRealty  
Steamship: Michael on Unsplash (<https://unsplash.com/photos/944sDSMQ778>), Tile: Nationaal Museum van Wereldculturen



Nikhef



# Collaboration has long since outgrown the one terminal

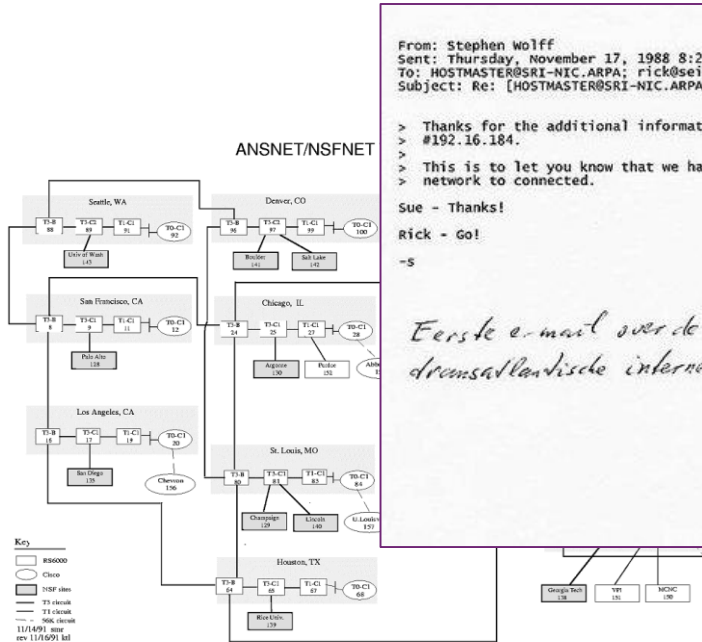


With one system using several racks  
and with just a few people hunched over them



Nikhef room H1.37 – terminal stations on the raised data floor of the computer room (H1.40, behind the glass-panel walls)

# Networking is the mainstay: be it for computers ... or for people



From: Stephen Wolff  
Sent: Thursday, November 17, 1988 8:28 AM  
To: HOSTMASTER@SRI-NIC.ARPA; rick@seismo.CSS.GOV  
Subject: Re: [HOSTMASTER@SRI-NIC.ARPA: Re: mcva internet connection]

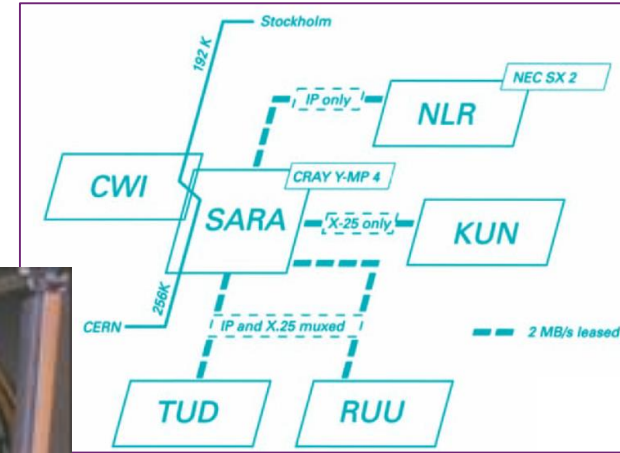
> Thanks for the additional information re: CWI-ETHER, net  
> #192.16.184.  
>  
> This is to let you know that we have changed the status of this  
> network to connected.

Sue - Thanks!

Rick - Go!

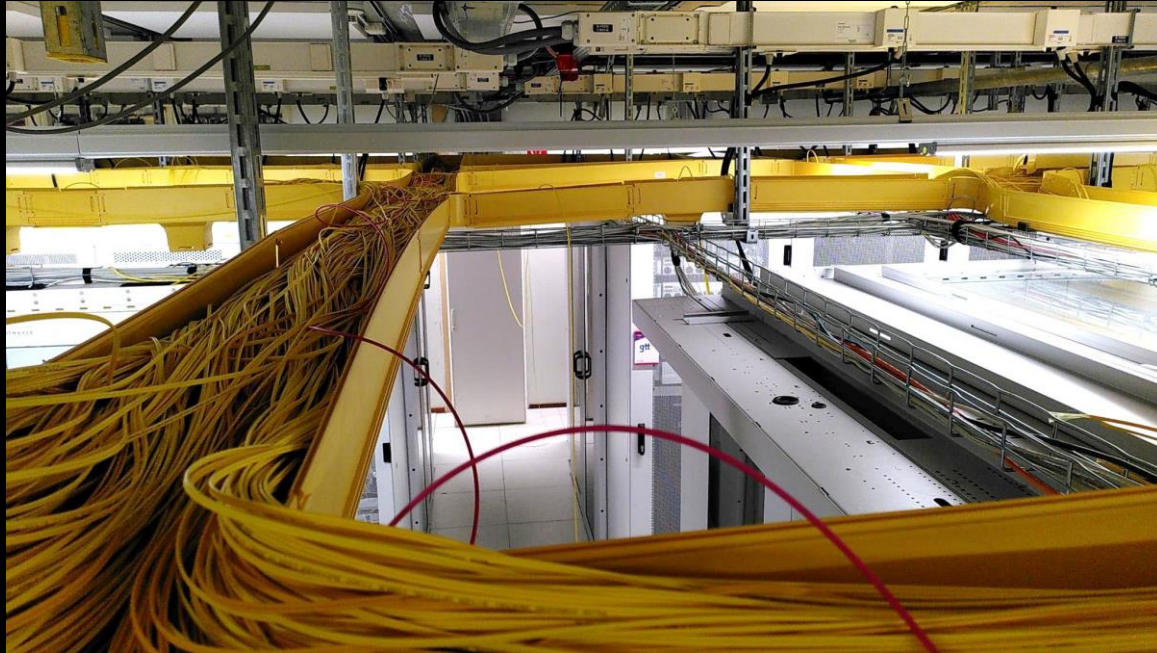
-S

*Eerste e-mail over de  
druisatlantische internet*



See <https://personalpages.manchester.ac.uk/staff/m.dodge/cybergeography/atlas/historical.html> for more historic maps ;  
right-hand image: SURFnet2, 1990, first email to MCVAX at CWI from <https://www.cwi.nl/en/news/cwi-celebrates-25-years-of-open-internet-in-europe-in-november/>  
(Piet Beertema, CWI, 1988); International Backbone Router Local Area Network "IBR-LAN" at Nikhef, room H1.40 as seen in 1996.

# The only constant element is the yellow colour ... and IP



Nikhef Housing has grown a bit since

- connectivity data centre focussing on global networking



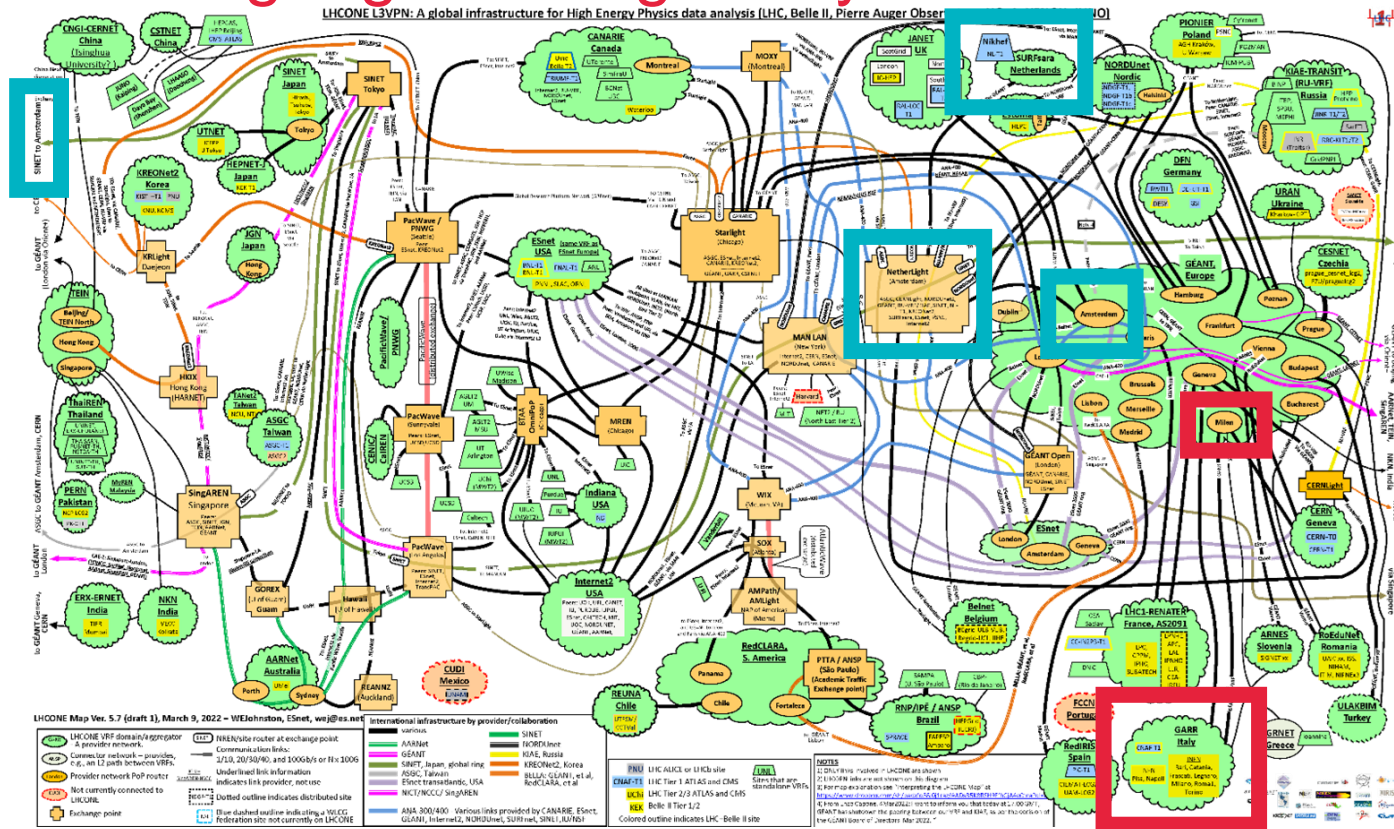
Nikhef *science* data centre

- federated in the SURF national Tier-1 facilities
- focus on throughput compute & storage

<https://www.nikhefhousing.nl/> PeeringDB data: <https://www.peeringdb.com/fac/18> (May 18, 2025)



# Networking together – globally connected research



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Graphic: Bill Johnston, ESnet, for LHCone





# Riding the infrastructure innovation chain together

## Computing Sciences Research



**Future Computer Systems and Networking Research in the Netherlands: A Manifesto**  
ICT Research Platform Netherlands, SIG Future Computer and Network Systems  
Editors: Alexandru Iosup (VU, A.iosup@vu.nl) and Fernando Kuipers (TU Delft, F.A.Kuipers@tudelft.nl)

**Executive summary**

**Society's engine for a responsible and sustainable future? Computer Systems!** Our modern society and competitive economy depend on a strong digital foundation and, in turn, on sustained computer systems research and innovation. Computer systems, ranging from small, embedded devices to large data centers and the networks that connect them, are a remarkable technology area with an outstanding impact on society. This manifesto focuses on the Netherlands, where data centers and related ICT infrastructure enable over 3.3 million jobs and over 60% of the GDP, and novel services and products, and where every €1 invested in such systems generates €15 in added value. Sustained investments in capable networking infrastructure have made the Netherlands home to one of the largest data hubs in the world. Cloud adoption exceeds 90% for economic organizations, and 65% for government and public education organizations. Our overarching goal with this document is to highlight the grand societal, technological, and scientific opportunities and challenges in future computer systems and networking (the CompSys area), and to outline how to maintain the leading position the Netherlands has in this area.

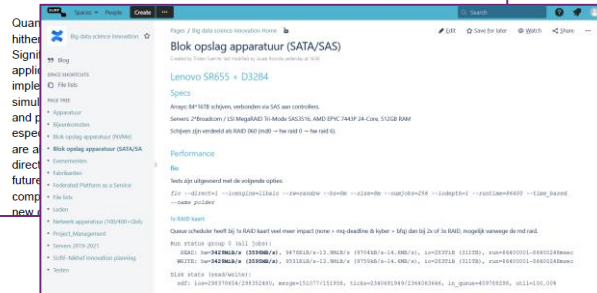
Future-proof digitalization requires ICT research and development (R&D), now. The Dutch Government and societal stakeholders have identified an urgent need to expand economic and social activities by leveraging and integrating ICT in their knowledge, processes, operations, and capabilities.

## Operational Research (near-term, NextGen storage, 800G+ network, QC & simulators)

### From Quark to Quantum ... with LHCb

Jacco de Vries: Maastricht University/Nikhef jdevries@nikhef.nl  
Daniel Campora: Maastricht University/CERN dcampora@cern.ch  
Kareljan Schoutens: UvA/QuSoft c.j.m.schoutens@uva.nl  
David Groep: Nikhef davidg@nikhef.nl  
Ariana Torres: SURF ariana.torres@surf.nl

### Introduction



## Operational innovation (procurement, systems vendor co-engineering)

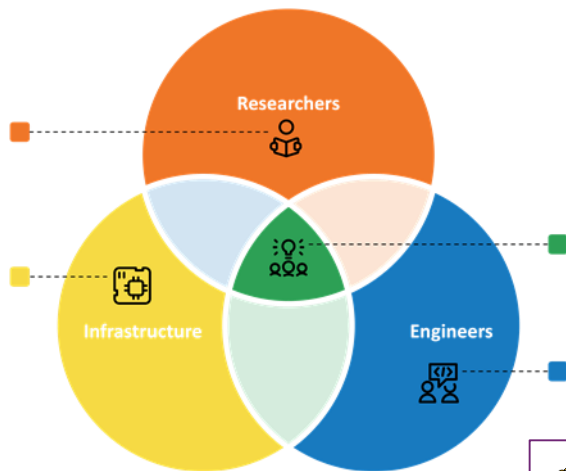


scaling and validation with applications

Images: SLICES-RI, CompSysNL, UM & SURF QC, SURF SOIL BDRI,  
Computing and networks for research crossing borders with ease NationaleSpeeltoin.nl @Nikhef

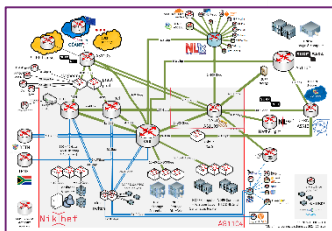


# SURF Experimental Technologies Platform & Nikhef Nationale Speeltuin



**SURF-ETP**  
Open and collaborative environment to foster the assessment of cutting-edge technologies and methodologies.

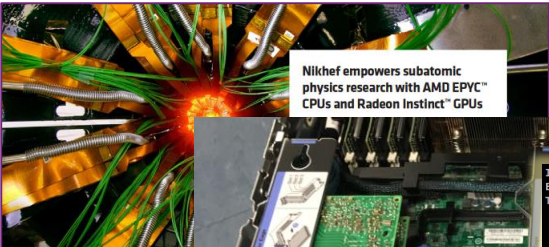
**Engineers**  
Leverage their technical skills and motivation to surf the state-of-the-art.



The screenshot shows the SURF Experimental Technologies Platform website. The header includes the SURF logo, a 'Spaces' dropdown, a search bar, and a 'Log in' button. The left sidebar lists navigation options: iRODS, JupyterHub for education, Object Store, ODISSEI Secure Supercomputer, Persistent Identifiers (PIDs), Research Drive, Service Desk, Snellius, LUMI, NLSRC, and Experimental Technologies Platform (which is expanded to show 'Available technologies', 'Stories', 'Call for proposals 2024', and 'FAQs Experimental Technologies Platform'). The main content area is titled 'Overview' and 'Compute', displaying a grid of hardware and software options: AMD Instinct MI210, NVIDIA Grace Hopper Superchip, Intel GPU Max 1100, Xilinx ALVEO U250, NextSilicon Maverick, Asus CRL-G116U-P3DF, Xilinx VCK5000 Versal, Cerebras WSE-2, and Cornelis Omni-Path Express. The 'Network' section shows the Nokia 7750 SR-1x-48D. The 'Storage' section features the Fungible FS1600. At the bottom right, there is a 'Begin' button for 'Achtbaan's Snelheidstester'.

<https://servicedesk.surf.nl/wiki/display/WIKI/Experimental+Technologies+Platform> and <https://www.surf.nl/en/etp>; <https://nationalespeeltuin.nl>; <https://www.nikhef.nl/pdp/doc/facility>

# And since speed does matter ...



Nikhef empowers subatomic physics research with AMD EPYC™ CPUs and Radeon Instinct™ GPUs

CUSTOMER

# Nikhef

INDUSTRY

Subatomic Physics

CHALLENGES

Increasing data throughput with higher I/O and memory bandwidths

SOLUTION

Deploying AMD EPYC™ processors and Radeon Instinct™ GPUs

RESULTS

Faster processing and the ability to harness GPU-accelerated machine learning to cope with rapidly expanding experimental data volume

AMD TECHNOLOGY AT A GLANCE

AMD EPYC™ processors with 32 cores  
AMD EPYC™ 7002F processors with 64 cores  
AMD Radeon Instinct™ M50 GPUs

TECHNICAL PARTNER

Lenovo

AMD + NIKHEF CASE STUDY

Interface: ae66, Enabled, Link is Up  
Encapsulation: ethernet, Speed: 1200000mbps

Traffic statistics:

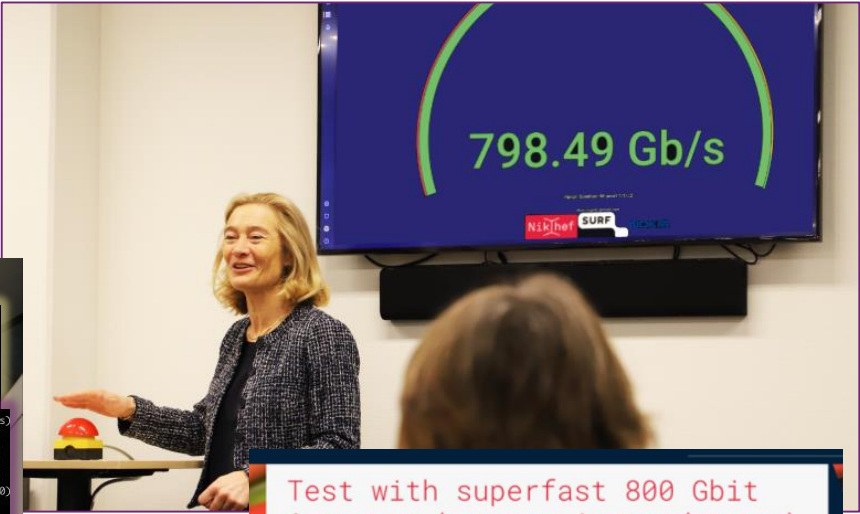
Input bytes:	491308044270834	(522659585576 bps)	Current delta
Output bytes:	55684866	(49256 bps)	
Input packets:	767668082831	(1020790999 pps)	
Output packets:	418932	(48 pps)	

1.02 Bpps

Dr. Arjan Houtzamer, Head of the team to AMD EPYC™ processors and Radeon Instinct™ GPUs, which delivered the performance Nikhef's workloads required and the solution price that aligned with their budget.

**Data-hungry science**  
Nikhef is involved in many different experiments, but all of them require a considerable level of computing power. "About 100 scientific staff work at Nikhef," explains Aaij. "These staff usually work on one (or sometimes more than one) of the experiments Nikhef is involved in."

number of collisions detected by about a factor of 10," says Aaij. "This means that the experiments will start producing a similarly increasing amount of data. If we look at the growth of storage space and compute capacity over time, then we do not expect to even get close to a factor 10 in increase of performance for a flat budget. We need to deal with that, because we need to process the data. Otherwise, we can't do science with it." This is where AMD EPYC™ processors and GPU acceleration have offered the best solutions to satiate the hunger for growing data processing ability.



Test with superfast 800 Gbit internet between Amsterdam and CERN successful

15 April 2024

Nokia and SURF have successfully tested an 800 Gbit/s data connection between Nikhef in Amsterdam and CERN in Geneva. Such a connection is needed to transmit data from the upcoming high-luminosity LHC accelerator.

The test used existing fiber-optic connections through Belgium and France toward Geneva in Switzerland over a total distance of 1,648 kilometers. An 800 Gbit/s connection is about a thousand times faster than the Internet connection in an average household.

Nokia's latest photonic technology, the sixth-generation super-coherent Photonic Service Engine (SPE-6s), was deployed in the tests, along with 16QAM-shaped modulation. The results of the tests will be announced in more detail next week at a Nokia expert conference in Athens.

Companies Double Current Performance R the New Bar at 6.55 Million Read IOPS

Image: Minister of Economic Affairs M. Adriaansens launched the Innovation Hub with Nikhef, S

estomgeving-voor-supersnelle-netwerktechnologie

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# Our science data flows are somebody else's DDoS attack



Het begon in 2018. Een bijzondere samenwerking tussen overheden, internetproviders- en exchanges, academische instanties, non-profitorganisaties en banken. Nadat duidelijk was dat de aanval was uitgevoerd door een 'red team' is verantwoordelijk voor de aanvallen, het 'blue team' voor de verdediging. Een van de partijen die aan de avond meedoet is [Nikhef](#). Tristan, IT architect bij Nikhef, geeft aan "dat zij dit

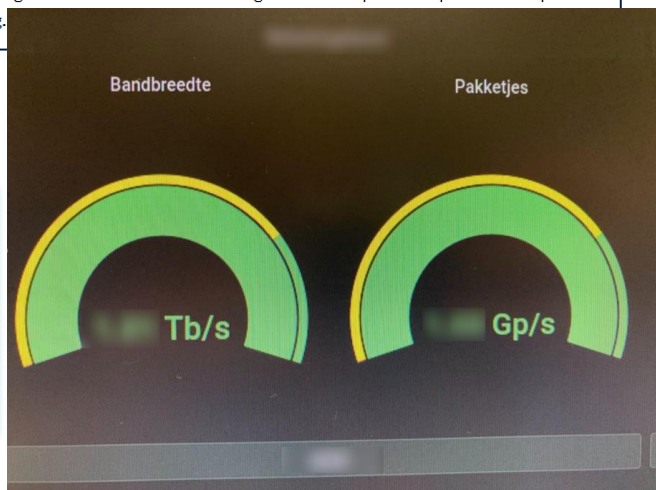
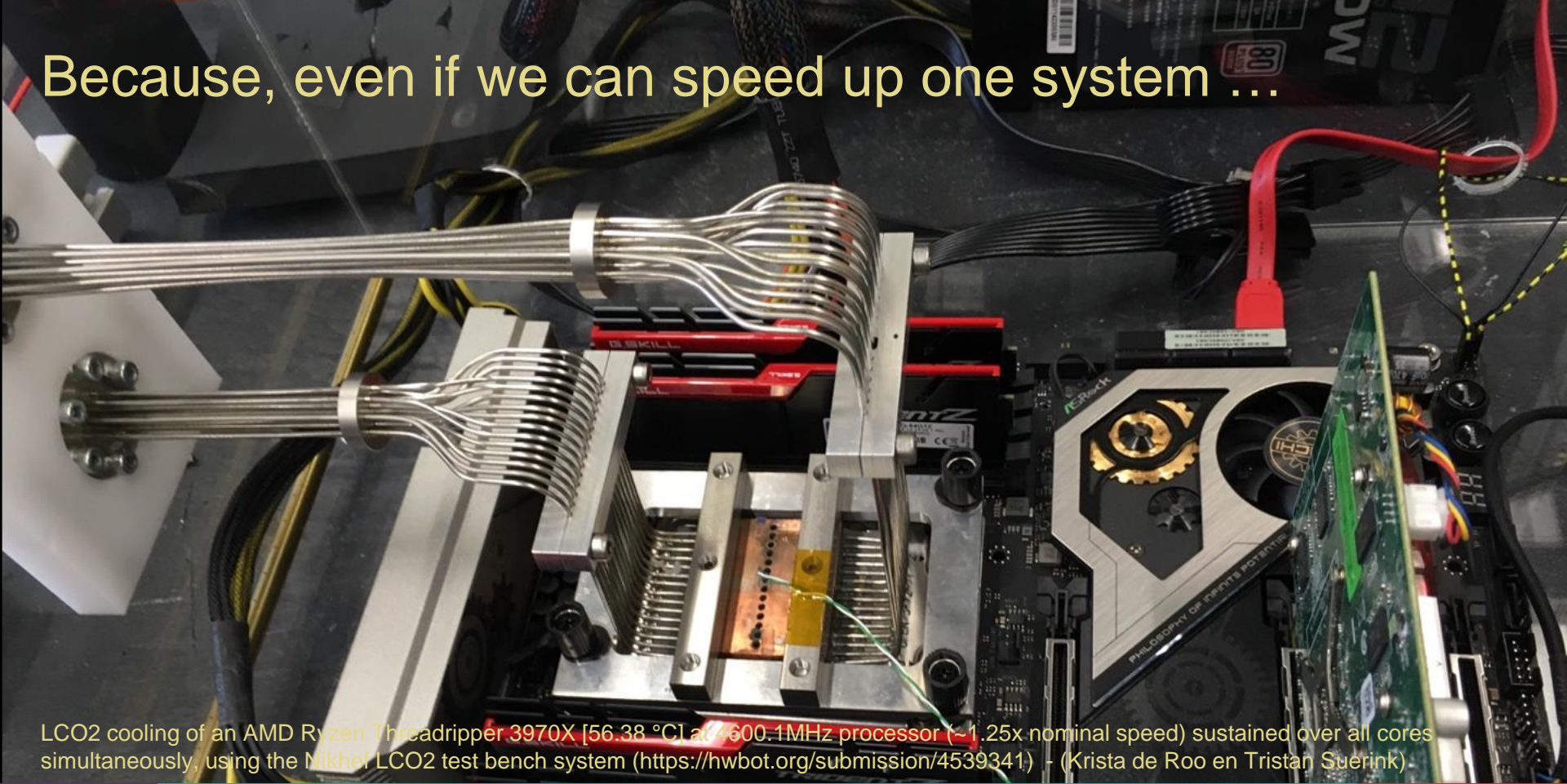


Image sources: [belastingdienst.nl](#), [rws.nl](#), [nu.nl](#), [werkentegennederland.nl](#)

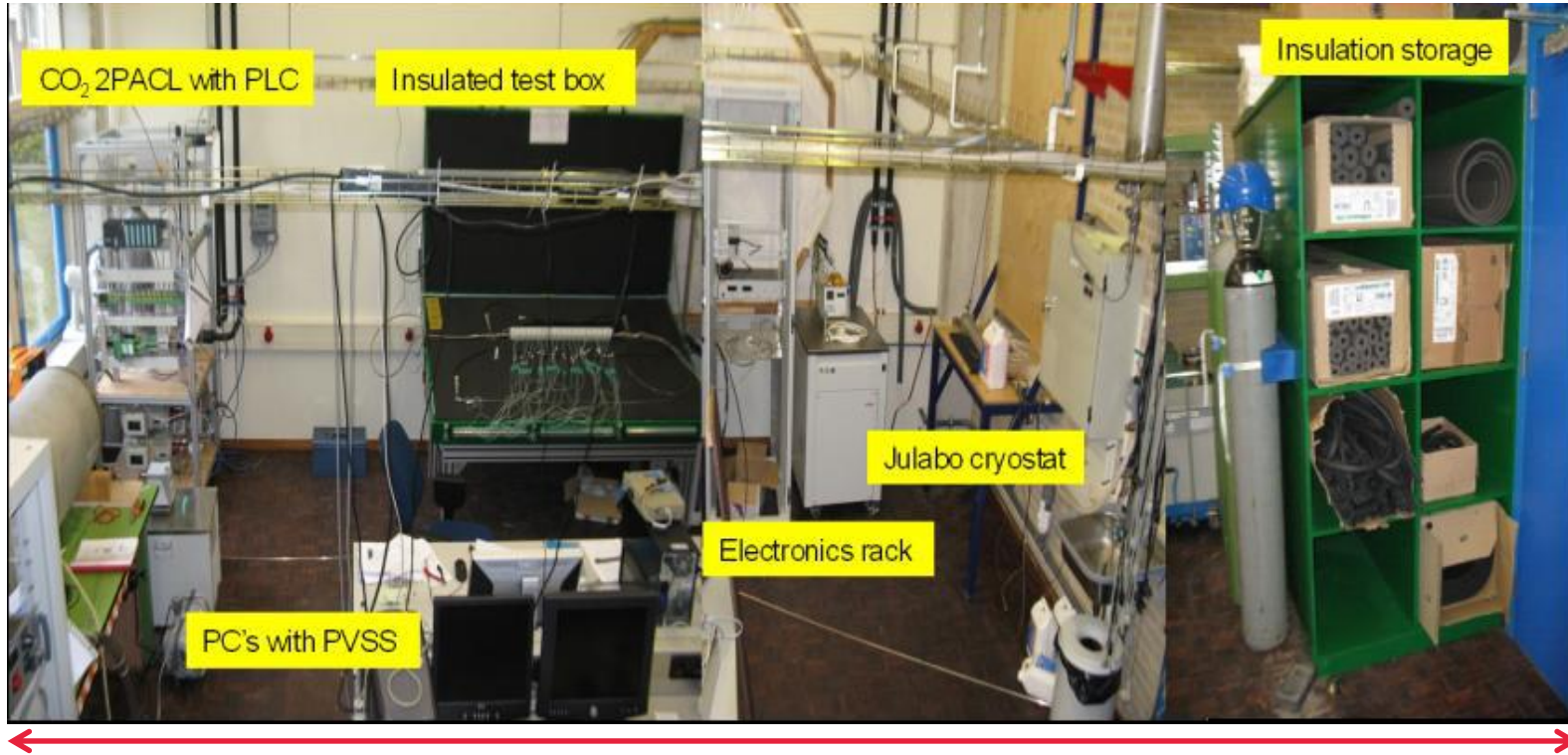


Because, even if we can speed up one system ...



LCO2 cooling of an AMD Ryzen Threadripper 3970X [56.38 °C] at 4600.1MHz processor (~1.25x nominal speed) sustained over all cores simultaneously, using the Nikhef LCO2 test bench system (<https://hwbot.org/submission/4539341>) - (Krista de Roo en Tristan Suerink)

... it is not always the most scalable solution!



Nikhef 2PA LCO2 cooling setup. Image from Bart Verlaet, Auke-Pieter Colijn *CO<sub>2</sub> Cooling Developments for HEP Detectors* <https://doi.org/10.22323/1.095.0031>

# Molto grazie



**SURF**

Nikhef



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 <https://orcid.org/0000-0003-1026-6606>

